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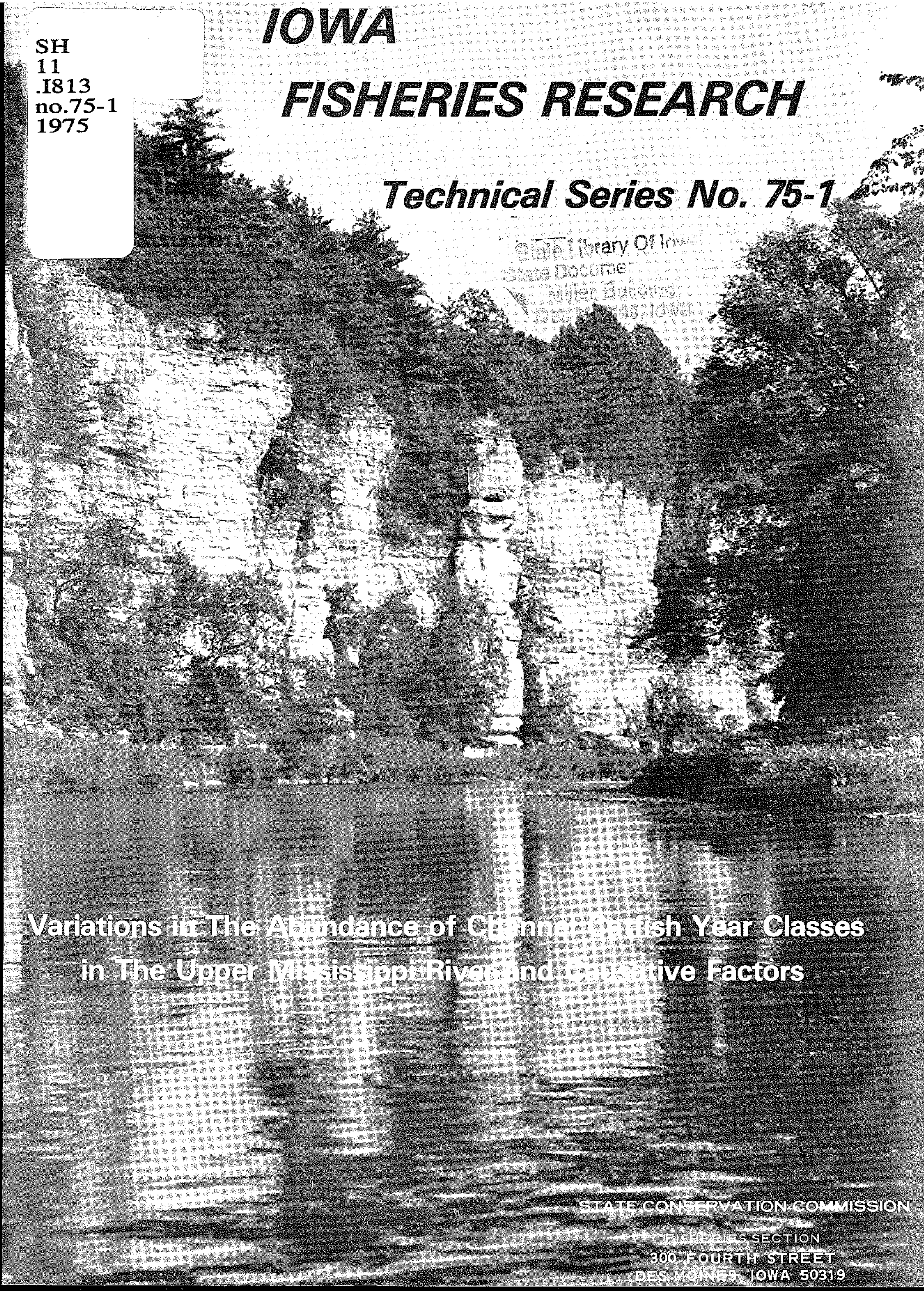

Variations in The Abundance of Channel Catfish Year Classes in The Upper Mississippi River and Causative Factors

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VARIATIONS IN THE ABUNDANCE OF CHANNEL CATFISH YEAR CLASSES IN THE UPPER MISSISSIPPI RIVER AND CAUSATIVE FACTORS[1]

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ABSTRACT

Vital statistics for channel catfish were described for Pools 9, 11, 13 and 18 in the Mississippi River to determine differences in year class abundance and causative factors. The 1970 year class was the most abundant. Very poor year classes occurred in 1971 and 1972. The 1973 year class was slightly better than 1974. Year class abundance of channel catfish was established in the first year of life during spawning or hatching. No cause and effect relationships could be correlated with pesticides in eggs, ovarian parasites, fecundity or water level fluctuations. Spawning time and intensity was correlary to water temperature, but had no direct association to establishment of year class strength. Turbidity also influenced spawning, but was not adequately measured to determine its total effect. Factors that were suspected to be involved, but not evaluated in this study, were adult population density, abundance of predator and competator species, food availability, and the quality of spawning habitat. More than a single factor obviously affects year class abundance. Trawling in the main channel of the stream during August was determined to be the most satisfactory method of surveying year class strength of 0-age channel catfish.

INTRODUCTION

Channel catfish is a valuable commercial food fish in the upper Mississippi River basin. Annual harvest from 1953-1964 averaged over 1.75 million lbs with more than 70% of the catch taken adjacent to Iowa (Nord, 1967). Iowa fishermen reported annual harvests up to 800,000 lbs. At current market prices the wholesale value exceeds $300,000.

Fishing pressure is quite high along the river resulting in cropping soon after channel catfish reach the 13 inch legal size limit (Helms, 1967). Changes in year class abundance cause large annual harvest fluctuations. Increasing the statutory size limit from 13 inches to 15 inches was recommended as a remedial measure for reduction of what appeared as overharvest of immature fish (Helms, 1969). Weight of the fishery would increase with these restrictions by permitting growth in standing crop before cropping and minimize fluctuations in harvest by reducing dependence of the fishery on fewer year classes. The proposed increase in the legal size limit met strong opposition from commercial fishermen because the smaller catfish which can be used for individual serving by restaurants are in greatest demand.

The current study had two principle objectives. First, to determine causes of variation in year class abundance; and second, to develop and evaluate a survey technique which can be used to determine year class strength and predict potential yield.

DESCRIPTION OF STUDY AREAS

Channel catfish populations from four of the 11 navigation pools bordering Iowa were selected for investigation. These include Pool 9 near Lansing, Pool 11 near Dubuque, Pool 13 near Bellevue and Pool 18 near Burlington (Figure 1).

Pool 9 extends from river mile (RM) 679.2 to 647.9, encompassing 27,900 surface acres. Aquatic habitat consists of .3% tailwaters, 7.9% main channel, 5.9% main channel border, 4.8% side channel, 35.3% slough and 45.8% lake (Helms, 1968). Water quality is excellent with no major metropolitan pollution sources. Though water clarity is generally higher than downstream pools, silt turbidity is introduced periodically via the Upper Iowa River, the mouth of which is located at RM 671.1. Dense growths of aquatic vegetation are present throughout most of the shallow backwater habitats. The five year mean (1969-1973) commercial fish harvest from Pool 9 is 76.4 lbs/A. Catfish contribute 6.8% or 5.2 lbs/A.

Pool 11 extends from RM 615.1 to 583.0. Aquatic habitat comprises 19,600 surface acres consisting of .3% tailwaters, 11.9% main channel, 8.9% main channel border, 7.7% side channel, 10.6% slough and 60.7% lake. Pool 11 is also devoid of major metropolitan and industrial sources of pollution. Water clarity is often low because of silt from agricultural land runoff introduced by the Turkey River at RM 608.2 and other small tributary streams. Turbidity is quite pronounced following periods of heavy rainfall. Overall commercial fish harvest

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[1]Study was partially financed by Project 2-178-R; Commercial Fisheries Research and Development Act (PL 88:309) administered by the National Marine Fisheries Service, NOAA.

