MARINE FISHERIES PROGRESS REPORT

NOVEMBER 1, 1950-JANUARY 31, 1951

General

On November 1 Edwin Holmberg began work as a permanent member of the marine fisheries section. Just before Christmas, Al Pruter returned to the University of Washington to finish his last term needed for graduation. He will rejoin the department at the end of winter term. Eldon Korpela, who had been working as a temporary biologist, left on January 1 to accept a position with the Columbia River Packers Association.

From November 27-29 George Harry and Al Pruter attended the opening ceremonies for the new School of Fisheries building at the University of Washington.

From December 4-6 George Harry attended a regular meeting of the Pacific Marine Fisheries Commission in San Francisco.

On January 30 George Harry attended a meeting of biologists held in Portland to coordinate coastal salmon and black cod studies.

During the period of this report a review of the bait fisheries of Oregon was revised and submitted.

Dr. Fiekowsky has been cooperating in an effort to work up methods of analyzing the racial data gathered on local and Japanese albacore. The racial analysis has been halted temporarily until more time can be given to solving the various technical difficulties involved.

Most of the effort during the past three months has been directed toward working up the otter trawl data gathered since January, 1948. A summary of the progress on the statistical analysis, sampling at

sea in 1950, and the mink food studies is presented here.

A report on progress made in determining the age of albacore is also presented.

Routine sampling of the catches by the otter-trawlers has continued when possible.

Preliminary Statistical Analysis of the Oregon Otter Trawl Landings, 1942 - 1946

Introduction

The statistical analysis of the Oregon otter trawl landings has one principal objective. This is to obtain, if possible, some measure of the changes in abundance of the various species of fish landed by this fishery. The principal species, i.e., Dover, English, and petrale sole and rockfish (Sebastodes flavidus, S. melanops, S. pinniger, S. alutus and others are all landed as rockfish) are being studied at this time.

The landings from June, 1941 to March, 1947 have been recorded on punch cards (one landing per card) for more convenient manipulation. All landings after March 31, 1947 are handled by the IBM machine in the Portland office.

The current study is being conducted on the five complete years of 1942 through 1946. The work of transcribing each landing onto a punch card was completed in August, 1950. For each landing the following information was entered on the card: (1) port of landing and company (buyer); (2) month, day, and year of landing; (3) pounds of each species landed; (4) boat name; (5) boat number; (6) length of boat; and (7) tonnage of boat. The following information has been punched along edges of each card: (1) area of landing (d.s.)*; (2) date landed (i.s.)**; (3) weight of rockfish (i.s.); (4) weight of English sole (i.s.); (5) boat number (i.s.); (6) weight of petrale sole (i.s.); (7) weight of Dover sole (i.s.); (8) weight of dogfish livers (i.s.); (9) weight of flounder (i.s.); (10) species landed (all) (d.s.); (11) length of boat (d.s.); and tonnage of boat (d.s.).

* Direct Sort
** Indirect Sort

Prior to the inauguration of the punch cards in the winter of 1950, a tally was made of the numbers of landings made by month and year for every boat in the Oregon otter trawl fleet during the period, June, 1941 to March, 1947. These data have proved invaluable in the preliminary analysis of the punch cards.

For the present, at least, the study has been confined to only the complete years of 1942-46 inclusive, thus omitting June-December of 1941 and January-March, 1947 in order to deal with more homogeneous data. If the need should arise to include these omitted data, this can be accomplished quite easily. It is planned to include 1947, 1948, and 1949 in the final analysis of this fishery.

Area to be studied

Area was the first and simplest problem encountered. Since the fishing areas for the Astoria, Newport, and Coos Bay otter trawl fleets were more or less separate, the landings were also separated by port.

The Astoria landings constitute approximately 90 percent of the total for Oregon and so these have been selected for the initial attempt at analysis. Subsequent discussion deals only with Astoria otter trawl landings unless otherwise specified.

Time of year to be studied

The second problem involved was time. Should we use the landings throughout each year, or for some portion thereof. We know that during the winter months bad weather limits the fishing time with regard to both numbers of trips per month and length of trip. During the summer months the average length of trip and the number of trips per month is little affected by adverse weather. Thus an "average" pounds per landing computed for an entire year would merely indicate

a midpoint between two extremes, i.e., a period of good fishing conditions and poor fishing conditions. In addition, this "average" would be at the mercy of such seasonal variations as mild and extreme winters.

A second complication is the dogfish shark fishery (for livers) which begins in the late fall and continues through the winter. This fishery tended to "carry" the otter trawlers through the winter months when the food fish are not abundant on the grounds.

Accordingly, a graph was made of the numbers of boats fishing during each month of each year and the average numbers of landings per boat for the same periods (Figure 1). Here a seasonal trend is evident to some extent, even though landings of all species are included.

A second approach was made by plotting the landings of Dover, English, and petrale sole by month and year in terms of percent of each yearly total (Figures 2, 3, and 4). Here the seasonal nature of the food fishery becomes more evident. For Dover sole, 84 to 99 percent of the total annual landings are made between April and September. For English sole, for the same period, the percentages vary from 47 to 86 percent, while the percentages for petrale are 73 to 94 percent. The unusually low percentage (47) for English sole during April to September, 1945 was probably due to unusually good weather in October and December. This same characteristic is reflected in the petrale landings during the same period. This supposition has not been verified. The Dover sole disappear from the grounds in October and do not usually reappear until the following April.

Considering the evidence presented, it was deemed permissible

to limit the time period studied to that of April to September (incl.) for 1942 through 1946.

Significant Species

The problem of determining which species are being sought and which are incidental in each trip is indeed a difficult one for the otter trawl fishery. The four principal food fish constitute 90 percent or more of practically every landing, but rarely are they landed separately of each other. The common occurrence is for one or two species to dominate a landing. The degree of domination becomes the critical point. For example, a petrale landing of 4,000 pounds would certainly be significant if the total landing were, say, 6,000 pounds. However if the same petrale landing was made from a total landing of 40,000 pounds, its significance would certainly be questionable with respect to fishing effort expended on petrale. In the former example, the 4,000 pounds represented 67 percent of the total landing and it would seem reasonable to say that the major fishing effort was expended on petrale. In the latter case, only 10 percent of the total landing was petrale, and in this case the petrale could only be considered as incidental in the catch.

In order to gain some insight into this problem prior to handling all the punch cards (some 6,700 in all), the Astoria landings for June 1942 and 1947 were taken out of the files for close examination. The percentages of the four principal species were computed for all landings. Then three percentage levels (>19%, >29%, and >39%) were chosen as possible minima (Table 1). It was immediately apparent that for any large numbers of landings there would be some overlap.

That is, for example, during June, 1946, there were 76 landings of Dover sole which were greater than 19 percent of the total landing, but among these there were also 16 English, seven petrale, and eight rockfish landings which also accounted for more than 19 percent of the total. Examination of the figures for all three levels indicates that the 30 percent level most nearly approximates an optimum level. That is, there is the sharpest decline in the number of overlaps, but there is no corresponding disproportionate decrease in numbers of landirgs to be used. This same pattern is also evident with respect to English, petrale, and rockfish.

Accordingly any landing greater than 29 percent of the total landing was considered as "significant", and used in the calculations. In other words, if a boat made a landing of which 30 percent or more was, say, Dover, that trip was considered as a trip for Dover sole. Also, if there were two species, say Dover and English sole, which each constituted 30 percent or more of the total landing, then the trip was counted once as a Dover trip and once as an English trip.

Linkage

In order to obtain some continuity to the landings from year to year it was decided to establish some form of linkage among the boats. Thus for a boat's landing to be used in any one year the boat must have also fished either the previous or following year.

A boat-length frequency polygon was drawn for each year, which included only these linkable boats (Figure 5). There is a considerable range in size among the boats, and also an increase in the 60-64 foot class after 1944. Little can be done about this increase in

numbers of large boats at this early stage, but the extreme sizes (both large and small) were eliminated. Thus, all boats less than 40 feet and greater than 69 feet were taken off the linkage list. This entailed discarding three small boats (35', 35', and 36') and three large boats (72', 75', and 77').

Catch Per Trip

Once the percentages and totals were calculated for the linkage boats through the period April through September, 1942-46, it was a simple task to sort the cards by species, copy off the appropriate figures (landings greater than 29 percent of the total), add them by month, and total for each year. This much has been completed in time to be included in this report.

Tables 2, 3, and 4 summarize the results by year for Dover, English, and petrale sole. The rockfish figures have not yet been compiled. The two sets of figures for the years 1943, 1944, and 1945 are a result of linkage. For any year (except the first and last) in a linkage period the landings to be used may come from three classes of boats, i.e., (1) boats which fish the year in question and the previous year; (2) boats which fish the year in question and the following year; and (3) boats which fish the previous year, the present year, and the following year. This necessitates two totals, one of which includes (1) and (3), while the other includes (2) and (3). The last two columns (total landings for all of Oregon during the period April through September and January through December of each year) were included in order to show the magnitude of the total data with relation to the selected. Unfortunately the total landings for the Astoria have not been computed

from the punch cards. This will be the next step in the present analysis.

The Dover sole catch per trip fluctuates considerably (Table 2). The drop in 1944 from 14,000 pounds per trip (as opposed to 18,000 pounds per trip in 1943 and 17,000 pounds per trip in 1945) appears to be caused by a sharp decline in fishing effort rather than a decline in abundance. Two factors may account for this. One was a switch to tuna fishing by some boats during August and September, and the second an increased demand for rockfish. Approximately 11 million pounds of rockfish (second highest landing in the short history of the fishery) were landed in 1944 as compared to approximately 1.5 million pounds of Dover, 2.0 million pounds of petrale, and 1.0 million pounds of English. During 1945, the catch per trip again rose to approximately the 1943 level with an increase in fishing effort (93 landings in 1945 and 58 in 1944). However, in 1946, despite a further increase in fishing intensity (101 landings to 180) the catch per trip fell off to a level lower than any previous year. Assuming that the data are good, it would appear that by 1945 the "cream" or accumulated stocks of virgin fish had been cleaned off.

The English sole apparently (we have not verified this yet) started slowly in the market and the demand was poor during most of this period (Table 3). With the exception of the decline in catch per trip in 1944 (same as in Dover sole), the trend is distinctly upward. It will certainly be interesting to watch the trend for the later years (1947-49) which will soon be analyzed.

The petrale sole appear to be the poorest shape of the three principal species of flatfish (Table 4). Their catch per trip levels

appear to be declining throughout the period, and at no time is the average catch per trip very large. It appears questionable whether there were any large stocks of petrale in the Astoria area at any time.

Conclusion

The results to date have been quite satisfactory although much work remains to be done to check, as much as possible, the accuracy of the results. The total landings by species (Dover, English, petrale, and rockfish) by port should be obtained. Also the total landings by species of the linkage boats. Similar data for rockfish will be compiled. Although the term rockfish includes at least four principal species, the great amount of fishing effort expended must be summarized in order to place the three principal species of flatfish in their true position in the fishery.

Should the present approach be deemed satisfactory it will then be extended to include the data for 1947, 1948, and 1949 from the IBM sheets.

Otter Trawl Sampling at Sea in 1950

In the previous progress report, June-November 1950, the otter trawl sampling at sea was first discussed. The purpose of the sampling was outlined, the sampling procedure was given, analysis procedure was explained, and some preliminary results were discussed. Changes in analysis and further results will be presented at this time.

Size Selectivity by the Fishermen

A method for determining the size selectivity or discard of commercial species by the fishermen was described in the last report. An error has been discovered in Table 5 under step two and three. Step two should read:

Step two: Estimated total numbers caught greater than 38cm = 6900 fish.

Step three should read:

Step three: Estimated total numbers caught = $\frac{\text{Est. total nos. caught } >38\text{cm.}}{\%\text{ Boat sample } >38\text{ cm.}}$ = 13,660 fish.

The remainder of the example willdiffer accordingly. The procedure given is correct. The calculation differs.

This method involves estimation of the 50 percent discard level at the start of the problem, and has been abandoned because of the difficulties involved. To find the 50 percent level it was necessary to determine the point of no discard (zero discard point) and work back to the 50 percent point. Estimating the zero discard point incurs enough error without introducing more error in estimating the 50 percent point. A second method has been evolved using the point of no discard on the length-frequency distributions of the boat and

dock samples.

The new method consists of adjusting the size of the dock length-frequency sample to the size of the boat sample from the size of zero discard and larger. It was noted that the two sample curves were similar in characteristics to the right of the zero discard size. All that needed to be done was increase the smaller (usually the dock sample) so that an equal number of fish to the right of the zero discard size were treated in each sample. An illustration of this is given in the petrale sample of experiment No. 1. When both length-frequency samples were smoothed by threes, the boat sample contained 251 fish 41.25 cm. in length and larger. The dock sample contained 89 fish 41.25 cm. and larger. To make them equal the frequency of each length interval in the dock sample was multiplied by 2.8 ($\frac{251}{88} = 2.8$) the resulting dock sample length-frequency curve is shown with the boat curve in Figure 6. The difference in the left slopes of the two curves results from the discard by the fishermen.

We can now use our samples as representative of the activities of the fishing operation. The dock sample total (566 fish) is proportioned to the total landing or in this experiment 8838 fish. The total number landed was obtained by first finding the average length of the dock sample, and converting this to average weight using the length-weight equation. The total pounds landed were then converted to total numbers landed by dividing by the average weight. In this problem 17596 pounds ÷ 1.991 pounds (av. wt.) gives 8838 fish. The total boat sample (870.3 fish) represents the total catch of fish taken in the net. As the boat sample is 154 percent larger than the dock sample, we can say that the total catch will be 154 percent larger than the total landing in numbers of fish (8838 x

1.54 = 13,593 fish caught). The difference (4758 fish) represents the number discarded, and is 35 percent of the number caught.

To obtain the weight of fish discarded the adjusted length-frequency samples were converted to weight-frequency by multiplying the frequency by the weight at each length interval in the distribution, and the resulting boat and dock weight-frequency distributions were treated as outlined above.

Another refinement incorporated into this analysis, consists of applying the shrinkage found in the Dover and English sole between the time the fish are taken aboard and the time they are sampled in the bins ashore. An average of one half centimeter shrinkage was found in these two species. No shrinkage has yet been demonstrated in the petrale sole, and no correction was applied to this species in the analysis. To explain the mechanics of the correction it is first necessary to elaborate on the procedure of handling the sample statistics. Measurements were made to the nearest one half centimeter and when tabulated these were grouped into whole centimeter intervals with the mid-point necessarily at the one-quarter centimeter. This means that there are two size-groups in each interval, but shrinkage would tend to move the shorter of the two groups from the larger interval into the next shorter interval. This group at the time the dock sample is taken has shrunk, and is now the upper group in the length interval. Lacking information on the size of the group displaced by shrinkage, we arbitrarily added one half of the individuals in each size interval to the next larger size interval. The effect of shrinkage was thereby minimized in the two species (Dover and English sole) which were found to shrink in size.

The results of the discard analysis are given in Table 5. The English sole are discarded in greater percentages according to the average for these samples. Dover sole seem to be discarded least. The average percent discard for Petrale is higher than was thought to occur. No attempt has been made to translate the averages found in these samples to the fleet activities as a whole.

The mesh size has been included in the table, and shows the tendency towards a negative correlation between the size of mesh used and the amount of fish discarded.

When presented to the fishermen, this material will show the extra labor they are put to in discarding small fish caught in the smaller mesh nets.

Mesh Selectivity

Europeans have been involved in this study for some 65 years in the North Sea, and elaborate studies have been carried out on the round fishes of the Grand Banks. California has been able to legislate rather stringent measures based on savings gear studies there. In spite of all the work done on the subject, no standard or routine method of analysis has been evolved by which the escapement of fish through any particular mesh size can be measured. The reason for this is that the escapement at any particular time is a function of the abundance of each size group present on the grounds. The mesh size being tested should take a certain percentage from each size group present, but there must be some provision made to determine the abundance of each size group in order to learn what percentage the mesh under consideration is taking. The abundance of each size group in the fishery will vary not only in time but

also in space. A number of techniques have been used to find out the relative abundance of the various size groups of fish present and thereby the percentage of escapement or retention of the mesh size being studied. The trouser leg trawl is such a technique, but its disadvantages is that the smaller mesh leg having more resistance to the water will therefore fish more efficiently than the loose flopping, larger mesh leg. Alternate drags using cod ends of varying size mesh is perhaps best suited to our purposes, and one attempt was made to use this technique in these experiments (Exp. No. 5). In experiment No. 5 operations were started in deep water using a 4.8" mesh cod end. Unfortunately, strong tidal currents forced the vessel to leave the area. The 3.8" mesh and 5.3" mesh cod ends were fished in a different spot where small size fish predominated. The samples of 3.8" and 5.3" mesh are comparable, but neither are comparable to the 4.8" mesh cod end.

No provision was made to make comparable drags in the other experiments. For this reason the material has been worked up by the two methods usually employed in the analysis of gear selectivity, and as it falls into a rather typical pattern that is about as much as can be said for the material not knowing the relative abundance of each size group of fish present during each experiment.

The first graph of Dover sole figure 7A, shows the length frequency distribution for Exp. No. 5 using 3.8" and 5.3" mesh sizes. The curve for the 4.8" mesh also tested in this experiment is included although it is not comparable. The 4.8" mesh was fished in a different area and the abundance of smaller fish was not encountered while it was in use. These curves have been adjusted so that they all include 500 fish greater than 39 centimeters. Forty centimeters

was chosen as the point above which no selectivity of small fish was evident. Theoretically, the same number of fish have at that level passed through or have been captured by each net. We have based these studies upon the escapement through the bag or cod end of the net as other investigators have shown that most of the escapement occurs in this part of the trawl net.

The length frequency curves in Figure 7A show the pattern found generally when comparing mesh selectivity samples. The 3.8" mesh caught many more of the smaller fish than did the 5.3" mesh fished on the same grounds. The 4.8" mesh was fished on different grounds where the small fish were not in as great abundance according to the investigators on the trip.

The type of curves in Figure 7B were used by W.C. Herrington in his Modifications in gear to curtail the destruction of undersized fish in otter trawling, U.S. Bureau of Fisheries Invest. Report No. 24, to compare the selectivity of various mesh nets on haddock.

The values used to plot the selectivity curve are the numbers of fish t ken by the small mesh at each length interval expressed in percent. This method demands the use of comparable drags, and does not show the selectivity of the available population as there is escapement of small fish from the small mesh net. We need a curve of the actual population available to which we can compare the catches of various mesh sizes. Then a more nearly correct point of selectivity could be determined, and proper conservation could be more easily effected.

Another method of graphing mesh selectivity used in the California investigations is depicted in Figure 7C. These curves represent the percentage of accumulative frequency up to the interval

where 100 percent of the fish are thought to be retained by the mesh in use. This point is usually one, two, or three intervals to the right of the mode at the point at which the greatest slope begins. For the 3.8" mesh it has been taken at 37 cm. From the name given the curve it would appear that the 3.8" mesh net will retain or catch, say, 50 percent of the individuals 33 centimeters long passing through the mouth of the net. Actually, this is not strictly true. This may be true at 0 or 100 percent, but 50 percent accumulative frequency would merely include 50 percent of the sample individuals under the length-frequency curve smaller than the point of 100 percent retention. Often this curve is reversed 0 percent is made 100 percent, and 100 percent is made 0 percent. Then the curve is called an escapement curve. Either way the curves merely give a means of comparing the selectivity of two or more mesh sizes. The 4.8" mesh was omitted from the graph because it coincided almost exactly with the 5.3" curve. The female 50 percent maturity line has been drawn into the B and C graphs.

Herrington's selectivity curves perhaps give a better comparison as they compare the large mesh to an artificial population curve as represented by the smaller mesh catch curve, but comparable samples must be used. Where comparable data are not available the so-called retentioncurves can be plotted to show the pattern of escapement.

All the Dover sole boat sample length frequencies of adequate size from the 1950 sampling trips have been adjusted to 500 fish greater than 39 cm. and are presented in Figure 8. Admittedly, the samples may have come from different populations or the same population at different biological phases, but a general pattern presents itself with few exceptions, and more facts may develop the reasons

for the exceptions. From left to right the left hand slopes fall in approximate order from small to large mesh. The larger meshes retaining fewer small fish.

