RECOVERY POTENTIAL ASSESSMENT OF ROCKY MOUNTAIN SCULPIN (*Cottus* sp.), EASTSLOPE POPULATIONS, IN ALBERTA

Rocky Mountain Sculpin (Cottus sp.),
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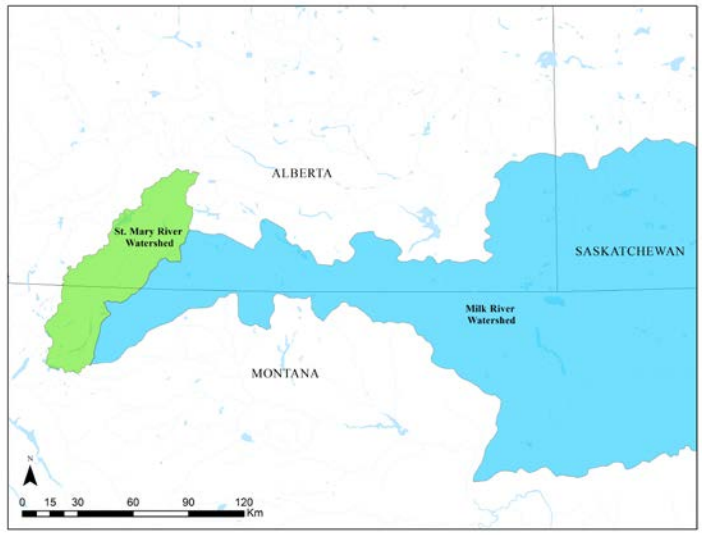

Figure 1. Locations of the St. Mary River and Milk River basins.

Context:

*The Rocky Mountain Sculpin (*Cottus *sp.) is a small freshwater fish found in Canada in the St. Mary and Milk rivers systems of Alberta and the Flathead River system of British Columbia. In 2006, the St. Mary and Milk rivers populations (known at that time as "Eastslope" Sculpin) were officially listed as Threatened under the* Species at Risk Act *(SARA). In 2007, those populations were listed as Threatened under Alberta's* Wildlife Act*. At that time they were identified as the St. Mary Shorthead Sculpin. Currently, sculpins occurring in the Flathead, St. Mary and Milk rivers systems in Canada are recognized as the Rocky Mountain Sculpin (*Cottus *sp.).*

A species Recovery Potential Assessment (RPA) was conducted by DFO Science to provide the information and scientific advice required to meet various requirements of the SARA and assess the recovery potential of Rocky Mountain Sculpin in Alberta. This Science Advisory Report is from the March 22-23, 2011, Recovery Potential Assessment (RPA) of Rocky Mountain Sculpin (Eastslope populations). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- In Alberta, Rocky Mountain Sculpin is known to occur in the St. Mary River system above the St. Mary Reservoir and in lower portions of Aetna and Lee creeks; in the North Milk River; and in the Milk River upstream of its confluence with the North Milk River and downstream of the confluence to within 85 km of the Montana border.
- There is insufficient information to identify Rocky Mountain Sculpin in the six waterbodies as genetically-discrete populations. Currently there are no barriers to movement within the St. Mary River system or within the Milk River system; only downstream movement is possible from the St. Mary River system to the Milk River system, by means of the St. Mary Canal. In this assessment each waterbody is referred to as a stock rather than a population.
- This species occupies cool, clear headwater rivers and tends to be more common in silt-free rocky substrates near stream margins with low to moderate water velocities.
- During spawning, nests are constructed under rocks or sometimes on aquatic vegetation or instream debris; the male remains near the nest for several weeks keeping it clean of silt and other debris until the eggs hatch. The nest meets the SARA definition of residence.
- No estimates of abundance have been obtained to date but repetitive sampling at some sites allows comparisons between stocks. The status of Rocky Mountain Sculpin is Good for the St. Mary and North Milk rivers, Fair for the Milk River below the confluence, Poor for the Milk River above the confluence and Unknown for Lee and Aetna creeks.
- A Minimum Viable Population (MVP) of at least 1,480 adults was estimated when the probability of extinction was 0.01 over 100 years, the probability of catastrophic (50%) decline was 0.15, and the extinction threshold was two adults (one female and one male). A population of this size was predicted to require 0.12 ha of suitable habitat.
- A MVP of 1,480 adults was predicted to go extinct in 42 years (range: 25-68). When survival of all ages was improved by 20%, the population began to grow, and the risk of imminent extinction was eliminated.
- The dynamics of Rocky Mountain Sculpin populations are particularly sensitive to perturbations that affect the survival of immature individuals (from hatch to age-2) and the collective survival of adults (ages 2-8).
- The greatest threat to the survival and persistence of Rocky Mountain Sculpin in Alberta is habitat degradation and loss, especially as a result of flow alteration. Drought conditions in combination with water regulation and extraction have the potential to significantly reduce the quantity and quality of sculpin habitat.
- There remain numerous sources of uncertainty related to Rocky Mountain Sculpin: life history and biological characteristics including young-of-the-year and juvenile survival rates, population growth rates and seasonal movements; habitat requirements particularly for eggs and fry and for overwintering; the frequency and magnitude of catastrophic events and true extinction thresholds; and an understanding of the environmental factors that limit their existence.

