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OUTLOOK FOR THE ALASKA HERRING FISHERY IN 1943

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When the first preliminary investigations of the herring fisheries of Alaska were undertaken in 1925, it was stated, "The rational use of this fishery and the desire to keep it at a point of maximum productivity without endangering the future supply demands a knowledge of two things: (1) we must know how the species is withstanding the strain of the fishery; (2) we must know what natural changes in abundance are occurring, so they will not be confused with the effects of fishing, that they will be understood, and, if possible, foretold."[1/] Investigations on as extensive a scale as funds permitted have been made each year since that time and pertinent facts have been assembled. They have been used in varying degrees as a basis for the Government's program of fishery management in Alaska. With present wartime need for fishery products as food, fish meal for animal feeding, and oils, both edible and non-edible, for industrial use and for the manufacture of munitions, the herring fishery of Alaska assumes increasing importance. How far we have gone in meeting the needs for maximum production, and in achieving the goals set forth above that make maximum production possible, will be apparent in the following pages. This report has been prepared to make available, especially to those engaged in the industry, certain salient facts which are now known about the Alaska herring and their bearing upon the management of the resources.

Of first importance to the industry is an answer to two questions: (1) Why does the abundance of herring fluctuate so widely from year to year? and (2) How large a supply of herring may be expected in the coming season? In answer to the first question, it may be stated that in the herring, as in any population of living creatures, abundance is governed by the ratio of the birth rate to the death rate. Because the effective birth rate is so variable, and the death rate in adult life so high, great natural fluctuations in the number of individuals must inevitably follow. As to the second question, certain events have recurred with regularity, and their effects on the abundance of the stocks have been found to be

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1/ Rounsefell, George A. Contribution to the biology of the Pacific herring (Clupea pallasii) and the condition of the fishery in Alaska. Bulletin, Bureau of Fisheries, Volume 45 (Fisheries Document 1080). 1930.

consistent. Through continued study there is now sufficient knowledge to provide a fair basis for estimating the birth and death rates, and so to predict available supplies in advance of the opening of the fishing season. Such a prediction for each of the three important producing districts is presented herein.

Because the terminology applied to fishery problems is specialized, a definition of a few of the terms is included to insure a clear understanding of their application in the following discussions.

Abundance refers to the numbers of fish in the sea (stocks), and is not to be confused with availability, which often governs the size of the catches.

Age composition refers to the relative numbers of individuals at each age in the stocks, reduced to a percentage basis.

Year of life refers to the age of the individual but differs from ordinary terminology in that a three-year fish, for example, has passed two "birthdays", instead of the three as referred to in ordinary usage and thus is in its third year.

Year class is the entire brood of young fish hatched in any one year. If the hatching and survival of young is outstandingly successful in one year as compared with other years, the resulting brood is so very abundant that it is spoken of as a dominant year class.

Effective birth rate is used in the limited sense of applying only to the numbers of individuals surviving to enter the adult stocks, and does not consider the numbers hatched. This interpretation is made necessary by the fact that only a small (but variable) percentage of individuals hatched survive to enter the stocks, and it is only these survivors which are effective in replacing losses among the adults.

The reader will understand, of course, that fishery biologists have developed an accurate and reliable method for determining the age of individual herring by counting the winter marks which are revealed by microscopic examination of the scales. The general features of the life history of the Pacific herring, which differ materially from those of the Atlantic herring, have been worked out by fishery biologists of the United States and Canada. These may be reviewed in the following publications:[2/]

1930. Rounsefell, George A. Contribution to the biology of the Pacific herring (Clupea pallasii) and the condition of the fishery in Alaska. Bulletin, Bureau of Fisheries, Volume 45 (Fisheries Document 1080).

1931. Rounsefell, George A. Fluctuations in the supply of herring (Clupea pallasii) in Southeastern Alaska. Bulletin, Bureau of Fisheries No. 2.

2/ These publications are available for purchase from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

1932. Rounsefell, George A. and Edwin H. Dahlgren. Fluctuations in the supply of herring, Clupea pallasii, in Prince William Sound, Alaska. Bulletin, Bureau of Fisheries No. 9.

1935. Rounsefell, George A. and Edwin H. Dahlgren. Races of herring, Clupea pallasii, in Southeastern Alaska. Bulletin, Bureau of Fisheries No. 17.

