International Commission for the Northwest Atlantic Fisheries

Serial No. 5161
(D.c.3)

ICNAF Res.Doc. 78/II/9
(Revised)

SPECIAL MEETING OF STACRES - FEBRUARY 1978

Catch compositions during the 1977 Scotian Shelf international fishery with emphasis on the silver hake and squid (Illex) fisheries

by

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Introduction

An international observer program was initiated on the Scotian Shelf (Div. 4VWX) as a means of evaluating the by-catches which occurred during the International fishery. In order to resolve by-catch problems, in small mesh gear fisheries, the small mesh bottom trawl fisheries regulations for Div. 4VWX were agreed at the Nineth special meeting of ICNAF in Tanerife, Spain in December 1976. The regulations provide for the use of small mesh bottom gear (under 130 mm codends) inside a line as described in Fig. 1 during the period 15 April-15 November. Midwater fishing with small mesh gear was not regulated.

As part of bilateral scientific agreements between Canada and both Cuba and the USSR, each country agreed to provide and train technicians in the methods of sampling. Once this group was found proficient they were assigned to vessels within the Cuban and USSR 4VWX silver hake fleets. It was further agreed that a proportion of the data collected would be exchanged with the participating countries.

During the early summer of 1977, the Canadian government entered into a Japanese initiated research program in order to study the amount of by-catch associated with off-bottom trawl gear. This provided an opportunity to study a directed fishery for squid *(Illex illecebrosus)* in relation to by-catch problems of different gears.

This paper emphasizes the squid fishery employing data obtained during the 1977 observer program.

Materials and methods

The Canadian Observer Program commenced on April 23, 1977 with a staff of 16 trained biological technicians. The distribution of observers were 4 aboard USSR and 3 on Cuban vessels such that any time a total of 7 observers were at sea. Canadian staff were matched by 4 Cuban and 2 Japanese observers who worked in pairs with the Canadians. The 4 observers provided by the USSR worked independently except for 1 cruise during October. The program terminated in November with a total of 47 trips sampled from 6 Cuban, 1 Japanese and 15 Soviet vessels.

Data concerning the location, depth, time and catch composition were collected from each set either by the observer, or in his absence it was copied from the log book. In addition to these data, each observer collected at least one complete sample each day. Such samples consisted of the following data:

(i) Set details

(ii) Catch composition - including kept and discarded weights

(iii) Length frequencies - randomly obtained and measured at 1 cm intervals with sexed frequencies for all species except cod *(Gadus morhua)* and haddock *(Melanogrammus aeglefinus)*.

(iv) Otoliths - collected from all finfish species, being removed from the first fish measured in each cm length group by sex.

(v) Sexual maturity - collected from squid *(Illex illecebrosus)*

The areas sampled were within ICNAF Subdiv. 4Vs and Div. 4W and 4X. The areas fished were at the discretion of the captain with no influence by the observer. Most vessels were allowed to use 60 mm small mesh bottom trawl outside the small mesh gear line. Only 3 out of the 4 observed Soviet vessels were licenced to fish with small meshed bottom trawl outside the line.

The logistics of transporting the observers to Cuban vessels was for the most part dependent upon the Field Services Branch of the Canadian Department of Fisheries and Environment. The USSR representatives coordinated the transportation of the observers to vessels within their fleet. The Japanese vessel used during the experiments returned to port several times to unload research personnel.

Mesh measurements were conducted when the appropriate ICNAF guages were available. Otherwise, data from the ship's personnel was used.

Designation as to whether a particular set was directed towards one particular species in preference of another was determined either by consultation with the ships officers or based on the technicians observations. In the latter instance, the observer would designate the major fraction of the catch as the species for which that set was directed.

Results

Catch Distribution. The observer program collected the majority of data from an area near the small mesh gear line in depths between 100 and 200 metres (Figs. 2 and 3). The majority of sets observed were by bottom (73%) rather than midwater trawls (15%) (Table 1). The remaining 12% were by Japanese off-bottom gear. Coverage of all non-Canadian vessels was 15% of the vessel days fished (as reported to the Canadian government).

Observations for those vessels carrying Canadian biological technicians were 24% of the various national catches (Tables 2 and 3).

Sampling adequacies have been calculated similar to those employed by Akenhead (1976) in his studies of the ICNAF data base. Summarized on the stock basis, the only species not adequately sampled was the Div. 4VWX witch *(Glyptocephalus cynoglossus)* stock. This is understandable since only 958 kg of witch flounder was recorded by the observers.

In order to study the catch composition it was necessary to investigate the spatial distribution of the observed vessels not only from a gear aspect but also their effort in relation to stock distributions. A series of maps depicting catch per unit of effort (cpue = kg/hr) were plotted on 10' x 10' grid maps (Waldron, 1977). These were compared to those maps prepared by Scott (1976a, 1976b) from summer research vessel cruises. Bottom trawl silver hake cpue for all countries was found to be on the average highest in the Sambro Banks area with the largest concentrations of effort along the small mesh gear line during the observer program (Fig. 4). This is in agreement with those results reported by Scott (1976a).

Midwater trawl cpue for silver hake combined for all countries was much lower than that of the bottom gear and were predominantly concentrated inside the small mesh gear line (Fig. 5).

The cpue maps for squid *(Illex)* indicated wide catch distributions for this species when both gears were employed (Figs. 6 and 7). Scott (1976b) described a relatively homogenous cpue for the Scotian Shelf area with notably high concentrations between 100 and 200 metres.

Observations for squid caught by midwater trawls showed this gear type produced larger cpue as compared to bottom trawls (Fig. 7).

The cpue distribution maps for the remainder of commercially valuable species emulate those reported for silver hake and *Illex*. The overall percentage composition of these species constitutes 4% of the total observed catch for bottom trawl. Midwater trawls produce a catch lower in by-catch (1%) regardless of which species was directed.

Silver hake distributions. A seasonal trend was noted for the silver hake fishery. Observations for the USSR show the highest cpue using both bottom and midwater trawls occurred in July. Both the Emerald Basin and southwestern Sable Island Bank areas had the highest cpue.

The Cuban fishery produced larger silver hake cpue during June for both midwater and bottom gears. The majority of sets occurred along the small mesh gear line for the period April to July while during August, effort was diverted to the Emerald Basin area. For the month of June, observed cpue peaked with the highest rates occurring in an area inside the small mesh line.

The Japanese catches of silver hake represent a by-catch of their squid fishery. Observer data was collected during a Canada-Japan gear efficiency study (Waldron 1977a). Monthly variation in effort is dependant upon the experimental design and is not indicative of a typical "search and capture" fishing operation.

Squid *(Illex)* distributions. The midwater trawl fishery for the USSR produced predominantly higher catch rates distributed inside the small mesh gear line (Fig. 8). The catches of squid observed for the bottom trawl fishery occurred along the southwestern part of the Sable Island Bank and Emerald Bank (Fig. 9). The midwater cpue of squid was highest in June while those of the bottom trawl peaked in July. The majority of squid *(Illex)* catches occurred between 100 and 200 metres.

The Cuban midwater trawl fishery for squid was observed for the months of June through August with the fishing intensity concentrated along the small mesh gear line (Fig. 10). High cpue for *Illex* occurred in all months sampled. Cuban cpue for squid *(Illex)* employing bottom trawl increased from April to June where it remained relatively high until mid-August when the fleet moved out of the area. Earlier in the season, the effort was concentrated along the small mesh gear line when, during August, a portion of the effort was diverted to the Emerald Basin area.

The Japanese fishery, as previously stated was fundamentally a research cruise. However, the first phase of the experiment may be regarded similar to the rest of the observer program since the vessels fishing activity was at the discretion of the captain. There were only 2 types of gear used, off-bottom chain and bobbin types. The majority of the effort was expended inside the small mesh gear line in waters between 100 and 300 metres (Fig. 11).

The by-catch recorded during what would be described as a predominately squid fishery was lower for the chain type as opposed to both the bobbin and bottom gears.

Catch compositions. Catch compositions for each country, gear and ICNAF Division were analyzed to distinguish the affects of gear and area. During the observer program the Canadian technicians were designating which species was directed. An analysis using these criteria was done. It indicated the problems in using such broad descriptions of fishing activities as being directed when countries are licenced to fish more than one species. Throughout the analysis one point became evident and that was the midwater fishery is predominately squid while the bottom fishery is mainly silver hake. It was further noted that the midwater fishery caught fewer of the

by-catch species than the bottom fishery. The midwater fishery has a by-catch (excluding both squid and silver hake) of 2.84%, while under the same circumstances the bottom fishery had a by-catch of 4.18% by weight.

In order to surmount the problem in terminology the catch composition was divided into percentile frequency groups. The data was extracted from the species compositions observed during each set where silver hake was present. The percentages of both silver hake and squid *(Illex)* for each percentile class was calculated as a percent of the total catch for that group. These figures were then plotted for both midwater and bottom trawls (Figs. 12 and 13).

The fact that neither curve meets at exactly 50% composition is explained by the presence of other species in the catch. The curve for the midwater gear shows the effects of the low by-catches since it crosses slightly below 50%. The bottom trawl produces a curve which crosses much below 50% reflecting the large amount of by-catch associated with the bottom trawl fishery. The inflection in the curve of squid at 0%, silver hake is caused by the extremely high catches of haddock (4.4) and mackerel (35mt).

The results of the analysis are presented in Tables 4 and 5. The rows for silver hake and squid represent the catches as summarized from the percent composition of either silver hake or squid in each set. The resultant tables can be assumed to represent the catch and assocaited by-catches when either silver hake or squid are the main species caught.

