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Capelin Stock Assessment in NAFO Divisions 3NO Based on Data from Trawl Surveys

by

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Abstract

The purpose of this work is to assess the current state of capelin stock in Divisions 3NO. Indices of capelin trawl biomass obtained in Canadian random-stratified bottom trawl surveys have been used as the indicators of capelin stock dynamics. In 2018, trawl biomass of capelin in Divisions 3NO was 45.7 thousand tons. In 2019, trawl biomass has decreased, reaching 17.2 thousand tons. In 2020, the survey was not completed. The average catch in 2018-2019 per 1 km2 was 0.13 t and 0.04 t respectively. Fishery was conducted in the years when this value was equal or higher than 2 t/km2. Capelin stock in Divisions 3NO remains at the very low level.

Introduction

Estimation of capelin stock (Mallotus villosus) in Divisions 3NO was based on the results of Russian and Canadian acoustic surveys conducted before 1993. In all subsequent years, data on capelin by-catch in Canadian trawl surveys of demersal fish has been the only source of data on state of the capelin stock. Before 1995, Yankee 41-5 trawl and Engel 145 Hi-Lift trawl were used. Since autumn 1995, Campelen 1800 shrimp trawl has been applied as a standard sampling gear. After taking in use the new trawl, bycatch of capelin increased greatly, and this made it even more difficult to interpret the obtained results.

Since capelin is a pelagic fish, a bottom trawl cannot be used as adequate sampling gear for quantitative estimation of the stock. Therefore, relationship between biomass indices from bottom trawl survey and stock size remains unclear. As analytical methods could not be applied, the purpose of this work was to estimate the current state of capelin stock in the Divisions 3NO using available indirect data.

Fishery and management

Fishery for capelin started in 1971 and total catch was maximal in mid-1970s with the highest catch of 132 000 tons in 1975. The fishing was closed in 1979-1986 and then reopened in 1987-1992. Annual catches in this period did not exceed 25 thousand tons. In subsequent years, due to abrupt decline of the stock size, target fishery for capelin was restricted. Highest historical catches were taken by Russia (former USSR), Norway, Iceland and Japan (Table 1). First TAC of capelin was set for the first time in 1974 and in 1977-1978 it reached 200 thousand tons, then TAC was reduced to 30 thousand tons in 1990-1992. Considering that the catch did not exceed TAC in the whole regulation period, the decline of the stock size observed since early 1990s, could hardly be caused by overexploitation of the stock. A similar idea about capelin stocks in NAFO Subareas 2 and Divisions 3KL was expressed by J. Carscadden (DFO, 2000).

Because of dramatic decline of the capelin stock size since 1993, the moratorium on specialized fishery for capelin was imposed as a regulation measure.

Research surveys

Acoustic surveys of capelin stock in Divisions 3NO were conducted by the USSR/Russia in 1975-1994 and Canada in 1981-1992. For the purpose of this assessment and to uphold the time series, Canadian Spring bottom trawl surveys in 1995-2019 have been used as the source of data. The spring survey in 2020 was not completed and thus data from it is not available.

Biological characteristics

Compared to the 2018 year assessment, when one modal class of 14-15 cm was expressed in the length composition of capelin and 8-9 cm recruits were observed, in 2018-2019 capelin length was presented with a modal class of 16 cm in 2018 and 15 cm in 2019. Also in 2019, a significant portion of 7-8 cm juvenile was observed (Fig. 1). In contrast, in 2018 a relatively small amount of juveniles mostly 10 cm long was registered. Proportion of males and females in 2018 was 0.49 and 0.44 correspondingly. In 2019, this proportion was 0.33 for males and 0.22 for females. Relative number of juveniles in 2018-2019 constituted about 0.07 and 0.44 respectively (Figs. 2, 3). Dependency between capelin length and mean weight has shown a decrease of mean weight in length classes from 160 mm in 2019 compared to 2018 (Fig. 4).

Stock assessment

Stock assessment based on acoustic survey data

Acoustic surveys of the capelin stock in Divisions 3NO were conducted by the USSR/Russia in 1975-1994 and Canada in 1981-1992. Now, it is difficult to compare the results of these surveys since some Russian assessments were merged for Divisions 3LNO. However, both surveys showed that maximum stock size was registered in 1988 and then an abrupt decline was observed after 1990 (Table 2). Despite the collapse of the stock registered by surveys conducted in Divisions 3LNO, TAC remained at the same level of 30 thousand tons for 2 years afterwards.

