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USA-USSR COOPERATIVE GROUND FISH SURVEY, FALL 1969

by

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INTRODUCTION

The 1969 cooperative groundfish survey was the third survey of the series begun in 1967 with the principal objective of developing more accurate abundance indices for groundfish. Joint groundfish studies in 1969 were conducted on the USA research vessel Albatross IV and the USSR scouting vessel Ekliptika during the period 8 October - 28 November. The area from Cape Hatteras to Georges Bank was again surveyed jointly as in 1968 and operations were further extended to the Nova Scotian shelf.

In this document we present a brief summary of the 1969 joint operations and some results of fishing power comparisons between USA and USSR trawls, and catch per haul statistics among areas and years. Analysis is limited to a few selected species. A comprehensive analysis of the US-USSR joint studies still remains to be done.

METHODS

Station allocation for the Cape Hatteras to Georges Bank segment followed exactly the same stratified random sample design used in the 1968 joint survey (Lux, et al., 1969). Details of this method, and the methods of sampling catches and processing data were given by Grosslein (1968). The same principles were used in stratification, allocation of stations, and sampling catches, on the 1969 survey of the Nova Scotian Shelf.

As in past cooperative ventures there was partial exchange of personnel and close cooperation between the scientific groups on the two vessels. After completion of the joint groundfish studies, there was a complete exchange of data.

Albatross IV, a stern trawler, again used the #36 trawl towed at 3.5 knots which has been standard for USA groundfish surveys; specifications of the #36 trawl were as given by Grosslein (1968), except that ground cables were not used. Ekliptika, a side trawler, used both the #36 trawl and a 24.6 m trawl towed at 3.7 - 3.8 knots, but with various rigging for different parts of the survey as described below. The 24.6 m trawl is basically similar in design to the 27.1 m USSR trawl used by the Soviet vessels in 1967 and 1968, except that the 24.6 trawl is a larger net, with a larger square and overhang than the 27.1 trawl. The footrope of the 24.6 is about 45 percent longer than the footrope of the 27.1 trawl, whereas the headropes of the two USSR trawls are nearly the same. Rigging of the 24.6 trawl for most of the 1969 operations was similar to that for the 27.1 trawl in 1968. Complete specifications of the 24.6 m trawl will be described in a later report. Measurement of the mouth area of the 24.6 m trawl, while towing, has not yet been made.

As in past surveys, bathythermograms were taken at each trawl station and at selected locations along the cruise track. In addition Albatross IV obtained samples of fish eggs and larvae at each trawl station with a step-oblique plankton tow from 50 meters.

Cape Hatteras to Georges Bank

The area from Cape Hatteras to Georges Bank was surveyed jointly by the two vessels during the period 8 October - 8 November, and included the same sampling strata surveyed in 1968 (Figure 1). Ekliptika used the 24.6 m trawl without rollers on this segment of the 1969 survey.

Albatross IV completed 194 trawl stations and Ekliptika occupied 120 stations, of which 13 were hauls with the two vessels towing side-by-side (Figure 2). Frequent tear-ups and large catches with the 24.6 m trawl, plus an unusual amount of rough weather, made operations slower on Ekliptika and required elimination of scheduled stations particularly near Cape Hatteras. On this segment of the 1969 survey, Ekliptika used oval door of 3.5 m.

Nova Scotian Shelf

With the help of R. G. Halliday, Fisheries Research Board of Canada, St. Andrews, New Brunswick, the Scotian Shelf was subdivided into 30 sampling strata whose geographic and depth boundaries (≤ 50 , 51-100, 101-200 fathoms) were related to fish distribution (Figure 3). Sampling strata 31 and 32 are identical with those used in past surveys by Albatross IV, and the remainder, with a few minor exceptions, follow the scheme suggested by Dr. Halliday and discussed with the authors prior to the survey by Ekliptika. The areas north of Banquereau and those labeled "mixed depths" were excluded from the survey because of their

complex nature and lack of time.

The original cruise plan called for both vessels to survey jointly the Browns-LaHave area, and then for Albatross IV to complete the remainder of its standard fall survey in the Gulf of Maine, and Ekliptika to finish the Scotian Shelf. Refueling problems interrupted this plan and the vessels operated independently, although there was an exchange of two scientists from each vessel during most of this phase.

Albatross IV made 22 hauls in its standard sampling strata in the Browns-LaHave area during the period 15-18 November (see Figure 2), and then completed the rest of the Gulf of Maine (stations and strata for this segment not shown). Ekliptika began its survey near Sable Island, proceeded eastward to Banquereau and then returned westward as far as LaHave Basin within the period 13-27 November. Attempts to use the 24.6 m trawl without rollers resulted in frequent and severe damage, and thus most of the 66 stations completed during this segment were made with a USA #36 trawl fitted with 40 m ground cables, and using 3 m² oval trawl doors (Figure 4). The remaining 28 stations for Ekliptika in the Browns-LaHave area, were completed during the period 1-10 December (Figure 4). On the first haul of this series, all but the rollers and floats of the #36 trawl were lost. For the remaining 27 stations a 24.6 m trawl was used rigged with the rollers from the #36 trawl; no serious tear-ups were experienced with this combination.

RESULTS

Fishing Power Comparisons.

As was expected, the 24.6 m trawl made considerably larger catches than the #36 trawl and comparisons with 1968 suggest that the 24.6 m trawl also has greater fishing power than the 27.1 m trawl. The percentage frequency distributions of catches for the three trawls clearly show a much higher frequency of large catches by the 24.6 m trawl (Table 1). In the area from Cape Hatteras to Nantucket Shoals (strata 1-8, 61-76) about 45 percent of the catches with the 24.6 m trawl exceeded 1000 pounds, as compared with seven percent for the 27.1 m trawl in 1968, and one and ten percent in 1968 and 1969 respectively, for the #36 trawl. On Georges Bank (strata 9-25) catches in excess of 1000 pounds accounted for 14 percent of the 24.6 m hauls as compared with two percent for the 27.1 m trawl in 1968, and zero percent for the #36 trawl in both 1968 and 1969 (Table 1).

Table 1. Percentage frequency distributions of total catches (pounds) by USA and USSR trawls, in two strata sets in 1968 and 1969.

Total Catch (pounds)	Strata 1-8, 61-76				Strata 9-25			
	1968		1969		1968		1969	
	#36	27.1m	#36	24.6m	#36	27.1m	#36	24.6m
≤ 500	90	78	87	42	97	92	98	65
501-1000	9	14	6	11	3	6	2	20
1001-2000	1	5	3	22	--	--	--	10
2001-4000	--	2	3	14	--	2	--	4
>4000	--	--	1	10	--	--	--	--
<u>Total number</u> hauls	100	78	98	62	90	65	89	49

The basic similarity in the catch frequencies for the #36 trawl in both years, and the fact that no major change in species composition was observed, suggest that the differences between the frequencies for the 27.1 and 24.6 trawls reflect real differences in fishing power, and not a difference in availability of fish between years.

