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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 are the only available at the present time indicators of capelin stock dynamics. In 2013, trawl biomass of capelin in Divisions 3NO was 74.9 thousand tons. In 2014, trawl biomass increased sharply and was 227.3 thousand tons. The average catch in 2013-2014 per 1 $km^2$ was 0.51 t and 0.98 t respectively. The estimate in 2014 corresponds increasing of the stock from sharp decrease in 2009. Fishery was conducted in the years when this value was equal or higher than 2 $t/km^2$. 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, by-catches 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 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, the target fishery for capelin was banned. 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 ban on target 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.

1) Canadian Spring bottom trawl surveys in 1995-2014.

## Biological characteristics

Compared to the 2013 year assessment, when one modal class of 16 cm was expressed in the length composition of capelin and 10 cm recruits was observed, in 2014 a length was two modal classes 13-14 and 16 cm (Fig. 1). Proportion of males and females in 2013 was 0.45 and 0.55 correspondingly. In 2014, proportion was 0.43 for males and 0.56 for females. A number of juveniles in 2013 constituted about 0.06 % (Fig. 2). In 2014 it's sharply increased and was 1.33 % (Fig. 3). Relationships between capelin length and weight (Fig. 4), obtained with the use of GLM procedure have shown decreasing of mean weight in length classes from 150 mm in 2014.

## 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 3 LNO, TAC remained at the same level of 30 thousand tons in 2 years.

In recent years, STACFIS several times has advised 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 1996-2008, trawl biomass of capelin in Divisions 3NO varied greatly from 3.9 to 114.7 thousand tons (Fig. 5). In 2009-2011, trawl biomass sharply decreased to the level of 4 thousand tons. In next three years, trawl biomass gradually increased until it was 74.9 thousand tons in 2013. In 2014 the biomass increased up to three times and was 227.3 thousand tons, the highest level for the entire period.

Based on the results of classification average catches per 1 $km^2$ in 1990-2004, the estimate in 2011 corresponds to the lowest level of the stock observed in the period since 1996. In 2013, the average catch per 1$km^2$ obtained by bootstrapping of values of actual catches, was 0.51 t/$km^2$, and sharply increase in 2014 for the level 0.98 t/$km^2$ (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 2014 give grounds for extention of the Scientific Council advice about the ban on target fishery for capelin in 2015-2017. A more precise estimation of the stock will be possible if trawl-acoustic surveys are resumed.

*Distribution of capelin stock*

In 2013 capelin stock distributed mainly in 3N Division. In 2014 main concentrations was registered in 3O division on the slopes of the bank, and the biggest catches was taken in the central shallow part of the bank (Fig. 7, 8).

**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 | 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 |
| 1998 | | | | | | | | | | | | | | **0** | 0 |
| 1999 | | | | | | | | | | | | | | **0** | 0 |
| 2000 | | | | | | | | | | | | | | **0** | 0 |
| 2001 | | | | | | | | | | | | | | **0** | 0 |
| 2002 | | | | | | | | | | | | | | **0** | 0 |
| 2003 | | | | | | | | | | | | | | **0** | 0 |
| 2004 | | | | | | | | | | | | | | **0** | 0 |
| 2005 | | | | | | | | | | | | | | **0** | 0 |
| 2006 | | | | | | | | | | | | | | **0** | 0 |
| 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 |
| **Total** | **477** | **10625** | **974** | **56** | **27763** | **230** | **18616** | **184960** | **8695** | **500** | **7** | **7765** | **324696** | **585364** | |

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 (thou. 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.