In recent years, STACFIS has repeated the advice to conduct investigations of capelin stock in Division 3NO by means of trawl-acoustic surveys to allow comparison with historical time series. However, this advice was not followed.

Indices of capelin biomass according to the data from Canadian spring surveys

Indices of the capelin biomass obtained by Canadian random-stratified bottom surveys are the only available at the present time indicators of capelin biomass dynamics. Since autumn 1995, Campelen 1800 shrimp trawl has been used as a standard sampling gear instead of Engel 145 Hi-Lift trawl and the catch rate of Campelen trawl for capelin appeared to be much higher (Lilly and Simpson, 2000).

The applicability of biomass indices obtained by Campelen trawl for the capelin stock assessment was studied by identification of a relationship between trawl and acoustic biomasses of capelin in Division 3L obtained in 1999-2004 (Gorchinsky and Golovanov, 2005).

In 1996-2015, trawl biomass of capelin in Divisions 3NO varied greatly from 3.9 to 227.3 thousand tons, the highest level for the entire period (Fig. 5). In 2016, biomass indices declined to the historical minimum 3.8 thousand tons. The 2017-2019 period was characterized by increase with follow-up decline; biomass index having reached 17.2 thousand tons.

Based on the results of classification average catches per 1 km2 in 1990-2004, the estimate in 2011 corresponds to the lowest level of the stock observed in the period since 1996. In 2018, the average catch per 1 km2 obtained by bootstrapping of values of actual catches, was 0.012 t/km2, and decreased in 2019 for the level of 0.006 t/km2 (Fig. 6). Fishing was conducted in the years when this parameter exceeded or was approximately close to 2 t/km^2.

The results of assessment show that the capelin stock in Division 3NO remains in depressive state (Shibanov et al. 2002; Gorchinsky 2003, 2004; Gorchinsky and Golovanov, 2005; Golovanov and Gorchinsky, 2006). Results of analysis of the capelin stock status in 2019 give grounds for extension of the Scientific Council advice about the ban on target fishery for capelin in 2021-2023. A more precise estimation of the stock will be possible if trawl-acoustic surveys are resumed.

Distribution of capelin stock

In 2018, capelin stock distributed roughly evenly between Divisions 3N and 3O, while in 2019, the catches have been concentrated in 3O Division. In 2018, largest catches were registered on the southern slope the bank (the 'Tail' area), and a single significant catch in 2019 has been taken in the western part of the bank (Fig. 7).

Acknowledgments

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Table 1. Nominal catch and TAC of capelin in NAFO Divisions 3NO (tons)

Year	BGR	CAN	CUB	DDR	ISL	IRL	JPN	NOR	POL	E/PRT	ROM	EST	E/ESP	RUS	**Total**	TAC
1970															**0**	
1971														750	**750**	
1972	166													20598	**20764**	
1973		1658						41293	203					83721	**126875**	
1974		3698						43682		500			4016	48855	**100751**	148000
1975					15814		2734	37477	4306				3748	67704	**131783**	180000
1976	311	5233			8839	230	5007	23178	3778					63610	**110186**	180000
1977		36	700		2994		3746	21499	401					17322	**46698**	200000
1978				56	116		665	4237	7		7			119	**5207**	200000
1979															**0**	0
1980															**0**	0
1981															**0**	0
1982															**0**	0
1983															**0**	0
1984															**0**	0
1985			3												**3**	0
1986															**0**	0
1987							793							14	**807**	10000
1988							1395	1094						4738	**7227**	15000
1989							2222	4085						3189	**9496**	28000
1990			85				2054	8415						14076	**24630**	30000
1991			118												**118**	30000
1992			65												**65**	30000
1993			3												**3**	0
1994															**0**	0
1995															**0**	0
1996															**0**	0
1997															**0**	0
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2007															**0**	0
2008															**0**	0
2009															**0**	0
2010															**0**	0
2011															**0**	0
2012															**0**	0
2013															**0**	0
2014													1		**1**	0
2015															**0**	0
2016												5			**5**	0
2017															**0**	0
2018															**0**	0
2019															**0**	0
2020															**0**	0
Total	**477**	**10625**	**974**	**56**	**27763**	**230**	**18616**	**184960**	**8695**	**500**	**7**	**5**	**7765**	**324696**	**585369**	

Note: TACs in 1974-1978 are merged for NAFO Div. 3LNO.

