THE DISTRIBUTION OF THE WINTER FLOUNDER, *Pseudopleuronectes americanus*, AND ITS BEARING ON MANAGEMENT POSSIBILITIES

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The winter flounder, *Pseudopleuronectes americanus*, is one of the select group of American North Atlantic fish that is equally popular with both the commercial fisherman and the salt water angler. While the commercial fishery is widely scattered along the coast from Maine to New Jersey, its chief center of activity is southern New England and New York. In these areas, the bulk of the catch is taken by small otter trawlers under five net tons and generally manned by less than three men. The boats fish out of many scattered points such as Provincetown, Hyannis, Woods Hole, and New Bedford, Massachusetts; Point Judith and Galilee in Rhode Island; New London and Stonington in Connecticut; and Northport, Port Jefferson, Mattituck, Montauk, Babylon and Freeport in New York--to mention but a few of the more important ports of landing. Interspersed among these ports are many other minor ports out of which one or more boats may fish.

The small size of the winter flounder dragger confines its fishing activity to the shoal waters adjacent to the shore and also to within a relatively short distance of its home port. Thus, the economic well-being of the fishermen and their families is dependent on a continued good supply of fish in a relatively limited area.

The sport fishery for winter flounders is most important south of Cape Cod, particularly in the waters around Long Island, New York, where the proximity of the recreational facilities of Long Island to the large population of New York City has encouraged the development of an extensive sport fishery for many species of fish including the winter flounder. Similarly, an extensive sport fishery has developed in Rhode Island, Connecticut, and New Jersey, particularly near population centers. Many of the fish are caught off docks, piers and shore, or from row boats, and to a lesser extent from power boats. The gear used is relatively simple and inexpensive, ranging from hand lines to light rods and reels with one to three hooks attached close to the sinker or to a "spreader" rig made from a piece of wire. Sea worms and clams serve as bait. The ready availability of the winter flounder to the angler and the simple and inexpensive gear needed to catch it are to a great extent responsible for the large sport fishery for winter flounder.

Aside from the recreational value of the winter flounder to the sportsman, towns adjacent to important fishing grounds benefit monetarily from the angler's activities. Money obtained from the sale of bait, tackle, food, drinks, and gasoline and from rental of rooms and boats materially adds to the income of many primarily "resort" towns. A scarcity of winter flounders on accessible grounds discourages sportsmen from visiting these towns, and this results in a decreased revenue.

All in all, it may be concluded that the winter flounder is of such importance in the region of southern New England and New York that every effort should be made to insure a good supply of fish.

Available information on the life history and distribution of the winter flounder indicates the possibility of developing a management program which could accomplish this purpose. The fundamental biological data upon which the proposed management program is based may be divided into three categories: 1. The early life history and distribution of the young of the winter flounder; 2. The size and age composition of the winter flounders subject to the commercial and sport fisheries; 3. The distribution of winter flounders of sizes subject to the commercial and sport fisheries.

1. The Early Life History and Distribution of the Young of the Winter Flounder.

The early life history and distribution of the young of the winter flounder is fairly well known. In southern New England and New York, spawning occurs in shoal waters of from one to three fathoms from about mid-December through May (Bigelow and Welsh, 1925, p. 505; Perlmutter, 1939, p. 21). The peak spawning period varies throughout the range of the species according to the temperature of the water which, on the shallows of the spawning grounds, fluctuates considerably in relation to changes in air temperature. Unlike most commercial species of fish, the eggs are not buoyant but sink to the bottom where they stick together in clusters (Breder, 1923, p. 311). Masses of such eggs often are found on the commercial fyke nets set for winter flounders in the shoal waters along the channels of Great South Bay, New York.

The predominant physical forces affecting the movement of eggs and larvae in the protected waters of the spawning habitat are wind and tide. Because the winter flounder eggs are adhesive and demersal, their distribution is relatively little affected by wind and tide. Consequently, it is reasonable to conclude that the young in any one area are primarily the product of spawning fish in that area.

Throughout the first year of life, the winter flounder is mainly limited to the shoal waters along the shores of the bays and estuaries where it is readily captured by beach seines. As they grow older, the fish tend to wander away from the shores into the deeper, adjacent waters.

2. The Size and Age Composition of the Winter Flounders Subject to the Commercial and Sport Fisheries.

In obtaining information on the size composition of the winter flounder catch, particular attention was paid to the more important fishing areas in southern New England and New York, including Nantucket Shoals off southern Massachusetts; the region off Point Judith and Watch Hill, Rhode Island; and Long Island Sound, Gardiners Bay, the Peconic Bays, Shinnecock, Moriches, and Great South Bay on Long Island, New York.

Winter flounders in Long Island, New York waters enter the commercial and sport fisheries at from 7 to 8 inches depending on locality and season (Lobell, 1939, p. 78-81; Perlmutter, 1940, p. 16). Many of these smaller-sized fish are retained by the angler, but in commercial practice, fish under 10 inches in length are usually thrown back since they are undesirable as market fish. The same general conditions hold for southern

New England waters. Length frequency samples of the commercial catch of winter flounders taken from May 1940 through February 1942 off Watch Hill, Rhode Island--an area fished by both Connecticut and Rhode Island boats--show fish entering the catch at from 7 to 9 inches (35 to 45 half-centimeters). This was also true for the region of Point Judith, Rhode Island during approximately the same period, Figure 1. In the Nantucket region, winter flounders enter the commercial catch at 10 inches (50 half centimeters) in length. Smaller fish are not taken, primarily because the flounder fishermen in that area use a large mesh net which permits unmarketable sizes of flounders and "trash" fish, particularly the sculpin, Myoxocephalus octodecimspinosus, to go through.

Preliminary age studies of winter flounders in New York waters show that fish between 8 and 10 inches long are 2 to 3 years old, (Lobell, 1939, p. 86; Perlmutter, 1940, p. 16). Furthermore, field observations in the New York Area indicate that fish in this size category are mostly mature, which is in agreement with observations made by Bigelow and Welsh (1925, p. 505). Information on the ages of winter flounders in southern New England waters is not available but may be expected to be similar to results obtained in New York waters.

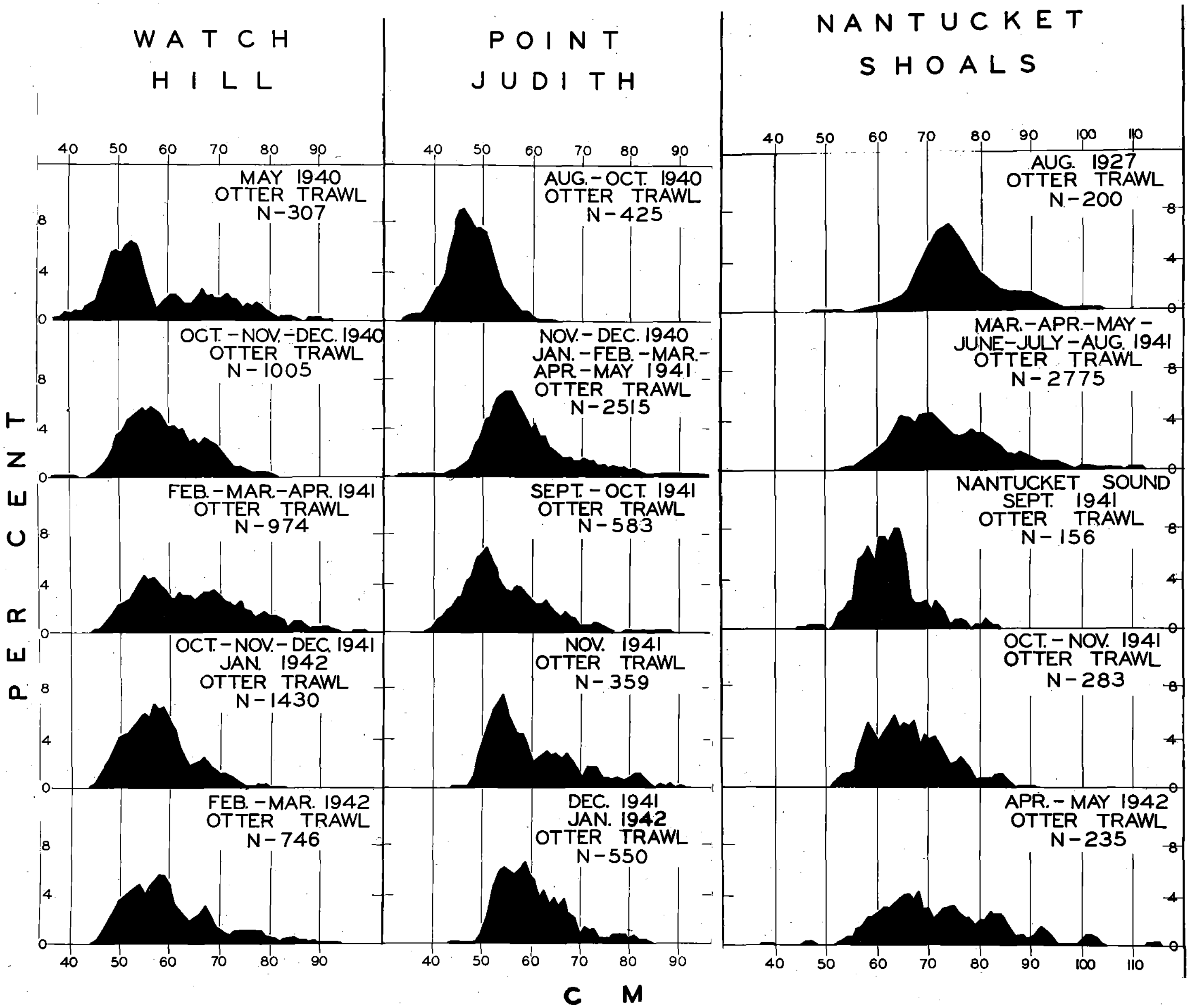

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Figure 1. Length composition of blackback caught off Watch Hill and Point Judith, Rhode Island and Nantucket Shoals, Massachusetts. Measurements to nearest half-centimeter. Data smoothed by a moving average of threes.

Summing up, it has been established that 1. The young of the winter flounder in an area are mostly the product of local spawning; 2. They remain in the shoal water near the shores of the bays and estuaries during the first year of life; 3. As they grow older, they tend to move off into adjacent deeper water and in the second and third years, begin entering into the catch of the commercial and sport fisheries.

3. The Distribution of Winter Flounders of Sizes Subject to the Commercial and Sport Fisheries.

Information on the distribution of winter flounders subject to the commercial and sport fisheries was obtained primarily by means of tagging experiments. Samples of fish from the catch of commercial fishermen or taken by otter trawls and fykes operated by Fish and Wildlife Service personnel, were marked with celluloid disc tags. The technique used, numbers of fish tagged, and localities in which fish were tagged will not be discussed in detail at the present time. Preliminary information on these subjects is contained in reports by Lobell, 1939; Perlmutter, 1940, and will be described in greater detail in a future report.

In planning the tagging experiments, a particular effort was made to distribute them as widely as possible throughout the more important winter flounder fishing areas, as shown in Figure 3. Experiments were conducted in the Great South Bay, Shinnecock, and Moriches Bay regions off southern Long Island; the western and eastern Long Island Sound region accessible to the northern Long Island and Connecticut fishermen; the Peconic and Gardiners Bay area accessible to the eastern Long Island, Connecticut, and Rhode Island fishermen; Point Judith, Narragansett Bay, and Block Island Sound areas accessible to the Rhode Island fishermen; and the Nantucket Sound and Shoal areas accessible to the southern Massachusetts fishermen.

To facilitate analysis of the data, the coastal waters from Massachusetts to New Jersey were divided into nine areas, Figure 2. Area 1 is the Jersey Coast; Area 2, Great South Bay, Moriches Bay and Shinnecock Bay on the south shore of Long Island, New York; Area 3, the ocean off the eastern part of the south shore of Long Island, New York; Area 4, Long Island Sound; Area 5, Block Island Sound including the Peconic Bays and Gardiners Bay; Area 6, Narragansett Bay and the waters east of Point Judith to Martha's Vineyard; Area 7, east of Martha's Vineyard, the waters about Nantucket and Nantucket Shoals; Area 8, Massachusetts Bay; Area 9, waters off Cape Ann, Massachusetts. Returns from these experiments are summarized in Figure 3.

