

Proceedings of the Iowa Academy of Science

Volume 90 | Number

Article 5

1983

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Recommended Citation

Goeman, Timothy J. (1983) "Freshwater Drum Spawning and Fecundity in the Upper Mississippi River," *Proceedings of the Iowa Academy of Science*: Vol. 90: No. 4 , Article 5.

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Freshwater Drum Spawning and Fecundity in the Upper Mississippi River

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One hundred freshwater drum ovaries from 1981 collections were examined to provide spawning and fecundity information for the long-term fisheries monitoring program at the Quad Cities Nuclear Power Station. Objectives were to estimate freshwater drum fecundity in the Upper Mississippi River and relate sexual maturity to size or age. The mean fecundity estimate for ripe fish was 85,800 ova per female. Total estimated number of ova showed no relationship with length or weight, but there was a relationship with age. Mean number of ova for a given age group increased with age. Female freshwater drum in Pool 14 may become sexually mature at age 4, but females age 5 and older comprised over 95% of the 100 females representing the spawning population.

INDEX DESCRIPTORS: fecundity, spawning, freshwater drum, Upper Mississippi River.

One aspect of power plant operation which has the potential to cause deleterious effects on a fish population is entrainment. Power utilities confronted with assessing fish entrainment on the Mississippi River have been particularly concerned with freshwater drum (*Aplodinotus grunniens* Rafinesque) since the semibouyant eggs from these pelagic spawners are more susceptible to entrainment than other ichthyoplankton (Rasmussen 1979, Swedburg and Walburg 1970, Butler 1965).

Since there is little literature available regarding the reproductive biology of the freshwater drum, a study was initiated to provide fecundity information that could be used to evaluate freshwater drum entrainment at the Quad Cities Nuclear Power Station on Navigation Pool 14 of the Upper Mississippi River. Western Lake Erie (Daiber 1953) and Missouri River (Swedburg and Walburg 1970) freshwater drum studies provided some fecundity data, but recent information regarding this species in the Mississippi River was desired.

Objectives of this study were to obtain fecundity estimates for freshwater drum in the Upper Mississippi River and relate sexual maturity to size or age.

METHODS

Freshwater drum ovaries were collected from fish in Navigation Pool 14 of the Upper Mississippi River during 1981. Upon removal from the fish, ovaries were weighed and preserved in 10% formalin. Fish were weighed (g) and measured (TL in mm) and otoliths were removed for age determination.

Fecundity analyses were focused on freshwater drum collected between 1 May and 1 October. Five ovaries were selected each week during this period from randomly selected specimens; sample size was 100.

Each ovary was subsampled using a 7 mm diameter coring tube after the total volume of the ovary had been determined by water displacement in a graduated cylinder. Cores (subsamples) from the anterior, middle, and posterior areas of one ovary lobe were measured volumetrically to the nearest 0.5 ml and transferred to vials containing modified Gilson's solution as recommended by Bagenal and Braum (1978). After at least two days in the modified Gilson's solution the ova in each subsample were separated from any remaining ovarian tissue and counted. Thirty ova in each subsample were measured to the nearest 10 μ using an ocular micrometer. Some clouding and opaqueness of ova were observed due to initial preservation in 10% formalin. Primordial cells were not counted.

Mean ovum diameter for each ovary examined was derived from 90 ova measurements; 30 ova from each of the 3 ovary subsamples. Mean ovum diameter was based on fewer than 90 ova measurements if fewer than 30 ova were found in any of the 3 subsamples.

The total estimated number of ova in each ovary was calculated by the function $F = \frac{NV}{5}$ where F = the fecundity estimate,

N = the number of ova counted in 3 subsamples,
S = the total volume sampled in 3 subsamples and
V = the total volume of the ovary.

RESULTS AND DISCUSSION

Fecundity

Two criteria were developed to determine which freshwater drum ovaries would yield accurate fecundity information. The first of these was mean ovum size of each ovary. The largest ova (typically 500-800 μ in diameter) were likely those which were mature and would soon be shed since they had passed earlier developmental stages described by Daiber (1953). Smaller ova (generally 250-400 μ) were difficult to separate and enumeration of these ova was considered inaccurate. Each ovary exhibited a distinct size frequency tending toward one of these size ranges (250-400 μ or 500-800 μ), although a size continuum existed within each ovary. Therefore, fish having a mean ovum size of 450 μ or greater were ripe and considered representative of fish near spawning and likely yielded the most accurate fecundity estimates. Conversely, fish with mean ovum size of less than 450 μ were not considered representative of ripe spawners and were rejected from the analysis. A second criterion was chosen to eliminate fish which had spawned or were nearly spent, since fecundity estimates calculated for these fish would yield results which were artificially low and inaccurate. Fish which did not have at least 30 ova present in each ovary subsample were eliminated using this rationale. Although this procedure did not eliminate all fish which had commenced to spawn, it provided a discrete point for exclusion of obviously spent females.

