OBSERVATIONS ON THE LIFE HISTORY AND MOVEMENT OF THE GOLDEYE, HIODON ALOSOIDES IN MONTANA

by

WILLIAM J. HILL

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

Fish and Wildlife Management

Approved:

_____
Head, Major Department

_____
Chairman, Examining Committee

_____
Dean, Graduate Division

MONTANA STATE UNIVERSITY
Bozeman, Montana

August, 1965

VITA

The author, William J. Hill, was born in Great Falls, Montana, October 11, 1941, to Mr. and Mrs. Arthur Hill. He graduated from Great Falls Central High School in 1959. In the fall of 1959, he entered Montana State College and in June, 1963, received a Bachelor of Science degree in Fish and Wildlife Management. He began graduate studies at Montana State College in the fall of 1963.

During the summer months of 1961–1964, he was employed by the Montana Fish and Game Department. He held a graduate assistantship in the Zoology and Entomology Department at Montana State College for the academic year of 1963–1964.

ACKNOWLEDGEMENTS

The writer wishes to extend gratitude to all who helped in the course of this study. Dr. C. J. D. Brown directed the study and assisted in preparing the thesis. Nels A. Thoreson of the Montana Fish and Game Department suggested the problem. He also gave valuable field assistance along with Dr. R. J. Graham, Edward Nevala, James Posewitz, Melvin Kraft, Jack Robinson, and Steve Swedeberg. The Montana Fish and Game Department financed the study under Federal Aid to Fisheries Restoration Projects F-5-R-13 and F-5-R-14.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The life history and movement of goldye in Montana was studied in the summers of 1963 and 1964. Specimens were secured from Fort Peck Reservoir, the Missouri River, Marias River, Teton River, and Belt Creek by gill nets, angling, electro-fishing, and toxicants. Specimens collected for an age and growth study ranged in age from 0 through VIII. Scales of 747 goldeye were examined. These showed that fish grew 4.0 inches during each of the first 2 years and 1.3 inches for each year thereafter. There was little difference in growth rate between areas. Females were larger than males after the fourth year. The ratio of male to female goldeye for all Montana areas combined was 1:1.1. Slightly more males than females were found in the rivers while more than twice as many females as males were found in Fort Peck Reservoir. Most of the fish were ripe between April 17 and June 8 and presumably spawned at this time. The number of eggs per female ranged from 4,288 to 10,164 (average, 6,913). Of 2,221 goldeye tagged, only 37 were recaptured. Three of these moved between 30 and 75 miles while the other 34 moved less than 2 miles.

INTRODUCTION

The goldeye in Montana is very abundant in the Missouri River and its tributaries below Morony Dam and in the Yellowstone River and its tributaries below the mouth of the Big Horn River. This species is not exploited for sport or commercial purposes in Montana and is considered detrimental to more desirable fishes. For this reason, it has been controlled by toxicants in some areas. A study was undertaken to gain basic knowledge about goldeye which might be useful in the management of this species.

The life history and movement of goldeye (Hiodon alosoides) in Montana was investigated from June 12, 1963, to September 27, 1963, and from March 20, 1964, to September 28, 1964. Previous work on this species in Montana was limited mainly to Fort Peck Reservoir. Peters (1964) reported on the age and growth of goldeye. Phenicie (1950) compared the relative abundance of goldeye to yellow perch. Studies on the age and growth of this species outside of Montana include those of Martin (1954) in Lake Texoma, Oklahoma, and Grosslein and Smith (1959) in the Red Lakes, Minnesota. Battle and Sprules (1960) made observations on the development of goldeye in Lake Claire, Alberta. The present study in Montana covered four collection areas on Fort Peck Reservoir, three on the Missouri River, three on the Marias River, two on the Teton River, and two on Belt Creek (Figure 1).

