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Distribution of Northern Shortfin Squid (*Illex illecebrosus*) in Subarea 3 Based
on Multi-species Bottom Trawl Surveys Conducted During 1995-2005

by

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Abstract

Maps indicating the distributions of northern shortfin squid (*Illex illecebrosus*) during spring (1996-2005) and autumn (1995-2005) bottom trawl surveys were prepared to determine the most appropriate survey sampling strata to use in deriving annual relative abundance and biomass indices for the portion of the stock in Subarea 3. During both the spring and autumn surveys, *I. illecebrosus* are distributed in only a few strata rather than across many strata. Spring surveys indicate an inshore migration from deeper waters during May to shallower waters of the Grand Banks during June. Most of the *Illex* catches during the autumn surveys occurred offshore in deep water, during October-mid-December, but some catches also occurred near shore during the same time period. It is expected that utilization of the proposed subsets of strata from each survey will improve the precision of the annual relative abundance and biomass indices of *Illex*. However, annual precision estimates must be computed to confirm this expectation. In addition, it is unknown whether the survey distribution patterns reflect the timing of the surveys in relation to the species' annual migrations through the survey areas or whether they reflect *Illex* abundance.

Introduction

Data from two research survey series are used to derive relative abundance and biomass indices for *I. illecebrosus* in Subarea 3 (Hendrickson *et al.* 2004). Stratified mean number per tow and weight per tow indices are currently derived using all strata sampled by the Canada Division of Fisheries and Oceans (DFO) during research bottom trawl surveys conducted during spring (April-June) in Divisions 3LNOP and during autumn (mainly September-December) in Div. 3KLNO (Doubleday, 1981). *I. illecebrosus* indices are only available for surveys conducted since 1995 because the species was not consistently identified in earlier surveys (E. Dawe, CA DFO, pers. comm.). Beginning in autumn 1995, the trawl used in both surveys was changed from an Engels Hi-rise trawl to a Campelen 1800 shrimp trawl, the latter being smaller in overall size and containing smaller mesh. The two surveys cover large areas and occur over an extended time period which may or may not coincide with annual *Illex* migrations onto the Grand Banks during early summer and off the Grand Banks during autumn (Dawe and Hendrickson, 1998). As a result, in 2004 the Scientific Council recommended (NAFO, 2005) that the spatial distribution of *I. illecebrosus* during each of the two surveys be examined to determine the most appropriate subset of strata to use when deriving relative abundance and biomass indices from these surveys.

Materials and Methods

ArcView software © ESRI was used to map the distribution of *I. illecebrosus* caught during spring (April-June, 1996-2005) and autumn (mainly September-December, 1995-2005) multi-species research bottom trawl surveys conducted in Subarea 3 by the Canada DFO, Newfoundland and Labrador Region. Sampling protocols and details of the stratified random survey design are described in (Doubleday, 1981). Survey sampling coverage of Subarea 3 varied between seasons and consisted of Div. 3LNOP during spring and Div. 3KLMNO during autumn. The autumn survey is conducted by two vessels (R/Vs *Teleost* and *Wilfred Templeman*) using a Campelen 1800 shrimp trawls. The spring survey is conducted with a single vessel (R/V *Wilfred Templeman*) and the same Campelen trawl. Sampling coverage and timing of the spring surveys have been fairly consistent since 1996, but the autumn survey has undergone changes that include: incomplete spatial coverage, extension of the timing of the survey, and vessel changes (Brodie, 2005). Sampling at depths >731 m was sporadic during 1995-2004 and some strata in Div. 3L and 3K were not sampled during the 2004 autumn survey. Spatial and temporal sampling coverage in Div. 3M was inconsistent, so *Illex* catches from survey strata in Div. 3M are not included in the computation of autumn survey indices. Survey stations and *Illex* catches in Div. 3M are shown on the distribution maps presented herein for illustrative purposes only.

The locations of stations with and without catches of *I. illecebrosus* were mapped according to the GPS location logged at the end of each tow, for all tows unaffected by gear damage ("gear operation" code = 1 or 2) and regardless of tow distance. Maps of *Illex* densities, expressed as number per tow, were prepared separately for the spring and autumn surveys. The number of tows with *Illex* catch was summarized by survey, stratum, and year to identify which strata contain stations with a high frequency of *Illex* catches within and across years.

