Egg Development in a High-Density Black Crappie (*Pomoxis nigromaculatus*) Population

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ABSTRACT

Female black crappie (Pomoxis nigromaculatus) were collected from Richmond Lake, South Dakota, and egg-diameter frequencies were examined to document spawning strategy during 1994. Two hundred and sixteen adult females [mean total length (TL) ± SE = 204 ± 1 mm] were collected and 85,572 egg diameters were measured. Female black crappie gonadosomatic-index (GSI) values exceeded 8% from 18 May to 22 June 1994, and the density of larval black crappie caught with an ichthyoplankton net peaked on 8 June 1994. The GSI values and larval catches indicated that the population, as a whole, had a single extended spawn from mid-May through mid-June. However, patterns of egg-diameter distributions were inconsistent among individual female black crappie. It appeared that some females spawned only once during 1994, while others probably spawned twice.

INTRODUCTION

Management problems most commonly associated with crappies (Pomoxis spp.) stem from recruitment problems [i.e., too much or too little recruitment (Hooe 1991), or too variable recruitment (Hayward and Arnold 1996)]. Goodgame and Miranda (1993) indicated that the length of the spawning season could influence recruitment of age-0 largemouth bass (Micropterus salmoides). Multiple spawners typically have longer spawning seasons compared to single spawners. For example, largemouth bass typically spawn for four weeks, while bluegill (Lepomis macrochirus) may spawn for up to three months. Extended spawning periods may enhance larval survival by reducing intraspecific competition for zooplankton during any one time period.

Crappies are generally thought to exhibit spawning behavior similar to largemouth bass. However, Scott and Crossman (1973) noted that female black crappie (P. nigromaculatus) probably spawn with different males in more than one nest. Furthermore, Whiteside (1962) reported that many white crappie (P. annularis) released only a portion of their eggs during a spawning event, indicating that this species had the potential to spawn more than once within a spawning season. We were interested in knowing whether the black crappie is a single or multiple (i.e., fractional) spawner. Fractional spawners typically are identified based on patterns in egg-diameter frequencies for that species prior to and during the spawning season (e.g., Mackay and Mann 1969). We monitored patterns of egg development in female black crappie collected from a South Dakota reservoir to obtain information on the spawning strategy used by black crappie.

STUDY SITE

Richmond Lake is a 336-ha impoundment in northeastern South Dakota. The impoundment has a shoreline development index of 5.8, mean depth of 4.6 m, maximum depth of 8.8 m, morphoedaphic index of 71, and does not thermally stratify during the summer. The watershed is primarily agricultural land, of which 48% is cropland and 52% is pasture (Koth 1981). The black crappie population is characterized by high density, slow growth, and relatively consistent recruitment (Guy and Willis 1993, 1995a, 1995b).

METHODS

Ovary collection. Black crappie were sampled with trap (modified fyke) nets (1.3- X 1.5-m frame, 13-mm bar mesh, 1.2- X 23-m lead) on 24 April, weekly from 18 May to 19 July, and on 8 August 1994. The objective of this schedule was to sample the fish throughout their spawning season. Eighteen female black crappie per sample date were placed on ice and returned to the laboratory for processing. Fish were measured (total length to nearest millimeter) and weighed (to nearest gram). Ovaries were removed, weighed (to nearest 0.01 g), cut in half and then cut longitudinally, turned inside-out, and placed in modified Gilson's fluid (Snyder 1983) to harden eggs and free them from ovarian connective tissue. Samples were shaken vigorously three or four times during the first 48 h of preservation and periodically thereafter until they were processed. A subsample of eggs from each black crappie was placed on a Ward zooplankton counting wheel where $\geq$325 egg diameters were measured to the nearest 0.05 mm under a binocular dissecting microscope using an ocular micrometer. Because not all eggs were spherical, egg diameters were measured as they appeared on the horizontal scale of the ocular micrometer. A gonadosomatic-index (GSI) value was calculated for each female by dividing ovary weight by total body weight and multiplying by 100 (Nikolsky 1963).

Larvae and juvenile collection. Larval black crappie were sampled weekly with a 0.76-m diameter ichthyoplankton net (mesh size = 500 μm) towed just under the surface at 1-2 m/sec perpendicular to shore (within 15 m) from 25 May to 28 July 1994. Two replicate tows were collected on each sampling date. A flow meter mounted in the mouth of the net allowed estimation of the volume of water filtered, and hence, larval density. All collected fishes were preserved in ethanol and returned to the laboratory. In the laboratory, black crappie were identified, counted, and measured (total length to nearest millimeter). Juvenile black crappie were sampled with 10 trap nets set overnight on 1 September 1994. Total lengths were recorded for all juveniles captured.

