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The Icelandic Shrimp Fishery (*Pandalus borealis* Kr.) at Flemish Cap in 1993-1999

by

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Abstract

Some 10 Icelandic vessels have been fishing for shrimp in the waters at the Flemish Cap in 1998 compared to 14 in 1997 and 7 in 1998. In this paper there are logbook information on the Icelandic fishery for the years 1993 through 1999. The standardized catch rate to a fixed size of trawl has recently increased considerably or from 191 kg/hour in January-July 1997 to 281 and 246 kg in 1998 and 1999 respectively.

Introduction

The Spanish investigators (EU) have been measuring the biomass index of northern shrimp at the Flemish Cap since 1988 in their annual bottom trawl survey at Flemish cap. In 1993 the fishery was initiated by Canada, followed closely by Faroe Islands and Iceland.

The fishery was some 24-33 thousand tons in the years 1993-1995 to increase in 1996 to 48 thousand tons.

In this paper all the information from the Icelandic investigators is gathered. From the logbooks comes effort, catch and CPUE is calculated.

Materials and Methods

The logbook data include catch and effort. Although all skippers send in the logbooks the, but information on landings can be obtained from the Fisheries Directorate in Iceland. Thus effort was raised by dividing the nominal catch with the calculated CPUE from the logbooks of two periods of the year into the nominal catch of the same periods in the years 1993-1999.

The difference between single trawl and double trawl was studied by looking at logbook data from Icelandic vessels fishing at Flemish Cap. The size of shrimp trawl is always given as the number of meshes of the circumference of the belly. The size of mesh there is always back-calculated to that of a 40 mm mesh size although the mesh size is usually much larger. Some vessels apply more than one size of trawl but the size of trawl is stated for each tow. Only the data from one stratum was used, namely those from the north west stratum. To overcome seasonal differences it was chosen to calculate first average catch in kgs per trawling hour per month and the corresponding mean size of each trawl type, single and double. There appeared to be some learning process, so only months where there was a minimum of 50 tows of each trawl type was applied. In order to calculate standardized CPUE the standard size of trawl was chosen to be 3 000 meshes and kg/trawling hour was divided by the mean gear size to get kg per mesh per hour and then the kgs were multiplied by 3000 to get the standard for each trawl size. The standardized CPUE of double trawls divided by the standardized CPUE of single trawls in the same month gave the difference of single trawl to double trawl (Table 2). On average the conversion factor turned out to be 1.9.

As usual Icelandic observers sampled shrimp onboard all Icelandic vessels in the years 1998 and 1999. The shrimp were measured fresh to the nearest 0.5 mm using Vernier calipers. Observers then sorted each length class into males and females using the method of Rasmussen (1953) and the females further into primiparous and multiparous using the sternal spine criterion of McCrary (1971).

Catch and Effort data

In 1999 the fishery was carried out since February. The catch so far is 7 200 tons (Table 1) as compared to some 4 thousand tons at the same time in 1998 (Skúladóttir, 1998). Iceland set a total allowable catch (TAC) for Icelandic vessels at 9 300 tons for the year 1999 as compared to 6 800 tons for 1998. The total catch of 1998 was 6 573 tons.

As stated above the difference between double trawls and single trawls turned out to be about 1.9 in CPUE for the same size of trawl. Thus effort of double trawls was multiplied by 1.9 for correction. The mean standardized CPUE (3 000 mesh trawl) for the year 1997 was the lowest ever for Iceland or 191 kg per trawling hour (177 kg in the raw data) for the period January through July (Table 1 and 3). In 1998 the mean CPUE for the same period was much higher or 281 (282 kg raw data) and finally in 1999 the standardized CPUE was 246 (270 raw data). The average size of gear used in 1999 was the largest ever used by Iceland , namely 3291 meshes. The size of trawl started to be almost 3 100 meshes in 1993 to decrease to below 2 700 in 1995 and then it increased gradually there after. At the same time the use of twin trawls has increased from about less than 50% by catch in 1993 to about 70% in 1998 and 1999 (Table 3).

The distribution of effort by area is shown by months and years in Fig. 1. Note the difference between the years 1997 and 1998 for the lack of tows in the south east area. Looking at tows by months the months of April and June of 1998 are different in that there are tows at shallow depths in the north east area. In March and April in 1999 there is a lot of effort spent in the shallow area between 100 and 140 fathoms (Fig 1, Fig. 11 and Table 4). The size of shrimp in that depth stratum does not seem to be any different from that of the deeper stratum of 140-200 fathoms. In 1999 8% of the catch was taken from depth stratum 100-140 fathoms as compared to just over 3 % on the average for the years 1994-1999.

The length frequency distributions of Icelandic samples from 1998 and 1999 are shown in Fig. 2-14. Males are shown by the solid line. Primiparous is the dotted line and the broken line represents the multiparous females. In 1998 the two-year-olds appear first in April to increase gradually till December in 1998 (Fig. 2). In 1999 the two-year-olds do not seem as numerous as in 1998. The three-year-old males are as usual quite prominent, but these seem to be a bit smaller in 1999 than in 1998. In July, e.g. the mean size of three-year-old males is about 19 mm in 1998 but only 1.3 mm CL in 1999. The primiparous peak appears to be bimodal and broad in most months of 1998 (Fig. 2).

The differing height of peaks can be studied further in relation to depth and month. In 1998 the 2 group seems to have a tendency to occur at less depth than other groups where as in 1999 there seem to be smaller shrimp above 200 fathoms than below. The older animals have generally a tendency to be more numerous at greater depths although there are sometimes exceptions from this, see e.g. the multiparous females in April 1998 which are most numerous at the depth 101-140 fm (Fig. 5).

By-catch

The by-catch of redfish was 0.4 % in 1999 as compared to 0.7 % in 1998 and 1.6 and 1.4 in 1996 and 1997 respectively. Wolffish was 0.1% in 1999 and 1998. 0.6% by-catch in 1999 compared to 1 % in 1998. Greenland halibut was 0,07% in 1999 as compared to 0.1% in 1998. Very little American plaice was observed and no cod. Altogether there was 0.64% by-catch in 1999 as compared to 1% in 1998.

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Table 1. Catch (tons) effort (trawling hours *1.9 when double trawl) and CPUE (kg/hr) of Icelandic vessels at Flemish Cap.

	January - July				August - December			
Year	Month	CPUE	Effort	Catch	Month	CPUE	Effort	Catch
1993					Aug	320.4	1334	427.4
					Sep	349.8	1034	361.7
					Oct	231.7	334	77.4
	Jun	380.2	1767	671.8	Nov	306.8	588	180.4
	Jul	342.4	1097	375.6	Dec	236.5	537	127.0
	Subtotal	365.7	2864	1047.4	Subtotal	306.7	3827	1173.9
	Total	365.7	2918	1067.0	Total	306.7	3834	1176.0
1994	Jan	228.5	144	32.9	Aug	175.3	1657	290.4
	Feb	371.8	510	189.6	Sep	126.9	476	60.4
	Mar	295.5	531	156.9	Oct	125.4	492	61.7
	Jun	256.4	1297	332.5	Nov	115.5	181	20.9
	Jul	212.9	2653	564.8	Dec	75.0	8	0.6
	Subtotal	248.6	5135	1276.7	Subtotal	154.2	2814	434
	Total	248.6	6693	1664.0	Total	154.2	4123.74	636
1995	Feb	280.0	65	18.2	Aug	178.0	4869	866.9
	Mar	246.8	711	175.5	Sep	134.1	2928	392.5
	Apr	149.9	1487	222.9	Oct	166.3	2088	347.2
	May	260.1	2617	680.7	Nov	144.4	1074	155.1
	June	248.9	3733	929.2	Dec	174.5	740	129.1
	Jul	249.5	6625	1653.0				
	Subtotal	241.5	15238	3679.5	Subtotal	161.6	11699	1890.8
	Total	241.5	16932	4088.5	Total	161.6	21868.5	3534.4
1996	Jan	207.2	1755	363.7				
	Feb	251.7	1326	333.7				
	Mar	261.8	4604	1205.1	Aug	165.4	8156	1349.4
	Apr	211.2	10754	2271.2	Sep	167.1	8089	1351.7
	May	189.1	12749	2410.2	Oct	129.7	5482	711.2
	Jun	202.5	13933	2821.5	Nov	137.9	1456	200.8
	Jul	235.9	11963	2821.5	Dec	158.1	253	40.0
	Subtotal	214.2	57084	12226.9	Subtotal	155.9	23436	3653.1
	Total	214.2	64760	13871.0	Total	155.9	43688.7	6810.0
1997	Jan	175.8	413	72.6	Aug	206.7	4252	879.0
	Feb	214.7	621	133.3	Sep	202.4	3476	703.6
	Apr	135.0	514	69.4	Oct	222.0	2519	559.1
	May	141.4	3736	528.2	Nov	192.5	1039	200.0
	Jun	167.7	5386	903.2	Dec	176.9	429	75.9
	Jul	209.2	5802	1213.7				
	Subtotal	177.3	16472	2920.4	Subtotal	206.4	11715	2417.6
	Total	177.3	19478	3453.3	Total	206.4	14681	3029.6
1998 *	Feb	217.2	297	64.5	Aug	256.4	3184	816.3
	Mar	206.8	812	167.9	Sep	184.5	5028	927.5
	Apr	229.5	880	202.0	Oct	196.3	3612	708.9
	May	414.8	2820	737.2	Nov	204.6	1761	360.3
	Jun	332.1	3537	1169.7	Dec	222.5	644	143.3
	Jul	854.0	4117	1174.7				
	Subtotal	282.1	12463	3516.0	Subtotal	207.8	14229	2956.3
	Total	282.1	12657	3570.8	Total	207.8	14446.6	3001.5
1999 *	Jan	350.5	382	133.9	Aug	250.8	3642	913.4
	Feb	288.9	1854	535.7	Sep	235.5	1371	322.9
	Mar	252.9	3484	881.2				
	Apr	248.5	5966	1482.3				
	May	286.9	5814	1668.1				
	Jun	276.5	4566	1262.7				
	Subtotal	270.3	22066	5963.9	Subtotal	246.6	5013	1236.3
	Total	270.3	22066	5963.9	Total	246.6	5013	1236.3

Table 2. Comparison of cpue of single trawl to cpue of double traw in the same months. The area is the northwest area (No. 3) of Flemish Cap. Kg/hr is standardized to a trawl size of 3000 meshes.

