# The biology and status of the Arctic grayling in Sunnyslope Canal, Montana

by Scott Alan Barndt

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Biological Sciences
Montana State University


Abstract:
The Arctic grayling (Thymallus arcticus) in Sunnyslope Canal were studied to examine factors limiting this population. Population characteristics, fish movements, winter habitat conditions, survival beneath ice cover, spawning, movements and habitat use of age-0 fry, and the presence of other species were examined. Results of this study confirm that Arctic grayling in the upper, 9 km of the Sunnyslope Canal represent a self-sustaining population that reproduces successfully in this unusual habitat, and that survives in remnant pools sustained by water leaking through the gates at Pishkun Reservoir and from springs along the canal during an extended, seven-month period when water does not flow through the canal. Reproduction within the canal was confirmed by a combination of observations: young fry were captured in drift nets 5.8 km downstream from the dam, but not at the outlet at Pishkun Reservoir; age-0 young were both visually observed and captured by seining within the canal; and spawning behavior was seen and developing embryos subsequently collected at a site within the canal. Fish seined in remnant pools, before pools froze over in autumn and then after ice-cover thawed in spring, indicated that overwinter survival was high (at least 75.4% through the winter of 1994-95, 89.5% in 1995-96). Dissolved oxygen concentrations remained high beneath ice cover, from 3.4 to 13.1 mg/l. Locations of recaptured fish and telemetry of radio-tagged fish indicated that they remained in the same pools through the winter. Recaptures of fish marked during the summer flow period and telemetry of radio-tagged fish indicated that fish moved upstream in the canal as water flows were reduced and then stopped at the end of the irrigation season. Concentrations of age-0 young within the upper part of the canal, including within the outlet tunnel beneath the dam, strongly suggested that they also move upstream as flows diminish. Telemetry of larger fish and downstream captures of age-0 and older fish suggested that many fish move down during summer flows and appear to be the source of grayling found in irrigation ditches diverted from the canal and in pools remaining at the lower drop structures after flows cease. During the summer flow period, canal grayling appeared to thrive, with good condition factors and among the fastest growth rates of any population in Montana. Success of grayling in the canal appears related to a combination of their ability to spawn under the flow and substrate conditions present, the ability of age-0 young to maintain position and survive within the upper canal, the tendency of both age-0 and older fish to move upstream as flows are reduced at the end of the irrigation season, their ability to overwinter in a few, remnant pools in the upper canal, the apparent habitat suitability of the canal for grayling during the summer flow period, and the apparent unsuitability of the canal for the principal, non-native potential competitors and predators present-rainbow trout (Onchorhyncus mykiss) and northern pike (Esox lucius). Numbers of fish (not including early age-0 grayling) remained low throughout the two-year study period, with about 62 to 120 estimated present from spring of 1995 to spring 1996. The loss of thousands of age-0 fish into the reservoir in fall 1994 during repair work at the dam, and continuing, apparently natural, downstream loss of fish have contributed to continuing low numbers, but other factors limiting the population are not known.

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Scott Alan Barndt

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Date

Chairperson, Graduate Committee

Approved for the Major Department

12/6/96
Date

Head, Major Department

Approved for the College of Graduate Studies

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Date

Graduate Dean

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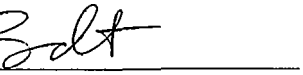
Signature 

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## ABSTRACT

The Arctic grayling (*Thymallus arcticus*) in Sunnyslope Canal were studied to examine factors limiting this population. Population characteristics, fish movements, winter habitat conditions, survival beneath ice cover, spawning, movements and habitat use of age-0 fry, and the presence of other species were examined. Results of this study confirm that Arctic grayling in the upper, 9 km of the Sunnyslope Canal represent a self-sustaining population that reproduces successfully in this unusual habitat, and that survives in remnant pools sustained by water leaking through the gates at Pishkun Reservoir and from springs along the canal during an extended, seven-month period when water does not flow through the canal. Reproduction within the canal was confirmed by a combination of observations: young fry were captured in drift nets 5.8 km downstream from the dam, but not at the outlet at Pishkun Reservoir; age-0 young were both visually observed and captured by seining within the canal; and spawning behavior was seen and developing embryos subsequently collected at a site within the canal. Fish seined in remnant pools, before pools froze over in autumn and then after ice-cover thawed in spring, indicated that overwinter survival was high (at least 75.4% through the winter of 1994-95, 89.5% in 1995-96). Dissolved oxygen concentrations remained high beneath ice cover, from 3.4 to 13.1 mg/l. Locations of recaptured fish and telemetry of radio-tagged fish indicated that they remained in the same pools through the winter. Recaptures of fish marked during the summer flow period and telemetry of radio-tagged fish indicated that fish moved upstream in the canal as water flows were reduced and then stopped at the end of the irrigation season. Concentrations of age-0 young within the upper part of the canal, including within the outlet tunnel beneath the dam, strongly suggested that they also move upstream as flows diminish. Telemetry of larger fish and downstream captures of age-0 and older fish suggested that many fish move down during summer flows and appear to be the source of grayling found in irrigation ditches diverted from the canal and in pools remaining at the lower drop structures after flows cease. During the summer flow period, canal grayling appeared to thrive, with good condition factors and among the fastest growth rates of any population in Montana. Success of grayling in the canal appears related to a combination of their ability to spawn under the flow and substrate conditions present, the ability of age-0 young to maintain position and survive within the upper canal, the tendency of both age-0 and older fish to move upstream as flows are reduced at the end of the irrigation season, their ability to overwinter in a few, remnant pools in the upper canal, the apparent habitat suitability of the canal for grayling during the summer flow period, and the apparent unsuitability of the canal for the principal, non-native potential competitors and predators present-rainbow trout (*Onchorhyncus mykiss*) and northern pike (*Esox lucius*). Numbers of fish (not including early age-0 grayling) remained low throughout the two-year study period, with about 62 to 120 estimated present from spring of 1995 to spring 1996. The loss of thousands of age-0 fish into the reservoir in fall 1994 during repair work at the dam, and continuing, apparently natural, downstream loss of fish have contributed to continuing low numbers, but other factors limiting the population are not known.