Another comparison of the fishing power of the 24.6 and #36 trawls was provided by 13 pair-tows (side-by-side hauls) made at various locations during the 1969 joint survey, two to five tows per location (see Figure 2). Ratios of total catches for the four sets of pair-tows show that the 24.6 m trawl caught three to five times the weight of fish taken by the #36 trawl in each set, although species composition varied widely among sets (Table 2). With the exception of spiny dogfish, USA/USSR catch ratios of various species groups for all 13 pair-tows combined, are all smaller (indicating greater fishing power differentials) than catch ratios for corresponding groups from the 1968 survey (1968 figures in parentheses in Table 2). The 1968 data in Table 2 represent the ratios of stratified mean catches (in pounds) for corresponding species groups in the entire area covered by the 1968 joint survey. Although the 13 pair-tows by themselves hardly constitute an adequate comparison of fishing power, the results are nevertheless consistent with expectations.

A more comprehensive measure of relative fishing power is provided by the comparison of catch per haul statistics for combined sets of sampling strata. Comparison of stratified mean (log) pounds per tow values for all species combined, show that the 24.6 trawl consistently made bigger catches than the #36 trawl throughout the entire survey area from Cape Hatteras to Georges Bank; and the differential was of the same order of magnitude as that observed for the 13 pair-tows (Table 3). Differentials varied with species, and as in previous years the fishing power of the larger trawl was relatively greater for red and silver hake than

Table 2. Total catch in pounds by USA (Albatross IV, #36 trawl) and USSR (EKLIPTIKA, 24.6 m trawl) vessels in 13 side-by-side hauls by species groups.

Species Group	hauls 4,5		hauls 1-3		hauls 11-13		hauls 6-10		13 hauls combined		
	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	
Sharks	24	32	0	0	0	0	0	0	24	32	.75
Spiny dogfish	0	18	23	206	0	t	2072	9848	2095	10,072	.21 ^{2/} (.21)
Skates & Rays	66	191	t	9	16	30	14	199	96	429	.22 (.61)
Pelagic	8	11	53	61	1	6	18	552	80	630	.13 (.57)
Demersal	52	290	12	1111	31	150	189	3087	284	4638	.06 (.38)
Flounders	3	3	10	23	17	23	304	804	334	853	.39 (1.06)
Benthic Invertebrates	t	t	2	16	t	t	16	t	18	16	1.12
Squid	30	23	634	2190	24	144	236	740	924	3097	.30
Total	183	568	734	3616	89	353	2849	15,230	3855	19,767	
Ratio, USA/USSR	.32		.20		.25		.19		.20		(.39)

1/ Catches less than 1 pound indicated as t (trace).

2/ Ratios based on 1968 survey for comparable species groups - see text.

Table 3. Stratified mean catch in pounds (log_e scale) per 30-minute haul for selected species and all species combined in 1969 by stratum set and vessel (USA - Albatross IV; USSR - EKLIPTIKA).

Stratum set	Species														
	Spiny dogfish		Silver hake		Red hake		Cod		Haddock		Yellowtail		All species		
	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	
61-68 ^{1/}	0	0	0.006	0.076	0.020	0	0	0	0	0	0	0	4.511	6.459	0.14
69-72	0.440	0.627	0.113	0.978	0.304	0.580	0	0	0	0.763	0.524	3.873	5.942	5.942	0.13
73-76	2.447	3.720	0.355	1.388	0.296	1.109	0	0	0	1.640	2.300	4.605	6.030	6.030	0.24
1-4	3.415	3.782	0.766	1.879	0.636	1.964	0	0	0	2.366	2.197	4.764	7.078	7.078	0.10
5-8	4.000	4.486	1.553	3.518	1.951	2.960	0.538	0.587	0.148	0	2.186	2.010	5.606	6.943	0.26
9-12	1.855	3.919	1.342	3.676	0.857	1.724	0.338	0.331	0	0.157	1.418	1.041	4.512	6.144	0.20
13-15	0.682	0.722	0.620	2.616	1.108	2.069	0.168	0	0	0.195	1.817	1.949	3.708	4.774	0.34
16-18	0.261	0.336	0.405	1.699	0.930	1.512	0.463	0.817	0.544	*1.358	1.740	2.343	3.700	5.041	0.26
19-20 ^{2/}	2.058	1.158	1.511	2.769	1.241	2.914	1.664	1.616	0.685	1.154	1.748	3.422	4.577	5.770	0.30
21-25 ^{2/}	0.917	1.724	1.047	3.904	0.317	1.033	2.442	3.474	2.552	3.496	0.460	0.453	4.838	6.565	0.18
61-76, 1-12															
Mean	2.056	2.961	0.719	2.086	0.727	1.516	0.153	0.171	0.025	0.030	1.404	1.415	4.671	6.478	
Variance	0.024	0.067	0.005	0.024	0.009	0.029	0.004	0.008	0.001	0.001	0.019	0.036	0.024	0.015	
Fishing power factor ^{3/}	.40		.25	.46			---		---		.99		.16	.16	
13-25															
Mean	0.990	1.039	0.920	2.824	0.848	1.836	1.316	1.631	1.099	1.694	1.353	1.958	4.273	5.618	
Variance	0.018	0.048	0.015	0.051	0.015	0.075	0.025	0.019	0.022	0.068	0.025	0.065	0.022	0.018	
Fishing power factor ^{3/}	.95		.15	.37		.73	.55		.55		.26		.26	.26	

^{1/} EKLIPTIKA made hauls only in three strata of this set: 65 (5 hauls), 66 (2 hauls), 67 (1 haul).

^{2/} EKLIPTIKA made no hauls in stratum 25.

^{3/} Fishing power factor is the antilog of the difference between log means, USA - USSR.

for other groundfish species such as cod, haddock, yellowtail and spiny dogfish (Table 3). Another similarity with past years was that in the southern area differentials were fairly consistent in small stratum sets and they tended to increase with level of abundance (Figure 5). Comparison of fishing power factors (antilog of difference between stratified log means, USA-USSR) for selected species within the two main divisions of the survey area and among the three years, 1967-1969, demonstrates conclusively the greater fishing power of the 24.6 relative to the 27.1 as well as the #36 trawl (Table 4).

Table 4. Fishing power factors (see Table 3 for definition) for selected species and all species combined in 1967, 1968 and 1969, by stratum set.

Species	Strata 1-12, 61-76			Strata 13-25 ^{1/}	
	1967	1968	1969	1968	1969
Spiny dogfish	.98	.64	.40	1.20	.95
Silver hake	.31	.30	.25	.70	.15
Red hake	.40	.67	.46	.84	.37
Yellowtail	1.32	1.34	.99	1.48	.55
Cod	-	.83	.98	.86	.73
Haddock	-	-	-	1.12	.55
All species	.62	.56	.16	.86	.26

It should be recognized that estimates of fishing power factors based on ratios of stratified means for wide areas, are subject to larger sampling errors than estimates based on pair-tows or comparisons made within very restricted experimental areas such as in the 1967 gear comparisons reported by Hennemuth (1968). On the other hand, the factors based on many stratum sets do reflect a wider range of habitats and abundance levels, and in that sense provide a more complete picture of fishing power differentials. The tendency for size of differential to be related to level of abundance (size of mean) for individual species was apparent in the 1969 data as well as in previous years, and this may be partly due to the effects of positive skewness in catch frequencies even after transformation to the log scale.

