Proceedings of the Iowa Academy of Science

Volume 66 | Annual Issue Article 72

1959

Growth of the Walleye in the Des Moines River, Boone County, Iowa

James C. Schmulbach
Iowa State University

Growth of the Walleye in the Des Moines River, Boone County, Iowa[1]

By James C. Schmulbach

Abstract. Even though the habitat is marginal, a considerable fishery exists for walleyes in the Des Moines River. Tagging studies indicate the annual rate of harvest to be about 10 percent. The size of the population is evidently limited by frequent fish kills due to high water temperatures in the summer and oxygen depletion in the winter. Considerable variation in growth exists within age groups and between year classes. Possible explanations include: (1) sexual differences, especially between fish over four years old; (2) frequent fish kills which result in vacancies in the habitat; (3) low water levels during certain years; and (4) frequent stocking of fry, fingerlings, and yearlings during different seasons. The growth and general well-being of Des Moines river walleyes are about average when compared with those in other parts of the country.

The importance of the walleye, *Stizostedion vitreum* (Mitchill), to sport fishing has stimulated many age and growth investigations. Most of these studies have been concerned with populations of lake-dwelling walleyes. Relatively little information is available on walleyes which inhabit streams and rivers.

Although the Des Moines River is not ideal walleye habitat, a fishery of considerable importance exists for this species in that part of the river above U. S. Route 30. Creel census work on the Des Moines River in Boone County indicated that walleyes comprised 16.4 percent of the total number of fish caught in the fall of 1957 (Schmulbach, 1958). During the spring and summer seasons of 1957 and 1958 walleyes made up less than 4 percent of the total catch. Regardless of the season, walleyes attract many fishermen to the river and are more important to the river angler than their abundance in the total catch indicates. Walleyes rank third behind the channel catfish and the carp in the total catch of Des Moines River fishermen.

Forty-four adult walleyes were captured, tagged, and returned to the Des Moines River in 1958, and at least four of these tagged fish were caught by anglers in the same year. A minimum rate of harvest of 10 percent supports the assumption that walleyes are a much sought fish.

---

[1]Journal paper No. J-3637 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1373. Iowa Cooperative Fisheries Research Unit, sponsored by the Iowa State Conservation Commission and Iowa State College, wtih the cooperation of the U. S. Fish and Wildlife Service, Department of the Interior.

Periodic fish kills in the Des Moines River during both summer and winter probably act as limiting mechanisms on the walleye population. One reported fish kill due to high water temperature occurred in July, 1955, and apparently decimated the walleye population in certain reaches of the river (Muncy, 1956). Also, winter die-offs of fish are not unusual because low water levels combined with heavy ice covers often result in depletion of oxygen in the water.

It is questionable whether walleyes in the study area reproduce naturally. The Iowa State Conservation Commission has stocked young-of-the-year and yearling walleyes in the Des Moines River on numerous occasions. Table 1 lists the number of walleyes stocked since the summer kill of 1955 in Boone County and Webster County, the county adjacent to Boone County on the north. The young walleyes were not marked in any manner so it was impossible to distinguish hatchery reared from possible naturally spawned walleyes.

Materials and Methods

All specimens used in the study were taken from that section of the Des Moines River which lies between the low head dam at Fraser

Table 1

Number of Young Walleyes Stocked in the Des Moines River in Boone and Webster Counties by the Iowa State Conservation Commission, 1956 Through 1958[1]

		Boone County			Webster County		
Year	Month	Fry	Fingerlings	Yearlings	Fry	Fingerlings	Yearlings
1956	May	1,000,000			2,250,000		
	June					15,000	
	August					3,750	
	September		11,000				
	October		10,000				
	November					10,000	
1957	May				500,000		10,000
	June			9,000			
	September			2,000			
1958	May	500,000			250,000		
	October		7,000				
	Totals	1,500,000	28,000	11,000	3,000,000	28,750	10,000

[1]Information provided by the Fisheries Division of the Iowa State Conservation Commission, Mr. K. M. Madden, superintendent.

and the waterworks dam at Boone, a distance of approximately 7 miles. Except for a few deep holes, the river normally is shallow in this section with water depths in summer averaging three feet or less. Sand, gravel, and bedrock are the predominant bottom types. The stream gradient of 1.5 feet per mile insures a reasonably rapid stream flow. For a more complete description of the Des Moines River study area see Starrett (1950).