		Single trawl				Double trawl				
Year	Month	Kg/hr	No. tows	Av. Size of trawl	3000 Meshes Kg/hr	Kg/hr	No. tows	Av. Size of trawl	3000 Meshes Kg/hr	Coefficient Double/single
1994	7	210.3	276	3056	206.4	509.8	74	3000	509.8	2.469
	8	151.5	95	2562	177.4	406.4	54	3183	383.0	2.159
1995	6	258.8	98	2644	293.6	480.8	61	3315	435.1	1.482
	7	258.2	209	3042	254.6	476.0	176	2736	521.9	2.050
	8	190.1	135	2893	197.1	348.0	120	2820	370.2	1.878
	9	165.6	103	2965	167.6	218.4	61	2354	278.3	1.661
	10	233.0	53	4000	174.8	290.8	54	2888	302.1	1.729
1996	3	246.3	254	2823	261.7	551.8	151	3000	551.8	2.108
	4	215.2	624	2815	229.3	415.2	238	2859	435.7	1.900
	5	199.2	679	2762	216.4	380.8	316	2838	402.5	1.860
	6	205.0	572	2909	211.4	382.2	321	2792	410.7	1.943
	7	191.3	352	2997	191.5	310.6	219	2792	333.7	1.743
	8	160.9	101	2735	176.5	285.6	89	2712	315.9	1.790
	10	157.8	128	2734	173.2	220.4	72	2795	236.6	1.366
1997	5	169.7	80	3340	152.4	261.2	142	2669	293.6	1.926
	6	198.6	163	3228	184.6	295.8	141	2718	326.5	1.769
	7	242.6	179	3251	223.9	326.0	132	2565	381.3	1.703
	8	240.6	170	3241	222.7	366.2	96	2688	408.7	1.835
	10	233.2	70	2485	281.5	401.2	67	2868	419.7	1.491
1998	5	236.1	76	3332	212.6	564.6	172	2995	565.5	2.660
	6	256.6	63	3046	252.7	639.2	93	3067	625.2	2.474
	7	260.8	160	2932	266.8	586.4	139	2980	590.3	2.212
	8	319.7	62	3069	312.5	520.6	164	3009	519.0	1.661
	9	222.2	55	3358	198.5	353.0	282	3045	347.8	1.752
	10	306.3	59	4115	223.3	362.2	212	3118	348.5	1.561
1999	4	252.1	100	3342	226.3	497.8	96	3072	486.1	2.148
	5	270.4	135	3539	229.2	481.4	210	3305	437.0	1.906
	6	274.8	198	3408	241.9	531.4	298	3434	464.2	1.919
	7	282.9	85	3460	245.3	548.2	263	3477	473.0	1.928
Average		227.9	183.9	3106	220.9	414.2069	155.6	2934	419.791	**1.899**
Stdev		44.2	169.1	383	39.6	115.4	83.8	255	99.0	0.301
St. Error		8.4	32.0	72	7.5	21.8	15.8	48	18.7	0.057
Number of months										29
Total No. of tows			5334				4513			

Table 3. Landings and some averages calculated from the Icelandic logbooks.
CPUE is only from the period January - July.

Year	Nominal Catch Tons	Twin trawls % of catch	Trawl size No. of meshes	Unstandardized CPUE	CPUE at size 3000 trawl
1993	2 243	46.0	3087	366	356
1994	2 300	56.2	2975	249	251
1995	7623	57.6	2688	242	270
1996	20681	57.8	2805	214	229
1997	6483	54.6	2782	177	191
1998	6572	74.7	3016	282	281
1999	7147	68.7	3291	270	246

Table 4. Catch of shrimp (kgs) from log books by depth strata on the Flemish Cap 1994-1999.

1994	Depth fm 1-100		Depth fm 101-140		Depth fm 141-200		Depth fm 201-300		Depth fm >301		Total	Total
Month	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%
1					30577	97.4	815	2.6			31392	100.0
2			349	0.2	8082	4.4	166290	90.9	8201	4.5	182922	100.0
3					40734	27.4	29402	19.8	78634	52.9	148770	100.0
4												
5												
6					228336	72.3	87396	27.7	125	0.04	315857	100.0
7					259372	48.0	281127	52.0			540499	100.0
8					67250	23.7	213102	75.2	3093	1.1	283445	100.0
9					31448	59.5	21391	40.5			52839	100.0
10					46415	75.3	14950	24.2	300	0.5	61665	100.0
11					18017	93.0	1356	7.0			19373	100.0
12					601	100.0					601	100.0
Total 1994	0	**0.0**	349	**0.02**	730832	**44.6**	815829	**49.8**	90353	**5.5**	1637363	100.0

1995	Depth fm 1-100		Depth fm 101-140		Depth fm 141-200		Depth fm 201-300		Depth fm >301		Total	Total
Month	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%
1												
2					16750	92.3	1400	7.7			18150	100.0
3			47550	27.4	124750	71.8	1400	0.8			173700	100.0
4			37050	17.6	153929	73.1	19500	9.3			210479	100.0
5			1500	0.2	539106	81.0	124788	18.8			665394	100.0
6					259647	28.7	635954	70.4	8107	0.9	903708	100.0
7					823551	51.3	772532	48.1	10104	0.6	1606187	100.0
8			3117	0.4	284436	33.4	564065	66.2			851618	100.0
9			2600	0.7	299596	78.7	78253	20.6			380449	100.0
10			800	0.2	256380	74.3	87650	25.4			344830	100.0
11			1700	1.1	81373	52.8	69723	45.3	1200	0.8	153996	100.0
12			26260	20.3	90288	69.9	12512	9.7	50	0.04	129110	100.0
Total 1995	0	**0.0**	120577	**2.2**	2929806	**53.9**	2367777	**43.5**	19461	**0.4**	5437621	100.0

1996	Depth fm 1-100		Depth fm 101-140		Depth fm 141-200		Depth fm 201-300		Depth fm >301		Total	Total
Month	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%
1			1940	0.5	242356	68.5	109339	30.9			353635	100.0
2			8500	2.5	263209	78.9	61986	18.6			333695	100.0
3			246715	20.5	896472	74.4	61437	5.1	500	0.04	1205124	100.0
4			488378	21.5	1084700	47.8	453478	20.0	244672	10.8	2271228	100.0
5			9931	0.4	1009597	42.2	1131708	47.3	243318	10.2	2394554	100.0
6			10102	0.4	977909	34.7	1773075	62.9	55910	2.0	2816996	100.0
7			2049	0.1	709740	33.6	1388454	65.8	10439	0.5	2110682	100.0
8					712341	52.8	612807	45.4	24276	1.8	1349424	100.0
9			33433	2.5	963094	71.3	353343	26.2			1349870	100.0
10			18957	2.7	478687	67.3	212991	29.9	581	0.1	711216	100.0
11			295	0.1	39133	19.5	161323	80.4			200751	100.0
12					33014	82.5	6986	17.5			40000	100.0
Total 1996	0	**0.0**	820300	**5.4**	7410252	**49.0**	6326927	**41.8**	579696	**3.8**	15137175	100.0

Table 4.
Cont'd

1997	Depth fm 1-100		Depth fm 101-140		Depth fm 141-200		Depth fm 201-300		Depth fm >301		Total	Total
Month	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%
1					64021	88.2	8567	11.8			72588	100.0
2					49140	36.9	84141	63.1			133281	100.0
3												
4	1686	2.4			43871	63.2	23850	34.4			69407	100.0
5	1112	0.2	5187	1.0	275838	52.2	196892	37.3	49140	9.3	528169	100.0
6	1530	0.2			153081	16.9	571396	63.3	177155	19.6	903162	100.0
7	3300	0.3	509	0.04	697428	57.5	510075	42.0	2376	0.2	1213688	100.0
8					331232	37.7	547082	62.3	200	0.02	878514	100.0
9			2666	0.4	369438	52.5	330459	47.0	1056	0.2	703619	100.0
10	2590	0.5	1134	0.2	250855	45.0	301366	54.1	1226	0.2	557171	100.0
11					5504	2.8	187136	96.3	1755	0.9	194395	100.0
12							72112	95.0	3767	5.0	75879	100.0
Total 1997	10218	**0.19**	9496	**0.18**	2240408	**42.03**	2833076	**53.15**	236675	**4.44**	5329873	100.0

1998	Depth fm 1-100		Depth fm 101-140		Depth fm 141-200		Depth fm 201-300		Depth fm >301		Total	Total
Month	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%
1												
2					44656	69.2	19863	30.8			64519	100.0
3			1875	1.1	116085	70.1	47701	28.8			165661	100.0
4	5364	2.7	194233	96.1	2439	1.2					202036	100.0
5	3386	0.5			320321	43.5	274883	37.3	138580	18.8	737170	100.0
6	7051	0.6	24469	2.1	490260	41.9	611887	52.3	36004	3.1	1169671	100.0
7					299439	25.5	779266	66.3	96030	8.2	1174735	100.0
8					262978	32.4	544690	67.0	5100	0.6	812768	100.0
9			500	0.1	239746	25.8	647931	69.9	39288	4.2	927465	100.0
10			824	0.1	183710	25.9	519944	73.3	4448	0.6	708926	100.0
11			935	0.3	2615	0.7	269960	74.9	86742	24.1	360252	100.0
12					60952	42.5	30405	21.2	51975	36.3	143332	100.0
Total 1998	15801	**0.24**	222836	**3.45**	2023201	**31.29**	3746530	**57.94**	458167	**7.09**	6466535	100.0

1999	Depth fm 1-100		Depth fm 101-140		Depth fm 141-200		Depth fm 201-300		Depth fm >301		Total	Total
Month	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%	Catch kg	%
1					64021	88.2	8567	11.8		0.0	72588	100.0
2			2600	1.9	54567	40.7	75842	56.6	900	0.7	133909	100.0
3			244274	45.6	184826	34.5	106410	19.9	161	0.0	535671	100.0
4			291696	33.1	556243	63.1	31077	3.5	2164	0.2	881180	100.0
5	3215	0.2			539847	36.4	593786	40.1	345465	23.3	1482313	100.0
6	7786	0.5			124304	7.5	1520162	91.4	10775	0.6	1663027	100.0
7					186987	14.8	1063487	84.2	12176	1.0	1262650	100.0
8			11350	1.2	212033	23.2	685934	75.1	4106	0.4	913423	100.0
9			31572	9.8	146286	45.3	144654	44.8	365	0.1	322877	100.0
Total 1999	11001	**0.15**	581492	**8.00**	2069114	**28.47**	4229919	**58.20**	376112	**5.18**	7267638	100.0

1994-1999		**%**		**%**		**%**		**%**		**%**		**%**
Average		**0.10**		**3.21**		**41.54**		**50.74**		**4.40**		100.0

