MARINE FISHERIES PROGRESS REPORT
June-November, 1950

In June the seasonal help reported for work. Al Lasater and John Laurie were assigned to the Astoria Laboratory. Clancy Bevington was sent to Yachats to work on the surf smelt. Bob Balkovic was transferred from Astoria to Newport to work on the otter trawl and tuna studies at that port. In July, Balkovic resigned and Bevington was transferred to Newport to take his place. These three men worked through the summer, returning to school in September.

Al Pruter began work on the black cod on a temporary basis but was changed to a permanent member of the staff in August. He is being paid from Pacific Marine Fisheries funds for the present.

In the last part of September, Eldon Korpela was hired as a temporary Aquatic I and on October 1 Charles Woelke was transferred from razor clams to marine fisheries on a temporary basis.

On November 1 Edwin Holmberg was made a permanent member of the marine fisheries section.

During the period of this report George Harry attended the Tri-State meeting held in Bellingham on July 23-24. Progress reports were given on the marine fisheries work at this meeting. On August 25-27 George Harry attended the second annual tuna research meeting at San Francisco. A progress report on Oregon's albacore research was presented with emphasis on the racial studies. During the period from July 31-August 4, the entire permanent staff made a tour of the various research laboratories. Mr. Harry also attended the Sardine Conference meetings in LaJolla during the period June 29-July 1.

Otter Trawl

The otter trawl work at sea has been concentrated on taking samples of the commercial catch on the boats. This work will be summarized later in the report. Routine sampling of the market landings has continued both in Newport during the summer and at Astoria during the entire year. In addition samples of mink food have been taken at Newport. No mink food samples have been taken in Astoria although some mink food has been landed. None of the biologists have been present during the short time it takes to unload a mink food trip.

Two savings gear experiments were undertaken during the summer. The first trip was to compare the length-frequencies of Dover sole caught by three different size cod-ends. This trip was fairly successful but the second trip for English sole was a complete failure because of the weather conditions and lack of fish. A summary of the savings gear experiment will be presented later in this report.

After the bad weather began in the fall, the emphasis on the otter trawl program was changed to working up the data collected since the research program began in January, 1948. The statistical analysis of the catch records on the hand punch cards has been started. A complete analysis of the tagging returns is underway. An analysis of the samples taken at sea during the summer is being undertaken. The general biological data gathered are being worked up. An experiment has been set up and is partially completed to test the effect of various types of handling and freezing on the lengths of English, petrale, and Dover soles. This experiment will be described later in this report.

Black Cod

A section on the black cod work started this year is included in this report.

Surf Smelt

The intention at the beginning of the summer was to have one man stationed at Yachats to work only on surf smelt. However, because of the resignation of one of the temporary men, it was only possible for one man to devote part of his time to the smelt investigation. Most of the effort in this program was applied to gathering scales and otoliths, making estimates of the catch, getting samples for racial studies, and discovering where spawning runs occur or have occurred in the past.

Otter Trawl Market Samples

The market samples for English, petrale, and Dover soles for 1948, 1949, and 1950 have been graphed. These graphs represent the raw data with no correction factors applied. There seems to be no very great change in the size of the petrale males (Fig. 1). The females seem to show some decrease in length over this three-year period, although a more exact analysis will have to be made before this can be proved. The ratio of males to females is quite different in the three years which may be due to differences in the time of sampling. The percent of males on the fishing grounds changes during the year.

The Dover sole, both males and females, appear to show little change in size composition (Fig. 2). Neither do the English sole (Fig. 3) show any striking changes in size.

Size Changes of Sole Due to Commercial Handling

At first it was believed that freezing the tagged specimens which were recovered at the fish houses might be a major cause of the shrinkage that was often apparent between the time of tagging and the time of recovery. To test the effects of freezing, samples of English, petrale, and Dover soles selected over a large size range were taken from the bins, measured to the nearest millimeter, and frozen. The Dover sole were frozen

Figure 1. Petrale L.-F. by Percent For 1948-1949-1950 (thru Oct.)
Astoria Area

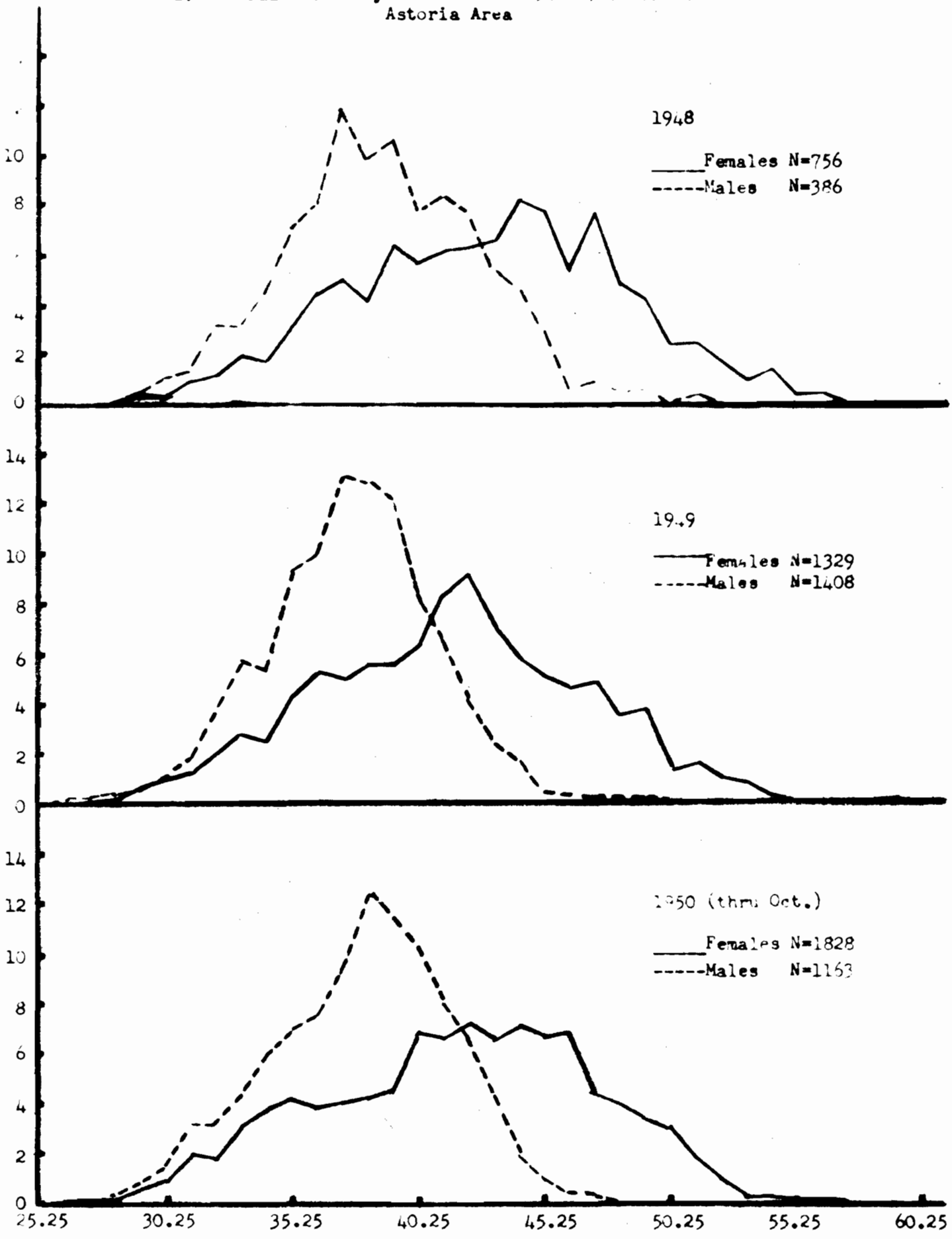


Figure 2. Dover Length Frequency by Percent for 1948-1949-1950 (thru Oct.)
Astoria Area

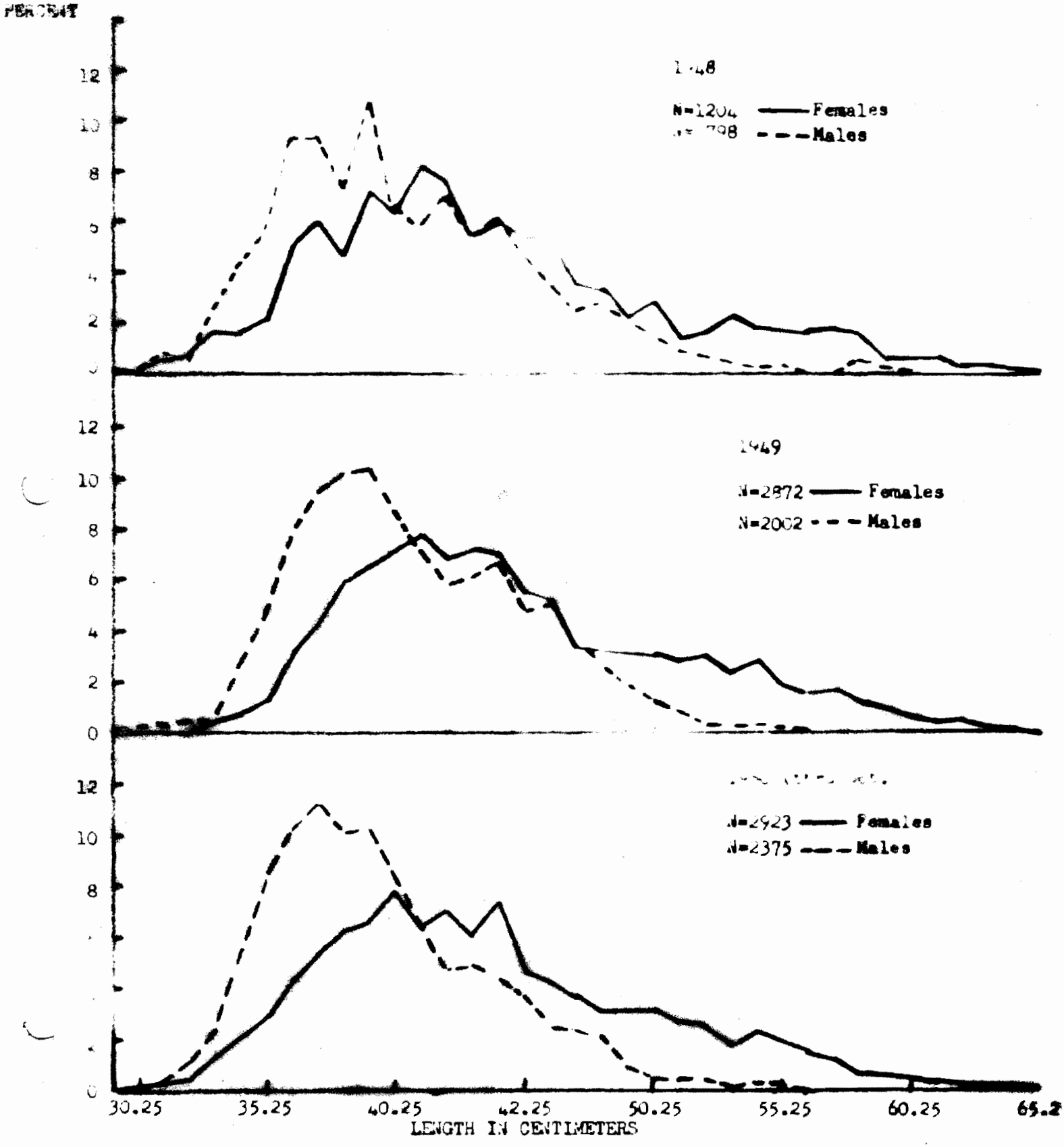
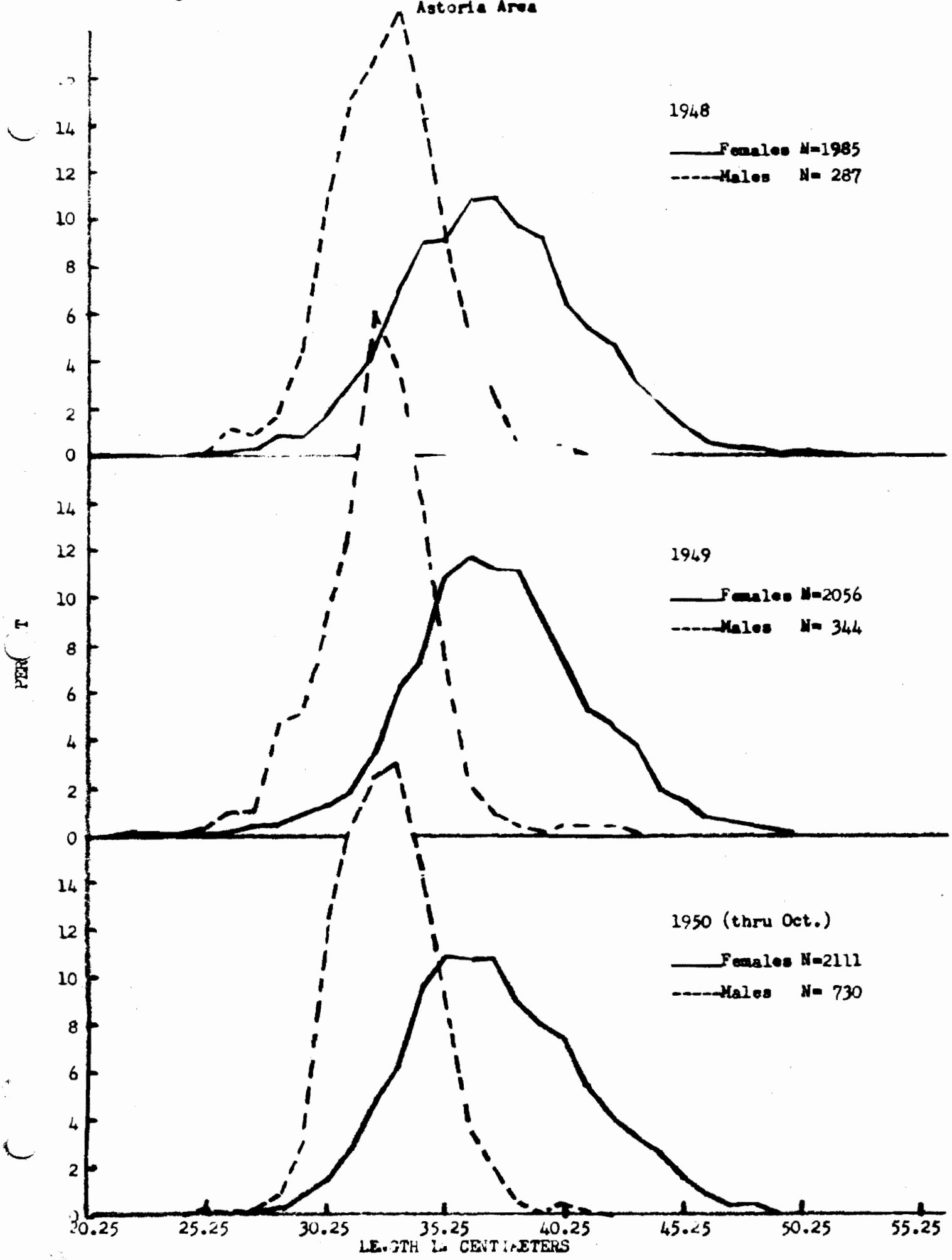


Figure 3. English L.F. by Percent For 194[illegible]-49-195[illegible] thru Oct.
Astoria Area



September 25 at 1430 and taken from the freezer at 0800 September 29. The fish were again measured after thawing (Fig. 4).

