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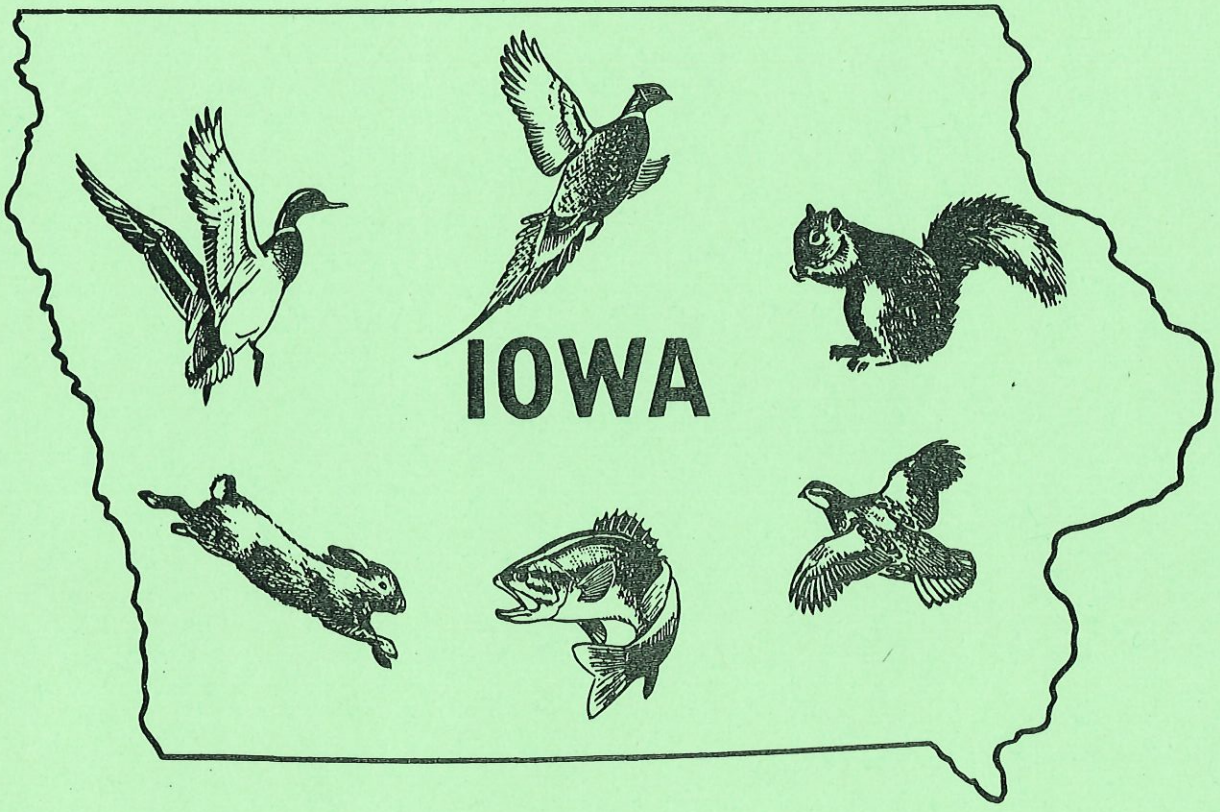
QUARTERLY BIOLOGY REPORTS



FISH AND GAME DIVISION — BIOLOGY SECTION
STATE CONSERVATION COMMISSION

QUARTERLY BIOLOGY REPORTS
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AGE AND GROWTH OF CHANNEL CATFISH IN THE HUMBOLDT IMPOUNDMENT DES MOINES RIVER

Robert W. Hollingsworth
Fisheries Biologist

The fish population of the Humboldt Impoundment was studied intensively prior to 1962. Further investigations were not conducted until recently. Data for age and growth studies were obtained from channel catfish in the area during October, 1967. Length-weight and body-spine relationships are presented. Growth rate and factors influencing it in this situation are discussed.

PRELIMINARY REPORT ON THE EFFECTS OF INCREASED POPULATION EXPLOITATION ON GROWTH OF CHANNEL CATFISH

Jim Mayhew

and

Don Kline
Fisheries Biologists

Investigations on the effects of increased exploitation of a channel catfish population were initiated in the Des Moines River in 1966. Schnabel estimates indicated a population of about 102,000 fish in the 20-mile study area. In 1967 this population was subjected to a 17.1% harvest of the population by intensive netting. Carp, carpsucker and flathead catfish were also removed from the area. No changes in growth were noted between the 2 years. Length-weight relationships and the periodicity of growth remained about the same despite increased harvest. Exploitation at this rate had no measurable effect on channel catfish growth.

BRIEF SUMMARY OF WEST OKOBOJI LAKE CREEL DATA - 1946-66

Terry Jennings
Fisheries Biologist

A creel census has been employed on West Okoboji annually since 1946. There have been three methods used for collection of catch data. Each method and results are discussed. Yellow perch have been the dominant species in 18 of the past 21 years. The have comprised between 29 and 79 per cent of the total catch annually. Since 1957 the estimated total harvest has ranged between 93,213 and 272,595 fish. Bullhead ranked number two in the creel. Peak harvest years for this species was 1958 and 1959 when an estimated total of 179,235 and 184,608 were caught. Bluegill is third in abundance. An average of 42 pounds of fish per acre have been harvested annually since 1957. Since 1960 the catch rate has ranged between 1.94 and 2.73 fish per hour. Before 1960 the catch rate was between 0.82 and 1.39 fish per hour. The average annual fishing pressure for the 1961-66 period decreased 58 per cent compared to during the 1957-58 period. The majority of this decrease came during the open water fishing period.

PROGRESS REPORT NO. 2 - CATFISH TAGGING STUDIES ON THE WAPSIPINICON RIVER - BUCHANAN COUNTY

Robert Schacht
Fisheries Biologist

Population estimates were made for channel catfish at the Buchanan County study area on the Wapsipinicon River. Using tag and recapture data between June 11th and October 25th, 1965, an estimate was made using the Schnabel method. During the sampling period 3,280 fish were taken of which 2,854 were marked and released. Subsequently 426 fish were recaptured. The channel catfish population was estimated at 10,400 fish. Estimate yields of 8,478, 6,426, 10,301 and 24, 179 were made for July, August, September, and October respectively. Total catch is presented graphically and includes a sample of 740 fish in June, 504 in July, 351 in August, and 1,342 in September. Two hundred and six catfish were aged from spine samples. Total lengths at time of capture averaged 8.5, 11.0, 11.8, 13.9, 14.9, 17.1, 18.0, 19.3, and 22.0 inches for the second through tenth year of life in the July sample.

TRENDS IN CHANNEL CATFISH HARVEST IN THE MISSISSIPPI RIVER

Don R. Helms
Fisheries Biologist

Beginning in 1960 a decline was noted in the commercial harvest of channel catfish. Radical fluctuations have occurred since that time. Most of this fluctuation is attributed to over harvest in 1958 and 1959 when soybean cake was introduced as bait. Harvest is dependent upon small fish which are cropped off as rapidly as they reach the legal size limit. Variation in year-class abundance has caused sizeable immediate fluctuations in harvest. A model of fish harvest at 10 and 30 percent mortality at 13 and 15 inch size limits is presented.

THE GOLDEYE IN MISSOURI RIVER OXBOW LAKES

Bill Welker
Fisheries Biologist

Goldeye were collected from five Missouri River oxbow lakes in 1963 and 1964 by field personnel from the Iowa Conservation Commission; Nebraska Game, Forestation and Parks Commission; and United States Fish and Wildlife Service. Population were significantly larger, at the 88 per cent confidence level, in the lakes that open to the river than in those lakes which are completly separated from the river. There was no statistical difference in population size at the 88 per cent confidence level among the closed lakes or among the open lakes. Reproduction appears limited in all lakes. Age and growth data were collected from the open lakes.

RESULTS OF INTENSIVE NETTING FOR COMMERCIAL FISH SPECIES IN CORALVILLE RESERVOIR--1967

Larry R. Mitzner
Fisheries Biologist

Studies have continued on the commercial fish species at Coralville Reservoir. Intensive sampling was resumed on March 31 and continued through November 4, 1967. All carp, carpsucker, buffalo and channel catfish taken this season were removed from the reservoir. Carp comprised 39.5 per cent of the catch by weight. Carpsucker, buffalo and channel catfish contributed 28.7, 6.4, and 13.9 per cent of the catch, respectively. Slat, bait, pound and buffalo nets were used for 2,970 net days. Discussion is given on the efficiency of type of gear through the season. The marked/unmarked ratio of channel catfish increased in 1967 indicating an error in the population estimate based on 1966 recaptures. An adjusted estimate of 76,476 was established for the study area. Rate of exploitation of 17.5 and 11.9 per cent was incurred on the pool and headwaters catfish populations.

RESULTS OF 3 YEARS OF WOOD DUCK ROOST COUNTS

Richard Bishop
Game Biologist

During September of 1967, 1966 and 1967, there were 69 wood duck roost counts made by Biology, Game, Conservation Officer and Fish and Wildlife Service personnel in Iowa. Drastic changes in water conditions (Sept. 1965 extremely wet, Sept. 1966 and 1967 very dry) and interference of the early teal season held all 3 years caused some marked changes in roosting habits of the wood ducks. Several roosts that were used heavily one year received little use the next year, or vice versa. The tremendous variations in both the roosting habitat and the behavior of the ducks at the roosts made the interpretation of the counts very difficult from the standpoint of trying to measure population trends. To meet the conditions necessary to guarantee an adequate sample of roost counts properly taken would require a significantly greater expenditure of time than it was possible to devote to this particular type of count during the past 3 years.

LAND CLEARING IN THREE SOUTHERN IOWA COUNTIES SINCE 1956

M. E. Stempel
Game Biologist

In southern Iowa there are still remnants of once extensive brushy upland game cover. Cost-share and privately financed brush removal are further reducing the amount of remaining game cover. Three counties are considered here. Davis, Monroe and Wapello counties had an average of 125 farms cleared each year for the past three years. On 14 farms (1,820 acres) in Wapello County, since 1956, 75 acres of woody cover was removed. This included 22 percent of the choice quality upland game cover.

QUAIL SURVEYS ON TWO AREAS IN SOUTHERN IOWA, 1967

M. E. Stempel
Game Biologist

Gene Hlavka
Game Biologist

Quail counts on the two study areas in southern Iowa were continued in 1967. The Wapello Area is situated southwest of Ottumwa; the Decatur-Wayne Area, about 8 miles north of the Iowa-Missouri boundary in south central Iowa. Coveys are located with the aid of dogs and by "sign" in both autumn and winter. The standard roadside whistling cock counts are conducted from May through August. The 1967 brood stock on both areas totaled 36 coveys --- an increase of 4 coveys over the 1966 brood stock. More than 14 weeks of quail calling indicated good production in 1967. The fall 1967 covey counts on both areas totaled 50 --- decreases of 10 coveys from 1966 and 4 from 1965. It took 1.3 hours to flush a covey during the fall count in 1967. Quail sighted per 100 miles driven on combined census routes on the two areas increased from 14 in 1966 to 22 in 1967. Farmers' estimates of the number of coveys were up in 1967.

PROGRESS REPORT ON RACCOON AND BEAVER TAGGING STUDIES

Robert L. Phillips
Game Biologist

During 1966 and 1967 there were 56 raccoon and 26 beaver marked with ear tags and released. The purpose of tagging the species was to obtain information on movements and mortality which would aid in the setting of sound harvest regulations. At the present time, little or no information of this type is available for Iowa conditions. No conclusions are presented at this time since the studies are incomplete. This progress report is being given now because the biologist in charge of the project has accepted other employment.

WINTER TO SPRING MOVEMENT OF PHEASANT HENS

Richard C. Nomsen
Game Biologist

A total of 28 hens and 9 cocks were trapped and marked with numbered back tags to study the winter to spring movements of pheasants on the Winnebago Research Area. A forty-mile route was established in the vicinity to determine the extent of dispersal. The winter to spring movement of 12 marked hens varied from 0.3 miles to 1.2 miles and averaged 0.56 miles. Observations were made on 4 cocks and they had moved an average of 0.46 miles from the wintering area.

AGE AND GROWTH OF CHANNEL CATFISH IN THE HUMBOLDT IMPOUNDMENT, DES MOINES RIVER

Robert W. Hollingsworth
Fisheries Biologist

The Humboldt Impoundment is a $5\frac{1}{4}$ mile section of the West Fork of the Des Moines River enclosed by hydro-electric dams at either end. The dams are inoperative, but remain effective barriers to the passage of fish except during high water. Such isolation of a reach of stream is unique and the fish population of the area was rather intensively studied by Harrison from 1949 to 1962. The impoundment was rotenoned in 1956 in an attempt to eradicate the fish population which was dominated by rough species. The renovation was initially successful and good populations of game fish developed. However, by 1962, Harrison felt that rough fish were again dominant (Harrison, 1962). No further investigations were conducted on the impoundment until 1967 when this study of channel catfish began. Data for determination of growth rate and length-weight relationship were obtained from 217 catfish captured by electro-fishing and netting on October 23.

LENGTH-WEIGHT RELATIONSHIP

Fish were separated into one inch groups and the mean length and weight determined for each group. The length-weight relationship for Humboldt channel catfish is best described by the equation

$$\log W = -1.9218 + 3.3267 \log L$$

where L = total length in inches
and W = weight in hundredths pounds.

The observed and calculated weights for each length group appear in Table 1 and are plotted graphically in Figure 1. The difference between the observed and calculated values is not significant at the 0.01 level of probability ($t = .52$; 0.01 level = 2.76; 28 d.f.)

Table 1. Observed and calculated weight of channel catfish in the Humboldt impoundment.

Size Group	Mean Total Length	Mean Weight Observed	Mean Weight Calculated	Deviation	Number in Group
6.0 - 6.9	6.3	.06	.05	- .01	4
7.0 - 7.9	7.8	.12	.11	- .01	24
8.0 - 8.9	8.3	.14	.13	- .01	20
9.0 - 9.9	9.4	.21	21	.0	28
10.0 -10.9	10.3	.29	.28	- .01	37
11.0 -11.9	11.4	.36	.39	+ .03	37
12.0 -12.9	12.4	.47	.53	+ .06	31
13.0 -13.9	13.5	.64	.69	+ 05	18
14.0 -14.9	14.3	.75	.83	+ .08	4
15.0 -15.9	15.6	1.04	1.11	+ .07	6

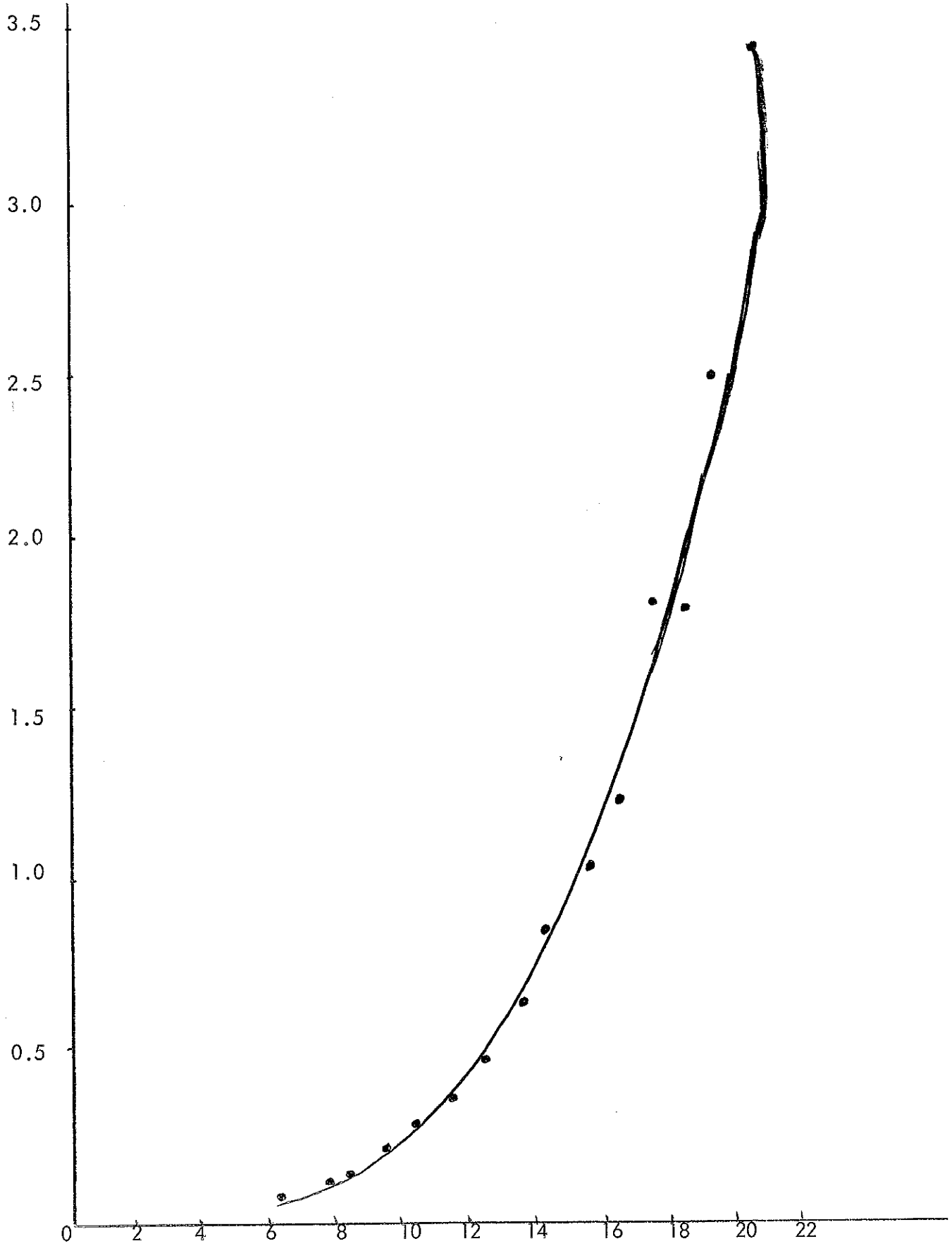
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
2
4
6
8
10
12
14
16
18
20
22

Table 1. Continued

Size Group	Total Length	Mean Weight Observed	Mean Weight Calculated	Deviation	Number in Group
16.0 - 16.9	16.5	1.34	1.35	+.01	3
17.0 - 17.9	17.6	1.81	1.65	-.16	2
18.0 - 18.9	18.4	1.80	1.93	+.13	1
19.0 - 19.9	19.3	2.48	2.27	-.21	2
20.0 - 20.9	20.8	3.46	2.90	-.56	1

BODY-SPINE RELATIONSHIP

Spines from 217 catfish were decalcified using the technique described by Perry (1967). A cross section from each spine was prepared by slicing it with a razor blade. The sections were placed on a micro-projector and the edge of the spine image, each annulus, the center of the first annulus, and the total length of the fish were marked on tagboard strips. The spine radii were measured in millimeters from the strips and the data were separated into 10 mm groups based on spine radius. Mean total length (inches) and mean spine radius (mm) were determined for each group.

