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A cohort analysis of the ICNAF Divisions 3NØ witch stock

by

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This stock is situated generally along the southwest slope of the Grand Bank (Division 3Ø) and along the tip of the Bank (Division 3N). There is very little directed fishery for witch in Division 3NØ and hence, is primarily a by-catch of other groundfish species in this area such as American plaice and redfish.

Landings over the past 10 years have fluctuated from 4,700 tons in 1969 to 15,000 tons in 1971. This stock came under international regulation in 1973 and a quota of 10,000 tons annually has been in effect since 1974, however, the actual catch over these years has been generally in the vicinity of 6,000 tons per year.

This has been the first year that enough data has been available to do a cohort analysis (1974-77). In previous years the assessments of this stock were done by yield per recruit analyses based on average catches over the past 10-12 years.

Calculation of numbers at age

In 1974 and 1975, samples were obtained from only the second quarter of the year, therefore, it was assumed to be representative of fishing for the whole year (Bowering 1977). The samples in 1976 and 1977 were taken for each quarter and applied to the appropriate catches. The weighted average length was calculated from the length frequencies for each quarter or year and an average weight computed from the equation $W = .00063709L^{3.6142}$ where W = weight in grams and L = length in centimeters (Bowering 1976). From these average weights, the total number of fish caught in each year could be calculated using total landings. The total numbers caught at age were then computed by breaking down the total numbers caught by the percentages sampled at each age.

Terminal F

Since this fishery is primarily a by-catch fishery and is more concentrated at certain times of the year than others, effort and catch per unit of effort have no real value in determining levels of fishing mortality for this species. Because of lack of this type of data, terminal F (or Starting F) was essentially based on the average level of fishing mortality over several years as taken from catch curves (Bowering 1977). A terminal F of 0.50 for males and females was therefore used to initiate the calculations.

Partial recruitment

Partial recruitment was obtained from a matrix of catch numbers at age (by sex) averaged over the 1974-76 period. These were then used to estimate the population numbers for each year sampled (Tables 2 and 3).

Catch projections

Fishing mortality values based on the partial recruitment patterns were also determined to duplicate the 1978 Total Allowable Catch using an average recruitment of 22,000 for males and 35,000 for females (Tables 4 and 5).

Assuming the same recruitment and fishing mortality pattern, the 1979 catches were projected at the $F_{0.1}$ level averaged over the fully recruited age groups (Tables 4 and 5). The catch during 1979 from this projection at $F_{0.1}$ should be approximately 6,000 metric tons. The various fishing mortality levels are plotted on yield per recruit curves presented in Fig. 1.

References

- Bowering, W.R. 1976. Length-Weight Relationship in Witch Flounder (*Glyptocephalus cynoglossus*), in the Newfoundland Area. Intern. Comm. Northw. Atlant. Fish. Res. Bull. No. 12, 1976.
1977. An updated witch assessment for ICAF Divisions 3N and 3Ø. Intern. Comm. Northw. Atlant. Fish. Res. Doc. 77/VI/12, Ser. No. 5032.

3NØ Witch

Table 1. Nominal catches of witch in ICAF Divisions 3N and 3Ø for 1967-77 ('000's metric tons).

YEAR	CANADA	FRANCE	USSR	UK	POLAND	GDR	OTHERS	TOTAL
1967	2,863		8,565	26	29	20		11,503
1968	1,503	18	9,078					10,599
1969	479	6	4,215					4,700
1970	723	1	6,039					6,763
1971	178	10	14,774					14,965
1972	3,419	17	5,738	3	3			9,177
1973	4,943	20	1,714	5	9			6,691
1974	2,807	1	5,235	2				8,045
1975	1,137		5,019					6,168
1976	3,044		2,991				12	6,035
1977	3,001		2,805					5,806

Table 2.

