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**Status of the Scotian Shelf shrimp (*Pandalus borealis*) fishery 1994**

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. Last year the TAC was increased, with the recommendation that it be held at that level for several years to watch for evidence of impacts on the population.

Commercial CPUE indicates an increase in biomass over 1993, this is supported by fishermen's opinion as scored in a questionnaire. Limited port sampling data do not show any detrimental effect of the increased landings of the last few years on the population, as seen by the percentage of females carrying eggs, or changes in the size frequency distribution.

It is felt that the increased TAC applied last year should be held constant and monitored for at least another two years.

## Résumé

Ces dernières années, la pêche de la crevette (*Pandalus borealis*) dans la région de Scotia-Fundy s'est développée et ses débarquements atteignent maintenant un niveau record. L'an dernier, on a augmenté le TAC et recommandé qu'il reste au même niveau pendant plusieurs années afin que l'on puisse observer ses effets sur la population.

Les prises commerciales par unité d'effort (PUE) dénotent une hausse de la biomasse en 1993, ce que confirment les opinions exprimées par les pêcheurs dans un questionnaire. Les données limitées d'échantillonnage au port ne révèlent pas d'effet néfaste de la hausse des débarquements des quelques dernières années sur la population, d'après le pourcentage de femelles porteuses d'oeufs ou les changements dans la distribution de la fréquence des tailles.

On estime que le TAC accru adopté l'an dernier doit demeurer constant et être surveillé pendant au moins deux autres 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, the requirement for the use of a Nordmøre separator grate, and a Total Allowable Catch (TAC).

Up until 1992, this fishery had been under exploited, usually taking less than 10% of the TAC (Etter and Mohn 1989) (Figure 2). The main reason for this was that 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 was caught in 1992 and 1993 (Tables 1 and 2). In 1993, the quota for areas 14 and 15 was combined, and it was caught in these areas by July 12. In 1994, the TAC was increased and applied as a single TAC to all three fishing areas. In addition to this, the inshore component of the fleet chose to go with individual vessel quotas. This spread the landings out through the year, with landings recorded from March to December of 1994.

## Methods

### Commercial Data

Data on the fishery were 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 in the eighties 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 22 limited entry licences, and one exploratory licence that was not issued in 1994. All of the Scotia-Fundy vessels with limited entry licences for 4VW were active in 1993 (Table 4). All six eligible midshore vessels were active in 1994 (Table 5).

As part of an Industry-Government Working Group Agreement, only the six midshore Gulf vessels that have a history of fishing in this area are eligible to fish in SFA 13 to 15 for the 1993 to 1995 period. 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.

The quota for the area is split, with 75% allocated to the inshore category and 25% to the midshore. 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 has been 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 the longest history in the fishery and the CPUE index that has been used in the past is based on correction factors to convert catch rates for the various types of trawls to that of a standard, a Western 2A (Table 2).

This year, in order to have a more analytical analysis, the CPUE from twenty vessels that had fished in 1993 and 1994 were analyzed with a multiple regression model using year, month, area and vessel as categorical components. As the main point of interest was the year effect and the data series is short, interactions were not examined in this model. It is felt that although some of the interactions would be significant and improve the fit of the model, the model is not a predictive one and so the best fit is not the goal. With only two years of data, interpretation of the meaning of the interactions would be conjecture at best, and thus they were not included.

### **Port Sampling**

An attempt to collect port samples through the groundfish port sampling program encountered many problems, and was only successful in gathering partial information from six samples in May to October.

A complete sample was obtained from late in the season in conjunction with an experimental inshore trap fishery.

### **Questionnaire**

A questionnaire was circulated to all licence holders after the end of the season (Appendix A). The purpose of the questionnaire was to gather more information on the gear being used in the fishery, and to attempt to incorporate the knowledge of the fishermen in a non-subjective manner. It asked them to compare 1994 to 1993, and rate their catch rate, their overall impression of shrimp abundance, and the level and areal distribution of effort. All ratings were on a five point scale. It also asked for their impression of the use of a TAC as a management tool. They were asked to rate the use of a TAC, if the present size is appropriate, the use of individual vessel quotas, and the application of a single TAC to the whole area.

### **Survey Data**

There was no survey conducted in 1994 but another industry-sponsored survey using a commercial vessel is planned for 1995. The biomass estimates for the past surveys are given in Table 6.

## **Results**

### **Commercial data**

The distribution of commercial effort, CPUE, catch and counts for the three areas for 1994 are shown in Figures 3 to 8. The CPUE index from the Gulf vessels (Table 2) shows an increase over last year in both the unstandardized and standardized series (Figure 9).

The data from the questionnaire on the size of gear being used show some of the problems with the use of correction factors to standardize CPUE. The initial correction factors were based on the ratio of the product of wingspread and headrope height of the trawl in question, to that of a Western 2A. One of the vessels that has been in this series from the start has always used the same brand name of trawl. When the standardization was first set up the dimensions of the trawl were a 59 foot wingspread and a 16.4 foot headrope height. This gave a correction factor of 3 for converting to a Western 2A. The type of trawl has stayed the same

through time and so the correction factor for this vessel has remained constant. The questionnaire shows that this gear now has a wingspread of 135 feet and a headrope height of 26 feet. This would give it a correction factor of 11.1 instead of 3. Even with accurate dimensions of the trawls, these conversion factors are rough ratios of the area swept by the gear, and do not take into account the gear geometry or the vertical distribution of the shrimp. This would mean they are not accurate measures of the relative fishing power of the trawls.

The linear regression analysis of CPUE (Table 7) shows that Year, Month, Area and Vessel effects were all highly significant. The main effect of interest, Year, shows that the catch rate in 1994 was significantly higher than in 1993. A post Hoc test (Tukey HSD multiple comparisons) of the significant Area effect shows that SFAs 14 and 15 were not significantly different but that SFA 13 was significantly ( $P = 0.000$  and  $0.04$ ) lower than the others.

### **Port sampling**

The size frequency distributions from the last DFO survey in the fall of 1988, the industry survey in 1993, and the July to November port samples from 1994, are compared in Figure 10. The breakdown of ovigerous versus non-ovigerous females, in comparison to past samples, is given in Table 8.

### **Questionnaire**

At the time of this report, questionnaires had been received from 20 of the 29 active licence holders. The results for the ratings are given in Table 9. Not all questions were answered on some of the replies. Two fishermen stated that they did not score the first four questions as this was their first year fishing, and so they could not make comparisons to 1993. Others did not supply a reason for not answering all questions.

The opinion of the fishermen, as given in the questionnaire, indicates an increase in biomass. The two ratings of 1 in the first two questions were given by a fisherman that explained in the comments that he had problems with his gear in 1994, and so although he based his answers on his fishing success he felt that "It seemed like every year from the start (1989) the stocks have looked better than the year before and last year being the best ever". This means that 100% of the fishermen say catch rates are stable to increasing, and 100% say that the biomass is higher to much higher in 1994 than in 1993. Since this is a limited entry fishery, the scoring of effort as similar to 1993 is expected. A fisherman giving a score of 1 in the third question accompanied it with the comment that the individual quotas had spread out the fleet through the year. The questions on management show a strong preference for a TAC, with most saying it is about the right size, but more scoring it as too low than too high. On the question on individual vessel quotas, there was a lot of comments to the effect that they were favored if they were non-transferable but opposed otherwise. The three captains scoring as strongly opposed to them were all midshore vessels, which are presently fishing competitively for the midshore 25% of the TAC. Some of the opposition from this fleet may come from the fact that there is now a reallocation of uncaught quota within the inshore fleet prior to reallocating between fleet sectors. This reduces the chances of the midshore fleet receiving more quota towards the end of the year. Two midshore captains were also the only two not favoring a single TAC for the three SFAs rather than separate ones.

