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THE STOCKS AND MIGRATIONS OF THE YELLOWTAIL FLOUNDER *LIMANDA FERRUGINEA* (STORER)

By

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ABSTRACT

The activities of the commercial fishing fleet show that yellowtail are caught mostly in waters from 15 to 30 fathoms deep along the shore from near Cape Ann, Mass. to off Long Island, New York. Smaller quantities are taken on offshore banks. Samples of the catch show considerable heterogeneity in size and sex composition from season to season and from area to area. Returns from tagging experiments demonstrate considerable intermingling of all of the groups of yellowtail west of Nantucket Shoals.

At least part of the stock west of Nantucket Shoals migrates seasonally in an east-west direction .

This stock west of Nantucket Shoals produces 60 to 90 percent of the total U. S. yellowtail landings. The production from this stock which is caught by vessels from New Jersey, New York, Connecticut, Rhode Island, and Massachusetts increased to an all-time peak of 63 million pounds in 1942, abruptly declined to 20 million pounds in 1945, and rose slightly to 25 million pounds in 1946.

CONTENTS

	Page
Introduction	3
Fishing grounds and production	10
Composition of the commercial catch	19
Tagging experiments	28
Stocks and migrations of small yellowtail flounders	37
Summary and conclusions	42
Literature cited	47
Appendix A	49
Appendix B	54

ILLUSTRATIONS

FIGURE — Page

1. The statistical areas on the New England banks 10
2. The areas producing yellowtail flounders in 1943. Each dot represents a catch of 1,000,000 pounds. This chart indicates the total production except that off Jones Beach, Long Island, Cape Ann, Mass., and Georges Bank which all together produced only about 3,000,000 pounds . 11
3. The locations where tagged yellowtail flounders have been released. The circled information includes the number of the experiment as in table 5, the date of release, and the number of fish tagged 32
4. The distant recaptures from the yellowtail released off Jones Beach (No. 1), Montauk Point (No. 2), and Provincetown (No. 3) 32
5. The distant recaptures of yellowtail released 14 to 16 miles SE. of No Mans Land (Nos. 4, 10), 47 to 50 miles SE. by S. of No Mans Land (Nos. 5, 11), and off Nauset Beach Light (No. 9) 34

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INTRODUCTION

The yellowtail flounder, *Limanda ferruginea* (Storer), is also commonly called the dab, rusty dab, and mud dab. Among the fishing ports of New England it is most commonly known as the yellowtail and derives this name from the lemon yellow color of the under or blind side of the caudal fin, caudal peduncle, and margins of the dorsal and anal fins. The remainder of the blind (left) side is white and both eyes are on the upper side of the head. The yellowtail is a flatfish with the principal coloring only on the side which has eyes. The coloration is typically brownish with rusty red spots. When the young are hatched they have an eye on each side of the head, as do other fishes, and swim in a normal fashion; but as they reach the length of about one-half inch the left eye migrates over the top of the skull to a position near the right eye and the fish takes up life reclining on its left side. On rare occasions a left-handed specimen is found, the right side being the blind side.

The food of the yellowtail flounder (Bigelow and Welsh, 1925, p. 498)[1] consists chiefly of the smaller crustaceans, such as amphipods, shrimps, etc., and likewise of the smaller molluscs, both univalves and bivalves, and worms. It is also known to eat small fish.

The yellowtail is mostly found in depths ranging from 15 to 30 fathoms on sandy bottoms but occasionally is captured near shore or from as deep as 30 to 60 fathoms. The range of the species extends from the northern shores of the Gulf of St. Lawrence, northern Newfoundland, to Virginia, but is apparently rare south of New York (Hildebrand and Schroeder, 1928, p. 168).

About 1930 the yellowtail was considered to be one of the less desirable flounders by the fishing industry. It is thinner than the blackback and not as attractive when sold as caught, without dressing. During the 1930's two factors helped to establish the yellowtail as a basis for a principal fishery. The blackback flounder declined considerably in abundance and the fishermen sought a more available species. At the same time the filleting business in New York City and later in New Bedford was searching for an abundant, low-priced fish to fillet. Yellowtail was available to the small draggers (otter trawlers), it was a fine-flavored fish, and was abundant enough to be relatively low in price. Landings increased from 15,952,000 pounds in 1938 to 68,938,000 pounds in 1942. Data are not available on landings prior to 1938 because all species of flounders were thrown together in the statistics, but the fishermen report that only small quantities of yellowtail were landed in these earlier years.

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[1] Publications referred to parenthetically by date are listed in the Literature Cited, p. 47.

The yellowtail ranked fifth in importance among New England fisheries in 1942 (Anderson and Power, 1946) in terms of poundage and value as landed. The quantity landed was exceeded by the weight of haddock, rosefish, cod, and sea herring;and the value was exceeded by that of haddock, rosefish, cod, and lobsters. The yellowtail fishery is especially important to the fleet of small otter trawlers which operate from New Bedford and Woods Hole, Massachusetts; Point Judith, Newport, and Block Island, Rhode Island; Stonington, Conn. [illegible], and Montauk and Greenport,N. Y. [illegible]. In 1946 about 225 registered vessels from 5 net to 50 gross tons operated out of these ports. In addition to these an estimated 75 more smaller draggers were in operation. All of these 300 vessels were used principally in the flounder fisheries, either yellowtail, blackback, or both.

The continued decline of yellowtail which is shown by the decline in landings from the peak of 68,936,000 pounds in 1942 to 32,748,000 pounds in 1946 has caused the fishermen of this area no little concern. The blackback which declined in the early 1930's has never recovered its former abundance. With these two species depleted the fisherman can turn to no other important species. Small quantities of swordfish, lobsters, scup, red hake, weakfish, and others are occasionally sought by the small vessels when the fish are available and prices are favorable but no other species ever has been more than a supplement to the main pursuit of flounders for the majority of these vessels.

If measures are taken to regulate, protect, or otherwise attempt to improve any stock[2] of fish, it is of fundamental importance to know the geographical and political extent of that stock. This must include knowledge of the availability of the stock to the fishing fleets of separate states or countries at all times during the lifetime of the individual fish making up the stock. Also, it is important to learn any separation between stocks of the same species. It is commonplace to find different stocks of the same species in different locations fished by different fleets in varying amounts. It should be anticipated that regulations benefiting one stock are not likely to benefit another under different conditions even though it is the same species of fish.

Three methods are used in the following description of the stocks and migrations of yellowtail flounders. First, the localities in which the fleet captures yellowtail are described and the quantities taken in those localities are tabulated. Second, we have compared the average size and the sex compositions of samples from the commercial catch. These data serve merely to demonstrate differences in the composition of the populations. Third, the results of tagging experiments are summarized. These experiments demonstrate the movements of individual fish.

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[2] The term stock is used here to mean a group of fish of one species in which the individual fish intermingle.

It is recognized at the outset that this knowledge of the stocks and migrations is all obtained from the activities of the fishing fleet. We have no knowledge of the availability or movements of yellowtail outside the fishing grounds. The region from the Hudson Canyon to Nantucket Lightship, between 30 and 60 fathoms, much of which is immediately offshore from the yellowtail fishing grounds, is fished scarcely at all for any demersal species. It comprises an area of roughly 5,000 square miles. We know very little about the fish populations living there. Unquestionably this area has been explored occasionally by fishing vessels and it is most probable that the fish populations will not support a fishery. However, it is entirely possible that parts of it could be frequented by groups of yellowtail flounders undetected by the fishermen. Thus the information presented here possibly will be subject to modifications if the fishing fleet or research vessels explore other grounds.

FISHING GROUNDS AND PRODUCTION

The yellowtail production from the several fishing banks has been landed in ports from New Jersey to Maine. The data on landings were obtained from various government publications, State records, and individual dealers' records. Appendix A lists in detail the sources of data on landings for the years 1940 - 1946 inclusive. These data on production by port were used as a basis for the compilation of production by fishing grounds.

