IOWA CONSERVATION COMMISSION
FISHERIES SECTION

FEDERAL AID TO FISH RESTORATION
ANNUAL PERFORMANCE REPORT
STREAM FISHERIES INVESTIGATIONS
PROJECT NO. F-89-R-2

Study No. 602-1 - Population Dynamics of Smallmouth Bass in the Maquoketa River and Other Iowa Streams

Job No. 1: Population characteristics of smallmouth bass in the Maquoketa River
Job No. 2: Effects of habitat variation on the stream biota
Job No. 3: Physical and chemical characteristics of the Maquoketa River
Job No. 4: Population characteristics of smallmouth bass in other northeast Iowa streams

PERIOD COVERED: 1 JULY 1977 - 30 JUNE 1978

FEDERAL AID TO FISH RESTORATION

ANNUAL PERFORMANCE REPORT

STREAM FISHERIES INVESTIGATIONS

PROJECT NO. F-89-R-2

Study No. 602-1 - Population Dynamics of Smallmouth Bass in the Maquoketa River and Other Iowa Streams

Job No. 1: Population characteristics of smallmouth bass in the Maquoketa River
Job No. 2: Effects of habitat variation on the stream biota
Job No. 3: Physical and chemical characteristics of the Maquoketa River
Job No. 4: Population characteristics of smallmouth bass in other northeast Iowa streams

TABLE OF CONTENTS

ANNUAL PERFORMANCE REPORT

RESEARCH PROJECT SEGMENT

STATE: Iowa

PROJECT NO.: F-89-R-2

STUDY NO.: 602-1

JOB NO.: 1

NAME: Population Dynamics of Smallmouth Bass in the Maquoketa River and Other Iowa Streams

TITLE: Population characteristics of smallmouth bass in the Maquoketa River

Period Covered: 1 July, 1977 through 30 June, 1978

ABSTRACT: Smallmouth bass population dynamics were studied in two areas of the Maquoketa River, Delaware County. Bass were captured in spring and autumn by electrofishing. Length, weight, and scale samples were taken from many bass while some were tagged prior to release. These data were supplemented by an expandable sport fishery survey. Estimates of smallmouth bass populations were computed. Spring sampling accounted for 2,956 bass while the autumn catch was 1,156, 23% were 200 mm (7.9 in) in length or greater. Bass growth was superior to that of fish in most streams in Iowa averaging 105, 194, 267, 325, 374, 411, 481, 510 and 529 mm (4.1, 7.7, 10.5, 12.9, 14.8, 16.2, 19.0, 20.1 and 20.9 in) for ages I-IX. Density of smallmouth bass in Area I was 88 N/ha (35.6/ac) and standing stock was 9 kg/ha (8.0 lbs/ac) while in Area II the density and standing stock was 741 N/ha and 45 kg/ha (300.1 N/ac and 40.1 lbs/ac), respectively. Densities of bass < 200 mm (7.9 in) were 70 and 695 bass/ha (28.3 and 281.3 bass/ac) for Areas I and II, respectively; while density of bass ≥ 200 mm (7.9 in) was 6 and 15 kg/ha (5.4 and 13.4 lbs/ac), respectively. Information from 696 angler interviews in Area I and 2,173 contacts in Area II estimated a total harvest of 79 smallmouth bass or 3.6 kg/ha (3.2 lbs/ac) from Area I and 713 bass or 20 kg/ha (17.8 lbs/ac) from Area II. Catch rates were .02 and .08 bass/hr for Area I and II, respectively. Exploitation of bass ≥ 200 mm (7.9 in) was 37% in Area I and 55% in Area II while total annual mortality was 62% and 66%, respectively. Critical size of smallmouth bass in Area I was 348 mm (13.7 in), ages IV-V; and 520 mm (20.5 in), ages VIII-IX, for Area II.

Author: Vaughn L. Paragamian
Fishery Research Biologist

Date prepared: 30 June, 1978

Approved by: Don Bonneau
Fishery Research Supervisor

STUDY OBJECTIVE

To identify the physical, chemical, and biological factors that influence smallmouth bass population abundance and structure in the Maquoketa River, and similar northeast Iowa streams and utilize these factors to develop strategies for experimental management of the smallmouth bass fishery.

JOB 1 OBJECTIVE

To determine the numerical population size, production and reproductive success, mortality and angler exploitation of smallmouth bass from two separate study areas of the Maquoketa River in Delaware County.

INTRODUCTION

Approximately 4,500 miles of streams flow through northeast Iowa and contain a diversity of fish species. A statewide survey of Iowa anglers in 1975 documented the importance of stream fishing in this region. Among the fish species sought by fishermen was smallmouth bass.

Fish management personnel identified two elements that have significant impact on smallmouth bass populations, these are overharvest and habitat deterioration (personal communication; Dave Moeller, Don Degan and Gaige Wunder). The importance of these factors in controlling abundance of smallmouth bass must be quantified prior to development of a management plan for the species.

STUDY BACKGROUND

Smallmouth bass are an important native fish species in northeast Iowa streams. A recent survey of anglers in Iowa indicated fishermen preferred to fish in streams over all others. Regard for the smallmouth bass fishery was expressed as early as the 1940's when food habits and growth of bass were studied (Tate, 1949a and 1949b). This investigation revealed 99% of the bass in the study streams were age IV or younger and downstream drift appeared responsible for the lack of older fish. Other studies documented the importance of tributary streams for smallmouth bass reproduction and the deleterious impact of heavy precipitation during post-spawning periods (Cleary, 1956). Creel survey data indicated smallmouth bass comprised up to 2% of the catch in the Wapsipinicon River, 11% in the Maquoketa River and 15% in the Iowa River (Schacht, 1965a and 1965b).

Recent smallmouth bass life history investigations in the Turkey River revealed few fish were age V or older and that fish growth was comparable to other midwestern streams (Ackerman, 1974). The study also revealed smallmouth bass comprised 6% of the total electrofishing and net gear catch.

Another life history investigation of smallmouth bass in the Upper Iowa River (Wunder, 1976) showed a population density of 163 bass/km (263/mi) from 76-483 mm (3-19 in). Few smallmouth bass fishermen were found, but their catch and success was reported similar to that of other midwestern streams.

The Maquoketa River was selected as the primary study stream; it is a typical river in northeast Iowa containing a variety of habitat. Smallmouth bass abundance in the river varies from pool to pool and angling pressure and access is similar to other streams.

Maquoketa River headwaters and about 50% of its watershed are found in the Iowan Surface (Figure 1), to the north and east lies the Palezoic Platueau. While the remaining 50% passes through the Southern Iowa Drift Plain. The Maquoketa River traverses 225 km (140 miles) and five counties from its origin to its mouth at the Mississippi River and drains 4,474 sq km (1,843 sq mi).

Two study areas were selected on the Maquoketa River in Delware County (Figure 2). Area I located at Pin Oak County Conservation Board Park, was 5 km (3 mi) south of Manchester. The study area is about 1.44 km (.89 mi) in length and contains 3.97 ha (9.81 ac). Area II, located 3 km (2 mi) west of Delhi, begins at the base of Delhi Dam and extends 3.54 km (2.2 mi) downstream. Area II contained 10.03 ha (24.77 ac). Area I was subdivided into two segments and Area II into 10. Each segment was comprised of a single pool and riffle.

METHODS AND PROCEDURES

Smallmouth bass were captured with a 230 V AC boomshocker during spring (April-early May) and autumn (late September-early October), weighed and measured in total length (TL). Bass < 200 mm (7.9 in) were marked by clipping the bottom caudal fin and larger bass received a left pelvic clip (half of fin). About 20% of the bass $\geq$ 200 mm (7.9 in) were also tagged with serially numbered Floy anchor tags. Scale samples were collected from about 200 fish. All bass were released.

A numerical population estimate was calculated for each segment by the Chapman modification of the Schnabel multiple census function

$$\hat{N} = \frac{\Sigma(M_t C_t)}{\Sigma R_t + 1}$$

where

$\hat{N}$ = population estimate

M_t = total number of marked fish at large on day t

C_t = the total catch for day t, and

$R_r + 1$ = the total number of recaptures + 1

Variance of $\hat{N}$ was computed by treating the medium sized R sample as a normally distributed variable (Ricker, 1975)

$$V(1/N) = \frac{R + 1}{\Sigma(C_t M_t)^2}$$

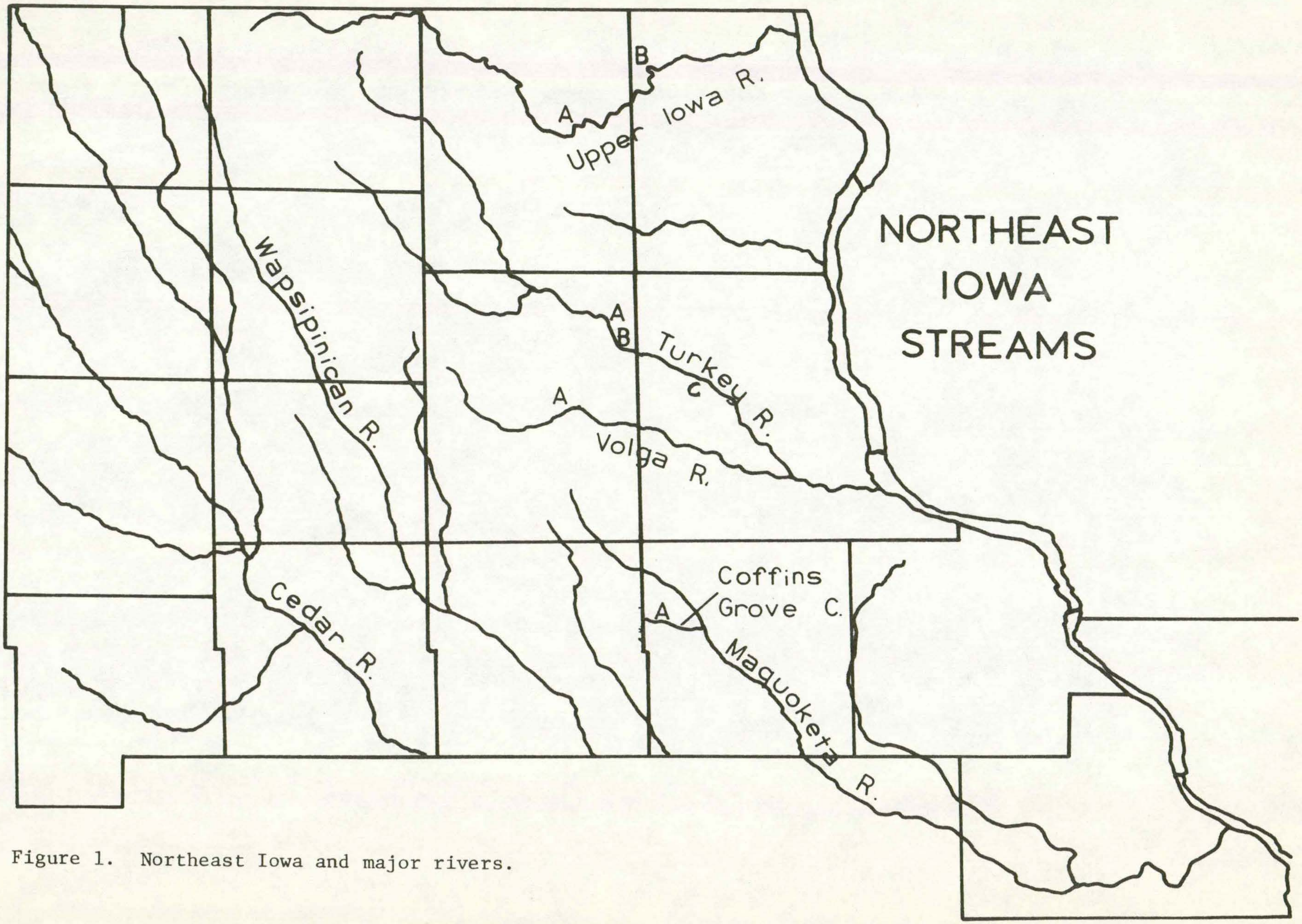

Figure 1. Northeast Iowa and major rivers.

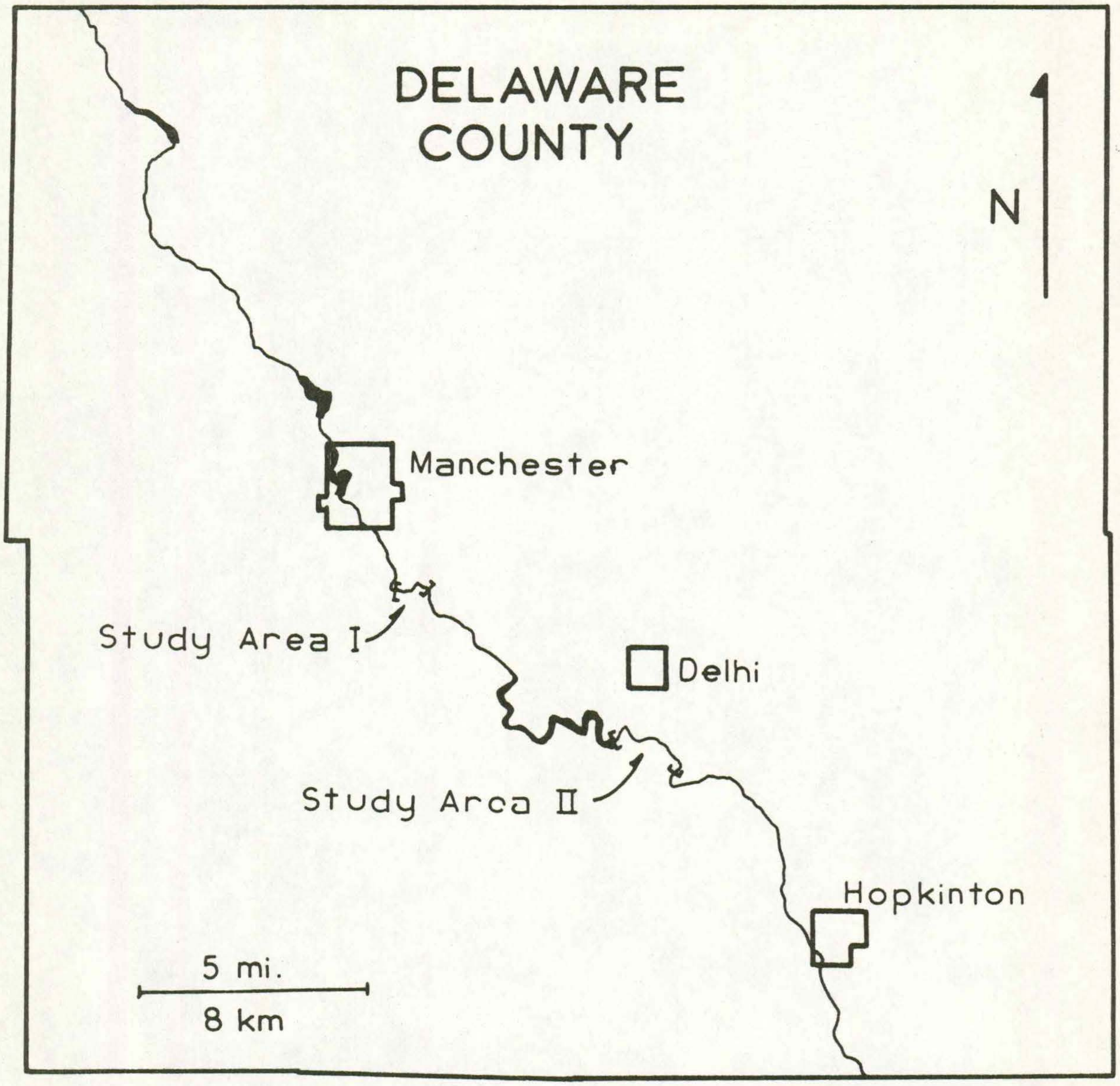

Figure 2. Maquoketa River Study Areas I and II, Delaware County.

