

Landings per Unit of Effort, Age Composition and Total Mortality
of Yellowtail Flounder (Limanda ferruginea) in Subarea 5Z

by

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ABSTRACT

Yellowtail abundance in subarea 5, in terms of catch per day, increased up to 1963 because of high recruitment from the 1958-60 year classes. Subsequent year classes have been smaller, and abundance presently is dropping. The annual total mortality rates for the southern New England ground and Georges Bank, estimated from catch per day by age group in 1960-65, were 64% and 63% respectively. The sum of limited information on the natural mortality rate suggests that it is no more than 15% per year and that it may be less than this.

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Yellowtail flounder are caught on three grounds off New England: the southern New England ground, Georges Bank, and the Cape Cod ground. Each ground supports a relatively separate group of fish (Lux, 1963). The southern New England and Georges Bank groups, for which abundance, age composition, and mortality data are here given, supply about 90 percent of the catch.

Growth of yellowtail is rapid, fish entering the catch at age 2 and being fully recruited by age 4 (Lux and Nichy, Lab. Ref. 67-2). They make their peak contribution to the catch at age 3, and since exploitation is intense few fish survive beyond age 6.

Apparent abundance, measured by landings per day (Lux, 1964), has varied widely in the period over which records have been obtained, dropping between 1943 and the mid-1950's, then increasing up to 1963, and then decreasing in 1964-65 (table 1). Preliminary data for 1966 indicated that the 1964-65 decrease was continuing. Landings per day by age group in 1960-65 (tables 2 and 3 and figure 1) show that strong year classes spawned in 1958, 1959, and 1960 contributed greatly to the increased abundance of recent years.

Fishing effort increased with increasing abundance in 1960-63 (table 1). However, when abundance dropped in 1964-65, effort, instead of decreasing as well, continued to increase, reaching its highest level for the entire period of record in 1965.

The total mortality rate in 1960-65 was estimated from the survival from one year to the next of fully recruited fish from the

1954-60 year classes (table 4, figure 2). Survival ratios of 0.36 and 0.37 for the southern New England and Georges Bank groups indicate that total mortality rates on age groups 4 through 7 were about 64 and 63 percent per year ($Z = 1.02; 1.00$) values which would be considered high in most fisheries.

Table 1.--Landings, landings per day, and days fished
on the southern New England ground and Georges
Bank in 1943-65 (landings and landings per day are
in metric tons).

Year	Southern New England			Georges Bank		
	Total landings	Landings per day	Days fished	Total landings	Landings per day	Days fished
1943	18,039	3.17	5,681	1,262	6.37	198
1944	10,615	2.55	4,164	1,664	7.66	217
1945	10,368	3.63	2,852	1,356	4.81	282
1946	10,824	3.01	3,596	868	3.75	232
1947	12,111	2.66	4,550	2,257	4.70	480
1948	9,919	1.96	5,047	5,656	5.04	1,122
1949	4,673	1.44	3,248	7,300	2.93	2,493
1950	4,709	1.54	3,062	3,892	2.38	1,636
1951	2,786	1.48	1,889	4,311	2.68	1,611
1952	2,989	1.26	2,364	3,651	2.29	1,596
1953	1,976	1.37	1,442	2,897	2.33	1,241
1954	1,515	1.26	1,200	2,886	2.08	1,385
1955	2,180	1.42	1,529	2,945	2.39	1,234
1956	3,541	1.54	2,297	1,594	2.02	790
1957	5,440	2.30	2,396	2,301	2.80	821
1958	8,905	2.43	3,666	4,533	3.24	1,400
1959	7,737	1.58	4,904	4,130	2.10	1,969
1960	7,842	1.77	4,439	4,446	2.20	2,018

Table 1. --Cont'd

Year	Southern New England			Georges Bank		
	Total landings	Landings per day	Days fished	Total landings	Landings per day	Days fished
1961	11,630	2.48	4,686	4,247	2.34	1,816
1962	17,765	3.30	5,383	7,767	3.31	2,347
1963	24,295	4.06	5,976	10,990	4.56	2,409
1964	20,753	3.70	5,613	14,910	4.20	3,552
1965	20,338	3.06	6,644	14,244	3.18	4,486

Table 2. --Estimated numbers by age group of yellowtail flounder landed per standard day fished on the southern New England ground in 1960-65.