The ability to direct a fishery towards either silver hake or squid would appear to be possible when data is summarized for those gears which were observed to report zero catches of squid and S. hake (Tables 6&7). Again, the squid fishery was observed to be predominately a midwater fishery while conversely, the silver hake fishery would be described as a bottom fishery.

The Japanese experiment using the bottom, off-bottom bobbin and off-bottom chain gear types was directed rather successfully for squid with resultant low by-catches when either off-bottom gear was used (Waldron et al, 1977, Waldron and Gray 1978).

The fishery in 4VWX was investigated for trends through time. At the time of writing it was not possible to study the affects of time and gear. As stated previously 79% of all sets recorded for the Soviet Union and 87% for Cuba were bottom trawls. This leaves room for frequent changes of gear which could create some, but not all of the fluctuations evident in Figs. 14 and 15. Regardless of the gear affects, it is evident that in the majority of cases both species can be persued independantly.

DISCUSSION

The International Observer program has allowed scientists from all participating countries to more fully understand the complexities of the offshore fisheries. Zilanov (1976) describes the by-catch composition in a Soviet directed silver hake fishery as not over 4% for bottom gears. The main by-catch species were herring, mackerel and argentine. There is no mention of squid which indicates that during the course of the research, 1970-76,squid were not available to the bottom trawl fishery. Both Canadian research data and ICNAF Statistical Bulletins report catches of squid for the USSR since 1975 which would further indicate that it is possible to conduct a directed silver hake fishery.

The exclusion of squid catches in the 1977 observed USSR silver hake fishery yields a by-catch of 4%. However, regarding squid as a by-catch of the silver hake fishery increases this by-catch to 10%. Therefore, in the establishment of any quota for squid the amount removed in the silver hake fishery must be taken into consideration.

The spatial and temporal distributions of squid and silver hake indicates that both could be selectively fished. The Cuban silver hake cpue peaked in June while the actual catch decreased. The squid fishery depicts two catch peaks in June and the other in July (Fig. 15). The cpue does not follow any trend for the season using midwater trawls while it

increased when bottom gear was employed. These facts are difficult to interpret at this time without further analysis. One explaination could be that a great deal of time might have been spent in searching activities. Cuba set fewer times per day than the USSR which could account for the fact that the Cuban fishery does not follow the typical activity of the Soviet Union (Table 8). A further explaination was that more effort was directed to the squid fishery.

The fact that the midwater fishery is almost exclusively a squid fishery while the bottom trawl fishery is silver hake indicates that for both Cuba and USSR the fisheries can be selective.

Tables were constructed on the basis of sets where either squid or silver hake were the main species caught. For a silver hake fishery employing midwater trawls as opposed to bottom trawls the ratio of squid to silver hake increases 50% (.121 to .245) (Table 9). When squid is the main species caught, the largest percentage of silver hake is removed in the bottom trawl fishery (Table 10).

The most apparent observation to be made from these tables is that the by-catches produced by midwater trawls are convincingly lower than those associated in bottom trawl fisheries. From the Canada-Japanese experiments using 3 different gear types it became evident that the further from the ocean floor the gear fished the lower the amount of by-catch (Waldron et al., 1977).

The silver hake fishery is the largest foreign fishery in 4VWX at the present moment. Based upon the 1978 quotas and employing the data on catch ratios it is evident that if Cuba was allotted in 1978 the same 1977 squid quota of 3,000 tons, that 83% would be taken in a silver hake fishery (Table 11). The USSR appears to be more selective towards silver hake than the Cubans in that only 22% of the squid allocation (15,000 ton) would be removed in a silver hake fishery.

SUMMARY

The Observer Program demonstrates that the international fishery in 4VWX can be divided by gear and main species caught. The bottom trawl fishery is primarily for silver hake while the midwater trawl fishery is predominately squid.

The highest by-catches occur in the silver hake bottom trawl fishery while the by-catch is much lower in the squid midwater trawl fishery. The fishery producing the lowest degree of by-catch is the Japanese off-bottom chain trawls.

Weekly fluctuations in percentage composition indicates that squid and silver hake are being fished, at certain times, exclusive of each other. This coupled with data presented by studying percentile classes and the previous Canada-Japan experiment indicates that it would be possible to selectively fish for squid.

Ratios of by-catch to both squid and silver hake provide a quick method to access the affects of new quotas on each species. Examination of the assigned silver hake quotas for Cuba and Japan clearly show that Cuba would catch most of 1977 squid quota in a silver hake fishery.

REFERENCES

AKENHEAD, S.A. 1976. Adequacy of sampling for TAC stocks, 1974. ICNAF Summ. Doc. 76/VI/33. 13 p.

SCOTT, J.R. 1976a. Summer distribution of groundfish on the Scotian Shelf in 1970-74. FMS Tech. Rept. No. 635.

1976b. Distribution of squid *(Illex illecebrosus)* on the Scotian Shelf. 1970-74. ICNAF Res. Doc. 76/XLL/139.

WALDRON, D.E. 1977. Preliminary analysis of data collected from the International Observer Program April-September, 1977. CAFSAC Working Doc. 77/22.

WALDRON, D.E. AND D.F. GRAY. 1978. The affects of gear types on the Japanese squid *(Illex illecebrosus)* fishery.

WALDRON (et. al). 1977. Analysis of Squid *(Illex illecebrosus)* by-catch levels using three different trawling gear types (CAFSAC Working Paper 77/23).

ZILANOV, U.K. 1976. On specific composition and size of by-catch obtained while conducting the specialized searching and fishing for silver hake, herring and mackerel in Subareas 4, 5 and S.A. 6. ICNAF Res. Doc. 76/XII/158.

Table 1. Number of observed sets during the 1977 Scotian Shelf Fishery.

Gear	Cuba No. Sets	Japan No. Sets	USSR No. Sets	Total
Bottom	495	41	559	1095
Midwater	72	0	151	223
Bobbin	0	80	0	80
Chain	0	106	0	106
Total	567	227	710	1504

Table 2: Days fished and biologically observed during the 1977 Scotian Shelf International Fishery.

Country	4V		4W		4X		Total 4VWX		4VWX
	Vessel days Fished	Observed	Vessel days Fished	Observed	Vessel days Fished	Observed	Vessel days Fished	Observed	% Observed
Bulgaria							113	0	0
Cuba				201		13	326	214	66
Denmark	11	0	30	0	22	0	70	0	0
FRG			16	0			16	0	0
France	26	0	14	0			40	0	0
Italy	> 3	0	>75	0			>78	0	0
Japan (squid)		14		46		4	418	64	15
Japan (tuna & swordfish)							168	0	0
Poland							>54	0	0
Romania							>16	0	0
Spain			>53				>53	0	0
USSR		0		199		9	1797	208	12
Total	>40	14	>188	446	22	26	>3149	486	15

* Data derrived from Flash Print-outs. The largest species recognized as being caught in 4VWX was selected as the minimum effort (days fished) applied to the area.

Table 3. Percentage[1] of total catch by weight observed for each country for 1977.

SPECIES	CUBA	JAPAN	USSR
S. Hake	48.0	100+	6.4
Squid (*Illex*)	36.6	20.0	8.8
Argentine	6.4	0.4	2.0
Cod	27.5	20.0	9.4
Haddock	46.4	100[2]	49.3
Pollock	25.7	100[2]	3.7
Am. Plaice	-	-	6.4
Yellowtail	-	-	100[2]
Redfish	100[2]	38	3.7
Flatfish (Unspecified)	37.4	100+	100[2]
Total Coverage	42.0	13.0	7.0

[1] Percentages were calculated by dividing the observed catch by the catch as reported in the Canadian Flash System.
[2] Denotes species where Canadian biological technicians observed more than what was reported.

Table 4. Combined catch composition of directed fisheries using bottom trawls during the 1977 Observer Program. All catches are summed for each country and are expressed in Kg.

MAIN SPECIES	HADDOCK	SILVERHAKE	SQUID	ARGENTINE	AM.PLAICE	YELLOWTAIL	COD	REDFISH	POLLOCK	MACKEREL	WITCH	OTHER
SILVERHAKE	16812.	2700372.	325615.	13887.	2714.	4462.	10265.	19568.	5501.	31054.	843.	37519.
SQUID	9970.	124289.	1174008.	1887.	1463.	3253.	6648.	886.	1288.	19885.	92.	2274.
SILVERHAKE-SQUID	25.	26465.	26465.	0.	11.	231.	230.	10.	14.	200.	3.	23.
NO SPECIES DIRECTED	1904.	0.	0.	0.	52.	578.	586.	5.	249.	18401.	0.	230.
TOTAL CATCH	24712.	2851126.	1526089.	15774.	4241.	8544.	17728.	20471.	7064.	49468.	938.	40055.

Table 5. Combined catch composition of directed fisheries using midwater trawls during 1977 Observer Program. All catches are summed for each country and are expressed in Kg.

MAIN SPECIES	HADDOCK	SILVERHAKE	SQUID	ARGENTINE	AM.PLAICE	YELLOWTAIL	COD	REDFISH	POLLOCK	MACKEREL	WITCH	OTHER
SILVERHAKE	0.	82983.	20187.	0.	7.	0.	0.	0.	0.	859.	0.	600.
SQUID	174.	10257.	1445328.	0.	0.	0.	2.	0.	0.	330.	1.	6126.
SILVERHAKE-SQUID	0.	2600.	2600.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NO SPECIES DIRECTED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL CATCH	174.	103260.	1468006.	0.	7.	0.	2.	0.	0.	1189.	1.	6726.

Table 6. Percentage of Observed Sets which reported no squid catches during the 1977 4VWX Observer Program

Gear	Cuba	Japan	USSR	Total
Bottom	16	0	36	25
Midwater	0	-	0	0
Bobbin	-	0	-	0
Chain	-	0	-	0

Table 7. Percentage of Observed sets which reported no Silver Hake catches during the 1977 4VWX program.

