HATCHING DATES AND DAILY GROWTH
OF AGE-0 BLACK CRAPPIES IN
PICKEREL LAKE, SOUTH DAKOTA

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ABSTRACT

We assessed hatch dates and daily growth rates of age-0 black crappies Pomoxis nigromaculatus during 2001 and 2002 in Pickerel Lake, South Dakota. Hatching of black crappies in Pickerel Lake during 2001 occurred over a duration of 39 d, beginning on May 26 (day 146) and continuing until July 5 (day 185). Hatching duration during 2002 was much shorter, occurring over a 19-d period from June 5 (day 157) to June 25 (day 176). Mean hatch date was significantly different ($P = 0.01$) between 2001 (June 14) and 2002 (June 16); however, this represented a difference of only 2 d. Daily growth rate of age-0 black crappies was significantly correlated ($r = 0.48$, $P = 0.03$) to hatch date in Pickerel Lake during 2001 indicating that later hatched crappies tended to exhibit faster growth than crappies hatched earlier in the year; this relationship was not apparent in 2002. Daily growth rates did not significantly differ ($P > 0.05$) between years, and on average age-0 black crappies grew 0.68 mm/d (SE = 0.01) from swim-up until time of capture in August. In both years, hatch date and daily growth explained 99% of the variability in total length (TL) of age-0 black crappies collected in August ($R^2 = 0.99$, $P = 0.0001$). In both years, daily growth explained the majority of variation (62-68%) in TL of age-0 black crappies, while hatch date explained most of the remaining variability (31-37%).

INTRODUCTION

Black crappie Pomoxis nigromaculatus populations in many South Dakota natural lakes demonstrate erratic recruitment (Guy and Willis 1995). Hatching date can influence the growth rates (Travnichek et al. 1996; Sammons et al. 2001) and potential survival (Pine and Allen 2001) of age-0 crappies Pomoxis spp., consequently affecting crappie recruitment. Previous studies have shown a positive relationship between individual body sizes and overwinter survival in other centrarchids (Shuter and Post 1990; Miranda and Hubbard 1994; Cargnelli and Gross 1997). DeAngelis et al. (1993) linked starvation vulnerability of smallmouth bass Micropterus dolomieu to body size, with the smaller individuals exhibiting higher mortality than larger individuals. Shuter and Post (1990) reported a reduction in the ability of age-0 fishes to compensate metabolic demands and survive winter due to reduced feeding activity experi-
enced for the duration of ice cover on a lake. Hatch timing can determine age-0 centrarchid sizes entering their first winter (Goodgame and Miranda 1993; Cargnelli and Gross 1996; Sammons et al. 1999), consequently affecting age-0 fish survival and the size distribution of age-0 cohorts following cold-water periods (Shuter and Post 1990; DeAngelis et al. 1993).

Earlier-hatched crappies often grow slower than later-hatched individuals within the same age-0 cohort (Travnichek et al. 1996; Pine and Allen 2001; Sammons et al. 2001). However, earlier hatch dates could offset faster growth rates achieved by later-hatched individuals (Ludsin and DeVries 1997). Consequently, earlier-hatched individuals of an age-0 cohort can potentially attain larger sizes before winter onset relative to later-hatched members within the same cohort (Cargnelli and Gross 1996; Ludsin and DeVries 1997; Sammons et al. 1999).

Increased growth rates of later-hatched black crappies have been shown to compensate for delayed hatching dates and later-hatched cohorts may disproportionately contribute to year class strength (Pine and Allen 2001). However, Sammons et al. (2001) documented faster mean growth across years for earlier-hatched crappies relative to later-hatched cohort members in a Tennessee reservoir. To determine if hatch timing influenced age-0 black crappie size structure and daily growth in Pickerel Lake, South Dakota we estimated hatching dates and daily growth rates of age-0 black crappies.

METHODS

Age-0 black crappies were collected from 380-ha Pickerel Lake (Day County) during the first week of August in 2001 and 2002 using a bag seine (15.2-m long, 6.4-mm bar mesh). Sampling sites (N = 20) were randomly selected and remained fixed throughout the duration of the study to reduce bias in catch per unit effort (CPUE; number per seine haul) that might result from inconsistent black crappie catchability among sites. All black crappies were measured (total length, TL) to the nearest mm and sagittal otoliths were removed from randomly selected fish for hatch-date estimation from daily ring enumeration (Sweatman and Kohler 1991). Otoliths were wiped clean on a paper towel and placed in vials to air dry for a minimum of 2 weeks prior to mounting. One whole otolith per fish was mounted to a slide (convex side down) with cyanoacrylic cement and otolith images were projected through a binocular compound microscope (400 x) to a television monitor to aid in enumeration of daily rings. An individual reader counted daily rings three times under magnification and the average of the three counts was used to estimate hatching date. In some instances, otoliths were wet polished on 1,000-grit sandpaper and a drop of immersion oil was added to improve clarity. Daily growth (DG) from swim-up until time of capture was determined as:

\[ DG = \frac{(TL - 4 \text{ mm})}{(\text{average ring count} - 4 \text{ d})} \]
because black crappies hatch at approximately 4 mm and swim-up approximately 4 d after hatching (Travníček et al. 1996).

Mean hatch dates were compared between years using a t-test for unequal variance between samples (Schlotzhauer and Littell 1997). Variance in daily growth rates and variance in TL of age-0 black crappies in seine hauls were equal between years; hence, means were compared with a t-test. The relationship between hatch date and daily growth was assessed using Pearson correlations. For both years, stepwise multiple regression was used to determine the relative importance of hatch date and daily growth in explaining variation in TL of age-0 black crappies collected in August.

