NEEDS FOR BASIC RESEARCH IN LIMNOLOGY AND FISHERY BIOLOGY IN OKLAHOMA

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Twenty years ago the total surface area of the lakes in Oklahoma was less than 10,000 acres. At that time 79 small reservoirs had been built by municipal governments for city water supplies, or by the federal government for water conservation and wildlife use. Between 1930 and 1940, 92 more lakes were built. In the past ten years the rate of lake construction has declined, but the size of new impoundments has increased tremendously, due chiefly to the efforts of the U. S. Army Corps of Engineers. Before the construction of our many impoundments, fishing, duck hunting, and other forms of aquatic recreation were relatively unimportant and chiefly confined to the streams of eastern Oklahoma and the larger rivers of the central part of the state.

Early aquatic research in Oklahoma was confined chiefly to surveys of the distribution of fishes and other aquatic animals. There was little demand for aquatic biologists. Educational institutions were still growing and just beginning to realize their research obligations. Biological research had not progressed sufficiently to emphasize investigations of Oklahoma waters.

The above situation has decidedly improved. At the present time Oklahoma has approximately 225 lakes and 100,000 farm ponds with a total surface area of more than 300,000 acres. This acreage is proposed to be doubled within the next ten years.

Sport fishing is now one of the most important sources of recreation in the state; more than that, it has become an industry to the state. There is an ever increasing demand for commercial fishing in Oklahoma. More and more people are enjoying swimming, boating, and general outing due to our newly created lakes. All this has created a justifiable demand for practical aquatic research. Furthermore, Oklahoma's educational system has been vastly improved. Its colleges and universities are undertaking all types of scientific research. In this program aquatic research must not be neglected.

Oklahoma presents a great opportunity to contribute valuable information to a new field of scientific investigation, the aquatic biology of man-made lakes. Nearly 100 per cent of Oklahoma's lakes are man-made. The aquatic biology of such lakes is practically unknown. Careful extensive and intensive research can answer many important questions both academic and practical. It is the purpose of this paper to indicate research needs that might stimulate and guide researchers along the most vital paths. Much valuable research has already been done, and is being done at the present time. Such workers as W. H. Irwin and J. G. Mackin have pioneered limnological research in Oklahoma and the value of their work should not be slighted. The same must be said of the fishery research of A. D. Aldrich, George A. Moore, W. H. Thompson, and A. O. Weese.

LIMNOLOGY. The value of limnological research and the information that it provides has been recently emphasized in those states where aquatic research has been in progress for many years. It is basic research, vital to the understanding of more practical problems. Since, in a sense, we are just beginning such a research program in Oklahoma, we should turn our first efforts toward extensive limnological research. There is a definite need for a classification of all Oklahoma lakes. Once these lakes are classified, the classification could be kept up to date as new reservoirs are constructed and as the present ones mature. Classification of our lakes should be considered from three basic standpoints: the physical, chemical, and biological features. In making such a classification, it must be kept in mind that all of these categories are definitely interrelated.

The morphometry of a lake and the topography of its drainage area can most simply be shown by a good map. Such a map should not only show the outline of the lake, its depth, directional orientation, the topographical features and geology of its drainage area, and other such basic features, but also bottom types, aquatic vegetation, inundated standing timber and stump fields, shore vegetation, water fluctuation levels, and industrial plants, mines, and other possible sources of pollution. Preparation of such maps would be expensive and would take several years; however, the problem of obtaining these maps is not as serious in Oklahoma as in other states since outline maps are already in existence for most lakes. Such outline maps were necessary for proper lake construction. Well trained field crews could add the necessary additional information to the maps within a few hours. These maps would then be available for aquatic biologists, wildlife experts, etc., and could also be distributed by the Game and Fish Department to the general public at a small charge. Supplemental up-to-date information regarding the physical, chemical, and biological features of the lake themselves should accompany the maps.

Temperature and turbidity are two important factors of Oklahoma lakes which are worthy of consideration in lake classification. The water of our lakes varies from very clear to very turbid. In any given lake the turbidity is variable from season to season, and from year to year; however, it appears possible in most cases to classify a lake according to its relative turbidity.

The temperature of a lake should be considered from the standpoints of seasonal range and thermal stratification. Many factors influence the lake temperature—size, depth, source of water, rain, turbidity, orientation with prevailing winds, latitude, solar radiation, etc. Recent investigations have failed to indicate thermal stratification in many of the larger, deeper Oklahoma lakes where such stratification was expected. At the same time, contrary to expectation, thermal stratification has been found in many small lakes.

