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NORTHERN PACIFIC HALIBUT FISHERY

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GROWTH OF PACIFIC HALIBUT

BY

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FOREWORD

The Convention of 1953 between Canada and the United States for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea continued the conservation objectives of three previous conventions, and requires that stocks of halibut be developed to levels which will permit maximum sustained yield and that the stocks be maintained at those levels.

Maximum sustained yield can be determined on a theoretical basis provided certain characteristics of the stocks are known, among these is the rate of weight increase or growth of the halibut. In its continuing study of the dynamics of the halibut population in the Northern Pacific Ocean and Bering Sea, the Commission began its investigation of the growth of halibut in 1925. This report reviews those studies and includes recent observations on growth based chiefly on otolith radius measurements.

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INTRODUCTION

The International Pacific Halibut Commission has from the beginning of its investigations in 1925 considered an understanding of growth of halibut to be of prime importance to the scientific management of the resource. The emphasis, however, has shifted from a qualitative description of average weight by age to a quantitative measure of the rate of growth. In the early investigations of growth the difference between the average weight at each age of halibut from the intensively-fished grounds off British Columbia and Southeastern Alaska and those from less intensively fished grounds west of Cape Spencer, Alaska were used to corroborate the results of tagging, and indicated that intermingling of adults between the grounds south and west of Cape Spencer was minimal. In addition, the early growth studies indicated that a minimum size limit and closure to fishing of grounds frequented by high proportions of young halibut would increase the yields.

More recently, the main research objective of the growth investigations has been to provide quantitative measures of growth rate suitable for use in mathematical models designed to determine the maximum sustainable yields of the various stocks. Also, with the increase in average weight at each age of halibut on all grounds, it is necessary to determine not only the period and duration of the increase in growth rate but also the magnitude before estimates of maximum sustainable yield can be made.

This report provides background data utilized in earlier growth reports of the Commission, and as such treats the growth of Pacific halibut in a general manner. It seeks to establish the historical changes in growth in the halibut populations and to define the timing, extent and to suggest the causes of the changes that have occurred. Unlike earlier reports on growth, rates are not estimated from these data but growth is expressed as percent deviations of average length from long-term averages at each age.

REVIEW OF LITERATURE

To provide perspective to the current studies this review of the literature covers a few important background references to age and growth studies in flatfish, and to some of the current growth theories as they may apply to the problem at hand, and statements on growth of Pacific halibut made in earlier Commission reports.

Discussion of methods of determining age and growth of Atlantic halibut *(H. vulgaris)* and plaice *(P. platessa)* as well as discussions of the early life history of these species are found in Jensen (1928), Jespersen (1917, 1926, 1936), Buchanan-Wollaston (1923, 1926), Sigurdsson (1956) and McCracken (1958). Growth theories which have been applied to halibut are discussed by Bertalannfy (1938), Ricker (1958) and Richards (1959). The manner in which the size and rate of growth of fish influences the yield from a stock is discussed by Petersen (1903), Baranof (1926), Graham (1929), Russell (1942), Beverton and Holt (1957) and Ricker (1958).

The initial investigations of the Commission included a study of the growth of halibut from the various fishing grounds (IFC, 1931).

It was demonstrated that males grow much more slowly than females and that the halibut on the grounds west of Cape Spencer, Alaska (Area 3) were slower growing than halibut south of Cape Spencer (Area 2). Because of the greater growth rate in Area 2, the fish enter the fishery at a relatively earlier age than those of Area 3 and are subjected to the intensive fishery for a longer period which results in a

younger age structure in the population. Consequently, it was expected that less spawn would be produced from the faster growing but younger southern stocks. This assumption was substantiated by investigations of the abundance of eggs and larvae and the statistics of the fishery (IFC, 1930).

The original separation of the grounds for regulatory purposes at Cape Spencer, Alaska was based primarily on the different response of the stocks in the two regions to fishing and results from tagging experiments. However, in addition, the differences in average weight at each age of the halibut to the south (Area 2) and west (Area 3) of Cape Spencer was a further consideration in the decision since the several stocks concerned were recognized as possessing "distinctive rates of growth," (IFC, 1930).

The importance that the Commission attached to the growth of halibut in maximizing the yield is evident in the establishment of two "nursery" areas, (IFC, 1931). One in Dixon Entrance off Masset and one off Prince of Wales Island, Alaska near Timbered Islet. These areas were populated predominately by fast-growing young halibut. It was shown that since the rate of weight increase is great in young halibut additional yield could be obtained by protecting these ages from capture by the fishery until they were older.

The differences in growth between the halibut to the south and west of Cape Spencer, Alaska are of ". . . vital importance in explaining the fluctuations in catch which occur and in the determination of the type of fishery necessary to secure a maximum yield." (Thompson and Bell, 1934). Average weights at each age for male and female halibut from the Goose Islands and Yakutat grounds were given. The above authors determined that, based on average weights, halibut on these grounds increased in weight approximately 21 percent annually. This value was used subsequently in a numerical model to demonstrate the effect on yield of the change in intensity of fishing.

Thompson and Van Cleve (1936) considered "actual age-weight relationships" in a comparison of two hypothetical stocks. They showed that, given a constant natural mortality and the actual rates of growth, it is possible to increase fishing sufficiently so that the amount of spawn is reduced.

By the late 1940's it had become apparent that the growth rate of halibut in Area 3 had undergone a marked increase since the late 1920's. On both the Portlock and the Shumagin Islands grounds, female halibut at nearly all ages beyond 7 years were about twice as heavy in 1950 as in the late 1920's (IPHC, 1954). In a preliminary explanation of the increase in growth rate it was suggested that the fish on Portlock Bank in 1927 and on the Shumagin grounds in 1929 had been exposed to a density depensatory situation, that is, they had ". . . lived under the crowded conditions that exist in little-fished stocks." While on the other hand, ". . . the fish in the 1949 and 1950 catches from the same ground had lived under the relatively low stock densities of the 1930's." Observations on the growth of plaice *(Pleuronectes platessa)* have indicated marked responses in growth following large changes in population size or food supply (Beverton and Holt, 1957).

In 1956 detailed studies of growth were undertaken with the objectives being " . . . to determine when and where changes have occurred and are occurring and, ultimately, to ascertain their causes." (IPHC, 1957). These studies utilized measurements of the widths of the annual growth zones in otoliths to calculate the lengths of fish at each earlier age. During the period from 1956 to 1960 the growth

zones of approximately 15,000 otoliths were measured for fish taken on the Goose Islands, Upper Hecate Strait, inside Southeastern Alaska, Portlock and Shumagin Islands grounds (IPHC, 1957, 1958, 1959 and 1960b).

Such a method makes possible the reconstruction of the pattern of growth of individual year classes of fish covered by past and current age materials.

It was necessary at the outset of the investigation of the back-calculation method of studying growth to determine if there was a consistent relationship between the otolith radius and body length of the fish irrespective of age. Using otoliths of halibut taken on grounds between Vancouver Island and the Bering Sea between 1927 and 1956 and ranging in size from approximately 10 to 200 cm., Southward (1962) described a relationship between body length of halibut and otolith radius. One of the means of confirming this technique was to show that actual average lengths of tagged fish lay between the calculated average lengths for the years before and after tagging.

In determining the yield per recruitment of the Area 2 and 3 halibut stocks (IPHC, 1960a), growth rate was expressed as

$$g = \frac{1}{\triangle t} \ln \left[\frac{W_{t+\triangle t}}{W_t} \right] \qquad (1)$$

where g is the instantaneous rate of growth and $\triangle t$ is one year. Age-specific values of g were determined utilizing back-calculations of lengths of fish on the Portlock-Albatross grounds in 1926 and 1956 and on the Goose Islands grounds in 1956. Since the growth rate in Area 2 had not changed greatly between 1935 and 1956, the period for which adequate age materials were available, the 1956 growth rate was considered as representative of the entire period for Area 2. The change in growth rate in Area 3 had been great and the 1926 rate was used in computations of yield for the beginning of the period and the 1956 values for the later years. These respective growth rates for Areas 2 and 3 were used subsequently in Report No. 31 (Chapman, Myhre and Southward, 1962) to determine the maximum sustainable yield of the halibut stocks as of 1960.

The growth of halibut in Bering Sea was studied also using back-calculated lengths determined from measurements of otolith radii (Dunlop, et al, 1964). Growth rate was expressed as the instantaneous rate, g, described earlier, and was computed from observed weights between succeeding ages of halibut in the commercial landings taken from the Polaris ground in April of the years 1958 through 1963. Inasmuch as there is year-to-year variability in the growth of the fish, an average growth rate, $\bar{g}$, for each age between 6 and 28 for the period 1958 to 1963 was computed. It was shown from back-calculated data that the growth rate of halibut in Southeastern Bering Sea had increased since the early 1930's, coincident with that observed in the Gulf of Alaska (Area 3) and also that up to the early 1950's that the increases were of similar magnitudes in both areas.

Novikof (1964) in a comprehensive report on the biology of Pacific halibut in the Bering Sea, shows that the growth rate of halibut in Southeastern Bering Sea is highest followed by halibut of the central and northwestern regions. Those halibut of the Gulf of Olyutorski and the Sea of Okhotsk grow the slowest. Data are included on the age distributions for various regions as well as length and weight frequencies.

In general, Novikof's findings in Southeastern Bering Sea agree with those of the Commission.

By 1960 it appeared that in Area 2 the year classes originating since the middle 1950's and which were currently entering the fishery were growing faster than those which entered previously (IPHC, 1961). However, there were insufficient data at that time to be able to distinguish to what extent gear selectivity may have contributed to the phenomenon. This apparent increase in growth rate of the halibut in Area 2 was further reported in subsequent Annual Reports of the Commission (IPHC, 1962; IPHC, 1966).

In addition to studying the empirical aspects of growth the Commission has examined theoretical aspects of the growth of halibut. Southward and Chapman (1965) studied the application to Pacific halibut of Bertalannfy's (1938) growth equation which regarded growth as the net result of two opposing processes, catabolism and anabolism. They considered the solution of the general differential equation

$$\frac{dl}{dt} = nL^m - kL \qquad (2)$$

where n, m and k are constants. Integration of the above leads to

$$L_t^{1-m} = L_\infty^{1-m} - \left[L_\infty^{1-m} - L_o^{1-m}\right]e^{-k(1-m)t} \qquad (3)$$

where L_o is the length of the fish at age zero, m governs the proportion of the maximum length, L_∞, and k is the growth rate. Richards (1959) has shown that k/m is the actual relative growth rate at the point of inflection of the curve and k/(2m+2) is the weighted mean growth rate on a proportional basis. The above equation for length at time, t, is a generalized form and the standard Bertalannfy growth equation is a special case. The generalized form reduces to either the exponential or Gompertz equation, depending upon the value of m.

Samples from five year classes (1941-1946) from the Portlock-Albatross grounds were selected for study by Southward and Chapman. Lengths of each fish at earlier ages were obtained through back-calculation of otolith radii measurements. It was shown that the maximum length, L_∞, and the weighted mean growth rate K/(2m+2), are dependent upon the age of the fish, and that the rate of change between metabolic rate and weight, m, as well as the relative growth rate, K/m, are not dependent upon age. Statistical tests indicated that any changes in weight-length relationship associated with the age of the halibut do not contribute significantly to the change in L_∞ and K(2m+2). Errors-of-estimate of the fitting procedure were studied, as was the effect on the estimated growth parameters of different age compositions. It was shown that if the age composition varied greatly that the change in growth parameters would be sufficient to alter the estimate of maximum sustainable yield.

In a simulation study of the Pacific halibut fishery (Southward, 1966) growth of the Area 2 halibut was described by the Gompertz equation which had resulted frequently in the fitting of halibut growth data using the generalized growth equation (3). In the simulation study it was necessary to express the average weight at each age in a form so that any increase or decrease in weight due to a density relationship or to environmental changes would be reflected and maintained in the

growth history of the fish. To accomplish this, average weight was expressed as

$$W_{t+\triangle t} = W_t + \triangle W_{(t,t+\triangle t)} \quad (4)$$

where $\triangle t$ is the time interval of computation, and Wt is the weight at age t computed from the Gompertz equation. The parametric values of the Gompertz equation were determined empirically from observed age-weight data.

SOURCE AND TREATMENT OF DATA

Collection of Data

The Commission has for many years systematically collected age materials from commercial landings from most of the major fishing grounds (Figure 1) on the coast (IPHC, 1960a). The series of otoliths used in this study from the Goose Islands and the Portlock grounds began in 1935 and are continuous to date with the exception of a four-year gap in the Portlock series from 1945 to 1948 inclusive. Annual samples from the grounds in Upper Hecate Strait and from the Shumagin Islands grounds are available since 1950; the collection from the inside grounds of Southeastern Alaska was begun in 1958. In addition the Commission has collected otoliths from fish unsuitable for tagging during each tagging experiment since 1925. These along with otoliths collected in 1914 by the late W. F. Thompson from catches obtained on Goose Islands grounds as well as on the then newly-discovered Portlock ground provide a 65-year series of back-calculated lengths for the two areas from which the growth patterns back to the turn of the 20th century can be derived.

To maintain intraseasonal consistency between succeeding years only otoliths which had been collected from May-June fishing were used for the measurement of growth in all areas except Bering Sea where otoliths were collected from the March-April fishery.

Calculation of Length

Approximately 140 otoliths were used for each year for each of the major grounds under study. The radius of each growth zone was measured along the ventral axis in a manner described by Southward (1962) with the exception that instead of using enlarged photographs the direct image of the otolith was magnified 20 diameters with a baloptican-like projector.

The otolith radius was converted into centimeters of body length by the equation

$$\ln(Y) = -1.32086 + 1.30795 \ln(X) \quad (5)$$

where Y is the body length and X the otolith radius. The calculated lengths were then tabulated by year class.

Average body lengths were computed for each age between 1 and 20 for the Goose Islands, Upper Hecate Strait, inside Southeastern Alaska*, Portlock, Shumagin Islands and Southern Bering Sea grounds. Since the average back-calculated length for a given age is composed of observations from several different samples, each taken in a different year, the effects of gear selectivity are minimized except in those cases where all of the fish in the sample are very young.

*The term "inside Southeastern Alaska" when used to indicate fishing grounds refers to those grounds in the channels and sounds of the Alexander Archipelago. Similarly, the term "outside Southeastern Alaska" refers to the fishing grounds offshore of the Alexander Archipelago.