Comparisons between the #36 and the 24.6 trawls were also made for the Browns-LaHave part of the Scotian Shelf, based on the independent coverage by the two vessels in the 1969 operations. However, of the individual species listed in Table 3, only cod and haddock were sufficiently abundant to provide meaningful comparisons with the areas west of Browns Bank. Stratified mean (log) pounds per tow for the four strata on the Scotian Shelf surveyed by Albatross IV (see Figure 2), were compared with mean values for strata 31, 32, 41, 42, 45-48, covered by Ekliptika (Figures 3,4), and representing about the same area. The fishing power factors were .67 and .15 respectively for cod and haddock, and these values were lower (reflecting greater fishing power differential) than corresponding values of .73 and .55 for cod and haddock on Georges Bank (see Table 3). The factor for all species combined was .33 for the Browns-LaHave area, which was intermediate between the values for Georges Bank and the southern region.

Comparisons between the 24.6 and #36 trawls for the remainder of the Scotian Shelf survey by Ekliptika, were not made because there were so few cases where both trawls were fished in the same stratum. However, a quick appraisal of the data showed that the 24.6 trawl made very much larger catches than the #36; in fact, the #36 trawl catches were so small there is some question whether the gear was fishing at normal efficiency.

In summary, although analysis is not complete we have concluded that the 24.6 m trawl is unnecessarily large for a survey of groundfish. What advantages there may be in the still greater fishing power of the 24.6 as compared with the smaller trawls, seem to be far outweighed by the problems of handling such large catches.

Accuracy of Abundance Indices

In evaluating the groundfish survey from the standpoint of accuracy, the principal question is the size of difference in true abundance which we can detect with some known probability and cost. This obviously is a most difficult question in the absence of absolute abundance measures with which to compare catch per haul statistics. Nevertheless, indirectly we are gaining some insight into the accuracy of the survey method. We present here a brief evaluation of sampling errors associated with mean abundance indices from all three joint US-USSR surveys.

Approximate 95 percent confidence limits about stratified mean catch per haul statistics for red and silver hake, spiny dogfish, yellowtail and all species combined, are shown in Figure 6 by year and major strata sets. The coefficients of variation of these compound means are on the order of 10 percent. However, these data illustrate the fact that even though there is a large differential in fishing power between two trawls, sampling errors associated with such means can mask the differential. For example, in the 1968 survey with the 27.1 and #36 trawls, there were significant differences between red and silver hake catches with the two trawls in the southern part of the area but not on Georges Bank (Figure 6). Similarly differences in spiny dogfish means were significant only in the southern area for the 24.6 vs #36 trawl comparisons in 1969 (Figure 6).

Another comparison of interest for a given pair of trawls is between years within the same area or vice versa. Abundance trends in the strata set (1-12, 61-76) from 1967 to 1968 appeared the same for dogfish, silver hake, yellowtail and all species combined, but not for red hake, where the US index increased and the USSR index decreased, with differences appearing

significant within each year (Figure 6). Comparing indices between strata sets in 1968 we see that both trawls showed apparent lower abundance of dogfish and red hake on Georges Bank, and about the same abundance of yellowtail in both areas; however, the USSR index of silver hake was significantly lower on Georges Bank whereas the US index was the same in both areas (Figure 6). In 1969 the USSR silver hake index appeared significantly greater on Georges Bank than in the southern area, whereas the US silver hake index was only slightly greater (Figure 6).

Although these abundance indices are on the whole rather more consistent than inconsistent, there are enough discrepancies to indicate that blind acceptance of statistical confidence limits can lead to erroneous conclusions. These discrepancies may arise from factors such as variability in performance of trawls from haul-to-haul as well as the variability in fish distribution. In any case closer study of data by individual sampling strata and future monitoring of trawl performance on routine surveys should help clarify the situation.

Distribution of principal species

We present here only a few observations on fall distribution of selected groundfish species in relation to general patterns of bottom temperature. So far this aspect of the joint surveys has received little attention.

The general impression of biologists taking part in the fall surveys of the past three years is that no major changes occurred in fish distribution throughout the area from Cape Hatteras to Georges Bank. With the exception of spiny dogfish, this is confirmed by Albatross IV catch-per-haul statistics for several principal groundfish species, which show a relatively stable distribution pattern of abundance in October, 1967-1969; the only marked difference was that the abundance center of spiny dogfish was further south in 1967 than in 1968 and 1969 (Figure 7). It should be noted that the same shift was observed for both US and USSR indices (Lux, et al, 1969); and this consistency within small stratum sets tends to restore confidence in the accuracy of the abundance indices.

Bottom temperature patterns were very similar in October, 1967 and 1968, and in those years the cold cell of bottom water characteristically offshore in the mid-Atlantic Bight region (southeast of Long Island) until late autumn, was still pronounced. However, in October 1969 this cold cell was already partly dispersed (see Figure 8), and offshore bottom temperatures were about 2°C warmer than in 1967 and 1968.

Turning now to the Nova Scotian shelf, it is possible to show only a very general abundance pattern from the 1969 data. Recall that Ekliptika used different trawls in an irregular pattern on the Scotian Shelf. Consequently, there is no good basis for estimating fishing power differentials among the trawls (and riggings) used. Nevertheless, simple mean catch (pounds) per haul statistics were computed for selected species by individual sampling strata (Table 5, Figures 9, 10). Although no allowance was made for trawl type, (see Figure 4 for stations by trawl type), these means provide an approximate picture of high and low areas of relative abundance for the principal species (Figures 9, 10). Unfortunately, Dr. Sauskan has not yet had the opportunity to help interpret these data.

The general pattern of bottom temperature on the Scotian Shelf is shown in Figure 11 (courtesy of Dr. R. G. Halliday). These temperatures were obtained by Ekliptika over the period 15 November to 10 December. Because of the complex hydrography of the Scotian Shelf, these data provide only a generalized view of bottom temperature distribution.

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Table 5. Mean catch in pounds per 30-minute haul for selected species and all species combined by individual sampling strata. Survey of Nova Scotian Shelf in 1969 by USSR vessel EKLIPTIKA.

ICNAF Subdivision	Stratum	Number hauls	SPECIES											
			Cod	Haddock	Yellowtail	Plaice	Silver hake	Sea herring	Argentine	Mackerel	Redfish	All species		
4X	31	4	23	208	t	8	t	3						
	32	4	48	496	2	3			62	2			318	
	41	2	12	80		1	5	t	t	1			750	
	42	2	8	392				t		1			122	
	43	2		2		1	58	2					404	
	44	3				t	1			19			112	
	45	2	54	250		2				2			7	
	46	3	30	103	2	13	t						316	
	47	4	9	32		2	8	2			t		184	
	48	4	8	20		3	2	t		27			90	
	49	4		1		2	26			12		t	41	
												1	55	
Total hauls		34												
4W	50	2		8		4	1	t	t			9	24	
	51	3				t	3		t			4	9	
	52	3			t	1	2					t	11	
	53	5	2	5		2	t	t				t	9	
	54	2		2	3	2						1	6	
	55	4	59	334	28	4		1				t	480	
	56	4	1			t	1		1			9	23	
	59	3	42	78	2	33	4	2				8	208	
60	2	168	44	16	8	t	1			t		264		

Table 5. Continued

ICNAF Subdivision	Stratum	Number hauls	SPECIES										All Species	
			Cod	Haddock	Yellowtail	Plaice	Silver hake	Sea herring	Argentine	Mackerel	Redfish			
	62	3	3		50	6	t				t			110
	63	4	4	4	82	2	3							124
	64	3	2	13	5	38	1							108
	65	3			t	t	6			1		34		46
Total hauls		41												
4V	61	3			3	5					t	1		9
	66	4			2	14						t		25
	67	4		t	6	2						t		38
	68	3			3	14						70		55
	69	2								4				74
	70	2						1						78
Total hauls		18												

