APPENDIX.

Memorandum on the Results of Investigations into the Contents of Certain Bays on the South Coast of Devon.

SUBMITTED FOR THE INFORMATION OF THE SUB-COMMITTEE OF ENQUIRY APPOINTED BY THE DEVON SEA FISHERIES COMMITTEE (SEPTEMBER, 1896).

By

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IN the following Memorandum I propose to lay before the Sub-Committee of Enquiry, appointed by the Devon Sea Fisheries Committee, certain facts with regard to the contents of two of the bays on the South Coast of Devon, in which I have conducted trawling experiments, and then to point out the bearing of these facts on the practical questions before the Committee.

I. The experiments, to which reference will be made, were conducted at different times during the months of October to December of last year (1895); and the bays investigated were Start and Teignmouth Bays. The trawling smack *Thistle*, of Brixham, was engaged by the Association for the purposes of the investigation. All the food-fish which came on board were measured to the nearest quarter of an inch. The results of the several hauls were tabulated and compared with one another, and though these were not as many as I should have desired, the results obtained are such as to lead me to suppose that a fairly correct idea was gained of the relative numbers of fish of different sizes, belonging to the different species, which any similarly equipped vessel, fishing on the same grounds at that time of year, might be expected to catch. It is, of course, quite possible that there is a certain amount of variation in the numbers of fish of different sizes inhabiting these bays from year to year; and in considering the results which will be given below, this fact must be borne in mind.

The first fact which comes out clearly as the result of these experiments is, that *plaice* and *dabs* are far more numerously represented than any other species. Compared to the destruction of plaice and dabs effected by trawling,

the destruction of other species is insignificant, and may, I think, for practical purposes, be left out of account.

The following table gives the actual numbers of fish of different species caught in four hauls in Teignmouth Bay (taken on October 30th and December 2nd and 3rd), and in three hauls in Start Bay (taken on October 31st and December 4th).

TABLE I.

Actual numbers of fish of different species caught in the Bays.

	START BAY (3 Hauls).		TEIGNMOUTH BAY (4 Hauls).
Plaice	559	.....	1088
Dabs	890	.....	511
Common Sole	35	.....	8
Merry Sole	—	.....	4
Turbot	1	.....	2
Brill	2	.....	2
Whiting	144	.....	61
Pouting	4	.....	40
Cod	1	.....	—
Grey Gurnard	57	.....	2
Tub	8	.....	—
John Dory	11	.....	—

While plaice and dabs appeared in every haul in considerable numbers, the other species captured were obtained in relatively small numbers, and in most cases not in every haul.

In considering, then, the populations of the two bays in detail, we may confine our attention to the plaice and the dabs.

We may now proceed to set forth the results arrived at, by adding together the numbers of *plaice* of all the different sizes obtained in all the hauls taken in October and December in the two bays. The results are expressed in percentage of the total number of these fish caught in these hauls.

TABLE II.

Showing the relative numbers of **plaice** *of different sizes taken in Start and Teignmouth Bays in columns* I. *Columns* II. *express the percentage number of plaice up to the corresponding size,* e.g., "43·1 *per cent. of all the plaice caught in Start Bay were* 12 *inches and under in size.*"

	START BAY.		TEIGNMOUTH BAY.	
Inches.	I.	II.	I.	II.
7	0·35	—	3·9	2·9
8	1·4	1·0	8·3	9·9
9	3·9	4·1	12·1	20·5
10	6·6	10·5	22·9	40·6
11	13·6	22·1	27·4	69·1
12	20·75	43·1	15·2	87·6
13	20·9	62·0	6·3	95·4
14	13·7	77·8	2·4	98·25
15	9·3	88·5	0·4	99·1
16	4·1	94·3	0·7	99·6
17	2·7	97·4	0·2	100·0
18	0·9	98·2	—	—
19	0·35	98·9	—	—
20	0·5	99·4	—	—
24	0·35	100·0		

We may now point out certain results which may be deduced from an inspection of this table. It will be seen that the plaice in Teignmouth are, on the whole, smaller than those in Start Bay; and that, whereas half the plaice in the former were $10\frac{1}{2}$ inches or under, in the latter, the length on either side of which half the fish are found to lie is $12\frac{1}{2}$ inches. It now remains to consider what percentage of the plaice in either bay fall below the limit of maturity.

Mr. Cunningham's investigations on the limit of maturity of plaice on the South Coast showed that the higher limit for plaice was 15 in.; that is to say, that if it was desired to impose such a size limit as to wholly prevent the capture of immature plaice, the limit we should impose would be as high, but no higher, than 15 in. On the other hand, it has been shown that—with only very occasional exceptions—no plaice under 9 in. is mature. A plaice between 9 and 15 in. in length may or may not be mature.