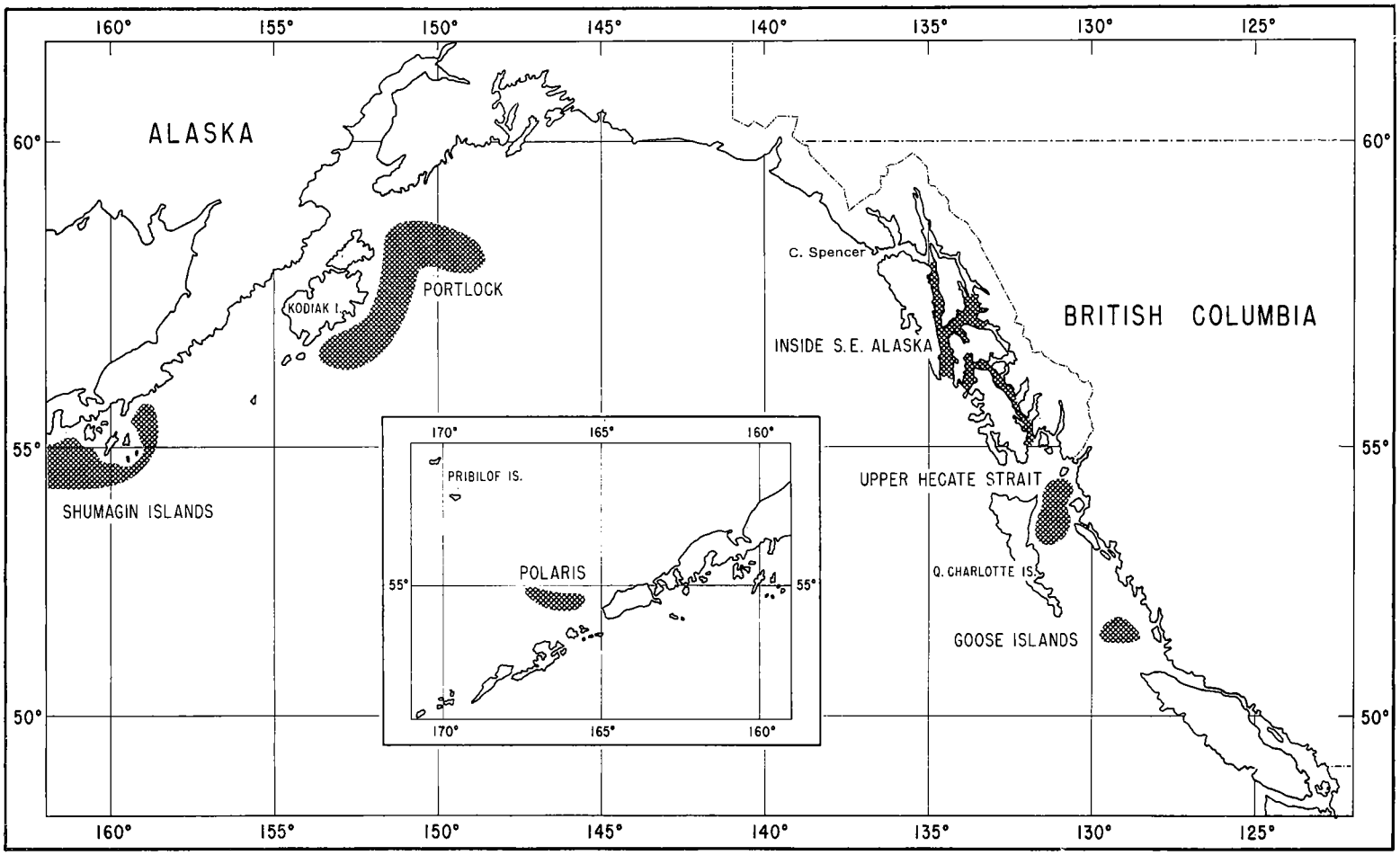

Figure 1. Map of the Pacific coast showing the major fishing grounds between the British Columbia coast and the Bering Sea.

The calculated lengths were converted to weight by means of a calculated average length-weight relationship and percentage deviations of the lengths at each age from the long-term average were computed. Inasmuch as the weight is obtained from a functional relationship of length, the percentage deviations in terms of weight are not given.

Sex Composition of the Catch

Due to the faster growth of female halibut the proportion of females in the catches is critical to an evaluation of changes in growth. If the percentage of females in the catch has increased then an increase in the average weight at each age would be expected and vice versa.

The data used in this study are from catches in which the sex ratio is unknown since the sex of eviscerated halibut cannot be identified and the landed catches are all dressed at sea. The Commission, however, has maintained for some years an observer program involving Commission personnel in which the sex of the dressed fish on individual commercial trips is recorded. Also, the sex of all fish unsuitable for tagging is recorded. These data have been examined to ascertain whether or not the sex ratio of the catches has changed in favor of a higher proportion of females.

The percentage females in the observer trips from Goose Islands, Portlock, Chirikof and Shumagin Islands grounds for the period 1960 to 1965 are given in Table 1. With the exception of 1964 and 1965 in the Goose Islands data there is little indication of a trend in the proportion of females on any of the grounds, though the data are highly variable. The high proportion of female halibut is not borne out by catches of the tagging operations in the same year. The reason for the higher proportion of females in 1964 and 1965 is not known but may reflect the movement of the vessels away from traditional fishing locations. The variability is probably due to the small number of samples and the small number of obervations in each sample.

Examination of the proportion of females at each age from 6 to 12 in the tagging data (Table 2) generally substantiates the findings from the observer data. With the exception of the Upper Hecate Strait region there has been a decrease in the percentage of females at age 11 and 12 and some indication of an increase in females at ages 6 and 7. The proportions have tended to remain constant at ages 8, 9 and 10. Because of the properties of North American setline gear which select for large fish, a decrease in proportion of females of older ages would be expected following the intensification of the fishery in the early 1950's.

Examination of the lengths of fish from some recent observer trips from the Goose Islands grounds, in which the data can be separated according to the sex of

Table 1. Percentage of Females in the Commission Catches of Vessels Accommodating an Observer from the International Pacific Halibut Commission During May and June.

Goose Islands		Portlock Grounds		Shumagin Islands		Chirikof Island	
Year	%	Year	%	Year	%	Year	%
1960	35.4	—	—	1960	80.6	1960	76.6
1961	49.4	1961	73.1	—	—	1961	82.6
1962	33.8	1962	81.0	1962	88.2	1962	83.7
1963	35.0	1963	80.2	1963	82.0	1963	76.7
1964	61.4	1964	71.6	1964	83.1	1964	71.4
1965	83.9	1965	60.7	1965	77.3	—	—

Table 2. Percentage Females in Catches from Tagging Charters.

Age:		6	7	8	9	10	11	12
Goose Islands	1936	52	54	47	61	45	77	60
	1965	44	52	54	53	30	49	43
Hecate Strait	1953	47	52	38	38	35	32	36
	1960	59	41	47	33	49	44	70
	1965	73	36	30	100	59	81	89
Southeastern Alaska	1953	40	47	51	30	34	61	74
	1960	55	47	32	40	32	48	56
Portlock Grounds	1954	64	54	64	64	67	79	82
	1963	67	52	66	66	56	71	66
Shumagin Islands	1956	65	80	81	82	75	87	92
	1964	49	51	60	57	69	88	87
	1965	100	83	79	96	86	84	68

the fish, indicates that the proportionate change in average length at each age is nearly the same between the sexes. Also, the increases in actual size of the one- and two-year-olds in recent years is greater than the observed differences between male and female halibut of these ages.

It would appear therefore, that there is little reason to believe that the observed increase in average size is merely the result of a significant increase in the proportion of females in the catch.

DISCUSSION

There are several general features of the growth history of halibut indicated by the data in Tables 3 to 8 (pages 22-37) and shown in Figures 2 to 7. These are summarized as follows:

1. In all areas there has been an increase in the average weight at each age since the mid-1950's.
2. Some individual year classes appear to have grown at a greater or lesser rate than the average.
3. Marked changes in growth are reflected in the changes occurring in the catch per unit effort.
4. There is some suggestion of a density-dependent relationship between growth and population size.

Because gear selection tends to cause disproportionate representation of the faster growing members of the young ages, generally those under 5 years old, the contribution of the most recent year classes, which are only represented by the catches of young fish, must be interpreted with greater caution than is the case with earlier year classes; and since sample-size variation for the older ages, above 15 years, becomes consequential, discussion of growth in this report will be directed chiefly towards those ages less than 15 years and over 5 for the more recent year classes.

Weight at Each Age

The average weight by age of halibut has increased at nearly all ages since the mid-1940's (Tables 3 to 8). The increase, has been the greatest on the Upper Hecate Strait and Portlock grounds and the least on the Polaris ground on the Bering Sea edge as indicated by percentage deviations (Figures 3, 5 and 7).

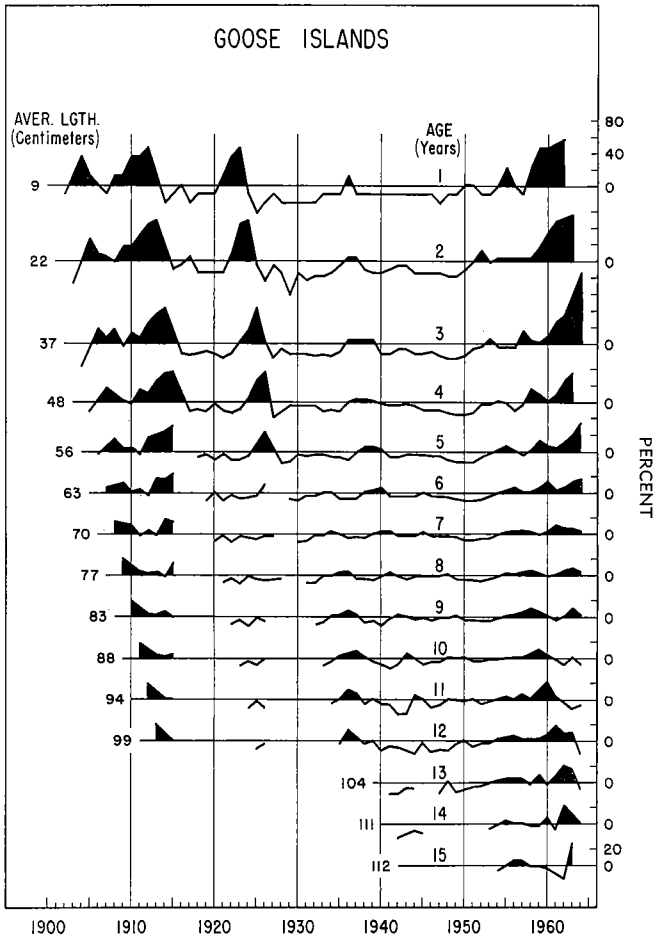

Figure 2. Length-frequency distributions of halibut taken on Goose Islands grounds expressed as percent deviations from a long term average length.

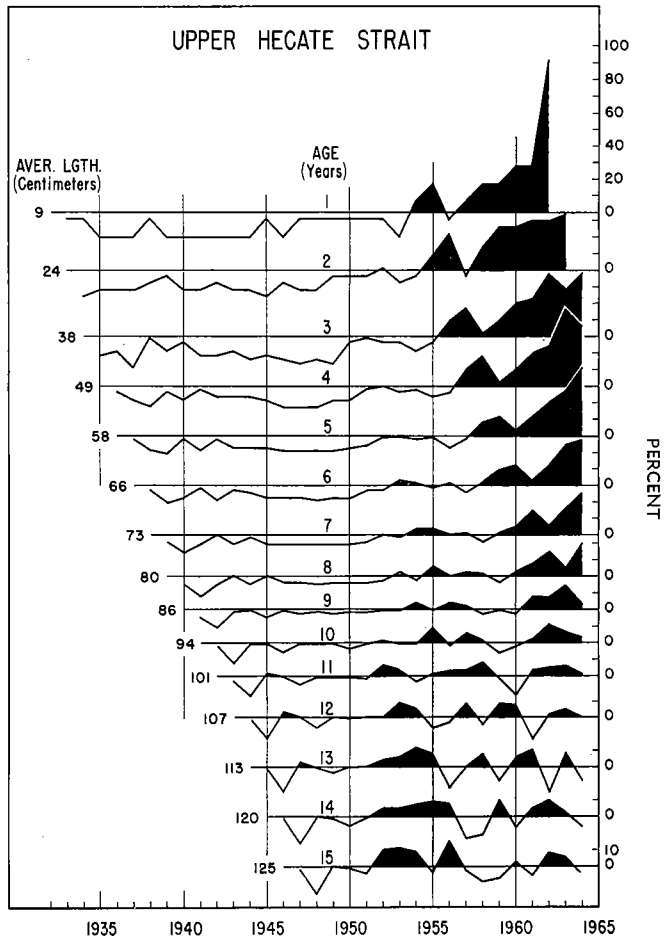

Figure 3. Length-frequency distributions of halibut taken on Upper Hecate Strait grounds expressed as percent deviations from a long term average length.

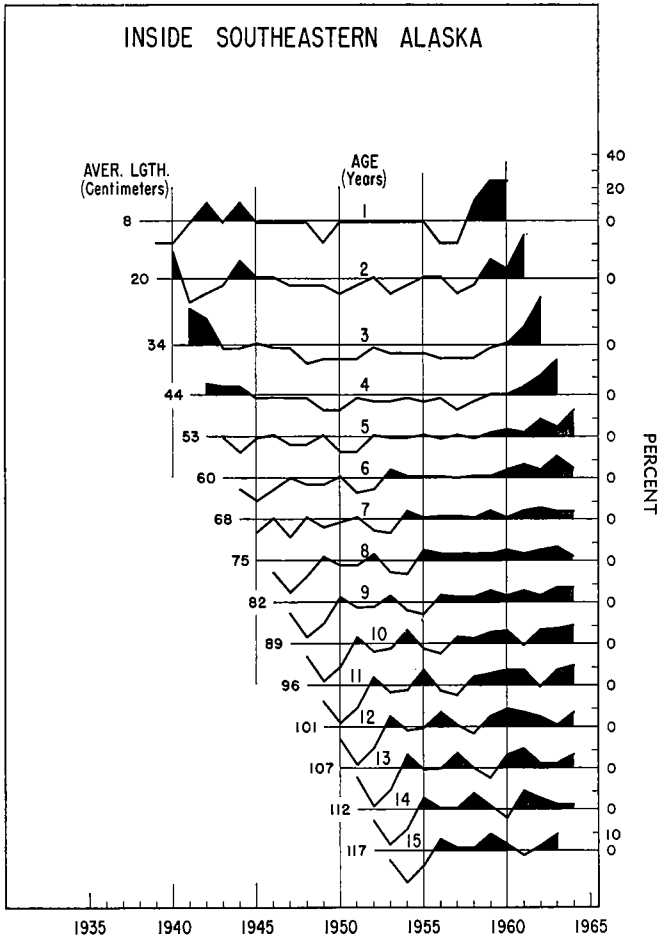

Figure 4. Length-frequency distributions of halibut taken on Southeastern Alaskan grounds expressed as percent deviations from a long term average length.

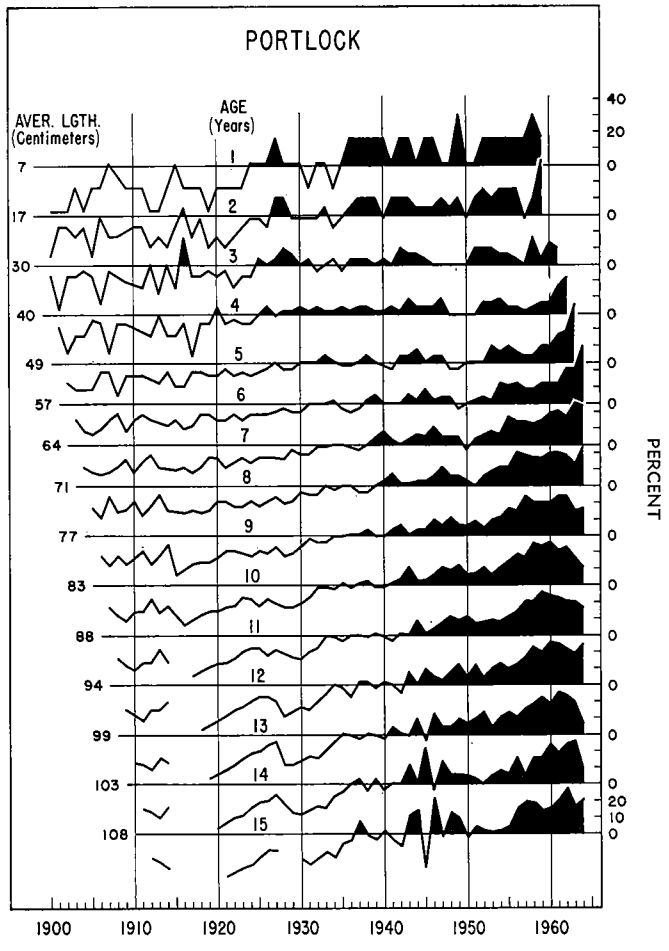

Figure 5. Length-frequency distributions of halibut taken on Portlock grounds expressed as percent deviations from a long term average length.

The growth patterns in the Goose Islands and Upper Hecate Strait data show a close similarity (Figures 2 and 3). The relatively long period of stability evident in these two areas from 1930 to 1950 led to the statement in 1960 that ". . . the growth of Area 2 halibut has not changed greatly, at least during the past two decades," (IPHC 1960a, p. 16). It was not until the 1954-1959 year classes began to enter the fishery as fast-growing four-year-olds that it became apparent in the data that the growth rate was increasing off the British Columbia coast. More recent year classes are growing at an even faster rate as evidenced by the still increasing average weight of the younger ages, generally below age 6 or 7. Even though the data in Table 2 do suggest some increase in the proportion of females at ages 6 and 7, the increase in growth is greater than can be attributed to the growth of females alone.

