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MANUSCRIPT REPORT--FILE

MR--F 16

DIFFERENTIAL PRODUCTIVITY OF BRISTOL BAY SPAWNING GROUNDS

by

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March 1964

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Bristol Bay escapement surveys covering a period of several years show that, irrespective of fluctuations in total numbers on a system, certain grounds display a greater consistency than others, with normally high abundance levels and few poor years. That such large populations are the result of equally large numbers of parent fish in seasons past is discounted by the fact that, if this were the only factor involved, all other grounds would be equally populous.

Because this phenomenon is a case of differential survival in conjunction with known conditions, it is worthy of further study, as these conditions may provide the basis for discovering limiting factors in all red salmon areas. If certain grounds consistently produce more young per spawner than others, all grounds should be systematically classified so that escapements to each ground can be expressed in terms of expected returns and a more accurate system forecast prepared. Furthermore, if particular spawning grounds show survival patterns related to changes in natural conditions, then the way may be pointed to correlation of these conditions with red salmon survival in general.

Where costly stream improvement, such as opening of spawning ground by laddering or removing obstruction is contemplated, it is important to be able to give priority to those grounds likely to produce the greatest return on the investment. Here again, the knowledge of the potential of grounds by type is essential.

Spawning ground productivity is here assumed to be reflected in the numbers of spawners returning to a ground over a period of several years in relation to the maximum that can be accommodated by the area. Also of importance as a measure of the worth of such grounds is the consistency of returns. Grounds that tend to produce heavily year after year without following the abundance trends of the system, would indicate normally above-average conditions little affected by varying natural factors. Sporadic heavy returns interspersed with poor years would indicate a basically good ground responding to varying external survival influences. Constantly poor returns indicate unsatisfactory gravel or water quality.

Spawning populations in Bristol Bay are assessed by standardized aerial survey methods described by Eeles (1947)[1] and Eicher (1953)[2]. All spawning grounds are visually surveyed at least twice during the spawning season. In addition, selected index areas are photographed to provide permanent records, some thousand pictures being taken annually. From aerial coverage and ground surveys made in the period from 1938 to the present, the number of fish needed to saturate each spawning ground has been approximated. The index to the spawning population of each ground is expressed as a percentage of the maximum effective number of spawners.

Examination of the records of individual grounds surveyed during the past 13 years reveals that magnitude and consistency of returns to these grounds is not haphazard, but falls into levels according to the type of ground. About 95 percent of the Bristol Bay red salmon are accommodated on three major types of spawning grounds:)1 beach areas, 2) runoff streams, 3) streams connecting lakes. While these categories could be further sub-divided, it is sufficient for the purpose of this paper to limit them thus.

1/ "Measurement of Salmon Spawning by Means of Aerial Photography", Pacific Fisherman, Feb. 1947.

2/ "Aerial Methods of Assessing Red Salmon Populations in Western Alaska", Journal of Wildlife Management, Vol. 17, No. 4, October, 1953.

Beach spawning takes place on the flat shallows of lake shores, and is confined to areas where underground seepages carry off waste products and protect the eggs from freezing in the shallow water. Such spots are characterized by hills rising abruptly from the water adjacent to shallow areas near the beach. The majority of spawning on the Nushagak systems today is this type. The systems of the Kvichak River drainages support minor beach spawning, as does also the Naknek River system; however, this type of spawning is unimportant in the Egegik and Ugashik districts.

Runoff streams are the common variety found widespread, of varying length and heading in minute tributaries or glaciers in the hills. Rain, melting snow, or subsurface drainage resulting from these, provide the water for this type. As runoff streams are numerous and often several miles in length, their potential red salmon production is seemingly great. On the Nushagak, this type is of negligible importance; the Kvichak beaches provide moderate spawning, and those of the Naknek a small amount; however, the principal spawning of the Egegik and Ugashik takes place on this type.

Connecting streams are those that tie the many lakes of a single drainage into one system. They are characteristically short and broad. Few are more than a few miles in length, and some are but a few hundred yards from outlet to mouth. This type supports a significant part of the spawning of the Nushagak, Kvichak and Naknek, a lesser amount on the Egegik, and is unimportant on the Ugashik. Probably the greater part of the Kvichak and Naknek spawning is accommodated by this type.

Figure "A" shows the spawning returns to the five major Bristol Bay spawning districts expressed in percentages of maximum effective utilization of the spawning grounds by type of ground, as well as a summation of these returns in total. The figures are compiled from survey records of the 70 most prominent spawning grounds, including 18 beaches, 25 runoff streams, and 27 connections. Only those grounds with records for nine or more years are included. The average of each type on each system is shown to indicate the level of production. Coefficients of variation, which are inversely proportional to the consistency of returns (a smaller number means greater consistency), are 71.8 for beach areas, 78.4 for runoff streams, and 52.9 for connections. From these data it is apparent that in all districts, spawning grounds of connecting streams produce the largest returns, and what may be of greater importance, are much more consistent. Over the entire Bristol Bay District, the runoff streams in turn appear more productive than beach areas, with the minor exception of the Nushagak.

Not easily shown graphically or otherwise is the comparatively steady production of connecting streams in years of overall poor production. In many such years on some systems, the only returns of effective numbers have been to this type. This phenomenon has been particularly noticeable on the two Nushagak systems.