The petrale and English soles were handled in the same manner, except that they were frozen 4-1/2 days (Fig. 5). There was a definite shrinkage in all three species averaging about one-half a centimeter. The base line represents the lengths of the fish when first measured in the bins. The dotted lines show the variations from the original lengths after being frozen. All lines were fitted by the method of semi-averages. The fish in each experiment were all measured by the same person so that there would be no errors due to differences in measuring by different observers. Included in Figures 4 and 5 are fish from a later experiment which were put through a more elaborate process and that part of the experiment which was comparable to the original was graphed. The lines from both experiments are quite similar.

Next it was decided to try to find out the variation in length, if any, from the time the fish were brought on deck at sea until they finally reached the biologists, usually after being frozen. To undertake the experiment, a biologist, Eldon Korpela, was sent to sea aboard a dragger. Fish were measured at sea as soon as possible after being brought on board. However, because of rough weather two or three hours sometimes elapsed before all the fish could be measured; it was necessary to leave the petrale sole overnight because no lights were available for measuring in the dark.

Samples of Dover and petrale were measured from the first day's catch at sea and Dover sole only were measured on the second day. Also, four English sole were measured. At the end of the second day the boat was forced back to port by bad weather and the next morning all the fish were remeasuredat the fish house. The fish from the first day at sea and those

Figure 4. Dover Sole Shrinkage From Bin Through Freezer
Two Experiments

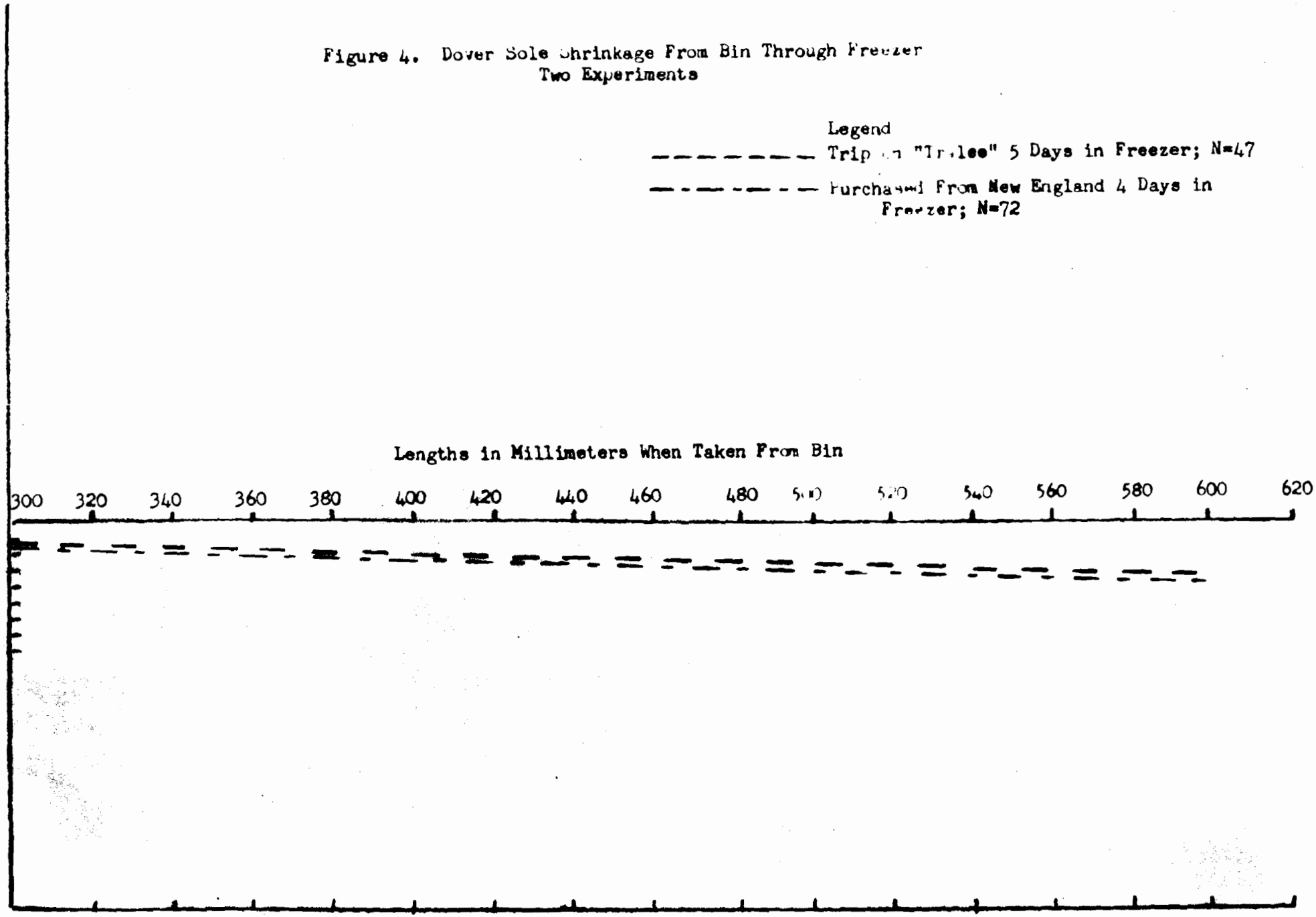
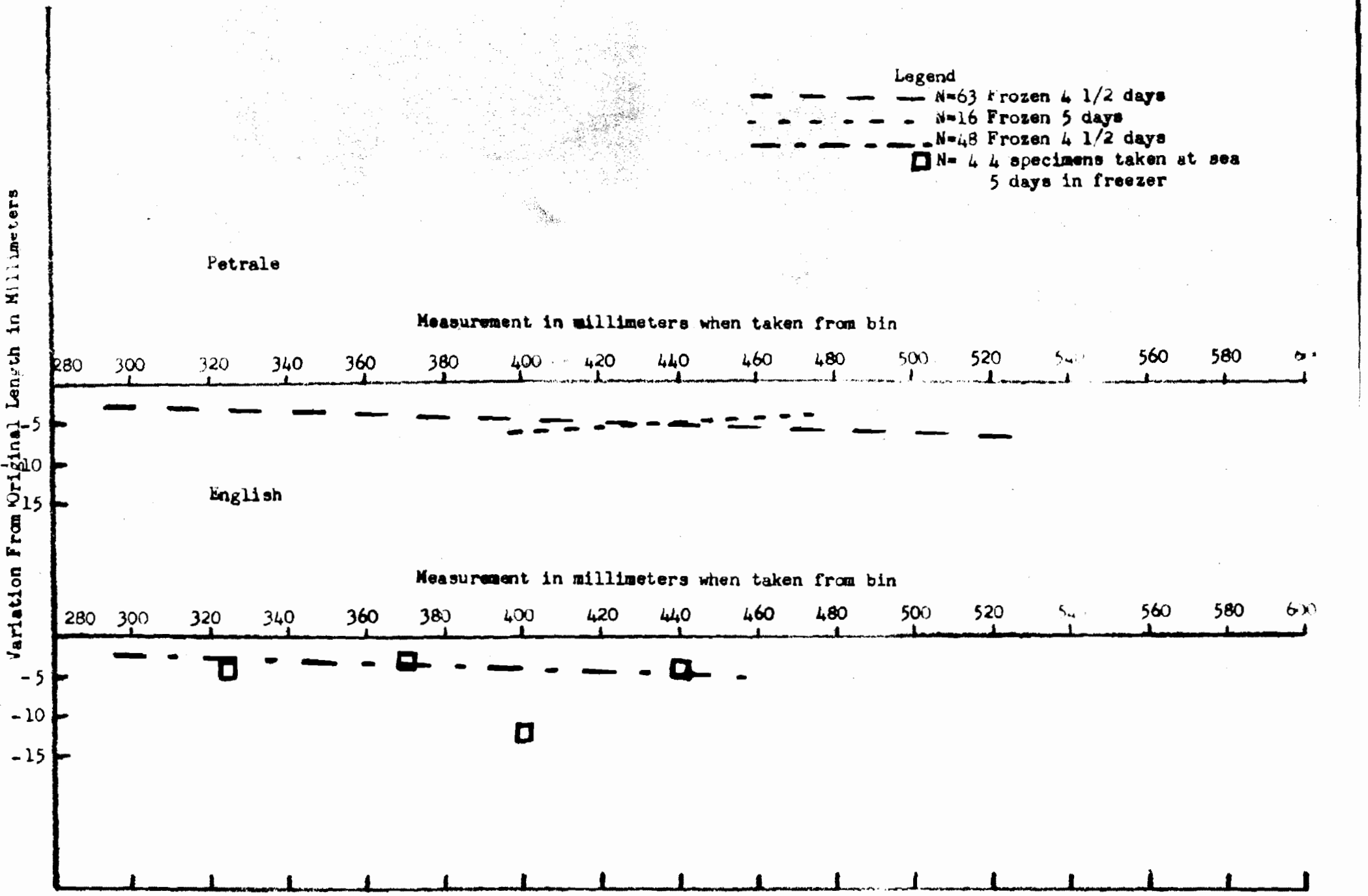


Figure 5. Shrinkage of Sole from the bin through a freezing process.



from the second day were kept separate. Twenty-two Dover sole from the first day and 25 from the second day were iced down in the cannery and left for 48 hours after which time they were measured again. They were next placed in the freezer and kept there five days and then measured for the last time (Figs. 6 and 7).

The remaining 33 Dover sole, after being measured at the dock were immediately placed in the freezer for 48 hours and then measured once again (Figs. 6 and 7). The English and petrale soles were all measured after being unloaded at the dock, then were iced down in the fish house for 48 hours, remeasured, frozen for five days, and then measured for the last time.

The various treatments caused a shrinkage of the Dover and English soles of up to one centimeter. However, the petrale sole became appreciably longer after being iced down on the boat and in the bins (Fig. 8). It was only after being in the freezer that the petrale shrank and then only to about the original lengths. The explanation of this lengthening of the petrale sole is not readily apparent, and the experiment will be repeated.

In order to summarize the results found with the Dover sole, the fish caught during the first and second days were combined into one large sample. The lengths at the various states of the experiment were then graphed (Fig. 9).

Otter Trawl Tagging Program

As of November 1, 1950, 346 tagged English, Dover and petrale sole have been recovered, and information concerning these recoveries has been entered on punch cards. Although an analysis of the program has not yet been completed, some of the more salient features are included with this report as a matter of general interest.