BACKGROUND

The Rocky Mountain Sculpin (*Cottus* sp.) is a small freshwater fish found in Canada in the St. Mary and Milk rivers systems of Alberta (Figure 1) and the Flathead River system of British Columbia. The St. Mary and Milk River populations are disjunct and biogeographically isolated from those of the Flathead River system so they may comprise a separate designatable unit (DU). In 2005, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed Rocky Mountain Sculpin in the St. Mary and Milk rivers of Alberta—then known as “Eastslope” Sculpin—and designated it as Threatened (COSEWIC 2005). In August 2006, “Eastslope” Sculpin was officially listed as Threatened under the *Species at Risk Act* (SARA). In December 2007, it was similarly listed as Threatened, though identified as the St. Mary Shorthead Sculpin, under Alberta’s *Wildlife Act.*

This Recovery Potential Assessment (RPA) focuses on the Rocky Mountain Sculpin, and is a summary of the peer-review meeting that occurred on March 22-23, 2011, in Lethbridge, Alberta. This Science Advisory Report summarizes the main conclusions and advice from the science peer review.Two research documents provide an in-depth account and the full list of references for information summarized in this report. One presents background information on the species biology, habitat preferences, current status, threats and mitigations and alternatives (Watkinson and Boguski 2013), and the other presents information on allowable harm, population-based recovery targets, and habitat targets (Young and Koops 2013).The proceedings report summarizes the key discussions of the meeting (DFO 2013).

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 *C.bairdii* complex*.* Currently, sculpins occurring in the Flathead, St. Mary, and Milk rivers systems of Canada are recognized as Rocky Mountain Sculpin (*Cottus* sp.).

Species Biology and Ecology

In general, sculpins are small fish with large heads and no air bladders. The Rocky Mountain Sculpin can be identified by the incomplete lateral line (21-26 lateral line pores), absence of prickles behind the pectoral fin and 13-15 pectoral fin rays. Mature males have a yellow-orange band on the top of the first dorsal fin and are darker than females. Breeding females retain their colour but have noticeably swollen abdomens.

Information on the life history and biology of Rocky Mountain Sculpin is limited, with most published information available from Montana populations. Some information is available from studies conducted or ongoing in the St. Mary and Milk rivers systems.

Age, Growth, and Maturity

In Alberta, young-of-the year (YOY) were 30–40 mm total length (TL) by the end of their first summer and yearlings were at least 50 mm TL. Rocky Mountain Sculpin in the North Milk River can grow to at least 114 mm. Sexual maturity is not reached until at least 23 months of age.

Reproduction

The spawning season for *Cottus* species may range from February to August, depending on location. Results from a spawning ecology study on Rocky Mountain Sculpin in southwestern Montana indicated that, in general, males arrived earlier than females at the breeding sites, and were ripe earlier. Nests are constructed under rocks or sometimes on aquatic vegetation, wood or debris. Males typically spawned with one to four females and then remained near the nest site for up to several weeks. 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.

Little is known about the reproduction of these fish in Alberta. Fecundity is directly related to size, and ranges from 68 to 368 eggs for females 57−87 mm TL in the St. Mary River. Depending on temperature, eggs likely hatch within two to three weeks. It has been reported that gravid pre-spawning female Rocky Mountain Sculpin were present in the St. Mary River in mid-May at a water temperature of 8.1°C, and later males were guarding eggs in 15°C water near the same location.

Rocky Mountain Sculpin spawn every year once they are mature. 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.

Diet

Cottids are generalist and opportunistic ambush predators that engulf prey items whole. Sculpins forage at night and eat mostly bottom-dwelling invertebrates. Adults will eat fry and eggs of their own species.

