# PROGRESS REPORT ON THE SECOND YEAR STUDY OF SHOVELNOSE STURGEON IN THE MISSISSIPPI RIVER

By

Don R. Helms
Fisheries Research Biologist

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Fisheries Section

Jerry M. Conley
Superintendent of Fisheries

James Mayhew
Supervisor of Fisheries Research

*Abstract:* The second segment of the three year Federal Aid Project 2-156-R-2 was completed 30 June, 1973. The study was designed to investigate commercial shovelnose sturgeon harvest, study the life history and evaluate the present reporting system. Commercial harvest was low except during the final month of the period because of high water levels. As a result, only 879 fish were examined at commercial landings. Data were collected for age structure, size distribution and maturity of these fish. Fecundity was also determined. Additional samples totaling 843 fish were captured for tagging and determination of seasonal growth and sexual development. Age and growth, length-weight relationships, condition factors and other body measurements were calculated. Movement and growth increments were calculated from over 100 recaptured fish during the second year of study. Expanded attempts using meter and drift nets were again unsuccessful in capturing larval sturgeon, but juvenile sturgeon appeared quite frequently in trawl samples.

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## INTRODUCTION

The Fisheries Section of the Iowa Conservation Commission initiated a three-year study of shovelnose sturgeon in the Mississippi River bordering Iowa on 1 July, 1971 in cooperation with the National Marine Fisheries Service (PL:88-309). Objectives of the study included investigation of life history, evaluation of commercial exploitation and examination of the current reporting system for catch statistics of this species.

The following report covers project activity in the second year investigation during the period 1 July, 1972-30 June, 1973. Except as indicated, methods and procedures are identical to those described in the first annual report (Helms, 1972).

## COMMERCIAL HARVEST INVENTORY AND REPORT SYSTEM

Little was accomplished toward this objective during the second year. No commercially harvested fish were found at landings until late in the segment. Fish sampled at markets and landings in 1972 were presented in the first annual report and due to high water, fishing did not begin in 1973 until late June.

A summary of samples collected at commercial landings during the second project segment are presented in Table 1.

Fin samples taken from commercially harvested fish during the first segment were aged by microprojection of cross sections. The results will be discussed in a later section of this report on age and growth of shovelnose sturgeon.

Commercial fishermen contacted were encouraged to report catches promptly and accurately. Improvement of the reporting system was not immediately noticeable from previous years. Effort to improve the accuracy on commercial fishery statistics will continue during the remaining segment.

## LIFE HISTORY INVESTIGATIONS

### SEXUAL DEVELOPMENT

Biweekly samples of shovelnose sturgeon from Pool 13, totaling 188 specimens, were collected during the period 5 April-29 November, 1972 to determine the age and size at maturity and seasonal sexual development. Each fish was measured, weighed, and aged. Gonads were removed, measured volumetrically and examined for sexual development.

Testes were separated from gonadal fat, and volumes were determined both with and without attached fat tissue. Separating the ovaries from fatty tissues was not practical, so it was included in the ovary weight.

Gonads of immature males appeared as dark yellow longitudinal bands, 1-3 mm wide on the dorsal surface of the gonadal fat and comprised < 5% of the whole organ. Developing male gonads made up 15-30% of the organ, while fully developed gonads exceeded 10 mm in diameter and were equal to or greater in volume than the attached fat. Mature testes were grey color and appeared as a homogeneous mass.

Table 1. Summary of sturgeon examined at commercial landings during the second year of investigations, 1973.

| Pool | Date | Number measured for fork length | Number sampled for aging |
|---|---|---|---|
| 9 | 6/11 | 276 | 70 |
| | 6/15 | 142 | |
| | 6/18 | 118 | 69 |
| TOTAL | | 536 | 139 |
| 13 | 5/28 | 28 | 38 |
| | 6/19 | 29 | 29 |
| | 6/21 | 47 | 4 |
| | 6/22 | 29 | 2 |
| | 6/25 | 36 | |
| | 6/26 | 44 | |
| | 6/27 | 18 | |
| TOTAL | | 241 | 73 |
| 17 | 6/14 | 15 | |
| 20 | 6/26 | 87 | 53 |
| GRAND TOTAL | | 879 | 265 |

In contrast, ovaries had a laminated appearance. Very small specimens were white or grey along the dorsal surface but, being laminated, were easily distinguished from testes. Eggs in developing ovaries first appeared as minute yellow specks, graded to combinations of yellow and white, white, white and black, and all black eggs. The presence of yellow or white with black eggs was commonly referred to as salt and pepper.

Percent of body weight contributed by gonads (fat included) for the 88 males and 100 females were examined by age and period. Contribution of testes to body weight increased with age in males through age IV and stabilized in older fish at about 6%. All age II and III males were immature. Forty percent of age IV were mature or developing. The preponderance of mature and developing fish of this age appeared after the 1972 spawning season. Only 5 age V fish were included in the samples, and 3 were immature. Three males from age VI and older were mature (Table 2).

Contribution of ovaries to body weight for ages II, III and IV was comparable to the testes. However, contrary to testes, female gonads continued to increase in size with age after age IV. Overall contribution to body weight

Table 2. Size of testes expressed as percent of body weight by period and age for 88 male shovelnose sturgeon from Pool 13 in 1972. Sample size is in parenthesis.

| | Age | | | | | |
|---|---|---|---|---|---|---|
| Date | II | III | IV | V | VI | VI+ |
| 4/19 | | 2.5 (3) | 5.3 (2) | | | |
| 5/3 | | 3.6 (1) | 4.7 (13) | | 5.8 (1) | |
| 5/17 | | | 6.0 (6) | | | |
| 5/31 | | 2.9 (5) | | | | 5.5 (1) |
| 6/14 | 1.3 (2) | 5.0 (2) | 4.9 (2) | | | |
| 6/28 | | 6.6 (1) | 7.1 (1) | | | |
| 7/12 | 2.6 (1) | 3.8 (1) | 3.4 (1) | | | |
| 7/26 | | 3.2 (2) | 5.8 (1) | | 6.7 (1) | |
| 8/9 | | 3.2 (2) | 3.6 (1) | | | |
| 8/23 | | 2.5 (1) | 6.9 (2) | | | |
| 9 6 | 2.3 (1) | 3.3 (1) | 4.2 (1) | | | |
| 9/20 | | 2.3 (1) | 11.3 (1) | 8.0 (1) | | |
| 10/4 | 2.6 (1) | 2.1 (1) | 6.0 (1) | 9.4 (1) | | |
| 10/18 | 1.4 (1) | 2.8 (1) | 5.3 (1) | | | |
| 11/1 | .6 (1) | 4.1 (6) | | | | |
| 11/15 | 1.9 (3) | 2.2 (2) | 4.8 (3) | | | |
| 11/29 | | 3.4 (5) | 4.9 (1) | 2.1 (1) | | |
| Mean | 1.8 | 3.3 | 6.0 | 5.8 | 6.3 | 5.5 |
| Number of fish | 10 | 35 | 35 | 5 | 2 | 1 |
| Percent mature or developing | 0 | 0 | 40 | 40 | 100 | 100 |

was 2, 3.3, 6.6, 7.5, 11.6, 12.5 and 15% for ages I-VII and VII+ (Table 3). The seasonal change in the ratio of ovary weight to body weight resulted from spawning.

All females younger than age V were immature, and only one age V fish was found with developing ova. Age VI fish contained developing ova, while ages VII and older displayed various stages of egg development. Black eggs were observed in ages VII or older through the period 30 May-14 June. The first spawned sturgeon was captured on 24 May (Table 4).

Table 3. Size of ovaries expressed as percent of body weight by period and age for 100 female shovelnose sturgeon from Pool 13 in 1972. Sample size is in parenthesis.

