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SPAWNING PATTERNS OF GIZZARD SHAD AT TAYLORSVILLE LAKE, KENTUCKY

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ABSTRACT—Spawning patterns of gizzard shad (*Dorosoma cepedianum*) in Taylorsville Lake, Kentucky, differed for 1990 and 1991. Spawning activity was characterized as multi-modal in 1990 and unimodal in 1991. Initiation of spawning in each year occurred in late April even though water temperature warmed earlier in 1991. Spawning in gizzard shad decreased when temperatures reached 24 to 25°C, and a "thermal shut-off" of spawning activity occurred near 30°C. Variations in water-temperature regimes during the 2 years are believed to have influenced the spawning patterns of gizzard shad in Taylorsville Lake.

Variations in spawning periodicity of gizzard shad, *Dorosoma cepedianum*, have been documented in different systems. Length of the spawning period which generally begins when water temperatures exceed 16°C (Shelton et al., 1982; Heidinger, 1983) ranges from 4 weeks (Bodola, 1965) to at least 6 or 7 weeks (Netsch et al., 1971; Shelton et al., 1982; Willis, 1987). Spawning usually occurs from late March or early April through May or June depending on location (Shelton et al., 1982; Willis, 1987). Some gravid females have been collected as late as July (Willis, 1987; Buynak et al., 1992) and August (Jester and Jensen, 1972). Documented spawning patterns of gizzard shad usually follow a unimodal pattern of increase and decrease and do not indicate multi-peaks in spawning activity; possible multi-peaks in spawning activity were illustrated by Netsch et al. (1971).

Spawning periodicity and duration can be influenced by stages of egg maturation (Jester and Jensen, 1972; Willis, 1987), condition of adult fish prior to the spawn (Willis, 1987), and size structure of the adult population (Willis, 1987; Buynak et al., 1992). Heidinger (1983) reported there may be a "thermal shut-off" at approximately 30°C that ceases spawning activity for threadfin shad (*Dorosoma petenense*). The purpose of the present study was to determine the spawning pattern for gizzard shad in Taylorsville Lake, Kentucky, in 1990 and 1991.

MATERIALS AND METHODS

Taylorsville Lake, a 1,234-ha multi-purpose impoundment, is located in the Bluegrass Region of central Kentucky. The lake, impounded in 1983, has a maximum depth of 24.0 m and a mean depth of 8.5 m. Major inflow is the Salt River with watershed land use consisting primarily of agriculture (70%) and silviculture (11%). The lake has a storage ratio of 0.26 years, a main stem length of 29.8 km, and a shoreline length of 120.7 km. The lake was classified as being eutrophic to hypereutrophic (Anonymous, 1992).

Gonodal-somatic indices (GSI = ovary weight/total body weight X 100) were determined for adult, female gizzard shad collected from Taylorsville Lake using electrofishing gear. Fresh ovaries and fish were weighed to the nearest 0.1 g, and total length of fish was measured in millimeters. During 1990, data were obtained weekly from 14 May through 19 June; a final sample was taken on 3 July. During 1991, data were collected weekly from 19 March through 31 May. Mean GSIs and 95% confidence intervals were calculated for each sampling date. Surface water temperatures were monitored throughout the sampling period.

Larval (age 0) gizzard shad were collected each year at three stations using a tandem pair of 0.5-m diameter push nets (0.5-mm mesh). Nets were pushed for 3 min at speeds of 1.1 m/sec. Volume of water filtered in each sample was determined with a General Oceanics digital Flowmeter. Samples from push nets were collected weekly from 25 April through 12 July 1990; a final sample was taken on 26 July. In 1991, weekly samples were collected from 1 May through 27 June. Additional samples were collected on 16 July and 1 August 1991. Total length of larvae was measured to the nearest millimeter, and larvae <10 mm in total length were used to describe spawning periodicity. Mean densities (number per 10 m^3) and 95% confidence intervals were calculated for each sampling date.

RESULTS

Spawning patterns of gizzard shad in Taylorsville Lake were characterized for 1990 and 1991 with GSIs and larval data. For 1990, GSIs indicated that spawning began in late April, a few days after surface water temperatures reached 16°C (Fig. 1). Densities of larvae and GSIs indicated three distinct peaks in spawning activity. Peaks in densities of larvae occurred 7 to 13 days after peak GSIs. Major spawning activity extended about 7 weeks from late April to mid-June; a few larvae were collected through 12 July (Fig. 1). Gonodal-somatic indices showed that the major portion of the spawn was completed when surface water temperature reached 25°C on 12 June. Surface water temperatures remained below 30°C through 3 July.

