The fluvial Arctic grayling (Thymallus arcticus) of the upper Big Hole River drainage, Montana
by George Alton Liknes

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University


Abstract:
The distribution and habitat requirements of the stream-dwelling Arctic grayling in the upper Big Hole River drainage were studied in 1978 and 1979. Study section's 1-4 were established on the upper Big Hole River and Section 5 on its principle tributary, the North Fork of the Big Hole. Arctic grayling were found in Sections 1 and 2 and in 11 tributary streams, including the North Fork, in the study area.

The number of Arctic grayling captured per electrofishing run per kilometer in Sections 1, 2 and 5 were 16.9, 5.3 and 4.9, respectively. Population and standing crop estimates of Arctic grayling were 35/km and 6.7kg/km for the size range 25.1-29.7 cm in Section 1. The number of hours water temperatures exceeded 17 C on Sections 1 and 2 in 1979 were significantly lower than Sections 3 and 5 during comparable periods of time. The mean depth of Section 1, where densities of Arctic grayling were greatest, was 28.4 cm (±22.6), mean width was 12.21 m (±4.92), mean velocity was 0.21 m/s (±0.15) and the gradient was 0.29%. Suitable spawning substrate was present and aquatic vegetation was abundant. The mean depth of Section 2 was 39.7 cm (±30.6), mean width was 15,95 m (±5.02), mean velocity was 0.33 m/s (±0.23) and the gradient was 0.23%. The mean depth of Section 3 was 37.3 cm (±23.1), mean width was 48.09 m (±14.75), mean velocity was 0.21 m/s (±0.15) and the gradient was 0.11%. The growth rate of Arctic grayling in the upper Big Hole River drainage was less than in six other populations. Arctic grayling in the Big Hole River reached sexual maturity at age III at which time they had a back-calculated length of 27.5 cm.

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Date 3/27/81

# THE FLUVIAL ARCTIC GRAYLING (*THYMALLUS ARCTICUS*) OF THE UPPER BIG HOLE RIVER DRAINAGE, MONTANA

by

George Alton Liknes

A thesis submitted in partial fulfillment
of the requirements for the degree

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in

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## ABSTRACT

The distribution and habitat requirements of the stream-dwelling Arctic grayling in the upper Big Hole River drainage were studied in 1978 and 1979. Study sections 1-4 were established on the upper Big Hole River and Section 5 on its principle tributary, the North Fork of the Big Hole. Arctic grayling were found in Sections 1 and 2 and in 11 tributary streams, including the North Fork, in the study area. The number of Arctic grayling captured per electrofishing run per kilometer in Sections 1, 2 and 5 were 16.9, 5.3 and 4.9, respectively. Population and standing crop estimates of Arctic grayling were 35/km and 6.7kg/km for the size range 25.1-29.7 cm in Section 1. The number of hours water temperatures exceeded 17 C on Sections 1 and 2 in 1979 were significantly lower than Sections 3 and 5 during comparable periods of time. The mean depth of Section 1, where densities of Arctic grayling were greatest, was 28.4 cm (±22.6), mean width was 12.21 m (±4.92), mean velocity was 0.21 m/s (±0.15) and the gradient was 0.29%. Suitable spawning substrate was present and aquatic vegetation was abundant. The mean depth of Section 2 was 39.7 cm (±30.6), mean width was 15.95 m (±5.02), mean velocity was 0.33 m/s (±0.23) and the gradient was 0.23%. The mean depth of Section 3 was 37.3 cm (±23.1), mean width was 48.09 m (±14.75), mean velocity was 0.21 m/s (±0.15) and the gradient was 0.11%. The growth rate of Arctic grayling in the upper Big Hole River drainage was less than in six other populations. Arctic grayling in the Big Hole River reached sexual maturity at age III at which time they had a back-calculated length of 27.5 cm.

# INTRODUCTION

Arctic grayling (*Thymallus arcticus*) were once widely, but intermittently distributed in the Missouri River and its tributaries above the Great Falls in Montana (Vincent, 1962; Henshall, 1906). Today, the only substantial population of stream-dwelling Arctic grayling in Montana is found in the upper Big Hole River and its tributaries. This remnant population of Arctic grayling contains only fish native to Montana. However, Arctic grayling from stocks originating elsewhere in Montana were planted in the upper Big Hole River from 1937-1962 (Mont. Dept. of Fish, Wildlife and Parks files).