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | II | III | IV | V | VI | VII | VII+ |
| 4/19 | .8 (1) | | 3.5 (3) | | | | |
| 5/19 | | 3.2 (1) | 4.7 (5) | | | | 16.5 (1) |
| 5/17 | | 4.8 (1) | 7.1 (1) | | | 16.1 (1) | |
| 5/31 | 2.5 (1) | | 3.7 (3) | | | 19.9 (1) | 15.0 (2) |
| 6/14 | | 3.0 (2) | 5.1 (2) | | | 7.3 (1) | 19.8 (3) |
| 6/28 | 1.4 (1) | 2.9 (3) | 5.4 (4) | | | | |
| 7/12 | 1.4 (2) | 4.6 (2) | 6.5 (2) | | | | |
| 7/26 | 1.2 (3) | 4.5 (1) | 8.5 (1) | | | 6.7 (1) | |
| 8/9 | 3.0 (1) | 1.6 (2) | 7.9 (3) | | 17.9 (1) | | |
| 8/23 | 4.0 (3) | 1.8 (1) | 5.6 (2) | 3.4 (1) | | | |
| 9/6 | 2.4 (1) | 2.3 (2) | 7.6 (4) | | | | 8.6 (1) |
| 9/20 | 2.2 (2) | 4.1 (2) | 5.3 (2) | 9.3 (1) | | | |
| 10/4 | 2.0 (1) | 3.4 (2) | 8.0 (1) | 5.8 (1) | 7.3 (1) | | |
| 10/18 | 2.0 (1) | 2.3 (2) | 9.8 (4) | | | | |
| 11/1 | | | 6.0 (2) | 9.5 (1) | | | |
| 11/15 | | 4.0 (1) | 10.0 (1) | | 9.7 (1) | | |
| 11/29 | 1.1 (1) | | 8.3 (1) | 9.5 (2) | | | |
| Mean | 2.0 | 3.3 | 6.6 | 7.5 | 11.6 | 12.5 | 15.0 |
| Number of fish | 17 | 22 | 41 | 6 | 3 | 4 | 7 |
| Percent mature or developing | 0 | 0 | 0 | 17 | 100 | 100 | 100 |

Table 4. Ovarian development of 20 shovelnose sturgeon of age V and older from Pool 13 in 1972.

| Age | Date | Fork length (inches) | Weight (lbs) | Gonad weight/ body weight (%) | Development |
|---|---|---|---|---|---|
| 5 | 8/23 | 25.6 | 2.34 | 3.4 | Immature |
| 5 | 9/20 | 26.6 | 3.36 | 9.3 | Immature |
| 5 | 10/4 | 26.6 | 2.80 | 5.8 | Immature |
| 5 | 11/1 | 25.7 | 3.39 | 9.5 | Immature |
| 5 | 11/29 | 26.9 | 3.02 | 11.2 | White eggs |
| 5 | 11/29 | 25.3 | 2.45 | 7.8 | Immature |
| 6 | 8/9 | 26.5 | 3.56 | 17.9 | Salt & pepper |
| 6 | 10/4 | 27.2 | 3.29 | 7.3 | Salt & pepper |
| 6 | 11/15 | 28.0 | 3.23 | 9.7 | Yellow eggs |
| 7 | 5/17 | 26.2 | 3.32 | 16.1 | Black eggs |
| 7 | 5/24 | 27.2 | 3.49 | 19.9 | Black eggs |
| 7 | 6/6 | 28.8 | 3.77 | 7.3 | Spawned out |
| 7 | 7/26 | 28.8 | 3.84 | 6.7 | Spawned |
| 8 | 6/14 | 26.9 | 3.19 | 21.9 | Black eggs |
| 8 | 9/6 | 29.5 | 4.47 | 8.6 | Salt & pepper |
| 9 | 5/31 | 28.0 | 3.72 | 19.5 | Black eggs |
| 9 | 6/7 | 28.8 | 4.61 | 25.9 | Black eggs |
| 10 | 5/24 | 30.7 | 5.25 | 10.5 | Spawned out |
| 10 | 6/14 | 27.8 | 4.17 | 11.5 | Salt & pepper |
| 11 | 5/3 | 28.8 | 4.32 | 16.5 | Black eggs |

Based on these observations, it appeared initial spawning commenced for female sturgeon at age VII, while most males spawn at age V. Monson and Greenbank (1947) also examined shovelnose sturgeon size and maturity in the upper Mississippi River. They sampled 503 females and 374 males during the period May-September, 1946. Although age was not determined in their study, results were similar as males matured at a smaller size than females.

## SIZE COMPARISONS OF LEFT AND RIGHT GONADS

In examining gonad sizes, it appeared in most instances the left gonad of both sexes was slightly larger than the right. As a result, data were separated. Observations were made on 84 males and 95 females (Table 5). Comparison by a Student's t test indicated the size difference between left and right was not significant ($.10 < P < .20$). In males, the left gonad averaged 55.5% of the total volume while in females, the left gonad averaged 54.2%.

Table 5. Preponderance of size differences between left and right gonads of shovelnose sturgeong.

| | Male | Female |
|---|---|---|
| Number of fish | 84 | 95 |
| Left > right | 76 | 82 |
| Right > left | 3 | 6 |
| Left = right | 5 | 7 |

## FECUNDITY

Additional fecundity data were collected at commercial landings in Pool 9 and 13 during May and June, 1973. Absolute fecundity was determined from 25 ml sample counts from 16 ripe females ranging in size from 24.2 inches FL (2.36 lbs) to 33.6 inches (6.20 lbs).

Ovaries averaged 17.8% of the body weight with a range of 12.2-27.1, and while fat was virtually absent in some, the maximum fat content was 45%.

Eggs measured 92-143 per ml and total counts ranged from 13,908 to 51,217 and averaged 24,325. Egg production did not appear to be related to fish size. Eggs per lbs ranged from 5,751 to 11,408 with a mean of 7,721 and a standard deviation of $\pm$1,910 (Table 6).

## EARLY LIFE HISTORY

Efforts to collect larval sturgeon continued in 1972. Meter net sampling was conducted for 20 weeks from 6 April-17 August. Three 5-minute samples were collected at each of two stations once a week. Station 1 was located in the tailwaters of Lock and Dam No. 12. Station 2 was in main channel border habitat seven miles downstream at the lower end of a one mile long gravel bar known locally as Sand Prairie.

Table 6. Total egg counts and ovarian-body weight ratios of 16 shovelnose sturgeon sampled during 1973.

| Date | Fork length (inches) | Body weight (lbs) | Ovary weight / body weight (%) | Fat in gonad (%) | No. of eggs per ml | Est. No. of eggs per female |
|---|---|---|---|---|---|---|
| 5/28 | 25.2 | 2.21 | 15.2 | 19.7 | 114 | 13,908 |
| 5/31 | 25.8 | 2.58 | 14.3 | 10.1 | 109 | 16,384 |
| 5/31 | 25.9 | 2.65 | 18.5 | 20.0 | 104 | 18,635 |
| 5/31 | 26.0 | 2.56 | 15.8 | 2.2 | 132 | 23,760 |
| 5/31 | 27.1 | 3.32 | 17.3 | 20.0 | 95 | 19,718 |
| 5/31 | 28.2 | 4.26 | 17.2 | 5.0 | 96 | 30,288 |
| 5/31 | 33.6 | 6.20 | 20.8 | 5.0 | 92 | 51,217 |
| 6/11 | 24.2 | 2.36 | 27.1 | 35.2 | 143 | 26,922 |
| 6/11 | 24.8 | 2.71 | 16.7 | 4.9 | 120 | 23,400 |
| 6/11 | 25.0 | 2.62 | 12.2 | 4.8 | 105 | 14,531 |
| 6/11 | 25.4 | 2.57 | 14.4 | 5.1 | 110 | 17,513 |
| 6/11 | 25.8 | 2.69 | 18.8 | 5.0 | 123 | 26,876 |
| 6/11 | 25.9 | 2.65 | 20.8 | 10.0 | 134 | 30,128 |
| 6/11 | 27.0 | 3.12 | 17.6 | 24.6 | 120 | 22,601 |
| 6/11 | 27.8 | 3.99 | 17.7 | 15.0 | 95 | 25,949 |
| 6/11 | 30.5 | 4.76 | 20.8 | 45.0 | 111 | 27,374 |
| Mean | | 3.20 | 17.8 | 14.5 | 113 | 24,325 |
| Sample standard deviation | | | 3.5 | 12.3 | 15 | 8,904 |

Efforts were expanded in 1972 to include bottom drift net collecting. Cone-shaped drift nets 4-ft in length and having a rectangular opening 2-ft x 1.5-ft were anchored on the bottom for a 10 minute period. Mesh size of both meter and drift nets was 32 meshes per inch.