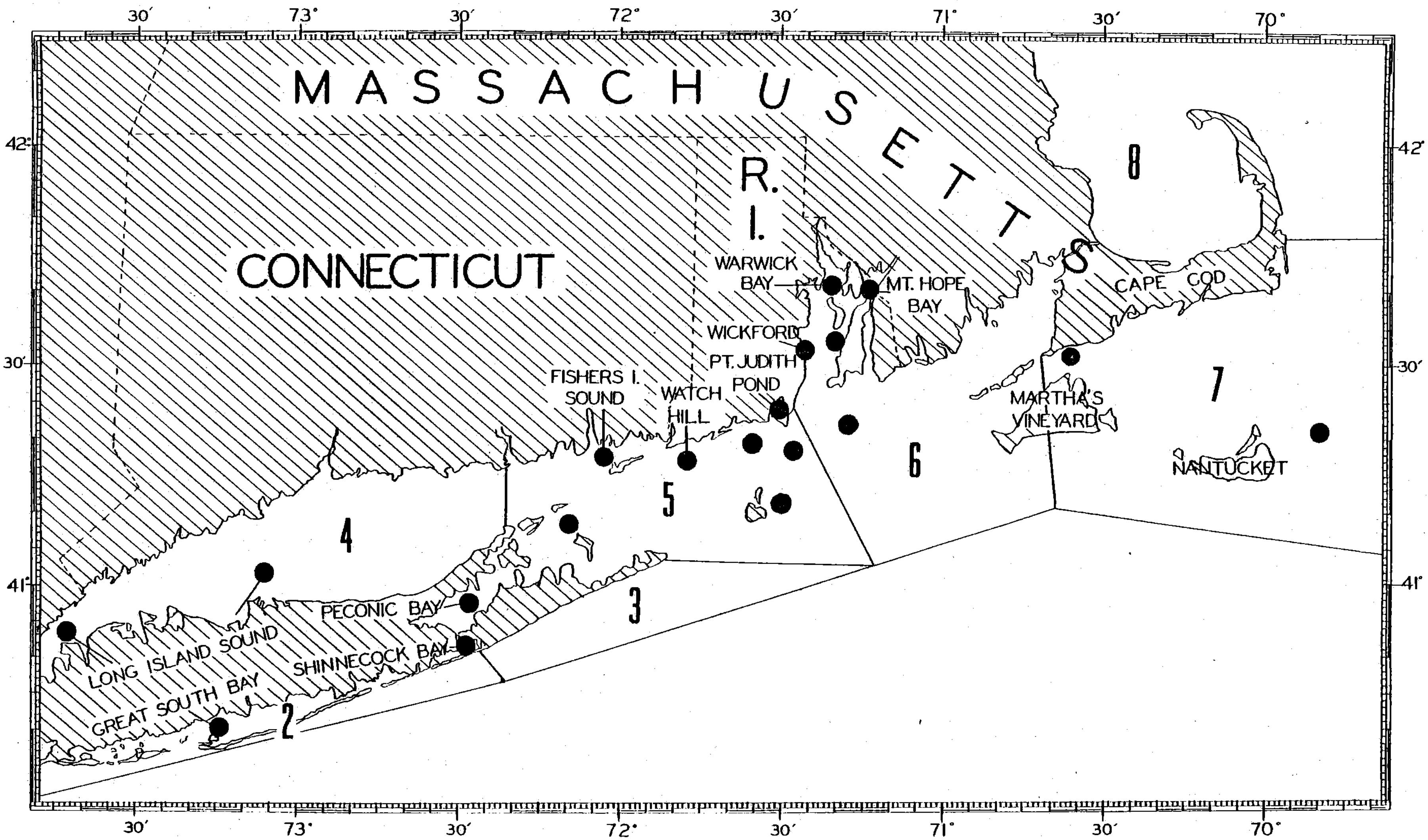

Figure 2. Areas used in analysis of blackback tagging experiments. Solid circles indicate tagging localities. Area 1, New Jersey Coast; Area 2, Great South Bay, Moriches Bay, and Shinnecock Bay; Area 3, ocean off the eastern part of the south shore of Long Island; Area 4, Long Island Sound; Area 5, Block Island Sound including the Peconic Bays and Gardiners Bay; Area 6, Narragansett Bay and the waters east of Point Judith to Martha's Vineyard; Area 7, east of Martha's Vineyard, waters about Nantucket and Nantucket Shoals; Area 8, Cape Cod Bay; Area 9, vicinity of Cape Ann, Massachusetts.

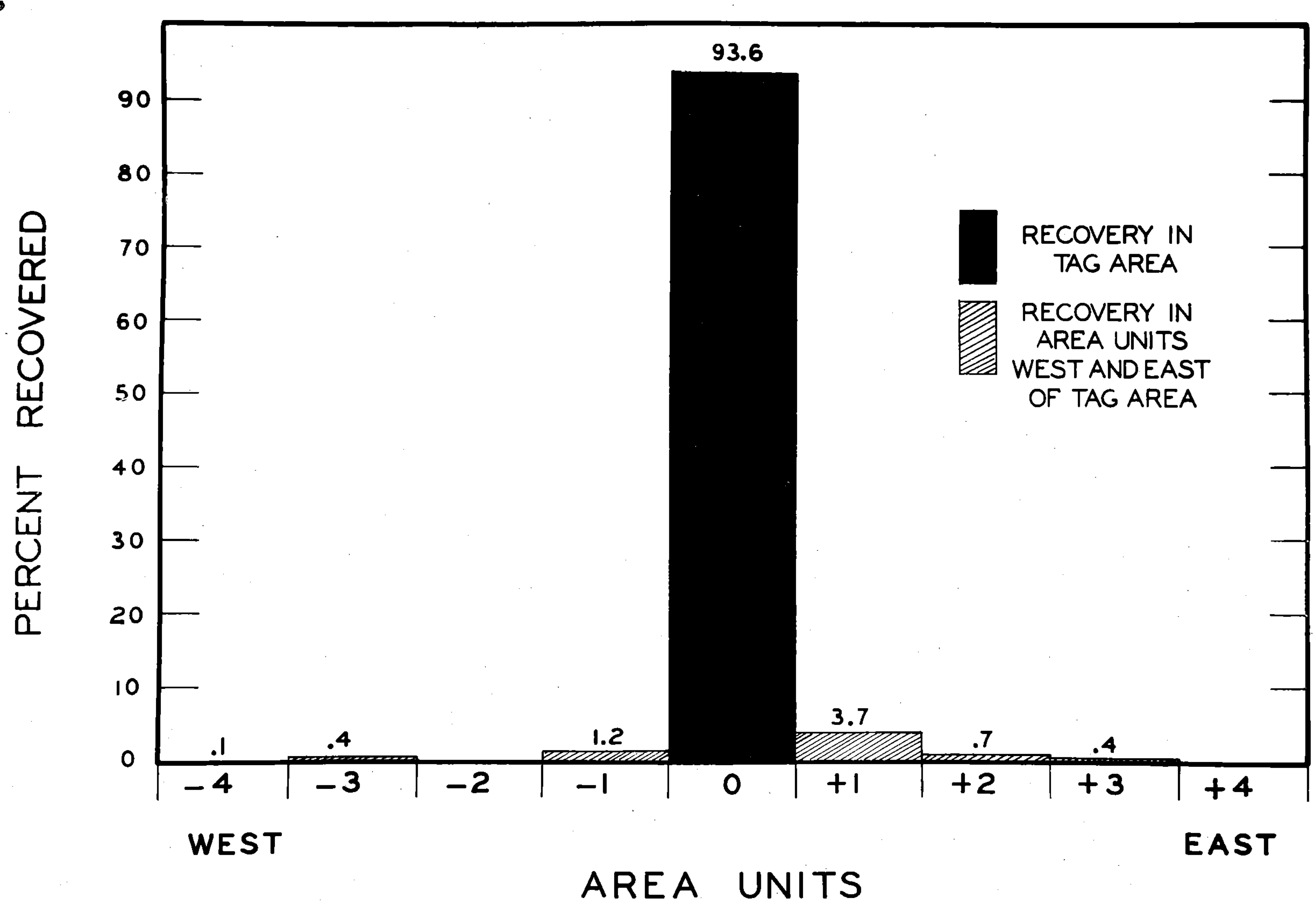

Figure 3. Percentage of winter flounders recovered from tagging experiments in southern New England and New York bays in the tag area and by area units west and east of the tag area; 10,172 fish tagged, 1,767 recaptured.

The area in which the fish were tagged is numbered zero. Each of the nine areas mentioned previously are considered as area units. Going east from the tag area, the area units are consecutively numbered from +1 to +4 and west from --1 to --4. The percentage of returns in the tag area is indicated by the solid bar and returns in other areas by the hatched bars. Out of a total of 10,172 fish tagged in southern New England and New York bays, 1,767 were recaptured. Of these, 93.6 per cent were recovered in the tag area and 4.9 per cent in the adjacent eastern and western areas. Therefore, it may be concluded that the winter flounders in southern New England and New York bays are largely localized stocks. Any movement of fish away from these bays is not a directed migration but rather a gradual dispersion from population centers, a characteristic phenomenon with non-migratory animals.

Management Possibilities

Since young winter flounders are the product of local spawning and the stocks of adult fish drawn upon by the sport and commercial fisheries remain highly localized, it follows that each of these resident stocks offers the same management possibilities to nearby communities as do their clams, oyster, and scallop resources. To get the most out of such a natural community resource, certain basic statistical and biological information is essential including: 1. The annual drain on the flounder population, (total catch); 2. The effect of this drain upon the relative size of the population, (catch per unit of effort); 3. The annual recruitment, (obtained from the age composition of the stock and the catch per unit of effort.)

Such information can be obtained through well-planned tagging experiments, collection of complete statistics on the total catch and effort expended, and supporting biological data such as age, composition of the stock, growth, and length--weight relationship. With these data as a foundation, it would be possible to determine the maximum amount of fish that could be removed each year from a local stock without injury to the stock and to regulate the catch accordingly.

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THE FLOUNDER FISHERY, PAST AND PRESENT

By ALFRED PERLMUTTER

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The history of the flounder fishery is closely linked with changes in public taste. Back in 1870, the then known species of flounders, most important of which was the blackback, were unpopular with the average consumer. The catch was taken by such gear as traps, hook and line, and spears, in many instances while fishing for other kinds of fish. Gradually, increased consumer demand and accompanying higher prices led to increased activity in the blackback fishery. Beam trawls, already extensively used in Europe, were introduced into the American flounder fishery for the first time in 1895 by the Cape Cod small boat fleet and gradually the use of the beam trawl spread among the other small boat fleets along our Atlantic coast. By the early 1900's, the cumbersome beam trawl had been replaced by the more easily handled otter trawl and a vessel otter trawl fishery had developed to exploit the offshore banks.

Wholesale adoption of the beam and then the otter trawl by the flounder fishermen led to the discovery of large numbers of flounders of species that previously had been considered rare or were entirely unknown. Because at the time there was only a limited local market for yellowtail most of them were discarded at sea. Development of the vessel otter trawl fishery working offshore banks led to the introduction of three additional species of flounders to the market; namely, lemon sole, gray sole and dab. However, most of the catch of the three species of flounders was taken incidentally while other fish were being sought and no particular effort was made to develop a fishery for the flounders alone.

At the present time flounders are still incidental in the catches of the larger offshore vessels, but increased demand for the lemon sole, gray sole and dab have encouraged smaller offshore vessels to fish exclusively for these species on some of their trips or at certain times of the year.

While changes in the offshore fisheries for lemon sole, gray sole and dab have been gradual and unspectacular in nature, the reverse is true in the inshore fisheries for blackback and yellowtail. Widespread use of the otter trawl by the inshore fishery for blackbacks resulted in increasingly larger catches of fish each year reaching a peak catch in the early 1930's roughly restimated at 40,000,000 pounds. Since then the catch of blackback has steadily declined to a level of 12,000,000 pounds in 1941. Part of the decline in catch of blackback is due to a decrease in their abundance. The fact that fewer blackback were available to the fishermen further contributed to the decline in catch by forcing blackback fishermen to seek other species of fish, particularly the yellowtail.

Fortunately for the fishermen concerned the demand for yellowtail, which previously had a limited market, suddenly increased greatly. As recently as 1930 most of the yellowtail caught were discarded at sea, only a few being marketed locally during the winter. About 1935 there developed a limited year-round market for yellowtail and by 1937 the catch had risen to 20,000,000 pounds valued at $500,000. Both the catch and the value remained approximately the same over the next two years but by 1940 the catch had increased to 37,000,000 pounds and the value to $775,000. Increasing consumer demand and the development of a fillet industry for yellowtail further stimulated the fishery until in 1941 the catch was over 50,000,000 pounds valued at $1,500,000.