ASSESSMENT

Historic and Current Distribution and Trends

The St. Mary River flows northeast through Montana into Alberta where it meanders north to the St. Mary Reservoir (Figure 2). The North Milk and Milk rivers also flow north from Montana into Alberta, where the North Milk River joins the Milk River which flows eastward through the southern portion of the province, and then south back into Montana. In Alberta, the drainage areas of the St. Mary and Milk rivers systems are 2,400 km² and 6,500 km², respectively. The headwaters of the St. Mary River originate in the Rocky Mountains at higher elevations in Glacier National Park, thus this river has relatively dependable flow during summer months. In contrast, the Milk River is a foothills and prairie stream with a significantly smaller high-elevation drainage area than the St. Mary River, therefore it produces less water.

Since the Milk and St Mary rivers are internationally shared, they are governed by the Boundary Waters Treaty, which describes how these waterbodies are to be divided between the United States and Canada. Both systems have been severely impacted by changes in their seasonal flow regimes. Since 1917, water has been diverted from the St. Mary River in northwestern Montana via the St. Mary Canal into the North Milk River. 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. 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, after which ramping down of the diverted flow occurs. The river reverts to natural flows for the remainder of the winter season, albeit within a somewhat modified river channel. Under severe drought conditions, such as those of 2001-2002, there may be little or no surface flow during the winter months and the lower Milk River can be reduced to a series of isolated pools until spring, although subsurface flows may continue. In the upper Milk River, upstream of its confluence with the North Milk River to the Montana Border, surface flow is occasionally reduced to zero in the months of July to March resulting in isolated pools. Low flow conditions do occur in the St. Mary River system, but surface flow is uninterrupted year-round.

The Rocky Mountain Sculpin occurs in the Milk and North Milk rivers of the upper Missouri River system, and in the St. Mary River and two of its tributaries (Lee and Aetna creeks) that drain into the Saskatchewan-Nelson rivers system. There is insufficient information to identify Rocky Mountain Sculpin in these waterbodies as separate (genetic) populations so each is referred to as a stock rather than a population in this assessment. Rocky Mountain Sculpin may move within the Milk River and its tributaries and within the St. Mary River and its tributaries, but between the two rivers systems only downstream movement is possible via the St. Mary Canal. The potential for mixing among these stocks is unknown.