Three stations were sampled. Stations 1 and 3 were adjacent to meter net Stations 1 and 2. Station 2 was located at the junction of main channel and main channel border habitats at the end of a submergent rock wing dike. Weekly samples were collected with the meter net samples for 12 weeks, 13 April-29 June.

Identification and analytical procedures were identical to those followed the previous study segment (Helms, 1972).

Meter net tows resulted in the capture of 15,278 fish from 13 genera, a group of unidentified minnows and suckers and an unknown group of fish.

Identifiable genera were: *Aplodinotus*, (freshwater drum); *Cyprinus*, (carp); *Dorosoma*, (gizzard shad); *Esox*, (northern pike); *Hiodon*, (mooneye); *Ictalurus*, (channel catfish); *Lepomis*, (bluegill and sunfish speices); *Lepisosteus*, (gar); *Noturus*, (stone cat and/or madtoms); *Percina*, (log perch and darters); *Pomoxis*, (black and white crappie); *Morone*, (white bass); *Stizostedion*, (walleye and sauger).

Drift nets captured 6,279 fish. Although this method was generally less effective than meter net tows, all genera captured by meter netting and one additional genus (*Polyodon*), paddlefish) were captured in drift nets.

*Hiodon* was the only genus captured in greater numbers by drift net. No larval sturgeon were captured by either technique. Dates of first collections and frequency of occurrence modes (Table 7) were similar for drift and meter net collections.

Table 7. Dates of initial collections, modes of occurrence and numbers of larval fish collected in Mississippi River Pool 13 in 1972.

| Group | Date of first collection | | Mode of occurrence | | Numbers collected | | |
|---|---|---|---|---|---|---|---|
| | Meter net | Drift net | Meter net | Drift net | Meter net | Drift net | Combined |
| *Aplodinotus* | 5/18 | 5/25 | 6/1 | 6/1 | 4,775 | 2,250 | 7,025 |
| *Cyprinus* | 5/18 | 5/18 | 6/8 | 5/18 | 4,326 | 472 | 4,798 |
| *Dorosoma* | 5/25 | 5/18 | 6/1 | 6/8 | 245 | 18 | 263 |
| *Esox* | 5/11 | 5/4 | - | - | 1 | 1 | 2 |
| *Hiodon* | 5/18 | 5/18 | 5/25 | 5/18 | 60 | 407 | 467 |
| *Ictalurus* | 6/22 | 6/15 | - | 6/22 | 1 | 5 | 6 |
| *Lepisosteus* | 6/1 | 6/1 | - | 6/1 | 2 | 4 | 6 |
| *Lepomis* | 5/4 | 6/1 | 6/15 | 6/8 | 248 | 20 | 268 |
| *Noturus* | 6/22 | 5/11 | - | 5/11 | 1 | 6 | 7 |
| *Percina* | 5/11 | 5/4 | 5/18 | 5/18 | 120 | 60 | 180 |
| *Polydon* | - | 5/18 | - | 5/18 | 0 | 2 | 2 |
| *Pomoxis* | 5/18 | 5/18 | 5/25 | 5/25 | 479 | 52 | 531 |
| *Roccus* | 5/18 | 5/18 | 6/8 | - | 192 | 11 | 203 |
| *Stizostedion* | 5/11 | 5/11 | 5/18 | 5/11 | 30 | 24 | 54 |
| Minnows & suckers | 5/11 | 5/11 | 5/18 | 5/18 | 4,185 | 1,521 | 5,706 |
| Unknowns | - | - | - | - | 613 | 1,426 | 2,039 |
| Total | | | | | 15,278 | 6,279 | 21,557 |

Drum, carp and the minnow-sucker group were captured in sufficient numbers for analysis of variance of catch means (Table 8). There was no significant difference between trials ($P > .05$), but differences between stations and between weeks were highly significant ($P < .01$).

Table 8. Factorial analyses of variance of catch mean for larval fishes caught in drift nets and meter net samples in Pool 13 of the Mississippi River.

| Source of variations | Fish species | | | | | |
|---|---|---|---|---|---|---|
| | Meter net | | | Drift net | | |
| | Drum | Carp | Minnows | Drum | Carp | Minnows |
| Station | ** | ** | ** | ** | ** | ** |
| Trial | ns | ns | ns | ** | ns | ns |
| Station x trial | ns | ns | ns | ns | ns | ns |
| Interval | ** | ** | ** | ** | ** | ** |
| Station x interval | ** | ** | ** | ** | ** | ** |
| Trial x interval | ns | ns | ns | ns | ns | ns |
| Station x trial x interval | ns | ns | ns | ns | ns | ns |

ns - non-significant value.

** - 99% confidence level.

Carp and drum were generally more abundant at Sand Prairie than at tailwaters station (Table 9-10). The wing dam station was more productive for drum in drift net samples. The minnow-sucker group was most abundant at the tailwaters station (Table 11).

Table 9. Number of larval drum collected by gear, station and interval in 1972.

| | Meter net | | | Drift net | | | |
|---|---|---|---|---|---|---|---|
| | Station | | | Station | | | |
| Date | 1 | 2 | Stations combined | 1 | 2 | 3 | Stations combined |
| 5/11 | 2 | | 2 | | | | |
| 5/18 | 219 | 265 | 484 | | | | |
| 5/25 | 733 | 2,145 | 2,878 | 160 | 12 | 278 | 450 |
| 6/1 | 66 | 349 | 415 | 237 | 667 | 122 | 1,026 |
| 6/8 | 122 | 339 | 461 | 37 | 93 | 54 | 184 |
| 6/15 | 65 | 226 | 291 | 51 | 188 | 33 | 272 |
| 6/22 | 27 | 39 | 66 | 38 | 160 | 36 | 234 |
| 6/29 | 20 | 19 | 39 | 9 | 66 | 9 | 84 |
| 7/6 | 5 | 7 | 12 | | | | |
| 7/13 | 33 | 9 | 42 | | | | |
| 7/20 | 30 | 56 | 86 | | | | |
| 7/27 | | 1 | 1 | | | | |
| Total | 1,322 | 3,455 | 4,777 | 532 | 1,186 | 532 | 2,250 |

Table 10. Number of larval carp collected by gear, station and interval in 1972.

| | Meter net | | | Drift net | | | |
|---|---|---|---|---|---|---|---|
| | Station | | | Station | | | |
| Date | 1 | 2 | Stations combined | 1 | 2 | 3 | Stations combined |
| 5/18 | 12 | 382 | 394 | 4 | 15 | 100 | 119 |
| 5/25 | 68 | 112 | 180 | 68 | 6 | 17 | 91 |
| 6/1 | 97 | 301 | 398 | 18 | 5 | 24 | 47 |
| 6/8 | 90 | 863 | 953 | 11 | 23 | 62 | 96 |
| 6/15 | 29 | 130 | 159 | 10 | 4 | 14 | 28 |
| 6/22 | 44 | 102 | 146 | 6 | 13 | 2 | 21 |
| 6/29 | 145 | 484 | 629 | 27 | 20 | 23 | 70 |
| 7/6 | 12 | 28 | 40 | | | | |
| 7/13 | 16 | 83 | 99 | | | | |
| 7/20 | 11 | 6 | 17 | | | | |
| 7/27 | 10 | 10 | 20 | | | | |
| 8/3 | 724 | 486 | 1,210 | | | | |
| 8/10 | 21 | 60 | 81 | | | | |
| Total | 1,279 | 3,047 | 4,326 | 144 | 86 | 242 | 472 |

Table 11. Number of larval minnow-sucker group collected by gear, station and interval in 1972.

