INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 2905
(D.c.3)

ICNAF Res.Doc. 73/5

ANNUAL MEETING - JUNE 1973

Status of yellowtail fishery in ICNAF Divisions 3L, 3N and 30[1]

by

T. K. Pitt
Fisheries Research Board of Canada
Biological Station, St. John's, Nfld.

Published in ICNAF RES. BULL. NO. 11: 125-134

Introduction

Commercial fishing for yellowtail flounder on the Grand Bank began in 1965. The stock apparently expanded during the past several years (Pitt, 1970) and landings increased rapidly especially since 1968 (Table 1). Yellowtail flounder were first recorded in commercial quantities in both research and commercial catches on the southern half of the bank (Division 3N) but gradually spread to most of the shallower localities (less than 91 m). At the 1972 annual meeting of ICNAF a preliminary quota of 50 thousand tons for 1973 was agreed upon. This document attempts to give more precise estimates of abundance from what is suggested as a more accurate assessment of the stock than previously presented (Pitt, 1972).

Methods

The virtual population method as modified by Gulland (1965) and Jones (1961, 1968) has been used by several authors in assessments of N.W. Atlantic fish stocks and was used here to obtain values of fishing mortality (F) for the various ages of the year-classes. The method first of all requires estimates of the total annual number of fish caught at each age for a period of years. In this case the numbers caught at each age since the fishery began, 1965-71, were calculated from the total landings and the age distributions from sampling of the commercial catch of Canada(N) trawlers. In addition to the numbers caught, estimates of instantaneous natural mortality (M) and the exploitation rate at the older age groups, $E(1-e^{-Z})$, were also required.

In previous documents (Pitt, 1971 and 1972) it was shown that M for Grand Bank yellowtail was probably greater than 0.25 and perhaps not more than 0.40. In this assessment a value of 0.30 was used.

Pitt (1972) using the catch per 100 hours fishing calculated total mortality rates (Z) averaging from 1.21 to 1.89 for the fully recruited age groups of a number of year-classes. Using the catch per unit fishing intensity of yellowtail landed by Canada(N) trawlers (Table 2) gave total mortality (Z) rates averaging around 1.30. With an M of 0.30 the exploitation rate based on F = 1.0 was used as a starting value for the computations.

Fishing intensity was calculated by weighting the effort of the Canada(N) fleet by the total area fished (in square nautical miles) by that fleet.

Age and length data were available for Divisions 3L and 3N only so that values of F and stock size were estimated from these combined divisions. Catch and effort data however were available for Division 30 so that catch per hour and catch per unit fishing intensity also includes that division.

[1] Revision of Sp.Mtg.Res.Doc. 73/5 presented to Special Commission Meeting, FAO, Rome, January 1973.

Results

Estimates of stock abundance

The catch per unit effort for total effort and catch in Divisions 3L, 3N and 3O for Canada(N) (Fig. 1) appears to indicate that after an initial decline in 1966 and 1967 the stock has remained relatively stable at 320 to 400 kg (700-900 lb) per hour. However the catch per hour with yellowtail as the main species suggests a gradual decline from 1965 to 1969 at which point it stabilized at about 600 kg (1300 lb) per hour. Total effort with yellowtail as the main species has increased from 3000 hours in 1965 to 43,500 in 1970 and 63,000 in 1971 and will probably reach 72,000 hours in 1972.

The catch per unit effort, however, may not be a good index of abundance since it is probable that with the gradual spread of yellowtail to most shallow localities, small catches in the periferal localities have tended to reduce the overall catch per hour for Divisions 3L, 3N and 3O combined. Catch per unit fishing intensity is therefore perhaps a better index of abundance.

For the three subdivisions combined there was a general increase in the catch per unit fishing intensity (Fig. 2). The peak in 1968 can perhaps be attributed to unusually high catches in two particular statistical areas (St. John's Station statistical units) of 3L and 3O during September. From 1968 to 1971 in Division 3N there was a general upward trend. Division 3L however indicated a fluctuation condition with a reduction since 1970. Division 3O which normally produces small catches has shown a gradual increase after decreasing sharply from the peak in 1968 as previously noted.