The Dover sole sample retention curves are shown in Figure 9. These were claculated in the same way as described for Experiment No. 5. All the samples fall into line except the 4.6" mesh sample taken off Newport.

The optimum retention rate and the mesh size required to retain this rate for Dover sole are not evident from this material.

The material for English sole has been treated in a similar manner. The adjusted length-frequency curves are shown in Figure 10, and the retention curves are shown in Figure 11. Except for the smaller size the length-frequency curves are very similar to the Dover sole sample curves. English sole appear to be more sharply selected by the various mesh sizes sampled in these studies. Additional samples may prove or disprove this theory. The graphs show a wide range of selectivity of small fish. By the wide range in selectivity is meant the greater distance between the left hand slopes of the curves as compared to the Dover curves. The same change in mesh size causes a greater difference in the numbers of small English sole caught than it does with small Dover sole.

Perhaps these curves will prove useful in helping the fishermen choose the proper mesh size for the species of fish he is desirous of catching. The variety of utilization expressed in these data indicate the difficulty of determining an optimum mesh size which will combine proper utilization with conservation of the stocks of flatfish in our fishery.

Figure 12 shows the adjusted length-frequency distributions of Petrale sole. Experiment No. 1 was actually made in the Newport area. It, therefore, compares more closely to the Newport Experiment No. 2. The latter sample was of a 5.5" rope or hog-ring cod end. Its close approximation of the 4.9" curves indicate that their retention qualities are similar. The adjusting was made along the sections of the curves having similar slope in these samples because the wide variation in the number of larger fish present would have increased the height of the sample having a small percentage of large fish out of proportion to the other sample curves. This procedure may produce the best reproduction of acutal conditions.

It is disappointing that the few samples of Petrale sole obtained covered such a small range in mesh sizes. There are a small amount of data still to be extracted from the boat sampling, and these data may throw more light on the escapement of Petrale and other species as well.

Petrale sole mesh retention curves (Figure 13) show even less range of variation in the meshes sampled than did the length-frequency curves. The retention curves have less slope than the English sole retention curves and only slightly less slope than the flattest of the Dover curves. The size range of the retention curves falls between those of English and Dover sole.

Many more figures than these are necessary to determine the proper mesh size for conservation of the species in the otter trawl fishery, and for the benefit of anyone who may in later years seize upon this material as a basis for regulation it should be stated that the change should be gradual to soften the effects upon the fishing industry.

This report indicates progress to date. As was mentioned above, there is more material on the three important commercial species yet to be extracted from the original boat samples. Further analysis may be justifiable with the adjusted boat samples. Utlimately, incorporating the discard study we can show fishermen the proper mesh size to use and cut the labor and discard to a minimum.

Mink Food Study

In about 1925 the first Oregon mink ranch was established. During the early years of the industry there was no fishery for marine bottom fish in Oregon waters and consequently the mink ranchers were obliged to depend on other species of fish for mink food, such as starry flounder caught incidentally by the salmon gill netters, carp, and Columbia River smelt.

In 1937 and 1938 an Oregon otter trawl fishery began to develop, principally operating from Astoria and Newport. The most important species landed were English, petrale, and Dover soles, and the various species of rockfish. These fish were filleted and the carcasses made excellent food for mink. Soon the mink farmers depended almost exclusively on the otter-trawl fleet for mink food.

During World War II market conditions for bottom fish were excellent, and as a result scrap from the fillet plants was abundant. After the war, however, the demand for bottom fish decreased and sometimes fish carcasses were scarce. In order to get food for their mink, some mink ranchers ordered whole fish to be brought in by the otter trawlers, even though at a higher price than the fillet scrap. A few mink raisers actually prefer whole fish, even at a higher price, because they believe that the fillet scrap is often partially spoiled by the time it reaches the mink.

In 1949 there were about 200 mink farmers in Oregon and the annual value of the pelts and breeding stock was about $2,000,000 or more according to Mr. Willard Sheldon, statistical director of the National Board of Fur Farm Organizations. Mink farming is now an important Oregon industry and food for the mink is a major concern

of the mink ranchers.

When the research on the Oregon otter-trawl fishery began in January, 1948, one of the first problems encountered was to determine the effect on the stocks of fish of feeding whole fish to mink. On the one hand some fishermen declared the stocks of food fish were being depleted because of their use for mink food, and on the other hand some mink farmers insisted that no damage was being done since the fish used were either scrap fish or small fish that would otherwise be discarded dead and wasted entirely.

The problem confronting the research staff was to determine the species being used as mink food, the sizes being used, the quantities taken, and the effect on the stocks of food fish. The species and sizes could be obtained by sampling the catches at the dock, but estimating the amounts taken was more difficult. This difficulty arose because much of the whole fish landed for mink food was sold directly to the mink farmers at the dock and no official records were made of the transactions.

Sampling of the Whole Fish Used as Mink Food

The first sampling of mink food was accomplished in the summer of 1948. On August 19, a fishing vessel with a load of both human food and mink food fish caught off the Columbia River was met at the dock. This boat had separated its catch at sea, placing the food fish and mink food in different bins. The net used had a cod-end of 4 1/2 inch stretched mesh including one knot, which is about the average used for food fish. Random samples of the English sole to be used both for mink food and human consumption were taken. In the mink food sample, 111 of the fish were females and 215 were males.

(Fig. 14). In the food fish sample there were 130 females and 16 males. Two-thirds of the English sole thrown into the mink food bin because of their small size were males while 89 percent of the fish retained for human consumption were females. This latter figure compares quite closely with the 1948 total market sample of 89 percent females based on random samples of 2272 English sole taken during the entire year. About 8 percent of the females used for mink food were smaller than the 50 percent maturity size (30 centimeters).

On October 19 random samples of both human and mink food fish were taken from an otter-trawler which had fished off the Columbia River principally for Dover sole using a 5 1/4 inch double bag cod-end (the last 25 meshes doubled over to strengthen the bag). In the mink food sample there were 58 rex sole (Glypotocephalus zachirus), 49 Dover sole (Microstomus pacificus), 2 Bellingham sole (Isopsetta isolepis), 1 sand dab (Citharichthys sordidus), and 1 arrow-tooth flounder (Atheresthes stomias). The only species of commercial importance in this sample was the Dover sole. While the rex sole is an excellent food fish it is not marketed extensively at the present time because of its small size and thin fillets. (Fig. 15).

The Dover sole samples from both the mink food and fillet fish were measured but only the fillet fish were sexed (Fig. 16). The large Dover sole were kept for food fish and the smaller ones were used for mink food. Separation of the two categories was not clear-cut and 61 percent of the mink food Dover sole were larger than the discard size (36 centimeters).

Almost all of the Dover sole taken for human consumption were females. Usually there is not such a heavy proportion of females in

the market samples, the reason for the great preponderance of females in this case possibly being that the males had already left the grounds for the spawning areas in deeper water.

On the next trip (October 20-22) made by the boat discussed in the previous paragraphs, a biologist went along primarily for tagging. However, a few Dover sole were measured each drag before the fish were sorted for size. The total number measured was 319 fish. Very few Dover sole were taken smaller than the usual discard length of 36 centimeters (Fig. 17). The length-frequency distribution of the Dover sole samples taken before sorting at sea was quite similar to the Dover sole market samples for the entire season (Fig. 18). This indicated that on this trip for mink food, the net captured larger Dover sole than the average for the season. Large amounts of small fish were not being taken in the net.

However, if the discard length was the same on this trip as on the previous one (about 40 centimeters) a considerable percentage of Dover sole large enough for food fish were used for mink food. About 34 percent of the catch was between 36 centimeters, the usual discard size, and 40 centimeters.

During the 1948 season, three trips, in addition to the one already mentioned, were made aboard boats which were bringing in both mink food and food fish. While aboard these vessels the biologists estimated the percentage by numbers of the various species in each drag and the percentage of the food fish retained for mink food (Table 6). No actual counts were made nor were the fish measured, except that a sample of the English sole was taken at the dock from the August 17 and 18 trip (Fig. 14).

The estimates of the composition of the drags at sea show that the greatest percentage of the fish taken were English sole followed by flounders (Platichthys stellatus) and rex sole in smaller numbers. The flounders and rex sole are not of great importance as a commercial fish but the English sole is one of the three most important flatfish landed in Oregon.

Unfortunately, the species that were used for mink food were not separated and it was difficult to get the total pounds landed by species. The estimates made by the biologists at sea were based on numbers of fish rather than pounds and there is a fairly large (about 15 percent) miscellaneous category that makes converting pounds to numbers difficult. However, the total weight of all the fish landed was known and the fish receiver estimated the pounds by species (Table 7) for each trip.

For the three trips a total of 81,051 pounds of both food fish and mink food were landed. There were an estimated 35,963 pounds of English sole in this total, and little else of importance for human consumption. The August 19 sample indicated that about 37 percent by weight (11,484 pounds) of the English sole sold for mink food were large enough to be used for filleting. This 11,484 pounds represents 14 percent of the total pounds of all species landed.

It was evident from the samples taken in 1948 that English and Dover sole large enough to be used for filleting were being fed to the mink. However, how much whole fish were being used could not be determined because of the lack of landing records for mink food.

In 1949 sampling of the mink food continued, and in addition an estimate was made of the pounds of whole fish and fillet scrap used for mink food. This estimate was made by sending each mink farmer

a questionnaire and checking the returns by personal interview. Four questions were asked:

1. How many mink were fed in 1947, 1948, and 1949, respectively.
2. How many pounds of whole bottom fish were used in these years.
3. How many pounds of fillet scrap were used.
4. What was the total poundage of all types of food.

The Oregon Fox and Mink Association assisted greatly in this survey by enclosing the questionnaires in their October, 1949, News Letter and requesting that the form be returned in the enclosed stamped and addressed envelope. Letters were sent to 191 members of the Association and also non-members for whom addresses were available. An estimated 87 percent of the total mink ranchers of the state were sent questionnaires.

Analysis of Questionnaires Sent to Mink Ranchers

Returns were received from 57 (30 percent) of the mink ranchers contacted. The returns were divided into three groups: (1.) those from the coastal regions (2.) those from the Willamette Valley and Medford area and (3.) those from east of the Cascade Mountains (Table 8).

The returns tabulated in Table 8 were used as a proportion of all the mink ranchers to determine the total number of mink in the state and the amount of whole fish, fillet scrap, and other food fed annually.

For example, in 1949 there were an estimated 95 mink ranchers in the coastal area. Returns which could be used were received from 22 (23 percent) of these mink ranchers. Dividing the appropriate figures for 1949 in Table 8 by 0.23 gives the total number of mink

in the coast area and the total amount of whole fish, fillet scrap, and other food fed for the year. The same procedure was followed for the Willamette Valley and Eastern Oregon areas (Table 9).

Interviews indicated that there was no great change in the total number of mink ranchers since 1947, so the same procedure was also applied to the 1947 and 1948 data.

The returns indicated that in 1949 each mink was fed an average of 99 pounds of food. About 155,000 mink consumed over 15 million pounds of food. Approximately 8 1/2 million pounds of the total were fillet scrap and 4 1/2 million pounds were whole fish.

The interest of the fishing industry has been centered on how much whole fish by species is used for mink food. The total consumption of whole fish by the mink, here estimated at 4 1/2 million pounds, is a very large poundage to be used for mink food. For example, in 1949 the poundage of each of the four most important species of bottom fish landed in Oregon was as follows: English sole 1,092,493 pounds; Dover sole 3,003,574 pounds; petrale sole, 1,514,762 pounds; and rockfish (all species) 4,737,478 pounds. A total of 10,348,307 pounds of the most important bottom fish species were landed in Oregon compared with a total of about 4,455,000 pounds of all whole fish landed for mink food.

However, all of the whole fish landed for mink food were not of commercial importance for human consumption. Furthermore, 1949 was an abnormal year because many of the Oregon fillet plants were closed part of the year because of market conditions. This forced many mink ranchers who would ordinarily have used fillet scrap to buy whole fish. Although the total food consumption by the mink increased in 1949, the consumption of fillet scrap decreased, which

resulted in a disproportionate increase in the amount of whole fish required by the mink ranchers. However, even in 1948 about 3,270,000 pounds of whole fish were used for mink food.

Analysis of the 1949 Mink Food Landings

Sampling of the mink food catches was again undertaken in 1949. Because of the irregular nature of the landings previously mentioned, samples of mink food were difficult to obtain. Twelve samples were taken, 7 in the Astoria area and 5 at Newport. The numbers of fish were converted to pounds and the percents by species calculated for each sample (Tables 10 and 12). The total pounds by species were then estimated for each landing sampled, (Tables 11 and 12) using the percents calculated in Tables 10 and 12. Then the pounds landed by species for each trip sampled were combined for the Astoria and Newport areas, respectively, and the combined percents by species calculated. It was these latter percentages which were used to estimate the total pounds by species of whole fish used for mink food in 1949.

Since there wereconsiderable differences in the amounts of the various species landed in the Astoria area and at Newport, it was necessary somehow to split the total amount of whole fish fed to the mink (4 1/2 million pounds) into Newport fish and Astoria fish. This was done arbitrarily by dividing the coast and valley mink ranches into two groups. One group was composed of the mink ranches nearest Astoria (67 percent) and the second group was of the mink ranches nearest Newport (33 percent). For the purpose of this analysis, the first group received their fish from Astoria and the second from Newport. No whole fish were shown in the

questionnaires from east of the Cascade Mountains. The location by counties of the Oregon mink ranchers for whom addresses are known is shown in Figure 19.

Using this arbitrary system 2,985,000 pounds of whole fish for mink food were landed in the Astoria area and 1,470,000 pounds at Newport. The average percents by pounds by species calculated in Tables 11 and 12 from the mink food samples were used to estimate the total pounds by species landed for mink food in each area (Table 13).

Mink Food Sampling in Astoria

In the Astoria area an estimated 1,116,000 pounds of rex sole were landed, followed by Dover sole 940,000 pounds, rockfish 639,000 pounds, and English sole 131,000 pounds. The rex sole, as mentioned before, are not used to any great extent for human food and the rockfish, although landed for filleting, have not been fished heavily since the close of World War II because of poor market conditions.

The Dover sole and the English sole were the two most important commercial species used for mink food during 1949 in the Astoria area.

Most of the male English sole captured by the otter-trawl nets are too small for filleting, although the great majority of them are mature fish. These small males are discarded unless the boats are fishing for mink food. In the 1949 mink food samples taken in the Astoria area there were 1.3 females for every male but in the food fish samples there were six females for every male (Fig. 20). These small, mature, male English sole are wasted when they are discarded at sea because practically all of them are dead. They should be harvested. However, a cod-end small enough to capture a large percentage of the mature English males will also capture immature

female English, petrale, and Dover sole if it is fished in an area where the small fish are present. Sixteen percent of the female English sole landed for mink food in 1949 were smaller than the 50 percent maturity size (30 centimeters).

The cod-ends used by the boats fishing for mink food in the Astoria region were in most cases a little smaller than the usual cod-ends of 4 1/2-5 inch stretched mesh including one knot. As a result smaller fish were probably taken by the mink food fishermen than by the human food fishermen.

Combining the sexes in the mink food and food fish samples respectively and drawing in the usual discard line (32 centimeters) indicated the relative numbers of English sole larger than the discard size (Fig. 21). Sixty-six percent by weight of the English sole in the mink food samples (52 percent by numbers) were large enough for filleting. An estimated 131,000 pounds of English sole were taken in the Astoria area for mink food and 66 percent of this yields 87,000 pounds large enough for filleting.

Almost a million pounds of Dover sole were landed in the Astoria area for mink food during 1949. Length-frequency samples were taken both of the mink food and fillet fish landings (Fig. 22).

The females predominated in both the mink food and fillet fish at almost the identical ratio (1.46 and 1.43 to one respectively). There was not such a great sexual difference in size which is one reason there were relatively more males in the Dover sole fillet fish samples than there were in the English sole samples. The smaller Dover sole, which would presumably be predominately males, were not present in abundance in the mink food either because they were not numerous on the fishing grounds or because they escaped through the meshes of the net. Even a 3 3/4 inch cod-end did not

capture an abundance of the fish under 32 centimeters (Fig. 7) indicating that they may have been in deeper water.

Sixty-four percent of the female Dover sole in the mink food samples were smaller than the 50 percent maturity size (39 centimeters) and 15 percent of the fillet fish were smaller than 39 centimeters. However, in many cases the large Dover sole were separated from the mink food and the small Dover sole were discarded from the fillet fish. If the nets used for both types of fishing are similar and, in particular, have the same size mesh in the cod-ends about the same percentage of small Dover sole should be retained in both cases. This also assumes that small Dover sole are not being caught deliberately which is not likely since they do not seem to be readily available.

The mode of the Dover sole mink food samples, both sexes combined, was at 35 centimeters and that of the fillet fish was at 39 centimeters (Fig. 23). Forty-five percent by numbers and 62 percent by weight of the Dover sole used for mink food were above the 36 centimeter discard size. Applying the latter percentage to the estimated total pounds of Dover sole landed for mink food in the Astoria area yields 583,000 pounds of Dover sole large enough to be used as fillet fish actually used for mink food.

Newport Mink Food Sampling

At Newport, 74 percent by weight of the mink food landed in 1949 was English sole. This amounted to slightly over a million pounds. Another 7 percent (107,000 pounds) of the landings for mink food was petrale sole.

The length-frequency mode of the male English sole landed in Newport for mink food was at 27 centimeters (Fig. 24) and the mode

from the Astoria area was 31 centimeters. For the females, the mode was at 38 centimeters for Newport and 34 centimeters for Astoria. Although the length-frequency mode for the females was at a larger size in Newport, the percent below the 50 percent maturity size also was greater at Newport than at Astoria (34 percent and 16 percent respectively). From the above, it may be concluded that not as many of the large fillet-sized English sole were sorted from the mink food in Newport as Astoria and that relatively more smaller fish were caught for mink food in Newport.

When both sexes were combined, (Fig. 25) 33 percent of the English sole sampled from the Newport mink food (55 percent by weight) were large enough to be used for fillet fish. When applied to the estimated total landings, this percentage yields approximately 598,000 pounds of English sole in the mink-feed large enough for filleting.

Because of the better demand for petrale sole for fillet fish, they were in most cases carefully sorted. Of the 40 petrale sole measured in the mink food, 36 were smaller than the discard size of 35 centimeters (Table 14). The sex ratio was approximately 50-50. All of the females were smaller than the 50 percent maturity size.

In 1949 an estimated 1,222,000 pounds of English sole were landed in Oregon for mink food and 1,092,000 pounds were landed for human food. However, there were an estimated 1,366,000 pounds of English sole actually caught by the boats fishing exclusively for fillet fish. The difference between the pounds caught and the pounds landed was the discard which was estimated from the average percent by weight of English sole discarded at sea in 1950 (Table 5). Of the estimated 1,222,000 pounds of English sole landed in Oregon for mink food in 1949, about 684,000 pounds (63 percent) were large

enough to be used for fillet fish.

A total of about 940,000 pounds of Dover sole were landed in Oregon for mink during 1949. Slightly over three million pounds of Dover sole were landed for human consumption during this period. Of the 940,000 pounds used for the mink 583,000 pounds (62 percent) were large enough for filleting.

Mink Food Samples, 1950

In 1950 four mink food samples were taken at Newport. The samples averaged 53 percent English sole. Other species of importance in the mink food were Bellingham sole 21 percent, sand dabs 9 percent, and petrale sole 6 percent.

There were slightly over two males for each female English sole in the mink food samples and about one male to 14 females in the fillet fish samples (Fig. 26). In 1949 the ratio of males to females was 0.7 to 1.0. The increase in the percentage of males in the mink food samples was probably caused by closer sorting of the larger females from the mink food samples.

A total of 25 female and 13 male petrale sole were measured in the mink food. The largest female was 32 centimeters, well below both the 50 percent maturity size and the usual discard size.

No mink food samples were taken in the Astoria area during 1950.

Summary

1. In 1949 there were approximately 200 mink ranchers in Oregon and the annual value of the pelts and breeding stock was about $2,000,000.

2. Market samples of the whole fish landed by the otter-trawlers for mink food in 1948 showed that several species not important for human food were being utilized but that English, petrale, and Dover

soles, which are important human food fish, were also being used.

3. It was estimated from questionnaires sent to the mink ranchers that in 1949 about 8 1/2 million pounds of fillet scrap and 4 1/2 million pounds of whole fish were consumed by mink in Oregon.