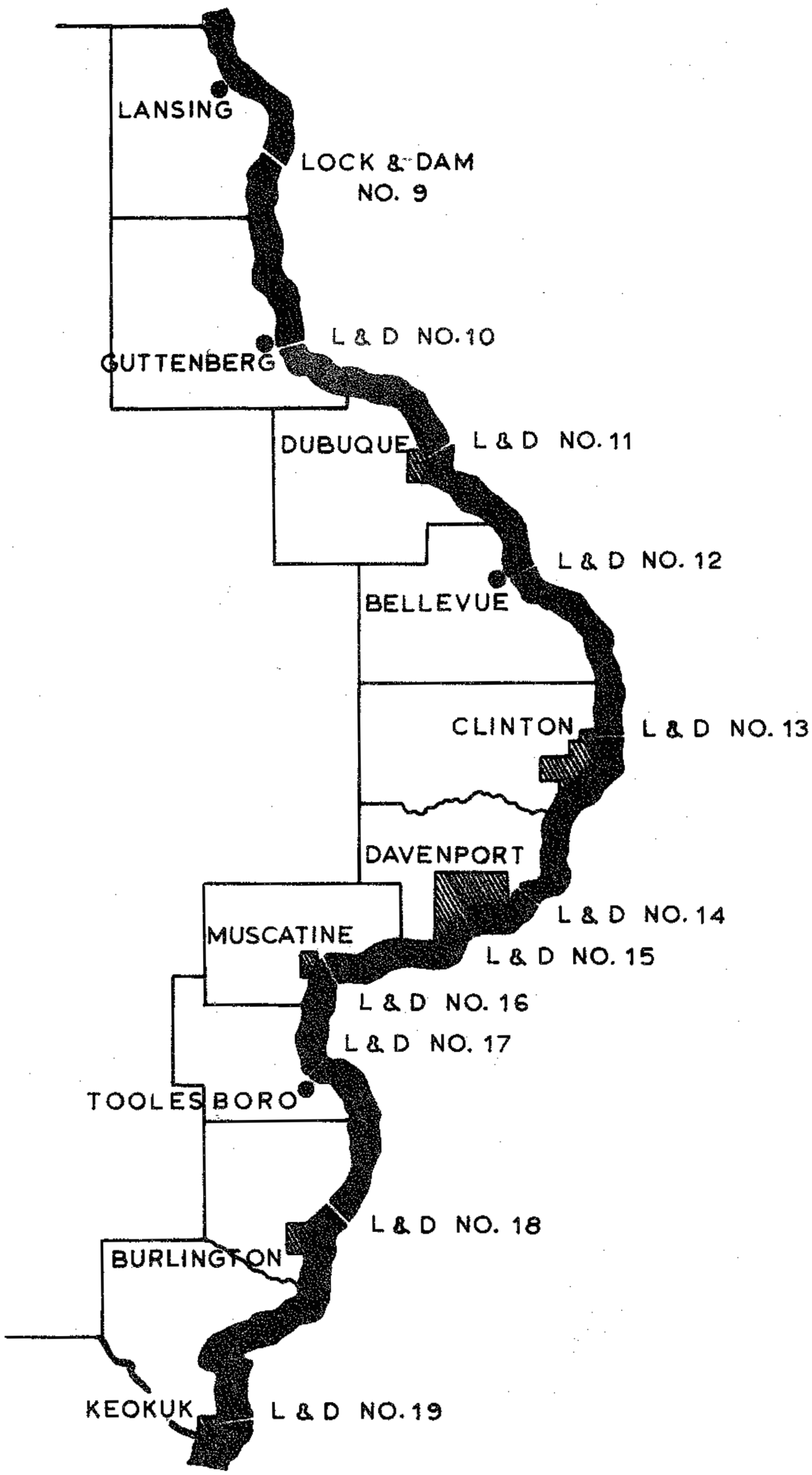

Figure 1. Location of pools sampled for channel catfish in Mississippi River.

is considerably lower than Pool 9 with 26.3 lbs/A. Catfish harvest is similar, 5.9 lbs/A, and contributed 22.8% of the fishery.

Pool 13 is located between RM 556.7 and 552.5. It encompasses 26,970 surface acres consisting of .3% tailwaters, 10.1% main channel, 10.1% main channel border, 4.9% side channel, 10.1% slough and 64.5% lake. Although generally devoid of metropolitan sources of pollution, *Sphaerotilus* originating at Dubuque (RM 578) is abundant throughout the pool during late winter during some years (Helms, 1970). Pool 13 is increasingly more turbid because of agricultural runoff from local tributary streams, especially the Maquoketa River at RM 548.7. Harvest of commercial fish in Pool 13 is 27.1 lbs/A. Catfish harvest is about 4.3 lbs/A, 15.2% of the total catch weight.

Pool 18 extends from RM 437.1 to 410.5 and contains an area of 12,650 surface acres. Backwaters and lake habitats make up a smaller fraction of the area of this pool than in other pools. Habitat consists of .7% tailwaters, 22.1% main channel, 20.5% main channel border, 14.8% side channel, 10.5% slough and 31.6% lake. Pool 18 contains heavy silt turbidity throughout much of the year, and submerged aquatic vegetation is nearly absent in most of the pool. *Sphaerotilus* originating at Muscatine (RM 453) is present during winter months. The total commercial harvest, 64.6 lbs/A, is nearly as high as in Pool 9 and exceeds all pools in catfish harvest with a catch of 9.3 lbs/A, 14.5% of the total catch weight.

CHANNEL CATFISH REPRODUCTION POTENTIAL

The first year of life is most important in establishing year class abundance for most fish species. Investigations of variation in channel catfish year class strength commenced with an effort to determine spawning potential. Observations on spawning success and young survival until the size limit was reached followed.

The investigations of spawning potential included fecundity, analysis of eggs for pesticides and ovary examination for parasites.

FECUNDITY

Fecundity data (Table 1) were collected in all four pools during each season, 1972-1974, from 277 fish ranging in size from 13.0 inches (.55 lbs) to 28.8 inches (12.5 lbs). Ova were counted in 10 ml aliquots from ovaries preserved in 10% formalin. Total ova counts ranged from 2,894 to 36,376.

Linear regression equations for total length and weight on ova were completed using the simple functions Y = a + b TL and Y = a + b Wgt, where Y = total ova, TL = total body length in inches and Wgt = body weight in lbs. Coefficient for solution of the equation were as follows: Ova = -19,999 + 1,887 TL and Ova = 5,238 + 3,356 Wgt. Sixty-eight percent of the variation in ova counts were explained by length and 66% by weight.

Table 1. Sample size and body measurements of channel catfish examined for fecundity from four pools of the Mississippi River.

	Pool 9	Pool 11	Pool 13	Pool 18
Sample size				
1972	21	18	16	26
1973	22	17	17	17
1974	30	30	32	31
Range in body length in inches				
1972	15.4-21.9	13.5-25.7	14.2-23.3	13.2-20.3
1973	13.1-22.5	13.3-25.8	13.1-26.0	13.0-24.0
1974	13.4-22.0	13.8-25.5	13.9-28.8	13.0-24.3
Range in body weight in lbs				
1972	1.27-4.13	.94-6.65	.98- 5.23	.77-3.20
1973	.86-4.41	.85-7.95	.88- 7.70	.88-5.35
1974	.99-4.32	.96-7.30	.92-12.50	.58-4.50

Multiple regression of TL and Wgt on ova ($Y = a + b_1TL + b_2Wgt$) was: Ova = -10,200 + 1,137 TL + 1,430 Wgt. About 69% of the variation was explained by the independent variables.

Separate calculations of linear regressions and multiple regressions of TL and Wgt on ova were made to determine differences between pools and years (Tables 2 and 3). All years were found to be statistically identical ($P > .05$), and there was no significant difference between pools for length on ova. There was a significant difference ($P < .05$) between some pools in regresison of weight on ova. Intercept (a) was greater in Pool 11 than Pools 13 and 18, and slope (b) was greater in Pool 18 than for Pools 11 and 13.

Overall egg production averaged 6,088 ova/lbs of fish with a standard deviation of ± 1,858. There were no significant differences between pools or years in egg production (Table 4).

PESTICIDES IN OVARIES

Ovaries were analyzed for pesticide content as a possible factor influencing production of young. Sampling was designed to delineate differences between years, pools, and size of fish. Two size groups (13-15 and 17-19 inches) of fish were selected for analysis. Composite samples from each size were collected from commercially harvested fish during spawning seasons in 1972-1974 (Table 5). Samples were wrapped in aluminum foil, sealed in plastic bags and frozen until collections were completed.

Table 2. Simple linear regression components of total body length and weight on ova number by pool in the Mississippi River.