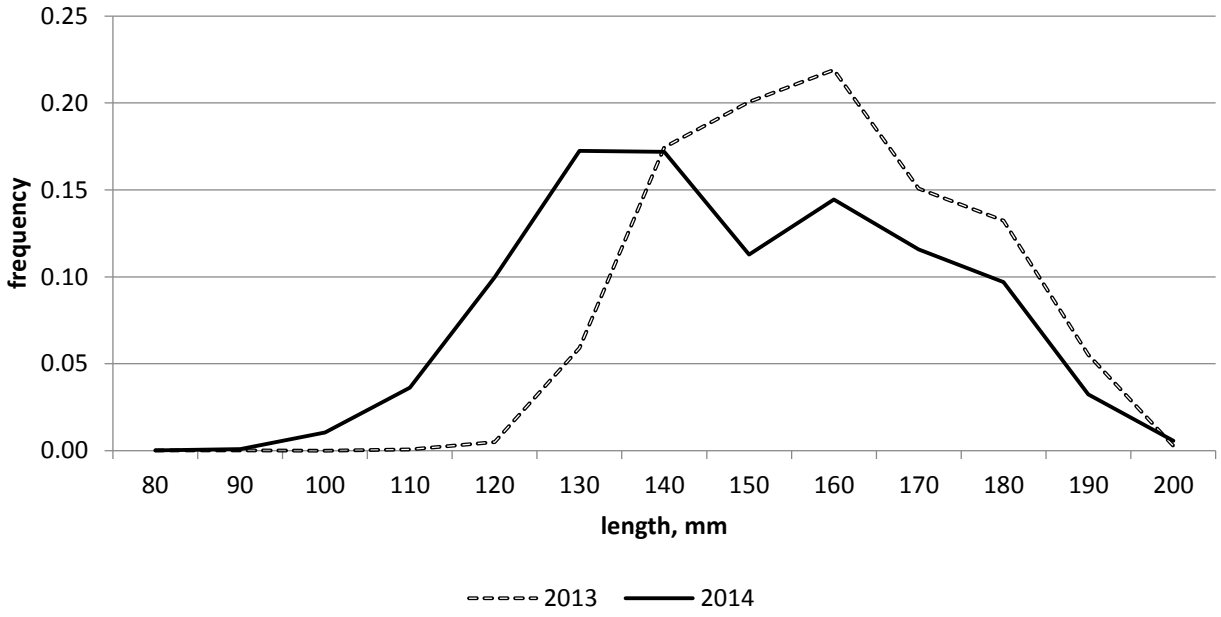


Fig. 1. 3NO capelin length series from spring surveys in 2013-2014.