4. Sampling of the 1949 mink food landings and questionnaires sent to the mink ranchers indicated that approximately the following poundages were landed in Oregon:

a. English sole	1,222,000 lbs.	e. Petrale sole	106,000 lbs.
b. Rex sole	1,116,000 lbs.	f. Starry flounder	78,000 lbs.
c. Dover sole	983,000 lbs.	g. All others	311,000 lbs.
d. Rockfish	639,000 lbs.		

5. Sixty-six percent by weight (52 percent by numbers) of the English sole in the market mink food samples taken in the Astoria area during 1949 were large enough for filleting. At Newport, the percentages were fifty-five percent by weight and 33 percent by numbers.

6. Relatively more small English sole were taken for mink food in the Newport area than in the Astoria area in 1949.

7. Sixty-two percent by weight of the Dover sole mink food samples taken in the Astoria vicinity in 1949 were larger than the discard size.

8. Poor market conditions for the otter-trawl species in 1949 probably resulted in a greater consumption of whole fish by mink than is the usual case.

Conclusions

Whether or not the mink food fishery is tending to deplete the stocks of fish used for human consumption depends primarily on the conditions of these stocks. If the various species are being fished

heavily for human consumption, the added pressure of a mink food fishery might be harmful to the stocks of fish. However, when market conditions for fillet fish are good, the fishermen sort out the fish of fillet size more carefully because of the better price paid. This leaves the smaller fish and so-called scrap fish to be used for mink food. Observations by Fish Commission biologists have indicated that almost all of the English, petrale, and Dover soles brought aboard otter-trawlers are dead before sorting of the catch is completed. These small fish and the scrap fish should be utilized rather than returned to the ocean dead. A law providing that the mesh in the cod-ends must be larger than a designated minimum size would allow many of the smaller fish to escape through the cod-ends.

When market conditions for fillet fish are mediocre or poor, as was the case in 1949, the surplus not needed to perpetuate the stocks of food fish at a high level should be utilized for mink food or for other purposes rather than wasted entirely.

Analysis of the catch records of the bottom fish species during World War II years and shortly thereafter when the fishing effort was most intense indicates that the stocks of petrale sole utilized by the Astoria otter-trawlers have been heavily fished and are in poor condition. The stocks of English sole, Dover sole, and rockfish, however, appear to be still in relatively good condition.

Even though, with the exception of the petrale sole, the stocks of food fish being used by the Astoria otter-trawlers appear to be in good condition, it is believed that measures should be taken to decrease the pressure on the stocks of food fish by the mink ranchers.

The reason for this is that with our present knowledge of the complicated otter-trawl fishery it may not be possible to detect the early harmful effects caused by a mink food fishery. Furthermore, some of the mink food fishermen are using, and others may be tempted to use, smaller mesh in cod-ends than is the usual practice of the fishermen. This results in the capture of an undue proportion of immature females, particularly English and petrale sole. Also, the mink food fishermen may be inclined to fish in areas where immature fish, in particular English sole, congregate.

Recommendations

1. It is recommended that the minimum size mesh used in the cod-end be 4 1/2 inches, stretched mesh, center to center of the knots, which will leave an opening of about 4 inches with a standard 120 thread cod-end treated for preserving in a standard way.
2. It is recommended that nursery areas for immature fish, if and when they are found, be closed to all fishing. This applies particularly to English sole because the young of this species are found more abundantly in shallow water where they are easily available to the otter-trawlers.
3. Efforts should be made to encourage the use of scrap fish not now in demand by the mink ranchers. Diet experiments have been undertaken by the Fish and Game Department at Oregon State College using some of these species and the results will be published soon. (One result, not for public distribution until published, is that the turbot, which is now not wanted by either the fish plants or mink ranches, is a very desirable food for producing large mink).

4. Sampling of the catches aboard the fishing vessels in 1950 indicates that approximately one half of the total pounds landed at sea is discarded. Efforts should be made to utilize this wasted fish for mink food or some other use.

5. Studies of the mink food fishery should be continued.

Albacore Age Determination

Length-frequency studies have been relied upon for years in analyzing albacore populations. The two characteristic modes obtained in most of these curves are thought to be age classes. The immediate purpose of this work is to discover if there is any possible method of determining the age of these fish. Secondly, it is hoped that we can discover the meaning of the modes in the length-frequency curves. If these represent age groups, the previous length-frequency data on albacore will have more meaning, and we can continue studying the fish in this rather simple manner.

Three samples of 50 fish were collected: 2 samples from Northern California albacore and one sample from Japanese albacore. Scales and spines were collected and body length measurements were taken as the fish were butchered. Tags were placed on the fish to enable the collection of vertebrae as the fish were cleaned after being precooked.

Scales were collected from above the lateral line near the second dorsal fin. The first 3 or 4 spines were taken from the first dorsal fin. A cut was made anteriorly separating the connecting tissues of the spines and the supporting interneurals thereby obtaining the whole spine. The vertebra supporting the first haemal arch was collected from each fish. This is almost invariably on the tenth vertebra, and was readily identifiable.

Some thirty scales have been mounted from the Japanese albacore sample, and these show rings. Whether they represent age marks has not been determined. The pilchard method of cleaning and dry mounting seems most satisfactory, but the process is slow. Every scale must be selected as many are not readable.

The spines were dried and an approximate 0.5 m.m. section was cut from the base of the first dorsal spine with a jewelers' fret saw. The sections show definite and easily read rings in the outer zone when mounted in a permanent balsam medium. However, the inner zone or center of the spine is interspersed with numerous ducts. These obliterate any rings that might be in this central region. No attempt has been made to correlate the rings with age.

The vertebra were placed in 10 percent N Potassium hydroxide for several days and then fixed in 95 percent alcohol. This failed to produce readable rings, and further technical details are being sought before proceeding with this work. It is hoped that the three methods together will produce a workable method of age determination for albacore possibly supported by one or both of the other methods.

Table 1. Numbers of Overlap Species at the 20, 30, and 40 Percent Minima for Astoria Otter Trawl Landings, June, 1942 and 1946.

	1942 - June - Astoria			1946 - June - Astoria		
	19%	29%	39%	19%	29%	39%
DOVER	31	31	31	76	68	60
English	0	0	0	16	6	2
Petrale	0	0	0	7	2	1
Rockfish	0	0	0	8	0	0
ENGLISH	0	0	0	95	84	65
Dover	-	-	-	16	6	2
Petrale	-	-	-	16	7	1
Rockfish	-	-	-	12	9	3
PETRALE	37	32	31	41	30	21
Dover	0	0	0	7	2	1
English	0	0	0	16	7	1
Rockfish	10	3	2	7	2	0
ROCKFISH	12	6	6	45	37	32
Dover	0	0	0	8	0	0
English	0	0	0	12	9	3
Petrale	10	3	2	7	2	0

TOTAL LANDINGS FOR:

1. 1942 - June - Astoria: 82
2. 1946 - June - Astoria: 204

Table 2. Total Pounds Landed, Number of Trips, and Pounds Per Trip (Apr.-Sept.) for Significant (>29% of total) Landings of Dover Sole at Astoria by Linkage Boats for 1942-1946, incl., Together with Total Oregon Landings of Dover, Apr.-Sept. and Jan.-Dec., for 1942-1946, incl.

YEAR	LANDINGS IN LBS.	NO. OF TRIPS	LBS. PER TRIP	TOTAL OREGON LANDINGS (Apr.-Sept.)	TOTAL OREGON LANDINGS (Jan.-Dec.)
1942	1,370,802	86	15,940	2,108,278	2,308,508
1943	4,189,560	233	17,981	6,295,580	6,431,666
1943	5,275,086	284	18,574		
1944	756,146	53	14,267	1,364,588	1,593,469
1944	826,476	58	14,250		
1945	1,613,583	93	17,350	2,273,292	2,704,216
1945	1,808,668	101	17,908		
1946	2,203,208	180	12,240	3,173,780	3,197,988

Table 3. Total Pounds Landed, Number of Trips, and Pounds Per Trip (Apr.-Sept.) for Significant (>29% of total) Landings of English Sole at Astoria by Linkage Boats for 1942-1946, incl., Together with Total Oregon Landings of English, Apr.-Sept. and Jan.-Dec., for 1942-1946, incl.

YEAR	LANDINGS IN LBS.	NO. OF TRIPS	LBS. PER TRIP	TOTAL OREGON LANDINGS (Apr.-Sept.)	TOTAL OREGON LANDINGS (Jan.-Dec.)
1942	4,065	2	2,033	139,326	227,793
1943	93,678	17	5,510		
				508,260	898,639
1943	90,423	16	5,651		
1944	107,848	36	2,996		
				658,575	1,057,701
1944	96,007	34	2,824		
1945	61,360	12	5,113		
				510,756	1,096,601
1945	182,553	28	6,520		
1946	1,320,764	185	7,139	3,360,287	3,950,609

Table 4. Total Pounds Landed, Number of Trips, and Pounds Per Trip (Apr.-Sept.) for Significant (>29% of total) Landings of Petrale Sole at Astoria by Linkage Boats for 1942-1946, incl., Together with Total Oregon Landings of English, Apr.-Sept. and Jan.-Dec., for 1942-1946, incl.

YEAR	LANDINGS IN LBS.	NO. OF TRIPS	LBS. PER TRIP	TOTAL OREGON LANDINGS (Apr.-Sept.)	(Jan.-Dec.)
1942	1,327,455	168	7,902	3,318,846	3,745,236
1943	548,700	67	8,190		
				3,400,749	3,805,094
1943	657,938	79	8,328		
1944	351,867	52	6,767		
				1,871,382	2,019,162
1944	400,042	47	8,512		
1945	218,567	35	6,245		
				1,151,872	1,574,143
1945	260,925	46	5,672		
1946	624,721	148	4,221	2,695,619	2,984,092

Table 5. Fishermen Selectivity Data by Species

DOVER

Month	Exp. No.	Pounds Landed	Numbers Landed	Pounds Caught	Numbers Caught	Pounds Discarded	Numbers Discarded	Percent Pounds Discard	Percent Numbers Discard	Mesh Size
May	1	12480	6420	18850	13041	6369	6454	33.79	49.49	4.9"
June	3*	32614	21503	32614	21503	--	--	--	--	5.0"
June	5+	2016	1438	3583	3535	1567	2097	43.73	59.33	3.8"
July	8*	15352	8955	15352	8955	--	--	--	--	5.3"
Aug.	9	11290	6865	13923	10440	2633	3575	18.91	34.24	4.3"
Aug.	10*	11600	5629	11600	5629	--	--	--	--	5.3"?
Aug.	Newport 1	21075	11000	22959	12471	1884	1471	8.21	11.79	4.6"
Totals		104411	60372	115298	72039	10884	11500	9.44	15.96	

PETRALE

Month	Exp. No.	Pounds Landed	Numbers Landed	Pounds Caught	Numbers Caught	Pounds Discarded	Numbers Discarded	Percent Pounds Discard	Percent Numbers Discard	Mesh Size
May	1	17596	8838	21645	13593	4050	4758	18.71	35.00	4.9"
Sept.	12	12622	6580	15794	9746	3171	3166	20.08	32.49	4.9"
Aug.	Newport 2	15794	8411	17039	9496	1246	1085	7.31	11.43	5.5" Rope
Totals		48012	23829	54478	32835	8467	9009	15.54	27.44	

ENGLISH

Month	Exp. No.	Pounds Landed	Numbers Landed	Pounds Caught	Numbers Caught	Pounds Discarded	Numbers Discarded	Percent Pounds Discard	Percent Numbers Discard	Mesh Size
May	2	24497	28115	31971	43500	7475	15386	23.38	35.37	5.0"
June	4A	1573	1470	3716	5881	2143	4411	57.67	75.00	4.6"
July	8*	21727	24684	21727	24684	--	--	--	--	5.3"
Aug.	10	7021	7479	8069	9493	1048	2013	12.99	21.21	5.3"?
Sept.	12	31478	32694	42385	51235	10906	18542	25.73	36.19	4.9"
Totals		86296	94442	107868	134793	21572	40352	20.00	29.94	

* No discard + Not considered a random sample and not used in computing totals or averages.

Table 6. Estimates of the Catch Composition by Numbers Aboard Mink Food Boats, 1948. (4 1/2" stretched mesh cod-end)

Date	Drag No.	Percent by Numbers								Est. of total Pounds Landed
		Rex	Eng.	Pet.	Turbot	Dover	Hake	Flounder	Misc.	
Aug. 8	1	30	25	15	8				22	---
	2		30	30	8			5	27	---
	3		50		5		10	30	5	---
Aug. 9	1		40				30		30	
	2		40					40	20	300
	3		50					20	30	---
	4		70		5		5	10	10	---
Average for trip		4	44	6	4		6	15	21	
Aug. 11	1		40					30	30	---
	2	30	30					20	20	---
	3	20	40					30	10	---
Aug. 12	1	5	50					35	10	---
	2		40	40					20	---
Average for trip		11	40	8				23	18	
Aug. 17	1	20	60						20	5,500
	2		70					15	15	4,000
Aug. 18	1		70			5		5	20	3,500
	2	5	60			5		15	15	10,000
	3	5	40		5	5		40	5	12,000
	4		70					10	20	11,000
Average for trip		5	62		1	3		14	16	

Distribution of Catch, all trips combined.

Bellingham Sole	All used for mink food.
English "	Estimated 10% used for food fish; remainder for mink food.
Petrale "	Large petrale used for food fish; small for mink food.
Dover "	All except a few large ones used for mink food.
Skates	All thrown back apparently in good condition.
Hake	All of them thrown back dead.
Arrow-tooth "	All thrown back dead.
Crabs	Crabs thrown back mostly in good condition.
Flounders	Estimated 10% used as human food; remainder for mink food.
Dogfish	Livers removed and carcasses discarded.
Green rockfish	All used for mink food.
Orange rockfish	All used for mink food.
Ling cod	Large ones used for food fish; small ones for mink food.
True cod	Large ones used for food fish; small ones for mink food.
Black cod	Large ones used for food fish; small ones for mink food.
Halibut	All returned to the water in good condition.
Rex Sole	All used for mink food.
Sand dabs	All used for mink food.

Table 7. Estimated Pounds of English Sole Used for Mink and Human Food From Three Sea Trips, 1948

Date	Total Pounds Landed	Estimated Pounds of English Sole Landed	Estimated Number of English Sole Used for Human Food	Estimated Pounds of English Sole Used for Human Food	Estimated Number of English Sole Used for Mink Food	Estimated Pounds of English Sole Used for Mink Food	Estimated Pounds of English Sole Large Enough for Filleting
Aug. 10	31,191	9,000	1,233	1,233	11,096	7,767	2,874
Aug. 13	3,743	2,338	320	320	2,883	2,018	747
Aug. 19	46,127	24,625	3,373	3,373	30,360	21,252	7,863
Total	81,051	35,963	4,926	4,926	44,339	31,037	11,484

Table 8. Tabulation by Areas of Returns From Questionnaires Sent to Mink Ranchers

	WEST OF COAST RANGE			WILLAMETTE VALLEY		
	1947	1948	1949	1947	1948	1949
Number of mink	12,006	16,708	20,649	6,681	10,186	10,874
Pounds whole fish fed	343,400	452,900	760,047	60,050	150,750	195,594
Pounds fillet scrap fed	874,534	1,211,388	1,180,334	344,150	474,295	564,475
Other food fed	169,922	198,991	264,955	74,010	157,721	146,777
Total pounds fed	1,387,856	1,863,279	2,205,336	478,210	782,766	906,846
Total food fed per mink	116	112	107	72	77	83

	EAST OF CASCADE MOUNTAINS		
	1947	1948	1949
Number of mink	No Information	144	215
Pounds whole fish fed		0	0
Pounds fillet scrap fed		0	945
Other food fed		9,600	15,456
Total pounds fed		9,600	16,401
Total food fed per mink		67	76

Table 9. Estimated Poundages Fed by Mink Farmers in 1947, 1948 and 1949. Also Estimate of Mink Numbers.

COAST

	1947	1948	1949	Total
Number of Mink	80,040	83,540	89,778	253,358
Pounds whole fish	2,289,333	2,264,500	3,304,552	7,858,385
Pounds fillet scrap	5,830,227	6,056,440	5,131,886	17,019,053
Other food	1,132,813	994,955	1,151,978	3,279,746
Total pounds fed	9,252,373	9,316,395	9,588,416	28,157,184

EASTERN OREGON

	*1947	1948	1949	Total
Number of Mink	1,800	1,800	1,792	5,392
Pounds whole fish	0	0	0	0
Pounds fillet scrap	0	0	7,875	7,875
Other food	120,000	120,000	128,800	368,800
Total pounds fed	120,000	120,000	136,675	376,675

VALLEY

	1947	1948	1949	Total
Number of Mink	55,675	67,907	63,956	187,547
Pounds whole fish	500,417	1,005,000	1,150,553	2,655,970
Pounds fillet scrap	2,867,917	3,161,967	3,320,441	9,350,325
Other food	616,750	1,051,473	863,394	2,531,617
Total pounds fed	3,985,084	5,218,440	5,334,388	14,537,912

ENTIRE STATE

	1947	1948	1949	Total
Number of Mink	137,515	153,247	155,535	446,297
Pounds whole fish	2,789,750	3,269,500	4,455,105	10,514,355
Pounds fillet scrap	8,698,144	9,218,907	8,460,202	26,377,253
Other food	1,869,563	2,166,428	2,144,172	6,180,163
Total pounds fed	13,357,457	14,654,835	15,059,479	43,071,771

* No returns from questionnaires.
Estimated same as 1948.

Table 10. Mink Feed Samples, Astoria Area, 1949

	Dover Sole	English Sole	Petrale Sole	Rex Sole	Bellingham Sole	Sand Dabs	Flounders	Skates	True Cod	Shad	Green Rockfish	Black Rockfish	Red Rockfish	Sebastodes alutus	Sablefish	Ling Cod	Arrow-tooth Sole	Tom Cod
January 14 (96 fish)																		
Percent by weight in sample		6.3	3.1	40.6		29.2			4.2	3.1							8.3	5.2
June 3 (158 fish)																		
Percent by weight in sample	38.6	6.3	1.3	39.9	0.6	1.3		0.6	2.5	1.9	1.9	1.9	3.2					
June 24 (139 fish)																		
Percent by weight in sample	44.6	4.3		36.7		0.7	3.6	2.9					3.6		1.4	2.2		
July 1 (192 fish)																		
Percent by weight in sample	19.0	3.0		8.0							27.0		20.0	23.0				
July 11 (238 fish)																		
Percent by weight in sample	44.1	1.3		50.8	0.4		2.1	0.4									0.8	
August 8 (129 fish)																		
Percent by weight in sample	23.3	21.7	0.8	46.5		3.1		0.8					3.9					
August 18 (278 fish)																		
Percent by weight in sample	25.2	1.4		67.6	2.9	1.8		1.1										

Total number in samples = 1230

Table 11. Estimated Total Pounds by Species in Each Load Sampled, Mink Feed, Astoria Area, 1949

Date	Dover Sole	English Sole	Petrale Sole	Rex Sole	Bellingham Sole	Sand Dabs	Flounders	Skates	True Cod	Shad
January 14	--	25	12	162		117			17	12
June 3	5261	859	177	5438	82	177		82	341	259
June 24	22077	2129		18167		347	1782	1436		
July 1	10868	1716		45576						
July 11	12260	361		14122	111		584	111		
August 8	3491	3251	120	6967		464		120		
August 18	9783	543		26242	1128	699		427		
Total Pounds	63740	8884	309	75674	1321	1804	2366	2176	358	271
% by species, all landings combined	31.5	4.4	0.2	37.4	0.7	0.9	1.2	1.1	0.2	0.1

Table 11. Estimated Total Pounds by Species in Each Load Sampled, Mink Feed, Astoria Area, 1949 (Continued)

Date	Green Rockfish	Black Rockfish	Red Rockfish	Sebastodes alutus	Sablefish	Ling Cod	Arrow-tooth Sole	Tom Cod	Total
January 14							33	21	399
June 3	259	259	436						13,630
June 24			1782		693	689			49,502
July 1	15,444		11,440	13,156					57,200
July 11						222			27,771
August 8		-	584						14,997
August 18									38,822
Total Pounds	15,703	259	14,242	13,156	693	1311	33	21	202,321
% by species, all landings combined	7.8	0.1	7.0	6.5	0.3	0.6	--	--	

Table 12

Mink Food Samples, Newport, 1949

July 16	Dover Sole	Eng. Sole	Pet. Sole	Rex Sole	Belling-ham Sole	Sand Sole	Sand Dabs	Floun-ders	Rock-fish	Ling Cod	Arrow-tooth Sole	Totals	No. of fish in sample
% by wt. in sample	7.1	80.9	7.1	2.4	2.4								53
Est. total wt. in landing	613	6990	613	207	207							8,630	
July 20													
% by wt. in sample	3.4	58.6	10.3	3.4	2.3	2.3	4.6	14.9					96
Est. total wt. in landing	358	6164	1083	358	242	242	484	1567				10,498	
July 28													
% by wt. in sample	20.4	38.8	2.0						6.1	24.5	8.2		42
Est. total wt. in landing	245	466	24						73	294	98	1,200	
Aug. 11													
% by wt. in sample		93.8	3.1	1.9	0.6		0.6						203
Est. total wt. in landing		14689	485	298	94		94					15,660	
Sept. 8													
% by wt. in sample	1.3	57.2	11.3		5.7	10.1	5.7	8.8					177
Est. total wt. in landing	123	5409	1069		539	955	539	832				9,466	
Total lbs. in all landings sampled	1339	33718	3274	863	1082	1197	1117	2399	73	294	98	45,454	
% by species, all landings combined	2.9	74.2	7.2	1.9	2.4	2.6	2.5	5.3	0.2	0.6	0.2		

Total number of fish in samples = 571

Table 13. Pounds of various species of whole fish fed to mink, 1949 season.

