Marine Fisheries Progress Report
May - July, 1951

The months of May, June, and July marked the beginning of the summer field season, the results of which are shown in this report. Seasonal help consisted of Al Jones, George Hirschhorn, and Verna Engstrom at Astoria and Dick Lakey at Newport. Lakey resigned August 6 to take a higher paying position as a service station attendant.

On June 17, 18, and 19, the personnel of the Astoria laboratory helped with the annual census of young razor clams.

From June 21 - 27 George Harry attended the annual sardine conference which was held in San Francisco. A report has been submitted on this meeting.

On June 28, the laboratory acquired a new Chevrolet pick-up truck.

On July 30 and 31 Dr. Fiekowsky was at the laboratory consulting on statistical procedures.

Otter Trawl

Results of the 1948 and 1949 tagging program

In past progress reports some of the results of the tagging experiments have been presented. In this report a more complete analysis of the tagging program is undertaken.

On April 27, 1948, bottom fish were tagged for the first time off the Oregon coast. The procedure established on this trip aboard the dragger Marian F, and followed on all subsequent trips, was for a biologist to accompany a fishing vessel and tag fish from the commercial catch. This procedure was necessary because Oregon does not have a research vessel. In almost all cases the captains and crews of the fishing vessels were very cooperative. The only expenses aboard the fishing vessels were for meals and the market price of the fish tagged.

The equipment needed for tagging consisted of Petersen type tags and nickel pins, tagging pliers, a live box, a net for taking fish from the live box, celluloid sheets for recording the data, pencils, and a measuring board.

The discs used for tagging were 9/16 of an inch in diameter with a hole 0.040" in diameter and were 0.035" thick. The discs were made of cellulose acetate. The colors were white, yellow, red, with a few blue, blue and white, and red and white. When white discs were used, they were placed against the dark side of the fish. One disc was marked with the notation "Oregon Fish Commission, Astoria," along with a letter and number. The other disc was blank, and the pin connecting the two discs through the flesh was made of nickel. Later experience showed that nickel was an unfortunate choice, because some (the exact percentage is not known) of the pins corroded, usually from the center out, often forming a hollow shell. There was undoubtedly a loss of tags due to this corrosion of the pins.

The tagging pliers were of the long nosed, side cutting type. In the tagging operation, the nickel pin was placed through the hole in the numbered disc and the disc was pushed back against the head of the pin. The pin was then grasped with the pliers and the point pushed through the flesh of the fish about an inch beneath the middle of the dorsal fin. The pin was pulled through the other side of the fish until the numbered disc rested firmly against the skin. Then the blank disc was placed over the protruding end of the pin and pushed against the skin of the fish. The excess length was cut from the pin with the pliers and a loop made in the end of the nickel wire so that the pin would not pull through the hole in the disc.

The live box was 50 inches long, 21 inches deep, and 27 inches wide at the bottom. The two sides sloped in toward the top which prevented some splashing. The box was made of waterproof plyboard. On top of the tagging box and at one end was a removable measuring board.

Usually only one biologist made a tagging trip because of the inconvenience caused when more than one extra person was aboard. When the vessel reached the fishing grounds and before the first drag was completed, the biologist set up his gear. Tags and pins were placed in a convenient location and the tagging box was filled with water. Celluloid sheets were on hand to record the tagging data.

As soon as the net was emptied on the deck of the vessel, the tagger picked out usually between 30 and 80 lively fish in good condition and placed them in the tagging box. The salt water in the tagging box was renewed from time to time by water from the vessel's wash-down hose.

A fish to be tagged was removed from the live tank with a dip net and the length taken to the nearest one-half centimeter on the measuring board. Then the tag was applied and the fish thrown overboard. The fish were graded as to condition into three categories. Lively fish with no apparent injuries were classified No. 1; fish with a slight split in the fin or other minor marks and not quite so lively were No. 2; those with more serious injuries and in obviously poor

Name of Boat ______________________________

Date of Landing ____________________________

Total Drags for ENTIRE Trip _________________

Area Where MOST of Fish Were Caught___________

Tabulation of Drags

Biologist: ____________________ Boat: ____________________

Date	Drag No.				Drag No.				Drag No.				Drag No.			
Net Out																
" on Bottom																
" off Bottom																
" Aboard																
Area Caught																
Fathoms																
Area Released																
Fathoms																
Direction of Drag																
Water Temperature																
Direction of Current																
Wind																
Weather and Sea Condition																
Est. Wt. of Catch																
*Percent of total number of fish in drag which are of this species.	Percent of Catch *	Fraction of each species discarded	Number Tagged		Percent of Catch	Fraction of each species discarded	Number Tagged		Percent of Catch *	Fraction of each species discarded	Number Tagged		Percent of Catch *	Fraction of each species discarded	Number Tagged	
Dover																
English																
Petrale																
Rex																
Turbot																
Flounder																
Sand Dab																
Bellingham																
Sand Sole																
Sable																
Ling Cod																
True Cod																
Dogfish																
Hake																
S. flavidus																
S. melanops																
S. pinniger																
Misc.																
No. of Skate																
No. of Crabs																
Totals																

Note: Place remarks and breakdown (in numbers of fish) of Misc. for each drag on back of this sheet.

condition were No. 3. The species, length, tag number, condition, and in the case of the English sole, sex, were recorded on the celluloid sheet. The sex of the English sole can be readily determined, except in some cases with small fish, by holding the fish up to the light which causes the ovary extending into the body cavity to become visible through the translucent flesh.

Almost all of the tagging was done in the area between Willapa Bay on the north and Tillamook Head on the south, which covers a distance of about 45 nautical miles. This is the area in which the activity of the Astoria fleet in concentrated. Some tagging was done outside of this area because occasionally a vessel decided to fish a different location in the course of a trip. The biologists had no control over where fishing was done. The area to be fished depended on the judgement of the captain, although usually the general area in which fishing was to be carried out was decided before leaving the dock. Fish were tagged in waters from 5 fathoms to 90 fathoms in depth.

Tagging extended through the summers of 1948 and 1949. Most of the tagging in both years was carried out in July and August.

In addition to recording the tagging information, the biologists were obliged to keep a record of each trip on forms provided for the purpose (see example). These forms provided essential information such as the time each drag started and ended, the area fished, direction of the drag, temperature of water, etc. Also an estimate was made of the percent by numbers of the species in the catch and the percentage of each species discarded at sea.

In a tagging program it is just as important to recover the tags as to put them out. It has been the policy of the Department of Research not to pay rewards for the recovery of tags, so it was necessary to us other means to insure recovery of the tags. Before any fish were tagged posters advertising the program were placed in practically all fillet plants from Seattle to San Francisco. The Washington State Department of Fisheries and the California Bureau of Marine Fisheries aided in the recovery program. Biologists talked with many workers in the fillet plants to gain their cooperation. A letter was sent to the captain of each vessel in the Oregon Fleet explaining the program and also each captain was interviewed in person by a biologist.

Individuals finding tagged fish were requested to record the area of capture, name of vessel making the capture, and the dat Often only part of this information was given but in most cases the required data could be obtained with a few additional inquiries. The fish with the tag in place were usually frozen until they were collected by a biologist. Occasionally only the tag was recovered. During the season of heavy fishing biologists checked each fish plant at least twice a week and often daily.

During 1948 and 1949 a total of 5648 fish of 26 species and 11 crabs (Cancer magister) were tagged from boats operating from Astoria (Table 1). A few of these were tagged outside of the Willapa Bay to Tillamook Head area. Most of the fish tagged were English sole, Petrale sole, and Dover sole, the three most important species of flatfish. Tags were placed on 2532 English sole, 2066 Dover sole, and 670 Petrale sole, which accounted for 93 percent of the tagged fish and crabs. Fewer Petrale sole were tagged than the other two species, because this species was encountered less frequently. The 44 fish in the unclassified category in 1948 resulted when the data from part of one trip were lost. A few fish tagged in 1949 were also placed in the unclassified category for various reasons.

Table 1.

Number of Fish Tagged and Recovered from Trips Made out of Astoria

Species	Number Tagged in 1948	Total Recoveries (toJan.1,1952)	Number Tagged in 1949	Total Recoveries (to Jan.1,1952)
Bellingham sole	2	0	7	0
Black Rockfish (S. Melanops)	9	0	1	0
Chinook Salmon	3	1	1	0
Crab	11	1	0	0
Dogfish shark	39	1	2	0
Dover sole	474	45	1592	139
English sole	857	64	1675	140
Halibut	0	0	1	0
Ling cod	32	1	28	2
Petrale sole	171	11	499	38
Ratfish	0	0	1	0
Red Rockfish (S.pinniger)	0	0	1	0
Red sole	7	0	11	0
Rock sole (Lepidopsetta bilineata)	0	0	1	0
Sablefish	18	0	35	3
Sand Dab (C. sordidus)	0	0	2	0
Sand sole (Psettichthys melonostictus)	11	1	2	0
Skate (Raja binoculata)	0	0	2	0
Slender sole (Lyopsetta exilis)	0	0	1	0
Soup-fin shark	1	0	0	0
Spiny-cheeked Rockfish (Sebastolobus alascanus)	1	0	0	0
Starry flounder	10	1	10	0
Sturgeon (green)	17	1	0	0
Sturgeon (white)	3	0	0	0
True cod	0	0	1	0
Turbot (Atheresthes stomias)	1	0	4	0
Yellow-tailed rockfish (S. flavidus)	44	1	15	0
Unclassified	44	0	8	0

Some attempts were made to tag three of the most important species of rockfish. No success was had with Sebastodes pinniger (red rockfish or canary) because specimens even from relatively shallow water did not survive. The yellow-tailed or green rockfish (Sebastodes flavidus) particularly when caught in relatively shallow water of 15 or 20 fathoms, seemed to survive tagging best, and one fish has been recovered after being free almost three years. The black rockfish (Sebastodes melanops) did not appear to do quite as well as the yellow-tailed rockfish under tagging treatment and none have been recovered.

The principal objective of the tagging program was to determine the amount of migration undertaken by the three species studied. It is of primary importance in any study of a fishery to know whether the stocks of fish are isolated or whether there are migrations between the various fishing areas. Another objective was to determine the amount of growth made while the fish were at liberty. There was also the possibility that some measure of the fishing intensity might be arrived at.

Probably the most important results to be obtained from the tagging experiments are those dealing with the amount of migration the fish exhibit. Schools of fish from off the Columbia River, for example, might conceivably migrate to Destruction Island off the northern Washington coast and there be subjected to a heavy fishery by the Seattle otter trawl fleet. Flatfish from off Newport or Coos Bay might move south into northern California waters and there be fished heavily by the Eureka fleet. Since each of the states regulates its own waters it is necessary to know whether any possible better management practices put into force by Oregon will need the cooperation of either or both of the adjoining states to be effective.

Table 2.

Movement of English sole

1948 Tagging Experiment		
Distance Traveled	Number	Percent
<30 miles	44	81.5
30-89 miles	0	0.0
>89 miles	10	18.5
1949 Tagging Experiment		
<30 miles	105	91.3
30-89 miles	3	2.6
>89 miles	7	6.1

Table 3.

Movement of Petrale sole

1948 Tagging Experiment		
Distance traveled	Number	Percent
<30 miles	4	40.0
30-89 miles	3	30.0
>89 miles	3	30.0
1949 Tagging Experiment		
<30 miles	21	84.0
30-89 miles	4	16.0
>89 miles	0	0.0

Table 4

Movement of Dover sole

Distance traveled	Number	Percent
1948 Tagging Experiment		
<30 miles	36	100.0
30-89 miles	0	0.0
>89 miles	0	0.0
1949 Tagging Experiment		
<30 miles	97	97.0
30-89 miles	2	2.0
>89 miles	1 (doubtful)	1.0

Table 5.

Movement of English sole

Recoveries from 1948 and 1949 Tagging combined

Distance traveled	Number	Percent
<30 miles	149	88.2
30-89 iles	3	1.8
>89 miles	17	10.0

Table 6.

Movement of Petrale sole

Recoveries from 1948 and 1949 Tagging combined

Distance traveled	Number	Percent
<30 miles	25	71.4
30-89 miles	7	20.0
>89 miles	3	8.6

Table 7

Movement of Dover sole

Recoveries from 1948 and 1949 tagging combined

Distance tr.veled	Number	Percent
<30 miles	133	97.8
30-89 miles	2	1.5
>89 miles	1 (doubtful)	0.7

Table 8.
Seasonal Movement of English Sole

Period	Distance traveled	Number	Percent
Dec.-Feb.	<30 miles	13	68.4
	30-89 miles	0	0.0
	>89 miles	6	31.6
March-May	<30 miles	22	81.5
	30-89 miles	2	7.4
	>89 miles	3	11.1
June-August	<30 miles	52	88.1
	30-89 miles	1	1.7
	>89 miles	6	10.2
Sept.-Nov.	<30 miles	64	97.0
	30-89 miles	0	0.0
	>89 miles	2	3.0

In order to show the amount of migration undertaken by the English, petrale, and Dover sole, tables were constructed showing the numbers and percents of fish tagged between Willapa Bay and Tillamook Head which migrated less than 30 miles, between 30 and 89 miles, and farther than 89 miles (Tables 2, 3, and 4). This table includes recoveries to August 1, 1951. Eighty-one percent of the English sole tagged in 1948 and niney-one percent tagged in 1949 migrated less than 30 miles. Eighteen percent of the English sole tagged in 1948 and six percent tagged in 1949 migrated farther than 89 miles. (Table 2) Of the 10 petrale recovered from the 1948 tagging, four had migrated less than 30 miles and three had migrated more than 89 miles. From the 1949 tagging, 21 recoveries weremade after a migration of less than 30 miles and no migrations over 89 miles were recorded (Table 3).

The Dover sole appeared to migrate less than the other two species. There were 36 recoveries from the 1948 tagging, all of them after migrations of less than 30 miles. From the 1949 tagging, 100 recoveries were made. Two of these recovered fish made migrations between 30 and 89 miles, and there is a possibility of one migration farther than 89 miles (Table 4). It should be pointed out that during the period of these experiments there was little fishing for Dover sole along the Oregon and Washington coasts except on the grounds off the Columbia River, and off Newport in 1951. There was, however, a rather heavy fishery for Dover sole off Eureka, California.

The returns from the two tagging years have been combined for each of the three species to show the amount of migration from both years (Tables 5, 6, and 7). From these tables it can be concluded that there is only a small amount of migration among the English and petrale soles. Occasionally an English or petrale sole migrated to waters off Eureka, over 300 miles to the south, or to northern Washington waters, 150 miles to the north. Most of the tagged fish of these two species, however, exhibited little migration and the Dover sole were particularly non-migratory.

However, there is a definite movement of the Dover sole in October from the fishing grounds to offshore spawning areas. There are practically no Dover sole taken commercially between October and the following May. That an offshore movement takes place is indicated by three recoveries made in April 1950 by the boat Valhalla II and one made in November 1951 by the boat Ida Mae. The Valhalla II caught the tagged Dover sole while engaged in an exploratory trip into waters of 200 fathoms southwest of the Columbia River. Ordinarily vessels fishing out of Astoria have not fished in waters much over 100 fathoms, although deep dragging gear is now becoming common and during the winter of 1951-1952 there was considerable fishing in waters over 200 fathoms, particularly for Pacific Ocean Perch (Sebastodes alutus), it was during this period that the Ida Mae captured a tagged Dover sole in 210 fathoms southwest of the Columbia River.

These recoveries demonstrate one weakness of a tagging program to determine migratory habits in which the intensity of fishing the various grounds is different but cannot be measured because of a lack of the proper data. In this case, recoveries of Dover sole in waters over 200 fathoms have been few, probably because there has been little fishing in waters of this depth. Likewise, if there are no boats, or only a few fishing up or down the coast from a tagging area there will be fewer recoveries made than under conditions of a heavy fishery. The number of tag recoveries should be weighted by the intensity of fishing to depict the migrations accurately. However, there are heavily fished areas both to the north and south of the Columbia River. The large Seattle otter trawl fleet fishes the grounds off northern Washington and Vancouver Island. At Newport, about 100 nautical miles south of Astoria, there is another sizeable fleet of vessels which fish the nearby waters. There are usually about three vessels dragging out of Coos Bay, which is 80 miles south of Newport, and off northern California and southern Oregon there is a heavy fishery by the Eureka fleet. Thus even though the tag recoveries cannot be weighted exactly by the fishing intensity in the various areas, any considerable migration from the area off the Columbia River should be demonstrated. A possible exception is the Dover sole because, except off the Columbia River and Eureka, the fishery for this species during the period under discussion was light. It is possible that for this reason the tag returns of Dover sole indicate less migration than is actually the case.

It might also be said that the efficiency of tag recovery is much greater in Astoria than in the other ports. This is undoubtedly true but unfortunately since the time of first tagging in 1948, there has been at least one biologist stationed at each of the principal ports where tags might be recovered, and if any significant number of tags were landed they would almost surely have been detected.

During the period of heavy winter storms between the last part of October and into March otter trawl trips are infrequent. There is a possibility that during this period the three species might make extensive spawning migrations, returning to the principal fishing grounds in the late winter and early spring after spawning has been completed without such migration being detected. In order to get some measure of such a seasonal migration, the year was divided into four parts and in each part the number of tag recoveries and the distance traveled was recorded. Recoveries to September 1,1951 are listed (Table 8, 9, and 10).

Table 9

Seasonal Movement of Petrale Sole

Period	Distance traveled	Number	Percent
Dec.-Feb.	<30 miles	3	100.0
	30-89 miles	0	0.0
	>89 miles	0	0.0
March-May	<30 miles	6	54.5
	30-89 miles	5	45.5
	>89 miles	0	0.0
June-Aug.	<30 miles	7	63.6
	30-89 miles	2	18.2
	>89 miles	2	18.2
Sept.-Nov.	<30 miles	10	90.9
	30-89 miles	0	0.0
	>89 miles	1	9.1

Table 10

Seasonal Movement of Dover Sole

Period	Distance Traveled	Number	Percent
Dec.-Feb.	<30 miles	0	-
	30-89 miles	0	-
	>89 miles	0	-
March-May	<30 miles	4	80.0
	30-89 miles	1	20.0
	>89 miles	0	0.0
June-August	<30 miles	83	95.4
	30-89 miles	3	3.4
	>89 miles	1	1.2
Sept.-Nov.	<30 miles	54	100.0
	30-89 miles	0	0.0
	>89 miles	0	0.0

There is some indication of a differential migration by season for the English sole (Table 8). In the period from December through February, 6 of the 19 recoveries (32 percent) were from fish which had migrated more than 89 miles. There were no recoveries from fish which had migrated between 30 and 89 miles. In the March through May period, 7 percent of the recoveries were from fish which had migrated between 70 and 89 miles, and 11 percent had migrated over 89 miles. In the June through August period 2 percent migrated between 30 and 89 miles and 10 percent migrated over 89 miles. In the September through November period there were two recoveries (3 percent) of tagged fish which had migrated farther that 30 miles.

