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Status of the Newfoundland and Labrador Snow Crab Resource in 1998

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Abstract

Data on catch rate, size (carapace width, CW) and molt status (chela allometry) from various sources were used to infer resource status of Newfoundland and Labrador snow crab (*Chionecetes opilio*). Data from 1995 to 1998 fall bottom trawl surveys were particularly useful. These surveys, conducted near the end of the fishing season, indicated an apparent northward shift of the population over the past 3 years. Legal-sized males were broadly distributed throughout much of the survey area but were absent across much of the shallow southern Grand Bank. A substantial commercial biomass was indicated for 1999 throughout Div. 2J3KLNO, comparable to that of the previous year. Continued strong recruitment was indicated for 1999 but longer-term prospects are uncertain. Biomass estimates from 1996-1998 spring Div. 3Ps bottom trawl surveys were unrealistically low, highly variable, and unreliable. A trap survey in White Bay (NAFO Div. 3K) showed that males were segregated by size in inshore strata, with small males predominantly in the shallowest strata. A great increase in trap survey catch rates of intermediate-sized crabs in White Bay during 1994-98 suggests that there may have been density-dependent and size-related changes in distribution patterns in recent years. Incidence of bitter crab disease (BCD) has increased, especially in Div. 3K, since 1994.

Résumé

Des données sur le taux de capture, la taille (largeur de carapace, LC) et le stade de mue (allométrie des chélipèdes) de sources diverses ont été utilisées pour en déduire l'état de la ressource de crabe des neiges (*Chionecetes opilio*) de Terre-Neuve et du Labrador. Les données des relevés du chalut de fond de l'automne 1995 à 1998 se sont avérées particulièrement utiles. Ces relevés effectués vers la fin de la saison de pêche indiquent un déplacement vers le nord de la population au cours des trois dernières années. Les mâles de taille légale étaient généralement répartis dans la majorité de la zone des relevés, mais absents de la plus grande partie de la zone peu profonde du sud du Grand Banc. Une biomasse d'importance commerciale appréciable, comparable à celle de l'année précédente, a été notée pour 1999 dans les divisions 2J3KLNO. Un recrutement important et maintenu a aussi été noté pour 1999, mais les perspectives à plus long terme demeurent incertaines. Les estimés de biomasse obtenus à partir des relevés de printemps au chalut de fond effectués de 1996 à 1998 en 3Ps étaient invraisemblablement bas, fortement variables et non fiables. Un relevé au casier dans la baie White (div. 3K de l'OPANO) a montré que les mâles étaient répartis selon la taille dans la strate côtière, les mâles de petite taille se trouvant surtout dans la strate de moindre profondeur. Une grande augmentation des taux de capture du relevé au casier de crabes de taille intermédiaire dans baie White de 1994 à 1998 porte à croire que les variations de l'allure de la répartition des dernières années aient pu être dépendantes de la densité et liées à la taille. L'incidence de la maladie du crabe amer s'est accrue, notamment en 3K, depuis 1994.

Introduction

This document presents research data from various sources and fishery data toward evaluating the status of the Newfoundland and Labrador snow crab (*Chionecetes opilio*) resource in 1998 and projecting fishery performance in 1999. Data sources include the fall 1995-98 bottom trawl surveys throughout NAFO Div. 2GHJ3KLNO and spring 1996-1998 Div. 3Ps bottom trawl surveys. Data are also presented from NAFO Div. 3K September trap surveys in White Bay during 1994-98 and in Notre Dame Bay during 1996-98. Data from at-sea sampling by fishery observers and from the dockside-monitoring program are also utilized.

Methods

Bottom Trawl Surveys

Data Collected:

Data on total catch number and weight were acquired from the 1995 to 1998 fall stratified random bottom trawl surveys, which extended throughout NAFO Div. 2J3KLNO. The 1996-98 surveys also extended to NAFO Div. 2GH and to inshore strata, not included in the 1995 surveys. Data were also acquired from 1996-1998 NAFO Div. 3Ps spring bottom trawl surveys. These surveys utilized the Campelen 1800 survey trawl in standard tows of 15 min duration.

All males were measured in carapace width (CW, mm) and chela height (CH, 0.1 mm). Shell condition was assigned one of three categories: (1) new-shelled - these crab had molted in spring, have a low meat yield, and are assumed to recruit to the fishery in the following year, although an unknown portion may be retained late in the current season; (2) intermediate-shelled – these crab last molted in the previous year and represent new recruits to the fishery of the current year; (3) old-shelled – these crab have been available to the fishery for at least 2 years. Occurrence of bitter crab disease (BCD) was also noted. BCD is caused by the haemoparasitic dinoflagellate *Haematodinium spp.*. Infected crabs are recognized by orange-pink coloration on the dorsal surface and an opaque white 'cooked' appearance to the ventral surface.

Treatment of Biological Data:

A schematic model of snow crab recruitment (Dawe et al. 1997) was followed in assigning individuals to population components for subsequent analysis. Based on this model, data were grouped into classes for each of three biological variables:

i) Carapace Width (CW) – based on growth per molt data (Moriyasu et al. 1987, Taylor and Hoenig 1990, and Hoenig et al. 1994), three main size groups were established: legal-sized crabs (≥95 mm CW); Sub-legal 1, those which would achieve legal size after one molt (76-94 mm CW); and Sub-legal 2, those which would achieve legal size after two molts (60-75 mm CW). All other males were pooled into a category of small males (<60 mm CW). This group was divided into two groups (40-59 mm CW and <40 mm CW) to describe the effect of size on incidence of BCD from fall bottom trawl surveys.

ii) Chela Allometry – males develop enlarged chelae when they undergo a final molt, that may occur at any size larger than about 40 mm CW. Therefore only males with small chelae will continue to molt and subsequently recruit to the fishery. A model which separates two 'clouds' of chela height on carapace width data ($CW = 0.0806CS^{1.1999}$) was applied to classify each individual as either large-clawed or small-clawed.

iii) Shell Hardness – males that undergo their terminal molt in the spring will remain new-shelled throughout the fishery season of that year and will not be fully hardened and retained by the fishery until the following year. It is assumed that all males with small chelae remain new-shelled between molts. In reality, however, an annually-variable proportion of small-clawed males will not molt in any given year ('skip molters') and so will develop 'older shells' between molts. For each year that a crab skips a molt, it's eventual recruitment is delayed by a year.

Analysis of Data:

Spatial distribution throughout NAFO Div. 2GHJ3KLNO was examined using the fall survey data for 1995-98. The SPANS Spatial Analysis System (Burke 1997, Kulka 1998) was used to describe density distribution of each of four size groups of males; legal-sized (>94 mm CW), Sub-legal 1 (76-94 mm CW, Sub-legal 2 (60-75 mm CW), and small males (<60 mm CW).

Minimum trawlable biomass estimates were generated using STRAP (Smith and Somerton 1981) separately for each of the above size groups of males, as well as for each of immature and mature females. Biomass estimates for each group were generated by NAFO Division using 1996-98 fall survey data for Divs. 2J3KLNO and using 1996-98 spring survey data for Div. 3Ps.

To examine size composition of males, carapace widths were grouped into 3 mm intervals and adjusted up to total population abundance. Each size interval was partitioned by claw type.

NAFO Div. 3K Inshore Sampling

A trap survey was carried out during September of 1994-98 in White Bay (management area 3B, Fig. 1). Each set, at depths of 183 m and greater was comprised of 6 baited traps separated by 45 m. The catches from end traps (large-meshed) were not sampled. The 4 traps sampled in each set included 2 large-meshed traps, and 2 small-meshed traps. Sets were apportioned among three depth strata (201-300 m, 301-400 m, and 401-500 m), and were randomly allocated within each stratum. During 1997 and 1998 the survey also extended to Notre Dame Bay (management areas 3C-D, Fig. 1) where two depth strata (201-300 m and 301-400 m) were sampled using the same sampling protocol. In September 1998 comparative sampling was conducted between traps and the Campelen 1800 survey trawl, toward estimating trawl catchability for snow crab. Comparative sets were conducted on each of 40 stations, 8 in each of the 3 White Bay and 2 Notre Dame Bay strata described above. Details of sampling with both traps and trawl were as already described.

Biological sampling and grouping of crabs by size followed the same protocols as outlined above for bottom trawl surveys.

Results and Discussion

NAFO Div. 2GHJ3KLNO Fall Bottom Trawl Surveys

Spatial Distribution

The fall distribution of males throughout NAFO Div. 2J3KLNO in 1998 was similar in many respects to that during 1996 and 1997 (Fig. 2), as previously described (Dawe et al. 1998). Males were broadly distributed throughout the Div. 2J3KLNO survey area but were absent from Div. 2GH. They were also absent from most of the deepest sets (mostly >800 m) along the Div. 3KL slope. Largest males (legal-size and Sub-legal 1 (Fig. 2a-b) were also usually absent from innermost sets at depths <300 m in Div. 2J3K where smaller males were caught (Fig. 2c-d). For all three years of complete surveys (1996-1998) it generally appeared that highest densities for largest males were associated with offshore areas (Fig. 2a-b) whereas those for smallest males (Fig. 2c-d) extended into inshore areas as well. For all years generally, and for 1998 in particular, no crabs were caught over a broad area of the shallow (<100 m) southern Grand Bank (Fig. 2).