Methods

Goldeye were collected by experimental gill nets in Fort Peck Reser-

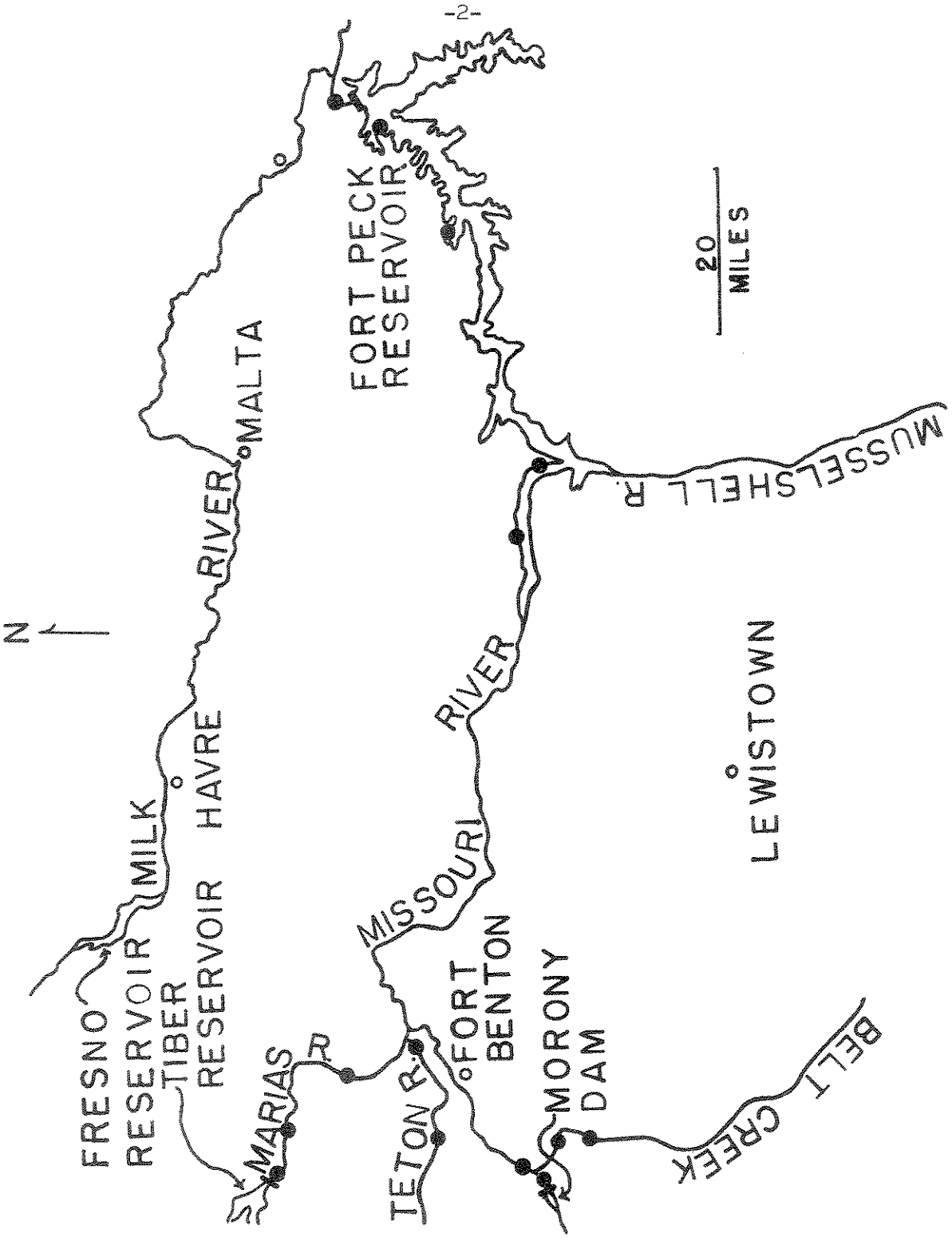

Figure 1. Study area. Black dots represent sampling sites.

voir and the Missouri River below Fort Peck Dam. These proved to be most effective when floated on the surface overnight. Specimens were secured by angling in the Marias River, Belt Creek, and the Missouri River above Fort Peck Reservoir, and by electro-fishing in the Teton River. Small individuals were collected by toxicants (rotenone) on the upper end of Fort Peck Reservoir.

Total lengths to the nearest 0.1 inch and weights to the nearest 0.01 pound were taken on all fish collected. Scale samples for age and growth studies were secured from the left side of the fish in the area between the dorsal fin and lateral line. Annuli were identified with the aid of a scale projection machine.

LIFE HISTORY

Age and Growth

Total calculated lengths were secured for each year-class with the aid of a nomograph. A straight-line relationship between scale and body length was assumed. The average calculated total lengths of goldeye from each area are given in Table 1.

Fort Peck Reservoir

Goldeye from Fort Peck Reservoir ranged in age from 0 through VII. A total of 249 young-of-the-year was secured in the upstream-end of the reservoir on August 21, 1964. They ranged from 1.4 to 3.3 inches in total length (average 2.3). Battle and Sprules reported about the same growth rates for young-of-the-year goldeye from Lake Claire, Alberta.