The body-spine relationship plotted in Figure 2 is best described by the equation

$$\log L = -1.2586 + 1.1970 \log R$$

where L = total length in inches
and W = spine radius in millimeters

Correlation coefficient of the regression is significant at the 0.05 level of probability ($r = .993$). The difference between the observed and calculated lengths is not significant at the 0.01 level of probability ($t = .033$; 0.01 level = 2.88; 18 d.f.).

A nomograph described by Carlander and Smith (1944) was used in back calculating lengths for each year of life.

GROWTH RATE

Grand average total lengths for each year of life for ages I through IX are 1.7, 5.2, 8.0, 10.3, 12.1, 13.5, 15.0, 16.2, 17.7, 18.1 and 19.8, respectively (Table 2).

Grand average total length increments were 1.7, 4.4, 3.4, 0.6, 1.3, 1.1, 1.3, 2.3, 1.0, 2.2, and 1.7 inches for 11 years of life (Table 2). The greatest gain was made during the second year, typical of Iowa catfish.

With exception of the first year, this is faster growth than found by Harrison in the impoundment in 1954, but it falls short of that which he observed in 1957 after renovation (Table 3). It is far slower than the growth reported by Mayhew (1967) for channel catfish in the lower reaches of the Des Moines River. Intense competition for food and space from

Table 2. Calculated total length and increment for each year of life for channel catfish in the Humboldt Impoundment

Year Class	Number in Group	Age Group	Mean total length at Annulus											Mean TL At capture
			1	2	3	4	5	6	7	8	9	10	11	
1966	4	I	1.5											6.1
1965	42	II	1.5	7.6										9.5
1964	36	III	1.6	6.0	8.2									10.1
1963	61	IV	1.6	5.8	8.4	10.1								11.4
1962	38	V	1.7	5.3	8.4	10.4	11.7							12.5
1961	21	VI	2.0	5.0	8.2	10.4	11.8	13.0						13.8
1960	10	VII	---*	4.0	7.6	10.4	12.2	13.6	15.0					16.1
1959	3	VIII	---*	4.0	7.7	9.4	12.2	13.6	15.0	16.1				17.1
1958	1	IX	---*	5.6	8.7	11.0	12.1	13.2	15.4	16.7	18.0			19.3
1957	1	XI	---*	3.2	6.9	10.4	12.8	14.0	14.7	15.9	17.3	18.1	19.8	20.8
Mean Calculated Length			1.7**	5.2	8.0	10.3	12.1	13.5	15.0	16.2	17.7	18.1	19.8	
1966	4	I	1.5											
1965	42	II	1.5	6.1										
1964	36	III	1.6	4.4	2.2									
1963	61	IV	1.6	4.2	2.6	1.7								
1962	38	V	1.7	3.6	3.1	2.0	1.3							
1961	21	VI	2.0	3.0	3.2	2.2	1.4	1.2						
1960	10	VII	---	2.3	3.6	2.8	1.8	1.4	1.4					
1959	3	VIII	---	2.3	3.7	2.7	2.8	1.4	1.4	1.1				
1958	1	IX	---	3.9	3.1	2.3	1.1	1.1	2.2	1.3	1.3			
1957	1	XI	---	1.5	3.7	3.5	2.4	1.2	0.7	1.2	1.4	.08	1.7**	
Mean Calc. Increment				3.5	3.2	2.5	1.8	1.3	1.4	1.2	1.4			
Mean Observed Increment			1.7**	4.4	3.4	0.6	1.3	1.1	1.3	2.3	1.0	2.2	1.7	

* First annulus eroded into spine lumen

** Based on calculated data

a dense rough fish population probably supresses catfish growth in the Humboldt Impoundment. The species composition observed while electro-fishing the area in 1967 appears in Table 4. Rough fish composed 89.4 per cent of the total. Even though all species are not equally vulnerable to electric shock, the table indicates the relative dominance of rough fish. Low water levels, which also impede normal growth, are typical of this stretch of river after mid-July. The deeper portions of the impoundment are largely silted in and the upper $2\frac{1}{2}$ to 3 miles of naturally flowing water cannot be navigated in late summer.

SUMMARY

1. The length-weight relationship of Humboldt channel catfish is described by the equation $\log W = -1.9218 + 3.3267 \log L$.

2. The body-spine relationship is: $\log L = -1.2586 + 1.1970 \log R$.

3. Grand average total lengths for each year of life for ages I through XI are 1.7, 5.2, 8.0, 10.3, 12.1, 13.5, 15.0, 16.2, 17.7, 18.1, and 19.8 respectively.

4. Grand average total length increments are 1.7, 4.4, 3.4, 0.6, 1.3, 1.1, 1.3, 2.3, 1.0, 2.2, and 1.7 inches for 11 years of life.

5. The slow growth rate of channel catfish in the Humboldt Impoundment is probably caused by competition with a vast rough fish population and by low water levels during a large portion of the growing season.

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Perry, W. G. Jr.
1967. An improved method of sectioning catfish spines for age and growth studies. Prog. Fish Cult. 29(1):12.

Table 3. Total lengths of Des Moines River channel catfish for each year of life

Area	Year	1	2	3	4	5	6	7	8	9	10	11	Collector
Humboldt*	1954		5.5	7.0	8.6	9.4	11.9	12.1	13.6	14.3	14.5	17.6	Harrison
Humboldt*	1957		8.5	10.5	12.4	13.5	15.0	16.6					Harrison
Humboldt**	1967	1.7	5.2	8.0	10.3	12.1	13.5	15.0	16.2	17.7	18.1	19.8	Hollingsworth
Marion Co.**	1967	3.8	7.5	9.1	11.5	13.9	15.8	17.7	19.9				Mayhew

* Average Observed Lengths
** Average Calculated Lengths
Harrison (1957)
Harrison
Mayhew (1967)

Table 4. Species composition of Humboldt Impoundment fish population as observed by electro-fishing, 1967

Species	Number	% of Total
Carp	2,041	56.0
Carpsucker	638	17.5
Redhorse	271	7.4
Buffalo	230	6.3
Channel Catfish	179	4.9
White Sucker	80	2.2
Bullhead	95	2.6
Crappie	38	1.0
Walleye	Trace	Trace
Yellow Bass	Trace	Trace
Sunfish	Trace	Trace
Northern Pike	Trace	Trace
Total	3,643	97.9

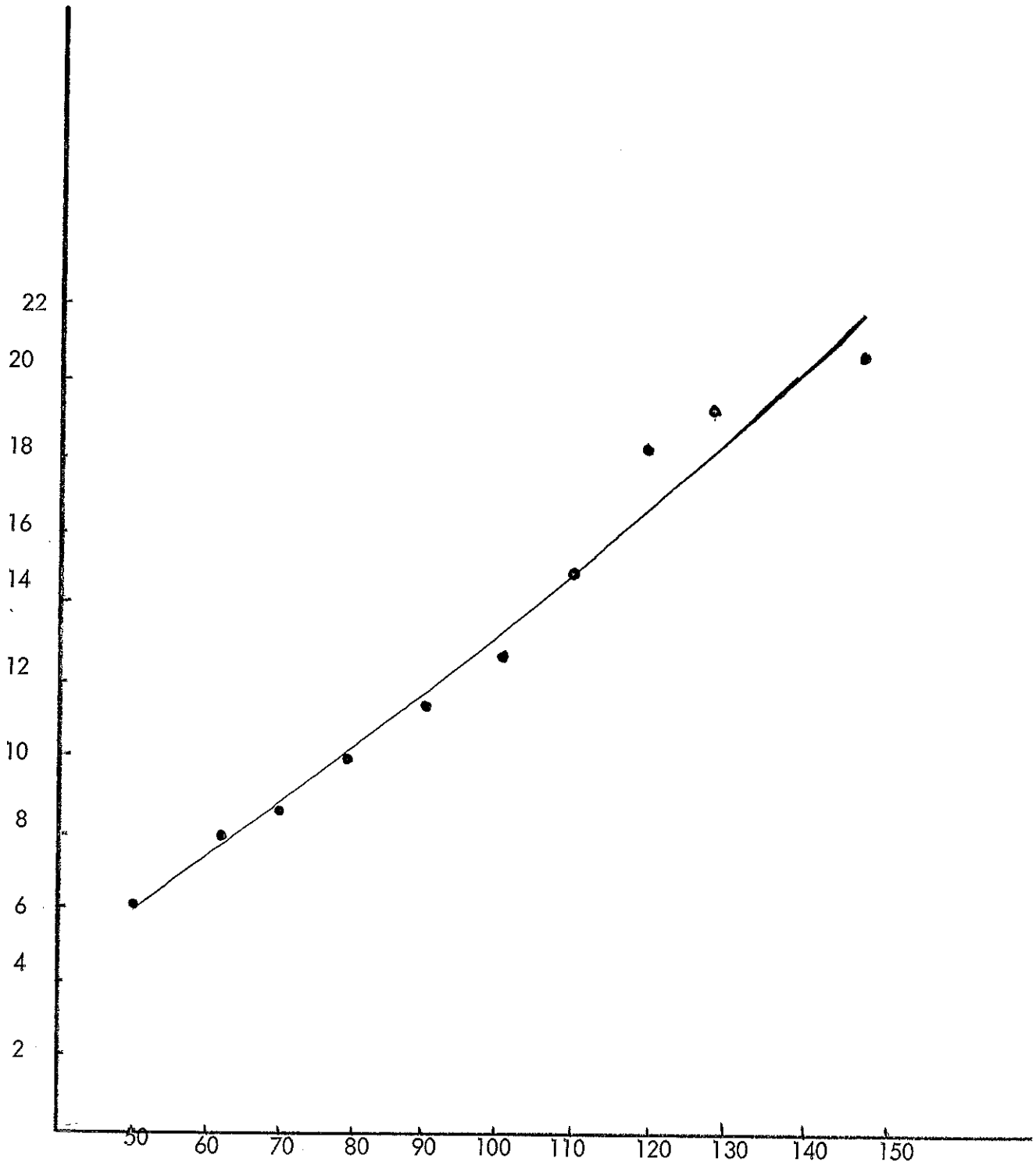

Figure 2. Body-spine relationship

PRELIMINARY REPORT ON THE EFFECTS OF INCREASED POPULATION EXPLOITATION ON GROWTH OF CHANNEL CATFISH

Jim Mayhew

and

Don Kline
Fisheries Biologists

Investigation of proper utilization through increased exploitation of fish populations with commercial or industrial value in the Des Moines River began in 1966. This project was partly sponsored as a cost-sharing research project with the Bureau of Commercial Fisheries. Studies of fish populations in the Des Moines River by the Iowa Conservation Commission and Iowa State University Fisheries Research Unit revealed gross under-utilization of the fishery resource by the existing sport fishery. Harrison reported long stretches of the river were not fished by anglers because of inadequate access.

A 20-mile section of the Des Moines River in Marion County was selected for the study area. Boundaries of the study area were located approximately 9 miles below and 11 miles above the Highway 14 bridge. Ackerman had previously conducted studies on species composition, channel catfish movement, and angler harvest in this area. Within 2 years Red Rock Reservoir will impound the entire study area.

During the first year of study an estimate of the channel catfish population was made within the area boundaries. Investigations of intrastream movement and distribution of tagged channel catfish that had been started the previous year were also continued because of their importance to the population estimate. Data were also collected for determination of growth rate and age structure of the population.

During the second year of study the catfish population was to be exploited to a maximum of 20% of the estimate. This rate could be increased or decreased instantaneously depending upon response of the remaining channel catfish population to increased harvest. Various biological indicators could be continually monitored to detect changes in the population. As long as the response to increased harvest did not indicate deleterious effects on the remaining population, exploitation would continue at a controlled rate at various levels.

This is a preliminary report on the effects of controlled harvest on the length-weight relationship, growth in length and weight, and periodicity of growth of channel catfish in the Des Moines River.

RESULTS

Schnabel estimates of the channel catfish population in 1966 yielded an adjusted estimate of 102,000 fish within the study boundaries. During 1967 this population was exploited at a 17.1% rate, or 17,465 fish. In addition 1,053 carp, 999 river carpsucker, and 45 flathead

catfish were also harvested in the area. Several hundred fish of other species were also caught, but having no commercial or industrial value were released.

Spine samples for age and growth studies and appropriate measurements of length and weight were obtained from a representative number of fish during both years. These samples were processed identically to those of Sneed (1951), Marzloff (1955) and Harrison (1957).

Length-Weight Relationship

The general parabola, $W=c\,L^{n}$, where L represents total length in 0.1 inches, W represent weight in 0.01 pounds and c and n are empirically estimated constants, was used to determine the length-weight relationship. These relationships were based on measurements of 540 fish in 1966 and 370 fish in 1967 (Figure 1). The length-weight equations, determined by fitting straight line to common logarithm transformation of length and weight were:

$$1966 - \text{Log } W = -2.5274 + 3.0709 \text{ Log } L$$
$$1967 - \text{Log } W = -2.4325 + 2.9832 \text{ Log } L$$

Analysis of covariance (Table 1) indicated there is no significant difference ($P>0.05$) between the length-weight relationships in the 2 years.

Table 1. Analysis of covariance of length-weight relationships in 1966 and 1967

Test of Regression Coefficients:

Source	Errors of Estimate		
	d.f.	Sum of Squares	Mean Squares
Mean within years	60	.0181	.003
Deviation from individual regressions	59	.0151	.00026
Difference between coefficients	1	.003	.003

Test of Adjusted Means: $F = 11.538$, 1 and 59 d.f.

Source	d.f.	ΣX^2	ΣY^2	ΣXY	Errors of Estimate		
Total	62	1.656	15.1095	4.999	61	.0184	-
Between years	1	.0008	.0057	.0021	-	-	-
Within years	61	1.6552	15.1038	4.997	60	.181	.00036
Differences for testing adjusted means					1	.0003	.00036

$F = 1.15$, 1 and 62 d.f.