In Southeastern Alaska it was not until the appearance of the 1958 year class that an increase in growth could be detected (Figure 4). Such a delayed effect is typical for this region. While changes in age composition and reaction of the stocks to fishing in Southeastern Alaska have been of the same magnitude as off the British Columbia coast, they usually lag behind the latter by one or two years.

On the Portlock grounds off Kodiak Island growth increased beginning approximately with the 1915 year class and has continued to date (Figure 5). However, there was a tendency for the growth to be relatively stable during the decade from the mid-1930's to the mid-1940's.

The Shumagin Islands grounds show nearly the same growth characteristics as the Portlock grounds (Figure 6). Beginning with the 1934 year class there has been a steady increase and since the mid-1950's the weight of fish of all ages has increased regardless of whether or not the year class was above average during its early life.

In Bering Sea the average weight at nearly all ages has increased also since the mid-1950's (Figure 7). Even though the Bering Sea fishery on the Polaris ground did not commence until 1958, the series of back-calculated lengths is nearly as extensive as those from Southeastern Alaska and the Shumagin Islands, due to the very old fish in the initial catches.

The length-frequency data have been summarized and are shown in combined form for every other age from age 2 to 12 for the grounds in Area 2 (Figure 8) and for every other age from 6 to 14 for the grounds in Area 3 (Figure 9). As indicated in these figures there has been a pronounced increase in growth among fish 6 years of age and younger and a noticeable increase in the older ages in Area 2 since approximately 1960. The increase in growth of the fish from Area 3 has been of the same magnitude and duration. However, due to the nature of the Area 3 fishery the younger ages in the most recent data are not as well represented as is the case in Area 2.

Growth Rate Changes by Year Classes

It is apparent from examination of the percentage deviations in the accompanying figures that the growth of the individual year classes has not been uniform. In the Goose Islands data the growth of the early year classes show those of 1900 to 1912 was above the long term average during the young ages but was below during the older ages (Figure 2). Throughout the 1930's and the 1940's the growth of nearly all year classes was below average for the life of the year classes. During the late

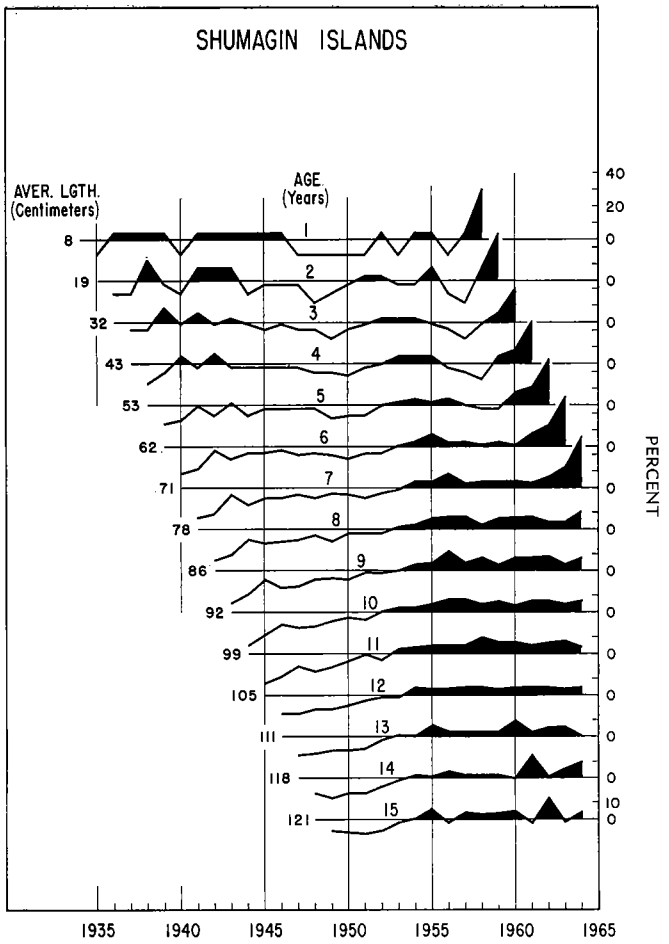

Figure 6. Length-frequency distributions of halibut taken on Shumagin Islands grounds expressed as percent deviations from a long term average length.

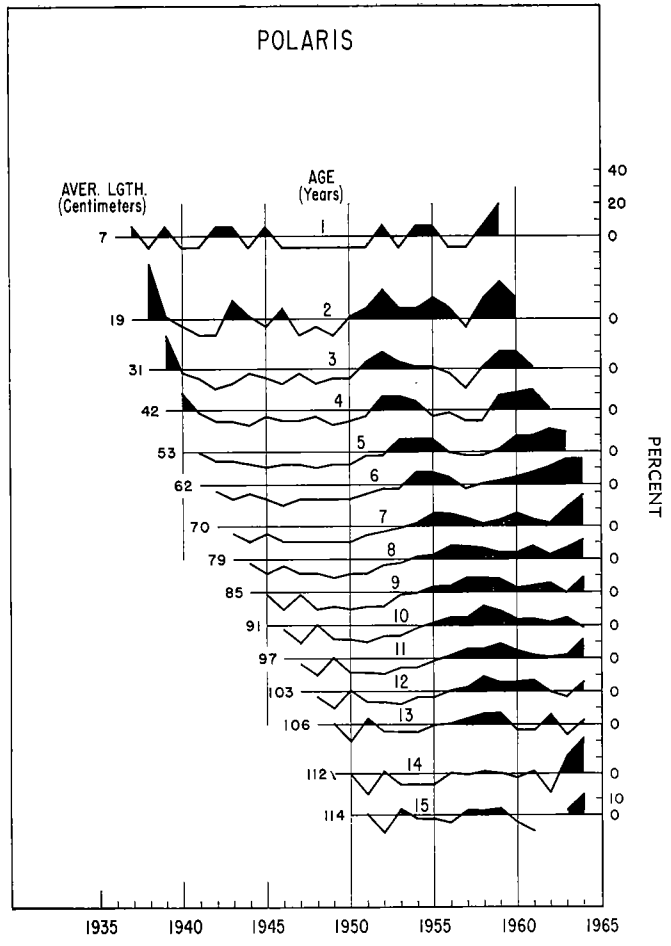

Figure 7. Length-frequency distributions of halibut taken on Polaris grounds expressed as percent deviations from a long term average length.

1940's and early 1950's the growth of some of the year classes began below average but increased until by the older ages they were above average. The growth of the recent year classes since about 1960 has begun greatly above average and appears to be continuing at such a level.

On Portlock (Figure 5) the growth of the earlier year classes in the series of data was below average and there has been a trend of increasing growth with each succeeding year class until the most recent classes which are much above average.

Data for the other grounds, that is, Hecate Strait, Southeastern Alaska, Shumagin Islands and Bering Sea (Figures 3, 4, 6 and 7), does not cover the period prior to the late 1930's, but on all grounds there has been an increasing trend in growth with the more recent year classes showing the greatest increase.

Growth and Catch per Unit Effort

At several points in the history of the Area 2 fishery changes in catch per unit effort can be related to changes in growth, particularly the catch per unit effort of the younger, smaller sizes of fish. In the industry halibut are classified for market purposes as chickens, medium or large* depending upon their weight. Between the ages of 4 and 6 halibut usually weight from 5 to 10 pounds and are classified as chickens. The categories medium and large are not as definitive in terms of their age composition since the weight range for each age is great.

The selectivity of the gear affects the size at which a year class enters the commercial fishery and the rate of growth determines the length of time a year class will on the average remain in the trade-weight category of chicken halibut. Inasmuch as the majority of chicken halibut in Area 2 are a single age, namely 5 years, marked changes in growth are reflected in the catch per unit effort of chicken halibut.

During the long period of relatively stable growth of halibut on the Goose Islands grounds (Figure 2) there were four short periods centred about 1926, 1932, 1938 and 1944 when the catch per unit effort of the trade category of chicken halibut increased sharply (Bell, Mss.). If it is assumed that the average age of chicken halibut is 5 years then the increase in catch per unit effort coincides with years in which the 5-year-old halibut were at or above average size. This was particularly evident in 1926 and 1938 and to a lesser extent in 1932 and 1944. Conversely the much-below-average size of 5-year-old halibut in 1936 and 1941 is associated with low values of catch per unit effort of chicken halibut.

Similarily, the increase in catch of chicken halibut per unit effort on Upper Hecate Strait grounds (Figure 3) in 1951 and 1952 corresponds to an increase in the weight of five-year-old halibut in those years.

The growth data for the inside grounds of Southeastern Alaska (Figure 4) are based on samples consisting of fish from several grounds; consequently, it is not possible to relate changes in growth of such grouped data with changes in catch per unit effort of chickens of specific grounds.

The coincidence of an increase in catch of chicken halibut per unit effort and age groups of above average size would not be as evident in the Portlock data as in the Goose Islands data due mainly to the lower catch of small-sized fish. Also a slightly lower growth rate at younger ages causes the young halibut to remain in

*The trade weight categories are: chicken, 5 to 10 pounds; medium, 10 to 60 pounds; and large, over 60. All weights are eviscerated, head off.

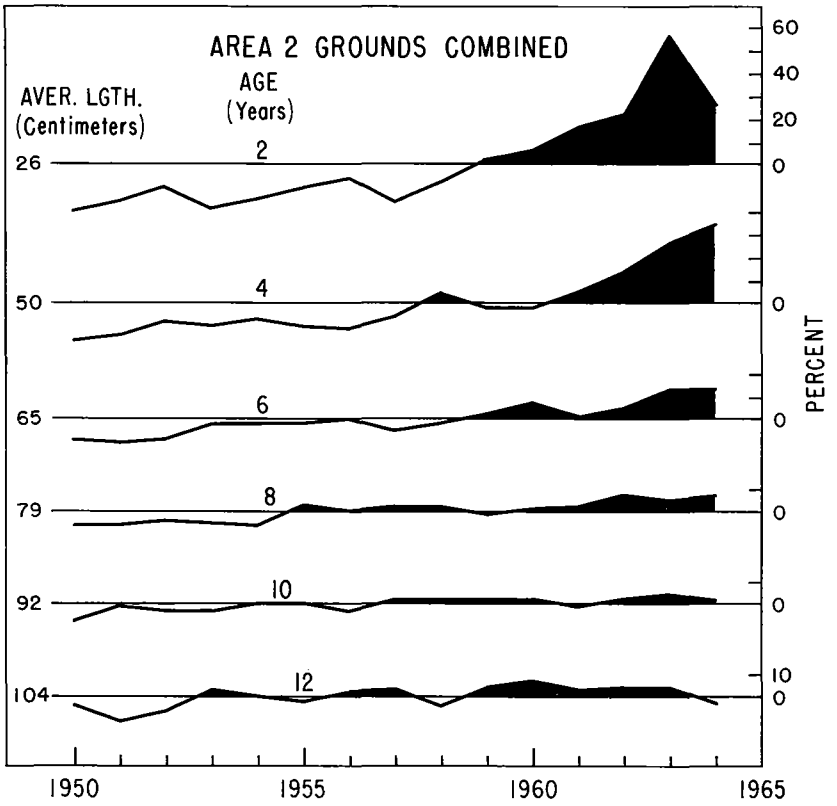

Figure 8. Combined length-frequency distributions of halibut taken on grounds in Area 2 expressed as percent deviations from a long term average.

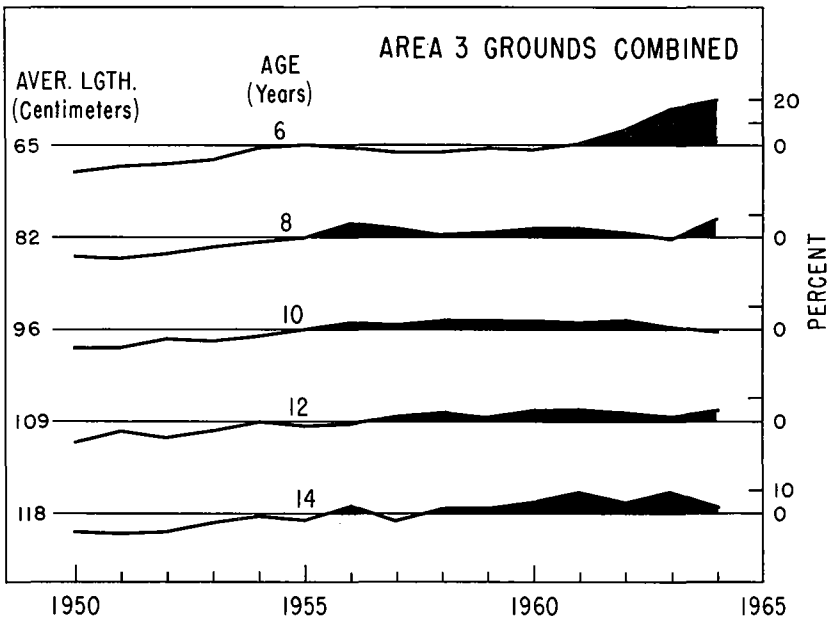

Figure 9. Combined length-frequency distributions of halibut taken on grounds in Area 3 expressed as percent deviations from a long term average.

the 5 to 10 pound category for a greater time thereby making the relationship between catch per unit effort of 5 to 10 pound fish and an increase in average size of 5-year-old fish less definitive.

It is not possible to associate increases in the catch per unit effort of the trade category mediums 10-60 pounds in either Area 2 or 3 with increases in the size of a given age group. The medium category has such a large range, from 10 to 60 pounds, that it includes fish of almost all ages. In general, however, the increase in catch per unit of medium-sized halibut in the middle and late 1950's and the early 1960's can be attributed to a great extent to the increase in growth of all age groups.

Changes in growth rate can materially affect the proportion of the various trade-weight categories in the catch. During the period from about 1928 to the early 1950's when the percentage deviations of the ages comprising the chicken category were generally below average (Figure 2), the catch of chicken halibut per unit effort on the Goose Islands grounds increased to a new level and was relatively constant until the early 1950's when it decreased. The effect of a slower growth would be for a year class to remain in the chicken halibut category for a longer period of time. The more rapid growth of the recent years would cause a year class to appear in the catch at a younger age and to pass through the chicken category more rapidly. The current decrease in catch per unit effort of chickens may reflect the increased rate of growth as well as possible changes in recruitment and selectivity by the fishery.

Density-Dependent Growth and Stock Density

Since the early 1950's the average weight of halibut of all ages has increased on all grounds from Goose Islands to Bering Sea. The most pronounced increase has occurred in the youngest fish, but the older fish have shown the increase as well. The weight by age during the early ages of the year classes which reached ages 12 to 15 years during the early 1950 period generally had been less than the long-term average, yet the growth at all ages of these groups increased during the period following the early 1950's and the average weight of these fish during their older years exceeded the long-term average.

Removals from most grounds during the period from 1950 to 1960 were at a high level. The catches, particularly from Area 2, were increased in an effort to test the productive potential of the stocks (Chapman, Myhre and Southward, 1962, Appendix Table A). The effect of the increase in removals was twofold: first, the overall abundance of the population was reduced and secondly, the numbers of older and consequently larger fish were reduced. By 1957 the foregoing process had been effected in Area 2 and the growth of the various year classes in the population had begun to accelerate. The increase in growth of the youngest fish occurred first and was the most rapid. The increase in removals in Area 3 did not occur until after 1957, but this was also followed by an increase in average weight of the most recent ages entering the fishery.

Ketchen and Forrester (1966) have indicated a density-dependent relationship between the growth and abundance of petrale. Off British Columbia between 1947 and 1952 the growth of that flounder was below the long-term average and was above average during the period 1953 to 1957. These periods correspond to periods of high and low catch per unit effort respectively. It was also noted that between 1947 and 1952 the sea water temperatures off the British Columbia Coast were

lower than average and could have induced the changes noted. However, until more is known about the intra-and inter-specific competition of petrale and other associated flounders in a changing environment these authors felt that they were unable to attribute the changes to either cause.