These data indicate that there may be a greater migration of English sole during the winter than during the remainder of the year. This period of possible greater migration corresponds with the spawning period.

Even if a winter migration were definitely proved to take place, any possible management practices would not be greatly affected because a high percentage of the English sole are captured during the spring, summer, and early autumn, when the fish have presumably returned to the fishing grounds. During the winter when more of the fish might be in other areas there is little fishing because of stormy weather.

The few petrale sole recovered from a known area give no indication of a seasonal migration during the spawning period. In fact, if there is any seasonal variation in the migration pattern, the greatest amount ofmovement appears to be in the spring and summer.

The Dover sole are rarely taken in the winter, and consequently no tagged fish were recovered in the winter during the period of this analysis.

Although little migration has been demonstrated for any of the three flatfish studied, it is of interest to know the direction of the movement that does take place. The recoveries of English sole do not indicate either a predominately southerly or northerly migration (Table 11). Fish migrating less than 30 miles are regarded as stationary. From the 1948 and 1949 tagging combined, there were 10 recoveries to the north and also 10 to the south up to August 1, 1951. The statement can again be made that the intensity of fishing to the north and south will influence the number of tags recovered. As mentioned previously, there is considerable otter trawling both to the north and south, although the exact intensity cannot be measured in either direction with the available statistics.

Although there have been few recoveries of petrale sole where area of capture was known, the small amount of data does not indicate a distinct movement either to the south or to the north (Table 12).

The Dover sole recoveries indicate little movement either to the north or south.

Another type of movement might be a gradual dispersal from the point of tagging. Such a movement would be demonstrated if the length of time the fish were at liberty is correlated directly with the distance from the tagging site. Such does not appear to be the case, either for the English or petrale soles. (Tables 13 and 14) The data in the two tables show such a lack of correlation between days at liberty and distance in miles from the tagging site that no correlation coefficient has been calculated. The Dover sole, as explained before, exhibited little migration of any sort

Another type of presentation of the same data also shows no indicationof a pronounced dispersal from the tagging area (Tables 15 and 16). In these tables the percentages of fish which migrated less than

Table 11

Direction of Migration of English Sole

1948 Tagging Experiment

Year of Recovery	1948		1949		1950		1951		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Stationary (<30 miles)	24	89.3	16	76.2	3	60.0	1	33.3	44	77.2
Migrated North	2	7.1	2	9.5	1	20.0	1	33.3	6	10.5
Migrated South	1	3.6	3	14.3	0	-	0	-	4	7.0
Migration unknown	1	3.6	0	-	1	20.0	1	33.3	3	5.3

1949 Tagging Experiment

Year of Recovery	1949		1950		1951		Total	
	No.	%	No.	%	No.	%	No.	%
Stationary (<30 miles)	54	91.5	36	65.5	15	88.2	105	80.2
Migrated North	2	3.4	2	3.6	0	-	4	3.1
Migrated South	0	-	6	10.9	0	-	6	4.6
Migration unknown	3	5.1	11	20.0	2	11.8	16	12.2

Table 12

Direction of Migration of Petrale Sole

1948 Tagging Experiment

Year of Recovery	1948		1949		1950		1951		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Stationary (<30 miles)	1	16.7	2	100.0	1	50.0	0	0	4	36.4
Migrated North	3	50.0	0	-	0	-	1	100.0	4	36.4
Migrated South	1	16.7	0	-	1	50.0	0	0	2	18.2
Unknown	1	16.7	0	-	0	-	0	0	1	9.1

1949 Tagging Experiment

Year of Recovery	1949		1950		1951		Total	
	No.	%	No.	%	No.	%	No.	%
Stationary (<30 miles)	10	90.9	9	60.0	2	50.0	21	70.0
Migrated North	0	-	1	6.7	1	25.0	2	6.6
Migrated South	0	-	1	6.7	1	25.0	2	6.6
Migration unknown	1	9.1	4	26.7	0	-	5	16.7

Table 13

Relationship between the number of days at liberty after tagging and the distance from the point of tagging.

English sole

Days out	Distance in miles from tagging site									
	0-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	240-270	271-300
0- 60	56	0	0	2	1	0	0	0	0	0
61- 120	16	0	0	0	1	0	0	0	0	0
121- 180	6	0	0	1	1	1	0	0	1	0
181- 240	7	0	1	1	0	0	0	0	0	0
241- 300	10	1	1	0	2	0	0	0	0	1
301- 360	13	0	0	0	0	0	0	0	0	0
361- 420	17	1	0	1	1	0	0	0	0	0
421- 480	9	0	0	0	0	0	0	0	0	0
481- 540	2	0	0	0	0	0	0	0	1	0
541- 600	4	0	0	0	0	0	0	0	0	0
601- 660	4	0	0	0	0	0	0	0	0	0
661- 720	8	0	0	1	0	0	0	0	0	0
721- 780	1	0	0	0	0	0	0	0	0	0
781- 840	0	0	0	0	0	0	0	0	0	0
841- 900	0	0	0	0	0	0	0	0	0	0
901- 960	0	0	0	0	1	0	0	0	0	0
961-1020	0	0	0	0	0	0	0	0	0	0
1021-1080	1	0	0	0	0	0	0	0	0	0

Table 14

Relationship between the number of days at liberty after tagging and the distance from the point of tagging.

Petrale sole

Days out	Distance in Miles from Tagging Site									
	0-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	240-270	271-300
0- 60	6	1	0	1	0	0	0	0	0	0
61- 120	1	0	0	1	0	0	0	0	0	0
121- 180	1	0	0	0	0	0	0	0	0	0
181- 240	1	0	0	0	0	0	0	0	0	1
241- 300	4	1	1	0	0	0	0	0	0	0
301- 360	3	0	0	0	0	0	0	0	0	0
361- 420	0	0	0	0	0	0	0	0	0	0
421- 480	1	0	0	0	0	0	0	0	0	0
481- 540	1	0	0	0	0	0	0	0	0	0
541- 600	2	0	0	0	0	0	0	0	0	0
601- 660	1	1	0	0	0	0	0	0	0	0
661- 720	1	1	0	0	0	0	0	0	0	0
721- 780	0	0	0	0	0	0	0	0	0	0
781- 840	0	0	0	0	0	0	0	0	0	0
841- 900	0	0	0	0	0	0	0	0	0	0
901- 960	0	0	0	0	0	0	0	0	0	0
961-1020	0	0	0	0	0	0	0	0	0	0
1021-1080	1	0	0	0	0	0	0	0	0	0

Table 15

Relationship between the number of days at liberty after tagging and the distance from the point of tagging

English sole

Days out	Distance Traveled	Number	Percent
0 - 60	<30 miles	56	94.9
	30 miles or more	3	5.1
61-120	<30 miles	16	94.1
	30 miles or more	1	5.9
121-180	<30 miles	6	60.0
	30 miles or more	4	40.0
181-240	<30 miles	7	77.8
	30 miles or more	2	22.2
241-300	<30 miles	10	66.7
	30 miles or more	5	33.3
301-360	<30 miles	13	100.0
	30 miles or more	0	0.0
361-420	<30 miles	17	85.0
	30 miles or more	3	15.0
421-480	<30 miles	9	100.0
	30 miles or more	0	0.0
481-540	<30 miles	2	66.7
	30 miles or more	1	33.3
541-600	<30 miles	4	100.0
	30 miles or more	0	0.0
601-660	<30 miles	4	100.0
	30 miles or more	0	0.0
661-720	<30 miles	8	88.9
	30 miles or more	1	11.1
721-780	<30 miles	1	100.0
	30 miles or more	0	0.0
781-840	<30 miles	0	0.0
	30 miles or more	0	0.0
841-900	<30 miles	0	0.0
	30 miles or more	0	0.0
901-960	<30 miles	0	0.0
	30 miles or more	1	100.0
961-1020	<30 miles	0	0.0
	30 miles or more	0	0.0
1021-1080	<30 miles	1	100.0
	30 miles or more	0	0.0

Table 16

Relationship between the number of days at liberty after tagging and the distance from the point of tagging

Petrale sole

Days out	Distance Traveled	Number	Percent
0-60	<30 miles	6	75.0
	30 miles or greater	2	25.0
60-120	<30 miles	1	50.0
	30 miles or greater	1	50.0
121-180	<30 miles	1	100.0
	30 miles or greater	0	0.0
181-240	<30 miles	1	50.0
	30 miles or greater	1	50.0
241-300	<30 miles	4	66.7
	30 miles or greater	2	33.3
301-360	<30 miles	3	100.0
	30 miles or greater	0	0.0
361-420	<30 miles	0	0.0
	30 miles or greater	0	0.0
421-480	<30 miles	1	100.0
	30 miles or greater	0	0.0
481-540	<30 miles	1	100.0
	30 miles or greater	0	0.0
541-600	<30 miles	2	100.0
	30 miles or greater	0	0.0
601-660	<30 miles	1	100.0
	30 miles or greater	0	0.0
661-720	<30 miles	1	50.0
	30 miles or greater	1	50.0
721-780	<30 miles	0	0.0
	30 miles or greater	1	100.0
781-840	<30 miles	0	0.0
	30 miles or greater	0	0.0
841-900	<30 miles	0	0.0
	30 miles or greater	0	0.0
901-960	<30 miles	0	0.0
	30 miles or greater	0	0.0
961-1020	<30 miles	1	100.0
	30 miles or greater	0	0.0

30 miles and 30 miles or more were calculated for successive 60-day intervals to 1080 days. There is an initial dispersal of the English sole up to a period of about 120 days after tagging. After this first general dispersal there is little further movement. A total of 123 recoveries, where the area of recapture was known, were made within a year after the tagging date. Fifteen (12.2 percent) of these recovered fish had migrated farther than 30 miles. Fifty tagged fish were recovered after being at liberty between one and two years, and only 5 (10percent) had moved more than 30 miles.

The same type of table for the petrale sole has too few returns to be significant. Of the 22 fish recovered in the first year after tagging, six (27.3 percent) had migrated farther than 30 miles. Only nine fish were recovered after being at liberty more than one year, and of these, two (22.2 percent) had moved more than 30 miles.

Recoveries of tagged fish should not only indicate the amount of movement but should also measure the growth of the fish after tagging. As mentioned previously, most of the recoveries were made from the fish plants, where the usual procedure is to freeze tagged fish until they are picked up by a biologist. The fish are measured in the laboratory, after they have thawed, the sex determined, and the left otolith taken. The information of importance, such as time and place of tagging, size when tagged, and area of recovery is then entered on a hand punch card.

The lapse of time and the treatment of the tagged fish after being recaptured and before being measured could possibly have some effect on the length of the fish. Often the tagged fish are frozen two or three days before being measured. Even when the tagged fish is recovered at the dock there has generally been an interval of two or three days following the capture of the fish.

In order to test the effect of various types of handling and storage on the fish, biologists went to sea aboard otter trawl vessels and measured and tagged English, petrale, and Dover soles immediately after the fish were brought aboard. The fish were tagged with a Petersen type numbered disc so that they could be identified again. All measurements were made to the nearest milimeter by placing the fish on a measuring board.

On October 16, 1950, 41 Dover sole were measured at sea. Fish were selected to cover the size range caught. Measurements were made as soon as possible after the catch was brought aboard. However, because of a rough sea some of the fish were not measured until up to three hours had elapsed. After being tagged, the fish were iced down in the same manner as the remainder of the catch.

On October 17, thirty-nine more Dover sole were measured, tagged, and iced. Rough seas prevented further fishing and the boat proceeded into the dock on the afternoon of October 17.

The next day all the Dover sole were measured again when the catch was unloaded between 10 a.m. and 2 p.m. Twenty-two Dover sole from the catch of October 16 and 25 from October 17 were iced in a box which was kept on the cement floor of the fish plant for two days. This treatment represented the normal procedure of fish landed at the plants.

The remaining 33 Dover sole from the catch of both days combined were measured at the time of unloading and placed in the freezer for 48 hours. Then they were thawed and measured once again.

The fish iced down in the fish plant for 48 hours were measured again at the end of this period and then placed in the freezer for five days. After being frozen, they were thawed and measured for the last time.

The various treatments used caused a distinct shrinking of the

Dover sole. In order to picture this shrinkage graphically, a horizontal base line was drawn to represent the lengths of the fish when first measured. A scale in millimeters at right angles and downward from this line was drawn, which measured the amount of shrinkage. Then the mean shrinkage for fish between 298 and 459 millimeters and the mean shrinkage between 459 and 604 millimeters were calculated. The mean lengths of the fish in these two size categories were also calculated. The mean lengths were plotted against the mean amount of shrinkage in both size categories and the two points connected by a line.

The fish taken October 16 and measured at the dock shrank an average of about 7 millimeters. Those taken October 17 and measured at the dock shrank an average of 4 millimeters.

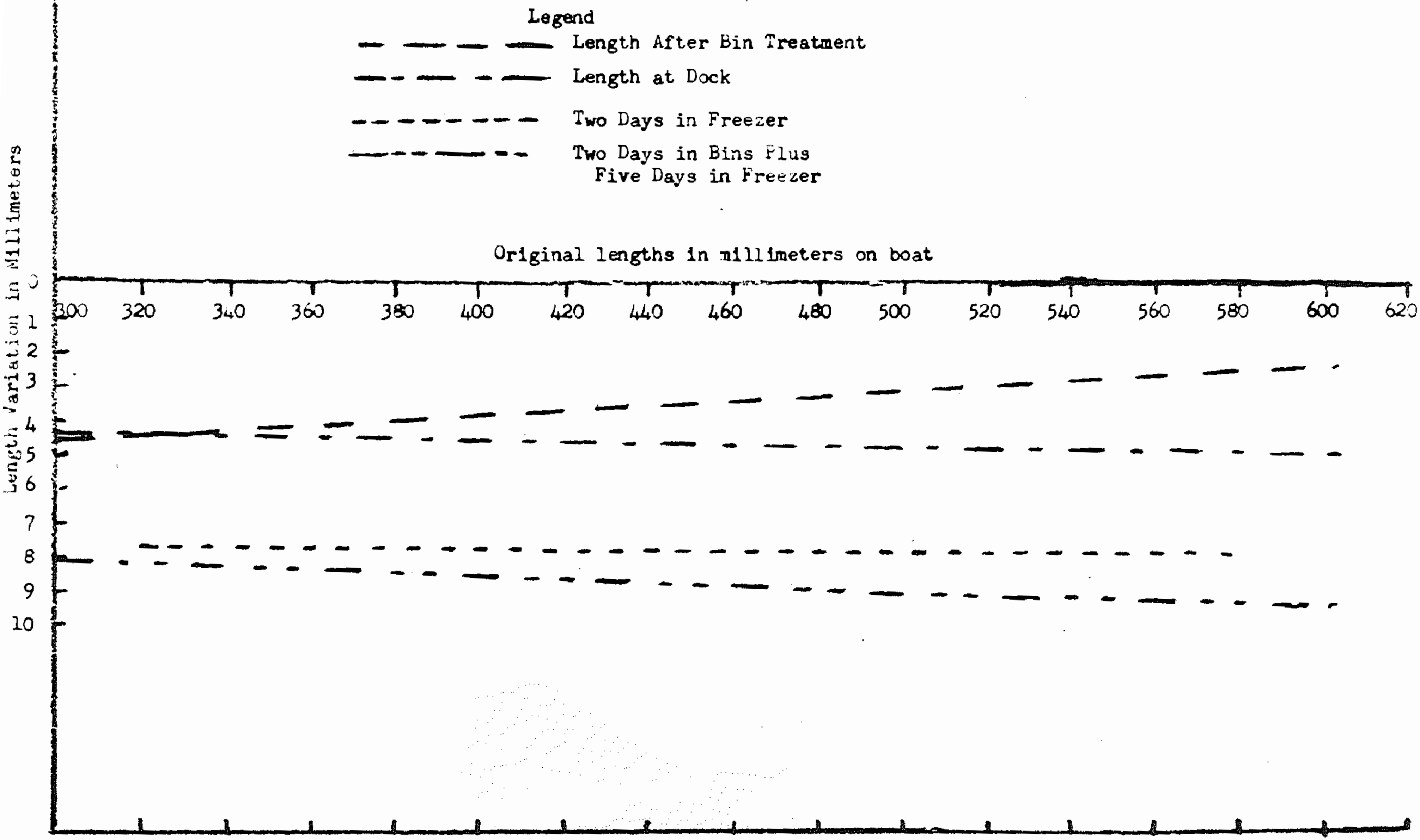
Dover sole taken October 16 and measured after two days in the freezer shrank an a verage of 9 millimeters. Those taken October 17 and measured after two days in the freezer shrank an average of 7 millimeters.

Dover sole from the October 16 catch shrank an average of 4 millimeters after being iced for two days and 9 millimeters after two days in ice and five days in the freezer. Fish taken October 17 shrank 3 millimeters and 8 millimeters after similar treatment.

There is some difference in the amount of shrinkage of Dover sole taken October 16 and those taken October 17, particularly in the measurements made at the time of unloading the catch. As would be expected, the fish caught first shrank the most in general and the differences gradually disappeared with length of storage.

Because an average correction factor to be applied to total length measurements was desired, the data for the two days at sea were combined (Fig.1). Two days at sea is a practical time period to use for obtaining correction factors because usually the companies want boats taking Dover

Figure 1. Length Variation Resulting From Commercial Handling of Dover Both Days at Sea Combined.



sole to land their catch within 48 hours. The reason for this is that the great amount of slime on the Dover sole makes adequate icing at sea difficult.

The mean shrinkage for the two days combined was as follows: (1) fish measured at the time of unloading in the fish plant, 5 millimeters; (2) after two days in ice in the fish plant, 4 millimeters; (3) after two days in the freezer, 8 millimeters; (4) after two days in ice and five days in the freezer, 9 millimeters. These shrinkages were all calculated by using the lengths taken at sea as the base measurement.

There was some difference between the amount of shrinkage in the small and large fish. For the four procedures given in the previous paragraph the mean shrinkage of the 10 smallest fish and the 10 largest fish was calculated. In all cases the largest fish shrank more than the smallest, the mean difference being between one and three millimeters.

The measurements in this experiment were all made in millimeters, but when live fish were tagged at sea all measurements were made to the nearest 1/2 centimeter. Therefore any corrections applied to the length of the tagged fish at the time of recovery must be in intervals of 1/2 centimeter. The results of the experiments on the shrinkage of Dover sole indicate that all fish measured after being iced should have a correction factor of 1/2 centimeter added to the length and fish measured after being frozen should have 1 centimeter added.

These factors have been applied to all the recoveries of Dover sole. This could be done because at the time of recovery the type of treatment the tagged fish had received was recorded.

This same type of experiment was carried out for English and petrale sole on a trip at sea aboard the otter trawl vessel Marion F. on

February 27 and 28, 1951. On February 27, 60 English sole and 40 petrale sole were selected from the catch, the length of each was recorded to the nearest millimeter, and the fish were tagged and iced. The next day, the lengths of 40 English sole and 60 petrale sole were recorded, and the fish tagged and iced. These fish were selected to cover the size range captured. All fish were measured within 1/2 hour of the time they were brought aboard.