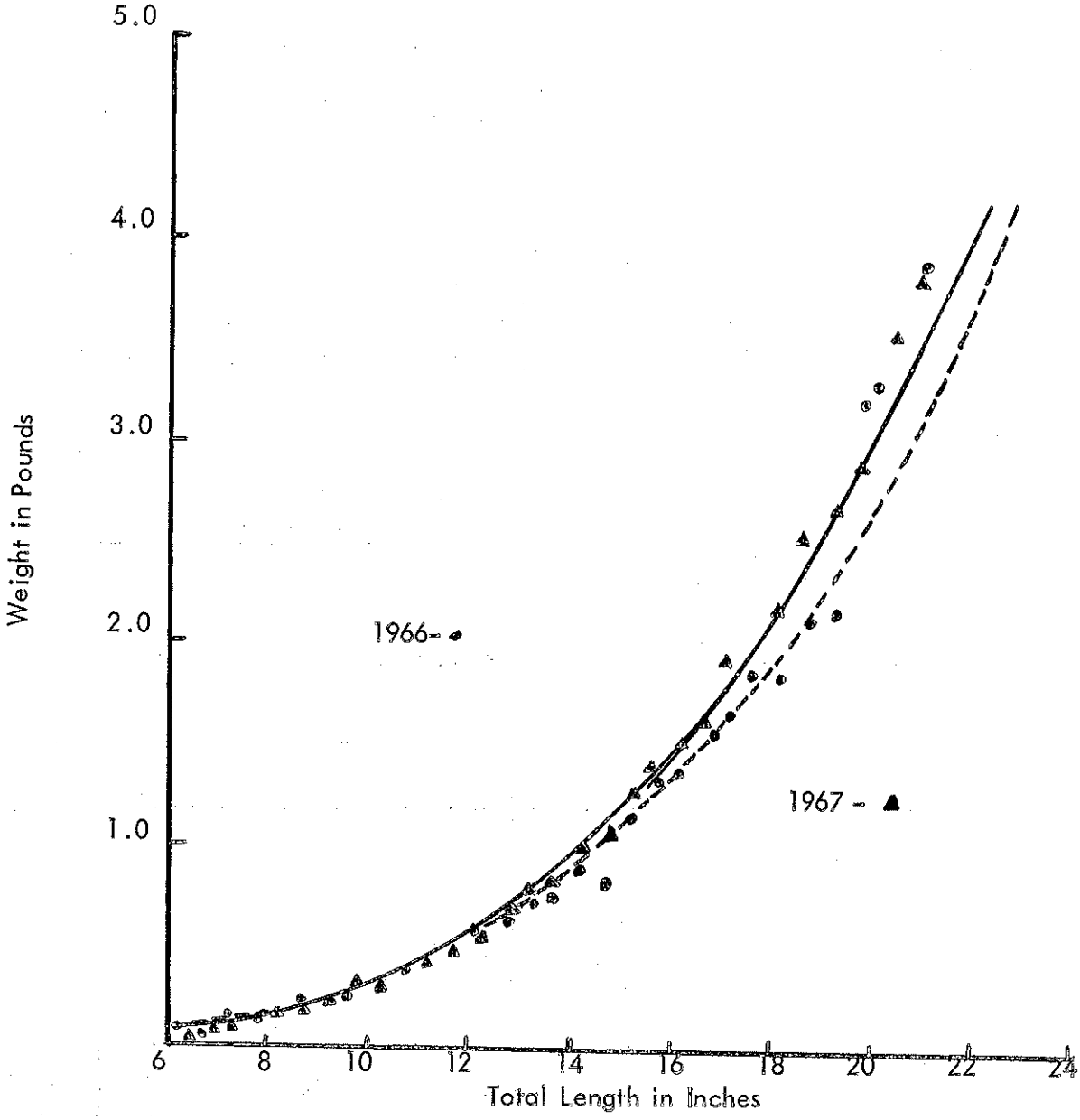

Figure 1. Length-weight relationship of channel catfish in 1966 and 1967 in the Des Moines River

Table 2. Calculated total length at each year of life for channel catfish in 1966, Des Moines River

Year Class	No. in Group	Age Group	1	2	3	4	5	6	7	8
1965	40	I	4.1							
1964	62	II	4.0	8.2						
1963	72	III	3.4	7.4	10.2					
1962	76	IV	3.5	7.7	10.0	10.7				
1961	86	V	3.9	7.8	9.3	12.3	14.7			
1960	68	VI	3.8	6.3	8.8	11.3	13.9	16.2		
1959	36	VII	-*	7.2	8.5	10.9	13.5	16.0	17.9	
1958	4	VIII	-*	7.8	9.8	12.1	13.6	15.3	17.5	19.9
Gr. Avg. Cal. Length			3.8	7.6	9.1	11.5	13.9	15.8	17.7	19.9
Increment of Average			3.8	3.4	1.5	2.4	2.4	1.9	1.9	2.2
Gr. Avg. Cal. Increment			3.8	3.8	2.1	2.2	2.3	2.2	2.1	2.4
Sum of Increments			3.8	7.2	8.7	11.1	13.5	15.4	17.3	19.5

* Annulus eroded into lumen of spine.

Table 3. Calculated total length at each year of life for channel catfish in 1967, Des Moines River

Year Class	No. in Groups	Age Groups	1	2	3	4	5	6	7	8	9	10
1966	17	I	3.6									
1965	79	II	2.9	6.0								
1964	109	III	2.3	6.5	8.5							
1963	68	IV	2.7	6.5	9.9	12.4						
1962	44	V	2.1	5.2	8.2	11.1	13.3					
1961	40	VI	3.8	7.2	8.8	10.5	13.0	14.9				
1960	6	VII	-*	7.7	10.0	12.5	14.4	15.8	17.2			
1959	1	VIII	-*	7.2	9.1	11.4	13.9	16.2	17.2	19.4		
1958	3	IX	-*	7.8	9.2	12.1	14.8	16.9	19.2	21.1	23.1	
1957	1	X	-*	7.8	11.2	13.9	15.5	17.8	19.4	21.5	23.1	24.2
Gr. Avg. Cal. Length			3.2	6.9	9.4	12.0	14.2	16.3	18.3	20.7	23.1	24.2
Increment of Average			3.2	3.7	2.5	2.6	2.2	2.1	2.0	2.4	2.4	1.1
Gr. Avg. Cal. Increment			3.2	3.8	2.4	2.5	2.2	2.0	1.6	2.1	1.8	1.1
Sum of Increments			3.2	7.0	9.4	11.9	14.1	16.1	17.7	19.8	21.6	22.7

* Annulus eroded into the lumen of spine.

Since there is no significant difference in the regression coefficients of 1966 and 1967, a pooled regression can be computed for the combined sample. This resulted in the least squares equation:

$$\text{Log } W = -2.4779 + 3.027 \text{ Log } L$$

The slope of the pooled regression indicates the weight of channel catfish in the Des Moines River increases greater than the cube of the length, but this difference was not significant at the 95% level of sampling probability (standard error of slope, S = .4368, to = 1.326, 61 d. f.)

Body-Spine Relationship

Establishment of a mathematical relationship between length and spine radius was necessary for accurate back calculation of growth. Trial plots of the two variables, spine radius (R) and total length (L), by 2-inch size intervals for 1966 fish and 1-inch size groups for 1967 fish indicated the relationship was curvilinear (Figure 2). An acceptable regression line was fitted to these data by transformation of exponential values of the variable into logarithms. The body-spine equations for the 2-years can be described by the least squares equations:

$$1966 - \text{Log } L = .5919 + 1.0749 \text{ Log } R$$
$$1967 - \text{Log } L = .4814 + 1.2786 \text{ Log } R$$

High correlation ($P \leq 0.05$) was achieved for both years (1966, r = .855 and 1967, r = .986 with these regression coefficients.

Back calculation of total length at each annulus was determined by construction of a nomograph to accomodate the calculated body-spine relationship. In this device curvilinearity of exponential values was identical to the log-log transformation of length and spine radius. Calculated total length was mechanically shifted on the length scale of the nomograph to the calculated intercept of the regression line.

Calculated Growth in Length

Estimates of general growth rates in Tables 2 and 3 were computed by grand averages of calculated total length and successive summation of grand average increments of length. Total length at the end of each year of life was almost identical in the 2 years ($t = 0.07$, $P < 0.09$, 14 d.f.). Greates difference occurred in age group I where 1966 fish were 0.6 inch longer, and age group III where 1967 fish were 0.8 inch longer. There was no clear systematic change in growth rate with increased age of fish or with additional harvest of fish from the study area.

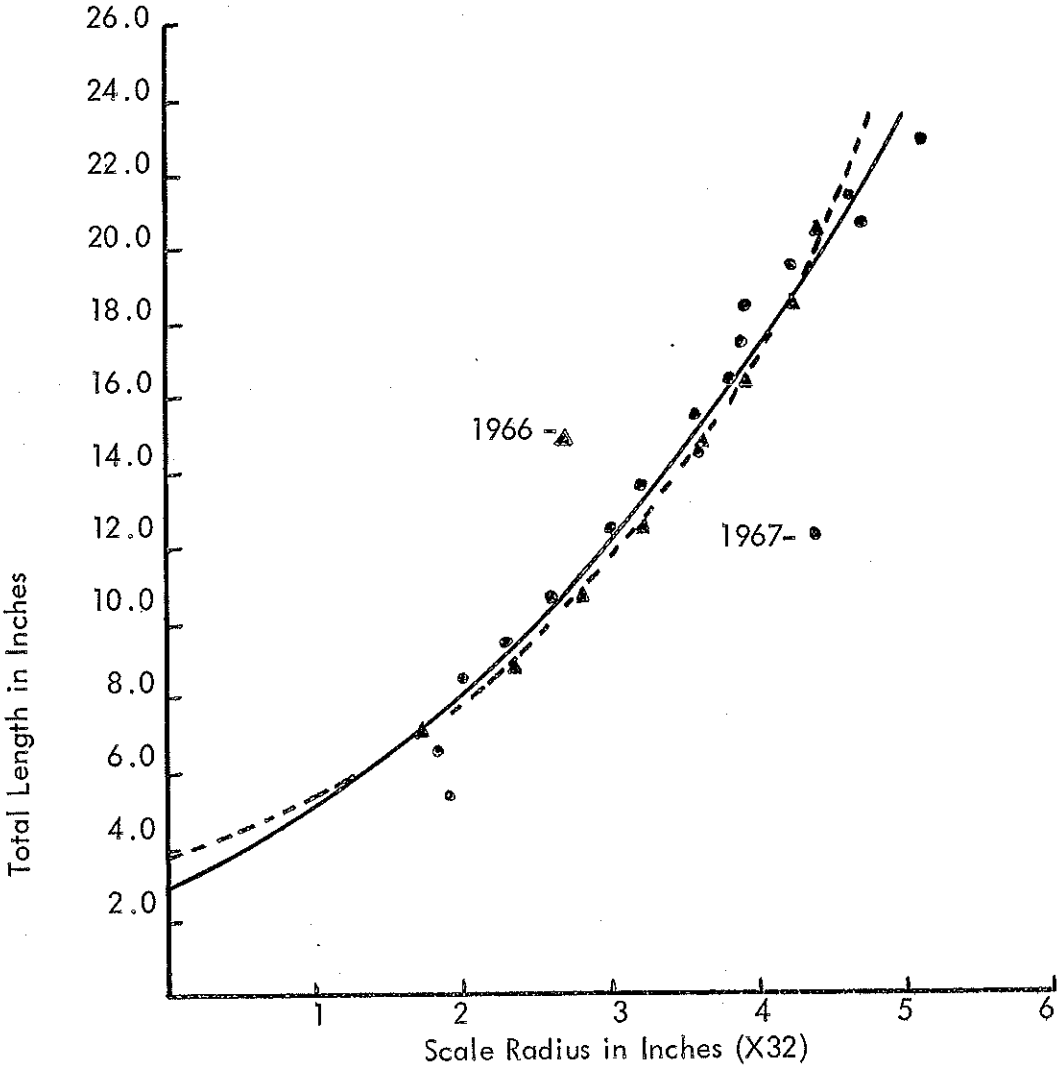

Figure 2. Body-spine relationship for 1966 and 1967 for channel catfish, Des Moines River; broked line represents 1966 data.

Calculated Growth in Weight

The calculated weight of channel catfish for each year of life was determined by applying the appropriate length-weight relationship of individual years to the sum of average increments. Growth in weight between the 2 years did not differ significantly ($t = 0.35$, $P > 0.7$, 14 d.f.). Mean calculated weight for the first 8 years of life was .02, .13, .32, .60, 1.03, 1.61, 2.31 and 3.36 pounds, respectively, for the 1966 sample. In 1967 corresponding weight at each year of life was .01, .12, .3, .61, 1.01, 1.53, 2.16 and 3.11 pounds respectively. Greatest difference occurred in the eighth year of life, where the 1966 sample was 0.25 pounds heavier. During both years there was a systematic increase in weight increments throughout the life of the fish.

Periodicity of Growth

Harrison (1957) pointed out growth of channel catfish is not constant throughout the growing season. He stated there was great acceleration in growth in early summer, with a gradual slowing in mid-summer, and very slow growth in late summer and autumn. Studies in 1966 in this investigation concurred with these findings. Approximately 68% of the annual growth in 1966 of fish in their fourth year of life was completed by July. Samples in August revealed 77% of the growth had been completed. All growth was complete by September.

Monthly spine samples were also collected in 1967 to measure the changes that occurred in growth pattern with increased population exploitation. All fish in these samples were also in their fourth year of life. In the June samples 60% of the growth was completed. By this date approximately 6 % of the annual growth in 1966 of fish in their fourth year of life was completed by July. Samples in August revealed 77% of the growth had been completed. All growth was complete by September.

Monthly spine samples were also collected in 1967 to measure the changes that occurred in growth pattern with increased population exploitation. All fish in these samples were also in their fourth year of life. In the June samples 60% of the growth was completed. By this date approximately 6% of the catfish population had been removed from the study area. By July the rate of exploitation had increased to 13.4% and 80 per cent of the annual growth was completed. All growth was completed by September regardless of additional exploitation. The general pattern of channel catfish growth was identical during the 2 years.

DISCUSSION

Response of a fish population to a gradual reduction of population density can assume many different features. The channel catfish population was reduced approximately 17% in a 5-month period in this study. During this time, harvest by the sport fishery remained relatively constant. That is, there was no noticable reduction in catch success or quality of fish caught by anglers. This was also characteristic in net catches. Catch success was affected more by environmental factors than by the reduction of population density.

Part of the population void could have been reduced by increased movement of channel catfish outside the study area to within the boundaries. This would require differential movement where more fish would move into the study area than were moving out of the area.

Another response could be accelerated recruitment of fish into the size group commonly caught by the nets. This would depend upon acceleration of growth rates. During the second year of study there were no detectable changes in the length-weight relationship, growth in length and weight, and periodicity of growth as the population was exploited. Consequently, it is concluded that an exploitation rate of less than 20% by intensive netting had no effect upon the channel catfish population.

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BRIEF SUMMARY OF WEST OKOBOJI LAKE CREEL DATA - 1946-66

Terry Jennings
Fisheries Biologist

INTRODUCTION

West Okoboji is Iowa's deepest natural lake (132 feet). This glacial lake has a surface of 3,788 acres. It is eutrophic, and supports high populations of fish.

Creel data were first collected on West Okoboji in the summer of 1946, and has continued annually since that time. Prior to 1953 census techniques were varied. During 1946 and 1948 the months May through August were censused. In 1947 May through October was checked. Only May and June were censused in 1949, and during 1950, 1951, and 1952 the census periods extended from May and June and December through February. Since 1953, the entire fishing season has been checked.

Three census methods have been used: The first (1946-52) was a contact census with certain boat liveries also assisting in the collection of data. The second method (1953-56) was also a contact type but conducted only by a census clerk. The third (1957-66) has been a comprehensive type. Estimates of total harvest and fishing pressure are obtained by this method. During 1960, the open water period was censused by straight contact one day a week. The ice fishing period was censused using comprehensive methods.

ANGLER HARVEST

Yellow Perch

Yellow perch have been the most important species caught by anglers in 18 of the 21 years. (Table 1). They have comprised between 29 and 79 per cent of the total harvest. Since 1961 this species has become of greater importance. Twice between 1946 and 1960 perch contributed more than 60 per cent to the total harvest. In the six years from 1961 through 1966 they comprised more than 60 per cent in five years. Peak harvests of perch have occurred at 2 to 3 year intervals since 1953. Average weights of the yellow perch caught between 1957 and 1966 ranged from 0.33 to 0.52 pounds.

Bullhead

During most of the past 21 years, bullhead has been the second most abundant species. Peak harvest years were 1958 and 1959 when an estimated 179,235 and 184,608 were caught, respectively. Estimated harvest has ranged between 67,609 and 10,895 fish since then. Average weight has ranged between 0.39 and 0.67 pounds.

Bluegill

Bluegill is the only other species which added significant numbers to total harvest. Estimated hook and line catches between 1957 and 1966 have ranged from 13,168 to 93,205 fish. Mean weight of bluegills has remained stable at about 0.41 pounds.

Table 1. Number, and average weight of yellow perch, bullhead, and bluegill caught in West Okoboji Lake.

Year	Yellow Perch		Bullhead		Bluegill	
	No.	Avg. Wt.	No.	Avg. Wt.	No.	Avg. Wt.
			Contact Type Census			
1946	8,510		1,578		2,897	
1947	25,927		5,316		3,121	
1948	23,556		4,043		3,891	
1949	6,815		3,721		1,601	
1950	5,292		3,062		584	
1951	14,512		8,061		1,292	
1952	17,914		8,192		1,402	
1953	36,585		7,551		5,550	
1954	16,959		11,643		3,371	
1955	31,310		7,977		3,795	
1956	25,616		7,453		2,671	
			Comprehensive Type Census			
1957	128,832	0.52	122,802	0.67	58,094	0.50
1958	122,216	0.43	179,235	0.43	93,205	0.35
1959	110,680	0.39	184,608	0.39	86,705	0.33
1960	*					
1961	243,898	0.45	51,552	0.53	31,635	0.47
1962	93,213	0.45	24,893	0.53	13,168	0.40
1963	173,371	0.47	15,626	0.46	28,356	0.40
1964	111,367	0.43	10,895	0.65	24,486	0.42
1965	131,517	0.44	67,609	0.39	23,368	0.42
1966	272,595	0.33	23,780	0.44	30,129	0.33

* Complete year not censused by comprehensive methods.