A parallel situation exists in the growth history of halibut. As noted earlier, there is a good visual correspondence between the increase in average weight and the reduction in the weight of the stock. The growth of halibut during the late 1940's was generally lower than average and during the mid-1950's was increasing. These two periods agree well with the growth patterns of petrale as reported by Ketchen and Forrester. This correspondence in growth patterns of the two species over the 10-year period might suggest that growth generally was affected by changes in the environment; possibly the lower than average sea water temperatures. However, the growth of halibut increased sharply after 1957 following the greater removals in the late 1950's, while the growth of petrale decreased during the same period. This lack of correspondence between the growth of petrale and halibut in recent years supports the hypothesis that the growth of halibut may be to a considerable extent density-dependent.

The effect of fishing is not as evident in the data from Southeastern Bering Sea as in the Pacific. In Southeastern Bering Sea the same general increases in average weight at each age begins in the early 1950's as in the other regions on the coast and continues until the present date. However, the general increase may be primarily the result of change in the physical environment. While the same response in growth can be detected following the initial fishing in 1958 the pattern of increased growth was already established by the early 1950's. The increase began prior to the commencement of the fishery and has not been as pronounced as in the other areas; in the Bering Sea the increase in the growth of the younger fish was approximately 10 percent, while in the other areas it was nearly 60 percent.

CONCLUSION

The growth of halibut is complex, and it is unlikely that all of the changes in growth can be explained by a density-dependent reaction. Similarly, it would be an oversimplification to assume that all changes in growth were caused by changes in the physical environment. Rather the changes are no doubt the result of a combination of changes in the environment as well as a density-dependent response.

It appears that the growth of halibut in the Northeastern Pacific has increased following the large removals in the early and mid-1950's and that this increase in growth has probably been amplified by changes in the physical environment which has favored growth. In Southeastern Bering Sea the increase in growth began prior to the development of a fishery in the region and is probably primarily the result of changes in the environment, but there is also some indication that a density-dependent response occurred following the removals in the early 1960's.

Table 3. Average length (cm.) and average weight (lbs.) computed from otolith radii measurements by age and year.

Goose Islands Grounds												
Year	Age: 1		2		3		4		5		6	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1902	8	0.01	—	—	—	—	—	—	—	—	—	—
1903	—	—	16	0.07	—	—	—	—	—	—	—	—
1904	12	0.02	—	—	26	0.30	—	—	—	—	—	—
1905	10	0.01	28	0.39	—	—	42	1.5	—	—	—	—
1906	9	0.01	24	0.23	43	1.6	—	—	54	3.3	—	—
1907	8	0.01	23	0.20	39	1.1	55	3.6	—	—	67	6.5
1908	10	0.01	22	0.18	43	1.6	52	3.1	64	5.7	—	—
1909	10	0.01	26	0.30	35	0.84	48	2.2	58	4.1	70	7.8
1910	12	0.02	26	0.30	41	1.4	46	1.9	58	4.1	64	5.7
1911	12	0.02	29	0.44	39	1.1	54	3.3	54	3.3	65	6.1
1912	13	0.04	32	0.61	45	1.8	52	3.1	65	6.1	61	5.0
1913	—	—	33	0.68	49	2.4	59	4.4	—	—	74	9.3
1914	7	0.00	—	—	52	3.1	63	5.4	69	7.3	73	8.8
1915	8	0.01	20	0.13	—	—	64	5.7	73	8.8	77	10.4
1916	9	0.01	21	0.15	32	0.61	—	—	—	—	—	—
1917	7	0.00	23	0.20	31	0.55	42	1.5	—	—	—	—
1918	8	0.01	19	0.11	32	0.61	43	1.6	52	3.1	—	—
1919	8	0.01	19	0.11	33	0.68	42	1.5	54	3.3	57	3.8
1920	8	0.01	19	0.11	32	0.61	46	1.9	50	2.6	63	5.4
1921	10	0.01	19	0.11	30	0.49	42	1.5	54	3.3	57	3.8
1922	12	0.02	24	0.23	32	0.61	41	1.4	50	2.6	61	5.0
1923	13	0.04	32	0.61	37	0.93	43	1.6	50	2.6	58	4.1
1924	8	0.01	33	0.68	42	1.5	49	2.4	53	3.1	59	4.4
1925	6	0.00	21	0.15	52	3.1	59	4.4	60	4.7	61	5.0
1926	7	0.00	17	0.08	38	1.0	64	5.7	69	7.3	69	7.3
1927	8	0.01	21	0.15	30	0.49	38	1.0	—	—	—	—
1928	7	0.00	19	0.11	34	0.76	42	1.5	48	2.2	—	—
1929	7	0.00	13	0.04	32	0.61	45	1.8	49	2.4	58	4.1
1930	7	0.00	19	0.11	32	0.61	45	1.8	54	3.3	57	3.8
1931	7	0.00	17	0.08	32	0.61	45	1.8	53	3.1	61	5.0
1932	7	0.00	18	0.09	31	0.55	45	1.8	54	3.3	61	5.0
1933	8	0.01	18	0.09	32	0.61	42	1.5	54	3.3	63	5.4
1934	8	0.01	19	0.11	31	0.55	43	1.6	52	3.1	63	5.4
1935	8	0.01	21	0.15	33	0.68	42	1.5	52	2.8	59	4.4
1936	10	0.01	23	0.20	38	1.0	47	2.1	50	2.6	59	4.4
1937	8	0.01	23	0.20	38	1.0	49	2.4	55	3.6	59	4.4
1938	8	0.01	20	0.13	38	1.0	49	2.4	59	4.4	64	5.7
1939	8	0.01	19	0.11	38	1.0	48	2.2	59	4.4	65	6.1
1940	8	0.01	19	0.11	32	0.61	46	1.9	57	3.8	67	6.5
1941	8	0.01	20	0.13	32	0.61	45	1.8	52	3.1	61	5.0
1942	8	0.01	21	0.15	34	0.76	45	1.8	52	3.1	61	5.0
1943	8	0.01	21	0.15	34	0.76	46	1.9	54	3.3	61	5.0
1944	8	0.01	19	0.15	32	0.61	45	1.8	54	3.3	61	5.0
1945	8	0.01	19	0.15	32	0.61	43	1.6	54	3.3	63	5.4
1946	8	0.01	19	0.15	33	0.68	43	1.6	53	3.1	61	5.0
1947	7	0.00	19	0.15	31	0.55	43	1.6	53	3.1	61	5.0
1948	8	0.01	18	0.09	30	0.49	41	1.4	50	2.6	60	4.7
1949	8	0.01	18	0.09	30	0.49	40	1.2	49	2.4	58	4.1
1950	9	0.01	20	0.13	31	0.55	40	1.2	49	2.4	57	3.8
1951	9	0.01	22	0.18	34	0.76	41	1.4	49	2.4	57	3.8
1952	8	0.01	25	0.27	35	0.84	46	1.9	52	3.1	58	4.1
1953	8	0.01	22	0.18	39	1.1	46	1.9	55	3.6	61	5.0
1954	9	0.01	23	0.20	35	0.84	48	2.2	57	3.8	63	5.4
1955	11	0.02	23	0.20	35	0.84	47	2.1	60	4.7	65	6.1
1956	9	0.01	23	0.20	35	0.84	43	1.6	57	3.8	68	6.9
1957	8	0.01	23	0.20	42	1.5	46	1.9	54	3.3	64	5.7
1958	11	0.02	23	0.20	38	1.0	55	3.6	57	3.8	64	5.7
1959	13	0.03	26	0.30	37	0.93	52	2.8	64	5.7	67	6.5
1960	13	0.03	30	0.49	40	1.2	48	2.2	60	4.7	72	8.3
1961	—	—	33	0.68	46	1.9	52	3.1	59	4.4	65	6.1
1962	14	0.04	—	—	49	2.4	60	4.7	63	5.4	68	6.9
1963	—	—	35	0.84	—	—	64	5.7	68	6.9	72	8.3
1964	—	—	—	—	68	6.9	—	—	76	9.8	74	9.3

Table 3.—(continued)

Goose Islands Grounds

Year	Age: 7		8		9		10		11		12	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1902	—	—	—	—	—	—	—	—	—	—	—	—
1903	—	—	—	—	—	—	—	—	—	—	—	—
1904	—	—	—	—	—	—	—	—	—	—	—	—
1905	—	—	—	—	—	—	—	—	—	—	—	—
1906	—	—	—	—	—	—	—	—	—	—	—	—
1907	—	—	—	—	—	—	—	—	—	—	—	—
1908	80	11.6	—	—	—	—	—	—	—	—	—	—
1909	—	—	92	18.4	—	—	—	—	—	—	—	—
1910	77	10.4	—	—	99	23.3	—	—	—	—	—	—
1911	69	7.3	81	12.2	—	—	104	27.9	—	—	—	—
1912	73	8.8	78	11.0	86	15.1	—	—	112	34.6	—	—
1913	69	7.3	80	11.6	85	14.3	92	18.4	—	—	118	40.8
1914	82	12.9	76	9.2	88	15.9	90	17.5	96	21.2	—	—
1915	80	11.6	88	15.9	82	12.9	93	19.3	95	20.3	99	23.3
1916	—	—	—	—	—	—	—	—	—	—	—	—
1917	—	—	—	—	—	—	—	—	—	—	—	—
1918	—	—	—	—	—	—	—	—	—	—	—	—
1919	—	—	—	—	—	—	—	—	—	—	—	—
1920	64	5.7	—	—	—	—	—	—	—	—	—	—
1921	69	7.3	70	7.8	—	—	—	—	—	—	—	—
1922	63	5.4	74	9.3	76	9.8	—	—	—	—	—	—
1923	68	6.9	69	7.3	80	11.6	80	11.6	—	—	—	—
1924	67	6.5	76	9.2	74	9.3	86	15.8	85	14.3	—	—
1925	65	6.1	73	8.8	82	12.9	81	12.2	92	18.4	90	17.5
1926	68	6.9	72	8.3	78	11.0	88	15.9	85	14.3	96	21.2
1927	68	6.9	—	—	—	—	—	—	—	—	—	—
1928	—	—	74	9.3	—	—	—	—	—	—	—	—
1929	—	—	—	—	82	12.9	—	—	—	—	—	—
1930	63	5.4	—	—	—	—	89	16.7	—	—	—	—
1931	64	5.7	70	7.8	—	—	—	—	96	21.2	—	—
1932	69	7.3	70	7.8	76	9.8	—	—	—	—	104	27.9
1933	69	7.3	77	10.4	78	11.0	81	12.2	—	—	—	—
1934	72	8.3	77	10.4	85	14.3	86	15.1	90	17.5	—	—
1935	70	7.8	80	11.6	86	15.1	92	18.4	95	20.3	96	21.2
1936	67	6.5	81	12.2	90	17.5	95	20.3	106	29.2	112	34.6
1937	68	6.9	74	9.3	86	15.1	97	22.3	102	25.6	104	27.9
1938	67	6.5	74	9.3	78	11.0	90	17.5	90	17.5	96	21.2
1939	70	7.8	72	8.3	80	11.6	85	14.3	95	20.3	100	24.4
1940	72	8.3	76	9.8	74	9.3	82	12.9	89	16.7	88	15.9
1941	73	8.8	80	11.6	82	12.9	78	11.0	89	16.7	93	19.3
1942	69	7.3	76	9.8	86	15.1	82	12.9	78	11.0	92	18.4
1943	69	7.3	74	9.3	84	13.6	95	20.3	78	11.0	88	15.9
1944	69	7.3	76	9.8	81	12.2	89	16.7	100	24.4	84	13.6
1945	72	8.3	76	9.8	82	12.9	82	12.9	95	20.3	107	30.5
1946	69	7.3	76	9.8	80	11.6	85	14.3	86	15.1	86	15.1
1947	69	7.3	77	10.4	82	12.9	85	14.3	88	15.9	89	16.7
1948	69	7.3	78	11.0	82	12.9	90	17.5	96	21.2	88	15.9
1949	68	6.9	74	9.3	85	14.3	89	16.7	95	20.3	96	21.2
1950	65	6.1	74	9.3	81	12.2	90	17.5	93	19.3	100	24.4
1951	65	6.1	73	8.8	81	12.2	86	15.1	96	21.2	93	19.3
1952	67	6.5	72	8.3	80	11.6	86	15.1	90	17.5	97	22.3
1953	67	6.5	74	9.3	80	11.6	88	15.9	93	19.3	97	22.3
1954	70	7.8	76	9.8	82	12.9	88	15.9	96	21.2	102	25.6
1955	72	8.3	80	11.6	85	14.3	89	16.7	99	23.3	104	27.9
1956	73	8.8	78	11.0	86	15.1	90	17.5	95	20.3	106	29.2
1957	74	9.3	81	12.2	88	15.9	90	17.5	102	25.6	102	25.6
1958	73	8.8	82	12.9	92	18.4	95	20.3	96	21.2	102	25.6
1959	70	7.8	80	11.6	89	16.7	99	23.3	104	27.9	102	25.6
1960	73	8.8	77	10.4	85	14.3	93	19.3	115	37.6	107	30.5
1961	78	11.0	78	11.0	81	12.2	88	15.9	99	23.3	118	40.8
1962	76	9.8	82	12.9	84	13.6	82	12.9	92	18.4	109	31.8
1963	76	9.8	84	13.6	92	18.4	90	17.5	85	14.3	110	33.2
1964	74	9.3	81	12.2	86	15.1	85	14.3	88	15.9	85	14.3

Table 3.—(continued)

Goose Islands Grounds

Year	Age:	13		14		15		16		17		18	
		cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1902		—	—	—	—	—	—	—	—	—	—	—	—
1903		—	—	—	—	—	—	—	—	—	—	—	—
1904		—	—	—	—	—	—	—	—	—	—	—	—
1905		—	—	—	—	—	—	—	—	—	—	—	—
1906		—	—	—	—	—	—	—	—	—	—	—	—
1907		—	—	—	—	—	—	—	—	—	—	—	—
1908		—	—	—	—	—	—	—	—	—	—	—	—
1909		—	—	—	—	—	—	—	—	—	—	—	—
1910		—	—	—	—	—	—	—	—	—	—	—	—
1911		—	—	—	—	—	—	—	—	—	—	—	—
1912		—	—	—	—	—	—	—	—	—	—	—	—
1913		—	—	—	—	—	—	—	—	—	—	—	—
1914		122	46.2	—	—	—	—	—	—	—	—	—	—
1915		—	—	126	51.7	—	—	—	—	—	—	—	—
1916		—	—	—	—	—	—	—	—	—	—	—	—
1917		—	—	—	—	—	—	—	—	—	—	—	—
1918		—	—	—	—	—	—	—	—	—	—	—	—
1919		—	—	—	—	—	—	—	—	—	—	—	—
1920		—	—	—	—	—	—	—	—	—	—	—	—
1921		—	—	—	—	—	—	—	—	—	—	—	—
1922		—	—	—	—	—	—	—	—	—	—	—	—
1923		—	—	—	—	—	—	—	—	—	—	—	—
1924		—	—	—	—	—	—	—	—	—	—	—	—
1925		—	—	—	—	—	—	—	—	—	—	—	—
1926		96	21.2	—	—	—	—	—	—	—	—	—	—
1927		—	—	—	—	—	—	—	—	—	—	—	—
1928		—	—	—	—	—	—	—	—	—	—	—	—
1929		—	—	—	—	—	—	—	—	—	—	—	—
1930		—	—	—	—	—	—	—	—	—	—	—	—
1931		—	—	—	—	—	—	—	—	—	—	—	—
1932		—	—	—	—	—	—	—	—	—	—	—	—
1933		—	—	—	—	—	—	—	—	—	—	—	—
1934		—	—	—	—	—	—	—	—	—	—	—	—
1935		—	—	—	—	—	—	—	—	—	—	—	—
1936		—	—	—	—	—	—	—	—	—	—	—	—
1937		—	—	—	—	—	—	—	—	—	—	—	—
1938		—	—	—	—	—	—	—	—	—	—	—	—
1939		—	—	—	—	—	—	—	—	—	—	—	—
1940		—	—	—	—	—	—	—	—	—	—	—	—
1941		89	16.7	—	—	—	—	—	—	—	—	—	—
1942		90	17.5	92	18.4	—	—	—	—	—	—	—	—
1943		97	22.3	—	—	—	—	—	—	—	—	—	—
1944		97	22.3	102	25.6	—	—	—	—	—	—	—	—
1945		—	—	99	23.3	—	—	—	—	—	—	—	—
1946		—	—	—	—	95	20.3	—	—	—	—	—	—
1947		90	17.53	—	—	—	—	97	22.3	—	—	—	—
1948		106	29.2	—	—	—	—	—	—	—	—	—	—
1949		92	18.4	—	—	—	—	—	—	—	—	—	—
1950		—	—	—	—	—	—	—	—	—	—	—	—
1951		99	23.3	—	—	—	—	—	—	—	—	—	—
1952		100	24.4	—	—	—	—	—	—	—	—	—	—
1953		104	27.9	104	27.9	—	—	—	—	—	—	—	—
1954		107	30.5	—	—	106	29.2	—	—	—	—	—	—
1955		109	31.8	115	37.6	—	—	112	34.6	—	—	—	—
1956		110	33.2	112	34.6	120	44.2	—	—	118	40.8	—	—
1957		109	31.8	112	34.6	119	42.5	146	82.6	—	—	122	46.0
1958		102	25.6	109	31.8	112	34.6	—	—	—	—	—	—
1959		113	36.1	109	31.8	112	34.6	123	47.9	—	—	—	—
1960		102	25.6	119	42.5	109	36.1	131	57.9	—	—	—	—
1961		112	34.6	104	27.9	—	—	—	—	122	46.0	—	—
1962		126	51.7	135	64.6	96	21.2	107	30.5	—	—	128	53.7
1963		122	46.0	—	—	143	77.2	—	—	—	—	—	—
1964		97	22.3	113	36.1	—	—	—	—	—	—	—	—