At the principal New England ports of Boston, Gloucester, New Bedford, and Portland, the captain or representative of each vessel landing is interviewed by the personnel of the Fish and Wildlife Service, his exact fishing locality determined, and the catch assigned to a statistical area or subarea (Figure 1). The production by subarea is published monthly for these principal ports by the Fish and Wildlife Service. At the smaller ports occasional interviews with the fishermen have been obtained. These have been used as a basis for assigning the catch to subareas. This method has certain limitations but usually the fleets of the smaller ports fish a much more restricted area than the fleets of the major ports. Usually the catch can be assigned to a statistical area with a negligible error. A detailed account of the breakdown of the landings into fishing areas is given in Appendix B.

Sheet 1 of 1

The statistical areas and subareas (Figure 1) are the same as those which have been used by the Fish and Wildlife Service in its Current Fishery Statistics bulletins since 1943. The major areas designated by the Roman numerals XXI, XXII, and XXIII were defined by the North American Council on Fishery Investigations (1932). These areas were slightly modified and the lettered subareas which represent a further subdivision were developed from studies of the fishing localities by Herrington and Rounsefell (unpublished manuscript). We have made an additional division in area XXIII to separate the fishing grounds off southwestern Long Island (S. W. L. I.) and southeastern Long Island (S. E. L. I.).

The principal yellowtail fishing grounds are shown in Figure 2. The total production for 1943 is indicated by dots, each of which represents a production of 1,000,000 pounds. The fishing grounds indicated by the concentrations of dots in Figure 2 are based on a compilation of the catch of yellowtail as assigned to unit areas from daily interviews with captains on almost all of the 3,695 trips landed at New Bedford in 1943. (A unit area is a rectangle 10 minutes of latitude and longitude on a side. The actual size is about 10 by 7 miles). 1943 was a typical year. The yellowtail fleet has fished the same grounds every year from 1942 to 1946 with very little change.

The principal fishing grounds extend along the 20-fathom contour from south of Montauk Point to south of Nantucket. This region has been divided into subareas XXII-O, XXII-Q, XXII-S, and XXIII (Figure 1 and Table 1). The three subareas XXII-O, Q, and S contributed 81 percent of the total United States landings of yellowtail flounder in 1943.

Insert Table 1

Lesser fishing grounds are located off Jones Beach, Long Island; off Nauset on Cape Cod, in Cape Cod Bay; off Newburyport, Mass; and on Georges Bank. Yellowtail fishing off Jones Beach is chiefly seasonal, occurring during February and March at which time a small concentration of fish appears. The concentration of yellowtails off Nauset affords vessels from Provincetown and an occasional vessel from New Bedford fair fishing during the spring, summer, and fall months. The fishing grounds within Cape Cod Bay are somewhat more extensive and occur chiefly along the western side of the bay from Gurnet Point to the bay entrance of the Cape Cod Canal and on Stellwagen Bank. Yellowtails are caught incidentally in small quantities in all four of the subareas on Georges Bank. There are few favored fishing grounds for yellowtails on these banks except at certain limited seasons. For the past five winters, with the exception of the winter of 1947, yellowtails have appeared on Cultivator Shoal (II-H) in such numbers that some of the medium draggers which normally fish for haddock and cod on Georges Bank have fished particularly for yellowtails for a period of two to three months. And in 1945 a similar phenomenon occurred during August on the fishing ground known as "Turn of the Bank" (II-H). Apart from these two seasonal concentrations, yellowtails are caught in limited numbers on Georges Bank.

TABLE 1.—Estimated yellowtail flounder production by fishing area (in thousands of pounds)

Year	Month	Area XXI[1]	B	C	D	E	F	G	H	Area XXII[1] J	K	N	O	Q	R	S	T	Area XXIII[1]	Total[2]
1942	Jan.	8			2	261	1	16	371	*	21	16	74	3,986		571		250	5,578
	Feb.				2	265	*		16		10	2	28	2,263		1,088		398	4,071
	Mar.	*[3]			2	320	2	28	50	1	69	3	3,419	918		1,836		583	7,231
	Apr.	6			1	38	6	197	12	93	495	2	943	886		3,316		465	6,460
	May	17				25		115	11	65	144	12	374	1,179		1,210		134	3,285
	June					45		197	8	72	23	2	50	3,271		1,113		214	4,995
	July	9				61	1	163	2	27	14	*	645	4,618		479		240	6,258
	Aug.					18		355	5	10	19	*	3,931	3,092		287		143	7,861
	Sept.					36	1	629	*	7	24		4,682	471		190		96	6,135
	Oct.					84		42	*	3	21		6,313	804		519		260	8,047
	Nov.			8		168		3	8	6	77	20	1,881	1,740		525		252	4,688
	Dec.	*				224		40	625	*	4	15	6	2,541		539		332	4,327
	Total	41		8	7	1,545	11	1,785	1,108	284	921	72	22,346	25,769		11,873		3,367	68,937
1943	Jan.	1			4	235	1	5	784	*	8	25	1,238	2,542		752		273	5,867
	Feb.				22	257	2	14	208		5	2	1,513	1,289		674		279	4,263
	Mar.				5	149		276	12		46	46	2,373	1,132	14	923		387	5,365
	Apr.	11		8	4	68	*	69	8	89	398	26	260	1,669	8	627		329	3,576
	May	32			*	95		165	55	86	226	23	142	722		458		207	2,210
	June	38			6	55		83	25	69	124	26	130	1,599	2	301		100	2,556
	July	12		3		52		78	171	20	61		35	2,999	17	283		104	3,836
	Aug.	40			*	56		128	2	3	27	8	1,639	3,496		355		180	5,943
	Sept.	1			*	31	2	56	1	6	19		3,845	726		205		103	4,997
	Oct.	2		3	*	157	2	54	*	11			1,785	106		94		81	2,297
	Nov.	159			1	561	1	16	11	8	83	60	105	1,531	47	144		79	2,807
	Dec.	25			10	160	*	1	2	*	*	*	2	186	*	339		236	962
	Total	321		14	54	1,876	9	955	1,279	293	997	216	13,087	17,997	89	5,155		2,358	44,680
1944	Jan.				10	298		51	1,480	*	73	42	55	2,283	7	1,115		441	5,856
	Feb.	2			8	220		78	360		15	48	567	1,774	3	1,233		353	4,660
	Mar.	*	*	*	8	212		172	691	9	69	15	1,063	860	26	1,352		415	4,892
	Apr.	11			7	164		163	19	45	91	18	284	705	*	1,101		498	3,134
	May	69			11	133	*	236	62	24	28	35	41	426	5	514		246	1,830
	June	12			6	37		67	13	21	8	16	49	442	51	359		176	1,257
	July	60				56	*	244	9	8	3	14	49	1,724	6	682		280	3,136
	Aug.	24				70		188	3	13	26	15	827	1,614	*	433		240	3,452
	Sept.	2			2	121		100	2	5	10		92	46		12		6	399
	Oct.	34			*	153		138	2	7	4	2	14	169		309		155	986
	Nov.	148			3	262	*	14	11	8	40	8	52	243		428		226	1,424
	Dec.	245		12	1	99	*	59	277		13	8	16	231		272		121	1,356
	Total	608		12	56	1,825	2	1,510	2,929	140	380	221	3,109	10,547	99	7,810		3,137	32,385
1945	Jan.	93			*	125		16	945		13	17	13	492		422		195	2,333
	Feb.	30				333		30	507	*	3	3	261	606		347		159	2,279
	Mar.	20			3	170		283	172	3	13	5	716	1,568		626		291	3,870
	Apr.	57		1	1	105		299	21	26	61	22	33	107		224		82	1,045
	May	517			5	137	*	165	39	9	4	58	20	58	3	120		53	1,187
	June	532				38		79	46	33	3	47	30	65	2	56		28	961
	July	684	1			18	*	54	24	23	53	24	9	687	26	731		174	2,510
	Aug.	564				23		59	31	23	461	8	48	1,933	19	126		60	3,355
	Sept.	191		*	2	39		57	3	36	58	2	488	1,800		48		24	2,750
	Oct.	1,037				69		109	11	11	12		2,273	535		142		71	4,271
	Nov.	575		8	6	196		6	27		28	34	1,357	1,929	2	408		177	4,753
	Dec.	434			3	128	*	16	41	4	2	22	88	195	1	364		162	1,459
	Total	4,734	1	9	20	1,381	1	1,173	1,866	168	711	242	5,336	9,976	53	3,615		1,482	30,768
1946	Jan.	13			3	222		54	385		1	32	445	519		862		397	2,933
	Feb.	1				262		19	150	2	6	4	209	544		331		160	1,688
	Mar.	1				82		334	26	7	32	25	980	1,243		809		367	3,906
	Apr.	26			*	57		277	29	13	38	49	45	174	2	308		154	1,172
	May	110			5	59		180	25	35	84	79	49	161	6	263		132	1,188
	June	266				151		65	50	14	5	10	27	452	3	888		268	2,199
	July	759			1	103		108	16	5	17	25	95	1,802	28	260		77	3,296
	Aug.	544			5	75		107	7	16	167	69	1,102	390		78		39	2,599
	Sept.	29			2	72		112	3	25	2		1,348	392		104		52	2,141
	Oct.	92			4	87		70	3	17	45	17	2,347	742		279		145	3,848
	Nov.	560				131	3	12	45	38	159	2	1,422	853		445		145	3,815
	Dec.	336			7	114		21	64	15	52	3	10	2,569		494		278	3,963
	Total	2,737			27	1,415	3	1,359	803	187	608	315	8,079	9,841	39	5,121		2,214	32,748