THE KODIAK DISTRICT

As a background to a discussion of the probable abundance of herring in this district in 1943, it will be useful to review the history of the fishery for the past several years. Operations in the Kodiak district were confined to mild curing until 1935, with the withdrawals by the fishery from these stocks in the five-year period 1930 - 1934 averaging but little over five-and-a-third million pounds. The demands on the stocks of herring were enormously increased by the introduction of reduction operations, so that the average annual withdrawals over the following eight-year period (1935 - 1942) increased 10 times, amounting to 54 million pounds. This increased withdrawal has had a marked effect on the stocks.

The abundance level preceding 1935 was high, not only because withdrawals by man in those years were at a minimum, but because several spawnings during the preceding years had been successful ones, including especially those of 1926 and 1931. In effect, the birth rate had exceeded the death rate, and, because of this favorable ratio, a large reserve of older fish had accumulated. Consequently, in the first years of the intensive fishery which followed the beginning of reduction operations, not only were the catches large, but these catches included a considerable percentage of older, and consequently larger individuals.

In contrast, after 1935, withdrawals increased, and in all years but two (1939 and 1942) the deaths exceeded the replacements, so that between 1935 and 1938 the real abundance declined. It was partially restored by the replacements of young fish which entered the fishery in 1939, but the stocks declined again in 1940 and 1941. Because of the accumulation of older fish, which remained available for several years after the expansion began, this decline was not immediately apparent, nor did it serve to reduce the total catches. Despite this very considerable reserve supply, however, greater and greater effort was expended in obtaining loads as the years passed, and by 1940 the size of the average delivery began to decline, although the decline in abundance was not readily apparent until 1941. In that year long periods of slack fishing gave proof that the former abundance of herring no longer existed. Fortunately, the ratio of replacements to withdrawals was again very favorable in 1942, so that the abundance was again increased and the catches were again large, although this time they were composed predominately of young fish.

In order to trace these changes in abundance to their source, an analysis of the contributions of the several year classes has been made. (Table 1.) These data, presented below in terms of the number of fish

of each age represented in the catches of the past six seasons, demonstrate beyond question that the spawnings of 1931, 1936, and 1939 were highly successful ones, that the 1935 hatch was above average, and that the contributions of the 1932, 1933, 1934, 1937, and 1938 spawnings were meager in comparison.

Table 1.-Estimated numbers of herring taken from each year class in the Kodiak District (Shelikof Straits only) from 1936 to 1942. (In millions of fish.)

Year of hatch	Year of capture							Total removed from each year class
	1936	1937	1938	1939	1940	1941	1942	
1926	3.0	2.5	1.0	1.0	0.7	--	--	8.2
1927	8.3	6.6	4.3	1.6	.4	--	--	21.2
1928	7.0	5.6	5.1	2.6	.4	--	--	20.7
1929	7.6	5.9	4.2	3.1	.9	--	--	21.7
1930	11.9	9.4	5.6	3.4	.9	0.4	--	31.6
1931	144.6	114.8	78.9	53.0	12.1	4.7	0.2	408.3
1932	3.2	4.6	12.5	5.7	2.1	4.3	.5	32.9
1933	2.5	6.6	5.9	4.7	2.7	2.2	.6	25.2
1934	.8	4.1	7.9	6.8	4.9	4.7	.6	29.8
1935	--	2.8	11.7	42.1	29.1	31.9	6.6	124.2
1936	--	1.8	23.5	133.8	71.5	112.6	31.4	374.6
1937	--	--	--	2.1	2.6	8.7	2.9	16.3
1938	--	--	--	--	.5	5.9	4.7	11.1
1939	--	--	--	--	--	26.9	63.6	90.5
1940	--	--	--	--	--	.8	14.6	15.4
Total removed each year	188.9	164.7	160.6	259.9	128.8	203.1	125.7	1231.7

These estimates are based on the known percentage contribution of each year class to the total catch of each year, with the average weight at each age known. Of course, in appraising these contributions it must be remembered that the greatest numbers of any year class are available in their early life (from the 4th to the 7th years) so that the year classes preceding 1930, being taken only as older fish, are not adequately represented, and those year classes following 1937 have not yet completed their contributions. Nevertheless, the fact outstandingly shown is that the success of fishing operations over a period of years has been largely dependent on only three or four abundant year classes, and has not been equally distributed over the many which have entered the fishery during these years. It is obvious that the effective birth rate varies tremendously from year to year, and that fluctuations in the abundance of the entire stock must necessarily follow.

