FORTY-SEVENTH LEGISLATURE.

SENATE. No. 7.

REPORT OF COMMISSION ON FISHERIES.

To the Senate and House of Representatives:

Appointed by the Governor, Commissioners under the "Resolve relative to the Restoration of Sea Fish to the Rivers and Inland Waters of Maine," approved January 28th, 1867, we present herewith a report of our investigations.

Foreseeing that both the money and time at our command would be insufficient to permit a thorough examination of all the waters of the State, we decided to make a complete survey of at least one of our large rivers, and proceed with the others as far as we were able, leaving their examination to be completed at some future time. For this reason, as will be seen, we have given more attention to the Kennebec than to any other river, although there are others of equal importance.

We are enabled to make a tolerably complete report on the Mousam, Presumpscot, Kennebec, East Machias, Cobscook and Denny's rivers; and a partial report on the Saco, Androscoggin, Penobscot, Machias and St. Croix. There remain unnoticed, the Piscataqua, York, Kennebunk, Nonesuch, Royal's, Sheepscot, Damariscotta, Pemaquid, Medomak, St. George, Union, Tunk, Narraguagus, Wescongus, Chandler's, Pinmaquan, and various smaller streams on the coast; and all of the St. John waters.

Although thus incomplete, so far as local examination is concerned, our investigations have nevertheless been sufficiently extended to enable us to discuss intelligently the questions proposed in the resolve.

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Numerous publications have been consulted, and more or less information embodied in the report has been obtained from each of the following: Holmes' Report on the Fishes of Maine; Article "Aquæculture" in Maine Agricultural Report, 1864; Article on Kennebec County in Agricultural Report for 1865; Perley's Reports on the Fisheries of New Brunswick; the Reports of the Fish Commissioners of Massachusetts and Vermont; Storer's Fishes of Massachusetts; Baird's Report on the Fishes of the New Jersey Coast; Pell's Edible Fishes of New York; Agassiz's Lake Superior; Bulletin of the Museum of Comparative Zoology, Cambridge; Norris' American Angler; Ashworth's Essay on the Practical Cultivation of a Salmon Fishery; Bertram's Harvest of the Sea; Buckland's Fish Hatching. We have also drawn from letters from various persons.

We have received material assistance from many gentlemen, among whom we may mention Mr. Nathan Cummings of Portland, Mr. Walter M. Brackett of Boston, Mr. James H. Cochrane of Augusta, William Atkinson, Esq., of Emden, Mr. A. D. Murray of the Forks, Hon. A. P. Emerson of Orland, George B. Burns, Esq., of Calais, Mr. U. S. Treat of Eastport, Dr. James Cochrane of Monmouth, Mr. John Brown of Bowdoinham, Mr. S. L. Boardman of Augusta, Mr. Thomas Ashworth of Bath, England, and advice and information from many others.

We have been favored with free season tickets on the following passenger routes: Portland and Kennebec Railroad, Portland and Rochester Railroad, Grand Trunk Railroad, Portland and Machias Steamboat Line, and occasional passes on the Portland, Saco and Portsmouth Railroad, Concord (N. H.) Railroad, and International Line of Steamers to St. John.

We have been in communication with the Commissioners of Massachusetts and New Hampshire as directed. On the 28th of February, 1867, a meeting was held in Boston, attended by the Commissioners of Maine, New Hampshire, Vermont, Massachusetts and Connecticut, for the purpose of exchanging views and concerting action. An organization was effected by the choice of Hon. H. A. Bellows of New Hampshire as Chairman and Col. Theodore Lyman of Massachusetts as Secretary. The body assumed the name of "New England Commissioners of River Fisheries," issued a circular to enlist the coöperation of persons interested, (see Appendix A,) and adjourned to meet at the call of the secretary. A subsequent meeting was held in November. We

also met the New Hampshire Commissioners at Concord, in August, to confer with reference to the Androscoggin, Saco and Salmon Falls rivers; and the examination of the falls at Rumford and Hiram was undertaken in consequence of that conference.

We may as well state here the action of the other New England States. Massachusetts and New Hampshire have undertaken the restoration of salmon and shad to the Merrimac river. Fish-ways have been built over all the dams on the river; and as salmon were extinct, the eggs of that species have been brought from the Miramichi river in New Brunswick, and hatched in the upper part of the Merrimac. Shad have also been hatched near Concord, and some millions of them turned into the river. There is good reason to expect success. The Lawrence dam has already been surmounted by sea-fish. The same States, joined by Vermont and Connecticut, have undertaken to restore salmon to the Connecticut river, and shad to its upper portion. On this river the work is less forward than on the Merrimac; but the fish-ways are planned and are to be built the coming season. Many millions of shad were artificially hatched during July, 1867, at Holyoke. On both these rivers severe restrictions have been placed upon the fisheries for several years to come, by which time it is hoped there may again be fish to catch.

It seems desirable to preface the discussion of the questions proposed by some notice of the principal food of fishes that come within the scope of this report, and their habits, particularly those that pertain to their reproduction. Of the species that dwell alternately in the sea and in the rivers, and may come under the application of the term "sea-fish," the most important are the salmon, shad, alewife, smelt, striped bass. Of the purely fresh water species, or varieties that exist in our fresh waters without communication with the ocean, we may place Sebago and Schoodic salmon, trout, togue, smelt, whitefish, white perch and pickerel among the most important, although there are others that yield a considerable amount of food. With the purely marine species we have nothing to do.

Salmon.

(*Salmo salar*, Linn.)

This species is common to both the European and American shores of the North Atlantic. The first place among all fishes has very generally been conceded to it. The richness of its flesh,

the large size it attains, and its abundance in all waters well suited to its growth and multiplication, are all points in its favor. It has produced a vast amount of human food, probably unequalled by any single species of river fish, and only surpassed by some marine species, like those of the Cod and Herring families. At the present time, however, the Salmon is suffering from neglect and persecution. So peculiarly is it exposed to the attacks of man, so greedy and relentless has been the pursuit, and so regardless of their necessities has been the management of the waters, that in many rivers, both in Europe and America, it has become utterly extinct, and in very few of the remainder does it yield anything like the number that it was wont.

To give an extended account of its habits and economy here will be less necessary, since the essay appended contains a very complete discussion of the important points. But we will glance at the principal facts known in reference to it.

Salmon live mainly in the sea; that is, they obtain most or nearly all their food there. Yet they can only breed in shallow, running fresh water, such as they find in the rapids of rivers and small streams. To such localities they each year resort for that purpose, in many cases journeying hundreds of miles against the current of the river to reach them, and surmounting, by persevering efforts, many falls. Although the breeding fish begin to enter the rivers early in the spring, they lay no eggs until fall, and during all the time of their stay in fresh water they are constantly falling away in weight, and deteriorating in quality. Like the most of our common fishes, they reproduce their kind by eggs which are extruded from the female fish in an undeveloped and unfecundated state. The male fish performs his office of fecundation after the eggs are extruded into the water. The salmon select gravelly bottoms and running water, and as the eggs are laid they bury them in the gravel. For many days these eggs lie here developing. In the cold rivers of Maine it is not probable that they hatch in less than one hundred and fifty days; so that eggs deposited in November would not hatch until April. After depositing their eggs, the salmon, in very poor condition, return to the sea, where but a few months are necessary to restore them to their normal weight and quality. The young fish, from the time of its birth, remains one or two years in the fresh water of its native streams. During this time it is unfitted for salt water, and immersion in it would cause speedy death; so unlike the full-grown

fish that it was long supposed to be a separate species, and called "parr." At the end of this stage, when one or two years old, it assumes the outward appearance of the adult fish, and being now fitted to live in salt water, moves down to the sea. It is now known in Europe as "smalt." A residence of a few months in the sea increases its size wonderfully, and it returns weighing several pounds. This stage is called by the English "grilse." Both sexes are now, at the age of eighteen to thirty months, fertile, and come into the rivers to spawn. Each subsequent visit to the sea adds greatly to their weight.

One of the most interesting facts in the history of salmon, is the instinct which leads them back to spawn in the very streams where they passed their infancy. Probably there is some exception to this rule, but it is so nearly universal, that of many salmon that were marked in Scotland, dismissed to the sea, and retaken on their return, not one of which we have read was taken in any other than its native river.

Smelt.

(*Osmerus viridescens*, Le Sueur.)

Belonging to the salmon family, the smelt differs from most of its kin in spawning in the spring. April and May are the months in which it breeds with us. Its migrations are therefore different from the salmon. In the summer time it is sometimes caught along shore in the salt water. With the approach of cold weather in the fall these fish make their way into the tidal creeks and rivers, gradually ascending them into fresh water, where they spawn in the spring. Late in April or early in May they run up into shallow water on the shores of rivers or into small brooks and deposit their eggs, generally on stones, to which they adhere by a glutinous substance that accompanies them. Here in the running water they hatch in a short time. During the winter the smelts are caught with hooks through the ice or with traps or weirs. They yield a large amount of food, a great many thousand of them being taken and marketed during the cold weather, and a few being for sale nearly every month in the year. In quality they have no superior among all the inhabitants of our waters, unless it be the white fish.

Shad.

(*Alausa praestabilis*, De Kay.)

Belonging to a family which furnishes a vast amount of food to

man in the shape of herrings, alewives, pilchards, anchovies and sardines, our shad deservedly stands at the head of them all. It is, as its name indicates, "the preëminent shad." Abundant in numbers and of fair size, its flesh is fine grained, of delicate flavor, of rich and nutritious quality.

This species is common along the whole Atlantic coast from Georgia to the gulf of St. Lawrence. It is therefore a more southerly species than the salmon. They enter the rivers at about the same time with the salmon, but unlike that species spawn in the warm summer months. They enter the Kennebec in April; fishing for them commences at Georgetown on the first of May, in Merry-meeting bay on the fifth, at Augusta on the tenth. In the Cathance river, a tributary of the Kennebec, fishing commences in April about the twenty-fifth, and perhaps sometimes earlier.

How long shad remain in the rivers is not certainly known, but in our latitude it must be about two months. The first return shad are found coming down the Kennebec at Georgetown about the 20th of June, and, according to some testimony, continue to be seen until August. They are not so agile as salmon, and do not ascend the fresh waters so far from the sea. On the Kennebec they used to ascend in vast numbers as far as the Sebasticook river. A large detachment turned aside into this tributary, and the remainder kept on up the main river. On reaching the Sandy river, much decreased in numbers, the main portion of the shad turned into this river which they ascended as far as Farmington. On the Penobscot the limit of shad on the west branch is just above the mouth of Milinocket stream; on the east branch they reach a point one hundred and seventy miles from the sea.

The most that has been known about the reproduction of shad heretofore has been little more than mere conjecture, founded in some points on known but unexplained phenomena. We know, however, that they breed in tidal rivers as well as in the more elevated waters, and apparently in a gentle current. Whether they ever reproduce in salt or brackish water, or in still fresh ponds, we may consider unsettled points. It is probable that their manner of spawning is similar to that of the alewife which will be described, and that the place of deposit is in shoal water. In Merry-meeting bay their eggs are first found to be ripe on the 20th or 25th of May in an ordinary season; but a cold swollen state of the river delays them until June. A few days of warm weather hastens their maturity wonderfully.

A series of experiments was tried in July last at Holyoke, on the Connecticut river, under the auspices of the Massachusetts Commissioners of River Fisheries, which has brought to light some very interesting facts in relation to the reproduction of shad. Some of the main points have been communicated to us. It is ascertained that female shad produce on the average 100,000 eggs each; that they can be taken from the seined fish, artificially impregnated, and successfully hatched in a floating apparatus in the gentle current of the river; that in water of a temperature of seventy-five degrees, which is about the average of river water in summer, the eggs of shad hatch into living fish in sixty hours after they are taken from the parent; that the young shad, now almost invisible, immediately seek the deep water of the channel, where, near the surface, with head up the stream, they drop slowly down with the current. It was estimated that between the 3d and 20th of July thirty millions of shad were thus hatched in floating wooden boxes with bottoms of wire cloth, and turned into the Connecticut river. After a few preliminary trials the success attending the hatching was wonderful. Out of a lot of eggs numbering about ten thousand only seven failed to hatch. The eggs can be easily transported in water. Dr. Fletcher of Concord carried home from Holyoke several millions of them in a few tin pails, and hatched them in the Merrimac river. These facts suggest wonderful capabilities. The expense attending the operation is insignificant; and it seems highly probable that for a small outlay enough shad can be thus produced to make a very appreciable improvement in the fishery in any river.

With regard to the rate of growth and length of life in the shad we know but little. Of the young, however, we know that they are seen going down toward the sea during the last of the summer and the fall, being then several inches in length and hundreds of times their weight when first hatched. The Massachusetts Commissioners have figured in their last report two young shad taken on the fourteenth of August, one and three quarters and three and a half inches long respectively; and another taken on the twenty-sixth of September four and a quarter inches long. In Merrymeeting Bay they are seen in great numbers as late as November, when they are about three inches long. There comes into the salt and brackish tide waters a school of "sea shad" that are not breeding, and are in much better condition than the breeders. Their average size is less than the latter, but they range from the

size of an alewife to that of a full grown shad. Mr. Brown of Bowdoinham suggests that these sea shad are mostly those that have not arrived at the breeding age, and that those as large as alewives are yearlings.

To mark young shad and by retaking them at an advanced age ascertain their rate of growth, as has been done with salmon, could perhaps be done. But shad die with a slight injury. When captured and put into a tub of water for transportation alive, they are apt to dash wildly about until their heads are mangled by coming in contact with the sides of their prison. It was found impracticable to confine newly hatched shad; they died rapidly under the best care that could be given them. As they are taken for food they do not average in weight more than three pounds, probably, although they sometimes reach twelve pounds. When packed in salt on the Kennebec, one hundred and twenty fill a barrel.

Though so timid and susceptible to injury, shad do not appear to be very fastidious in some respects. They habitually run in slugglish muddy tidal streams of our State. In some of the estuaries of the Bay of Fundy they are caught plentifully in the very advance waves of a swiftly rushing tide, which is little more than a mass of tumbling silt, into which it is impossible to see a foot.

Their food is a mystery. When caught their stomachs are generally empty; and from the time they enter the fresh rivers until they have completed their spawning, they are like salmon falling constantly away in flesh and deteriorating in quality. In the sea, however, they doubtless find nutritious diet, for when taken there they are in their very best condition, fat and rich. Devoid of teeth, they cannot be supposed to feed on an active prey, although small marine species of fish have been found in their stomachs, and they have been taken in Bowdoinham by a hook baited with small fish for bass. It is more reasonable to suppose that minute, possibly microscopic creatures, which abound in the sea, form their ordinary food.

Alewife.

(*Alausa tyrannus*, De Kay.)

Though inferior to its elder brother, the shad, both in size and quality, the alewife excels in numbers and hardiness. Vast numbers once swam in all suitable waters through the State, and it is found from the Bay of Miramichi to the Chesapeake. To the

north of us it is called "gaspereaux." In the Middle States, and in many localities in Maine, it is called "herring." In our own State, it has endured against the disadvantages that man has put in its way much better than shad or salmon. There is less of wildness and timidity about its character than is the case with those fish. It is a domestic sort of fish, taking so kindly to civilization, that it has been the subject of numerous experiments in cultivation, so successful that they will deserve some notice by and by.

The alewife, in its migrations, generally precedes the shad into the rivers; but in Eastern river, Dresden, the shad comes earliest. They are taken together by seines and weirs. Yet the alewife often chooses for its spawning grounds quiet lakes and ponds, and to reach them pushes up out of the rivers into the smallest brooks, which the shad never does. It seems particularly to delight in shallow, boggy waters, yet it is capable of breeding in tidal waters, as it does in the Kennebec. Clear, cold streams it always avoids.

Alewives begin to appear in our rivers in April, sometimes in March. By the first of May a few of them are taken in Dresden, and in Augusta. Yet the main body does not appear until late in May, or, in some rivers, until June. The fishermen distinguish three separate "schools," or "runs," of different sizes, and appearing in succession, the first run being largest and most valued. Of the first run in E. Machias, 370 fill a barrel; of the second run, 400; of the third run, 600. Those of the third run, although small, are yet fat and good.

Unlike the salmon, alewives are deterred from entering a stream by an unusual flow of water, and always wait until it partially subsides. Their movements are consequently irregular in point of time. They advance by day in all difficult or exposed places, as in the passage of rapids and fish-ways, falling back or remaining stationary during the night. Warm, sunny days are particularly acceptable to them, and they may then be seen in great multitudes. Although of small size, they will stem very considerable rapids, and reach great altitudes, if at the end of the journey there is a suitable breeding place. Their limit on the Sandy river was 120 miles from the sea; on the east branch of the Penobscot, not much less than 200 miles.

From Mr. John Brown of Bowdoinham, we have learned the following facts in relation to the spawning of alewives. In the month of June, in shallow water, over weedy flats, and along the

edge of the channel, they may be seen and heard rising repeatedly to the surface, making a great swirl in the water and disappearing. On observing closely, it was found that several alewives, sometimes as many as six or eight of both sexes, rose together, and the eggs and milt could be distinctly seen falling to the bottom. To make certain, some of them were caught in the act, and search at low water revealed at a little depth multitudes of eggs among the weeds on the bottom in the same spot where the fish had been observed. The operation is performed oftener at night. It has been accurately observed in a weir, where the eggs dropped upon a board floor. About the middle of June begin to be seen in the water of the bay around Abagadasset point, myriads of pairs of eyes, each pair with a tail. Whether these were shad or alewives the observers were unable to determine, but since the experiments at Holyoke indicate that the young shad seek the center of the river, it is probable that these were alewives. In the fall they can be distinguished, and many alewives linger there in November.

After spawning, the alewives commence their return to the sea. The time when they reach it varies with the distance they have to travel. In some cases they have pushed up into small ponds or mere pools, whose overflow is so slight, that a few days of dry weather completely dries it up, and cuts off their retreat; in this situation they sometimes have to wait until the fall rains release them. Mr. Treat, in his experiments at Red Beach, found that the old alewives came dawn early in July, having a very short distance to travel. They were followed by the young late in July and early in August. The descent of the young alewives generally occurs later than this—extending into September. It is a most interesting sight to witness their march. They proceed in a dense column, frequently miles in length, following all the sinuosities of the shore. Over falls they let themselves down tail first, as indeed all fish do. If obliged to pass a precipitous fall they are not much injured by it, unless thrown violently against rocks or upon the apron of a dam. When no other way presents, they will pass through an ordinary mill wheel, apparently with little harm. When so small and light they are much less liable to injury than the full grown fish.

When the young alewives first go to the sea, they are two to four inches long. How fast they grow from that time is not certainly ascertained, but we have reason to believe that they do not attain maturity in less than three years. It has been generally

found that when a piece of water has been newly stocked with alewives they do not reappear until the third year. At Red Beach, Mr. Treat saw nothing of his until the fourth year, when they came to the mouth of the stream in great numbers. Yet we are informed of an instance in Massachusetts where an artificial pond was constructed on a brook where alewives were never seen before; a few mature fish were introduced and bred there; and in the following year full grown alewives came into the brook trying to ascend to the pond. That they do not die immediately after spawning, as has by many been supposed to be the case with shad, has been abundantly proved. Mr. Treat shut them into one of his ponds and kept them five months; at the end of that time they seemed to be much improved. To ascertain the cause he opened several of them and found their stomachs filled with their own young. This sort of cannibalism is without doubt exceptional. In their natural condition it is not probable that they feed upon other fish.

Alewives are neither so timid nor so tender as shad. They can be dipped out of the water and put into tubs without injury, and can by an occasional change of water be carried many miles overland. Advantage has been taken of this, to restock some waters that had been exhausted.

Striped Bass.

(*Roccus lineatus*, Gill.)

This species ranges from New Brunswick to Georgia. From New York south it is called "Rock-fish." It is perhaps most abundant in the latitude of Virginia. It differs from the species we have noticed before in the important characteristic that it feeds habitually and voraciously while in the fresh water. They are consequently taken readily with the hook, and as a game fish rank near salmon. The bass then, resort to the fresh water for the double purpose of spawning and feeding. Of the exact location of their spawning grounds we can say but little. It is a well known fact that they do not proceed so far inland as salmon, shad or alewives. Norris, in the "American Angler's Book," says: "An erroneous opinion prevails that rockfish ascend fresh rivers above the head of tide to spawn; but food is their only object. They generally spawn in tidal creeks and rivers, where smaller streams of fresh water enter."

Mr. Pell, who has reared them in small ponds, says that they

spawn in March, some say they spawn in the fall, while the fishermen of Merrymeeting bay say they spawn in the summer. The latter say that they are found in June full of spawn, but never appearing to be ripe during the shad fishery which sometimes extends into the early days of July; that in the fall they are in excellent condition, and contain no spawn unless in the very first stages of formation.

Says Mr. Baird: "The development of their young is very rapid, as when they go to the sea in the fall they have already attained a length of four inches." Yet in the Kennebec individuals of that size are abundant at all seasons. In the winter they are frequently taken in considerable numbers in smelt nets.

In their migrations to and from the sea we cannot trace much regularity.

Bass grow to a great size, one being on record which weighed 84 pounds. In Washington Market specimens weighing 30 or 40 pounds are not unfrequently seen; but further north a fish of 20 or 30 pounds is rare. Yet even in Maine this was a large fish—we say *was*, for through the greater part of our State only a few small ones are now met with. They are highly esteemed for food.

In the Saco and Kennebec rivers this species was once very abundant, but has decreased to an alarming extent—more than shad or alewives. In Dresden, in Eastern river, they were once taken in such numbers as to sink the ice on which they were deposited, and now not a bass has been taken there for several years. They were taken frequently on the rapids at Augusta fifteen years ago, but are now rare. They also ascended as far as Waterville, and to some distance on the Sebasticook.

The striped bass being such a voracious fish, there is no doubt that it feeds to a great extent on young alewives and shad in rivers where they abound; for it always follows the shad into the rivers. It is worth while to consider whether the bass does not in this manner devour quite as much as he is worth. A large bass would be capable of devouring a great many young fish every day, and when the bass are plenty they might make great inroads on the numbers of those prolific species. We might, therefore, expect that when freed from this ravenous foe both shad and alewives would increase faster. If this is really the case, we ought to be partially consoled for the loss of such a noble fish as the bass.

Sebago Salmon.

(*Salmo sebago*, Girard.)

The term "Land-locked Salmon," as used in the resolve authorizing this commission, has been understood as applying to this variety, also to the fish caught in the Schoodic waters at Grand lake. The belief was that these were mere varieties of the true sea salmon, *Salmo salar*, which had in some way lost the instinct which prompts that species to seek the sea, and thus remaining constantly in the fresh water were "land-locked." Knowing, however, that ichthyologists are not all agreed on this question, and appreciating the importance of caution in announcing opinions on a question of science, we prefer for the present to designate these varieties as *Sebago* and *Schoodic* salmon, being sure that the term *salmon* is properly applied to them as distinguishing them from *trout*, and leaving it for some competent authority to make such a careful comparison between them and the *Salmo salar* as shall settle the question of their identity or diversity. If, however, it be decided that these are not identical, then we know of no salmon to which the term *land-locked* can properly apply; for it seems to imply that a sort of imprisonment has taken place—that a species accustomed to visit the sea has been shut up in the fresh waters until it has lost its original instincts, and become a purely fresh water fish.

The Sebago salmon, however, is none the less valuable, in case it does lose its claim to such noble parentage. Its flesh is as sweet, and its game qualities as great in either case. This species was once quite abundant in the waters connected with Sebago lake; but torch and spear, and exclusion from the spawning grounds, have made great inroads on their numbers. Probably not more than a thousand of them are now taken annually. Nathan Cummings, Esq., of Portland, has given us much information about these fish. He says that when the Cumberland and Oxford Canal was building, during the first winter the workmen sent away fifty barrels of them. Mr. Cummings used to fish for them very successfully at the outlet of Sebago lake, but for some years he has tried them there to no purpose. They are still brought in limited numbers into Portland each spring and fall, mostly from the lower part of Crooked and Songo rivers.

The principal breeding grounds of this salmon at the present time are on Crooked river, below Edes Falls, in the town of Na-

ples, and in Bear brook, at the head of Long pond, near Harrison village. They make their first appearance in the direction of their spawning beds about the first of September; in Crooked river a little earlier than in Bear brook. In the latter stream the males come first alone, and run back and forth in the mouth of the brook until the last of the month, when they are joined by a few females, but these are still very few until the 15th of October. Soon after this date they begin to ascend the rapids to spawn. It is not often, however, that any of them are mature and commence spawning until the 20th. They come then in considerable numbers, and soon finish spawning. Very few are found in the brook as late as November 14th, although probably they sometimes spawn later. Crooked river is a larger stream, and they report different habits in some respects. The very first that come into the stream are males, but after that the females seem to head the advance, and the males follow them; taking the whole of September, the males are not more numerous than the other sex. In the whole season there are more 'males. They sometimes continue to spawn very late. The state of the water has a great influence on their motions at this time. A rise is followed by a plentiful run of fish.

Their beds are made in the gravel where the current is rapid, but just on the verge of a ripple in the water; rarely seen on the lower side of a ripple. They make large excavations, the sand and gravel from which are carried out by the current, and form a mound below. These excavations are sometimes three feet in diameter, and are made by more than one pair. A large number of both sexes are sometimes seen together in one hole. No fighting is observed amongst the males. It is more common, however, to see a single pair working together, lying side by side in the nest. They make the excavations by fanning with the tail, no digging with the head being observed. On favorite grounds the nests encroach on each other on all sides, frequently lying one above another like a row of potato hills; but whether one pair makes more than one nest has not been ascertained. The work of spawning is carried on at night, and by day the fish are rarely to be seen on the beds. Their ascent of the stream also occurs by night. The old fish eat nothing during this season; but small males are taken with their stomachs full of eggs. The adult males are very different in appearance from the other sex, being much deeper and thinner, with larger and more pointed heads. The lower jaw is furnished at the spawning season with a singular recurved pro-

cess, sometimes near an inch in length, which shuts into the roof of the mouth; it is conical in form, either truncated or with the apex bent backward. On an adult male of one pound weight this was present, but not so fully developed as in the larger specimens. In younger individuals it was wanting. Both jaws in this sex are so curved as to prevent the closing of the mouth. A male of six inches length had a forked tail, eight or nine black bars across the side, twelve large vermillion spots on the side. One that measured eight and one-half inches in length has the same forked tail, and the bars on the side, but they are very faint, and the vermillion spots have changed to maroon; the hook on the jaw not yet visible.

The spawning grounds of this species are very limited. Those of Long pond are confined to Bear brook. Those of Sebago are mostly limited to two or three miles of Crooked river. In former times they ranged at the spawning season the whole length of Crooked river, as far, at least, as North Waterford, and great numbers of them were taken at many points; but they were never known to ascend the river at any other season than fall, farther than the first gentle rapids near its mouth. This is rather singular; for the sea salmon (*S. salar*) ascends rivers of smaller size than this in June, and passes the summer in them. The grand fishing place in May was from the junction of Crooked and Songo river several miles down. The fish took bait eagerly, and were then in superior condition. They left this ground as early as the last of May, but at the outlet they were taken much later. In the lake itself they were only caught in the track of the rafts that came down across the lake into Presumpscot river, and the arrival of the rafts at the outlet was always the signal for good fishing there. In Long pond they are never caught—only when entering the brook, and in the spring only a few small ones are taken there.

The size attained by the Sebago salmon is very considerable. The average of those taken in the fall, is for the males 5 pounds; for the females, a little more than 3. A female 25 inches long weighs 5 pounds; a male of the same length weighs 7 pounds. Of two males 29 inches long, one weighed 9 pounds 14 ounces, the other 11 pounds 4 ounces. Some extreme weights may be given. One was taken the past season at Edes falls that dressed 14½ pounds. The largest on record was caught by Mr. Sawyer, of Raymond. Its weight was 17½ pounds, and is vouched for by Franklin Sawyer, Esq., of Portland. These old fish are seldom

caught with the hook ; and of those taken in the spring and summer, when they are in season, the average weight would be less than indicated by the above.

These fish are said to be about as plenty as they were ten years ago. But it is strange that they can maintain their numbers against such persecution as follows them. The spear is very fatal. In Bear brook nearly all the breeding males are destroyed before the females are ready to spawn. In 1858 a law was passed for their protection, which would enable them to recruit their numbers were it enforced.

We consider this variety worthy of being propagated and disseminated through the State.

Schoodic Salmon.

This inhabits the waters of the St. Croix river, where, in former years, it descended as far as Calais. Its principal haunt at the present time, is Grand lake and Grand lake stream. In size, it is inferior to the *Sebago salmon*, averaging in June not more than a pound and a half, in the fall a little larger ; Mr. B. W. French of Calais, who is well acquainted with these waters, never saw one heavier than 4½ pounds. In other respects it is not at all inferior to the Sebago fish. Its habits are nearly the same. It follows the rafts of timber across Grand lake in the spring, and continues in the stream until July. It then disappears, and returns about the 10th of September. It begins to spawn in October and finishes in December. It takes the hook, fly or bait, at all seasons when it is in Grand lake stream, and being very abundant, it affords a great deal of sport and a large amount of delicious food. That locality is visited by sportsmen from all parts of the country. At the time of our visit on the first of June, thirty or thirty-five persons were there encamped to fish. A party of three who were just leaving, had been there two weeks, and their total catch was 621 salmon, 18 togue and 11 trout. Norris gives the following memoranda of a Philadelphia sportsman at this place :

"June, 1856.—Three rods, six days, 634 trout, 872 pounds.
"June, 1857.—Three rods, six days, 432 fish, 642 pounds.
"June, 1858.—Two rods, eight days, 510 fish, 725 pounds.
One rod, six hours, 65 fish, 94 pounds.
"Average time of fishing four and a half hours per day."