Gear	Cuba	Japan	USSR	Total
Bottom	9	2	3	6
Midwater	65	-	66	65
Bobbin	-	5	-	5
Chain	-	49	-	49

Table 8. Relationship between number sets, hours and days observed during the 1977 4VWX fishery regardless of gear type.

Country	Total No. Fishing Hrs.	Total No. Sets	Total No. Days Fished	No. Hrs./ Set	No. Hrs/ Day	# Sets Per Day
Cuba	1573	556	240	2.83	6.6	2.3
Japan	319	225	54	1.42	5.9	4.2
USSR	2021	695	217	2.9	9.3	3.2
Total	3913	1477	511	2.7	7.7	2.9

Table 9. Silver hake ratio's derived from the 1977 Canadian observer Program when silver hake was the main species sought[1] in ICNAF Div. 4VWX.

Gear Type	Mesh Size	Country	Haddock	S. Hake	Squid *(Illex)*	Argent-ine	Am. Plaice	Yellowtail	Cod	Redfish	Pollock	Mackerel	Witch	Other	Total By-catch (Excl. Squid)	Catch of S. Hake (Kg)
Bottom	60	Cuba	.011	1.000	.272	.012	.0004	.0004	.003	.002	.006	.007	.0002	.006	.047	747954
Bottom	46	Japan[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	
Bottom	60	USSR	.003	1.000	.063	.003	.001	.002	.004	.010	.001	.003	.0004	.017	.044	1952300
Bottom	60	All	.006	1.000	.121	.005	.001	.002	.004	.007	.002	.004	.0003	.0139	.045	2700372
Midwater	60	Cuba	-	1.000	.258	-	-	-	-	-	-	.018	-	-	.018	47664
Midwater	60	USSR	-	1.000	.228	-	.0002	-	-	-	-	.0001	-	.0173	.018	34739
Midwater	60	All	-	1.000	.245	-	.0001	-	-	-	-	.010	-	.007	.018	82403
Bobbin	42	Japan	.0004	1.000	.152	-	.003	-	.003	.0004	.002	-	.0004	.024	.032	2295
All Gears		Cuba	.010	1.000	.271	.0109	.0004	.0003	.003	.0014	.0053	.008	.0002	.005	.045	795618
All Gears		Japan	.0004	1.000	.181	-	.036	.017	.003	.0004	.002	-	.001	.042	.102	2412
All Gears		USSR	.003	1.000	.065	.003	.001	.002	.004	.009	.001	.003	.0003	.017	.043	1987039
All Gears		All	.005	1.000	.124	.005	.001	.002	.004	.007	.002	.004	.0003	.014	.044	2785070

[1] Main species selected when it constituted the larger portion of a set.

[2] Japan's catches using bottom gear always had squid as the largest catch/set.

Table 10. Squid ratios derived from the 1977 Canadian observer program when squid was the main species sought in ICNAF Div. 4VWX.

Gear Type	Mesh Size	Country	Haddock	S. Hake	Squid *(Illex)*	Argent-ine	Am. Plaice	Yellowtail	Cod	Redfish	Pollock	Mackerel	Witch	Other	Total By-catch (Excl. Squid)	Catch of S. Hake (Kg)
Bottom	60	Cuba	.0118	.1259	1.000	.0001	.0002	.0001	.0025	.0005	.0016	.0292	.00004	.0015	.0477	607041
Bottom	46	Japan	.0087	.0380	1.000	.0091	.0021	.0003	.0012	.0027	.0004	.0004	.0002	.004	.0291	176433
Bottom	60	USSR	.0032	.1054	1.000	.0005	.0024	.0080	.0126	.0002	.0006	.0051	.0001	.0016	.0345	390534
Bottom	60	All	.0085	.1059	1.000	.0016	.0012	.0028	.0057	.0008	.0011	.0169	.0001	.0019	.0405	1174008
Midwater	60	Cuba	.0002	.0158	1.000	-	-	-	.000002	-	-	.0006	-	.0071	.0078	366071
Midwater	60	USSR	.0001	.0116	1.000	-	-	-	-	-	-	.0001	-	.0033	.0035	1079149
Midwater	60	All	.0001	.0126	1.000	-	-	-	-	-	-	.0002	-	.0042	.0046	1445220
Bobbin	42	Japan	.0046	.0406	1.000	.0345	.0007	.0001	.0001	.0015	.0011	.0001	.0001	.0047	.0475	194352
Chain		Japan	.000004	.0060	1.000	.0037	.0001	-	-	.0001	.0001	.000004	.00001	.0074	.0114	272129
All Gears		Cuba	.007	.0870	1.000	.0001	.0001	.0001	.002	.003	.001	.018	.00002	.004	.0353	986112
All Gears		Japan	.004	.025	1.000	.014	.001	.0001	.0004	.001	.0005	.0001	.0001	.006	.0272	642914
All Gears		USSR	.0001	.037	1.000	.0001	.0010	.0020	.003	.0001	.0002	.0010	.00002	.0030	.0105	1469763
All Gears		All	.0040	.05000	1.000	.0030	.0005	.0011	.0010	.0020	.0004	.0005	.0070	.00004	.0195	3098789

Table 11. Expected yields for a 1978 silver hake fishery estimated from the ratios calculated during the 1977 observer program when silver hake was the main species sought. Weights in metric tons.

Gear	Country	1978 Quota S. Hake	Ratio of S. Hake Taken in a S. Hake Directed Fishery	Portion of Quota on Directed S. Hake Fishery	Haddock	S.Hake	Squid	Argent-ine	Am Plaice	Yellow-tail	Cod	Redfish	Pollock	Mackerel	Witch	Other	Total Bycatch
All	Cuba	10,300	.89	9,133	91	9,133	2,475	99.5	3.7	2.7	27	12.8	48	73	68	46	411
All	USSR	52,000	.97	50,317	151	50,317	3,271	151	50	100	201	453	50	151	15.1	855	2,164
All	All	63,400	.94	59,462	297	59,462	7,373	297	59	119	238	416	119	238	18	832	2,616

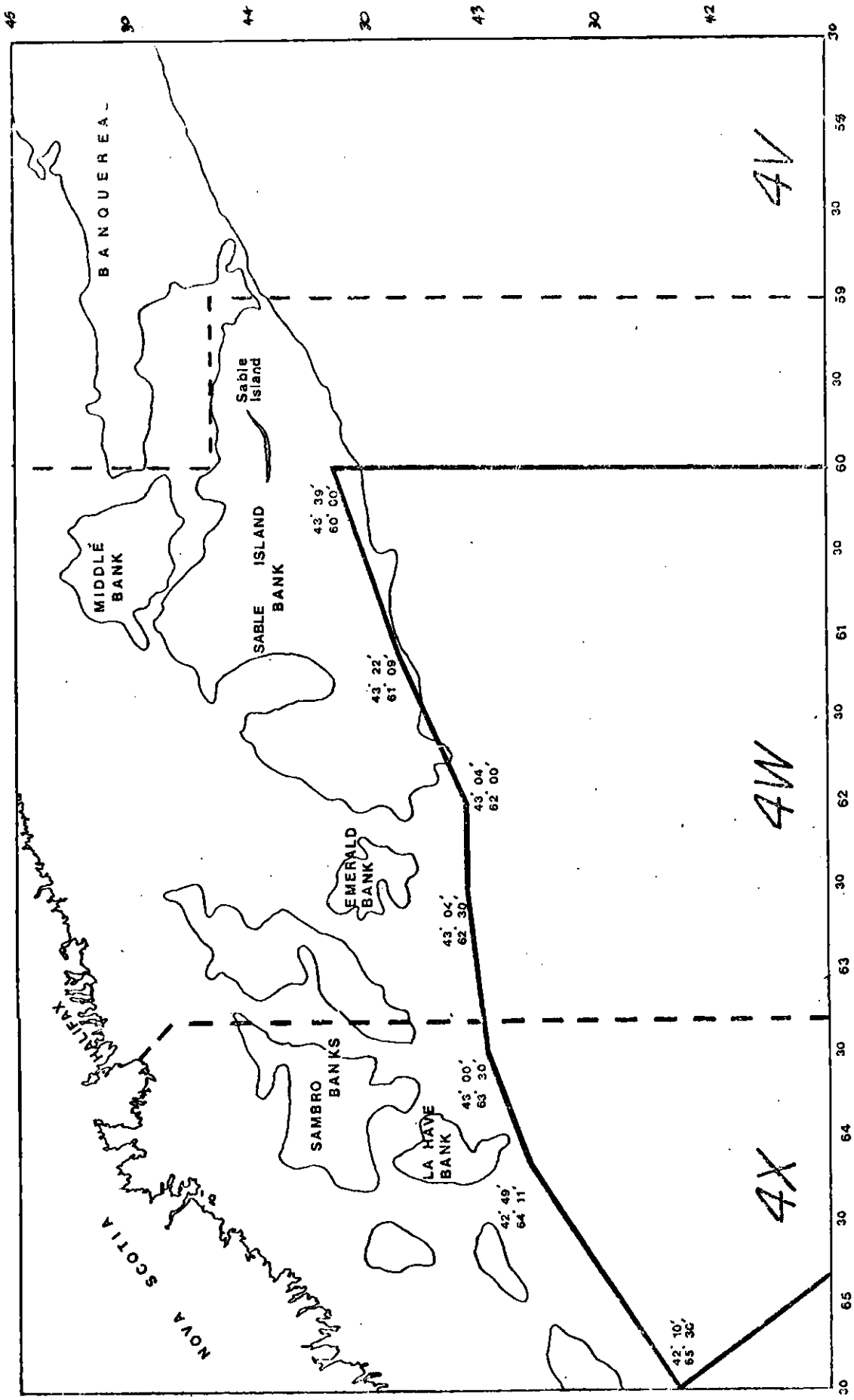

Fig. 1. Major sampling area on the Scotia Shelf, showing the small-mesh gear lines.