Table 3.—(continued)

Goose Islands Grounds

Year	Age: 19		20		21		22		23	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1902	—	—	—	—	—	—	—	—	—	—
1903	—	—	—	—	—	—	—	—	—	—
1904	—	—	—	—	—	—	—	—	—	—
1905	—	—	—	—	—	—	—	—	—	—
1906	—	—	—	—	—	—	—	—	—	—
1907	—	—	—	—	—	—	—	—	—	—
1908	—	—	—	—	—	—	—	—	—	—
1909	—	—	—	—	—	—	—	—	—	—
1910	—	—	—	—	—	—	—	—	—	—
1911	—	—	—	—	—	—	—	—	—	—
1912	—	—	—	—	—	—	—	—	—	—
1913	—	—	—	—	—	—	—	—	—	—
1914	—	—	—	—	—	—	—	—	—	—
1915	—	—	—	—	—	—	—	—	—	—
1916	—	—	—	—	—	—	—	—	—	—
1917	—	—	—	—	—	—	—	—	—	—
1918	—	—	—	—	—	—	—	—	—	—
1919	—	—	—	—	—	—	—	—	—	—
1920	—	—	—	—	—	—	—	—	—	—
1921	—	—	—	—	—	—	—	—	—	—
1922	—	—	—	—	—	—	—	—	—	—
1923	—	—	—	—	—	—	—	—	—	—
1924	—	—	—	—	—	—	—	—	—	—
1925	—	—	—	—	—	—	—	—	—	—
1926	—	—	—	—	—	—	—	—	—	—
1927	—	—	—	—	—	—	—	—	—	—
1928	—	—	—	—	—	—	—	—	—	—
1929	—	—	—	—	—	—	—	—	—	—
1930	—	—	—	—	—	—	—	—	—	—
1931	—	—	—	—	—	—	—	—	—	—
1932	—	—	—	—	—	—	—	—	—	—
1933	—	—	—	—	—	—	—	—	—	—
1934	—	—	—	—	—	—	—	—	—	—
1935	—	—	—	—	—	—	—	—	—	—
1936	—	—	—	—	—	—	—	—	—	—
1937	—	—	—	—	—	—	—	—	—	—
1938	—	—	—	—	—	—	—	—	—	—
1939	—	—	—	—	—	—	—	—	—	—
1940	—	—	—	—	—	—	—	—	—	—
1941	—	—	—	—	—	—	—	—	—	—
1942	—	—	—	—	—	—	—	—	—	—
1943	—	—	—	—	—	—	—	—	—	—
1944	—	—	—	—	—	—	—	—	—	—
1945	—	—	—	—	—	—	—	—	—	—
1946	—	—	—	—	—	—	—	—	—	—
1947	—	—	—	—	—	—	—	—	—	—
1948	—	—	—	—	—	—	—	—	—	—
1949	—	—	—	—	—	—	—	—	—	—
1950	—	—	—	—	—	—	—	—	—	—
1951	—	—	—	—	—	—	—	—	—	—
1952	—	—	—	—	—	—	—	—	—	—
1953	—	—	—	—	—	—	—	—	—	—
1954	—	—	—	—	—	—	—	—	—	—
1955	—	—	—	—	—	—	—	—	—	—
1956	—	—	—	—	—	—	—	—	—	—
1957	—	—	—	—	—	—	—	—	—	—
1958	126	51.7	—	—	—	—	—	—	—	—
1959	—	—	131	57.9	—	—	—	—	—	—
1960	—	—	—	—	135	64.6	—	—	—	—
1961	—	—	—	—	—	—	138	69.4	—	—
1962	—	—	—	—	—	—	—	—	143	77.2
1963	151	91.5	—	—	—	—	—	—	—	—
1964	—	—	—	—	—	—	—	—	—	—

Table 4. Average length (cm.) and average weight (lbs.) computed from otolith radii measurements by age and year.

Upper Hecate Strait Grounds

Year	Age: 1		2		3		4		5		6	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1933	9	0.01	—	—	—	—	—	—	—	—	—	—
1934	9	0.01	20	0.13	—	—	—	—	—	—	—	—
1935	8	0.01	21	0.15	34	0.76	—	—	—	—	—	—
1936	8	0.01	21	0.15	35	0.84	47	2.1	—	—	—	—
1937	8	0.01	21	0.15	31	0.55	45	1.8	57	3.8	—	—
1938	9	0.01	22	0.18	38	1.0	43	1.6	53	3.1	64	5.7
1939	8	0.01	23	0.20	35	0.84	47	2.1	52	2.9	59	4.4
1940	8	0.01	21	0.15	37	0.93	45	1.8	57	3.8	61	5.0
1941	8	0.01	21	0.15	34	0.76	48	2.2	53	3.1	65	6.1
1942	8	0.01	22	0.18	34	0.76	46	1.9	57	3.8	60	4.7
1943	8	0.01	21	0.15	35	0.84	46	1.9	54	3.3	64	5.7
1944	8	0.01	21	0.15	33	0.68	46	1.9	54	3.3	63	5.4
1945	9	0.01	20	0.13	34	0.76	45	1.8	54	3.3	61	5.0
1946	8	0.01	22	0.18	33	0.68	43	1.6	53	3.1	61	5.0
1947	9	0.01	21	0.15	32	0.61	43	1.6	53	3.1	61	5.0
1948	9	0.01	21	0.15	33	0.68	43	1.6	53	3.1	60	4.7
1949	9	0.01	23	0.20	32	0.61	45	1.8	53	3.1	61	5.0
1950	9	0.01	23	0.20	37	0.93	45	1.8	54	3.3	61	5.0
1951	9	0.01	23	0.20	38	1.0	48	2.2	55	3.6	64	5.7
1952	9	0.01	24	0.23	37	0.93	49	2.4	58	4.1	64	5.7
1953	8	0.01	22	0.18	37	0.93	47	2.1	58	4.1	68	6.9
1954	10	0.01	23	0.20	35	0.84	48	2.2	57	3.8	67	6.5
1955	11	0.02	26	0.30	37	0.93	46	1.9	58	4.1	65	6.1
1956	9	0.01	29	0.44	42	1.5	47	1.81	54	3.3	67	6.5
1957	10	0.01	23	0.20	45	1.8	54	3.3	57	3.8	63	5.4
1958	11	0.02	27	0.34	39	1.1	58	4.1	63	5.4	67	6.5
1959	11	0.02	30	0.49	42	1.5	50	2.6	65	6.1	72	8.3
1960	12	0.02	30	0.49	46	1.9	54	3.3	60	4.7	74	9.3
1961	12	0.02	31	0.55	47	2.1	59	4.4	65	6.1	68	6.9
1962	18	0.09	31	0.47	53	3.1	61	5.0	70	7.8	74	9.3
1963	—	—	32	0.52	47	1.81	72	8.3	74	9.3	82	12.9
1964	—	—	—	—	53	2.7	67	6.5	82	12.9	84	13.6

Year	Age: 7		8		9		10		11		12	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1933	—	—	—	—	—	—	—	—	—	—	—	—
1934	—	—	—	—	—	—	—	—	—	—	—	—
1935	—	—	—	—	—	—	—	—	—	—	—	—
1936	—	—	—	—	—	—	—	—	—	—	—	—
1937	—	—	—	—	—	—	—	—	—	—	—	—
1938	—	—	—	—	—	—	—	—	—	—	—	—
1939	70	7.8	—	—	—	—	—	—	—	—	—	—
1940	65	6.1	76	9.8	—	—	—	—	—	—	—	—
1941	69	7.3	70	7.8	82	12.9	—	—	—	—	—	—
1942	73	8.8	76	9.8	77	10.4	92	18.4	—	—	—	—
1943	69	7.3	80	11.6	85	14.3	82	12.9	97	22.3	—	—
1944	72	8.3	76	9.8	86	15.1	93	19.3	88	15.9	106	29.2
1945	69	7.3	80	11.6	82	12.9	93	19.3	102	25.6	93	19.3
1946	69	7.3	77	10.4	86	15.1	88	15.1	100	24.4	110	33.2
1947	69	7.3	77	10.4	84	13.6	93	19.3	95	20.3	107	30.5
1948	69	7.3	76	9.8	85	14.3	93	19.3	100	24.4	100	24.4
1949	69	7.3	77	10.4	84	13.6	93	19.3	100	24.4	107	30.5
1950	69	7.3	77	10.4	85	14.3	90	17.5	100	24.4	106	29.2
1951	70	7.8	77	10.4	85	14.3	93	19.3	99	23.3	107	30.5
1952	73	8.8	78	11.0	86	15.1	95	20.3	107	30.5	107	30.5
1953	72	8.3	82	12.9	86	15.1	93	19.3	104	27.9	116	39.2
1954	76	9.8	78	11.0	90	17.5	93	19.3	97	22.3	112	34.6
1955	76	9.8	85	14.3	86	15.1	102	25.6	102	25.6	100	24.4
1956	73	8.8	80	11.6	90	17.5	92	18.4	104	27.9	104	27.9
1957	74	9.3	82	12.9	88	15.9	99	23.3	104	27.9	116	39.2
1958	70	7.8	81	12.2	84	13.6	95	20.3	109	31.8	102	25.6
1959	74	9.3	77	10.4	86	15.1	88	15.1	99	23.3	116	39.2
1960	77	10.4	82	12.9	84	13.6	92	18.4	89	16.7	115	37.7
1961	84	13.6	86	15.1	93	19.3	96	21.2	104	27.9	93	19.3
1962	77	10.4	92	18.4	93	19.3	104	27.9	106	29.2	109	31.8
1963	85	14.3	84	13.6	99	23.3	100	24.4	107	30.5	112	34.6
1964	92	18.4	96	21.2	89	16.7	97	22.3	102	25.6	107	30.5

Table 4.—(continued)

Upper Hecate Strait Grounds

Year	Age:	13		14		15		16		17		18	
		cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1933		—	—	—	—	—	—	—	—	—	—	—	—
1934		—	—	—	—	—	—	—	—	—	—	—	—
1935		—	—	—	—	—	—	—	—	—	—	—	—
1936		—	—	—	—	—	—	—	—	—	—	—	—
1937		—	—	—	—	—	—	—	—	—	—	—	—
1938		—	—	—	—	—	—	—	—	—	—	—	—
1939		—	—	—	—	—	—	—	—	—	—	—	—
1940		—	—	—	—	—	—	—	—	—	—	—	—
1941		—	—	—	—	—	—	—	—	—	—	—	—
1942		—	—	—	—	—	—	—	—	—	—	—	—
1943		—	—	—	—	—	—	—	—	—	—	—	—
1944		—	—	—	—	—	—	—	—	—	—	—	—
1945		112	34.7	—	—	—	—	—	—	—	—	—	—
1946		96	21.2	118	40.9	—	—	—	—	—	—	—	—
1947		116	39.2	100	24.4	122	46.0	—	—	—	—	—	—
1948		112	34.6	119	42.5	104	27.9	128	53.7	—	—	—	—
1949		109	31.8	118	40.8	125	49.8	109	30.5	132	60.1	—	—
1950		113	36.1	113	36.1	123	47.9	131	57.9	113	36.1	135	64.6
1951		113	36.1	119	42.5	119	42.5	129	55.8	137	67.0	118	40.8
1952		118	40.8	126	51.7	137	67.0	125	49.8	135	64.6	132	60.1
1953		120	44.2	126	51.7	138	69.4	143	77.2	131	57.9	137	67.0
1954		126	51.7	129	55.8	135	64.6	141	74.5	174	146.8	146	82.6
1955		122	46.0	131	57.9	120	44.2	143	77.2	155	101.0	115	37.6
1956		99	23.3	129	55.8	144	79.9	122	46.0	151	91.5	113	36.1
1957		113	36.1	104	27.9	122	46.0	—	—	97	22.3	160	111.2
1958		122	46.0	107	30.5	113	36.1	126	51.7	—	—	104	27.9
1959		104	27.9	132	60.1	116	39.2	118	40.9	166	126.1	—	—
1960		120	44.2	112	34.7	128	53.7	119	42.5	109	31.8	125	49.8
1961		125	49.8	126	51.7	118	40.8	135	64.6	92	18.4	129	55.8
1962		96	21.2	132	60.1	135	64.6	104	27.9	140	71.9	96	21.2
1963		123	47.9	123	47.9	132	60.1	123	47.9	109	31.8	143	77.2
1964		104	27.9	113	36.1	119	42.5	137	67.0	144	79.9	—	—

Year	Age:	19		20		21		22		23	
		cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1933		—	—	—	—	—	—	—	—	—	—
1934		—	—	—	—	—	—	—	—	—	—
1935		—	—	—	—	—	—	—	—	—	—
1936		—	—	—	—	—	—	—	—	—	—
1937		—	—	—	—	—	—	—	—	—	—
1938		—	—	—	—	—	—	—	—	—	—
1939		—	—	—	—	—	—	—	—	—	—
1940		—	—	—	—	—	—	—	—	—	—
1941		—	—	—	—	—	—	—	—	—	—
1942		—	—	—	—	—	—	—	—	—	—
1943		—	—	—	—	—	—	—	—	—	—
1944		—	—	—	—	—	—	—	—	—	—
1945		—	—	—	—	—	—	—	—	—	—
1946		—	—	—	—	—	—	—	—	—	—
1947		—	—	—	—	—	—	—	—	—	—
1948		—	—	—	—	—	—	—	—	—	—
1949		—	—	—	—	—	—	—	—	—	—
1950		—	—	—	—	—	—	—	—	—	—
1951		120	44.2	—	—	—	—	—	—	—	—
1952		—	—	—	—	—	—	—	—	—	—
1953		137	67.0	—	—	—	—	—	—	—	—
1954		158	107.7	149	88.4	—	—	—	—	—	—
1955		126	51.7	—	—	154	97.7	—	—	—	—
1956		—	—	—	—	—	—	155	101.0	—	—
1957		179	160.4	—	—	—	—	—	—	—	—
1958		—	—	—	—	—	—	—	—	—	—
1959		106	29.2	—	—	—	—	—	—	—	—
1960		—	—	112	34.6	—	—	—	—	—	—
1961		107	30.5	—	—	116	39.2	—	—	—	—
1962		135	64.6	109	31.8	—	—	119	42.0	—	—
1963		102	25.6	119	42.5	115	37.6	—	—	122	46.0
1964		141	74.5	106	29.2	125	49.8	—	—	—	—

Table 5. Average length (cm.) and average weight (lbs.) computed from otolith radii measurements by age and year.

