Fish Stocking

as related to the management of inland waters

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Stocking lakes and streams is probably one of the most valuable means of maintaining good fishing. To produce a reasonable supply of fish, however, stocking must be based upon accurate information regarding the requirements of the body of water. Conditions within each lake or stream determine the species of fish that is best suited to that environment. If others are used the results may be harmful rather than beneficial. Stocking is only one tool in the management program, and it should be used in conjunction with a well-rounded plan which will increase carrying capacity of the waters.

Each body of water has limitations in its productive capacity, depending upon a number of factors, but primarily upon fertility. It is futile to attempt to increase the carrying capacity, except for a limited period of time, by stocking more fish than the waters will support. Often measures other than stocking are more beneficial in improving fishing.

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FISH STOCKING AS RELATED TO THE MANAGEMENT OF INLAND WATERS[1]

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Contents

BILLIONS of young fishes and fish eggs are produced and released each year from hatcheries operated by the Fish and Wildlife Service in nearly all parts of the country. Fish-cultural activities have been prosecuted with varying intensity in Federal fish hatcheries since 1872. The purpose is twofold. It was originally hoped to assist in maintaining the supply of food fishes by means of artificial propagation. Later, the work was expanded with the purpose of building up or restoring the stocks of game fishes for which there is a tremendous recreational demand. This latter function is performed by the Federal Government for the same reason that it maintains national parks—to respond to the insatiable public call for wholesome, noncommercialized recreation.

Public angling resources are public assets, and their values have been too frequently recounted to need repetition here. There are eight million licensed anglers in the country. Many others who fish are not required to have licenses. It is estimated that from ten to thirteen million individuals go fishing each season. The tremendous pressure they create upon the supply of most sought after fishes imposes a necessity for the employment of artificial measures to offset it. The foremost of these artificial measures is stocking from hatcheries, but there is a widespread lack of understanding as to the significance of stocking and its effect on fishing waters.

Inland fishing waters may be classified according to management practice. They range from intensively cultivated private or public fish ponds and carefully managed and regulated natural waters of Governmental or other agencies, to waters for which no management

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policies have been set up and to which only general conservation laws apply. There may be all types in between depending upon the degree to which management is exercised.

The uses to which these fishing waters may be subjected will in the same way be varied and may include such objectives as the production of fishes for food; or they may have the control of erosion as the primary, and the fish crop as an additional aim; or they may have purely recreational objectives, with health and aesthetic values paramount. The amount of fish produced may thus be a secondary consideration in some cases and a primary one in others.

12,536

Figure 1.—The objective: a well stocked, properly managed trout stream.

Corresponding to varying management policies, fish-stocking methods must be different for different bodies of water. Fingerlings may be furnished for new artificially created waters. Virgin lakes in isolated regions, not now containing desirable species, may be provided with fishes suited to the special environment.

One might include among the waters primarily in need of stocking, those which now have species unsuited to existing conditions. A notable example is the presence of yellow perch or bass in trout waters. In such cases, it is desirable to remove the whole population and replace it with fishes that are adapted to prevailing conditions, and which can be expected to yield a reasonable return in good fishing.

Newly created or impounded waters such as farm fish ponds, cattle tanks, or storage reservoirs have assumed new importance as

outlets for hatchery fishes. This is a result of increased emphasis upon ponds as an adjunct to soil erosion control and the use of the fishes produced in them as a supplementary source of food and recreation. They have also assumed a new importance because they can be managed to maintain good fishing over a period of years.

Finally, hatchery stock is supplied to waters that have been seriously depleted as a result of overfishing, pollution, or other special circumstances. Thus, the stocking program becomes part of a program of rehabilitation.

It is a very common public conception, that "poor fishing" can be remedied automatically by stocking and that all streams, ponds, and lakes can be made to produce fishing without limit if stocked heavily. These views are erroneous, and it is the purpose of this paper to show that fish hatcheries supplement and accelerate, but do not replace, natural processes. Fish hatcheries are a vital element in building up and maintaining fish populations but their production must be used to meet actual needs. They cannot produce effective results unless they are operated in conformity with the concept that they are a part of a much larger over-all management program.

There are many instances in which stocking has been futile because of a lack of knowledge as to the real deficiencies of the waters. In many other cases, stocking has maintained fishing where otherwise it would not exist. To stock or not to stock is a question which must be answered in the light of full, specific information, good judgment, and accepted fish-management practices.

To understand better where stocking is applicable and the reasons for designating certain numbers and species of fishes for certain waters, it may be well to give a brief description of habitats and the part that stocking plays in the management program.

FACTORS DETERMINING FISH DISTRIBUTION

Each body of water is a closed environment with its own set of conditions. The climate of a section of the country in which water areas are located may, in a general way, determine the climate within these bodies of water, but there is much variation between water areas in the same region. It is upon these climates, or habitat conditions within each body of water, that the natural distribution of fishes depends. It is these factors which determine what species of fish will grow best and produce the best fishing and, therefore, should determine the fishes to be stocked.

One of the fundamental climatic factors is temperature. It determines, in a broad way, the general types of fishes to be found, or to be stocked, in a body of water. In general, fresh-water fishes may be classed as cold- or warm-water species.