Despite these similarities among years, there were also differences. For all size groups, the distribution of highest densities generally became fragmented and shifted to the north over the period 1995-1998 (Fig 2). This was particularly evident for smallest males (Fig. 2d). Highest densities of largest (legal-sized) males appear to have shifted south as well, along the eastern Div. 3LNO slope (Fig. 2a). Such changes in distribution of largest males could be accounted for by annual area-specific changes in exploitation rate relative to recruitment level. However this would not account for similar trends in the smaller size groups. The apparent northward shift of small crabs <60 mm CW

(Fig. 2d) could be accounted for by area-specific variation in production or early survival, but this is not consistent with the similarity in trends among all size groups.

Biomass:

Biomass estimates are interpreted qualitatively because the catchability of the survey trawl for snow crab is unknown, but is known to be less than 1. Minimum trawlable biomass estimates are presented for population components defined by size for males (Table 1) and by maturity for females (Table 2). Changes in biomass estimates between 1997 and 1998 by NAFO division for both mature and immature females also reflect the apparent northward shift noted for males (Table 2).

The precision of biomass estimates for legal-sized crab in 1998 was highest for Div. 3K and Div. 3L (±23%), and lowest for Div. 3N (±74%), and Div. 3O (±76%). However, precision was considerably higher for estimates generated for Div. 2J3KLNO overall (±14%). For all components, confidence limits were especially broad for NAFO Div. 3NO, probably due to the highly aggregated distribution in those areas. Biomass estimates for Div. 3NO are not considered to be reliable. Estimates for legal-sized males are considered to represent residual (post-fishery) biomass levels, although a small proportion of the annual catch was taken during the October-December survey period in each year.

The STRAP residual biomass estimate of Div. 2J3KLNO legal-sized crabs in 1998 (85,008 t) was 11% higher than in 1997 (76,516 t) (Table 3). It has doubled in Div. 2J since 1996, whereas it returned to 1996 levels for more southern areas. This is consistent with the apparent northward shift in distribution of all components generally. As suggested earlier, this trend, for legal-sized crabs, could be accounted for by lower exploitation rates in Div. 2J than in southern areas during the recent period of strong recruitment. This is supported by the relatively low ratios of catch to fall biomass index for Div. 2J during the past three years, especially in 1998 (Table 3).

However, such fishery effects cannot account for the similarity in trends among all population components. In fact, an increase in biomass in Div. 2J and a decrease in more southern areas is most striking for the smallest population components; small males <60 mm CW and immature females (Tables 1 and 2). This suggests that there may be area-specific annual changes in catchability which are common to all population components. Alternatively, it is also possible that trends in biomass of small crabs, although similar to those in largest crabs, may be due to different effects, such as density-dependent processes.

Biological Characteristics:

Size composition of males throughout Div. 2J3KLNO in 1998 (Fig. 3) indicated a continuation of trends noted in the previous year (Dawe et al. 1998). The modal size of large males increased slightly from 95 to 98 mm CW in 1998. However, modal length of largest males with small claws decreased due to recruitment to the legal-sized (and predominantly large-clawed) group by small-clawed males which were almost of legal size in 1997. Abundance of smallest males continued to decline in 1998 (Fig. 3). A 'trough' evident at about 40-70 mm CW in 1996 and 1997 persisted in 1998, perhaps reflecting low catchability of this size group. Such low catchability could be related to size and distribution, especially with respect to substrate type, for this component. For example, catchability of this size group may be low on rough shallow-water inshore strata, where the trawl may not maintain constant contact with the bottom.

The decline in abundance of small males (<60 mm) since 1995 was most pronounced in those smaller than about 40 mm CW (Fig. 3). While this decline was widespread, there was spatial variation in sizes affected and timing of the decline (Fig. 4). A decline in Div. 2J was apparent only in 1998, and only in smallest males sampled (11-20 mm CW). In the more southern areas such declines were first evident much earlier and in larger crabs than in Div. 2J. The most pronounced drop in abundance in Div. 3K occurred in 1997, one year earlier than in Div. 2J, when two modal groups centered at about 20 mm and 29 mm CW declined sharply (Fig. 4). In Div. 3L, the decline was sharpest another year earlier, in 1996, and in relatively large modal groups, which were at about 26 mm and 38 mm in 1995. Throughout Div. 3KLN the modal group of smallest crabs sampled, about 8-23 mm CW, had declined greatly in abundance in 1998.

These apparent great declines in abundance of small crabs may be due to density-dependent processes related to increase in abundance of larger crabs. They may represent an artifact if the catchability of small crabs has decreased in recent years, due for example to competitive displacement of small crabs to shallow strata with rough bottom type.

Alternatively, density dependence may directly affect abundance of small crabs through cannibalism. Lovrich and Sainte-Marie (1997) showed that cannibalism is common in the northern Gulf of St. Lawrence, where small crabs of about 15-30 mm CW are predominantly cannibalized by adult (large-clawed) males of about 50-120 mm CW. They also found that in the laboratory newly-settled instar I crabs (about 3 mm CW) were cannibalized by males of about 8-50 mm CW. It has been hypothesized that cannibalism by progressively larger crabs on immature crabs, for four years immediately following settlement, determines year-class strength and maintains an endogenous population cycle (Sainte-Marie et al. 1996, Lovrich and Sainte-Marine 1997).

The fall survey biomass of new-shelled males within the legal-sized group (>94 mm CW) increased from about 36.7 x 10^3 t (48%) in 1997 to about 53.6 x 10^3 t (63%) in 1998 (Table 4). This approximate 46% increase in biomass of new-shelled legal-sized males in 1998 reflects strong recruitment to this size group by small-clawed sub-legal 1 crabs (prerecruits) which were almost legal-sized in fall 1997 (Fig. 3).

Projection of Biomass and Recruitment:

Projection of biomass based on the 1996-1998 fall survey data (Table 5) suggests that the 1999 initial biomass will be comparable to that of 1998. The projected continued high initial biomass is primarily due to an increase in the biomass of 'residual' large-clawed crabs, most of which were new-shelled in fall 1998. These crabs will be older-shelled and fully-available to the fishery in 1999. Meanwhile, the contributions to the initial biomass of legal-sized crabs due to growth of small-clawed crabs both within the legal-size group as well as from the Sub-legal 1 group (prerecruits) is expected to decline. For the prerecruits, this represents a 22% decline in projected recruitment from that for 1998 (Table 5).

The ratio of catch to initial biomass index does not estimate absolute exploitation rate, because catchability of the survey trawl is less than 1, so initial biomass is underestimated. However this ratio does indicate that the exploitation rate has been stable during 1997-1998, not exceeding 0.40 (Table 5).

Although recruitment has remained strong recently, prospects are uncertain in the future. This uncertainty is partly due to an apparent gradual decline in biomass of immediate prerecruits (76-94 mm CW) in the past two years. Also, recruitment to the fishery (as relatively old-shelled crabs) may be affected by unknown levels of direct and indirect fishing mortality on legal-sized new-shelled crabs. The likelihood of low catchability of small prerecruits (<76 mm CW) by the survey trawl, together with unknown annual variability in proportions which 'skip-molt', further contribute to this uncertainty. The apparent regular decline in abundance of very small males (<40 mm CW) represents a source of uncertainty for the longer term. Males of about 40 mm CW may begin to recruit to the legal-size group (as new-shelled males) within about four years (Sainte-Marie et al. 1995). As noted earlier, it is currently uncertain whether the apparent decline in abundance of very small males reflects change in catchability or increased mortality.

NAFO Div. 3Ps Spring Bottom Trawl Surveys

Biomass estimates for NAFO Div. 3Ps from spring pre-fishery surveys during 1996-98 are highly unreliable, as indicated by broad confidence intervals (Table 6). Such poor estimates are probably due to a high degree of aggregation of biomass, as described for Div. 3NO from the fall surveys. The estimated initial (spring) biomass of legal-sized (including new-shelled) crabs for 1997 was lower than both the 1996 biomass estimate (5,397 t, Table 6) and the 1997 catch (4,753 t) by a factor of 4. It almost doubled in 1998, but remained unrealistically low. Such low estimates probably reflect lower catchability in spring than fall, associated with distribution and behavior patterns during spring molting and mating seasons.

Because of inadequate sampling by the spring surveys, it is not possible to infer recruitment trends from size composition. However spring size frequencies (Fig. 5) show that a 'trough' at about 40-70 mm CW remained stationary throughout 1996-98, as noted from the fall Div. 2J3KLNO surveys. This supports the suggestion of low catchability of this size group by the survey trawl.

