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Recommended Citation

Becker, David A.. 1971. Impoundment Effects on Water Quality as Reflected in Parasitism of Reservoir Basses. Arkansas Water Resources Center, Fayetteville, AR. PUB051. 14

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PUB-051

Impoundment Effects On Water Quality As Reflected In Parasitism Of Reservoir Basses

by
DAVID A. BECKER



WATER RESOURCES RESEARCH CENTER

Technical Completion Report

Project A-009-Ark.

University of Arkansas

Fayetteville

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IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN
PARASITISM OF RESERVOIR BASSES

WATER RESOURCES RESEARCH CENTER
UNIVERSITY OF ARKANSAS
A-009-ARK PROJECT COMPLETION REPORT

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Project Completion Report

Project No.: A-009-ARK

Agreement No.: 14-31-0001-3004

Starting Date: July 1967

Completion Date: June, 1970

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ACKNOWLEDGEMENT

The work upon which this report is based was supported in part with funds provided by the Office of Water Resources Research, U.S. Department of the Interior, under Grant Number A-009-ARK as authorized under the Water Resources Research Act of 1964, P.L. 88-379 as amended by P.L. 89-404.

INTRODUCTION

Our aquatic environments are rapidly becoming useless as natural resources through pollution from various sources. It is therefore necessary for us to further understand the various means which relate to this process. The interrelationships between the physico-chemical and biological water qualities undergo marked changes during the ageing of a reservoir. Eutrophication of these impoundments render them relatively useless as natural resources. It thus becomes apparent that we must gain further knowledge of these processes if we are to devise methods for proper reservoir management.

It is postulated that impoundment effects on water quality may be reflected in the parasitism of reservoir basses. Physico-chemical changes in water quality have diverse effects on the aquatic flora and fauna. Conversely, the quality of reservoir water may be affected by the organisms that reside within it.

Parasites, their intermediate hosts, and the fish hosts are indicators of biological water qualities which are very important integrated parts of the food web of a reservoir. The intricate interrelationships of these biological water qualities with the physico-chemical ones must be fully understood if we are to maintain reservoirs as useful natural resources.

In a newly impounded reservoir, fishing success declines after the first five to seven years (Izyumova, 1959). This decline is primarily in sports fishes and is known to continue to decline with age in many

reservoirs (Jenkins, 1958). As sport fishing is a multi-million dollar industry in this country, it is of economic importance that its success be continually cultivated. Certain parasites apparently affect the condition factor, K ("plumpness"), of black basses (Drach, 1970). In addition, fishermen hesitate to fish where their catches are "grubby" or "wormy". It is therefore necessary for us to comprehend the various cause and effect relationships so intimately associated with these biological conditions of water quality.

The evidence of the above remarks indicates that this investigation would reveal certain aspects concerned with the ageing of a reservoir which have implications relating to fisheries biology, reservoir management, recreation, pollution, and economics.

Since 1962, the principal investigator has been funded by various state and federal agencies to perform pre- and postimpoundment studies of the helminth and crustacean parasites of black basses in Beaver Reservoir in northwestern Arkansas. This eight-year, uninterrupted investigation is still in progress, and the actual collection of fishes continued through the summer of 1969.

OBJECTIVE, RESULTS, AND DISCUSSION

Objective 1. The first objective of this study was a qualitative and quantitative pre- and postimpoundment survey of the helminth and crustacean parasites of the black basses, Micropterus dolomieu Lacepede, M. punctulatus (Rafinesque), and M. salmoides (Lacepede).

The fluctuations in per cent infection of each parasite in each fish host were studied and compared on an annual basis. General trends in the development of the ichthyoparasite fauna in this newly impounded

reservoir were compared with previous studies made in other reservoirs. It is interesting to note the comparative findings of the postimpoundment studies with those of Russian investigators: Bauer, 1954; Dogiel, Petrushevski, and Polyanski, 1958; Izyumova, 1959; Kosheva, 1959; and Prost, 1964.

This objective was met through Master of Science theses by Holmes (1964), Heard (1965), Evans (1968), Owen (1969), and Norman (1971). The latter three theses were funded by project number A-009-ARK, and were submitted to the OWRR. The preimpoundment survey was published by Becker, Heard, and Holmes (1966).

In a newly impounded reservoir, the fluctuations that occur in per cent infection of a particular parasite depend to a great extent upon the life cycle of the parasite. Those parasites with a direct life cycle (monogenetic trematodes, copepods, and leeches) find favorable conditions in the reduced flow rate and turbidity of the water resulting from impoundment. In general these parasites increase in incidence of infection following impoundment. Parasites which develop with a change of hosts (digenetic trematodes, cestodes, acanthocephalans, and nematodes) generally undergo an abrupt reduction in numbers during the first years of existence of the reservoir. This is explained by the fact that connections are broken between the intermediate and definitive hosts. The population of intermediate hosts (snails, amphipods, mussels, ostracods, and copepods) develop slowly while the fish population develops rapidly over the entire reservoir after impoundment. In later years with the adaptation of the intermediate hosts in the reservoir, the host-parasite relationships are re-established and the

incidence of these parasites may increase. The increase in population of piscivorous birds which serve as the definitive hosts for many of the digenetic trematodes is a factor that contributes to the increasing development of these forms. Changes in the ichthyofauna, associated with the suppression and extinction of some species and increased development in others, is also a factor in the development of a fish parasitofauna in a new reservoir.

The data obtained from this study show that some of the parasites have adjusted to the new environment of the reservoir, some are in the process of adjustment, and others seem to have become extinct or extremely rare in Beaver Reservoir.