Concern for the continued well-being of this unique population of stream-dwelling Arctic grayling in the upper Big Hole River drainage has recently increased. Only small numbers of Arctic grayling have been found in previous sampling of the river and they may soon be subjected to additional biological and physical impacts. Brown trout (*Salmo trutta*) are believed to be pioneering the area and oil exploration is underway in the drainage.

The purpose of this study was to determine the distribution, relative abundance and habitat requirements of the stream-dwelling Arctic grayling in the upper Big Hole River. Field work was conducted from June to September in 1978 and from April to September in 1979.

# DESCRIPTION OF STUDY AREA

The upper Big Hole River drainage is located in southwestern Montana in Beaverhead, Deer Lodge and Silver Bow counties. It extends from the Bitterroot Mountains south of Jackson to Divide. It receives tributaries from the Bitterroot Range on the west, the Anaconda Range on the north and the Pioneer Mountains on the east. The area of the Big Hole River drainage is approximately 7,175 $km^2$ (Heaton, 1960).

The study area extended over approximately 90 km from the headwaters of the upper Big Hole River to Sportsman Park (Figure 1). Upstream from Pintlar Creek (Figure 1), the Big Hole River lay in several braided, meandering channels. Below Pintlar Creek the river was confined to a single channel in a narrow canyon. A sagebrush-grassland vegetation type was present on the foothills surrounding the tributary streams but the land adjacent the river in the study area was extensively irrigated for the production of hay. The riparian vegetation in the study area was primarily grasses, sedges and willows. Some conifers were present on the river below Pintlar Creek.

The average annual discharge of the upper Big Hole River at a site 14.5 km southwest of Jackson was 1069 $m^3$ from 1940-1954 (MDNRC, 1979). The maximum recorded discharge was 26.56 $m^3/s$ and the minimum flow was 0.142 $m^3/s$ (Aagaard, 1969). The mean discharge at a site approximately 8 km north of Jackson, Montana was 4.4 $m^3/s$ between July 26 and September 15, 1978 (Wells and Rehwinkel, 1980).