NAFO Div. 3K Inshore Sampling

Small-meshed trap catch rates of Sub-legal 1 and smaller males (about 40-75 mm CW) continued to increase in 1998 in the two shallower depth strata of White Bay (Fig. 6), as noted in the previous year (Dawe et al. 1998). This increase began in 1996 and is most prevalent in the shallowest stratum (201-300 m). Such an increase in intermediate-sized crabs also became apparent in 1998 in the deepest stratum (Fig. 6). This supports the view that the consistent 'trough' seen in size compositions of trawled samples, at about 40-70 mm CW, reflects inadequate sampling. Sampling of this size group may be inadequate due to an aggregated distribution (e.g. in inshore areas) and quite possibly low catchability of the trawl especially on hard, shallow-water substrates. The great increase in trap catch rates of such intermediate-sized crabs in White Bay since 1995 suggests competitive displacement from preferred substrates in deeper strata by larger crabs.

To investigate relative differences in trawl catchability of such intermediate-sized crabs among depth strata, comparative sampling with traps and the Campelen trawl was carried out in September, 1998. Catch rates of small-meshed traps and trawl were generally similar within the deepest stratum of White Bay (Stratum 613 at >400 m, Fig. 7) and in the intermediate-depth stratum in Notre Dame Bay (Stratum 610; 310-400 m, Fig. 8). However, the trawl catch rate was lower than that of small-meshed traps by a factor of about 3 in White Bay intermediate depth stratum 614 (Fig. 8). Trawl catch rates were lowest in the shallowest strata of both White Bay and Notre Dame Bay however, where they were lower than those from small-meshed traps by a factor of about 10 (Fig. 9).

This provides direct evidence that the catchability of intermediate-sized crabs by the Campelen trawl is particularly low in shallow inshore strata with rough substrates. However it provides no insight regarding catchability of the trawl for very small crabs (<40 mm CW), because neither gear collected crabs of such small sizes. Such small crabs are generally not collected by small-meshed traps, particularly in areas where larger crabs are prevalent.

Bitter Crab Disease

Bitter Crab Disease (BCD) has been found almost exclusively in new-shelled crabs of both sexes, indicating that it is fatal within a year of infecting its host. Data from fall 1996-98 multispecies fall surveys indicate that the disease is most prevalent in Div. 3K and is virtually absent in Div. 3NO (Fig. 10). Throughout Div. 2J3KL it has remained most prevalent in small crabs of 40-59 mm CW, with 8.4% of that size group infected in Div. 3K in 1998.

Inshore Div. 3K trap surveys during September have approximately corresponded with the peak season of incidence of BCD in Alaska tanner crab (*Chionecetes bairdi*) (Love et al. 1993). These surveys indicate that in White Bay incidence of BCD has increased overall since 1995, and it appears to have progressed to deeper strata and larger crabs (Fig. 11). No such clear trends were evident in Notre Dame Bay in 1997 and 1998.

Effects of Fishing Practices

A two-tiered pricing system was in effect during 1996 and 1997, with a higher price paid for largest ('premium') crabs (>101 mm CW) than for smaller legal-sized crabs (95-101 mm CW). This pricing system promoted the practice of 'high-grading', whereby smaller, lower-priced crabs were discarded at sea (Dawe et al. 1998). This pricing system was replaced by a single price for 1998, but a 'tolerance limit' was established whereby this single price was paid for the total catch if the percentage small crab did not exceed 20%. Comparison of the size structure of landed crab (sampled by dockside grading) with that from a variety of research-based sources (Table 7) shows that percentage 'premium' crab was generally lower in 1998 than in the previous two years from dockside grading. However, it was higher in landed crab than within research samples, and exceeded 80% in three of the four divisions sampled. Comparison of observer samples with those from dockside grading suggested that high-grading was practiced in Div. 3L and Div. 3Ps, but not in Div. 3K, in 1998. The level of indirect fishing mortality imposed by this practice on small legal-sized crabs is unknown.

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Table 1. Minimum trawlable biomass estimates for males from the 1997 and 1998 **(highlighted figures)** fall bottom trawl surveys by NAFO Division and population component.

NAFO Div.	Biomass (t)	95% confidence limits		Mean kg/set
		Lower	Upper	
Legal-size males (>94 mm)				
2J	11,741	5,455	18,026	3.17
	14,579	**8,236**	**20,831**	**3.93**
3K	27,736	19,087	28,385	4.37
	22,180	**17,088**	**27,272**	**4.08**
3L	29,002	19,592	38,411	4.27
	29,538	**22,719**	**36,358**	**4.34**
3N	6,120	-16,647	28,887	2.39
	13,597	**3,571**	**23,623**	**5.31**
3O	1,917	-157	3,992	1.10
	5,132	**1,207**	**9,056**	**1.89**
Sub-legal 1 (76-94 mm)				
2J	1,753	1,181	2,325	0.47
	3,660	**2,473**	**4,846**	**0.97**
3K	7,021	5,731	8,311	1.29
	6,864	**5,296**	**8,432**	**1.26**
3L	11,906	6,882	16,929	1.75
	12,744	**9,196**	**16,292**	**1.87**
3N	1,948	-10,041	13,937	0.76
	2,872	**-11,019**	**16,764**	**1.12**
3O	447	20	874	0.26
	1,338	**-51**	**2,727**	**0.49**
Sub-legal 2 (60-75 mm)				
2J	338	116	561	0.09
	541	**326**	**756**	**0.15**
3K	1,826	1,306	2,346	0.34
	1,836	**1,189**	**2,482**	**0.34**
3L	1,815	1,145	2,484	0.27
	1,523	**969**	**2,078**	**0.22**
3N	236	93	379	0.09
	148	**4**	**0.3**	**0.06**
3O	120	-78	319	0.07
	187	**-105**	**480**	**0.07**
Small males (<60 mm)				
2J	248	160	335	0.07
	600	**165**	**1,035**	**0.16**
3K	862	634	1,090	0.16
	660	**406**	**914**	**0.12**
3L	885	545	1,225	0.13
	470	**-95**	**1,035**	**0.07**
3N	93	13	174	0.04
	19	**-0.05**	**36**	**0.01**
3O	57	20	94	0.03
	38	**11**	**64**	**0.01**

Table 2. Minimum trawlable biomass estimates (for females) by maturity category and NAFO Division from 1997 and 1998 (**highlighted figures**) fall bottom trawl surveys.

NAFO Div.	Biomass (t)	95% confidence limits		Mean kg/set
		Lower	Upper	
Immature females				
2J	124	82	166	0.03
	314	**93**	**534**	**0.08**
3K	385	290	479	0.07
	360	**252**	**469**	**0.07**
3L	465	-532	1,463	0.07
	243	**-1,239**	**1,725**	**0.04**
3N	24	12	36	0.01
	8	**-1.2**	**17**	**0.003**
3O	23	0.91	46	0.01
	20	**-4**	**44**	**0.007**
Mature females				
2J	149	-458	756	0.04
	199	**51**	**347**	**0.05**
3K	633	337	928	0.12
	273	**364**	**181**	**0.05**
3L	879	656	1,102	0.13
	319	**177**	**460**	**0.05**
3N	44	4	84	0.02
	93	**-795**	**982**	**0.04**
3O	100	-51	251	0.06
	146	**-186**	**479**	**0.05**

Table 3. NAFO Div. 2J3KLNO annual catch and fall survey biomass index by NAFO Division, 1996-98.

NAFO Div.	Year	Catch (t)	Residual fall biomass (t)	Catch/Fall Biomass Index
2J	1996	3,090	7,291	0.42
	1997	3,166	11,741	0.27
	1998	3,651	14,579	0.25
3K	1996	14,185	22,971	0.62
	1997	14,830	27,736	0.53
	1998	16,487	22,180	0.73
3LNO	1996	16,847	45,689	0.37
	1997	22,185	37,039	0.60
	1998	23,511	48, 267	0.49
TOTAL 2J3KLNO	**1996**	**34,122**	**75,951**	**0.45**
	1997	**40,181**	**76,516**	**0.53**
	1998	**43,649**	**85,026**	**0.51**

Table 4. Comparison of biomass, t x 10^3 and percentage by weight (in parentheses) of new-shelled crabs within the legal size and sub-legal 1 size groups from fall 2J3KLNO surveys during 1996-98.

Year	New-shelled Legal-size (>94 mm CW)	 Sub-legal 1 (76-94 mm CW)
1996	39.5 (52)	18.0 (57)
1997	36.7 (48)	13.2 (57)
1998	53.6 (63)	16.2 (59)

Table 5. Projection of initial biomass of legal-size crabs (all shell categories) from fall Div. 2J3KLNO surveys.

Year projected	Standing stock		Projected recruitment (t)[3]	Projected initial biomass (t)	Catch/Initial Biomass Index
	Residual large-clawed (t)[1]	Projected growth			
1997	61,688	12,162	26,876	100,726	0.40
1998	66,845	20,036	24,470	111,351	0.39
1999	75,226	16,372	21,051	112,650	

[1] Large-clawed legal-sized crabs do not subsequently molt and so would be intermediate-shelled or old-shelled and fully available to the fishery in the subsequent (projected) year.

[2] Small-clawed legal-sized crabs molt and grow (by about 19 mm CW) but remain new-shelled and generally unavailable to the fishery in the subsequent year.

[3] Small-clawed prerecruit crabs of 76-94 mm CW molt, grow (by about 19 mm CW) and 'recruit' to legal size in the subsequent year but would remain new-shelled and generally unavailable to the fishery of that year.