A total of 209 walleyes was collected for study in 1956 to 1958. The majority of the adult walleyes were taken by anglers or with

an electrical shocker powered by a portable 115 volt, 1500 watt AC generator. Young-of-the-year walleyes in 1958 were collected with a common sense minnow seine 15 feet long and 4 feet deep.

Length measurements were recorded to the nearest tenth of an inch and weights to the nearest ounce. Total length was considered as that distance from the tip of the snout to the tip of the caudal fin when compressed. Standard length was considered as that distance from the tip of the snout to the posterior edge of the hypural plate, marked externally by a crease when the caudal fin is bent to either side. Since there appeared to be a marked difference in the ratio of standard length to total length between the walleyes below and above 10 inches in total length, the conversion factors are listed separately:

13 fish, ranging 8 to 10 in. T.L.:
Standard length (mm.) = 20.7 Total Length (in.)

75 fish, ranging 10 to 24.6 in. T.L.:
Standard length (mm.) = 21.3 Total length (in.)

Scales were removed from all fish from an area several scale rows below the lateral line and even with the middle of the spinous portion of the dorsal fin. Impressions were made of the scales on clear plastic strips by means of a roller press of the type described by Smith (1954). Scale impressions were examined on a standard scale projector at approximately 42 magnifications. All scales were read at least twice. If there was disagreement between the first two readings, the scales were read a third time. All differences in interpretation were resolved by the third reading although the interpretation of certain scales is still subject to question.

Age and Growth

Interpreting the age of walleyes from scale impressions was facilitated by measurements of young-of-the-year specimens from 1956 and 1957 which aided in the location of the first annulus on walleyes taken in 1957 and 1958. The 1956 year class, which was the first large year class after the summer kill of walleyes in 1955, dominated the walleye population of the river. It was relatively easy to follow this year class (Table 2) and use the average size of these individuals as a check against back-calculated growth.

Young-of-the-year walleyes grow steadily throughout the growing season (Table 2). During midsummer one- and two-year-old walleyes grow very little. Most growth in adult walleyes occurs in the late spring and early fall. Stroud (1949) found that seasonal growth among age groups I through IV varied between the age groups but in general, the greatest seasonal growth was observed in late spring and again in late summer. Little or no growth occurred in mid-summer in the Tennessee reservoir.

Table 2

Mean Total Length (Inches) at Time of Capture of Des Moines River Walleyes for Age Groups 0-II, 1955-1958 Year Classes

		1956 year class			1957 year class			1958 year class		
Age group	Month of collection	No. of fish	Mean T.L. (inches) at capture	Range	No. of fish	Mean T.L. (inches) at capture	Range	No. of fish	Mean T.L. (inches) at capture	Range
0	July	1	5.4	—						
0	August				8	9.2	8.5-10.5			
0	September	12	8.6	8.0-9.3	1	10.0	—			
0	October-November	2	6.8	4.9-8.6				75	3.8	2.9-5.1
I	June-July	3	11.3	11.0-12.0	4	10.7	10.4-11.5			
I	August	7	11.5	10.5-12.6						
I	September-October	4	12.0	11.9-12.1						
II	May	7	12.5	10.9-14.0				1955 year class		
II	June	7	13.6	12.9-14.6						
II	July	14	13.9	12.9-15.2				5	13.3	13.0-13.9
II	August	15	14.0	12.6-15.1				3	13.7	13.2-14.0
II	September	8	13.9	11.8-15.4				4	13.6	13.2-14.1
II	October	7	14.3	12.9-15.1						

The cause of the great difference in growth between young-of-the-year walleyes in 1956 and 1957 and in 1958 (Table 2) can partially be explained by the summer kill of walleyes recorded in 1955. Evidently this kill left vacancies in the river habitat. The annual increments calculated from scales for the first year of life (Table 4) indicate that walleyes in 1956 and 1957 responded to these vacancies and grew at a slightly faster rate than the preceding years. The large size of young-of-the-year collected in 1957 was partly a matter of size selection since these were fish caught by anglers and were probably the larger individuals of the year class. Young-of-the-year walleyes were very abundant at the Boone Dam during the fall of 1958, and all specimens were taken at this location on October 30.

