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Scotia-Fundy Shrimp Stock Status - 1987

by

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Abstract

The Scotia-Fundy shrimp (*Pandalus borealis*) fishery covers three areas with depths > 100 fm, referred to as Canso, Louisbourg, and Misaine holes. These areas have been continuously underexploited over the past years, as in 1987 only 152 t (7.1%) of the total quota of 2140 t were taken. This represents an exploitation rate of 2.0% based on the total biomass estimate (Etter and Mohn, 1987).

Effort was low again this year with seven boats reporting catches. Of these, three were from New Brunswick (>65 ft) and accounted for about 91% of the total catch. Of the total, 148 t was taken from the Louisbourg area which was 13.8% of the Louisbourg quota of 1070 t. The remaining 4 t was caught in Misaine with no catches reported in Canso. The other four boats involved in the fishery were Cape Breton based vessels (<65 ft). The fleet fished mainly with the Sputnik and Yankee 41 shrimp trawls with a regulation 40 mm mesh size. This fishery is seriously affected by a 10% by-catch limit which is difficult to attain in this area.

Résumé

La pêche à la crevette nordique (Pandalus borealis) de la région Scotia-Fundy couvre trois zones situées à des profondeurs de plus de 100 brasses, désignées sous le nom de trous de Canso, de Louisbourg et de Misaine. Au cours des dernières années, ces zones ont toujours été sous-exploitées: en 1987, seulement 152 t (7,1 %) du contingent toal de 2140 t ont été capturées. Ces prises correspondent à un taux d'exploitation de 2,0 % d'après l'estimation de la biomasse totale (Etter et Mohn, 1987).

L'effort a de nouveau été faible cette année, sept bateaux ayant déclaré des captures. De ce nombre, trois provenaient du Nouveau-Brunswick (plus de 65 pieds) et ont prélevé près de 91 % du total des prises. Du total des prises, 148 t provenaient de la région de Louisbourg, ce qui représentait 13,8 % du contingent de Louisbourg fixé à 1 070 t. Les quatres autres tonnes ont été prélevées dans le trou de Misaine, aucune prise ne provenant du trou de Canso. Les quatre autres bateaux qui ont participé à la pêche étaient des navires dont le port d'attache était au Cap Breton (moins de 65 pieds). Les pêcheurs utilisaient surtout les chaluts à crevette Sputnik et Yankee 41 de maillage réglementaire (40 mm). Cette pêche est gravement touchée par une limite de prises accessoire fixée à 10 % difficile à atteindre dans cette zone.

Input Data

Commercial Data

Commercial data for this report came from the logbooks and the Foreign and Domestic Quota Monitoring Unit, Fisheries Operations Branch. The logs were at about 83% coverage with the official statistics for these areas.

The average yearly commercial catch rate (corrected values to Yankee 36 trawl) for Louisbourg was 39.9 kg/h (Table 1) which is the lowest value seen in the past six years (Table 2). The correction factors used are shown in Table 3. This low catch rate may be a result of the very high coverage rate of log information this year. The information that was available this year that has not been in the past was from boats that landed their catch in Northern New Brunswick. The low catch rate may therefore be a factor of spoiled catch. The total landings this year of 152 t is an increase from the past two years and is consistent with the increase in effort. Table 3 shows commercial catch rates according to gear type. There seems to be trend toward using larger nets in this fishery, as in the past year the Sputnik has been used more often than in the past. This may also account for the decrease in the average catch rate of commercial vessels as it is corrected for the smaller Yankee 36. After correction factors have been applied there appears to be a substantial difference between gear types, indicating perhaps overcorrection and a need for research on trawl efficiency.

Figure 1 shows monthly catch rates from the commercial fishery and research cruises for the period 1977 to 1987. The commercial catch rates show a falling trend through the years, although 1982 and 1985 are slightly different in that they don't really reflect a general decrease in catch rates during the season. It also shows a very high catch rate in the fall research cruise of 1987 that does not correspond to the commercial catch rate at the time.

Research Data

As has been the practice for the past six years, two research cruises were completed in 1987 (May and October). Standard tows were carried out, as in previous years, for half hour durations at a nominal speed of 2.5 knots using a Yankee 36 trawl with a 40 mm mesh size. The results of these surveys are displayed in Table 4 and graphically in Figures 2 and 3. The shrimp catches from research cruises are corrected taking tow length into account. The holes are defined by the 100 fm depth contour, where stations were allocated randomly inside the single stratum for Canso and Louisbourg holes. The Misaine stations were random stations which are carried over from year to year to save searching time for fishable bottom.

The average catch (kg/tow) as seen in Table 5 shows an increase in Canso and Misaine catch rates in 1987, with a slight decrease in Louisbourg. There appears to be an increasing trend from 1985 values. The shrimp fraction by weight, approximately 23% of the total catch in 1987 (Tables 6 and 7), is higher than any value seen previously, except for the 1983 research data. As before, the commercial logs show a higher catch percentage of shrimp than the research cruises, presumably because the fishing captains are directing for clean catches. The redfish by-catch from the commercial logs which in the past has been frequently above the 10% limit seems to have decreased this year while remaining high in the research cruises. The by-catch levels from the research data are closer to the values seen in cruises previous to last year's where there were high numbers of cod and silver hake. Figure 4 shows the cod and redfish by-catch size distributions from the research cruises in 1987. From these it appears that Louisbourg has the highest by-catch levels of cod while Misaine has the highest for redfish. The peak of redfish (20 cm) in Louisbourg in the fall (which was from one unusually large tow containing mostly redfish) consisted of smaller animals than those seen in the Misaine area (35 cm).

Samples of shrimp approximating 500 animals, were collected for each tow completed. These animals were individually measured and sexed to determine length frequency distributions. The distribution figures are based on measurement of carapace length, to 0.1 mm, and then grouped into 0.5 mm groupings. Figure 5 separates the data by area showing similar distributions for the three holes. Grouping the data by sex we get Figures 6a and 6b, with the number at the top of each figure being the number of individuals in the total sample. In comparing the graphs from the 1982-1987 spring/fall research cruises we can see the large portion of transitionals that are present in the spring disappear from the population in the fall. We also detect two peaks of males supposedly representing two year classes which can be followed from spring to fall where they peak at a slightly higher length. This is also shown in Table 8 where the peaks have been labeled as group I-IV+. Here in the fall, groups III and IV+ become a single group of females.

According to McCrary (1971) the presence of sternal spines in female pandalids determines them as not having previously spawned. Dividing the females from the 1987 research cruises into those that have previously spawned and those that have not, as determined by the condition of the sternal spines, we see from Figure 7 that the females with sternal spines are present in larger numbers in the spring, and appear to have the same size distribution as spawned females. Table 9 covers the percentage of females with sternal spines from 1982-87 and generally shows a higher number of females with sternal spines in the spring compared to the fall. The spring of 1987 revealed an exceptionally high percentage (14.9%) of these females. Using this information to do a regression analysis, we see from Figure 8 there is

an inverse relationship between the number of females with sternal spines and those without. It also appears that from Figure 9 there is a slightly negative correlation between transitionals and spawned females and a positive one between transitionals and females with sternal spines.

There were two stations done in the fall 1987 cruise in the Canso area that were repeated one week later. The length frequencies for these samples (Figure 10) show very similar distributions between the initial station and its repetition. Also, two exploratory tows done in both the spring and fall cruises of 1987 shown in Figure 2 and 3 (outside the three areas and closer to shore) showed relatively high catches of shrimp. This indicates that the biomass estimates based on the three fishing areas outlined are not encompassing the complete abundance of animals and therefore would represent an underestimate. The length frequencies of the samples in these exploratory areas are shown in Figure 11 and indicate a very high incidence of males in the spring samples with virtually no females present. In the fall the males are not as abundant and there is a large group of females present indicating some movement of animals from one area to another. We also see a slightly smaller size of animal in the modes determined for these exploratory samples compared to the samples from the original areas.

Figures 12a and 13a show normalized research catch rates for Louisbourg and Canso holes. The catches from each station are normalized by dividing by the average catch for that particular cruise and plotted according to area to make comparison possible. We can from these maps pick out some patches of high concentrations of shrimp. These concentrations do not appear to be correlated with depth (Figures 12b and 13b) and do not seem to follow close to the 100 fm contour as reported by some fishermen.

When we consider biomass estimates we see a low value in April 1985 (Figure 14) with a slight increase since that time. As an index of stock health, the number of ovigerous females was compared to those non-ovigerous (Table 10). In the fall virtually all females are ovigerous as in our fall sampling from 1982-1987, approximately 153 out of 34,600 females were not.

Bottom temperatures collected for approximately 50% of the research tows revealed a slightly increasing trend from 1982-1987 (Figure 16b). When grouped by area in Figure 16a, it appears that the high temperatures seen in Canso last spring, are back to previous levels, and correspond to increased catch rates in 1987 for this area.

Assessment Results

For each hole the biomass was estimated by areal expansion, where the horizontal opening of the research gear was assumed to be 36 ft. The standard tow was 1/2 h at 2.5 knots giving a length of 1.25 nautical miles and a swept area of approximately 1/135 of a square nautical mile. The areas of the three holes measured by polar planimeter (using the 100 fm contour) were 276.4, 472.2, and 442.2 square nautical miles for Canso, Louisbourg, and Misaine respectively. Tow lengths as seen in Figure 15, ranged from 1.1 to 2.2 km and show no relationship between longer tows and higher catches. The tows were however corrected for length as defined by the start and end positions. The catch rates

(kg/tow) for all research cruises have been calculated taking tow distance into account, resulting in generally lower average catch rates than previously stated. The average catch rates from the research cruises were standardized to Western 2A catch rates by multiplying by 1.5 to account for the vertical distribution above the Yankee 36 (Labonté, 1980).

Biomass, standard error, and proposed catch levels (t) from survey data, 1987.

Area	Cruise			Recommended catch levels*
	May	October	Avg.	
Canso	1248 ±482	2082 ±498	1665	580
Louisbourg	1972 ±365	3752 ±516	2862	1000
Misaine	2429 ±331	4007 ±384	3218	1130
Total			7745	2710

* Rounded to the nearest tens.

The recommended catch levels were derived from the biomass estimates (see above table) using an exploitation rate of 35% as was used in previous analysis and recommended by CAFSAC.

Quotas (t).

Year	Canso	Louisbourg	Misaine	Total
1980	1086	1553	2382	5021
1981	--	--	--	--
1982	1000	1400	1800	4200
1983	1400	2000	2400	5800
1984	1400	1800	2500	5700
1985	1350	1790	2420	5560
1986	740	1460	1600	3800
1987	210	1070	860	2140
*1988	580	1000	1130	2710
**1988	370	1160	1050	2580

* Proposed values.
** Values based on the average of biomass estimates from 1986-87.

The recommended catch level of 2710 t (determined from the 1987 biomass estimate) is up from last years value. However when you use the average biomass estimate for the last two years (Table 11) you get a lower level of 2580 t. Last year's quotas were determined on the average biomass of 1985 and 1986.