Age determinations were made on 239 additional goldeye which ranged

Table 1. Average calculated total lengths of goldeye from different areas in Montana (Number of fish in parentheses).

Location	Age group							
	I	II	III	IV	V	VI	VII	VIII
Fort Peck Reservoir	3.9 (239)	8.1 (169)	10.4 (102)	11.5 (74)	12.2 (41)	12.7 (9)	15.7 (1)	
Missouri River Above Fort Peck Reservoir	3.9 (95)	7.9 (95)	10.2 (94)	11.2 (81)	12.0 (29)	12.6 (4)		
Below Fort Peck Dam	4.3 (66)	7.8 (57)	10.0 (41)	11.3 (16)	11.9 (2)			
Marias River	3.9 (142)	7.9 (142)	10.1 (140)	11.2 (112)	11.9 (49)	12.2 (4)		
Teton River	4.1 (205)	8.2 (205)	10.3 (199)	11.5 (172)	12.1 (62)	13.7 (8)	15.4 (2)	16.0 (1)

from 4.7 to 16.8 inches in total length (average 10.2) and from 0.03 to 2.08 pounds (average 0.37) taken at various places in the reservoir. The annual average growth increments (inches) for all age groups were as follows: I–3.9; II–4.2; III–2.3; IV–1.1; V–0.7; VI–0.5; VII–3.0. Age group VII was represented by only one fish so it probably is not representative. The oldest fish from this area was 7 years, 16.8 inches long and weighed 2.08 pounds. This was also the largest specimen collected during the study.

Missouri River

Above Fort Peck Reservoir: Ninety-five goldeye from this area were in age groups II through VI and ranged from 10.9 to 13.1 inches in total length (average 11.9) and from 0.32 to 0.55 pounds (average 0.43). The annual

average growth increments (inches) for all age groups were as follows: I—3.9; II—4.0; III—2.3; IV—1.0; V—0.8; VI—0.6. The oldest fish was 6 years, 13.1 inches long, and weighed 0.51 pounds. This was also the largest specimen taken from this area.

Below Fort Peck Dam: Sixty-six goldeye taken from this area were in age groups I through V and ranged from 7.5 to 13.2 inches in total length (average 10.3) and from 0.12 to 0.60 pounds (average 0.31). The annual average growth increments (inches) for all age groups were as follows: I—4.3; II—3.5; III—2.2; IV—1.3; V—0.6. The oldest fish was 5 years, 12.5 inches long, and weighed 0.50 pounds. The largest specimen was 4 years old, 13.2 inches long, and weighed 0.60 pounds.

Marias River

A total of 142 goldeye from the Marias River were in age groups II through VI and ranged from 9.9 to 13.2 inches in total length (average 11.8) and from 0.22 to 0.65 pounds (average 0.44). The annual average growth increments (inches) for all age groups were as follows: I—3.9; II—4.0; III—2.2; IV—1.1; V—0.7; VI—0.3. The oldest specimen was 6 years, 13.0 inches long, and weighed 0.53 pounds while the largest was 5 years old, 13.2 inches long, and weighed 0.55 pounds.

Teton River

The Teton River sample consisted of 205 goldeye in age groups II through VIII. They ranged from 10.4 to 16.3 inches in total length (average 12.0) and from 0.29 to 1.34 pounds (average 0.49). The annual average growth increments (inches) for all age groups were as follows: I—4.1;

II—4.1; III—2.1; IV—1.2; V—0.6; VI—1.6; VII—1.7; VIII—0.6. The small sample in age groups VI (6), VII (1), and VIII (1) may not be representative. The oldest fish from this area was 8 years, 16.3 inches long, and weighed 1.34 pounds. This specimen was also the largest taken from this area and the oldest collected from all areas.

Combined Areas

The areas have been combined since little difference was noted in calculated total lengths. The maximum difference in calculated total lengths from all areas was 0.4 inch for the first 3 years involving 747, 668, and 576 fish, respectively, and 0.3 inch for the fourth, fifth, and seventh years involving 455, 183, and 3 fish, respectively. The sixth year had a difference of 1.5 inches and was represented by 25 fish. The small sample size in older age groups may account for the irregular variations in calculated total lengths.

No difference was found in the calculated total lengths between sexes for the first 3 year groups. However, in the fourth year, females (54 specimens) average 0.4 inch longer than males (58) and in the fifth year, females (62) averaged 0.7 inch longer than males (9). None of the males and only 18 females were older than 5 years. This suggests a greater longevity for females. Martin (1954) reported that female goldeyes in Lake Texoma, Oklahoma, were larger than males after their third year of life. In spite of the differences found in the present study, the sexes were combined. This facilitated the comparison of growth rate of Montana goldeye with those studied elsewhere.