| | Meter net | | | Drift net | | | |
|---|---|---|---|---|---|---|---|
| | Station | | | Station | | | |
| Date | 1 | 2 | Stations combined | 1 | 2 | 3 | Stations combined |
| 5/11 | | 1 | 1 | | | 1 | 1 |
| 5/18 | 1,407 | 518 | 1,925 | 483 | 172 | 99 | 754 |
| 5/25 | 269 | 386 | 655 | 59 | 18 | 131 | 208 |
| 6/1 | 34 | 61 | 95 | 462 | 36 | 12 | 510 |
| 6/8 | 2 | 4 | 6 | | 2 | | 2 |
| 6/15 | 10 | 32 | 42 | 3 | 2 | | 5 |
| 6/22 | 30 | 94 | 124 | 3 | 6 | | 9 |
| 6/29 | 511 | 141 | 652 | 8 | 23 | 1 | 32 |
| 7/6 | 177 | 111 | 288 | | | | |
| 7/13 | 10 | 15 | 25 | | | | |
| 7/20 | 119 | 34 | 153 | | | | |
| 7/27 | 30 | 170 | 200 | | | | |
| 8/3 | 3 | 9 | 12 | | | | |
| 8/10 | 1 | 5 | 6 | | | | |
| 8/17 | | 1 | 1 | | | | |
| Total | 2,603 | 1,581 | 4,184 | 1,018 | 259 | 244 | 1,521 |

## RELATIONSHIP OF FORK TO STANDARD AND TOTAL LENGTHS

Measurements of fork, standard and total lengths were taken from 635 fish. Fork length (FL) was measured from tip of snout to the fork in caudal fin. Standard length (SL) was measured to the tip of upper lobe of the caudal fin. Total length (TL) included the caudal filament or whip located on the dorsal lobe of the caudal fin.

The ratio SL:FL was 1.12 and did not change significantly with increased body size (Table 12). The ratio TL:FL changed as fish size increased. Small fish (FL < 8 inches) had a ratio of 1.50 while the ratio for large fish averaged 1.15 (Table 13) resulting mainly from disproportionately slower growth of the filament. The filament is highly subject to loss by injury and caused extreme variation in TL:FL ratios. As a result, TL for small fish varied $\pm$ 3 inches ($P < .05$); and large fish varied $\pm$ 2 inches.

Table 12. Relationship of standard length to fork length.

| Length group | Number | Mean fork length | Mean standard length | Standard length/ fork length | Standard deviation of ratio (SL/FL) | 95% confidence limits |
|---|---|---|---|---|---|---|
| 7.0- 7.9 | 1 | 7.6 | 8.6 | 1.13 | | |
| 8.0- 8.9 | 1 | 8.7 | 9.9 | 1.14 | | |
| 11.0-11.9 | 3 | 11.7 | 12.9 | 1.10 | | |
| 12.0-12.9 | 5 | 12.3 | 14.1 | 1.15 | .015 | ± .4 |
| 13.0-13.9 | 14 | 13.4 | 15.1 | 1.13 | .019 | ± .5 |
| 14.0-14.9 | 10 | 14.5 | 16.5 | 1.14 | .009 | ± .3 |
| 15.0-15.9 | 20 | 15.6 | 17.8 | 1.14 | .029 | ± .9 |
| 16.0-16.9 | 20 | 16.5 | 18.8 | 1.14 | .011 | ± .4 |
| 17.0-17.9 | 39 | 17.5 | 19.6 | 1.12 | .027 | ± .9 |
| 18.0-18.9 | 41 | 18.5 | 20.9 | 1.13 | .019 | ± .7 |
| 19.0-19.9 | 53 | 19.5 | 22.2 | 1.14 | .020 | ± .8 |
| 20.0-20.9 | 56 | 20.5 | 23.4 | 1.14 | .020 | ± .8 |
| 21.0-21.9 | 66 | 21.5 | 24.3 | 1.13 | .024 | ±1.0 |
| 22.0-22.9 | 72 | 22.4 | 25.1 | 1.12 | .019 | ± .9 |
| 23.0-23.9 | 61 | 23.4 | 26.2 | 1.12 | .018 | ± .8 |
| 24.0-24.9 | 51 | 24.4 | 27.1 | 1.11 | .023 | ±1.1 |
| 25.0-25.9 | 39 | 25.4 | 28.2 | 1.11 | .027 | ±1.3 |
| 26.0-26.9 | 42 | 26.4 | 29.6 | 1.12 | .018 | ± .9 |
| 27.0-27.9 | 20 | 27.3 | 30.6 | 1.12 | .019 | ±1.0 |
| 28.0-28.9 | 14 | 28.4 | 31.5 | 1.11 | .018 | ±1.0 |
| 29.0-29.9 | 4 | 29.5 | 33.0 | 1.12 | .015 | ± .9 |
| 30.0-30.9 | 1 | 30.5 | 33.7 | 1.10 | | |
| 31.0-31.9 | 1 | 31.0 | 34.5 | 1.11 | | |
| 33.0-33.9 | 1 | 33.6 | 37.3 | 1.11 | | |

Table 13. Relationship of total length to fork length.

| Length group | Number | Mean fork length | Mean total length | Total length/ fork length | Standard deviation of ratio (TL/FL) | 95% confidence limits |
|---|---|---|---|---|---|---|
| 7.0- 7.9 | 1 | 7.6 | 10.8 | 1.42 | | |
| 8.0- 8.9 | 1 | 8.7 | 13.1 | 1.51 | | |
| 11.0-11.9 | 3 | 11.7 | 17.0 | 1.45 | .193 | ±4.4 |
| 12.0-12.9 | 5 | 12.3 | 18.1 | 1.47 | .113 | ±2.7 |
| 13.0-13.9 | 14 | 13.4 | 19.7 | 1.47 | .126 | ±3.3 |
| 14.0-14.9 | 10 | 14.5 | 20.6 | 1.42 | .153 | ±4.3 |
| 15.0-15.9 | 20 | 15.6 | 20.9 | 1.34 | .102 | ±3.1 |
| 16.0-16.9 | 20 | 16.5 | 21.8 | 1.32 | .084 | ±2.7 |
| 17.0-17.9 | 39 | 17.5 | 22.8 | 1.30 | .076 | ±2.6 |
| 18.0-18.9 | 41 | 18.5 | 23.3 | 1.26 | .072 | ±2.6 |
| 19.0-19.9 | 53 | 19.5 | 24.0 | 1.23 | .055 | ±2.1 |
| 20.0-20.9 | 56 | 20.5 | 24.2 | 1.18 | .049 | ±2.0 |
| 21.0-21.9 | 66 | 21.5 | 26.0 | 1.21 | .049 | ±2.1 |
| 22.0-22.9 | 72 | 22.4 | 26.4 | 1.18 | .045 | ±2.0 |
| 23.0-23.9 | 61 | 23.4 | 27.4 | 1.17 | .038 | ±1.8 |
| 24.0-24.9 | 51 | 24.4 | 28.1 | 1.15 | .041 | ±2.0 |
| 25.0-25.9 | 39 | 25.4 | 29.0 | 1.14 | .049 | ±2.5 |
| 26.0-26.9 | 42 | 26.4 | 30.1 | 1.15 | .039 | ±2.0 |
| 27.0-27.9 | 20 | 27.3 | 31.1 | 1.14 | .027 | ±1.4 |
| 28.0-28.9 | 14 | 28.4 | 32.4 | 1.14 | .029 | ±1.6 |
| 29.0-29.9 | 4 | 29.5 | 33.9 | 1.15 | .033 | ±1.9 |
| 30.0-30.9 | 1 | 30.5 | 34.3 | 1.12 | | |
| 31.0-31.9 | 1 | 31.0 | 34.5 | 1.11 | | |
| 33.0-33.9 | 1 | 37.3 | 39.8 | 1.18 | | |

## AGE AND GROWTH

Age and growth was determined from samples in Pools 9, 10, 11, 13, 17 and 19.

### POOL 9

Samples for age and growth in Pool 9 were principally from commercially harvested fish examined at markets. Smaller fish captured for tagging studies were used for supplemental age and growth data. As a result, size distribution was disproportionately influenced to include a high percentage of fish > 20 inches FL.

