

# IDENTIFICATION OF NEW ENGLAND YELLOWTAIL FLOUNDER GROUPS

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## ABSTRACT

Data from yellowtail flounder marking experiments, fin ray counts, and the incidence of infestation by trematode parasites are reported. A distinguishable, although not completely discrete, group of yellowtail

was recognized on each of three adjoining New England grounds: a southern New England group, a Cape Cod group, and a Georges Bank group.

A study of the subpopulations of the commercially important yellowtail flounder, *Limanda ferruginea*, was undertaken to identify clearly the exploited yellowtail groups found off New England. Data from marking experiments, fin ray counts, and the incidence of infestation by trematode parasites were used for the purpose. Results of this study are reported here.

Fisheries workers have sometimes applied different meanings to terms that are commonly used to identify fractions of fish populations. To avoid misunderstanding, the terms used in this paper are therefore defined here. Definitions for "population" and "group" given by Marr (1957) are:

**Population.**—A population of fish includes all individuals of a given species when there are no subspecies or, if there are subspecies when their distributions are not discrete.

**Group.**—A group is a fraction of a population with distinctive characteristics, the nature of which (phenotypic or genotypic) has not been determined.

Under these definitions, yellowtail found off New England are members of the same population since there are no recognized subspecies. Yellowtail groups are the presently distinguishable parts of this population.

## YELLOWTAIL FLOUNDER FISHERY

Large-scale exploitation of yellowtail began in the 1930's. Annual United States landings rose to a peak of 70 million pounds in 1942 and then declined to a low of 12 million pounds in 1954. In more recent years landings have averaged about 30 million pounds. About 70 percent of the catch is landed at New Bedford, Mass., with other southern New England ports accounting for a large part of the remainder.

Royce, et al. (1959) defined three principal yellowtail fishing grounds fished by United States vessels (fig. 1). The southern New England ground covers the area from off eastern Long Island to south of Nantucket Island (statistical subareas XXII O, Q, R, S, and area XXIII). The Georges Bank ground is the large shoal ground east of the southern New England ground (subareas XXII H, J, M, and N). The Cape Cod ground, the least important of the major grounds in terms of catch, is found off the tip of Cape Cod and extends northward along the Massachusetts coast (subareas XXII E, and G).

## MARKING EXPERIMENTS

In the years 1942-49 Royce, et al. (1959) marked 2,597 fish in 14 different lots on the three principal fishing grounds. They obtained 377 recoveries. Movements were generally found to be within the grounds, but there was also some

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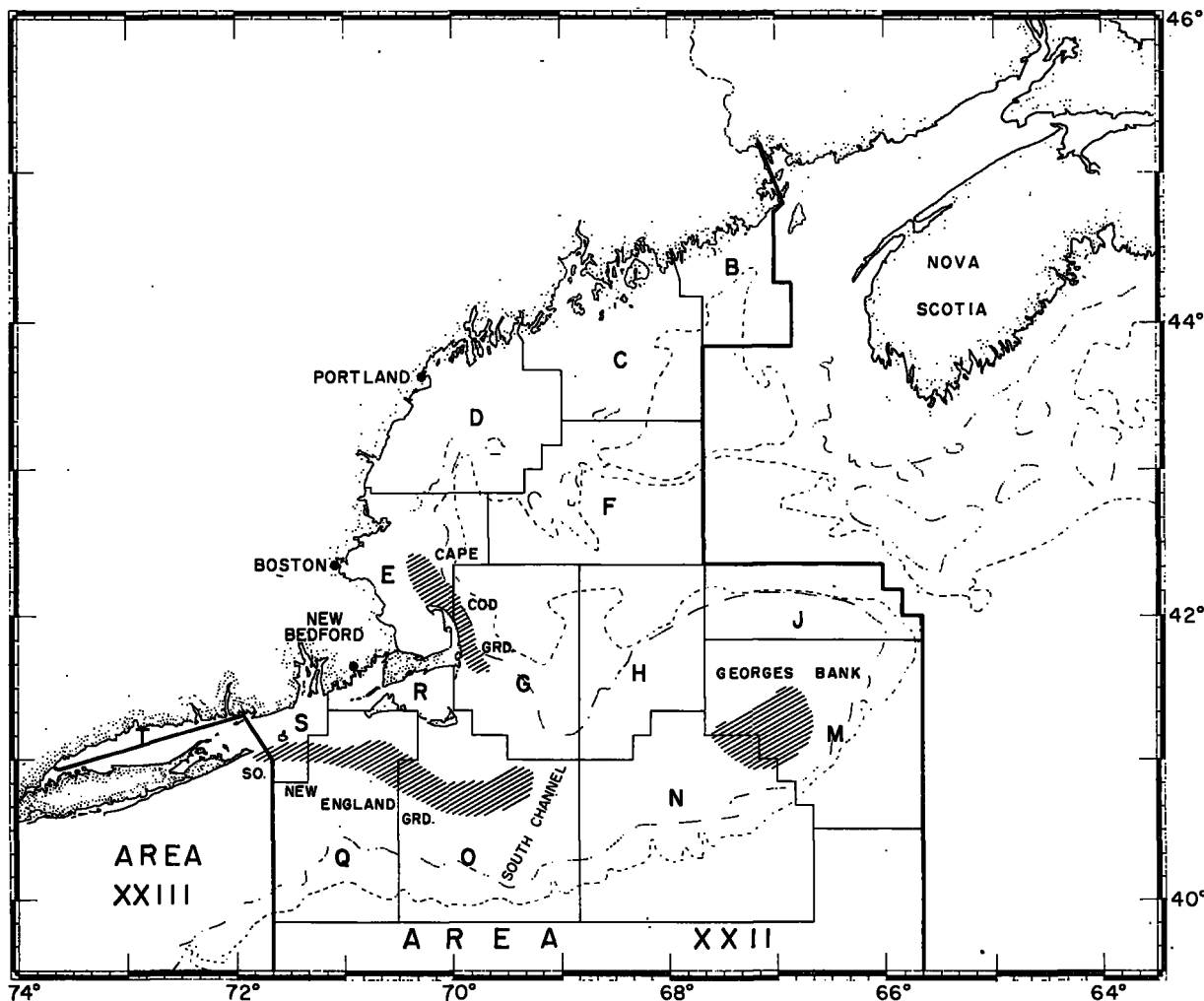


