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Witch Flounder Biomass Estimates in Divisions 3LNO and Their Possible Relation to Water Temperature From Russian 1980-1994 Research Surveys

by

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Abstract

Witch flounder biomass estimates in Divisions 3LNO from Russian 1980-1994 research surveys are presented. The largest biomass estimates registered in 1984 and 1885 in Div. 3L and in 1988 and 1991 in Divs. 3NO at water prebottom temperature about 0.2°C and 0.6-1.2°C, correspondingly.

A dense relation (\mathbb{R}^2 > 57%) between pre-bottom temperature and biomass estimates in all Divisions has been revealed, however a dependence characters differed from each other greatly.

Introduction

During long-term fishery, witch stock size and their catch in the area of the Grand Newfoundland Bank were objected to sufficient fluctuations. The largest catches were obtained in early 1970-ies and mid-1980-ies. Because of the sharp decrease of witch stock after 1991, this species has lost its commercial importance, and NAFO Scientific Council recommended to suspend this species fighery since 1985.

One of the possible reacons influencing the stock assessment and character of its distribution is changes of hydrological regime in witch habitats on slopes of Great Newfoundland Bank.

An attempt to analyse a relation between changes in witch biomass estimates and water temperature from 1980 to 1984 from Russian research surveys in the area of the Grand Newfoundland Bank is made in the papar.

Materials and Methods

To obtaine comparable long-term biomass estimates, data of trawl surveys carried out annually in spring/summer down to 800-850 m depths in Divs. SLNC were used. A standard fish-counting bottom trawl 31.2/27.3 with small mesh size insertion in the codend (a = 8-12 mm) was used.

Surveys were carried out by stratified-random pattern (Doubleday, 1981). A method of their conducting had been presented in detail earlier (Bulatove, Chumakov, 1985); Kusmin, 1992).

Witch biomass estimates for 1980-1993 were revised. Calculations repeated the estimates, presented earlier, excluding 1991 and 1993, when recalculated values turned out to be slightly higher than those by calculations done in previous years.

To characterize environmental conditions, long-term data on water temperature along the hydrological section 8-A, obtained in October-November, 1980-1992, as well as on the bottom water temperature in Divs. 3L, 3N, 3O in 1980-1994, were used. Water temperatures were measured during travil surveys just before or after travilings. In 1992, no travil surveys were carried out in the area of the Grand Newfoundland Bank.

Geographical location of 8-A section is presented in Figure 1. Method of calculation and temperature data series are presented in papers (Borovkov and Tevs, 1988: 1992).

Results and Discussion

Managing of witch stock in the area of the Grand Newfoundland Bank is carried out by singling out of some TAC for the north-eastern slope of the bank (together with Divs. 2J + 3K) and southern slopes (Divs. 3NO). From the point of view of fisheries, they are unequal in importance, since from the early of 1980-ies the total catch in Divs. 3NO (especially 3O) was noticably higher than in 2J + 3KL (Fig. 2). The Hamilton Bank is considered the northern bounder of witch distribution. Hydrological regime near the northern bounder is cheracterized in Average by lower water temperature in the pre-bottom layer compared to that on the gouthern slopes on the Grand Newfoundland Bank. In some years temperature difference can reach 2.5°C (Fig. 3). Although witch is a surythermal species and occured in catches at water temperature of -1 to +10°C, it is considered that its temperature optimum is about 3°C, therefore the dwelling conditions in Divs. 3NO are evidently more favourable.

Estimations of witch biomass from Russian surveys fluctuated in 1980-1984 sufficiently (Fig. 4, Tables 1, 2, 3). The largest numbers in Div. 3L were obtained in 1984 and 1985 at mean water temperature near bottom about $\emptyset.2\,^{\circ}$ C. In Divs. 3NO the heightened estimates of biomass were registered at water temperature of $\emptyset.6-1.2\,^{\circ}$ C in 1982, 1985, 1986, 1988 and 1991. The analogous estimates from Canadian studies showed in many cases the similar tendency of stock changes, however, values were as a rule higher (Bowering et al., 1994).

The possible reason of high bicmass estimates in the mentioned years is short-period shifts of witch within the area of the Great Newfoundland Bank and their re-distribution into high density concentrations in some areas of strata, relatively big in square. This can lead to heightened biomass estimates in some strata in consequence of a number of trawlings unrepresentative for this year in these strata and, in general, for the whole Division. Typical aramples of such heightened estimates can be biomass values in strata 345 and 546 for Div. 3L in 1988 and 1985, as well as in strata 336 and 354 for Div. 30 in 1981.

An attempt to determine quantitatively the possible correlation between water temperature on the 8-A section and witch biomass in the area of the Grand Newfoundiand Bank turned out to have no success. Back relation of mean strength (correlation coefficient is 0.58) was registered between water temperature averaged in 50-200 m layer in parts AB and witch biomass estimates in Div. 3L, obtained a year after doing of hydrological section 8-A (Fig. 5, 6, Table 4).

