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*SALMON
FISHERIES.*

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SALMON LADDER OVER NATURAL ROCKS, OUGHTERARD FALLS.

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Jane Telleray

Just found you

THE
SALMON FISHERIES
OF
ENGLAND,
1868,

From authentic information obtained for the House of Commons, to which is added valuable and exclusive information, extracted from the Reports of the Commissioners of Fisheries in

FRANCE, AMERICA, NORWAY, & RUSSIA,

BY

THOMAS ASHWORTH, ESQ.

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(1465)

SALMON FISHERIES

ENGLAND

THE NEW AMERICAN BOOK CO. & SONS

NEW YORK AND LONDON, 1884

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NATURAL SALMON PASS.

The Frontispiece is a Lithographed Drawing of a natural Salmon ladder at Oughterard Falls, in Connemara, over which thousands of Salmon pass every year. The fall is less than one foot in five—the fish leap from a deep hole at the foot of the fall, and by a succession of short leaps from irregular resting places, at the backs of prominent rocks, by which the current is split, they are enabled to pass up step by step, to their breeding grounds. The stream is about 30 feet in width, and has three lakes above the falls, with various tributaries in which the Salmon deposit their ova.

THE
SALMON FISHERIES
OF
ENGLAND,
1868.

The following information is thought to be of consequence to those interested in the Salmon Fisheries of the United Kingdom.

The Conservators of the Fishery Boards in the various districts of England are for the most part well aware of the defects of the law regarding the Preservation of Salmon, but there are many who, although they have a great interest in the question, do not sufficiently understand the present position in which their river properties stand, and it is, therefore, with a view of showing these matters in their true light that the following reliable information is now circulated.

In 1860 a Royal Commission "of inquiry into the Salmon Fisheries of England and Wales was issued with the view of increasing the supply of a valuable

article of food, for the benefit of the public, &c. On the 7th of February, 1861, the Commission issued their Report, containing 545 pages of evidence, with a Report of 35 pages, from which we copy the extracts.

In 1861 a Bill was introduced into Parliament, based upon the recommendations contained in the Report of the Royal Commission.

This Bill had been prepared with the intention of superseding all the provisions of the existing Acts, by combining their requisite and useful provisions, in one general Act. It proposed to repeal upwards of twenty of these ancient salmon fishery Acts.

The new Bill in its progress through Parliament was divested of many of its most useful provisions, which the ancient statutes had also previously contained.

Owing to these changes in the Bill, the result was found to be that these ancient Statutes were most improvidently repealed by the Salmon Fishery Act of 1861, and no corresponding enactments were substituted. Experience now proves that the laws at present in force do not supply adequate means for enforcing a free passage for the salmon to their spawning beds; the previous Acts did this.

The following are a few of the repealed Statutes:—

Excepting Magna Charta 1224.

The Act of 1350, "New Weirs shall be pulled down and not repaired."

The Act of 1369, "The penalty of him that setteth up or enhanceth Weirs, One Hundred Marks to the King."

The Act of 1399, A confirmation of former Statutes touching the pulling down of Weirs.

The Act of 1402, "Commissions shall be awarded to Justices to enquire of Weirs, Kidels, &c."

The Act of 1472, for taking away Weirs and Fish Garths.

The Act of 1531, for the pulling down of Piles and Fish Garthes in the Rivers Ouse and Humber.

The Act of 1558, for the Preservation of Spawn and Fry of Fish.

The Act of 1714, "For the better preservation of salmon (in the seventeen rivers referred to in the annexed table) be it further enacted that if any person shall lay or draw any kind of nets, engines, or other devices, or wilfully do or cause anything to be done whereby the spawn or fry of salmon, not being in length eighteen inches from the eye to the middle of the tail, shall be killed; OR SHALL hereafter make, erect, or set any bank, dam, hedge, or stank, net or nets, across the said rivers, whereby the salmon therein may be taken or hindered from passing or going up the said rivers to spawn, &c.; every person so offending who shall be convicted thereof shall forfeit the sum of £5 for every such offence, besides the fish taken, and the nets and engines used, or shall be committed to prison for three months, and the justices shall order such nets, engines, and devices made use of, to be seized and cut in pieces or destroyed in his presence, and shall also cause such banks, dams, hedges, or stanks, made or erected across the said river, to be demolished and removed at the charges of such offenders."

It is therefore evident how much importance the public, in former days, attached to a systematic protection of a nutritious and valuable article of commerce, and cheap food for the people, produced without cost from the public, by our English Salmon Rivers. The following return of the loss of spawning area of the seventeen rivers mentioned in the Act of 1714 will shew the damage which has been going on during the last 100 years or thereabouts.

AREA OF LOST SPAWNING GROUND.

Names of Rivers.	Length in Miles from Commissioners' Report.	Area of Catchment Basin, square miles.	Area from which Salmon are excluded by weirs, sq. miles.	Area from which salmon are excluded by both weirs and pollutions.	Area accessible to salmon, square miles.
Severn	178	4437	2400		2037
Teme	60				
Dee (Chester)	93	850	450		400
Wye	148	1655	775		880
Wear (Durham)	70	455		420	35
Tees	95	744	300		444
Ribble	61	501	250		251
Mersey	68	1706		1706	
Dun (Yorkshire)	68	721		721	
Aire and Calder	134 $\frac{1}{2}$	802		802	
Ouse	59 $\frac{1}{2}$				
Swale	71				
Wharfe	75'55	1905	1205		700
Ure and Nidd	61 $\frac{1}{2}$				
Derwent	72 $\frac{1}{2}$	928	568		360
Trent	167	3543	2043		1500
		18,247	7991	3649	6607

From the foregoing table the extent of injury to the seventeen rivers named in the Statute of 1714 may be easily calculated. It will be seen that of the 18,247 square miles formerly available for Salmon, being the area of Catchment Basin, there are now only 6,607 square miles left accessible for the fish, a large portion of which being nearer the mouths of the rivers than at their upper waters, is not fitted for breeding purposes; there is therefore only about one-third of the area left that existed about one hundred years ago, whereas 11,640 square miles have been destroyed or rendered nearly unproductive by weirs and pollutions.

The consequence of this great loss of spawning ground to the fish has become very apparent, and, whereas the Salmon Fisheries of Ireland were reported by the Commissioners many years ago to produce "£300,000 a-year and more," and they are now estimated at a value of £330,000. It is very improbable that the Salmon Fisheries of England and Wales are worth £30,000 a-year, although the quantity of water naturally available for Salmon in England is far greater than in Ireland. There are seventy-three mill weirs on the Severn, the rental of the water power of which, as compared with steam power, we may estimate at from £40 to £50 each, or say £3,650 a year—and to produce this amount of power the salmon have been excluded from 324 miles of streams. The money value of Salmon produced from the remaining streams (of 344 miles) we may estimate, by Mr. Miller's Report, at from £6,000 to £7,000 a year; but if all the former breeding grounds had remained accessible to Salmon over an area of 4,400 square miles, it is possible that the gross produce of the Severn might have been similar to the rivers at Waterford, the income of which, as stated by Mr. Ffennell, is £40,000 a-year,—from an area of 3,400 square miles, or to the gross produce

of the River Tay, which exceeds £30,000 a-year, from an area of 2,200 square miles, with a fishery rental of £17,618 a-year.

The following areas of English salmon rivers have been taken from the Commissioners' Report.

				Total.
English rivers, area square miles	..	..		55080
<i>Deducting the following rivers destroyed by Weirs and pollutions.</i>				
			Square Miles.	
Thames, area	..	..	5162	
Mersey	..	..	1706	
Aire and Calder	..	..	802	
Don and Went	..	..	721	
<i>Deducting all rivers between the Humber and the Medway, being too stagnant, and some converted into sluices and canals, are unproductive.</i>				8391
Ancholme—Lincolnshire	..	..	408	
Ladd and Withern	..	..	65	
Steeping	..	..	102	
Witham	..	..	1052	
Welland	..	..	707	
Nene	..	..	1055	
Ouse, Wash—Cambridgeshire	..	..	2894	
Yare, Wareney—Norfolk	..	533 339	872	
Blythe	..	..	71	
Alde	..	..	127	
Deben	..	..	159	
Orwell	..	..	257	
Stowe—Harwich	..	..	420	
Colne—Essex	..	..	200	
Braine—Maldon	..	..	420	
Crouch—Essex	..	..	150	
				8959
The above area	..	..	8391	
Add Anglesea and small rivers polluted and not accessible to salmon, say				17350
				3000
Deduct				20350
				20350
Area of English salmon rivers	..	..	34730	
Area of Irish rivers, square miles	..	..	22947	
English excess of area	..	..	11783	

The foregoing calculations, shewing the area of the Catchment Basin of the salmon rivers of Ireland are taken from the evidence of Mr. Ffennell in the Report of the Select Committee of the House of Lords on the rivers of Scotland, July, 1860.

	Miles.
The area of the salmon rivers of Ireland	22947
Taken from the Commissioners' Report of 1861 (at page 438, see Maps), the area of all the rivers in England and Wales, is found to be	55080
From these deduct the rivers not adapted for salmon, between the Humber and the Medway, and those destroyed by pollutions, the Thames, Mersey, Aire, Calder, &c., &c. See particulars	20350
Which leaves the area of salmon rivers in England and Wales in square miles at	34730
Or an excess of area as compared with the rivers of Ireland of	11783

The 22,947 miles in Ireland produce about £330,000 in money value of salmon annually, or at the rate of £14 16s. 3d. per square mile.

At the same rate of produce the 34,730 square miles of rivers in England should produce £514,000, whereas we find that these 34,730 square miles do not produce more than £30,000 annually in money value, or 17s. 3½d. per square mile.

The facts above stated are taken from the printed Reports and Evidence of Fishery Commissioners.

We can scarcely be surprised that our ancestors for 500 years should have passed such stringent laws for the protection of salmon as an article of food, when we see the loss this country has sustained.

At the time the Act of 1714 was passed, Parliament required that the navigation of our rivers should not be intercepted by mill weirs, and that the salmon should also have a free passage to their spawning grounds—the only motive powers then in use being by windmills and water wheels.

About the end of the last century, steam power

was discovered, and has gradually superseded water power, which in consequence by comparison has become so far depreciated that at the present time unappropriated waterfalls are of little or no value, owing to the great expense of erecting wheels, goits, dams, etc., and the loss sustained by the great irregularity in the supply of water, when compared with that obtained by the use of a steam engine; so that however valuable water power may have been in the last century, steam power has become much more valuable and available as a substitute in our day. We think it could be shown that some of our salmon rivers would now be more valuable by the substitution of steam and their restoration to the original purposes of the salmon fisheries.

We may here make a comparison between two adjoining rivers:—the Wye has no weirs upon it and has an area of about 600 square miles of salmon breeding ground. The Teme has an area of 625 square miles from which the salmon are shut out by twenty-four mill weirs, the water power of which may be taken at £50 each, or £1,200 a-year. There is no doubt that the salmon from the Wye is of double the value as a fishery, when compared with the rents of the water power on the Teme.

The strongest evidence we have on record to prove the value of our salmon rivers is to be found in the stringent character of the ancient statutes for their protection. The water of many of these rivers is as pure at the present time as it was centuries ago, and would no doubt become equally valuable in the production of food, if cultivated, assuming that these obstructions could be removed or abated by the substitution of steam, or by the erection of proper fish passes over them, with some equable division of the water, by allowing the salmon to have it during the night and the millers during the day.

The value of a salmon fishery depends upon the extent of its breeding ground. The three rivers at Waterford contain an area of 3,400 square miles, and have at least a produce of salmon, amounting to £40,000 a-year, whereas the Severn has an area of 4,437 square miles, but with seventy-three weirs, and the produce may be taken at about one-sixth part of that amount.

The Report of the Special Commissioners, Ireland, 1865, states that 11,333 men are employed in the salmon fisheries; the gross amount of Licence duties amounted to £6,722 16s. 8d. They say, "In salmon fisheries protection produces fish, and fish provide the money wherewith protection may be purchased."

The Licence duties on the Shannon, with an area of 4,544 square miles, amounted so £1,531 10s. 0d. In the Waterford district, with an area of 3,400 square miles, they produced £1,158.

The Weirs on the Thames have done more towards exterminating the Salmon in that river than even the pollutions of London, inasmuch as the Tyne, although fearfully polluted at Newcastle and BELOW, is clear of Weirs and obstructions ABOVE, and is therefore one of our best English Salmon Rivers.

The Thames Navigation Act, 1866, prohibits, under a heavy penalty, directly or indirectly, the opening into the River Thames, or into any watercourses within three miles communicating with it, any new sewage or any other offensive or injurious matter into the Thames; and as to such channels as before the passing of the Act had conveyed sewage or other deleterious matter into the Thames—that if after a sufficiently long notice, which might be further extended by the Board of Trade, the flow of all deleterious matters were not stopped, those through whose neglect it happened should be guilty of a misdemeanor, and liable to a

penalty of £100, and of £50 for every day during which such offence was continued.

The provisions of this Act appear to be very wholesome, and it is desirable they should be applied in all similar enactments and extended to the whole country, and the enforcement of them be committed to proper persons to secure the object in view—that of cleansing our streams and making them wholesome, with as little injury to the manufacturers and as little expense to the cities and towns adjoining the rivers, as may be practicable.

I have selected the Thames as the worst case on record: with an area of 5,162 square miles, when compared with the Tay, the Spey, or Waterford, it should produce salmon worth £50,000 a-year. The sewage is now carried into the sea, and the pollutions in the upper streams suppressed. If all the weirs could be abolished, and steam power substituted for water power, and the navigation converted into a canal, then these artificial weirs or cesspools for filth would be removed, and the water would flow in its pure state to London, and the metropolis would have an abundant supply of water from its own river, and save some of the enormous outlay of £8,600,000 in bringing water from the sources of the Severn. We doubt if any one would estimate the cost of substituting steam power in place of the milling power, and altering the navigation to a canal, at an annual charge of £344,000 a-year, the interest at four per cent. on £8,600,000; and London would then possess an unlimited supply of pure water from the Thames—with some salmon in addition.

In order to explain the condition of the Thames, I have made a few extracts from the Report of the Commissioners on the Prevention of Pollutions of Rivers on the state of the Thames, 1866. “The waters of the River Thames rise in the Cotswold

Hills, in the Bath oolite and lias series; the head spring is 340 feet above the ordnance datum; the perennial flow of the Thames is spring water. Some portion of the bed and banks are muddy; but by far the greater length of the river's banks, and bed, is gravel, rock, clay, and marl. The length from the source to the estuary is 201 miles; the area is about 5,162 miles, of which, the area, above Hampton, there is 3,676 square miles. The Thames' main stream has 61 mills upon it, and upon fourteen other tributaries, 299 mills. It is now navigable from the estuary nominally to Lechlade, but practically not beyond Oxford. Many of the weirs and locks are old and in a ruinous condition, from decay and neglect. The rude and antiquated mode of working the navigation by 'flashes,' still prevails, and is highly injurious. Some of the weirs retain a head of water, so as to prevent land-drainage, and permanently to waterlog large areas of agricultural land on both margins of the river. At Oxford the suburbs and even urban portions of the city are at times seriously, and as regards the health of the inhabitants, dangerously, flooded by reason of the impediments offered to the free flow of the flood water, by Sandford and other weirs, etc."

The area above Oxford appears to be about 600 square miles, and is about fifty miles above Hampton, "with a population of 71,520, having three towns with a population of 2,000 and over." "Whereas above the point at which the pumps are placed at Hampton, there is a population of 900,000, within an area of 3,676 square miles, and eighty-nine towns with a population of over 2,000 each."