The cold-water species include various members of the trout family, the charrs, the grayling, the salmons, and the whitefishes. All are propagated either by State or Federal hatcheries, but not all are available for general distribution.

Rainbow trout and brook trout are the two most common cold-water species distributed. Other fishes may be distributed in more limited numbers. Rainbow and brook trouts thrive in water with a maximum summer temperature approximating 70° F. Under certain conditions both species may tolerate a higher temperature for

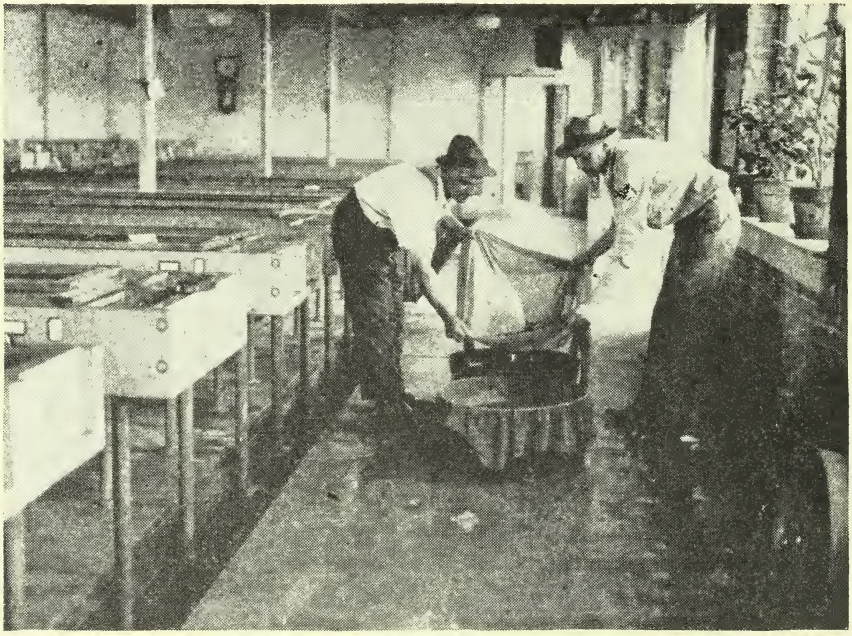

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Figure 2.—Treating fish at a hatchery for the prevention of disease.

short periods of time. The rainbow trout is able to withstand higher temperatures for longer periods than the brook trout.

However, the ability of either the rainbow trout or the brook trout to maintain itself, as with all species of fish, is dependent upon spawning conditions and the ability of the young to survive. The maximum temperature of a stream for these species should not be over 54° or 55° F. during the spawning season. There are many streams that may have the necessary survival temperature but do not meet other requirements for the fish to reproduce. These streams might provide a home for trouts, but there would be no increase from natural reproduction and the stock could not be maintained without continual replacement by stocking.

In addition to temperature, certain other conditions for spawning must be correct. Trout spawn in the riffles of streams on gravel bars where the eggs lodge in the gravel. Spawning takes place in lakes, usually on gravel bars where spring water seeps up from the bottom. Good trout streams include a suitable balance between riffle and pool areas or other hiding places where trout may lurk and capture their food. The proper balance between riffles and pools, combined with the quality of the protective and food-producing areas, as well as the size of the stream, determine its carrying capacity. An increased rate of stocking will not increase carrying capacity, and if the stream is overstocked, a stunted population of fish may result.

Other game fishes found in the northern sections of the United States include the wall-eyed pike, the great northern pike, and the muskellunge. The wall-eyed pike is found in lakes and rivers that have sandy or gravel bottoms or rock ledges. The eggs hatch in water temperatures up to about 60° F. The great northern pike and the muskellunge may be common in lakes that are more mature in their ecological development. Such lakes are characterized by a muddy bottom and more prolific vegetation and by higher water temperatures.

The range of the smallmouth black bass overlaps that of the cold- and the other warm-water fishes. This species may be found in the lower reaches of a trout stream where the water is too warm for trout. In general, the habitat requirements are met by the clearer lakes and streams with sandy or gravel areas for spawning. The hatching temperature of the eggs is much higher than for trout so that the range of distribution is much wider. Smallmouth black bass thrive from the Canadian provinces to Florida. Black crappie and the rock bass are distributed over much the same territory and are found in similar habitats.

The largemouth black bass is probably the most popular of our warm-water fishes. Its range is widespread, and it is the predominant species over the greater part of the country. It is adapted to both the cooler waters of the northern section and the very warm waters of the South where a 10-pound specimen is not uncommon.

The largemouth black bass is less selective in its breeding habits than the smallmouth, and will spawn around the base of vegetation and on roots and debris. The ideal lake for this fish is warm and has, at least, one-third to one-half of the bottom covered with vegetation. Vegetation is necessary in affording protection from the cannibalistic adults to both the young bass and to forage fishes which utilize the vegetation for spawning.

Inhabiting a similar range is the bluegill sunfish, which attains its largest size in southern Georgia and Florida, where it may weigh 2

pounds or more. In the southern range the white crappie is also common, as are various sunfishes including the red-ear and the red-breast of the Atlantic slope. The warmouth bass is confined to the muddy and weedy waters of the South which are less suited to other game species.

