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Assessment of Northern Shortfin Squid (*Illex illecebrosus*) in Subareas 3+4 for 2005

by

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Abstract

Two general levels of productivity have been identified for the Subareas 3+4 component of the northern shortfin squid (*Illex illecebrosus*) population based on trends in nominal catches, research vessel survey relative biomass indices, and squid mean weight (Rivard *et al.*, 1998; Hendrickson, 1999). A period of high productivity (1976-1981) occurred between two low productivity periods (1970-1975 and 1982-2004). During 2005, the relative biomass index from the Canadian Division 4VWX July survey was well below the 1982-2004 average and the mean size of squid in the 2005 survey was smaller (69 g) than the 1982-2004 average (77 g). The 2005 nominal catch in Subareas 3+4 (559 mt) was also low relative to the 1982-2004 average (3 400 mt). Based on these trends, the Subareas 3+4 stock component remained in a state of low productivity in 2005.

Introduction

Northern shortfin squid (*Illex illecebrosus*), a species with a lifespan of less than one year (Dawe and Beck, 1997; Hendrickson, 2004), is considered to constitute a unit stock throughout its range of exploitation in the Northwest Atlantic Ocean, from Newfoundland to Cape Hatteras, North Carolina (Dawe and Hendrickson, 1998).

The onset and duration of the fisheries in each Subarea generally reflect the timing of squid migrations through each fishing area. Subarea 3 catches are primarily from a small-boat jig fishery that occurs in shallow, nearshore waters of Newfoundland. During 1987-2001, squid were harvested from Subarea 4 by an international bottom trawl fishery for silver hake (*Merluccius bilinearis*), *I. illecebrosus* and argentine (*Argentina* sp.) that occurred on the Scotian Shelf (Hendrickson *et al.*, 2002). International fleets, comprising midwater and bottom trawlers, began fishing for northern shortfin squid in Subareas 5+6 in 1968 (Dawe and Hendrickson, 1998). Since 1987, landings from Subareas 5+6 have been from a directed bottom trawl fishery that occurs primarily in the Mid-Atlantic Bight (NEFSC, 1999).

Although the resource is continuously distributed between Cape Hatteras and inshore Newfoundland during summer through autumn, it is considered, for management purposes, to be composed of two components. Management of the northern component, in Subarea 3 (Newfoundland) and Subarea 4 (Scotian Shelf and Gulf of St. Lawrence), is based on an annual Total Allowable Catch (TAC) established by the Northwest Atlantic Fisheries Organization (NAFO). The TAC has been set at 34 000 t since 2000. The southern component (Subareas 5+6) is located within the Exclusive Economic Zone (EEZ) of the United States and has been managed by the Mid-Atlantic Fishery Management Council since 1977. The annual TAC for the Subareas 5+6 component has been set at 24 000 t since 2000. This document provides an evaluation of the status of the Subareas 3+4 component in 2005 based on trends in commercial fishery data, research vessel survey relative abundance and biomass indices, and relative fishing mortality indices.

Materials and Methods

Commercial Fishery Data

Nominal catches have been recorded from the Subarea 3 fishery since 1911 (Dawe, 1981) and from the Subarea 4 fishery since 1920 (ICNAF, 1973). Landings from Subareas 5+6 have been recorded since 1963 (Lange and Sissenwine, 1980). Nominal catches from Subarea 3 and Subarea 4 are presented for 1953-2005 and for 1963-2005 for Subareas 5+6.

Subarea 4 catches after 1987 represent the sum of catches (kept fraction only) of northern shortfin squid in the Scotian Shelf international fishery (for silver hake, *I. illecebrosus* and argentine) plus catches from the Canadian Zonal Interchange Format (ZIF) Database. The ZIF database contains catches by Canadian vessels and international vessels with Canadian allocations. Squid catches in the international fishery were obtained from the CA DFO Maritimes Observer Program Database. Catch data from the Observer Program Database are considered the most accurate because there has been 100% observer coverage in the Subarea 4 international fishery since 1987 and the data are collected on a tow-by-tow basis (Showell and Fanning, 1999).

