

Challenges of Crappie Management Continuing into the 21st Century

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White crappie *Pomoxis annularis* and black crappie *P. nigromaculatus* are among the principle species sought by anglers in the midwestern and southeastern United States. The focus of management activities aimed at improving crappie fisheries has shifted over the years, and the published literature reflects this shift. Three symposia on crappies sponsored by the American Fisheries Society have been significant contributors to the body of knowledge on crappie ecology and management. The third in this series, entitled "Challenges of Crappie Management Continuing into the 21st Century," was held at the society's 130th Annual Meeting in St. Louis, Missouri, in 2000. The organizers' objective was to compile the most current work on crappie ecology and management and help set the direction for research in the next decade. The symposium consisted of 15 platform presentations and 5 posters. Fourteen papers follow as the proceedings of this symposium. This introduction will try to show how the focus of research has shifted and the role that these symposia have played in that shift.

Mitzner (1984) identified the "small-crappie syndrome" as a common theme in papers from the first crappie symposium, "Crappie Management: Problems and Solutions," which was held at the 44th Midwest Fish and Wildlife Conference in 1982. As early as the 1940s, management activities

centered on reducing abundance through mechanical or chemical removal. These techniques have been used sparingly over the past 30 years because of their high costs and short-term benefits. Investigations of the interactions within crappie trophic communities (O'Brien et al. 1984; Ellison 1984) published in the first symposium led Mitzner (1984) to conclude that management activities were moving toward prey management. Published accounts of the effects of prey stockings on crappie population structure range from beneficial effects on community food webs (Bartholomew 1966; Li et al. 1976; Mosher 1984) to neutral effects (Boxrucker 1986; Boxrucker 1993; Hale 1996) and potentially negative effects (Crowl and Boxrucker 1989; DeVries and Stein 1990; Guest et al. 1990; DeVries et al. 1991). Mitzner (1984) also set the stage for another shift in management strategies by pointing out that managing angler harvest has the potential to rectify the small-crappie syndrome.

A second crappie symposium, entitled "Crappie Biology and Management," was held in conjunction with the 120th Annual Meeting of the American Fisheries Society in Pittsburgh, Pennsylvania, in 1990. Many of the papers published in connection with this symposium were descriptive in nature, with the topics including culture (Smeltzer and Flickinger 1991), aging (Hammers and Miranda 1991; Sweatman and Kohler 1991), movements and habitat use (Markham et al. 1991), relative weight (Neumann and Murphy 1991), and population characteristics (McDonough and Buchanan 1991; McInerny and Degan 1991; Colvin 1991a). The first accounts of the effects of minimum length limits on crappie population structure were published in the proceedings of this symposium (Colvin 1991b; Webb and Ott 1991). Reed

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and Davies (1991) and Larson et al. (1991), also participants in this symposium, cautioned against the use of restrictive harvest regulations due to the high levels of natural mortality seen in some crappie populations in Alabama and Georgia. Published accounts of the use of length limits to manage crappie fisheries increased following this symposium (Allen and Miranda 1995; Allen et al. 1998; Maceina et al. 1998; Hale et al. 1999; Boxrucker 2001). The use of length limits in crappie fisheries has been refined, with either a 229-mm or a 254-mm limit being used depending on the population's growth rate. Equilibrium yield models have assisted in refining the use of length limits (Maceina et al. 1998; Slipke and Maceina 2001). Currently, 15 of 27 states in the Northcentral and Southern Divisions of the American Fisheries Society manage crappie fisheries with length limits.

Crappie recruitment was historically thought to be cyclic, with strong year-classes being produced every 2–5 years (Swingle and Swingle 1967). However, despite the importance of crappies as sport fish, little research into the factors affecting their recruitment has been published. Environmental variables were identified as possible influences on year-class strength (Jenkins 1955; Goodson 1966; Mathur et al. 1979), yet little cause-and-effect data were presented. In the first crappie symposium, O'Brien et al. (1984) discussed the effects of abiotic factors on the survival of early life stages. In the second crappie symposium, Mitzner (1991) presented the relationships between crappie year-class strength and various environmental variables, including water level, turbidity, substratum, and wind.

Crappie recruitment dynamics were the focus of an increasing amount of research in the 1990s. Water temperature influences spawning times and subsequent growth and survival, with later-hatching cohorts experiencing higher temperatures, growth, and survival (Pine and Allen 2001). Dubuc and DeVries (2002) failed to identify consistent relationships between reservoir productivity and larval crappie density. Guy and Willis (1995) found differences in the recruitment variability of crappies in South Dakota based on landscape characteristics. Recruitment was less variable in systems with high shoreline development indices (i.e., more embayments). The recruitment of black crappies in South Dakota was also less variable in systems with high watershed : water body surface area ratios (Guy and Willis 1995). Water level fluctuations have increasingly been suggested as a primary influence on crappie recruitment. High in-

flows and subsequent water releases in spring and summer can lead to the reduced recruitment of crappies (Pope et al. 1996; Maceina and Stimpert 1998). High winter water levels had a positive influence on crappie year-class strength in Alabama tributary impoundments (Maceina and Stimpert 1998), yet the mechanisms underlying this relationship are not clear. Allen and Miranda (2001) used a population model to conclude that crappie recruitment was quasi-cyclic due to random fluctuations in the environmental variables and density-dependent mechanisms. Allen and Miranda (1998) developed an age-structured model to help explain the effects of erratic recruitment on crappie management alternatives, particularly the use of length limits.

