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THE COORDINATION OF MOSQUITO CONTROL
WITH WILDLIFE CONSERVATION ^{1/}By Clarence Cottam, Senior Biologist, in Charge Section of Food
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In order that the subject of this paper may not convey the erroneous impression that the Biological Survey is attaining some degree of proficiency in mosquito control, it should be stated at the outset that mosquito control is not a function of this Bureau. The Survey is charged with certain duties pertaining to the study, restoration, conservation, and management of the Nation's resources in wildlife. From a Federal aspect, mosquito control, however, rather than being a function of this Bureau, lies within the province of the Bureau of Entomology and Plant quarantine and the Malaria Control Division of the Public Health Service. There is no desire on the part of those connected with the Survey to usurp a function that has wisely been delegated to others who may rightly claim expertness in that field. The members of the Survey, however, do have some knowledge of birds and other animals and of the conditions that affect wildlife and its habitat. Since its establishment more than 50 years ago, the Bureau has been studying intensively and continuously the food habits and environmental needs of many wildlife forms and the factors affecting the various species. A vast fund of information on the environmental requirements and preferences of wildlife has thus been collected by biologists through the years.

The results of these studies clearly reveal that certain practices employed in mosquito control are frequently detrimental to desirable species of wildlife, and that their continuance at the present rate, without modification or correction, constitutes a menace to one of our most important heritages - the Nation's great natural resource in wildlife. To underestimate the practical and the aesthetic value of wildlife in the further development and occupancy of our idle lands would be a grave mistake. The national resource in wildlife must be maintained.

Attempts to fulfill our obligation in perpetuating the Nation's desirable forms of wildlife sometimes bring the Biological Survey into con-

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flict with other interests, not least of which are some of those concerned with mosquito control. There are enough examples, however, of a kind of control that has not appreciably interfered with wildlife conservation to warrant the belief that many of the conflicts between the two interests could well have been avoided. Certainly, the apparent excellent results of some mosquito-control work, such as that of Clarke and Myer in Illinois, and Crosthwait in Maryland, lead to the hope that conservation and mosquito-control interests as a whole can be more harmoniously coordinated if the proponents of each are but equal to the task.

As a background for the discussion of certain factors pertaining to the possible coordination of wildlife conservation and mosquito control, it should be understood that the personnel of the Biological Survey includes a number of men who have had considerable training in the field of entomology and that fundamental entomological knowledge is being increased continuously by their researches and experiences, especially as a result of the many years of study of the food habits of insectivorous birds and other animals. They feel able, therefore, to speak with some degree of understanding on the entomological as well as the wildlife aspects of the problems involved in the coordination of conservation and control.

The first requisite for such a coordination, it seems to me, is a mutual recognition of certain fundamental rights and obligations of both wildlife-conservation and mosquito-control interests. For example, one of the primary duties of the Biological Survey is to restore, protect, and manage wildlife and its habitat. Other governmental agencies are concerned with developing methods for the control of insects that affect man and animals. The Biological Survey cannot approve drainage projects that become unnecessarily destructive to wildlife. On the other hand, this Bureau heartily approves and recognizes the necessity and the beneficial results of such control.

To all of us the mosquito is an obnoxious pest and its frequent presence about our homes makes it all the more objectionable. All agree that its extermination would benefit mankind exceedingly. The matter in question, however, is how mosquito elimination is to be accomplished.

From the conservation standpoint, mosquito-control projects range widely in type. Some are concerned with the elimination of mosquitoes in such areas as urban centers, where the question of wildlife conservation does not enter. Others involve control on aquatic areas that constitute waterfowl habitat more or less remote from any human habitation. Under natural conditions, the menace and annoyance from mosquitoes in these remote places does not warrant the destruction of the wildlife values of the particular area by ruinous drainage methods. The wildlife conservationist has no sympathy with the type of mosquito-control project that is based on nothing more fundamental than merely the benevolent desire to employ relief labor. Such a project furnishes an outlet for relief labor, to be sure, but so would the tearing down of churches, schools, and other public structures. The unnecessary destruction of an essential part of a great natural resource for the purpose of mosquito control is comparable to the curing of dandruff by scalping, or the riddance of rat infestation by burning a granary. Any justifiable mosquito-control

operation should proceed as far as is reasonably possible along lines that have regard not only for effective mosquito control but for conservation principles as well, so as to assure the fullest possible protection to wildlife, and thus serve the greatest public interest. That this can be done is exemplified in the mosquito-control work of J. Lyell Clarke, in Illinois, S. L. Crosthwait, in Maryland, and Milton H. Price, in Rhode Island, which is especially commendable as tending to harmonize wildlife and mosquito-control interests.