Table 2. Estimate of capelin stock according to the data of Russian and Canadian acoustic survey in 1975-1994 (thousand tons)

Year	USSR 3LNO	CAN 3NO	Year	USSR 3LNO	CAN 3NO
1975	1050*		1985	2200	212
1976	685*		1986	1491	494
1977	1000		1987	2161	229
1978	310		1988	3900	561
1979	483		1989	2455	28
1980	0		1990	3752	
1981	109	223	1991	118	
1982		419	1992		4
1983	346	219	1993	315	
1984	2880	85	1994	83	

* biomass of mature capelin in Divisions 3NO.

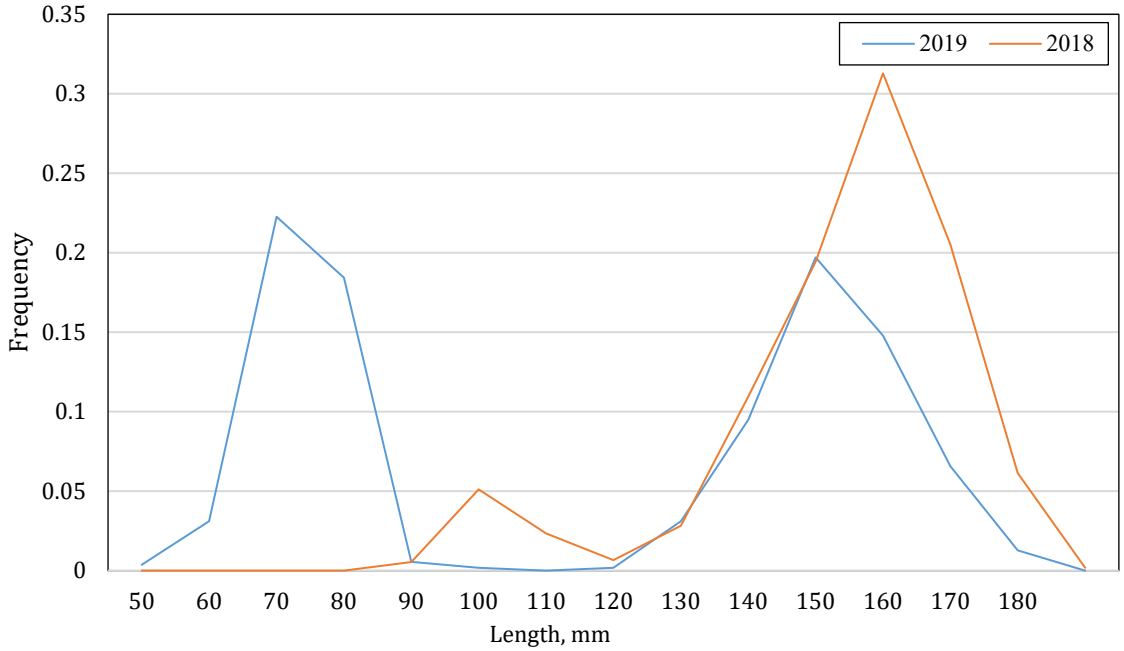

Figure 1. 3NO capelin length series from spring surveys in 2018-2019.