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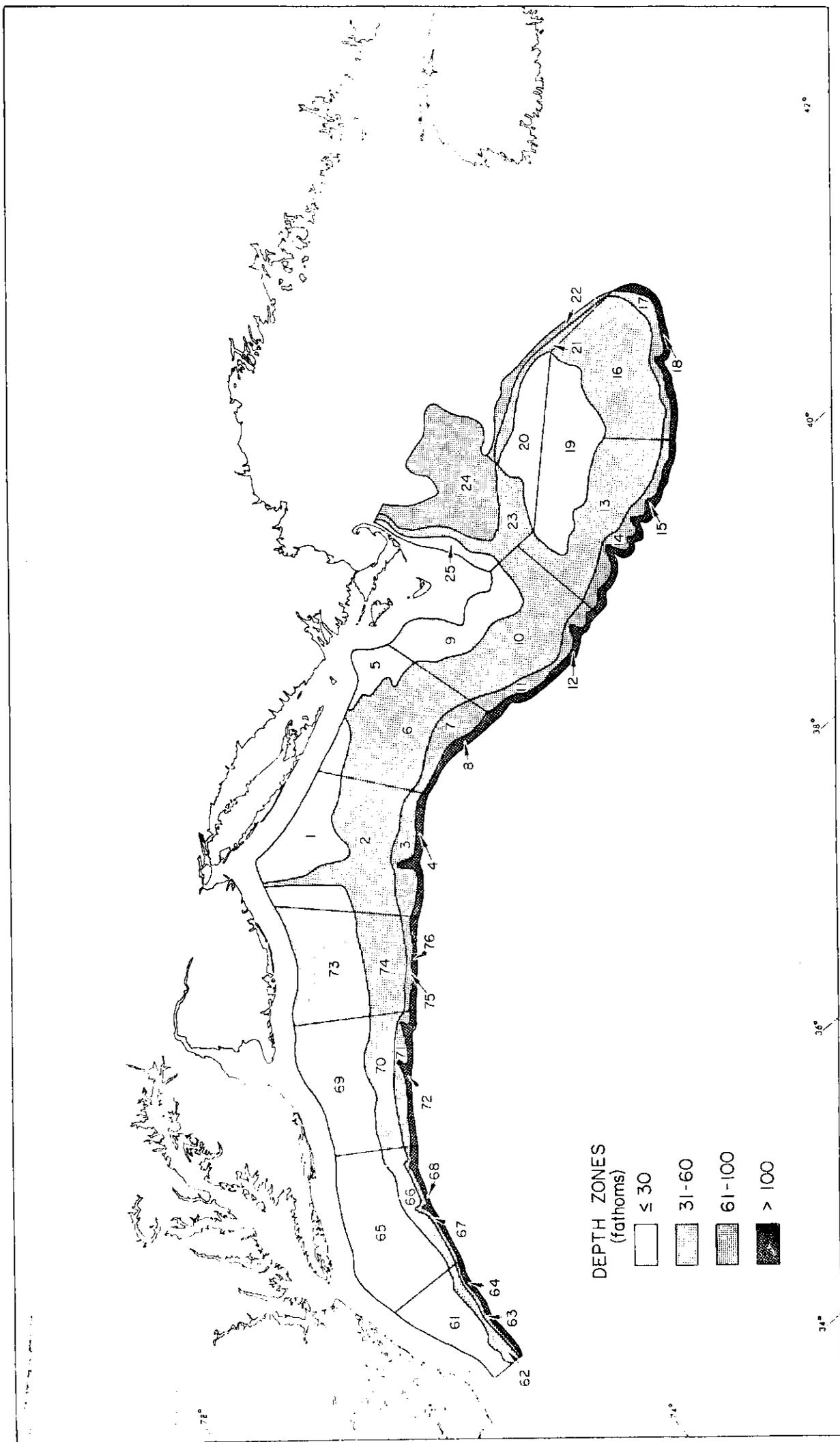


Figure 1. Sampling strata covered simultaneously by the US and USSR vessels in the 1969 joint groundfish survey.

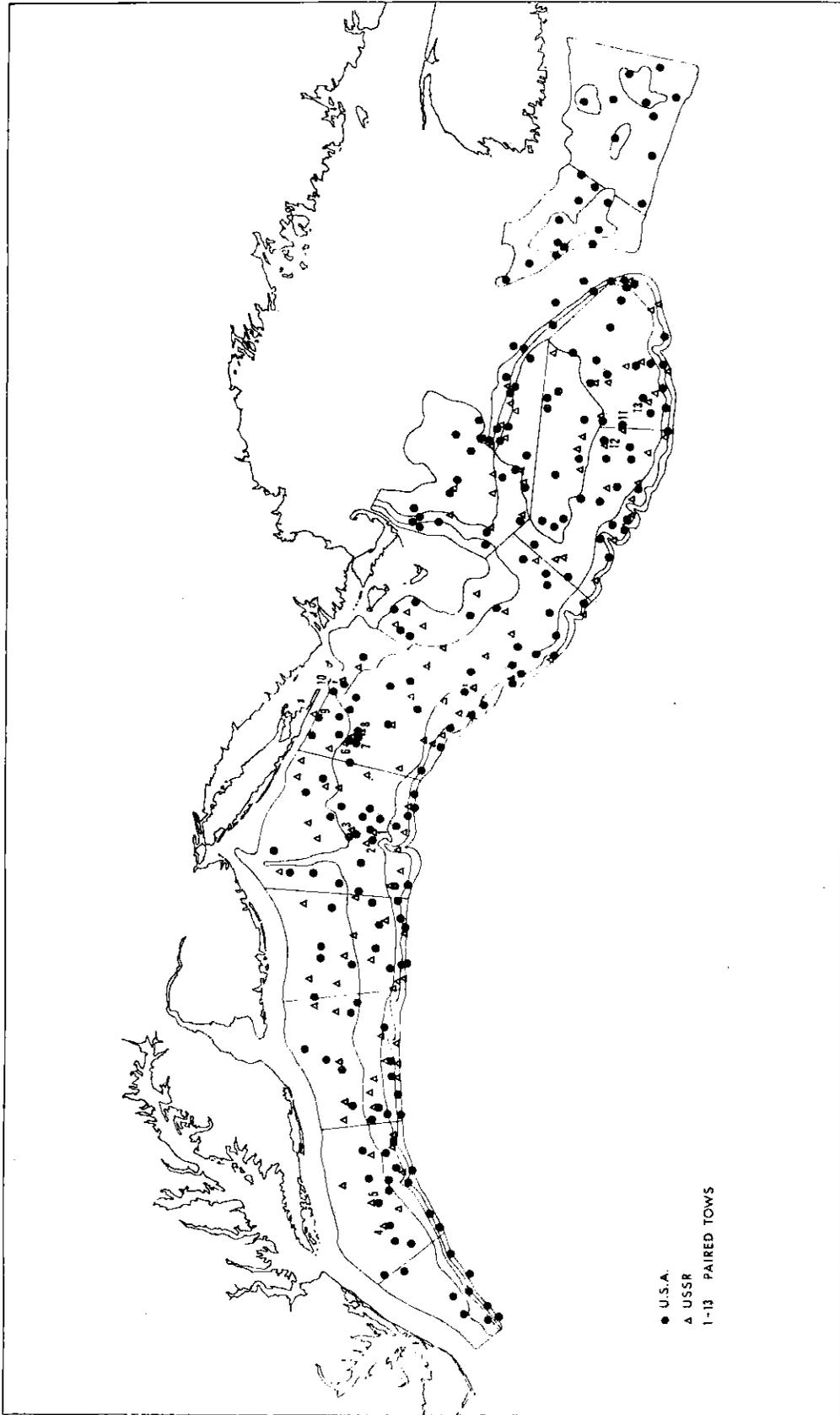


Figure 2. Otter trawl stations occupied during the USA-USSR groundfish survey in 1969. Strata and stations off western Nova Scotia were surveyed independently by Albatross IV.