Attached comments, some several pages long, supported the scoring and added some additional information. There were two comments that with the introduction of vessel quotas for the inshore segment of the fleet, and the spreading out of the effort through the year, that more effort was put into finding areas with large shrimp and that areas of small shrimp were avoided. The comparison of the port sampling length frequencies with those from the last two surveys supports this. There is a definite shift to larger sizes in the distribution. The combination of these factors was also felt to have kept the price up through the year.

## 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 increased TAC. The amount of shrimp being taken out of this area has increased dramatically the last three 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 life span of the organism being exploited and shrimp are relatively short lived, but neither of these effects are obvious in this fishery.

The distribution of effort and catch shows that the combining of the quotas for the three areas has resulted in a greater concentration of the fishery in Misaine Hole. The ability to take their quota anywhere in the three areas, and the increased targeting of large shrimp should be beneficial to the fishery from a yield-per-recruit standpoint. Fishing mortality is shifted off of the younger, immature shrimp and onto the older shrimp. As long as the reproductive potential of the stock is not threatened, this would allow a slight increase in fishing mortality while still optimizing yield-per-recruit.

The regression analysis of the data provides a much more powerful tool for examining trends in CPUE than the use of conversion factors. As more data are obtained, differences between vessels can be examined to see what controls them. It may be possible to group similar vessels, or to analyze them using a non-categorical measure of fishing power. As more data for the latter half of the year are obtained, seasonal trends in CPUE can be examined in relation to life-history patterns or suspected movements in and out of the holes.

The significant increase in CPUE over 1993 shown in this analysis is an indication of an increase in abundance, but there are two important but opposing factors that may be influencing it. This is still a fairly new fishery and the captains of the vessels are gaining experience each year. This could result in an increasing CPUE even with a stable biomass. An opposing factor is indicated by the comments from the inshore fishermen suggesting that with the introduction of vessel quotas they put more effort into finding large shrimp. This would be expected to produce a slight drop in CPUE if large shrimp did not always give the highest catch rate. These factors mean that the interpretation of an increasing CPUE as indicating an increasing biomass should be made with caution, but it is an interpretation supported by the results of the questionnaire.

It is often commented that the fishermen are the ones that are closest to what is going on in the fishery, and not enough use is made of their knowledge. The method of using a questionnaire with a scoring system holds promise as a means of using this information in a quantitative fashion. By quantifying the opinions of the fishermen in this manner, one can incorporate it into the assessment process and make statistical comparisons from year to year and between categories of fishermen.

The indications are that this is a healthy stock. Questionnaire results show that the fishermen believe that their catch rates are up and that abundance has increased over last year. There are some small shrimp showing in the length frequencies, over 99% of the females were carrying eggs in the November sample, and CPUE appears to be increasing. It is recommended that the TAC remain at its present level for at least another two years, and that port sampling be increased to monitor changes in the stock structure.

## References

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Table 1. TACs and total catch (t) for the Scotian Shelf shrimp fishery, 1980 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	1160	1050	370	2580	93
1990	1160	1050	370	2580	104
1991	1160	1050	370	2580	804
1992	1160	1050	370	2580	1850
1993	1160	1490*		2720*	2044
1994		3100		3100	3074

\* 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
1994	8	2656	410	3074	202.4	54.5

\* CPUE from Gulf based vessels.

\*\* 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
1994	25	75

Table 4. Limited entry and exploratory shrimp licenses issued in Scotia-Fundy from 1985 to 1994 according to designated fishing areas. Number in brackets is number of active licences.

NAFO Area						
Year	Exploratory 4VW	Limited Entry			Total	Active
		4VW	4VWX	4X		
1985		7 (0)	2 (0)	19 (0)	28	0
1986		6 (0)	3 (0)	18 (0)	27	0
1987		5 (1)	3 (0)	17 (0)	25	1
1988		5 (1)	3 (0)	17 (0)	25	1*
1989		5 (0)	3 (0)	17 (2)	25	2
1990	12 (3)	5 (0)	4 (0)	16 (0)	37	3
1991	9 (6)	5 (4)	4 (0)	16 (0)	34	10
1992	14 (14)	5 (2)	4 (4)	16 (1)	39	21
1993	14 (13)	5 (5)	4 (4)	15 (2)	38	24
1994	**	18 (18)	4 (4)	15 (1)	37	23

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

\* Does not include an offshore vessel permitted to fish in 4VW in 1988.

\*\* There is one exploratory licence but it was not issued in 1994.

Table 5. 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
1994	-	6*	6

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.

Table 6. Biomass estimates (t) from Spring and Fall surveys for 1982-1993.

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

Table 7. Output from multiple regression analysis of shrimp logbook data for 1993-1994.

LEVELS ENCOUNTERED DURING PROCESSING ARE:					
YEAR					
93	94				
MONTH					
3	4	5	6	7	8
9	10	11	12		
VESSEL					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16		
SFA					
13	14	15			

11 CASES DELETED DUE TO MISSING DATA.

DEP VAR: LNCPUE N: 1042 MULTIPLE R: 0.568  
SQUARED MULTIPLE R: 0.322

ESTIMATES OF EFFECTS B =  $(X'X)^{-1} X'Y$

		LNCPUE
CONSTANT		4.868
YEAR	93	-0.141
MONTH	3	0.429
MONTH	4	-0.336
MONTH	5	0.145
MONTH	6	0.228
MONTH	7	0.107
MONTH	8	0.165
MONTH	9	-0.068
MONTH	10	-0.451
MONTH	11	-0.312
VESSEL	1	0.058
VESSEL	2	0.227
VESSEL	3	0.266
VESSEL	4	0.069
VESSEL	5	-0.108
VESSEL	6	-0.017
VESSEL	7	0.073
VESSEL	8	-0.287
VESSEL	9	-0.072
VESSEL	10	-0.427
VESSEL	11	0.204
VESSEL	12	-0.061
VESSEL	13	-0.194
VESSEL	14	0.036
VESSEL	15	0.268
SFA	13	-0.147
SFA	14	0.113

Table 7 - Continued.

ANALYSIS OF VARIANCE					
Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
YEAR	8.329	1	8.329	36.402	0.000
MONTH	24.683	9	2.743	11.987	0.000
VESSEL	30.484	15	2.032	8.882	0.000
SFA	4.496	2	2.248	9.824	0.000
ERROR	231.998	1014	0.229		

## LEAST SQUARES MEANS.

			LS MEAN	SE	N
YEAR	=	93	4.727	0.046	500
YEAR	=	94	5.009	0.047	542
MONTH	=	3	5.297	0.248	4
MONTH	=	4	4.532	0.067	72
MONTH	=	5	5.013	0.036	354
MONTH	=	6	5.096	0.037	253
MONTH	=	7	4.975	0.046	156
MONTH	=	8	5.034	0.056	101
MONTH	=	9	4.801	0.076	49
MONTH	=	10	4.417	0.109	22
MONTH	=	11	4.556	0.145	12
MONTH	=	12	4.962	0.117	19
VESSEL	=	1	4.926	0.065	82
VESSEL	=	2	5.095	0.108	25
VESSEL	=	3	5.134	0.114	22
VESSEL	=	4	4.937	0.088	42
VESSEL	=	5	4.760	0.068	70
VESSEL	=	6	4.851	0.104	27
VESSEL	=	7	4.942	0.066	88
VESSEL	=	8	4.581	0.075	59
VESSEL	=	9	4.796	0.055	92
VESSEL	=	10	4.441	0.074	58
VESSEL	=	11	5.072	0.061	86
VESSEL	=	12	4.807	0.060	104
VESSEL	=	13	4.674	0.058	102
VESSEL	=	14	4.904	0.075	60
VESSEL	=	15	5.136	0.066	98
VESSEL	=	16	4.836	0.102	27
SFA	=	13	4.721	0.062	188
SFA	=	14	4.981	0.042	691
SFA	=	15	4.902	0.056	163

Table 7 - Continued.

