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Evaluation of a 23-cm Minimum Length Limit for Black and White Crappies in a Small South Dakota Impoundment

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Abstract.—[redacted]

Minimum length limits for crappies *Pomoxis* spp. have only recently been used as a tool by fisheries managers and had not been implemented by the South Dakota Department of Game, Fish, and Parks (SDGFP) prior to 1996. Generally, minimum length limits should only be applied to crappie populations of low to moderate density that have moderate to fast growth (by the standards of the region) and whose size structure has been negatively affected by angler harvest. Minimum length limits should not be applied to high-density, slowly growing crappie populations (Colvin 1991; Allen and Miranda 1995) because they would compound the problem of overpopulation by further increasing crappie density and intraspecific competition. The success of minimum length limits for crappies has been mixed. Positive results have been reported by Colvin (1991) and Webb and Ott (1991), while negative results have been reported by Hale et al. (1999), Larson et al. (1991), Reed and Davies (1991), and Boxrucker (1999).

The size structure of the populations of black crappie *P. nigromaculatus* and white crappie *P. annularis* in Lake Alvin, South Dakota, was deemed undesirable by fisheries managers (SDGFP, unpublished data). Anglers complained about the small average size of crappies harvested from the lake, while the relative abundance of these populations was lower than that of other South Dakota crappie populations, which exhibited high density and slow growth (Guy and Willis 1993). Age and growth data indicated that the Lake Alvin crappies were growing at a satisfactory rate near the statewide average (Guy and Willis 1995). Guy and Willis (1993) also reported that the size structure of the black and white crappies collected with trap nets in Lake Alvin during 1990 was below the range necessary for a balanced population. Trap-net samples showed few fish older than age 2, indicating either that the fish were being harvested at a young age or that natural mortality was limiting their survival. The combination of low to moderate density, moderate growth, small size, and young age structure suggested that the Lake Alvin crappies were being overharvested.

Before the regulation changes were implemented, SDGFP biologists conducted an angler opinion survey at Lake Alvin to evaluate how receptive anglers might be to harvest regulations on crappies. Initially, anglers were asked their opinion

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regarding a 20-cm minimum length limit. Of the anglers who responded, 91% were in favor. These initial respondents were resurveyed to assess their opinions regarding a 23-cm minimum length limit; 93% of those who responded were in favor. With public support, SDGFP instituted a 23-cm minimum length limit for both species in Lake Alvin beginning 1 January 1996. The objective of this study was to evaluate the effects of this length limit on the black and white crappie populations in Lake Alvin.

Study Site

Lake Alvin is a 36.4-ha permanent warmwater impoundment located in southeastern South Dakota that is owned and managed by SDGFP. The impoundment is eutrophic, has a moderate level of turbidity, and contains few submerged macrophytes (Stueven and Stewart 1996). The prey base available to crappies primarily consists of zooplankton and macroinvertebrates (SDGFP, unpublished data). Lake Alvin's close (<35 km) proximity to Sioux Falls (the highest human population density in South Dakota) has likely contributed to high angling effort in the past. Lindgren (1991) reported 21,762 angler-hours of fishing effort there from April through September 1989.

Methods

Crappie populations were sampled annually (1992–1999) during late June–early July using trap nets (modified fyke nets with 19-mm-bar mesh, 0.9-m × 1.5-m frames, and 18.3-m leads). Each standard sample consisted of 10 net nights at a fixed location. All crappies were counted from each net. A random sample of fish (up to the first 100 of each species) was measured (total length) to the nearest millimeter and weighed to the nearest gram. All comparisons in this study were made for black and white crappies separately.

Changes in relative abundance were monitored in terms of catch per unit effort (the number of fish age 1 and older per trap net per night [CPUE]). Because the CPUE data were not normally distributed (SAS Institute 1996), statistical comparisons were made after a logarithmic transformation ($\log_{10}[n + 1]$) of the data. Because samples collected over consecutive years were likely correlated through time, we used repeated-measures analysis of variance (ANOVA) for fixed sampling locations to compare mean CPUE in the pre- and postregulation periods (Maceina et al. 1994). We considered 1992–1995 to be the preregulation period and 1996–1999 to be the postregulation period. Tests were replicated using different covariance structures (i.e., compound symmetry and autoregressive). The model with the lowest Akaike information criterion value was considered to have the best fit.

The size structure of both populations was assessed in terms of the relative stock density of 23-cm fish (RSD-23; Wege and Anderson 1978). The minimum stock length was 13 cm for both species (Gabelhouse 1984). Differences between the mean pre- and postregulation RSD-23 were determined with *t*-tests.