Table 6. Minimum trawlable biomass estimates by population component from the 1996, 1997 and 1998 (**in bold**) spring bottom trawl surveys in NAFO Div. 3Ps.

Population component	Year	Biomass (t)	95% Confidence limits		Mean kg/set
			Lower	Upper	
Legal-sized males (>94 mm CW)	1996 1997 **1998**	5,397 1,246 **2,190**	1,839 637 **1,192**	8,955 1,854 **3,189**	2.33 0.45 **0.76**
Sublegal 1 males (76-94 mm CW)	1996 1997 **1998**	1,419 321 **421**	89 170 **199**	2,748 473 **643**	0.61 0.12 **0.15**
Sublegal 2 males (60-75 mm CW)	1996 1997 **1998**	162 64 **92**	48 24 **48**	275 103 **135**	0.07 0.02 **0.03**
Small males (<60 mm CW)	1996 1997 **1998**	179 50 **102**	89 11 **64**	269 90 **141**	0.08 0.02 **0.04**

Table 7. Percentage of large (>101 mm CW) crab by weight within catches of legal-sized (>95 mm CW) crab from various sources, 1996-98. Values in parentheses are based on data excluding new-shelled crabs.

		NAFO Division						
Year	Source	2J	3K	3L	3N	3O	3P	4R
1996	Spring survey						69.6 (69.9)	
	Fall survey	86.1 (90.1)	76.3 (80.1)	70.9 (72.7)	70.6 (71.2)	84.6 (85.3)		
	White Bay		80 (72.9)					
	Observer (at sea)	78.3	82.8	67.8				90.3
	Dockside grading	**87.1**	**95.3**	**93.9***			**87.7**	**90.3**
1997	Spring survey						75.5 (76.2)	
	Fall survey	87.4 (92.0)	78.6 (85.3)	71.8 (68.7)	67.5 (70.6)	86.1 (88.6)		
	White Bay/ Notre Dame Bay		71.9 (69.6)					
	Dockside grading	**97.9**	**92.6**	**87.7***			**93.5**	**84.4**
1998	Spring survey							
	Fall survey	85.4 (87.5)	79.3 (79.5)	65.9 (62.0)	79.4 (85.3)	82.2 (78.5)		
	White Bay/ Notre Dame Bay		63.1 (64.6)					
	Observer (at sea)	92.2 (92.3)	90.3 (90.2)	68.7 (68.8)			75.1 (75.1)	
	Dockside grading		**88.6**	**83.9***			**89.5**	

* actually represents 3LNO

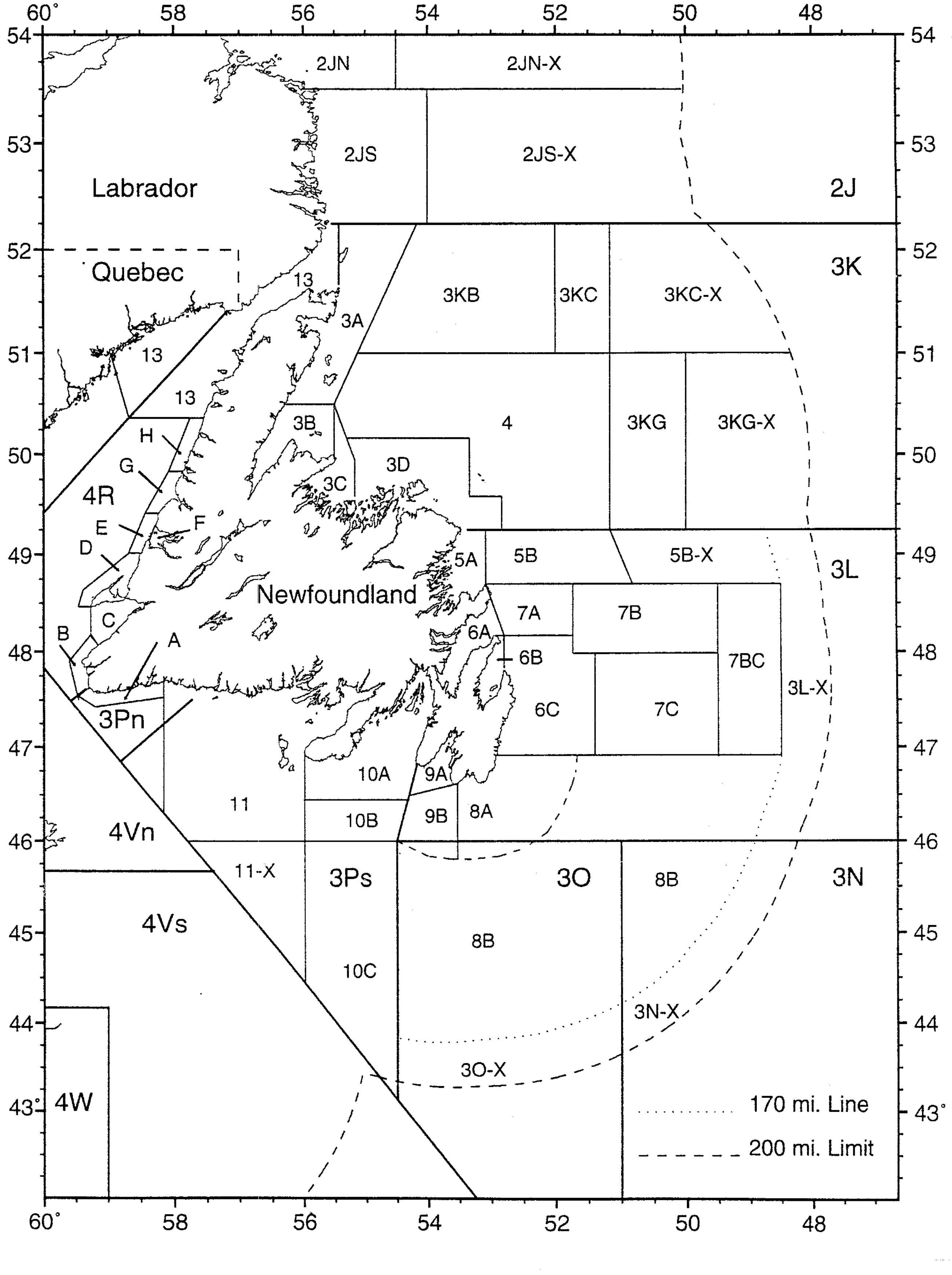


Figure 1. 1998 snow crab management areas

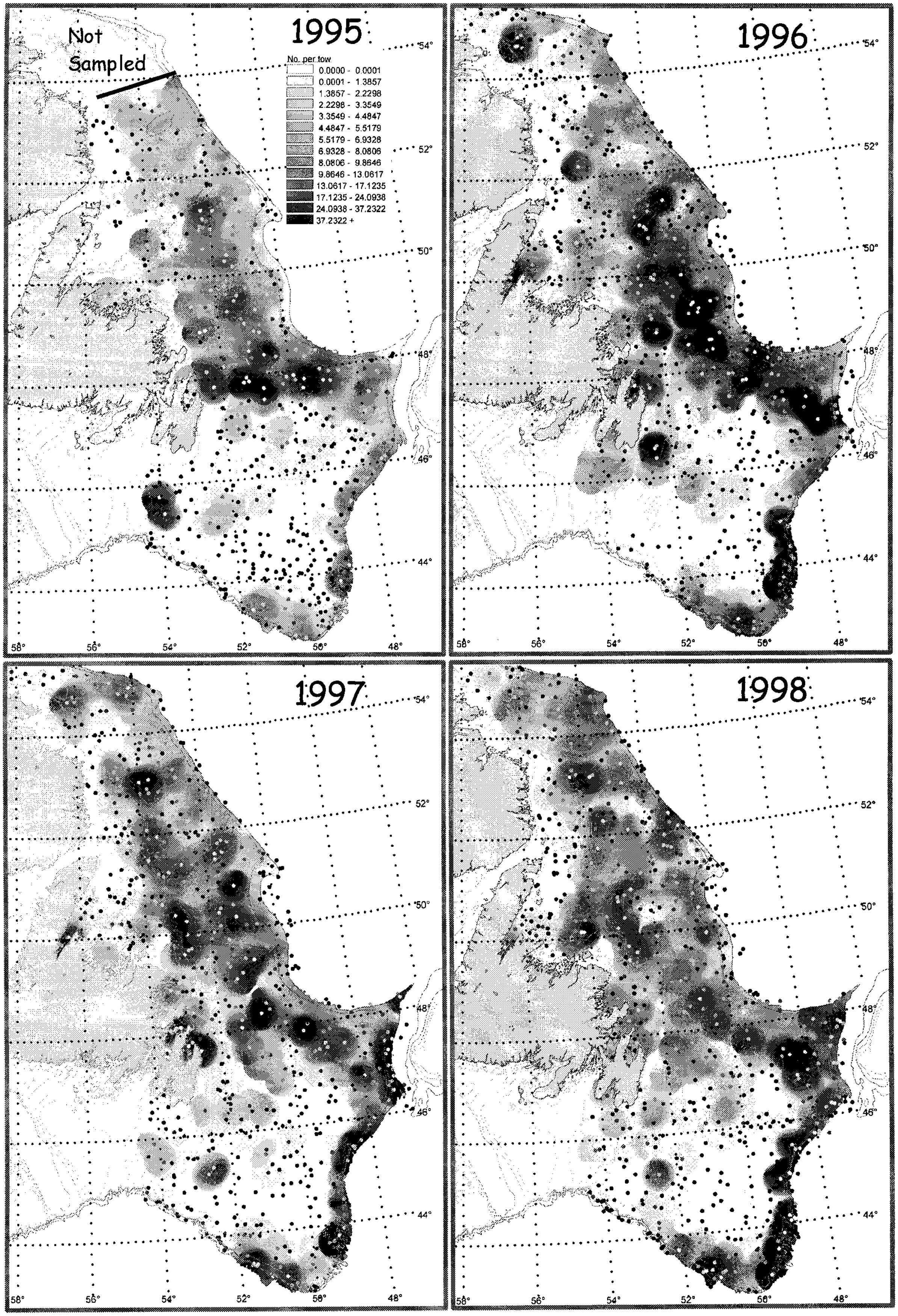


Figure 2a Distribution of legal sized males (greater than 94 mm) from fall 2J3KLNO Campelen surveys, 1995-1998. Set locations are illustrated as dots in reverse grey shades.