FIGURE 1.—Chart of the New England fishing areas showing the three principal grounds where yellowtail flounder are caught. Depth contours are for 50 and 100 fathoms. Statistical areas are those adopted by the North American Council on Fishery Investigations (Rounsefell, 1948).

interchange of fish between the grounds. From these results and the distribution of fishing effort, they concluded that yellowtail flounder on each of the fishing grounds were relatively separate, but that there was some intermingling between groups.

In this study 1,800 yellowtail in 12 lots were tagged and released on the three principal grounds to obtain further information on yellowtail movements and the degree of separation of fish on these grounds (table 1). There were 431 recoveries from these lots.

Recapture locations obtained from the fishermen usually were given in the form of Loran bearings for the general area of fishing operations. These

locations and areas where tagged fish were released are reported in table 1 by subarea, using statistical subareas (fig. 1).

#### METHODS

The fish, aside from lots 7 and 8, were tagged from catches of commercial otter trawlers. Lots 7 and 8 were tagged from research vessel catches. A plastic Petersen disk,  $\frac{1}{16}$  inch in diameter, was attached to each side of the nape of the fish with a stainless steel pin pushed through the nape. One disk carried a serial number; the other, instructions to the finder. Sex of each fish and its total length in millimeters were recorded at time of tagging. Sex was determined by holding the

fish before a light. The ovaries extend posteriorly from the intestinal cavity along the ventral interhaemal spines and appear as a dark area. Since

there is only a very slight posterior extension of the testes, no dark area is apparent in this region of males.

TABLE 1.—Areas of tagging, dates of tagging, numbers tagged, and numbers recaptured, by area and calendar quarter following tagging, for 1955 and 1957 yellowtail flounder marking experiments

[Capital letters indicate statistical subareas]

Period of recovery	Number of fish recaptured in area											Unknown	Total		
	XXII														
	E	G	H	J	M	N	O	Q	R	S	XXIII				
Lot No. 1: 1 fish tagged April 8, 1955, XXII Q															
July-September 1956						1									1
Total						1									1
Lot No. 2: 93 fish tagged April 21, 1955, XXII S															
April-June 1955										3			4	7	
July-September 1955					1								1	1	
October-December 1955							1	2					1	4	
January-March 1956									2					2	
April-June 1956							1							1	
October-December 1956								1		1			1	3	
January-March 1957													1	1	
April-June 1957							1							1	
July-September 1957													1	1	
October-December 1957									1				1	1	
Total					1		3	4		6			8	22	
Lot No. 3: 25 fish tagged April 28, 1955, XXII Q															
April-June 1956													1	1	
July-September 1956	1													1	
January-March 1957								1						1	
Total	1							1					1	3	
Lot No. 4: 27 fish tagged May 9, 1955, XXII S															
May-June 1955										3				3	
October-December 1955								1						1	
July-September 1956		1												1	
October-December 1956													1	1	
Total		1						1		3			1	6	
Lot No. 5: 126 fish tagged June 22-24, 1955, XXII O															
June 1955							1							1	
July-September 1955							1							1	
October-December 1955					2		3	4					3	12	
January-March 1956								2				2	2	6	
April-June 1956							1			1			2	4	
October-December 1956							2						1	3	
January-March 1957							1	1						2	
July-September 1957													1	1	
October-December 1957							2	1						3	
January-March 1958													1	1	
October-December 1958							1							1	
Total					2		12	8		1	2		10	36	
Lot No. 6: 24 fish tagged July 23-26, 1955, XXII S. (No recaptures reported.)															
Lot No. 7: 7 fish tagged February 14, 1957, XXII Q															
July-September 1957								1					1	2	
October-December 1957													1	1	
July-September 1958					1									1	
April-June 1959									1				1	1	
January-March 1960														1	
Total					1			1	1				3	6	