The marked increase in catch and value of yellowtail from 1937 to 1941 is graphically shown in the adjoining figure. The relative importance of yellowtail also has increased from 40 percent of the catch and 25 percent of the value of all flounder landings in 1937 to 70 percent of the catch and 60 percent of the value in 1941.

Because of the sharp decline in catch and abundance of blackbacks and the marked increase in catch of the yellowtail the attention of the Service's flounder investigators has been directed primarily toward a study of these two species. Flounder fishermen are cooperating in the work by keeping log records of current catches and permitting examination of their catch records for previous years.

Mr. William C. Herrington

WINTER FLOUNDER STUDIES IN NASSAU COUNTY, NEW YORK

By ALFRED PERLMUTTER

In Charge, Flounder Investigations

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A report submitted to the Board of Supervisors of Nassau County, New York, July 1941, as part of the study of the winter flounder fishery of Nassau County conducted by Nassau County in cooperation with the Fish and Wildlife Service.

During the past year, the study of the winter flounder fishery of Nassau County was mainly limited to western Long Island Sound, which constitutes the most important flounder fishing area.

There are two main objectives in the study of the winter flounder fishery of western Long Island Sound:

1. To determine whether-or-not the abundance level of this species is being maintained and to develop remedial measures if overfishing is evident.

2. To determine whether an increase in legal size limit from 6 inches to 10 inches would be of practical value to the fishery.

Little progress has been made in the first of these objectives because determination of the level of abundance of winter flounder can be attained only over a period of years. Further, it will involve procuring detailed records of the amount of catch, the amount of gear fished and how long it took to make the catch. Such information is not available at present, nor is there any established agency that is able to obtain it. It is therefore strongly urged that a local system be established for the collection of these data since they are fundamental in the study of a fishery.

More progress has been made with the second objective, to determine whether an increase in legal size limit of the winter flounder from 6 inches to 10 inches would be of practical value to the fishery. During 1939, information was obtained on winter flounders in Long Island Sound as part of a study of winter flounders in Suffolk County waters conducted by that county in cooperation with the Fish and Wildlife Service. In general, an increase in legal size limit of winter flounder from 6 inches to 10 inches was found to be desirable but western Long Island Sound was an exception. Under suitable circumstances, allowing a fish to grow from the legal size limit of 6 inches to the proposed size limit of 10 inches leads to considerable gain in weight, for 6-inch fish average less than one-eighth of a pound, and 10-inch fish range from three-eighths to one-half pound. But the proposed increase in size limit would lead to complete destruction of the winter flounder sport fishery in western Long Island Sound for most of the fish caught there are under 10 inches in length and are known to grow more slowly than stocks in other waters of Long Island.

However, western Long Island Sound may be important as a spawning ground and nursery area for winter flounders, and as such contribute extensively to the support of the middle Long Island Sound fishery. For that reason, it may be desirable to protect the western Long Island Sound flounders to a larger size.

To test the contribution of the western Long Island Sound stock to the middle Long Island region, tagging experiments were carried on off Matinicock Point near Glen Cove. Of 353 fish tagged in April 1940, 23 percent or 82 fish were recovered to the present date and of 143 fish tagged in April 1941, 14 percent or 20 fish were recovered to the present date. All but five of the fish recovered were taken by the sport fishery in or near the vicinity of tagging. Of the exceptions two were caught by commercial fishermen, one off Block Island and the other near Fishers Island and the remaining three by sports gear off Northport, Port Jefferson, and Rye. While it is possible that as the fish become older and larger, ~~that~~ more will move to the middle Long Island region, present returns from tagging experiments indicate little movement in that direction of fish 10 inches or less in size. Consequently, protecting fish to 10 inches in length in western Long Island Sound would contribute little to the stock in middle Long Island Sound.

Therefore, since from past observations it was shown that an increase in the size limit of winter flounder in western Long Island Sound from 6 inches to 10 inches would lead to a serious curtailment of the sport fishery and because recent evidence indicates but slight contribution of this stock to other areas, it is recommended that the 6-inch size limit be maintained in the western Long Island Sound region. The results affirm a previous recommendation.

O.K. card and copy of publication to
Washington on 12/18/41

BLACKBACK OR LEMON SOLE?

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In 1905, the first New England otter trawler tried its hand at offshore fishing, concentrating its efforts mainly in the region of Georges Bank and South Channel. By 1913, five other boats had joined the fishery and the fleet has been growing steadily since. Among the new kinds of fish caught by those early boats was one that had the general appearance of a giant blackback. Because of its yellowish color, it was called lemon sole.

In time the lemon sole became a common species in the market and brought a higher price than the blackback. While originally the term "lemon sole" had applied only to those giant yellow-tinged flounders from Georges Bank, the general appearance of the lemon sole and blackback was so similar that separation of the two in the market was based entirely on size. Irrespective of the region in which they were caught, fish three pounds and up were listed as lemon sole and fish less than three pounds as blackbacks. The market separation of the lemon sole and blackback on the basis of size rests on the assumption that lemon sole are large blackbacks. But there is a possibility that the lemon sole and blackback are distinct kinds of fish and that a blackback can never grow up to become a lemon sole. If this is so, then their biology, abundance and productivity must be studied separately. Several methods are being used to determine whether or not the lemon sole is merely a large blackback or a separate species of fish.

One method of approach to the problem is determination of differences in the number of scales, fin rays and vertebrae (segments of the backbone) between fish inshore and on Georges Bank. Preliminary study indicates differences between the lemon sole as found on Georges Bank and blackbacks of similar size found inshore along the coast. Another method of approach is through tagging experiments. Movement of blackbacks from inshore waters to Georges Bank would be direct evidence that at least a part of the lemon sole stock on Georges Bank is nothing more than large blackbacks.

To tag blackbacks, celluloid discs, 1/2 inch in diameter, one red, the other white, are attached by means of a pure nickle pin in the region just back of the head of the fish. A white disc is placed on the black side of the fish and a red disc on the white side. By recording the number on the disc and the date and place the fish was released and comparing these notes with information on the place and date of recapture of the same numbered fish, it is possible to determine movement and amount of mixing of stocks of fish.

In a recent experiment, 495 blackbacks from the catch of the Nantucket dragger Ebenezer were tagged. They were released in the vicinity of Dilberry Shoal, 10 miles ESE of Great Point Light, Nantucket. The results of the tagging experiment will show whether blackbacks on Dilberry Shoal move offshore to Georges Bank and are caught there as larger fish, the so-called lemon sole, or whether they move inshore and are merely another local stock of blackbacks.

It is planned to tag fish off Nantucket, Cape Cod and Georges Bank to obtain further information on the relationship of the blackback and lemon sole.

No image available.

FIGURE .—Tagging blackbacks. A white celluloid disc is placed on the black side and a red celluloid disc (see above) on the white side. The discs are fastened to the fish in the region just back of the head by means of a pure nickel pin. After measuring the fish on the rule shown in the foreground the number and size of the fish are listed in a record book.

Presented October 31,1941, Second Annual Conservation Congress by Worcester Natural History Society, Clark University, Worcester.

Two copies and publication cards sent to Washington on Nov. 21, 1941 - accompanied by one set of lantern slide prints.

THE WINTER FLOUNDER AS A SPORTS FISH

What we know about its life history and habits

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Probably most of you at some time or other have seen, caught, or eaten the winter flounder. Although readily distinguished from other kinds of fish because of its flat body and the arrangment of both eyes on the same side of the head, the winter flounder is often confused with other species of flounders particularly the summer flounder or fluke.

SLIDE 1 - Reading Book while Sitting on Barrel

If we consult some authoritative book on the identification of fishes as our friend Ulva C. Weed is doing, major differences between the winter flounder and the fluke are at once evident. Both the winter flounder and the fluke have one side white and the other side colored.

SLIDE 2 - Winter Flounder and Fluke

Notice that when the two species are laid out colored side up with the lower jaw facing us, the winter flounder is swimming toward the right and the fluke toward the left. Also, the winter flounder's mouth is small and extends only to the front of the eye, while the fluke's mouth is much larger and extends to the back of the eye.

In recent years there has been considerable interest in the sport fishery for winter flounder. We know, for example, that in Long Island, New York, the sport fishery takes about as many winter flounders as the commercial fishery; and tagging experiments indicate that in some parts of Connecticut and Rhode Island a major share of certain stocks of winter flounder is taken by the sport fishery. The exact amount of the sport catch is unknown since no records of this activity are kept. However, we do know that the commercial catch for 1938, the last year for which records are available, was over 18½ million pounds.

While the sport fishery for winter flounder is directly important because a large number of the fish caught are utilized for food, the real value of the fishery is an indirect one.

SLIDE 3 - All Fishing About Him

The winter flounder may be taken in early spring and late fall, seasons of the year when few other species are biting. Furthermore, flounder fishing is inexpensive and everywhere accessible; consequently, a greater number of people are able to enjoy this recreation.

The winter flounder is widely distributed in bays and estuaries from Maine to New Jersey.

SLIDE 4 - Gloucester

Here we see a region North of Cape Cod noted for its flounder fishing. All through the Anisquam River and around Gloucester Bay as far as the breakwater at Eastern Point, flounders may be readily caught.

SLIDE 5 - Long Island

Going further south to the region of Long Island, New York, we find western Long Island Sound, Great South Bay, Moriches Bay, Shinnecock Bay and the Peconic Bays, all favorite flounder fishing areas. Also to be considered is the Mystic River of Connecticut and the Great Salt Pond of Rhode Island.

SLIDE 6 - New Yorkers Map of the United States

as well as hundreds of other places equally favored by flounder fishermen, places which some of you may have fished and can readily locate on this map.

Depending on the locality, winter flounders are commonly fished for from open and charter boats, rowboats, banks and docks.

SLIDE 7 - Party and Open Boats

Here is a group of open and party boats fishing in one of the Long Island Bays. Open boats, as the name implies, are available to any fisherman who is willing to pay a fare of from 1½ to 2 dollars. The boats are often of large size. For example, in Long Island they include converted sub-chasers of over a hundred feet in length. Charter boats are generally smaller in size than open boats. They cater to private parties of from eight to twelve people and are hired by the day at a price ranging from 15 to 25 dollars.

SLIDE 8 - Rowboat and Bank Fishermen

Rowboats are even more extensively used than open or charter boats in fishing for winter flounder. Rowboats may be rented by the day or part of a day at a cost of from 50 cents to one dollar. An additional charge of 50 cents is made for towing the boat to and from the fishing grounds or for the use of an outboard motor. Dock and bank fishing for winter flounders is also very popular, particularly during February and March when it is a bit too cold to remain inactive in a boat for any length of time.

Whatever the method used in fishing for flounders, the amount of enjoyment and recreation received by the fishermen can hot be gauged in dollars and cents. However, the return to the local community as a result of the sport fishery for winter flounder is more concrete.

SLIDE 9 - Tackle Store

Such things as gasoline and oil, food and sports clothes, tackle and bait, bought by winter flounder anglers contribute to the support of many communities. Consider one item alone, bait. In 1939, Maine sold 15,000,000 worms valued at $113,000 and in 1940, 9,500,000 worms valued at $71,000. A large number of these worms was used in the sport fishery for winter flounder.

SLIDE 10 - Canoe Place

Here are flounder fishermen at Canoe Place, Long Island. The winter flounder fishery in this area helps appreciably in supporting the community. The group of anglers shown here have just gotten off the Long Island Railroads "Fisherman Special". The "Fisherman Special" is an excursion train run from the heart of New York City to Canoe Place and Montauk, at the eastern tip of Long Island and about 125 miles from the city. The enthusiasm of the anglers upon reaching their destination is an unforgettable sight.

SLIDE 11 - Fisherman Running

There is a general rush to the restaurants for a hot cup of Java, followed by a dash to the tackle shops for last minute needs, and then a race for the most popular of the open part boats.

However, in the past several years the sport fishery for winter flounder has been faced with the problem of a growing scarcity of fish. A growing scarcity of winter flounders is also reported by the commercial fisheries. In order to determine the factors responsible for the scarcity of winter flounder so that measures might be taken to bring back good fishing, a study of the winter flounder was begun in 1938. Examination of fisheries records indicates a decline in the winter flounder catch of the North Atlantic region. I shall not go into a detailed explanation of the figures involved except to cite the case of Long Island, New York, where the catch of all species of flounders fell from 5,500,000 pounds in 1931 to less than 3,000,000 pounds in 1938. A large part of the 1931 and 1938 catch consisted of winter flounders.

Our problem is to determine the causes of the growing scarcity of winter flounder and to recommend measures necessary for the recovery of the fishery. To do this certain biological and statistical information must be obtained. It is primarily about the biological information that we will concern ourselves today. That is, what type of biological information is needed for the solution of our problem and how and where can we obtain it.

