Emergency Report:

Alberta Native Cutthroat Trout Populations & Critical Habitat at Risk

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FWR
Freshwater Research Limited

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Cover photo: Girardi Creek, designated critical habitat for threatened native Alberta westslope cutthroat trout under Canada's Species At Risk Act (SARA), has been diverted by a plugged culvert down the ditch and former roadway of Highway 3, the Crowsnest Highway, in southern Alberta, 25 June 2017. Critical habitat downstream from the blockage was substantially dewatered, apparently for days. Destroying any part of critical habitat is contrary to section 58(1) of SARA.

The Girardi Creek population of cutthroats is rare among Alberta remnant stocks in showing no trace of the rainbow trout genome that is widespread in the Crowsnest River and all other drainages in the Alberta native cutthroat range, so is of extremely high value for conservation.

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Summary

I and Nick Pink of the Alberta Wilderness Association conducted a brief survey of 29 streams holding designated critical habitat for threatened Alberta native westslope cutthroat trout, listed as threatened under Canada's Species At Risk Act, in August 2017 to document emergent threats to them requiring immediate action. Only my observations and commentary on those habitats that are most at risk are documented briefly in this report. The following table summarizes the issues.

Critical habitat	UTM Location, NAD83	Date	Issue
Evan-Thomas Creek	11U 0631104E 5639379N and upstream to barrier falls	since 2014	Population thought to be extinct due to extreme flooding in 2013. Follow-up survey needed before freeze-up fall 2017.
South Todd Creek tributary	11U 694842E 5514395N	2017/08/15	Poor installation of new culvert causing under-substrate flow, blocking route for overwintering and spawning
Syncline Brook	11U 687325E 5468464N	2017/08/15	Small but valuable population at high risk of extinction; critical habitat is presently dry, with blockages to movement, high stranding risk, poor overwintering habitat
Silvester Creek	11U 0660224E 5637351N & upstream	To 2017/08/24	Critical habitat is in imminent danger of drying up, isolating parts of the cutthroat population, potentially destroying overwintering habitat, and making other overwintering habitat inaccessible. There is ongoing heavy erosion of a very dense road network in Silvester Creek watershed, leading to high sediment loading to critical habitat. Continued logging of an already heavily-logged watershed with accompanying new road-building promises to simply add to critical habitat destruction.
Girardi Creek	11U 0672726E 5500432N	from 2014 to 2017	Stream was recently diverted by blocked culvert, stopping water flow to critical habitat and blocking fish movement. Ongoing blockages are inevitable due to inadequate repair work and a highway culvert that is inadequate to pass high loads of coarse sediment.
Jumpingpound Creek tributary	11U 0643619E 5648138N	2017/08/25	Population at severe risk of being lost; critical habitat is virtually dry, with subsurface flow blocks upstream and downstream movement to overwintering habitat

Critical habitat	UTM Location, NAD83	Date	Issue
Mockingbird Creek	0636724E 5696625N, 0636696E 5696614N, 0636531E 5698643N	2017/08/25	This population is at severe risk of being lost, if it has not died out already. Critical habitat is virtually dry.
O'Haggen Creek	11U 0689183E 5478013N	2017/08/15	Critical habitat is drying up, creating isolated pond-like segments in which water temperatures could become lethally high; drying is also creating blockages to upstream and downstream movement, isolating parts of the population, and impeding access to overwintering habitat. Overwintering mortality is likely to be high

Alberta's few remaining westslope cutthroat trout populations are almost all small, and are distributed among many small, unproductive, highly isolated, highly fragmented habitats. In conserving small populations, it is essential to keep numbers as large as possible, and to retain as much genetic diversity as possible. This is done to minimize the chance that entire populations could be wiped out by random catastrophes, to maximize the chances that the populations can adapt and survive to changing environments, and to avoid the damaging consequences of genetic drift (loss of genetic variation due to chance) and inbreeding, which allows more frequent expression of deleterious gene forms.

In Alberta's westslope cutthroat trout, much of the genetic diversity that we need to retain is distributed among, rather than within, populations. For this reason, and because our remaining stocks are already severely depleted, conserving Alberta's native cutthroat trout requires that we retain every one of the remaining populations. We can't afford to lose any more of the remaining genetic variation in this species without significantly reducing our ability to recover native stocks to a point where they will again be self-sufficient.