Among the more widely distributed species are the catfishes. They are associated with most other fishes, but may live in waters entirely unsuited to other game species. In some sections they are classed as game, in others as commercial, fishes. Different species of catfishes are found in various sections of the country, but one or two have a general range. The catfishes will live in muddy waters where other fishes may not reproduce, and are popular for stocking in regions where erosion keeps the waters turbid, and where other species are less able to maintain themselves.

This, in a general way, gives a brief account of the distribution of fresh-water game fishes under natural conditions, and of the reasons why they occur where they do. When waters are being restocked with hatchery fishes, these factors of temperature and spawning requirements must govern the selection of species to be used or the stocking program will not be successful. Moreover, it should always be borne in mind that stocking is only one of the means of improving fishing.

CHANGED CONDITIONS AFFECT FISHING RETURNS

Waters located near centers of population frequently are overfished. Stocking them should help to keep up the fish population and improve fishing, and is justifiable as it yields a reasonable return for the money spent. In metropolitan areas, such as New Jersey or Connecticut, continuous stocking is probably the only means of providing trout fishing for the numerous anglers.

In many instances, the reduction in fishing return is due to a decrease in fish populations brought about by climatic or habitat changes. Forests in the neighborhood of trout streams may have been cut down, creating changed living conditions in the streams. Water normally held back by a forest flows directly into the stream, bringing silt and mud and causing excessively high water and flood conditions at certain times of the year, and excessively low water and high temperatures at other times.

These changes are entirely foreign to the normal conditions to which trouts are accustomed. Spawning beds are washed away or silted over, temperatures become intolerable, normal food-producing areas are smothered, and stream flow is reduced to a mere trickle at certain times of the year, thus reducing the number of fish the stream can support. Obviously, in such cases remedies other than stocking are necessary.

Conversely, dams and storage reservoirs may make suitable new habitats. Below Norris Dam on the Clinch River in Tennessee, and Boulder Dam on the Colorado River there are a number of miles of stream in which there is good fishing for rainbow trout. Formerly, these areas did not support trout, but the reservoirs have cooled the water, stabilized the flow, and permitted the silt to settle. This new angling resource was developed by providing the stock of trout from fish hatcheries, and it may be necessary to continue stocking below

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Figure 3.—A typical impoundment changing the habitat from stream to lake conditions.

these impoundments since conditions are not favorable for natural reproduction.

Streams which might normally support smallmouth black bass or wall-eyed pike may be changed. This is occurring in the Mississippi River at the present time as a result of the installation of a series of dams to stabilize the flow of water and facilitate navigation. Gravel bars and riffles which afforded suitable spawning places are being silted over. Normally low temperatures will be raised as a result of stagnation and will increase growth of vegetation behind the dams. The fish fauna will be replaced by another more suited to the new conditions.

In such a case, restocking with the species of fish that are disappearing will not assist in restoring them. It will only retard their

disappearance. Original species that can no longer reproduce or tolerate the new living conditions are doomed. They will be replaced by species which are adapted. The largemouth black bass, the catfishes, and some of the rough fishes more characteristic of maturer waters may replace the wall-eyed pike and smallmouth bass.

Pollution may bring about changes in fish populations. Pollution of any type in excess reduces the numbers of fish either by killing them outright or by ruining spawning and living conditions. Even where polluted conditions have been corrected, the environment may remain changed. Pollution may have hastened the maturity of the basin by silting over spawning areas, by encouraging the growth of vegetation, and by raising the temperature of the water. Stocking with species adapted to the original habitat will not restore them. Living conditions have changed, and only a different population will survive.

In many sections of the country in waters where pollution has had no effect and fishes were abundant at one time, they may be restored if changes in the environment can be reversed. It may have been forgotten that areas around these bodies of water have been stripped of trees and the surface soil denuded. Anglers may have removed fish crops from the body of water year after year without an attempt being made to renew the fertility that produced the crops. Brush fires may have devastated surrounding areas, consuming organic matter in the soil and preventing natural fertilization of the waters. It is often not realized that all of the factors contributing to the reduction of fertility and the wasting of the land apply also to bodies of water into which the run-off from these lands drains.

The first reaction of the public in seeking to improve fishing is to request fingerlings for restocking. However, if seed stock is already present, it should be unnecessary to stock if habitat conditions are suitable for the fishes. Natural reproduction should compensate for the decrease in population, providing the area is not overfished.

Every farmer knows that poultry and other animals require a definite amount of range upon which to forage in order to thrive, and that only a certain number can be supported on a unit area. If an acre will produce 150 pounds of beef, increasing the number of cattle to the acre will not increase production. The same holds true for fishes. Just as crowded conditions may produce smaller cattle, less milk, or fewer eggs, in the same manner overstocking will produce smaller fishes.

Each body of water has a certain inherent fertility just as different tracts of land have different native fertilities. According to its fertility, each body of water will produce only a certain number of pounds of fish. Population studies have shown that a variety of

species should be present in certain relative proportions. Overfishing may change this balance, and restocking may restore it. By overstocking certain species, the populations of others may be reduced. However, no amount of stocking will increase permanently the total weight of a given species which the body of water will produce. There is plenty of evidence to show that overstocking is one of the more common causes of poor fishing.