There were 26 freshwater drum ovaries chosen from those examined which, based on these criteria, were ripe and were representative of the Pool 14 spawning population in the Upper Mississippi River. The estimated number of ova from these fish showed no significant relationship with length or weight, but there was a relationship with age (Figure 1). Mean number of ova for a given age group systematically increased with age. Linear regression fit to these data yielded the equation $y = -55.58 + 19.25x$ ($r = 0.619$, significant at the 0.05 level; slope was significantly different from zero, t-test, $P > 0.05$). This positive relationship was particularly apparent for ages 5-8 and may continue with older freshwater drum, although small sample sizes for ages 9-11 did not provide conclusive evidence regarding this trend. The overall mean fecundity estimate for 26 freshwater drum was 85,800 (Table 1). Swedburg and Walburg (1970) concluded the age and fecundity relationship also existed for freshwater drum from Lewis and Clark Lake on the Missouri River.

Age and Maturity

Fecundity analyses of these Mississippi River freshwater drum indicated some females in Navigation Pool 14 become sexually

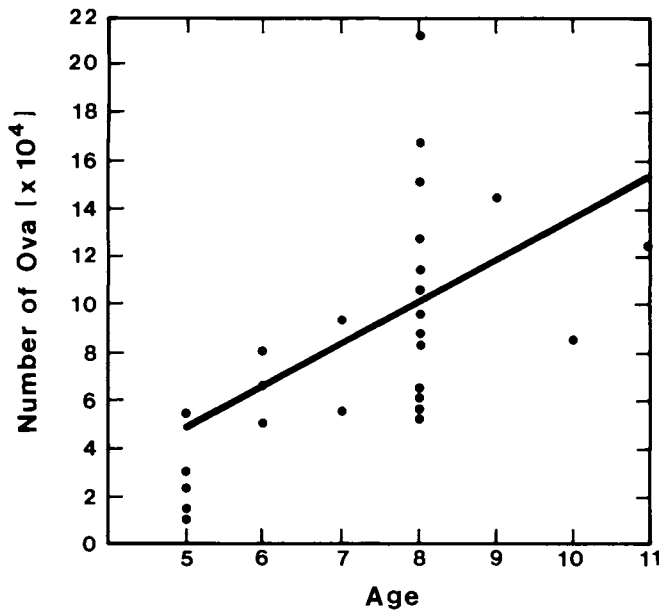


Fig. 1. A linear regression showing the increase in number of ova with age for 26 freshwater drum from Navigation Pool 14 of the Upper Mississippi River in 1981.

mature at age 4. One of three age 4 females exhibited criteria which suggested spawning had occurred. The other two females exhibited small ova which were in earlier stages of development. Age data from study fish indicated fish age 5 and older comprised over 95% of the female freshwater drum spawning population of Pool 14 during 1981.

Age structure of a population is a relevant consideration if extrapolation of fecundity information to a fish population in another navigation pool or another river system should be necessary. This conclusion was substantiated upon examination of the spawning population age structure. Relative contributions of each age class, based on age frequency, revealed high variability between age groups (Table 1). Since the proportional contribution of ova by each age group was dependent on abundance and mean fecundity for that age group (Table 1), relative contributions to total ova production of the population would vary depending on fluctuations in age class strength as discrete year classes increased in age.

Table 1. A summary by age class of 26 freshwater drum selected for fecundity analysis from Navigation Pool 14 of the Upper Mississippi River during 1981.

Age class	n	Mean fecundity	Relative contribution of age class ^a	Percent contribution of ova ^b
5	5	27,400	62.9	33.2
6	3	66,200	11.3	14.4
7	2	74,800	2.9	4.2
8	13	106,900	17.2	35.5
9	1	145,300	1.4	3.9
10	1	84,300	2.0	3.2
11	1	126,300	2.3	5.6
Total	26		100	100

$\bar{x} = 85,800$

^aThe determination of the freshwater drum age class distribution for 1981 was based on age data from 749 fish.

^bThe contribution of ova by each age class was the product of the relative contribution of a particular age class and the mean fecundity for that age class.

ACKNOWLEDGMENTS

This work was supported by Commonwealth Edison Company, Chicago, Illinois. D. R. Helms provided technical assistance.

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