He has applied the name "trout" to these fish, and by that name they are generally known ; but we prefer to call them *salmon*,

reserving the name *trout* for our common red spotted species (*salmo fontalis*).

We have not the data from which to compute with accuracy the number of these fish taken, but think it cannot be less than 12,000 annually. In the fall many more are taken than in May and June, for in the fall the spear is used on the spawning fish with great effect. Whether their numbers are decreasing seriously, is a question upon which there is a difference of opinion among those who are in the habit of fishing for them. Those, however, who have known them longest have very generally stated that that they are far from being as plenty as they were twelve years ago. More recent observers have failed to perceive any diminution of their numbers. We judge that the amount of fishing pursued for several years is too much for their natural increase. The act of the last Legislature, if enforced, would effectually prevent overfishing.

Trout.

(*Salmo fontalis*, Mitchell.)

This is the well known brook trout common all over the State in gravelly and pure streams. It also inhabits nearly all the lakes and ponds into which run streams which afford suitable spawning grounds. Varying greatly in size and aspect in different waters, and at different seasons, it has been described under several names by naturalists, and has received the common names of "speckled trout," "red spotted trout," "salmon trout," which last is a misnomer. This is the common trout of the Umbagog system of lakes, of Moosehead, and generally through the northern and central part of the State. The kind caught so abundantly at Grand Lake stream, and there called "trout," and that found in the Sebago region, and there called "Sebago trout" and "black spotted trout," are really *salmon*, and should be so designated; and the species called "lake trout" in Moosehead and some other waters is really *togue*.

The habits of the trout resemble those of the salmon. It spawns in running water, burying its eggs in the sand or gravel, in the fall of the year. The term of incubation is very long—not less than 160 days in our natural streams; so that the young trout do not make their appearance until spring. The trout does however sometimes spawn on the shores of lakes, on sandy and gravelly bars, as has been observed in Great pond in Belgrade and Rome;

and the Cobbossee Contee, where Dr. Cochrane of Winthrop has seen them spawning. What success attends the deposit of eggs in such a situation is uncertain, but doubtless fewer of them hatch than would be the case in running streams; and in a great portion of our lakes the bottom is too foul to admit of success. We shall find on the whole that trout never maintain their numbers in places where they are debarred from spawning in running water. There is in Sidney a small lake called Silver lake, of beautiful emerald water, of great depth, with clean sandy and stony shores, with neither outlet nor inlet. Into this were put a small number of trout. They all attained a large size, and were caught a few years afterwards. The whole number taken out did not exceed the number put in, and since those were taken no trout have ever been seen in the lake. It is not supposed that they bred at all. The same experiment was tried in a similar pond in Moscow, with the same result. In connection with these we may mention an experiment that resulted very differently. Maj. S. Dill of Phillips writes to the Maine Farmer: "In the fall of 1850 I put into the Sandy river ponds ten or twelve trout; for seven or eight years no indications of them were to be seen, notwithstanding thousands of people crossed those ponds every year. Since 1857 it is judged that not less than 2,000 pounds have been taken out annually. So far as I have been able to inform myself never a fish had been seen in either of those ponds prior to my *colonization.*" We presume these trout had access to running water in which to breed. In general, they spawn in streams of all sizes. In the rivers tributary to the Umbagog and neighboring lakes they are seen in great numbers in the fall busily engaged in depositing their eggs in the gravel, surrounded frequently by swarms of small fishes greedily watching for a chance to steal the eggs. While the female is depositing them, the male lies apart, occasionally making a dash amongst the little poachers. When engaged in spawning, trout are so intently occupied that they seem to have entirely lost their habitual shyness, and are therefore easily captured. They will frequently take the fly, but by no means so readily as at any other season. They are chiefly captured at this season by means of spears and grapnels, which are very deadly weapons. In small brooks they can even be taken out with the hand. There is a brook running through the village of Manchester Forks, where each year quite a number of trout, weighing from two to four pounds, are taken as they come up to spawn. A pair has some-

times been seen together in the brook, and frightened under the bank, when it was only necessary to reach the hand under and take them unresistingly out. Trout, like salmon, are very poor in quality at the spawning season, and it is surprising that people can eat them. Yet we presume that more of them are taken then than in any other part of the year.

The growth of trout is less rapid than that of salmon. Probably an increase of half a pound each year is not far from the average. In favorable circumstances they grow at the rate of a pound in a year. In the pond in Moscow referred to above, the trout when introduced were from three to five inches long, and seven years afterwards a number were taken the largest of which weighed seven pounds and the smallest five pounds.

Those trout taken in the brooks are very small, not averaging more than three ounces. In the lakes they attain a much greater size. In the Umbagog chain five pounds is not an uncommon weight, and fish occur weighing eight and even twelve pounds; but the average is found between one and two pounds. One hundred and ten trout taken there in December, 1860, weighed 122 pounds, being an average of a little more than one pound each.

This species is very easily domesticated, and thrives wonderfully in confinement. When young it will endure without injury much rough usage. This hardy character joined to its value in market renders it the best of all fish for artificial breeding and rearing. In our country the efforts of pisciculturists have been almost wholly confined to it. Trout breeding has already become an established branch of industry.

We shall have occasion to refer to this species again, in discussing the question of protection.

Togue.

(*Salmo tomah*, Hamlin.)

This species is in many localities known as "lake trout," a name which indicates the characteristic which most distinguishes it from the brook trout. It is found in lakes of considerable depth, rarely in rivers, and spawns habitually in still water on rocky shores and bars. Although it occasionally takes the fly of the sportsman, it so generally inhabits deep water, that its presence in the Tunk lakes in Hancock county was unsuspected for many years after the neighboring country was occupied. It is scattered all over the State, except in the southwestern counties, where Thompson's

pond in Poland is the only locality that we have learned. It does not occur in the Umbagog system, nor in the lakes of Kennebec county. But in the lakes of the upper Kennebec, of the Penobscot, of the St. John and of the St. Croix, it is common. It varies greatly in color, being in Grand lake on St. Croix of a lively salmon-yellow on the sides, dotted thickly with grey, with open spots showing the clear yellow ground work; and in Emden pond, although revealing the same markings to a close observer, yet presenting an almost uniform grey over all the lower part of the body. A Salmo found in the town of Wilton, has been supposed to be a distinct species, but it has in general appearance a close resemblance to the togue as caught in Grand lake, and a careful comparison will probably reveal no specific differences.

The spawning time of the togue is the fall of the year. Late in October they resort to shoal water and spawn on rocks and ledges. They come suddenly, finish the operation in a few nights, and immediately retire to deep water. It has been noticed that the females come to the spawning grounds first. The first night of their appearance nearly all will be females, and at the last nearly all males. They are accompanied and followed by a motley throng composed of nearly all kinds of fishes in the lake, eels and horn-pouts predominating. Probably few of the eggs escape them.

The quality of this fish is generally inferior to that of the trout. Its flesh lacks the delicate flavor. It is very fat, but not rich in taste. Yet when in season it is very good eating. It attains a great size, individuals having been found to weigh twenty-seven pounds, and ten pounds not being uncommon. In Wilson pond in Wilton, those weighing only two pounds are looked upon as curiosities, and the average is eight pounds. In other waters the average is much less.

On the St. John waters this fish is an important article of food with the inhabitants, less abundant than the white fish, but said to be preferred on account of superior size.

Besides the name of "lake trout" that of "tuladi" belongs to the same fish, and the "lunge" of Vermont and Canada is believed to be identical with our togue.

Blueback Trout.

(*Salmo oquassa*, Grd.)

This is a species peculiar to Rangely and Moosillamaguntic lakes, inhabiting the deep waters, and almost never taking the

hook, but coming up about the 10th of October in great numbers into the tributaries of those lakes to spawn, and returning after the middle of November. They are of some importance to the inhabitants, who take them with nets at the time of their migration. Their size is small, about eight or ten inches in length. Their quality is a matter of dispute, some extolling them very highly and others saying they are no better than suckers. Mr. Girard says of it: "The flesh of this fish is highly flavored, and more delicate than that of the brook trouts in Europe and America. It resembles *Salmo umbla* of the Swiss lakes, both in the peculiarity of its habits and its delicacy."

Smelt.

Smelts are scattered all over the State. It seems probable that we have more than one species. Whether either of them is identical with the salt water smelt we cannot say, but the resemblance is very close. In several localities they attain a large size. Those of Harrison are said to exceed half a pound in weight, and those of Belgrade to measure fourteen inches in length. In spring they approach the shores, and are sometimes thrown upon the land by a heavy wind, and perish in great numbers, the shores being lined with the dead. About the first of May they ascend the streams. In Monmouth they run into some very small rills that lead into Cochnewagn pond, and are dipped out in considerable quantities. In May, 1867, after it was supposed they were all gone, a fresh run occurred, that yielded thirty barrels. In quality the fresh water smelts are fully equal to those from the tide waters. Those from Monmouth have been placed side by side with smelts from Damariscotta, and received the preference.

Whitefish.

(*Coregonus.*)

Of this genus we possess at least one and probably more than one species. They occur principally in the central, northern and eastern portions of the State. The species found abundantly on the St. John and its tributaries has been referred to the species *C. albus*, but we doubt whether that is correct. Whether or not our whitefish is identical with the famous whitefish of the great lakes, it certainly partakes of that excellence which is a characteristic of all the members of the genus. In the Fish river region, in Moose-

head lake, in Schoodic Grand, they pronounce the whitefish the best of the fishes. Like nearly all the salmon family, to which they belong, they spawn in the autumn, and seem to prefer running water. On the Schoodic, they resort to Pocumpus thoroughfare, a strait about six rods long, connecting Pocumpus and Grand lakes, where the water is flowing from three to five feet deep, and the bottom sandy and gravelly. In November each year small quantities of them are taken here with the spear. One night Mr. B. W. French of Calais set a net thirty feet long at this thoroughfare, and in the morning had a barrel of whitefish. In Moosehead lake they sometimes take the fly. In June last we saw one taken with the fly near Mt. Kineo, by Artemas Libby, Esq., of Augusta. It weighed a pound and a half. Two trout weighing a pound each were taken at the same cast. They can be taken with the hook at any season of the year in deep water. Almost any bait will answer, but the best is a piece of a small fish. The most of them are taken in the winter. The greatest success is attained by sinking through a hole in the ice, at the end of a line, a "cusk" thoroughly gashed up with a knife. This remains there one day, and tolls a great many whitefish around. They are then taken by the smallest baits on small hooks. One winter many of these Moosehead whitefish were sold in Augusta, and their weight was so uniformly one pound that they received the name of "pound-fish," and the trouble of weighing was dispensed with by the mutual consent of seller and buyer.

The whitefish differs from most of its family in being nearly or quite destitute of teeth. Its mouth is small and tender. It has therefore none of the fierce pedatory character of the trout and togue. It probably feeds mostly on small aquatic animals of various kinds, such as insects, crustaceans and mollusks, being guiltless of the death of any of its fellow fishes.

White Perch.

(*Merone americana*, Gill.)

Its small size is the only fault we have to find with this species. Its average weight is not more than four or five ounces, although it sometimes attains the weight of two or three pounds. There is some reason to suppose its growth is more rapid than that of the yellow perch, for it is not usual to catch very small specimens as it is of that species. It is not so universally distributed as the yellow perch, not occurring in the south western part of the

State, and being frequently wanting in particular lakes in the midst of a district generally occupied by it. It inhabits generally those lakes and ponds emptying into the Kennebec as far north as Skowhegan, those tributary to the Penobscot still farther into the interior of the State, and the St. Croix, with the intervening country. This is supposed to be identical with the white perch that comes into the rivers in the spring with the alewives, and it is an interesting question, whether it is naturally a salt water species which has strayed into the fresh waters, and lost the instinct which should guide its return, or whether it was originally equally fitted to live in salt or fresh water. Some of the lakes in which it abounds have never been accessible to fish coming from the sea during the present age of the world. As an instance may be mentioned the Belgrade lakes.

The white perch spawns in the spring, but the precise method we have not ascertained. As the ice opens along the shores of the ponds, they are found to approach the shoal water, and about the first of May they run up many small streams, as at Winthrop village. These movements are probably connected with their reproduction.

At other seasons they constantly inhabit the deep water, where they are gregarious to a greater extent than the yellow perch, being rarely caught by fishing from shore. It is to be presumed, then, that they are far less destructive to small fish than the pickerel and yellow perch, which frequent the shores. In July their food is found to consist mostly of larvæ of insects, many larvæ or pupæ of the dragon fly, not a few small crustaceans, and rarely a small fish.

Pickerel.

(*Esox reticulatus*, Le Sueur.)

The pickerel was formerly confined to a small area in the State, but by the assistance of man has spread far and wide. It is very prolific, and its young appear to be hardy. It is fond of shallow still water, no doubt because it there finds its food, which consists of small fish of all kinds, of frogs and tadpoles. There is no other large species among us which so habitually frequents the shores. It is extremely greedy and voracious, and doubtles is the most destructive to young fish of all our species. Yet it increases rapidly, and grows so soon to edible size that it furnishes a great amount of food from a given area. Its quality is a matter of dis-

pute ; some detest it, and others prefer it to trout. We should bear in mind the adage, "*de gustibus non disputandum.*" The case of "Trout vs. Pickerel," is one in which so many are interested, that we shall have occasion to refer to it again under the head of *protection.*

Pickerel spawn in the spring, and their young hatch in two or three weeks.

Examination of the Rivers and other Waters.

This work was commenced on the first of May, and until July we proceeded together. We first examined the lower part of the Saco as far as Salmon Falls, in Hollis and Buxton, and from that proceeded to the Mousam, the whole length of which we explored. The Presumpscot was then examined as far as Sebago Lake, leaving the tributaries of Sebago until fall. After visiting Skowhegan and finding the Kennebec too high for our purpose, we proceeded to the eastern part of the State, and examined the lower portions of the Machias and East Machias rivers, Mr. Foster being already familiar with the latter, as also with the Cobscook, which next came under observation. We next passed up the St. Croix, viewed all the obstructions, and stopped two days at Grand Lake stream. We returned to Dennysville, examined Denny's river, and thence by way of Machias to the Kennebec. We reached North Anson on the 12th of June. From this point a three days tour was made up the Sandy river and down the Carrabasset. We then proceeded up the Kennebec to the Forks ; thence to Moose river bridge, and down Moose river by canoe to Moosehead lake. From Moosehead we proceeded to the Sebasticook, whose examination brought us to the close of June. During July Mr. Foster made another trip to the St. Croix, and completed the examination of that river. Mr. Atkins examined the fisheries on the lower Kennebec, and on some of its tributaries ; and in September surveyed portions of the upper Kennebec which were not visited in June, following the Kennebec down from the lake to the Forks, and Dead river from its mouth to Dead River plantation. Rumford Falls was next examined, that portion of the Androscoggin from Lewiston down, and the Little Androscoggin. In October Mr. Foster examined the main Penobscot as far as Howland, and several of its lower tributaries—the Eastern river, Passadumkeag, Piscataquis and Pushaw. Mr. Atkins examined the main tributaries of Sebago lake, Hiram Falls on the Saco, and that portion of the

Great Ossipee lying in Maine. This, with the exception of a few minor points, closed our work in this department.

We have not thought best to present a detailed itinerary, but to give the main facts elicited in a more condensed and more connected form.

Mousam.

The Mousam is eminently a salmon stream. Its source is in Mousam pond, which, with two smaller ponds leading into it, covers an area of nearly 3000 acres. Issuing from the pond in the town of Shapleigh, it pursues a course of 24 miles to the sea in a south-easterly direction. For the first few miles it flows through a granite country, but for twenty miles it is bordered by sandy plains where pitch pine and scrub oak are common. Its bed is therefore entirely composed of ledge, boulders, gravel and sand. The fall is considerable, and pretty evenly distributed through its length. When unobstructed its whole extent nearly, must have been suitable spawning ground for salmon.

The amount of water in the Mousam is very constant through the year. Both the pond at its head and the sandy land through which it flows for so much of its course conspire to this end; the one by forming a reservoir in which the waters from the granite hills are collected and fed out when wanted by the dam at its outlet, the other by absorbing surface water and emitting it through springs. The same causes also render the water pure. At all the mills on the river they report plenty of water and generally some to spare—their waste-ways are rarely dry. Freshets are on the upper part of the river unknown, the water never varying more than a few inches; on the lower portion a rise of more than a foot is unusual. Droughts have little effect.

The natural aspect of the river promises salmon, and tradition accords with it. From Judge Bourne of Kennebunk, we learn that the Mousam was once "full of salmon." Dr. Emerson informed him that one Wakefield once loaded a cart with salmon in a little while at the foot of his garden in Kennebunk. There were also shad and alewives; the shad still come into the river, but the salmon come no more.

The first dam on this river was built in Kennebunk a little above the site of the present structure in 1675. It was rebuilt in 1720 further down the river, and in 1774 on the present site, (that of

the upper dam at K.) Since 1720 a dam has been constantly maintained here.

The constancy of the supply of water, the freedom from freshets and droughts render the power derived from this river particularly safe and valuable. It is pretty well improved. There are between Mousam pond and the sea, 18 mill dams and one reservoir dam. We saw all but two of them. There is no special obstacle to the construction of a fishway over any of them, although they are often high, there being eight whose height exceeds ten feet. None of them are now provided with fishways, and we did not learn that they ever were.

The principal tributary of the Mousam, nearly equal in volume to the main stream, enters the latter on the left side in the town of Alfred. We did not examine it; but it is obstructed by dams at various points.

Were it undertaken to restock this river, salmon should be the kind selected, but it might at the same time be found practicable to increase greatly the amount of shad, and to breed alewives here to a certain extent. The construction of fishways over all the dams would cost three or four thousand dollars. It would further be necessary to breed salmon from the egg in the river, they being now entirely exterminated.

As to the results to be attained it is to be borne in mind that the mill-ponds now cover with dead water a great portion of the original shallow rapids where the salmon spawned. There are some left of course, but with the considerable diminution in their extent, it is reasonable to suppose that not so many salmon could be bred in the river as originally, unless resort should be had to artificial breeding. The cluster of fine springs in the town of Sanford which gives a name to the village of Springvale, would afford an admirable location for a breeding establishment.

Unless for the purpose of testing what can be done by artificial breeding, we think it would not be advisable to undertake to restock the Mousam until some less difficult task has been brought to a successful issue. We may then have more light upon the subject.

Saco.

Of this river our survey was only a partial one; yet it embraces the principal points of interest. Our personal examination extended to the lower part of the river as far as Salmon Falls in Buxton

and Hollis, to that portion lying in the town of Hiram ; and to the Great Ossipee river as far as Kezar Falls. The most of our information in relation to the river was obtained from Thomas Quimby of Biddeford, engineer, who furnished us with measurements of nearly all the falls on the river, and from Hon. Joseph Hobson and Tristram Jordan, Esq., of Saco.

One would naturally suppose that a river like the Saco, rising among the White mountains, and draining at least a third of their surface, would be liable to great and sudden fluctuations of its volume. However this may be on its upper waters, while still in New Hampshire, we find that in the lower part of its course it is one of the most constant of the large rivers, rarely subject to destroying freshets, and not seriously impaired by drought. It flows through a great extent of sandy country, and its principal tributaries are regulated by ponds and lakes. The channel of the main river is deep ; there is not a single ford from Fryeburg to the sea. Its water is pure, and in Biddeford and Saco is used for all domestic purposes.

The Saco was a salmon river. The difficult falls that naturally existed at Biddeford, and again at Salmon Falls, were doubtless sufficient to deter less active fish from ascending it very far. There have always been shad in the lower part of the river, but we found no tradition of their ever passing Biddeford. As to salmon, it is certain that they ascended as far as Hiram falls, where a great many were taken in old times ; and the Great and Little Ossipee rivers are reported to have been frequented by them. We could obtain no exact estimate of their numbers in former times, as they had ceased to be plenty beyond the recollection in the present generation. Mr. Jordan is aged sixty-nine, and had information obtained from his father and grandfather. It is very sure that salmon have not been plenty for eighty years ; and that at no time for the last sixty years have they been so abundant than a man could take more than five or six in a day at the Saco falls. For many years they have been entirely extinct. The last taken at Salmon Falls was in 1843. Mr. Benjamin Coolbrith, of Biddeford, has fished here for shad for the last twenty years, and has never taken a salmon.

The following table will show the obstructions on the Saco:

Distance from sea, miles.			Height of dam, feet.	
				[no dam.
45	Hiram Falls, .	–	–	Natural fall 80 feet 11 inch;
35	Steep Falls, .	1 dam,	12	
27	Bonny Eagle, .	1 dam,	10	Natural fall of 70 feet.
25	Moderation, .	1 dam,	12	
18	Bar Mills, . .	1 dam,	11	
16½	Salmon Falls, .	1 dam,	10	
15	Union Falls, .	1 dam,	14	
6	Biddeford and Saco,	2 dams,	6 26	On the Biddeford side are three dams of 6, 16 and 16 feet; cotton and woollen mills, dyeing, &c.

The most serious of these obstructions is the lower fall between Saco and Biddeford. An island here divides the river into two channels. The greater bulk of the water flows in the westerly channel on the Biddeford side, and here are situated all the cotton mills. In this channel the total fall of thirty-two feet is divided into two, of sixteen feet each, by two stone dams. The construction of fishways over both of these would be difficult, and the structures would be insecure; for there is no available location where either of them would be properly shielded from the force of freshets, laden frequently with heavy masses of ice, which might soon batter to pieces any ordinary structure. But on the east side of the island there is a better prospect of success. This channel carries much less water than the other, yet quite enough, we think, for the purposes of fish. Instead of two falls, there is here only one, of less than thirty feet. The water falls over a dam a few feet upon a narrow ledge, and thence leaps into a deep pool twenty feet below. On the east side of the fall stands a grist-mill, whose foundation wall is deflected at a considerable angle from the direction of the channel. Against this wall the fishway might be built as far as the south corner, where it would rest on the ledge; thence it should be reversed and carried back towards the fall, where its lower end would rest in the deep pool. By being thus built against the deflected wall of the grist mill, its main body would be out of the way of running ice or timber, which could only assail the upper end, and this might be shielded by some structure of timber. This location would have the further advantage of being out of the way of the impurities that come from the dyeing mills on the western channel, and which might

have some injurious tendency. On the other hand, there is a certain disadvantage attaching to the small amount of water running here, since the fish would choose the main channel, if the water were good. The cost of constructing this fishway would be about $3,000.

The upper dam at Saco is only about six feet high, and does not require a very extensive fishway.

The next obstacle is the dam at Union falls, in the town of Dayton. The water being high at the time of our visit (May 4th,) it was difficult to determine where a fishway should be located. To be secure against high water and floating material, it would doubtless need to be well ballasted, and it might be necessary to give it extra strength. An island here divides the channel, and near this are some gateways to regulate the water. A fishway built near these gateways would be beyond reach when it most needed some attention.

The dam at Salmon Falls is at the head of a narrow chasm, through which for half a mile the Saco rushes with great fury. The chasm is from twenty-five to forty feet wide, and in passing through it the river falls about sixty-six feet. Logs are driven down the Saco every year, and in this chasm they frequently jam, and block the channel so that the water rises at the foot of the dam nearly to its crest. In such a case as this any wooden structure would be floated from its place unless very strongly secured. Aside from this danger, which might be guarded against by ballasting and bolting to the ledge, and the danger from the impact of floating ice and logs, there is a very good location for a fishway near the west end of the dam. A dam has been maintained here as long as eighty years. It was carried away in 1843, and then rebuilt on its present site.

Of the obstructions at Bar Mills, Moderation, Bonny Eagle and Steep falls, we cannot speak, not having examined them. It is supposed, however, that fishways can be constructed there. The natural fall at Bonny Eagle is not represented to be very difficult, and information received at Hiram satisfies us that it did not prevent the passage of salmon.

There are no other dams on the main river, unless there be in Bartlett, N. H., or above.

The natural fall in Hiram was examined in October, mainly for the purpose of ascertaining whether the salmon ever ascended the Saco into New Hampshire, the Fish Commissioners of that State

desiring to ascertain whether they were interested in the opening of this river. The Saco at this point descends eighty feet eleven inches, by five successive plunges, neither of which is precipitous. The third from the top and the last are the most difficult. The third is a fall of eighteen feet, at an angle of forty degrees. The lowest is a fall of about thirty feet, at an angle of twenty-five or thirty degrees, and is torn into a torrent of spray. Neither of these falls into a deep pool, and both are practically impassable. Yet we did find a report that one Walker, who trapped beaver in Fryeburg, found the body of a large salmon at the "great jam," as many as seventy-five years ago. A high stage of water may so alter the aspect of the falls as to render it possible for an exceptional salmon to pass them; but practically this was their limit.

That salmon were once taken here is a common tradition in the vicinity; yet men who have lived here since 1815 have no personal recollection of it. The dam at Salmon Falls had cut them off earlier than that.

The Great Ossipee river enters the Saco from the west at Cornish, forty-two miles from the sea. It is a fine, rippling, gravelly stream. The only obstruction on it after it enters Maine is a dam at Kezar Falls, which would be an obstacle to salmon only in the drought of summer, and could easily be made passable at all times. Beyond the New Hampshire line are several dams. It is evident that salmon might have entered New Hampshire by way of this river, and there is no reasonable doubt that they did. Throughout its whole length also there is a great extent of excellent spawning ground.

The next important tributary of the Saco is the Little Ossipee river. This rises near the west line of the State. We did not examine it, but learn that it has several mill dams. It enjoys the reputation of having been a fine salmon stream in former times.

The fisheries of the Saco river are at the present day poor enough: only a few shad are taken, and they are yearly diminishing in numbers. This fishery is carried on by Frederic H. Lowell and Benjamin Coolbrith, by gill nets set in the river a short distance below the falls. In 1850 each of them took on an average twenty-five or thirty shad in a night by fishing a short time. (This was enough to supply their markets.) From that time to 1860 there was not much falling off. But for the last five years they have worked harder to get half the number of shad. Fifteen years ago bass were plenty: two men with a small net could load a wherry with them in a night; but not one has been taken here for

eight years. These men attribute the destruction of the fish to the refuse matter from the gas house in Biddeford, which is allowed to be washed into the river. It is no uncommon thing, they say, after a shower which brings down the tar into the river, to see great numbers of fish such as chubs and eels rising dead to the surface in the vicinity where this refuse enters the river. The tar floats all over the surface, and is found smearing the rocks on Eagle island at the mouth of the river.

Mr. Lowell states that he sets one net on the Saco shore, in the "bay," and one on the Biddeford shore; that in the former place he takes shad only on ebb tide, and in the latter place only on the flood. This phenomenon he thus explains: The tide runs with greatest force, both on the flood and on the ebb, in the channel next the Biddeford shore. On the flood it crowds all the impure water from the Biddeford side over into the bay on the east side, where the shad avoid it, and seek the purer water of the flood tide coming up on the west side. On the ebb, however, the impure water is drawn directly down the Biddeford shore, not any of it crossing into the "bay," which in its turn becomes filled with purer water, and therefore inviting to the fish.

Should it be undertaken to re-stock the Saco with fish, it would of course be necessary to construct fishways over all the dams, and in the case of the salmon it would be necessary to import their eggs, and breed them in the most promising locality, which, so far as our examination will enable us to judge, is the Great Ossipee tributary. Salmon once introduced would thrive, and we doubt not, with suitable regulations, become abundant. The river is not so well adapted to shad and alewives. The cost of opening the Saco cannot be accurately estimated without a completion of the examination. Whether it should be opened at an early date ought to depend partly upon the wishes of New Hampshire. It may be found practicable to construct a fishway over the Hiram falls, which would greatly increase the productive capacity of the river; but at the present time any recommendation in regard to it would be premature.

Presumpscot.

This river is the outlet of an extensive system of lakes and ponds, of which Sebago lake, the second in size in the State, is its immediate source. The area of Sebago lake is about 27,000 acres Its depth in some places is more than a hundred feet; and

in this vast reservoir the turbid water of the tributary streams deposits its sediment, and issues thence as a river of uncommon transparency, a character which is maintained for a long distance from the lake. The great extent of lake surface drained by the Presumpscot renders the power afforded by its fall very reliable, and it is well occupied by mills. Yet there is a considerable amount of rapid water in its course.

Our examination of the Presumpscot was made in May, and extended to all the obstructions on the river, but not to any of the branches, with the exception of the Duck pond stream. The upper waters, however, tributary to Sebago, were visited in October, and the most important examined. In the survey of the Presumpscot we found it crossed by eight dams, whose position and height are given in the table below. Two other points are given, which have been occupied by dams, and may be again.