Figure 6. Length Fluctuation of Dover Sole Due To Commercial Handling Day No. 1

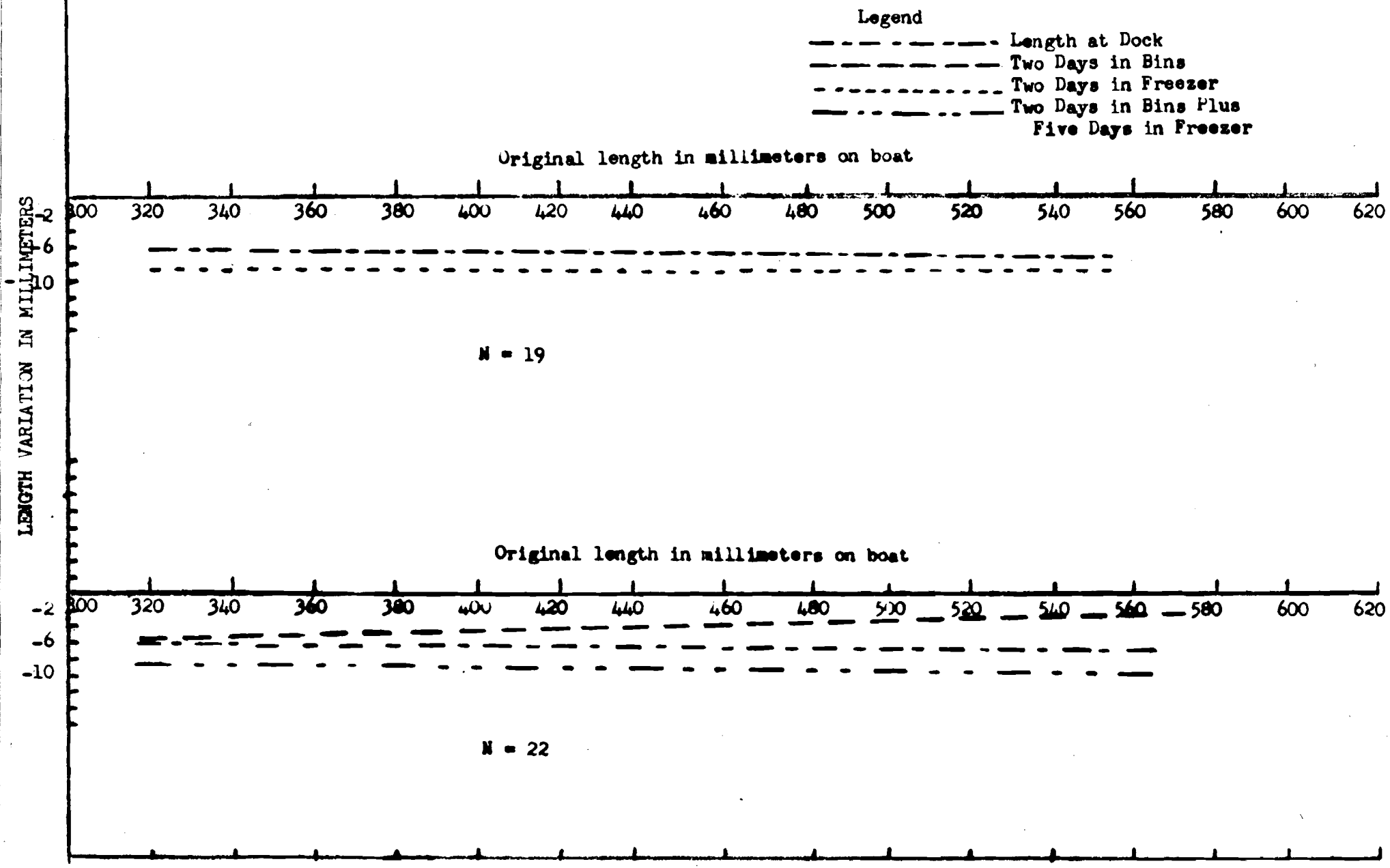


Figure 7. Length Fluctuation Of Dover Sole Due To Commercial Handling Day No. 2

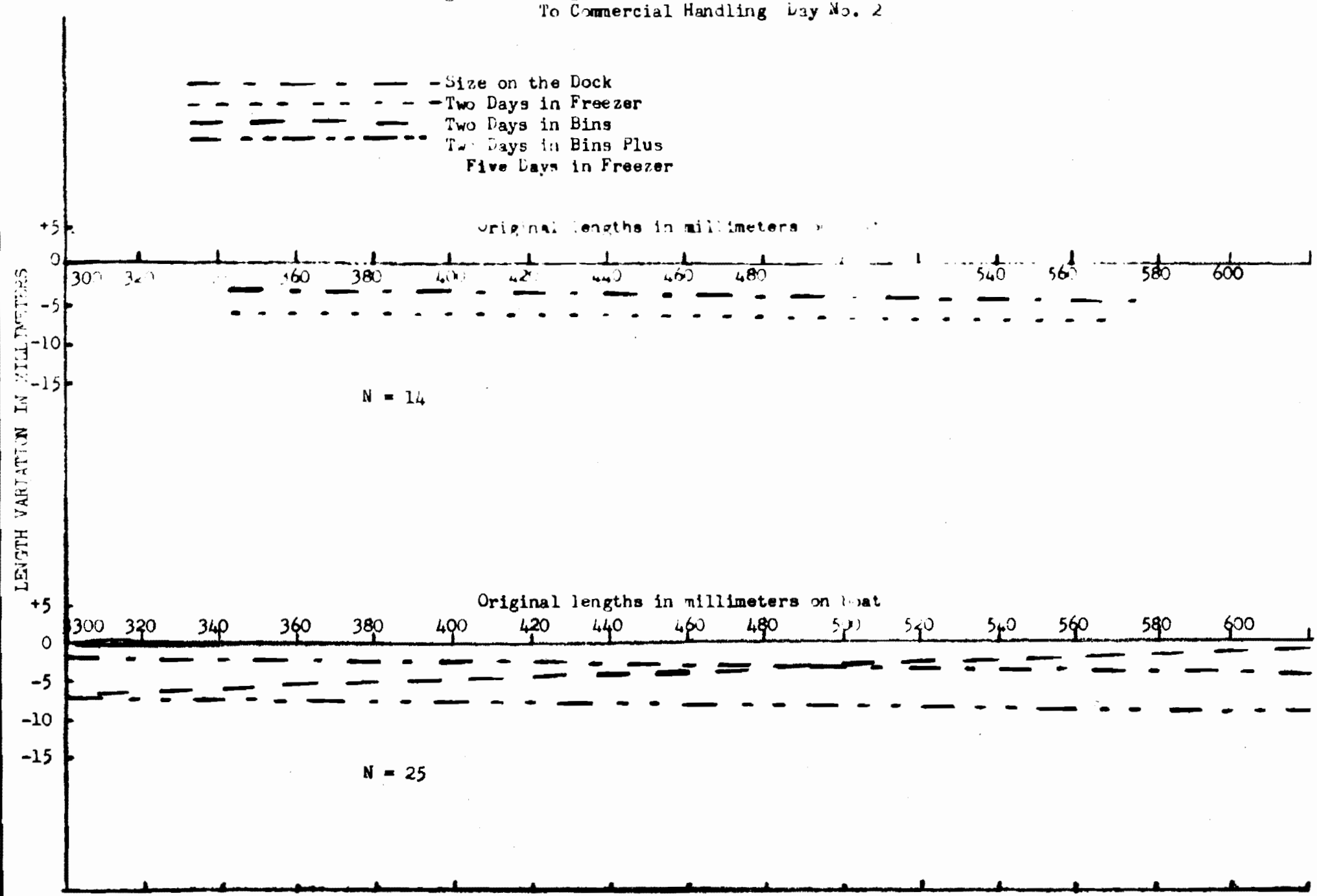


Figure 8. Length Fluctuation of Petrale Sole
Due To Commercial Handling

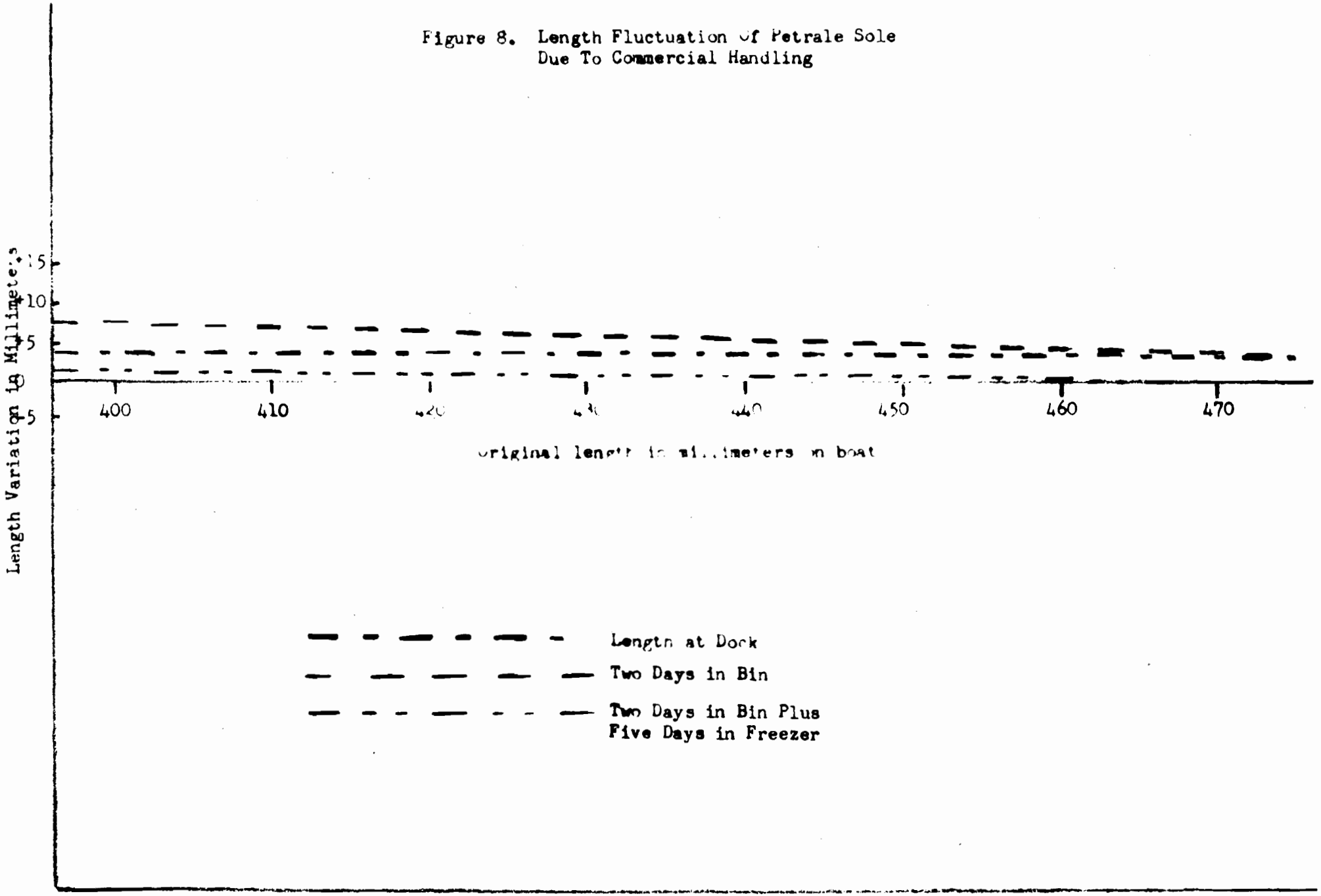
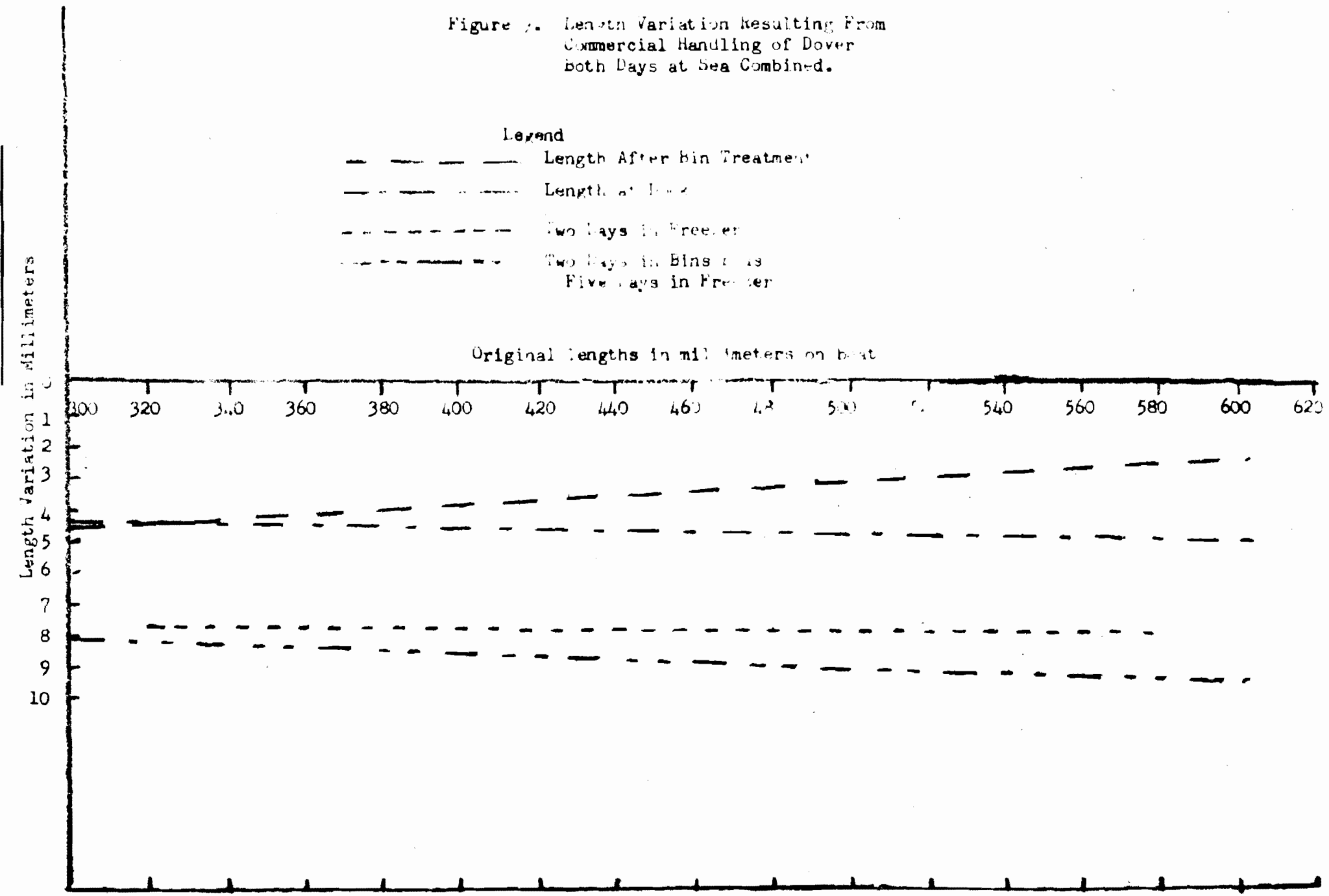


Figure 7. Length Variation Resulting From Commercial Handling of Dover Both Days at Sea Combined.



Percentage Recovery

Table 1 contains information concerning the percentage recovery of each species together with the number tagged and recovered.

Table 1. Percentage Recovery of Tagged English, Dover, and Petrale Sole.

Species	Number Tagged	Total Number Recovered	Percentage Rec'd
English	2,591	177	6.83
Dover	2,177	126	5.79
Petrale	736	45	6.11

At the time of tagging all fish were graded as to their condition: condition 1 being assigned to those fish in superior condition, condition 2 to those in fair condition, and condition 3 to those obviously in poor condition. As a means of determining the practicability of tagging fish which are not in a superior condition and in order to obtain information necessary for population studies, a comparison of the percentage recovery of each condition was made, and such information is included in Table 2.

Table 2. Percentage Recovery of Fish According to Their Condition at Tagging.

Species	Condition at Tagging	Percentage Recovery
English	1	7.42
	2	6.01
	3	2.79
Dover	1	7.66
	2	5.14
	3	3.18
Petrale	1	8.48
	2	4.05
	3	1.33

As indicated in Table 2 there is a significant difference for all three species between the percentage recovery of condition 1, 2, and 3, fish.

Movement

In the majority of cases all three species have been recovered within a short distance of the point of release. Specifically, 67.6 percent of the petrale sole have been recaptured within 14 miles of the tagging site, 86.5 percent within 45 miles of the tagging site, and 97.3 percent within 105 miles of the tagging site. The English sole show a similar movement pattern for 79.5 percent were recaptured within 14 miles, 89.1 percent within 45 miles, and 93.6 percent within 105 miles of the tagging site. Of the three species, Dover sole appear to be the more stationary, with 93.8 percent recaptured within 14 miles, 98.9 percent within 45 miles, and 100 percent within 105 miles of the tagging site. Figures 10 and 11 illustrate the number of recoveries of each species at the indicated distance in miles from the tagging site.