Chemical classification might be based on dissolved nutrients, alkalinity, and dissolved gases. Again it should be realized that all of these features fluctuate throughout the year and definitely change as a lake matures;

neverthless, a basic classification could be made. Moyle (4) states that in Minnesota total alkalinity and total phosphorus appear to be the most valuable indices to lake productivity. This might also be true of Oklahoma. In addition to phosphorus, nitrogen, sulfates, chlorides, and other nutrients should be studied.

The biological features of a lake are perhaps subject to greater and more frequent change than any of the others. Nevertheless, it is possible to classify lakes according to the quality and quantity of plankton, vegetation, bottom fauna, and certain other groups of animals which may or may not be present. A thorough knowledge of the existing organisms would not only indicate what is present, but would suggest habitat improvement and stocking policies.

Maps of Oklahoma lakes supplemented by information mentioned above would in many cases be of value only for a short time unless supplements were issued based on periodical re-examinations of the lakes. Extensive investigations of this sort have been made in many other states and are proving of great value to the scientists as well as the laymen. Furthermore, such an extensive study of Oklahoma lakes would greatly facilitate the intensive studies which are so vitally needed. We do not mean to imply that no intensive research need be done until the state is studied extensively. Many phases of intensive studies have already been completed and others are in progress at the present time. Nevertheless, these studies would have been greatly simplified had the information divulged by extensive research been available. For example, if an intensive study of turbidity, plankton cycles, or seasonal variations in bottom fauna is to be undertaken, reference to data provided by extensive studies could indicate the best bodies of water in which to work. Also, if an intensive study is to be made of any given body of water, the existing formation provided by the previous extensive study would expedite such research. After intensive study is made of any lake, reference to extensive studies might indicate other lakes that are sufficiently similar for application of the data procured.

An outline for a coordinated program of intensive limnological research would be closely similar to the outline of the extensive program discussed above. Intensive research, however, should be confined to one or a few bodies of water rather than being statewide. It should engross frequent (weekly), regular observations throughout the year. It should involve more chemical, physical, and biological factors than extensive research.

The study of these factors would be designed to pry into the dynamics of the freshwater environment in Oklahoma. A rather general program must be conducted first to provide a fuller appreciation of the relationship of the environmental factors for it is felt that these factors, although present in other parts of the country, are to be found in different combinations in Oklahoma. Once these general relationships are realized, specialized phases of related study may be undertaken.

Enough limnological information on Oklahoma waters is at hand to suggest a few of the more important specific problems awaiting investigation. These problems may have greatest value when undertaken as a part of a coordinated program of limnological research on a given body of water, but nevertheless, would have definite value when contributed as an individual study. Turbidity is perhaps one of our most important physical factors in aquatic environments of Oklahoma. Knowledge of the direct and indirect effects of turbidity on members of a food chain or any aquatic organism would be a valuable contribution. The relationship of the fertility of the drainage basin to the fertility of the lake; the life history and population trends of any aquatic invertebrates; the effect of high temperature on the aquatic flora and fauna; the factors affecting the distribution of aquatic vegetation in our lakes and streams; the rate of decomposition of bottom deposits; the nutrient cycle in a lake; the effects of water level fluctuations on plankton, vegetation, bottom

fauna, etc. are all problems of immediate interest and value. In short, limnological research may be conducted on practically any phase of study selected with valuable results. Research opportunities are abundant. The need is vital.

FISHERY BIOLOGY. The excellent fishing which has accompanied the creation of many of our Oklahoma impoundments has brought demand for fishery research. Considerable research has already been done, much of which has been of great value. Unfortunately, however, the emphasis has been upon practical research. Such research furnishes the answers to many problems, especially where the question is "what." Practical research rarely answers the question "why." Furthermore, most practical research is based on pure research which has preceded it. By neglecting basic research, we limit practical research.

Toward the end of the last century and in the beginning of the present century, several surveys were made of the fish fauna of Oklahoma and the surrounding states. This work has continued in more recent times by Hubbs and Ortenburger (1,2,5) and is being carried on at the present time by Dr. George A. Moore of Oklahoma A & M College. Dr. Moore is the first to admit that the study of the distribution of Oklahoma fishes has just begun. Basic research on fish distribution is of vital importance. It should be understood that the natural distribution of fishes is now almost impossible to determine. Many species have been introduced into areas where they did not naturally occur and many species have been lost to the fauna of a given region due to the changes brought about by man. Much of the knowledge that we have of the distribution of endemic species can be gained from the published works of early investigators. However, this was often incomplete and many errors were made due to erroneous identifications and failure to separate closely related species. A knowledge of the early distribution of the fishes of a given region is chiefly of academic interest, but is also of value in predicting the possible success of introduced species, and in noting faunal changes brought about by pollution, erosion, impounding, etc.