RESULTS AND DISCUSSION

Two hundred and sixteen adult female black crappie [mean total length (TL) = 204 mm (SE = 1.0); Figure 1] were collected and 85,572 egg diameters were measured. Female black crappie with GSI values exceeding 8% were collected from 18 May to 22 June (Figure 1). Pre-spawn females collected on 24 April had GSI values near 3%; eggs were starting to mature (Figure 2). Some of these females appeared to have two distinct modes in their egg-diameter frequencies -- one mode of the primary oocytes (circa 0.2-mm diameter; eggs that develop and mature during the subsequent year) and one mode of maturing eggs (Figure 2). Fishes displaying this pattern in egg-diameter frequencies typically are considered to be single spawners. However, some female black crappie had egg-diameter frequencies with three distinct modes -- one mode of the primary oocytes and two modes of maturing eggs (Figure 2). Multiple modes in egg-diameter frequency are indicative of multiple-spawning (fractional-spawning) fishes (e.g., Mackay and Mann 1969, Cox and Willis 1987). Based on the egg-diameter frequencies, eggs near 0.7 mm in diameter were mature oocytes ready to be spawned.

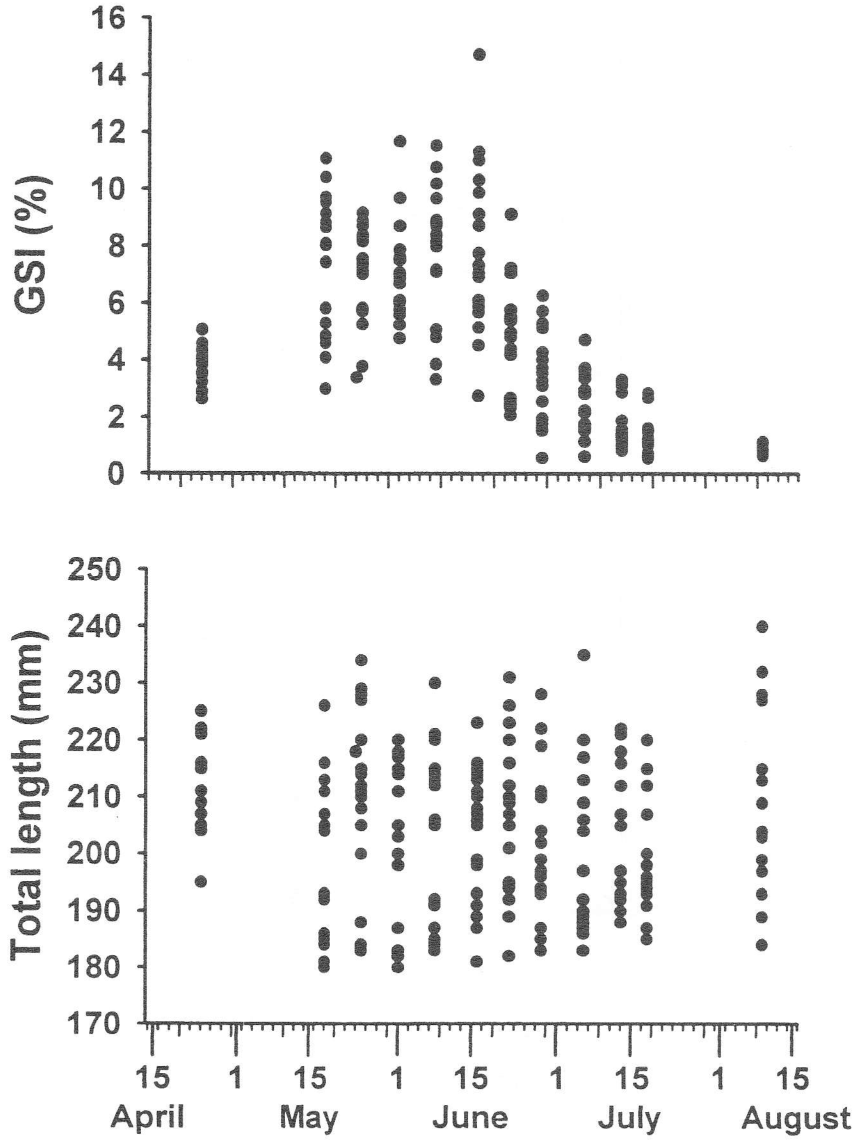

Figure 1. Total length and gonadosomatic index (GSI) of 216 female black crappie collected from Richmond Lake, South Dakota, during 1994.

Some females collected as late as 13 July still appeared capable of spawning, but by August, the ovaries of all female black crappie contained only primary oocytes (Figure 2).

