REPLY TO ROUNSEFELL'S "COMMENTS ON 'EVALUATION OF CAUSES FOR THE DECLINE OF THE KARLUK SOCKEYE SALMON RUNS AND RECOMMENDATIONS FOR REHABILITATION,' BY R. VAN CLEVE AND D. E. BEVAN"

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A detailed reply to Rounsefell's comments on our paper would involve repetition of those sections in which we have corrected misconceptions and errors in his paper of 1958. He has repeated many of the arguments he used in 1958 and has quoted parts of ours out of context. For a detailed reply to Rounsefell's "rebuttal" we refer you again to our paper. In it we have brought relevant information from older publications together with factual unpublished material from a number of agencies and some of the most recent knowledge of sockeye biology and behavior that has demonstrated the genetic basis of the racial structure of their populations. This has been described for both the Karluk and Fraser River stocks. We have used this information to interpret the past history of the Karluk sockeye salmon runs and from it have explained their continued decline. In view of the papers by Thompson (1950, 1951), Thompson and Bevan (1954), Hartman and Raleigh (1964), Raleigh (1967), Brannon (1967, 1972), and Gard and Drucker (1972),[3] there is no question that the Karluk sockeye salmon runs are divided into many races. It is unfortunate that this was not recognized earlier.

It is also unfortunate that while spawning sockeye were noted in the Karluk River and the upstream movement of fry was noted, that the Karluk River spawning races have not been studied. So far as we know the observations of Walker (1954)[4] were the first detailed observations of the upstream movement of fry through the weir and of the injuries sustained in that struggle. However, soon after those observations were made Bevan and Walker shifted from studying sockeye salmon to studying pink salmon, so they did not continue working on the Karluk River spawning or on the movements of the young sockeye salmon.

In repeating his disbelief in the existence of the races in the Karluk sockeye salmon as well as his recommendation of added protection of the midseason runs "because they are more productive," Rounsefell is not only inconsistent but confuses the time the fish enter the river or lake with the time they spawn. Those sockeye salmon that spawn in the side streams above the lake move up the river and spawn in their special spawning areas after a delay of several weeks in the lake. Karluk River spawners, however, wait in the river while others move into Karluk Lake and rest there until they are ready for spawning; consequently the average time between their passage and spawning is shorter for river spawners than for those which spawn in tributary streams. The movement of fish out of the lake and into the river noted by Bevan (1951)[5] was not a single observation but has been seen several times. Since the

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[3] Gard, R., and B. Drucker. 1972. Differentiation and cause of decline of sockeye salmon of the Karluk River system, Alaska. Unpubl. manuscr. Auke Bay Fish. Lab., Natl. Mar. Fish. Serv., NOAA, Auke Bay, AK 99821.

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[4] Walker, C. E. 1954. The red salmon smolt migration at Karluk Lake, 1954. Unpubl. manuscr. Univ. Wash., Fish Res. Inst., Seattle, WA 98195.
[5] Bevan, D. E. 1951. Karluk Lake stream surveys, 1948-1951. Unpubl. manuscr. Kodiak Isl. Res. Group, Univ. Wash. Univ. Wash., Fish. Res. Inst., Seattle, WA 98195.

same action has been observed to occur regularly at Brooks and Chilko Lakes it is obviously a regular part of the spawning behavior of sockeye salmon that spawn in rivers below lakes. It has not been observed regularly at Karluk Lake but it must occur, since the weir was made to pass fish downstream as well as upstream sometime in the late 1950's.

Thompson (1950, 1951) proved conclusively that the bimodal structure of the Karluk sockeye runs after 1921 was an artifact caused by the fishery. He provided a series of figures from the total weekly Karluk pack of the largest canner in that area, that showed the transition from a run with a single mode in the late 1890's through the gradual destruction of the center of the run, finally ending before 1921 with the two modes representing the spring and fall remnants. These had not been fished as hard as the center and after 1921 they were protected by federal regulations of the catch. Rounsefell's Figure 2, based upon runs since 1921, is therefore of no significance concerning the original runs.