The second requisite for coordinating mosquito-control and wildlife interests is cooperation. To assure against the production or retention of a mosquito hazard, it should be the duty of conservationists to obtain the assistance of competent entomologists in planning the establishment and development of wildlife sanctuaries and refuges that are to be located within mosquito-flight range of adjacent communities. On the other hand, those engaged in mosquito-control work, at least in areas where the conservation of wildlife is concerned, either should be sufficiently trained in biological and conservation principles to accomplish justifiable mosquito control without unnecessary damage to wildlife and its habitat, or should obtain the cooperation of competent conservationists throughout the planning and progress of the control work.

Marshes exist under such a wide variety of conditions as regards water and other factors that a method of mosquito control favorable to the conservation of wildlife in one area may be disastrous in another. It is assumed, however, that control on any marsh can be accomplished by the appropriate alteration of one or more existing conditions of the environment that favor mosquito production. Few conservationists subscribe to the view that all environmental conditions must be changed for success in mosquito control. Since marshes differ so widely with local conditions, the methods employed for the satisfactory elimination of mosquito breeding, and for the conservation of desirable features of the marsh, must be varied also from locality to locality. Control operations should be limited, where possible to those particular parts of the marsh that are mosquito-breeding units and to measures that are effective, yet not unnecessarily destructive to the marsh as a whole. A ditching method in use in those parts of Maryland where the tide range is slight may not be unduly detrimental to a waterfowl habitat, but the same system of ditching applied in areas that have an appreciable tide range may be extremely injurious to wildlife.

The results of the studies made by Dachnowski-Stokes on marsh soils reveal the fallacy of applying a standard ditching system for the control of mosquitoes in all marshes, as has sometimes been the practice along the Atlantic coast. To prevent avoidable injury by ditching to any marsh, therefore, the soil should first be carefully and adequately studied in profile sections. Then the ditching system should be so planned and so adjusted to the particular soil conditions that the ecological balances of the marsh will be harmed as little as possible. In important wildlife areas the wholesale destruction of habitat by improper drainage or other detrimental methods should not occur. In all such cases, there should be close cooperation between the two interests concerned, in a patient devising of appropriate methods of mosquito control and wildlife conservation for each particular set of conditions, on the basis of con-

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timed observation, experimentation, and large-scale application of the knowledge thus gained to specially chosen areas.

The work of J. Lyell Clarke, in Illinois, while it has not entirely passed the experimental stage seems to be an outstanding example of the application of conservation principles to mosquito control through the partial substitution of biological methods for mechanical drainage. The favorable experimental results of mosquito control by biological means have been for a great many years available in the literature on the subject. While there is need for further experimentation on biological methods of control, it is certain that the known possibilities have been by no means exhausted. For example, much success in mosquito control abroad has attended the introduction of our native top minnows. It would seem logical, therefore, to experiment in this country with exotic species of the same nature to determine the feasibility of supplementing our native species with others that may be more effective. Reports indicate that many species of native and exotic fishes, particularly top minnows, killifishes, and sunfishes, have been locally effective in controlling the mosquito pest. The limitation and extent of effectiveness of these and other forms should be determined. Other biological agents of control that already have some promise include a horde of predacious insects, spiders, hydrachnids and other water mites, parasitic nematodes, trematodes, protozoa, bacteria, fungi, and many species of plants, especially Utricularia, Lemna, Spirodela, Wolffia, and possibly certain of the odoriferous Characeae. It should be remembered that a slight alteration of an aquatic or marsh environment may shift the ecological balance to favor any or all of these organisms.

In important wildlife areas, especially where permanent ponds are involved, mosquito control should be attempted by biological methods rather than by mechanical drainage. The biological methods ordinarily improve rather than destroy wildlife habitat and aid in preventing an over-concentration of animal life in those areas where it can be more easily extirpated. Ponds that periodically go dry can be connected by shallow ditches to permanent bodies of water that serve as reservoirs for larva-devouring organisms, so that when wet seasons occur natural means of control will be always available.

Such methods of mosquito control are acceptable to conservationists. The diking and impoundment of water for the accomplishment of mosquito control by biological means also find favor with conservationists, especially when provision is assured for structural maintenance. In devising schemes of control, therefore, there should be close cooperation between conservation and mosquito-control authorities from the inception of a project to its completion in an area involving wildlife or its habitat. Each area should be considered as a separate unit and the control methods selected should be applied to suit local conditions, so as to effect satisfactory mosquito elimination and the conservation of important wildlife habitat.