1/See Figure 1 and text.

2/Slight discrepancies occur because of rounding.

3/Landings of 500 pounds or less are indicated by *

The general characteristics of yellowtail grounds are similar throughout their commercial range. Most of the yellowtails caught on inshore grounds are in 15 to 30 fathoms of water, and the fish caught on Georges Bank are in 20 to 50 fathoms with the exception of those taken on Cultivator Shoal in 5 to 7 fathoms. United States Coast and Geodetic Survey charts of these grounds show the bottom types to be sand, gray sand, sand and shell, sand and gravel, mud and sand, or hard mud and sand. It is apparent yellowtails shun rocky, stony, or soft mud bottoms.

The detailed statistics of the yellowtail flounder production for the five-year period 1942 to 1946 inclusive by month and sub-area are presented in Table 1. Critical examination of these data provides us with considerable information on the stocks available to the fishery.

Yellowtail landings in the United States ports from the Nova Scotian Banks (Area XII) rose spectacularly to a peak of 4,734,000 pounds in 1945. This occurred because vessels were restricted by insurance regulations from fishing the Nova Scotian Banks from 1942 to 1944 on account of war conditions. In 1945 and 1946 many vessels free of restrictions sought fish on the NovaScotian Banks because of the scarcity on Georges Bank. The decline in landings of yellowtail from 1945 to 1946 from this area probably occurred simply because it was more profitable to fish for haddock and cod and the yellowtail were not sought.

Landings from along the coasts of Maine and New Hampshire and from the central part of the Gulf of Maine were almost negligible during the period 1942 to 1946. In no year was the total more than 100,000 pounds from these four areas (XXII-B, C, D, and F). It is likely that only very small stocks exist here probably due to the scarcity of shoal water of 20 to 30 fathoms in the northern Gulf of Maine.

Yellowtail production from the vicinity of Cape Cod and Cape Ann varied but little over the five-year period. The total for areas XXII-E and G range from a high of 3,334,000 pounds in 1944 to a low of 2,553,000 pounds in 1945. Other years were intermediate. The average was about 2,900,000 pounds.

The production from Georges Bank (Subareas XXII-H, J, K, and N) shows but little important variation when considered as a whole. Here a peak of 3,677,000 pounds was reached in 1944 which declined to 1,913,000 pounds in 1946. Most of the production comes from northwest Georges (XXII-H) and southeast Georges (XXII-N). The quantities caught in the several years in each area have been somewhat erratic. On northwest Georges most of the yellowtail usually have been produced in January, February, March, and sometimes some in December. This is the winter run of yellowtail in the vicinity of Cultivator Buoy. On southeast Georges considerable quantities were caught in April 1942, April 1943, and in August 1945. Since most of the yellowtail which are caught on Georges Bank are taken incidentally to the catch of haddock and cod, little significance can be attached to the fluctuation in landings.

Yellowtail landings from Nantucket Sound (XXII-R) have been negligible. What few have been taken have been caught by vessels fishing primarily for blackback flounders.

The greatest amount of landings and the greatest fluctuations are to be foundin the production from the grounds west of Nantucket Shoals (Figure 2). Landings from the area south of Nantucket (XXII-O) decreased from 22,634,000 pounds in 1942 to 3,109,000 pounds in 1944 and then rose to 8,079,000 pounds in 1946. The catch from the area off No Mans Land (XXII-Q) declined steadily over the five-year period from 25,769,000 pounds in 1942 to 9,841,000 pounds in 1946. The production from off Block Island (XXII-S) dropped from a peak of 11,673,000 pounds in 1942 and then seemed to fluctuate up and down between 3,600,000 pounds and 7,800,000 pounds during the next four years. The production from area XXIII which is mostly taken in the vicinity of Montauk Point shows a similar up and down fluctuation but with the high point in 1942 and the low point in 1945. For these four areas as a group, a peak of 63,157,000 pounds was reached in 1942 and the production declined to 20,465,000 pounds in 1945 with a recovery to 23,080,000 pounds in 1946.

The monthly production figures for these areas west of Nantucket Shoals show considerable fluctuation. The production from each of the four areas (XXII-O, Q, and S and XXIII) is subject to great fluctuation within each year. In the usual pattern some months will show a production of only a few thousand pounds whereas certain other months may show a production of two to four million pounds. In most years yellowtail have been produced from the grounds off No Mans Land and south of Nantucket in greatest quantities from January to March and from July to October. Production from the Block Island area (XXII-S) and off Montauk has been somewhat more steady perhaps because the smaller vessels fish the inshore grounds during the more severe winter months from November to December and because yellowtail are more available there in April, May, and June.

The production peak usually does not occur in the same areas at the same time. Usually, the production peak during the summer months occurs first in the area off No Mans Land (XXII-Q) and a month or so later from the area south of Nantucket (XXII-O). Somewhat similar shifts are to be noted in the season from January to March although frequently these have not been as regular.

These phenomena indicate some movement of the yellowtail. Enough vessels are exploring the yellowtail grounds on all of these inshore areas to practically eliminate the possibility of overlooking any important groups of yellowtail. However, when new schools of yellowtail are located, the fleet frequently shifts almost as a group and may completely neglect schools of yellowtail which are perhaps only half as abundant as schools which they are fishing regularly. Also, to some extent, the fleet shifts to blackback flounder fishing in the months from April to June, and in 1944 to 1946 they largely neglected the yellowtail, if any, in the area off No Mans Land and south of Nantucket during these months. Nothing in these production statistics indicates whether the movement of the fleet is occasioned by direct movement of yellowtail from one subarea to another or by a successive invasion of the subareas by yellowtail from an offshore area. Fishermen have reported occasionally that they were following a school for a few weeks either to the eastward or westward according to the season. However, the regular decrease in landings during May and June and the occasional declines such as in September 1944 indicate that the yellowtail at times are much less available to the fleet. (The decrease in December 1943 was caused by a strike of fishermen. The vessels have been active at all other seasons.) Unquestionably, the yellowtail moved from the familiar fishing grounds. Such a movement might have been a migration en masse to unknown grounds or a dispersion of the schools to the point where it was unprofitable to fish them.

COMPOSITION OF THE COMMERCIAL CATCH

Since 1942 yellowtail flounders landed at New Bedford by the commercial fishing fleet have been sampled. An extensive series of length measurements and scale samples with data on the sex of the individual fish and the date and location of capture has been obtained. These data were gathered primarily for the purpose of studying the rate of growth and the composition of catch. They also furnish valuable information on the homogeneity of the yellowtail populations from the several fishing grounds.