Percent of Coast and Valley Mink Growers getting fish in Astoria Area	67% (100 mink farmers)
Percent getting food in Newport Area	33% (50 mink farmers)

Pounds whole fish fed in Coast and Valley	4,455,105
Pounds whole fish from Astoria Area	2,984,920
Pounds whole fish from Newport Area and South	1,470,185

Pounds by Species from Astoria Area

Rex (37.4%)	1,116,360	Rockfish (21.4%)	638,773	All others (5.3%)	158,201
Dover (31.5%)	940,250	English (4.4%)	131,336		

Pounds by Species from Newport Area

English (74.2%)	1,090,877	Flounder (5.3%)	77,920	All others 10.4%	152,899
Petrale (7.2%)	105,853	Dover (2.9%)	42,635		

Pounds by Species Both Areas Combined

English Sole	1,222,213	Rockfish	638,773
Rex Sole	1,116,360	Petrale	105,853
Dover Sole	982,865	Flounder	77,920
		All others	311,100

Table 14
Length-Frequency of Petrale Sole Used for Mink Food
Newport, 1949

Length	Not Sexed	Female	Male	Total
21	1	2	1	4
22				
23				
24				
25	1	1	3	5
26	1	1	3	5
27				
28	1	3		4
29		2	1	3
30			1	1
31			1	1
32		4		4
33			1	1
34		1	3	4
35		2	2	4
36				
37		1	1	2
38				
39				
40			1	1
41				
42				
43				
44				
45				
46				
47				
48			1	1
Totals	4	17	19	40

Figure 1. Frequency Polygons, by Year, of Monthly Totals of Oregon Otter Trawlers Fishing and Average Numbers of Landings per Boat, 1942-1946, incl.

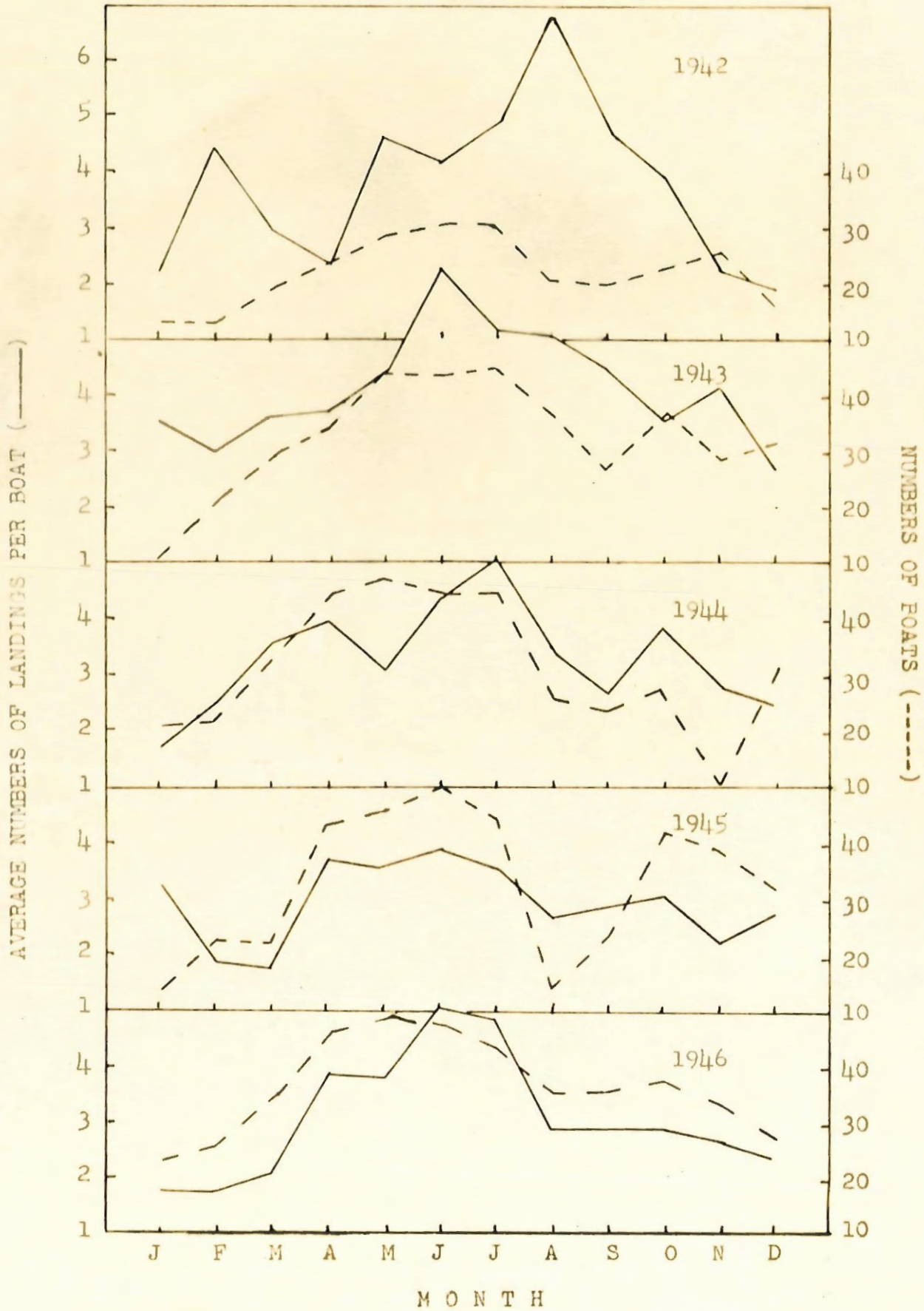


Figure 2. Oregon Dover Sole Landings Expressed as Monthly Percentages of Annual Totals, 1942-1946, incl.

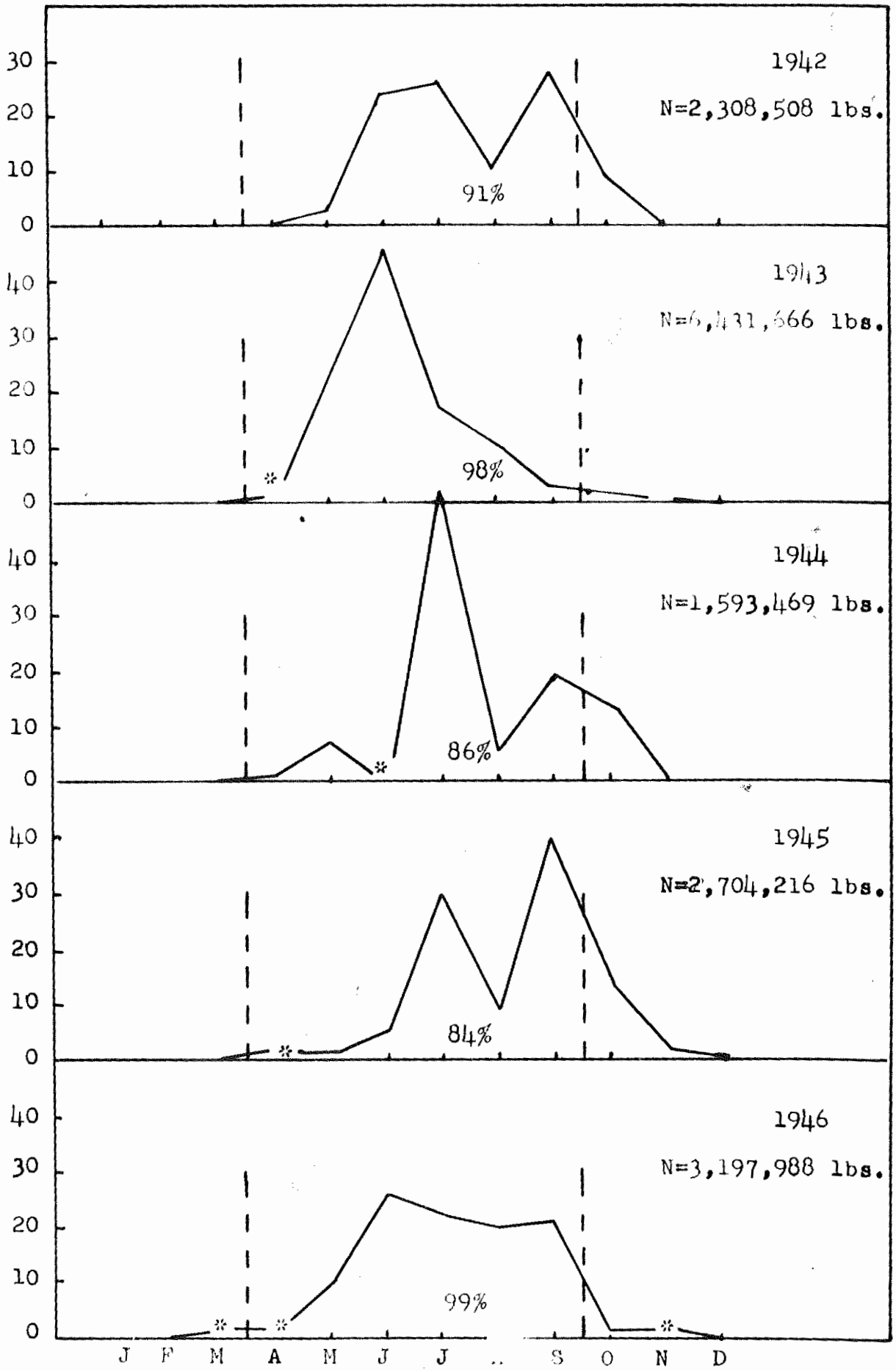
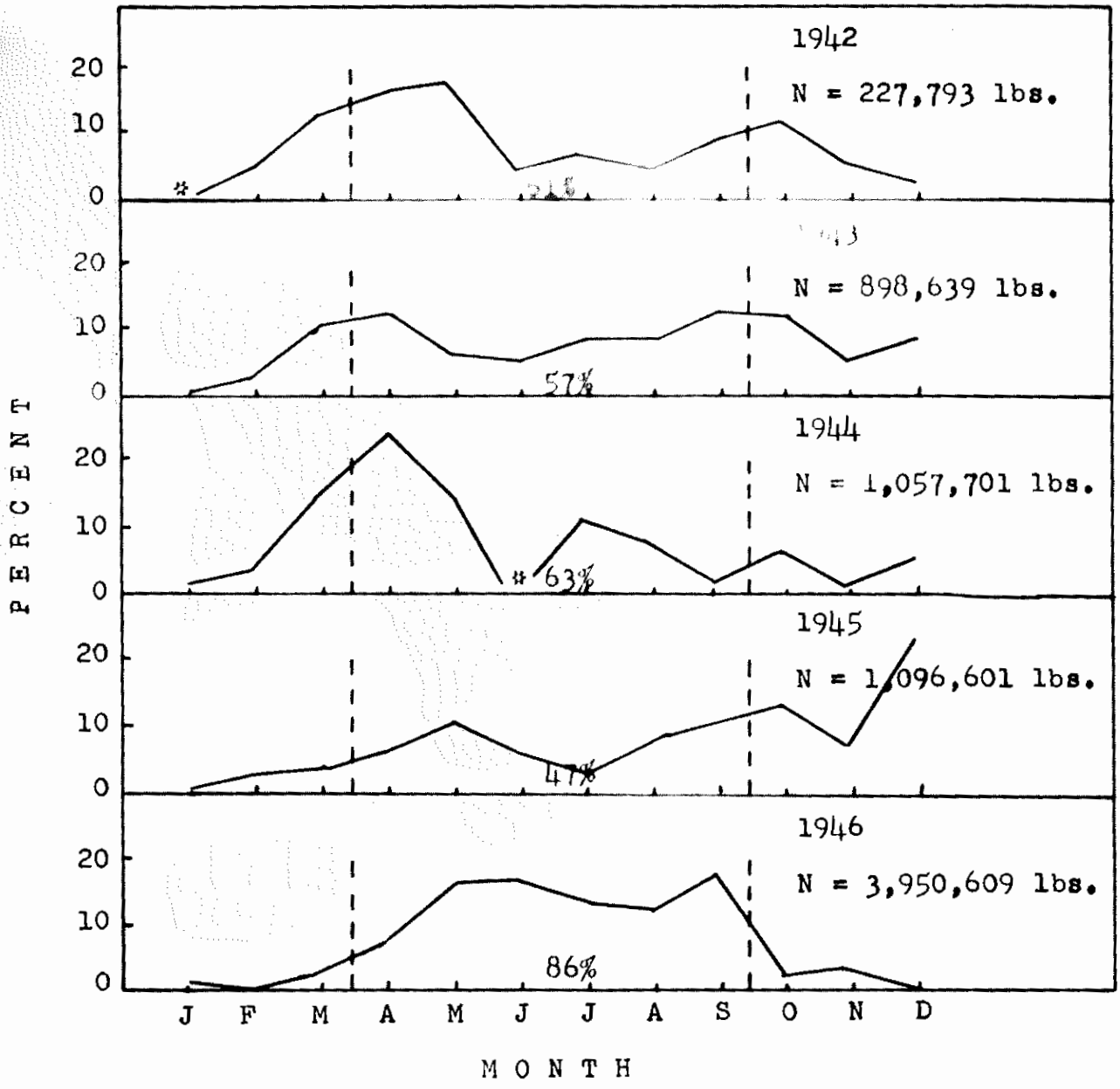
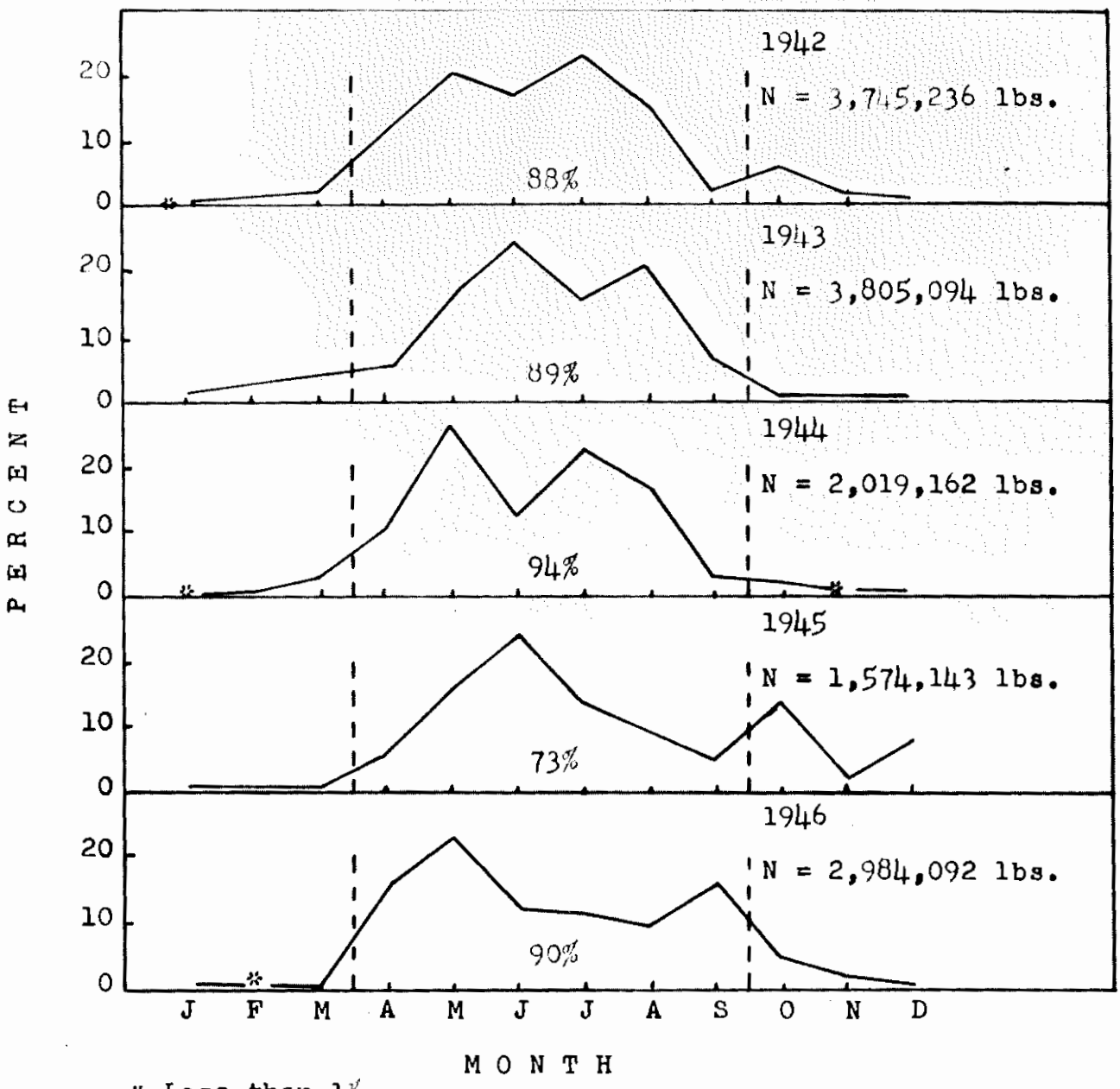


Figure 3. Oregon English Sole Landings Expressed as Monthly Percentages of Annual Totals, 1942-1946, incl.



