

TAGGING STUDIES TO DETERMINE
THE OFFSHORE-INSHORE EXCHANGE
OF GROUND FISH OFF OREGON AND WASHINGTON

FINAL REPORT

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By

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INTRODUCTION

The disposal of radioactive waste products is a serious problem facing scientists and the public. One solution proposed is to dump these waste products at sea, with the area off northern Oregon and southern Washington in 100 to 1,000 fathoms as one area of consideration. However, one of the problems to be resolved is the subsequent distribution of fishes present in the area where these wastes would be dumped. Do these fish move inshore to become available to fisheries and hence utilized by man?

The most practical method presently available to determine the migration of these deep water fishes is by tagging. Recoveries of tagged fish by the inshore fisheries would provide information on the offshore-inshore movements of these fish.

This is the final report on a cooperative study by the Atomic Energy Commission (AEC), Bureau of Commercial Fisheries (BCF), and Oregon Fish Commission (OFC) to determine the offshore-inshore movements of Dover sole (Microstomus pacificus) and sablefish (Anoplopoma fimbria). Funds for this study were made available from the AEC on a yearly contractual basis. This report will present the methods, materials, results, and conclusions of the work accomplished since initiation of the study in June 1961.

METHODS AND MATERIALS

During the period from June 1961 to May 1964, 9,013 Dover sole and 4,647 sablefish were tagged and released at approximately 25-fathom intervals from 50 to 450 fathoms in a 35-mile-long area southwest of the Columbia River (Figure 1). The tagging was done from the BCF vessel John N. Cobb and BCF chartered vessel Commando. The dates, depth, and numbers of fish tagged and released are shown in Tables 1 and 2.

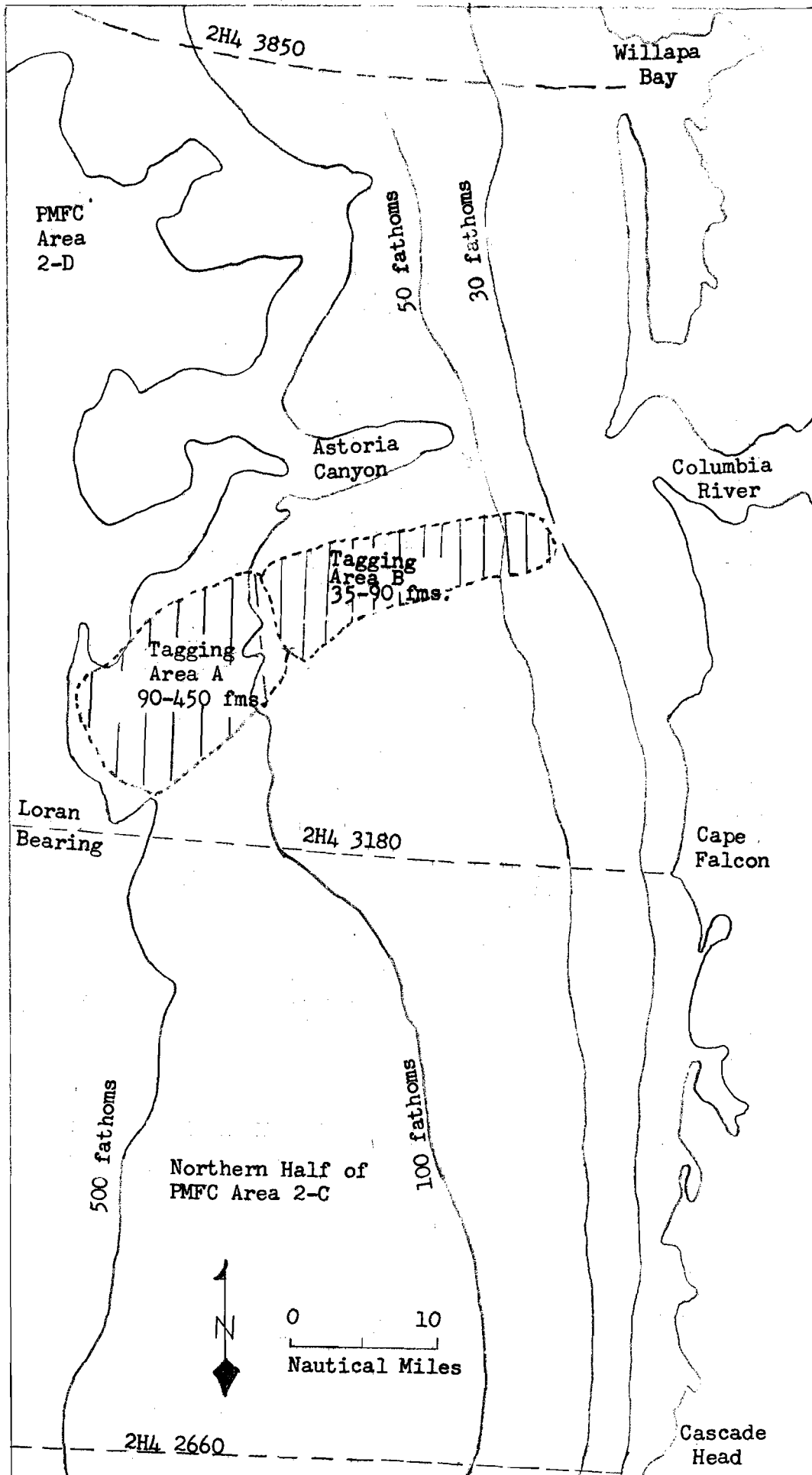


Figure 1. Area of investigation off northern Oregon and southern Washington.

Table 1. Numbers of Dover sole tagged June 1961 - May 1964 by depth and time of tagging, and percentage recovery through 1965.

Depth (fms)	1961						1962							
	6-6 to 6-9		9-11 to 9-17		12-6		3-3 to 3-12		5-18 to 6-5		8-26 to 9-1		11-2 to 11-3	
	No. Tagged	% Re- covered	No. Tagged	% Re- covered	No. Tagged	% Re- covered	No. Tagged	% Re- covered	No. Tagged	% Re- covered	No. Tagged	% Re- covered	No. Tagged	% Re- covered
25														
50								9	11.1				19	10.5
75								67	19.4	102	4.9		107	5.6
100	12	41.7	18	16.7			19	5.3	757	17.7	156	0.6	153	0.7
125	78	7.7					10	0	59	10.2				
150	25	8.0	5	0			13	0	35	2.9	64	0		
175	166	1.2	24	0			42	19.0	140	6.4	100	1.0		
200	124	3.2	62	1.6			83	7.2	128	5.5	91	0		
225	387	2.6	121	2.5			34	8.8	196	5.6	123	0		
250	292	1.4	74	1.4					160	1.3	35	0		
275			50	0			2	50.0	63	0				
300	36	0	30	3.3	68	0	11	0						
325	4	0												
350	2	0	3	0										
375							12	0						
400			4	0										
425							18	0						
450														

Table 1 (Continued)

Depth (fms)	1963								1964				Total No.	Total No.	Total Re-	Total % Re-	
	1-23 to 1-24		5-4 to 5-10		8-21 to 9-6		10-28 to 11-15		1-9 to 1-24		5-12 to 5-19						
	No.	% Re-	No.	% Re-	No.	% Re-	No.	% Re-	No.	% Re-	No.	% Re-					
25																	
50			16	0	41	9.8					1,347	21.5	1,432	296	20.7		
75			114	7.0	72	4.2					424	21.2	885	125	14.1		
100			157	12.1	37	5.4	100	7.0	21	14.3	726	8.8	2,156	240	11.1		
125			5	0	64	0							216	12	5.6		
150			75	0	148	0							365	3	0.8		
175			213	5.2	126	0							811	31	3.8		
200			122	3.3	148	0					200	0	990	22	2.2		
225			141	1.4	92	0							1,097	29	2.6		
250			90	3.3	64	0							680	10	1.5		
275					14	0							129	1	0.8		
300			6	0	8	0							159	1	0.6		
325	17	0											21	0	0		
350	4	0	2	0									11	0	0		
375	6	0											18	0	0		
400	10	0	4	0									18	0	0		
425	6	0											24	0	0		
450	1	0											1	0	0		

Table 2. Numbers of sablefish tagged May 1962 - May 1964 by depth and time.

Depth (fms)	1962				1963					1964			Total by Depth	% Tagged at each Depth
	5-18 6-5	8-26 9-1	11-2 11-3	Total	1-23 1-24	5-4 5-10	8-21 9-6	10-28 11-15	Total	1-9 1-24	5-12 5-19	Total		
25														
50						23	30		53		18	18	71	1.5
75		7		7		26	3		29				36	0.8
100	143	20		163		9	3	12	24	14	5	19	206	4.4
125						56	5		61				61	1.3
150		17	9	26		38	38		76				102	2.2
175		33		33	58	11	681		101				134	2.9
200		25		25	127	26	54		207	60	53	113	345	7.4
225		68		68	181	68	24		273				341	7.3
250	107	97		204	86	43	62		191				395	8.5
275	60			60			9		9				69	1.5
300	265	147		412	230	154	36		420				832	17.9
325		142		142	270	145	1		416				558	12.0
350		109		109	150	169	18		337				446	9.6
375		115		115	132		123		255				370	8.0
400		49		49	92	96	103		291		170	170	510	11.0
425					12		123		135				135	2.9
450					19		17		36				36	0.8
TOTAL	575	829	9	1,413	1,357	864	681	12	2,914	74	246	320	4,647	

Fish to be tagged were taken with a 400-mesh commercial otter-trawl net with $1\frac{1}{2}$ -inch mesh liner in the cod-end, and the tows were of 0.4 to 1.1 hour's duration. At the end of a tow, the catch was spilled on the deck and 100-300 viable Dover sole or 50-150 sablefish were sorted into a live tank. Fresh seawater was supplied by the vessel's pump. Two types of tags were used for Dover sole: $5/8$ -inch fluorescent orange Petersen discs with soft-tempered stainless steel pins and 8-inch orange double-barb dart tags of vinyl tubing. Six-inch vinyl plastic dart tags with nylon single-barb heads were used for tagging black cod.

The tagged fish were brought in as part of the catch of the commercial trawlers and, in the case of sablefish, occasionally longliners. The tags were recovered by daily canvassing of the fish processing plants in the Astoria and Warrenton areas and interviewing the vessel skippers and fishermen as they unloaded. Since the trawl vessels unload bottom fish at several ports along the Oregon coast and the project biologist was stationed at Astoria, it was necessary to travel the coast at approximately monthly intervals to pick up tags and gather catch data. As an incentive for fishermen and filleters to return all tags, a reward of \$.50 to \$.75 per tag, depending on the amount of recovery information available, has been paid since 1962. Whenever possible, the complete tag-bearing fish was recovered along with the date of recovery, location, and depth of catch. When the specimen was returned to the laboratory, scales and otoliths were removed for age analysis, length recorded for growth studies, and the sex recorded.