Research Survey Data

Fishery-independent indices of relative abundance (stratified mean number per tow) and biomass (stratified mean kg per tow) were derived for Subarea 4 and Subareas 5+6 from stratified random bottom trawl surveys conducted by Canada in Div. 4T (southern Gulf of St. Lawrence) during September (1971-2005), in Div. 4VWX (Scotian Shelf) during July (1970-2005), and by the United States of America in Subareas 5+6 during September-October (1967-2005). With the exception of the Div. 4T survey, which occurred during daylight during 1971-1984, sampling in all surveys was conducted around the clock. All strata were used to compute relative abundance and biomass indices for Div. 4T and Div. 4VWX. The sampling design and protocols used in the Div. 4T survey are provided in Halliday and Koeller (1981) and Koeller (1980). Different vessels were used to conduct the Div. 4VWX survey during 1970-1981 (CCGS *A. T. Cameron*), 1982 (CCGS Lady Hammond), 1983-2003 and in 2005 (CCGS *Alfred Needler*) (Fanning 1985), and 2004 (CCGS *Teleost*) (M. Showell, CA Department of Fisheries and Oceans, pers. comm.). However, there are no gear or vessel conversion coefficients available with which to standardize the survey indices prior to 2004. The 2004 indices were adjusted to account for a significant vessel catchability effect ($p < 0.012$), between the CCGS *Teleost* and the CCGS *Alfred Needler*, by multiplying the CCGS *Teleost* indices by a factor of 1.37 (M. Showell, CA Department of Fisheries and Oceans, pers. comm.). Vessel changes during the Div. 4T survey included use of the CCGS *Wilfred Templeman* during 2003, the CCGS *Teleost* during 2004, and the CCGS *Needler* and CCGS *Teleost* during 2005 (Hugues Benoit, CA Division of Fisheries and Oceans, pers. comm.). The CCGS *Teleost* will be used in future Div. 4T surveys. During 2003, there was also a reduction in the number of strata sampled in Div. 4T. The Div. 4T survey indices have been adjusted for diel and vessel catchability differences for 1985-2002 (Benoit and Swain, 2003) and for vessel catchability differences during 2004-2005 (Hugues Benoit, CA Division of Fisheries and Oceans, pers. comm.). There were no data available to adjust the 2003 indices for vessel catchability differences and not enough data available to determine whether there is a significant diel effect between the CCGS *Teleost* and the CCGS *Needler*. Survey indices computed for the Subareas 5+6 surveys include all offshore strata between depths of 27 and 366 m (Grosslein, 1969) and were adjusted for gear and vessel catchability differences (NEFSC, 1999).

Data from three research survey series were used to derive survey abundance and biomass indices for *I. illecebrosus* in Subarea 3. Swept area estimates of absolute abundance and biomass were derived, from all strata sampled during 1988-2005 in the July EU bottom trawl survey of the Flemish Cap in Div. 3M (Saborido-Rey and Vazquez, 2001). Due to a change in vessels, from the R/V *Cornide de Saavedra* to the R/V *Vizconde de Eza*, indices from 2003 onward were adjusted for differences in vessel catchability by dividing the R/V *Cornide de Saavedra* indices by 0.81 (the ratio of R/V *Cornide de Saavedra* catches to R/V *Vizconde de Eza* catches) (Antonio Vázquez, Instituto de Investigaciones Marinas, Spain, pers. comm.). Stratified mean number per tow and weight per tow indices were derived for all strata sampled by the Canada Division of Fisheries and Oceans (DFO) in autumn bottom trawl surveys conducted in Div. 3KLNO, mainly during September-December, and in spring bottom trawl surveys conducted in Div. 3LNOP in April-June (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 Department of Fisheries and Oceans, pers. comm.). Also, during autumn of 1995, the trawl used in both DFO surveys changed from an Engels Hi-rise trawl to a Campelen 1800 shrimp trawl, the latter being smaller in overall size and containing smaller mesh.

Fishing Mortality

Annual relative fishing mortality indices for Subareas 3+4, during 1970-2005, were computed by dividing the annual catches from Subareas 3+4 by the annual biomass indices from the July Div. 4VWX surveys.

Results and Discussion

Subareas 3+4 Fisheries

During 1992-1999, squid catches in the SA 4 international fishery ranged between 286 t (in 1999) and 3 997 t (in 1994) and were predominantly from the Cuban fleet. However, there has been no Cuban fishery since 1999 (NAFO 2003). Since 2000, Subarea 4 catches have been primarily from bycatch in Canadian trawl fisheries and have been less than 45 t (Table 1). Catches by international vessels were solely Russian and totalled 12 t in 2000 and 4 t in 2003 (NAFO 2003). During 2005, a Korean vessel using three types of experimental jigs caught 13 mt of *Illex* primarily in Subarea 4 during August and September (T.-Y. Oh, National Fisheries Research and Development Institute, Korea, pers. comm.). The total catch in Subarea 4 during 2005 was 30 t. During 1992-1999, annual catches in Subarea 3 from the Canadian inshore jig fishery were highly variable and ranged between 48 t (in 1995) and 12,748 t (in 1997) (Table 1). Since 2000, Subarea 3 catches have ranged between 23 t in 2001 and 2,277 t in 2004. The total catch in Subarea 3 during 2005 was 529 t.

Catches in Subareas 3+4 increased during the 1970s and reached a peak of 162 092 t in 1979 (Table 1, Fig. 1). During 1976-1981, total catches (Subareas 3-6) were dominated by those from Subareas 3+4; averaging 80 645 t in Subareas 3+4 and 19 661 t in Subareas 5+6. Following a 1979 peak, Subarea 3+4 annual catches declined sharply, to less than 1 000 t during 1983-1988. During 1997, Subareas 3+4 catches (15 614 t) reached their highest level since 1981 and were primarily from the Subarea 3 inshore jig fishery (12 748 t). After 1998, catches from Subareas 3+4 were less than 1 200 t, varying between 57 t (in 2001) and 2 311 t (in 2004). The total catch (559 t) in Subareas 3+4 remained low during 2005.

Subareas 5+6 Fishery

Catches from Subareas 5+6 reached a peak of 24 936 t in 1976 when an international fishery existed on the eastern USA shelf (Table 1, Fig. 1). Since 1987, the Subareas 5+6 fishery has consisted solely of domestic bottom trawlers. During 1987-1997, catches were generally in the range of 10 000-18 000 t. USA catches peaked in 1998 (23 597 t), but the fishery was closed beginning in August because the TAC (19 000 t) had been exceeded. During 1999-2003, catches from Subareas 5+6 varied between 2 750 t (in 2002) and 9 011 t (in 2000). The fishery was closed again in September of 2004, when the highest catch on record (26 097 t) was landed and the quota (24 000 t) was exceeded. During 2005, catches declined by 54% to 12 013 t.