On March 1, the sea was rough and the vessel proceeded into the dock. The tagged fish were again measured when the catch was unloaded during the morning of the same day (March 1). 50 fish of each species (English and petrale soles) were iced down in the storage bins of the plant. The other fifty fish of each species were placed in the freezer. On March 3, the fish iced in the bins were again measured and then placed in the freezer. During the same day the fish placed in the freezer March 1 were again measured. On March 12 the fish which had been moved from the bin to the freezer were measured for the last time. This period in the freezer was longer than is usual with tagged fish, a reason being that a large quantity of frozen produce was moved into the freezer and made the fish inaccessible.

Graphs similar to those constructed for the Dover sole were made to illustrate the shrinkage of the English and petrale soles (Fig. 2 and 3). The English sole shrank an average of 4 millimeters from the time they were measured on the boat until they were measured in the fish plant immediately after being unloaded from the boat. After two days of being iced down in the bins of the fish plant the English sole still exhibited a mean shrinkage of 4 millimeters. English sole frozen for two days after being unloaded shrank an average of 6 millimeters. Those iced down for two days in the fish plant and then frozen nine days shrank an average of 7 millimeters. All figures

FIG 2

SHRINKAGE RESULTING FROM COMMERCIAL HANDLING OF ENGLISH SOLE

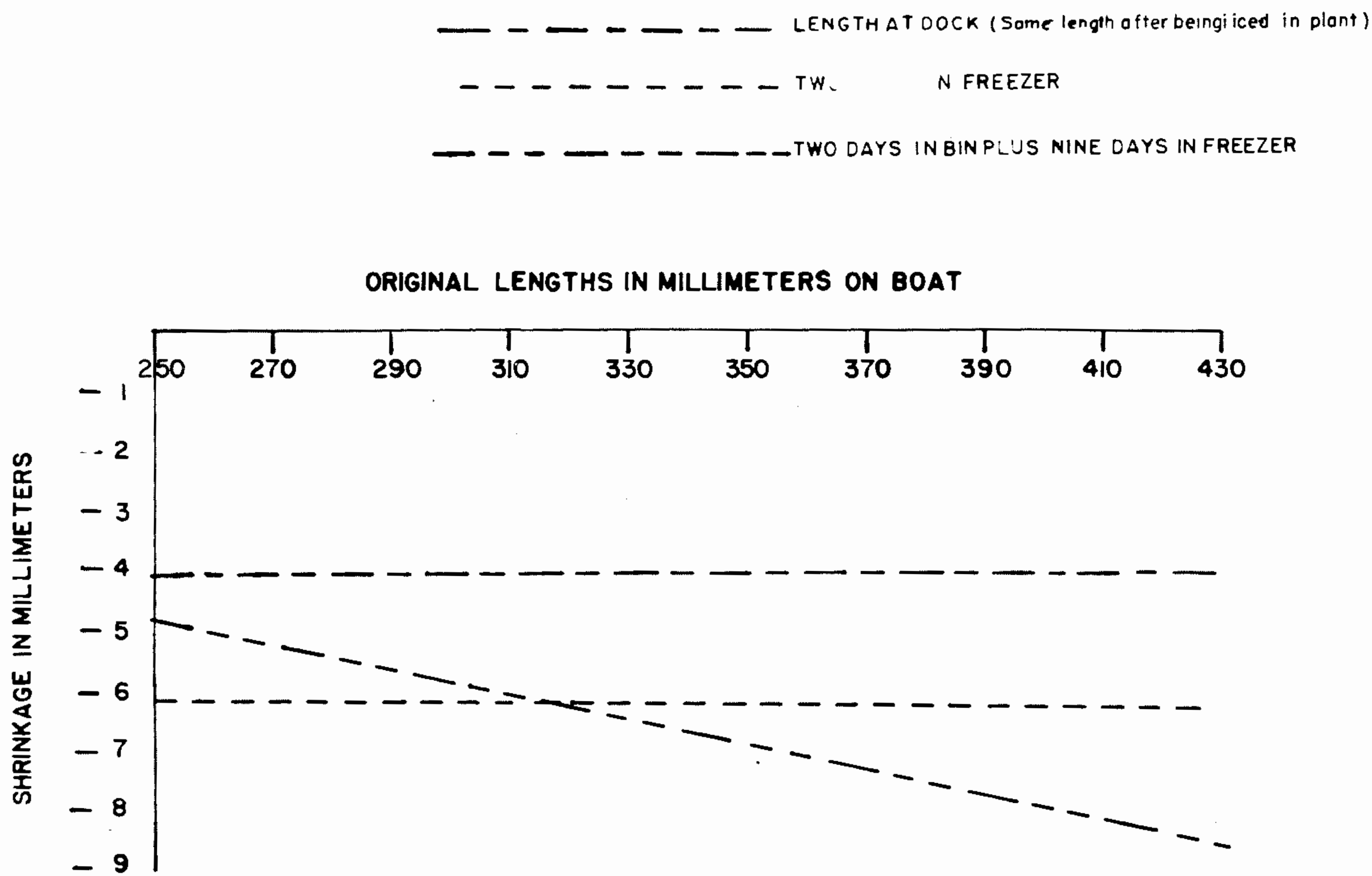
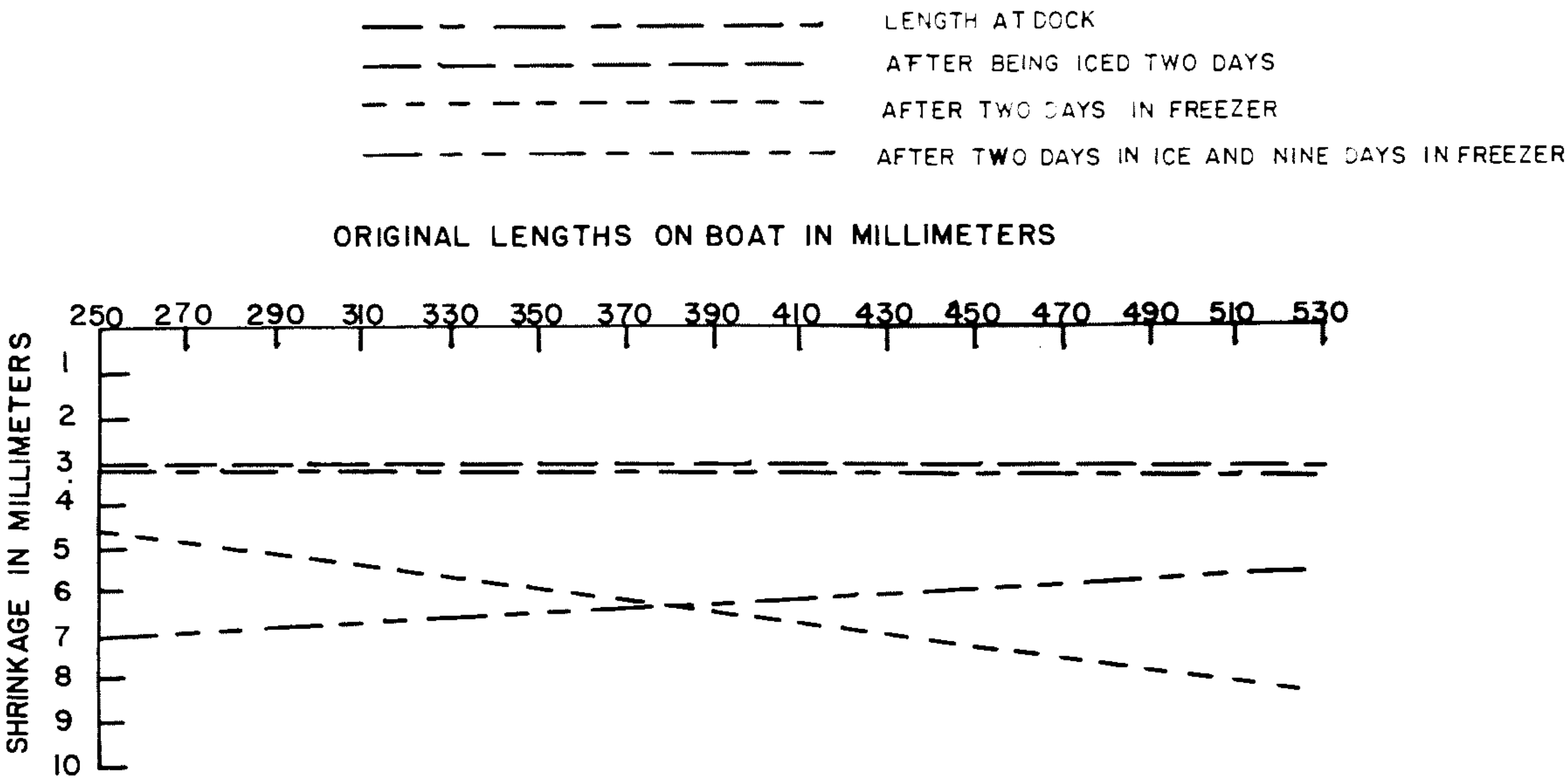


FIG. 3

SHRINKAGE RESULTING FROM COMMERCIAL HANDLING OF PETRALE SOLE



given are shrinkage from the first measurement on the boat. Because the range of the shrinkage of the English sole caused by these various treatments was between 4 and 7 millimeters, a correction factor of 1/2 centimeter was added to all recoveries of tagged English sole.

The mean shrinkage of the petrale sole was very similar to that of the English sole. From the boat to the dock there was a shrinkage of 3 millimeters. Petrale sole held another two days in ice still shrank only 3 millimeters, but those frozed two days after being unloaded at the fish plant shrank an average of 6 millimeters. The fish kept in ice two days in the fish plant and then frozen for an additional 9 days also shrank an average of 6 millimeters. All of the various treatments resulted in a shrinkage closest to 1/2 centimeter so this figure was used as a correction factor for each recovery of tagged petrale sole.

These experiments show that English petrale and Dover soles shrink when held in ice or frozen. The shrinkage is greatest is frozen fish. Most of the shrinkage takes place in the first day or two after freezing or icing. The results indicate a correction factor of 1/2 centimeter should be added to all recoveries of tagged English, petrale, and Dover sole except that 1 centimeter should be added to Dover sole which have been frozen before being measured. These correction factors were applied to the recoveries of tagged fish of the three species under study.

In order to arrive at a measure of the annual increase in length of English sole, the recoveries were grouped into periods of 11 through 13 months and 22 through 26 months between the time of tagging and recapture. The small fish grow more than the large ones and the females more than the males (Fig. 4). This is consistent with the results shown by the otolith studies. Females smaller than 39 centimeters

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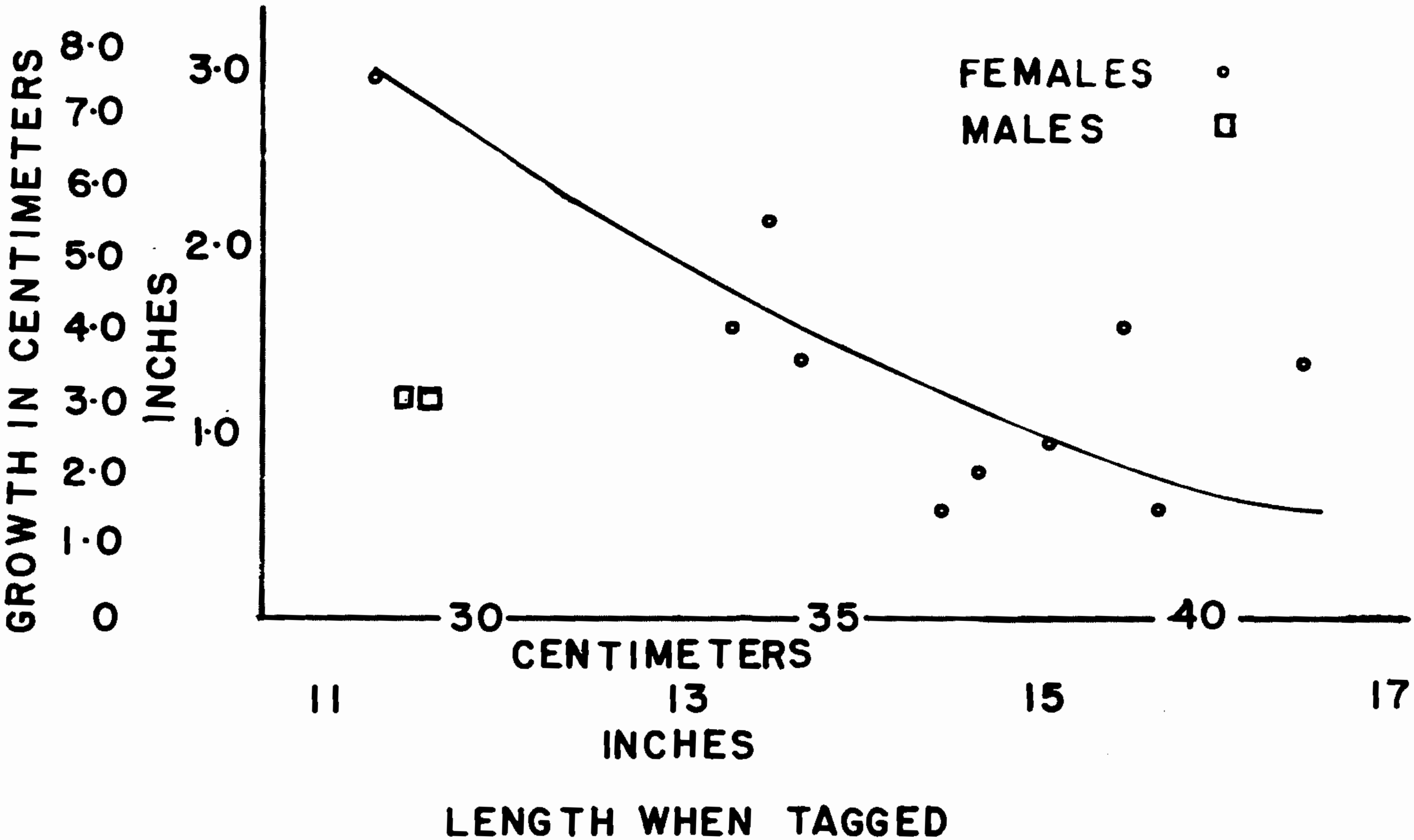
GROWTH OF ENGLISH SOLE AT LIBERTY 20 THROUGH 26 MONTHS



grew an average of 1.9 centimeters during the 11-13 month period and females larger than 39 centimeters grew an average of 0.9 centimeters. Males of all sizes combined grew an average of 0.6 centimeters during this period. Females under 39 centimeters at liberty from 22 to 26 months grew an average of 3.8 centimeters. There were not enough recoveries of females larger than 39 centimeters at liberty 22 to 26 months to give a reliable mean, nor were there enough recoveries of males to be of value.

The same time periods were used to group the returns of tagged Dover sole, and the same pattern resulted. The small fish increased in length more rapidly than the large ones and the females more than the males (Fig.5). Female Dover sole shorter than 45 centimeters in length at liberty 11 through 13 months grew an average of 1.9 centimeters, those 45 centimeters and larger grew an average of 1.0 centimeters. All males combined grew an average of 0.8 centimeters during the 11 through 13 month period between the time of tagging and the time of recapture. Dover sole females under 45 centimeters at liberty 22 through 26 months grew an average of 3.1 centimeters. Those 45 centimeters and over grew an average of 1.6 centimeters and the four males recovered grew an average of 1.8 centimeters.

Not as many recoveries of petrale sole have been made as of the other two species under study. The recoveries of fish at sea from 9 through 12 months after being tagged were grouped together. The same pattern of growth is shown as for the other two species (Fig.6). The average growth of the females of all lengths was 2.5 centimeters and the males 0.9 centimeters. There were not enough returns to make an analysis for a two year period.

In general, tagged English, petrale, and Dover soles grow at a slower rate than untagged fish, whose growth rate was determined from otoliths. The tag evidently has an adverse effect on growth.