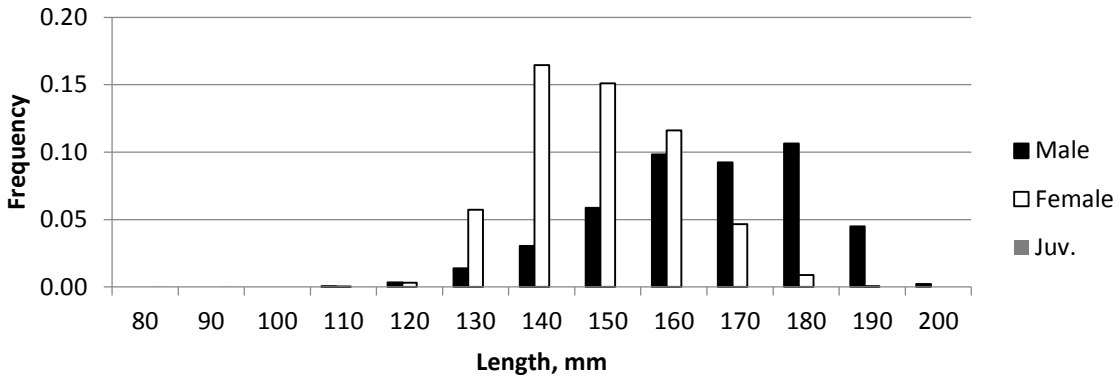


Fig. 2. Length composition of capelin on the spring survey data in 2013

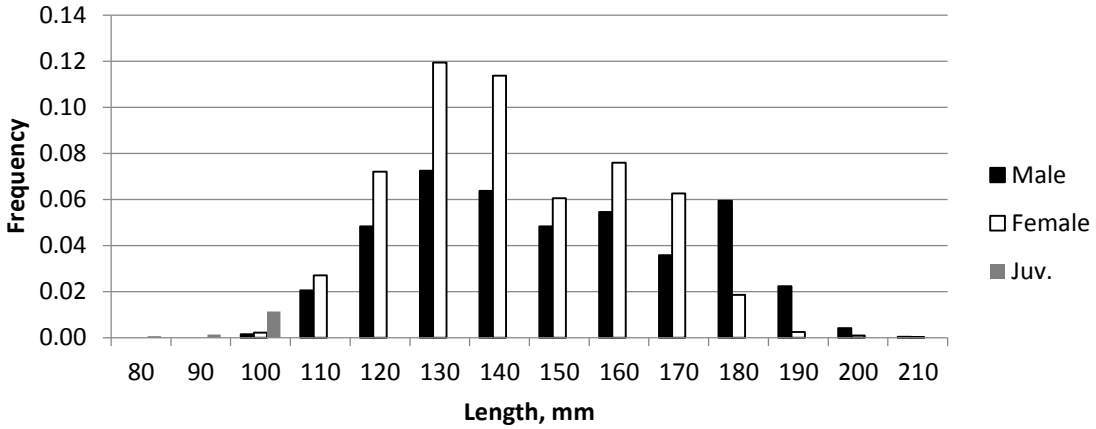


Fig. 3. Length composition of capelin on the spring survey data in 2014

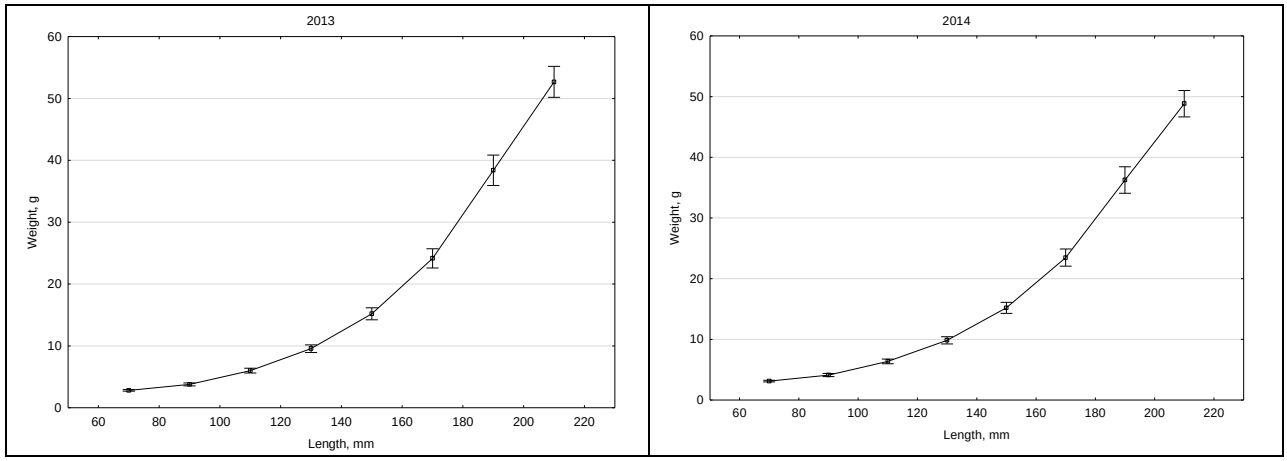


Fig. 4. 3NO capelin length-weight relationship in 2013-2014.

