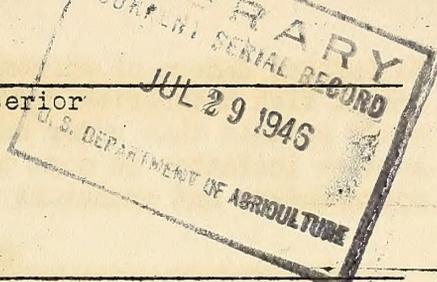


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Chicago, Ill.

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August 1945

BIRDS IN RELATION TO FISHES 1/

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INTRODUCTION

No important group of North American birds is more widely misunderstood in terms of economic relationships than the diverse assemblage commonly classed as "Fish-eating birds." Many persons lump the whole class as destructive because they assume that the so-called fish-eaters must be inimical to the popular and widespread sport of angling and even to commercial fishing. The name is not always properly applicable, however, as some of the birds so termed do not feed on fishes at all, others only to a limited extent, and many feed primarily on fishes that are either worthless to man or are themselves severely destructive to other fishes. While a few fish-eating birds are known

1/ This leaflet supersedes Wildlife Research and Management Leaflet BS-83 issued in May 1937 by the Bureau of Biological Survey, of the United States Department of Agriculture, which was revised from an article entitled "The Role of Fish-eating Birds" in the Progressive Fish Culturist (No. 14, Jan. 1936), a multigraphed periodical of the then U. S. Bureau of Fisheries.

to inflict damage of economic importance when protective measures are not taken around fish hatcheries and occasionally in newly stocked waters, a careful study reveals that under natural conditions such damage is usually slight and in most instances is more than offset by the birds consuming large numbers of spawn-eaters and predators of valuable fishes.

Causes of Fish Depletion

In most instances abundance and accessibility are the primary factors determining the type of fishes taken by birds. The more sluggish surface-feeding or shallow-water species not utilized as food by man, as menhaden, gizzard shad, killifishes, minnows, and suckers, greatly outnumber the valuable species and are more easily captured; in consequence they usually compose the bulk of the fish diet of fish-eating birds.

At one of the national conventions of the Izaak Walton League of America ex-President Hoover, an enthusiastic fisherman, laid the responsibility for the relative scarcity of certain food and sport fishes where it belongs when he stated:

"The history of our food fisheries over the last fifty years is a melancholy book that would have taken some of the calm and optimism out of Izaak Walton. At one time our littoral waters teemed with huge runs of salmon, shad, and sturgeon. But they were easy of capture because they come right up to the fisherman's hands once a year en route to spawn in our streams.

"Despite some feeble limitations imposed by State law, we have witnessed the practical destruction of the whole of the salmon, and shad, and sturgeon from the Atlantic Coast. We have seen the destruction of salmon along the Pacific coast until finally there is but one large salmon fishery remaining--that upon the Alaskan coast, where we still take \$50,000,000 a year in fish. But even Alaska, with the demoniac assistance of the tin can, will--unless it is vigorously restrained--have been lost in another ten years."

While a wider recognition of the abuses mentioned above has tended to retard this rapid decline, the future of public fishing is still being jeopardized by these factors.

Evil effects of man's onslaughts on the stock of fishes were noted in colonial days and they have grown with the increase of the human population. Drainage, pollution, and over-fishing, evils all traceable to man, are undoubtedly the primary causes for the present obvious decline. Placing any large part of the blame for the general fish shortage upon fish-eating birds is entirely unjustifiable. That these birds sometimes cause damage serious enough to call for some measure of local control is not denied, but reason and fairness to both fishermen and bird lovers should determine the policy toward these forms of wildlife.

Fish and Bird Relationships

In considering the problem of fish and bird relationships, it is to be remembered that when our fishes and fisheries were at their best, the fish-eating birds likewise were at their maximum abundance and comparatively free from control by man. In these circumstances it is difficult to believe that the birds have contributed greatly to the general decline of the fish population. If all fish-eating birds were exterminated, it would by no means insure unrestrained fishing nor would it noticeably alter the present fishing situation throughout the country.

That various kinds of fishes and most fish-eating birds are protected by law, either Federal or State, proves that both groups have considerable public value and that neither should be favored to the exclusion or detriment of the other. The fact that many fishing enthusiasts also are interested in and appreciate bird life indicates that decisions as to public policy regarding bird-fish relationships will not in the end be prejudiced. There is often found an extreme attitude either for or against the birds, however, on the part of groups influenced only by local or personal interests. It is perhaps natural for an ardent angler or commercial fisherman to consider the problem largely, if not entirely, from the viewpoint of fishing interests and to wish for extermination of every creature that he believes is inimical to his interests. Likewise the extreme sentimentalist or impassioned bird lover has little or no toleration for any degree of control of any form of bird life. Each group of enthusiasts should remember that the number of those with different interests is by no means small, that under such conditions compromises are almost always necessary, and that scientific methods should be relied upon to solve the difficulties.

