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Evidence of summer spawning of *Illex illecebrosus* (LeSueur) off the Northeastern United States

by

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Introduction

The short-finned squid, *Illex illecebrosus* (LeSueur), is distributed over a wide range of the Northwest Atlantic, generally from Newfoundland to Florida. In recent years this species has been the target of growing fisheries off both the USA and Canada, increasing the need for understanding of its life history and population dynamics. These subjects have been the topic of many recent papers (e.g., Squires 1967; Mesnil 1977; Lu and Roper 1979; Roper and Lu 1979; Amaratunga 1980; and Lange MS 1980) and several theories have been presented.

In general, evidence from Canadian waters indicate that *Illex illecebrosus* live about one year, spawning over a protracted season, during the winter, in that area. However, there is growing evidence that, in the waters off the United States, this species may spawn over a much longer period, possibly year round, with relative peaks in the winter and summer; and may survive as long as two years.

In this paper USA bottom trawl survey length frequency data are used to demonstrate the presence of juvenile *I. illecebrosus* (probably spawned during the summer), in the autumn of some years. Information on maturity states, by season for 1975-1979, is also presented to indicate possible time of spawning. Abundance and pre-recruit indices from USA autumn bottom trawl surveys (1967-80) are also provided. These indices indicate that when summer spawning is successful, as reflected by the high abundance of pre-recruits during the autumn, total biomass the following year is likely to be outstanding.

Data Sources and Methodologies

Seasonal length frequency data presented here (Table 1) are from standard USA bottom trawl surveys (Grosslein 1969) conducted between 1973 and 1979. Stratified random samples are pooled into three strata sets representing the Middle-Atlantic, Southern New England and Georges Bank areas (Figure 1). Length-frequencies are presented as percents so relative size distributions may be readily compared between seasons or years, while total catches, in numbers, are given to indicate differences in their magnitudes. Length-frequency data are compared with estimates of mean growth per month in order to estimate age at length and date spawned.

During USA spring, summer, and autumn bottom trawl surveys in 1975-79, the sex and maturity stage (Mercer 1973, and pers. comm.) were determined for a sample of the catch. Maturity data from this source were summarized within cruise, season, and area, by sex and maturity state, (Table 4) for individuals above and below 14 cm (the estimated least size at mat-

urity). In general, maturities are as follows:

0 - immature, sex determined
1 - early stages of development
2 - maturing
3 - mature - ready to spawn
4 - shows evidence of spawning

Abundance and pre-recruit indices (stratified mean catches per tow, in number, for all sizes and for individuals ≤10 cm) for *I. illecebrosus*, were calculated from USA autumn bottom trawl surveys, from 1967-80 (Lange MS 1980), based on tows made in the areas from the Mid-Atlantic to Georges Bank.

Average monthly growth estimates for *I. illecebrosus* range from about 1.1 cm/month (Lange MS 1980) to about 2.5 cm/month (Squires 1967). These growth rates are used to extrapolate autumn length-frequencies from 1973-79 surveys to demonstrate the probability of summer spawning. Autumn surveys have generally been conducted from late September to mid-November, spring surveys from early March to mid-May and summer surveys (1977-80, only) from late July through August.

Results and Discussion

Illex illecebrosus are not always available to the USA bottom trawl surveys, due to the timing and scope of the surveys relative to seasonal migrations and distributions of these squid. Spring surveys are conducted prior to onshore feeding migrations, and each survey covers only part of the range of this species. However, survey data are useful in estimating relative trends in abundance (autumn data) and size distributions of *I. illecebrosus*.

If autumn surveys are presumed to occur in October, individuals less than 5.5 cm (assuming 1.1 cm/month average growth) or 12.5 cm (assuming 2.5 cm/month) would presumably have hatched sometime after 1 June (i.e., during summer).

Pre-recruit indices (≤10 cm, Table 2) for 1974, 1975, and 1978 were relatively high when compared with earlier years. Length-frequency data from these years are given in Table 1. These data are presented as evidence of summer spawning.

In autumn, 1974, 35.4% of Mid-Atlantic *I. illecebrosus* catch was less than 6 cm in length, while 86.0% were less than 13 cm (Table 3). In the Southern New England and Georges Bank areas, no individuals below 6 cm were taken, but 28.6% and 27.0% of these area totals, respectively, were less than 13 cm. Over all three areas, 70.0% of the total 1974 autumn survey catch of *I. illecebrosus* were of pre-recruited size (≤10 cm), with the largest of these individuals probably the result of spawning which occurred after March 1 assuming a growth rate of 1.1 cm/month or after July 1 assuming a growth rate of 2.5 cm/month.