COHORT ANALYSIS JNO WITCH MALES										
NATURAL MORTALITY# 0.20										
PARTIAL RECRUITMENT MULTIPLIER										
	0.0010	0.0100	0.0900	0.2100	0.4500	1.0000	1.1700	1.3400	1.2700	1.0000
ASSUMED FISHING MORTALITY FOR LAST AGES										
	0.5000	0.5000	0.5000	0.5000						
ESTIMATED POPULATION										
AGE	YEAR	1974	1975	1976	1977					
8		21780.	23058.	79727.	116981.					
9		16043.	17812.	18856.	65254.					
10		6892.	12981.	14433.	15334.					
11		5669.	5041.	10446.	11547.					
12		5310.	3667.	3624.	8003.					
13		3805.	3409.	2167.	2055.					
14		2021.	2108.	1335.	624.					
15		1374.	974.	784.	306.					
16		483.	769.	359.	123.					
17		3.	328.	448.	58.					
KNOWN CATCHES.										
AGE	YEAR	1974	1975	1976	1977					
8		22.	25.	23.	53.					
9		170.	166.	115.	295.					
10		665.	201.	298.	612.					
11		1077.	556.	607.	1045.					
12		1037.	923.	1008.	1467.					
13		1114.	1609.	1271.	739.					
14		752.	1041.	870.	253.					
15		393.	485.	573.	137.					
16		74.	201.	260.	53.					
17		1.	118.	161.	21.					
ESTIMATE FISHING MORTALITY										
AGE	YEAR	1974	1975	1976	1977					
8		0.0011	0.0012	0.0003	0.0					
9		0.0118	0.0104	0.0068	0.0					
10		0.1128	0.0173	0.0231	0.0					
11		0.2357	0.1300	0.0664	0.0					
12		0.2431	0.3260	0.3673	0.0					
13		0.3909	0.7373	1.0446	0.0					
14		0.5298	0.7894	1.2729	0.0					
15		0.3801	0.7991	1.6509	0.0					
16		0.1857	0.3409	1.6151	0.0					
17		0.5000	0.5000	0.5000	0.5000					
POPULATION WTS AND NOS										
		1974	1975	1976	1977					
WT		22803.	24768.	40710.	65530.					
NO		63380.	70148.	132179.	220287.					
POPULATION WTS AND NOS AGE 8 TO 17										
		1974	1975	1976	1977					
WT		22803.	24768.	40710.	65530.					
NO		63380.	70148.	132179.	220287.					

Table 3.

COHORT ANALYSIS 3ND WITCH FEMALES												
NATURAL MORTALITY= 0.15												
PARTIAL RECRUITMENT MULTIPLIER												
	0.0040	0.0030	0.0300	0.0700	0.1900	0.3700	0.5100	0.6500	1.0000	1.3700	1.7800	1.0000
ASSUMED FISHING MORTALITY FOR LAST AGES												
	0.5000	0.5000	0.5000	0.5000								
ESTIMATED POPULATION												
AGE	YEAR	1974	1975	1976	1977							
8		35712.	33189.	88492.	11318.							
9		25402.	30717.	28412.	76155.							
10		17880.	21816.	26329.	24443.							
11		9607.	14994.	18371.	22470.							
12		6427.	7934.	12204.	15536.							
13		5421.	4609.	5819.	9866.							
14		3691.	3655.	2924.	3977.							
15		2317.	2298.	2258.	1593.							
16		1719.	1261.	1231.	1061.							
17		1139.	803.	679.	273.							
18		376.	466.	351.	96.							
19		294.	95.	248.	57.							
KNOWN CATCHES												
AGE	YEAR	1974	1975	1976	1977							
8		22.	166.	12.	21.							
9		51.	118.	12.	106.							
10		426.	438.	206.	338.							
11		361.	757.	298.	718.							
12		995.	1089.	687.	1309.							
13		1089.	1124.	1111.	1551.							
14		948.	958.	996.	834.							
15		790.	805.	951.	412.							
16		729.	438.	847.	390.							
17		554.	367.	527.	127.							
18		246.	166.	264.	53.							
19		108.	35.	91.	21.							
ESTIMATE FISHING MORTALITY												
AGE	YEAR	1974	1975	1976	1977							
8		0.0007	0.0054	0.0001	0.0							
9		0.0022	0.0041	0.0005	0.0							
10		0.0260	0.0219	0.0085	0.0							
11		0.0413	0.0560	0.0176	0.0							
12		0.1826	0.1601	0.0626	0.0							
13		0.2440	0.3050	0.2304	0.0							
14		0.3241	0.3320	0.4576	0.0							
15		0.4581	0.4743	0.6053	0.0							
16		0.6108	0.4689	1.3542	0.0							
17		0.7428	0.6782	1.8090	0.0							
18		1.2230	0.4838	1.6654	0.0							
19		0.5000	0.5000	0.5000	0.5000							
POPULATION WTS AND NOS												
		1974	1975	1976	1977							
WT		41457.	45082.	62091.	61927.							
NO		109985.	121839.	187316.	166846.							
POPULATION WTS AND NOS AGE 9 TO 19												
		1974	1975	1976	1977							
WT		33601.	37780.	42623.	59437.							
NO		74273.	84650.	98824.	155527.							