In considering the groups of birds commonly classed as fish-eaters, it is well to point out that they represent many families, the habitats and habits of which vary considerably, and, therefore, that the degree of predation of the various species differs materially. Some of them, including the yellow-crowned night heron and some of the sea birds, as dovkies, shearwaters, and petrels, rarely consume fish. Others prey only to a slight degree upon fish, and those chiefly species of no economic value. In fact, many of the so-called fish-eaters are no more piscatorially inclined than are some of the common land birds. In the present system of bird classification, as recorded in the American Ornithologists' Union's Check-List (1931), the families popularly considered to be fish-eating birds comprise 198 species and subspecies or varieties, or almost 14 percent of the total number of recognized forms of North American birds. They include the gulls, terns, loons, grebes, petrels, murrets, pelicans, cormorants, mergansers, herons, bitterns, and ibises, besides a number of land birds, including the osprey, bald eagle, kingfisher, and water ouzel.

Public opinion will not condone extreme aggressive measures against so large an assemblage of interesting birds. Furthermore, a large proportion of these birds are protected by Federal and State laws and cannot legally be killed except under official permit. Unwarranted control or extreme persecution of any of this group will be sure to bring effective opposition from interested organizations throughout the country.

Value of Nongame Birds

The question is frequently asked by those who would have nongame birds greatly reduced or exterminated locally, "What good are they and why object to such extermination?" Such inquiry has an economic motive, and it is true that on economic grounds alone the protection of various birds cannot be strongly urged, yet they may have esthetic appeal that is ample reason for their preservation and encouragement in reasonable numbers. One might as well inquire what good is a masterpiece of Rembrandt or Corot or an orchestral symphony of Beethoven! Their value is no less real than is that derived from the sale of stocks and bonds or of agricultural produce. The natural scene would be woefully incomplete without its living actors--among which many of the fish-eating birds, large, beautifully-colored, and of interesting habits, can ill be spared.

Some of the fish-eating birds, however, do "pay their way" and render valuable service from the purely utilitarian standard. Franklin's gull, the black tern, and to a lesser extent related species breeding inland, are among the most useful of the insectivorous birds. The beautiful sea-gull monument on Temple Square in Salt Lake City, Utah, erected at a cost of more than \$40,000 in grateful remembrance of the service of these birds to the early Utah pioneers in delivering them from a cricket plague, is indeed a fitting tribute to the California gull. Many fish eaters also feed on predaceous insects and other creatures that destroy the spawn and young of valuable fishes.

Fish-eating birds within reasonable limits, therefore, provide values that no country can afford to lose, despite the fact that they sometimes cause annoyance to anglers or slight losses to commercial fishermen. The appeal of a colony of nesting birds, such as egrets or pelicans, for example, without doubt has been a factor in attracting tourists to various parts of the country.

Unjust Charges Against Birds

It is well to bear in mind that, like most other creatures and within the limits of their peculiar diet, fish-eating birds feed on what is most common and most readily obtainable. Consequently they get as a rule only a small proportion of game or commercial fishes, as it usually is in relatively small proportion that these fishes occur. The great majority of both the game fishes and the species of greatest commercial value are also swifter and often inhabit deeper water than other species, and consequently escape the fate of the slower surface feeders. In some trout streams there may be a preponderance of trout over other fishes, yet even here the birds frequently find and capture insects, crustaceans, frogs, salamanders, or snakes more easily than they can obtain the elusive trout.

Condemnation is frequently directed against fish-eating birds because large plantings of fingerlings or fry are made in certain streams where comparatively few trout are subsequently retrieved. A few herons, kingfishers, or terns may appear as the only visible enemies, and on this circumstantial evidence the birds are convicted and summarily given capital punishment. The facts should not be forgotten that a scarcity of fish or a failure in fish production may result from a great variety of chemical, physical, and biological conditions, important among which are excessive sedimentation, insufficient dissolved oxygen, unfavorable temperatures, pollution, scarcity of food, cannibalism, predation by other fishes (often including the prized game species), and over-fishing. Since most of these factors are not evident to the casual observer, he is likely to conclude that the scarcity is due to any object of his disapproval that seems conspicuous at the moment. Birds are thus frequently unjustly condemned.