From the preceding brief statement, it should be clear that stocking is a technical matter. Fertilization, erosion control, habitat improvement, regulation of impounded waters, forage fish production, re-

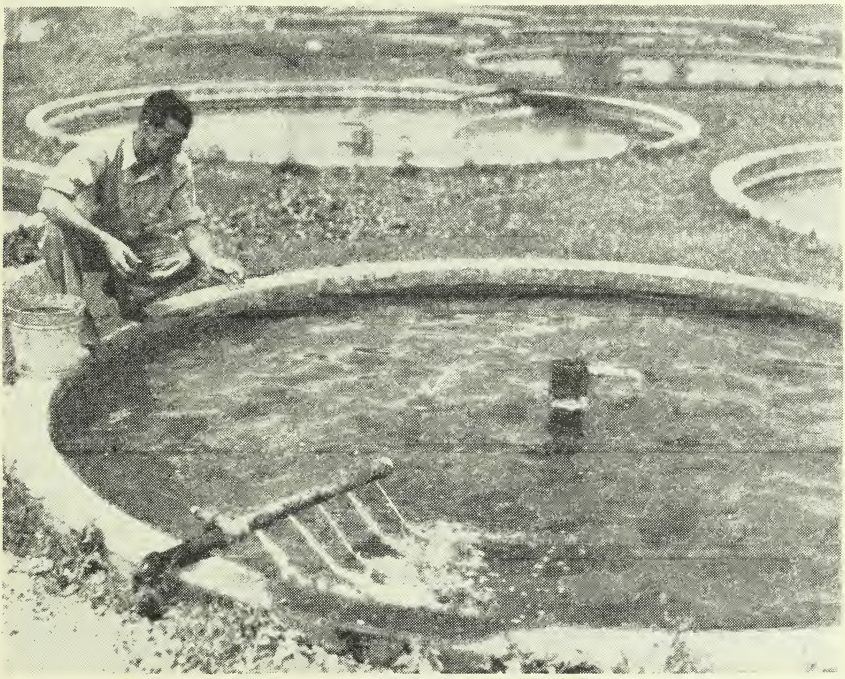

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Figure 4.—Feeding trout in hatchery pools.

forestation, and many other factors aside from the mere adding of certain fishes must be given due weight in a program for improving the fishing in any body of water.

It is only in recent years that research in the field of fishery biology has been translated into practicable working methods which can be used in managing fresh-water fish resources and particularly in guiding stocking policies. Purely scientific studies have progressed to the point of practical application.[2]

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[2] For an outline of the factors governing productivity of fishing waters and the methods followed in assaying such waters see: Fishery Circular 26, Instructions for conducting stream and lake surveys, by H. S. Davis, 55 pp., 1938. For sale by the Superintendent of Documents, Washington, D. C. Price 10 cents.

The results of research have brought about a gradual abandonment of the theory that stocking of any and all waters must be beneficial and that an unlimited increase in the number of hatcheries and in the volume of their production will automatically bring about a corresponding increase in the harvest of fresh-water fish.

Some States have set up stocking policies, and have proceeded on a program designed to classify the lakes and waters within their borders and have set up recommendations for stocking them. In view of these stocking programs and State management of waters for the improvement of fish production, and Federal management of waters within conservation areas such as national parks and national forests, the Fish and Wildlife Service has set up a policy for the distribution of fingerling fishes to managed waters.

This policy helps to do two things. It places the fishes in waters where surveys show that stocking is beneficial or necessary and, by stocking only a predetermined number of fish of an appropriate species and size, it prevents the waste of public money. The Service recognizes that fish are a crop and should be handled as such. It recognizes that hatchery production should be geared to the needs rather than that each hatchery should produce as many fish as possible. It is not conservation to produce fish where fish are not needed nor is it good conservation to stock them where other measures are required. The statement of policy is outlined below:

It is the policy of the Fish and Wildlife Service to allocate or distribute the output of its fish hatcheries in the following order of precedence:

(*a*) Primary obligation will be in the stocking of waters on lands under the control of the Federal Government, including national parks, national monuments, national forests, Indian reservations, Bureau of Reclamation reservoirs, areas under the control of the Tennessee Valley Authority, wildlife refuges administered by the Fish and Wildlife Service, areas directly controlled by the Farm Security Administration or other agencies concerned with the relief of agriculture, and any miscellaneous waters controlled or administered by other Federal Government agencies. For the purpose of this policy, ponds, reservoirs, etc., which are constructed on private lands with the aid and encouragement, either financial or otherwise, of the Federal Government, shall be included in the foregoing category.

(*b*) Secondary obligation shall lie in stocking State waters, including the lakes, streams, ponds, etc., which are open to public fishing. This stocking shall be carried on either by direct plant under the supervision of the Service's employees, by arrangement with State conservation departments, or by furnishing the fish in response to applications submitted by responsible organizations or individuals.

(*c*) After apportioning the hatchery output to meet the above obligations, any remaining fish may be utilized in filling applications for private waters, this term to be construed as meaning lakes, ponds, or streams which are not open to the general public and which are not commercialized in any way.

