2-4/52

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MARINE FISHERIES PROGRESS REPORT

February through April, 1952

GENERAL

On February 6 three biologists from the Oregon Cooperative Wildlife Research Unit at Corvallis spent the day at the Astoria lab in finding out about our methods of reading otoliths. They were interested in reading salmon otoliths taken from fish which had spawned in tributaries of the Umpqua River.

On February 25 George Harry and Eldon Korpela were in Newport to talk with Gordon White about shrimp explorations in the early spring.

On March 4 George Harry and Fred Cleaver were in Corvallis to interview students for summer work. George Harry also attended a meeting of the committee to arrange for the coming meeting of the American Society of Ichthyologists and Herpetologists to be held in Corvallis in June.

On March 20 George Harry went to Newport to see about getting otter trawl statistics from the fishermen when they land their catch. Final arrangements for the first shrimp exploratory trip of the summer were also made.

In March, Jergen Westrheim returned to the Astoria lab after having spent two terms at the University of Washington completing course work for a Masters degree.

During the period March 27 to March 29 the entire staff attended the Pacific Fisheries Biologists meeting at Gearhart.

OTTER TRAWL

Planning for Summer Work--1952

Considerable time was spent discussing and planning the activities for the approaching summer season. It was decided that the major emphasis would be placed on market sampling (principally for Dover sole), mink food sampling, and mesh experiments, subject to the amount of summer help available.

Statistical Analysis

During the month of April, the otter trawl statistics for Astoria landings of Dover, English, and petrale sole were compiled (for method, see MARINE FISHERIES PROGRESS REPORT---February through April, 1951). The results have been summarized in Tables 1, 2, and 3, which also include a recapitulation of the data for the years 1942 through 1947. The 1950 data are not complete as it was found that at least two boats have been omitted from the summary presumably due to a clerical error. These data will have to be checked more closely in the Portland office. Further analysis of the rockfish statistics has been deemed of little value since the fishermen have been subjected to limits on their catches for a great portion of the time since 1947.

During the period 1947 through 1949, the bottom fish markets were considerably depressed. As a result, strikes, limits, and allocation of trips produced conditions which make analysis difficult, if not impossible. The net result of the unstable economic conditions was to cause a shift of fishing effort during the "summer" (April-Sept.) period to the cheapest of the soles, i.e., Dover and turbot.

Emphasis has been placed on bringing these statistics up to date as soon as possible and consequently no time has been spent to study the results yet.

Early Life History Studies

Trips were taken to Newport on February 7, March 11, and April 1, 1952 to sample with a "try-net" the population of juvenile English sole in Yaquina Bay. The numbers of English sole in this bay large enough (about 3")

Table 1. Summary of Catch Analysis for <u>Dover Sole</u> with the Total Pounds, by Year, Landed in Oregon Jan. - Dec., in Astoria, Jan. - Dec., in Astoria April - Sept., in Astoria "Significant"; Numbers of "Significant" Landings; and Pounds per "Significant" Landing.

YEAR	TOTAL OREGON LANDINGS (Jan.-Dec.)	TOTAL ASTORIA LANDINGS (Jan.-Dec.)	TOTAL ASTORIA LANDINGS (April-Sept.)	TOTAL "SIGNIFICANT" LANDINGS (April-Sept.)	NUMBER OF "SIGNIFICANT" LANDINGS (April-Sept.)	POUNDS PER "SIGNIFICANT" LANDING
1942	3,745,236	2,100,708	1,875,064	1,304,098	82	15,904
1943	6,431,666	6,473,507	6,346,526	5,806,147	319	18,201
1944	2,019,162	1,292,155	1,111,903	955,736	70	13,653
1945	2,704,216	2,526,017	2,077,293	1,902,567	106	17,949
1946	2,984,092	2,969,746	2,953,387	2,678,838	217	12,345
1947	2,031,905	1,896,177	1,751,930	1,492,103	118	12,645
1948	2,808,264	2,628,548	2,347,823	2,145,394	159	13,493
1949	3,003,574	2,457,719	2,252,050	2,135,734	156	13,691
1950	6,348,251	3,769,553	3,656,008	3,543,392	267	13,271

Table 2. Summary of Catch Analysis for English Sole with the Total Pounds, by Year, Landed in Oregon, Jan.-Dec., in Astoria, Jan.-Dec., in Astoria April-Sept., in Astoria "Significant"; Numbers of "Significant" Landings; and Pounds per "Significant" Landing.

YEAR	TOTAL OREGON LANDINGS (Jan.-Dec.)	TOTAL ASTORIA LANDINGS (Jan.-Dec.)	TOTAL ASTORIA LANDINGS (April-Sept.)	TOTAL "SIGNIFICANT" LANDINGS (April-Sept.)	NUMBER OF "SIGNIFICANT" LANDINGS (April-Sept.)	POUNDS PER "SIGNIFICANT" LANDING
1942	227,793	126,516	86,015	4,065	2	2,033
1943	898,639	615,725	364,267	93,678	17	5,510
1944	1,057,701	744,966	499,239	122,945	41	2,999
1945	1,096,601	726,084	444,218	182,553	28	6,520
1946	3,950,609	3,015,254	2,796,694	1,834,115	256	7,165
1947	1,883,438	1,584,552	1,351,403	750,826	93	8,073
1948	3,320,869	2,227,152	1,955,812	1,443,999	138	10,464
1949	1,092,493	757,940	598,678	390,486	37	10,554
1950	2,420,639	1,714,748	1,485,964	860,215	95	9,055

Table 3. Summary of Catch Analysis for <u>Petrale Sole</u> with the Total Pounds, by Year, Landed in Oregon, Jan.-Dec., in Astoria, Jan.-Dec., in Astoria, April-Sept., in Astoria "Significant"; Numbers of "Significant" Landings; and Pounds per "Significant" Landing.

