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Status of the Scotian Shelf shrimp (*Pandalus borealis*) fishery 1993

by
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Abstract

The Scotia-Fundy shrimp (*Pandalus borealis*) fishery has expanded in recent years, and landings are at the highest level recorded for this fishery. An industry sponsored biomass survey was conducted in 1993. This was the first survey since 1988.

Survey biomass estimates and commercial CPUE indicate a stable stock with no indication of a detrimental impact due to the increased landings of the last few years.

It is felt that a cautious increase in the TAC could be applied, and that this should be held constant and monitored for a multi-year period.

Résumé

La pêche de la crevette (*Pandalus borealis*) dans la région de Scotia-Fundy a pris de l'expansion ces dernières années. Ses débarquements ont atteint un niveau record. Un relevé de recherche sur la biomasse organisé par l'industrie a été effectué en 1993. Il s'agissait du premier depuis 1988.

Les estimations de biomasse découlant de ce relevé et les PUE des pêcheurs commerciaux dénotent un stock stable, qui ne semble pas avoir souffert de la hausse des débarquements de ces dernières années.

On estime que l'on pourrait augmenter avec prudence le TAC, qui serait ensuite tenu constant et ferait l'objet d'un suivi pendant plusieurs années.

Introduction

The northern or pink shrimp, *Pandalus borealis*, is the only shrimp species of commercial importance in the Scotia-Fundy Region. Shrimp are crustaceans, as are lobsters, and have a hard outer shell which they must periodically shed (molt) in order to grow. The females produce eggs in the fall and carry them, attached to their abdomen, through the winter until the spring, when they hatch. The newly hatched shrimp spend 3 to 4 months as pelagic larvae, feeding up near the surface. At the end of this period they move to the bottom and take up the life style of the adults. The northern shrimp is a protandric hermaphrodite (Shumway *et al.* 1985). This means that it first matures as a male, at 2 to 3 years of age, but around age 4 it changes sex, to spend another 1 to 2 years as a female.

Shrimp are found throughout the eastern Scotian Shelf in deep water, preferring a temperature of 2 to 6°C, and a soft, muddy bottom. Catch rates are much higher during daylight when the shrimp are feeding near the bottom than at night when they spread out in the water column.

The shrimp fishery in the Scotia-Fundy Region is concentrated in three deep holes in the eastern Scotian Shelf (Figure 1). The three holes are Louisbourg hole - Shrimp Fishing Area (SFA) 13, Misaine hole - SFA 14 and Canso hole - SFA 15. The shrimp are fished with otter trawls, similar to the groundfish gear, with a 40 mm minimum mesh size. The main management tools are limits on the number of licences and size of vessels used, a minimum mesh size for the gear, and a Total Allowable Catch (TAC).

Up until 1992 this fishery had been underexploited, usually taking less than 10% of the TAC (Etter and Mohn 1989). Effort was restricted by a 10% groundfish by-catch limit that was difficult to conform to, and the fishery was frequently shut down due to the by-catch well before the shrimp quota was reached. This problem was overcome in 1991 with the introduction of the Nordmøre separator grate (Cooper *et al.* 1991, Butler and Robert 1992), and effort has greatly expanded. With the increased effort the quota in SFAs 14 and 15 has been caught the last two years (Tables 1 and 2). In 1993 the quota was caught in these areas by July 12 and the total catch was 2,044 t, the highest catch ever for this stock. A biomass survey was carried out this year for the first time since 1988.

Methods

Commercial Data

Data on the fishery was gathered from logbooks, the Scotia-Fundy and Gulf Region Statistics Branches, and Foreign and Domestic Quota Monitoring (Fisheries Operations Branch, Halifax). Statistics Branches in both regions record landings by NAFO area as opposed to Shrimp Fishing area. As these do not exactly correspond (Figure 1), positions from the logbooks are used to assign landings to SFAs.

The fishery was initially exploited by Gulf based vessels, but in the last three years this has changed, with Scotia-Fundy vessels taking most of the catch (Table 3). The vessels used in this fishery are midshore (65-100' LOA) from the Gulf Region, and inshore (LT 65' LOA) vessels from Scotia-Fundy. The licences from Scotia-Fundy consist of 9 limited entry and 14 exploratory licences. All nine of the Scotia-Fundy vessels with limited entry licences for 4VW were active in 1993 (Table 4) as were 13 of the 14 exploratory licence holders (Table 5). This increase in activity is due to both the introduction of the Nordmøre grate and the problems in the groundfishery. The limited entry licence holders are re-issued their licence if they have held or banked one the previous year. The exploratory licences are for one year and there is no guarantee they will be re-issued in subsequent years. The licence holders also have to meet specific participation requirements or their licence is revoked.

As part of an Industry-Government Working Group Agreement, for the 1993 to 1995 period, only the six midshore Gulf vessels that have a history of fishing in this area are eligible to fish in SFA 13 to 15. The eligibility of the vessels ceases upon vessel replacement or licence re-issue, but up to three vessels in any one year can be substituted from licenced Gulf vessels. Of the six eligible vessels, five were active in 1993 (Table 6).

The quota for the area is split, with 75% allocated to the inshore (LT 65' LOA) category and 25% to the midshore (65-100' LOA). This is in effect for the 1993-1995 period with the portion of the quota not caught by July 31 available to be temporarily transferred between quota categories.

There are few vessels in this fishery with more than a few years of fishing and so it is difficult to construct an index of Catch Per Unit Effort (CPUE, measured as kg of shrimp caught per hour fished). The Gulf based vessels have a longer history in the fishery but even most of these do not have an extensive record as vessels have changed. The CPUE index is therefore not based on a multiplicative model but uses correction factors to convert catch rates for the various types of trawls to that of a standard, a Western 2A. In addition, individual CPUE indices for the last three years were constructed for the two gulf vessels with the largest catches.

Survey Data

DFO conducted research surveys for the Scotia-Fundy shrimp stocks in 1980 and twice a year from 1982 to 1988. At that time they were discontinued due to budget constraints and the declining activity in the fishery. With the renewed interest and exploitation, an industry sponsored survey was carried out this year using two vessels, the *W.A. Moore* and the *April & Colette*. The *W.A. Moore* conducted the survey for Louisbourg hole (July 23-24), and the *April & Colette* for Misaine (Aug 17-19) and Canso (Sept 1-2) holes. All survey stations were carried out during daylight hours.

In an attempt to have some comparison with the older survey data the survey design was kept the same. Ten random stations were allocated within the 100 fathom contour for Canso and Louisbourg holes, and for Misaine hole the ten fixed stations that had been used in the older surveys were retained. The older surveys had been conducted with a Yankee 36 trawl using the *FRV E.E. Prince*.

There were gear and weather problems encountered during the survey. Most of the Canso stations were carried out in rough weather, and during the survey it was found that the doors did not appear to be fully opening the trawl on the *April & Colette*. The wingspread for this gear is usually 68 feet and the spread between the doors 145 feet, but during the survey measurements of warp angles indicated that the doors were only spread 120 feet. In talking to personnel at two manufacturers they felt that the reduction in wing spread would not be proportional to the reduction in door spread but would amount to a reduction of at most 10 feet and probably less than that. For this reason it was decided to calculate the biomass for a 63 foot wing spread. It was also found that the start of the tow had been recorded as 5 minutes after the trawl was put over. Experience with the *W.A. Moore*, which has a headrope height sensor, showed that the trawl takes approximately 15 minutes to settle, depending on depth. To correct for this the towing time for the *April & Colette* was estimated to be 20 minutes instead of 30 and the tow length adjusted for this.

The biomass estimates were carried out by areal expansion as done in the past, with catches adjusted to a standard tow length of 1.25 nautical miles and the area swept calculated from this and the wing spread. The estimates of the area of the holes, defined by the 100 fathom depth contour, were kept the same as in the previous surveys, 276.4, 472.2, and 442.2 square nautical miles for Canso, Louisbourg and Misaine holes respectively (SFAs 15, 13, 14).

Samples of approximately 500 shrimp were collected from each tow. These animals were weighed, measured, sexed and staged. They were grouped into immature and mature males, transitionals, and primiparous (first time spawners) and multiparous (have spawned at least once before) females for length frequency distributions.

Results

Commercial data

The commercial effort, CPUE, catch and counts for the three areas for 1993 are shown in figures 2 to 7. The CPUE index from the Gulf vessels (Table 2) shows an increase over last year but is not as large as that seen in the surveys.

Taking the two Gulf vessels with the largest catches for the last three years and calculating individual CPUE's and indexing them to 1991 gives index values of 1.0, 0.8 and 0.9 for one vessel and 1.0, 1.6 and 2.0 for the other.

Survey

The results for the survey stations are displayed in figures 8, 9 and 10 and in table 7. When compared to previous surveys the average catch per tow is up substantially, especially in Louisbourg hole (Table 8). Most of this is due to the larger trawls covering a larger width and height when compared to the Yankee 36. The biomass estimates from areal expansion shown in table 9 indicate that in Canso and Misaine holes the biomass is similar to what it was in 1988. Louisbourg hole appears to be up substantially from 1988 but much of this is probably attributable to the higher trawl of the *W.A. Moore*, which was used for this section of the survey.

The amount of by-catch caught during this survey was small in comparison to the older surveys, which were carried out without a separator trawl. In 1988 the spring and fall surveys had 57 and 43 percent shrimp in the catch respectively, which was the highest in the survey series. With the use of the Nordmøre grate during this survey, the catch consisted of 98 percent shrimp. The species composition is shown in table 10. The class "Miscellaneous" consisted largely of anemones, starfish, basketstars and other invertebrates, other finfish were mainly eelpout, lingcod and alligatorfish. Most of the by-catch consisted of juvenile redfish, flatfish and capelin. The Louisbourg catches were cleaner than the Canso and Misaine catches.