By imposing a size limit of 15 in. for plaice, we should, as I have just pointed out, wholly prevent the capture of immature plaice; but in so doing we should also prevent the capture of a certain number of plaice which have already arrived at maturity; and on the theory that the sole object to be kept in view is to permit the fish to spawn, it might be reasonably urged that the 15-in. limit is too high—since a considerable number of plaice under

this length are mature. Acquiescing in this objection, we may accept 12 in. as a reasonably effective limit, and may now consider what proportion of the plaice in the bays examined fall below this limit of maturity. An inspection of Table II. will show that while 43·1 per cent. of the plaice in Start Bay were 12 in. or under, the percentage of plaice in Teignmouth Bay 12 in. or less in length was no less than 87·6. Or, in round numbers, two-fifths of the fish captured in Start Bay, and more than four-fifths of those captured in Teignmouth, were under the length which I have agreed to call a reasonably effective limit of maturity.

We may now turn to consider the facts ascertained for dabs. These may be best understood from an examination of the table given below:—

TABLE III.

Showing the relative numbers of **dabs** *at the different sizes in all the hauls taken (October and December).*

START BAY.		TEIGNMOUTH BAY.	
Inches.	No. per cent.	Inches.	No. per cent.
$7\frac{1}{4}$ (and under)	28·7	$6\frac{1}{4}$ (and under)	26·0
8	17·2	7	17·6
9	29·0	8	23·7
10	11·7	9	17·3
11	7·5	10	10·4
12	3·2	11	2·8
13	1·9	12	1·1
14	0·4	13	0·5
15	0·1	13	0·5

The limit of maturity for the common dab has been placed at 7 in. by one observer, and at 6 in. by another. It has not yet, so far as I am aware, been definitely ascertained for the South-west Coast; and it is known that in the case of the plaice, at least, the limit of maturity varies with the locality. I should hesitate, therefore, to deduce from the figures above what proportion of the dabs captured were "immature," nor is there the same necessity for doing so as in the other case. For if a case is to be made out for prohibiting fishing in the inshore, while permitting it in the offshore waters, it cannot be made to rest on facts connected with the distribution of the common dab. Investigations made in the North Sea have seemed to indicate that the dab "is found everywhere, and at all stages, in every part of the North Sea, both inshore and offshore, and that, except in estuaries, it seems to spawn anywhere, without regard to depth of water or proximity to land." It is far otherwise with the plaice; in the case of which fish it may be said with certainty that they remain for the most part in inshore waters during the period of their immaturity, undergoing a migration seawards when they are ready to spawn.

It follows that the practical question of whether these inshore waters which I have investigated should be closed or not, must depend on whether restrictive measures are necessary for the protection of the plaice.

In bringing this part of the memorandum to a conclusion, I can but express my regret that I have been unable to properly investigate the catches of the deep-sea trawlers in the areas adjacent to the two bays, with a view to making an exact comparison of the percentage of immature plaice among the plaice of the offshore waters with the percentage of immature plaice among those which are captured in the bays.

I have purposely omitted to deal with the relative merits of the pleas offered on behalf of the Start Bay longshoremen on the one hand and the trawlers on the other—partly because the case for the former admittedly rests, in part at least, on grounds which it does not come within my province to consider. I shall be willing to explain myself further on this point, in giving evidence before the Committee, should they desire it.

II. An examination of the figures given above will show that fishing in the two bays considered involves a considerable destruction of immature plaice and dabs. It will be seen also that the destruction of fish of all other species is insignificant. It now remains to consider the bearing of these facts on the practical question before the Committee.

The destruction of immature flat-fish has been held to be injurious to the fisheries for two different reasons by those who regard the question from two distinct points of view. The reason most commonly given for objecting to this destruction is that, by destroying an immature fish, you eliminate not the fish only, but its possible offspring. It is maintained on the other hand (and this view is held by some biologists) that the supply of larvæ is more than sufficient to maintain an adequate stock of large fish, and that the destruction of a certain number of immature fish is not to be deprecated on the ground that the number of eggs and larvæ produced at the next spawning season will be proportionately diminished. Those, however, who hold this view are no less anxious to put a stop to this destruction for quite a different reason.

It has been pointed out that a plaice 14 in. in length weighs twice as much as a plaice of 10 in., and that it would be more profitable to the fisheries if a 10 in. plaice was allowed to grow to 14 in. before being caught, doubling its weight in the process, than if it were destroyed at 10 in. And this statement certainly holds good, unless the mortality of plaice from natural causes is such as to reduce the number of 10 in. plaice by a half in the time they would take to grow to 14 in. And that this is the case is extremely improbable.

It will be seen, then, that the destruction of immature fish is objected to by some because these fish have not yet had a chance of reproducing their species, and by others because they have not yet grown to the size at which it would be most profitable to capture them; and it will be noticed that these two grounds of objection are not in themselves inconsistent with one another.

I have drawn attention to both these grounds of objection, because the criticism mentioned above—to the effect that the supply of larvæ is more than adequate, and that there is no reason for anxiety as to the consequences that may follow the destruction of a certain number of immature flat-fish—is not infrequently urged by those who have no special knowledge of the subject; and I am anxious to point out that whether this criticism be accepted or not, the position generally adopted still holds good—that the destruction of small flat-fish is to be deprecated.