All measurements have been obtained in as nearly a random fashion as working conditions permit. No more than 100 fish have been measured from each vessel unloaded. These 100 fish usually have been distributed through several thousand pounds of the catch of the vessel. The usual system has been to measure the fish as they are being boxed. Each box holds 125 pounds. About 25 fish from one end of the box were measured and then other boxes were obtained until a sample of 100 fish was measured. If the measurements were obtained as fish were being unloaded, one to two thousand pounds of fish were unloaded between every box that was sampled. Perhaps it would be best to describe the method of sampling as haphazard in the statistical sense rather than strictly random. At any rate every effort has been made to insure that the sample accurately represents the catch.

An analysis of the average length provides important information on the variation in size composition with the season of the year and among subareas. Because female yellowtail average considerably larger than the males and the proportions of the sexes vary considerably, the analysis of the changes in average length has been restricted to females. Available data are presented in Table 2.

Study of the data on average lengths indicates that there are regular and fairly large changes associated with seasons of the year. Invariably, larger fish are caught in the winter than in the summer. Doubtless, this event is associated with growth and with the influx of a new group of small fish during the summer season of rapid growth. This phenomenon is important but not for our present purposes. We will simply recognize it and make sure it is not confounded with differences among areas.

TABLE 2.—Average length of female yellowtail flounders in the commercial catch landed at New Bedford, Mass.

Year	Quarter	Subarea XXII-H		Subarea XXII-O		Subarea XXII-Q		Subarea XXII-S	
		Number measured	Average length inches	Number measured	Average length inches	Number measured	Average length inches	Number measured	Average length inches
1942	4th			132	14.93	443	14.41		
1943	1st			929	15.96	514	14.53		
	2nd			14	13.22	1,077	14.11		
	3rd			788	15.00	1,508	13.64		
	4th					415	14.98		
1944	1st	341	16.13	100	15.52	804	15.22	224	14.23
	2nd					250	13.49		
	3rd			139	14.70	246	13.32		
	4th	540	16.90	332	15.13	253	14.98	64	14.93
1945	1st	1,119	16.62	1,036	16.13	1,383	15.81	112	14.95
	2nd							224	14.95
	3rd			432	14.21	1,251	13.92		
	4th			824	14.60	813	15.28	114	14.26
1946	1st	442	16.47	835	15.65	759	14.76		
	2nd					60	14.40		
	3rd			824	13.81	515	14.03		
	4th			1,531	14.90	768	14.83		

The differences in average size among the quarters and the seasons are mostly significant. An analysis of variance of the data for area XXII-O and XXII-Q for 1945 was made (Table 3). This analysis shows the difference among seasons and between subareas to be highly significant. Chance differences of such magnitude are to be expected far less than once in a hundred times. We have neglected the slight discrepancy caused by disproportionate numbers and because of this complication we have not bothered to calculate the interaction. Quite likely the interaction in this case would be significant; but since this year shows a reversal of the trend indicated by the other three years' data the interaction even though significant can not be interpreted with the data at hand. We have used the mean square for individuals as an estimate of the variance and calculated the least significant difference among means. If samples of 100 measurements each are compared, the least significant difference between means at the 1 percent level would be .55 inches. Correspondingly, significant differences for samples with 500 and 1,000 measurements are .24 inches and .17 inches, respectively. It is apparent that significant differences in the average size of the catch are the rule among the several subareas.

TABLE 3.—Analysis of variance of the length of yellowtail flounders from two areas and three seasons in 1945

Source of variance	Degrees of freedom	Sum of squares	Mean square
Individuals	5,795	329,009	57
Subareas	1	1,427	1/ 1,427
Seasons	2	98,998	1/ 49,499
Total	5,798	429,434	-

1/ Differences are highly significant.

The differences in the average size of the fish from the different fishing areas puts into figures what is generally common knowledge among the fishermen. The yellowtail from the Cultivator Buoy region (XXII-H) on Georges Bank are larger than those from any other locality. The table indicates that they exceed the average of the other subareas in each of the quarters of the year in which measurements were obtained. Yellowtail from off Block Island (XXII-S) are small. Here the table indicates that the average is smaller than that for any other subarea in quarters which may be compared. Also striking is the nearly consistent difference between the average size of the yellowtail in areas XXII-O and XXII-Q. (These are the adjoining statistical areas south of Nantucket and off No Mans Land.) In 11 of the 12 quarters in which adequate samples were obtained, the yellowtail from XXII-O averaged larger than those of XXII-Q. In the single exception, the second quarter of 1945, the average sizes in XXII-Q shows clearly they are larger than that of XXII-O.

Similar information on homogeneity has been obtained from a study of the sex ratios. The same samples have been used. The fish were sexed by slitting open the belly and examining the gonad or by looking at the gonad externally. In the yellowtail it is easy to see the outline of the ovary by holding the white side of the fish to a strong light and actually looking through it. In fish of the smallest commercial sizes the ovary has already started to elongonate posteriorly from the body cavity and recognition of the sex of the fish is quick and accurate.

Because of the differences among the sizes of the sexes, it is apparent that a difference in the proportion of the sexes would be produced by a variation in the size of smallest commercial fish. In other words, if at any time the fleet tended to catch smaller fish, it is likely that an increase in the percentage of males would be noticed. However, the lower limit of commercial sizes has been reasonably uniform since 1942. The fleet has generally used similar nets of the same mesh size which select the yellowtail between 11 and 12 inches quite sharply. Practically no yellowtail less than 11 inches are caught whereas the sharply rising curve indicates that relatively few longer than 12 inches escape the net.

The differences in the sex ratio are compared in Table 4. It is apparent from inspection that variation occurs among seasons and subareas with little regularity. At times the proportion of females has been highest in the third quarter of the year and at other times lowest in the same quarter. Differences between areas also appear to be rather irregular. If we compare XXII-O and XXII-Q it is found that the preponderance of females is greater first in one area and then in the other. The sums indicate the greatest fraction of females occurs in the Cultivator Buoy region on Georges Bank (XXII-H) and the smallest in the Block Island area (XXII-S).

Many of the differences are significant. Chi square tests of the differences in the ratio of males to females between area XXII-O and XXII-Q were made for each season. Differences exceeding the 5 percent level were found in 7 of the 12 quarters for which values were computed (second quarter of 1943 was omitted). Of these 7 that exceeded the 5 percent level, five exceeded the 1 percent level. It is evident that the catch of yellowtail from adjoining areas is quite heterogeneous in sex composition.

TABLE 4.—Sex ratio of yellowtail flounder in the commercial catch landed at New Bedford, Mass.

Year	Quarter	Subarea XXII-H			Subarea XXII-O			Subarea XXII-Q			Subarea XXII-S		
		Males	Females	Females per 100 males	Males	Females	Females per 100 males	Males	Females	Females per 100 males	Males	Females	Females per 100 males
1942	4th				64	132	206	362	443	122			
1943	1st				291	930	320	446	514	115			
	2nd				11	14	127	372	1,077	289			
	3rd				236	788	334	243	1,508	610			
	4th							194	415	214			
1944	1st	209	341	163	72	100	139	548	804	146	251	224	89
	2nd							204	250	122			
	3rd				68	139	204	167	246	147			
	4th	165	540	325	181	332	183	150	253	169	36	64	178
1945	1st	470	1,119	238	445	1,036	233	714	1,383	194	89	112	126
	2nd										178	224	126
	3rd				269	432	161	972	1,251	129			
	4th				533	884	166	467	813	174	88	114	129
1946	1st	152	442	291	367	835	227	592	759	128			
	2nd							40	60	150			
	3rd				480	824	172	290	515	177			
	4th				671	1,531	228	636	768	121			
Total		996	2,442	245	3,688	7,977	216	6,397	11,059	173	642	738	115

TAGGING EXPERIMENTS

The first experiments on tagging yellowtail were based on the experience derived from tagging blackback flounders which are very similar in body proportions. A tag constructed of two celluloid discs joined by a pure nickel pin was used in the first yellowtail tagging experiments and has been used in each subsequent one. This tag which was developed by Robert A. Nesbit of the U. S. Bureau of Fisheries as a modification of the Peterson bone-button type appears to be eminently adapted to flatfish tagging (Lobell, 1939 and Perlmutter, 1946). We have examined several dozen tagged yellowtails and blackbacks after recapture and we have never seen any evidence of soreness or of any tendency for the tag to work out of the fish. Certain of our experiments have indicated that a considerable proportion of the tagged fish died and returns were scant even from a heavily fished area. In several experiments, however, we have had more than 30 percent of the tags returned. One yellowtail has been recaptured more than four years after release. Several blackbacks have been recaptured more than five years after release and one was "out" eight years. Therefore, we believe that the tag itself causes little change in the life of the fish. The mortality which has occurred was probably the result of handling during the tagging operation.