RESULTS

During the period June 1961 to December 31, 1965, 755 Dover sole and 19 sablefish tags were recovered. Recoveries of Dover sole tags by year of tagging are shown in Table 3. The returns from sablefish tagging have been negligible; therefore, most of the time and effort has been directed toward Dover sole.

Table 3. Numbers of Dover sole recovered by year of tagging and recovery.

Year of tagging	Number tagged	Recoveries by Year					Total	% of tags recovered
		1961	1962	1963	1964	1965		
1961	1,585	9	14	9	10	0	42	2.6
1962	2,808		66	78	46	30	220	7.8
1963	1,902			26	23	13	62	3.3
1964	2,718				270	176	446	14.4
TOTAL	9,013	9	80	113	349	219	770	8.5

Although it was anticipated that a computer program would be used for the final analysis, the shortage of time brought about by the termination of the contract made this impossible.

Dover Sole

In order to better understand the offshore-inshore movements of Dover sole, the area of tagging has been divided into two zones as illustrated in Figure 1. Area B represents the shallow release zone, 35 to 90 fathoms, and Area A represents the release zone from 90 to 450 fathoms. A grid pattern, placed at 10-mile intervals east from 125° West longitude and along each 100 microsecond loran bearing line from 2H4 2600 to 2H4 3800, has been drawn over the entire area of tag recovery. These squares are approximately 8 by 10 miles and, although large enough to nullify minor errors which may have occurred in the reported location of tag recovery, are small enough to show the general pattern of movement. When the recoveries from each year's tagging are assigned to their area of return (Figures 2, 3, 4, and 5), a general northeast and inshore pattern of movement can be seen for the deep water releases (Area A) returned during the summer and early fall (May to November). Tag returns from Area B for the same period show either some inshore movement or no movement. Although the number of recoveries during

Loran Bearing

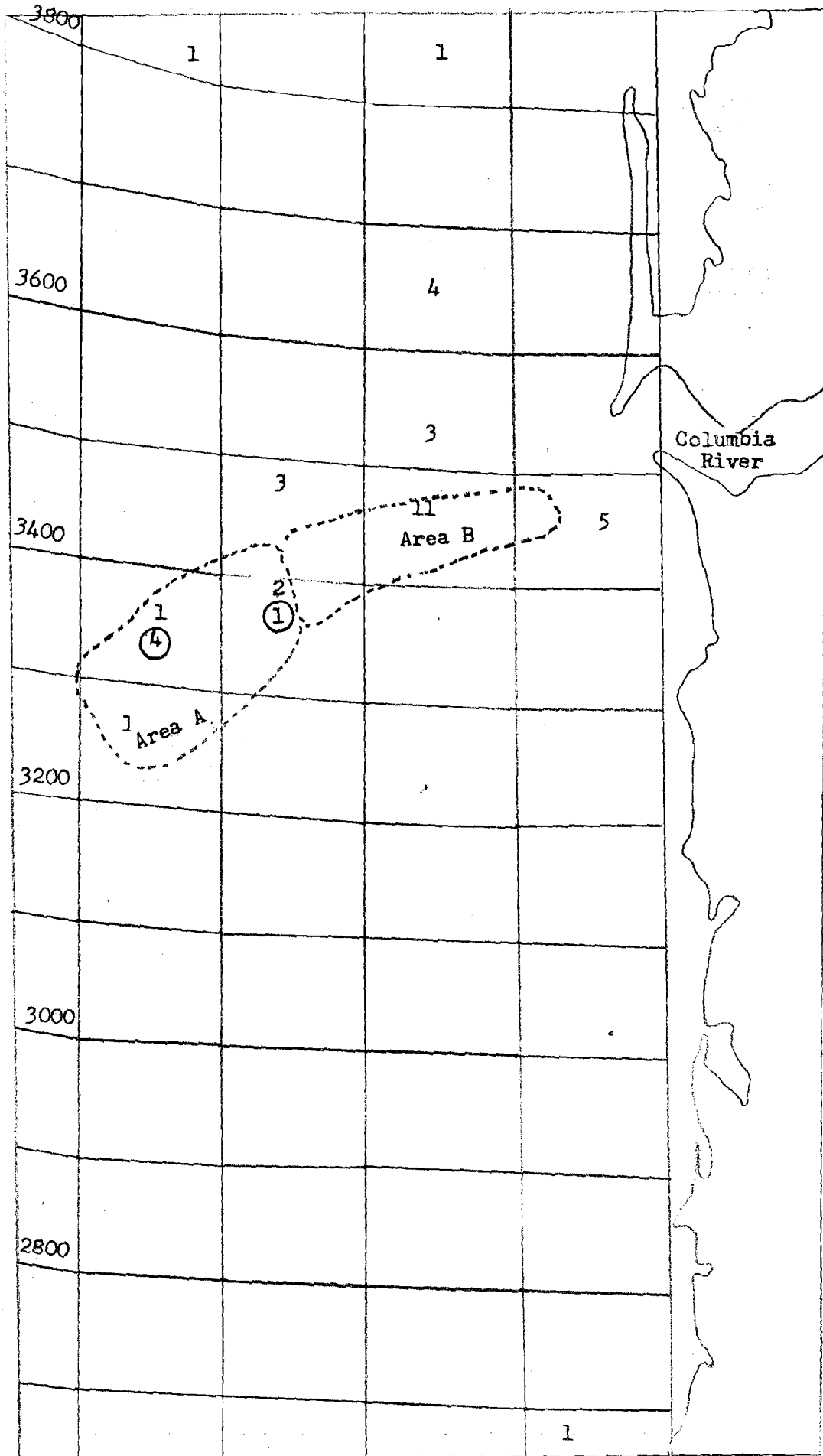


Figure 2. Tag recoveries through 1965, from 1,585 tagged Dover sole released in Area A during 1961 (no releases in Area B during 1961). (Circled numbers indicate tags recovered from November to May; all others were recovered from May to November.)

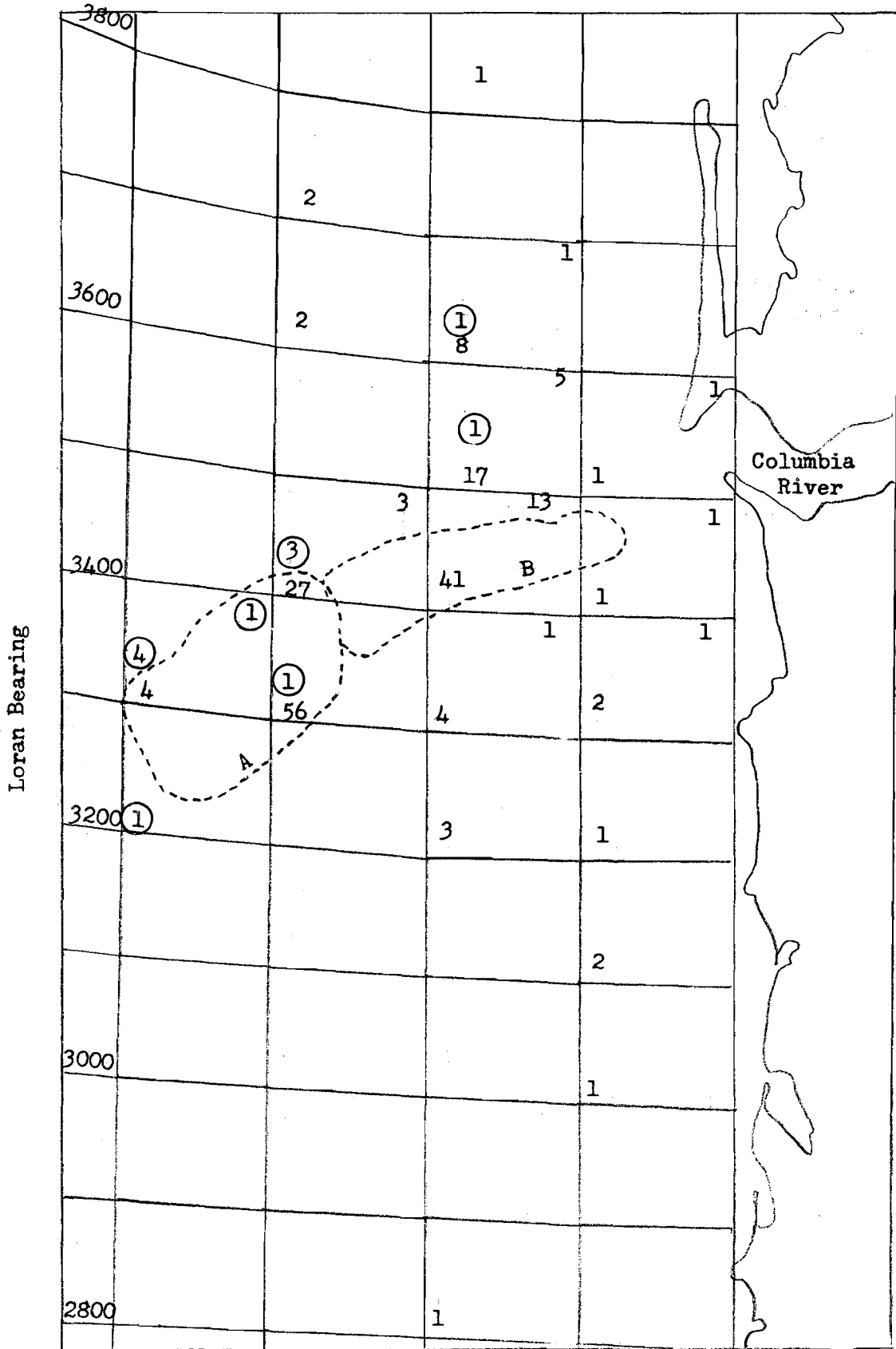


Figure 3. Tag recoveries through 1965, from 2,504 tagged Dover sole released in Area A and 304 released in Area B during 1962. (Numbers in upper right corner of each square are those recoveries from Area B; Area A recoveries are indicated in lower left corner. Circled numbers indicate tags recovered from November to May; all others were recovered from May to November.)