The size distributions are shown in figure 11 along with the those from the 1988 survey. There appears to be a slight increase in the modes for each group. The separate frequency distributions are shown in figure 12. There appears to be a mode around 28 mm in the Canso and Misaine samples that is absent in the Louisbourg samples. Cumulative frequency distributions for the three holes (Figure 13) show that Louisbourg hole has smaller shrimp than the other two holes. The fishermen and processors have reported an increase in the size of shrimp in the catch over the last few years. This appears when comparing the cumulative frequency distributions for the 1988 and present surveys which are plotted together in figure 14.

The numbers of ovigerous (carrying eggs on the abdomen) versus non-ovigerous females in the catch is shown in table 11, along with those from the older surveys. It is apparent that egg extrusion was taking place during the period of the survey and from this aspect the stock appears to be healthy.

Discussion

With the introduction of the Nordmøre grate and the decline in groundfish, effort in this fishery has increased, and it is now catching the TAC in Canso and Misaine holes. The amount of shrimp being taken out of this area has increased dramatically the last two years. Since previous effort was at such a low level, the stock at that time was considered to be essentially a virgin biomass. As a stock goes from a virgin biomass to being fully exploited, the standing stock biomass is expected to decline from its original level, and the mean size of animals in the population also declines. The extent of these reductions is largely dependent on the lifespan of the organism being exploited and shrimp are relatively short lived, but neither of these effects are obvious in this fishery.

There are many problems with comparing the biomass estimates from the earlier surveys with that resulting from this one. In the earlier surveys, catch rates were converted from a Yankee 36 to a Western 2A trawl by multiplying by 1.5. This was because the Yankee 36 with a 2.5 m vertical height, was found to have a catch rate two thirds that of the Western 2A, which was the most common commercial gear at the time. The Western 2A had the same horizontal opening as the Yankee 36 but twice the vertical height. Table 12 shows that the two trawls used in the present survey have different heights as well as different wingspreads. A higher height increases the catch rate depending on the vertical distribution of the shrimp, and thus would be expected to produce an increased estimate of biomass. The trawls used in this survey are wider than either of the older trawls. The vertical height of the *April & Colette* trawl is between that of the Western 2A and the Yankee 36. The *W.A. Moore* trawl has a much larger trawl, with an 5.5

m vertical height. There should probably be a slight correction factor for the *April & Colette* I.C. trawl, as it does not sample as high as a Western 2A but this factor would be small. Similarly, to make it comparable to the older results, a factor to decrease the *W.A. Moore* catch to that of a Western 2A should be employed. In theory the biomass estimate is based on area swept and thus should be sampling the entire vertical distribution of the shrimp. The higher trawl is representative of shrimp abundance although it would give a less conservative estimate than the former surveys. It is not clear how much of the biomass increase seen in Louisbourg hole is real versus due to the higher trawl. Unfortunately, as the doors used on the *April & Colette* during the survey period were only used during this period, catch rates from logbooks cannot be used to compare the efficiency of the two vessels.

Given these limitations, the survey results indicate a stable biomass, as does the CPUE index. Fishermen and processors say that the catch is composed of larger shrimp than in the past, and the survey length frequencies support this. The indications are that this is a healthy stock. The last time a TAC was set, in 1988, an exploitation rate was applied to the average biomass estimate for the last few years to even out variations in the annual biomass estimates. The exploitation rate used was originally based on the Sept Isles fishery, which had shown stability being fished at this level. Since that time there have been cases of stocks declining while fished at lower exploitation rates, and the Sept Isles fishery was allowed to expand and still showed stability to higher exploitation rates. This has led to the TAC level being based on the historical levels in the fishery, with adjustments made for apparent increases or decreases in the stock. Unfortunately this fishery does not have a history on which to base a TAC by this method.

Past sampling outside of the holes, current fishing patterns and shrimp by-catch from groundfish surveys, show that the stock covers an area larger than the 100 fathom holes, although these support the largest concentrations. The biomass estimates are therefore an underestimate of the total standing stock. Due to these reasons it is felt that there is no biological reason not to have a cautious increase in the TAC. It is recommended that this TAC be set for a multi-year period and the stock monitored for responses to this higher exploitation.

A separate question is that of a combined TAC for the whole area. There are differences in the size distributions between the three holes that vary through time. Louisbourg was the most heavily fished of the three from 1980 to 1990, as at that time it provided the best sizes and catch rates. It now contributes the least catch of the three areas. Experience with *Pandalus borealis* in other areas has indicated that shrimp are capable of moving throughout large areas. The quotas for Canso and Misaine were combined last year and there is a recommendation to combine some of the Northern shrimp management areas. There is little biological evidence to support a separate quota for Louisbourg. A combining of quotas would presently result in the Louisbourg quota being taken in the Canso and Misaine area, but if this is one stock there is no reason this should not be done.

References

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Table 1. TACs and total catch (t) for the Scotian Shelf shrimp fishery, 1986 to present.

Year	TAC			Total	Catch (t)
	SFA 13 Louisbourg	SFA 14 Misaine	SFA 15 Canso		
1980	1553	2382	1086	5021	984
1981		--	-	-	454
1982	1400	1800	1000	4200	569
1983	2000	2400	1400	5800	1010
1984	1800	2500	1400	5700	928
1985	1790	2420	1350	5560	133
1986	1460	1600	740	3800	126
1987	1070	860	210	2140	152
1988	1160	1050	370	2580	82
1989	1060	1050	370	2580	93
1990	1060	1050	370	2580	104
1991	1060	1050	370	2580	804
1992	1060	1050	370	2580	1850
1993	1060		1490**	2580	2044*

* Preliminary

** Includes 70 t allocation for survey.

Table 2. Scotian Shelf commercial shrimp landings and CPUE, 1977 to present.

Year	Catch (t)				CPUE (kg/h)*	
	SFA 13 Louisbourg	SFA 14 Misaine	SFA 15 Canso	Total	Unstd.	Std***
1977				269	128.5	104.5
1978				306	121.9	97.3
1979	295	8	534	838	174.6	128.0
1980	491	133	360	984	130.9	87.3
1981	418	26	10	454	131.8	92.8
1982	316	52	201	569	128.0	80.4
1983	483	15	512	1010	127.7	81.2
1984	600	10	318	928	109.5	77.6
1985	118	-	15	133	75.4	40.7
1986	126	-	-	126	87.3	58.1
1987	148	4	-	152	90.7	39.9
1988	75	6	1	82	85.1	51.0
1989	91	2	-	93	133.4	44.4
1990	90	14	-	104	134.5	44.9
1991	81	586	140	804	197.9	45.6
1992	63	1181	606	1850	176.3	43.8
1993**	431	1279	317	2044	193.0	47.0

* CPUE from Gulf based vessels.

** Preliminary

*** Standardized to a Western 2A trawl.

Table 3. Proportion (%) of the catch caught by Gulf and Scotia-Fundy based vessels from log and sales slip information.

Year	% Gulf	% Scotia-Fundy
1985	100	0
1986	100	0
1987	91	9
1988	96	4
1989	96	4
1990	99	1
1991	37	63
1992	23	77
1993	23	77

Table 4. Limited entry shrimp licenses issued in Scotia-Fundy from 1985 to 1993 according to designated fishing areas.

Year	NAFO Area			Total	Active
	4VW	Both 4VW and 4X	4X		
1985	7	2	17	26	0
1986	6	3	18	27	0
1987	4	3	17	24	4
1988	5	3	15	23	4
1989	5	3	15	23	3
1990	4	3	14	21	1
1991	5	3	17	25	4
1992	5	4	16	25	6
1993	5	4	15	25	11*

Source: Licensing Unit, Dept of Fisheries and Oceans, Scotia-Fundy Region.

* To November 15, 1993.

Table 5. Exploratory shrimp licenses issued in Scotia-Fundy from 1990 to 1993.

Year	Issued	Active
1990	12	3
1991	9	6
1992	14	14
1993	14	13*

Source: Licensing Unit, Dept of Fisheries and Oceans, Scotia-Fundy Region.

* To November 15, 1993.

Table 6. Gulf-based shrimp licenses by boat length overall (L.O.A.) issued for Scotia-Fundy for 1984 to 1993.

Year	<19.8m LOA	19.8-30.5m LOA	Active
1984	5	17	11
1985	5	17	4
1986	5	17	5
1987	5	17	3
1988	5	17	3
1989	5	17	2
1990	5	17	3
1991	5	17	5
1992	5	17	4
1993	-	6*	5**

Source: Licensing Unit, Dept of Fisheries and Oceans, Gulf Region.

* Vessels eligible to fish under an Industry - Government Working Group agreement for the 1993 to 1995 period. More Gulf based vessels still hold licenses but are not eligible under the terms of the agreement.

** To November 15, 1993.

Table 7. Tow information from survey tows.

Tow	Position	Time	Speed	Length (km)	Depth (m)	Shrimp (kg)	Bycatch (kg)	Std Catch (kg)	
Louisbourg									
1	453814	583306	1037	2.0	2.0	380	92	1	107
2	453913	585417	605	2.0	2.0	224	85	1	98
3	453949	584914	800	2.0	2.0	217	86	2	100
4	454729	584509	2025	2.0	1.8	267	17	0	22
5	455249	583641	1805	2.0	1.8	258	250	2	322
6	455000	583211	1620	2.0	1.8	285	79	1	102
7	454629	583323	1440	2.0	2.0	297	103	2	120
8	454440	582320	1215	2.0	2.0	351	306	3	354
9	453347	583459	920	2.0	2.0	266	170	2	197
10	453343	582119	630	2.0	2.0	314	77	0	89
								Average	151
Misaine									
1	444055	600056	610	2.2	1.5	208	47	1	73
2	444735	595807	740	2.2	1.4	222	48	1	82
3	445402	595801	920	2.2	1.4	179	47	1	81
4	445127	594407	1240	2.2	1.7	202	192	3	255
5	444137	593359	1655	2.2	1.4	176	56	5	95
6	445110	592805	1850	2.2	1.4	146	85	1	144
7	444616	585646	1100	2.2	1.4	223	56	1	95
8	444854	583555	855	2.2	1.4	198	29	3	49
9	445002	583041	745	2.2	1.4	246	97	2	164
10	445523	582012	545	2.4	1.7	231	77	2	102
								Average	114
Canso									
1	445328	600729	615	2.1	1.5	189	40	2	62
2	445343	605644	810	2.1	1.5	215	85	2	132
3	444947	605454	925	2.2	1.5	235	71	2	110
4	445235	605112	1050	2.2	1.4	183	56	3	95
5	445043	604417	1220		1.5	222	42	3	66
6	445044	603801	1340	2.1	1.4	254	56	2	96
7	445323	602351	1640	2.1	1.4	218	49	1	84
8	445707	601202	1010	2.1	1.5	152	60	1	94
9	445316	601152	1125	2.1	1.4	291	42	2	69
10	445028	601317	1225	2.1	1.2	287	43	4	80
								Average	89

Table 8. Average catch (kg) per standard tow length from research surveys.