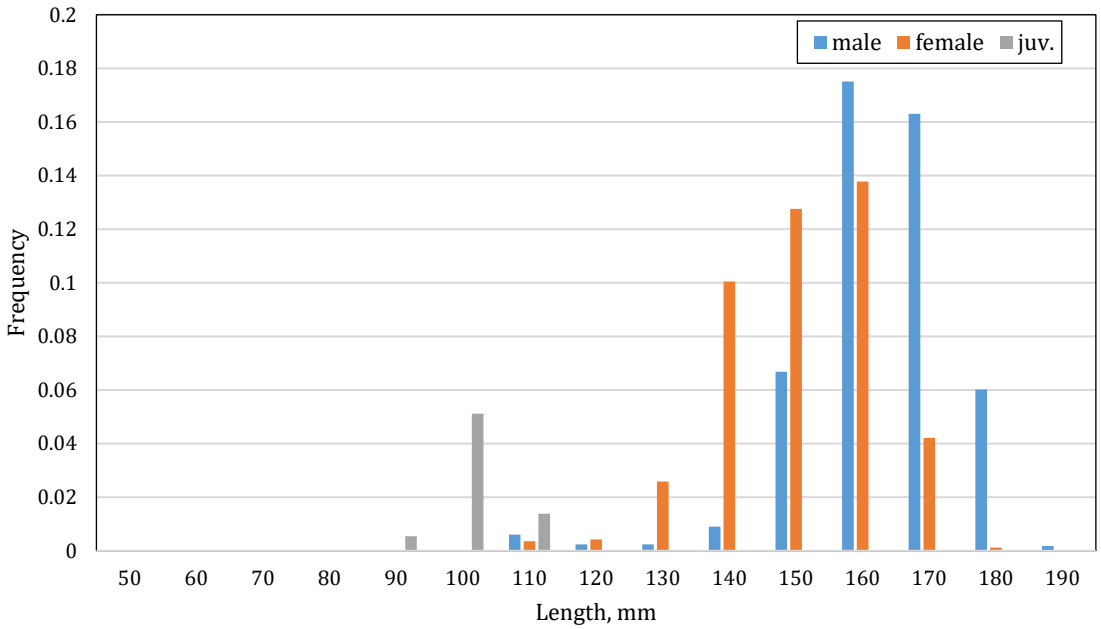

Figure 2. Length composition of capelin from the 2018 spring survey data.

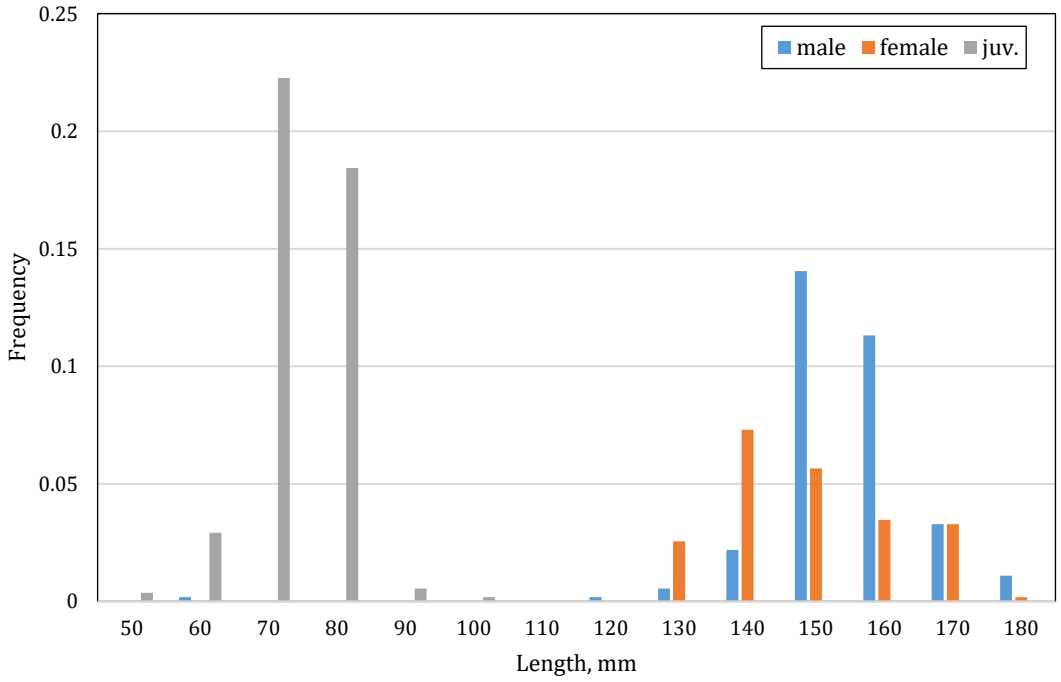

Figure 3. Length composition of capelin from the 2019 spring survey data.