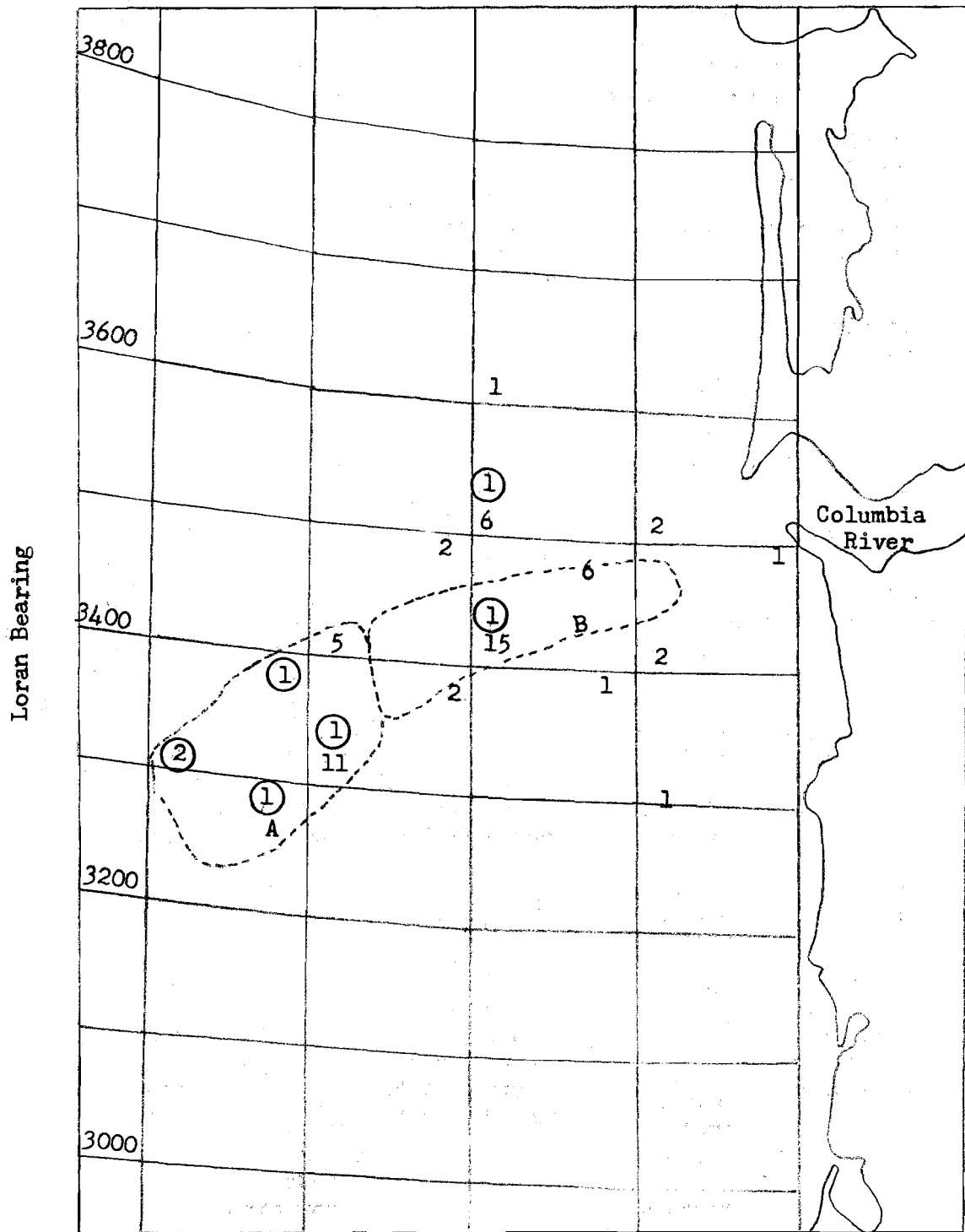


Figure 4. Tag recoveries through 1965, from 1,660 tagged Dover sole released in Area A and 242 released in Area B during 1963. (Numbers in upper right corners of each square are those recoveries from Area B; Area A recoveries are indicated in lower left corners. Circled numbers indicate tags recovered from November to May; all others were recovered from May to November.)

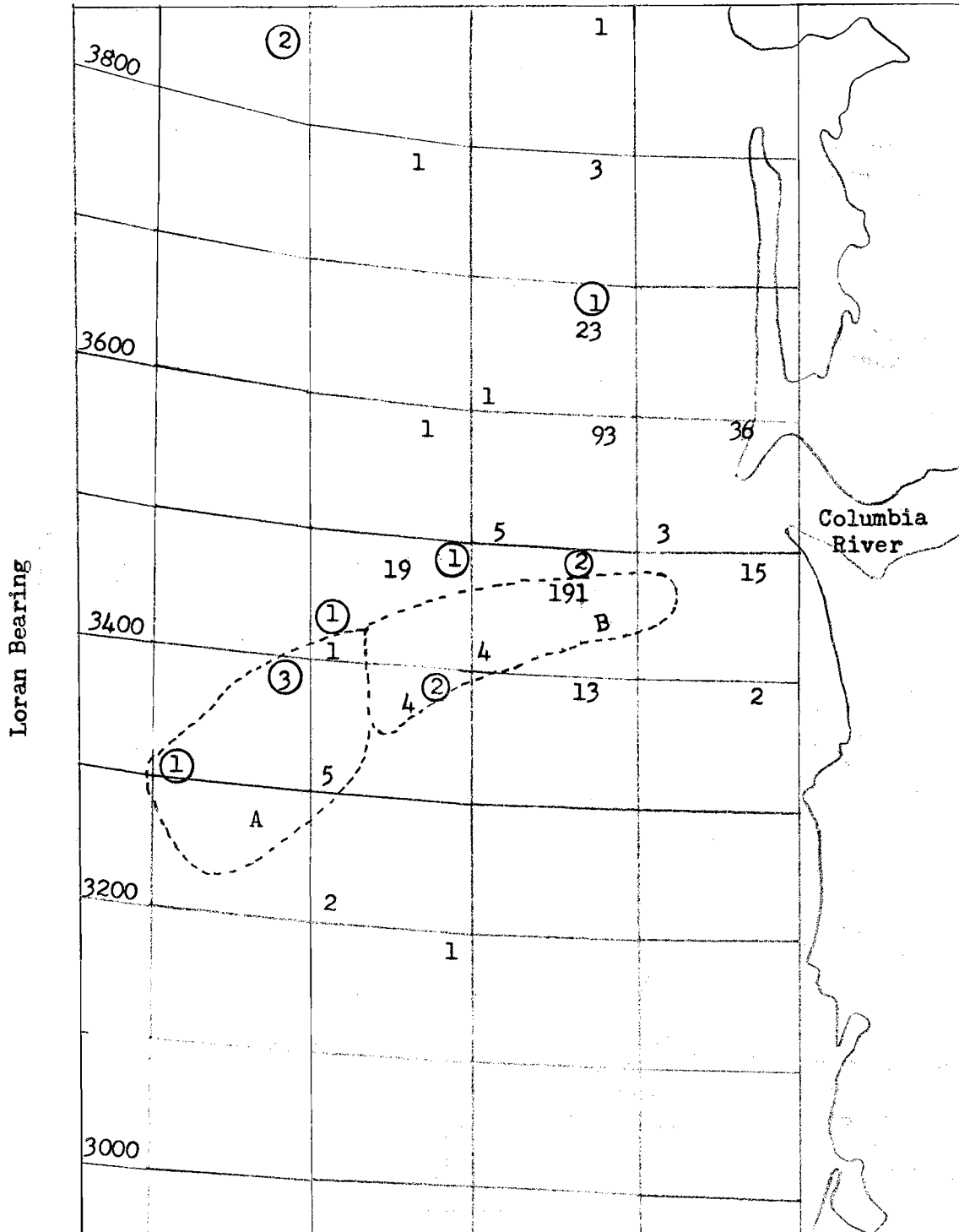


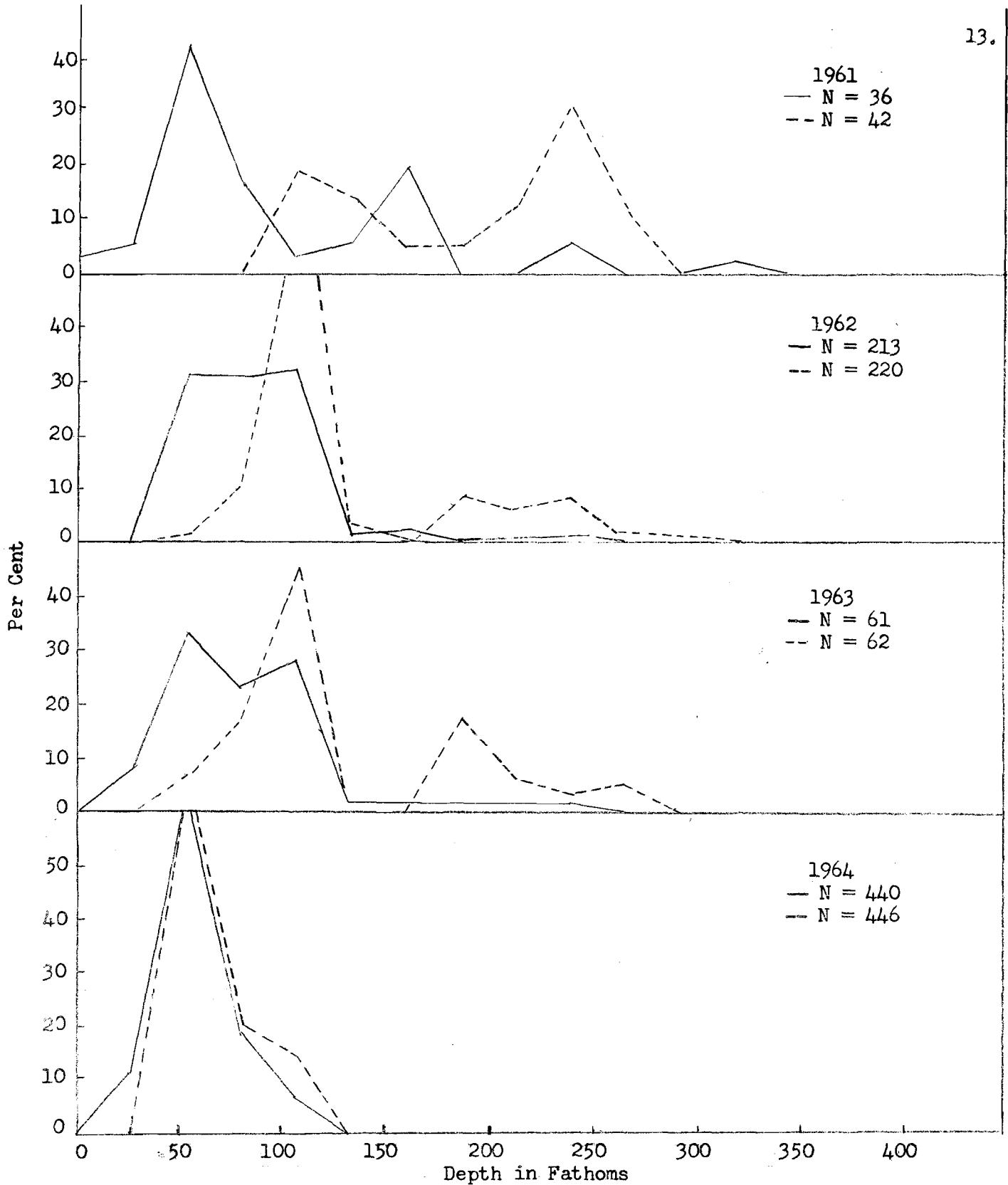
Figure 5. Tag recoveries through 1965, from 947 tagged Dover sole released in Area A and 1,771 released in Area B during 1964. (Numbers in upper right corners of each square are those recoveries from Area B; Area A recoveries are indicated in lower left corners. Circled numbers indicate tags recovered from November to May; all others were recovered from May to November.)

the winter and early spring (November to May) is much smaller, Area B releases in general show an opposite southwest movement to deeper offshore areas. Area A recoveries during this period show little or no movement. Although a few tags were recovered in Willapa Deep and as far south as Cascade Head, such movements were minimal, and no major north or south migration is shown.