Parameter	Pool 9	Pool 11	Pool 13	Pool 18
Total length on ova				
Sample size	73	65	63	75
Intercept (a)	-14,610	-15,542	-25,499	-18,985
Standard error of a (S_a)	-3,657	-3,501	-2,407	-2,024
Slope (b)	1,587	1,702	2,172	1,778
Standard error of b (S_b)	210	185	128	118
Coefficient of determination (R^2)	45%	57%	82%	76%
Weight on ova				
Sample size	73	65	63	75
Intercept (a)	3,825	8,453	4,398	2,087
Standard error of a (S_a)	1,189	1,268	536	727
Slope	4,120	2,520	2,482	4,671
Standard error of b (S_b)	500	344	143	336
Coefficient of determination (R^2)	49%	47%	91%	73%

Table 3. Multiple linear regression components of total body length and weight on ova number in four pools of the Mississippi River.

Parameter	Pool 9	Pool 11	Pool 13	Pool 18
Sample size	73	65	63	75
Intercept (a)	6,287	-37,058	3,969	-15,835
Standard error of a (S_a)	9,351	-9,806	4,409	-6,000
Coefficient b_1	-204	3,304	30	308
Standard error of b_1 (S_{b_1})	-769	707	308	501
Coefficient b_2	4,608	-2,765	3,438	749
Standard error of b_2 (S_{b_2})	1,909	-1,183	471	1,342
Coefficient of determination (R^2)	49%	61%	91%	76%

Table 4. Fecundity expressed as eggs per pound and the standard deviation for channel catfish by pool and year.

	Number of ova per each pound of body weight			
Pool	1972	1973	1974	Mean
9	6,526 ± 1,171	5,818 ± 3,228	6,344 ± 1,996	6,229 ± 2,234
11	6,713 ± 2,104	6,106 ± 1,760	6,249 ± 2,140	6,356 ± 2,008
13	5,748 ± 1,090	6,184 ± 1,442	6,390 ± 1,871	6,107 ± 1,575
18	6,355 ± 1,351	4,910 ± 1,146	5,711 ± 1,482	5,659 ± 1,482
Mean	6,336 ± 1,470	5,755 ± 2,154	6,174 ± 1,863	6,088 ± 1,858

Table 5. Number and size of fish selected for ovary pesticide analysis by pool and year.

Location	Size range in inches	Sample size 1972	1973	1974
Pool 9	13-15	--	6	7
	17-19	11	6	7
Pool 11	13-15	1	4	6
	17-19	8	1	7
Pool 13	13-15	3	4	5
	17-19	6	3	7
Pool 18	15	10	4	5
		10	4	9

Analyses were contracted by an independent firm using procedures identical to those reported by Morris and Johnson (1969). Pesticides quantitatively identified were: DDT, DDE, DDD, opDDT, Dieldrin and Heptachlor Epoxide.

The first tests were made to determine differences between large and small fish. Samples from Pool 18 taken in 1972 were selected for this comparison. Differences in concentrations of the pesticides (Table 6) did not vary sufficiently by size group to warrant separate analysis so remaining samples were pooled.

Table 6. Comparison of ovary pesticide levels of two size groups of channel catfish from Pool 18, 1972, in parts per billion (ppb).

Size range in inches	Pesticide (ppb) DDT	DDE	DDD	opDDT	Dieldrin	Heptachlor Epoxide
13-15	7	7	10	4	18	3
17-19	10	9	18	6	29	3

Test results showed very low pesticide levels, presumably having no effect on spawning. Ranges of pesticide content for the six compounds are listed in Table 7 by pool and year. No important patterns or trend over time or location were exhibited except for Dieldrin. Dieldrin ranged from 5 ppb in Pool 9, 1972, to 103 ppb in Pool 18, 1974, a systematic increase both in time and downstream locations. The present concentrations were not considered high enough to affect spawning, but continued elevation might cause serious consequences. Higher concentrations of Dieldrin in downstream pools is contributed by accumulated agricultural runoff associated with soil erosion where Aldrin is used for the control of corn rootworm (Morris and Johnson, 1970).

Table 7. Pesticide content of channel catfish ova in ppb by pool and year.

	1972	1973	1974	Mean
Pool 9				
DDT	.010	.009	.020	.013
DDE	.007	.007	.011	.008
DDD	.003	.007	.020	.010
opDDT	.005	.006	.010	.007
Dieldrin	5	5	13	8
H. Epoxide	.006	.005	.010	.007
Pool 11				
DDT	.005	.010	.016	.010
DDE	.003	.007	.008	.006
DDD	.002	.003	.016	.007
opDDT	.003	.006	.009	.006
Dieldrin	10	12	13	12
H. Epoxide	.003	.006	.009	.006
Pool 13				
DDT	.003	.008	.005	.005
DDE	.003	.004	.005	.004
DDD	.002	.003	.004	.003
opDDT	.002	.005	.003	.003
Dieldrin	13	18	29	20
H. Epoxide	.002	.008	.004	.005
Pool 18				
DDT	.009	.017	.005	.010
DDE	.008	.015	.005	.009
DDD	.014	.009	.009	.011
opDDT	.005	.010	.003	.006
Dieldrin	24	99	103	75
H. Epoxide	.003	.005	.013	.007

OVARIAN PARASITES

During previous studies worm-like parasites, presumably a fluke, were observed in ovaries of channel catfish in Pool 18. As a result, surveillance for this parasite was conducted during the present study for the purpose of associating the incidence of occurrence with young-of-the-year production.

Single ovaries collected in May and June for fecundity were examined for parasites. During the 3-year study period, none of the flukes were observed. Previous occurrence of ovarian parasites was mot likely an isolated infestation of minor importance.

SEASONAL SPAWNING ACTIVITY

Knowledge of the time, intensity and success of spawning was important in the study. Since precise measurement of these parameters was impossible, information and samples collected at commercial landings were used to make subjective estimates. A popular and successful method of capturing catfish during spawning season is to bait nets with several gravid female catfish. Overall catch success by this fishing method was the basis for evaluating spawning activity. Fishermen were questioned about dates of spawning runs, catch peaks, egg deposition in nets and the effects of changes in river conditions on catch success.

Because of the vast number of variables, it was difficult to associate environmental parameters with spawning activity. Temperature, turbidity and water level greatly affected spawning period catch success. Temperature decline or increase in turbidity lowered catch rates by reducing spawning activity. High water level resulted in spawning on wooded islands not generally accessable to conventional fishing techniques.

The information from fishermen was often conflicting. Much of this resulted from differences in gear, fishing techniques, types of areas fished and segments of the pool fished. Different pool segments varied considerably in depth, turbidity, and current velocity. Spawning occurred somewhat earlier in upper pool areas than in the more sluggish and often deeper downstream portions. Water warmed more quickly in the shallow back water and fishermen reported early spawning. Lower catch success was also reported by the onset of mud-laden water. Thus, sudden turbidity often affected the commercial fishing below tributary streams and not those fishing above nor near the opposite bank.

SPAWNING CHRONOLOGY OF CHANNEL CATFISH

The 1972 spawning season appeared to be similar in all pools. Initial spawning was observed between 17-20 May. Most gravid females taken during this period were redistributed among nets as bait. Peak harvest occurred 26-29 May and was followed by a sharp reduction in catch 30 May through 2 June. Harvest increased from 4-10 June with few spawners taken after 15 June.

The 1973 spawning run extended for a longer period than 1972 after beginning at a later date. Gravid females were not captured until the end of May and some fishermen expressed belief the run started on 7 or 8 June. First eggs were observed in nets on 10, 12, 9 and 16 June in the four pools, respectively. Peak activity was judged to have occurred from 10-15 June in Pools 11, 13 and 18, but no discernable peak was reported in Pool 9.

Cold rain and muddy water was responsible for a sharp decline in catch after 15 June in Pool 18, while a more gradual decline after 15 June in Pools 11 and 13 was attributed to cooling temperature. Most fishermen agreed the spawning run was complete by 22-25 June in the three upper pools and by 28-30 June in Pool 18.

The 1974 spawning season was later and extended longer than the 1973 season. Some fishermen, particularly in Pools 13 and 18 reported taking small numbers of spawners 24-26 May, but few were taken before 1 June. Most fishermen agreed the major run began 4-10 June and continued until the first week of July.

