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INVESTIGATIONS OF PREDATION ON FISHES IN MICHIGAN

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Realizing the fundamental relation of predation to efforts in the conservation and upbuilding of the game-fish supply, the Institute for Fisheries Research of the Michigan Department of Conservation organized an investigation of this problem in 1930. The object of the investigation was to study the habits of fish-eating vertebrates, so that their value or detriment to game-fish populations and game-fish propagation might be determined. It was planned, when these facts were learned, to develop the most effective control methods to be used under various environmental conditions. These methods were to be designed to assure a minimum loss of fishes to predators with complete justice and consideration for all animal species and all human interests involved.

The services of J. Clark Salyer, then a graduate student at the University of Michigan, were obtained. After working on the problem for two years, Salyer withdrew to accept positions elsewhere, and, since he has been head of the Migratory Waterfowl Division of the Biological Survey, he has been able to give but little time to the predator investigations. The information which had been accumulated at much effort and at a considerable investment of funds by the Department of Conservation and the University was consequently not brought to sufficient completeness to warrant its application to the solution of the predator problem.

Recognizing that it might be effective in carrying this research to the point of usefulness, the American Wildlife Institute came to the rescue, after consultation with Salyer and others. Through the financial aid of the Associated Fishing Tackle Manufacturers, a grant was made by the Institute to enable continuation of the work in Michigan. The state University furnished facilities for the work and the Department of Conservation through its Institute for Fisheries Research matched the fund allotted by the Wildlife Institute to further the investigation. This project was made the first to be undertaken under the initial Fish Management Cooperative Unit.

Predation has significantly existed as long as animal life. Attempts to regulate its ebb and flow, most of which have been based upon incomplete information, have had most undesirable and unexpected results. Continuation of such attempts therefore seems unwarranted.

A comprehension of the total problem of predation on fishes will be difficult to obtain, but will be needed for an accurate interpretation of the results of predation and for the development of effective control measures. Even an understanding of a small part of the problem, involving a very few animals or a limited locality, will be hard to attain. The ramified connections of the life-history of a single animal with those of others are very numerous and intricate. Therefore, even though one approaches the inter-relationships of a comparatively small group of animals from the apparently restricted aspect of predator and prey, he at once encounters a great need for a wide variety of life-history information. Searching, he soon finds this information sadly lacking or deficient. It is obvious, then, that though an initial approach to the problem of predation may be made through studies of food and feeding habits, the ultimate solution can only be realized after the facts so derived have been correlated with the life ways of all the animals involved. The analyses of the contents of

stomachs, intestines, and droppings, even with maximum explication of the items found, still show merely what an animal eats. A knowledge of the actual feeding habits is necessary to understand how the food is taken and under what circumstances. Further, the condition of the food when taken, whether living or dead, healthy or diseased, etc., and the availability of each food species and the proportion of its population consumed needs be known. The variations in feeding habits with age, size, and season, and the home range, numbers, migrations, value as game and esthetic value, and a host of other basic natural history information concerning each predator species must be understood before conclusions which approach completeness as to the status of the predator may be drawn.

The problems being attacked under this project are to continue and expand the study begun by Salyer on the nature and extent of vertebrate predation on fish, and to evaluate the effects of this predation; to learn which species are retarding the production of more and larger game fishes and how; to experiment with methods of controlling serious depredations by fish-eating animals without killing them; to establish a "clean bill of health" for species so deserving; and to inform sportsmen and fish culturists of the status of those animals which do eat fish so that they may come to know some pleasure rather than complete disgust at the presence of such animals in certain situations.

The field work is being continued in Michigan, but it is believed that the results of the research will be applicable in detail to other northern states and in general to the whole country. The animals which experience has shown to be most concerned are: the common local representatives of the heron family (*Ardeidae*), kingfisher, gulls (*Laridae*), terns (*Sternidae*) American merganser, common water snake (*Natrix s. sipedon*), common garter snake (*Thamnophis s. sirtalis*), snapping turtle (*Chelydra serpentina*), Blanding's turtle (*Emys blandingii*), soft-shell turtle

(Amyda spinifera), musk turtle (Sternotherus odoratus), common painted turtles of the genus Chrysemys, otter, and mink. An omission of uncommon or rare species has been necessary. Omitted to date because of limits imposed by time and facilities, although perhaps of utmost significance, are predacious fishes of game and non-game varieties. Of lesser significance, but still unstudied for similar reasons, are the mudpuppy or water-dog (Necturus m. maculosus) and the bullfrog (Rana catesbiana).