One possible explanation for the poor growth of walleyes in 1958 may be the very low water levels in the spring and the late summer and fall. Water levels were so low in September that free movement of larger fish up and down the river was impeded in several places by very shallow riffle areas. Young-of-the-year walleyes were probably not restricted in their movements but their supply of food may have been seriously depleted or not available.

Another factor which may have contributed to the poor growth of young walleyes in 1958 was the abundance of young walleyes. The spring of 1958 was exceptionally dry with very stable water conditions in the river. Stable water levels may have resulted in good survival of walleye eggs and fry. If walleyes in the river mature at total lengths of from 12 to 14 inches as in Clear Lake (Cleary, 1949), then it would have been possible for the larger members of the dominant 1956 year class to contribute to the spawning run in 1958. On the other hand, the low water may have favored survival of the stocked fry. Competition for food among young-of-the-year walleyes may have been keen under conditions of low water levels and a high population.

In back calculating the growth of fish one assumes that once scales are formed, the growth of the anterior scale radii and the body lengths are directly proportional. To determine whether the body-scale relationship was in the form of a linear regression, the scales from 54 walleyes were measured and compared with their total length. The body scale relationship was found to be approximately linear and may be expressed by the following formula: $L = -0.26$ inches $+ .528S$, where L is the total length in inches and S is the anterior scale radius in inches multiplied by 42. Back calculated growth was determined on the assumption that the distance between annuli was proportional to the growth during that year of life. A nomograph was used with 0 as the focal intercept (Carlander and Smith, 1944).

Table 3

Mean Calculated Total Lengths of Walleyes in Each Age Group Collected in the Des Moines River, Boone County, Iowa, 1957 and 1958

Age[1] group	Number of individuals	Mean total length (inches) at capture	Range in total length at capture	Total length in inches at each annulus								
				1	2	3	4	5	6	7	8	9
I	18	11.4	10.4-12.6	9.0								
II	69	13.7	10.9-15.4	8.3	11.4							
III	8	15.3	12.8-18.3	7.6	11.5	14.1						
IV	6	17.5	16.3-18.5	7.4	10.8	13.9	16.2					
V	3	19.0	18.7-19.2	8.1	12.1	15.4	16.9	18.3				
VI	4	21.0	20.0-22.0	8.2	12.1	14.9	17.2	19.2	20.4			
VIII	3	23.5	22.5-24.6	8.7	12.1	14.7	16.5	18.6	20.4	21.8	22.6	
IX	1	23.0	—	8.5	11.1	13.9	16.7	18.5	20.2	21.3	22.2	22.6
Grand average	112			8.4	11.5	14.4	16.6	18.7	20.3	21.7	22.5	22.6
Standard deviation				1.1	0.9	1.1	0.7	0.5	0.4	0.4	0.6	—
Mean annnual increment				8.4	3.3	2.8	2.1	1.9	1.6	1.3	0.9	0.4
Growth based on summation of increments				8.4	11.7	14.5	16.6	18.5	20.1	21.4	22.3	22.7
Equivalent mean standard length in mm.				174	246	307	354	399	433	463	480	482

[1]Two year classes are combined in each age group since collections were made over a period of 2 years.

The precise time of annulus formation of Des Moines River walleyes was not established during the period encompassed by the study. Annulus formation probably occurs in May or early June. Several walleyes taken in late May, 1958, had not completed annulus formation, whereas others taken in the same month had completed an annulus mark. Carlander (1945) and Cleary (1949) report that walleyes form annuli in late May or early June in Lake of the Woods, Minnesota, and Clear Lake, Iowa, respectively. Rose (1951) reported that all walleyes from Spirit Lake, Iowa taken in early July of 1946 and 1947 had annuli at the extreme anterior margin of their scales.