Estimations of stock size in Divisions 3L and 3N at the beginning of the year from the catches and the estimated F at each age point to a rapid increase in the numbers of fish present 5 years and older since the beginning of the fishery in 1965 (Table 3). At the beginning of 1965 the estimated stock size was 30 million fish and this increased to about 287 million in 1970 and 1971.

Estimates of F for 1965 to 1970 indicate that yellowtail flounder are fully recruited at age 7 (Table 4). A similar conclusion was derived from survival rates calculated from the numbers per unit fishing intensity (Table 1). The mean value of F for the fully recruited age groups 1967-70 was 0.80. From the stock size estimated from the 1970 parameters and the landings in 1971, F for the fully recruited age group was estimated at 0.65. Annual rates of instantaneous fishing mortality (1965-70) for the recruited age groups ranged from 1.17 to 0.74 (Table 4); however, because most of the annual catches usually did not produce fish older than 10 years, the averages are generally based on two ages only.

Yield curves (Fig. 3) using partial recruitment values were not very different from those calculated from F.A.O. tables using "knife edge" recruitment (Pitt, 1972). The optimal level of fishing occurred at F = 0.65 or at about 92% of the maximum yield.

The 1971 values of F for Divisions 3L and N were used to calculate total Grand Bank stock size, i.e. Divisions 3L, 3N and 3O, from the total landings and from this the stock size at the beginning of 1972. Since the Canadian landings (Canada(N) and Canada(M)) were available, estimates of total 1972 landings, based on previous years performances by other countries, were made and values of F and the stock size at the beginning of 1973 were estimated (Table 5).

The average number of 4-year-olds entering the fishery (1969-72) based on the average number of 5-year-olds was approximately 165 million fish. Since the yield curves (Fig. 3) are based on one million recruits entering the fishery at age 4, the long-term sustainable yield works out at approximately 37 thousand tons.

Using the same F values as in 1973 gave a projected catch of about 50,000 tons which was the quota set at the 1972 meeting. Fishing a little above "F opt" at F = 0.70 during 1974 should give a catch of about 39,000 tons (Table 5).

Discussion

There was evidence that up to 1971 at least the stock size of yellowtail has been increasing as this species spread to most of the shallower (91 m and less) areas of the bank. The catch per unit fishing intensity (Fig. 3) for Canada(N) declined however in 1972 in Divisions 3L and 3N but continued to increase slightly in Division 3O. Landings from Division 3O by the Canadian fleet were relatively small (Table 1) with the catch per hour and catch per unit fishing intensity at a comparatively low level. It appears that any further expansion of the stock would have to be in the latter Division.

The 1973 quota of 50,000 tons was based on an incomplete assessment in 1972 and it appears that landings of this magnitude will occur only at a relatively high fishing level, i.e. about 98% of the maximum yield per recruit. The prediction of the numbers of 4-year-olds present at the beginning of 1971 and hence the subsequent contributions of 5-, 6- and 7-year-olds in 1972, 1973 and 1974 respectively may be somewhat tenuous since 4-year-olds appear in the landings in comparatively small numbers usually in the autumn catches when they reach a size of 25-30 cm. However, the relatively high estimate of 4-year-olds in 1972 (Table 5) is consistent with estimates from research vessel surveys which indicated 3 to 4 times as many of this age group as in the 1971 data.

A problem in assessing yellowtail on the Grand Bank is getting a true estimate of the actual numbers caught since, besides the countries reporting yellowtail catches, there must be considerable numbers taken as by-catches and either discarded or put to industrial use and not reported as yellowtail flounder. The assessment therefore was made on the best available information.

References

Gulland, J. A. 1965. Estimates of mortality rates. Annex to Arctic Fisheries Working Group Report. ICES C.M. 1965(3) (mimeo).

Jones, R. 1961. The assessment of long-term effects of changes in gear selectivity and fishing effort. Mar. Res. No. 2: 1-19.

1968. Appendix to Report of the Northwestern Working Group. ICES C.M. 1968(20) (mimeo).

Pitt, T. K. 1970. Distribution, abundance and spawning of yellowtail flounder, Limanda ferruginea, in the Nfld. area of the N.W. Atlantic. J. Fish. Res. Bd. Canada 27: 2261-2271.