**POST HOC TEST OF LNCPUE FOR EFFECT: Shrimp Fishing Area**  
**USING LEAST SQUARES MEANS.**

USING MODEL MSE OF 0.229 WITH 1014. DF.  
 MATRIX OF PAIRWISE MEAN DIFFERENCES:

	13	14	15
13	0.000		
14	0.260	0.000	
15	0.181	-0.079	0.000

**TUKEY HSD MULTIPLE COMPARISONS.**  
**MATRIX OF PAIRWISE COMPARISON PROBABILITIES:**

	13	14	15
13	1.000		
14	0.000	1.000	
15	0.043	0.205	1.000

Table 8. Numbers of ovigerous/non-ovigerous individuals in samples from research cruises.

	Cruise	Non-ovigerous Females	Ovigerous Females	% Ovigerous
Spring	Apr 82	2638	650	19.8
	May 83	1330	2085	61.1
	May 84	2574	12	0.5
	Apr 85	3211	246	7.1
	May 86	1286	866	40.2
	May 87	351	1567	81.7
	May 88	2022	530	20.8
Fall	Nov 82	52	7016	99.3
	Nov 83	11	2917	99.6
	Oct 84	15	5716	99.7
	Oct 85	21	6551	99.7
	Oct 86	40	6396	99.4
	Oct 87	14	5852	99.8
	Sep 88	71	4920	98.6
1993 survey tows				
SFA 13	Jul 23-24	1236	114	8.4
SFA 15	Aug 17-19	321	1653	83.7
SFA 14	Sept 1-2	94	1889	95.3
Total		1651	3656	68.9
1994 November Port sample		2	258	99.2

Table 9. Results from questionnaire.

Question	Frequency of Score				
	1	2	3	4	5
<b>Stock status in shrimp fishing areas 13, 14 and 15</b>					
Your shrimp catch per haul in 1994 was:					
1 - much lower, 3 - about the same, 5 - much higher than in 1993.	1	0	4	4	7
Compared to 1993, in 1994 there was: 1 - Much less shrimp, 3 - about the same amount of shrimp, 5 - much more shrimp than in 1993.					
	1	0	0	2	14
<b>Fishing Effort</b>					
Compared to 1993 the fleet fishing effort in 1994 was:					
1 - much lower, 3 - about the same, 5 - much higher than in 1993.	2	0	11	2	2
Compared to 1993 the fishing effort in 1994 took place in:					
1 - a much smaller area, 3 - about the same area, 5 - a much larger area than 1993.	1	0	11	0	4
<b>Management of the fishery</b>					
Your feeling about an overall Total Allowable Catch (TAC) for shrimp is:					
1 - strongly against a TAC, 3 - neutral, 5 - strongly in favor of a TAC.	0	0	4	3	10
The current size of the shrimp Total Allowable Catch is:					
1 - much too low, 3 - about the right size, 5 - much too high.	3	3	12	1	0
The TAC for the <65' sector is divided into individual vessel quotas. Are you:					
1 - strongly against them, 3 - neutral, 5 - strongly in favor of them.	3	0	3	1	13
Your feeling about a single Total Allowable Catch (TAC) for shrimp fishing areas 13, 14, and 15 instead of separate TAC's for each area is:					
1 - strongly favour separate TAC's for each area, 3 - neutral, 5 - Strongly favour a single TAC.	2	0	0	0	16

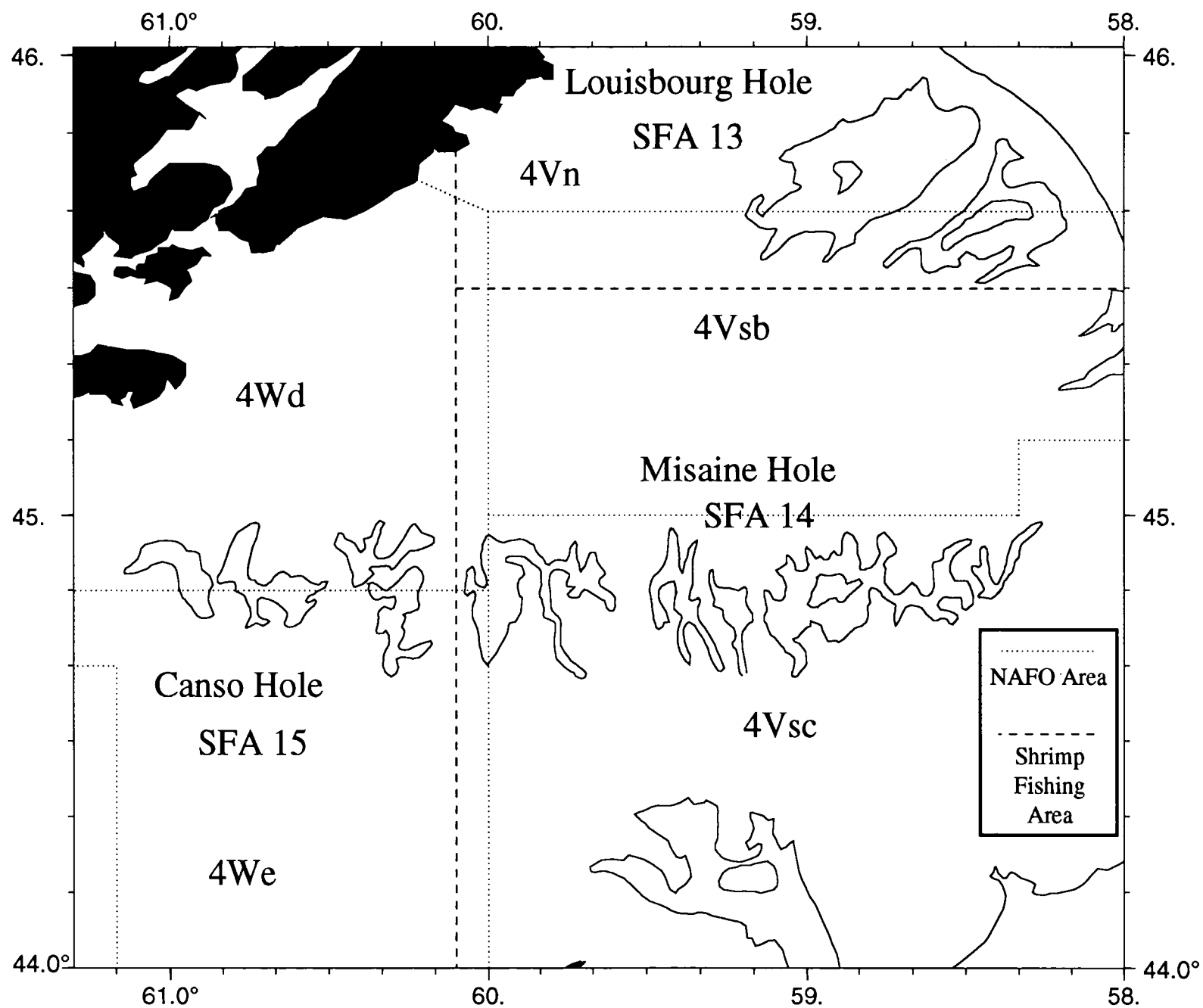


Figure 1. Shrimp Fishing areas on the Eastern Scotian Shelf.

