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# Assessment of Northern Shortfin Squid (*Illex illecebrosus*) in Subareas 3+4 for 2001

by

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## Abstract

Two general levels of productivity, since 1970, were previously identified for the Subareas 3+4 component of the northern shortfin squid (*Illex illecebrosus*) population based on trends in survey relative biomass indices and squid mean weight, as well as nominal catches (Rivard *et al*., 1998; Hendrickson, 1999). A period of high productivity (1976-1981) occurred between two low productivity periods (1970-1975 and 1982-2000). During 2001, pre-fishery, abundance and biomass indices for the July 4VWX survey were at the lowest level since 1970, similar to 2000. The mean weight of squid caught in this survey increased slightly from a time series low of 25 g in 2000 to 65 g in 2001. During 2001, the total catch in Subareas 3+4 (57 tons) was the second lowest since 1953. Based on these trends, the Subareas 3+4 stock component remained in a state of low productivity in 2001.

## Introduction

Northern shortfin squid (*Illex illecebrosus*), a species with a lifespan of about one year (Dawe and Beck, 1997), is considered to constitute a unit stock throughout its distributional range 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 area. Subarea 3 catches are primarily from a small-boat jig fishery that occurs in shallow, nearshore waters of Newfoundland. Since 1987, Subarea 4 catches have been primarily from an international bottom trawl fishery for silver hake, squid and argentine that occurs on the Scotian Shelf (Dawe and Hendrickson, 1998). International fleets, composed of 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).

Management of the stock component in Subarea 3 (Newfoundland) and Subarea 4 (Scotian Shelf and Gulf of St. Lawrence) is based on a Total Allowable Catch (TAC) established annually by the Northwest Atlantic Fisheries Organization (NAFO) and was set at 34,000 tons for 2001. Since 1977, the United States has managed the *Illex* stock

component in its Exclusive Economic Zone (EEZ) (Subareas 5+6). The TAC for the Subareas 5+6 stock component was 24,000 tons in 2001. This document provides an evaluation of the status of the Subareas 3+4 component in 2001, based on trends in commercial fishery data, survey relative abundance and biomass indices, and fishing mortality indices, with an emphasis on the present low productivity period (1982-2001).

## Materials and Methods

### Commercial Fishery Data

Historically, catches have been recorded from the Subarea 3 fishery since 1911 (Dawe, 1981) and from the Subarea 4 fishery since 1920 (ICNAF, 1973). Catches from Subareas 5+6 have been recorded since 1963 (Lange and Sissenwine, 1980). Fisheries data evaluated herein include nominal catches from Subarea 3 and Subarea 4 during 1953-2001. Landings from Subareas 5+6, during 1963-2001, are also presented.

Subarea 4 catches during 1987-2001 represent the sum of catches (kept fraction only) of Northern shortfin squid in the Scotian Shelf silver hake fishery 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 silver hake fishery were obtained from the Maritimes Observer Program Database. Since observer coverage in the SA 4 silver hake fishery has been 100% since 1987, and data are collected on a tow-by-tow basis (Showell and Fanning, 1999), catches from this source are considered the most accurate.

No biological samples of Northern shortfin squid were collected from the Subareas 4-6 catches during 2001 (NAFO, 2002a). Length and maturity data were collected, by sex, from the Newfoundland inshore jig fishery at one site during 2001.

### Research Survey Data

Fishery-independent indices of relative abundance (stratified mean number per tow) and biomass (stratified mean kg per tow) were available from stratified, random, multi-species bottom trawl surveys conducted by Canada in Div. 4T (southern Gulf of St. Lawrence) since September of 1971, Div. 4VWX (Scotian Shelf) since July of 1970, and by the United States of America in Subareas 5+6 during September-October since 1967. All strata were included in computations of the Div. 4T survey indices (Halliday and Koeller, 1981; Koeller, 1980) and the Div. 4VWX survey indices (Fanning, 1985). There were no gear or vessel conversion coefficients applied to indices from either of these two surveys. All offshore strata, between depths of 27-366 m (Grosslein, 1969), were included in the computations of survey indices for Subareas 5+6 and gear and vessel standardization coefficients were applied to these indices (NEFSC, 1999). With the exception of the Div. 4T survey, which occurs only during daylight, sampling was conducted around the clock.

Data from three research surveys were available to address a 2001 research recommendation to derive survey abundance and biomass indices for Subarea 3. Swept area estimates of absolute abundance and biomass were derived, from all strata sampled during 1988-2001, in the July EU bottom trawl survey on the Flemish Cap in Div. 3M (Saborido-Rey and Vazquez, 2001). Stratified mean number per tow and weight per tow indices were derived for all strata sampled during 1995-2001, in the autumn Div. 2J3KLNO bottom trawl survey conducted during September-December, and in the spring Div. 3LNOPs survey conducted during April-June (Doubleday, 1981). The survey trawl was changed in 1995 from an Engels Hi-rise to a Campelen 1800 shrimp trawl that is smaller in overall size and has smaller mesh. In addition, squid catches were not consistently recorded in earlier years during either of these surveys.

### Fishing Mortality

Annual fishing mortality indices for Subareas 3+4, during 1970-2001, were computed by dividing annual catches in Subareas 3+4 by the annual biomass indices from the July Div. 4VWX surveys.

## Results

### Subareas 3+4 Fisheries

During 1992-1999, squid catches in the silver hake fishery were predominantly from the Cuban fleet. However, effort in this fishery has declined during the past two years. The sole Russian trawler in this fishery caught 12 tons of squid in 2000 (Rikhter and Sigaev, 2001; NAFO, 2002b) and had no squid catch in 2001 (Rikhter and Sigaev, 2002, NAFO, 2002b). Annual catches in Subarea 4 were approximately 40 tons during 2000 and 2001 (Table 1). The Subarea 3 catch declined from 328 tons in 2000 to 23 tons in 2001.