1971. Age composition and estimates of total mortality for Grand Bank yellowtail flounder (Limanda ferruginea). ICNAF Res. Doc. 71/118, Ser. No. 2612.

1972. Assessment of yellowtail flounder in ICNAF Divisions 3L and 3N. ICNAF Res. Doc. 72/86, Ser. No. 2789, Redbook Part III, p. 72-78.

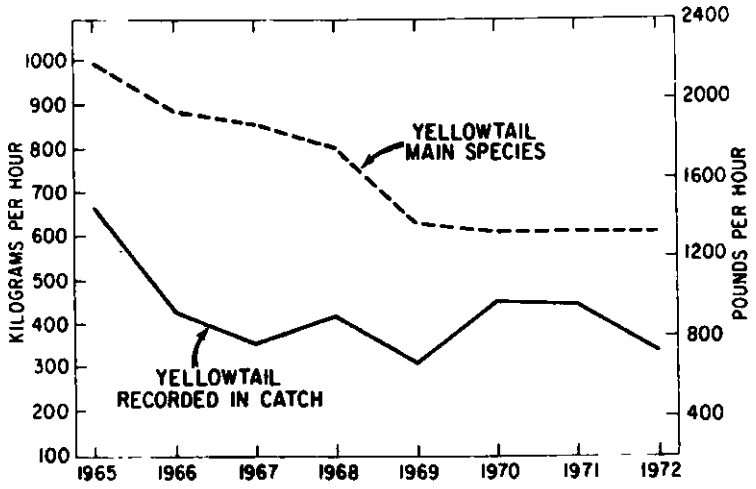

Fig. 1. Catch per hour of yellowtail flounder by Canada(N) stern trawlers. Broken lines, main species and solid lines, some yellowtail recorded in the catch.

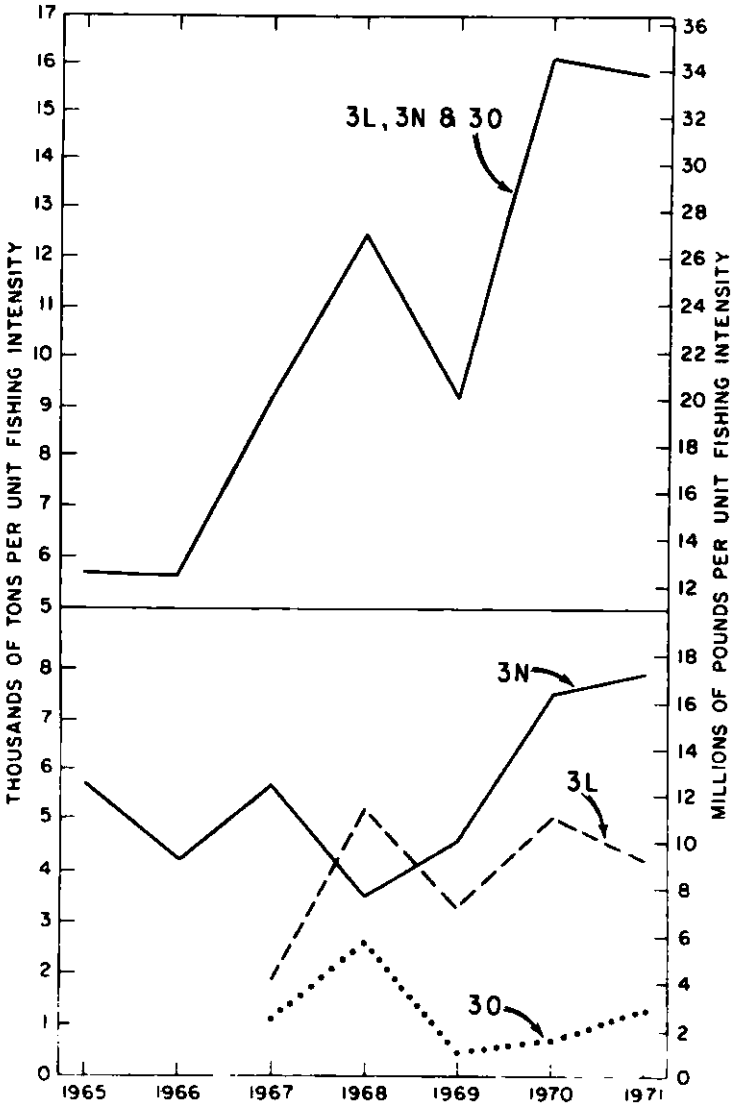

Fig. 2. Catch per unit fishing intensity 3LN and 0 combined, above and the separate divisions, below.