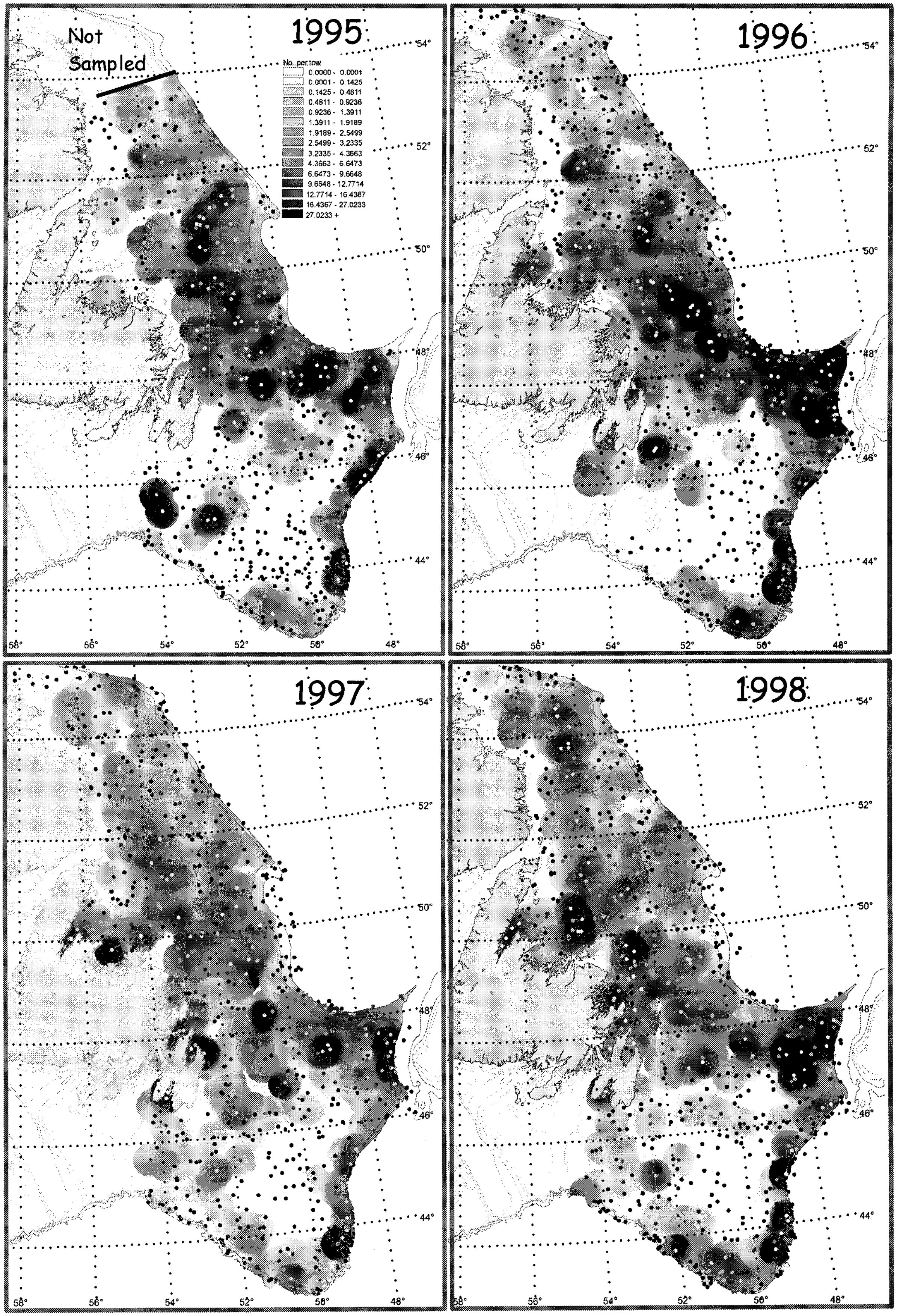


Figure 2b Distribution of sub-legal males (76-94 mm) from fall 2J3KLNO Campelen surveys, 1995-1998.Set locations are illustrated as dots in reverse grey shades.

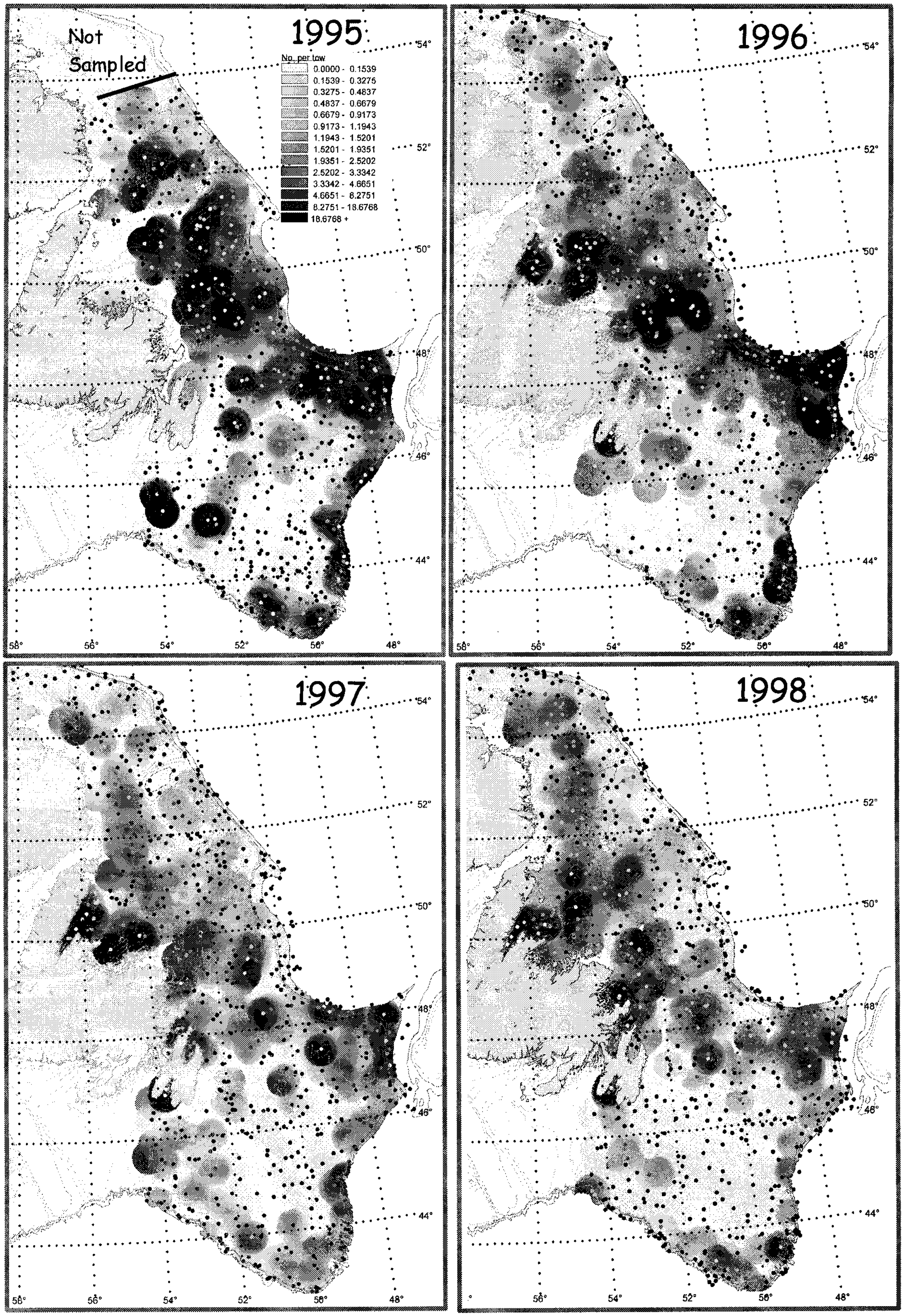


Figure 2c Distribution of sublegal 2 males, 60-75 mm from fall 2J3KLNO Campelen surveys, 1995-1998. Set locations are illustrated as dots in reverse grey shades.