Emergency action is needed to salvage the populations now at extreme risk, to control damage to critical habitat from human actions, and to survey other cutthroat populations and their critical habitats that could well be affected similarly. Longer-term recovery operations should be based on an Action Plan to guide the work, in which the role of each population and critical habitat is identified. That plan is now more than two years overdue, and is needed without further delay.

Contents

Introduction

Conserving at-risk species requires not just that they be protected from further decline and immediate loss, but that they also retain their ability to adapt and ultimately to evolve (Meffe 1986) so that they may survive in the face of ongoing environmental change. The latter two goals require that we retain the maximum remaining genetic diversity upon which adaptation and evolution can work. In the case of Alberta's native westslope cutthroat trout (*Oncorhynchus clarkii lewisi*), threatened under Canada's Species At Risk Act (SARA), genetic diversity exists primarily among, rather than within remnant populations (Leary *et al*. 1985, Taylor and Gow 2007). Conserving maximal genetic diversity in this species therefore means conserving the genome of every extant population (Allendorf and Leary 1988). I have summarized these and related ideas elsewhere (Mayhood 2014) to support the conceptual framework in the following two paragraphs.

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In early August 2017, I observed that Silvester Creek, designated critical habitat for a particularly important stock of westslope cutthroat trout, was declining rapidly in flow during a prolonged period of little rain to the point that discharge was barely measurable near the stream's confluence with the Elbow River. Three-month seasonal forecasts produced by Environment Canada (2017) predicted above normal temperatures and below normal precipitation for the period August through October 2017. Even lower flows could be expected, which could be highly detrimental to the trout stock. We could expect similar problems with the critical habitat of several other SARA-listed remnant stocks, almost all of which are small, isolated, and are therefore predisposed to loss from stochastic events.

I conducted a brief survey of readily-accessible, SARA-designated critical habitat streams in early and mid-August to determine to what extent other critical habitats might be at risk from very low flows. Nick Pink of the Alberta Wilderness Association conducted a similar survey in the Livingstone River drainage. This report documents my observations on just a few of the critical habitats I surveyed posing the most serious concerns. It also incorporates other relevant

observations from previous years at some locations where that was necessary to complete the picture.

The annotated photographs in the appendix should be viewed in connection with the notes on each site. They constitute most of the evidence supporting the discussion.

This report was prepared quickly to respond to an emergency situation needing the immediate attention of government authorities. Some supporting data is not reported here for the sake of making a quick response. If readers need additional information, please contact me at the coordinates on the title page.

Study Area

The study area is the eastern slopes of the Rocky Mountains within the Bow and Oldman river basins in southwestern Alberta, Canada. Some details of the specific sites sampled, all of them designated critical habitat streams, are available in the recovery strategy for the Alberta population of westslope cutthroat trout (DFO 2014). Much more is available directly from the author if required.

Methods

I surveyed 20 readily-accessible stream locations designated under SARA as critical habitat for Alberta native westlope cutthroat trout in August 2017. I georeferenced their position with a geographic positioning system receiver, photographed them to show their condition, occasionally measured water temperature when water was present, and made notes on the concerns relevant to the survival of the trout the habitats are expected to support. In some cases where I had previous relevant knowledge or data, I report that here.

Location readings were obtained with iHike GPS or Hunter NAV Camera on an Apple iPhone 5S, or with a Garmin GPSmap 60Cx receiver. NAV Camera readings printed on many of the photographs show positions at the photographer's location, and may not be identical to the location being photographed. Water temperatures were measured with a pocket thermometer calibrated at 0°C (ice-water bath) and at room temperature (~20 °C) against a laboratory grade mercury thermometer accurate to ±0.1 °C.

Selected Critical Habitats at Risk

Evan-Thomas Creek

Location: 11U 0631104E 5639379N and upstream to barrier falls

Date: Numerous dates 1995 to late July 2017

Issue: Population thought to be extinct due to extreme flooding in 2013. Follow-up survey needed before freeze-up fall 2017.

I believe this population likely has gone extinct. Immediate steps are needed to determine if there are any remnants of this small stock. If it is shown that some fish still survive, immediate work is required to salvage what remains, and to restore the population to a viable size.

Background

I have studied and fished this population numerous times over more than 20 years, often in the company of others. Prior to 2014, I and my colleagues have rarely, if ever, been unable to capture cutthroats. Since, and including, that year, neither I nor my angling partner have captured any cutthroats (Table 1).