Results

Northern shortfin squid are caught at few stations and at low densities during spring surveys in Divisions 3LNOP and autumn surveys in Div. 3KLNO (Fig. 1). The depth range sampled during spring surveys was 20-870 m and bottom temperatures ranged from -1.6 to 10.5°C. During spring surveys, sampling begins in April in Div. 3P, then progresses in a counterclockwise direction and ends in Div. 3L during June (Table 1). Sampling occurred during 4/2-6/30, but *Illex* were not caught until mid-April (Table 1). *Illex* were caught least frequently (at <1% of the stations) in Div. 3P during April and most frequently (at 10.2% of the stations) in Div. 3N, during mid-May through mid-June, and in Div. 3L (at 7.7% of the stations) during June (Table 1). Overall, *Illex* were caught at depths of 40-719 m. During May through mid-June, *Illex* are distributed along the outer edge of the Grand Banks at median depths of 291-297 m. During June, squid had also begun to migrate inshore. The occurrence of an inshore migration is confirmed by a decrease in median depth by Division, between April and June, at stations where *Illex* were caught (Table 1). The decrease in median depth was also associated with a reduction in median bottom temperature, by Division, from 5.1 to 2.3°C. Median depths were greater and median bottom temperatures were higher at stations where *Illex* were caught than for all stations sampled (Table 1).

The general sampling pattern during autumn surveys was similar to that which occurred during spring surveys, but the timing of the autumn survey and the strata sampled has been more variable than the spring survey since 1995. In particular, deeper strata are sampled during autumn surveys (depths ranging from 32-1,504 m). Bottom temperatures at these depths ranged from -1.5 to 10.3°C. *Illex* were caught at depths of 35-1,424 m. Sampling occurred during 9/22-2/1, but *Illex* catches only occurred during 10/2-1/7 (Table 1). *Illex* were distributed over a smaller survey area during autumn than in spring and were caught most frequently (at 16.9% of the stations) in Div. 3O and least frequently (at <1% of the stations) in the northernmost Division (3K, Fig. 1). Division 3O also had the highest median bottom temperature (5.4°C) at stations where *Illex* were caught during autumn. In all Divisions, median depths were greater and median bottom temperatures were higher, at stations where *Illex* were caught, than for all stations sampled (Table 1). During some years, *Illex* were not entirely distributed inshore during autumn. For example, during 1996, *Illex* were concurrently distributed both inshore and offshore in Div. 3L during 10/13-10/31, but later caught only at inshore stations during 11/5-11/10.

During the spring surveys in Div. 3LNO there were 56 strata that met the frequency criteria of having either two or more stations with *Illex* catch or of having stations with *Illex* catch during two or more years. The strata that accounted for 90% of the total number of stations with *Illex* catch during spring surveys included: 328-337, 340, 344, 351-358, 361, 385-386, 392, 717-722, 724-727, 730, 734-736, 761, 765, 769, 771, 773, 775, 784, 786, 789, 790,

792-793 and 800. During the autumn surveys in Div. 3LNO, 51 strata met the frequency criteria, and accounted for 95% of the total number of stations with *Illex* catch: 332-337, 345, 348, 355-360, 364-366, 368-370, 374, 376-383, 385-392, 712, 717-718, 720-733, 735-736. Not all strata were common to both surveys, in part, because additional deepwater strata are sampled solely during autumn surveys.

Discussion

Illex habitat during the spring and autumn surveys is concentrated in few strata. Therefore, rather than using all strata from each survey, two subsets of strata (one for each survey) are recommended for use in deriving *Illex* relative abundance and biomass indices in Subarea 3. The strata subsets do not include Div. 3K and 3P, which have few stations with *Illex* catches, and do not include those strata that constitute marginal *Illex* habitat (strata that do not meet the catch frequency criteria). Deriving indices based on the utilization of the proposed subset of strata from each survey is expected to improve the precision of the indices. However, annual precision estimates must be computed to confirm this expectation. In addition, it is unknown whether the survey distribution patterns reflect the timing of the surveys in relation to the species' annual migrations through the survey areas or whether they reflect *Illex* abundance.

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TABLE 1. Sampling periods, and median depths and bottom temperatures at stations with *Illex illecebrosus* catches, by Division, during Canadian spring (1996-2005) and autumn (1995-2005) research bottom trawl surveys.

Spring, 1996-2005		Stations with <i>Illex</i> catch				All stations	
NAFO	Sampling dates		% stations	Median bottom		Median bottom	
Division	All stations	Stations with <i>Illex</i> catch	with <i>Illex</i> catch	temperature (°C)	Median depth (m)	temperature (°C)	Median depth (m)
3P	4/2-5/11	4/18-5/5	0.8	5.1	356	1.4	152
3O	4/27-6/5	5/1-5/30	6.0	5.0	291	2.4	93
3N	5/13-6/19	5/18-6/14	10.2	3.2	297	2.0	73
3L	5/11-6/30	6/7-6/29	7.7	2.3	250	2.3	249
3K	not sampled	-	-	-	-	-	-
Autumn, 1995-2005							
3P	not sampled	-	-	-	-	-	-
3O	9/22-12/17	10/2-12/17	16.9	5.4	280	3.7	116
3N	9/27-12/16	10/16-11/20	2.3	3.6	410	2.6	89
3L	10/3-1/29	10/13-12/17	2.6	0.8	199	0.5	168
3K	11/4-2/1	11/14-1/7	0.9	3.3	469	3.0	315