Otter Trawl Sampling at Sea

Purpose

The purpose of the current study of the otter trawl fishery is to determine (1) catch composition, (2) selectivity of gear on the size of the commercial species, (3) selectivity by fishermen on the size of the commercial species, and (4) changes in ecological balance, if any, on the fishing grounds.

In a fishery such as the otter trawl which encompasses many species it becomes necessary to obtain as much information as possible about the numbers of species and the relative frequency of occurrence (percent constitution by numbers and pounds) in the fishery. What species are utilized? How are they utilized? What species are discarded? All of this information should be related to fishing area, depth, and season.

Figure 10. Movement of Petrale Sole as Determined by Recoveries of Fish Tagged in 1948 and 1949.

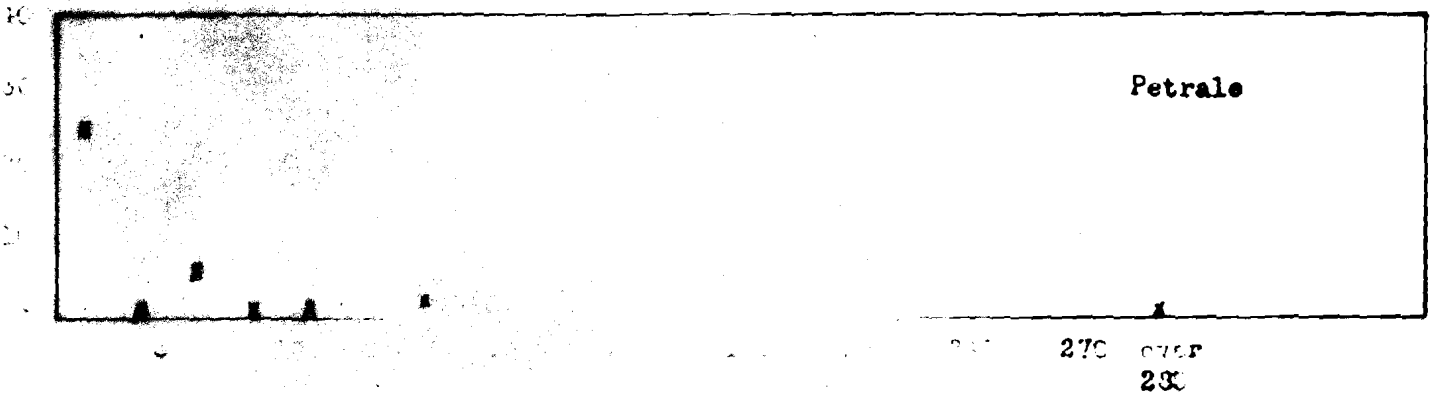
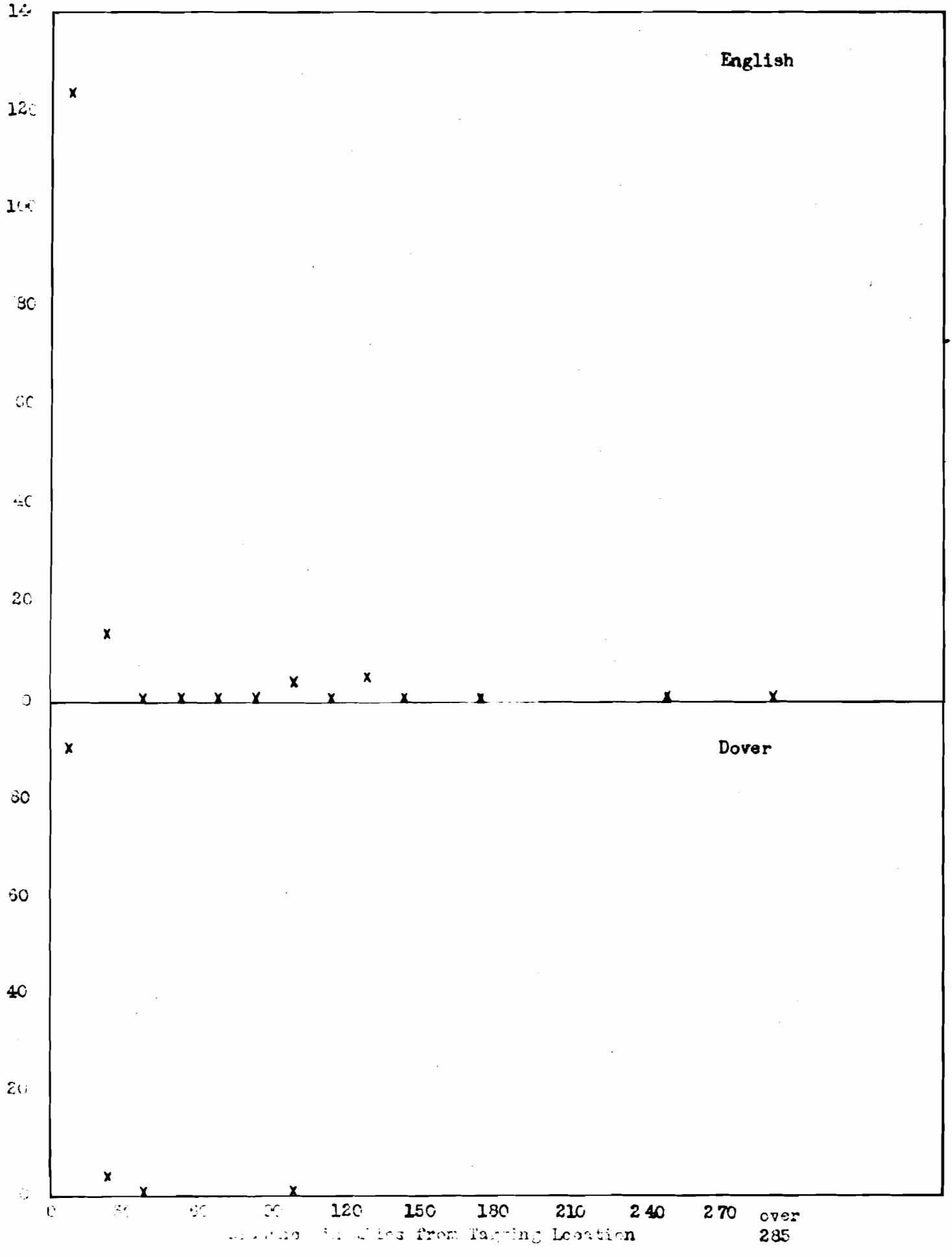


Figure 11. Movement of English and Dover Sole as Determined by Recoveries of Fish Tagged in 1948 and 1949.



With respect to the commercially important species, the question arises as to the selectivity of the gear on the size and age classes of each species. What size and age classes are taken by the gear now in use? What size and age classes would be taken by larger and smaller mesh sizes? What size and age classes would be taken by single or double cod ends of equal mesh size? What effect does a rope cod-end have?

Once the selectivity of gear has been determined it then becomes necessary to determine the effect of the selectivity by the fishermen upon the size and age classes in the catch. What size and age classes are discarded for each species? What portion, by numbers and pounds, are discarded?

The fourth factor to be considered is the change, if any, in the ecological balance on the fishing grounds? Is the ecological balance upset by the fishery? If so, to what extent? If there is such a change in the balance, what species are increasing in abundance and what species are declining?

Procedures for Obtaining the Data

Throughout the 1950 summer season (May 8 to September 14) trips were taken by the biologists aboard some of the otter trawlers operating out of Astoria, Garibaldi, and Newport. Eleven traps were made out of Astoria, two from Garibaldi, and two from Newport. During each of these trips the following information was collected: (1) random sa mple of the catch (before sorting by the fishermen), by species with measurements (to the nearest one-half centimeter) of all Dover, English, and petrale sole encountered; (2) random sample of the discarded Dover, English, and petrale measured to the nearest one-half centimeter; (3) random sample of Dover, English, and/or petrale sole landed, measured to the nearest one-half centimeter and sexed; (4) otoliths and/or scales, length, sex, location of capture, and

date of capture (from as many as possible) for "small" Dover (less than 30 cm.), English (less than 27 cm.), and petrale sole (less than 27 cm), and all sizes of black cod and shad; (5) description of net or nets used during the trip including the mesh size of the cod-end (a) when new, (b) before the trip, and (c) after the trip; (6) stomach samples from Dover, English, and/or petrale sole; (7) average weight of a bucketful of one of the abundant species discarded, e.g. rex or Bellingham sole, hake, etc.; and (8) complete log of trip including location and times of each drag, sea and weather conditions, surface water temperatures, estimation of total weight of gross catch, and net catch of each drag, percentage (by number) of each species discarded, and percentage of each species discarded alive.

A random sample of the catch from each daylight drag was taken in the following manner. The biologist selected a corner of one of the deck bins (port or starboard) away from where the fishermen were sorting, but in an area which appeared to represent a group of fish characteristic of the total catch (the four locations available to the sampler were the fore and aft ends of the starboard and port deck bins). In some cases the catch was small enough to be contained in the starboard deck bins only. The sampler then proceeded to take a vertical sample of all the fish in the area selected. The sampling ceased when the fishermen began sorting fish in the sampling area. In this sample, all Dover, English, and petrale sole were measured and all other species were tallied. "Small" Dover, English, and petrale sole, and all black cod and shad were set aside for further work. This vertical sample of the fish in the deck bins is referred to as the "Boat Sample" in the subsequent discussions.

At the end of the trip a random sample of the Dover, English, and/or petrale (the one or more predominant species in the landing) was taken in which the length (to the nearest one-half centimeter) and sex was recorded

for each fish. This is referred to as the "Dock Sample" in the subsequent discussion.

A complete description of the net or nets used during the trip was obtained from the skipper. A description of the net included the general type (eastern or western) and any special modifications not included in the standard type of net. The average mesh size of the cod end was obtained by measuring the length (including one knot) of every fifth mesh from the pucker rings to the forward end of the cod end. These measurements were averaged to obtain the average mesh size of the cod end.

Sometime during the trip the biologist collected a sample of 20 stomachs of Dover, English, or petrale sole. The date, location of capture, species, length, and sex were recorded with each stomach. The stomachs were wrapped in cheese cloth and preserved in 10 percent formalin.

At some other convenient time during the trip the biologist collected a bucketful each of one or more species of fish (not commercially important but relatively abundant in the catch), weighed them, counted them, and obtained an average weight. These rough average weights will be used to estimate the pounds of non-commercial species discarded.

Procedure for Analysis of Data and Preliminary Results

1. Catch Composition: Very little has been done at this early date in the analysis of the catch composition data for the season. A gross total has been compiled for numbers of species and their relative abundance in the catches for 13 trips originating in Astoria and Garibaldi (Table 3).

A total of 39,600 fish comprising 36 species were tallied during the period May 9 to September 14 by the biologists from the Astoria laboratory. Of these 36 species, each of 13 constituted one percent or more of the total. Twelve of the 36 species encountered were of commercial importance (disregarding mink food) to a greater or lesser degree, but only five of the 12

Table 3. Catch Composition by Species Found by Random Sampling of 39,600 Fish from the Catches of 13 Otter Trawl Trips Taken from Astoria and Garibaldi, Oregon. No correction factors yet applied.

SPECIES	NUMBERS	PERCENT
DOVER*	9,450	24
ENGLISH	6,426	16
PETRALE	2,552	6
Bellingham Sole	743	2
Black Cod	424	1
Flounder	245	1
Hake	3,948	10
Ratfish	248	1
Rex Sole	10,833	27
Sand Dab	2,176	5
Skate	423	1
True Cod	207	1
Turbot	948	2
Misc.**	977	2
TOTAL	39,600	99

* Those species underlined are marketed for food or fish oil all or part of the year.

** Miscellaneous Species (by numbers):

Curlfin Sole (3)
Dogfish Shark (41)
Eel Pout (1)
Halibut (34)
Ling Cod (121)
Rock Sole (3)
S. alutus (193)
S. dallii (1)
S. elongatus (29)
S. flavidus (173)
S. melanops (6)
S. mystinus (65)
S. paucispinous (39)
S. pinniger (94)
S. rubrivinctus (4)
Sand Sole (5)
Sea Poacher (1)
Sebastolobus alascanus (11)
Shad (47)
Slender Sole (86)
Sturgeon (2)
Tom Cod (17)
Wolf Eel (1)

accounted for one percent or more of the total fish examined. In Table 3 all species of commercial importance, other than mink, for food are underlined. These are the rough data and no correction factors have been applied.

The salient fact in this table is the high percentage of rex sole encountered. There is little demand for this species for food despite their excellent flavor. There is a limited demand for rex sole for use as mink food and occasionally some are sold in the fresh fish markets but with these exceptions, the species is currently being discarded at sea by the fishermen.

The method selected for obtaining the random sample of the catch by species and size (for commercially important flatfish) must be tested for the following possible sampling errors, (1) stratification of the fish by species, (2) stratification of any single species by size, (3) variation in the distribution of species by areas within a single deck bin, (4) variations in distribution of sizes of any single species by area within a single bin, and (5) variation in the distribution of species and sizes between deck bins. Tests have been made for sampling errors due to (1), (2), (3), and (4), but not for (5).

A graphical test was made to discover any sampling errors due to stratification by species using the data from the first sampling trip taken May 8-11, 1950. A total of 3,017 fish were sampled of which the most abundant species was petrale sole (867 fish or 28.7 percent of the catch). The second most abundant species was rex sole (790 fish, or 26.3 percent of the catch). Dover sole accounted for 21.5 percent (648 fish) of the catch, and English sole, eight percent (256 fish). There were 16 other species present in the sampling, but no single species accounted for more than four percent of the total sample. Petrale and rex sole were selected as representative of the food and scrap species, respectively for the following tests.

The sampling data were written up on engineering paper in columns of 50 lines each. Each drag was written up separately and all species were entered in the columns in the order of their appearance in the sample. In this way, the fish in column one would be those fish which lay above those in column two in the deck bin, etc. For the graphical tests, only the complete columns, i.e. those containing 50 fish were utilised in order to make the results comparable. The frequencies of petrale and rex sole per column (of 50 fish sampled) were plotted for each drag of the trip (Fig. 12). If there were any stratifica tion by species as the sampling proceeded down through the fish, this should be evidenced by a consistent change in the slope of the lines connecting the respective frequencies of petrale and rex sole for each column. There appears to be no such consistent pattern of positive or negative slope to the lines.

A second graphical test was applied to the same petrale data using the average lengths of petrale found in each column rather than the frequency (Fig. 13). The purpose of this was to determine if there was any change in size of fish sampled at different levels in the deck bins. Again there appears to be no consistent trend, and changes in average size which do occur do not seem to be significant.