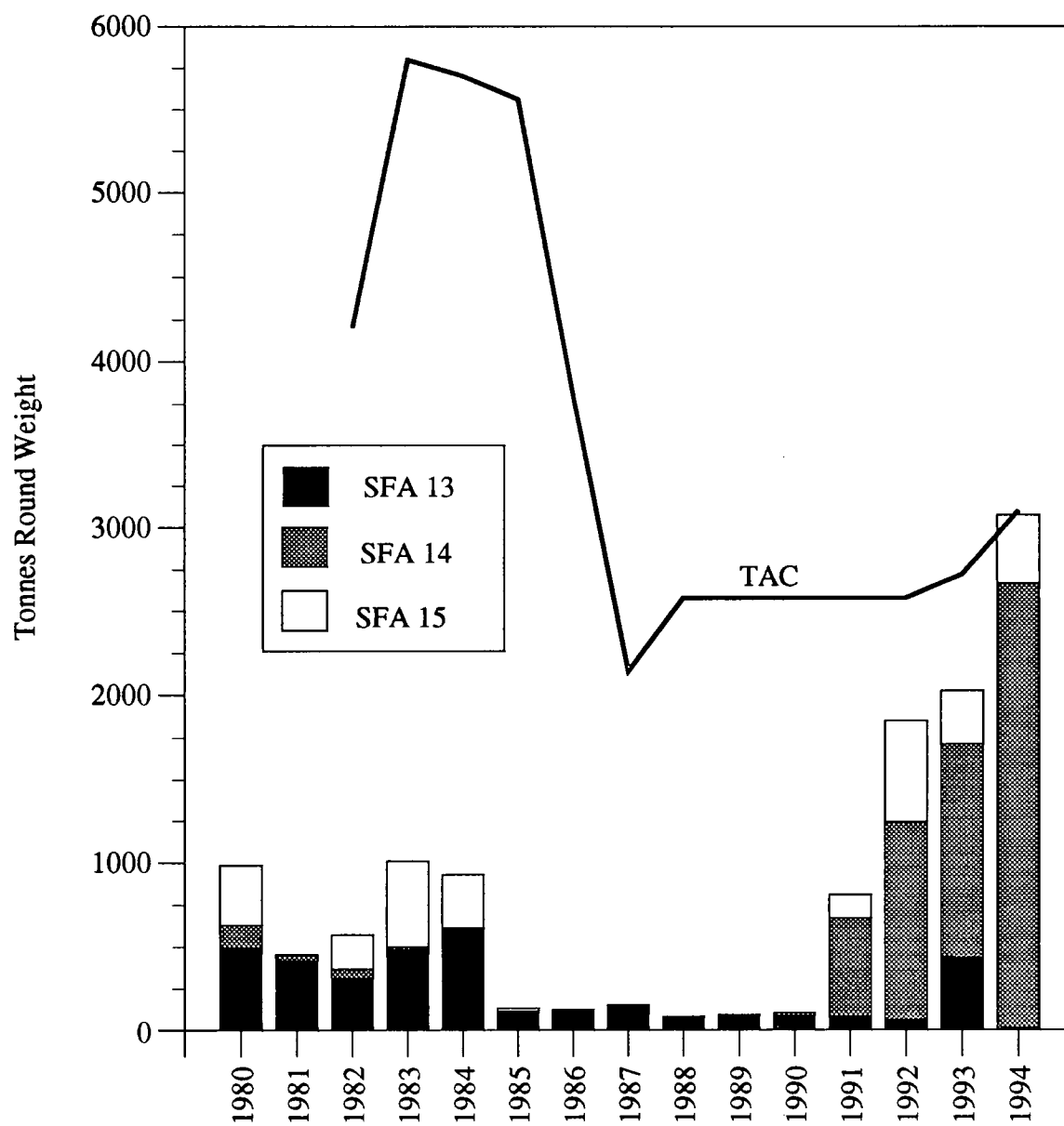


Figure 2. Shrimp landings and Total Allowable Catch (TAC) for the three Shrimp Fishing Areas (SFA) on the Eastern Scotian Shelf.



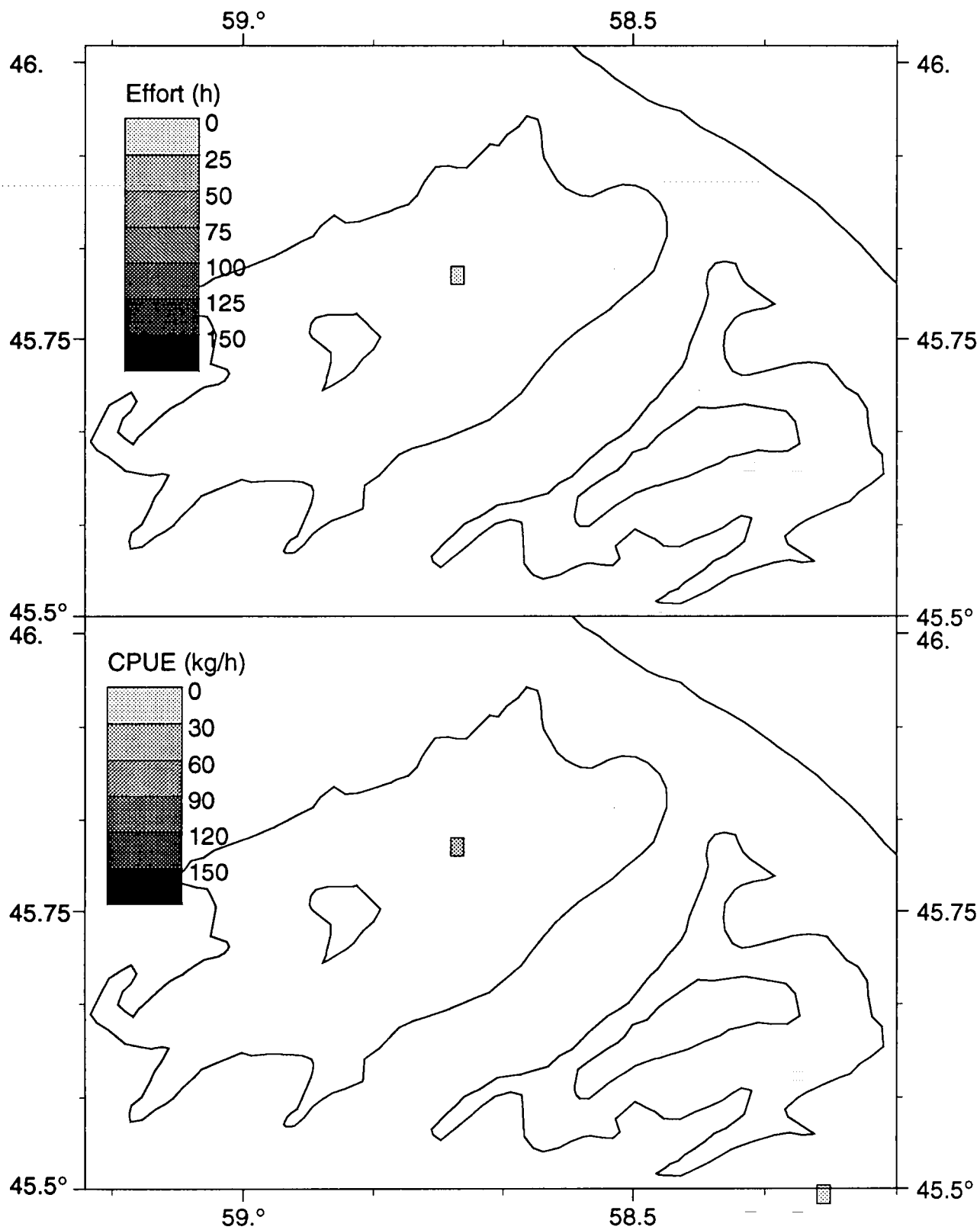


Figure 3. Distribution of effort and CPUE aggregated by one minute squares from commercial log data in SFA 13, Louisbourg Hole, for 1994.

