D. NORTHERN SHORTFIN SQUID (*Illex*) ADVISORY REPORT

State of Stock: It is not possible to evaluate current stock status as there are no reliable current estimates of absolute stock biomass or fishing mortality rate. However, based on a number of qualitative analyses, overfishing was not likely to have occurred during 1999-2002. Stock status with respect to biomass is unknown. Relative exploitation indices for the domestic U.S. fishery have declined since reaching a peak in 1999 and were below the 1982-2002 mean during 2000-2002 (Figure D2). The recent declines in mean body weights, as well as recently declining biomass indices from U.S. and Canadian surveys, suggest that the stock is currently in a low productivity regime (Figure D3).

Management Advice: Under current stock conditions the nominal TAC of 24,000 mt, which assumes a stock at B_{MSY}, may not be sufficient to prevent overfishing. Given uncertainties in stock distribution and population biology the fishery should be managed in relation to the proportion of the stock on the shelf and available to US fisheries.

Forecast for 2004: No forecasts were made.

Landings and Status Table (landings in '000 mt): Northern Shortfin (Illex) Squid

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Max	Min	Mean
US EEZ Domestic Landings[1]	18.0	18.3	14.1	17.0	13.6	23.6	7.4	9.0	4.0	2.7	23.6	2.0	11.8
US EEZ Foreign Landings[2]	0	0	0	0	0	0	0	0	0	0	24.7	0	6.2
Total US EEZ Landings[2]	18.0	18.3	14.1	17.0	13.6	23.6	7.4	9.0	4.0	2.7	24.7	0	12.8
Subareas 3+4 Landings[2]	2.7	6.0	1.0	8.7	15.6	1.9	0.3	0.4	0.1	0.2	162.1	0.1	17.1
Total Landings (All areas)[2]	20.7	24.3	15.1	25.7	29.2	25.5	7.7	9.4	4.1	2.9	179.3	1.6	29.9
Escapement Index in Numbers, US Fall Survey[3] (number/tow)	10.4	6.8	8.0	10.8	5.8	14.6	1.4	7.4	4.5	6.4	27.1	0.6	8.8
Escapement Index in Biomass, US Fall Survey[3] (kg/tow)	1.6	0.9	0.7	0.9	0.5	1.4	0.2	0.7	0.3	0.4	9.3	0.1	1.6
Average body weight (g), US Fall Survey[2]	159	128	84	87	89	94	136	94	72	70	327	70	153

[1]Min, max, mean for 1987-2002.
[2]Min, max, mean for 1968-2002.
[3]Min, max, mean for 1967-2002.

Stock Distribution and Identification: The *Illex illecebrosus* population is assumed to constitute a unit stock throughout its range of exploitation from Cape Hatteras to Newfoundland. Stock structure is complicated by the overlap of seasonal cohorts. This highly migratory, oceanic species tends to school by size and sex and, based on age validation studies, is an annual species. A recent statolith-based aging study of squid caught in a survey conducted in U.S. waters indicated that the oldest individual was about seven months of age (215 days). Spawning for this species was observed for the first time in a survey on the U.S. shelf, in the Mid-Atlantic Bight fishing area, in late May 2000.

Catches: During 1973-1982, total stock landings (NAFO Subareas 3-6) averaged 71,900 mt and were predominately taken from Subareas 3+4. Total landings during this time peaked at 179,300 mt. Since 1982, total landings have been dominated by the domestic fishery, with the exception of 1997. Prior to 1967, U.S. landings of squid (*Illex* and *Loligo*) averaged about 2,000 mt per year. A directed foreign fishery for *Illex* developed in 1968 in U.S. waters, continued through 1982, and ended in 1987 (Figure D1). Domestic landings increased during 1988-1994, to 18,350 mt, and then averaged 14,900 mt during 1995-1997. In 1997, Subarea 3+4 landings were nearly equal to US EEZ landings and were at their highest levels since 1981. In 1998, US EEZ landings (23,600 mt) reached the highest level observed since 1977, resulting in a fishery closure because the TAC (19,000 mt) was exceeded. US landings dropped by 69% between 1998 and 1999. During 2000-2002, US landings declined from 9,011 mt to 2,723 mt; the lowest level since 1988.

Observer data for 1995-2002 indicate that discarding of *Illex* occurs primarily in the *Illex* and offshore *Loligo* fisheries and is higher in the latter. During this time period, annual discards from both fisheries combined ranged between 53 and 453 mt, 0.5% -4.4% of the *Illex* landings, by weight.

Data and Assessment: *Illex illecebrosus* was last assessed in 1999 at SAW 29. Assessment of the U.S. population is hampered by the lack of information on abundance and distribution before and during the fishery. However, new information about the age, growth and maturity of squid caught by a special *Illex* survey conducted in U.S. waters was incorporated into a maturation-natural mortality model. The model estimated the natural mortality rate of mature females, which die after spawning, at 0.80 per week when the natural mortality rate of immature squid was fixed at 0.01 per week. Aging error was also incorporated in the model. These natural mortality estimates were incorporated in yield-per-recruit and egg-per-recruit models to estimate biological reference points.