The greater efficiency of spawning grounds on connecting streams may be due to any of several factors. More uniform temperature ranges which normally occur on such grounds, and in particular higher minimums, could easily be dominant in controlling success of hatch. Earlier-than-average hatches which usually occur on these streams may bring out the fry at a time when predators are less numerous or voracious or when other conditions are favorable for survival. Earlier hatch could also mean a longer growth period before seaward migration, producing larger migrants of enhanced ocean survival.

Whatever the basic cause may be, it should be discovered at the earliest possible date in order to obtain the key to differential survival on all Bristol Bay spawning grounds, and thus permit better forecasting of runs. Research in this problem should be neither costly nor difficult, and would involve mainly comparison of all aspects of spawning and hatching of the three types of ground. Fertilized eggs in cartridges of plastic screen buried in the gravel at the time of greatest spawning activity in grounds representative of each of the three major types and examined at intervals until hatching would reveal their relative hatching efficiency. Simultaneously, a constant record of temperatures in the gravel and water levels would be kept. Relative time of hatch and emergence from the gravel of fry would be noted, and the fish would be observed from time of hatch to adult stage through marking experiments to determine relative mortality in various life stages and such important features as length of freshwater residence and size at time of migration as affected by type of spawning ground.

Experimental work should also be undertaken to determine the feasibility of greatly increasing and stabilizing the production of runoff streams through creation of small artificial lakes in their headwaters above present spawning grounds. The production of many systems could thus be considerably enhanced, as all have more runoff streams than any other type, and most of these have narrow gorges near their sources where small, easily-constructed earthfill dams could impound reservoirs. Such reservoirs would not have to be unduly large, judging from the success of present connecting streams, some of which have only small lakes at their sources yet yield large returns. In many cases streams could easily be diverted through existing lakes. If the efficiency of the average connecting stream could be combined with the length of the average runoff stream, then theoretically a large increase in salmon production could be achieved.

It is true that many factors other than spawning or hatching success influence the survival of Bristol Bay red salmon, and it seems apparent that most of their population fluctuation is due to varying ocean survival; however the fact that these favored spawning grounds continue to produce at a consistently high rate is proof that initial fry production is reflected to some extent in eventual numbers of adults. At present it is not unusual for the connecting streams of a system to have more spawners than the grounds can efficiently accommodate, while adjacent runoff streams are virtually barren of fish. If all of these streams could be converted to the same productivity level, the numbers of fish surplus to spawning needs and hence available for packing would be greatly increased.

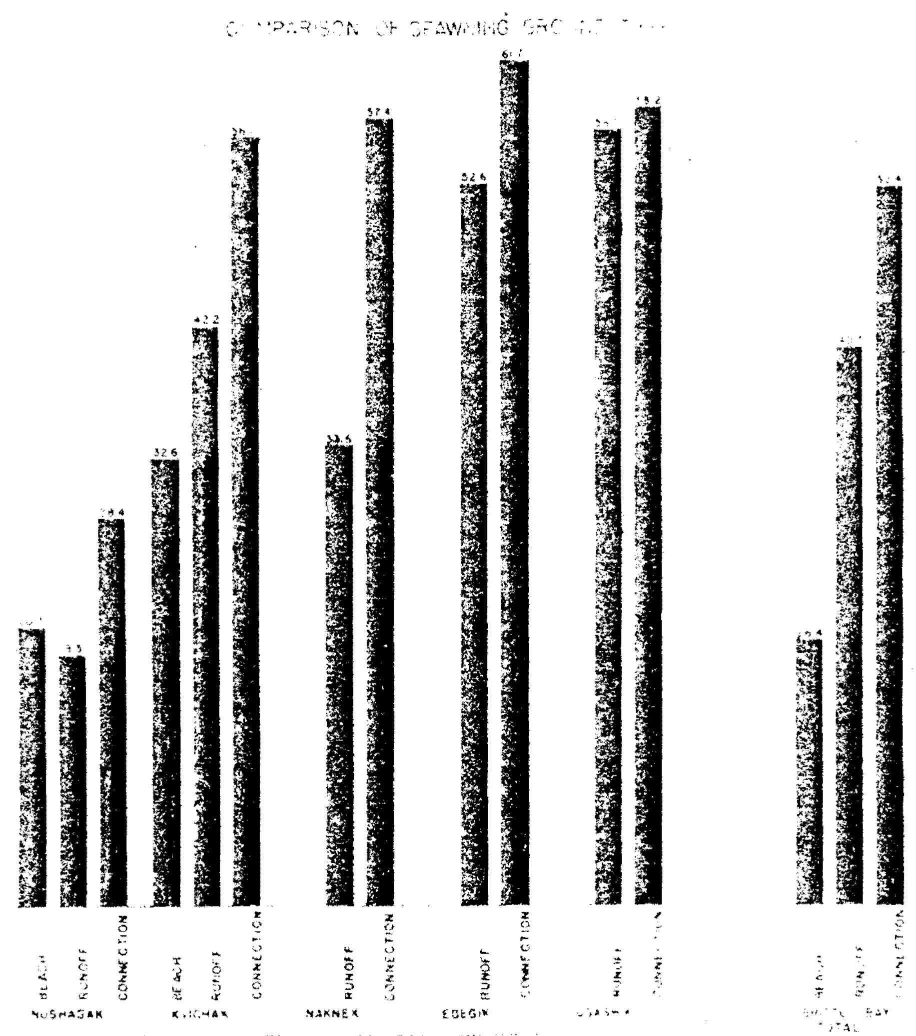

Figure 4.--Comparison of spawning ground types. Figures at top of bars, and length of bars, indicate utilization of spawning grounds in terms of percentage of maximum effective utilization.