Inside Southeastern Alaska Grounds

Year	Age: 1		2		3		4		5		6	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1939	7	0.00	—	—	—	—	—	—	—	—	—	—
1940	7	0.00	23	0.20	—	—	—	—	—	—	—	—
1941	8	0.01	17	0.08	41	1.4	—	—	—	—	—	—
1942	9	0.01	18	0.09	39	1.1	47	2.1	—	—	—	—
1943	8	0.01	19	0.11	33	0.68	46	1.9	52	2.9	—	—
1944	9	0.01	22	0.18	33	0.68	46	1.9	48	2.2	56	3.8
1945	8	0.01	20	0.13	34	0.76	43	1.6	52	2.8	52	2.8
1946	8	0.01	20	0.13	33	0.68	43	1.6	53	3.1	56	3.8
1947	8	0.01	19	0.11	33	0.68	43	1.6	50	2.6	60	4.7
1948	8	0.01	19	0.11	30	0.49	43	1.6	50	2.6	58	4.1
1949	7	0.00	19	0.11	31	0.55	40	1.2	53	3.1	58	4.1
1950	8	0.01	18	0.09	31	0.55	40	1.2	48	2.2	61	5.0
1951	8	0.01	19	0.11	31	0.55	43	1.6	48	2.2	55	3.6
1952	8	0.01	20	0.13	33	0.68	42	1.5	53	3.1	56	3.8
1953	8	0.01	18	0.09	32	0.61	42	1.5	52	2.8	63	5.4
1954	8	0.01	19	0.11	32	0.61	43	1.6	52	2.8	61	5.0
1955	8	0.01	20	0.13	32	0.61	42	1.5	53	3.1	61	5.0
1956	7	0.00	20	0.13	31	0.55	43	1.6	52	2.9	61	5.0
1957	7	0.00	18	0.09	31	0.55	40	1.2	53	3.1	60	4.7
1958	9	0.01	19	0.11	31	0.55	42	1.5	52	2.8	61	5.0
1959	10	0.01	22	0.18	33	0.68	44	1.8	54	3.3	61	5.0
1960	10	0.01	21	0.15	34	0.76	44	1.8	55	3.6	63	5.4
1961	—	—	25	0.27	37	0.93	46	1.9	54	3.3	65	6.1
1962	—	—	—	—	43	1.6	49	2.4	58	4.1	63	5.4
1963	—	—	—	—	—	—	53	3.1	56	3.8	68	6.9
1964	—	—	—	—	—	—	—	—	61	5.0	64	5.7

Year	Age: 7		8		9		10		11		12	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1939	—	—	—	—	—	—	—	—	—	—	—	—
1940	—	—	—	—	—	—	—	—	—	—	—	—
1941	—	—	—	—	—	—	—	—	—	—	—	—
1942	—	—	—	—	—	—	—	—	—	—	—	—
1943	—	—	—	—	—	—	—	—	—	—	—	—
1944	—	—	—	—	—	—	—	—	—	—	—	—
1945	63	5.4	—	—	—	—	—	—	—	—	—	—
1946	69	7.3	70	7.8	—	—	—	—	—	—	—	—
1947	61	5.0	61	5.0	77	10.4	—	—	—	—	—	—
1948	69	7.3	68	6.9	65	6.1	82	12.9	—	—	—	—
1949	65	6.1	77	10.4	72	8.3	69	7.3	86	15.1	—	—
1950	67	6.5	73	8.8	85	14.3	77	10.4	74	9.3	93	19.3
1951	69	7.3	73	8.8	80	11.6	93	19.3	82	12.9	78	11.0
1952	64	5.7	78	11.0	80	11.6	85	14.3	100	24.4	88	15.9
1953	63	5.4	70	7.8	86	15.1	86	15.1	92	18.4	107	30.5
1954	72	8.3	69	7.3	78	11.0	96	21.2	93	19.3	99	23.3
1955	69	7.3	80	11.6	77	10.4	86	15.1	104	27.9	100	24.4
1956	70	7.8	78	11.0	86	15.1	84	13.6	93	19.3	109	31.8
1957	70	7.8	78	11.0	85	14.3	93	19.3	90	17.5	102	25.6
1958	69	7.3	78	11.0	85	14.3	92	18.4	100	24.4	97	22.3
1959	72	8.3	78	11.0	88	15.9	95	20.3	102	25.6	107	30.5
1960	69	7.3	80	11.6	86	15.1	96	21.2	104	27.9	112	34.6
1961	72	8.3	78	11.0	88	15.9	88	15.9	104	27.9	110	33.2
1962	73	8.8	80	11.6	86	15.1	96	21.2	95	20.3	107	30.5
1963	72	8.3	81	12.2	90	17.5	97	22.3	104	27.9	102	25.6
1964	72	8.3	77	10.4	90	17.5	99	23.3	107	30.5	110	33.2

Table 5.—(continued)

Inside Southeastern Alaska Grounds

Year	Age:	13		14		15		16		17		18	
		cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1939		—	—	—	—	—	—	—	—	—	—	—	—
1940		—	—	—	—	—	—	—	—	—	—	—	—
1941		—	—	—	—	—	—	—	—	—	—	—	—
1942		—	—	—	—	—	—	—	—	—	—	—	—
1943		—	—	—	—	—	—	—	—	—	—	—	—
1944		—	—	—	—	—	—	—	—	—	—	—	—
1945		—	—	—	—	—	—	—	—	—	—	—	—
1946		—	—	—	—	—	—	—	—	—	—	—	—
1947		—	—	—	—	—	—	—	—	—	—	—	—
1948		—	—	—	—	—	—	—	—	—	—	—	—
1949		—	—	—	—	—	—	—	—	—	—	—	—
1950		—	—	—	—	—	—	—	—	—	—	—	—
1951		100	24.4	—	—	—	—	—	—	—	—	—	—
1952		82	12.9	104	27.9	—	—	—	—	—	—	—	—
1953		93	19.3	89	16.7	110	33.2	—	—	—	—	—	—
1954		115	37.6	99	23.3	95	20.3	116	39.2	—	—	—	—
1955		106	29.2	120	44.2	106	29.2	100	24.4	120	44.2	—	—
1956		107	30.5	113	36.1	125	49.8	113	36.1	104	27.9	123	47.9
1957		116	39.2	113	36.1	119	42.5	129	55.8	119	42.5	110	33.2
1958		107	30.5	123	47.9	119	42.5	126	51.7	135	64.6	122	46.0
1959		100	24.4	115	37.6	128	53.7	118	40.8	131	57.9	148	85.5
1960		115	37.6	107	30.5	122	46.0	135	64.6	119	42.5	151	91.5
1961		120	44.2	125	49.8	113	36.1	115	37.6	135	37.6	123	47.9
1962		110	33.2	120	44.2	120	44.2	116	39.2	119	42.5	—	—
1963		110	33.2	116	39.2	128	53.7	154	97.7	110	33.2	113	36.1
1964		115	37.6	115	37.6	—	—	—	—	—	—	—	—

Year	Age:	19		20		21	
		cm.	lbs.	cm.	lbs.	cm.	lbs.
1939		—	—	—	—	—	—
1940		—	—	—	—	—	—
1941		—	—	—	—	—	—
1942		—	—	—	—	—	—
1943		—	—	—	—	—	—
1944		—	—	—	—	—	—
1945		—	—	—	—	—	—
1946		—	—	—	—	—	—
1947		—	—	—	—	—	—
1948		—	—	—	—	—	—
1949		—	—	—	—	—	—
1950		—	—	—	—	—	—
1951		—	—	—	—	—	—
1952		—	—	—	—	—	—
1953		—	—	—	—	—	—
1954		—	—	—	—	—	—
1955		—	—	—	—	—	—
1956		—	—	—	—	—	—
1957		126	51.7	—	—	—	—
1958		115	37.6	132	60.1	—	—
1959		128	53.7	119	42.5	—	—
1960		155	101.0	120	44.2	122	46.0
1961		140	71.9	—	—	123	47.9
1962		126	51.7	—	—	—	—
1963		—	—	162	114.8	—	—
1964		—	—	—	—	—	—

Table 6. Average length (cm.) and average weight (lbs.) computed from otolith radii measurements by age and year.

Portlock Grounds

Year	Age: 1		2		3		4		5		6	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1900	5	0.00	13	0.04	28	0.39	—	—	—	—	—	—
1901	5	0.00	16	0.07	22	0.18	37	0.93	—	—	—	—
1902	5	0.00	16	0.07	28	0.39	31	0.55	44	1.8	—	—
1903	6	0.00	15	0.05	28	0.39	35	0.84	42	1.5	52	2.8
1904	5	0.00	16	0.07	29	0.44	35	0.84	42	1.5	48	2.2
1905	6	0.00	13	0.04	28	0.39	39	1.1	42	1.5	47	2.1
1906	6	0.00	17	0.08	23	0.20	38	1.0	47	2.1	49	2.4
1907	7	0.00	15	0.05	29	0.44	31	0.55	47	2.1	52	2.8
1908	—	—	15	0.05	28	0.39	38	1.0	40	1.2	54	3.3
1909	6	0.00	—	—	27	0.34	38	1.0	46	1.9	48	2.2
1910	6	0.00	16	0.07	—	—	37	0.93	46	1.9	52	2.8
1911	6	0.00	16	0.07	26	0.30	—	—	46	1.9	54	3.3
1912	5	0.00	14	0.04	30	0.49	35	0.84	—	—	52	2.8
1913	5	0.00	15	0.05	25	0.27	40	1.2	44	1.8	—	—
1914	6	0.00	14	0.04	30	0.49	35	0.84	47	2.1	50	2.6
1915	7	0.00	16	0.07	26	0.30	35	0.84	43	1.6	52	2.8
1916	6	0.00	18	0.09	35	0.84	38	1.0	43	1.6	49	2.4
1917	6	0.00	15	0.05	28	0.39	30	0.49	47	2.1	50	2.6
1918	6	0.00	17	0.08	28	0.39	38	1.0	47	2.1	54	3.3
1919	5	0.00	14	0.04	29	0.44	38	1.0	46	1.9	54	3.3
1920	6	0.00	15	0.05	28	0.39	42	1.5	46	1.9	52	2.8
1921	6	0.00	14	0.04	29	0.44	38	1.0	48	2.2	52	2.8
1922	6	0.00	15	0.05	26	0.30	39	1.1	46	1.9	54	3.3
1923	6	0.00	16	0.07	28	0.39	38	1.0	47	2.1	52	2.8
1924	7	0.00	17	0.08	28	0.39	38	1.0	46	1.9	54	3.3
1925	7	0.00	17	0.08	31	0.55	40	1.2	47	2.1	54	3.3
1926	7	0.00	16	0.07	30	0.49	42	1.5	48	2.2	54	3.3
1927	8	0.01	19	0.11	31	0.55	40	1.2	50	2.6	55	3.6
1928	7	0.00	19	0.11	33	0.68	41	1.4	48	2.2	56	3.8
1929	7	0.00	17	0.08	32	0.61	41	1.4	48	2.2	55	3.6
1930	7	0.00	17	0.08	30	0.49	42	1.5	50	2.6	55	3.6
1931	6	0.00	17	0.08	31	0.55	41	1.4	50	2.6	58	4.1
1932	7	0.00	17	0.08	29	0.44	42	1.5	50	2.6	58	4.1
1933	7	0.00	18	0.09	30	0.49	41	1.4	52	2.8	58	4.1
1934	6	0.00	16	0.07	31	0.55	41	1.4	50	2.6	59	4.4
1935	7	0.00	17	0.08	29	0.44	42	1.5	49	2.4	56	3.8
1936	8	0.01	18	0.09	31	0.55	41	1.4	49	2.4	55	3.6
1937	8	0.01	19	0.11	31	0.55	42	1.5	50	2.6	56	3.8
1938	8	0.01	19	0.11	31	0.55	42	1.5	52	2.8	59	4.4
1939	8	0.01	19	0.11	30	0.49	41	1.4	50	2.6	61	5.0
1940	8	0.01	17	0.08	31	0.55	41	1.4	49	2.4	58	4.1
1941	7	0.00	19	0.11	30	0.49	42	1.5	48	2.2	58	4.1
1942	8	0.01	19	0.11	33	0.68	41	1.4	52	2.8	58	4.1
1943	8	0.01	19	0.11	32	0.61	44	1.8	52	2.8	61	5.0
1944	7	0.00	18	0.09	32	0.61	42	1.5	54	3.3	59	4.4
1945	8	0.01	18	0.09	31	0.55	42	1.5	50	2.6	63	5.4
1946	8	0.01	18	0.09	30	0.49	42	1.5	52	2.8	59	4.4
1947	7	0.00	19	0.11	30	0.49	44	1.8	52	2.8	60	4.7
1948	7	0.00	18	0.09	30	0.49	40	1.2	48	2.2	60	4.7
1949	9	0.01	19	0.11	30	0.49	40	1.2	48	2.2	56	3.8
1950	7	0.00	17	0.08	30	0.49	40	1.2	50	2.6	58	4.1
1951	7	0.00	19	0.11	33	0.68	40	1.2	50	2.6	59	4.4
1952	8	0.01	20	0.13	33	0.68	43	1.6	50	2.6	60	4.7
1953	8	0.01	19	0.11	33	0.68	43	1.6	55	3.6	59	4.4
1954	8	0.01	20	0.13	32	0.61	44	1.8	53	3.1	65	6.1
1955	8	0.01	20	0.13	32	0.61	42	1.5	55	3.6	64	5.7
1956	8	0.01	20	0.13	31	0.55	42	1.5	53	3.1	65	6.1
1957	8	0.01	17	0.08	30	0.49	41	1.4	52	2.8	63	5.4
1958	9	0.01	19	0.11	35	0.84	42	1.5	52	2.8	63	5.4
1959	8	0.01	23	0.20	31	0.55	43	1.6	55	3.6	65	6.1
1960	—	—	—	—	34	0.76	43	1.6	55	3.6	65	6.1
1961	—	—	—	—	33	0.68	47	2.1	58	4.1	65	6.1
1962	—	—	—	—	—	—	49	2.4	59	4.4	70	7.8
1963	—	—	—	—	—	—	—	—	67	6.5	70	7.8
1964	—	—	—	—	—	—	—	—	—	—	78	11.0

Table 6.—(continued)