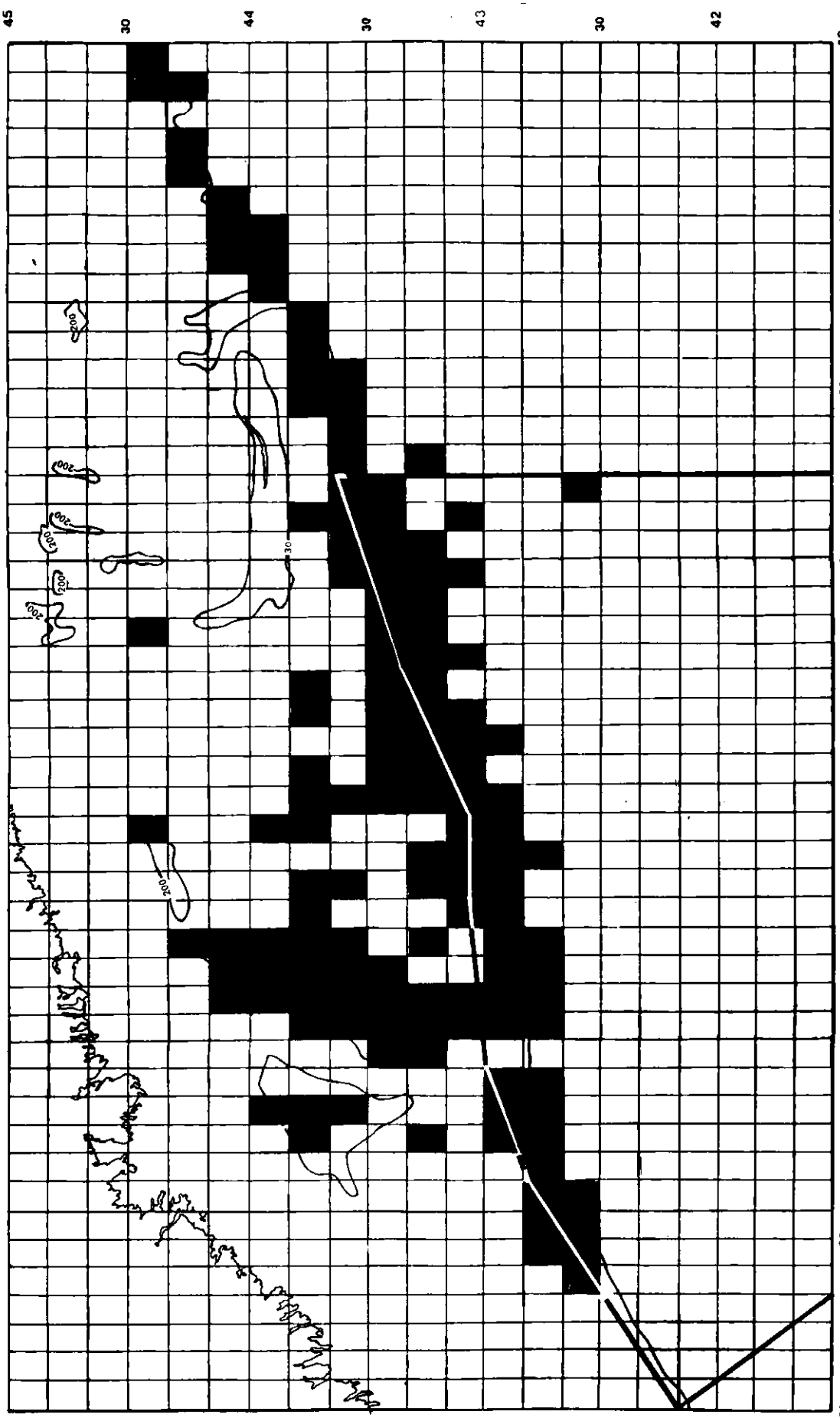

Fig. 2. Distribution of all observed sets using bottom trawl.

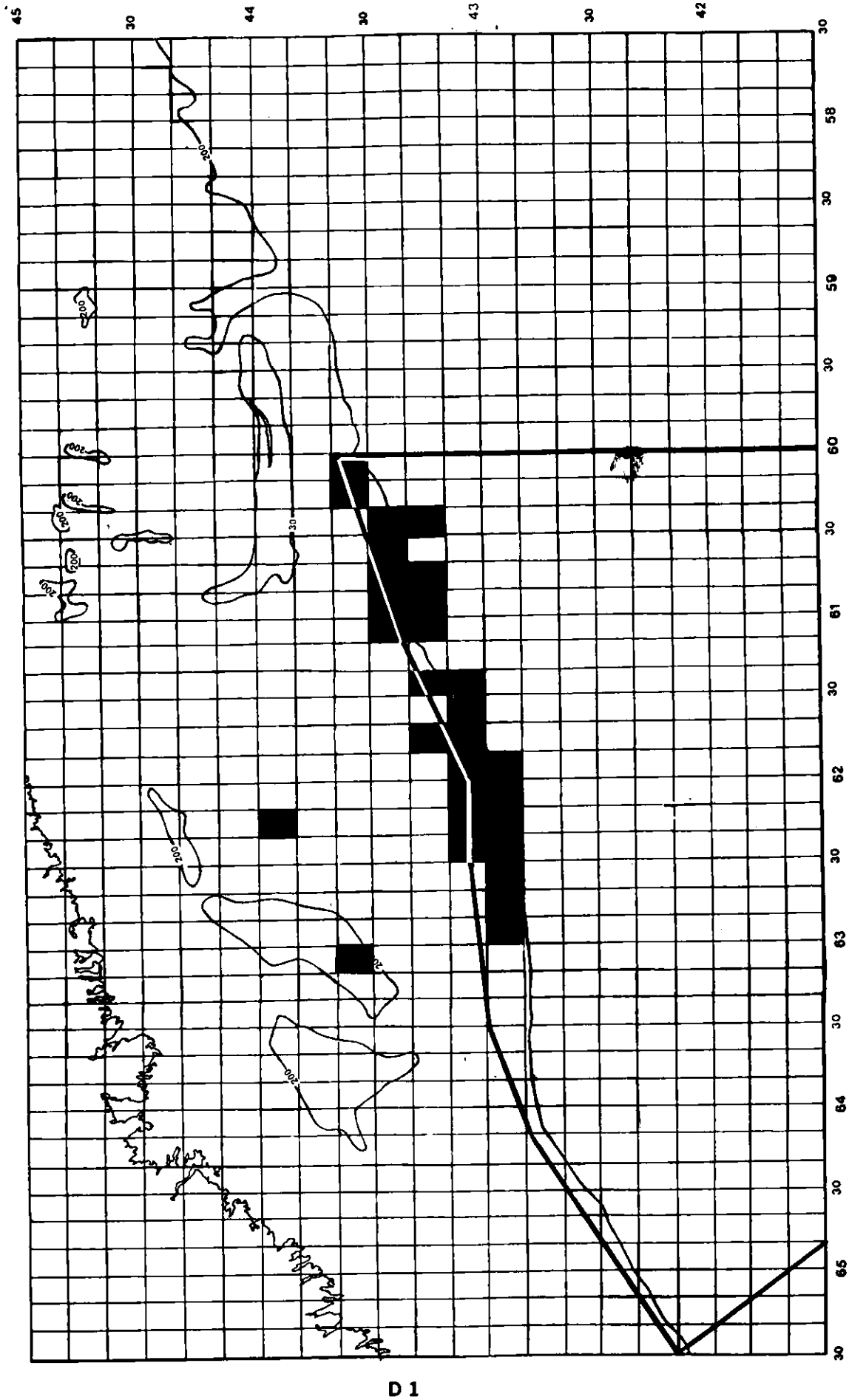

Fig. 3. Distribution of all observed sets using midwater trawl.