For 1991, GSIs and densities of larvae indicated the spawn was unimodally distributed (Fig. 2). Indices showed that spawning began near the end of April at least 17 days after surface water temperatures reached 16°C. The major portion of the spawn lasted 4 to 5 weeks extending from late April through 20 May; no larval shad was collected in push-net samples after 6 June. The major portion of the spawn was completed when surface water temperatures reached 24°C on 20 May. Surface water temperatures reached 30°C by 31 May. Ovaries of gizzard shad collected on this date were being reabsorbed as ovaries were fluid-filled with no sign of viable eggs present.

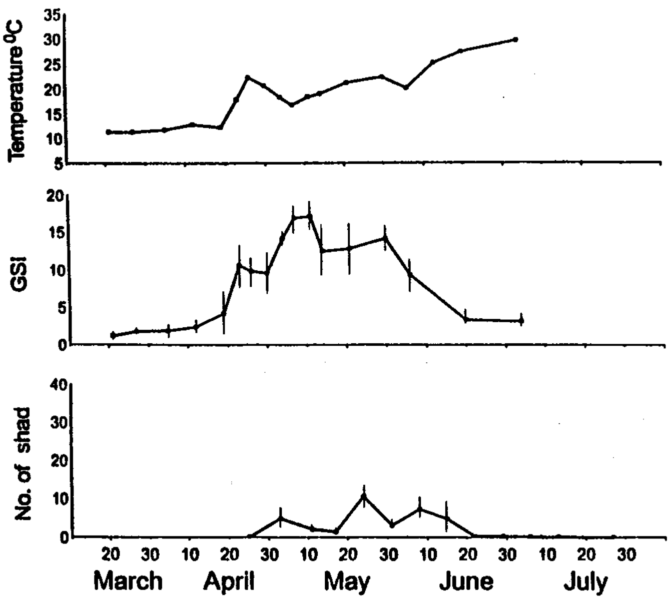

FIG. 1. Temperature, gonodal-somatic indices, and the number of <10-mm long gizzard shad/10 m^3 collected from Taylorsville Lake from 22 March to 3 July 1990. Vertical bars represnt 95% confidence intervals.

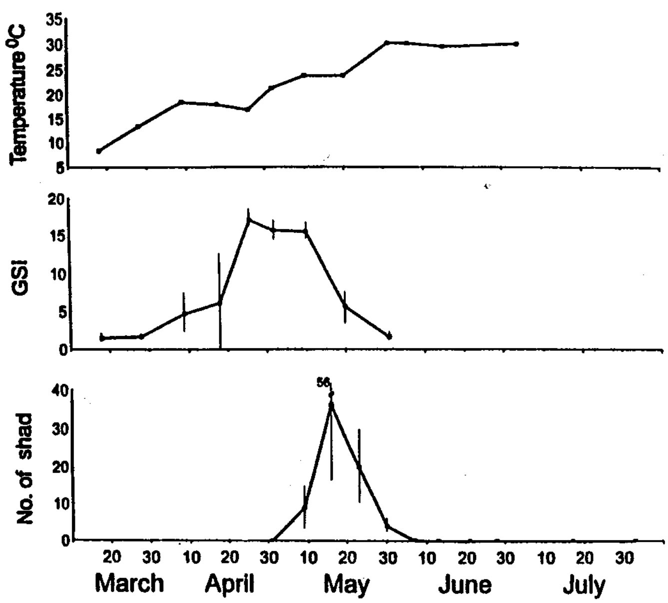

FIG. 2. Temperature, gonodal-somatic indices, and the number of <10-mm long gizzard shad/10 m^3 collected from Taylorsville Lake from 19 March to 3 July 1991. Vertical bars represent 95% confidence intervals.

DISCUSSION

Differences in spawning patterns observed at Taylorsville Lake could be related to several factors. Multi-modal spawning activity as detected by GSIs for 1990 might easily have been explained by the more frequent sampling in 1990 making it easier to detect minor peaks. However, a similar multi-modal pattern also was indicated for 1990 but not for 1991 using densities of larvae from push-net samples taken with similar effort in both years.

Size structure of the population of adult shad could influence spawning patterns (Willis, 1987; Buynak et al., 1992). At Taylorsville Lake in 1989, even though a single peak in spawning activity occurred, variations in the time of spawning relative to the size of female gizzard shad were found (Buynak et al., 1992). Gonodal-somatic indices for fish $\geq$175 mm were below levels indicating spawning capability after mid-June; shad <175 mm were capable of spawning through the end of July. Willis (1987) also found that larger gizzard shad (270-299 mm) spawned over a shorter period (2-3 weeks) than do smaller fish (170-219 mm) which remained in spawning condition for 6 weeks. A difference in size structure of adults could influence not only peaks in spawning activity but also the length of the spawning period. Size structure of the adult population prior to spawning in Taylorsville Lake in 1990 and 1991 is unknown. However, of the total number of gizzard shad $\geq$114 mm collected at Taylorsville Lake in studies using rotenone, 96.8 and 95.9% were between 114 and 190 mm in 1990 and 1991, respectively, indicating size structure of adult shad was similar in both years.