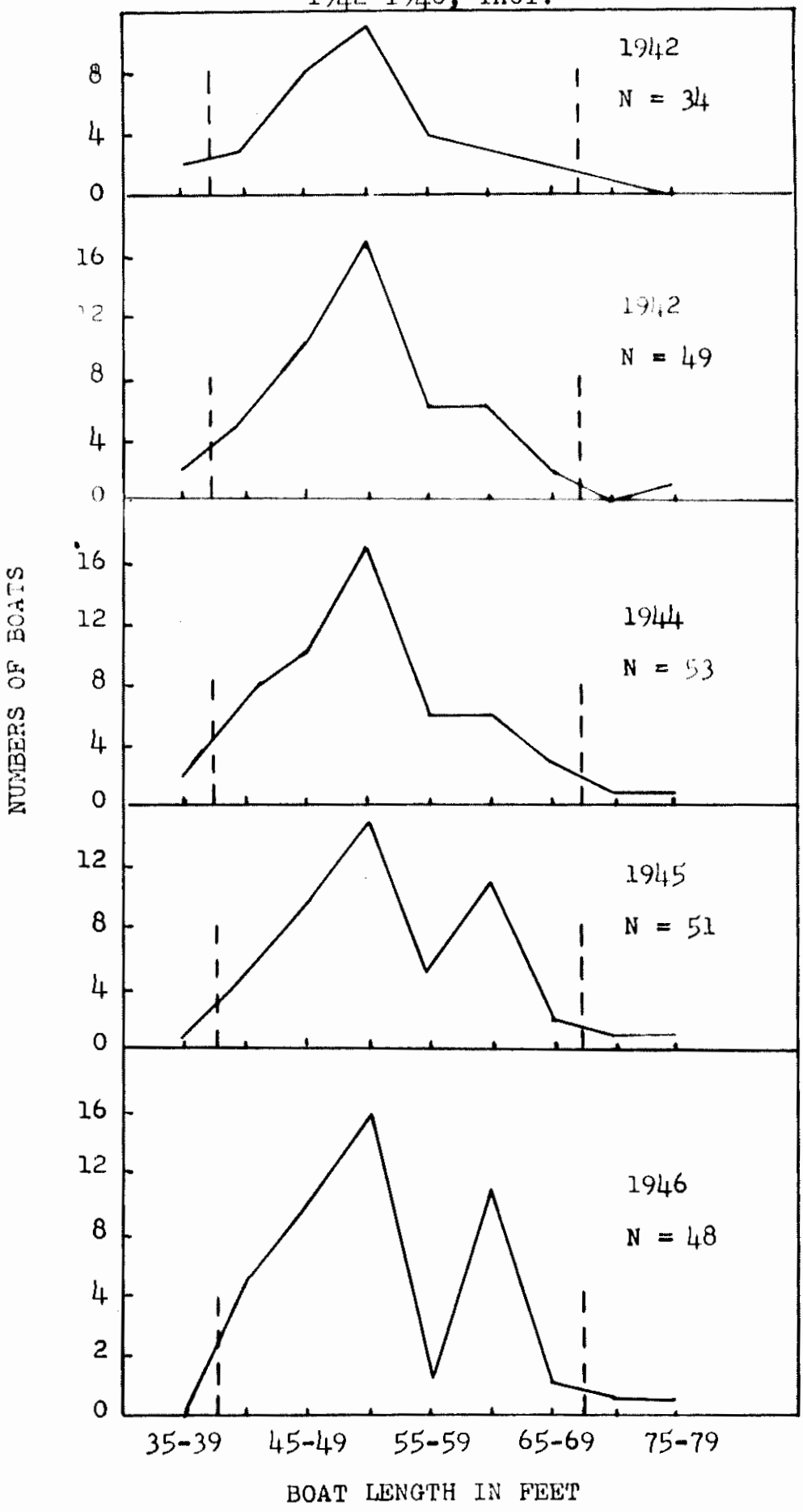
* Less than 1%

Figure 4. Oregon Petrale Sole Landings Expressed as Monthly Percentages of Annual Totals, 1942-1946, incl.



* Less than 1%

Figure 5. Linkage Boat Length-Frequency Polygons (five foot intervals) for Oregon Otter Trawl Fleet, 1942-1946, incl.



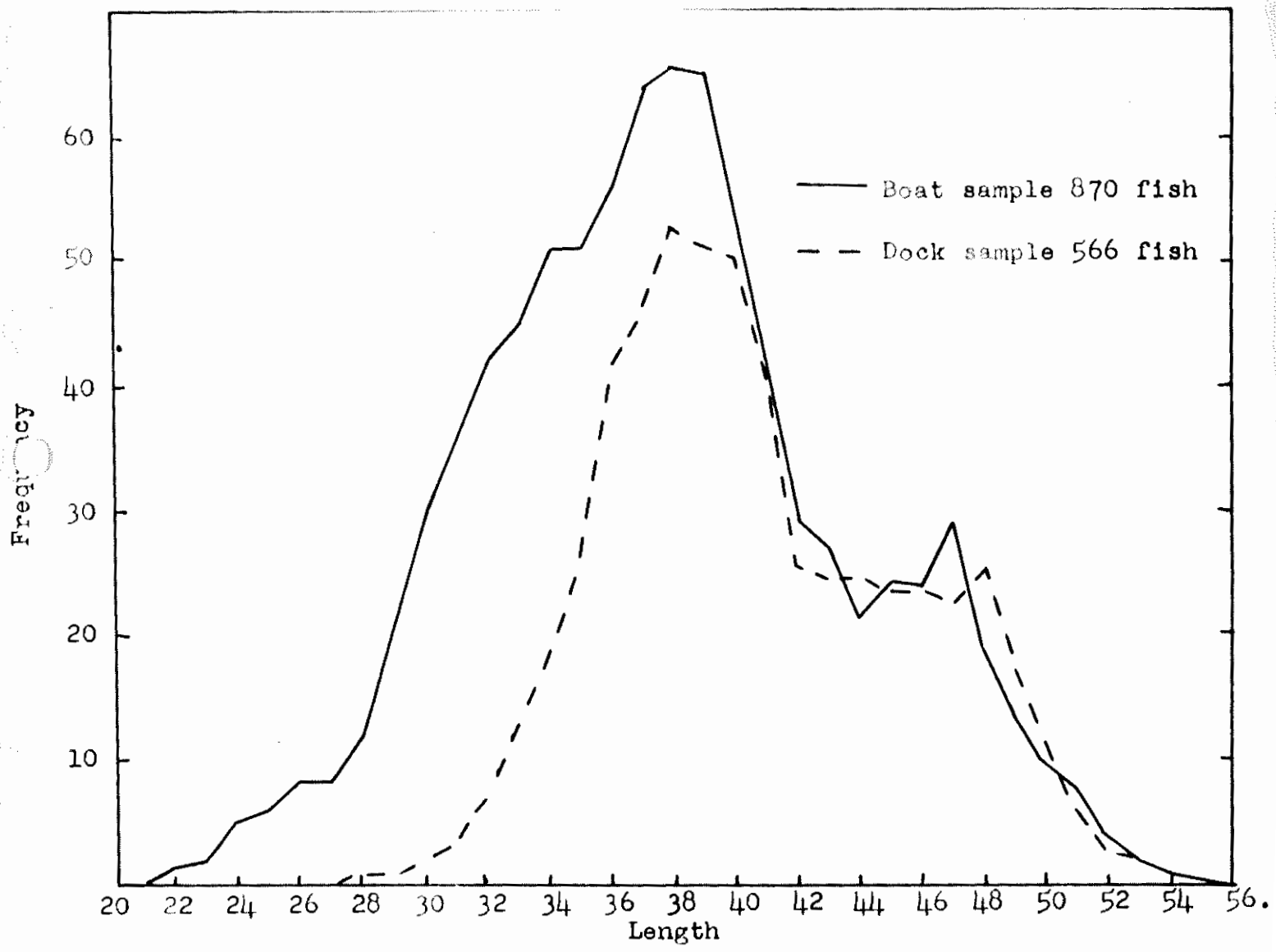


Figure 6. Petrale sole length frequency distribution from experiment no. 1 showing how the dock sample is adjusted to the boat sample. In this experiment the two curves were adjusted from 41 cm. and larger.

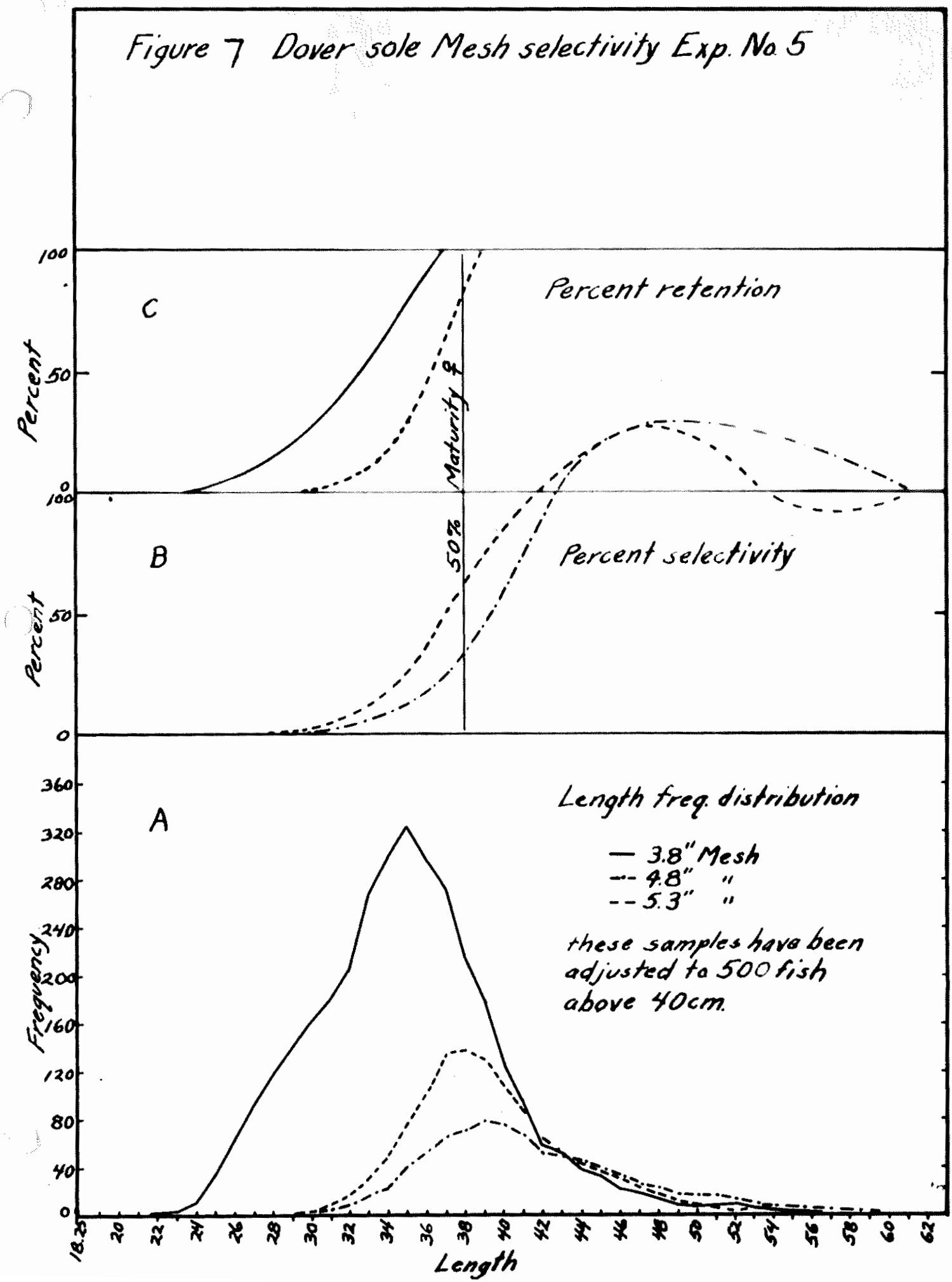


Figure 7 Dover sole Mesh selectivity Exp. No 5
C
Percent retention
Percent
100
50
0
Maturity ♀
100
B
50%
Percent selectivity
Percent
50
0
360
A
Length freq. distribution
320
— 3.8" Mesh
-- 4.8" "
-- 5.3" "
280
these samples have been adjusted to 500 fish above 40cm.
240
Frequency
200
160
120
80
40
0
18.25
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
Length

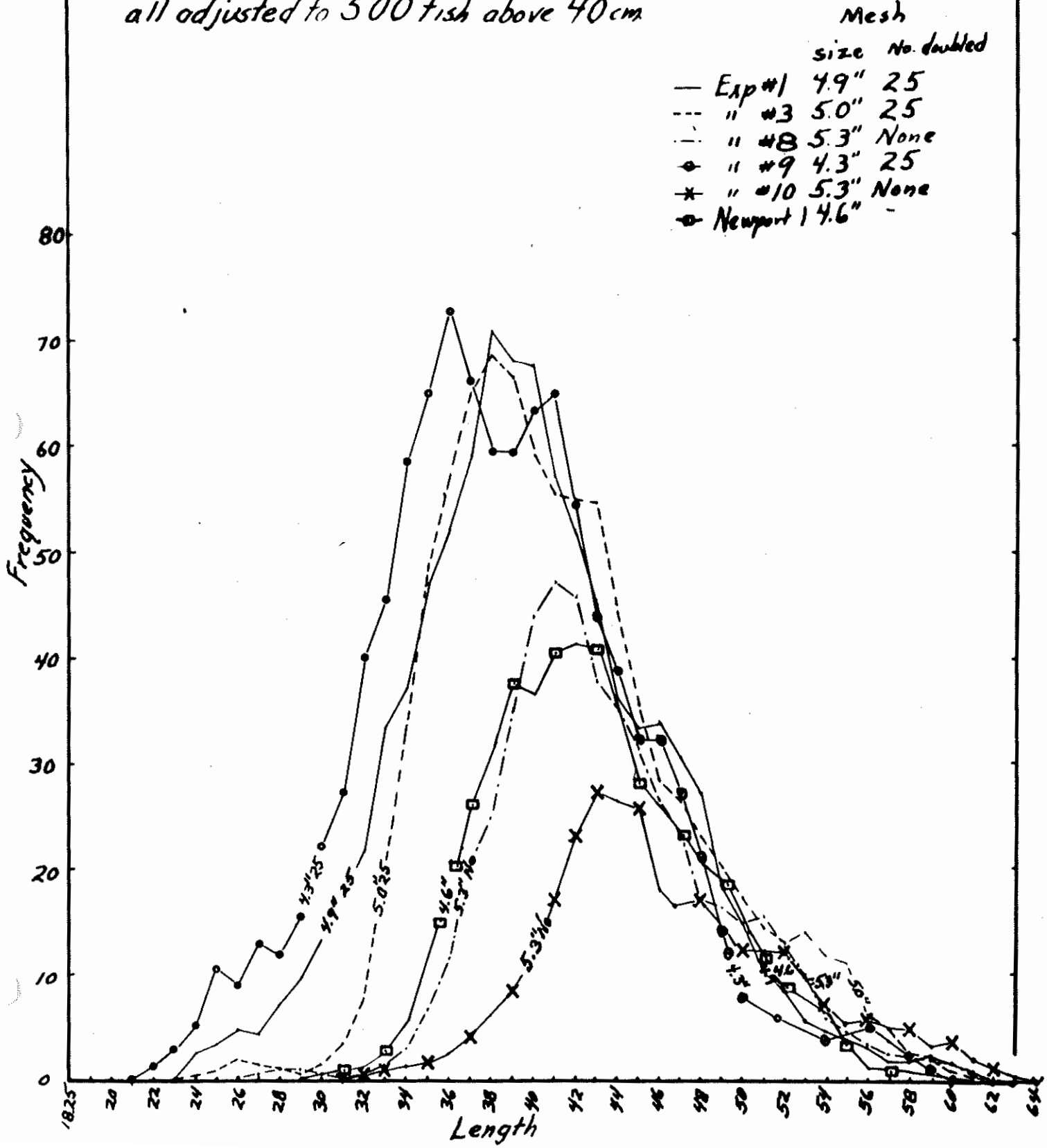
Figure 8

Dover 1950 Length-frequency

Mesh Selectivity

Boat Samples

all adjusted to 500 fish above 40 cm



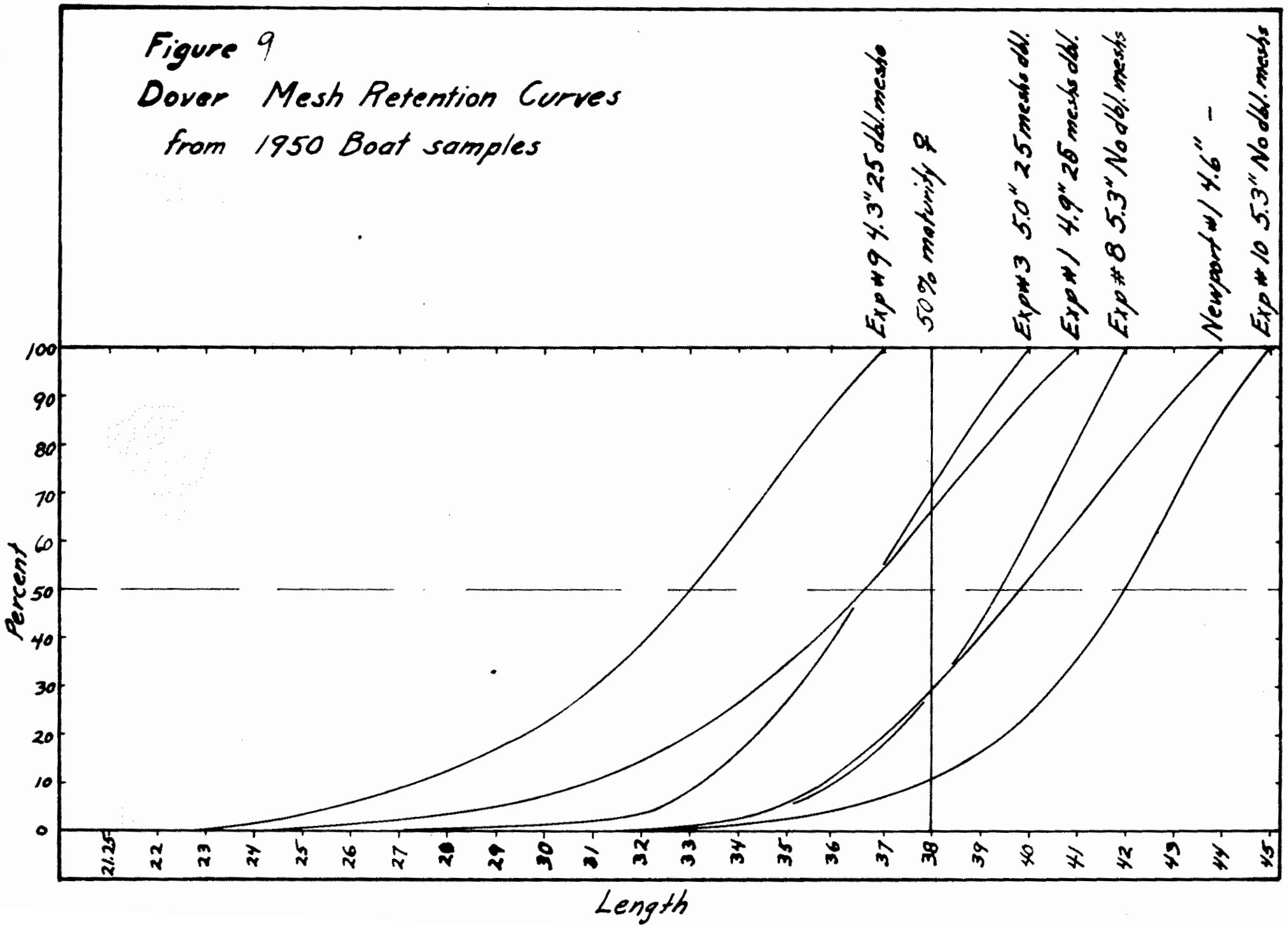


Figure 9
Dover Mesh Retention Curves
from 1950 Boat samples
Exp #9 4.3" 25 dbl. mesh
50% maturity ♀
Exp #3 5.0" 25 mesh dbl.
Exp #1 4.9" 28 mesh dbl.
Exp #8 5.3" No dbl. mesh
Newport #1 4.6" –
Exp #10 5.3" No dbl. mesh
Percent
100
90
80
70
60
50
40
30
20
10
0
21.25
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
Length