YEAR	TOTAL OREGON LANDINGS (Jan.-Dec.)	TOTAL ASTORIA LANDINGS (Jan.-Dec.)	TOTAL ASTORIA LANDINGS (April-Sept.)	TOTAL "SIGNIFICANT" LANDINGS (April-Sept.)	NUMBER OF "SIGNIFICANT" LANDINGS (April-Sept.)	POUNDS PER "SIGNIFICANT" LANDING
1942	3,745,236	1,887,334	1,620,736	1,075,332	128	8,401
1943	3,805,094	1,569,160	1,289,143	673,153	79	8,521
1944	2,019,162	1,255,934	1,167,035	460,706	64	7,199
1945	1,574,143	884,332	715,820	280,120	47	5,960
1946	2,984,092	1,720,097	1,633,663	836,403	193	4,334
1947	1,443,936	1,139,141	965,092	440,481	96	4,588
1948	2,658,550	1,452,869	1,287,692	813,133	124	6,558
1949	1,514,762	863,615	681,384	367,380	68	5,403
1950	3,175,310	1,746,020	1,568,222	1,132,200	166	6,820

to be captured by the "try-net" were probably quite low as the three trips netted only 16, 21, and 24 English sole, respectively. Numerous crabs were caught during the operations so that the net was apparently functioning properly. No length-frequency polygons were included in this report due to the paucity of new data.

Mesh Experiments

A tentative plan of action has been drawn up for the cooperative mesh experiments to be carried out this summer aboard the California Division of Fish and Game's research vessel, "Scofield". Copies of the outline have been sent to W. E. Ripley (California Div. F. & G.), A. T. Pruter (Washington Dept. of Fisheries), and F. C. Cleaver (Oregon Fish Commission) for perusal and comments.

Pacific Ocean Perch (Sebastodes alutus)

During the last six months occasional samples of ocean perch have been taken from which length, sex, condition of ovaries, and scales have been collected. Approximately 500 scales have been read (each at least three times). The consistency of the reader has been 60 percent (297 "agreements" in 494 scales). "Consistency" has been determined by comparing the results of three independent readings of each scale (by the same reader). If two or more readings are in agreement, the reading is considered as an "agreement". Sufficient data are not available at this time to test the reliability of the scale reading method.

The principal effort has been placed on mounting and reading scales. No analysis of the "age" readings or other data (length-frequency, length-weight, sex ratio, age and size at maturity, time of spawning, or fecundity) has been made.

ALBACORE

Age Determination

Scales from 206 fish collected in the 1951 season were mounted in sodium silicate and read by examination with the projection microscope. Ninety-three scale samples from the 1950 season were also mounted and read for comparison with 1951. Samples of 24 small fish (50 to 57 cm) from the 1949 season were studied to learn the age of this small group. Lastly, 42 scale samples were examined from fish taken by the researchers with the John N. Cobb on their 1950 cruise. The latter two groups of scales were mounted in glycerine jelly.

Two additional mounting media were tried. These were glycerine jelly and a toluene solution of synthetic resin. The glycerine jelly proved satisfactory for albacore scales, and possibly better than sodium silicate as the latter develops air bubbles around the larger scales as it dries. The synthetic resin made the scales opaque and therefore unreadable. The opacity was thought to result from mounting the scales wet. No attempt was made to improve upon the technique in using the synthetic resin.

The original method of counting the erosional checks was not found to be consistent with the length-frequency modal groups as expected. New York investigators (Westman, et al, 1941 and 1942) studying bluefin tuna, Thunnus thynnus, described and illustrated a method of counting bands of narrow circuli as annuli. This method was applied to the albacore scales with seemingly good results. The two methods are illustrated in Figure 1. Table 1 compares the results of reading the 1951 samples by both the erosional check or old method and the new method adopted from the New York work. By the old method three ring classes were consistently found within each modal group which is not compatible with the accepted theory that the modal groups represent age classes. Ring classes obtained by the new method

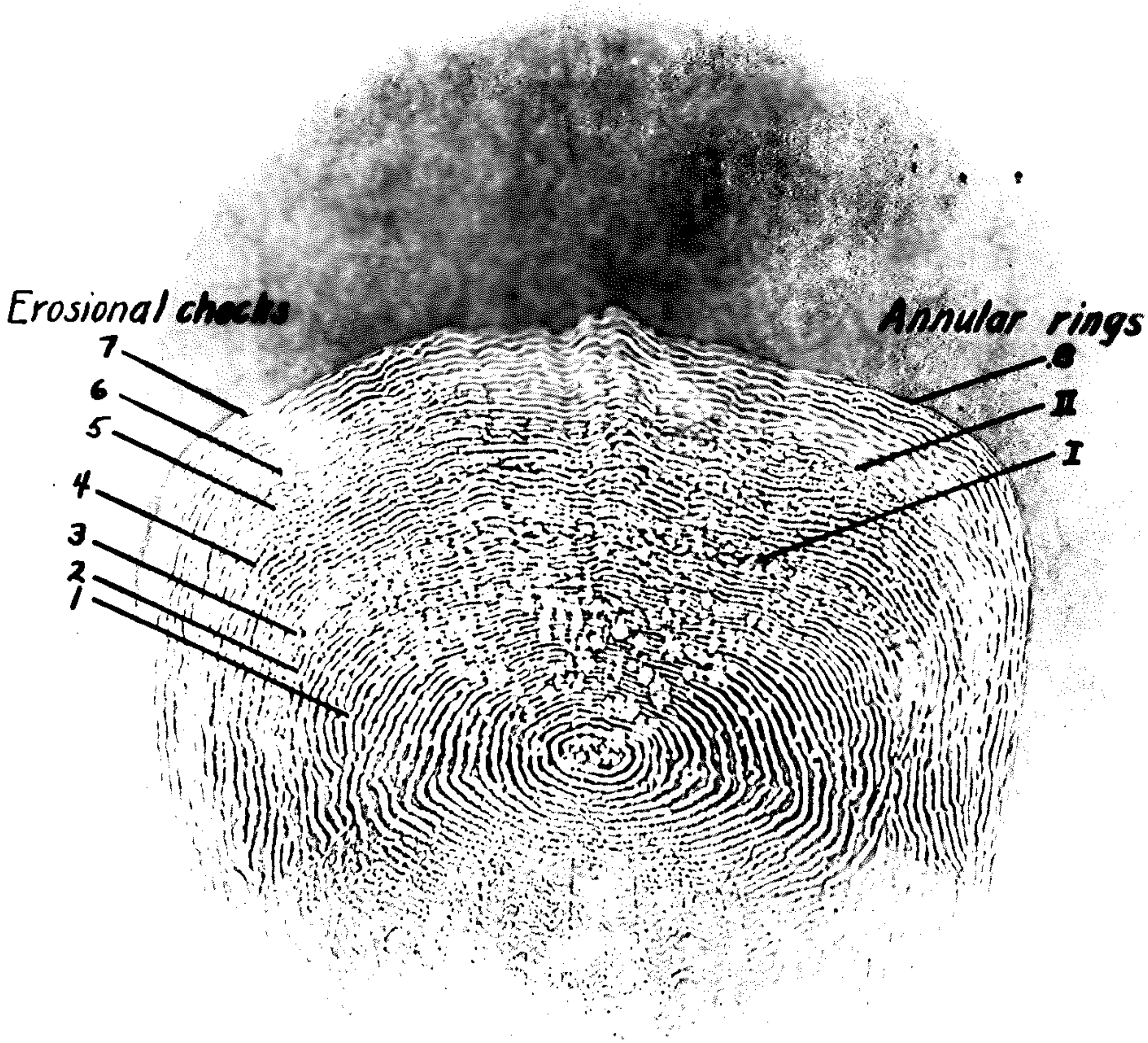


Figure 1   Negative reproduction of an albacore scale magnified 35.4 diameters with the Rayoscope, projection microscope. The fish was caught July 24, 1950 on a trolling jig off the mouth of the Columbia river. The third annular ring is forming (2.8 rings). Body length – 712 mm.

