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REPORT ON EULACHON INVESTIGATION
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HISTORY

A copy of the following letter from the Supervisor of Fisheries at New Westminster to the Chief Supervisor of Fisheries was forwarded to the Pacific Biological Station, accompanied by a request for information on its subject:

"I beg to advise Mr. A. Monk, of Monk and Co., fish dealers, City, stated he had received a communication from a fur farmer resident in the State of Washington, requesting quotations on 200 tons of eulachons delivered to the Pacific Coast Terminals, Cold Storage, City, for freezing, later to be exported for food for fur-bearing animals held in captivity in the State of Washington. It is understood other fish dealers on the New Westminster waterfront have received similar inquiries.

"It is the opinion of Mr. Monk and some eulachon fishermen on the Fraser river that a run of this fish on the river may be composed of fish maturing at one or two years of age and spawning only once. If so, the contemplated toll from the run for export would result in an unwarranted drain and early depletion.....It is felt by those interested that export of this product in large volume should be discouraged until such time as an investigation can be carried out on the life history of this fish and regulations arranged as required for the purpose of conservation. The writer concurs in this view.-
R.W. MacLeod."

This letter was acknowledged by Dr. W.A. Clemens, Director of the Pacific Biological Station, and the following comment was then received from Major Motherwell:

"It would certainly be very helpful if your Branch could undertake some investigation of the eulachon question, with a view to making available at this office such information as would make it possible to intelligently decide as to what action should be taken in the way of conservation measures".

INFORMATION ON FILE

Information on hand at the time of the request consisted chiefly of the results of a questionnaire submitted by Dr. Hart to Fishery Officers on all parts of the coast. The answers indicated that runs of eulachon occur at certain seasons in all the large rivers of the mainland, and a few smaller ones, particularly in the Bella Coola and Butedale areas. These runs evidently represent spawning migrations, and in all localities are observed only during the period from March to May. The distance travelled upstream is not believed to be great, and in many cases is probably not more than five miles or so above the upper limit of brackish water, although eulachon are reported nearly as far up the Fraser river as Chilliwack. The runs are subject to considerable annual fluctuation in numbers in some localities, but in others are reported as being fairly constant.

Recently the impression has been current that the runs of eulachon in the Fraser river were falling off. Although the statistics published by the Fisheries Department are not particularly well-suited to biological analysis, the figures for the yearly catch and the number of nets licensed annually since 1921 have been plotted and these do indicate a downward trend in the yearly catch over a period of years (Figure 1 (from Pacific Progress Reports, No. 40, p. 18)).

PROCEDURE

The investigation was carried out by Dr. J.L. Hart, assisted by Mr. J.L. McHugh. Material for examination was secured in person by the investigators, and also through the co-operation of Mr. R.W. MacLeod. On April 5, 1939, Dr. Hart made a trip to New Westminster, interviewed fishermen and fish buyers, and examined in detail a sample of gill-netted fish. During the period May 8 to May 11, Dr. Hart and Mr. McHugh visited the river with the gasboat "Ronavic", made hauls with plankton net and drag seine, and examined several gill net samples. In addition, samples of the commercial catch were secured at intervals throughout the season through the courtesy of Mr. MacLeod. The fish in these samples were examined for length, weight, sex, sexual condition, number of vertebrae, and age.

RESULTS

Parts of the findings of the investigation were published as a Progress Report of the Pacific Biological Station (Pacific Progress Report, No. 40, p. 17-22, June, 1939). Since the work carried out was in the nature of a preliminary survey, and limitations were imposed by lack of time and funds, certain problems of the life history of the fish remain unapproached. However, definite information was gained in answer to the questions of particular interest to the Fisheries Department.

The following table gives details of the samples examined:

Date	Method of Capture	Number of Fish		Av. Length in mm.		Sex Ratio	
		♂	♀	♂	♀	♂	♀
Apr. 5	Gill net 1 1/4"	76	34	165	169	69	31
Apr. 12	Gill net 1"	130	57	159	157	69	31
Apr. 24	Gill net 1 1/8"	97	59	153	152	62	38
" 24	" " 1 1/2"	76	14	179	178	82	18
May 9	Dip net at surface	7	1	171	-	88	12
May 9	Gill net 1 1/4"	26	50	161	163	32	68
May 9	Dead on shore	206	4	158	156	98	2
May 10	Seined at shore	10	0	160	-	100	0
May 17	Gill nets - series	37	81	167	168	31	69
May 19	Gill nets - series	10	91	168	164	10	90
May 23	Gill nets - series	3	13	174	156	19	81

Length Distribution

It is unfortunately the case that gill nets are selective in their action and, accordingly, provide samples which do not present a true picture of the population under examination. It has been shown for the Pacific herring that not only is there an apparent increase in length as the size of the mesh increases, but also a change in the proportions of the fish of various ages, a change in the sex ratio, and a change in the proportions of spent and unspent fish. For this reason, the information provided by an examination of samples from the commercial catch is limited. However, a study of the plotted length frequency distributions of the various samples showed the presence of more than one mode or hump on the curves, suggesting the presence of at least two age groups of fish. As is shown in the following section, this suggestion is substantiated by studies of scales and otoliths.

Observations on Scales and Otoliths

From examination of the scales and otoliths it was concluded that in most cases a single winter check was present, although two could be detected in a few cases.