Pre-recruits made up 77.4% of the total 1975 *I. illecebrosus* abundance index, with 3.6% of the southern New England and 8.8% of the Georges Bank catch at less than 6 cm. In the Mid-Atlantic area, no individuals less than 6 cm were taken in 1975. Percent catches of less than 13 cm *I. illecebrosus*, in 1975, were 15.7%, 77.7%, and 53.0% for the Mid-Atlantic, southern New England, and Georges Bank areas.

In 1978, the pre-recruit index was the second highest of the time series (1967-79), but was associated with a very high total abundance index, and therefore, accounted for only 18.1% of that total index. In the southern New England area, 24.6% of the stratified catch was less than 6 cm, and 44.2% was less than 13 cm. In the Mid-Atlantic and Georges Bank areas, only 1.6% and 11.8% of the area totals were less than 13 cm, however, in terms of absolute numbers, and since the total abundance was so high, these represent substantially greater relative abundances than in most years.

Maturity data for *Illex illecebrosus* greater than 14 cm mantle length (minimum size at maturity) by year (1975-79), season, area, and sex, and pooled over years, are presented in Table 4. These data are useful as indicators of time of spawning. Females do not become mature until just prior to spawning while males may show signs of advanced maturation some time prior to mating (O'Dor et al. 1980).

Data from annual spring surveys are limited, as indicated above, with a total of 456 individuals, 14 cm and above, sampled between 1975-79. Pooled over years, about 21.9% of the males and 2.1% of the females in the Mid-Atlantic area were mature (stages 3+) during the time of the spring survey, while 51.6% of the males and 60.4% of the females were in developing stages (1, 2). Much lower proportions of *I. illecebrosus* were mature in the other three areas studied.

Samples from summer surveys are available for 1977-79 although few samples were taken in 1979. Pooled over the three years, a total of 1,027 individuals were examined. In the middle-Atlantic no males (from a total of 5) and 10.5% of the females (from a total of 19) were mature. Georges Bank provided 68.5% of the total pooled summer samples and in that area 17.3% of the males and 0.3% of the females were mature (stages 3, 4) during summer. These individuals would probably spawn in the near future, and it is highly unlikely that individuals this mature would delay spawning until the winter (5 months).

Autumn surveys provided 63.8% of the total pooled samples, with 44.3% of those from the Georges Bank area. In that area, 44.3% of the sampled males and 1.1% of the females were mature (stages 3-4). From the Gulf of Maine (accounting for 22.2% of the autumn data), 63.8% of the males and 1.5% of the females were mature. Most of these mature individuals will probably spawn offshore over the winter as part of the major spawning group during that season.

In Figure 2, autumn research vessel survey pre-recruit indices are plotted against recruited abundance the following autumn. Within the figure, a straight line has been drawn indicating the approximate minimum number of recruits that results from a particular level of pre-recruited abundance. Deviations below the line are small, whereas deviations above it are sometimes quite large.

Three of the four years of highest recruited abundance were preceeded by the three years of highest pre-recruit abundance. Thus, it appears that successful summer spawning (as indicated by a high autumn pre-recruit abundance) is indicative of high abundance the following year. In some cases (1977), even a relatively low autumn pre-recruit abundance may be followed by high abundance of recruited sized *I. illecebrosus*. In such cases, winter spawning success is probably responsible.

Conclusions

Illex illecebrosus, in the area off the Northeastern United States, probably spawn, to some extent, through most of the year. Although fully mature females are rarely observed during any season, apparently mature males were present in each season, and in most areas (pooled data). Autumn samples contained the highest proportion of mature individuals in most years, and overall, indicating the consistency of winter spawning. However, significant proportions of *I. illecebrosus* were found to be mature during the spring and summer to indicate spawning occurs in the summer and autumn as well.

The importance of summer spawning varies between years as indicated by size distributions of autumn survey samples. However, these length frequencies indicate that perhaps as much as 86% (35% if slower growth, 1.1 cm/month, is assumed) of the *I. illecebrosus* in the Mid-Atlantic area in the autumn, of some years, may be the result of summer spawning. Although percentages are lower in other areas, they still indicate that summer spawning may occur, in the southern New England and Georges Bank areas, to a lesser degree, in some years. Years of high autumn pre-recruit abundance (1974, 1975, 1978 and 1979) have been followed by years of high total

abundance (indicating that summer spawned individuals probably survive the winter).

