Evaluation of a Crappie Length Limit on Lake Chicot, Arkansas

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Abstract: Population characteristics for black *Pomoxis nigromaculatus* and white crappies *P. annularis* combined were simulated using a dynamic pool model to determine if the current 254-mm length limit is practical at Lake Chicot, Arkansas. Catch curve regressions were used to estimate annual mortalities, and exploitation was estimated with two consecutive tag reward studies. Exploitation was adjusted for tag loss, tagging mortality, and non-reporting. Average annual mortality was 78% and adjusted exploitation was 17%. The model predicted no significant changes in PSD, RSD-P, RSD-M, or population abundance as a result of removing the length limit. However, the model predicted a significant increase ($P < 0.05$) in the number of crappies harvested and yield if the length limit is removed. The length limit probably has not affected most population characteristics because of low exploitation and high recruitment variability. According to the simulations, removal of the length limit at Lake Chicot would increase angler opportunity to harvest crappies, while maintaining essentially the same size structure and population abundance. A creel survey of crappie anglers would be beneficial to identify angler preferences and measure the level of support for the current length regulations.

Key words: crappies, length limit, Lake Chicot, model

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Fishing for crappies (*Pomoxis* spp.) has traditionally been a spring activity. However, more advanced equipment and technology in recent years has allowed anglers to efficiently harvest crappies year-round. Increased angler pressure has led to a need for more restrictive management of many crappie fisheries (Noble and Jones 1999). Length limits have become common on lakes and reservoirs across the country and are possibly the most widely used tools to influence fish populations (Wilde 1997).

Though population modeling allows *a priori* evaluations of length limits (Johnson 1995), many populations are not modeled prior to length limit implementation. This often forces managers to make post-implementation management decisions, based on post-implementation population characteristics. Inevitably, some lakes with crappie population characteristics that are not suitable for length limits have been selected for such regulations anyway.

Lake Chicot, Arkansas, is a 2024-ha oxbow lake of the Mississippi River with a maximum depth of 9.2 m and a mean depth of 4.2 m. Crappie anglers at Lake Chicot were increasingly more vocal and organized in the early 1990s than they had been historically. Lake Chicot also experienced some hydrological changes that may have altered the traditional fishing grounds and subsequently the catch rates during that time period (J. Smith, Arkansas Game and Fish Commission, pers. commun.). The combination of these events led to implementation of a 254-mm length limit on crappie from Lake Chicot by the Arkansas Game and Fish Commission in 1994.

The length limit was placed on Lake Chicot without estimations of the crappie population characteristics at that time and without the use of a model to predict likely changes due to the length limit. The regulation has been in effect for 10 years, so an evaluation of the current dynamics of the crappie population and the utility of maintaining the regulation are appropriate. The efficacy of the length limit has not been evaluated. The objective of this study was to simulate the characteristics of the Lake Chicot crappie population with and without the current 254-mm length limit.

Methods

Black *(P. nigromaculatus)* and white *(P. annularis)* crappies were collected with trap nets in April 1999 and April 2000 for consecutive one-year tag reward studies to estimate annual exploitation. Each net consisted of two 0.9–1.8 m steel frames with three 0.75-m diameter hoops covered with 13-mm bar mesh attached to a 0.9–15 m lead of 13-mm bar mesh. Fish were tagged between the pterigiophores of the spiny rays of the dorsal fin with fluorescent pink or yellow Floy FD 68B t-bar tags using a Floy Mark II tagging gun (Larson et al. 1991, Maceina et al. 1998). Tags were individually numbered and labeled with the phrase “AGFC REWARD 800-367-3557.”

Tag returns were encouraged through a reward system. Returned tags were each worth US$5, with the exception of fourteen $20 and four $100 randomly designated tags each year. Posters explaining the study, tag-return procedures, and the reward system were displayed at all boat ramps, tackle shops, and many local businesses.

Angler exploitation was estimated as the proportion of tags returned to fish tagged (Ney 1999). Tag returns from crappies that were caught and subsequently released by anglers were excluded from the exploitation estimate. Exploitation was adjusted for tag loss, tagging mortality, and non-reporting (Keefer and Wilson 1993). Tag loss was estimated by double-tagging 10% of crappies tagged for the exploitation study, and was measured as the percentage of crappies reported without double tags that should have been double tagged. Tagging mortality was estimated from a 15-day pilot tagging study. A non-reporting rate of 39.6% was estimated from literature on crappies (Larson et al. 1991, Zale and Bain 1994, Miranda et al. 1997).