Discussion

The biomass estimates in 1987 show an increase from 1985-86 values which were a considerable decrease from previous years (Figure 14). The fact that these years show a greatly decreased biomass from previous years suggests that in using a long-term average to determine recommended catch levels, one is ignoring a strong indication of a

change in biomass. Even so, exploitation rates have never reached their quota levels. The abundance of shrimp in Canso and Misaine seem to be on the rise in 1987 while Louisbourg does not. The extremely low numbers of shrimp seen in Canso in the spring of 1986 which may or may not have been related to the high temperatures and/or an increase in silver hake evident at that time, are not as low in 1987. The temperatures and levels of by-catch have returned to a value closer to the overall average for this area. This suggests a fluctuating biomass driven more so by biotic and/or environmental factors, than by fishing. The past three years saw virtually no commercial exploitation in this area.

It appears that the presence of mature or spawned females may inhibit the formation of females from the transitional stage. (Figure 8). When females withput sternal spines are present in large numbers, females with sternal spines are not. In determining confidence levels in a regression analysis of the two groups of females (for each individual area and the three areas combined) it appears they are all significant at a 5% confidence level except Misaine. Since the females with sternal spines are present in larger numbers in the spring they may be the result of males that have put on a large spurt of growth during the winter months. The spurt is evidenced from the difference in the distances between peaks in the spring compared to the fall. There is a larger distance between the mature male peaks from the fall to the spring compared to the spring to the fall (Table 8). This all goes to support the idea that spawned or mature females may inhibit females with sternal spines and transitionals. This is complementary to the supposition that animals may pass directly to the female stage in times of depressed biomass. Presumably, this is a result of the same mechanism that inhibits the formation of transitionals and females with sternal spines when the mature female biomass is high.

The recommended catch level based on the 1987 biomass estimate is 2710 t. Using the average biomass estimate for 1986-1987 you get a lower value of 2580 t. The recommended catch level used to determine a quota last year was based on an average of the two previous years.

Unless changes occur this potentially valuable resource will likely continue to be underexploited in the near future. Although prices are favourable, the catch rates at this time are not high enough to entice participation. The by-catch limit also poses a problem since it seems to be very difficult to adhere to this limit when directing for shrimp. This would seem to necessitate a provision in legislation.

References

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Labonté, S.S.M. 1980. An assessment of shrimp stocks off southeast Cape Breton, South Esquiman and North Anticosti. Can. Atl. Fish. Adv. Comm. Res. Doc. 80/67.

McCrary, J.A. 1971. Sternal spines as a characteristic for differentiating between females of some Pandalidae. J. Fish. Res. Bd. Canada 28: 98-100.

Table 1. Monthly commercial shrimp fishing information for Louisbourg and Misaine areas (1987).

	May	June	July	Aug	Sept	Oct	Yearly
Louisbourg:							
Catch (kg)	9979	27818	47440	10433	20865	4211	120746
Effort (un)	111	305	512	105	195	75	1303
Effort (cor)	333.0	422.0	1119.5	315.0	585.0	225.0	2999.5
CPUE	30.0	65.9	42.4	33.1	35.7	18.7	40.3
Misaine:							
Catch (kg)			3761			1685	5446
Effort (un)			59			30	89
Effort (cor)			76.7			90.0	166.7
CPUE			49.0			18.7	32.7
Both areas:							
Catch (kg)							126192
Effort (un)							1392
Effort (cor)							3166.2
CPUE							39.9

Table 2. Scotian Shelf commercial shrimp landings and CPUE.

Year	Catch (t)				CPUE (kg/h)	
	Canso	Louisbourg	Misaine	Total	Unstd.	Std.*
1977				269	128.5	104.5
1978				306	121.9	97.3
1979	534	295	8	838	174.6	128.0
1980	360	491	133	984	130.9	97.3
1981	10	418	26	454	131.8	92.8
1982	201	316	52	569	128.0	80.4
1983	512	483	15	1010	127.7	81.2
1984	318	600	10	928	109.5	77.6
1985	15	118	--	133	75.4	40.7
1986	--	126	--	126	87.3	58.1
1987	--	148	4	152	90.7	39.9

* Standardized to a Yankee 36 trawl.

Table 3. Catch rates (kg/h) for commercial boats off southwestern Cape Breton, 1987.

No. of boats	Gear type	Louisbourg Area	Misaine Area	Cor. factor
1	Sputnik	33.22	18.72	3.0
2	Yankee 41	63.56	49.04	1.3

Table 4. Tow information from scientific research cruises.

Cruise	Area	Tow #	Depth (fm)	Bottom temp	Shrimp (kg)	Cor. (kg)	Total (kg)
May 1987	Canso	1	133	2.3	1	1	430
		2	106	1.8	15	10	64
		3	105	1.9	15	11	74
		4	102		12	8	60
		5	105	2.6	11	7	47
		6	111		3	2	14
		28	157		36	27	59
		29	111	1.7	57	41	106
		30	132	1.6	122	91	143
		31	127	1.4	33	25	61
	Louisbourg	7	129	3.9	32	21	73
		8	128	3.8	49	32	127
		9	147	3.8	32	24	79
		10	131		33	25	136
		11	132	3.8	46	33	98
		12	134		11	8	31
		13	149	3.9	12	13	34
		14	167	3.9	14	11	43
		15	180		1	1	84
		16	136		34	38	100
	Misaine	17	131		72	56	183
		18	139	0.6	29	25	71
		19	129	0.8	45	34	88
		20	164	0.8	40	36	77
		21	130		25	33	107
		22	132	1.5	38	25	106
		23	107	1.4	24	19	76
		24	118	1.5	21	15	47
		25	111	1.7	24	16	54
		26	124		23	16	44
		27	127	1.8	30	22	816
Total					940	726	3532

...Contd.

Table 4. Contd...

Cruise	Area	Tow #	Depth (fm)	Bottom temp	Shrimp (kg)	Cor. (kg)	Total (kg)
Oct 1987	Canso	1	104	3.3	13	8	117
		2	106	3.3	35	29	208
		3	104	3.2	19	18	125
		4	109	2.1	8	8	251
		5	118	3.1	34	31	202
		6	110		11	10	129
		7	162	3.0	89	83	151
		8	135	2.2	70	59	88
		9	107	2.1	62	51	123
		10	134	2.2	80	75	104
	Louisbourg	22	156	3.0	77	66	580
		23	142		14	14	47
		24	151	4.1	20	19	248
		25	151	4.1	53	58	96
		26	145	4.1	31	26	94
		27	130	3.8	54	49	241
		28	124	3.8	47	43	117
		29	129	3.5	37	34	93
		30	112	3.6	38	51	137
		31	151	3.7	37	32	104
	Misaine	11	120	2.7	57	50	347
		12	114		38	37	255
		13	113	2.3	48	40	103
		14	116	2.3	33	28	1655
		15	131	2.3	50	42	177
		16	138	2.0	32	27	229
		17	119	1.2	54	57	234
		18	145		38	35	151
		19	133	1.5	60	56	132
		20	135	1.6	80	75	177
		21	122	1.6	54	43	158
Total					1373	1254	6873

Table 5. Average catch (kg/tow) from research cruises.

Year	Area		
	Canso	Louisbourg	Misaine
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

Table 6. Percentage catch composition of shrimp tows.

Species	May	June	July	Sept	Oct
	Res**	Com*	Com*	Com*	Res**
Shrimp	26.5	56.7	69.8	49.1	20.4
Cod	18.2	32.8	20.7	3.3	12.3
Redfish	26.0	5.4	2.9	43.8	36.9
Flatfish	8.8	3.1	2.0	1.8	10.6
Hake	14.0	0.1		0.4	13.4
Halibut	-	0.6	0.1		-
Haddock	-	0.1		0.2	-
Pollock	-	0.9	4.2	0.7	-
Misc	6.5	0.3	0.4	0.8	6.5
Total shrimp catch (kg)	726	14889	34766	11793	1254

* Commercial log data.
** Research cruises.

Table 7. Corrected catch rates in kg/h (left-hand column) and percentages (right-hand column) of individual species in research cruises (1982-87).

Cruise	Shrimp		Cod		Redfish		Flatfish		Hake		Misc.		Total
Apr 82	58	20	76	26	72	25	34	12	--	--	51	18	291
Nov 82	120	21	117	21	50	9	86	15	147	26	48	8	568
May 83	212	37	100	17	160	28	47	8	--	--	58	10	578
Nov 83	169	33	83	16	16	3	58	11	122	24	62	12	510
May 84	132	24	140	25	222	40	30	5	--	--	31	6	561
Oct 84*	64	13	88	18	86	18	43	9	169	35	35	7	486
Apr 85	32	19	35	21	49	30	24	14	--	--	27	16	167
Oct 85	50	19	34	13	63	24	18	7	80	31	17	6	261
May 86	71	13	170	32	90	17	37	7	117	22	50	9	537
Oct 86	34	11	31	10	107	35	28	9	86	28	21	7	307
May 87	47	26	32	18	46	26	16	9	25	14	12	7	177
Oct 87	81	20	49	12	147	37	42	11	53	13	26	7	398

*Change of trawl door.

Table 8. Length (mm) of shrimp at peaks of length frequencies by sex.

Year	I	II	III	IV+
Spring				
1982	14.5	19.0	22.5	25.0
1983		18.0	23.0	25.0
1984	14.0	20.0	23.0	24.0
1985		19.5	23.5	24.5
1986	15.5	20.5	23.5	24.5
1987	15.5	20.0	23.5	24.5
Fall				
1982	17.0	20.0	25.0	
1983	17.0	20.0	24.0	
1984	16.0	21.0	25.0	
1985	17.0	19.5	25.0	
1986	17.0	20.5	25.0	
1987	16.5	20.5	24.5	

Table 9a. Females with sternal spines as a percentage of total females (Spring).

Year	Canso		Louisbourg		Misaine		Total	
	#	%	#	%	#	%	#	%
Apr 82	6/826	(0.7)	4/1532	(0.3)	1/920	(0.1)	11/3278	(0.3)
May 83	8/1030	(0.8)	5/1234	(0.4)	11/1139	(1.0)	24/3403	(0.7)
May 84	33/611	(5.4)	41/1130	(3.6)	37/840	(4.4)	111/2581	(4.3)
Jul 84	5/165	(3.0)						
Apr 85	19/861	(2.2)	1/1243	(0.1)	4/1348	(0.3)	24/3452	(0.7)
May 86	10/133	(7.5)	82/866	(9.5)	8/1152	(0.7)	100/2151	(4.7)
May 87	76/382	(19.9)	78/876	(8.9)	131/655	(20.0)	285/1913	(14.9)

Table 9b. Females with sternal spines as a percentage of total females (Fall).