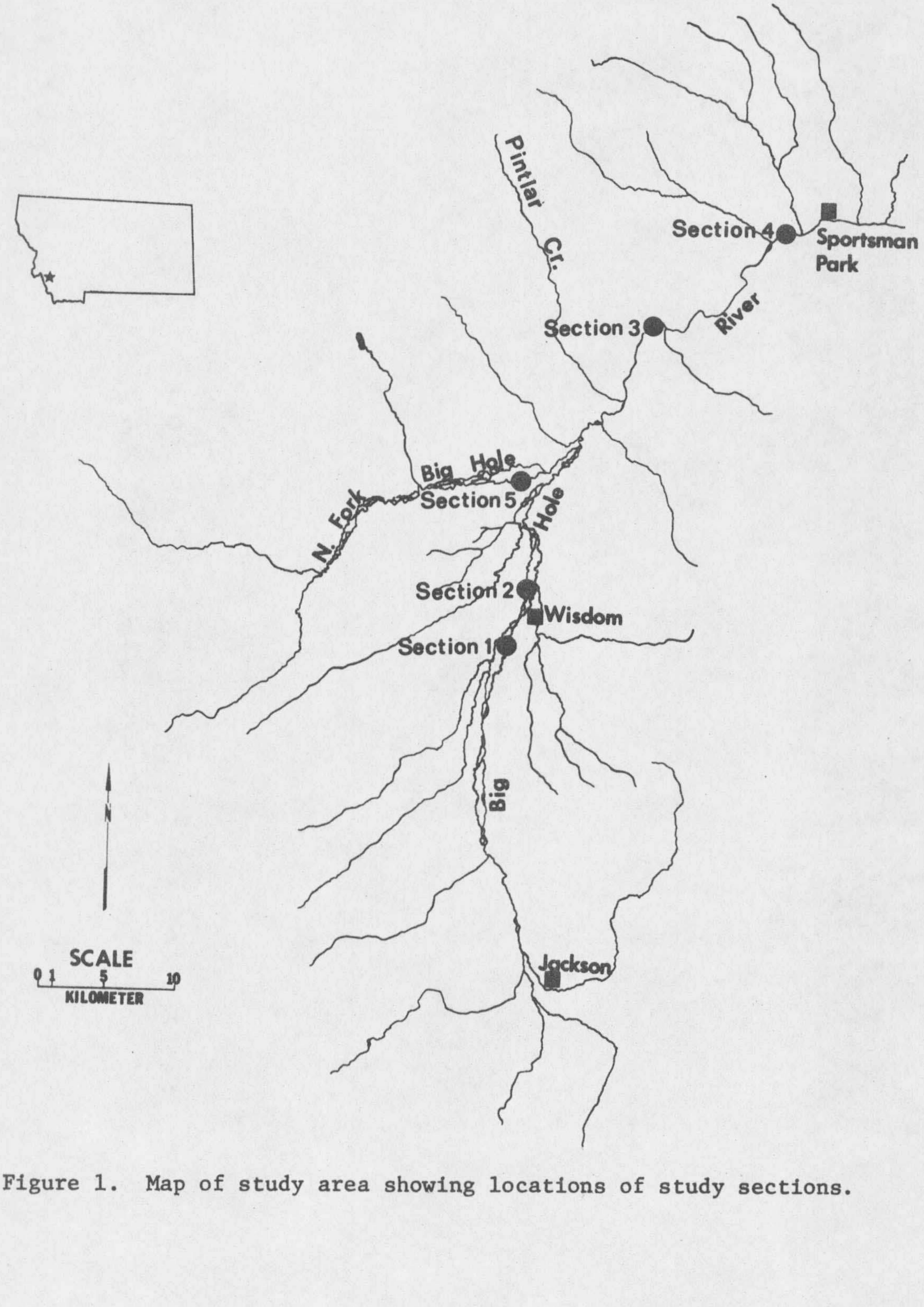


Figure 1. Map of study area showing locations of study sections.

Five sections were established for detailed study (Figure 1). The legal description and lengths of each section is given in Appendix Table 8.

## METHODS

The distribution of Arctic grayling in the upper Big Hole River drainage was determined from collections made by angling, electrofishing, drift nets and seines. Five sections of the river were electrofished for estimates of fish populations. Population estimates were calculated using Chapman's modification of the Petersen formula (Ricker, 1975).

The physico-chemical parameters of the water at stations on Sections 1, 2, 3 and 5 were measured at least every 15 days from mid-June to early September in 1979. Concentrations of dissolved oxygen were determined using the azide modification of the Winkler method (APHA, 1976). Alkalinity and hardness were determined by titration. Conductivity was measured with a Beckman RB3-Solu Bridge. The pH was determined in the field with an Orion model 407 Specific Ion Meter. Temperatures were recorded with Ryan model D-15 thermographs. Water temperatures at Sections 1, 2 and 3 were continually recorded from April 21 to September 1, 1979 and on Section 5 from June 23 to August 25, 1979. Water temperature analysis was performed using TEMP, a computer program developed by Dr. D. E. Burkhalter.

Selected parameters of the physical habitat in Sections 1, 2 and 3 were measured for correlation with the populations of Arctic grayling in these sections. In areas containing braided channels, only the major channel was habitat-typed and electrofished. The length of each section was measured down the center of the channel. The length of each pool and riffle was recorded and a pool-riffle periodicity and ratio calculated. The pool-riffle periodicity is the mean distance between riffles in terms of mean stream widths for the section (Leopold and Langbein, 1966). Pools were defined as areas with reduced water velocities in which the surface was smooth and had maximum depths equal to or greater than 0.5 m. Riffles were defined as all areas not designated to be pools.

Thirty-seven transects or sample points were established perpendicular to the channel on each section. The distances between the transects on Sections 1, 2 and 3 were 45, 100 and 150 m, respectively. Transects were located only on the upper half of Section 1 because the lower half of the section was completely dewatered in 1979. However, the habitat in the upper portion of Section 1 appeared to be representative of the entire section. Velocities were measured at 0.6 of the depth below the surface with a Gurley AA current meter. Measurements were made at intervals of 1 m across each transect in Section 1 and 2 and at every 3 m in Section 3. Water depth was recorded to the nearest centimeter at intervals of 0.5 m on each transect. Thalweg depth and velocity was measured on each transect. Discharges were calculated from the point velocities and depths of selected transects. The length of each transect was divided into length in pool and length in riffle. The gradient for each section was obtained from USGS topographical maps.