The largest fish was 30.5 inches FL, but no weight was collected. Age I-XII grand average calculated lengths at each year of life were: 8.4, 12.5, 16.1, 18.8, 20.7, 22.5, 23.8, 25.0, 25.9, 26.7, 27.1, and 27.4 inches (Table 14).

POOL 10

Seventeen fish were captured in July at Pool 10. Twelve were tagged and released. Five were preserved for later study and fin rays were collected for age determination. Ages I-IV and VI were represented in the sample. Grand average calculated lengths at each year of life were 8.6, 12.9, 16.9, 19.7, 21.8 and 23.0 (Table 15).

Table 14. Calculated fork lengths at each year of life for 137 shovelnose sturgeon from Pool 9.

| Year class | Age group | Number of fish | Year of life 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1971 | I | 1 | 10.3 | | | | | | | | | | | |
| 1970 | II | 2 | 8.7 | 13.1 | | | | | | | | | | |
| 1969 | III | 6 | 7.7 | 12.4 | 16.3 | | | | | | | | | |
| 1968 | IV | 54 | 8.5 | 13.3 | 17.0 | 20.3 | | | | | | | | |
| 1967 | V | 24 | 8.1 | 12.5 | 16.4 | 19.2 | 21.9 | | | | | | | |
| 1966 | VI | 17 | 7.8 | 12.2 | 15.9 | 19.0 | 21.4 | 23.5 | | | | | | |
| 1965 | VII | 14 | 8.0 | 12.2 | 15.5 | 18.4 | 21.0 | 22.9 | 24.9 | | | | | |
| 1964 | VIII | 5 | 7.3 | 11.3 | 15.5 | 18.7 | 21.3 | 23.6 | 25.4 | 26.9 | | | | |
| 1963 | IX | 5 | 8.2 | 13.0 | 16.1 | 18.6 | 20.6 | 22.9 | 24.5 | 25.7 | 27.1 | | | |
| 1962 | X | 7 | 8.2 | 12.5 | 15.3 | 17.9 | 19.7 | 21.6 | 23.5 | 25.1 | 26.7 | 28.0 | | |
| 1961 | XI | 1 | 9.1 | 12.7 | 17.1 | 19.5 | 21.0 | 22.6 | 22.7 | 24.6 | 25.7 | 26.8 | 27.8 | |
| 1960 | XII | 1 | 10.0 | 12.9 | 16.2 | 17.8 | 19.1 | 20.6 | 21.8 | 23.0 | 24.1 | 25.3 | 26.5 | 27.4 |
| Grand average length | | | 8.4 | 12.5 | 16.1 | 18.8 | 20.7 | 22.5 | 23.8 | 25.0 | 25.9 | 26.7 | 27.1 | 27.4 |
| Average annual increment | | | 8.4 | 4.1 | 3.6 | 2.7 | 1.9 | 1.8 | 1.3 | 1.2 | .9 | .8 | .4 | .3 |

Table 15. Calculated fork lengths at each year of life for 17 shovelnose sturgeon from Pool 10. Figures in parenthesis are observed lengths at time of capture.

| Year class | Age group | Number of fish | Year of life 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 1971 | I | 5 | 8.9 (12.7) | | | | | |
| 1970 | II | 7 | 8.3 | 13.4 (16.7) | | | | |
| 1969 | III | 2 | 9.3 | 13.6 | 17.3 (18.9) | | | |
| 1968 | IV | 2 | 8.1 | 13.2 | 16.8 | 19.3 (20.9) | | |
| 1967 | V | 0 | | | | | | |
| 1966 | VI | 1 | 8.4 | 11.3 | 16.5 | 20.1 | 21.8 | 23.0 (24.5) |
| Grand average length | | | 8.6 | 12.9 | 16.9 | 19.7 | 21.8 | 23.0 |
| Average annual increment | | | 8.6 | 4.3 | 4.0 | 2.8 | 2.1 | 1.2 |

POOL 11

Fin rays were taken from 17 of the 30 fish collected for tagging during September in Pool 11. Ages I-IV and VI were represented in the sample. Grand average calculated lengths at each year of life were 7.8, 12.9, 16.9, 19.5, 21.8 and 22.7 inches (Table 16).

Table 16. Calculated fork length at each year of life for 17 shovelnose sturgeon from Pool 11. Figures in parenthesis are observed lengths at time of capture.

| Year class | Age group | Number of fish | Year of life 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 1971 | I | 6 | 8.0 (13.6) | | | | | |
| 1970 | II | 4 | 8.0 | 13.2 (17.3) | | | | |
| 1969 | III | 1 | 7.1 | 13.4 | 18.5 (22.2) | | | |
| 1968 | IV | 5 | 8.0 | 13.1 | 17.2 | 20.4 (23.5) | | |
| 1967 | V | 0 | | | | | | |
| 1966 | VI | 1 | 7.9 | 11.9 | 15.0 | 18.5 | 21.8 | 22.7 (28.4) |
| Grand average length | | | 7.8 | 12.9 | 16.9 | 19.5 | 21.8 | 22.7 |
| Average annual increment | | | 7.8 | 5.1 | 4.0 | 2.6 | 2.3 | .9 |

POOL 13

Eighteen biweekly samples (April 5-November 29) totaling 1,160 fish were collected in Pool 13 during 1972. Subsamples were examined to determine seasonal growth. Growth increments were calculated for ages I-IV.

Age 0 fish were absent from all but two samples and could not be used to determine growth increments in the first year of life. Inaccuracy in assessing growth increment in older fish and the absence from most samples also precluded using fish older than age IV.

No growth was discernable until 17 May. Most growth occurred during June, July and early August. After this date error in sampling masked true growth rate (Table 17).

Table 17. Cumulative growth increments for shovelnose sturgeon of ages I-V at biweekly samples in Pool 13. Figures in parenthesis represent sample size.

| Date | Age I | | II | | III | | IV | | V | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4/5 | | | 0 | (1) | 0 | (3) | 0 | (9) | | |
| 4/19 | | | 0 | (2) | 0 | (2) | 0 | (7) | | |
| 5/3 | 0 | (1) | | | 0 | (2) | 0 | (18) | | |
| 5/17 | .9 | (2) | 0 | (7) | 0 | (2) | 0 | (8) | 0 | (1) |
| 5/31 | 1.5 | (9) | 0 | (1) | 0 | (5) | 0 | (4) | | |
| 6/14 | 2.2 | (11) | 1.7 | (5) | 1.1 | (4) | .4 | (4) | | |
| 6/28 | 3.2 | (15) | 1.8 | (4) | 1.5 | (4) | 1.4 | (5) | | |
| 7/12 | 3.5 | (6) | 3.5 | (4) | 1.8 | (3) | 2.8 | (3) | | |
| 7/26 | 3.6 | (2) | 2.5 | (10) | 2.1 | (4) | 2.0 | (2) | | |
| 8/9 | | | 3.4 | (3) | 2.5 | (4) | 2.2 | (3) | | |
| 8/23 | | | 4.2 | (10) | 3.5 | (14) | 2.6 | (13) | 1.9 | (1) |
| 9/6 | | | 4.3 | (7) | 3.1 | (22) | 3.0 | (33) | 2.4 | (3) |
| 9/20 | 5.6 | (9) | 4.4 | (36) | 4.0 | (18) | 2.5 | (14) | 2.3 | (2) |
| 10/4 | 4.2 | (1) | 3.9 | (12) | 4.4 | (2) | 2.8 | (2) | 3.4 | (2) |
| 10/18 | 5.4 | (1) | 4.1 | (5) | 2.8 | (4) | 3.3 | (5) | | |
| 11/1 | 5.8 | (2) | 4.2 | (11) | 3.1 | (5) | 2.8 | (4) | 3.4 | (1) |
| 11/15 | 5.3 | (1) | 3.4 | (5) | 3.0 | (5) | 3.6 | (4) | | |
| 11/29 | 3.3 | (1) | 4.6 | (6) | 2.7 | (4) | 2.8 | (4) | 2.4 | (2) |
| Mean FL at last annulus | 8.9 | (61) | 12.4 | (139) | 16.9 | (107) | 20.4 | (142) | 23.1 | (12) |

Age and growth was determined from 461 fin samples for ages I through XI. Grand average calculated length at each year of life was 8.3, 12.4, 16.1, 19.1, 21.3, 23.6, 25.4, 26.2, 27.6, 28.5, and 28.8 inches (Table 18).