RELATIONSHIP BETWEEN SPAWNING CHRONOLOGY AND ENVIRONMENTAL FACTORS

Examination of water temperature and gage height data suggested catch success during spawning was most closely related to temperature, particularly with respect to initial spawning activity, which in most instances began about 65 ^{0}F on 16 May. This temperature was not attained in 1973 until 2 June. In 1974, 65 ^{0}F was exceeded on 22-23 May only to drop below this temperature until the end of the month. Initial catches and presumably incipient spawning activity corresponded with these dates.

Seasonal differences in catch success were also reflected by river stage and turbidity associated with land runoff. River discharge was higher in 1973 than 1972, particularly in lower pools. Pools 11, 13, and 18 remained 5-9 ft above 1972 levels and commercial fishermen experienced difficulty taking fish both because of increased current velocity in traditional fishing grounds and a tendency for catfish to spawn in inaccessable wooded areas.

In comparison, river stage was less exaggerated at Pool 9. During 1972, river stage dropped throughout the 15 May-15 June period from 28 to 25 ft. The river stage began at 29 ft on 15 May, 1973 and crested 4 ft above 1972 levels on 1 June and returned to 25 ft on 15 June. In 1974, river levels crested on 20 May and rose again beginning 1 June continuing throughout much of the spawning period and crested 20 June in Pool 9 and 25 June in Pool 18.

QUALITY OF COMMERCIAL CATCH DURING SPAWNING

Although records of catfish catches during spawning for previous years were not available, most fishermen indicated 1972 was nearly normal in all pools. Water levels were below stages which floods timbered areas and the effects of high water causing spawning to occur in timbered areas was unimportant that year.

Quality of the catch during spawning in 1973 by commercial fishermen varied within pools as well as between pools. Pool 18 was considered by most to be good or better than average in 1973. Pool 13 fishermen stated 1973 was the worst year in many because of high water. In Pool 11, opinions ranged widely from good to far below average. About one-half of the fishermen contacted thought it was better than 1972 with others stating it was worse. Pool 9 fishermen stated the spawning run was poor because it began late in the year and occurred during rapidly declining water levels. The water was too high initially and too low at the end.

Fishermen in all pools commented that the 1974 spawning season was the best for fishing in many years and resulted in a steady, long lasting period of high catch. Water levels were generally raising and temperature increased systematically rather than fluctuating.

AGE AND GROWTH STATISTICS OF CHANNEL CATFISH

Age and growth statistics were computed from subsamples containing 1,699 fish captured in bait nets in 1972. Analyses were conducted to determine differences between pools, seasonal changes in growth rate, body condition and other biological parameters. Five or fewer fish were selected within each 1/2 inch interval, weighed to the nearest .01 lbs, measured in total length to the nearest .1 inch and a pectoral spine collected for aging. Aging was accomplished by projecting a sectioned spine image (40X) onto a screen for interpretation. Annuli radii were measured along the anterio-ventral portion of each section. Annular measurements and length-weight data were computer analyzed by the SHAD program (Mayhew, 1973). Age and growth statistics were computed for each pool with monthly samples processed independently. Total estimated body length at each annulus was back calculated by direct proportion with the origin at 0. Monthly growth increments were determined by subtracting mean calculated length at last annulus from the corresponding length at capture. Samples were collected during 1973 and 1974 in an identical manner for computation of monthly incremental growth and body condition.

Channel catfish of ages I-V were represented in all pools except Pool 13 where age V was absent. One age VI fish was examined from Pool 18. Age and growth statistics were similar for each month, so data were combined within pools by averaging monthly data. Resulting mean body length at the last annulus (Table 8) were similar to the grand average calculated length (Table 9) in all pools for ages I-III. Variations of age III or older were attributed to small sample size.

Similar growth was observed through age II in all pools. After age II, fish in Pools 9 and 11 were larger than those in Pools 13 and 18. Calculated body length at each age for combined pools was 4.0, 7.5, 10.7, 13.3, 12.9 and 17.6 inches for the first six years of life. Grand average calculated length at each year of life for combined pools was 3.7, 7.3, 10.4, 12.9, 13.4 and 17.6 inches from the same ages.

Table 8. Calculated body length in four Mississippi River pools. Monthly range in calculated body length is subtended.

Age	Pool 9	Pool 11	Pool 13	Pool 18	Mean
I	3.5 3.4- 3.6	3.9 3.3- 5.5	4.0 3.8- 4.3	4.4 3.9- 5.1	4.0
II	7.8 7.3- 8.5	7.5 7.0- 8.7	7.6 7.2- 7.9	7.2 6.8- 8.3	7.5
III	11.1 10.4-11.9	11.3 10.4-13.8	10.3 9.3-11.0	10.1 9.6-10.9	10.7
IV	14.5 a	11.7 9.5-13.4	12.7 10.5-14.5	14.3 a	13.3
V	15.2 a	10.3 a		13.1 a	12.9
VI				17.6 a	17.6

[a]No range in calculated body length determined.

Table 9. Grand average calculated body length of channel catfish at each year of life in four Mississippi River pools. Monthly range in calculated body length is subtended.

Year of life	Pool 9	Pool 11	Pool 13	Pool 18	Mean
1	3.6 3.3- 4.1	3.6 3.2- 3.9	3.9 3.6- 4.3	3.9 3.7- 4.1	3.7
2	7.5 7.3- 7.9	7.2 6.6- 8.0	7.2 6.5- 7.9	7.1 6.6- 7.6	7.3
3	11.0 10.1-11.9	10.5 8.5-13.8	9.9 9.0-11.1	10.1 9.1-11.1	10.4
4	13.6 12.6-14.5	11.0 9.5-12.3	12.7 10.5-14.5	12.7 11.1-14.3	12.9
5	15.2 a	10.3 a		13.9 a	13.4
6				17.6 a	17.6

[a]No range in calculated body length determined.

LENGTH-WEIGHT RELATIONSHIP OF CHANNEL CATFISH

The length-weight relationship expressed by the transformed linear equation

$$\log_{10}W = a + b \log_{10}L$$

where W = weight in lbs and L = body length in inches were computed each month by pool in 1972. Overall mean for the b values was 3.067 with individual pool means of 3.097 for Pool 9, 3.128 for Pool 11, 3.058 for Pool 13 and 2.986 for Pool 18 (Table 10). Testing the means in a t-distribution showed no significant difference between b values at the 95% level. Therefore, length-weight relationships were considered identical in all pools of the Mississippi River and were not computed after 1972.

Table 10. Regression coefficients, standard error of coefficients, and correlation coefficients of length-weight relationship for channel catfish from four pools of the Mississippi River.

Parameter estimated	Pool 9	Pool 11	Pool 13	Pool 18	Mean
Intercept (a)	-3.663	-3.691	-3.635	-3.557	-3.637
Standard error of a (S_a)	- .051	- .063	- .136	- .082	- .083
Slope (b)	3.097	3.128	3.058	2.986	3.067
Standard error of b (S_b)	.051	.065	.082	.084	.071
Correlation coefficient (r)	.991	.986	.985	.982	.986

COEFFICIENTS OF CONDITION OF CHANNEL CATFISH

Coefficients of condition (C) were computed as a measure of relative plumpness for the purpose of comparing seasonal well being. During the first two years of study, C was computed at 1/2 inch length intervals by month for each pool (Helms, 1973 and 1974). Large fish tended to be more plump than small ones, particularly during July and August. Adult females taken in pre-spawning condition during the months of May and June also exhibited high ponderal indices.

Seasonal comparisons using total samples were not possible because adult fish were not present in all samples. To eliminate bias caused by inconsistant sample sizes of adult fish, only fish measuring 6-12 inches were used to compare ponderal indices by year, month and pool.

Ponderal indices of 6-12 inch fish varied by year and season with each pool having similar trends (Table 11). The overall average with months and years combined was 27 in all pools. Condition factors for years combined increased in May-July, followed by a continual decline through October with modes occurring in July. Condition factors for months combined were highest in 1973 with 1972 and 1974 being nearly equal.

Table 11. Coefficients of condition, C, for channel catfish ranging from 6.0-12.0 inches in body length from four pools of the Mississippi River from 1972-74. Monthly range in C value is subtended.

