Setting the stage for conservation success: large-scale watershed renovation and re-introduction of cutthroat trout in the Rocky Mountain region of the USA

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Introduction

The cutthroat trout (*Oncorhynchus clarkii*) is native to the Rocky Mountain and coastal areas of the western United States (US) and is classified into as many as 14 subspecies (e.g., Behnke, 1992). Seven major inland subspecies of cutthroat trout historically occupied most accessible cold water environments from Canada to southern New Mexico. However, all subspecies have incurred significant range reductions primarily due to competition and introgression with introduced salmonids, but also from habitat degradation and exploitation (Young, 1995; Shepard *et al.*, 2005; Pritchard & Cowley, 2006). Lahontan (*O. c. henshawi*) and greenback (*O. c. stomias*) cutthroat trout are listed as threatened under the US Endangered Species Act (ESA) and the other inland subspecies have either been petitioned for listing under the ESA or are considered species of concern by state and federal agencies.

We focus on the northern- and southernmost inland subspecies, although considerations are likely similar for all subspecies. Westslope cutthroat trout (WCT, *O. c. lewisi*) were historically the most widespread subspecies - occupying an estimated 90,800 km of streams and rivers throughout the Columbia and Missouri basins headwaters - but the range of genetically

Released westslope cutthroat trout in Cherry Creek - September 2012

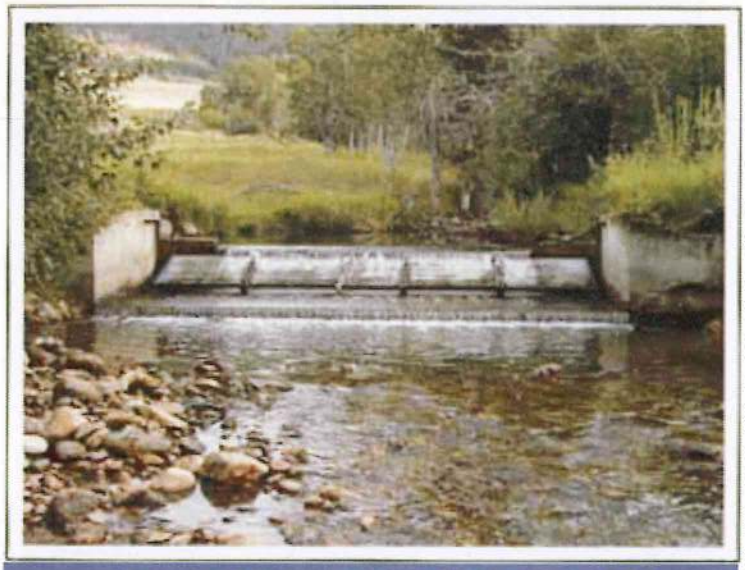
pure populations has been reduced by 76% (Shepard *et al.*, 2005). On the east side of the Continental Divide occupied habitat reduction has been even more dramatic, exceeding 95%. WCT were petitioned for listing under ESA in 1997 but determined not warranted for listing in 2003. Rio Grande cutthroat trout (RGCT, *O. c. virginalis*) were historically found in about 10,700 km of habitat in the upper Rio Grande basin of Colorado and New Mexico, however the distribution of genetically pure populations of this more arid climate subspecies has been reduced by 92% (Pritchard & Cowley, 2006; Alves, 2008). This subspecies was petitioned for listing in 1998 and was added to the candidate list in 2008. Both WCT and RGCT are given special status recognizing their conservation need by the states in which they are found and by federal land management agencies (e.g., a species of special concern by Colorado, and a sensitive species by the US Forest Service). As such, range-wide conservation agreements are in place to guide conservation and restoration activities for WCT and RGCT. Priorities include protecting existing populations and establishing new ones (Montana Cutthroat Trout Working Group 2007; RGCT Conservation Team 2009).

Goals

- Goal 1: Develop a project working group that collaboratively defines leadership roles and responsibilities for all aspects of project coordination, planning, implementation, research and monitoring.
- Goal 2: Select a re-introduction site encompassing a large geographic area with high quality and diverse habitats to support a robust cutthroat trout population with diverse life-history strategies able to resist threats such as climate change, catastrophic events, and invasive species.
- Goal 3: Eliminate non-native competitors in the re-introduction site (watershed or portion thereof) through physical and/or chemical renovation, and prevent their recolonization.
- Goal 4: Establish a self-sustaining population of cutthroat trout large enough to withstand environmental and demographic stochasticity and likely to persist over the long-term (>100 years) with little or no human intervention.
- Goal 5: Establish a monitoring strategy, including relevant research partnerships, that evaluates key project aspects and allows adaptive management of all strategies and methods as the project unfolds, and to improve and guide future efforts.
- Goal 6: Provide the public with opportunity to experience the restored cutthroat trout population.