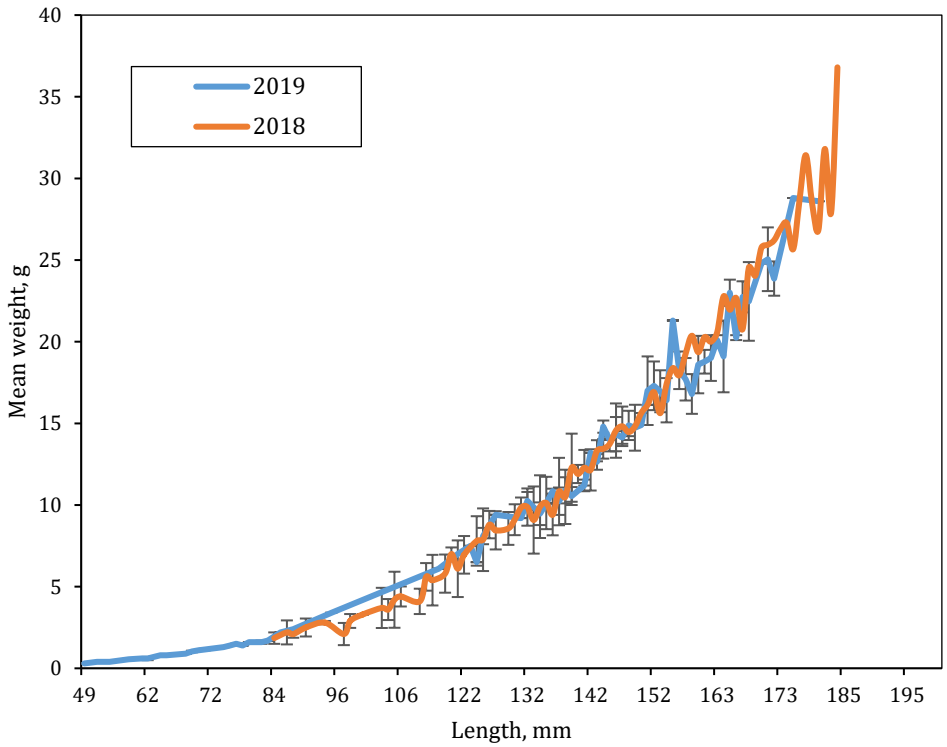

Figure 4. 3NO capelin length-weight diagram in 2018-2019.

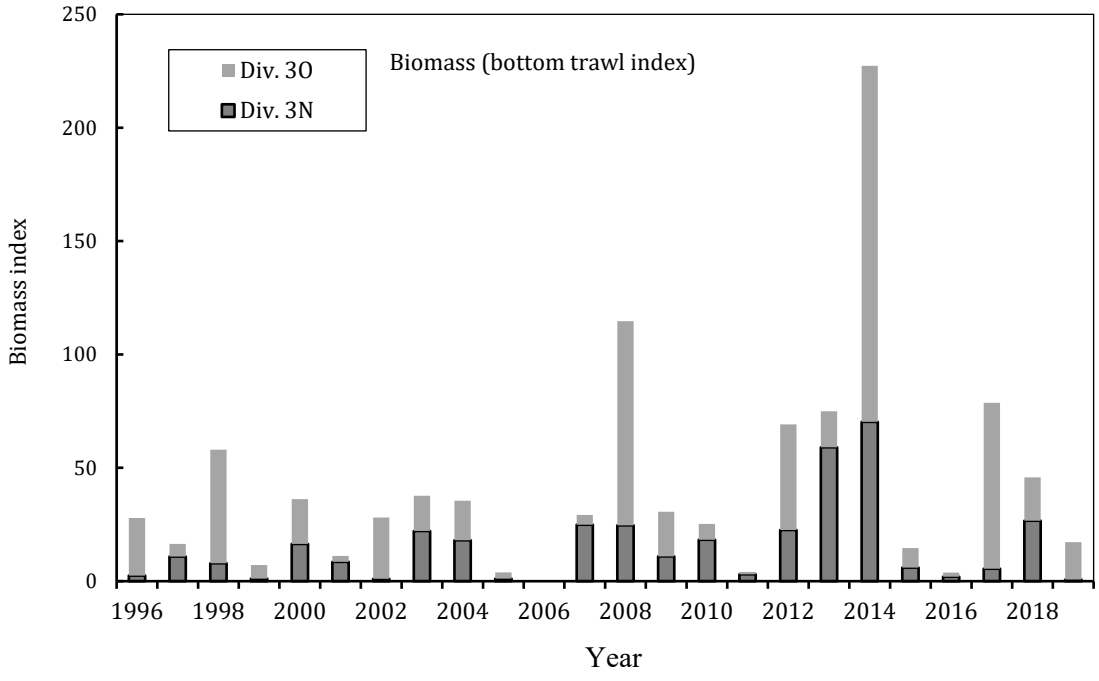

Figure 5. Estimates of trawl biomass of capelin in Div. 3NO according to the data of Canadian spring surveys conducted in 1996-2019.