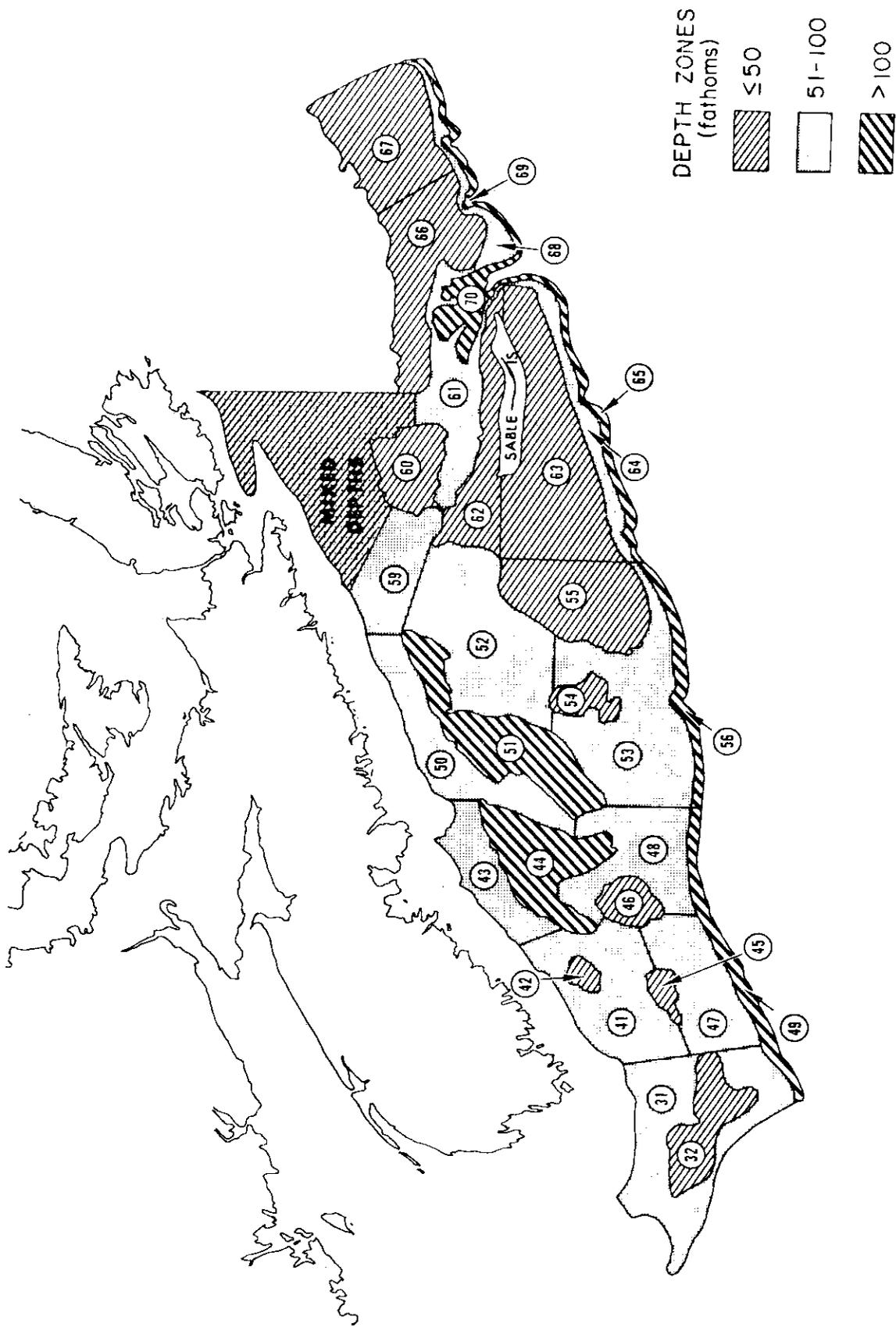


Figure 3. Sampling strata used in the 1969 survey of the Nova Scotian Shelf by the USSR vessel EKLIPTIKA.