Distance from sea, miles.	Place.	Height of dam.
27	Sebago Lake source,	–
25	Lindsley's Falls,	14½ feet.
24½	Steep Falls,	11½ "
23	Great Falls,	20 "
18½	Gambo Falls;	8 "
17	Little Falls,	–
16½	Nullison Falls,	12 "
10	Saccarappa, 2 dams,	10 "
		14 "
9	Cumberland Mills,	9 "
1	Presumpscot Falls,	–

At Presumpscot falls there is now no obstruction which is insurmountable to fish. The river descends swiftly over and among ragged ledges; but alewives and shad pass this point every year. There was a dam here near the natural fall, which was built as early as 1802, but it was entirely broken down fifteen years ago. This fall will probably be occupied by mills at no distant day.

At Cumberland Mills there is a stone dam nine feet high, and impassable. Were it not for exposure to the force of the current in time of floods, the best location for a fishway would be in the corner of the dam next the mills; but it should be securely covered. The entire power is used by a paper mill, which is now making printing paper, and using 1400 or 1500 pounds of chloride of lime and twenty-five or thirty gallons of oil of vitriol per week. The liquid refuse from the bleaching vats is finally turned into the river.

At Saccarappa there are two dams. The lower, of fourteen feet, can be best surmounted by a structure at the east end, near the flume. The upper dam is about ten feet high, and rests partially against a small ledgy island, which is nearest the west shore. On the west of this island there is a natural passage-way between it and a ledge which supports a corner of the dam. In this passage-way a fishway might be constructed, with little cost, and would be well shielded from floating ice and timber. The power furnished by the river here is employed by numerous mills, but we did not learn of any pollutions. The principal lumber mills on the river are here.

The dam at Nullison falls is twelve feet high in mid river, but on the east end is only eight feet high. Against the wall of the woollen mill on the left bank of the river is probably the best location for a fishway. It would need to be well protected against ice and logs; of the latter seven million feet passed this point this year for the mills at Saccarappa.

The next point noted in the table, Little falls, was formerly the site of a mill; but mill and dam have entirely disappeared, and there is now only a log pier built into the river from the left bank, to assist in driving timber. The fall is about thirteen feet and is rather sharp, but not a serious obstacle to salmon. If alewives were to ascend the river beyond this point, a fishway might be easily built for them on the left bank.

The dam at Gambo falls is eight feet high at the head of the fall, but it has two wings extending down the river, of which that on the left side is very long, and attains a height of twenty feet. In the latter is a waste gate, and just above this gate a fishway might be safely built, running down alongside the dam, if a guard were built to prevent the water falling over upon it. This water power is owned by the Oriental Powder Company, whose works are located here.

The fall of the water at Great falls is about twenty feet, but it is a gradual descent, the dam being but a slight one. Salmon could pass this readily, and later in the season alewives could probably do the same. It might be necessary to assist the latter by some simple structure. The mills here are various manufactories of lumber.

At Steep falls is an old log dam in a bad state of preservation. There were mills here, but they were carried away by a flood

years ago. The dam cannot be passed by fish without a fishway. One could be best made by opening the dam at a point near the right or west bank of the river, where the water falls over the ledge. The height of the dam is eleven feet six inches.

The last or uppermost dam on the river is at Lindsley's falls, commanding the water of the "basin," and essentially of the lake. It is a log dam, and is fourteen and one-half feet high. The water is sometimes drawn below its crest, but not more than a foot. The best location for a fishway is at the east end of the dam, running it down the stream, and reversing it so that its foot may rest near the dam. The "basin" is a broad expanse of the river immediately after it leaves the lake.

Songo.

This is the main affluent of Sebago lake, and may be considered as forming the upper portion of Presumpscot river. Songo river is a sluggish stream forming the outlet of Long pond, a sheet of water covering about 6,000 acres. A slight fall in the course of the river is overcome by a lock for the passage of canal boats to Harrison, at the head of the pond. Into Long pond flow three considerable streams, namely, one from Crotched pond, in Bridgton, Bear brook, from Waterford, and the outlet of Anonymous pond, at Harrison village. The first is occupied at Bridgton Center by six dams, affording power to several woollen factories, in which dyes are used, to a tannery, and other mills. The water that comes from Crotched pond is very clear. Trout (Sebago salmon?) are reported to have peopled this stream formerly, but there are none now. Bear brook is the outlet of several ponds in Waterford. It is principally noticeable as being one of the spawning grounds of the Sebago salmon. Its immediate source is Bear pond, and between this and Long pond the stream is interrupted by two dams, one of which has been built seventy years. From the lower of these to the pond is the spawning ground of these salmon, which will be referred to again. Another dam is in process of construction on the lower part of the brook, which will destroy most of the spawning ground. Above Bear pond, at Waterford City, is only a small stream, occupied by six dams, varying in height from eight to fifteen feet. The stream at Harrison village is small, but being very constant in volume, is fully occupied by mills—grist-mill, wire factory, and lumber mills. Of more importance than the Songo is its largest tributary.

Crooked river. This enters Songo on the left, three miles above its mouth. We traced this river as far as North Waterford, and found it flowing through a sandy country, and abounding in gravelly shallows, evidently a favorite breeding ground of the salmonidæ. The waters of this river are much discolored by iron and peaty solutions. The volume is generally even, but occasionally dangerous freshets occur. Ten or twelve years ago several of the lower dams were carried away by an ice freshet. A rise of four feet is very unusual.

We collected no information about the ascent of this river by sea fish; but sufficient research would probably bring to light some traditions on that point, although the dams on the Presumpscot shut them all out many years ago. At the present time, the only fishery that is of value here is that of the Sebago salmon, and the information relative to it will be embraced in our remarks on that species.

We examined six dams, situated as in the table.

Miles from Sebago Lake.		Height.	When built.
55	Songo Pond source, . . .	–	–
42	At North Waterford, . . .	8 feet,	before 1807.
32	McWain's, (or Robinson's Mills,)	11 "	–
31	Holden's Mills, . . .	11 "	1831.
23	Bolster's Mills, . . .	9 "	about 1817.
20	Scribner's Mills, . . .	7 "	" 1844.
10	Edes Falls, ...	8 "	" 1827.

The distances given are those of the winding course of the river, the distance in a direct line from source to mouth being about thirty miles. Besides the dams examined there are seven enumerated on this river above No. Waterford. At Edes falls a stone dam of eight feet height, stops the ascent of any fish. A way might be constructed on either side of the river, but on the west side is the best pool for its foot to rest in. At Scribner's mills the dam is under a bridge. A fishway might be safely built against the east pier of the bridge, where it would be protected from floating ice, and rest in a deep pool. The best location for a fishway at Bolster's mills is on the west side of the river, against the wall of a carding mill. Both Holden's and Robinson's dams are much out of repair, very leaky, and encumbered with lodged drift wood. If these are put in good repair, fishways might be built—for the former at the east end of the dam, and for the latter at the west end, against the mill. If not repaired, holes should

be opened through them, for in their present condition they are serious obstacles to fish. The dam at No. Waterford is not very formidable, and when the water is high trout and suckers have been known to pass it. Yet if it were undertaken to stock the river, a fishway would be needed. All these structures should be firm enough to withstand the force of floods and floating ice.

Two other tributaries of Sebago lake, North West river and the outlet of Thomas pond, are of some importance, but we had not time to examine them.

The Presumpscot was originally peopled with salmon, shad, alewives and several other species. We have the testimony of Mr. James Lord, aged eighty-five, who lives near the Presumpscot falls, to their abundance. The salmon were practically destroyed by the erection of the dam at the head of the tide about 1802. That year they accumulated in unusual numbers below the dam in their attempts to pass it, and a great many were caught. At the present time there is no doubt that a few salmon run into the river each year; for they are occasionally taken. In 1866 four were taken with a dipnet at Presumpscot falls. The shad still run in small numbers as far as Cumberland Mills. Mr. Lord has fished for them with a dipnet at the falls, and took twenty-five large shad in one day seven years ago; but last year only twelve. A great many used to be taken in weirs at the mouth of the river. Alwives are more abundant: in 1864 or '5 twenty thousand of them were taken by one dipnet at the falls. Probably they breed in the dead water of the river. Yet it is a singular fact that last year numbers of them ascended the Duck pond stream as far as the works of the Cumberland Bone Company at the outlet of the pond. The mills occupy the whole stream, but at a slight expense a fishway might be made to let them pass into the pond without sensibly detracting from the power.

It would seem that the bright pure waters of this river are better fitted for salmon than the other species; and we think that efforts to restock it should have them first in mind. We regret that we were not able to ascertain by observation what extent of breeding ground for them is still left in the river; but, although the mill-dams have covered much of it with dead water, there is reason to believe that many gravelly rapids remain. It would not however be wise to confine operations to the Presumpscot proper, but to open Crooked river and other tributaries above Sebago lake where lie extensive breeding grounds. The shad would thrive through

all the gentle portions of the Presumpscot, could they be induced to pass the obstructions in sufficient numbers. There can be no doubt that alewives find somewhere in these waters congenial nurseries. They are not generally found breeding in such pure waters as those of Sebago lake, but if this should be found to be fitted to their wants, or if they could be induced to find their way through the lake into the many ponds which empty into it, the numbers that could be bred here are immense.

The opening of Crooked river to sea salmon would assist the Sebago salmon to recruit its thinned ranks. We could hardly expect from that variety such remunerative results as from one that would visit the sea for food; but probably it would be worth while to open this river for its sake alone.

Androscoggin.

Of the Androscoggin we can give only a meager report. The lower portion was visited as far as Lewiston, and the vicinity of Rumford falls examined.

The Androscoggin was a salmon river, and the salmon ascended as far as Rumford falls, breeding in the main river and in most of the tributaries. On the Little Androscoggin they were known to breed opposite Paris Hill, but their ascent was stopped by Snow's fall, two miles from West Paris. Lewiston falls were difficult, but did not prevent the passage of salmon. At Rumford, however, occurs a formidable cataract, quite impassable to fish. At this point, within one mile, the river falls 162 feet. One half of this descent, about 80 feet, is in one plunge at an angle of thirty or forty degrees, over a ragged ledge. The water rushes down with fearful velocity, and reaches the lower basin all white and frothy. The spray is scattered several hundred feet. This fall settles the point that salmon never reached the State of New Hampshire by this route. The last seen at this point were more than fifty years ago. One or two were then taken; but Mr. Joseph Hall, aged eighty-five, who has lived in this vicinity all his life, remembers no other instance. The tradition however prevails, that in former times they were very abundant at the foot of Rumford falls, and in Swift river, a tributary entering just below. At Lewiston salmon were caught as late as 1815. Col. Wm. Garcelon of Lewiston, recollects this fact; and also that the first dam built at Brunswick was a low one and did not prevent the passage of salmon; but that higher ones subsequently built entirely cut them off. At the

present time none ascend the river. Alewives used to breed in Sebattus stream; they too are exterminated.

The fishery now carried on in Merrymeeting bay and between that and the sea was examined in connection with the Kennebec, and will be referred to as belonging to that river; although a portion of the same should be placed to the credit of the Androscoggin; for the fisheries extend up the western arm of the bay into the month of the Androscoggin, and the tidal portion of the river furnishes a considerable number of shad.

The Androscoggin abounds throughout its whole extent in shallow, gravelly rapids. It is interrupted by few dams, and millponds have not destroyed the salmon's breeding grounds. The obstructions at Brunswick are two dams, one thirteen feet high the other twenty. On the lower one an excellent chance for a fishway is afforded by the protection of the island in the middle of the river. A fishway might be built against its north-eastern side, and be here sheltered from the destructive effects of floods and floating materials; the height to be surmounted would, moreover, be lessened to seven feet by building at this point. The upper dam is more difficult. The best location is near the north shore, in a natural cleft in the ledge on a small island. The work should be of the most substantial character and heavily covered to protect it from destruction by the floods.

At Lisbon is a dam sixteen feet high, with a good chance for a fishway over the unoccupied end.

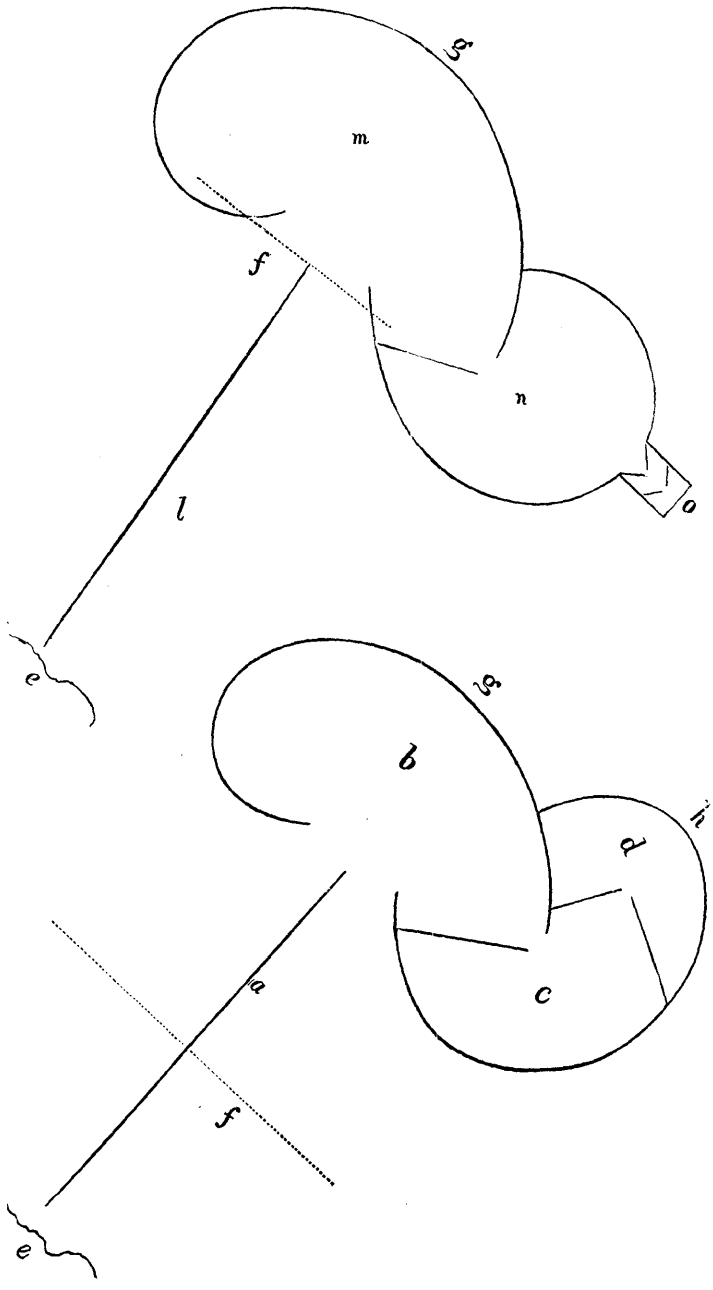
At Lewiston the construction of a fishway, although perfectly practicable, would be less easy than on the lower falls, and it might be deferred until the lower part of the river were stocked with salmon. Even Rumford falls may at some day be surmounted.

On the Little Androscoggin, below Mechanic Falls, are three dams, but the highest of them is only eight feet. At Mechanic Falls is a dam twelve feet high, affording power to an extensive paper mill. None of these are formidable.

With this brief and incomplete account we must dismiss the Androscoggin. It is a noble river, and so far as we have examined, promises an easy task and great results to the cultivation of salmon. It should be thoroughly examined hereafter.

Kennebec.

The Kennebec is formed by many tributaries of diverse charac-



RIVER FISH WEIRS.

ter. Some are the outlets of extensive systems of lakes; some are sluggish lowland streams, and some come down from the mountains. Among the former are the Cobbossee Contee, the Messalonskee and the Sebasticook; among the latter are the Sandy river and Carrabasset. It has itself a broad, gentle current for many miles before reaching the tide, broken, in its natural state, by few rapids; and its fresh waters rise and fall with the tide for thirty miles before they mingle with those from the sea. It is, therefore, well fitted, in some of its parts, to produce all the kinds of fish that dwell in this latitude. It has breeding grounds for salmon in its own bed, and in the most of its tributaries above Richmond, particularly in the Sandy, Carrabasset and Dead rivers, and in a multitude of small streams entering its upper portion; for shad in all the tidal portions, and the main river as far as they may choose to go, in the tidal tributaries like Cathance river, and in the Sebasticook and lower Sandy; for alewives in all those parts allotted to the shad, and in all the lakes and ponds to which they might be introduced.

The fisheries of the Kennebec are now carried on by means of weirs, drift-nets and seines. The weirs are of two kinds—the shoal water weir, and the deep water weir. We have illustrated both. The upper figure represents a shoal water weir. The "leader" (*l*) is a row of stakes, generally woven with brush, leading out from the shore. Its extremity is at the entrance of the "big pound" (*m*). The big pound is likewise of stakes filled with brush, and its entrance thirty feet wide. This leads by a passage five feet wide into the little pound (*n*), and this into the pocket (*o*), which is a frame about sixteen feet long and ten feet wide, with sides of netting, and a board floor. The fish following the shore meet the leader, turn and follow it into the big pound; here they follow the side around until they pass into the little pound, and from that into the pocket, where they are left by the receding tide and taken out at low water. The form of the enclosures leads the fish constantly forward, and they rarely or never find their way back through either of the passages. The line *e* represents the land or high water mark, and *f* is low water mark.

The lower figure represents a deep water weir: *e* is the shore line; *f*, low water mark; *a*, leader; *b*, "pasture;" *c*, round pound; *d*, fish pound; at *g* is ten feet depth at low water; at *h*, thirteen feet. This leads the fish constantly forward as does the other weir into the fish pound; but here they are not left by the tide but

must be taken out with a seine or purse-net. The round pound and the fish pound, and sometimes other parts, are made of netting.

The form of these, and the position of the different parts, is sometimes varied, but the figures show the general form. Of these there were built this year below Bath, 23; from Bath to Richmond, 37; total, 60. All those below Bath, except three, were shoal water weirs; all in Merrymeeting bay were deep water weirs, and in some cases were carried into deeper water than represented. Merrymeeting bay is made to include those of Abagadasset and Cathance rivers. Deep water weirs can only be built where the tide is sufficiently gentle to admit of the use of a seine in the fish pound. Hence so few on the lower Kennebec, where the tide is very strong.

These weirs are built as soon as the ice is out of the river, and fishing commences from May 1st to 10th. They are maintained until the last of June, rarely into July, and then are taken up and stored until the next season. On the lower part of the river, however, they are sometimes maintained through the summer, to catch menhaden, and various small fish for bait. But whenever the fishing is closed, the nets are removed from the pockets to save them, for in water they very soon rot. One season rots out that portion which is beneath low water.

The weirs described are called summer weirs, and are built above high water, being never covered by the tide. There is another class of weirs used in taking smelts. These are built lower, and are covered at half tide. In them the fish are never enclosed, until on the ebb the water gets down below the tops of the weirs. These are not kept in order during the ordinary fishing season, the smelt season not commencing until fall. Of these there are about seven on the Kennebec. Their average catch of smelts may be put at $300 or $400 worth yearly. In some locations they pay much better.

Of drift nets, many are used in the small rivers and near the sea, and several on the rapids at Augusta. We have learned of four seines used at present, two in Eastern river and two at Augusta.

The statement is very generally made, and it appears to be the fact, that the most of the shoal water wiers do not pay. The cost of building them is about $50 or $60. The average gross return is $300, or less. Then there is the value of labor, salt, &c. Many

of the shad are shipped fresh to Boston, where they bring from ten to twenty-five cents each, expense of shipping being one cent. The rest are salted, and then worth about ten dollars per barrel. The salmon are marketed fresh. The deep water weirs cost $300 or $400. One that yields $800 is thought to do a good business. They sometimes yield less than their cost, and their average may be put at not far from $600.

Of drift nets there were in Cathance river in 1866, fifteen; and the greatest number of shad taken that year by one drift net was 900; average, 400; but that was a very poor season for them. In Eastern river less were caught than in Cathance. The seines at Augusta during the past season made a total failure.

In estimating the value of the summer fisheries, we can only make an approximation, as it is difficult to obtain correct data. The owners of weirs are not communicative on the amount of fish taken. But the nearest estimate we can make is as follows:

From 20 shoal water wiers,	$6,000
" 40 deep water wiers,	24,000
" other sources,	4,000
Total,	$34,000

The number of fish caught may be roughly estimated as follows:

	Salmon.	Shad.	Alewives.
From 20 shoal weirs,	–	40,000	150,000
" 40 deep weirs,	–	160,000	1,000,000
" other sources,	–	25,000	50,000
Total,	100 ?	225,000	1,200,000

The fishing season of 1867 was an exception to the general average. While less shad and alewives were taken than the above estimates indicate, the number of salmon was greater than for any one of the last seventeen years. We think the following estimate is very near the truth:

Below Bath,	700 salmon.
Between Bath and Richmond,	430 "
In Augusta,	70 "
Total for 1867,	1,200 "

Of the value of the smelts and other kinds taken we have no estimate. The smelts are, however, of no small importance.

They are principally taken in weirs and in bag nets beneath the ice.

Touching the former abundance of the fish, we have the testimony of sundry persons. Mr. Ezra W. Emmons of Georgetown, sixty-nine years of age, has always lived on the Kennebec, and been familiar with its fisheries. He says that fifty years ago there were twice or three times as many weirs as now. At the same time there were a great many set-nets, and as many salmon were taken by them as by the weirs. A Mr. Emerson fished with a weir, and one year, for several days in succession, took 6,000 or 7,000 shad each tide. The salmon used to average forty-five each tide.

There were inspected of shad caught in the three towns of Bowdoinham, Dresden and Woolwich, during several years, as follows:

1830,	802 barrels,	1834,	926 barrels,
1831,	1833 "	1835,	900 "
1832,	659 "	1836,	346 "
1833,	620 "		

Mr. John Brown of Bowdoinham, the inspector, says that seven-eighths of those caught were inspected. This would indicate a yield of 1,000 barrels, or 120,000 shad in that district each year. There were only two weirs in Merrymeeting bay at that time, and a few in Eastern river, &c., all shoal weirs. The most of the fishing was done with drift-nets in the small rivers like Cathance, and with four or five seines; most of the people only fished for their own supply, and sold the surplus. At the present time, in the same district, forty deep water weirs, several seines, and a large number of drift-nets take about 180,000 shad. Few salmon were taken in this district.

In Eastern river, thirty years ago (says Mr. David Burke), there was eight or nine weirs, each of which took 6,000 or 8,000 shad and 100 barrels of alewives per year; and about the same amount was taken by seines and drift-nets. This indicates, in this river alone, a catch of 100,000 shad and 640,000 alewives per year. In 1846 one seine took 4,719 shad; in 1847, 3,319; and in 1852, 2,500.

At Augusta, Mr. William Kennedy estimates the number of salmon taken in 1820 at 4,000. There were twelve drift-nets engaged in the fishery. The year that the Augusta dam was built, Mr. K. caught more than usual, namely, 500; but from that time

the fish immediately fell away, and very soon the yield was only twelve per year. In 1866, fishing with a seine, he only took two salmon. In 1822, in one day, a seine was known to take 700 shad. About 1857 a seine took yearly 3,000 shad and 20,000 alewives. In 1867 the fishery was a total failure.

Charles Hume of Augusta used to fish at Waterville with a drift-net from 1830 to 1837, and took 150 salmon yearly. But he says the fishing at that place had been falling off for many years. Total catch at Waterville, 2,000 salmon. In 1838 he came to Augusta, the dam being built, and that year caught 300 or 400 salmon. From this time they in a few years declined to fifteen or twenty yearly, and after 1850 to four or five, and some years none. Salmon used to be brought down to Augusta from Waterville and sold at four cents per pound, but the price at the mouth of the river was six cents.

Mr. William Getchell, who owned the small island in the middle of the river at Ticonic falls, Waterville, and fished there with a dip-net from 1804, used to take $500 or $600 worth of shad and alewives annually. With his three boys he had taken 1,100 shad and twenty salmon in an afternoon. One day four men, of whom he was one, dipped out and boated ashore 6,400 large shad. The most of the salmon fishing was with drift-nets below the falls. Mr. Getchell had counted eighty-two of these nets, each employing two men with a canoe, fishing at one time. He estimates the average at forty canoes, and that each took three salmon a day. This gives 4,800 salmon in forty days' fishing.

From Samuel Philbrick, Esq., of Skowhegan, we learn that there were many salmon and shad caught at that point, although the falls were not favorable for fishing, and nearly all the fish passed by. The fishing here was with dip-nets, and a man would not generally dip more than twenty shad in a day. A trap set for salmon, in 1808, and several years after, used to average six salmon a day. At Carritunk falls there was better fishing, and it was easy to load a boat with salmon in a day.

Col. Christopher Thompson of Emden used to fish at Carritunk falls. The greatest catch he ever knew with a drift-net was sixty in one night. The year when the Augusta dam was carried away he and his brother caught thirty.

We have many more statements, but these will suffice. To show the extreme difficulty of arriving at a reliable estimate of the former produce of the river, we will make two calculations on the

number of salmon taken in 1820. In the first place, take Mr. Kennedy's estimate, that in that year were taken in Augusta 4,000. In 1867 the whole number taken in Augusta was 70, and in the whole river 1,200. By proportion we have 70 : 4,000 :: I,200 : 68,571. This indicates 68,000 as the produce of the river from Augusta down. Now take Mr. Emmons' estimate that there were about 60 weirs below Bath at that time, and that they used to average 45 salmon a tide, or 90 per day. Assuming 40 days as the length of the fishing season, 3,600 were taken by each weir, or 216,000 in all.

The last estimate may seem very large, but it is by no means incredible, when we compare it with the yield of some European rivers. The Tay, for instance, in Scotland, draining a basin not one-third as large as that of the Kennebec, produces to its proprietors a yearly rental of £15,000 ; and that portion between the Isla and the sea has in some years yielded over 100,000 salmon. The river of Galway, of smaller size, draining about one-ninth as large a basin as the Kennebec, yielded in 1864, 20,512. In 1866, 31,000 salmon taken in the harbor of St. John, were sent fresh to Boston. Of one thing we feel assured, that long before the Kennebec was closed with dams, its course was so encumbered with weirs that a small part of the salmon could reach the breeding ground.

Of shad and alewives we cannot form an estimate ; but the quantity was greater than that of salmon. 3,000 barrels are estimated to have been taken in the Sebasticook at Clinton yearly.

CHART OF KENNEBEC RIVER.

Western Tributaries.	Miles from Sea.		Miles from Sea.	Eastern Tributaries.
Moose river; sluggish; black water; unobstructed,	162		164	Roach river.
	154	Moosehead lake driv. dam.		
	146	Indian pond driving dam.	147	Indian stream, current various; water clear.
Chase's stream, rapid, 5 driving dams,	142			
Dead stream, cascade at mouth,	141		138	Black stream, very rapid near its mouth; driving dams.
Cold stream, rapid, 3 or 4 driving dams,	135			
Dead river, 15 miles rapid; 25 miles dead; Grand falls 28 feet high, 15 miles from mouth,	132		134	Moxie stream, cascade 52 feet near its mouth.
Pierce pond stream, very rapid and impracticable,	125		125	Pleasant pond stream, crystal water; 1 mill dam, 1 driving dam.
Carrying Place stream, rapid,	119			
Houston brook, rapid; cascade 2 miles from river,	114		111	Austin stream, rapid; 1 mill dam, 1 driving dam.
	104	Carratunk falls; natural, 16½ feet.		
			103	Fall brook, 6 mill dams near its mouth.
Carrabasset river, rapid and gentle; gravelly and stony bed; clear water; 3 dams to Kingfield, 2 above,	96			
	91	Madison; dam. Former limit of shad.		
Sandy river, rapid and gentle; bed varies from ledge to sand; 3 dams to Phillips, several above,	89		76	Wesserunsett river, 6 dams to Brighton, 2 to Madison lake.
	78	Skowhegan falls, dam 13 ft.	70	Sebattus creek.
	65	Somerset Mills, dam 9 ft.	59	Sebasticook river, mostly gentle or sluggish; drains 25,000 acres of lakes; to Newport lake, 34 miles, 5 dams; on west branch to Moose lake, 3 dams; on 25-mile stream to Unity lake, 2 dams.
	63	Kendall's Mills, dam 7 ft.		
	60	Ticonic falls, no obstructions.		
Messalonskee stream drains 23,000 acres of lakes, rendered inaccessible by a cascade of 30 feet,	58		49	Seven mile brook, drains several lakes and ponds; 3 dams.
	43	Augusta, dam 16½ feet.	35	Worromontogus stream, 3 dams.
Cobbossee stream drains 13,000 acres of lakes, 8 dams within one mile of its mouth,	36		33	Nehumkeag stream and pond.
			24	Eastern river, tidal.
Abagadassett point,	20	Merrymeeting bay.		
Abagadassett river, tidal,	19			
Cathance river, tidal.				
Androscoggin river.				
Winnegance creek,	10		4	Back river.
		Atlantic ocean.		