Larval black crappie first appeared in ichthyoplankton samples on 25 May; abundance peaked on 8 June and declined to zero on 28 June (Figure 3). However, a single larval black crappie was collected on 28 July. Based on the length of that individual (12-mm TL), it probably was spawned during early- to mid-July. We discontinued larval trawls on 28 July because no larval black crappie had been caught since 22 June. Thus, we do not know whether additional larval black crappie may have been collected in August. By fall, the length distribution of juvenile black crappie collected with trap nets during the fall was unimodal (Figure 4); however, the trap nets had a mesh size of 13 mm (bar measure) and may not have been effective for smaller black crappie.

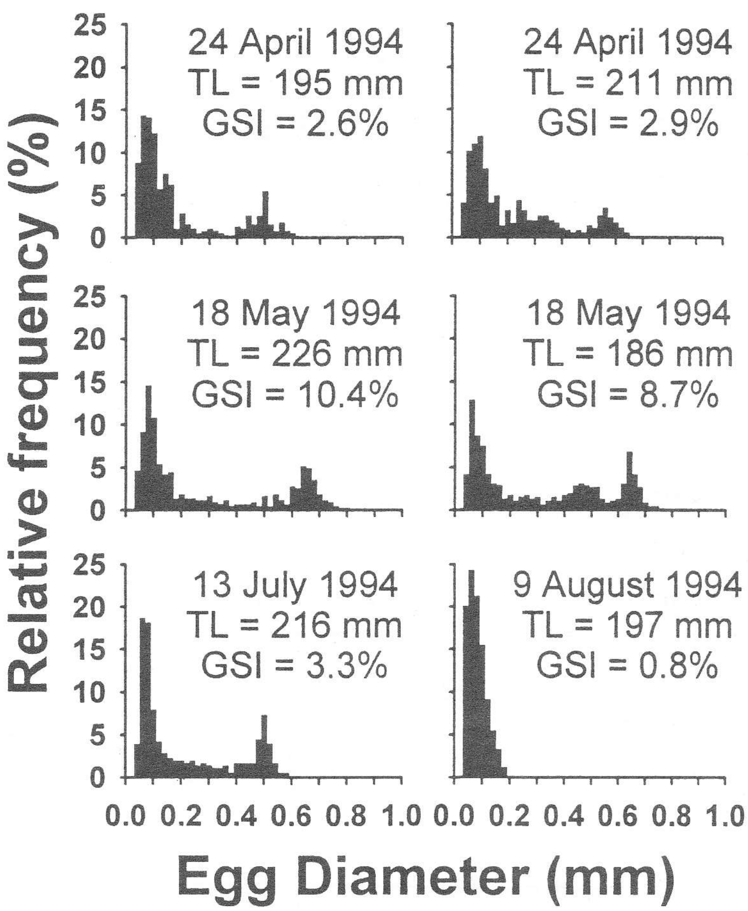

Figure 2. Egg-diameter distributions ($N \geq 325$) for six female black crappie ovaries collected from Richmond Lake, South Dakota during the 1994 spawning season. The date of collection, total length (TL; mm) and gonadosomatic index (GSI) values are given for each fish.

The GSI values and larval catches indicated that the black crappie population, as a whole, had a single extended spawning period from mid-May through mid-June. However, the patterns of egg-diameter distributions were inconsistent among individual females. Some female black crappie may have spawned only once during 1994, while others demonstrated the potential to spawn at least twice during the season. We speculate that this inconsistency might be the result of sampling a high-density, slow-growing population. Perhaps a lower density population with faster growth rates, and likely having greater food abundance per crappie, might more consistently show multiple modes in egg-diameter frequency.

