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Pre-season Distribution and Abundance of Squid *Illex Illecebrosus* on the Scotian Shelf, 1981

by

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INTRODUCTION

STACRES, in February 1978, recognized that in short-lived species such as Illex, catch quota should be determined on the basis of abundance of the resource in the season under regulation (ICNAF Redbook 1978). Pre-season research surveys were thought to greatly assist in defining the quota. In June 1978 the Molluscan Section of the Invertebrates and Marine Plants Division, Fisheries and Oceans Canada, undertook annual June pre-season surveys in the Scotian Shelf, and some abundance estimations have resulted (Amaratunga and McQuinn, 1979; Young and Amaratunga, 1980). Data from the June 1-11, 1981 survey on the RV Lady Hammond are analyzed in this report and compared with similar aspects of previous surveys.

The history of management advice provided by ICNAF and NAFO for the Illex fishery (Amaratunga, 1980) shows that TAC is the most important management regime. The TAC, including present operational TAC of 150,000 MT, was determined from relative abundance indices developed from groundfish research survey data (NAFO Redbook, 1980). These abundance estimates were made from stratum areal expansion (Koeller, 1980). The areal expansion method was used to estimate biomass in the present study, with the recognition of limitations of the method as indicated earlier by Amaratunga and McQuinn (1979). It is anticipated that an annual series of these data will provide refinement to defining quota.

METHODS

The Scotian Shelf was arbitrarily divided into five sections (Fig. 1, Table 1) in order to evenly distribute stations along the Shelf edge. An attempt was made to randomly but equally distribute stations in three depth strata within each area. Strata used were those defined for groundfish surveys (Halliday and Kohler, 1971); Stratum I = <92.0 m, Stratum II = 92.1-183.0 m, and Stratum III = >183.1 m.

Station operations consisted of a ½ hour trawl using the Western 2A bottom trawl and determining temperature and salinity using Knudsen bottles.

In addition to the standard bottom trawl survey, an Engle Midwater Trawl (EMT) survey was carried out off the Shelf edge. At four stations (Fig. 1), 15 minute trawls were made at 100 m, 200 m, and 300 m depths.

Standard station data and catch data (Amaratunga and McQuinn, 1979) and Illex morphometrics (Amaratunga and Durward, 1979) were recorded at each station.

RESULTS AND DISCUSSION

A total of 66 bottom trawl stations were completed (Fig. 1); 57 of these were located along the Shelf edge - 12 stations each in Sections 1-4; and because of the presence of lobster pots, only 9 stations in Section 5. The remaining 9 stations were in the Emerald Basin and LaHave Basin area (Fig. 1). Four EMT stations were attempted; one was in Section 3 and three were in Section 4. The EMT stations were placed a minimum of 10 miles from the Shelf edge.

The combined total catch from all EMT stations was 59 kg, of which the total Illex catch was only 2.7 kg (Table 2) and hence were omitted for biomass estimations.

In the bottom trawl survey, biomass estimations were made from only those 57 stations along the Shelf edge. The remaining 9 stations from Emerald and LaHave Basin resulted in very small catches of Illex (Table 3) and are considered separately.

Illex were caught in 50 of the 57 stations on the Shelf edge. The combined total catch of 8.61 MT consisted of 505.9 kg of Illex. Breakdown of catches by section is given in Table 4. Illex catches in Sections 4 and 5 represented 41.1% and 32.5% of the total Illex catch respectively.

In the 92.1-183.0 m depth stratum, 87.3% of the Illex were caught (Table 5). Operations extended through a depth range of 87.5-262.5 m, with 18 stations at <92.0 m, 23 stations between 92.1 and 183.0 m, and 16 stations at >183.1 m. Highest catch rates in 1978 were also in a similar depth stratum of 101-200 m (Amaratunga and McQuinn, 1979). 6-13.3°C and 26.0-29.0°/oo. The highest mean catches of Illex per tow were in the 8.1-10.0°C temperature range (Table 6). In temperatures ranging from 8.1-12.0°C, 93.9% of the Illex were caught, while 66.6% were caught at 8.1-10.0°C. The highest mean catches of Illex per tow were in the 27.1-29.0°/oo salinity range (Table 7). In salinities ranging from 27.1-29.0°/oo, 77% of the Illex were caught, while 36.9% were caught at 28.1-29.0°/oo.

Smallest mean size of Illex was encountered in the shallowest stations, while the largest mean size was encountered in the deepest stations (Table 5). Similarly, the smallest mean size of Illex was encountered in the coldest temperature range (Table 6) and lowest salinity range (Table 7), while the largest means sizes were in the warmest temperature range and highest salinity range.

Diurnally, 81.5% of Illex were caught between noon and midnight, with highest mean catch per tow occurring during this period (Table 8). The mean size of Illex, however, was smallest during the same period.