Confidence intervals were also calculated. Total population estimates for each study area was derived by an independent estimate.

Scale impressions were made on cellulose acetate slides and viewed on a scale projector at 40X. Annuli were counted and measurements made along the anterior scale radius. Scale measurements, lengths, and weights were processed by computer (Mayhew, 1973).

An expandable sport fishery survey was conducted by the Fish Management Branch to determine angler catch and harvest of smallmouth bass. Exploitation was expressed as the ratio of marked fish observed in the creel to the number at large. Instantaneous total mortality was computed from age distribution.

FINDINGS

SMALLMOUTH BASS SIZE STRUCTURE

Spring sampling accounted for a catch of 2,956 smallmouth bass; of which, a length frequency distribution was constructed for 897 fish (Table 1). Bass ranged from 65 mm (2.6 in) to 530 mm TL (20.9 in). Weights ranged from 2 g (< .01 lbs) to 2 kg (4.4 lbs). Autumn sampling accounted for a catch of 1,156 bass and a length frequency distribution was tabulated for 1,124 ranging from 35 mm (1.4 in) to 529 mm TL (20.8 in) (Table 1). Weights ranged from 1 g (< .01 lbs) to 2.2 kg (4.9 lbs).

WEIGHT-LENGTH RELATIONSHIP AND CONDITION FACTORS (K)

The weight-length relationship of smallmouth bass from Area I was

$$\log_{10}W = -5.22 + 3.15 \log_{10}TL$$

and bass from Area II was

$$\log_{10}W = -5.35 + 3.19 \log_{10}TL$$

The K factors of bass, arranged in 10 mm (.4 in) class intervals, sampled in Area I ranged from .93 to 2.11, with a mean of 1.35, while K factors of bass in Area II ranged from 1.10-1.67, with a mean of 1.34. Statistical comparisons of weight-length relationships and K factors showed no significant difference between study areas.

GROWTH

Scale samples and lengths were collected from 81 smallmouth bass in Area I and 136 bass in Area II.

Body-scale regression for bass from the Area I sample was

$$TL = 48.49 + 1.83\ ScR$$

Table 1. Length frequency distribution of smallmouth bass captured in the Maquoketa River, spring and autumn, 1977.

Class interval (mm)	Class interval (inches)	Spring Number	Spring Percent	Autumn Number	Autumn Percent
30- 49	1.2- 1.9			1	< 1
50- 69	2.0- 2.7	1	< 1	4	< 1
70- 89	2.8- 3.5	24	3	86	8
90-109	3.6- 4.3	159	18	118	10
110-129	4.3- 5.1	163	18	78	7
130-149	5.1- 5.9	32	4	353	31
150-169	5.9- 6.7	36	4	231	21
170-189	6.7- 7.5	93	10	89	8
190-209	7.5- 8.2	114	13	52	5
210-229	8.3- 9.0	67	7	21	2
230-249	9.1- 9.8	50	6	17	2
250-269	9.9-10.6	27	3	17	2
270-289	10.7-11.4	31	3	25	2
290-309	11.4-12.2	26	3	9	1
310-329	12.2-13.0	23	3	10	1
330-349	13.0-13.8	18	2	2	< 1
350-369	13.8-14.6	8	1	6	1
370-389	14.6-15.4	9	1	3	< 1
390-409	15.4-16.1	5	1		
410-429	16.2-16.9			1	< 1
430-449	17.0-17.7	6	1		
450-469	17.8-18.5	2	< 1		
470-489	18.6-19.3	2	< 1		
510-529	20.1-20.9			1	< 1
530-549	20.9-21.7	1	< 1		
Total		897		1,124	

while the relationship for bass in the Area II sample was

$$TL = 48.44 + 2.00\ ScR$$

These relationships were used to back-calculate total body length at each annulus. Average TL for bass ages I-VI in Study Area I were 106, 185, 280, 331, 364 and 382 mm (4.2, 7.3, 11.0, 13.0, 14.3 and 15.0 in), respectively (Figure 3). Average TL for bass ages I-IX in Study Area II were 105, 178, 254, 320, 384, 440, 481, 510 and 529 mm (4.1, 7.0, 10.0, 12.6, 15.1, 17.3, 18.9, 20.1 and 20.8 in), respectively (Figure 3).

POPULATION ESTIMATES AND STANDING STOCK

Smallmouth bass population estimates were computed during spring and autumn for each segment and area. In addition, estimates were further partitioned by computing estimates of bass < 200 mm (7.9 in) and larger bass (Table 2).

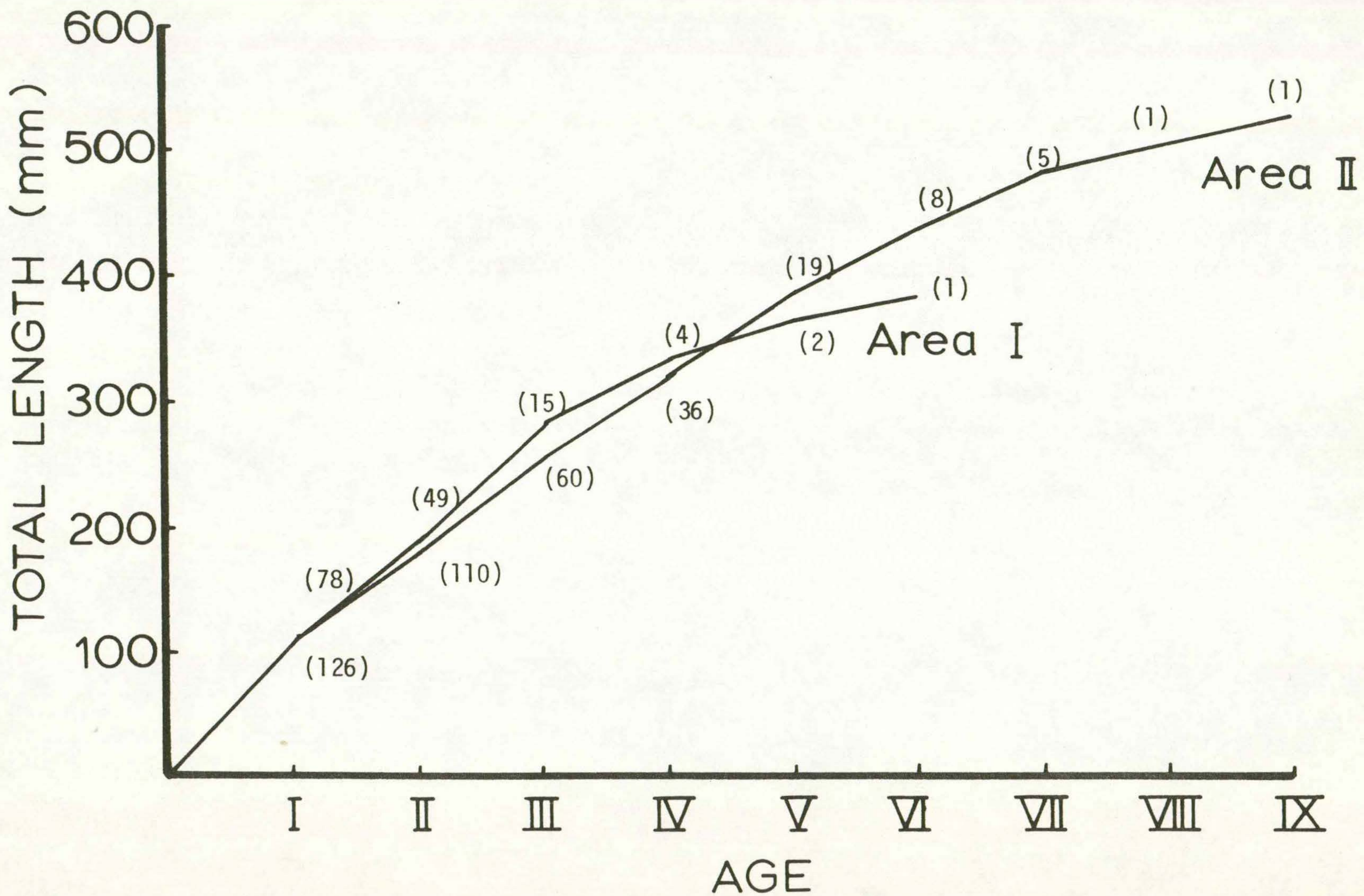

Figure 3. Back calculated total lengths at annulus for smallmouth bass in Areas I and II, Maquoketa River, 1977, sample size in parenthesis.

Table 2. Population estimates and estimated standing stock of smallmouth bass < 200 mm and ≥ 200 mm in study segments of the Maquoketa River, spring 1977.

	< 200 mm				≥ 200 mm			
	Population size ($\hat{N}$)	Confidence interval	Standing stock (kg/ha)	Standing stock (lbs/ac)	Population size ($\hat{N}$)	Confidence interval	Standing stock (kg/ha)	Standing stock (lbs/ac)
Area I								
Segment 1	166	121- 260	2.4	2.1	26	19- 40	3.3	2.9
Segment 2	110	68- 288	4.2	3.7	109	46- ∞	180.4	161.0
Total	276[a]	218- 422	3.0	2.7	73	59-111	6.1	5.4
Area II								
Segment 1	497	353- 841	17.7	15.8	22	13- 57	5.8	5.2
Segment 2	842	639-1,235	29.2	26.0	26	16- 64	17.1	15.3
Segment 3	1,833	1,432-2,546	53.9	48.1	46	28-133	8.6	7.7
Segment 4	1,162	906-1,621	49.7	44.3	53	23-154	11.4	10.2
Segment 5	486	315-1,064	94.0	83.9	93	59-213	88.0	78.5
Segment 6	9	6-∞	1.1	1.0	--	---	---	---
Segment 7	579	465- 767	78.4	70.0	56	34-147	31.0	27.7
Segment 8	428	311- 687	9.1	8.1	57	41- 95	16.2	14.5
Segment 9	773	501-1,693	24.7	22.0	32	18-125	11.0	9.8
Segment 10	140	93- 283	6.2	5.5	52	29-263	9.1	8.1
Total	6,969[b]	6,206-7,946	30.3	27.0	463	381-590	14.9	13.3

[a]62.5% area age I.

[b]91.9% are age I.

Standing stock of smallmouth bass was calculated from the numerical population estimates and mean bass weight in each segment (Table 2). Total standing stock was computed from the mean weight of bass in each area and population estimate.

Smallmouth bass sampling during autumn was not as effective as spring; consequently, population estimates calculated during the later season had wide confidence intervals and many could not be computed. An estimate of 167 0-age smallmouth bass or .6 kg/ha (.5 lbs/ac) was calculated for Segment 1 of Area I from catching 82 and recapturing 13. A total catch of 156 0-age bass in Area II and the recapture of 8 yielded an estimate of 1,345 0-age smallmouth bass or 1.4 kg/ha (1.2 lbs/ac). A total catch of 23 bass from 120-200 mm TL (4.7-7.9 in) in Segment 1 of Area I and the recapture of 4 resulted in an estimate of 35 bass, while a catch of 765 and recapture of 20 resulted in an estimate of 9,938 bass in Study Area II, 991 bass/ha (401 N/ac). Bass estimates $\geq$ 200 mm (7.9 in) were unsuccessful in both areas and although most meet criteria established by Robson and Regier (1964) recaptures were so few it is doubtful the few estimates calculated are accurate.

SMALLMOUTH BASS MOVEMENT

Sixty-two smallmouth bass were tagged during the first trial of the spring sampling period; of these, 32 were recaptured at least once. Tagged bass were recaptured 46 times, four fish were recaptured three times and one fish was recaptured four times. Fourteen bass were tagged in Area I, of which, 14 recaptures occurred for 8 fish. Only one bass was recaptured outside the segment of original capture; however, the fish was captured a week later back in the segment of original capture.

Smallmouth bass sampled in Area II exhibited greater movement as compared to fish sampled in Area I. Of the 32 recaptured marked bass 47% were captured outside of the segment of original capture, about 33% were one segment upstream or downstream, the remainder had moved further (Table 3). Of the bass that moved 33 percent were bass tagged in Segment 5 of Area II.

Movement of bass upstream from Area I was not determined but electrofishing for bass downstream from the area was made with no detectable movement. Upstream travel by bass in Area II was impossible because of the Delhi Dam. Downstream movement was not important. Captures of approximately 75 smallmouth bass $\geq$ 200 mm (7.9 in) downstream from Area II revealed three marked fish while a catch of 100 smaller fish provided no recaptures. Population estimates were not adjusted because of movement.