Year	Canso		Louisbourg		Misaine		Total	
	#	%	#	%	#	%	#	%
Nov 82	4/2190	(0.2)	1/2223	(0.0)	9/2640	(0.3)	14/7053	(0.2)
Nov 83	2/1597	(0.1)	1/1323	(0.1)			3/2920	(0.1)
Oct 84	0/1488	(0.0)	0/2022	(0.0)	2/2221	(0.1)	2/5731	(0.0)
Oct 85	2/1719	(0.1)	1/2340	(0.0)	6/2511	(0.2)	9/6570	(0.1)
Oct 86	6/1342	(0.4)	4/2764	(0.1)	16/2329	(0.7)	26/6435	(0.4)
Oct 87	2/1701	(0.1)	0/2064	(0.0)	3/2098	(0.1)	5/5863	(0.1)

Table 10. Numbers of ovigerous/non-ovigerous individuals in samples from research cruises.

		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
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

Table 11. Research vessel biomass estimates (t)

Year	Area		
	Canso	Louisbourg	Misaine
1978	3900	5600	--
1979	2900	4300	9600
1980	--	--	--
1981	3000	4100	5000
1982	3180	3970	3080
1983	6410	5970	10560
1984	2550	4250	5120
1985	760	2330	2170
1986	460	3760	2760
1987	1670	2860	3220
Average	2760	4130	5190

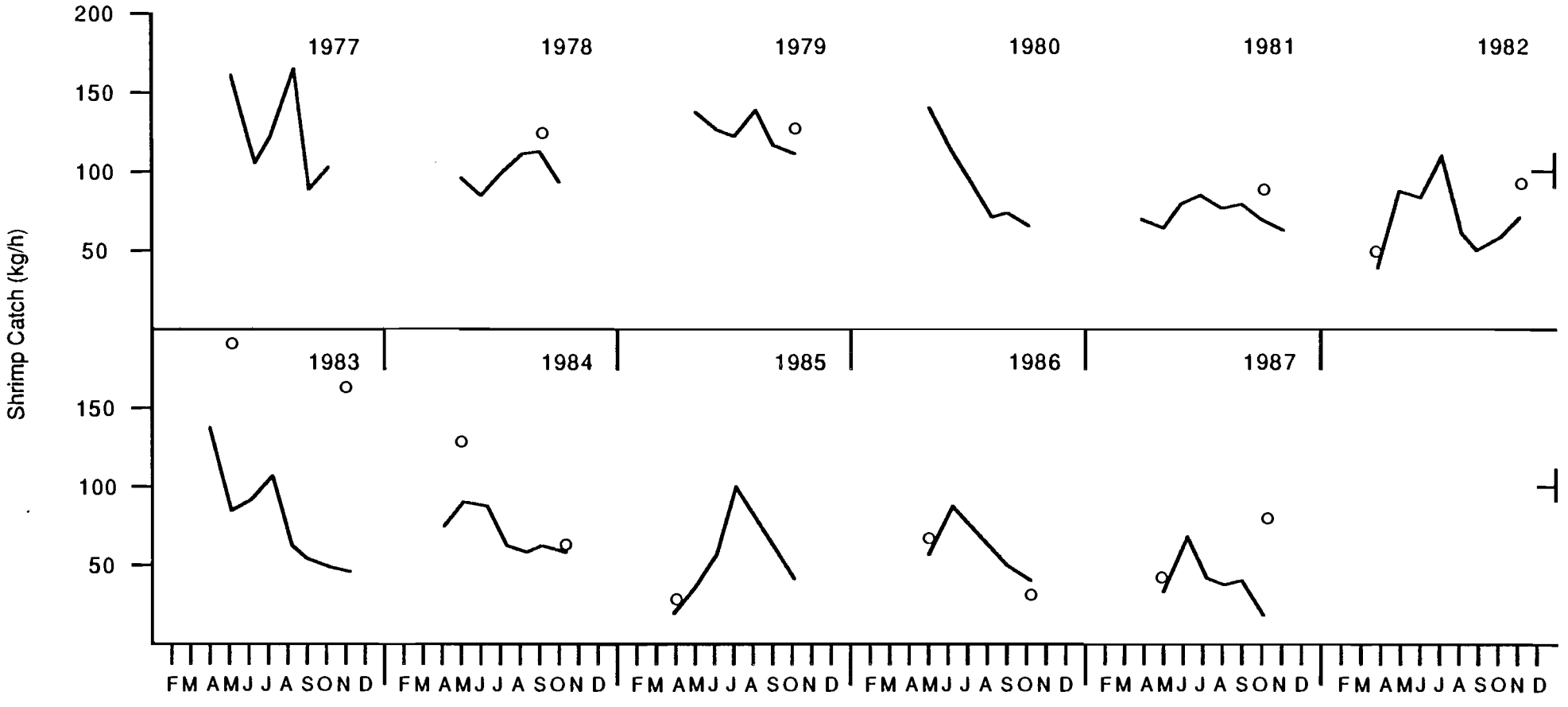


Figure 1. Shrimp catch rates by month from 1977-1987.

——— commercial boats (standardized)

o research cruises

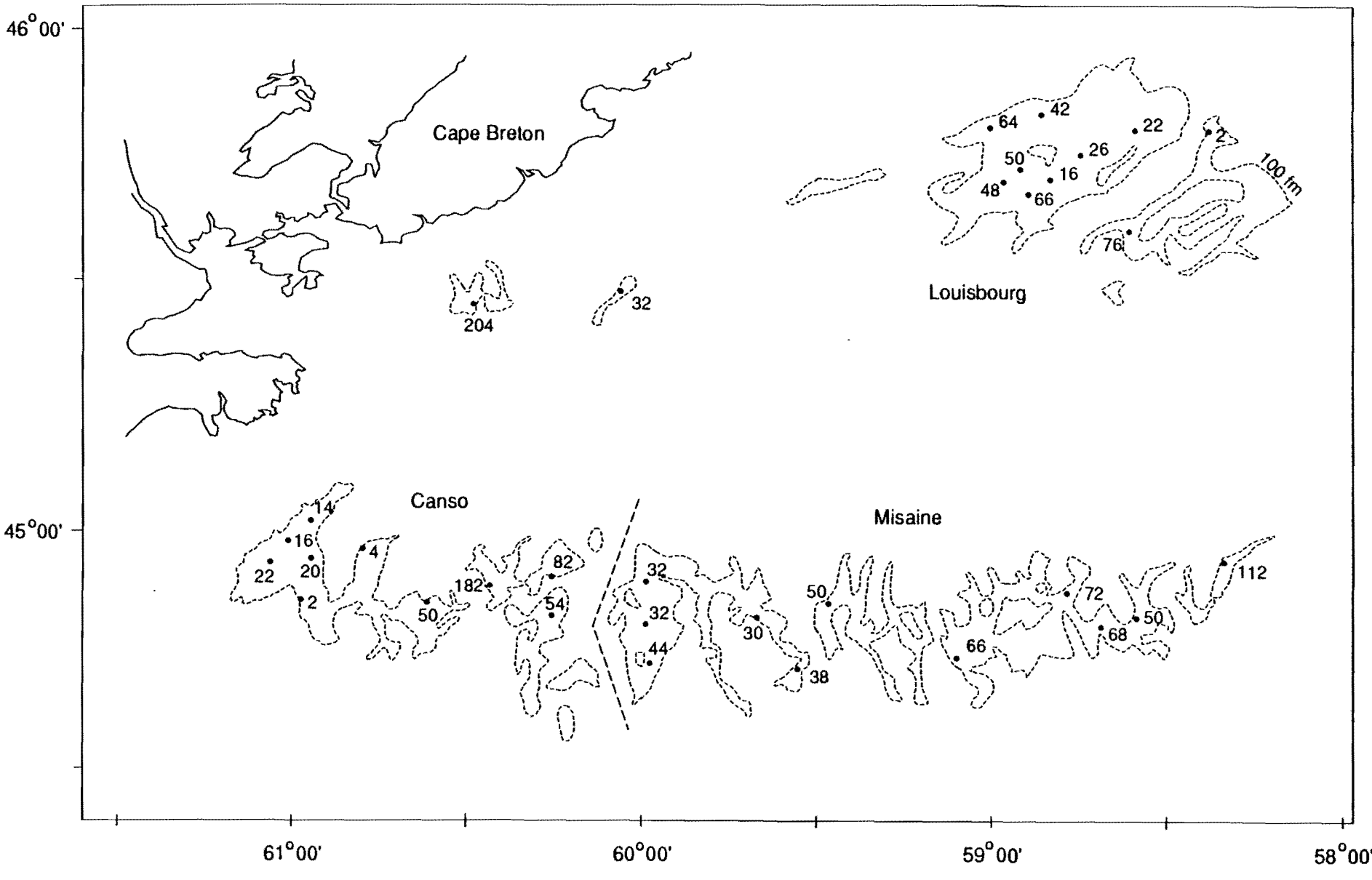


Figure 2. Shrimp catch rates (kg/h) from the May 1987 research cruise.