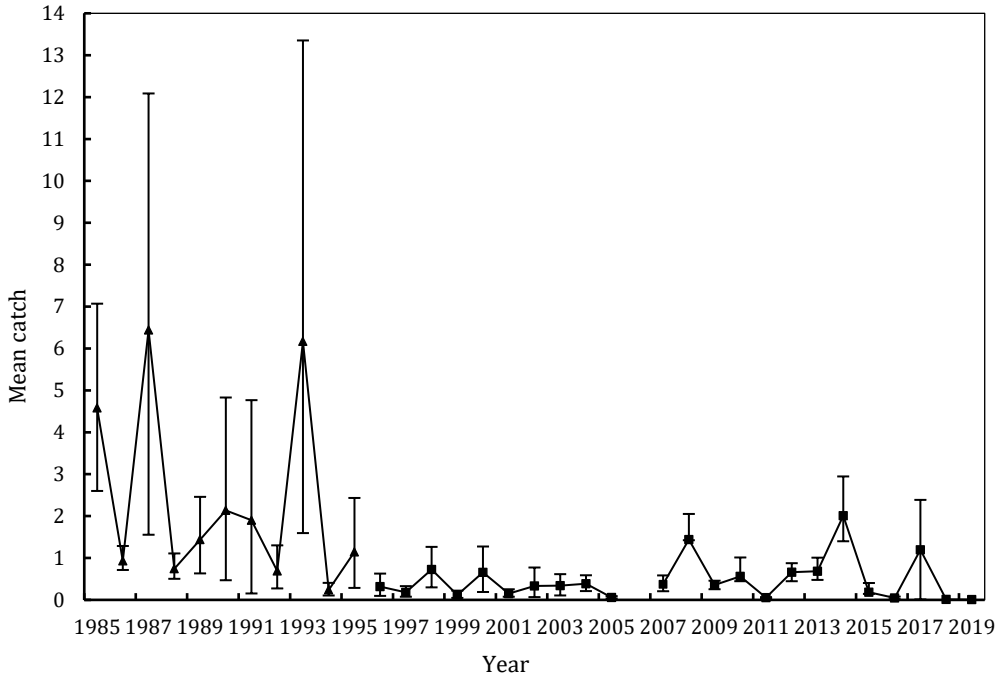

Figure 6. Average catch (t/km^2) according to the data of Canadian spring surveys in Div. 3NO.

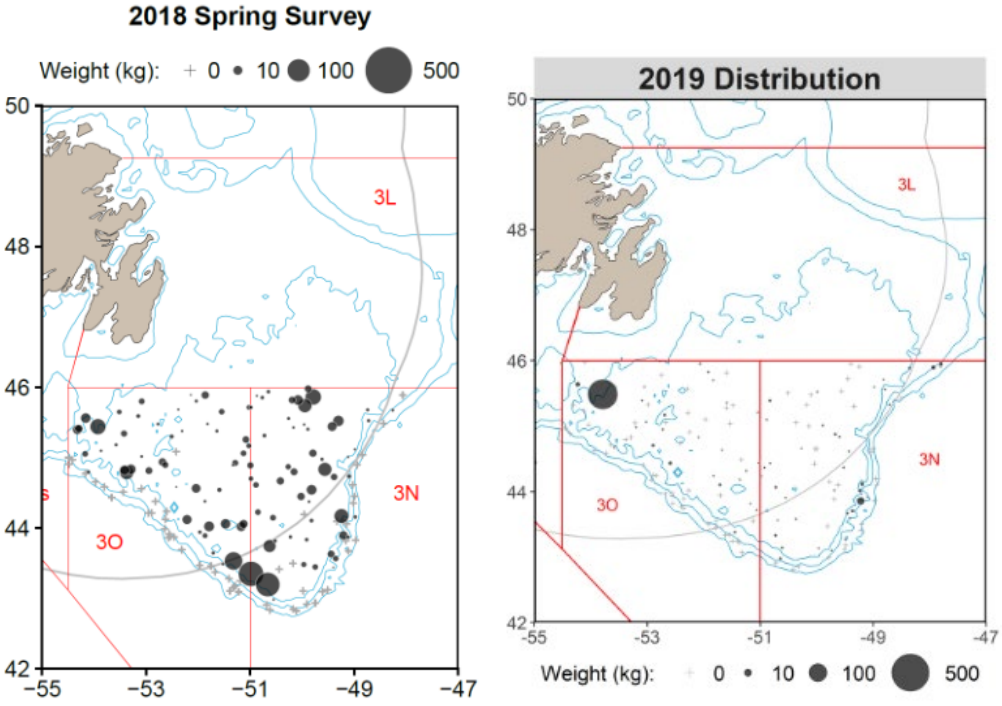

Figure 7. Distribution of capelin catches in Div.3NO in spring surveys, 2018 (left) and 2019 (right).