Catches in Subareas 3+4 increased during the 1970s and reached a peak of 162,092 tons 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 tons in Subareas 3+4 and 19,661 tons in Subareas 5+6. Following a 1979 peak, Subarea 3+4 annual catches declined sharply, to less than 1,000 tons during 1983-1988. During 1997, Subareas 3+4 catches (15,614 tons) reached their highest level since 1981 and were primarily from the Subarea 3 jig fishery (12,748 tons). Since 1997, catches in Subareas 3+4 have declined to less than 1,000 tons, and in 2001 (57 tons), were the second lowest since 1953.

### Subareas 5+6 Fishery

Catches in Subareas 5+6 reached a peak of 24,900 tons in 1976 and have ranged between 2,000 tons and 23,000 tons since this time (Table 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 tons. Catches during 1998 (23,597 tons) reached their highest level since 1977 but this lead to closure of the fishery in August because the TAC (19,000 tons) was landed. Since then, the Subareas 5+6 catch declined sharply, from about 9,000 tons in 2000 to about 3,900 tons in 2001, representing the second lowest level since 1988.

### Catches from Subareas 3-6

The timing and duration of fisheries varies by Subarea. Since 1992, fisheries in Subareas 4 and 5+6 have occurred during June-October with a July peak in catches. The Subarea 3 fishery has occurred during July-November with a September peak in catches (Fig. 2).

Combined catches from Subareas 3-6 decreased from 25,500 tons in 1998 to approximately 4,000 tons in 2001; the lowest level since 1988 (Table 1, Fig. 1). This decline was due to decreases in all fishery areas, but primarily from Subareas 5+6.

### 3.4 Survey Abundance and Biomass Indices

Annual survey trends in relative abundance (stratified mean number per tow) and biomass (stratified mean kg per tow) are shown in Fig. 3 and presented in Table 2. The Div. 4VWX July survey generally occurs prior to the Subarea 3 fishery and during the early phase of the Subarea 4 fishery, so it can be considered a pre-fishery biomass index. This survey encompasses a larger expanse of *Illex* habitat in Subarea 4 than does the Div. 4T survey. 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 1982-2000, averaging 2.6 kg/tow (Fig. 3, Table 2). During 2001, indices of relative abundance (4.1 squid per tow) and biomass (0.3 kg per tow) from the Div. 4VWX survey were the second lowest since 1970.

Abundance indices from the two other pre-fishery surveys, the Canadian spring survey in Subarea 3 and the EU July survey on the Flemish Cap (Div. 3M), do not appear to track the same trends as the Div. 4VWX July survey (Fig. 4). The Flemish Cap likely represents marginal habitat for *Illex* and the Canadian survey is conducted during April-June, a time when squid may not have migrated from oceanic waters onto the continental shelf in some years (Dawe and Warren, 1993). The Canadian spring survey indices are of much lower magnitude than the Div. 4VWX indices (Fig. 4, Table 3), in part because the entire survey area does not consistently represent suitable *Illex* habitat during that time of year.

The survey in Subareas 5+6 occurs during September-October and can be considered a post-fishery biomass index. Other post-fishery indices include the September Div. 4T survey, which appears only to capture squid during periods of high abundance, and the September-December Div. 2J3KLNO survey. The latter indices are much lower in magnitude (Table 3), but appear to track the Subareas 5+6 indices (Fig. 5). The signal to noise ratio of these indices may be improved if they are derived from a subset of strata that consistently serves as *Illex* habitat during that time.

**Body Size**

Mean weights of squid caught in the Div. 4VWX survey indicate that squid were larger during the high productivity period and smaller during the low productivity period (Fig. 6). Mean weights in this survey increased from 25 g in 2000 to 65 g in 2001. However, the mean weight of squid from the Subareas 5+6 autumn survey declined from 95 g in 2000 to 72 g in 2001, the lowest value of the time series.

Mean mantle lengths from the Newfoundland inshore jig fishery, during September of 2001 (18.9-19.9 cm), were slightly larger than those observed in 2000, but remained smaller than during 1976-1982 (Dawe *et al*., 2001).

**Fishing Mortality Indices**

Annual fishing mortality indices for Subareas 3+4 were high during 1977-1981, reaching a peak of 4.09 in 1978 (Table 4, Fig. 7) and averaging 1.67 during the high productivity period (1976-1981). High levels during 1976-1981 were attributed to increased catches and low survey indices (Fig. 8). Since 1982, relative fishing mortality rates have been much lower and averaged 0.18 during 1982-2001.

## Discussion

Relative abundance and biomass indices, as well as the mean weight of squid caught in the Div. 4VWX July survey, were very low during 2001. These data suggest that the Subarea 3+4 stock component remained in a low productivity state during 2001. Based on these trends, the Subareas 3+4 stock component remained in a state of low productivity in 2001.