Catches from Subareas 3-6

The timing and duration of the northern shortfin squid fisheries vary by Subarea. Since 1992, the Subarea 4 and 5+6 fisheries have occurred during June-October, with peak catches in July. The Subarea 3 fishery has occurred during July-November with peak catches in September (Hendrickson *et al*., 2002).

Total catches from Subareas 3-6 declined by 70% between 1998 and 1999, then ranged between about 3 000 t and 9 400 t during 2000-2003 (Table 1, Fig. 1). This decline occurred across all Subareas, but was primarily due to the lack of a directed fishery in Subarea 4. Catches declined by more than 50% between 2004 and 2005, from 28 408 t to 12 572 t, respectively, and was primarily due to a large decline in the catches from Subareas 5+6.

Survey Abundance and Biomass Indices

Annual trends in relative abundance (stratified mean number per tow) and biomass (stratified mean kg per tow) are shown in Fig. 2 and presented in Table 2 for the three surveys with the longest time series. The Div. 4VWX survey generally occurs prior to the fishery in Subarea 3 and during the early phase of the Subarea 4 fishery. Therefore, the Div. 4VWX survey is considered as a survey of pre-fishery biomass. Relative biomass indices from the Div. 4VWX survey indicate a period of high productivity during 1976-1981, averaging 12.6 kg/tow, followed by a low productivity period during 1982-2004, averaging 3.0 kg/tow (Fig. 2, Table 2). The large increase in the biomass index during 2004 was followed by a 2005 index (0.7 kg/tow) that was below the average level for the low productivity period.

Abundance indices from the Subarea 3 pre-fishery EU survey conducted in July on the Flemish Cap (Div. 3M) does not appear to track the same trends as the Div. 4VWX July survey probably because the Flemish Cap represents marginal *Illex* habitat (Table 3, Fig. 3). Although the Canadian survey in Div. 3LNOP is conducted during April-June, a time when squid may not have completed their migration onto the continental shelf during some years (Dawe and Warren, 1993), the indices track those of the Div. 4VWX survey more closely than the July 3M indices. Both time series showed a sharp increase in the 2004 biomass index, followed by a decline during 2005. However, the 3LNOP indices are lower in magnitude (Table 3, Fig. 3), probably because they occur earlier and the entire survey area does not consistently represent suitable *I. illecebrosus* habitat during the time that the survey is conducted.

The survey in autumn survey in Subareas 5+6 occurs late in the U.S. fishing season and reflects post-fishery biomass. Other late-season surveys include the September Div. 4T survey and the Div. 3KLNO survey which is conducted mainly during September-December. Indices from the latter two surveys are much lower in magnitude than the Subareas 5+6 indices (Table 3). Indices from the Div. 3KLNO survey and the Subareas 5+6 survey exhibit similar trends but the Div. 4T does not (Fig. 4) suggesting that Div. 4T represents marginal *Illex* habitat.

In 2003, the Subareas 5+6 survey abundance index was the highest value in the survey time series (28.5 squid/tow) (Table 2). However, unlike abundance indices from the high productivity period (*i.e.* 1976-1981), the relative biomass index in 2003 was low (1.95 kg/tow), reflecting much smaller mean body size of squid in 2003 than during 1976-1981. Despite the record high abundance index in 2003, squid were not caught in large numbers at multiple stations, rather the 2003 index reflects a large catch (3,573 squid) at a single station. During 1981, when the abundance index (27.1 squid per tow) was similar to that of 2003 (Table 2), catch rates were high at multiple stations. During 2004 and 2005, biomass indices in Subareas 5+6 remained low.

Body Size

Mean body weights of squid were largest during the high productivity period (1976-1981) and lower during the low productivity periods in both the Div. 4VWX July survey and the Subareas 5+6 autumn survey (Fig. 5). Mean weights were much larger in the Subareas 5+6 survey than in the Div. 4VWX survey during the high productivity period. However, this size disparity subsequently decreased due to a gradual decline in the mean size of squid in the Subareas 5+6 survey, such that squid from both surveys were of similar size (about 70-85g) during 2001-2003. This size range is similar to the 1982-2002 average size (75 g) of squid caught in the Div. 4VWX surveys (Fig. 5). During 2005, the body size of squid in Subareas 5+6 was the lowest on record (67 g) and of a size similar to squid from Div. 4VWX.

Relative Fishing Mortality Indices

Annual relative fishing mortality indices for Subareas 3+4 were high during 1977-1981, reached a peak of 4.09 in 1978 (Table 4, Fig. 6) and averaged 1.67 during the high productivity period (1976-1981). High levels during 1976-1981 were attributed to large catches and low survey indices. During 1982-2004, relative fishing mortality indices were much lower and averaged 0.17. The relative fishing mortality index for 2005 (0.08) was below the average for the low productivity period (Table 4).