These two graphical tests are largely subjective in nature and some latitude in judgement is possible. An attempt will be made to develop more refined and objective tests to apply to these data when time permits.

A test of the variation in distribution of species by area within a single deck bin was made during September 9-14, 1950. Two biologists took a trip together on an otter trawler from Astoria. Throughout the trip the regular procedures were followed, and in addition the two biologists sampled from the same bin (port or starboard), but at opposite ends.

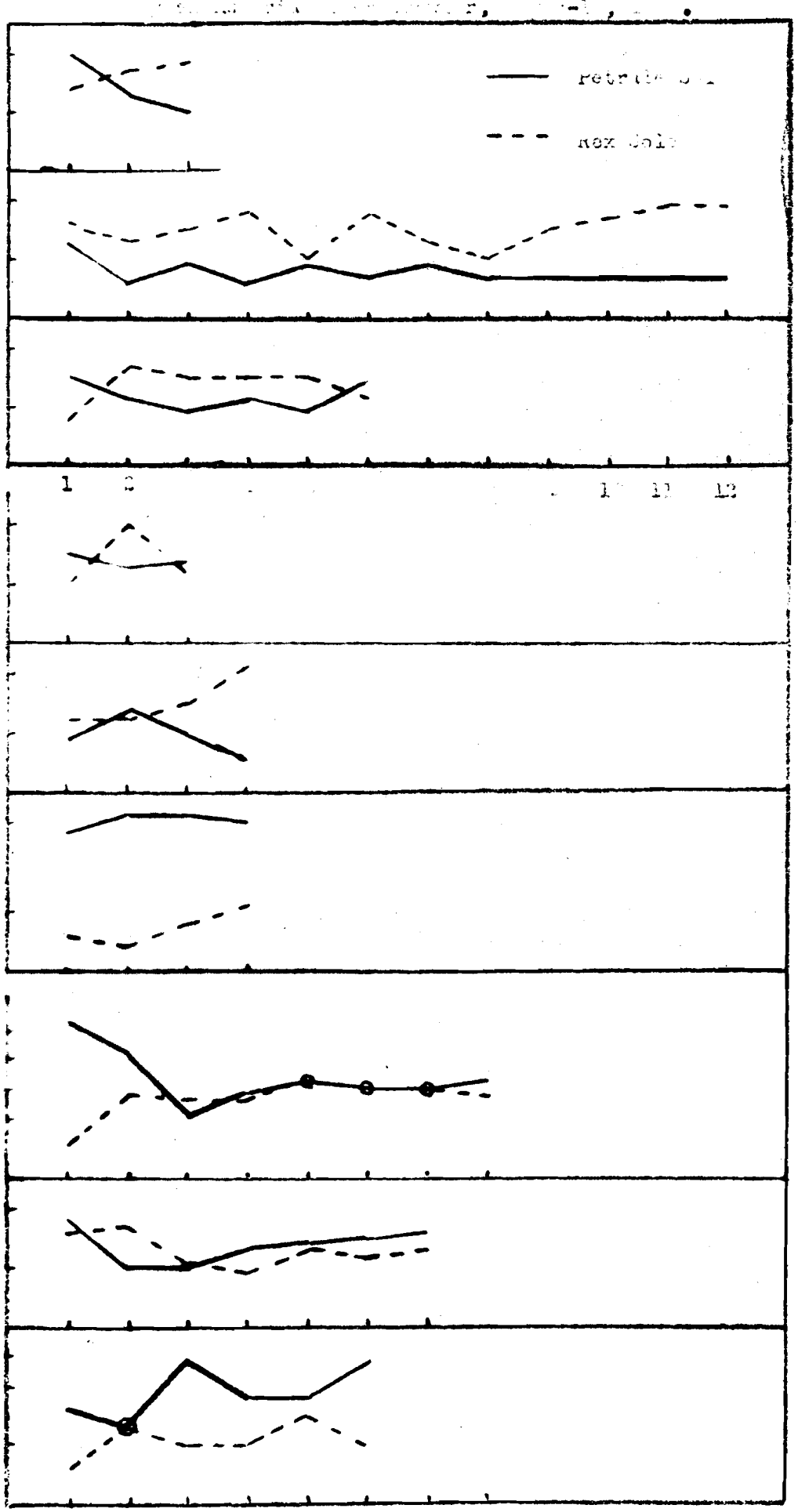

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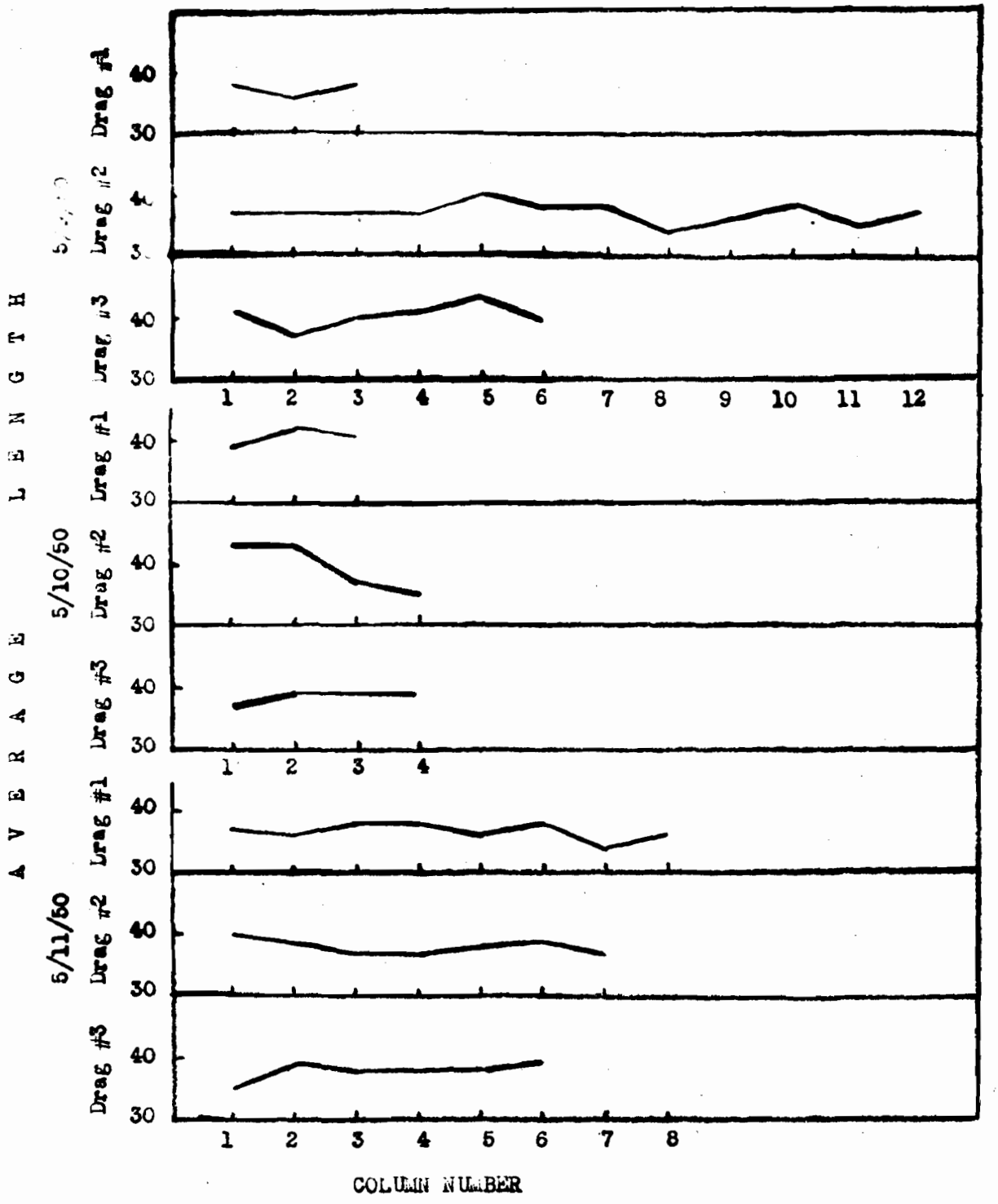
Figure 13. Average Lengths of Petrale Sole by Column in the Random Samples of the Catches Made by an Astoria Otter Trawler, May 8-11, 1950.



Simultaneous and approximately equal samples were taken of all the daylight drags during the trip. At the conclusion of the trip the data were written up as separate trips and then compared.

The two tallies by species coincided closely, even to the extent that both biologists encountered the same species, except for one sand sole tallied by biologist "A" and none by biologist "B" (Table 4).

The test of the variability by size for any single species was made on the English sole since this species accounted for over 50 percent, by number, of the gross catch and was the principal species being sought by the fishermen on this trip. The length frequencies for the boat samples taken by biologists "A" and "B" were also similar (Fig. 14). For the unsmoothed curves the range for sample "A" was 19.25 to 47.25 cm. with the mode at 32.25 cm., while for "B" the range was 19.25 cm. to 49.25 cm. with the mode at 33.25 cm. There appears to be little difference between the two figures.

A test for the variation in species and size between bins was not made due to the lack of time during the latter part of the season, but should be accomplished during the 1951 season.

In conclusion, there is apparently no significant stratification, vertically or horizontally, of the fish by size or species within the port or starboard deck bins selected for sampling. It is not known if there is a difference in distribution by species or size between the two bins, but most of the fish are usually placed in one bin.

2. Selectivity of Gear: The 1950 experiments on the effect of gear and fisherman's selectivity upon the commercially important species in the Oregon otter trawl fishery has been conducted on the three species of flatfish, i.e. Dover, English, and petrale sole. Of these, the experiments on Dover sole most nearly approximate the initial goals of the summer's work,

Figure 14. English Sole Length Frequency Polygons for [illegible]
Boat Samples Taken by Biologists "A" and "B", [illegible].

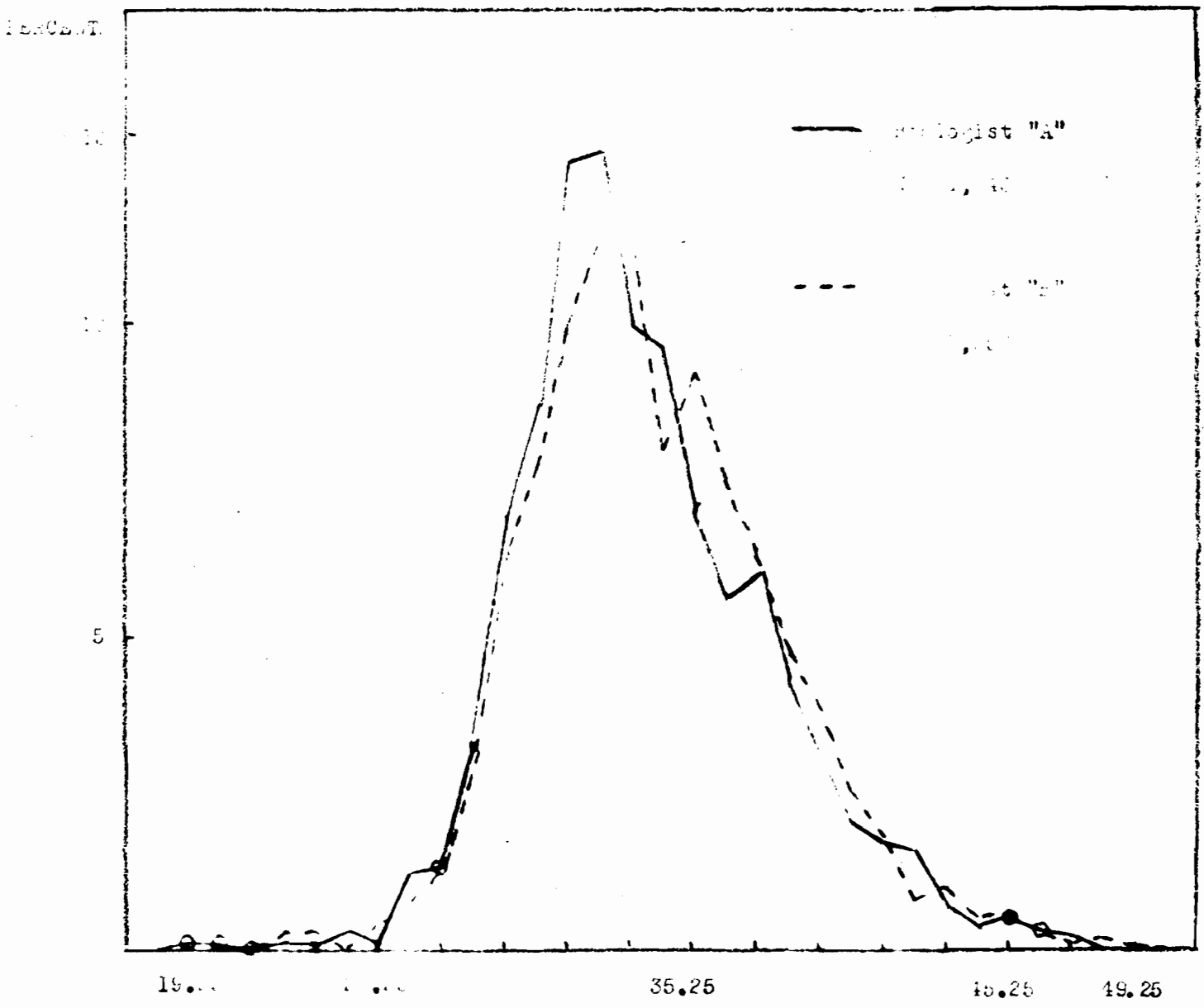


Table 4. Catch Composition by Species Found by Biologists "A" and "B" in Randomly Sampling 2,540 and 2,487 Fish, Respectively, During One Otter Trawl Trip.