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Table 1. Nominal catches (t) of *Illex illecebrosus* in NAFO Subareas 3 and 4, during 1953-2001, and Subareas 5+6 (U.S. EEZ), during 1963-2001, and TACs in Subareas 3+4 and Subareas 5+6.

| | | | Total | | Total | | |
|---|---|---|---|---|---|---|---|
| | Subarea | Subarea | Subarea | Subareas | Subareas | TAC (t)[1] | |
| | 3[2] | 4[3] | 3+4 | 5+6[4,5] | (3-6)[6] | 3+4 | 5+6 |
| Year | (t) | (t) | (t) | (t) | (t) | | |
| 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 |

| | Subarea 3[2] | Subarea 4[3] | Total Subarea 3+4 | Subareas 5+6[4,5] | Total Subareas (3-6)[6] | TAC (t)[1] 3+4 | 5+6 |
|---|---|---|---|---|---|---|---|
| 1996 | 8,285 | 457 | 8,742 | 16,969 | 25,711 | 150,000 | 21,000 |
| 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 | 3,939 | 3,996 | 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 | 11,513 | 15,162 | | |

[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 Subsareas 3+4

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

[3] SA 4 catches during 1987-2001 were updated based on catches in the Canadian Observer and ZIF Databases

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

[5] Subareas 5+6 catches during 1994-2001 are provisional

[6] Catches during 2001 are provisional for all Subareas

Table 2. Indices of relative abundance (stratified mean number/tow) and biomass (stratified mean kg/tow) from bottom trawl surveys conducted in Subareas 5+6 (Sept-Oct, 1967-2001), Div. 4VWX (July, 1970-2001), and Div. 4T (Sept. 1971-2001).

| | Subareas 5+6 | | Division 4VWX | | Division 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 | 0.16 |
| 1972 | 2.2 | 0.3 | 6.6 | 0.7 | 0.05 | 0.01 |
| 1973 | 1.5 | 0.4 | 10.9 | 1.5 | 0.08 | 0.02 |
| 1974 | 2.8 | 0.4 | 13.4 | 1.8 | 0.06 | 0.00 |
| 1975 | 8.7 | 1.4 | 44.8 | 5.0 | 2.47 | 0.51 |
| 1976 | 20.6 | 7.0 | 231.2 | 42.7 | 30.76 | 8.04 |
| 1977 | 12.6 | 3.7 | 50.9 | 9.5 | 25.73 | 7.61 |
| 1978 | 19.3 | 4.5 | 16.4 | 2.3 | 55.95 | 15.87 |
| 1979 | 19.4 | 6.1 | 91.4 | 14.2 | 28.47 | 8.14 |
| 1980 | 13.8 | 3.3 | 23.3 | 2.2 | 18.04 | 4.58 |
| 1981 | 27.1 | 9.3 | 35.5 | 4.9 | 5.76 | 1.67 |
| 1982 | 3.9 | 0.6 | 26.0 | 2.1 | 0.38 | 0.08 |
| 1983 | 1.7 | 0.2 | 76.9 | 2.1 | 0.09 | 0.00 |
| 1984 | 4.5 | 0.5 | 14.1 | 1.5 | 0.03 | 0.00 |
| 1985 | 2.4 | 0.4 | 80.2 | 2.7 | 0.48 | 0.11 |
| 1986 | 2.1 | 0.3 | 7.7 | 0.4 | 0.08 | 0.01 |
| 1987 | 15.8 | 1.5 | 4.9 | 0.4 | 0.16 | 0.02 |
| 1988 | 23.2 | 3.0 | 47.3 | 2.7 | 1.33 | 0.40 |
| 1989 | 22.4 | 3.3 | 26.3 | 2.7 | 0.30 | 0.04 |
| 1990 | 16.6 | 2.4 | 40.6 | 4.8 | 0.88 | 0.14 |
| 1991 | 5.2 | 0.7 | 27.1 | 1.8 | 0.12 | 0.03 |
| 1992 | 8.2 | 0.8 | 121.7 | 7.3 | 0.28 | 0.05 |
| 1993 | 10.4 | 1.6 | 79.0 | 5.4 | 0.58 | 0.10 |
| 1994 | 6.8 | 0.9 | 45.3 | 4.2 | 0.26 | 0.10 |
| 1995 | 8.0 | 0.7 | 33.9 | 2.4 | 0.16 | 0.02 |
| 1996 | 10.8 | 0.9 | 11.9 | 0.9 | 0.70 | 0.11 |
| 1997 | 5.8 | 0.5 | 52.0 | 4.8 | 0.96 | 0.17 |
| 1998 | 14.6 | 1.4 | 10.0 | 0.9 | 0.96 | 0.21 |
| 1999 | 1.4 | 0.2 | 16.7 | 2.0 | 0.23 | 0.05 |
| 2000 | 7.4 | 0.7 | 4.0 | 0.1 | 0.19 | 0.02 |
| 2001 | 4.5 | 0.3 | 4.1 | 0.3 | 0.08 | 0.01 |

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. 2J3KLNO (Sept-Dec) and in Div. 3LNOPs (April-June), during 1995-2001, and swept areas estimates of total biomass (tons) and abundance ('000 t) from EU bottom trawl surveys conducted in July on the Flemish Cap in Div. 3M during 1988-2001.

| Year | Flemish Cap Survey July | | Division 2J3KLNO Survey Sept-Dec | | Division 3LNOPs Survey April-June | |
|---|---|---|---|---|---|---|
| | Total Abundance ('000 t) | Total Biomass (t) | (number/tow) | (kg/tow) | (number/tow) | (kg/tow) |
| 1988 | 46 | 5 | | | | |
| 1989 | 86 | 8 | | | | |
| 1990 | 18,698 | 1,647 | | | | |
| 1991 | 14,454 | 1,159 | | | | |
| 1992 | 897 | 66 | | | | |
| 1993 | 27 | 1 | | | | |
| 1994 | 3,002 | 211 | | | | |
| 1995 | 57 | 1 | <0.01 | <0.01 | 0.040 | 0.001 |
| 1996 | 1,286 | 87 | 0.08 | <0.01 | 0.240 | 0.040 |
| 1997 | 956 | 64 | 0.14 | 0.01 | 0.300 | 0.040 |
| 1998 | 1,178 | 71 | 0.84 | 0.05 | 0.120 | 0.024 |
| 1999 | 701 | 18 | 0.03 | 0.00 | 0.030 | 0.005 |
| 2000 | 175 | 3 | 0.09 | 0.01 | 0.001 | <0.001 |
| 2001 | 469 | 7 | 0.04 | 0.01 | 0.003 | <0.001 |