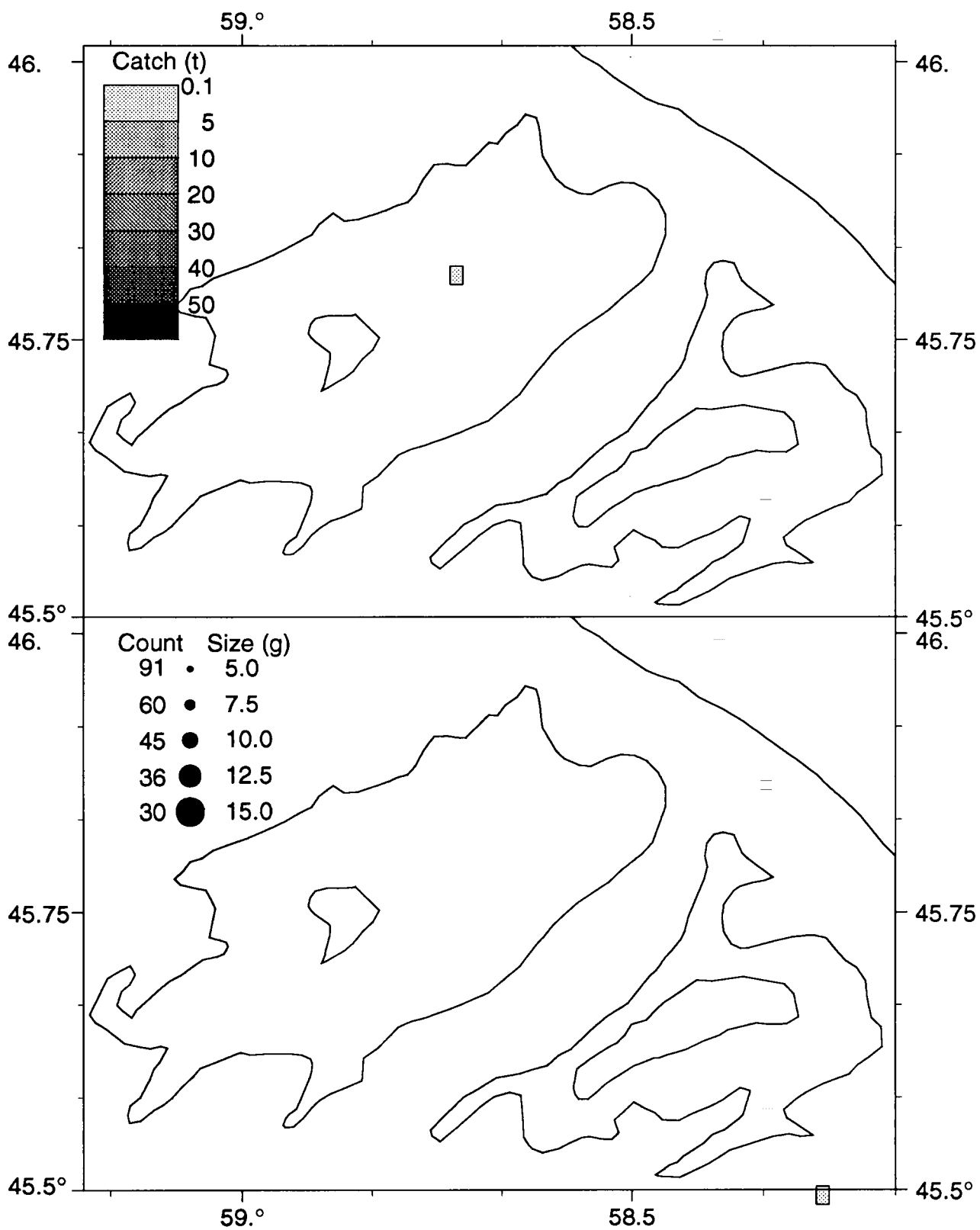


Figure 4. Distribution of commercial catch aggregated by one minute squares and of mean shrimp sizes in SFA 13, Louisbourg Hole, from logbooks for 1994.

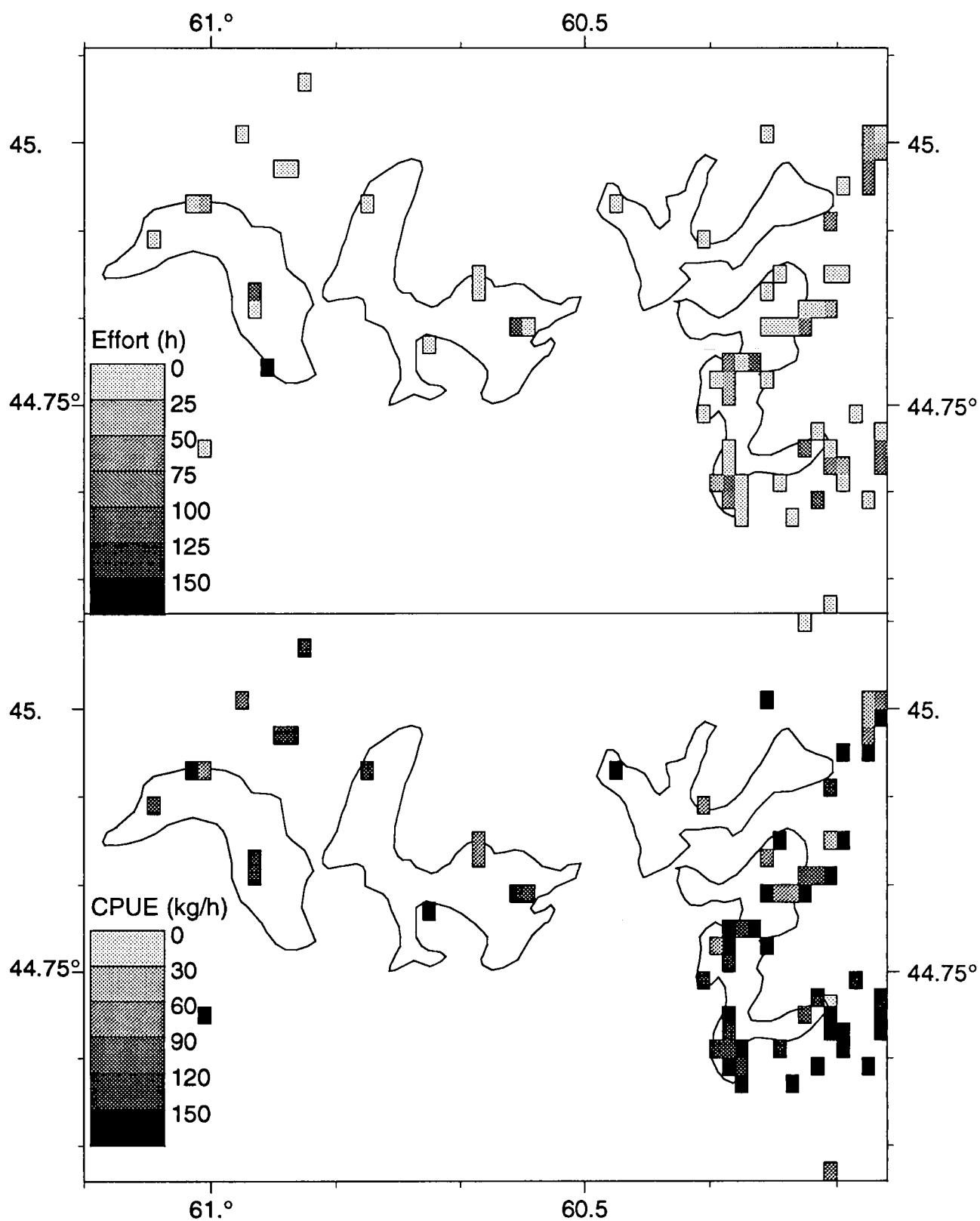


Figure 5. Distribution of effort and CPUE aggregated by one minute squares from commercial log data in SFA 15, Canso Hole, for 1994.