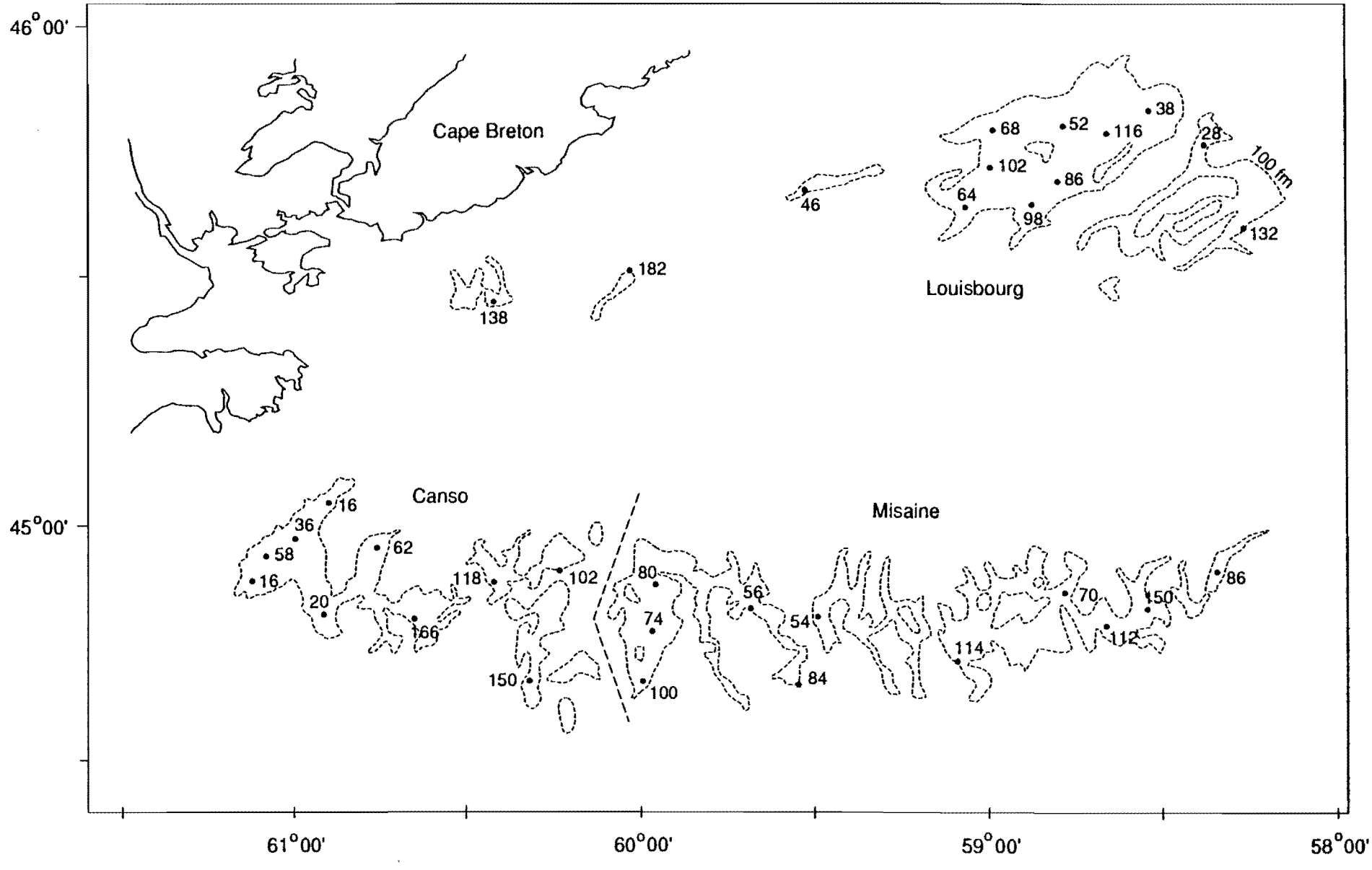


Figure 3. Shrimp catch rates (kg/h) from the October 1987 research cruise.

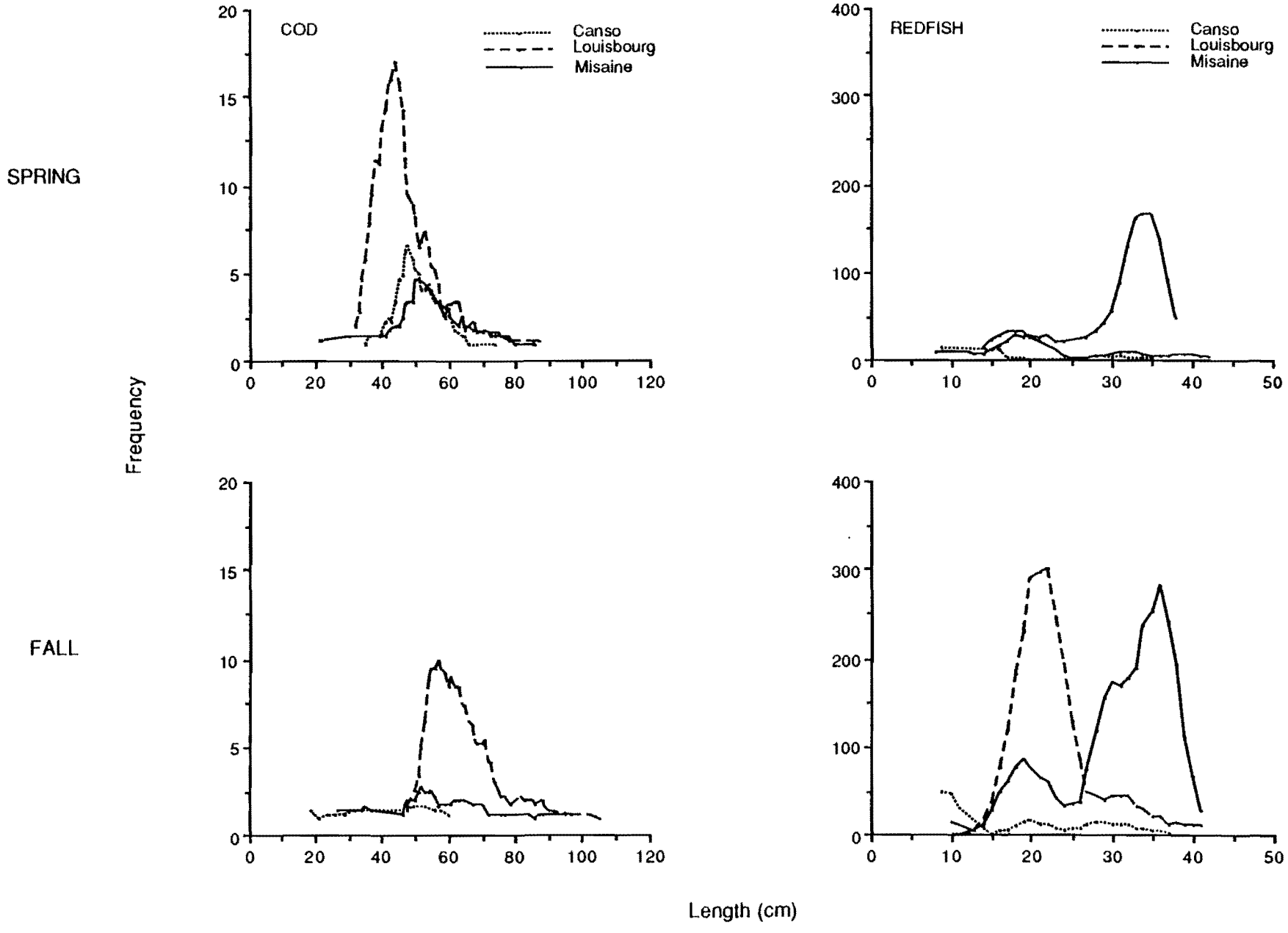


Figure 4. Length frequencies (by area) of cod and redfish by-catches in 1987 research cruises.

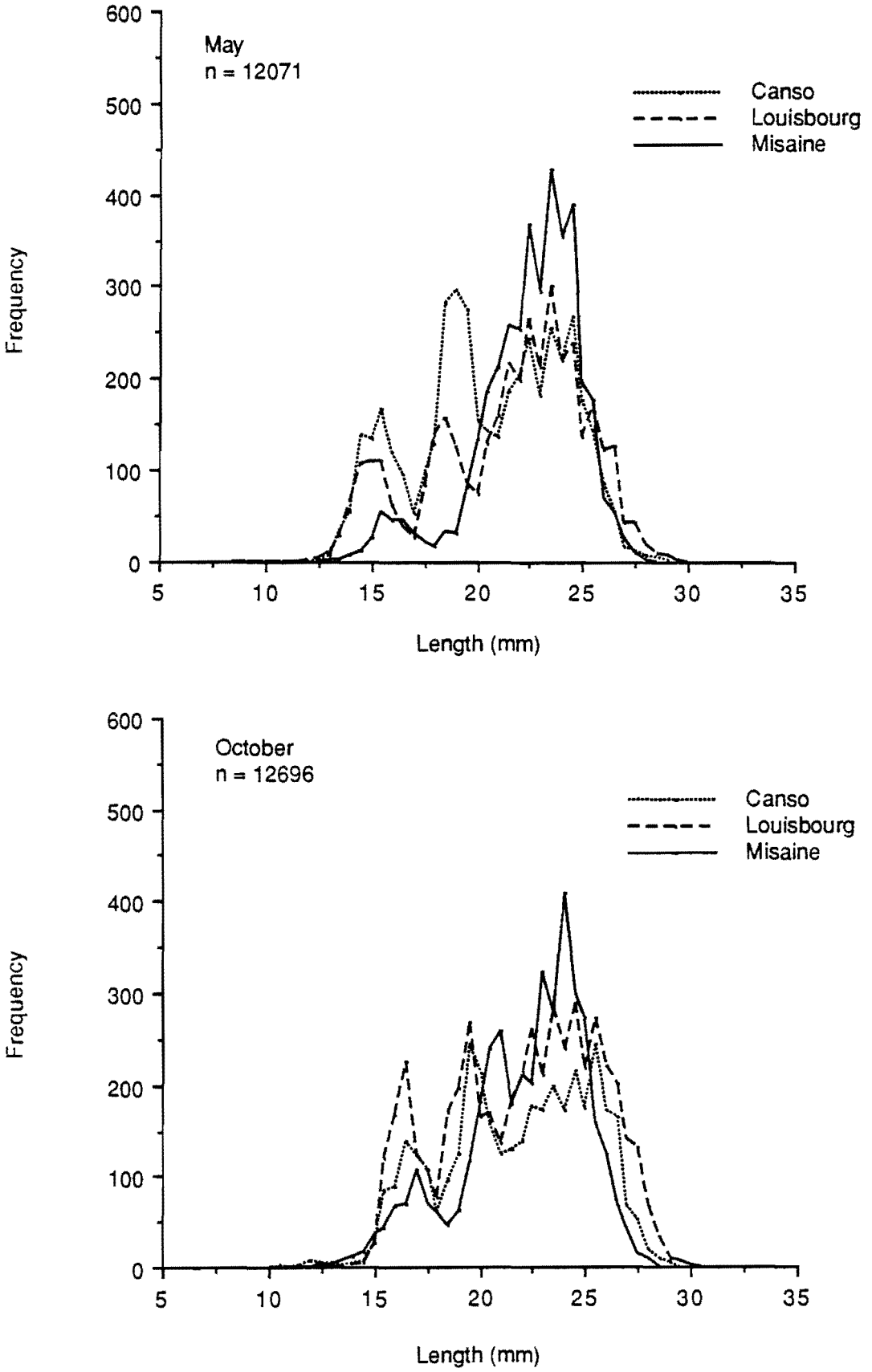


Figure 5. Shrimp length frequencies by area, 1987.