Shoreline cover within 1.5 m of either side of the transect was measured. The area of overhanging brush within 1.0 m of the surface of the water was measured. Debris and undercut banks within 0.6 m of the water surface were measured. The area of aquatic plants and the area of instream cover provided by debris within 1.5 m of each side of the transect were measured also.

The composition of the bottom materials in each section was determined by estimating the length of each type of material along each transect. The bottom materials were classified after Wentworth (1922) as bedrock (unbroken, solid rock), boulders (>26 cm in diameter), rubble (6.4-26 cm in diameter), gravel (2 mm-6.3 cm in diameter) and fines (<2 mm in diameter).

The general condition of the banks at the end of each transect was qualitatively evaluated as stable or unstable. An unstable bank was defined as one exhibiting evidence of recent soil erosion or sloughing.

Mean values for water velocities, water depths, thalweg velocities and depths, pool widths, riffle widths and bottom materials were calculated for each section. A mean value also was calculated for each physico-chemical parameter on each section.

The variance of the standing crop estimates were calculated using the equation (Gerking, 1967):

$$V(B) = V(\bar{w}N) = \bar{w}^2V(N) + N^2V(\bar{w}) + 2\bar{w}N\text{cov}(\bar{w},N)$$

where V(B) = variance of standing crop,

$\bar{w}$ = mean weight of sample,

$V(\bar{w})$ = variance of the mean weight,

N = population estimate and

V(N) = variance of the population estimate.

Fulton's condition factor was computed using the formula (Bagenal and Tesch, 1978):

$$K = \frac{100\ w}{1^3}$$

where K = condition factor,

w = total weight and (g)

1 = total length. (cm)

The total length-weight relationship was determined for Arctic grayling using the equation (Bagenal and Tesch, 1978):

$$\log W = \log a + b(\log L)$$

where W = total weight,

L = total length

and a and b are constants.

The Monastyrsky method modified by Hile (1941) was used to back-calculate lengths at age of fish with the equation which adjusted for allometry:

$$\log L_n = \log L + b(\log S_n - \log S)$$

where $L_n$ = total length of fish at age n,

$L$ = total length of fish,

$b$ = regression coefficient of logarithmic scale radius-total body length regression,

$S_n$ = anterior scale radius at annulus n and

$S$ = total anterior scale radius.

The FIRE 1 computer program (Hesse, 1977) was used to analyze age and growth data.

Statistical tests were performed according to methods in Snedecor and Cochran (1967) using MSUSTAT (Lund, 1979) and SPSS (Nie et. al., 1975). Significant differences were those in which the probability of obtaining the same results by chance was less than 0.05.

# RESULTS

## Population Characteristics

### Distribution of Arctic grayling

Arctic grayling were collected from seven locations on the upper Big Hole River and from 11 tributary streams including a collection from Francis Creek by J. Decker-Hess and that from LaMarche Creek by E. Vyse (Figure 2). Age 0 Arctic grayling were collected from all of these sites on the river and from seven tributary streams. Age I+ or older fish were found at two locations on the river and in ten tributaries. Both age 0 and age I+ or older Arctic grayling were collected at two locations on the river and in six tributary streams. The Arctic grayling found in tributaries were taken near the mouths of the streams except in Miner and Mussigbrod creeks, where they were captured upstream and downstream, respectively, from lakes containing populations.

Although Arctic grayling are most abundant near the headwaters in the upper Big Hole Basin, individuals have been found further downstream. Arctic grayling were captured by personnel of the Montana Department of Fish, Wildlife and Parks in an electrofishing section that included Section 4 of the present study (Peterson, 1974) and in a section near Bryant Creek (Wells and Rehwinkel, 1980). The farthest downsteam Arctic grayling are known to be found is Melrose, Montana (J. Wells and V. Kozakiewicz, personal communication).