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Table 1. Length frequencies for *Illex illecebrosus*, from USA surveys, by season, in stratified mean percent, by area, with total catch in area, 1973-79.

1a. 1973 Length frequencies

Year	1973					
Season	Spring			Autumn		
Area	Mid-Atl	SNE	Georges Bank	Mid-Atl	SNE	Georges Bank
LENGTH CM						
1						
2						
3				5.0		
4						
5						
6					3.2	
7						
8					1.7	
9					.6	
10				4.4	1.8	3.2
11				1.1	3.5	2.8
12				1.4	2.7	3.4
13				2.8	2.8	5.5
14			11.8	4.6	3.9	4.7
15	11.1		17.4	1.8	3.9	6.2
16		22.0	23.6	14.8	3.0	2.1
17	12.7		11.8	12.7	15.7	7.8
18	12.7		23.6	16.0	14.2	10.2
19		10.2		11.2	22.7	5.6
20		15.3	11.8	10.4	2.8	14.4
21				7.6	3.5	10.1
22	12.7			3.4	3.7	7.0
23				1.6	3.0	2.6
24	12.7	12.4		.4	3.7	3.6
25	25.4			.8	3.0	3.1
26	12.7	10.2			.6	1.0
27		19.7				.5
28						3.2
29		10.2				1.2
30						1.8
31						
32						
33						
34						
TOTAL NO.	8	9	9	123	57	166
MEAN LEN	21.6	22.4	16.7	16.8	17.4	18.9

Table 1b. 1974 Length frequencies

Year			1974			
Season		Spring		Autumn		
Area	Mid-Atl	S.N.E.	Georges Bank	Mid-Atl	S.N.E.	Georges Bank
LENGTH CM						
1						
2	1.0					
3	.3			2.6		
4	.4			13.8		
5				19.0		
6	.4		6.6	19.0	1.5	
7	1.3	.3		15.2	1.3	
8	3.1	.7	3.3	3.2	4.5	5.0
9	3.7		13.2	6.6	6.3	2.6
10	3.4	1.4	.9	.8	8.0	5.5
11	8.2	.5	4.2	3.0	5.1	5.5
12	21.4	10.6	25.0	2.8	1.8	8.3
13	18.2	22.2	18.0	.3	2.9	
14	9.3	32.8	14.4	.6	3.8	3.4
15	8.7	18.7	9.3	.9	1.7	2.9
16	6.5	9.6	1.8	.8	7.6	1.4
17	3.4	.5		1.5	6.2	3.0
18	.7	.6		2.2	7.3	
19	.8	1.3		2.0	5.0	8.1
20	.3			2.2	12.2	8.4
21	.3			1.6	11.6	14.8
22	.6	.6		1.0	6.8	3.8
23	1.7			.6	2.2	8.6
24	3.1	.2		.1	2.6	5.6
25				.2	.2	3.7
26	1.6					1.9
27			3.3	.1		.3
28						5.6
29	1.6					.3
30					1.4	.7
31						.6
32						
33						
34						
TOTAL NO.	213	331	40	98	190	538
MEAN LEN	13.7	14	12.3	8	16.4	18.5

Table 1c. 1975 Length frequencies

Year			1975			
Season		Spring			Autumn	
Area	Mid-Atl	S.N.E.	Georges Bank	Mid-Atl	S.N.E.	Georges Bank
LENGTH CM						
1						
2						
3					.4	
4					.4	1.5
5	3.4				2.8	7.3
6	1.9				4.8	9.8
7	5.0				7.3	5.9
8	9.7			1.0	14.4	7.3
9	17.4	28.4		.6	11.7	4.7
10	23.0		22.8	2.8	12.6	6.3
11	12.8			6.3	12.8	7.4
12	7.6		18.5	5.0	10.5	2.8
13	1.3			6.2	4.8	.2
14	5.0		10.1	6.8	1.1	1.1
15	.7	3.0	17.8	5.3	1.1	1.3
16	.4			11.3	.7	.4
17	.4	29.4	4.3	4.8	1.4	.4
18	1.6	21.8	17.9	11.3	1.6	1.5
19	1.0	5.8	4.3	6.5	1.7	1.3
20	.4	11.6		6.0	2.8	3.7
21	.4			9.3	1.5	2.8
22	.4			6.3	1.6	5.2
23	.4			3.2	1.3	5.0
24	.4			2.8	1.7	6.6
25	3.4			2.0	.5	3.6
26				1.6	.2	2.0
27				.6	.1	4.3
28				.2	.1	3.4
29				.1	.1	2.7
30	3.4					1.3
31						.2
32						
33						
34			4.3			
TOTAL NO.	16	13	73	307	1920	485
MEAN LEN	11.5	15.3	14.8	17.26	11.06	15.20