In the tag used the celluloid discs were one-half inch in diameter and were laminated with the printing covered with a layer of clear celluloid. One of the discs was white and printed with USFWS — NA — and the serial number. The letters stand for U. S. Fish and Wildlife Service — North Atlantic. The other disc was red and printed with Fish and Wildlife Service, Washington, D. C. — Return Both Discs — Reward. The nickel pin was 1-5/16 inches long and 1/32 inches in diameter.

The tag was attached to the fish between 1 and 2 inches in back of the head and about 3/4 inch from the base of the fin by pushing the nickel pin through the muscular part of the body. One disc was threaded on the pin before inserting it. The other disc was placed on the pin and the pin looped over with pliers. A total of about 1/8-inch slack was allowed between the two discs for growth of the fish.

Prior to 1946 yellowtail were tagged from commercial otter trawlers. A scientist would go along on a regular commercial fishing trip, buy part of the catch, and tag and release it alive immediately after capture. This method has had certain disadvantages. Fishermen are always glad to cooperate but it has been impossible to always arrange trips to the place and at the time desired. Adequate tanks for holding the fish alive on the deck of a commercial otter trawler cannot be arranged. In 1946 the Fish and Wildlife Service vessel Skimmer was available and was fitted with a holding tank. Two groups of yellowtail were tagged with this equipment in 1946. A summary of all tagging experiments on yellowtails is shown in Table 5.

TABLE 5.—Summary of tagging experiments on yellowtail flounder

No.	Date of release	Locality	Depth (fathoms)	Number released	Number[1] returned	Percent[1] returned
1	Feb. 24, 1942	8-9 miles S of Jones Beach, N. Y.	14	227	78	34.4
2	Mar. 2, 1942	16-20 miles SW of Montauk Point, N. Y.	22	240	51	21.2
3	Mar. 18, 1942	5 miles NW of Race Point, Mass.	27-28	405	24	5.9
4	June 10, 1943	16 miles ESE of No Mans Land, Mass.	21	131	11	8.4
5	Oct. 22-24, 1942	47 miles SE X S of No Mans Land, Mass.	24	286	22	7.6
6	Feb. 28-29, 1944	8 miles SE of Point Judith, R. I.	20	15	2	13.3
7	Jan. 28-31, 1945	3 miles W of Cultivator Buoy on Georges Bank	5-12	189	23	12.2
8	Jan. 17-18, 1946	2 miles E of Cultivator Buoy on Georges Bank	10-12	100	6	6.0
9	June 14, 1946	5-8 miles SSE of Nauset Beach Light, Mass.	15-25	138	12	8.7
10	July 19, 1946	14 miles SE of No Mans Land, Mass.	20-23	158	26	16.5
11	Aug. 21-23, 1946	50 miles SE½S of No Mans Land, Mass.	19-24	228	42	18.4

1/ Includes number returned through Dec. 31, 1946.

The return of the yellowtail tag depends on the cooperation of the person who recaptured the fish. A reward of $1.00 has been paid to all persons who have returned a tag and who have told us all they knew of the circumstances surrounding the recapture. Most fishermen on this coast are familiar with fish tagging and return the tags promptly. However, a substantial number of tags are returned by workers in shore plants and even occasionally by housewives. We believe that this occurs because the tag is unnoticed rather than ignored. Information on the locality of capture has been available from 70 percent of the tags returned.

Yellowtail have been tagged for several purposes other than that of determining migrations. Information is expected on natural and fishing mortality from these experiments. Some of the experiments have been designed to provide information on the deaths resulting from tagging in order to improve the technique of handling the fish alive. Scale samples and measurements have been taken from the tagged fish in order to calculate growth and to study the scale increments. These data will be reported in future papers. At present we will discuss the information which is available on migrations and which is much more complete than the data on mortalities, techniques, and growth.

Tagged yellowtail have been released on all of the important United States fishing grounds including the grounds off Long Island, Block Island, Southern Massachusetts, Cape Cod, and on Georges Bank (Table 5 and Figure 3). The returns have not been numerous from all of the experiments but nearly all of the groups of fish on the important banks are well represented.

The returns are itemized according to date and locality of recapture in Table 6. The areas of recapture are listed in order from west to east and thus the entries in the table indicate the direction of migration.

The returns from the yellowtail released off Jones Beach and Montauk indicate a seasonal migration from west to east and back. The fish moved eastward from April to June from the region south of Long Island (XXIII) to the region south of No Mans Land (XXII-O) (Figure 4). Later in the season some of the fish were recaptured south of Nantucket (XXII-O). In November and December the fish moved westward and again were recaptured off Long Island in January to March. The returns from the Jones Beach experiment show that yellowtail were recaptured off Jones Beach in 1943, 1944, and 1946 during January to March and off southern Massachusetts in 1942, 1943, and 1945 during the summer months.

TABLE 6.—The returns of tagged yellowtail flounders according to date and locality

Date on release	Date of recapture		Locality of recapture[1]									Total no. returned
			XXIII		XXII							
			S.W.L.I.	S.E.L.I.	S	Q	O	G	E	H	Unknown	
227 fish, 8-9 miles S. of Jones Beach, N. Y. Feb. 24, 1942 Area XXIII-C	1942	Feb.	3									3
		Mar.	9									9
		Apr.	3									3
		June			4	1					3	8
		July		1	1	9					1	12
		Aug.				5					4	9
		Sept.				4					1	5
		Oct.				1	3				2	6
		Nov.		1							1	2
		Dec.					1					1
	1943	Jan.	1									1
		Feb.	1									1
		Apr.	1									1
		July				3						3
		Aug.				4					1	5
		Sept.					1					1
		Oct.					1					1
	1944	Jan.	1									1
		Mar.									1	1
		May									1	1
		Nov.									1	1
	1945	Sept.				1						1
	1946	Jan.	1									1
		June									1	1
	Total		20	2	5	28	6				17	78

240 fish, 16-20 miles SW. of Montauk Point, N. Y. Mar. 2, 1942 Area XXIII-B	1942	Mar.		1	2					2	5
		Apr.		1	3					5	9
		May		1	2	1				2	6
		June			1	3				1	5
		July				5				2	7
		Aug.				1				2	3
		Oct.				2	1			2	5
		Nov.				1					1
		Dec.								2	2
	1943	Jan.		1		1					2
		Feb.		1	1						2
		May			1						1
		Nov.								1	1
	1944	Mar.		1							1
		Aug.								1	1
	Total			6	10	14	1			20	51
405 fish, 5 miles NW. Race Point, Mass. Mar. 18, 1942 Area XXII-E	1942	Mar.						9		7	16
		Apr.						3		1	4
		May						1		1	2
		July						1			1
	1943	Mar.						1			1
	Total							15		9	24

131 fish, 16 miles ESE. No Mans Land, Mass. June 10, 1943 Area XXII-Q	1943	June				1				1	2
		Aug.				2					2
		Sept.				1	1			1	3
	1944	Jan.								1	1
		Apr.			1						1
	1945	Aug.				1					1
	1946	Jan.	1								1
	Total		1		1	5	1			3	11
286 fish, 47 miles SE X S. of No Mans Land, Mass. Oct. 22-24, 1943 Area XXII-Q	1943	Oct.					12			2	14
	1944	Jan.								1	1
		Feb.								1	1
		Mar.					1				1
		Apr.			1	1					2
	1945	Apr.								1	1
		Nov.								1	1
	No date									1	1
	Total				1	1	13			7	22