With a spread of effort over the rather large number of species which we have just listed, it has become necessary to restrict our present search for information to the channels afforded by analyses of food items present in the digestive tract and to limited field and experimental observations. To render the identification of the often fragmentary remains of fishes and other animals found in the stomachs more rapid and certain, we have built up extensive series of comparative materials such as skeletons, mounted scales, and otoliths (ear stones) of Michigan fishes. Dermestid beetles were used for removing the flesh to obtain articulated skeletons and pancreatin was used for digesting flesh from bones for disarticulated skeletons. In the actual routine of analysis, kinds, number, size, and volume of each item are determined and recorded. With the aid of the comparative material, the original size of the fish eaten is computed, even though only isolated bones remain. Mutual checks on all determinations are made by a graduate assistant and the author.

Two major categories of predation on fishes present themselves for investigation. One is the condition created at hatcheries and rearing stations where fish-eating animals are more or less literally baited by the abnormally high and usually unprotected concentrations of fishes. The other is predation on wild or natural waters. The second category includes both game-fish waters and those which do not contain sport-fish such as marshes, heavily polluted waters, small, warm creeks, and certain Great Lakes

shoal waters. Predation in all habitats frequented by a predator needs be considered in order to obtain a complete picture.

Predation was early identified as a major menace to the economy of the artificial propagation of fishes in outdoor troughs, raceways, and ponds. It has therefore been customary to kill the fish-eating or supposedly fish-eating animals which have been attracted to the hatcheries and rearing stations. This has been the practice wherever bass and sunfish (Centrarchidae), trout (Salmonidae), forage or bait fishes (usually Cyprinidae), and aquarium fishes are raised in the open. Outstanding among the animals affected by this control are the fish-eating birds and the water and garter snakes. Other species of snakes, the turtles, and the mammals which stray onto hatchery grounds are greeted with the same destruction regardless of the absence of any incriminating evidence other than their presence about fish-cultural establishments. Upon the casual examination of the stomach contents of a few individual predators, particularly those with suspicious bulges in the mid-region, fish culturists have found some of them gorged with prized fishes and have therefore justified their control. It must be said that control measures have often been overdone and that all too frequently vertebrate predators have been blamed for an unfair proportion of the usual unaccountable hatchery losses. Less obvious causes of death such as disease, malnutrition, cannibalism, harmful temperature and chemical conditions in the water, mortality from careless handling and other more indirect factors have thus been overlooked or hidden.

Perhaps as a carry-over from the competitive campaigns of "vermin" control, many fish culturists have come to have feelings of hatred and disdain regarding the animals which may be reducing their production of fishes. Monuments of figures are erected as a result of their constant predator campaigns. One of our larger states gives the following record

of predator control at some twenty hatcheries and rearing stations, for four years ending with 1936:

Great Blue Heron	450
Green Heron	350
American Bittern	350
Kingfisher	5400
Snakes	1000
Turtles	425

Other animals recorded as killed in the program in greater or lesser numbers during the same period include mergansers, coots, gulls, owls, blackbirds, "whistlers" (probably American goldeneye), "white cranes" (probably snowy egret), raccoons, muskrats, moles, etc.

It would seem obvious that the incomplete information and prejudices which have hitherto incited the destruction of predators about fish-cultural establishments should be replaced by a body of sound facts and interpretations. Toward this end, stomachs and intestines from the animals killed in the control of predators about the hatcheries and rearing stations in Michigan, with records as to date, place and time of capture, have been preserved for some years. Much of this material has already been analyzed and the investigation is being actively continued. This material is supplemented by studies of the predation pressure at various hatcheries, of fluctuations in this pressure reflected by the numbers of predators taken through the years, and of the seasonal variations in predation.