"The weirs above Oxford are very similar to the rymer locks, fixed with movable tackle, called flashboards, overfalls, and ground gates; in times of flood the whole apparatus can be removed."

“The water impounded at a weir may be used for navigation, irrigation, fisheries, mills, water supply. These various river interests, at least the important ones, may be reconciled under a good system of river economy.”

“Weirs immediately cause land flooding.”

The Commissioners say,—“Matters have much changed since the first mill was built on the banks of the Thames. Water power, formerly so precious, is now scarcely more than an auxiliary to steam. Trade has quitted the river for the railway. Every year the land adjoining to a mill gains in value, and it is now easy for a man to do injury to lands, to the amount of several times its own value.”

“What we should suggest with respect to weirs is, that the property in all the weirs on the Thames, now vested in private owners, and the liability to maintain the same weirs, should be transferred to the body which has the government of the river.” Above Oxford:—“The water is pounded at a weir in one of the upper reaches, above Oxford, and then let down by opening the weirs, and is passed from reach to reach, the barges riding on the crest of the wave; without these flashes the navigation cannot be conducted even below Oxford.” The Commissioners by their bye-laws prescribe that there shall be two such flashes per week. “The system of flashes is a mere makeshift.”

“Floods occur every year. Thousands of acres of land, with many roads and footpaths, vast areas of urban lands, and even streets, have been for several weeks under water, lands have been destroyed, local traffic interrupted, and human health lowered.”

“Above Oxford the navigation works are in utter decay; the channel is unnavigable, and traffic may be said to have ceased. Below Oxford the navigation is still maintained, but only by the pernicious makeshift

of flashes. The pound locks are out of repair and ineffectual. The Commissioners are unable to improve the existing state of the navigation. As a body they are insolvent. They have a bonded debt amounting to £88,400, upon the security of their tolls, and no interest has been paid for several years."

"Whether the navigation of the Upper Thames, or any part of it, can ever be made profitable, as a commercial undertaking, is a question on which we would express no opinion. If the navigation is to live against the competition of railways, it will only be after it has been placed in thorough good repair and working order," etc., etc. "That traffic should under such a system exist upon the river, in the face of railway competition, is a thing utterly impossible," etc., etc., *i.e.*, under present arrangements.

The above extracts are taken from the Commissioners' Report, and shew the present state of the Thames navigation. These mill dams are the receptacles for all the refuse and filth that passes down the river, and over which the water supplied to London has to flow, and in consequence becomes polluted.

If the navigation and the milling power could be purchased, and the *latter* converted into steam power, the river water would then flow along its natural bed and be kept pure by constant æreation; thousands of acres of land that now are covered by floods during the winter season would be left dry, and promote the health of the population, and valuable crops *sometimes* destroyed by the summer floods, would be saved.

This principle is not only applicable to the Thames but to the weirs and many mill dams all over the Kingdom, which are most serious hindrances to the effective drainage of our main valleys, and are most detrimental both to their agricultural value and to the health of the people who inhabit them.

If this object could not be effected on the lower

Thames, it might be restricted to the district above Oxford, with an area of about 600 square miles, which we will assume would produce as much pure water as would supply the wants of London within a third of the distance of the proposed supply from the sources of the Severn, and at a probable saving of millions of outlay, and would create a salmon fishery on the Thames without inflicting an injury on the Severn salmon fisheries.

The Metropolis would thus be supplied from the sources of its own river: on the contrary, if it was thought desirable to retain the mill weirs on the lower Thames, there are only 61 dams on the main river, between Oxford and London, and by adopting Mr. Ffennell's calculation, fish passes might be placed over these for £60 each, making an outlay of £3,660, and thereby enable the salmon to go to Oxford and the upper Thames streams beyond, so soon as the upper part of the river was relieved of its ruinous navigation, and enable them to spawn in streams extending over an area of 600 square miles—an extent of breeding ground nearly equal to that of the Wye.

One very important question still remains to be considered. I allude to such rivers as still possess some salmon, but where they have been, so nearly, destroyed by having been shut out from their natural spawning ground for fifty years by impassable weirs, that the quantity has become so far diminished that the licence duties are perfectly inadequate both to protect the fish and to construct passes for them over the weirs—no fish and no funds—such, for instance, as the Humber and its tributaries, with an area of 9,661 square miles, of which area not more than 2,200 square miles, on the Ouse, the Trent, and Derwent, are accessible to the salmon, with a still greater limit to their breeding ground, and of which there are many similar cases, but to a smaller extent,

in many other rivers where the water remains as pure as it was centuries ago. The Government having abolished the old laws, the difficulty has been increased of applying a remedy to such rivers where the salmon have been unlawfully exterminated. If Government would advance money, to be applied in the construction of fish passes, and to be repaid out of licence duties during the ensuing twenty-five years, some of these rivers might be restored. Or if power were given to Boards of Conservators to levy a rate not exceeding ten per cent. upon the rated value of every fishery, this might in many cases enable them to raise funds, or borrow money upon the security of the rate—similar to that of the River Tay, or follow the example of America, “where all persons who build dams on streams annually frequented by fish, do so under an obligation to keep up sufficient fishways for the passage of such fish, unless they are relieved by a special act of the legislature.”

In conclusion, I believe the general opinion of those most interested in the welfare of the salmon fisheries in the United Kingdom is to be summed up under the heads of the three following requirements.

Free passage of the salmon to their natural spawning grounds, to be paid for by Government, they having repealed the Acts giving this right, with ten hours' supply of water out of twenty-four, and to allow no fishing with nets within 100 yards of the mill dams.

All minor details, as to nets and close time, to be arranged under the supervision of the Home Office, if recommended by the several Boards of Conservators, under the control, after a public enquiry, and with the advice of the Inspectors.

The main object the promoters of Salmon Preservation had in view in 1861 was to prevent the extinction of the salmon. In repealing the ancient laws

they wished to remodel and consolidate them in one Act and substitute a more easy mode of procedure for enforcing them.

It now appears, however, that, although great general benefit has arisen to the Salmon Fisheries of England by the clearing away of innumerable fixed engines in the tideway, and by an improved system of protection to Salmon, neither the Act of 1861 nor the amended Act of 1865, as they now stand, give sufficient *authority for enforcing a free passage of fish to their natural breeding grounds in the upper streams* where alone they can be safely bred, and that the Act of 1861 in repealing that portion of the old Acts, which enforced a free passage for the fish, an unfortunate mistake arose, which it is necessary to remedy as quickly as possible, in order that our English Salmon Fisheries may be fully developed.

A very moderate supply of water, if properly arranged, will enable fish to run over mill dams, but where the miller has built too large a mill for the size of the river and takes the WHOLE of the water down his mill race, it is impossible that the best system of Fish Ladder or Pass ever invented can be of much use, so long as the Fish have no water to get access to it or to pass over the fishway.

It will be seen therefore how very desirable it is that a more efficient Act than that of 1865 should be passed, and it is hoped that all persons in the United Kingdom interested in the preservation and protection of the Salmon species will lend their assistance by every means in their power to obtain from Parliament improved legislation.

The various Boards of Conservators are already engaged in reporting to the Inspectors of Fisheries the alterations required in order to carry out more efficiently the Acts of 1861 and 1865. And inasmuch as it has been proved in Ireland that different

rivers cannot always be controlled by the same general rule, there can be little doubt that great improvements may be made by modifying the law in various localities according to the natural capabilities of the rivers of the United Kingdom, which have now been for the first time carefully inquired into and reported upon by the Royal Commissioners and Inspectors of Fisheries.

On the Severn the Commissioners inform us that the area is 4,437 square miles, and Mr. Alexander Miller informs us that there are 668 miles of streams with seventy-three mill weirs.

These seventy-three owners of mills we will assume obstruct a tenth part of the bed of the river by means of weirs placed across the stream, all of which to a greater or less degree exclude the salmon from their spawning ground, and destroy it by converting it into deep pools; and whilst obstructing the river for water power destroy their own salmon fishery as well as that of nine-tenths of the other proprietors of the river, who have no interest in the mills, and whose salmon fisheries in these rivers were protected for upwards of five centuries, until 1861. Thus at least nine-tenths of the salmon fishery proprietors of the Kingdom were sacrificed for the benefit of the other tenth, viz. the mill owning proprietors, and the nation lost food worth nearly half a million a-year when compared with the produce of Scotch and Irish rivers, of which the Commissioners say:—"They are not superior in natural capabilities to England and Wales, and at the present moment far more productive." It is estimated that a sum of £2,000 would make the seventy-three mill weirs on the river Severn passable to salmon, and would probably yield an increased return of food to the country from these 4437 square miles of at least £40,000 a-year, to the mutual benefit of both the owners of mills who

are fishery owners, and proprietors of river fisheries who are not mill owners.

As there are but three parties interested in this question, we will endeavour to explain their relative positions, as they naturally occur.

1st. The ancient riparian proprietors of the banks and bed of the river, whom we will call the salmon fishery proprietors.

2nd. The mill owning proprietors, who have contrary to statutes built weirs across the rivers—for their own private benefit.

3rd. The public, who have been deprived of valuable and nutritious food.

We will first deal with the ancient salmon fishery proprietors. The Act of 1865 has destroyed all fixed engines in our estuaries, on the principle that it was a transference of the property of the river proprietors to those on the sea coast, and this, with the power of protecting the salmon in the accessible portions of the upper waters, has greatly improved the produce of the fisheries. But if the Legislature considered it necessary to abolish these unlawful destructive engines, in order to improve our fisheries, how much more important is it now to remove or at least render less mischievous by making fish passes over the most destructive engine that was ever invented, which has destroyed the property of the ancient fishery proprietors as well as of the public.

The mill owning proprietors for many years have built these walls across our salmon rivers, contrary to statute law. They do not occupy the tenth part of the length of our rivers, and have destroyed the property of the fishery proprietors and the public food to the amount of (by comparison with the Irish rivers) half-a-million of pounds a year. This food can only be restored by allowing the salmon to resort to the upper waters, where alone they can be safely bred.

It has been supposed that the water power used in manufacturies of this country was of much greater importance than the fisheries. I have endeavoured to collect reliable information upon the extent and value of all the water power in the United Kingdom, by comparison with steam power, and the only information I have met with has been from the Factory Inspectors Report, 1862, from which I have taken the following extracts:—

All the Cotton mills in the United Kingdom are included in the 18,465 horse-power, but there are in Lancashire, York, Gloucester, and Derby, cotton, woollen, worsted, flax, and silk mills, in districts in which the waters are polluted and destroyed as salmon rivers, over an area of 8,500 square miles, and these I have deducted from the Factory Inspectors Summary:—	
Cotton	5037
Woolen	3505
Worsted	1443
Flax	365
Silk	524
11092	
Also all the water power used in Scotland, as follows:—	
Cotton	3708
Woolen	3592
Worsted	176
Flax	1800
Silk	180
7256	
And also in Ireland:—	
Cotton	290
Woolen	529
Worsted	682
Flax	2394
Silk	60
3845	
Leaving the amount of water power in England and Wales used in manufacturies, as regulated or salmon producing rivers, at	
2886	

		Indicated Horse power.	
		Steam.	Water.
Summary of Cotton Factories in the United Kingdom, see p. 65, total Cotton mills ..	..	281663	12467
Summary of Woollen, p. 78, United Kingdom ..	..	26879	9598
„ Worsted, p. 103, „ ..	..	26234	1970
„ Flax, England and Wales, p. 110 ..	..	8505	976
„ Flax, Scotland, p. 110 ..	..	12512	994
„ Flax, Ireland, p. 110 ..	..	10710	2384
„ Silk, in the United Kingdom, p. 129..	..	6186	864
„ Hemp in England, p. 138 ..	..	39	0
„ Hemp in Scotland, p. 138 ..	..	88	0
„ Jute in England, p. 188 ..	..	62	0
„ Jute in Scotland, p. 138 ..	..	1736	60
„ Jute in Ireland, p. 138 ..	..	245	0

All the Cotton mills in the United Kingdom are included in the 12,467 horse-power, but there are in Lancaster, York, Chester, and Derby, cotton, woollen, worsted, flax, and silk mills, in districts in which the waters are polluted and destroyed as salmon rivers, over an area of 9,500 square miles, and these I have deducted from the Factory Inspectors Summary :—

Cotton ..	8633
Woollen ..	3265
Worsted ..	1455
Flax ..	365
Silk ..	374

14092

Also all the water power used in Scotland, as follows :—

Cotton ..	3766
Woollen ..	2292
Worsted ..	176
Flax ..	1800
Jute ..	60

7294

And also in Ireland .—

Cotton ..	290
Woollen ..	529
Worsted ..	82
Flax ..	2384
Silk ..	60

3345

Leaving the amount of water power in England and Wales used in manufactures, upon unpolluted or salmon producing rivers, at—

3886

28617	374869	28617
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	Horse Power in Water.
Waterpower upon salmon rivers used for manufacturing purposes	3886
Adding to the above three corn mills for every other kind of mill, excluding all mills in Lancaster, York, Derby and Chester, and all mills between the Humber and the Medway, over an area of 8,604 square miles as unproductive of salmon	11658
Estimated total amount of water power used upon salmon rivers in England and Wales in horse power ..	15544

The water power for milling and manufacturing purposes appears to be 28,617 horse power, or seven per cent. when compared with the steam power at 374,869 horse power, or 93 per cent. of the whole ; and the total quantity of water power used upon salmon rivers may be estimated at 15,544 horse power. Many of the mills do not exceed six or ten horse power each, on small streams. A few may be taken at twenty horse power and upwards each ; if we take them to average twenty horse power each, we get 777 weirs, or at twelve horse power each we get 1,295 weirs. I will estimate the larger number, that is, 1,295. Of these weirs one-half may be taken at four feet in height and under, and these could easily be made passable to salmon ; the remaining half, or 647 weirs, I will estimate at the maximum rate of £60 each, according to Mr. Ffennell's calculation ; thus, 647 at £60 each would amount to £38,820, say £40,000 as the expense of making fish passes over all the weirs upon salmon rivers, extending over an area of 34,730 square miles, in England and Wales.

It appears from the Fishery Commissioners' maps of all the rivers in England and Wales, that there are

Rivers with an area of	20 to	100 square miles	..	154
„	100 to	300 „	..	32
„	300 to	600 „	..	15
„	600 to	1000 „	..	5
„	1000 to	5000 „	..	12
Total				218

We will assume the fish passes are to be made at the expense of the riparian proprietors of the rivers, or by their Boards of Conservators, with a provision that when so made, every fish pass shall have a supply of the whole water of the river to run through such passes for ten hours of each night, say from 7 o'clock in the evening to 5 o'clock next morning. There may be a few cases in which the mill owner has worked his mill both day and night, and in such cases where the miller can prove that he has done so for the previous five years, that the conservators shall compensate him for any loss that he may sustain beyond the fourteen hours, for the water power that he may be deprived of during any portion of the year, and during which it may be required by the salmon passes. Under these circumstances the mill owner would sustain no injury. The fishery proprietors having incurred this expense, it would only be reasonable that their water bailiffs should be allowed to traverse the banks of the rivers for the purpose of protecting the salmon during the spawning season.

The few mills that work both night and day absorb all the water that the river may produce, and it is obvious that a fish pass of the best construction would be of no avail in such instances. Having thus provided a ten hours' supply during the night over the fish passes, and that no fish shall be caught within a hundred yards of any weir, and that the water bailiffs shall have the power to traverse the banks of every river in order to protect the fish, otherwise the efforts of the conservators would be defeated. Salmon is a migratory animal that can only be bred in the upper streams of a river; they are fed in the sea, and if you exclude them from a river, or exclude them from the sea, they may soon become extinct.