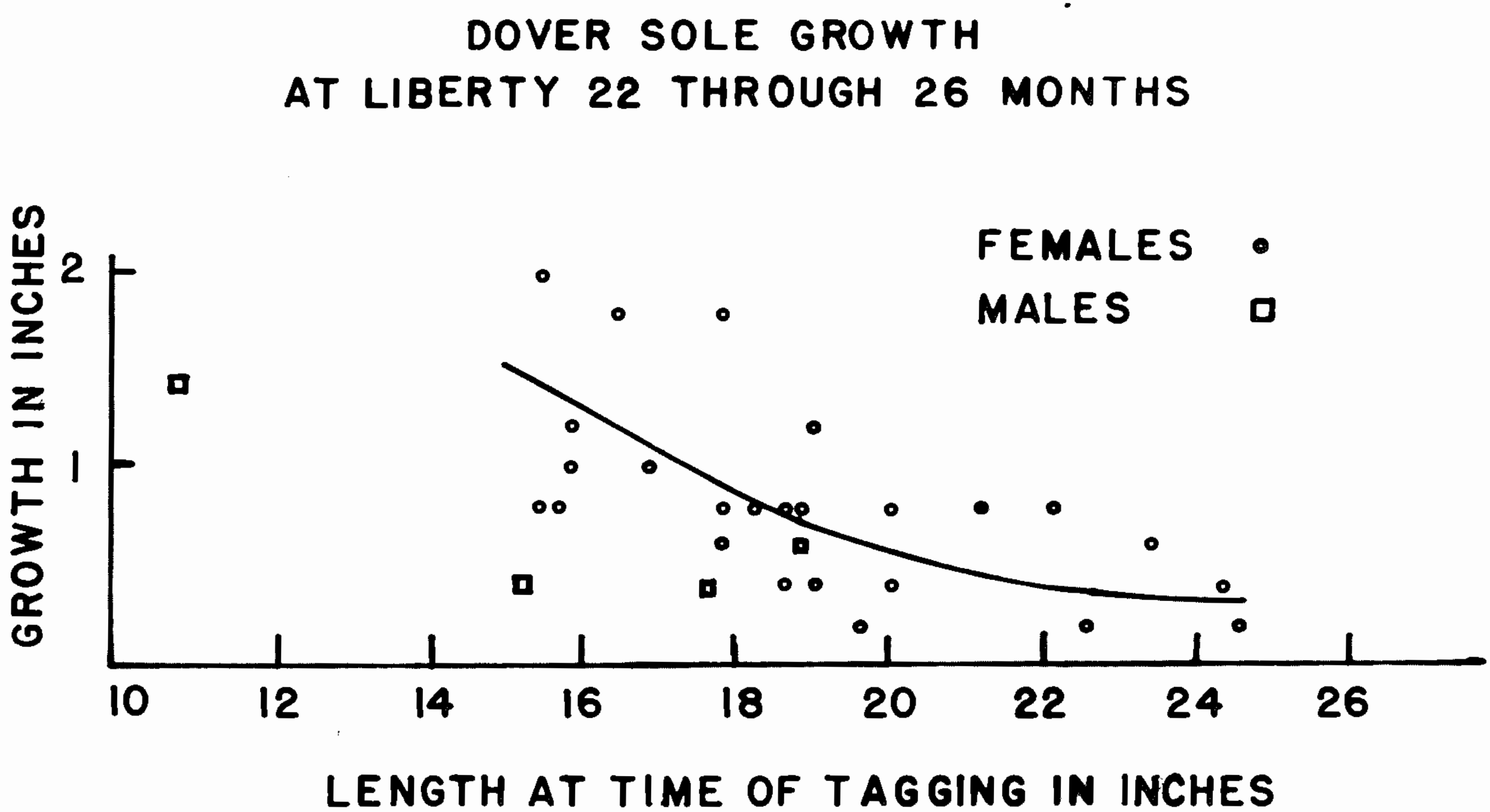
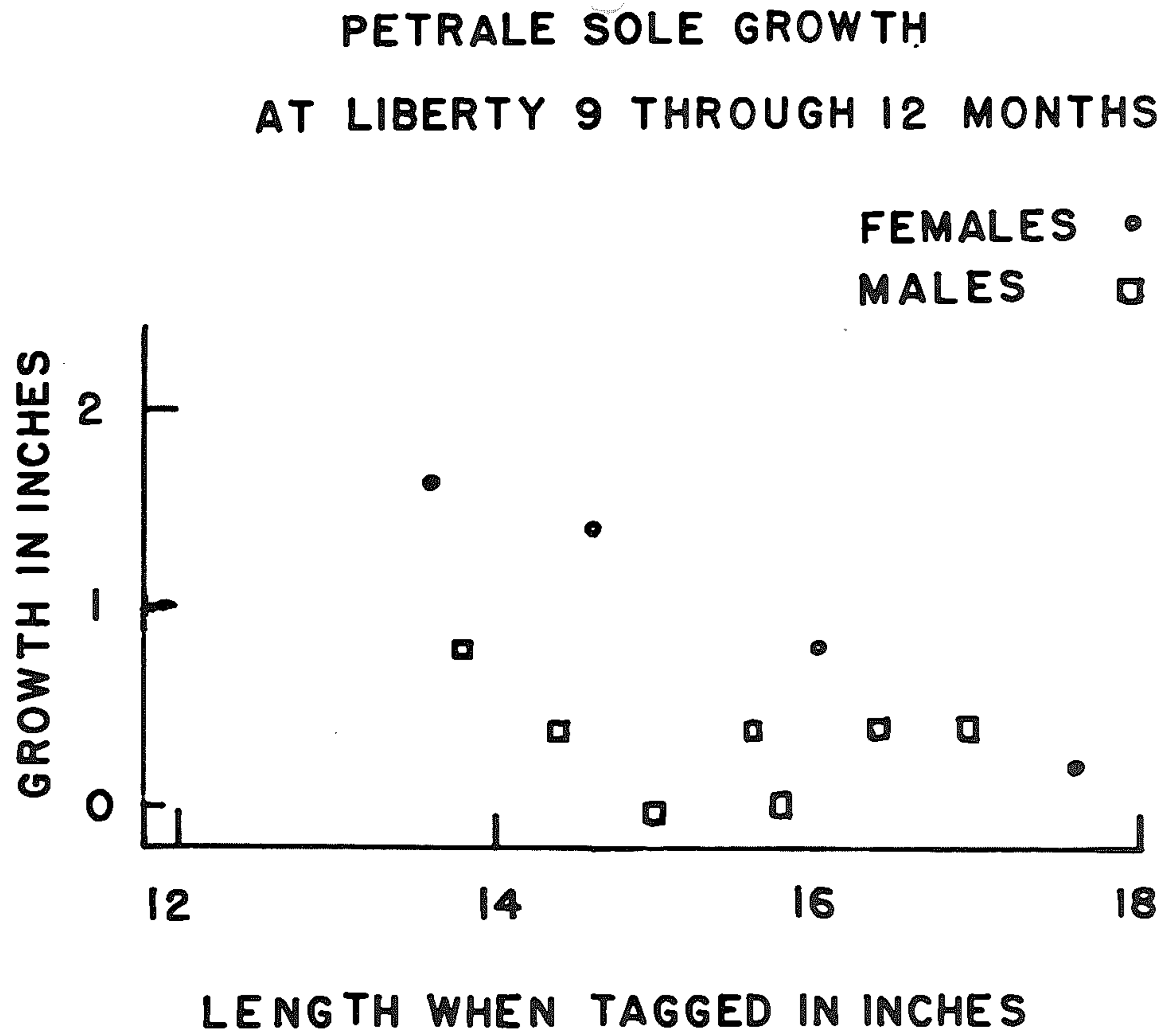

DOVER SOLE GROWTH
AT LIBERTY 22 THROUGH 26 MONTHS
FEMALES
MALES
GROWTH IN INCHES
2
1
10
12
14
16
18
20
22
24
26
LENGTH AT TIME OF TAGGING IN INCHES

FIGURE 6


PETRALE SOLE GROWTH
AT LIBERTY 9 THROUGH 12 MONTHS
FEMALES
MALES
GROWTH IN INCHES
2
1
0
12
14
16
18
LENGTH WHEN TAGGED IN INCHES

There are several factors which make a critical analysis of the tag returns for fishing mortality rates difficult if not impossible. Most important is an unknown loss of tags caused by corrosion of the pins. A few of the pins recovered after two or three years show little or no corrosion. Most are badly corroded and easily broken by a slight twist. Correcting for this loss is a difficult problem.

Another diffidulty is caused by great variation in the fishing intensity. During 1948 and 1949 market conditions for flatfish were poor and consequently fishing was sporadic. However, the demand for bottom fish improved considerably in 1950 and 1951 and fishing intensity was heavy during these two year.

There were other factors which influenced the rate of return of tagged fish and attempts were made to measure some of them. One of these was the condition of the fish at the time it was tagged. Because tagging was necessarily done from commercial fishing vessels, each fish before being tagged was subjected to the rigors of a regular commercial drag, usually lasting about 1 1/2 hours. Commercial treatment of the fish undoubtedly caused them to be weaker than if tagging had been done from an experimental vessel with drags of short duration and more careful handling of the fish.

As mentioned in a previous paragraph, all fish tagged were classified as to condition. The recovery rates to August 1, 1951, are much less from the No. 2 and No. 3 fish than from No. 1 specimens (Table 17).

Table 17. Recovery rates of English, petrale, and Dover sole classified as to condition.

	Condition #1	Condition #2	Condition #3
English sole	9.0	6.1	2.2
Petrale sole	8.7	7.6	1.7
Dover sole	10.6	6.7	3.4

The condition of the fish at the time of tagging has a pronounced effect on the percent of tags that will be recovered. For this reason, in any critical study of mortality rates, only fish in the best condition should be tagged. Even using the best specimens available there is undoubtedly a loss due to tagging mortality. This is particularly true when tagging must be carried out from commercial vessels, and long drags result in heavily packed loads in the nets, with resulting injury to the fish.

There are still other factors which might have caused variation in the rate of recovery of tagged fish. Among these are (1) size of the fish tagged, (2) Sex of the fish tagged; (3) Skill of the individual tagger, (4) Number of fish tagged from each drag, (5) Depth at which the fish were captured, (6) Time of the day when the fish were tagged, (7) Equipment available on the tagging vessel, and (8) Roughness of the sea. The effects of most of these conditions are at least roughly measured when the fish is rated as to condition.

In order to demonstrate any possible difference in the rate of return of tagged English sole caused by difference in sex or size, the tag returns from the 1948 and 1949 experiments were grouped by sex and size (Table 18).

Table 18. English sole, percentage recovery by sex and size groups - 1948 tagging

Length in Centi-meters	Males			Females			Sexes combined		
	Number Tagged	Number Recov-ered	Percent Recov-ered	Number Tagged	Number Recov-ered	Percent Recov-ered	Number Tagged	Number Recov-ered	Percent Recov-ered
<33	218	6	2.8	32	2	6.3	318	9	2.8
33 - 37	98	8	8.2	232	24	10.3	372	32	8.6
38 - 42	2	1	50	93	8	8.6	110	10	9.1
43 - 47	0			8	2	25.0	9	2	22.2
>47	0			1	1	100.0	1	1	100.0
(1949 tagging)									
<33	283	8	2.8	92	2	2.2	404	10	2.5
33 - 37	112	4	3.6	415	38	9.2	549	43	7.8
38 - 42	3	0	0	398	45	11.3	414	46	11.1
43 - 47	2	1	50.0	101	11	10.9	107	12	11.2
>47	0	0		8	1	12.5	9	1	11.1

It is evident from these tables that size has an influence on the rate of recovery. The fish under 33 centimeters in length are smaller than the usual discard length, and for this reason a smaller return is expected. These small fish, if captured again, might easily be discarded unnoticed when the fish are sorted at sea. Some of the tagged fish from 33-37 centimeters might also be discarded in this manner. There is no significant difference in the percentage of recovery of fish larger than 37 centimeters, particularly from the 1949 experiment when greater numbers were tagged and recovered.

A comparison of the recovery rates of males and females in the two size groups in which males were tagged in effective numbers (<33 and 33-37 centimeters) shows that in three of the four groups (two groups from the 1948 and two from the 1949 tagging) the females were recovered at a higher rate than the males. However, this could easily be explained, particularly in the 33-37 centimeter size group, by the fact that most of the females are in the upper range of this size group, while most of the males are in the lower range. Because the rate of return of tags increases with the size of the fish, the difference is probably caused by size rather than sex. It is difficult to group in such a way that this size difference is overcome and still retain significant numbers of tagged fish. In the <33 centimeters size group the females were recovered at a greater rate from the 1948 tagging and the males from the 1949 tagging. The lengths of the fish of both sexes within this size group are more alike than in the 33-37 centimeter group.

There are other important data entirely apart from the tagging results in this table. In spite of the fact that the fish to be tagged were selected more or less at random, there is a great preponderance of males among the English sole less than 33 centimeters. In 1948 in this size group almost seven males were tagged to each female and in 1949 the ratio was almost three males to each female. This preponderance of males in the smaller size groups has been demonstrated also in the sampling at sea, and in the sampling of fish used as mink food.

The difference in the rate of recovery in the various size groups of Petrale soles are not as apparent because of the smaller number of fish tagged. (Table 19). However, even the small number of recoveries shows some indication of a greater recovery rate among the larger fish. Most of the fish smaller than 36 centimeters were discarded.

Table 19. Percentage recovery of Petrale sole by size groups

1948 tagging

	Number Tagged	Number Recovered	Percent Recovered
<36 cm.	36	0	0
36 - 45 cm.	104	7	6.7
46 - 55 cm.	26	3	11.5
>55 cm.	0	0	0
	1949 tagging		
<36 cm.	78	3	3.9
36 - 45 cm.	290	21	7.2
46 - 55 cm.	38	1	2.6
>55 cm.	1	0	0

The Dover sole, also, exhibit a higher recovery rate among the larger fish (Table 20). Fish under 37 centimeters are mostly discarded.

Table 20. Percentage recovery of Dover sole by size

1948 tagging

	Number Tagged	Number Recovered	Percent Recovered
<37 cm	91	1	1.1
37 - 46 cm.	253	15	5.9
47 - 56 cm.	115	11	9.6
>56 cm.	13	0	0
	1949 tagging		
<37 cm.	262	9	3.4
37 - 46 cm.	828	52	6.2
47 - 56 cm.	323	31	9.6
>56 cm.	74	8	10.8

A third factor which might affect the rate of recovery is the skill of the individual tagger. The recovery rates from the tagging of the three principal taggers in 1949 varied from 5 to 8 percent. However, the person with the highest rate of recovery also tagged fish of a larger average size than those tagged by the other two investigators. As shown previously the recovery rate of larger fish is greater than for smaller ones. The tagger with the lowest rate of recovery released many fish in an area where the fishing intensity was not as great as in the other areas. There is, then, no demonstrable relationship between the skill of the tagger and the rate of tag recovery.

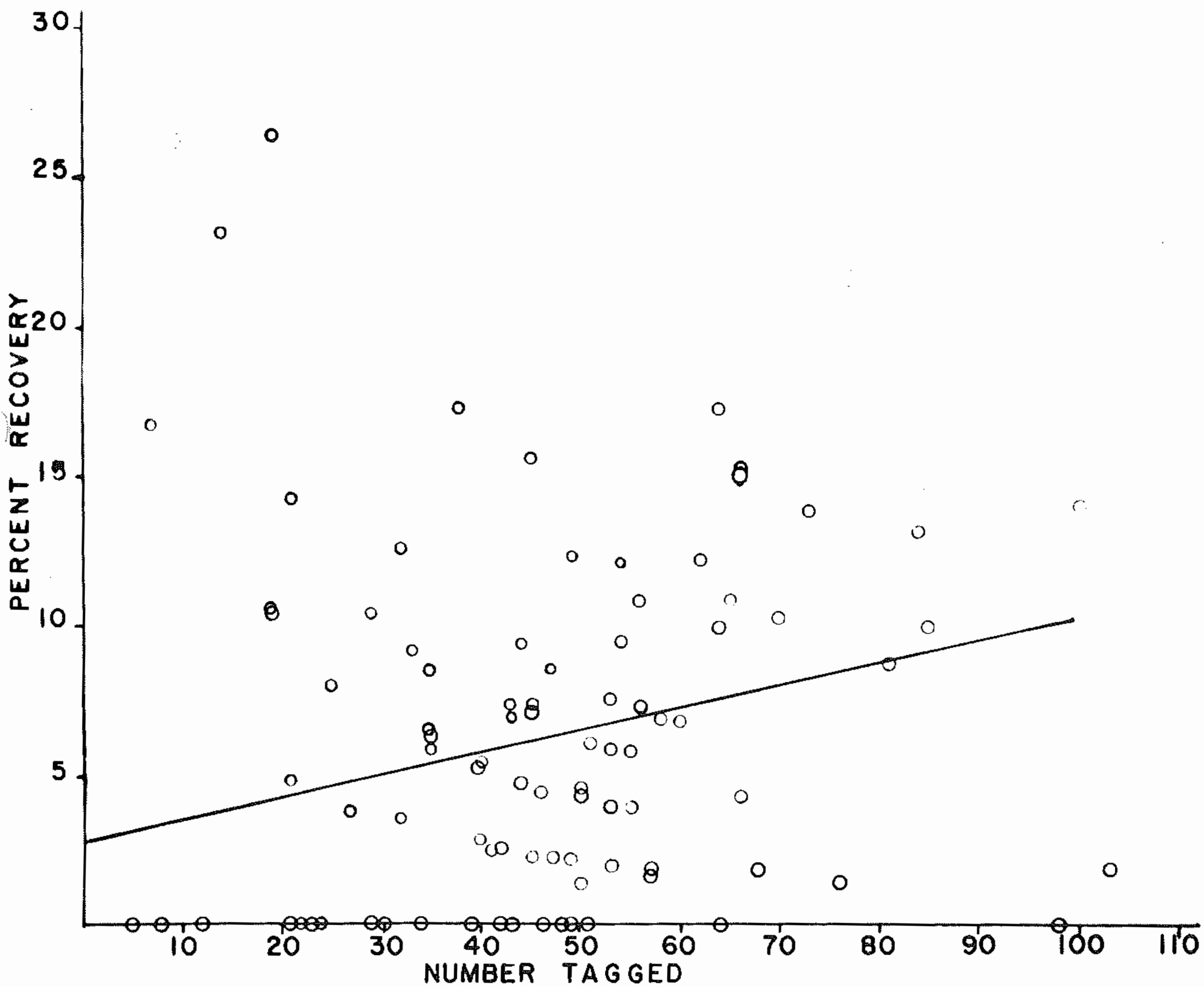
As explained previously, all fish to be tagged were placed in a tagging box filled with water. Because of the limited capacity of the box there might be a relationship between the number of fish placed in the box and the rate of recovery. Too many fish tagged from one drag might weaken the fish and lower the recovery rate. To get a measure of this effect, the recovery rate when 30 or fewer English, Petrale and Dover soles combined were tagged, was compared with the recovery rate when 60 to 103 fish were tagged (Fig.7). For the former, the recovery rate was 6.4 percent and for the latter, 8.2 percent. This is contrary to the results expected and may be best explained by the fact that often the reason for only a few fish being tagged was that weather conditions were poor. Stormy weather acts adversely on both the fish and often also on the tagger. This reversal of the expected is also shown by fitting a line to the data by the method of least squares. The equation for this line is $Y=2.91 + .074\ X$. The correlation coefficient for these data is .07, but such a small correlation is not significant with the number of degrees of freedom indicated.

The depth of capture might effect the rate of recovery because it takes longer for the net to be hauled in from a greater depth and presumably there would be more injury to the fish. Again the results for the English, Petrale, and Dover soles were combined. The mean recovery rate for fish tagged in relatively shallow waters of 30

FIG. 7

RELATIONSHIP BETWEEN THE NUMBER OF FISH TAGGED EACH DRAG AND THE PERCENTAGE RECOVERY OF ALL SPECIES COMBINED

(Each Circle Represents One Drag)



fathoms and under was 6.8 percent, and the rate for fish tagged in the deeper waters from 60 to 102 fathoms was 3.6 percent. The recovery rate for waters between 30 and 60 fathoms was 9.9 percent.

A line was fitted to these data by the method of least squares and the equation derived was $Y=9.36 - .065\ X$ (Fig. 8). The coefficient of correlation for these data was $R=-.25$, and the probability that this value could have arisen by chance lies between .05 and .01. There does seem to be a slight inverse correlation between the depth at which tagging is carried out and the rate of recovery.

There is a higher mean rate of recovery of the three species combined from drags made in the afternoon (8.0 percent) than from morning drags (4.2 percent) (Fig. 9). There is no ready explanation for this difference. The correlation may actually be with a third unknown factor other than time.

It was thought that boats better equipped for tagging might yield higher rates of return of tagged fish. The mean recovery rates for the seven vessels used for tagging in 1949 ranged from 23 to 9.0 percent for the English, Petrale, and Dover soles combined. However, there was as much variation between the same boats on different trips as among the mean rates of each of the seven vessels. For example, the recovery rates of one vessel on two different trips were 1.5 and 8.3 percent. The recovery rates from five trips of another vessel ranged between 4.6 and 10.9 percent. Still another vessel on which the water pump could not be used to aerate the water in the tagging box when the vessel was under way had a rate of tag return of 9.0 percent. The mean for all vessels was a 6.1 percent tag return.