TABLE 1.—Areas of tagging, dates of tagging, numbers tagged, and numbers recaptured, by area and calendar quarter following tagging, for 1955 and 1957 yellowtail flounder marking experiments—Continued

[Capital letters indicate statistical subareas]

Period of recovery	Number of fish recaptured in area											Unknown	Total		
	XXII														
	E	G	H	J	M	N	O	Q	R	S	XXIII				
Lot No. 8: 45 fish tagged February 26, 1957, XXII S															
July-September 1957					2		1	1							4
October-December 1957							3	1							4
January-March 1958								3							3
April-June 1958							1								1
July-September 1958					2										2
October-December 1958							1								1
January-March 1959							1								1
April-June 1959							1								1
July-September 1959							1								1
January-March 1960							1								1
Total					4		9	5							18
Lot No. 9: 447 fish tagged April 4 and April 12, 1957, XXII S															
April-June 1957		1						6		13					20
July-September 1957							7	5						1	13
October-December 1957		1					10	2							13
January-March 1958								1		4	8				13
April-June 1958								6	1	3				1	11
July-September 1958							2								2
October-December 1958					1		4	1		1					7
January-March 1959							4	2						1	3
April-June 1959								2							2
July-September 1959		1						2							1
October-December 1959								2							2
April-June 1960										1					1
Total		3			1		25	25	1	22	8		3		88
Lot No. 10: 547 fish tagged May 1-4, 1957, XXII G															
May-June 1957	3	79												4	86
July-September 1957	11	4													15
October-December 1957	4	5												3	12
January-March 1958	6														6
January-March 1960		1													1
Total	24	89												7	120
Lot No. 11: 28 fish tagged May 5, 1957, XXII G															
May-June 1957		6												1	1
July-September 1957		1													1
October-December 1957		1													1
July-September 1958														1	1
Total		8												2	10
Lot No. 12: 430 fish tagged August 21-23, 1957, XXII M															
August-September 1957				1	31									3	35
October-December 1957				1	12									2	15
January-March 1958					2			2		1					5
April-June 1958					7										8
July-September 1958				1	37	1								1	40
October-December 1958				1	5		1								8
January-March 1959					1										1
April-June 1959				1											1
July-September 1959					3	3								2	8
Total			2	4	98	5	1	2		1			8		121

Nearly all fish marked on the southern New England and Cape Cod grounds were tagged during the spawning season in the spring. It is therefore probable that relatively pure groups were tagged on those grounds. On Georges Bank, the fish were tagged during August, considerably after

the spawning season, so these fish may not have been of a pure Georges Bank group.

A reward of one dollar was paid for each returned tag, and after May 1958 an additional dollar was paid if the fish was returned with the tag. Most of the recovered tags were recaptured during the