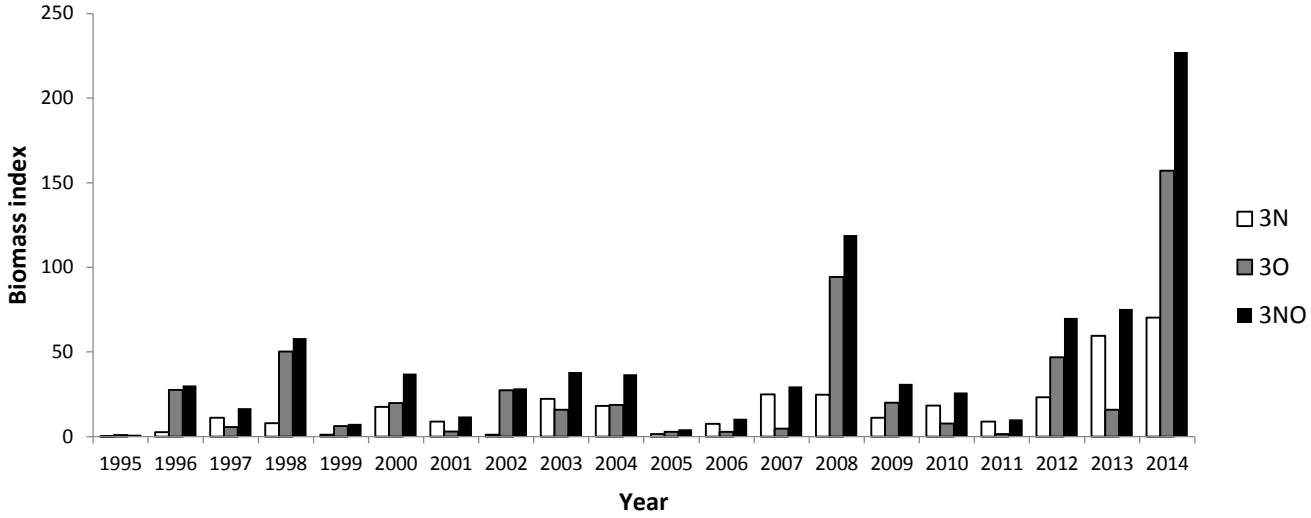


Fig. 5. Estimates of trawl biomass of capelin in Div. 3NO according to the data of Canadian spring surveys conducted in 1995-2014.

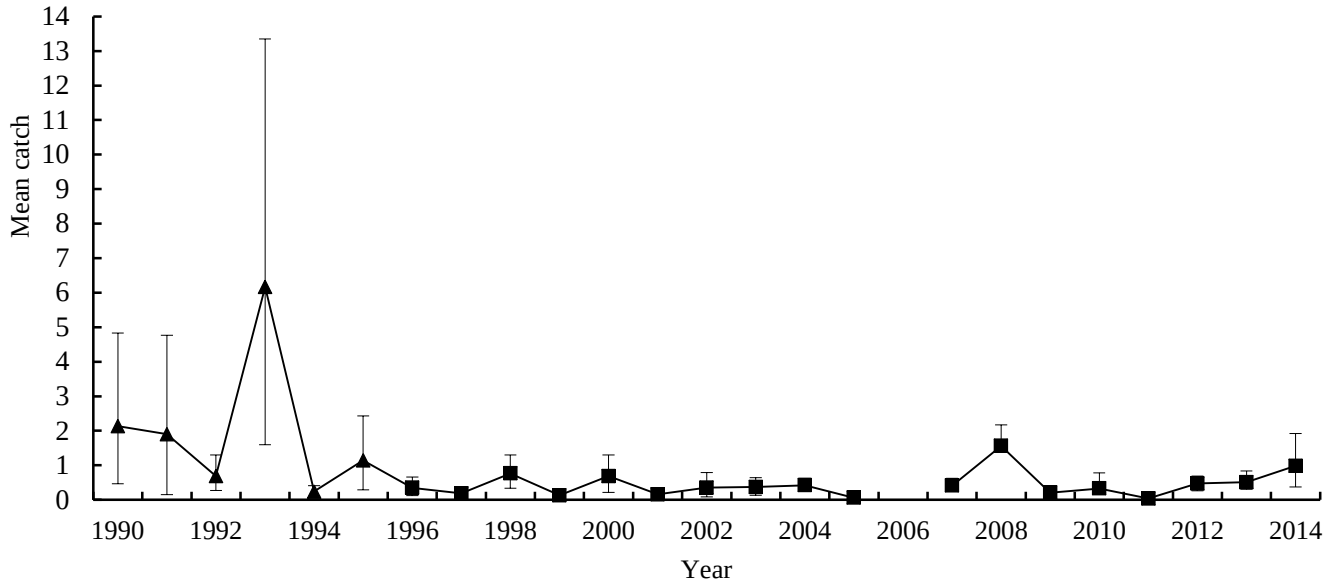


Fig. 6. Average catch (t/km$^2$) according to the data of Canadian spring surveys in Div. 3NO.

