No. 1775

SPECIAL REPORT

OF THE

BOARD OF COMMISSIONERS ON FISHERIES AND GAME

RELATIVE TO THE

FISH AND FISHERIES OF BUZZARDS BAY.

JANUARY, 1916.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
32 DERNE STREET.
1916.

The Commonwealth of Massachusetts.

Commissioners on Fisheries and Game,
State House, Boston, Jan. 11, 1916.

To the Honorable Senate and House of Representatives.

We herewith transmit a special report upon the investigation of the fishery conditions in Buzzards Bay, as ordered by chapter 104, Resolves of 1913; chapter 44, Resolves of 1914; and chapter 19, Resolves of 1915.

Respectfully submitted,

G. W. FIELD,
Chairman.

The Commonwealth of Massachusetts.

Special Report relative to the Buzzards Bay Fisheries.

In considering the problem of Buzzards Bay it is essential first to consider to what extent Buzzards Bay can be made to contribute to a definite and regular fish supply placed upon the market in sanitary condition, in favorable competition with flesh and fowl. Buzzards Bay is, beyond question, a breeding place for many valuable species, of which further detail is given later. The preservation of Buzzards Bay as a breeding ground is essential and possible. In order to secure the most satisfactory results in the briefest time, it is necessary, first of all, to remove the largest possible number of fish the presence of which is prejudicial to the increase of the most valuable species; secondly, the largest possible number of breeding fish of the most satisfactory varieties must be maintained; thirdly, the conditions must be made as favorable as possible for rearing, in the shortest possible time, the largest possible number of young fish of these valuable species. In order to do this, some attention must be given to the kinds of species present, for the reason that certain species are mutually exclusive. There is always present in the bay a sufficient quantity of fundamental food, *e.g.*, plankton, consisting chiefly of microscopic plants and animals, including their eggs and young, to rear a large quantity of the less valuable fish, such as minnows, alewives, herring, sand eels, and others, — fish which in turn serve as food for raising a satisfactory number of such valuable food fish as bluefish, squeteague, striped bass, pollock and others. The presence of sufficient quantities of the less valuable species thereby lessens the cannibalism among the important species. The value of Buzzards Bay as a State asset lies first in the fact that it is relatively shallow water, into which empties a large number of

streams which are capable of producing enormous quantities of alewifes and similar species feeding upon microscopic plants, etc., and therefore furnishing all the conditions necessary for maintaining a fabulous quantity of valuable carnivorous fish. The bay is still further valuable from the fact that it is adapted for furnishing a quick supply of fish for market or for bait, as well as favorable conditions for recreational fishing. Its geographical position and contour render fishing in some parts of the bay possible when inclement weather would preclude it in the open sea.

We find that there are sixty-eight species of fish regularly inhabiting the bay. Of these, thirty-two are now used for food; nine are directly injurious, through preying upon the more valuable species. Govin estimated that every pound of dogfish and other shark was produced at a cost of twenty pounds of other fish.

We have thus far been unable to secure any reliable figures upon the yield per acre in the waters of the bay, but there appears to be no reason why it should not yield in the same proportion as other bodies of water apparently less favorably situated. As a general proposition, favorable bodies of water should yield in proteid food three times as much as an equal area of land. Neither have we been able to secure reliable evidence upon the annual catch per man in Buzzards Bay. In brief, as must be expected, we have no results at all comparable to those of Brandt in "Studies in the North Sea." We have no observations upon the survival or the migration of marked fish which have been liberated.

We have collated, so far as records would permit, the catches made under various conditions and places in the bay, and we have made observations upon the quantities of fish taken and the number of fish unnecessarily wasted in transit from the water to the consumer. Our observations give us some inkling of the susceptibility of various species to capture by net, both in fixed traps or pound fishing, in gill netting, trawls and in the beam, now replaced by otter trawls. We have some observations upon the serious effects which result from the destruction of certain species on the way to the spawning ground, notably the case of alewives, striped bass, scup and white perch, and

suggest that this unnecessary destruction may be lessened by suitable regulation of the nets, although such regulation as a practical matter is a difficult one to bring about. That the susceptibility of fish to capture by nets varies with the species was brought out by Wemyss Fulton, who found that when 5,906 fish of twenty-five species were taken in the pocket of an otter trawl, 32,237 escaped from the meshes, — that is, 19 per cent. were taken and 81 per cent. escaped. The otter trawl was found to be most deadly to fish of the flounder type, — less so to the haddock. Of the round fish, as high as 96 per cent. escaped from the meshes.

The species which are most susceptible to destruction in Buzzards Bay, and therefore to ultimate extermination, are the alewife, shad, striped bass, white perch, scup, squeteague and bluefish. Other species which appear to be taken in the traps but on account of their wide distribution are not seriously affected, primarily from the fact that their eggs are laid promiscuously over all the surface of the ocean, both within Buzzards Bay and outside, are mackerel, menhaden, butterfish, bluefish and squeteague.[1]

The species most destructive to the more valuable fish are, of course, primarily, sharks and dogfish. Incidentally, skates, rays, puffers, sea robins and other kinds should be destroyed in quantities.

Much has been said both for and against the methods of trap fishing, but it all crystallizes into the proposition that Buzzards Bay, if properly handled, should furnish more fish than can properly and economically be taken out by hand lines; that certain species which can profitably be removed from the bay do not bite the hook, such as menhaden and butterfish in limited quantities; that sharks and dogfish appear without doubt to be increasing in the bay, and therefore definite means should be taken for diminishing their numbers. The logical method of doing this is by a limited number of traps fished at times when it means the greatest destruction of the enemies of the fish with the least destruction of the valuable and breeding fish. This can best be effected by a small number of traps so distributed

[1] The small squid may be beneficial in that they serve as food for large fish, while the larger squid may be exceedingly destructive to schools of small fish.

as to serve in the neighborhoods remote from the important centers of distribution, where the food is required to meet the needs of the people, in this way working minimum damage to the productive capacity of the bay.

In making this report upon the development and maintenance of the fisheries of Buzzards Bay we have placed on record a vast number of facts which promise to be of present or future value. Two distinct types of problems are involved: first, those which can be settled by facts already available; and second, those requiring the consideration of facts not yet available but necessitating investigation and observations extending over a period of years.

Fundamentally we are seeking to determine, as far as possible, what is the normal annual crop of fish which can be taken in Buzzards Bay without injuring the future source of supply; secondly, the best methods of harvesting and marketing this annual supply. In the past an excessive number of traps and seines has made the fishing in the bay practically a gamble. More nets and traps were established than could expect a remunerative season, the owners taking a chance of the fish striking their particular trap. This leads to excessive cost through the undue amount of capital and labor tied up. The expense of catching fish is a necessary factor in the cost of those fish to the consumer, and every well-devised effort to bring fish upon the market at the lowest possible cost of capture and in the best possible sanitary condition is for the benefit of the consumer. Massachusetts is situated most favorably upon the coast in reference to the spawning and feeding grounds of a large variety of fish, and Buzzards Bay appears to be an important area in which fish spawn and the young in incredible numbers are grown.

Among the important benefits of trap and net fishing should be cited the following: —

1. It furnishes important food fish fresh, at once cheaper to the poor people and yet attractive to the residents who come to the seashore from a distance.

2. It furnishes a considerable quantity of bait, not alone locally but also for the important fishing centers of the State, — Provincetown, Gloucester and Boston.

3. It furnishes employment for worthy men in catching and distributing fish.

4. It makes considerable local business and puts money into circulation.

5. If wisely carried on, it destroys considerable quantities of sharks and other injurious fish.

6. As an economic proposition fish are of no value until placed upon the market in a cheap manner and under sanitary conditions. Hand lining alone is not likely to furnish an adequate market supply or to harvest the annual yield in an economical manner.

7. The present condition of the bay, in which trap fishing is forbidden, chiefly benefits the owners of the Rhode Island traps off Sakonnet Point, to the prejudice of Massachusetts citizens.

On the other hand, trap and net fishing is found to kill the breeding adults on or near the spawning places, and thus, if carried to excess, leads to inevitable depletion of the stock; there is considerable destruction of the young below marketable size. It tends to monopolization of the fishing opportunities. It is particularly destructive to alewife and shad fisheries, and thereby is exceedingly injurious from the fact that the abundance of young alewives and herring attract within the radius of the fishing operations of Massachusetts men quantities of bluefish, squeteague, pollock, bass and other valuable fish. If traps and nets are used in excessive numbers there results a waste of time and capital for those who do not chance to strike the fish.

We believe that a maximum amount of food and bait should be furnished without detriment to the maintenance of the annual yield. Buzzards Bay is one of the most valuable assets of the Commonwealth, at present relatively undeveloped, and should be handled for the purpose of making it a source of food and recreation to every inhabitant of the State. Intimately connected with the present depletion of the bay is the depletion of the shad and alewife fisheries, and a complete change of method of handling these fisheries is urged. Suitable action should be taken for preventing the pollution of the bay and its tributaries. Every legitimate effort should be made to secure Federal legislation for so controlling the taking of migratory

fish as may secure an equitable distribution of opportunities for wisely utilizing every phase of the fisheries assets, whether personal, State or national.

The following are the conclusions and recommendations of the Commission: —

1. The general principle of restriction is correct for Buzzards Bay, as it can be shown that the bay possesses great advantages for the spawning of fish and rearing young fish. But to secure a local supply of fresh fish, a limited number of traps, not exceeding eight, should be permitted to be maintained under special regulations and in such localities as best to serve the the largest number of people, without making an unnecessary destruction of breeding fish or of fish below the optimum market size.

2. To obtain the full benefit of a closed season in Buzzards Bay, trap fishing off Sakonnet Point in Rhode Island should be restricted. The good results of restriction in Massachusetts are largely negatived at the present time, since they are not correlated with necessary restrictions elsewhere. To this end there should be Federal regulation of the taking of migratory fish.

3. Menhaden fishing or other fishing on a large scale in the bay should not be allowed, but provision should be made whereby the lobster fishermen may obtain menhaden in reasonable and necessary quantities for bait.

4. Regulation and re-establishment of the alewife fishery should be under State control.

5. Future investigation on the Buzzards Bay fisheries would be of value, chiefly along these lines: —

(*a*) Studies of spawning habits and of life histories of fish and crustacea in the bay, and proper measures taken to increase the yield of mollusks, lobsters and edible crabs.

(*b*) More complete statistics of the catch in the bay by traps and by the line fishermen, for the purpose of determining the actual production of the bay.

(*c*) Seining of portions of the bay on a large scale at intervals during the year, to determine the actual population of measured areas at various times.

(*d*) To confirm and to extend the observations necessary to develop and maintain Buzzards Bay as one of more prominent

and increasingly valuable assets of the State for the production of food fish, of food and bait mollusks, and crustacea, for the benefit of all the people.

In addition to the report of our biologist, David L. Belding, which is submitted herewith as covering the details of this investigation, we retain as office records, available in our office, a very considerable amount of original data and of records collected from various sources.

Dr. George W. Field, *Chairman, Commissioners on Fisheries and Game, State House, Boston, Mass.*

Sir: — I respectfuly submit the following report upon the investigation of the fishery conditions in Buzzards Bay. The work was carried on under the provisions of chapter 104 of the Resolves of 1913, chapter 44 of the Resolves of 1914, and chapter 19 of the Resolves of 1915.

Respectfully submitted,

David L. Belding,
Biologist.

Introduction.

Buzzards Bay has played an important part in the development of the fisheries which have made Massachusetts famous. In colonial days its tributaries during the spawning season were crowded with shad, salmon, striped bass and alewives, while schools of mackerel, bluefish, sea bass, butterfish, scup and menhaden were found within its boundaries.

In early days the abundance of fish afforded a cheap and valuable food supply at the very doors of the inhabitants. Within the last two hundred years conditions have radically changed. The present supply is but a small portion of the great natural production described by historical writers, — a condition which has been brought about by a variety of causes both local and general. The flourishing condition of former days may never again be attained, but by the proper regulation of our fisheries present conditions can be improved greatly. The potential value of such a body of water as Buzzards Bay as an asset of the Commonwealth is indeed great, and the problem of developing the fishing resources to their former natural productivity is essentially important and worthy of the most careful consideration.

Preliminary Report.

A preliminary report is submitted at this time for the following reasons: —

1. The investigation covered but a portion of one year in 1913, the act not having passed until June 4, 1913, thereby leaving out April and May, two of the best trap-fishing months. In 1914 and 1915 the season included the month of May, but the investigation, according to the provisions of the acts, was limited to the statistical returns of the trap fishermen.

2. Any three or even ten years may not be typical. To arrive at definite or satisfactory conclusions, such an investigation should be carried on over a rather long series of years.

3. The complexity of some of the problems for which solutions are required precludes the possibility of satisfactory answers in three years. Certain problems involved have been settled tentatively, others remain but partly solved.

Value of Investigation.

Since 1892 many legislative battles over the Buzzards Bay fisheries have disclosed two distinctly opposing parties, the one in favor of opening the bay to all fishing, the other in favor of restricting the industry to hand-line fishing. Only by accepting and using as a working basis such facts as are backed by authority, by statistics and by scientific research can the proper solution of the Buzzards Bay problem be secured, and the results of this investigation be made of value in subduing the activities of those who have a prejudiced attitude of mind for and against "opening the bay." It is expected that the completed work will furnish not alone an adequate basis for legislation, adapted to making Buzzards Bay increasingly valuable to all classes of our population, but also will disclose certain facts concerning the fisheries which will benefit fishermen and consumers alike.

As a foundation for the correct solution of these problems, a comparison of the past and present fisheries in Buzzards Bay is essential.

Past Fisheries.

We have examined and correlated material upon the following subjects: —

(*a*) *Fish.* — Records of the United States Bureau of Fisheries and of the Massachusetts Department of Fisheries and Game, both published and unpublished, of the species and quantities of fish taken in the bay.

(*b*) *Traps.* — United States Bureau of Fisheries, Marine Biological Laboratory records, statistical returns of the fisheries to the Massachusetts Department of Fisheries and Game, and reports of the individual trap fishermen.

(*c*) *Testimony.* — Interviews with fishermen and with other residents of the various Buzzards Bay towns and in Rhode Island.

(*d*) *Legislative History.* — The arguments presented at committee hearings and the various laws enacted.

Present Fisheries.

We have studied: —

(*a*) *Fish.* — Spawning, food and habits of the species in Buzzards Bay in 1913, 1914 and 1915, as far as time permitted.

(*b*) *Traps.* — In 1913 four traps were set in Buzzards Bay and records were obtained. Two were set by W. T. Dunn at South Dartmouth and two at Woods Hole, one each by the United States Bureau of Fisheries and the Marine Biological Laboratory. In addition, records were secured from Vineyard Sound and Rhode Island traps. In 1914 eight traps were located in the bay. In addition to those of the previous years, one trap each was set by D. P. Bosworth & Co. at Cuttyhunk, Otis B. Luce at Quisset Harbor, Alvin F. Waite and Benjamin T. Smith at South Dartmouth. In 1915 twelve traps were set in all, the new traps in new locations being set by O. B. Daggett at Naushon, H. Nelson Luce off Penzance, Woods Hole, and John R. Fish, Jr., at Horse Neck Beach, while the Cuttyhunk trap was discontinued.

(*c*) *Boat Fishing.* — Various types of boat fishing prohibited at present, viz., gill nets, "trawl," beam and otter trawl, were

used in various parts of the bay to supplement the trap records, and to ascertain the size, quantity and species of fish taken, and the "dead liners" of each method.

Testimony.

The testimony of the fishermen is interesting as showing the history of trap and other methods of fishing in Buzzards Bay, but it is frequently biased either in favor of or against free fishing, and therefore often conflicting. Without co-ordinate knowledge of the existing biological conditions, it is difficult to sift the true facts from the false. Therefore, such testimony is, at best, of but secondary value.

The same applies to testimony in previous years before legislative committees. In a broad sense practically every argument in favor of or against trap fishing in Buzzards Bay, however sincere or true the conclusion, can be shown to have been based upon an erroneous interpretation or perversion of facts set forth in fluent but misleading language.