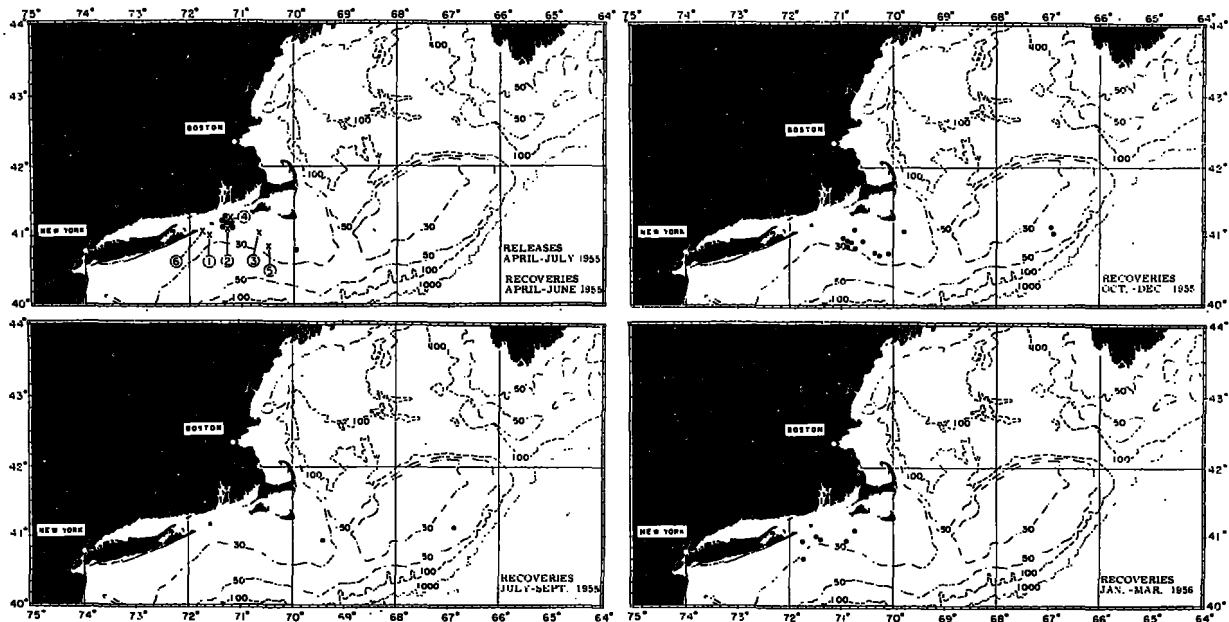


FIGURE 2.—Tagging on the southern New England ground, April–July 1955, lots 1 to 6. (Locations of releases indicated by X's; recoveries, by calendar quarters, indicated by dots.)

first 3 years following the release. All were taken by otter trawlers.

Tags and tagged fish were recovered mostly by fishermen or workers unloading catches, who gave them to Bureau of Commercial Fisheries personnel stationed at ports of landing. Reliable recovery information usually accompanied these returns. Other tags were not found until the fish had reached fillet plants or fish markets. Recovery information for these tags frequently was lacking or was unreliable.

## RESULTS

### Southern New England Ground, 1955

In 1955, 296 yellowtail in 6 lots were tagged and released at the locations shown by X's in the first chart of figure 2. Through August 1960, 68 of the fish, 23 percent of the total tagged, were recaptured (table 1).

Recaptures by calendar quarters for the first year following tagging show the seasonal movement patterns (fig. 2). Spring recoveries (April–June 1955) were mostly from areas of tagging. The two recoveries during the summer months (July–September 1955) showed that some movement to the eastward had occurred. One August recapture had crossed Great South Channel, which separates the southern New England ground from

Georges Bank, and was caught on southeastern Georges Bank, a distance of about 200 miles from release point. Fall recoveries (October–December 1955) were mostly from the middle and eastern parts of the southern New England ground, but two recaptures in October also were from subarea M of Georges Bank. Winter recoveries (January–March 1956) were caught near release points or somewhat to the westward of them.

Where tagged fish were caught depended largely upon the distribution of fishing effort. Effort was low on the southern New England ground in the summer months, and only one recapture was obtained there. In the fall, effort increased greatly, and the number of recoveries went up as well. Fishing effort on Georges Bank was highest during summer and fall months. Fish tagged on the southern New England ground were recaptured on Georges Bank only in these seasons.

The pattern of recoveries for the first year after release indicated that yellowtail moved to the eastward in summer, with three tagged fish being recaptured as far east as Georges Bank, and to the westward in winter months. Recaptures in subsequent years (table 1) suggest that this pattern was repeated. One fish, however, (table 1, lot 3), moved far to the northward to the Cape Cod ground, subarea E. This return was the only indication from these releases of intermingling

between yellowtail from the southern New England and Cape Cod grounds.

#### Southern New England Ground, 1957

In February and April 1957, 499 yellowtail in 3 lots were tagged on the southern New England ground and released at the locations shown by X's in the first chart of figure 3. Through August 1960, 112 of the fish, 22 percent of the total tagged, were recaptured (table 1).

The seasonal distribution of recoveries is shown by calendar quarters during the year following tagging (fig. 3). There were no recaptures in February and March of 1957. Spring recaptures (April-June 1957) were mostly from the release areas, although a number of fish were caught well to the eastward of these points. One recapture was from the Cape Cod ground, subarea G, again indicating that some movement to this ground from southern New England waters takes place. Summer recaptures (July-September 1957) were mostly from the eastern part of the southern New England ground. However, two fish had crossed Great South channel and were caught on Georges Bank, subarea M. Fall recaptures (October-December 1957) were spread over the middle and eastern parts of the southern New England ground. In addition, one fish was recaptured on the southern part of the Cape Cod

ground, subarea G. Winter recaptures (January-March 1958) all were from the western part of the southern New England ground. Several of them were from area XXIII, well to the westward of points where they had been released the preceding spring. Recaptures after the first year at liberty (table 1) showed that the general seasonal pattern of returns described above was repeated.