Perhaps the most vital research needed in the field of fishery biology in Oklahoma is the intensive study of fish life histories. There have been many such studies made of the important game fishes of other areas. These should be repeated in Oklahoma. In addition, we need to study carefully the life histories of the fishes of possible commercial importance, forage fishes, and the so-called "obnoxious" fishes—in other words, an intensive study of all the fishes present in the fauna of the area.

At the present time considerable work is being done on the age and growth of Oklahoma fish. Again, however, this research is too closely confined to the more well-known game species. Little is known about the ages and rates of growth of our coarse and forage fishes. Only meager knowledge exists on the spawning habits, the migration and movements, the good habits, and the intra-specific relationships of any of our fresh water fishes. At what time of year do such fishes as the large mouth and spotted black bass, the white bass, the black and white crappie, the flathead, blue, and channel catfish spawn in Oklahoma? At what age and/or size do they reach sexual maturity? How long do they live? What is the maximum size attained? These questions can be easily answered for many groups of individuals of these species raised in our hatcheries. Whether or not the situation is the same in our larger ponds and reservoirs remains to be seen.

The food and feeding habits of fishes need intensive study here in Oklahoma. This should be done on a year-round basis and for a period of several years. Furthermore, stomach analyses should be made with fresh material rather than preserved. How much food (by weight, volume, and calories) does a fish require daily to grow properly and develop? Which of the food organisms are most efficiently converted into the greatest amount of fish flesh?

Do fish directly derive nourishment from dissolved nutrients? Investigation on comparative rates of digestion of different foods, for different species of fish, for different water temperatures need to be made. An intensive study of the life history of any species of Oklahoma fish would at least partially answer most of the questions listed above regarding that species.

The information which exists regarding the life history of the goldeye, *Amphiodon alosoides*, is a good example of the meager knowledge of the life histories of Oklahoma fish. Until recently, this species was relatively unknown in Oklahoma. It was not officially described as a part of our fauna until 1948 (6). It is one of the most abundant species in Lake Texoma and is rapidly increasing its numbers in many other lakes. We do not know where the fish spawns, when it spawns, or where the young live, and we know little of its longevity or the rate of growth. Males and females have been taken ranging in size from about 7 to 14 inches, and we have never seen a ripe male. At the same time, gravid females in a near ripe condition have been taken almost throughout the year. Food habits of these fish are little known. We know that it is primarily carnivorous, but does it feed on black bass, crappie, etc., and in so doing deplete their populations? Perhaps it is a valuable source of food for our game fishes. This also is undetermined at the present time. We could list many species whose habits are equally unknown.

The effects on the fish fauna of physical and chemical environmental factors such as turbidity, fluctuation in water level, dissolved gases, temperature, morphometric features, etc., are little known in Oklahoma. The possibilities of using water level fluctuations as a tool of fishery management are great; however, a careful study must be made before it can be put to good use. Certain undesirable fish might be partially eradicated by well-timed drawdowns or rises in water level. With inadequate information, however, such controlled fluctuations might do more harm than good by destroying some game fish.

The need for anatomical, embryological, and physiological research in the field of ichthyology must not be omitted. If we knew more about these aspects of ichthyology, many of the habits of fishes could be quickly and easily explained. Moore and McDougal (3) in their study of the retina of the goldeye show that due to the structure of the retina, the fish should be quite sensitive to intense light, and the eyes should function most efficiently during the twilight hours. This contributes appreciably to the explanation of the fact that the goldeye is rarely taken near the surface during the day, but is very commonly taken there in the evening, at night, and in the early morning. Successful daytime collections of goldeye are almost invariably made in deep water where comparatively small amounts of light penetrate.

The work of E. B. Powers and colleagues on the physiology of fishes exemplifies the importance of physiological research in explaining the habits of fishes. The migration of salmon, one of the most interesting and baffling problems of fishery biology, has been chiefly explained by physiological research.

The number of basic research possibilities in limnology and fishery biology in Oklahoma is unlimited. At the present time there is a vital need for such research and this need will increase as more lakes are built and as more practical problems arise.

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