	Condition factor				
Year collected	Pool 9	Pool 11	Pool 13	Pool 18	Mean
1972	27 26-29	27 25-28	26 23-29	26 25-27	26.5
1973	28 26-31	28 26-31	28 27-30	28 26-31	28
1974	27 25-29	27 25-28	25 24-28	26 23-31	26

Condition factors for individual samples varied somewhat between pools and reflected specific circumstances for that time and place. This was expected as environmental conditions differed between pools. Stress conditions within the study period did not appear to be a factor in reducing body condition sufficiently to affect survival. With the exception of Pools 13 and 18 in September and October, 1974, C remained above 25.

SEASONAL GROWTH OF CHANNEL CATFISH

Monthly growth increments were used as an indicator of variation in monthly environmental conditions between river pools and sample years. Since ages II and III were consistently present in all samples, subsamples were selected from these two groups for comparison. Ten or fewer specimens from each age group were selected by eliminating fish showing abnormal growth. Each age group was weighed equally and pooled (Table 12).

Total increments for years combined in each pool based on October samples were 2.6, 3.1, 3.0 and 2.7 with a combined average of 2.9 inches. Pools 11 and 13 had greater total increments than Pools 9 and 18 in all years. Pool 18 exhibited the longest growing season and Pool 9 the shortest.

Table 12. Seasonal cumulative growth increment for channel catfish age groups I and II from four pools of the Mississippi River from 1972-74. Calculated increments are equally weighted.

	Body length increment in inches				
	Pool 9	Pool 11	Pool 13	Pool 18	Mean
May					
1972	.2	.2	.2	.6	.3
1973	.3	.5	.5	.6	.5
1974	.4	.4	.4	.4	.4
Mean	.3	.4	.4	.5	.4
June					
1972	1.3	1.7	1.3	.8	1.3
1973	.5	.7	.8	.7	1.0
1974	.8	.7	.6	.6	.7
Mean	.9	1.0	.9	.7	.9
July					
1972	2.7	2.8	2.8	1.6	.25
1973	1.4	1.5	1.4	1.5	1.5
1974	1.5	1.6	1.2	1.4	1.4
Mean	1.9	2.0	1.8	1.5	1.8
August					
1972	3.0	3.0	3.0	2.1	2.8
1973	2.0	2.0	2.0	2.1	2.0
1974	2.6	2.4	2.3	2.3	2.4
Mean	2.5	2.5	2.4	2.2	2.4
September					
1972	3.1	3.1	3.2	2.2	2.9
1973	2.5	3.0	2.9	2.6	2.8
1974	2.7	2.8	2.8	2.7	2.8
Mean	2.8	3.0	3.0	2.5	2.8
October					
1972	[a]	3.2	3.2	2.3	2.9
1973	2.7	3.0	3.2	3.0	3.0
1974	2.4	3.0	2.6	2.7	2.7
Mean	2.6	3.1	3.0	2.7	2.9

[a]No sample was available.

Growth increments for pools combined were greatest for 1973 and least in 1974, but there were differences between pools. Growth in Pools 9 and 11 was greatest during 1972 and slowest in Pool 18 during 1972.

Greatest monthly growth for pools combined occurred in 1972 during June and July.

Greatest monthly growth for combined pools and years occurred during July followed by August, June, September, May and October. Again, there were wide differences between pools and years. In 1972, greatest growth occurred during the months of June and July. In 1973, growth was equally distributed from May-August peaking in September. In 1974, greatest growth occurred in August followed by July, with slow growth occurring in June.

Fewer differences were noted between pools than years. For combined years peak growth occurred in all pools during July. June and August followed in percentage of annual growth increment in all but Pool 18, where June growth was comparably low in 1972. June growth in 1972 in Pools 9, 11 and 13 was outstanding compared to other years and is attributed largely to elevated water temperatures early in the year.

Considering latitude and location, Pool 18, the southern most pool, has the warmest water temperature and longest season for growth. This advantage, however, was apparently compensated by growth inhibiting factors. The primary factor suspected at present is competition from other species. Carp and drum were caught in greater numbers in bait nets in Pool 18 than in other pools and appeared to be primarily important in retarding catfish growth.

0-AGE CHANNEL CATFISH ABUNDANCE

Young-of-the-year channel catfish populations were sampled with otter trawls and shoreline seining from July-October each year to determine spawning success and develop a survey technique for assessing year class abundance.

Trawl samples were collected with a 16 ft modified semi-balloon otter trawl by attaching a 5-ft extension of 1/8 inch Ace web to the cod end. A minimum of 10 hauls were made monthly in each pool. Tows lasted 2 1/2 minutes and were pulled upstream at a velocity of about 4 knots. Trawling was confined to the upstream portion of each pool in main channel and main channel border habitats (Sternberg, 1970). Depth of tows varied from 8-15 ft.

Seine haul collections consisted of semicircular sweeps along the shoreline with a 6 x 30 ft x 1/4 inch drag seine. A minimum of 25 hauls were made monthly in each pool. Sampling was identical with the annual survyes conducted during September by the Iowa Conservation Commission since 1967.

Seine haul sites were located throughout each pool and selected so they included a wide variety of river habitat. Many were located adjacent to dredge spoil deposits, but fresh deposits were avoided. Bottom types included gravel, clean sand, silt and hard mud. Bottom slope and depth varied, but steep slopes, deep holes, beds of vegetation and obstructions were avoided. Several problems precluded establishment of permanent sampling stations. New spoil deposits at sampling sites, silt deposition, shoreline erosion and monthly water level fluctuations caused difficulty in retaining sites selected at the start of the study. When altered conditions made sites unsuitable, alternate nearby sites were sampled.

Both trawl and seine haul fish collections were preserved in 10% formalin for examination.

TRAWL SAMPLES OF 0-AGE CATFISH POPULATIONS

During the 3-year study period 2,283 fish were captured in 708 trawl tows. Young channel catfish was the most prevalent species representing over 40% of the total catch. Fourteen other fish species were identified. Catch effort (C/E) by trawling was highest in Pool 18, while in the other pools C/E was quite similar. Grand average C/E over all years and months was .7, .8, 1.0 and 2.7 fish per tow in the four pools, respectively. Overall monthly distribution of C/E was 1.4 in July, 1.7 in August, 1.5 in September and .7 in October (Table 13).

Variation in sampling conditions with the otter trawl between years and months limited interpretation of year class abundance to general trends. Catch effort by trawling in Pool 9 showed the 1973 year class was most abundant with a C/E of 1.6 fish per tow followed by .3 in 1972 and .1 in 1974. Highest C/E in this pool was achieved in July and August followed by infrequent catches in September and October. In Pool 11, more variations occurred between the monthly samples, but C/E of young channel catfish was higher in 1972 and 1973 than 1974. Overall mean C/E was 1.1 per tow in 1972 and 1973 compared to .2 per tow in 1974. Trawl samples in Pool 13 showed the 1972 year class was prevalent with a C/E of 1.6 fish per tow followed by 1.3 per tow in 1973 and .1 per tow in 1974. In Pool 18 highest C/E was attained in 1973 with 2.3 fish per tow followed by 1.1 per tow in 1972 and .6 per tow in 1974.

Comparison of overall C/E values for 0-age channel catfish with the trawl showed quite clearly the 1973 year class more abundant than the other two groups. In fact, by individual pool samples, it was surpassed only once in Pool 13 during 1972. The 1972 year class ranked second in abundance in the trawl samples, while the 1974 year class was least abundant in all pools. Minor monthly fluctuations occurred in C/E by trawl, but highest catch success usually occurred in August. Except for 1974, the C/E of 0-age fish in trawl samples followed catfish spawning effort interpreted from commercial fishermen catch success. The commercial catch success statistics in this season indicated the spawning season was longer and was more intense than other years. Higher commercial catches this year was attributed to ideal water temperature and river stage in traditional fishing grounds.

Size distribution of 0-age catfish catches were examined to determine if variations between years were related to varied environmental conditions and observations of commercial harvest during spawning. Length range of the sample was interpreted to reflect the length of spawning time, while modes in the distribution were used to determine variations in spawning intensity and success.

Table 13. Catch effort of 0-age channel catfish in trawl samples from four pools of the Mississippi River from 1972-74.