Portlock Grounds

Year	Age: 7		8		9		10		11		12	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1900	—	—	—	—	—	—	—	—	—	—	—	—
1901	—	—	—	—	—	—	—	—	—	—	—	—
1902	—	—	—	—	—	—	—	—	—	—	—	—
1903	—	—	—	—	—	—	—	—	—	—	—	—
1904	56	3.8	—	—	—	—	—	—	—	—	—	—
1905	54	3.3	63	5.4	—	—	—	—	—	—	—	—
1906	53	3.1	58	4.1	68	6.9	—	—	—	—	—	—
1907	54	3.3	67	6.5	63	5.4	72	8.3	—	—	—	—
1908	56	3.8	60	4.7	68	6.9	68	6.9	76	9.8	—	—
1909	59	4.4	61	5.0	64	5.7	65	6.1	72	8.3	80	11.6
1910	54	3.3	65	6.1	67	6.5	70	7.8	70	7.8	77	10.4
1911	58	4.1	59	4.4	70	7.8	70	7.8	74	9.3	74	9.3
1912	61	5.0	63	5.4	64	5.7	76	9.8	74	9.3	80	11.6
1913	56	3.8	68	6.9	68	6.9	69	7.3	81	12.2	80	11.6
1914	—	—	61	5.0	73	8.8	73	8.8	74	9.3	85	14.3
1915	55	3.6	—	—	59	4.4	—	—	—	—	—	—
1916	56	3.8	60	4.7	—	—	63	5.4	—	—	—	—
1917	54	3.3	61	5.0	64	5.7	—	—	67	6.5	—	—
1918	56	3.8	60	4.7	65	6.1	68	6.9	—	—	69	7.3
1919	60	4.7	61	5.0	65	6.1	70	7.8	72	8.3	—	—
1920	60	4.7	65	6.1	67	6.5	70	7.8	74	9.3	74	9.3
1921	56	3.8	65	6.1	70	7.8	72	8.3	74	9.3	77	10.4
1922	58	4.1	63	5.4	70	7.8	73	8.8	76	9.8	80	11.6
1923	60	4.7	63	5.4	69	7.3	77	10.4	80	11.6	82	12.9
1924	58	4.1	65	6.1	68	6.9	76	9.8	82	12.9	85	14.3
1925	60	4.7	63	5.4	70	7.8	73	8.8	82	12.9	88	15.9
1926	60	4.7	65	6.1	69	7.3	76	9.8	78	11.0	88	15.9
1927	60	4.7	67	6.5	72	8.3	74	9.3	81	12.2	85	14.3
1928	59	4.4	64	5.7	68	6.9	72	8.3	—	—	77	10.4
1929	63	5.4	65	6.1	69	7.3	72	8.3	77	10.4	—	—
1930	61	5.0	69	7.3	72	8.3	74	9.3	76	9.8	82	12.9
1931	61	5.0	68	6.9	76	9.8	77	10.4	80	11.6	80	11.6
1932	64	5.7	68	6.9	74	9.3	82	12.9	82	12.9	85	14.3
1933	64	5.7	72	8.3	74	9.3	82	12.9	88	15.9	89	16.7
1934	65	6.1	70	7.8	77	10.4	81	12.2	88	15.9	95	20.3
1935	65	6.1	72	8.3	77	10.4	84	13.6	86	15.1	93	19.3
1936	64	5.7	72	8.3	78	11.0	82	12.9	89	16.7	88	15.9
1937	63	5.4	69	7.3	78	11.0	84	13.6	89	16.7	96	21.2
1938	64	5.7	69	7.3	80	11.6	85	14.3	88	15.9	96	21.2
1939	68	6.9	72	8.3	77	10.4	82	12.9	90	17.5	93	19.3
1940	70	7.8	74	9.3	77	10.4	82	12.9	88	15.9	96	21.2
1941	67	6.5	77	10.4	80	11.6	84	13.6	86	15.1	95	20.3
1942	65	6.1	73	8.8	82	12.9	86	15.1	90	17.5	90	17.5
1943	67	6.5	73	8.8	78	11.0	92	18.4	89	16.7	102	25.6
1944	69	7.3	74	9.3	80	11.6	85	14.3	97	22.3	95	20.3
1945	68	6.9	74	9.3	80	11.6	85	14.3	90	17.5	104	27.9
1946	72	8.3	76	9.8	85	14.3	88	15.9	92	18.4	99	23.3
1947	68	6.9	80	11.6	82	12.9	92	18.4	95	20.3	97	22.3
1948	68	6.9	76	9.8	86	15.1	90	17.5	99	23.3	102	25.6
1949	68	6.9	76	9.8	82	12.9	93	19.3	97	22.3	106	29.2
1950	63	5.4	74	9.3	82	12.9	88	15.9	99	23.3	99	23.3
1951	67	6.5	72	8.3	84	13.6	89	16.7	95	20.3	106	29.2
1952	69	7.3	76	9.8	81	12.2	92	18.4	96	21.2	99	23.3
1953	70	7.8	78	11.0	85	14.3	88	15.9	97	22.3	104	27.9
1954	69	7.3	80	11.6	86	15.1	92	18.4	96	21.2	107	30.5
1955	76	9.8	80	11.6	90	17.5	95	20.3	99	23.3	104	27.9
1956	74	9.3	86	15.1	89	16.7	99	23.3	102	25.6	106	29.2
1957	74	9.3	85	14.3	96	21.2	97	22.3	107	30.5	110	33.2
1958	73	8.8	84	13.6	93	19.3	104	27.9	107	30.5	116	39.2
1959	74	9.3	84	13.6	93	19.3	102	25.6	112	34.7	113	36.1
1960	77	10.4	86	15.1	93	19.3	104	27.9	110	33.2	119	42.5
1961	78	11.0	86	15.1	96	21.2	100	24.4	109	31.8	118	40.8
1962	76	9.8	85	14.3	96	21.2	102	25.6	107	30.5	115	37.6
1963	81	12.2	81	12.2	89	16.7	97	22.3	107	30.5	112	34.6
1964	80	11.6	89	16.7	90	17.5	92	18.4	104	27.9	118	40.8

Table 6.—(continued)

Portlock Grounds

Year	Age:	13		14		15		16		17		18	
		cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1900		—	—	—	—	—	—	—	—	—	—	—	—
1901		—	—	—	—	—	—	—	—	—	—	—	—
1902		—	—	—	—	—	—	—	—	—	—	—	—
1903		—	—	—	—	—	—	—	—	—	—	—	—
1904		—	—	—	—	—	—	—	—	—	—	—	—
1905		—	—	—	—	—	—	—	—	—	—	—	—
1906		—	—	—	—	—	—	—	—	—	—	—	—
1907		—	—	—	—	—	—	—	—	—	—	—	—
1908		—	—	—	—	—	—	—	—	—	—	—	—
1909		—	—	—	—	—	—	—	—	—	—	—	—
1910		82	12.9	—	—	—	—	—	—	—	—	—	—
1911		81	12.2	88	15.9	—	—	—	—	—	—	—	—
1912		78	11.0	86	15.1	92	18.4	—	—	—	—	—	—
1913		85	14.3	82	12.9	89	16.7	95	20.3	—	—	—	—
1914		82	12.9	89	16.7	85	14.3	95	20.3	100	24.4	—	—
1915		—	—	—	—	—	—	—	—	—	—	—	—
1916		—	—	—	—	—	—	—	—	—	—	—	—
1917		—	—	—	—	—	—	—	—	—	—	—	—
1918		—	—	—	—	—	—	—	—	—	—	—	—
1919		73	8.8	—	—	—	—	—	—	—	—	—	—
1920		—	—	76	9.8	—	—	—	—	—	—	—	—
1921		78	11.0	—	—	80	11.6	—	—	—	—	—	—
1922		81	12.2	82	12.9	—	—	82	12.9	—	—	—	—
1923		85	14.3	84	13.6	86	15.1	—	—	85	14.3	—	—
1924		88	15.9	89	16.7	88	15.9	89	16.7	—	—	86	15.1
1925		89	16.7	92	18.4	93	19.3	92	18.4	93	19.3	—	—
1926		93	19.3	93	19.3	97	22.3	99	23.3	95	20.3	97	22.3
1927		95	20.3	97	22.3	97	22.3	102	25.6	104	27.9	99	23.3
1928		81	12.2	—	—	—	—	—	—	—	—	—	—
1929		81	12.2	86	15.1	—	—	—	—	—	—	—	—
1930		—	—	85	14.3	92	18.4	—	—	—	—	—	—
1931		86	15.1	—	—	88	15.9	96	21.2	104	27.9	—	—
1932		85	14.3	90	17.5	—	—	93	19.3	96	21.2	—	—
1933		90	17.5	89	16.7	96	21.2	—	—	—	—	104	27.9
1934		95	20.3	96	21.2	93	19.3	100	24.4	—	—	99	23.3
1935		100	24.4	99	23.3	102	25.6	99	23.3	104	27.9	—	—
1936		99	23.3	104	27.9	104	27.9	109	31.8	93	19.3	110	33.2
1937		97	22.3	107	30.5	116	39.2	109	31.8	126	51.7	—	—
1938		100	24.4	100	24.4	107	30.5	123	47.9	120	44.2	—	—
1939		99	23.3	107	30.5	104	27.9	109	31.8	129	55.8	123	47.9
1940		97	22.3	100	24.4	110	33.2	104	27.9	—	—	—	—
1941		104	27.9	104	27.9	104	27.9	115	37.6	107	30.5	—	—
1942		100	24.4	104	27.9	100	24.4	96	21.2	112	34.6	—	—
1943		99	23.3	116	29.2	120	44.2	107	30.5	—	—	143	77.2
1944		109	31.8	104	27.9	123	47.9	125	49.8	125	49.8	—	—
1945		96	21.2	126	51.7	85	14.3	—	—	—	—	—	—
1946		112	34.6	100	24.4	132	60.1	90	17.5	—	—	—	—
1947		104	27.9	118	40.8	106	29.2	138	69.4	93	19.3	—	—
1948		104	27.9	110	33.2	122	46.0	112	34.6	144	79.9	104	27.9
1949		109	31.8	110	33.2	118	40.8	126	51.7	118	40.8	151	91.5
1950		106	29.2	109	31.8	106	29.2	123	47.9	120	44.2	—	—
1951		109	31.8	107	30.5	113	36.1	110	33.2	128	53.7	126	51.7
1952		113	36.1	104	27.9	110	33.2	116	39.2	110	33.2	—	—
1953		104	27.9	109	31.8	109	31.8	115	37.6	123	47.9	118	40.8
1954		110	33.2	112	34.6	110	33.2	116	39.2	119	42.5	131	57.9
1955		113	36.1	110	33.2	113	36.1	120	44.2	113	36.1	126	51.7
1956		110	33.2	120	44.2	125	49.8	122	46.0	118	40.8	125	49.8
1957		115	37.6	109	31.8	129	55.8	129	55.8	132	60.1	135	64.6
1958		118	40.8	120	44.2	128	53.7	132	60.1	137	67.0	119	42.5
1959		122	46.0	120	44.2	123	47.9	132	60.1	138	69.4	148	85.5
1960		118	40.8	129	55.8	125	49.8	125	49.8	140	71.9	143	77.2
1961		125	49.8	123	47.9	131	57.9	128	53.7	125	49.8	140	71.9
1962		123	47.9	129	55.8	138	69.4	126	51.7	129	55.8	129	55.8
1963		119	42.5	131	57.9	126	51.7	135	64.6	131	57.9	144	79.9
1964		106	29.2	113	36.1	131	57.9	—	—	—	—	107	30.5

Table 6.—(continued)

Portlock Grounds

Year	Age: 19		20		21		22	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1900	—	—	—	—	—	—	—	—
1901	—	—	—	—	—	—	—	—
1902	—	—	—	—	—	—	—	—
1903	—	—	—	—	—	—	—	—
1904	—	—	—	—	—	—	—	—
1905	—	—	—	—	—	—	—	—
1906	—	—	—	—	—	—	—	—
1907	—	—	—	—	—	—	—	—
1908	—	—	—	—	—	—	—	—
1909	—	—	—	—	—	—	—	—
1910	—	—	—	—	—	—	—	—
1911	—	—	—	—	—	—	—	—
1912	—	—	—	—	—	—	—	—
1913	—	—	—	—	—	—	—	—
1914	—	—	—	—	—	—	—	—
1915	—	—	—	—	—	—	—	—
1916	—	—	—	—	—	—	—	—
1917	—	—	—	—	—	—	—	—
1918	—	—	—	—	—	—	—	—
1919	—	—	—	—	—	—	—	—
1920	—	—	—	—	—	—	—	—
1921	—	—	—	—	—	—	—	—
1922	—	—	—	—	—	—	—	—
1923	—	—	—	—	—	—	—	—
1924	—	—	—	—	—	—	—	—
1925	90	17.5	—	—	—	—	—	—
1926	—	—	93	19.3	—	—	—	—
1927	102	25.6	—	—	96	21.2	—	—
1928	—	—	—	—	—	—	—	—
1929	—	—	—	—	—	—	—	—
1930	—	—	—	—	—	—	—	—
1931	—	—	—	—	—	—	—	—
1932	—	—	—	—	—	—	—	—
1933	—	—	—	—	—	—	—	—
1934	112	34.6	—	—	—	—	—	—
1935	102	25.6	115	37.6	—	—	—	—
1936	—	—	104	27.9	122	46.0	—	—
1937	—	—	—	—	—	—	—	—
1938	—	—	—	—	—	—	—	—
1939	—	—	—	—	—	—	—	—
1940	129	55.8	—	—	—	—	—	—
1941	—	—	135	64.6	—	—	—	—
1942	—	—	—	—	—	—	—	—
1943	—	—	—	—	—	—	—	—
1944	—	—	—	—	—	—	—	—
1945	—	—	—	—	—	—	—	—
1946	—	—	—	—	—	—	—	—
1947	—	—	—	—	—	—	—	—
1948	—	—	—	—	—	—	—	—
1949	104	27.9	—	—	—	—	—	—
1950	—	—	—	—	—	—	—	—
1951	—	—	—	—	—	—	—	—
1952	113	36.1	—	—	—	—	—	—
1953	—	—	—	—	—	—	—	—
1954	118	40.8	—	—	—	—	—	—
1955	140	71.9	125	49.8	—	—	—	—
1956	131	57.9	135	64.6	—	—	—	—
1957	128	53.7	131	57.9	—	—	—	—
1958	—	—	—	—	—	—	—	—
1959	125	49.8	—	—	—	—	—	—
1960	149	88.4	132	60.1	—	—	—	—
1961	107	30.5	154	97.7	138	69.4	—	—
1962	135	64.6	110	33.2	148	85.5	146	82.6
1963	135	64.6	140	71.9	—	—	144	79.9
1964	170	134.1	119	42.5	—	—	—	—

Table 7. Average length (cm.) and average weight (lbs.) computed from otolith radii measurements by age and year.

Shumagin Islands Grounds

Year	Age: 1		2		3		4		5		6	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1935	7	0.00	—	—	—	—	—	—	—	—	—	—
1936	8	0.00	18	0.09	—	—	—	—	—	—	—	—
1937	8	0.00	18	0.09	31	0.55	—	—	—	—	—	—
1938	8	0.00	22	0.18	31	0.55	38	1.0	—	—	—	—
1939	8	0.00	19	0.11	35	0.84	41	1.4	47	2.1	—	—
1940	7	0.00	18	0.09	32	0.61	45	1.8	48	2.2	52	2.8
1941	8	0.00	21	0.15	34	0.76	42	1.5	53	3.1	54	3.3
1942	8	0.00	21	0.15	32	0.61	46	1.9	50	2.6	61	5.0
1943	8	0.00	21	0.15	33	0.68	42	1.5	54	3.3	58	4.1
1944	8	0.00	18	0.09	32	0.61	42	1.5	50	2.6	60	4.7
1945	8	0.00	19	0.11	31	0.55	42	1.5	52	2.8	60	4.7
1946	8	0.00	19	0.11	32	0.61	42	1.5	52	2.8	61	5.0
1947	7	0.00	19	0.11	31	0.55	42	1.5	52	2.8	59	4.4
1948	7	0.00	17	0.08	31	0.55	41	1.4	52	2.8	60	4.7
1949	7	0.00	18	0.09	29	0.44	41	1.4	49	2.4	59	4.4
1950	7	0.00	19	0.11	31	0.55	40	1.2	50	2.6	58	4.1
1951	7	0.00	20	0.13	32	0.61	42	1.5	50	2.6	60	4.7
1952	8	0.00	20	0.13	33	0.68	43	1.6	53	3.1	60	4.7
1953	7	0.00	19	0.11	33	0.68	45	1.8	54	3.3	63	5.4
1954	8	0.00	19	0.11	33	0.68	45	1.8	55	3.6	64	5.7
1955	8	0.00	21	0.15	32	0.61	45	1.8	54	3.3	67	6.5
1956	7	0.00	18	0.09	31	0.55	42	1.5	55	3.6	64	5.7
1957	8	0.00	17	0.08	29	0.44	41	1.4	53	3.1	64	5.7
1958	10	0.01	21	0.15	32	0.61	39	1.1	52	2.8	63	5.4
1959	—	—	25	0.27	34	0.76	45	1.8	52	2.8	64	5.7
1960	—	—	—	—	39	1.1	47	2.1	57	3.8	63	5.4
1961	—	—	—	—	—	—	54	3.3	59	4.4	67	6.5
1962	—	—	—	—	—	—	—	—	68	6.9	70	7.8
1963	—	—	—	—	—	—	—	—	—	—	81	12.2
1964	—	—	—	—	—	—	—	—	—	—	—	—