# INTRODUCTION

Historically, relict populations of Arctic grayling (Thymallus arcticus) (hereafter interchangeably referred to as "Arctic grayling" or "grayling") occurred in two regions within the lower 48 states of North America, within the present states of Michigan and Montana. These populations were geographically isolated as the southernmost populations of Arctic grayling by the Wisconsin glaciation, and both have undergone severe declines within the last century. The Michigan population became extinct by 1936, and the Montana populations have declined until the species persists in its native habitat only in the Big Hole River and Red Rock Lakes (Vincent 1962, Kaya 1992). Both of these populations are reduced from their former numbers. The Big Hole population retains the important distinction of being the only fluvial (entirely riverine) population remaining in the lower 48 states. This is a change from historic grayling distribution in Montana, as fluvial grayling were once widespread and locally common in the upper Missouri River drainage above the Great Falls whereas the Red Rock Lakes (and possibly nearby Elk Lake) contained the only adfluvial (stream spawning, lake dwelling) population in the state. In contrast to fluvial populations, lacustrine populations have become more common by stocking mountain lakes, both in Montana and other states (Kaya 1990).

The decline of the Arctic grayling in its native habitat is attributed to three factors: (1) degradation of habitat, especially by dewatering for irrigation; (2) interactions with non-native salmonids; and (3) overharvest (Vincent 1962, Kaya 1992). Recent studies have focused on determining important factors limiting native fluvial grayling (i.e., Magee

and Byorth 1994, Jeanes 1996). Such studies could have important applications to current recovery and reintroduction efforts.

A population of Arctic grayling located in an unusual habitat, the Sun River Slope Canal (Sunnyslope Canal), offered a unique opportunity to study factors which can affect the species. In 1971, Montana Department of Fish, Wildlife and Parks (FWP) biologist Bill Hill determined that Arctic grayling were present in the Sunnyslope Canal. This canal begins at the dam forming Pishkun Reservoir, and these fish occupy a fluvial habitat, at least during the four to five month irrigation season. During this period, the canal carries up to 47.5 cubic meters per second ($m^3/s$) or about 1680 cubic feet per second (cfs). During the remaining seven months, the canal is completely dewatered, with the exception of intermittent pools extending for about 5.8 km from the dam, and isolated pools at the base of concrete "drop structures" further downstream.

Arctic grayling were stocked in Pishkun Reservoir at least seven times in 1937, 1939, 1942 and 1943 (Everett 1986, Hill 1988, Kaya 1990). Records do not clearly indicate the source of these grayling but they likely originated from Madison River/Ennis Reservoir stocks (Everett 1986, Kaya 1990). Grayling subsequently became established in Sunnyslope Canal apparently from passage through the outlet of fish from these stockings, or their progeny. Some people report the presence of grayling in the canal since the 1940's (L. Vincent, Greenfields Irrigation District (GID), pers. comm.), and they have certainly been present since 1971, when Hill observed their presence. Arctic grayling apparently no longer exist in the reservoir, as the last reported catches of grayling were in 1971 and 1981 (Hill pers. comm.). Grayling in the canal have attracted some angler interest. In the past, anglers reportedly lined up below the reservoir

outlet "shoulder-to-shoulder" to catch grayling (T. Tabor pers. comm.) and would "fill buckets" with their catch (L. Vincent pers. comm.).

The Sunnyslope Canal Arctic grayling are genetically distinct from all other Montana grayling populations (Everett 1986, Leary 1990). Despite their likely derivation from Madison River/Ennis Reservoir stock, as well their relatively short existence in the canal, Everett found that the Sunnyslope Canal population shows significant separation from both Red Rock Lake stocks and stocks descendent from the Madison River/Ennis Reservoir population (Everett 1986). Further, Sunnyslope grayling show similar separation from the Big Hole River population (Figure 1).

This present study was initiated in 1994 to determine the conditions under which this population persists within the unusual environment of this seasonally intermittent canal. The purpose of the study was to determine whether there is a self-sustaining population of Arctic grayling in Sunnyslope Canal, adapted to inhabiting the canal and reproducing during summer flow and surviving non-flow conditions, including during winter. This hypothesis was tested by examining:

(1) population abundance, age-size distribution, and individual growth rates;

(2) fish movements, during flow and after;

(3) winter habitat conditions and survival of grayling beneath ice cover;

(4) spawning times, substrates, and locations; and

(5) distribution, movement, and habitat use of age-0 fry and juveniles.

(6) presence of potential competing species.