If the abundance has fluctuated because of these changes in birth rate, then as the abundance of the entering stocks changed, the average catch of the average vessel should have fluctuated in response, unless some disturbing factor such as a change in the effectiveness of the fishing unit were to interfere. A measure of this average catch for each season since 1936 has been calculated, and the data are presented in table 2. The indices of this table show the relative success of each season's fishing.

Table 2.-Indices of fishing success, computed from the average catch per vessel in each year, compared to the grand average of the catches of the combined years. 1938 base year = 100.

Year	Index	Interpretation of indices
1936	87.1	Abundance high because of tremendous number of offspring from 1931 spawning together with a reserve of older fish accumulated during years prior to 1935. Increase in size of vessel from 34 to 53 net tons during period accounts for apparent (not real) increase in abundance.
1937	90.4	
1938	100.0	
1939	99.4	Decline in older age groups compensated by the entrance of the offspring of the 1936 spawning.
1940	73.4	Abundance declining because of failure of the 1937 and 1938 spawnings to contribute their normal share to the support of the stocks.
1941	59.3	
1942	92.9	Abundance increased by the entrance of the offspring of the 1939 and 1940 spawnings.

These indices confirm the statement that a decline was evident between 1939 and 1941, and that the entrance of a new group of recruits in 1942 did reestablish a higher level of abundance.

There is much information to be gleaned from these data of age composition and of average size of catch aside from an explanation of the changes which have occurred in the past. With this information at hand, it is possible to determine the ages at which the juveniles enter the adult stocks and the average rate of mortality in adult life. In turn these data offer positive information on the age composition to be expected in the coming season and, finally, this makes possible a prediction of the abundance to be expected.

A full explanation of the procedures which were followed in obtaining these estimates is more involved than space here permits. Briefly, it consists of statistical analyses of the age composition combined with the calculated factor of abundance of the stock for a series of years and the average mortality rate established over the period for which data are available (1937-1942).

With estimates of the rates of recruitment and of mortality at hand, the most probable age composition for the coming year can be predicted simply by multiplying the observed age data of the present year by the survival factors for each age. Thus the number of 4-year fish available in 1943 should approach 3.2 times the number of 3-year fish in 1942; so likewise should the 5-year fish approach 1.7 times the number of the 4-year fish, the 6-year fish approach 0.9 times the number of 5-year fish, and each age group over six years should approximate 50 percent of its numbers in the preceding year.

The reason that there are more fours than threes is that the influx of young entering the fishable adult stocks in their fourth year has been greater than the mortality which occurred among those of the same year class that had entered the adult stocks in their third year. So, also, more recruits from the same spawning have entered the adult stocks in their 5th year than had been removed by mortality among those already in the adult stocks in their 3rd and 4th years. The number of recruits entering the fishable stocks in their 6th year nearly, but not quite, compensated for those removed. From the 7th year on, there is no recruitment and the numbers decrease at a nearly constant rate approaching 50 percent.

The question arises of how accurate these predictions will be. The most obvious test of their accuracy is to apply these factors to each age composition since 1937, and to compare the predicted age composition with the actual composition observed in the following year. Accordingly, these estimates were computed, and the comparisons made. These showed remarkable agreement. Of the 56 possible comparisons, 49 fell within 5 percent of the expected, 5 fell within 10 percent, and only two fell outside of the 10 percent limits. There is reason for considerable confidence in the predicted age composition in 1943.

On this basis the predicted composition for the Kodiak district is as follows:

Age in 1943	Year class	Percentage composition
3rd year	1941	7 2/
4th year	1940	24
5th year	1939	56
6th year	1938	2
7th year	1937	1
8th year	1936	8
9th year	1935	2

2/ The prediction of 7 percent as three-year fish is based only on the average contribution of this age group for the past six years. As first year entrants, no other prediction is available.