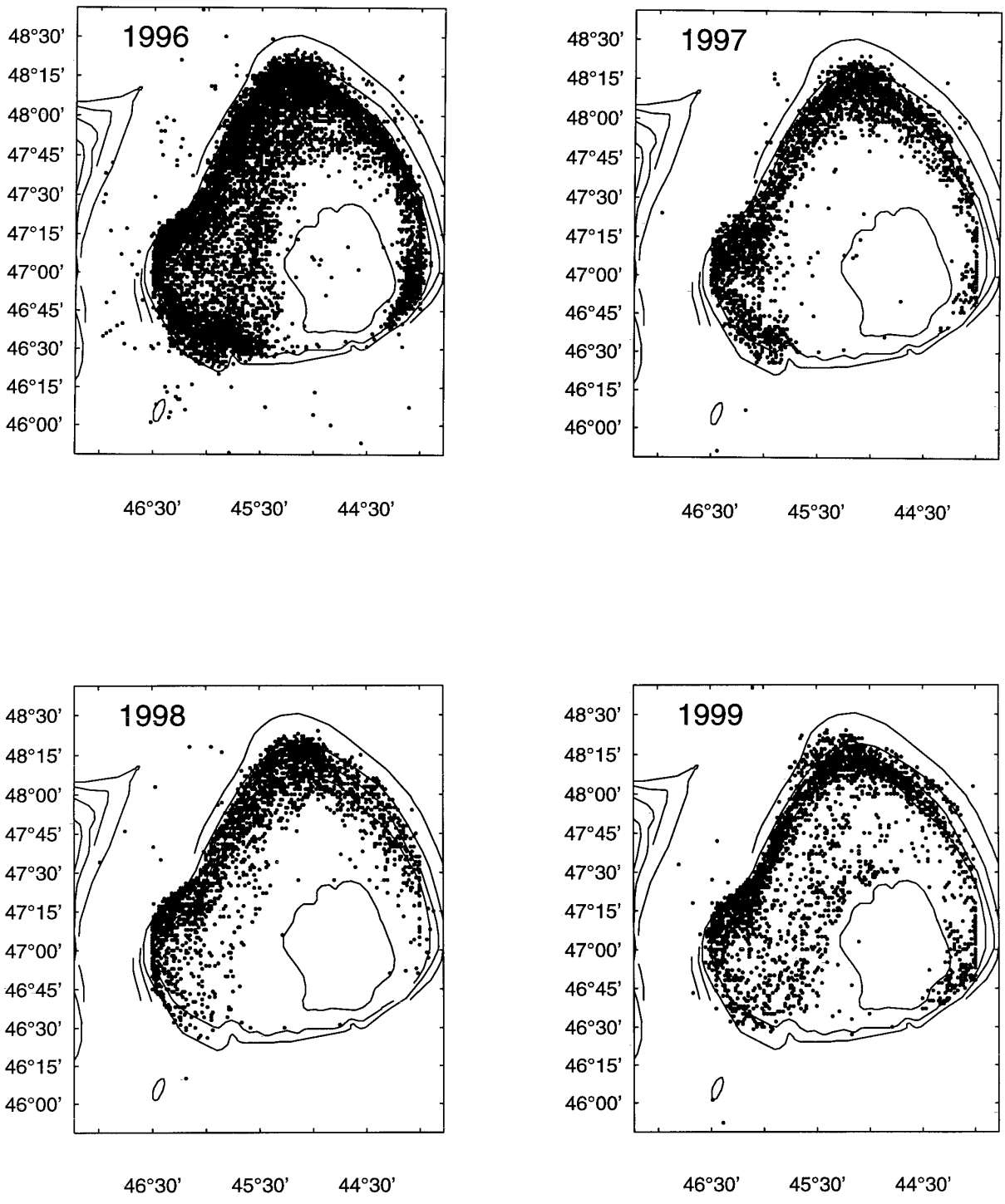
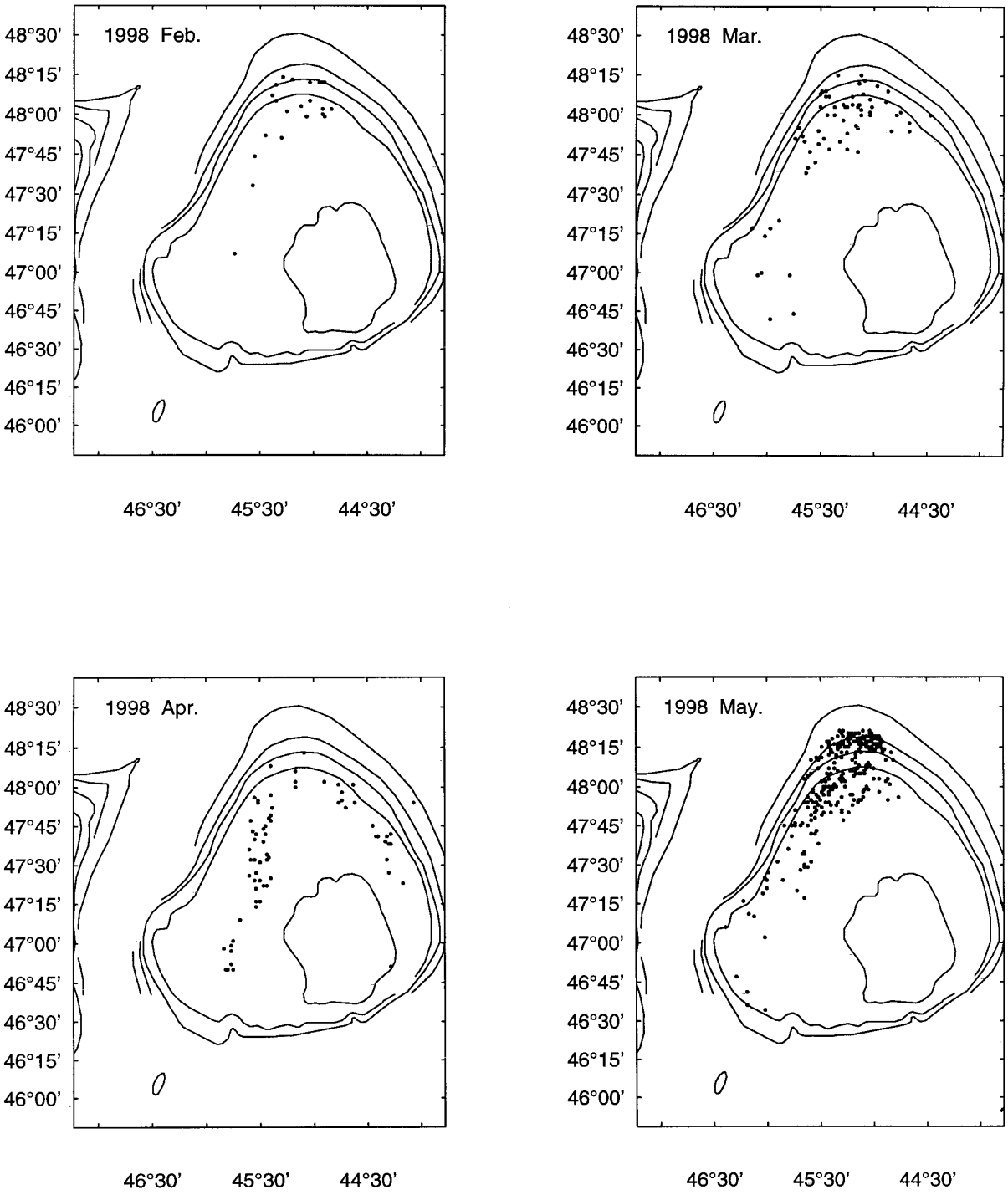


Fig. 1. Towing positions of the Icelandic fleet on Flemish Cap in 1996-1999.



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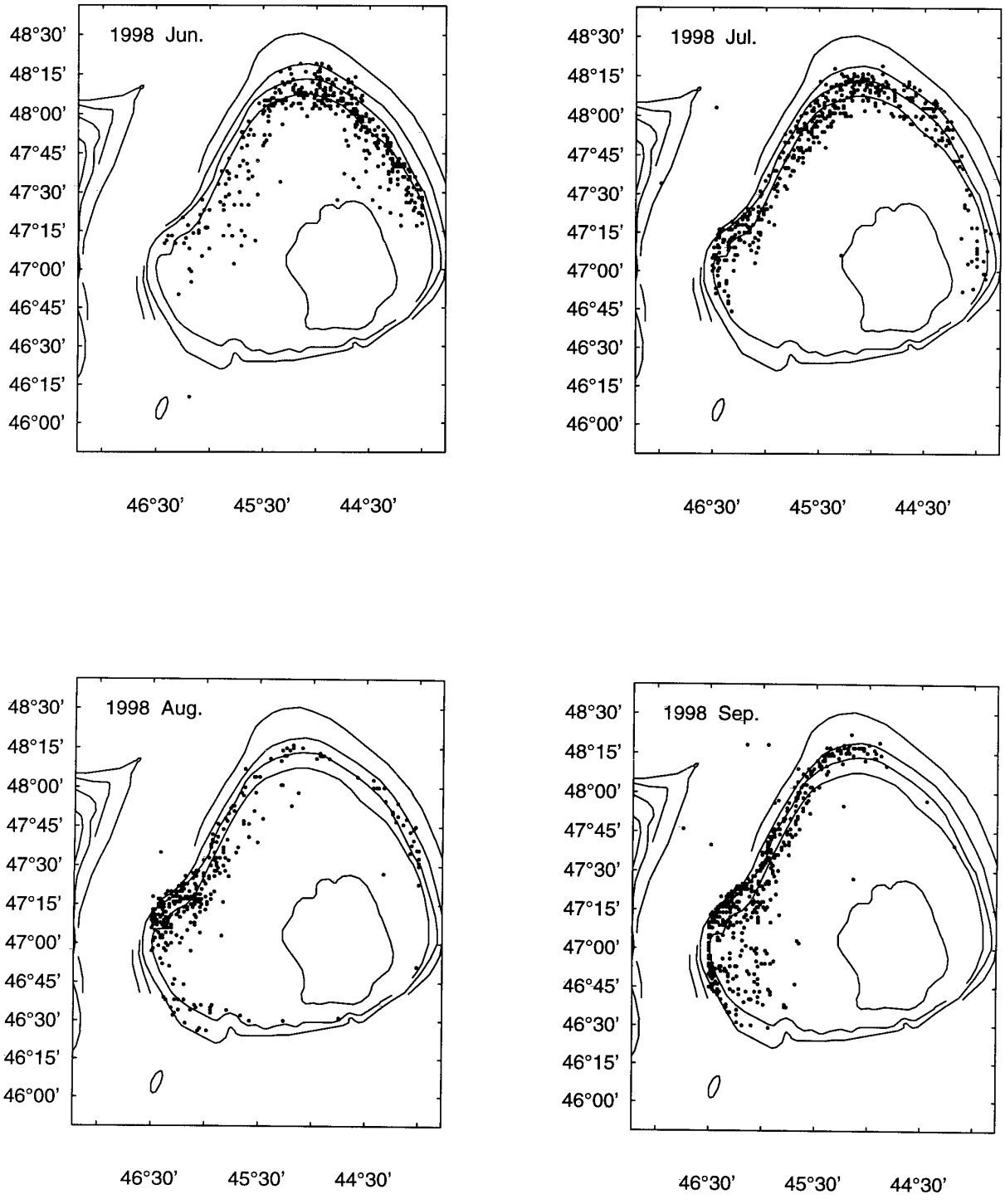