The Service will continue to receive applications bearing Congressional endorsement as in the past. However, the Service will exercise full freedom of action in assigning species and determining the time and method of delivery. It shall be the Service's effort to cooperate as far as possible with the applicants

and members of Congress who have endorsed the applications but the applications shall be handled in accordance with the priority set forth above. Giving special attention and service to applicants shall be minimized. Applications for trout and related species filed after March 1 shall be carried over for filling during the succeeding year unless there is a surplus of fish on hand. The comparable deadline for warm-water and pond species shall be June 1.

Applications which for any of the foregoing reasons remain unfilled at the end of two years will be automatically canceled.

STOCKING PROCEDURE

Species of Fish Distributed

Federal fish hatcheries are located in almost every State. These hatcheries are so situated as to serve the surrounding territory to the best advantage. Their output may be divided into two classifications: commercial and game fishes. Species that are protected and reserved for sport fishing in one area may be open to commercial fishing in another area, and vice versa. State laws govern this classification. A concrete example is the lake trout, which is the basis of an extensive commercial fishery in the Great Lakes, but is protected as a game fish elsewhere along with the rainbow trout and brook trout.

Since most of the fish hatcheries propagating commercial species collect the eggs in cooperation with the fishermen, they are located near where the commercial catch is landed. Along the Atlantic seaboard the species handled in this way include pollock, cod, haddock, flounder, mackerel, and lobster. In addition, Atlantic salmon and terrapin are being hatched experimentally to determine whether the prospects for rehabilitation of these species in certain areas may warrant further expansion of propagation activities. Certain anadromous fishes (species which come from salt into fresh water to spawn) are hatched in the same area. These include the shad and herring. On the Pacific coast are located the important salmon fisheries, and all species of Pacific salmon are propagated.

There are also hatcheries propagating Great Lakes commercial fishes, including lake trout, whitefish, pike-perch, and lake herring. The eggs are collected from fishes taken in the commercial catch, and are hatched and returned to natural spawning areas. Thus are conserved potential fishes which would otherwise be lost to the industry by a process that may be likened to a byproduct recovery.

The hatchery operations with which the public is more familiar are those having to do with game fishes. Although numerically the output is small compared with the hatch of commercial fishes, the game fishes are reared to a larger size and require much more space and equipment, and more complicated hatchery procedures.

The hatcheries for game fishes are distributed over the whole country. The species handled at each are selected according to their adaptability to the region where the hatchery is located. From the

New England States, southward in the Appalachians to Tennessee and northern Georgia, across the northern section of the United States, and throughout the mountain sections of the West to the Pacific coast, various species of trout are propagated. Many stations in this area propagate no other fishes.

Scattered throughout the same territory and on the southern edge of this range are stations propagating both trouts and the pond species that inhabit warmer waters.

12,609

Figure 5.—Circular pools in which trout can be grown to legal size before release.

Within the range of cold-water species and in the extreme South and Southwest are certain hatcheries that propagate warm-water species exclusively. These pondfishes, as they are called, are nest builders and cannot be stripped of their eggs as is done with cold-water fishes. Furthermore, they prefer live food, and artificial feeding has not been entirely successful. As a consequence, they must be propagated in large ponds on natural food, and in contrast to the trouts which are artificially fed, their production is limited by the number of acres of water in use. Because of their cannibalistic habits, production of black basses is further limited.

Some forage minnows are propagated incidentally to other hatchery operations, but are used mainly at the hatcheries. No definite program of forage fish propagation for general distribution has been

adopted. Likewise, no provision has been made for the propagation of exotic or aquarium fishes. These may be procured from dealers in aquarium specialties.

12.611

Figure 6.—Hatchery ponds in which warm-water fishes are produced to stock farm fish ponds.

COOPERATIVE AGREEMENTS

Subsequent to management policies being established for various areas, certain cooperative agreements have been made with State and Federal agencies, and sportsmen's and other organizations interested in stocking game fishes. As an illustration of these activities, the following examples may be cited:

The United States Forest Service and the National Park Service have certain waters which require continuous stocking under management plans. Rearing stations are built within these areas to which small fingerling trout are brought from the Fish and Wildlife Service hatcheries and reared to the proper size by a Service fish-culturist. This saves expense in transportation and assures the cooperator a constant supply of larger fish.[3]

[3] For convenience hatchery stock is commonly designated according to the following nomenclature: Eggs; eggs or ova up to the time of hatching (eyed eggs are eggs in which the eyes of the embryo are visible). Fry: fish which have hatched, but which have not yet started to feed, being dependent upon the food reserve of the yolk sac. Advanced fry: fry which have commenced to feed but have not reached a length of 1 inch. Fingerlings: fish from 1 inch in length up to an age of 1 year from time of hatching. They may be classified by number to indicate length as "fingerling No. 3," a fish 3 inches long; and yearlings—fish older than 1 year from time of hatching, and less than 2 years. After 2 years most hatchery fish are classed as adults.

In some instances the various States may supply a portion of the funds for propagating fishes. In this way they are assured of a predetermined proportion of the total output of the hatchery. Some States supply eggs for hatching and the fingerlings are apportioned between the Service and the State.