Important in the problem of winter flounder conservation is the determination of the composition of winter flounder stocks in various regions. If, for example, the winter flounders in, let us say, Cape Cod Bay remain in that area and do not mix with flounders in Buzzards Bay or off Georges Bank, then the biology of the Cape Cod Bay stock of flounders and the effect of the fishery on that stock can be studied independently of other areas. If, on the other hand, the Cape Cod Bay flounders move to Georges Bank and Buzzards Bay, it would be necessary to study the three populations all at the same time, for they are not independent of each other. You can go now, Ulva.

SLIDE 12 - Tagged Winter Flounder Showing White Disk.

Tagging has been found to be one of the fastest and most efficient ways of obtaining information on the composition of winter flounder stocks. Briefly, the tagging procedure is somewhat as follows. Generally, fish are captured by means of flounder drags. To prevent undue injury to the fish used for tagging, the flounder drag is never fished more than one-quarter to one-half the customary two-hour drag of the commercial fishermen.

A measuring board is used to obtain the length of the fish. This board consists of a flat piece of wood to which a nose block has been nailed at one end and in which a metal rule has been set in a groove running the length of the board. The rule is marked off in units of half-centimeters, five of which equal one inch. Each fish is measured by placing its snout flush against the upright nosepiece and reading off the number on the rule which is covered by the extreme end of the tail.

While the fish is being measured, a few scales are taken from the tail region of the body at a point where the upper and lower fins end. Scales from this region have been found to be more desirable for determining ages of winter flounders than scales from any other region of the body. Sex is determined throughout the spawning season by rubbing the white side of the fish in the direction from tail to head. In the male, the white side feels rough and in the female, smooth. Of course, should the fish be ripe, the sex is easily determined by the flow of eggs or milt. The length and sex are recorded and the scales placed in the little notebook shown above and the tag number of that fish is also recorded. This fish is now ready to be tagged. The tag used consists of two celluloid disks, one-half inch in diameter, one white and the other red, placed one on each side of the fish in the position just back of the head, and bound together by a pure nickel pin. The disc is placed on the black side of the fish and has inscribed on it the legend "U.S.F.W.S." the abbreviation for United States Fish and Wildlife Service, and a tag number.

SLIDE 13 - Tagged Fish Showing Red Disk

The red disk is placed on the white side of the fish and contains the legend "U.S.F.W.S.", "Return both disks, Washington, D.C., Reward".

SLIDE 14 - Tag Return Folder

The tag return folder shown here is distributed to individuals fishing in regions where tagging experiments are being conducted and to fishermen who have sent in tags from recaptured flounders. On the inside of the folder is a space for recording the recaptured tag number. Beneath this, information is requested concerning the locality in which the tagged fish was caught. On what date? In what depth? Length of fish? When was tag seen? Kind of gear? Name of boat? Name of finder? Street and number? City? State? The diagram to the right illustrates the region from which scales should be taken for use in age studies, a subject which will be discussed presently. The diagram covers a small envelope into which both the scale sample and tags are placed. On the outside of the folder is our office address and a brief summary of the purpose of tagging experiments, stating that:

"The United States Fish and Wildlife Service is conducting tagging operations to gain all possible information on the habits, migrations, spawning seasons, and rate of growth of food fishes. The cooperation of the fishermen who take tagged fish is necessary to the success of this enterprise. The signer of this card will receive full information as to date and place of tagging, distance of place of recapture from tagging location, and other general information of interest. A REWARD will be paid for each tag sent in with locality and date and such other information as can be furnished. The blanks on this shipping tag indicate those facts which will be particularly useful."

The word "reward" has been mentioned twice in the past few minutes.

SLIDE 15 - Tagged Fish Reward Dream

It's only fair to warn you that the dollar reward offered for the return of a tag together with the required information is not large enough to justify visions of a new car or boat.

SLIDE 16 - Movement of Winter Flounders in Rhode Island and Connecticut Waters

The results of some of our tagging experiments are illustrated in this slide which shows the movements of winter flounder in Connecticut and Rhode Island Waters. The black circles indicate the areas where fish were tagged and the black squares the areas in which fish were recaptured. In all cases a large number of fish were recaptured near the tagging locality even as much as three years later. Notice that the fish in Warwick Bay and Mt. Hope Bay moved out of their home areas and travelled as far outside of Narragansett Bay as Brenton Reef and Pt. Judith; and that fish tagged in the east passage and the west passage of Narragansett Bay in the general region of Wickford also travelled as far offshore as Brenton Reef and Pt. Judith. Fish tagged in Pt. Judith Pond moved as far offshore as half the distance to Block Island from Pt. Judith. A few went to the region off Pt. Judith and still others to the mouth of the west passage of Narragansett Bay. Occasionally, a fish travelled further to the eastward to Nantucket. Fish taggrd at Watch Hill and in Fisher's Island Sound moved to the eastward to the region midway between Pt. Judith and Block Island. Several individuals travelled as far to the eastward as Nantucket. Generally, fish did not travel more than   miles away from the region in which they were tagged. In all of the experiments it was found that the movement out of the bays to more offshore waters is a seasonal one: that is, fish 3 years old or older tend to move out of the bays during the summer and to scatter in the deeper, cooler offshore waters. In the fall, however, they return to inshore waters, where they spawn the following spring.

Similar results have been obtained with stocks of flounders tagged in Long Island, N. Y., in Vineyard Sound, Mass., and in Johns Bay, Me. It is evident, then, that the winter flounder can be separated into definite stocks of fish since movement is mainly limited to seasonal movements from the shallow, warmer bays to the deeper, cooler, offshore waters in the summer and a return to these bays in the fall for spawning the following spring.

Results from tagging experiments now in progress and from future tagging experiments will serve to better identify these local stocks.

As I mentioned previously, in general, fish of about three years and older move out of the warm, shallow bays in summer.

SLIDE 17 - 3-Year Scale of Winter Flounder

You may have wondered how we could be sure that the fish were of that age, which brings us to the method of determining age in the winter flounder. Doubtless all of you are familiar with the rings showing in the stumps of trees. The distance between these rings or circuli indicates how fast the tree grew during a particular period. If growth was fast, the rings are far apart. If growth was slow the rings are close together. Thus, in summer the rings would be far apart and in winter they would be closer together. A band of summer and winter rings therefore indicates one year's growth. By counting the number of summer and winter bands in the tree stump the age of the tree may be determined. A similar pattern of summer and winter bands appears on the scales of the winter flounder.

It has been found that throughout the summer months, there is a rapid growth of the winter flounder which is reflected in the wide spacing of the rings or circuli of the scale. As winter approaches, the rings grow closer together. Consequently, there appear on the scales two contrasting bands, one lighter and more dispersed, the summer band; and the other darker and denser, the winter band. One summer and one winter band comprise a year's growth. I might mention that distinct summer and winter bands are not always apparent in the first year's growth and that other methods are therefore used to determine this growth. Thus, we see the first year's growth at the center and the base of the scale; then a fast period of growth for the following summer and a slow period of growth for the following winter, making the fish 2 years old at that time; then a third period of rapid growth followed by a third period of slow growth making the fish 3 years old.

SLIDE 18 - 5-Year Scale of Winter Flounder

Similarly, the age can be determined for this fish. I year; fast growth, slow growth, 2 years; fast growth, slow growth; 3 years; fast growth, slow growth, 4 years; fast growth, slow growth, 5 years.

From age determinations by means of scale reading much additional information is obtained. It is possible to determine the ages of flounders which are being caught most rapidly; the age of the flounder when it first spawns; and how fast the flounders grow in different areas. The difference in rate of growth in fish from different areas is useful to substantiate the distinctness of certain stocks as shown by tagging studies. Closely related to our study of the movements and ages of the winter flounder is the study of the sizes of the fish which comprise the local stocks.

SLIDE 19 - Length Frequencies

To put the information on sizes of fish into a form which permits immediate and easy analysis, we resort to length-frequency diagrams. Length-frequency diagrams are not used exclusively by the fisheries biologist, but are standard tools in other sciences. They are simply a method of graphically showing the number of individuals or things in a given group that fall into certain size classes.

Let me point out some practical conclusions which may be drawn from the series of winter flounder length frequencies on this slide. On the lower horizontal line, the size of the fish has been indicated in inches, starting with 4 inches and going to 14 inches in the diagrams to the left; and starting with 4 inches and going to 18 inches in the diagrams to the right. For the benefit of you who would rather think of winter flounder in terms of pounds, the approximate weight of each size of fish has been placed in the upper right-hand corner.

Fish of 6 inches average a little over 1/16 of a pound
Fish of 8 inches a little over 3/16 of a pound
10 inches a little over 6/16 of a pound
12 inches less than 3/4 of a pound
14 inches over 1 pound
16 inches less than 1-3/4 pound

On the vertical line to the extreme left, the percentage of fish of a certain size is indicated, as for example, 0 percent, 5 percent, and 10 percent. For convenience in discussion, the bays have been labelled A Bay, B Bay, C Bay, and D Bay instead of their customary names.

Let us consider A Bay first, the diagram shown in the upper left-hand corner. These fish were taken by rod and reel in June 1940. Notice that the majority of the fish caught were between 8 and 13 inches. Skipping the next diagram and going to B Bay as shown in the diagram in the lower left-hand corner, fish caught in the same month by sports gear were of about the same length as fish in A Bay. As a matter of fact, A and B Bays are continuous with one another and this similarity of size composition at the same time of the year would suggest that the fish in A and B Bays are of the same stock; but of course, additional evidence would be needed to substantiate or disprove this hypothesis. Let us now look at the diagram at left center of the slide: the sport catch in B Bay during October 1939. Notice that most of the fish are between 8 and 10 inches, while in June of the following year, as shown in the lower left diagram, fish between 10 and 13 inches are in the majority. This clearly substantiates the results obtained in our tagging experiments, for the small fish caught in October are the summer resident stock of fish less than 3 years old, while the larger fish caught in June consist of some of the resident stock which has reached the age of three, and older fish which had moved into the bay in the late fall of 1939 to spawn.

Going into a different region, C Bay shown in the upper right diagram, we find the sport catch in April 1940 took a large percentage of fish less than 10 inches, which sizes were released by the fyke net fishermen in D Bay during the same month, as indicated in the lower right diagram. In the upper right and middle right diagrams, you may notice two little symbols close to the dot-dash line and the dash line. These signify the sex of the fish measured. The circle with the cross beneath it is the length frequency of the females and the circle with the arrow off one side, the length frequency of the males. Notice that in C Bay, females were more common in the sport catch, while in A Bay the fyke net fishermen took a larger number of males than females.

From observations made in both the field and the laboratory, we have found it expedient to depend on actual measurements of fish rather than on estimates of sizes of fish as reported by the fishermen.

SLIDE 20 - Taxidermist

Too often 10-inch fish look larger than the really are, and are reported as "about one foot long." Sometimes the reverse is true, and a 10-inch tagged fish which is recaptured a few days after its release is reported as "about 9 inches." That is a shrinkage of one inch in a few days. I dread to think what the fate of this particular fish would be in, say, a relatively few months, if the rate of shrinkage in size were to continue.

SLIDE 21 - Group of Winter Flounders

Here is a group of winter flounders from Long Island Sound posed for a family portrait. From what we have discussed today, what can we say about this group of fish? For one thing, they belong to a localized stock which tends to remain in the general region of Long Island Sound moving more offshore toward the ocean in the summer and returning to the spawning area in the Sound in late fall.

We know that the largest fish is 12 inches long and 5 years old and weighs a little less than 3/4 of a pound; that the fish in the center is 11 inches long, 4 years old, and a little over 1/2 pound; the fish at the bottom. 10 inches long, 4 years old, and 3/8 of a pound; and the two fish on the left, 9 and 7 inches long, the larger a 3-year-old weighing 1/4 of a pound and the smaller a 1-year-old weighing 1/8 of a pound. The two small fish on the right are 5 and 3 inches long; both are young of the year and weigh less than one ounce apiece.

From the biological data which have been presented, it has been possible to draw certain practical conclusions. I will not attempt to show how the above biological information has been applied in practice, but rather will refer you to a report to Suffolk County, New York, published last October, in which an increase in size limit from the legal 6 inches to 10 inches was recommended for certain Long Island bays. The purpose of this increase in size limit is to permit the winter flounder to grow to a size that makes it more valuable as a pan fish and more desirable as a sport fish, thus assuring better utilization of the flounder supply.

It is expected that as more biological data are collected in the New England and New York areas and more detailed records of catch become available, the factors responsible for the growing scarcity of winter flounders will be determined and measures be recommended to assure better fishing.