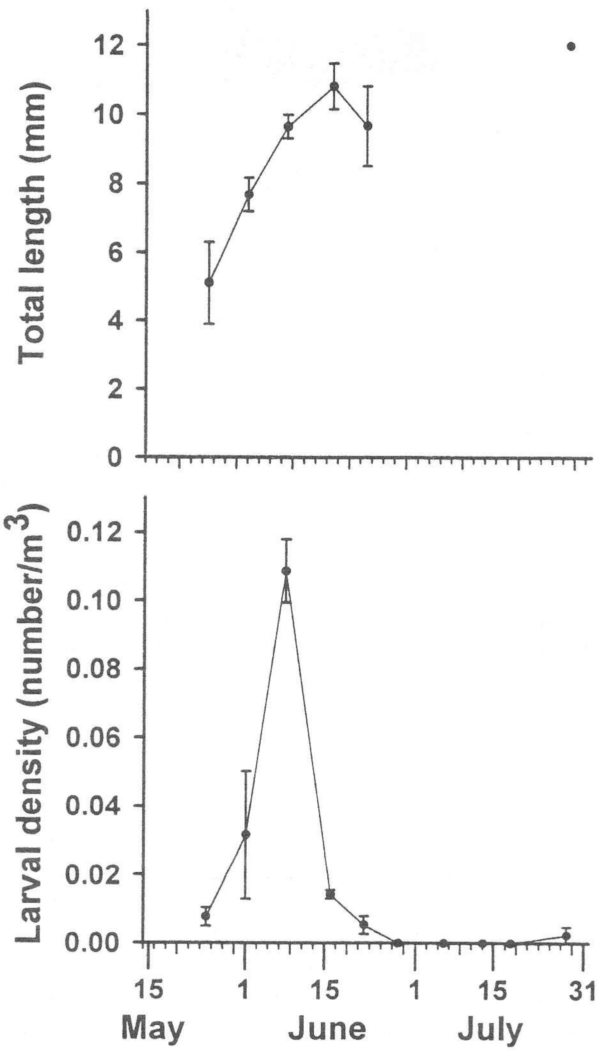

Figure 3. Mean (± SE) density and mean (± SE) total length (mm) for larval black crappie collected with an ichthyoplankton net (mesh size = 500 um) towed perpendicular to shore (within 15 m) from 25 May to 28 July 1994 in Richmond Lake, South Dakota.

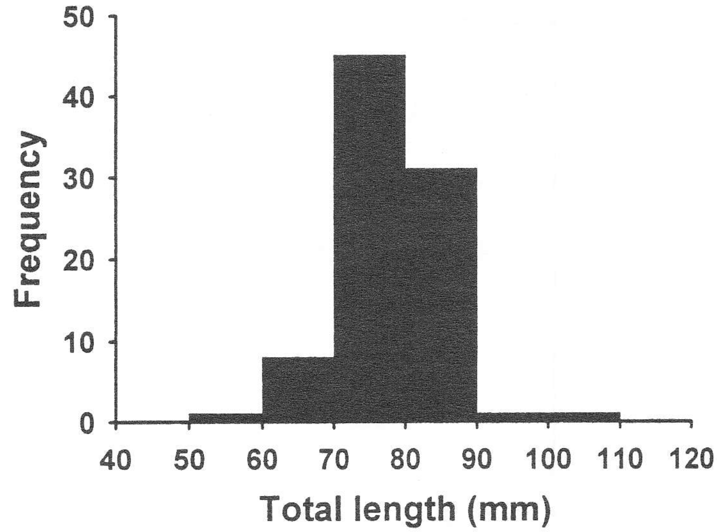

Figure 4. Length frequency of age-0 black crappie collected in 10 trap nets set overnight on 1 September 1994 in Richmond Lake, South Dakota.

The female black crappie with two modes of maturing eggs apparently invested more energy in the mode of larger eggs (i.e., the number of larger maturing eggs was greater than the number of smaller maturing eggs). If true, these fish probably invested more energy in their first spawn if they spawned twice. Additionally, few if any late-spawned black crappie were collected in the fall with trap nets (assuming that they were effectively sampled by this gear).

Cox and Willis (1987) reported a similar pattern for gizzard shad (Dorosoma cepedianum) GSI values in Melvern Reservoir, Kansas, and concluded that the gizzard shad had an extended single spawn. They also reported that individual gizzard shad spawned multiple times during the spawning season and found a bimodal distribution of age-0 gizzard shad during the fall.

Multimodal length distributions of age-0 crappies during the fall are relatively common (Siefert 1969). Potential causes of multimodal distributions of age-0 fishes include multiple spawning adults, differential spawning times of adults, and differential growth of larvae spawned over an extended time period (Shelton et al. 1979, Timmons et al. 1980, DeAngelis and Coutant 1982, Willis 1987). It is unclear what causes a multimodal distribution of age-0 crappies during the fall. Siefert (1969) reported that differential spawning times of adult white crappie in Lewis and Clark Lake, South Dakota, coupled with differential growth of larval crappie, led to a multimodal distribution of age-0 crappie in the fall. Based on catches of crappies (both species combined) less than 15 d old, Mitzner (1987, 1991) observed apparent bimodal and trimodal spawning activity in Rathbun Lake, Iowa. However, he was unable to determine if the spawning activities were a result of differential spawning times between white and black crappies, or if extended spawning seasons occurred for one or both species.

We found evidence that some black crappie in Richmond Lake could have spawned more than once in 1994, which is a potential explanation for the extended length frequencies of age-0 black crappie observed in the fall. Similarly, Whiteside (1962) found that white crappie in Lake Texoma, Texas-Oklahoma, only released part of their eggs during a single spawning event, indicating that individual fish possessed the ability to spawn more than once during a spawning season. An assessment of patterns in egg-diameter development for black crappie in a higher-quality population (i.e., lower density and faster growth) might add insight into the spawning periodicity of this species.

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