	Year	Canso	Louisbourg	Misaine
Yankee 36 trawl	1982	56.8	41.4	34.2
	1983	114.5	62.3	117.4
	1984	45.6	44.5	57.0
	1985	13.6	24.3	24.1
	1986	8.2	39.3	30.7
	1987	29.8	29.9	35.8
	1988	49.4	30.9	50.3
Larger trawls	1993	88.67	114.03	150.89

Table 9. Biomass estimates (t) from Spring and Fall surveys for 1982-1993.

Year	Months		Fishing Area						Total
			Canso		Louisbourg		Misaine		
1982	April	Nov.	4411	8496	3944	13611	5793	6153	10230
1983	May	Nov.	8894	5244	7159	8375	10743	-	22940
1984	May	Oct.	4758	1578	6882	3637	7169	5658	11920
1985	April	Oct.	1138	940	1244	4595	2384	3157	5260
1986	May	Oct.	341	585	5561	1953	3938	1700	6980
1987	May	Oct.	1248	2082	1972	3752	2429	4007	7550
1988	May	Sept.	2306	3218	2288	3628	3258	5667	10180
1993				3070		5021		4442	12533

Table 10. Bycatch composition from survey tows, + present, ++ significant, +++ abundant.

	Redfish	Flatfish	Hake	Sculpin	Herring	Turbot	Skate	Wolffish	Misc.	Other fin	Capelin	Squid	Greyscale
Louisbourg													
1	+	+								+	+		
2	+	+	+								+		
3	+	+	+			+			+		+		
4		+									+		
5		+	+										
6		+	+								+		+
7		+	+								+		
8		+	+								+		
9										+			
10													
Canso													
1	+++	+++								+			+
2	+	+++							+	+	+++		+
3	++	+++								+	++		+
4	+++	+++		+			+			+	+	+	
5	+++	+++		+						+++		+	
6	+++	+++					+			+			
7		+++								+	++		
8	+++	++					+			+			
9	+++	+									+	+	
10	+++	++								++	+++		
Misaine													
1	+++	+			+					++			+
2	+++	+			+					+++			+
3	+++	+			+	+			++	+			+
4	+++	++						+			++		+
5	+++	++					+	+					+
6	+++	+++										+	+
7	+	++									+		
8	+	+++						+		+			
9		+++									+++		
10	+++	++		+		+	+				+		

Table 11. Numbers of ovigerous/non-ovigerous individuals in samples from research cruises.

	Cruise	Non-ovigerous Females	Ovigerous Females
Spring	Apr 82	2638	650
	May 83	1330	2085
	May 84	2574	12
	Apr 85	3211	246
	May 86	1286	866
	May 87	351	1567
	May 88	2022	530
Fall	Nov 82	52	7016
	Nov 83	11	2917
	Oct 84	15	5716
	Oct 85	21	6551
	Oct 86	40	6396
	Oct 87	14	5852
	Sep 88	71	4920
1993 survey tows			
SFA 13	Jul 23-24	1236	114
SFA 15	Aug 17-19	321	1653
SFA 14	Sept 1-2	94	1889
Total		1651	3656

Table 12. Vessel and trawl data for vessels in 1993 4V-W shrimp survey.

Vessel:		
Name	W.A. Moore	April & Colette
LOA	19.8	13.7
HP	670	350
Trawl:		
Type	#1168 Shrimp Trawl	1000 mesh I.C. Denmark Trawl
Doors	Bison 10 1/2	Bison
Mesh (mm)	40	40
Footrope (m)	52	44
Headline (m)	44	33
Height-centre (m)	5.5	3.7
Height-wings (m)	3.7	2.4
Wing spread (m)	21	20-21

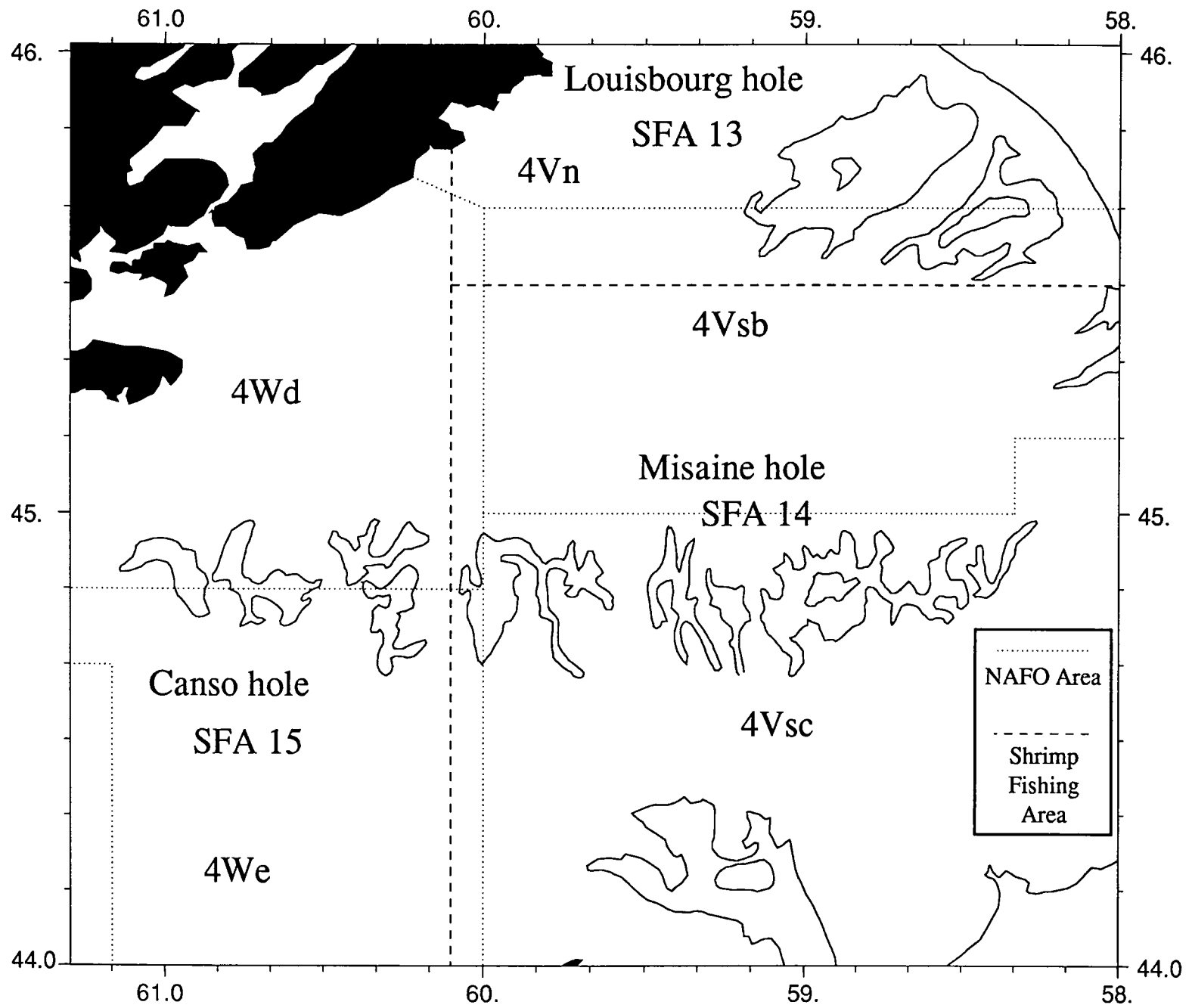


Figure 1. Shrimp Fishing areas on the Eastern Scotian Shelf.