The standard deviations (Table 3) indicate a considerable variation in growth among individual fish of the same age, as has also been reported by Eddy and Carlander (1939), Carlander (1945), Stroud (1949), and Eschmeyer (1950). Part of the variation, particularly in the size at the first annulus, may be the result of fish coming from various sources (Table 1). Data for the sexes were combined in the present study because many of the walleyes which were angled were sexually immature and determination of the sex of walleyes during summer and fall is difficult. However, it is known that females grow more rapidly than males especially after the third or fourth year of life (Stroud, 1949; Eschmeyer, 1950; Rawson, 1957; Slastenenko, 1956).

Des Moines River walleyes averaged approximately 8.4 inches in total length at the end of their first year of life and 11.5, 14.4, 16.6, 18.7, 20.3, 21.7, 22.5, and 22.6 inches at the ends of the next eight successive years of life (Table 3). There was a gradual decrease in the mean annual growth increment as the fish grew older.

Table 4
Annual Growth Increments, in Inches, of Des Moines River Walleyes in the 1948 to 1957 Year Classes

Year of life	Increment of growth in calendar year									
	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
9									0.4	
8								0.9	0.5	1.0
7							1.1	1.3	1.4	
6						1.7	1.7	1.8		1.4
5					1.8	1.6	2.4		1.7	1.6
4				2.8	1.8	1.8		2.1	2.3	2.0
3			2.8	2.6	2.5		2.9	3.2	3.0	2.6
2		2.6	3.2	3.5		4.1	3.5	3.5	3.4	3.0
1	8.5	9.3	8.5		8.2	7.7	8.0	7.7	8.6	8.6
Number of fish collected in										
1957	1	1	—	—	1	3	1	12	14	—
1958	—	—	2		4	2	3	7	57	4

Table 5
Calculated Growth and Ponderal Index of Walleyes Reported From Various Waters

Locality	Number of fish	Mean K	Average calculated total length (inches) reported from various waters											
			1	2	3	4	5	6	7	8	9	10	11	12
Present study	112	1.58	8.4	11.5	14.4	16.6	18.7	20.3	21.7	22.5	22.6			
Cedar River, Iowa (Mayhew 1956)	—	1.34	7.3	12.5	16.1	18.2	19.7	23.1	24.9	26.0	27.6	30.0		
Various Iowa lakes (Carlander, 1948)	216	1.64	5.0	9.2	12.4	15.0	17.1	18.6	19.9	21.5	23.2	24.7	25.9	26.6
Clear Lake, Iowa (Cleary, 1949)	319	1.49	5.9	10.9	14.5	17.2	19.3	21.4	23.6	26.3	27.0	27.7	28.1	
Spirit Lake, Iowa (Rose, 1951)	312	1.64	7.2	11.1	14.4	17.5	19.9	22.2	23.7	24.9	26.0	27.8		
Minnesota lakes (Eddy and Carlander, 1939)	6,599	—	4.9	9.1	12.7	15.8	19.1	21.6	24.2	26.6	28.2			
Wisconsin lakes (Schloemer and Lorch, 1942)	1,132	1.45	5.4	9.8	13.2	15.9	17.8	19.5	21.8	23.3	24.8	26.1		
Norris Reservoir, Tenn. (Stroud, 1949	2,898	1.51	10.3	16.4	18.7	19.9	20.8	21.0	22.1	24.9				

Lee's phenomenon of apparent change in growth rate was not evident (*i.e.*, the older fish do not tend to have smaller calculated lengths than do the younger fish at the same annuli).

The growth increments for 1957 were mostly lower than those for equivalent aged fish in 1956 (Table 4), perhaps an indication that the 1956 year class was somewhat filling the niche in the river environment. Shrinking water levels in 1957 may also have had an effect.