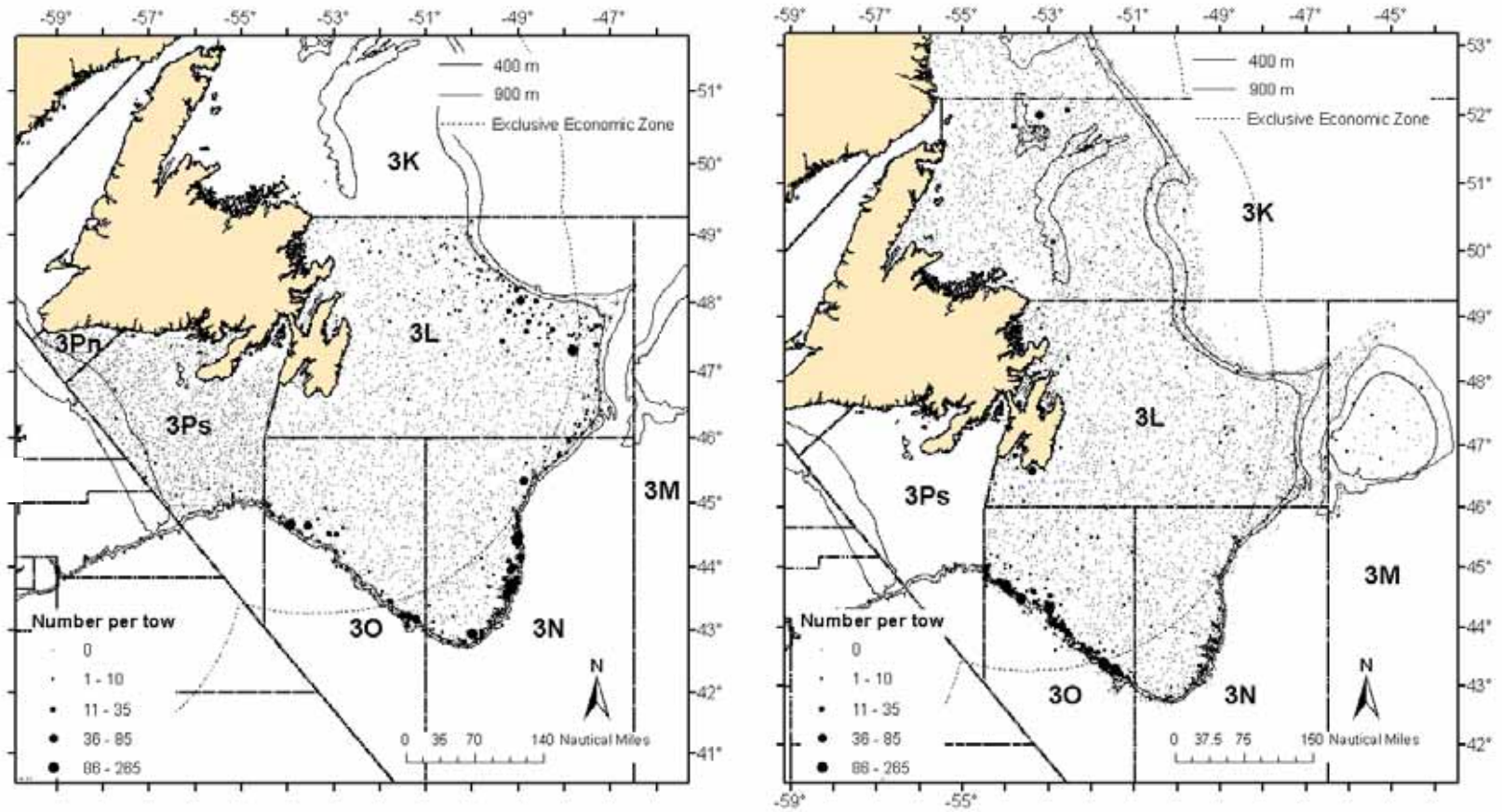


Fig. 1. Distribution of *Illex illecebrosus* caught in Subarea during spring (April-June, 1996-2005, left panel) and autumn (September-December, 1995-2005, right panel) multi-species bottom trawl surveys conducted by the Department of Fisheries and Oceans, Canada.