These two I consider indispensable requisites for the restoration of our fisheries, and until they are con-

ceded the public, who have been deprived of a vast amount of valuable food and saleable property, can never expect to see it restored.

The question as to the effect of ordinary sewage from a town I contend is not so destructive to fish as is generally conceived, as wherever aquatic insects are bred in, and washed out of the sewers into a river of any magnitude, vast quantities of fish may be seen hovering around the mouths of the sewers, and evidently feeding upon this insect food washed into a river, but there are, no doubt, cases where the quantity of sewage may become a perfect nuisance when cast into streams too insignificant to carry it away. On the Avon, at Bath, the greatest number of anglers are to be seen within 50 yards of the mouths of these sewers.

The most deadly pollutions are gas tar, lime, lead washings, and poisonous matters, all of which should be excluded from every river, as they are from the Thames, under the Navigation Act, 1806. And it would be most advisable for Governments in the first instance, without waiting any further report from the Commissioners of Pollutions, to adopt their suggestion that all chemical matter should be confined to filtering pits, when a large portion of the refuse could be recovered in a useful form.

The bag and stake nets and other fixed engines have been justly abolished. In the instructions contained in Her Majesty's Commission of the 31st July, 1860, it is stated to be "a Commission of inquiry into the Salmon fisheries of England and Wales, with a view of increasing the supply of a valuable article of food for the benefit of the people."

With these instructions the Commissioners proceeded to investigate the condition of all the salmon rivers in the Kingdom, and printed the result of

their investigation upon 545 pages, with a Report appended to the same of 36 pages, and it is from the latter Report that we have copied a few extracts, in order to show how inefficiently the Fishery Act of 1861 carried out their recommendations and intentions.

From the reliable information we have before us it will be clearly seen that the value of our fisheries has been so much damaged by the various mill dams all over the country, that some remedy is *absolutely* necessary to prevent the annihilation of salmon altogether. For example, nothing would be more just than some enactment to compel millers—most of whom have gained their rights at the expense of the public interest—to give up part of the water now used in milling for the purpose of enabling a passage to be made for fish, and this may be done either by securing an alternate use of the water by day and night, or in some equable manner apportioning the water for some days in each week, so as to combine both interests without seriously injuring either.

The object therefore of the present Statement is to enable all Members of Parliament and others connected with the Salmon Fisheries to have a correct insight into the actual requirements of the public right to enforce the cultivation, protection, and natural capabilities of the various rivers for producing a valuable supply of food; and to shew the unfairness of enactments which allow the public interest at large to be severely damaged for the benefit of a few individuals.

APPENDIX.

Extracts from the Reports of the Commissioners appointed to enquire into the Salmon Fisheries of England and Wales.

I.

* * * * In spite of the disadvantages which now attach to them these large rivers with their unobstructed estuary are well worthy of attention and if a free passage were opened through them the fisheries would be of great value.

Viewing, then, the rivers in England and Wales as a whole, and setting aside those waters which have been poisoned by mines, or greatly contaminated by the pollutions arising from manufactures, there remains still a vast area possessing great natural advantages for the production of salmon. The rivers of England and Wales exceed in extent those of either Scotland or Ireland, which supply great quantities of salmon, and yield a large revenue. They embrace a full average proportion of water well suited for the breeding of fish, with rapid streams, and deep pools, and the upper parts contain good gravelly spawning beds. They thus possess every requisite for increasing the supply of a valuable commodity, were not the bounty of nature frustrated by the perverseness or negligence of man.

It had been alleged in certain petitions presented to Parliament shortly before the issuing of this Commission, that the supply of salmon from the rivers and fisheries of England and Wales had of late years considerably diminished. We made it our first object to ascertain in the several localities we visited, how far such an allegation is founded on fact. We regret to state that it has been fully substantiated by the evidence.

In some rivers the fact is patent and notorious. Salmon formerly abounded, but have now almost or altogether ceased to exist. These are the cases in which mines or manufactures have poisoned the waters or obstructions have been erected, by which the fish have been blocked out from the breeding grounds.

The instances of extinction are but few; those of diminution, in a greater or less degree, exist in every river that we visited.

These facts were generally attested by living witnesses speaking from their own experience, particularly by fishermen and others who had good opportunities of observation. The decrease of fish is in most cases stated to have been very great; in some rivers the present supply is described as not being more than 1 in 10, 1 in 20, or even 1 in 100 compared with what the witnesses personally recollect. There might be some ground to suspect exaggeration in these statements, although they were almost universal, were they not supported by other evidence of a very cogent nature. It was proved for example:—

1. That the price of the fish had greatly increased.
2. That the rents paid for fisheries had much diminished.
3. That the numbers of persons and boats employed in the fisheries had fallen off.

Lastly. It was shown by the evidence of authentic records and documents that the number and weight of fish actually taken in former times were much greater than at present.

We need scarcely observe that such a result is extremely unsatisfactory, above all, when it is remembered that it has taken place in the face of a large increase of price and a greatly extended market. If a fishery was let for £400 a-year, when salmon was commonly sold on the spot at 4d. a lb., what should be said of a rental which has dwindled down to £10 or even £5, while the fish has increased threefold or fourfold in price, and the tenant has direct access to the largest markets in the kingdom? It is obvious that the produce of such fisheries must have decreased in even a greater ratio than their rental.

In regard to this species of property, we feel called upon to notice a circumstance with which we were much impressed—that, generally speaking, much apathy and indifference prevailed on the part of the proprietors respecting it. In most cases the owners of private fisheries appear to take little pains either to protect their rights or to increase their rentals. No doubt the depressed condition and falling value of this kind of property have had a discouraging effect on their minds. But probably they have been in a still greater degree deterred from making exertions or incurring expense in protection or improvement by the difficulties which, in the present state of the law, oppose themselves to any concerted attempt to ameliorate the fisheries.

It is certainly not attributable to any defects in the elements of value. The sources of wealth exist to a greater extent unimpaired, but their development is checked by artificial causes; chiefly by the want of the facilities which proper legislation might give for combined action among those whose interests urgently require it.

The contrast presented by the values of some of the private fisheries in Scotland and Ireland, when compared with those of this part of the kingdom, is very striking. It was stated by the late Duke of Richmond to a committee of the House of Commons in

1850 that the clear profit of his fishery on the river Spey had amounted in the preceeding year to £12,460. The Duke of Beaufort possesses a right of fishing about 20 miles in extent on the lower part of the Wye, a river which in regard to its natural capabilities may be regarded as second only to the Severn. The rental which his Grace receives for the fishery is only £120 per annum. This is a striking, but by no means a solitary case of extreme depression.

The conclusion as to the decline of the salmon fisheries, to which the evidence and records above referred to have led us, was irresistibly confirmed by what we ourselves witnessed in the course of our inspection. We had opportunities of seeing those causes in full operation to which the destruction of the fish was generally ascribed, and we have no hesitation in declaring that in the face of the impediments and barriers, and other destructive agencies, which exist on all the rivers, it is impossible that any other result than a great deterioration of the fisheries could have taken place; indeed, it is in some cases a matter of surprise, not that the supply should have greatly fallen off, but that the breed should not have been totally extinguished.

Of all the evils that affect the fisheries artificial obstructions must beyond all question be regarded as the most pernicious. It is obvious that to exclude the fish from entering the rivers at all is a surer way of destroying the breed than even the most deadly mode of making war upon them when they are there. Moreover it is certain that these barriers to the passage of the fish, even if they do not absolutely shut them out, offer great facility and encouragement to the unfair means employed for destroying them.

In many parts of England and Wales we found weirs and dams extending across the whole breadth of the rivers, presenting from their height and construction great obstacles to the ascent of the fish, in some cases absolutely impassable in any state of the water, in most others insurmountable except in time of fresh or flood. In very few instances had any mode of passage for the ascending fish been provided in the shape of stairs or ladders, and in no instance were such conveniences properly constructed.

Of the rivers in which this evil exists to the greatest extent we may specify the Ouse, Wharfe, Eure, Derwent, and others in Yorkshire, in which salmon formerly existed in good quantity, and which are well adapted by nature to produce them, but from which they are now all but totally excluded. We may instance also the Severn, Dee, Tyne, Lune, Derwent in Cumberland, Tawe, Torridge, Avon (Hampshire), and Test.

II.

Of the lamentable destruction of animal life and waste of human food which is caused by the stoppage or detention of the fish by these barriers, no one who is at all acquainted with the habits of the

salmon will need to be informed. The instinct by which these fish are impelled at a certain season of the year to make their way from the sea for the purpose of depositing their spawn, the early breeding fish ascending to the higher parts of the stream, the later fish in succession sowing the lower portions with their seed, so that in the natural state of things the whole course of a river so far as it affords suitable spawning ground, becomes stocked with the ova, is one of the most beautiful arrangements of nature, but it is effectually thwarted by these obstructive contrivances of man. Meantime the spawning beds in the upper parts of the stream are left unstocked, and the proprietors and inhabitants above are robbed of their due share of what should be the common property.

We could scarcely express in too strong terms our conviction that the existence of these obstructions in the rivers, unprovided with any means for enabling the fish to get up to spawn, is a cause fully adequate, even if no other existed, to account for the gradual disappearance of the fish, and that if effectual means be not taken to obviate this evil the gradual extinction of the breed of salmon in the rivers thus circumstanced must in no long time be anticipated.

A reference to the old and fundamental principles of the statutes relating to fisheries will show how decidedly the law of England from a time anterior to the oldest of these erections has set itself against any attempt to create fishing monopolies by obstructing the free run of salmon throughout the rivers, and how it strove, in spite of incessant attempts to defeat its injunctions, to give effect to the natural law of distribution, by which the occupants from source to sea are entitled to their fair share of the produce of the waters.

It clearly appears, therefore, that from very early times down to the present reign, it has been the constant aim of the Legislature, however thwarted by the negligence or cupidity of individuals, to insure a free passage to the salmon ascending and descending the rivers in obedience to their natural instinct, and to remove all artificial obstructions to their so doing. But, besides these statutory prohibitions, it is clearly laid down by the best authorities that the erection of weirs in a public river so as to injure and obstruct the passage of fish is a public nuisance at common law, and that no length of time will legitimate the continuance of such an obstruction.

It remains for us to specify the measures which, in our opinion, are needed to remedy the evils now prevailing, and to restore the fisheries to that state of productiveness which their natural capabilities admit of. Some of those remedies are indeed obvious, and with regard to most of them there is not much difficulty in suggesting the steps which ought to be taken, provided the practical difficulties which may arise in adopting them can be overcome. We trust that the impression of the existing evils, and of the obligation of remedying them, may be so strong as to induce a vigorous effort on the part of the Legislature to carry through, in the interest of the public, those statutory measures on which the well-being, and indeed the existence of the salmon fisheries of England and Wales depend.

structed; but as no two weirs are similar, the form of the ladder will require to be varied according to circumstances. The entrance to the ladder should always commence from some favourite pool at the foot of the weir, where the fish resort in the greatest numbers, and the ladder so curved as to bring the mouth of it over the pool, and the flood waters so controlled by dam boards as not to inundate the ladder and thus cast the fish back.

May 21st, 1867.

SALMON FISHERY.

ADDRESSED TO THE PRESIDENT AND COUNCIL OF
THE INTERNATIONAL CONGRESS TO PROMOTE
THE CULTIVATION OF FISHERIES, HELD
AT BRUSSELS, 1865.

CHAPTER I.

INTRODUCTORY REMARKS.

Our salmon fisheries of Great Britain are naturally very productive, but it is not until a recent period that science has been devoted to this subject, or has led to important practical results or discoveries. In developing the natural history and habits of the salmon, the following facts are ascertained.

The migrations 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 the fisheries and culture, the results of which, both to the interests of salmon fisheries, and to the general public, are now beginning to demonstrate themselves throughout Great Britain.

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.

CHAPTER I.

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 important 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.

Where salmon place their eggs they may be seen and protected, or destroyed, 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 labour 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 labour 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 labours. 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 creature;* 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 owing to the development of enterprise—the invention of more skillful appliances for the capture of fish; and the dis-

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

covery 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 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, 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 pro-

portion to the number actually caught*—the result of our labours 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 birth-place; 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 moreavenous 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,

* 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.

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 has been occasionally 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 migratory instinct, it returns back to the fresh water, and again to the river where it reproduces its species.

* 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 upwards, and that some do not remain in the sea longer than a few months.

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 birth-place. 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 almanack.

CHAPTER II.

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 in large streams, 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 get into the smallest and most elevated streams in which they can swim and find shelter. The small streams are found, in area, to be the most productive—even those not exceeding from three to six feet in width, with pure water and gravel beds. 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 know 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 favourite 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 become the food of other fish 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 larger are the pools and 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 6 lbs. in weight,

whilst in others, very similar, the fish are often 9 lbs. each; in this latter case we may suppose the ocean and the river afford them a supply of better food in greater abundance.

We may assume that the food in the ocean may be greater in some or less in other seas. The food in the rivers varies. Some rivers drain a peaty, poor soil, in which the fish from its infancy is stunted, 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 some 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 40 or 50 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 flow 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 dif-

* 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. They went to the sea as lean kelts, and had become fat from the quantity of food they had found.

ferent 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.

CHAPTER III.

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 possess an *adequate extent of accessible and suitable breeding ground*. Salmon can only be bred in fresh water, and it is in the *small streams* or upon shallow gravel beds 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. 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 rippling 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 the sea, and ascend to the small streams to deposit their spawn. To effect this object, a licence 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, in which the proprietor lays out £1,000 a year, in addition to the licence duties, in protecting the breeding fish from being killed by poachers whilst on the spawning-beds; upon my own fishery about a hundred men are so employed, at a great cost.

Penalties are imposed upon any man who is found

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

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 salmon. 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*. 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.

CHAPTER IV.

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, and in the rivers, 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 £330,000 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 Doo-hulla, not more than ten feet in width, but having several tributaries, 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 with lakes upon it, 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 licence 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 left their food on the

sea coast and passed through the brackish water, and arrived, by means of floods, in the upper portions of the river or lake 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, 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 all 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, or any large fish, to remain in it, except during these periodical floods, during which they spawn, and then they retire to the lake for shelter and return to the sea.

CHAPTER V.

CULTIVATION OF A SALMON RIVER.

I shall now proceed in my endeavour 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 at least four years to produce marketable salmon of the average weight. Now we have a migratory creature 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, in 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 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 perfectly 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 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.

CHAPTER VI.

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, namely, 600, of ova out of its stomach, and placed them in a separate box, where many 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, their natural enemies, 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 fish 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 my friend 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 $170\frac{1}{4}$ lbs. exclusive of the roe, which weighed $139\frac{1}{2}$ ounces. 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,

while 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 3,000 ever became a marketable fish.

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 a 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. Ffennell 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.*

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 an-

* 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, and 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 pollack, seals, fishing frog, *Lophius piscatorius*, or otter. 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.

nilhilating 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, 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 fish 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 attendant 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 employ about 100 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.

By this means the money value of a fishery may be increased. From natural causes, beyond the power of man to discover, it will be seen that great irregularity occurs in 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, for fifty years, during which no two years are similar:—

AN ACCOUNT OF THE FLUCTUATIONS OF LORD GREY'S KIN- FAUNS 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 Kingfauns during the ten years that stake nets remained was diminished to 46,663 salmon, but for the ten years after their removal the quantity in-

creased 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 1865. 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
„ 1853	„	8,715	17	6
„ 1854	„	9,269	6	5
„ 1855	„	9,977	13	5
„ 1856	„	10,199	10	4
„ 1857	„	10,772	0	5
„ 1858	„	11,487	2	5
„ 1859	„	12,884	14	0
„ 1860	„	13,827	10	7
„ 1861	„	14,109	15	7
„ 1862	„	14,080	12	0
„ 1863	„	14,232	16	6
„ 1864	„	16,742	5	2
„ 1865	„	17,618	0	7

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 September, instead of 26th 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 August instead of 14th September, (since closed on the 20th August.)

