REPRODUCTIVE BIOLOGY OF CHAIN PICKEREL IN LAKE CONWAY, FLORIDA

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Abstract: The reproductive biology of chain pickerel in Lake Conway, Florida was studied from July 1976 to June 1977. The overall ratio of females to males was 1.1:1.0. Spawning apparently took place in shallow water among thick *Vallisneria* during a sharply defined period from December to February. Average fecundity per female was 1232. Youngest fish to spawn were 2 years old.

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Chain pickerel (*Esox niger*) are generally distributed along the Atlantic seaboard of North America from Nova Scotia to central Florida, along the Gulf Coast westward to Texas, and north in the Mississippi Valley to Missouri (Scott and Crossman 1973). Chain pickerel have broad enviromental tolerances, being found in almost all habitat types within its range.

Various aspects of chain pickerel reproduction have been studied in the northern segments of the species range (Needham 1920, Underhill 1940, Saila and Horton 1957, Wich and Mullan 1958, Armbuster 1961, Miller 1962). However, other than the observations of DeJean (1951) in Alabama ponds, little data exist on chain pickerel reproduction in the South. The purpose of this paper is to present information on the general reproductive biology of chain pickerel in Lake Conway, Florida. These data were obtained as part of a larger project concerned with the environmental impacts of grass carp introduction.

This study was funded by the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi and administered by the Florida Game and Fresh Water Fish Commission. The present paper was adapted from a state report of limited distribution. Project assistants Roy Land, M. Dale Jones, and Michael Rebel assisted in field sampling and laboratory work.

METHODS

The study site was Lake Conway, Orange County, Florida. This area is in the Central Highland physiographic unit (Cooke 1945). Average altitude of this area falls between 15.3 and 25.9 m above mean sea level. The surface is blanketed with a layer of highly permeable marine sand that is separated from the porous limestone of the Florida aquifer by a layer of impervious sediments.

Orange County has a subtropical climate with only 2 pronounced seasons - winter and summer. The average annual rainfall is 1.3 m (Lichtler et al. 1968). Summer thunderstorms account for most of the precipitation.

The Lake Conway chain is a complex of 3 small, natural lakes (Gatlin, Conway, and Little Lake Conway) that totals 728 ha. This system comprises the uppermost portion of the Kissimmee River drainage and empties via Little Mere Prairie and Boggy Creek to the lower lakes region. The shoreline has been altered by urban-

ization. Shorelines have a narrow fringe of emergent cattail (*Typha latifiola*), maidencane (*Panicum heitomon*), torpedo grass (*Panicum repens*), and lake rush (*Fuirena americana*). Dominant submergent vegetation includes eelgrass (*Vallisneria americana*), nitella (*Nitella megacarpa*), Illinois pondweed (*Potamogeton illinoensis*), and hydrilla (*Hydrilla verticillata*). Substrate is primarily sand, except in areas of dense vegetation where a thick layer of organic detritus has been deposited. The lake is mesotrophic. The bottom contours are rather steep in many areas as compared to the gradually sloping shoreline characteristic of other central Florida lakes.

Fish were collected monthly along the lake margins with a boat electroshocker from July 1976 to May 1977. At least 25 specimens were collected monthly, although more specimens were usually taken. Water temperature was taken weekly with a field thermometer.

All chain pickerel were weighed to the nearest 0.1 g, measured in total length (TL) to the nearest millimeter, and dissected so that sex and degree of maturation could be determined. Gonads were classified in the following stages according to Nikolsky (1963): I - immature; II - resting; III - mature; IV - gravid; and V - spent.

Ovaries were removed from 33 gravid females and preserved in Gilson's fluid, which contained the following ingredients (Simpson 1951): 100 ml 60% alcohol; 880 ml water; 15 ml 80% nitric acid; 18 ml glacial acetic acid; and 20 g mercuric acid. This mixture not only hardens the eggs, but also helps to liberate them by breaking down ovarian tissue. Ova counts were made by subsampling gravimetrically. Approximately 10% of each ovary was weighed, counted, and total fecundity estimated by proportion. Ovarian contents include 3 classes of eggs (Crossman 1962), but only mature ova were totaled. Diameters of 5 mature eggs from each ovary were measured.

RESULTS AND DISCUSSION

Sex ratio

The sex ratio of 288 chain pickerel was 151 females to 137 males (1.1:1.0). A chi square test revealed that there was no significant difference between the number of males and females. As shown in Fig. 1, males were encountered in slightly greater numbers below 450 mm, whereas above 450 mm, females dominated. The larger number of males in the intermediate size groups and females in the largest sizes is apparently due to the greater growth potential of females versus males with increasing age and the greater longevity of females (Crossman 1962). This results in a "piling up" of successive year classes of males in the intermediate sizes as succeeding age-groups of males catch up with older, slower-growing males. The greater life span and continued rapid growth of females results in a dominance of females in the larger sizes as the growth of males slows down and mortality increases.