Black and white crappies were collected with trap nets during fall 2001 (September to December), 2002 (November to December), and 2003 (October to December) to estimate population characteristics. Total length (mm) was measured for all crappies. Sagittal otoliths were removed from a subsample of fish each year to age crappies. Sub-samples consisted of 10-20 fish per 25-mm length group each year. Otoliths were removed from 279, 104, and 79 crappies in 2001, 2002, and 2003, respectively. Sub-samples represented 22%, 33%, and 24% of all crappies sampled during 2001, 2002, and 2003, respectively. An age-length key was developed each year and applied to crappies that were measured and released that year. Estimates of annual recruitment to age-1 were taken from the trap net data. Catch curve regressions (Ricker 1975) were used to estimate instantaneous annual mortality for each year. Total annual mortalities were derived from instantaneous annual mortalities. Natural mortality was presumed to be the difference between total annual mortality and exploitation (type II fishery, Ricker 1975).

Fishery Analyses and Simulation Tools version 2.0 (Slipke and Maceina 2001) was used to simulate crappie population characteristics with and without a 254-mm length limit. Thirty iterations of the dynamic pool model, with and without the length limit, were run with random, normally-distributed recruitment. Average recruitment was set at 100 fish/ha (SD = 100). Changes in Proportional Stock Density (PSD), Relative Stock Density-Preferred (RSD-P), RSD-Memorable (RSD-M), population abundance, harvest, and yield were evaluated using a nonparametric Wilcoxon rank sum test ($\alpha = 0.05$; Ott 1984) after assessing normality of data using the Shapiro Wilk test (Zar 1999). The PSD was the number of crappies ≥ 200 mm divided by the number of crappies ≥ 130 mm multiplied by 100% (Flickinger et al. 1999). The RSD-P and RSD-M were the number of crappies ≥ 250 mm and ≥ 300 mm, respectively, divided by the number of crappies ≥ 130 mm multiplied by 100%. Stock, quality, preferred, and memorable size designations for crappies are 130 mm, 200 mm, 250 mm, and 300 mm, respectively (Table 21.1; Flickinger et al. 1999). Black and white crappies were combined for this study and evaluated together as one management unit.

Results

There were 565 and 626 crappies tagged in April 1999 and April 2000, respectively. Sixty tags were returned during the first tag reward study. Fourteen of the tags were from fish caught and released. Therefore, exploitation was 8% and exploitation adjusted for non-reporting was 13%. Eighty-three tags were returned from the second tag reward study, but seven of those tags were from fish released after capture. Exploitation from the second study was 12% and exploitation adjusted for non-reporting was 20%. No tag loss was recorded during this study. All fish caught by anglers that were initially double-tagged were returned with double-tags (N = 14). There was no tagging mortality during the pilot study. Therefore, the average adjusted exploitation of the two tag reward studies was 17%.

Average annual recruitment to age-1 (3.1 fish per net night, SD = 3.1) was variable during the three years of trap-netting. Total annual mortalities for 2001, 2002,

Table 1. Simulated output population characteristic means (with standard deviation) for a crappie fishery regulated with a 254-mm length limit or no length limit scenario. The model was run with random, normally distributed recruitment. Average recruitment was 100 fish/ha (SD = 100). Scenarios for a population characteristic in the same row lacking a common letter were significantly different ($P < 0.05$).

	Length limit	No length limit
PSD (%)	50.9 (34.4)^{A}	48.8 (32.7)^{A}
RSD-P (%)	26.0 (27.8)^{A}	19.2 (18.4)^{A}
RSD-M (%)	13.2 (29.7)^{A}	6.4 (18.1)^{A}
Population abundance (fish/ha)	15.2 (15.2)^{A}	14.2 (9.0)^{A}
Harvest (fish/ha)	0.9 (0.4)^{A}	2.4 (1.5)^{B}
Yield (kg/ha)	0.3 (0.1)^{A}	0.5 (0.2)^{B}

and 2003 were 74%, 82%, and 77%, respectively. Therefore, average total annual mortality was 78%. Using the average adjusted exploitation and assuming crappie mortality is additive, natural mortality was estimated to be 61%.