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.

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.

CHAPTER VII.

SUCCESS IN SALMON BREEDING.

Although I was the first to try the experiment of breeding salmon artificially in the United Kingdom, and have continued the system to the present time, yet time and experience have convinced me that the increase in the produce and value has not arisen from the adoption of any artificial means of hatching and rearing the young fish, but in consequence of increased 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 some 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.

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 traverse 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.

CHAPTER VIII.

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 I.) 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 22nd, 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 in 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, repealing

all the ancient Acts, and another in 1865, to amend and improve the previous Act of Parliament. The object of these various laws was to protect the parent salmon in the breeding season, and to prevent an undue proportion 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 which I need not explain.

CHAPTER IX.

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 endeavour 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 the Furbogh, all the fish might be easily destroyed, and the public would thereby sustain the loss of so much food.

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

3rd. 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 60 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 breed, 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 Ballo-sidare corn mills, about twenty feet in height; the third is at Callooney. 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 after eleven years the number of salmon caught has been stated at ten thousand fish in one year; area, 260 square miles.

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 grounds, and were protected whilst upon them.

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 inter-

cept the fish in their free passage up and down, until they arrive at the falls of the Rhine at Schaffhausen, a distance of nearly four hundred miles in length of the main river, with various tributaries. The natural instinct of the fish leads it to the uppermost mountain streams, about sixty miles in length, lying between Basle and Schaffhausen; the first, 300 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 300 miles any fish could be caught by lines and baits, and comparatively but very few are caught 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 300 miles from the sea, and caught in Holland, where the people only invent the most destructive nets that have ever been conceived of—800 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, and deep pools.

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 and 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 re-

striction ; 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 a 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.

2nd. 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.

3rd. 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 60 feet, the falls at Schaffhausen being from 45 feet to 60 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 is based upon my own experience of what I have seen, 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, over this vastly increased area.

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 is 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 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 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 inscruta-

ble 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.

CHAPTER X.

CONCLUSION.

Thus then I have endeavoured 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, 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 neighbours 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 labours 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.

N.B.—A Medal with the following inscription from the “Société Scientifique, Exposition Internationale de Pêche et Aquiculture, 1866. Recompense Monsieur T. Ashworth, élève de Saumons, memoire sur l’elevage des Saumons.”

AMERICAN RIVER FISHERIES.

THE Commissioners of Fisheries have kindly presented me with a copy of their Report, 1868, for the States of Maine, New Hampshire, Vermont, Massachusetts, and Connecticut.

As the Report consists of 50 pages, I regret that I can only make the following extracts.

The State has made annual grants for the improvements of their fisheries, and for making "fishways" over the weirs and dams, and has also provided laws for the protection of the fish, artificial breeding, and the construction of fishways by millowners.

The United States have wisely followed the example of the French Government, for the improvement of their fisheries, as the following extracts will show :—

COMMONWEALTH OF MASSACHUSETTS.

REPORT.

To His Excellency the Governor and Honorable Council.

The Commissioners of Fisheries, appointed under chapter 238 of the Acts of 1866, beg leave respectfully to present their Second Annual Report.

The fishways at Lowell and at Lawrence, as had been hoped, were finished, and the water let on, last spring; and thus the Merrimack was once again opened, after being closed for eighteen years. Although the violent current could not be at once regulated in the long fishway at Lawrence, it is gratifying to know, that, notwithstanding this unfavourable circumstance, salmon passed over this dam, and over that at Lowell, and were taken early in June near Nashua, in New Hampshire. It seems therefore reasonable that the five years "jubilee" allowed by law to this river, assisted by artificial breeding, should make fish abundant therein.

Shad also appeared at Nashua, but it is not certain that these actually surmounted the Lawrence fishway, for about five hundred were, by order of the Commissioners, carried above the Lawrence dam; a difficult operation, because this fish, like most of those with loose scales, is extremely tender, and survives neither confinement nor rough handling. They were taken with the seine about two miles below the dam; were at once put into a tank of cold well water, and carried in a wagon to the mill-pond, where the wagon was backed into the river, and the fish speedily liberated. All attempts to transport them long distances failed; but it is yet possible that this might be done by icing the water till the fish was nearly paralyzed; just as a trout laid on moist snow will live for hours, though it would speedily die if exposed to a warm sun. In addition to those which were thus artificially transported, it is probable that a few passed up the fishway, because fishes resembling shad or alewives were seen going up. That eels found no difficulty was quite plain when the water was drawn off, and the whole floor of the pass was found to be alive with them, great and small. Like unwelcome guests, they came many and early, and ready to devour all the spawn of useful fishes that they could find.

New Hampshire has completed the work on this river, by putting ways on all the important dams within her borders; and the experiments there have fixed the conclusion that "Foster's fishway," described and figured in the last Report, is by far the cheapest, simplest, and most effective of those now known. It is only where the space is limited that the box-way, or double stair, like that at Lowell, is desirable.*

The salmon ova planted last autumn in the Pemigewasset, by order of the New Hampshire Commissioners, are thought to have done well, and the young parrs have been seen this autumn by Dr. William W. Fletcher, of Concord, who has had this service in charge, and who has successfully hatched and raised a number of parrs in a little spring near his house. Dr. Fletcher is just back from an expedition after salmon ova to New Brunswick.

As to the great Hadley Falls dam on the Connecticut, it is true that the 10,000 dollars actually voted for restocking rivers and ponds might, in part, be applied to making a fishway under the plea that this was among "appliances and structures useful for the passage of the fish." But then this sum would not be enough. In their Report of last year (page 3,) the Commissioners stated that 10,000 dollars was a minimum estimate for this fishway; and subsequent examinations have tended to raise this estimate to

* On the Susquehanna, at Columbia, Col. James Worrell has made a fishway by cutting a section forty feet long out of the dam, down to a level somewhat below that of the water underneath the dam. Beginning at this, at its lowest point, an inclined plane with sides (in other words, a trough) is constructed *up stream*, in and beyond the thickness of the dam. Through this—what may be termed *reversed*—fishway the shad passed last spring in numbers, and, for the first time in nearly thirty years, were seen fifty miles, above on this river and the Juniata. The result shows that shad not only return to their place of birth, but will, when occasion offers, penetrate *beyond* it.

12,000 dollars at the lowest, and to 17,000 dollars at the highest.

These delays, be they right or wrong, on the part of private corporations, are the more to be regretted, because the State has shown the utmost activity and good faith in trying to repair any injuries to fisheries whether at home or abroad; and it is proper to add that on the Merrimack River the companies have shown a large spirit, and have been ready to go beyond what the law absolutely required of them.

The law passed at the last session, together with the progress of the work in hand, have turned the attention of the Commissioners to various plans for restocking our waters by artificial or natural propagation. As this whole subject, though not new, is certainly NOVEL to our people, it is well to consider to what point we have come, here in New England, in the matter of animal food. We have come, then, to good beef at 35 cents a pound, poultry at 33 cents, sea fish at 20 cents, and other things in proportion. As to game, we have come to grouse, venison, quails, and ducks, brought 1,200 miles by railroad, and sold at high prices to people who can afford such delicacies. Time was when our country boys could go to the next brook and catch enough good trout for a meal; now one may buy a pound trout if he has got half a dollar wherewith to pay for it, and he will probably get a newly spawned fish, speared in its bed, and which the fish-monger is prepared to prove was "caught out of the State!" People complain, and the legislature passes game laws, and nobody pays any attention to them after they are passed. Why? Because we insist on considering wild animals as our remote forefathers considered them, when men were scarce and wild animals were plenty. In a new country the first settlers may properly have, not only liberty, but in some things license; license to till land

anywhere, to cut wood anywhere, to shoot and trap game anywhere, to catch fish anywhere and in any way. All such things are then too plenty. As population increases land and wood become PROPERTY, until, as in Tuscany, the one is cultivated by the square rod, and the other, as in Paris, is sold by the pound. This is the march of civilization; but in our march of civilization we have very thoughtlessly trampled under foot a most valuable PROPERTY, because of a vague idea that it was game, and, by immemorial right, belonged to anybody and to everybody. And to-day there is many an honest fellow who might safely be trusted with untold gold, but who, nevertheless, would not scruple to steal trout from your brook. This feeling gets strength from the loose impression that game, like the Indian, is doomed, and that the last shad or trout is soon to be caught,—a sort of Dr. Fear-the-worst theory.

Let our people once clearly understand that these fish and these oysters are real PROPERTY, to be increased and to be raised in value like other property, and there will be no more difficulty about the rights of owners.

Laws have hitherto done little to check the destruction of valuable fishes, and that from the rivalry of the very men who should support such. If there was blame, it lay at the door of the weir people, who took all the young fish. Nearly all agreed, however, that the fish had diminished in numbers and in size, but they attributed this failure, with striking unanimity, to the Holyoke dam.

The average yearly take of shad in Connecticut is estimated at 628,500.

The chief elements of the general questions are these:—

1. At what periods do the salmon, the shad, &c., come into, and go out from, our rivers?

2. When they go out, do they remain near the river mouth, or do they stand out far into the deep sea, or do they retreat in a direction parallel with the coast, to the warmer waters of the South ?

The different classes of fishermen, and the different modes of fishing, have been considered at some length, in order to show that LAWS ALONE will scarcely provide for a great increase of our valuable fishes, and this because there is a greater or less opposition and rivalry among those classes, which breaks up unanimity of PROTECTION, while the effect of their combined action is unanimity of DESTRUCTION. That good laws will be a wholesome check there can be no doubt, but they alone will not suffice to make our rivers and ponds a sure source of abundant food in the same sense that our pastures are so.

On artificial breeding the Commissioners intend, if possible, to make experiments next summer on a large scale, both in the Connecticut and Merrimack Rivers. If seconded by the authorities of Connecticut, there is no reason why the fisheries, within two or three years, should not be a good deal augmented.

When the fishway at Lowell was building some of the factory superintendents (very intelligent men about FACTORIES,) said that the fish must have a schoolmaster to teach them to go up those steps ! The next year shad and salmon DID go up, and without any schoolmaster. The nearer we get to the truth the more it stands out that artificial propagation and free passage over dams are the two great conditions of restocking rivers. The question of pollution assumes a smaller proportion. It now appears that sawdust does not kill trout, but their SPAWN only, and that chemicals, unless in unreasonable quantity, do not much affect a great stream. The dreaded Winsor Locks turn out to be comparatively innocent of the destruction of young shad. Reasonable care

and just regulations will keep all these pollutions within bounds, and render our streams fit habitations for their people. Shad are by no means the only fish that may be increased by artificial breeding. The salmon has already been spoken of, and a table has been given to illustrate this part of its history.

Thirty years ago no fresh salmon were brought to our market from the British Provinces, simply because the Ponobscot, the Kennebec, and the Androscoggin were full of them, while the Canadians had already exhausted the tributaries of the St. Lawrence above, and including, the River Jaques Cartier. Now we have shut out the fish by high dams, such as those at Augusta, at Great Works, &c. But the Canadians, by wise legislation, have re-peopled their streams, and the St. Lawrence at present boasts 87 salmon tributaries.

These black bass, apparently impelled by no other feeling than that of restlessness, performed an underground journey of fifteen miles in a brick aqueduct whose greater diameter was six feet !

The alewife, (*alosa tyrannus*), although very inferior to the species above cited, is valuable, first, on account of its great prolificness, and secondly, because in its ascent from the sea it will penetrate in vast numbers the smallest brooks. At the spawning season it is extremely tame, and will crowd into the locks of a canal, or any unusual place, whereas the shad is much more shy, and only effects the more open parts of a stream. On the Agawam River, the alewives, after passing up a small ditch, whose lower end was among the clatter of mill-wheels, and 250 feet of which were covered, pushed through an under-ground drain a thousand feet long, in order to get to the pond where they spawned. This under-ground drain became stopped, and the young alewives could not get to the sea. Some of them were taken in January, and had

not grown since October, for they were no bigger than in that month. Others, taken afterwards, were two-thirds of their natural size; but whether these last were old fish that had been shut in, or whether they were lane-locked young of a previous season, or of the same season, could not be determined. In a brook whose water was so cold that the alewives avoided it, Mr. Tisdale tried an important experiment. He put a dam across, and in the pond thus formed put live alewives. These bred there, and they and their young passed over the dam to the sea. The next spring large numbers of alewives passed up this brook, for the first time on record, and were seen leaping at the face of the dam, in vain attempts to surmount it. This is a crucial experiment, so far as concerns the theory that a fish returns to its birthplace to spawn, even under an unfavourable condition, (cold water,) but it does not certainly prove that the alewife gets its growth in a single year. For those that were seen might have been the original breeders, together with some companions which they led from their usual course up the warm stream. So far as is known, neither the alewife nor the shad get their growth in less than four or five years. The instinct of return to birthplace is not absolute among these migratory fishes; there are apparently certain stragglers—wrong-headed individuals, which, like some men, refuse to do a thing simply because others do not do it. And again, the instinct may be modified by circumstances. Thus in 1848, when the Merrimack was closed by the Lawrence dam, the alewives, finding their path barred at that point, faced about, descended the river, coasted along shore to the Ipswich River, and, to the astonishment of the inhabitants, suddenly filled that little stream almost solid. A similar fact was reported in the British Provinces, where the salmon, alarmed at the change in shape of a river's mouth by new stake-

nets, quitted the Natashquan, and entered the neighbouring Kegaska, where they were recognised by their superior size. On almost all our streams the alewives have been exterminated by weirs, by scoop-netting, and especially by dams, which shut them from their favourite ponds. But if our people will imitate the action of those interested in Mystic River* they will get the fish back in great abundance. The act (chap. 149, 1867,) simply forbids fishing for five years, and the people themselves have seen that a suitable fishway is made over the dam at the outlet of the pond. This action must come from the people themselves. It has been the policy of the Commissioners to enforce reform upon the public. They have tried to publish all important information on the subject, and have held themselves ready to aid those who asked for advice or for the protection of the laws. To extend and to unite their influence, the Commissioners of Maine, New Hampshire, Vermont, Massachusetts, and Connecticut have made an informal association under the name of New England Commissioners of River Fisheries.† They hold meetings from time to time, and endeavour to establish a common policy for New England, in the attempt to restore our indigenous fishes and to introduce new ones. In conclusion, the Commissioners beg leave to pre-

* See Appendix, B.

† The following are the names and addresses of the Commissioners :—

Maine—Charles G. Atkins, Augusta ; N. W. Foster, East Machias.

New Hampshire—Hon. H. A. Bellows, (Chairman,) Concord ; W. A. Sanborn, Weir's.

Vermont—Prof. A. D. Hagar, Proctorsville ; Hon. Charles Barrett, Grafton.

Massachusetts—Alfred R. Field, Greenfield ; Theodore Lyman, (Secretary,) Brookline.

Connecticut—H. Woodward, Middletown ; James Rankin, Old Saybrook.

sent the following summary of their present position and requirements.

1. As to MONEY. Of the appropriations respectively of 7,000 dollars and of 10,000 dollars, there will probably remain subject to their draft, at the close of this year, about 10,500 dollars. During the next year there will be needed, for the prompt erection of the great fishway at Holyoke, a sum of 15,000 to 17,000 dollars, and for the important attempts in the artificial breeding of fish, on a large scale, not less than 5,000 dollars, or a total of 22,000 dollars. As there will doubtless be over 10,000 dollars on hand to begin with, a further appropriation of 12,000 dollars ought to suffice.