Limit Reference Points

For data-poor stocks, such as the Subareas 3+4 *Illex* stock component, the NAFO Study Group on Limit Reference Points recommends that 85% of the maximum observed biomass index be used as a proxy for B_{lim}, assuming that the highest index is equal to B_{MSY} (SCS Doc. 04/12). For all NAFO stocks, F_{lim} is considered as F_{MSY} or a proxy thereof. However, *Illex* is a sub-annual, semelparous species. Recruitment is strongly influenced by environmental conditions (Dawe and Warren, 1993), and as a result, the Subareas 3+4 stock component has experienced low and high productivity states. During the low productivity state, since 1982, the response of the Div. 4VWX relative biomass indices to fishery removals has been inconsistent (a high annual biomass index has not consistently been associated with a high nominal catch during the same year). For example, the Div. 4VWX biomass indices were at a similar, medium level during 1993 and 1997 yet the Subareas 3+4 catches were more than five-fold greater in 1997 than in 1993 (Table 4). During 2004, the biomass index was the second highest on record, yet the catches were only 2 300 t and below the 1982-204 average (4 400 t) and similar to the catch in 1993. Given this inconsistency and the lack of a stock-recruitment relationship, limit reference points or proxies thereof are not currently estimable for the Subareas 3+4 stock component.

Summary

In 2005, relative abundance and biomass indices from the Div. 4VWX July survey were well below the 1982-2004 average. The relative fishing mortality index was also low. The mean size of squid in the 2005 survey (69 g) was smaller than the 1982-2004 average (77 g). Based on these trends, the Subareas 3+4 stock component remained in a state of low productivity in 2005.

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Table 1. Nominal catches (t) of *Illex illecebrosus* in NAFO Subareas 3 and 4 during 1953-2005 and Subareas 5+6 (U.S. EEZ) during 1963-2005, and TACs in Subareas 3+4 and Subareas 5+6.

Year	Subarea 3[2] (t)	Subarea 4[3] (t)	Total Subarea 3+4 (t)	Subareas 5+6[4,5] (t)	Total Subareas (3-6)[6] (t)	TAC (t)[1] 3+4	TAC (t)[1] 5+6
1953	4,460	51	4,511		4,511		
1954	6,700	115	6,815		6,815		
1955	7,019	269	7,288		7,288		
1956	7,779	450	8,229		8,229		
1957	2,634	335	2,969		2,969		
1958	718	84	802		802		
1959	2,853	258	3,111		3,111		
1960	5,067	24	5,091		5,091		
1961	8,971	50	9,021		9,021		
1962	482	587	1,069		1,069		
1963	2,119	103	2,222	810	3,032		
1964	10,408	369	10,777	360	11,137		
1965	7,831	433	8,264	522	8,786		
1966	5,017	201	5,218	570	5,788		
1967	6,907	126	7,033	995	8,028		
1968	9	47	56	3,271	3,327		
1969	21	65	86	1,537	1,623		
1970	111	1,274	1,385	2,826	4,211		
1971	1,607	7,299	8,906	6,614	15,520		
1972	26	1,842	1,868	17,641	19,509		
1973	622	9,255	9,877	19,155	29,032		
1974	48	389	437	20,628	21,065		71,000
1975	3,751	13,945	17,696	17,926	35,622	25,000	71,000
1976	11,257	30,510	41,767	24,936	66,703	25,000	30,000
1977	32,754	50,726	83,480	24,795	108,275	25,000	35,000
1978	41,376	52,688	94,064	17,592	111,656	100,000	30,000
1979	88,833	73,259	162,092	17,241	179,333	120,000	30,000
1980	34,780	34,826	69,606	17,828	87,434	150,000	30,000
1981	18,061	14,801	32,862	15,571	48,433	150,000	30,000
1982	11,164	1,744	12,908	18,633	31,541	150,000	30,000
1983	5	421	426	11,584	12,010	150,000	30,000
1984	397	318	715	9,919	10,634	150,000	30,000
1985	404	269	673	6,115	6,788	150,000	30,000
1986	1	110	111	7,470	7,581	150,000	30,000
1987	194	368	562	10,102	10,664	150,000	30,000
1988	272	539	811	1,958	2,769	150,000	30,000
1989	3,101	2,870	5,971	6,801	12,772	150,000	30,000
1990	4,440	6,535	10,975	11,670	22,645	150,000	30,000
1991	1,719	1,194	2,913	11,908	14,821	150,000	30,000
1992	924	654	1,578	17,827	19,405	150,000	30,000
1993	276	2,410	2,686	18,012	20,698	150,000	30,000
1994	1,954	3,997	5,951	18,350	24,301	150,000	30,000
1995	48	1,007	1,055	14,058	15,113	150,000	30,000
1996	8,285	457	8,742	16,969	25,711	150,000	21,000