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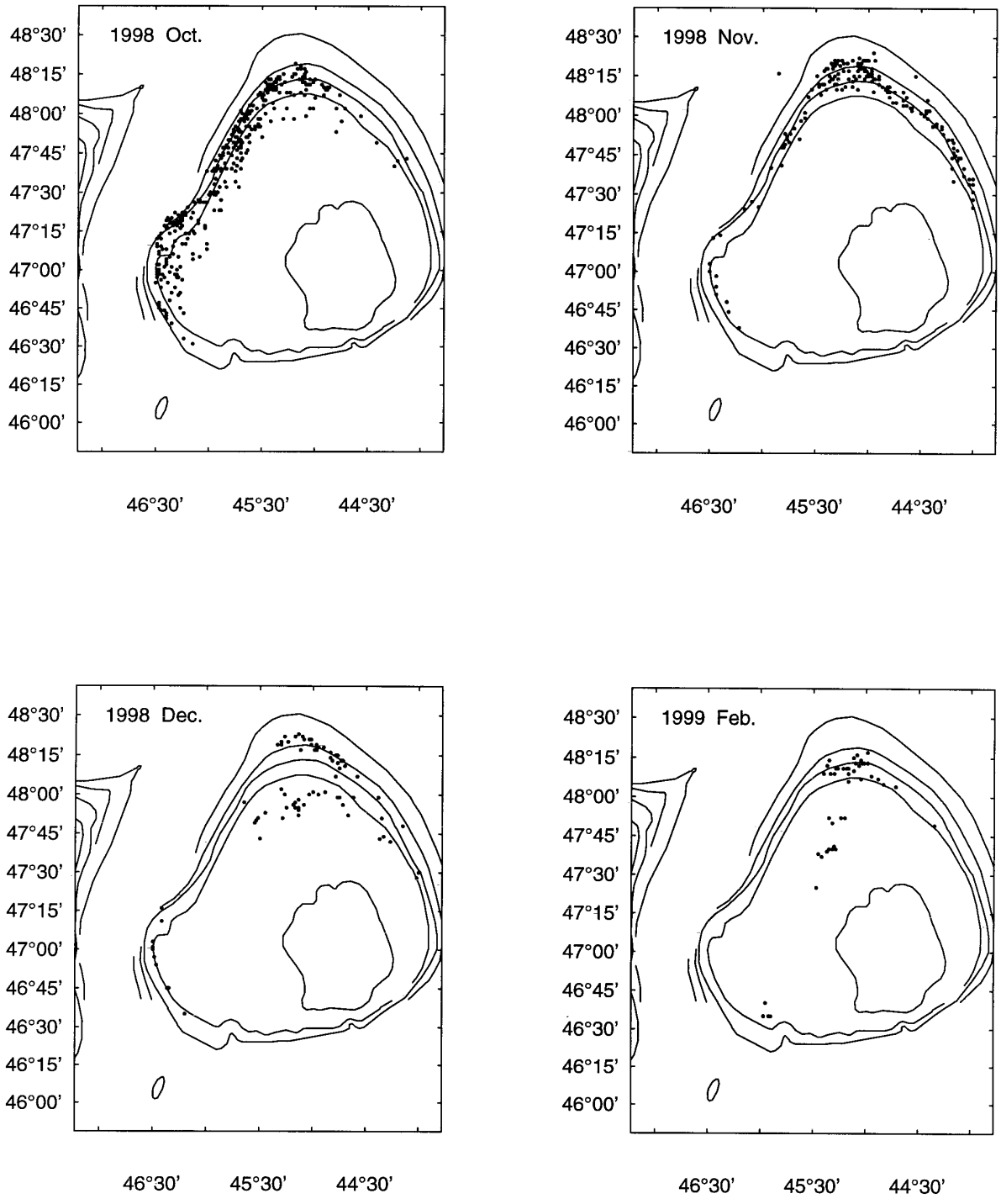
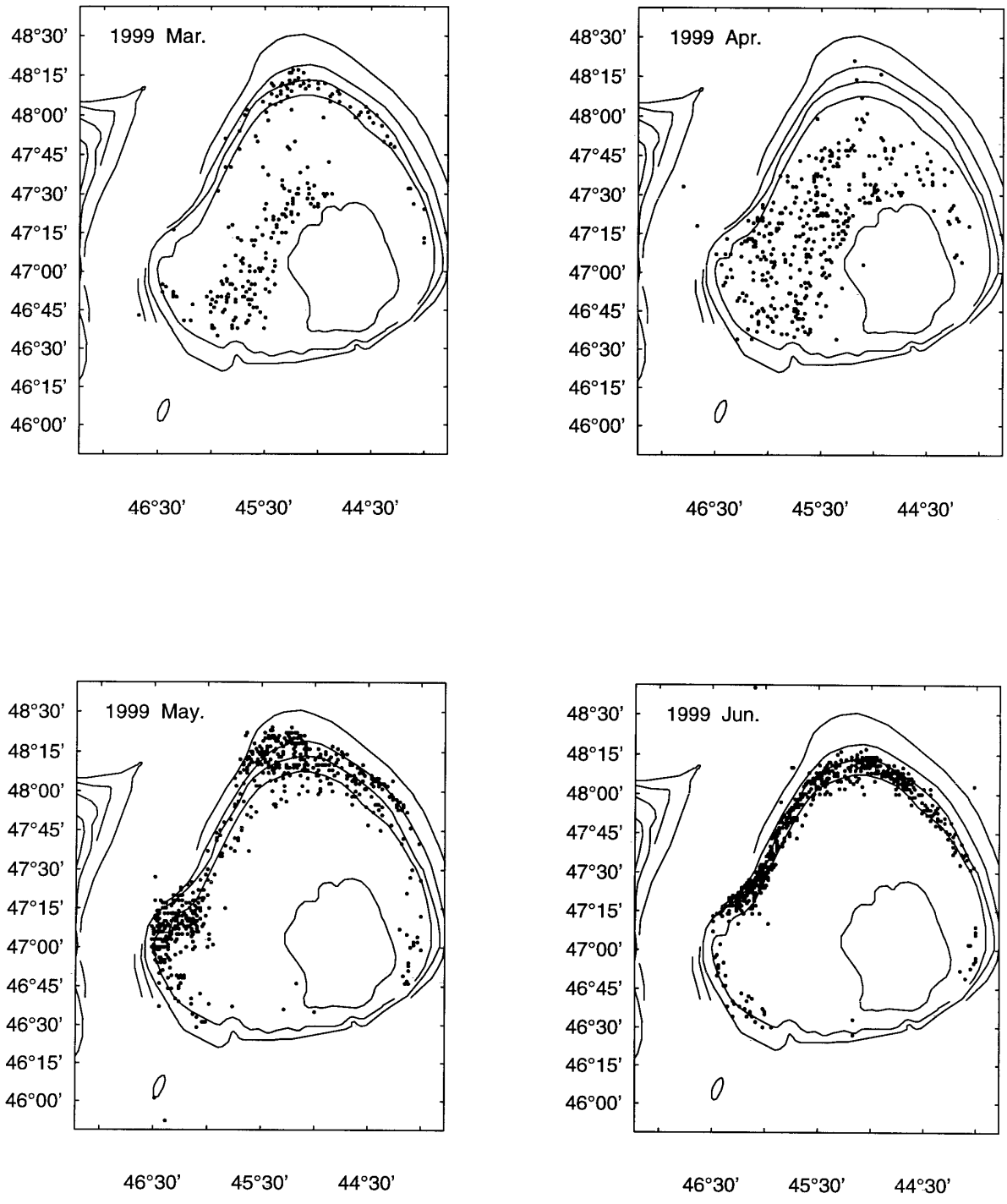


Fig. 1. Towing positions of the Icelandic fleet on Flemish Cap.



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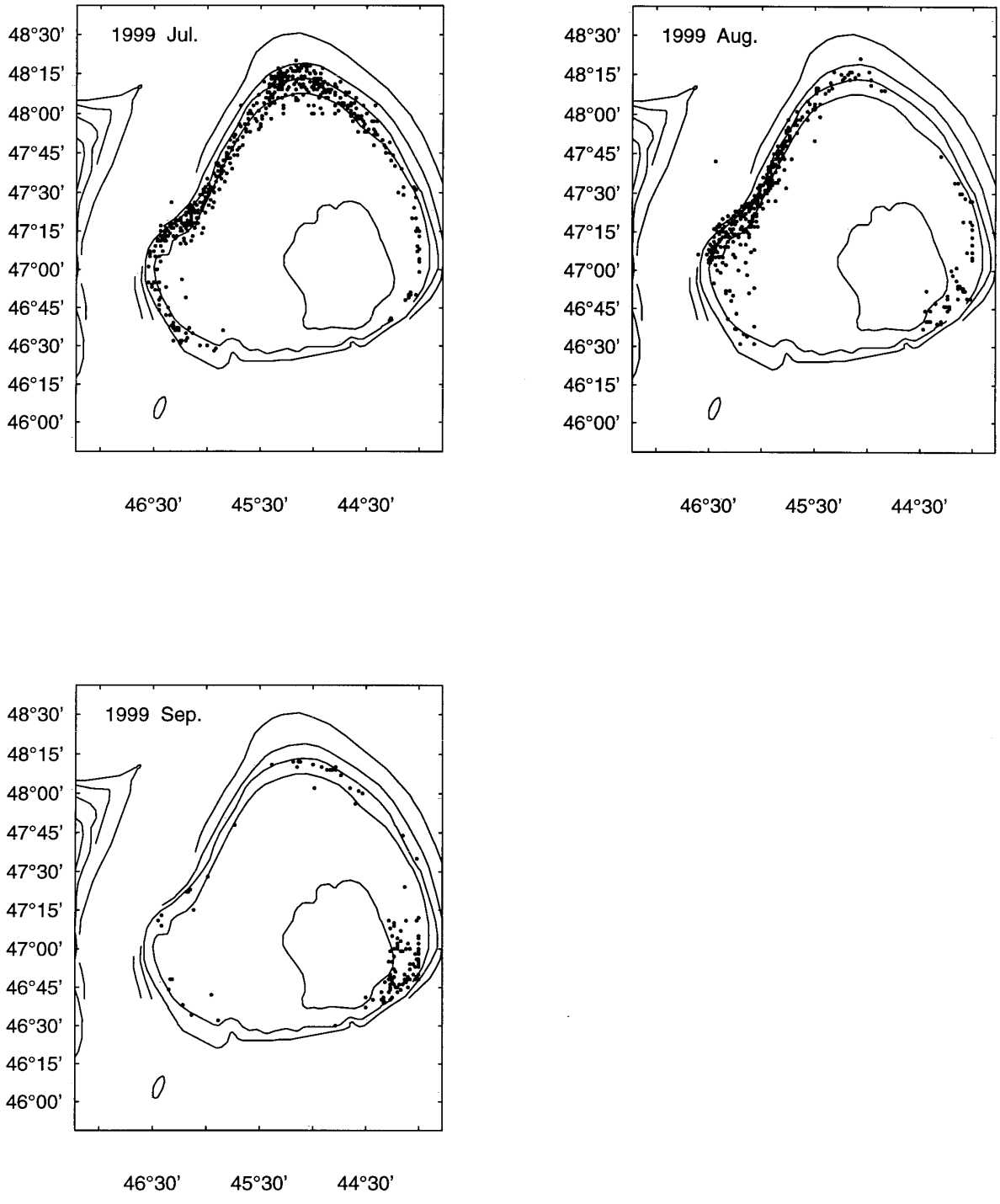

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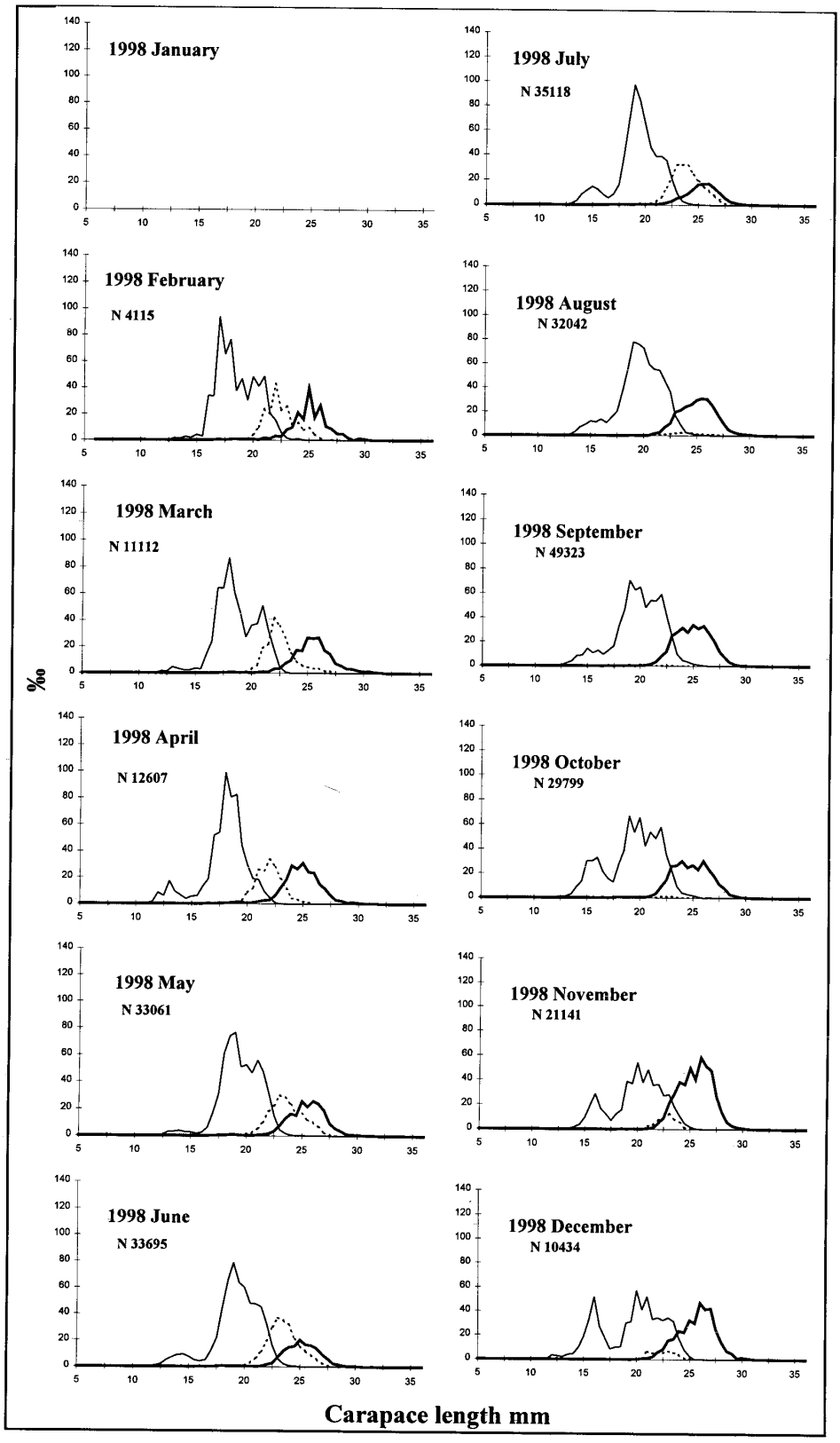

Fig. 2 The length frequency distribution of northern shrimp at Flemish Cap by months in 1998.