15 fish, 8 miles S X E of Point Judith, R. I. Feb. 28-29, 1944 Area XXII-S	1944	Mar.			1					1
		July							1	1
	Total				1				1	2
189 fish, 3 miles W of Cultivator Buoy on Georges Bank Jan. 28-31, 1945 Area XXII-H	1945	Jan.						7		7
		Feb.						8	4	12
		Mar.						2		2
		Apr.							1	1
	1946	Jan.						1		1
	Total							18	5	23
100 fish, 2 miles E. of Cultivator Buoy on Georges Bank Jan. 17-18, 1946 Area XXII-H	1946	Jan.						2	2	4
		Feb.						1		1
		Mar.						1		1
	Total							4	2	6
138 fish, 5-6 miles SSE. of Nauset Beach Light June 14, 1946 Area XXII-G	1946	June							2	2
		July							2	2
		Aug.				1	3		1	5
		Sept.					1			1
		Nov.							1	1
		Dec.							1	1
	Total					1	4		7	12

158 fish, 14 miles SE. No Mans Land, Mass. July 19, 1946 Area XXII-Q	1946	July				7					7
		Aug.				4	3			2	9
		Sept.				3	2			2	7
		Oct.								1	1
		Nov.			1					1	2
	Total				1	14	5			6	26
228 fish, 50 miles SE½S. No Mans Land, Mass. Aug. 21-23, 1946 Area XXII-O	1946	Aug.					16			5	21
		Sept.				1	5			7	13
		Oct.				1	4				5
		Nov.								1	1
		Dec.				2					2
	Total					4	25			13	42

1/The numbers and letters refer to international areas and the subdivisions as shown in figure .

It may be significant that none of the yellowtail tagged at Montauk were recaptured at Jones Beach. The yellowtail tagged at Jones Beach returned year after year but those tagged at Montauk returned westward only as far as Block Island and Montauk. This would indicate that these two groups of fish which intermingled during the summer months on the grounds off southern Massachusetts separated again on this westward migration.

This westward migration during the winter months leaves a question regarding the movements of the group of fish which support the fishery off No Mans Land during the months from January to March. The major part of the commercial catch (Table 1) was taken off southern Massachusetts during these months but the tagged fish were recaptured mostly off Long Island.

The yellowtails which were tagged off Race Point on the north end of Cape Cod were all but one recaptured from Cape Cod Bay. The exception migrated to the flounder grounds between Cape Ann and the Isle of Shoals.

The yellowtails which were tagged off southern Massachusetts in areas XXII-O and XXII-Q were tagged in the summer and fall months. Those released in XXII-Q off No Mans Land moved first to the eastwardin XXII-O and then to the westward off Block Island (XXII-S) and in one instance as far westward as Jones Beach (Figure 5). Those released off Nantucket (XXII-O) moved westward to XXII-Q and XXII-S. None of these tagged fish were recaptured east or north of Nantucket Shoals and Cape Cod.

Two groups of tagged yellowtail were released near Cultivator Buoy on Georges Bank. All recaptures were made within a few miles of point of release. All recaptures were made within three months of the time of release except one which was captured a year later. The fishermen report that these yellowtail are caught at Cultivator Buoy nearly every winter between December and March. At other times the yellowtail appear to be scattered on Georges Bank (Table 1). Whether these are the same group of fish remains uncertain.

One group of tagged yellowtails was released off the east side of Cape Cod near Nauset Beach Light. These were released in June 1946 and only limited information is now available on returns. Of the 12 recaptured, seven returns were made without information on the place of recapture but it was indicated that these were caught by the Provincetown fleet which fishes east and north of Cape Cod. Four more were said to have been caught near the place of release. One, however, was recaptured south of Nantucket in XXII-O. This is the only authenticated instance of a yellowtail having crossed Nantucket Shoals.

These tagging experiments indicate that the movement of yellowtail across Nantucket Shoals and South Channel is very limited. They show that the yellowtail between Long Island and Nantucket Shoals which are pursued by the fishermen of New Jersey, New York, Connecticut, Rhode Island, and Massachusetts intermingle to a large extent.

The yellowtail which inhabit Cape Cod Bay do not intermingle with those west of Nantucket Shoals but the intermigration between Cape Cod Bay and east of Cape Cod is not clear. No migrations[3/] were recorded between these two localities but the distance is only about 30 miles, no physical barrier is known to exist, and the tagging experiments were not sufficiently comprehensive to indicate that intermigrations could not occur quite frequently.

3/ One of the yellowtail tagged off Hauset was recaptured just off Plymouth in Cape Cod Bay about May 1, 1947.

STOCKS AND MIGRATIONS OF SMALL YELLOWTAIL FLOUNDERS

Yellowtail flounder spawning commences by the middle of March and continues through August near Gloucester (Bigelow and Welsh, 1925, page 499). Our observations in 1943 indicated that spawning began the latter part of April and was completed by the first of July on grounds off No Mans Land (XXII-Q). The egg is buoyant, spherical, very transparent, and averages about 0.9 mm. in diameter. Hatching takes place in 5 days at a temperature of 50° to 52° F. The larvae or fry are symmetrical and pelagic up to a length of one-half inch or more at which time they assume flat-fish characteristics and take up life on the bottom.

During incubation and while in the pelagic stage, the eggs and fry spawned on grounds off southern Massachusetts are subject to drift by currents and wind action. From drift bottle experiments it has been demonstrated that currents sweep in from southern Georges Bank and the western side of South Channel, around Nantucket Shoals, striking Martha's Vineyard and the mainland between Cay Head and Montauk Point during April and May (Walford, 1938). Because of these currents, any yellowtail flounder eggs spawned or hatched on grounds off southern Massachusetts (XXII-Q and XXII-O) should be carried inshore during their pelagic stages and take up life there on the bottom when they become demersal.

Several attempts have been made to obtain small yellowtail flounders employing various methods. In October 1942 a trip was made by the senior author aboard a commercial dragger to the fishing ground known as "the Corner" in subarea XXII-O. On this trip the cod end of a standard commercial net was lined with 1-inch mesh for several tows in an effort to capture immature yellowtails of the smaller sizes on the regular fishing grounds. The smallest yellowtail captured on this trip measured 8.56 inches. At numerous times during the past 4 years, collecting jars have been placed aboard commercial draggers operating out of New Bedford with the request that fishermen save any small yellowtails they might catch in their normal dragging operations. This method has not proved very successful. Few small fish have been secured in this manner, the smallest of which measured approximately 2.1 inches. This specimen was taken in March 1943 off Cox Ledge in subarea XXII-Q. When the fishermen have reported capturing small yellowtails and have brought them ashore the specimens almost invariably are over 7 inches in length.

Efforts were made in September and October 1943 and again in August, September, and October 1945 to capture immature yellowtail flounders with the Fish and Wildlife Service vessel "Skimmer". The vessel was fitted with a single drum winch and other necessary equipment for dragging operations. The nets used for this exploratory fishing were 1-1/2" mesh shrimp trawls, the cod ends of which at times were lined with 3/4" mesh netting. With a knowledge of the spawning date in waters off southern Massachusetts and the drift from currents, young yellowtail were expected to be found inshore from the grounds where the adults were taken commercially during the spawning season. Experimental fishing for yellowtail flounders was conducted in 1943 in Buzzards Bay, Vineyard Sound, and Nantucket Sound, and in 1945 inshore from and on the commercial grounds between No Mans Land and Montauk Point. This fishing was done approximately 4 months after the initial spawning to insure the possibilities of catching immature yellowtails employing normal dragging operations and fine-mesh nets.

In 1943 13 stations were occupied — 2 in Buzzards Bay, 3 in Vineyard Sound, and 8 in Nantucket Sound — without capturing any small yellowtail. In 1945 23 stations from off Gay Head to N by W of Cerberus Shoal in Block Island Sound were occupied without capturing small yellowtail. The tows in 1945 sampled areas both inshore and on the commercial fishing grounds and on all types of bottom so that it is felt the area from No Mans Land to Montauk Point was covered adequately. In July 1946 a tagging trip was made with the Skimmer to the commercial grounds 8 to 14 miles SE of No Mans Land (XXII-Q). The cod end of the net was lined with 1-inch mesh netting. Twenty tows were made and all the yellowtails caught were tagged, the smallest of which measured 8.2 inches. Although no small yellowtails were captured during exploratory fishing and tagging operations, small specimens ranging from 2 inches upwards were captured of the following species: blackback flounder, butterfish, cunner, four-spotted flounder, scup, sea bass, sea robin, squid, and whiting so it is felt that had any immature yellowtails been on the grounds explored, they would have been retained by the net.