Frequently the worst enemies of the young of economically valuable fishes are the larger individuals of their own kind or others of similar habits. With a series of stomachs of Arctic terns from Alaska, sent to the Fish and Wildlife Service for analysis, were six stomachs of trout. While the contents of the former clearly showed that the birds had been feeding on small numbers of the young trout, in this instance their depredation, although conspicuous, was minor in comparison with the destruction being wrought by the large cannibalistic trout. All six of the trout had fed exclusively on young salmon, having 23, 22, 14, 14, 13, and 13 parrs, respectively, in their stomachs. This threat to salmon parr was fully

realized by the superintendent of the United States Fisheries Station at Afognak, Alaska, more than twenty years ago when he wrote that: "The run of bluebacks has been on the decline for the past four years, and if steps are not taken soon to retard the Dolly Varden trout from following the salmon to the spawning beds, they will in a short time become extinct."

Ecological Limits on Fish Abundance

Most anglers fail to realize that for each body of water there is a limit beyond which the fish population cannot go. This limit may be expressed either in pounds or numbers; consequently if there are many fish present, they will of necessity be small. It has been said by experienced fish culturists that there is no way in which large numbers of good-sized trout can be grown on natural food alone. When the fish-carrying capacity of a stream has been reached there must be an alteration of the stream ecology with an increased food supply if more fish or more pounds of fish are to survive, and this may be impossible of achievement.

FOOD OF BIRDS CONDEMNED BY ANGLERS

Only by examination of stomach contents or of regurgitated food items can one be sure of the kinds of food eaten by most species of birds in the wild state. Because fish-eating birds are aquatic or semi-aquatic and capture most of their prey when at least partially submerged, the need is all the greater for laboratory examination to identify their food. The Fish and Wildlife Service made such studies of the food of fish-eating birds, many in such numbers as to represent all times of the year as well as a wide variety of localities. The results, which present a fair picture of their food tendencies, are the basis of the following accounts of the food of the principal species.

Pelicans

A number of investigations have been conducted in response to complaints of depredations by brown pelicans. During the World War there was a meat shortage and when our people were called upon to eat more fish, pelicans, as well as many other fish-eating birds were vigorously condemned because the cry went up from fishermen and fish dealers that the inroads made by fish-eating birds, particularly the brown pelican, made it impossible for them to make good catches. Extermination of the bird was urgently demanded. Consequently investigations by the Federal Government, State departments, societies, and museums ensued. The Louisiana coast from Pearl River on the east to Sabine River on the west was thoroughly investigated, pelicans collected, and their nesting colonies critically examined. The results brought an almost complete vindication of the birds. In this particular area 97 percent of the fishes taken were menhaden and 3 percent silversides, not a single food fish being found. A similar detailed investigation in Florida showed that menhaden comprised 91.4 percent of all food taken, while fishes valued as food by man made up only 1.1 percent of the total. In further studies, carried on by the National Association of Audubon Societies in Tampa Bay, 1,276 fishes were picked up at a pelican colony. Of these, only 39 were food fishes. At another Florida colony, 3,428 fish specimens were collected, of which only 27 were of marketable species and those were not of highly prized varieties.

The interesting and attractive white pelican of the West, the very existence of which only a few years ago, was seriously threatened, likewise

is vigorously condemned by many fishermen. Under unusual circumstances it may do some damage, yet field and laboratory investigations show that it usually consumes food of little or no value to man. Two careful investigations made in Nevada resulted in complete vindication of the bird.

Pelicans are not divers and because of their large size, short legs, and awkward movements, they appear incapable, except perhaps locally, of very serious depredations.

Double-crested Cormorant

Cormorants, distant cousins of the pelicans, also come in for their share of condemnation but Howard Mendall found in a study conducted for the Main Department of Marine Fisheries ^{2/} that 80 percent of the food eaten consisted of cunners or sculpins, which are known to be direct enemies of commercial fish. While a few desirable fishes were taken by these birds, Mendall concluded that "The double-crested cormorant is rendering considerable aid to the fishing industry." Along other parts of the coast, some condemnation is directed against the birds because they take fish out of pound nets. If the fishermen haul in their catch at daybreak, however, serious loss is avoided, because the birds are not nocturnal feeders.

P. A. Taverner, who made a detailed study for the Canadian Government of the relationship between this cormorant and the salmon in the Gulf of St. Lawrence, writes that the total effect, if any, of bird enemies upon salmon is small.