Thank you, ladies and gentlemen.

SLIDE 22 - Good Night and Good Fishing

Good night and good fishing.

April 24, 1939

PROGRAM FOR FLOUNDER INVESTIGATIONS, SUFFOLK COUNTY, LONG ISLAND, N.Y.

by

Milton J. Lobell
Jr. Aquatic Biologist
In Charge, Flounder Investigations, U.S.Bureau of Fisheries

Suffolk County directly accounts for almost the entire commercial catch and for at least 75 percent of the sports catch of flounders in Long Island waters. For many years, the bays have been fished by county residents who have looked to the sea for their livelihood. More recently, tourists and sportsmen have become acquainted with the pleasures afforded by salt-water angling and have flocked into your county in ever-increasing numbers. The benefits of this development are apparent. Thousands of dollars are spent annually for boat hire, gear, bait, transportation, food and lodging, and liquor, which never would be spent in this region if you had no fishing to offer.

Now, let us examine more carefully that which we are offering to the world. Since I am particularly interested in flounders, I will confine my remarks to that species.

We must know before we can put any work on an efficient basis, What is the condition of the flounder stock in your waters? Are flounders becoming more abundant? Less abundant? Or are they just maintaining themselves? It is common knowledge that the strain of fishing is increasing. Can the population stand that strain or has it already begun to decline due to the intensity of fishing? I am inclined to agree with the information given me by men who have fished in this region. They say that flounders are declining in numbers. At any rate, we all agree that the abundance has not increased.

How are we going to be able to find out what the condition of the stock is? It's going to take all the cooperation we can get from both the commercial operators and the sportsmen. We are going to ask them to keep simple records of where they fished, how long they actually fished, and how much or how many fish they caught each day. By comparing these records for several years, we can determine just what is happening to the stock.

The second part of this program concerns itself with a study of the fish themselves. We would like to answer this question: Are you dependent on fish produced elsewhere or do you produce fish taken in significant quantities outside of your region? If we are going to expend time and money in trying to build up our supply of fish, we should be satisfied that our efforts will benefit the fishery in this region. If the fishermen are catching flounders that are produced in some other region, it will be necessary to develop a cooperative program. If your fish are caught in large amounts in other sections, you cannot hope for complete success unless cooperation can be established.

I believe that we can, in general, say that <u>your</u> flounders are <u>your</u> problem. We have conducted tagging experiments in your waters for several years. I have here a chart showing roughly the extent of migration of the fish tagged and where they were originally tagged. By far the greatest percentage of these fish was caught by fishermen operating in waters in or immediately adjoining Suffolk County. In addition, fish from Connecticut, Massachusetts, and Rhode Island are available to your fishermen during the summer in the waters between Gardiners Island and Block Island.

The winter flounder problem is complicated because the population tends to be split up into a number of racial groups. Work we have already done indicates that such groups may be found in Peconic Bay, in Long Island Sound, in Great South Bay, and possibly in the Shinnecock-Moriches area. We know that the Peconic Bay fish (which in the summer migrate seaward to the area between Gardiners and Block Island) average considerably larger in size than fish from other regions. It will be necessary to determine the condition of the stocks in these bays, to find out what proportion of each is drawn on by the fishery, and to what extent these groups intermingle.

A great deal of talk is heard regarding size limits. One must have a sound basis on which to recommend a size limit. This basis must naturally include the rate of growth of the fish and the age at which they spawn. I have discussed the probability that different waters support groups of flounders that grow at different rates. If this is true, size limits must be gauged to suit the conditions of each area. We are interested in getting the maximum return in pounds of fish without endangering the chances for the future. If we can do this by removing the fish at 6 inches, all right. But if the fish continue to grow rapidly up to 10 inches, it would be foolish to catch them at 6 inches providing that death by natural causes does not exceed the increase in poundage through growth. In other words, we cannot afford to waste fish, but must take into account both the growth rate and death rate. We must also consider the size at which they spawn. If the fish spawn at a size below the size limit, all well and good; if they spawn above the minimum size limit, you're cutting your own throat by setting such a low limit.

I think I have made it quite clear that any size restrictions must be based on biological study in order to be effective. You are probably wondering how we are going to find out all these things.

No doubt, you have heard at one time or another about the Government employee who was wasting his time measuring fish and scraping scales to put into little envelopes. On the surface, I suppose, it does sound rather humorous. Yet, by properly analysing these data, we can answer the questions I have outlined. We can determine the age from the scales. Knowing the age and the length or weight, we can work out the rate of growth. By studying the spawning fish, we can determine the age and size at spawning. By examining the data on the size and age of fish taken by various fishing gear, we can determine the effect of each type of gear on the population. We can also determine the age composition of the stock in each of the racial groups I have previously mentioned. This will give us the information to ascertain whether regions such as Long Island Sound support a stock of young fish or whether the fish there are slow growing.

You would like to know how many fish can safely be removed from, say, Peconic Bay in any one season. So would I. We have ways of finding out. By tagging a number of fish each year for several years, and by knowing the intensity of fishing, we can get a good approximation of the proportionate amounts of fish caught and at what age they are caught. By working in the growth rate and age at maturity, we can arrive at a figure which will assure us of sufficient stock to carry the population at a high level.

For some years, hatcheries have planted flounder fry in Long Island waters. The part that this activity plays in maintaining the supply should be determined. We will have means available to study the time and extent of natural spawning. Also, we can devise means to get an approximation of the relative survival of naturally-spawned eggs and larvae. Hatchery plantings can be tested only by careful experimentation which will require several years of work. Other factors such as the disappearance of eelgrass may have had a large effect on the survival of young.

I have one practical experiment that may be fruitful. I refer to the transplantation of young fish. If Long Island Sound or Shinnecock-Moriches supports a stock of fish with a much lower rate of growth than the Peconics, I see no reason why young fish from those areas could not be liberated in the Peconic or Gardiners Bay region. However, let us proceed with a great deal of caution. Understand that we do not intend to rob those other areas of fish. The only condition that would permit the regular practice of transplantation would be that these areas were overcrowded. Supposing that we take Shinnecock-Moriches as an example. If we thin out the population of small fish, then more food would be available to those remaining and consequently, their total size would more than compensate for the small fish removed. At the same time, the transplanted fish would have the benefit of the richer and less densely populated feeding areas in Peconic and Gardiners Bays. Remember, that this experiment is dependent on a number of factors, any one of which might render the work useless. But, should the experiment pan out, it means that thousands of fish can be added each year to the Peconic area without endangering any other area; in fact, all areas would be benefited. Such work has been extensively carried out with North Sea flatfish. In

Denmark, these transplants are made annually with signal success.

In closing, I wish to stress one point. You are going to ask, naturally: "What can we expect as the result of your year's work?". We can give you production statistics, some studies on the growth rate, and perhaps some information on suitable size limits. I want to suggest strongly, here, that this program be planned for at least three years—longer, if possible. Given that length of time, we will have four seasons for comparison. Our tagging and transplanting experiments will be completed, racial studies and growth rate studies will be able to furnish us the information we desire for recommending suitable size limits. All in all, as each year of the three goes by, we will have an enhanced picture; whereas, one year's study, no matter how well carried on, will give us no basis for comparison.

IN REPLY REFER TO

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Washington 25, D. C.

September 5, 1945.

Dr. Alfred Perlmutter,
Post Office Building,
Gloucester, Massachusetts.

Dear Dr. Perlmutter:

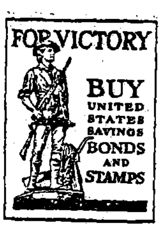
With further reference to your letter of July 6, I am including my comments on your paper, "Effectiveness of hatchery plants in maintaining the supply of blackback flounders.

Very truly yours,

Elmer Higgins, Chief,
Division of Fishery Biology.

Enclosure 2283385

CC to Mr. Herrington
Mr. Bailey



Comments on "Effectiveness of hatchery plants in maintaining the supply of blackback flounders."

My first general comment on this paper is that the style is too terse and telegraphic. The reader must pore over the tables and graphs and make his own interpretations. These should be incorporated in the text.

The report is in reality in two parts, one dealing with Great South Bay and using one method of approach and the other dealing with Boothbay Harbor and using a quite different method of analysis. The two are not adequately separated nor introduced.

Instead of multiplying known quantities by $1\frac{1}{4}$, $1\frac{1}{2}$, etc., to show the worst possible picture of hatchery results, it would be preferable to base the analysis entirely on actual data that can be supported without question. In this regard table 1 does not indicate that the catches are in thousands of fish.

The method used in estimating the total flounder population of Great South Bay from a single tagging experiment of 291 fish is open to serious question. You have taken the 21 percent recovery from each method of fishing as a minimum tag return ignoring entirely the error involved. The standard error for 21 percent of 291 fish is 2.4 percent. In other words your return of 21 percent may be either high or low. There is no possible justification for increasing this figure by $1\frac{1}{2}$ times and 2 times as you have done. You have apparently overlooked another fact, that is, that the 21 percent tag recoveries of the sport fishery came from an estimated catch of 154,000 fish, while the 21 percent recoveries of the commercial fishery came from a catch of 277,000 fish. This would indicate extreme variation in returns. Certainly it needs full and adequate explanation if the data are to be used. Perhaps you have noted that doubling the 42 percent return from both types of fishing gives an 84 percent recovery, which is obviously an unwarranted exaggeration.

On page 4 you assume that the tagged fish distributed themselves at random throughout the population, but as mentioned above there may be grave doubts as to whether this holds true. I note that there is no mention of the size composition of the tagged fish but I assume that they are the same fish shown as captured by otter trawl in January 1938 (Fig. 2), and the same 291 fish mentioned in the last paragraph on page 4. If they are the same fish the proportion of 204 females to 82 males raises the question as to whether this sample is actually representative of the Great South Bay population. There is no indication as to whether this is a single catch or a combination of samples.

Your section 4 on page 4 and 5 adds nothing to the paper since you disregard the material presented as inadequate and use a 50% sex ratio, and I would recommend omitting it entirely.

In section 5 on page 5, you state that "field observations on blackbacks during 1940 showed the females to be ripe at 10 inches and over." Because the whole report hinges on the relative amount of young produced by natural and artificial means this statement is wholly inadequate. Your statement implies that there is a sharp line at 10 inches beyond which all female blackbacks are mature. Whether 50% or 100% are mature at 10 inches makes a great difference in your results. You go on to state that, "The commercial catch consists primarily of fish over ten inches, and it is therefore considered that the entire commercial catch comprises mature females." Aside from the fact that approximately half the catch is males, your size frequencies in Figure 2 show this statement to be seriously in error. Again you are warping your analysis to present the worst possible picture of hatchery operations. This whole section on the proportion of mature females requires both a proper curve for maturity and a properly weighted size frequency of your population. Neither have been presented.

In section 6 on page 5, you have again fallen into the error of making a bald statement of fact without any supporting data. Just how did you determine that "each female was capable of producing 413,000 eggs." What is the relation between size and weight of the females and egg production? Is the total ~~quantity~~ quantity of eggs that you state a female is "capable of producing" realized in hatchery practice? How did the hatchery determine the number of eggs? What original observations, if any, did you make on the quantity of eggs in female blackbacks? How many specimens entered into your average and what error was involved?

In section 8, page 6, the first two paragraphs are out of place as they discuss results before the data on which they are based have been presented. It is apparent that you have no data on natural survival of eggs. The laboratory data on survival are at best very sketchy. Your one jar experiment is unreliable since you have no replicates or other means for judging of its significance. Certainly you are not justified in using laboratory survival as a measure of natural survival.

Your paper gives no figures on the total output of fry at Woods Hole, or what portion of the fry were released in Great South Bay. Perhaps, these plants were but a very minor part of the operations.

The analysis of the effect of hatchery plants on the stock of blackbacks in the vicinity of Boothbay Harbor depends almost entirely on the catch-per-fyke truly representing the abundance of the blackback population. From the very low tag recoveries obtained (page 8) and the fact that only 2 tags were recovered during 3 fishing seasons by the hatchery, it would appear that the fyke netting by the hatchery either took but a tiny proportion of an abundant population, or your conclusion as to the population being non-migratory (based on inadequate data) is erroneous. Either conclusion seriously vitiates your results.

I note that you based your conclusions on the age of blackbacks at Boothbay Harbor (top of page 9) on your age analysis made south of Cape Cod. This may be seriously in error.

Your whole analysis on page 9 is based on casual inspection of the data without any statistical treatment; furthermore you have not shown the fry plants by years so that anyone can form any judgment as to the validity of your observations.