The Present Law.

1. The provisions of the present law regulating the Buzzards Bay fisheries may be summarized as follows: —

(*a*) Fish traps of all kinds are prohibited.

(*b*) The use of all types of seines and nets, except alewife seines and eel fykes in tributaries, is forbidden.

2. The law combines two legislative acts relative to (*a*) movable fishing apparatus (chapter 192, Acts of 1886) and to (*b*) stationary traps (chapter 205, Acts of 1893).

3. In 1886 the use of seines and nets, except in Fairhaven waters, was forbidden. The act was directed against the menhaden fishermen. In 1890 the exemption of Fairhaven was removed, and the act thereby applied to the whole of Buzzards Bay.

4. Between 1886 and 1893 various towns prohibited trap fishing by special regulations, a movement which started at the head of the bay, where hand-lining was popular. Finally, in 1893 an act was passed applying to the entire bay.

Purse Seining of Menhaden.

This type of fishing, prohibited in 1886, was never popular with the trap fishermen, the hook and line fishermen or the summer residents. It was chiefly carried on by Rhode Island and New York firms, and furnished little employment to Massachusetts men.

At the present time public opinion is distinctly against opening the bay to menhaden steamers. The monetary value of the menhaden fishery as a source of fertilizer and the improvement of business by the establishment of factories are cited in favor of menhaden purse seining. The arguments against menhaden fishing are (*a*) "the destruction of a food attracting other fish;" (*b*) "the driving away of food fish;" (*c*) "the capture of other fish with the menhaden;" (*d*) "the destruction of a fish which could be taken in traps and gill nets by the Massachusetts fishermen for bait;" (*e*) not a Massachusetts industry;" (*f*) "the steamers are a nuisance."

Under existing conditions the opening of Buzzards Bay in any manner or degree to the menhaden steamers is undesirable. Provision, however, should be made to permit the lobstermen to obtain menhaden for bait by the use of gill nets under suitable regulations. Such a procedure would be of great benefit to the fishermen if a practical plan can be devised for avoiding conflict with the other fisheries.

Otter Trawling.

The results of many sets made by us indicate that the greater part of Buzzards Bay is not adapted to this method of fishing, owing to boulders on the bottom.

Gill Net.

Excellent catches of menhaden were made during the summer. A few other fish, principally scup and butterfish, were taken. This method would be of value to the lobster fishermen for securing bait, if it could be so safeguarded that only menhaden could be taken.

Line Trawls.

Quantities of tautog, with a very few scup, were taken on trawls. Dogfish, usually *Acanthias americanus*, Storer, commonly called "smooth dog," were caught. This species was especially destructive to the food fish on the trawl.

Hand-line Fishing.

It is the general opinion that hand-line fishing is on the decline. The catches are less than twenty-five years ago, and it is said to be no longer commercially profitable.

Rhode Island Traps.

1. The trap fishery of Rhode Island is of great value. Large catches are made each spring.

2. The position of the traps is such that they offset to a great extent the benefit derived from reserving Buzzards Bay as a breeding place for migratory fish.

3. The floating traps off Sakonnet and Newport extend at the present time nearly two-thirds the way across the entrance of Buzzards Bay, in the form of a triangle. These traps are so placed that the leader of one trap runs practically from the bowl of the next trap, making an unbroken line approximately ten miles in extent on each side of the triangle.

4. The number of traps, especially the offshore floating traps, has increased in the last fifteen years.

Year.	Sakonnet Point.	Offshore.	Total Number.
1898, ...	34	25	119
1909, ...	87	73	271
1911, ...	93	66	277

The 1909 report of the Rhode Island Commission on Inland Fisheries states: "Especially noticeable is the continued increase in number in the Sakonnet River and offshore divisions, where the cordon of traps is being extended and covers new territory each year. The fishermen are continuing to push their traps a surprisingly great distance offshore."

Fish trap of United States Bureau of Fisheries at Woods Hole. Boats arriving to haul trap.

Fish trap of United States Bureau of Fisheries at Woods Hole. Hauling the trap.

Fish trap of United States Bureau of Fisheries at Woods Hole. Bailing the fish from the trap into the "live" car.

The percentage of offshore to total traps has increased from 21.5 in 1900 to 31 in 1910.

5. The average catch per trap has diminished with the increase in the number of traps. The only available figures are from Newport, and those probably give a fair comparison, although the argument may be advanced that the shipment of fish from other points has increased.

Years.	Total Number of Traps.	Offshore Traps.	Barrels of Fish shipped from Newport.		
			Total.	Average Catch per Trap.	Average Catch per Trap, May and June.
1896–1900,	125	26.0	32,832.2	262.7	151.7
1901–1905,	193	37.6	54,220.2	280.9	170.0
1906–1910,	271	73.8	53,705.6	198.2	107.7

6. Over one-half the catch of fish are taken during the northern migration in May and June. From the census of 1888 and 1898 the per cent. of fish by weight is as follows: —

	Per Cent.
Scup,	47.0
Alewife,	8.9
Flatfish,	7.7
Sea bass,	4.8
Butterfish,	2.5

7. The floating traps are huge affairs, 270 feet long, 120 feet wide, 80 feet deep, with a leader 1,800 feet in length, and are valued between $800 and $1,000. In recent years there have been unsuccessful attempts made to secure legislation to require a certain distance between traps, thus enabling fish to pass through, instead of forming a practically complete barrier, as at present.

8. The fish which escape these traps pass into Buzzards Bay through the openings from Vineyard Sound, or enter by the narrow strip of water outside the Rhode Island traps. It is also possible for some fish to escape capture directly by the Rhode Island traps, but considering the amount of scup taken on their eastern migration, these traps, through their number and location, are extremely detrimental to the Buzzards Bay

fisheries, and to the value of Buzzards Bay as a breeding place for useful fish.

9. A similar increase in the number of traps off Cape Hatteras and the Jersey shore has been reported. These traps are taking the migratory fish in the same manner as the nearby Rhode Island traps.

10. Federal control of the migratory fish and fisheries is the most practical means of correcting the existing conditions relative to the unwise and unnecessarily destructive exploitation of migratory fish.

Food Fish.

The fish which were commercially important in Buzzards Bay in 1913 to 1915 were: —

Butterfish.	Tautog.
Scup.	Sea bass.
Mackerel.	Menhaden.
Flounders.	Alewife.
Squeteague.	Herring.

In addition, the following fish have been valuable in previous years, but are no longer commercially important in the bay: —

Bluefish.	Striped bass.
Bonito.	Shad.

The first appearance of certain species off Newport for the past six years, according to the reports of Rhode Island Commission of Inland Fisheries, is as follows: —

Fish.	Dates.	Approximate Date.
Butterfish,	April 16-May 10,	May 1.
Mackerel,	April 17-May 6,	May 1.
Sea bass,	May 1-May 8,	May 4.
Scup,	April 19-May 2,	April 25.
Squeteague,	May 4-June 14,	May 20.

Practically all these fish are migratory. The flounder and the tautog are migratory only to a limited degree. The spring run of these fish takes place usually during May and June.

Predaceous Fish.

The common predaceous fish found in Buzzards Bay are as follows: —

Smooth dogfish.	Skates (various species).
Spiny dogfish.	Rays (various species).
Goosefish.	Sharks (various species).

All of these species are used as food in Europe and Asia, but are not extensively utilized in the United States.

Other abundant fish not used for food at the present time are certain of the —

Sea robins.	Swellfish.
Sculpins.	

Certain species should be used as food. Sharks are often sold as and are a worthy substitute for swordfish. Dogfish are edible, as are portions of skates, sculpins and sea robins. In the future these fish will be sold for food, as is the custom at the present time abroad. Other uses, such as for fertilizer, oil, etc., can be made of many at present apparently useless species.

Dogfish, sharks, skates, rays and goosefish prey upon the food fish.

It is difficult to actually determine whether the number of predaceous fish has increased during the last twenty years. Testimony of fishermen upon this point is well-nigh valueless. For the last thirteen years records of the trap of the United States Bureau of Fisheries indicate that there has been an increase in the number of dogfish at Woods Hole. In the five years from 1898 to 1902 the average catch in the Buzzards Bay fish trap of the United States Bureau of Fisheries was 342.4 dogfish; from 1903 to 1908 the average catch was 806.6; and from 1909 to 1913, 1,637.8.

Trap Fishing.

The commercial aspects of trap fishing at the present time are shown in this table: —

Year.	Number of Traps.	Total Number of Days set.	Value of Gross Catch.	Revenue to State.	Average Gross Catch per Day per Trap.
1913, ...	3	253	$570 60	–	$190 20
1914, ...	9	790	5,218 50	$365 29	579 83
1915, ...	11	1,344	5,011 77	350 82	455 61

The poor season in 1913 was due to (*a*) an "off year;" (*b*) late start, the months of April, May, and with the South Dartmouth traps June, being lost; (*c*) the Marine Biological Laboratory trap was not operated primarily for commercial purposes.

Increased returns in 1914 were due chiefly to (*a*) the additional catch in the Cuttyhunk trap, which was not operated in 1913 and 1915; (*b*) a large run of mackerel on east side of the bay, shown chiefly in catch of the Quisset Harbor trap. In 1915 the catch in this trap was about one-half the 1914 yield.

The 1915 season was less successful than the previous year: (*a*) the returns for the traps on the west side of the bay were approximately the same for 1914 and 1915; (*b*) the traps on the east side gave only about one-half the 1914 production.

Comparison of 1914 and 1915.

Owner of Trap.	Number.	Location.	1914.	1915.
B. T. Smith, ...	–[1]	Mauchaum, South Dartmouth,	$644 57	$728 09
Alvin Waite, ...	–[1]	Salters Point, Dartmouth, .	478 43	522 00
Wm. T. Dunn, ...	2	Ricketson Point, Dartmouth,	343 14	161 00
Otis B. Luce, ...	1	Quisset Harbor, ...	1,760 06	824 48
Marine Biological Laboratory,	1	Uncatena, ...	922 44	405 29

It has been demonstrated that trap fishing can be conducted profitably in Buzzards Bay but that the returns are less than in the years previous to 1893. If permitted it should yield immediate returns to one class of fishermen and furnish a limited number of men with employment.

If trap fishing is to be allowed, it should be regulated by the Commonwealth, with uniform rules as to size of mesh, dimen-

[1] One in 1914, two in 1915.

sions of trap, etc. A suitable rental should be paid each year for the privilege.

Trap fishing destroys quantities of small fish, since "strainers" are seldom used. Trap fishermen estimate that not over 5 per cent. of the entire catch is destroyed. Estimates from a carefully tended trap, where precautions were taken to separate the small fish, indicate that the numerical waste is considerably higher, — probably between 20 and 25 per cent. of the total catch. Care on the part of the fishermen, the use of "strainers," and the separation of the schools of small fish would do much to lessen the danger from this source.

Buzzards Bay fisheries have generally declined. Trap fishing in Buzzards Bay has not been the only cause, as the decline has continued during its prohibition of trap fishing, but undoubtedly the presence of fish traps would have accelerated the decline. The main causes lie outside of Massachusetts, principally in the waters of Rhode Island and to the south.

Fish Food.

Buzzards Bay contains large quantities of plankton, which constitutes the fundamental food supply for the small fish. The presence of small fish, such as minnows, sand eels, silversides, herring, alewives and menhaden, together with large quantities of squid, attract the larger fish. The warm water, the numerous inlets and coves, and the fresh-water streams make possible this production of abundant food for fish.

The alewife has long been a source of profit as a food fish and as bait for the commercial fisherman, but it has a greater value as a natural source of food, which attracts the larger fish to our shores. In this way the decline of the alewife fishery has affected the supply of larger fish, and the decrease in alewives has been a prominent factor in the disappearance of the bluefish, striped bass, squeteague and other predaceous migratory fish which formerly resorted to these feeding grounds. Owing to its importance a special survey of the alewife fishery was made. The results of this investigation show that —

1. This fishery has declined approximately 75 per cent.
2. The causes of the decline have been overfishing, pollution

and the careless and unnecessary obstruction of the streams by milldams and cranberry bogs.

3. Only a few of the streams have a fishery of any value at the present time.

4. Many fisheries can be re-established by the proper stocking and regulation of the streams.

5. The present laws governing the alewife should be remodeled and the fisheries placed under State control.

Pollution.

Buzzards Bay receives manufacturing and sewage waste in two ways: —

1. Immediate sources, *i.e.*, New Bedford sewers.

2. Remote sources, *i.e.*, polluting material discharged into creeks entering the bay.

At New Bedford the sewage passes into the bay from forty-five outlets and thirty mills discharge chemical waste products, while Fairhaven has six outlets and several manufacturing plants. Recently Mattapoisett has installed a sewer emptying into the bay.

For sanitary reasons the pollution is more serious for the shellfish industries than from the standpoint of fish conservation. In the immediate vicinity of excessive pollution fish cannot live, and the constant emptying into the bay of such material will tend to drive fish elsewhere. Pollution may have been a contributing factor in the decline of the fisheries, but it is one of the minor causes, owing to its local nature.

Buzzards Bay as a Spawning Ground.

1. *Qualifications.* — It was not possible to solve this problem by an investigation limited to part of a year. Certain facts have been determined, others obtained from various writings and from the testimony of fishermen. Buzzards Bay is a part of a large spawning ground embracing Vineyard Sound, the south side of Cape Cod and Long Island Sound. Whether it is of greater value than other waters as a spawning ground has not been determined, although it has the natural conditions which attract the fish and in this way undoubtedly possesses special advantages.

The young of the glut herring, scup, sea bass and numerous small bait fish, menhaden, shad, alewife, tautog, cunner, butterfish, swellfish and flounder have been taken at different stages of development in the waters of the bay. The young of other fish have not been identified so that a complete series from the egg could be obtained from Buzzards Bay. All observed facts bear out the statement of Vinal Edwards, collector for the United States Bureau of Fisheries for over forty years, who stated in 1892 that Buzzards Bay is a breeding ground and good nursery for scup, sea bass, tautog and warm-water fish.

2. *Spawning of Certain Species.* — The following is of interest: —

Bluefish. — A few have well-developed spawn on arrival in the latter part of May, but there is no proof that they spawn in the bay.

Bonito. — June; present from June to October 1.

Butterfish.[1] — June.

Mackerel. — Spawns during the middle and latter part of June, off shore.

Menhaden. — Spawns in June, but probably not in Buzzards Bay.

Sea bass.[1] — Middle of May to first of July.

Squeteague. — Spawns about June 1.

Scup.[1] — Early in June.

Striped Bass. — Does not spawn in Buzzards Bay, but formerly did in the tributaries.

Shad.[1] — Arrives about May 1, remaining only a week. Contains well-advanced spawn on arrival. Spawns in the tributaries.

Alewife.[1] — March and April. Spawns in the tributaries.

Tautog.[1] — June and July.

Further study of the spawning habits of these fish is necessary before more than a broad, general statement of the value of Buzzards Bay as a spawning ground can be definitely made.

Arguments.

Various arguments for and against trap fishing have been stated at committee hearings in past years. The majority are based on faulty premises. Since these same points may again be brought forward at subsequent hearings, it is well to consider the actual value of these stock arguments.

Arguments against Trap Fishing. — 1. Buzzards Bay is an

[1] Species that are definitely known to spawn in Buzzards Bay.

especially favorable spawning ground and a nursery for numerous migratory fish.

Per contra: Definite proof that Buzzards Bay is a special spawning ground different from or superior to the neighboring waters has never been obtained, although the fact that it has special advantages as a nursery for young fish is undoubtedly true.

2. Trap fishing is the cause of the decline in the fishery.

Per contra: There have been no traps in the bay for years, yet the decline has continued. The excessive trap fishery in Rhode Island has doubtless been a prominent cause of this decline, in co-operation with the decline of the alewife and shad fisheries in the tributary streams. Nevertheless, the decline cannot be attributed entirely to trap fishing in Buzzards Bay, for excessive catching of breeding fish in the Middle Atlantic States has also been a contributing factor.