Inland colonies are frequently condemned to an unwarranted degree although some of them undoubtedly destroy valuable fishes. Threat of complete destruction of one of the two remaining colonies in one of the North Central States was made because local sportsmen believed the birds were responsible for destroying all the fish in a lake that formerly had afforded some of the best fishing in the State. A careful investigation revealed that excessive alkalinity, resulting from greatly lowered water levels throughout a period of many years, made the production of any valuable species of fish impossible in this lake. Stomach examination of a series of these birds collected there showed that 75 percent of the food consisted of the axolotl stage of the tiger salamander, 20 percent of bullheads taken from an adjoining prairie slough, and the remaining 5 percent of the five-spined sticklebacks, which were the only fish capable of enduring the high alkalinity of the lake.

Kingfisher

One of the most maligned yet one of the most interesting of our avifauna is the belted kingfisher. Its conspicuousness and distinctive color, flight, call, habits, and solitary nature make it an acquaintance and an object of real interest for almost everyone who frequents the out-of doors. At hatchery ponds this species probably is more frequently responsible than all other birds for depredations on small fish, and occasionally on newly stocked streams it may cause real damage unless protective measures are employed. These places are comparatively insignificant, however, in relation to the extent of available feeding territory throughout the country.

^{2/} The Relationship of Certain Sea Birds to the Fishing Industry of the State of Maine. Dept. Sea and Shore Fisheries, Maine, Bul. (reporting investigations 1933-34), 28 pp.

Examination of 313 stomachs of kingfishers, collected in widely different sections of the country, showed that less than half the fishes taken were of kinds usually eaten by man. Crawfishes formed 16 percent of the total food, frogs more than 5 percent, and water beetles about 4 percent. Because the bird occurs singly or in pairs and is so widely distributed, it is probable that its depredations are comparatively unimportant except at fish hatcheries and on planted streams. At these places appropriate protective measures can often greatly lessen the damage. Furthermore, it should be remembered that many of the fishes taken are noted enemies of sporting varieties in that they feed extensively on spawn of the species prized by man.

Great Blue Heron

Because of its large size and nature of feeding, the great blue heron is both widely known and condemned by inland fishermen. In its feeding, the bird is usually solitary, yet at its nesting sites it is distinctly gregarious.

In its food tendencies the bird is predominantly a fish-eater, yet among other foods taken in quantity are small mammals (especially meadow mice), dragonfly nymphs, water beetles, water bugs and other aquatic insects, crawfishes, snakes, salamanders, and leeches. Many items in its diet are species that are predacious upon young fishes or fish spawn. Away from hatcheries under normal conditions it is certain that the bird consumes far more fishes of species of no value to man than it does of those sought by the angler. Furthermore, many of those not utilized in human consumption are direct enemies of, or competitors with, the valuable food fishes.

To illustrate, a series of 8 stomachs from a popular trout stream in western Montana (collected in mid-June 1936)--a stream that has been well stocked with Loch Leven trout in addition to having an abundant supply of native trout--revealed such spawn-eaters as 28 suckers, 15 frogs, 9 sculpins, besides 7 trout, 1 minnow, 1 mouse, and several large water tigers (Dytiscidae) and dragonfly nymphs (Aeschnidae), both of which groups of insects prey extensively on small fishes. It is obvious that in this series the great blue heron's destruction of large numbers of well-known fish predators or spawn-eaters more than offsets damage to the trout supply.

Examination of the stomachs of 189 great blue herons, collected throughout the year from the Atlantic to the Pacific and from Canada to the Gulf of Mexico, disclosed that nongame fishes of little or no commercial value made up 43.16 percent of the food, while valuable species composed 24.8 percent, and unidentified fish remains 3.59 percent. Insects, amounting to 8.15 percent, included chiefly aquatic forms, among which the dragonfly nymphs and adults made up the greatest proportion. Crawfishes formed 6.54 percent of the total food and other crustaceans 0.91 percent. Amphibians, mainly frogs, and reptiles, chiefly snakes and turtles, made up 4.25 percent, while mice and shrews comprised 4.66 percent. Miscellaneous invertebrates and vegetable debris formed the remainder. When not overabundant the bird is unquestionably a natural asset. At fish hatcheries and occasionally on planted small streams, however, it is known to be destructive. Preventative measures or control, therefore, are a necessity in such circumstances, but it should be remembered that herons are protected by Federal law, and permits should be obtained when control of the birds is necessary.

Green Heron

The green heron, or "fly-up-the-creek", is probably the most familiar of the small herons, as it ranges throughout the United States and its usual tameness makes it an object of interest to a large group of lovers of the wooded streams. It appears to prefer tree-bordered channels to open marshes or lake margins.