Table 4. 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 1970-2001. Fishing mortality indices were divided by 10,000 to scale the values.

| Year | SA 3+4 Nominal Catch (t) | Divison 4VWX July Survey Biomass Index (kg/tow) | 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 | 340 | 0.1 | 0.34 |
| 2001 | 57 | 0.3 | 0.02 |
| Average | | | |
| 1976-1981 | 80,645 | 12.6 | 1.67 |
| 1982-2001 | 3,717 | 2.5 | 0.18 |

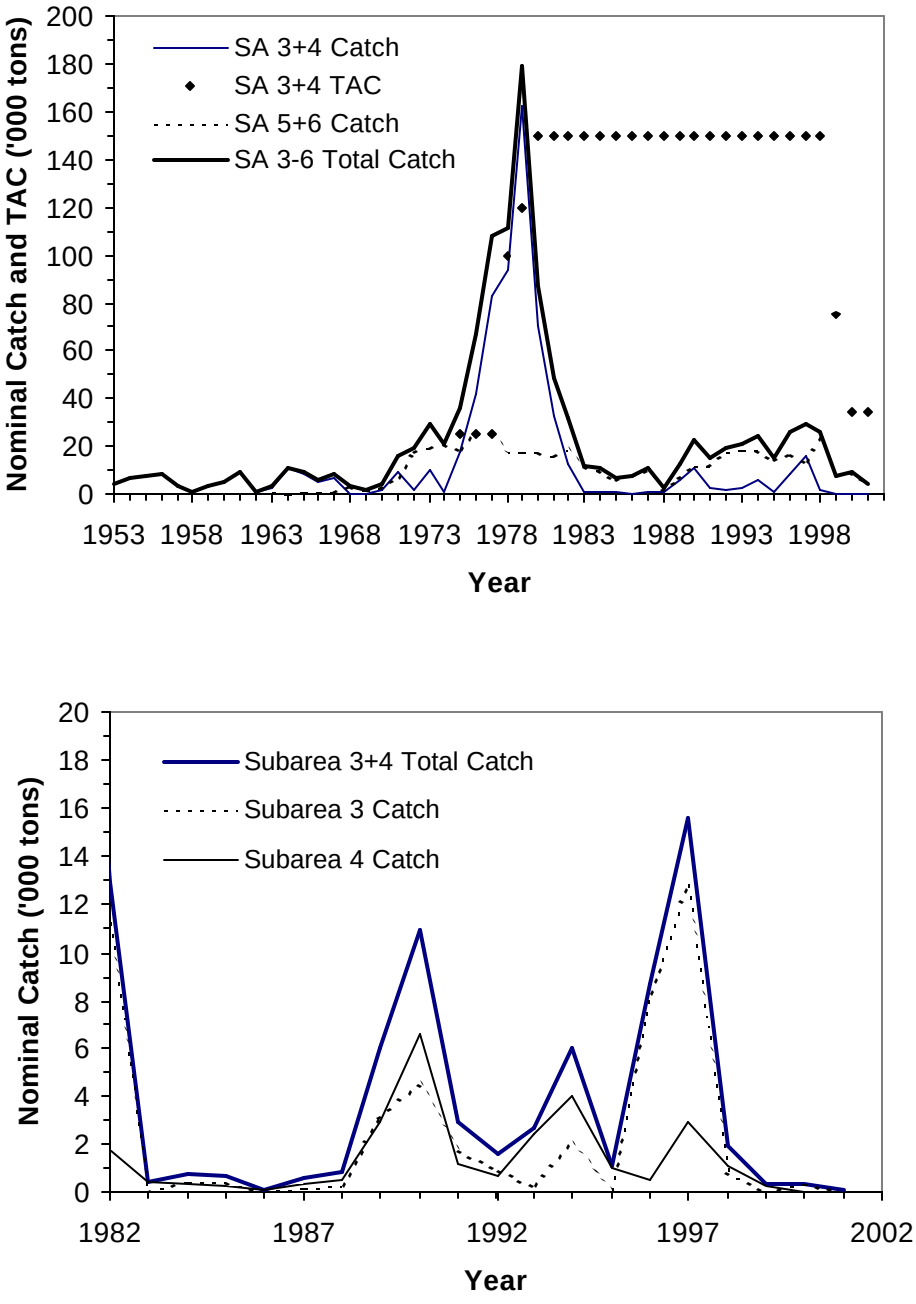


Fig. 1. Nominal catches ('000 tons) of *Illex illecebrosus* and TACs in Subareas 3 and 4, during 1953-2001, and Subareas 5+6 during 1963-2001 (top) and nominal catches in Subarea 3 and Subarea 4 during 1982-2001 (bottom).