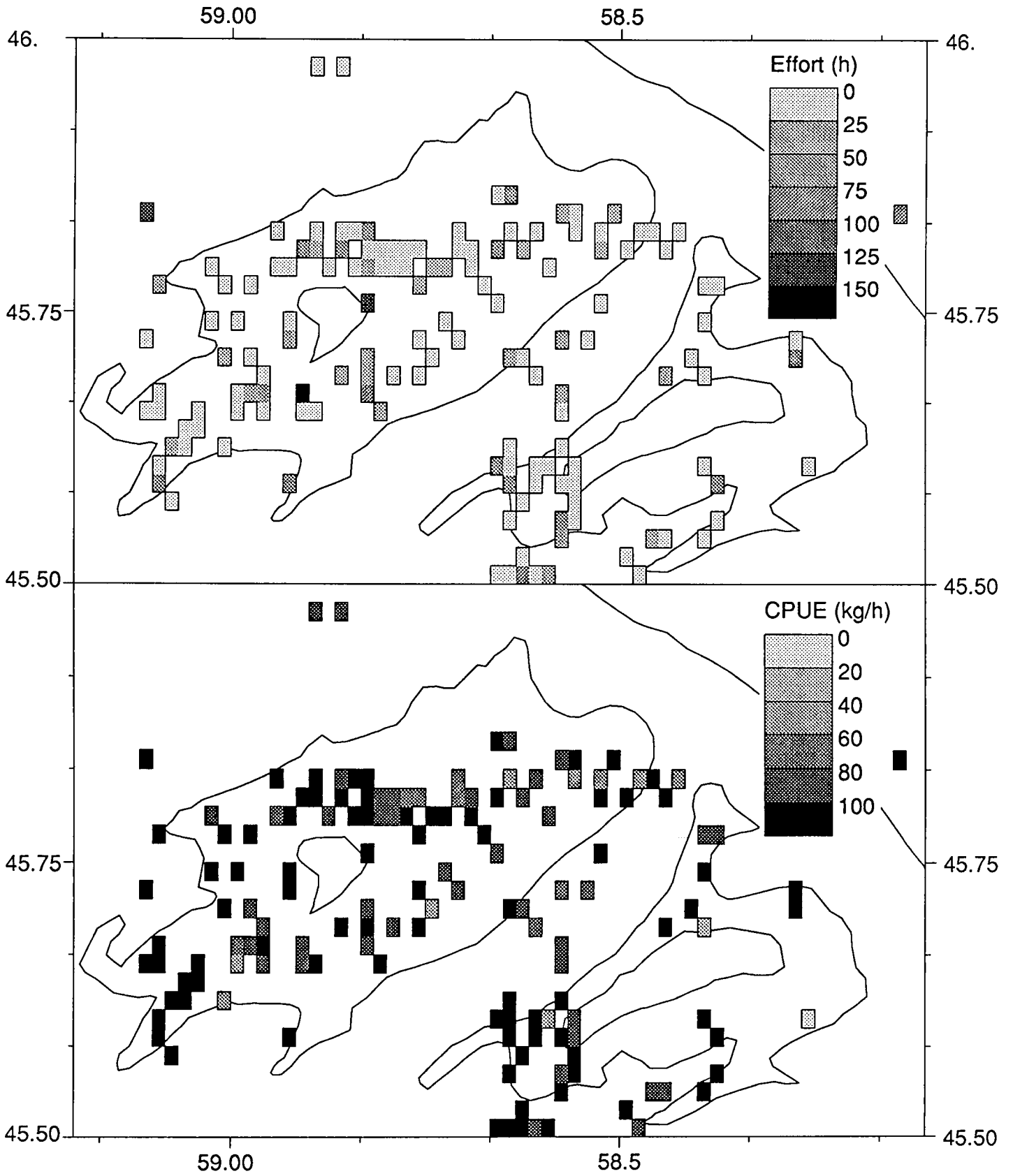


Figure 2. Distribution of effort and CPUE aggregated by one minute squares from commercial log data in SFA 13, Louisbourg hole, for 1993.

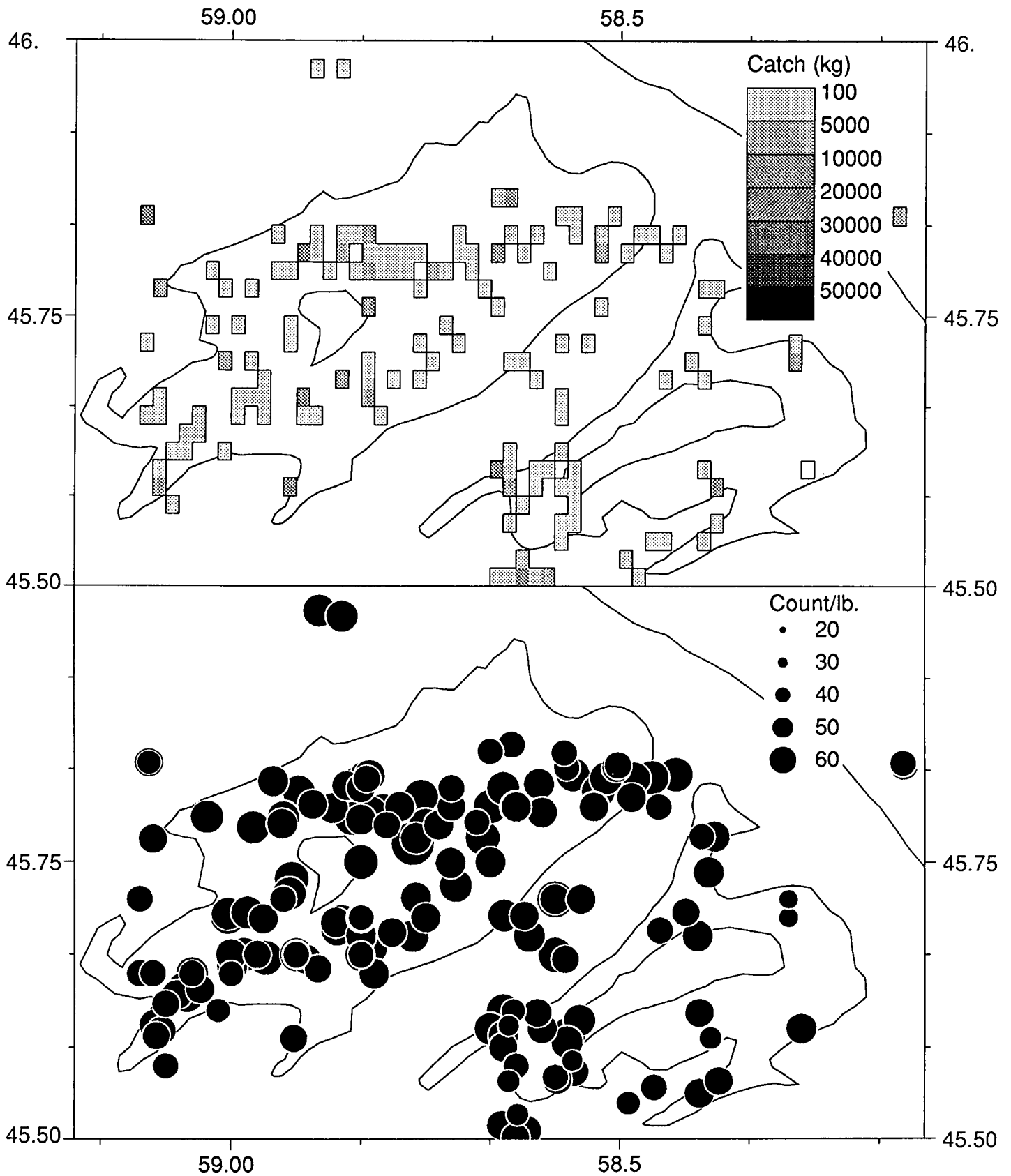


Figure 3. Distribution of commercial catch aggregated by one minute squares and of shrimp sizes in number per pound for SFA 13, Louisbourg hole from logbooks for 1993.

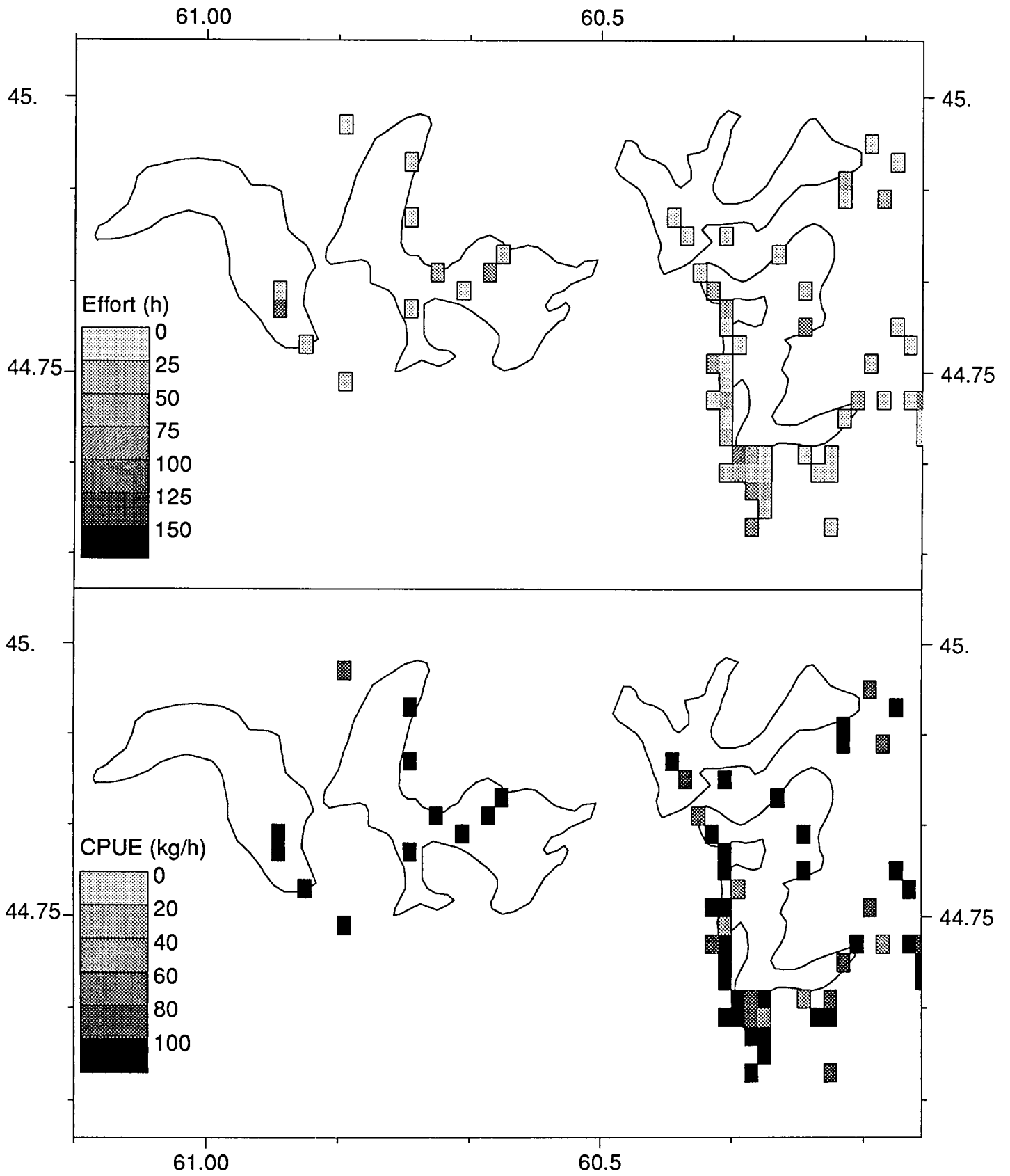


Figure 4. Distribution of effort and CPUE aggregated by one minute squares from commercial log data in SFA 15, Canso hole, for 1993.