A study of the food of 277 of these herons, collected throughout their range, reveals that the angler and commercial fisherman have little to fear from its feeding activities. Only a little more than one-twentieth of its diet was found to be composed of fishes prized as human food. Most of these were sunfish and pickerel, and a large part of them were found in stomachs collected around the ponds of a Missouri fish hatchery. But even in the series of 23 birds collected at hatchery ponds, valuable fishes made up less than one-sixth of the food, while such enemies of fish fry as the crawfish made up 47.57 percent of their diet, and aquatic insects, including a large proportion of dragonfly nymphs, predaceous diving-beetle larvae, and large water bugs (Belostoma sp.), also enemies of fry, formed 22.09 percent of the food. Thus the herons' valuable work in eliminating many natural enemies of fish fry probably compensated for the few "pan fish" taken at this hatchery. The following summary of the food of the green heron is based on laboratory examination of 255 well-filled stomachs: Fishes of little or no commercial value, principally killifishes, minnows, gobies, and silversides, 38.52 percent; valuable fishes, chiefly sunfish, pickerel, and a few bass (no trout found in the entire series), 5.91 percent; undetermined fragments of fishes, 0.96 percent; crustaceans (principally crawfishes), 20.64 percent; and insects (chiefly dragonfly nymphs, aquatic bugs, aquatic beetles, and grasshoppers), 23.65 percent. Spiders and miscellaneous invertebrates made up the remaining small percentage.

Thus it appears that this little heron is worthy of rigid protection under natural conditions, and even at the seminatural hatchery ponds it seems occasionally at least to be destroying far more predators of fry than it does valuable fishes. This remark would not apply, however, to artificial ponds where these predators are kept under strict control.

Black-crowned Night Heron

The black-crowned night heron, the nocturnal feeding habits of which are well known throughout the entire country, is occasionally reported to cause some destruction of valuable fishes at hatcheries. Under natural conditions, however, there is little to fear from its feeding activities. The contents of 117 stomachs, collected from the Atlantic to the Pacific and from Canada to the Gulf of Mexico, and studied by the Fish and Wildlife Service, indicate an extremely varied diet. While fish made up 51.53 percent of its food, the quantity of game species was negligible, and pan fishes or valuable commercial species (chiefly bullheads, yellow perch, sunfish, pickerel, and flounders) formed only 12.7 percent, whereas fishes of low commercial value and unimportant or destructive species (principally minnows, killifishes, suckers, carp, and river herring) composed 37.1 percent; the remaining 1.73 percent of fish was too completely digested to be identified. In addition to these items it was found that nearly 22 percent of the food was made up of crustaceans (crawfishes, crabs, and shrimps); more than 16 percent of aquatic insects, including many species known to be predaceous on fish fry; more than 6 percent of frogs;

nearly 3 percent of mice and native rats; and most of the remainder was composed of spiders and worms. It thus appears that there is little cause for condemning the black-crowned night heron on the grounds of its feeding activities in its natural environment and that its food includes considerable quantities of a number of forms that are inimical to the interests of man.

Yellow-crowned Night Heron

The yellow-crowned night heron, which normally occurs only in the southern half of the United States, has been unjustly condemned as a destroyer of game fishes and frogs, despite the fact that it rarely ever eats fish. The stomach contents of 120 of these herons were examined in the laboratory and only one fish was found in the entire series and this was of no commercial or sporting value. Nearly the entire food was made up of crustaceans, of which crawfishes, together with a few crabs, formed more than 98 percent. Crawfishes being preponderantly destructive, their consumption by this bird is greatly to its credit.

American Bittern

The American bittern, variously known as "slough-pump", "shite-poke", and "marsh hen", is frequently charged with being an important destroyer of game fishes. This member of the heron family usually feeds in the concealment of the densest beds of marsh vegetation, where there is little opportunity to obtain game fishes, and its peculiar habit of remaining motionless, beak pointed skyward, when approached by an intruder adds much interest not only for bird students but for the average country boy as he drives the cattle home from lowland pastures at sundown. Its unusual call, far from musical, consists of a slow, hollow punker-er-lunk, but it is a most welcome indication in the marshy regions of the Northern States that summer is near.

Field observations in numerous areas and the laboratory examinations of nearly 160 stomachs collected throughout the United States and southern Canada indicate that under natural conditions these birds should not be considered a menace to the interests of anglers or commercial fishermen. Less than a tenth of the food was found to be composed of valuable fishes and most of these were the common pan varieties--sunfish, yellow perch, bullheads, and pickerel. Trout occurred in only one of the stomachs, while bass were found in two, but all three of these were collected at fish hatcheries. It is only at such places that control of the bittern is occasionally warranted.