Here again the locations of recovery were related to the distribution of fishing effort. Effort expended during the summer and fall was mostly on the eastern part of the southern New England ground, where most recaptures were obtained. In the winter and spring, effort was primarily on the western part of the ground, and most tagged fish were caught there in those seasons.

The seasonal distribution of recoveries from lots 7, 8, and 9 indicated that annual migrations occurred which were similar to those shown by the 1955 experiments. The movement patterns were as follows: (1) There was a general movement of fish from the western to the eastern part of the southern New England ground in spring and summer. A few fish had moved as far to the eastward as Georges Bank by late summer and early fall. (2) There was a general movement of fish from the eastern to the western part of the southern New England ground in fall and winter. (3) There was a small amount of movement of southern

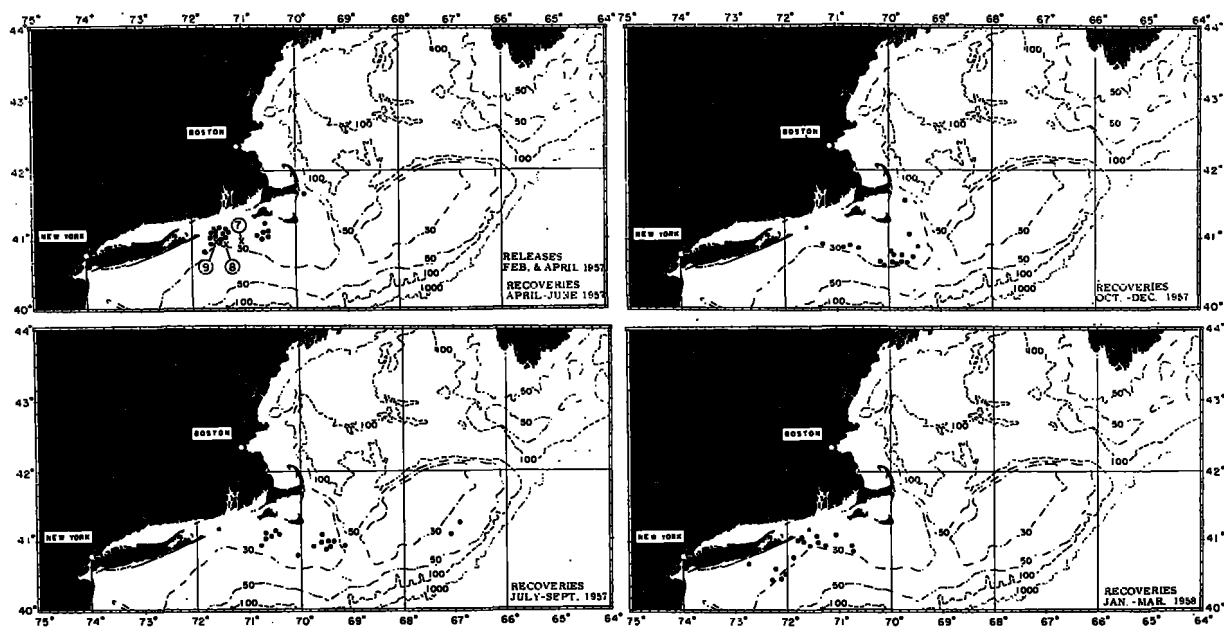


FIGURE 3.—Tagging on the southern New England ground, February and April 1957, lots 7 to 9. (Locations of releases indicated by X's; recoveries, by calendar quarters, indicated by dots.)