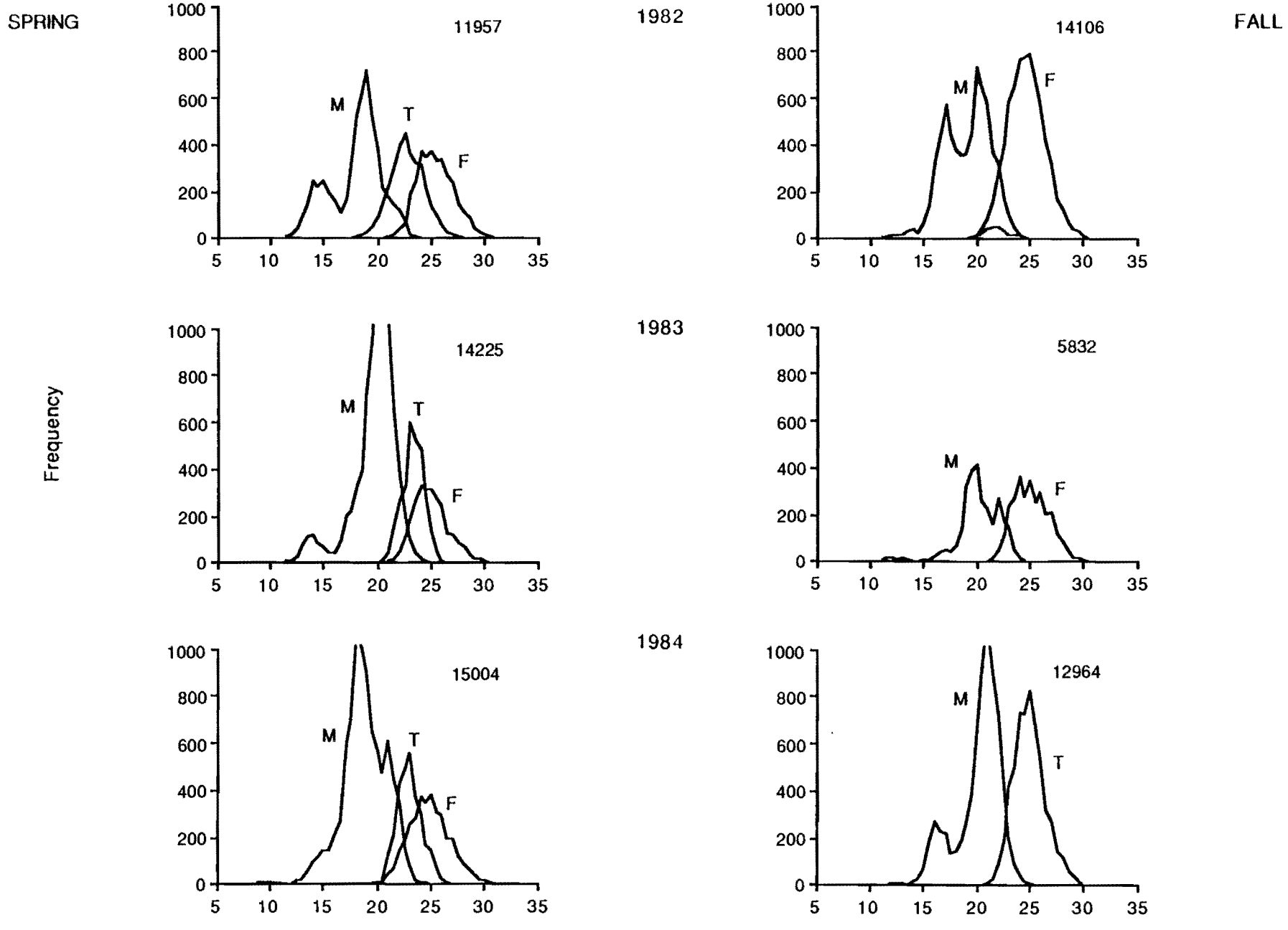


Figure 6a. Shrimp length frequencies by sex (1982-1984).

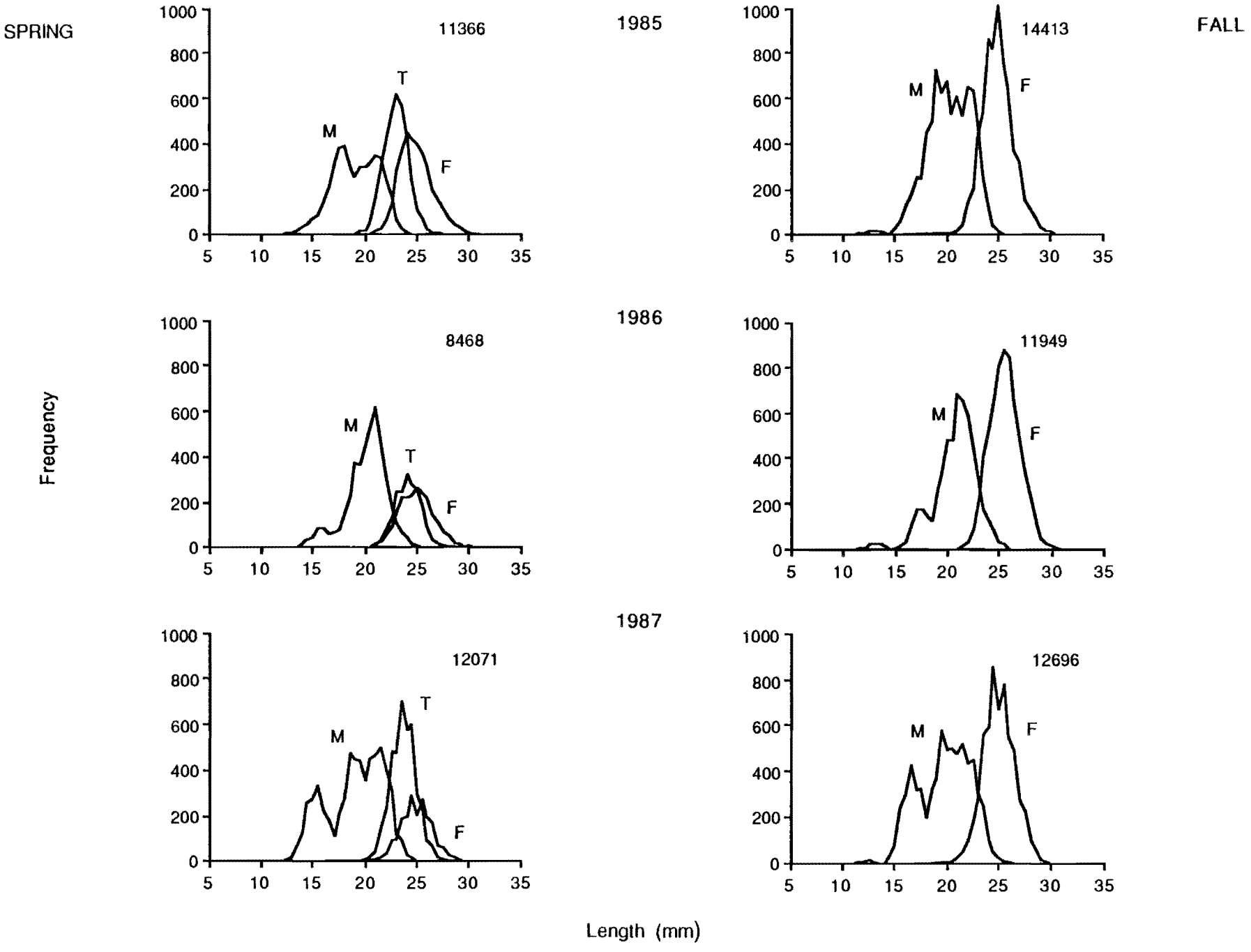


Figure 6b. Shrimp length frequencies by sex (1985-1987).

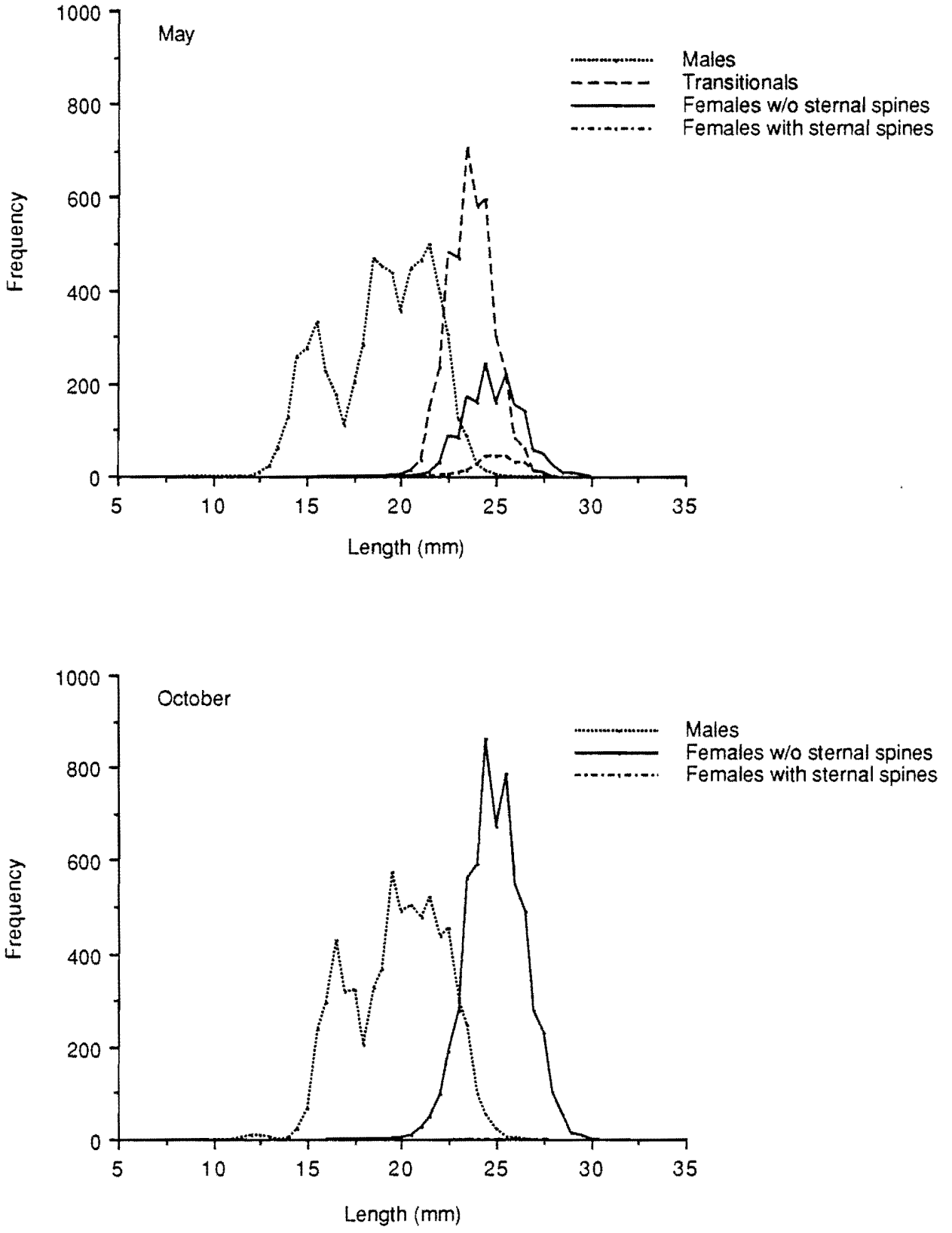


Figure 7. Shrimp length frequencies by sex (differentiating females by sternal spines), 1987.