A tabulation of the contents of 133 well-filled stomachs revealed that insects formed 23.13 percent of the food; frogs and salamanders, 20.55 percent; crawfishes, 18.98 percent; mice and shrews, 9.64 percent; valuable fishes 9.67 percent; fishes of little value (chiefly minnows and sticklebacks), 9.55 percent; unidentified fish remains, 1.07 percent; snakes 5.21 percent; and the remainder was made up of small quantities of crabs, spiders, and miscellaneous invertebrates.

Other Herons

Egrets, little blue herons, and other members of the heron family are too frequently sought out and killed in their marshy habitats or at their tree roosts on the pretext of saving game or commercial fishes. The more extreme opponents of fish-eating birds recommend--and no doubt practice whenever

opportunity permits, and often illegally--"control" of all such species. The general food tendencies of these birds are somewhat similar to those of the other members of their family, already described. Within limits all these birds take what is common and easy to get. Most of them feed primarily on fishes, but not largely upon game species, and often upon the enemy and competitor varieties--species that frequently constitute a major obstacle to restocking operations.

Gulls and Terns

The gulls and terns represent the family of fish-eating birds most numerous in species and they frequent both inland and coastal waters. As previously indicated, Franklin's gull, the black tern, and other inland species are among the most valuable destroyers of insects in agricultural sections. The value of gulls as scavengers around harbors and commercial fishery stations is too well known to need further comment. A study of the foods of all the species occurring in the United States reveals that valuable fishes form a minor part of their diet and that all of them are worthy of protection, except when overly abundant or under very localized and unusual conditions, such as where a few species, including the herring gull, may occasionally become a menace to shell-fish beds, blueberry plantations, and rarely to the lobster industry. Considering the widespread abundance of this large group of birds, complaints from fish-hatchery workers against their depredations have been rare.

Water Ouzel, or Dipper

Some condemn, even vigorously, the delightful and fascinating little water ouzel, or dipper, of western mountain streams as an important destroyer of sporting fishes. While it has occasionally been known to feed on the small fry and ova of trout and salmon in hatchery ponds, it should be remembered that this bird is smaller than a robin, is solitary in its habits, and rarely can be considered abundant. Under natural conditions its destruction of fish is trivial. This blithe water sprite is an exquisite songster and sings even in the dead of winter when few of nature's feathered progeny are present to add a cheering note. He must be cold indeed who measures nature and her worth only by rod or reel. The Fish and Wildlife Service has examined 60 stomachs of this interesting bird and has found that it subsists largely on aquatic insects, many of which are enemies of young fishes. In this series of ouzels, six had fed on small fishes, four of which (sculpins and a sucker) were of species known to feed on spawn, one was unidentifiable, and only one was a valuable game fish--a trout. While no fish eggs were found in any of the stomachs, it is probable that small numbers are sometimes taken.

Osprey, or Fish Hawk

Another bird that occasionally preys on larger fishes in hatchery ponds, but rarely takes valuable game species under natural conditions, is that master of flight, the osprey, or fish hawk. Forty-three of these birds, collected in 14 States, the District of Columbia, and 2 Canadian Provinces, representing every month from April to October, were examined in the laboratory. Sluggish fishes formed the bulk of their diet and only one contained an important game fish--a trout. Suckers and menhaden formed by far the most important single

item of food, composing nearly 43 percent of the total. Other fishes taken frequently included yellow perch, bullheads, sunfish, carp, and flounders, but small numbers of tautog, tomcod, and gobies also were found.

Mergansers

To many hunters and fishermen mergansers are all just "fish ducks" and therefore worthless or of value only as a target for practice shooting. Nevertheless, the males are among the most beautiful of all North American waterfowl, and with the exception of one species, the group can rarely be considered unduly destructive to valuable fishes. There are three distinct species of mergansers in this country, one of which--the American--sometimes causes noticeable damage. The red-breasted merganser closely resembles it, but is rarely found on trout waters and feeds much less on game fish. The little fish duck, or hooded merganser, though known to feed rather freely on small and unimportant fishes, also consumes considerable quantities of crustaceans and insects. So far as known, all three species of mergansers, within their range of diet, feed on the species that are most available. Consequently, the more abundant and sluggish varieties constitute the major items of food. While able to capture swifter fishes, these birds follow the course of least resistance and obtain their food with the minimum expenditure of effort. The American merganser is occasionally abundant on the smaller trout streams but is more common on rivers and open lakes; the red-breasted is most plentiful along the coast; while the American is more common inland and, therefore, is the form most vigorously condemned. On the larger bodies of water these birds usually are not destructive.