To learn a measure of relation between water temperature in the pre-bottom layer and witch biomass estimates simed at decreasing of short-period fluctuations, the indices smoothed by 7 terms with the help of sliding averaging were used. Results of an regressional analysis justify on a high measure of relation between smoothed characteristics defined by the determination coefficients of B2.14 X, 57.30 X and 79.93 X for Divs. 3L, N and O, correspondingly (Tables 5, 8, 7). Relation between water temperature and biomass estimates is specific for each of Divisions and expressed by a parabolic dependence for Div. 3L and linear models with opposite sign coefficients of slope of a regressional straight line for Divs. 3N and 30 (Fig. 7, 8, 8).

The highest witch biomass estimates were as a rule registered in years with moderately warm and normal water heating in pre-bottom layers (1985-1988). In the northern part of the area, influenced by cold water masses in the greatest measure compared to other areas, the temperature optimum during fish concentrating is mostly expressed: from 0.3 to 0.7°C. At temperature higher or lower these values, biomass estimates decrease. In Div. 3N, water temperature increase is followed by the correspondent in time biomass estimates increase, whereas in Div. 30 - by decrease.

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723 550-731 156 302 84 90.5 148.9 192.1 80.9 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 154 760 732-914 1327.3 760 732-515 553.3 760 732-914 1327.5 760 732-3 1348.5 760 1992 1348.5 760 1992 1348.5 760 1992 1348.5 760 1992 1348.5 760 1992 1348.5 760 1392 1348.5 760 1392 1548.5 760 1392.5	4.9.1	550-731	7 C		.,		63.2	9 . 6	2	58.	82.7	38.6	61.7 67.7	87.3	167.1	•
760 732-914 154 • Totel 3558.3 587.8 3245.3 618 1371.9 2135.5 553.3 1248.8 1043. 1327 588.1 523 Mote: dote for 1992 are absent.	824.	550-731	156			· · ·		305	Ť	• _ . 	90.5	248.9	192.1		80.9	.A
 Totel Totel 3558.3 587.8 3245.3 613 1371.9 2135.5 553.3 1248.8 1043. 1327 588.1 543 Motel dote for 1992 are absent. 	26	5 2 2 . OL 4	후날 -													्या १९ २२
 Total 3558.3 587.8 3145.3 618 1371.9 2136.5 553.3 1248.8 1043.2 1327 588.1 642 Moter data for 1992 are absent. 	<u>}</u>								•						·	r
mote data for 1992 are absent.		Total		3558,3	587.8	3245.3	613	1371.9	2135.5	553.3	1248.8	1043.0	1327	538.1	673	53 2 - 5
	note: do	ta for 19	92 are abse	ut.												

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	Depth	Ares of					e.	tears						*	
st ratum	រ ៥៨១៩ ៣	stratum so.miles	1980	1981	1982	1983	1984	1985	1986	1937	1938	1989	1990	1661	1993
330	57-91	2 089	445	208.9	53		139.3							-	
331	57-91	. 456		5.0		213.4	96.8	24.8			61.5				
338	57-91	1898	334.2	633.8	276.4	•	246	543.6	951.3	3*836	1230	573.6	56.2	1633,9	255.8
340	57-91	1716			141.8	•	25.4		1.191	-		- 1•6	38.1	•	
351	57-91	2520		•	657.4			619.7	÷						
352	57-91	2580	260.9	. •	827.3	367.6	271.4	47.8			206.1.	- 293	151.1		459.9
353	57-91	. 1282	33.4	582.5	1655.4	448.4	2.1.705	249.3	· 554		1013.2	505.4,	132.8	619.8	
					-				•						
332	93-183	1047	545.4	68.8	457.9	92.3	224.9	71.3	1,7221	1374.7	679.5	1.181.1	765.4	2389	696°5
756	93-183	948	71.4		183.4	`.	66.7	105	1779	3,98.6	1736.1	102		853.2	111
939	93 -1 83	585	•		•	151.7	1037.1	28.9		-			•	•	30.5
ME	93-183	474	193.4	194.4	709.9	105.2	43.3	663.6	400.3	112.4	171	46.5	20.9	2052.6	240.4
329	93-183	1721					•	46.7		25.5					583 6
		. '											•.		
336	185-274	121	2.9	11.8	•		7.2		11.4	151.2	225.2	15.1	8.8	2673	. 15-3
355	185-274	.103	151.7	υ Ο	13.2			29.4	3.3	16	44.1	107	1213.9	۰ ۲	5
333	185-274	151	35.2	14.4	5.4	1.7	5.6	0.7		30.6	7 5	9.4	15.8	298.3	18.5
-			•	-		•.		•					•		
•	•				•	· · ·								•	
334	275-366	96			0.8		-	0.9			. 23.1	0.5	55.1	104.8	8.3
335	275-366	58.		1.9	•		ų.,	*	7.2	8.6	39.2	22.6	Q	531.4	31.4
355	275-366	. 61		5 F	80			11	6 B	115.5	4.5	241.3	181.6		5-57 57
	363 640	1.66	1 - 1	4 - 1	U V			14 17 17		~	<u>ن</u> م	u C			с С
119	367-549	16							2.4	3.8	53 7) () () () () () () () () () () () () () (୍ୟ ଭ	53.9	12.0
721	367-549	76				2.1	5.2	43.3	4.9	475.3	139.6	294.7	61.2	146.7	3.16
•					•									•	
() . E	11 E 093	12.1						÷			•				
		4 C T					7 T			1.51	J				0 .
720	550-731	105					Ø	8°0.		ດ ອ	22°3	5 5	6		03 64
722	550-731	6				1	ମ ଅ	44.8		29.62	8.3	502	32.9	7.3	20.2
	rotal		2674.9	1757.4	5001.9	1283.7	2507.2	3,55.5	5895.7	3858.6	6830.4	2 943 - 7	2748.1	11497.1	1996.3
Note: d.	sta for 19	92 are absen	at.												