POOL 17

A sample of 117 sturgeon were captured by drifting a trammel net in Pool 17 on 28-29 September, 1972. All fish captured were weighed, measured, tagged, and the anterior pectoral fin ray was removed. Two fish had tail damage from unknown causes and one was a young-of-year. The computer program, SHAD, (Mayhew, 1973) was used to compute growth for the remaining 114.

Table 18. Calculated fork lengths at each year of life for 461 shovelnose sturgeon from Pool 13.

| Year class | Age group | Number of fish | Year of life 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1971 | I | 63 | 8.9 | | | | | | | | | | |
| 1970 | II | 124 | 7.8 | 12.5 | | | | | | | | | |
| 1969 | III | 103 | 7.9 | 12.8 | 16.6 | | | | | | | | |
| 1968 | IV | 138 | 7.7 | 12.6 | 17.7 | 21.9 | | | | | | | |
| 1967 | V | 14 | 7.7 | 11.0 | 16.0 | 19.8 | 21.3 | | | | | | |
| 1966 | VI | 7 | 8.2 | 12.8 | 16.2 | 19.6 | 22.8 | 24.9 | | | | | |
| 1965 | VII | 5 | 8.7 | 12.9 | 17.1 | 20.1 | 23.4 | 26.3 | 29.2 | | | | |
| 1964 | VIII | 2 | 8.3 | 13.0 | 16.7 | 19.3 | 22.3 | 24.1 | 25.8 | 27.5 | | | |
| 1963 | IX | 2 | 7.5 | 11.2 | 13.9 | 17.1 | 19.7 | 22.4 | 24.6 | 26.9 | 28.4 | | |
| 1962 | X | 2 | 9.5 | 12.5 | 15.3 | 17.6 | 19.5 | 21.6 | 23.7 | 25.4 | 27.9 | 29.3 | |
| 1961 | XI | 1 | 9.3 | 12.5 | 15.0 | 17.4 | 20.0 | 22.1 | 23.8 | 25.1 | 26.5 | 27.7 | 28.8 |
| Grand average length | | | 8.3 | 12.4 | 16.1 | 19.1 | 21.3 | 23.6 | 25.4 | 26.2 | 27.6 | 28.5 | 28.8 |
| Average annual increment | | | 8.3 | 4.1 | 3.7 | 3.0 | 2.2 | 2.3 | 1.8 | .8 | 1.4 | .9 | .3 |

Length frequency by age are presented in Table 19. Although length distributions within age groups are normal, overlap between ages was sufficient to prevent verification of age determinations from the length frequency distribution.

Table 19. Length frequency distribution by age for 115 shovelnose sturgeon collected 28-29 September, 1972 in Pool 17.

| Length group | Age 0 | I | II | III | IV | V | Ages combined |
|---|---|---|---|---|---|---|---|
| 9-10 | 1 | | | | | | 1 |
| 12-13 | | 1 | | | | | 1 |
| 13-14 | | 4 | | | | | 4 |
| 14-15 | | 8 | | | | | 8 |
| 15-16 | | 9 | 5 | | | | 14 |
| 16-17 | | | 11 | | | | 11 |
| 17-18 | | | 14 | | | | 14 |
| 18-19 | | | 14 | 4 | | | 18 |
| 19-20 | | | 3 | 7 | | | 10 |
| 20-21 | | | 1 | 13 | 2 | | 16 |
| 21-22 | | | | 7 | | | 7 |
| 22-23 | | | | 1 | 3 | | 4 |
| 23-24 | | | | | 4 | 1 | 5 |
| 24-25 | | | | | | 1 | 1 |
| 25-26 | | | | | 1 | | 1 |
| Total | 1 | 22 | 48 | 32 | 10 | 2 | 115 |

Body condition (C) range was 9-19 and increased with body size (Table 20). Length weight relationship expressed by the least squares equation

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

was

$$\log_{10} W = -4.560 + 3.526 \log_{10} FL$$

where W = body weight in lbs and FL = fork length in inches and a and b are constants. Standard deviations for the regression coefficients were $\pm$ .083 and $\pm$ .066. Correlation coefficient for this fit was .981.

Grand average calculated fork lengths at the end of each year of life were 8.2, 13.2, 16.9, 19.6 and 22.6 inches (Table 21).

Table 20. Body condition (C) of 114 shovelnose sturgeon from Pool 17.

| Length group | Number in group | Fork length (inches) | Weight (lbs) | Condition (C) |
|---|---|---|---|---|
| 12-13 | 1 | 12.5 | .18 | 9 |
| 13-14 | 4 | 13.7 | .30 | 11 |
| 14-15 | 8 | 14.6 | .36 | 11 |
| 15-16 | 14 | 15.5 | .43 | 11 |
| 16-17 | 11 | 16.7 | .58 | 12 |
| 17-18 | 14 | 17.6 | .69 | 12 |
| 18-19 | 18 | 18.6 | .79 | 12 |
| 19-20 | 10 | 19.4 | .97 | 13 |
| 20-21 | 16 | 20.6 | 1.20 | 13 |
| 21-22 | 7 | 21.5 | 1.36 | 13 |
| 22-23 | 4 | 22.4 | 1.64 | 14 |
| 23-24 | 5 | 23.5 | 1.93 | 14 |
| 24-25 | 1 | 24.8 | 2.98 | 19 |
| 25-26 | 1 | 25.7 | 3.02 | 18 |

Table 21. Calculated fork lengths at each year of life for 115 shovelnose sturgeon from Pool 17. Figures in parenthesis are observed lengths at time of capture.

| Year class | Age group | Number of fish | Year of life 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 1972 | 0 | 1 | (9.9) | | | | |
| 1971 | I | 22 | 8.2 (14.6) | | | | |
| 1970 | II | 48 | 7.8 | 12.7 (17.5) | | | |
| 1969 | III | 32 | 8.6 | 13.8 | 17.6 (20.2) | | |
| 1968 | IV | 10 | 8.3 | 12.9 | 16.7 | 19.9 (22.8) | |
| 1967 | V | 2 | 8.1 | 13.4 | 16.4 | 19.3 | 22.6 (24.1) |
| Grand average length | | | 8.2 | 13.2 | 16.9 | 19.6 | 22.6 |
| Average annual increment | | | 8.2 | 5.0 | 3.7 | 2.7 | 3.0 |

POOL 19

A sample of 110 sturgeon were captured by drifting a trammel net during 26-27 September, 1972. All fish caught were weighed, measured, tagged and released. The right anterior pectoral fin ray was removed for aging. Five fish were young-of-the-year. The remaining 105 were used for computation growth as in Pool 17.

Length frequency distribution showed considerable overlap between ages as before (Table 22). Condition factors (C) ranged from 10 to 18 (Table 23). Fish of similar sizes in Pools 17 and 19 had similar condition factors.

Table 22. Length frequencies by age for 110 shovelnose sturgeon collected 26-27 September, 1972 in Pool 19.

| Length group | Age 0 | I | II | III | IV | V | VI | Ages combined |
|---|---|---|---|---|---|---|---|---|
| 7- 8 | 1 | | | | | | | 1 |
| 9-10 | 4 | | | | | | | 4 |
| 12-13 | | 1 | | | | | | 1 |
| 13-14 | | 1 | | | | | | 1 |
| 14-15 | | 5 | 3 | | | | | 8 |
| 15-16 | | 1 | 3 | | | | | 4 |
| 16-17 | | 1 | 4 | | | | | 5 |
| 17-18 | | | 3 | | | | | 3 |
| 18-19 | | | 7 | 2 | | | | 9 |
| 19-20 | | | 11 | 16 | | | | 27 |
| 20-21 | | | 2 | 20 | 1 | | | 23 |
| 21-22 | | | 1 | 14 | 1 | | | 16 |
| 22-23 | | | | 3 | 3 | | | 6 |
| 25-26 | | | | | 1 | | | 1 |
| 26-27 | | | | | | | 1 | 1 |
| Total | 5 | 9 | 34 | 55 | 6 | 0 | 1 | 110 |

Length-weight relationship was

$$\log_{10} W = -3.988 + 3.083 \log_{10} FL$$

with standard deviation for the regression coefficient of ± .167 and ± .130, respectively. Correlation coefficient for this fit was .920.