Table 1. Albacore scale readings compared to length of fish.

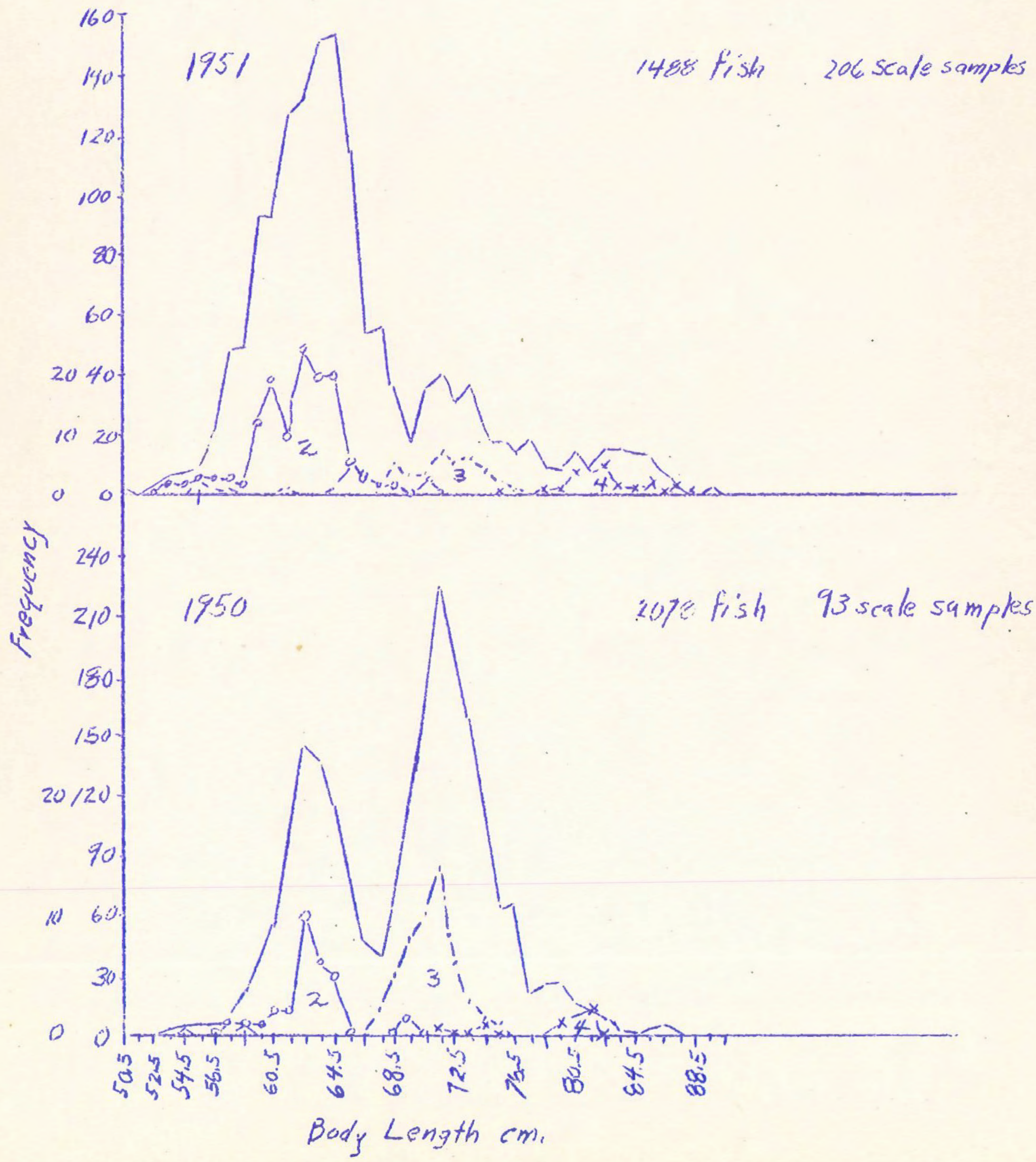
Body Length-Rings	1951 Erosional Checks Old Method						1951 Annular Rings New Method				1950 New Method			
	3	4	5	6	7	8	1	2	3	4	1	2	3	4
500-509														
510														
520														
530		3						3						
540		2						2			1			
550	2	2	1				2	3						
560	1	2						3						
570	3	1					1	3				1		
580	1		1				-	2			1	1		
590	1	8	3					12				1		
600-609		11	3					19				2		
610		7	2	2				10	1			2		
620		14	9	1				24				10		
630		4	14	2				20				6		
640		3	14	3				20	1			5		
650		1	8	2			A	6	5					
660		1	3	2				3	3					
670			2	1				2	1				2	
680		1	5	1				2	5				5	
690			1		1		-		3			3	8	
700-709		1	2	2				2	3				10	
710			2	4		1			7				14	1
720				4	2				6				6	
730			1	3	2				6				3	
740				3	1		B		4				4	2
750				2					1	1			1	
760					1				1				1	
770										1				
780				1						1				
790					1		-			4				1
800-809			1		2					3				
810					3					5				2
820				1	4					1				
830					1					1				
840				1						2				
850					2									
860										1				
870						1								
880														
890														
900-909														

conformed to the modal groups as expected. There are usually two erosional checks to each annulus, although this ratio does not always hold true. One check usually precedes the narrowly spaced circuli, and one can usually be found just outside the annular formation. The youngest fish in the fishery are one year old rather than three years old as determined by the old method. Because of the inconsistencies involved in the erosional check readings this method was discarded in favor of the new method.