A tabulation of the contents of 130 stomachs of the red-breasted merganser revealed that 34.23 percent of the food was composed of fishes that have no commercial value, chiefly minnows, killifishes, and sticklebacks. Low-grade commercial fishes, principally carp and suckers, formed 3 percent. Valuable commercial species and popular game or pan fishes made up 14.38 percent, but did not include a single trout. Unidentified fragments of fish composed 25.08 percent of the total contents, and miscellaneous items, chiefly crawfishes and shrimps, made up 23.31 percent.

The American merganser is known occasionally to make particularly serious inroads on the trout supply when concentrated on narrow sections of trout streams at times when the surface of larger bodies of water is frozen solid. Tabulation of the stomach contents of 107 of these fish ducks, many of which were collected on Canadian and Michigan trout streams, revealed that 27 contained trout. Fishes having no commercial value, including considerable numbers of destructive spawn-eating species (chiefly minnows, sticklebacks, sculpins, darters, and killifishes), made up 33.27 percent of the food, while valuable commercial or game fishes including trout, and popular pan fishes formed 32.79 percent. Low-grade commercial fishes (chiefly suckers and carp) constituted 7.52 percent, and unidentified fish fragments made up 7.42 percent. Miscellaneous items, composed principally of crawfishes, frogs, insects, and vegetable debris, formed the remainder.

An examination of the contents of 138 hooded merganser stomachs revealed that this duck does not eat nearly so large a proportion of fish as do the other two fish ducks. Fishes of little commercial or sporting value formed

24.48 percent of the diet. Game or pan fishes and commercially valuable species made up 15.18 percent, and unidentified fragments of fishes amounted to 4.17 percent. Crawfishes composed 22.27 percent of the total food, and other crustaceans, 10.31 percent. Insects, chiefly aquatic species, formed 13.41 percent; amphibians (principally frogs), 5.96 percent; and mollusks, 0.26 percent. The remainder was made up of vegetable matter, most of which probably was incidentally taken.

PREVENTIVE OR CONTROL MEASURES

Because fish-eating birds in moderate abundance, under natural conditions, are a public asset, reasonable effort should be made to prevent their depredations upon the desirable fish supply and so avoid the need for destructive control methods. There is no doubt that some of the birds may cause intolerable destruction under special conditions, particularly at fish hatcheries or at rearing ponds, and in such situations protective measures are necessary. Most fish-cultural work, however, is supported by public funds, and those in charge have a duty to the general public to prevent any unnecessary destruction of a national resource, whether it be fish or fowl.

Screening and Wiring Ponds

It is natural that fish-eating birds should appear at hatchery ponds, for a virtual banquet table is there set for them. Therefore, every practical means of preventing damage should be attempted before any destruction is carried out by the use of guns or traps.

Screening or wiring of tanks or small ponds, as described in Department of Agriculture Leaflet No. 120, "Excluding Birds from Reservoirs and Fishponds" (copies available free from the Office of Information, U. S. Department of Agriculture, Washington, D. C.), is frequently possible at moderate expense, and a number of States are now working along this line. Edward R. Hewitt, who has long been engaged in fish-cultural work, regards it as a necessity to use such protective measures. In a recent article in Outdoor Life he wrote 3/ :

"The only sure way to raise trout successfully is to do it in tanks completely screened from vermin. When the trout are 9 to 10 inches long they can be raised in ponds, if they get reasonable protection from birds and other marauders. When the large fish are put out they remain in the stream only a short time until they are caught. In this way, losses due to vermin are reduced to a minimum. Therefore, the really practical way to get the most for our money and efforts is to raise the trout in completely protected areas until they are big enough to be put into the streams or grown still larger in semiprotected ponds.

3/ Outdoor Life 76 (2): 64, Aug. 1935.

While screening with wire mesh is the surest way of gaining complete protection, this method is sometimes found impracticable because of the cost or of physical obstacles to its use.

Earl E. Hoover, biologist of the New Hampshire Department of Fish and Game, recently reported that the American bittern had caused considerable trouble in a pool at one of the hatcheries. The hatchery men noted that the bitterns could not stand and feed in very deep water and that when coming to feed they would always alight on land or in very shallow water and then wade out to places where the fish were concentrated. He stated that the depredations had been stopped by the following means: A strip of poultry netting was erected around the entire pool, placed in the shallow water a few inches from the margin, so that it projected a foot above the surface (18 inches would probably be more effective). The bitterns were found invariably to alight on the landward side of the fence and walk back and forth along the shore trying to find an opening. While this method may not be entirely effective for bitterns in other sections, it is worthy of experimentation when depredations are known to be caused by those birds.

