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REPORT ON PIPER'S LAGOON

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During the period from July 23rd to September 5th, 1930, inclusive, a general survey of Piper's Lagoon was made, with regard to its suitability for rearing salmon under natural sea conditions. A series of temperature records was taken, plankton was collected with fine and coarse tow nets, and some rough quantitative estimates were made of the plankton brought into the lagoon on the flood tides.

Piper's Lagoon has a very narrow entrance channel, which could easily be controlled with a dam or screen. The lagoon is, however, very shallow and this, together with the fact that the entrance is some feet above zero tide level, seems to counteract most of the advantages arising from the ease with which the entrance could be placed under control.

The lagoon normally goes dry, with the exception of a narrow channel along the north side and a few shallow pools, when the falling tide reaches a level of about six feet above normal zero. The result of this is, of course, that during the period of low tide the lagoon is dry from the time the falling water passes the six-foot level until after the next flood reaches this height. During the periods of lower high water, the lagoon may frequently remain dry for a period of two tides.

Considerable dredging operations within the lagoon and at its mouth could overcome the difficulties just outlined to some extent. In view of the fact that the whole lagoon bottom is sandy, it would be necessary to line any pools which might be dredged with retaining walls, otherwise sand would soon fill them again. In order to make the lagoon suitable for the retention of live fish, it would be necessary to hold water to a certain depth at all times. At least two feet of water would seem desirable. This would make necessary the construction

of a retaining dam at least two feet high across the mouth. This, again, would bring another difficulty, for a fresh supply of water would not begin to enter the lagoon until the rising tide had reached a level of about 8 feet above zero, unless, of course, screened gateways were left to allow the water to enter as soon as it reached the dam. These would have to be closed when the next falling tide reached the level of the top of the dam.

A dam across the entrance would also decrease the exchange of water with its contained food organisms. In its present condition the exchange is already very slight when there is no great rise and fall of tide. The average depth of water in the lagoon at present is only about six feet on a very high (13.5 or 14 ft.) tide.

During the periods of small tides, with little or no exchange of water, it is possible that the water might become stagnant and that the natural food supply might be so reduced as to interfere with the natural growth of the fish. Furthermore, during the warm portion of the summer it is quite probable that the water retained within the lagoon would become too warm for the welfare of the fish in it.

From the foregoing, it would appear that, if Piper's Lagoon were to be used for retaining and raising young salmon, it would be necessary to lower, by extensive dredging, a considerable portion of the lagoon in order that water might be retained in quantities sufficient to accomodate the fish, and in the summer months to prevent the temperature becoming too high during the low tide periods. Furthermore, it would seem necessary to lower the level of the mouth of the lagoon to permit a greater exchange of water bearing food organisms, if natural feeding is to be adhered to in the experiment.

Temperature readings throughout the period of the survey revealed that in the shallow pools left at low tide, temperatures at least as high as 26°C. are reached during the hot summer days. In the channel along the north side temperatures of 25°C. were recorded. It is quite probable that even higher temperatures than these were reached, for the two temperatures just stated were recorded about 10:00 A.M. on a hot day. The cooler water of the incoming tide did not reach these portions of the lagoon until about 1:00 P.M.

Other temperatures taken throughout the summer at or about full tide ranged from 17°C. to 22°C. The average was about 19.7°C.

If water to a depth of not less than two feet were retained in the lagoon at all times, it is probable that a temperature of 25°C. or 26°C. would not be reached, but with temperatures as high as 21°C. recorded at the mouth of the lagoon toward the last of the flooding tide, it is probable that temperatures within the lagoon might still become too high for salmon. In hatchery practice a temperature above 22°C. is looked upon as dangerous for salmon.

Plankton tows were taken during the period of the survey. Two nets, one of coarse (#) bolting silk, and one of fine "tarentulle" material were used. The nets were about 25 in. long with the open end 12 in. in diameter. In addition to tows, quantitative samples were taken by straining measured quantities of water through the fine net.

The material retained by the coarse net proved to be mostly Ctenophores (Pleurobrachia), with a very few small crustacean, bivalve, and echinoderm larvae, and an occasional small pelagic tunicate (Oikopleura).

Examination of the material from the fine net, which was mostly used, showed it to be composed mainly of:

1. Crustacean larvae, all very small, probably suitable for food for young fry and fingerlings, but likely to be too small for larger fish.
2. Rotifers.
3. Tunicates -- all very small.
4. Bivalve larvae - small, shell just beginning to form.
5. Nematode worms - microscopic in size.
6. Miscellaneous larvae - few and all small (Mollusc, Polychaete and Echinoderm).
7. Diatoms were, of course, present in great quantities, but it is doubtful if they are of any great value as food for fish other than perhaps very young fry.