Comparison of Growth Rates

When compared with growth of walleyes from other Iowa waters (Table 5), the Des Moines River walleyes show above average growth during the first year but below average growth in later years. The only other study of a river population (Mayhew, 1956) indicates more rapid growth of walleyes in rivers than in lakes. Data on Minnesota and Wisconsin lakes given for comparative purposes indicate slower growth during the first four years than in the Des Moines River. Growth data on walleyes from Norris Reservoir, Tennessee, are included to show how rapidly walleyes grow in a new environment in the South.

Length-Weight Relationship

The length-weight relationship (Table 6) can be described by the equation:

$$\text{Log } W = -2.422 + 3.140 \text{ (Log L)}$$

where W = weight in ounces
and L = total length in inches

This equation was fitted to the mean weights of fish arranged by one inch size classes.

Ponderal Index

The general "well being" or relative plumpness in fish is indicated by the ponderal index figures, K and C, where

$$K = \frac{W\ 10^5}{L^3} \qquad \text{and} \qquad C = \frac{W\ 10^5}{L^3}$$

if W = weight in grams and L = standard length in millimeters

if W = weight in pounds and L = total length in inches

In the present study there was a slight tendency for the longer fish to have larger C values (Table 6). This indicates that longer walleyes were slightly heavier for their length than younger walleyes. The mean K value for all ages and sexes was 1.58 while the mean C value was 33.4. Walleyes from the Des Moines River compare favorably with walleyes from other waters insofar as ponderal index figures are concerned (Table 5).

Table 6
Mean Weight and Ponderal Index, C, at One Inch Size Groups, of Des Moines River Walleyes, 1957 and 1958

Total length in inches	Number of fish	Actual weight in ounces		Calculated[1] weight in ounces	Mean C	Number of fish
		Mean	Range			
10.0-10.9	2	6.3	5.5-7.0	6.1	34.3	2
11.0-11.9	3	9.0	8.0-10.0	8.1	36.7	3
12.0-12.9	5	9.6	8.0-11.0	10.3	32.5	9
13.0-13.9	10	13.3	11.0-16.0	13.4	33.3	21
14.0-14.9	10	16.3	14.0-20.0	16.8	32.7	19
15.0-15.9	8	18.1	16.0-20.0	19.5	32.2	8
16.0-16.9	1	22.0	—	22.9	33.4	1
17.0-17.9	1	32.0	—	27.6	40.9	1
18.0-18.9	1	28.0	—	33.1	30.8	2
19.0-19.9	1	39.0	—	39.2	35.6	1
20.0-20.9	1	46.0	—	48.3	34.4	1
21.0-21.9	1	61.0	—	60.0	37.8	1
22.0-22.9	1	68.0	—	62.1	39.9	1
23.0-23.9	1	76.0	—	74.4	37.6	1
24.0-24.9	1	88.0	—	88.2	37.0	1
Mean	47	—	—	—	33.4	72

[1]Calculated by the formula $W = -2.422 + 3.140 (\log L)$.

Summary and Conclusions

Even though the Des Moines River in Boone County is marginal habitat for walleyes, a considerable fishery for this species does exist. Evidently fish kills in the summer due to high water temperatures and in the winter due to oxygen depletion limit the size of the walleye population. Des Moines River walleyes show good growth during the early years of life, especially during their first year. Some walleyes enter the fishery during their first summer of life. Tagging studies indicate that the annual rate of harvest of walleyes amounts to about 10 percent of the walleye population, a rather high rate.

Considerable variation in growth exists within age groups and between year classes. Some of the possible explanations for growth variation among Des Moines River walleyes include:

1. Sexual differences in growth, especially between fish over four years old.
2. Frequent fish kills resulting in vacancies in the habitat and thus more food for each remaining fish.
3. Low water levels during certain years.
4. Frequent stocking by the Iowa State Conservation Commission of fry, fingerlings, and yearlings during different seasons resulting in growth variations, especially in the younger fish.