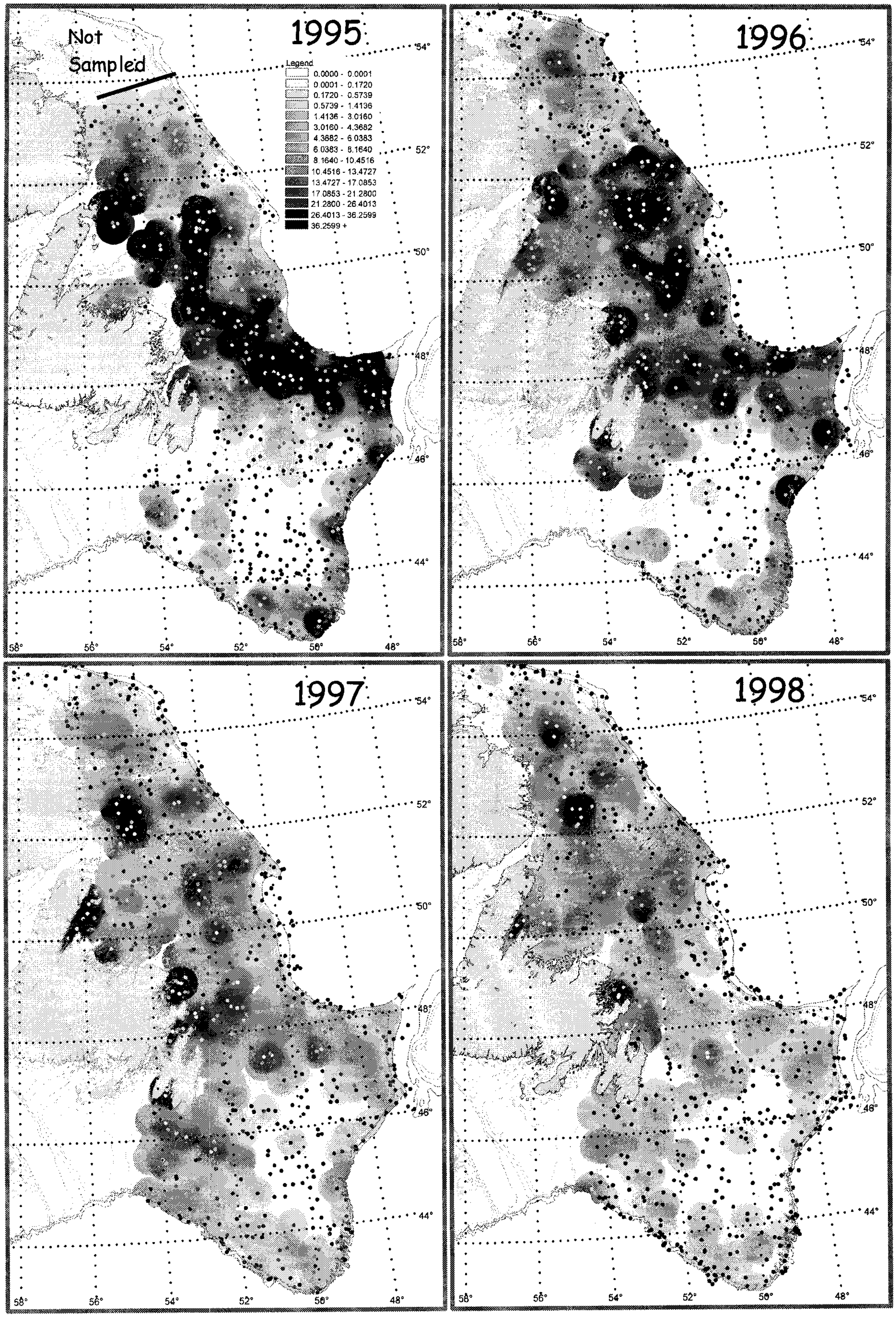


Figure 2 d Distribution of males less than 60 mm from fall 2J3KLNO Campelen surveys, 1995-1998. Set locations are illustrated as dots in reverse grey shades.

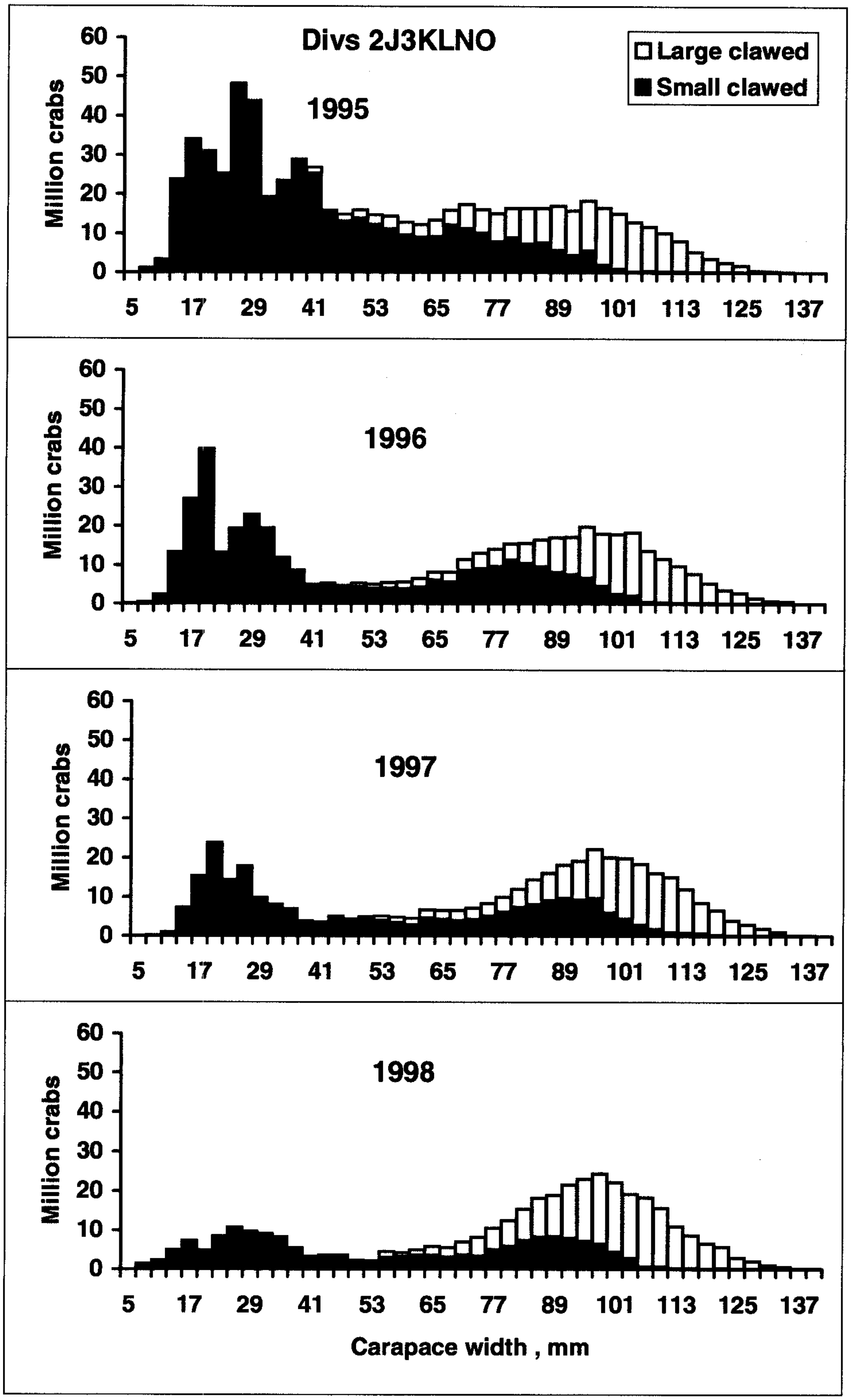


Figure 3. Size distributions from Div. 2J3KLNO fall surveys by year and claw type