SPECIES	BIOLOGIST "A"		BIOLOGIST "B"	
	Nos.	%	Nos.	%
DOVER SOLE	60	2.4	63	2.5
ENGLISH SOLE	1,343	52.9	1,256	50.5
PETRALE SOLE	187	7.4	271	10.9
Bellingham Sole	91	3.6	81	3.3
Dogfish Shark	12	0.5	12	0.5
Flounder	74	2.9	98	3.9
Halibut	1	few	1	few
Hake	202	8.0	231	9.3
Ling Cod	11	0.4	12	0.5
Rex Sole	392	15.4	282	11.3
Sand Dab	20	0.8	14	0.6
Sand Sole	1	few	0	-
S. flavidus	2	0.1	11	0.4
S. melanops	1	few	3	0.1
S. pinniger	2	0.1	8	0.3
Shad	15	0.6	29	1.1
Skate	55	2.2	47	1.9
Tom Cod	7	0.3	4	0.2
True Cod	13	0.5	14	0.6
Turbot	51	2.0	50	2.0
TOTALS	2,540	100.1	2,487	99.9

and for the purposes of continuity, the following discussions will deal with Dover sole only, with only brief notations of the corresponding progress which has been made on English and petrale sole.

a. By size; The selectivity of gear, by size, will be difficult to determine since it appears that the schools of fish vary somewhat in their size ranges so that even the most carefully conducted mesh experiment will have to be repeated to insure that the minimum sizes of fish have been encountered on the grounds.

A preliminary mesh experiment was conducted on Dover sole during the period of June 24-26, 1950. A small otter trawler was chartered from Astoria.. Three single-mesh cod ends of different mesh size (3.8", 4.8", and 5.3") were tried on successive days. The entire catch for each drag was counted by species, and, with the exception of approximately one-half of the second drag on June 25, all Dover, English, and petrale sole were measured to the nearest one-half centimeter.

The original plan was to spend three days in the same area, but strong tidal currents in the area chosen for the first day's operation prevented this. An area was found in somewhat shallower water on the second day in which there were no such adverse currents and the boat remained there for two days. The 3.8" mesh cod end was used for two drags on June 25, and the 5.3" mesh was used for two drags on June 26. Since practically all the catch of the important flatfish species (Dover, English, and petrale) were to be measured, the two biologists asked the skipper to point out the minimum size of flatfish for each species which he would keep for marketing. For the Dover sole this size was approximately 36 centimeters. Practically all Dover sole less than 36 centimeters were discarded by the biologists during their measurements. The net catches for each day were iced down in separate bins in the hold and weighed out separately at the dock. In addition,

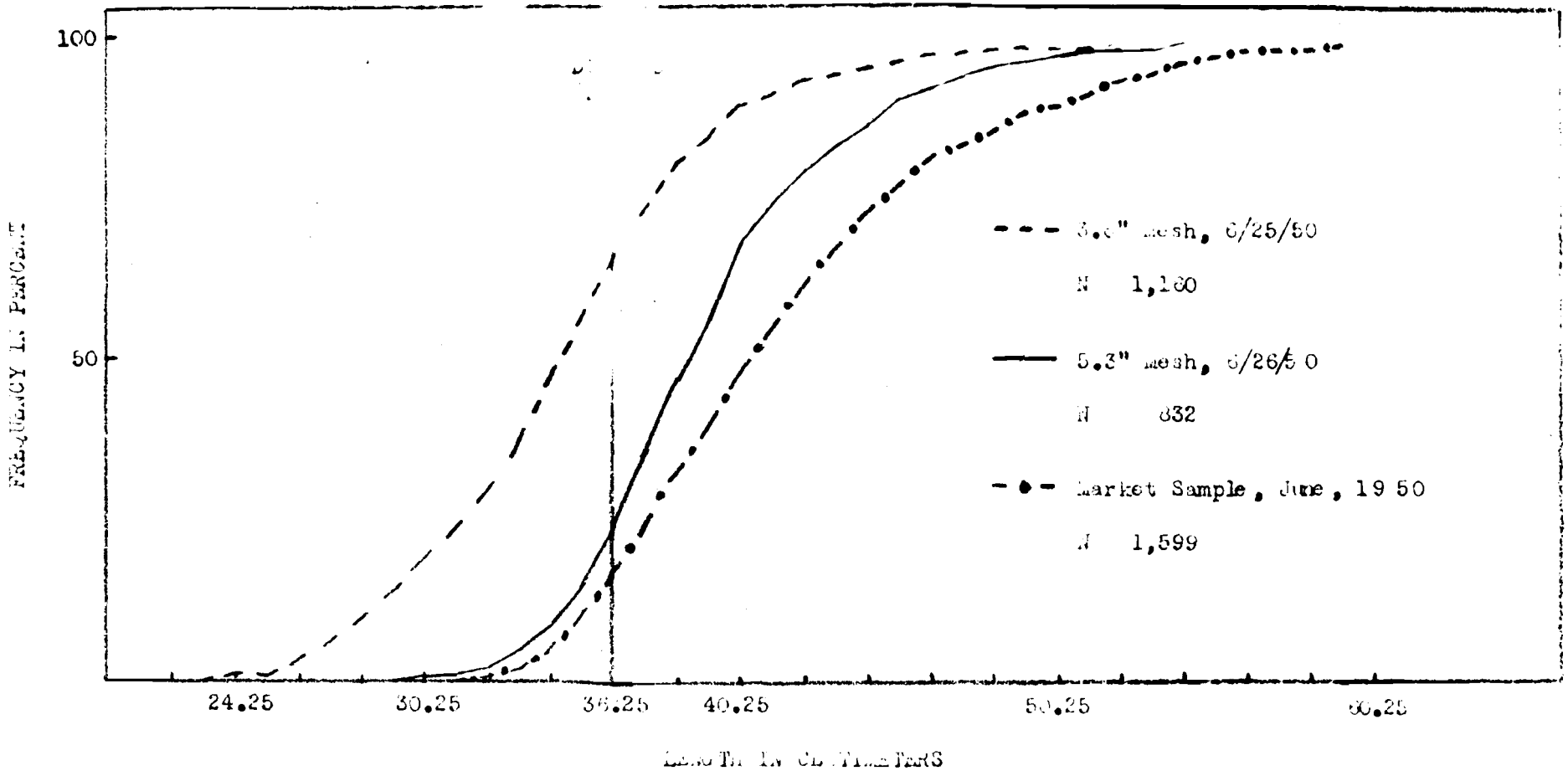
a random sample of 376 Dover sole was taken (length and sex) from the June 25 catch.

The cumulative length-frequency (by percent) for the gross catches of Dover sole for the two comparable days, June 25 and 26, were plotted together with the cumulative length-frequencies (by percent) for the June, 1950 market samples (N equals 1,599) of Dover sole taken at the Astoria docks (Fig. 15). There is a striking difference between the curves for the 3.8" and 5.3" meshes. For the gross catch by the 3.8" mesh, 66 percent of the Dover sole were equal to or less than 36 centimeters (the discard size), while for the 5.3" mesh, only 24 percent were equal to or less than 36 centimeters. It must be remembered that these are single-mesh cod ends. The more common cod end in the fishery is double-meshed, i.e. there is a double bag of mesh for all or part of the cod end, principally to provide protection against the heavy wear to which this end of the net is subjected.

A comparison of the curve of the June market sample with the other two curves in Figure 15 must be done with considerable caution since the catch curves for the 3.8" and 5.3" meshes represent the range of size for the gross catch rather than the net catch as represented by the market sample curve. A second source of variation, not apparent in the data, is that the discard size is not uniform with regard to boat or time. The variation in discard size by boat has been apparent to some degree previously, and this summer it was found that when the fish were less abundant or the demand for them was higher than usual, there was a tendency among some of the fishermen to lower their discard size. These two factors have not been dealt with here and are merely mentioned in passing.

Disregarding the possible sources of error for the moment, 16 percent of the fish in the June market sample were equal to or less than 36 centimeters, while for the gross catch of the 5.3" mesh, 24 percent were 36 centimeters or less. It would appear that the 5.3" mesh (single cod end) would

Figure15. Cumulative [illegible] Percent) of Dover Sole Sampled from [illegible]tter Trawl Net of 3.[illegible] Otter Trawl Net of [illegible] and, (3) [illegible], 1950.



reduce the numbers of non-marketable fish in the gross catches of the otter trawl nets.

b. By Age: The selectivity of gear by age can only be determined in a qualitative manner. That is, it will be possible to state which age classes are present in the catch, but it is not possible, with these data, to determine the percentage of each age class which is selected by the gear.

The selectivity of gear upon the age classes of Dover, English, and petrale sole can be determined directly by taking a random or rectilinear sample of otoliths, together with length and sex, in conjunction with the length-frequencies of the gross catch.

A second method would be to take a random or rectilinear sample of otoliths (with length and sex) of those fish discarded by the fishermen. Adequate samples giving length, sex, and otoliths have already been obtained for the marketable fish by means of the regular market sampling since 1948.

The second method of obtaining the age classes present in the gross catch is now being used. Approximately 400 otoliths have been collected for each of the three principal species (Dover, English, and petrale) together with the necessary information on sex, length, date, and location of catch.

3. Selectivity by Fishermen: The profitable operation of the filleting plants is dependent upon maintaining as high a percentage yield of saleable meat from the filleted fish as possible. As a result the plants have imposed minimum size limits upon the various species of flatfish purchased. Unfortunately these minima are greater than the minima imposed by the fishing gear upon the populations of fish. It is the intention of this portion of the project to determine the magnitude of the difference between the gross catches and net catches of the principal species of flatfish. This difference is conveniently expressed as percentage discards by numbers and

pounds, of each species. It is also important to determine this difference with respect to its effect upon the age classes of each species present in the fishery. In other words, what age classes are selected by the nets, and what age classes are selected for marketing from the gross catch?

a. By Size: The method devised to estimate the percentage by size of the gross catch of Dover, English, and petrale sole which is discarded at sea involves four readily obtainable factors. They are (1) a random sample of lengths for each species in the gross catch (Boat Sample), (2) a random sample of lengths for each species in the net catch marketed (Dock Sample), (3) the total pounds landed for each species, and (4) the length-weight relationship for each species.

An outline of the simple mathematical procedures is presented in Table 5 using as an example the data obtained for Dover sole during the trip taken May 8-11, 1950 (Fig. 16). Following is a step-by-step discussion of the calculations.

Step One: The estimated total numbers landed (6,900 fish) is computed by dividing the actual total pounds landed (12,480 lbs) by the average weight (1.8 lbs.). The average weight is determined by computing the average length (44 cm) of the fish in the Dock Sample and obtaining the corresponding weight from the length-weight curve.

Step Two: The estimated total number landed greater than 38 centimeters (6,300 fish) was taken directly from length frequency table of the Dock Sample. The 38 centimeter length was selected by inspection as the theoretical discard level. It is assumed, for the subsequent calculations, that approximately as many fish will be rejected above 38 centimeters as below, within a range set by the smallest size appearing in the Dock Sample. In this case the theoretical range of selection was 34 to 42 centimeters. The actual distribution will undoubtedly be skewed to the smaller sizes, but this

Figure 13. Dover Sole Length Frequency Polygons for BOAT and DOCK Samples Taken During the Astoria Otter Trawl Trip, May 8-11, 1950.

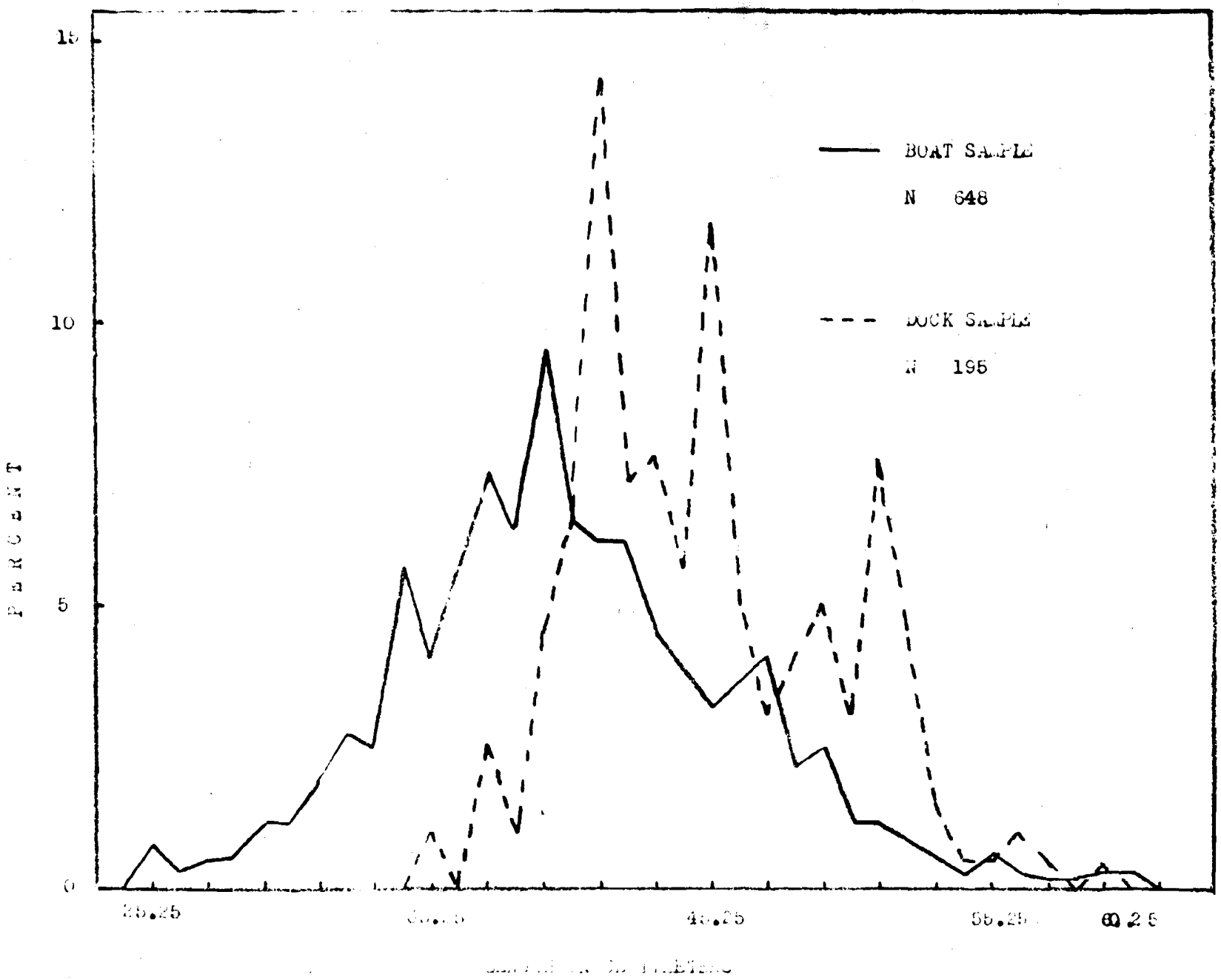


Table 5. Outline of Steps in Estimating Percentage Discard, by Numbers and Weight, for Dover Sole from Otter Trawl Trip Taken May 8-11, 1950.