2. As to LAWS. Those now in force seem enough ; and it only remains for this Commonwealth to comply with the condition made by Connecticut in the law passed by her last Assembly, by which the taking of shad in the Connecticut River is forbidden, except between the 15th of March and the 15th of June, and between sunrise of Monday morning and sunset of Saturday evening ; and further, that no salmon shall be taken before March 15th, 1872 ; all, however, on condition that Massachusetts shall impose the same limitations of time. The Commissioners therefore recommend that these restrictions be extended to that part of the Connecticut River lying within the limits of this Commonwealth, provided that the fish commissioners be allowed to take all fish needed to re-stock this or any other waters of the Commonwealth.

All of which is respectfully submitted.

THOMAS LYMAN,
ALFRED R. FIELD,

Commissioners.

APPENDIX EXTRACTS.

ARTIFICIAL BREEDING OF TROUT AND SHAD.

The artificial breeding of fishes is, in theory, familiar to most people, but in practice, very little is known of the necessary details.

In France, thanks to the labours of Professor Coste in carrying out the discoveries of Joseph Remy, pisciculture has become a true industry. The Imperial establishment at Huningue, founded fifteen years ago, produced, in 1861, 16,000,000 of eggs. These were of several species, (all, however, of the Salmonidæ,) viz., the Fera, (*coregonus fera*), which is like our white fish; the Ombre chevalier, (*Salmo umbla*) called in the Tyrol, Sälbling, and in England, Charr; the large and valuable Danube salmon, (*salmo hucho*), called Huchen by the Germans; the great trout of the lakes, (*Salmo Trutta*), which is the Seeforelle of the Germans, Truite Saumonée of the French, and sea trout of the English; the common salmon, (*salmo solar*), and the European brook trout, (*Salmo fario*), called Forelle by the Germans. This excellent establishment is (or was) nevertheless defective in two respects; first, in the imperfect means of getting eggs, which are collected at distant points, and consequently arrive often in bad condition; whereas, so extensive and well appointed a place should, in most cases, raise or keep its own breeding fish; secondly, in the small variety of fish cultivated, and those all of one family. All of which is said not to criticize what has been effected, but to point out what may be in future expected. To breed trout successfully there are needed (1,) good and abundant water; (2,) proper apparatus; (3,) a regular supply of breeding fish; (4,) general skill and care in the operation; (5,) plenty of food. The water should be of a spring; pure, clear, and as near 47° the year round as may be. Moreover, it should flow constantly. To avoid the mud and overflow of freshets, the breeding ponds should never be in the main stream. But this should be dammed, and from the mill-pond thus made, a canal or a flume should be led to supply the needful water. At the mouth of this canal may be a sluice-gate against freshets, and there must be, also, a barrier to prevent the escape of the fish. This may be either a water-wheel moving below in a casing, and turned by the current, or, if there should be a little fall, a horizontal raised grating may be placed just under it. These contrivances are better

than a vertical screen, which gets clogged with leaves, &c., and does permit floating food to pass, which is a very important item. This food consists of an immense variety of organisms, such as larvæ of dragon flies, minute crustacea, water worms and beetles, young fishes, aquatic snails, &c., &c. Its quantity may be increased by placing a slanting boom at the mouth of the canal in such a way as to turn into it whatever the current brings down. The lower part of the canal should be about 4 feet wide and 2 feet deep, and its bottom should be of clean gravel, while the top is loosely covered with boards.

This is the spawning bed. Beyond comes a pool or a pond for breeding-fish, and furnished with a screened outlet. Such a pool should be 4 feet deep, and its bottom weedy or earthy and in no case covered with *gravel*. Other and smaller pools may be provided for the young fish of different sizes, each with a good conduit of running water and a screened outlet. The hatching house must also be supplied by a conduit of running water and with a screened outlet. This building is a simple close shed with small windows which can be darkened at pleasure. Within are double ranges of shallow troughs, communicating, by little sluice-gates, with a supply trough, which, in turn, is filled from the lower end of the conduit outside the building. This lower end is fitted with three flannel strainers, through which the water passes, and then enters the supply trough through a little sluice-gate. These strainers should be placed at an angle, so as to present much surface, and should be made to slip in and out, so that they may be frequently washed. Moreover, a sluice-gate should always be placed *below* strainers, otherwise it gets clogged by leaves, &c. Each spawn-trough in the range is 18 inches long by 12 wide, and is separated from its neighbours by a ridge $1\frac{1}{2}$ inches high. The sides may be as high as 8 inches, which gives a chance to back up the water, and make a trough of that depth, after the fry hatch. The water furnished to each single range by the sluice-gate should be equal to an inch stream with a three inch head. The water runs down the range with a gentle current about an inch deep, to secure which, a fall of 1 inch in 6 feet is enough. Hatching troughs are usually made of wood, with a bottom of half an inch of perfectly clean gravel about the size of peas.

To render the hatching house comfortable in the winter a stove may be placed beyond the troughs. The pool, if 4 feet deep, 25 broad, and 40 long, will each contain several thousand breeding fish, weighing from half a pound to a pound and a half. The bottom is left earthy, in order that they may not deposit their spawn on it. As soon as late autumn approaches the trout pair, and seek the congenial gravel of the covered spawning bed.

For very large fish, like salmon, it is convenient to have a second man, who holds the tail, giving the other full use of his left hand. It is not necessary to pay attention to the different *pairs* of trout; males and females may be taken indiscriminately, and the produce of

the whole mixed in a common pan. The water now assumes a milky tinge, from the milt of the male while the ova sink at once to the bottom, and there *stick fast*. They appear as little round bodies about three-sixteenths of an inch in diameter, (or larger, if the parent be large,) of a pale yellow or an orange hue, according as the parent has white or pink flesh.* They must be left in the pan as long as they will stick, which will be fifteen or twenty minutes.† Then the water must be gently drained off, fresh water poured in, and this washing repeated once or twice. And here is the golden rule for treating eggs of fishes: never *touch* them, but move them by *moving the water* in which they lie. The washed eggs are now ready to be spread in the hatching trough, which is done by tilting the pan, and allowing them to slide gradually out, so that they do not lie on top each other, and are not overcrowded. They may be further arranged by agitating the water with a turkey's wing feather. There may be placed about four thousand in each square, which is eighteen by twelve inches. They should be allowed to remain undisturbed, but should be constantly watched, and those which die or are attacked with mould, should be removed with forceps. The minute vegetable growth, so fatal to eggs and even to young fish, is very likely a true *conferva*, at least we may judge so from Vogt's description of the parasitic plant that attacks the eggs of *Coregonus*. To avoid it the precautions are:—1st, pure running water of the right temperature; 2nd, very clean gravel washed in boiling water; 3rd, the use of wood for troughs which is well dried, and free from knots and acid juices; 4th, the protection from dust, dirt, and sediment; 5th, protection from strong sunlight. Green discovered this by observing that where a band of sunshine fell from an uncovered window across the troughs the ova within that limit died. A dead ovum may readily be recognized by its dull opaqueness. It looks like a drop of tallow. Furthermore, the troughs should be guaranteed against mice, water-insects, and snails. Where sediment chances to settle on the ova the water should be stirred with a feather until the current has carried off the deposit. If spawn is to be sent away, the best time is from twenty to forty days after impregnation, when the eyes show through the eggs as two black specks. Take live moss, with long fine stems, and wash it till perfectly free from dirt, place a layer of it, whilst moist, in a tin box with holes in the bottom, place therein a layer of spawn, then another layer of moss,

* The colour of the flesh plainly does not depend on the crustacean food which the trout gets, according to the theory of Dr. Gunther. Trout raised in Green's pools, and having the same chance for food of this kind, are sometimes pink and sometimes white fleshed. There is some reason to think this peculiarity hereditary.

† This *temporary sticking* is an extraordinary provision of nature, to enable the eggs to cling to the bottom, and resist the current, until the parent has had time to cover it by sweeping gravel over it with her tail. It is probable that Vogt was mistaken in supposing the eggs of salmonidæ had no viscous coat; it is perhaps in a soluble form. (Agassiz and Vogt in *Poissons d'eau douce*.)

then another of spawn, till the box is full. Put on a tin cover firmly, and pack the box with sawdust in another and considerably larger one. If kept cool the spawn will be good for at least fifty days, and it has been thus preserved for eighty-five days. The best temperature is about 50° . At over 65° eggs suffer severely. The minimum time for hatching is fifty days, the maximum one hundred and fifty days. Then the little troutling lies feebly on its side, and for forty-five days subsists entirely on the gradually absorbed yolk-sac, which in nature seems to serve the double end of food and of an anchor to hold it down among the gravel. At the end of that period the little fish is free, and needs feeding. Now the water should be backed up several inches deep in the troughs, and the fish fed twice a day with raw beef liver cut as fine as jelly and bruised with water, and very slowly given to them, so that it may be eaten up clean.

Water is to be had in plenty, but *food* is the turning point of profit or no profit in fish breeding. The little ones will get enough food in a proper pond or brook if simply left to themselves; but to grow the larger fish rapidly, extra food in large quantities will be required. The way to get this is the way of Comacchio: to breed one fish to feed another; and to let the first gain its own living from insects or water-plants. Near the sea-coast vast quantities of little fish may be had for the catching; among which may be named the "friars" (*fundulus*) that swarm in salt water ditches and creeks. These scalded and given to trout produce a rapid growth, some getting to half a pound and more in a year. There seems no reason why every inland fish-breeding establishment should not hatch artificially large quantities of small fish entirely as food for the more valuable trout.

TROUT BREEDING.

A trout-breeding establishment should have five artificial ponds of an acre each, and four feet deep. These would hold 1,000,000 of marketable fish. It should have two or three natural ponds, of a dozen or twenty acres each, where fish could be bred wherewith to feed the trout; and finally, it should have pools for the breeding fish, and hatching-houses in proportion to the quantity to be raised.

BREEDING SALMON.

Salmon for breeding should be treated like trout. They should be taken in nets (from a late run if possible,) and confined in a running stream of some depth, and of a proper bottom, with shady banks, and with hiding-places. From the stream should lead gravelly, covered trenches, suitable for spawning beds, into which the pairs of salmon would go in their season, and whence they could be taken for breeding. The only difference would be that, whereas the trout are kept from year to year, the salmon must be returned to the river in order that that might go to the sea. Seth Green, who sat two days in a tree to watch the salmon spawn, corroborates the account

given by Shaw a quarter of a century ago. The nests, or excavations, are made not with the nose, but with the tail. Many of the ova are neither impregnated nor covered, and are carried down stream, where shoals of trout await them. The method of the trout is almost identical. The female lies close to the bottom with her head up stream, and gently fanning with her tail; a few inches above lies her mate keeping a sharp look out for all intruders, at whom he darts furiously whenever they approach; even the female rushes at them when they are numerous. From time to time, she, by a spiral contortion of the body, brings her tail with a strong sweep against the gravel; and this, after a while, makes a rough depression or "nest." Over this she stays and begins a kind of serpentine motion of the body, the object of which seems to be to work the eggs from the ovary into the abdominal cavity. Presently the ova are ejected with a convulsive tremor of the muscles, and simultaneously the male throws the milt into the water. The eggs are covered in part by the current, in part by the tails of the fish; but many are not impregnated at all, and many more are swept down stream, where they are eaten by expectant fish.

Our trout shows many variations even in neighbouring localities. Old John Trout, the veteran angler of Webster's day, could distinguish unfailingly a fish from Monument River, Red Brook, or Marshpee Brook (all streams emptying near each other on the south side of Cape Cod;) and that not from colour, but from shape. The Dublin lake trout of New Hampshire are well known for their peculiar delicacy of form.

ARTIFICIAL BREEDING OF SHAD.

Early in last summer, Seth Green offered to come, at his own expense, and try to hatch the eggs of the shad at Holyoke, provided the New England Commissioners would furnish the necessary apparatus. This man bids fair to prove the Remy of this country, not because he has succeeded in hatching a certain number of trout, but because he has originality, as well as skill, and large ideas, as well as originality. He has a living faith that our rivers, ponds, and bays may, by artificial breeding, be so filled with fish, that, to use his own words, "the people can't catch 'em out, if they try." With more truth than fancy, he says, "Let your State spend a tenth part in planting fish of what it spends in planting corn, (that don't pay for the rising), and every poor man may have a fish dinner the year round." The newspapers and periodicals have spoken of him, only to say that he is a noted sportsman. To be a crack shot, and to throw a fly eighty feet are things of no great matter, but to increase and cheapen the food of a whole people is worthy the devotion of a lifetime.

Having taken the ripe fish with a sweep-seine, he removed and impregnated the ova in the way already described for trout. These, to the number of some millions, he spread in boxes; but, to his great

mortification, every one of them spoiled. Nothing daunted, he examined the temperature of the brook, and found, not only that it was 13° below that of the river (62° to 75°), but that it varied 12° from night to day. This gave the clue to success. Taking a rough box, he knocked the bottom and part of the ends out, and replaced them by a wire gauze. In this box the eggs were laid, and it was anchored near shore, exposed to a gentle current that passed freely through the gauze, while eels or fish were kept off. To his great joy, the minute embryos were hatched at the end of sixty hours, and swam about the box, like the larvæ of mosquitoes in a cask of stagnant water. Still, though the condition of success was found, the contrivance was still imperfect; for the eggs were drifted by the current into the lower end of the box, and heaped up, whereby many were spoiled for lack of fresh water and motion. The best that this box would do was ninety per cent., while often it would hatch only seventy or eighty per cent.

The result was a triumph. Out of 10,000 ova placed in this contrivance, all but seven hatched! In spite of these delays, and of the imperfect means at hand for taking the fish, Green succeeded in hatching, and setting free in the river, many millions of these tiny fry.

In confinement they cannot be kept, because the yolk-sac does not suffice for their support for more than one or two days. But care must be taken to liberate them in a *safe place*. Green observed that, on setting them free among the shallows near shore, the dace (*Argyreus*) and other little fishes rushed to the spot, and commenced jumping at them. In the stomach of a dace he found fourteen shad fry. Then, by a series of most ingenious experiments, he discovered that the fry, so far from frequenting the shallows, like many minnows, *made directly for the main current, in mid-river*. How different this from the young trouts that lie almost helpless for forty-five days, and then are fain to hide behind stones and roots! Whereas, these minute, transparent, gelatinous things push boldly for the deep, swift current, where they are too insignificant to be attacked by the great fishes.

So the fry must be let go in the proper way by towing the boxes into mid stream, or by liberating them during the night, when their enemies do not feed.

The ovaries of a full-grown shad (*Alosa praestabilis*) weigh at the spawning season about thirteen ounces, without the membranes. With a common lens, three sizes of ova are at once distinguished. The first have a diameter of 8-100ths to 9-100ths of an inch. These are transparent and ready to be laid; the second, 4-100ths to 5-100ths of an inch; the third, 2-100ths of an inch. These two smaller sizes are opaque; they are still found after the fish has spawned, and are the crops ready to mature the next year and the year after. This state of the ovary has its parallel in the turtle, and possibly in all of the vertebrata.

It is scarcely necessary to add that the microscope shows other and smaller ovarian eggs. An ovary of the size above mentioned contains about 70,000 ova, ready to be laid. Their diameter increases, as soon as they are put in water and impregnated, from 9-100ths to 13-100ths of an inch. This is by the endosmosis of water between the yoke and the shell membrane.* Of the embryonic development, we have, as yet, only an imperfect outline to present. Forty-one hours after impregnation, the condition of the embryo is, on the whole, in advance of that of *coregonus* on the thirty-third day. The under surface, from the nose to the beginning of the ventral, is in close contact with the yolk, which is composed of a great number of rounded divisions, such as are seen in the complete segmentation of that body, while its surface is flecked with pigment stars, of which a less number may be distinguished on the forward part of the trunk.