In the case of the largemouth black bass especially, the demand can scarcely be met by present hatchery production. Sportsmen's organizations and other agencies are encouraged to maintain rearing ponds for basses or trouts which can be stocked with fry or fingerlings from Service hatcheries and reared to a larger size. The fingerlings are at the disposal of the agency maintaining the ponds, and insure a constant supply where the Service hatcheries cannot meet the large demand for this size. In some States, fish must be released in accordance with stocking policies. Usually a certain proportion of these fingerlings are used to fill Federal applications for fish to stock contiguous waters. The Service will supervise the selection of sites and the construction of rearing ponds and, when requested, will furnish advice concerning the conduct of operations.

DISTRIBUTION OF GAME FISHES

A special type of transportation pail with a capacity of about 5 gallons is used for most distribution. The pail is wide and is fitted with a perforated cover which has a large hole in the center. This permits inspection, icing, or aerating as necessary. The fish-carrying capacity of the pail is determined by the species, temperature of the water, length of the haul, and size of the fish. Prior to development of this container, ordinary 10-gallon milk cans were used for transporting fishes and they are still utilized to a considerable extent. Other containers such as galvanized ash or garbage cans, barrels, tubs, or stock tanks are used successfully for short hauls.

The Service operates two especially equipped railroad cars in connection with distribution from its hatcheries. Under normal conditions, they travel approximately 50,000 miles each year. The distribution cars are of the Pullman type and travel in passenger trains. They are designed to carry from 265 to 325 regulation pails of fish, and are equipped with both steam and electric air compressors for forcing air into the containers to renew the supply of oxygen in the water.

Many deliveries from these cars are made to applicants while the train makes its customary stops to receive and discharge passengers. Applicants may not all reside in the immediate vicinity of the railroad over which the distribution car has been routed. In this case, it is necessary for a car messenger to accompany pails of fish on a side trip by baggage car, returning to a designated point to meet the distribution car.

For a number of years, the important railroads of the country have granted the Federal Government the privilege of carrying in baggage cars on passenger trains shipments of fish when accompanied by at-

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Figure 7.—Interior of a fish car showing transportation pails and aerating device.

tendants. The only requirements have been that each messenger be provided with a first-class fare, and that the number of regulation cans to be carried be restricted on any one shipment.

Several railroad companies have volunteered free transportation or reduced rates for the distribution cars of the Fish and Wildlife Service when engaged in planting fish in waters adjacent to their lines. This cooperation demonstrates the value that railroad operators place on the maintenance of well-stocked fishing waters in the regions served by their lines.

With the development of automotive transportation facilities, the railroad cars are being gradually replaced by trucks. Hatcheries have increased in number and are more favorably located so that trucks may cover the waters of the country within a radius of 200 to 300 miles of the hatchery.

Trucks for the transportation of fishes may be equipped in various ways, and new ideas are being constantly developed. This Service and several of the States are using especially designed tanks mounted on trucks. Such tanks are usually made of steel and are supplied with removable splash boards. If climatic conditions require it, they may be insulated. A transverse partition in the front of the tank forms a compartment where ice is packed to keep down the temperature of the water.

While the general design of most tanks is similar, there are various methods of aerating the water. Some trucks are equipped to carry standard cylinders of oxygen. Connections from a cylinder through a regulator valve allow the oxygen to be liberated in the bottom of the tank through porous plugs. As the oxygen bubbles through the water, part of it is dissolved and the carbon dioxide removed. For the same purpose, compressed air may be forced into the water by means of a separate motor-driven compressor or by means of a compressor operated from the truck motor or drive shaft.

Another method employed, is the use of a centrifugal pump to circulate the water. The water is drawn through a screened intake at the bottom of the tank and pumped under pressure to pipes above the tank. It is sprayed over the surface of the water in the tank in fine jets, sometimes after having been circulated through an ice compartment to cool it. A fan-driven blast of air may be forced through a spray of water to cool the water, embodying the principle of the portable air-conditioning units. Various modifications of these and other methods have been developed experimentally.

Some of the trucks now employed by the Service are equipped to carry regulation distribution cans. These are usually arranged in two tiers, one above the other, on either side of the truck bed. The same aerating methods may be used as for the tanks. The main air lines over each series of pails are equipped with branches, one to each can, and the lid of each pail has a large opening for the hose supplying oxygen or air.

Most of the agencies participating in cooperative agreements with the Service have taken over the transportation and stocking of waters within their jurisdiction. The Forest Service transports fingerlings from Service hatcheries or rearing stations to the waters to be stocked. Many of the States have taken over the transportation of fishes within their own boundaries, or in some instances, the applications of both State and Federal origin may be filled from either State or Federal hatcheries depending upon which is the nearest source.

Some sportsmen's organizations and many clubs and individuals have arranged to transport fishes made available in response to their applications. In some instances, fingerling trouts have been transported by airplanes to mountain lakes which were previously stocked by means of pack-train or were otherwise inaccessible.

Private applicants are now being asked to come to the hatchery for their fishes where practicable. When enough applications have been received from a particular locality to warrant the use of a truck, the applicants may be asked to meet the truck at some central place or at various points along a route to receive their fishes. Each applicant must assume the responsibility for the final stocking of his own quota of fingerlings. If he is not at the appointed place at the designated time, it becomes necessary to dispose of the fish otherwise, since they cannot be left or held without attention.