A chain pickerel sex ratio of 1.3 females to 1.0 males was obtained during various Massachusetts surveys (Wich and Mullan 1958). Armbuster (1961) found a sex ratio of 1.0:1.0 for Long Lake, New York, but cautioned that it may not be typical because of the sample size.

Sex ratios of chain pickerel in Lake Conway showed a seasonal trend, in which the females were dominant during the fall and early winter months, but then

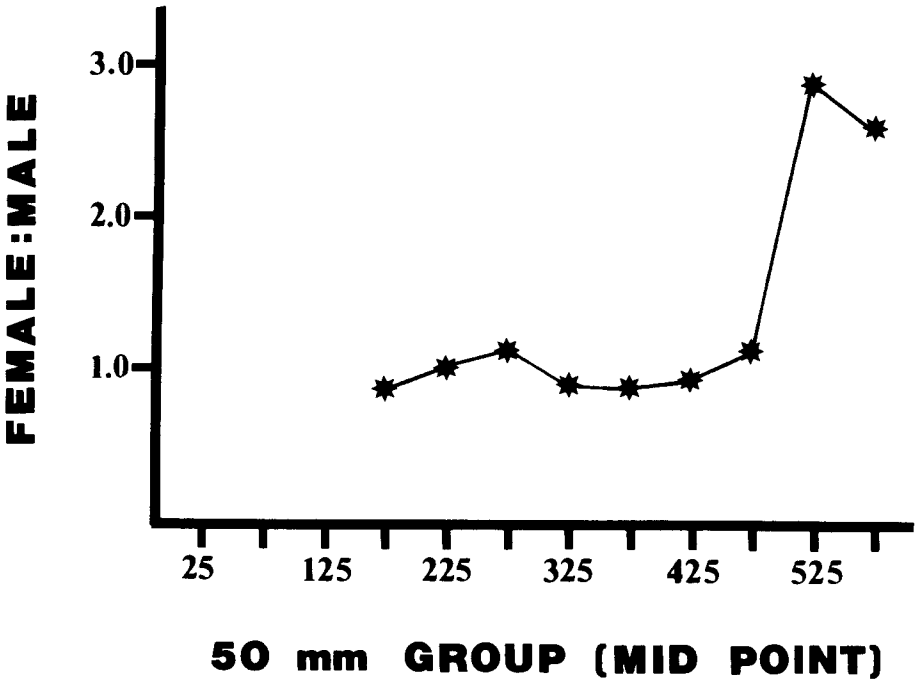

Fig. 1. Size variation in female: male sex ratios in Lake Conway chain pickerel.

declined in the spring and summer (Fig. 2). This period of dominance by females roughly corresponded to the time of gonad maturation and spawning. Casselman (1975) found increased dominance of female northern pike during the late winter; he concluded that females require more food than males when they are accumulating reproductive products, and that the more intensive foraging activity of females at this time makes them more susceptible to capture.

Gonad maturation and spawning

Monthly variation in chain pickerel ovary development is illustrated in Fig. 3. A sharply defined winter spawning period from December through February is evident. Discounting fish smaller than 250 mm, there was a tendency for the dominant (in terms of percent occurrence) ovary stage to progress from undeveloped (ie., resting and/or immature) to mature to gravid to spent. Developed ova were found from September through February. The percentage of mature gonads peaked in October and November, but declined to 6% in January and 17% in February. Gravid gonads were taken from November through February; this stage dominated from December through February. Spent gonads were detected from December through March only. Adults exhibiting no evidence of reproductive development were taken from June through August 1976 and in April and May 1977.

A survey of the literature of reproductive biology of fishes revealed that temperature and photoperiod are the most important factors influencing time of