In an attempt to measure the effect of the condition of the sea at the time of tagging on the rate of tag return, each drag during the 1949 season was placed in one of three categories. All of the English,

FIG. 8

RELATIONSHIP BETWEEN THE DEPTH OF WATER DURING TAGGING AND THE PERCENTAGE RECOVERY OF ENGLISH, PETRALE, AND DOVER SOLE COMBINED

(Each Circle Represents One Drag)

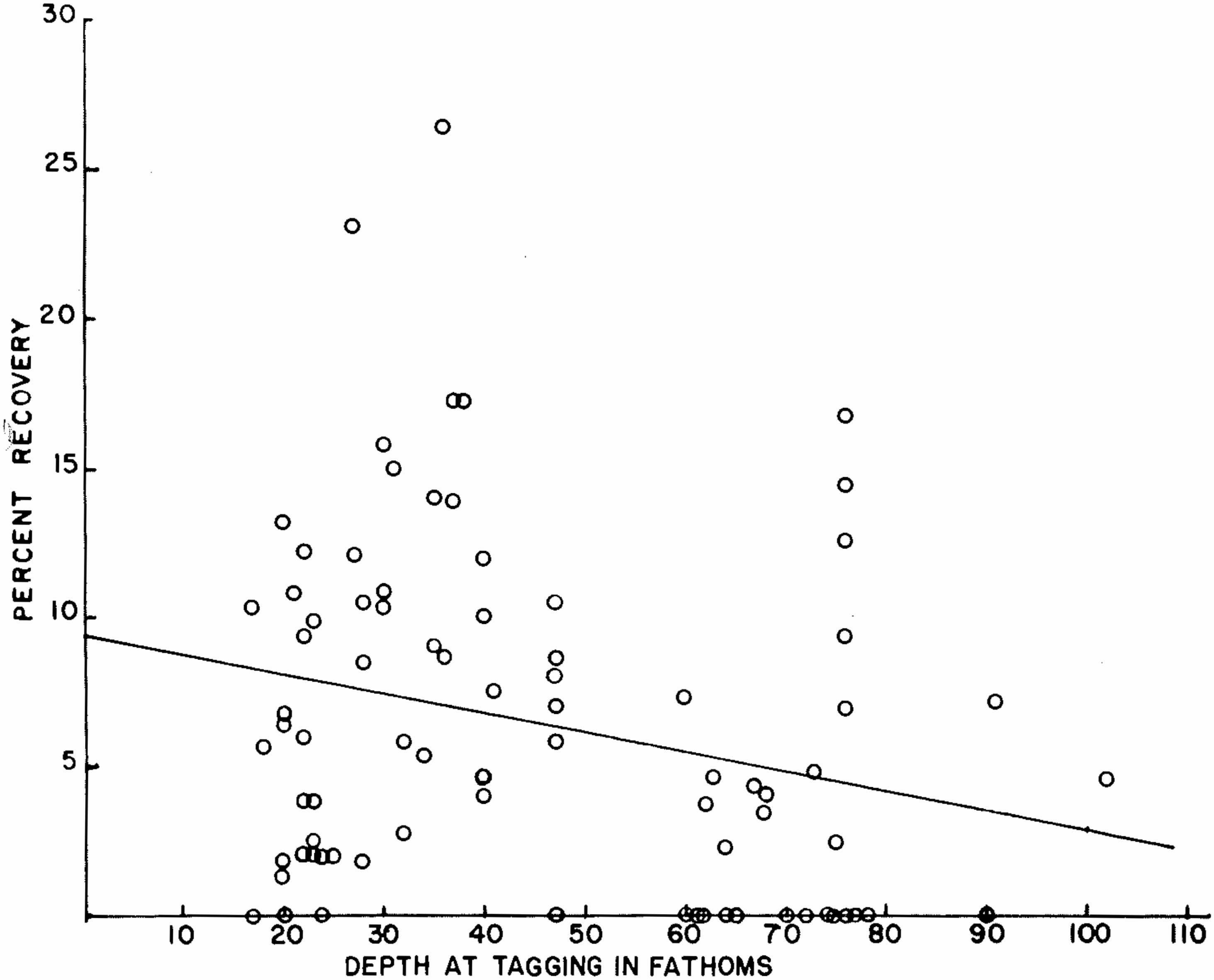
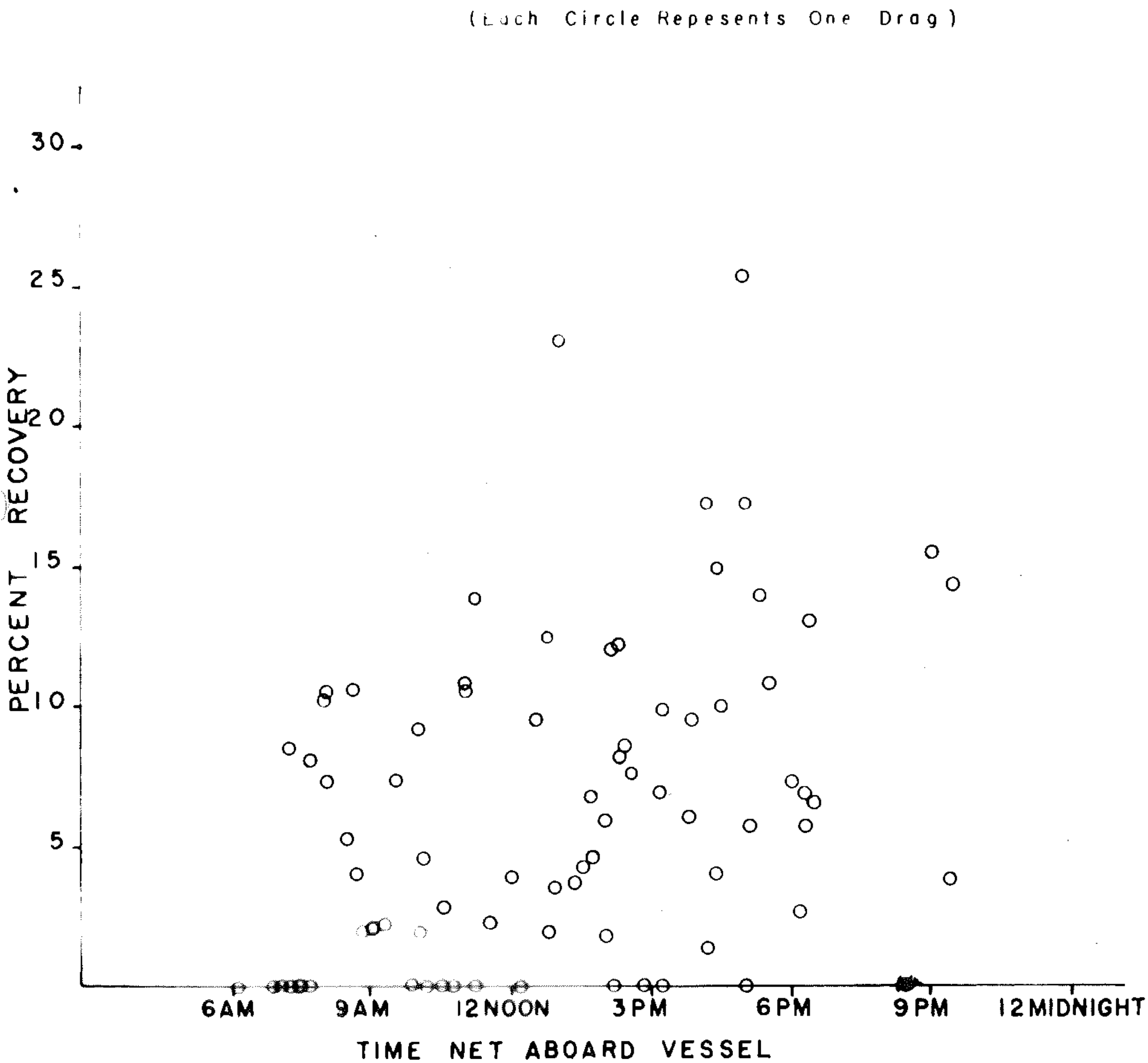


FIG. 9

RELATIONSHIP BETWEEN TIME OF TAGGING AND PERCENTAGE RECOVERY OF ENGLISH, PETRALE, AND DOVER SOLES COMBINED



Petrale and Dover soles tagged in a calm sea were combined and the recovery rate found to be 5.7 percent. The recovery rate of fish tagged in a moderate sea was 6.2 percent, and in a heavy sea was 4.2 percent. As would be expected, the fish tagged when the seas are rough showed the lowest recovery rate, although the difference was slight.

Most of the factors examined in the previous paragraphs are so interrelated that it is difficult to separate their effects. There are two conditions affecting the rate of return enough to be emphasized. It is first of all important to tag only fish in the best possible condition when the returns are to be used for determining mortality rates. In order to tag fish in good condition, tagging should be carried out as far as possible under ideal sea conditions and with the best possible equipment. This suggests that tagging from a commercial vessel under ordinary fishing conditions is not the best method, although sometimes it is the only method available. Second, only fish which are large enough to be fully recruited into the fishery should be used for establishing mortality rates.

There was some loss of information from tags which were not turned in or turned in with incorrect information. In order to arrive at an estimate of this loss in Astoria, tagged fish were placed in the holds of fishing vessels at sea without the knowledge of the crew. Not more than three tagged fish were placed in the hold during any trip. From 1949 to 1951, 16 tagged fish were placed in the holds and 14 of these (88 percent) were recovered. The rate of recovery was very good, at least in Astoria, and in a tagging experiment where it is important to have all possible returns a correction factor could be applied. However, in only 7 of the 14 recoveries was the correct boat given as having brought in the tag. Such a mistake can easily be made because usually tagged fish are not found until after they have been unloaded and mixed with the catches from other boats. This mistake would occasionally result in recording an incorrect migration, but the error is usually not important because boats landing at the same time have often fished in the same general area.

For the reasons previously set forth, the rates of tag returns will be treated in only the most general terms. There were returns from tagged fish of 11 different species, but only the English, Petrale, and Dover soles were tagged in appreciable numbers (Table 1).

The following discussion relates to fish tagged in the area between Tillamook Head and Willapa Bay and the recovery rates are calculated to January 1, 1952. In 1948, 819 English sole were tagged and 60 (7.3%) have been recovered (Table 21). In 1949, 1516 English sole were tagged and 136 (9.0%) have been recovered. There were 166 Petrale sole tagged in 1948 of which 11 (6.6%) have been recovered and of the 423 tagged in 1949 there have been 32 (7.6%) recoveries. In 1948, 474 Dover sole were tagged and 44 (9.3%) have been recovered, and 1540 were tagged in 1949 of which 139 (9.0%) have been recovered.

Most of the recovery rates from 1948 through 1951 follow the expected pattern (Table 1). The greater recovery rates for the 1949 tagging reflect the greater intensity of the fishery in 1950 and 1951. However, the recovery rates by year for Dover sole tagged in 1948 do not fit the general pattern. Of the 474 Dover sole tagged in 1948, 12 (2.6%) were recovered in 1949 but 17 (3.8%) were recovered in 1951. These rather peculiar results will be discussed in greater detail later in this paper.

The total rates of recovery for the three species are quite similar. From the heavier tagging carried out in 1949 the rate of recovery ranged from 7.6 percent for the Petrale sole to 9.0 percent for both the English and Dover soles. In general, the Dover sole appear to be

Table 21

Recaptures of tagged English, Petrale, and Dover sole to January 1, 1952 (includes all fish tagged between Tillamook Head and Willapa Bay)

Species	Year Tagged	Number Tagged	Recoveries: During Tagging Year		Tagging Year Plus one		Tagging year plus two		Totals Through Plus two	Tagging Year plus Three		Year Unknown	Totals	
			No.	%	No.	%	No.	%	%	No.	%		No.	%
English sole	1948	819	28	3.4	21	2.7	5	0.6	6.6	5	0.6	1	60	7.3
	1949	1516	59	3.9	55	3.8	22	1.6	9.0	-	-		136	9.0
Petrale sole	1948	166	6	3.6	2	1.3	2	1.3	6.0	1	0.6		11	6.6
	1949	423	11	2.6	15	3.6	6	1.5	7.6	-	-		32	7.6
Dover sole	1948	474	4	0.8	12	2.6	11	2.4	5.7	17	3.8		44	9.3
	1949	1540	45	2.9	56	3.7	38	2.6	9.0	-	-		139	9.0

Table 22

Recaptures of tagged English, Petrale, and Dover sole in No. 1 condition and fully recruited to the fishery. (English sole 38 cm. and over, Petrale and Dover sole 43 cm. and over) (Fish tagged between Tillamook Head and Willapa Bay, recoveries to January 1, 1952)

Species	Year Tagged	Number Tagged	Recoveries: During Tagging Year		Tagging Year Plus one		Tagging Year Plus two		Totals Through Plus two	Tagging Year plus Three		Totals	
			No.	%	No.	%	No.	%	%	No.	%	No.	%
English sole	1948	77	6	7.8	5	7.0	1	1.4	15.6	3	4.3	15	19.5
	1949	324	21	6.5	22	7.3	7	2.5	15.4	---	-	50	15.4
Petrale sole	1948	16	2	12.5	0	0.0	1	7.1	18.8	1		4	25.0
	1949	33	2	6.1	3	9.7	0	0.0	15.2	-	-	5	15.2
Dover sole	1948	110	1	0.9	2	1.8	4	3.7	6.4	6		13	11.8
	1949	245	11	4.5	16	6.8	13	6.0	16.3	-	-	40	16.3

fished more intensely, followed by the Englishand petrale sole.

It has been emphasized previously that fish in the best condition when tagged and fish fully recruited to the fishery yield the highest rates of tag recovery. Using the returns from fish both in the best condition and fully recruited to the fishery would perhaps give more accurate rates of return than those calculated for the entire experiment. However, the number of fish which fulfill both these requirements is not great (Table 22). Only the returns from the 1949 tagging will be used in this brief analysis because of the small number fulfilling these requirements tagged in 1948. The rates of return, to January 1, 1952, for all the fish and for fish in the best condition and fully recruited to the fishery are as follows: for English sole 9.0 percent for the former and 15.4 percent for the latter, an increase of 71 percent; for the petrale sole 7.6 percent and 15.2 percent, an increase of 100 percent; and for the Dover sole 9.0 percent and 16.3 percent, an increase of 81 percent. It should be noted that there were only 33 petrale sole tagged in 1949 which were both in the best condition and fully recruited to the fishery.

The percentages of recoveries in themselves mean little, but they may be of some significance when compared with other experiments of a similar nature. Because of unknown loss of tags due to pin corrosion, eventthis approach may be used with caution. Unfortunately, there are no published reports of the percentage of recovery of tagged English sole. Cleaver (1949), however, has given the results of several European experiments on flatfish, selected at random, during periods of time when the intensity of fishing was heavy. Th This table is here reproduced (Table 23).

Table 23. Some percentages of recovery from European tagging experiments.

Author	Tagging Year	Area	Species	Percent Recovery
Johanssen, A. C.	1916	Kattegat	S. vulgaris	22.3
"	"	and Baltic	R. maximus	74
"	"	"	"	46
Bowman, A.	1933	Shetlands	P. Platessa	23
Bjerkon, P.	1934	Norway	"	9.2
"	"	"	"	29.4
"	"	"	"	20.9
"	"	"	"	36.5
"	"	"	"	38.2
"	"	"	"	35.2
"	"	"	"	29.5
"	"	"	"	48.8
Faning, A. V.	"	Iceland	"	3.5
"	"	"	"	26

The periods over which recoveries were made in these experiments conform quite closely to that of the Oregon experiments. In all of the examples except three the recovery rates of the European experiments were higher, and usually considerably higher, than the recovery rate of English sole in the best condition and fully recruited which were tagged in 1949. These figures might indicate that the fishing intensity on the heavily fished European grounds is greater than for English sole in Oregon waters, but because of the pin corrosion such a conclusion must be viewed with caution.

There is one tagging experiment with which the recovery rates of Petrale sole can be compared. In 1942 and 1943, Cleaver tagged Petrale sole off the coast of northern Washington. The recovery rates for these experiments by November 30, 1945, were 22.1 percent for fish tagged in 1942, and 21.5 percent for fish tagged in 1943. The amount of time over which these recoveries were made conforms almost exactly to the Oregon studies. In fact, the two experiments are similar in most respects. The same type of nickel pins were used in both experiments and tagging was carried out from commercial vessels. The rates of recovery from the Oregon experiments (6.6% from the 1948 tagging and 7.6% from the 1949 tagging) are about one-third those for the Washington tagging. The conclusion to be reached from this comparison is that fishing intensity for Petrale sole along the Oregon coast is much lighter now than it was off northern Washington in 1942 and 1943. As the abundance of the Petrale sole has declined, the emphasis has shifted to catching English and Dover soles.

There are no published reports of tagging experiments on Dover sole which can be used for comparison with the Oregon experiments. The recovery rate for fish in the best condition and fully recruited to the fishery was 16.3 percent from the 1949 tagging, considerably less than most of the European experiments cited. Again, any conclusions regarding the relative fishing intensities of the two areas must be approached with caution.

The 1948 tagging of Dover sole gives such a peculiar pattern of recovery in successive years that this experiment must be examined more thoroughly. The rates of recovery for the Dover sole from the 1949 tagging and for the English and Petrale soles from both the 1948 and 1949 tagging declined rapidly in successive years as is expected. From the Dover sole tagged in 1948, however, 17 recoveries were made in 1951, compared with 11 recoveries in 1950, 12 in 1949, and 4 in 1948.

It was apparent during the 1951 fishing season that an abnormal number of Dover sole tags were being recovered from a trip made in October 1948. On this trip 142 Dover sole were tagged, which constituted 30 percent of the total number (474) of Dover sole tagged in 1948. Of the 17 recoveries in 1951 from the 1948 tagging, 15 (88%) were from the October trip. It seemed apparent that this October trip was yielding some rather peculiar results and that it should be analyzed further.

This tagging trip was made on October 20 and 21, 1948, aboard the dragger Jimmy Boy and all tagging was done in the customary manner. Most of the fish were tagged in depths ranging from 59 to 73 fathoms of water at the east end of the Astoria Canyon off the Columbia River. Thirty of the fish were tagged while enroute toward the North Jetty of the Columbia River.

Thirty recoveries were made, to January 1, 1952, from the 142 Dover sole tagged, yielding a recovery rate of 21 percent. There were no recoveries in 1948 because the tagging trip was one of the last trips, if not the last, made for Dover sole that year. In 1949, 10 recoveries were made; in 1950, 5 recoveries; and about 2 or 3 should have been expected in 1951 at this rate of decrease. Instead of the 2 or 3 recoveries expected, 15 tagged fish were found in 1951.

What is the explanation for this relatively large tag return in 1951 contrary to every expectation? One possibility is a large increase in fishing effort during the 1951 season. Our statistics do not indicate an increase in effort anywhere near large enough to cause these results, nor do the returns from the 1949 tagging of Dover sole indicate such a possibility. The best explanation seems to be that these tagged fish did not distribute themselves randomly in the population, but rather stayed in one group and for some unknown reason this group became extraordinarily available to the fishery in 1951.

Mesh Selectivity

Five charter trips were made on Astoria otter trawl fishing vessels this summer as a continuation of the research on the escapement of small fish from otter trawl nets of various size mesh.