Because the increase in the numbers of recruits from the 1940 and the 1939 year classes (as 4's and 5's) will exceed the decline in the numbers of the older age groups, there will be an increase in the abundance of herring in this district in the coming season. However, because the reserve of older individuals from which the fishery made heavy catches in past years no longer exists, the total catch should not be expected to equal that of those early years. Good management dictates that the catch shall not be greater than will permit these groups to survive in some abundance until a new successful spawning has matured to enter the stocks. Thus, while a moderate increase in the catch is justified on the basis of these findings, further increases must depend on future heavy contributions from year classes not yet mature.

The method of assessing the rate of recruitment, as above outlined, will permit an appraisal of the abundance of each entering year class. This information, coupled with a knowledge of the rate of decline of the older age groups, will place the industry on the sound basis of being able to withdraw the maximum catches each year without danger of encroaching too heavily on the brood stock essential to the perpetuation of the stocks. If Nature has been provident so that large numbers of recruits may be expected, the industry will reap the benefits; if replacements are inadequate to maintain large catches, the industry will have such knowledge beforehand, and will be able to govern its operation in accordance. The outlook for 1943 is good.

PRINCE WILLIAM SOUND DISTRICT

The Prince William Sound fishery has been more intensively exploited over a longer period of time than has that of Kodiak. Therefore, the Sound, more clearly than Kodiak, demonstrates the extreme fluctuations which occur in the abundance of our Alaska herring. As to the history of the fishery in this district, the first small operations began in 1913. The initial expansion occurred under the demand for additional foodstuffs during World War I. For the next decade large-scale curing operations were carried on, with small reduction units being introduced primarily as a means of utilizing the waste incidental to curing. Under this intensity of fishing, there followed a decline in the abundance of the older age groups, and by 1927 these curing operations had been sharply curtailed for lack of suitable fish. In the season of 1929, the progeny of the highly successful 1926 spawning entered the stocks, and the abundance was raised to a very high level. Because these recruits were then of a size too small for salting, the mild-cure industry continued its decline, in spite of this new abundance of herring.

In 1930 the first large reduction plant was installed in the district. Its operation was successful largely because of the presence of such great numbers of this 1926 year class, which remained in the stocks in abundance for several years. For the five years following 1930 the newly introduced reduction operations continued on a relatively small scale. The abundance

continued high because the removals were not great, and the replacements, even though moderate, were adequate to compensate. Then, in 1934, the young from the successful 1931 spawning entered, to further bolster the stocks to a new high abundance level. Under these favorable conditions the reduction industry expanded further, so that by 1939 there was four times the 1930 - 1934 average of reduction equipment in operation. The increased demands made on the stocks under this increased intensity, coupled with the low replacement rate of the years following 1931, again resulted in reduced abundance levels. This decline was climaxed in 1942, when six vessels operating for two and a half months, were able to take only three and a half million pounds, compared to catches averaging nearly 135 million pounds annually by a comparable fleet during the 1930 - 1934 period of peak abundance.

Before entering into a detailed discussion of this fishery and of the prospects for 1943, it is necessary to have an understanding of a situation which is peculiar to this district. This unique situation is the occurrence of two separate "runs" of herring, the so-called "summer" and "fall" runs, which are usually separated by a period of slack fishing.

The summer runs have been noted to be composed largely of individuals of the younger age groups, i.e., of 3- to 5-year, and more infrequently of 6-year fish. The fall runs, on the other hand, have been composed largely of the older individuals in the stocks, those 6 years of age and older. To substantiate this, the age composition data available from 1937 to date have been tabulated and examined. The fact was established that the 1926 year class supported the summer fisheries of 1929 and 1930, as 4- and 5-year fish. This year class was not present in numbers in the fall catches of either of those years. While this same dominant class was not present in numbers in the summer catches of 1931 or 1932, it did support the fall operations of those years as 6- and 7-year fish. Further, it is known that the 1931 year class supported the summer fishery of 1934 as 4-year fish, but that the fall fishery of that year was still dependent largely on the 1926 year class. Data for 1933, 1935, and 1936 are not available, but from 1937 to date the same situation has been found to hold. The summer catches of 1937, 1939, and 1940 were composed of the 1935 and 1936 year classes in their 3rd to 6th years of life; the 1941 and 1942 catches were dependent on the 1939 year class as 3- and 4-year fish respectively, supplemented in 1942 by the 1940 year class as 3-year fish. In none of these instances was there a significant number of fish in the summer fishery older than six years. The fall fisheries of 1937, 1938, and 1939 were supported by the 1931 year class as 7-, 8-, and 9-year fish. Since 1939 the fall catches have been meagre. This is because there have been but few older individuals available, the result of a decline in the abundance of the 1931-1936 year classes.