ANGLER CATCH AND EXPLOITATION

Sport fishery survey data from Areas I and II of the Maquoketa River were used to determine smallmouth bass harvest, catch rates, angler pressure, and exploitation. An estimated 4,549 fishermen fished 3,257 hours in Area I and an estimated 10,020 anglers fished 10,502 hours in Area II (Table 4). Smallmouth bass harvest and catch rate was higher in Area II than Area I; 713 bass and .08 bass/hr compared to 79 bass and .02 bass/hr. Bass weight was similar, 4 kg/ha (3.6 lbs/ac) for Area I compared to 20 kg/ha (17.8 lbs/ac) for Area II.

Exploitation of smallmouth bass $\geq$ 200 mm (7.9 in) was computed by expanding the number of fin clipped bass observed during the sport fishery survey. In Area I fishermen harvested 11 smallmouth bass of which 3 were marked providing an estimated harvest of 19 bass of 51 marked fish at large for an exploitation of 37 percent. Estimated exploitation was 55 percent for bass in Area II. The survey clerk saw 152 bass during the survey period of which 30 were fin clipped, providing an estimated harvest of 138 marked fish of 250 at large.

AGE STRUCTURE OF HARVEST

Age class composition to harvest in Areas I and II was obtained by scale sample analysis from 121 angler captured smallmouth bass. Smallmouth bass entered the catch in their second year of life and approximately 86% of the bass caught were age I-III (Table 5). Size ranged from 150-450 mm (5.9-17.7 in). Average length was 259 mm (10.2 in) and 242 mm (9.5 in) for Areas I and II, respectively.

Table 5. Length frequency distribution of angler caught smallmouth bass in Areas I and II of the Maquoketa River, 1977.

Class interval (mm)	Class interval (inches)	Number	Percent
150-169	5.9- 6.6	10	6
170-189	6.7- 7.4	8	5
190-209	7.5- 8.2	11	7
210-229	8.3- 9.0	16	10
230-249	9.1- 9.8	18	11
250-269	9.9-10.6	27	16
270-289	10.7-11.4	22	13
290-309	11.5-12.2	18	11
310-329	12.2-13.0	11	7
330-349	13.0-13.8	5	3
350-369	13.8-14.5	10	6
370-389	14.6-15.3	3	2
390-409	15.4-16.1	5	3
450-469	17.8-18.5	1	1
Total		165	

ANNUAL MORTALITY

Age distribution provided an estimated instantaneous total mortality of .99 for Area I, ages II-VI, and 1.07 for Area II, ages II-IX (Figure 4). Total annual mortality was 62% for Area I and 66% for Area II.

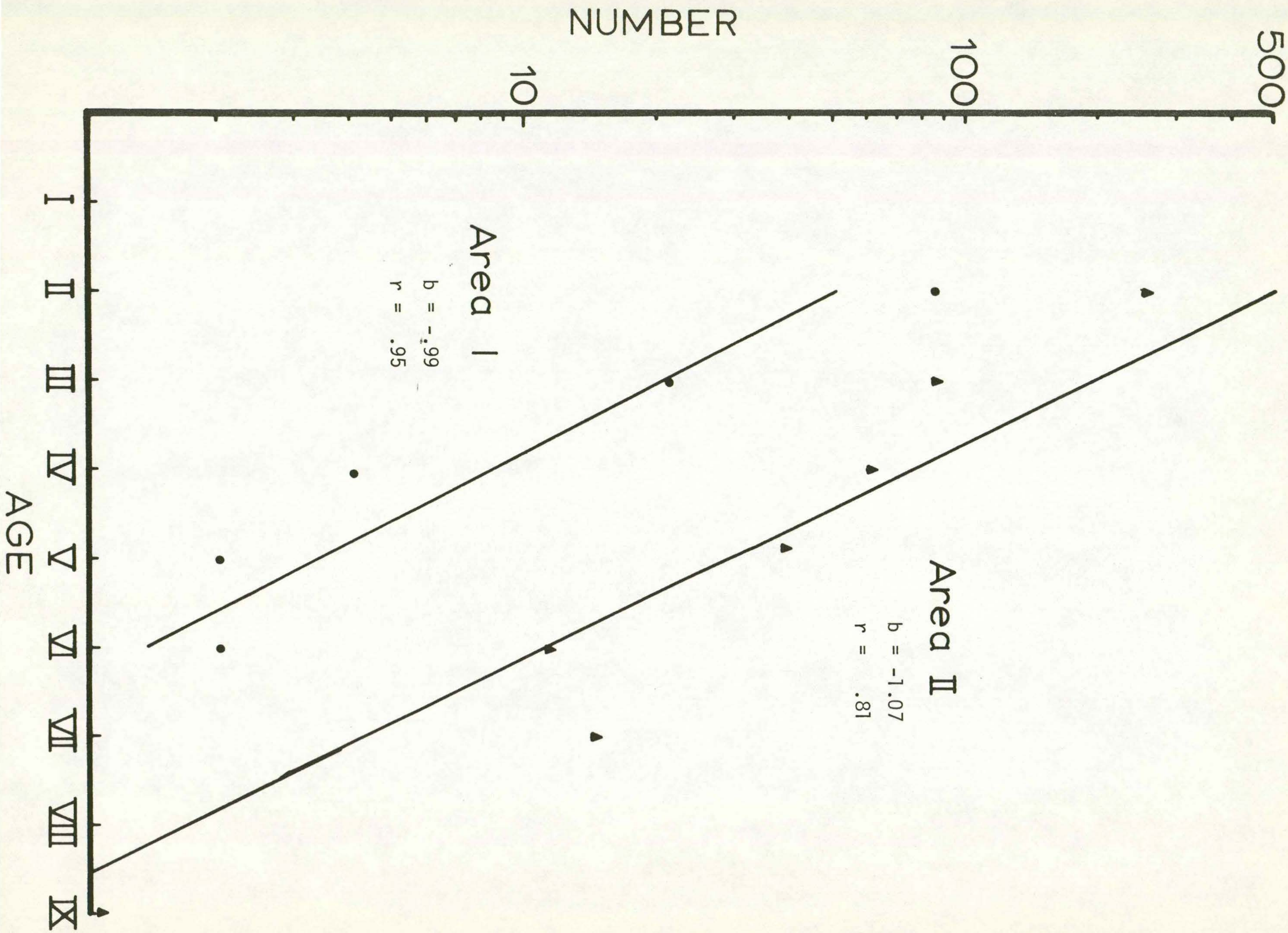

Figure 4. Age structure for smallmouth bass, Areas I and II, Maquoketa River, 1977.

CRITICAL SIZE

Smallmouth bass critical size (Ricker, 1945) was estimated to determine the length and age at which a year class of bass attains maximum biomass. Critical length was 331-364 mm (13-14.3 in) and ages IV and V for bass in Area I and of 510-529 mm (20.1-20.8 in) and ages VIII-IX for bass in Area II (Tables 6 and 7).

Table 6. Back calculated length and weight and instantaneous growth (G) and natural mortality rate (M) for smallmouth bass, Maquoketa River, Area I.

Age	Length (mm)	Weight (g)	G	M
I	106	14		
			1.7548	.398
II	185	84		
			1.3056	.398
III	280	308		
			.5266	.398
IV	331	522		
			.2996	.398
V	364	704		
			.1522	.398
VI	382	820		

Table 7. Back calculated lengths and weights and instantaneous growth (G) and natural mortality rate (M) of smallmouth bass, Maquoketa River, Area II.

Age	Length (mm)	Weight (g)	G	M
I	105	5		
			1.6836	.178
II	178	67		
			1.1341	.178
III	254	210		
			.7369	.178
IV	320	438		
			.5816	.178
V	384	783		
			.4350	.178
VI	440	1,210		
			.2834	.178
VII	481	1,603		
			.1934	.178
VIII	510	1,950		
			.1108	.178
IX	529	2,176		

DISCUSSION OF FINDINGS

Growth of bass in the Maquoketa River was superior to that of most Iowa streams. Smallmouth bass grew at a rate slower than that of fish in the Des Moines River (Reynolds, 1964) for the first four years of life then exceeded it. Growth was greater than that in the Turkey River (Ackerman, 1974), Upper Iowa River (Wunder, 1975), and Coffin Creek (Tate, 1947), and was comparable to that of the same population in an earlier investigation (Degan, 1976).

Comparison of population estimates between areas and segments demonstrated dramatic changes in bass abundance within short distances. In general, the density of bass in Area II was 10-fold greater than that of Area I, most of the difference is indicative of changes in the proportion of smallmouth bass habitat as demonstrated in Job 3 of this report.

Movement of bass < 200 mm (7.9 in) is not serious because of their sedentary nature, but movement of larger fish influenced population estimates in each segment. Over 50% of the recaptured bass in Area II were within the segment of original capture, many other bass were recaptured within one segment of original capture but 33% of the movement was of bass tagged in Segment 5. Movement of marked bass from Pool 5 reduced the numerical estimates of other pools and increased the estimate in Pool 5; thus, movement accounts for the exceptionally high density and standing stock of bass ≥ 200 mm (7.9 in) in this pool. Movement of bass in Area I was unimportant.

Catches of smallmouth bass > 200 mm (7.9 in) during the autumn sampling period was seriously biased by movement of bass into deep pools. Segments that were inhabited by all size ranges of bass during spring electrofishing provided similar catches during early autumn sampling; however, catches of larger bass decreased as water temperature dropped, 10 bass/hr (26 September) at about 12°C to 6.8 bass/hr (6 October) at 4°C. Catch of larger bass on the last trial were limited to Segments 1-4 of Area II. Segments 1-4 contained the three deepest pools of Area II: Segment 2 was 4.9 m (16 ft), Segment 1 was 3.7 m (12.1 ft) and Segment 4 was 1.9 m (6.2 ft).

Survival of 0-age bass may have been supressed by the preceding age class. A strong 1976 year class was evident during spring and fall sampling. During mid-spring schools of 0-age smallmouth bass in the "black fry" stage could be observed at the river margin and were frequently accompanied by an adult male. 0-age bass were also associated with cobble and gravel substrate, the same region occupied by age I bass. During fall sampling 0-age bass were relatively uncommon in comparison to age I fish and were captured in the same habitat type. Intraspecific competition for food or space and cannibalism were the probable reasons for failure of the 1977 year class.

Standing stock of smallmouth bass in Area II was exceptional in comparison to other streams. Standing stock computed for Area II was 45 kg/ha (40 lbs/ac) while an estimate of about 9 kg/ha (8 lbs/ac) was calculated for Area I. Ranges of 52 to 83 kg/ha (46 to 74 lbs/ac) of smallmouth bass were recorded for Livingston Branch, Wisconsin (Brynildson and Troug, 1965) while a standing stock of 33 kg/ha (29 lbs/ac) was determined for Jordan Creek, Illinois (Larimore et al., 1962). A mean of 17.5 (15 lbs/ac) and 15.1 kg/ha (13 lbs/ac) smallmouth bass were estimated in the Plover and Red Cedar Rivers, Wisconsin (Paragamian and Coble, 1975), respectively,; 17.9 kg/ha (15 lbs/ac) in the Potomac River, Maryland (Sanderson, 1958) and 9.0 and 8.6 kg/ha (8 and 8 lbs/ac) for smallmouth bass in Huzzah and Courtois Creek, Missouri (Fajen, 1972).

Fishing pressure of 820 and 1,050 h/ha (332 and 425 h/ac) for Areas I and II, respectively, was greater than that supported by other streams in North America. Surber and Seaman (1949) estimated fishing pressure at 143 h/ha (58 h/ac) for the South Branch Potomac River, Maryland; Sanderson (1958) estimated 74 and 98 h/ha (30 and 40 h/ac) for Potomac River, Marlyland; Funk and Fleener (1966) found a range of 77-133 h/ha (31-54 h/ac) for Niangua River, Missouri; Fleener (1971) estimated ranges of 353-477 h/ha (143-193 h/ac) and 264-469 h/ha (107-190 h/ac) for Huzzah and Courtois Creeks, Missouri; while Paragamian and Coble (1975) found 318 h/ha (129 h/ac) for Red Cedar River, Wisconsin. Easy public access to most of the stream and lack of public fishing waters nearby are the most important reasons for the attraction to the study areas. It should be noted most fishermen were seeking crappie and channel catfish but caught and readily accepted smallmouth bass during their endeavor.

A substantial portion of the numerical density and weight of the smallmouth bass population was comprised of fish ages I and II. About 94% of the numerical population estimate was comprised of bass under 200 mm (7.9 in) while about 66% of the total weight was also of small bass. Such size structure places heavy reliance of the fishery on the younger segment of the population. Eighty-six percent of the angler catch in the Maquoketa River were age I-III while the mean size was 259 mm (10.2 in) and 242 mm (9.5 in) for Areas I and II. These findings were similar to other sport fishery surveys conducted on rivers with no minimum length limits (Brown, 1960; Paragamian and Coble, 1975; and Fleener, 1975).

Fishing mortality accounted for a substantial segment of total annual mortality of smallmouth bass in the Maquoketa River. Total annual mortalities of 62 and 66% were computed for Areas I and II, respectively, while angler exploitation was 37% and 55%.. Harvests up to 20 kg/ha (17.8 lbs/ac) were greater than total standing stocks of many bass populations across North America (Paragamian and Coble, 1975).

The large critical size of smallmouth bass in the Maquoketa River, 331-364 mm (13-14.3 in) and 510-529 mm (20.1-20.8 in) for Areas I and II, was due to excellent growth and low natural mortality, .398. The latter is a serious underestimate of true natural mortality (M). Since exploitation of bass older than age I was high it is very difficult to measure true natural mortality with precision. In a similar case, natural mortality of bass in Huzzah Creek, Missouri, was immeasureable since angler exploitation nearly equalled total annual mortality before implementation of a 305 mm (12 in) size limit (Otto Fajen, Missouri Department of Conservation, personal communication).

RECOMMENDATIONS

Continue study as outlined in this report with the following exception. Marking of bass ≥ 200 mm (7.9 in) will be done by excising the right pelvic fin and those < 200 (7.9 in) by removing a small portion of the top caudal fin. Survival of smallmouth bass ≥ 200 mm (7.9 in) will be determined by identifying bass marked in 1977 and 1978 in the creel survey and electrofishing, thus the proportions of bass marked in the two years can be used to estimate survival.

LITERATURE CITED

Ackerman, G. 1974. Turkey River investigation. pp. 83-99. *In* D. Bonneau, ed., 1973 Fisheries Completion Reports and 1974 Management Plans and Stocking Guidelines. Iowa Cons. Comm., Des Moines, Iowa. 275 pp.