Table 4.

WITCH 3ND MALES								
NATURAL MORTALITY# 0.2000			YEAR 1976					
AGE	POP. NO. XX10-3<	CATCH NO. XX10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.	
8	22000.	23.	0.002	0.258	5676.0	5.9	17976.1	
9	18856.	115.	0.007	0.296	5581.4	34.0	15330.3	
10	14433.	298.	0.024	0.347	5008.2	103.4	11536.5	
11	10446.	607.	0.067	0.405	4230.6	245.8	7998.2	
12	3624.	1008.	0.364	0.490	1775.8	493.9	2061.8	
13	2167.	1271.	1.013	0.594	1287.2	755.0	644.3	
14	1335.	870.	1.221	0.716	955.9	622.9	322.4	
15	784.	573.	1.546	0.745	584.1	426.9	136.6	
16	359.	260.	1.515	0.816	292.9	212.2	64.6	
17	448.	161.	0.500	0.901	403.6	145.1	222.5	
TOTAL	74452.	5186.			25795.7	3045.1	56293.5	

WITCH 3ND MALES								
NATURAL MORTALITY# 0.2000			YEAR 1977					
AGE	POP. NO. XX10-3<	CATCH NO. XX10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.	
8	22000.	53.	0.003	0.258	5676.0	13.7	17958.1	
9	17976.	295.	0.019	0.296	5320.9	87.3	14440.6	
10	15330.	612.	0.046	0.347	5319.6	212.4	11987.1	
11	11537.	1045.	0.106	0.405	4672.3	423.2	8495.3	
12	7998.	1467.	0.226	0.490	3919.1	718.8	5223.8	
13	2062.	739.	0.498	0.594	1224.7	439.0	1025.9	
14	644.	253.	0.561	0.716	461.3	181.1	301.0	
15	322.	137.	0.624	0.745	240.2	102.1	141.4	
16	137.	53.	0.551	0.816	111.7	43.2	64.6	
17	65.	21.	0.440	0.901	58.2	18.9	34.1	
TOTAL	78071.	4675.			27004.0	2239.6	59671.9	

WITCH 3ND MALES								
NATURAL MORTALITY# 0.2000			YEAR 1978					
AGE	POP. NO. XX10-3<	CATCH NO. XX10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.	
8	22000.	14.	0.001	0.258	5676.0	3.6	17999.5	
9	17958.	112.	0.007	0.296	5315.6	33.1	14601.8	
10	14441.	784.	0.062	0.347	5010.9	272.0	11115.5	
11	11987.	1460.	0.144	0.405	4854.8	591.1	8498.9	
12	8495.	2054.	0.308	0.490	4162.7	1006.4	5109.6	
13	5224.	2375.	0.685	0.594	3102.9	1410.9	2155.3	
14	1026.	520.	0.802	0.716	734.6	372.0	376.7	
15	301.	166.	0.918	0.745	224.2	124.0	98.4	
16	141.	76.	0.870	0.816	115.4	61.7	48.5	
17	65.	29.	0.685	0.901	58.2	26.5	26.6	
TOTAL	81638.	7589.			29255.3	3901.3	60030.7	

WITCH 3ND MALES								
NATURAL MORTALITY# 0.2000			YEAR 1979					
AGE	POP. NO. XX10-3<	CATCH NO. XX10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.	
8	22000.	6.	0.000	0.258	5676.0	1.5	18006.7	
9	17999.	60.	0.004	0.296	5327.8	17.8	14682.3	
10	14602.	439.	0.034	0.347	5066.8	152.3	11558.7	
11	11116.	763.	0.079	0.405	4501.8	308.8	8412.7	
12	8499.	1197.	0.168	0.490	4164.4	586.3	5880.4	
13	5110.	1454.	0.374	0.594	3035.1	863.9	2877.8	
14	2155.	697.	0.438	0.716	1543.2	499.4	1139.1	
15	377.	136.	0.501	0.745	280.7	101.1	186.8	
16	98.	34.	0.475	0.816	80.3	27.7	50.1	
17	48.	14.	0.374	0.901	43.7	12.4	27.3	
TOTAL	82004.	4799.			29719.8	2571.3	62821.9	

Table 5.