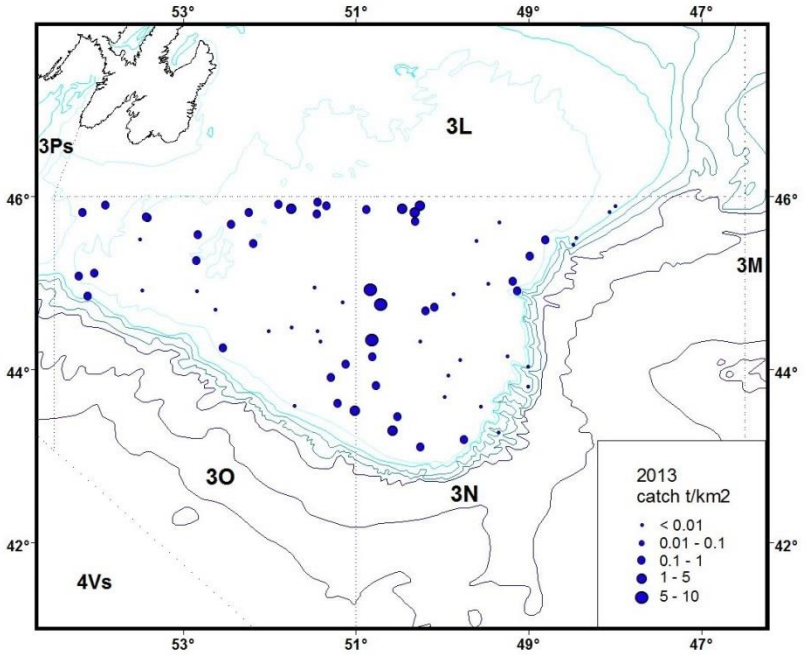


Fig. 7. Distribution of tows with zero trawling in Div.3NO in spring, 2013.

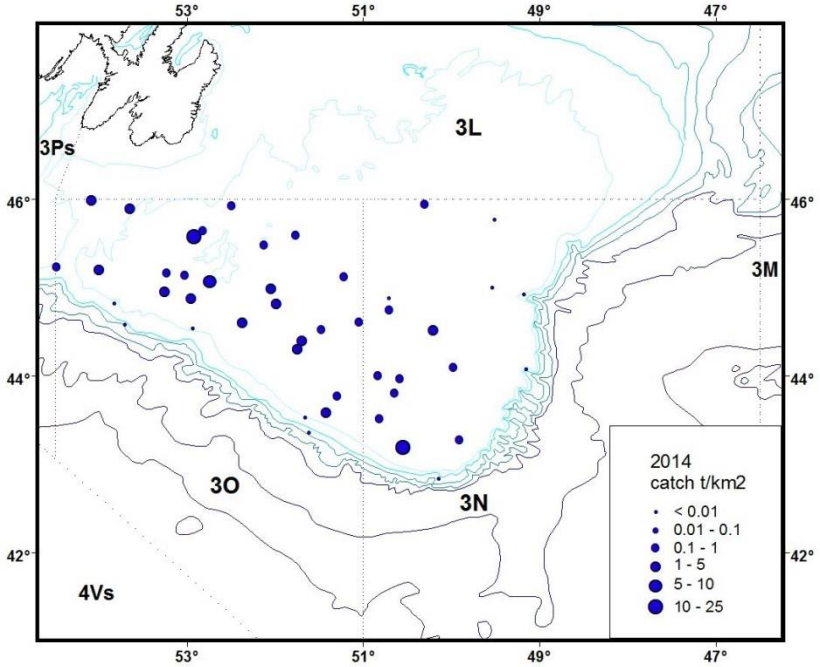


Fig. 8. Distribution of tows with zero trawling in Div.3NO in spring, 2014.