The first trip aboard the "Destiny" was of three days' duration, May 14, 15, and 16, 1951. Ten drags were made using 1.5 inch, 3.5 inch, 4.5 inch, and 5.0 inch mesh cod ends. Four and a half inch mesh nets were used with all cod ends. The smaller mesh cod ends tended to fill with mud. On this trip the 5.0 inch cod end was attached to the end of the 4.5 inch cod end which was left open. This also filled with mud. The small mesh cod ends and the two cod ends tied tandom proved too much of a load for the "Destiny" which is somewhat under-powered.

The size of the samples was not large because fewer drags were made with each of the various sized cod ends. The value of samples for individual comparisons was therefore weakened. The material was used together with the other trips made, and appears in the combined data in this report.

Another complication arose on this particular trip which exhibited itself when the data for the petrale and English sole were processed. Small fish of these two species were not present in any abundance which made it appear that the small mesh cod ends were not retaining the small fish. Small Dover sole were present and the difference in selectivity could be seen clearly. No selectivity appeared using 1.5 inch, 3.5 inch, and 4.5 inch cod ends for either Petrale or English sole. Selectivity of these species was apparent only using the 5.0 inch cod end. Unfortunately, such aberrations are difficult to detect at the time of the experiment.

On the "Destiny" trip burlap was used in the hold to separate the catches of the various sized mesh cod ends. The samples were stowed in burlap sacks. The weights of the catches from the cod ends were obtained as were the weights of the samples. It was planned to use these weights in testing the theory that the larger size mesh cod ends produce larger catches of marketable fish, but due to the aberrancies listed previously, and to the fact that the Dover went for mink food, no attempt was made toward this end. The fish were well preserved on this comparatively short trip, but the burlap had an insulating effect which would possibly cause the fish to spoil on a longer trip. For this reason the use of burlap for separation catches in the hold was discontinued.

Four charter trips were made aboard the "Rose Ann Hess" in various areas along the coast. On those trips a cod end with a mesh of one size was fished for a day and at the end of the fishing day, the cod end was replaced by another with a different size mesh. This cod end was then fished all the following day and replaced the next night. This allowed an accumulation of larger samples taken from a larger number of drags with a minimum loss of fishing time. The process of changing the cod ends required as much as two hours. If fishing is suspended during the day to change cod ends a full drag is lost. A method of changing the cod ends rapidly is being considered for future experiments.

The same area was fished on each succeeding day. No apparent discrepancies were evidenced using this technique, and it was not considered a disqualifying factor.

For comparison and analysis the data collected on the five trips have been combined and are shown in this form in Figures 10 to 15. Figures 10 to 12 are the unsmoothed and unadjusted combined data. Analysis of the data in this form is impossible. The difference between samples in this form exists primarily because it is practically impossible to determine the sample size in the field that will make

Figure 10. Dover sole length-frequency

1951 Mesh Experiment Combined Data

Unsmoothed and Unadjusted

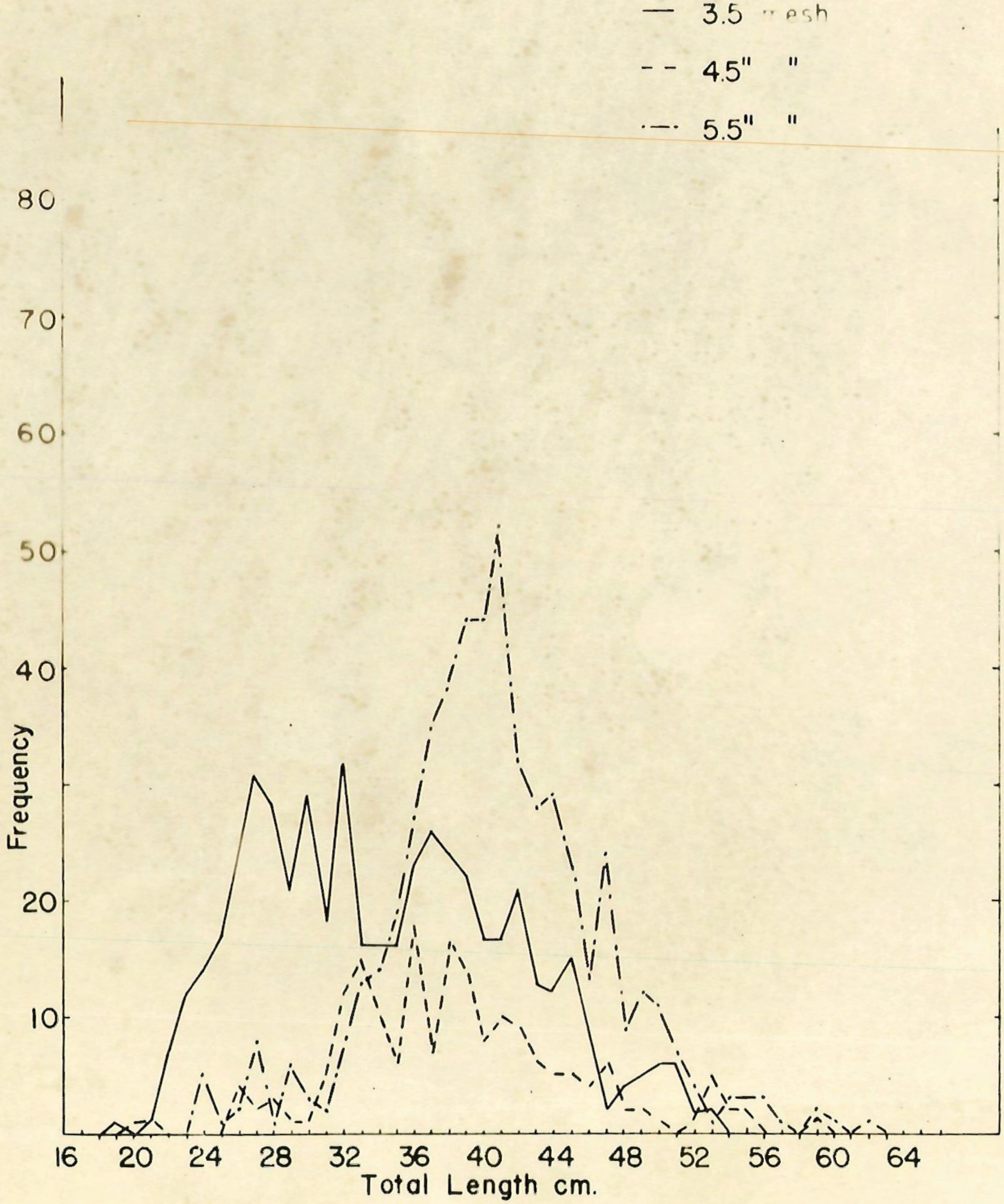


Figure 11. English sole length-frequency

1951 Mesh Experiment Combined Data

Unsmoothed and Unadjusted

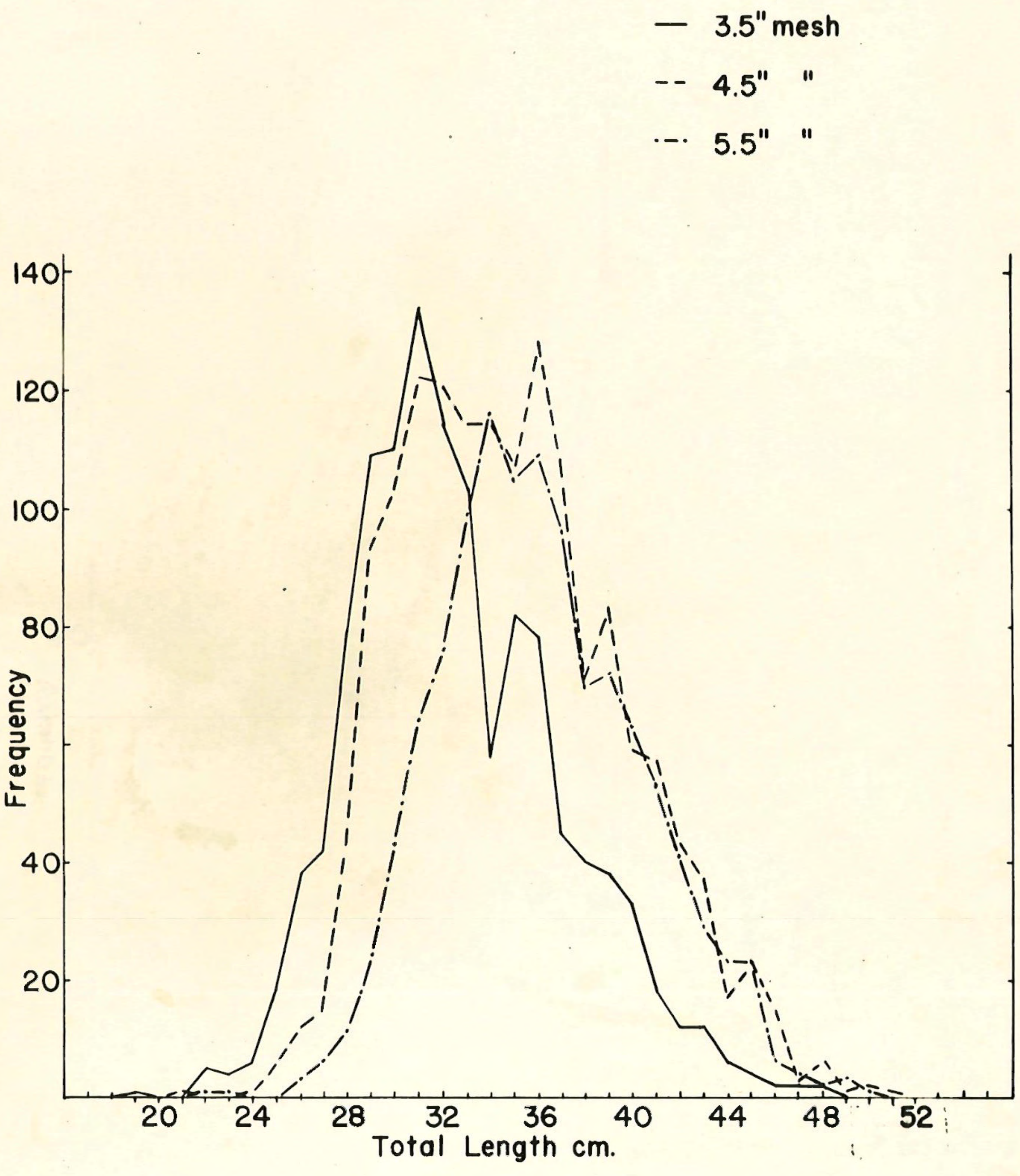


Figure 12. Petrale sole length-frequency

1951 Mesh Experiment Combined Data

Unsmoothed and Unadjusted

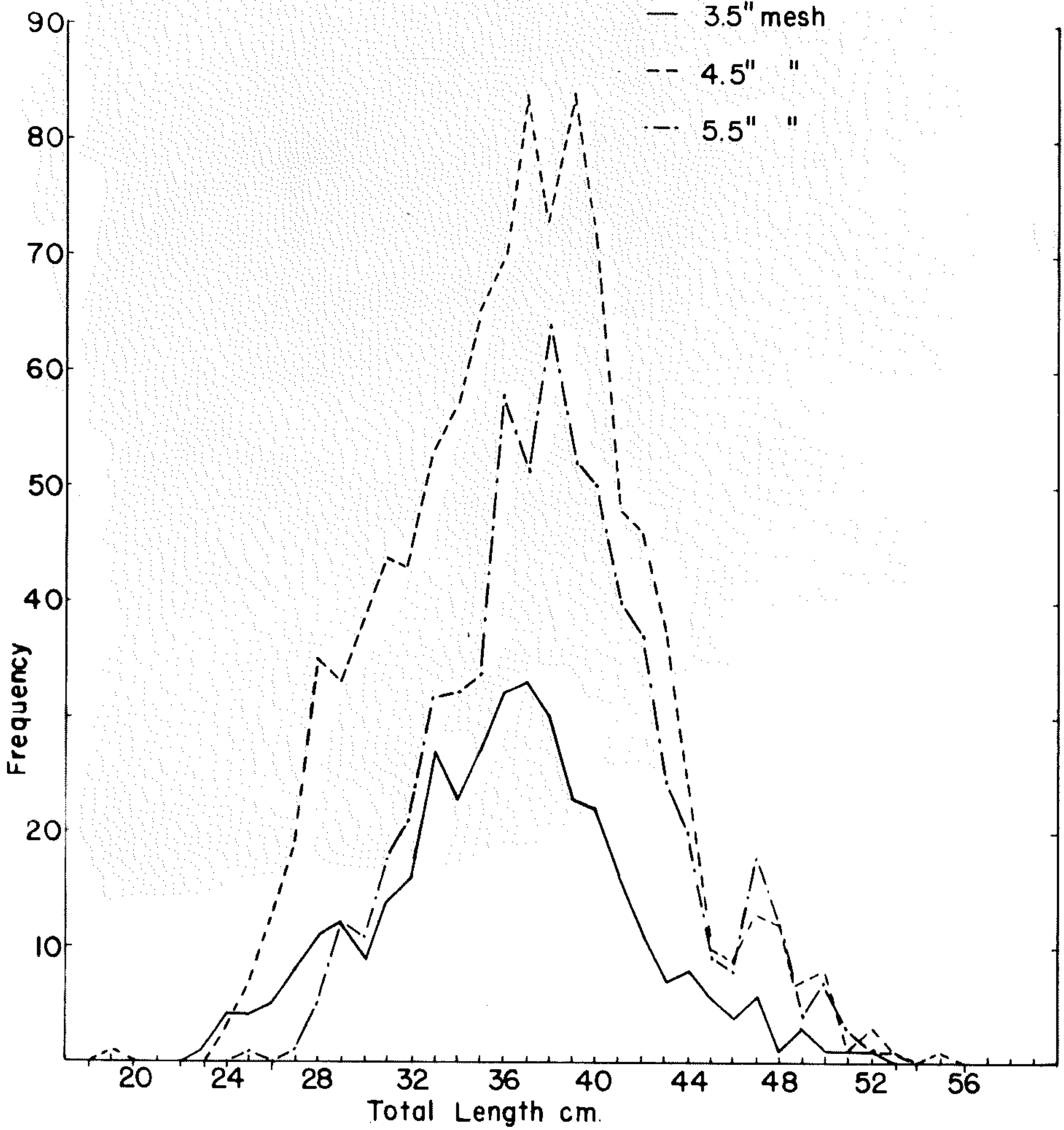


Figure 13. Dover sole length-frequency

1951 Mesh Experiment Combined Data

Smoothed 3's Adjusted to 500 fish > 40 cm.

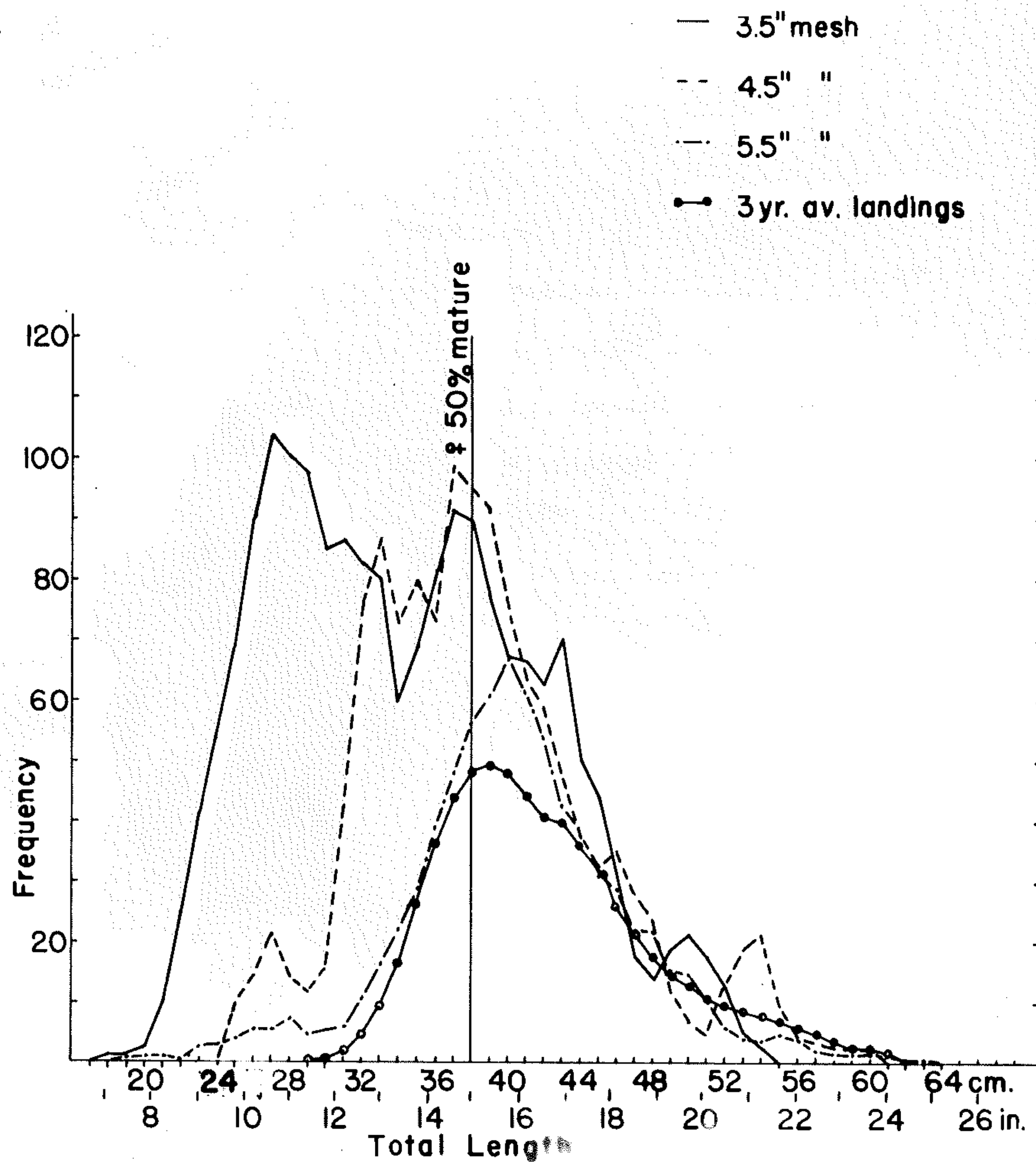


Figure 14. English sole length-frequency

1951 Mesh Experiment Combined Data

Smoothed 3's Adjusted to 400 fish > 35 cm.