Success Indicators:

- Indicator 1: A functional working group with effective leadership that provides a regular forum for professional discussion, project planning, delegation of duties, risk-benefit analyses, project implementation, monitoring and adaptive management, and dispute resolution.
- Indicator 2: Complete removal of targeted non-native species from the re-introduction site.
- Indicator 3: Establishment of a genetically pure, consistently reproducing (e.g., multiple age classes) cutthroat trout population that persists without chronic management or intervention.



Temporary fish movement barrier on Cherry Creek

- Indicator 4: A robust cutthroat trout population that supports recreational (e.g., angling) use and provides genetically pure gametes and individuals in support of other regional cutthroat trout restoration and re-introduction projects.
- Indicator 5: Monitoring and research insights published in peer reviewed literature and adaptively integrated into project implementation allowing the project to proceed more effectively and inform future restoration efforts.

Project Summary

We review case studies of two of the largest cutthroat trout restoration projects ever undertaken in the United States. These case studies embody the goals and challenges inherent in other cutthroat trout recovery projects.

Case Study 1 - Cherry Creek Native WCT Project, Madison River Drainage, Montana (MT): This project encompasses approximately 100 km of stream habitat and 3 hectares of lake habitat suitable for cutthroat trout, and is the largest piscicide renovation project ever completed for the purpose of cutthroat trout conservation. The majority of the project is on private lands and is a collaborative effort among the private land owner - Turner Enterprises, Inc. - and public resource management agencies - MT Fish Wildlife and Parks and the US Forest Service. The Cherry Creek project began with establishment of a collaborative working group, feasibility analyses, and environmental planning in 1997. Opposition to the use of piscicides and non-native fish removal, through a series of legal and administrative challenges, delayed initial piscicide application until 2003. Because of the large spatial scale of the project, the watershed was treated in four "phases", with each phase treated on at least two separate occasions. The piscicide antimycin was applied at a targeted rate of 10 ppb (active ingredient) to remove rainbow (*O. mykiss*), brook (*Salvelinus fontinalis*), and Yellowstone cutthroat (*O. c. bouvieri*, stocked in Cherry Lake in the 1920's) trout from phases 1 and 2. Rotenone (50 ppb a.i.) was used to eliminate the non-native trout in phases 3 and 4. While phases were isolated from recolonization during treatment by natural or temporary man-made fish movement barriers, the entire project area is protected from reinvasion by an 8 m waterfall at the downstream end of phase 4. Piscicide applications were completed in 2010.

In 2006, WCT introductions began in phase 1 via remote stream-side egg incubators and were completed by stocking young of year fish in phase 4 in 2012. Approximately 37,000 eyed eggs and 8,500 young of year fish from multiple wild populations and a hatchery conservation broodstock were introduced. All temporary fish barriers were removed in 2011 to reconnect the phases. Post-treatment monitoring documented WCT throughout the mainstream project area by 2012 and at least two years of natural reproduction, while finding no remaining non-native salmonids. Throughout the project researchers and managers collaborated on project implementation and evaluation, which most efficiently used available resources. Research and monitoring will continue to follow population recovery, comparative survival and fitness of the source stocks, movement into vacant habitats, and impacts to non-target organisms. The Cherry Creek project is a significant conservation achievement for WCT on the east side of the continental divide. This project increases the stream km occupied by WCT in the Madison River basin from 7 km to over 100 km or from 0.3% of historical occupancy to almost 5%. Perhaps more importantly the success of the Cherry Creek project, and lessons learned from, has catalyzed several other cutthroat trout re-introduction projects in southwestern MT. It is important to note that due to the large barrier falls, the Cherry Creek project area was historically fishless. Thus, this project is actually a novel introduction of WCT to a previously inaccessible area within the subspecies historic range.