Figure 2 shows the approximation of the age groups with the modal groups in the length-frequency curves. The 62 centimeter group corresponds to the 2 ring age group. The 72 centimeter group corresponds to the 3 ring age group. A scattering of 1 ring fish in the smaller (50 cm) fish and 4 ring fish around 80 centimeters were found. No zero or 5 ring scales were found in this study.

In the early season (July) most of the scales show evidence of annulus formation in the form of narrowing circuli interspace at the edge of the scale. Some scales show little or no such evidence of narrowing. A month later in the season some scales show a distinct annulus and a small increment of new growth while others appear as first described with little or no evidence of narrowing circuli. Toward the season's end, September and October, some scales show an increment of new growth of about half the amount that would be expected from that of the previous rapid growth zones. Other scales are still in the original stage of little or no annulus formation. This possibly bears out the previously observed indications that immigration occurs throughout the season, but it makes the interpretation of scales difficult, especially when the time of season that a particular fish has been taken is not known. For instance, a scale from a 62 centimeter fish at the start of the season would show one good annulus, a wide rapid growth zone and possibly a slight narrowing of circuli at the edge. Late in the season

Figure 2 Comparison of "age" classes, found by reading scales, with the modal groups of the length-frequency curves (unweighted), Albacore



the scales from the same length fish might show the same formation or two good rings with a fairly wide marginal increment of rapid growth. Such a scale in the early season would indicate a 3 ring fish.

Fortunately, perhaps, the scales studied in both years were arranged chronologically throughout the season which alleviated the problem. For future studies a decimal system representing growth increment will be used to help counteract the confusion. This method is described later.

Some difficulty was found interpreting scales from fish with body lengths intermediate in position between two modal groups. The scales of these fish exhibit a rather pronounced false annulus zone close to the nucleus which is sometimes mistakenly counted for an annulus. Inspection of the interspace between this false annulus and the first true annulus usually shows that the circuli in this zone are spaced equally to the circuli inside of the false annulus, and not widely spaced as is found between true annuli.

All of the scales examined had at least one ring or annulus. No zero year class fish were seen. All of the scales had three or four erosional checks associated with the first annulus, one occurring half way in the wide rapid growth zone outside of the first annulus. From the original method the four and five erosion check scales fell into the 62 centimeter modal group, predominately. The 72 centimeter modal group was characterized by five, six, and seven erosion checks. If these groups are two and three year old fish, it would follow that an average of two erosion checks are formed each year, although imperfections are evident through elimination or indistinctness of some checks.

Theorizing on the cause for the erosion checks one cannot help but attribute them to migrations between feeding areas. During migrations a fish might drain its stored resources causing scale erosion. The check midway in the rapid growth zone coupled with the observation of but half the usual rapid growth increment late in our season indicates another feeding area equal or better than that found in our season. Also this second feeding season continues throughout most of the winter, ending with or close to the start of our season. There may also be a delay in accretion of growth to the scale which confuses this picture.

In 1949 a group of exceptionally small fish were found late in the season off of northern California. Twenty-four scale samples were mounted for study as these small fish could be the "zero" year class which was not found in the regular sampling. The majority of these fish up to 55 centimeters were one ring fish. The annulus in most was followed by a wide increment of new growth as would be expected in the late season. The two fish between 55 and 58 centimeters were two ring fish. This matches very closely the length-frequency modal grouping. It is apparent from this study that fish of the year, 0 age class, do not enter the fishery as such, but first enter the fishery as one ring fish the following year.

The 42 scale samples from the John N. Cobb 1950 cruise matched previous findings very closely. No evidence of age selection could be found between the two types of gear in use, gill net and troll.

Annulus Formation

It was mentioned earlier that the annulus is apparently formed after the albacore approach the Pacific coast at the start of the season.

To overcome confusion in analyzing the results of readings the amount of increment at the scale edge was given in decimals, i.e., 1.1, 1.8, 1.9, 2.0, 2.1, etc. The following criteria were used: 0.3 to 0.7 indicated the fish was in the process of adding rapid growth as shown by widely spaced circuli at the edge. Naturally, judging the width of an outer zone of rapid growth would be least accurate, but this zone is not critical. A decimal of 0.8 indicates a few narrowly spaced circuli at the edge of the scale with the zone of widely spaced circuli just inside of these. A decimal of 0.9 was used to represent a considerable band of narrowly spaced circuli, but with no new rapid growth at the edge and 0.0 indicates a condition similar to 0.9, but having a narrow increment of rapid growth with no new circuli formed. The latter decimal is used as definite evidence for complete annulus formation. The decimals 0.1 and 0.2 are similar in that one or more widely spaced circuli are to be seen at the scale edge with the annulus immediately inside these circuli.

Table 2. 1951

Increment	Early Season Frequency	Late Season Frequency
0.5	1	0
0.6	0	0
0.7	3	0
0.8	11	2
0.9	17	2
0.0	14	4
0.1	0	21
0.2	0	9
0.3	0	4
0.4	0	7

Table 2 shows the shift of the amount of increment from the 0.8 and 0.9 groups in the early season to the 0.1 and 0.2 groups later in the season. This is taken as evidence of the annulus formation immediately prior to or after appearing in the Oregon fishery. An apparent imperfection in the presence of 0.8 and 0.9 complete annuli in the late season data can be explained by the possible immigration of new fish into the fishery. These fish are termed "new" in that they are approaching the coast for the first time for the season.

Circuli counts were made of approximately 100 fish, 44 in the early season sample and 57 in the later sample. The number of circuli included in the formation of each annulus were counted as well as the total count for the scale. Counts were made from the nucleus out the antero-lateral axis. This axis was selected for its better readability and lesser deviation between scales of the same fish and those of different fish.

It should be mentioned that the variability of the size of the scales lessens the accuracy of this phase of the study. An effort was made to obtain scales from a small area midway along the second dorsal fin and from this point midway to the lateral line on the left side of the fish, but the size and shape of the scales taken varied greatly.

A fair degree of correlation was obtained from the body length to total circuli counts despite variation in the scales (Figure 3). The correlations were: 44 early season fish $r = 0.6006$, $p < .01$, and 57 late season fish $r = 0.638$. $P < .01$ (that an r of 0.638 could be obtained by chance if r were truly zero). The mean XY for each modal group both for early and late season fish was plotted and each joined by the broken line. The increment of circuli in season is almost equal to the difference between modal groups, or what would be considered the yearly increment. Growth of body length in season only accounts for about one-fifth of the annual growth. It is hard to account for this discrepancy. Of course, this line of reasoning may be in error as it is based on the old, and never proven, assumption that scale circuli are laid down at a reasonably constant rate.