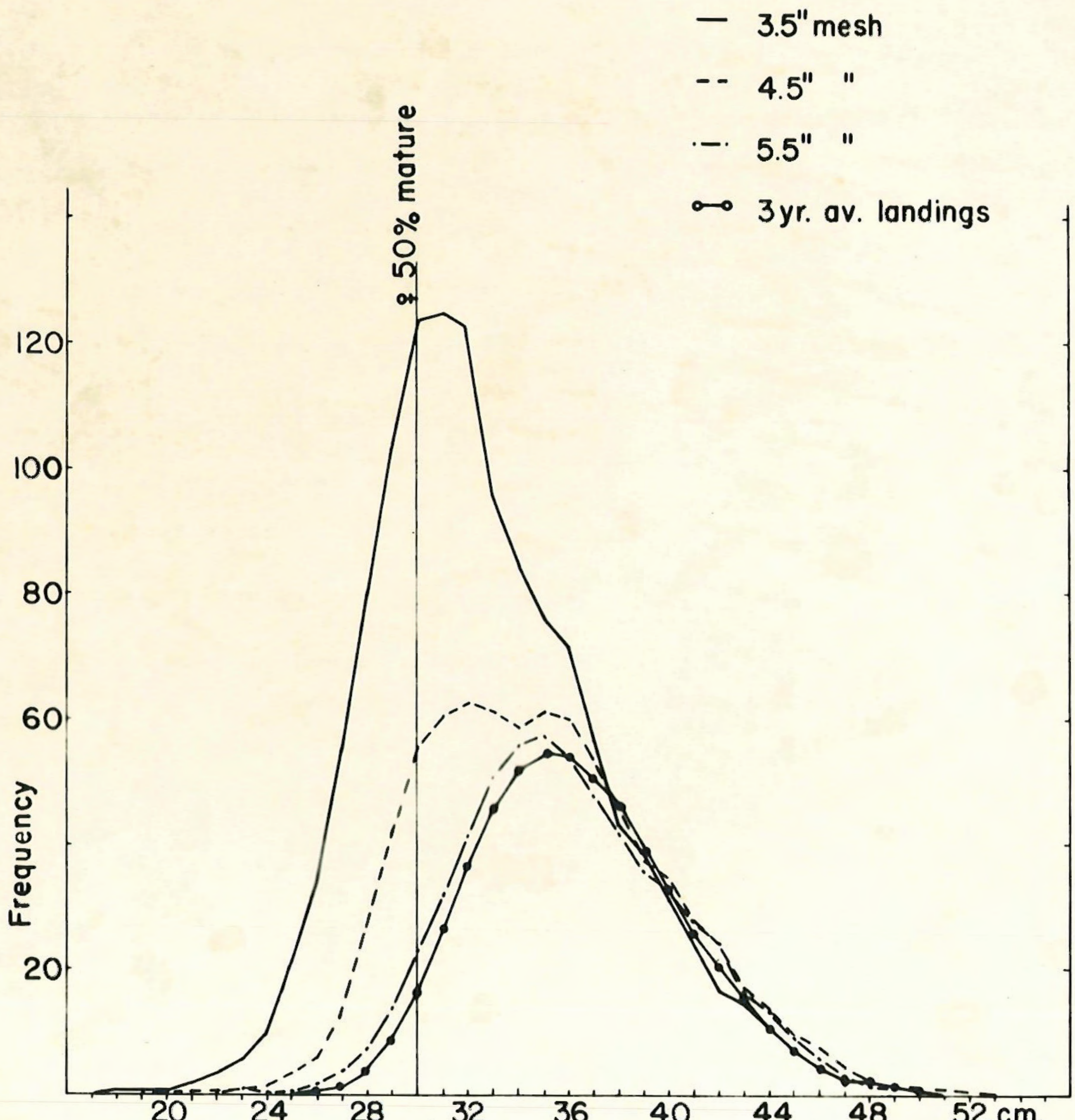
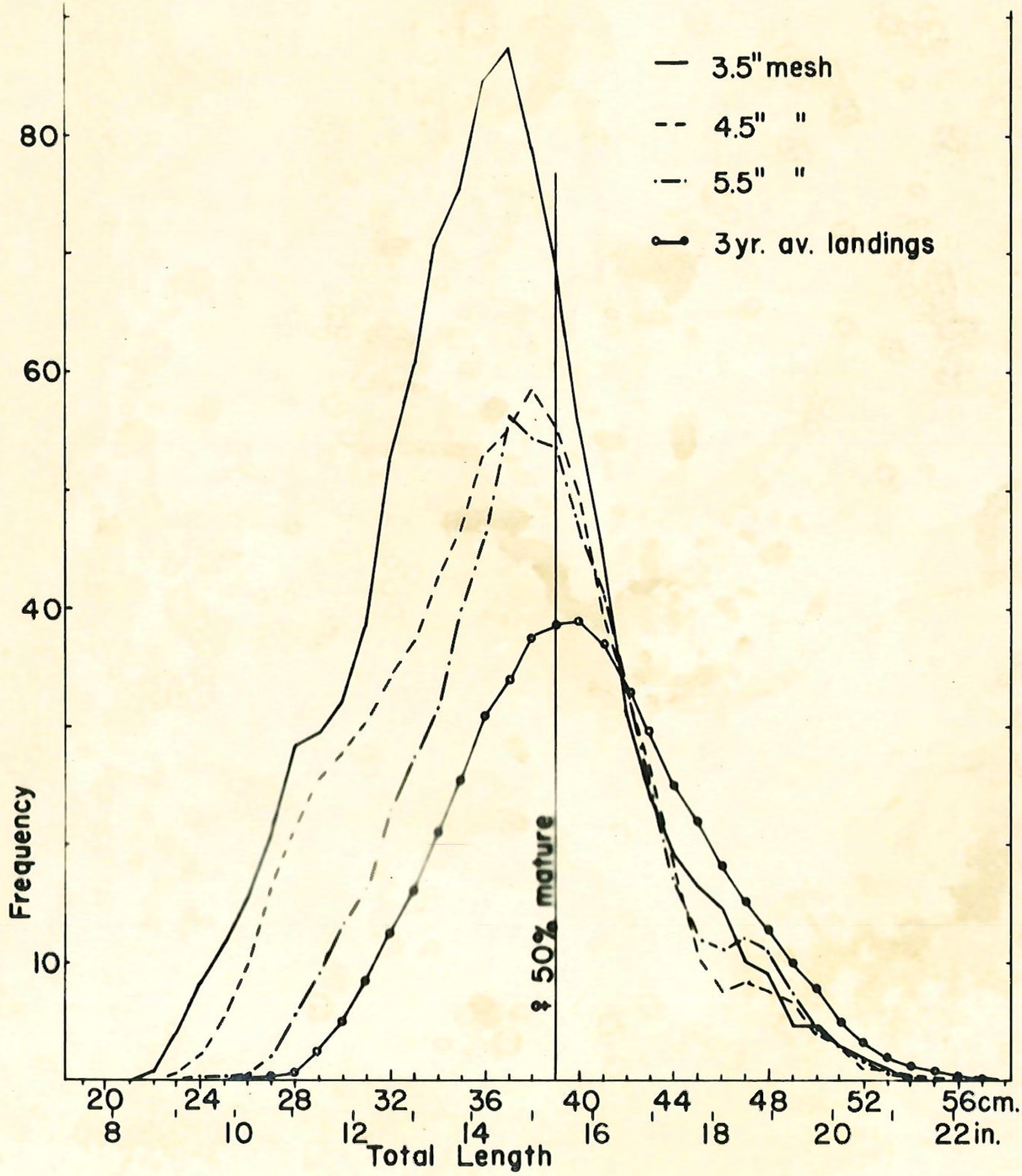


Figure 15. Petrale sole length-frequency

1951 Mesh Experiment Combined Data

Smoothed 3's Adjusted to 100 fish at 41,42 and 43 cm.



it comparable to other samples. Fortunately, the stocks sampled are practically one and the same. If the same numbers of large fish, which are little affected by differences in mesh selectivity, were sampled, the samples would be comparable. The same result can be obtained by adjusting the samples taken to include the same numbers of large fish. Our samples have been adjusted so that the same number of large fish were taken by each different mesh size cod end. Figures 13 to 15 give the smoothed and adjusted samples for the three species involved. To the latter three figures has been added the three year average market length frequency samples for the years 1948, 1949 and 1950. These samples are fish measured at the dock and represent the fish marketed by the fishermen after the unwanted small fish have been discarded. The fish so discarded will not survive and are lost to the fishery.

For all three species the 5.5" mesh cod end (stretched mesh including one knot) selects the same or slightly smaller fish than the fishermen can market. If all the fishermen were to use 5.5" mesh cod ends they would probably retain all the marketable fish and allow the small unsaleable fish to survive to be caught later when they have reached marketable size.

Table 24 shows first the percentage of small fish in the various catches. We chose to term as small fish all the fish under the size at which one half of the females have reached maturity. It will be noted that all the meshes tested took a larger percentage of these small fish than the fishermen marketed on the average for the three year period. The second column based upon the average Oregon landings for the three year period shows the poundage of small fish that would have been discarded by the fishermen if any one of the three mesh sizes had been in general use. Actually the 4.5" mesh was in general use which means that approximately 1,700,000 pounds of small Dover sole were wasted; 630,000 pounds of small English sole were wasted, and 630,000 pounds of Petrale were similarly lost. Column three converts the wasted poundage to the number of fish involved.

It has been shown that by adopting 5.5" mesh cod ends on their 4.5" mesh nets the fishermen could reduce the waste of small fish to a near minimum for all three species principal to the fishery. This would help perpetuate the fishery of these species at a more nearly maximum yield, but more conservation may be needed to maintain the highest perpetual crop of fish, especially for Petrale. Table 25 gives an idea of the actual conservation affected by various sizes of mesh. This is based upon allowing the 50 percent mature females to escape. From this standpoint, Dover sole is afforded no protection by 3.5" and 4.5 " mesh while 5.5" mesh gives fair escapement of females. The escapement of English sole is small using 3.5" mesh, fair to good using 4.5" mesh, and high using 5.5" mesh. There was little escapement of Petrale females for the mesh sizes tested. If Petrale are to be preserved, larger mesh cod ends must be used, but as this might eliminate a large part of the other species in the catch such action can hardly be recommended at this time. No knowledge is available to permit the adoption of an escapement rate necessary to preserve a species in a fishery. No one has shown that the escapement of a definite number of females has produced any definite number of fish to the fishery. Lacking these ideal conditions, close observation of the catch per unit of fishing effort must be made to follow the results of an existing escapement rate of females.

Complicating factors within the fishery make the adoption of 5.5" mesh by the fishermen difficult. Rosefish and dogfish shark would gill badly stopping fishing operations until the fish could be

Table 24.

Destruction of Small Sole
1951 Mesh Experiments

Dover sole 38 cm. (15 inches)*			
	% smaller than 39 cm. (15.4 inches)	Yearly total Pounds of Small fish Discarded	Yearly numbers of small fish Discarded-Total
3.5" mesh	73.7	2,150,000	3,170,000
4.5" mesh	54.3	1,500,000	1,600,000
5.5" mesh	34.9	370,000	360,000
1951 Landings	34.0		
3 Year Average	29.3		
English sole 30 cm. (12 inches)*			
	% <31 cm.		
3.5" mesh	34.6	1,540,000	2,600,000
4.5" mesh	18.6	475,000	770,000
5.5" mesh	8.4	81,500	136,000
1951 Landings	3.3		
3 Year average	5.1		
Petrale sole 39 cm. (15.4 inches)*			
	% <40 cm.		
3.5" mesh	76.1	1,200,000	1,110,000
4.5" mesh	70.5	630,000	530,000
5.5" mesh	62.5	380,000	240,000
1951 Landings	50.1		
3 year average	47.2		

* Size at which females are 50% mature.

Table 25.

Escapement of Females to spawn once. 1951 Mesh Experiments

Dover sole - 38 cm. (15 inches)*

3.5" mesh	no escapement
4.5" mesh	no escapement
5.5" mesh	42% escapement

English sole - 30 cm. (12 inches)*

3.5" mesh	12% escapement
4.5" mesh	60% escapement
5.5" mesh	84% escapement

Petrale sole - 39 cm. (15.4 inches)

3.5" mesh	no escapement
4.5" mesh	12 % escapement
5.5" mesh	22 % escapement

* Size at which females are 50 % mature

pulled out one by one from the large meshes. Dogfish fishing has not been pursued extensively in the past few years, but the fish do appear on the grounds in the winter months and would be a nuisance at that time. Rosefish are taken in deeper waters all year, and there is some gilling with the 4.5" mesh in present use. The fishermen could not be expected to use larger mesh for capturing these fish, especially as there is no waste of small unmarketable rosefish in these catches.

It is a rather general practice for fishermen to add or double back another layer of mesh to the cod ends of their nets. This is done to add strength to the cod end in lifting heavy catches aboard the fishing vessel. Samples taken in the past indicate that this may have the effect of reducing the mesh size approximately one half inch. Cod ends doubled in this manner may take small fish at a rate comparable to single cod ends approximately one half inch smaller in mesh size. It is planned to experiment with double cod ends in future studies as it is felt that comparable escapement of small fish can be gained by using larger outside mesh. The rate of gilling of rosefish should also be established.

Enforcement of any mesh regulation could best be carried out by making the possession of smaller than prescribed mesh illegal. This could be enforced within the waters of Oregon. The fishery takes place beyond the three mile limit and is also pursued by fishermen subject to the laws of other states. These out-of-state fishermen exploit the same fishing grounds as the Oregon fishermen off the Oregon coast and the desired conservation of this fishery would be damaged. Any mesh regulation should be made in cooperation with Washington and California to be fully effective. Seasonal mesh regulations would be equally difficult to set because the species which should be protected occur all year in the fishery. Requiring the fishermen to use larger mesh on sole only would be difficult to enforce. It may be necessary to have some gilling of rosefish in order adequately to protect the stocks of sole.

It should be mentioned that the mesh measurements used in this work have been taken to include one knot with the mesh parallel and held taut. A ruler is butted against the inside of one knot and read at the outside edge of the next knot. This method accords with the Oregon law which states that a mesh must be measured from the center of one knot to the center of the next. Unfortunately, a small fish encounters the opening from the inside of one knot to the inside of the next knot in its attempt to escape the net. Also unfortunately, trick nets could be rigged with large knots or some device to circumvent the law. For a mesh regulation to be of most value, the legal method of measuring mesh should be adjusted to specify the size of the opening required for the escapement of small fish. Cod ends are usually constructed of 120 medium lay cotton thread which makes up into a knot one half inch long. For five inch mesh legal measure the actual mesh opening would be 4.5 inches. The California law based on 4.5 inch inside measurement is identical with our 5.0 inch mesh as we measure it to include one knot.

Market Sampling

The market sampling procedures for Dover, English, and Petrale sole has been modified somewhat during the summer season (beginning in June) of 1951. The sample size has been increased from 200 to 400 fish and the numbers of otoliths taken were raised from 25 to 55.

It is hoped that these modifications will provide a better insight into the age composition of the stocks of important flatfish in this area. The results, so far, of the 1948 and 1949 tagging indicate that there is little or no movement of the local fish out of the area. This is especially true for the Dover sole.

The results of the market sampling program through July 31, 1951, are discussed in the following paragraphs by species. The fishermen did not fish during most of May due to a price dispute so that regular market sampling didn't begin until June.

Dover Sole

During June and July, 12 samples (totalling 4,411 fish) of Dover sole were taken. Nine of these samples (totalling 3,206 fish) were taken from catches made in the local area.

All the otoliths (660) from the 12 samples have been read once while fresh. Since the Dover otoliths are so difficult to read after prolonged storage it was decided that an attempt should be made to read as many as possible while they are fresh to determine if their readability can be improved. A grading system for otolith readability (A, B, or C) was used in order to have some means of comparison between the readings of fresh and stored otoliths.

English Sole

During June and July four samples (1,398 fish) of English sole were taken. Two samples (800 fish) were taken from catches in the local area and two samples (598 fish) from catches made to the northward.

None of the otoliths have been read to date. The paucity of English sole samples has been due to the lack of English sole landings in Astoria. The fishermen have not been fishing for these fish because they are allegedly too scattered on the grounds, and further that the Dover sole are more available with less trouble of sorting.

Petrale Sole

No Petrale sole were sampled during June and only two samples (743 fish) during July. The principal petrale sole fishery now occurs during April, May, and early June for the Astoria Fleet. Due to the aforementioned price dispute, the Astoria fleet was in port during the time the petrale were plentiful on the local grounds.

Life-History Studies

Most of the work has been completed on the length-weight relationship, time of spawning, age and size at maturation, and fecundity of Dover, English, and petrale sole. Thus it was decided that some time could now be allocated to studying the early life histories of these three species. Where are the larvae and juveniles found? What is their growth rate? A host of other such questions can be raised.

The first puzzle to be solved is perhaps the most difficult. That is, where are they found. Since even the spawning grounds, if such specialized areas exist, are not known for any of the three species, the problem becomes indeed difficult.

Our tools for the search consist of three types of nets, a beach seine, a shrimp "try-net", and an otter trawl cod-end with 1-1/2 inch mesh.

The beach seine was designed for two-man operation. It is to be used on the beaches of the bays and ocean. The net is 70 feet long. Two 25 foot wings (10 feet deep) are attached to a center section 20 feet long and 20 feet deep. The mesh in the wings is 3/4 inch, while the mesh in the center section is 1/2 inch. Two main lines (3/8 inch manila rope) each 200 feet long are used to haul in the net.

The "try-net" is a miniature otter trawl net, complete with 12 inch by 20 inch otter boards. It is approximately 16 feet long tapering with a depth of about 4 feet at the wings. The mesh is 1-1/2 inch throughout. This type of net is used by the shrimp fishermen off the Texas coast for prospecting (hence the name, "try-net") for shrimp schools. This enables the fishermen to avoid risking their large (and expensive), regular shrimp trawls until a school of shrimp has been located. The net allegedly has a working depth to 40 fathoms according to the manufacturer. It will be used in the bays and outside the surf in the ocean.

The cod-end with 1-1/2 inch mesh which was ordered for use in the mesh experiments presents considerable pro ise for use in prospecting for these small fish. The cod-end was built to standard specifications with regard to the regular cod-ends used by the otter trawl fleet. It is approximately as long and as wide as the larger-meshed cod-ends.

The first trial of the beach seine occurred July 5, 1951 on the Clatsop Beach (0.9 and 1.3 miles south of the South Jetty). The net was fished in a lagoon lying between the main beach and a "boat-bar" approximately 300 feet offshore.

Four sets were made during low low water slack, but no flatfish were caught. A few perch and some shrimp were the only species encountere'. The action of the surf caused the cork line to over-run the lead line in the surge at beach-edge so that the net almost emptied itself. If a four to six foot bag could be added to this net, this difficulty would probably be eliminated.

The second trial occurred July 6 in a small lagoon (300 feet wide and 600 feet long) lying to the landward of the main surfline. Again four sets were made which netted crabs, perch, shrimp, sand sole, and cottids in order of abundance. One set netted all the crabs (62, of all sizes), while the other sets netted from one to two fish each. In this case there were no waves or surf action to invert the net so that it can be safely presumed that no fish were lost in this manner.

On July 25 the beach seine was fished in Tillamook Bay (Crab Harbor) but no flatfish were caught. However, 25 small salmon (downstream migrants) were captured. The strong tidal currents carried the net a considerable distance up-bay before the net could be hauled in.

From the limited use of this seine it appears that a bag must be added to the net so that it will fish efficiently in the surf. Aside from this, however, it is quite possible that the small flatfish we are searching for do not inhabit the areas in the ocean available to the beach seine.