T**able 1**. Angling catch records of trout from Evan-Thomas Creek show the apparent recent loss of westslope cutthroat trout from designated critical habitat. Numbers are the number of individual trout caught and landed so that they that could be identified. WSCT- westslope cutthroat trout, BKTR - brook trout, BNTR, brown trout.

Date	WSCT	BKTR	BNTR	# anglers/ observers	Comments
1995-2011	common	rare	rare	various	For fall 2010, see Gifford (2011), and Gifford and Mayhood (2014) for details and interpretation, and the former for details of catches and habitat data
2012/8/16	6	1		2	
2013/10/15	4			2	
2014/5/13				1	no fish seen
2014/6/4				1	no fish seen
2015/1/13				1	underwater videos at possible overwintering locations, no fish seen
2015/1/23				1	underwater videos at possible overwintering locations, 2 trout (species unknown) seen at 2 separate locations
2015/12/9				1	no fish seen
2016/7/20		1		2	
2016/8/24		8		2	
2017/07/15-31		4		1	reported by Dermot Kinsella

In 2010-2011 I supervised a final-year undergraduate student doing her major study on this population (Gifford 2011). We evaluated westslope cutthroat trout distribution, habitat use and abundance. Our best estimate of the population size of late juvenile to adult cutthroats was 108, with 95% confidence limits of 48 to 270 (Gifford and Mayhood 2014). A population that small has a rule-of-thumb probability of just 25% of persisting for at least 40 generations (Gifford and Mayhood 2014). The stock was clearly at serious risk of extinction from random adverse events.

It appears that fatal random event occurred in 2013. In June of that year, major floods swept the Bow River drainage. Evan-Thomas Creek was especially hard hit, with floodwaters scouring the entire valley bottom, depositing and reworking huge quantities of gravel from upstream, filling critical pools relied upon by cutthroat trout for holding water and overwintering (Gifford 2011). While we were able to capture a few cutthroats in fall of the flood year, we have not seen any since.

South Todd Creek tributary

Location: 11U 694842E 5514395N Altitude ~1440 m

Date: 2017/08/15 1111h MDT

Issue: Poor installation of new culvert causing under-substrate flow, blocking route for overwintering and spawning

Free movement of westslope cutthroat trout is blocked by a faulty culvert replacement. At present flows and less, fish are unable to reach overwintering habitat, or to access spawning habitat next spring. This problem must be rectified prior to freeze-up of fall 2017, or part of the South Todd Creek population could be lost, and the only identified spawning location could be isolated from the remaining population.

Background

A large replacement culvert has been installed to allow a tributary of South Todd Creek to pass under North Burmis Road. Cobble and boulder-sized shot rock that has been extensively installed at the inlet and outlet for erosion control, which causes flow to go subsurface at the west fence line at the present discharge. This tributary is not designated as critical habitat; however, I was shown seven trout upstream of the fence line (at 11U 694786E 5514387N NAD83 datum) by the property owner, who says that fish up to 10 inches (25 cm) occupy the creek upstream from her house. She says that cutthroat spawn on her property in this tributary above the road in spring.

This tributary is *de facto* critical habitat whether it is formally designated or not. Biologically, it forms part of the designated critical habitat in the South Todd Creek mainstem. The new construction now, at a minimum, blocks adult-size trout above the road from moving downstream to overwintering habitat in the mainstem South Todd Creek. In spring, it could

block most mature-sized trout from moving upstream to spawn at discharges similar to those observed.

I believe that this construction blockage constitutes destruction of a part of critical habitat, which is illegal under section 58(1) of Canada's Species At Risk Act. Free movement of trout through the culvert, coupled with erosion protection, need to be restored before freeze-up in fall 2017 to permit trout to move to safe overwintering habitat, and to allow passage in the spring to the only identified spawning site above the road.

Syncline Brook

Location: 11U 687401E 5468578N NAD83 datum, Altitude 1408m

Date: 2017/08/15

Issue: Small but valuable population at high risk of extinction; critical habitat is presently dry, with blockages to movement, high stranding risk, poor overwintering habitat

This population has high demonstrated value for restoration and recovery, but is at continuing very high risk of extinction due to its small size and unusually challenging habitat. Steps need to be taken as soon as possible to salvage and redistribute the genetic resources represented by the Syncline Brook stock before they are lost completely.