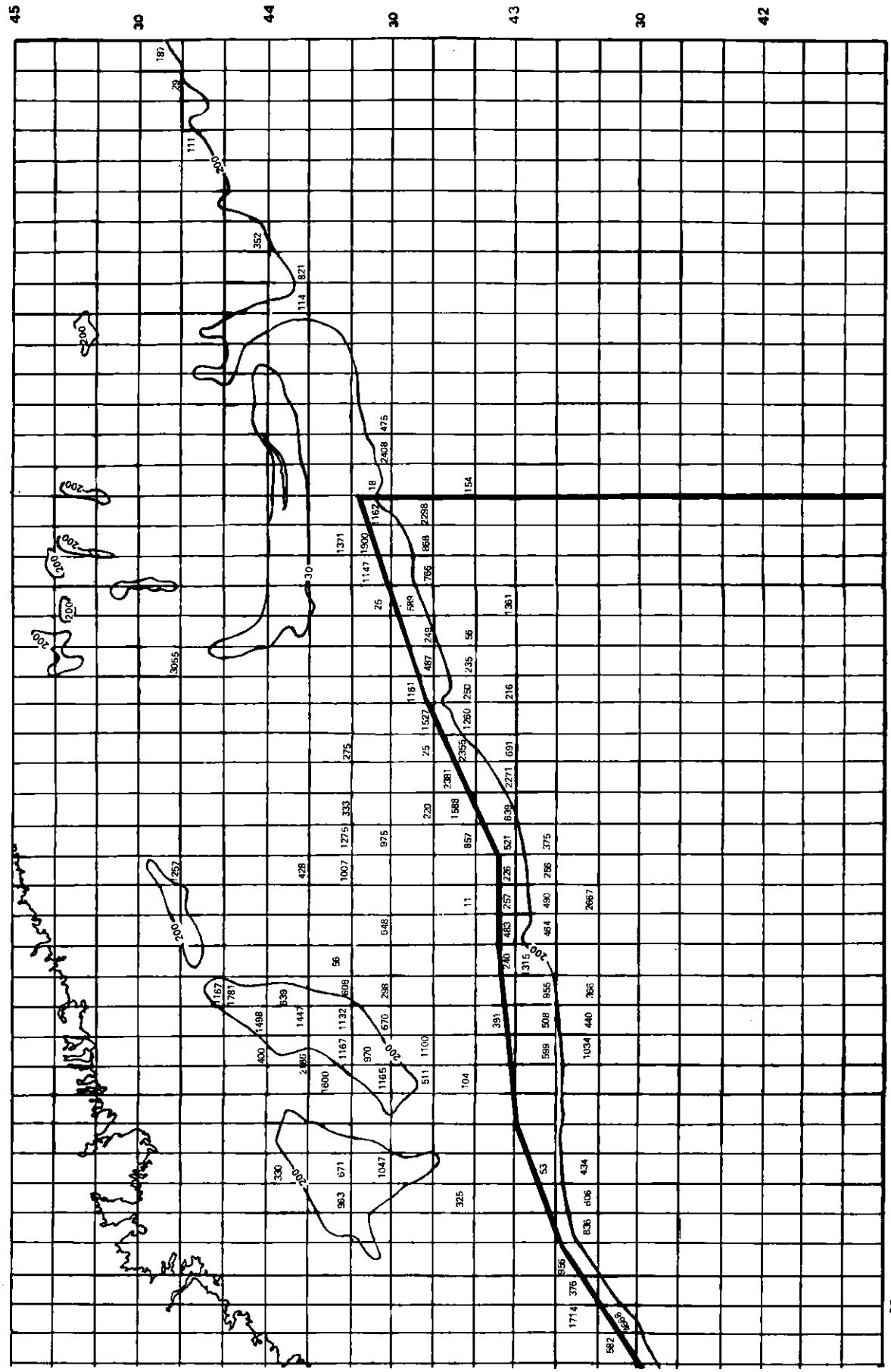

Fig. 4. Silver hake catch per effort (kg/hr) by 10 min. squares for all countries using observer data.

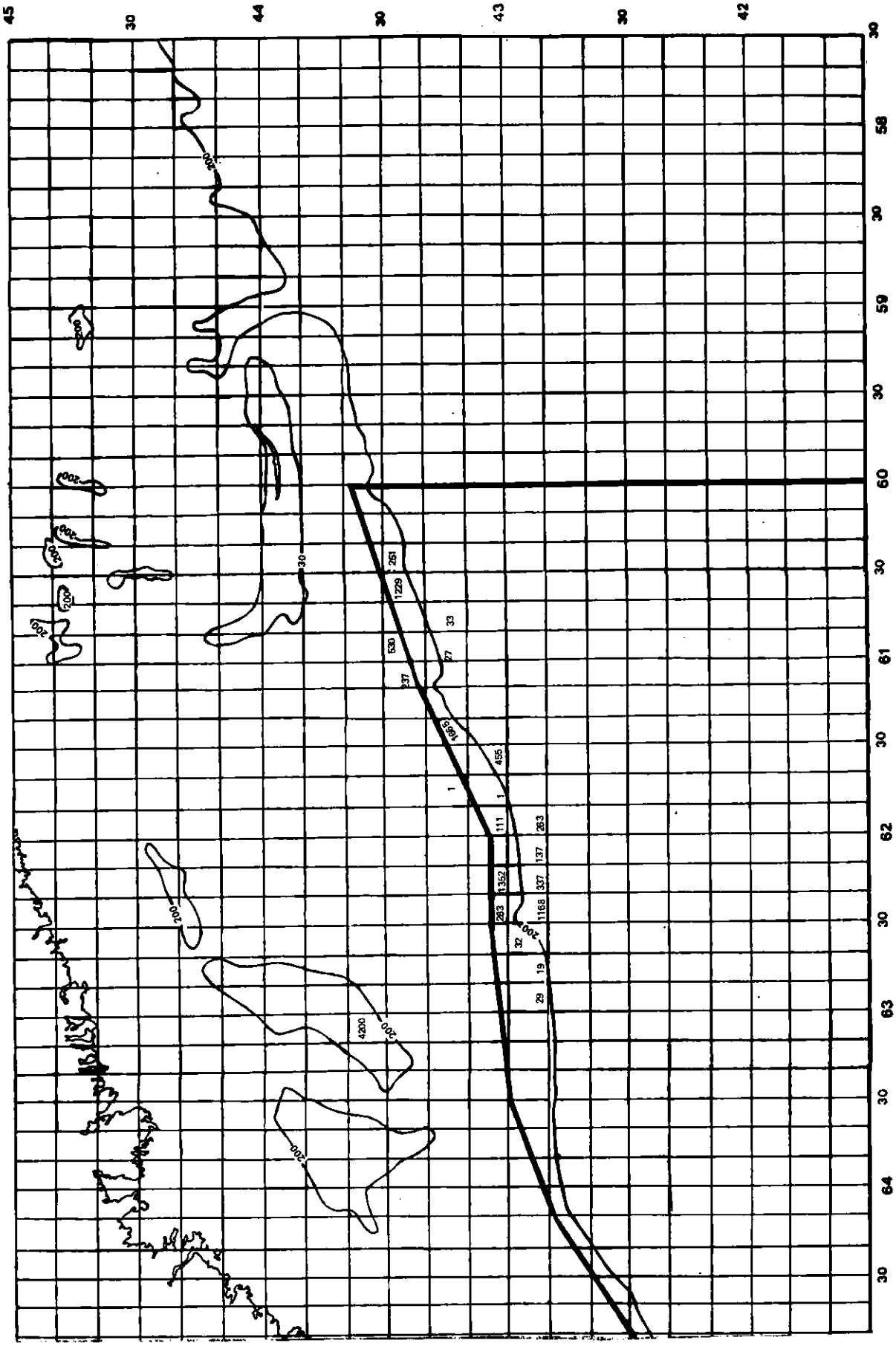

Fig. 5. Distribution of silver hake C/E for midwater trawls observed, (all countries combined).

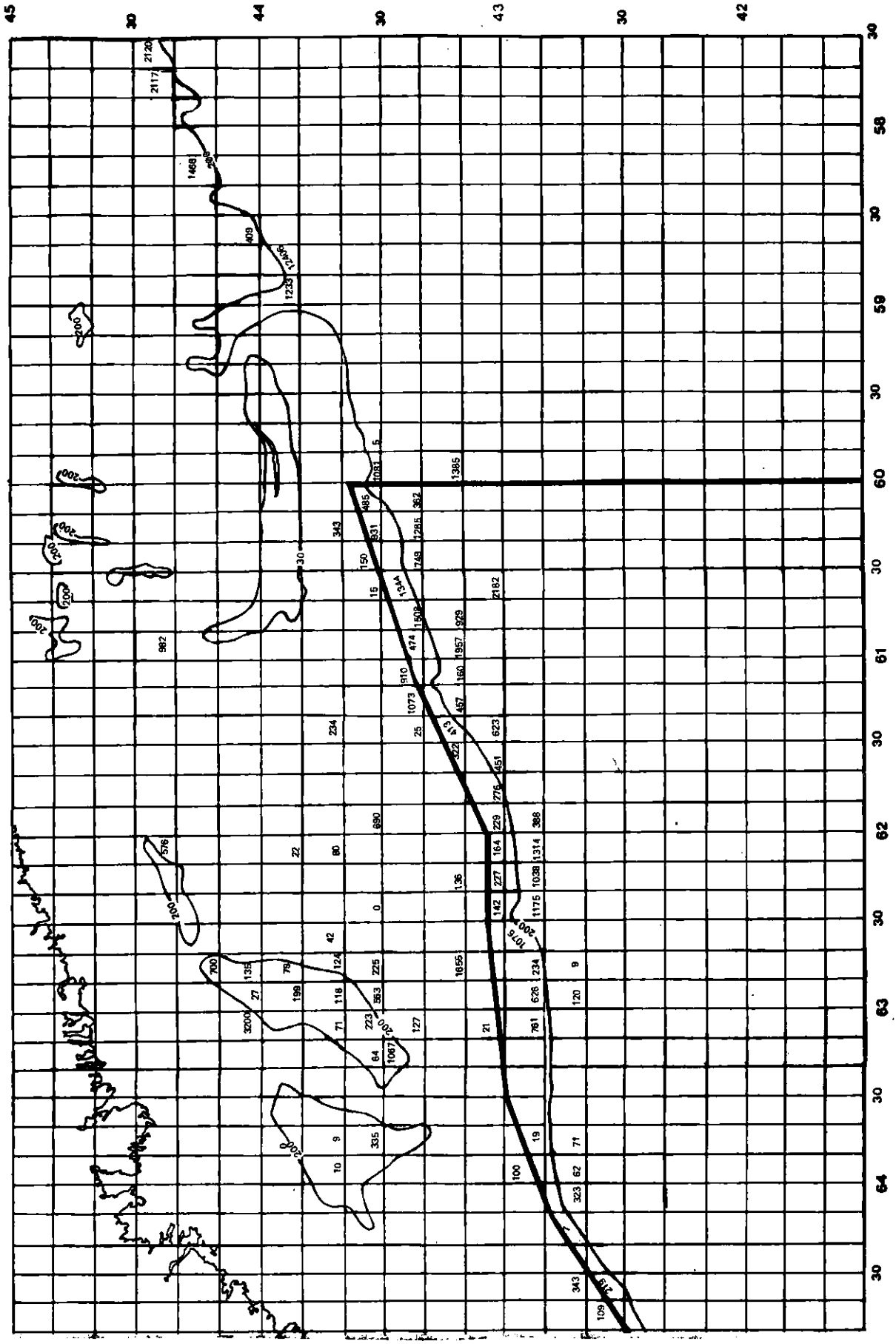

Fig. 6. Squid (Illex) C/E (kg/hr) for observed bottom trawl sets, (all countries combined).