3. The sport of hand-line fishing brings summer people to Buzzards Bay.

Per contra: This was a sound and consistent argument in 1892, but to-day conditions have so changed that the summer people would come to the shores of Buzzards Bay even if fishing were poor, though good line fishing is doubtless an additionally important and valuable attraction.

4. Trap fishing is injurious, as the fish "hug the shore" in their migration.

Per contra: It has been shown that the fish follow the shore only in a general sense, and therefore the traps can catch only a percentage of the total number.

5. Hand-line fishing would benefit the poor man by making it possible for men with small capital to secure a livelihood.

Per contra: Under present conditions the poor man would be little benefited, but if fishing were improved, hand-lining would furnish a valuable food supply for the poor man.

Arguments in Favor of Trap Fishing. — 1. Trap fishing destroys the predaceous fish.

Per contra: These fish were formerly often merely liberated, not killed, by the trap fishermen in the rush of hauling the trap. At present many of these fish could be utilized for food or fertilizer.

2. Trap fishing would bring extra business to the Buzzards Bay towns.

Per contra: The business would be limited to a few men.

3. The price of fish would be cheaper.

Per contra: This usually would not hold true, as the price depends upon the transportation facilities and the market demands at centers of distribution. To-day more fish are caught than are economically utilized.

4. Trap fishing would furnish bait for the fishermen. This is a reasonable argument, as at the present time there is often scarcity of bait for the lobster fishermen and fishing boats.

5. Buzzards Bay is not a spawning ground for the fish taken in the traps.

Per contra: While this point has not been completely determined, there is evidence to prove that many fish spawn in Buzzards Bay.

Acts authorizing the Investigation.

The three acts under which this work was carried out are as follows: —

Acts of 1913, Chapter 104.

Resolve to provide for an Investigation of the Fisheries of Buzzard's Bay.

Resolved, That the board of commissioners on fisheries and game is hereby directed to make an investigation and report upon the fish and fisheries of Buzzard's bay, with particular reference to the quantities and species of edible and non-edible fish to be found therein, the effect of the present laws and restrictions in respect to the taking of fish therein, and the methods of taking fish.

For the purpose the said commissioners may employ additional assistance and experts, and may establish, operate and maintain fish traps or pounds, and may authorize others, under their direction, and in such manner and on such terms as they may deem expedient, to establish, operate and maintain fish traps and pounds, and may purchase, hire, lease, set, operate and maintain movable or stationary apparatus and boats for taking fish; and may take such other action as may be deemed proper for carrying out the purposes of this resolve. The said commissioners may sell or authorize the sale of fish taken for the purposes of this investigation, and may sell any apparatus or boats acquired hereunder, and the proceeds shall be paid into the treasury of the commonwealth.

The said commissioners, if they so desire, may hold one or more public hearings, at such times and places as they may appoint, for the purpose

of hearing persons interested and of obtaining statistics and other information. The said commissioners shall report to the general court on or before the second Wednesday of January, nineteen hundred and fourteen, the result of their investigations, together with such recommendations as in their opinion are calculated to increase and perpetuate the annual yield of useful fish from Buzzard's bay and its tributaries; and in said report the commissioners shall state whether in their opinion the existing laws governing the fisheries in Buzzard's bay should continue to remain in force, be repealed, or modified, and if modified, to what extent, and they shall also submit with their report such drafts of proposed legislations as may be necessary to carry said recommendations into effect.

The commissioners may expend from the treasury of the commonwealth a sum not exceeding twenty-five hundred dollars in carrying out the purposes of this resolve. [*Approved June 4, 1913.*

ACTS OF 1914, CHAPTER 44.

RESOLVE TO PROVIDE FOR THE CONTINUATION OF AN INVESTIGATION OF THE FISHERIES OF BUZZARD'S BAY.

Resolved, That the board of commissioners on fisheries and game is hereby directed to continue its investigation of the fish and fisheries of Buzzard's bay, as provided by chapter one hundred and four of the resolves of the year nineteen hundred and thirteen, with particular reference to the quantities and spawning of edible and non-edible fish frequenting the bay.

For the said purposes the commissioners may establish, operate and maintain fish traps or pounds, and may authorize others, under their direction, to establish, operate and maintain fish traps and pounds; and may set, operate and maintain movable or stationary apparatus and boats for taking fish, and may take such other action as may be deemed by them proper for carrying out the purposes of this resolve. The proceeds of the sale of any fish taken under this resolve shall be used in such manner as, in the discretion of said commissioners, will facilitate their investigation.

The commissioners shall report to the general court on or before the second Wednesday of January, in the year nineteen hundred and fifteen, the result of the investigation, with such recommendations as in their opinion may tend to perpetuate and increase the annual yield of useful fish in Buzzard's bay and its tributaries. [*Approved April 13, 1914.*

ACTS OF 1915, CHAPTER 19.

RESOLVE PROVIDING FOR THE CONTINUATION OF AN INVESTIGATION OF THE FISHERIES OF BUZZARD'S BAY.

Resolved, That the board of commissioners on fisheries and game is hereby directed to continue its investigation of the fish and fisheries of Buzzard's bay, as provided by chapter one hundred and four of the re-

solves of the year nineteen hundred and thirteen, with particular reference to the quantities and spawning of edible and non-edible fish frequenting the bay.

For the said purposes the commissioners may establish, operate and maintain fish traps or pounds, and may authorize others, under their discretion, to establish, operate and maintain fish traps and pounds; and may set, operate and maintain movable or stationary apparatus and boats for taking fish, and may take such other action as may be deemed by them proper for carrying out the purposes of this resolve. The proceeds of the sale of any fish taken under this resolve shall be used in such manner as, in the discretion of said commissioners, will facilitate their investigation.

The commissioners shall report to the general court on or before the second Wednesday of January, in the year nineteen hundred and sixteen, the result of the investigation, with such recommendations as in their opinion may tend to perpetuate and increase the annual yield of useful fish in Buzzard's bay and its tributaries. [*Approved March 11, 1915.*

The first act, which was approved June 4, 1913, provided for an investigation of the fisheries of Buzzards Bay particularly in respect to the quantity of fish, the present methods of fishing and the effect of the present laws upon the fisheries. The provisions are, briefly: —

1. An investigation of the fisheries in Buzzards Bay.
2. A particular study of the quantities of edible and non-edible fish inhabiting the bay at the present time.
3. Present methods of catching fish.
4. The effect of fishing methods now prohibited in Buzzards Bay when applied to present conditions.
5. The employment of suitable assistants and experts.
6. The use of boats and fishing gear of all kinds.
7. The authorization of responsible person to conduct experimental fishing.
8. Provisions for the sale of fish and apparatus.
9. The holding of public hearings, if desired, by the commissioners, and the collection of testimony and evidence.
10. The submitting of a report embodying the results of the investigation with such recommendations as seem calculated to increase and perpetuate the annual yield of useful fish.

The provisions of the second and third resolves continued the investigation upon the fish and fisheries of Buzzards Bay by stipulating that the commissioners might establish, operate and

maintain fish traps or authorize others to do so under their direction, and that the proceeds from the sale of fish were to be used in such manner as to facilitate the investigation. These resolves did not essentially differ from the first except that the lack of an appropriation for carrying on the investigation proved a serious and permanent drawback to the value of the work. For this reason it is impossible to furnish from the records for 1914 and 1915 any further facts than the actual cost of operating the fish traps and the yield in fish according to the figures returned to this office by the individual fishermen, who had set traps under contract with the Commissioners on Fisheries and Game. Statistics showing the number of the different fish in Buzzards Bay for a long term of years would be of great value, as interpreting the possibilities of Buzzards Bay as a fishing ground and as an index of the general effect upon the Massachusetts fisheries of the large number of traps off Sakonnet Point in Rhode Island and further south. However, in considering the value of such statistics, accuracy is the most essential, and in the years to come the veracity of statistics such as were obtained during 1914 and 1915 will be open to criticism that they were from partisan sources. If future investigation is to be carried on for a series of years suitable provision should be made to enable this department to conduct an investigation of trap fishing which would be over and above criticism.

It is essential that records should be taken in all parts of the bay at the same time. In 1914 the withdrawal of the trap at Cuttyhunk and the trap on the eastern side of Buzzards Bay at an early date made the comparison for the remaining months of the summer impossible, and proved a considerable detriment in formulating the statistics for that year. Such circumstances arise from the fact that certain of the men who carry on the trap fishing under the provisions of the above act are imbued not alone with the desire to accumulate accurate statistics but chiefly with the idea of obtaining the privilege for commercial purposes. This is evident from the fact that the traps were kept down only during the good fishing months and not during the latter months of the summer. In such cases partial statistics are almost as worthless as none at all, and it is evident

that if reliable statistics are to be obtained a different method of investigation must be pursued.

The causes which led to the passing of the resolve of 1913 and the subsequent one of 1914 date their origin back to 1886, when Buzzards Bay was first closed to seining, and to 1893, when trap fishing was prohibited throughout the entire bay. At that time and ever since there have been two parties, — the one in favor of unrestricted fishing and chiefly represented by men interested in trap fishing and their numerous sympathizers, the other desirous of keeping Buzzards Bay free from commercial fishing. The latter party was represented by some residents and a few commercial hand-line fishermen, who considered trap fishing as encroaching upon their livelihood, by the sportsmen and recreational fishermen and by the Old Colony Club. Ever since 1892 bills have come annually before the legislative committee on fisheries and game petitioning for the opening of Buzzards Bay to trap fishing. Each time that the advocates of an open bay have entered the legislative arena with a bill of this sort there have resulted long drawn-out legislative battles, in which much money, time and energy have been wasted, and no change has ever been made. Such legislative strife has resulted not only in loss of time and money to those interested, but has proved an expense to the Commonwealth by burdening the Legislature and legislative committees with an endless and useless discussion upon the fisheries of Buzzards Bay. It is therefore highly desirable that this question be decided, as far as may be, once for all.

The present acts are legitimate offsprings of former bills which have appeared in previous years. Openly they appear as an appeal for a much-needed investigation of fishery conditions in Buzzards Bay. However, it is merely an approach to an old subject from a new angle, and once more this report will resurrect the old strife. In previous years this matter has often been thrashed out, and so much antagonism has existed between the two parties that a report of this kind, no matter how exact or impartial, will not be accepted as creditable evidence by one or the other faction, and the same stubborn antagonism as of old will continue. If such a state of affairs exists, as will in all probability occur, the time, labor and results of this in-

vestigation from a practical standpoint will be of little avail. It is hoped, therefore, that the facts presented in this report will be considered solely from the standpoint of the statistics themselves, and that the reader will not be biased by the various arguments put forth by the advocates of either side, since practically every argument which has ever been advanced upon the question of the fisheries of Buzzards Bay can be or has been shown to be based upon fictitious data or fallacious reasoning. Only by taking the accredited facts which are here presented and placing the correct interpretation thereupon can the Legislature decide what may best be done with the fisheries of Buzzards Bay.

The Problem.

The problems presented by this investigation are of two kinds: (1) those capable of being solved in a short period of time; (2) those which require several years to be accurately determined. Unfortunately, most of the individual problems connected with this investigation fall under the second classification, and unless systematic work is conducted for a series of years, can never be adequately answered. The main question, as to whether Buzzards Bay should be open to all types of fishing or restricted to certain branches, resolves itself into several subsidiary problems which must first be answered in order to interpret properly their bearing upon the main issue. The following problems are grouped according as to whether they have been completely or incompletely determined by this investigation: —

Determined. — 1. The approximate quantity of the different species of fish found in Buzzards Bay during the summers of 1913, 1914 and 1915.

2. Commercial possibilities in the prohibited types of fishing.

3. To what extent, if any, such prohibited methods are injurious.

4. The influence of food and bait upon the abundance of fish, particularly with regard to the alewife fishery.

5. The influence of pollution upon the fisheries.

6. The effect of the Rhode Island fish traps upon the fisheries of Buzzards Bay.

7. A comparison of fishing conditions and trap fishing of twenty-five years ago with the present situation.

Incompletely determined. — 1. The extent to which Buzzards Bay is a spawning ground.

2. Whether the value of Buzzards Bay in terms of the commercial fisheries equals its value as a fish-producing area.

3. The possible effect of opening the bay to all types of fishing at the present time.

4. A specific method of increasing the supply of food fish in Buzzards Bay.

Presentation.

It is the aim of this report to present in their entirety the miscellaneous facts which have been disclosed during the past three summers rather than to make any abstract deductions. A few conclusive and positive facts regarding the present condition of the fisheries in Buzzards Bay are of greater value as a basis for proper legislation than all theories, partisan or nonpartisan, deduced from complete or incomplete evidence. Records for but two or three years are neither a true nor an accurate test of the fisheries in Buzzards Bay, since fishing conditions are continually fluctuating. Only by a series of observations covering a period of ten to twenty years may satisfactory conclusions on many important problems be reached. Many years of investigation are required before satisfactory solutions may be advanced for all the problems associated with it. The results of the past three summers are presented with the hope that they will be sufficient, from a practical standpoint, to furnish a reliable working basis for the proper management of the situation in Buzzards Bay.

An established principle of the Commissioners on Fisheries and Game is the development of fishing resources of the Commonwealth by increasing the available fish supply, and meanwhile affording suitable facilities for the development of legitimate fishing industries along lines consistent with the conservation of the fisheries. The legislative policy of the past has been an attempt to preserve the fisheries by restricting the catch in most instances, *e.g.*, with the mollusk fisheries, — an unsound and erroneous economical principle.

The true solution of our fishing problem is to increase the

supply by cultural methods and restrict the catch only when such measures may be used in combination with cultural methods, or when it becomes advisable to reserve certain areas exclusively for reproductive reservations. The immediate problem is to decide whether the value of Buzzards Bay for the continuous annual production of fish is a greater benefit to the fisheries of Massachusetts than would be the immediate cash value of its fisheries, which would result in intermittent harvests, the profits from which would naturally be decreased by the added cost of installing and maintaining an unnecessarily large number of traps.

Courtesies.

Through the courtesy of the National Commissioner on Fish and Fisheries, Dr. Hugh M. Smith, the Bureau of Fisheries has provided this department with laboratory facilities, wharfage and a certain amount of fishing gear during the investigation, as well as furnishing needed assistants and placing at our disposal many important records. Special mention should be made of aid and advice furnished by Collector Vinal Edwards, Directors E. B. V. Pope and H. Mitchell, Superintendents Lock and Thomas, and Capt. R. V. Veeder; and acknowledgment should also be made to G. M. Gray, curator, and Dr. Gilman A. Drew of the Marine Biological Laboratory.

In 1913, Roy S. Corwin of Williamstown, W. G. Vinal of Wellfleet, George F. Hopkins of Brewster and Clifton Eldredge of Harwichport were engaged in the summer investigation, and Deputy Commissioner Charles L. Savery of Marion made observations upon hand trawl fishing during September at the headwaters of the bay. Messrs Vinal and Eldredge took charge of the boat fishing at Woods Hole, while Mr Hopkins covered the traps and territory on the west side of the bay, and Mr. Corwin covered the east side in addition to conducting laboratory work at Woods Hole. In the autumn he collected data upon the alewife fisheries, and upon the pollution of the streams entering Buzzards Bay. In 1914 and 1915 Leslie J. Gilbride of Roslindale acted as assistant. The work of all the assistants, and in particular that of Mr. R. S. Corwin, is worthy of commendation.

Methods of Investigation.

To facilitate matters the investigation was divided into two distinct parts, each with its own particular bearing upon the problem: (1) an historical study of past conditions in Buzzards Bay from all available records; (2) a survey of the present status of the fisheries for comparison with past conditions and with other localities.

Past Conditions. — Records of previous years were obtained from a variety of sources. Some proved of great value, others were entirely worthless. Every accessible subject was investigated and large quantities of material were collected. The chief sources of information were as follows: —

The records of the United States Bureau of Fisheries, both published and unpublished, furnished through the courtesy of Commissioner Hugh M. Smith, gave much valuable information concerning the habits and species of fish inhabiting the bay.