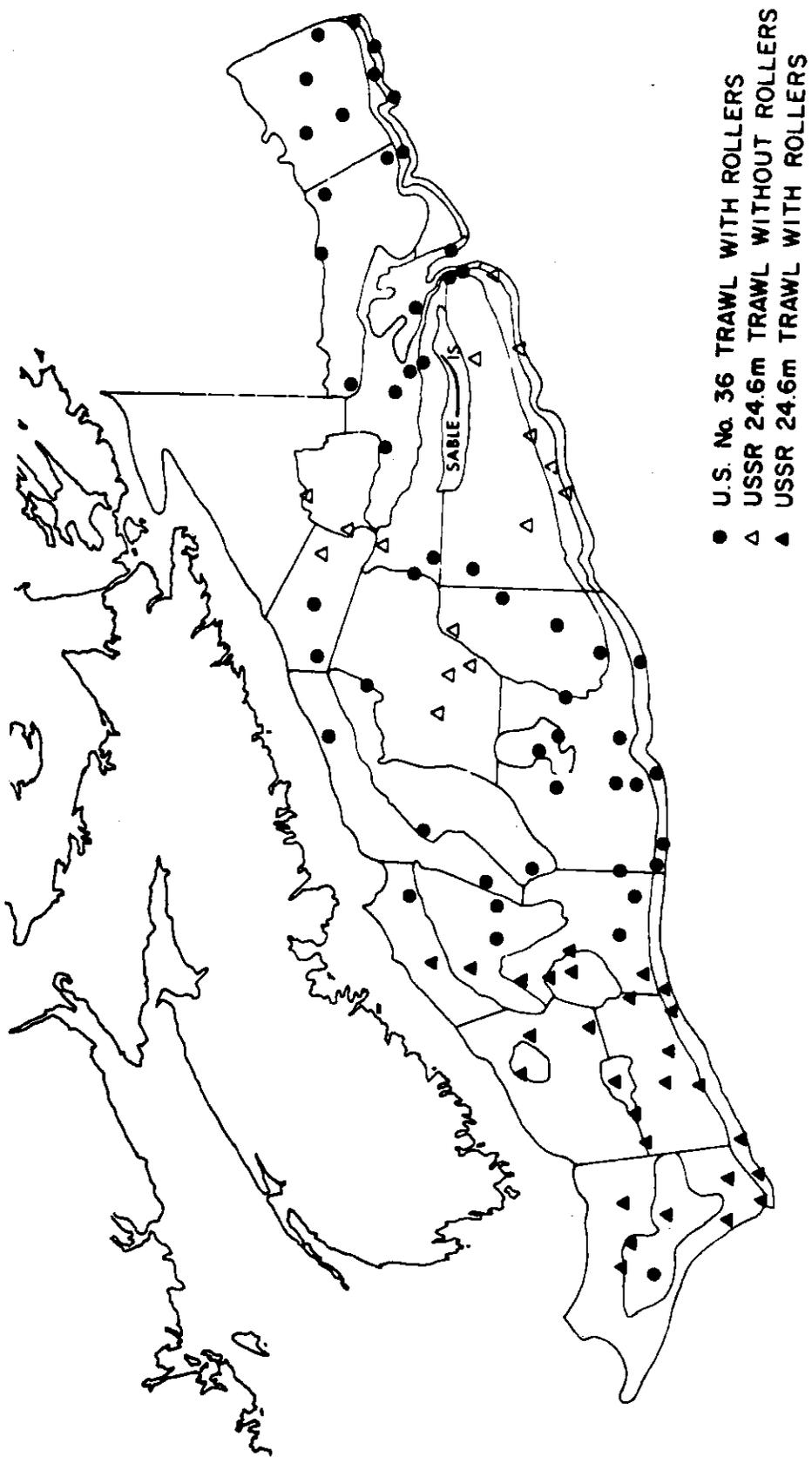


Figure 4. Otter trawl stations occupied by USSR vessel EKLIPTIKA during 1969 joint US-USSR groundfish survey.

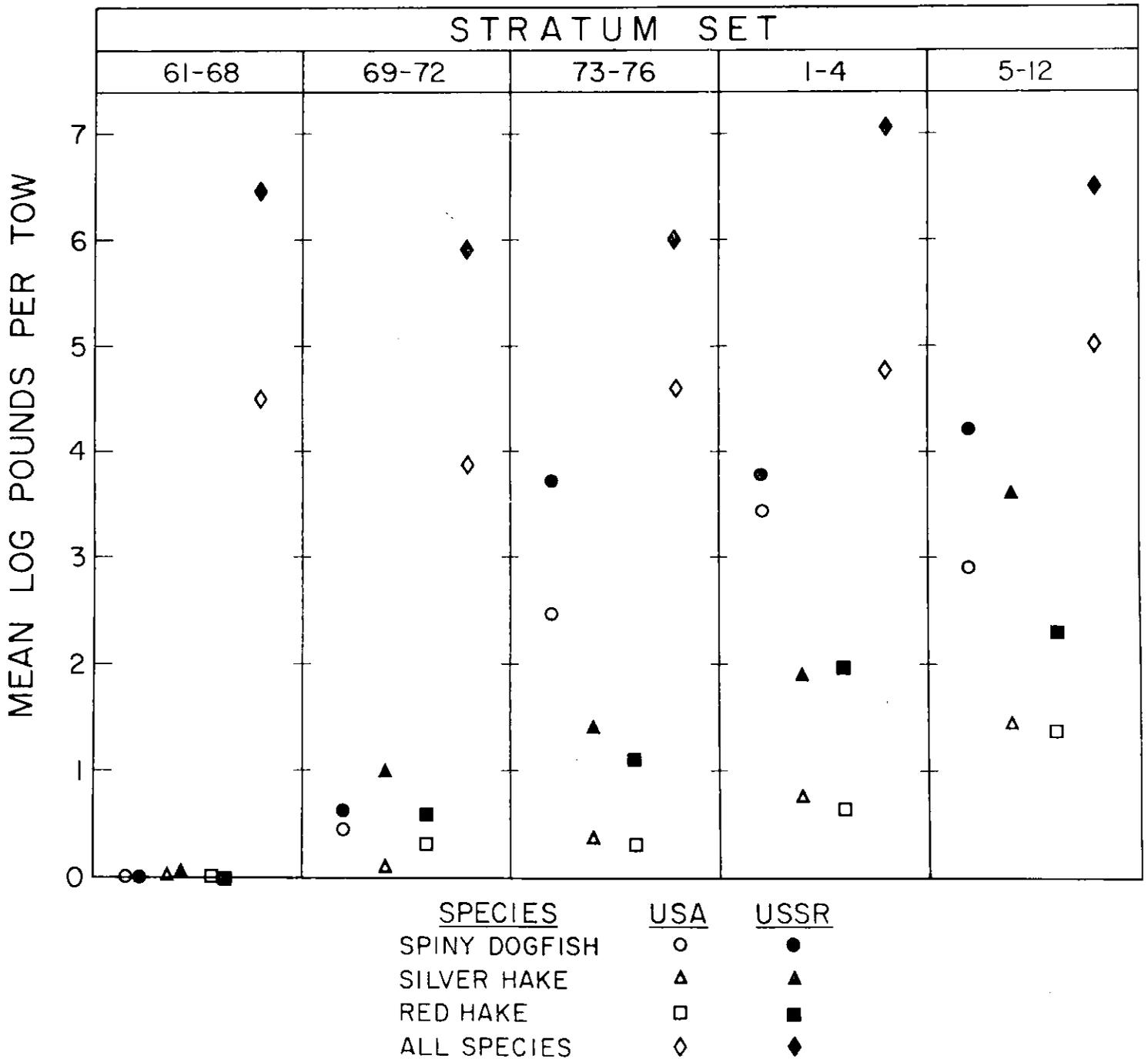


Figure 5. Stratified mean catch in pounds (log_e scale) of selected species, and all species combined, for five stratum sets covering the area from Cape Hatteras to Nantucket shoals, in the 1969 joint US-USSR survey.