Table 1d. Length frequencies

Year			1976			
Season	Spring			Autumn		
Area	Mid-Atl	S.N.E.	Georges Bank	Mid-Atl	S.N.E.	Georges Bank
LENGTH CM						
1						
2						
3						
4						
5					.2	
6				3.7	.5	.2
7				3.5	1.3	
8				.7	1.2	.1
9	.4				.4	.1
10	1.2		4.2		.1	.1
11	1.6	1.3	12.5	.1	.1	.2
12	3.8		12.5	.1	.1	.1
13	9.8			.6	.1	.1
14	19.1	8.9	8.3	.4	.8	
15	30.0	7.3	4.2	3.1	.3	.1
16	10.7	21.5	17.2	5.4	.2	
17	7.3	17.5	17.8	4.3	1.7	.2
18	3.4	14.2	23.3	4.4	1.2	.4
19	4.0	16.2		3.7	2.7	4.4
20	5.0	3.7		5.2	5.5	12.5
21	1.9	2.0		6.7	11.1	15.5
22	.7	1.7		6.8	16.8	15.6
23	.4			7.2	11.3	15.5
24		5.7		7.7	8.4	10.6
25	.3			6.8	11.2	8.9
26	.4			8.2	9.4	9.1
27				11.2	8.9	4.6
28				4.6	3.9	1.2
29				3.5	1.5	.4
30				1.2	.6	
31				.8	.3	.1
32					.1	
33						
34				.1		
35						
36						
37					.1	
TOTAL NO.	166	32	16	935	2729	2616
MEAN LEN	13.09	13.66	15.06	21.44	22.17	22.64

Table 1e. 1977 Length frequencies

Year				1977					
Season	Spring			Summer			Autumn		
Area	Mid Atl	S.N.E.	Georges Bank	Mid-Atl	S.N.E.	Georges Bank	Mid Atl	S.N.E.	Georges Bank
LENGTH CM									
1									
2									
3									
4					.3				
5			1.3		.3		5.9	.4	.1
6	6.0						7.0	.6	
7				.1	.1		1.1	2.7	
8				.1			.3	2.7	
9				1.2			.8	1.9	
10	5.8		32.5	2.5			.4	1.3	
11	1.3	5.3	6.4	.4				1.2	.4
12	19.4	14.3	25.2	.3	.2		.3	.4	.4
13	12.4	12.7	17.6	.2	.3			.8	.3
14	13.7	18.1	6.2	.4	.3		1.0	1.0	.2
15	8.0	15.2	4.7	1.0	1.0	.4	2.0	.3	.3
16	2.7	23.2	3.4	6.1	2.7	1.3	3.2	1.0	.7
17	7.5	6.5		25.2	10.3	2.3	2.5	.7	1.1
18	4.0	1.5		36.1	9.2	8.3	5.9	1.2	.9
19	6.7			19.0	13.6	11.4	8.1	.8	1.1
20	4.0			5.1	19.4	18.5	7.0	1.9	4.2
21	3.5			2.0	12.6	17.2	3.6	7.0	10.9
22	2.2		2.7	.3	7.4	11.8	8.1	8.2	17.2
23	1.9	1.6			7.5	11.2	9.0	17.2	16.0
24					6.7	7.2	7.8	11.9	11.9
25					4.5	5.9	3.5	8.3	11.8
26					2.7	2.4	4.5	8.7	9.4
27	.9	1.6			.5	1.6	8.3	7.2	6.1
28					.2	.3	7.1	5.8	4.0
29					.2	.2	1.7	3.4	1.7
30							.7	2.1	.6
31					.1		.2	.8	.4
32								.5	.1
33					.1				
34									.1
35									
36									
37									
TOTAL NO.	60	27	46	1902	1350	2688	874	1643	1772
MEAN LEN	14.42	12.33	10.95	17.41	15.39	21.21	19.8	22.2	23.4