Our own reports gave detailed records of the catch in Buzzards Bay and Vineyard Sound since 1870, and the attested returns of fishermen during the past ten years were available. Unfortunately, many fishermen did not submit their returns, and the records therefore do not designate the total valuation of the fisheries. However, from a practical standpoint and for comparative purposes, the records of trap and net fishing are entirely satisfactory as illustrating the commercial value.

The records of the fish trap of the United States Bureau of Fisheries, which has been maintained in Buzzards Bay during the last ten years, proved valuable.

Records of the old fish traps in the bay were obtained from the filed returns and old accounts of the trap fishermen. In most instances the size, shape and location of the trap and record of the catch were obtained.

The testimony of many fishermen and shore residents, both previous trap owners and persons opposed to trap fishing, was taken by special interviews. Town reports, which furnished little information except records of permits to put out fish traps, were consulted, and from the miscellaneous material thus collected the history of trap and net fishing in Buzzards Bay

was obtained. The suggestions and opinions of the various men were classified.

Present Conditions. — An effort was made to obtain some idea as to the quantity and species of fish in the bay during the various fishing months, chiefly through fish traps and boat fishing.

1. *Traps.* — Under the provisions of the act authorizing the investigation the commissioners were given the power to permit certain traps to be placed in the waters of the bay, subject to their oversight. In 1913 four traps were placed in Buzzards Bay proper, and were located as follows: —

The Marine Biological Laboratory trap at Woods Hole on the north shore of Naushon Island, near the site formerly occupied by the trap of Mr. Prince Stewart, thus affording a valuable comparison.

The trap of the United States Bureau of Fisheries, located south of Quisset Harbor, where the same trap has been located for the past fifteen years.

A trap on the west side of Clarks Cove, South Dartmouth, operated by W. T. Dunn of South Dartmouth.

A trap at Ricketson's Point, South Dartmouth, operated by W. T. Dunn of South Dartmouth.

In addition, records were secured from traps located just outside the boundaries of the bay, *i.e.*, (1) a trap at Cuttyhunk, owned by Bosworth and Veeder; (2) a trap in Quick's Hole, owned by H. Nelson Luce; (3) the Vineyard Sound trap of the Marine Biological Laboratories, situated on the south side of Naushon Island, and (4) other traps in Vineyard Sound.

In addition to the traps placed in the bay in 1913 several new traps were located in the following places in 1914: —

On the north side of the island of Cuttyhunk, by David P. Bosworth & Company.

At the entrance of Quisset Harbor, by Otis B. Luce of Vineyard Haven.

Off Salters Point, South Dartmouth, by Alvin Waite.

Off Machaum in South Dartmouth, by Benjamin T. Smith.

In 1915 three other traps were set, while the Bosworth trap was discontinued.

Near Kettle Cove on the island of Naushon, by Oved S. Daggett.

Off Penzance, Woods Hole, by H. Nelson Luce.

At Horse Neck Beach, Westport, by John R. Fish, Jr.

For these traps records were made of the species of fish taken, edible and non-edible, their number, weight and value; the number of young fish taken and destroyed; the food of the different species; and the cost of maintaining and tending the traps. Unfortunately, no traps were located at the head of the bay.

2. *Boat Fishing.* — Traps accounted only for the fish that frequent the shores. In order to obtain an accurate and definite idea of the fish inhabiting the whole bay, it was necessary to supplement the trap records with boat fishing, since statistics gathered from line fishermen at the head of the bay proved of little value.

The oyster boat of Capt. James Monahan of Wareham was hired for the summer of 1913, and with it daily records were taken in various parts of the bay under the supervision of W. G. Vinal, chiefly by using prohibited types of fishing gear. The otter trawl, the oyster dredge, gill nets and line trawls were employed, and accurate records of the results from these types of fishing were made. Owing to the lack of suitable gear and the necessary men, no extensive seining was done. To obtain a fair estimate of the quantity of fish in the bay at any one time, many miles of seines should be set, requiring the services of several vessels, — an extensive and expensive undertaking utterly beyond the available resources. If such a procedure could be carried out several times during the season, a fairly correct estimate of the quantity of fish might be obtained. As it was, the oyster boat answered its purpose in determining the value of the above-mentioned types of fishing, and records were made of the quantity, size, weight, spawn and food of the fish thus taken.

In the headwaters of the bay in September several sets with line trawls were made in order to obtain some idea of the prevalence of fish in the headwaters of the bay. These records, however, were conducted only through the month of September, and were primarily intended to serve as a check upon the data obtained from the hand-line fishermen in the upper part of the bay. An effort was made to obtain all available and ac-

credited facts from the boat hand-line fishermen in the vicinity of New Bedford and along the north shore of Buzzards Bay. However, in spite of the number of men interviewed, the figures cannot be considered as complete or correct indicators of the condition of the fisheries in the bay, and their bearing upon the subject must be given only such weight as their source should warrant.

3. *Statistical Records.* — From the records of the United States Bureau of Fisheries, statistics of the fisheries in Buzzards Bay, in Vineyard Sound and other parts of the Atlantic coast were obtained for 1913 to 1915 for comparison. These previous records of the United States Fish Commission dealt chiefly with the various fish frequenting Buzzards Bay, particularly the young of the different species which spawn in Buzzards Bay and their habitat.

Historical Résumé.

In considering the conditions which have led up to the present situation, it is perhaps well first to analyze the law which closed Buzzards Bay to commercial fishing in 1893 and to present a brief review of the circumstances which led up to the closure. In this problem several antagonistic forces have been at work, namely, the menhaden fishermen and seiners, the trap fishermen, the commercial hand-line fishermen, the sportsman fishermen, the summer residents, and the members of the Old Colony Club. The interests of practically all these factions have been radically at variance, with the inevitable result of prolonged legislative strife during the past twenty years.

Legislation.

In 1865 an act was passed regulating the taking of menhaden in the waters of Buzzards Bay and Vineyard Sound, whereby the capture of menhaden by the use of purse seines in these waters was restricted before the fifteenth day of June in each year at the mouth of any river where a herring fishery was established by law.

In 1870 an act was passed for the fisheries in the headwaters of Buzzards Bay whereby no person was allowed to set or use any movable net or to establish any fish weir north of a line

drawn from the entrance of West Falmouth Harbor to Upper Island Light, thence in a straight line to Great Neck Point on the Marion shore, under a penalty of not less than $20 and not more than $100 for each offence and the forfeiture of the offender's fishing apparatus.

In 1874 the limits under the act of 1870 were extended to the waters northwest of a straight line from Angelica Point in the town of Mattapoisett to the central point of Ram's Island, then west to Mattapoisett. The provisions of this act were applicable between the twenty-fifth day of March and the fifteenth day of May of each year.

In 1880 it was enacted that from the first of May to the 15th of June in each year no person should set any stationary apparatus for catching fish, except gill nets between the hours of 6 o'clock on Sunday morning and 6 o'clock on the succeeding Sunday evening, so as to catch fish in the tidal waters of Dukes County and of the county of Bristol and of the towns of Mattapoisett, Marion and Wareham, and in the tidal waters of the towns of Falmouth and Sandwich at and near Buzzards Bay.

In 1886 an act was passed regulating the use of movable net apparatus in Buzzards Bay, the essential features of which are the same as exist in the present law restricting the use of movable net-fishing apparatus in Buzzards Bay. All gill netting was prohibited by this act except in a portion of the town of Fairhaven, within a line drawn from Commorant Rock southwest to the buoy on West Island Rips, and from thence westerly in a straight line through the buoy on West Island Ledge to the town line of Fairhaven. It likewise did not affect in any way the fish weirs or the use of nets or seines in the shad and alewife fisheries in any of the streams emptying into Buzzards Bay. This act was aimed against the menhaden fishery, and was for the purpose of doing away with "pogy" steamers in Buzzards Bay. This law was carried to the Supreme Court by the menhaden fishermen, and the decision was rendered that Massachusetts could regulate her fisheries within three miles of her own shore in whatever manner she saw fit. The result of that act was to do away with menhaden fishing in Buzzards Bay.

The act which restricts, at the present time, the methods of fishing in Buzzards Bay consists essentially of two parts, as follows: —

1. The regulation of movable apparatus. This part of the law, in substantially the same form as at the present time, was passed in 1886 (chapter 192) as an act for the protection of the fisheries in Buzzards Bay.

2. The regulation of stationary net apparatus, which was passed in 1893. In other words, the law is a composite creation formulated for two separate purposes, — the former for the prevention of menhaden fishing, the latter for the prevention of trap fishing. The provisions of the act (Revised Laws, chapter 91, sections 121 to 126, inclusive) as it now stands upon the statute book are as follows: —

Traps prohibited in Buzzards Bay.

Section 121. Whoever sets, uses or maintains any trap, weir, pound, yard or other stationary apparatus of any kind for the taking of fish in the waters of Buzzards bay or in any harbor, cove or bight thereof shall be punished by a fine of not less than one hundred nor more than five hundred dollars, or by imprisonment for not more than six months.

Nets prohibited in Buzzards Bay.

Section 122. No person shall draw, set, stretch or use any drag net, set net or gill net, purse or sweep seine of any kind for taking fish in the waters of Buzzards bay or in any harbor, cove or bight thereof within the jurisdiction of this commonwealth. Whoever violates, or aids or abets in the violation of, the provisions of this section shall be punished by a fine of not more than two hundred dollars for each offence.

Penalties.

Section 123. A net or seine which is used in violation of the provisions of the preceding section and a boat, craft or fishing apparatus which is employed in such illegal use, and all fish found therewith, shall be forfeited. An inhabitant of a town bordering on said bay may seize and detain for not more than for y-eight hours any net or seine found in use in violation of the provisions of the preceding section, and any boat, craft, fishing apparatus and fish found therewith, so that they may be seized and libelled.

When Nets are Nuisances.

Section 124. All nets and seines in actual use which are set or stretched in violation of the provisions of section one hundred and twenty-two and one hundred and twenty-eight are declared to be common nuisances.

Fishing Rights in Buzzards Bay.

SECTION 125. The provisions of the four preceding sections shall not affect the corporate rights of any fishing company situated on Buzzards bay, nor the use of nets or seines in lawful fisheries for shad or alewives in influent streams of said bay.

Limits of Buzzards Bay.

SECTION 126. In the statutes of this commonwealth the term "waters of Buzzards bay" shall be deemed to mean the body of water commonly known as Buzzards bay and extending southwesterly to a line drawn from Cuttyhunk lighthouse to the southerly extremity of Gooseberry neck in the town of Westport.

The provisions of this act resulted in the restriction of Buzzards Bay to practically all forms of fishing except hand-line fishing. In brief, the conditions imposed were as follows: —

1. Trap fishing of all kinds was forbidden within the limits of the bay.
2. Seines and nets of all types, except alewife seines and eel fykes, were forbidden.
3. Severe penalties for the violation of the provisions of this act were instituted.
4. All nets and seines set in violation of the provsions of this act were declared common nuisances.
5. Apparatus and boats used in violation of this act were forfeited.
6. The boundaries of Buzzards Bay were definitely limited.

The Closure of Buzzards Bay.

Buzzards Bay since 1892 has been entirely free from trap fishing and seining except for certain trap leases on the west side, which did not expire for some years after the law was passed. For this reason, in the early '90s a number of traps were still set in Buzzards Bay in spite of the law, especially since several licenses were purposely granted for a term of years just previous to the passage of the act. During the last fifteen years the only fish traps in Buzzards Bay have been conducted by the Marine Biological Laboratory and the United States Bureau of Fisheries at Woods Hole, for scientific

purposes. Just outside the borders of Buzzards Bay traps have been set at Cuttyhunk and Vineyard Sound.

At the present time in Buzzards Bay the Commonwealth has a body of water which has been practically closed to all net fishing for a period of approximately twenty years. The justification for this law is found in the claim that the welfare of the fisheries as a whole demanded its reservation for a breeding ground for the fish. Considerable doubt exists in the minds of many persons whether such a principle is of value as applied to Buzzards Bay for the reason that the more valuable fish are mostly migratory, and are caught in large quantities elsewhere, *i.e.*, in Rhode Island just outside the restricted areas. It was for the purpose of determining the true relation of these factors that the collection of data bearing upon fishing conditions in Buzzards Bay was undertaken.

The events leading up to the passage of the act of 1886 are interesting. The presence of "pogy" steamers proved a nuisance to summer residents and to local fishermen, since the menhaden acted as food for more valuable fish, and their destruction in large quantities, as well as of other schooling fish, proved unpopular. For that reason little difficulty was encountered in restricting the use of gill nets and seines in Buzzards Bay. The only opposition came from the menhaden fishermen, especially from the large firms domiciled in Rhode Island.

On the other hand, the crusade against trap fishing brought out a spirit of conflict between the trap fishermen and their friends on one hand, and the line fishermen, summer residents and sportsmen, headed by the Old Colony Club, on the opposing side. The results between the years 1886 and 1892 showed a gradual restriction in the use of fish traps in the various towns along Buzzards Bay. Beginning with the towns on the eastern and upper waters of the bay, permits for setting fish traps were restricted by special laws. Such measures were first in force in the towns at the headwaters of Buzzards Bay which had never carried on extensive trap fishing.

In 1890 the exemption of the act of 1886 was removed from Fairhaven, and it was declared illegal to set any movable fish apparatus anywhere within the waters of Buzzards Bay, thus

The "Henry S. Rogers," a gasolene oyster dredge used in the Buzzards Bay investigation.

Baiting the trawl line.

practically eliminating gill netting within the entire bay. In 1889 Fairhaven declined to set fish traps. In 1891 Fairhaven also voted to eliminate trap fishing, leaving only the towns of Mattapoisett and Dartmouth where trap fishing was continued. In 1891 the provisions of the act of 1886 in respect to the fish weirs and the use of nets and seines in the shad and alewife fisheries in the streams entering Buzzards Bay was confirmed.

In 1891 there was a meeting at Bourne in the interest of the protection of the fisheries of Buzzards Bay. Many prominent citizens expressed themselves in favor of doing away with trap fishing in Buzzards Bay. Action by the Old Colony Club finally took the form of the bill which, after bitter conflict, became a law in 1893, prohibiting trap fishing in Buzzards Bay. This act, intended for the better protection of the fisheries, stipulated that no traps, weirs, pounds or stationary apparatus for the taking of any kind of fish should be kept, maintained or used for the taking of fish in Buzzards Bay. It was also stipulated that the selectmen of the towns bordering on Buzzards Bay should have no power or authority to grant licenses to construct fish weirs, but that nothing should forbid the maintenance of fish weirs under licenses previously granted until the terms of such licenses expired. The argument for closing this body of water was based on two points: (1) that Buzzards Bay was a natural spawning ground; (2) that the supply of fish was declining, and that trap fishing was the cause or at least was hastening the decline.

The effect of the passage of the law of 1893 resulted in a considerable number of trap fishermen being thrown out of employment. Previous to the passage of the law there were forty traps in the bay which were employing anywhere from two to five men each, including the employment of various packers and men engaged in the handling and preparation of the fish for market. There was, likewise, a loss in material, such as nets, gears and other equipment, which could not economically be diverted for use in the other fisheries. The majority of the trap fishermen, anticipating the reopening of the bay within a few years, stored their nets and gears, with the result that after several years they were forced to sell their

nets at a considerable loss. To some extent the general public was affected by the diminution in the supply of fish, particularly among the inhabitants of shore towns. This argument was used with considerable effect by the advocates of trap fishing, who maintained that with the traps in the bay fish could be furnished in greater quantities and at a cheaper rate to the local inhabitants. However, as most of the fish was shipped to Boston and New York markets, the benefit to the local people was of little consequence.

Fish.