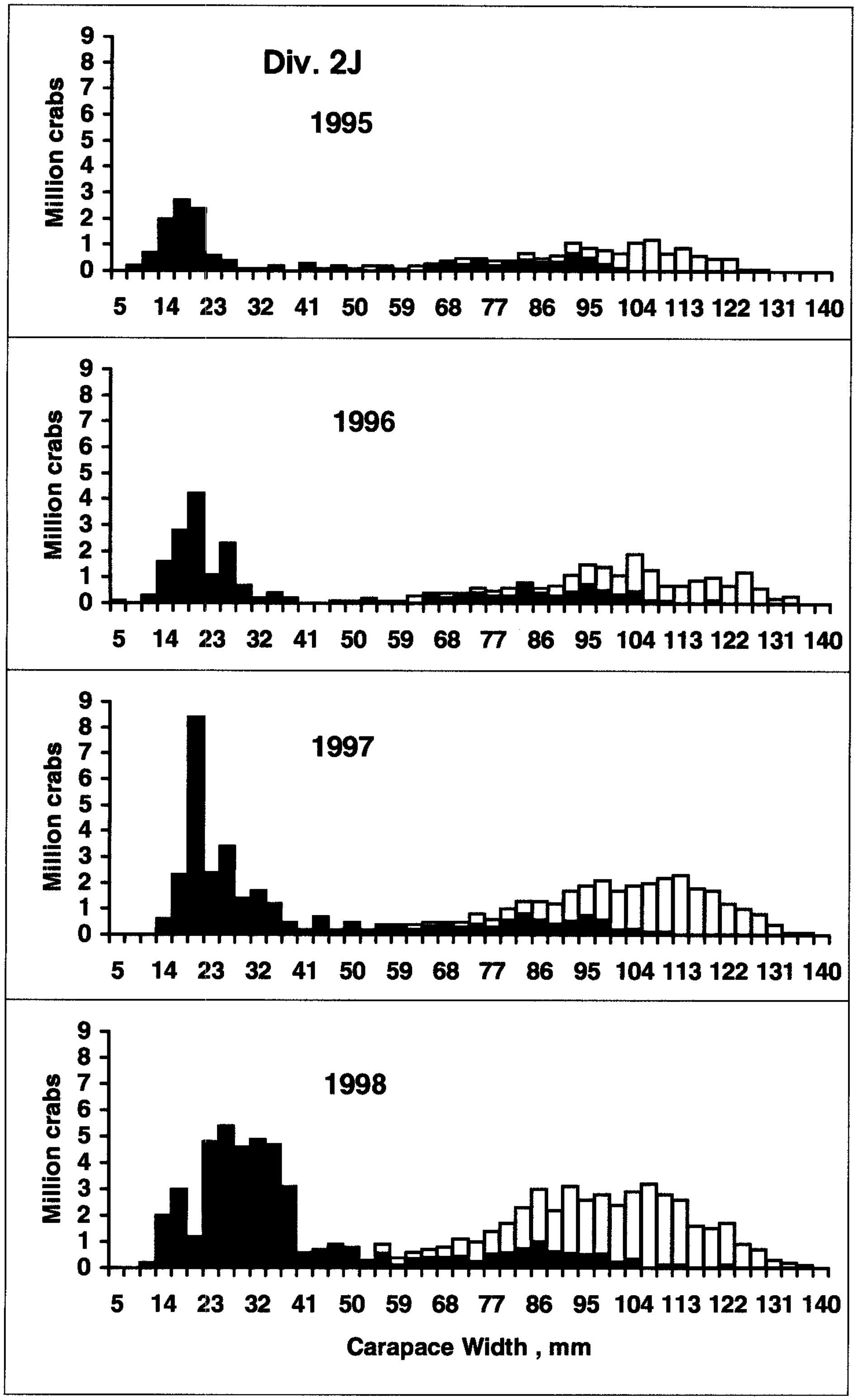


Figure 4. Size distributions from fall surveys by year and claw type for each division

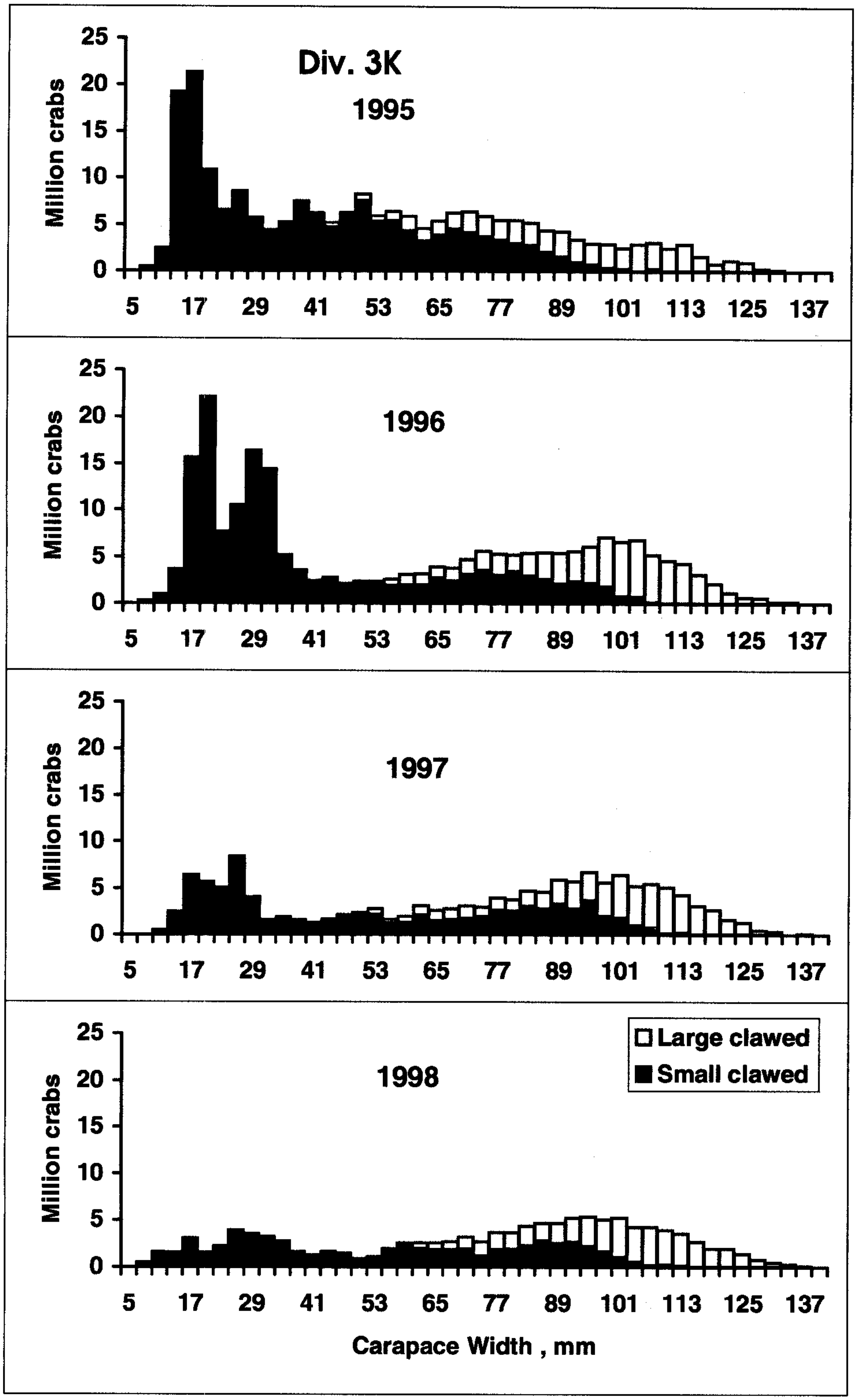
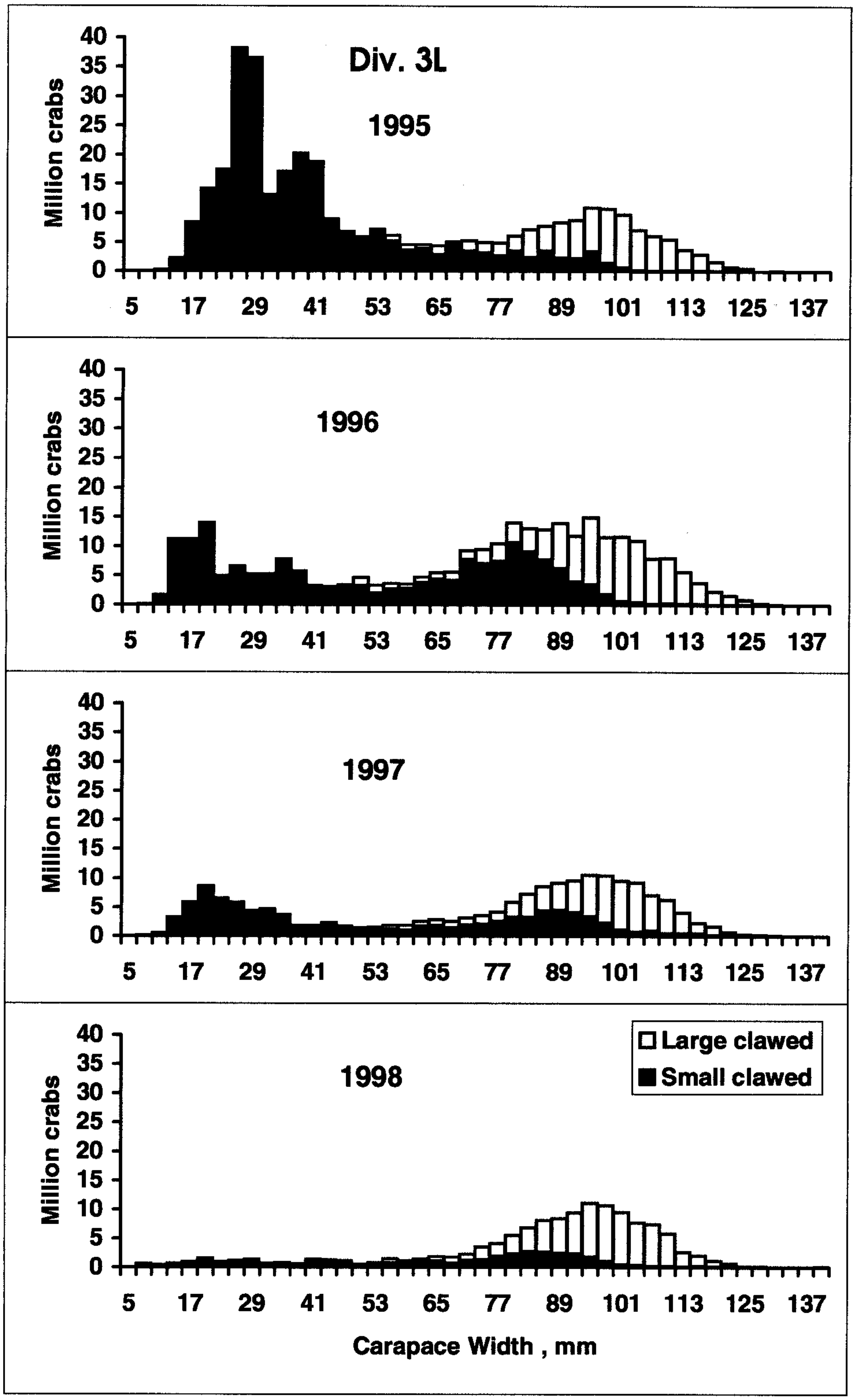