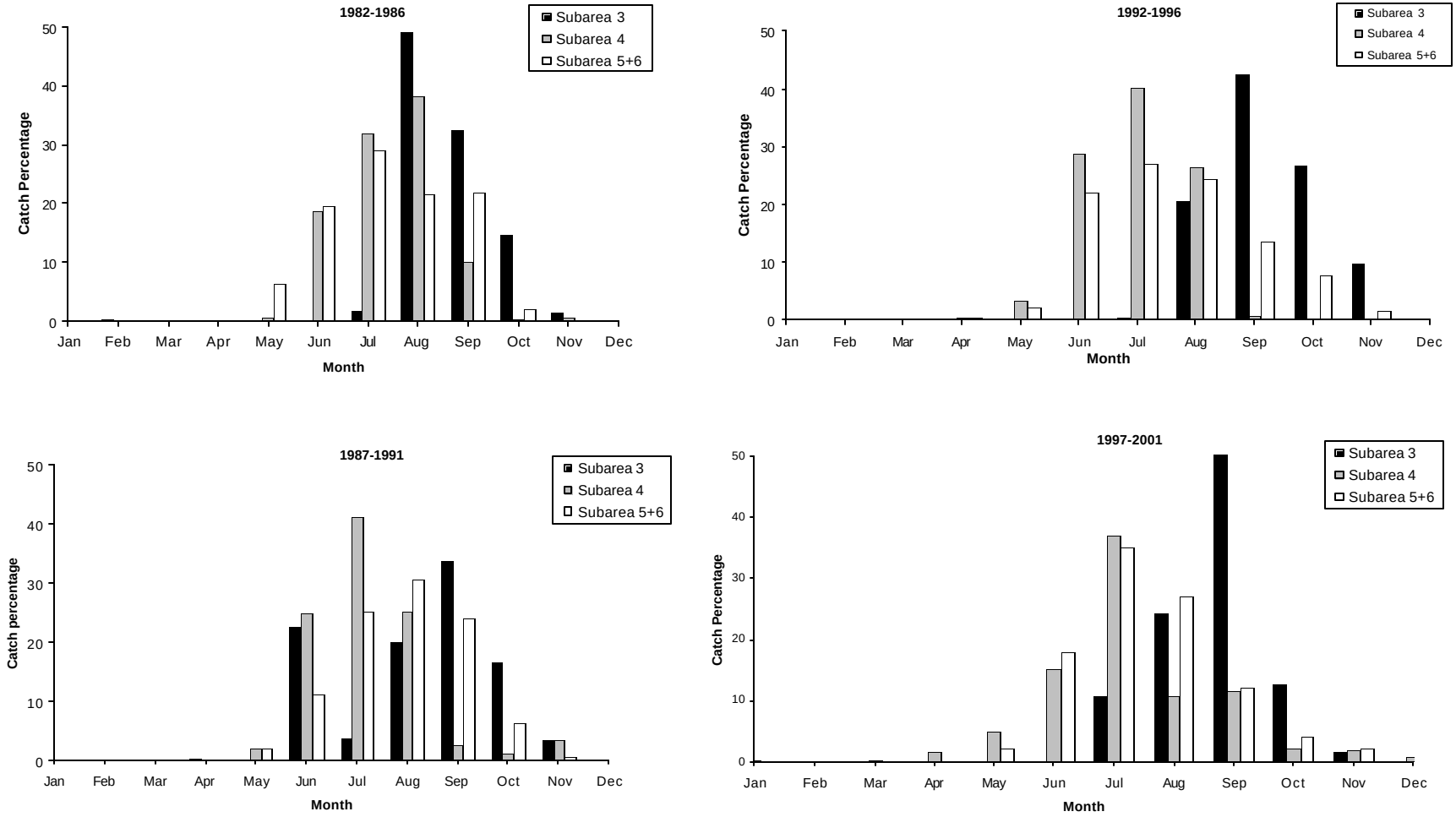


Fig. 2. Average percentage of nominal catches of *Illex illecebrosus*, by month and Subarea, during 1982-1986, 1987-1991, 1992-1996 and 1997-2001.

