Dynamics of White Crappie Exploitation in an Oklahoma Tailwater Fishery

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We conducted a tagging study of white crappie (*Pomoxis annularis)* to evaluate the exploitation dynamics and environmental variables influencing angler exploitation rates in the Kaw Dam tailwater in north-central Oklahoma. The relationships among the exploitation rates and concurrent water quality measurements and weather data were determined by multiple regression analyses. White crappie exploitation was positively correlated with discharge and photoperiod, with discharge being the most important environmental variable in the model. Because high discharges promoted the immigration of white crappie into tailwaters, the results of our tagging study suggest that extremely high discharges also promoted emigration downriver of at least a few of these individuals. We suggest that variations in discharge can be used to anticipate changes in the recreational use of warmwater tailwater fisheries.

INTRODUCTION

Warmwater tailwaters are popular for recreational angling, primarily because of their ease of access (*1*,*2*), high catch rates (*3*), and the availability and variety of fish residing therein (*1*,*2*,*4*). Dams often block the upstream migration of fish, thereby concentrating the fish and creating large and varied sport fisheries (*5*-*7*). Fish are also carried over dams during periods of high discharge, further increasing angling opportunities in the tailwaters (*2*,*8*,*9*). White crappie (*Pomoxis annularis)* is an important sport species in many tailwaters (*5*,*10*,*11*) because the fish are highly susceptible to entrainment during periods of high discharge (*8*,*11*,*12*).

Angling success is directly related to the presence and behavior of both the anglers and the fish, which are in turn influenced primarily by variations in the climate and the environment (*13*). Discharge is one of the primary environmental factors affecting the angler's use of tailwater fisheries (*14*,*15*). However, efforts to manage warmwater tailwater fisheries are impractical and often impossible because the quantity, quality, and timing of releases is dependent on fluctuating weather patterns and downstream flow requirements. Nevertheless, developing a deeper understanding of the impacts of water releases on tailwater fisheries would give the managers of fisheries and the project managers of flood control reservoirs the ability to anticipate and minimize any detrimental effects.

We conducted a fish tagging and concurrent environmental monitoring study to better define effects of various environmental factors on exploitation of white crappie in an Oklahoma reservoir tailwater fishery. This information provides guidance for more effectively managing these fisheries.

METHODS

Study Area: Kaw Reservoir is located on the Arkansas River in northcentral Oklahoma about 13 km east of Ponca City. Kaw Reservoir was authorized as part of the Flood Control Act of 1962 and was impounded in 1976. In addition to providing flood control, it is a component of the system of upstream reservoirs that maintains adequate flows for the

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Proc. Okla. Acad. Sci. 1998;**78:**35-40

Arkansas River navigational system. It also provides water for municipal and industrial uses in northcentral Oklahoma and is used intensively for recreation, including angling. The drainage area of Kaw Reservoir is about 18,850 km^2. Maximum water depths near the dam range from 17 to 26 m and stratification usually occurs from June through September with a thermocline at depths of 13 to 17 m.

The tailwater below the dam is accessible to both bank and boat anglers, although boat angling is severely curtailed during low-discharge periods. Accessibility extends from the dam along both banks to about 1.5 km downstream. Kaw Dam has a maximum recorded discharge capacity of 1200 m^3/s. During the course of this study, fluctuations in discharge resulted from a combination of weather and downstream water requirements. Sport fishes present in the tailwater included white crappie, white bass *(Morone chrysops),* striped bass (*M. saxatilis),* walleye *(Stizostedion vitreum),* channel catfish *(Ictalurus punctatus),* and flathead catfish *(Pylodictis olivaris).*

White Crappie Exploitation Investigation: Exploitation rates of white crappie in the Kaw Reservoir tailwater were estimated by a tag-return study in 1988. Netting and tagging was conducted from February through May; four trap nets, fished for 24 h two to three times per week, were used to capture these fish. Individuals captured in each net were counted, and those with total length >200 mm were marked with a numbered anchor tag and released. Handling crappie at temperatures >15 °C causes high mortality (*16*); therefore, tagging was discontinued after 7 May 1988 when the water temperature reached 15 °C. Trap netting was continued, however, until 21 June 1988 when low water levels made sampling in the tailwater impossible.

Signs detailing the tagging effort were posted in the tailwater area to familiarize anglers with the study and encourage them to return the tags. Tag check stations were set up at two local bait stores and at the Oklahoma Department of Wildlife Conservation's Northcentral Regional Office. Customized, limited edition, reward caps were provided to anglers as an incentive to return the tags.