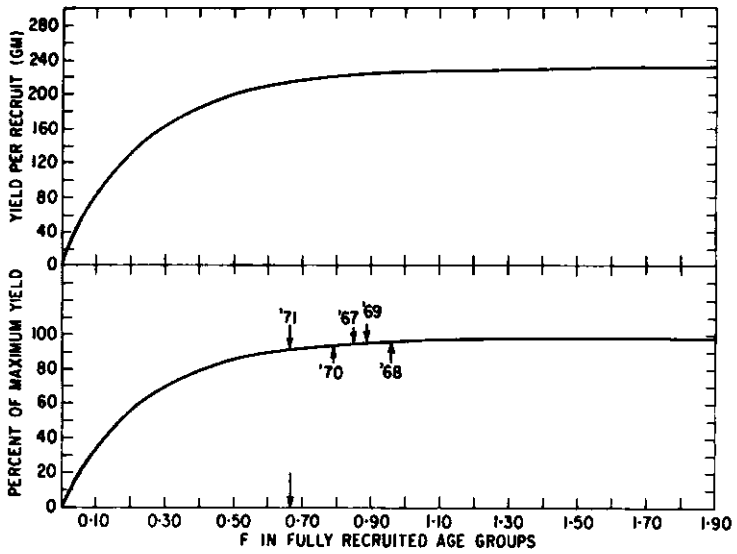

Fig. 3. Yield per recruit (above) and percentage of maximum yield (below) for yellowtail flounder based on partial recruitment. Arrow at base shows "optimal level". Fishing levels for 1967-71 are indicated.

Table 1. Nominal catches of yellowtail flounder in ICNAF Divisions 3L, 3N and 3O (metric tons). "Other" landings up to 1970 based on USSR 1970 breakdown of unspecified flounder.

Year	Country	Division 3L	Division 3N	Total 3L & N	Division 3O
1965	Canada(M)	115	951	1,066	
	Canada(N)		2,001	2,001	6
	Other		19	19	
	TOTAL	115	2,971	3,086	6
1966	Canada(M)	57	1,737	1,794	300
	Canada(N)	5	1,948	1,953	138
	Other		2,035	2,035	
	TOTAL	62	5,720	5,782	438
1967	Canada(M)	118	429	547	81
	Canada(N)	334	1,081	1,415	78
	Other		3,451	3,451	
	TOTAL	452	4,961	5,413	159
1968	Canada(M)	632	149	781	
	Canada(N)	2,164	1,081	3,245	107
	France(S.P.)	3	5	8	
	Other	60	5,138	5,198	
	TOTAL	2,859	6,373	9,232	107
1969	Canada(M)	3,217	1,048	4,665	273
	Canada(N)	2,033	3,840	5,873	53
	Other	19	1,867	1,886	
	TOTAL	5,269	6,755	12,424	326
1970	Canada(M)	718	2,069	2,787	156
	Canada(N)	6,657	13,003	19,660	183
	Other	16	3,426	3,442	
	TOTAL	7,391	18,498	25,889	339
1971	Canada(M)	874	3,150	4,024	196
	Canada(N)	5,741	13,851	19,592	392
	Other	16	8,172	8,178	4,948
	TOTAL	6,631	25,173	31,794	5,536

Table 2. Survival rates and total mortality (Z) based on catch per unit fishing intensity.