Anonymous. 1976. Fishing in Iowa. Iowa Cons. Comm., Des Moines, Iowa. 49 pp.

Brown, E., Jr. 1960. Little Miami River headwater-stream investigations. Ohio Dept. Nat. Res., Div. Wildl., 143 pp.

Brynildson, C., and J. Troug. 1965. The structure of the smallmouth bass population in Livingston Branch, Iowa County, 1958-1964. Wisconsin Cons. Dept. Invest. Memo. 258. 10 pp. (Mimeo).

Cleary, R. 1956. Observations of factors affecting smallmouth bass production in Iowa. J. Wildl. Mgt. 20(4):353-359.

Degan, D. 1977. Biological survey of several smallmouth bass streams. pp. 212-216. *In* D. Bonneau, ed., 1976 Job Completion Reports 1977 Management Plan and Stocking Guidelines, Iowa Cons. Comm., Des Moines, Iowa. 411 pp.

Fajen, O. 1972. The standing crop of fish in Courtois Creek. Missouri Dept. Cons., Fed. Aid Fish and Wildl. Res. Proj. F-1-R-20, Work Plan No. 10, Job No. 1, 29 pp.

Fleener, G. 1971. A quantitative creel census of Huzzah and Courtois Creek. Missouri Dept. Cons., Fed. Aid Fish and Wildl. Res. Proj. F-1-R-20, Work Plan No. 10, Job No. 3, 18 pp.

Fleener, G. 1975. Harvest of smallmouth bass and associated species in Courtois Creek. pp. 250-256. *In* H. Clepper, ed., Black Bass Biology and Management. Sport Fishing Institute, Washington, D.C. 533 pp.

Fleener, G., J. Funk, and P. Robinson. 1974. The fishery of Big Piney River and the effects of stocking fingerling smallmouth bass. Missouri Dept. Cons., Jefferson City, Missouri, Aquatic Ser. No. 9, 32 pp.

Funk, J., and G. Fleener. 1966. Evaluation of a year-round open fishing season upon an Ozark smallmouth bass stream, Niangua River, Missouri. Missouri Dept. Cons., D-J Series 2. 21 pp.

Larimore, R., Q. Pickering, and L. Durham. 1952. An inventory of the fishes of Jordan Creek, Vermillion County, Illinois. Ill. Nat. Hist. Surv. Biol. Notes. No. 29. 26 pp.

Mayhew, J. 1973. SHAD - A computer program for the computation of age and growth statistics of fish. Iowa Fish. Res. Tech. Ser. No. 73-1. Iowa Cons. Comm., Des Moines, Iowa. 37 pp.

Paragamian, V., and D. Coble. 1975. Vital statistics of smallmouth bass in two Wisconsin rivers and other waters. J. Wildl. Manage. 39(1):201-210.

Reynolds, J. 1965. Life history of smallmouth bass, *Micropterus dolomieui* Lacèpéde, in the Des Moines River, Boone County, Iowa. Iowa State J. Sci. 39(4):417-436.

Ricker, W. 1945. A method of estimating minimum size limits for obtaining maximum yield. Copeia 1945(2):84-94.

Robson, D. and H. Regier. 1964. Sample size in Petersen mark-recapture experiments. Trans. Am. Fish. Soc. 93(3):215-226.

Sanderson, A., Jr. 1958. Smallmouth bass management in the Potomac River basin. Trans. N. Am. Wildl. Conf. 23:248-262.

Schacht, R. 1965a. Results of a voluntary creel census on northeast Iowa rivers in 1964. Iowa Cons. Comm., Quart. Rpts. 17(2):17-20.

Schact, R. 1965b. Five years of officer contact creel census on northeast Iowa streams, 1960-64. Iowa Cons. Comm., Quart. Rpts. 17(3):41-43.

Surber, E. and E. Seaman, 1949. The catches of fish in two smallmouth bass streams in West Virginia. West Virginia Cons. Comm. Tech. Bull. 1. 37 pp.

Tate, W. 1949. Growth and food habit studies of smallmouth black bass in some Iowa streams. Iowa St. Coll. J. Sci. 23(4):343-354.

Wunder, G. 1976. Management of smallmouth bass stream. pp. 205-209. *In* D. Bonneau, ed., 1975 Job Completion Reports 1976 Management Plan and Stocking Guidelines. Iowa Cons. Comm., Des Moines, Iowa. 349 pp.

ANNUAL PERFORMANCE REPORT
RESEARCH PROJECT SEGMENT

STATE: Iowa

PROJECT NO.: F-89-R-2

STUDY NO.: 602-1

JOB NO.: 2

NAME: Population Dynamics of Smallmouth Bass in the Maquoketa River and Other Iowa Streams

TITLE: Effects of habitat variation on the stream biota

Period Covered: 1 July, 1977 through 30 June, 1978

ABSTRACT: 0-age smallmouth bass and small forage species were sampled with a bag seine for eight biweekly intervals. Adult fish were captured by electrofishing. Macroinvertebrates were sampled with a drift net and zooplankton were caught by straining a standardized volume of water through a Wisconsin style plankton net. Seine hauls captured 28,549 fish of 32 species in Area I while 170 fish of 12 species were taken in Area II. Orangespotted sunfish comprised 80% of the catch in Area I while brook silversides ranked second (8%) and 0-age smallmouth bass < 1%. 0-age smallmouth bass dominated the fish samples in Area II (39%) followed by brook silversides at 38%. Electrofishing resulted in catches of 256 fish of 16 species in Area I and 723 fish of 19 species in Area II. C/E ranged from 162-700 fish in Area I and 23-388 for segments of Area II. Golden redhorse, quillback carpsucker, white sucker, hog sucker, and carp dominated the numerical catch. Abundance and diversity of benthos was greatest in gravel, cobble and bedrock habitat. Chironomidae were the most numerous benthos followed by Hydroppschidae, Baetidae, and Caenidae. Seasonal abundance of the taxa varied depending upon life cycles. Zooplankton samples were dominated by Rotifers with Cladoceran and Copepods about equally represented. Greatest abundance of zooplankton occurred in spring samples.

Author: Vaughn L. Paragamian
Fishery Research Biologist

Date prepared: 30 June, 1978

Approved by: Don Bonneau
Fishery Research Supervisor

JOB 2 OBJECTIVE

To determine the effect of habitat variation and temporal change of the numerical density and distribution of benthos, zooplankton, and forage fish in two study areas of the Maquoketa River in Delaware County.

INTRODUCTION

The objective of this study segment was to identify those organisms associated with smallmouth bass populations, their spacial and temporal distribution, and relative importance. A basic knowledge of macro and micro organisms associated with a fish population aids in further understanding the stream ecosystem.

METHODS AND PROCEDURES

Young-of-the-year fish and small forage fish populations were sampled with a 15.2 x 1.8 m x 6 mm (50 ft x 6 ft x .25 in) bag seine at biweekly intervals commencing in mid-June, for eight sampling periods. Three seine haul sites were established in each study area (Figures 5 and 6). Area I, site 1 was located below a riffle and contained cobble and gravel substrate, site 2 was silt and sand, site 3 was immediately below a lowhead dam and contained sand and cobble. Area II, site 1 was above a riffle, comprised of cobble and gravel, site 2 was comprised primarily cobble, substrate at site 3 was sand and was located below a riffle. Seine hauls consisted of one radial sweep from the stream margin, all fish, with the exception of some juvenile cyprinids, were identified and enumerated.

Fish populations were also systematically sampled with a 230 V AC electrofishing unit during August. Catch per effort hour (C/E) was calculated for each segment to determine relative abundance. Species composition by number, weight, and distribution was also determined. Sampling was conducted by traversing the margins of each segment and the elapsed time used to compute (C/E), captures were limited to fish age I and older.

Benthic populations were sampled in April and August at three stations (A, B, and C) in each area. Generally stations in each area varied in habitat and replicated samples were taken from each station. In Area I station A was a bedrock riffle, B was silt and sand region while C was a sandy region. At Area II A was a rock-riffle area, B was gravel and cobble, while C was sand. Samples were taken with a 381 x 381 mm (15 x 15 x .05 in) frame drift net with 1 mm mesh. The net was placed flush on the substrate, an area approximately the size of the net opening was disturbed down to about 75 mm (2.8 in) when possible. Samples were preserved in 70% ethanol and the organisms identified and enumerated under 1.5-6X mangification.

Zooplankton populations were sampled identical to benthos samples. Replicate samples were collected at each station by straining two 1.1 liter units of water with a Kemmerer bottle through a Wisconsin style plankton net with No. 00 silk

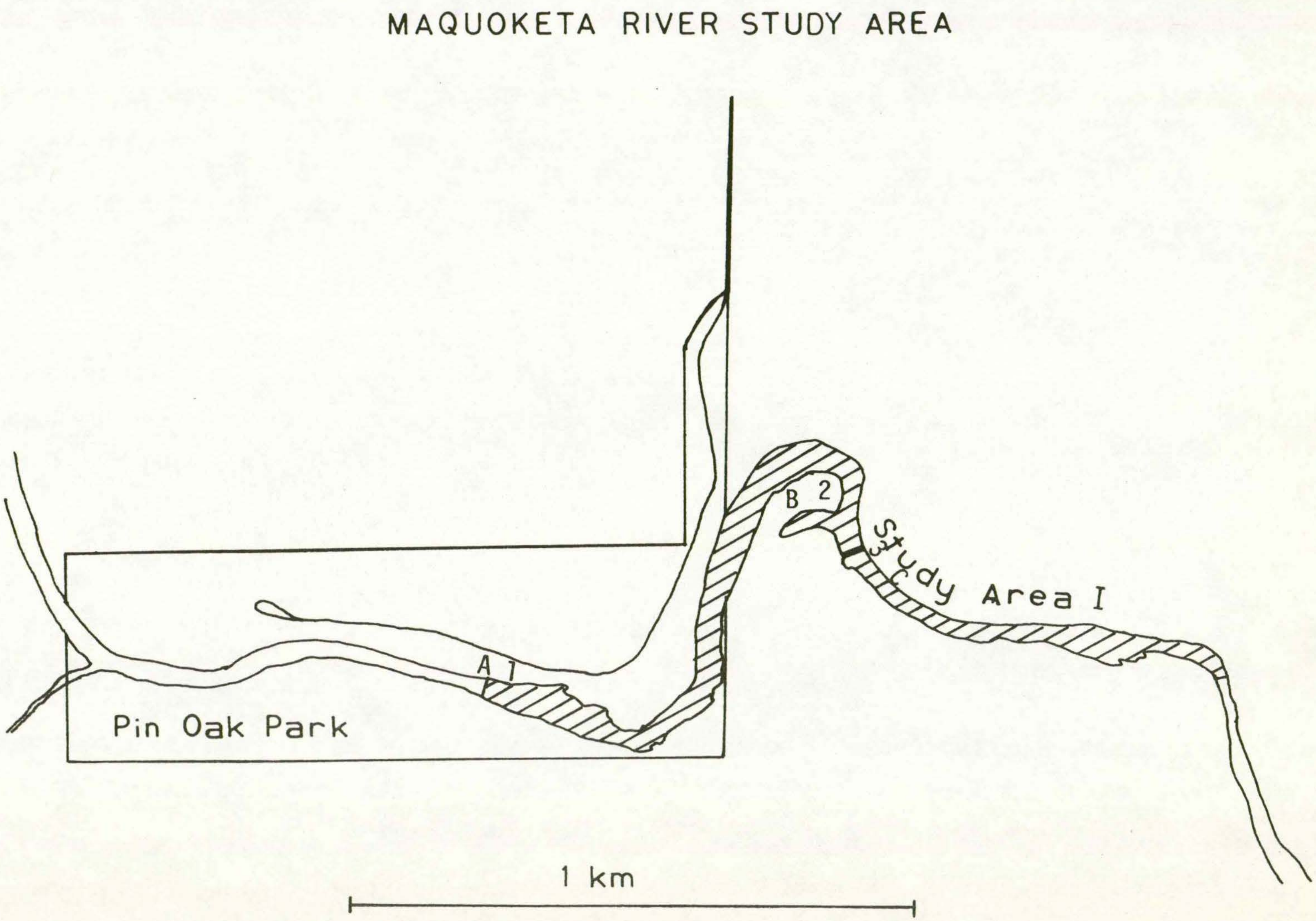

Figure 5. Maquoketa River, Area I, seine haul sites 1, 2 and 3, and benthos and zooplankton sampling stations A, B and C.