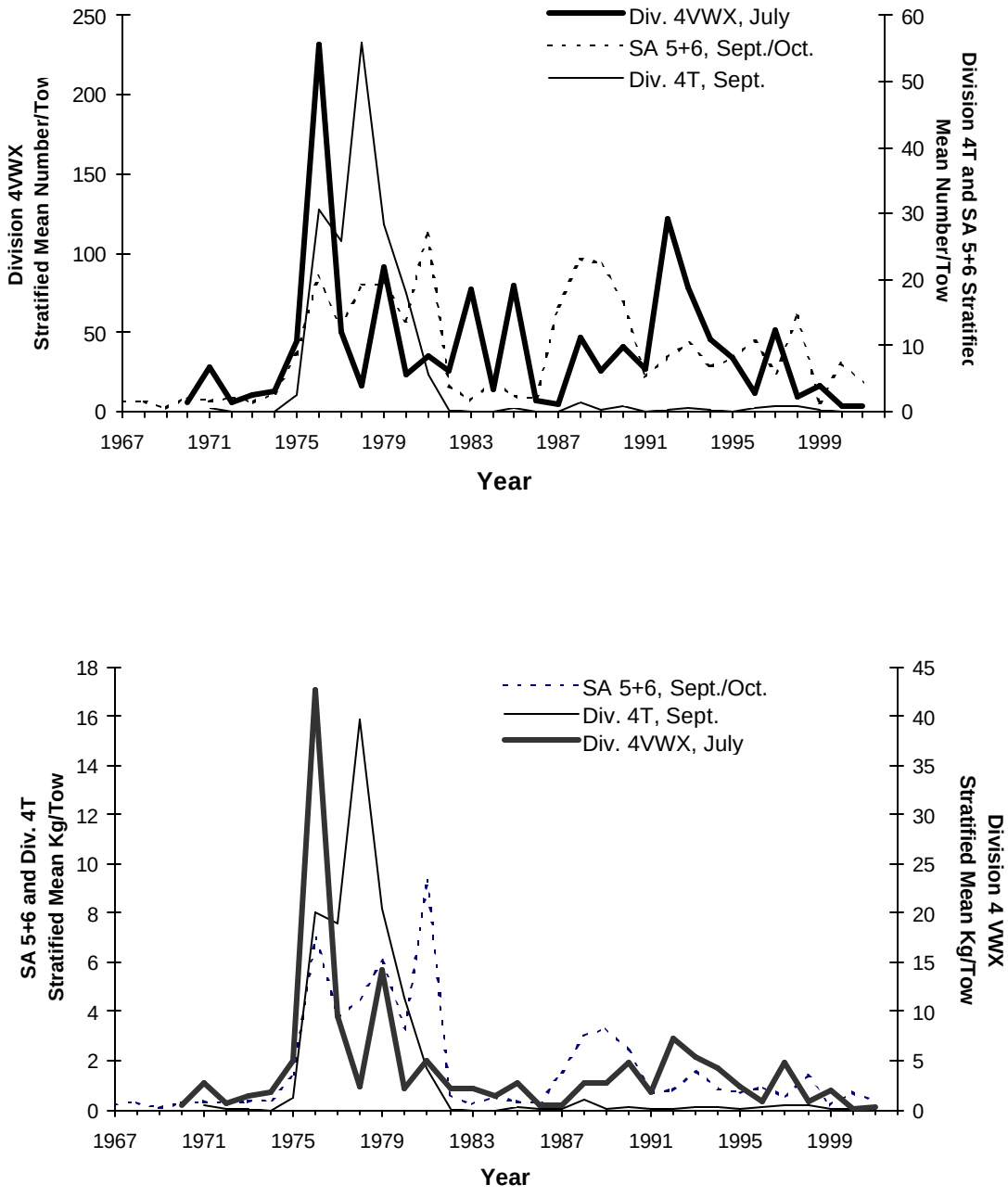


Fig. 3. *Illex illecebrosus* relative abundance (stratified mean number/tow) (top) and biomass indices (stratified mean kg/tow) (bottom) from the Div. 4VWX surveys (July, 1970-2001), Div. 4T surveys (September, 1971-2001), and Subareas 5+6 surveys (September-October, 1967-2001).

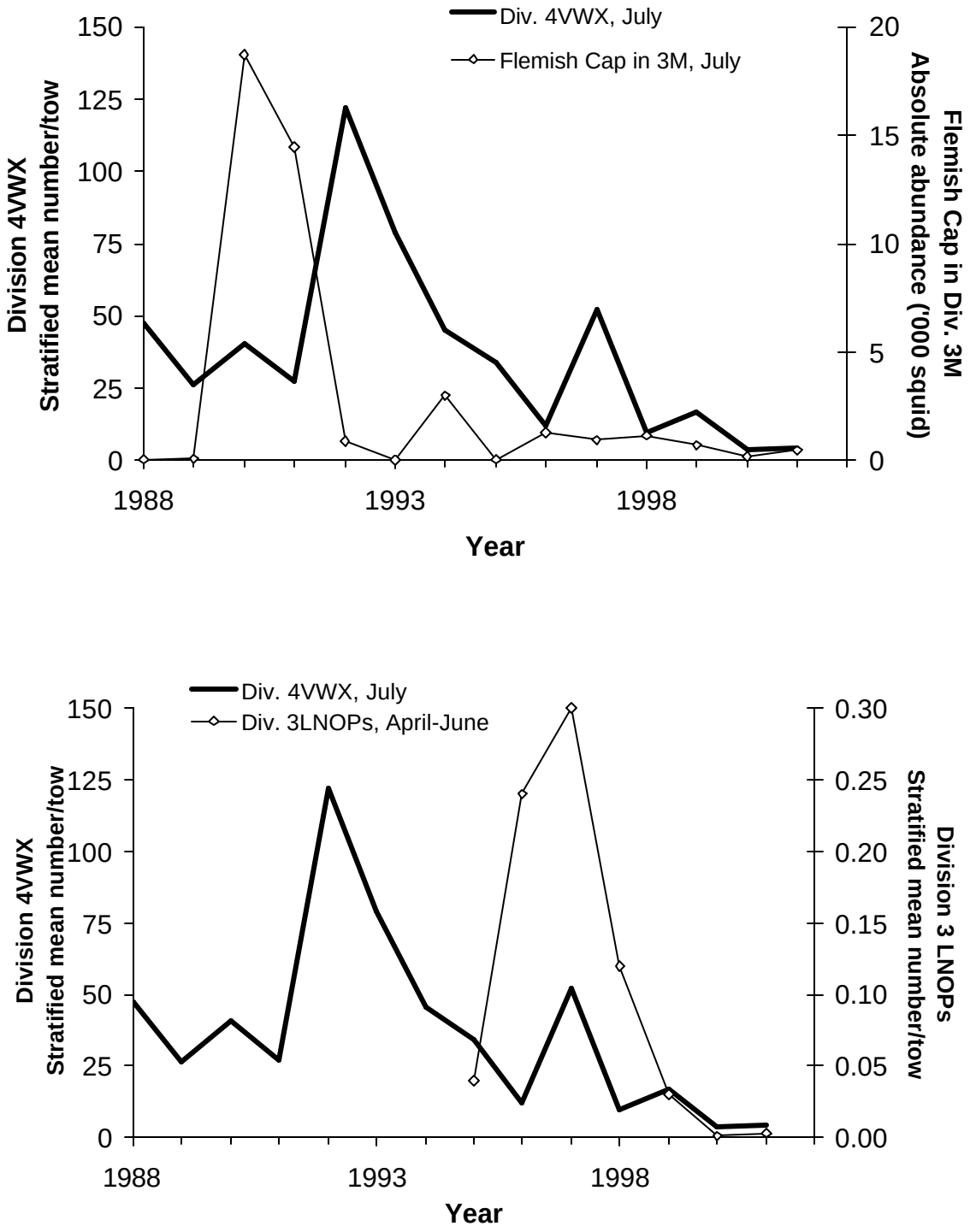


Fig. 4. Abundance indices (stratified mean number/tow) of *Illex illecebrosus,* during July of 1988-2001, in the Canadian bottom trawl surveys in Div. 4VWX (July) and bottom trawl surveys on the Flemish Cap in Div. 3M (absolute abundance, '000 squid) (top) and the Canadian surveys in Div. 3LNOPs (April-June) (bottom).