The analysis and interpretation of predation at the hatcheries and rearing stations has gone far enough to prove that some sort of control of certain predators is required, for the efficient production of fish. The investigation has not yet gone far enough to date to warrant publicity on just what benefits may be expected from given degrees of control of each main hatchery predator.

An effort is also being made to determine how the control of hatchery predators may be effected most satisfactorily from all viewpoints, and

considering all interests involved. Experiments are being conducted and set up to find out how readily the destruction of hatchery fish may be prevented by means other than the killing of the predators. The output of the fish-cultural establishments may be increased when effective and reasonably economical means are found for the control of predation at hatcheries and rearing stations, particularly if the control can be effected without the destruction of the fish-eating animals.

Regarding the second category of predation on fishes, that which occurs in the wild on populations composed of stocked and naturally supplied game-fishes, we conclude that man is the most effective predator, at least on many waters. Proof of this statement is found in the returns on tagging and creel censuses of the Institute for Fisheries Research. The next most important role is probably being played by the predacious fishes, including such sport-fishes as trout and bass as well as the so-called noxious species as the gar and bowfin (dogfish). Obviously, the effects of fishing and the feeding of predacious fishes must also be considered in obtaining a complete understanding of how game fish are being destroyed and how their supply is consequently being depleted; and thus of how the depletion can be prevented or offset, to the end that more game fish will be available for the angler.

By studying the marks of predators on large number of fish collected dead and dying in streams, Salyer was very successful in establishing the identity of the various fish-eaters which were responsible for a considerable proportion of the killings. Each predatory species was found to have a characteristic method of attack and to leave recognizable marks on the prey. Information has thus been obtained as to sizes (often far over legal) and kinds of fish which are exposed to attack, and has significantly supplemented other data dealing with the causes for death of fish in streams.

Large amounts of time and effort have gone into the accumulation of specimens from the wild. Staff members of the University Museums, Institute for Fisheries Research, the Fish, Game and Law Enforcement Divisions of the Conservation Department, the W. K. Kellogg Bird Sanctuary, and private individuals have contributed to our supply of materials. These cooperating agencies have used our standard label for each specimen, to assure uniformity and completeness in the data.

The author has spent several weeks in the field obtaining specimens and data from observations. Birds were collected with 12-gauge shotgun, or were observed in nesting, ranging, and feeding activities with the aid of binocular field glasses. Snakes were captured from their several habitats. Turtles were taken in variously styled traps made of seine twine of assorted meshes, were observed under water by aid of water glass and polarizing "sun-glasses," and studied experimentally in sizeable aquaria and pens at the Kellogg Bird Sanctuary and in the laboratory.

Areas were selected, in conjunction with those on which the Institute for Fisheries Research is conducting fish population density studies, for future determination of actual predation pressure. Additional habitats are being selected for study to determine the role of bank and overhead shrub cover in excluding predacious birds, conversely to determine the degree to which the vulnerability of the fish to the bird predators is increased through the clearing out of this cover or through flooding (as by beaver). Important also will be a study of the possible effects of different types of stream-improvement devices either in increasing the carrying capacity of the streams for fish by affording additional protection or in decreasing the supply of fish by making habitats favorable for the predators; for instance, by installing brush which is attractive to water snakes or by digging holes in trout streams deep enough to maintain northern pike.

Consideration will also be given to the extent to which fishing on a stream or lake prevents predation, especially from fish-eating birds.

As a result of the investigation, a clearer concept of the status of each predatory species studied will arise. Those animals unjustly accused as fish predators will be given the clean slate which they deserve and pressure of control removed from them. Assorted methods of predator control which have been tried and proven will be available for use in reducing the usual large annual toll by predatory species, both about hatcheries and on lakes and streams, and in reducing the numbers of animals destroyed each year under the name of predator control. Important basic life history data will have been compiled and recorded for several species of animals. It will be a relatively simple matter to apply the facts derived to provide more protection by law for certain species and perhaps less for others as conditions demand. It is firmly believed that applications of the facts and interpretations resulting from this investigation will not only aid in increasing the crop of game fishes, but also in assuring man of the major portion of the cropping rights to these fishes.

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By Karl F. Lagler
In Charge of Predator Investigations