Table 1. Continued

Year	Subarea 3[2] (t)	Subarea 4[3] (t)	Total Subarea 3+4 (t)	Subareas 5+6[4,5] (t)	Total Subareas (3-6)[6] (t)	TAC (t)[1] 3+4	TAC (t)[1] 5+6
1997	12,748	2,866	15,614	13,629	29,243	150,000	19,000
1998	815	1,087	1,902	23,597	25,499	150,000	19,000
1999	19	286	305	7,388	7,693	75,000	19,000
2000	328	38	366	9,011	9,377	34,000	24,000
2001	23	34	57	4,009	4,066	34,000	24,000
2002	228	30	258	2,750	3,008	34,000	24,000
2003	1,084	44	1,128	6,391	7,519	34,000	24,000
2004	2,277	34	2,311	26,097	28,408	34,000	24,000
2005	529	30	559	12,013	12,572	34,000	24,000
AVERAGES							
1976-1981	37,844	42,802	80,645	19,661	100,306		
1982-1986	2,028	538	2,566	10,637	13,203		
1987-1991	1,945	2,301	4,246	8,488	12,734		
1992-1996	2,297	1,705	4,002	17,043	21,046		
1997-2001	2,787	862	3,649	11,527	15,176		
2002-2004	1,196	36	1,232	11,746	12,978		
1982-2004	2,205	1,187	3,392	11,924	15,316		

[1] TACs during 1974 and 1975 for Subareas 5+6 include *Loligo pealeii* and, during 1975-1977, countries without allocations were permitted to land 3,000 t in Subareas 3+4

[2] SA 3 catches include a small amount from Subarea 2

[3] SA 4 catches from 1987 onward were updated based on catches in the Canadian Observer and ZIF Databases

[4] Subareas 5+6 catches during 1963-1978 were not reported by species and are proration-based estimates by Lange and Sissenwine (1980)

[5] Subareas 5+6 catches during 1994-2005 are provisional

[6] Catches from all Subareas during 2003-2005 are provisional

Table 2. Indices of relative abundance (stratified mean number/tow) and biomass (stratified mean kg/tow) from research vessel
bottom trawl surveys conducted in Subareas 5+6 (Sept-Oct, 1967-2005), Div. 4VWX (July, 1970-2005), and Div. 4T (Sept, 1971-2005).

	Subareas 5+6		**Div. 4VWX**		**Div. 4T**	
Year	**(number/tow)**	**(kg/tow)**	**(number/tow)**	**(kg/tow)**	**(number/tow)**	**(kg/tow)**
1967	1.6	0.2				
1968	1.6	0.3				
1969	0.6	0.1				
1970	2.3	0.3	5.6	0.4		
1971	1.7	0.3	28.5	2.8	0.72	0.20
1972	2.2	0.3	6.6	0.7	0.05	0.02
1973	1.5	0.4	10.9	1.5	0.08	0.03
1974	2.8	0.4	13.4	1.8	0.06	0.02
1975	8.7	1.4	44.8	5.0	2.47	0.54
1976	20.6	7.0	231.2	42.7	30.77	8.29
1977	12.6	3.7	50.9	9.5	25.74	7.62
1978	19.3	4.5	16.4	2.3	52.83	15.04
1979	19.4	6.1	91.4	14.2	28.47	8.19
1980	13.8	3.3	23.3	2.2	18.05	4.61
1981	27.1	9.3	35.5	4.9	5.76	1.70
1982	3.9	0.6	26.0	2.1	0.39	0.13
1983	1.7	0.2	76.9	2.1	0.09	0.02
1984	4.5	0.5	14.1	1.5	0.04	0.02
1985	2.4	0.4	80.2	2.7	0.32	0.12
1986	2.1	0.3	7.7	0.4	0.12	0.01
1987	15.8	1.5	4.9	0.4	0.22	0.05
1988	23.2	3.0	47.3	2.7	1.33	0.42
1989	22.4	3.3	26.3	2.7	0.97	0.24
1990	16.6	2.4	40.6	4.8	1.37	0.29
1991	5.2	0.7	27.1	1.8	0.17	0.03
1992	8.2	0.8	121.7	7.3	0.65	0.11
1993	10.4	1.6	79.0	5.4	0.83	0.13
1994	6.8	0.9	45.3	4.2	0.79	0.18
1995	8.0	0.7	33.9	2.4	0.32	0.03
1996	10.8	0.9	11.9	0.9	1.09	0.19
1997	5.8	0.5	52.0	4.8	0.89	0.14
1998	14.6	1.4	10.0	0.9	1.34	0.30
1999	1.4	0.2	16.7	2.0	0.47	0.11
2000	7.4	0.7	4.0	0.1	0.27	0.03
2001	4.5	0.3	3.3	0.2	0.08	0.01
2002	6.4	0.4	13.0	1.1	0.11	0.02
2003	28.5	1.9	12.1	0.9	0.22	0.05
2004	5.1	0.4	163.5	17.7	1.61	0.37
2005	11.0	0.7	9.6	0.7	0.46	0.10
Average 1982-2004	9.4	1.0	39.9	3.0	0.59	0.13

Table 3. Indices of *Illex illecebrosus* relative abundance (stratified mean number/tow) and biomass (stratified mean kg/tow) from Canadian bottom trawl surveys conducted in Div. 3KLNO (mainly Sept-Dec) and in Div. 3LNOP (April-June) during 1995-2005, and swept areas estimates of total biomass (tons) and abundance (‘000s of squid) from EU bottom trawl surveys conducted in Div. 3M (July) during 1988-2005.