A further breakdown of the circuli count-per-annulus data into the frequency of number of circuli per annulus is given in Figure 4. The data were smoothed by the a + 2b + c method. The large amount of overlap in the counts is evidenced. The multiplicity of modes in the groups can be variously explained or conjectured upon: (1) errors in reading age as shown by scales; (2) variability, aforementioned, in the shape of the scales from different fish; (3) separate races of fish with different growth rates;

Figure 3 1951 Albacore Relationship of total circuli per scale to body length

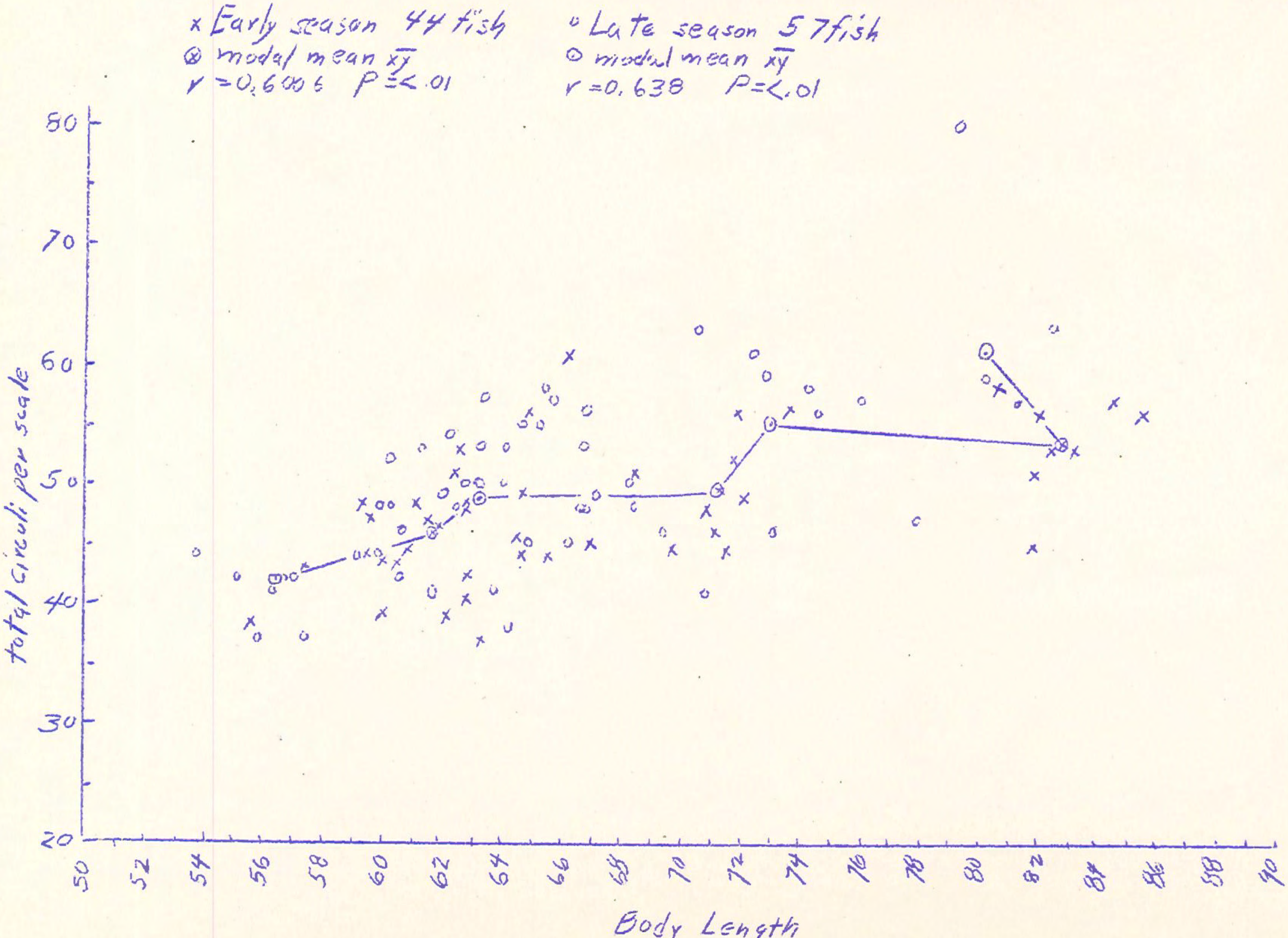
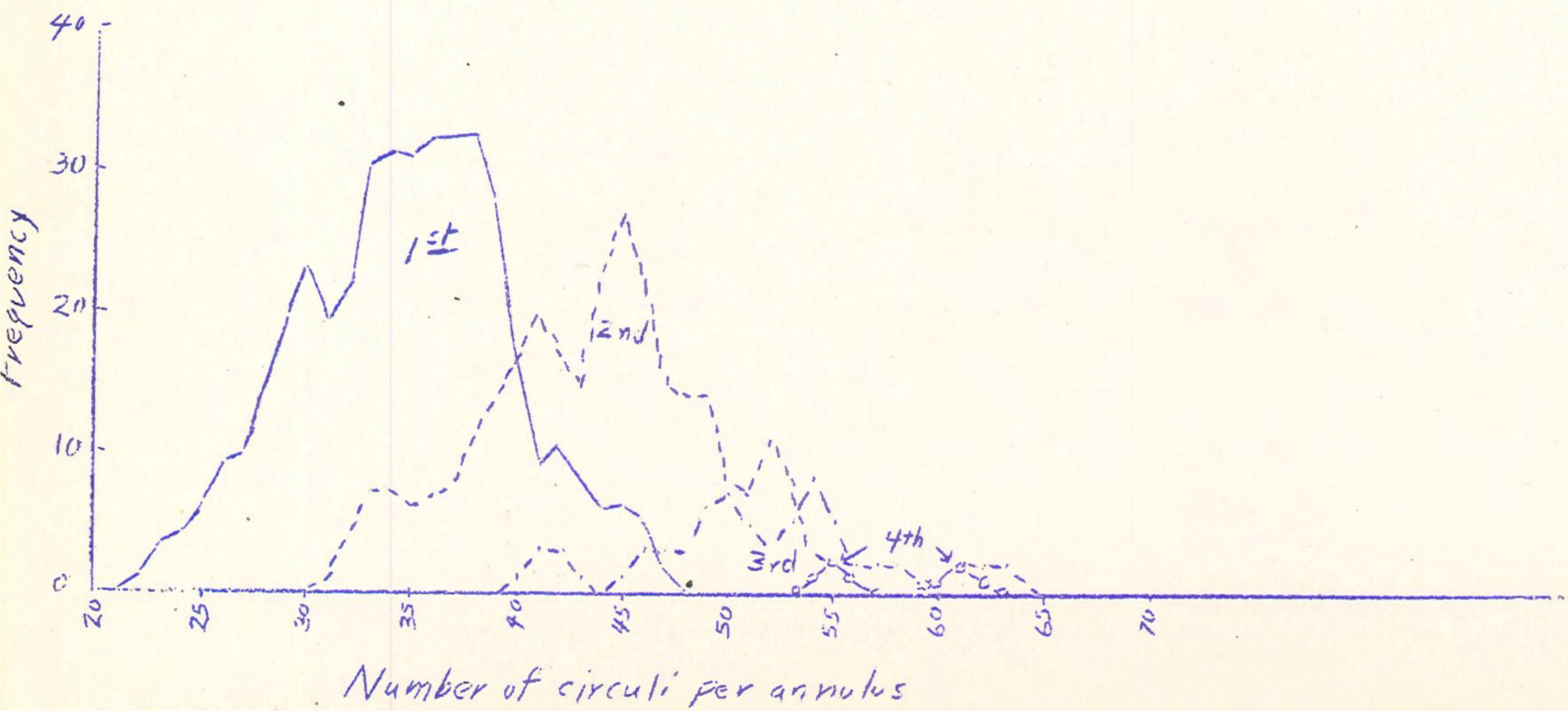