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Table 4. Analysis of variance results from linear regression model relating witch flounder stock biomage and water temperature in 50-200 m layer on section 8-A (parts AE) in Div. 3L, 1980-1994 (time series of stock assessments is shifted on 1 year).

	Regression enelysis	- linear mod	141: Y = 4 +	bx
Parameter	Estimato	8t. error	T-value	Prob. level
Intercept Blope	4.37420 -3.89289	Ø.92865 1.81186	4.71026 -2.14879	.00119 .06015

Analysis of variance

Source	Sum of squares	DY I	Mean Square	T-ratio	Prob. level
Nodel	84.12849	1	34.12849	4 61731	.06016
Error	66.51897	9	7.39100		
Correlatio	n coefficient	= -Ø.68	230	R ² = 33.91	¥

Table 5. Analysis of variance results from parabolic regression model relating witch flounder stock and water temperature near the bottom in Div. 3L, 1980-1994.

	Model fitting resul	ltg Y =	Å*x^2 +	B*x +	C
	Estimate	Bt. error			Patio
A	-11865.0471	1742.73887			-6.88828
В	12014.0503	1690.00523			7.10888
С	1254.8227	322.09338			3.89521

	WRWINNIN OI ANLINHCA	IOF LDS	TOTT LAWLARATOR	
Source	. Sum of squares	D1	Hean square	Ratio
Nodel	1.37022B	3	4.567427	1.052152
Error	4775503.8	11	434136.7	

 $\mathbf{R}^2 = 82.14$ X

Table 8. Analysis of variance results from linear regression model relating witch flounder stock biomess and water temperature mear the bottom in Div. 3N, 1982-1893.

Paramatar	Estimata	R	t APPAR		Prob logal
					FEGD. 1844.
Intercept	-72.3165	3	58.128	-0.20192	.84310
Slopa	1560.76	3	73.719	4,17829	.00109
	Ane ly si	10 2.	varianca		
Bource	Sum of squares	Df	Mean square	F-ratio	Prob. lev.

_____ Correlation coefficient = 0.85593

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Red	ression analysis	11	near model: 1	: = 4 + DI	
Parameter	Estimate	•St	. error	T-value	Prob. level
Intercept	6791.84		96.999	17.10720	. 00000
Slope	-2208.46	2	06.817	-7.19583	.00001
	Analys:	is of	variance	•	
Source	Sum of squares	Df	Mean square	F-ratio	Prob level
Nodel	13957035	1	13957035	5.178 2 1	. 80081
Error	3504285.4	13	268668.4		





Fig. 1. Location of oceanographic stations on hydrological Section 8-A (parts A,B,C).



Fig.3 . Temperature of water near the bottom in Divs. 3L,N,O 1980-1994



Fig.4 _ Stock assessments of Witch flounder in Divs. 3L,N,O 1980-1994



Fig.5 Stock assessments of Witch flounder in Div. 3L in 1981-1994 and water temperature in 50-200 m layer on section 8-A, part AB in 1980-1992

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`(time series of stock assessments is shifted on 1 year).





Fig. 7 .Actual and smouthed values of water temperature (A), stock assessments of Witch flounder (B) and their relationship (C) in Div. 3L,1980-1994.

Noving Average of 7 Jerms



Fig. 8 .Actual and smouthed values of water temperature (A), stock assessments of Witch flounder (B) and their relationship (C) in Div. 3N,1980-1993.



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Fig. 9 .Actual and smouthed values of water temperature (A), stock assessments of Witch flounder (B) and their relationship (C) in Div. 30,1980-1993.