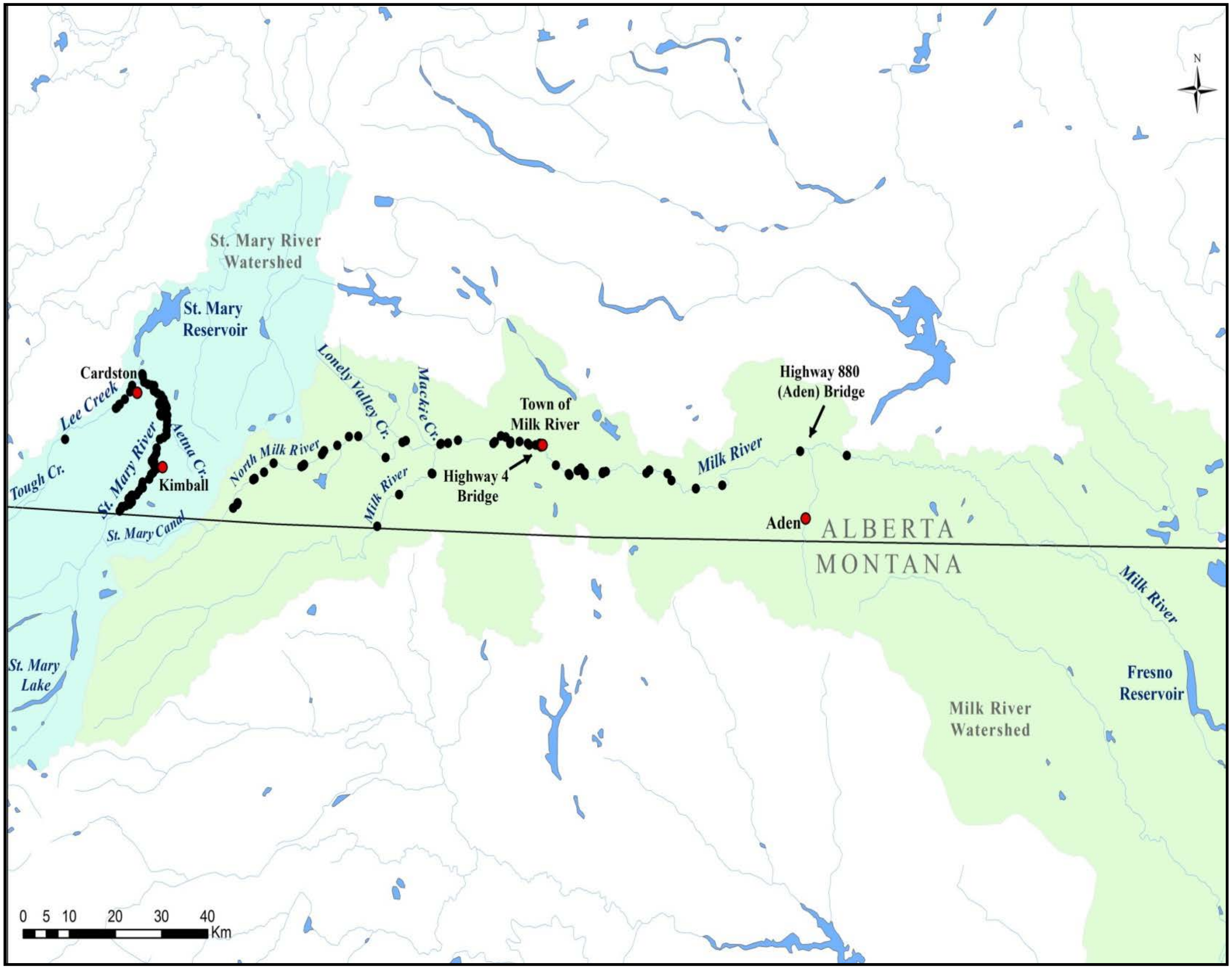

Figure 2. Distribution of Rocky Mountain Sculpin in Alberta.

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. Whether this species occurred farther downstream in the St. Mary River before the dam was constructed in the late 1940s is unknown.

Milk River system

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.

Historic and Current Abundance and Trends

No estimates of abundance have been obtained to date but repetitive sampling at some sites allows comparisons between stocks. Each stock was assessed in terms of its abundance and trajectory, which produced an overall status rating (Table 1).

Rocky Mountain Sculpin is abundant in the St. Mary River upstream of the St. Mary Reservoir. Since 2007, a total of 2,787 quadrats (1 m^2) have been sampled with an average density of 0.62 individuals per quadrat, producing an estimate of 750,000 Rocky Mountain Sculpin (all age classes) in the St. Mary River. The estimate of fish per quadrat has been consistent between years. These data indicate that the Relative Abundance Index and Trajectory for this stock is High and Stable, respectively, resulting in a Stock Status of Good.

No abundance or trend data are available for the Lee Creek stock. On the basis of limited sampling, Rocky Mountain Sculpin appears to be 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. The Relative Abundance Index and Trajectory for Lee Creek are currently Unknown, resulting in a Stock Status of Unknown.

Aetna Creek has been sampled once (in 2009) and that was in the lower 300 m of the creek. Thus, the Relative Abundance Index and Trajectory of that stock are currently Unknown, resulting in a Stock Status of Unknown.

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. Three decades of studies involving various collection techniques have not revealed an increase or decrease in sculpin abundance. The Relative Abundance Index is High and Trajectory is likely Stable, producing a Stock Status of Good.

The Milk River from the upstream Montana border crossing downstream to the confluence with the North Milk River has low numbers of Rocky Mountain Sculpin. Only a few specimens have been 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 Milk River. The Relative Abundance Index is Low and Trajectory is Unknown, producing a Stock 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, with a declining gradient in habitat quality, to its last known distribution 85 river kilometers upstream from the downstream crossing into Montana. 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 Trajectory is Stable. Using the mid-point of the Relative Abundance Index produces a Stock Status of Fair.

Table 1.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.

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. The distribution of Rocky Mountain Sculpin in the St. Mary and Milk rivers systems has been strongly linked with stream gradient and substrate type. 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 typically less than 3.5 NTU, and dissolved oxygen levels of at least 7.4 mg/L. Most sampling for Rocky Mountain Sculpin is conducted in water less than 1 m deep.