RESULTS AND DISCUSSION

Mean seining CPUE for black crappies in Pickerel Lake ranged from 21.7 per haul (SE = 17.4) in 2002 to 86.9 per haul (SE = 3.8) in 2001. Total lengths of age-0 black crappies in August seine hauls varied substantially, ranging from 19 to 56 mm (Fig. 1). Mean TL of age-0 black crappies was not significantly different ($P > 0.05$) between years (36 mm).

Hatching of black crappies in Pickerel Lake during 2001 occurred over a duration of 39 d, beginning on May 26 (day 146) and continuing until July 5 (day 185; Fig. 2). Hatching duration during 2002 was much shorter, occurring over a 19-d period from June 5 (day 157) to June 25 (day 176; Fig. 2). Mean hatch date was significantly different ($t = -2.69$, df = 27, $P = 0.01$) between 2001 (June 14) and 2002 (June 16); however, this represented a difference of only 2 d. In 2001, black crappies in

Figure 1. Length frequency of age-0 black crappies collected by shoreline seining during August of 2001 and 2002 from Pickerel Lake, South Dakota.
Pickerel Lake began hatching approximately 10 d earlier and continued hatching 5-8 d longer than in 2002. Hatching durations reported here may be shorter than in other South Dakota waters. Previous larval sampling in South Dakota lakes revealed the presence of larval crappie during late July and early August (Pope and Willis 1998). Additionally, August 2001 seine surveys on Waubay Lake, a 6278-ha lake located approximately 1.6 km from Pickerel Lake, yielded numerous age-0 black crappies that were < 20 mm TL (D. Isermann, unpublished data). Pickerel and Waubay lakes differ greatly in size and volume, which likely results in differential water warming rates, which could affect the timing of black crappie spawning events. Although the presence of these smaller fish throughout the summer suggests that in some South Dakota lakes black crappie hatching may be much more protracted than reported here, age-0 crappies of this size may not have been adequately sampled by our seine. In Pickerel Lake, black crappies < 20 mm were rare (1 of 419) in the August seine samples we collected.

Hatching durations reported here were shorter than those reported for age-0 black crappies in one Florida lake (12 weeks; Pine and Allen 2001) and for age-0 white crappies P. annularis in a Tennessee reservoir (42-53 d; Sammons et al. 2001), but were similar to crappies (21-32 d; white, black, and F1 hybrid) in Weiss Lake, Alabama (Travnichek et al. 1996) and hatch durations reported by Pope and Willis (1998) for two other South Dakota waters. Pope et al. (1996) did find evidence of multiple egg clutches in some female black crappies collected from a South Dakota impoundment.

Mean daily growth rates did not significantly differ between years ($t = -0.43$, df = 61, $P = 0.67$), and on average age-0 black crappies grew 0.68 mm/d.
(SE = 0.01) from swim-up until time of capture in August (Fig. 3). Mean daily growth rate exhibited by age-0 black crappies in Pickerel Lake was substantially lower than those reported by Pope and Willis (1998) for two other South Dakota waters (1.03-1.18 mm/d); however these earlier estimates did not account for crappie size at time of swim up (4 mm; Chatry and Conner 1980), which likely inflated estimates of daily growth. Mean daily growth rates of age-0 black crappies in Pickerel Lake were similar to or lower than rates reported for populations in the southeastern United States (0.52-0.82 mm/d; Travnichek et al. 1996; Pine and Allen 2001; Sammons et al. 2001).

Daily growth rates of age-0 black crappies were significantly correlated to hatch date in Pickerel Lake during 2001 ($r = 0.48$, df = 21, $P = 0.03$) when hatch duration was more protracted, indicating that later-hatched crappies tended to exhibit faster growth than crappies hatched earlier in the year; this relationship was not apparent in 2002 when hatching occurred over a shorter duration. Previous studies have noted relationships between hatch timing and daily growth of age-0 crappies, demonstrating that crappies hatched later in a given year exhibited faster daily growth than earlier-hatched members of the same cohort (Travnichek et al. 1996; Pine and Allen 2001; Sammons et al. 2001). Increased growth of later-hatched crappies has been potentially linked to warmer water temperatures experienced by later-hatched fish (Pine and Allen 2001; Sammons et al. 2001). Our results suggest that the relationship between hatch timing and daily growth may occur as a function of hatching duration, with shorter hatching windows resulting in a reduced probability of differential growth among crappies hatched on different dates.

In both years, hatch date and daily growth explained 99% of the variability in TL of age-0 black crappies collected in August ($R^2 = 0.99$, $P = 0.0001$). Dai-

![Daily growth rates (mm/d) for age-0 black crappies collected from Pickerel Lake, South Dakota during August of 2001 and 2002.](image)
ly growth explained the majority of variation in TL of age-0 black crappies \( r^2 = 0.62-0.68; \ P < 0.05 \), while hatch date explained most of the remaining variability \( r^2 = 0.31-0.37; \ P < 0.05 \). Multicollinearity may have existed between hatch date and daily growth in 2001, as we found a significant correlation between these two variables.

Previous research has suggested that hatch date may regulate recruitment of centrarchids through differential growth and survival of fish hatched during different time periods (Cargnelli and Gross 1996; Pine et al. 2000; Pine and Allen 2001). Despite the positive relationship between daily growth and hatch date in 2001, our results suggest that, regardless of hatch timing, daily growth rates play an important role in determining the size attained by age-0 black crappies in Pickerel Lake during their first growing season. Hence, variation in daily growth within an age-0 black crappie cohort could result in differential survival if mechanisms such as foraging efficiency, predation, and overwinter survival operate in a size-selective manner similar to that reported for other species (Cargnelli and Gross 1996; Fullerton et al. 2000; Pine et al. 2000).

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