The biomass estimates were developed from the squid catch weights by the areal expansion method. The area swept by the trawl, K (hectares), is the product of the distance between the trawl doors, D (meters), and the distance trawled, L (the product of boat speed and the trawl time). That is,

$$K = D \times L \text{ (where D and L are in meters).}$$

The catch per unit area Ca (kg/ha) is:

$$Ca = Co/K \times q,$$

where Co is weight (kg) of Illex caught in kg and q is a catchability coefficient: q was given the value of 1.0 (Amaratunga and McQuinn, 1979).

Ca estimates were made for each set, and a mean catch per unit area, $\overline{Ca}$, was computed for each section (Table 9). The boundaries for each section, for the purpose of these calculation, were defined by predetermined longitudes and by the mean width (mean of 12 width measurements in each section) between the depth contours 87.5 m and 262.5 m - minimum and maximum depths sampled along the Shelf edge. The areas (H) of each section are given in Table 1. The Ca was then expanded to the area of the section (H) to obtain biomass per section (Table 9). The total biomass at the entire Shelf edge between the contours of 87.5 m and 262.5 m (Fig. 1) is 527.8 MT. At an average weight of 62.3 gm/squid during this time, the estimated squid biomass represents 8.53×10^6 animals. Mean squid catch per unit area was also computed for each depth stratum, and Table 11 gives corresponding estimations of biomass.

These 1981 distribution and abundance patterns apparently represent an early immigration phase, when juvenile squid first arrive on the Shelf regions, after spending their early developmental stages in the slope and Gulf Stream water masses (Amaratunga et al., 1980; Froerman et al., 1981). The major concentrations of Illex were limited to the Shelf edge, with very few encountered farther inshore in LaHave and Emerald Basin areas (Table 3). Previous early-season surveys (Amaratunga and McQuinn, 1979; unpublished data, 1980) have indicated that the onset of Illex movement inshore from the Shelf edge areas first became apparent with concentrations occurring in the LaHave and Emerald Basin areas. In the 1978 survey this became evident when during the early period of the survey (June 3 and 4, 1978), catch rate in Emerald Basin was

low (0.16 kg/ha) compared with 2.59 kg/ha in the latter period of the survey (June 16-18, 1978).

During this early immigration period in 1981, Illex concentrations were greatest in the western reaches of the Shelf edge, with highest catch rates in Sections 4 and 5 (Table 4). Data from the June 3-18, 1978, survey (Amaratunga and McQuinn, 1979) also show early immigration occurring in the western region of the Shelf edge. Similar calendar days of the 1978 and 1981 surveys (as opposed to considering environmental conditions) show comparable catch rates of 0.624 kg/ha in 1978 in the vicinity of Section 4 (Ca = 0.713 kg/ha). However, in 1979, which was conducted in an earlier period, the highest catch rates of 5.067 and 7.610 kg/ha were more easterly in the area of Sections 3 and 1 respectively.

The objective of the EMT survey was to locate the immigrating Illex in water masses immediately outside the Shelf edge. Sampling stations were therefore to be placed every 10 mi on 50 mi transects traversing outward from the Shelf edge from each section. The sampling methods were similar to previous surveys that resulted in the capture of Illex larvae and juveniles (Amaratunga et al., 1980; Froerman et al., 1981). The survey, however, was abandoned after four stations because of gear difficulties.

The four EMT stations resulted in the capture of 64 Illex (Table 2). These Illex were significantly smaller in size range than those on the Shelf edge. They were in fact representative of intermediate size classes between the Illex that had immigrated to the Shelf and those found in the offshore water masses during May, 1981 (Froerman et al., 1981). Thus, the presnt EMT survey provides preliminary biological and environmental data (Table 2) on the immigrating Illex.

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Table 1. Areas of each section of the Scotian Shelf edge calculated by the product of estimated width between depth contours at 87.5 m and 262.5 m and distance between defined longitudes. (N.B.: Estimated width is a mean of 12 distance measurements.)

Section	Longitude	$\bar{X}$ width of contours (km)	Area of survey area
1	57°-59°	15.93	2.612×10^5 ha
2	59°-61°	17.00	2.788×10^5 ha
3	61°-63°	14.82	2.430×10^5 ha
4	63°-65°	23.07	3.783×10^5 ha
5	65°-66°30'	16.07	1.976×10^5 ha

Table 2. Summary of station and Illex data from the EMT operations outside the Scotian Shelf edge.