St. Mary River

The St. Mary River habitat, where it enters Alberta from Montana to the St. Mary Reservoir, is dominated by gravel and cobble substrate and generally moderate water velocity. The reservoir, which has very steep banks and almost no littoral zone, likely represents a major obstacle to downstream dispersal of Rocky Mountain Sculpin in the St. Mary River. Given that multiple cohorts of this species 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

Much of the substrate at the few sites on Lee Creek that have been sampled consisted of gravel and cobble with moderate to low gradient.

Aetna Creek

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

North Milk River

Habitat in the North Milk River is dominated by gravel and cobble with moderate gradient. Overwintering habitat may not be limiting for Rocky Mountain Sculpin in the North Milk River under normal winter flow conditions. 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

Gravel with a moderate gradient dominates the habitat in the Milk River from the Montana border downstream to the confluence with the North Milk River. Surface flow in the upper portion of the Milk River 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

Rocky Mountain Sucker nests are constructed under rocks, typically 0.12 to 0.38 m in diameter, or sometimes on aquatic vegetation, wood, or debris. The water depth at the location of the nests was over 0.3 m, and surface water velocities ranged from 0 to 1.4 $m \cdot s^{-1}$.

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

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. In the Flathead River in autumn, YOY were associated with sand and detritus substrates in pools, root-wads, back-channels, and shallow embayments.

Adults

Adult Rocky Mountain Sculpin in the Flathead and St. Mary rivers were found in waters of 0.3-0.8 m deep, with mean water column velocities of 0.5-1.3 $m \cdot s^{-1}$ water velocity, and gravel or cobble substrate. During the day, adults shelter in the substrate and at night emerge to forage along river edges in the shallows (<0.3 m) where there is little surface current (<0.1 $m \cdot s^{-1}$). In autumn, larger males in the Flathead River system moved to areas with faster surface velocities (>0.6 $m \cdot s^{-1}$) with large rocks and boulders, suggesting that breeding territories may be established at that time of year. During the non-breeding season, this species may be quite sedentary. The home range of Rocky Mountain Sculpin in a small Montana stream was less than 46 m of longitudinal stream channel, with maximum observed dispersal of 180 m.

Residence

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.

Allowable Harm

Allowable harm was assessed in a demographic framework with the assessment involving perturbation analyses of population projection matrices and including a stochastic element. Outputs of the analyses included calculation of a population growth rate and its sensitivity to changes in vital rates. (See Young and Koops (2013) for complete details of the model and results.) Based on the mean vital rates, the population growth rate of Rocky Mountain Sculpin was estimated to be, on average, in decline ($\lambda = 0.87$), but given the uncertainty around the estimates the trajectory of individual stocks cannot be confirmed as either increasing or decreasing.

Elasticity analysis showed that population growth rate is most sensitive to perturbations of adult survival (ages 2-8) but also very sensitive to changes in survival of YOY and juveniles (from hatch to age-2) (Figure 3, panel 1). Although the means of deterministically and stochastically determined elasticities are nearly identical, elasticities are still sensitive to stochastic variation (Figure 3, panel 2). Comparing correlations among vital rates and elasticities shows that the uncertainty in these elasticities can be largely attributed to uncertainty in the estimate of age-0 survival. The pattern of elasticities is also sensitive to whether the population is growing or in decline (Figure 3, panel 3). When there is population growth, the population is very sensitive to juvenile survival, and the importance of reproduction decreases with age. If the population is in decline, the importance of survival varies less with age, but the fecundity of older fish is more important than that of younger fish.

The minimum recovery efforts for each vital rate depended on the stochastic element. From a precautionary perspective (i.e., assuming the highest effort of all methods), the modelling analyses suggested a minimum improvement of 40% to juvenile survival (both ages 0 and 1), 37% to survival of adults or 20% to survival of all ages. A fecundity rate that is 138% higher than the current estimate would be required to achieve stabilization.

Recovery Targets

Recovery Targets and Times

Demographic sustainability was used as a criterion to set recovery targets for Rocky Mountain Sculpin (Young and Koops 2013). Demographic sustainability is related to the concept of Minimum Viable Population (MVP), and was defined as the minimum adult population size that results in a persistence probability of 99% over 100 years (approximately 77 generations). Probability of extinction decreases as a power function of population size. MVP targets were chosen to optimize the benefit of reduced extinction risk and the cost of increased recovery effort. Using an extinction threshold of two adults (one male and one female), simulations indicated that MVPs for a Canadian population of Rocky Mountain Sculpin are about 320 adults (range: 230-400) or 1,100 adults (range: 850-1,480) assuming the chance of catastrophic decline (50%) was 10% or 15% per generation, respectively (Figure 4). Given the possible decline of the Rocky Mountain Sculpin populations and the objective of demographic sustainability, a population abundance recovery target of at least 1,480 adults Mountain Sculpin is proposed.