APPLICATIONS FOR FISHES

Application forms for hatchery fishes may be obtained from the Department of the Interior, Fish and Wildlife Service, Chicago 54, Ill. The forms should be filled out carefully and returned to the Chicago office. Care must be given to filling out these application forms since employees of the Service are unable to investigate the various bodies of water individually. The information on the form is designed to enable the Service to determine the species of fish that should be stocked and the number. Careful consideration should be given to replies to such questions as the size of the body of water, maximum temperature, and related subjects.

Application forms are first checked in the central office of the Fish and Wildlife Service. In many instances, they are then forwarded to the Conservation Department of the appropriate State for review before filling. Many States have a stocking policy for each district so that applications must be reviewed by them to prevent stocking with the wrong species, or to prevent stocking by both the State and Federal Government. Some States have stocking quotas determined on the basis of surveys which have shown that only a given number of fish should be planted. All applications for stocking waters within

national forests or national park boundaries should be approved by the Federal agency concerned since the requirements of most of these areas have been determined by Service biologists.

After approval, the application is transmitted to the hatchery which will fill it. This, in some instances, may be a State fish hatchery. The hatcheryman informs the applicant of the exact time when the fish will be available at the hatchery or at a predetermined point of distribution.

The distribution of trouts is arranged early in the year and, unless there is a surplus of fish, requests submitted after March 1 are carried over for filling during the following year. Black basses, sunfishes, crappies, and other warm-water species are supplied from May to December and, in order to receive attention before the following winter, requests for them should be filed prior to June 1. So as to coordinate the distribution of fish from State and Federal hatcheries in New York, all applications for stocking New York waters, submitted in any one calendar year, are filed for attention the following calendar year.

In its distribution of fish, the Service sends out certain species in the form of fingerlings or yearlings. This is especially true with regard to brook, Loch Leven, and rainbow trouts. At some stations, however, in order to prevent overcrowding, it is necessary to distribute a portion of the product before this stage is reached. The basses, sunfishes, and other pondfishes are distributed from 3 weeks to several months after they are hatched. Toward the end of the season, the basses shipped usually measure from four to six inches, and the sunfishes may be two or more inches long.

The commercial species, such as whitefish, lake trout, pike-perch, and others are hatched in large numbers and are usually released as fry. Eggs of some species are distributed to State hatcheries and occasionally to applicants with the understanding that the resultant fry are to be planted in public waters.

In making allotments on applications the following items are taken into consideration: (1) The area of water to be stock as stated in the application, (2) size and number of fish available for distribution, (3) distance the fish have to be transported, and (4) the recommended number, which may be based on the findings of a biological survey of the area.

Sometimes it is not possible to furnish applicants with more than a sufficient number of fish for brood stock, and it is expected that these will be protected and allowed to reproduce. An approved application is not an order for a specified number of fish; the applicant is merely sharing in the apportionment of those produced because the season's

crop cannot be arbitrarily increased to meet special demands. The supply in any one year is limited, and equitable treatment of all applicants may force the restriction of allotments upon individual applications to numbers much less than desired.

CARE OF FISH IN TRANSIT

Since fishes are living animals, it is imperative that precautions be taken to safeguard them in transit and at the time of stocking. The measures necessarily vary with the species, the season of the year, and the part of the country in which they are transported.

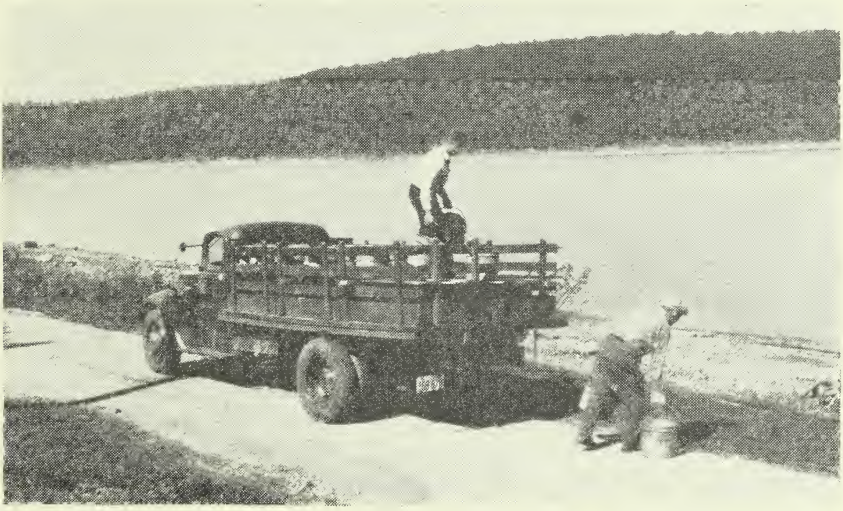

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Figure 8.—A truck equipped to transport standard pails.

When a large number of fish are confined in a shipping can or tank, they soon consume the oxygen dissolved in the water, especially if the vessel is allowed to stand still. It is important, therefore, that applicants receiving fish plant them as soon as possible. While the fish are in transit in a vehicle the splashing of the water serves to renew the oxygen supply, especially if the road is rough. On a smooth road, the wheels on one side of the vehicle may be run on the shoulder where it should be rough enough to cause the water to splash and in that way become aerated.