Trends in research survey indices of relative abundance and biomass and average body weights of *Illex* were examined, in addition to trends in LPUE indices. Relative exploitation rates for the U.S. fishery were computed based on the annual ratios of U.S. landings to autumn survey biomass indices.

An in-season assessment model that estimates weekly fishing mortality rates and stock size was run using 1999 landings, effort and squid length composition data from the landings. Unlike the SARC 29 assessment model, the new model incorporated recruitment and spawning and non-spawning estimates of natural mortality estimates from the maturation-natural mortality model. The results were considered preliminary however, as the model requires more rigorous testing.

Biological Reference Points: The current FMP specifies B_{MSY} as 39,300 mt and F_{MSY} as 1.22 per year. Ensuring adequate spawning stock escapement is of primary importance in the management of *Illex*; an annual species with highly variable interannual recruitment. A %MSP-based reference point that would ensure adequate spawning stock escapement should be evaluated for management use.

SFA Control Rule: The Amendment 8 control rule states that when the stock biomass exceeds B_{MSY}, the overfishing threshold is F_{MSY}, and target F is 75% F_{MSY}. Below B_{MSY}, target F decreases linearly and is set to zero when stock size is at the biomass threshold of $\frac{1}{2}B_{MSY}$.

Fishing Mortality: Relative exploitation rates (U.S.landings/NEFSC autumn survey biomass indices) for the U.S. fishery generally increased between 1988, the inception of the domestic fishery, and 1999. After the 1999 peak, relative exploitation rates declined and were below the 1982-2002 average during 2000-2002 (Figure D2). Fishing effort (days fished) and area fished declined during 1999-2002 due to a decline in fleet size and the number of trips. Weekly fishing mortality rates were estimated for 1999 using an in-season assessment model but the results are considered preliminary and are not included in this assessment.

Recruitment: Oceanographic conditions influence levels of recruitment and the distribution of recruits to fishery areas and have been shown to affect *Illex* squid recruitment in the Newfoundland jig fishery. During 1999-2002, surface and bottom temperatures in the autumn and spring bottom trawl surveys were warmer than average. The average size of squid in the landings, during 1999-2002, was smaller than during most years since 1994. This trend is likely indicative of environmental effects on stock productivity. Autumn bottom temperature anomalies were correlated with autumn survey biomass and abundance indices and spring survey mean body weights.

Statolith-based age analysis indicates that *Illex* spawns throughout most of the year and that in U.S. waters, recruitment occurs throughout the fishing season with several peaks.

Stock Biomass: The current level of stock biomass is unknown. The Canadian research bottom trawl survey occurs on the Scotian Shelf in July, near the start of the U.S. fishing season, and can be considered to represent a pre-fishery, relative biomass index. The U.S. autumn bottom trawl survey occurs primarily after the U.S. fishery and can be considered a relative index of spawner escapement. Both surveys indicate that the stock has remained in a low productivity state since the 1976-1981 high productivity period (Figure D3). Another indication that the stock is at a low level of productivity is the extended period of low mean body weights which has occurred since 1982, in both the U.S. (autumn) and Canadian (July) surveys (Figure D3). Mean body weights of squid from the U.S. autumn survey were below the 1982-2002 average during 2000-2002.

Special Comments: *Illex illecebrosus* is a highly migratory, transboundary species with a maximum observed age of 215 days for squid from U.S. waters. The overfishing definition currently in place for this stock, F_{MSY}, is not only difficult to estimate given the available information, but may also perform poorly given the stock's production dynamics.

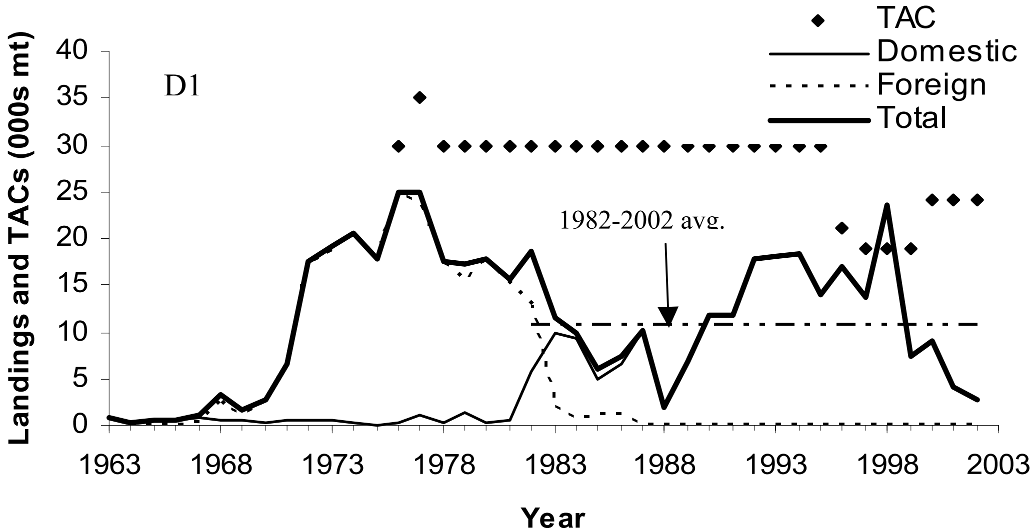
Cooperative research projects with the *Illex* fishing industry have been conducted since SARC 29 and have resulted in improvements in the data available for the current assessment. These projects included a pre-fishery bottom trawl survey of *Illex*, the collection of tow-based fisheries and biological data, and electronic logbook reporting, and should continue.