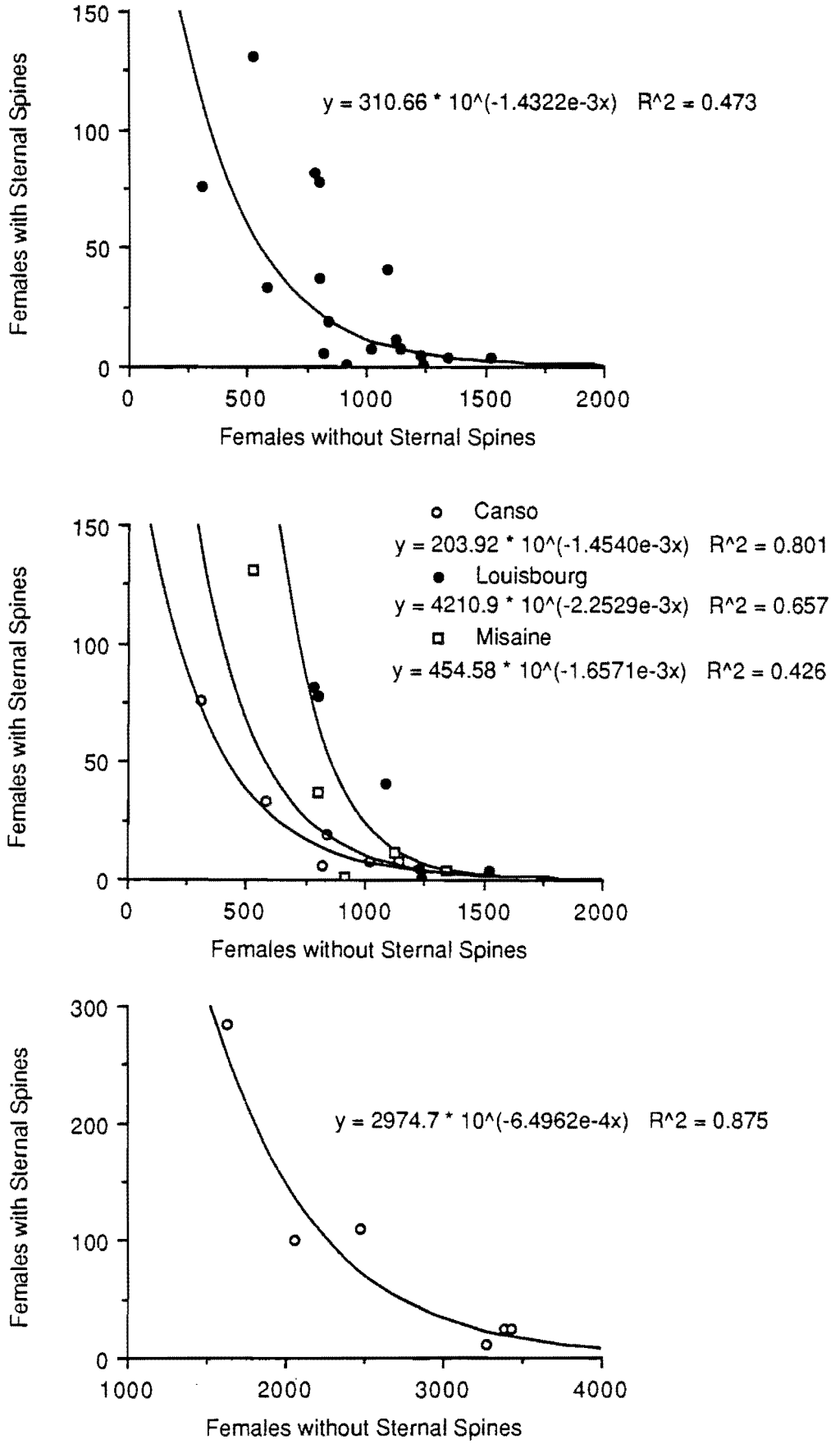
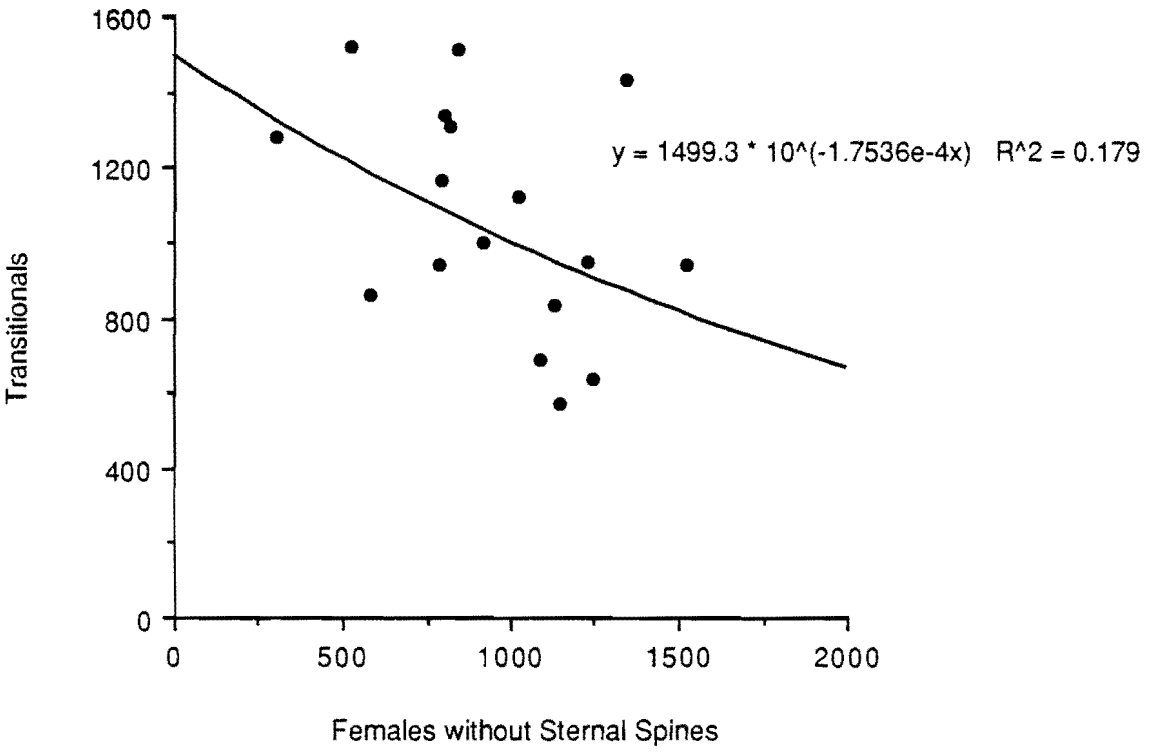


Figure 8. Regression analysis comparing females with sternal spines to those without.



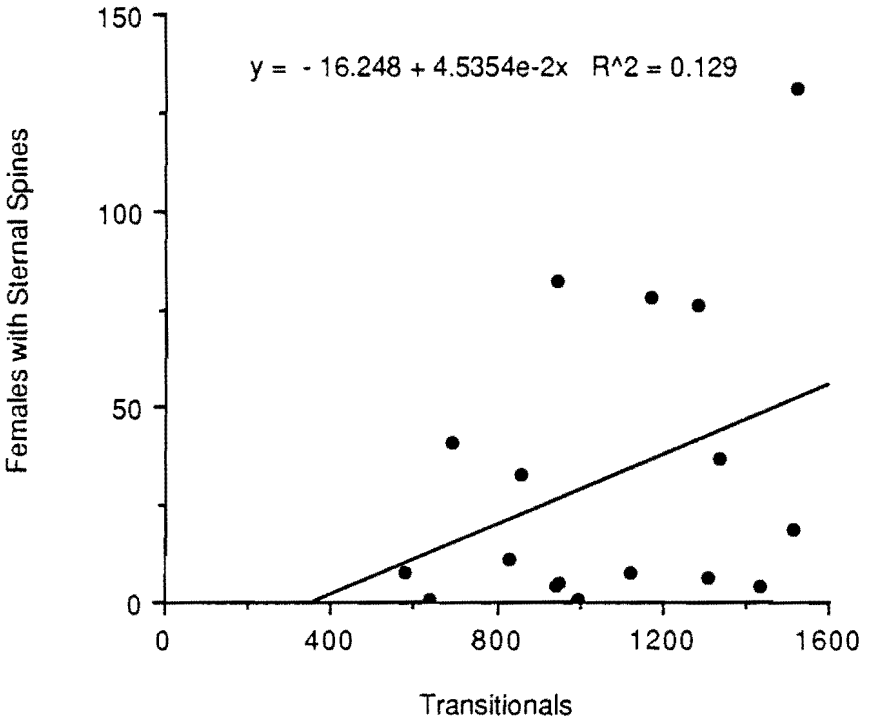


Figure 9. Regression analysis comparing transitionals to females with and without sternal spines.

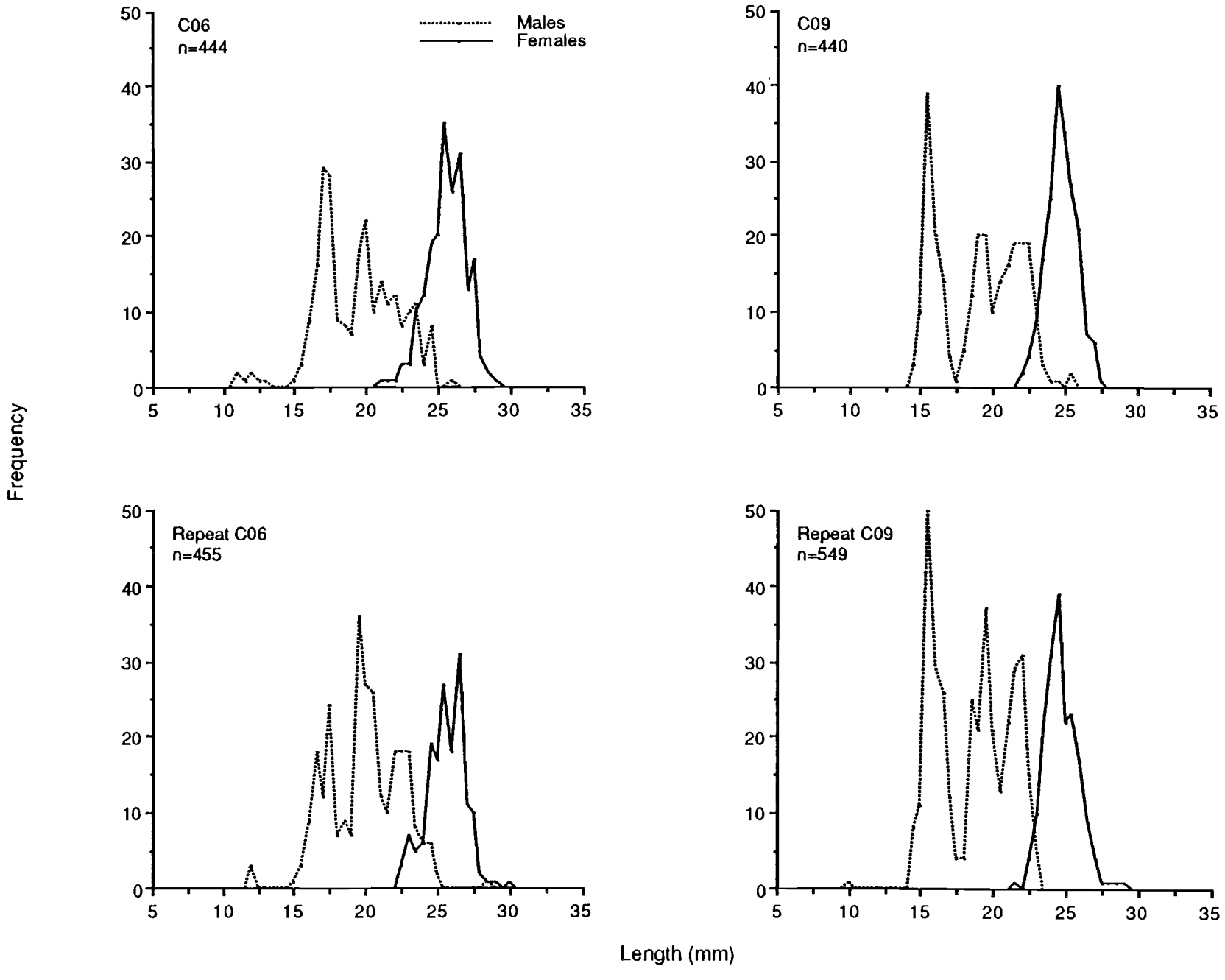


Figure 10. Stations and repetitions from the Canso area in the October 1987 research cruise.