Other Species

Crappie, northern pike, walleye, largemouth bass, smallmouth bass, white bass, sheepshead, catfish carp, and pumpkinseed have also been recorded in the creel. Walleye is probably the most sought after species in the lake. However, because of the physical characteristics of the basin unfamiliarity often results in very low angler success. Anglers with adequate knowledge of the lake are a minority, but enjoying a high catch rate. Walleye exploitation studies in 1964 indicated angler exploitation rate was only 7.5 per cent annually. Average weight of walleye has ranged between 1.54 and 2.97 pounds.

Total estimated harvest of fish since 1967 has ranged between 66 and 21 pounds per acre with a mean of 42 pounds per acre.

Table 2. Estimated total angler harvest from West Okoboji in pounds per acre, 1957-59, 1961-66.*

Year	Pounds per acre harvested
1957	66
1958	64
1959	45
1961	54
1962	24
1963	35
1964	21
1965	32
1966	35

* 1960 was excluded from the above table because only the winter fishing periods was censused using comprehensive methods.

HARVEST RATE

The average catch rate has ranged between 1.94 and 2.73 fish per hour since 1960 (Table 3). Prior to that the average catch rate varied between 0.82 and 1.39 fish per hour. In recent years there seems to have been a shift from general fishing (for bullheads, bluegill, etc.) to greater preference for yellow perch. With high catch rates for this species a majority of anglers fishing for perch could sharply increase the catch rate.

Table 3. Average number of fish creeled per trip and per hour from West Okoboji Lake, 1946-66

Year	Fish per Trip	Fish per Hour
1946	4.35	1.36
1947	4.55	1.39
1948	4.11	1.25
1949	3.07	0.86
1950	2.66	0.89
1951	2.74	0.82
1952	2.91	0.85
1953	2.56	1.14
1954	2.67	1.08
1955	3.00	1.33
1956	2.30	1.10

Table 3 Continued.

Year	Fish per trip	Fish per hour
1957	3.66	1.06
1958	4.04	1.17
1959	5.14	1.12
1960	6.00	2.14 *
1961	6.62	2.73
1962	6.30	2.47
1963	5.52	1.94
1964	5.13	2.00
1956	6.60	2.31
1966	6.28	2.25

* Ice fishing only

ANGLING PRESSURE

Because census periods were inconsistant and methods of data collection varied, it is impossible to compare annual fishing pressure recorded prior to 1953. Data collected between 1953 and 1956 based on census clerk observation indicated fishing pressure was quite heavy. The number of angler contacts ranged from 16,863 to 22,541 during the three year period. Although the census after 1957 is represented by total estimates, and not comparable to the previous censuses, trends of pressure can be established. The heavy fishing pressure of the 1952-56 period continued through 1959. During the first 3 years of the comprehensive census estimated angler trips ranged between 81,531 and 109,642 (Table 4). After 1961 there was a gradual decline in total angling trips. It is estimated fishing pressure declined 58% between the 1961-66 period and 1957-59 period.

Table 4. Fishing pressure by angler from 1946 through 1966 in West Okoboji Lake. (Angler trips before 1957 are based on census clerk contacts).

Year	Angler trips	Hours	Hours per trip
1946	6,620	21,213	3.20
1947	9,695	31,553	3.25
1948	12,243	40,253	3.29
1949	5,975	21,192	3.71
1950	5,165	15,336	2.96
1951	11,287	38,722	3.43
1952	11,451	39,089	3.41
1953	22,541	50,575	2.24
1954	16,863	41,630	2.45
1955	19,039	42,946	2.26
1956	17,806	38,054	2.14
1957	100,131	339,144	3.39
1958	109,642	378,233	3.45
1959	81,531	284,863	3.49
1960	14,336	40,139	2.80*
1961	53,904	130,767	2.43

Table 4. Continued

Year	Angler trips	Hours	Hours per trip
1962	23,696	60,688	2.56
1963	44,771	127,610	2.85
1964	30,336	77,910	2.57
1965	36,299	103,786	2.87
1966	54,618	157,568	2.88

The major portion of the decrease in angling trips was experienced during the open water fishing period (Table 5). Open water trips declined 67 per cent during the 1961-66 period compared with the 1957-59 period. Winter fishing trips decreased only 10 per cent in the same period. Estimated fishing trips during the winter have fluctuated greatly in recent years. Open water angler trips have remained relatively constant since 1961. The average ice fishing trip lasted slightly longer than the average open water trip (3.29 hours to 3.03 hours).

Table 5. Trips, hours and time per trip for open water and ice fishing periods on West Okoboji Lake, 1957-66

	Ice Fishing			Open Water Fishing		
Year	Trips	Hours	Hr./T	Trips	Hours	Hr./T
1957	18,176	69,001	3.80	81,955	270,143	3.30
1958	14,872	55,259	3.72	94,814	322,974	3.41
1959	12,417	47,444	3.82	69,114	237,419	3.44
1960	14,336	40,139	2.80	*		
1961	15,444	44,002	2.85	38,460	86,765	2.26
1962	6,880	20,836	3.03	16,816	39,852	2.37
1963	18,038	58,370	3.24	26,733	69,240	2.59
1964	9,053	27,578	3.05	21,310	50,332	2.36
1965	5,636	15,797	2.80	30,663	87,989	2.87
1966	25,926	84,187	3.25	28,692	73,381	2.56

* Not censused by comprehensive methods

SUMMARY

1. Yellow perch have been the dominant species in the creel 18 of the past 21 years on West Okoboji Lake.

2. Bullhead and bluegill followed in importance.

3. Total harvest has annually averaged about 42 pounds of fish per acre. The range has been between 21 and 66 pounds per acre.

4. Since 1960 average catch rates have ranged between 1.94 and 2.73 fish-per-hour. Prior to 1960 the range was from 0.82 to 1.39 fish-per-hour.

5. There has been a 58 per cent reduction in the average number of annual fishing trips in recent years. The majority of this decrease came during open water fishing.

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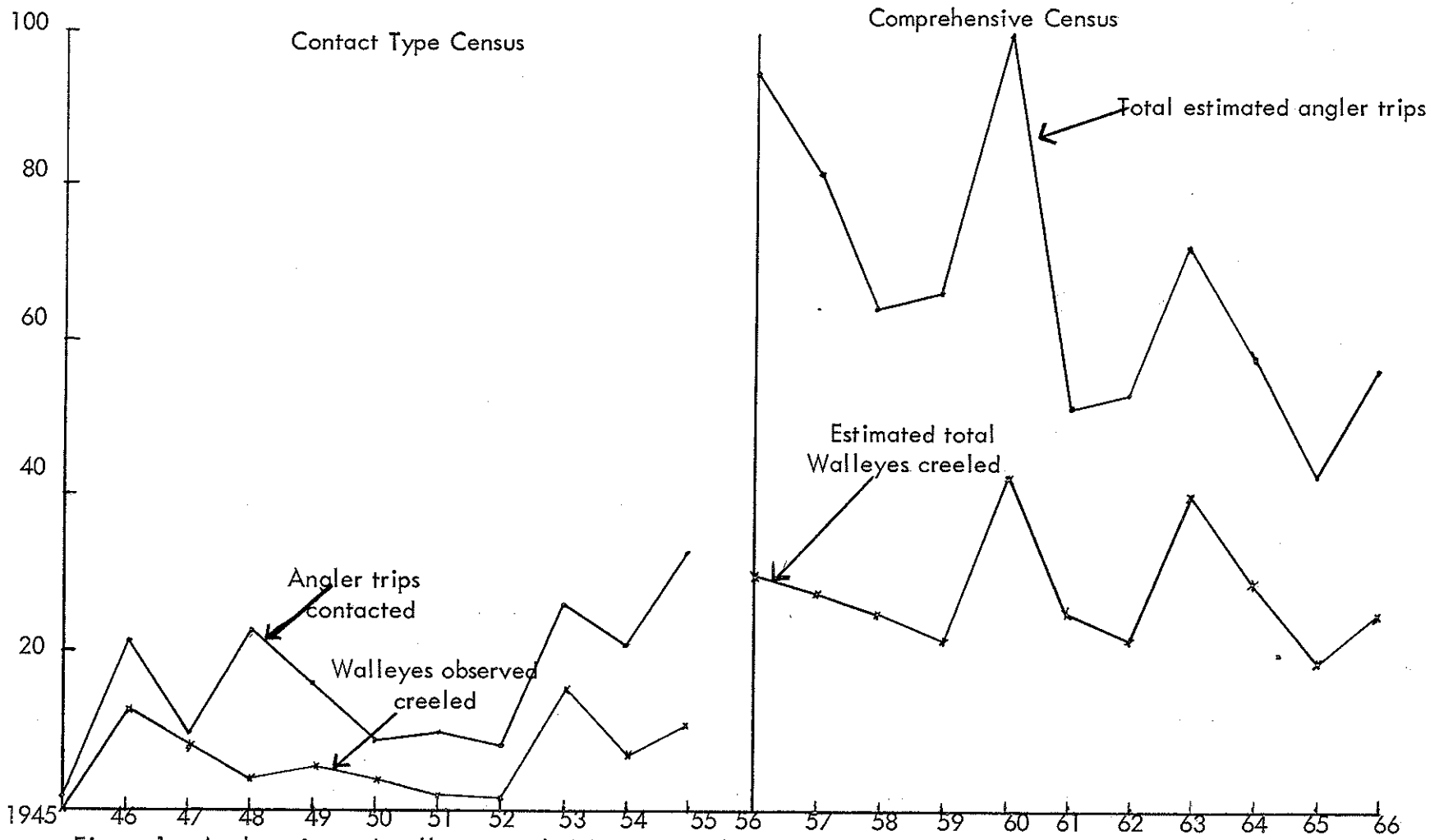

Figure 1. Angler trips and walleyes creeled for Spirit Lake, 1945 - 1966

PROGRESS REPORT NO. 2 - CHANNEL CATFISH TAGGING STUDIES ON THE WAPSIPINICON RIVER

Robert Schacht
Fisheries Biologist

A channel catfish tagging project was initiated on the Wapsipinicon River above Independence in June of 1965. The purpose of this study was to determine movement and population size. Data were also obtained for age and growth studies.

The study area begins 0.7 miles upstream from the Independence dam and extends upstream for 4.1 miles. Approximately 2.4 miles of the study area is impounded with the additional 1.7 miles, immediately above the impoundment, classified as flowing water environment.

Hoop nets and slat traps baited with cheese, soybean cake, or with adult female fish during the spawning season were used. Catfish were tagged internally with a small serially numbered tag. The adipose fin was removed from each fish to allow identification upon recapture.

RESULTS

Using mark and recapture data a population estimate was made by the Schnabel method. During 1965, 3,280 fish were captured between June 11th and October 25th. Two thousand eight hundred and fifty-four additional catfish were also marked during the period. Recaptures totaled 426 and yielded a cumulative population estimate 10,040 fish. Separate estimates were also made for July, August, September, and October. Fish captured by monthly intervals varied from 124 in October to 1,411 in September. Seven hundred and forty-five fish were captured in June, 553 in July, and 447 in August for a total of 3,280 for the year. Recaptures varied from a low of 3 in June to a high of 253 in September. Thirteen recaptures were taken in October, 61 in July, and 96 in August. Population estimates were 8,478 for July, 6,426 for August, 10,301 for September and 24,179 for October. The September estimate is considered to be the most accurate because of the larger sample taken. The estimate of 10,301 compares favorably with the season estimate of 10,040.

Estimation of population densities in a stream is very difficult because all methods assume there is a closed population. Because channel catfish can move great distances a fundamental assumption is in danger. Movement in the study area is not considered to have affected the estimate greatly. Of 167 recaptures taken in the study area it was shown that 67 per cent had moved less than one mile. Mortality (angling, natural, and tagging) is not measured but assumed minimal since the mark and recapture period lasted only several months. Recruitment is assumed to have no influence since sampling nets did not capture young-of-the-year fish.

One-inch frequency intervals in percent of total catch is presented in Figure 1. Twenty-one per cent of the June catch was made up of the 10 inch group. The next most abundant group was the 11 inch group which comprised 15 per cent of the catch. The remaining groups were less than 8 per cent. In July, over 500 fish were caught. Three peaks were evident at 11, 14, and 16 inches. These groups comprised 13, 14, and 12 per cent of the catch respect-

ively. The August sample of over 350 fish had the 12 and 13 inch groups comprising 14 per cent of the catch each, followed by 14 and 15 inch groups at 12 per cent each. In September over 1,340 fish were sampled. The 12 inch group comprised 22 per cent of the catch followed by the 11 inch group at 16 per cent.

Peaks of most age groups in the length frequency histogram were not well defined because of overlapping. At most only three to four age groups were indicated in any one month. The peak at the 10 inch group in June appears to be repeated in the September sample as the 12 inch group indicating a 2 inch increment for this group.

Spines were removed from 206 fish for aging. Catfish were aged for the mean total length at time of capture (Table 1). Spines taken in July, August, and October were aged separately. In July 119 spines were collected. Catfish reached a total length of 8.5, 11.0, 11.8, 13.9, 14.9, 17.1, 18.0, 19.3, and 22.0 inches from the second through the tenth year of life when taken in July. Fish aged for August and October did not vary greatly from the July sample, the only exception being that yearling fish were sampled. The mean length for these fish were 6.4 inches in the August sample and 6.8 inches in October.

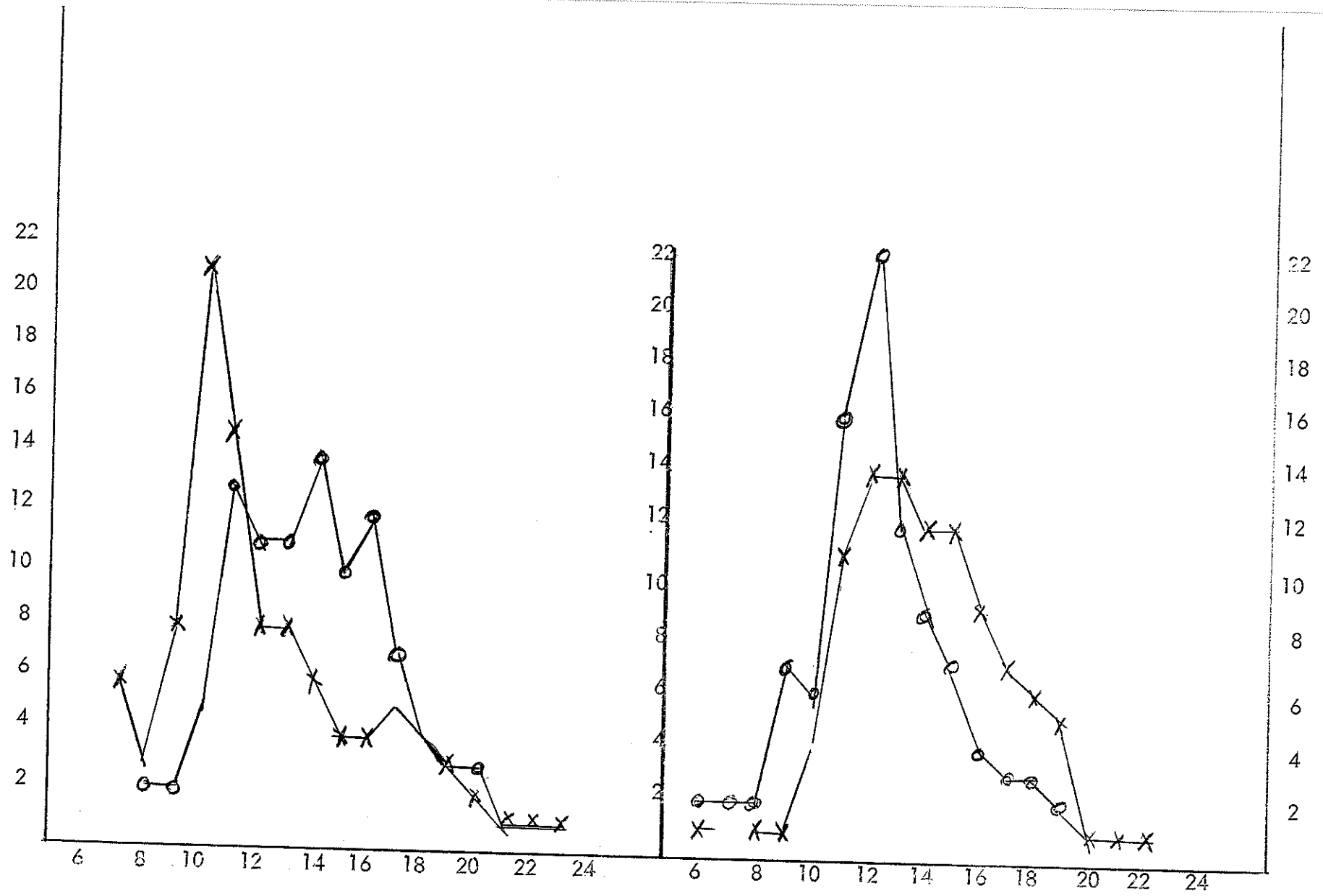

Figure 1. Length frequency of channel catfish taken in June, July, August, and September 1965.