Figure 6 shows the tag recoveries by depth of release and recovery for each year. The recovered fish show a definite movement to shallower water. It is apparent that a very high percentage of the tags are returned in the depth range of 25 to 100 fathoms.

The per cent recovery by depth of tagging (Table 1) has been graphically presented in Figure 7. A higher recovery rate is shown for fish released in 100 fathoms or less. If we correlate monthly Dover sole catch patterns by depth from the northern half of Pacific Marine Fisheries Commission Area 2-C and all of Area 2-D (Figure 1) with tag returns by depth tagged, a partial explanation for the tagging depth and per cent recovery relationship is obtained. About 80% of the Dover sole landed from the northern half of PMFC Area 2-C and all of Area 2-D for the period 1961-63 (Tables 4, 5, 6) were caught in less than 90 fathoms, while 86% of the total recoveries were from 100 fathoms or less. In addition, over 75% of the yearly landings from 1961-63 were made from May through September and over 85% of the tags were recovered during this same period (Table 7). It is apparent, therefore, that those fish tagged and released in less than 100 fathoms during May or June of any one year would be subjected to an intense fishery. This partially explains the high recovery rate for 1964 when 1,347 releases were made at 50 fathoms in May of that year.

As noted earlier, the percentage return for deep-water releases has been low (Table 1) compared to the percentage return for shallow releases. One explanation has been offered for the higher return rate for shallow releases. However, if Dover sole do migrate inshore and offshore, as has already been suggested, then



— Recoveries by depth recovered expressed as a per cent of total recoveries.
 - - - Recoveries by depth tagged expressed as a per cent of total recoveries.

Figure 6. Dover sole tag recoveries by depth tagged and recovered expressed as a per cent of total tags recovered. (The depth of recapture is not known for all recoveries - this explains the difference in N.)

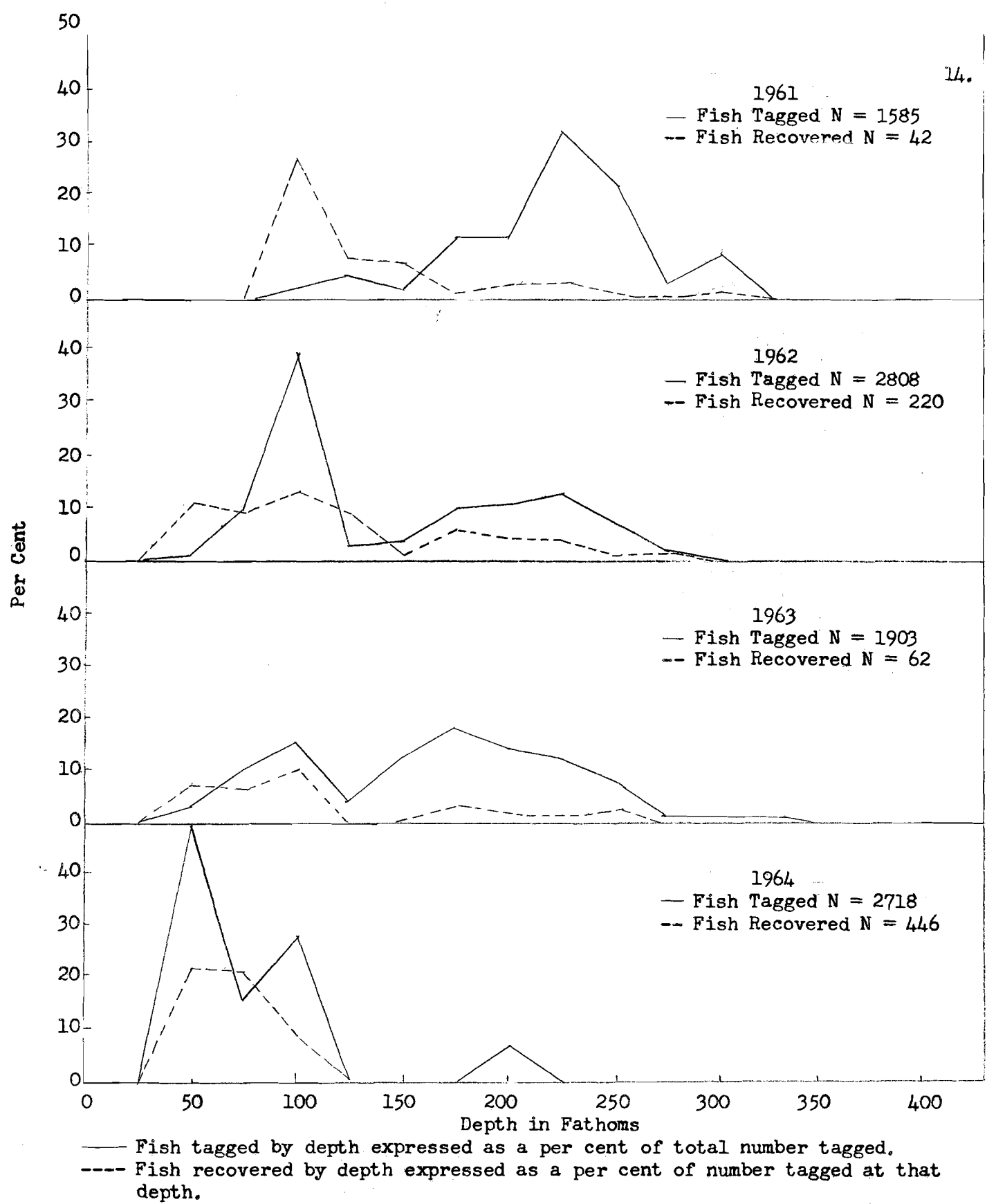


Figure 7. Per cent of Dover sole tagged and recovered by depth of tagging.

Table 4. Dover sole landings in 1961 at Astoria for PMFC areas 2-C (northern half) and 2-D, showing area, month, and depth of catch.
(Landings in thousands of pounds.)

Month & Area	Depth (Fathoms)							Total by Month & Area
	0-30	30-60	60-90	90-120	120-150	150-180	180-230	
January								
2-D	-	1	-	-	-	-	5	6
N. Half 2-C	-	-	-	-	-	-	-	-
February								
2-D	-	-	-	-	-	-	-	-
N. Half 2-C	-	-	-	-	-	-	-	-
March								
2-D	-	5	-	-	1	2	12	20
N. Half 2-C	-	-	-	-	-	-	-	-
April								
2-D	-	30	-	10	8	8	-	56
N. Half 2-C	-	-	-	-	-	-	-	-
May								
2-D	11	114	52	10	4	-	-	191
N. Half 2-C	-	17	11	1	2	-	-	31
June								
2-D	8	152	102	-	-	-	-	262
N. Half 2-C	-	-	9	-	4	-	-	13
July								
2-D	31	91	49	12	-	-	-	183
N. Half 2-C	-	2	-	-	5	-	-	7
August								
2-D	19	59	151	13	10	-	-	252
N. Half 2-C	3	3	-	-	4	-	-	10
September								
2-D	9	92	55	17	17	-	-	190
N. Half 2-C	-	-	17	-	1	-	-	18
October								
2-D	6	96	7	-	-	-	-	109
N. Half 2-C	-	-	-	-	3	-	-	3
November								
2-D	-	80	19	-	1	1	14	115
N. Half 2-C	-	-	-	1	-	-	-	1
December								
2-D	-	-	-	-	-	-	-	-
N. Half 2-C	-	-	-	-	-	-	-	-
TOTAL	87	742	472	64	60	11	31	1,467

Table 5. Dover sole landings in 1962 at Astoria for PMFC areas 2-C (northern half) and 2-D, showing area, month, and depth of catch. (Landings in thousands of pounds.)

Month & Area	Depth (Fathoms)						Total by Month & Area	
	0-30	30-60	60-90	90-120	120-150	150-180		180-230
January								
2-D	-	-	5	-	-	-	12	17
N. Half 2-C	-	-	-	-	-	-	-	-
February								
2-D	-	-	-	-	-	1	-	1
N. Half 2-C	-	-	-	-	-	-	-	-
March								
2-D	-	-	-	3	1	1	20	25
N. Half 2-C	-	-	-	-	-	-	-	-
April								
2-D	-	10	4	2	5	6	-	27
N. Half 2-C	-	-	-	-	4	-	-	4
May								
2-D	28	39	13	42	26	-	-	148
N. Half 2-C	-	2	-	3	2	2	-	9
June								
2-D	5	75	89	23	1	-	-	193
N. Half 2-C	-	5	-	2	14	-	-	21
July								
2-D	18	106	61	16	-	-	-	201
N. Half 2-C	-	9	8	-	2	-	-	19
August								
2-D	27	112	26	9	-	-	-	174
N. Half 2-C	-	-	5	1	1	-	-	7
September								
2-D	26	172	28	17	-	-	-	243
N. Half 2-C	-	-	-	-	1	-	-	1
October								
2-D	1	32	22	16	-	-	-	71
N. Half 2-C	-	-	-	-	-	-	-	-
November								
2-D	-	19	7	-	-	-	-	26
N. Half 2-C	-	-	-	-	-	-	-	-
December								
2-D	-	-	-	-	-	2	-	2
N. Half 2-C	-	-	-	-	-	-	-	-
TOTAL	105	581	268	134	57	12	32	1,189

Table 6. Dover sole landings in 1963 at Astoria for PMFC areas 2-C (northern half) and 2-D, showing area, month, and depth of catch.
(Landings in thousands of pounds.)

Month & Area	Depth (Fathoms)						Total by Month & Area	
	0-30	30-60	60-90	90-120	120-150	150-180		180-230
January								
2-D	-	-	-	1	-	-	33	34
N. Half 2-C	-	-	-	-	-	-	-	-
February								
2-D	-	-	-	-	-	-	1	1
N. Half 2-C	-	-	-	-	-	-	-	-
March								
2-D	-	2	-	-	-	-	-	2
N. Half 2-C	-	-	1	-	-	2	-	3
April								
2-D	1	17	-	2	1	4	6	31
N. Half 2-C	-	-	-	-	2	-	-	2
May								
2-D	8	91	54	8	-	-	1	162
N. Half 2-C	-	3	-	-	4	-	-	7
June								
2-D	10	94	85	33	-	3	-	225
N. Half 2-C	-	2	-	-	-	-	-	2
July								
2-D	15	216	42	2	-	-	-	275
N. Half 2-C	-	2	1	1	-	-	-	4
August								
2-D	14	224	230	28	-	-	-	496
N. Half 2-C	-	-	-	4	3	-	-	7
September								
2-D	4	223	25	23	4	-	8	287
N. Half 2-C	2	-	-	-	8	-	-	10
October								
2-D	2	74	20	16	-	-	8	120
N. Half 2-C	-	-	-	-	-	-	-	-
November								
2-D	-	1	-	-	-	-	16	17
N. Half 2-C	-	-	-	-	-	-	-	-
December								
2-D	-	1	-	-	-	-	29	30
N. Half 2-C	-	-	-	-	-	-	-	-
TOTAL	56	950	458	118	22	9	102	1,715

Table 7. Recoveries of tagged Dover sole by depth and month, 1961 through 1965.