The new in-season models for fishing mortality and stock size estimation and reference points appear promising and should be further developed.

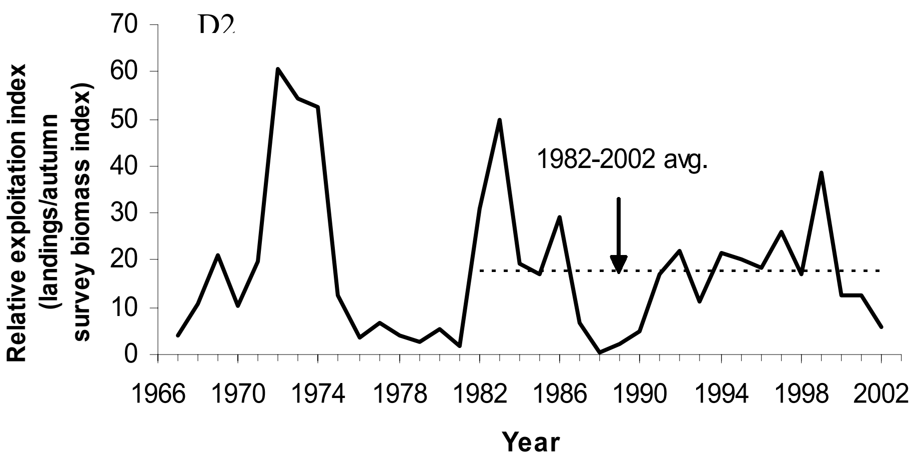
The merits of alternative approaches to managing the illex fishery, including constant quota, constant effort, real-time management, and constant escapement should be investigated, recognizing the available biological information models and uncertainty.

Current reference points may not ensure adequate spawning escapement for the stock as a whole. Management should consider the implication of increased exploitation relative to the necessity of adequate escapement of spawners and the role of the species as an important forage item in the ecosystem. Adequate spawner escapement from all fishery areas (NAFO Subareas 3-6) is required to ensure sufficient recruitment during the subsequent year.

Sources of Information: Report of the 37th Northeast Regional Stock Assessment Workshop, Stock Assessment Review Committee (SARC) Consensus Summary of Assessments (NEFSC Ref. Doc. 03-xx); Report of the 29th Northeast Regional Stock Assessment Workshop, Stock Assessment Review Committee (SARC) Consensus Summary of Assessments (NEFSC Ref. Doc. 99-14); Report of the 21st Northeast Regional Stock Assessment Workshop, Stock Assessment Review Committee (SARC) Consensus Summary of Assessments (NEFSC Ref. Doc. 96-05d); Hendrickson, L.C. In Review. Population biology of northern shortfin squid (*Illex illecebrosus*) in the northwest Atlantic Ocean and initial documentation of a spawning site in the Mid-Atlantic Bight (USA). ICES J. Mar. Sci.; Hendrickson, L.C., D.A. Hiltz, H.M. McBride, B.M. Northand J.E. Palmer. 2003. Implementation of electronic logbook reporting ina squid bottom trawl study fleet during 2002. Northeast Fish. Sci. Cent.Ref. Doc. 03-07. 30 p.; Hendrickson, L.C., E.G. Dawe and M.A. Showell. 2003. Interim monitoring report for the assessment of northern shortfinsquid (*Illex illecebrosus*) in Subareas 3+4 during 2002. NAFO SCR Doc.03/48. Ser. No. N4866. 13 p.; Dawe E. G. and L. C. Hendrickson. 1998. A review of the biology, population dynamics, and exploitation of short-finned squid in the Northwest Atlantic Ocean in relation to the assessment and management of the resource. NAFO SCR Doc. 98-59.



Trends in Commercial Landings and TACs, Illex



Relative exploitation indices in the US fishery, 1967-2002, Illex

Relative biomass indices and Illex mean body weights in the Canadian July bottom trawl survey (top), during 1970-2002, and in the U.S. autumn bottom trawl surveys (bottom) during 1967-2002.