Observations upon the number, species and habits of the fish are of great value in considering the influence of commercial methods upon the fisheries of Buzzards Bay. In this connection a study of the food conditions in Buzzards Bay — from the simple plankton, the floating food of the small fishes, to the small fish themselves, which in turn serve as food for the large predaceous fish — is of importance. Therefore, considerable time has been devoted to the study of existing conditions in regard to the alewife or branch herring fishery, especially in those streams which enter the headwaters of Buzzards Bay. It is important to know what species of fish enter the bay, at what seasons, and what the proportion of non-edible fish is to the more valuable edible fish. Other facts, which must also be given due consideration, are a comparison of conditions, present and past; whether the fish in their migrations follow the shore lines or are found throughout the bay; whether or not there has been a decline; what changes are apparent in the species and abundance of fish; whether the food supply has changed, and whether trap fishing can be carried on in Buzzards Bay without damage to the best interests of the fishery. Such numerous facts all bear in large measure upon the main problem of reserving the bay, and are largely co-ordinated by a study of the statistics of the fisheries of the present time as compared with previous years, though due consideration must be given the spawning and other habits of the fish.

Species inhabiting Buzzards Bay.

Alewife.
Barracuda.
Sea bass.
Striped bass.
Bluefish.
Bonito.
Butterfish.
Horse Crevalle.
Yellow Crevalle.
Cero.
Cod.
Cunner.
Cutlass fish.
Smooth dogfish.
Spiny dogfish.
Common eel.
Lamprey eel.
Filefish.
Summer flounder.
Winter flounder.
Four-spotted flounder.
Hogchoker.
Sand dab.
Foolfish.
Garfish.
Goosefish.
Common hake.
King hake.
Glut herring.
Round herring.
Sea herring.
Kingfish.
Mackerel.
Menhaden.
Pilot fish.
Pollock.
Sharp-nosed ray.
Large sting ray.
Remora.
Rudder fish.
Sailor's-choice.
Salmon.
Big-eyed scad.
Mackerel scad.
Sculpin.
Scup.
Common sea robin.
Striped sea robin.
Common shad.
Hickory shad.
Dusky shark.
Hammer-head shark.
Leopard shark.
Sand shark.
Thresher shark.
Barn-door skate.
Summer skate.
Winter skate.
Smelt.
Spanish mackerel.
Squeteague.
Squid.
Sturgeon.
Swellfish.
Tautog.
Tomcod.
Whiting.

Commercially Important Fish.

Alewife.
Sea bass.
Striped bass.
Bluefish.
Bonito.
Butterfish.
Cod.
Common eel.
Summer flounder.
Winter flounder.
Four-spotted flounder.
Hake.
Mackerel.
Menhaden.

Pollock.	Squeteague.
Salmon.	Squid.
Scup.	Tautog.
Shad.	Tomcod.
Smelt.	Whiting.
Spanish mackerel.	

Commercially Valuable Fish now present in Paying Quantities.

For bait: —

Menhaden (also valuable for oil).
Alewife (also used for food).
Sea herring (also used for food).
Squid.

For food: —

Sea bass.
Butterfish.
Flounders.
Mackerel.
Scup.
Squeteague.
Tautog.

Fish formerly important but now absent or taken in Small Quantities in Buzzards Bay.

Bluefish.	Pollock.
Bonito.	Shad.
Striped bass.	Salmon.
Cod.	Smelt.
Hake.	Spanish mackerel.

Common Non-edible Fish.

Smooth dogfish.	Sea robins.
Spiny dogfish.	Sharks.
Goosefish.	Swellfish.
Rays.	Skates.
Sculpins.	

The above list includes the so-called non-edible species most commonly taken in the fish traps, the number of dogfish, sea robins and swellfish at times running high. These fish are a considerable nuisance to the fishermen in hauling the traps. At present these species have little commercial importance and are thrown away. In the future we shall undoubtedly eat many of these forms, but at the present time the public taste has not

been educated to appreciate this type of food. The use of dogfish as a food has long been advocated; skates are used in England; sculpins and sharks are eaten by the Italian population of our cities. The time is not far distant when thrift not waste will characterize all our fishing operations. Many of these species, especially the dogfish, sharks, skates and goosefish, destroy enormous quantities of the most valuable species, and are therefore the cause of great economic waste, as well as a nuisance to the fishermen.

Past Abundance.

In considering the abundance of the catch of fish in traps in past years some fishermen place scup as the most numerous, others consider the alewife as such, with scup a close second. Next in order in abundance is the butterfish; then come in varying order tautog, flounder and sea bass. In Rhode Island, the catch of fish, arranged in order of their relative abundance, is approximately as follows: scup, sea bass, butterfish, flounders and mackerel; the considerable quantity of squid taken can hardly be classed with the edible fish. These fish, according to Benjamin T. Smith of South Dartmouth, have appeared in the traps of that neighborhood in the following order: April, herring and shad; May, squeteague, butterfish and mackerel; June and July, scup, mackerel, squeteague, flounders and bluefish, and in the fall, squeteague. Alvin Waite of South Dartmouth, a trap fisherman of many years' experience, gives the various species in the order of their arrival as tomcod, flatfish, sculpin, glut herring, alewife, shad, sturgeon, summer flounder, four-spotted flounder, mackerel, hake, pollock, smelt, various species of shark, hickory shad, striped bass, sand dab, skate, spiny dogfish, tautog, menhaden, butterfish, scup, sea robin, squid, whiting, squeteague, bluefish, spanish mackerel, goosefish, kingfish, sea bass, bonito and herring.

Commercial Importance.

It is of importance to the trap fishermen that certain species be obtained in greater abundance than others, thereby insuring a more profitable return for the season's work. As an instance of this can be cited the catch of mackerel made by Otis B.

Luce in his trap off Quisset Harbor, in the early part of the summer of 1914. The entire profit from his trap resulted from the catch of mackerel, which were taken in greater abundance than in any other trap in the bay. Fish which were formerly commercially important are no longer taken in Buzzards Bay in the quantities in which they were taken in former years. Beyond question there has been a decline in certain species, such as striped bass, bluefish and shad, which are no longer taken in the great numbers they were twenty, fifty or seventy-five years ago. On the other hand, the run of scup and butterfish is perhaps more abundant than in former days, and likewise squeteague, which within the last fifteen years has in some degree taken the place of bluefish. The fisheries of Buzzards Bay have not remained stationary, they have been constantly changing, to meet varying conditions. But when we consider the entire fishery of the bay with regard to the number and species of fish, we find that there has been a general decline, since certain species once of great value are now exterminated so far as Buzzards Bay is concerned.

Migration.

For many years it was the impression that the fish entered Buzzards Bay by following the shores, a stock argument used by the opponents of trap fishing to illustrate the great destruction from trap fishing. The trap fishermen, on the other hand, declared that the traps took only a small portion of the fish, which were abundant over the bay as well as near the shore. It is now evident that the fish do not "strike in" by closely following the shore, but move upon the shore in manner similar to the waves of the sea, striking the shore at an angle. In the upper portions of the bay perhaps they may follow the shore in order to get to the shallow water for spawning, but there is no adequate proof that the shore line is followed to the exclusion of the other waters.

The fishermen who have been engaged for years in trap fishing state that the fish enter the bay on the eastern side, citing as proof the fact that the different species, especially mackerel and scup, are taken a week earlier by the traps on the Falmouth shores than at the western entrance to the bay. Un-

questionably, after entering Buzzards Bay, owing either to the warmer water near the shore or some unknown cause, the fish frequent the shore water. For that reason the argument that trap fishing takes only a portion of the fish is erroneous, as the greater part of the fish undoubtedly lie near the shore; but it is evident that they enter Buzzards Bay directly from the open ocean and Vineyard Sound.

Predaceous Non-edible Fish.

The so-called non-edible fish are the smooth dogfish, spiny dogfish, skate, ray, sculpin, sea robin, shark, swellfish and goosefish. Of these, the two dogfish and the various other species of shark do the most damage to the fisheries. The voracious goosefish undoubtedly is a destructive enemy, but owing to its numerical inferiority it is relatively of minor importance.

The smooth dogfish (*Acanthias americanus*), sometimes known as the dog shark or horned fish, frequents all kinds of bottom in the shallow waters of the bay. It is taken to a large extent in traps, on hand lines and occasionally in seines, being present from May to November, and is especially abundant during June. It has a length of about three feet, with a slender body tapering from the dorsal fin to the tail. The smooth dogfish differs from the spiny dogfish in the absence of a dorsal spine, and in having a greater size and a blunt head. Its food consists of crustacea, chiefly crabs and small fish, especially menhaden.

The spiny dogfish (*Squalus acanthias*), sometimes known as the horned dogfish, inhabits both coasts of the Atlantic, and is especially common on the fishing banks. It is an infrequent visitor to Buzzards Bay and Vineyard Sound, in striking contrast to its pestiferous abundance along other parts of the coast. Formerly it was very numerous in this region, in fact, to such an extent as to form the chief source of "fish guano," produced at the old Woods Hole factory. Its food consists of ctenophores, squid and various other fish, such as whiting, hake, mackerel, etc.

The various sharks taken from the waters of Buzzards Bay are the sand, hammerhead, leopard, dusky and thrasher.

The sand shark (*Carcharias littoralis*) is a small but voracious fish inhabiting the coast from Cape Cod to Cape Hatteras; its average size is about five feet, although specimens twelve feet long have been obtained. It is abundant everywhere in the shoal waters of Vineyard Sound and Buzzards Bay from June to November, and serves as a source of amusement to hand-line fishermen. Its food consists of lobsters, crabs, squid, menhaden, sea bass, scup, butterfish, flounders, alewives, squeteague, sea robins and bonito.

It has long been an argument of the trap fishermen that traps were a benefit to the fisheries of Buzzards Bay in that they destroyed the useless predaceous fish, and that since the abolition of trap fishing the number of sharks, dogfish and skates has markedly increased, to the detriment of the commercial fisheries. This question involves a consideration of (1) the methods of disposing of fish in the days of trap fishing; (2) whether they have increased or not since trap fishing has been abolished; (3) how much damage these fish actually do to the commercial fisheries; and (4) how can this problem best be solved for Buzzards Bay.

Destruction. — In spite of the argument of the trap fishermen that large numbers of dogfish, skates and sharks were formerly destroyed by traps in Buzzards Bay, there is no definite proof that the trap fishermen ever have or ever will destroy a sufficient number of dogfish to offset any increase. The trap fisherman in hauling his trap works hard, is pressed for time, and usually rushed to get his fish to market. If a large number of dogfish and sharks are taken, unless they can be used as fertilizer or sold at a profit there is no incentive to destroy them, which inevitably results in the rapid return to the water of the living fish. Seiners and other fishermen show a similar lack of foresight in merely tossing the dogfish from the nets without taking time to kill them. This state of affairs certainly existed in the former days of trap fishing, since fishing is strictly a commercial proposition in which the fisherman has time only to do those things which will bring him in the greatest returns, and never can be in a position to take a great amount of time for the purpose of destroying these fish unless opportunity is given him to market them

at a profit. In 1914 and 1915 many large sharks from the experimental traps in South Dartmouth were sold for food and fertilizer.

Increase. — A fairly accurate idea concerning the increase or decrease in numbers of these different species may be obtained from a comparison of the catch of the trap of the United States Bureau of Fisheries for a period of sixteen years. This trap was located all this time in the same place, — south of Quisset Harbor, Buzzards Bay. Statistics indicate that there has been some increase in the number of certain non-edible predaceous fish in Buzzards Bay during the last sixteen years, in this way corroborating the observations of the fishermen. The hasty conclusion that this increase was due to the absence of traps should not be reached. Undoubtedly there has been an increase in predaceous fish, particularly the dogfish, along our entire coast, as shown by the evidence submitted in the 1905 report of this department. A natural increase must be considered legitimate for Buzzards Bay when compared with other waters. Whether this increase is abnormal is a problem difficult of solution. Buzzards Bay as a spawning ground and food center attracts many of the fish upon which the shark and spiny dogfish feed, and also furnishes an abundance of desirable food such as is favored by the smooth dogfish. Statistics from the trap of the United States Bureau of Fisheries, which, since 1898, has been situated for the months of July and August south of Quisset Harbor on the Falmouth shore, have shown a surprising increase in the number of smooth dogfish. The average per day for the five years between 1898 and 1902 was 1.44 dogfish; between 1900 and 1905, 7.23 dogfish; between 1905 and 1910, 18.94 dogfish; and between 1910 and 1915, 22.24 dogfish. These statistics, coming from accredited sources, are of extreme importance as indicating an unquestionable increase in the number of smooth dogfish. During the same period there was only a small catch of spiny dogfish, probably due to the fact that this species arrives in larger numbers during May and October. In 1897 it was comparatively scarce at Woods Hole, and has been ever since. Insufficient data render impossible any conclusion as to its increase. The records of the Woods Hole

trap show that in sixteen years 5 leopard sharks, 5 thrasher sharks, 19 hammerheads, 86 dusky sharks and a larger number of sand sharks were caught. In considering the first three it is impossible, owing to the small number taken, to arrive at any conclusion, although about the same number of hammerhead sharks were taken each year. It is interesting to note that several hammerhead sharks were taken in the experimental gill nets in 1913. The dusky shark showed practically no increase or decrease, and the number was not sufficient to permit conclusions being drawn. Some indications of the abundance of sharks of the sand variety were obtained. The average catch per day for the five years between 1898 and 1903 was .736; between 1900 and 1905, .737; between 1905 and 1910, .766; and between 1910 and 1914, .340.

Damage. — The damage done by predaceous fish not only concerns the fishermen, but indirectly affects every consumer of sea food. It has been a well-nigh universal practice, conforming to local market preference, to confine the fisheries to relatively few species, notably the mackerel, cod, salmon, bluefish, striped bass, shad, etc., and to throw overboard, either alive or dead, such fish as did not readily meet the market demands. Thus we have gone on for generations killing both the adults and the young of the fashionable food species, and have brought about both a local and a general decline in certain cases. Consequently, while we have impaired the reproductive capacity of certain species by killing large quantities of old and young individuals, the dogfish and other sharks have come to be proportionately more numerous, and have destroyed a relatively greater number of food fish.

As a result of previous investigations in 1905 we found that 50 per cent. of the total weight of fish caught were dogfish, as nearly as could be determined. In addition to the time lost in hauling up and liberating these dogfish, and the loss of opportunity to catch marketable fish on the hooks occupied by the dogfish, the total actual cost of catching these dogfish amounts to at least $160,000. Besides this the damage by dogfish to marketable fish on the hooks and in nets amounts to at least $250,000. At a fair estimation every dogfish which reaches

mature size, say 5 to 7 pounds, will have eaten at least 20 pounds (undoubtedly more) of marketable fish. Massachusetts fishermen catch annually at least 27,000,000 dogfish, which must have eaten 540,000,000 pounds of marketable fish, and these, even at one cent per pound, figure up to an annual damage in Massachusetts waters alone of between five and six million dollars. A corresponding tribute is laid by the dogfish upon the fisheries of Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, the Carolinas, Georgia and Florida, as well as on the Pacific coast.

Solution. — The solution of the non-edible and predaceous fish problem will be found in their utilization either for food or for manufacturing purposes. In the last few years many experiments upon the use of the dogfish for fertilizer have been made, and the Federal government has investigated the production of oil from this species. Previous reports of this commission, issued in 1905 and 1911, have considered in detail the destructiveness of the dogfish and the different methods of utilization. The establishment of a reducing plant in Massachusetts would be in many ways a benefit to the fish industries.

The time will come when dogfish, sharks, skates, etc., will be used for food, and it is even conceivable that dogfish fins and tails may be put on the market in the same manner as shark's fins and tails are sold in China, where they are considered a great delicacy. Some Chinese are reported as operating a "dried fish plant" at Santa Monica, Cal., where they preserve the flesh of the shark. This flesh is cut off in strips, sprinkled with sugar and placed in position on drying screens until cured. It is said to be considered a great delicacy, and finds ready sale in large quantities. Recently, efforts have been made to put sharks on the market as fresh food fish. Instances of sales in Boston and New Bedford markets have been recorded. The flesh of the shark and dogfish is clean, although somewhat coarse, and should prove a substantial food. It is reported that the Italians in New York highly prize the flesh of the shark.