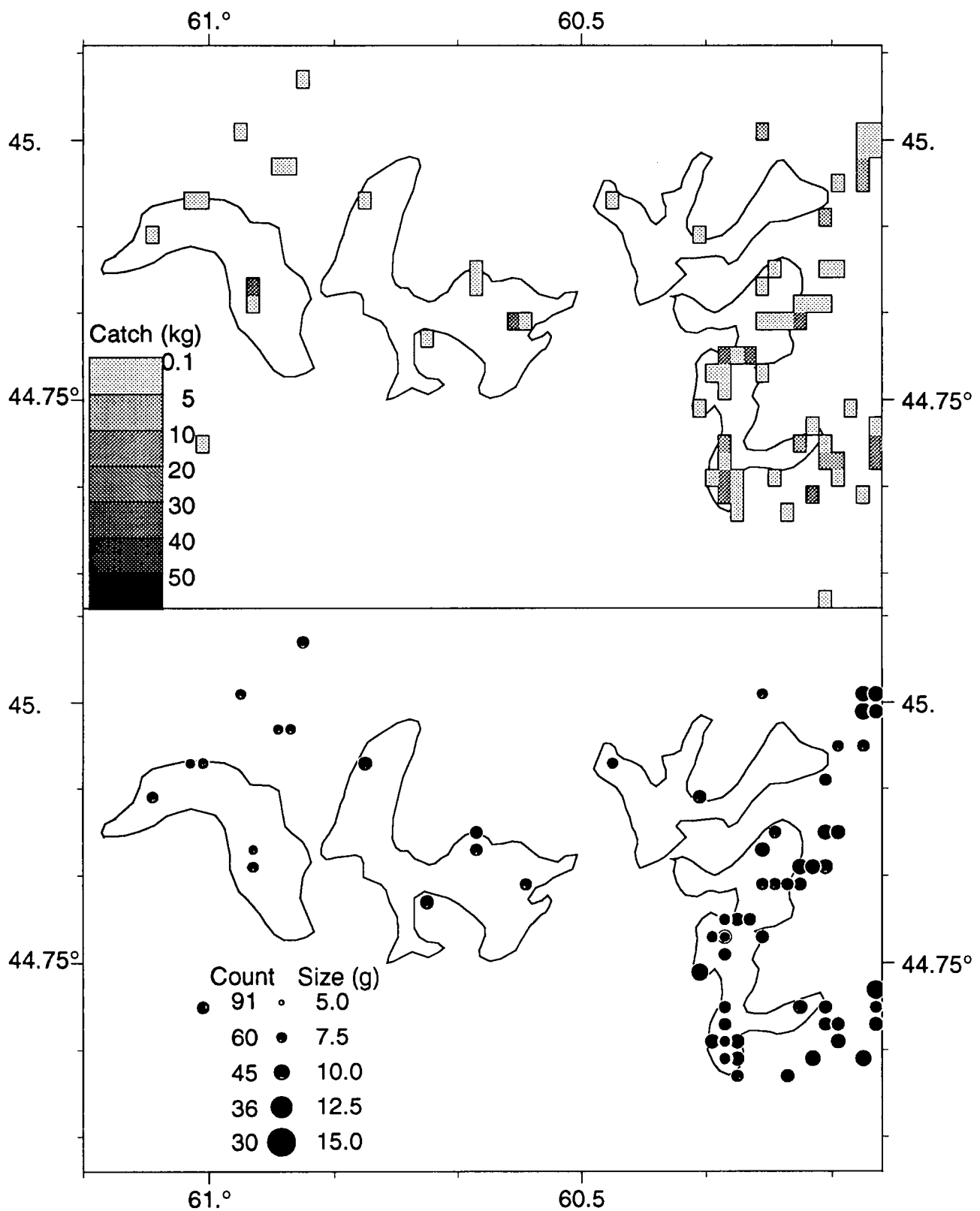


Figure 6. Distribution of commercial catch aggregated by one minute squares and of mean shrimp sizes in SFA 15, Canso Hole, from logbooks for 1994.