Year	Age: 7		8		9		10		11		12	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1935	—	—	—	—	—	—	—	—	—	—	—	—
1936	—	—	—	—	—	—	—	—	—	—	—	—
1937	—	—	—	—	—	—	—	—	—	—	—	—
1938	—	—	—	—	—	—	—	—	—	—	—	—
1939	—	—	—	—	—	—	—	—	—	—	—	—
1940	—	—	—	—	—	—	—	—	—	—	—	—
1941	58	4.1	—	—	—	—	—	—	—	—	—	—
1942	60	4.7	64	5.7	—	—	—	—	—	—	—	—
1943	68	6.9	67	6.5	69	7.3	—	—	—	—	—	—
1944	64	5.7	74	9.3	74	9.3	74	9.3	—	—	—	—
1945	67	6.5	72	8.3	81	12.2	80	11.6	82	12.9	—	—
1946	67	6.5	73	8.8	77	10.4	86	15.1	86	15.1	93	24.4
1947	68	6.9	74	9.3	78	11.0	84	13.6	92	18.4	93	24.4
1948	67	6.5	76	9.8	81	12.2	85	14.3	89	16.7	96	21.2
1949	69	7.3	73	8.8	82	12.9	88	15.9	92	18.4	96	21.2
1950	68	6.9	77	10.4	81	12.2	90	17.5	95	20.3	99	23.3
1951	67	6.5	77	10.4	85	14.3	89	16.7	99	23.3	102	25.6
1952	69	7.3	77	10.4	85	14.3	93	24.4	96	21.2	104	27.9
1953	70	7.8	80	11.6	86	15.1	95	20.3	102	25.6	104	27.9
1954	74	9.3	81	12.2	89	16.7	95	20.3	103	26.7	110	33.2
1955	74	9.3	84	13.6	90	17.5	97	22.3	104	27.9	109	31.8
1956	77	10.4	85	14.3	96	21.2	100	24.4	104	27.9	109	31.8
1957	73	8.8	85	14.3	90	17.5	100	24.4	104	27.9	110	33.2
1958	74	9.3	81	12.2	92	18.4	97	22.3	109	31.8	110	33.2
1959	74	9.3	84	13.6	89	16.7	99	23.3	106	29.2	109	31.8
1960	74	9.3	84	13.6	92	18.4	96	21.2	106	29.2	110	33.2
1961	73	8.8	85	14.3	92	18.4	99	23.3	104	27.9	110	33.2
1962	76	9.8	82	12.9	93	24.4	99	23.3	106	29.2	110	33.2
1963	80	11.6	82	12.9	89	16.7	97	22.3	107	30.5	109	31.8
1964	93	24.4	88	15.9	92	18.4	99	23.3	103	26.7	110	33.2

Table 7.—(continued)

Shumagin Islands Grounds

Year	Age:	13		14		15		16		17		18	
		cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1935		—	—	—	—	—	—	—	—	—	—	—	—
1936		—	—	—	—	—	—	—	—	—	—	—	—
1937		—	—	—	—	—	—	—	—	—	—	—	—
1938		—	—	—	—	—	—	—	—	—	—	—	—
1939		—	—	—	—	—	—	—	—	—	—	—	—
1940		—	—	—	—	—	—	—	—	—	—	—	—
1941		—	—	—	—	—	—	—	—	—	—	—	—
1942		—	—	—	—	—	—	—	—	—	—	—	—
1943		—	—	—	—	—	—	—	—	—	—	—	—
1944		—	—	—	—	—	—	—	—	—	—	—	—
1945		—	—	—	—	—	—	—	—	—	—	—	—
1946		—	—	—	—	—	—	—	—	—	—	—	—
1947		99	23.3	—	—	—	—	—	—	—	—	—	—
1948		100	24.4	107	30.5	—	—	—	—	—	—	—	—
1949		102	25.6	104	27.9	113	36.1	—	—	—	—	—	—
1950		102	25.6	107	30.5	112	34.6	122	46.0	—	—	—	—
1951		104	27.9	107	30.5	110	33.2	119	42.5	131	57.9	—	—
1952		109	31.8	112	34.6	113	36.1	116	39.2	128	53.7	135	64.6
1953		113	36.1	116	39.2	119	42.5	119	42.5	123	47.9	132	60.1
1954		112	34.6	120	44.2	122	46.0	125	49.8	125	49.8	129	55.8
1955		119	42.5	119	42.5	129	55.8	131	57.9	135	64.6	131	57.9
1956		115	37.6	122	46.0	119	42.5	134	62.3	138	69.4	134	62.8
1957		115	37.6	120	44.2	126	51.7	125	49.8	135	64.6	146	82.6
1958		115	37.6	120	44.2	125	49.8	135	64.6	128	53.7	120	44.2
1959		115	37.6	120	44.2	126	51.7	134	62.3	141	74.5	137	67.0
1960		123	47.9	118	40.8	128	53.7	128	53.7	143	77.2	146	82.6
1961		115	37.6	134	62.3	119	42.5	135	64.6	138	69.4	154	97.7
1962		118	40.8	119	42.5	137	67.0	128	53.7	129	55.8	155	101.0
1963		118	40.8	125	49.8	119	42.5	146	82.6	134	62.3	140	71.9
1964		112	34.6	129	55.8	126	51.7	115	37.6	162	114.8	—	—

Year	Age:	19		20		21		22		23		24	
		cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1935		—	—	—	—	—	—	—	—	—	—	—	—
1936		—	—	—	—	—	—	—	—	—	—	—	—
1937		—	—	—	—	—	—	—	—	—	—	—	—
1938		—	—	—	—	—	—	—	—	—	—	—	—
1939		—	—	—	—	—	—	—	—	—	—	—	—
1940		—	—	—	—	—	—	—	—	—	—	—	—
1941		—	—	—	—	—	—	—	—	—	—	—	—
1942		—	—	—	—	—	—	—	—	—	—	—	—
1943		—	—	—	—	—	—	—	—	—	—	—	—
1944		—	—	—	—	—	—	—	—	—	—	—	—
1945		—	—	—	—	—	—	—	—	—	—	—	—
1946		—	—	—	—	—	—	—	—	—	—	—	—
1947		—	—	—	—	—	—	—	—	—	—	—	—
1948		—	—	—	—	—	—	—	—	—	—	—	—
1949		—	—	—	—	—	—	—	—	—	—	—	—
1950		—	—	—	—	—	—	—	—	—	—	—	—
1951		—	—	—	—	—	—	—	—	—	—	—	—
1952		—	—	—	—	—	—	—	—	—	—	—	—
1953		141	74.5	—	—	—	—	—	—	—	—	—	—
1954		137	67.0	146	82.6	—	—	—	—	—	—	—	—
1955		143	77.2	144	79.9	152	94.6	—	—	—	—	—	—
1956		134	62.3	—	—	—	—	—	—	—	—	—	—
1957		—	—	138	69.4	—	—	—	—	—	—	—	—
1958		146	82.6	—	—	—	—	—	—	—	—	—	—
1959		128	53.7	143	77.2	—	—	—	—	—	—	—	—
1960		151	91.5	135	64.6	134	62.3	—	—	—	—	—	—
1961		134	62.3	154	97.7	140	71.9	—	—	—	—	—	—
1962		144	80.0	141	74.5	—	—	146	82.6	—	—	—	—
1963		163	118.5	148	174.9	—	—	—	—	149	88.4	—	—
1964		144	79.9	—	—	—	—	—	—	—	—	154	97.7

Table 8. Average length (cm.) and average weight (lbs.) computed from otolith radii measurements by age and year.

Polaris Grounds

Year	Age:	1		2		3		4		5		6	
		cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1937		8	0.01	—	—	—	—	—	—	—	—	—	—
1938		7	0.00	24	0.23	—	—	—	—	—	—	—	—
1939		8	0.01	18	0.09	38	1.0	—	—	—	—	—	—
1940		7	0.00	17	0.08	31	0.55	47	2.1	—	—	—	—
1941		7	0.00	16	0.07	30	0.49	42	1.5	53	3.1	—	—
1942		8	0.01	16	0.07	28	0.39	40	1.2	50	2.6	60	4.7
1943		8	0.01	20	0.13	29	0.44	40	1.2	50	2.6	57	3.8
1944		7	0.00	18	0.09	31	0.55	39	1.1	49	1.6	59	4.4
1945		8	0.01	17	0.08	30	0.49	41	1.4	48	1.5	57	3.8
1946		7	0.00	19	0.11	29	0.44	40	1.2	49	1.6	55	3.6
1947		7	0.00	16	0.07	31	0.55	40	1.2	49	1.6	57	3.8
1948		7	0.00	17	0.08	29	0.44	41	1.4	48	1.5	57	3.8
1949		7	0.00	16	0.07	30	0.49	39	1.1	49	1.6	57	3.8
1950		7	0.00	18	0.09	30	0.49	40	1.2	49	1.6	57	3.8
1951		7	0.00	19	0.11	33	0.68	41	1.4	52	2.8	59	4.4
1952		8	0.01	21	0.15	35	0.84	46	1.9	52	2.8	61	5.0
1953		7	0.00	19	0.11	33	0.68	46	1.9	57	3.8	61	5.0
1954		8	0.01	19	0.11	32	0.61	45	1.8	57	3.8	67	6.5
1955		8	0.01	20	0.13	32	0.61	41	1.4	57	3.8	67	6.5
1956		7	0.00	19	0.11	31	0.55	42	1.5	53	3.1	65	6.1
1957		7	0.00	17	0.08	28	0.39	40	1.2	52	2.8	61	5.0
1958		8	0.01	20	0.13	32	0.61	40	1.2	52	2.8	63	5.4
1959		9	0.01	22	0.18	35	0.84	46	1.9	54	3.3	64	5.7
1960		—	—	20	0.13	35	0.84	47	2.1	58	4.1	65	6.1
1961		—	—	—	—	32	0.61	48	1.5	58	4.1	67	6.5
1962		—	—	—	—	—	—	43	1.6	60	4.7	69	7.3
1963		—	—	—	—	—	—	—	—	59	4.4	72	8.3
1964		—	—	—	—	—	—	—	—	—	—	72	8.3

Year	Age:	7		8		9		10		11		12	
		cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1937		—	—	—	—	—	—	—	—	—	—	—	—
1938		—	—	—	—	—	—	—	—	—	—	—	—
1939		—	—	—	—	—	—	—	—	—	—	—	—
1940		—	—	—	—	—	—	—	—	—	—	—	—
1941		—	—	—	—	—	—	—	—	—	—	—	—
1942		—	—	—	—	—	—	—	—	—	—	—	—
1943		68	6.9	—	—	—	—	—	—	—	—	—	—
1944		64	5.7	77	10.4	—	—	—	—	—	—	—	—
1945		68	6.9	72	8.3	84	13.6	—	—	—	—	—	—
1946		64	5.7	76	9.8	77	10.4	89	16.7	—	—	—	—
1947		64	5.7	72	8.3	84	13.6	82	12.9	95	20.3	—	—
1948		64	5.7	72	8.3	77	10.4	92	18.4	88	15.9	100	24.4
1949		64	5.7	70	7.3	78	11.0	84	13.6	99	23.3	92	18.4
1950		64	5.7	72	8.3	77	10.4	84	13.6	90	17.5	104	27.9
1951		67	6.5	72	8.3	78	11.0	82	12.9	90	17.5	96	21.2
1952		68	6.9	76	9.8	78	11.0	86	15.1	89	16.7	96	21.2
1953		70	7.3	77	10.4	84	13.6	86	15.1	93	19.3	95	20.3
1954		72	8.3	80	11.6	85	14.3	90	17.5	93	19.3	100	24.4
1955		76	9.8	81	12.2	89	16.7	93	19.3	97	22.3	100	24.4
1956		76	9.8	85	14.3	89	16.7	96	21.2	100	24.4	104	27.9
1957		74	9.3	85	14.3	93	19.3	96	21.2	104	27.9	106	29.2
1958		72	8.3	84	13.6	93	19.3	102	25.6	104	27.9	112	34.6
1959		73	8.8	82	12.9	92	18.4	99	23.3	107	30.5	109	31.8
1960		76	9.8	82	12.9	88	15.9	95	20.3	103	26.7	109	31.8
1961		73	8.8	85	14.3	89	16.7	95	20.3	100	24.4	110	33.2
1962		72	8.3	81	12.2	90	17.5	93	19.3	99	23.3	103	26.7
1963		78	11.0	84	13.6	85	14.3	96	21.2	100	24.4	100	24.4
1964		84	13.6	88	15.9	93	19.3	90	17.5	110	33.2	109	31.8

Table 8.—(continued)

Polaris Grounds

Year	Age: 13		14		15		16		17		18	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1937	—	—	—	—	—	—	—	—	—	—	—	—
1938	—	—	—	—	—	—	—	—	—	—	—	—
1939	—	—	—	—	—	—	—	—	—	—	—	—
1940	—	—	—	—	—	—	—	—	—	—	—	—
1941	—	—	—	—	—	—	—	—	—	—	—	—
1942	—	—	—	—	—	—	—	—	—	—	—	—
1943	—	—	—	—	—	—	—	—	—	—	—	—
1944	—	—	—	—	—	—	—	—	—	—	—	—
1945	—	—	—	—	—	—	—	—	—	—	—	—
1946	—	—	—	—	—	—	—	—	—	—	—	—
1947	—	—	—	—	—	—	—	—	—	—	—	—
1948	—	—	—	—	—	—	—	—	—	—	—	—
1949	107	30.5	—	—	—	—	—	—	—	—	—	—
1950	95	20.3	112	34.6	—	—	—	—	—	—	—	—
1951	110	33.2	99	23.3	115	37.6	—	—	—	—	—	—
1952	102	25.6	115	37.6	103	26.7	122	46.0	—	—	—	—
1953	102	25.6	106	29.2	120	44.2	107	30.5	125	49.8	—	—
1954	102	25.6	106	29.2	112	34.6	125	49.8	110	33.2	128	53.7
1955	106	29.2	106	29.2	112	34.6	115	37.6	131	57.9	113	36.1
1956	107	30.5	113	36.1	110	33.2	115	37.6	119	42.5	134	62.3
1957	110	33.2	112	34.6	118	40.8	115	37.6	119	42.5	122	46.0
1958	113	36.1	115	37.6	118	40.8	122	46.0	119	42.5	123	47.9
1959	113	36.1	113	36.1	119	42.5	118	40.8	126	51.7	116	39.2
1960	103	26.7	110	33.2	110	33.2	95	20.3	96	21.2	119	42.5
1961	103	26.7	115	37.6	104	27.9	122	46.0	99	23.3	106	29.2
1962	112	34.6	100	24.4	—	—	110	33.2	—	—	104	27.9
1963	100	24.4	125	49.8	118	40.8	—	—	119	42.5	—	—
1964	109	31.8	137	67.0	129	55.8	—	—	—	—	122	46.0

Year	Age: 19		20		21		22	
	cm.	lbs.	cm.	lbs.	cm.	lbs.	cm.	lbs.
1937	—	—	—	—	—	—	—	—
1938	—	—	—	—	—	—	—	—
1939	—	—	—	—	—	—	—	—
1940	—	—	—	—	—	—	—	—
1941	—	—	—	—	—	—	—	—
1942	—	—	—	—	—	—	—	—
1943	—	—	—	—	—	—	—	—
1944	—	—	—	—	—	—	—	—
1945	—	—	—	—	—	—	—	—
1946	—	—	—	—	—	—	—	—
1947	—	—	—	—	—	—	—	—
1948	—	—	—	—	—	—	—	—
1949	—	—	—	—	—	—	—	—
1950	—	—	—	—	—	—	—	—
1951	—	—	—	—	—	—	—	—
1952	—	—	—	—	—	—	—	—
1953	—	—	—	—	—	—	—	—
1954	—	—	—	—	—	—	—	—
1955	131	17.9	—	—	—	—	—	—
1956	116	39.2	134	62.3	—	—	—	—
1957	137	67.0	120	44.2	137	67.0	—	—
1958	126	51.7	140	71.9	123	47.9	140	71.9
1959	123	47.9	141	74.5	—	—	—	—
1960	104	27.9	131	57.9	141	74.5	—	—
1961	—	—	—	—	146	82.6	165	122.2
1962	—	—	—	—	—	—	—	—
1963	107	30.5	—	—	—	—	—	—
1964	—	—	—	—	—	—	—	—

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