The solution of the local Buzzards Bay problem is not in allowing Buzzards Bay to be reopened to trap fishing, but in

readjustment of the handling of these products for commercial purposes. The mere presence of traps would not mean the destruction of these fish unless they were commercially profitable, so that the fisherman could derive a suitable revenue. Trap fishing to be of any value in solving the predaceous fish problem should be carried on during the entire summer at certain particularly important points, *i.e.*, western entrance of the bay, and should not be limited to a few early summer months.

Methods of Fishing.

Under the law of 1893 practically all movable and stationary seines and large nets were included, and for this reason it may be well to consider the different forms of prohibited fishing and their effect upon the fishing conditions in Buzzards Bay. Likewise, it is desirable that other forms of fishing at present used in Buzzards Bay be compared with the prohibited types. The status of each fishery should be determined in regard to its destructiveness, and how it can best be improved for the benefit of all fishermen.

Hand-line Fishing.

Hand-lining is a primitive method of catching fish originating with the savage Indians. The early colonist improved upon the bark line and the bone hook of the Indians, and later substituted the steel hook and string line, finally reaching the silk line and expensive rod of the sporting fishermen. Whatever the method, fancy or simple, costly or cheap, it is hand-line fishing, and every lover of fishing, whether for sport or for a livelihood, enjoys it. The usual procedure is to go to the fishing grounds in a boat, anchor and proceed to fish, sometimes with a rod, more often with a simple hand-line. In certain favorable localities it is possible to fish from bridges or from the shores. The various fishing grounds in Buzzards Bay are numerous, although perhaps the most noted is Cleveland's Ledge.

From the testimony of persons who have lived for years on the shore of Buzzards Bay hand-line fishing has declined. The catches of fish at the present time are much smaller than in former years on the same grounds, if reliance can be placed on testimony of this sort, and in this case it should be of value.

Hand-line fishing, both as a sport and as a business, has declined. This decline has been rather in the amount of catch than in the number of fishermen. Statistics of the hand-line fishery at the present time are hard to obtain, and it is practically impossible to make an accurate estimation of the total catch in Buzzards Bay so numerous and so irregular are the fishing parties.

Hand-lining is, of all means, the least destructive method of fishing. The number of fish thus taken are less than with all other kinds, but it is less adaptable for market fishing than the more rapid methods. The fish usually taken with the hand-line are tautog, scup and flounders, occasionally bluefish and squeteague. The arguments in favor of hand-line fishing are —

1. Hand-lining would attract numerous summer visitors. In 1892 this was an excellent argument, but in 1913 to 1915 it is of little value, as summer people would come to Buzzards Bay any way, because of its other attractions.

2. Hand-line fishing would favor the poor man and enable him to obtain a living. At the present day a man industrious enough to get a living by hand-lining would be able to get a living at any work.

3. Hand-line fishing is not destructive.

Trawl-line Fishing.

The trawl line consists of a ground line to which are attached the "ganging," which consists of a short line of about three feet, with hooks. At each end of the ground line is an anchor to which buoys are attached. The trawl line used in 1913 in Buzzards Bay by this department had approximately three hundred hooks. The trawl is baited and coiled in a tub ready to set when the fishing schooner reaches the grounds. This method of fishing is used extensively by line fishermen, both in deep and shallow water fishing, and is little more than an extension of the hand-line method. The bait usually consists of fish, clams, squid, cockles, etc. In the work in Buzzards Bay the baits used were cockles, scallops, clams, hermit crabs and fish. Various experiments were made with the different kinds of bait to determine the success of the different varieties. It

was therefore necessary to count the hooks when hauling the trawl in order to obtain a record of the effectiveness of each kind of bait. In small bodies of water, such as Buzzards Bay, the fishing grounds are usually selected near ledges or on a rocky bottom. In the experimental work the trawl was usually run from a rocky bottom to an adjacent mud or sand area for the purpose of comparing the results of the catch.

The catch for the summer, arranged in order of abundance, consisted of smooth dogfish, tautog, sea bass, toad fish, scup, summer flounder and cunner, which were caught in different parts of the bay during the month of August. The results that were obtained from the use of different kinds of bait were as follows. It is hardly fair to draw any definite conclusions from results covering such a limited scope, but these facts were brought out.

1. Contrary to the prevailing opinion that tautog preferred hermit crabs for bait, it was found that on the trawl lines a larger number were taken with the cockle or winkle as bait.

2. Sea bass were evidently omnivorous, large numbers of mud crabs being found in their stomachs.

3. Dogfish were practically the only fish caught in any number with fish bait, indicating the probable damage to trawl-line fishing.

4. The summer flounder was caught chiefly with the cockle.

5. Scup were taken in relatively few numbers, although they were abundant in the traps at that time.

The records of the trawls set in the upper part of the bay between August 19 and September 25, on both rocky and sandy bottoms, at Dry Ledge, Little Bird Island, Four Buoys and Weweantic River, when fiddler crabs and fish were used for bait, showed a catch consisting of toad fish, dogfish, tautog and eels, arranged in the order of abundance.

From the records upon the line of trawl fishing, it can be stated that while this method is superior to the ordinary hand-lining, the results were far from satisfactory. Indications were that it would hardly be profitable for any man to make an extensive livelihood from line fishing in the bay. However, the good fishing grounds were not selected in Buzzards Bay, as

the trawl was set in different places each day, and the catch therefore would be very much less than if the method were pursued steadily on the regular fishing grounds. The object of the investigation with the trawl was to determine the abundance of the fish caught by this method in the various parts of the bay, and not to determine how great a quantity could be obtained from the choice fishing ground in the bay. However, it is sufficient to show that the abundance of fish in Buzzards Bay which can be taken by line fishing is much less than in former years.

The Gill Net.

This type of fishing was first introduced in the early part of the nineteenth century, and in 1880 became in general use among the fishermen, possibly owing to the difficulty of securing adequate bait for line fishing. It is an extremely useful method of fishing, and in recent years, if permitted, would have been of great aid to the lobster fishermen in Buzzards Bay in obtaining menhaden for bait. These fish are abundant during the summer months in Buzzards Bay and are readily taken in quantities in gill nets. The gill net, such as used in the experimental work in the bay, was of the mackerel type, which could not be set in less than three fathoms of water.

The use of the gill net in Buzzards Bay in 1913 did not prove a financial success. The principal catch consisted of menhaden, and this fish readily succumbs to the warm weather, thus demanding that the net be hauled each day. The gill nets were usually set at the middle of the bays and coves. The largest catches were obtained at the mouth of the bay. Among the fish taken in the gill net may be enumerated, in order of their abundance, menhaden, butterfish, dogfish and sand sharks.

It is hoped that some method may be devised whereby the lobster fishermen in Buzzards Bay may be given an opportunity to set gill nets for menhaden in order to obtain a supply of fresh lobster bait. By certain restrictions as to the time of catch in the summer and as regards the type of net little damage will be done to the other fisheries of the bay. Butter-

fish, bluefish, scup and mackerel can be caught in gill nets, but unless exceptional conditions exist during the middle of the summer the lobster men should be able to set these seines without seriously interfering with any fish but the menhaden.

Seining.

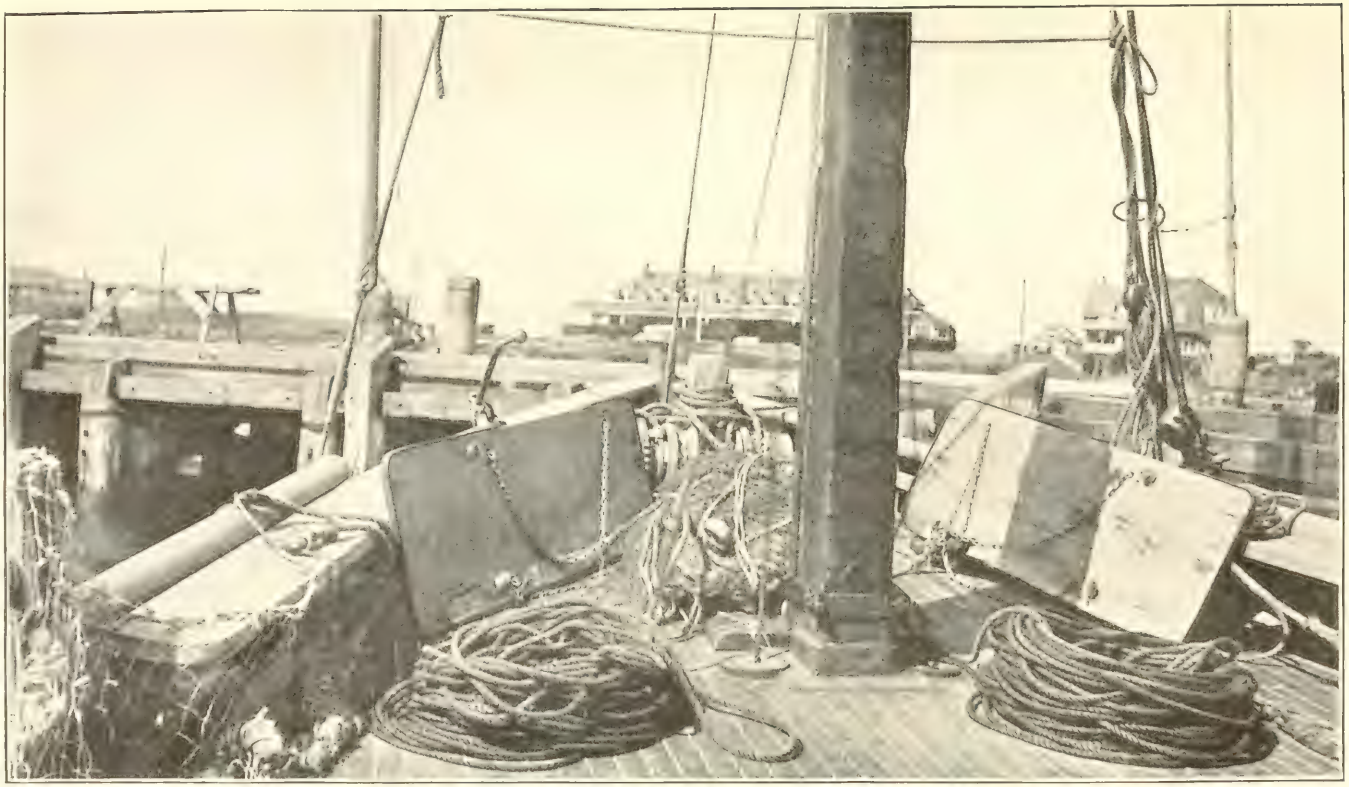
There are several types of seines in use, the principal form being the purse seine, such as is used in the menhaden fishery, and the drag seine. These different types have gradually been developed from the primitive drag net. Practically all surface and free-swimming fish can be taken by this method.

It would have been eminently desirable, in order to obtain figures upon the abundance of fish in Buzzards Bay in any one season, to have had an appropriation sufficient to enable this department to hire a large schooner, with a full equipment of seines, to make a set in different portions of the bay on a large scale, in order to obtain an approximate idea of the quantity of fish in Buzzards Bay. The abundance of fish, except as shown by the traps, will never be known in Buzzards Bay until some method of wholesale seining is experimentally employed.

The use of seines in Buzzards Bay was chiefly confined to menhaden fishing, which was abolished in 1886, when the use of seines was forbidden. The majority of the fishermen consider that the wholesale capture of menhaden by the pogy steamers would be objectionable, as it would destroy the food which serves to entice the larger fish to the waters of Buzzards Bay. Likewise, other fish were said to be taken with the menhaden. The main arguments in favor of the menhaden fishery seem to rest upon the furnishing of fertilizer to the farmers and the establishment of an industry which would employ men in or near the shore towns. The oil is used for tanning leather and in the manufacture of soap and paint oil. The rest of the fish is used for fertilizer.

Buzzards Bay should never be opened to seining in such a manner that it would permit the entrance of menhaden steamers. The supply of fish at the present time in the bay is too small to allow any depletion by this method, and the fishermen

Gill net with menhaden.



Otter trawl ready for lowering.

do not desire this type of fishing to be resumed. The summer residents are opposed to it, and the consensus of opinion is that menhaden seining in Buzzards Bay would be of little value to the industries of Massachusetts.

River Fishing.

Small seines and dip nets are permitted under the present law in the streams entering Buzzards Bay for the purpose of taking alewives, and eel fykes are allowed. Except for purely local regulations by the different towns the law does not interfere with taking alewives or eels in the streams entering the bay. Nevertheless, it is important, for the continuation and development of the alewife fishery, that proper measures and regulations be enacted.

Otter Trawl.

In 1893, as a result of the report on the "Beam Trawl Fishery of Great Britain," by Capt. J. W. Collins, published by the United States Commission in 1889, the use of the beam trawls for catching flounders from sail boats was undertaken at Provincetown. This method has now extended along the south side of Cape Cod and as far north as Salem. The beam trawl has been supplanted within the past few years by the more serviceable otter trawl. The use of the otter trawl was prohibited by law in the waters of Buzzards Bay. For the purpose of investigation, a gasolene oyster dredger equipped with two otter trawls from 55 to 60 feet in width was used in 1913, and a large portion of the bay was covered. The speed of the boat was about three miles an hour when dragging the net. The average time the net was down was thirty-five minutes. The actual working width of the net was estimated as 40 feet.

The results of the use of the otter trawl may be summarized as follows: —

1. The trawling ground in Buzzards Bay consists of a small area centering about Cleveland's Ledge.

2. The rough bottom due to rocks and possibly wrecks makes

trawling in Buzzards Bay impracticable, although it is possible that with men who knew thoroughly the character of the bottom in different parts of the bay it might be profitable to use the otter trawl, but in the majority of cases the character of the bottom is such as to render trawling an expensive undertaking, owing to the destruction of the nets.

3. The varieties of fish obtained in the otter trawl between July 18 and August 13 were winter flounder, summer flounder, four-spotted flounder, sand dab, skates, dogfish, whiting, hake, puffer and sea robin. At no time was a sufficient quantity of these fish taken for marketing.

4. Buzzards Bay should be fished in colder weather if any profit is to be obtained from this method of fishing, owing to the fact that the chief source of revenue is derived from the winter flounder, which during the summer months was not found in any abundance.

5. Numerous species of fish probably can avoid being taken in the slow-moving trawl, and those fish that inhabit the rocky ledges cannot be taken, from the fact that the bottom is unsuited for the manipulation of the net.

6. To determine whether the smaller species might not be entrapped in the otter trawl and passed through the meshes of the net a fine-meshed bag was attached to the free end. The results show that practically no small fish were taken.

7. By the use of buoys it was possible to operate the otter trawl at various depths in the water. The results of the hauls made at various levels above the bottom were entirely negative, as no fish were taken. However, with a fast-moving boat and larger net it is conceivable that certain fish might be taken by such a method. The limited observations that were made indicate that this method of supra-bottom fishing is impracticable.

8. It is evident that by trawling there is great danger of the commercial extirpation of the slow-moving winter flounder. The flounder is a migratory fish only in the sense that it changes from near localities, and it can be nearly totally destroyed in any confined territory, such as a small bay. Unquestionably the small otter trawl can destroy the flounder fishing in a limited locality, and it will be interesting to note

the effect of their present introduction upon the abundance of the winter flounder in Vineyard Sound and on the south side of Cape Cod. In this respect the small trawl is proving a greater menace than the more widely famed deep-sea trawl, and it is earnestly hoped that some means of restricting the use of the small type in different localities in southern Massachusetts may be devised in order to save from complete extermination the flounder fishing.

The Oyster Dredge.

Dredgings were made in different parts of Buzzards Bay with the oyster dredges to determine the availability of the bottom for oyster culture. By the use of the dredge a fair idea of the prevalence of starfish and oyster drills, the quantity of shells and the character of the bottom in different parts of the bay could be obtained.