Depth in Fathoms	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	
													Number	Per Cent
0-25	-	-	-	-	3	-	5	9	2	1	-	-	20	2.7
25-50	-	-	-	-	4	24	63	25	48	24	3	-	191	25.5
50-75	-	-	-	1	28	92	66	71	70	32	2	1	363	48.4
75-100	-	-	-	-	12	26	9	6	9	4	4	-	70	9.3
100-125	-	-	1	4	13	25	8	5	8	12	-	-	76	10.1
125-150	-	-	-	3	5	2	1	1	-	-	-	-	12	1.6
150-175	-	-	3	-	-	1	-	-	-	-	-	-	4	0.5
175-200	-	-	-	2	-	-	-	-	-	-	-	-	2	0.3
200-225	-	-	3	2	-	-	-	-	-	-	3	3	11	1.5
225-250	1	-	-	-	-	-	-	-	-	-	-	-	1	0.1
TOTAL NO.	1	0	7	12	65	170	152	117	137	73	12	4	750	
%	0.1	0	0.9	1.6	8.7	22.7	20.3	15.6	18.3	9.7	1.6	0.5		
Unknown													20	
GRAND TOTAL													770	

those fish tagged in deep water should become available to the fishery. Only 2.3% of the 4,540 fish released at depths over 100 fathoms has been recovered. Of the 4,473 fish tagged in 100 fathoms or less, 14.5% has been recovered. What are the reasons for this differential availability?

Length-frequency distributions by year of the tagged fish are shown in Figure 8. Although the distributions show small variations from year to year, they are very comparable. The 1961 fish, which were tagged from 100 to 400 fathoms, have a larger modal size than the 1964 fish, which were mostly tagged at less than 100 fathoms. Fish tagged during 1962 and 1963 were from both shallow and deep areas.

A composite picture of the length-frequency distributions of all tagged fish and per cent recovered by centimeter group is shown in Figure 9. The per cent recovered increases to a high at 42 centimeters after which fluctuations in the recovery rate are probably caused by the small numbers of fish tagged. It is apparent that smaller Dover sole have less chance of being recovered and that the length-frequency distribution of each group of tagged fish has some influence on the per cent recovered. However, fish tagged in deep water (100-400 fathoms, 1961 data, Figure 8) are of similar or larger size than fish tagged in shallow water (50-75 fathoms, 1964 data, Figure 8).

Since Dover sole cannot be sexed externally, the sex ratios of tagged fish are unavailable. However, on several occasions, fish left over after tagging had ceased were sexed. Figures 10 and 11 show the average size by depth and sex of fish that were not tagged. If we assume that the untagged fish are of the same size and sex composition as tagged fish, then a definite increase in average size as depth increases is shown. Therefore, the difference in availability cannot be explained by a size differential.

The per cent of males occurring in these samples is shown graphically by depth in Figure 12. The percentage of fish tagged by depth is also shown.

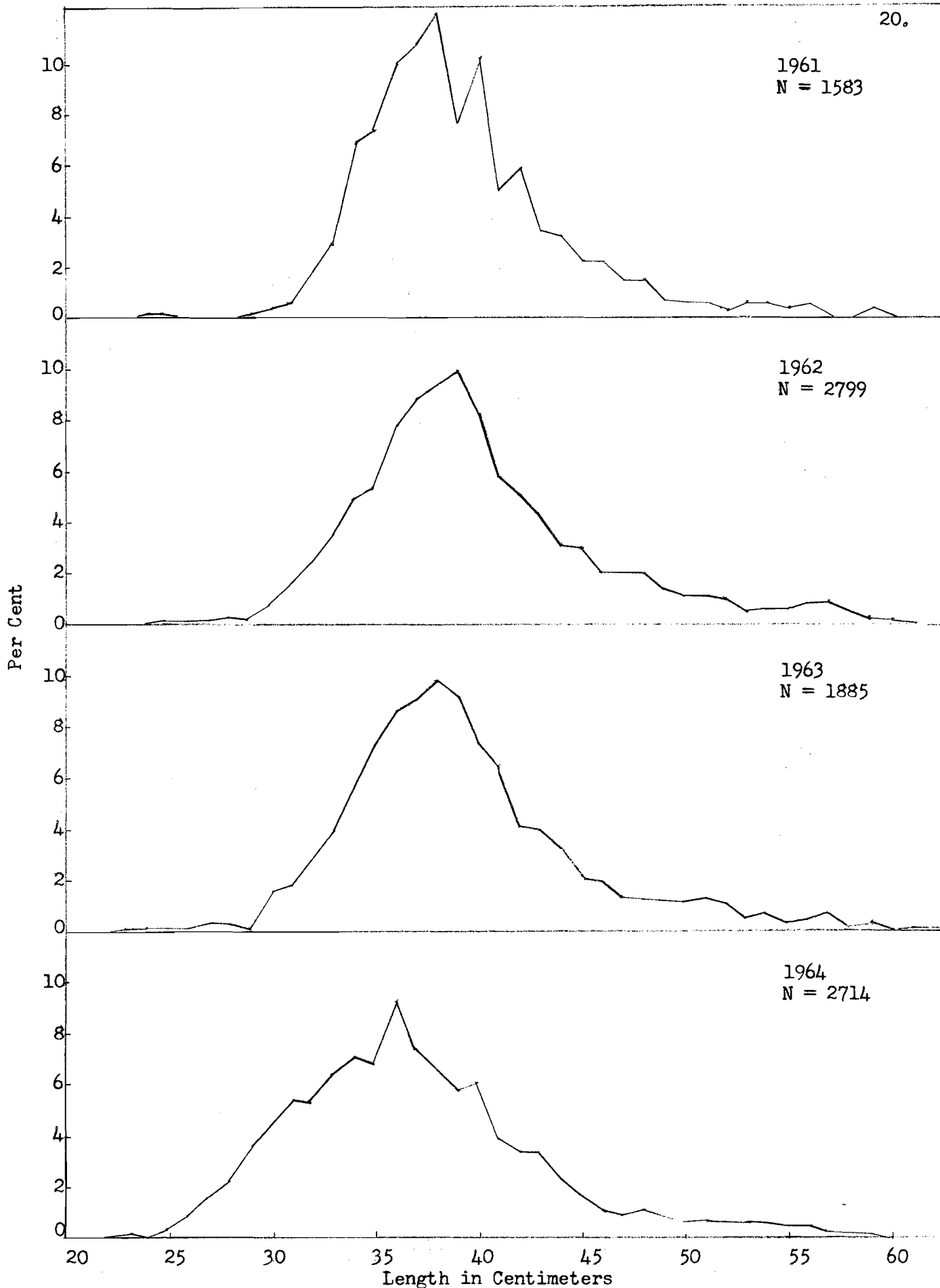


Figure 8. Length-frequency distribution of tagged Dover sole by year of tagging.

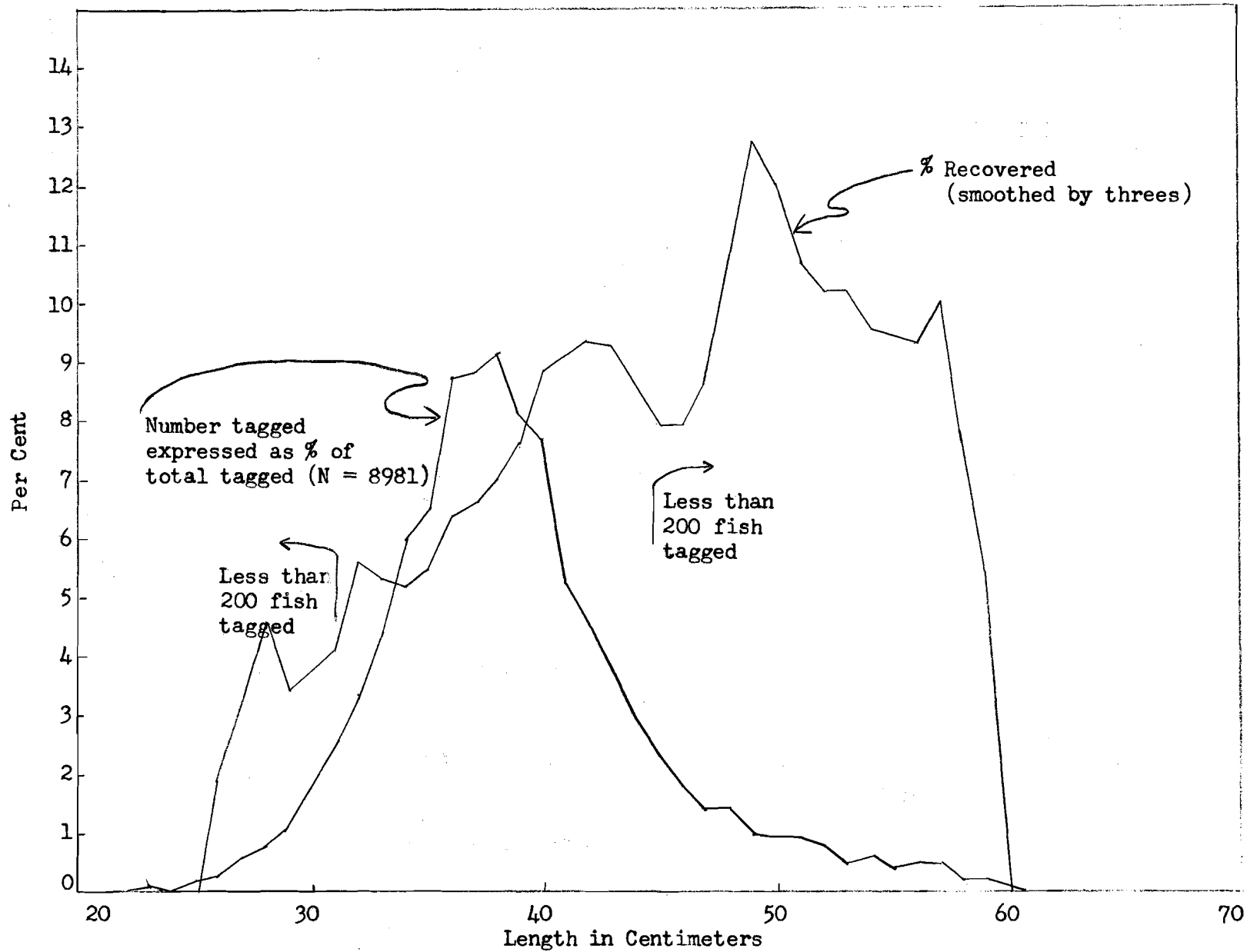


Figure 9. Length-frequency distribution of tagged Dover sole and per cent recovered by centimeter groups through 1965.