When the vessel is standing and no other method of aeration is available, a dipper may be used. Sufficient aeration may be accomplished by dipping the water and letting it fall into the container from a height of about 2 feet. This process should be repeated as often as the fish show signs of distress by coming to the surface of the water to gulp air.

With cold-water fishes, low temperature is an important factor in keeping them alive. The colder the water the more oxygen it holds in solution, and the slower the life processes of the fish, with consequent reduction in oxygen demand. The proper temperature may be maintained by wrapping the can with wet sacking or by placing ice on or around it. A suitable temperature for trout is about 50° F.

The temperature affects warm-water fishes also, but in a more limited way. Fishes that have been acclimated to cold water, as in our more northern areas, may have the temperature reduced without much hazard. This is less true southward as bass in the southern extremes of their range become less and less resistant to cold. It has been found in the southernmost States that if the temperature is reduced radically, the fishes appear to reach a destination in good condition, but develop fungus and die in a few days. At some hatcheries the use of ice has been eliminated, or it is employed sparingly.

Before planting any fish, the temperature of the water in the vessel in which they are transported should be nearly the same as that of the water into which they are to be liberated. This is especially important when ice is used and the temperature change is great. To equalize the temperature, some of the water in each container should be replaced with water from the body of water where the fish are to be stocked. The change should be gradual and at least half an hour should be consumed in changing the temperature through a range of 8° F.

Young trout should be placed in small spring-fed tributaries that are not frequented by adult fishes, and in places where there is an abundance of natural food and cover. Pondfishes should be planted in shallow water and in vegetated areas where they have protection from predators. All stock should be disseminated as widely as possible to take full advantage of available cover and food supply.

It is an excellent plan to study the waters to be stocked before the arrival of the fingerlings so that the most suitable areas for planting them may be known. When the consignment arrives, a dipper should be used to aerate the water and to liberate the fish, a few in each place, at well-spaced intervals. Most game fishes are prolific breeders and with care in making the plant, a few will provide adequate stock for small ponds and streams.

In large lakes and river systems, hatchery stocking will be less effective, or slower in showing results, because allotments of fish are ordinarily less than the waters will accommodate. The fish population inhabiting a moderately large lake or a few miles of river may have a potential reproductive capacity equal to the entire output of one or more hatcheries. Since it is rare that the entire production of a hatchery can be devoted to a single body of water, stocking necessarily represents only a fractional percentage of what natural reproduction may provide if it is not inhibited by unfavorable factors.

Figure 9.—The proper method of releasing trout.

PREDATOR CONTROL

To the average angler, predators appear to be of paramount importance in relation to good fishing. Minks, raccoons, frogs, snakes, herons, fishhawks, fish-eating ducks, kingfishers, turtles, and predatory fishes are some of the common enemies. The amount of destruction by these enemies is related to their abundance in different sections and to the abundance of food other than fishes. For instance, herons may feast almost entirely on tadpoles if these are more abundant than fishes. Kingfishers may take species other than game fishes if the former are abundant.

Most hard-shelled turtles are vegetarians or scavengers. Two groups are more largely predatory; namely, the snapping and the soft-shelled turtles.

In the case of gars, there is some evidence to support the idea that when the adults are brought under control, and the waters adequately stocked with fingerling bass, the gar population will remain stable. If man upsets the balance of nature, where predators and supporting fishes have coexisted for a long period of time, predominance of the predator is usually the result.

Evidence in all fields of conservation is lending more and more credence to the belief that all predators should not be eliminated. There should be, rather, a natural balance of predator and non-predatory species. Evidence of this is the fact that in the absence of predators, the game-fish population may expand until it overruns the food supply, leading to overpopulation.

The management plan for farm ponds emphasizes the use of a game-fish predator (bass) in order to assure the best production of pan-fishes. A sound policy in dealing with predators, and even with coarse or trash fishes, which merely compete with game fishes for a common food supply, is to keep their numbers at a moderate level. Dominance of coarse fishes, such as carp, may justify reduction in their numbers by seining.

OTHER MANAGEMENT MEASURES

Other management measures include stream and lake improvement, fertilization, planting of fish food organisms, control of vegetation, regulation of fishing, control of water levels, and flowages (where practicable) including the management of watersheds. These are technical matters and problems, and management measures should not be undertaken without technical advice and guidance. Recommendations based on field studies may be obtained from State fish and game departments in some cases. The Fish and Wildlife Service generally exercises this function on lands under Federal control. Any attempt to apply management practices without knowing the requirements, and without sound technical advice as to how, when, and where these measures should be applied, may result in wasted effort and, in some cases, failure.

Under present conditions this Service and the State fish and game departments can determine with considerable accuracy where, when, and in what volume, fish planting should be carried on. Adherence to established policies as to planned stocking may result in some requests for fish being rejected. Such decisions will not be arbitrary, but will be guided by conscientious efforts to apportion the available supply of hatchery fishes so as to bring the best results. Such a program is solely in the interest of the anglers themselves.

Reasonably precise knowledge is replacing guesswork. This knowledge emphasizes that in many cases, under the artificialities of present-day utilization of inland aquatic resources, purely artificial measures, such as hatchery stocking, are vital elements in the maintenance of these resources. The problem is one of better utilization of fish hatchery output rather than abandonment or expansion of hatchery programs.

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