Case Study 2 - Costilla Creek Native RGCT Project, Rio Grande River Drainage, New Mexico (NM) and Colorado (CO): The most ambitious watershed renovation project ever initiated on behalf of cutthroat trout, the Costilla Creek project encompasses approximately 190 km of stream habitat and 20 lakes. A collaborative effort among Vermejo Park Ranch, NM Department of Game and Fish, CO Parks and Wildlife, US Forest Service, and Trout Unlimited, this project was initially designed to include only 22 km of stream and four lakes protected by a man-made fish migration barrier. Project planning was initiated in 1998 and piscicide (antimycin) was first applied in 2002 to remove non-native brook, rainbow, and brown (*Salmo trutta*) trout from historical RGCT habitat in the headwaters of Costilla Creek. RGCT were re-introduced by stocking 9,500 young of year fish from CO Parks and Wildlife RGCT hatchery broodstock into the renovated stream habitat for three consecutive

Crew member applying piscicide in a tributary to Costilla Creek - August 2011

Costilla Creek project notification

years (2002 - 2004). By 2005 the post-treatment RGCT population was similar in average size and overall abundance to the pre-treatment non-native trout population. Unfortunately during a 2004 lake restocking event, rainbow trout were inadvertently introduced back into the project area.

Administrative and regulatory resistance prevented immediate localized (to stocking sites) retreatment to remove the non-natives and by 2007 hybrid rainbow-RGCT trout were captured. In 2008 a large portion of the project area was successfully retreated with rotenone (50 ppb a.i.) to remove these hybrids. This time, mixed-aged individuals from the NM Department of Game and Fish RGCT hatchery broodstock were introduced (1,900 in 2008 and 10,200 in 2009) and the population recovered by 2010, with no evidence of hybrids or other non-natives remaining. A 2007 environmental assessment proposed expanding the project area to its current size. Watershed renovation is currently ongoing in phases, but the project is complicated due to its size; regulatory requirements; the need for at least seven man-made, temporary fish movement barriers; a 15,700 AF reservoir, and public resistance. To date over 100 km of stream (50% on private land) and 10 lakes have been successfully chemically renovated and restocked with RGCT. If this project is fully completed by 2020 as scheduled it will represent a 20% increase in the amount of stream RGCT currently occupy within their historical range. This project is the flagship restoration effort on behalf of RGCT for the NM Department of Game and Fish. Planning and implementation of the Costilla Project is largely responsible for the development of consistent NM state guidelines regarding the use of piscicides, and for re-development of the Department's native cutthroat trout hatchery broodstock; both important steps for range-wide restoration and conservation of the species.

Major difficulties faced

- Selecting restoration and re-introduction sites of suitable conservation scale, where both landowners and managers will participate, with sufficient habitat quality to allow long term persistence of re-introduced populations.
- Regulatory requirements, administrative processes, and public resistance to the use of fish toxicants (piscicides) requires a significant investment of time, resources, and emotional energy prior to project implementation in the field.
- Locating accessible temporary and permanent barrier sites suitable for designs that are affordable, removable, and functional to keep non-native trout from reinvading the project site during and after piscicide application.

- Finding suitable donor populations for re-introduction when there are few remaining wild sources or hatchery sources that may not meet genetic objectives or withstand removal of individuals or gametes.
- Assurance that all non-native fish have been removed typically requires at least one piscicide application where no mortalities are observed.
- Minimizing the loss of recreational opportunities (e.g. angling or hiking) within the project area, especially on publicly owned reaches of water.

Major lessons learned

- It is critical to establish an effective collaborative project working group that meets regularly to define project goals, assigns organizational responsibilities, conducts project planning, develops annual work plans, handles public outreach, facilitates frank discussion, and flexibility is key.
- Committed project personnel can and need to be consistent and persuasive with agency and organizational administrators to overcome the social, political, and logistical challenges these types of projects inevitably encounter.
- Designing restoration and re-introduction projects within an experimental or research framework provides an opportunity to collect real-time information that can inform ongoing as well as future projects regarding implementation, methodologies, impacts, and population recovery, among other things.
- Removal of non-native fishes and re-introduction of native fish can be successful over relatively large spatial scales and in complex, diverse habitats if implemented methodically across the landscape.

Success of project

Cherry Creek Westslope Cutthroat Trout Project:

Highly Successful	Successful	Partially Successful	Failure
√			

Costilla Creek Rio Grande Cutthroat Trout Project:

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reason(s) for success/failure:

- Implementation of a systematic approach to completely remove non-native competitors over a large scale was instrumental in achieving successful eradication.
- An effective collaborative partnership between private conservation organizations and public resource management agencies created a shared vision, spread financial obligations, and pooled resources.
- Using the best available science and a real-time experimental framework informed project planning, implementation, and cutthroat trout re-introduction

in an adaptive manner and led to improvements and increased efficiency on the project.
- Selection of re-introduction sites with high quality and diverse habitat at a scale appropriate to support all life stages of native cutthroat trout has allowed the re-introduced population to persist.
- Persistence and mutual support of project partners through significant social, political and logistical challenges maintained the cohesion and will to complete the project.
- A conservation minded private landowner willing to withstand the risk of failure.

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