The inability to capture immature yellowtail flounders with fine-meshed nets on grounds where they would most surely be deposited by currents and the extreme rarity with which the fishing fleet captures the small fish indicates that the nursery grounds must exist in areas that are not explored. The spawning area of the bulk of the adult population of yellowtail flounders is not known. Some spawn on the grounds between Nantucket Shoals and Montauk Point but usually they are relatively scarce during the spawning season. It is entirely possible that the principal spawning area may be some distance off-shore from the regular commercial grounds and the fry descend to the bottom before the currents carry them to inshore areas. There is an extensive area between the 30 and 40 fathom centours from Nantucket Lightship to Hudson Canyon which is outside the regular fishing grounds and rarely visited by commercial draggers. Very little is known of the fish populations inhabiting the area.

There is also the possibility that the nursery grounds of the yellowtail flounder may be located off southern Long Island. Larval and post-larval forms were captured in Block Island Sound and along the south shore to Jones Inlet during May and June in 1938 (Perlmutter, 1938, page 51). Unfortunately no exploratory fishing was done off southern Long Island with the "Skimmer" although several unsuccessful tows were made in the vicinity of Southwest Ledge and Cerberus Shoal, areas where larval forms were taken by Perlmutter in 1938.

Until adequate exploration can be undertaken the location of the nursery grounds and much of the life history of the young yellowtail flounder must remain speculative.

SUMMARY AND CONCLUSIONS

Records of the activity of the commercial fishing fleet of New England and New York show that the principal source of yellowtail flounders is from grounds situated 10 to 30 miles from the shore from off Cape Ann, Mass. to the vicinity of New York City. Almost all of them are caught in water between 15 and 30 fathoms deep on flat, sandy bottom. Smaller quantities of yellowtail are produced from Georges Bank and the Nova Scotian Banks. Samples of the commercial catch which show the size and proportion of the sexes of the yellowtail indicate that the catches are quite heterogeneous. They vary in size and sex composition even in adjoining areas and from season to season. Tagging studies, however, show a large amount of intermingling of the yellowtail which are pursued by the commercial fisheries along the southern shores of New England between Nantucket Shoals and Long Island. It was considered likely that the yellowtail located along the eastern shore of Massachusetts from Nantucket Shoals to Cape Ann also intermingled to a considerable extent. Migrations across Nantucket Shoals are probably negligible. Returns from the tagging experiments on Georges Bank were too few to show migration, if any exists.

At least part of the yellowtail in the southern New England stock migrate seasonally in an east-west direction. They moved to the eastward about June after the spawning season and then to the westward about December.

Small yellowtail of less than 8 inches were not present in appreciable numbers on the commercial fishing grounds or inshore from these grounds along the southern coast of New England and it was concluded that it was likely that the majority of the yellowtail spawn and the young grow up in locations that are not now fished by the commercial fleet.

The production data by statistical subarea, the composition of the commercial catch, and the results of tagging experiments indicate there probably are at least five different stocks of yellowtail flounder which are pursued by New England fishermen. These stocks are those inhabiting the Nova Scotian Banks, the northern Gulf of Maine, the grounds off eastern Massachusetts, Georges Bank, and those on the grounds off southern New England. The estimated United States production from these five stocks of yellowtail flounder is presented in Table 7 for the seven-year period, 1940-1946. The production for 1938 and 1939 is included also, but the data make it possible to separate only the production of the Nova Scotian Banks from the total.

TABLE 7.—Summary of estimated yellowtail flounder production by stocks (in thousands of pounds)

Year	Nova[1] Scotian Banks, Area XXI	Area: Off Maine and New Hampshire, Areas XXII-B-C-D-F	Area: Eastern Mass., Area XXII-E-G	Area: Georges Bank, Areas XXII-H-J-M-N	Area: Off southern New England, Areas XXII-O-Q-R-S and XXIII	Total[2] New England Banks, Areas XXII and XXIII	Total[2] All areas
1938	666					[3] 22,607	23,273
1939	443					[3] 27,715	28,158
1940	585	115	2,081	1,167	34,515	37,878	38,463
1941	597	74	1,700	1,829	53,529	57,132	57,729
1942	41	26	3,330	2,385	63,157	68,896	68,937
1943	321	77	2,828	2,785	38,665	44,359	44,680
1944	608	70	3,334	3,670	24,702	31,777	32,385
1945	4,734	31	2,553	2,988	20,465	26,034	30,768
1946	2,737	30	2,774	1,913	25,294	30,011	32,748

1/These data are entirely from United States landings. They include the total production from the New England Banks but only a fraction (perhaps about half) of the total production from the Nova Scotian Banks. The balance is caught by ships of other nations.

2/Slight discrepancies occur because of rounding.

3/The data available will not permit a rational breakdown within the New England area.

The data presented in Table 7 were compiled by combining the data on production by subarea from Table 1 for the years 1942 through 1946. Prior to 1942 the catch by area was compiled only for the landings at Boston, Gloucester, and Portland. However, examination indicated that the production by port could be assigned to stocks with a negligible error. This was done to arrive at the production figures for 1940 and 1941. Data on production by port were not available for 1938 and 1939 except for Boston, Gloucester, Portland, New York City, and New Bedford. Production for the Nova Scotian Banks was obtained from the landings at Boston, Gloucester, and Portland, the only ports at which the catch data by area were obtained, by assuming that all vessels fishing the Nova Scotian Banks landed at one of these ports. Information from fishermen and others indicates that this assumption is valid.

The material here presented shows that the sharp fluctuation in the United States landings of yellowtail flounders has occurred primarily because of the fluctuation in the landings from the southern New England stock. The other stocks contributed only from 10 to 40 percent of the total catch. This southern New England stock is subject to a fishery which is prosecuted by vessels from New Jersey, New York, Connecticut, Rhode Island, and Massachusetts.

The smaller stock along the eastern coast of Massachusetts is fished almost entirely by fishermen from the State of Massachusetts. Yellowtail on Georges Bank are caught incidentally to the fishery for haddock and cod which is conducted mostly by fishermen from Massachusetts but also, to a lesser extent, by the fishermen from New York.

This study summarizes a part of the information which the Fish and Wildlife Service is accumulating on the yellowtail flounder. Other aspects of the problem of determining the effect of fishing on the stock will be presented at a later date.

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APPENDIX A

SOURCES OF DATA ON PRODUCTION OF YELLOWTAIL, 1940-1946[1]

The following paragraphs contain the details concerning the sources of the production data by ports. Where more than one source was available for any single year, preference was given to that source considered most reliable.

1. PORTLAND, MAINE; BOSTON, AND GLOUCESTER, MASS.

a. 1938: Fishery Industries of the United States 1939, Administrative Report No. 41: total production for the year, pages 279-336.

b. 1939: Fishery Statistics of the United States 1939, Statistical Digest No. 1: total production for the year, pages 44-90.

c. 1940-1945: Landings at Certain New England Ports, Statistical Bulletins and Current Fishery Statistics, United States Department of the Interior, Fish and Wildlife Service[2]: all data by statistical subarea.

d. 1946: New England Landings, Current Fishery Statistics: all data by statistical subarea.

1/ All dates are inclusive.

2/ Unless otherwise specified all publications are those published by the U. S. Department of the Interior, Fish and Wildlife Service, Washington, D. C.

2. NEW BEDFORD, MASS.

a. 1940: monthly landings copied from dealers' records.

b. 1941: monthly landings compiled from hails telephoned to Boston Fishery Market News Service by the port agent (Atlantic Fishermen's Union).

c. 1942: Landings of Fishery Products at New Bedford, Mass. Current Fishery Statistics 108: landings by months.

d. 1943 (Jan-June): monthly landings by subarea compiled from dealers' records and daily interviews.

e. 1943 (July)-1945: Landings by Fishing Craft at New Bedford, Mass., Current Fishery Statistics: all data by statistical subarea.

f. 1946: New England Landings, Current Fishery Statistics: monthly landings by subarea.