Figure 4 1951 Albacore Frequency of circuli counts per annulus.
101 fish smoothed by 4s



(4) variability of growth among fish of any one size group, that is the larger fish of a year class would have more circuli per annulus than the slower growing and therefore smaller fish. All these factors have their effect, but reading errors were suspected. Reference was made to the original body lengths for the questionable readings, and in two out of three cases it was found that the body length was intermediate between two main length-frequency modal groups. By placing the fish into the adjacent group to which it probably belonged the questionable modes were practically eliminated. Reading errors are being caused by the confused pattern in the scales of these intermodal fish.

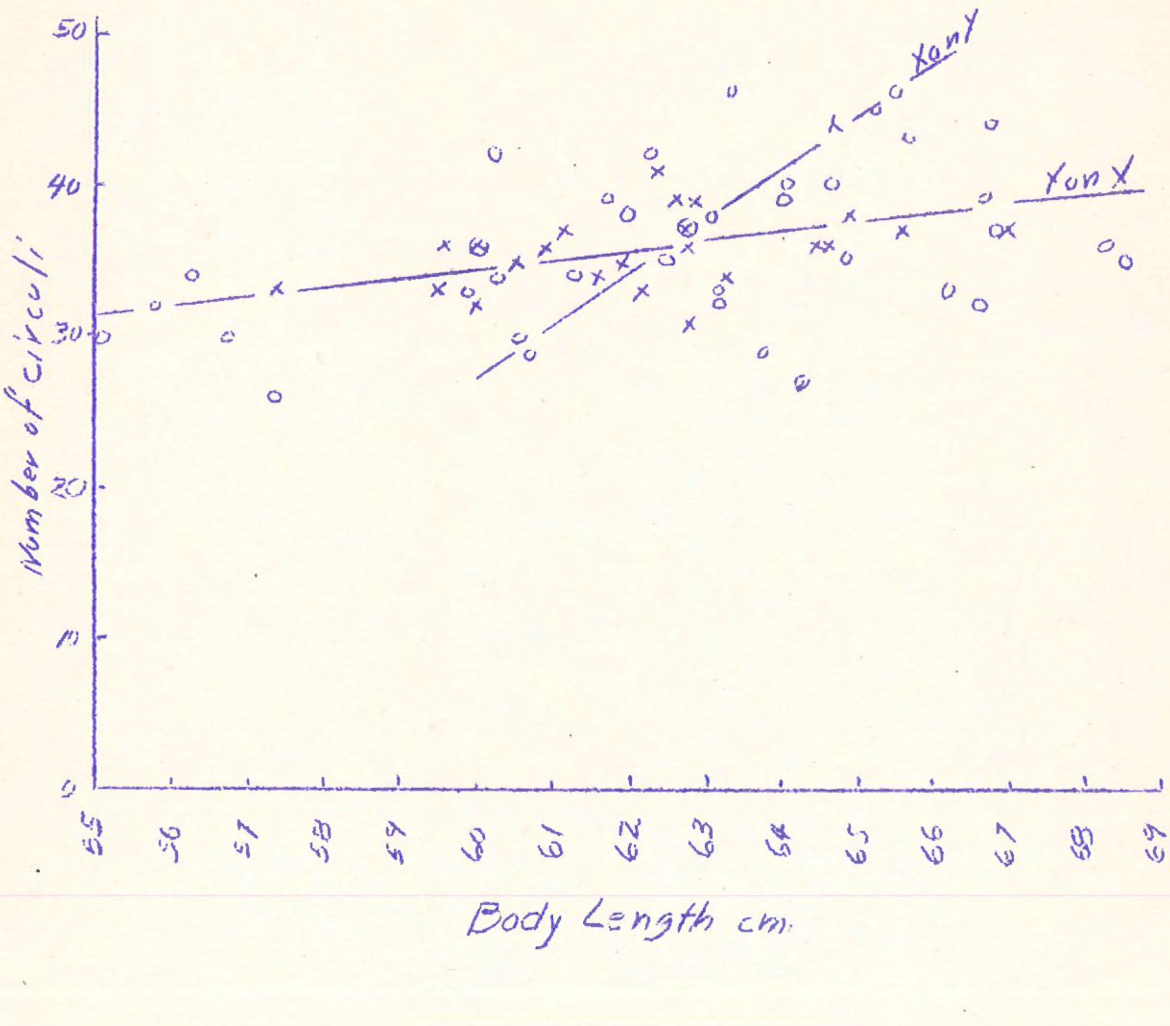
No counts were made to measure the amount of scale variability, but a few measurements were made in an earlier exploratory study. The measurements were taken out the lateral radius and out the anterior radius of the scale. A ratio was obtained between the anterior radius to the lateral radius. The ratio varied from 1:1 to 1:1.5. The 1:1 scales being round or square, and the 1:1.5 scales were rectangular in shape with intergradation. The scales were taken from the same relative position on the fish. The circuli counts could be expected to follow a similar pattern as erosion can be observed on the scales, and greater erosion of the anterior edge removes more circuli in that region of the scale which evidently accounts for the change in scale shape. Thus far we have no knowledge of races within our stocks of fish.