Age	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	
5/4	9.952	10.073	8.480	1.105	5.087	9.235	
6/5	2.611	1.556	1.716	1.037	22.227	8.771	
7/6	1.544	1.404	1.358	0.583	2.279	0.756	
8/7	0.385	0.607	0.280	0.255	0.455	0.153	
9/8	0.087	0.503	0.254	0.154	0.133	0.222	
10/9	0.124	0.663			0.345	0.567	
G.M 8/7 to 10/9	0.161	0.587	0.267	0.198	0.275	0.268	
Z	1.83	0.53	1.32	1.62	1.21	1.32	Mean = 1.31
$\frac{\Sigma\ 8\text{-}10}{\Sigma\ 7\text{-}9}$	0.224	0.587	0.251	0,228	0.376	0.151	
Z	1.50	0.53	1.38	1.48	0.98	1.89	Mean = 1.29

Table 3. Estimates of stock size of yellowtail flounder from ICNAF Divisions 3L and 3N ($\times 10^{-3}$).

Age \ Year	1965	1966	1967	1968	1969	1970	1971	1972**
4	28,666	62,111	64,167	135,000	176,470	147,059	118,846*	
5	15,412	26,309	53,734	62,153	131,912	134,908	108,823	87,827
6	7,859	9,537	20,396	42,597	51,074	107,797	108,345	84,435
7	3,491	4,913	3,744	12,628	25,004	32,774	56,257	56,556
8	1,655	1,574	1,179	1,349	4,479	10,436	10,809	27,957
9	1,062	332	426	215	267	947	2,813	8,096
10	354	198	160	143	44	74	351	917
11	85	71	53	53		22		115
12	34	17		18				
Σ 5+	29,919	42,978	79,692	119,136	212,779	286,958	287,392	265,903

* estimated from mean F and 1971 landings
**estimated from 1971 stock size and F for that year

Table 4. Estimates of fishing mortality of yellowtail flounder from ICNAF Divisions 3L and N.

Age \ Year	1965	1966	1967	1968	1969	1970	Mean 1967-70	% from fully recruited age group
4	0.02	0.01	0.007	0.003	.001	.002	0.003	0.4
5	0.05	0.13	0.06	0.06	.02	.02	0.04	5.0
6	0.16	0.48	0.19	0.24	0.16	.24	0.21	28.0
7	0.50	1.28	0.70	0.74	0.55	.90	0.72	100
8	1.28	1.07	2.0	1.23	1.20	.66	1.02	100
9	1.40					.67	0.67	100
Mean Age 7+	F = 1.06	1.17	0.85	0.98	0.88	0.74		

Table 5. Estimates of probable landings based on 3L, 3N and 3O catch in 1971 and estimated catch in 1972. F values used in 1971 are from 3LN stock size and landings. Catches for 1972 estimated from Canadian landings. ( ) age, N = stock size at beginning of year, F = fishing mortality and C = nominal catch (N & C x 10^{-3}).

Year-class		1971	1972	1973	1974
1961	N	(10) 613	(11) 184		
	F	0.90	1.80		
	C	321	138		
1962	N	(9) 3,260	(10) 1,063	(11) 106	
	F	0.82	2.0	1.80	
	C	1,607	879	79	
1963	N	(8) 15,472	(9) 7,241	(10) 2,744	(11) 274
	F	0.46	0.67	2.0	0.70
	C	4,985	3,100	2,146	121
1964	N	(7) 63,830	(8) 31,724	(9) 8,470	(10) 3,625
	F	0.40	1.02	0.67	0.70
	C	18,383	18,002	3,749	1,606
1965	N	(6) 149,027	(7) 83,455	(8) 30,711	(9) 8,200
	F	0.28	0.70	1.02	0.70
	C	32,339	37,211	17,382	3,633
1966	N	(5) 186,690	(6) 131,617	(7) 85,419	(8) 31,434
	F	0.05	0.13	0.70	0.70
	C	7,841	14,110	37,841	13,925
1967	N	(4) 126,923	(5) 93,796	(6) 64,813	(7) 42,193
	F	0.003	0.07	0.13	0.70
	C	330	5,336	6,870	18,691
1968	N		(4) 239,165	(5) 177,075	(6) 122,358
	F		0.003	0.07	0.20
	C		623	10,358	19,210
1969	N				(5) 177,075
	F				0.04
	C				7,330
Catch tons			49,183	49,674	39,084

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 2905
(D.c.3)

ICNAF Res.Doc. 73/5
Addendum

ANNUAL MEETING - JUNE 1973

Status of yellowtail fishery in ICNAF Divisions 3L, 3N and 3O

by

T.K. Pitt
Fisheries Research Board of Canada
Biological Station, St. John's, Nfld.