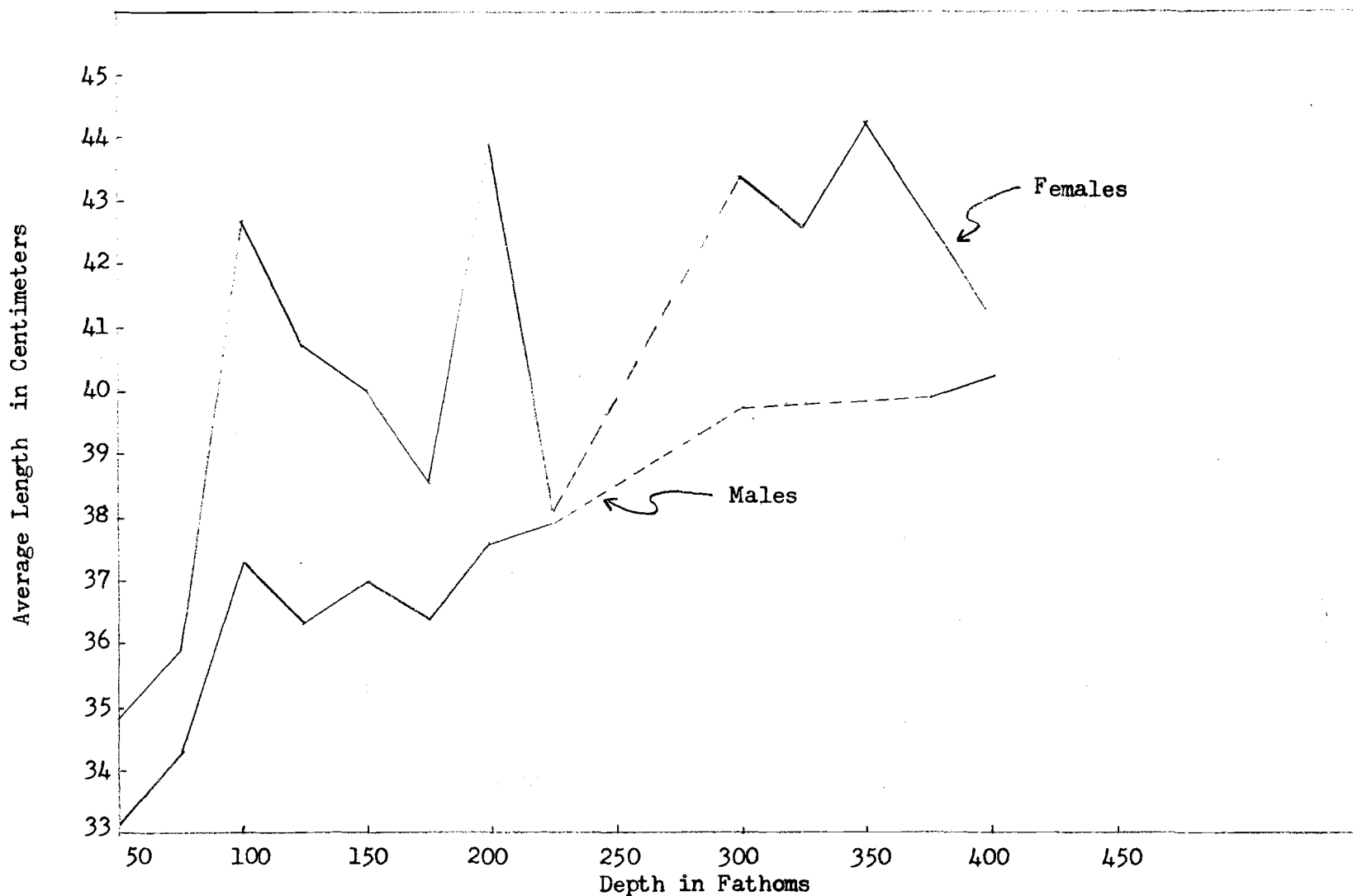


Figure 10. Average size by sex of Dover sole by 25-fathom depth intervals, August 26 - September 1, 1962 and August 19 - September 6, 1963 samples combined.

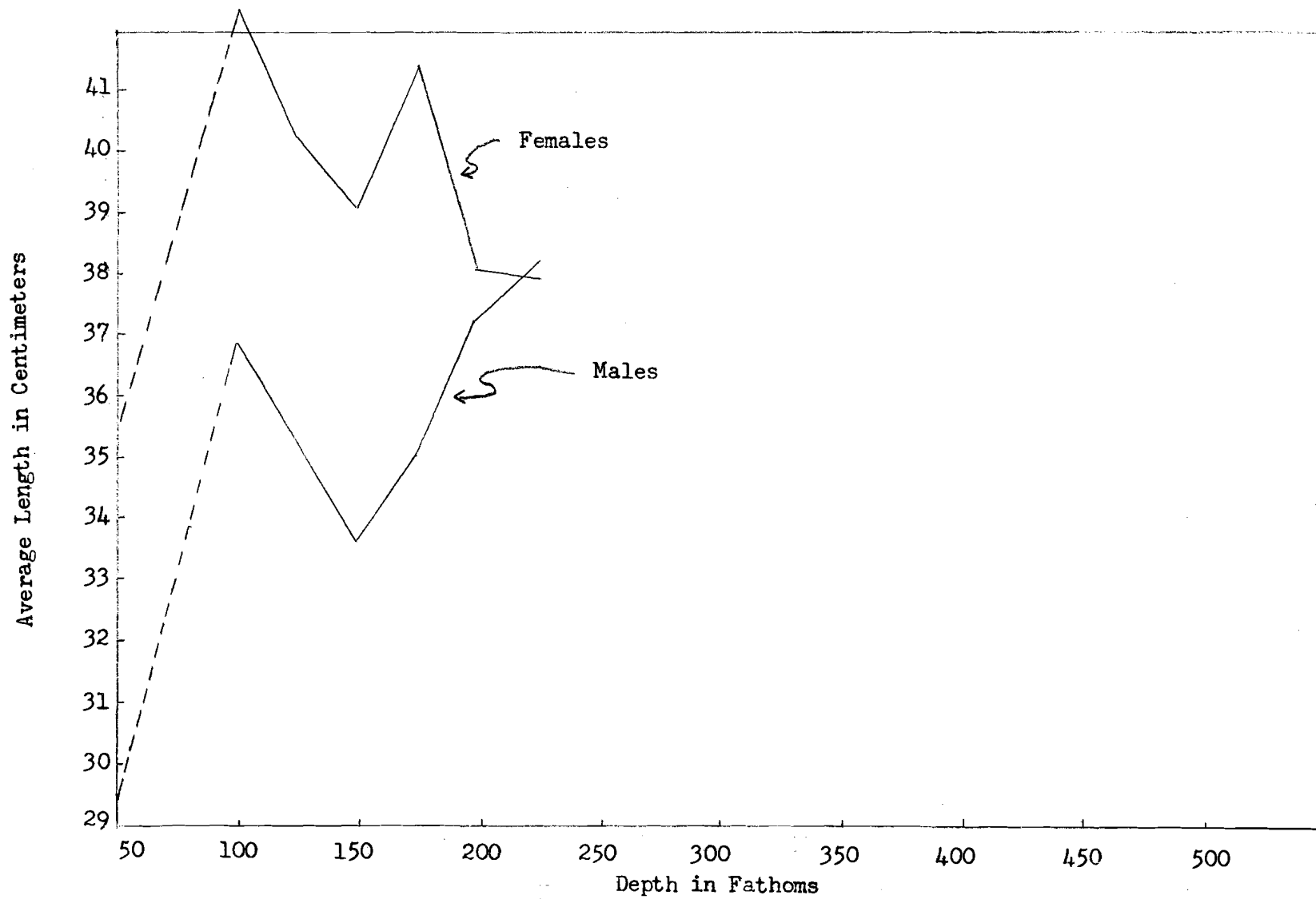


Figure 11. Average size by sex of Dover sole by 25-fathom depth intervals, May 4-19, 1963 and May 12-19, 1964 samples combined.