Year	Div. 3M Survey July		Div. 3KLNO Survey Sept-Dec		Div. 3LNOP Survey April-June	
	Total Abundance (‘000s of squid)	**Total Biomass (t)**	**(number/tow)**	**(kg/tow)**	**(number/tow)**	**(kg/tow)**
1988	57	6				
1989	94	10				
1990	22,949	2,033				
1991	17,726	1,431				
1992	1,085	81				
1993	31	1				
1994	3,677	260				
1995	70	1	<0.01	<0.01	0.04	<0.01
1996	1,590	107	0.08	<0.01	0.24	0.04
1997	1,179	79	0.14	0.01	0.30	0.04
1998	1,456	88	0.84	0.05	0.12	0.02
1999	860	22	0.03	<0.01	0.03	0.01
2000	214	4	<0.01	<0.01	0.09	0.01
2001	579	9	<0.01	<0.01	0.04	0.01
2002	530	9	<0.01	<0.01	0.25	0.02
2003	3,990	222	0.48	0.02	0.19	0.03
2004	4,490	470	0.07	0.02	1.55	0.10
2005	1,400	78	0.30	0.04	0.91	0.05

Table 4. Relative fishing mortality indices (SA 3+4 nominal catch/Div. 4VWX July survey biomass index) of northern shortfin squid (*Illex illecebrosus*) in Subareas 3+4 during 1970-2005. Indices were divided by 10,000 to scale the values.

Year	SA 3+4 Nominal Catch (t)	Div. 4VWX July Survey Biomass Index (kg/tow)	Relative Fishing Mortality Indices
1970	1,385	0.4	0.35
1971	8,906	2.8	0.32
1972	1,868	0.7	0.27
1973	9,877	1.5	0.66
1974	437	1.8	0.02
1975	17,696	5.0	0.35
1976	41,767	42.7	0.10
1977	83,480	9.5	0.88
1978	94,064	2.3	4.09
1979	162,092	14.2	1.14
1980	69,606	2.2	3.16
1981	32,862	4.9	0.67
1982	12,908	2.1	0.61
1983	426	2.1	0.02
1984	715	1.5	0.05
1985	673	2.7	0.02
1986	111	0.4	0.03
1987	562	0.4	0.14
1988	811	2.7	0.03
1989	5,971	2.7	0.22
1990	10,975	4.8	0.23
1991	2,913	1.8	0.16
1992	1,578	7.3	0.02
1993	2,686	5.4	0.05
1994	5,951	4.2	0.14
1995	1,055	2.4	0.04
1996	8,742	0.9	0.97
1997	15,614	4.8	0.33
1998	1,902	0.9	0.20
1999	305	2.0	0.02
2000	366	0.1	0.37
2001	57	0.3	0.02
2002	258	1.1	0.02
2003	1,128	0.9	0.13
2004	2,311	17.7	0.01
2005	559	0.7	0.08
Average 1976-1981	80,645	12.6	1.67

1982-2004	3,392	3.0	0.17

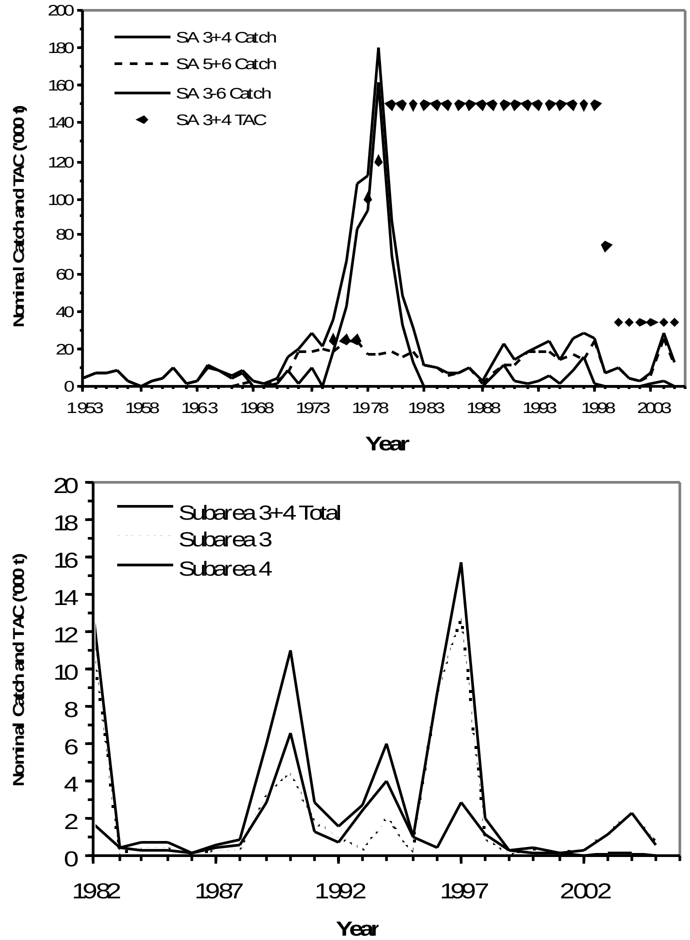


Fig. 1. Nominal catches ('000 t) of *Illex illecebrosus* and TACs in Subareas 3 and 4 during 1953-2005, and Subareas 5+6 during 1963-2005 (top) and nominal catches in Subarea 3 and Subarea 4 during 1982-2005 (bottom).