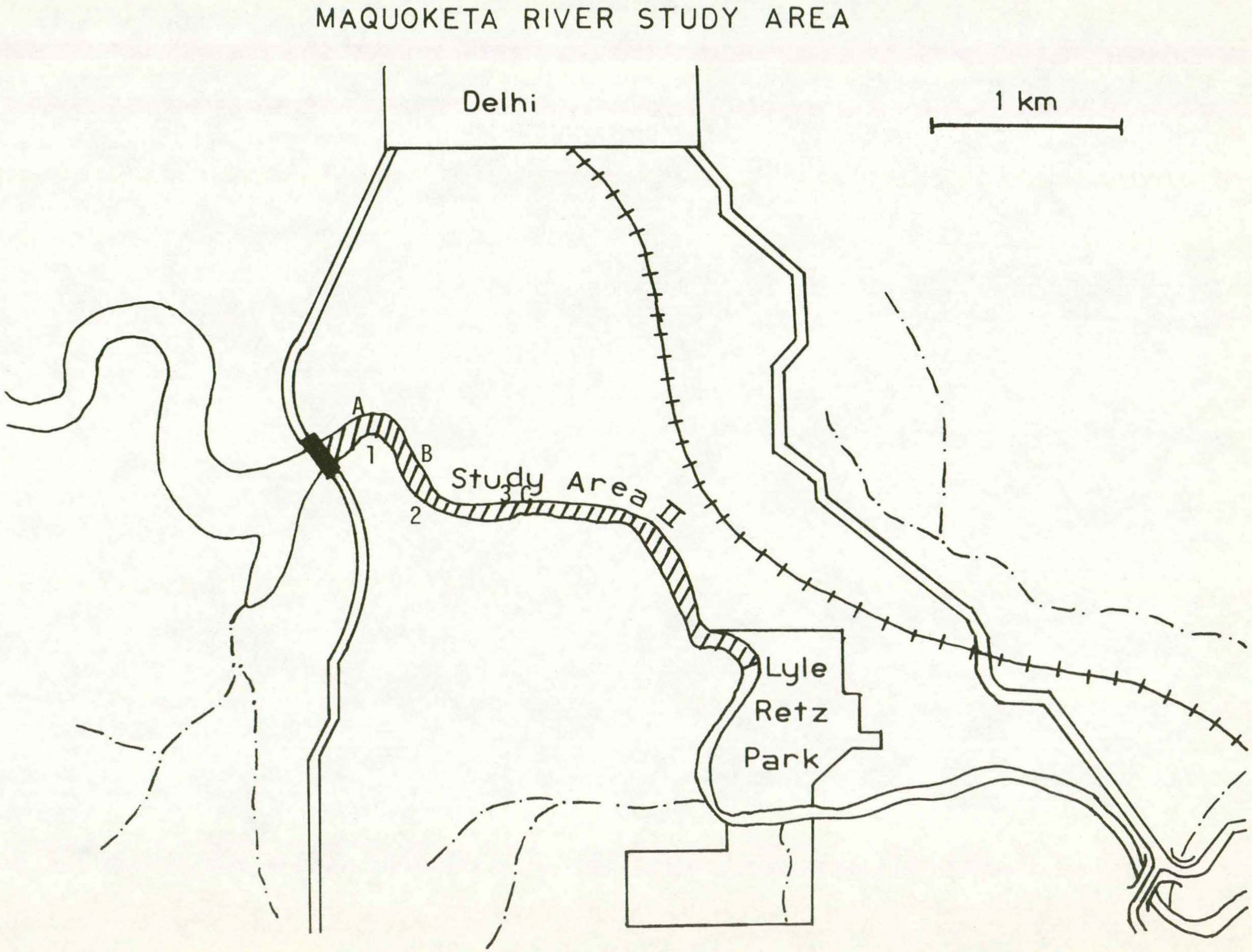

Figure 6. Maquoketa River, Area II, seine haul sites 1, 2 and 3 and benthos and zooplankton sampling stations A, B and C.

bolting. Samples were preserved in 70% ethanol. For identification and enumeration the concentrated sample was diluted to about 200 ml. Counts of zooplankton were made in five aliquots in a 1 ml Palmer nanoplankton cell. A mean of the five counts and two samples was calculated and expanded to express zooplankton density in number per liter (N/ℓ).

FINDINGS

Seine hauls captured 28,549 fish at Study Area I and 170 from Area II. The catch consisted of 32 species from Area I and 12 from Area II (Table 8).

Young orange-spotted sunfish was the most abundant species captured in Area I (76%) followed in importance by six species of *Notropis* (12%) and brook silversides (7%). Twenty-two 0-age smallmouth bass accounted for < 1% of the total catch. 0-age smallmouth bass was the most numerous species captured in Area II comprising 39% of the catch followed in importance by brook silversides, 38%, and *Notropis sp.*, 16%.

Electrofishing effort accounted for 257 fish from 16 species in Area I and 723 fish of 19 species from Area II. Total catch in weight was 86 kg (189 lbs) and 272 kg (595 lbs), respectively (Table 9). Catch per hour of effort ranged from 1-126 fish/hr for Area I and < 1-56 fish/hr for Area II. Biomass of both areas, was comprised primarily of non-sport species, about 90% of 86 kg (189 lbs) in Area I and 92% of 272 kg (595 lbs) in Area II. Quillback carpsucker, golden redhorse, and carp contributed most of the weight in the catch, while smallmouth bass was the most important sport fish.

Variations in C/E and weight of species within and between segments were obvious (Tables 10, 11 and 12). Also, the number in the catch and C/E provide the same information on population abundance. However, when annual comparisons are made C/E will provide a meaningful index to changes in relative abundance.

Four to eight orders of invertebrates were identified in samples collected during April and August at Areas I and II. Samples from three stations in Area I produced 743 invertebrates in April and 1,968 in August while in Area II benthic invertebrate totals of 591 and 91 were collected for the same periods. Individual totals for each family or genera were used to compute densities (Tables 13 and 14).

Rotifera and Cladocera were found in both sampling areas, but *Copepoda* and *C. nauplii* were sampled only in Area II (Table 15). Zooplankton density was greatest in Area II. Zooplankton density in Area I averaged 230 N/ℓ in April and 8 N/ℓ in August. Samples from Area II produced densities of 1,267 N/ℓ and 174 N/ℓ for April and August.

Table 8. Species composition of seine hauls at each seine site from study areas on Maquoketa River, June through September, 1977.

	Area I						Area II					
	Site 1		Site 2		Site 3		Site 1		Site 2		Site 3	
	N	%	N	%	N	%	N	%	N	%	N	%
R trout					1	.004						
Q carpsucker			65	8.4	280	1.0						
H sucker	2	.2	20	2.6					1	3.7	2	2.2
W sucker	2	.2	3	.4	77	.3						
G redhorse	3	.3	1	.1							4	4.3
S redhorse			1	.1								
Carp					10	.04						
Stoneroller	1	.1	1	.1	37	.1						
B minnow	1	.1	69	8.9	145	.5						
H chub					9	.03						
NC chub					14	.05						
C shiner	53	6.0	61	7.9	104	.4						
Notropis sp.	798	89.9	486	63.0	2,046	7.6			3	11.1	25	26.9
B bullhead					157	.6						
S catfish					9	.03					1	1.1
S bass	7	.8	12	1.6	3	.01	25	50.0	19	70.4	22	23.7
L bass					60	.2						
G sunfish	2	.2	1	.1	22	.08						
Pumpkinseed	1	.1										
O sunfish	1	.1	6	.8	21,561	80.2						
Bluegill	4	.5	3	.4	7	.03	1	2.0	2	7.4		
R sunfish	3	.3	1	.1	1	.004						
R bass			1	.1	6	.02						
B and W crappie	1	.1			229	.9						
B silversides	1	.1	1	.1	2,059	7.7	24	48.0	2	7.4	39	42.0
Y bass					29	.1						
W bass					10	.04						
J darter	8	.9	39	5.1	14	.05						
Total	888		771		26,890		50		27		93	

[a] Includes spotfin, spot tail, emerald, young-of-year common, red, and golden shiner, plus unidentified shiners.

Table 9. Species composition, weight, and catch per hour of electrofishing effort (C/E) for Study Areas I and II, Maquoketa River, August, 1977.

	Area I					Area II				
	N	% total number	Total weight (kg)	% total weight	C/ξ	N	% total number	Total weight (kg)	% total weight	C/ξ
Walleye						2	.3	.3	.11	.76
Y bass	1	.4	< .1	.03	1.33	4	.6	.8	.29	1.52
W bass	2	.8	.1	.04	2.67	3	.4	.8	.29	1.14
S bass	14	5.5	2.9	3.36	18.70	121	16.7	14.8	5.44	46.01
R bass	29	11.3	3.3	3.83	38.70	17	2.4	1.6	.59	6.46
L bass	2	.8	.7	.81	2.70	3	4.1	1.1	.41	1.14
G sunfish	10	3.9	.6	.70	13.30	6	.8	.4	.15	2.28
Bluegill	1	.4	< .1	.03	1.30	12	1.7	1.2	.44	4.56
B crappie	1	.4	.1	.04	1.30	1	.1	.2	.07	.38
W crappie	7	2.7	.8	.93	9.30	4	.6	.8	.29	1.52
O sunfish	1	.4	< .1	.03	1.30					
Carp	34	13.3	19.6	22.74	45.30	20	2.8	33.4	12.28	7.60
W sucker	32	12.5	10.1	11.72	42.70	101	14.0	22.7	8.35	38.40
Q carpsucker	12	4.7	4.8	5.57	16.00	124	17.2	64.0	23.54	47.15
H sucker	12	4.7	5.3	6.15	16.00	49	6.8	15.7	5.77	18.63
G redhorse	95	37.1	37.4	43.39	126.70	146	20.2	51.0	18.76	55.51
S redhorse	2	.8	1.2	1.39	2.70	96	13.3	39.7	14.60	36.50
B lamprey	1	.4	.1	.03	1.30					
C catfish						7	1.0	5.7	2.10	2.66
B buffalo						6	.8	17.6	6.47	2.28
B bullhead						1	.1	< .1	.03	.38
Total	256	100.1	86.2		341.30	723	103.9	271.9		274.88

Table 10. Species composition, weight, and catch per hour of electrofishing effort (C/E) for segments of Study Area I, Maquoketa River, August, 1977.

	Segment 1		Segment 2	
	C/E	Total weight (kg)	C/E	Total weight (kg)
Y bass			2	< .1
W bass			4	.1
S bass	52	2.8	2	.1
R bass	60	1.8	28	1.5
L bass	4	.6	2	.1
G sunfish	36	.6	2	< .1
Bluegill			2	< .1
B crappie			2	.1
W crappie	4	.3	12	.5
O sunfish	4	< .1		
Carp	36	14.7	50	4.9
W sucker	96	7.6	16	2.5
Q carpsucker	44	4.7	2	< .1
H sucker	20	2.1	14	3.2
G redhorse	340	32.7	20	4.7
S redhorse			4	1.2
B lamprey	4	< .1		
Total	700	67.0	162	19.2

Table 11. Species composition and catch per effort hour (C/E) by electrofishing segments of Study Area II.

	Segment									
	1	2	3	4	5	6	7	8	9	10
Walleye		8								
Y bass	12	4								
W bass		4	8							
S bass	32	40	92	80	36	24	40	32	28	58
R bass			24	4			8		32	
L bass					4				8	
G sunfish	8	8						3	4	
Bluegill		20	12			4	12			
B crappie		4								
W crappie	4							3	8	
Carp		24	16				16	10	4	6
W sucker	16	32	12	20	80	12	20	19	52	109
Q carpsucker	44	48	62	104	28		32	83	36	38
H sucker	4	8	12	20	52		8	16	32	32
G redhorse	32	40	64	72	108	12	44	58	88	42
S redhorse	20	36	68	80	36	40	32		12	48
C catfish			8	8			8		4	
B buffalo	12	8	4							
Bullhead							4			
Total	184	284	372	388	344	92	224	224	308	333

Table 12. Total weight (kg) of electrofishing catch in segments of Study Area II.

	Segment									
	1	2	3	4	5	6	7	8	9	10
Walleye		.3								
Y bass	.6	.2								
W bass		.4	.4							
S bass	.4	1.6	1.8	1.5	1.6	.4	1.8	2.3	1.1	2.3
R bass			.6	.1			.1		.8	
L bass					.6				.5	
G sunfish	< .1	< .1						< .1	< .1	
Bluegill		.3	.4			.1	.4			
B crappie		.2								
W crappie	.2							.2	.4	
Carp		13.3	5.9				5.8	5.0	.9	2.5
W sucker	.9	2.2	1.0	1.1	4.2	.4	1.5	1.9	4.2	5.3
Q carpsucker	5.9	7.6	7.8	13.2	3.5		5.0	13.0	3.8	4.2
H sucker	.2	.2	1.3	2.7	4.2		.7	1.2	2.9	2.3
G redhorse	2.8	2.7	6.6	8.8	10.2	.4	4.1	3.8	8.8	2.8
S redhorse	2.1	1.8	7.7	8.7	4.2	4.6	3.9		1.6	5.1
C catfish			1.2	2.3			1.4		.8	
B buffalo	9.8	5.4	2.4							
Bullhead							< .1			
Total	23.0	36.1	36.7	37.9	28.4	6.0	24.7	27.3	25.7	24.4

Table 13. Mean numerical density (N/m^2 and N/ft^2), per station, of macroinvertebrates, Maquoketa River, Areas I and II, April, 1977.

	Area I Station						Area II Station					
	A		B		C		A		B		C	
	N/m^2	N/ft^2	N/m^2	N/ft^2	N/m^2	N/ft^2	N/m^2	N/ft^2	N/m^2	N/ft^2	N/m^2	N/ft^2
Diptera												
Chironomidae	3,727	346	48	5	572	53	1,109	103	2,439	227	14	1
Simulidae	324	30										
Stratiomyidae			7	1								
Psychodidae												
Psychoda									7	1		
Ephemeroptera												
Caenidae												
Caenis	7	1					413	38	7	1		
Baetidae	303											
Coleoptera												
Elmidae												
Stenelmis	14	1					7	1				
Haliplidae												
Peltodytes							14	1				
Tricoptera												
Hydropsychidae	7	1										
Hydroptilidae	7	1										
Corixidae			96	9								
Amphipoda												
Gamarus							21	2				
Decapoda												
Orconectes							7	1				
Isopoda							28	3				
Nematoda												
Unidentifiable					7	1			7	1		
Total density	4,389	380	151	15	579	54	1,599	149	2,460	230	14	1

Table 14. Mean numerical density (N/m and N/ft), per station, of macroinvertebrates, Maquoketa River, Areas I and II, August, 1977.

	Area I Station						Area II Station					
	A		B		C		A		B		C	
	N/m^2	N/ft^2	N/m^2	N/ft^2	N/m^2	N/ft^2	N/m^2	N/ft^2	N/m^2	N/ft^2	N/m^2	N/ft^2
Diptera												
Chironomidae	2,025	188	269	24	448	42	158	15	103	10	124	12
Simulidae	14	1										
Chaoboridae												
Chaoborus									41	4		
Tipulidae	7	1										
Ephemeroptera												
Ephemeridae			48	5								
Caenidae							14	1	7	1		
Baetidae	909	85										
Tricorythidae												
Tricorythodes	7	1										
Coleoptera												
Elmidae												
Stenelmis	41	4									28	3
Tricoptera												
Hydropsychidae	9,507	884			14	1						
Hydroptilidae	41	4			14	1						
Coleoptera												
Corixidae			193	18								
Amphipoda												
Gamarus	7	1										
Nematoda			14	1			14	1	103	10	76	7
Total density	12,558	1,169	524	48	476	44	186	17	254	25	228	22

Table 15. Zooplankton density (N/ℓ), mean of combined sites by area, and period, Maquoketa River, 1977.