Monitoring of Environmental Variables: Daily discharge rates (m^3/s) from Kaw Dam were provided by the U.S. Army Corps of Engineers office at Kaw Reservoir. Dissolved oxygen concentration (mg/L) and water temperature (Celsius) were monitored two to three times per week using a Hydrolab Surveyor II electronic sensor meter. SUNRISE, a software program written to determine the times of sunrises and sunsets, was used to calculate photoperiod (h) (*17*).

Analyses: We determined exploitation rates of white crappie using two methods: (a) by dividing the number of tags that were returned by anglers during the entire study by the total number of white crappie tagged; and (b) by calendar weeks, expressed as number of tags returned by anglers divided by number of tagged white crappie still at large.

Unreported tags, lost tags, and mortality induced by tags can adversely influence estimates of exploitation rates. Zale and Bain (*18*) found non-reporting of tags to be 33% when reward hats were given. Stubbs (*19*) estimated a tag loss rate of 1. 1% per month, and a tagging mortality rate of 4.8% per month for Oklahoma white crappie. These values were used to adjust exploitation estimates for our study.

Discharge was expressed as a mean of the seven daily mean discharges for each calendar week (seven-day interval). Dissolved oxygen and water temperature were expressed as a mean of those values collected for each calendar week and photoperiod was expressed as a daily mean for each calendar week. Multiple-regression procedures (*20,21*) were used to generate a model to determine the degree of association between white crappie exploitation rates and environmental variables. The lowest mean-square error value was used as the criterion for choosing the best model (*20*). Standardized partial regression coefficients were used to determine importance of environmental variables (*20,21*). Residual analysis was performed on each model to test for normality, linearity, and homogeneity of variance. The model was also tested for multicollinear-

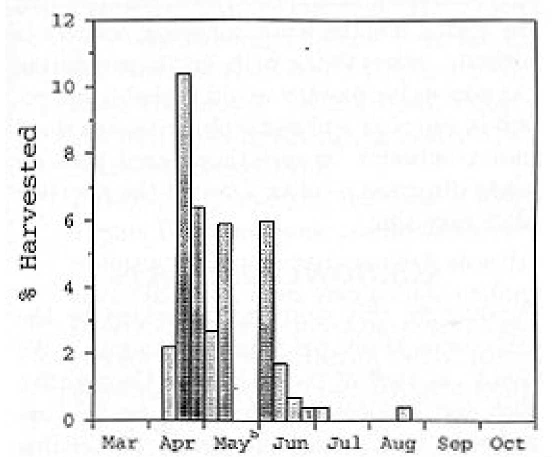

Figure 1. Weekly tag return rates[a] for white crappie in the tailwater of the Arkansas River below Kaw Dam, Oklahoma, March-October 1988.

[a] Number of tags returned each week by anglers divided by number of tagged white crappie still at large. [b] The tailwater was closed to angling during the last two weeks in May.

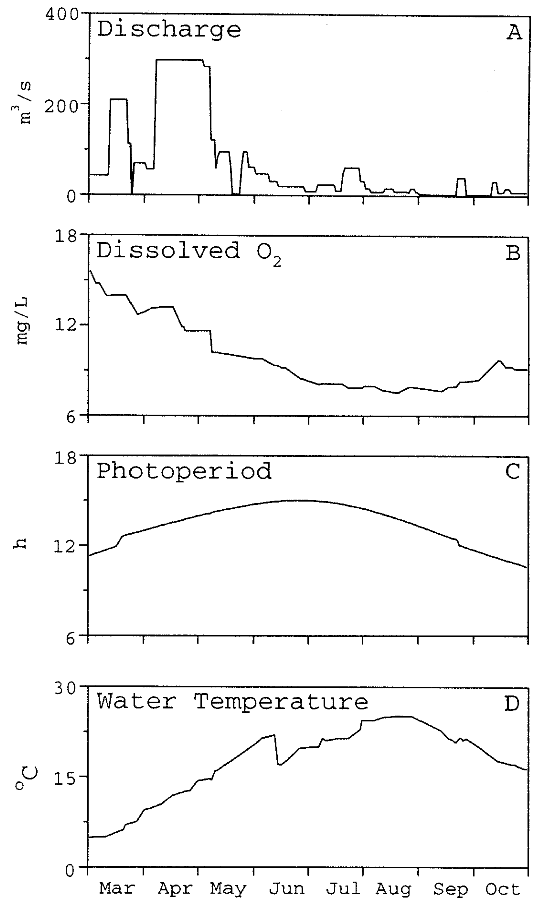

Figure 2. Trends in daily discharge (A), dissolved oxygen (B), photoperiod (C), and water temperature (D) for the tailwater of the Arkansas River below Kaw Dam, Oklahoma, March–October 1988.

ity (*20,21*). Because the results of the residual analysis indicated that the variance was not homogenous for the model, the data were transformed from H, the percent harvested, to Y, with $Y = \log_{10}(H + 1)$. Statistical significance was set at $P = 0.05$.