LEGISLATION, 1868.

AS TO FREE PASSAGE OF FISH, BY FISHWAYS, OVER WEIRS.

By the law of this Commonwealth, all persons who may build dams on streams annually frequented by fish, do so under an obligation to keep open sufficient fish-ways for the passage of such fish; unless they are relieved by a special Act of the legislature.

The following is the legislation which concerns this Report more particularly :—

[CHAP. 62.]

An Act to protect the Shad Fishery in the Connecticut River.

Be it enacted, &c., as follows :—

SECT. 1. No person shall set, draw, or sweep any seine or net, the meshes of which are less than two and one-fourth inches square when new and dry, for the purpose of catching shad or any other fish in that part of the Connecticut river which is within the limits of this Commonwealth, and below the dam across said river at Holyoke, between the first day of May and the fifteenth day of July, during each year.

* The same takes place in a less degree in the egg of *Coregonus* (white fish.) (Carl Vogt, loc cit. p. 27, Pl. I fig. 9.) Accustomed only to eggs of trout, Green was much astonished to behold the mass of ova swell to near twice its first bulk.

SECT. 2. Every person violating the provisions of the preceding section shall be liable to a fine of not less than ten nor more than fifty dollars for each offence, to be recovered in any court competent to try the same ; one-half of said fine to inure to the use of the town in which the offence shall be committed, and the other half to the person who shall prosecute therefor.

SECT. 3. This act shall take effect upon its passage. [*Approved March 2, 1864.*]

[CHAP. 238.]

An Act concerning the Obstructions to the passage of Fish in the Connecticut and Merrimack Rivers.

Be it enacted. &c., as follows :—

SECT. 1. The governor, by and with the advice and consent of the council, is hereby authorized to appoint two persons to be commissioners of fisheries in the Merrimack and Connecticut rivers, who shall hold said office for the term of five years, unless sooner removed therefrom. And in case of any vacancy in said board, the governor shall have power to fill the same.

SECT. 2. Said commissioners shall forthwith examine the several dams on said rivers in this Commonwealth, and shall, after notice to the owners of said dams, determine and define the mode and plan upon which fish-ways shall be constructed suitable and sufficient in their opinion to secure the free passage of salmon and shad up said rivers during their accustomed seasons.

SECT. 3. It shall be the duty of the commissioners appointed under this act, when they shall have determined upon the method and plan for such fish-ways, to submit a full and specific statement and description of the same to any board of commissioners empowered to act by the state of New Hampshire, upon the same or similar subjects, for their approval.

SECT. 4. If any plan so submitted shall be approved by the said commissioners for the state of New Hampshire, the commissioners under this act shall forthwith upon such approval being expressed, furnish a copy of the plan adopted for each dam to the proprietors thereof, and shall file a copy of each of such plans in the office of the secretary of the Commonwealth, with an affidavit of the fact that the same has been furnished to said proprietors, which affidavit shall be full proof of the facts therein stated.

SECT. 5. If the several proprietors of said dams shall consent to construct said fish-ways according to the several plans adopted for their respective dams, at their own expense, the commissioners under this act may agree with the proprietors of the several dams so to do. And when the same shall have been constructed within such reasonable time as said commissioners shall prescribe, and according to said plans, with such minor variations therein as said commissioners shall approve, the said commissioners shall certify said construction to the

secretary of the Commonwealth, and the same shall for the period of five years from the passage of this act be taken and deemed as in lieu of the fish-ways, which said proprietors respectively are now required by law to keep and maintain over, at, or around their respective dams. But said proprietors respectively shall be required to keep said fish-ways on their respective dams in good repair, and to maintain the same for the period of five years from the passage of this act to the satisfaction of said commissioners; and during the period of said five years the liability of said proprietors respectively to build and maintain the fish-ways now by law required of them shall be suspended.

SECT. 6. When said fish-ways shall have been constructed as aforesaid, the commissioners under this act shall prescribe in writing the times when the same shall be kept open and obstructed, with power to change such times as they may deem judicious. And a copy of such prescriptions shall be served on each of such proprietors, and the certificate of said commissioners of the manner in which the same have been served shall be full proof of the fact.

SECT. 7. If any proprietor of any dam shall refuse or neglect, for the period of thirty days from the time said commissioners shall have furnished said proprietors with the plan, as herein before provided, to agree with said commissioners for the building at, over, or around his dam of the fish-way prescribed by the plan furnished such proprietors by said commissioners, then said commissioners shall be authorized to contract in behalf of this Commonwealth for the construction of the fish-way at, over, or around the dam of said proprietor so refusing or neglecting. And said commissioners shall thereupon cause such fish-way to be constructed with all reasonable dispatch. And the expense thereof shall be a charge against the owner of such dam, and the same may be recovered of said proprietor in an action of contract in the name of the Commonwealth, with costs and twelve per cent. interest on the amount of such expense from the time when the same shall have been demanded of such proprietor by said commissioners.

SECT. 8. Whenever, in the construction of any such fish-way, the property of any person not liable by law to provide a suitable and sufficient fish-way at, over, or around such person's dam, shall be taken for the purpose of such fish-way, the said commissioners shall, upon the application in writing of the person aggrieved, assess a reasonable compensation therefor, to be paid by the Commonwealth. And any person aggrieved by such assessment shall have the right to have such compensation determined by a jury, in the manner provided by the General Statutes for the assessment of damage occasioned by the laying out of highways.

SECT. 9. Said commissioners shall have power to contract with the proprietor of any dam on either of said rivers, for the suspension for five years from the passage of this act of the liability of said proprietor to construct at his own expense any fish-way at, over, or

around his said dam, upon the payment by said proprietor to the treasurer of the Commonwealth of such a sum of money as said commissioners shall deem reasonable, and a copy of any such contract, attested by said commissioners, shall be filed in the office of the secretary of the Commonwealth.

SECT. 10. Said commissioners shall have power to contract with the Essex Company for the construction of the fish-way prescribed by said commissioners over the dam of said company, at Lawrence, by said company, at an expense to the Commonwealth not exceeding seven thousand dollars, the said Essex Company to pay the expense of such building over and above the said amount so to be paid by the Commonwealth.

SECT. 11. The compensation of each of said commissioners shall be determined by the governor and council.

SECT. 12. The commissioners appointed under this act shall have power to construct, or to contract for the construction of, such appliances and structures as they may think essential or useful for the passage of the fish herein named up and down said rivers, and for their protection in such passage.

SECT. 13. Said commissioners may in their discretion delay the definite construction of fish-ways on the Connecticut river, until they shall be satisfied that such legislation has been adopted by the state of Connecticut as shall in their opinion be necessary to secure the free passage of the fish above named through the part of said river running through said state of Connecticut.

SECT. 14. There shall be appropriated and paid by the treasury of the Commonwealth a sum not exceeding seven thousand dollars, to defray the expenses of the commissioners herein created and of constructing the fishways herein provided for.

SECT. 15. Any person who shall neglect or refuse to keep open or maintain any fish-way at the times prescribed by the commissioners under this act, shall forfeit the sum of fifty dollars for each day's neglect or refusal so to keep open or maintain said fish-ways, to be recovered by indictment in the county where said dam, or a part thereof, is situated, one-half thereof to the use of the complainant and the other half to the use of the Commonwealth.

SECT. 16. This act shall take effect upon its passage. [*Approved May 15, 1866.*]

[CHAP. 249.]

An Act for the protection of Trout and Black Bass.

Be it enacted, &c., as follows:—

SECT. 1. Whoever takes or catches any trout in any rivers, streams, or ponds, between the twentieth day of September and the twentieth day of March, or within the time aforesaid sells, buys, or has in his possession any trout so taken within this State, shall forfeit one dollar for each trout so caught or taken, sold, bought, or had in possession.

SECT. 2. Whoever shall take or catch any fish called black bass in any of the ponds within the limits of this Commonwealth, from the first day of December to the first day of June, or at any time, except with hook and line, shall forfeit a sum of not less than two nor more than twenty dollars for each offence, to be recovered by prosecution before any court competent to try the same.

SECT. 3. In all prosecutions for forfeitures under the provisions of this act, the fact of sale, purchase, or possession shall be evidence that the trout or black bass so sold, purchased, or had in possession, were taken within this state. [*Approved May 22, 1866.*]

[CHAP. 344.]

An Act to regulate Fisheries.

Be it enacted, &c., as follows :—

SECT. 1. The commissioners of fisheries appointed under chapter two hundred and thirty-eight of the acts of the year eighteen hundred and sixty-six, in addition to their powers and duties under said act, are hereby authorized to examine all the dams upon rivers in this Commonwealth over and around which the proprietors are now required by law to keep and maintain fish-ways, and said commissioners shall determine whether said fish-ways are suitable and sufficient for the passage of such fish as are found in said rivers ; and if, after inspection, the said commissioners shall find said fish-ways are unsuitable or insufficient for the passage of fish, or are out of repair, or are not kept open at suitable times, they shall give notice to the proprietors of said dams of any defect in their fish-ways, or that the fish-ways are not kept open the proper time. And said commissioners shall further, in writing, prescribe the times for keeping open and unobstructed said fish-ways, and what repairs may be necessary, and what changes, if any, should be made for improving said fish-ways.

SECT. 2. Any person or corporation who shall neglect or refuse to keep open or maintain any fish-way at the times prescribed by the commissioners under this act, shall forfeit the sum of fifty dollars for each day's neglect or refusal so to keep open or maintain said fish-way, to be recovered by indictment in the county where said dam, or any part thereof, is situated, one-half to the use of the complainant and the other half to the use of the Commonwealth.

SECT. 3. There shall be appropriated and paid out of the treasury of the Commonwealth a sum not exceeding ten thousand dollars, to defray the expenses of the commissions, first, in restocking the rivers of Massachusetts with shad, salmon, and alewives ; second, in restocking the ponds in this Commonwealth, for the purpose of propagating black bass and other fish. [*Approved June 1, 1867.*]

[CHAP. 289.]

An Act to regulate Fishing in Merrimack River, and for other purposes.

Be it enacted, &c., as follows:—

SECT. 1. No person shall fish with a seine in Merrimack river, nor in any manner take or catch shad, salmon or alewives in said river, until the fifteenth day of April, in the year eighteen hundred and seventy-one, under penalty of the forfeiture of the seine and of five dollars for each shad or alewife, and fifty dollars for each salmon taken: *provided*, that the fish commissioners shall be allowed from time to time to take such fish as may be required to re-stock the Merrimack or any other rivers.

SECT. 2. No person shall fish within four hundred yards of any fish-way on Merrimack river, nor trespass within the limits of the same, under a penalty of fifty dollars.

SECT. 3. The fish commissioners are hereby empowered to cause any tributaries of the Merrimack river to be opened to the passage of shad, salmon, and alewives, by directing the proprietors of dams in such tributaries to build suitable fish-ways over their dams.

SECT. 4. The mayor and alderman of any city and the selectmen of any town bordering on the Merrimack river shall appoint one or more suitable fish-wardens and fix their compensation, to see to the execution of the provisions of the first and second sections of this act. [*Approved May 31, 1867.*]

[CHAP. 149.]

An Act for the re-stocking of Mystic River and its tributaries with Fish.

Be it enacted, &c., as follows:—

SECT. 1. The right to take alewives or shad from Mystic river or its tributaries, or from Mystic pond, shall be and hereby is suspended for the period of five years next ensuing, and no net, seine, or weir shall be set therein during said period.

SECT. 2. Any person violating the provisions of this statute shall forfeit one dollar for every alewife or shad so taken.

SECT. 3. All prosecutions under this act shall be commenced within thirty days from the time of committing the offence.

SECT. 4. The several "committees for the preservation of fish" of the towns of Medford, Somerville, West Cambridge or Winchester, may remove and destroy any and all nets, seines or weirs found in said waters during the said period of five years. (*Approved April 13th, 1867.*)

The following is the Act of New Hampshire, and it has been followed by another, prohibiting the taking of shad and salmon in the Merrimack:—

"That if any person shall erect or maintain any dam or weir upon the Connecticut or Merrimack rivers, or upon the Pemigewasset or Ammonoosuck or Winnipisiogee rivers, or Baker's river, without providing a suitable fishway over or through the same, which shall be approved in writing by the Fish Commissioners, and be kept open during the months of May and June, in each year, he shall forfeit and pay, for each day's continuance of said dam without such fishway, the sum of ten dollars, to be recovered by indictment, for the use of the county in which the offence is committed. *Provided*, that this law shall go into effect whenever, and not before, suitable fishways for the passage of sea-fish over the dams on said river or rivers, below the boundary of this State, shall have been commenced; which fact is to be determined by the proclamation of the governor." (*Approved July 1, 1805.*)

The following is the Act of Connecticut touching the investigation by the Coast Survey; also the Act referred to in this Report, and which regulates the fishing:—

(Private Acts and Resolutions of the General Assembly of the State of Connecticut, May session, 1867. Page 254.)

"*Resolved by this Assembly*, That the fish commissioners who may be appointed by his excellency the Governor be, and are, hereby authorized to take steps necessary to procure information through the superintendent of the United States Coast Survey, in all matters pertaining to the fishing interest; to learn, as far as possible, what general laws govern fish along our coast in regard to propagation, migration, &c.; *provided, however*, that the investigation of (the) same shall not be attended with any special outlay from the State treasury." (*Approved July 27, 1867.*)

[Chapter III.]

An Act in addition to "An Act for Encouraging and Regulating Fisheries." *Be it enacted, &c.:*

SECT. 1. No person shall take from the Connecticut river any shad, at any other time than between the fifteenth day of March and the fifteenth day of June in each year; and no person shall set or draw any net or seine for the purpose of taking fish in said river, at any other time than between the rising of the sun on Monday morning and the setting of the sun on Saturday evening of each week; and every person who shall at any other time, take any shad, or set or draw any net or seine, in said river, or aid or assist therein, shall forfeit the sum of one hundred dollars to the treasury of the State; *provided*, that nothing in this section shall apply to taking of fish by order of the commissioners for the purpose of artificial or natural propagation of the same.

SECT. 2. No persons shall take from the Connecticut river, any salmon, before the fifteenth day of March, A.D. 1872, and any person so taking salmon. shall pay to the treasury of the county where such offence is committed a fine of twenty dollars for each fish so taken.

SECT. 3. All complaints for violation of this Act, and of the Act to which this Act is an addition. may be made to the superior court by the State's attorneys of the several counties where the offences are committed, and where the nuisances exist; and whenever the superior court is not in session, such State's attorneys may make complaint to a justice of the peace in any town adjoining the water at the place where such offence is committed, and such attorney shall receive the same fees for services as for trials in superior court, which fees shall be taxed as part of the costs of prosecution.

SECT. 4. For the purposes of this Act and of all Acts regulating and relating to fisheries, the rivers, streams, coves, inlets and bays and sounds, and all parts thereof, within the jurisdiction of the State, shall be deemed to be entirely in either county and in either town adjoining said waters, at a place where any violation of this Act is committed, and the State's attorneys, sheriffs, and deputy-sheriffs of said counties respectively, and the constables and justices of the peace of said towns respectively, shall act in relation thereto, in the same manner as though said river was entirely in the county to which said sheriffs, deputy-sheriffs, and State's attorneys belong, or in the town to which said justices of the peace or constables belong.