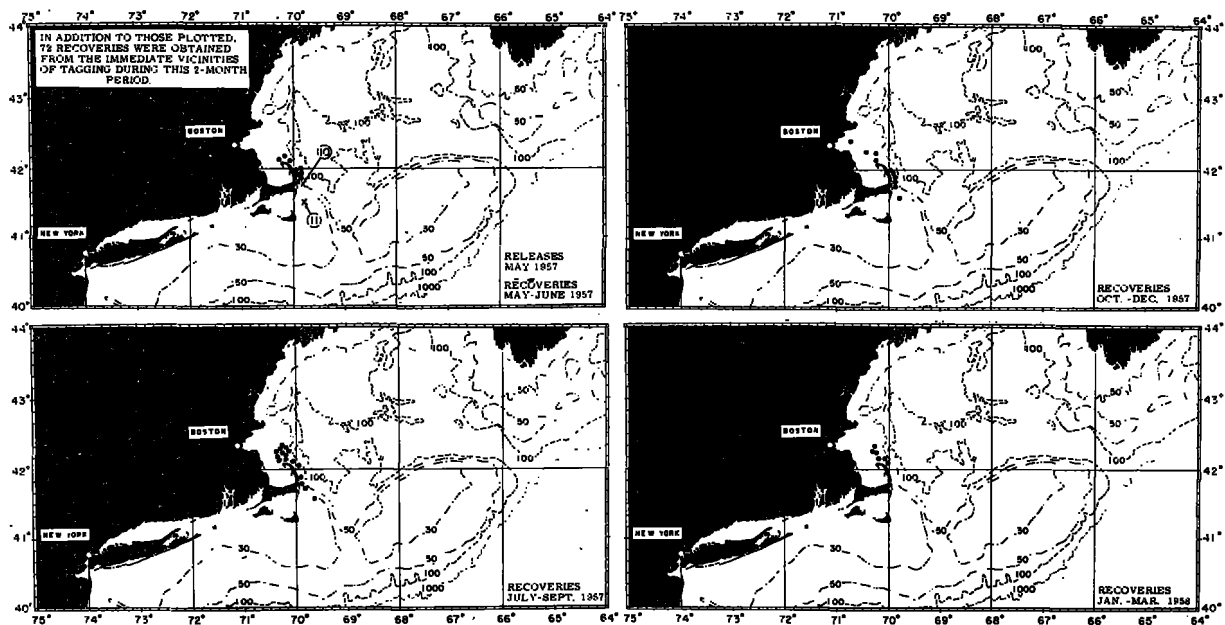


FIGURE 4.—Tagging on the Cape Cod ground, May 1957, lots 10 and 11. (Locations of releases indicated by X's; recoveries, by calendar quarters, indicated by dots.)

New England yellowtail to the southern part of the Cape Cod ground, but the seasonal nature of this movement was not clear.

#### Cape Cod ground, 1957

In May 1957, 575 yellowtail in 2 lots were marked on the Cape Cod ground and released at the locations shown by X's on the first chart of figure 4. Through August 1960, 130 of the fish, 23 percent of the total tagged, were recaptured (table 1).

Recaptures by calendar quarters during the year following tagging show the movement patterns (fig. 4). The numerous spring recaptures (May-June 1957) were mostly from the immediate vicinity of tagging, although some northward movement was indicated. Summer (July-September), fall (October-December), and winter (January-March 1958) recaptures showed further evidence of a northward movement from the release point. Almost no recaptures were obtained from these releases after the first year following tagging (table 1).

The recovery patterns on the Cape Cod ground suggest that a northward dispersal of yellowtail occurred rather than an annual migration. No movement from the Cape Cod ground to either of the other two major grounds was indicated.

#### Georges Bank, 1957

In August 1957, 430 yellowtail were marked on Georges Bank and released at the location indicated by the X on the first chart of figure 5. Through August 1960, 121 of the fish, 28 percent of the total tagged, were recaptured (table 1).

Recapture positions for each calendar quarter in the 16 months following tagging (fig. 5) show the seasonal movements. Summer recaptures (August-September 1957) were mostly from the vicinity of marking, although one fish had moved about 40 miles to the eastward. Fall recaptures (October-December 1957) all were from Georges Bank, with two of the recoveries showing a northward movement on the Bank. Winter recaptures (January-March 1958) showed that some westward movement had occurred. Three of the five fish recaptured in this quarter had moved west across South Channel and were caught on the southern New England ground, about 200 miles west of the point of release. Spring recaptures (April-June 1958) were widely scattered about the vicinity of tagging. Summer recaptures (July-September 1958) were tightly clustered around this area. The pattern of fall recaptures (October-December 1958) was similar to that of the preceding fall, with scattered returns from over the Bank. One fall recapture, however, was from the eastern part of the southern New England