Table 1. Average observed total lengths of channel catfish at time of capture from the Wapsipinicon River at Independence

Date Collected	Number in Sample *	Number of Annuli									
		I	II	III	IV	V	VI	VII	VIII	IX	X
July 1965	119	-	8.5 (1)	11.0 (1)	11.8 (14)	13.9 (9)	14.9 (24)	17.1 (26)	18.0 (26)	19.3 (14)	22.0 (4)
August 1965	38	6.4 (2)	8.8 (2)	10.4 (3)	11.7 (10)	12.4 (6)	14.5 (2)	-	19.1 (4)	20.6 (6)	22.5 (3)
October 1965	49	6.8 (12)	8.9 (5)	10.9 (7)	12.1 (14)	13.2 (4)	14.8 (3)	16.3 (3)	18.7 (1)		

TRENDS IN CHANNEL CATFISH HARVEST IN THE MISSISSIPPI RIVER

Don R. Helms
Fisheries Biologist

Commercial fishing statistics have been collected by the five states adjoining the upper Mississippi River since 1953. As a result, there is a continuous record of the commercial harvest of channel catfish. The following report discusses recent trends in channel catfish harvest in the Iowa segment from 1955. Data collected during 1953 and 1954 are not included because methods of collection were not reliable. It is also necessary to emphasize that methods of collecting commercial statistics during the past five years have improved. Hence, the more recent catch data tends to be greatly magnified in proportion to the data obtained prior to this period.

Inaccurate reporting by commercial fishermen are also involved. However, trends established by reported catch closely resembles actual harvest. This is demonstrated by the fact that trends established by the three adjoining states are similar.

The trend in catfish harvest (Figure 1), was static in 1955 and 1956, rose to a peak in 1958 and 1959, and declined in 1960. Since that time, radical fluctuations have occurred.

During the initial period of low yield (1960 and 1961), many complaints were received from commercial fishermen stating they were unable to catch channel catfish and the fish they caught were small. As a result of these complaints, studies were initiated to determine the status of the population. In 1963 Schoumacher[1] found that 71 per cent of the fish harvested were under 15 inches in total length (within two inches of the legal size limit), and only 2 per cent were over 20 inches. Similarly, age structure of 91 per cent of the harvest was comprised of two age-classes. Age IV contributed the bulk of the catch until July when Age III became more important. Later studies have supported these findings.

Recent fluctuations in harvest are believed due to dependence of the fishery on only two age-groups. The abundance of individual year-classes determine fishing success for each year.

Records prior to 1960 are rather scarce. However, samples of lengths reported from the Lansing Market (pool 9) by Greenbank and Monson in 1944 and 1945 (unpublished data) indicates the average size was much larger. Although their samples were taken during the latter part of the summer (a period when smaller fish tend to dominate the catch), only 21.5 per cent were under 15 inches in total length.

This change is believed to have resulted from overharvest by immediate cropping of legal size fish in 1958 and 1959. This might be explained by the fact soybean cake was introduced as a bait about this time. As near as can be determined, soybean cake was first used in 1957 by George Dahlsten of Burlington. According to Mr. Dahlsten, it worked extremely well and became widely used by other fishermen in the lower three pools by 1958. A year later, soybean cake was also introduced into the upper portion of the river.

By separating catch statistics into the upper section (pools 9, 10 and 11), the central section (pools 12 through 16) and the lower section (pools 17, 18 and 19), we see that there was a corresponding delay in the peak of harvest (Figure 2). The lower section crested in

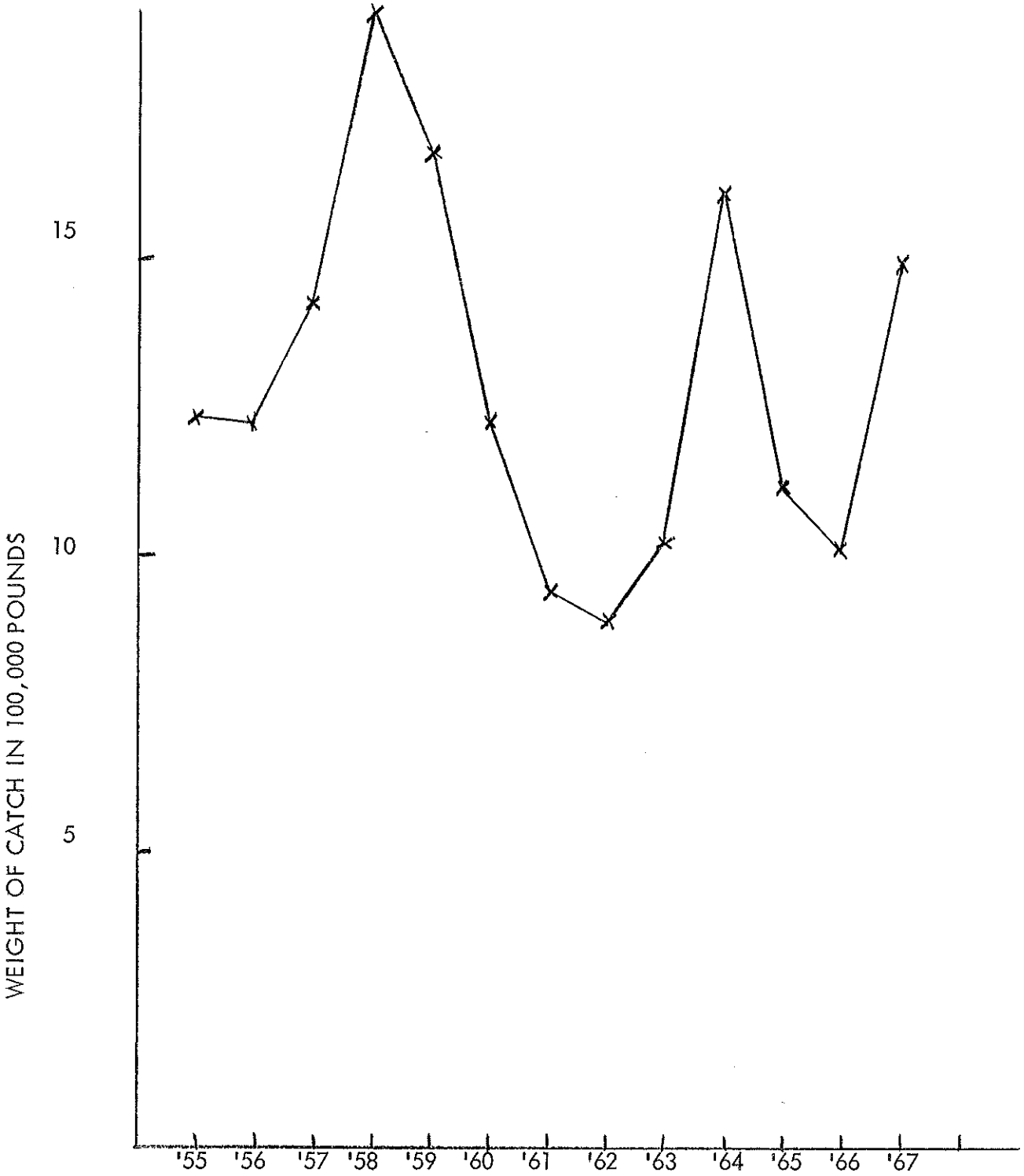

Figure 1. Annual commercial catch of channel catfish in the Mississippi River bordering Iowa from 1955 through 1967.

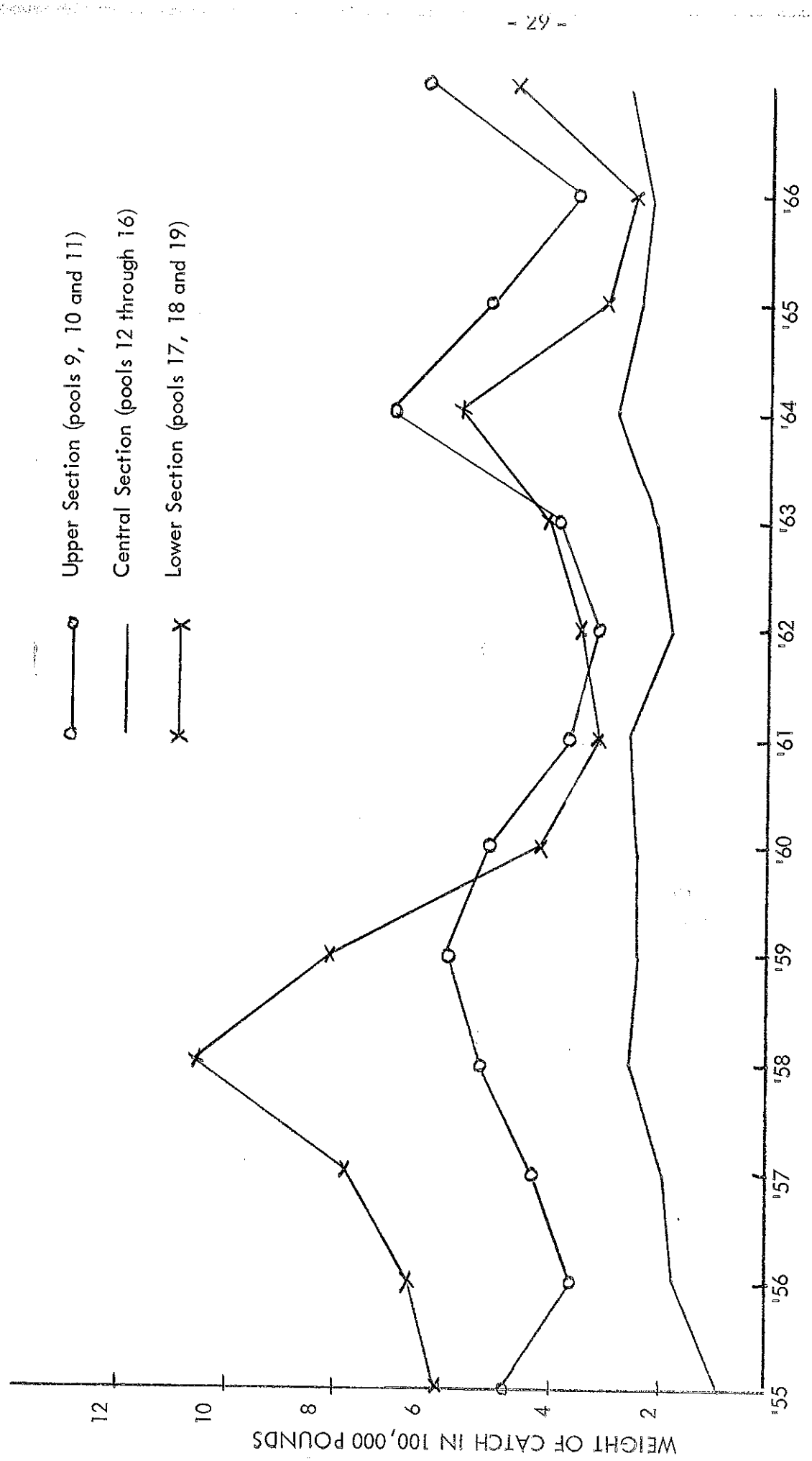

Figure 2. Annual commercial catch of channel catfish in the Mississippi River bordering Iowa from 1955 through 1967.

1958, while the upper section peaked in 1959.

The central section is not fished heavily by large operators using baited nets as are the other two sections. This area was not as drastically affected by the use of soybean bait, and there was not a pronounced increase in catch associated with its introduction.

Future fish harvest will depend upon year-class abundance. A survey of sub-legal catfish in 1967[2] indicated a relatively small 1964 year-class and a large 1965 year-class. Thus, poor fishing is expected in 1968 followed by a better 1969 season.

These fluctuations are not desirable for maintaining a fishery. Many full time fishermen have been forced into other vocations.

One solution to the problem would be to increase protection of smaller fish. This would enable the population to expand to the environmental carrying capacity, increasing the population weight available for harvest. It would also change the age structure contributing to harvest and reduce fluctuations caused by year-class abundance.

This could be done by placing a minimum mesh size limit on gear or increasing the size limit. Increasing the size limit from 13 to 15 inches would result in population loss from natural mortality during the time fish are growing the additional 2 inches. Natural mortality plus fishing mortality at present is approximately 40 per cent with each two inch increase in length. Natural mortality should not exceed 10 per cent. According to the model presented in Table 1, loss of 10 per cent by number would be compensated by an increase of approximately 30 per cent by weight. Further analysis reveals a natural mortality of 30 per cent could be assumed and the fishery would still remain constant.

FOOTNOTES

[1]Schoumacher, Roger,
"A Brief Preliminary Report on Commercial Channel Catfish" Quarterly Biology Report. Vol. XVI, No. 1, pp. 10-15. (1964)

[2]Helms, Don R.,
"Progress Report on the 1967 Mississippi River Channel Catfish Studies," Quarterly Biology Report. Vol. XIX, No. 2. (1967)

Table 1. Model of anticipated changes in harvest associated with a two inch increase in size limit based on length-frequency data collected from 3,000 channel catfish sampled at monthly intervals during 1964 and 1965 from pool 9 of the Mississippi River.*

Total Length (inches)	Average Weight (pounds)	Number	Weight	Per cent by Weight	Calculated Change in Numbers and Weight with a 2-inch Increase in Size Limit			
					Ten Per cent Natural Mortality		Thirty Per cent Natural Mortality	
					Number	Weight	Number	Weight
13	0.79	26.74	21.12	16.15				
14	0.95	24.90	23.66	18.08	24.07	27.68	18.73	21.54
15	1.15	17.33	19.93	15.24	22.41	31.82	17.43	24.75
16	1.42	11.13	15.80	12.08	15.60	26.83	12.14	20.88
17	1.72	7.47	12.85	9.82	10.02	20.74	7.08	16.15
18	2.07	3.89	8.05	6.16	6.72	16.40	5.22	12.74
19	2.44	2.82	6.88	5.26	3.50	10.36	2.72	8.05
20	2.96	2.01	5.95	4.55	2.54	9.02	1.98	7.03
21	3.55	1.44	5.11	3.91	1.81	7.51	1.44	5.85
22	4.15	.94	3.90	2.98	1.30	6.24	1.02	4.90
23	4.80	.50	2.40	1.83	.85	4.85	.67	3.82
24	5.70	.47	2.68	2.05	.45	2.97	.35	2.31
25	6.60	.27	1.78	1.36	.42	3.11	.32	2.37
26	7.40	.06	.44	.34	.24	1.97	.18	1.48
27	8.20	.03	.25	.19	.08	.75	.06	.56
28	9.00							
Totals		100	130.80	100	90	170.25	70	132.43

* Length-frequency data collected by Alan Finke of the Wisconsin Department of Natural Resources.

THE GOLDEYE IN MISSOURI RIVER OXBOW LAKES

Bill Welker
Fisheries Biologist

The goldeye, Hiodon alosoides (Rafinesque), is quite common in the Missouri River and occasionally found in some of its tributaries (Harlan and Speaker, 1956). However, there has been little data collected from the Missouri River ox-bow lakes. A cooperative fishery survey was conducted on five of the largest ox-bow lakes in 1963 and 1964 by the Iowa Conservation Commission; Nebraska Game, Forestation and Parks Commission; and United States Fish and Wildlife Service. A previous Biology Quarterly Report (Vol. 16, No. 1) describes the physical and biological aspects of these lakes. The major physical difference among these lakes is that two (Desoto Bend and Upper Decatur) are completely separated from the river by rock and pile or soil levees. The three remaining lakes (Omadi, Snyder, and Lower Decatur) are open to the river at the downstream end.

ABUNDANCE

The median catch in a series of 15 gill nets fished at each lake was compared at the 88 per cent level of probability to compare abundance (Table 1).

Table 1. Eighty-eight per cent confidence intervals represented by ranges in number of goldeye per net which would encompass the true median catch in a series of 15 experimental gill nets fished in five Missouri River ox-bow lakes during 1963 and 1964

	1963		1964	
Lake	Number caught	Confidence interval	Number caught	Confidence interval
Omadi	63	2 - 6	37	1 - 4
Snyder	52	1 - 5	24	0 - 3
Lower Decatur	69	1 - 3	41	0 - 3
Upper Decatur	16	0 - 0	2	0 - 0
Desoto Bend	1	0 - 0	0	0 - 0

The confidence intervals for all lakes open to the river overlapped both years. There was no significant difference in abundance at the 88 per cent confidence level. The confidence intervals for the lakes closed to the river are mathematical understatements both years and have significantly smaller populations of goldeye than the lakes open to the river.

It is obvious that considerably more goldeye were caught with equal effort in the open lakes than in the closed lakes. Considerably more were also caught in Upper Decatur (closed lake) in

1963 than in the other closed lakes. A possible explanation might be the unusually high spring water levels in the river in 1963 which caused damage to the upstream levee and allowed a considerable amount of river water to enter the lake. This could have allowed additional goldeye to enter the lake. The soil levees at Desoto Bend are constructed to prevent damage by high water levels in the river.

AGE AND GROWTH

A limited amount of age and growth data was collected from the open lakes (Table 2).