There were no significant differences in PSD, RSD-P, RSD-M, and population abundance as a result of removing the length limit (Table 1). However, there were significant increases ($P < 0.05$) in the number of crappies harvested and yield when the length limit was removed.

Discussion

Fisheries managers often have to make management decisions based on incomplete data or in the absence of data. Similarly, managers do not always have the financial or temporal resources to dedicate to a single fishery. Anglers across the country have become more accustom to management of many fisheries and phrases such as "catch and release" and "trophy slot limit" are common language amongst those anglers. Calls for more intensive management of all sport fishes have strained managers' resources. Historically, it has been common for regulations to be implemented without clear justification (Noble and Jones 1999) or to initially be more restrictive than necessary and subsequently be relaxed.

The Lake Chicot crappie population is characterized by rapid growth, which is a favorable characteristic when considering length limits on a population. However, the population also is experiencing low exploitation, high natural mortality, and high recruitment variability (CV = 100%). Despite rapid growth, fisheries with low exploitation and moderate to high conditional natural morality are unlikely to benefit from length limit regulations (Allen and Miranda 1995). Additionally, Allen and Pine (2000) found that when the coefficient of variation for crappie recruitment exceeds 90%, as it does in Lake Chicot, detectable changes in population abundance or size structure are unlikely, even with appropriately long evaluation periods. Current knowledge of the dynamics of the Lake Chicot crappie population suggests that detectable differences in the population due to the length limit would be difficult to discern.

The Lake Chicot crappie population exhibited characteristics that were less than ideal for length regulations, and the simulations suggested that harvest and yield would increase if the length limit were removed. Colvin (1991) used an equilibrium yield model to assess a 254-mm length regulation for crappies in Missouri reservoirs. He predicted trends in harvest and quantified changes in harvest with creel surveys. Colvin's model predicted a 16% increase in harvest without a length limit. Using data from the four years before and following restrictions, harvest in the James River Arm of Table Rock Lake and Stockton Reservoir declined by 66% and 26%, respectively (Colvin 1991). However, Colvin noted that poor recruitment was likely responsible for differences between model predictions and observations. Maceina et al. (1998) evaluated crappie response to a 254-mm minimum length limit set on Weiss Lake, Alabama, in 1990 with an equilibrium yield model. Their model predicted a 20% increase in harvest with no length limit. Our model predicts harvest would more than double without a length limit on Lake Chicot.

Yield will increase 67% if the length limit is removed when the model reaches equilibrium. Once the model reaches equilibrium, yield will remain the same every year thereafter. Equilibrium takes six years to reach in our model because we inputted six age-classes of crappies. Hale et al. (1999) observed yield decrease in an Ohio reservoir after a length limit implementation. Decrease in yield was attributed to slow growth and high conditional natural mortality. Though growth is high at Lake Chicot, conditional natural mortality is excessively high. Alternatively, Webb and Ott (1991) observed increases in yield at three Texas reservoirs after implementation of a length limit. They concluded that a length limit would increase yield because of low conditional natural mortality at this reservoir.

Management Implications

From a biological perspective, managers should consider removing unnecessary harvest regulations on crappie fisheries. Length limits are not equally effective on all crappie fisheries. There are a variety of population characteristics that should be considered when addressing length limit implementation or removal. Lake Chicot's regulation scenario described here is not unique, and most likely occurs regularly in lakes and reservoirs across the country. Managers should frequently review crappie length regulations and adjust them as needed for the benefit of anglers.

A creel survey conducted on Lake Chicot to determine crappie angler preferences and support for the existing length limit would be useful. If anglers prefer to catch higher numbers of smaller crappies, then our data suggest the length limit should be removed. The simulations suggest that size structure will not be negatively affected by length limit removal, though average weight will most likely decrease. Anglers preferring to catch lower numbers of heavier crappies would most likely be in favor of the length limit. However, anglers should be made aware that, regardless of whether the length limit is removed, the number of crappies in the population is not being affected by the limit.

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