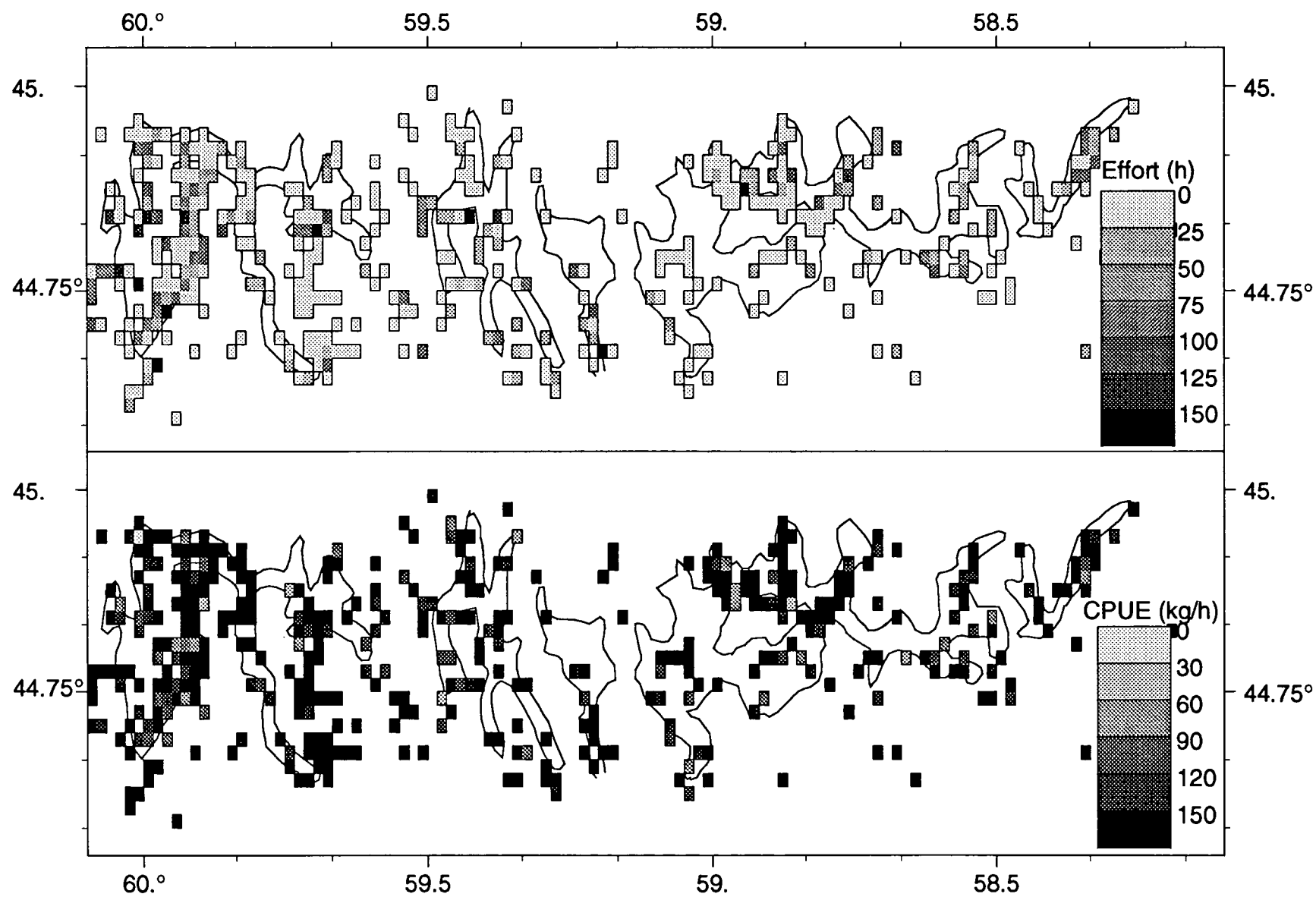


Figure 7. Distribution of effort and CPUE aggregated by one minute squares from commercial log data in SFA 14, Misaine Hole, for 1994.

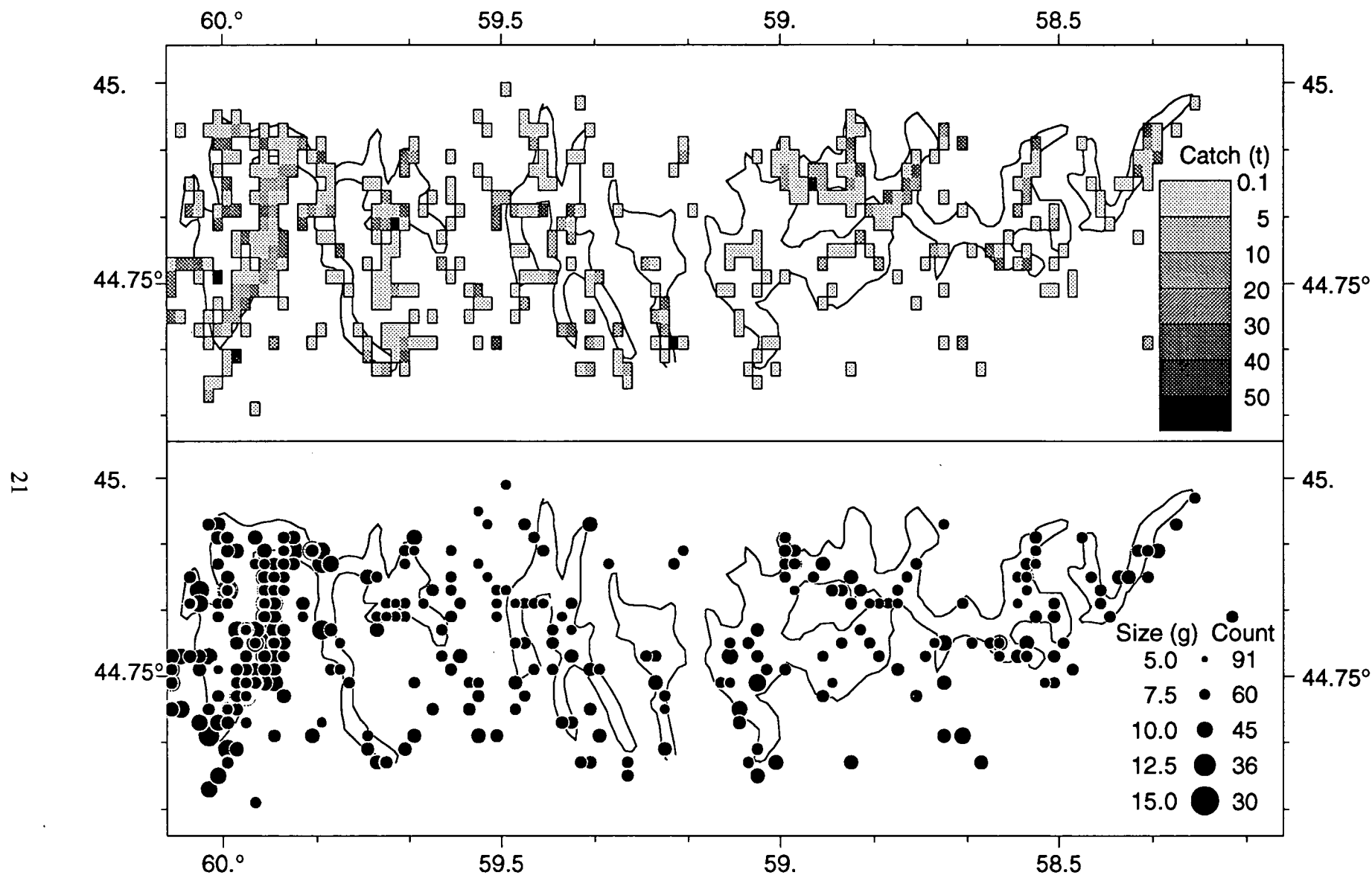


Figure 8. Distribution of commercial catch aggregated by one minute squares and of mean shrimp sizes in SFA 14, Misaine Hole, from logbooks for 1994.