Background

The lower end of designated critical habitat was dry on the above date. Dry conditions often extend far upstream in this creek, favouring high rates of stranding. I have previously found trout stranded in an isolated bedrock pool within the designated critical habitat. Salmonids, including westslope cutthroat trout, are known to enter the streambed through interstices in the substrate, to overwinter in the hyporheic zone (Nelson 1962, several references mentioned by Shepard *et al*. 1984:14, Boag and Hvenegaard 1997). Presumably the fish also use the hyporheic as refuge during low flows.

The Syncline Brook population appears to be extremely small. Blackburn (2010) was able to identify a total of only 14 cutthroat trout specimens 70 mm in fork length or longer, over two electrofishing sampling dates in summer of 2010, over a reach that must have included virtually all of the surface habitat at that time. There is little surface habitat available to the fish in most years, and most of the lower reaches of the stream are dry shortly after spring runoff.

That this population has been able to persist over several decades of isolation in such a harsh habitat, and has remained genetically uncompromised (Mayhood and Taylor 2011), is a testament to its fitness and adaptation to the local environment. But such a small, isolated population has little chance of survival in the long term (Mayhood 2014), and is perpetually at risk of extirpation by stochastic events, of which the loss of the Evan-Thomas Creek stock in 2013 is a notable recent example.

Silvester Creek

Location: From barrier falls at 11U 0660224E 5637351N, upstream to Silvester-Muskeg watershed divide, including tributaries, especially known but undesignated critical habitat (overwintering) in a major tributary below a barrier falls at 11U 0659832E 5635706N, NAD83 datum.

Date: To 2017/08/24

Issues: Critical habitat is in imminent danger of drying up, isolating parts of the cutthroat population, potentially destroying overwintering habitat, and making other overwintering habitat inaccessible. There is ongoing heavy erosion of a very dense road network in Silvester Creek watershed, leading to high sediment loading to critical habitat. Continued logging of an already heavily-logged watershed with accompanying new road-building promises to simply add to critical habitat destruction.

All of these issues are likely to lead to a reduction in population size, rendering the population at greater risk of extinction. Immediate action is needed to locate those parts of the population at most risk and salvage them, minimizing the likely effects of lost critical habitat by at least temporarily moving a small part of the population to secure habitat elsewhere. The trail system needs to be disconnected from the stream network or reclaimed entirely, and further development in this watershed (e.g., logging) needs to be disallowed until the security of this stock can be assured.

Background

The Silvester Creek population, at approximately 1100 fish 70 mm fork length or longer (Paul *et al*. 2008), is relatively large for a headwater creek stock. Its critical habitat, however, is under chronic pressure from continuing clearcut logging, and from sediment delivery from an extensive off-highway vehicle network (Erdle and Mayhood 2014). Suspended sediments delivered from this network likely destroy anywhere from 20% to as much as 60% of the eggs and larvae in some years (Mayhood 2013a). This population has about a 63% probability of persisting over the long term, based on its present size (Mayhood 2013a).

While conducting research on this creek this year, I noticed unusually low and steadily declining streamflows in August. At present (9 August 2017), flow is barely measurable immediately above the barrier falls approximately 70 m above the confluence with the Elbow River. Flows further upstream are very low as well (24 August 2017) in a reach in which I observed spawning in June. Flows are also extremely low and declining below a barrier falls in the main tributary serving as overwintering habitat (Paul and Dormer 2005). Further declines would likely make this reach inaccessible and unsuitable for overwintering. Further declines in flow would also isolate parts of the population in separate pools and short reaches where they could be subject to rising temperatures, and from which they also would be unable to move to suitable thermal or overwintering habitat. Water temperatures are within thermal criteria now (peaking at 16°C or less, depending on location), but if flow stagnates, temperatures could increase rapidly. Cutthroats often must move to remain in habitable water

during winter, and low flows can block those movements, exposing them to mortality (Brown and Mackay 1995, Brown 1999).

I have also observed new flagging and notations indicating a new haul road, suggesting that even more logging is contemplated for this basin, a large proportion of which has been logged already, with incomplete hydrological recovery to this point. The effect of even more clearcut logging will most likely be to increase runoff and peak flows (e.g., BC Forest Service 1995), and increasing erosion from additional roads and trails. Damage to channel conformation and streambed composition are a likely outcome. I and a colleague have documented existing problems with erosion and sediment sources in this drainage elsewhere (Mayhood 2013a, 2013b, 2015; Erdle and Mayhood 2014). More is in preparation from our research this spring and summer.