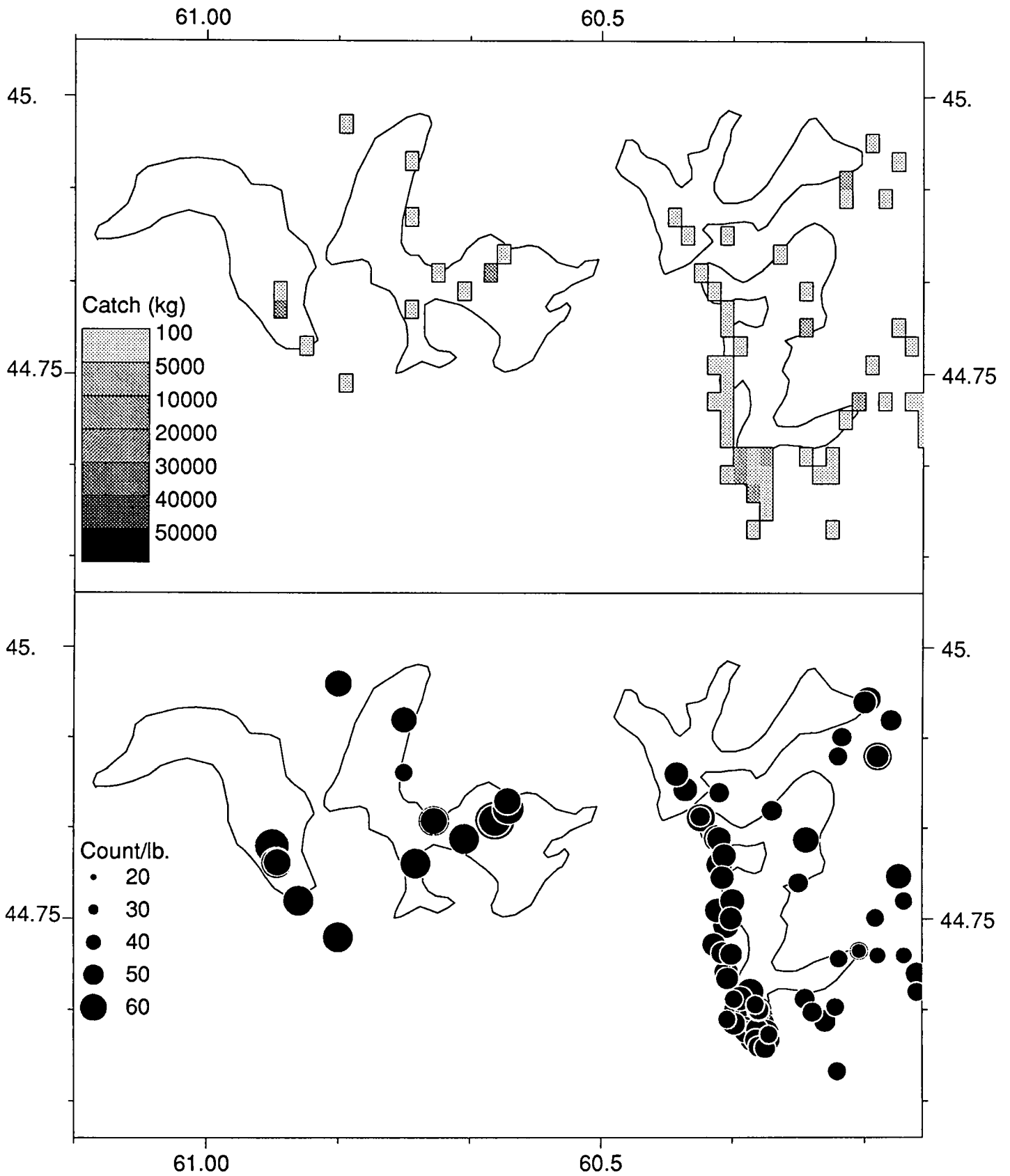


Figure 5. Distribution of commercial catch aggregated by one minute squares and of shrimp sizes in number per pound for SFA 15, Canso hole, from logbooks for 1993.

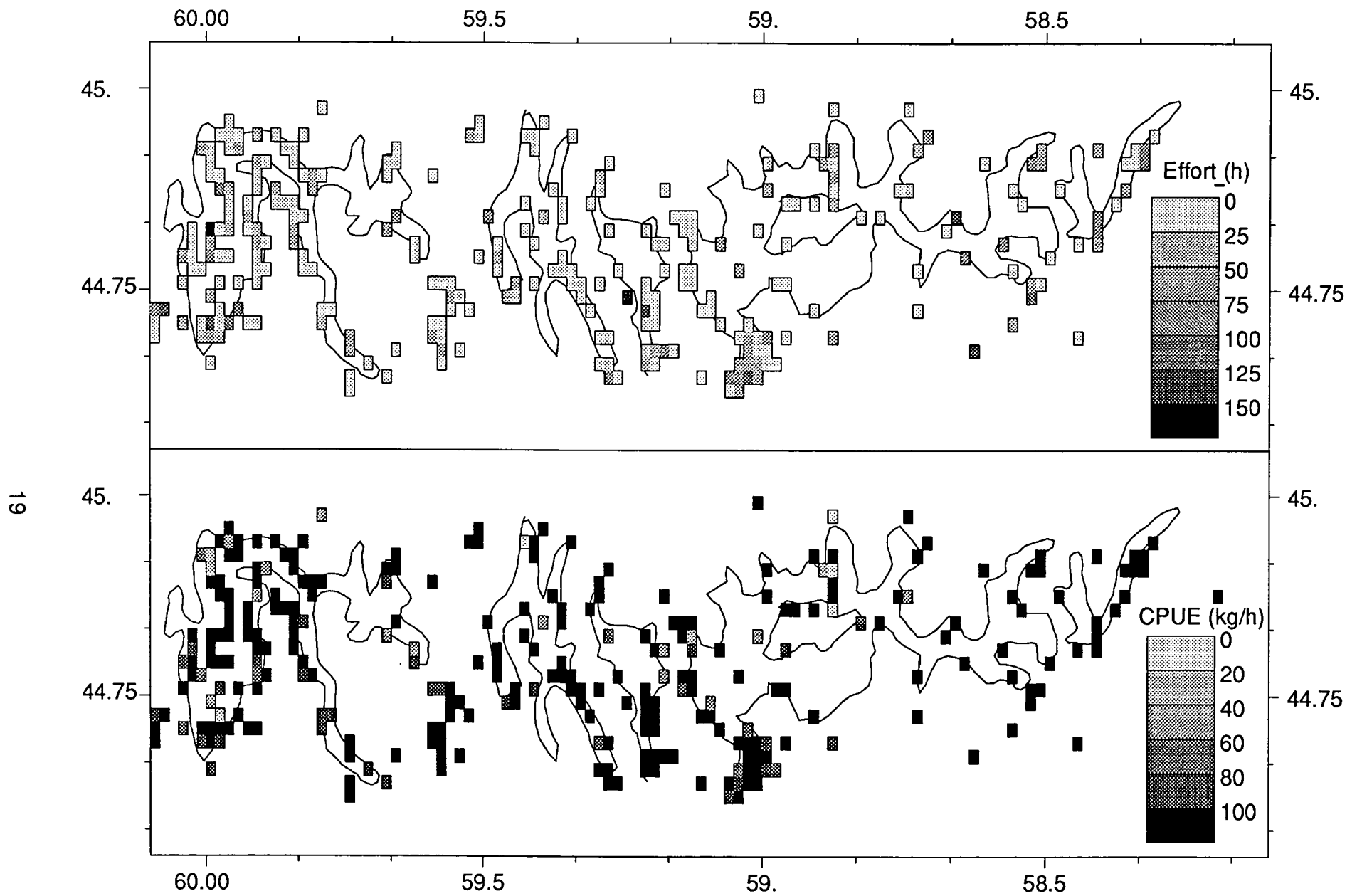


Figure 6. Distribution of effort and CPUE aggregated by one minute squares for SFA 14, Misaine hole, from logbooks for 1993.