The reports of the International Pacific Salmon Fisheries Commission document the variability in age at which fish of the same race return from the sea to spawn. Every peak cycle of the major Fraser River races is normally preceded by a large run of 3-yr-old jacks that are almost all males. The peak years are also usually followed by a large run of 5-yr-old fish. This is shown in the annual reports of the Commission which describe the returns from the large Adams River run or from the Chilko run. This variability in age of return is part of the normal variability within any race of sockeye and represents the adaptability of each race to environmental variations. The age of return of each race is never fixed, though in the successful ones most fish usually return at a certain age. The variation in age of return provides protection against disasters such as occurred at Hells Gate on the Fraser River in 1913, and increases the probability of survival of each race. Of course if a number of different races are lumped together as Rounsefell has done for both the Karluk and Fraser Rivers and the variations in returning age classes are studied without regard for the individual variation of each race, the results are meaningless. Correlations between the main age group and inconsequential segments of any group of races such as those mentioned by Rounsefell on page 655 of his comments are of no significance and certainly do not prove that races do not exist in the Karluk. Variations in time and space of the numbers of 5- and 4-yr-old fish must be expected though the returning fish of each race to be most successful conform in time within each season with limits imposed upon it by the composite of environmental factors that race encounters during its entire life history. We would expect the most successful portions of the run to produce the most "strays" that return at odd times and places.

It is difficult to appreciate Rounsefell's dismissal of the numbers of redds estimated for the terminal streams, lateral streams, and lake beaches in the Karluk watershed by the biologists who have been working on the Karluk (see Rounsefell page 658 and compare with Burgner et al., 1969). Rounsefell multiplied the number of potential redd sites noted by Burgner et al., in terminal streams by 4, in lateral streams by about 4.2 and on the lake beaches by 10 with no apparent justification other than his statement that the estimates made by Burgner et al. cannot be taken seriously. Using his most conservative factor of 4, he should also have increased the number of potential redd sites in the Karluk which would then exceed 500,000. The Karluk River could be expected to accommodate about 1,000,000 spawners. This would in fact agree with 3 times the 400,000 estimated to have spawned there in 1926, i.e., when that figure is multiplied by the difference observed by Bevan and Walker (1955) between stream estimates of spawners and weir counts which they established on Moraine Creek (see our paper page 631). This also agrees with the factor of about 3.0 established for Forfar Creek, one of the small streams in the Stuart Lake system of the Fraser River when the senior author was chief biologist for the International Pacific Salmon Fisheries Commission. Much as we have always admired the pioneering biological work of Rutter we cannot conceive that his stream counts would be more accurate than those of our modern salmon biologists. How-

ever, it is useless to argue about the relative numbers of sockeye that spawn in the Karluk River since the weir was moved to its present location in 1945. As noted in our paper this reduced the productivity of the Karluk runs to a new low level (see our Figure 2) and altered the relative numbers of the different races in the system. The weir must have had an especially adverse effect on the Karluk River spawners so that the proportion of 10% of the total run established by the Auke Bay Fisheries Laboratory staff after 1950 must have been far below the original proportion.

Shuman's (1950) estimate of high mortality of sockeye salmon due to Kodiak bears introduced by Rounsefell could have been associated with the large population of Kodiak bears resulting from lack of hunting during World War II. With more intensive hunting since then it is probable that predation is not as heavy as Shuman observed. We agree that this is a factor that should be studied.

It is probable if the sockeye salmon runs could be rebuilt in the Karluk system that natural cycles would again appear. However, artificial manipulation of the size of the sockeye salmon runs as Rounsefell (1958) recommends to restore the "cyclical abundance," which was characteristic of the period after 1921, should not be attempted before restoration of their abundance has been accomplished since they seem already to have been overburdened with manipulation and experimentation.

Testing the conclusions reached in our paper would be the height of simplicity: merely remove the weir from the upper Karluk River (as well as from all the other streams in the Karluk watershed) and maintain the present fishing intensity on the Karluk sockeye salmon. The cost would be minimal, especially if the biological work on the Karluk runs were restricted to observation of the adults and young from the stream banks and lake shore. Modern acoustical gear could be used on the lake to estimate numbers of both adults and young without harming them and stream counts of spawners would serve as a basis for comparison with past years. Concern with "complete counts" such as is theoretically obtained from the weir is fallacious because the weir counts do not include sockeye that remain in the Karluk River below it and as we have indicated the weir must have a major adverse effect on both young and adults.

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