Condition was monitored through relative weight (W_r; Wege and Anderson 1978), which was determined from standard weight equations recommended by Neumann and Murphy (1991). Relative weight was summarized by length group (stock−quality [13–19 cm], quality−preferred [20–24 cm], preferred−memorable [25–29 cm], and memorable−trophy [30–37 cm]; Gabelhouse 1984) to identify any length-related trends in W_r for each population. Statistical comparisons were made with ANOVA to test for differences in mean W_r among length categories within years. A least-squares means multiple-range test was used to detect differences in mean W_r among length categories when the overall ANOVA was significant.

Age-and-growth analyses were conducted from 1995 to 1999 based on crappie scales. A scale sample was removed from the first five fish collected per centimeter-length-group during standard sampling. The mean length at capture of age-3 crappies was used to monitor growth changes during the study. We used *t*-tests to compare the postregulation mean length at age 3 with the 1995 baseline estimate.

Results and Discussion

The relative abundance of crappies varied throughout the study. Mean trap-net CPUE ranged from 5 to 66 fish/net night for black crappies and from 6 to 63 fish/net night for white crappies between 1992 and 1999 (Table 1). Years of low relative abundance (1993–1995) were not confined to Lake Alvin; other black crappie populations in the state exhibited a similar decline in abundance during the same period, including Lakes Richmond and Mina (Pope 1996) and Lake Mitchell (SDGFP, unpublished data). The mean log-transformed CPUE was significantly ($P < 0.0001$) higher in the postregulation period for both species. However, because of inherent variability in crappie recruitment, we cannot attribute this difference to regulation effects (Pope and Willis 1998).

TABLE 1.—Mean catch per unit effort (number of fish ≥age 1/net night [CPUE]) ± SE, relative stock density of 23-cm fish (RSD-23), and mean length (mm) ± SE at time of capture for age-3 black and white crappies collected with trap (modified fyke) nets during late June–early July 1992–1999 from Lake Alvin, South Dakota. Means are presented for the pre- (1992–1995) and postregulation (1996–1999) periods. Age-and-growth analysis was not conducted prior to 1995.

	Black crappies			White crappies		
Year and means	CPUE	RSD-23	Mean length at age 3 (mm)	CPUE	RSD-23	Mean length at age 3 (mm)
1992	63 ± 16	0		63 ± 23	3	
1993	11 ± 3	0		37 ± 12	1	
1994	5 ± 1	3		10 ± 3	15	
1995	7 ± 1	3	207 ± 9.0	6 ± 2	13	220 ± 9.3
1996	35 ± 11	0	199 ± 3.1	43 ± 8	2	215 ± 2.2
1997	13 ± 5	2	209 ± 1.5	40 ± 10	4	212 ± 3.6
1998	41 ± 7	1	211 ± 2.5	27 ± 9	3	213 ± 0.7
1999	66 ± 10	2	202 ± 2.4	44 ± 15	3	205 ± 2.6
Means						
Preregulation	22 ± 5	2	207 ± 9.0	29 ± 10	8	220 ± 9.3
Postregulation	39 ± 8	1	205 ± 2.4	39 ± 11	3	211 ± 2.3

Throughout the study, few fish of either species longer than 23 cm were sampled, as evidenced by the low RSD-23 values (Table 1). There were no significant differences in the mean RSD-23 for black crappies ($P = 0.81$) or white crappies ($P = 0.25$) between the pre- and postregulation periods. Thus, the size structure of the crappie populations did not increase after implementation of the 23-cm minimum length limit.

In most years, there was a significant ($P < 0.05$) negative trend in mean W_r with increasing fish length (Figure 1). Stock−quality and shorter (≤19 cm) fish usually had mean W_r values above 100. However, once fish reached 20 cm, mean W_r values usually fell below 100. During several years, fish of 20 cm or more had W_r values less than 90. Relative weight is a good indicator of prey availability (Wege and Anderson 1978; Liao et al. 1995; Marwitz and Hubert 1997; Porath and Peters 1997). Therefore, the longer crappies in Lake Alvin may not have had sufficient prey available to maintain acceptable body condition, which would affect their growth potential.

The postregulation mean length of age-3 fish at time of capture was not significantly different from that in the 1995 baseline growth data for either black crappies ($P = 0.99$) or white crappies ($P = 0.23$) (Table 1). Even though growth was moderate compared with that of other crappie populations in South Dakota, the lack of prey fish in the system required Lake Alvin crappies to subsist on zooplankton and macroinvertebrates (SDGFP, unpublished data). The annual growth increments of fish more than 20 cm long (consistently <1 cm) were deemed unacceptable for both species (Bister 2000).

A concurrent angler creel survey revealed that harvest rates were much lower from 1995 to 1999 (0.01–0.25 fish/h; Bister 2000) than historically (0.40–0.63 fish/h in 1989–1990; Lindgren 1991). In the later years, crappies were apparently not able to maintain the growth rates needed to reach legal size and become available to angler harvest. They may also have been vulnerable to natural mortality owing to the suspected limited prey availability for the larger (≥20-cm) fish in the system. Although no benefits from the minimum length limit were apparent, anglers continued to be supportive of the regulation (Bister et al. 2000).