Girardi Creek

Location:

Date: several dates, from 2014 to 2017

Issue: Stream was recently diverted by blocked culvert, stopping water flow to critical habitat and blocking fish movement. Ongoing blockages are inevitable due to inadequate repair work and a highway culvert that is inadequate to pass high loads of coarse sediment.

These issues, if they persist, are likely to reduce suitable critical habitat, trout movement, and cutthroat trout population size. Already they have destroyed parts of critical habitat, which I believe contravenes section 58(1) of the Species At Risk Act.

Background

I have visited this stream on several occasions since 13 December 2014. At that time, I assessed habitat and attempted to locate overwintering cutthroat trout with the aid of underwater photography, surveying nearly the entire channel from its confluence with the Crowsnest River to a logging road bridge 1.75 km upstream (straight-line measurement). The bridge, access road and an adjacent off-road vehicle (OHV) trail combined were a source of fine sediment at the upper end of the survey reach. At that time, the culvert under Highway 3 was flowing with a maximum depth in the culvert inlet of 21.5 cm, which is readily passable by trout. I observed no overwintering trout.

On 26 May 2016, I observed recent OHV tracks through Girardi Creek in gravel on the upstream side of the Highway 3 culvert. The stream at this point was wide and very shallow. The culvert entrance was almost full of gravel. There was a deposit of fine sediment (mud) above the present waterline downstream from the culvert.

On 28 July 2016, I observed again much evidence of OHV crossings on the upstream side of the Girardi Creek culvert under Highway 3. The culvert inlet was barely passable to trout.

On 14 November 2016 there was much evidence in the gravel upstream of the Highway 3 culvert of OHVs crossing Girardi Creek. Many of the stones were coated in a cream-coloured deposit tightly affixed to them, which I take to be precipitated limestone. The culvert entrance

was again nearly full of gravel, though still passable to trout. There was more silt than usual above and below the culvert.

On 25 June 2017 the Highway 3 culvert was plugged with gravel, being completely buried on the entrance side, and almost completely full of gravel on the downstream side. The upstream side showed many recent OHV tracks crossing the creek. Girardi Creek had been diverted down the south ditch of Highway 3 eastward toward the Crowsnest River about 350 m distant. The diverted creek was eroding and headcutting a channel into the ditch. About halfway to the river, the creek had left the ditch and had spread thinly over an abandoned piece of the old highway, entered its south ditch, then apparently spilled over a high, steep bank into the river. The entire reach was impassable to trout.

The flow of what was left of Girardi Creek downstream from the highway was much attenuated relative to the flow above the highway. The habitat below the highway was very shallow and divided into several channels, rejoining at the fence line.

On 15 August 2017, the Highway 3 culvert on Girardi Creek had been cleaned of much of the gravel, the entrance being 60-70% open. Girardi Creek had been placed back in its channel. The gravel on the upstream side had been pulled back out of the channel onto the banks, and some small concrete curbs had been placed across the place OHVs had used to ford the creek. I saw no evidence of OHVs crossing recently. New cobbles and boulders had been place along the left bank above the culvert, apparently in an attempt to contain the stream within a single, deeper channel. The channel below the culvert had likewise been reshaped to make it deeper, by drawing gravel out of the channel and onto the banks. Flow below the culvert had been restored.

In my opinion these repairs recently made to Girardi Creek critical habitat at the Highway 3 crossing are temporary, and do not solve the underlying problem at this site. The culvert is not large enough to pass the creek and its heavy load of gravel-sized sediment. This culvert will continue to plug up with gravel intermittently, with the results just described. It needs to be replaced by a bridge of sufficient span to pass the creek and its load of gravel downstream. In the meantime, every time the culvert plugs, some part of critical habitat will be destroyed, contrary to section 58(1) of the Species At Risk Act.

The effect of these ongoing episodes of habitat destruction on the protected trout population will be to block movements of trout within the designated critical habitat, with the likely consequence that some parts of the population may be unable to move to access suitable spawning or overwintering habitat. By intermittently mobilizing large quantities of fine sediment during repair work, there could be large increases in mortality of eggs and larvae (Weaver and Fraley 1993, Newcombe and Jensen 1996), or reductions in suitable overwintering habitat: small juveniles in particular use interstices among stones that would be filled in by fine sediment (several references mentioned by Shepard *et al*. 1984:14).

Blackburn (2011) captured 36 westslope cutthroat trout in the creek 30 June 2010, but did not calculate a population estimate. There is no evidence of any contamination by the rainbow

trout genome in this population (Mayhood and Taylor 2011), making it only one of about 14 remnant pure populations, so is of especially high value for conservation.