	Area I		Area II	
	April	August	April	August
Rotifera	200	4	1,237	156
Cladocera	30	4	4	14
Copepoda	0	0	18	4
C. nauplii	0	0	18	0
Total	230	8	1,267	174

DISCUSSION OF FINDINGS

Total seine catch at Area I was over 100-fold greater than that of Area II despite the fact Area II had considerably more habitat diversity. Several factors were responsible, about 96% of the catch in Area I was taken at site 3. Site 3, located approximately 8 m (26 ft) downstream of a lowhead dam formed a barrier to upstream movement of small fish, had higher oxygen level in comparison to other regions of the stream, and contained habitat diversity. Thus, site 3 was not representative of Area I as were sites 1 and 2 which were predominately silt and sand. A second factor was the greater abundance of smallmouth bass in Area II versis Area I, 741 bass/ha (307 N/ac) and 88 bass/ha (36 N/ac), respectively. The high predator density in Area II undoubtedly resulted in a high predation. In addition 2 of three sample sites of Area II was comprised of cobble and boulder substrate. The larger rock of this area made it impossible to make a seine haul without snagging the net on the numerous rocks, as a consequence many fish escaped during the process of dislodging the net. Difficulty in making seine hauls was also experienced at site 1 of Area I because of some cobble substrate however the high predator base was absent from this region.

Non-sport fish dominated the species composition and biomass of the Maquoketa River study area, which is typical of streams inhabited by smallmouth bass (Fajen, 1972; Ackerman, 1974; and Fleener et al., 1974). Golden redhorse, quillback carpsucker, white sucker, hog sucker, carp, and other non-game species comprised 60% by number and 90% of the weight in the electrofishing catch. Smallmouth bass contributed 14% by number and 5% by weight.

The greater numerical abundance and diversity of macroinvertebrates at gravel, cobble, and/or bedrock sample sites in comparison to silt and sand regions of the Maquoketa River is typical of benthic communities. Hynes (1972) concluded that as the stones of the substratum increased in size it added to the complexity of the benthic habitat and in turn produced a more diverse invertibrate fauna, he added that sand was a poor habitat thus offered little to diversity or abundance. Factors not studied in this investigation that are also important to the abundance of macroinvertebrates include current velocity, temperature, oxygen and other water chemistry parameters.

From this limited study it appears that as a family Chironomidae are the least specialized in habitat needs, occupying all segments of the stream that were studied. While Chironomids were found at all sample sites their greatest abundance was found at rocky sites. Only Nematoda were found at a similar abundance in sand as well as rock. Fauna that were specific to rock substrate were Baetidae, Caenidae, and Hydropschidae.

Species composition of the benthic community was dominated by Chironomidae and to a lesser extent by Baetidae and Hydropschidae. It was not possible to determine whether one or more Chironomidae species were dominant during the two study periods. One shortcoming of a qualitative sampling scheme was apparent by the change in the abundance of Hydropschidae and Simulidae between April and August. It is common knowledge that some organisms will appear and disappear during a series of sampling periods depending on whether or not the organism is multi- or univoltine.

Microinvertebrate sampling in the Maquoketa River indicated a typical lotic fauna comprised primarily of Rotifera and secondarily of Cladocera and Copepoda (Eddy, 1932 and Hynes, 1972). Hynes (1972) noted that Cladocerans and Copepoda are seldom abundant in running waters.

Differences in zooplankton densities between study areas was due to planktonic life in Hartwick Lake. Zooplankton densities of Area II were nearly six-fold greater than Area I in April and 19 times greater in August. This also is a common phenomenon (Eddy, 1932 and Cushing, 1964).

Most of the zooplankton produced in the Maquoketa River undoubtedly originates in backwaters. Hynes (1972) believes that even active zooplankton cannot maintain themselves against slight flows of several millimeters per second thus most zooplankton populations cannot develop.

Several factors influenced the seasonal abundance of zooplankton in the Maquoketa River. Discharge rate during April sampling was not sufficiently different from August to cause a flushing effect of life in backwater regions. The most probable reason was due to natural seasonal population trends as demonstrated by Walburg, et al. (1971) and Mayhew (1977).

RECOMMENDATIONS

Continue sampling of fish populations as outlined in this report. Collections of macro- and micro-invertebrates should be terminated since the objective was accomplished. Qualitative determination of the taxa present and their distribution was completed.

LITERATURE CITED

Ackerman, G. 1974. Turkey River investigation. pp. 83-99. *In* D. Bonneau, ed., 1973 Fisheriés Completion Reports and 1974 Management Plans and Stocking Guidelines. Iowa Cons. Comm., Des Moines, Iowa. 275 pp.

Cushing, C. 1964. Plankton and water chemistry in the Montreal River lake-stream system, Saskatchewan. Ecology 45:306-13.

Eddy, S. 1932. The plankton of the Sangamon River in the summer of 1929. Ill. Nat. Hist. Surv. Bull. 19(5):469-486.

Fajen, O. 1972. The standing crop of sih in Courtois and Huzzah Creek. Missouri Dept. Cons., Fed. Aid Fish and Wildl. Res. Proj. F-1-R-20, Work Plan No. 10, Job No. 1, 29 pp.

Fleener, G., J. Funk, and P. Robinson. 1974. The fishery of Big Piney River and the effects of stocking fingerling smallmouth bass. Missouri Dept. Cons. Aquatic Series 9, 32 pp.

Hynes, H. 1972. The ecology of running waters. Univ. of Toronto Press. 555 pp.

Larimore, W., Q. Pickering, and L. Durham. 1952. An inventory of the fishes of Jordan Creek, Vermillion County, Illinois. Biol. Notes No. 29, Ill. Nat. Hist. Survey. 26 pp.

Mayhew, J. 1977. The effects of flood management regimes on larval fish and fish-food organisms at Lake Rathbun. Iowa Fish. Res. Tech. Series No. 77-2. Iowa Cons. Comm., Des Moines, Iowa. 46 pp.

Walberg, C., G. Kaiser, and P. Hudson. 1971. Lewis and Clark Lake tailwater biota and some relations of the tailwater and reservoir fish populations. pp. 449-467. *In* G. Hall ed., Reservoir Fisheries and Limnology. Amer. Fish. Soc. Special Publ. No. 8, 511 pp.

ANNUAL PERFORMANCE REPORT

RESEARCH PROJECT SEGMENT

STATE: Iowa

PROJECT NO.: F-89-R-2

STUDY NO.: 602-1

JOB NO.: 3

NAME: Population Dynamics of Smallmouth Bass in the Maquoketa River and Other Iowa Streams

TITLE: Physical and chemical characteristics of the Maquoketa River

Period Covered: 1 July, 1977 through 30 June, 1978

ABSTRACT: Physical characteristics of two areas of the Maquoketa River, Delaware County, were measured. Eleven water chemistry parameters were monitored monthly at both areas. Seven substrate particle sizes were distinguished and these ranged from silt < .2 mm (< .01 in) to boulders ≥ .6 m (24 in). Comparison of substrate composition was made by determining the distribution and proportional make up of particle size and combining the results into associated subgroups. Silt and sand comprised 80% of the substrate in Area I, while Area II contained 78% gravel and cobble substrate. Mean monthly stream discharge rate ranged from 4.55 CMS (160 CFS) in October to 1.07 CMS (38 CFS) in January. Gradient of Area I was .51 m/1,000 m (.51 ft/1,000 ft) while that of Area II was .57 m/1,000 m (.57 ft/1,000 ft). Bass abundance in relation to habitat was determined by simple regression analysis. Statistical analysis showed the density and standing stock of smallmouth bass to be positively associated to the proportion of cobble and gravel substrate in a curvilinear relationship.

Author: Vaughn L. Paragamian
Fishery Research Biologist

Date prepared: 30 June, 1978

Approved by: Don Bonneau
Fishery Research Supervisor

JOB 3 OBJECTIVE

To measure the physical characteristics and chemical composition of two study areas of the Maquoketa River and associate these variables to the abundance of smallmouth bass.

INTRODUCTION

General habitat requirements for smallmouth bass are common knowledge, however, the association between habitat quality, quantity and abundance of smallmouth bass is poorly documented.

Water chemistry characteristics in most northeast Iowa streams are similar, species composition of micro- and macro-organisms are generally the same, and soil types are generally common to the streams. The greatest difference appears to be the diversity of the various substrates and stream size. This study segment aids in devising a stream classification system based on physical and chemical components.

METHODS AND PROCEDURES

Study areas were mapped and gradients measured with an alidade, transit, plane table and stadia rod using standard survey procedures. The prevailing stream margin was measured and at 10 m (35 ft) intervals a perpendicular transect to the adjacent bank was taken. Each transect was subdivided into 1 m (3.3 ft) intervals to sample substrate and measure depth. This information as well as other structure was recorded on maps. Substrate type was identified by 7 particle size ranges (Table 16). Particle samples were visually inspected or squeezed between fingers to determine texture and then assigned to the category most fitting.

Table 16. Substrate classification system and numerical code.

Particle size interval	Code number	Name of loose aggregate
≥ .6 mm	B	Boulders
> 256 mm	1	Boulder-gravel
64-256 mm	2	Cobble-gravel
16- 64 mm	3	Coarse pebble gravel
2- 16 mm	4	Fine pebble gravel
.2- 2 mm	5	Sand
< .2 mm	6	Silt

Maps were brought into the laboratory to measure area, width, lengths, compute gradient, and to place depth contours at 0-.5, 1, 1.5, 2, and > 2 m intervals (0-1.6, 3.3, 4.9, 6.6 and > 6.6 ft). This was accomplished with a planimeter and a metric ruler. Each study area was subsequently divided into segments and each segment was distinguished by a riffle-pool. Study segments were further measured with grid paper to determine proportion of substrate types and the area within depth contours.

Monthly discharge rates for 1976 and 1977 were obtained from USGS. Two water collection sites were established on the Maquoketa River, one at Pin Oak County Conservation Board Park, centrally located in Study Area I, and a second 20 m (66 ft) downstream from Delhi Dam in Area II. Water samples were transported to the laboratory for immediate analysis utilizing a Hach kit. Dissolved oxygen (DO) was analyzed on site. Additional parameters measured were: pH, alkalinity, hardness, nitrates, nitrites, orthophosphate, metaphosphate, total inorganic phosphate, total organic phosphate, and total phosphate.

FINDINGS

STUDY AREA AND SEGMENT DIMENSIONS

Study Area I contained 3.97 ha (9.8 ac) and was 1.44 km (.9 mi) length. Study Area II was 10.02 ha (24.8 ac) and was 3.54 km (2.2 mi) long (Table 17). Area I was divided into two segments with mean depths of .76 (2.5 ft) and .25 m (.9 ft). Area II contained ten segments with mean depths ranging from .30-1.02 m (1-3.3 ft). Maximum depths of Area I were .8 m (2.6 ft) and 3.0 m (9.8 ft) for Segments 1 and 2, respectively; while, maximum depths in Area II ranged from .6 m (2.0 ft) for Segment 6 to 4.9 m (16 ft) for Segment 1.

DEPTH CONTOURS

Proportion of surface area within .5 m (1.6 ft) depth intervals were also computed (Table 18). Segment 1 of Area I contained the greater proportion of water, of the two segments, deeper than 1 m (3.3 ft), 11% as opposed to none. Of the ten segments in Area II, Segment 2 in Area II contained the greatest amount of water deeper than 1 m, 39% of the surface area. Conversely, Segments 6 and 10 were devoid of a water deeper than 1 m (3.3 ft).

SUBSTRATE

Substrate aggregates were combined into subgroups to simplify analysis of substrate proportions and distribution (Table 19). All study segments contained the same types of substrate but the proportions and combinations varied considerably

DISCHARGE RATES

Mean monthly discharge rates in 1976 ranged from 11.17 CMS (394 CFS) in March to 2.02 CMS (71 CFS) in September (Table 20). Mean values in 1977 ranged from 4.55 CMS (160 CFS) in October to 1.07 CMS (38 CFS) in January.

Table 17. Physical dimensions of the Maquoketa River study areas and segments.

Area	Segment	Length (Km)	Mean width (M)	Surface area (ha)	Mean depth (M)	Maximum depth (m)
I	1	.94	29.0	2.73	.76	3.0
I	2	.49	23.9	1.23	.26	0.67
Total		1.44		3.97		
II	1	.26	38.7	1.06	.77	4.9
II	2	.27	28.2	0.77	1.02	3.7
II	3	.33	32.9	1.08	.47	0.9
II	4	.56	27.1	1.59	.40	1.9
II	5	.18	23.4	0.42	.44	1.2
II	6	.19	26.2	0.54	.30	0.6
II	7	.20	19.5	0.50	.77	1.2
II	8	.62	24.7	1.60	.54	1.8
II	9	.26	23.4	0.81	.46	1.8
II	10	.62	25.3	1.60	.30	0.9
Total		3.54		10.02		

Table 18. Proportion of segment surface area within .5 m depth intervals.

Area	Segment	0-.5	.5-1	1-1.5	1.5-2	2+
I	1	49.8	38.5	6.4	3.5	1.7
	2	97.2	2.8	---	---	---
II	1	48.6	35.4	4.6	1.9	9.4
	2	33.2	28.2	11.6	12.9	14.1
	3	57.7	42.6	0.5	---	---
	4	76.0	19.2	2.8	2.0	---
	5	62.5	36.8	0.7	---	---
	6	89.6	10.4	---	---	---
	7	62.5	33.3	4.7	---	---
	8	48.2	45.5	5.7	0.6	---
	9	67.2	24.2	7.4	1.2	---
	10	90.0	10.0	---	---	---

Table 19. Substrate composition in each segment of Areas I and II of the Maquoketa River, 1977.

Area	Segment	Percent Silt - Sand	Percent Fine Gravel - Cobble	Percent Cobble - Boulder	Percent bedrock
I	1	92.9	22.4	12.3	9.8
	2	74.0	25.4	3.7	36.9
II	1	1.9	77.8	44.4	0
	2	3.3	89.2	16.0	0
	3	31.6	92.3	25.5	0
	4	77.2	71.5	24.7	0
	5	69.2	94.7	12.8	0
	6	86.9	95.1	3.8	0
	7	93.8	85.5	6.2	0
	8	94.9	67.4	4.7	0
	9	80.8	90.2	16.6	0
	10	81.6	64.7	0	0

Table 20. Estimated discharge rate[a], cubic meters per second (CMS) for the Maquoketa River at Delhi Dam, 1976 and 1977.