This study indicates that minimum length limits should be applied cautiously to small-impoundment crappie populations that demonstrate even moderate abundance and growth. In addition, the patterns in W_r relative to crappie length indicated that food supplies for the larger crappies were not adequate to support increased abundance even before the regulation was implemented. Even though Lake Alvin crappies exhibited moderate growth rates compared with those of other populations in South Dakota, a sufficient prey base is likely required to allow these fish to consistently grow to larger sizes. If fish do not survive long enough to attain lengths that are greater than the minimum length limit, the regulation has no benefit to anglers. For this reason, this regulation was removed in January 2000.

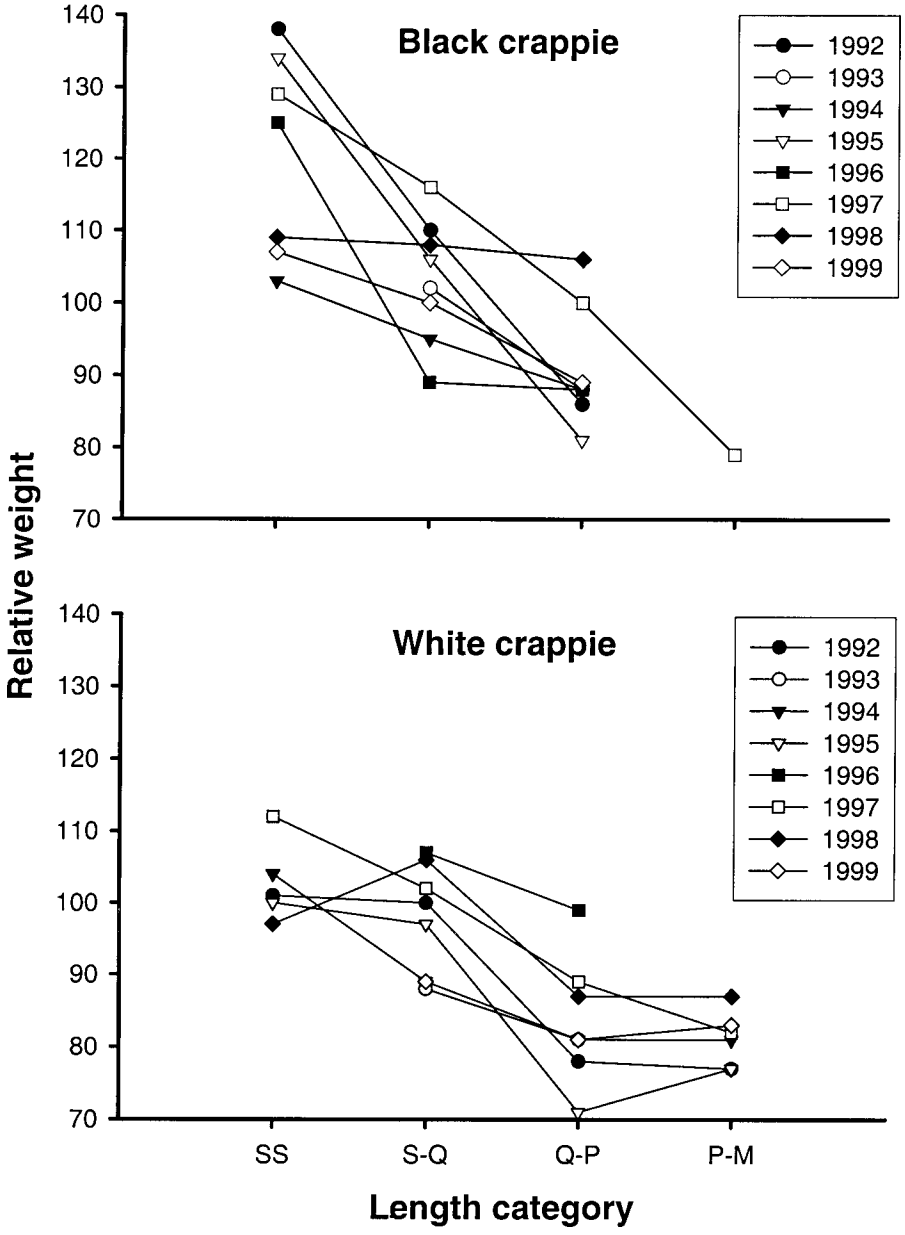

FIGURE 1.—Mean relative weights by length category for black and white crappies collected with trap nets during late June–early July 1992−1999 from Lake Alvin, South Dakota. Length categories are as follows: SS = substock (<13 cm); S−Q = stock to quality (13–19 cm); Q−P = quality to preferred (20–24 cm); and P−M = preferred to memorable (25–29 cm).

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