Most of the plankton organisms were surface and shore forms. This is quite as would be expected, for between the lagoon and the deep water of the Strait of Georgia is Hammond Bay, which is comparatively shallow, a great portion of it being exposed at low tide. Such conditions produce many shallow water and shore forms, and on account of the shallowness of Hammond Bay and its fairly well protected mouth, it is probable that most of the water flowing into it from the Strait during flood tides is surface water. Similarly, it follows that the tide of the lagoon is in a great measure a back and forth movement of the water of Hammond Bay. Consequently, there is still less probability of water from the deeper layers of the Strait of Georgia, bearing the larger organisms on which older salmon feed, reaching the lagoon.

Plankton collected from the quantitative samples of water was diluted to a measured volume. These were thoroughly agitated and samples of 2.5 c.c. or 5 c.c., depending on the concentration of the sample, were placed in a Syracuse watch

glass, and the more common forms were enumerated with the aid of a low power microscope. From these counts, estimates of the number of organisms per gallon of water in the original sample were calculated. A number of representative estimates made in such a way follow:

I. July 23rd.

Five samples of ten gallons each taken at the mouth of the lagoon at regular intervals from 2:30 P.M. to 5:00 P.M., extending over the period of inflowing tide.

Forms	No. per gallon	
Crustacean larvae	40.	
Rotifers	20.	
Nematodes	2.4	Amount of settled plankton .17 c.c. per gal.
Bivalve larvae	1.6	
Gastropod eggs	1.4	
Annelid larvae	.6	

II. July 24.

Twenty gallons from middle of the lagoon at high tide (13.4 ft.

Forms	No. per gallon	
Crustacean larvae	27.	
Rotifers	17.	Amount of settled plankton .65 c.c. per gal.
Tunicates	11.	
Nematodes	1.8	
Gastropod larvae	1.2	
Bivalve larvae	.6	
Polychaete larvae	.6	

III. July 25.

Eleven samples of 2 gallons each, taken at the entrance to the lagoon at regular periods from 3:00 P.M. to 5:40 P.M., covering the greater portion of the flood tide.

Forms	No. per gallon	
Crustacean larvae	71.	
Rotifers	24.5	
Tunicates	3.	Amount of settled plankton .53 cc. per gal.
Bivalve larvae	9.	
Nematodes	7.	

IV. July 25.

Ten gallon sample at entrance to lagoon at end of flood tide.

Forms	No. per gallon	
Crustacean larvae	32.	
Rotifers	3.	
Tunicates	10.	Amount of settled plankton .53 c.c. per gal.
Nematodes	9.	
Bivalve larvae	5.	
Gastropod eggs	3.	

V. July 28.

Ten gallon sample from middle of lagoon at nearly full tide.

Forms	No. per gallon	
Crustacean larvae	68.	
Rotifers	92.	
Tunicates	50.	Amount of settled plankton .6 c.c. per gal.
Bivalve larvae	8.	
Gastropod eggs	3.	

Forms	No. per gallon
Nematodes	1.
Polychaete larvae	1.

VI. August 11.

A. 25 gallons from upper end.

B. 25 gallons from lower end.

Both samples taken at full tide.

Forms	No. per gallon A	No. per gallon B
Crustacean larvae	46.	84.
Rotifers	3.3	7.7
Tunicates	5.	10.
Bivalve larvae	0.	2.
Echinoderm larvae	.8	0.

Amount of settled plankton .96 c.c. per gal.

VII. August 26.

Fifty gallons dipped at intervals down the center of the lagoon at full tide.

Forms	No. per gallon
Crustacean larvae	151.
Rotifers	8.
Tunicates	.5
Polychaete larvae	1.5
Bivalve larvae	16.

VIII. September 5.

Samples taken at nearly full tide.

A. 50 gal. at lower end of lagoon.

B. 25 gal. at middle of lagoon.

C. 100 gal. at upper end of lagoon.

Forms	No. per gallon		
	A	B	C
Crustacean larvae	282.	230.	323.
Rotifers	264.	249.	317.
Polychaete larvae	.6	0.	1.8
Settled plankton per gal. (cc.)	.06	.04	.02

In summary, it is suggested that while Piper's Lagoon might be made suitable for the retention of salmon for a time by more or less extensive dredging and by building a low dam across its mouth to prevent it from going dry between tides, it is probable that during the hot months of the summer the temperature of the water held within the lagoon might rise so high as to be unsuitable for salmon. Furthermore, it is suggested that the organisms brought into the lagoon naturally are not of such kinds as would prove satisfactory for food of any but very small fish.