The St. Mary River population of Rocky Mountain Sculpin is currently estimated at 127,500 adults. Under current estimated conditions (i.e., assuming a population growth rate of 0.87), and in the absence of recovery efforts or additional harm, a population of this size is expected to go extinct in approximately 76 years (range: 52-110; Figure 5). A population of 1,480 (MVP) was predicted to go extinct in 42 years (range: 25-68). When survival of all ages was improved by 20%, the population began to grow, and the risk of imminent extinction was eliminated. Improvements to fecundity were the least effective recovery strategy.

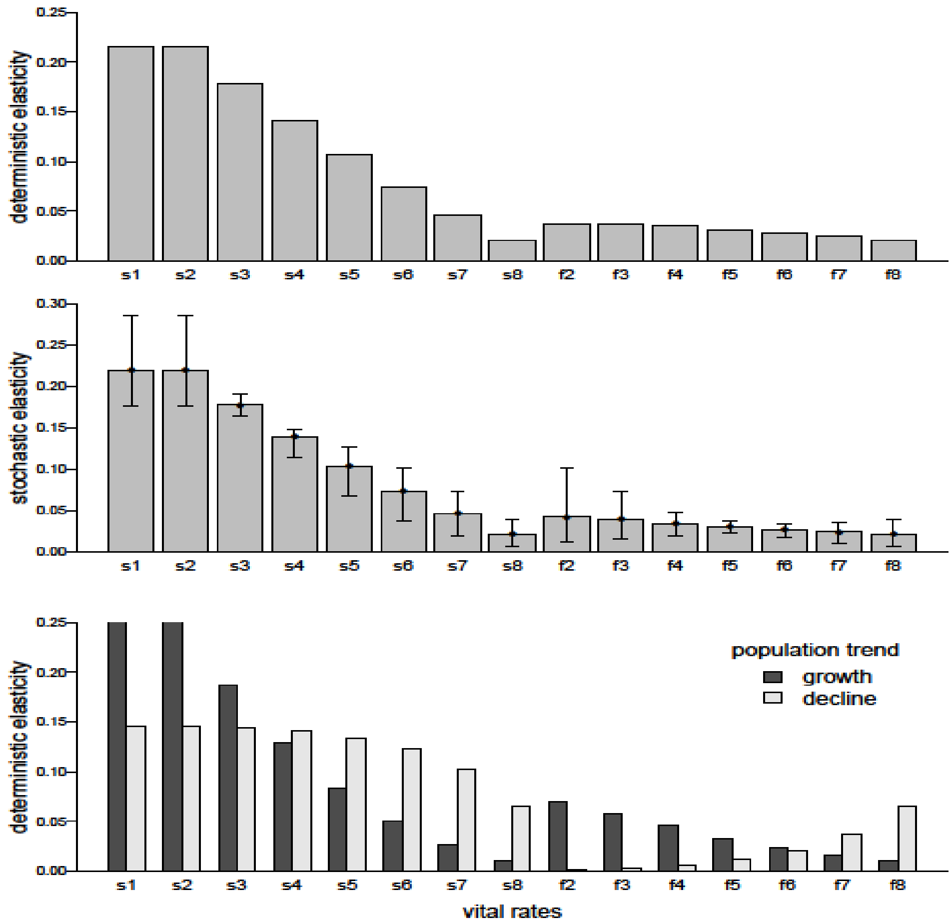

Figure 3. Results of the deterministic (panel 1) and stochastic (panel 2) perturbation analysis showing elasticities (ε_v) of the vital rates: annual survival probability of age j-1 to age j (s_i) and fertility (f). Stochastic results include associated bootstrapped 95% confidence interval. Panel 3 shows deterministic elasticity of a growing population (St. Mary River, 2006) and a declining population (Milk River, 2006).

