pletely. The ice of the Chippewa lobe extended to the southwestward for a distance of 150 miles beyond the Keweenaw Peninsula, and terminated there at an altitude some 300 feet above the level of West Bluff. It over-rode the Porcupine Mountains and other land areas near the Wisconsin line, where the relief is 500 and more feet higher than at West Bluff. To do this it must have been 1,000 feet or more above West Bluff for the surface of the ice sheet slopes downward toward its border.

If, as Fernald claims, the "relic-species" found in the Keweenaw Peninsula are hold-overs of a "formerly wide-spread and somewhat generalized Tertiary flora" (p. 217), then it is necessary to assume that the species in question not only survived the Wisconsin stage of glaciation but likewise the much longer and more wide-spread Illinoian stage as well. It is difficult for the glacialist to understand how the botanist gets his "relic flora" through an interval of 150,000 to 200,000 years of ice refrigeration, as represented by the Wisconsin and Illinoian stages, to say nothing of the much more protracted pre-Illinoian time, in the transition from the Tertiary to the present. Certainly the interval involving the wide-spread activities of pre-Wisconsin glaciation can not be neglected in the proper interpretation of the problem.

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"MIGRATION" AND "HOMING" OF PACIFIC SALMON[1]

IN a recent issue of SCIENCE[2] Professor A. G. Huntsman stated that he was unable to find a single clear case of a salmon returning to its natal stream from a place in the sea away from the area influenced by the fresh water of its natal stream. He also assumed that salmon, when wandering in the sea beyond the gradient produced by their natal streams, become lost and may reach neighboring streams or travel farther to sea. Since Professor Huntsman has included the Pacific salmon of the genus Oncorhynchus in his category I would like to give evidence which shows that these salmon migrate to sea far beyond the influence of the gradients produced by their parent streams, mature and then return to their parent streams to spawn.

The Fraser River and its tributaries in British Columbia form one of the largest river systems on the Pacific coast of North America. This river system is noted for its high production of sockeye salmon (*O. nerka*) which form over 90 per cent. of the commercial catches of sockeyes in the Swiftsure Bank-Puget Sound-Fraser River region.[3] There are also a number of other streams of considerable size in this region, but only a few of them support populations of sockeye salmon, which in all form only a small fraction of the populations of the Fraser River system.

The majority of the Fraser River sockeyes migrate to and from the sea through the channels immediate to the river's mouth and the adjoining channel of the Strait of Juan de Fuca. The fresh waters of the Fraser River as well as those of all the streams in the Puget Sound area flow seaward through the Strait of Juan de Fuca. Since there are rapid tide movements in this strait these fresh waters become mixed shortly after they enter the strait. There is also a rapid mixing of the fresh waters with the salt water throughout the course of the strait so that no definite gradient is maintained. Hence if all the Fraser River sockeyes had to mature within an area in the sea influenced solely by the river's water or else become lost, they would all have to mature within the channels immediately adjoining the river's mouth. During the many years the salmon fisheries have been carried on in these channels as well as in the Strait of Juan de Fuca there is no record of the catch of partially mature sockeyes in these waters at any time in the year. In the years when salmon traps were operated in this region they were set weeks before the beginning of the spawning migration and yet no catches of partially mature sockeyes or adults were ever made at this time. In fact no adult salmon are ever caught within these waters except during the season of the spawning migration, which extends from May to October. During this period they are caught in the open sea on Swiftsure Bank as well as in the Strait of Juan de Fuca and the adjoining channels through which they migrate to the Fraser River.[4] This is certainly sufficient evidence to show that the adult sockeyes which return to the river to spawn each season mature within the open sea far beyond the gradient produced by the fresh waters of the river.

Evidence which shows that the adult sockeyes which migrate into the Fraser River are native to it may be found in the studies of Dr. R. E. Foerster at Cultus Lake, British Columbia.[5] This lake forms the headwaters of a tributary to the Fraser River. Thousands of young sockeye salmon from Cultus Lake have been marked by removing two or more of their fins. The adult salmon bearing these marks have been recovered by the fishery on Swiftsure Bank in the open sea, in the Strait of Juan de Fuca, in the waters in the immediate vicinity of the mouth of the Fraser River and in the river. Large numbers of adults bearing the marks have also been recovered at Cultus Lake. The

[1] Published by permission of the U. S. Commissioner of Fisheries.

[2] SCIENCE, 85: 313–314, 1937.

[3] A complete description of this region and the commercial salmon fisheries it supports is given by G. A. Rounsefell and G. B. Kelez, Special Rept. U. S. Bureau of Fisheries, 1935.