In making the records of the different localities in the bay, a chart divided into numbered squares was made, so that the exact location of any dredging or trawling could be determined. In this way it was possible to obtain a considerable number of charted observations which may be of value later on in the development of the bay for oyster culture. The results of the dredgings indicate that there are large areas in the bay apparently suitable for oyster culture on a large scale.

Trap Fishing.

Trap fishing is the result of a gradual evolution. In its most primitive form among the Indians the fish trap or weir consisted of a framework of poles intertwined and interspersed with twigs and withes. The name of the Ware River arose from the presence of the old Indian fish weirs, and in Hingham the Weir River evidently has derived its name from a similar source. The colonists soon imitated the Indians by placing in the coastal streams the different forms of weirs, and as time went on extended the fishing to the salt water. Along the coast of Maine this type of weir was used for years. The use of netting brought about modifications on the old style of weirs, and a gradual improvement in the type.

At the present time in Massachusetts there are several types.

On the north shore of Cape Cod the fish trap is locally known as a weir, and varies in that it is situated on the outer edge of flats exposed at low tide, owing to the $10\frac{3}{4}$ feet rise and fall. The fishermen drive with their wagons to the traps at low tide and remove the fish, a much easier process than where the fisherman is required to haul his trap in deep water. Off Sakonnet Point, Rhode Island, floating traps anchored and buoyed but not supported by wooden poles are used. In Buzzards Bay the typical trap has a 500 to 600 foot leader stretched on wooden poles. At the termination of this leader is a receptacle known as the "heart," into which the fish are directed by the leader. From the heart there is an opening into the "bowl," where the fish are finally caught, and often there is an additional pound or pocket for holding the fish for the market.

The traps should be adapted to the locality in which they are placed, as it is necessary to have the netting close to the bottom and well leaded to catch flatfish. Likewise, the netting of the trap should project above the water at high tide. The trap consists of a leader usually 600 feet long or of variable length, according to the size of the trap and the distance from the shore. Poles for the leader, usually oak, hard pine, ash, maple, spruce, cherry or hickory, range from 50 cents to $2 apiece, and are driven at 20 to 30 foot intervals. The length of the poles range from 10 to 40 feet, according to the depth of the water. In an ordinary trap 16 poles are used in the "heart," 16 in the "bowl," and from 35 to 200 would be used in building a trap, the number varying according to the size. The body of the trap ranges from 25 to 40 feet, some being square, others rectangular or even circular in form. The cost of driving these poles by sand pump or piledriver averages about 50 cents a pole, the amount of labor necessarily varying with the consistency of the soil.

The mesh used for the body of the trap is usually 3-inch, although $1\frac{1}{2}$-inch mesh is occasionally used for eels and $2\frac{1}{2}$-inch for squid. The twine is considered as about one-third the value of the entire trap, and about 600 pounds are necessary for the average trap. Nine to twenty-four thread twine, at a price of 27 to 40 cents per pound, is used. The average length of life of the tarred netting ranges from two and one-

half to three years. Prices run from $450 to $500, and even as high as $1,000, for the larger traps. Double traps with short leaders are occasionally used. The gross stocking of a trap is about $1,000 a year, while the net stock is from $450 to $700, according to the labor and expense. There are great fluctuations in the catch in various years, in some seasons the traps yielding a large catch, in others scarcely paying expenses. Nevertheless, these traps pay a fairly steady income and a fairly good living to the men engaged in the business.

The floating traps off Sakonnet are generally considered to be worth $1,000 apiece, although some of them are probably not worth much over $800. Some are 80 feet deep, 120 feet wide and 70 feet long, with leaders 1,800 feet in length. A 4-inch mesh is used at the back of the floating traps which is said to allow the small fish to swim away unharmed; 5 to 10 inch mesh forms the leader, although a number of the traps have 8-inch mesh. The floating traps are set from 12 to 18 fathoms deep. The season usually lasts from May 1 to July 1, and in the fall from August 15 to November 1, when a smaller number of traps are used in the water.

In Buzzards Bay the first traps are reported to have been set at Gooseberry Neck in Westport in 1858. This early trap was an anchored trap. Later, a trap was located on the Elizabeth Islands. In 1868 the first trap was placed on Sconticut Neck by Mr. S. P. Dunn. The body of this trap was 30 feet square, and it was situated in 20 feet of water. It was put out under the direction of a man from Rhode Island, and was followed by a second trap at a cost of $135 for the trap proper and $292.99 for setting and other equipment. Returns from this trap were especially good during the first two years, the largest catch being alewives, which brought down the condemnation of the citizens of Mattapoisett, since they considered that it interfered with their river alewife fishery.

In 1870 a trap was placed by Seth Thomas west of Machaum Point, close to the location of the present trap of B. T. Smith. This was followed by a trap in Clark's Cove by John Haines, presumably near the location of the present trap of William T. Dunn. The first trap at Nonquit was set in 1895.

Fish Traps in Buzzards Bay. — The experimental fish traps in Buzzards Bay during 1913, 1914 and 1915 were as follows, the numbers corresponding to their location on the map: —

1. John F. Fish, Jr., ... Horse Neck Beach.
2. Benjamin T. Smith, ... Machaum.
3. Benjamin T. Smith, ... Machaum.
4. Alvin F. Waite, ... Salter's Point.
5. Alvin F. Waite, ... Salter's Point.
6. William T. Dunn, ... Ricketson's Point.
7. William T. Dunn, ... Clark's Cove.
8. Otis B. Luce, ... Quisset Harbor.
9. United States Bureau of Fisheries, . . Woods Hole.
10. H. Nelson Luce, ... Penzance, Woods Hole.
11. Marine Biological Laboratory, . . . Uncatena Island.
12. O. B. Daggett, ... Naushon Island.
13. D. P. Bosworth & Co., ... Cuttyhunk Island.

1913.

Owner.	Serial Number.	Number of Traps.	Date set.	Date removed.	Number of Days down.	Financial Returns.	State Revenue.
W. T. Dunn, ...	6–7	2	July 7	Dec. 22	168	$270 54	–
Marine Biological Laboratory,	11	1	June 12	Oct. 18	85	300 06	–
Total, ...	–	3	–	–	253	$570 60	–

1914.

Marine Biological Laboratory,	11	1	May 10	Oct. 31	174	$922 44	$64 57
W. T. Dunn, ...	6–7	2	May 16	Oct. 20	157	343 14	24 02
Otis B. Luce, ...	8	1	May 10	Aug. 19	101	1,760 06	123 20
D. P. Bosworth & Co., . .	13	1	May 9	July 10	49	1,069 86	74 89
Benjamin T. Smith, . . .	2	1	June 15	Nov. 12	150	644 57	45 12
Alvin Waite, ...	4	1	May 25	Oct. 31	159	478 43	33 49
Total, ...	–	7	–	–	790	$5,218 50	$365 29

1915.

W. T. Dunn, ...	6–7	2	Mar. 26	Oct. 28	215	$161 00	$11 27
John R. Fish, Jr., ...	1	1	May 23	Nov. 6	167	921 30	64 49
H. Nelson Luce, ...	10	1	May 6	Sept. 23	155	595 93	68 47
Otis B. Luce, ...	8	1	May 6	Sept. 23	140	824 48	57 71
Marine Biological Laboratory,	11	1	May 15	Nov. 5	160	405 29	28 37
Benjamin T. Smith, . . .	2-3	2	Apr. 12	Sept. 30	171	728 09	50 96
Obed Daggett, ...	12	1	May 12	Nov. 9	181	471 43	33 00
Alvin Waite, ...	4-5	2	Apr. 22	Oct. 28	189	522 00	36 54
Total, ...	–	11	–	–	1,378	$5,011 77	$350 81

The Effect of Trap Fishing. — The question as to whether trap fishing pays commercially at the present time is somewhat difficult to answer adequately in three years, with only a limited number of traps in the bay. Whether with a large number the experimental traps would have yielded it less is difficult to say, but indications point to the fact that there would have been some diminution in the average catch. The results in the past three summers are hardly as favorable as twenty years ago. The best paying trap in Buzzards Bay during 1914 was that of Otis B. Luce, at Quisset Harbor. This trap in the early part of the summer obtained large quantities of mackerel, and from this source was able to make a fairly good season. The Marine Biological trap and the trap of the United States Fish Commission were not run essentially for commercial purposes, and therefore the results from these traps can hardly be estimated in terms of dollars and cents. However, with the Marine Biological Laboratory the catch for 1914 was better than the 1913 catch, but on the whole it hardly paid the cost of maintenance. With the traps of William T. Dunn the result of the catch as rendered indicated that commercially there was no profit in trap fishing at his location; as it was conducted the yield was insufficient to pay for the cost of the traps and the labor involved. The results from the traps of Alvin Waite and Benjamin Smith in South Dartmouth indicate more favorable conditions. These men reported that the catch of 1914 compared favorably with the catch in former years, and that indications were such that it would pay to continue trap fishing. However, their profits were not very great for 1914. The trap of David P. Bosworth of Cuttyhunk was fairly successful, but if compared with the large catches of former years in this locality the results for 1914 were little better than fair.

To sum up the results from a commercial standpoint it can be said that trap fishing is not remunerative, but that it gives sufficient promise to the trap fishermen so that the persons having the traps are anxious to continue. When compared with the catch in former years, as shown by the returns at this office, there is no question that the yield at the present time is much less, in spite of the higher price of fish and the facilities for marketing.

Trap fishing evidently paid before the bay was closed, but if any reliance can be placed on testimony there had been a steady diminution in the traps during the last few years before 1893. It can probably never pay to such an extent as formerly, but unquestionably trap fishing can be carried on at a slight profit at the present time in Buzzards Bay, but it is doubtful whether any extensive operation with a large number of traps can ever be conducted.

The decline of the catch in trap fishing and the decline of the fisheries in general is attributed to several sources.

1. The increase in pollution, especially in the vicinity of the Acushnet River, is thought by many fishermen to have driven away the fish which once frequented these waters. The catch in the traps near New Bedford and the low returns possibly can be explained from this standpoint.

2. The argument is advanced by fishermen that motor boats drive away the fish. This argument, however, is of little value, according to the investigations of Prof. G. H. Parker at Woods Hole, since he found that motor boats had little if any effect on the fish.

3. The increase in the number of sharks, dogfish and other injurious fish is given as one of the causes of the depletion of the supply of food fish, and is stated by the trap fishermen as an argument for the extension of traps in order to destroy these swimming foes.

4. The increase in traps, especially near Cape Hatteras and the New Jersey shores, and the encroachment of Rhode Island traps off Sakonnet Point, is perhaps the most important reason for the decline of the fisheries in Buzzards Bay.

5. In general there has been a decline of the fisheries along the entire coast and the decline in Buzzards Bay is only part of a general decline. With certain species of fish explanation of changes in their migratory habits from sources external about Buzzards Bay probably can account for the variation in their attendance, and in a large measure account for their scarcity.

The destruction of small fish in the traps is a fairly important item. The trap fishermen cannot afford to take time to properly sort the small fish from the large. Naturally, quanti-

ties just undersized are taken to market and thrown out as unfit for sale. The very small fish usually come in comparatively large schools, and they can be liberated by the fishermen by emptying the entire trap if time is taken.

At the Marine Biological Laboratory at Woods Hole attempts were made to screen these fish with certain sized mesh, but this method proved impracticable. Accurate figures cannot be obtained as to the destruction of the small fish, but in all probability it is much larger than appears on the surface, and far larger than is claimed by the trap fishermen. In the most carefully tended traps, where time was not the factor that it is in traps run for commercial purposes, it was found that considerable quantities of small fish were wasted in this manner, both by being destroyed in the boats or with the other fish when they were packed for market. It is one of the most important arguments against trap fishing that can be advocated, and until trap fishermen devise suitable means and use suitable care in preserving the young fish, trap fishing will always in this way be of more or less menace to the fisheries.

Rhode Island Trap Fishing. — Rhode Island is primarily a fishing State, because of her. commanding situation in the western and northern waters of Vineyard Sound. The menhaden seining and the trap fishing, which have been developed to a marked extent in that State, have been detrimental to the fisheries of Massachusetts, especially in the influence exerted upon Buzzards Bay. Rhode Island traps, which block the entrance to Buzzards Bay, have an important bearing upon the question of maintaining this body of water as a reservation. While Buzzards Bay has been closed as a breeding reservation, trap fishing has steadily developed in Rhode Island, and a line of floating traps has gradually extended out until it now practically blocks the entrance to Buzzards Bay. For this and other reasons, trap fishing in Buzzards Bay will never produce the quantity of fish which it should normally yield.

The following tables and statements show the great increase in the number of traps off Sakonnet Point, blocking the entrance to Buzzards Bay: —

Date.	Providence River.	East Greenwich.	West Passage.	Mount Hope Bay.	East Passage.	Offshore.	Block Island.	Watch Hill.	Sakonnet River.	Total.
1870, .	6	1[1]	4[1]	3[1]	4	–	–	–	19	37
1879, .	3	–	11	1	16	9	–	–	7	47
1898, .	4	6	26	9	15	25	–	–	34	119
1899, .	3	10	23	11	15	24	–	–	35	121
1900, .	4	16	24	16	12	29	–	–	34	135
1901, .	7	15	24	13	14	26	–	–	52	151
1902, .	6	22	27	13	14	27	–	–	52	161
1903, .	7	21	32	13	16	30	–	–	72	195
1904, .	6	27	33	7	14	49	6	–	78	220
1905, .	6	26	33	11	20	56	6	–	82	240
1906, .	6	35	27	11	20	64	6	–	80	249
1907, .	7	37	30	12	22	70	6	–	87	271
1908, .	7	38	32	12	22	73	–	–	87	271
1909, .	7	31	32	12	26	73	8	–	88	277
1910, .	9	29	26	14	20	71[2]	8	18	92	287

[1] Estimated number for that district.
[2] Previous to 1910 "offshore" division includes traps in the Watch Hill District.

In the 1900 report of the Rhode Island Commissioners of Inland Fisheries for the year 1900 is the following statement: —

It is certainly worthy of note that while Rhode Island is profiting by her one hundred fish traps, giving employment to many of her residents and receiving a generous income from her exports, Buzzards Bay, although offering no greater inducement to the hook and line fishermen, is yielding little or nothing because of the closure of the area to the trap fishermen by legislative enactment.

In the report of 1906 the following statement appeared: —

The distance which the traps have been placed from shore has increased very markedly. The immense traps of the Fisheries Company last season extended in an unbroken line for a distance of three miles from Sakonnet Light, and the results of the past season's fishing have caused the fishermen to decide to still further extend their traps in the coming year. Offshore fishing has also been carried on later in the fall, with good success.

In the report for 1909 the Rhode Island commissioners stated: —

Especially noticeable is the continued increase in the number of the Sakonnet River and offshore divisions, where the cordon of traps is being extended and covers new territory each year. The fishermen are continuing to push their traps a surprisingly great distance offshore.

Fish Shipments from Newport.

Date.	Production (Barrels).	Traps.	Average per Trap (Barrels).	May and June Production (Barrels).	May and June Average per Trap (Barrels).
1898,	34,065	119	286.2	20,251	170.7
1899,	34,917	121	288.5	19,916	164.5
1900,	38,184	135	282.8	25,778	190.9
1901,	50,500	151	334.4	35,810	237.1
1902,	53,986	161	353.3	31,898	198.1
1903,	54,382	195	278.8	33,944	174.0
1904,	62,106	220	282.3	35,869	163.0
1905,	50,127	240	208.8	26,531	110.6
1906,	60,855	249	244.4	30,396½	122.1
1907,	59,674	271	220.2	30,653	113.1
1908,	48,814	271	180.1	27,950	103.1
1909,	46,031	277	166.2	27,087	97.7
1910,	53,154	287	185.2	29,786	103.8

Date.	Total Traps.	Offshore.	Per Cent. Offshore.
1898,	119	25	21.0
1899,	121	24	19.9
1900,	135	29	21.5
1901,	151	26	17.2
1902,	161	27	16.7
1903,	195	30	15.4
1904,	220	49	22.0
1905,	240	56	23.3
1906,	249	64	25.7
1907,	271	70	25.8
1908,	271	73	26.9
1909,	277	73	26.3
1910,	287	89	31.0

The floating traps at Sakonnet are open at both sides. They run offshore in a wedgelike fashion, the two sides of the triangle forming what are known as the "firing lines." These floating traps are practically connected, as but a small space is left between them. The traps located within the "firing lines" catch but a small portion of the fish, the outer line taking the majority. In previous years efforts have been made to put a bill through the Rhode Island Legislature which would allow for a space of 3,000 feet between adjoining traps and limit the length of the leaders to 2,000 feet, but opposing interests have been too strong and the bill has successively been defeated. The object of this measure was to enable a certain percentage of the fish to run the gauntlet of outer traps for the benefit of the inside traps and for spawning purposes.