Table 2. Total number, total length range and mean total length for year classes of goldeye taken in 1963 and 1964 from the open lakes

Year class	Number	Total length range	Mean total length
		1963	
1962	12	7.5 - 10.0	9.5
1961	50	10.2 - 13.9	13.0
1960	11	11.8 - 16.9	14.9
1959	6	15.0 - 16.1	15.6
		1964	
1962	41	11.3 - 14.9	12.9
1961	6	14.4 - 16.0	15.1
1960	5	15.0 - 15.8	15.4

There was little difference in mean total lengths of similar age groups taken either year. Sample size was too small to allow comparison of growth between lakes.

REPRODUCTION

Since there is apparently a significantly smaller population of goldeye in the closed lakes, reproduction appears limited in these areas. No young-of-the-year were collected from the open lakes, either they do not enter until older or there was sampling error. The author believes reproduction of goldeye in any of these lakes is limited.

SUMMARY

1. During 1963 and 1964 there was a statistically larger population (at the 88 per cent confidence level) of goldeye in the open oxbow lakes than in the closed lakes.

2. There was no significant difference in population size among the closed lakes or among the open lakes.

3. Reproduction appears limited or not present in the closed lakes. Either reproduction is also limited in the open lakes or young-of-year do not enter until older.

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RESULTS OF INTENSIVE NETTING FOR COMMERCIAL FISH SPECIES IN CORALVILLE RESERVOIR 1967

Larry R. Mitzner
Fisheries Biologist

Intensive netting operations on Coralville Reservoir were initiated March 31 and continued through November 4, 1967. All captured carp, carpsucker and buffalo were disposed of or given to the residents of the surrounding community. All catfish were also removed and transferred to Lake MacBride.

During the season 34,312 fish weighing 34,224 pounds were caught. (Table 1). Carp comprised 39.5 per cent of the catch by weight. Carpsucker, buffalo and channel catfish contributed 28.7, 6.4 and 13.9 per cent to the catch, respectively. Crappie, northern pike, bullhead, walleye, white bass, largemouth bass, northern redhorse, bluegill, flathead catfish, green sunfish, pumpkinseed, and stonecat contributed to the remaining 11.4 per cent and are listed as others in the tables.

Table 1. Catch from March 31 through November 4, 1967, including the pool and headwaters or Coralville Reservoir

Species	Weight (lb.)	Number	Mean Weight	Scales taken
Carp	13,551	9,791	1.38	639
Carpsucker	9,853	5,249	1.88	637
Buffalo	2,176	1,152	1.89	356
Channel Catfish	4,744	10,842	0.44	784
Others	3,900	7,296	0.54	---
Total	34,224	34,312	1.00	2,416

Netting effort totalled, 2,970 net days during the year. Deployment of this effort for slat, bait, pound and buffalo nets was 67.0, 15.8, 14.7, and 2.6 per cent of the total time respectively. An attempt was made to utilize each type of gear intensively during that part of the season when it was most effective (Table 2).

Netting was most successful when the reservoir was low (elevation 670 m.s.l.) and stable. After June 3, the reservoir began to rise and fluctuate causing success to decrease. After September 9, the reservoir level increased from elevation 680 m.s.l. to 683.3 m.s.l. on September 30. During this period both slat and bait net efficiency increased to a high for the season then gradually decreased to November 4, when fishing was terminated.

During 1966 the ratio of marked/unmarked channel catfish was 1:38.4 in the pool, 1:35.7 in the headwaters. In 1967; 1 8.3 in the pool and 1:27.6 in the headwaters (Table 3). It would be expected that the ratio would have decreased instead of increasing. This phenomenon indicates that the population estimate made by Mitzner (1967) in 1966 may be lower than calculated. The error could be due to (1) marked fish had a higher mortality than unmarked, (2) marked fish tended to lose their marks,

Table 2. Catch for various gear during the bi-weekly periods for Coralville Reservoir. Weight is in units of pounds and effort is net days.

	Pound Net		Buffalo Net		Slat Net		Bait Net	
	Weight	Effort	Weight	Effort	Weight	Effort	Weight	Effort
March 26	1111	7	20	3	145	46		
April 8								
April 9	4758	48			359	157		
April 22								
April 23	6192	58			134	129		
May 6								
May 7	1247	16			43	94		
May 20								
May 21	2168	16			142	102		
June 3								
June 4	3434	61			154	89	8	2
June 17								
June 18	2337	56			262	188	50	4
July 1								
July 2			77	17	113	124	113	18
July 15								
July 16	1165	53	306	57	164	212	583	30
July 29								
July 30	2954	56			133	124	501	49
Aug. 12								
Aug 13	1485	51			111	99	400	40
Aug 26								
Aug 27	578	12			51	88	16	16
Sept. 9								
Sept 10					223	109		
Sept 23								
Sept 24					535	143	1083	91
Oct 7								
Oct 8					173	130	414	122
Oct 21								
Oct 22					292	155	103	98
Nov 4								
Total	27429	434	403	77	3034	1989	3271	470

Table 3. The ratio of marked/unmarked and number of recaptures for 1966 and 1967 in the pool and headwaters of Coralville Reservoir.

	1966				1967		
	No. Marked	Marked/ Unmarked	Type Recapture Headwaters	Pool	Marked/ Unmarked	Type Recapture Headwaters	Pool
Pool	2807	1/38.4	11	70	1/8.3	121	532
Headwaters	2574	1/35.7	66	10	1/27.6	137	58
Total	5381	1/36.4	77	80	1/11.9	258	590

(3)all recaptured marked fish were not identified, (4) the catchable population was increasing by recruitment or unmarked immigrants, (5) marked fish were not as easily caught as unmarked, (6) marked fish were not distributed randomly throughout the range of the catchable population. The fact that the incidence of marked fish increased in 1967 eliminates the first four reasons as possible errors. The later two reasons are therefore responsible for the apparent error. Ratios obtained in 1967 are considered to be more reliable than in 1966 and can be used to adjust the population estimate for intra- and inter- study area movement.

The population estimate based on 1967 recapture data is 31,135 for the pool, 45,341 for the headwaters and 76,476 for the entire study area. Exploitation rates of 17.5 and 11.9 per cent were incurred on the pool and headwaters populations, respectively.

Comparisons have been made on length-weight relationships between 1966 and 1967 for carp, carpsucker, channel catfish and buffalo. Channel catfish length-weight relationship was significantly different at the 0.05 level of probability. Catfish under 16 inches were in better body condition in 1966 than 1967. Length-weight relationship of carp also differed significantly at the 0.05 level of probability. Carp in 1967 were in better condition than in 1966. There was no significant difference at the 0.05 level of probability for carpsucker and buffalo between 1966 and 1967.

All scales collected in the 1967 season have been mounted in preparation for aging and calculation of growth.

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RESULTS OF 3 YEARS OF WOOD DUCK ROOST COUNTS

Richard Bishop
Game Biologist

INTRODUCTION

Wood duck roost counts were conducted during September in 1965, 1966, and 1967, at various locations throughout the state. The counts were made by Game Section men, Conservation officers, Biologists and Fish and Wildlife Service personnel. The roost counts are a continuation of the counts started by former I.S.U. graduate student Dale Hein in a project designed to attempt to detect wood duck population trends.

METHODS

Areas that were known to have been used as roosts by wood ducks were selected for roost counts. Past results of Hein's work indicated that middle September was the best time to make these counts for locally produced wood ducks. The counts were conducted from a low elevation vantage point near the roost site where the observer could gain all the light advantage in late evening or early morning. This was usually a position that faced the sun to allow the observer to see late arriving birds or early leaving birds. Data indicate that evening counts were more acceptable than morning counts. Thus most counts were conducted in the evenings. Information on location of roost, weather data, water levels, and data on the time of the flight were recorded. A copy of the data sheet is presented in Table 1. The evening counts were started at 1 hour before sunset and continued until 40 minutes after sunset. The exact dates of the counts varied from year to year due to the interference of the special early teal seasons.

RESULTS

September of 1965 was extremely wet and Iowa experienced one of the highest water levels in several years. This resulted in birds roosting in areas that were previously dry. Some known roosting sites were not used at all and others were only used slightly due to the change in water conditions. Several counts were not made due to the high water and others produced no wood ducks to count. In addition to water conditions an early teal season from September 11 through the 19th had run its course before most of the counts were made. A total of 18 counts was made and all were made in the evening. The duration of the flights varied from 20 minutes to 91 minutes and averaged 47 minutes. Results of the counts made in 1965 are shown in Table 2.

September of 1966 was as dry as September of 1965 was wet. Only trace amounts of rain were recorded during the month. This drastic change in water conditions from one year to the next resulted in changes in roosting patterns of wood duck populations. The 1966 special teal season was later than in 1965 and most of the counts were conducted before the season. The season ran from September 17 to September 25. The teal season no doubt altered the results of those counts made after the season. All but two of the 30 counts were made in the P.M.. The duration of the flights varied from 15 minutes to 105 minutes and averaged

55 minutes. Results of the 1966 counts are shown in Table 3.

Roost counts were conducted on 21 roosts during September of 1967. The fall of 1967 was similar to 1966, in that water levels were very low and wood ducks used different areas as roosting sites. All of the counts were made prior to the beginning of the teal season on September 16. Results of the 1967 counts are presented in Table 4.

Results of the 3 years of roost counts are compared in Table 5. Observations on spring breeding populations and summer production made by state personnel indicated a fairly high fall population in 1965, a slightly higher fall population in 1966, and a slightly lower one in 1967. The data from 15 roost counts indicate a slight decrease in the 1966 fall population of 12 birds per roost. Data from 18 counts show a larger decrease in the 1967 fall population, with an average of 46 fewer birds per roost as compared to 1966. These data correspond fairly well with field observations, but there are several limiting factors in these data which may make their accuracy questionable.

DISCUSSION

Different water levels and the interference of the teal season caused some very drastic changes in the roosting habits of Iowa wood ducks. Several roosts that were used heavily one year received little use the next year and vice versa. On at least two areas on the Mississippi River the birds changed their roosting spot to one near by and consequently only a few birds were recorded. This was a result of abnormal water levels. In the prairie marsh region wood ducks sometimes change roosting marshes for one reason or another. Vegetational changes and water level conditions often cause this.

Variations of the roosting habitat and the behavior of roosting populations of wood ducks have been reported by most of the observers. The conditions that alter the data obtained from particular wood duck roost counts point very strongly to the fact that they are subject to great variation. There are many human variations also that tend to affect the data.

Hein, in his unpublished doctoral thesis, stated that he believes that fall roost counts can predict population trend changes. The data he obtained were subject to detailed statistical analysis, and the results indicated that you could probably detect changes of greater magnitude than 15% of the population. However, the criteria that these data are based on demands a knowledge of nearly all roosts each year in the area being censused and that an adequate sample of these roosts must then be checked. This would require considerable effort by several people to keep up to date on location of wood duck roosts each year statewide. (As one step in this direction, a questionnaire was sent to personnel in the western half of the state asking them to list the locations of any wood duck roosts known to them in their part of the state; the replies are tabulated in Appendix A for future reference.) The number of roost counts made would have to be considerably larger than the number that is now being done. If this project were put on the priority list and a select number of individuals could spend a good share of their time in September working on roost counts, and all counts were made under good conditions, then confidence could be placed in them. Hein did not have to contend with such drastic weather changes and with a special teal hunting season during the month the counts should be made. This makes it difficult to apply his results to these of the past 3 years.

The biggest problems that confront the reliability of these data are that only a sample of roosts have been counted and that the counts were sometimes conducted more at the observer's convenience than that of the necessity of the count. Many counts were made under weather conditions that were not ideal, and sometimes the observers were not in the correct location to obtain the best results. In several cases the restrictive time element forced counts to be taken at the wrong time under adverse conditions. In other instances the roosting conditions changed slightly, but the observer was not aware of this until after the count was made. Time was usually not available for repeating counts. It was also found that counts made on consecutive days by the same observers varied greatly. The time that most counts are conducted is very important and weather conditions affecting migration can alter the data considerably. All of this adds up to the need for concise scheduling of a sizeable experienced work force having limited available time.

Even if the roost count data collected are reliable, they are obtained after the hunting season regulations are established. These data would give us an idea of fall populations and reproductive success which can be used to establish facts on the populations for long term evaluations and future research reference. Such was recognized by Hein. However, the data that are most needed for management purposes must be obtained prior to August 1 in order that current population conditions can be taken into consideration. This requires data on spring breeding populations and reproductive success.

CONCLUSION

Under the present project procedure there are simply not enough wood duck roost counts being properly conducted to accurately detect fluctuations of the wood duck population within acceptable limits on a statewide basis. There are many variable conditions that alter results of counts at particular roosts, and thus make their reliability questionable. If the project could be expanded and sufficient counts made by experienced men with available time in September to accurately conduct the counts, these data should then be dependable within acceptable limits. The required emphasis can be put on this project, is questionable that it should be continued in the future, but instead more effort put into developing suitable techniques for measuring statewide spring breeding populations and reproductive success. This would be particularly true if the early teal seasons are continued.

Table 1. Wood duck roost count form

ROOST: _____

OBSERVER: _____

DATE: month _____ day _____ 19____ AM _____ PM _____

LOCATION: NE ¼ _____ NW ¼ _____ SE ¼ _____ SW ¼ _____
Section _____ Township _____ N ____ S ____ Range _____ E ____ W ____

WEATHER DATA:

wind: _____ mph (estimate) Wind from (check one below):
N ____ NE ____ E ____ SE ____ S ____ SW ____ W ____ NW ____
Temperature during past 24 hours: maximum _____ °F minimum _____ °F

Barometer: _____ _____ in. Hg. rising _____ steady _____ falling _____

Amount of sky covered by clouds (check one below):
0-20% _____ 21-40% _____ 41-60% _____ 61-80% _____ 81-100%

Atmosphere (check one below):
clear _____ haze _____ precipitation _____ fog _____

Water: normal stage at _____
plus _____ or minus _____ _____ _____ ft. (to nearest tenth-ft.)

FLIGHT DATA:

No. wood ducks counted: _____ Most came from (check one):
N ____ NE ____ E ____ SE ____ S ____ SW ____ W ____ NW ____

Illumination: (logarithm to base 2 of foot-candles of incident light)
start _____
peak _____
end _____

Local sunrise or sunset: _____ CST
Time of flight: (minutes from sunrise or sunset)
start _____
peak _____
end _____

Duration of flight: _____ minutes
Latitudinal position of roost to nearest tenth degree: _____
Day of year (Jan. 1 equals "001"): _____
Observation conditions: excellant _____ good ____ fair _____ poor _____

Table 2. Wood duck roost counts - 1965

AREA	UNIT(location)	COUNTER	DATE	NO. COUNTED
Noble Lake	Missouri River	Swanson	9/28	32
Colyn	Chariton	Ripple	not used	
Brown's Slough	Chariton	Ripple & Hlavka	9/24	100
Long Pond	Bays Branch	Niermeyer	9/27	340
Rice Lake	Lake Mills	Whitaker	9/24	34
Burr Oak Lake	Ingham High	Howing	9/24	250
West Swan	Ingham High	(not run)		
Big Marsh	Sweet Marsh Unit	Dalziel	9/25	133
Sweet Marsh A	Sweet Marsh Unit	Richey	9/23	112
Sweet Marsh C	Sweet Marsh Unit	Richey	9/22	0
Meyers Pond	Sweet Marsh Unit	Fagenbaum	9/23	169
Cardinal Marsh	Sweet Marsh Unit	Bishop & Hoth	9/21	126
Coralville	Otter Creek	(not run)		
Goose Pond	Odessa	(not run)		
L. Goose Pond	Odessa	(not run)		
Muskrat Lake	Odessa	(not run)		
Swift Chute	Odessa	(not run)		
Brenton Slough	Polk-Dallas Co.	Huff	9/23	178
Osage	Osage	Roemig	9/25	18
Dan Green Slough	Ruthven	Fredrickson	9/1	300
Dan Green Slough	Ruthven	Fredrickson	9/11	150
Dan Green Slough	Ruthven	Jones	9/29	89
Paint Creek	Mississippi River	Bishop & Hoilien	9/22	51
Union Slough	Refuge H-3	Ferguson	8/11	*78
Union Slough	Refuge H-5	Ferguson	8/25	*257