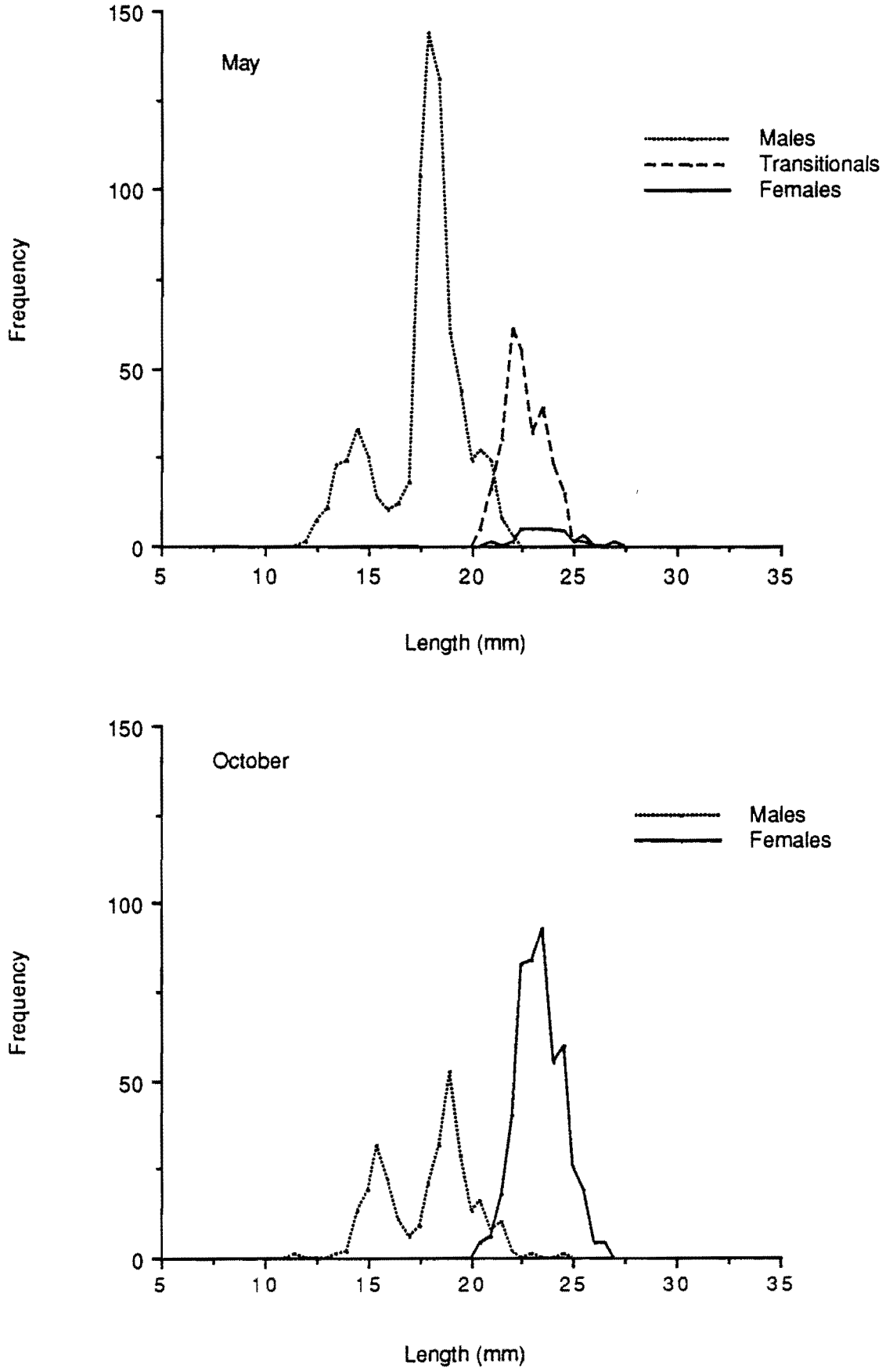


Figure 11. Shrimp length frequencies by sex from the exploratory tows, 1987.

Figure 12a. Normalized catches for Canso area (1982-1987).

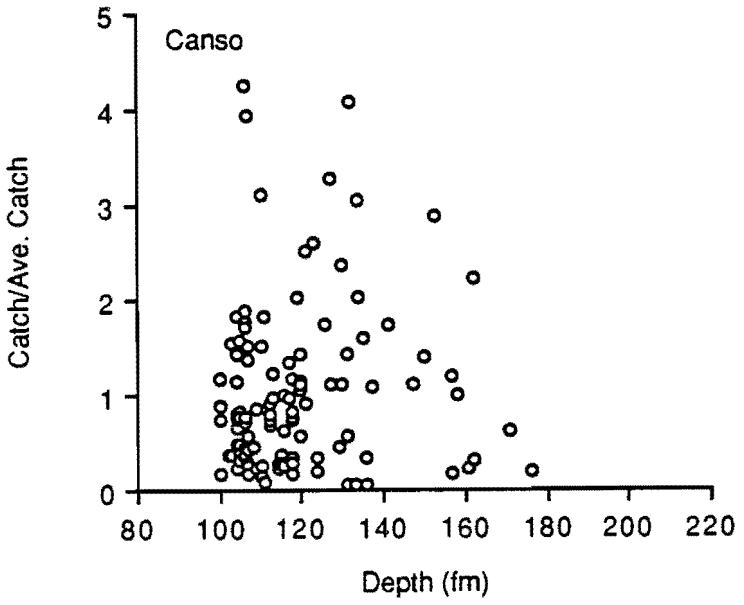


Figure 12b. Normalized catches verses depth (Canso).

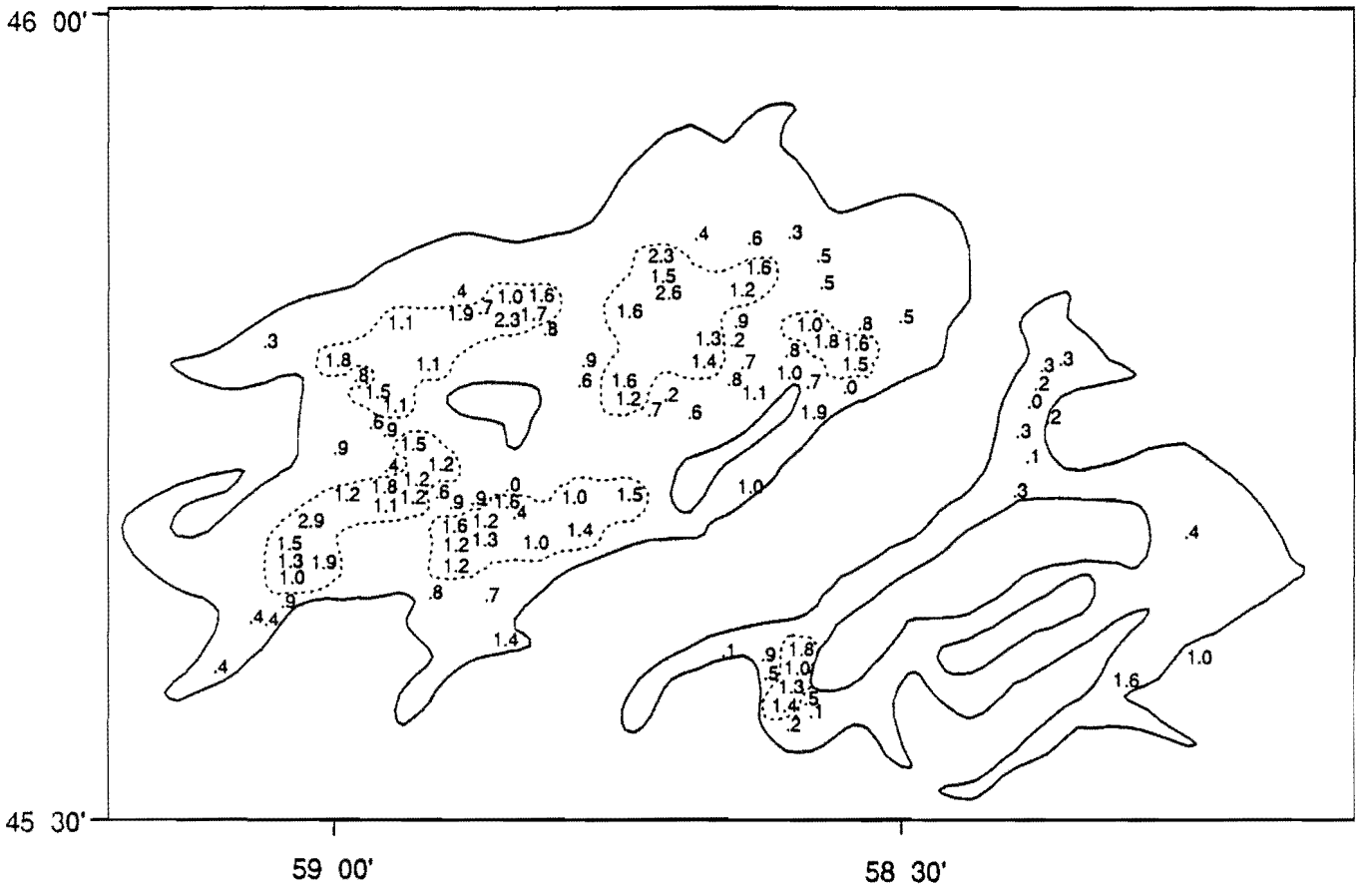


Figure 13a. Normalized catches for Louisbourg area (1982-1987).