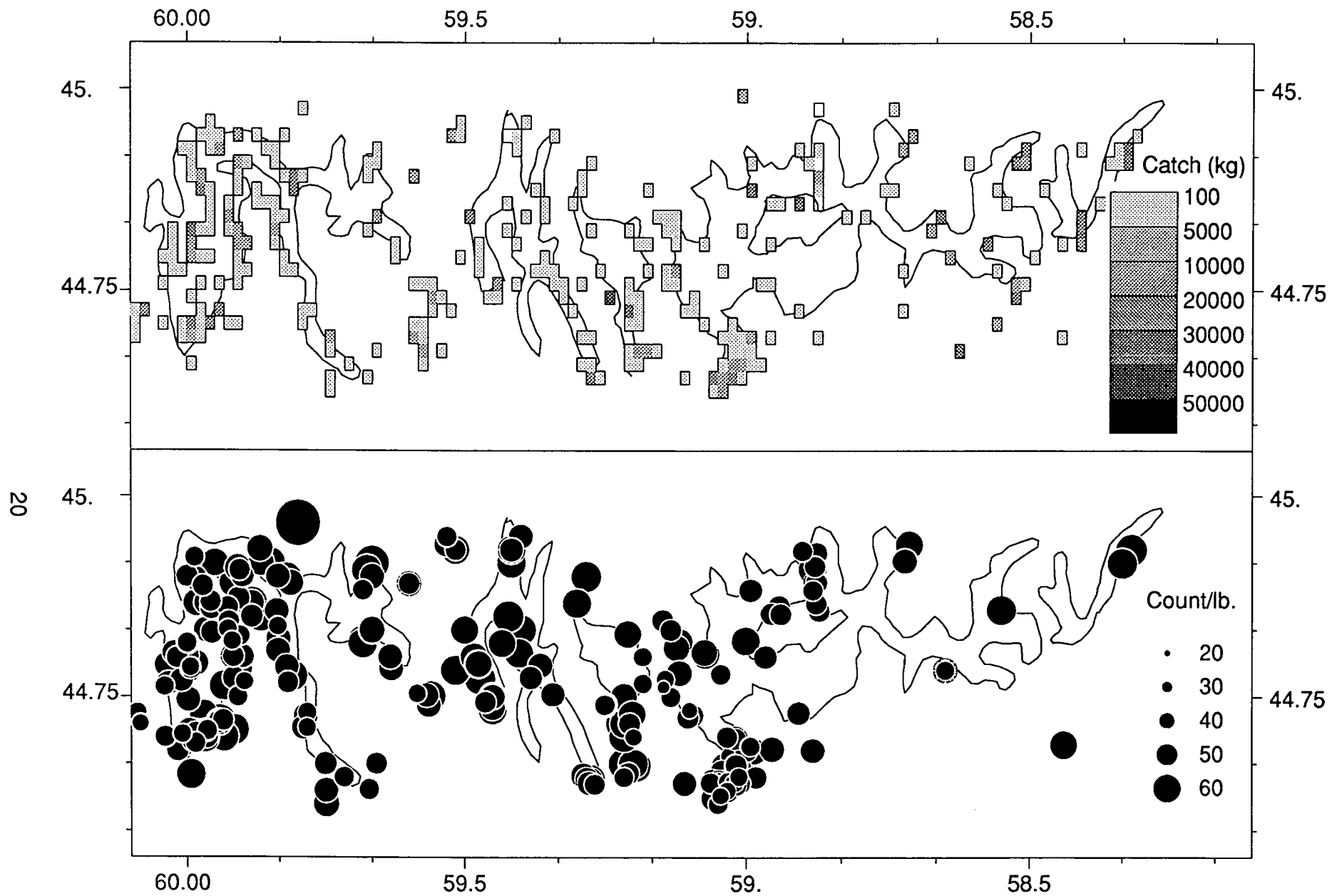


Figure 7. Distribution of commercial catch aggregated by one minute squares and of shrimp sizes in number per pound for SFA 14, Misaine hole, from logbooks for 1993.

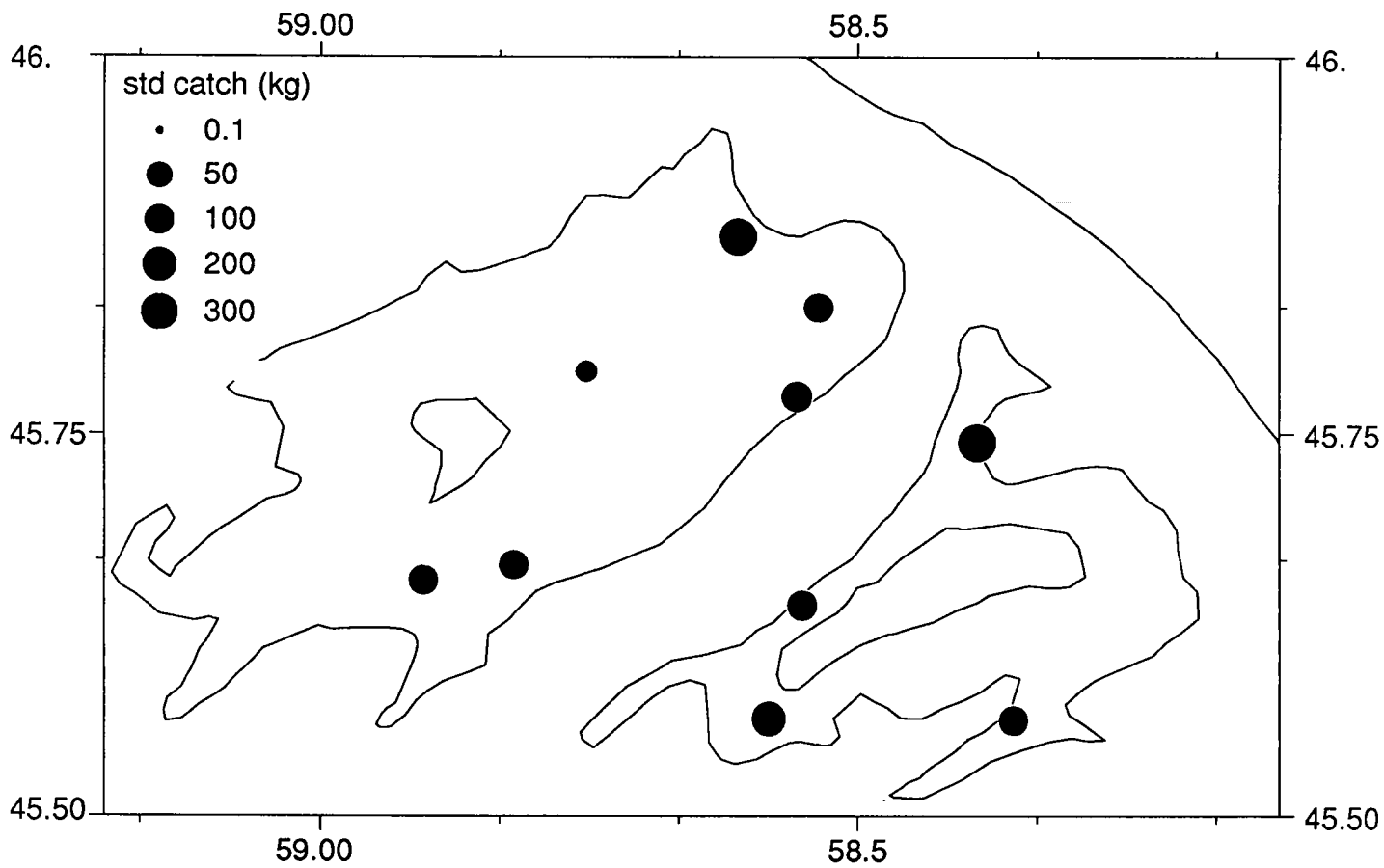


Figure 8. Catch per standard tow for Louisbourg (SFA 13) stations.

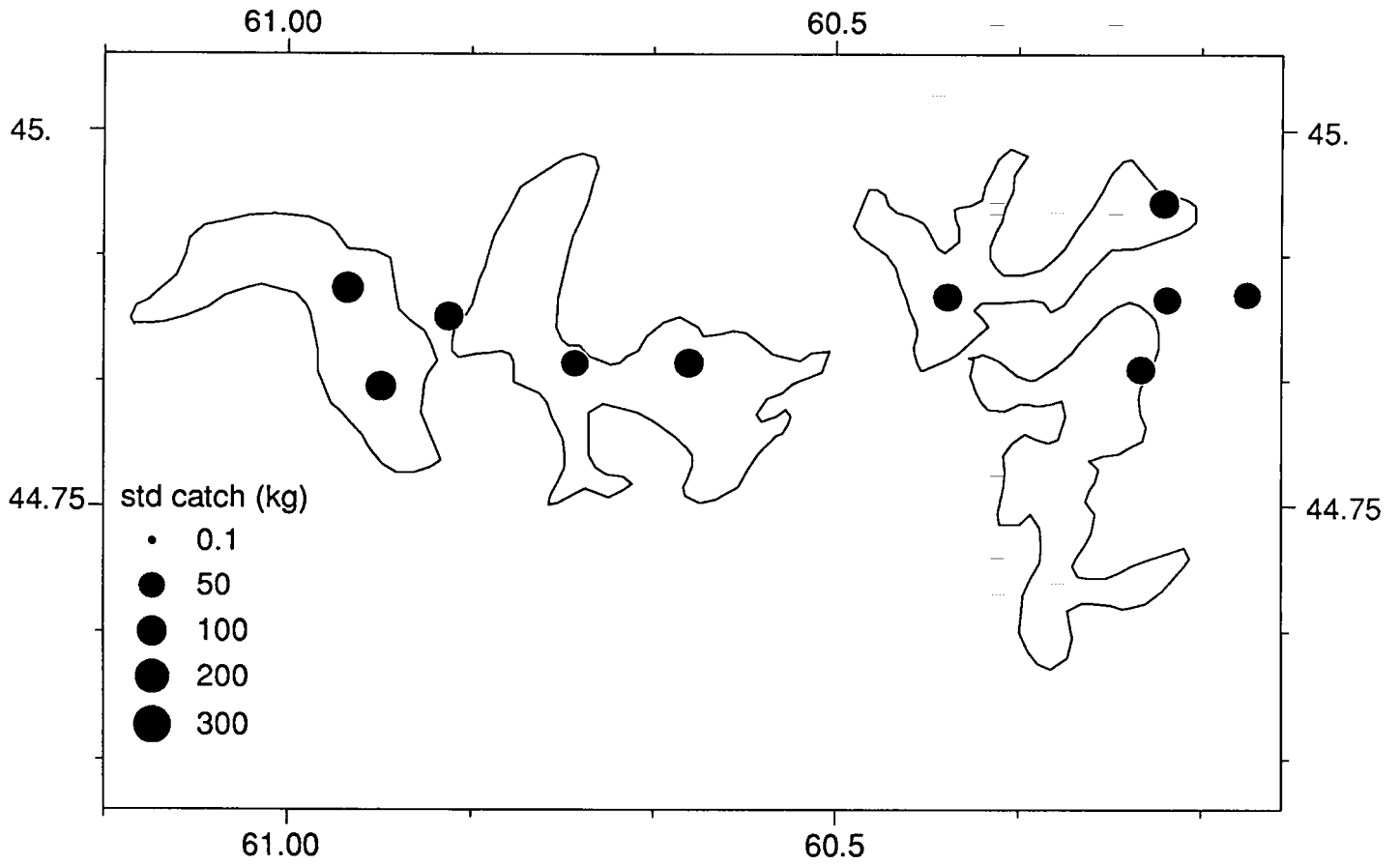


Figure 9. Catch per standard tow length for Canso (SFA 15) stations.