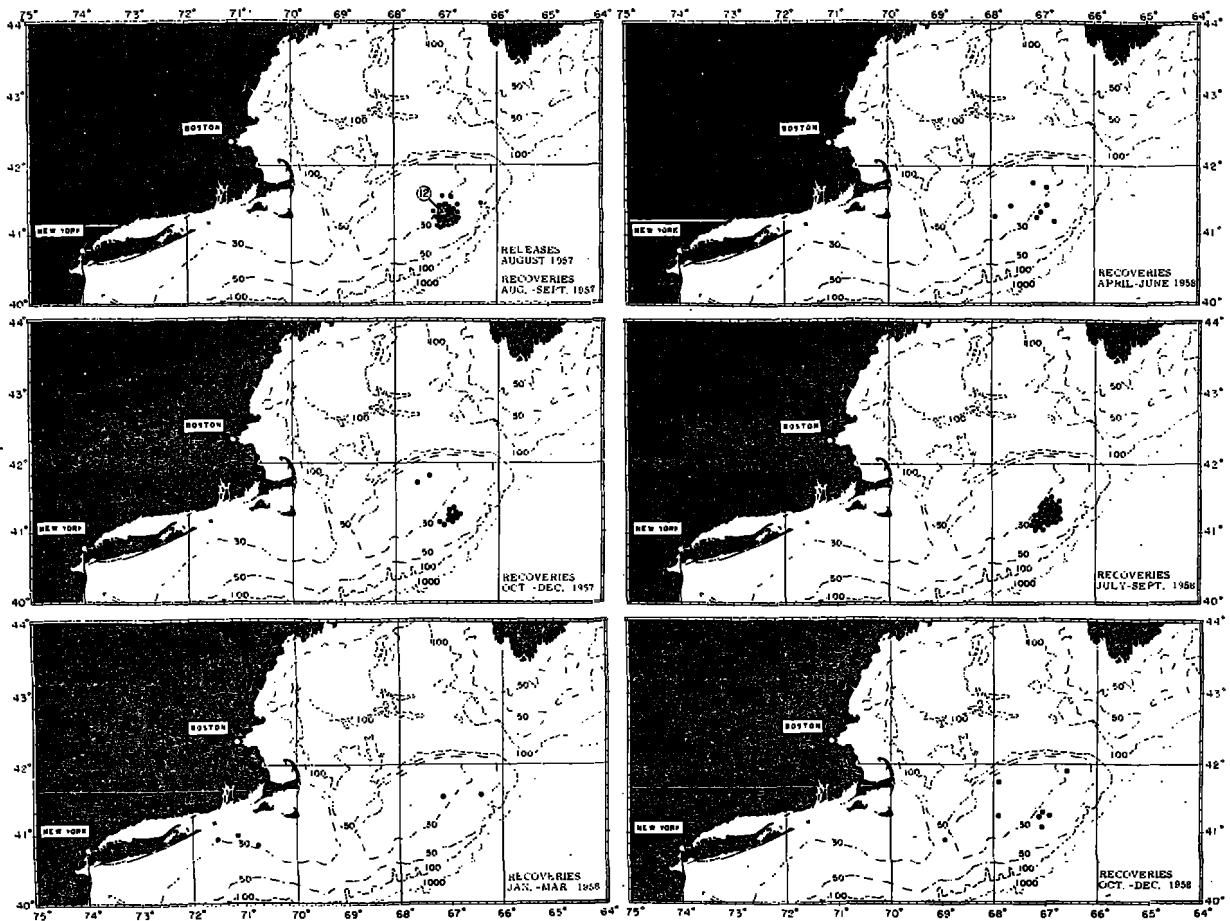


FIGURE 5.—Tagging on Georges Bank, August 1957, lot 12. (Location of releases indicated by the X; recoveries, by calendar quarters, indicated by dots.)

ground, subarea O, and one was from the northwestern part of Georges Bank, subarea H. Recaptures during 1959, while few in number, showed that the patterns described above were repeated (table 1).

Recovery positions of Georges Bank releases were principally determined by the distribution of fishing effort. Effort on the Bank was greatest during the summer, and it was concentrated in the vicinity where tagged fish were released. Most Georges Bank recoveries were obtained during the summer months, and they were from the area where fishing activity was greatest.

The following migration patterns were shown by yellowtail tagged on Georges Bank. (1) There was some movement to the westward during the winter months; a few of the fish were recaptured as far to the west as the southern New England ground. The fish apparently returned to the vicinity of tagging on Georges Bank in the

summer. (2) Although there was some movement to other parts of Georges Bank from the release point, there was no clear migration pattern on the Bank itself. Most Bank recaptures were from area of release. (3) No movement from Georges Bank to the Cape Cod ground was indicated.

### FIN RAY COUNTS

In a comparative study of Nova Scotian and southern New England yellowtail flounder, Scott (1954) investigated meristic and morphometric variation in fish from both of these areas. He found a significantly higher number of dorsal and anal fin rays in Nova Scotia yellowtail than in those from southern New England. Dorsal and anal fin ray counts were therefore selected to compare yellowtail from the New England grounds.



Frequency distributions and means of fin ray numbers for fish from the three New England grounds are given in table 2. Analysis of variance indicated that there was no significant difference in fin ray numbers between the grounds, and it was concluded that yellowtail from the three grounds were the same with respect to these meristic characteristics.