* Roost counts made in September estimated 1000 birds at H-5 and over 400 at H-3

Table 3. Wood duck roost counts - 1966

AREA	UNIT (location)	COUNTER	DATE	NO. COUNTED
Noble's Lake	Missouri River	Bridges	9/16	26
Colyn	Chariton	Ripple	9/16 a.m.	36
Brown's Slough	Chariton	Garner	9/16	290
Long Pond	Bays Branch	Niermeyer	9/14	0
Finn Pond	Bays Branch	Niermeyer	9/27	320
Rice Lake	Rice Lake Unit	Whitaker	9/16	87
Burr Oak Lake	Ingham-High	(not run)		
West Swan Lake	Ingham-High	(not run)		
Ingham Lake	Ingham-High	Howing	9/14	542
Big Marsh	Sweet Marsh Unit	Richey	9/17	16
Sweet Marsh A	Sweet Marsh Unit	Dalziel	9/16	12
Sweet Marsh C	Sweet Marsh Unit	Dalziel	9/14	44
Meyer's Pond	Sweet Marsh Unit	Dalziel	9/13	90
Cardinal Marsh	Sweet Marsh Unit	Hoth	9/12	4
Coralville	Otter Creek	Simonson	9/15	276
Goose Pond	Odessa	Vollink	9/15	116
Brenton Slough	Polk-Dallas Co.	Huff	9/14	300
Osage	Osage	Roemig	9/15	42
Dan Green Slough	Ruthven	Jones	9/14	352
Dan Green Slough	Ruthven	Jones	9/15	141
Dan Green Slough	Ruthven	Jones	9/16	568
Union Slough	Refuge H-3	Ferguson	9/15	278
Union Slough	Refuge H-3	Ferguson	9/27	206
Union Slough	Refuge H-4	Ferguson	8/25	432
Union Slough	Refuge H-4	Ferguson	9/1	600
Union Slough	Refuge H-5	(dry)		
Wiese Slough	Odessa Unit	Nichols	9/10	123
Wiese Slough	Odessa Unit	Nichols	9/10 a.m.	40
Yellow River	Miss. River	Bishop	9/8	306
Buck Creek	Miss. River	Bishop	9/7	324
Paint Creek	Miss. River	Hoilien	9/20	24
Village Creek	Lansing Dist.	Federal	9/16	23
Village Creek	Lansing Dist.	Federal	9/30	18
Yellow River	McGregor	Federal	9/15	111
Lock & Dam 9	McGregor	Federal	9/14	64
Lock & Dam 9	McGregor	Federal	9/27	32
Wisconsin Roost	McGregor	Federal	9/15	113
Bertom Lake	McGregor	Federal	9/14	146
Lynn Hollow	McGregor	Federal	9/16	201
Lynn Hollow	McGregor	Federal	9/27	373
Grant River	McGregor	Federal	9/14	9
Spring Lake	McGregor	Federal	9/28	600

Table 4. Wood duck roost counts - 1967

AREA	UNIT (location)	COUNTER	DATE	NO. COUNTED
Noble's Lake	Missouri River	Bridges	9/14 p.m.	84
Colyn	Chariton	Ripple	9/11	8
Brown's Slough	Chariton	Hlavka	9/7	1
Long Pond	Bays Branch	Niermeyer	9/14	125
Finn Pond	Bays Branch	Niermeyer	9/15	190
Ingham Lake	Ingham-High	Howing	9/13	476
West Swan Lake	Ingham-High	Tindall	9/13	80
Big Marsh	Sweet Marsh Unit	Richey	9/11	7
Sweet Marsh A	Sweet Marsh Unit	Dalziel	9/15	100
Sweet Marsh C	Sweet Marsh Unit	Dalziel	9/14	25
Meyers Pond	Sweet Marsh Unit	Fagenbaum	9/14	16
Cardinal Marsh	Sweet Marsh Unit	Downing	9/9	18
Coralville	Otter Creek Unit	Simonson	9/10	161
Otter Creek	Otter Creek Unit	Swanson	9/15	93
Goose Pond	Odessa	Vollink	9/13	568
Weise Slough	Odessa	Jennings	9/15*	80
Brenton Slough	Polk-Dallas Co.	Huff		
Dan Green Slough	Ruthven	Jones	9/9	421
Dan Green Slough	Ruthven	Jones	9/10	351
Paint Creek	Mississippi River	Hoilien	9/15	11
Buck Creek	Mississippi River	DeCook	9/12	44
Yellow River	Mississippi River	DeCook	9/13	7

* All counts were made in P.M. except Weise Slough

Table 5. Results of three years wood duck roost counts in Iowa

AREA	WOOD DUCKS NO. COUNTED		
	1965	1966	1967
Noble's Lake	32	26	84
Colyn	0	36	8
Brown's Slough	100	290	1
Long Pond	340	0	125
Finn Pond		320	190
Rice Lake	34	87	
Ingham Lake		542	476
Big Marsh	133	16	7
Sweet Marsh A	112	12	100
Sweet Marsh C	0	44	25
Meyers Pond	169	90	16
Cardinal Marsh	126	4	18
Coralville Reservoir		276	161
Goose Pond		116	568
Brenton Slough	178	300	0
Osage Roost	18	42	
Dan Green Slough	300	568	421
Paint Creek	51	24	11
Union Slough H-3	400+	278	
Buck Creek		324	44

Appendix A. Reported recent locations of wood duck roosts in western Iowa (other than those already listed in Tables 2-5)

Area of Roost*	County	Reported by **
1. Riverton Area	Fremont	J. Shipley, W. Garrett
2. Taylor Slough	"	" "
3. Co. Road Dam Impoundment	Mills	C. Hein
4. Carr Lake	Pottawattamie	W. Garrett
5. Lake Manawa	"	"
6. Round Lake	Harrison	" , R. Bridges
7. Tyson Bend	"	R. Johnson, "
8. Louisville Bend	Monona	J. Bruun
9. Big Sioux River	Plymouth & Sioux	G. Newell
10. Big Sioux Mgmt. Area	Lyon	L. F. Tellier
11. Gitche Manitou	"	"
12. Rush Lake	Osceola	"
13. Prairie Lake	Dickinson	D. Nelson
14. McClellan's Beach	"	M. Ashby
15. Little Sioux	"	"
16. "	Cherokee	F. Starr
17. L. S. above Linn Grove Dam	Buena Vista	"
18. Pasture Pond Fish Hatchery	Sac	J. Wallace
19. Five Island Lake	Palo Alto	V. Holmes
20. Bradgate Area	Humboldt	F. Rokenbrodt
21. Eagle Lake	Hancock	J Edwards
22. Iowa River Segment	Wright	"
23. Goose Lake	Greene	D. Zmolek, K. Niermeyer
24. Hardin Creek	"	J. Ripple
25. Lakin Slough	Guthrie	K. Niermeyer
26. Nicholson Ford	Marshall	W. Harvey
27. Stanley Mill Bridge	"	"
28. Soldiers Home Goose Pond	"	"

* More exact locations - twp., sect. no., dist. from town or road - available for most.

** Western Iowa personnel not shown either listed areas already included in Tables 2-5 or reported no wood duck roosts known to them in their territory.

LAND CLEARING IN THREE SOUTHERN IOWA COUNTIES SINCE 1956

M. E. Stempel
Game Biologist

The primary Iowa quail range is in the southern counties. Only a portion of the brush and timber has been removed because much of the land is of poor quality and it yields little income. This upland game cover is a remnant of formerly widespread woodlands. In the southern Iowa counties there is also some good quality soil, but this was cleared of timber and brush long ago, because the cultivated crops grew well and the cash return was high.

Timber and brush removal programs are carried on under three plans. The first of these is an ASC plan through which some money is available to promote tree and brush removal under public-private cost-share agreement. The second is carried out by farmers who do clearing at their own expense. The third is the "Tenco", or ten-county, program which is also cost-share. All programs are now in effect, but the third type is not yet wide-spread, as it is a corporation effort and requires considerable planning. The first two plans and their effects will be discussed.

This paper sets forth results of land clearing since 1956 in Davis, Monroe and Wapello counties. Sources for information on cost-share are the SCS, ASC and the Extension offices. To obtain information on 14 specific farms land owners or farm operators were interviewed an aerial photo was used, and my own records from this particular area were checked. This report covers a 10-year period.

ASC AND SCS REPORTS

The Brush Control Program

Land clearing comes under ASC Practice B-3. The name of the practice is "Controlling Competitive Shrubs". To be approved the brush control work must be done with bull-dozers. No spraying is permitted. Steep land does not qualify for restoration, and amount of payment has been no more than $12 per acre. This is under a cost-share plan on a 50-50 basis.

Only woody plants under six inches in diameter could be cut. If land which has been cleared under cost-share is put into row crop, the land operator must repay the amount received from the plan. Cost-share is available for increasing forage production after clearing, by fertilizing, liming and seeding.

Results of the Program in Davis, Monroe and Wapello Counties

A short description of land clearing in Davis County will illustrate the general long-time operation of the program in the three counties concerned. In Davis County there are about 1200 farms. The peak years for land clearing were before 1957. In recent years it was estimated by the SCS office personnel that about 500 acres were cleared of brush and small trees. As an example of what is being done under this plan in 1967, the total amount approved for

renovation in Davis County was 173 acres. This was on 25 farms. There was no clearing under this plan in 1966 or 1965. In Wapello County 117 farms (1,208 acres) were cleared in 1967; in Monroe county the figure was 238 farms (3,549 acres).

For the three counties above, there was land clearing on 375 farms during 1967, 1966 and 1965; this was an average of 125 farms per year and the average amount cleared per farm was was 13 acres (Table 1).

REPORT ON 14 FARMS IN WAPELLO COUNTY

The 14 farms consisted of a total of 1,820 acres; and three sources of information were used in estimating the amount of clearing on the land. These items were : an aerial photo, the farmer's opinion, and my knowledge of the territory which is either in or near our Quail Research Area in Wapello County. Since all cover areas are irregular in shape, and difficult to measure, only estimates are available on size of the sites (Table 2).

Methods of Clearing

Farmers received cost-share toward machine operation in clearing a certain amount of land approved as pond sites as well as pasture improvement. Also there was financial assistance for terrace construction and a portion of seeding, liming and fertilizing. The farmers bore all cost of removing brush from fence rows; clearing and filling ditches, and some of the reseeding. The farmers also bore the expense of pasture renovation in those cases where thinly scattered brush and timber was removed.

Results

In 1956 there was a total of 285 acres of all types of brush and timbers on the 14 farms under study. This included the sites where brush and trees were thinly scattered, as well as areas where woody growth was dense. The latter is usually the high grade game cover which is necessary for long time survival of game.

Since 1956 a total of 75 acres of all classes of woody cover was removed. This was a little more than four percent of all farm acreage and 26 percent of this type of cover.

There were 134.5 acres of high grade, or choice, game cover in 1956. Since 1956 a total of 29.5 acres of this cover was removed; this was about 22 percent of the choice cover which had existed in 1956. This was dense cover composed of trees, brush and grass. There were weeds in many places. Much of this was alongside ditches and in ditches and fence rows. On some of the farms all of the high grade game cover was eliminated by these clearing operations.

CONCLUSIONS

There are three plans under which woody cover may be removed in order to produce more cattle forage. These three plans are: (1) The ASC practice which is a public-private cost-share plan; (2) tree and brush cutting by the land owner at his expense; (3) a plan which

includes government subsidy of corporate farming practices.

For each of the past 3 years an average of 125 farms had some cost-share allowance for renovating pastures. There was wide-spread clearing at private expense, and some corporation type farms are planned or have been established.

An example of the results of clearing is given for Wapello County in fairly good quail country on 14 farms, where in 1966 about 210 acres of woody cover remained. Ten years before, the figure was 285 acres. Twenty-two percent of the good quail and rabbit habitat was destroyed during the brush and tree removal operations.

There are numerous reasons for renovating, improving, or restoring pasture land. For example, when land prices are high the production per acre must be high in order to make a profit. Recently in some areas in Wapello County, land taxes have gone up 70 percent, and this too forces the landholder to try for greater production in order to meet expenses.

Table 1. Land cleared under ASC cost-share in three southern Iowa counties, 1965-66-67

Year	No. of Farms Involved			
	Davis Co.	Monroe co.	Wapello Co.	Total
1967	20	67	40	127
1966	0	59	38	97
1965	0	112	39	151
Totals	20	238	117	375
	No. of acres cleared			
1967	173	1,102	544	1,819
1966	0	850	326	1,176
1965	0	1,597	338	1,935
Totals	173	3,549	1,208	4,930

Table 2. Amount of brush clearing 1956-1966, inclusive, on 14 farms in Wapello County

Acreage of 14 farms	Acreages of woody cover in 1966	Acreages cleared in 10 years	Acres cleared in 1966	% cleared in 10 yrs.
All types of woody cover				
1,820	210	75	2	26
Good grade woody upland game cover				
	105	29.5		22

QUAIL STUDIES ON TWO AREAS IN SOUTHERN IOWA, 1967

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INTRODUCTION

Two quail study areas are located south of Highway 34 in Iowa's primary quail range (Stempel and Hlavka, 1966). The Wapello Area is situated southwest of Ottumwa in Adams, Green and Center Townships of Wapello County. Little Soap Creek drains the Wapello Area. Bottomlands and ridgetops are in grain and hay. Slopes are in brush or timber. The Decatur-Wayne Area comprises parts of Clay and Jefferson Townships in western Wayne County in addition to parts of High Point and Woodland Townships in eastern Decatur County. This former Iowa State University quail study area is located about 8 miles north of the Iowa-Missouri boundary in south central Iowa. Steele's Creek ditch drains this area. Grain crops are raised in the flood-plain. For the most part the terrain in both areas is sloping to hilly. The soils are somewhat acid. There are numerous small ponds. Up and down hill farming still continues; many gullies are caused by erosion. Tree and brush removal is occurring, coupled with the shift in land husbandry toward livestock grazing.

Quail population data is gathered on the study areas during all four seasons of the year. This data can be compared to statewide counts. In addition, a field record is kept of the rabbits and pheasants sighted.

METHODS OF CENSUSING

Game biologists conduct the early fall and late winter quail counts with the aid of dogs. Covey searches are limited to grain field edges and adjoining travel lanes or cover patches. Abandoned farmstead grounds are also scouted. When snow cover is present, coveys can be located by their trails. Other quail sign (calling, roosts, feathers, droppings or tracks) and actual walking time of the counts are recorded. Farmers are also asked for their estimates of the number of coveys on their farms.

At two-week intervals from May through August standard roadside whistle counts are conducted on each study area. The number of different cock quail heard calling at each of 10 stops (listening points) on a preselected route is recorded. All sightings of quail are also noted.

After each month of the hunting season, five farmers on each study area are interviewed about hunting activity on their farms. Questions are asked about the number and size of the hunting parties and the farmer's opinion of the quail population.

RESULTS OF STUDIES

Winter Studies

Late February-early March quail counts were conducted without the benefit of snow cover in both 1966 and 1967. Thirty six coveys were located on the two areas in 1967; 32 coveys, in 1966 (Table 1).

Spring and Summer Studies

Quail production is usually high when grain crop production is also high. Iowa's 1967 corn crop is the largest of record; the soybean crop, a near record (Crop and Livestock News, December 1967). April was a month of violence with high winds, hailstorms and tornadoes. May was unusually cool and dry. June was cool and wet --- the wettest in 95 years. July and August were sunny and cool. September was cool and dry. October was noteworthy for the greatest abundance of snowfall in Iowa in that month since 1925. The May to October period was the coolest since 1917 (Climatological Data - Iowa, for months concerned). Although the spring weather seemed to vary from dry to wet, these extremes were tempered by some moderate weather which encouraged field crop production.

Calling by cock quail reflects production. Calling at a high rate over a long period indicates good nesting effort and usually good quail production. In 1967 calling was well underway in May. It was high in July and continued at a good level through August (Figure 1). This long calling period of 14 weeks was similar to that of 1966 and again indicated high quail production.

Another indicator of high quail production in 1967 was the large number of quail sighted per 100 miles driven on the combined study area census routes. In 1967, 22 quail were observed per 100 miles driven; in 1966, 14 quail per 100 miles driven.

Autumn Studies

The fall 1967 quail count was begun on October 26 and completed on November 28 on the Wapello Area. At the Decatur-Wayne Area this count commenced on October 18 and was completed on November 17. The weather during the census period was cool with some periods of rainfall and was mostly favorable for using a dog in locating quail. Finding coveys was made more difficult by heavy cover and unharvested grain fields. In 1967, 50 coveys were located on both areas (Table 2). This was 7 coveys fewer than the average for the preceding two years. In 1967 it took 1.3 hours to flush a covey. This was about the same as the 1965-66 average. In 1967 the farmer's estimate of 43 coveys was 9 coveys above the average estimate for the preceding 2 years.