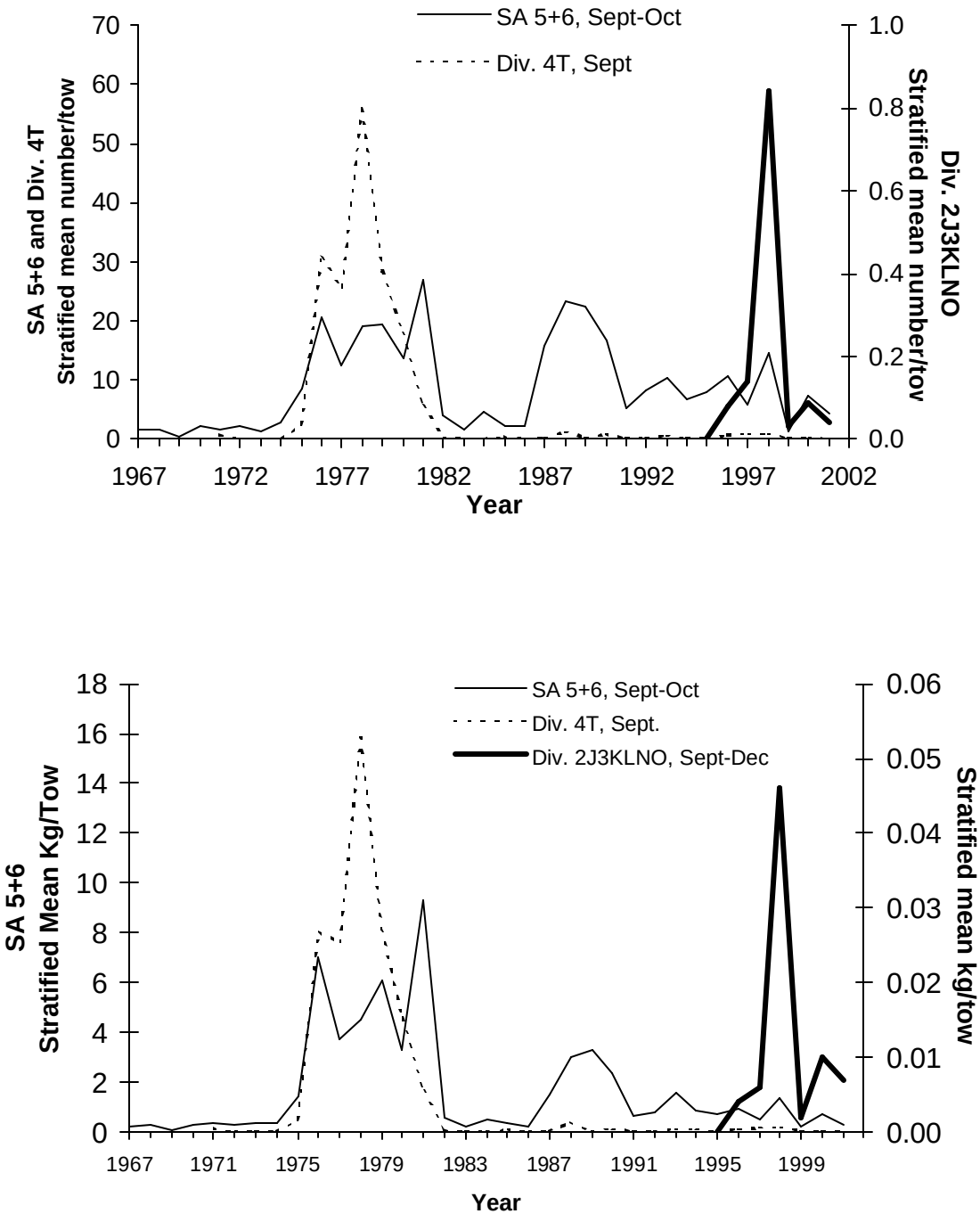


Fig. 5. *Illex illecebrosus* indices of relative abundance (stratified mean number/tow) (top) and biomass (stratified mean number/tow) (bottom), during autumn, from the Canadian bottom trawl survey in Div. 2J3KLNO (1995-2001) and Div. 4T (1971-2001) and the U.S. bottom trawl surveys in Subareas 5+6 (1967-2001).