The two distinct spawning patterns of gizzard shad in Taylorsville Lake in 1990 and 1991 possibly is related to differences in water-temperature regimes. In 1990, temperatures remained relatively stable (11.1-12.8°C) from 22 March through 19 April, increased rapidly to 22.2°C on 26 April, and then declined to 16.7°C on 7 May. Gonodal-somatic indices show that the first peak in spawning activity occurred near the end of April within a few days after water temperatures reached 16°C. In 1991, water temperatures increased rapidly and exceeded 16°C by 9 April. Even though water temperatures warmed more quickly to 16°C, the reported temperature for initiation of spawning in gizzard shad (Bodola, 1966; Shelton et al., 1982; Heidinger, 1983), spawning was not detected by GSIs until at least 17 days after water temperature exceeded 16°C. Spawning activities began in both years near the end of April.

Bodola (1965) found that gizzard shad spawn in response to increasing water temperature in western Lake Erie, where they spawned in large numbers at 19.4°C. When water temperature decreased to 18.3 and 18.6°C, the number of shad spawning on gravel bars declined. This behavior might account for the multiple peaks in activity indicated in 1990 in Taylorsville Lake since greater fluctuations in temperature were observed then than in 1991.

Differences also were observed in the duration of spawning activities of gizzard shad in Taylorsville Lake. Heidinger (1983) suggested an upper "thermal shut-off" at about 30°C that caused spawning to cease for threadfin shad. In our study, GSIs and densities of larval shad in 1991 indicate that most spawning activity was completed by the end of May; no larva < 10 mm was collected after 6 June. Surface water temperature reached 30°C by 31 May and remained above 28.9°C through 7 July. In 1990, major spawning activities continued through 20 June, with low numbers of small gizzard shad collected through at least 10 July. In 1990, surface water temperature remained below 30°C through 3 July.

The spawning pattern of gizzard shad in Taylorsville Lake is influenced by water temperature. A "thermal shut-off" of spawning activity occurred at about 30°C; major spawning activity was completed when water temperature reached 24 to 25°C. Early cessation of spawning could result in a decrease prey base for predators. The decreased availability of small gizzard shad could negatively affect growth and survival of predators, particularly in reservoirs with active predator-stocking programs. Timing of predator-stocking programs could be enhanced by determining the stage of spawning in shad and prey availability prior to stocking.

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LITERATURE CITED

ANONYMOUS. 1992. The distribution of nutrients and phytoplankton in Taylorsville Lake, Kentucky. Hydrology and Hydraulics Section. Louisville District, US Army Corps Eng., Louisville, Kentucky.

BODOLA, A. 1965. Life history of gizzard shad *Dorosoma cepedianum* (LeSueur), in western Lake Erie. US Fish Wildl. Service Fish. Bull., 65:391-425.

BUYNAK, G. L., R. S. HALE, AND B. MITCHELL. 1992. Differential growth of young-of-year gizzard shad in several Kentucky reservoirs. N. Amer. J. Fish. Mgmt., 12:656-662.

HEIDINGER, R. C. 1983. Life history of gizzard shad and threadfin shad as it relates to the ecology of small lake fisheries. Pp. 1-18 *in* Proceedings of the Small Lakes Management Workshop, Pros and Cons of Shad. Iowa Conserv. Comm., Des Moines.

JESTER, D. B., AND B. L. JENSEN. 1972. Life history and ecology of the gizzard shad, *Dorosoma cepedianum* (LeSueur) with reference to Elephant Butte Lake. New Mexico Agric. Exp. Sta. Res. Rept., 218:1-56.

NETSCH, N. F., G. M. KERSH, JR., A. HOUSER, AND R. V. KILAMBI. 1971. Distribution of young gizzard shad and threadfin shad in Beaver Reservoir. Amer. Fish. Soc. Special Publ., 8:95-105.

SHELTON, W. L., C. D. RIGGS, AND L. G. HILL. 1982. Comparative reproductive biology of the threadfin and gizzard shad in Lake Texoma, Oklahoma-Texas. Pp. 47-51 *in* Proceedings of the Fifth Annual Larval Fish Conference (C. F. Bryan, J. V. Conner, and F. M. Truesdak, eds.). Louisiana Cooperative Fish. Res. Unit, Baton Rouge.

WILLIS, D. W. 1987. Reproduction and recruitment of gizzard shad in Kansas reservoirs. N. Amer. J. Fish. Mgmt., 7:71-80.