The Kennebec issues from Moosehead lake a broad, shallow river of dark water. Its current is rapid, over a bed by turns ledgy and stony. After passing through a sluggish expansion called Indian pond, it falls rapidly away from the level of the surrounding country, contracts its channel, foams over a few low precipices, and then flows swiftly through a deep and narrow channel between steep and lofty banks to the Forks. In this part of its course there are few gravelly shoals. The water has swept the ledge very clean. At the Forks the lofty banks recede a little, a narrow strip of interval appears, and the river spreads out over a stony bottom. Dead river now enters, increasing the amount of water one-quarter, or at some seasons one-half. From this point to Skowhegan the river flows over a stony and gravelly bed, occasionally interrupted by ledges and falls, at a rapid rate. In May it flows not less than six miles an hour. The high banks recede gradually, and are soon broken down; and by the time the river reaches Anson it is flowing through a gently undulating country. From the west come in the Carrabasset and Sandy rivers, both mountain streams, varying more in volume than any other tributaries, bringing in much clearer water than the Kennebec. From Skowhegan to Augusta is a great deal of dead water, caused by the dams; but there are rapids between Kendall's Mills and Waterville, and in Vassalboro. Just below Waterville the Kennebec receives, on the west the waters of Messalonskee stream, draining the Belgrade lakes, and on the east the Sebasticook river, which in the summer adds more to its volume than any other tributary. This was the principal alewife river. At Augusta the tide is felt, but the current is not reversed for some miles further down. The gravel that has been washed down by the river lies in beds as far as Hallowell. Eighteen miles from the sea the Kennebec and Androscoggin unite to form Merrymeeting bay. At this point the water is usually fresh; but when the rivers are low it is brackish as far as Richmond.

The course of the Kennebec is interrupted by several natural falls.

Distance from sea, miles.	
144	Nameless, 14 feet, nearly perpendicular.
104	Carratunk falls, 16½ feet, perpendicular.
89	Norridgewock falls, limit of shad and alewives.
77	Skowhegan falls, passable.
60	Ticonic falls, passable.

The two lower falls were passed easily by alewives, salmon and shad, but not by smelts, bass or sturgeon. At the Norridgewock falls the shad and alewives turned aside into the Sandy river. Salmon are known to have passed Carratunk falls, and have been seen in the Dead river. The upper fall on the Kennebec is very difficult; but it is reported on very good authority that salmon have passed this, and been seen about Moose river.

The fact that salmon passed Carratunk falls is worth examining. At this point the whole Kennebec rushes down over a precipice sixteen and a half feet into a deep chasm several hundred feet long and less than fifty feet wide. The depth of the chasm is unknown. Logs more than fifty feet long go down end first, disappearing with great velocity; but they are never heard to strike bottom, and after a long absence reappear, generally, it is said, the same end uppermost that disappeared first, and leap into the air, or standing upright one-third or one-half submerged, go whirling down the chasm. Those who have witnessed the ascent of salmon, say that one was first seen to leap several times a few feet out of water a little way down the chasm. He was then seen to emerge from the water a few feet from the fall and obliquely towards it, with such velocity as to rise twelve or thirteen feet through the air, and strike head first the face of the falling water at that height. If he struck the water in a line with its motion a sort of hesitancy was observed, and then in a moment he moved forward and over the crest of the fall; but the least deviation from a true line sent the fish backward to try again. The same salmon (known by a mark on his back,) was seen to try to leap the fall six times unsuccessfully, and succeed at the seventh attempt. Some observers thought that about one in three succeeded in passing. It would seem that this feat must require the utmost strength of a salmon, and perhaps only the strongest would succeed. Besides this main channel there were two smaller passages, one on either side of the river, where it is said salmon sometimes ascended, and where they were taken by dip nets. One hole is pointed out where nine salmon were once taken at a single dip. The eastern passage might be converted into an easy fish-way, if the main fall should prove too difficult.

The passage of Carratunk falls was evidently rendered possible by the great depth of water from which the salmon could spring into the air, acquiring momentum enough to carry them two-thirds of the way up, and by the thickness of the falling sheet, which

gave them room to swim after striking. The fall above the forks is of a different character. It is not quite so high, but lacks the deep pool at its foot. At the time of our examination in September it was impassable; but a heavy body of water, such as flows in May, might so alter its character as to render it practicable to salmon. There are several other falls on the upper part of the river, but as none are more difficult than Ticonic falls they are not specified. Besides the natural obstructions mentioned, there are on the Kennebec six mill dams and two log driving dams. They are as follows:

Distance from sea, miles.	Location.		
154	Outlet of Moosehead lake,		driving dam.
146	Foot of Indian pond,		do
91	Madison Bridge,	mill dam,	passable with high water.
78	Skowhegan,	do	impassable.
65	Somerset Mills,	do	passable with high water.
63	Kendall's Mills,	do	do
60	Waterville,	do	no obstruction in 1867.
43	Augusta,	do	impassable.

The dam at Augusta is the most formidable of these. It creates a head of nearly seventeen feet. It is quite insurmountable by any kind of fish. The few salmon and alewives that have been seen above Augusta since its erection must have passed through the lock. A fishway was constructed over the dam some years ago under the supervision of the County Commissioners. It was located at the west end of the dam. Considerale expense was laid upon it, but through some fault in its construction it was not capable of withstanding the force of floods, and of the floating logs which always accumulate at that end of the dam. The first freshet racked it badly, and opened such seams in its cemented bottom that the water wasted before it reached the foot of the fishway. Another freshet completed the work of destruction. The structure, therefore, never had a fair trial. We think, however, that the grade was too steep, and the water too much broken to answer the purpose. A better situation is on the east end of the dam, against the wall of the lock. The current does not draw the logs and ice in here as at the west end; and from whatever floating material may threaten, it may be protected by a breakwater of timber, such as is now built there to protect the wall of the lock. In case the dam is raised three feet, as is anticipated by the proprietors, the fishway will have a foundation ready built for two-thirds of its length. It should not be less than 150 feet long, and about 14 broad, running directly down river along side the lock and the long pier. Its walls should be built of squared tim-

ber, and present a smooth, solid face to the water, with no holes nor crevices into which a log might thrust itself and pry the structure to pieces. It should be heavily covered in, the cover sloping like a roof toward the middle of the river, to slide off any ice or timber that might come down upon it. It should be so bolted down, or ballasted with stone, that there should be no danger of its floating away. The cost may be estimated at about $2,000. If properly constructed, we see no reason why a fishway here should not be a success. It is very certain that it can be made to stand. It is equally certain that it can be so made that fish can pass up if they choose.

The present dam at Waterville only extends to the middle of the river, leaving the eastern side open and nearly in its natural shape. A new one is, however, in contemplation, which will cross the river farther up. This will doubtless require a fishway.

The dam at Kendall's Mills is of timber, about seven feet high. It is in very bad condition, and expected yearly to be carried away by the freshets, in which case a more stable structure will be put in its place. At present there is all summer a stream of water running around the east end of the dam where it abuts upon a ledge, which, in a high state of the river, is sufficient for the passage of salmon. On the 28th of June this year it appeared to be ample. At any rate a small outlay would render it sufficient at all seasons. Built in 1836. The dam at Somerset Mills is nine feet high. It is in better condition than that at Kendall's Mills; but it has a similar gap at the east end, through which a great deal more water flows than is necessary for a fishway; but it needs to flow in a more compact body, which could be easily effected. Built in 1834. That salmon actually pass these two dams is a fact. They have occasionally been seen above them, and during the last season several were taken at Skowhegan.

At Skowhegan is an impediment nearly equal to that at Augusta,—being quite impassable. The total fall is about 13 feet. An island occupies the middle of the river, and dams are built from this to either shore. The south channel was closed by a low structure as early as 1810, but the north or left channel remained in its natural condition until about 1847. The best location by far for a fishway is at the island end of the south dam. It would here be sheltered by the island, secure from the freshets. The conformation of the channel is such, that all floating logs and ice are

carried heavily against the south shore, requiring a strong boom to sheer the logs back into the channel.

At Madison bridge we find a wasteway around the west end of the dam, in an old mill race, which allows the passage of fish except in drought. It can with little expense be made to suffice.

The only obstructions that remain to be noticed are the two log-driving dams on the upper part of the river. These are employed to regulate the flow of water during the driving season, May and June; and at other times that at the outlet of the lake performs the office of a reservoir-dam for the mills on the lower part of the river. They are built of wood, and form series of gates. That at the lower end of Indian pond has twenty gates, each seven feet wide, and a rollway or log-sluice fifty feet wide; the water drops through the gates about ten inches, slides in a very thin sheet across an inclined platform eleven feet, and falls three feet into the pool below. This examination was in September, when the water was low, and the rollway dry; and the total fall was about five feet. It was practically impassable, and would be a serious obstacle to salmon, although when there is more water the ascent may be possible.

The dam at the outlet is a less serious obstacle than the above, and in an ordinary stage of the water would be easily passable through the sluice; but in September the sheet of water even in the sluice was too thin. The difficulty in both these dams might be easily remedied.

The *Cathance* and *Abagadassett rivers* are small tidal creeks, and have no dams that require attention. Eastern river is nearly of the same character, but has a stream entering it in which it is thought that salmon may have spawned, now shut up by a dam at the head of the tide; and another coming from a pond where alewives might breed, also now closed.

Worromontogus stream drains several ponds in which alewives used to breed—now obstructed by several dams.

Cobbossee-Contee stream is a second-rate tributary, draining 21 ponds with a water surface of 13,000 acres. It must have been an excellent breeding ground for alewives. We know that at a very early date salmon and shad ascended the stream, as well as alewives. But these waters were long ago closed by a dam at Gardiner. In the old records of the town of Monmouth, then called Wales, we find that in 1787 a "fish committee" was chosen, consisting of three men; and in 1788 they are styled "Committee to

see that the fishways are kept open according to law." They were appointed as "Fish Committee" each year until 1806, when they cease to be mentioned. Winthrop for several years appointed a committee to obtain the opening of a fishway through the dam at Gardiner. But they were unsuccessful: reporting on one occasion that Squire Gardiner refused to do anything about it. The stream is now obstructed by dams at Gardiner to such an extent as to render the opening of the upper waters to fish a considerable undertaking. There are eight dams within one mile of the Kennebec, and they are generally high. There are ten dams to the first lake, and most of the others are cut off by them.

The *Seven Mile brook* is a very important stream, although in size only third rate. It drains several ponds, and these formerly produced great quantities of alewives. The fishery has been regulated by six different acts. There are several dams on the stream which would require fishways should the alewives be restored.

Sebasticook.

The Sebasticook is a tributary of the first rank. It is the outlet of many lakes and ponds of which the principal are China lake, Unity lake, Moose lake and Newport lake, having an area of 4000 acres each. This characteristic rendered it principally an alewife river, and of those fish it produced immense numbers. It also yielded a great many shad, and some salmon. The most fish were taken in the town of Clinton, now Benton, and the town was vested with the right to take the fish by their agents, a fish committee, subject to certain conditions. They were to distribute a certain number gratis to the poor, and then sell to the inhabitants at a set price, and finally could dispose of the residue as they saw fit. Great quantities were sold to strangers, the ordinary price being twenty-five cents a hundred. Newport also had full control over the fisheries in that town. There were free fisheries on all other parts of the river and its tributaries. Indeed the fisheries were all free until a falling off in the supply warned the people that there must be some regulations. On this point we have the testimony of Mr. Beriah Brown of Benton, now 78 years old. Seventy years ago he followed the man who took the fish. Also of Maj. Japheth Winn, who has lived at Benton fifty-five years. The tributaries of the Sebasticook were very early obstructed by dams through which in most cases inefficient fishways were left—generally a mere gap, or a pile of stones; and the number of the

fish had been falling off for many years before the town of Clinton assumed control of its fisheries. The dam at the upper falls in Clinton was built before the war of 1775, but a gap for fish was left in it. About 1809 a dam was built at the lower falls twelve feet high, with no fishway. It stood five or six years, and in that time had so impoverished the fisheries that the selectmen cut it away, and allowed the fish to ascend to their breeding grounds. The town in 1814 obtained the act anthorizing them to control the fisheries, and the first year after cutting away this dam the fishery was leased for two or three years to one James Ford, he agreeing to pay yearly 200 fish to each man, woman and child in Clinton, and to sell as many more as should be wanted at a set price. From this time the fish increased again rapidly and the town began to sell the fishery yearly at auction. The price obtained varied from $500 to $1200 or $1500; the purchaser being bound to distribute gratis to the poor and sell to all townsmen at a fixed price. The year of the closing of the Augusta dam the fishing sold for $225. One or two years before for $500.

Mr. John Holbrook, 65 years of age, has lived in Newport all his days. Within his memory alewives came here in great numbers, with a few shad and now and then a salmon. Forty-five years ago they were not so plenty as formerly. Thirty years ago they began to diminish rapidly, and in a few years were entirely gone.

The obstructions on the Sebasticook now existing are six dams, situated as follows:

From Kennebec, miles.	
34	Newport pond, outlet.
34	Newport Mills; built before 1837.
29	Detroit, 7 feet; built about 40 years ago.
10	Clinton, 5 feet.
5	Benton—upper falls, 8 feet; built before 1775.
4	Benton—lower falls, 5 feet; old dam, 1809; new, 1847.

The dam at Benton lower falls has a sluiceway twenty feet wide and three feet deep, near its west end, which was not closed during the last season until the 20th of June. With a suitable arrangement of the plank this might answer for the passage of fish. Over the upper dam a way might easily be constructed at the east end by bolting down some timbers and blasting a short passage out of the ledge. At Clinton and Detroit the task would be easy,

but they must be guarded against ice. At Newport the milldam would require a fishway, but presents no difficulty. The dam at the outlet hardly hinders the passage of fish. The river was not examined above this point, although the alewives used to run as far as Stetson pond.

Of the branches, we examined the Pittsfield branch as far as Moose lake or pond, the Twenty-five Mile stream,—and have gathered some information about others. The west branch from Moose lake has three dams, one at Pittsfield and two at Hartland, neither of which presents any difficulty in constructing fishways; all three would require them. At Hartland there has been a dam 67 years, but as long as the alewives came there was a hole left for them to pass into Moose lake. Into the latter runs Main stream, crossed by several dams which were not examined.

The Twenty-five Mile stream is the outlet of Unity lake. Near its mouth in the town of Burnham is a dam built 35 years ago, 12 feet high. Seven miles up the stream is another dam, and beyond that Unity lake. Tributary to Twenty-five Mile stream is Sandy stream, of rapid flow, obstructed by two dams.

The streams draining Lovejoy's and Pettie's ponds are obstructed each by one dam. The latter has a dam which has stood without a fishway for 60 years. The stream draining Plymouth pond has four dams. The Vassalborough stream is much obstructed, but was not examined.

All the lakes and ponds of Sebasticook river are admirably adapted to the breeding of alewives. The restoration of these fish would be a comparatively easy matter. Plenty of the live fish or their spawn can be obtained at Augusta or below. The construction of ten fishways would give them access to the three largest lakes with a surface of 10,000 or 12,000 acres. If undertaken on the right scale and perseveringly carried forward great return might be expected in a few years. Abijah Crosby of Benton, was an enthusiast on this subject, who might have accomplished much had he been supported by the public opinion. He went so far as to introduce live alewives to Pettie's pond, Unity and Newport lakes; they bred there, the young fish were seen going down the stream, and some of them caught; fishways were built over several of the dams on the Sebasticook, and had that built at Augusta proved a success, the alewives would now have been again established in the Sebasticook river.

Messalonskee.—This is the outlet of the Belgrade lakes, which

have a water surface of 23,000 acres. The stream is occupied by nine dams, and there are others on the upper waters. But the lakes have not been accessible during the present geological age, owing to a precipitous fall of nearly forty feet at West Waterville.

Wesserunsett.—On this river are six dams, and on the branch which drains Madison lake are two more. Not examined.

Sandy.

This is one of the mountain streams. "Thunder-shower" rivers they are appropriately called. The Sandy sometimes rises in twelve hours as many feet, and causes great destruction by sweeping away dams, mills and bridges. Its upper waters are clearer than ordinary, and it maintains through its extent a greater transparency than the Kennebec.

The Sandy river has very little dead water. Its sources are in a granitic region, and for some miles it is leaping over ledges and boulders. At Phillips its bed becomes stony, then gravelly, and when it reaches Farmington it is sandy. From New Sharon down there are many miles of pebbly rapids. In the lower part is a good deal of gentle current. Through a great part of its course it is winding through a sandy interval, where both its banks and its bed are constantly shifting. This is particularly the case in the town of Farmington. Altogether it has a great many miles of spawning ground for salmon, and but a limited extent suitable for shad or alewives. Both the latter however came into the river, and ascended as far as Farmington. The alewives appear to have bred in Temple pond. The salmon went much farther. The lower part of the river maintained an excellent shad fishery. Salmon were taken at various points with spear and net. Mr. John Tibbets of New Sharon used to set a net for them, and had taken three while getting his net into the water. From several others in New Sharon we have information to the same effect. Seventy years ago they were plenty in Strong. But in 1804 the New Sharon dam was built. This stopped shad and alewives, but a fishway is said to have been maintained for a few years which permitted salmon to pass. A few years later another dam was thrown across the river nearer its mouth, and the fishways were no longer maintained. It is probable however that in high water the salmon could still pass all the obstructions, for Mr. David Hunter of Strong took a salmon there only forty years ago. Into its mouth and lower tributaries they still came. In Sawyer's stream, in

Stark, they spawned in great numbers. Mr. Levi G. Sawyer has seen and taken many of them there, but only in the fall and winter. In October they came, and were seen spawning; and sometimes were observed through the ice. They were diminishing for several years before 1837. That year Mr. Sawyer took two, and they were his last. A salmon weighing 22 pounds was caught in this stream.

The extensive gravelly rapids of the Sandy river fit it peculiarly for the production of salmon. The only drawback is the fact that in some parts its bed is occasionally shifted by the floods. Making all allowance for that, however, we shall still find an abundance of spawning ground for them. Shad and alewives also will be able to breed here as well as of old.

The obstructions that we have examined are the three dams at New Sharon, Farmington Falls and Phillips. There are no others in a distance of fifty miles; but above Phillips are several that we did not see. The dam at New Sharon is only seven feet high, yet it is rather difficult. There is no location for a fishway which will not be exposed to all the dangers of floods. Probably the best place is near the south end, but it must be well covered and heavily ballasted. At Farmington Falls is a dam seven feet high. The difficulty here, as at New Sharon, is the danger from freshets. The ice sometimes jams below the dam and endangers the whole structure. A fishway might be built alongside the sawmill on the south side. It must be very firm. At Phillips we apprehend less trouble, for although the height of the fall is not far from twenty feet, the ledge assists us. By blasting, a fishway can be easily made, where the water runs down in a crooked channel on the west side of the river.

Of the tributaries of the Sandy, we can speak of several. Sawyer's stream in Stark, a salmon stream, has two dams, and at West Mills a natural fall of 30 feet. Muddy brook, incorrectly named, the outlet of Clearwater pond, of unsurpassed purity, has four dams; Little Norridgewock has two. Wilson stream in Wilton has in twelve miles eleven dams: it was once frequented by salmon and alewives. On Temple Mill stream was built in 1783 the first mill in that region, at Walton's Mills. Many barrels of alewives were taken at the tail of this mill. The stream is now obstructed by four dams. Fairbanks stream has only one dam, near the river. The northeast branch has three. All these tributaries and many smaller ones which have not been noticed contain

spawning ground for one species or other, and some of them may be advantageously opened when the river is.

Carrabasset.

This is similar to the Sandy river. Its source is among the mountains, and it is subject to very sudden variations in volume. It has the same clean, stony, gravelly and sandy bottom, over which the water glances with a shallow current. But it is more transparent, and has even less dead water. It is eminently a salmon river, and we obtained no tradition of shad or alewives ever having visited these parts. As early as the month of June the salmon ascended the river to Kingfield, or farther; and they have been seen spawning near Salmon village, thirty miles from the Kennebec. At various points on the Carrabasset salmon were taken by spear and dip-net. Maj. C. Steward of North Anson remembers when "tons" of them were caught at that place. At New Portland so many were sometimes taken that only the bellies were saved, the rest of the fish being thrown away. They disappeared from the river; but during the year when the Augusta dam was carried away, they ascended again to Kingfield, and twenty were taken at North Anson village. There is no serious obstruction below Kingfield. The mill-dam at North Anson does not cross the river, and, as we saw it in June, was no hindrance to salmon. Another dam at New Portland falls would require a little attention. In June there was a gap near the centre of the river which would allow the passage of fish if the water were high, but in September this was closed, the water being low. It could be easily arranged to pass salmon without wasting water. At Kingfield there is a low dam which might be passable in a flood, but at other times would require a fishway. It might be a very simple structure, but special pains should be taken to make it firm. Above Kingfield, on the north branch, are no dams. On the south branch there is one dam of ten feet at Oliver's mills, with a good chance for a fishway against the mill on the left side of the stream. At Salem village is another dam, where a fishway would be required if it were thought desirable to carry salmon above this point, which is doubtful.

There is in the Carrabasset a great extent of breeding ground, and it ought to produce a great many salmon. The work of opening it would be little, and it should be among the earliest opened after the main Kennebec.

It has several tributaries that were examined. Emden stream, the outlet of Emden lake, has very pure water; it is dammed at the outlet and again at its mouth. Fishways might be constructed if after the Carrabasset were opened it should appear desirable. On Gilman stream there is a new dam erecting, which will prevent the passage of fish. The greater part of the stream is muddy, and little fitted for the breeding of salmon. On the upper portion, in Lexington, there is better ground, but several dams. Not very promising. Lemon's stream, at West New Portland, is not adapted to salmon.

Between the Carrabasset and Dead river there are, on both sides of the Kennebec, several third and fourth rate streams, but none of large size. They are all rapid, and come tumbling down into the river from high land, which here approaches very near the Kennebec. On the west side particularly there is a steep descent, down which the water rushes with fearful velocity. Pierce pond stream is said to descend 900 feet in three miles, and when a drive of logs is coming down its violence is fearful, snapping and splintering the heaviest timber, and sweeping the stones and gravel of its bed out into the Kennebec, where it blocks the channel, and is forming a new rapid. Those streams on the east side are less impetuous, and the larger ones, Fall brook, Austin stream and Pleasant pond stream, are under the control of mill-dams. The purity of their waters is worth going far to see. Pleasant pond is famous for its trout, and the stream which conveys its waters to the Kennebec is so transparent that it is difficult to imagine anything more pure. There are several smaller rills of the same character. All of these tributaries are naturally suited well for the breeding grounds of salmon, and some of them are still available for that purpose.

Dead River.

This is very commonly known as the "West Branch" of the Kennebec, as the place of its entrance into that river is called the "Forks," the main Kennebec from the lake to the Forks being known as the "East Branch." The Dead river, however, has never so large a volume as the main river, and in the summer season is sometimes only a quarter as large. Its character, too, is different; for while the Kennebec above the Forks is generally narrow and deep, with ledgy shores, interrupted by occasional falls and near the lake by broad eddies, the Dead river for 15 miles

is very uniform in its character, constantly falling over a broad bed of boulders and gravel. From the Forks to Grand falls the current is at no place too rapid to pole a boat against, but the numerous boulders prevent the use of boats. Above Grand falls the character of the river justifies its name; there are only two rapids in 25 miles; it pursues a serpentine course through richest meadows. Its head waters are, however, among the hills and have the characteristics of all hill-streams.

The salmon has a namesake here in "Salmon stream," the first large brook above the Forks. The story is, attested by several witnesses, that salmon were seen lying in great numbers at the mouth of this stream, whence its name. Very likely there was an eddy here once, but the furious torrents that drive timber out of the stream have also driven a bed of gravel and stones into the river. Mr. Luther Moore, who has lived at Bingham 78 years, says that salmon used to run above the Forks on the East Branch ten miles, and on the West Branch sixteen miles. That would just carry them to Grand falls on the Dead river, and to the only difficult fall on the main river. We see no reason to doubt that salmon ascended on Dead river to Grand falls, and found many spawning grounds on the way.

Grand falls was examined in September, and the low stage of the water allowed a careful survey. The whole river falls over a precipice 28 feet 6 inches, upon a ledge, and thence slides into a pool of no great depth. But even if the depth of the pool were equal to that at Carratunk falls, no fish would ever be able to scale a wall of water 28 feet high. If it is found that there are sufficient breeding grounds to warrant on the head waters of the river, a fish-way may be constructed here, but that is a question for the future.

The only tributaries of consequence entering below Grand falls are on the north side; for the watershed on the south side is very near the river. There are four streams from which timber is driven, and each of which has one driving dam, and several of a smaller size. All would afford some breeding ground. The largest is Spencer stream, which abounds in trout.

Above Dead river are two large streams on the west side, and three on the east. Cold stream has a volume equal to that of the Cobbossee stream at Gardiner, and at the point where we crossed it, was rippling over an even bed of small boulders. Promises well. It is a good trout stream. Moxie stream is chiefly remarkable for a cascade 110 rods from its mouth, which prevents the ascension

of fish. A plumb line measurement gave its total height 52 feet—46 feet in a single plunge. Our information regarding the tributaries in this quarter, as well as most of those on the Dead river, was obtained from Prescott Williams, trapper and guide, at the Forks. A few points were personally inspected. There is some available breeding ground on them.

Tributary to Moosehead lake are eighteen rivers and large brooks, of which we have minute descriptions from Edw. G. Masterman, hunter and guide, of Greenville. Fourteen of these are of sufficient volume to float timber, and have been used for that purpose. They are in general more gentle than those streams entering the upper Kennebec and lower Dead river. Nearly all have gravelly bottoms, but they drain a large extent of boggy land, which colors their waters of various shades of red and brown. The color of the lake, indeed, suggests that of its tributaries. All of the larger, if we except Soccatean stream, are very dark. The lightest are Lily bay north brook, and the two Squaw brooks. These tributaries are not much encumbered with driving dams. Roach river has more than any other—namely, three. Lily bay north brook and Tomhegan stream have one each, and Soccatean stream has none. Moose river has but one, and that is out of repair. We cannot but think that if salmon should reach Moosehead lake they would find in these tributaries a great extent of secure and productive breeding ground. That salmon will pass through a body of standing water and enter its tributary streams, is well established. Witness the Galway fisheries in Ireland, where the entire brood must pass through Lough Corrib. As to the fact of their ever having traversed Moosehead lake, there might be some doubt; but we have from Wm. Atkinson, Esq., of Emden, the fact that Solomon Russell, while trapping on the upper waters of Moose river, saw a large number of salmon there. John Wilson, father of Rev. Jesse Wilson, of Anson, often saw them in Moosehead lake.

Moose River.

Moose river is the only tributary of the lake that we examined. Its current, with occasional interruptions, is sluggish. It is a common saying among the inhabitants, that it runs up on one side and down on the other. It is navigable for sixty miles by canoes, with a few carries. The water is very dark. In the deep, still reach at its mouth it has an intense, inky blackness. At any place on the river it is difficult to see bottom at the depth of three feet.

There is a great deal of boggy land along the shore, and the tributaries coming in through this are dark, although their sources are in some cases the clearest of spring brooks. Trout flourish in these waters, notwithstanding their blackness, and there is good reason to believe that of salmon they would prove very productive, if that species should ever reach them. The long reach of dead water at the mouth of the river would not be very inviting, but we question whether it would discourage the ascent of salmon native to the river. It would be well worth while to breed them in some suitable brook on the upper waters, and see whether they would ever return from the ocean. The head waters of Moose river are among the mountains, and as far as possible removed from sluggishness. Concerning these, and all the tributaries, we received much information from Thara Adams, hunter and trapper.

We travelled by canoe from the settlement at Moose River bridge to Moosehead lake, a distance of thirty miles. There are five or six miles of rapids, mainly between Long pond and Brassua lake. The river bed is here full of boulders, with now and then a gravel bed. Sometimes the ledge appears. The canoe had to be taken out of the water only at one point, namely, at the old dam below Long pond. This dam is the only one on the river, and is now in ruins, presenting no hindrance to the passage of fish.

The banks of Moose river all along give evidence that it is a gentle stream, subject to no great variation in volume. Its flow is regulated by several large sheets of water, among which are Attean, Wood and Holeb ponds. Below the bridge four feet rise is the extreme limit of freshets.

We have no hesitation in advising that measures be speedily taken to restore the fish to the Kennebec and its tributaries. In order to this, fishways should be built over all the dams in the main river, and on the principal tributaries. Meanwhile alewives should be bred first in the lakes of the Sebasticook, shad in the river at some place above Augusta; and salmon might with advantage be bred in some of the upper waters. But it would also be necessary to restrict the fishing, forbidding it entirely above Augusta, and limiting it below. With even the present machinery of weirs on the lower river it would be a very slow and tedious task to restock the upper waters, and if their construction is permitted without restraint, the least increase in the fish will be followed by

new weirs. Laws might be passed restricting their operations to certain days in the week, and requiring gates to be left open in the weirs, but they would be evaded as such regulations have been heretofore, without some strenuous exertions to enforce them. Unless they can be restricted materially, they should be forbidden entirely for severally years. No fishing should be allowed near the Augusta dam; for the salmon would accumulate there, before passing the dam, as they always do below any obstruction, and a drift-net or two would take a great part of them.

Penobscot.