Table 1f. Length frequencies

Year			1978			
Season	Spring			Autumn		
Area	Mid Atl	SNE	Georges Bank	Mid Atl	SNE	Georges Bank
LENGTH CM						
1						
2					1.1	
3					5.0	
4					7.4	
5					11.1	.4
6					12.0	.5
7				.1	5.1	.1
8	6.5				.8	.6
9				.2	.3	1.4
10	6.5				.2	3.5
11	13.0			.4	.4	2.6
12	6.5			.9	1.0	2.7
13	13.0	18.1		1.7	1.1	1.7
14	20.0	18.1		2.9	2.8	1.4
15	13.0			1.1	2.9	1.5
16	3.1			3.1	3.7	2.2
17	1.6	27.6		4.3	3.5	2.3
18	15.2		100.0	7.4	4.4	2.3
19	1.6	18.1		13.5	7.9	2.6
20		18.1		20.6	6.9	4.6
21				14.7	4.5	7.4
22				9.4	4.2	10.0
23				9.5	2.3	12.5
24				5.1	3.1	11.7
25				3.2	3.2	10.9
26				1.7	2.8	6.4
27				.2	1.3	4.5
28					.6	2.6
29					.3	1.7
30						1.6
31						.3
32						
33						
34						
35						
36						
37						.3
TOTAL NO.	182	10	1	7998	2494	1226
MEAN LEN	13.6	14.6	16	20.1	13.5	21.3

Table 18. 1979 Length frequencies

Year				1979					
Season		Spring		Summer			Autumn		
Area	Mid-Atl	S.N.E.	Georges Bank	Mid-Atl	S.N.E.	Georges Bank	Mid-Atl	S.N.E.	Georges Bank
LENGTH CM									
1									
2									
3		1.6		.2	.1				
4					.1			.1	
5			1.2		.1		.2	.1	
6	4.0	.8		.2	.1		.2	.6	.2
7	2.6	2.5		1.0	.1	.1	.2	4	.3
8	2.6	3.4	1.2	2.3	.2			4.4	.4
9		9.2	1.2	4.1	.2	.1	.2	5	.6
10	6.9	7.9	1.2	2.7	.4	.1		3.2	1.0
11	6.9	1.6	1.3	1.2	.3	.1	.2	1.4	1.1
12	6.4	1.6		.8	.4		.3	.5	.4
13	5.4	6.4	7.9	.6	.3		.2	.2	.2
14	12.1	12.6	29.0	.6	.5		.7	.2	.1
15	10.0	14.4	26.0	1.5	.7		.4	.1	.1
16	18.7	15.4	21.2	3.7	.4	.2	.2	.2	
17	6.8	7.9	2.7	2.6	.7	.8	.2	.2	
18	8.6	3.9	5.6	4.5	4.1	3.5	.6	.7	.1
19	8.4	3.2		12.1	12.1	6.7	2.7	1.8	.3
20		2.8	1.5	20.6	23.5	23.4	10.4	5.7	2.7
21	.6	2.1		17.7	19.8	24.7	17.4	11.2	13.4
22		.9		8.9	12.9	17.4	17.1	11.9	21.9
23		.9		6.8	10.8	9.3	9.9	9.2	20.5
24		.6		4.2	8.2	8.0	14.0	11.0	10.6
25				2.3	3.0	3.6	11.5	12.4	7.3
26		.3		.4	.7	1.3	8.6	7.6	6.2
27				.3	.1	.4	3.6	4.6	5.8
28				.1	.1	.1	1.1	2.4	3.6
29				.2	.1	.2	.1	.8	2.2
30								.1	.7
31								.4	.2
32				.2					
33				.2					
34									.1
35									
36									
37									
TOTAL NO.	109	166	81	610	1937	1922	1423	3103	5460
MEAN LEN	14.2	14	14.7	19	20.8	21.3	22.5	20.5	22.9

Table 2. Pre-recruit and total abundance indices, in numbers, for *Illex illecebrosus*, 1967-80.