	Catch effort in fish per trawl tow				
	July	August	September	October	Mean
Pool 9					
1972	.3	.2	.6	---	.3
1973	2.2	3.0	---	1.1	1.6
1974	.3	---	---	---	.1
Mean	.9	1.1	.2	.4	.7
Pool 11					
1972	1.2	1.5	1.0	.6	1.1
1973	.2	2.6	.5	1.1	1.1
1974	.2	.2	.5	---	.2
Mean	.5	1.4	.7	.6	.8
Pool 13					
1972	.2	2.9	3.3	---	1.6
1973	1.1	1.4	1.1	1.4	1.3
1974	---	.3	---	.1	.1
Mean	.7	1.5	1.4	.5	1.0
Pool 18					
1972	2.2	.5	2.1	.9	1.4
1973	7.5	4.0	7.2	2.5	5.3
1974	.5	4.1	1.1	---	1.4
Mean	3.4	2.9	3.5	1.1	2.7
Pools combined					
1972	1.0	1.3	1.8	.4	1.1
1973	2.8	2.8	2.2	1.5	2.3
1974	.3	1.2	.4	[a]	.5
Mean	1.4	1.7	1.5	.7	1.3
Grand average	1.4	1.7	1.5	.7	

[a]Less than .05 fish per haul.

Grand average monthly body lengths were 1.3, 1.9, 2.6 and 2.7 inches (Table 14). Mean length of young catfish in Pool 18 was below average in all samples except July, 1972, and September and October, 1973. Late spawning or slow growth might explain these results. Late spawning, as indicated by the presence of smaller fish, would lower mean length values.

Table 14. Mean total length of 0-age channel catfish captured by trawling in four pools of the Mississippi River. Sample size is listed in parenthesis.

	Total body length in inches							
	July		August		September		October	
Pool 9								
1972	1.2	(5)	1.8	(3)	2.4	(9)		
1973	1.4	(29)	1.8	(42)			2.6	(16)
1974	.8	(4)	2.4	(6)	2.6	(1)		
Mean	1.1		2.0		2.5		2.6	
Pool 11								
1972	1.7	(18)	1.8	(21)	2.7	(14)	2.7	(8)
1973	1.5	(3)	1.8	(37)	2.8	(7)	2.9	(16)
1974	1.0	(3)	2.3	(3)				
Mean	1.4		2.0		2.8		2.8	
Pool 13								
1972	2.0	(2)	2.1	(44)	2.4	(52)		
1973	1.1	(28)	1.8	(22)	2.9	(18)	3.3	(22)
1974			2.0	(4)			2.2	(1)
Mean	1.6		2.0		2.7		2.8	
Pool 18								
1972	1.4	(26)	1.3	(8)	2.2	(32)	2.5	(14)
1973	1.1	(28)	1.8	(22)	2.9	(18)	3.3	(22)
1974	.8	(7)	1.4	(61)	2.5	(17)	2.3	(28)
Mean	1.1		1.5		2.5		2.7	
Grand average	1.3		1.9		2.6		2.7	

Although most samples were too small for interpretation, the larger samples exhibited a variety of patterns. Distribution of the 0-age catch in 1973 during July and August in Pool 9 was skewed toward smaller fish indicating successful spawning early in the season which declined gradually throughout the remainder of the season. Assuming spawning commenced at 65°F, Pool 9 water temperature was suitable for spawning near 1 June. Temperatures gradually rose to 78° on 12 June and remained above 70° for the season. In this instance, water temperature probably resulted in concentrated spawning effort early in the season.

The skewed distribution, however, did not conform with catch information provided by fishermen. They indicated no discernable peak in catch success in Pool 9 that year. The most probable cause for this was fishermen were mostly unprepared for fishing in early stages and were collecting bait fish when spawning commenced.

Total length distribution of 0-age fish in trawl samples in Pool 11 was uniform in 1972 and bimodal in 1973. The greatest frequency of occurrence in 1973 was among small fish, probably resulting from late, intensive spawning. Flatness of the 1972 length distribution substantiated observations that no peak catch periods occurred during spawning. The 1973 season was characterized by high catches from 10-15 June followed by a sharp decline. During this period, water temperature reached 75^0.

Pool 13 catches of 0-age catfish exhibited slight skewedness toward larger fish in the 1972 distribution and flat, bell shaped distribution in 1973. The latter may be explained by higher water level and more gradual warming in 1973. Observations of commercial catches were similar in both years with spawning taking place 10-15 days earlier in 1972.

Length distribution in Pool 18 was very flat in 1972 with numerous small fish appearing in late season samples. Poor spawning conditions may have caused some delayed spawning, but water temperature did not explain these results. Temperature rose rapidly, increasing from 60-70^0 during an 8 day period (13-21 May) and remained above 70^0 thereafter. Water level decreased, remaining low after June 1, and may have been a contributing factor. Commercial harvest observations indicated spawning commenced 20 May and continued through 10 June with peak activity occurring 26-29 May.

Length distribution of the 1973 catch had no definable mode. This year, temperature approached 65^0 on 25 May, dropped slightly, then rose steadily 30 May-14 June to 78^0. Water level remained stable. Commercial harvest began 1 June, increased 7-8 June to a high 10-15 June and dropped sharply following a cold rain. After 15 June water level rose about 12 inches and temperature decreased from 78^0 to 73^0.

Samples in 1974 had a short, normal distribution. Harvest of spawning fish this year began 24-26 May, increasing 4-10 June and continued through 30 June. Water temperature during this period continually fluctuated raising gradually from 65^0 to 73^0. The drop of water temperature from a high of 71^0 on 6 June was associated with rising water level immediately following decreased water levels.

SEINE SAMPLES OF 0-AGE CATFISH POPULATIONS

During the study period 15,494 fish were captured in 1,424 seine hauls in all pools. Twenty-three fish species were identified. Channel catfish young made up slightly more than 7% of the numerical sample, ranking third in catch importance. Catch effort was too low in Pools 9, 11, and 13 for valid comparisons of year class abundance. Maximum C/E in these pools was .8 fish per haul, and no 0-age catfish were collected during 14 of the 27 sampling efforts (Table 15). Seine samples in Pool 18 were more conclusive with C/E ranging up to 24.9 fish per haul, with fish found in all samples. The seine samples in Pool 18 indicated the 1974 year class was strongest followed in importance by 1973 and 1972. A great portion of the overall strength of the 1974 year class was from the 24.9 fish per tow captured in August, 1974. In comparison with trawl samples in this pool, relative year class strength was exactly opposite. But, if the August, 1974 sample was excluded, then the 1973 year class was most abundant, the same as with trawl samples.

Table 15. Catch effort of 0-age channel catfish by shore seine in four pools of the Mississippi River.

	Catch effort in fish per haul			
	August	September	October	Mean
Pool 9				
1972	--	--	--	--
1973	.1	--	--	[a]
1974	.2	[a]	--	.1
Mean	.1	[a]	--	[a]
Pool 11				
1972	--	--	--	--
1973	.7	.1	.2	.3
1974	.2	.3	[a]	.2
Mean	.3	.1	.1	.2
Pool 13				
1972	.1	.4	--	.2
1973	.8	.1	--	.3
1974	--	--	--	--
Mean	.3	.2	--	.2
Pool 18				
1972	.1	.1	[a]	.1
1973	1.5	.6	8.5	3.5
1974	24.9	1.2	1.0	9.0
Mean	8.8	.6	3.2	4.2
Grand average	2.4	.2	.8	1.1

[a]C/E was less than .05 fish per haul.

Pool differences in C/E may have resulted from physical characteristics of the river and relative effectiveness of sampling gear for 0-age catfish under varied conditions as well as population densities. Pool 9 water is clear with abundant clean, shifting sand deposits along the shoreline of the main channel. Conversely, Pool 18 is turbid and characterized by silt deposits.

Variation in monthly C/E was related mostly to numerical population density and gear vulnerability. The lack of fish in July was attributed to small body size. Fish were not large enough to be captured in 1/4 inch mesh material at that time. Although, August was most productive, escapement remained a problem, and a large percent of fish, more so in some years than others, passed through the seine. Declining C/E in September and October were related both to lower numbers in population and autumnal movement into deeper water. The latter was particularly true in upstream pools during October. High water and changing shorelines also reduced effectiveness of shore seining. During some sampling periods, suitable haul sites were not available and alternate, less productive sites were substituted.

Differences in length distribution of fish captured by seining and trawling resulted largely from size selectivity. Few fish < 2 inches were captured by seine, whereas trawl samples included individuals in postlarval development measuring .6 inches.