Year and quarter	Number of annual rings								Total
	1	2	3	4	5	6	7	7+	
<u>1960</u>									
Jan-Mar	--	67	503	689	830	111	22	---	2,224
Apr-June	--	942	684	502	422	21	59	40	2,670
July-Sept	18	2,748	829	667	320	65	---	---	4,634
Oct-Dec	4	4,523	663	533	148	36	---	---	5,920
<u>1961</u>									
Jan-Mar	--	55	3,702	328	278	150	27	9	4,554
Apr-June	--	256	3,032	217	256	116	---	---	3,872
July-Sept	--	2,486	3,388	260	227	110	13	---	6,490
Oct-Dec	--	3,682	3,690	626	200	100	33	17	8,349
<u>1962</u>									
Jan-Mar	--	95	3,948	1,621	161	67	13	10	5,914
Apr-June	--	260	5,208	1,158	161	19	14	2	6,822
July-Sept	--	1,301	5,052	1,644	62	33	14	---	8,106
Oct-Dec	--	3,938	8,005	1,510	278	55	22	20	13,829

Table 2. --Cont'd

Year and quarter	Number of annual rings								Total
	1	2	3	4	5	6	7	7+	
<u>1963</u>									
Jan-Mar	--	34	4,880	3,775	803	147	15	---	9,654
Apr-June	--	96	4,748	3,156	530	109	28	---	8,667
July-Sept	--	1,241	5,592	3,723	618	30	27	---	11,231
Oct-Dec	18	3,239	5,352	1,862	399	4	17	---	10,890
<u>1964</u>									
Jan-Mar	--	11	2,203	3,000	1,536	306	8	6	7,070
Apr-June	--	149	1,283	1,178	1,322	---	168	---	4,098
July-Sept	--	1,644	2,383	2,462	2,649	129	47	---	9,313
Oct-Dec	16	2,931	1,916	2,134	1,165	264	15	8	8,449
<u>1965</u>									
Jan-Mar	--	95	2,952	1,795	1,385	558	114	8	6,908
Apr-June	--	159	2,105	812	962	580	73	6	4,697
July-Sept	--	1,705	3,356	902	982	551	39	4	7,539
Oct-Dec	--	3,383	2,395	1,057	595	203	55	---	7,688

Table 3. --Estimated numbers by age group of yellowtail flounder landed per standard day fished on Georges Bank in 1960-65.

Year and quarter	Number of annual rings							Total
	2	3	4	5	6	7	7+	
<u>1960</u>								
Apr - June	501	921	646	573	81	33	25	2,783
July - Sept	2,384	1,788	697	431	16	---	---	5,321
<u>1961</u>								
Apr - June	130	2,554	747	225	170	55	71	3,953
July - Sept	1,398	3,091	304	227	103	26	10	5,160
<u>1962</u>								
Apr - June	69	2,821	1,361	332	235	100	38	4,958
July - Sept	1,498	3,889	1,235	338	139	37	16	7,152
<u>1963</u>								
Apr - June	40	3,730	1,613	746	90	31	27	6,277
July - Sept	805	8,091	2,025	380	98	14	22	11,436
<u>1964</u>								
Apr - June	100	2,328	3,676	649	106	50	11	6,919
July - Sept	851	3,108	3,695	785	88	95	7	8,630

Table 3. --Cont'd

Year and quarter	Number of annual rings							Total
	2	3	4	5	6	7	7+	
<u>1965</u>								
Apr - June	50	2,197	1,317	1,103	227	66	29	4,988
July - Sept	328	3,188	1,630	966	210	50	24	6,395