Year	Total Abundance	Pre-recruit Abundance
1967	2.1	0.7
1968	2.3	0.6
1969	0.8	0.3
1970	3.4	0.2
1971	1.9	0.6
1972	3.5	1.8
1973	1.3	0.3
1974	3.0	2.1
1975	12.4	9.6
1976	28.7	0.6
1977	15.8	1.1
1978	28.4	5.1
1979	32.1	2.6
1980	17.0	0.7

Table 3. Proportion of *Illex illecebrosus* from USA bottom trawl surveys (1973-74) that were probably spawned during the summer, assuming two different growth rates[1].

Growth Rate	1.1 cm/month			2.5 cm/month		
Area	Middle Atlantic	S. New England	Georges Bank	Middle Atlantic	S. New England	Georges Bank
Year						
1973	.050	.000	.000	.119	.137	.094
1974	.354	.015	.000	.860	.286	.270
1975	.000	.036	.088	.157	.777	.530
1976	.000	.002	.000	.081	.039	.008
1977	.059	.004	.001	.158	.112	.011
1978	.000	.246	.004	.016	.442	.118
1979	.002	.002	.000	.013	.193	.233

[1] Assuming average monthly growth measurements of 1.1 cm (Lange MS1980) and 2.5 cm (Squires 1967), which would approximately relate to individuals <6 cm and <13 cm, respectively, during the autumn surveys.

Table 4. Maturity states of *Illex illecebrosus*, by season, year, area, and sex, for individuals of greater than estimated minimum size at maturity (≥14 cm).

a. Spring, 1975-1979.

		Males						Females					
Year		0	1	2	3	4	Σ	0	1	2	3	4	Σ
1975	MA				4		4				1		1
	SNE						-						-
	GB				3		3				1		1
	GM						-						-
1976	MA	3	2				5	2					2
	SNE						-						-
	GB						-						-
	GM						-						-
1977	MA	12	5	12	5		34	14	8	1			23
	SNE		1				1		4				4
	GB						-						-
	GM						-						-
1978	MA		4	1	2	1	8		8				8
	SNE	53	8	1		1	63	34	32				66
	GB	42	46				88	95	12				107
	GM						-						-
1979	MA	2	9		2		13	2	12				14
	SNE						-		1				1
	GM	5	2	1			8	2					2
1975-	MA	17	20	13	13	1	64	18	28	1	1		48
1979	SNE	53	9	1		1	64	34	37				71
	GB	47	48	1	3		99	97	12		1		110
	GM						-						-
Total		117	77	15	16	2	227	149	77	1	2		229

Table 4b. Summer 1977-1979.

		Males						Females					
Year		0	1	2	3	4	Σ	0	1	2	3	4	Σ
1977	MA			2			2		11				11
	SNE						--						--
	GB	5	59	44	52		160	26	212	6			244
	GM	2		7			9	2	9	48			59
1978	MA							1				1	2
	SNE		1	30	5		36	1	15	14	1		31
	GB	1	28	135	4	1	169	19	104	6		1	130
	GM	1	17	49	4		71	35	55	3	1		94
1979	MA	2	1				3	2	3		1		6
	SNE						--						--
	GB						--						--
	GM						--						--
1977-79	MA	2	1	2			5	3	14	--	1	1	19
	SNE		1	30	5		36	1	15	14	1		31
	GB	6	87	179	56	1	329	45	316	12		1	374
	GM	3	17	56	4		80	37	64	51	1		153
Total		11	106	267	65	1	450	86	409	77	3	2	577

Σ = 1027

Table 4c. Autumn, 1975-1979

Year		Males						Females					
		0	1	2	3	4	Σ	0	1	2	3	4	Σ
1975	MA	36	17	4	27		84	29	55		1		85
	SNE	55	19	14	28		116	45	40		1		86
	GB	3	9	3	14		29	3	23	1	1		28
	GM		8	2	27		37	1	41		1		43
1976	MA	6	20	1	46		73	7	111		2		120
	SNE	11	7	1	39		58	11	97				108
	GB				2		2		8				8
	GM	2	1	14			17	2	68		1		71
1977	MA			2	1		3		6				6
	SNE	3	6		2		11	9	12				21
	GB	8	5	11	100		124	6	201		2		209
	GM	1	1	13	13	2	30	2	50	1	1		54
1978	MA	1	4				5		5				5
	SNE	13	9	7	1		30	1	35				36
	GB	84	99	56	77	14	330	55	317	4	4		380
	GM	4	23	28	65	16	136	2	126	2	2		132
1979	MA		4	4	4		12	1	17				18
	SNE						-						-
	GB	6		1	6	14	27	5		16			21
	GM			4	6	10	20		41				41
1975-	MA	43	45	11	78		177	37	194		3		234
1979	SNE	82	41	22	70		215	66	184		1		251
	GB	101	113	71	199	28	512	69	549	21	7		646
	GM	5	34	48	125	28	240	7	326	3	5		341
Total		231	233	152	472	56	1144	179	1253	24	16		1472