The Penobscot has suffered less loss of fish than any other large river in the State. Various causes have conspired to prevent so effectual a closing as has taken place on the other rivers, and as a consequence salmon and shad still ascend the river for many miles. On the east branch they are caught yearly near the mouth of the Wassataquoik stream, and doubtless ascend farther. On the west branch they both certainly reach Grand falls near the mouth of Millinocket stream, and it is reported that both of them have been seen near North Twin lake. At this place there is a driving dam which is reported to be sixteen feet high, and a serious obstruction to fish; but it probably does not stop salmon. Edward G. Masterman of Greenville, saw a dead salmon on the west branch above the Moosehead carry in 1862, and says that in August and September of any year he can catch young salmon from six to twelve inches long at Ripogenus falls.

The fisheries of the Penobscot are at the present time of considerable value. We have not sufficient information to enable us to form an estimate of the amount of fish taken. We know, however, that the lower part of the river is thickly studded with weirs, and their number is increasing, which would not be the case if the business were very unprofitable. We think there are as many as 500 weirs on the river. If they take as many fish as those on the Kennebec they must obtain from this source alone not less than 12,000 salmon and 2,500,000 shad. There is, however, reason to believe that the catch per wier, particularly of salmon, is greater than in the Kennebec. In one day, during the past season, there were taken at Lincolnville 3,500 pounds of salmon, valued at $1,700. Yet the yield of this river must be far below what it is capable of producing.

The dams on the main Penobscot are four in number, at Veazie, at Basin mills, at East Great Works, and at Oldtown. That at Veazie when first built closed the river, and for several years the fish were stopped at this point; but at present it is no obstruction, a channel being worn around the end through which fish pass. The dam of the Basin mills has long aprons for the passage of rafts, but the water is too swift for the easy ascent of fish. A fishway could be easily built, and is much needed. The dam at East Great Works is five feet six inches high. There is a long apron built to run rafts over, but it is with great difficulty that salmon and shad pass the dam. It would, however, require but a small expense to enable them to pass easily. At Oldtown the dam does not close the river during the run of fish; but the passage is narrow, and box-traps are set on the falls; they are said to have taken about a hundred salmon here during the past season.

Of the tributaries, we can speak briefly of the Eastern river in Orland, the Pushaw, the Passadumkeag and the Piscataquis.

The Eastern river is obstructed by four dams. There are no fishways, and the fish are carried past the dams by locking them through. Only alewives, however, will enter the locks. Suitable fishways might be constructed for less than one thousand dollars, which would enable the alewives to pass up more freely; and it might then be found practicable to breed other species above the dams. The branch of the Penobscot into which this river empties, between Verona and Orland, is, however, much encumbered with weirs, and if it were undertaken to restore the fish in abundance to the Eastern river it would be necessary to restrict them for some years.

The Pushaw was once frequented by alewives and shad. There are two dams on it now, about ten feet high. There are also in its way several dams on the branch of the Penobscot which it enters, of which those at Orono are the main obstructions.

The Passadumkeag was once well stock with salmon, shad and alewives, but the fishery is represented as being now destroyed—cause, the erection of dams. At Lord's mills, twelve miles from its mouth, is a dam twelve feet high.

On the Piscataquis the dam at Howland in its present condition does not prevent the passage of salmon, and from that point to Dover the river is clear. At Dover are two dams, and there are also dams at Foxcroft, Guilford, Abbot and Blanchard.

We have seen enough of the Penobscot to warrant us in saying

that no river in the State promises such great results in the cultivation of fish. It should be one of the first to receive attention. It has already such a stock of breeding fish, is so slightly obstructed by dams, and has such a vast extent of breeding ground on its upper waters, that very speedy results might with reason be expected to follow any well-directed efforts. It needs a very careful examination, which should embrace not only the obstructions existing in the shape of dams on its upper waters and its tributaries, but the method and extent of the fishery carried on in the tide waters at its mouth; for we have reason to believe that there is more fishing than is compatible with any increase of the fish.

Machias.

This river once abounded in salmon and alewives and shad. At the falls at Machias village, some years since, a man could dip sixty salmon in a day. At this point a dam was built a long while ago; but as it did not completely close the river, it was never a serious hindrance to salmon, and alewives were for many years maintained in the river by dipping a large number over the dam each year. The upper dam at Machias and that at Whitneyville stopped the passage of fish. There are no other mill-dams on the river.

A few years ago a movement was started to restore the fish, and suitable fishways were built over the dam at Whitneyville and the upper dam at Machias. At the lower dam it was found difficult to build a wooden way that would stand; and recourse was had to a pool blown out from the ledge, and a piece of timber bolted down in such a way as to assist the ascent of alewives; this answers the purpose only when the water is at a particular height at the time when the alewives ascend, a conjunction of circumstances that has occurred but once since its construction. The dipping of alewives over these falls has been discontinued, and they are now practically extinct. Salmon were destroyed before, and no one has taken sufficient interest in the matter to introduce them again.

We have here an instance of rank injustice to the mill-owners, who were required to construct at a considerable expense, fishways, which have thus far been of no use, because those who insisted on their construction were not sufficiently in earnest to introduce and protect the fish. With the fishways kept in order,

salmon would find an easy way of access to their breeding grounds, and if properly protected might become again abundant.

East Machias.

Salmon and shad were once abundant in this river; but it is naturally better fitted for alewives than for any other species, and their numbers were immense. It drains several large lakes and numerous small ones, having an aggregate surface of about twenty thousand acres. In these the alewives find ample breeding grounds.

Mill-dams were early built on the lower part of the river, and they, with reckless fishing, had so reduced the vast primitive numbers of the fish that in 1849 not more than two barrels of alewives were taken. But about that time a careful cultivation commenced, and an improvement was soon visible. Fishways had been built over the dams at East Machias These were kept in repair, and gradually improved until they were found to meet the wants of the fish tolerably well, yet they cannot be said to be perfect. The fishing was restricted. There has been a gradual, yet constant improvement until the present time, when the value of the fish taken varies from $1000 to $1500 annually, the alewives being rated at one or two dollars a barrels according to the year. With good management it is not doubted that in future this yield will be vastly increased.

There are three mill-dams on the main river, two at East Machias village, at the head of the tide, and one at the village of Jacksonville. These are all provided with fishways. There is another at the outlet of Gardiner's lake, where the fish are accustomed to pass into the lake by a natural wasteway. On the upper part of the river are several driving dams which are some seasons very serious obstacles to the alewives.

The mode of fishing is with dip-nets entirely; and as the fish come up over the rapids near the shore in dense columns, it is found to be a very productive mode. On a good fish day at one of the best stands one man will dip many barrels of alewives. A few salmon and shad are taken, not only below, but also above the dams, showing that they must have passed the fishways.

Cobscook.

This small river was once well peopled with salmon and alewives, and shad are mentioned in an act for protection in 1828.

Three dams, built near the head of the tide, completely destroyed the salmon, and the alewives were so reduced that not more than a dozen were taken yearly. In 1861 a movement was begun by W. S. Peavey, Esq., and others of Whiting to restore the fish. Fishways were that year built over the dams, and 31 alewives were placed in the lakes at the head of the river. The numbers of the fish have since been nearly as follows: From 1862 to 1864, very few; in 1865 and '66 increasing; in 1867 very abundant, crowding the fishways all day long. Scarcely any fishing as yet, the people being sufficiently provident to understand that it is of prime importance that the river should first become well stocked with fish. The entrance to the lower fishway is some distance below the dam; and it was observed during previous years that the alewives all came up under the mill, passing by the fishway, and lay there some time before finding their way. But in 1867 they all went directly to the fishway, so that while this was crowded all day several persons dipping under the mill caught not more than 100. The cultivation of the alewives is thus proceeding satisfactorily. Salmon have not yet been introduced, but might be profitably. It is a good trout stream, not yet invaded by pickerel.

Denny's.

In its primitive state this river abounded in salmon, shad and alewives. The shad disappeared early, but the salmon and alewives continued with fluctuations in numbers to ascend the river until 1846. Since the first settlement of the country there has been a dam at Dennysville near the mouth of the river, but a broad wasteway through a natural channel at one end of it allowed the passage of fish. But in 1846 a dam was erected one mile above, which was quite impassable. The alewives were so nearly extinguished that it was the general impression that not one was left; a few were however occasionally seen by persons about the falls. The salmon could still breed in limited numbers below this dam, and were never entirely destroyed. In 1858 these upper mills were burned, and the dam destroyed. This allowed the fish again to ascend the river, but the alewives were still shut out from Meddybemps lake, their natural breeding ground, by a dam at the outlet; a fishway was constructed here by Mr. Foster in 1863. Now for the results. The salmon ascend the river to its head, but have not yet shown the expected degree of increase; cause, the fishing

with set-nets at the mouth of the river, and the poaching around the lower mills, aided by the failure of water in summer in the shallow wasteway which serves as a fishway. The alewives, however, have shown a remarkable increase: in 1865 perhaps two barrels were taken; in 1866, 15 barrels; in 1867, 240 barrels; in such a multitude did they come during the last season that in four hours 6 dip-nets took 60 barrels.

The only dams now existing on the main river are at the outlet of Meddybemps lake and at Dennysville. The former is provided with a fishway. The latter needs one; for the wasteway by which fish ascend, is frequently dry long before the salmon have passed up; its lower end is some distance below the mills, and the salmon seeking to ascend through the deep water of the main channel gather in the holes under the mills where they are stolen out by poachers; one man declared that in 1864 he took 96 salmon here with a dip-net. There is a good chance to build a fishway between the two mills.

The set-nets are at a point known as the "Narrows." They are fifty feet long and about six feet deep; and are set on the upper edge of the eddies at low-water mark, running downward and toward the mid channel at an angle of forty-five degrees. They are covered by the tide at two or three hours flood. Few salmon are taken on the flood tide, most of them passing over the nets up river; but when it ebbs they fall back, play into the eddies and are taken in the nets. The number usually set here is stated to be less than ten, but Mr. Walter M. Brackett has counted as many as thirteen or fourteen at one time. The channel being at this point very narrow and crooked they are able to work at a great advantage, and we think they take more salmon than ought to be taken until they have time to fully stock the river. We advise that the length of the nets be restricted to forty feet, and their distance from each other be increased to two hundred feet. The number of salmon taken here has been from two to three hundred per year, according to some estimates, but it is difficult to arrive at the truth.

The principal tributary of Denny's river, Cathance stream, is of very pure white water from Cathance lake. This is said to have formerly produced more salmon than the main river. It has three dams. The lower one, at Great Works, needs a fishway; the two above have natural wasteways which with a little clearing out will make excellent fishways. This branch ought to be opened.

St. Croix.

The St. Croix was formerly very productive of salmon, shad and alewives. Perley, in his report on the fisheries of New Brunswick, states that the average catch of salmon at Salmon falls, in Calais, was 18,000 annually. Gaspereaux (alewives) came in such quantities that it was supposed they could never be destroyed. The numbers of shad were almost incredible. The fisheries did not diminish up to 1825. Until that time the dams had fishways; but in that year the Union dam was built without a fishway, and the fisheries instantly fell off. We have the testimony of Mr. Ferdinand Tinker, of Milltown, to the abundance of fish up to 1825. Perley says the whole number of salmon taken in 1851 was 200. Since that time they have remained about the same until 1866, when 300 were caught. In 1867 there was a still farther increase. Mr. Treat, of Eastport, attributes this late increase of salmon to the influence of Porter's stream, a tributary on the New Brunswick side of the river, to which they sometimes have access at the breeding season.

The obstructions on this river are the dams at Union mills, at Milltown, at Baring, at Princeton. The dam at Union mills is at the head of the tide, and it is supposed that at high water it may sometimes be passed by salmon. It has usually been provided with a fishway, but there is none now in working order. One should be built on the New Brunswick side, and would cost about $1,000. At Milltown there has been a gap left between the two wing dams for the passage of fish, but it is subject to be filled with logs and other drift stuff. An abutment built obliquely across the head of the passage would remedy this evil. Cost not far from $50. At Baring the water runs around the end of the wing dam on the American side; and an outlay not exceeding $150 would provide a suitable pass at all seasons. At Princeton a fishway should be constructed on the North side through the wing dam, and ending in a good pool of water. Cost about $300. On the upper tributaries are occasional driving dams, some of which would at times probably obstruct the passage of fish. They should all be examined, and fishways built where needed; but this may be deferred till the main river is opened.

But it will be nearly useless to build fishways and attempt to restock the river with salmon unless some stringent law is enforced with reference to the time, manner and place of fishing.

The drift-nets are now thrown as near to the Union dam as a boat can venture, within a few feet of the falling water, and there is no respect of days. Every salmon that approaches the dam is doomed. If there were a fishway but few would ever succeed in entering it. We are happy to state that the mill owners evinced a very laudable readiness to do their part by constructing and maintaining fishways, but they with reason objected to being compelled to incur the necessary expense unless sufficient restriction be put on the fishing below to insure that the outlay shall not be in vain. For the present we suggest the prohibition of all fishing for salmon, shad or alewives within half a mile of the Union dam, or in any part of the river above for several years.

The St. Croix being a boundary river between Maine and New Brunswick, there should be concert of action by the bordering states. We have not been able to confer with the proper officials of the Dominion, but suggest that such a conference should be had at an early day.

Recapitulation.

To recapitulate, the history of the fisheries is the same in nearly all of the rivers. In a state of nature the waters were well stocked with the salmon, shad and alewife and other edible varieties. This supply lasted until after the country was peopled. But little decline had been experienced at the beginning of the present century. Since then many rivers have become almost entirely depopulated, and we do not think one in the state can be found that has maintained its fisheries in a fair degree. Salmon have been utterly extinguished in the Mousam, Saco, and Cobscook, and a further examination would probably show the same fact in relation to other rivers.

Causes of Decay.

The causes that have led to the present state of things are—

First—*Impassable dams.*

Second—*Overfishing.*

Third—*Pollution of the water.*

The first and second are the principal causes with us, the third having operated only in a few localities to a limited extent.

It is hard to say what share of the blame each must bear, but it is very certain that *the erection of impassable dams* is alone sufficient to account for the entire extinction of the migratory fishes in

all waters above the obstructions; and if they are erected below all the breeding grounds, the race is extinguished from the whole river. It needs no argument to show that if a species is prevented from reaching those places in which alone it can reproduce its kind, it must soon become extinct. It has been shown that salmon can only breed in shallow running streams of fresh water: when shut out from such places, it ceases to reproduce, for although the eggs might escape from the fish in tide waters, they would never be deposited in the manner which is essential to their development, and no young would ever come of them: the old brood would in a few years die, and with them the race would come to an end. It is also evident that if deprived of a portion only of their breeding grounds, the numbers of the fish must suffer a corresponding diminution. An acre of land will not produce so much grain as two acres, nor will a mile of water produce so many fish as two miles. Artificial propagation and cultivation may step in, and produce an unnatural abundance, but in a state of nature we find that other things being equal the produce of a number of rivers is in exact proportion to the extent of their breeding grounds. We can never expect the Denny's river to produce as many salmon as the Penobscot; nor can we expect the latter to produce so many with half its tributaries closed as when they are all open. Again, these fishes are strongly attached to old haunts: they always seek to return to their native streams and lakes: there are thus many distinct communities of them, using a common thoroughfare to and from the sea, but separating as they advance, and each band repairing to its own tributary and its own lake. The fishermen on the lower Kennebec could with certainty distinguish by their appearance many separate bands of alewives; one belonging to the Eastern river, one to the Seven Mile brook, another to the Sebasticook, and so on. The Sebasticook school has been seen passing in a dense body directly across the mouth of the Seven Mile brook, not one of them swerving from the line of march. The Sebasticook shad, too, were distinguished from all others. Now what effect must it have on creatures with such strong attachments to bar their way and turn them all back into strange waters at the most critical of all seasons, the breeding season?

That the dams have had the effect attributed to them is indisputable. The history of our fisheries exhibits plainly that whenever a high dam has been erected across a river the fisheries above have at once ceased; those immediately below have for a year or

two flourished unwontedly on the multitudes stopped by the barrier, and then they, too, have declined; that the total produce of the river has fallen away in inverse proportion to the distance of the dam from the sea; that if all the breeding grounds of a species have been cut off, that species has entirely disappeared. The dams have more effect on salmon than on any other kind, because their breeding grounds are always above tide water, and therefore more frequently cut off; less on smelts, shad and alewives, because they breed in fresh tidal waters as well as in more elevated situations, and most rivers have a certain extent of fresh water below any obstructions that have been erected. Their effect on bass is much less, because they never ascend the rivers so far as either of the preceding, and breed nearly altogether in tide water. A glance at the state of some of our rivers will illustrate this. The Mousam has an impassable dam at the head of the tide, three miles from the sea; there are no salmon, few shad. The Saco has an impassable dam at the head of the tide, six miles from the sea; there are some shad, but no salmon. The Kennebec has an impassable dam at the head of the tide, forty miles from the sea, there being half a mile of gravelly shallows just below the dam, where the tide has almost no effect; the produce of the river is a few salmon, (average one hundred per year,) a quarter of a million of shad, and more than a million of alewives. The Penobscot has now no dam that is impassable, and it produces more fish than all the rest of the state.

It is more difficult to trace the effect of *excessive fishing*, for its action is more gradual than that of the dams; nevertheless we believe it has had a very important influence. In the case of striped bass it has been the main agent of destruction, and that species has in all our rivers sadly diminished. It is very plain that if a great many fish are taken in any season there will be a corresponding diminution of the number of eggs laid at the next breeding season; fewer eggs result in fewer fish. To be sure the fecundity of fishes is such that they will bear a great drain upon their numbers before a decrease becomes perceptible; but there must be a point at which their reproductive powers will fail to make good the numbers destroyed. To ascertain this point, to know how many fish may be taken without diminishing the supply is a problem of no little difficulty. In the case of menhaden and other prolific marine species it may be that the supply will hold good against any demand that will be likely to be made upon it, but there is no doubt

that in the case of our fluviatile species, who yearly come within the easy grasp of man, the limit has in many of our rivers been already reached and passed. In no other way can we account for the decreasing numbers of the shad and alewives on the Kennebec since 1850; or for the fact that the Penobscot produces only one tenth part of the salmon it is naturally fitted to yield. Amongst the fresh water fishes diminution from this cause is occuring constantly and is evident to every one. The limited extent of our fresh waters when compared with the sea will at once suggest to us that their population must be much less in numbers, and therefore exhausted by a less amount of fishing, yet it is perfectly logical to suppose that the one is capable of exhaustion by the same means as the other, it being only a question of time.

The third cause, *pollution of the water*, has, as we have stated, exerted but little influence in our waters as yet, but we present some considerations on that point. We have not been able to give the subject that attention which it deserves, but we find the matter so well treated in the report of the Massachusetts Commissioners for 1865, that we present some of their conclusions.

"Lime is as deadly to salmon as to trout; gas-works, too, are bad, and the arseniates thrown out from dye-houses are highly injurious. City sewage, unless in great quantities, will not drive them away, as is shown by salmon going up the Dee, and past the city of Chester, whose sewers empty into the river. The effect of gas-works depends, perhaps, upon the details of the manufacture. In great cities, where gas is made in large quantities, the secondary products of the distillation, such as tar, coal oils, ammonia, &c., are saved and sold. But in small towns these products are allowed to run off in a drain, and are then very deleterious to fish." "The pollutions thrown out by dye-houses, and by factories where cloths are printed, vary, of course, according to the dyes, mordants, soaps, and other materials that are used. Where cotton cloths are printed, a great deal of madder is discharged, which hardly can be deleterious, except as resembling sawdust. Indigo is valuable, and is chiefly used up in the dye-house; nor is it probably injurious to animal life. Woollen print works would perhaps throw out a greater variety of pollutions than those for cotton; soap, in great quantities, when wool or cloth is washed; arseniate of soda; free sulphuric acid (especially in the making of the madder extract called garancine), and many other substances. But it would be a great mistake to fancy these poisons

as passing down stream in their pure form. Chemical changes of surprising rapidity are constantly going on. Deleterious substances are almost immediately precipitated, or by combination, are neutralized. Hence the well-known power of rivers to 'work themselves clean.'" Analyses of samples of the water of the Merrimac, taken below the Lawrence mills, in their vicinity, and at a time when the impurities from the dyeing and print works were supposed to be at a maximum, gave from three to five grains of solid matter to the gallon, consisting not of concentrated poisons, but chiefly of harmless salts of lime, iron and ammonia. "When we add that a gallon of average Cochituate water contains about two and a half grains of solid matter, and the same measure of common well water about sixteen grains, a sufficient idea may be got of the relative purities, so far as solid matter is concerned. But we must not go on so fast as to assume that therefore there is nothing in this water to disgust and drive away certain kinds of fish. The niceness of some fishes shows that, despite their defective organization in this respect, they have a sense that answers the ends of taste and smell." "Nevertheless, one fact of great importance may be derived from these analyses, namely, that if foul water can be confined, for a short distance only, to one side of a river, it will be purged of all its active poisons, and will be in a condition to join the main current. In such a case, the centre and opposite side of a river would at all times be pure." "Paper mills should not be omitted from the list of chief offenders against the purity of streams. Owing to their shiftless habit of shovelling the lime from their bleaching boilers into the water, the brooks on which these mills stand run the risk of being quite depopulated. Nor are dye and print works quite innocent of making unnecessary dirt. It is their practice to throw sediment from their vats, and many things not at all connected with mere clothes washing, directly into the river. This is simply slovenly. The lime is a valuable manure, as are many others of the chemical products. Nay, according to one of the best chemists in Lawrence, even the fat acids of the soap suds might be extracted, to the great economy of the woollen mills. The washing of printed cloths may properly be considered as an excusable pollution of a river, because it demands a large quantity of flowing water; and were the pollutions confined within these reasonable and necessary limits, the difficulty of restocking large rivers with fish would be much diminished, or quite done away with. In a

word, a fair stream is a mechanical power and a lavatory, but it is *not* a common sewer."

The only pollution which has yet been sufficiently extensive in Maine to cause any serious apprehensions, is that of sawdust; and we are inclined to think that the injury arising from this source has been much overrated. That it is directly injurious to the fish has not yet been demonstrated; and extended observation has not discovered an instance in which fish are known to avoid it. On the contrary, they are often seen advancing with the greatest intrepidity through the thickest of a discharge of sawdust from a mill. There is, however, another way in which this substance is injurious to all feeding fish. Great drifts of it settle down upon bottoms that were before well peopled with insects and other small creatures, and destroy all life. This deprives the fish of a portion of their feeding ground, and compels them to seek new pastures.

Remedies.

To restore the sea fish to our waters these conditions are essential:

First, *that fishways be built over all impassable dams.*

Second, *that excessive fishing be prevented.*

Third, *that the waters be not poisoned.*

Fourth, *that in some cases fish be bred in the waters to be restocked.*

The construction of fishways demands a careful elucidation; since not only is that the prime condition of success, but the doubt enveloping the matter has been the great bugbear which has caused many thinking men to consider it impossible to bring the fish back.

Salmon and alewives are known to easily surmount a very considerable fall, if it only be broken into a number of eddies in which they can rest successively after each move forward, sliding up from one to another through a very sharp descent of water. But over nearly all dams the water pours in an unbroken sheet, either vertically, or over a long inclined rollway, where it acquires such velocity that few fish can stem it, and at the same time spreads out into a sheet too thin to allow them freedom of motion, frequently at the end of the rollway leaping several feet through the air into the water below. It has been proposed to open holes through the dams at the bottom of the stream; but through such an aperture the water would rush with a velocity that the fish might be unable to stem; and besides, it would be out of reach, incapable of regu-

lation, wasteful of water, and very dangerous to the dam. A straight sluice from the crest of the dam to the water below, with an easy grade, has been tried, but having nothing to check its velocity, the water acquired in a long sluice a momentum that the most vigorous fish could not resist. A greater degree of success was attained by imitating nature more closely. But few natural falls are of a simple shape. Those that are easiest ascended by fish have many boulders or ledges in the way, forcing the water to pursue a crooked path, making a succession of plunges, whirling and eddying in rocky basins. It was found easy to imitate this, by putting into the straight sluice something to check the force of the water, or by building a series of basins into which the water should successively leap. If the fall is over a ledge, a very satisfactory way may be sometimes constructed by throwing up stones in such a manner as to check the current and form basins or eddies, as is done at Damariscotta.

In Europe fishways have so far as we know been only used for salmon, and have generally received the name of "salmon ladders" and "salmon stairs." They have been constructed in various ways, and have been found to answer the purpose for which they were designed; but being only for salmon they might not answer our purpose, who have to deal also with shad and alewives, less vigorous fish; and they all seem to be rather wasteful of water. It is unnecessary, however, for us to go abroad for information on this point. For many years fishways have been successfully built on some of our own rivers, and continued experiment has at last developed a style of construction which we present, believing that it combines the essential features in a fishway better than any other, being simple in construction, and therefore cheap, easy for the fish, and economical of water. It is the result of long continued experiment and observation at East Machias.

Fig. 1 is a plan of a fishway 57 feet long, 10 feet wide, and 4 feet 5 inches deep, adapted to a dam five or six feet high. It consists of a straight sluice, divided into sections by bulkheads (*b*, *b*,) built across it obliquely from opposite sides alternately, leaving a narrow passage (*c*, *c*,) at the upper end of each bulkhead; *d* represents the dam; *a*, *a* the walls of the fishway; and the arrows indicate the course of the water.

Fig. 2 represents a cross section at the upper end; showing movable planks, (*m*,) which may be put on or removed at pleasure to regulate the breadth of the open passage way, (*o*,) and thereby

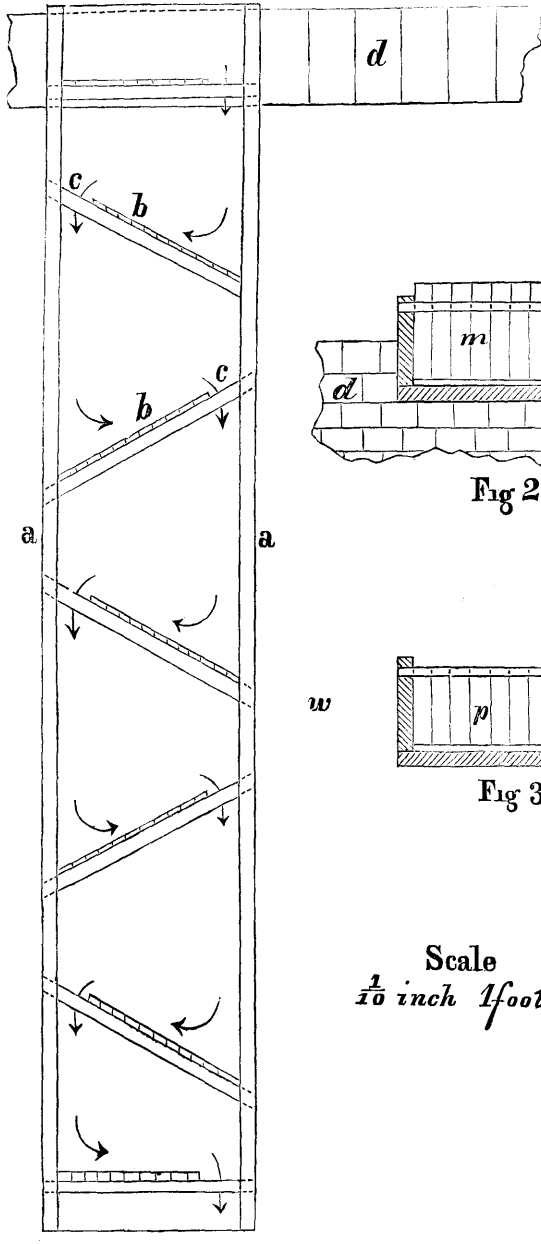


Fig 1.

Fig 2

Fig 3

Scale
$\frac{1}{10}$ inch 1 foot.

the amount of water flowing into the fishway; also showing how the fishway is set into the dam (*d*).

Fig. 3, shows the lower bulkhead, *p* being the plank of the bulkhead, *o* the passage way, *w* the surface of the water in which the foot of the fishway is immersed.

If it has a proper grade, (about one foot in ten,) the water will pass gently from one section or bay to another without breaking, and in each bay will form a deep pool in which the fish may rest, although there is little danger of their becoming weary, for the ascent is very easy.

It is necessary to so place the head of the fishway that there shall always be enough water running into it. It must be remembered that the water, in most places, is liable to get below the crest of the dam in the summer season. It will be necessary, then, in such cases, to cut down into the dam deep enough to insure that the floor of the fishway shall always be below the surface of the water in the mill-pond. This matter must be determined by the circumstances of each case.

The fishway should have its lower end always partially immersed; for if the water drops from the end into the river below, though it be but a slight fall, the fish will hesitate long before attempting it, and will experience some difficulty in getting into the fishway. The structure should be built long enough to guard against this difficulty. Its lower end should furthermore be placed in a tolerably deep pool, if possible in the main channel. Most of our dams have such a pool on their lower side, and if the foot of the fishway can be placed in this, its position will be the very best. This can easily be accomplished by reversing, or making an elbow in the fishway and bringing it directly back toward the fall. Indeed, there is no necessity for having it straight in any case. It may be bent into any number of angles, and its foot placed just where it is thought best. If it end very near the main fall it will be readily found by the fish; but if it is carried far down along the bank, they will generally pass it in their ascent, and delay some time at the foot of the dam, before finding the way.