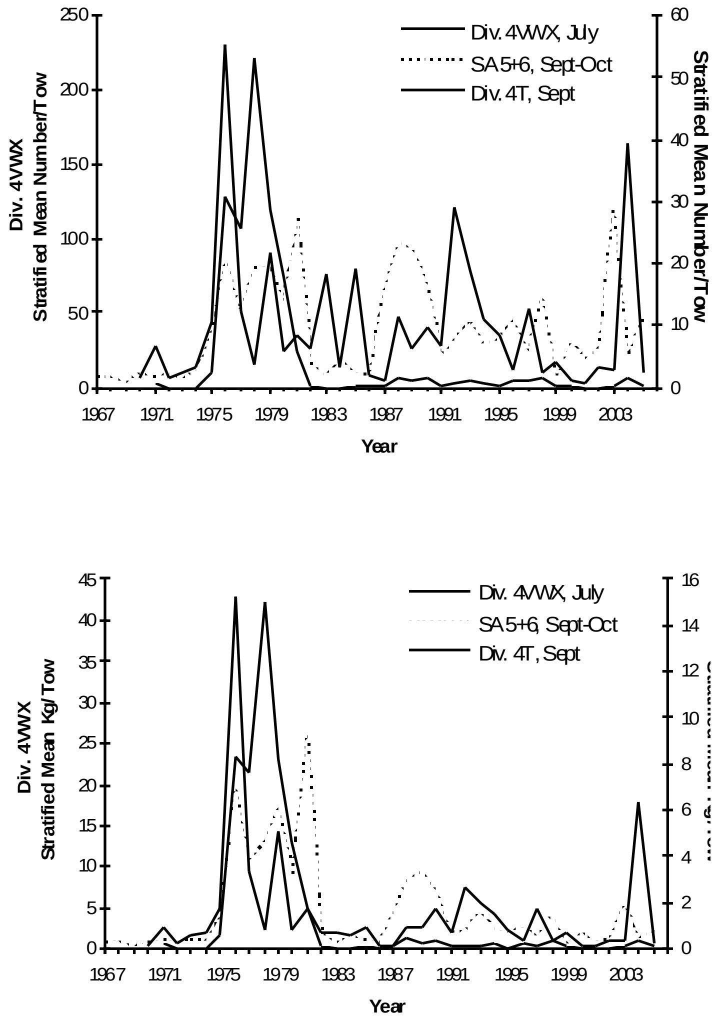


Fig. 2. *Illex illecebrosus* relative abundance (stratified mean number/tow) (top) and biomass indices (stratified mean kg/tow) (bottom) from the Canadian Div. 4VWX (July, 1970-2005) and Div. 4T surveys (September, 1971-2005), and the U.S. surveys in Subareas 5+6 (September-October, 1967-2005).

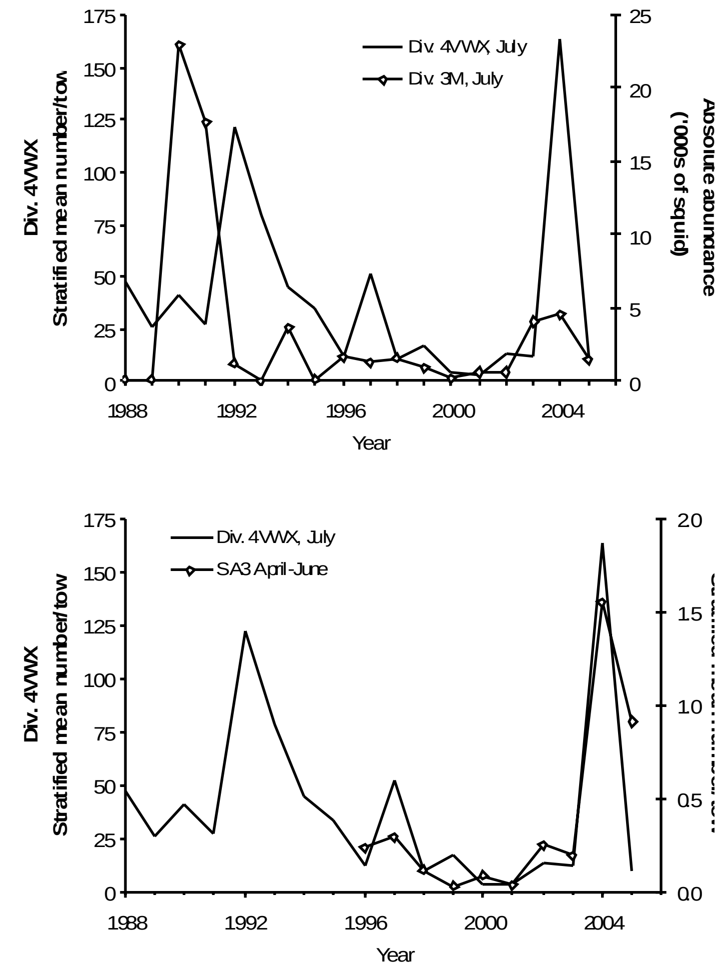
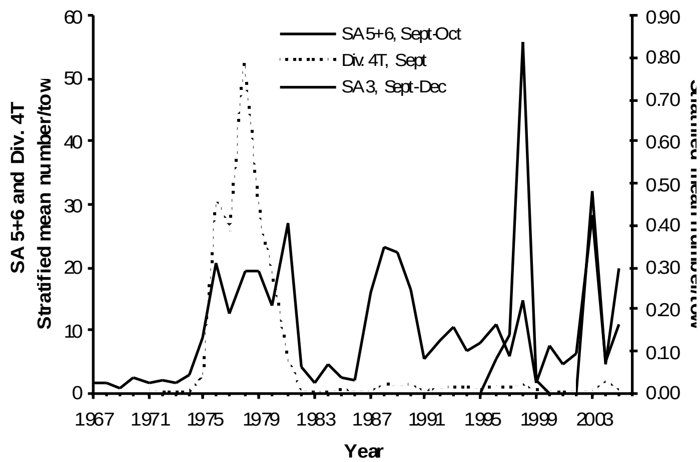