The Nevada Fish and Game Commission reported that Howard S. Doyle had been successful in excluding great blue herons from a 2-acre hatchery pond by stringing small telephone wires across it in one direction (no cross wires were used). The wires were placed about 2 feet apart and 2 feet above the surface of the water. The superintendent of the hatchery stated that the herons still fly over the pond but the wires frighten them away and shooting is no longer necessary, although formerly a guard had been stationed near the pond much of the time to shoot them.

Open reservoirs in some of the northeastern States have been effectively protected against concentrations of gulls by stringing wires about 4 feet apart across the width and length of the pools at a height of 4 or 5 feet above the surface of the water, thus creating a covering of 4-foot squares over the reservoir. The size of these squares can be increased or decreased, depending on the particular type of birds involved. More specific details are contained in the Leaflet (No. 120) above referred to.

Use of Traps

It has long been a common practice of fish culturists to use pole traps around hatchery ponds in the control of certain fish-eating birds, particularly the kingfisher. This method, as ordinarily practiced, is unnecessarily cruel and, as it usually results in the indiscriminate destruction of a large number of valuable song or insectivorous birds, it should be avoided unless all other methods have proved unsatisfactory. When perching sites used by kingfishers are scarce around hatchery ponds those remaining can frequently be eliminated by covering them with small boards through which several long nails have been driven, the sharp points projecting upward about 3 inches.

Frightening devices in great variety have been used to forestall bird damage. Some of these can be adapted for use around hatchery ponds or along sections of trout streams where destruction of fishes by birds has occurred. A few of those that are most worthy of trial in such situations are described below.

Frightening Birds by Day

Bird depredations at hatchery ponds and in trout waters usually are greatest immediately after sunrise and late in the afternoon, although many birds feed actively all day long when they are caring for their young. Along trout streams one of the simplest frightening devices consists merely of a piece of shiny tin about 8 to 12 inches square suspended by one corner from a supple willow pole about 6 feet long by means of a raw-hide thong 2 feet long. The pole should be placed where it can be seen to best advantage by the birds and pushed into the soil at an oblique angle, so that the tin can swing freely and twist in the breeze, thus casting reflections in any direction. Rectangular 5-gallon oil cans furnish an easy source of shiny tin; since each can readily be cut into several squares of the desired size,

A rotary modification of the square-tin frighteners consists of two pieces of shiny tin suspended by thongs 2 feet long from opposite ends of a light board about 5 feet long, 4 or 5 inches wide, and 1/2 inch thick. This board is then mounted in a horizontal position at the top of a 6-foot post, with the narrow edge placed perpendicularly on a short axle. This can easily be accomplished by nailing a short piece of 2 by 4 timber along the middle of the light board and drilling through it edgewise a hole slightly larger than the diameter of the axle, after which it should be greased heavily and inserted on the axle. If properly balanced it is then free to revolve in the wind, the tin squares twisting on their thongs at the same time. An axle equipped with ball bearings would increase the effectiveness by permitting freer and more rapid movement of the horizontal arm.

Spinner reflectors, as described and illustrated in Wildlife Leaflet BS-149, placed at frequent intervals around hatchery ponds, are worthy of careful experimentation.

In some localities, inverted shiny cans equipped with clappers have proved effective when suspended in a similar fashion. A small hole is punched in the center of the bottom of a 1-gallon can and the free end of a thong pushed through it. A small wire ring is then tied to this end of the thong. A steel nut or bolt is suspended from the ring by means of a stout cord slightly shorter than the height of the can, so that the nut acts as a bell clapper when the can sways in the wind. The noise thus produced aids in frightening the birds.

Well constructed, "human-effigy" types of scare crows with shiny strips of tin suspended from their arms can be used. Mounting them on a well-lubricated axle, so that they can turn in the wind, increases their effectiveness.

"Scare-birds" constructed of excelsior, brightly dyed primary wing feathers or tail feathers from large poultry, and a strip of shiny tin cut in the shape of the profile of a hawk's head with neck outstretched are worthy of experimentation as bird frighteners for the smaller species of fish-eaters. A wad of excelsior is bound with strong cord into a moderately tight oval mass about 10 inches long and 4 to 5 inches thick, resembling the body of a bird. The shiny tin head is bound into place at the larger end of the excelsior body by inserting the outstretched neck at the time the body is being constructed. Several long-quilled wing feathers are then pushed into both sides of this body far enough to anchor them in a horizontal position, inclined slightly backward to resemble outspread wings. Tail