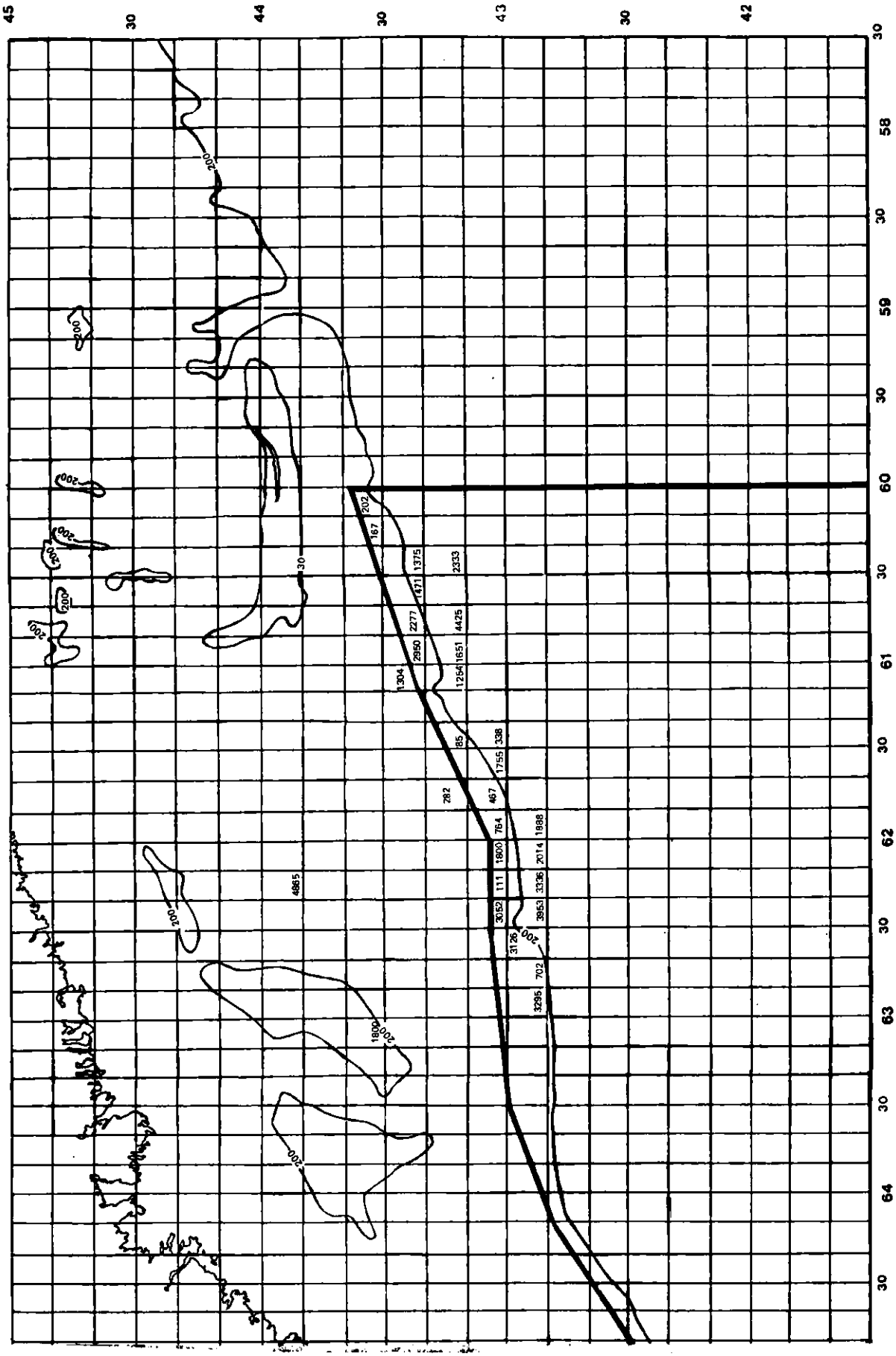

Fig. 7. Squid (Illex) C/E (kg/hr) for observed midwater sets, (all countries combined).

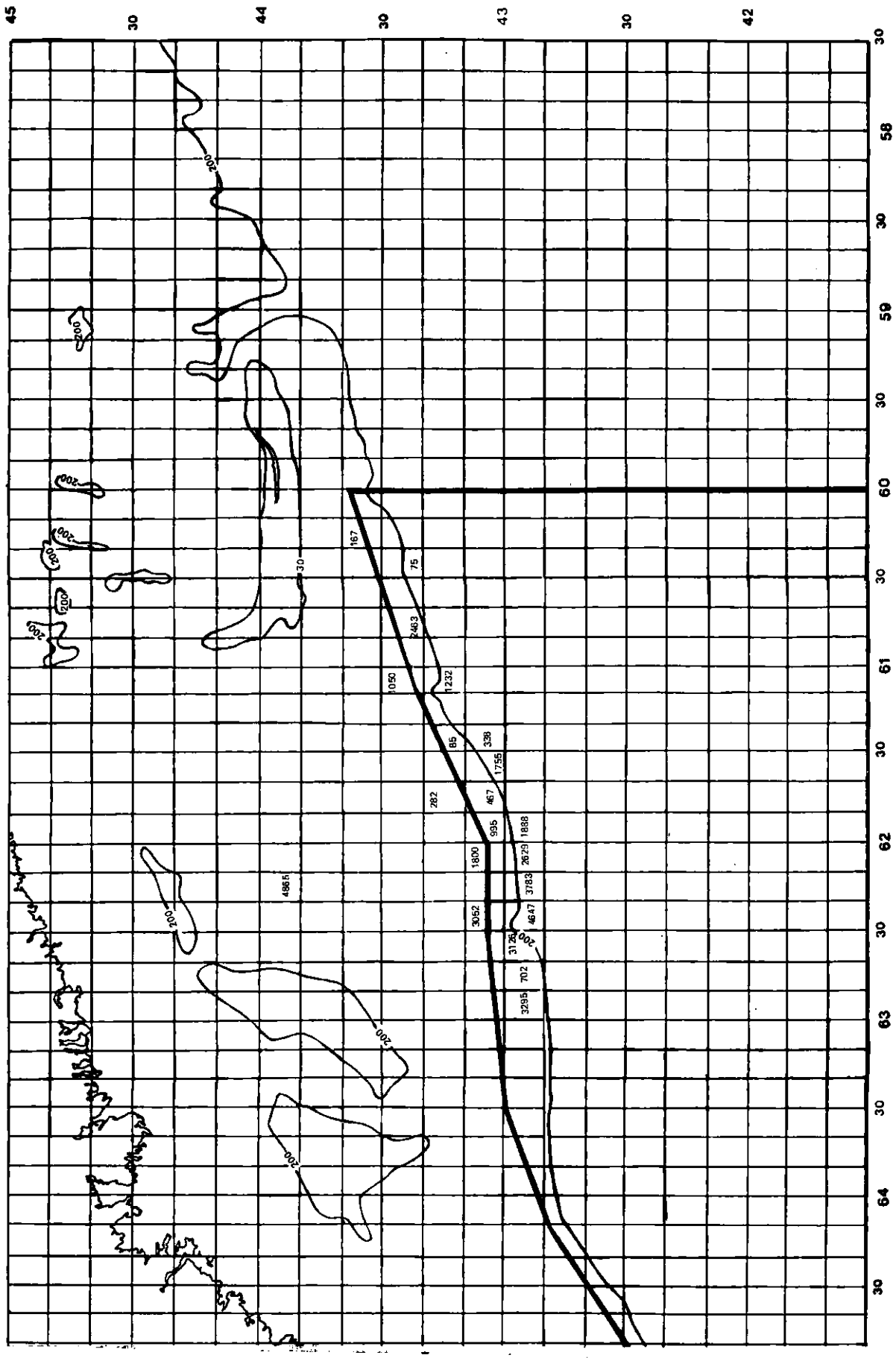

Fig. 8. Distribution of USSR squid (Illex) C/E (kg/hr) for pelagic trawl from June-September, 1977.