[4] See H. O'Malley and W. H. Rich, Rept. U. S. Comm. of Fish., 1918, app. viii, 38 p.

[5] R. E. Foerster, *Jour. Biol. Board Canada*, 3: 36, 1936.

first marked salmon that have been recovered each season have been caught on Swiftsure Bank and in the region of the Strait of Juan de Fuca. Therefore, these results, together with those of the commercial fishery, show that the adult sockeye salmon migrating into the Fraser River each season are native to it and come from the open sea, where they have matured.

Mr. G. B. Kelez in his studies of the coho salmon (*O. kisutch*) of the Puget Sound region has found a similar relationship in the commercial catches of these salmon, and from his marking experiments, data unpublished, has found that they are native to the streams of the region.

Another good example of the migrations and homing of the Pacific salmon may be found in the studies of the pink salmon (*O. gorbuscha*) of southeastern Alaska. This part of the territory is composed, for the most part, of a group of large islands known as the Alexander Archipelago. There are over 900 streams in this region, which range in size from mere trickling creeks to large rivers. Practically all these streams support populations of pink salmon. Many are only a few hundred feet apart at their mouths and flow into bays. Others are more or less isolated along the shores of inlets. As many as 25,000 pink salmon may be found spawning each year in creeks not more than a few yards in width and a half mile in length. The areas in the bays and inlets influenced by the fresh waters of these streams are so small that it would be impossible for more than a few salmon to mature within them, let alone thousands of fish. Furthermore, no half-grown pink salmon have ever been found within the inside waters among the islands throughout the entire region. Nor are any adult pink salmon found within these waters except during the season of the spawning migration, which extends from June to October.

Salmon traps are operated by the commercial fishery along the shores of the main channels of entry into the inside waters among the islands. Since these traps are stationary units of gear, the time of appearance of the salmon runs in the channels may be determined readily from the time in the season the trap catches are made. Records of the daily catches of these traps have been collected for a period of 20 years. There has never been a year when some of these traps were not set prior to the beginning of the salmon runs. The first traps to catch pink salmon each season have been invariably those located near the entrances of the channels into which the salmon migrate from the open sea. Observations in the offshore waters shortly before the pink salmon begin their migrations into the channels have revealed the presence of these fish in large schools milling about but gradually moving towards the shore.

That these pink salmon return to their parent streams in southeastern Alaska is also not a matter of conjecture. In the spring of 1931 I marked 50,000 pink salmon fry by removing two of their fins at a small stream flowing into Olive Cove on Etolin Island.[6] This stream is more or less isolated from other pink salmon streams in the district. The adult salmon bearing the marks returned to Olive Cove in the summer of 1932. At this time a search was made in all the neighboring streams for marked salmon, but none were found. This would indicate that there is a high degree of homing in the pink salmon. However, I have not assumed that this would be true of all streams, for from my studies of the return of marked pink salmon to the Duckabush River on Hood Canal, Washington, I found there was a certain degree of straying from the parent stream.[6] The Duckabush River is located on the canal between and within a few miles of two other streams of similar size. Marked adult pink salmon were found in both of the neighboring rivers, but the great majority of the returns were to the parent stream. Hence it is not improbable that the pink salmon populations in streams more or less isolated from other streams may show little tendency toward straying, whereas populations in streams in the vicinity of other streams may show some degree of straying into the neighboring streams. Furthermore, I am not aware of any biologists at the present time thoroughly familiar with the life histories of the Pacific salmon who are of the opinion that any of the species return to their parent streams with unerring accuracy. The studies of Dr. A. L. Pritchard on the homing of the pink salmon[7] as well as my own studies indicate that the homing of these salmon is of a sufficient degree to justify conservation measures on the basis of the parent stream principle.

The practical application of this principle in the conservation of all the species of Pacific salmon has given most satisfactory results. The U. S. Bureau of Fisheries has records to show that the protection of the salmon populations in individual streams has brought about a great increase in their abundance and that when this protection is removed the populations again decline in abundance. In view of the evidence both from the practical as well as the scientific standpoints the Bureau of Fisheries is firm in its conviction that this principle is sound both in theory and practice.

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CANNIBALISM AND PRIMITIVE MAN

QUALITIES are often attributed to fossil men which, upon the evidence offered, would in any Primate court of justice be considered actionable. It is time that a

[6] See F. A. Davidson, *Bull.* U. S. Bur. Fish., 48: 15, 1934.

[7] A. L. Pritchard, Ann. Rept. Biol. Bd. Canada, 1933.