In locating a fishway regard should always be had to the character of the stream; if subject to floods laden with floating ice and timber, a sheltered position should be chosen if possible; and it should always be placed where it can be reached and regulated.

The character of the stream will also determine the solidity necessary in the structure. It may sometimes be built entirely of

plank; but on the large rivers greater solidity will be required. It must then be built upon a solid foundation so that it may not be racked to pieces; the walls, both of the foundation and the superstructure should be without holes or crevices which would allow a log to get under and pry them apart; build them up of solid timber spiked together.

The amount of water used by a fishway will depend on various circumstances. In the figure we have calculated about four square feet, and think that would be sufficient in nearly all cases. The passage ways are two feet wide, and when the water is high will use six square feet; but not more than that should be allowed in a fishway of these dimensions, for it would either cause too great force in the current, or an overflow at the sides, which would spill the fish. In small streams, where there is a scarcity of water for mills, the amount used might be much less, particularly where alewives alone are to pass. The amount of water can always be regulated by the movable plank at the upper bulkhead, and when necessary its height in the fishway may be regulated by increasing or lessening the width of the passage ways. At times the upper passage may be closed entirely, as in winter.

If liable to be overflowed in a freshet, the fishway should be covered heavily, to prevent it from destruction; and a cover in every case will be found advantageous to the fish. If in an exposed position, the covering may incline towards the middle of the stream, in such a manner that any floating material that may be thrown upon it may slide off into the river.

The style of construction here recommended has been adopted in nearly all cases on the Merrimac river.

This fishway is not an experiment. It is already a demonstrated success. It has so far been used mostly for alewives, but through those at East Machias salmon and shad pass every year. There are many incredulous people who utterly disbelieve that it is practicable to pass fish over a dam through a fishway. All such should visit East Machias, or Whiting, or Red beach, during the ascent of alewives. The sight of the myriads of fish entering and leaving the fishways, and lying in their bays in such dense bodies that not one can turn around without the permission of its neighbors, is more convincing than any arguments that could be presented here. That they are well adapted to the wants of salmon we cannot doubt. In Europe, particularly in the British isles, the construction of "salmon ladders" over dams has been practiced with

complete success for many years; and the structures have generally been much more difficult than those in use with us. As an instance of the readiness with which salmon pass up through a ladder, we quote from Mr. Thomas Ashworth: "I may state that I own an extensive salmon river, where at about half a mile from the tideway there is an insurmountable mill weir (or dam,) with a well-constructed salmon ladder over it. I have no doubt that 40,000 salmon annually pass through an opening at the top of it only two feet in width." This is the river of Galway, which yields now 20,000 salmon yearly. In the same waters is a most remarkable fishway. Lough Mask discharges into Lough Corrib; but a portion of the intervening lands is so porous that the water disappears before reaching the lower lake. Over this porous ground was laid an iron trough 1,000 feet in length and of sufficient capacity to carry the water and fish; this leads to the bottom of a salmon ladder thirteen feet high. Salmon have already passed through this way to the upper waters.

The construction of fish-ways devolves, by the law of the state, upon the owners of dams, and as far as our observation has extended, there has been a very general readiness to comply with the requirements of the law in that respect, whenever there is sufficient assurance that the state will pursue such a policy as shall insure some practical results.

Excessive fishing must be prevented. This proposition is self-evident, and needs no demonstration. But the specific measures necessary to secure this end are not so evident. The fishery of the rivers is a regular industry of great importance, and we must be careful not to unnecessarily clog its wheels with laborious and unproductive modes. It would be easy to enact that no fish should be taken except with the hook; but while such a law would answer the purpose of saving the fish, it would be disastrous to the fisheries economically, for fish that cannot be caught and used are of no value. Again, the use of the dip-net might on some rivers be the very best way of taking fish; but on the broad, tidal waters of the Penobscot or Kennebec it would be a very unsatisfactory instrument of capture. Thus the same regulations would not be suited to all rivers. This fact has been recognized in the legislation on this subject, and each river, and in some cases each tributary, has its peculiar law. Besides the manner, the time and place of fishing may be prescribed by law in such a way as to prevent excessive fishing, allowing it to proceed only on certain days

and seasons, and in particular places. But to enable us to recommend specific measures for general application would require a more careful study of local circumstances and existing laws than we have yet bestowed. The legislation of the State on the fisheries has been voluminous. The whole number of acts on the statute books is not far from two hundred. About one hundred and fifty of these are in force at the present time. Their provisions are extremely varied, being mostly of a local character. A thorough revision of them is very desirable, that as far as possible they be incorporated into a general act; and that if local regulations are still necessary they may be based upon some system. A portion of these laws relate to the fresh water species, and so far as relates to trout and other members of the salmon family in the inland waters, we shall in this report recommend a general law.

The waters must not be poisoned. Some suggestions on the prevention of this evil are contained in the extracts we have made from the report of the Massachusetts Commissioners. We have not been able to give this point such investigation as would warrant us in advising any specific action.

Fish must be bred in exhausted waters. For instance, in the Saco there are now no salmon. The old brood has been entirely killed out. We are not sure that any of the salmon now feeding in the neighboring sea will enter it when the breeding season approaches, for they all belong to other rivers, where they were bred, and all know the way home. But if some of the eggs of salmon are hatched in the Saco, the salmon that come from them are natives of that river, and may be dismissed to the sea with the perfect assurance that they in due time will return. Where salmon still remain in considerable numbers in the lower part of a river, as in the Kennebec, it might be sufficient simply to build the fishways; but even then it is uncertain how well the salmon that might ascend would scatter themselves about through the different tributaries. It is the same with shad and alewives; only we have in their case a more clannish spirit, even—those of different tributaries rarely mingling or passing into any waters but their own. The Sebasticook alewives, although now so many years exiled from their old home, are still a nation by themselves, as distinct as the Jews.

Instances of Success.

Now, supposing these conditions all fulfilled, what reason have we to expect success? All the materials for an answer to this question that lie before us are too voluminous to be presented. We can only select. And first let us quote some instances of success at home.

The East Machias river was originally an excellent alewife river, but by the erection of impassable dams and reckless fishing, they were eighteen years ago reduced to a yield of two barrels yearly. By the construction of fishways and careful attention the yield has now been raised to $1,000 or $1,500 worth yearly; the price being from one to two dollars per barrel. The cost of the fishways was less than $1,000.

The Cobscook or Orange river, in Whiting, was practically depopulated by dams, not more than a dozen alewives being taken yearly, and those at the head of the tide. In 1861 alewives were carried into the lakes, and fishways built; in 1867 an abundance of fish crowding the fishways.

Denny's river. Alewives and salmon formerly plenty: but greatly diminished;—the alewives being practically exhausted, by impassable dams. Obstructions being removed in 1858, the alewives have increased, as witness the number caught, as follows: in 1865, 2 bbls.; in 1866, 15 bbls.; in 1867, 240 bbls.

Red Beach. Alewives bred in a lake, by U. S. Treat, none having been there before; the young went to the sea in large numbers, and at the expiration of four years returned; after dipping them over for several years, a fishway was constructed over a dam twenty-six feet high, and the alewives in large numbers passed through it to the waters above.

It would seem almost too early to speak of success on the Merrimac river, but the Massachusetts Commissioners announce that salmon and shad have ascended the fishway over the high dam at Lawrence and been seen above.

In Canada the salmon rivers had by neglect—just such neglect as they have received in Maine—been reduced to an alarmingly small yield. The government addressed itself in earnest to the project of restoring them to their former abundance. Strict laws were enacted, compelling the erection of fishways, preventing excessive fishing, and protecting the fish during the breeding season. A rigid enforcement of these laws has resulted in a marked improvement: salmon fry now swarm in the rivers.

In Great Britain and Ireland the subject has for some years been receiving a great deal of attention; and the recent progress and present state of their salmon fisheries is a sufficient answer to the assertion sometimes made that civilization is incompatible with the existence in abundance of the migratory species. The Vermont Fish Commissioners state, from personal observation, that the salmon is now the most abundant kind of fresh water fish for sale in London, and that the price has declined within a few years from four shillings to one shilling per pound. Among the many instances of successful cultivation we will mention the most prominent, that of a small river mentioned by Mr. Ashworth, at Ballisodare, in Ireland. It was originally destitute of salmon, being cut off from the sea by three perpendicular falls of an aggregate height of seventy feet. Ladders were erected over these falls, and salmon ascended to the breeding grounds above in such numbers that in the eleventh year after their construction ten thousand salmon were taken. The Galway fishery may also be instanced. In 1853 it was in an exhausted condition, and only yielded 1,603 salmon. By careful cultivation the yield gradually increased, and in 1864 was 20,512.

Value of the River Fisheries.

What is the value of these fisheries? The want of statistics prevents our making an accurate estimate of their present or past value. But the present gross product of all the river fisheries in the state may be safely set at less than a quarter of a million of dollars annually. This is a very considerable sum, but is far beneath what they ought to yield. We may judge of this by comparing the yield of the fisheries in some regions where they are better cared for. Mr. Ashworth states that "The salmon fisheries in Ireland produce in money value about £340,000, (equal to near $1,700,000,) annually, by cultivation and care, ladders over weirs, &c." The yield of the Scottish salmon fisheries is stated to be nearly £500,000, or $2,500,000, annually. Neither Ireland nor Scotland has so large a territory as Maine, and their fisheries are regarded as only partially developed, there being at the present time a steady increase in all well managed rivers. Besides, we can cultivate shad and alewives, and can derive from them as great a revenue as from the salmon. Are we not, then, warranted in the belief that with proper cultivation our river fisheries may be made to yield millions of dollars worth of food each year? Can

we afford to allow these great resources to lie longer undeveloped?

Introduction of New Varieties of Fresh-water Fish.

In introducing new kinds of fish to any waters, it is of course presupposed that the kind to be introduced is superior in some important respect to the kinds already inhabiting it: superior either in its value as an article of food, in its game qualities, in the degree to which it will thrive in its new home, or in its ability to utilize some waste product of the waters. Moreover, the kind to be introduced must possess certain negative qualifications: it must not be unduly destructive of other valuable species.

The family of the white fishes, mostly belonging to the genus *Coregonus*, stands very high among the fresh-water fishes, and our attention has been directed chiefly toward them in considering this question. In the quality of the flesh they excel all other species. In some waters they thrive wonderfully. They are never predatory in their habits, having tender, toothless mouths, fitted only to feed on small, unresisting creatures; and would therefore be harmless to other species. There is some reason to believe that much of their food consists of minute animals which entirely escape the common species, such as trout and perch. There is already in many of our waters one species of Whitefish, which is well worth dissemination, abounding in the waters of the St. John, and found in less numbers in Moosehead and the Schoodic lakes. Its weight is generally less than a pound. The whitefish of most importance abroad and probably a separate species from ours is the principal food fish of the Great lakes, (*Coregonus sapidissimus*, Agassiz.) We have much information in relation to it from Dr. Garlick of Cleveland, and Mr. Geo. Clark of Ecorse, Michigan. Their average weight is $2\frac{3}{4}$ lbs. Dr. Garlick says: "I regard this the best fish in the world. It can be said of it, as it cannot be said of any other fish, you never tire of its being on the table. You will like it every day in the year. It is fat and delicate, and highly nutritious. Everybody loves it, everybody wants it. The Indians in the Lake Superior region get fat on it, and eat nothing else for months every year, not even using salt with it. And what is strange, no one knows what it feeds on. I have opened the stomachs of hundreds of them, and never found a particle of food, nothing but a kind of mucus; the coats of the stomach half an inch thick, and covered with fat to nearly an inch in thickness,

—a great delicacy when properly prepared. But you can never transport the living fish,—not even the young ones. I have taken thousands of them at the Sault Ste. Marie rapids for bait to catch the large brook trout there. They made their first appearance about the first of July, and at that time were about an inch and a half long. Although I took great pains to keep them alive, they would all die within fifteen minutes after finding themselves caged up. So if you get these fish you will be compelled to transport the ova."

Mr. Clark is engaged in the fishery in Detroit river. He estimates the total catch of whitefish in that river alone, this year, to be half a million or more in number, weighing a million and a half of pounds, or seven hundred and fifty tons. At the retail price in Boston these would be worth $250,000. Mr. Clark has a pound with an area of an acre and a half, six feet deep, made by enclosing with stakes a portion of Detroit river, in which he keeps whitefish from November until the last of the winter, when they are caught out and marketed. They are first taken with a seine before they have spawned, and most of them spawn here in the pound. The operation is in the following manner: the opposite sexes approach each other, turning partially on the side, and the male appearing to attach himself by his soft flexible mouth to the female near her gills; then both fish dart off through the water together, and as they go the female ejects the eggs and the male the milt, in such a way that they mingle together and fall to the bottom. They move ten or twenty feet at a time, and each time eject several hundred eggs. Mr. Clark placed seives on the bottom at night, and in the morning found many thousand impregnated eggs on them. Mr. Clark has taken the pains to procure, pack and send to us two separate lots of these eggs, to assist us in ascertaining the best mode of packing and transportation. Of the first lot, packed in cotton batting, in sand and in river grass, a few survived the journey, out of fifty thousand; but of the other lot, packed in river mud and partially frozen, not one survived. Further experiment would no doubt bring to light a method by which they could be successfully brought.

This species we consider worth introducing. Of course, however, we cannot say that it will thrive as well in our waters as in the Great Lakes. That it, or a closely allied species, will thrive in small and shallow pieces of water we know. Mr. Andrew L. Williams of Canandaigua, N. Y., informs us that there is a lake in

that vicinity about five miles long and half to three-quarters of a mile wide, with an extreme depth of thirty feet, which was some years ago alive with whitefish weighing from two to six pounds. The same species now inhabits Seneca, Cayuga, and Canandaigua lakes, where it attains a size and perfection said to be superior to those of Lake Ontario. Another species inhabits Otsego lake, and has the reputation of being the most delicious of all. We are indebted to Mr. P. P. Cooper of Cooperstown, for interesting facts concerning it. The average weight is two pounds or more, but individuals have weighed six pounds; it brings readily double the price of the Ontario fish. There is a whitefish in Lake Winnepesaukee, probably identical with our own; we have received a small lot of their eggs, in good condition, from Mr. J. S. Robinson of Meredith, N. H.

Regarding the black bass (*Grystes nigricans*, Agass.) we have collected some information. It is a very common species in all of the Canadian lakes, except Superior, and on the St. Lawrence river, Lake Champlain and its tributaries. It is also found in several localities in the interior of New York, and has been introduced into some of the waters of Connecticut, Massachusetts and New Hampshire. From Mr. S. T. Tisdale of East Wareham, Mass., we have the following: "They were introduced to the waters of this region by myself, in 1850, '51 and '52, to the extent of some two hundred, with which I stocked some ponds in this vicinity. They were procured at Saratoga lake, N. Y., and brought here. For some five years all fishing for them was discouraged, after which they were caught in great abundance, from two to four pounds in size, and are now caught, in the season for fishing, of similar size, with a few of larger size,—five to seven pounds; the largest yet known to be caught weighing seven and one-half pounds. Incessant fishing has depleted the supply somewhat, still our ponds afforded a good supply last year. The season for taking them is confined from June 1st to December 1st, with stringent law for any violation. They spawn in May, in four to ten feet depth of water, excavating shallow basins, where they remain protecting their spawn and young until able to provide for themselves. They will increase as rapidly as perch, and as a table fish and affording sport in their capture, rank in the first class. They are now taken in two of the ponds first stocked; others were stocked, but being smaller are not so much fished. I stocked a lake in New Hampshire last May, taking twenty-one fish from

one of my ponds, and sending them to their destination. This number, or even less, will stock any large water so that in a few years the result will be satisfactory. My plan is to catch the fish, keep them in tanks or cans until they are hardened, then forward. The success of introducing black bass into the waters of New England is a fixed fact. The first experiment was made by myself, and some twenty-five ponds in this county have been stocked from their progeny."

As an article of food the black bass has an excellent reputation; his game qualities are among the first; we cannot doubt that he would thrive in most of our waters, and would be a decided advance on yellow perch and pickerel. Yet he has some bad characteristics. He belongs to the perch family, and like the yellow perch and striped bass is very voracious. He would feed to a great extent on other fishes; and would not confine himself to devouring worthless species, but would prey upon young trout, salmon, smelts, white perch, shad, alewives and any other kind that he could catch. Very likely he would prove as great an enemy to trout as is the pickerel,—perhaps greater. If he should get down into the shad rivers, as he undoubtedly would, to a certain extent, he would devour many times his weight of young shad;—yet we must bear in mind that if the young shad should go down to the sea instead of being eaten by black bass, something else would eat the most of them there, and that they have always had a worse enemy close at hand in the striped bass. It is difficult to say whether on the whole the black bass would do most good or harm; but considering that we have so many fresh water ponds now inhabited by yellow perch and pickerel, shiners and other small fish, which yield nothing of consequence, considering that the black bass is of a superior size and probably equal quality to the white perch, considering that he would be able to make his way and thrive against any foe that he would find, we are inclined to think that more good than harm would come from putting him into those waters. Yet inasmuch as we have a large aquatic territory inhabited principally by trout which are highly prized by most of the people, the black bass should be carefully excluded from all trout waters.

The "landlocked salmon" has been alluded to under the head of *Sebago salmon*. We regard it as a kind worthy of dissemination through the State.

There may be some other species that will prove themselves

worthy of introduction. If any species exists which is principally a vegetable feeder, and which is of fair quality, it should by all means be introduced. But we are not aware that there is any such fish.

With regard to the introduction of new varieties we will say that we have commenced some experiments with a view to ascertain in what way this can best be accomplished; but nothing practical has yet been done. The experiments not having yet reached a conclusion it is now too early to predict the result. An attempt was made in the fall to obtain spawn of the Sebago salmon, and with much difficulty a small lot was obtained; but the illegal practice of spearing the breeding fish had so reduced the number of males that difficulty was experienced in securing them at the right time to fecundate the eggs, and but few were fecundated. Those that were obtained were placed for incubation in hatching troughs erected in Manchester. A quantity of the eggs of a species of whitefish (*Coregonus*) of Lake Winnepesaukee were received from Mr. J. S. Robinson of Meredith, N. H., and are now incubating in Manchester. Two lots of whitefish eggs were obtained from Mr. Geo. Clark of Ecorse, Michigan; and from one of them a few were saved alive, and are now incubating. We hope that these experiments may be continued until some practicable way of transporting the whitefish eggs may be ascertained. With the black bass, nothing has yet been done. Their spawning season is in May and we had not arrived at any conclusion in regard to their merits, in season for operating last May.

Protection of Fresh water Fish.

Protective legislation should aim to save our valuable species from destruction either by man or by other fishes. Trout and other members of the salmon family are regarded as our most valuable species, and it seems that some legislation is necessary to preserve them. It is notorious that they are rapidly becoming scarce. Not only through the thickly settled sections but in the waters of the interior the diminution is very marked. Gentleman who have frequented Moosehead lake all agree that the trout in that lake have fallen off in numbers more than one-half within the last ten years. The same story is told by all the old residents. At Moose river bridge the decrease is said to be even greater. At the Forks it is now considered very good luck to get a dozen trout in a forenoon's fishing. In the Umbagog lakes the same

thing is taking place. We have noticed the decline of the Sebago salmon. In many of our lakes and ponds in the settled sections where trout were plenty within the recollection of the inhabitants, they are now almost extinct. This decrease of the trout is owing to three main causes:—*first,* overfishing; *second,* the erection of dams which have cut them off from their breeding grounds; *third,* the introduction of pickerel. The overfishing has been at all seasons of the year; in the interior where trout are still the most abundant fish it is principally in fall and winter; but all through the State a great destruction occurs in the spawning season—say from September to December. The trout then come up into the shallow streams, where they are particularly exposed and can be easily captured. They are then unfit for food, but that seems to make no difference with their pursuers who either eat them or find a ready market for them. Trout are less prolific than most fishes, and cannot stand the heavy drafts that are made on their numbers. It is necessary to restrict the fishing in some way, and as we regard their capture on their spawning beds as more destructive than the fishing at any other season, and as they are then so inferior food, it seems desirable that they should be protected from all destruction during the spawning season. The erection of dams has in many instances been prejudicial to the trout, as it has to the salmon. Cut off from a great part of their breeding grounds, of course they cannot, without some artificial assistance, maintain their numbers. We are not, however, prepared to say how far it would be advisable to attempt a remedy by building fish-ways. In some cases it would pay to build them for trout alone, but we must bear in mind that it is impossible to obtain such results from a purely fresh water species as from one that feeds in the sea. Thirdly, the introduction of pickerel. Not perhaps because they feed more on trout than on any other species; for as they lie amongst the weeds in the shallow water they pounce upon almost any young fish that come within their reach; it is very common to find them feeding on both yellow perch and sunfish, not deterred by their sharp spines; but trout are less able to bear the loss sustained than are those prolific species. To be sure, the trout retaliate by eating young pickerel, but these latter are produced in such numbers and grow so rapidly that they soon get the mastery in any waters well adapted to them. The fact of pickerel displacing the trout when the two are brought into contact is too well known to need a demonstration; but we will cite some facts

to show the extent to which this has occurred. "All of the ponds and streams," says Mr. C. T. Chase of Dixfield, "which empty into the Androscoggin from the north above the outlet of Wayne pond were originally stocked with trout exclusively, excepting the small fry, such as minnows, smelts, chubs, shiners, &c. The streams emptying in from the south were stocked mostly with pickerel, catfish, brindle perch, with the small fry named above. Many of the ponds and streams emptying in from the north have been supplied with pickerel; and in some instances the trout have entirely disappeared, in others they seem partially to hold possession." On the Kennebec the waters on the west side were stocked with trout and no pickerel, and those on the east side below Skowhegan with pickerel. We have a succinct account of the introduction of pickerel to the waters of the Cobbossee Contee from Dr. James Cochrane of Monmouth. It seems that in 1817 or 1818 they were brought from the Great Androscoggin pond and placed in Winthrop south pond—now known as Anebescook lake. From this they were transferred to other parts of that system of lakes, until they have reached nearly every part of it. It appears that about 1823 or 1824 they were also introduced into the Cobbossee stream above Gardiner from Nehumkeag pond, east of the Kennebec,—(see Mr. Boardman's article on Kennebec county in Agricultural Report for 1865, page 158). Of the results Dr. Cochrane says: "Previous to their introduction white perch and trout were abundant in the ponds, now the perch are less abundant and the trout are nearly destroyed." In the Belgrade lakes the same thing occurred later; it is said to be twenty years since the pickerel were first introduced, but they have already become more numerous than the trout, and the latter are becoming very scarce. Further north, we find that pickerel were brought from Madison pond into the waters of Gilman stream, a tributary of the Carrabasset. Twelve or fourteen years ago pickerel were introduced to Dead river. At that time trout were very abundant, but now have almost entirely disappeared from that portion between Chain lakes and Grand falls, while the pickerel have become numerous. There are said to be pickerel in Pierce pond, but no farther north in the Kennebec valley. Williamson says: "This species of fish was first brought to Penobscot county in 1819, and put into Davis pond in Eddington, where they have increased surprisingly; but they devour the white perch, which is of as much or more value, and their immigration has not received much welcome." Pickerel

were unknown to the upper Penobscot previous to 1824. That year they were introduced into Mattanawcook dead water in Lincoln, and they have now reached Seboois Grand lake, at the head of Seboois river; on the west branch they have not yet reached Milinocket and Pamedumcook lakes. From the Penobscot they were transferred to the St. Croix twelve or fourteen years ago, by carrying a number of them from Baskahegan lake to Little Musquash lake. From the latter lake they have spread into all the St. Croix waters; the trout (*Salmo fontalis*) has given place to them on the lower lakes, but the Schoodic salmon and togue stand their ground better. From the St. Croix they have been transferred to Meddybemps lake, on the Denny's river, and have in some way obtained a footing in the East Machias river, where they have become abundant.

It is worthy of note that in all these cases the pickerel have increased rapidly. Dr. Cochrane says that eight pickerel were put into Cochnewagan pond in 1825, and in 1833 they had increased to such an extent that he was able to catch a handsone string of them, averaging three pounds in weight. And it is worth while to consider whether our ponds do not yield a greater weight of pickerel per acre than they would of trout. The quality of the former is very generally conceded to be inferior, but we are not aware that it is less nutritious.

We advise that legislation should forbid the introduction of pickerel into any waters where they do not now exist. The same prohibition should rest against sunfish and yellow perch, and the indiscriminate introduction of black bass should not be permitted.

The laws for the protection of trout will apply to a certain extent to whitefish, togue and salmon. These spawn in the fall, and togue and salmon are then unfit for food; even the whitefish is not so good then as at other seasons. In the principal habitat of the latter fish, the Madawaska region, it forms a very important part of the living of the inhabitants, and we are not sure that they can there be taken in sufficient quantity for use in any other way than by netting them while they are approaching their spawning grounds; until more is known on this point we will not advise that prohibition to take whitefish in the fall extend to that region.

There is a large portion of the lakes in the southern part of the State where neither trout nor salmon are found in any quantity, where their restoration seems impracticable, except by a continued system of artificial breeding. Their natural breeding grounds are

destroyed or placed beyond their reach by dams; the waters are filled with pickerel, perch and sunfish; and altogether are unfitted for the abode of those highly esteemed varieties. What shall be done, then, for the protection of these waters? The species already there will stand overfishing better than any of the trout family, and therefore need less protection. We hardly think there is any danger of exhaustion by fishing with the hook alone. The spear and net are used with more effect upon pickerel and white perch. In waters where there is any fair probability of the trout regaining possession, it might be well to protect them and remove the restrictions on spearing pickerel. But where there is no prospect of making any more valuable fish abundant, it would be poor policy to exterminate those which we now have. As between white perch and pickerel we would make a distinction in favor of the former, which is one of our best fishes, lacking only in size; but the extent of the injury done by the pickerel is not sufficiently clear; they seem to flourish well in the same waters. Anebescook lake is at the same time the most productive of pickerel and white perch of all the lakes of that system. Yet it is probable that the perch would be more numerous without their persecutors. We think some careful observation is necessary to determine whether more food is produced from a lake stocked with white perch alone or from one stocked with white perch and pickerel together. Until we can answer this question, it is doubtful whether one of these should be protected at the expense of the other. We therefore refrain from recommending any other legislation in reference to pickerel than that they be not introduced to any new waters. For the protection of white perch we suggest that none should be taken during April and May, except with the hook; that would cover their spawning time; but perhaps this action is not yet necessary.

The use of nets, other than dip-nets, should not be permitted in the fresh waters, so long as there is free fishing. Yet we are aware that in advising against their use we are not in accordance with good economy. It is good economy to encourage such a manner of taking fish as shall yield the greatest returns for the labor expended; and the use of hook and line is the most expensive way of taking fish. To be sure, the net would soon exhaust the supply, but its use might be discontinued until the fish had recruited their numbers. But where every person in a community has a conceded right to a portion of the fish in the neighboring

lake, it seems to him like robbery for another to take all with a net. So if it be the policy of the State to allow free fishing, nets must be forbidden. It may be necessary to make some exceptions in favor of particular localities, and this is not intended to apply to the fishery for the migratory kinds.

Our fresh water fisheries are, in general, economically valueless, or perhaps worse than valueless. If we except the winter fishing, not a tenth part of the labor, time and money employed in the pursuit of the fresh water fishes, finds an adequate return in food. We say economically, because we do not wish to be understood as saying that everything is worthless which does not possess a cash value,—which does not contribute to the clothing and feeding of man. It is well worth while to have some such means of sport and recreation as is afforded by fishing with hook and line; and in this respect all of our waters are of value. But it should be the aim of legislation to encourage the production of food, and to encourage those methods of production which yield the best return. Can not then our interior waters be made to contribute something appreciable to our supply of food? Must these broad lakes continue only to be a field for recreation? It is the opinion of eminent pisciculturists that an acre of water is capable of yielding continuously a greater amount of food than an acre of land. Our lake surface is about equal to one-third of our improved land, and the realization of that estimate implies the increase of our resources thirty or forty per cent. We think it very desirable that some effort be made to ascertain how this part of the public domain can be developed.

Artificial Culture.

To the art of fish-culture, which has already taken rank as a regular industry, we must look for the development of a method by which some very considerable returns may be obtained from our now unproductive waters. The process of artificial incubation seems capable of increasing to an almost unlimited extent the numbers of the fish. In a state of nature a great waste occurs, which the enormous fecundity of fishes is barely able to balance. The greater part of this waste occurs in the eggs which fail to hatch; and artificial incubation is so much more perfect than the natural method, that by the former a hundred eggs may be brought to life where not more than ten would be hatched by the latter. The operation, too, is very cheaply performed, and it would seem that

the lakes might be easily filled with fish of any desirable variety. But just here another problem meets us in the face—the problem of food. We know of no fish that will thrive without a supply of animal food. Of this there is a certain amount in all our natural waters; but we cannot tell how much, nor how many fish can find nourisnment on a given area. But evidently this supply of food is capable of exhaustion, and will be exhausted, or partially so, whenever too many fish are put into any water—that is, when it is overstocked. It then becomes necessary to furnish food from some other source; and unless this be done, the fish will suffer from scarcity. A regular system of feeding has been pursued by trout-breeders with signal success. Their operations have been in small artificial ponds, but there is nothing to hinder the application of their system to large bodies of water except the lack of material for food. Liver has generally been employed for this purpose, and where it can be obtained in sufficient quantity it forms a cheap and excellent food for trout; whether it would pay to feed it to fish of less value than the trout is not certain; and the amount of liver and other refuse meat that could be obtained would go but a little way toward feeding the possible inhabitants of our broad lakes. However, there are other sources of food not yet developed, from which it may at some day be found practicable to draw the materials for fish-food. A vast field for discovery is here opened.