3. PROVINCETOWN, MASS.

a. 1940-1943 (July): monthly landings compiled from hails to Boston Fishery Market News Service.

b. 1943 (August)-1946: monthly landings from records of the Mass. Dept. of Conservation, Division of Marine Fisheries.

4. WOODS HOLE, MASS.

a. 1940-1943 (July): monthly landings compiled from hails to Boston Fishery Market News Service.

b. 1943 (August)-1946: monthly landings copied from records of the Mass. Dept. of Conservation, Division of Marine Fisheries.

5. CHATHAM, MASS.

a. 1943 (August)-1946: monthly landings copied from records of the Mass. Dept. of Conservation, Division of Marine Fisheries. Landings prior to this date are unavailable and yellowtail landings are considered to be negligible.

6. PLYMOUTH, MASS.

a. 1944 (October)-1946: monthly landings compiled from original dealers' records. The only records available date back to October 1944. Landings prior to this date are considered to be negligible.

7. NANTUCKET, MASS.

a. 1944-1946: monthly landings compiled from original dealers' records. Landings prior to 1944 are considered to be negligible.

8. RHODE ISLAND.

a. 1940: Fishery Statistics of the United States, 1941: Statistical Digest No. 7: total production for the year.

b. 1941: monthly landings compiled from daily shipments into New York City as reported by the New York Fishery Market News Service.

c. 1942: New England Fisheries, 1942: Current Fishery Statistics 164 gives total production for the year. Monthly landings were compiled from daily shipments into New York City.

d. 1943-1946: monthly landings compiled from daily shipments into New York City as reported by the New York Fishery Market News Service.

9. CONNECTICUT.

a. 1940-1941: Twenty-fourth Biennial Report of the Connecticut State Board of Fisheries and Game, State of Connecticut, Public Document No. 19: landings by months.

b. 1942: New England Fisheries, 1942: Current Fishery Statistics 164: total production for the year. Monthly landings compiled from daily shipments into New York City.

c. 1943-1946: monthly landings compiled from daily shipments into New York City as reported by the New York Fishery Market News Service.

10. NEW YORK CITY, NEW YORK.

a. 1940-1944: Landings by Fishing Craft at New York City, Current Fishery Statistics 193: landings by months.

b. 1945: Landings by Fishing Craft at New York City, Current Fishery Statistics 269: landings by months.

c. 1946: landings compiled by months from fishing craft weighouts as reported by the New York Fishery Market News Service.

11. LONG ISLAND, NEW YORK.

a. 1940-1946: monthly landings compiled from daily shipments into New York City as reported by the New York Fishery Market News Service.

12. NEW JERSEY.

a. 1940-1946: monthly landings compiled from daily shipments into New York City as reported by the New York Fishery Market News Service.

Although certain data on the production of yellowtail flounders are available for years prior to 1940, landings prior to this date are compiled by the home port of the vessel instead of the port in which the trips were landed. In view of this, it is impossible to assign landings of yellowtail flounders prior to 1940 to individual subareas except that it is assumed that all of the production from the Newfoundland and Nova Scotian Banks was landed at the ports of Boston, Gloucester, and Portland. These datahave been used in conjunction with the total landings as reported by the production in 1938 and 1939.

APPENDIX B

TREATMENT OF THE DATA ON PRODUCTION, 1940-1946

The information necessary to assign the landings of yellowtail flounder to statistical subareas (fishing areas) was obtained as follows:

1. PORTLAND, MAINE; GLOUCESTER and BOSTON, MASS., 1938-1946, and NEW BEDFORD, MASS., Oct. 1942-1946.

Data were collected daily by the Fish and Wildlife Service and mostly published in the form of Current Fishery Statistics bulletins by the United States Fish and Wildlife Service.

2. NEW BEDFORD, MASS.

Landings at this port from January to September 1942 were assigned to statistical subareas according to information compiled from log book records which had been kept by several of the captains fishing out of the port.

3. CHATHAM, MASS.

The fishing fleet consists of 30 or more line trawlers, 35-45 feet in length, which, as a rule, fish the same grounds throughout the year. According to interviews with fishermen in 1946, the area fished extends from #6 Buoy to #10 Buoy on the western side of South Channel in depths ranging from 15 to 30 fathoms on hard rocky bottoms shunned by otter trawlers. All species of fish landed at Chatham can be assigned to the subarea II-G with a negligible error.

4. PROVINCETOWN, MASS.

The fleet consists of 35 to 40 small otter trawlers which follow a regular seasonal pattern of fishing for yellowtail. During the winter months of November to March, the fleet fishes Cape Cod Bay and Massachusetts Bay, statistical subarea II-E, and during the rest of the year they fish east of Cape Cod on the western side of South Channel in statistical subarea II-G. On the basis of this information, which was gathered through interviews with captains of vessels operating out of Provincetown, the landings of yellowtail flounder were assigned to the two subareas for the months indicated.

5. PLYMOUTH, MASS.

The fleet fishing out of Plymouth consists of less than 20 small otter trawlers which regularly fish Cape Cod Bay and Massachusetts Bay, statistical subarea II-E, and all landings of yellowtail flounders have been assigned to this subarea.

6. WOODS HOLE, MASS.

The regular fleet consists of 15 or more small otter trawlers and 2 medium otter trawlers that fish the same grounds fished by the New Bedford fleet of small otter trawlers. Trips are landed there occasionally by New Bedford vessels so that the landings of yellowtail flounders at Woods Hole were assigned to statistical subareas according to the data collected at New Bedford on grounds fished by small otter trawlers.

7. NANTUCKET, MASS.

Most of the vessels landing in this port are small and medium draggers that commonly fish the same grounds fished by the New Bedford fleet and land there but occasionally. The same vessels also land in New Bedford or Woods Hole so that the landings at Nantucket were assigned to statistical sub-areas according to the landings by vessels at New Bedford.

8. PORTS IN RHODE ISLAND, CONNECTICUT, AND LONG ISLAND, NEW YORK.

As stated in Appendix A, landings at ports in these states were obtained from shipments into New York City since no other source was available except for the States of Rhode Island and Connecticut for 1942. The total monthly shipments from Rhode Island for 1942, being somewhat lower than the production as reported by Current Fishery Statistics 164, New England Fisheries, 1942, were multiplied by the factor 3.505 to raise them to the same level. This factor was obtained by dividing the reported production by the total shipments and was applied to Rhode Island shipments for the succeeding years 1943-1946.

The monthly shipments into New York City from Connecticut for the years 1942-1946 were multiplied by the factor 1.49. This factor was obtained by dividing the 1942 production as reported by Current Fishery Statistics 164 by the total shipments for the same year to bring the shipments up to the same level.

The total monthly shipments into New York City from ports in Long Island were assumed to represent the monthly production since the data on production reported by the New York Fishery Market News Service seemed less reliable.

Landings at these ports were assigned to statistical subareas according to information gathered from interviews with fishermen from these ports. This information was obtained in October and November 1946.

9. NEW YORK CITY, NEW YORK.

Landings of yellowtail flounders at this port were assigned to the same subareas as those landed at New Bedford, except that II-E was omitted, since the fleet commonly fishes most of the grounds fished by the New Bedford fleet. This was the opinion of captains of both small and medium draggers landing fish at New York City.

The assignment of yellowtail flounder landings at ports other than Portland, Me., and Boston, Gloucester, and New Bedford, Mass., where the interview system is a daily operation, is admittedly less accurate. The proportion of the total yellowtail landings assigned to subareas according to daily interview data was as follows: 1943 - 64.1%, 1944 - 50.9%, 1945 - 68.8%, 1946 - 64.1%. The remaining proportion of the landings each year was assigned to subareas according to occasional interviews with fishermen in other ports and probably better represents the average yearly fishing activities rather than the month to month distribution as does the port interview system.