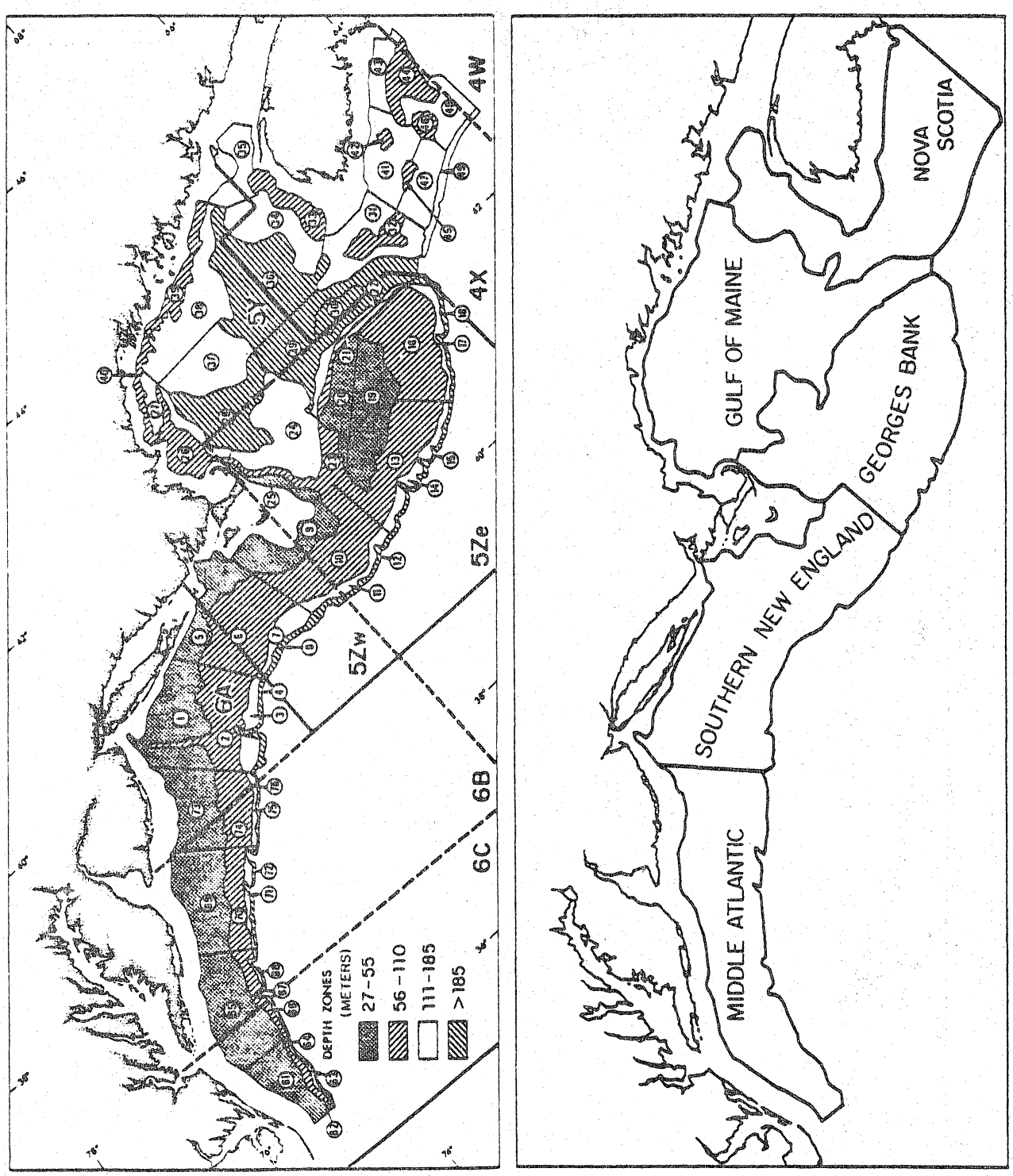

Figure 1. USA bottom trawl survey stratas (A) and geographical areas (B) of the Northwest Atlantic, off the Northeast USA.