It follows that, looking at the matter from a purely biological standpoint, we cannot regard with favour any proposal to effect a change in the bye-law which will permit the destruction of a greater number of under-sized flat-fish; and if such a change is to be advocated at all, it must be on grounds which it does not come within our province to consider.

It may, however, be reasonably asked whether, and if so to what extent, the fisheries in which the Committee is especially interested are likely to be benefited from a continuance of the restrictions now in force. Granting that an abolition of the restrictions against trawling within the areas under consideration would be detrimental to the fisheries as a whole by decreasing the number of flat-fish, have we any right to expect a material improvement, supposing that these restrictions remain in force? This question does not admit of a simple answer. Looking at the fisheries as a whole, it may, of course, be rightly said that the preservation of young flat-fish will be beneficial for reasons mentioned above; but if I am asked by the Committee to say whether restrictions enforced by them in a particular area will lead to an increase in the number and size of the flat-fishes in that area, I shall be unable to answer the question. I may be allowed to refer in this connection to certain experiments and observations made by the Naturalists under the Scotch Fishery Board.

The experiment of closing certain bays (part of the Firth of Forth and St. Andrew's Bay) to trawlers has been tried since 1886: and hauls have been regularly made in the closed areas, at intervals since that date, to test the effect of the closure. The results show that there have been fluctuations in the number of flat and round fishes in these closed areas, but no steady increase since the dates when the areas were first closed. This statement holds good, not only for the closed areas, but for the open areas adjacent to them.

It might, of course, be urged that this is enough to show that it is useless to close a particular area to trawlers, inasmuch as no increase in the number of fishes results from such a proceeding. But, granting that, as time goes on, the condition of the bays remains what it is—and no increase in the number of flat-fishes they contain is seen to result from the closure—the above conclusion would still, in my opinion, be unjustifiable. It would, in fact, only be justifiable if the flat-fishes inhabitating such a bay at any time were confined to that bay during the whole of their lives. But this is not what happens in Nature. Plaice, for instance, which, as a rule, are confined to inshore waters during the period of their immaturity, go out into deep waters

to spawn. But it by no means follows that their offspring will return to the areas whence their parents came. I may quote Dr. Fulton (of the Scotch Fishery Board) on this point:—

"The floating eggs and larvæ derived from a particular spawning area may be carried considerable distances in a definite direction in a comparatively short space of time, and may hence form the source of supply, not to adjacent parts of the coast" (whence, presumably, the spawners came), "but to parts situated a considerable distance from it."

It will be seen, then, that before we can know what will be the effect of closing particular inshore waters, it is necessary to discover the spawning ground to which the fish from these waters resort, and then to determine the direction of the prevailing surface currents. Not till this has been done is it possible to say where the beneficial effect of closing any particular inshore waters is likely to be felt.

In the case of the areas in which I have conducted experimental trawlings, no information at present exists, so far as I am aware, on these points. It is not, therefore, possible to say whether the preservation of immature plaice and dabs in Start and Teignmouth Bays will lead to an increase in the number of these fish in the bays in question, or even in their immediate neighbourhood; but the general proposition still holds true, that the destruction of immature flat-fish is detrimental to the fisheries at large.

Further, it is impossible to give any answer to the question *to how great an extent* are the fisheries likely to benefit from the continuance of the present restrictions, or *what amount* of damage is likely to result from their abolition. It is impossible to make any quantitative estimate of the effect of closing a particular bay, unless we know among other things the proportion which the number of immature fish in the bay bears to the total number of fish of that species in the neighbouring district. And further, though of course it is true that the preservation of the immature fish in such a bay will result directly—and perhaps also indirectly—in an increase in the numbers of the species, the admission has to be made that we cannot be certain that the catches of any individual fishermen will be materially improved in consequence.

Before bringing this memorandum to a close, it is, I feel, necessary to point out that the considerations offered above are an attempt to set forth the view which I think must be taken by those who are interested in the welfare of the fisheries as a whole, of any proposal to remove restrictions which were designed for the preservation of the immature flat-fish. But I am aware that the question before the Committee may be complicated by considerations with which I have not attempted to deal.

The question which the Committee has immediately to consider—whether a particular change in the law should or should not be enacted—is not one which ought, in my opinion, to be directly put to any scientific authority. The immediate effect of such a change—the sudden imposition, for instance, of a size-limit, or the closure of certain inshore waters—may entail great hardship on particular "local communities." The Committee will be

cognisant of the fact that a proposal in favour of a restrictive bye-law has been definitely opposed on the ground that particular local interests would be thereby endangered. An argument of this kind can only be dealt with by those who are acquainted with the nature and extent of the local interests involved; and it is possible that the disturbance caused to particular communities by a restrictive measure may be such as to render its enactment undesirable. Whether it is so or not, in any case before the Committee, I am not qualified to judge; and I am here only concerned to point out that, inasmuch as considerations of this kind lie outside the province of a biologist, but may properly be brought to the notice of the Committee, the responsibility of definitely advising the retention or abolition of a bye-law is one which I should do wrong to accept.