SECT. 5. The Governor shall appoint three Commissioners who shall hold office for one year, and until their successors are appointed, and whose duties shall be to make complaints of all violations of the Acts relating to fisheries, to the proper informing officer, to consider the subject of the introduction, protection, and culture of fish in our waters, to co-operate with fish commissioners of other States, and to make report of such facts and suggestions as may be material to the Legislature.

SECT. 6. Such Commissioners shall receive for their services, the sum of three dollars per day, and their actual disbursements while employed in such official duty.

SECT. 7. The limitation of the time of taking shad and salmon in the first and second sections of this Act, shall not take place until the legislature of Massachusetts at its next session shall prescribe the same limitations to the catching of shad and salmon in said river as are contained in said sections. All parts of the Act to which this Act is an addition and inconsistent herewith, are hereby repealed. (*Approved July 26, 1867.*)

*EXTRACTS BY Mons. HERMANN BAARS,
SPECIAL COMMISSIONER for the FISHE-
RIES AND NAVIGATION OF
NORWAY, 1867.*

NORWAY is a narrow region, intersected by numerous deep bays, and encompassed by thousands of small islands. The most numerous fish are the cod, or gadus, and herrings.

The cod fishery station at Lofaten extends over a distance of about 60 miles, the population is about 20,000, occupied chiefly in the cod fishery, at Lofaten. This cod fishery alone employs about 5,500 boats, manned by 21,000 men, who catch ordinarily from 20 to 25 millions of cod-fish annually. The sea is so tempestuous during the winter fishing season, that it is impossible to carry on the fishing for more than two days in the week.

The produce of the boats is very variable, but frequently in a single voyage they bring back from 10 to 12,000 cod-fish, and 12 barrels of cod liver oil, and 10 barrels of roe, of the value of about 3,500 franks, or £140, or £25 per man.

Besides the fishery of Lofaten there are smaller fisheries at Nordland and Tondhjem, extending over less than 40 miles, there are 3,000,000 cod-fish caught which are dried and cured.

A more important fishery extends along the coast of Western Tinmarkin.

The fishery of Eastern Tinmarkin yields 10 or 12,000,000 of cod-fish annually, and of a finer quality.

The Romsdal, Nordmelk, &c., the fishery employs 1,200 to 1,500 boats, and produces from 6, to 8,000,000 of cod-fish which are dried and cured, and they salt and reserve for their own use the roe, but they sell the liver of the fish for medicinal oil, manufactures of which have establishments on that part of the coast, the tradespeople in the towns of Christiansund, Molde, and Aalesund, equip boats for this object.

Norway does not live on this great cod fishery alone. In the northern districts a large portion is exported. At Tinmarkin there are 20,000 barrels of cod-fish—the result of the summer fishing—sent away in Russian boats, which bring in exchange rye, flour, and flax, from the White Sea.

From numerous other kinds of fish a considerable revenue is also derived, and employment afforded to a large number of people. Many kinds of cod-fish are found along the coast of Norway. The fish are migratory, and the men follow them. The cod livers are cleaned, and washed, and placed in tin pots, and the oil extracted by

steam, and is divided into five qualities. France buys nine-tenths of all the roe of fish.

THE HERRING FISHERY.

Whilst northern Norway devotes itself to the cod fishery, the southern Norwegians prepare for the herring fishery, which mainly lies between Cape Lindesnas and Cape Stat, the navigation herring fishery in the 9th century was one of the chief sources of the wealth of the country, and has never since ceased to be actively pursued, although singular changes have taken place in its visits to the coast—for instance, we know that in the first half of the 16th century the winter herring was very abundant in the neighbourhood of Bergen, whilst in 1567 it appears to have altogether deserted these feeding-grounds. During the first half of the 17th century it had returned again, and from 1650 to 1654, there was a total cessation of the fishery, in all probability the herring did not return to that coast until about 1699 or 1700, from that time up to 1784, the influx was variable but always productive. In 1784 it disappeared and the fishery was not reopened until 1808; from that time it has continued without interruption to the present year. The boats are 30 feet in length, and 10 feet in width, and three to four feet deep, manned by four or five men, and geared with from fifteen to thirty nets.

The herring fishery employs about 6,000 boats, manned by 30,000 men. From an estimate, which extends to 1854, the fishery to the south of Bergen gave employment to 3,749 boats with nets, and carrying 15,311 men. 316 fishery companies employed 6,628 men to the south of Bergen.

On the north of Bergen there were 1,261 boats, with nets, and employing 5,596 men, and twenty-four fishing companies, comprising 455 persons.

In 1860 these figures were increased for the northern fishery to 2,632 boats and nets, and manned by 12,781 men, and by 27 companies, formed of 608 men. Sometimes thousands of boats are to be seen drawing their nets—they estimate the number of boats at 6,000, and the number of fishermen at 33,000.

In 1865 the whole number of people employed in the winter herring fishery, taking sailors and all others employed, the number was estimated at not less than 50,000, the annual produce of this fishery has fluctuated between 600 and 800,000 barrels of fresh herring, of which only about 50,000 barrels were consumed in the country; the average price of a barrel has been 10 franks or 8s.—the net gain of each man realised about 200 to 270 franks, say about £11 each for the winter herring season.

The summer herring fishery is also of great importance. It is impossible to value exactly its product; but it is probable that it is from 4 to 500,000 barrels—a barrel contains 550 herrings. Nearly

all the fishermen own the boats and nets they use. The herrings are principally sent to Russia, Prussia, Sweden, Great Britain, &c.

The produce of the sprat is estimated at 40 to 50,000 barrels.

THE MACKEREL FISHING.

Each boat produces about from 1,000 to 3,000 each night, but by the barrage (large) nets the fishermen sometimes catch 10,000 to 20,000 in a single haul of the net. This fishery has been so much developed in the last few years that there are now about 2,500 boats, which have caught from thirty to thirty-five millions of fish during a season. They are so abundant that they are preserved in ice and sent to England. The roe of the mackerel that are consumed in Norway, as well as the cod roe, are sent to France, as bait for the catching of sardines.

LOBSTERS.

The lobster fishery is of great importance in the northern districts of northern Norway, for it not only supplies a very much prized food for the population, but it supplies an export commerce amounting in value to not less than from 7, to 800,000 francs a year, (£32,000), and in addition to the crab fish.

OYSTERS.

All along the coast from Namsenfiord to Christianafiord you meet with banks of oysters, some of large extent. They supply the wants of the country; but in consequence of ignorance or negligence many of the oyster banks have been destroyed or exhausted. Now, however, they are beginning to better understand the value of these natural sources of wealth. The existing banks are treated with much more care, oyster culture is becoming much more general, and there is every reason to believe that this shell fish will become one of the most important products of the country.

SALMON AND TROUT.

There is scarcely a river or rivulet in Norway of any importance in which the salmon is not found—justly named the noblest of fishes. The salmon fisheries have been justly regarded as one of the great sources of national wealth. It is met with in the sea on almost every part of the coast, and in most of the fiords; but it is very rarely in large quantities, in consequence of the ignorant avidity of the fishermen, who have partly depopulated these waters by capturing the young salmon. The law forbids the catching of salmon from the 14th September to the 14th of February; it forbids the placing of nets across the rivers, or any fixed engine across the entrance to the rivers that might exclude the salmon from mounting the streams; it has fixed the mesh of the nets at a minimum of 6 centimetre, and prevents the catching of any fish of less than 21 centimetre in length.

The law has also cultivated the science of pisciculture, has transferred the salmon to lakes where it had previously not been known, and has erected ladders over many water-falls and insurmountable obstacles, which justifies the belief that the salmon will be more abundant in Norway.

In the spring the salmon come from the sea, where they live during the winter, and mount the rivers to the lakes.

It is impossible to value exactly the produce of this fishery, but it is estimated at 2,000,000 francs, or £80,000. 100,000 kilos, about 200,000 lbs. English weight, of fresh salmon are exported in ice every year to England.

In Norway a great number of the proprietors of rivers let the right of fishing, at comparatively large rents, to English amateurs who spend the summer in Norway, and who, independently of the rent they pay, give up the fish they capture.

The trout visits the same rivers as the salmon, and the fishing of these two fish are regulated by the same laws and is exercised in the same manner.

SEALS

Are found along the coast of Norway, and in this fishery they man about 20 ships, of from 200 to 300 tons each, with crews of from 40 to 50 men each. The produce amounts to 2 or 2½ millions of francs, (£80,000).

RIVERS AND LAKES.

Norway possesses a great number of rivers and lakes, but, from neglect, the majority do not yield much fish. There is good reason to hope that this state of things will be rapidly improved. The taking of small fish has been prohibited in all seasons, and experiments in pisciculture have been commenced on a large scale, and has succeeded beyond all expectation. Numerous lakes have been stocked with fish, and they have increased prodigiously. As we have already stated, the salmon has been introduced into rivers and waters where it had previously never been known.

The value of these fresh-water fisheries cannot be estimated at less than from 1½ to 2 millions of francs per annum (£60,000).

The following table shews exactly the amount and value of the annual exports of the fisheries of Norway, and we may see from the following figures it is considerable, and is always increasing:—

	Francs.	£	s. d.
Winter herrings, 600,000 barrels at 18 francs	10,100,000	432,000	0 0
Summer herrings, 200,000 do. at 20 francs	4,000,000	160,000	0 0
Cod, salted, 22,000,000 kil., at 40 francs the 100 kil.	8,800,000	352,000	0 0
Cod, dried, 12,000,000 kil., at 35 francs the 100 kil.	4,200,000	168,000	0 0
Salted fish, 60,000 barrels, at 20 francs	1,200,000	48,000	0 0
Fish liver oil, 60,000 barrels, at 90 francs	5,400,000	216,000	6 0
Roe (rogues of fish), 35,000 barrels, at 60 francs ..	1,750,000	70,000	0 0
Lobsters, 2,000,000, at 30 cents (about 2½d.) each ..	600,000	24,000	0 0
Fresh fish	1,000,000	40,000	0 0
Fish guano, 30,000 kilos., at 20 francs the 100 kilos.	70,000	2,800	0 0
The consumption of the country may be estimated at	12,000,000	480,000	0 0
The total produce of the fisheries	49,820,000	1,992,803	6 0

Total stated at 50 millions of francs, or two millions of pounds, English, annually.

There are no imposts placed upon the sea fisheries, but no fishing is allowed on Sundays, and the fisherman has to pay the owner of the land on the coast something for landing his nets.

The right of fishing in the lakes and rivers belongs to the proprietors of land adjoining.

Fishing on the coast is interdicted to strangers to a distance of one Norwegian mile.

It is further stated that the population of Norway was 1,701,365. The annual value of the agricultural produce is stated at £4,800,000, the forests at £2,200,000, and the fisheries at £2,000,000 ; consequently the fisheries annually produce food of the value of £1 : 3s. 6d. for every man, woman, and child.

In the fishing season about 100,000 persons find employment.

Salmon, mackerel, lobsters, and crabs are sent, packed in ice, to England—of the value of about £80,000 annually.

RUSSIAN FISHERIES.

*EXTRACTS FROM THE REPORT ON THE
FISHERIES OF RUSSIA, BY C. DANIL-
EWSKY, PRESIDENT OF THE
COMMISSION.*

It has not been possible to obtain exact statistics of the extent of the Russian fisheries. Some belong to the crown, others to great proprietors. Fishing and the preparation of the fish is done by wholesale. The fishermen are hired for the time, at fixed wages, and all the fish they catch are taken to a central establishment, called "Vataga." The fish are hung up in a building erected upon piles, at high water mark. Here they are opened, the intestines quickly taken out and separated, and the fish prepared as required. Some are taken to ice caves, where they are salted in large tubs. Each operation is performed by a clever workman, and an account is kept of every fish and lb. of cavier, isinglass, and vésiga. There are

many dozens of such establishments on the mouth of the Volga, but the largest in the world is on the Oural. It is known by the name of the "divine fishery." The value of the produce of this fishery cannot be less than 500,000 silver roubles (about £87,500) a year. There are days in April when they catch £4,000 worth of fish. It might be easy to obtain exact statistics of these establishments if the distrust of the tenants, farmers, was not so great. As the Russian laws prevent the sea and lakes being private property these stations are only found at the mouths of rivers. Parts of the Caspian Sea and Sea of Azov belong to the Cossack corporations. Some of these have fixed imposts on the produce of these fisheries. This enables us to find out the amount of their produce, but in other parts it is impossible, especially when they are worked by small fishermen without much means. We may, however, calculate the value of the fisheries of Russia in Europe at not less than £3,500,000 annually. The Caspian Sea, with the lower parts of the Volga, Furel, Oural, and Lerek, at about £1,837,500; the Sea of Azov at about £700,000; the Baltic at £218,750; the White Sea at £175,000; and the Black Sea at £105,000. The produce of the five seas which bathe the coasts of Russia in Europe may be valued at £2,975,000 annually. The value of the fisheries in the interior of Russia, the lakes and upper parts of the rivers, are not certain, but are probably not less than £437,500 annually. Lake of Peypous—125,000 tons of dried sprats or smelts, with other fish, valued at £105,000; Lake Koubinskoie, in Voligda, at £26,250; Lakes Ladoga, Onega, &c., at £262,500; and Volga and its affluents about £70,000. It is very difficult to make an account of the quantity of fish, owing to the difference in the measurements or weights used. The different products of the sturgeon, caviat, &c., are sold at 10s. per 40 lbs.; other fish 5s. per 40 lbs. The total quantity may be estimated at 25,000,000 pouds (of 40 lbs. each), or a thousand millions of pounds (livres), not counting what is consumed in the country by 100,000 fishermen and their families. We know of but one work which enables us to make a comparison of our fisheries, namely, "Researches in Natural History, on the Coast of France," by M. M. Audin and Milne Edwards. According to these writers, the quantity of cod and its products caught in the waters of Newfoundland by France is 1,375,000 pouds, which are worth 1,885,000 roubles, or about £314,000. English fisheries in Newfoundland—2,700,000 pouds, about 108 millions of pounds. The produce of the American fisheries is not given, but they cannot be less than the English—108 millions of lbs. weight. The produce of the Newfoundland fisheries, including the coasts of Labrador, belonging to these three nations must therefore be 6,800,000 pouds, at a value of 37 millions francs, or £1,480,000. The value of this fishery is therefore less than that of the Caspian Sea. In this work the French fisheries are estimated as worth 13,500,000 francs, or £520,000. The produce of the Norwegian fisheries in herrings and cod only, are, according to infor-

mation collected on the spot, about £1,248,325. In summing up the separate values of the Newfoundland, Norwegian, and French fisheries we arrive at the sum of £3,140,000, which does not equal the produce of the seas, principal lakes, and rivers of Russia in Europe. From this comparison arises two questions—How is it that with such an abundance of fish Russia exports so little? and how is it that such comparatively insignificant lakes as the Caspian and Azov are able to rival in produce the greatest part of the Atlantic Ocean and a part of the Mediterranean? The first of these is easily answered. Russia is inhabited by 70 millions of persons. Besides this, during most of the religious fasts, observed on 150 days in the year, fish is the only animal food used. Russia even imports upwards of £300,000 worth of fish (1,500,000 herrings and from 4 to 500,000 cod, principally from Norway, besides sardines, anchovies, and other fish used for sauces and preserves,) while she does not export more than £12,500 worth. The second of these questions can only be answered by an examination of the natural history of fish, or rather of waters. In the fresh or brackish lakes of the Caspian and Azov every thing unites in producing abundance of fish—the quantity of organic matter, and the great growth of vegetable life, producing again insects and infusoria, on which the fish are nourished. The Sea of Azov does not exceed 44 feet and the Caspian 50 feet in depth. This slight depth encourages an abundant growth of plants and animal food for the fish. There is also another cause for the riches of these lakes. The mouths of the rivers separate into many small streams before entering the lakes. In these the plants grow abundantly, and there the fish lay their eggs, the young fish being both protected from their enemies and well fed and nourished. It is difficult to calculate the separate quantities of the different kinds of fish. 1st, there are 4 species of sturgeons, of which the value is probably about £1,200,000. These fish are known under the commercial name of red fish. 2nd, the fish used in the manufacturies for oil, &c., viz., the sandre, two kinds of herrings, breme, tarane, and smelts, valued at £175,000. 3rd, the cod, carpe, salmon, and white salmon, valued at £87,500. The salmon is found in the North Sea and in the rivers. The white salmon in the Volga, Dwina, and Petchora. The quantity of this fish amounts to 100,000 pounds, or 4,000,000 lbs. 4thly, fish of the value of £34,000, navaga and chemaia. The navaga fish is found in the White Sea, in the Gulf of Onega, in the Dwina, in the Mezene, and near the mouth of the Petchora. It is little esteemed, probably on account of its great abundance. A child may easily, in a short winter's day, catch 1,500 by line. It is much esteemed in the interior of Russia. The chemaia is found in the Seas of Azov and Caspian, and they are worth £175,000. They are prepared like red herrings, and are mostly valued where they are caught. There is also the sprat, which is prepared in great quantities at Reval, seasoned with spice, and put in little glass pots for sale. Mackerel are only found in the Black Sea,

and are prepared and salted like herrings. Chub are the principal fish of the Black Sea, and are taken in millions on the coast of the Crimea and in the Dniester. They are prepared like red herrings, and are worth £34,000.