To summarize, in each of the years of record, the abundance has reflected the presence of the dominant year classes. In those years in which such dominant classes were young, and so present in the summer fishery, the catches in this period were high; in those years in which these groups were older and had entered the fall fishery, the catches in that period were high. The conclusion suggests itself: There must be a differential schooling of the stocks in this district, with the young being

Table 3.—Estimated numbers of herring taken from each year class in the Prince William Sound District from 1937 to 1942. (In millions of fish)

Year of hatch	Year of Capture												Total contribution of each year class
	1937		1938		1939		1940		1941		1942		
	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall	
1926	---	2.4	---	1.2	---	1.1	---	---	---	---	---	---	4.7
1927	0.8	10.8	---	2.6	---	1.9	---	---	---	---	---	---	16.1
1928	---	9.4	---	4.9	0.3	.3	---	---	---	---	---	---	14.9
1929	2.3	8.2	0.2	10.6	.3	1.9	---	---	---	---	---	---	23.5
1930	1.5	8.5	.6	7.9	.5	2.9	0.2	0.4	---	0.1	---	---	22.6
1931	13.0	88.9	2.9	85.8	1.8	40.1	1.1	4.0	0.2	.2	---	---	238.0
1932	6.1	5.2	1.5	11.0	1.0	3.0	---	.3	.2	.3	---	---	28.6
1933	8.4	10.3	2.3	8.8	1.2	2.3	.2	.4	---	.3	---	---	34.2
1934	23.7	8.7	10.9	5.1	1.2	.4	.4	.4	.2	.6	---	---	51.6
1935	95.6	21.3	140.2	47.5	87.0	42.4	24.0	32.3	10.3	18.5	0.1	0.5	519.7
1936	1.5	.5	32.9	18.3	138.0	28.6	37.8	44.1	17.9	32.2	---	.7	352.5
1937	---	---	---	---	18.3	1.9	6.8	18.9	6.4	9.5	---	.1	61.9
1938	---	---	---	---	1.2	.1	9.0	45.9	19.3	14.6	.1	.4	90.6
1939	---	---	---	---	---	---	---	.7	137.8	8.5	4.5	3.0	154.5
1940	---	---	---	---	---	---	---	---	2.3	.4	4.2	1.0	7.9
1941	---	---	---	---	---	---	---	---	---	---	.6	---	.6
Total withdrawals by years	317.1		395.2		377.7		226.9		279.8		15.2		1621.9

present in greatest numbers from early June to late July, and with the older individuals being available from the latter part of August until the close of operations.

This conclusion is borne out in table 3, which shows the estimated numbers of individuals taken from the several year classes present in the summer and fall fisheries since 1937. It must be remembered that only the year classes from 1934 through 1936 are fully represented in this table, because those hatched prior to 1934 had been in the fishery for one or more years before 1937. So also, those hatched after 1936 will presumably contribute to future catches, so are not fully represented. Despite these limitations, it is quite evident that as the various year classes matured, they no longer appeared in numbers in the summer fishery, but entered the fall runs instead. It is also evident that the 1931, 1935, 1936, and 1939 year classes were successful here, as they were in Kodiak, and that the contributions of the other year classes were meager by comparison.

With this background knowledge, the 1942 failure is more easily understood. The low catch in that year must be attributed in large measure to the failure of the 1939 year class to appear in the summer fishery in expected numbers. This 1939 class, which was so largely responsible for the increased abundance of the Kodiak stocks in the 1942 season, had entered the Prince William Sound fishery in 1941 as 3-year fish, contributing heavily to the support of that season's operation. Unfortunately, because of the small size of this age group and the disproportionate number of individuals removed to obtain the catch in that year, their numbers were seriously reduced. The 1940 year class, present as 3-year fish, lacked sufficient strength to compensate for the reduced abundance of the 1939 class, and the catch for the summer period was very low. Here, again, the death rate had exceeded the effective birth rate, and the inevitable decline had followed. Responsible in part for the low catch, however, was the late starting date of July 9th, a date too late to permit the fishermen to take full advantage of the peak of the early run.