The above results and conclusions are based on preimpoundment studies over a two-year period, and an early postimpoundment study spanning a four-year period. The parasites from fish hosts collected in 1968 and 1969 remain to be identified. It will take a graduate student at least two years to perform this task.

Objective 2. The second objective was to determine the effect of the intensity of infection on the condition factor ("plumpness") of each host, the possibility of parasite preference of host species and sex, and the relationship between the average number of parasites and the age of the host. This objective was accomplished by Drach (1970). This study encompassed the two preimpoundment years and the first three years of postimpoundment. This work was funded by project number A-009-ARK, and the thesis submitted to the OWRR.

It was found that the parasite fluctuations from year to year in general followed the outline as described above. However, it was

noted that the lack of intermediate host availability could not account for all fluctuations following impoundment. The average number of parasites per infected fish was found to fluctuate much less than the per cent infection.

An attempt was made to determine if the per cent of infection increased with length, as length was assumed to be a valid indication of age. The per cent infections increased with the length of the fish indicating that the majority of parasites relied mainly on exposure time of the host. Two parasites (the monogenetic trematode Clavunculus bursatus and the acanthocephalan Neoechinorhynchus cylindratum) decreased in per cent infection in both hosts as the hosts aged. This indicates that the parasites are either causing the death of the host or that the host is avoiding new infections either by physiological or behavioral means. The decrease in C. bursatus is correlated with an increase in another monogenetic trematode Urocleidus principalis. Since both of these parasites are found in the same niche on the host it was speculated that the fluctuations in these parasites may be due to intraspecific competition. The copepod Ergasilus caeruleus was found to increase in Micropterus salmoides but not in M. punctulatus.

Eight species of parasites were selected because of their abundance and/or pathogenicity. Comparisons were made for each of these parasites to determine any fluctuation in the average number of parasites per infected fish as the fish aged. The degree of parasitism remained steady for the bass tapeworm Proteocephalus ambloplitis (both plerocercoid larva and adult), the acanthocephalan Neoechinorhynchus cylindratum, the nematode Spinitectus carolini, and the leech

Illinobdella moorei. The relative consistence in the degree of infections of these parasites led to the speculation that there is a definite limit above which the host cannot support any more parasites or that there is a rather definite level of infection that is lethal to the host. The monogenetic trematode Urocleidus furcatus and the digenetic trematode Posthodiplostomum minimum indicated a steady increase in the degree of infection as the host grew older. This increases the confusion as to the pathogenicity of these species.

The effect of the intensity of infection on the condition factor of each host was determined for the same eight species of parasites. A definite lower weight was noted only in heavy infections of Neoechinorhynchus cylindratum in Micropterus punctulatus and M. salmoides, and Ergasilus caeruleus in M. salmoides.

Differences in species and sex composition of hosts was not believed to be influenced by parasitism. It was speculated that Ergasilus caeruleus presents the most immediate threat. It was also noted that the reoccurrence of Neoechinorhynchus cylindratum, Posthodiplostomum minimum, Achtheres micropteri, and Spinitectus carolini may be a future threat to the basses.

Plans are in progress to complete the postimpoundment investigations begun by Drach (1970) so that they will span the two-year pre-impoundment and the six-year postimpoundment periods.

Objective 3. This objective was an attempt to correlate the results of the postimpoundment survey with the preimpoundment survey in an effort to identify and relate those physico-chemical changes in water quality which appear to affect directly or indirectly the food web which includes the parasites of basses and their hosts.

The investigations pertaining to this objective are currently in progress. In 1970, a proposal by the principal investigator to continue this objective was submitted to the Water Resources Research Center at the University of Arkansas under the Annual Allotment Program, but was not funded. Instead, the principal investigator was awarded a new grant (A-013-ARK). The objectives of this new grant will allow objective 3 above to be completed, as comparisons will be made between Beaver Reservoir (a relatively new impoundment) and an old impoundment, Lake Fort Smith, Arkansas. The new grant period is from July 1, 1970 through June 30, 1973.

In conjunction with objective 3 above, Norman (1971) made a qualitative and quantitative survey of the helminth and crustacean parasites of black basses at three selected sites at the lower end of Beaver Reservoir. These sites were monitored during the first four years of impoundment, and this investigation was preliminary to objective 3 above, so that tentative partial indications may be made concerning the relationships of physico-chemical environmental factors with the parasites of black basses. The values for the physico-chemical parameters of temperature, conductance, dissolved oxygen, transparency, hydrogen ion concentration, calcium hardness, and total hardness at the selected sites were obtained from the U. S. Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, South Central Reservoir Investigations, Fayetteville, Arkansas (personal communication). The dates of these physico-chemical values correspond as nearly as possible to the collection dates of the hosts.

Due to the preponderance of these data which were intensively collected over an eight-year period, more time is necessary for

computer analyses, so that intelligent and valid conclusions may be drawn. However, the pilot study instigated by Norman (1971) allowed the principal investigator to realize that certain tentative correlations concerning parasitism and physico-chemical data can be made. The results of this pilot study revealed that there was generally a significant positive correlation at the 0.01 level ($r = 0.75$, d. f. = 34) between water temperature and per cent infection with monogenetic trematodes. The temperature range of 82-83 F generally resulted in the highest incidences of parasitism with monogenetic trematodes. However, it should be noted that at temperatures above 82 F, 50-100% of the fishes were infected with monogenetic trematodes. The pathogenicity of monogenetic trematodes is well documented, with high incidences causing death of the hosts.

It is impossible at this time to make any other preliminary correlations. The data will be analyzed in the near future by multiple regression analysis in order to elicit the interrelationships between the incidence of infection and the physico-chemical parameters. This will be accomplished and the results published in conjunction with project A-013-ARK now in progress.

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