The tarane, found in the Sea of Azov, may one day be much valued. It belongs to the family of the cyprinoides, which come up the Volga in the spring. They might be taken in immense quantities if the larger fish did not monopolize the attention of the fishermen. Now this fish is almost neglected, and only serves as food for larger kinds of fish. There are only 2 kinds of purely salt-water fish in Russia—the cod and herring. Before the commission of inquiry into the fisheries of the north of Russia, it was supposed that the rivers of Archangel were full of fish. But the Petchora furnishes at the most only £17,000 worth of fish, and the Dwina, also an immense river, does not produce enough for the population on its banks. If it exports a few thousands of *sterlets* and a few hundreds of pounds of salmon it imports some hundreds of thousands of pounds (of 40 lbs. each) of cod from Norway and Lapland. It is still supposed that the rivers of Siberia abound with fish. We may imagine that with the scarcity of population they are as well stocked as it is possible for them to be. But the figures when looked into seem insignificant. The district of Borayso, which extends over all the lower course of the Obe, produces £16,000 worth of fish, and only 7,000 pounds (40 lbs.) of sturgeon, or 28,000 lbs. weight.

What is this compared with the Oural, a river which never exceeds in its lowest part 400 feet of width, but the produce of which is no less than a million of roubles, 4,000,000 lbs.,—100,000 pounds of sturgeon, four million pounds; or the Conra which pays to the crown a rent of £59,250. It may be at once supposed that this scarcity of the northern rivers, is owing to the great cold which is unfavourable to the development of organic life; but this cannot be the principal or only cause. If we look south we shall find other rivers, with the most favourable attributes for abounding with fish, equally unproductive. The Danube, for instance, surpasses all but the Volga in size, and apparently possesses every most favourable condition, yet, notwithstanding, they import a great deal of fish, and this even of the lowest quality (the taram). At the Delta of the Danube belonging to Russia there are establishments for fishing like those in the Caspian; these only produce 30,000 pounds, or 120,000 lbs. weight of sturgeon. Whilst there is as much produced in one arm of the Couban (the Potoka) which is only 200 feet wide, and 9 versts in length.

The Nile, Ganges, or Mississippi must produce few fish, as the countries, through which they flow, import fish from Newfoundland, Norway, &c. It is owing to the great freshwater lakes that the Russian rivers are so productive. A river in itself cannot produce the same quantity of fish as those which flow into these lakes. The Volga, for instance, including its delta and upper waters, is in all

1,500 square versts, or 30 geographical square miles, while the Caspian Sea is at least 40 times this extent, or 36,000 square miles.

The principal engines of fishing are the lines, without bait, and the pocket nets, two kinds which are used to catch 9-10ths of all the fish in Russia. It is needless to describe the pocket net, as it is much the same as that used in other countries; but I must say something in regard to the line, because in our belief it is only used in the Caspian, and Sea of Azov. This apparatus consists in a line of 50 fathoms in length, to which are attached at the distance of 10 or 12 inches lines with hooks at the end of different sizes according to the fish for which they are used. They are placed in the sea or rivers so that the hooks float at some distance from the bed. These hooks are used without bait, and the fish are caught by chance as they come in contact with the hooks.

The lower part of the Oural and the adjacent sea belongs to the Cossacks, 80,000 souls. They consider it the property of their army, received from the Government for military services. The fisheries, therefore, have fixed regulations, which are seldom altered. Each man possesses certain rights to the fishery, according to his military rank. The fishing is principally carried on in the winter, cold being favourable to the transport of the fish. There are 16 fishing stations, and the most systematic order is observed in their working. Those fish which ascend the Oural in autumn in great quantities do not return to the sea the same year, but remain to winter in the river, if they are not disturbed. When the water begins to get colder they seek the deep basins, called *yatoves*, where they pass the winter under the ice, in a kind of dormant state. To encourage this peculiarity in the fish, the Cossacks have always not only forbidden any fishing in summer, but take the utmost care that they shall not be disturbed. No one is allowed to cross the rivers in boats except in urgent need, horses and cattle may not water in the river, and no one is allowed to shoot, and even lights in the windows at night are forbidden. Steamboats have to stop at the mouths of the rivers, and even in the coasting trade, which the Cossacks carry on with Astrakan, the vessels were obliged to enter a harbour some distance from the rivers mouth. Thus the Oural river is entirely devoted to fishing.

In some of the Cossack villages an old man is appointed as guardian of the Oural. He must observe the fish closely in order to discover the number in such and such a *yatove*. These men acquire such experience that they not only can tell the different kinds of fish but even their sex.

There are two modes of catching the fish. In the lower part of the Oural, the fishing begins in the month of October. All who are going to take part in the fishing assemble on the 1st in the village of Antonooskaid, from which place they commence. They number of the fishermen is 8,000, with 3,000 little boats. The instruments used for this kind of fishing is a kind of bag-net, seven

fathoms wide, with two wings, upper and lower. They drag this along the bed of the river by means of two boats. Fishing begins at sunrise, and continues till the distance determined on is fished. The day after is spent in selling the fish to the numerous merchants who follow the fisherman, and who prepare the fish in different ways. In the upper part of the Oural fishing is only carried on in winter, when the river is covered with ice. They fish here also in parties, and the only instrument used is a hook. This is very large and made of steel, with a wooden handle which may be lengthened according to the depth of the water. Sometimes it is as much as 63 feet in length (9 fathoms). In order to keep it vertical, in the current there is besides a weight attached to the hook, sometimes 40 lbs. in weight.

This mode of fishing commences at 10 o'clock in the morning, as the fishermen have to assemble in their sledges from the surrounding villages. The most profound silence is observed. A cannon is fired as the signal, when each man runs on to the ice, and piercing holes in the ice plunge their hooks into the water. The holes are generally a foot or 14 inches in diameter. In a few minutes the ice is pierced with holes like a sieve. By this time the hitherto half dormant fish, frightened by the noise, begin to move about, and, of course, soon get hooked.

When a man feels that a sturgeon is on his hook, he draws it gently up. This is not difficult with the fish in its half torpid state. Sometimes, however, it happens that an enormous sturgeon is hooked of the weight of twenty to fifty pounds, 800 lbs. to 2,000 each. He then calls his comrades to help him, as the hole must probably be widened. Sometimes the ice gives way after fresh holes are made, and they become too numerous. This is the favourite mode of fishing with the cossacks. The river is open to the poorest, it only requires a man to possess a hook, a sledge, and some provisions of oatmeal—the fish itself being too dear. There is also a great deal of hazard connected with it. It is a kind of lottery in which a man may gain more than £16 10s. in a quarter of an hour. The value of the last-named fisheries is about £50,000 a-year. The revenue which the Russian Government derives from its fisheries is 800 to 900,000 roubles, and, adding to this what is derived from the tax on salt used in the preparation of fish, the amount may be reckoned at £333,300. The cost of the Oural fisheries, including nets, boats, &c., is not less than £29,150. The fish is preserved in three different ways—by freezing, salting, and drying. The Oural produces £87,000 worth of fish in ice, and £95,830 of salted fish. In these large establishments the sturgeon fish is placed in large caves, which are sometimes hollowed out of the hills, and form long corridors frequently 100 fathoms in length supported by wooden columns. On the floor of these passages and piled up by the walls are large cases filled with fish. They often contain from 40 to 100,000.

Besides these methods some kinds of fish are smoked—as, for instance, a small kind of herring.

The sturgeon is prepared in another manner, called *en balyk*. The back of the fish is dried and salted, afterwards coloured with saltpetre, and flavoured with pepper, cloves, and laurel leaves. It is highly valued when thus prepared, as the process is difficult and does not always succeed. It sells for £3 for 40 lbs. weight in the places where it is made.

The other products of the sturgeon are caviar, isinglass, and vesiga. Caviar is the roe of the sturgeon, and is of two kinds—liquid and solid—according to the manner of preparation. The liquid caviar is the most highly prized, and is, therefore, prepared in the largest quantities. The best is made in Astrakhan, and is sold there, at wholesale price for as much as £5 for 40 lbs., while at Moscow and Petersbourg the retail price is about 3s. 4d. a pound. The solid caviar is not worth so much. Isinglass is obtained from the swimming bladder of the sturgeon. This vessel is well soaked in water to get rid of all the fat and useless matter. It is there separated from its skin, and dried in rolls. When dry it is done up in bundles for sale. The best is known under the name of patriarch, because it is prepared in the fisheries which belong to the patriarch of Moscow, just as the convent of Solovetsky provides the best herrings from the Baltic. The preparation called vesiga is made from the substance contained in the backbone of the sturgeon. It is in the form of a long riband, and is thus dried for sale. It is a great delicacy, eaten in patés, and sometimes with the flesh of the fish itself, and is sold for £3 : 6s. for 40 lbs. weight. Of this about 28,000 lbs. is sold. The last product worthy of mention from the different kinds of fish is oil, the value of which is £83,300. It is employed for many uses—for manufactures, medicine, and food. In some fish it is only found in the liver, while in others it is procured from all parts of the body. The method of preparing medicinal oil from the liver of the cod was first discovered in Norway, but they are now able to make it in Lapland, and as a proof of their success 14,000 lbs. of cod liver-oil have been ordered from our fishery here for use in the military hospitals. The livers are prepared by means of hot water, and sometimes by the heat of the sun, which dissolves the oil and separates it from the useless matter. That which is made from whole fish is prepared differently. This method is very wasteful, as much of the fish does not produce oil. Herrings have been principally used until lately, as there was formerly a great prejudice in Russia against their being consumed as food. Unhappily, though this prejudice has almost died out, a hundred millions of herrings are still used for the extraction of oil every year.

The sea manimals constitute another important branch of Russian commerce, which equals at least £83,300. Besides those caught in the northern seas there is a species of seal found in the Caspian, and in the mouths of the Volga and Oural. In the principal centre of

this fishery upwards of 100,000 seals are caught annually. In one night of 1846 they killed 1,300 seals on an island near the mouth of the Oural. They are taken in three ways—on the islands, by means of nets, and in winter on the ice.

In the Caspian Sea, they hunt the seals on the islands. They land in boats while the seals are basking in the sun, and surround them so that they have no chance of escape, killing them with large cudgels. In this manner 10,000 seals are taken in one day. They then cut off the head, skin the seal—the fat adhering to the inner part of the skin. The bodies are buried, or are taken some distance and thrown into the sea. When not prejudicial to the other fisheries the seals are also caught in nets. Hunting seals in the Caspian in winter has lately been forbidden, as the young ones were killed in great quantities, on account of their thick, silken furs, which being white dyed easily, and the seals would have been exterminated.

Seals abound in much greater quantities in the White Sea, but, nevertheless, there is not half the quantity of oil produced as in the Caspian, on account of the greater difficulty in catching them, or rather in transporting the bodies and skins of the animals. The hunters have to take boats and provisions with them, and, in some parts, when the seals are on the moving icebergs, and have to be hunted and killed there, the chase is very hazardous, as it is difficult to tell where the wind may carry the iceberg; if it should be towards the ocean the hunters may perish from cold and want of food. They have then no chance but to embark in their slight boats and seek the land. In this chase they shoot the seals, and the men must be very clever shots, for if a seal should only be wounded it utters a cry which alarms the whole herd. Neither the discharge of guns, nor yet the dead bodies of their companions can frighten the seal like this cry which will at once spoil the whole chase.

There is also a kind of dolphin of great size, and some importance in the White Sea, where it is caught for the sake of its oil, in large nets of thick cord. This fish is sometimes three or four fathoms in length. The morse or bearded seal is caught near Nova-Zembla. It is valued for its skin and teeth, besides the oil it produces, but it is caught in small numbers. The mode of extracting the oil from the skins of these animals is to expose them in the sun, when the oil trickles from them, and this produced is of the finest quality. In one large establishment in Astrakhan 400,000 lbs. of oil are annually produced. The total value of Russian products from the sea mammals cannot be less than £83,300.

March 21, 1868.

My dear Sir,—We have no certain data on which to offer a reliable estimate of the total quantities and value of the fish annually caught in the seas of the United Kingdom. I have prepared and sent you

the nearest approach to it that I can glean from all the sources of information on the subject within my reach.

Believe me,

Yours very truly,

JAMES CAIRD,

Chief Commissioner appointed to investigate the state of the British sea fisheries.

Estimated weight and value of sea fish annually caught in the British seas :—

120,000 tons of White fish, at £20	per ton	... £2,400,000
250,000 „ Herrings, at £15	„	... 3,750,000.
20,000 „ Mackerel, at £15	„	... 300,000.
20,000 „ Sprats, at £7 10s.	„	... 150,000.
3,000 „ Pilchards, at £16 10s.	„	... 50,000.
12,000 „ Oysters, at £20 10s.	„	... 250,000.
20,000 „ othershell fish at £5	„	... 100,000.
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445,000		£7,000,000.

The river fisheries—salmon, trout, eels :—

England		£30,000
Ireland		330,000
Scotland		200,000
<hr/>		560,000
		<hr/>
		£7,560,000

Having endeavoured to give some information relative to the Salmon Fisheries of England and Wales. and some further information relative to the fisheries of America, France, Norway, and Russia, it might be both interesting and valuable to give in conclusion the following statistics of the annual produce of all the fisheries :—

Fisheries in Norway		£2,000,000
Fisheries in Russia, as follows :—		
Caspian Sea, with the Volga, Oural, &c.,	£1,837,500	
Sea of Azov		700,000
Baltic		218,758
White sea and Arctic Ocean		175,000
Black Sea...		105,000
Lakes and rivers of the interior of Russia	338,750	
<hr/>		£3,500,000

According to the account published by Messrs. Audin and Milne Edwards, the produce of the sea fisheries of France is estimated at £520,000

The fisheries of Newfoundland extend over an area of about 600 miles by 200 miles, and belong to England, France, and America, and are estimated to produce about 270 million lbs. amounting to £1,480,000

Mr James Pithey

Nottingham

Mr James
Pittway 1880