The fall fishery of 1942 depended on the individuals of the 1935 and 1936 year classes, now of an age to enter the fall fishery. The intensive operations of the preceding five years had already removed 520 million fish from the 1935 class, and 353 million from the 1936 class, so it was to be expected that their abundance would be diminished by 1942. That this was the case was demonstrated by the poor catch in the fall fishery of that year.

Pertinent to a discussion of the past season in Prince William Sound is the fact that tags affixed to Sound fish in the season of 1941 were recovered at Kodiak in 1942. Of the 15,000 fish tagged in the Sound, 71 recoveries were made at Kodiak.

The full significance of the recovery from Kodiak of these tags is difficult to evaluate. While such a large recovery is too great to be attributed to "straying" and must have represented a large-scale migratory

movement of at least that particular body of fish which was tagged, it does not necessarily imply that the stocks supporting the two districts are homogeneous. It is significant in this regard that no recovery of Kodiak tags was made from Prince William Sound, although the smaller number of tags affixed in Kodiak (less than 4,000) and the small catch from which recoveries could have been made may well account for this circumstance.

If these two districts were supported by a common stock, many unexplained inconsistencies would remain, especially consistent differences which occur in the age compositions of the two districts. The summer and fall "runs" which typify the Sound fishery are not found at Kodiak. Then, too, in the more intensively exploited Prince William Sound district, the older age groups declined in abundance more rapidly than did the same age groups in Kodiak. Such a condition would not prevail if these areas were supported by a single, freely mixing, homogeneous stock. Therefore, until a more adequate study can be made of the interrelationship of these bodies of fish, it cannot be accepted as established that a common stock supports the two districts; rather such an assertion must be limited to stating that at least a part of the stocks supporting the two districts has a common origin. On this basis each district must be dealt with separately, but reservations must be included because deviations from the expected appear more probable in view of this admittedly unexpected finding.

What, then, are the prospects for a successful operation in this district in 1943? The summer fishery will be supported by the year classes of 1939, 1940, and 1941. With the failure of the 1942 operation as a background, it appears that at least the first two of these are not adequate to support an intensive fishery, and certainly should not have extensive withdrawals imposed against them. There are, however, certain arguments to support the contention that the individuals remaining of the 1939 and 1940 classes will be sufficiently numerous to warrant a small-scale operation. The first of these is the more than ordinary abundance of the 1939 class, as already established; the second, that the late starting date in 1942 did not permit of a true test of abundance.

The data available from this district are yet too meager to permit an evaluation of the rates of increment and of mortality, as was possible at Kodiak. However, the chance of survival of the various age groups here may be assumed to follow in a general way the rates as established for that district. The chance of a 4-year fish surviving to age 5 has been found to be in the ratio of 1.7 to 1, which would indicate an increase of the 1939 class as 5-year fish available in 1943. So, also, the chance of a 3-year fish surviving to age 4 has been found to be in the ratio of 3.2 to 1, so that approximately three times the numbers of the 1940 year class (as 4-year fish in 1943) may be expected over the numbers of this year class available in the past season. In addition to these, there will also be some recruitment from the 1941 spawning, whose members will appear for the first time next year. The contribution to be expected from this class is as yet unknown, but even if these young fish were to appear in abundance it would be ill-advised to reduce their ranks by excessive withdrawals, since the rehabilitation of this district must depend on the survival of such entering year classes.

As to the fall fishery, since the 1931 year class has been entirely expended, the fall operations will depend largely on the classes of 1936 and 1935 (as 8- and 9-year fish). The 1942 operations clearly demonstrated that their numbers have been so seriously decimated that with the added mortality of approximately 50 percent during the intervening year, it becomes apparent that these will not be able to contribute in any significant numbers to the fishery of 1943. Barring the possibility that these year classes had emigrated in large numbers from this area in 1942, and will reappear in abundance in 1943, the prospects for a successful operation in the coming fall season are very poor.

Certainly any operation in this district in 1943 should not make more than a minimum withdrawal on the young age groups in the summer period, nor should an abundance of fish in the fall be anticipated. The rehabilitation of the herring fishery in this district to its former level must await the entrance of successful year classes not yet mature.