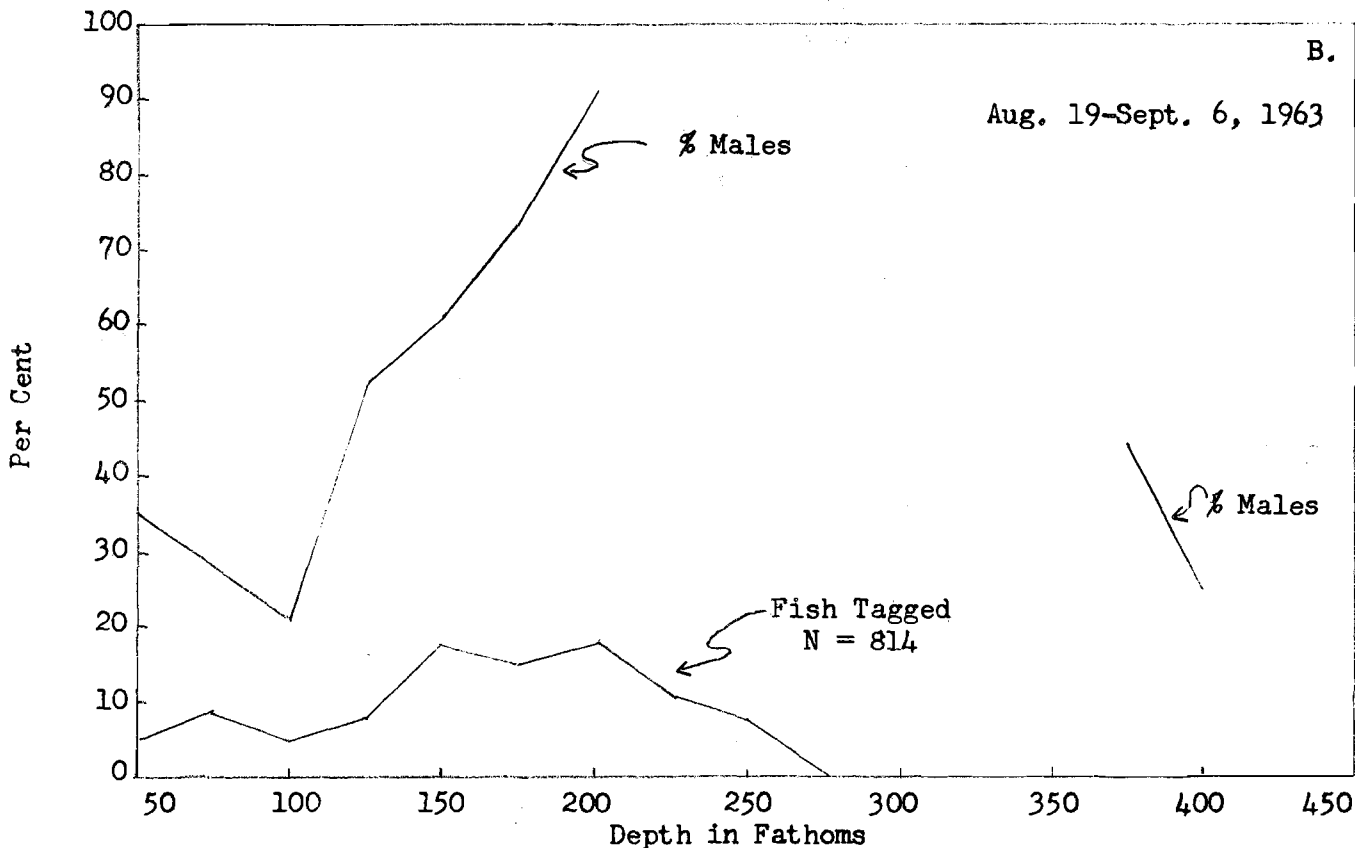
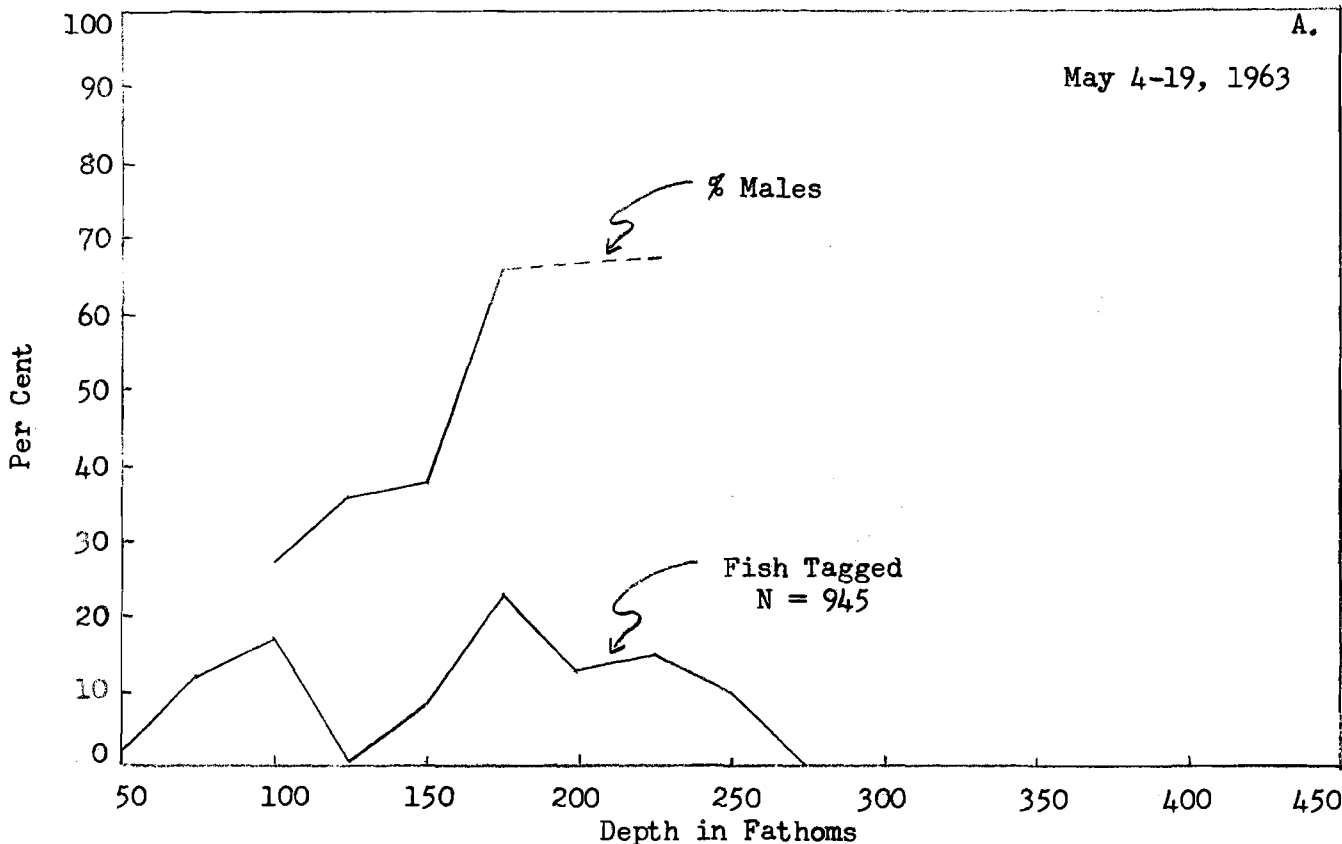


Figure 12. Number of Dover sole tagged by 25-fathom depth intervals and per cent of males occurring in untagged samples for periods (A) May 4-19, 1963; (B) Aug. 19-Sept. 6, 1963; (C) Nov. 2-3, 1962; and (D) May 12-19, 1964.

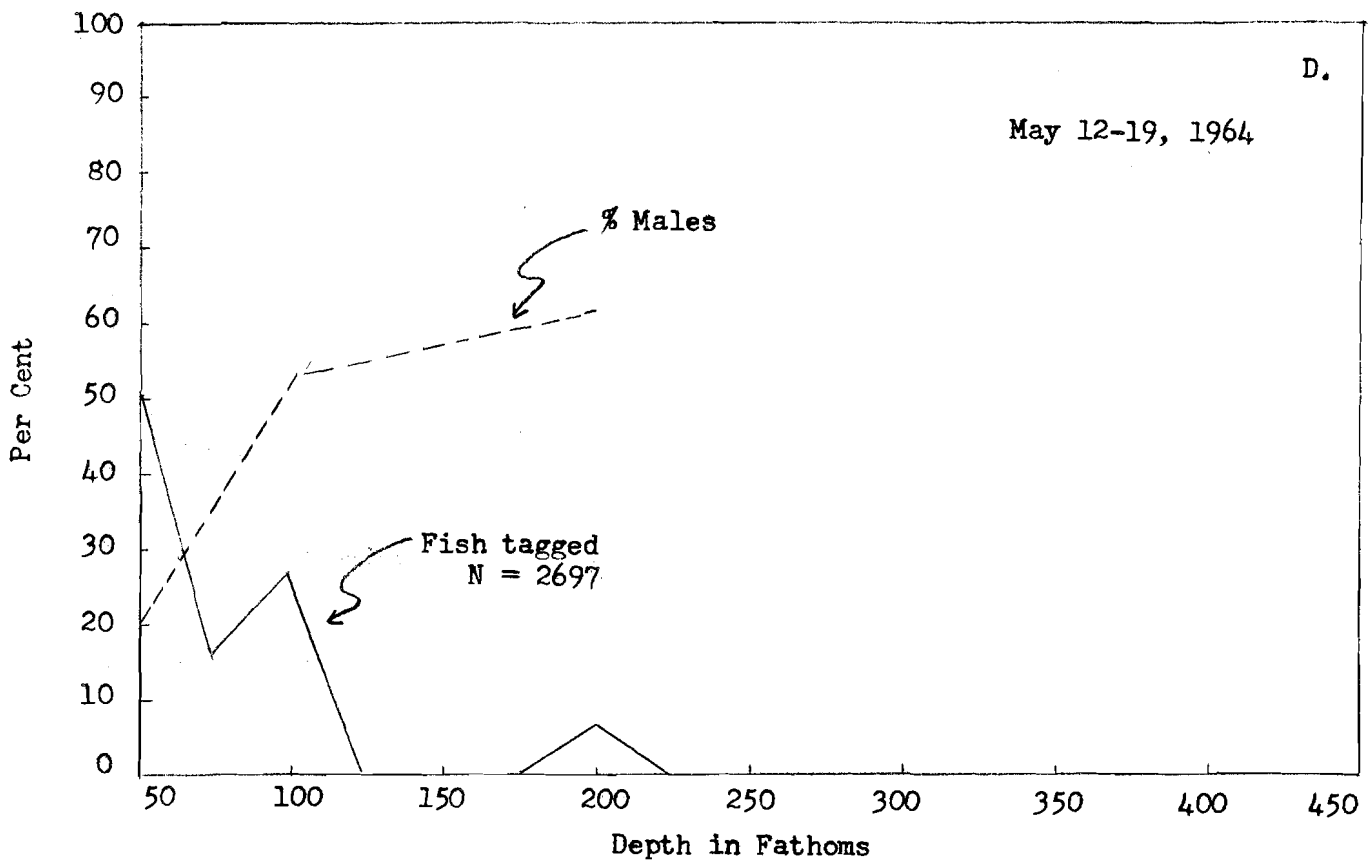
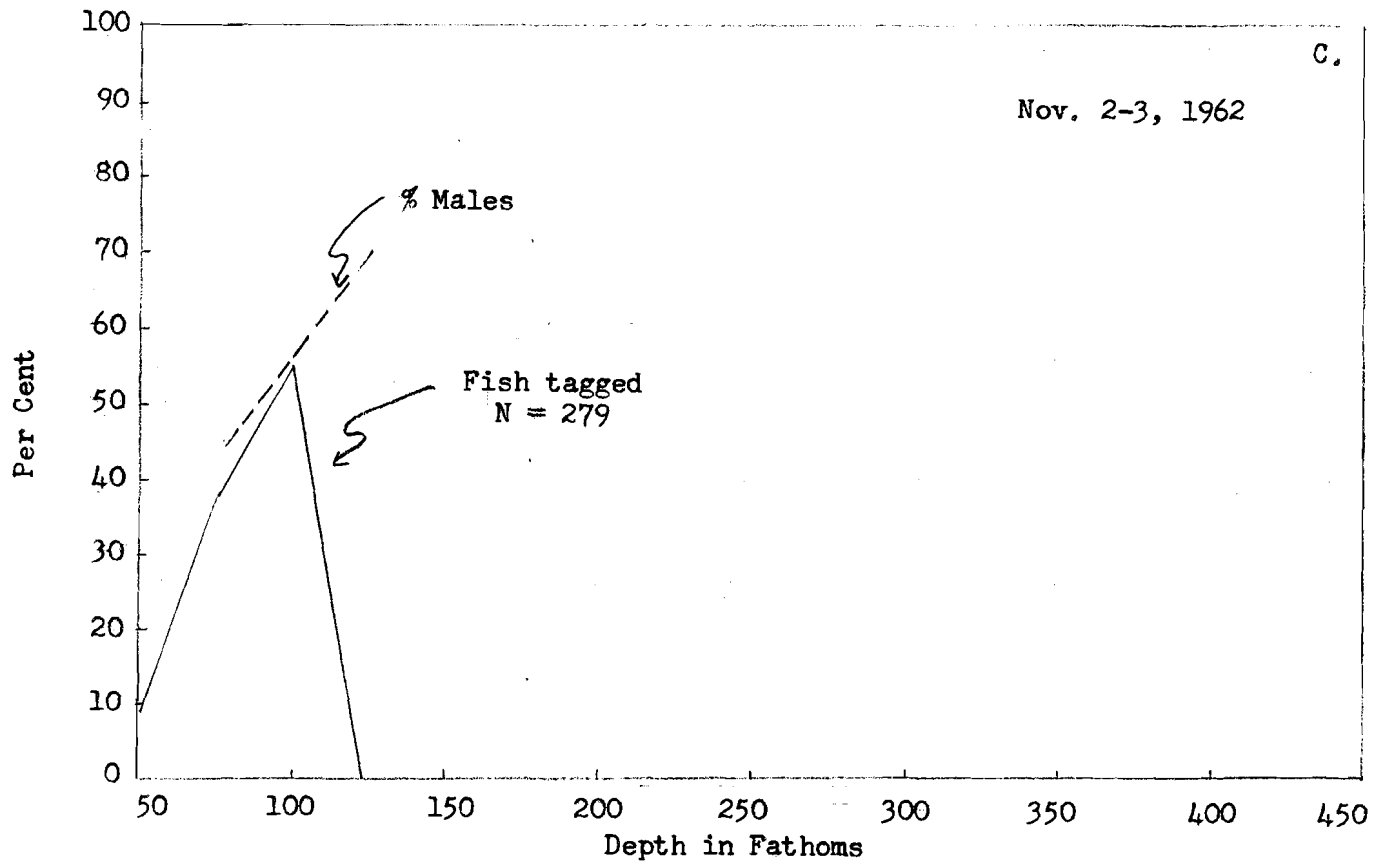


Figure 12 continued.