Minimum Area for Population Viability

Minimum area for population viability (MAPV) is a quantification of the amount of habitat required to support a viable population. Variables included in the MAPV assessment include MVP values and area required per individual (API values). API values were estimated from an allometry for river environments from freshwater fishes. An MAPV was estimated for each life stage and then an MAPV for the entire population was estimated by summing across all life stages. The stable stage distribution for Rocky Mountain Sculpin is 96.91% YOY, 1.67% age-1, and 1.43% adult individuals (ages 2-8). With a target MVP of 1480 adults, under a 0.15 probability of catastrophe per generation, a population of this size was predicted to require 0.12 ha of suitable habitat. This MAPV estimate assumes that age-0, age-1 and adult fish require

0.004 m^2, 0.13 m^2, and 0.24-1.15 m^2 of habitat, respectively, and does not account for any overlapping of individual habitats (sharing) that may occur.

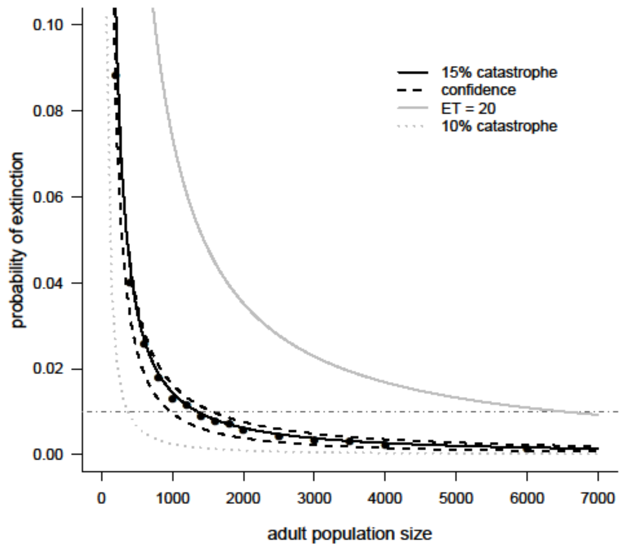

Figure 4. Probability of extinction within 100 years of 10 simulated Rocky Mountain Sculpin populations, at equilibrium, as a function of adult population size. Black curves assume a 15% probability of catastrophic decline (solid = mean, dotted = max and min of 10 runs), and an extinction threshold of two adults. Grey curves represent 10% probability of catastrophe (dotted), or 15% probability of catastrophe and an extinction threshold of 20 adults. Dashed horizontal reference line is at 0.01 and intersects curves at the associated MVPs.

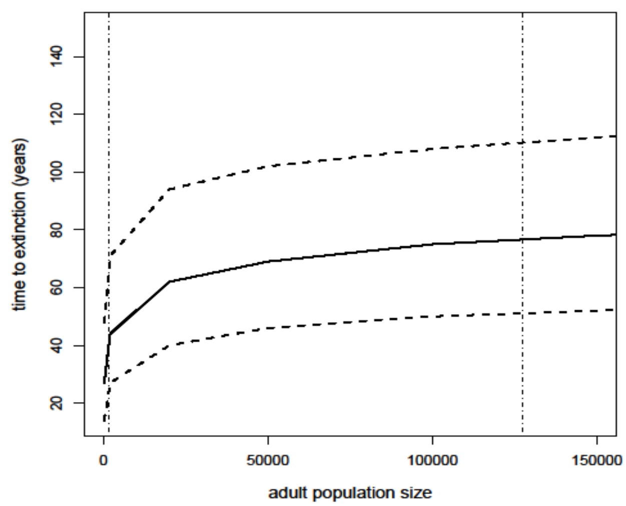

Figure 5. Time to extinction of 10 simulated Rocky Mountain Sculpin populations in decline (λ = 0.87), as a function of adult population size. Median (solid) and 95% bootstrapped confidence interval (dashed). Vertical reference lines represent the Minimum Viable Population size (MVP=1,480 adults), and the estimated abundance in St. Mary River (127,500 adults).

Threats to Survival and Recovery

A number of threats to the habitat and survival of Rocky Mountain Sculpin have been identified throughout its range. The Rocky Mountain Sculpin is a riverine species that has adapted to survive in cool, clear, running waters, thus the most significant threats to this species are likely those that alter the natural flow regime causing habitat loss or impairment. In the St. Mary and Milk rivers systems such threats include changes in flow resulting from the St. Mary Diversion, water removal (e.g., for irrigation, municipal, recreational, industrial and domestic use), and impoundment. Drought is a natural occurrence in this region which, in recent years, has likely exacerbated the effects of habitat loss and degradation. Species introductions, contaminants and toxic substances and degradation of riparian areas have also been identified as potential threats to this species.