HUNTING ACTIVITY

The 1967-68 quail season of 100 days commenced on October 21 and terminated on January 28. Nearly 10 percent of the hunting activity on the study areas occurred in October (Table 3). November, December and January had 41, 31, and 18 percent of the

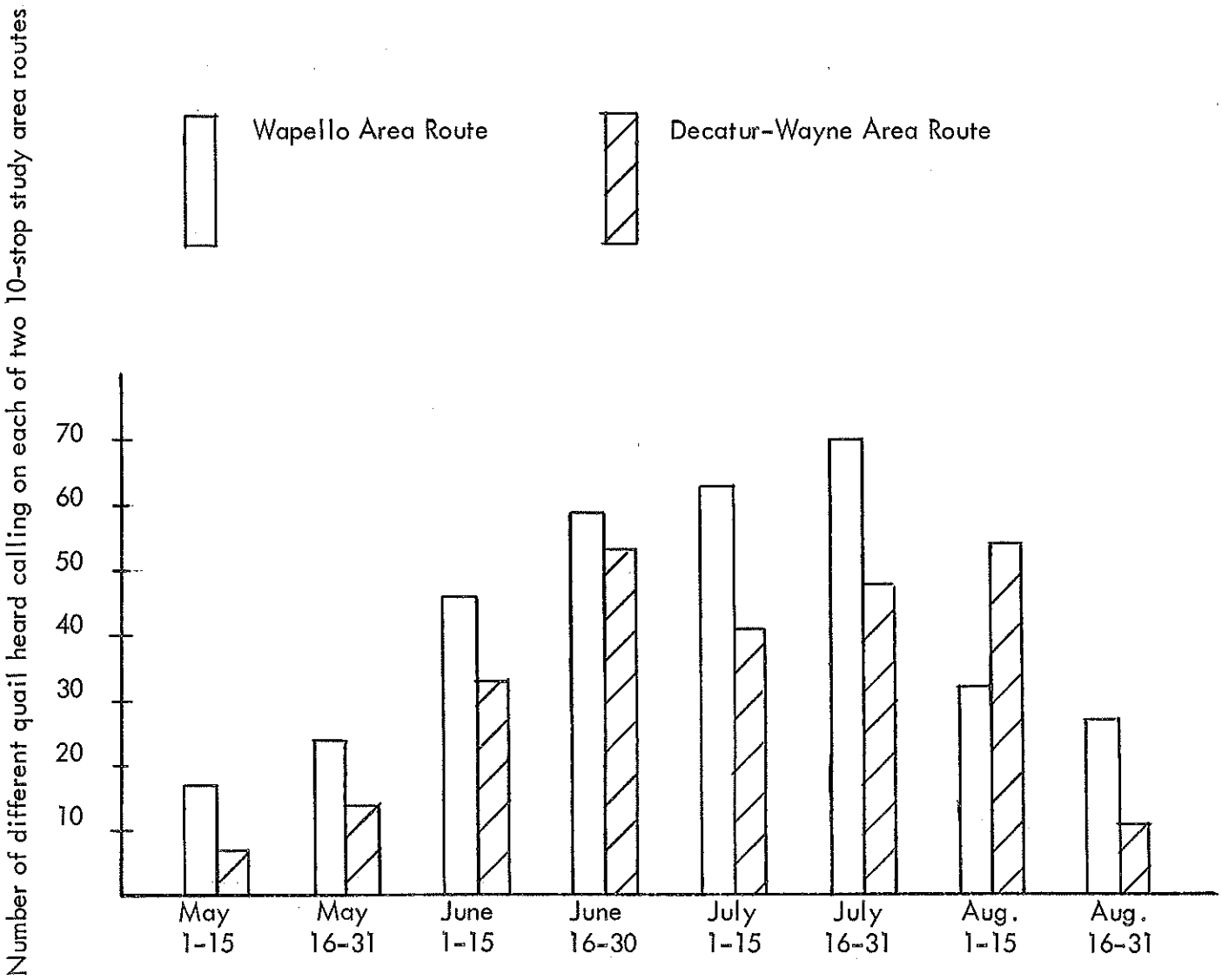

Figure 1. The length and peak of the quail calling period as recorded by different observers on the Wapello and Decatur-Wayne Areas, 1967

hunting activity, respectively. On the Decatur-Wayne Area the presence of ringneck pheasants is an added incentive to hunting. Some hunting without permission was reported on both areas.

DISCUSSION

The winters of 1965-66 and 1966-67 in southern Iowa were characterized by light snow cover. Spring 1967 was greeted by the presence of 36 coveys on both study areas. The brood stock had increased by 4 coveys, the estimated population by 60 birds. The quail were off to a good start. Then June came---the wettest June in 95 years. The precise effect of all this wetness in uncertain. At the least, quail production may have been delayed.

The extent of the quail calling period in 1967 was similar to that of 1966. In both years there were over 14 weeks of significant quail calling. Quail sightings per 100 miles driven on the census routes were also high in both years. Good production was indicated for 1967. However, the number of coveys located on both areas during fall 1967 was down by 7 from the 1965-66 average. It may be that fewer coveys were located because of interference of heavy vegetation and unharvested grain fields. On the Decatur-Wayne Area the setter used would annoyingly become "lost" by chasing pheasants in standing corn. Any quail scattered in standing corn would be next to impossible to locate.

Although both 1966 and 1967 were very good years for quail, 1967 seemed to be slightly less favorable than 1966 for quail production.

SUMMARY

1. Quail counts were continued on two study areas, Wapello and Decatur-Wayne, in 1967.

2. The spring brood stock on both areas increased by 4 coveys. Thirty six coveys were located in 1967; 32 coveys, in 1966.

3. More than 14 weeks of significant quail calling indicated good production in 1967.

4. Fifty coveys were located on both areas during fall 1967. This was 7 coveys fewer than the 1965-66 average for both areas.

5. The hours per covey flush in fall 1967 for both areas was 1.3. The average for the preceding 2 years was 1.4 hours.

6. Quail sighted per 100 miles driven on the census routes increased from 14 in 1966 to 22 in 1967.

7. Nearly 10 percent of the quail hunting activity on both study areas was in October (11 quail hunting days). November, December and January had 41, 31 and 18 percent of the hunting activity, respectively.

Table 1. Results of winter 1967 quail counts on the Wapello and Decatur-Wayne Areas, compared to the 1966 winter counts of both areas

	1967*				1966*
	Wapello Area	Decatur-Wayne Area	Both Areas		Both Areas
No. of coveys located	22	14	36		32
Flush	4	13	17		
Sign	18	1	19		
No. of quail estimated	270	154	424		364
Flush	58	143	201		
Sign	212	11	223		
No. of hrs. spent walking	11.2	24.8	36.0		30.5
Hrs. per covey flush	2.8	1.9	2.1		2.5
Farmer estimate of no. of coveys	4	4	8		5

* No snow cover present during counts

Table 2. Results of fall 1967 quail counts on the Wapello and Decatur-Wayne Areas compared to the 1965-66 average of both areas

	1967			1965-66 Avg.
	Wapello Area	Decatur-Wayne Area	Both Areas	Both Areas
No. of coveys located	25	25	50	57
Flush	7	24	31	
Sign	18	1	19	
No. of quail estimated	264	280	544	793
Flush	71	265	336	
Sign	193	15	208	
No. of hrs. spent walking	9.5	32.1	41.6	41.0
Hrs. per covey flush	1.4	1.3	1.3	1.4
Farmer estimate of no. of coveys	17	26	43	34

Table 3. Summary of quail hunting activity reported at five farms on each of two areas, Wapello and Decatur-Wayne, 1967-68

	Wapello Area		Decatur-Wayne Area		Both Areas		Percent of Hunting Activity on Both Areas		
	No. of Parties	No. of Hunters	No. of Parties	No. of Hunters	No. of Parties	No. of Hunters	Parties 1967-68	Parties 1966-67	1965-66
October*	1	2	3	5	4	7	10	19	-
November	8	15	8	21	16	36	41	27	53
December	5	11	7	24	12	35	31	27	26
January*	4	9	3	9	7	18	18	27	21
TOTALS	18	37	21	59	39	96	100	100	100

* October had 11 quail-hunting days; January, 28.

PROGRESS REPORT ON RACCOON AND BEAVER TAGGING STUDIES

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INTRODUCTION

This report will serve as a summary of the raccoon and beaver tagging data collected in 1966 and 1967. The purpose of tagging both species was to collect information on movements and mortality which would aid the Conservation Commission in setting sound harvest regulations. At the present time no information of this type is available for Iowa conditions. No conclusions are presented at this time because the studies are incomplete. Perhaps if additional data is collected at a future date, definite results will be forthcoming. This status report is being given now because the biologist in charge of the project has accepted other employment effective in January 1968.

RACCOON

During the summers of 1966 and 1967 raccoons were delivered to the Wildlife Research Station by Conservation Officers and Game Section personnel. These animals were raised at the Station until they could adequately feed for themselves, then released into the wild at various locations in the state. Each animal was marked with a numbered "clamp type" ear tag. Fifty-two animals were raised and released during the two years of study. Four raccoons (three juveniles and one adult) were captured incidental to the beaver live-trapping in 1967. These animals were tagged and released at the site of capture.

There have been six tag recoveries to date (Table 1). All reported mortality was attributed to hunting and trapping.

One of the tagged animals, a juvenile male, moved 10 miles from the release site. The remaining five raccoons moved less than $\frac{1}{2}$-mile before being killed.

Table 1. Summary of raccoon tagging data, 1966 and 1967.

Year	No. of Animals Tagged by age		No. of Tag Recoveries	Cause of Mortality	
	Juvenile	Adult		Hunting	Trapping
1966	21	3	5	3	2
1967	31	1	1	0	1

BEAVER

A beaver tagging study was initiated in August of 1967. Beaver were captured in August, September and October using Hancock and Bailey live-traps. Twenty-six beaver were captured during the study and marked with a "clamp type" tag in each ear. Sex and weight data was collected on all animals whenever possible. (Table 2). Twenty-two of the beaver were released at the site of capture. The remaining four "problem beaver" were transplanted to other areas with suitable habitat.

Thus far there have been no reported tag recoveries. However, the 1967 trapping season has just opened (Dec. 16th) as this report is being written.

Table 2. Sex and age class data for beaver captured in 1967

Location	Sex			Age Classes	
	Male	Female	Unknown	Kits	Adults
Central Iowa	8	6	6	7	13
Northeast	4	1	1	4	2

A PROGRESS REPORT

WINTER TO SPRING MOVEMENT OF PHEASANT HENS

R. C. Nomsen
Game Biologist

A total of 28 hens and 9 cocks was trapped and marked with back tags to study the winter to spring movements of pheasants on the Winnebago Research Area. Two cocks and 2 hens were killed by predators during the trapping operation.

The number of hens per section on the Winnebago Area and vicinity as determined by direct winter counts varied from 2 to 38 hens. It was estimated that the spring population averaged 16 hens per section, with higher populations in areas immediately surrounding safe winter cover. For example, there were 38 hens wintering at Teig's abandoned farm grove where 20 hens were tagged (Table 2). Subsequent roadside counts in this segment averaged 2.4 hens per mile compared with 1.1 hens per mile in the other segments.

Winter trapping was started on February 15, 1967 and completed March 6. Four Ohio-type traps were used - two at Teig's abandoned farm grove, one each at Oppedahl's and Elvebak's farm groves. Traps were baited with ear corn but kept open until birds were observed visiting the site. Yellow numbered back tags were used at Teig's, red at Elvebaks, and dark blue at Oppedahls. The trapped birds were tagged soon after capture and taken about $\frac{1}{4}$ mile up-wind where they were released in the direction of the winter cover area. All but 2 or 3 of the released birds thus returned to the original site of capture.

A forty-mile roadside route was established in the vicinity to aid in determining the extent of dispersal. This route was checked 8 times between April 27 and May 24th. Observations of all pheasants sighted were recorded on maps so that distance could be measured from the trapping site. Tagged individual birds were identified with a spotting scope.

The winter to spring movement of 12 marked hens varied from 0.3 miles to 1.2 miles and averaged 0.56 miles (Table 1). Eight of the 12 hens moved a half mile or less; only 2 moved one mile or more from the trapping site. Observations were made on 4 cocks and they had moved an average of 0.46 miles from the wintering area.

Sightings of all birds were recorded to help determine the effective range of a winter cover area. Hens recorded in each $\frac{1}{2}$-mile segment away from the tagging site are listed in Table 2, with a comparison of tagged and untagged hens observed. Hens in a particular wintering area contributed very little to the nesting population over 1 mile from the winter concentration point.

This project will be continued in 1968 and it is hoped that a greater number of hens can be tagged in a single concentration. Observations could be intensified in the smaller area so that a more accurate check on individual birds could be made.

Loss of safe winter cover in Iowa's northern pheasant range has been very noticeable during recent years. We should try to obtain more precise information concerning the extent of spring dispersal in order to give sound and practical recommendations concerning the need for such cover.

Table 1. Winter to Spring Movements of Hen Pheasants

Individual Hen	Average distance in miles	Number of Sightings
Red 1	0.6	1
Red 3	0.5	1
Red 5	1.0	2
Red 8	0.4	3
Yellow 5	0.3	1
Yellow 6	0.3	2
Yellow 7	0.8	3
Yellow 13	0.4	2
Yellow 15	1.2	1
Yellow 18	0.4	1
Yellow Unknown	0.3	
Yellow Unknown	0.5	
	0.56 average distance	

Table 2. Comparison of Tagged and Untagged hens sighted in Each Segment Surrounding Trapping Site

Segment	Road Mileage In Segment	Area of Segment	Total Hens Observed	Tagged Hens Observed	% of All Hens tagged
0-1/2 mi.	1.7	0.8 sq.mi.	33	8	24%
1/2-1 mi.	4.3	2.4 " "	34	3	9%
1-1 1/2 mi.	6.9	3.9 " "	78	2	3%
1 1/2-2mi.	10.6	5.5	104	0	0%
Totals	23.5	12.6	249	13	5%

THE 1967 ARCHERY DEER SEASON

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Game Biologist

INTRODUCTION

Modern archery hunting of deer dates back to 1953 when hunting was first permitted. In that memorable season only 10 archers took the field and one was successful. Since then annual, more liberal, seasons have encouraged ever-increasing numbers of hunters to adopt the sport.

The 1967 season extended from September 30 to November 30. Shooting hours were $\frac{1}{2}$ hour before sunrise to $\frac{1}{2}$ hour after sunset each day. The bag and possession limit was one deer of any sex or age. In 1967, 4,413 licenses were sold as compared to 4,576 in 1966.

METHODS

Each hunter, whether or not he hunted or was successful, was required to return a card to the Conservation Commission recording the various aspects of his hunting effort and success. These cards were coded by Commission personnel and submitted to Data Processing of the Comptroller's office where they were subjected to computer analysis. The information submitted in this report was derived from the above source.

RESULTS

Card Returns

Report cards were returned by 4,046 (91.6%) of the licensed hunters. Data concerning number of hunters, number of deer killed, and percent success in this report has been corrected to account for those hunters who did not return a report card. This was done by using 37 cards returned too late for computer analysis and expanding the data from them to represent all 367 cards not submitted to Data Processing.

Hunting Success

Of 4,413 licenses issued, 276 were not used. The remaining 4,137 hunters reportedly killed 791 deer for a success rate of 19.1%. This is a higher rate of success than occurred during any prior season (Table 1) and well above that of 1966 (13.3%).

During 44,275 hunting trips 3,773 reporting hunters saw 43,618 deer and hunted 173,080 hours. This is an average of about 1 deer and 3.9 hours per trip. The average reporting hunter expended 45.5 hours afield. Successful hunters spent slightly more time, 50.9 hours afield. Altogether, 233 hours of hunting was required per deer bagged.

Of 3,773 reporting hunters, 405 (10.7%) crippled one or more deer. In all, 447 deer were reported crippled; or, 1 deer crippled for every 8.4 hunters. This represents 6 deer crippled for every 10 killed.

More successful hunting trips were made in the afternoon than during the morning. Two hundred sixty seven deer were taken in the morning (35.9%) and 477 (64.1%) were taken after noon.

Based on 3,775 reports, 2,165 (57.4%) archers hunted only in their home counties, 924 (24.5%) hunted only outside their home counties, and 686 (18.1%) hunted in their home counties plus in other counties.

Farmers killed only 37 of the deer taken. All other occupation groups harvested 754 (95.6%).

Biological Data

Bucks were killed more frequently than does (451 males/ 293 does) as reported by hunters. One hundred seventy hunters reported killing fawns. Adult deer were taken by 574 (77.1%) hunters.

DISCUSSION

The high success rate enjoyed by archers during 1967 can be attributed to two factors The 62 day season (Table 1) was 11 days longer than any previous season; hence, more hunting time was permitted. In 1966 a split season, 30 days before and 21 following the gun season, was tried. Hunting success fell from 18.8% in 1964 and 16.4% in 1965 to 13.3% in 1966. Obviously the split season of 1966 had an adverse effect on archery success.

Biological data obtained from hunter reports is of questionable value. Hunters probably do not report sex in the true ratio in which deer are killed. They report far more bucks than does. This is in conflict with the data gathered by technical personnel of the Conservation Commission which shows a much more even sex ratio. Even though hunters may be accurately reporting sex of deer killed it seems that the point has been made (consistency year after year) and there is little to gain by asking for this information in the future.

The same point can be made for age as reported by hunters. Based on data gathered by Commission technicians fawns comprive 40% or more of the bag. However, the hunters report half this percentage. In this instance, many hunters probably cannot properly age deer.

These reports by hunters on sex and age of deer killed are merely a duplication of more reliable data obtained elsewhere. Therefore, it seems advisable to discontinue asking hunters to report these items in the future.

Table 1. A Summary of Archery Deer Seasons, 1953 to 1967

Year	Number Days in Season	Number of Bow Hunters	Number of Deer taken by Bow	Hunter Success Rate (%)
1953	5	10	1	10.0
1954	12	92	10	10.9
1955	23	414	58	14.0
1956	31	1,280	117	9.1
1957	31	1,228	138	11.4
1958	30	1,380	162	12.4
1959	31	1,627	255	16.2
1960	44	1,772	277	16.0
1961	48	2,191	367	17.1
1962	51	2,404	404	16.9
1963	51	2,858	538	18.8
1964	51	3,678	670	18.8
1965	51	4,159	710	16.4
1966	51	4,021	579	13.3
1967	62	4,137	791	19.1