TOTAL POUNDS LANDED (known) 12,480 lbs.

Step One: ESTIMATED TOTAL NUMBERS LANDED = $\frac{\text{TOTAL LBS. LANDED}}{\text{AVER. WEIGHT}}$ = 6,900 fish

Step Two: EST. TOTAL NUMBERS GREATER THAN 38 CM = 6,300 fish

Step Three: EST. TOTAL NUMBERS CAUGHT = $\frac{\text{EST. TOTAL NOS. LANDED} > 38 \text{ CM}}{\% \text{ BOAT SAMPLE} > 38 \text{ CM}}$ = 10,700 fish

Step Four: EST. TOTAL POUNDS CAUGHT = (AV. WT.)(EST. NOS. CAUGHT) = 13,900 lbs.

Step Five: EST. TOTAL LBS. LANDED = (EST. NOS. LANDED)(AV. WT.) = 11,900 lbs.

Step Six: EST. TOTAL LBS. DISCARDED = (EST. LBS. CAUGHT) - (EST. LBS. LANDED) = 2,000 lbs.

Step Seven: EST. % LBS. DISCARDED = $\frac{\text{EST. LBS. DISCARDED}}{\text{EST. LBS. CAUGHT}}$ (100) = 14%

Step Eight: EST. TOTAL NOS. DISCARDED = (EST. NOS. CAUGHT) - (EST. NOS. LANDED) = 4,400 fish

Step Nine: EST. % NOS. DISCARDED = $\frac{\text{EST. NOS. DISCARDED}}{\text{EST. NOS. CAUGHT}}$ = 41%

skewness will probably tend to balance out with regard to weight if not numbers. In a later discussion the percentage error in the entire method has been estimated for a special case and will be discussed.

Step Three: The estimated total number of fish caught (10,700 fish) is obtained by dividing the estimated total number of fish landed greater than 38 centimeters (59.1 percent). This step is justified by assuming that the portion of the Dock Sample which is beyond the effect of selection (or has been corrected for it) will in turn be a sub-sample of the Boat Sample and possess the general characteristics thereof.

Step Four: The estimated total pounds caught (13,900 lbs.) is calculated by multiplying the estimated total numbers caught (10,700 fish) by the average weight (1.3 lbs.) of the fish caught. The average weight of the fish caught is obtained by computing the average length (39 cm) of the fish in the Boat Sample and converting this to average weight from the length-weight curve.

Step Five: The estimated total pounds landed (11,900 lbs.) is determined by multiplying the estimated total numbers landed (6,900 fish) by the average weight (1.8 lbs.). The average weight was the same as used in Step One.

Step Six: The estimated total pounds discarded (2,000 lbs.) is the difference between the estimated total pounds caught (13,900 lbs.) and the estimated total pounds landed (11,900 lbs.).

Step Seven: The estimated percentage pounds discarded (14 percent) is the quotient of the estimated total pounds discarded (2,000 lbs.) by the estimated total pounds caught (13,900 lbs.) multiplied by 100.

Step Eight: The estimated total numbers discarded (4,400 fish) is the difference between the estimated total numbers caught (10,700 fish) and the estimated total numbers landed (6,900 fish).

Table 6. Estimated Numbers and Pounds of Dover Sole Discarded During an Otter Trawl Trip Taken June 24-26, 1950.

	Estimated	Actual	% Error
Total Numbers Caught	3,700	3,441	7
Total Numbers Landed	1,600	UNK.	-
Total Numbers Discarded	2,100	UNK.	-
% Numbers Discarded	57	UNK.	-
Total Pounds Caught	3,600	UNK.	-
Total Pounds Landed	2,200	2,016	8
Total Pounds Discarded	1,400	UNK.	-
% Pounds Discarded	39	UNK.	-

Albacore Report

1950 Season

The first albacore of the 1950 season were landed at Astoria on July 10. These fish were caught 80-100 miles southwest of Cape Lookout. During the remainder of July and until the second week in August, catches by jig boats were very good. Most of the fish were caught between Cape Lookout and Grays Harbor from 35-50 miles at sea.

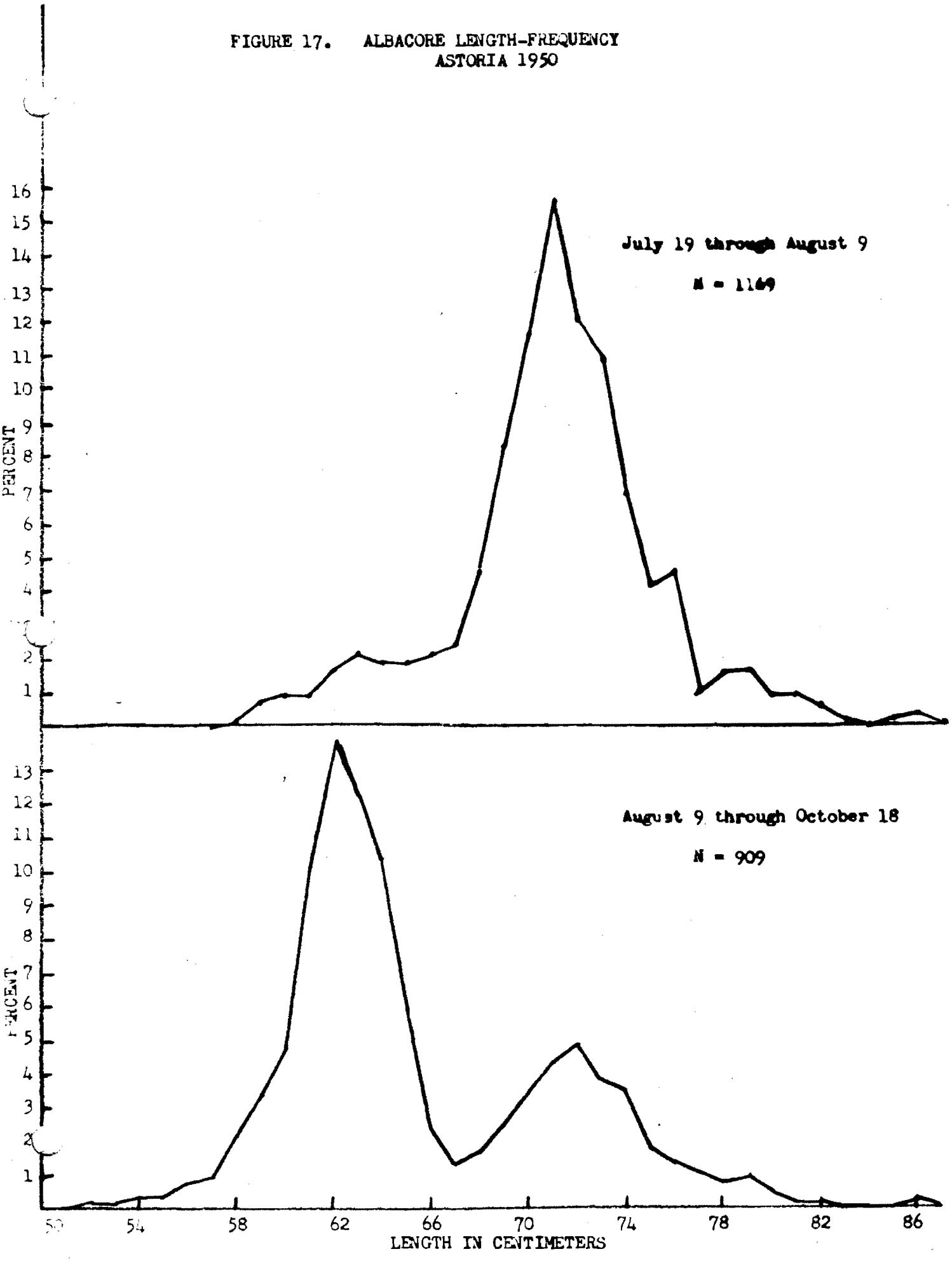
After the middle of August the fish almost disappeared from the waters off Oregon. The landings, which had given promise of a record year, dropped off abruptly. The usual bait boat fishery did not develop in August. In fact, practically no bait tuna were landed, at least in Oregon, during the 1950 season.

However, as the fishery in Oregon disappeared for the season, catches off Northern California began to increase. By the first part of September good catches were being made off Eureka. Fishing continued good until the last half of October. Much of the albacore landed in Eureka was trucked to Astoria for canning.

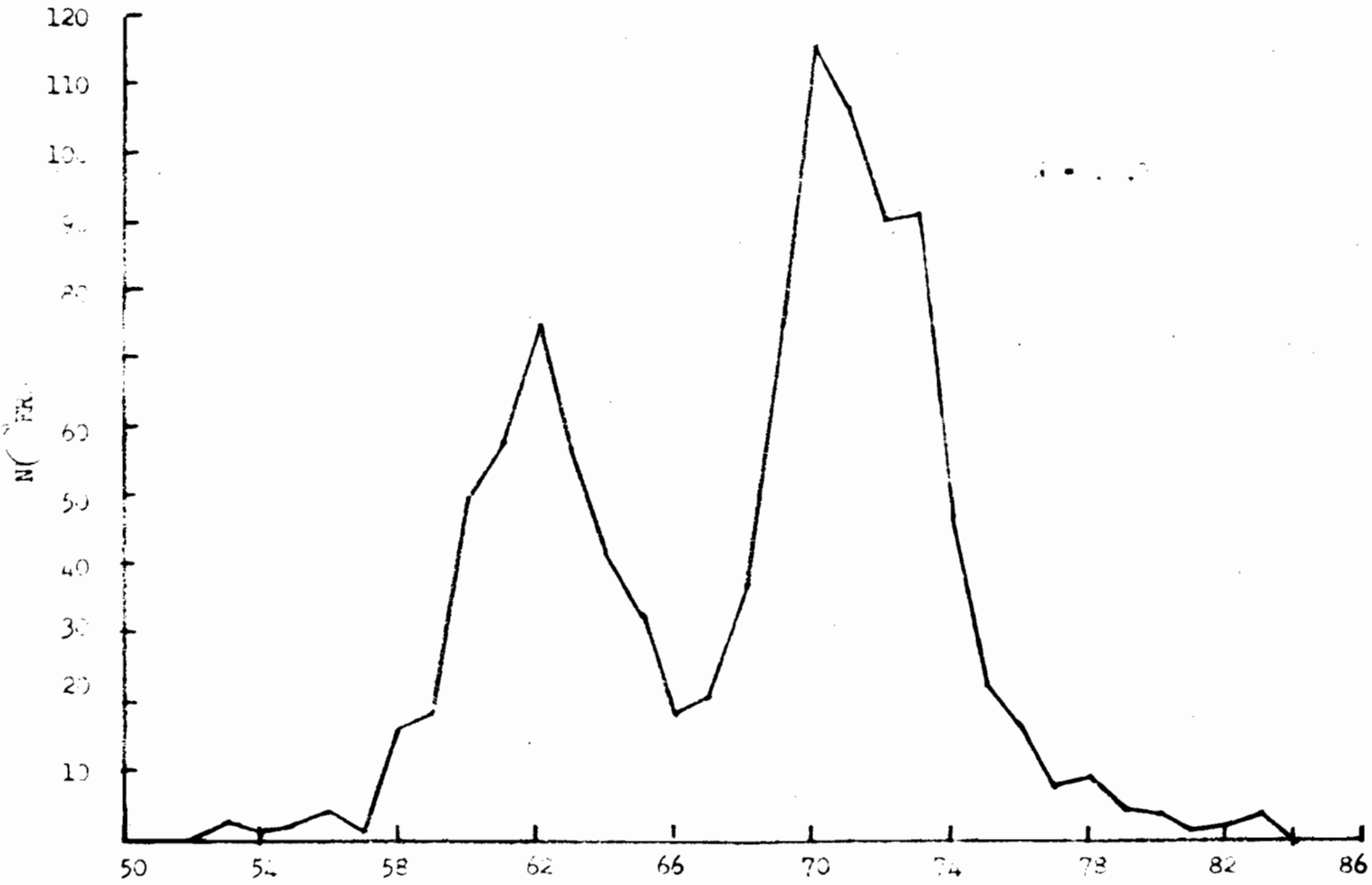
As in previous seasons, market length-frequencies were taken at Astoria and Newport. Also scales and dorsal spines were taken for age readings.

During the first part of the season, the fish were almost entirely of the large size group (Fig. 17) with the mode at 71 centimeters. After August 9 the smaller size group with a mode at 62 centimeters entered the fishery (Fig. 17). Combining length-frequencies for the season gives the two usual size groups (Fig. 18). The Newport length-frequencies for the (Fig. 19) were much the same as those at Astoria. The last sample from off Eureka was taken at Astoria on October 18, although fish were landed after this date.

FIGURE 17. ALBACORE LENGTH-FREQUENCY
ASTORIA 1950



19. ALBACORE LENGTH-FREQUENCY
NEWPORT 1950



Some additional morphometric data for racial studies were gathered during the last part of the season. A beginning has been made in working up the morphometric data gathered on local albacore in 1949 and on fresh Japanese albacore by Don McKernan in 1950. Each of the measurements has been plotted against body length (or head length in some cases). Graphic presentation of the data appears to show no significant differences in body proportions between local and Japanese albacore. Dr. Seymour Fiekowsky, statistician at Reed College, is now developing statitistical methods for comparing the body proportions of Japanese and local albacore.

Edwin Holmberg, who joined the marine fisheries section November 1 is now working on age determination of the albacore. He intends to try dorsal spines, scales, and vertebrae.

PRELIMINARY OBSERVATIONS ON THE SABLEFISH INVESTIGATION

The sablefish is known by several different names along the Pacific Coast, some of the more common of which are: black cod, coal cod, blue cod, skilfish and coalfish. In the states of Oregon and Washington the term "black cod" is the more common, but the term "cod" is actually inappropriate, for Anoplopoma fimbria is a member of the skilfish family (Anoplopomidae). This species ranges from southern California to northwestern Alaska, and it supported a fishery by long-line vessels as early as 1884.

Sablefish is marketed fresh, frozen, salted and hot-smoked; and there are indications that it has possibilities as a quick-frozen, packaged product. Both the liver and viscera are good sources of vitamin A.