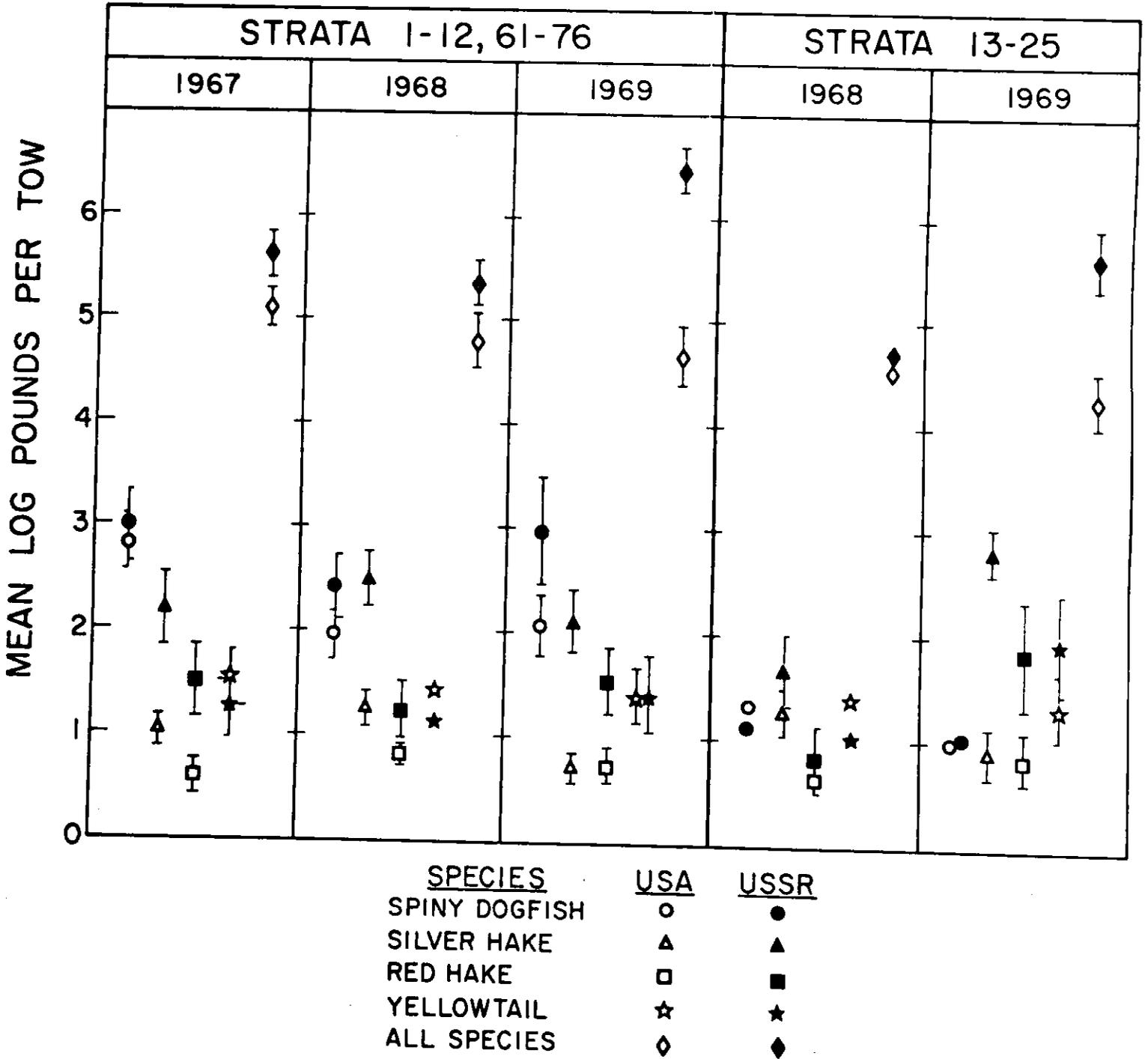


Figure 6. Stratified mean catch per haul statistics for selected species by major strata sets in joint US-USSR surveys, 1967-1969. Strata 1-12, 61-76 (Cape Hatteras to Nantucket Shoals), Strata 13-25 (Georges Bank). Approximate 95 percent confidence limits shown as vertical lines.

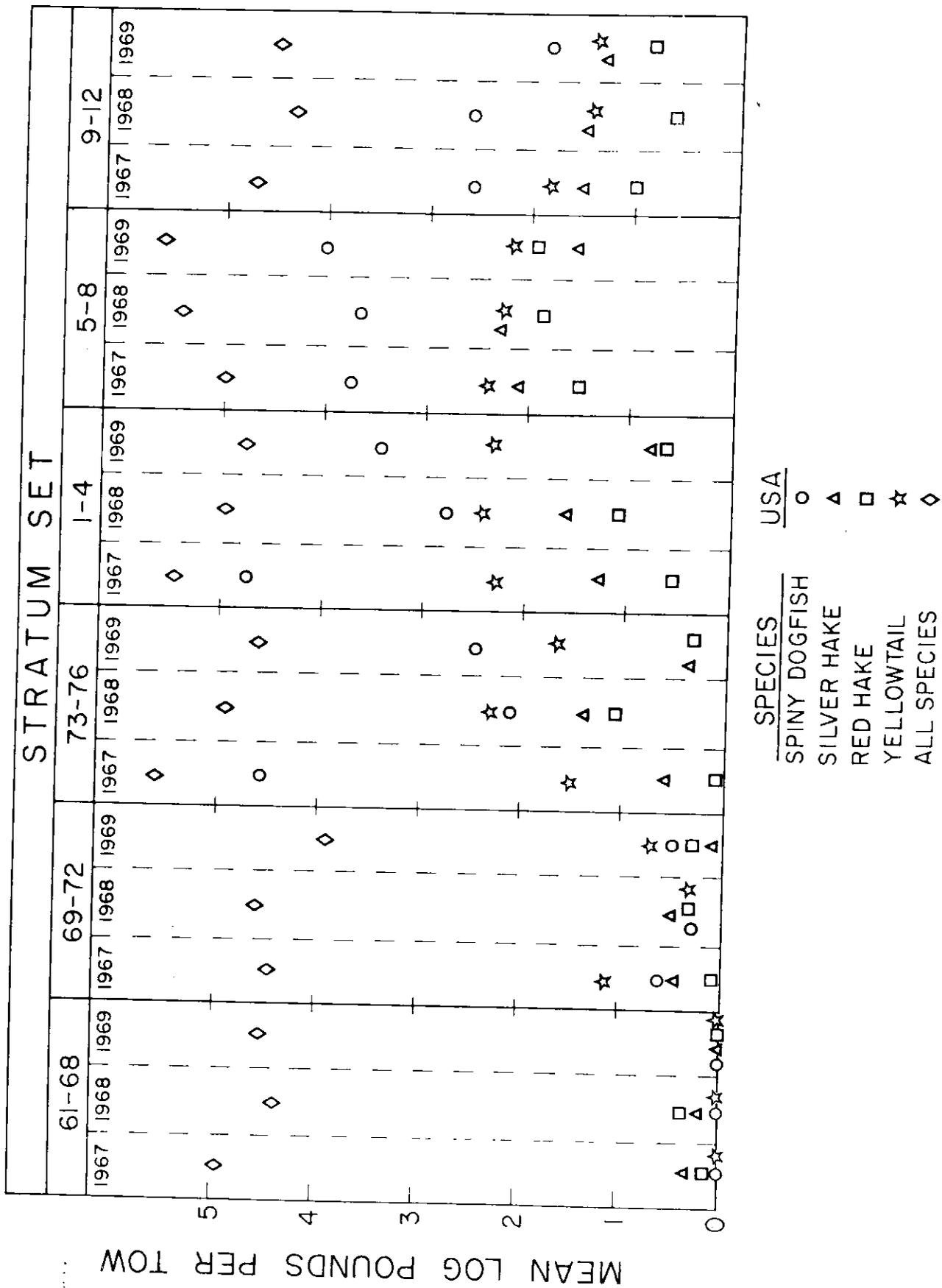


Figure 7. Stratified mean log catch (pounds) per 30-minute haul of selected species by USA vessel Albatross IV during joint US-USSR surveys of the area from Cape Hatteras to Nantucket Shoals, 1967-1969.



Figure 8. Bottom temperature pattern during Albatross IV groundfish survey in autumn, 1969.