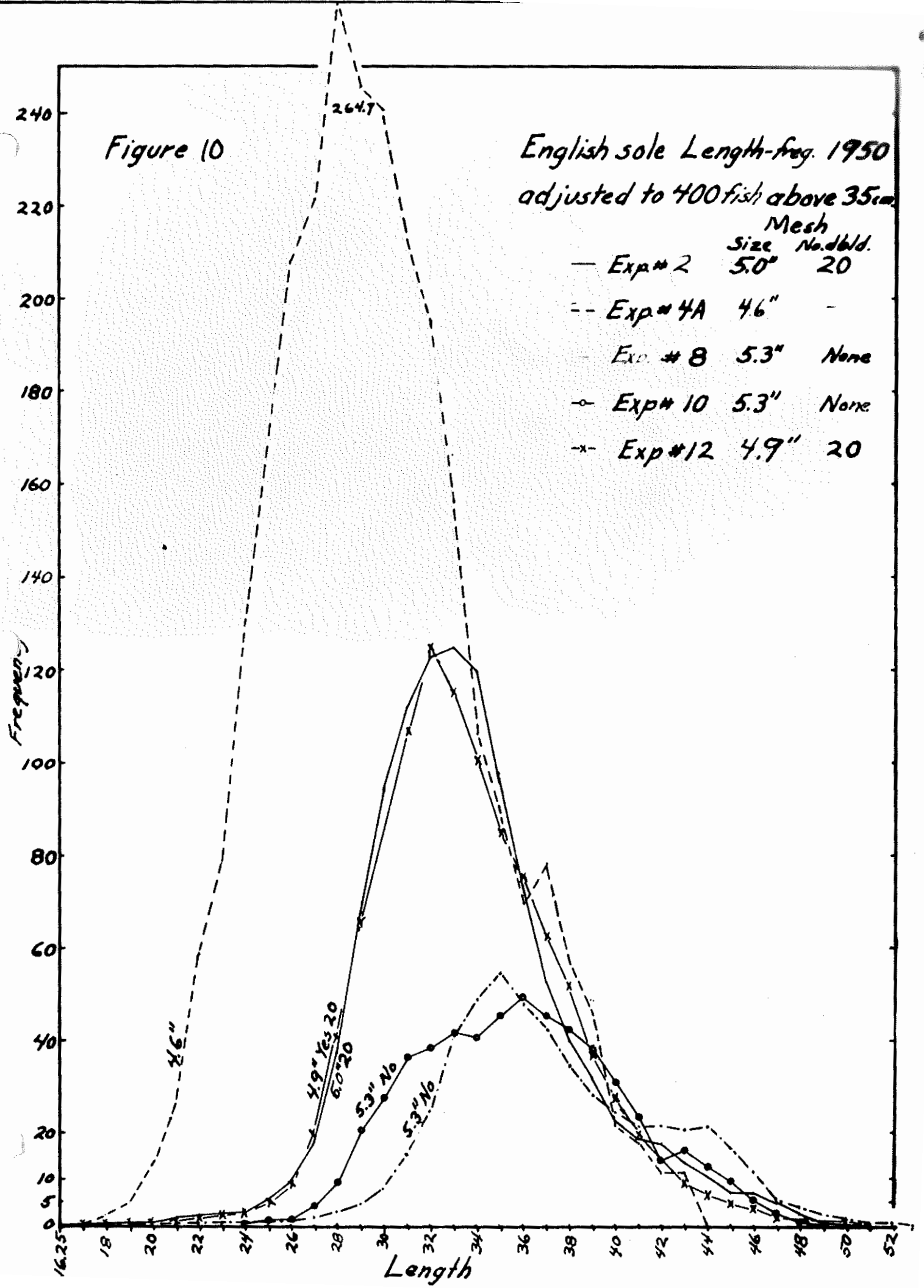


Figure 10
English sole Length-freq. 1950
adjusted to 400 fish above 35cm
Mesh
Size No. d&l.
Exp # 2 5.0" 20
Exp # 4A 4.6" -
Exp # 8 5.3" None
Exp # 10 5.3" None
Exp # 12 4.9" 20
264.7
4.6"
4.9" Yes 20
6.0" 20
5.3" No
5.3" No
Frequency
Length
240
220
200
180
160
140
120
100
80
60
40
20
10
5
0
16.25
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52

Figure 11
English sole Mesh Retention Curves
1950 Boat samples

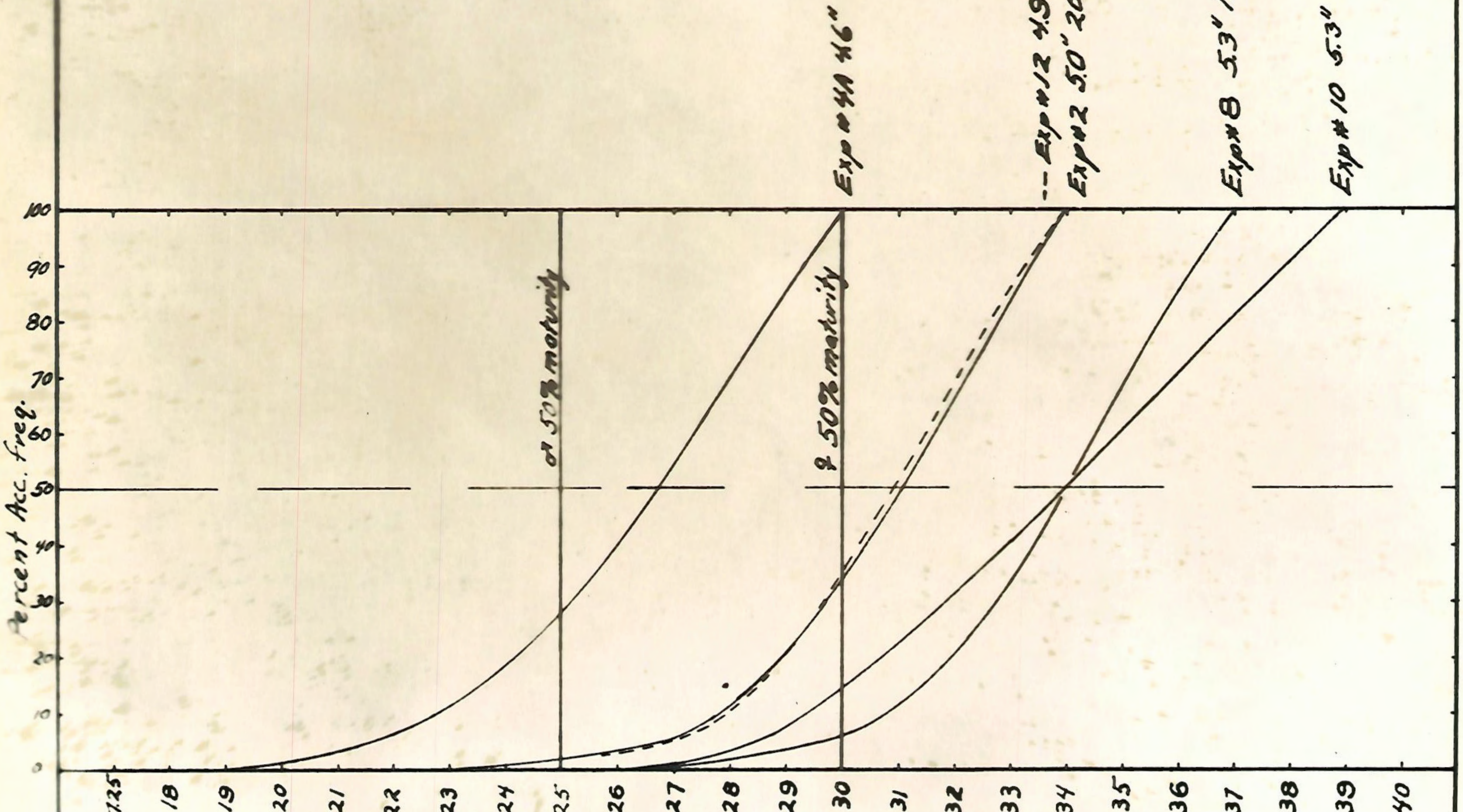


Figure 12

Petrale sole Length frequency

1950 Boat samples

adjusted to 100 fish at the

41, 42 and 43 cm [illegible]

	Mesh size	No. d'bld.
— Exp#1	4.9"	25
--- Exp#12	4.9"	20
Newport #2	5.5" Hog-ring	

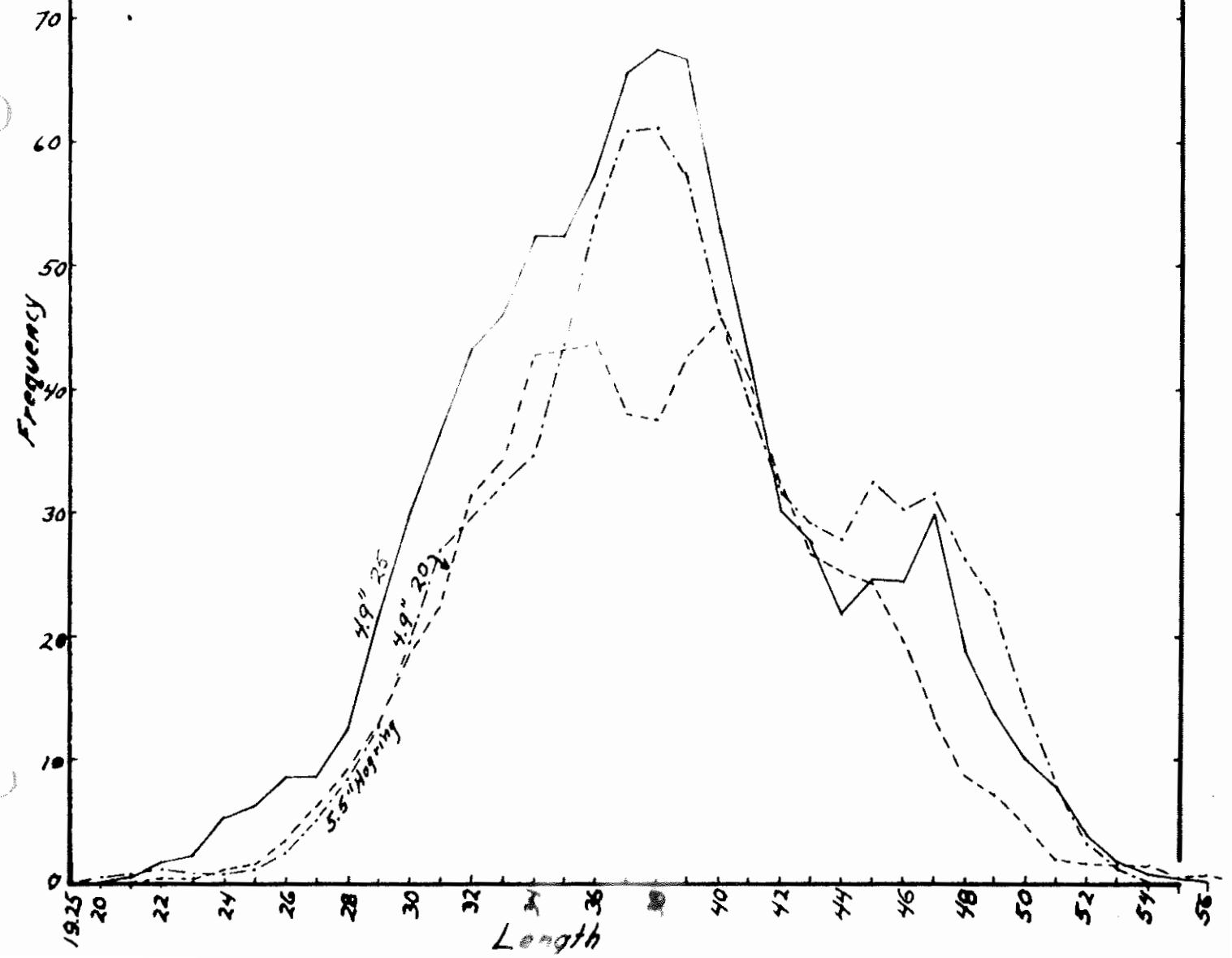


Figure 13

Petrale sole Mesh Retention Curves

1950 Boat samples

	Mesh size	No. dbl.
— Exp. #1	4.9"	25
--- Exp. #12	4.9"	20
Newport 2	5.5"	Hog ring