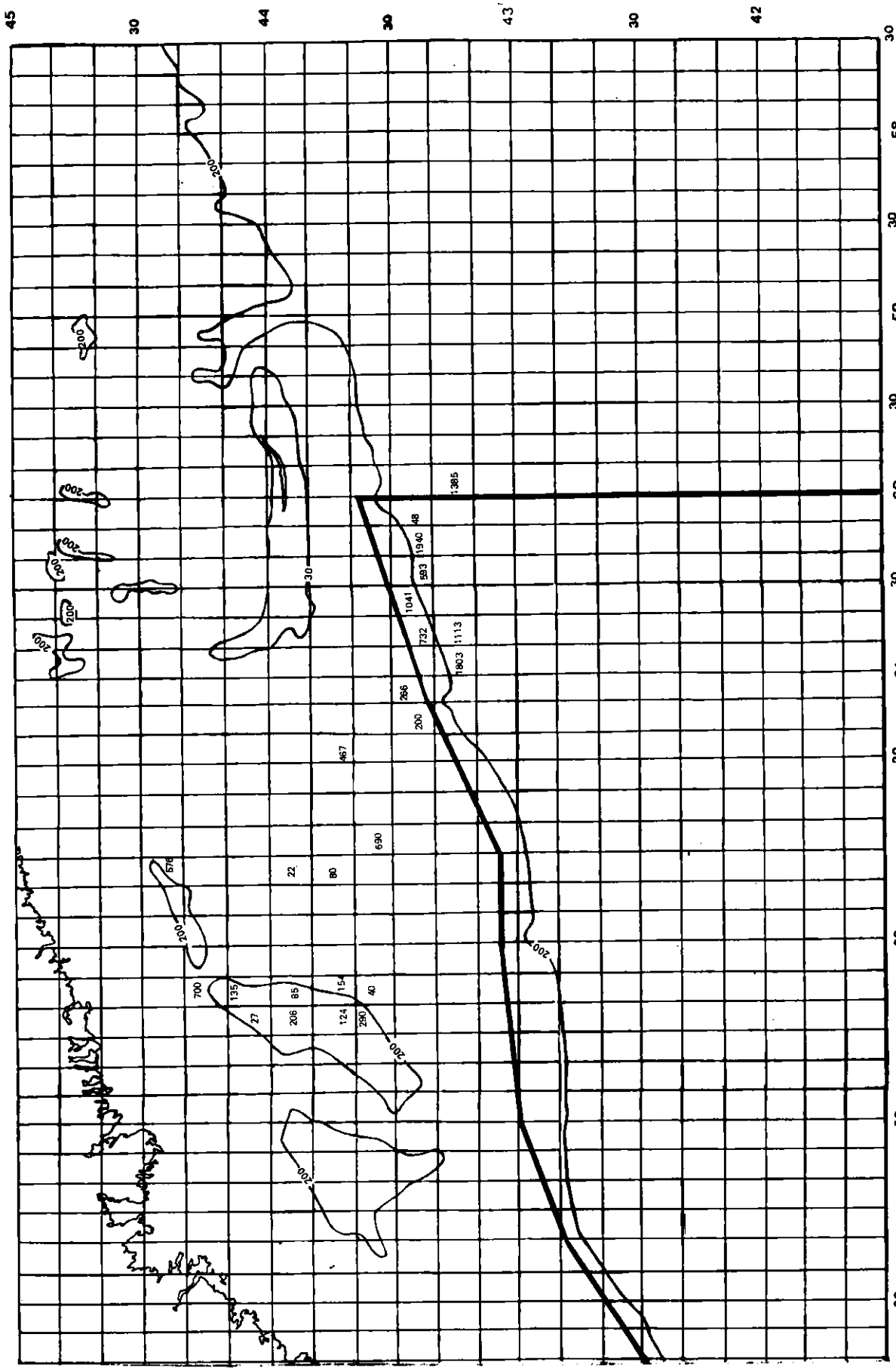

Fig. 9. Distribution of USSR squid (Illex) C/E (kg/hr) for bottom trawl from June-September, 1977.

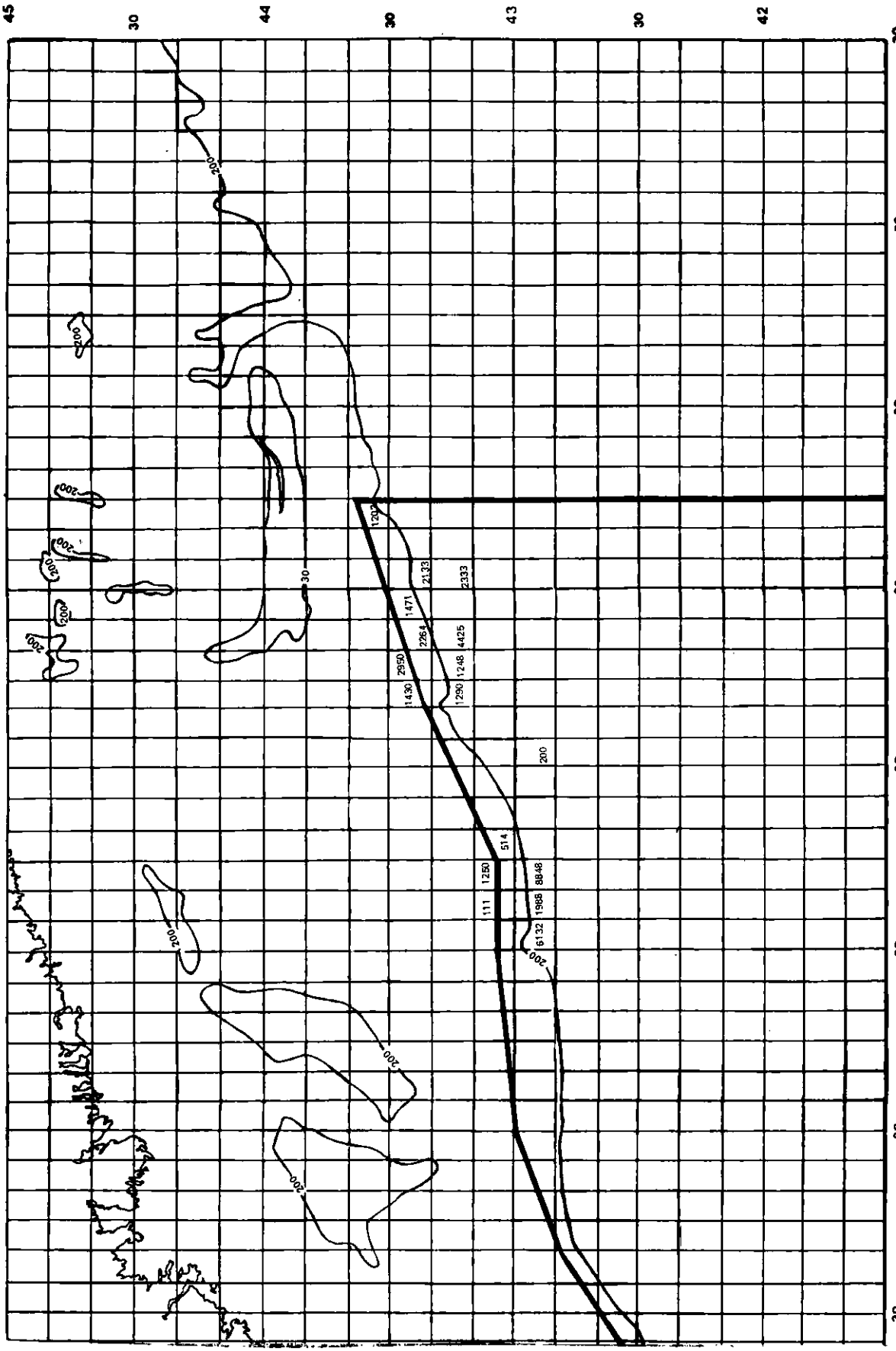

Fig. 10. Distribution of Cuban squid (Illex) C/E for midwater trawl June-August, 1977.

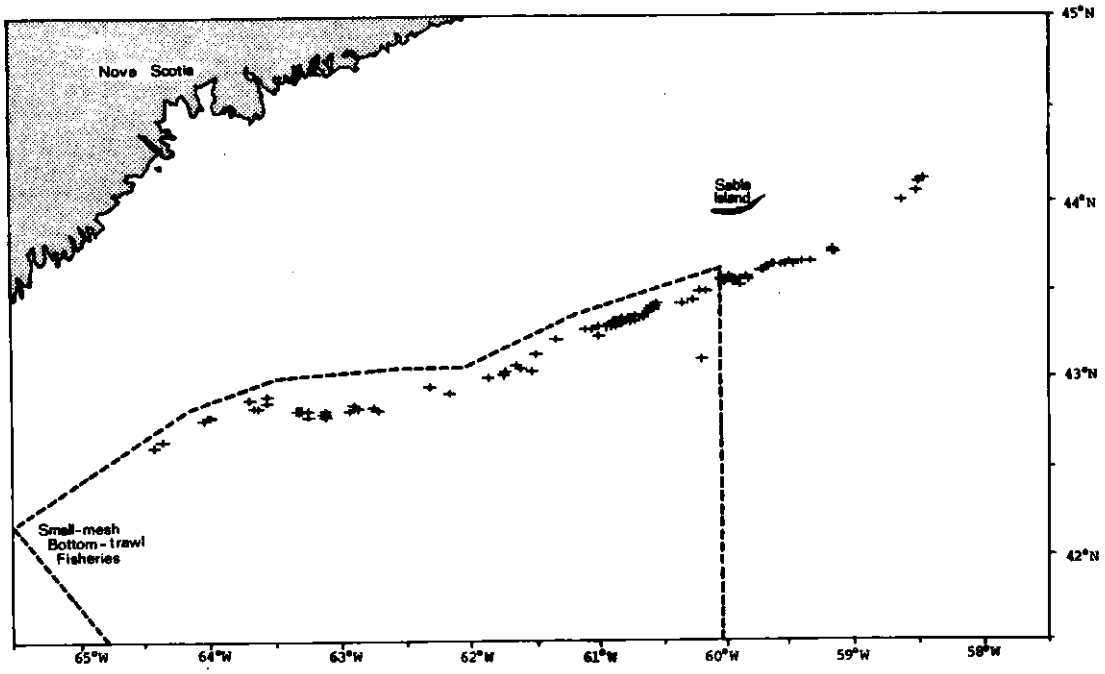

Fig. 11. Sampling locations for Phase I of Japanese experiment.