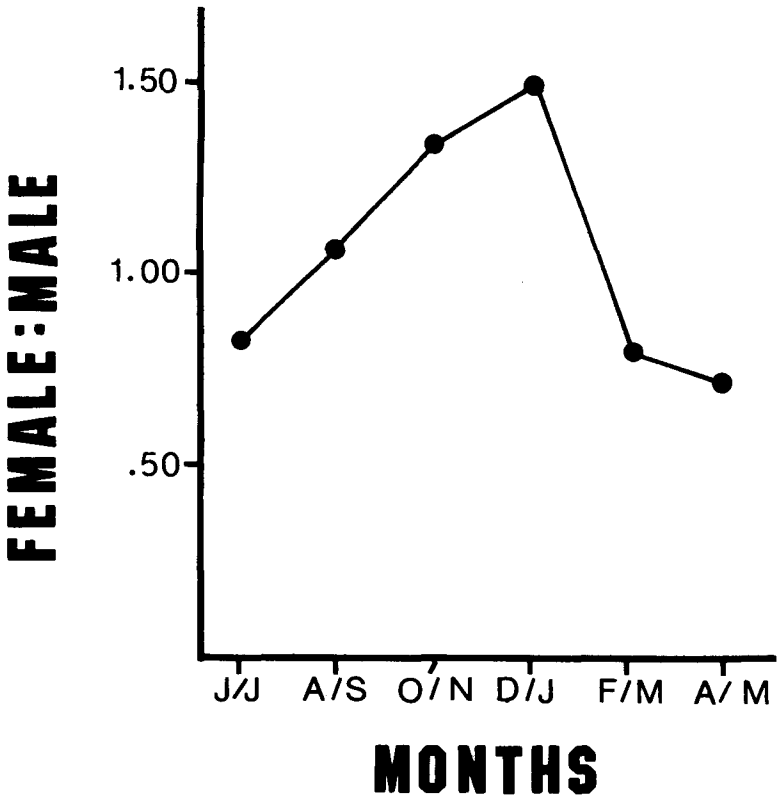

Fig. 2. Seasonal variation in female: male sex ratios in Lake Conway chain pickerel.

spawning and probably affect chain pickerel as well. Based on my observations, chain pickerel in central Florida spawn during the coldest part and during the shorter days of the year. Water temperature was approximately 22 C when spawning commenced and later dropped to 15 C during peak spawning in January and February.

Actual time and duration of spawning varies with latitude and with the character of the spring season. In the North, chain pickerel spawn in the spring and very shortly after the ice melts; this occurs anytime from March through May when water temperatures range from 8.3 to 11.1 C (Scott and Crossman 1973). Alabama chain pickerel are reported to spawn at 16 C (DeJean 1951). Embody (1918) reported spawning at a temperature approaching 9 C in New York. Armbuster (1961) observed fish spawning in Ohio ponds from April 10 to April 25, with water temperatures ranging from 2 C to 22 C. Leach (1927) reported that chain pickerel spawned over an extended period and that the youngest fish spawn first. In 1 instance, ripe chain pickerel have been observed in the fall (Miller 1962).

Literature on the spawning act and early life history of chain pickerel was summarized by Scott and Crossman (1973) and Mansuetti and Hardy (1967).

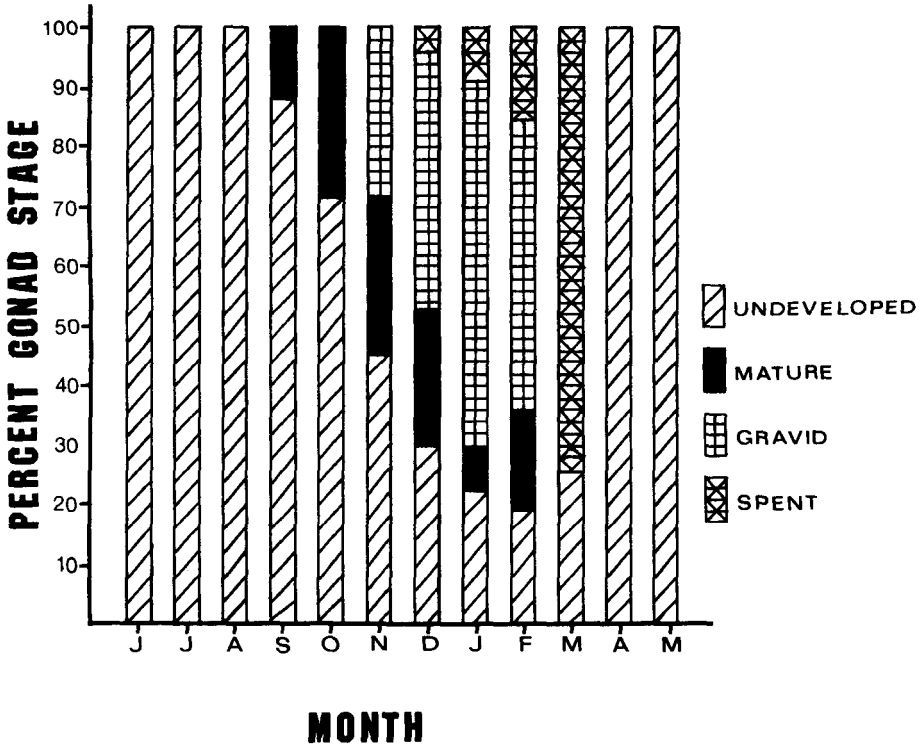

Fig. 3. Monthly variation in gonadal development in Lake Conway chain pickerel larger than 250 mm (undeveloped is a composite of the resting and immature stages).