Table 2. Average calculated total lengths for all Montana goldeye.

Age group	No of fish	Total length (inches) Year of life 1	2	3	4	5	6	7	8	Range in length at capture
I	79	3.8								4.7- 9.4
II	92	4.2	8.1							7.8-11.2
III	121	4.3	8.3	10.3						9.0-12.7
IV	272	4.0	8.1	10.3	11.4					10.5-13.5
V	158	3.7	7.7	10.0	11.3	12.0				11.0-13.9
VI	22	3.7	7.9	10.1	11.3	12.2	12.7			12.3-15.3
VII	2	6.2	10.3	12.3	13.6	14.1	14.7	15.5		15.7-16.8
VIII	1	3.7	8.2	11.0	12.7	13.8	14.3	15.5	16.0	16.3
Total	747 Average	4.0	8.0	10.2	11.4	12.1	12.9	15.5	16.0	

Calculated total lengths of Montana goldeye are compared with other studies on this species (Table 3). Reports by Peters (1964) for goldeye

Table 3. Comparison of calculated total lengths of Montana goldeye with those from other areas.

Location	Number of fish	Average calculated total length (inches) 1	2	3	4	5	6	7	8
Lake Texoma, Okla. (Martin)	817	7.5	8.8	11.2	12.6	13.2	14.2		
Red Lake, Minn. (Eddy & Carlander)	625	2.8	6.4	9.4	11.0	12.5	13.6		
Red Lake, Minn. (Grosslein & Smith)	1165	4.1	8.3	11.3	12.9	14.1	15.0	15.8	16.6
Fort Peck Reservoir (Peters)	312	4.6	8.8	11.2	12.3	13.3	14.1		
Present study	747	4.0	8.0	10.2	11.4	12.1	12.9	15.5	16.0

collected in 1949 in Fort Peck Reservoir, Montana, Martin (1954) in Oklahoma, and Grosslein and Smith (1959) in Minnesota, all show greater growth than those found in the present study. Goldeye in this study showed greater growth in the period of the first 4 years of life than did specimens from Minnesota (Eddy and Carlander, 1942), but the latter grew more rapidly in the fifth and sixth years of life than did Montana specimens.

The oldest female goldeye collected in Montana was 8 years, 16.3 inches long and weighed 1.34 pounds. The oldest male was 5 years, 12.4 inches long, and weighed 0.54 pounds. The largest fish was a 7-year-old female, 16.8 inches long, and weighed 2.08 pounds. The largest goldeye collected by Martin (1954) in Oklahoma was a 6-year-old female, 14.7 inches long, and weighed 1.24 pounds, while the largest reported in the literature was from Ohio (Trautman, 1957). This had a total length of 20.0 inches and a weight of 3.13 pounds.

Sex Ratios

The goldeye shows sexual dimorphism in that the lower edge of the anal fin is straight or slightly concave in the female, while this fin has a large convex lobe in the male (Martin, 1954). This difference facilitated obtaining sex ratios without internal examination of the gonads. The sex ratio of males to females from all Montana areas combined was 1:1.1 (Table 4). Slightly more males than females were found in the rivers, except the Marias where the ratio of males to females was 1:1.5. Females were more than twice as abundant as males in the Fort Peck Reser-

Table 4. Comparison of sex ratios of goldeye from Montana with those from other areas.

Location	Number of fish	Males (%)	Females (%)	Sex ratio
Marias River	93	39.7	60.3	1:1.5
Teton River	812	53.1	46.9	1:0.9
Missouri River Above Fort Peck Reservoir	415	59.3	40.7	1:0.7
Fort Peck Reservoir	450	29.1	70.9	1:2.4
Missouri River Below Fort Peck Dam	37	51.4	48.6	1:0.9
Combined Areas	1807	47.8	52.2	1:1.1
Red Lake, Minnesota (Grosslein & Smith)	389	56.0	44.0	1:0.8
Lake Texoma, Oklahoma (Martin)	889	27.9	72.1	1:2.6

voir collections. Martin (1954) also reported females to be more than twice as abundant as males in Oklahoma. The Fort Peck ratio is higher than that found in Minnesota by Grosslein and Smith (1959). Sex ratios in the present study may not be entirely representative because of certain possible bias in sampling.