Mean length by month for pools and years combined were 2.3, 2.6 and 2.9 for August-October (Table 16). Mean length of fish in August samples, being biased by the lack of small fish were larger in all pools than samples collected by trawling. October samples also differed from fish collected by trawling. Sampling error was largely responsible because of small sample size.

Seine samples were considerably less reliable than trawl samples because of these factors and it remains doubtful if this type of sampling is applicable to assessment of year class abundance.

AGE STRUCTURE OF BAIT NET CATCHES

The number of channel catfish in each age group captured with bait nets was estimated by extrapolating aged subsamples in proportion to length-frequency distribution in each month. Mesh size used was size selective and few fish < 6 inches total body length were taken. Consequently, age I catfish, as evidenced in year class distributions of bait net catches were not highly vulnerable to capture until late in the sampling season. Most age II catfish exceeded 6 inches and did not escape. Age III and older catfish became progressively more available to commercial harvest as they reached the 13 inch size limit. As a result, ages II and III dominated bait net catches.

Monthly age frequency of the catch was pooled by year at each location (Table 17). Resulting age distribution for combined pools and years was 24% age I, 44% age II, 26% age III and 6% age IV. Young-of-the-year and ages V-IX each represented less than .05% of the catch. Age II was most abundant in all pools in 1972, and age III dominated the catch in 1973. In 1974, age I was most abundant in all but Pool 9 where age II was somewhat higher.

Except for Pool 18, all locations exhibited similar trends in year class abundance. The 1970 and 1973 year classes were above average while other year classes were below. Pool 18 differed in that the 1969 year class was equally important as the 1970 year class. This group was low in abundance in other pools. Slower growth in Pool 18 resulting in a slightly lower vulnerability of age III to commercial fishing was the causative factor.

The best overall year class was in 1973 which ranged 42-138% above the mean. The 1970 year class was second, ranging from 45-109% above average. The poorest year class occurred in 1971 and ranged from 31-59% below the mean.

Table 16. Mean body length of 0-age channel catfish captured by shore seining. Sample size is listed in parenthesis.

	Total body length in inches		
	August	September	October
Pool 9			
1972			
1973	2.6 (4)		
1974	2.4 (6)	2.6 (1)	
Mean	2.5	2.6	
Pool 11			
1972			
1973	2.5 (26)	2.7 (3)	3.1 (6)
1974	2.2 (7)	2.6 (12)	3.4 (1)
Mean	2.4	2.7	3.3
Pool 13			
1972	2.6 (2)	2.1 (11)	
1973	2.3 (21)	2.9 (2)	
1974			
Mean	2.5	2.5	
Pool 18			
1972	1.6 (4)	2.6 (3)	2.2 (1)
1973	2.3 (49)	2.8 (21)	2.8 (220)
1974	1.9 (254)	2.3 (38)	2.3 (28)
Mean	1.9	2.6	2.4
Grand average	2.3	2.6	2.9

Table 17. Age frequency distribution in percent for channel catfish captured in bait nets from four pools of the Mississippi River.

	Number in sample	Percent occurrence in age class 0	I	II	III	IV	V	VI	VII	VIII	IX
Pool 9											
1972	2,381		11	84	5						
1973	2,354		19	27	53	1					
1974	974		34	41	12	13					
Pool 11											
1972	4,112		13	85	2	a					
1973	347		28	23	47	2					
1974	468		48	26	19	7	a		a		
Pool 13											
1972	2,632		9	70	19	2					
1973	439		15	32	49	3	1				a
1974	1,972		39	23	21	17	a				
Pool 18											
1972	1,908		7	63	30	a	a				
1973	758	1	13	31	41	14	a		a	a	a
1974	1,169		57	20	11	12	a				
Pools combined											
1972	14,033		10	76	14	1	a	a			
1973	3,898	a	19	28	48	5	a		a	a	a
1974	4,583		45	28	16	12	a		a		

[a]Less than .5% frequency occurrence.

Bait net catches consisted largely of ages II-IV, indicating the best age distribution data obtained by this sampling method was 1970-1972. Small sample size made year class strength less predictable at each end of this range. Young-of-the-year trawl and seine sampling from 1972-74 was not comparable with biat net catches. Comparisons, however, were made with September young-of-the-year seining surveys conducted annually by the Iowa Conservation Commission since 1967.

Both bait netting and the September survey indicated a strong year class in 1970 followed by poor production in 1971 and 1972 in all pools, but discrepencies occurred in relative abundance, particularly during poor years. This was attributed to sampling error in 0-age sampling as there was wide C/E variation in individual hauls.

CAUSES FOR VARIATIONS IN YEAR CLASS ABUNDANCE

The data strongly indicated year class abundance among channel catfish population, as in most other fish species, was established during the first year of life. Changing rank in relative abundance of age I and older fish never occurred in the samples. This was demonstrated by the comparatively greater abundance of the 1970 year class first noted in September seine haul surveys at age 0 and observed later in bait net catches.

Accepting this hypothesis, the next step was to establish critical points affecting channel catfish young production. Catch effort in monthly 0-age samples, although not totally reliable because of sampling error, indicated there was no significant changes in relative abundance between pools or years from July-October. Thus, establishment of year class abundance was presumed to occur at spawning.

Pesticide content in ovaries and parasitism of ovaries were eliminated as influencing factors. Pesticides were found in very low concentrations and ovarian parasites were never found, although they were observed earlier.

Sedimentation and water clarity are known to influence spawning and silt turbidity is generally accepted as a critical factor in the vulnerability of fingerling catfish to predator species. Water clarity decreased progressively downstream as siltation and silt turbidity increased. This parameter was not effectively measured in the study because of the variation complexity among individual pools. But, turbidity was most certainly involved in the trend toward higher catfish populations in southern pools.

Water temperature and water level fluctuations were also considered important factors. Water temperature had a strong influence on spawning chronology and intensity. Spawning usually began when mean daily water temperature reached $65^{0}F$. Spawning activity also changed with water temperature (Figure 2). Neither spawning time nor length of the spawning period was associated with year class abundance. For example, the 1973 season was judged from commercial catch success to be shortest but resulted in a stronger year class than 1974 in which spawning was earlier, longer and more intense.

Water level apparently affected fishing effort during the spawning period more than it affected spawning and survival of 0-age catfish. Water level would affect spawning activity and hatching success, especially if water levels fell drastically during the spawning period leaving nest sites above the water line. Chances of this happening in catastrophic proportions are remote with present operational procedures used by the Corps of Engineers to maintain the navigation system.

Although various water level fluctuation patterns were apparent when year class abundance was determined (Table 18), no particular association between year class strength was conclusive. The 1970 and 1971 catfish year classes were opposite in abundance, but water levels from May through October were nearly identical. Moderate spring levels declined from mid-June through July and remained low through the remainder of the summer both years. 0-age catfish production also differed in 1973 and 1974, but water level fluctuations were similar. Water levels declined during May and June, 1973 but increased during this period in 1974,