Fig. 3. Abundance indices (stratified mean number/tow) of *Illex illecebrosus*, during July of 1988-2005, in the Canadian bottom trawl surveys in Div. 4VWX (July) and the EU bottom trawl survey in Div. 3M (absolute abundance, '000 squid) (top) and the Canadian surveys in 3LNOP (April-June) (bottom).



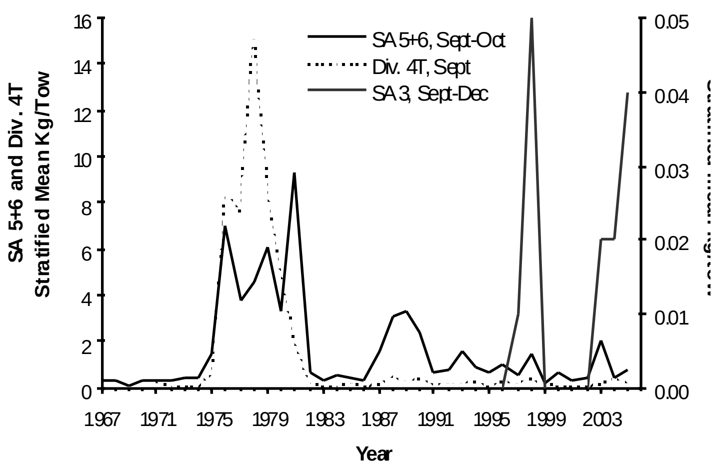


Fig. 4. *Illex illecebrosus* indices of relative abundance (stratified mean number/tow) (top) and biomass (stratified mean number/tow) (bottom), during autumn, from Canadian bottom trawl surveys in Div. 3KLNO (1995-2005) and Div. 4T (1971-2005) and U.S. bottom trawl surveys in Subareas 5+6 (1967-2005).

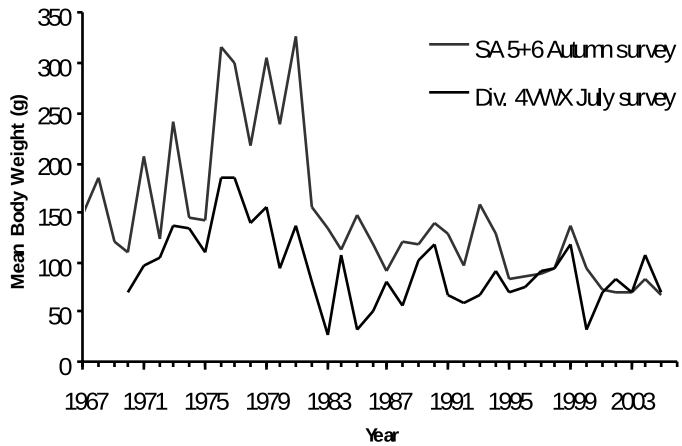


Fig. 5. Mean weight per individual (g) of *Illex illecebrosus* caught in the Subareas 5+6 autumn bottom trawl surveys (1967-2005) and Canadian Div. 4VWX July bottom trawl surveys (1970-2005).

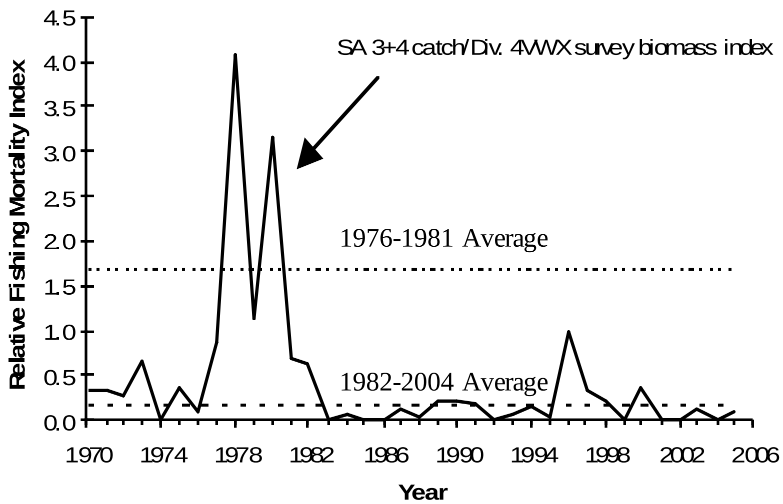


Fig. 6. Relative fishing mortality indices (SA 3+4 nominal catch/Div. 4VWX July survey biomass index) in Subareas 3+4 during 1970-2003, and averages during the high (1976-1981) and low (1970-1975 and 1982-2005) productivity periods. Indices were divided by 10 000 to scale the values.