Jumpingpound Creek tributary

Location: 11U 0643619E 5648138N NAD83 datum

Date: 2017/08/25 15:02h MDT

Issue: Population at severe risk of being lost; critical habitat is virtually dry, with subsurface flow blocks upstream and downstream movement to overwintering habitat

Background

This tiny tributary of upper Jumpingpound Creek apparently holds the remnant stock of native cutthroat trout with the lowest rate in the drainage of introgression from rainbow trout. Restoring a viable population to the Jumpingpound system will rely on this stock. Flow was extremely low at the Powderface Trail culvert crossing on the above date, showing no surface flow for a short distance above the crossing. Unless flow increases by freeze-up, extensive ice blockage and dry areas will block trout from moving to find safe overwintering sites. To minimize the chance of losing the stock, its local adaptations and genetic resources, some fish (if they still exist) from this population should be captured and moved to safe refuge until adequate flows return to this creek, and a coherent plan has been prepared for recovering the Jumpingpound Creek population.

Mockingbird Creek

Locations: 0636724E 5696625N and 0636696E 5696614N, both near the mouth; 0636531E 5698643N in the headwaters.

Date: 2017/08/25

Issue: This population is at severe risk of being lost, if it has not died out already. Critical habitat is virtually dry.

Background

Mockingbird Creek was dry (both channels) within designated critical habitat at the Waiparous Road crossing near the mouth when visited on the above date. The creek channel was damp, but barely flowing, at a cutline crossing in the headwater above designated critical habitat on the same date. Natural Resources Canada's 1:50,000 topographic mapsheet 82 O/6 Edition 3, current to 1994, shows three small ponds about halfway between the above locations, but Google Earth imagery shows this area to be, at most, a wet meadow. At best, critical habitat in Mockingbird Creek has been severely reduced by the current drought.

A more complete survey is needed to determine if this creek still holds a stock of cutthroat trout somewhere along its length, and if so, if it is capable of supporting them through the winter. If not, and if a remnant of the population still exists, some portion of it should be

rescued and held in secure habitat elsewhere until a plan for recovery and maintenance of the Waiparous Creek complex of cutthroat stocks has been developed.

Recent flagging in the headwaters, which I observed on the sampling date, appears to indicate yet another road or trail is planned the Mockingbird Creek watershed. Additional linear disturbance and resource development affecting cutthroat designated critical habitat in this drainage is a threat to that habitat, and should not be permitted until a credible recovery and maintenance plan has been prepared for cutthroat trout in the Waiparous drainage.

O'Haggen Creek

Location: 11U 0689183E 5478013N

Date: 2017/08/15 13:53h MDT

Issue: Critical habitat is drying up, creating isolated pond-like segments in which water temperatures could become lethally high; drying is also creating blockages to upstream and downstream movement, isolating parts of the population, and impeding access to overwintering habitat. Overwintering mortality is likely to be high

Background

Flow was extremely low in designated critical habitat on the above date, becoming nearly sub-gravel above the bridge. Below the bridge, O'Haggen Creek was a long, almost stagnant pond with negligible flow and a heavy growth of filamentous green algae. The water temperature was 16°C. I observed a single trout of 10-15 cm length below the bridge.

Given the seasonal forecast of below normal precipitation and above normal temperatures (Environment Canada 2017), further declines in flow should be expected. The outcome is likely to be a series of dry reaches separating a series of shallow pools vulnerable to high temperatures that are marginal for the survival of cutthroat trout.

A maximum daily temperature for cutthroat optimum growth of 13-15°C (Bear and McMahon 2007) is already being exceeded, favouring the rainbow trout genome and its upstream invasion (Rasmussen *et al*. 2010) in this lightly-hybridized stock (Mayhood and Taylor 2011). If maximum stream temperatures ultimately exceed the westslope cutthroat's upper incipient lethal temperature of only 19.6 °C (Bear and McMahon 2007), there could be significant mortalities.

When freeze-up occurs, the trout in this population will need to be able to move within O'Haggen Creek to find habitable water, especially during cold snaps, which can create additional blockages by anchor ice and ice dams in such shallow waters. Blockages which are already occurring only make this problem worse.

There is heavy use of this drainage by OHVs, creating substantial damage to the watercourse, especially in the headwaters. The area around the bridge is heavily used by cattle as well. Both may be contributing to the problems discussed here.