EMT station no.	Time (AST)	Tow depth (m)	Salinity ‰	Temp. (°C)	Illex catch weight (kg)	Illex numbers	Mean length (mm)	Length range (mm)
20.01	02:20	100	27.7	12.6	1.269	31	125.0	105-145
20.02	03:10	200	28.6	12.6	1.317	30	126.7	110-145
20.03	06:35	150	29.0	12.5	-	0	-	-
60.01	07:20	100	26.9	10.8	-	0	-	-
60.02	08:05	200	27.5	10.2	0.062	2	115.0	
60.03	09:26	300			-	0	-	-
61.01	14:45	100			-	0	-	-
61.02	15:20	200			-	0	-	-
61.03	16:05	300			0.070	1	149.0	-
62.01	11:24	100	27.7	10.8	-	0	-	-
62.02	12:13	200	29.0	11.8	-	0	-	-
62.03	13:05	300			-	0	-	-

Table 3. Summary of station and Illex data from the bottom trawl operations on Emerald Basin and LaHave Basin.

Station No.	Time (AST)	Tow Depth (m)	Salinity °/₀₀	Temp. (°C)	Illex catch weight (kg)	Illex numbers	Mean length	Length range (mm)
63	22:50	201	28.3	8.9				
64	1:20	140	27.8	8.1	0.068	1	55	55
65	04:47	111	28.5	9.9				
66	07:21	212	28.5	9.0				
67	10:37	187	28.3	7.8	0.3	4	152.5	135-190
68	13:55	140	27.9	11.0	2.5	38	150.2	105-185
69	16:20	187	28.0	8.5				
70	21:26	163	28.2	9.0				
71	00:30	232	29.0	10.2				

Table 4. Bottom trawl catch statistics from each section of the Scotian Shelf edge.

Section	No. of stations	Total catch (MT)	*Illex* catch (kg)	% *Illex* of catch	$\bar{X}$ *Illex* catch/tow (kg)
1	12	1.23	65.71	5.34	5.48
2	12	0.62	34.59	5.58	2.88
3	12	0.96	28.09	2.84	2.34
4	12	2.72	212.99	7.83	17.75
5	9	3.08	164.55	5.34	18.28
Totals:	57	8.61	505.93	5.88	8.88

Table 5. *Illex* catch and size data given by depth strata at the Scotian Shelf edge.

	<92 m	92.1-183 m	>183 m
$\bar{X}$ mantle length (mm)	139.5	143.5	147.9
mantle length range	105.0-180.0	100.0-195.0	100.0-205.0
$\bar{X}$ catch *Illex*/stn. (kg)	1.08	19.2	2.8
$\bar{X}$ wt. of squid (g)	58.0	59.9	72.3
$\bar{X}$ no. of squid/tow	18.5	320.5	38.8

Table 6. *Illex* catch and size data given by temperature strata at the Scotian Shelf edge.

	6.0-8.0	8.1-10.0	10.1-12.0	≥12.1
$\bar{X}$ mantle length (mm)	140.9	146.0	143.6	152.2
mantle length range	100.0-185.0	100.0-210.0	100.0-190.0	110.0-205.0
$\bar{X}$ catch *Illex*/stn. (kg)	1.8	14.7	8.5	1.8
$\bar{X}$ wt. of squid (g)	60.8	71.9	57.5	69.6
$\bar{X}$ no. of squid/tow	29.6	205.1	148.5	26.4

Table 7. *Illex* catch and size data given by salinity strata at the Scotian Shelf edge.

	26.0-27.0	27.1-28.0	28.1-29.0	>29.1
$\bar{X}$ mantle length (mm)	138.7	143.3	144.6	147.5
mantle length range	100.0-175.0	100.0-205.0	100.0-190.0	100.0-210.0
$\bar{X}$ catch *Illex*/stn. (kg)	0.64	12.3	13.7	6.9
$\bar{X}$ wt. of squid (g)	56.2	64.4	62.6	62.0
$\bar{X}$ no. of squid/tow	11.3	190.9	219.0	111.3

Table 8. *Illex* catch and size data given in relation to time of day at the Scotian Shelf edge.

	00:01-06:00	06:00-12:00	12:01-18:00	18:01-00:00
$\bar{X}$ mantle length (mm)	148.0	148.6	143.1	142.9
mantle length range	100.0-195.0	105.0-210.0	100.0-190.0	100.0-180.0
$\bar{X}$ catch *Illex*/tow (kg)	2.76	3.36	11.87	12.31
$\bar{X}$ wt. of squid (g)	64.1	66.2	60.3	61.7
$\bar{X}$ no. of squid/tow	43.1	50.8	196.9	199.5

Table 9. Estimated biomass and numbers of *Illex* in each section of the Scotian Shelf edge during the period of June 1-11, 1981.

Section	No. of stations	$\overline{Ca}$ (kg/ha)	H (ha x 10^5)	Biomass (MT)	$\bar{X}$ Wt *Illex* (g)	No. of *Illex*
1	12	0.2197	2.612	57.39	62.24	9.22×10^5
2	12	0.1157	2.788	32.26	58.95	5.47×10^5
3	12	0.0966	2.430	23.47	68.11	3.45×10^5
4	12	0.7129	3.783	269.69	64.68	4.17×10^6
5	9	0.7337	1.976	144.98	57.09	2.54×10^6
Totals:	57	0.3568	13.590	527.79	62.30	8.53×10^6

Table 10. Estimated biomass and numbers of *Illex* in depth strata at the Scotian Shelf edge during the period of June 1-11, 1981.