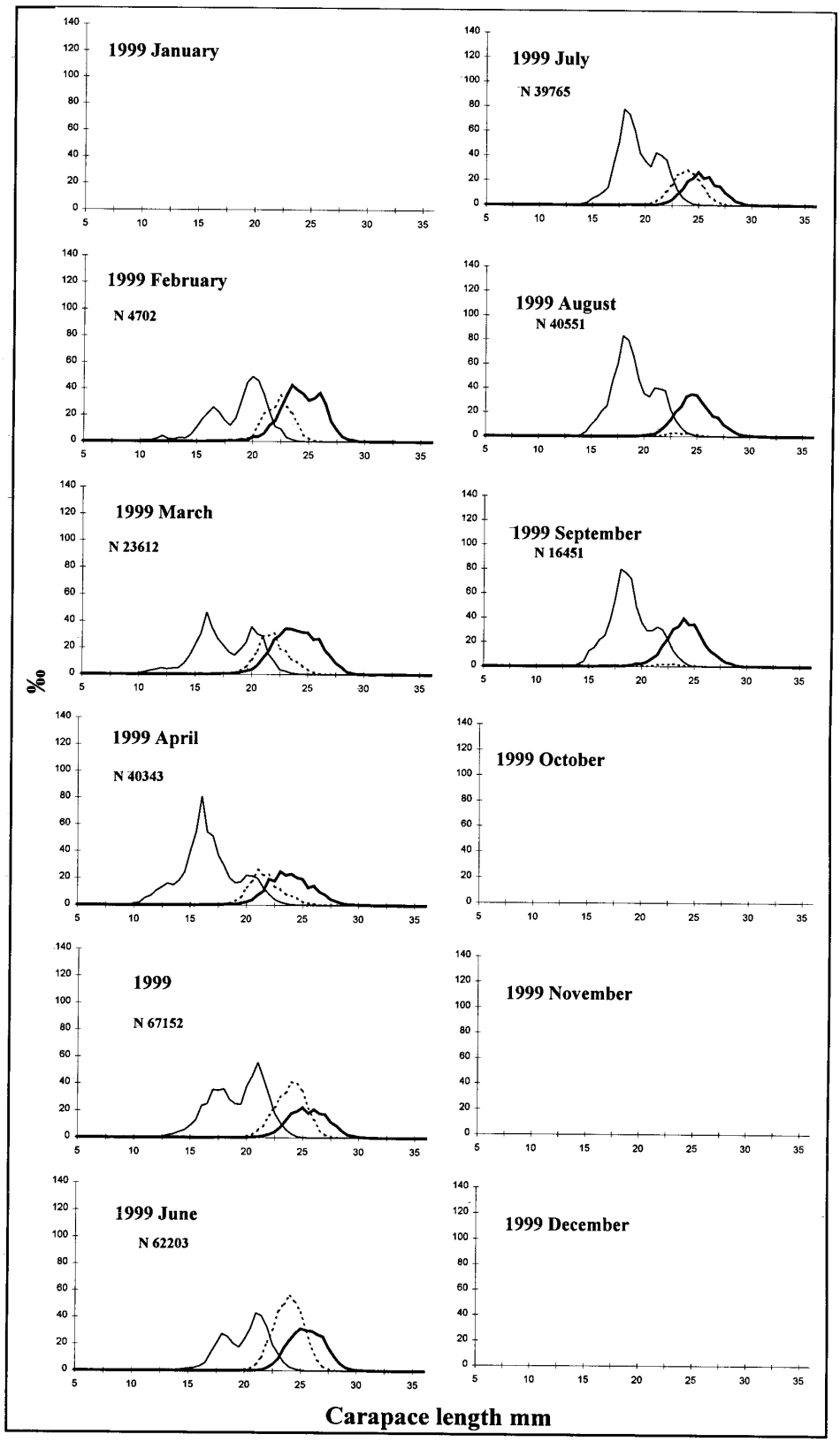

Fig. 3 The length frequency distribution of northern shrimp at Flemish Cap by months in 1999.

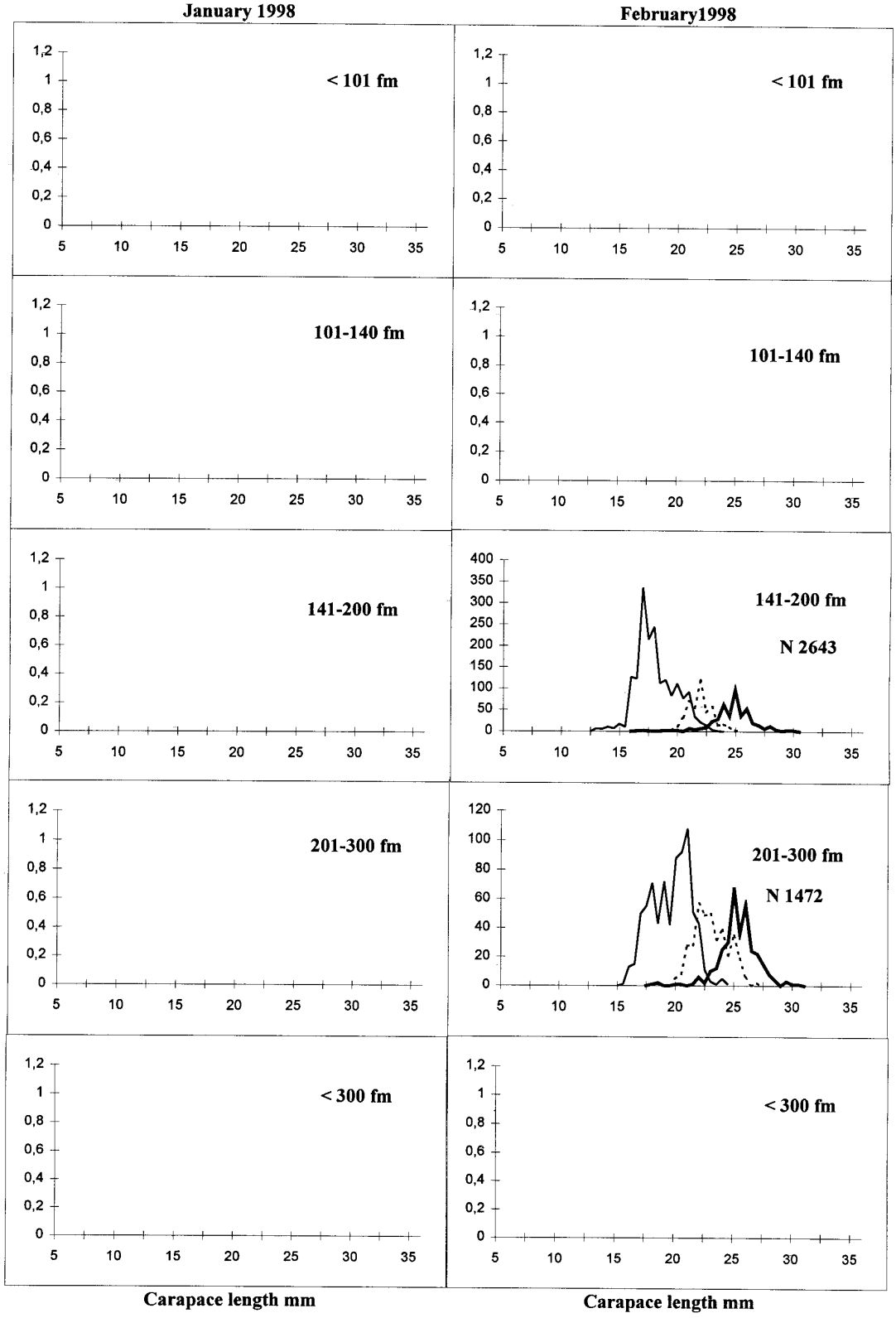

Fig. 4 The length frequency distribution of northern shrimp at Flemish Cap in February by depth in 1998.

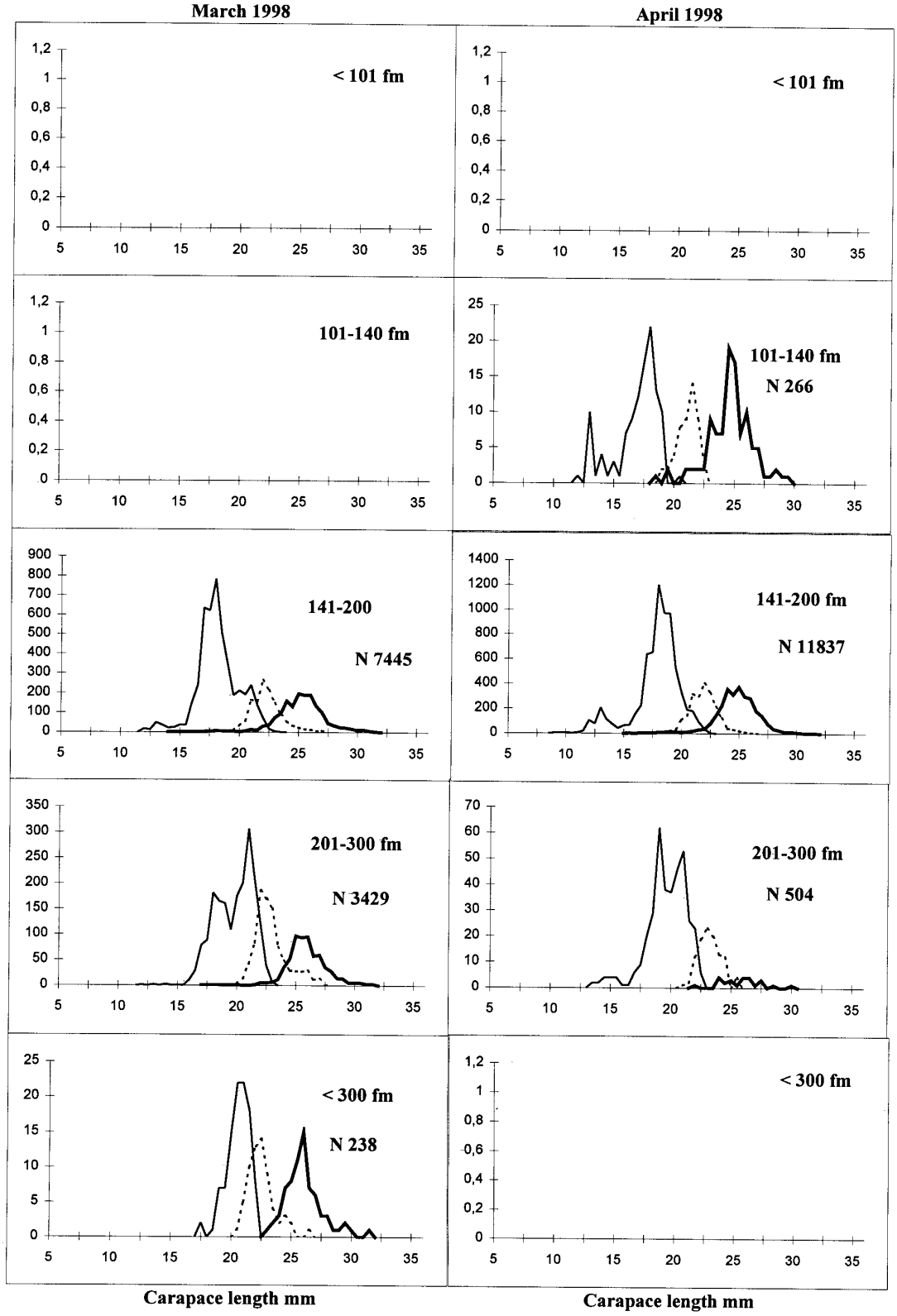

Fig. 5 The length frequency distribution of northern shrimp at Flemish Cap in March and April by depth in 1998.