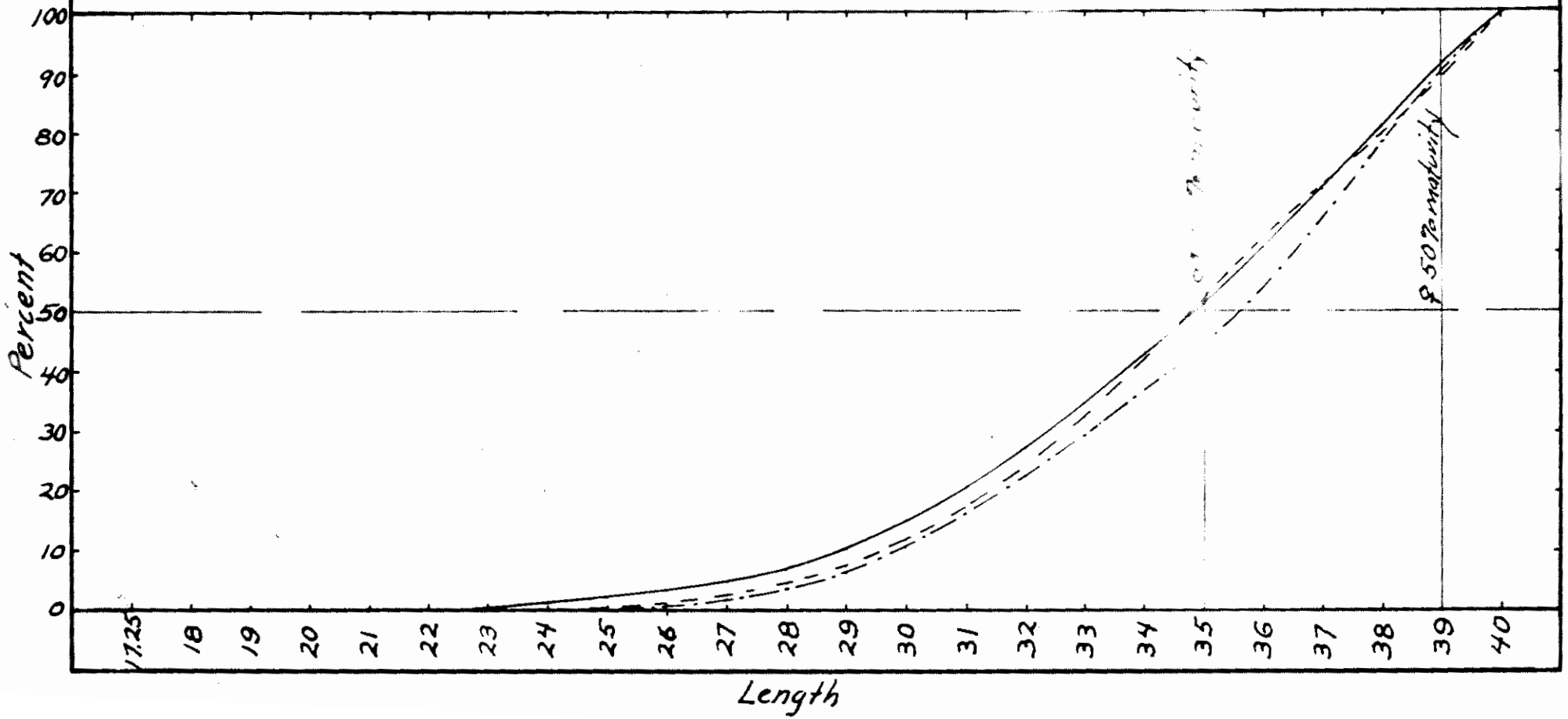


Figure 14 LENGTH-FREQUENCY ENGLISH SOLE, AUG. 19, 1948

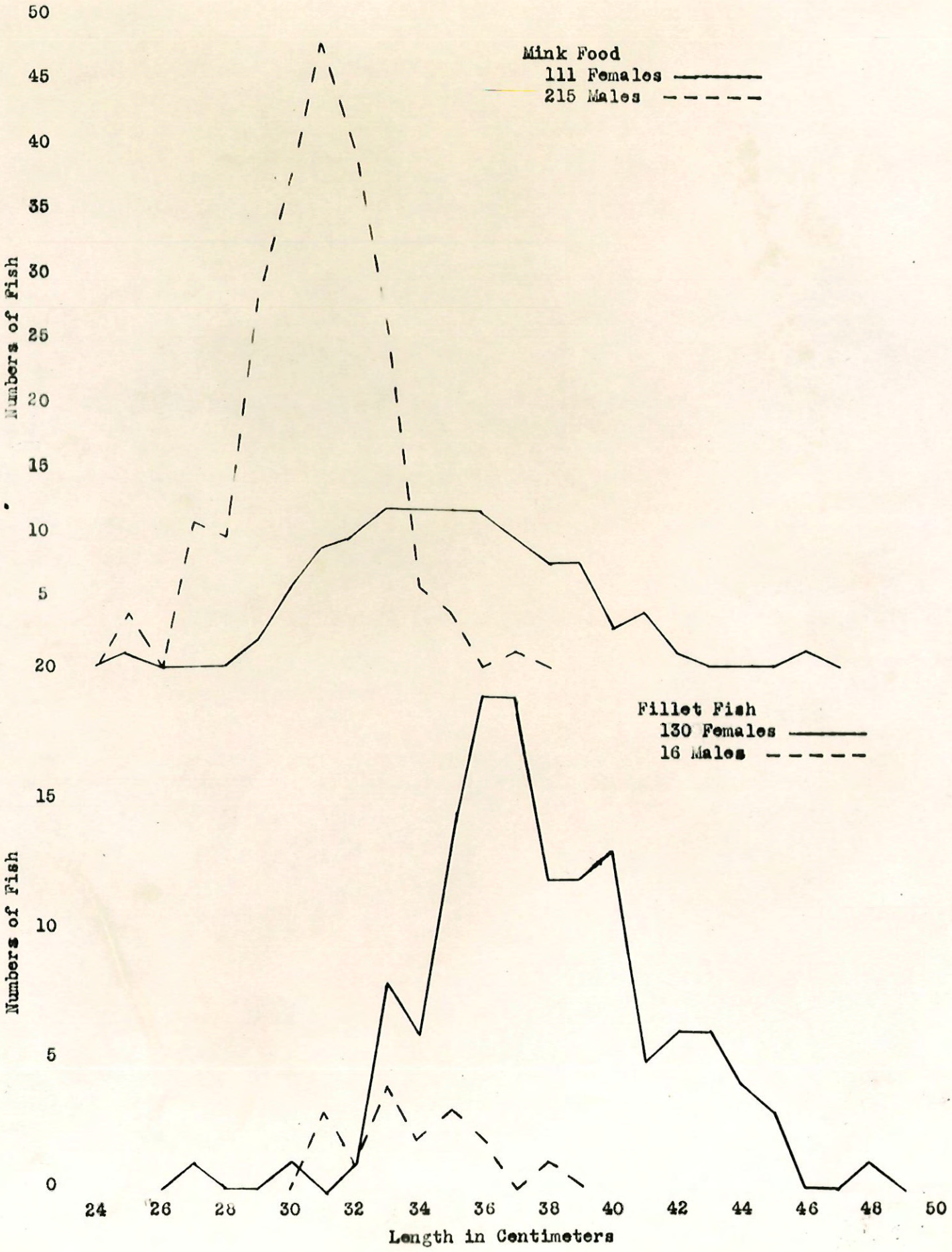


Figure 15 LENGTH-FREQUENCY REX SOLE USED FOR MINK FOOD, OCT. 19,1948

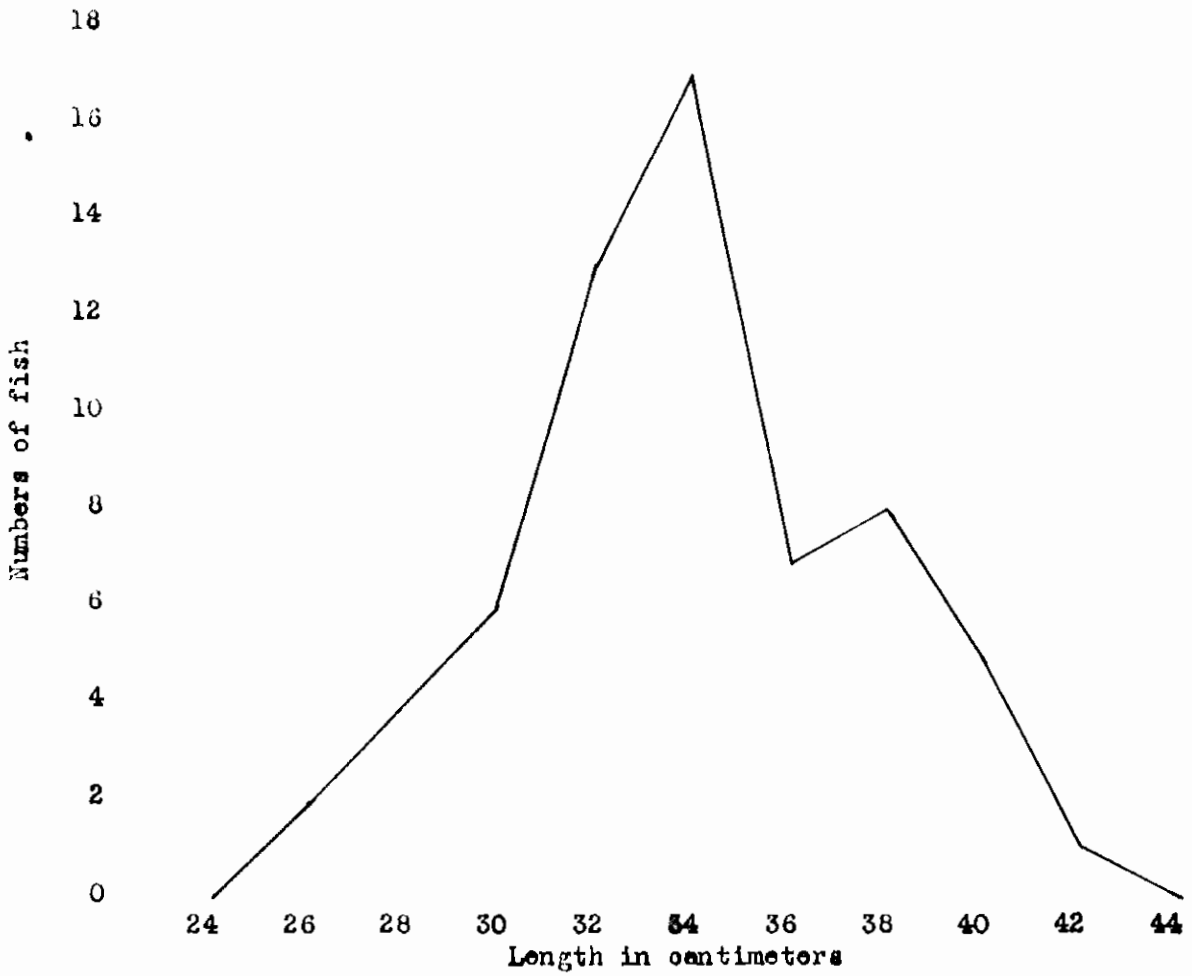


Figure 16 LENGTH-FREQUENCY DOVER SOLES, OCT. 19, 1948

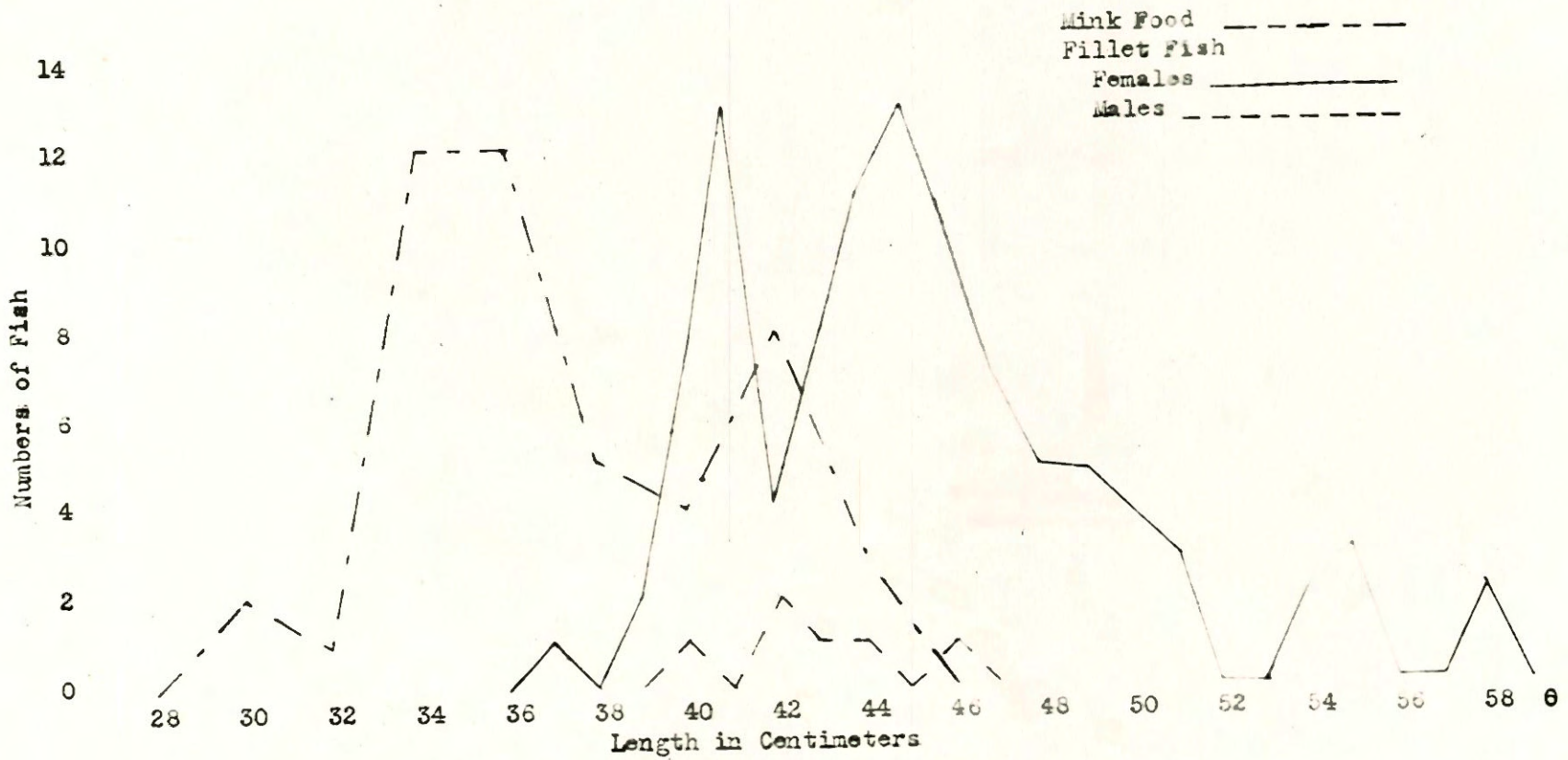


Figure 17 LENGTH FREQUENCY DOVER SOLE, OCT.20-22, 1948
SAMPLE TAKEN AT SEA BEFORE SORTING

N=319

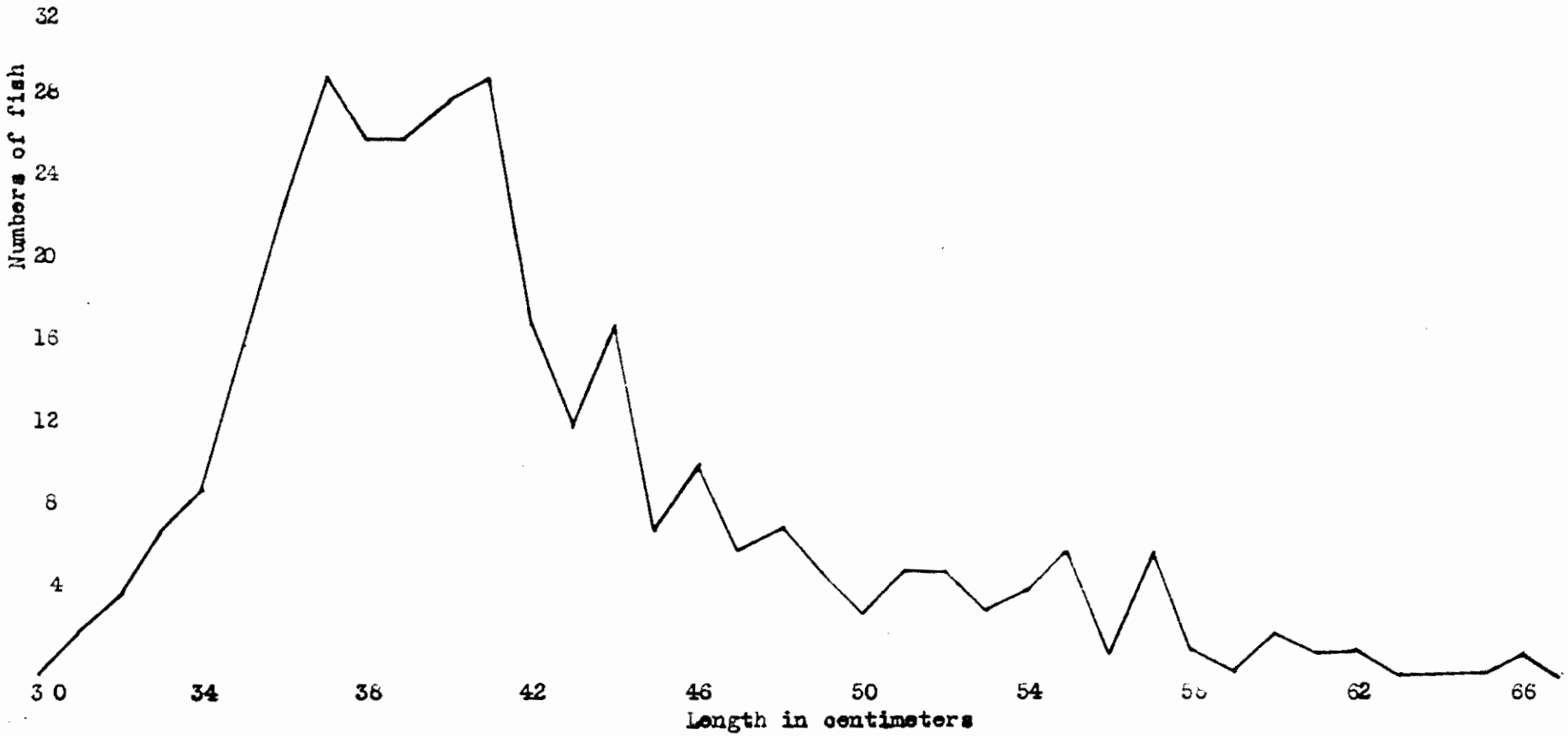


Figure 18 LENGTH-FREQUENCY DOVER SOLE, 1948

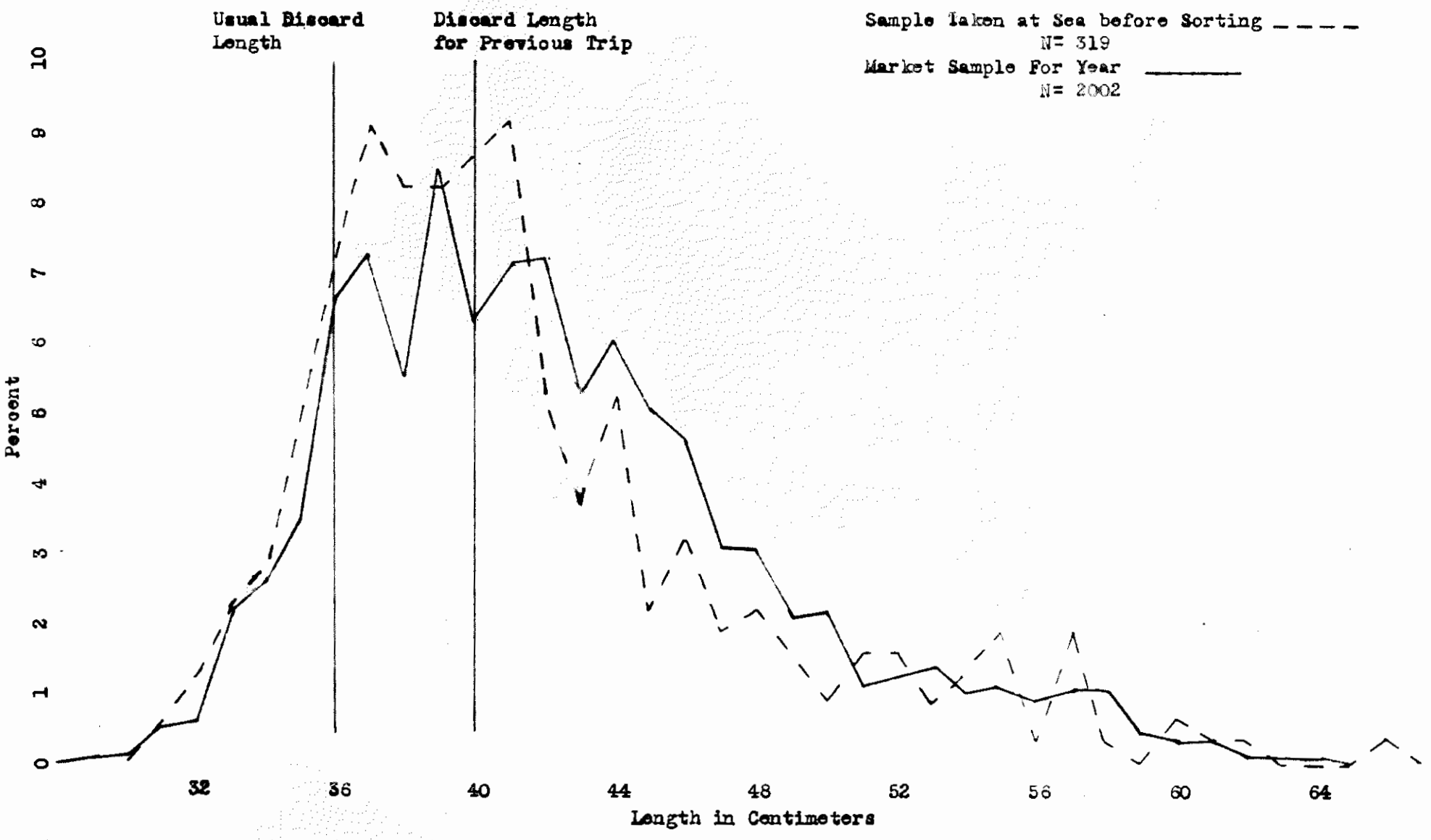


Figure 19 OREGON MINK RANCHES
by County

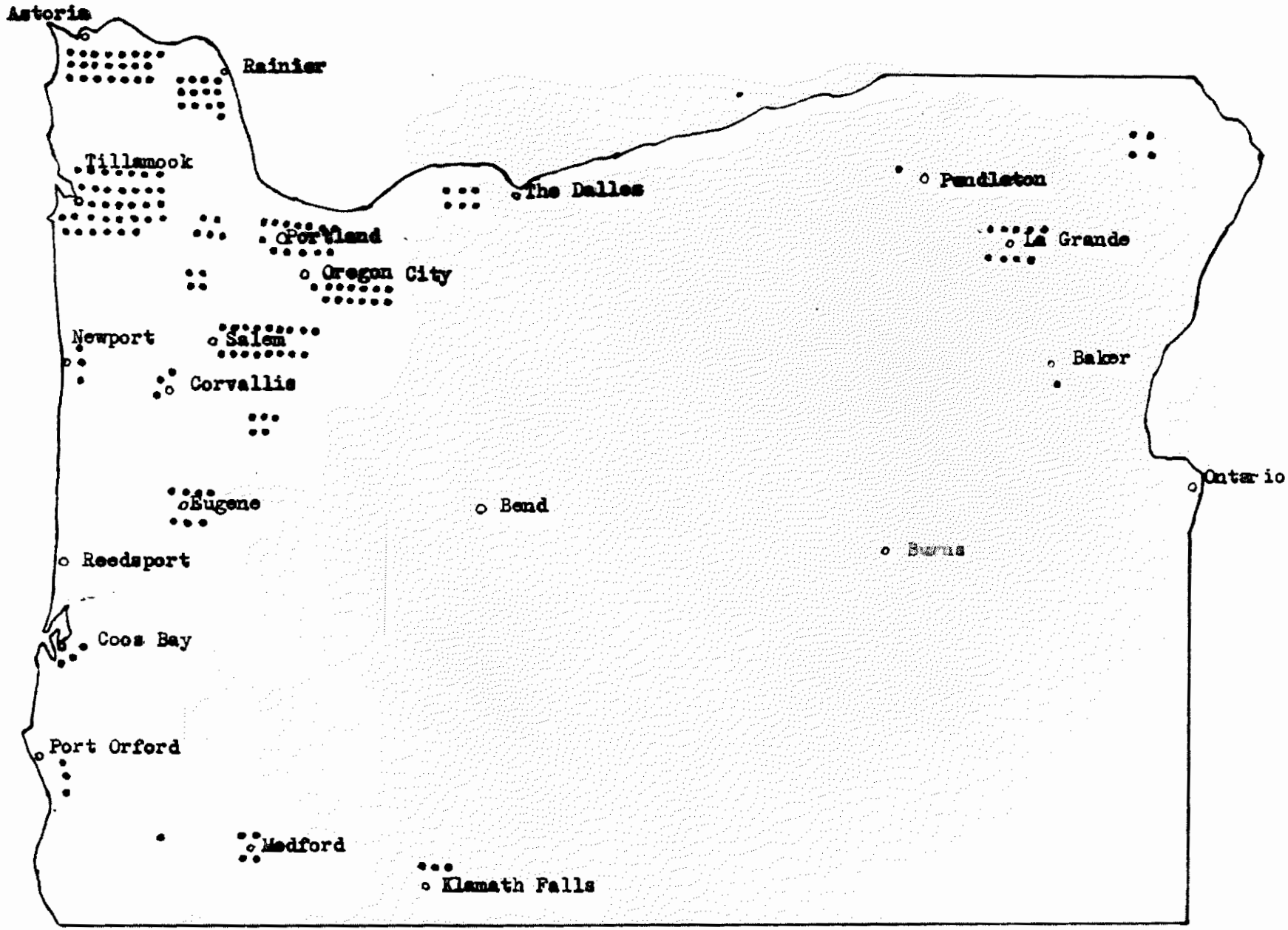