Several examples of successful coordination of wildlife-conservation and mosquito-control interests in the prosecution of projects can be cited. Mention has already been made of the outstanding cooperation enjoyed in the control projects under the supervision of J. Lyell Clarke in Illinois. In Maryland, wildlife interests have been protected by S. L. Crosthwait,

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throughout the progress of the mosquito-control work in Worcester County in assuring that detrimental effects on wildlife habitat would be held at a minimum. During the past year, wildlife interests have also received the cooperation of C. T. Williamson, who has constructed some valuable wildlife ponds in Suffolk County, Long Island. In Rhode Island, Milton H. Price apparently has also had success in controlling mosquitoes without lowering water levels and destroying wildlife habitat. On a 2,000-acre tract near Westerly he is digging ponds with radiating laterals in an intermittent marsh area. These ponds are then connected with a natural fish reservoir in the marsh so that natural enemies are always present in abundance. Similar methods have been successfully applied on Prudence Island without lowering the natural water levels, and it is understood that effective and satisfactory mosquito control has been thus achieved there.

Wildlife interests feel that water control rather than drainage should be practiced in any good waterfowl area in which there is need for mosquito control. Because of the great diversity of marsh conditions and the complex and varied requirements of the wildlife and the mosquitoes that frequent marshes, no uniform or standard treatment can be prescribed that will either adequately control the mosquitoes or develop the particular habitat that may be desired for any given number of valuable species. Consequently, attempts at drainage may do more harm than good.

In some areas control may be fully accomplished and wildlife interests well served by drawing off all surface water during the mosquito-breeding season and then appropriately impounding the area for wildlife during fall, winter, and early spring. During the growing season cultivated grains or desirable natural wildlife food plants can be grown in abundance. These plants can then be made available to wildlife when the water is impounded. The use of weir boards, and of tide and sluice gates on the area may be found practicable and effective in serving both mosquito control and wildlife conservation. With such structures, desirable water levels can be maintained or regulated as the need arises. In certain tidal marshes these structures will in no way obstruct the necessary tidal ebb and flow, yet at the same time they will insure the requisite minimum head of water. With these devices an optimum depth of water can be maintained in a flowage stream.

Any method of mosquito control based on the maintenance of a water level sufficient to meet the needs of wildlife is much preferred by most conservationists to drainage. Wildlife interests cannot be blamed for believing that extensive drainage of marshes results in an abnormal concentration of wildlife in areas unable to support more than the normal population. After all, it must be remembered that there is such a thing in Nature as the carrying capacity of an environment, whether it be mankind or wildlife. Drainage not only removes water from a marsh but also all life dependent upon it for existence. The earlier balance set by Nature is thereby displaced, and fishes, birds, insects, and all other natural enemies of the mosquito are driven into the few remaining restricted areas that cannot be drained by ditching. In other words the normal life of the marsh is forced to concentrate in areas unable to support it. There it becomes prey to all the ills that may assail it, whether these are dis-

cases, natural enemies, or poaching gunners. To expect that the small undrained habitat left for wildlife along the northern Atlantic coast will be sufficient to supply the needs of the wildlife population sought by the people of this Nation is similar to an expectation that the hungry appetites of an army can be satisfied with a ham sandwich.

The burning of marshes has been used as an adjunct to mosquito control, both by private individuals and by mosquito-control organizations. In the case of most wildlife habitats, conservationists vigorously condemn such practices as an unnecessary menace to wildlife, particularly when burning is undertaken during nesting seasons. Excessive burning of drained and dried marshes is ruinous to wildlife in that it removes both food and cover until another season has arrived. Through ditching, the marsh area capable of being burned is greatly increased, and fires on ditched marshes usually are more severe and destructive than on natural undisturbed areas. The use of such objectionable measures as fire encourages controversy by extremists on both sides of the control and wildlife camps and widens the gorge between them.

In conclusion, it should be emphasized that mosquito-control operations involving the destructive drainage of important and essential wildlife habitat can never be satisfactorily coordinated with wildlife conservation. Permanent ponds are an essential element of wildlife habitat and their drainage for mosquito-control purposes is usually not only imprudent but unnecessarily destructive to wildlife. Furthermore, the use of heavy oils instead of the less harmful larvicides as measures of mosquito control can rarely receive the approval or cooperation of conservation interests. The development of the New Jersey larvicide or pyrethrum spray was a distinct conservation measure.

All of us are heartily in favor of necessary and justifiable mosquito-control projects, that are intelligently planned, conducted, and maintained so as to assure satisfactory protection from mosquitoes, but some of us at least, will continue to oppose the prosecution of other types of projects as hitherto carried on that result in the unwarranted destruction of an exceedingly important natural resource in this country. Too much of the mosquito control of the past has been excessive and extreme, and apparently much of the work has been based on the principle that if a little is good much is better. This is as absurd as to assume that if one pill administered to a sick man will effect the necessary relief a hundred pills will do the job better.

Progressive mosquito-control workers fully realize that the public is demanding of those responsible for this necessary activity greater qualifications than the mere ability to dig a ditch that will meet engineering standards. Costly mistakes are inevitable as long as those engaged in mosquito control have scarcely a passing knowledge of entomology or of general biology. Mosquito-control workers and wildlife conservationists in the future should more closely coordinate their activities, so as to accomplish the purpose of each without jeopardizing the interests of either.