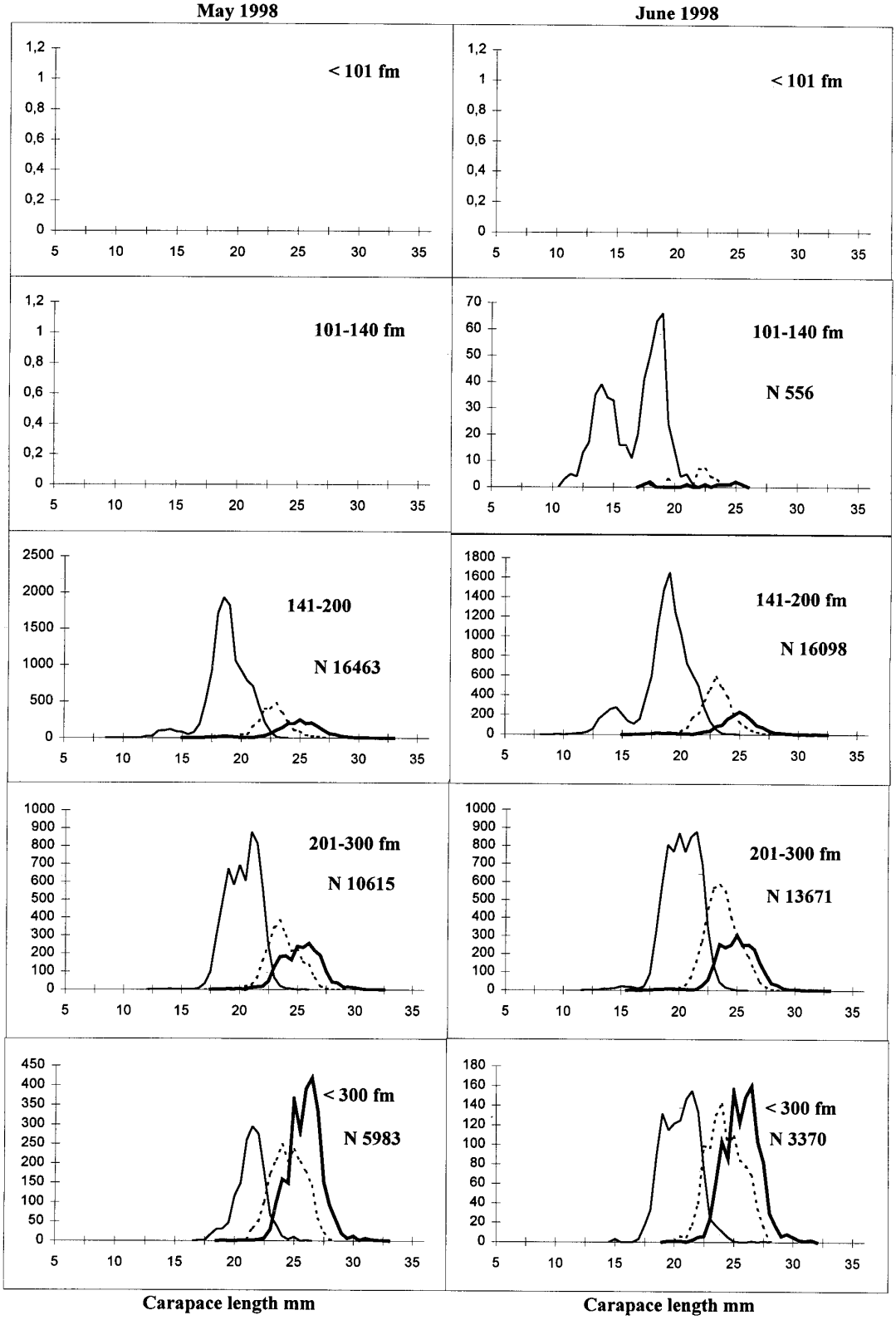

Fig. 6 The length frequency distribution of northern shrimp at Flemish Cap in May and June by depth in 1998.

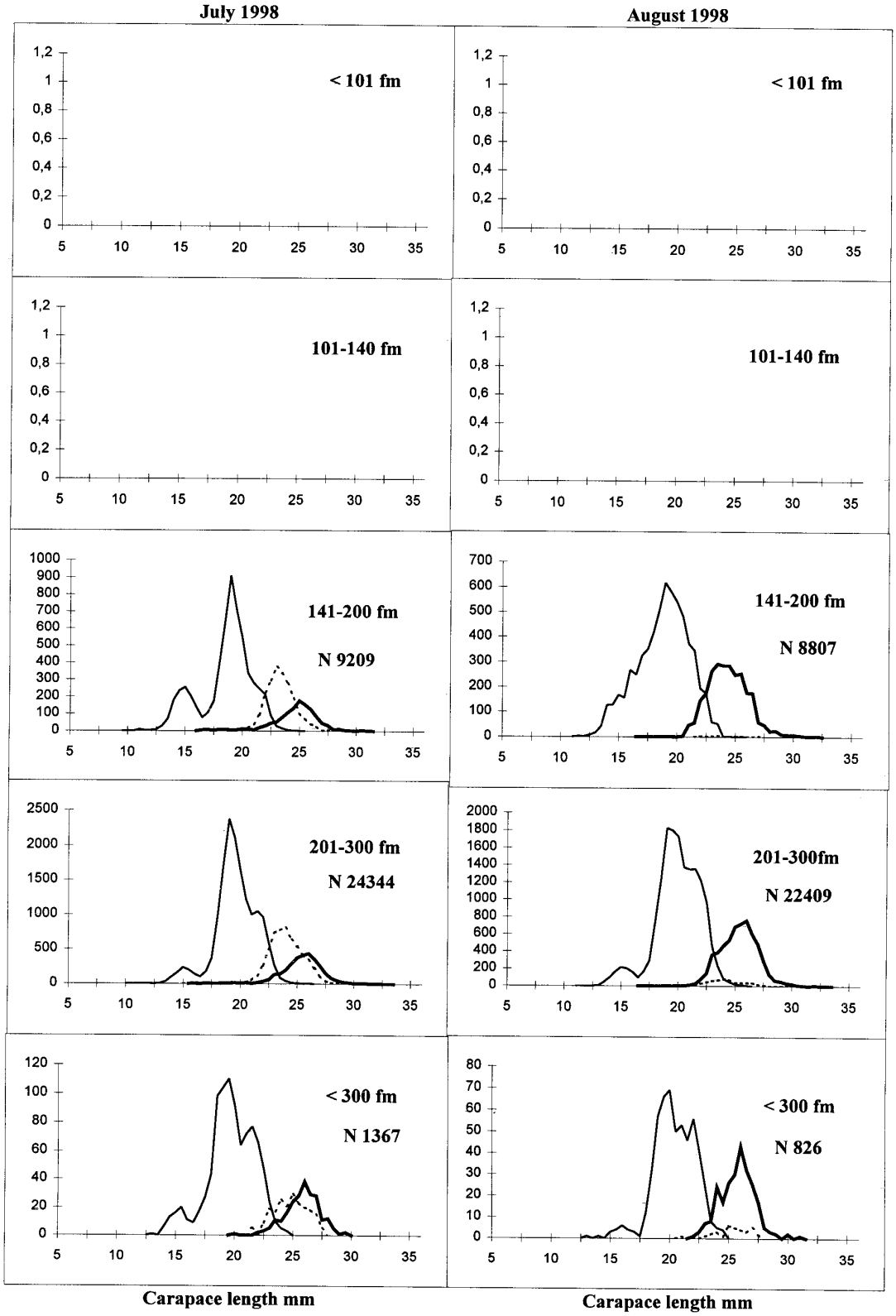

Fig. 7 The length frequency distribution of northern shrimp at Flemish Cap in July and August by depth in 1998.

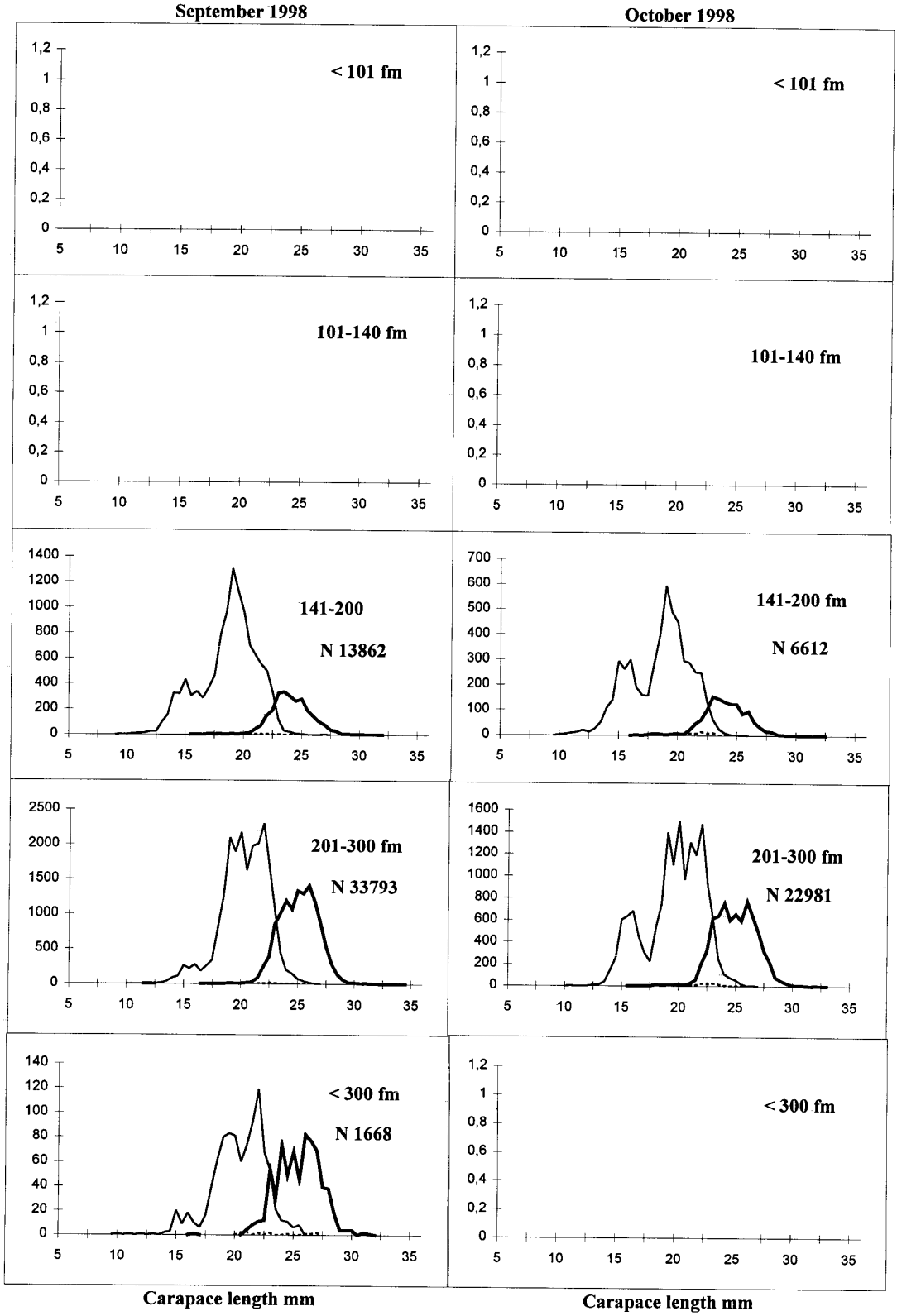

Fig. 8 The length frequency distribution of northern shrimp at Flemish Cap in September and October by depth in 1998.