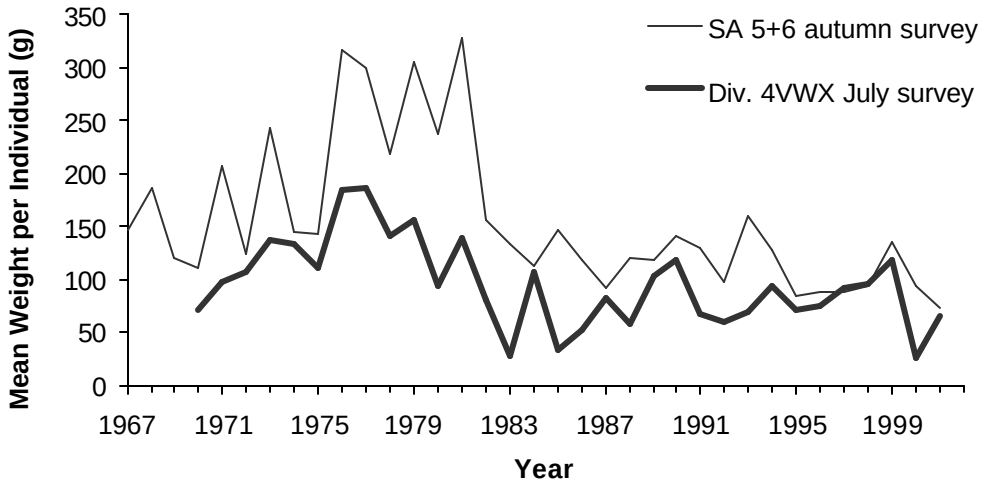


Fig. 6. Mean weight per individual (g) of *Illex illecebrosus* caught in the Subareas 5+6 autumn bottom trawl survey (1967-2001), Canadian Div. 4VWX July bottom trawl surveys (1970-2001).

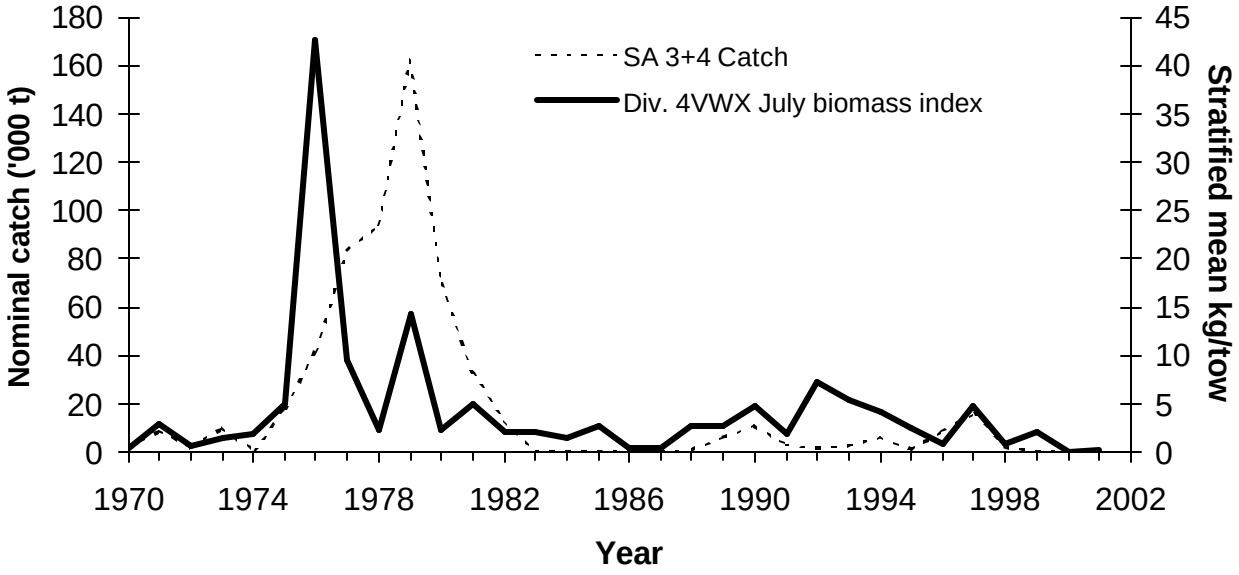


Fig. 7. Nominal catch ('000 t) in SA 3+4 and Div. 4VWX July survey biomass indices (kg/tow) during 1970- 2001.

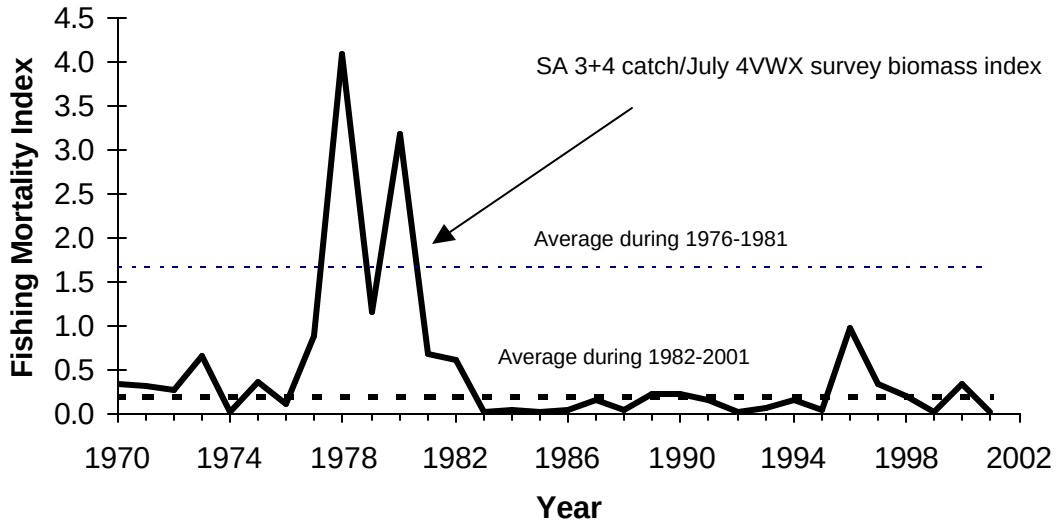


Fig. 8. Fishing mortality indices (SA 3+4 nominal catch/Div. 4VWX July survey biomass index) in Subareas 3+4, during 1970-2001, and averages during the high (1976-1981) and low (1982-2001) productivity periods. Fishing mortality indices were divided by 10,000 to scale the values.