

**MEASURING THE ABILITY OF FINGERLING BROOK CHARR TO
LEAP OVER WATERFALL BARRIERS**

Mandi M. Brandt
Department of Fishery and Wildlife Biology, Colorado State University
Fort Collins, Colorado 80523-1474
Phone: (970) 532-3562
Brandtmane@aol.com

Christopher A. Myrick
Department of Fishery and Wildlife Biology, Colorado State University
Fort Collins, Colorado 80523-1474
Phone: (970) 491-5657
camyrick@cnr.colostate.edu

EXTENDED ABSTRACT ONLY – DO NOT CITE

Introduction

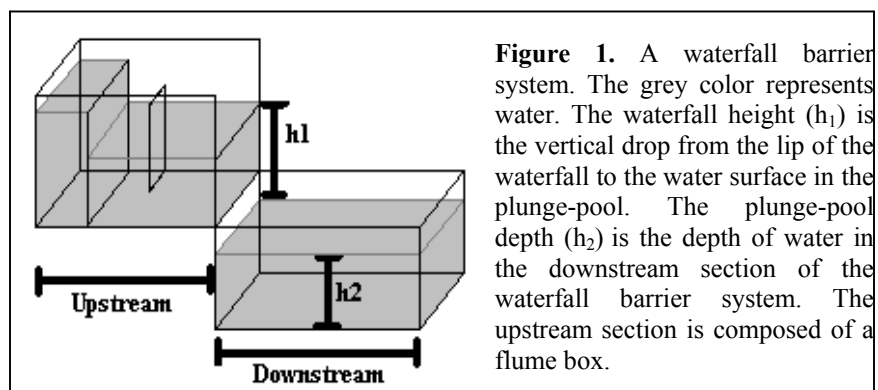
Declines and extinctions of native populations of greenback cutthroat trout (*Oncorhynchus mykiss stomias*) are partly a result of the introduction of non-native brook charr (*Salvelinus fontinalis*) (Behnke, 1992; Griffith, 1998). This is due to brook charr out-competing cutthroat trout for food and habitat in areas where both species occur (Behnke, 1992; Griffith, 1998). Management techniques that eliminate brook charr and protect cutthroat trout populations from interspecific competition have been proposed and tested. One strategy involves removing brook charr from an area and placing them downstream. However, brook charr tend to migrate upstream because of instinctive homing behavior (Belanger and Rodriguez, 2001). Another strategy is to poison sections of streams above barriers to eliminate all fish species present, and then re-introduce cutthroat trout (Stuber et al., 1988). This strategy is only successful when a barrier is present that prevents brook charr from migrating upstream. In order to construct an effective barrier to migration, the leaping abilities of brook charr must be known. This study was designed to quantitatively measure the ability of fingerling brook charr to leap over waterfall barriers.

Methods and Procedures

Design of Experimental Tank and Waterfall Barrier System

The experimental tank consisted of a raceway (the downstream section) and a flume box (the upstream section). The flume box consisted of two chambers separated by a divider. Water was pumped into the rear chamber. Water turbulence in the front chamber was reduced by the divider separating the two chambers, and by a partial divider in the front chamber. It was necessary to reduce the turbulence so that brook charr that successfully leapt over the barrier and into the front chamber had a place for refuge (Kondratieff, 2002).

The waterfall barrier system had a variable waterfall height (h_1) and plunge-pool depth (h_2) (Figure 1). Waterfall height (h_1) was changed by raising or lowering



the flume box. Plunge-pool depth (h_2) was regulated with different sized standpipes. Flow rates were held constant at 0.47 L/min to produce a 2 cm water depth at the lip of the 10 cm wide waterfall opening. Temperature was held at 10-12°C.

Experimental Design and Procedures

All experiments were conducted indoors under a natural photoperiod. The leaping abilities of brook charr were measured following a process outlined by Kondratieff (2002) which analyzes the interactions among different waterfall heights and plunge-pool depths. Twelve waterfall heights (2 to 24 cm, in 2 cm increments) and seven plunge-pool depths (6 to 18 cm, in 2 cm increments) were

used to test the leaping abilities of fingerling (30 mm to 100 mm total length) brook charr. All possible combinations of these waterfall heights and plunge-pool depths were tested.