Trawl Fishery

The recent expansion of the otter trawl fishery has placed additional demands upon the stocks. A practically unlimited demand during the years of 1941 through 1945 resulted in large landings of large and small fish by both the long-line and trawl fisheries. Since many of these fish were probably immature, the result was the removal of large numbers of individuals before they were able to propagate the species. At the present time the fish companies in Oregon will not generally accept fish from the trawlers of a dressed weight less than six pounds, and as a result concentrations of such fish are avoided whenever possible by the fishermen. In some instances, however, large numbers of undersized specimens are unavoidably taken by the trawlers, and the mortality among such fish is estimated as high as 95 percent by some observers.[1/]

1/Bell, F. Heward and Gharrett, John T., The Pacific Coast Blackcod, Anoplopoma fimbria, Copeia, June 30, 1945, (2):94-103.

Relative Abundance

It is the consensus of opinion among the fishermen that the sablefish is not nearly as abundant now as during former years. Halibut schooners operating out of Seattle during the months of October and November formerly landed catches of 40,000 to 60,000 pounds at Astoria between 1936 and 1939. In contrast, a catch of 20,000 pounds per similar trip is considered unusually large at the present time. A general decrease in the average size of the sablefish taken by long-line vessels has also been noted by the fishermen in recent years.

Whether this decline in abundance has resulted from the natural failure of several successive year classes, overfishing of adults, or destruction of large numbers of undersized fish cannot be answered at the present time. Since the size and age at maturity and correlation between the size of the spawning populations and the size of the resultant year classes are as yet unknown, the results of the removal of large numbers of undersized fish cannot be accurately determined at the present time.

In considering the question of relative abundance, it is apparent that the total catch is of little use, for it is regulated to a considerable degree by changes in the public demand for the species. At the present time it appears that the most practical method of determining changes in abundance during former years is by comparing catches of individual vessels, especially long-liners, for similar periods during successive years. A system such as that used for the California sardine (Sardinops caerulea) might be used, in which the catch of individual boats for a designated period during one year is expressed as the percentage of the catch made during the same period of the previous year. The chain linkage system developed by Fisher in 1926 might then be used to link the geometric means of the percentages

of a series of boats from one year to the next.

Regulation

The sablefish fishery is not subjected to any regulation at the present time, except that imposed by the fish companies and the abundance of the species itself. The low price of sablefish combined with an apparent scarcity of the species presently serves to discourage an intensive fishery by long-line vessels. Such a condition is reflected in the decision of many vessels which normally fish sablefish during the summer months to fish for albacore this summer instead.

The Present Investigation

The general decline in abundance during past years has resulted in the formation of a coordinated investigation of the sablefish fishery by the member agencies of the Pacific Marine Fisheries Commission. Its object is to collect pertinent information concerning the biology and statistics of the fishery, to analyze such information and if necessary to undertake a cooperative management program among the member agencies.

Tagging Program

As a means of acquiring information concerning the migratory habits, rate of growth and age of the sablefish, a tagging program was conducted off the Oregon coast this summer; a total of 2,092 fish were tagged during the period of June 24 through September 21. This is in addition to 48 fish tagged during the summers of 1948 and 1949. A total of 295 of the fish tagged this summer were tagged on long-line vessels and 1,797 on otter trawlers. The fish were tagged and measured in a large tagging box, and

the length was recorded as the distance from the most anterior portion of the head to the fork of the tail. Measurements were taken to the nearest one-half centimeter, and information concerning the condition of the fish was recorded at the time of release. In order to provide information concerning the validity of age determinations and the time of formation of annuli, scales were removed from every second fish tagged. By comparing the scales taken at the time of tagging with those from the recovered fish it should be possible to better answer the question as to the practicability of the use of scales for age determination.

Table 7 included information concerning the individual tagging trips. With the exception of the "Z" tag series, which is of the newly developed nylon-streamer type, all the tags used are of the Petersen disc type. The first 295 fish were tagged beneath the first dorsal fin and the remainder beneath the second dorsal fin. The figures referred to in Table 7 represent the length-frequencies of the fish tagged on the indicated dates, and the trips of June 24, June 25 and July 19 were made on a long-line vessel while the remainder were made on trawlers. All tags are of the Astoria series, and in all cases yellow identification discs and red blank discs were used.

A figure (Fig. 20) is included for every tagging trip except that of June 25, at which time only those fish were tagged which were below the size accepted by the fish companies from long-line vessels, i.e. under five pounds dressed weight. Since on the remaining trips every sablefish--with very few exceptions--caught was tagged, the length-frequencies of the fish tagged on such trips should provide a representative sample of the sablefish populations in that area, limited of course by the selectivity of the fishing gear involved. Figures 20a and 20b represent fish tagged on the same long-line vessel, figures 20c, 20d, and 20f those tagged on the same trawler and figures 20e and 20g those tagged on another trawler.

Figure 20.

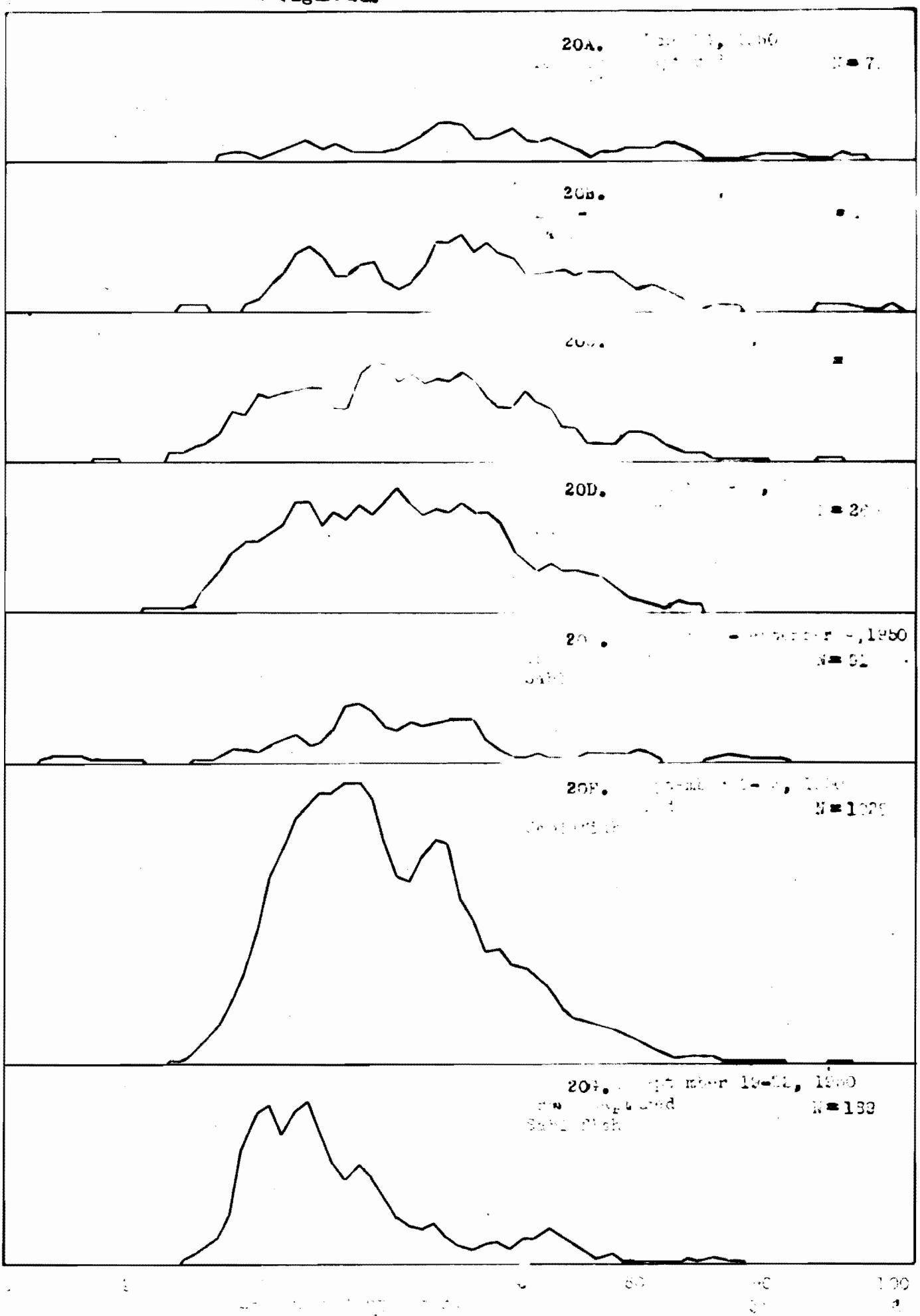


Table 7. Information Concerning the Sablefish Tagged During the Summer of 1950.

Date	Tag Numbers	Locality	Depth of Capture in Fathoms	Figure
6/24	P-3000-3069	N.W. by W. from Coos Bay	130	1
6/25	P-3070-3138	" " " " " " "	130	
7/19	P-3139-3294	" " " " " " "	130	2
8/12-8/15	P-3295-3423	" " " " " " "	120-140	3
	*Z-103-144	" " " " " " "	" "	"
	*Z-200-250	" " " " " " "	" "	"
8/17-8/20	P-3450-3718	W.N.W. of Umpqua River	130-135	4
8/31-9/4	P-3719-3809	W. of Yaquina Head	50-140	5
9/9-9/13	P-3810-4839	W.N.W. of Umpqua River	130-135	6
9/19-9/22	P-4840-5028	W. of Yaquina Head	104-160	7

* Nylon-streamer tags.

It can be seen from the figures that in general the long-line vessels capture a higher percentage of large fish than do the trawlers. It should be remarked that the trawl catches illustrated were taken in waters of a similar depth to that in which the long-line catches were made, and the majority of trawlers normally operate in shallower water where they capture much larger quantities of undersized fish. For example, examination of the catches of several trawlers operating in water of depths between 30 and 40 fathoms showed that the majority of the sablefish were of a length between 30 and 50 centimeters.

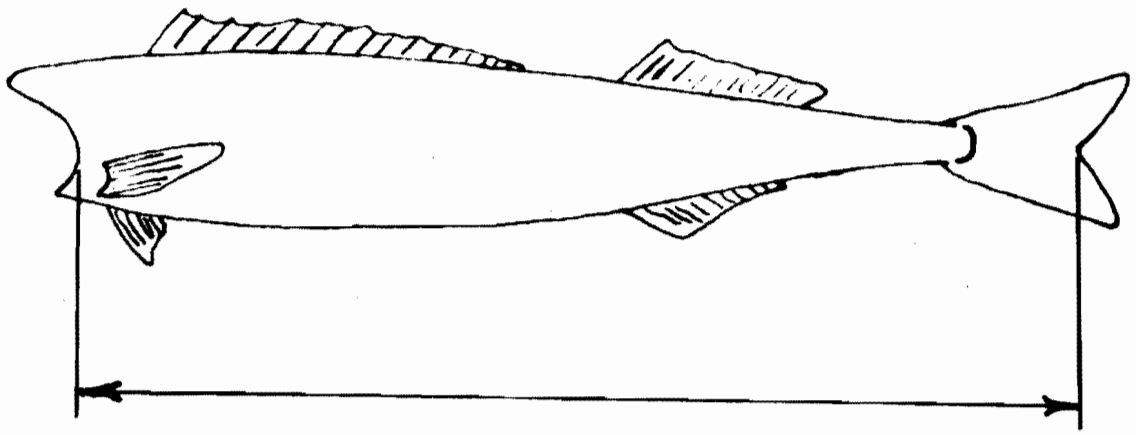
As of October 6, seven tags have been recovered, two of which were released in 1949. The time between release and recovery varied from 17 to 445 days and the distance travelled from 0 to 240 miles. The longest migration was recorded for a specimen released about 23 miles W.S.W. of Newport, Oregon on July 10, 1949 and recovered W.S.W. of Cape Flattery on September 28, 1950. Two other specimens, 57.5 and 59.5 centimeters in length, showed a growth of 1.0 centimeters each in less than 60 days.

Market Samples

As part of the general investigation, an effort was made to secure length-frequency samples of the market landings of sablefish on the Oregon coast. Because of the very limited demand for this species at the present time, however, very few long-line vessels have been engaged in the fishery this year; and it has not been possible to obtain many samples. A large percentage of the sablefish measured represent those taken by otter trawlers incidentally to their other catches.

Since sablefish are landed dressed, i.e. heads off, it was necessary to devise some standard method of measurement. The method used has been to measure from the most posterior portion of the pectoral girdle to the fork of the tail, as illustrated in Figure 21. The length is measured

Figure 21. Points of Measurement of Dressed Sablefish.



in millimeters with a large pair of tuna calipers.

In order to determine the age composition of the catches, scales have been taken from the first 20 fish encountered in each sample.

Age Determinations

Since the fish are landed with the heads off, the only structures available for age determinations are scales and fin rays. Preliminary investigations indicated that fin rays were not suitable, and as a result various methods of mounting scales were attempted in order to find the one best adapted to the scales of the sablefish. Among the media in which the scales were mounted were sodium silicate, glycerine, syrup, poly-vinyl alcohol and air. In addition, cellulose impressions were made.

None of these methods proved successful, for it was soon apparent that once the mucus on them had dried the scales were not readable. As with the California sardine, it was found that a moderately successful method of cleaning the dried scales is to soak them in a 10 percent solution of sodium hydroxide, rinse in water, neutralize in a 10 percent solution of acetic acid and finally rinse in water again. When the scales are cleaned in this manner and then mounted in air it is possible to distinguish check marks on many of them but a large number are still not readable. The best method found to date is to place the scales in small vials containing a very weak solution of carbolic acid, which prevents them from drying. They may then be removed from the vials at a convenient time, cleaned with a small brush and mounted in air.

Other Studies

In addition to the aforementioned studies, preliminary work has been done on the feeding habits of the sablefish and the length-weight relationship. A total of some 175 pounds of sablefish has been sent to the California

Division of Fish and Game and to the Commission's laboratory at Clackamas for morphological and morphometric studies.

Sebastodes Alutus

Since sablefish were tagged on trawlers fishing for "ocean perch" or "rosefish" (Sebastodes alutus), an excellent opportunity was presented for acquiring information concerning this new and expanding fishery. A random sample of 150 fish was accordingly taken during each trip, and the lengths of these fish were measured to the nearest millimeter. Each fish was sexed and the degree of maturity noted, and scales were taken for age determinations from every fifth fish encountered in the sample. In addition, information concerning the percentage composition by number of fish for each of the various species encountered in each drag of the net was recorded along with information concerning the duration and direction of drag, weather conditions and water temperatures.

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