Figure 20 ENGLISH SOLE, 1949, ASTORIA AREA

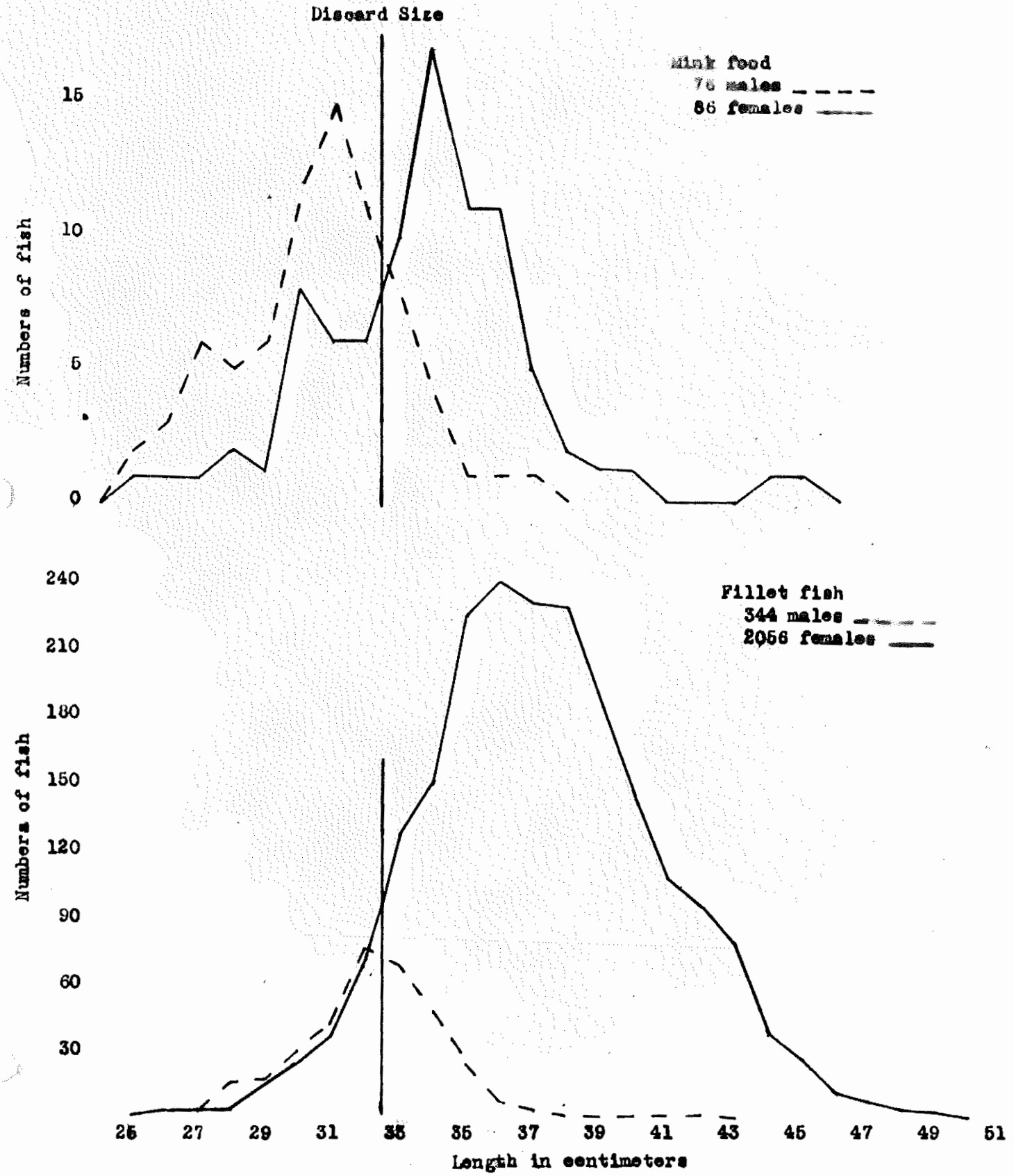


Figure 21 ENGLISH SOLE, ASTORIA AREA, 1949

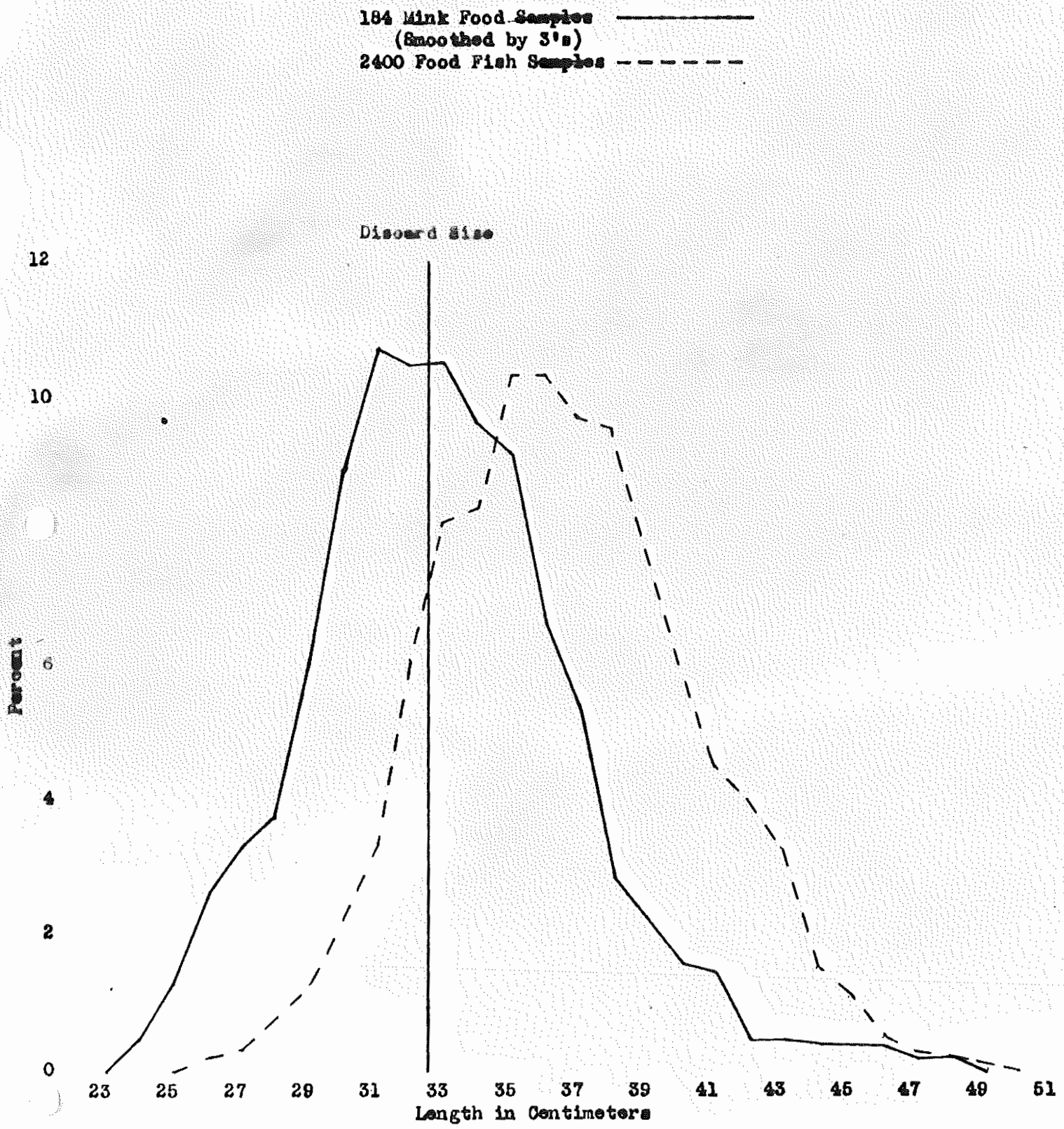


Figure 22 DOVER SOLE, ASTORIA AREA, 1949

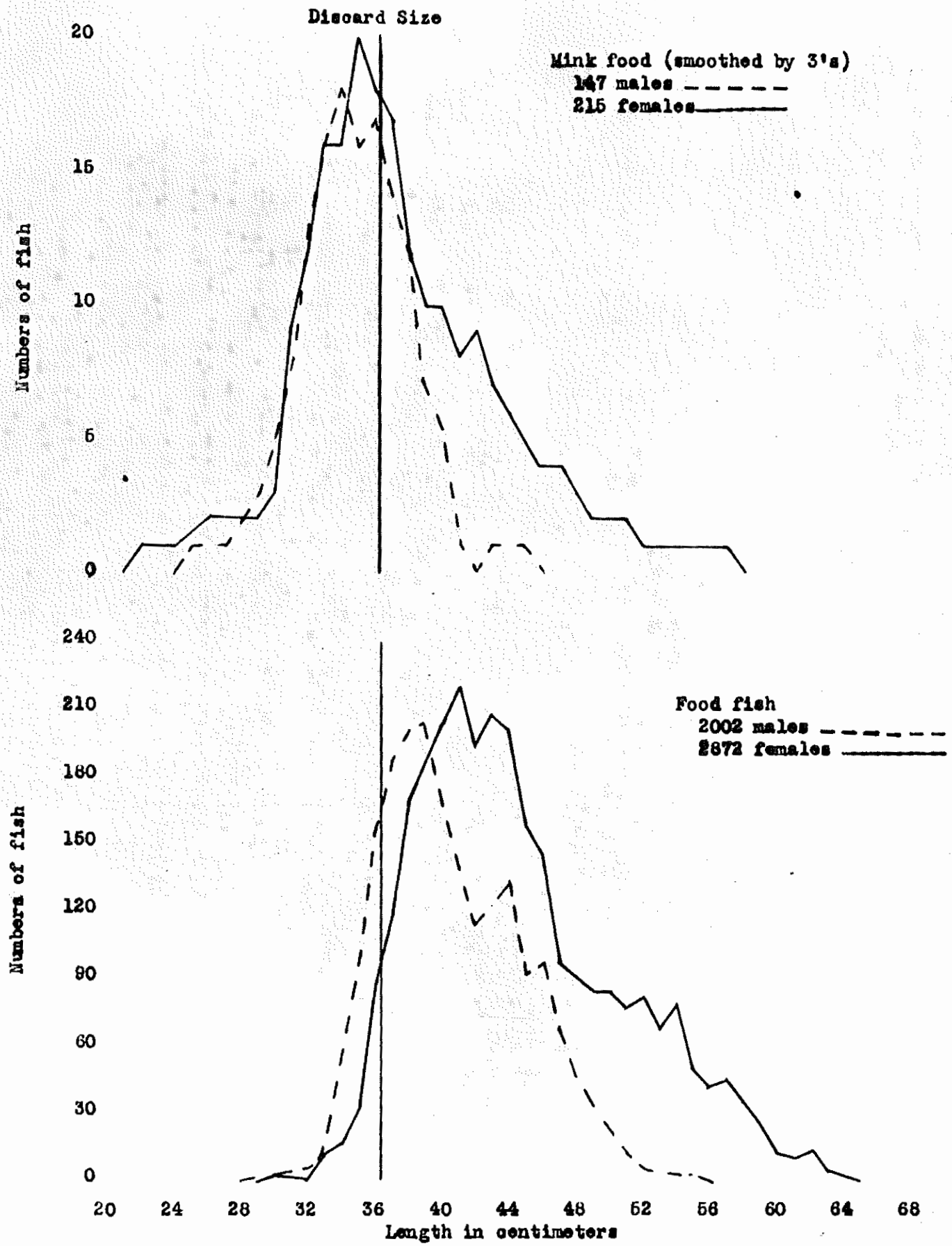


Figure 23 DOVER SOLE LENGTH-FREQUENCY, ASTORIA AREA, 1949

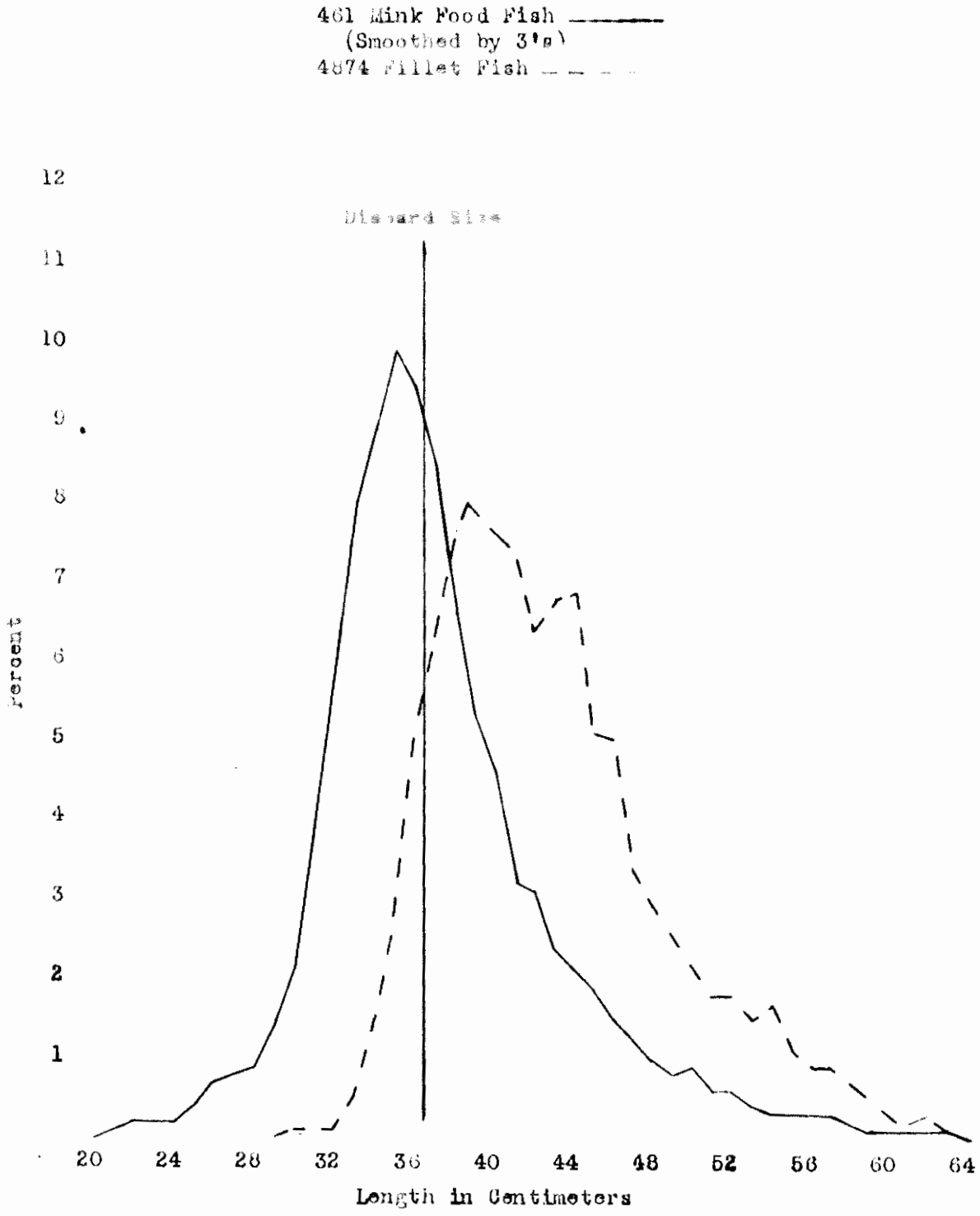


Figure 24 ENGLISH SOLE LENGTH-FREQUENCIES, NEWPORT, MINK FOOD, 1949

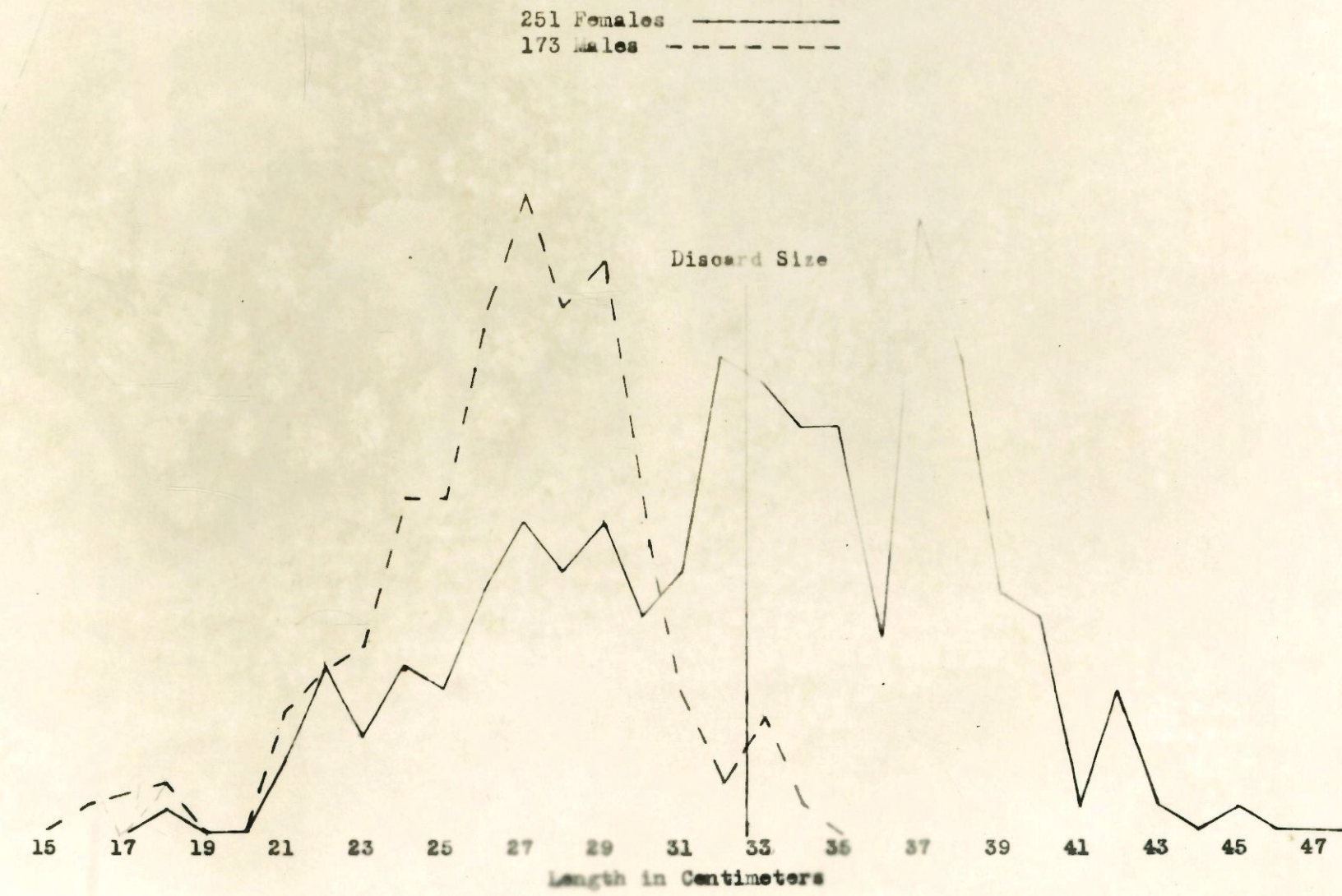


Figure 25 ENGLISH SOLE LENGTH-FREQUENCIES, NEWPORT, 1949

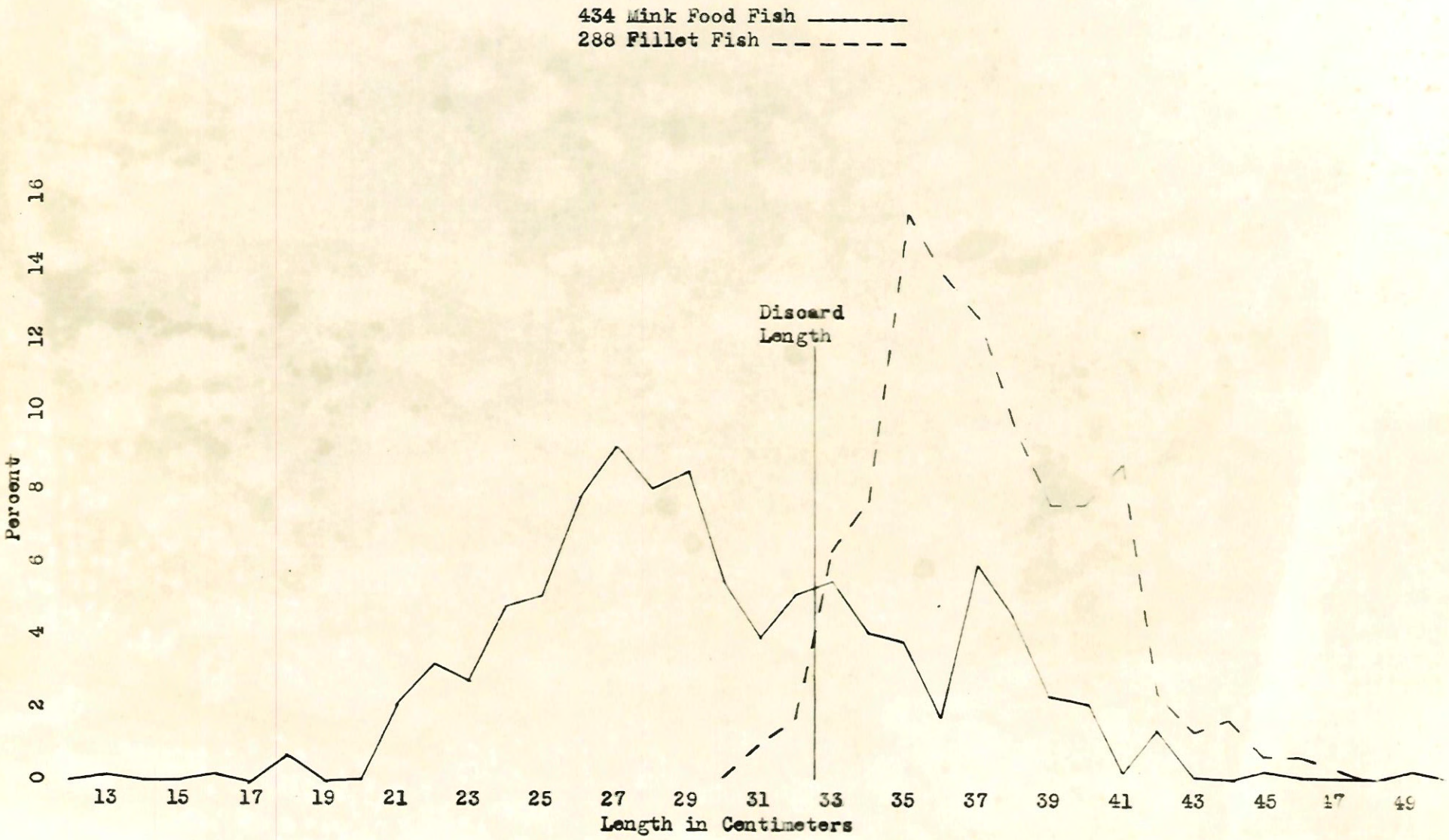


Figure 26 LENGTH-FREQUENCY ENGLISH SOLE, 1950

NEWPORT