Depth	No. of stations	$\overline{Ca}$ (kg/ha)	H (ha x 10^5)	Biomass (MT)	$\bar{X}$ Wt. *Illex* (g)	No. of *Illex*
92-183 m	23	0.7706	5.063	390.18	59.9	6.5×10^6
<92 m & 183 m	34	0.1614	8.527	137.62	64.9	2.1×10^6

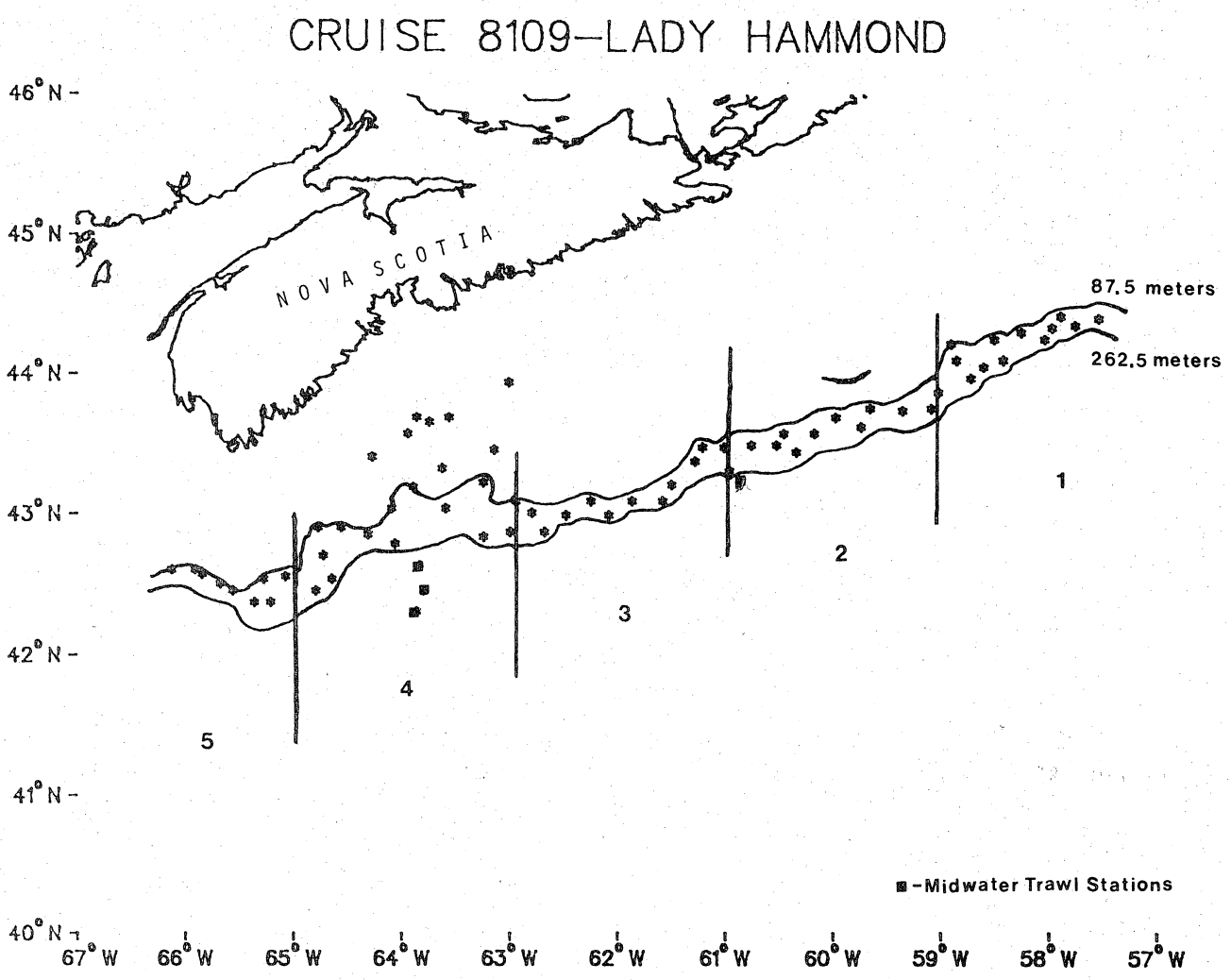

Fig. 1. Map showing station locations within the five sections on the Scotian Shelf and Shelf edge. Contour lines at 87.5 m and 265.5 m, used in the areal expansion calculations, are shown.