Information from the two previous symposia on crappies set the stage for the papers from this symposium. Whereas the majority of manuscripts from the 1990 symposium were descriptive, most of those that follow evaluate management strategies. Six of the papers deal with exploitation. Estimates of exploitation were typically made from tag-return data and were subsequently used in conjunction with catch curves to estimate natural mortality rates. This information was then used to model the potential effects of length limits on crappie fisheries (Boxrucker 2002a, this issue; Isermann et al. 2002a, this issue). Miranda et al. (2002, this issue) found that the uncertainty surrounding estimates of tagging mortality, tag loss, and particularly reporting rate led to imprecise estimates of exploitation in spite of the high costs of data collection. These authors suggested that indirect measures of exploitation (i.e., condition, total mortality estimates, length and age distributions, and increased recruitment variability) be used rather than expensive tag-and-reward programs. Isermann et al. (2002a) used equilibrium yield models to evaluate Tennessee's statewide 254-mm minimum length limit on the yield of crappie fisheries. The authors grouped the study reservoirs into three categories: those in which 229-mm or 254-mm length limits would increase yield, albeit at the expense of the number of crappies harvested; those in which length limits had no impact on yield; and those that were negatively impacted by length limits. The authors suggested that applying length limits to fisheries using a categorical approach was preferable to using a single, areawide regulation. Bister et al. (2002, this issue) and Hurley and Jackson (2002, this issue) reported decreased growth rates in crappie populations in South Dakota and Nebraska, respectively, as a result of length limit

regulations. The 229-mm length limit was removed from Lake Alvin, South Dakota (Bister et al. 2002), while Hurley and Jackson (2002) recommended removing the 254-mm length limit from two small Nebraska impoundments for only a portion of the year to help maintain crappie densities. Boxrucker (2002a) detailed population and angler creel characteristics prior to, during, and after the removal of a 254-mm length limit at an Oklahoma reservoir. Even though the abundance of quality- and preferred-size crappies and angler catch rates improved as a result of the length limit, angler dissatisfaction with the regulation led to its removal. This is in contrast to the positive angler sentiment in regards to harvest restrictions in the Sardis Lake, Mississippi, crappie fishery (Dorr et al. 2002, this issue).

Recruitment has been a common theme in all three crappie symposia. McKeown and Mooradian (2002, this issue) found that neither the low density of adult stocks nor the overwinter mortality of age-0 crappies was the cause of reduced recruitment (relative to historical levels) in Chautauqua Lake, New York. The authors concluded that management efforts aimed at increasing adult density would have little effect on recruitment and the subsequent recovery of the fishery to historical levels. Sammons et al. (2002, this issue) found that crappie recruitment in Tennessee tributary impoundments was positively related to high water levels during the prespawning period (January through March). Maciena and Stimpert (1998) found a similar relationship in Alabama tributary impoundments. These findings corroborate the need for managers to work closely with agencies controlling water levels to balance the need for flood control and hydropower with the optimization of fish recruitment.

Two papers in this symposium dealt with supplemental stocking, a little-used technique to improve crappie recruitment. The results of stocking black-nosed crappies (a morphological variant of the black crappie) in Tennessee impoundments were mixed, with contributions to year-class strength ranging from 0% to 93% (Isermann et al. 2002b, this issue). Racey and Lochmann (2002, this issue) determined that the year-class contribution of white crappies stocked into Lake Chicot, Arkansas, ranged from 0% to 3.1% and concluded that other management options to improve adult abundance should be considered.

Stocking predators to reduce the abundance of slowly growing populations of crappies was the topic of two papers in this symposium. The con-

cept was introduced by Willis et al. (1984) in the first crappie symposium. Saugeyes (walleye *Stizostedion vitreum* × sauger *S. canadense*) were stocked into Richmond Lake, South Dakota, to improve the size structure of a black crappie population (Galinat et al. 2002, this issue) and into Thunderbird Reservoir, Oklahoma, to improve that of a slowly growing white crappie population (Boxrucker 2002b, this issue). The growth rates and size structure of both crappie populations improved following the introduction of the saugeyes. Boxrucker (2002b) cautioned that consideration must be given to the effects of such biomanipulation on all trophic levels and that thorough evaluations need to be conducted both before and after implementing it.

Spier and Heidinger (2002, this issue) investigated the effects of turbidity on the growth of juvenile and adult black and white crappies. No differences were found in the growth of juveniles, but the weight gain of adult black crappies was higher than that of adult white crappies at low turbidity.

The last paper of this symposium details the effects of electrofishing settings on capture efficiency and injury to black crappies (Dolan et al. 2002, this issue). Although direct current minimized injury and mortality, it has limited applicability in low-conductivity situations. The authors suggest the use of 60-Hz pulsed-DC as an alternative in low-conductivity systems.

The importance of crappies as sport fish ensures that research into their ecology and management will continue. Recruitment dynamics appear to be the focus of current work, with water level manipulation having the potential to significantly impact year-class strength. Refining the timing and duration of high water periods is needed, along with strategies to improve working relations with water management agencies. The expanded use of population models will assist managers in selectively applying harvest regulations. Many crappie populations have a high rate of natural mortality that negates the potential benefits of length limits, even when there is fast growth and high exploitation. Research into the causative mechanisms in populations exhibiting high natural mortality will broaden management alternatives.

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