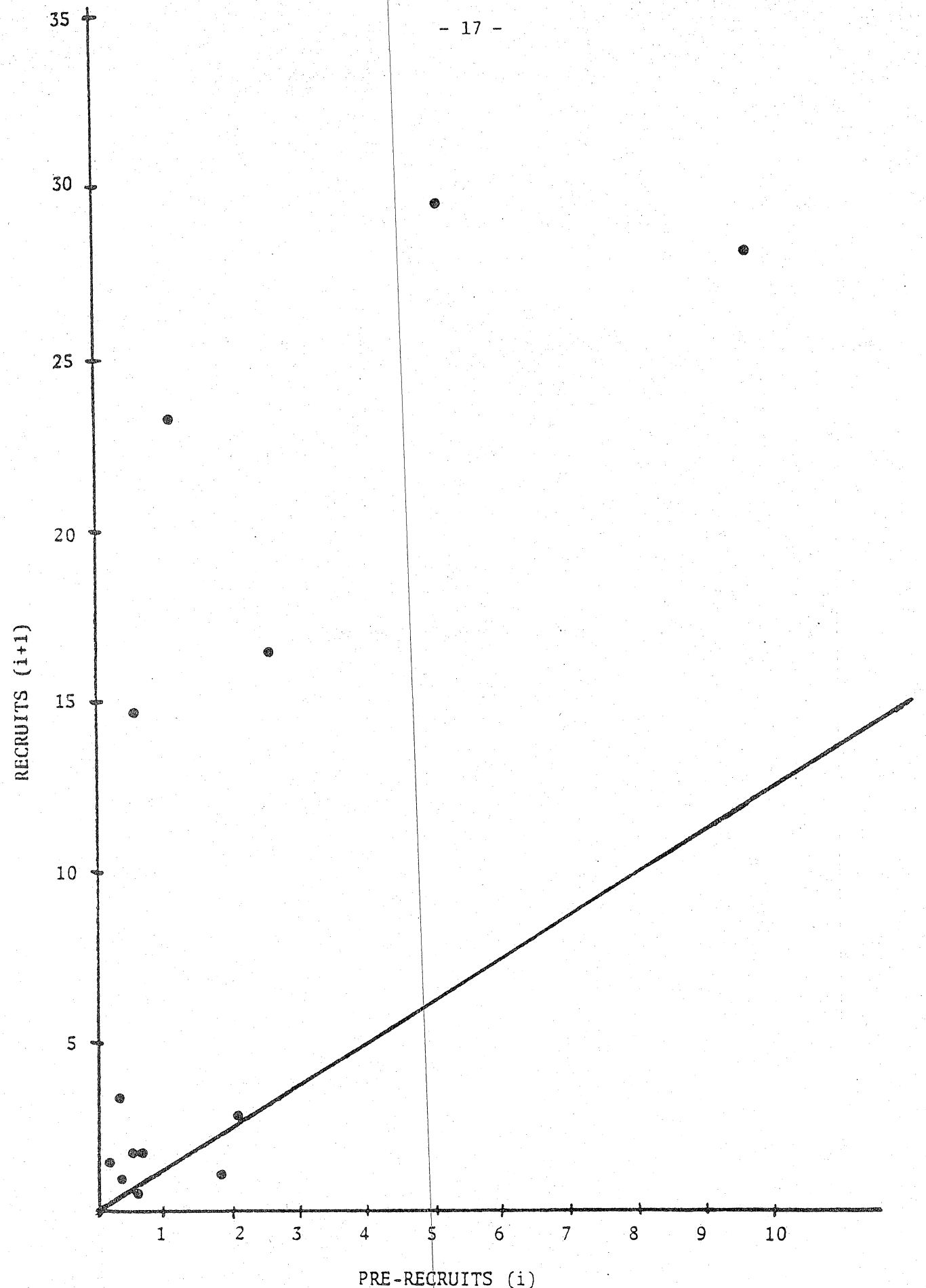

Figure 2. USA autumn research vessel survey pre-recruit indices , in year i, versus recruited abundance indices of year i+1, with line indicating approximate minimum numbers of recruits resulting from particular levels of pre-recruits