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 and Threat Impact. It is important to note that threats may not always act independently. One threat may directly affect another, or the interaction between two threats may introduce an interaction effect. As it is quite difficult to quantify these interactions, each threat is evaluated independently. The Threat Likelihood and Threat Impact ratings were subsequently combined in the Threat Status Matrix resulting in the final Threat Level (Table 2).The Spatial Extent of each threat was categorized as Widespread or Local and the Temporal Extent as either Chronic or Ephemeral (Table 3). (See Watkinson and Boguski 2013 for definitions of threats-related terms and a description of each threat and its potential *impacts* on Rocky Mountain Sculpin.)

Table 2. 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 3. Overall effect 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

Mitigation and Alternatives

Habitat Loss/Degradation

Many of the 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) (Coker et al. 2010), 17of which apply to the freshwater system. This guidance should be referred to when considering mitigation and alternative strategies for habitat-related threats. They were developed to mitigate or limit threats, however since they were not developed to specifically consider species at risk 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 4 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 4 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.

Table 4. 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. Preventing introductions is a more effective strategy for mitigating this threat than removal once they have become established. The potential for mitigating the impacts of species introductions once they occur is likely low.

Mitigation

- Physically remove non-native species from areas known to be inhabited by Rocky Mountain Sculpin.
- Monitor watersheds 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.

Mitigation

- Non-lethal sampling (e.g., observational studies)
- Sampling under a SARA permit

Alternatives

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

Sources of Uncertainty

Information is lacking on key aspects of the life history, biology and habitat requirements of Rocky Mountain Sculpin in Alberta. For example, knowledge of the species' reproductive ecology, YOY and juvenile survival, population growth rates and seasonal movements is limited. There is also little or no information available on population structure in the Milk River system or Lee and Aetna creeks. Specific habitat needs, particularly for eggs and fry, are unknown. Overwintering requirements and habitats also have not been described. The response of this species to potentially limiting environmental factors, including temperature extremes, turbidity, and flow, and their ability to adapt to different conditions, are uncertain. Knowledge of the frequency and magnitude of catastrophic events and true extinction thresholds of Rocky Mountain Sculpin in Alberta are needed for population modelling to assess allowable harm, determine population-based recovery targets and conduct long-term projections of population recovery. Finally, microsatellite (DNA) research of Rocky Mountain Sculpin in the St. Mary and Milk rivers 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. 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 2.08×10^8 m^3 of water has flowed annually through the St. Mary Canal into the North Milk River over the past two decades. 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 $m^3 \cdot s^{-1}$.

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.

SOURCES OF INFORMATION

This Science Advisory Report is from the March 22-23, 2011, Regional Recovery Potential Assessment of Rocky Mountain Sculpin. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule. A complete list of references can be found in the documents cited below.

Coker, G.A., Ming, D.L., and Mandrak, N.E. 2010. Mitigation guide for the protection of fishes and fish habitat to accompany the species at risk recovery potential assessments conducted by Fisheries and Oceans Canada (DFO) in Central and Arctic Region. Version 1.0. Can. Manuscr. Rep. Fish. Aquat. Sci. 2904. vi + 40 p.

COSEWIC. 2005. COSEWIC assessment and status report on the “eastslope” sculpin (St. Mary and Milk River population) *Cottus* sp. in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 30 p.

DFO. 2003. National code on introductions and transfers of aquatic organisms. Ottawa, ON. 53 p.

DFO. 2013. Proceedings of the regional recovery potential assessment (RPA) of Rocky Mountain Sculpin; March 22-23, 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2013/022.

Watkinson, D.A. and Boguski, D.A. 2013. Information in support of a recovery potential assessment of Rocky Mountain Sculpin (*Cottus* sp.), Eastslope populations, in Alberta. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/062. iv + 32 p.

Young, J.A.M. and Koops, M.A. 2013. Recovery potential modelling of Rocky Mountain Sculpin (*Cottus* sp.), Eastslope populations, in Alberta. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/061. iv + 16 p.

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ISSN 1919-5087

Correct Citation for this Publication:

DFO. 2013. Recovery potential assessment of Rocky Mountain Sculpin (*Cottus* sp.), Eastslope populations, in Alberta. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/046.

Aussi disponible en français :

MPO. 2013. Évaluation du potentiel de rétablissement du chabot des montagnes Rocheuses (Cottus sp.), populations du versant est, en Alberta. Secr. can. de consult. sci. du MPO, Avis sci. 2013/046.