To minimize the chance of losing this stock, its local adaptations and genetic resources, some fish from this population should be captured and moved to safe refuge until adequate flows

return to this creek, and a coherent plan has been prepared for recovering and protecting it and its critical habitat.

Discussion

The critical habitats described above are just a few examples with major issues commonly faced by threatened westslope cutthroat trout in Alberta. My colleagues and I were able to survey a total of 29 of the approximately 50 designated critical habitats. I expect others are at risk as well. The results described here are sufficient to show that there are widespread serious problems with critical habitat among SARA-designated populations, that are sufficiently serious to require immediate intervention.

Small headwater populations have always been at heightened risk of extinction, but when the species was widespread, abundant, and occupied river and stream mainstems in well-connected networks, these losses would quickly be replaced by re-invasion from downstream. Now that the headwater stocks are isolated, extirpations are permanent. Lost stocks are replaced, if at all, by non-native trout that now dominate the mainstem habitats.

Each of the headwater stocks of native cutthroat trout is expected to be genetically unique and locally adapted to conditions in their home headwaters (Allendorf and Leary 1988, Drinan *et al*. 2012). So conserving the genetic diversity of cutthroat trout in Alberta means retaining every remaining population that we can. Every time we lose a headwater stock, we lose some part of the ability of the species to adapt and evolve, so we lose some part of our ability to restore the species. In the present context, this explains the urgency required to respond to the threats described here. Each individual headwater stock carries the potential to provide some critical advantage that may eventually be needed to restore viable populations of westslope cutthroat trout, and ultimately to recover enough of the ancestral native Alberta populations that they again require minimal special management, and can contribute to a viable sport fishery and the human economy.

Finally, long-term recovery operations should be based on an action plan in which the role of each population and critical habitat is identified. The plan should be designed to restore populations to the point where Alberta native cutthroat trout will continue to survive with a minimum of special management and with negligible risk of extinction. A conceptual framework for a suitable action plan is available (Mayhood 2014).

Acknowledgements

Caitlin Gifford and Heidi Erdle have done much work on Evan-Thomas and Silvester creeks, respectively, that has influenced my thinking on the issues in those creeks. Logan Boyer, supported by grants from the Bow River Basin Council and the Alberta Wilderness Association, assisted me with fieldwork on Silvester Creek. Nick Pink of the Alberta Wilderness Association conducted part of the quick field survey. Although I didn't use any of his material in this report, he was able to remove some potential problem creeks from the at-risk list, leaving me to focus on the remainder. Dermot Kinsella recently, and Mike Sawyer in the 1990s, assisted with fieldwork on Evan-Thomas Creek.

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Appendix: Annotated Photographs

Photographs have been compressed and formatted for screen viewing. High resolution originals are available from the author if needed.

Evan-Thomas Creek

13 January 2015: This plunge pool below the barrier falls is at the upstream end of the SARA-designated critical habitat. It was used by nearly half of the native cutthroat trout population for overwintering in 2010-2011 (Gifford 2011). At that time it was much deeper and more capacious. After the flood of 2013, the pool was largely filled in by gravel and cobbles: note the large deposit of gravel in the foreground. Underwater video in the plunge pool on this date found only a single trout, which could not be identified to species. We have found no cutthroat trout in this stream since October 2013 (Table 1).

South Todd Creek tributary

This tributary to South Todd Creek designated critical habitat is blocked by a badly-designed culvert replacement. The tributary is now impassable to trout from upstream (background). Unless this is rectified before freeze-up, trout above the barrier will be unable to reach overwintering habitat in the South Todd Creek mainstem (behind the photographer), and could perish. The tributary will be unusable as habitat for the listed population in the mainstem. Designation of the tributary as critical habitat awaits a legally-required action plan, now more that two years overdue, from Canada's Minister of Fisheries, Oceans and the Coast Guard.

This is the same culvert on South Todd Creek tributary as in the previous photograph, but looking into the outlet from the downstream side. The culvert is impassable to trout at present flows.

Syncline Brook

This photograph was taken looking upstream into the critical habitat reach from the lower boundary of the reach at 11U 0687325E 5468464N. The camera GPS reading may be incorrect as it had not had time to stabilize. The reach is dry and unavailable as surface habitat, although it may still support small trout deeper in the hyporheic zone.