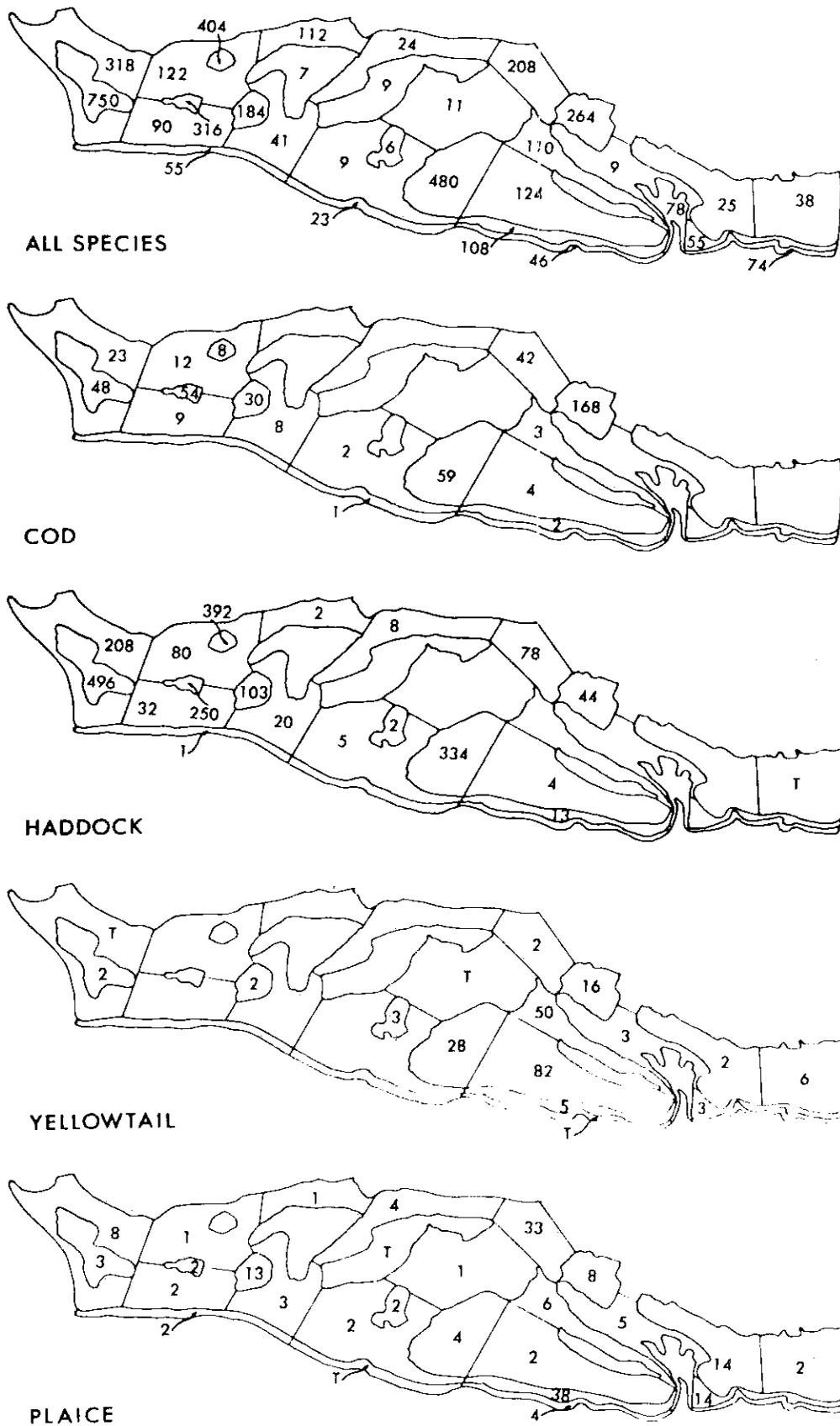


Figure 9. Mean catch (pounds) per 30-minute haul of selected species and all species combined, by individual sampling strata. Survey by USSR vessel EKLIPTIKA in November - December 1969. Catches of different trawl types combined in each stratum.

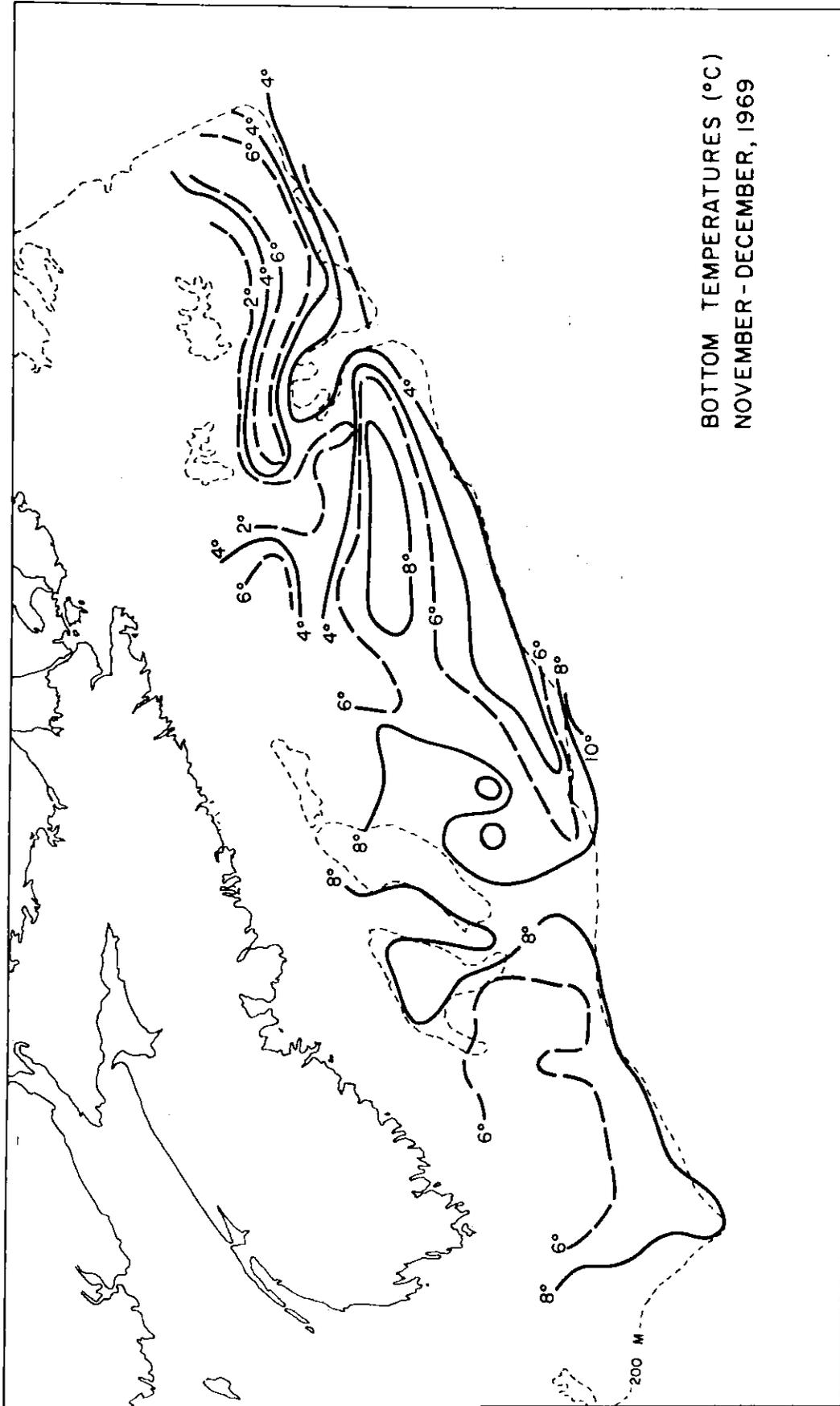


Figure 11. Generalized bottom temperature pattern on Nova Scotian Shelf, November - December 1969, based on data from USSR vessel EKLIPTIKA.