Spawning occurs at depths from a few centimeters to 3m in coves, mouths of inlets, swampy streams, and flooded lowlands among submergent vegetation or cattail marshes. The eggs are slightly adhesive and stick to vegetation. The young attach to vegetation with an adhesive gland for a period of about a week. I collected gravid females and post larval chain pickerel in *Vallisneria* beds 0.75 to 1.75 m deep.

The smallest sexually mature individual was a 252-mm male; the smallest mature female was 271-mm long. A 310-mm female was the smallest individual with gravid ovaries whereas the smallest ripe male was 345 mm long. An analysis of length-frequency distributions of chain pickerel in Lake Conway (Guillory 1981) showed that, at the time of spawning, age I fish were less than 300 mm in length. Based on this, some age I fish may become sexually mature but probably do not spawn until age II.

Size at maturity of chain pickerel varies considerably and it is probably due to differences in growth rates (Wich and Mullan 1958), with slow-growing populations maturing at a smaller size than faster growing fish. Age at sexual maturity is also related to growth rate and varies at different latitudes as well as at the

same locality. In the North, gonads may mature at age I, but spawning does not occur until age II (Wich and Mullan 1958) and may not occur until age III or IV (Underhill 1948). Alabama chain pickerel may spawn at 1 year of age (DeJean 1951). In a study of chain pickerel in a stream, lake, and pond in New York (Underhill 1948), the following was reported: in the stream a few 1-year-old females, about half of 1-year-old males, and practically all 2-year-old fish were mature; in the pond 3-year-old males and few 3-year-old females spawned; in the lake most 2-year-old fish were mature.

Fecundity

Fecundity was based on 33 gravid females. Ova counts ranged from 343 for a 397-mm fish to 2,604 for a 509-mm fish. The overall mean was 1232 ova. The calculated regression equation between fecundity and length was $\log F = 1.000 + 0.7720 \log L$, where F equals the number of primary ova and L equals the total length of the fish in millimeters. The correlation coefficient for these data was +0.23.

The low correlation coefficient was indicative of a weak relationship between fecundity and total length. This low correlation is related to the wide variation in number of eggs in medium size chain pickerel (i.e., <500 mm). However, all 6 > 500-mm chain pickerel that were examined contained more than 1500 eggs. Thus, while only a weak relationship existed between total length and fecundity when considering all size groups, chain pickerel over 500 mm had pronounced increases in egg production as compared to smaller fish. In fishes, the number of mature eggs increases with the size of the female (Bagenal 1966). The rate of increase is distinctly geometric (Hubbs et al. 1968). Length influences fecundity in Lake Conway chain pickerel but other factors, such as age and growth rate (Spanovskaya et al. 1963), body condition (Potapona et al. 1968), and possibly others, obscured the classical length-fecundity relationship.

There are conflicting reports given in the literature on chain pickerel fecundity because it is difficult to distinguish between the various stages of eggs, thereby making standarized counts difficult. The number of eggs varied from 6102 to 8410 for Rhode Island females 305 to 356 mm in length (Saila and Horton 1957) to 30,000 for 4.4 kg female (Needham 1920). Since eggs of 3 sizes are present in the ovary at any time, the latter estimate may have been an estimate of all eggs.

As in *Esox americanus* (Crossman 1962), chain pickerel ovaries contained eggs in 3 developmental stages, as contrasted with 2 in northern pike and muskellunge. Primary eggs (those most mature) were large, transparent, and amber yellow, while secondary and tertiary eggs were successively smaller, pale yellow-white and opaque. Diameters of primary eggs ranged from 1.5 to 2.5 mm.

In summary, the following observations were made on Lake Conway chain pickerel. A female:male ratio of 1.1:1.0 was observed. Females were dominant above 450 mm. A sharply defined winter spawning period from December to February was evident; chain pickerel are evidently cold water and short (but increasing) photoperiod spawners. Some age I fish may become sexually mature but they probably do not spawn until age II. The smallest gravid female and male were 310-mm and 345-mm long, respectively. The overall average number of mature eggs was 1232; the range was from 342 - 2,604. Ovaries contained eggs in 3 developmental stages.

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