RESULTS

White Crappie Tagging: A total of 686 white crappie were tagged, with assumed tag loss and tagging mortality likely leaving an estimated 603 tagged individuals available to anglers. After correcting for the estimated tag non-reporting, 157 of those individuals available to anglers were harvested, indicating a minimum exploitation rate of 26%. White crappie exploitation rates increased during April and, except for the last two weeks in May when the tailwater was closed to angling, remained relatively high during May and into June. The exploitation rate then declined during the latter part of June and remained depressed throughout the remainder of the study (Fig. 1)

Environmental Variables Trends: The discharge rates were highest during March and April, declined during May, and remained low throughout the remainder of the study (Fig. 2). Dissolved oxygen trends steadily declined through July, remained fairly constant during August and September, and then increased slightly during October. The photoperiod steadily increased through July and then steadily declined throughout the remainder of the study. Water temperature trends were similar, with peak temperatures occurring in August.

The multiple-regression model that best described white crappie harvest was

$$Y = -1.0071 + 0.0021\,(DS) + 0.0785(PP)$$

where $Y = \log_{10}(H + 1)$, H is the percent harvested, DS is the mean of the seven daily mean discharges for each calendar week, and

PP is the daily mean photoperiod for each calendar week. The model was significant ($P = 0.0001$) and accounted for 52% of the observed variance. White crappie exploitation was positively correlated with discharge and photoperiod. Standardized partial regression coefficients indicated that discharge was the variable that best described the white crappie harvest.

DISCUSSION

The estimated exploitation rate of 26% for white crappie in the Kaw Reservoir tailwater indicated that only a small percentage of white crappie were taken by anglers in the Kaw Reservoir tailwaters. These trends indicated that white crappie exploitation was low or nil after June. Tag-returns indicated that almost all of the tagged white crappie that were returned were caught within 200-300 m of where they were released after being tagged. However, one individual was caught during April, about 2 km from its release site, and two individuals were caught during June, about 4 km from their release sites. These three individuals were all tagged during April when dam discharges were at their highest.

White crappie typically prefer the low-velocity areas of rivers (*22*). High discharges seem to have caused downriver migration of a sizeable percentage of tagged individuals. Angling pressure is more intense in the tailwater area directly below the dam than it is downriver, thereby decreasing the likelihood that tagged individuals would be caught once they moved out of the vicinity of the dam. As discharges decreased, white crappie immigrating into the tailwater were probably less likely to move downriver. Exploitation of these individuals may have approached 100% since few tags were returned after June. Although those white crappie flushed out of the tailwater area may have migrated downriver to Keystone Reservoir, it is also possible that these individuals sought refuge in pools and backwater areas along the river.

Angling success can be enhanced as discharges increase (*23,24*), and in our study, discharge was the most important environmental variable affecting the white crappie harvest; low discharges proved detrimental to exploitation rates for white crappie. However, this relationship was in part due to the absence of crappie in the tailwater during the late summer and autumn months when discharges were low.

Effects of climate on the exploitation of white crappie are not well documented. The model indicated that white crappie exploitation increased as days became longer, probably because anglers spent more time angling.

Although high discharges may promote the migration of white crappie downriver, they also promote the entrainment of white crappie into the tailwater of Kaw Lake. This suggests that high discharges might be a useful management tool for maintaining white crappie fisheries in tailwaters. However, these discharges are not feasible at all times because of downstream flow requirements and fluctuating weather patterns, especially on flood control reservoirs. Our data also suggest that white crappie fisheries are highly seasonal in nature, presumably because white crappie are only entrained and carried over dams during the spring months when spawning activity is highest. Maintaining high discharges during the non-spring months would probably not result in reservoir white crappie being entrained into a tailwater because they would have already dispersed to other areas of the reservoir after spawning.

ACKNOWLEDGMENTS

Funding for this study was provided by the Oklahoma Municipal Power Authority. We thank the staff of the Oklahoma Cooperative Fish and Wildlife Research Unit for field assistance, Oklahoma Department of Wildlife Conservation fisheries personnel for collecting many of the tag returns, and B. O. Bolton, J. C. Boxrucker, D. E. Hicks, J. R. Jackson, R. W. Luebke, C. McDowell, H. E. Namminga, T. L. Warren, W. Van Winkle, and two anonymous reviewers for reviewing this manuscript.

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Received: 1997 Aug 30; Accepted: 1998 Feb 17.