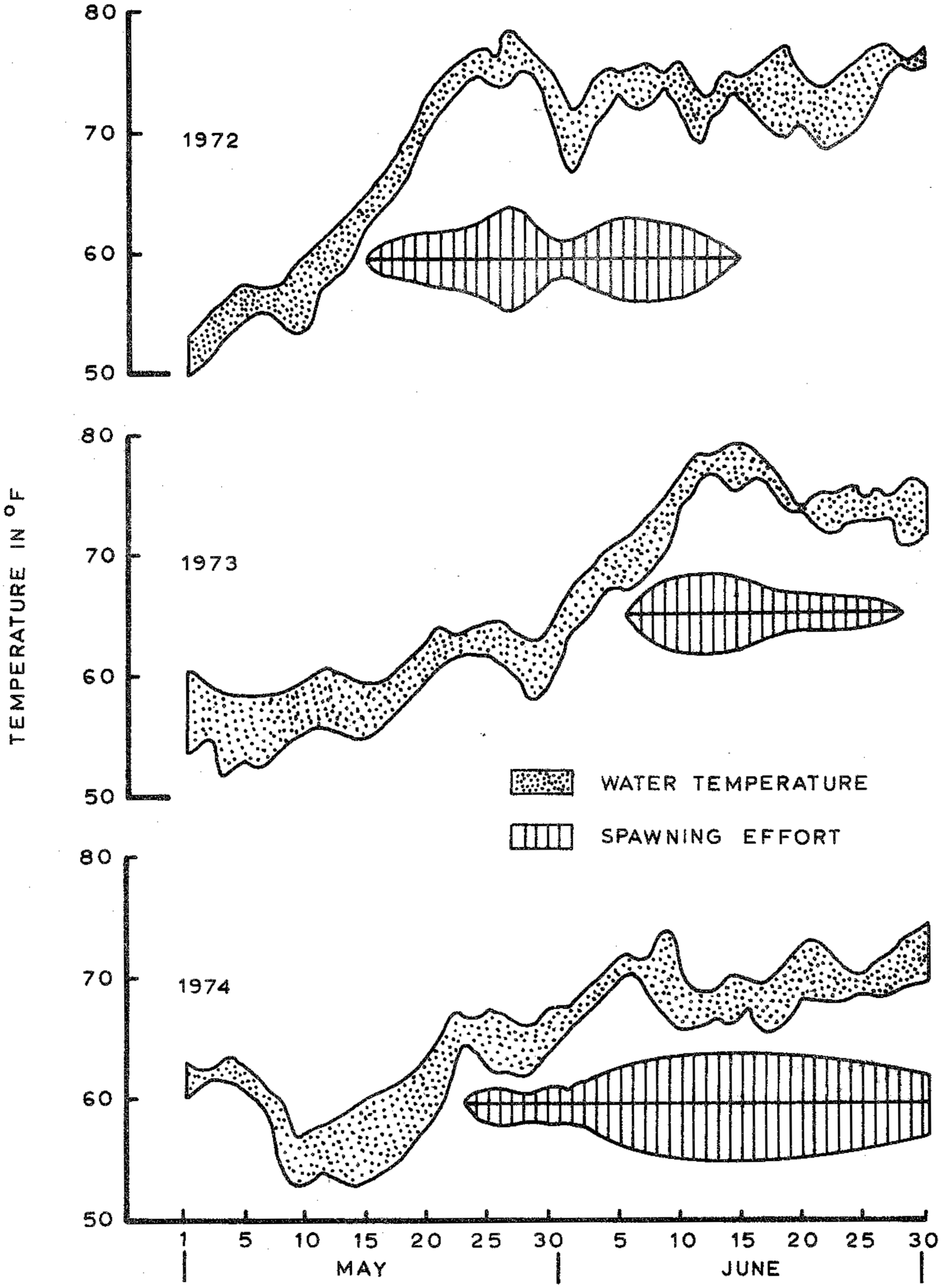

Figure 2. Water temperature in ^{0}F and channel catfish spawning chronology from May through June in 1972-74.

Table 18. Mean semi-monthly gage height at tailwater stations in four pools of the Mississippi River.

	May		June		July		August		September		October	
	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31
1970	13.6	13.0	14.1	10.8	8.3	8.5	7.8	7.5	7.8	8.9	8.9	9.4
1971	13.5	11.9	12.9	11.3	10.4	9.4	7.8	8.1	8.0	7.8	8.5	9.0
1972	16.7	13.1	11.7	11.1	9.8	11.5	15.4	13.1	12.2	11.9	14.5	12.0
1973	19.1	16.3	16.0	12.3	9.8	8.9	9.4	9.9	9.3	9.3	10.8	12.4
1974	14.0	15.7	15.4	16.9	12.3	11.0	11.5	11.1	10.7	10.5	10.5	10.5

remaining slightly higher than 1973 the remainder of the year. Surveys revealed production was higher in 1973 than 1974. It was therefore concluded that neither high nor low water years insure establishment of an abundant year class among channel catfish populations.

Results of this study suggest quite conclusively there is no factor completely responsible for variations in year class abundance and factors other than those measured were more important in 0-age channel catfish production. Among parameters not considered are adult population density, abundance of predator and competator species, food availability, and quantity and quality of spawning habitat.

Adult population density of channel catfish are known to fluctuate. This was clearly illustrated by varying size composition of the commercial catch. Contribution of small fish (under 15 inches) annually varied from 65-90% in some pools (Schoumacher, 1964, 1965; Helms, 1967). Monson (1947) found only 50% of the channel catfish in Pool 9 reached maturity at 15 inches in body length.

The presence of predator and competator fish species was documented by their abundance in 0-age sample results.

Food availability may be a primary contributing factor to the survival of 0-age channel catfish. Condition factors of 6-12 inch catfish were greater in 1973 than in 1972 or 1974, indicating greater food supply. Seine and trawl surveys correspondingly indicated higher population levels of 0-age channel catfish in 1973.

Although diminishing habitat may not have reached a critical stage, it will surely do so if the present loss rate prevails. Channel maintenance activities by the U.S. Army Corps of Engineers, particularly with respect to dredge spoil disposal practices, and continuing silt deposition in off-channel habitat since construction of navigation dams in the mid-1930's has resulted in continuous habitat loss. Inundation of stump fields and steep cut banks, primary spawning habitats, was partially compensated in some regions by rip-rap shore protection, especially where large boulders were used. The cavities created by spaces between large rocks are known to be used for spawning sites.

SURVEY METHODS FOR DETERMINATION OF YEAR CLASS STRENGTH

Variations in year class abundance of channel catfish ultimately affects harvest, therefore advanced identification of these harvest fluctuations would be useful for predicting commercial catch potential. Bait netting, shore seining and trawling were found to have predictive capability.

Bait netting was most reliable, but also had the disadvantage of requiring intensive sampling effort. The study indicated netting over a several month regimen was necessary to minimize seasonal bias. Spring and fall collections must be included to collect a broad spectrum of age groups in order to make valid comparisons between year classes. This method also required determination of age frequency.

Since year class strength was determined during the hatching stage, the simplest method of predicting future crops of catfish was to estimate spawning success. Shore seining and trawling were both effective. Shore seining, however, had several limitations. Wide variation between individual hauls made the obtaining of reliable sample sizes impractical The 25 seine hauls per sample seemed to produce dependable results most of the time and could be accomplished by a two-man crew in one work day.

Young-of-the-year catfish were not vulnerable to shore seine hauls because of small body size using 1/4 inch mesh web until September, and in some years escapement of small fish continued even later. By October, particularly in the northern pools, seasonal movement into deeper waters made shore seining less practical. Shore seining as a sampling technique should be limited to September.

Establishment of permanent sampling stations was impossible because of changing shoreline configuration and water level fluctuation. Mild flooding often eliminated sampling sites.

Trawling, on the other hand, captured greater numbers of 0-age catfish and seemed less affected by environmental changes. Trawling captured 0-age catfish throughout July-October. Catch effort was greatest in August and least in October, making July through September the most desirable months for trawl sampling. Less variation in catch between individual hauls was experienced in trawling than by seining. A minimum of 15, 2.5 minute tows were utilized and the sample size employed seemed satisfactory.

The range in C/E between pools was not as great for trawling as with shore seining, but habitat differences within pools continued to preclude direct comparisons. Both survey techniques required comparisons between years as well as within pools for precise comparison of relative year class abundance.

MANAGEMENT IMPLICATIONS

Discrete populations of channel catfish occur in nearly all navigation pools of the Mississippi River bordering Iowa, but the vital statistics of these populations rarely showed significant differences. Collections of young channel catfish indicated that year class abundance in a reach of stream was indicative of the entire stream. When young were abundant or scarce in one pool they usually occurred at the same magnitude in other pools. These results strongly indicated that the factor controlling spawning success prevailed throughout the entire stream.

The most critical period in the early life stages of catfish reproduction was during egg incubation. Sedimentation and water temperature were identified as the most important factors, but not the only factor effecting year class strength. Spawning length and intensity were not important in the determination of year class strength; the most abundant year class occurred during the shortest spawning season. Water level fluctuation, excluding gross decline, did not influence spawning success.

Results of the study suggested conclusively multiple factors control year class abundance of catfish in the Mississippi River and these factors, both environmental and biological are probably uncontrollable for changing spawning success. However, loss of spawning habitat is becoming a more important factor each year.

The affects of year class strength on future commercial catfish harvest could be predicted by several sampling methods. Bait net sampling of immature catfish populations proved most reliable, but also the most intensive and costly. Trawling was recommended as the most precise for sampling 0-age populations and predicting year class abundance.

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