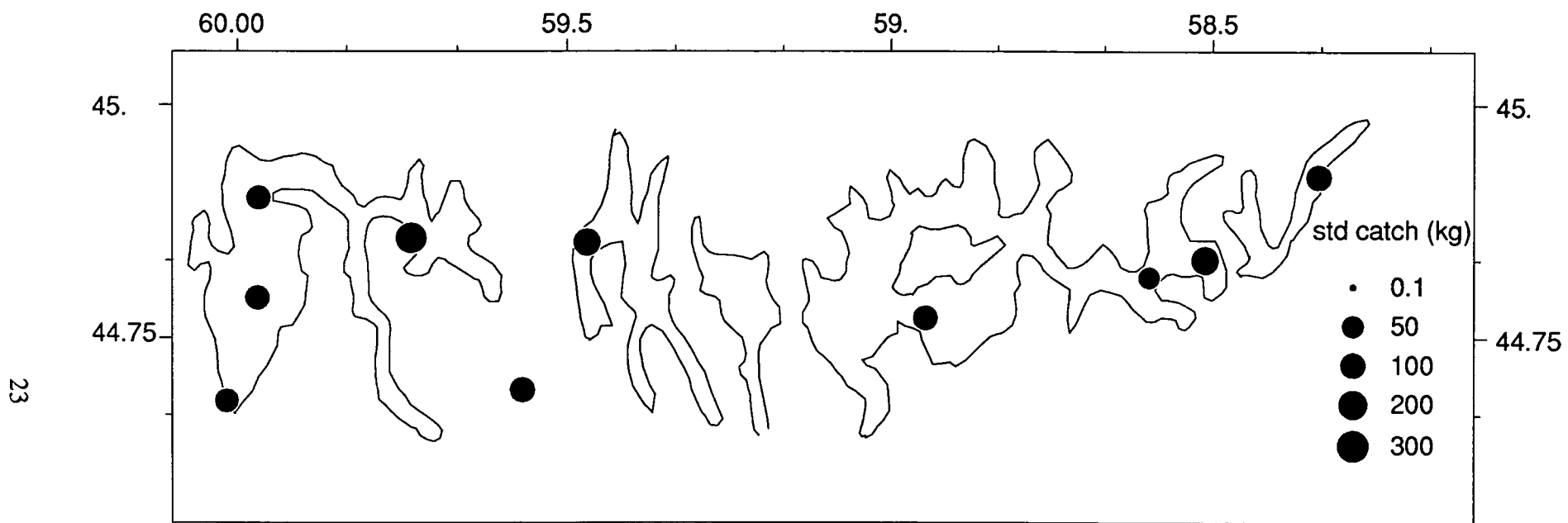


Figure 10. Catch per standard tow length for Misaine (SFA 14) stations.

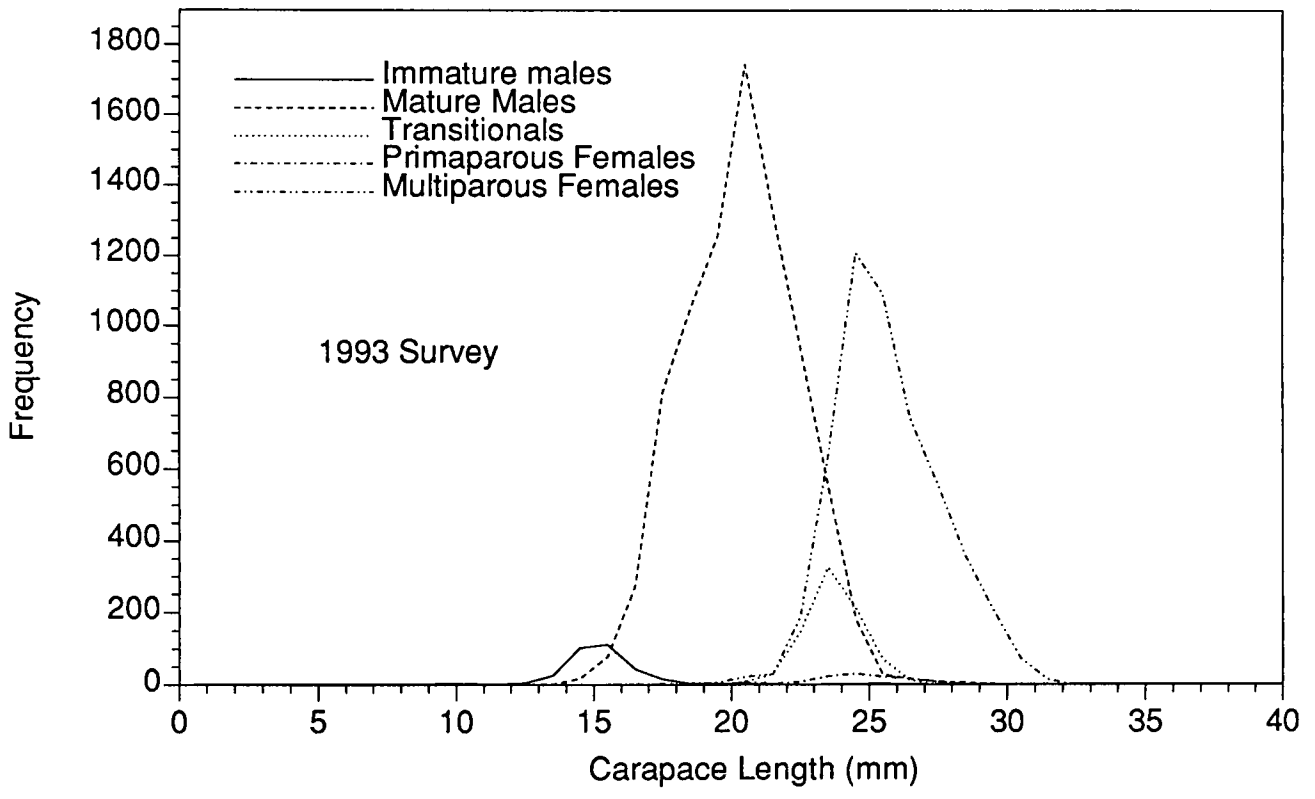
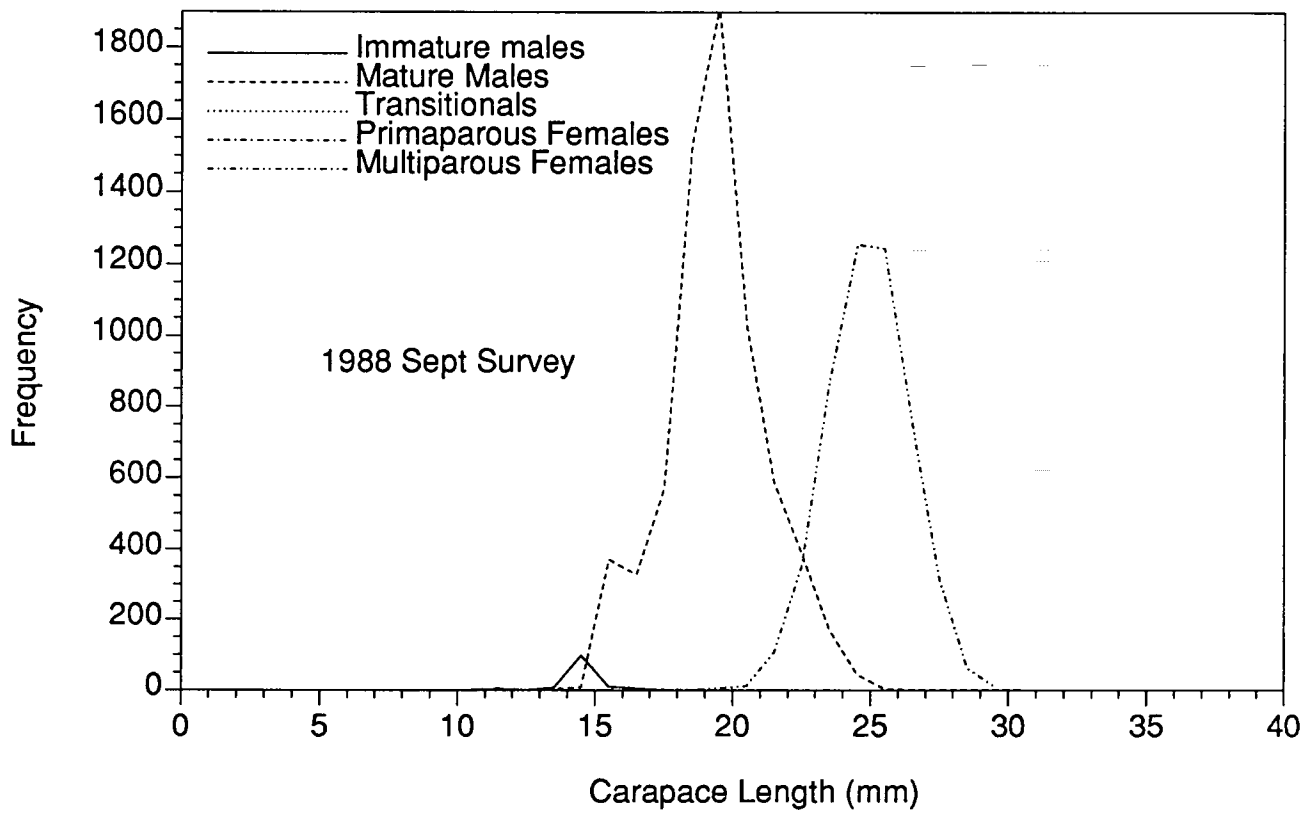


Figure 11. Shrimp length frequencies by sex from survey samples in 1988 and 1993.