In conclusion, I feel that there are too many points of importance in reaching your conclusions, upon which sufficient data are either lacking or have not been fully or adequately presented, to warrant publication of the paper. However, the subject is timely and important, and if the material is available, it should merit further study.

Please discuss this entire subject with Mr. Herrington and be guided by his advice.

IN REPLY REFER TO

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Post Office Building
Gloucester, Mass.

February 3, 1945

Mr. William C. Herrington
Fish and Wildlife Service
71 Mt. Auburn Street
Cambridge 38, Massachusetts

Dear Bill:

Enclosed is the original copy of my manuscript on the "Effectiveness Of Hatchery Plants In Maintaining The Supply Of Blackback Flounders, *Pseudopleuronectes americanus*," a copy of which has been forwarded to Dr. Higgins, as instructed in the memorandum dated August 9, 1944.

Your comments would be greatly appreciated.

Very truly yours,

Alfred Perlmutter,
Aquatic Biologist

AP:MD

Enclosure

Post Office Building
Gloucester, Mass.

February 3, 1945

Dr. Elmer Higgins
Fish and Wildlife Service
South Interior Building
Washington 25, District of Columbia.

Dear Dr. Higgins:

In accordance with your memorandum of August 9, 1944, I am transmitting herewith a copy of a report titled "Effectiveness Of Hatchery Plants In Maintaining The Supply Of Blackback Flounders, Pseudopleuronectes americanus."

The original copy has been sent to Mr. Herrington.

Very truly yours,

Alfred Perlmutter,
Aquatic Biologist

AP:MD

Enclosure

CC -- Mr. William C. Herrington

EFFECTIVENESS OF HATCHERY PLANTS IN MAINTAINING THE SUPPLY OF BLACKBACK FLOUNDERS, PSEUDOPLEURONECTES AMERICANUS

Alfred Perlmutter, Aquatic Biologist
United States Department of the Interior, Fish and Wildlife Service

The blackback flounder, *Pseudopleuronectes americanus*, supports an extensive commercial and sport fishery along the American Atlantic Coast, particularly in southern New England and New York. The value of this highly desirable food fish was recognized by the United States Fish and Wildlife Service early in the history of the fishery, and its marine hatcheries planted larval blackbacks regularly in an effort to maintain a large supply. Such plants continue to the present day. However, their effectiveness in maintaining the supply is unknown.

In the course of investigation of the blackback and blackback fishery by the Fish and Wildlife Service, it was considered essential that the contribution of hatchery plants to the supply be evaluated to determine whether or not areas showing a decline in abundance of blackbacks could be aided by plants of larval blackback. Records of blackback larvae-planting programs were available at the Service's marine hatcheries at Woods Hole, Massachusetts and Boothbay Harbor, Maine, and with these as a basis, a study was made of two areas of intensive planting activity; namely, Great South Bay, New York, and the vicinity of Boothbay Harbor, Figure 1. The effectiveness of hatchery plants in maintaining the abundance of blackbacks in Great South Bay was evaluated by the following procedure summarized in Table 1.

1. Number of Blackbacks Caught in Great South Bay in 1938 by the Sport Fishery.

New York State Conservation Department records show a 1938 catch of 277,000 fish by the Great South Bay sport fishery, (2) p.71. This figure is lower than the actual number of fish caught, since blackbacks are taken by an extensive and scattered small-boat fleet comprising both power and row boats, as well as from docks and piers, and complete coverage of catch was not possible with the available facilities. To compensate for incomplete coverage of the sport catch of blackbacks, it is assumed that the actual sport catch may have been $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$ and 2 times the tabulated catch, or 347,000 fish, 416,000 fish, 485,000 fish, and 555,000 fish respectively, with the probability that the lower rather than the higher values more truly represent the actual number of fish taken.

2. Number of Blackbacks Caught in Great South Bay in 1938 by the Commercial Fishery.

New York State Conservation Department records show a 1938 catch of 106,700 pounds of fish by the Great South Bay commercial fishery (2), p.68. Conversion of the catch in pounds to catch in number of fish presents a problem, since available length frequency data for that year is fragmentary with no samples of either fyke and otter trawl nets in February and no otter trawl samples in either March or April, Fig. 2.

To obtain an estimate of the number of fish taken by the commercial fisheries, the length-frequency distribution of blackbacks caught by otter trawl during January, 1938 was assumed to be representative of the total commercial catch throughout the fishery season. This furnishes a minimum figure for the number of blackbacks caught since the January length frequency shows a greater preponderance of large fish than frequencies at other times of the year, and the larger fish being heavier, the number of these fish making up the total catch in pounds would be less. The median length of fish in the January sample is 59 half-centimeters, having an average weight of 11.1 ounces, (3), p.15. By dividing the total catch in pounds by the weight of the median fish, 106,700 by 11.1 a minimum estimate of the number of blackbacks taken by the commercial fishery is obtained equal to approximately 154,000 fish. In compensation for the minimum figure obtained as well as for possible incomplete coverage of the commercial catch of blackbacks, the calculated number of blackbacks caught by the commercial fishery is increased $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$ and 2 times, giving respective values of 192,000, 231,000, 269,000, and 308,000 fish.

3. Total Population of Blackbacks Available to the Commercial and Sport Fisheries of Great South Bay in 1938.

By means of tagging experiments, it is possible to estimate the total population of blackbacks available to the commercial and sport fisheries of Great South Bay in 1938. Of 291 fish tagged in January, 1938, recaptures for the year were 21 per cent each for the sport and the commercial fisheries. However, these percentages must be minimum figures, since it may be expected that some tags will be lost or overlooked by fishermen, others may become detached, or some of the tagged fish may die as a result of tagging operations. To allow for these possible tag losses, it is assumed that the actual tag returns are too low and that they should be $1\frac{1}{2}$ times as large, or

31.5 per cent returns, and 2 times as large, or 42 per cent returns.

Assuming the tagged fish as distributing themselves at random throughout the blackback population in Great South Bay, then the percentage tag return and total catch can be used to evaluate the population available to the fisheries, which would be the calculated catch for 100 per cent tag recovery. Therefore, using the actual tag return value of 21 per cent and the assumed greater tag return of 31.5 per cent and 42 per cent together with the number of fish taken, a total population figure for 100 per cent tag returns is obtained for both the sport and commercial fisheries. Estimates of total population are also computed on the basis of catch equal to $1\frac{1}{2}$, $1\frac{3}{4}$ and 2 times the calculated catch. Subsequent calculations employ each of these population values.

4. Female Population of Blackbacks Available to the Commercial and Sport Fisheries of Great South Bay in 1938.

During the spawning period, from November through February in Long Island waters, it is possible to distinguish males from females even in green and in spent fish by examination of the white undersurface which is rough in the males and smooth in the females. This character is not dependable at other times of the year, since the roughness of the male is not as pronounced as during the spawning period, and also some of the females show signs of roughness. A sample of 291 fish taken by otter trawl in Great South Bay during the 1938 spawning period showed a preponderance of females over males and consisted of 82 males, 204 females, and 5 unclassified fish. However, since accurate sex determinations were not possible during other periods of the year and in order to obtain the most conservative estimate of the female population, it was assumed that females comprised 50% of the total population. Therefore, the figures obtained for total population are divided in half to obtain an estimate of the female population.

5. Female Spawning Population.

Field observations on blackbacks during 1940 showed the females to be ripe at 10 inches and over. The commercial catch consists primarily of fish over ten inches, and it is therefore considered that the entire commercial catch comprises mature females. This being so, the estimated female population based on the commercial catch is the same as the total female population based on that catch. However, the sport catch contains a large number of fish under ten inches, fish over ten inches comprising roughly two-thirds of the total sport catch. As a result, the female spawning population based on the sport catch will be only two-thirds of the total female population based on that catch. The sum of the female spawning population obtained by use of the commercial and sport catches of spawning females is the total female spawning population.

6. Potential Egg Production of the Spawning Female Population.

From Woods Hole Hatchery records on egg production for the period 1919 through 1936, it was determined that each female was capable of producing 413,000 eggs. Multiplying the total number of fish in the female spawning population by 413,000, the potential egg production is obtained.

7. Number of Eggs Reaching Hatchery Plant Stage Under Different Assumed Survival Values.

Blackback larvae are generally planted in the stage just before complete absorption of the yolk sac, (1), Pg. 3-315, Fig. A. Let us assume that under natural spawning conditions there are varying percentages of survival of eggs to that stage, namely 80, 50, 10, 1, .1, and .01 percent.

8. Relation of Hatchery Plants to Natural Increment With Different Rates of Natural Survival to Hatchery Plant Stage.

According to Woods Hole Hatchery records, the greatest number of fry ever planted in any one year in Great South Bay was 115,604,000 in 1932. If now, this plant is compared with the total number of young in Great South Bay computed under the various rates of survival, together with the number planted by the hatchery in the peak year of 1932, the percentage contribution of the hatchery to the number of larval blackbacks is obtained.

The results indicate that unless the natural mortality to the blackback larval stage at which plants are made is .1 per cent or greater, the contribution of hatchery plants is insignificant. At a natural survival of 80%, hatchery plants would contribute .02 to .09 per cent; at 50 per cent survival, .03 to .14 per cent; at 10 per cent survival, .17 to .69 per cent; at 1 per cent survival, 1.7 to 6.5 per cent; and at .1 per cent survival, 15 to 41 per cent.

Field experiments on the survival of blackback eggs to the hatchery plant stage under natural conditions were started, but adverse weather and inadequate facilities terminated them before completion.

However, laboratory experiments indicate that such low survival to the early larval stage as .1 per cent and .1 per cent are not likely. Scott, (4), using blackback eggs recovered from actual blackback spawning grounds, found that in the laboratory the lowest survival obtained under the most adverse temperature conditions, 10° C., was 3 per cent, while the survival under more favorable temperature conditions, 4-15° C., was from 28 to 87 per cent. Survival of 43 per cent was obtained for artificially-fertilized blackback eggs from impregnation to the hatchery plant stage in an experiment conducted by the author. A jar containing artificially-fertilized blackback eggs was kept at a temperature ranging from 8° to 13° C. Hatching began in 14 days and a sample taken at this time showed 93 dead eggs, 46 eggs just ready to hatch (1), pg.312, fig. i, and 23 newly hatched fish, (1), pg.315, fig. a.

Using the results obtained in the laboratory as indicative of survival in nature, it may be concluded that hatchery plants are, at most, of limited value in maintaining the supply of blackbacks in Great South Bay.

Another technique was employed to determine the effectiveness of hatchery plants in maintaining the supply of blackbacks in the vicinity of Boothbay Harbor, Maine. The bulk of the Boothbay Harbor hatchery plants are returned to thhe waters in the vicinity of the hatchery, and in this same area, fyke nets are set for capturihg spawn fish for use at the hatchery. Records are kept of the number of mature female fish caught, the number of fykes used, and the interval of time during which the fykes are set. The fishing season is roughly comparable from year to year, extending from late February to the end of April. The number of fykes fished in a season was variable in number, increasing gradually from 5 in 1909 to 24 in 1916 and 88 in 1925, and from then on 85 to 96 nets were used per fishing season, Table 2, Figure 3.

Tagging experiments conducted in the vicinity of Boothbay Harbor in 1939 and 1941 show that the fish are not migratory but remain in the general area fished by the hatchery traps. Furthermore, few fish are taken by the sport or commercial fisheries. Of 297 fish tagged in April 1939, only 12 had been recovered by the end of 1942—of which 2 were taken by the hatchery. Of 340 fish tagged in 1941, only 8 were recovered by the end of 1942.

Since the blackbacks in the vicinity of the hatchery appear to be a localized population and the commercial and sport fisheries take relatively few fish, it may be expected that the effect of the hatchery plants of larval blackbacks should be reflected in fluctuations in the hatchery catch-per-fyke of mature female blackbacks, which in turn may be considered as a rough measure of relative abundance. However, because of the increase in number of fyke nets in the period from 1909 through 1924, there is a possibility that gear competition may have influenced the catch-per-day. Therefore, the catch-per-day obtained in the period 1909 through 1924 may be considered less reliable as a measure of abundance than that obtained in the period from 1925 to 1940, in which the number of fyke nets employed was relatively constant.

The hatchery catch of females in 1939 and 1941 was comprised largely of fish from 10 to 15 inches in total length (unpublished data) averaging 3 to 5 years of age, (3), Table 2. It is assumed, therefore, that these age groups also predominated in the hatchery catch in other years for which information is not available. Therefore, hatchery plants made three, four, and five years previously should influence the relative abundance of mature female blackbacks taken by the hatchery fykes in any one year.