SO. NEW ENGLAND GROUND
JAN-DEC

GEORGES BANK
APR-SEPT

NUMBER OF FISH PER DAY'S FISHING

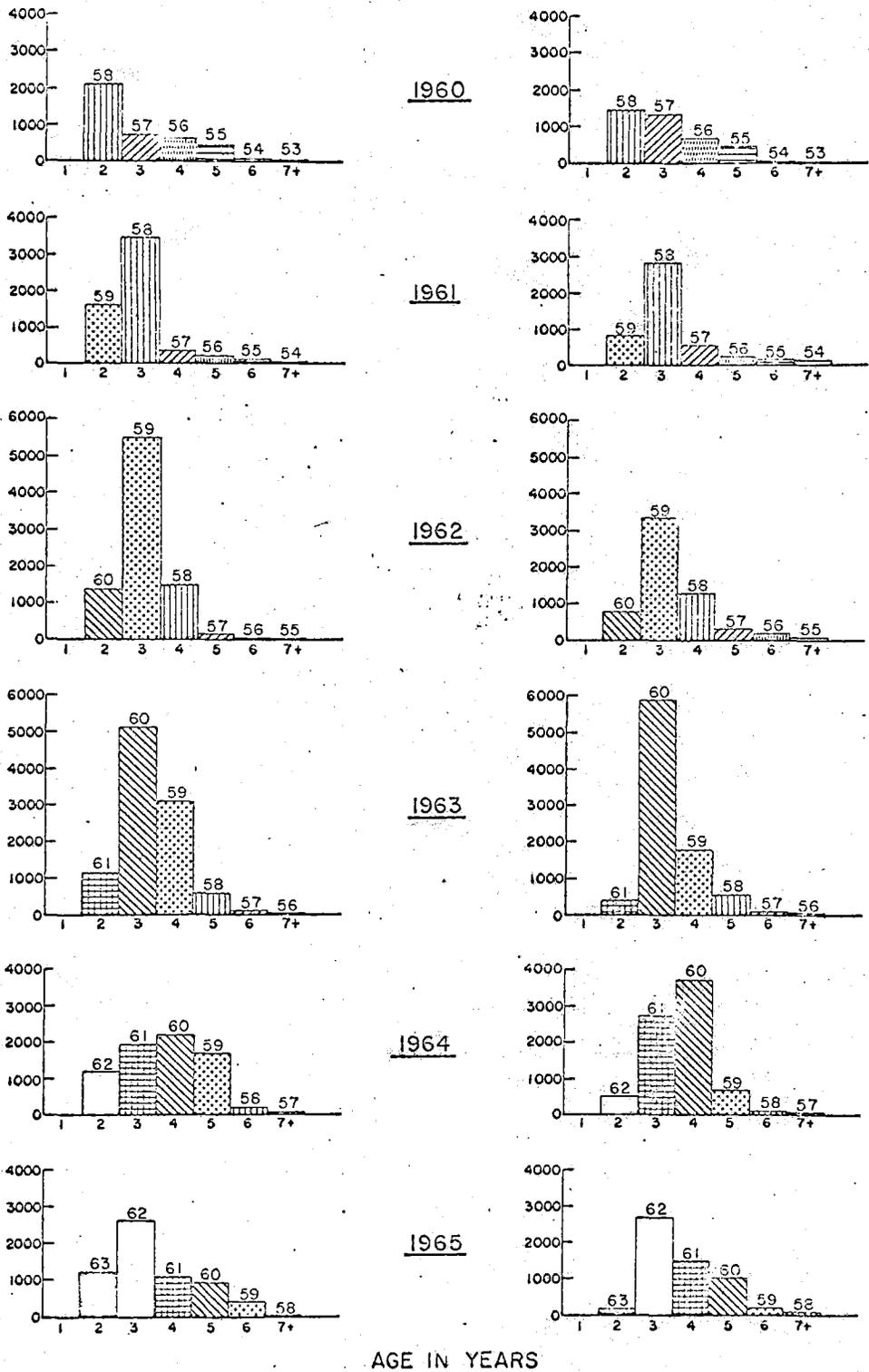


Figure 1. --The age compositions of yellowtail flounder on the southern New England ground and Georges Bank in 1960-65. (Numbers at tops of bars indicate year classes.)