SOUTHEASTERN DISTRICT

This district, the first in Alaska to support a herring fishery, and the district most intensively exploited for many years, has had no significant operation since 1939. For the twelve-year period preceding 1939, however, the average annual catch had exceeded 435,000 barrels. While operations here were carried on over a considerable area and on several distinct populations, nearly 80 percent of the catch was taken from the stock which frequents the waters adjacent to Cape Ommaney. This stock, which is taken in the Cape area during its summer feeding migration, originates at the Sitka spawning grounds. In addition to the large percentage of this stock taken in the Cape area, an estimated 5 to 10 percent of the total catch of the district was made on this same stock at the Kuiu Island and Warren Island fishing grounds.

To emphasize the importance of this population to the Southeastern fishery, the following table, showing the total catch taken each year in the district (1927 - 1939), and the percentage of each year's total which was taken from the Sitka population, is presented.

Year	Total catch in thousands of barrels	Contribution of Sitka population (percent)
1927	414	84
1928	487	74
1929	630	87
1930	567	81
1931	359	84
1932	394	73

1933	495	96
1934	535	91
1935	465	73
1936	294	67
1937	426	74
1938	178	41
1939	160	47

In most years of record, the abundance of this Sitka stock was dependent largely on the contributions of a single year class. Thus the 1926 class, which entered the catches in 1929, the 1931 class entering in 1934, and the 1935 class entering in 1937 were each largely responsible for maintaining the yield of this area for a period of years. The decline of the Southeastern fishery following 1937 resulted from the decline in the abundance of the 1931 year class, the same group which had been the main support of the Kodiak and of the Prince William Sound fisheries during the same period of years (1934 - 1939). Because the 1935 year class, on which the fishery came so largely to depend by 1938, was less abundant than were those of 1926 and 1931, it declined more quickly than did these latter, so that by 1939 it was considered advisable to close the Cape area to fishing, since it is dependent on this Sitka stock, in order to insure the survival of sufficient numbers of these fish to serve as brood stock. This curtailment would have served its intended purpose of protecting the decimated Sitka population and still would have permitted an observational fishery on this population in waters outside of the closed Cape area if the industry had reduced its scale of operations to meet the changed conditions. Large scale operations were continued in 1939, however, and those areas which remained open to fishing were the more intensively exploited in a vain effort to maintain production. Because no new abundant year class entered the Sitka stocks and because of the danger of continuing such intensive operations against the remaining populations other than that of Sitka, it was deemed necessary to suspend operations in the entire district until such time as the Sitka population had so increased in abundance as to warrant the reopening of the district. Subsequently, two limited operations were attempted. Each failed, principally because no new increment had been added to the decimated Sitka stocks.

That the contributions of a few of the many year classes which had entered the fishery during this period of years were of much more importance than were the others in supporting this fishery is made forcefully evident from an examination of the estimated contributions of the several year classes (1926 - 1937), in millions of fish, since 1929. These data are presented below.

Year class	Contribution in millions of fish
1926	1,074
1927	239
1928	121

1929	265
1930	79
1931	802
1932	42
1933	51
1934	79
1935	235 3/
1936	43 3/
1937	8 3/

The question of determining the present abundance of the Sitka population, then, resolves itself into one of establishing whether a new year class has entered these stocks, and, if the presence of such a group can be demonstrated, whether its abundance is sufficiently high to permit the withdrawal of a commercial catch without jeopardizing the number of potential spawners.

In answer to the first of these questions, there can be no absolute assurance that a new abundant year class has entered the stocks. There is, however, the background of past experience which leads to the conclusion that one such has developed, in that each year since 1929 for which comparable data are available the same spawning successes and failures have been evidenced in all three districts, e.g., in Southeastern, in Prince William Sound and in Kodiak.

In support of the assertion that the same dominant classes have been present in each of the districts, two tables are presented. The first of these (table 4) shows that in Southeastern and in Prince William Sound (the only districts for which we have directly comparable data), each of the dominant year classes (1926, 1931, 1935, 1936) has appeared simultaneously.