No sex ratios were taken during the 1961 tagging cruises. One trip was sampled during 1962 with approximately 10% of the total fish tagged during 1962 being tagged on this trip. Samples were taken during 1963 and 1964 from trips representing over 90% of the total fish tagged for each year. Except for the two samples taken at 375 and 400 fathoms, during August and September 1963, the per cent of males shows a definite increase beyond 100 fathoms. Hagerman (1952) reported that during the summer males comprised most of the catch from deep water.

It is apparent that those fish tagged in deep water during 1963 were mostly males (Figure 12 A and B). The fact that the recovery rate for deep water returns was low would suggest that most of the males do not migrate into the inshore areas of high fishing intensity. Further evidence of this is found in the sex ratios of the recoveries as shown in Table 8. Although more males were tagged in 1963,

Table 8. Tag recoveries by sex and year tagged.

Year tagged	Males recovered	Females recovered	Unknown	Total
1961	17	14	11	42
1962	66	122	32	220
1963	16	40	6	62
1964	87	290	69	446
TOTAL	186	466	118	770

over twice as many females were recovered.

Although the sex composition of the 1961 tagged fish is unknown, it is probable that the per cent of males was higher than in 1963. All of the 1961 tagging was done at 100 fathoms or more, and most at 200 fathoms or greater. Data presented in Figure 12 and the findings of Hagerman (1952) would suggest that mostly males are found at those depths where most of the tagging took place.

It is interesting to note that more males than females were returned from the 1961 releases (Table 8). From this indirect evidence, we can surmise that the 1961 tagged fish were mostly males and, as evidenced by the recovery rate, most of the males did not migrate inshore. Unfortunately, no direct evidence is available.

These findings agree with those of Hagerman (1952) and Westrheim and Morgan (1962) who reported that most of the males probably did not migrate onto the inshore grounds.

The 1962 and 1964 tagged fish and recoveries present somewhat different pictures. Very little sex ratio data are available for the 1962 tagged fish, but approximately 50% of the fish were tagged at 100 fathoms or less with most of the remaining fish tagged between 150 and 275 fathoms. If we assume, as suggested by the 1963 data, that the inshore fish were mostly females and the offshore fish mostly males, then the recovery pattern shown in Figure 6 is again explained by the lack of male migration to inshore areas. Approximately 50% of the fish tagged during 1964 were released at 50 fathoms and over 90% were released in 100 fathoms or less. As shown in Figure 12 D, most of the fish were females. The recovery rate from these has been very good.

Catch-per-effort data by depth (Figure 13) from tows made within the tagging area during the early and late summer of 1961-63 show two concentrations of Dover sole (Heyamoto and Pereyra, 1962; Heyamoto, Pereyra, and Alton, 1964). Although the available sex ratio data for 1961 and 1962 are inadequate for determining the composition of these concentrations, the 1963 data (Figure 12 A and B) show that the inshore concentration was mostly females and the offshore concentration was largely males.

Sablefish

Of the 4,647 sablefish tagged over a three-year period (Table 2), only 19 have been returned. The recoveries by year of tagging are shown in Table 9.

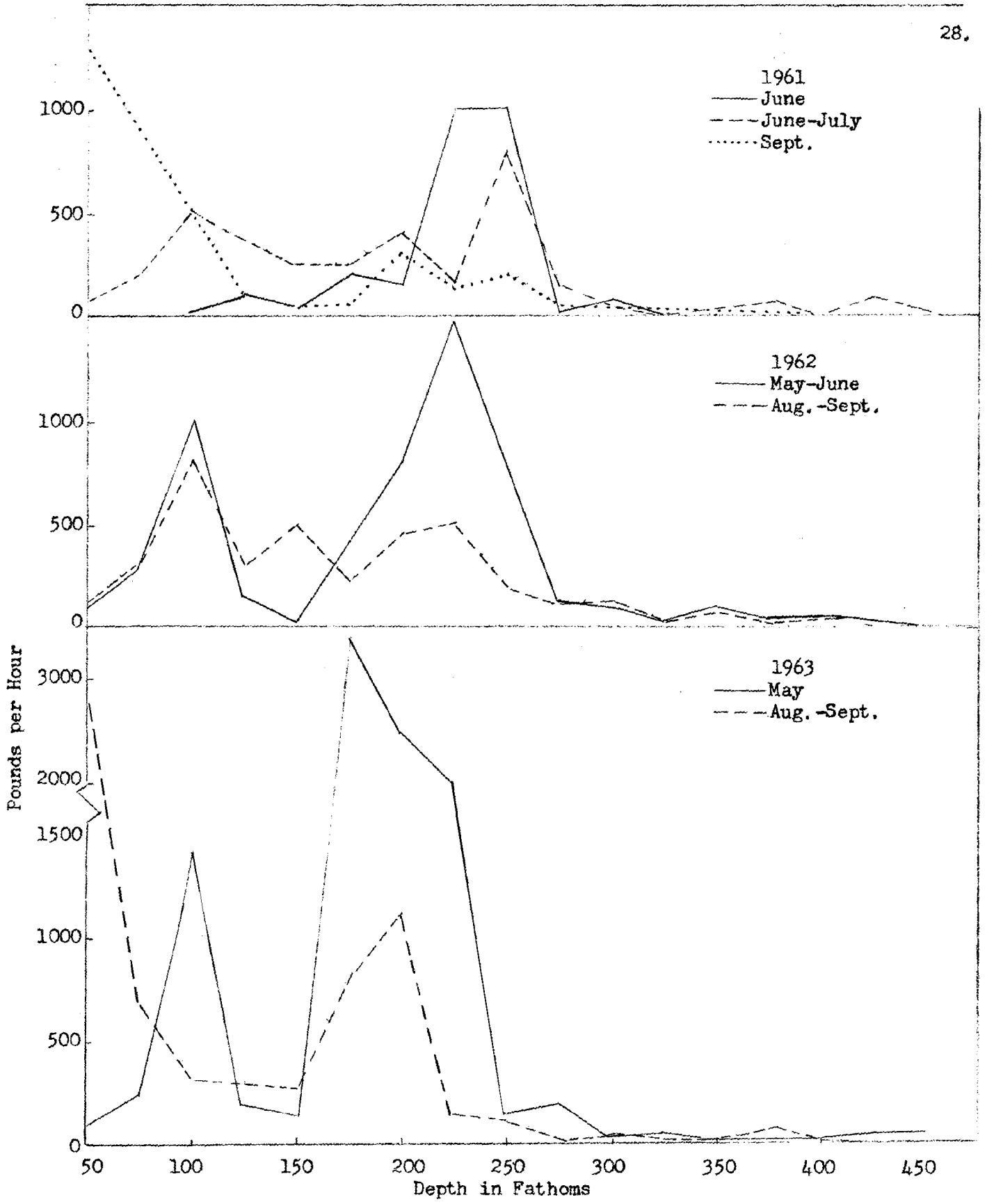


Figure 13. Dover sole catch-per-hour by 25-fathom depth intervals for 1961-63. (From Heyamoto and Pereyra, 1962; Heyamoto, Pereyra, and Alton, 1964).

Table 9. Numbers of sablefish tagged and recovered by year of tagging and recovery.

Year of tagging	Number tagged	Recoveries by year					Total	% of Tags recovered
		1961	1962	1963	1964	1965		
1961	-							
1962	1,413		1	2			3	0.2
1963	2,914			9	2	4	15	0.5
1964	320				1	-	1	0.3
TOTAL	4,647		1	11	3	4	19	0.4

The movements of sablefish have varied greatly. Of the 17 returns from which recovery data are known, five have moved more than 25 miles from the area of tagging; one went 120 miles north in four months; two went approximately 75 miles south; and two others went 275 miles south. The recovery rate of 0.4% is inadequate to draw any general conclusions regarding movements.

Sablefish tagging studies conducted in Washington, Oregon and California in 1950 and 1951 produced relatively low recoveries. The recovery rates for each state, approximately two years after initiation of the studies, were as follows: California 3.2%; Washington 2.9%; and Oregon 1.5% (Holmberg and Jones, 1954). At that time, the Oregon fishery was operating at a low level.

The low number of recoveries can probably be attributed to several factors, but the major reason appears to be the lack of fishing effort in the deeper waters where most of the marketable sablefish are found. No recoveries have been made from the minor Oregon long-line fishery. Most of the fish recovered have been those caught incidentally in the trawl catches. Since most of the larger sablefish are found at depths from 250 to 450 fathoms, the fish are not sought by local trawl fishermen at the present time.

A complete presentation and discussion of the distribution, abundance, and

size of sablefish found in deep water off the mouth of the Columbia River has been published by Heyamoto and Alton (1965).

SUMMARY

A cooperative study was initiated in June 1961 by the Atomic Energy Commission, Bureau of Commercial Fisheries, and Oregon Fish Commission to determine the offshore-inshore movements of Dover sole and sablefish.

During the period from June 1961 to May 1964, 9,013 Dover sole and 4,647 sablefish were tagged and released at approximately 25-fathom intervals from 50 to 450 fathoms in a 35-mile-long area southwest of the Columbia River.

Tagged fish were brought in as part of the catch of the commercial trawlers. Returns of tagged Dover sole show a northeasterly and inshore movement during the late spring and early summer. An opposite movement to offshore areas is shown during the late fall and early winter.

A higher recovery rate was found for Dover sole tagged in shallow water than for those tagged in deeper areas. Two factors appear to explain this differential recovery rate: (1) the fishery is most intense in the shallow areas during the summer; and (2) most of the deep-water tagged fish were males and the males do not move as far inshore as do the females. No difference in availability of deep-water tagged fish and those tagged in shallow water could be attributed to size.

Of the 4,647 sablefish tagged, only 19 were returned. The recovery rate is inadequate to draw any general conclusions regarding movements. The low number of recoveries can probably be attributed to several factors, but the major reason appears to be the lack of fishing effort in the deeper waters where most of the marketable sablefish are found.

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