A comparison of the catch-per-fyke--per-fishery season of mature female blackbacks with the combined hatchery plants made three, four, and five years previously shows little relationship between the two, Table 3, Figure 4. Years showing a small catch-per-fyke were often related to the largest plants made three, four, and five years previously. For example, the catch-per-fyke in 1934, 1935, and 1936 was relatively low, while the hatchery plants made three, four, and five years previously in the periods 1929-1931, 1930-1932, and 1931-1933 were the highest on record. Similarly, small hatchery plants were related to a relatively high catch-per-fyke, as for example hatchery plants made during the periods 1920-1922 and 1917-1919. Also, approximately the same sized plant is related to different catches-per-fyke, as for example the catch-per-fyke obtained in 1930, 1931, and 1937, and in 1925, 1926, 1939, 1940. The apparent lack of correlation of hatchery plants with the fluctuations in the catch-per-fyke in the vicinity of Boothbay Harbor, Maine would indicate that factors other than the hatchery plants are responsible for major fluctuations in abundance and as in Great South Bay, hatchery plants are, at most, of limited value in maintaining the supply.

Results obtained in the above studies indicate that hatchery plants of blackback larvae have little, if any, effect on the population of fish available to the fishery. Consequently, hatchery plants cannot be considered as a practical method of maintaining the supply of blackbacks in areas showing a decline in abundance.

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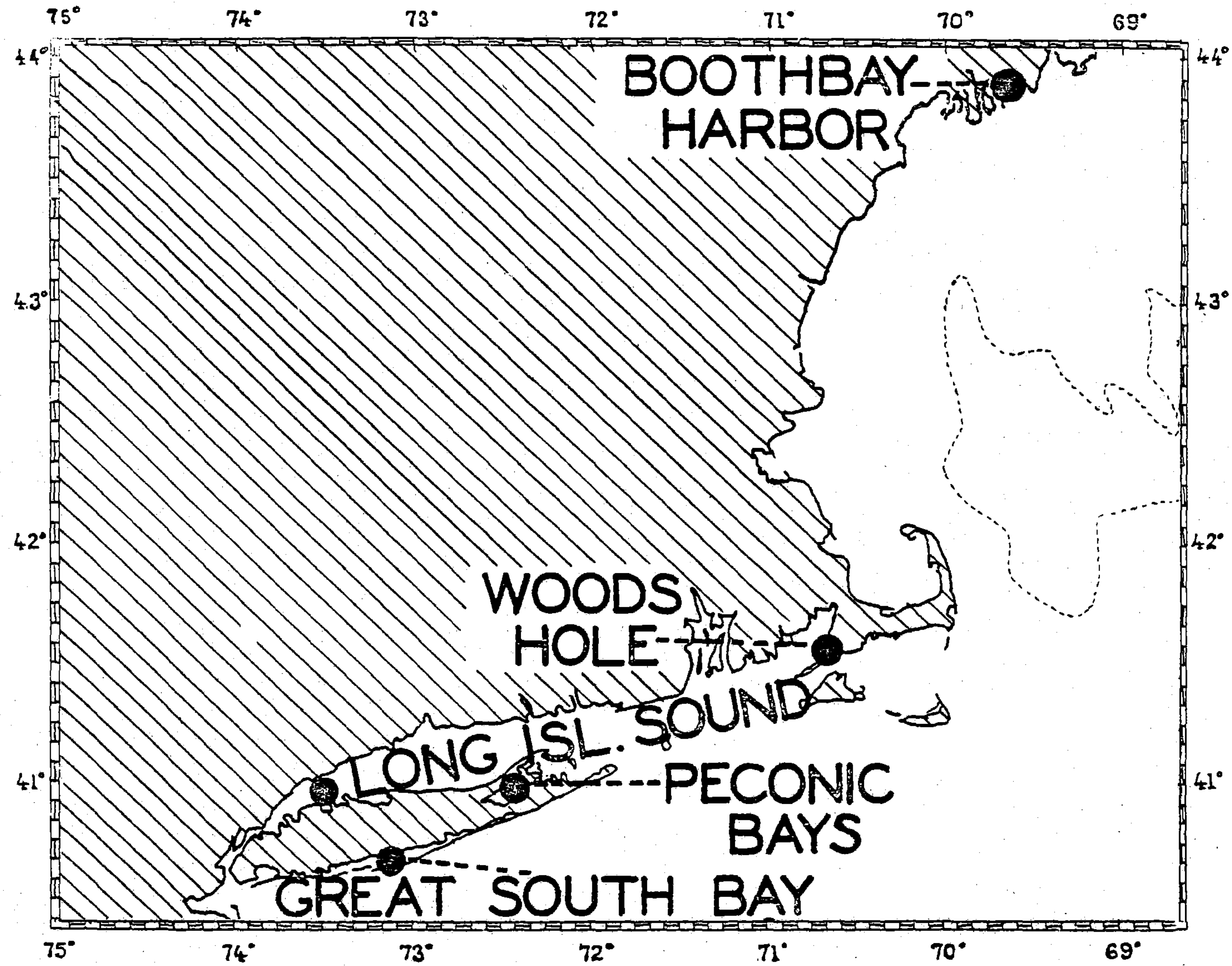

Fig. 1 Principle areas in which blackback larvae have been planted by the Boothbay Harbor and Woods Hole, Fish and Wildlife Service Hatcheries.

TABLE 1 .—Relative Contribution of Hatchery Plants of blackback fry Compared to Natural Production, Long Island—Great South Bay

	Item	Tabulated Catch		Tabulated Catch Times 1 1/4		Tabulated Catch Times 1 1/2		Tabulated Catch Times 1 3/4		Tabulated Catch Times 2	
		Comm.	Sport	Comm.	Sport	Comm.	Sport	Comm.	Sport	Comm.	Sport
Actual Tag Returns 21%	Number of Fish Caught	154	277	192	347	231	416	269	485	308	555
	Total Population	732	1,321	915	1,651	1,099	1,981	1,282	2,311	1,465	2,641
	Female Population	366	660	458	825	549	990	641	1,155	732	1,321
	Female Spawning Popul.	366	440	458	550	549	660	641	770	732	880
	Total Female Spawning Population	806		1,008		1,209		1,411		1,612	
	Potential EggProd'tion	332,878,000		416,304,000		499,317,000		582,743,000		665,756,000	
	Number of Eggs Reaching Hatchery Plant Stage If Survival Was .80	266,302,000		333,043,000		399,454,000		466,194,000		532,605,000	
	.50	166,439,000		208,152,000		249,658,000		291,371,000		332,878,000	
	.10	33,288,000		41,630,000		49,932,000		58,274,000		66,576,000	
	.01	3,329,000		4,163,000		4,993,000		5,827,000		6,658,000	
	.001	333,000		416,000		499,000		583,000		666,000	
	Relation of Hatchery Plant to Natural Increment If Survival to Hatchery Plant Stage was .80	.0004		.0003		.0003		.0002		.0002	
	.50	.0007		.0006		.0005		.0004		.0003	
	.10	.0035		.0028		.0023		.0020		.0017	
	.01	.0337		.0271		.0227		.0195		.0171	
	.001	.2584		.2180		.1886		.1660		.1483	
		Comm.	Sport	Comm.	Sport	Comm.	Sport	Comm.	Sport	Comm.	Sport
Actual Tag Returns Times 1 1/2 31.5%	Number of Fish Caught	154	277	192	347	231	416	269	485	308	555
	Total Population	488	880	610	1,100	732	1,321	854	1,541	977	1,761
	Female Population	244	440	305	550	366	660	427	770	488	880
	Female Spawning Popul.	244	293	305	367	366	440	427	514	488	587
	Total Female Spawning Population	537		672		806		941		1,075	
	Potential Egg Produc.	221,781,000		277,536,000		332,878,000		388,633,000		443,975,000	
	Number of Eggs Reaching Hatchery Plant Stage If Survival Was .80	177,425,000		220,029,000		266,302,000		310,906,000		355,180,000	
	.50	110,890,000		138,768,000		166,439,000		194,316,000		221,987,000	
	.10	22,178,000		27,754,000		33,288,000		38,863,000		44,397,000	
	.01	2,218,000		2,775,000		3,329,000		3,886,000		4,440,000	
	.001	222,000		278,000		333,000		389,000		444,000	
	Relation of Hatchery Plant to Natural Increment If Survival to Hatchery Plant Stage was .80	.0007		.0005		.0004		.0004		.0003	
	.50	.0010		.0008		.0007		.0006		.0005	
	.10	.0052		.0042		.0035		.0030		.0026	
	.01	.0497		.0401		.0337		.0290		.0255	
	.001	.3432		.2944		.2583		.2297		.2071	
		Comm.	Sport	Comm.	Sport	Comm.	Sport	Comm.	Sport	Comm.	Sport
Actual Tag Returns Times 2 42%	Number of Fish Caught	154	277	192	347	231	416	269	485	308	555
	Total Population	367	660	458	825	549	990	641	1,155	732	1,321
	Female Population	183	330	229	413	275	495	320	578	366	660
	Female Spawning Popul.	183	220	229	275	275	330	320	385	366	440
	Total Female Spawning Population	403		504		605		705		806	
	Potential Egg Produc.	166,439,000		208,152,000		249,865,000		291,165,000		332,878,000	
	Number of Eggs Reaching Hatchery Plant Stage If Survival Was .80	133,151,000		166,522,000		199,892,000		232,932,000		266,302,000	
	.50	83,219,000		104,076,000		124,932,000		145,582,000		166,439,000	
	.10	16,644,000		20,815,000		24,986,000		29,116,000		33,288,000	
	.01	1,664,000		2,081,000		2,499,000		2,912,000		3,329,000	
	.001	166,000		208,000		250,000		291,000		333,000	
	Relation of Hatchery Plant to Natural Increment If Survival to Hatchery Plant Stage was .80	.0009		.0007		.0006		.0005		.0004	
	.50	.0014		.0011		.0009		.0008		.0007	
	.10	.0069		.0055		.0046		.0040		.0035	
	.01	.0652		.0528		.0444		.0383		.0337	
	.001	.4113		.3580		.3169		.2850		.2584	

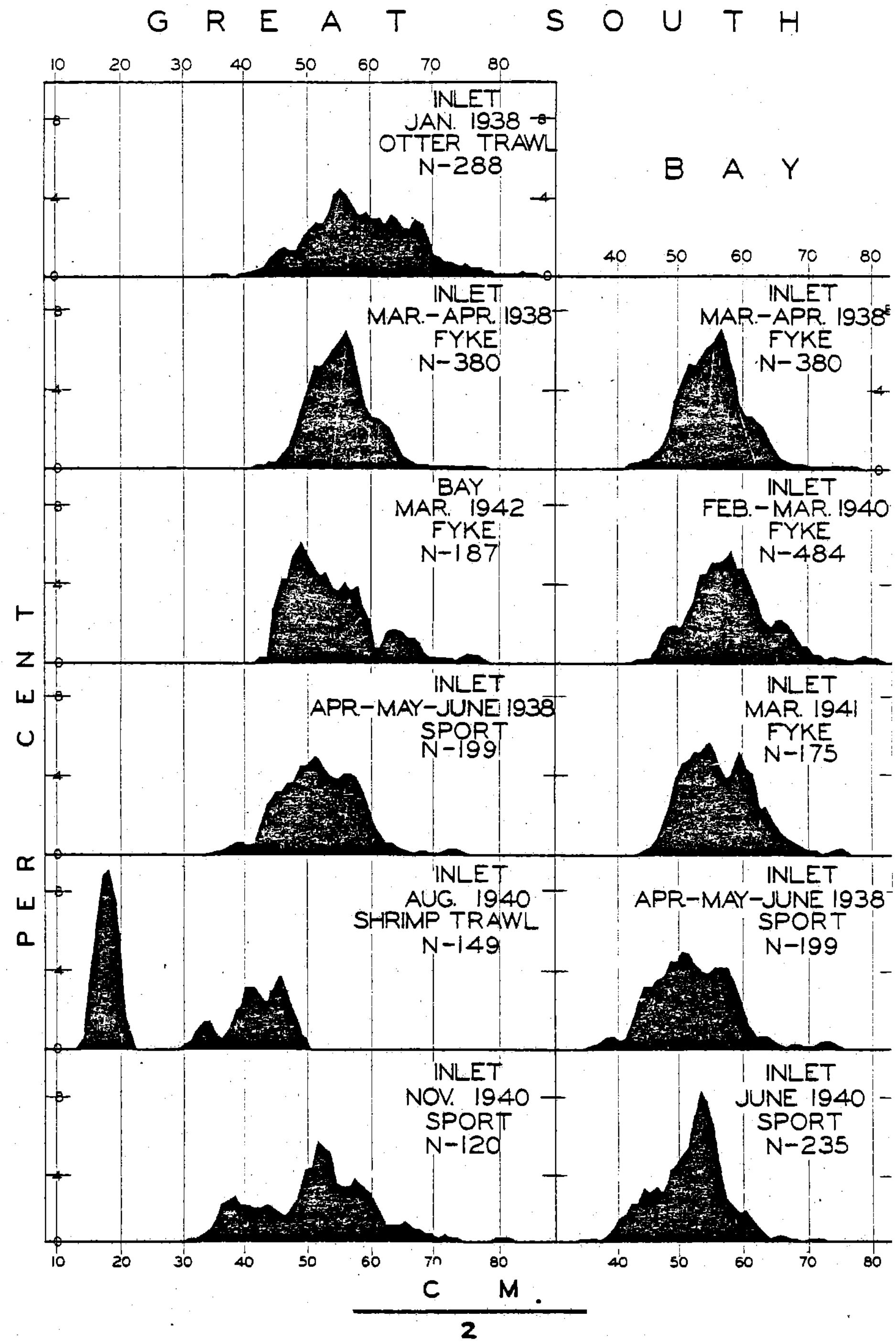

Fig. 2 Length composition of blackback caught in Great South Bay, New York. Measurements to nearest half-centimeter. Data smoothed by threes.