Month	1976			1977		
	Mean (CMS)	Minimum	Maximum	Mean (CMS)	Minimum	Maximum
January	2.48	2.02	3.41	1.07	0.92	1.23
February	6.80	2.02	21.63	4.41	1.14	16.19
March	11.17	5.39	66.41	3.78	2.35	5.75
April	7.39	4.12	16.06	2.99	2.43	3.21
May	6.33	4.33	10.56	2.79	2.15	4.10
June	3.55	2.85	4.92	1.83	1.49	4.90
July	2.75	2.30	5.51	3.22	1.43	15.24
August	2.41	2.08	3.31	3.18	1.83	6.77
September	2.02	1.31	3.38	3.94	1.92	19.86
October	2.09	1.28	2.54	4.55	3.14	6.25
November	2.14	1.55	2.85	3.81	2.01	4.74
December	1.43	0.85	2.40	3.16		

[a]Based on measurements taken at gauging station at Maquoketa, Iowa. Values were then derived by computing the watershed area at Delhi as 22.3% of that at Maquoketa.

STREAM GRADIENT

Stream gradients of the two study areas were similar but varied within segments. Area I had a total fall of .74 m (2.4 ft) or a gradient of .51 m/ 1,000 m (.51 ft/1,000 ft) while Area II dropped 2.03 m (6.66 ft) with a gradient of .57 m/1,000 m (.57 ft/1,000 ft) (Table 21). Segment 2 of Area I had the most acute gradient of all study segments, 1.33 m/1,000 m (1.33 ft/1,000 ft), while Segment 1 of Area II had the least with a gradient of .13 m/1,000 m (.13 ft/ 1,000 ft).

WATER CHEMISTRY

Fourteen water chemistry parameters were monitored monthly since November, 1977 (Tables 22 and 23). Dissolved oxygen and temperature showed the greatest temporal variation.

Table 21. Gradient of the Maquoketa River study areas and segments, in meters (m).

Area	Segment	Fall (m) Riffle	Fall (m) Pool	Segment total	fall/1,000 m
I	1	---	.08	.08	.08
	2	.27[a]	.40	.66	1.33
Area total fall				.74	
Total gradient					.51
II	1	37.13[b]	.03	.03[c]	.13
	2	.10	.01	.10	.38
	3	.10	.07	.17	.49
	4	.23	.14	.37	.65
	5	.11	.05	.16	.87
	6	.11	.08	.18	.92
	7	.26	.01	.27	1.31
	8	.20	.08	.27	.44
	9	.16	< .01[d]	.16	.59
	10	.27	.05	.32	.51
Area total fall				2.03	
Total gradient					.57

[a]Head at low head dam.

[b]Head at Delhi Dam.

[c]Does not include head of Delhi Dam.

[d]Fall was unmeasurable.

Table 22. Water chemistry parameters in mg/ℓ at Area I, Maquoketa River, November, 1977-June, 1978.

	November	December	January	February	March	April	May	June
Nitrate nitrogen	5.0	7.0	8.0	6.0	5.0	8.0	8.0	6.5
Nitrite nitorgen	.05	.04	.04	.03	.05	.04	.03	.07
pH	9.0	8.5	8.5	8.0	8.5	8.5	9.0	9.0
Total alkalinity	205.0	137.0	240.0	240.0	188.0	154.0	172.0	205.0
Ortho phosphate	.16	.30	.82	.40	.90	.40	.50	.34
Meta phosphate	.14	.30	.12	.20	.20	.19	.10	.16
Organic phosphate	.16	.10	.08	.10	.10	.20	.30	.70
Hardness ($CaCO_3$)	274.0	205.0	257.0	257.0	188.0	223.0	223.0	223.0
Dissolved oxygen	13.0	11.0	11.0	12.0	15.0	9.0	10.0	8.0
Temperature °C	5.0	0.0	0.0	0.0	0.0	6.0	13.0	16.5

Table 23. Water chemistry parameters in mg/ℓ at Area II, Maquoketa River, November, 1977-June, 1978.

	November	December	January	February	March	April	May	June
Nitrate nigrogen	5.0	7.0	7.0	6.0	5.0	6.0	8.0	8.5
Nitrite nitrogen	.09	.03	.02	.02	.03	.02	.04	.10
pH	9.0	8.5	8.5	8.5	8.5	8.5	8.5	9.0
Total alkalinity	172.0	188.0	205.0	240.0	205.0	120.0	154.0	205.0
Ortho phosphate	.10	.28	.36	.40	.44	.40	.70	.30
Meta phosphate	.60	.22	.14	.40	.06	.20	.10	.10
Organic phosphate	.10	.10	.10	.20	.06	.20	.90	.90
Hardness ($CaCO_3$)	274.0	257.0	257.0	240.0	257.0	188.0	305.0	257.0
Dissolved oxygen	15.0	12.0	13.0	10.0	14.0	9.0	9.0	7.0
Temperature °C	5.0	0.0	0.0	0.0	0.0	7.0	11.0	18.0

HABITAT PREFERENCE OF BASS

Habitat preference of smallmouth bass was determined by simple regression analysis. Density and standing stock of two size groups of bass were compared to the proportion of various substrate aggregates and to proportions of other physical features of segments. Two segments were omitted from testing, Segment 2 of Area I was not used because of a serious bias in population estimates and Segment 6 of Area II was not used because it lacked pool structure and fish.

The best predictor found was a transformed simple linear regression of bass abundance on proportion of gravel and cobble aggregates (code sizes 4, 3, and 2). The model took the form

$$\log_e Y = \alpha + \beta X$$

where

$\log_e Y$ = transformed density or standing stock of smallmouth bass

α = intercept

β = slope

X = substrate proportion

Four accurate predictor models were computed, two for bass densities and two for standing stocks (Table 24). Statistical testing in a t-distribution rejected the null hypothesis, $\beta = 0$, and the regression of bass abundance on proportion of gravel and cobble was significant ($P < .05$). Increases in the proportions of bass habitat increased the abundance of smallmouth bass in a curvilinear fashion.

Association of other variables were not statistically important in predicting smallmouth bass abundance in this study.

DISCUSSION OF FINDINGS

Study areas of the Maquoketa River contained substrate that ranged in size from silt to bedrock, the distribution and quantities of these components varied between segments. Study Area I is characterized as marginal smallmouth bass habitat containing vast stretches of silt and sand with little associated physical structure. Area II can be distinguished as having excellent smallmouth bass habitat. The area is comprised primarily of cobble and gravel substrate with numerous boulders, a minimal quantity of sand and silt, and distinct pools and riffles. The arbitrary classification of these study areas is substantiated by the findings of Job 1.

A small change in the proportion of cobble and gravel substrate could increase the abundance of smallmouth bass at a curvilinear rate. This phenomenon was most evident in the comparisons of smallmouth bass < 200 mm (7.9 in) to the proportion of cobble and gravel. Using the predictor equation a segment of river could contain 50% smallmouth bass habitat with a corresponding density 149 bass/ha (61 N/ac), a 25% increase in gravel and cobble would increase the density to

Table 24. Predictive models of proportion gravel and cobble-sized substrate to density and standing stock of smallmouth bass and values used in their statistical analysis.

Population parameter vs substrate size	$\log_e Y = a + b X$	S_b	95% C.I.	R^2
Density of bass < 200 mm vs proportion 4, 3, and 2	$\log_e Y = 2.63 + 4.75 X$[a]	.85	6.71 2.79	79%
Density of bass ≥ 200 mm vs proportion 4, 3, and 2	$\log_e Y = 1.52 + 2.87 X$[b]	.96	5.08 .66	52%
Standing stock of bass < 200 mm vs proportion 4, 3, and 2	$\log_e Y = -.43 + 4.69 X$[a]	1.01	7.02 2.37	72%
Standing stock of bass ≥ 200 mm vs proportion 4, 3, and 2	$\log_e Y = .52 + 2.71 X$[b]	1.14	5.34 .08	41%

[a]Significant at .01 level.

[b]Significant at .05 level.

89 bass/ha (200 N/ac). With a 25% increase in habitat smallmouth bass density could increase 300%. Comparisons for larger bass were also statistically significant, but not as evident. Other factors important to bass abundance and distribution are pool depth, exploitation and natural mortality.

Analysis of boulder and cobble substrate to the abundance of bass did not provide significant predictors. Although all age groups of smallmouth bass were captured among large boulders, cobble, and gravel young bass were not as abundant among boulders as they were in areas of cobble. The most likely reason for this observation is that the habitat is more diverse in smaller particle sized cobble and gravel and more young bass existed among these rocks than larger boulders, particles of a size smaller than gravel were too small to provide cover.

The qualitative association of smallmouth bass to gravel, cobble and boulder substrate as well as pools of moderate current is well documented in the literature (Larimore et al., 1952; Fajen, 1962; Munther, 1970; and Paragamian, 1976).

With the preponderance of information linking smallmouth bass to habitat it is evident that habitat is usually the limiting factor as to whether or not bass are present while fishing may ultimately determine population structure. Thus, protection of the stream enviornment is of paramount importance. Aiken (1936) recognized the principal need in order to preserve the native fauna of streams in Iowa was to protect stream habitat from agricultural siltation, via poor land use.

RECOMMENDATIONS

Mapping of the Maquoketa River is complete and the objectives accomplished with the exception of measuring current velocities. Current velocities will be measured.

LITERATURE CITED

Aiken, W. 1936. The relation of soil erosion to stream improvement and fish life. J. For. 34(12):1059-1061.

Fajen, O. 1962. The influence of stream stability on homing behavior of two smallmouth bass populations. Trans. Amer. Fish. Soc. 91(4):346-349.

Larimore, R., Q. Pickering, and L. Durham. 1952. An inventory of fishes of Jordan Creek, Vermillion County, Illinois. Illinois Nat. Hist. Surv. Biol. Notes. No. 29. 26 pp.

Munther, G. L. 1970. Movement and distribution of smallmouth bass in the Middle Snake River. Trans. Amer. Fish. Soc. 99(1):44-53.

Paragamian, V. 1976. Population characteristics of northern pike in the Plover River, Wisconsin. Prog. Fish Cult. 38(3):160-163.

ANNUAL PERFORMANCE REPORT

RESEARCH PROJECT SEGMENT

STATE: Iowa

PROJECT NO.: F-89-R-2

STUDY NO.: 602-1

JOB NO.: 4

NAME: Population Dynamics of Smallmouth Bass in the Maquoketa River and Other Iowa Streams

TITLE: Population characteristics of smallmouth bass in other northeast Iowa streams

Period Covered: 1 July, 1977 through 30 June, 1978

ABSTRACT: Smallmouth bass populations were sampled in Coffins Grove, Volga, Upper Iowa, and Turkey Rivers to determine population characteristics by electrofishing. Fish were measured, weighed and scale samples collected prior to release. Average back calculated growth rates for bass in Coffins Grove were 94, 176, 260, and 307 mm (3.7, 6.9, 10.2 and 12.1 in), for ages I-IV; 87, 156, 243, and 309 mm (3.4, 6.1, 9.6 and 12.2 in) for ages I-IV in Volga River; 98, 166, 219, 278, 318, 342, 412, and 430 mm (3.9, 6.5, 8.6, 10.9, 12.5, 13.5, 16.2, and 16.9 in) for ages I-VIII in Upper Iowa; and 111, 196, 277, 340, 387, and 460 mm (4.4, 7.7, 10.9, 13.4, 15.2 and 18.1 in) for ages I-VI in the Turkey River. Estimated bass growth for this investigation was greater than presented by earlier investigators. Annual mortality ranged from 42% in the Upper Iowa River to 55% in the Turkey River. Populations were comprised primarily of small, young fish. Catch per hour of electrofishing effort ranged from 73 bass/hr in the Upper Iowa River to 3.5 bass/hr in Coffins Grove Creek.

Author: Vaughn L. Paragamian
Fishery Research Biologist

Date prepared: 30 June, 1978

Approved by: Don Bonneau
Fishery Research Supervisor

JOB 4 OBJECTIVE

To assess the abundance, growth, condition, age structure, size structure, and mortality of smallmouth bass in study areas of Coffins Grove Creek, Upper Iowa, Volga, and Turkey Rivers and compare these statistics with those in the Maquoketa River study area.

INTRODUCTION

Smallmouth bass are indigenous to nearly all northeast Iowa rivers and many smaller streams. While smallmouth bass are native to these waters relative abundance varies widely. This segment of study documents the vital population characteristics of bass in several streams.

LOCATION OF STUDY AREAS

Coffins Grove, located in Delaware County, is a tributary of the Maquoketa River. The study area (T89N, R6W, Sec. 26 and 27) was bounded by a combination of timbered and pastured land. Substrate ranged from silt to boulder with sand predominant. Three sampling locations were established on the Turkey River, two in Fayette County (T94N, R7W, Sec. 3 and 14) and one in Clayton County (T93N, R5W, Sec. 34). Study areas in Fayette County contain smallmouth bass habitat with intermittent pools and riffles comprised of gravel, cobble, and sand. Land use was mainly corn row crops. The Clayton County study area was located upstream from the Elkader impoundment and the substrate was comprised of silt and sand and devoid of pool structure. One study area on the Upper Iowa River was located in Winneshiek County (T95N, R7W, Sec. 8 and 9) and the other in Allamakee County (T99N, R6W, Sec. 2, 3, 8, 9, 10, and 11). This region of the Upper Iowa River is characterized by rugged landscape, primarily pasture and timber. Substrate was primarily cobble with intermittent pools and riffles. A single sampling station was established on the Volga River located at the Volga River Recreation Area in Fayette County (T39N, R3W, Sec. 14). This segment of the Volga River is in forest land. Riffle substrate is cobble, boulders, and gravel while boulders and silt predominate in the pools. The Volga River is tributary to the Turkey River.

METHODS AND PROCEDURES

Smallmouth bass populations were sampled during June, 1977 with a 220 V AC boom shocker in the Upper Iowa and Turkey Rivers and a 110 V DC stream shocker in Coffins Grove Creek and the Volga River. Bass were measured in total length (TL), weighed, scale sample taken from 100 fish or the entire sample, and released. Electrofishing catch effort (C/E) was computed by maintaining a record of time elapsed between trials and the numerical catch.

Visual observations were used to determine bottom type.

Scale impressions were made on cellulose acetate slides, .76 x 75 x 130 mm (.04 x .04 x 5.1 in), at 3,000 psi on a scale press. Scale impressions were viewed on a scale projector at a magnification of 40X, annuli counted and measurements made along the anterior scale radius (ScR). Scale aging was verified by a second experiened viewer, little disparity was encountered, however, in such a case a brief discussion was ended by the decision of the second reader, the biologist. Scale measurements, lengths and weights were processed through the SHAD computer program (Mayhew, 1973).