Silvester Creek

Flow conditions are very low in upper Silvester Creek (24 August 2017), and are likely to continue to decline in the face of projected lower than normal rainfall and higher than normal temperatures for August through October (Environment Canada 2017). This site is more than 250 m above the upper boundary of designated critical habitat, but several hundred metres downstream from a site at which I observed cutthroats preparing to spawn in June. The upper reaches of the creek therefore are *de facto* critical habitat for this population. The upper reaches need to be afforded protection of critical habitat designation, which I have been assured will occur once the long overdue action plan is released. In the meantime they are unprotected under SARA. Silty runoff from this bridge and its road approaches continue to contaminate the creek at this point.The installed silt fences are inadequately maintained and ineffective. Enforcement is non-existent.

Silvester Creek SARA-designated critical habitat for threatened Alberta native westslope cutthroat trout nears surface zero-flow conditions in early August 2017. At normal flows, water spills over the entire sill in the foreground; now the sill is barely wetted. Flows are likely to continue to decline for reasons described above. Trout may become isolated in stagnant reaches and be trapped in waters that are too warm for them, resulting in mortalities, or they may be unable to seek suitable overwintering sites in late fall due to being isolated in the disconnected stagnant pools separated by lengths of dry streambed. An emergency rescue plan is needed.

This tributary of Silvester Creek provides overwintering habitat for substantial numbers of large cutthroats from Silvester Creek (Paul and Dormer 2005). If flows continue to decline as expected, this location could dry and become a barrier to upstream movement. Waters downstream would also become unsuitable overwinter habitat. A contingency plan is needed to ensure that adequate overwinter habitat is available through the 2017-2018 winter season, or to provide for rescue of some part of the population.

Girardi Creek

25 June 2017: The angle iron post (top photo) marks the buried inlet of an undersized culvert intended to pass Girardi Creek under the Crowsnest highway (Highway 3). The entire culvert was plugged with gravel on this date, and appeared to have been for some time, perhaps days, based on the degree of erosion of the overflow channel. The plug dewatered much of the channel below the highway (bottom photo), while Girardi Creek was diverted down the highway ditch. (next page).

The plug dewatered much of the channel below the highway

25 June 2017: Girardi Creek is diverted eastward down the Highway 3 ditch (top photo), eroding a new channel and eventually spreading over an abandoned piece of highway (cover photo). This event destroyed a part of critical habitat and appears to be a clear violation of section 58(1) of the Species At Risk Act.

By 15 August 2017, the culvert had been unplugged and much of the channel damage had been repaired (bottom photo), but it is evident that this culvert will continue to plug up and destroy critical habitat again. This site poses complicated problems in that it requires a fix that passes water and a high sediment load under the highway, but that sediment could quickly fill in the channel below a barrier downstream, making it passable. That barrier is probably the reason that the cutthroat population in this creek shows no sign of introgression with rainbow trout, common in the Crowsnest River. Work by a good fluvial geomorphologist is required on this problem very soon before serious damage is done to the population.

Jumpingpound Creek tributary

This small tributary was once a narrow channel. It was severely eroded and reshaped by the June 2013 flood. On 25 August 2017 it had very low flow which went subgravel for a short distance above the Powderface Trail, blocking fish movements past that point (top photo). Below the road, what exists of the flow spills thinly down sloped bedrock, forming another difficult impediment to fish movements (bottom photo). Flow is likely to continue to decrease through October. If a populations still exists in this creek it needs to be located and rescued.

Mockingbird Creek

Both channels of Mockingbird Creek were dry at the Waiparous Road culverts on 25 August 2017 (top and bottom photos). In the headwaters the channel had a puddle on a cutline that drained as a trickle beneath a small pile of sticks (next page). An immediate search of this stream needs to be made to discover and, if necessary, rescue any cutthroat trout that may be surviving in isolated wet habitat.


Date & Time: Fri Aug 25 12:09:20 MDT 2017
Position: 11 U 636559 5698660
Altitude: 1563m
Datum: NORTH AMERICAN 1983, Canada
Azimuth/Bearing: 272° N88W 4836mils (True)
Zoom: 1X

O'Haggen Creek

On 15 August 2017, O'Haggen Creek above the road crossing was barely flowing. At the first corner above the bridge, it was nearly sub-gravel, making movement past that location nearly impossible. Below the bridge the creek looked more substantial, but was really a near-stagnant elongated pond with a prominent growth of filamentous green algae. We can expect flows to decrease due to continuing abnormally low precipitation, while temperatures are likely to increase (Environment Canada 2017), putting the trout population at additional risk, especially of thermal stress.