Grand average calculated fork lengths at the end of each year of life were 8.5, 13.5, 17.3, 20.2, 22.6 and 25.0 (Table 24).

Table 23. Body condition (C) of 105 shovelnose sturgeon from Pool 19.

| Length group | Number in group | Fork length (inches) | Weight (lbs) | Condition (C) |
|---|---|---|---|---|
| 12-13 | 1 | 12.7 | .23 | 11 |
| 13-14 | 1 | 13.5 | .27 | 10 |
| 14-15 | 8 | 14.5 | .35 | 11 |
| 15-16 | 4 | 15.6 | .41 | 10 |
| 16-17 | 5 | 16.5 | .62 | 13 |
| 17-18 | 3 | 17.8 | .79 | 13 |
| 18-19 | 9 | 18.5 | .85 | 13 |
| 19-20 | 27 | 19.7 | 1.06 | 13 |
| 20-21 | 23 | 20.5 | 1.19 | 13 |
| 21-22 | 16 | 21.5 | 1.34 | 13 |
| 22-23 | 6 | 22.4 | 1.60 | 14 |
| 25-26 | 1 | 26.0 | 3.23 | 18 |
| 26-27 | 1 | 26.2 | 3.33 | 18 |

Table 24. Calculated fork lengths at each year of life for 110 shovelnose sturgeon from Pool 19. Figures in parenthesis are observed lengths at capture.

| Year class | Age group | Number of fish | Year of life 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 1972 | 0 | 5 | (9.3) | | | | | |
| 1971 | I | 9 | 8.4 (14.4) | | | | | |
| 1970 | II | 34 | 8.8 | 14.1 (18.1) | | | | |
| 1969 | III | 55 | 8.6 | 14.1 | 18.3 (20.5) | | | |
| 1968 | IV | 6 | 8.6 | 13.0 | 17.0 | 20.2 (22.3) | | |
| 1967 | V | 0 | | | | | | |
| 1966 | VI | 1 | 8.5 | 13.0 | 16.7 | 20.2 | 22.6 | 25.0 (26.2) |
| Grand average length | | | 8.5 | 13.5 | 17.3 | 20.2 | 22.6 | 25.0 |
| Average annual increment | | | 8.5 | 5.0 | 3.8 | 2.9 | 2.4 | 2.4 |

## SUMMARY OF AGE AND GROWTH

The number of sturgeon examined for growth in all pools was 857. Average body length (FL) at each year of life was 8.3, 12.9, 16.7, 19.5, 21.8, 23.3, 24.6, 25.6, 26.7, 27.6, 27.9 and 27.4 inches for the first 12 years. Downstream pools generally tended to show slightly faster growth rates, but differences between pools were probably not significant (Table 25).

## STURGEON TAGGING STUDIES

Seventy-five 2 1/2 minute trawl hauls and 337 trammel net drifts were made during the second year investigation and captured 843 sturgeon. The goal of tagging and releasing a minimum of 100 fish in alternate pools of the river was not attained. Sturgeon were especially difficult to capture in Pools 9 and 11 and only 34 and 14 were tagged, respectively. The goal was achieved in other pools with a total of 618 fish tagged (Table 26).

Large numbers of recaptured fish were taken in most pools during actual tagging effort. Commercial fishermen did not recover many tagged fish until late in the 1973 fishing season. Since most of the commercially recovered tags were not taken until late in the study segment, results will be reported in the next segment.

## GROWTH OF TAGGED FISH

Growth of recaptured sturgeon was difficult to evaluate because the rate of growth in length varied considerably by fish size and season. All sizes were tagged and recaptured throughout the year.

Growth of tagged fish was obtained from 107 recaptured sturgeon caught by experimental netting and cooperating commercial fishermen during both years. Most of the tagged sturgeon were recovered in Pool 13. Results were tabulated by body length at the time of tagging and the weeks at large (Table 27). Tagged fish at large over the winter months were excluded from calculations of mean weekly growth increment. Calculated weekly growth increments between the time of tagging and recapture were .23, .13, .17, .08, .06, .05 and .08 inches for fish at 2-inch intervals ranging 10-24 inches FL. Seasonal growth could not be evaluated.

Table 25. Grand average calculated fork lengths of shovelnose sturgeon at each year of life from selected Mississippi River pools.

| Pool | Number of fish | Year of life 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 137 | 8.4 | 12.5 | 16.1 | 18.8 | 20.7 | 22.5 | 23.8 | 25.0 | 25.9 | 26.7 | 27.1 | 27.4 |
| 10 | 17 | 8.6 | 12.9 | 16.9 | 19.7 | 21.8 | 23.0 | | | | | | |
| 11 | 17 | 7.8 | 12.9 | 16.9 | 19.5 | 21.8 | 22.7 | | | | | | |
| 13 | 461 | 8.3 | 12.4 | 16.1 | 19.1 | 21.3 | 23.6 | 25.4 | 26.2 | 27.6 | 28.5 | 28.8 | |
| 17 | 115 | 8.2 | 13.2 | 16.9 | 19.6 | 22.6 | | | | | | | |
| 19 | 110 | 8.5 | 13.5 | 17.3 | 20.2 | 22.6 | 25.0 | | | | | | |
| Average length | | 8.3 | 12.9 | 16.7 | 19.5 | 21.8 | 23.3 | 24.6 | 25.6 | 26.7 | 27.6 | 27.9 | 27.4 |

Table 26. Summary of fishing effort and number of sturgeon caught and tagged during the second year.

| Pool | Trawl | | Trammel net | | Total sturgeon captured | Number tagged |
|---|---|---|---|---|---|---|
| | Number caught | Sturgeon tagged | Number caught | Sturgeon tagged | | |
| 9 | 26 | 1 | 69 | 33 | 34 | 34 |
| 10 | 6 | 7 | 9 | 10 | 17 | 12 |
| 11 | | | 41 | 14 | 14 | 14 |
| 13 | 39 | 27 | 170 | 524 | 551 | 336 |
| 17 | 1 | 0 | 27 | 116 | 116 | 117 |
| 19 | 3 | 1 | 21 | 110 | 111 | 105 |
| Total | 75 | 36 | 337 | 807 | 843 | 618 |

Table 27. Mean growth increments of shovelnose sturgeon between the time of tagging and recapture by size and time at large. Sample size is indicated in parenthesis.

| Weeks at large | Number of fish | Fork length (inches) at tagging | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 & over |
| 1 | 33 | .2 (5) | | .3 (2) | .1 (3) | .1 (7) | .1 (11) | .2 (5) | |
| 3 | 28 | | | .3 (3) | .2 (1) | .1 (11) | .0 (8) | .2 (5) | |
| 5 | 7 | | | | .4 (2) | | .1 (3) | .1 (2) | |
| 7 | 2 | | | | | .4 (1) | .6 (1) | | |
| 9 | 3 | | 1.2 (1) | 1.1 (1) | | | | .5 (1) | |
| 11 | 3 | | | | | | .3 (3) | | |
| 13 | 1 | | | | 1.0 (1) | | | | |
| 15 | 1 | 3.8 (1) | | | | | | | |
| 17 | 1 | | | | | .8 (1) | | | |
| 19 | 1 | | | | | | .1 (1) | | |

Table 27 (Cont.).

| Weeks at large | Number of fish | Fork length (inches) at tagging | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 & over |
| 21 | 3 | | | | | .8 (1) | .2 (1) | .1 (1) | |
| 23 | 0 | | | | | | | | |
| 25 | 2 | | | | | | .5 (2) | | |
| 27 | 0 | | | | | | | | |
| 29 | 0 | | | | | | | | |
| 31 | 1 | | 1.2 (1) | | | | | | |
| 33 | 2 | | | | | | .5 (2) | | |
| 35 | 5 | | | | | 1.1 (1) | .9 (2) | .6 (2) | |
| 37 | 2 | | | | | | .9 (1) | | .2 (1) |
| 39 | 3 | | | | | | .5 (3) | | |
| 41 | 0 | | | | | | | | |
| 43 | 4 | | 2.9 (1) | | 1.2 (2) | | | | .1 (1) |
| 45 | 4 | | 3.6 (1) | | | 1.4 (2) | | .6 (1) | |
| 47 | 1 | | | | | .9 (1) | | | |
| Total | 107 | | | | | | | | |
| $\bar{X}$ increment per week* | | .23 | .13 | .17 | .08 | .06 | .05 | .08 | |

*Fish at large over the winter months were excluded from calculations.