From the accompanying map it may readily be seen that the great increase in offshore traps by their present position blocks approximately two-thirds of the western entrance of Buzzards Bay, thus seriously depleting the number of fish frequenting this body of water for spawning, and thereby nullifying to a considerable extent the benefits of such a reservation. Federal regulation of these traps would be a great advantage to Massachusetts.

Pollution.

A report upon the effects on the fisheries of conditions existing in the vicinity of the bay would indeed be incomplete without reference to pollution and the employment of tributaries for purposes other than fishing and ordinary navigation, and the consequent subordination of fishing interests to other interests. Investigation indicated that the fisheries of the bay are impaired to some extent when the bay is used as an accessory in the disposal of waste and sewage from —

1. Immediate sources, as in the case of towns or manufacturing plants located on the shore front which have placed sewer outlets in the tide waters of the bay.

2. Remote sources, as is the case when polluting material enters the bay after having first been discharged into tributary streams.

Immediate Sources.

The immediate sources of pollution can best be set forth by discussing separately each town bordering on the bay, and stating the character and quantity of pollution from each town.

New Bedford is a serious offender. This city discharges sewage from 36 outlets into New Bedford Harbor and from 9 outlets into Clark's Cove. In addition, the harbor waters receive waste directly from 25 manufacturing establishments, which is discharged through private sewers; and Clark's Cove receives the waste from 5 cotton mills. In the case of the cotton mills, the discharge consists of hot, greasy water from boilers and steam condensers, with the addition of sewage, the amount of which depends upon the number of operatives in the mill. Of a more harmful nature, however, is the discharge from other establishments (foundries, metal-working plants, and oil and soap factories), since it contains rust, poisonous chemicals, etc., in addition to sewage. In New Bedford there are also numerous mills and factories at a distance from the water's edge. Whether such concerns discharge into the harbor through private sewers or make use of the city sewers for the purpose is immaterial, since the ultimate destination of their wastes, in either case, is the bay.

Pollution from New Bedford is more serious from the standpoint of health and sanitation than from the standpoint of the fish conservationist. While the pollution of Clark's Cove, for instance, may not be sufficiently concentrated to kill marine fish forms, it may be present in adequate quantity to infect edible marine food forms, especially shellfish, although eels, flatfish and tautog might be infected. Nearly a score of fishermen dig quahaugs in close proximity to the sewer outlet in Clark's Cove.

Previous to 1904 typhoid cases in New Bedford were suspected of having originated from shellfish dug in New Bedford Harbor. Consequently "in August, 1904, the taking of shellfish was prohibited and rigidly enforced," etc. It appears, then, that New Bedford Harbor and Clark's Cove are portions of Buzzards Bay where direct pollution is adversely affecting the fisheries of the bay.

The new sewage disposal system, when completed, will reduce the injurious effects of the New Bedford sewage, since it will lessen the quantity emptied into the harbor, where it is but slowly diluted, and will discharge it into the bay in such place and manner that it will be harmless soon after it leaves the pipe.

Fairhaven discharges sewage from 6 sewers into New Bedford Harbor. The amount of such sewage is probably not excessive, but there is no method of determining readily the exact amount. Some half-dozen private residences on the lower harbor have sewer pipes which are generally in use during the summer season only.

The most noticeable evidence of direct pollution in Fairhaven is the case of the Atlas Tack Company. This large factory discharges a waste consisting of greasy water, rust and spent vitriol into a small creek (Crooked Creek), down which it flows for one-third of a mile. It is only slightly diluted when it enters the bay in what may be called Sconticut Cove.

Misuse of Tributary Streams.

Investigation also shows that the bay fisheries have probably been impaired through the employment of the tributary streams for purposes other than fishing, which have interfered with the river fisheries. The significance of this perversion of streams is made clear when the intimate relation between bay fisheries and river fisheries is explained, and the dependence of bay fisheries upon river fisheries set forth.

By "river fisheries" is meant white perch, striped bass, smelt, shad and especially alewife fisheries. These fishes, which frequent the rivers periodically, serve a twofold economic purpose, — they are a food for man and also for carnivorous marine fishes, such as bluefish, squeteague, pollock and mackerel, which are unquestionably attracted to the mouths of rivers by them. Therefore, if anything happens which decreases the number of river fishes, it decreases the quantity of food available for carnivorous fishes. The further result is that the carnivorous fishes, upon the failure or disappearance of their food supply in one region, leave that region for other localities where food is more plentiful.

Years ago it was patent that the bay fisheries were declining at an alarming pace. Testimony is also available which indicates that all kinds of river fisheries have fallen off, — perch, smelt, shad, but most noticeably the alewife. It is extremely probable that Buzzards Bay fisheries decreased coincidently with and because of the decline of the river fisheries. Not only has this decline resulted directly in a loss of food fish and revenue to persons engaged in the river fisheries, but it has also indirectly, but none the less surely, caused a decrease in the quantity of and profit from the bay fish.

One particular employment of the Buzzards Bay streams which has interfered with their fisheries is their use for water power, although, in several instances, the use of the water in connection with cranberry bogs has been injurious. The harmful feature in this connection is the presence of obstructions (dams) and these dams, due to the absence of fishways, are impassable to fish in their journeys to and from the spawning grounds. This has resulted in the alewives spawning below the obstructions or dams in places unfavorable for the development of the spawn. Repeated seasons of this sort of treatment have made it impossible for the alewives to maintain their numbers, and have removed all possibility of their increasing them. Due to the persistence of the alewife, a few have managed to reach suitable places, and therefore it has been possible of late years to behold a few schools in each stream in the spring. However, in most streams they have greatly decreased in number, and from some they have completely vanished.

The Development of Buzzards Bay.

In the light of present day knowledge, the fishing resources of Buzzards Bay may be advantageously developed along certain lines which, if correctly applied, should yield results for the benefit of the fisheries of the entire New England coast. The essential lines of development to which attention should be given are, first, its reservations as a spawning ground; second, an increase in the facilities for natural food production, which induce fish to enter the bay; third, the development of certain forms of commercial industry for the extermination of pre-

daceous fish, and for commercial benefits accruing to the fishermen; fourth, Federal control of the situation with regard to the trapping of fish in Rhode Island waters at the entrance to Buzzards Bay; fifth, the development of the oyster fishery of Buzzards Bay in simulation of that fishery in Long Island Sound; sixth, the re-establishment of the alewife fisheries, and the development of the streams and ponds connected with the tidal waters of the bay.

Reservation.

The time is approaching when there will be reservations made for the spawning grounds of the migratory fish of the ocean, as for the migratory birds. Certain areas along the Atlantic coast which are prolific in food, and afford natural conditions suitable for the spawning and reproduction of various species of fish, will be set aside as reservations, and fish frequenting these waters will be protected. With the decrease in all species of fish it is apparent that some course similar to this will have to be pursued by the Federal government, and it is also apparent that such action must be taken in the near future. Therefore, with regard to Buzzards Bay it should be the aim of Massachusetts to set a precedent for future Federal legislation governing the migratory fish. It is to be admitted that such action in one part of the Atlantic coast will be of little practical value to the fisheries as a whole for the time being, but it should prove an inestimable benefit as indicating advance toward proper regulation. In considering the reservation of Buzzards Bay as a spawning ground for fish, it should be considered from the viewpoint of the infallibility of general principles of reservation, and whether they should be extended to other waters.

In formulating such a principle for Buzzards Bay consideration should be made of the species which spawn in the bay, and whether these fish spawn elsewhere, as Buzzards Bay is undoubtedly but a portion of a large spawning ground extending along the entire southern New England coast. However, it is especially adapted for this purpose by reason of its shallow water, warmth, abundance of food, numerous estuaries and small rivers entering its headwaters. In fact, there are

MAP OF COAST OF RHODE ISLAND AND MASSACHUSETTS

The portion showing Narragansett Bay is an exact reproduction of a map accompanying the Report of the Rhode Island Commissioners of Inland Fisheries for year 1910. The portion showing Buzzards Bay is drawn to same scale.

Location and number of fish traps in and about Narragansett Bay are indicated as follows:

Green dots show traps (in shore and off-shore) Summer of 1879.
Red " " " " " " " " 1898.
Yellow " " " (part of in shore and all off shore) " " 1904.
Black " " " (in-shore and off-shore) " " 1910.
—o Experimental Fish Traps, Buzzards Bay. 1913-1915.

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few if any places so naturally adapted for such a purpose as Buzzards Bay, and as a reservation its influence upon the protection of fish should be of great importance. It is our opinion that, with special modification in regard to certain types of fish, Buzzards Bay is more important to the fisheries as a spawning ground than for immediate gain from a commercial standpoint. The testimony of Vinal Edwards of the United States Bureau of Fisheries, who has been engaged for twenty-one years in collecting young of the various species of fish in Buzzards Bay, is of special consideration. From his investigations, which date from the founding of the United States Bureau of Fisheries station, he is of the opinion — and unquestionably his opinion is of greater value than that of any living man at the present time, since he has been a practical fisherman in addition to conducting work for the Woods Hole station — that Buzzards Bay is a breeding ground and good nursery for the various species of fish, such as scup, sea bass, tautog and warm-water fish. Buzzards Bay is probably the best arm of the sea for the spawning of fish along the New England coast, apparently more favorable than Narragansett Bay.

Food Protection.

Buzzards Bay is especially favored in possessing an abundance of microscopic food forms in its waters. These food forms have been demonstrated by Peck in the report of the United States Bureau of Fisheries in 1893, which states that the temperature of the water of the bay in general is several degrees higher than is that of Vineyard Sound, and that in the upper portion of the bay brackish water is formed in the numerous inlets and estuaries, allowing a mixture of fresh and salt water microscopic forms to mingle with a third kind found in brackish water alone. Thus we have, in the upper region of the bay, an area particularly favorable for the growth and development of small fish of commercial importance, and also of small fish which serve as food for the larger fish, the former feeding on the floating microscopic material. The result of the large quantity of microscopic food also affects the large commercial fish, as these fish frequent the waters for the purpose of spawning and rearing their young, and likewise to prey

upon those species of fish which serve as their food. Thus we have in logical sequence a direct relationship between the abundance of plankton food in Buzzards Bay and the abundance of commercial fish frequenting its waters.

Nature has supplied these conditions. It is the duty of man to alter them in any way possible to increase the number of fish feeding in the bay. In case of a marked diminution of food forms there would also be a corresponding decrease in fish. It is impossible to tell whether there has been any great loss of fish food, but it is very apparent that there has been no increase, although no records are available. One fact that bears weightily upon the amount of fish food is the pollution entering Buzzards Bay from various sources, particularly in the region of the Acushnet River. Pollution to such an extent as is the case here manifests itself directly upon the fish and indirectly upon the fish through the food. The pollution, as we have shown in another part of the report, has its immediate sources directly in the bay and its remote sources in polluted streams entering the bay. Likewise, the cranberry bogs upon streams emptying into the bay, the damming of streams, the institutions which empty their waste products into water which ultimately reaches the bay, the encroachment of houses, sewerage systems, town wastes and other factors of civilization, all have indirectly contributed to the greater or lesser extent in the diminution of the food supply for the fish.

Therefore it should be realized that any pollution entering the bay should be carefully guarded against in the future, as the amount of available food will depend upon the extent to which the inroads of civilization are kept from infringing upon the natural conditions present.

Not only is the food supply of the fish threatened, but likewise the value of Buzzards Bay as a spawning ground, since young fish cannot live, eggs cannot develop and fish will not seek polluted waters for spawning purposes. For this reason in a large area in the vicinity of the Acushnet River, one of the most polluted streams in the State, fish can never spawn, and though this area was once of importance as a breeding ground it no longer is of any particular value. The conditions existing in this part of the bay can perhaps never be adequately re-

moved, but they can be confined to their present scope, and suitable provisions should be made restricting pollution to places already affected.

Oyster Fishery.

The development of the oyster grounds in Buzzards Bay is a matter of interest to the Commonwealth as a whole. At the present time these oyster grounds are situated along the shores, chiefly in the upper waters in the towns of Wareham and Bourne, and consist of small grants worked largely by individual oystermen. However, the deeper waters of the bay and those far out from shore offer possibilities for development of an extensive oyster industry similar to that now carried on in Long Island Sound. Conditions in Buzzards Bay are such as to respond admirably to oyster propagation on a large scale. The two factors preventing such an undertaking at the present time may only be overcome by large capitalization. The presence of starfish in Buzzards Bay would necessitate the expenditure of a great deal of labor, and the continual use of boats to protect the grounds from this enemy, and in many cases the bottom would have to be prepared in various ways with shells and gravel before oysters could be planted. Such difficulties have been surmounted in other places, and there is no reason why such methods may not find application here. As a preliminary, a survey should be made of the bottom of the bay. Then favorable places should be plotted and charted by experts, after which suitable inducements should be offered to large oyster companies to take up ground in more exposed and deeper waters, and to individuals and to small corporations to take the more accessible ground. By suitably regulating this business it might be made a benefit and a paying asset to the Commonwealth.

The question of pollution again is to be contended with in the case of the oyster industry as with other fisheries at the present time. It is absolutely essential to the oystermen that they shall be able to guarantee the purity of their products without dissimulation, and for this reason all pollution of whatever nature should be eliminated.

The Alewife Fishery.

One of the most essential considerations in a discussion of the fisheries of Buzzards Bay should be that of the entire reconstruction of the alewife fisheries. As is shown in the report upon the alewife fisheries, the alewife is no less valuable as a bait than it is as a food, and it has a very important bearing upon other fisheries of Buzzards Bay. The small alewife not only is a food for the bass, pickerel and other species in fresh-water ponds, but when it descends to the ocean it attracts to the vicinity of the stream large quantities of bluefish, squeteague, pollock and other fish which prey upon them, both small and adult. Therefore the opinion that the alewife fisheries are not only mere local assets is well grounded, as the regulation of these fisheries has a far-reaching effect upon other fisheries of the Commonwealth, and for the benefit of the fish consumers it should be conserved.

The causes leading to the diminution of the alewife fisheries may be briefly summarized as overfishing, dams and obstructions of various natures which prevent the passage of fish up rivers, the presence of cranberry bogs, deforestation, pollution, and inadequate, or rather ineffectual, laws which have governed these fisheries.

The solution of the alewife question lies rather in State than in town control. The foremost essential is that a sufficient number of alewives be allowed access to the spawning grounds. If this is accomplished each year, and there are no obstructions to passage to and from these spawning grounds, the alewife fishery is bound once more to rehabilitate itself. Therefore methods for the re-establishment of alewife fisheries in the different streams entering Buzzards Bay should be conducted along the following lines: —

First, by the removal of all obstructions of various natures now blocking the streams and preventing the passage of fish to the ponds for spawning.

Second, by the maintenance of suitable fishways for passage over dams and cranberry bogs.

Third, by the elimination of polluting material of all kinds.

Fourth, by having closed seasons on alewives for certain

periods of years, until the fisheries are once more *in statu quo*, when suitable provisions for catching them may be made.

Fifth, by the passage of laws properly regulating the leasing of alewife fisheries.

Sixth, by artificially stocking certain streams with spawning alewives.