Table 4. --Survival ratios for yellowtail flounder of age groups 4-7 from the 1954-60 year classes. (The ratios were computed from data of Tables 2 and 3, using only values based on 6 or more age determinations.)

Calendar quarter	Survival Ratio			Geometric mean
	Age group			
	4 - 5	5 - 6	6 - 7	
	<u>Southern New England ground</u>			
Jan - Mar	0.442	0.340	0.338	0.370
July - Sept	0.518	0.220	---	0.338
Oct - Dec	0.396	0.331	---	0.362
Geometric mean	0.449	0.291	0.338	0.356
	<u>Georges Bank</u>			
Apr - June	0.380	0.328	0.606	0.423
July - Sept	0.339	0.295	---	0.316
Geometric mean	0.359	0.311	0.606	0.366

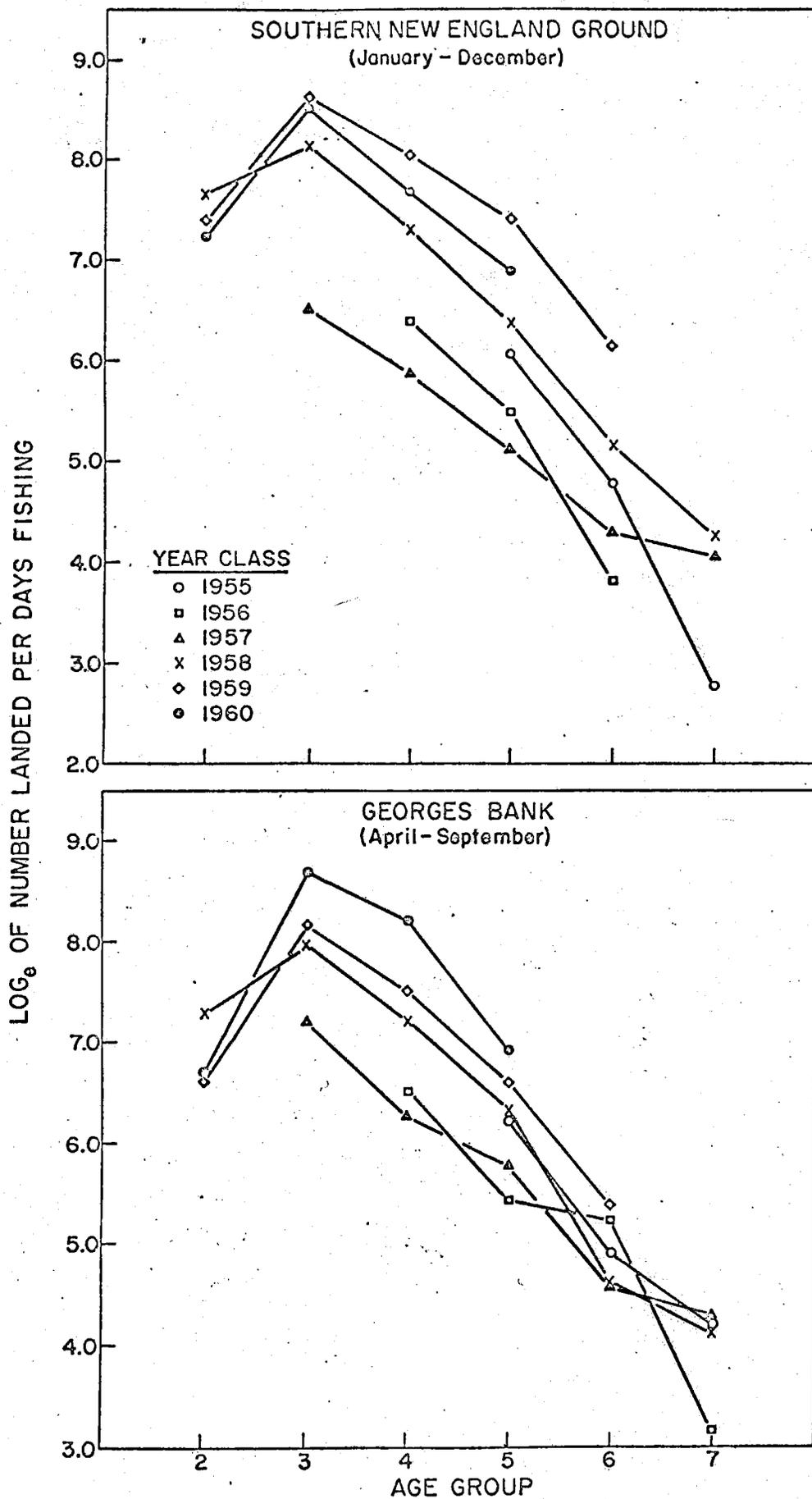


Figure 2. -- Catch curves for yellowtail flounder for the 1955-60 year classes on the southern New England ground and Georges Bank.

The high fishing effort of recent years probably increased total mortality in 1960-65 over that of previous years. Mortality was higher, for example, than the 54 percent per year ($Z = 0.78$) estimated from the data of Royce, Buller, and Premetz (1959) for age groups 4 to 6 in 1943-47 on the southern New England ground. Fishing effort continued to increase in 1966, and since apparent abundance still was decreasing from the peak level of 1963 total mortality presumably continued to increase as well.

We have insufficient data to estimate the natural mortality rate; generally, however, it is felt that losses of flatfish from natural causes are small. Natural mortality of the European plaice, for example, a species that is similar to the yellowtail, has been estimated to be 10% per year ($M = 0.10$) (Beverton and Holt, 1957).

Predation may in some cases be a leading source of natural mortality. Stomach analyses of all species of fish caught in New England groundfish surveys aboard Albatross IV in 1963-66 indicated, however, that predation was not a significant cause of mortality in yellowtail.