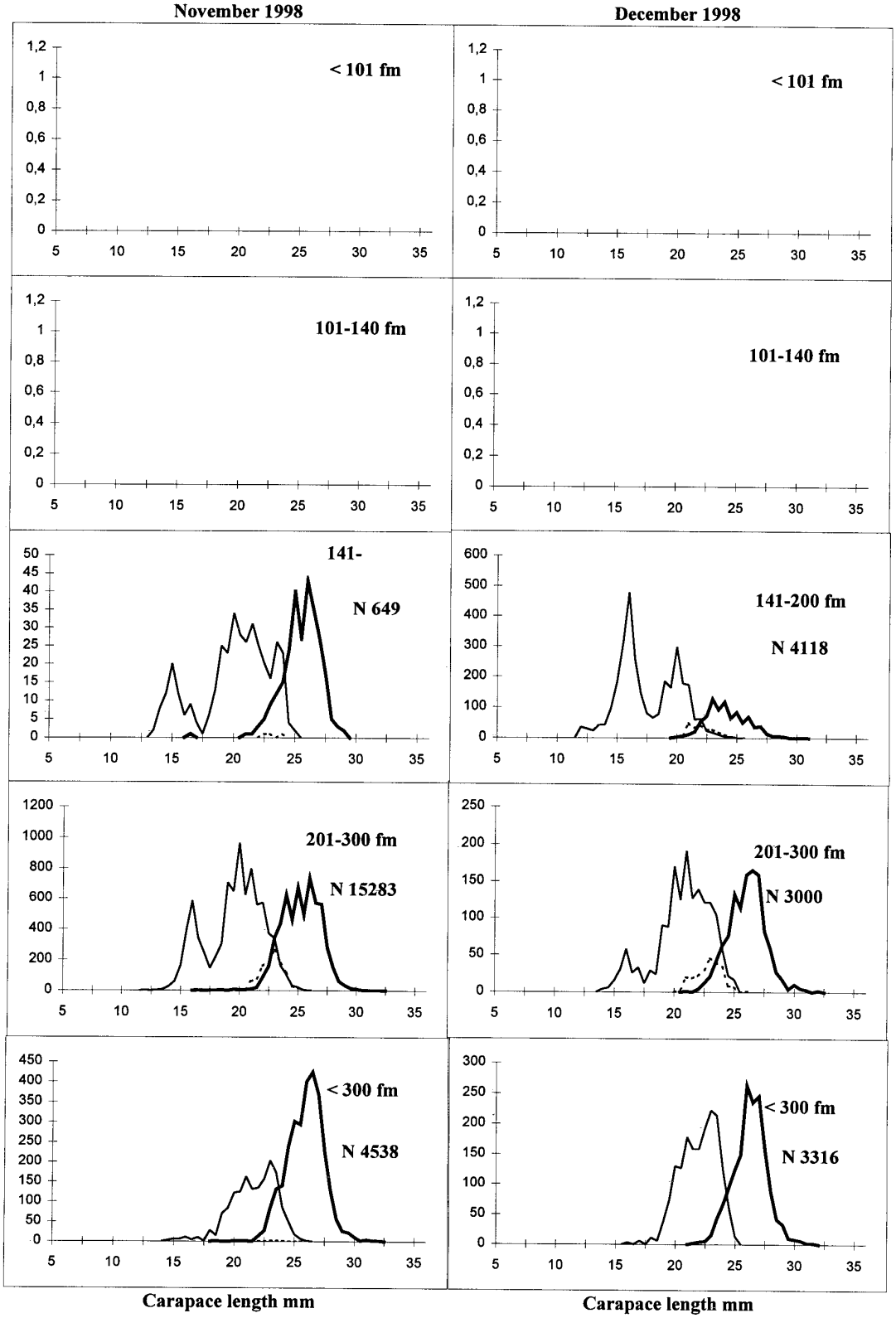

Fig. 9 The length frequency distribution of northern shrimp at Flemish Cap in November and December by depth in 1998.

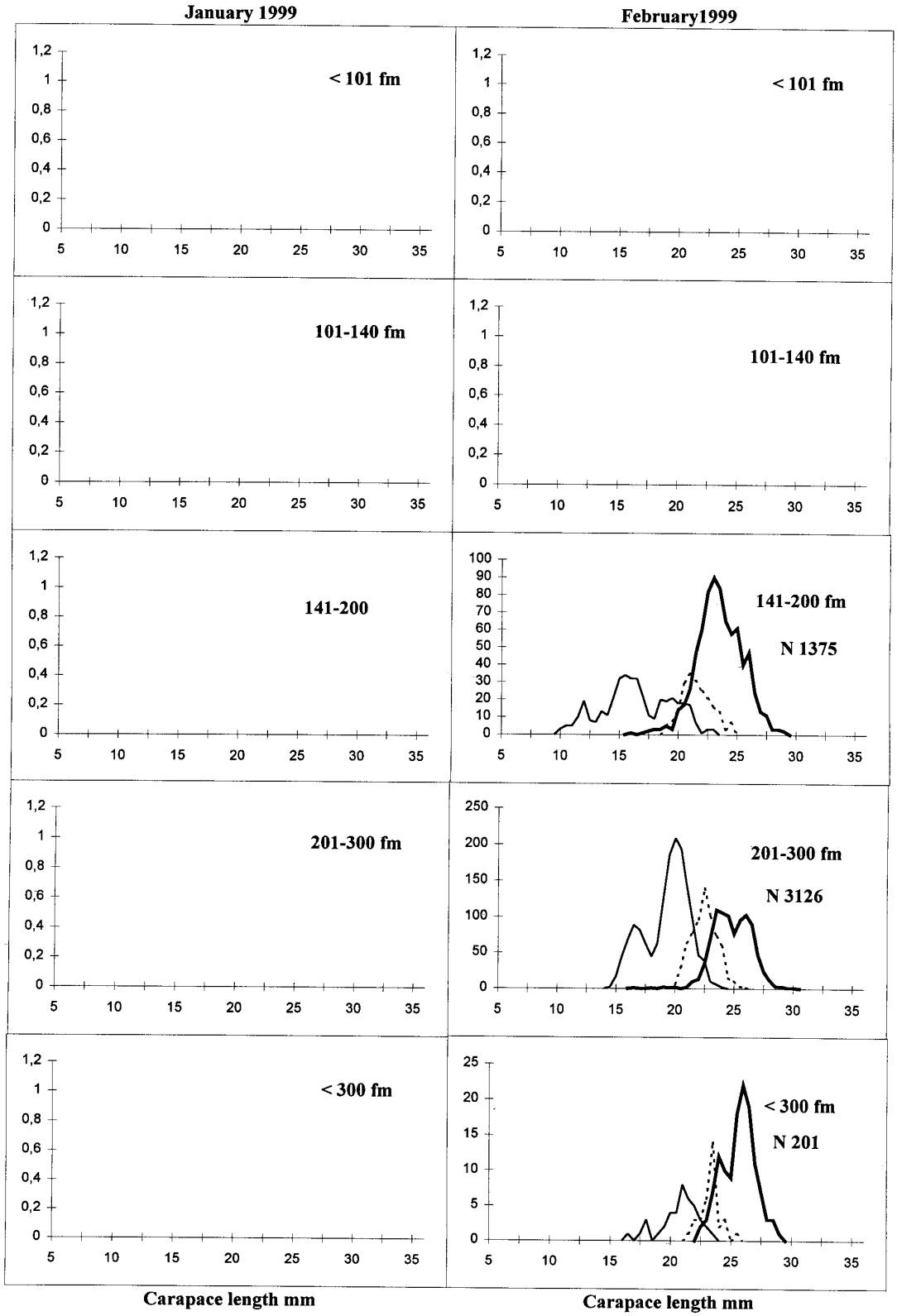

Fig. 10 The length frequency distribution of northern shrimp at Flemish Cap in February by depth in 1999.

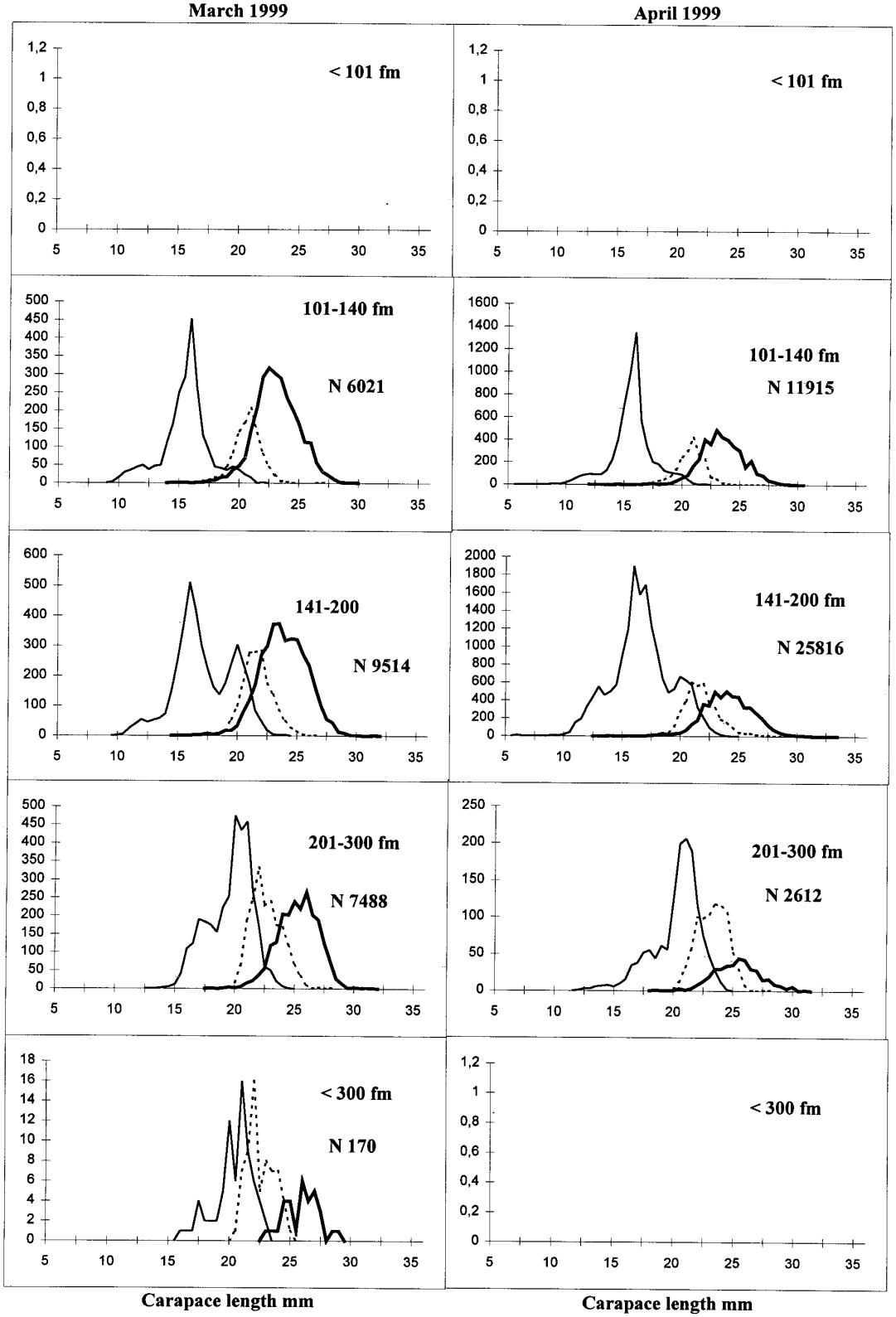

Fig. 11 The length frequency distribution of northern shrimp at Flemish Cap in March and April by depth in 1999.