The fourth possibility causes the normal curve in any population, but a test was made to discover the significance of this effect. Figure 5 is the relationship of number of circuli in the first annulus to body length. The early and late season samples were plotted differently to avoid the variability caused by the rapid growth in season. The number of circuli in the first annulus could be better defined by the number of circuli between

Figure 5 1951 Albacore Relationship of number of circuli in first annulus to body length

x Early season r = 0.45 P=<.05>02

o Late season r= 0.43 P<.01



the focus of the scale and the first annulus. Some correlation was found in the early season group with an r equal to 0.45 and p of between 5 percent and 2 percent that an r of 0.45 could be obtained by chance if r were truly zero. Therefore, smaller fish of a length group might be expected to have less circuli per first annulus than larger fish of the same group. The data were grouped, and the Y on X and X on Y least squares lines were added to the graph (Figure 5) to better show the relationship.

Weighting Length-frequency Samples

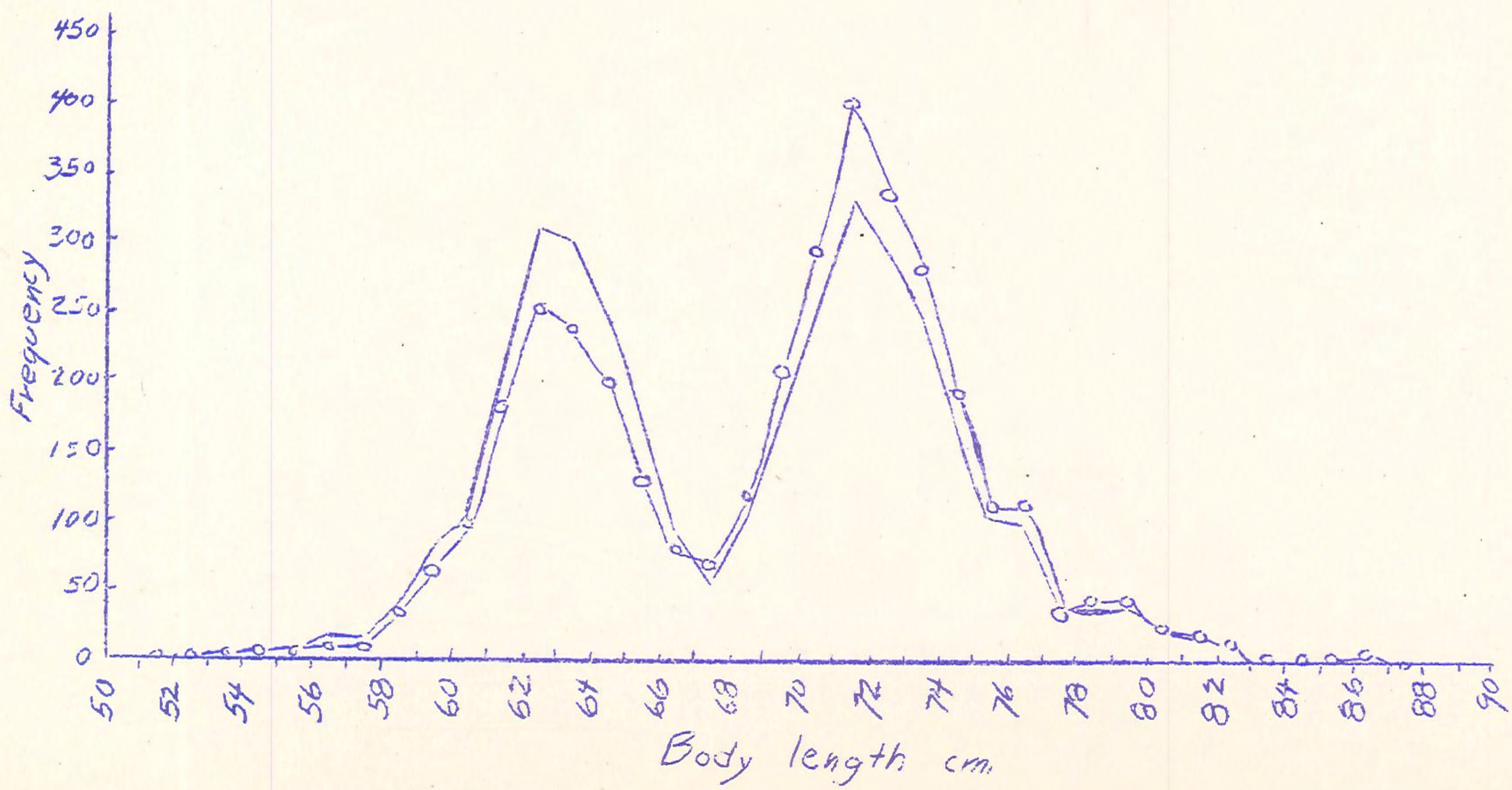
Without the use of mechanical means, such as a device to measure every one hundredth fish, the rate of sampling cannot be carried on proportionately to the rate of fishing with any degree of accuracy. Sampling of albacore by taking body length measurements and combining these into a frequency curve should be weighted to the fishing rate if the curves are to be representative of the sizes of fish in the catch. Sampling in any one season usually starts out vigorously as the early season catches come from directly offshore and are readily accessible to the sampler. Even if fishing should become good with increased landings, the sampling rate will drop as all canneries are landing fish and samplers cannot be everywhere at once to maintain a constant sampling rate. Sampling tends to slow in late season when fish are trucked in at all hours of the day and night, their origin usually forgotten or hopelessly mixed. In later years these fish have been trucked from southern Oregon and northern California, and represent an appreciable part of the total catch. The few late season samples are obtained at the expense of considerable time and effort.

Figure 6 has been drawn of the 1950 unweighted and weighted length-frequency curves and shows the effect of the heavier sampling of the larger early season at the expense of the smaller fish taken in the late season.