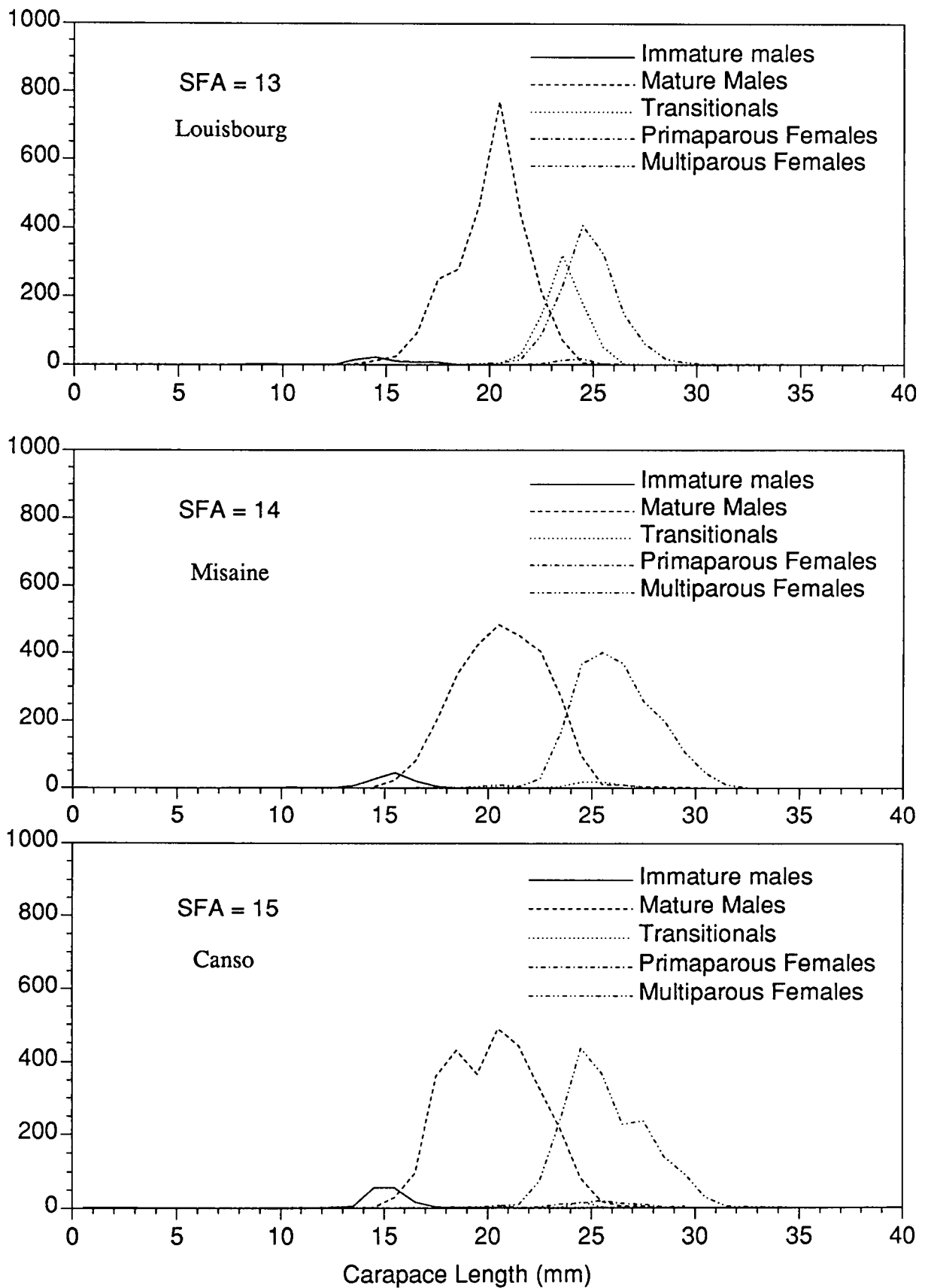


Figure 12. Length frequencies by sex for the three fishing areas from 1993 survey samples.

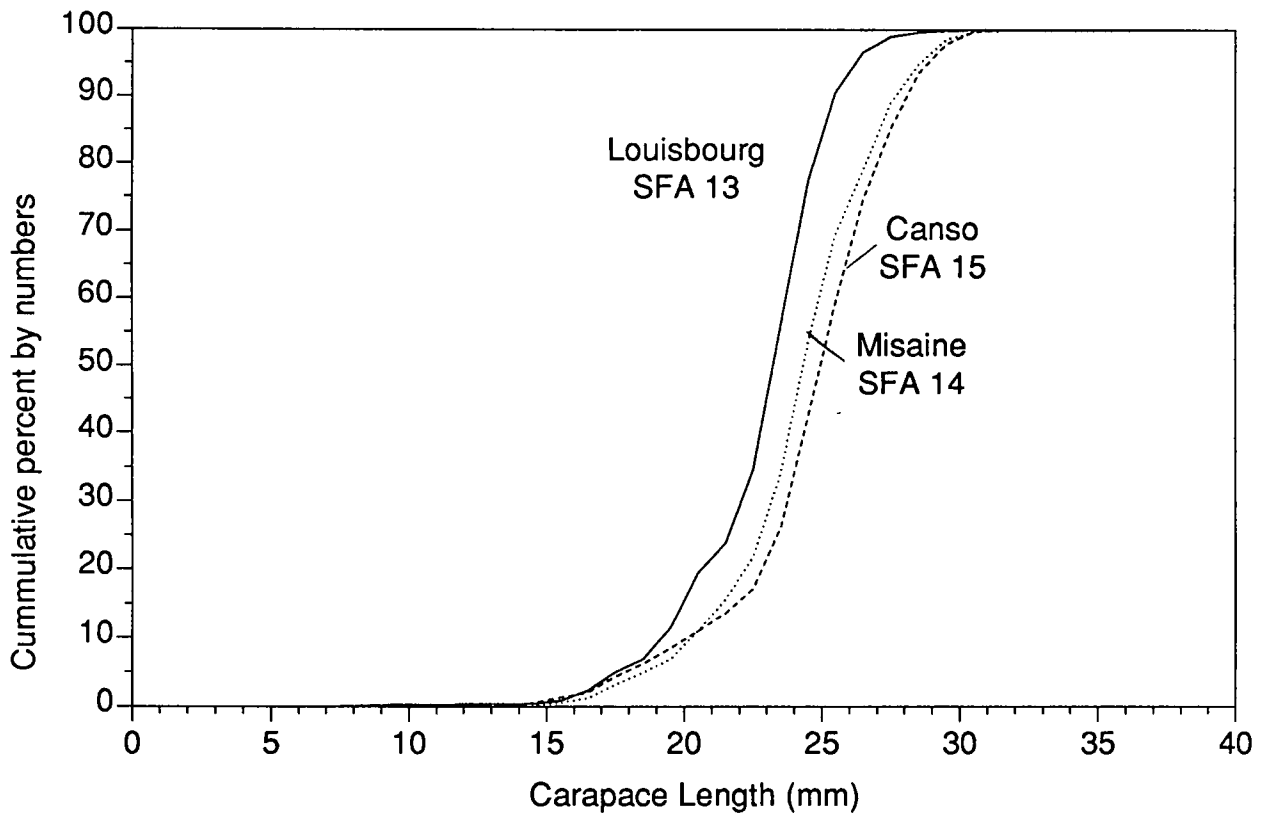


Figure 13. Cumulative frequency distributions for shrimp from the three fishing areas in 1993 survey.

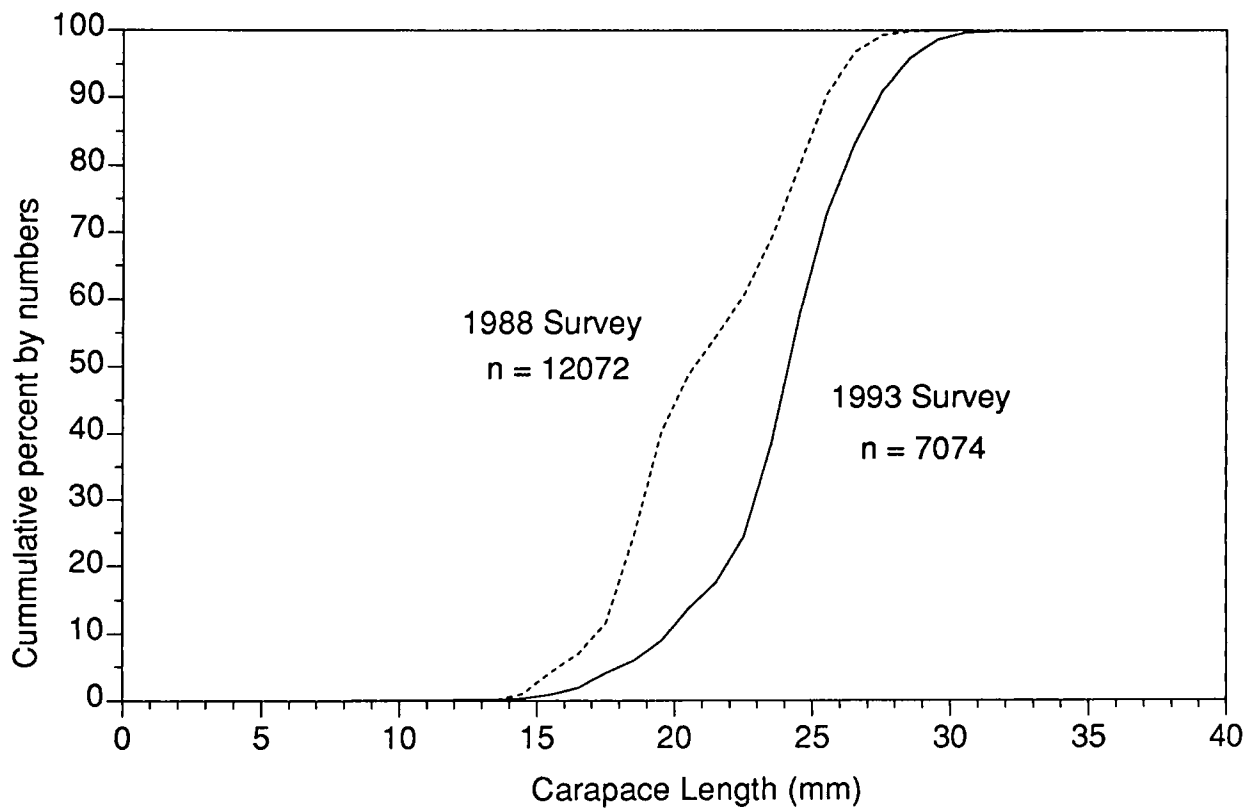


Figure 14. Cumulative frequency distributions of the 1988 and 1993 survey samples.