Annual mortality and instantaneous total mortality were calculated from sample age distribution.

FINDINGS

CATCH

During the season 41 smallmouth bass ages I-IV were captured in the Volga River (Table 25). Electrofishing in the Turkey River resulted in a catch of 133 bass ranging from ages I-VI. Sampling of the Upper Iowa River yielded a catch of 184 bass ages I-VI with one age VIII. Effort in Coffins Grove Creek produced a catch of 38 bass ages I-IV.

WEIGHT-LENGTH RELATIONSHIPS AND CONDITION FACTORS

Weight-length relationships computed for each population are listed in Table 26. K-factors were computed for each 15 mm (.6 in) class interval of each sample and the population mean computed from these data (Table 26).

Differences between the weight-length relationships of smallmouth bass populations were significant ($P < .05$) (Table 27). A statisitcal comparison of the b values in a t-distribution revealed bass in the Turkey and Upper Iowa Rivers had different slopes than those of the Volga River and Coffins Grove Creek.

GROWTH

Body-scale regressions for smallmouth bass were best described by the least squares equations

$TL = 37.48 + 2.03\ ScR$	Volga River
$TL = 54.04 + 1.80\ ScR$	Turkey River
$TL = 45.83 + 1.82\ ScR$	Upper Iowa River
$TL = 43.23 + 1.94\ ScR$	Coffins Grove River

These relationships were used to back calculate total length at each annulus by age class for each bass population (Figure 7).

Table 25. Length frequency distribution for smallmouth bass captured by electrofishing the Volga, Turkey, and Upper Iowa Rivers and Coffins Grove Creek, 1977.

		Volga River		Turkey River		Upper Iowa River		Coffins Grove Creek	
		N	%	N	%	N	%	N	%
70- 89	1.2- 1.9	1	2						
90-109	2.0- 2.7	5	12	2	2			4	11
110-129	2.8- 3.5	9	22	10	8	1	< 1	5	13
130-149	3.6- 4.3	3	7	8	6	12	7	7	18
150-169	4.4- 5.1			10	8	37	20	3	8
170-189	5.2- 5.9			10	8	23	13	1	3
190-209	6.0- 6.7	8	20	3	2	7	5	1	3
210-229	6.8- 7.5	5	12	11	8	21	11	5	13
230-249	7.6- 8.2	2	5	18	14	38	21	6	16
250-269	8.3- 9.0	2	5	17	13	20	11		
270-289	9.1- 9.8	1	2	12	9	6	3	2	6
290-309	9.9-10.6	2	5	11	8	5	3	3	8
310-329	10.7-11.4			5	4	5	3	1	3
330-349	11.5-12.2	3	7	5	4	5	3	1	3
350-369	12.3-13.0			6	5	4	2		
370-389	13.1-13.8			1	< 1				
390-409	13.9-14.6			1	< 1				
410-429	14.7-15.4								
430-449	15.5-16.1			1	< 1				
450-469	16.2-16.9			1	< 1	1	< 1		
470-489	17.0-17.7			1	< 1				
Total		41		133		184		38	

Table 26. Weight-length relationship, mean K-factors, and range of K-factors for smallmouth bass, June, 1977.

	Weight-length relationship	Range of K-factor	Mean K factor
Volga River	$\log_{10}W = -5.01 + 3.03 \log_{10}TL$	1.01-1.38	1.16
Turkey River	$\log_{10}W = -5.25 + 3.15 \log_{10}TL$	1.00-1.51	1.29
Upper Iowa River	$\log_{10}W = -5.26 + 3.17 \log_{10}TL$	1.27-1.82	1.45
Coffins Grove Creek	$\log_{10}W = -4.94 + 3.01 \log_{10}TL$	1.05-1.54	1.27

Table 27. Statistical comparison of weight-length relationship of smallmouth bass sampled from four Iowa rivers.

	b	S_b	N	t
Volga River	3.03	.021	43	2.014[a]
Turkey River	3.15	.013	121	1.980
Upper Iowa River	3.17	.015	119	1.980
Coffins Grove Creek	3.01	.043	36	2.030[a]

[a]Significant at the 95% level.

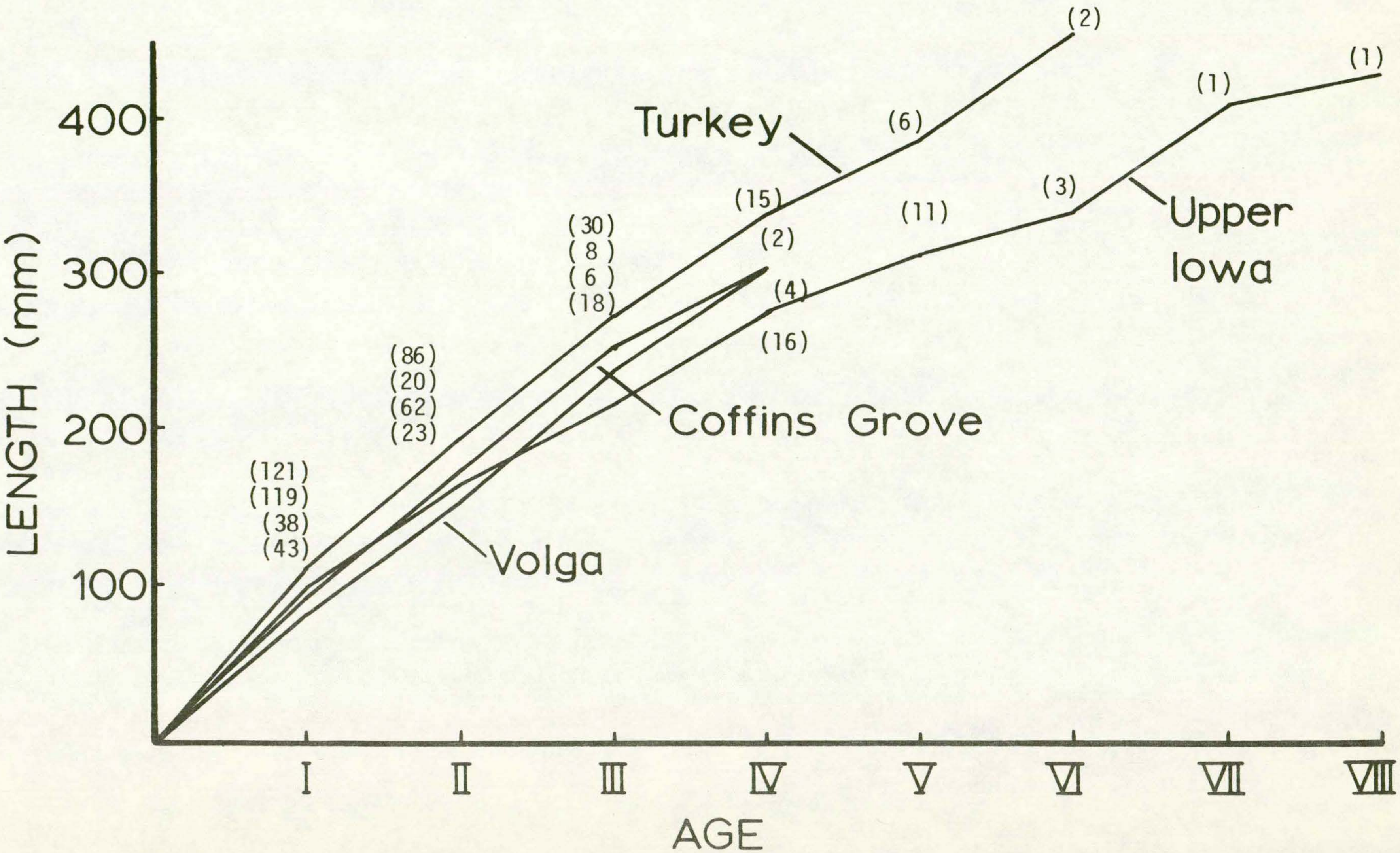

Figure 7. Average back calculated lengths of smallmouth bass in four streams in Iowa, 1977, sample size in parenthesis.

CATCH EFFORT AND DISTRIBUTION

Relative abundance of smallmouth bass varied considerably between rivers and within regions (Table 28). Greatest C/E of bass was recorded in the Upper Iowa River, 61.2 bass/hr, while the lowest was recorded in Coffins Grove Creek, 3.5 bass/hr. Differences in C/E values were most pronounced for the Turkey River where C/E ranged from 64 bass/hr to 16.8 bass/hr.

Table 28. Catch effort (bass/hr) of smallmouth bass in four study waters in northeast Iowa, 1977.

	Sampling segment	Catch	Catch effort bass/hr
Volga River	A	44	31.1
Turkey River	A	49	39.2
	B	32	64.0
	C	7	16.8
Total		88	40.7
Upper Iowa River	A	127	72.6
	B	60	46.2
Total		187	61.3
Coffins Grove Creek[a]	A	7	3.5

[a]Catch effort could not be calculated because of mechanical problems with electroshocker.

MORTALITY

Estimates of annual mortality, calculated from catch curves, were 50% for bass ages I-IV in the Volga River, 55% for fish ages II-VI in the Turkey River, 42% for bass ages I-VIII in the Upper Iowa River, and 54% for bass ages I-IV in Coffins Grove Creek (Table 29).

Table 29. Annual mortality, instantaneous total mortality, and correlation coefficient of smallmouth bass in four study rivers.

	A	Z	r
Volga River	50%	-.69	.80
Turkey River	55%	-.79	.99
Upper Iowa River	42%	-.53	.83
Coffins Grove Creek	54%	-.76	.99

DISCUSSION OF FINDINGS

Smallmouth bass populations of four study streams were similar to those reported in other investigations (Tate, 1949; Ackerman, 1974; Wunder, 1976; Degan, 1977). These populations were comprised primarily of small, young bass; 86% of the bass in the Volga River, 75% of the bass in the Turkey River, 85% of the bassin the Upper Iowa River, and 79% of the bass in Coffins Grove Creek were ages I and II. The severe loss of older bass is though to be due to angling mortality. Bass in these Iowa streams reach an acceptable length to many fishermen by their second year of life, 175-200 mm (6.9-7.9 in). It was also noted that large bass 300+ mm (11.8 in) were seldom captured within .5 km (.3 mi) of fishing access.

Growth of smallmouth bass in streams of this investigation were greater than that computed by other invesitgators for bass in the same waters. Calculations of grwoth for bass in Coffins Grove was the same at age I as reported by Tate (1947) but were 25 mm (1 in) greater at age II and about 50 mm (2 in) more at ages II and IV in this investigation. Bass in the Turkey River attained the same length at age I in this and Ackerman's investigation (1974) but back calculations for older fish were longer, 50 mm (2 in), in this study. Calculations of growth in this study for bass taken from the Upper Iowa River were about 25 mm (1 in) greater during their first two years of life than that reported by Wunder (1976) but were similar at older ages.

Variations in year calss strength of smallmouth bass were apparent in several bass populations. The 1975 year class of bass in the Turkey and Upper Iowa Rivers were well represented comprising 46% and 37% of the catch, respectively. In addition, the 1972 year class in the Upper Iowa River represented 7% of the catch at age V. The 1974 year class of bass from the Volga and Upper Iowa Rivers was poorly represented, 5% an- 2% of the catch, respectively. Preliminary information indicates some uniformity in year class strength between streams regionally. A better understanding of factors affecting year calss strength will be attained later in the study.

Abundance of cobble and gravel substrate within pools was the primary factor influencing smallmouth bass distribution and catch success. Pools comprised primarily of silt and sand contained few, if any, bass. The Upper Iowa River contained the preferred substrate and the highest C/E of 72 bass/hr on one segment, versus 16.8 bass/hr at the Elkader impoundment on the Turkey River. The lowest catch effort was on Coffins Grove Creek, 3.5 bass/hr, however this information was seriously biased because of mechanical problems with the stream electroshocker.

The only fish older than age IV were found in the Turkey and Upper Iowa Rivers. Gear avoidance by larger bass was felt to be the reason. Mechanical problems were encountered with the stream electrofishing unit and as a result several large bass were seen but not caught. Habitat selection offers yet another explanation, larger bass may have occupied the deepest pools that were about 1.5 m (4.9 ft) and could not be sampled efficiently with the stream electrofishing unit. Two other possible reasons are severe cropping of bass in the small streams by anglers and insufficient habitat for larger bass.

Variations in turbidity affected catch success. Although turbidity was not measured it was difficult to see stunned bass in turbid waters and in clear water many bass were observed swimming around the perceptive zone of the electrofishing unit. Reynolds (1978) found catch success of largemouth bass was unimodally related to water turbidity. Catches of bass were lowest at high turbidities and very clear water with the greatest catches generally being taken at a point between the two extremes.

RECOMMENDATIONS

Coffins Grove Creek and the Volga River should be resampled to obtain a suitable sample of the population. Sampling of the Turkey and Upper Iowa Rivers should be terminated since sufficient information was taken from bass populations of these rivers.

LITEATURE CITED

Ackerman, G. 1974. Turkey River investigations. pp. 83-99. *In* D. Bonneau, ed., 1973 Fisheries Completion Reports 1974 Management Plan and Stocking Guidelines. Iowa Cons. Comm., Des Moines, Iowa. 275 pp.

Degan, D. 1977. Biological survey of several smallmouth bass streams. pp. 212-216. *In* D. Bonneau, ed., 1976 Job Completion Reports 1977 Management Plan and Stocking Guidelines, Iowa Cons. Comm., Des Moines, Iowa. 411 pp.

Mayhew, J. 1973. SHAD - A computer program for the computation of age and growth statistics of fish. Iowa Fish. Res. Tech. Ser. No. 73-1. Iowa Cons. Comm., Des Moines, Iowa. 37 pp.

Reynolds, J. 1978. Problems related to efficiency and stock assessment by electrofishing. Mimeo. Univ. of Missouri Coop. Fish. Res. Unit. Columbia, Missouri. 4 pp.

Tate, W. 1949. Growth and food habit studies of smallmouth black bass in some Iowa streams. Iowa St. Coll. J. Sci. 23(4):343-354.

Wunder, G. 1976. Management of a smallmouth bass stream. pp. 205-209. *In* D. Bonneau, ed., 1975 Job Completion Reports 1976 Management Plan and Stocking Guidelines. Iowa Cons. Comm., Des Moines, Iowa. 349 pp.