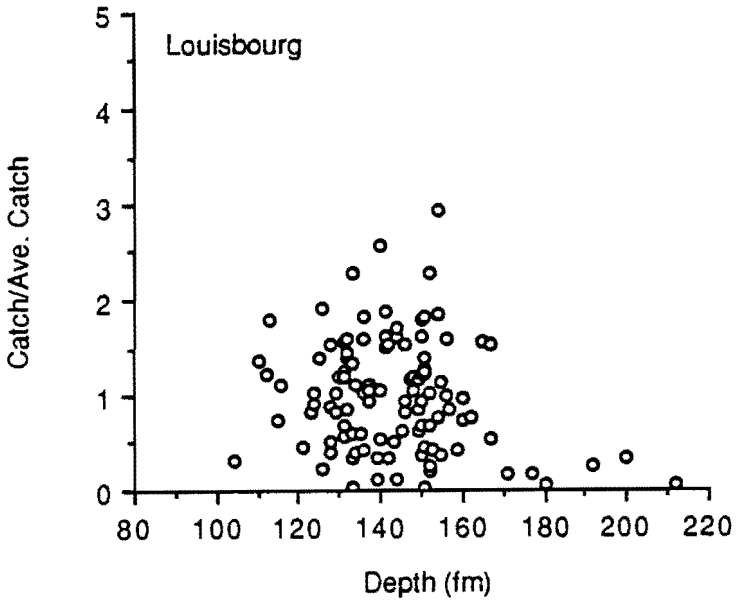


Figure 13b. Normalized catches verses depth (Louisbourg).

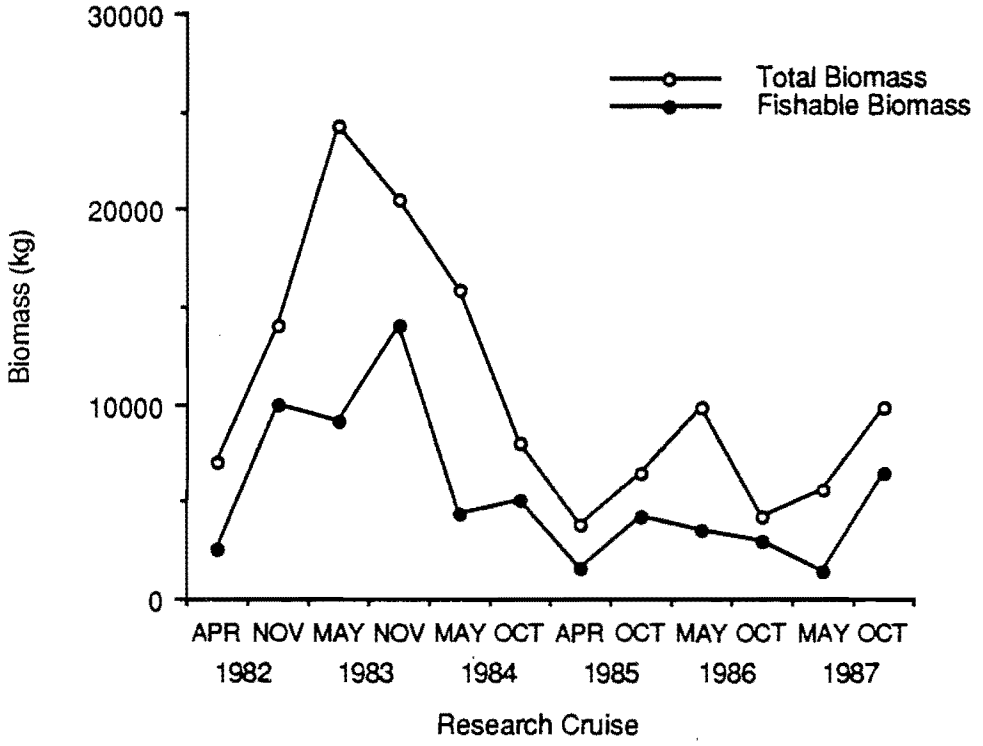


Figure 14. Biomass estimates from research cruises.

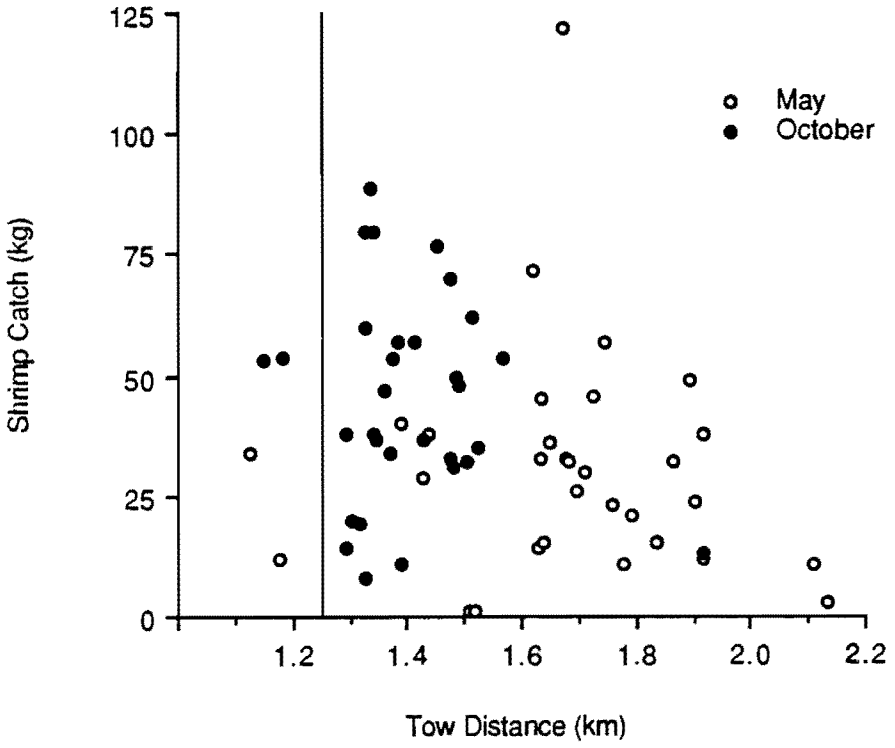


Figure 15. Shrimp catch per tow verses tow distance from 1987 research cruises.

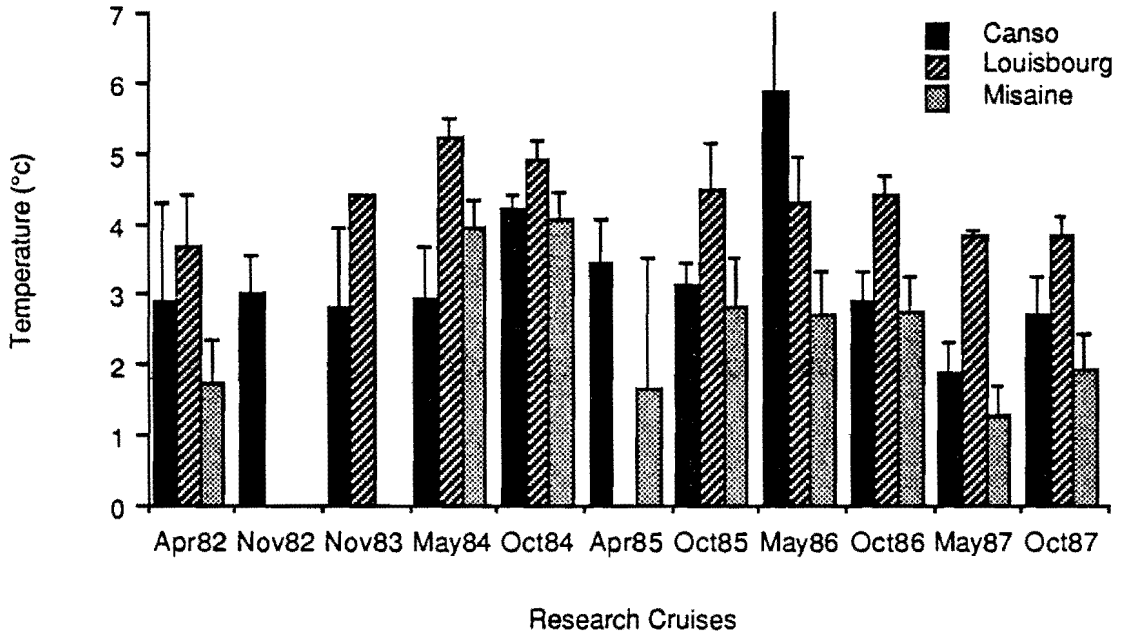


Figure 16a. Average temperature by area from research cruises.

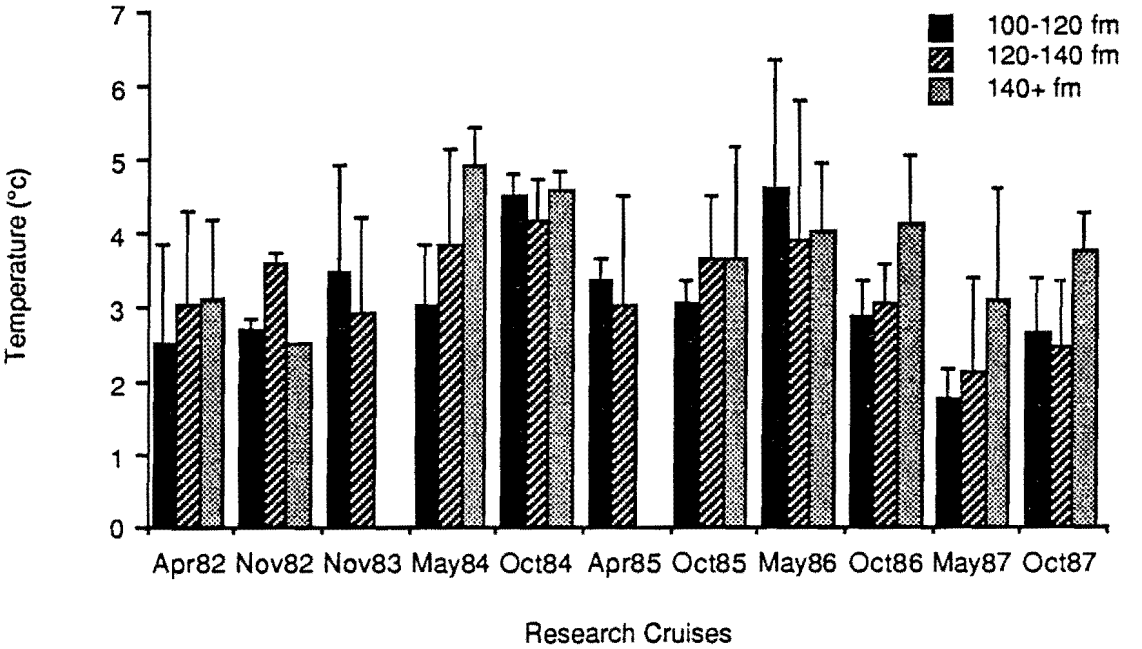


Figure 16b. Average temperature by depth from research cruises.