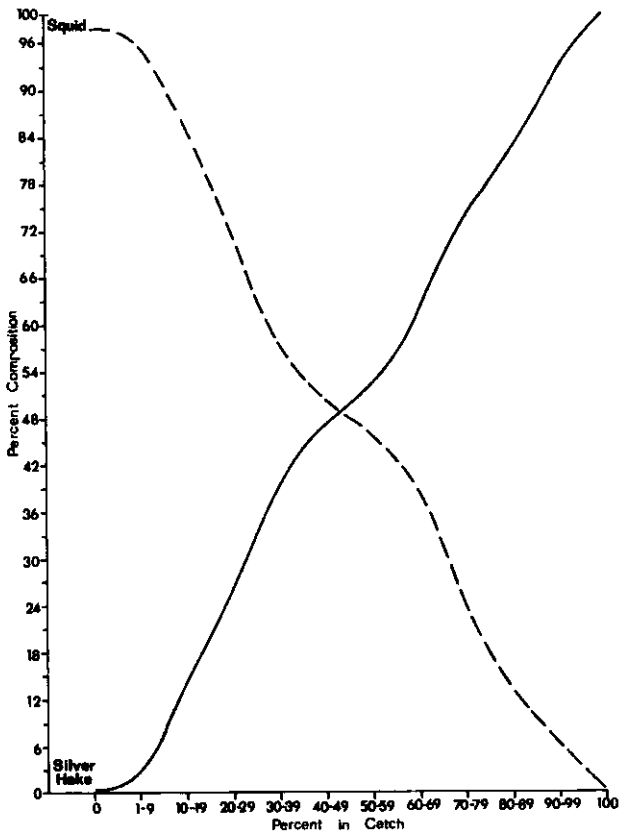

Fig. 12. Observed catches of squid (Illex) and silver hake during the 1977 midwater trawl fishery in 4VWX.

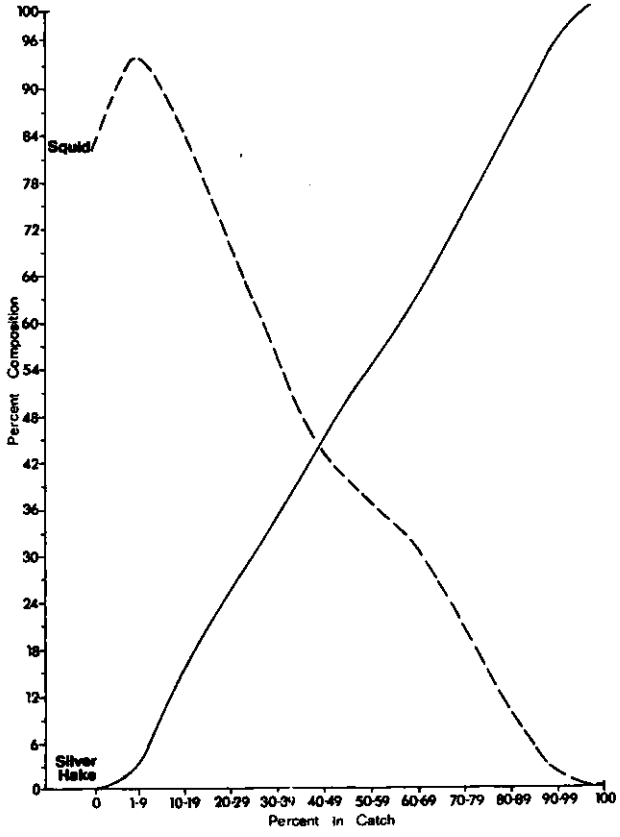

Fig. 13. Observed catches of squid (Illex) and silver hake during the 1977 bottom trawl fishery in 4VWX.

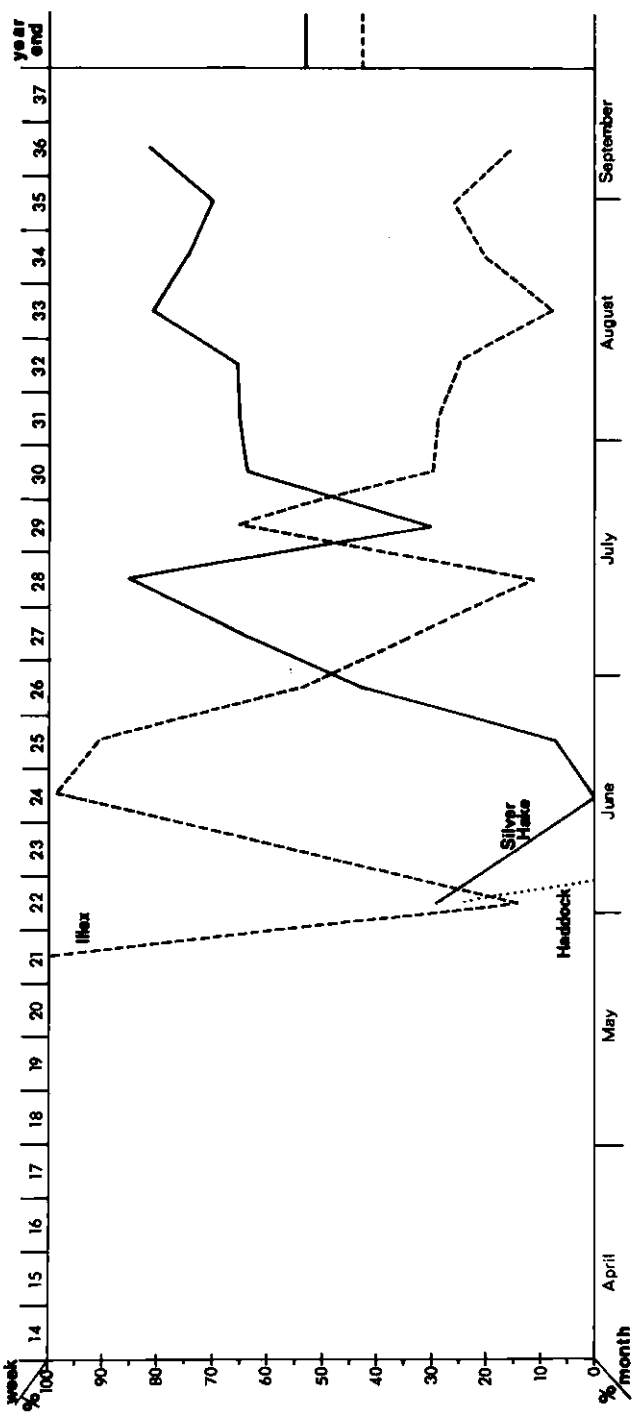

Fig. 14. Observed catch relationships between squid (Illex) and silver hake during the 4W USSR 1977 fishery.

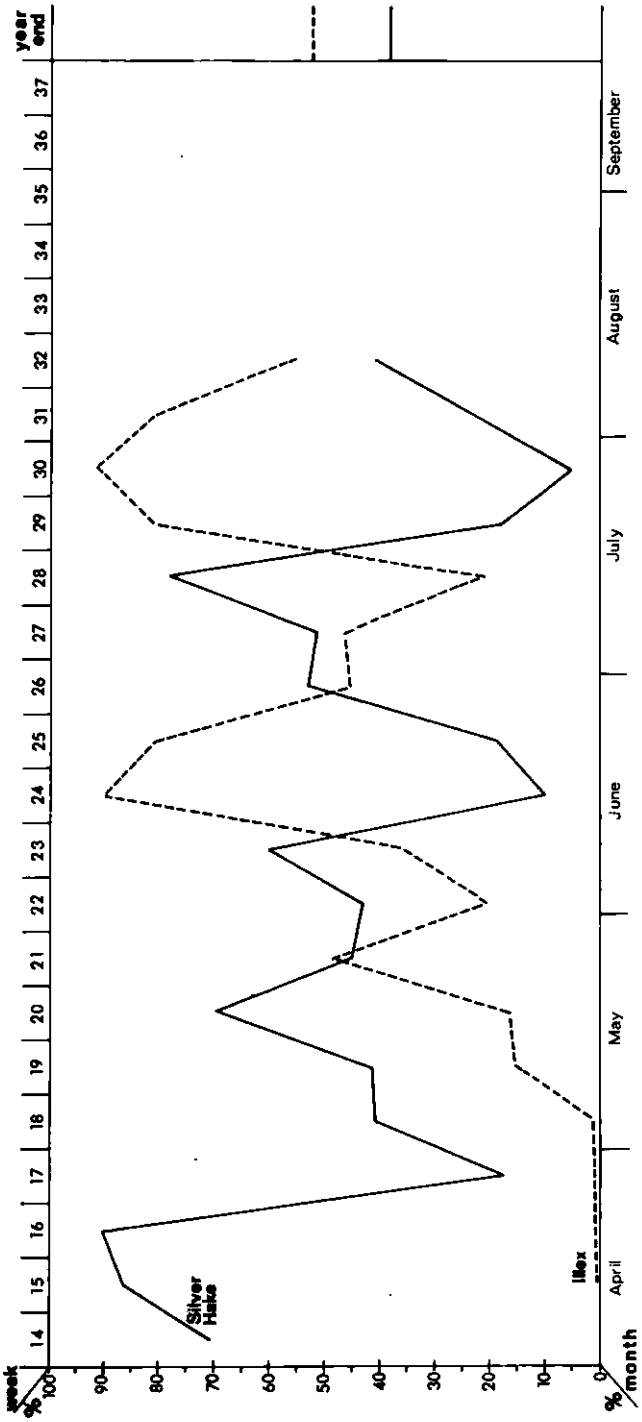

Fig. 15. Observed catch relationships between squid (Illex) and silver hake during the 4W Cuban 1977 fishery.