Spawning Period

Observations were made on the spawning period of goldeye in the Teton River in 1964. The first ripe males and females were noticed on March 31. No actual spawning was observed due to the high turbidity of the water but most of the spawning presumably occurred between April 17 and June 8. Ob-

servations were not made after the latter date because of extensive flooding in the study area. While most of the ripe males and females examined were 3 and 4 years old, respectively, a few males were 4 and a few females 3 years old. Grosslein and Smith (1959) reported mature goldeye of the same ages but Battle and Sprules (1960) found that males matured between 6 and 9 years and females between 7 and 10.

Fecundity

Ripe female goldeye (age groups III-VI) were collected from the Teton River on May 10, 1965, for the purpose of making egg counts. Actual counts were made on four fish, all of which were 4 years old. The total lengths and number of eggs for each fish were as follows: 11.5 inches—5,390; 12.0—6,241; 12.2—6,962; 12.8—6,855. Estimated counts were also made for these fish by first weighing the entire ovaries, then counting the eggs in a sample of approximately 10% of the ovaries from each fish. The total number of eggs from these samples was then calculated. The estimated number of eggs varied from 1.5% less to 5.6% more then actual counts for the four specimens. Using the above procedure, numbers of eggs were estimated for 21 additional females which ranged from 11.8 to 12.8 inches in total length and from 0.50 to 0.67 pounds. The number of eggs per female varied from 4,288 to 10,164 (average 6,913). Battle and Sprules (1960) reported that the number of eggs from goldeye in several Manitoba lakes ranged from 5,800 to 25,200 (average 14,150).

MOVEMENT

An attempt was made to determine the extent of movements of goldeye

in the areas studied in Montana. Fish were captured, marked, and recovered after release in the Marias River, Missouri River, and Belt Creek by angling, and in the Teton River by electro-fishing. A total of 2,221 specimens was marked with numbered yellow dart tags inserted below the dorsal fin. Only 37 marked fish were recaptured. The low number of returns for this species resulted from the lack of effort by fishermen. At least a few specimens were recaptured in each area where fish were marked. Of 692 goldeye tagged in the Marias River, 10 were recaptured. One of these (male) was caught 68 miles downstream, 13 days after release. The other nine (five females, four males) were taken within 2 miles from the place of release, 3 to 25 days after tagging. A total of 356 goldeye was tagged in the Missouri River and nine of these (four females, five males) were recaptured within ½ mile from the place of release, 2 to 8 days after liberation. Of 92 goldeye tagged in Belt Creek, two (males) were recaptured within ½ mile from the place of release, 6 and 29 days, respectively, after release. A total of 1,081 goldeye was tagged in the Teton River and 16 were recaptured. One of these (female) was caught 75 miles upstream, 45 days after release, while another (female) was recaptured 30 miles upstream, 38 days after release. Fourteen others (five females, nine males) were recaptured within ¼ mile of the release site, 1 to 7 days after liberation. Bodsworth (1950) was the only reference found concerned with the movement of goldeye. He made a general statement that they may move up to hundreds of miles.

LITERATURE CITED

Battle, Helen I., and William M. Sprules. 1960. A description of the semi-bouyant eggs and early developmental stages of the goldeye, Hiodon alosoides (Rafinesque). Jour. Fish. Res. Bd. Canada, 17(2): 245-266.

Bodsworth, Fred. 1950. That glamorous goldeye. Maclean's Magazine. Sept. 1, 1950, p. 15.

Eddy, Samuel, and Kenneth D. Carlander. 1942. Growth rate studies of Minnesota fishes. Minnesota Dept. Conservation, Bur. Fishery Research, Invest. Rept. No. 28. 64 pp.

Grosslein, M. D., and L. L. Smith. 1959. The goldeye, Amphiodon alosoides (Rafinesque), in the commercial fishery of the Red Lakes, Minnesota. Fish. Bull. U. S. Fish & Wildl. Serv., 60: 33-41.

Martin, M. 1954. Age and growth of the goldeye, Hiodon alosoides (Rafinesque) of Lake Texoma. Proc. Okla. Acad. Sci., 33: 37-49.

Peters, John C. 1964. Job completion report. Montana Fish & Game Dept. Helena, Montana. Project No. F-23-R-6. 76 pp.

Phenicie, Charles K. 1950. Progress report of the Fort Peck Reservoir fishery survey. Montana Fish & Game Commission. Bull. No. 3. 19 pp.

Trautman, Milton B. 1957. The fishes of Ohio. Ohio State Univ. Press. 683 pp.