The "try-net" was first used on July 18 in Tillamook Bay. A sport-cruiser was chartered and six drags (15-20 minutes each) were made in different areas (Crab Harbor to Coast Guard Boathouse in 18 to 36 feet of water) of the bay. The following species (with frequency) were encountered: Crab (C. magister, 51; C. productus, 1); English sole, 8; Sand Dab, 9; Hexagrammids, 1; Perch, 1; Cottids, 4; and Sebastodes sp.(?), 1. These results don't indicate any great abundance of English sole and no indication of the presence of Dover or petrale sole. The English sole ranged in size from 75 to 95 millimeters.

On July 25 the "try-net" was fished in Yaquina Bay on the chartered boat, "Bobby". This trip was very successful. A total of 343 English sole were taken. Of these, 22 were tagged and returned to the water, while the remainder were preserved in formalin for study. The new small surf-smelt tags (Petersen type: 3/8 inch diameter) were used to tag these fish. One starry flounder was also tagged at the same time. The English sole ranged in size from 55 to 175 millimeters with a principal mode at 115-119 mm and a secondary mode at 100-104 mm. Otoliths from 46 of these fish were taken for later reading.

From the information collected thus far, it appears that there may be considerable numbers of small English sole in Yaquina Bay and smaller numbers in Tillamook Bay. Apparently there are no Dover or petrale sole in either Yaquina Bay or Tillamook Bay.

Since the results are so encouraging it is intended that this study be continued by fishing every three or four weeks in Yaquina Bay, at least, throughout the year in order to determine when the young fish enter the bay and when they leave. It may also be necessary to conduct plankton sampling during the winter and spring months in order to capture the fish, if they enter the bay as pelagic larvae. It is hoped that a similar program can be started in the waters outside the bays during the next year.

The otter trawl cod-end with 1-1/2 inch mesh may also be of considerable value in fishing for these juveniles in the ocean. An excellent start was made on Dover sole during the month of May when, during the course of a mesh experiment, this cod end was used and a considerable number (225) small Dover sole were captured. These small fish ranged from 10 to 30 cm. Otoliths were taken from all the small Dover and the readings indicated that portions of the year classes I through V were present in this sample.

Subsequent attempts, however, have not yielded any more small Dover, English, or petrale sole, but it is possible that these small fish arenot to be found scattered throughout the main fishing grounds. They may only frequent certain locations.

Small Otoliths

As mentioned in the preceding Marine Fisheries Progress Report (Feb-Apr 1951) the otoliths from undersized Dover, English, and petrale sole have been collected in order to have a series throughout the year with which to determine, if possible, the time of annulus formation. For the period of May through July 1951 a total of 563 otoliths from Dover, English, and petrale sole have been collected. Some of these otoliths have been read once, but none have been read twice.

The Dover sole totals (313 otoliths) by month are: May, 225; June, 38; and July, 50.

The English sole totals (189) by month are: May, 16; June, 107; and July, 66.

The petrale sole totals (61) by month are: May, 10; June, 44; and July, 7.

Albacore

Fishery

The season was about ten days late in starting off the Oregon coast, and then the fish were not caught abundantly. Some 200 vessels were offshore trying their luck in the last week of July. Catches were erratic, depending on whether a boat found the few schools or not. The fish were estimated to have appeared three weeks late this year in southern California waters with no large catches being made.

The price of fish to the fishermen was not too stable at the start of the season. Large holdings of canned tuna, 1200 tons of duty free frozen Japanese albacore about to arrive, and a case price squeeze by fisheries brokers caused the comparatively low price to the fishermen. One canner was offering $350 per ton at the season's start, with most others offering $300 per ton. When this is converted to price per pound ($.15 to $.175), it is no wonder that one half the fleet talked of returning to salmon trolling, which continued fair to good, while the other half of the fleet talked of going south where fair catches of albacore (100 to 200 fish per day) could be expected.

Sampling

This year the sampling was to be done ashore which was fortunate as any sampling at sea would have been difficult and yielded meager results. The usual length frequency sampling would be continued as in the past. Scales and a few vertebra collections were planned for the age determination study. After extensive discussions with Dr. Fiekowsky, we hoped to discover the reasons for the significant statistical differences between morphometric samples of the local albacore. Samples were to be made in such a manner that the various factors thought to cause statistical variation could be eliminated or broken down and compared. Two large samples were to be made one at the first of the season and one at the end of the season. If the season continued over a long period, a third sample was to be taken in midseason. The fish were to be sexed and their age determined if possible. If possible, these samples were to be taken from fish of one area to eliminate the possibilities of differences between schools or races of fish. It seems of basic importance to know the effects of differences caused by sex, age composition, growth, racial composition, etc., within the local population of albacore before making statistical comparisons with populations from other areas.

SABLEFISH

Tagging Program

Although 2,092 sablefish were tagged during the 1950 season, it was felt that the tagging program should be continued during 1951 as a means of obtaining additional information concerning the migratory habits, rate of growth and age of the sablefish. The relatively small number of tag recoveries to date also demonstrated that a considerable number of tags must be put out in order to obtain a large enough number of recoveries to provide an accurate picture of the migrations.

Examination of the tag recoveries from the 1950 tagging illustrated that it was much more desirable to tag long-line captured sablefish than those caught by otter trawlers, because the percentage recovery of fish tagged on long-line vessels has been approximately three times that of those tagged on otter trawlers. This is because the long-line fish are in better condition after being caught than the otter trawlfish. Consequently, most of this summer's tagging was conducted aboard a long-line vessel.

It is now known that the nickel pin used in 1950 to fasten the tags to the sablefish was subject to corrosion and, as a result, it is quite possible that a considerable number of tags may have fallen off the fish. From an examination of the fisheries literature, it was found that german silver and stainless steel both possess corrosion resistant properties and are adaptable for use as pins. German silver, however, is quite brittle. All the pins used this summer were therefore made of one or the other of these two metals.

Following is a table (Table 26) listing the information concerning this summer's tagging. Tag numbers p-6000 through p-6342 were attached to otter trawl captured sablefish and the remainder th long-line captured fish.

Table 26. Information Concerning Sablefish Tagged During the Summer of 1951.

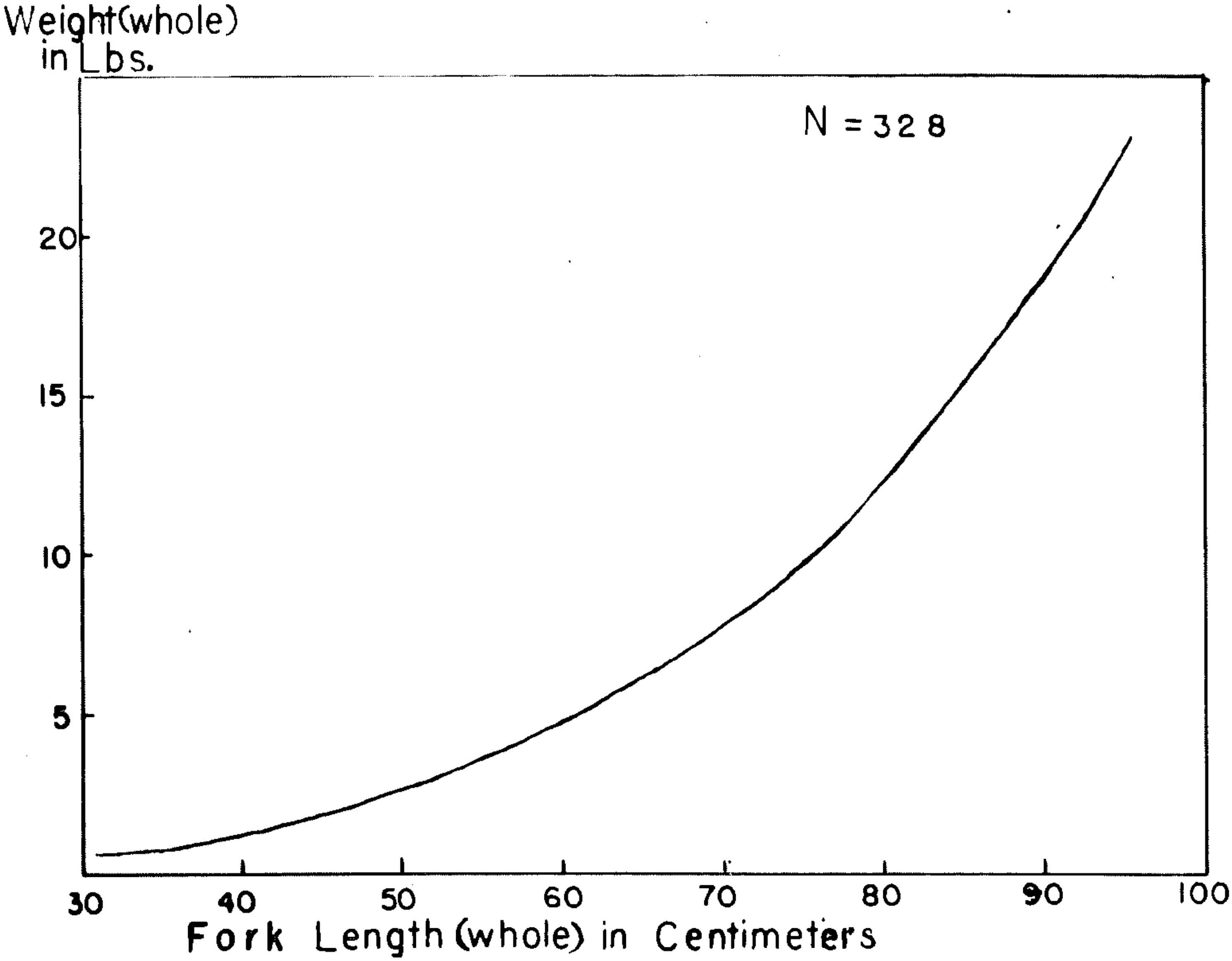
Date	Tag Numbers	Locality	Depth of Capture in Fathoms	Type of Pin
5/14	p-6000-6076	W. of Yaquina Head	80-90	german silver
5/15	p-6077-6189	" " " "	156	stainless steel
	p-6190-6194	W.N.W. of Yaquina Head	156	german silver
5/16	p-6195-6281	" " " "	156	german silver
	p-6282-6287	" " " "	156	stainless steel
5/17	p-6288-6342	" " " "	156	stainless steel
6/2	p-6343-6422	W. of Yaquina Head	95	german silver
7/2-3	p-6423-6539	N.W. by W. of Coos Bay	135	german silver
7/3	p-6540-6560	W.N.W. of Umpqua River	135	german silver
7/5	p-6561-6576	S.W. by W. of Yaquina Head	80-90	german silver

Length-Weight Data

Since sablefish are landed dressed, i.e., heads off and gutted, the length-weight data had to be obtained aboard fishing vessels(Fig.16). This curve was fitted by eye and represents the average weights by two centimeter intervals.

Figure 17 gives the length (whole) - weight (dressed) relationship of sablefish with the sexes combined. This curve was fitted in the same manner as Figure 16.

Figure 16. Length (whole) — Weight (whole) Relationship of Sablefish. Sexes Not Separated.



Age Determinations

The most successful method found to date of cleaning scales for use in age determination is to first soak them in a weak sulution of "Tide" soap for about 12 hours and then clean them with a stiff stencil brush. When the scales are cleaned in this manner and then put up as dry mounts, check marks are visible on the majority of them.

Approximately 400 scales have been mounted in this manner during the summer, but because of trouble experienced with the Rayoscope they have not yet been read.

The Present Condition of the Fishery

Despite a considerable increase in price offered to the fishermen for sablefish this summer ($0.13 to $0.15 per pound for long-line caught fish as compared to last summer's average price of $0.08 per pound) very few fish have been landed by long-line vessels. Immediately following closure of the halibut season several long-line vessels converted over to the sablefish fishery, but because of a scarcity of fish none of them were able to make profitable trips. As a result, the majority of the vessels tied up in port to await the appearance of albacore.

SURF SMELT

During the past two summers temporary personnel had been assigned to the surf smelt fishery, but since they did not report for work until June and left in September a complete record of a summer's run was never obtained. Since Al Pruter was transferred from Astoria to Newport in early May this summer, it was hoped that he would be able to obtain information concerning the early fishery in that area and that when the temporary help arrived in June it would be possible to continue the research program. Information concerning the early runs was obtained, but since Dick Lackey, who reported for work at Newport on June 22, quit on August 6, the research was sharply curtailed following that date.

Nevertheless, a brief summary of the data accumulated and the scheduled program of research will be presented here.

Length Frequencies

Several samples of spawning smelt were obtained during the months of May, June and July in the vicinity of Squaw Creek, located some 8 miles south of Yachats. Examination of Figure 18 shows that the early runs were composed of larger fish and a higher percentage of males than the later runs. Scale samples were taken, and if the time is available this winter the age composition of the runs will be determined.

Catch Statistics

As a means of acquiring information concerning the magnitude of the catches taken by sport fishermen, post cards were distributed at each of the beaches known to support smelt runs. These post cards were placed in weather-proof boxes and posted at conspicuous places along the beaches; they provided for information concerning the location, type of net used, amount of time the net was fished, time the run started and stopped, the number of nets in use on the beach and the total pounds of fish taken by the person filling out the post card. The information supplied from the post cards was supplemented by counts made by biologists during their visits to the beaches.

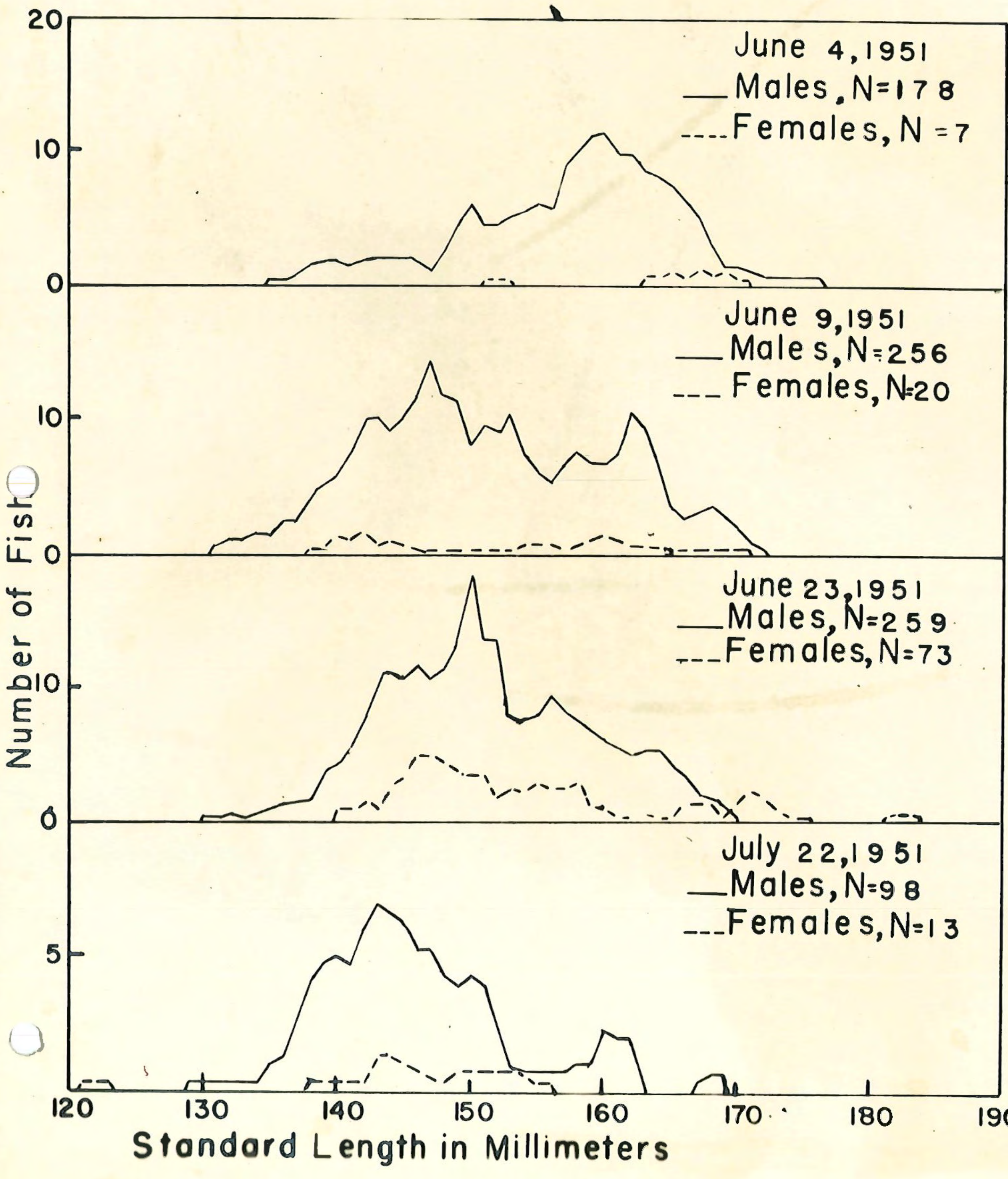
The number of post cards received to date has been disappointingly small, probably chiefly because the fishermen are afraid that they may lead to the imposition of further catch restrictions.

Tagging Program

Surf smelt were tagged for the first time this summer to furnish information concerning possible movement along the coast, growth rate and multiplicity of spawning. Because of the relatively small size of the smelt it was not possible to use the conventional 9/16" diameter Petersen tags, so special tags 5/16" in diameter with a hole of 0.30" diameter in the center were ordered. The discs are of two types: the identification discs are white with Fish Comm., Astoria stamped on them: and the numbered discs are red and are made up in series of 100 tags each. Each series is also identified by number. Both stainless steel and german silver wire of 0.29" diameter have been used for pins.

The tags were attached immediately below the insertion of the dorsal fin by running a pin through the fish and making a loop in the wire on the outside of each tag. Observation of tagged smelt held in a washtub indicated that they experienced little or no distress from the tagging, for they behaved in a similar manner to the untagged smelt.

Figure 18. Length Frequencies of Surf Smelt Taken at Squaw Creek on the Indicated Dates.



Since the tags were not delivered until the latter part of July, only a few smelt were tagged. Specifically, 16 smelt were tagged near Squaw Creek on July 20, and 4 at the same location on August 1st. No recoveries have been obtained to date.

Age determinations

Both scales and otoliths of surf smelt were examined, and it was found that scales were the more suitable for use in age determinations. Approximately 150 scales have been put up as dry mounts to date and will be read in the near future.

Location of Spawning Areas

George Harry and Al Pruter made a trip to the California border on July 24 through July 26 for the purpose of locating beaches supporting smelt runs. During the course of the trip a large number of residents were interviewed and considerable information was obtained concerning the existence, or non existence, of runs in the various areas.

Irregular runs are reported to occur in the vicinity of the Sixes and Pistol Rivers, and a few smelt are apparently taken on jigs in the mouth of the Rogue River. None of those runs are subjected to a very intense fishery, however.

George Harry

Ed Holmberg

Al Pruter

Jergen Westrheim

Aquatic Biologists