## MOVEMENT OF TAGGED FISH

In 1971 and 1972, 154 tagged sturgeon were recaptured and all occurred within the pool they were tagged. Distance and direction of movement was obtained from 144 (Table 28).

Table 28. Source of shovelnose sturgeon recaptures from which movement data was obtained in 1971 and 1972.

| | 1971 | | 1972 | | |
|---|---|---|---|---|---|
| Pool | Experimental netting | Commercial fishermen | Experimental netting | Commercial fishermen | Combined |
| 9 | 1 | | | 2 | 3 |
| 11 | 2 | 1 | | | 3 |
| 13 | 47 | | 38 | 44 | 129 |
| 17 | 4 | 1 | | | 5 |
| 19 | | 4 | | | 4 |
| Total | 54 | 6 | 38 | 46 | 144 |

Data from Pool 13 were sufficient for meaningful analysis. Recaptured fish from this pool in the first year came entirely from experimental netting. During 1972 most of the recaptured fish came from commercial fishermen.

Nearly 20% of the 47 sturgeon recaptured in 1971 were captured at the same location of marking. Twice as many were captured downstream as upstream, but the mean distances for both upstream and downstream movement was .3 mile. Maximum distances recorded were 2.9 miles upstream and 7.3 miles downstream (Table 29).

Table 29. Movement of shovelnose sturgeon recaptured by experimental netting in 1971.

| | Days at large | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | Combined |
| Upstream | | | | | | | | | |
| Number of fish | 2 | | | | 6 | 2 | | 1 | 11 |
| Mean distance (miles) | 0.1 | | | | 0.2 | 0.3 | | 0.9 | 0.3 |
| Percent | 13.3 | | | | 42.9 | 50.0 | | 20.0 | 23.4 |
| Downstream | | | | | | | | | |
| Number of fish | 11 | 3 | | 1 | 3 | 2 | 3 | 4 | 27 |
| Mean distance (miles) | 0.2 | 0.2 | | 0.1 | 0.3 | 0.2 | 0.3 | 0.6 | 0.3 |
| Percent | 73.3 | 60.0 | | 100.0 | 21.4 | 50.0 | 100.0 | 80.0 | 57.4 |
| No movement | | | | | | | | | |
| Number of fish | 2 | 2 | | | 5 | | | | 9 |
| Percent | 13.3 | 40.0 | | | 35.7 | | | | 19.1 |
| Total fish | 15 | 5 | | 1 | 14 | 4 | 3 | 5 | 47 |

In 1972 large numbers of sturgeon were recaptured in Pool 13 both by experimental netting and commercial fishermen. Of the 44 caught by commercial fishermen, 75% had moved upstream, 2.3% downstream and 22.7% were recaptured at the tagging site (Table 30).

Table 30. Movement of shovelnose sturgeon recaptured by experimental netting in 1972.

| | Days at large | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | Over 128 | Combined |
| Upstream | | | | | | | | | | |
| Number of fish | 1 | | | 1 | 2 | 3 | 2 | | 8 | 17 |
| Mean distance (miles) | 0.2 | | | 0.2 | 0.2 | 1.2 | 0.1 | | 0.7 | 0.6 |
| Percent | 100.0 | | | 50.0 | 67.0 | 50.0 | 40.0 | | 47.1 | 44.7 |
| Downstream | | | | | | | | | | |
| Number of fish | | 1 | | 1 | 1 | 1 | 3 | 2 | 7 | 16 |
| Mean distance (miles) | | 0.5 | | 0.5 | 0.2 | 3.0 | 0.3 | 0.2 | 0.4 | 0.5 |
| Percent | | 100.0 | | 50.0 | 33.0 | 17.0 | 60.0 | 100.0 | 41.2 | 42.1 |
| No movement | | | | | | | | | | |
| Number of fish | | | 1 | | | 2 | | | 2 | 5 |
| Percent | | | 100.0 | | | .33 | | | 11.8 | 13.2 |
| Total fish | 1 | 1 | 1 | 2 | 3 | 6 | 5 | 2 | 17 | 38 |

Data from 38 recaptured fish caught by experimental netting in 1972 differed greatly from those recovered by commercial fishermen. Upstream and downstream movement was nearly equal as opposed to the greater upstream movement noted in fisherman returns (Table 31). Mean distances moved in 1972 were 2.4 miles upstream and 1.7 miles downstream for the commercial fisherman recaptures, and .6 and .5 mile for experimental netting recaptures. Maximum distance traveled was 7.9 upstream and 1.7 miles downstream for commercial and 3.4 and 3.0 miles for experimental net captures. The distance moved did not increase with time at large.

Table 31. Movement of shovelnose sturgeon recaptured by commercial fishermen in 1972.

| | Days at large | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 4 | 8 | 16 | 32 | Over 128 | Combined |
| Upstream | | | | | | | | |
| Number of fish | | 1 | 5 | 7 | 4 | 5 | 11 | 33 |
| Mean distance (miles) | | 1.0 | 1.5 | 1.7 | 3.0 | 5.2 | 2.0 | 2.4 |
| Percent | | 33.3 | 71.4 | 77.8 | 100.0 | 50.0 | 100.0 | 75.0 |
| Downstream | | | | | | | | |
| Number of fish | | | | | | 1 | | 1 |
| Mean distance (miles) | | | | | | 1.7 | | 1.7 |
| Percent | | | | | | 10.0 | | 2.3 |
| No movement | | | | | | | | |
| Number of fish | | 2 | 2 | 2 | | 4 | | 10 |
| Percent | | 66.7 | 28.6 | 22.2 | | 40.0 | | 22.7 |
| Total fish | 0 | 3 | 7 | 9 | 4 | 10 | 11 | 44 |

Obviously these data were somewhat biased by location of tagging sites and the location of commercial fishing. Tagging effort and recoveries in the experimental fishery were most intensive approximately 2.5 miles downstream from Lock and Dam No. 12. The major commercial fishing grounds were in the tailwaters of this dam. As a result, tag returns from commercial fishermen were biased by increased opportunity to capture tagged fish that moved slightly upstream. The distance moved by fish in the experimental netting were curtailed by limitations in the area netted which resulted in movement outside the sampling site.

Fish recapture data from 1973 have not been analyzed in detail. However, from cursory examination large numbers of recaptured fish have been taken outside the pools in which they were tagged. All except one moved upstream. Maximum distance was 124.4 miles in 351 days. It is highly probable that movement between pools resulted from long periods of high river discharge when navigation dams were inoperative.

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## LITERATURE CITED

Helms, D. 1972. Progress report on the first year of study of shovelnose sturgeon in the Mississippi River. Ia. Cons. Comm., Fisheries Section, Ann. Prog. Report 2-156-R-1, Des Moines, Ia. 22 p.

Mayhew, J. 1973. SHAD - A computer program for the computation of age and growth statistics of fish. Ia. Cons. Comm. Fish. Res. Tech. Ser. No. 73-1, 13 pp - Appendix.

Monson, M. and J. Greenbank. 1947. Size and maturity of hackleback sturgeon. Upp. Miss. R. Cons. Comm. Tech. Commit. Fish. Progr. Rep., 3:41-44.