At the beginning of each trial, plunge-pool depth and waterfall height were adjusted. Pumps were then started and water was given the chance to level out. Once the experimental tank was ready, ten fingerlings were randomly selected from holding tanks and placed into the downstream section of the waterfall barrier system. Brook charr were given 24 hours to attempt to leap over the waterfall barrier. At the end of each 24-hour trial, each fish's position within the barrier system (upstream or downstream), weight, and length (standard length, fork length, and total length in mm) were recorded. Waterfall height and plunge-pool depth were also recorded. Data were analyzed at the end of the study using Microsoft Excel.

Results

More brook charr were able to leap over waterfall barriers that had low waterfall heights (Figure 2). No brook charr were able to leap waterfall barriers that had

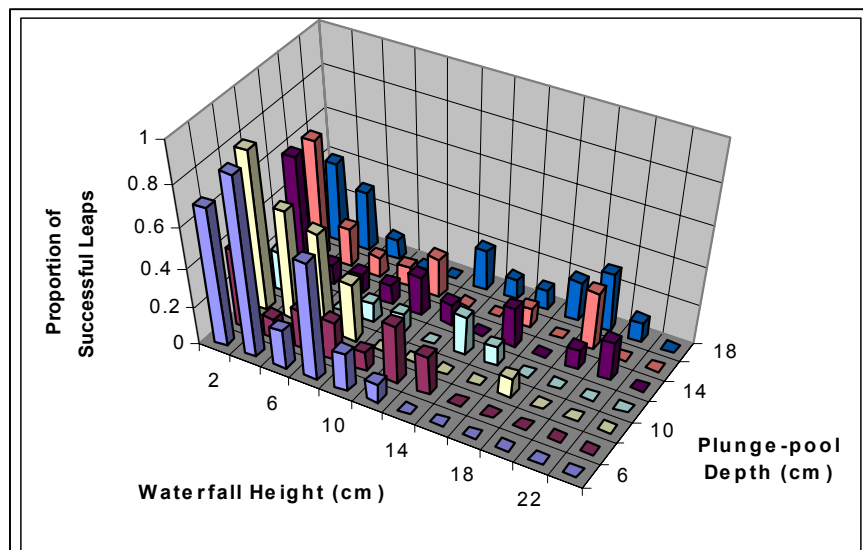


Figure 2. Proportion of successful leaps over a waterfall barrier by fingerling brook charr as a function of waterfall height (x-axis) and plunge-pool depth (z-

axis). Both waterfall height and plunge-pool depth were measured in centimeters. Proportions reflect the number of successful leaps out of 10 fish. waterfall heights of 24 cm (Figure 2). Plunge-pool depth had no conclusive effect on leaping abilities, as fish leapt over waterfall barriers that had both shallow and deep plunge-pool depths (Figure 2).

Discussion

As expected, more brook charr were able to leap over waterfall barriers that had lower waterfall heights. It was also expected that brook charr would be less likely to leap over waterfall barriers that had shallow plunge-pool depths. However, the results on the effect of plunge-pool depth on leaping ability were inconclusive. Brook charr leapt over waterfall barriers at both shallow and deep plunge-pool depths. It is thought that these inconclusive results are a factor of small sample size.

Although some results are inconclusive, this is an ongoing preliminary study. Modifications to the waterfall barrier system and experimental procedures, for a future study on the effects of light intensity or temperature on leaping ability, will be made based on this research.

Literature Cited

- Behnke, R.J. 1992. Native trout of western North America. American Fisheries Society Monograph 6: 275 pp.
- Belanger, G. and M.A. Rodriguez. 2001. Homing behaviour of stream-dwelling brook charr following experimental displacement. *Journal of Fish Biology* 59: 987-1001.
- Griffith, J.S. 1988. Review of competition between cutthroat trout and other salmonids. Pages 134-140 in R.E. Greswell, editor Status and management of interior stocks of cutthroat trout. American Fisheries Society, Bethesda, Md.
- Kondratieff, M. C. January 2002, personal communication.
- Stuber, R.J., B.D. Rosenlund and J.R. Bennett. 1998. Greenback cutthroat

trout recovery program: management overview. Pages 71-74 in R.E. Gresswell, editor Status and management of interior stocks of cutthroat trout. American Fisheries Society, Bethesda, Md.

Acknowledgments

I appreciate the help that Matt Kondratieff gave me with experimental design. I would like to give special thanks to the staff at the Colorado Division of Wildlife Research Hatchery for letting me use space at the Bellvue Research Hatchery. Funding for this project was provided by the USDA Forest Service Medicine Bow-Routt National Forest and by the Department of Fishery and Wildlife Biology at Colorado State University. All research described in this report followed guidelines set by Colorado State University's Animal Care and Use Committee protocol #01-111A-01.