Figure 6   1950 Albacore Effect of weighting on length frequency curves

— L-f weighted to 1/100 of monthly catch (3665 fish)

o-o L-f unweighted, adjusted to 3665 fish

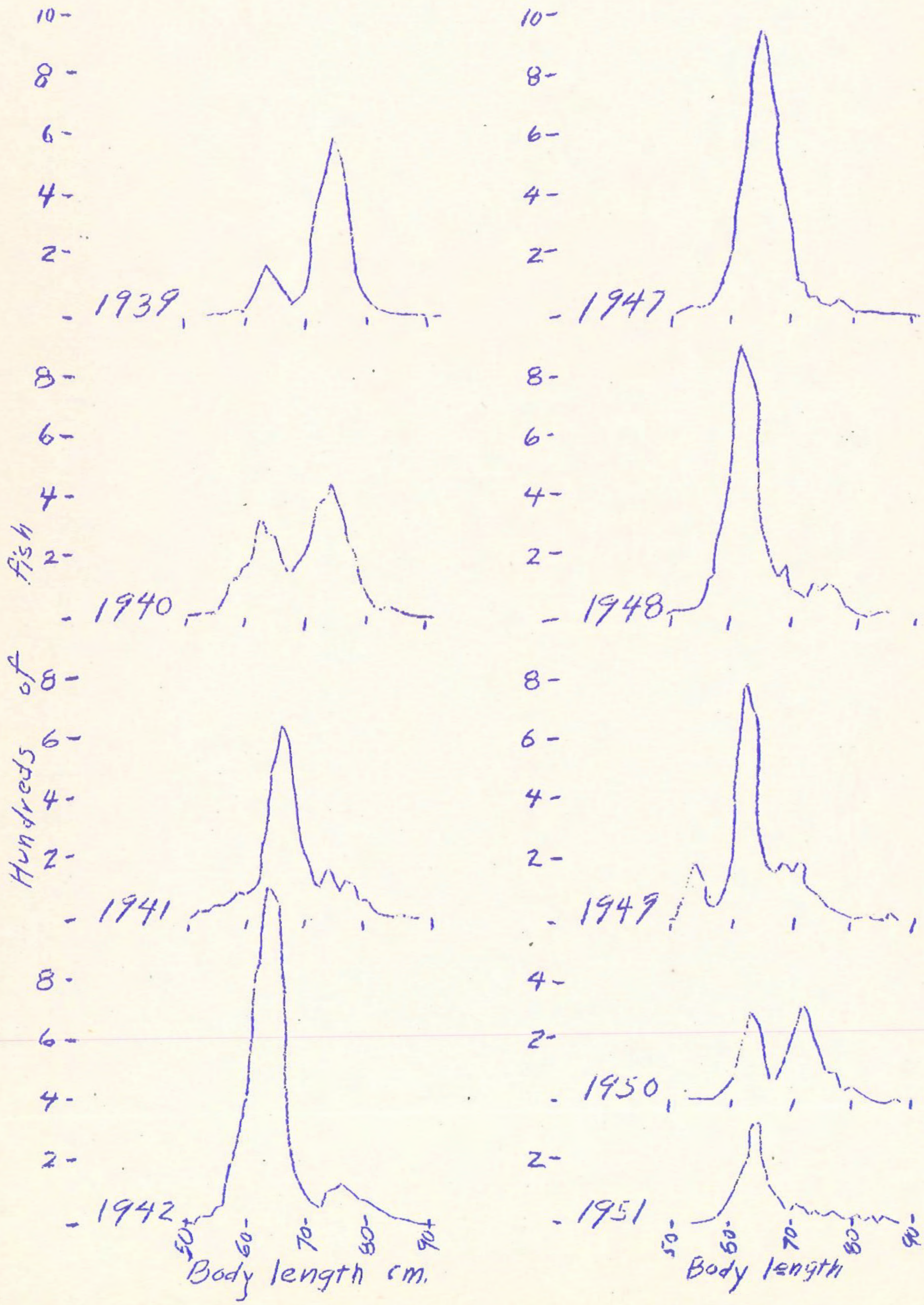


It should be appreciated that without the total number of fish derived from weighting the samples to the catch there was no way of knowing the number of fish to place in the unweighted curve. The shape of the curve was not changed appreciably in some years, but weighting was necessary to adjust the magnitude of the curve to the point where it would be comparable with other years.

The length-frequency samples were totaled for each month in the season. These were converted to a weight-frequency by multiplying each centimeter size frequency by its corresponding weight as determined from the length-weight relationships previously calculated. The total weight of the sample divided into the number of pounds landed that month gives a factor for expanding the sample weight to the catch weight. As the sample weight to catch weight is proportional to the ratio of sample numbers to catch numbers, the same factor can be used to expand the sample frequency into a catch frequency. This figure was reduced by 100 to facilitate calculations. The total weighted length-frequency for the season was obtained by totaling the monthly weighted length-frequency. All the sampling for past years has been weighted in the manner described above and appears graphically in Figure 7.

As stated previously, weighting the length-frequency curves to one-hundredth of the catch makes the curves for succeeding years directly comparable. The curves of 1939 through 1942 show the shift of the fishery from predominantly 72 centimeter fish to predominantly 62 centimeter fish. In 1939 the larger fish were more available or perhaps the fishermen sought them by preference. In 1940 the catch was balanced almost equally between large and small fish. An emphatic shift to the smaller group occurred in 1941. The large fish were either not available or it was more profitable to catch the smaller fish in greater quantity. A small sample, not shown

Figure 7 Oregon albacore length-frequency samples weighted to 1/100 of the monthly catch.



here, measured by the Canadians in 1944 indicates that the large fish predominated the catch in that peak year.

Interpretation of the later years, from 1947 on, is dangerous for the reason that Oregon's catch is not typical of the total northwest fishery as was shown in the November, 1951 to January, 1952 progress report. The landings in Oregon have declined where the northwest, Monterey northward, landings have increased. Oregon's weighted length-frequency samples must be combined with those taken in California, Washington, and Canada to determine the catch tendencies in numbers of fish.

Table 3 is included to show the changes in total catch and size of fish landed in Oregon.

Table 3

Year	Pounds Landed	Estimated Numbers Landed	Average Weight
1939	6,484,795	362,220	17.90
1940	9,286,261	584,160	15.90
1941	7,545,131	524,920	14.37
1942	10,942,956	852,400	12.84
1947	9,557,662	720,870	13.26
1948	8,004,327	656,690	12.19
1949	6,457,382	524,350	14.22
1950	5,490,517	366,460	14.98
1951	2,926,545	224,630	13.03

George Harry
S. J. Westrheim
Edwin Holmberg
Aquatic Biologists