TABLE 2.—Total number of blackback females caught by fyke nets, number of fyke nets fished, and average number of females per fyke; taken from records of the United States Fish and Wildlife Service Hatchery, Boothbay Harbor, Me., 1910–40

Year	Total number of females	Number of fykes	Number of females per fyke	Year	Total number of females	Number of fykes	Number of females per fyke
1909	. . . . .	5	. . . . .	1925	9,203	88	105
1910	5,550	10	550	1926	5,800	88	66
1911	4,788	14	342	1927	8,909	96	93
1912	4,568	. . .16/1	. . . 286	1928	9,230	96	96
1913	4,007	18	223	1929	8,996	96	94
1914	4,852	18	270	1930	12,798	96	133
1915	3,840	. . .21/1	. . . 183	1931	12,572	96	131
1916	5,454	24	227	1932	13,077	98	133
1917	7,775	. . .27/1	. . . 288	1933	12,510	98	128
1918	8,171	30	272	1934	3,683	85	43
1919	9,204	. . .40/1	. . . 230	1935	4,150	85	49
1920	6,113	51	120	1936	5,026	85	59
1921	6,298	55	114	1937	3,776	86	44
1922	7,000	. . .57/1	. . . 123	1938	2,444	88	28
1923	5,000	60	83	1939	2,762	. . .88/1	31
1924	6,000	78	77	1940	2,173	. . .88/1	25

/1 Estimated figure was obtained by averaging the number of fykes used in the preceding and the following year.

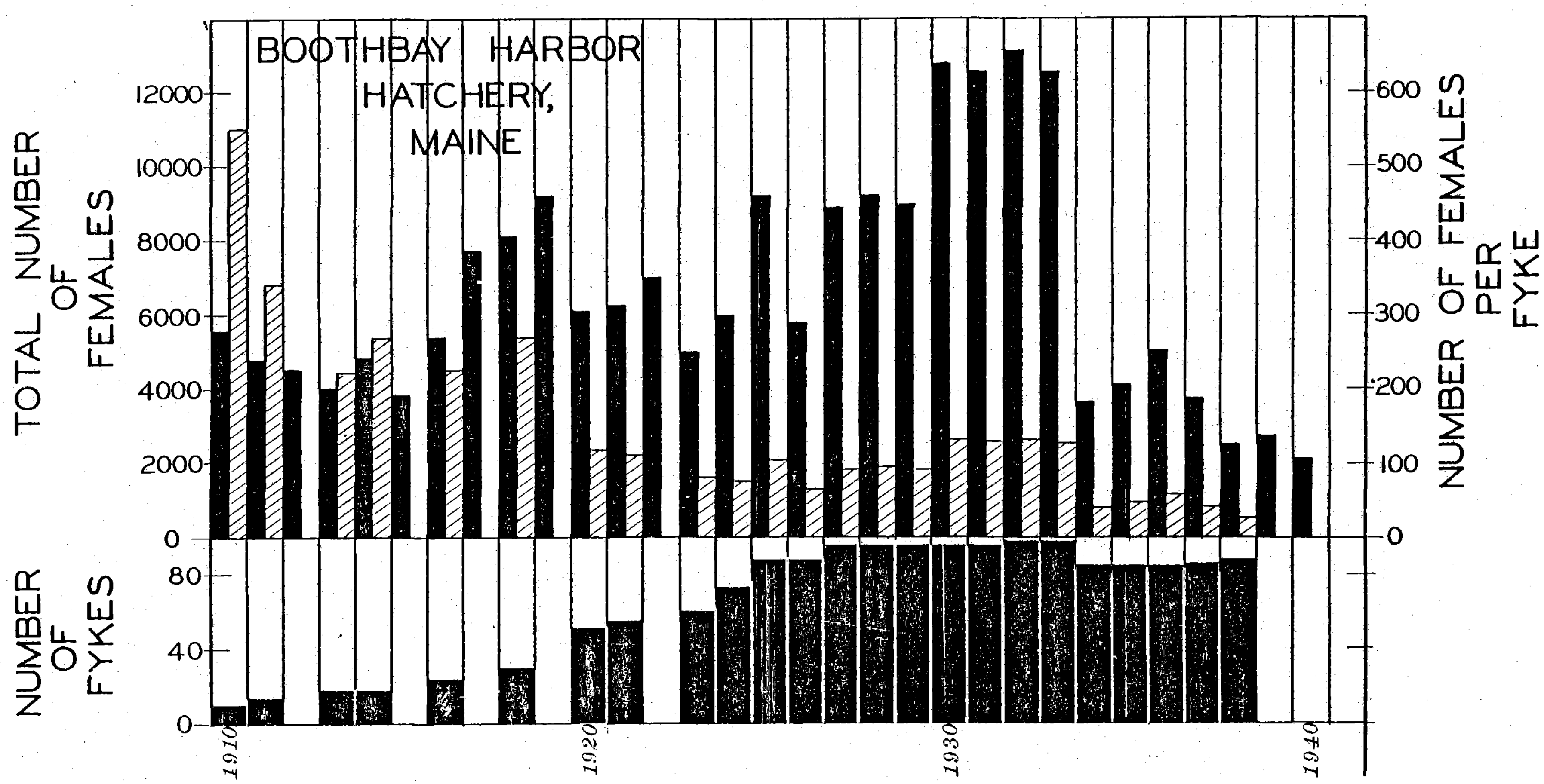

Fig. 3 Female blackback catch; United States Fish and Wildlife Service Hatchery, Boothbay Harbor, Maine, 1910—1940.
Total number of females caught, narrow solid bars; Number of females caught per fyke, hatched bars; Number of fykes fished, wide solid bars.

TABLE 3.—Relationship between Hatchery Plants of Blackbacks and Hatchery Catch-Per-Fyke of Females: United States Fish and Wildlife Service Hatchery, Boothbay Harbor, Maine, 1909-1940

FRY PLANTS /1		CATCH-PER-FYKE		FRY PLANTS		CATCH-PER-FYKE	
Years	Number in Billions	Years	Number of Females	Years	Number in Billions	Years	Number of Females
1931-1933	7.9	1936	59	1916-1918	3.0	1921	114
1930-1932	7.8	1935	49	1934-1936	2.9	1939	31
1929-1931	7.5	1934	43	1921-1923	2.8	1926	66
1928-1930	6.9	1933	128	1935-1937	2.8	1940	25
1927-1929	6.7	1932	133	1920-1922	2.7	1925	105
1926-1928	6.1	1931	131	1936-1938	2.5	1941	-
1932-1934	6.1	1937	44	1915-1917	2.2	1920	120
1925-1927	6.0	1930	133	1937-1939	2.1	1942	-
1924-1926	5.2	1929	94	1938-1940	1.9	1943	-
1923-1925	4.6	1928	96	1914-1916	1.7	1919	230
1933-1935	4.4	1938	28	1912-1914	1.6	1917	288
1917-1919	3.7	1922	123	1913-1915	1.5	1918	272
1922-1924	3.6	1927	93	1910-1912	1.5	1915	183
1918-1920	3.4	1923	83	1911-1913	1.5	1916	227
1919-1921	3.0	1924	77	1909-1911	1.1	1914	270

/1 Actual measured egg production. Hatchery superintendents' estimates of mortality from this egg stage to the planting stage varied from 4 to 12 percent.

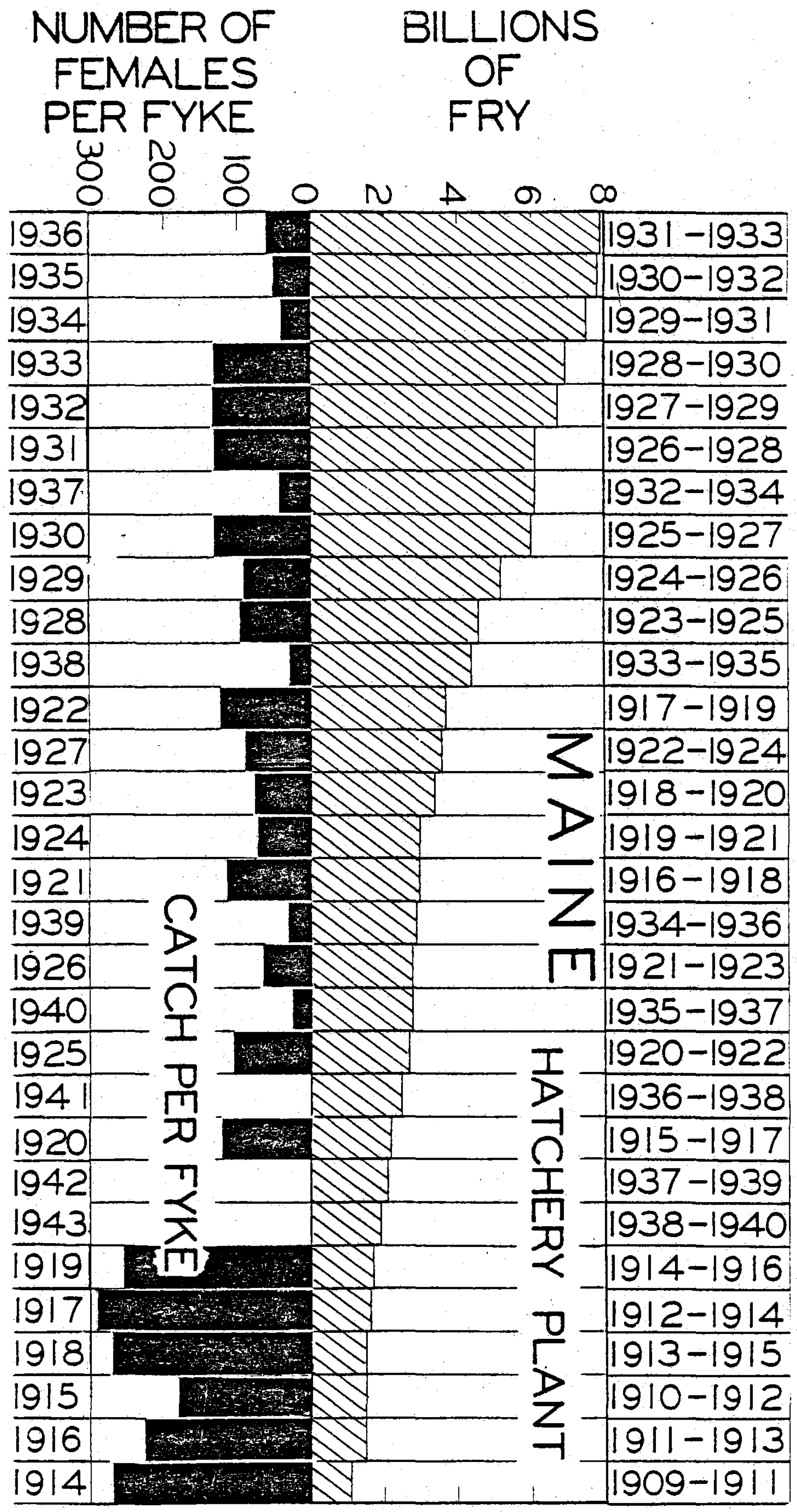

Fig. 4. Relationship between hatchery plants of blackbacks and the hatchery catch-per-fyke of females three to five years later; Fish and Wildlife Service Hatchery, Boothbay Harbor, Maine.