Young-of-the-year walleyes grew steadily throughout the growing season. Walleyes one-year-old or more grew rapidly in late spring and early fall but very little during mid-summer. The growth and general well being of Des Moines River walleyes are about average

when compared with walleyes in other parts of the country.

ACKNOWLEDGMENTS

The author wishes to express his appreciation to Dr. Kenneth D. Carlander for supervising the research and making suggestions for improving the manuscript. Thanks are due to Dudley Rehder for his assistance in the field and to Marvin Buchholz and other members of the Iowa Cooperative Fisheries Research Unit for their aid in interpreting scales.

Literature Cited

Carlander, Kenneth D. 1945. Age, growth, sexual maturity, and population fluctuations of the yellow pikeperch, *Stizostedion vitreum vitreum* (Mitchill), with reference to the commercial fisheries, Lake of the Woods, Minnesota. Trans. Amer. Fish. Soc. 73:90-103.

———. 1948. Growth of the yellow pikeperch, *Stizostedion vitreum vitreum* (Mitchill), in some Iowa lakes with a summary of growth rates reported in other areas. Iowa St. Univ. J. Sci. 22(3):227-237.

——— and Lloyd L. Smith, Jr. 1944. Some use of the nomograph in fish growth studies. Copeia 1944(3):157-162.

Cleary, Robert E. 1949. Life history and management of the yellow pikeperch, *Stizostedion vitreum vitreum* (Mitchill), of Clear Lake, Iowa. Iowa St. Univ. J. Sci. 23(2):195-208.

Eddy, Samuel, and Kenneth Carlander. 1939. The growth rate of walleyed pike, *Stizostedion vitreum* (Mitchill) in various lakes of Minnesota. Minn. Acad. Sci. Proc. 7:44-48.

Eschmeyer, Paul H. 1950. The life history of the walleye, *Stizostedion vitreum vitreum* (Mitchill), in Michigan. Mich. Dept. Conserv. Inst. for Fish. Res. Bul. 3.

Mayhew, James. 1956. A preliminary report on the age and growth of the yellow pikeperch, *Stizostedion vitreum* (Mitchill), in the Cedar River, Iowa. Quart. Biology Rept. Iowa St. Conserv. Comm. 8(2):35-40.

Muncy, R. Jess. 1956. Walleye population in the Des Moines River study area. Quart. Rept. Iowa Coop. Wildl. & Fish. Res. Units 22(1):30-31.

Rawson, D. S. 1956. The life history and ecology of the yellow walleye, *Stizostedion vitreum,* in Lac La Range, Saskatchewan. Trans. Amer. Fish. Soc. 86:15-37.

Rose, Earl T. 1951. Notes on the age and growth of Spirit Lake yellow pikeperch (*Stizostedion v. vitreum*). Proc. Iowa Acad. Sci. 58:517-525.

Schloemer, Clarence L. and Ralph Lorch. 1942. The rate of growth of the walleyed pike, *Stizostedion vitreum* (Mitchill), in Wisconsin's inland waters, with special reference to the growth characteristics of the Trout Lake population. Copeia 1942(4):201-211.

Schmulbach, James C. 1958. Seasonal changes in harvest and fishing effort on a section of the Des Moines River, Iowa. Paper presented at 20th Midw. Wildl. Conf., Columbus, Ohio, Dec. 15-17, 1958. (Mimeo.)

Slastenenko, E. P. 1956. The growth of yellow pikeperch, *Stizostedion vitreum* (Mitchill) in Three Mile Lake, Ontario. Canad. Fish. Cult. 19:17-24.

Smith, Stanford H. 1954. Method of producing plastic impressions of fish scales without using heat. Prog. Fish-Cult. 16(2):75-78.

Starrett, William C. 1950. Food relationships of the minnows of the Des Moines River, Iowa. Ecology 31:216-233.

Stroud, Richard H. 1949. Growth of Norris Reservoir walleye during the first twelve years of impoundment. J. Wildl. Mgt. 13(2):157-177.

IOWA COOPERATIVE FISHERY RESEARCH UNIT
DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY
IOWA STATE UNIVERSITY
AMES, IOWA