WITCH 3ND FEMALES								
NATURAL MORTALITY# 0,1500			YEAR 1976					
AGE	POP. NO. XX10-3<	CATCH NO. XX10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.	
8	35000.	12.	0.001	0.221	7735.0	2.7	30094.7	
9	28412.	12.	0.001	0.252	7159.8	3.0	24430.0	
10	26329.	206.	0.009	0.334	8793.9	68.8	22458.5	
11	18371.	298.	0.018	0.448	8230.2	133.5	15530.0	
12	12204.	687.	0.063	0.547	6675.6	375.8	9862.7	
13	5819.	1111.	0.230	0.702	4084.9	779.9	3979.4	
14	2924.	496.	0.454	0.838	2450.3	834.6	1598.3	
15	2258.	951.	0.599	0.971	2192.5	923.4	1067.7	
16	1231.	847.	1.308	1.081	1330.7	915.6	286.5	
17	679.	527.	1.710	1.294	878.6	681.9	105.7	
18	351.	264.	1.585	1.340	470.3	353.8	61.9	
19	248.	91.	0.499	1.441	357.4	131.1	129.6	
TOTAL	133826.	6002.			50359.3	5204.2	109604.7	

WITCH 3ND FEMALES								
NATURAL MORTALITY# 0,1500			YEAR 1977					
AGE	POP. NO. XX10-3<	CATCH NO. XX10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.	
8	35000.	21.	0.001	0.221	7735.0	4.6	30094.7	
9	30095.	106.	0.004	0.252	7583.9	26.7	25799.3	
10	24430.	338.	0.016	0.334	8159.6	112.9	20693.3	
11	22459.	718.	0.036	0.448	10061.4	321.7	18646.7	
12	15530.	1309.	0.096	0.547	8494.9	716.0	12143.3	
13	9863.	1551.	0.186	0.702	6923.6	1088.8	7048.2	
14	3979.	834.	0.255	0.838	3334.7	698.9	2654.2	
15	1598.	412.	0.324	0.971	1552.0	400.1	995.0	
16	1068.	390.	0.496	1.081	1154.2	421.6	559.6	
17	287.	127.	0.642	1.294	370.7	164.3	129.8	
18	106.	53.	0.766	1.340	141.7	71.0	42.3	
19	62.	21.	0.452	1.441	89.3	30.3	33.9	
TOTAL	144475.	5880.			55601.0	4056.9	118839.9	

WITCH 3ND FEMALES								
NATURAL MORTALITY# 0,1500			YEAR 1978					
AGE	POP. NO. XX10-3<	CATCH NO. XX10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.	
8	35000.	75.	0.002	0.221	7735.0	16.5	30055.6	
9	30095.	47.	0.002	0.252	7583.9	12.0	25858.7	
10	25799.	411.	0.017	0.334	8617.0	137.3	21824.8	
11	20693.	759.	0.040	0.448	9270.6	340.2	17107.4	
12	18647.	1795.	0.109	0.547	10199.8	982.0	14387.7	
13	12143.	2168.	0.213	0.702	8524.6	1522.0	8447.5	
14	7048.	1670.	0.293	0.838	5906.4	1399.7	4523.9	
15	2654.	772.	0.374	0.971	2577.2	750.1	1571.8	
16	995.	407.	0.575	1.081	1075.6	440.1	481.7	
17	560.	286.	0.788	1.294	724.1	370.3	219.0	
18	130.	78.	1.024	1.340	173.9	104.8	40.1	
19	42.	17.	0.575	1.441	61.0	24.9	20.5	
TOTAL	153806.	8487.			62448.9	6099.9	124538.3	