TABLE 2.—Frequency distributions and mean values of dorsal and anal fin ray numbers of yellowtail flounder from the three principal New England grounds

Number of dorsal rays	Southern New England ground 1957	Georges Bank 1957	Cape Cod ground 1957 and 1960	Number of anal rays	Southern New England ground 1957	Georges Bank 1959	Cape Cod ground 1957 and 1960
73	1		1	55			
74		3		56	1	1	4
75	2	2	1	57	2	4	7
76	2	2	7	58	5	10	7
77	8	7	8	59	11	22	13
78	8	12	11	60	7	25	20
79	10	15	11	61	7	15	19
80	17	19	8	62	5	16	11
81	15	14	17	63	1	8	11
82	10	15	10	64	1	7	5
83	7	7	10	65	1	4	
84	2	4	6	66		1	1
85	2	4	2				
86	2	4	2				
87		1					
88		1					
89			1				
Totals	86	110	95		41	113	98
Means	80.13	80.40	80.26		69.96	60.59	60.37

### INCIDENCE OF PARASITISM

Information indicating that Cape Cod ground yellowtail were geographically isolated from those of the southern New England ground and Georges Bank was obtained from the incidence of infestation by metacercariae of the trematode *Cryptocotyle lingua*. A large percentage of yellowtail from samples caught on the Cape Cod ground were infested with this parasite. In 1958, 36 percent of the fish from a sample of 370 were infested; in 1959, 38 percent of the fish from a sample of 61 were parasitized. No infested fish were observed in samples from either of the other grounds in these or in other years. This information suggests that yellowtail from the southern New England ground and Georges Bank do not inhabit the Cape Cod ground where they presumably could become infested with the parasite.

The initial larval hosts of *C. lingua* are periwinkles, *Littorina* spp., which inhabit shoreline waters in New England (Stunkard, 1930). Cercariae leave the periwinkles and penetrate and

encyst in the skin of fishes, the cysts appearing as black, pinhead-sized specks. The metacercariae apparently remain encysted throughout the life of the host fish. The cercariae are shed only in shoal water, where periwinkles are found, and they die within about 2 days if they fail to find a host. Yellowtail on the Cape Cod ground, in order to become hosts of the parasite, must therefore be found in water close to the shore at some time during their lives.

### SUMMARY AND CONCLUSIONS

Yellowtail flounder are caught on three fishing grounds off New England: the southern New England ground, the Cape Cod ground, and Georges Bank. Recoveries of fish marked on the southern New England ground showed that yellowtail there followed a migratory path that was chiefly within this ground. The fish moved to the eastward in spring and summer months and to the westward during the fall and winter. Some of the tagged fish moved greater distances, however, and were caught on the other two New England grounds. Of the 180 recoveries from southern New England tagged fish, 10 were made on Georges Bank during summer and early fall months, while 5 were made on the Cape Cod ground between late spring and early fall. This movement pattern coincided closely with the one shown by Royce et al. (1959) for the southern New England ground during the 1940's.

Recoveries of yellowtail marked on the Cape Cod ground indicated that there was a gradual northward dispersal of fish there. None of these releases were recaptured on either of the other principal grounds, indicating that they were a relatively local and stationary group. The incidence of infestation with the trematode parasite *Cryptocotyle lingua* furnished additional evidence that yellowtail of the Cape Cod group were separate from those found on the other fishing grounds. About one-third of the yellowtail from samples collected on the Cape Cod ground were infested with metacercariae of this parasite, while no infested fish were found on the other two grounds.

Recoveries of yellowtail marked on Georges Bank were mostly from area of tagging, subarea M, which is the part of the Bank that supports an intensive summer yellowtail fishery. Some

of the late fall and winter recoveries were from parts of the Bank to the north and west of the tagging point, suggesting that the migratory path on Georges Bank was to the westward during winter months and to the eastward in the summer. Four of the fish moved off the Bank and were recaptured on the southern New England ground during the winter. None of the fish were recaptured on the Cape Cod ground, indicating that there was no movement between the Georges Bank and Cape Cod groups.

Number of dorsal and anal fin rays were the same for all three yellowtail groups, indicating that there is no difference in these meristic characters.

Data presented here corroborate and strengthen conclusions of Royce, et al. (1959) regarding divisions of the New England yellowtail population. Each of the three principal fishing grounds supports a group of yellowtail which is essentially separate from fish on the other grounds, although a small amount of seasonal intermingling takes place between the groups.

#### ACKNOWLEDGMENTS

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Further thanks are due to the captains and crew members of the New England draggers *Portugal*, *Jacquelyn*, *Anna Grace*, *Comber*, and *Capt. Bill II*, from whose catches most of the yellowtail were tagged.

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