Some information on natural mortality was obtained from results of marking experiments. The overall return rate of tagged yellowtail usually has been about 25%. In one southern New England lot, however, in which only 7 fish were tagged and carefully handled aboard a research vessel all were returned within 56 months time (table 5). These 7 fish were caught and released in an area where fishing effort is light. Clearly, there were no losses from natural mortality or tagging mortality, and no tags became detached or were lost to the experiment through failure of the finders to report them.

From this lot the upper limit of natural mortality can be estimated by using the average time at liberty, 22 months, and calculating the probability, through binomial expansion, of no losses from natural mortality in this period at various assigned values of natural mortality. If the natural mortality rate is assumed to be 20% per year ($M = 0.22$), for example, the probability of no losses through natural causes in 22 months is 0.04. For an assumed mortality of 15% ($M = 0.16$), the probability is 0.10. From this it is suggested that natural mortality is less than 20%, and quite probably less than 15% per year, at least for the age groups dealt with here.

Table 5. --Recovery dates and lengths and ages at tagging of 7
yellowtail flounder tagged in February, 1957, on the
southern New England ground.

Recovery date	Length at tagging (cm)	Age at tagging (years)	Months at liberty
July, 1957	34	3	5
Sept. 1957	34	3	7
Nov. 1957	27	2	9
Aug. 1958	29	2	18
Apr. 1959	30	2	26
Jan. 1960	37	3	35
Oct. 1961	28	2	56

Literature Cited

Beverton, R. J. H. , and S. J. Holt

1957. On the dynamics of exploited fish populations.
U.K. Min. Agr. and Fish. , Fish. Invest. , Ser. 2,
19, 533 pp.

Lux, Fred E.

1963. Identification of New England yellowtail flounder
groups. U.S. Dept. of the Int. , Fish and Wildl. Serv. ,
Fishery Bull. 63(1): 1-10.

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1964. Landings, fishing effort, and apparent abundance in
the yellowtail flounder fishery. ICNAF Res. Bull.
No. 1: 5-22.

----- and F. E. Nichy

1967. Growth rates of yellowtail flounder, Limanda ferruginea,
on three New England fishing grounds. Lab. Ref.
67-2.

Royce, Wm. F. , R. J. Buller, and E. D. Premetz

1959. Decline of the yellowtail flounder (Limanda ferruginea)
off New England. U.S. Dept. of the Int. , Fish and
Wildl. Serv. , Fishery Bull. 146, 59: 169-267.