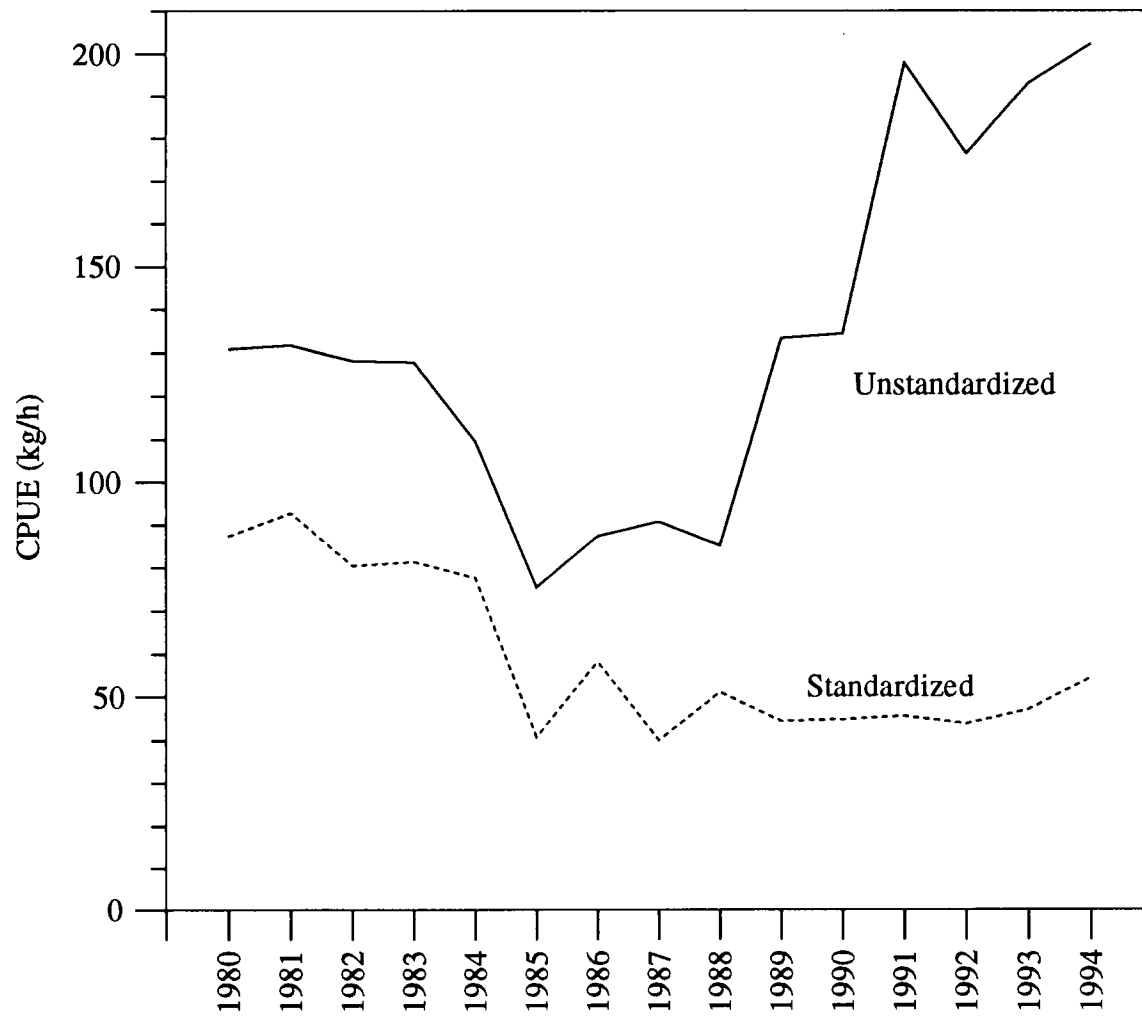


Figure 9. Unstandardized and standardized CPUE (kg/h) for the >65' LOA fleet sector.

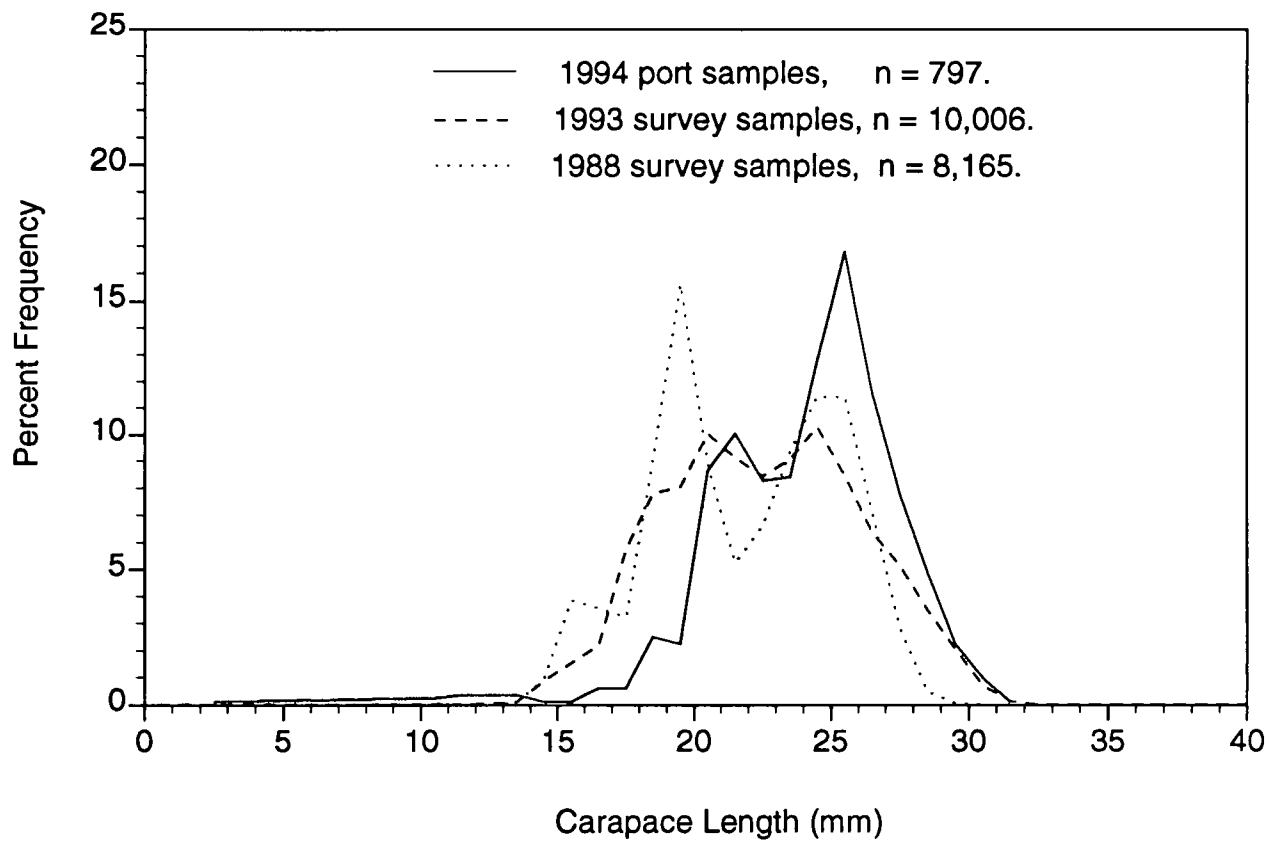


Figure 10. Comparison of 1988, 1993 and 1994 length frequency distribution.



## Appendix A: Questionnaire on the Scotian Shelf Shrimp fishery

### Background

Name of Captain completing this questionnaire: \_\_\_\_\_

Shrimp license number: \_\_\_\_\_

CFV number: \_\_\_\_\_

Percentage of the above vessels shrimp trips in 1994 for which you were aboard: \_\_\_\_\_

Total number of years (not necessarily continuous) you have fished shrimp: \_\_\_\_\_

Total number of years (not necessarily continuous) you have fished with any type of trawl: \_\_\_\_\_

### Shrimp Gear used in 1994

What is the type/make of shrimp trawl used on this vessel: \_\_\_\_\_

Who is the manufacturer: \_\_\_\_\_

What type/make of doors are used: \_\_\_\_\_

What is the wingspread (state whether in feet or meters): \_\_\_\_\_

What is the headrope height (state whether in feet or meters): \_\_\_\_\_

### Please circle the appropriate number in answer to the following questions

#### Stock status in shrimp fishing areas 13, 14 and 15

Your shrimp catch per haul in 1994 was:

1 - much lower, 3 - about the same, 5 - much higher than in 1993. 1 2 3 4 5

Compared to 1993, in 1994 there was: 1 - Much less shrimp, 3 - about the same amount of shrimp, 5 - much more shrimp than in 1993.

1 2 3 4 5

#### Fishing Effort

Compared to 1993 the fleet fishing effort in 1994 was:

1 - much lower, 3 - about the same, 5 - much higher than in 1993. 1 2 3 4 5

Compared to 1993 the fishing effort in 1994 took place in:

1 - a much smaller area, 3 - about the same area, 5 - a much larger area than 1993. 1 2 3 4 5

#### Management of the fishery

Your feeling about an overall Total Allowable Catch (TAC) for shrimp is:

1 - strongly against a TAC, 3 - neutral, 5 - strongly in favor of a TAC. 1 2 3 4 5

The current size of the shrimp Total Allowable Catch is:

1 - much too low, 3 - about the right size, 5 - much too high. 1 2 3 4 5

The TAC for the <65' sector is divided into individual vessel quotas. Are you:

1 - strongly against them, 3 - neutral, 5 - strongly in favor of them. 1 2 3 4 5

Your feeling about a single Total Allowable Catch (TAC) for shrimp fishing areas 13, 14, and 15 instead of separate TAC's for each area is:

1 - strongly favour separate TAC's for each area, 3 - neutral, 5 - Strongly favour a single TAC. 1 2 3 4 5

Use back of sheet for additional comments.