PLEASE SUBSTITUTE THE FOLLOWING TABLE FOR THE EXISTING ONE FOUND ON PAGE 8 OF THIS DOCUMENT.

Table 5. Estimates of probable catches based on 1972 nominal catches from Div. 3L and 3N. N for 1972 from 1971 F values ( ) = age, N = stock size at the beginning of the year, F = fishing mortality, and C = catch ($N \times C \times 10^{-3}$).

Year-class		1972	1973	1974
1961		(11)		
	N	115		
	F	2.5		
	C	113		
1962		(10)	(11)	
	N	915	230	
	F	1.08	0.75	
	C	537	106	
1963		(9)	(10)	(11)
	N	8,096	3,902	1,366
	F	0.43	0.75	0.75
	C	2,490	1,811	633
1964		(8)	(9)	(10)
	N	27,957	9,980	3,493
	F	0.73	0.75	0.75
	C	12,790	4,630	1,620
1965		(7)	(8)	(9)
	N	56,556	19,795	6,928
	F	0.75	0.75	0.75
	C	26,372	9,184	3,069
1966		(6)	(7)	(8)
	N	84,435	53,954	18,884
	F	0.15	0.75	0.75
	C	10,096	25,034	8,366
1967		(5)	(6)	(7)
	N	87,827	61,918	40,403
	F	0.05	0.15	0.75
	C	3,707	7,492	19,329
1968		(4)	(5)	(6)
	N	173,845[a]	128,471	90,572
	F	0.003	0.05	0.15
	C	452	5,422	14,219
1969				(5)
	N			128,000
	F			0.05
	C			5,524
	$\bar{F}$ = 0.75			
Total (T)		35,088	34,105	32,791
Div. 3O (est)		5,000	5,000	6,000
Total (Div. 3LNO)		39,088	39,105	38,791

[a] From mean F = 0.003 and 1972 catch

RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 2905
(D.c.3)

ICNAF Res.Doc. 73/5
Addendum 2

ANNUAL MEETING - JUNE 1973

Status of yellowtail fishery in ICNAF Divisions 3L, 3N and 3O

by

T.K. Pitt
Fisheries Research Board of Canada
Biological Station, St. John's, Nfld., Canada

Table 6. Estimation of total allowable catch, yellowtail, Div. 3LNO. N = stock size at beginning of year; F = fishing mortality, C = nominal catch. (N & C x 10^{-3}).

Year-class		Year 1971	1972	1973	1974
1962	N	2,813	917	231	70
	F	0.83	1.08	0.90	0.70
	C	1,400	537	121	30
1963	N	10,809	5,059	1,649	497
	F	0.46	0.82	0.90	0.70
	C	3,478	2,490	864	220
1964	N	56,257	27,957	9,981	3,004
	F	0.40	0.73	0.90	0.70
	C	16,176	12,700	5,230	1,328
1965	N	108,345	57,129	19,995	6,018
	F	0.34	0.75	0.90	0.70
	C	27,928	26,372	10,476	2,660
1966	N	(135,000)[1]	97,055	63,183	19,018
	F	0.03	0.13	0.90	0.70
	C	3,920	10,096	33,107	8,406
1967	N		(135,000)[1]	97,065	56,007
	F		0.03	0.25	0.70
	C		3,707	18,635	24,755
1968	N			(135,000)[1]	95,580
	F			0.045	0.20
	C			5,130	15,006
1969	N				(135,000)[1]
	F				0.035
	C				4,050
1970	N				
	F				
	C				
Catch (Div. 3LN)				45,775	35,000
Est. Div. 3O				5,000	5,000
Catch (Div. 3LNO)				50,775	40,000

[1] Assuming recruitment average of 5-year-olds in 1969 and 1970 and fishing at F_{opt} in 1974.

542