We had intended to present some farther remarks on the subject of artificial hatching and breeding, and have collected a mass of information relative to it; but for various reasons we have thought not best to treat the matter in this report. To do the subject full justice would make the report more bulky than we deem expedient. Those desirous of investigating will find the matter well treated in the article "Aquæ-culture," in the Agricultural Report for 1864.

Conclusion.

In conclusion we advise:

That measures be at once taken to restore the sea fish to our fresh waters, beginning with the four large rivers, Androscoggin, Kennebec, Penobscot and St. Croix, and their tributaries.

That the introduction of new species of fresh water fish of superior character, and the dissemination of our best varieties are desirable.

That a thorough revision of the laws on the subject of fish and the fisheries should be undertaken at an early day.

That for the present the following provisions be enacted:

For the sea fish: no salmon, shad, alewives or gaspereaux to be taken in any manner previous to the year 1873, in the following localities, namely: above a point one-half mile below the lower dam on each of the four rivers, Androscoggin, Kennebec, Penobscot and St. Croix.

For the fresh water fish:

1st, That no net, seine, weir or trap, except a dip-net, be used for taking fish in any except tide waters.

2d, That no trout, salmon, togue or whitefish be taken in any manner during the months of October, November and December.

3d, That no mascallonge, pickerel, pike, sunfish or bream, or yellow perch be introduced into any waters where they do not now exist.

4th, That black bass be not introduced without the approval of some competent authority.

5th, That the foregoing provisions shall not apply to the waters of St. John river and its tributaries; nor to the taking of the blue-back trout in Franklin and Oxford counties; nor to the taking of fish for the purpose of breeding, or for scientific purposes, in such manner and at such time as may be authorized by any officers into whose hands the State may commit this trust.

To better carry out the above measures, we advise the appointment, for a term of years, of commissioners, who shall possess the powers given to the present commission, and shall, in addition, be authorized to cause the construction of fishways on all rivers which they deem it expedient to open to sea fish.

All of which is respectfully submitted.

NATHAN W. FOSTER,
CHARLES G. ATKINS, } *Commissioners.*

January 16, 1868.

APPENDIX A.

CIRCULAR.

The New England Commissioners of River Fisheries wish to bespeak the attention and the assistance of all persons who are interested in the restocking of our fresh waters with valuable fish, such as the salmon, shad, herring, alewife, trout, black bass, striped bass, and lamprey eel.

These fish, half a century ago, furnished abundant and wholesome food to the people; but, by the erection of impassable dams, the needless pollution of ponds and rivers, and by reckless fishing, in all ways and at all times, our streams and lakes have been pretty much depopulated.

Luckily, the immense natural increase of fishes opens a way to their restoration. We have only to remove the causes of their destruction, and they will multiply enormously, without any care at all.

The causes of destruction are chiefly as follows:

1. Impassable dams. Over these, fishways may be built with little waste of water.

2. Pollution of water by lime, dyes, soap, sawdust, and other mill refuse. Much of all these should not be thrown at all into the water. As to the dirty water from wool or cloth washing, it may be confined to one side of the river by a plank screen placed opposite the raceway.

3. Destruction of young fish by mill-wheels, which may be avoided by a lattice placed across the mouth of the mill canal.

4. Destructive modes of fishing, among which we may include gill-nets, weirs, very long seines, pots, set-hooks, fire-fishing, and fishing through the ice; all of which should be by law forbidden.

5. Fishing too much, and at wrong seasons. For migratory fish, certain days in each week should be "closed,"—that is to say, no fishing should then be allowed; and the taking of trout on their spawning beds should be rigorously interdicted.

Massachusetts and New Hampshire have already passed laws for the opening of the Merrimac and the Connecticut to sea fish,

and for the encouragement of the breeding of valuable fresh water fish. Fishways have been erected upon the Merrimac, and many thousand salmon eggs have been planted in its upper waters.

By the interest and the assistance of the people at large, these cheap and important reforms may be carried through.

N. W. FOSTER, CHARLES G. ATKINS,	*Commissioners of Maine.*
H. A. BELLOWS, *Chairman*, W. A. SANBORN,	*Commissioners of New Hampshire.*
ALBERT D. HAGER, CHARLES BARRETT,	*Commissioners of Vermont.*
THEODORE LYMAN, *Sec'y*, ALFRED R. FIELD,	*Commissioners of Massachusetts.*
F. W. RUSSELL, HENRY C. ROBINSON,	*Commissioners of Connecticut.*

BOSTON, February 26, 1867.

APPENDIX B.

ESSAY on the Practical Cultivation of a Salmon Fishery, addressed to the President and Council of the International Congress, to promote the Cultivation of Fisheries, held at Arcachon, 1866. By Thomas Ashworth, Bath, England. (To this Essay was awarded the French Medal, 1866.)

Introductory Remarks.

The salmon fisheries of Great Britain are naturally very prolific; but it is not until a recent period that science has been devoted to this subject, or has led to practical results or discoveries, in developing the natural history and habits of the valuable fish—the salmon.

The inhabitants of the waters afford vast quantities of wholesome and nutritious food to the public, and by the study of salmon cultivation in our rivers and streams, useful renovations have been made, both in legislation and culture, the results of which—both to the owners of salmon fisheries and to the general public—are now beginning to demonstrate themselves throughout Great Britain.

When salmon place their eggs they may be seen and protected, whereas sea fish carry on their operations far beyond the care or knowledge of man.

The salmon is a migratory fish, ever on the move; some of them must have travelled hundreds and others thousands of miles during their lifetime between their feeding and breeding grounds, and it is only by the steady application of science and actual practice that we have discovered what little we now know. Any one who thinks he is going to understand the subject without labor will find himself mistaken, since many clever men who have been engaged all their lives in salmon fisheries have been compelled to acknowledge their great ignorance. The person who wishes to succeed will find that he must labor diligently and carefully; that he must not despair after repeated failures, but quietly work on, in spite of opposition, till he obtains the fruit of his labors. One thing is perfectly clear—unless the young salmon are bred, and the parents protected from their enemies, there can by no possibility be any

quantity of salmon, for the same reason that if there are no lambs there can be no sheep.

There are many persons in the kingdom who derive their living by the capture of salmon, and who exist by the sale of this produce, yet these know or care very little about the way or means by which their *water-farm* is sustained and supplied with a stock of fish.

Let us, therefore, ascertain something of the natural history and habits of the salmon, and study the various operations requisite for its cultivation, both by the natural process, and by artificial means, and try to discover its enemies, many of which are numerous, and of the most destructive character, as I shall presently explain.

The salmon is both a river and sea fish, returning to the stream in which it was bred, like the swallow to her own nest, the bee to its hive, or the pigeon to its dovecot; it belongs to its own particular river by the laws of Nature; it is a migratory, gregarious, and pairing animal;* it is bred in small streams suitable to its growth up to a certain period of its existence, but which would be insufficient to afford it food in a more advanced state, but which it must revisit to breed. From these small streams the young proceed in shoals down to their feeding-ground, and by instinct return in due time to the spawning-place. And hence the collective assembly scatters itself and forms into pairs, the *gregarious instinct being overcome by the pairing impulse.* At the mouths of rivers entering the sea, we see them move about in separate shoals. After being hatched in separate rivulets, the fry pass down to the ocean, and return in *distinct bands* each to its respective stream; for there is abundance of evidence that every river has a salmon peculiar in the shape and appearance to itself.

The sea fisheries of the United Kingdom have always supplied a much larger quantity of food to the population than the salmon fisheries; and it is gratifying to find from the report (1866) of the English Commissioners of the sea fisheries, that this supply has of late years greatly increased. The construction of railways and steamboats has afforded the means of speedy transit to this perishable article, yet the supply has kept pace with the demand. The ocean, out of her vast resources, can afford, we trust, a continuous increase without becoming exhausted, and this to an extent we possess no means of estimating. This increasing supply is

* I have abundance of facts to prove all these three words.

owing to the development of enterprise—the invention of more skilful appliances for the capture of fish; and the discovery of new grounds and fishing banks, not previously known to exist, in the bottom of the sea.

The Commissioners state that London alone consumes 80,000 tons of sea fish, not estimating salmon, herrings, sprats, eels, crabs and lobsters, oysters, mussels and shrimps; this in the aggregate greatly exceeds in weight the consumption of beef in London. They further state, "The most frequented fishing grounds are much more prolific of food than the same extent of the richest land. Once in the year, an acre of good land, carefully tilled, produces a ton of corn; or two or three hundred pounds' weight of meat, or cheese; the same area at the bottom of the sea, on the best fishing grounds, yields a greater weight of food to the persevering fisherman every week in the year."

"Five vessels, in a single night's fishing, brought in 17 tons of fish, an amount equal in weight to 50 cattle or 300 sheep. The ground which these vessels covered, during the night's fishing, could not have exceeded an area of 50 acres."

If we estimate the annual profit of 50 acres of the best land at £2 per acre, that is £100, and compare this with a single night's fishing of five vessels, producing 17 tons of fish, at £7 a ton, say £119, we may form some idea of the wonderful powers of production of a "fish farm" at the bottom of the sea, which, without any expensive tillage, produces more food in one night than a similar area of the best cultivated land in an entire year.

I am not aware that any accurate calculation has been formed of the annual value of the produce of the British fisheries. It is nearly certain there is yet a vast extent of fishing ground undiscovered at the bottom of the sea, and of its extent it is impossible to form any accurate estimate.

The fishing grounds of the deep sea, as well as the rivers, are subject to constant fluctuations in their productive powers, arising among other reasons from the fact that one class of fish depends for food upon the breeding capabilities of others. It may be assumed that whenever the enemies of one race eat up and destroy the excessive numbers of another, the supply of those so destroyed will be diminished thereby, until particular localities become so denuded, that the fish disappear for a time, or until reproduced in the course of nature. This we know to be the case in some

streams that have become salmon rivers, in which there had been previously an excessive quantity of trout. As the trout spawn a few weeks before the salmon, we may assume the salmon in the construction of nests for hatching their young have grubbed up the trout beds, and deposited their own in the same locality. Be that as it may, in a few years these trout streams have been converted into salmon streams.

This occurred a few years ago in the tributaries of the "Clare" Galway river, county Galway, Ireland, and this may be considered a fair illustration of what is probably constantly taking place elsewhere.

Since fish live upon fish food, their powers of reproducing their species are wisely ordained to be such as to keep up the balance of nature.

I will now mention what I consider a proof that the race of salmon do not escape from nature's law of destruction. My friend, Mr. R. Buist, of Perth, and myself, in the year 1852, ascertained from a statistical account of the salmon produced from the river Tay—one of the chief salmon fisheries in Scotland—the following remarkable conclusion:

Estimating the annual migration of fish up and down the river—adopting a fair standard as to the number of breeding fish, and the quantity of ova annually deposited in the beds of these streams in proportion to the number actually caught*—the result of our labors was most interesting; namely, that out *of every thousand eggs deposited by the parent fish (over a period of sixteen years,) not more than one fish was afterwards caught and converted into human food.*

Hence arose the question, what had become of the 999 eggs out of every 1,000 from which no fish had ever come to the nets? Some eggs, doubtless, had never been fecundated, and these would be unproductive; many others had most likely been devoured in an embryo state by aquatic insects, as well as by trout and other fish; others had been hatched, and in their infantile and helpless condition consumed by all classes of their natural enemies, near to their birthplace; some others, when more grown, had again supplied food to trout and other fish; whilst millions had migrated annually to the sea, and become delicious food to more ravenous

* Of this an accurate account had been kept under a Navigation Act—this being the only means by which so much accuracy could have been attained, as the fish were classified as grilse, i. e., salmon on its first return to a river, and salmon.

monsters of the deep, leaving one solitary fish, out of every 1,000 ova deposited, for the food of man.

How was this to be remedied? After carefully considering where the greatest destruction took place, (which we suppose to be on the spawning ground,) and how this could be obviated, it appeared to Mr. Buist and myself that the best mode of meeting the difficulty would be to collect the ova from the parent fish, hatch them artificially in boxes, and retain them in ponds till they were prepared for migration to the sea, and then to liberate them. This mode of cultivation has now been put in practice at Stormontfield, near the town of Perth, Scotland, since the year 1852 with great success, and the details have been published.

From the instances adduced, the question arises, By what means nations may effectively convert unproductive rivers into the means for supplying the largest quantity of valuable food to their public?

As a river fish, we may consider salmon by far the most valuable and the most important to cultivate.

We will suppose the salmon to reside half its life in salt water, and half in fresh; it is obvious that we know but little of its sojourn in the sea, except that it becomes fat and flourishing after going down in a very exhausted and impoverished condition, unfit for human food, distressed and tormented by parasites which attach themselves to its body, and of which it quickly rids itself in the salt water, where it no doubt finds abundance of food in the offspring of other fish;* in fact, we may conceive vast basins in the bed of the sea overflowing with crustacea and the fry of coarse fish, a salmon food as rich and palatable to the hungry salmon as the finest basins of turtle soup would be to a hungry man. And with this food it may gorge itself, and increase from the size of two ounces to five, six, or eight pounds in a few months; in fact, its growth is found after it has been in the sea a few months,† to be sixty times its previous weight, whereas in the rivers its chief food consists of insects and their larvæ, as well as loach and small eels.

After having renovated itself, it becomes the prey of other enemies, but ultimately, in obedience to the promptings of its migra-

*The late Professor Quekett believed the food of the salmon to be the ova of the Echinus or Sea Urchin, as he always found this in their stomachs. Herrings are also occasionally found in their stomachs.

†It has been proved that some smolts remain in the sea one year, and that some do not remain in the sea longer than a few months.

tory instinct, it returns back to the fresh water, and again to the river where it reproduces its species.

A few days ago, a salmon of 69½ lbs. was sold in London for £12 3s. 3d., being 550 times larger than it was on its first migration to the sea. A question may arise as to this fish's age. I have tried by various means to ascertain the ages of salmon, but, thus far, unsuccessfully. Probably at eight years of age, it might be 20 lbs., and since its birth it may have made twenty migrations to the sea, and travelled thousands of miles. This is one of the instances of the growth of the salmon, and of the value of the fish when full grown.

Salmon, unlike our domestic animals, which have to be carefully fed and sheltered for some years at a great cost, requires no maternal care to rear or feed it, but returns with the greatest regularity to its birthplace. Those fish which are caught at Rotterdam, and have travelled twenty times to the falls of the Rhine, will have journeyed 14,000 miles in twenty years; and this vast distance we may suppose it would accomplish with as much ease as a swallow would fly the same space, since fish, by their specific gravity, swim in the water as easily as birds fly in the air.

In short, the natural history and habits of the salmon evince such marvellous instincts, that those who practically study the subject for a lifetime appear to know but little about it; its time of breeding, return to and from the sea, appear to be fixed with as great precision as if they had been regulated by the dates of an almanac.

Spawning Grounds.

In rivers, say of 300 miles long, not more than half the distance may be suitable for the deposit of spawn, yet the fish spread their operations with wonderful uniformity over every eligible position, as well as over every stream that may be accessible to them; the smaller fish resort to the uppermost and smallest streams, whilst the larger ones select the deeper portions, but they *all* get into the smallest and most elevated streams in which they can swim and find shelter. The smallest streams are found, in area, to be the *most* productive—even those not exceeding from three to six feet in width; and of such streams in my own salmon fishery, at Galway, on the west coast of Ireland, we have thirty-three miles in length. Many of these in the summer seasons are not more than a few inches deep, with occasional pools, and in many places

are overhung by brushwood, or banks of earth and stones, under which the young fish escape readily from sight, and into which larger fish do not go, as there is not sufficient water to cover them. Here the young fish, being beyond the reach of their more formidable enemies, who devour them when they can, remain in safety till they are about three inches long. As they increase in size, they follow the stream into deeper pools, and thence migrate to the sea. I have in my fishery one stream divided into two tributaries of not more than from three to six feet in width, with springs at the head of it. This is a favorite resort for spawning fish; they will swim into this small stream with their backs frequently above the water, and where a boy with a stick might kill them with the greatest ease; and yet, when disturbed in their operations of spawning, they can only be driven away for a few minutes when they will return to the same gravel bed to complete their work. It may be readily conceived to be of the utmost importance that these fish should not be disturbed, chased away, or killed, as the ova deposited by them in *shallow* streams we find to be the most productive, and the young fish the best protected from the depredations of other larger ones until they are about six months old.

Any one who has ever seen an annual migration of thousands of smolts to the sea, and who then considers how comparatively few of these ever return as full-grown salmon, must not be surprised at this when we know that they are destroyed at every stage of their existence, both in the sea and river.

Constantly pursuing a perilous, vagabond life, annually travelling from the sea to the sources of rivers elevated hundreds of feet, in order to get to their natural breeding ground, they come in contact with every imaginable enemy, difficulty and obstruction, of which I shall speak hereafter.

Facts have proved that the largest fish are caught in the largest rivers, yet salmon resort to very small ones—the Furbagh river, in Galway, is only a few feet in width, and has a queen's gap of three feet wide through its weir, yet with a lake near to the river's source, it is frequented by salmon.

The larger the volume of water, the more is the shelter and sustenance to large fish, and they therefore probably live to a greater age than they otherwise would in a smaller stream. There are exceptions however to this rule. I am acquainted with a river, from thirty to forty miles in length, in which the fish do not average more than six pounds in weight, whilst in others very similar,

the fish are often nine pounds each; in this latter case we may suppose either the ocean or the river affords them a supply of better food.

We may assume that the food in the ocean is very similar in all cases. The food in the rivers varies. Some rivers drain a peaty, poor soil, in which the fish from its infancy is stinted, and consequently its growth is checked. Other rivers drain rich soils, abounding in insect life; hence in these the fish from their infancy are abundantly supplied with food, and the smolts are larger when they migrate to the sea than those born in rivers which drain a poor soil, just as a mountain sheep is smaller than another reared upon a rich lowland pasture.*

As to the quality of the water, this, I have no doubt varies in different rivers, from the nature of the soil and bed of the river over which the waters flow into the sea; as the same fish return from the sea to the river of which they are natives. It is also known that salmon traverse along the shores of the sea beyond their own river's mouth, for distances of forty or fifty miles, and pass and repass the mouths of other rivers, and yet return to their own native river to breed; for example, there are three or four salmon rivers empty into the Frith of Moray, in Scotland, in one bay; they all associate and live together for some months in the sea, until the period arrives for their return, when each class of fish returns to its own river, as they are well known to the fishermen who catch them, from there being distinguishing features in the shape of each class of fish known to inhabit these different rivers. This is one of the laws of nature which, if it were otherwise, too many fish might go into one river, and leave others deficient of stock, whilst we know they distribute themselves with marvellous uniformity over every portion of every river, to the extent of its breeding capabilities, and where new breeding ground has been added, by the removal of natural or artificial obstructions, the salmon extends its operations to the extent of these new streams, and soon occupies every available portion of every river that is accessible.

* The late Duke of Atholl, in March, 1859, caught three salmon, on their way to the sea, weighing 10, 11½, and 12½ lbs. each; these same fish having been marked by the duke by a copper band round their tails, returned in six months, and were again captured, having increased to 17, 18, and 19 lbs. each.

Requisites of a Salmon Fishery.

My object being to point out the indispensable requisites that constitute a prolific and well conducted salmon fishery, I shall now enter into the natural history of the salmon. In the first place, we may assume that no river can be productive of a large quantity of fish, unless it possesses an *adequate extent of suitable breeding ground.* Salmon can only be bred in fresh water, and it is in the *small streams* or upon shallow gravel beds alone, that they can be the most successfully hatched and reared, and also in clear rippling currents, free from mud and pollutions of every kind. This is evinced in the natural instincts of the parent fish, which always induces it to select such places as these. The sluggish portions of a deep river with mud banks, are therefore of *no value* for breeding purposes—if the ova should be deposited in such places it would soon become enveloped in mud, would be unproductive, or the young fry when hatched would die from the want of aerated and pure water. The next requisite is an adequate stock of breeding fish to occupy the spawning ground, every yard of which should be fully sowed with ova. If the number of parent fish should be insufficient to accomplish this object, just in the same proportion will the future catch *fall off*, and the profits be deficient. The young fish must be produced in great abundance, after which it is easy to devise the means of catching them when adults, and in dry seasons it is not difficult to destroy too many, to the injury of future years. To prevent any excessive destruction, the law in Ireland has wisely provided that no net shall be placed or fixed *across* any river, but that it shall be put in *and drawn out* upon the same side of the river, thereby allowing an adequate stock to escape up the stream; that no stake nets, bag nets, or "fixed engines," fixed or fastened in any way, shall be used, and that every salmon weir shall have a queen's "gap"* or opening always open of one-tenth the width of the river, in order that a stock of fish may pass up sufficient for reproduction. As a further precaution, the period during which it is illegal to catch salmon is fixed at not less than 168 days in each year, with some exception to anglers with a rod and line.

After having provided what may be deemed an adequate stock of breeding fish, the next important thing is to provide money to pay water bailiffs, to watch and protect the fish after they leave

* A free pass for the fish, which by law is open at all seasons.

the sea, and ascend to the small streams to deposit their spawn. To effect this object, a license duty is imposed upon all nets and rods used for capturing fish, and this duty on the Shannon, in Ireland, produced last year £1,313, and upon other rivers smaller amounts.

In addition to this sum, upon "several" (that is, "exclusive") fisheries, some of the proprietors also expend voluntarily large sums, for the purpose of increasing the protection. We have one instance at Ballina, county Mayo, in which the proprietor lays out £1,000 a year, in addition to the license duties, in protecting the breeding fish from being killed by poachers whilst on the spawning-beds; upon my own fishery upwards of 120 men are so employed, at a great cost.

Penalties are imposed upon any man who is found catching, chasing, or disturbing the salmon, or in cases where a salmon, or part of a salmon, is found in his possession during the 168 days of the close or protecting season. I need not say that the protection of a fishery in the breeding season requires great vigilance, and can only be conducted at a great expense; but where this is done efficiently, and the fish are allowed to deposit their eggs undisturbed, it is found that their powers of reproduction are so great as to amply repay all expenses.

Similar protection is given to the salmon in the breeding season upon the Scotch fisheries, the funds for which are raised from the proprietors, according to the annual value or the rent of each fishery.

In Ireland the law enables proprietors of fisheries to erect salmon ladders over mill weirs and natural obstructions, by means of which the fish are enabled to ascend the upper streams, where alone they can safely deposit their spawn, thereby increasing the productive powers *by extending the area of the breeding ground.* I have lately expended £1,700 in the construction of a salmon passage and ladder between Loughs Corrib and Mask, and through which salmon have passed the winter, 1865, into an extensive district of new breeding ground, from which they had previously been excluded. No doubt the sea can fatten the fish, but it is indispensable they should first be bred, as the quantity to be caught entirely depends upon the quantity that has been bred, and that again depends upon the extent of breeding ground, with ample protection for the fish in the breeding season.

As a similar code of laws is now in force in France, there can

be no doubt of the good results that will arise if they should be effectively administered, as without such laws any fishery property would become comparatively valueless, and the public would soon be deprived of a large supply of valuable and nutritious food.

Reasons for the unproductiveness of certain streams.

An allusion has been made to the value of fishing ground in the deep sea, as compared with a similar area of the best cultivated land; I may also say that the bed of a river of a well cultivated salmon fishery, is found to be relatively a vast deal more valuable than a similar area of the best cultivated soil on the banks of any river; at the same time, doubtless, there are districts in the ocean, from their physical construction, as unproductive as we find districts of unproductive land. This same principle is alike applicable to some now unproductive rivers, which must *ever* remain unproductive from their physical construction. But we have many rivers in Ireland that are unproductive, *not* from any physical defect in their salmon producing powers, but from another cause, viz: the great number of proprietors, which precludes the possibility of their agreeing to adopt any practicable system of cultivation involving the outlay of capital in the removal of natural and artificial obstructions, waterfalls, and mill weirs; in the requisite expense for protection to the fish, and in the subsequent division of the produce or annual income to be derived from such rivers. I have no doubt this is the case in other countries.

In order to remedy this difficulty it has been proposed that the right to cultivate and kill the fish in such rivers should be consolidated, and be converted into what we denominate a "several or exclusive fishery;" that is, placed in the hands of one or more owners, and the annual income be apportioned relatively to each proprietor. By this means, that which is now a barren, unproductive waste would be converted into the means of producing a vast amount of valuable and nutritious food for public use to the extent, in Ireland alone, of probably £100,000 annually, in which country the cultivated salmon fisheries now yield, in money value, about £350,000 annually.

Many of the rivers to which I have alluded as unproductive, possess some salmon at present, and in others where this is not the case they could easily be stocked from adjoining rivers. As an instance of the possibility of doing this, we have the river at Doohulla, not more than ten feet in width, but having several tri-

butaries, upon which a quantity of salmon ova had been deposited and hatched artificially; the fish so produced migrated to the sea, and afterwards returned to the place of their birth, and were caught in this small stream, although they might have resorted to other much larger contiguous rivers. As an instance of the importance of protection to the salmon during the breeding season, and as an evidence that this principle meets with public approbation, I need only mention the aggregate amounts of money raised for this purpose, as stated in the Commissioners' report. They say, "The gross amount raised from license duties for the protection of the fish in the close season was in 1863, £5,892 7s. 6d.; and in 1865, £6,722 16s. 8d., being an increase of £830 9s. 2d. as compared with the largest revenue ever previously raised for protection in Ireland."

I have made some allusion to the largest as well as the smallest of our salmon producing rivers, I may now add a few remarks upon these latter rivers.

It is only when the fish have passed through the brackish water, at the junction of sea and river, and arrived in the upper portions of the river that they are caught by anglers. Nature appears to have endowed them with a certain instinct, which induces them to surmount the greatest obstructions (short of a mill weir of six feet in perpendicular height) in order to get to the mountain streams that have gravelly beds. For instance, at Maam river, county Galway, the fish pass through, for twenty-eight miles, a lake in which they do not spawn, to the foot of a mountain more than 1,000 feet high; in fact, the summit of this mountain at Glenlusk is marked 1,436 feet above the sea. The source of the river is a spring, situated near the summit of this mountain, and in order to get to this we see large salmon struggle, during a flood, through a violent mountain torrent against a current falling at the rate of 200 feet per mile, and actually depositing their ova at an elevation at least of 1,000 feet above the sea! Such is the avidity with which they will seek any place suitable for the purpose of reproduction, and this instance appears to me one of the strongest proofs of the absolute necessity of making the rivers accessible, since we find these Maam streams most prolific, as they are stocked with young salmon (*i. e.*, parr) every year. The river itself is too shallow and too precipitous for the parent fish to remain in it, except during these periodical floods, during which they spawn, and then they retire to the lake for shelter and sustenance.

Cultivation of a Salmon River.

I shall now proceed in my endeavor to describe what I consider to be requisite for the practical and successful cultivation of a salmon river, as I only wish to apply practical principles to the subject. In the cultivation of land both skill and capital are indispensable requisites; the soil has to be ploughed and manured, and the seeds sown and cared for before the crop can be reaped; the cattle and sheep must be watched, protected, and fed with great care, in order to produce profitable results; we will consider a river to be a "fish farm," requiring an analogous treatment in order to produce similar results, and the question arises, How is this to be effected?

Upon the subject of artificially propagating salmon much has of late years been said and done. I have tried this system myself for many years, and have assisted others also, and in consequence much valuable information respecting the natural history and habits of this fish has been obtained; but as to results we possess no very accurate means of ascertaining their profitable effect, since the young fish can only be protected and detained in confinement till their instinct requires that they should be liberated and allowed to migrate with thousands of others to the sea. In considering the effect of any practical amount of artificial propagation of salmon compared with the natural process adopted by the parent fish itself, it will be requisite to estimate firstly, the quantity of ova that a given number of adult fish annually caught in any river (where they have free access to the streams above, from its source to the sea) can, or may have produced the previous year; and, secondly, the number of years required to produce an average stock of fish, varying in weight from 6 lbs. to 30 lbs. each. It is difficult to fix the average weight of fish caught in various rivers, but the annual number killed we will take to be 20,000 fish; experience has enabled me to arrive at the conclusion that it will require *four years* to produce marketable fish of the average weight of 7 lbs. each. Now we have a migratory animal to deal with, which we may hatch and protect for a certain number of months, but at the end of this period it becomes exposed in the river to the same chances of life as millions of others, going to and returning from the sea. Twice it goes to the sea before, on the average, the fish is fit to be caught; therefore, out of the forty-eight months of its average life, we may protect it only for a few months. I shall assume that the artificial propagation be continued simultaneously

with the natural process of breeding for four years; consequently, if any reliance is to be placed on artificial propagation it must be fairly tested by comparison with the natural process during a similar period of four years; or at any rate until the result can be proved by a return of marketable fish from *both* processes.