From this table it is evident that each dominant year class entering the Prince William Sound fishery entered the Southeastern fishery at the same time. This alone would indicate that the 1939 year class, which entered the Prince William Sound catches in 1941 should be present in considerable numbers in the Southeastern district in 1943.

Such a direct comparison cannot be made with the Kodiak fishery because comparable data are not available. However, estimates of the contributions of the several year classes which have passed through the fishery

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3/ Because of the closure of this district in 1939, the 1937 year class contributed only as 3-year fish, the 1936 year class as 3- and 4-year fish, and the 1935 year class as 3-, 4-, and 5-year fish. Therefore, the contributions of these three year classes are not directly comparable to those preceding them.

in each district during the past few years would serve to demonstrate which of the year classes were heavy producers, and so by inference would establish whether or not the same year classes were dominant in each. Accordingly, table 5 showing the following estimates of the contributions of the 1930 to 1936 year classes in the Prince William Sound and the Kodiak districts during the years 1937 - 1942 inclusive, was prepared. The data demonstrate that the 1931, 1935, and 1936 year classes, which were shown to have been overwhelmingly dominant in Southeastern and in the Sound, were likewise dominant in Kodiak.

Table 4.- Comparative age compositions of the Prince William Sound and Southeastern stocks in the first year of entrance of the dominant 1926, 1931, and 1935 - 1936 year classes.

Season	Year class	Age	Composition (percent)	
			Southeastern	Prince William Sound
1929	1926	4th year	89	93
	1925	5th year	5	2
	1924	6th year	2	1
	All others	- -	4	4
1934	1931	4th year	77	81
	1930	5th year	4	8
	1929	6th year	9	4
	1928	7th year	4	1
	All others	- -	6	6
1938	1936	3rd year	21	17
	1935	4th year	61	73
	1934	5th year	5	6
	1933	6th year	3	1
	All others	- -	10	3

Because the Prince William Sound district was exploited for some years before the Kodiak district, the 1931 year class in the Sound was considerably reduced in numbers before the first year of full scale operations in Kodiak. Unfortunately, lack of data precludes an estimate of the contributions of these classes in the years preceding 1937. This omission is reflected in the smaller proportionate contributions of the year classes preceding that of 1933 in Prince William Sound. The contributions of these year classes, had data been available prior to 1937 to make such comparisons possible, would have shown the magnitude of the 1931 year class in the Sound to have approached that of Kodiak. Yet, with the one exception of the 1935 year class (which was obviously more successful in Prince William Sound than in Kodiak) there has been a striking similarity between these districts.

Table 5.- Estimated numbers of herring taken from each year class in the Prince William Sound and Kodiak Districts from 1937 to 1942.
(In millions of fish)

Year class	Withdrawals (In millions of fish)	
	Prince William Sound	Kodiak
1930	23	32
1931	238	415
1932	29	46
1933	34	32
1934	52	38
1935	521	160
1936	355	410

It becomes apparent that, in general, the degree of success attending the spawning in each of the three districts has been comparable. If, then, it can be established that a new successful year class has entered the western fisheries, that same year class may be expected in Southeastern as well. It has been established that the 1939 spawning was a successful one in the western fisheries. In the Sound the progeny of this spawning entered into the fishery in their third year in 1941, yielding 146 million fish in that one year alone. In 1942 this year class, in its fourth year, contributed 7 million more. (Table 3.) In Kodiak the 1939 year class contributed 27 million fish in 1941; the successful 1942 operations in this district were heavily supported by this same group, which contributed 62 millions of its numbers in that season. (Table 1.) Compared with the contributions of the other year classes for which we have data for their first two years in the fishery, this is a favorable record. It is quite probable that the spawning of 1939 was successful in the Southeastern District.

It is evident from the past records of each of the districts that the offspring of a single spawning, if of unusual abundance, can support the fishery in that particular district for some years. However, since no measure of the true abundance of the 1939 year class in the Southeastern district is as yet available, and because it is known that the brood-stock was at a low level in the spawning year of 1939, the initial exploitation of this new year class must be cautiously undertaken. If the assumption that a large number of progeny from the 1939 spawning did survive is proven correct, and particularly if the subsequent spawnings have developed favorably, an expansion of this fishery to approach its earlier level will be justified. The prediction that the abundance levels in this district have partially recovered from the low of recent years will be on trial in this fishery in 1943.