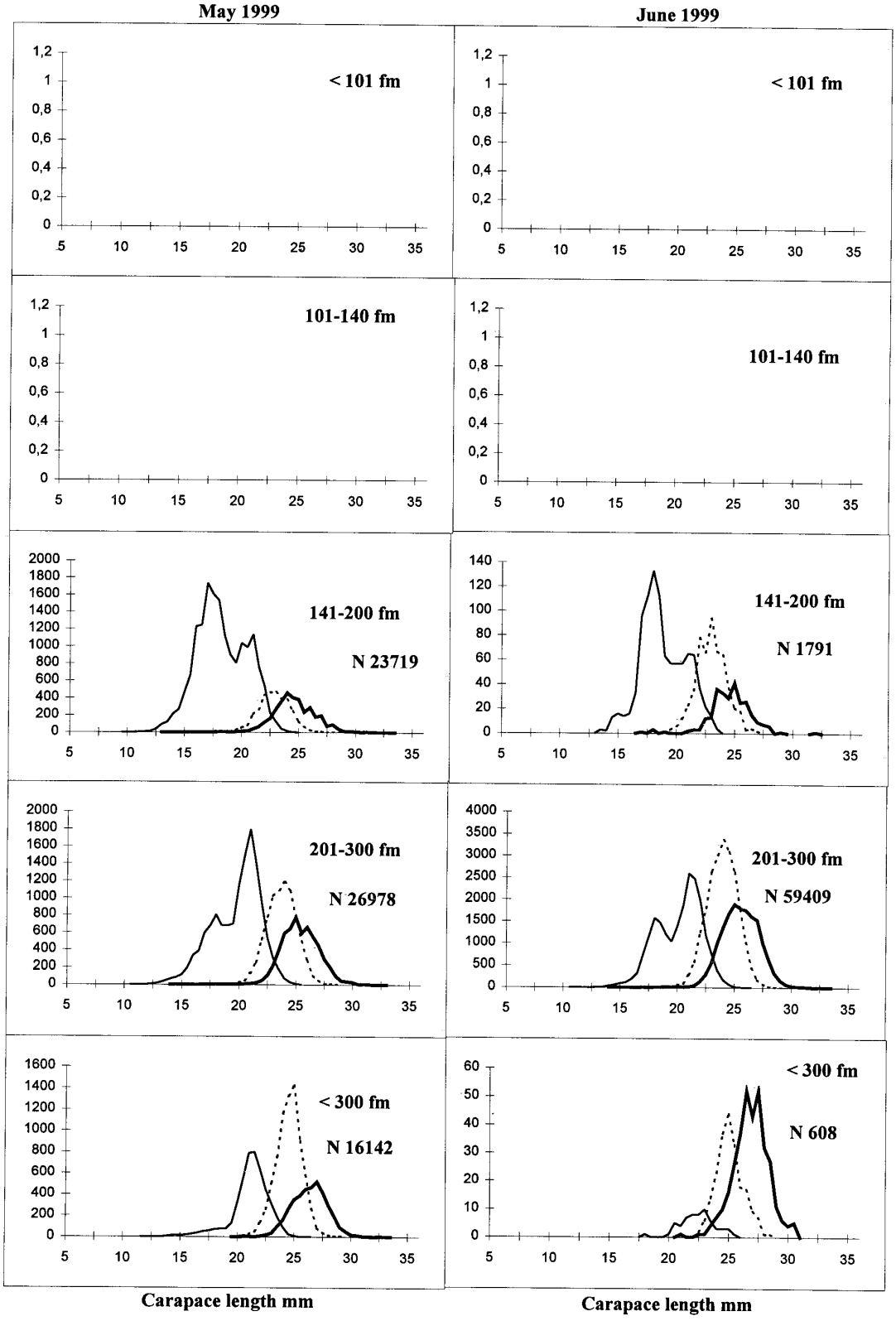

Fig. 12 The length frequency distribution of northern shrimp at Flemish Cap in May and June by depth in 1999.

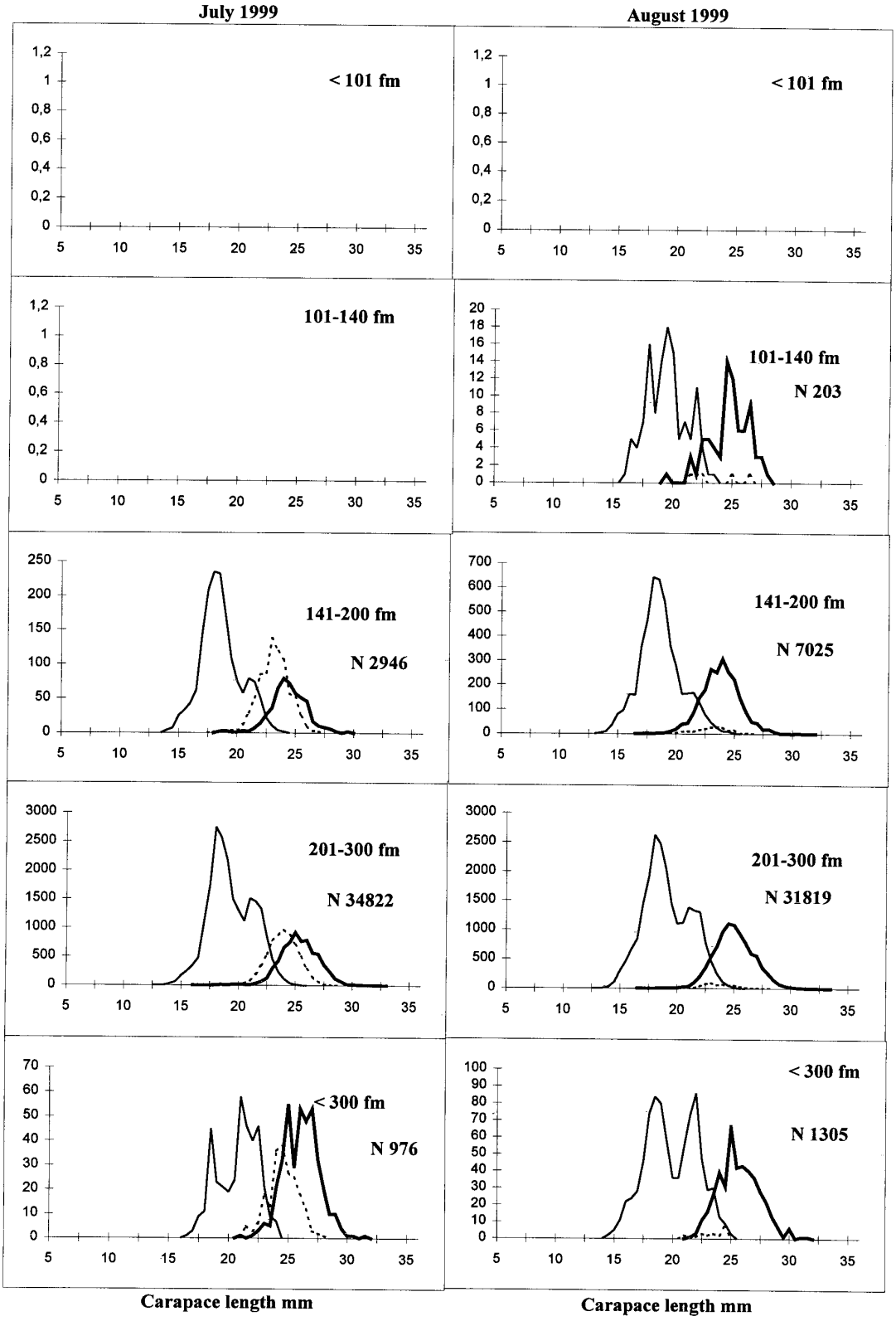

Fig. 13 The length frequency distribution of northern shrimp at Flemish Cap in July and August by depth in 1999.

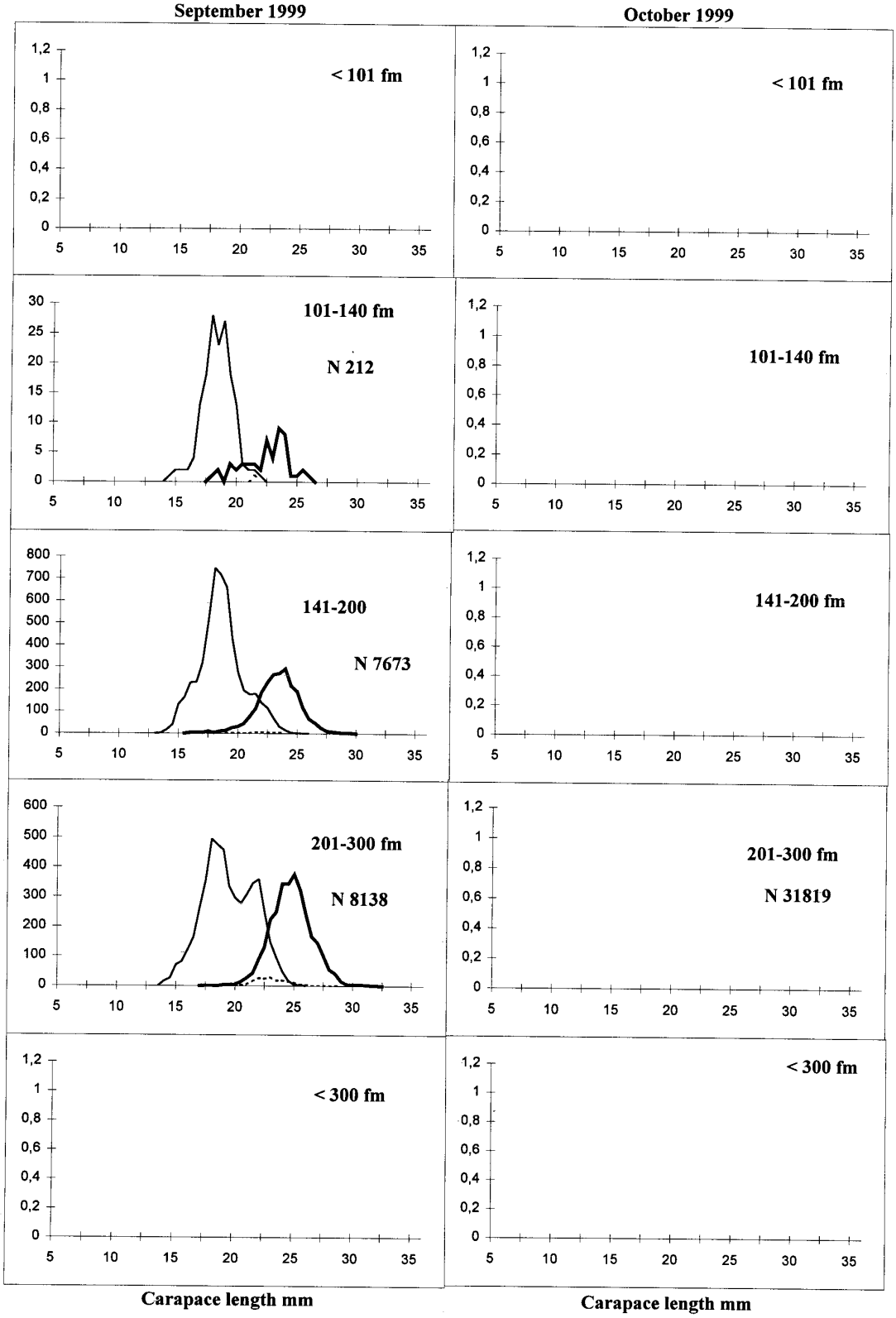

Fig. 14 The length frequency distribution of northern shrimp at Flemish Cap in September by depth in 1999.