WITCH 3ND FEMALES								
NATURAL MORTALITY# 0,1500			YEAR 1979					
AGE	POP. NO. XX10-3<	CATCH NO. XX10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.	
8	35000.	32.	0.001	0.221	7735.0	7.2	30094.7	
9	30056.	22.	0.001	0.252	7574.0	5.6	25848.4	
10	25859.	179.	0.008	0.334	8536.8	59.9	22096.5	
11	21825.	352.	0.017	0.448	9777.5	157.5	18458.9	
12	17107.	736.	0.047	0.547	9357.7	402.5	14042.8	
13	14388.	1181.	0.092	0.702	10100.1	828.8	11290.6	
14	8448.	939.	0.127	0.838	7079.0	787.0	6401.8	
15	4524.	630.	0.162	0.971	4392.7	612.0	3310.7	
16	1572.	323.	0.250	1.081	1699.1	349.6	1054.0	
17	482.	124.	0.324	1.294	623.4	160.9	299.9	
18	219.	73.	0.444	1.340	293.5	98.3	120.9	
19	40.	8.	0.250	1.441	57.8	11.9	26.9	
TOTAL	159518.	4601.			67326.6	3481.2	133039.7	

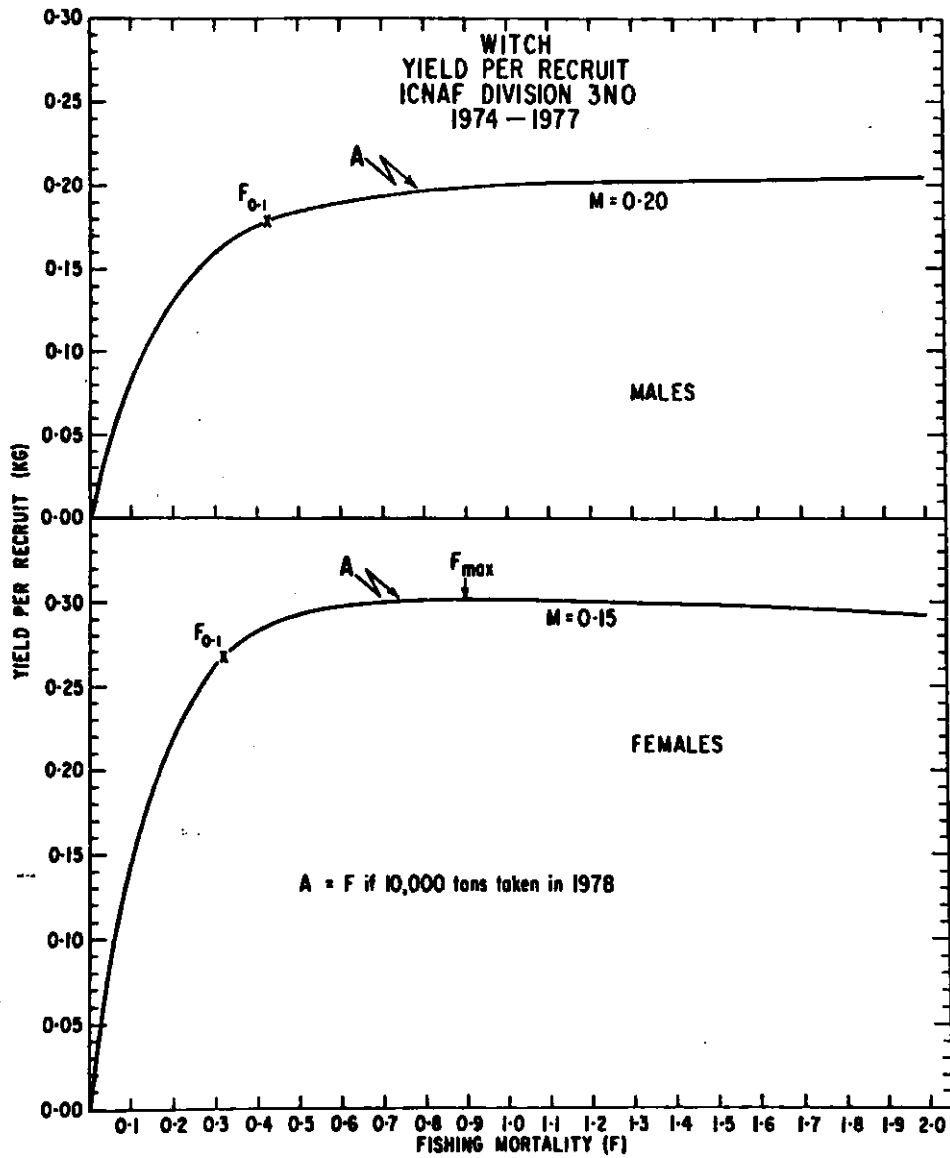


Fig. 1. Yield-per-recruit curves for male and female witch from ICNAF Divisions 3N and 3Ø.