In no case was it possible to recognize any indication of a spawning check on the scales. As the edges of the scales on all the spawning fish encountered were much eroded, spawning checks would be expected to show on the scales of fish which had recovered after one spawning and were making a second spawning migration. Accordingly, the absence of such checks is taken as indicating that none of the fish examined had spawned in the previous year.

From an examination of the scales and otoliths it was, accordingly, concluded that in all probability the majority of the fish were in the second year and a small percentage in the third year, but that none of the fish had spawned in a previous season.

Sexual Condition

The proportion of spent fish present in the gill net catches was negligible, although the gonads of practically all specimens examined were in an advanced state of development. The occasional spent female was observed and a few of the males were apparently spawned out. The dead males picked up on the shore were all evidently in a partly spent condition, and of the four females in this sample three had spawned. However, the presence of spent fish in catches throughout the season would seem to indicate that the period of spawning is of long duration, and extends at least from early in April until late in May.

Sexual Differences

In common with other species of smelt, considerable differences in appearance and structure exist between the male and female eulachon. The most apparent modification in the male is the presence of a firm, opaque, slimy substance, which in formalin-preserved specimens has the form of small tubercles. This occurs principally along the region of the lateral line, but also to a lesser extent on the back and head, and gives a characteristic rough appearance to the body. In addition, the muscles of the body wall have undergone considerable development, so that the body wall is considerably thicker, and the whole fish more firm and rigid than the female. The paired fins in the male are also distinctly longer and more robust than in the female.

Spawning

The muddy nature of the river water makes location of the spawning grounds and observation of the spawning act extremely difficult. A search was made for eggs and larvae by means of plankton hauls and by dredging. A few eggs and larvae were obtained in the plankton net, but these have not been definitely identified. The eggs were slightly greater in diameter than those taken from a nearly ripe female, contained embryos in various stages of development, and had been attached to some base by means of a short peduncle. The larvae were recently hatched, possessed a medium-sized yolk-sac, and averaged about 5 mm. in length.

Egg counts have been completed for two females. The lengths and egg numbers were 158 mm. and 179 mm., and 23,500 and 28,700, respectively. As

the number of eulachon in any river system is, presumably, relatively constant, it would appear that the eggs from each spawning population must produce offspring which approximately correspond to the parent population in abundance, sex ratio, and age distribution. If such actually is the situation for the eulachon the mortality from egg to adult is approximately 99.99 per cent.

Food

In no case did the digestive tract show any sign of food. The digestive organs were too small to be functional, the body cavity being almost entirely occupied by the ripening gonads. Evidently feeding ceases some time before spawning takes place.

Vertebral Number

Vertebral number is one of the most useful tools in examining the status of fish populations. As migration must be considered as a possible explanation of the variation in abundance of eulachon runs from year to year, advantage was taken of the opportunity to make vertebral counts on 325 Fraser river fish. The results give averages of 67.785 ± 0.055 for males and 67.967 ± 0.058 for females. These averages are placed on record for comparison with corresponding results from other river systems.

CONCLUSIONS

(1) A rough analysis of the catch statistics shows that the total eulachon catch in the Fraser river has tended to decline over a period of years.

(2) The annual run is undoubtedly a spawning migration. The spawning population is composed mainly of fish in their second year, although a small number of three-year-olds is present.

(3) Spawning probably takes place over the whole duration of the run, which corresponds approximately to the months of April and May.

(4) No evidence was obtained to show that any individual had spawned two years in succession, and it is therefore believed that death takes place soon after spawning.

(5) Samples of the commercial gill net fishery do not provide a true picture of the spawning population. This is due to the selection by gill nets of fish of certain size ranges in parts of the river suitable for fishing.

(6) Considerable sexual differences exist. The males assume a distinct coating of small tubercles on the sides, back, and head, possess longer paired fins, and apparently have a lower average vertebral count.

(7) Females of average size probably contain about 25,000 eggs.

(8) Feeding probably ceases soon after the commencement of the spawning migration.

RECOMMENDATIONS

(1) No reasons can be advanced for the downward trend in the annual eulachon catch on the basis of the present investigation. This can only be determined by an extended study of fluctuations in abundance from year to year. In the face of the facts presented here, it would seem inadvisable to open up new markets which would call for a substantial increase in the present intensity of fishing.

(2) In the meantime, if the value of the fishery appears to warrant further investigation, it is recommended that the investigation be continued along the following lines:

(a) Annual sampling programme - experiments to be attempted in developing a sampling method less selective than the gill net.

(b) Examination of the samples in detail, as has been done so far, paying particular attention to age composition of the samples.

(c) Comparison of eulachon runs from various rivers to determine whether or not migration between river systems is to be considered as an explanation of variation in the abundance of runs from year to year.

(d) An extensive search for eggs and larvae and an investigation of the location and extent of the spawning grounds. The artificial spawning and rearing of young as an aid in identification of the eggs and larvae which are collected.

(e) Fishery statistics as collected at present indicate numbers of licences and total catch, without giving any information concerning the actual fishing effort made by each licence holder. It is desirable that fisheries statistics be collected in somewhat more detail so as to permit estimates of actual fishing effort and from them to calculate with some certainty the changes in availability of fish to the fishermen. When such changes are determined and related to changes in actual abundance it may be possible to discover and define the gross biological phenomena before seeking their explanations.