I shall first consider the case of fish artificially hatched and reared for (say) fifteen months. The eggs collected from the fish may be fecundated and incubated artificially in a box, more perperfectly and in greater relative numbers than would be the case in the bed of a river by the fish themselves; and by using spring or filtered water, the destructive insects, as well as trout and larger fish, may be to a greater extent excluded during this period of fifteen months.

After the age of fifteen months, when the young fish are placed in the river, and go to and return from the sea (during which time we obtain our relative proportions of marketable fish from both sources), the question arises from which system have we derived the largest quantity at the least relative cost, commercially.

The 20,000 fish annually caught may vary in size, from 6 to 30 lbs. each. That various fish produce various numbers of ova I have no doubt; as I found one of 20 lbs. in weight to contain 26,636 ova, whilst another of 14 lbs. only contained 6,890 ova: taking the largest and smallest, we will assume that 20,000 fish had visited their breeding ground the previous year, and that one-half were females, and had produced 7,000 eggs each; that is, that 70 millions of eggs had been left in the rivers annually, and had produced one marketable fish to every 3,500 ova deposited. This large quantity of 70 millions of fish eggs annually deposited in a river, whose produce of marketable salmon only amounts to 20,000 fish, appears to be a very extraordinary estimate, and leads one to consider what becomes of the surplus, when we find only one in 3,500 of the eggs, deposited naturally, produces one fish that is ever caught, or becomes the food of man.

I shall next compare this with the largest number of ova, that we ever deposited in hatching-troughs at Galway in any one year, viz., 659,000; what number of marketable fish would this number of ova give us, at 3,500 ova to each fish? The answer would be, by the above rule, 188 salmon. These at an average weight of 7 lbs., at 1s. per lb., would be worth £65 16s.

The Destruction of Salmon Ova.

We should remember in the first place all fish derive their food, and sustain life from the offspring of other fish and insects; that salmon eat the eggs of salmon; for the most tempting bait the angler can use to catch a salmon, consists of a salmon's roe or eggs, and that possibly large salmon eat the smaller fry; that a single trout will devour 600 salmon eggs for breakfast, and repeat the same constantly, so long as any are to be found on the spawning ground. In December, 1852, we caught a trout on the spawning bed, and squeezed this number, viz., 600, of ova out of its stomach, and placed them in a separate box, where several of them came to life. We may suppose that of the eggs deposited, many are not covered with gravel to a depth sufficient to protect them from trout, and other fish; some are not fecundated, and become useless, and salmon and trout devour both the ova and the young salmon after it emerges from the egg, when in a very feeble state, and that probably millions may be thus destroyed.

Aquatic insects are most destructive in many places; as an instance of this I may state, that we once deposited 70,000 salmon ova in a beautifully clear stream for hatching, and when the time arrived for their vivifying we found they had been eaten by the embryo of the dragon-fly, and consequently we could not discover a single fish living, out of the 70,000 ova deposited; yet after all the losses which occur we often see a multitude of smolts (young salmon) go down to the sea every spring in April, and of which, numerically, only a very few ever return as adult fish, and that, numerous as are their natural enemies in the rivers, we may suppose they are equally numerous in the ocean. Seeing this vast destruction of the animals bred upon a fish farm to supply requisite food for the same species, what are the remedies to be applied? Cattle and sheep consume the produce of the earth; they are vegetarians, and may be multiplied and increased by the cultivation of the land; but the fishes of the sea and rivers provide their own food, they live by devouring each other, and are fed upon their own redundant powers of reproduction, which supply the wants of their race, leaving some only to escape to perpetuate their species, and out of these, man also takes his share.

According to Mons. Coste's calculations, a salmon carries 1,000 ova to every pound of her weight. I may here state that in September, 1863, I obtained the roe or ova of nine salmon from Mr. Hayllar, Brighton; these nine fish weighed 170¼ lbs. exclusive of

the roe, which weighed 139½ oz. I then enumerated the quantity contained in one ounce of the ova of each fish, and ascertained the number of ova to each pound in weight of fish, to be only 650, instead of 1,000. This I give as the result of a careful investigation, but I found a great want of uniformity both in the weight of the roe, and in the relative number of ova produced in different fish, as some produced a greater weight with a less relative number; from which we may assume that all salmon do not produce a similar quantity, and that the ova does not all become matured at the same time. We may assume that the average number procured from these nine fish may be a fair approximation to the general average, the result being 650 ova per pound in weight: one fish contained 1,332 ova to the pound in weight, whilst the eight other fish varied from 476 to 599 ova per pound.

In 1852, Mr. Buist and I, from the best information we then possessed, arrived at the conclusion that not one egg out of 1,000 ever became a marketable fish. In 1861, Mr. Ffennell and I arrived at the opinion that not one in 3,000 ever became marketable.

But very few salmon have been caught and identified as the produce of the Stormontfield ponds in ten years, yet a great benefit has been conferred on the public; inasmuch as there is no doubt that the ova have been hatched more safely, and the offspring better protected for fifteen months than would have been the case in the river; and an amount of information as to the natural history and habits of salmon has been obtained, of which an account has been published, 1862, by Mr. W. Brown, of Perth. After brief sojourn of fifteen months the young fish go to the sea, where their enemies are as numerous and more voracious than even those in the river, as Mr. Ffennel once saw twenty-six salmon fry taken from a black pollock; thus a sea fish worth sixpence in the market would, at this rate, consume in three months, at twenty-six per day, upwards of 2,000 young salmon, which, if they could have returned to the river, and been caught, would have been worth £500.*

* The enemies of the salmon are, according to Mr. Frank Buckland's list, as follows: To the eggs—floods, droughts, frost, mud brought down by the stream, trout, water shrimp, beetles. To the young fish—trout, other fish, larvæ of dragon-fly, water-beetles, especially dytiscus, ducks, and many other water birds and rats. To the adult fish—porpoises, cormorants, hakes, black pollock, seals, fishing frog, *Lophius piscatorius*. The greatest enemy of all is man, viz., poachers, who kill the parent fish at spawning time, and by erecting weirs across the streams, and thereby, while preventing them getting to their spawning ground, destroy their power of reproduction.

Man is another great enemy, not so much from the number he destroys, as from his intercepting the ascent of the fish to its breeding grounds, thereby annihilating the whole race by mill weirs, navigation weirs, dams, dykes, and fixed engines. These natural as well as artificial obstructions may be removed or overcome by ladders, as has been the case upon my own fishery, yet it requires skill, capital, and time to develop and cultivate the productive powers of any river; but it is indispensable that the breeding grounds should be made accessible to the salmon from its sources to the sea.

We have no means of destroying the natural enemies of the salmon in the sea, but in the fresh water we can increase the salmon by protection and care, or we may destroy them by capture. Over the insect tribe in the rivers we have no control, and even if we had, it would be unwise to interfere with them, as their larvæ, as well as the insects themselves, are the principal food of young fish; but we may suppose that far more of the ova of the genus salmo are destroyed by insects than by all their other enemies put together.

The trout, the pike, the otter, and fowls are also very destructive, but the dragon-fly and a vast quantity of other flies drop their eggs during the summer on the water; these eggs ultimately become the most deadly foe of the salmon by devouring (in their advanced stages of development) millions of salmon ova, assisted by water-beetles and numerous other insects.

Is it possible to overcome these difficulties by any other means than by artificial propagation? And if not by what means are we to procure the requisite ova, and rear the fish in sufficient quantities for fifteen months? If this system cannot be carried into effect practically and profitably, then we have no other left, but the efficient protection of our rivers by clearing them of destructive pollutions and affording a free passage for the fishes from the sources of the rivers to the sea.

In the production of non-migratory river fish, as trout, the artificial system may be successfully applied, as has been proved by Mr. Frank Buckland.

Now, with regard to profit; dealing commercially with this important natural history question, we must admit it is one of the greatest magnitude, yet at the same time, with the facts I have stated before us, who can say that any quantity of salmon that could be artificially bred would pay the incidental expenses attend-

ant upon a fish breeding establishment, when we see apparently in the result such insignificant returns of saleable fish?

The powers of reproduction are so great in salmon, that in a large stock of parent fish, well protected from poachers in the breeding season, would appear to consist the best mode of increasing the quantity; unlike cattle they require no houses, feeding or care. But in the breeding season they pass, as I have stated, into the smallest streams, and can be killed by the simplest and rudest implements; and to prevent this, I myself employ about one hundred and twenty water bailiffs night and day to protect them from injury, without which they would be killed, and their eggs destroyed; great attention must therefore be paid to the system of protection. The following statement will prove how far this system has been successful upon my own fishery, at Galway, in Ireland. This fishery had been allowed previously to run to waste, and it required judicious care and capital to bring it into a remunerative state of cultivation, all of which have been bestowed upon it.

I shall now explain the result of the system I have pursued for a period of twelve years, by stating the progressive increase in the capture of fish, in consequence of the breeding-ground having been previously extended by the construction of fish-passes and ladders over mill-weirs and obstructions, and by increasing the protection to the salmon in the spawning season upon the whole of the breeding-ground. The number of fish caught was in the following years as under:

		Salmon and Grilse.
1853	the number taken was	1,603
1854	" "	3,158
1855	" "	5,540
1856	" "	5,371
1857	" "	4,857
1858	" "	9,639
1859	" "	9,249
1860	" "	3,177
1861	" "	11,051
1862	" "	15,431
1863	" "	17,995
1864	" "	20,512

The money value of the fishery has increased in proportion to the number of fish captured. This will show how a proper system of

cultivation will improve a salmon river. From the above table it will be seen that some irregularity occurred in the annual returns; but in order to show this irregularity more fully, I submit a return of Lord Grey's fishery at Kinfauns, on the River Tay, near Perth, Scotland, for fifty years, during which period no two years are similar:

An Account of the Fluctuations of Lord Grey's Kinfauns Salmon Fishings on the Tay, 1788 *to* 1845. By Robert Buist.

Annual Capture of Salmon and Grilse.

For a period of 10 years, before the use of stake nets in the estuary.

Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.
1788,	5,773	1,538	1793,	7,866	2,155
1789,	9,796	1,083	1794,	9,924	1,549
1790,	6,635	1,829	1795,	9,392	2,320
1791,	8,639	1,320	1796,	6,285	441
1792,	15,242	2,206	1797,	7,451	2,629

For 10 years after stake nets were placed in the estuary.

Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.
1801,	6,635	3,061	1806,	4,072	1,242
1802,	7,037	1,141	1807,	5,306	2,209
1803,	4,208	887	1808,	3,371	1,132
1804,	4,051	3,219	1809,	3,393	1,072
1805,	5,458	1,258	1810,	3,132	947

For 10 years after total removal of stake nets.

Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.
1815,	8,239	7,674	1820,	6,328	10,780
1816,	10,811	12,746	1821,	9,879	6,310
1817,	15,056	7,719	1822,	6,435	4,638
1818,	10,080	7,026	1823,	4,998	7,317
1819,	10,743	12,220	1824,	7,532	10,461

For 10 years with stake nets on the coast, and before the Navigation Act.

Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.
1825,	7,005	12,774	1830,	5,828	10,605
1826,	3,500	7,000	1831,	3,218	6,836
1827,	2,629	6,078	1832,	5,292	9,822
1828,	4,721	12,342	1833,	3,672	9,016
1829,	5,556	7,853	1834,	5,960	10,196

For 10 years during the operations under the Navigation Act.

Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.
1836,	7,668	8,179	1841,	7,757	12,398
1837,	5,352	12,641	1842,	7,305	21,153
1838,	5,523	9,639	1843,	9,847	11,353
1839,	7,379	6,686	1844,	7,772	7,775
1840,	3,735	9,215	1845,	4,991	10,269

In order to show the destructive effect of stake nets (that is, fixed engines) by excessive capture near the mouth of the river, the quantity of salmon caught in the river at Kinfauns during the ten years that stake nets remained was diminished to 46,663 salmon, but for the ten years after their removal the quantity increased to 90,101 salmon. From this it is evident that "*whenever too large a proportion of the parent fish had been caught by any means, that the produce of future years had been diminished.*"

As a further confirmation of this fact I beg to call attention to the yearly rental of the fishings on the Tay from 1828 to 1864. The mode of letting was by open competition from year to year; thus we have the best test of its annual value. The total rental of the Tay and its tributaries was

		£	s.	d.
In 1828	rental	14,574	10	0
1829	"	14,529	10	0
1830	"	13,747	8	0
1831	"	13,874	0	0
1832	"	11,629	0	0
1833	"	11,577	0	0
1834	"	10,907	10	0
1835	"	10,856	10	0
1836	"	10,211	10	0
1837	"	10,150	6	0
1838	"	10,285	0	0
1839	"	10,498	0	0
1840	"	11,058	0	0
1841	"	10,846	5	0
1842	"	10,235	15	0
1843	"	10,512	5	0
1844	"	10,386	10	0
1845	"	10,751	15	0
1846	"	10,099	15	0
1847	"	11,421	10	0
1848	"	12,057	10	6
1849	"	10,729	16	0
1850	"	9,491	11	0
1851	"	9,530	0	0
1852	"	7,973	5	0

In 1828 the annual rental of the fishings was £14,574 10s. In this year Home Drummond's Act was passed, which made the net fishing legal up to 14th of September, instead of 26th of August; thereby enabling the proprietors to kill an increased number of parent fish on their way to the spawning beds, the effect of which we see was gradually to reduce the rent of 1828 from £14,574 10s. down to 1852, when the rental was £7,973 5s. The proprietors then began to get their eyes opened to the injurious effects of this extension of the fishing season, and agreed voluntarily to close their fishing on the 26th of August instead of 14th of September.

This year, viz., 1852, the breeding establishment at Stormontfields was commenced, and—with the netting season reduced by nineteen days—together gradually produced a good result, as the rental of the Tay, was increased thus:

		£	s.	d.
In 1853	it rose to	8,715	17	6
1854	"	9,269	6	5
1855	"	9,977	13	5
1858	"	11,487	2	5
1859	"	12,884	14	0
1860	"	13,827	10	3
1861	"	14,109	15	7
1862	"	14,080	12	0
1863	"	14,257	16	6
1864	"	15,000	0	0

I do not suppose that any stronger evidence can be adduced in support of the necessity of not killing too many of the parent fish, and of adequate protection to them on their spawning ground.

I have no doubt that fish, like other animals, also suffer from diseases, as no two seasons are alike productive; vast quantities are seen going to the sea, yet from some unknown causes we may have a bad season, and but few be caught. In very dry seasons they remain in the sea, and about the mouth of the river, when too many are in consequence caught; whilst in wet seasons they are more difficult to catch, and escape into the rivers and lakes. But one thing is very certain, they must be well looked after and protected from injury during the breeding season; they must have free access to all the small streams, over mill weirs and obstructions, as unless they are bred by millions they can never be found in the market by hundreds.

Success in Salmon Breeding.

Although I was the first to try the experiment of breeding salmon artificially in the United Kingdom of Great Britain, and have continued the system to the present time, yet time and experience have convinced me that this increase in the produce and value (as I have shown) of my own fishery has not arisen from the adoption of any artificial means of hatching and rearing the young fish, but in consequence of great care in the general cultivation of the fishery, and principally by protecting the parent fish, and by providing an ample stock of them to reproduce their species in large quantities, over a period of twelve years, and by closing the fishing season on 12th August, although by law we could continue to kill them till 31st of that month. This allows a greater number of parent fish to go up the rivers to breed. Our season for fishing in 1865 did not exceed about 135 days out of 365 in the year, the principal harvest being only for about forty days, between the months of March and August.

The Galway salmon fishery, of which I am the owner, consists of the exclusive right of fishing for every kind of fish therein in perpetuity, the legal title to which goes back to the year 1228. The salmon are principally caught within two miles of the sea, by cribs,* and by nets. The breeding ground extends over a district of about forty square miles, with two large lakes, Corrib and Mask, containing a surface of 66,000 acres, in addition to other smaller lakes.

There are fourteen rivers with spawning grounds in them that fall into Lough Corrib, with thirteen other tributaries falling into these main rivers of the total length of 297 miles.

The proportion of the 297 miles in Corrib district, upon which the salmon spawn, (and which we may denominate productive breeding ground,) extends over 137 miles in length. The portions through which the salmon pass, but do not spawn, extends over 160 miles, is composed of deep pools, sluggish in some places, and in others of precipitous rocks.

There are eleven rivers, of the length of 110 miles, in addition to the above, falling into Lough Mask, and from these the fish have been excluded until the winter 1865, when a passage was made for the first time over this rocky ground, and by means of a ladder they were enabled to ascend into Lough Mask.

* A trap placed on each side of the river into which the ascending fish pass, but cannot return.

Complaints having for many years been made by the proprietors of salmon rivers in England, Scotland and Ireland, of the destructive use of stake weirs and bag nets in rivers and estuaries, the subject has been brought before Parliament and fully investigated. In 1863 an act was passed for Ireland, which prohibited for the future the erection of any fixed nets whatever, and has provided for the construction within one year of "queen's gaps," or free passes, in all fishing weirs across rivers, and enlarging all those that now exist to not less than one-tenth part of the width of the river, these to be placed in the deepest part of the stream, with an uninterrupted free passage at all times. The same principle has since been applied to England, thereby to prevent the possibility of exterminating too large a proportion of the stock of breeding fish; the subject is placed under the care of the Fishery Commissioners. Water bailiffs are appointed to travers the banks of rivers, to examine fishing weirs, dams, engines, &c., to enforce the observance of the annual and weekly close time, by removing the obstructions and seizing the nets and engines illegally used; they are also empowered to seize foul fish during the annual close time season, and all fish passes, weirs, and the queen's gaps must be open to their inspection. They have the general powers of the coastguard and constabulary in Ireland, and are a most valuable acquisition to all the fisheries of the country.

Salmon Fishery Laws.

I now offer a few remarks upon the important results arising from a judicious system of legislation for the protection of the salmon, as we have had periods of great prosperity in our salmon fisheries succeeded by periods of equal depression, amounting almost to an extinction of the species (in particular rivers), which have arisen from mistaken legislation and other causes to which I wish as briefly as possible to allude.

It is well known that the salmon can only be bred in fresh water, in which it passes the first, and sometimes the second year of its existence, after which it migrates to the sea, in which it may remain only a few months, or from which it returns the same year, but occasionally it does not return for two seasons.

Different countries have enacted different laws to prevent the destruction of salmon during the spawning season. Scotland may be considered the richest known salmon-producing country, and at

a very early period it was found requisite to enact laws for the protection of the salmon fisheries; it is stated that as early as the year 1030 a law was passed in Scotland rendering "the catching of salmon fry and old salmon during the spawning season punishable." A similar law was passed in England in 1285. Another in Scotland, in 1214, was passed to prevent the use of nets in the middle of the river, and in the reign of Robert I., in 1318, a severe law was passed forbidding the erection of permanently fixed engines of any size or form whatsoever whereby the ascent of the fish up the river or their return to the sea might be obstructed. In 1424 (James 1.) another act prohibited the erection of all cruives and weirs; and in 1457 another act ordains that no weirs should be set up that could prevent the migration of salmon to the sea during the smolt time, under a penalty of £10; and under James III. it was enacted that all these laws should remain in force. In 1489, under James IV., it was enacted that the sheriffs should be ordered to destroy all illegal engines; in 1563 a still more stringent law was enacted, confirming the previous laws, and inflicting more severe penalties, and subsequently another and still more severe law was passed, under James VI., confirming the above laws, and to appoint distinguished individuals as conservators over all the rivers of Scotland, with full powers to inflict penalties of £200, or to imprison any infringer. These laws will evince the care our ancestors took of these noble fish; and so abundant did they become, that it is related in the "Life of Sir John Sinclair," that in July 22d, 1743, no less than 2,560 salmon were caught in one haul in the Thurso river. Since which various other laws have been passed, some of which have been found in practice detrimental and others beneficial. In 1814 the Tweed fisheries produced £20,000 in value, whilst in 1858 it was reduced to £5,000. In 1818 Lord Grey got £14,000 for his fishery on the Tay, and in forty years later this was reduced to £3,000.

In Ireland the Salmon Fishery Act was passed, 1842; this consolidated, amended, or repealed about twenty-six previous acts, extending over a period of 376 years, from 1466 to 1842. Further acts were passed in 1844, in 1845, in 1848, in 1850, and in 1863.

In England an act was passed in 1861, and another in 1865, to repeal, amend, and improve *thirty* previous acts of Parliament. The object of these various laws has been to protect the parent salmon in the breeding season, and to prevent an undue propor-

tion of adult fish from being caught in the rivers, thereby to sustain a sufficient stock of fish to reproduce their species and to prevent their becoming extinct. The details of these I need not explain, but the beneficial results of the two recent acts are obvious and admitted by all parties.

Examples of Cultivated Rivers.

As my object is to suggest what I consider to be the most profitable system of cultivating a salmon river, I shall endeavor to illustrate my views by stating a few facts as examples:—

1st. I have stated the example of the Furbogh river: it is so narrow that a man could easily leap across it in the summer season, at the place where it falls into the sea, and yet this has a salmon weir and cribs upon it for catching fish, with a Queen's gap of only three feet wide, for the fish freely to pass through at all times; but as there is a lake near to the source of the river, the fish naturally resort to it, and are bred and caught in considerable quantities even in this diminutive salmon fishery. Without the protection which the law affords to the proprietor of Furbogh, all the fish might be easily destroyed, and the public would thereby sustain the loss of so much food.

2d. I will allude to another, the Doohulla stream, of ten feet wide, in which salmon ova had been deposited, the fish artificially bred, they went to the sea, and have since been caught in considerable numbers.

3d. The only other example that I will give is the case of Mr. Edward Cooper, who possessed a river at Ballisodare, Sligo, at the mouth of which there are three precipitous cascades or waterfalls, of about sixty feet in height, to the foot of which the salmon resorted before ladders were made; he erected ladders over these falls by means of which the fish in one year found their way to the upper streams and lakes, there they naturally bred, returned to and from the sea.

These ladders are constructed over the first perpendicular rock of thirty feet, the water from which falls into the tide-way; the second falls are at Ballisodare corn mills, about twenty feet in height; the third is at Callooney, about twenty feet in height. Previously to the construction of these ladders not a single fish could ever surmount these falls, but after their construction the salmon passed up and down them with the greatest ease, and in

eleven years the number of salmon caught was upwards of ten thousand in one year.

This may be considered as the most successful and extraordinary example of the beneficial results arising from the practical cultivation of a salmon river without exception.

Previously this river had been entirely unproductive, and might have remained so had it not been for the intelligence and enterprise of a single individual, who erected ladders and enabled the fish to have uninterrupted access to their breeding ground, where alone they could reproduce their species, and without having recourse to any artificial system for propagating the ova; here we see nature accomplished the whole object so soon as the parent fish were allowed access to the spawning ground, and were protected whilst upon it.

I shall now allude to the finest salmon river in Europe, the Rhine, the river from which, probably, the largest numbers of the largest fish are obtained in the finest condition, and this without the least protection, care, cultivation, or cost of any kind from any man. It may be said to be the very best salmon river in Europe, and is *the least* cared for or cultivated. With no destructive pollutions of its waters, and with no natural or artificial obstruction to intercept the fish in their free passage up and down, until they arrive at the falls of the Rhine at Schaffhausen, a distance of nearly 400 miles in length. The natural instinct of the fish leads it to the uppermost mountain streams, about sixty miles in length, lying between Basle and Shauffhausen; the first, three hundred miles from the sea, is a large navigable muddy river, with deep pools, and so wide that it is impossible to destroy and exterminate the fish by any system of nets or means of capture that has yet been invented, and, moreover, it passes through the dominions of various governments. I do not suppose that for three hundred miles any fish could be caught by lines and baits, and comparatively but very few by nets, except near Rotterdam. The upper portions, supplied with the purest cool snow water from the Alps, are inaccessible to salmon, being intercepted by the falls of the Rhine.

I have previously shown, that the value of a salmon fishery consists in the extent of the breeding ground, and in the protection of the parent fish in the breeding season. In the case of the Rhine, the fish are bred in a country three hundred miles from the sea, and caught in Holland, where the people only invent the most de-

structive nets that ever were conceived of—eight hundred yards in length and worked by steamboats all the year round, and yet a large stock of parent fish escape, I have no doubt, owing to the great width of the water.

If such a river belonged to one state, or to one owner, it is not possible to conceive the extent to which it might be improved by cultivation.

As the fish resort to the upper streams above Basle for the sole purpose of breeding, and when they are out of season and unfit for human food they are killed there, as they are in Holland, without restriction; and if it were possible to kill them *all* the race would become extinct; but it is upon this Suisse breeding ground that the greatest injury is inflicted, by destroying the parent fish whilst in the act of reproducing their species in thousands.

Having very briefly and inadequately stated the position of this magnificent salmon river, the Rhine, I may take the liberty of suggesting the best mode of cultivating and improving it. Thus:

1st. No salmon should be caught above Basle except in the months of May, June and July; and the fish should be protected from injury by water bailiffs during the remaining nine months.

2d. That salmon ladders should be constructed on one side of the falls at Schaffhausen, thereby to enable the fish to ascend to the lake Constance and its tributaries, which would increase the extent of the breeding ground enormously.

3d. That the fish should be protected from injury in the breeding streams, and that none should be destroyed above these falls.

This may be said to be a national undertaking, and it would be no mean object for any nation to accomplish, considering that the height of this fall is only similar to that which has been overcome by the individual exertions of one gentleman (Mr. Cooper, at Ballisodare) over a waterfall of about sixty feet, the falls at Schaffhausen being from forty-five feet to sixty feet in height.

The Suisse might object to breed fish for the Dutch to kill; well, the Dutch might agree to pay to the Suisse a fourth part of the value of any quantity of salmon they might kill beyond their present produce, and their objection would be fairly met, and both parties would have conferred a mutual benefit upon each other, and the public would have derived a vastly increased quantity of valuable and nutritious food without sustaining any loss.

This advice which I now offer is based upon my own experience

of what has taken place upon my own fishery, and I have no doubt it could be confirmed by others similarly situated as to the vast number of eggs naturally deposited, and the innumerable shoals of fry produced, and of the smolts that migrate annually to the sea, if only the fish were allowed to ascend to their spawning beds and protected in the breeding season.

It is well known that one salmon caught in March is equal in value to three similar fish caught in July for the market. I consider it desirable to *open the fishing season early*, thereby to catch those in the finest condition, and *to close the season early*, thereby to allow a greater number of breeding fish to escape when they are of the least value.

I think it is very certain (as the experiments at Perth have proved) that all the fry do not migrate to the sea at fifteen months of age, but that some remain in the river or in the ponds to the second year, and that some of the salmon remain in the sea for two years, and do not return to the river to spawn every year. I believe that all the salmon we catch on my fishery for the first two months every spring are fish that could not have spawned the previous December, and although they go up to the rivers and lakes in February and March, yet they will not spawn until the ensuing November and December. Yet we have no proof that these fish continue only to spawn once in two years. Mr. John Miller, the tenant and manager of my fishery, says that he has seen 500 to 1,000 salmon caught on the north Esk river in the first week in February, and that hundreds of similar fish are also caught in the Tay and the Shannon that had not spawned the previous December, and that will not spawn until the next December.

These we may consider to be some of the inscrutable and secret works of nature, as Tillotson says, "the inscrutable perfections of the works of God."

I congratulate the French Government in having passed a law to prohibit the import and export of salmon and trout in the close season, from the 20th October to the 1st February, as this will materially support the fishery laws of Great Britain; and also in having passed a general law for the protection of the salmon and trout rivers in France by prohibiting fishing from the 20th October to the 1st February, and that no fish shall be caught in rivers whose width shall not exceed about 20 feet, as they are considered to be spawning beds, and below which width fish shall not be

caught except with certain implements under strict regulations, and that ladders are to be provided by the State to enable the fish to pass up to their spawning ground.

Conclusion.

Thus then I have endeavored to give some idea of the immense importance of the cultivation of the waters, and especially of salmon rivers, a subject which at the present time is so justly attracting the attention of the Emperor of the French himself, of philosophers, and of the whole nation of France.

The remarks I have made are not based upon speculation, but upon long experience and careful observation, during a series of years. These principles I have applied to the cultivation of my own fishery in Ireland, but I do not wish my experience to end there. I wish to give it to the public in general, not only in England but to the friends and neighbors of Englishmen—the French.

France has many fine rivers which require but the application of industry, skill and capital, to render them productive of food for the great and enlightened nation which inhabit it; and I trust the day is not far distant when the labors of the learned, scientific men of France, who have taken the study of the French fisheries under their charge, will be rewarded by the increase of the supply of food for the people from its rivers and the vast waters which wash its shores.

In presenting this essay to the President and Council of the "Exposition Internationale de Pêche et d'Aquiculture," at Arcachon, I must beg, not only on my own part, but also on the part of the salmon cultivators of Great Britain, to congratulate them on their zeal and industry, to wish them all success in the noble efforts they are making to promote the culture of the waters, not only of France, but throughout the civilized world.

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In Senate, January 20, 1868.

On motion of Mr. HOUGHTON, laid on the table and 800 copies ordered to be printed for the use of the Legislature.

THOMAS P. CLEAVES, *Secretary.*