Figure 4. Continued



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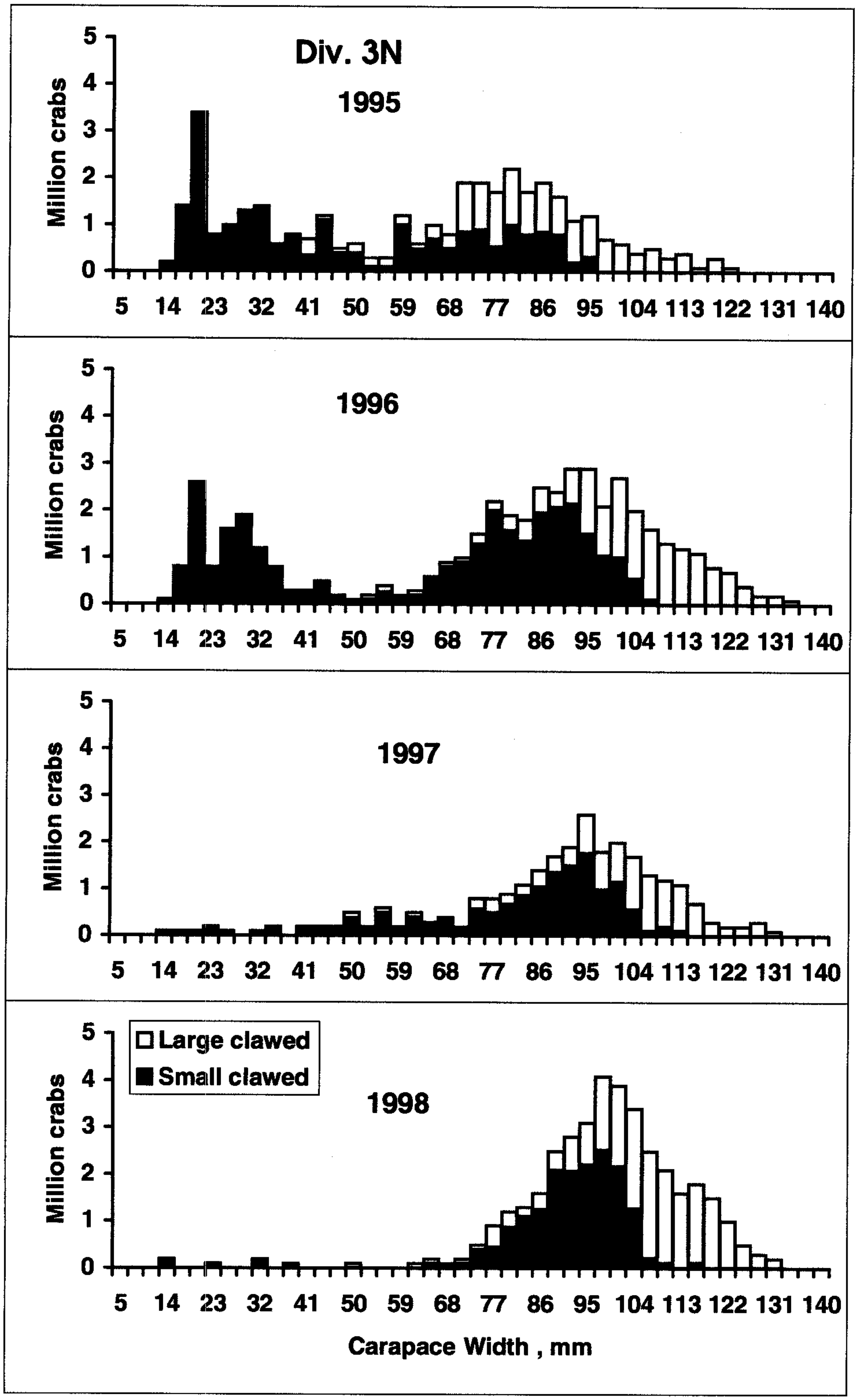

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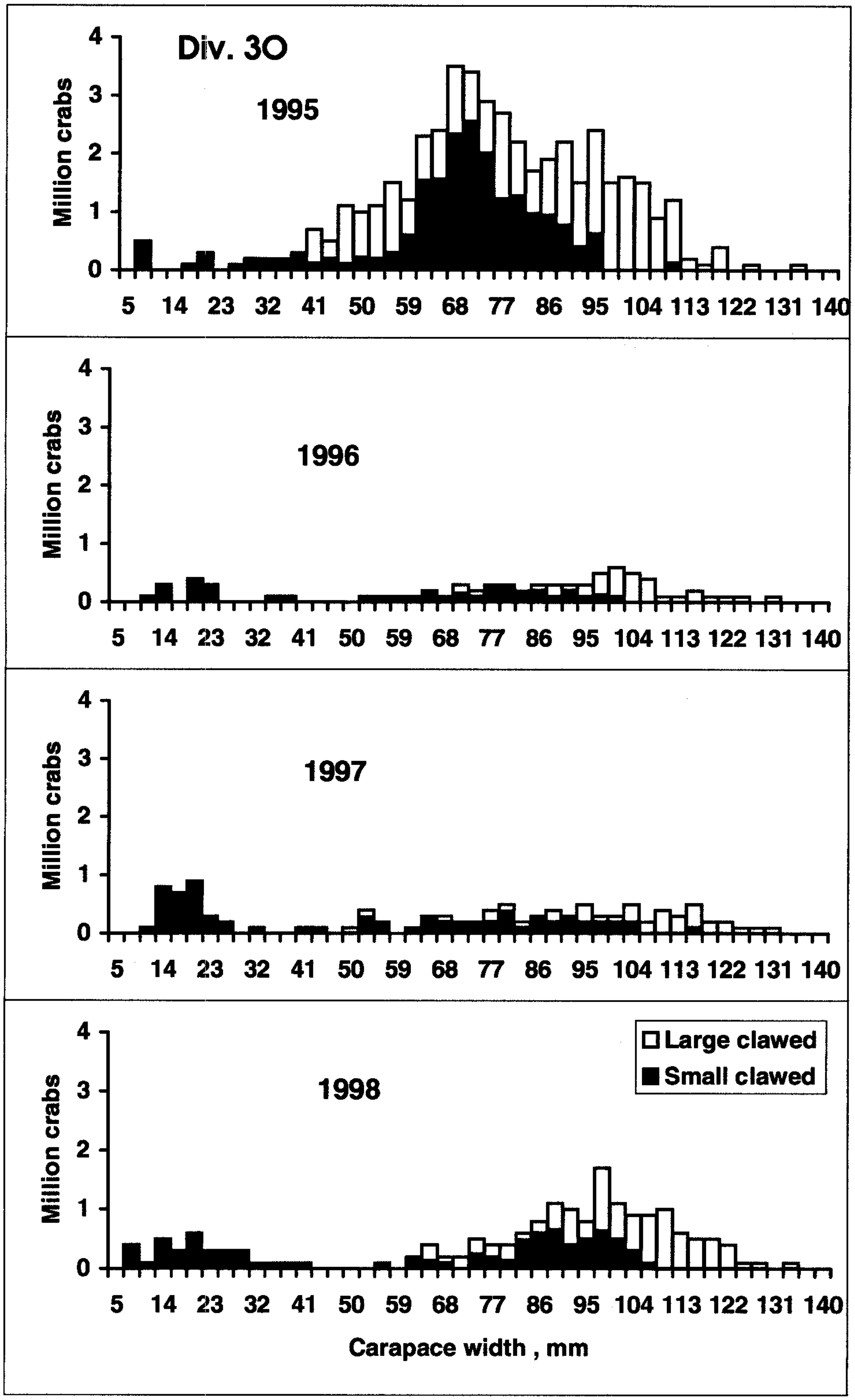

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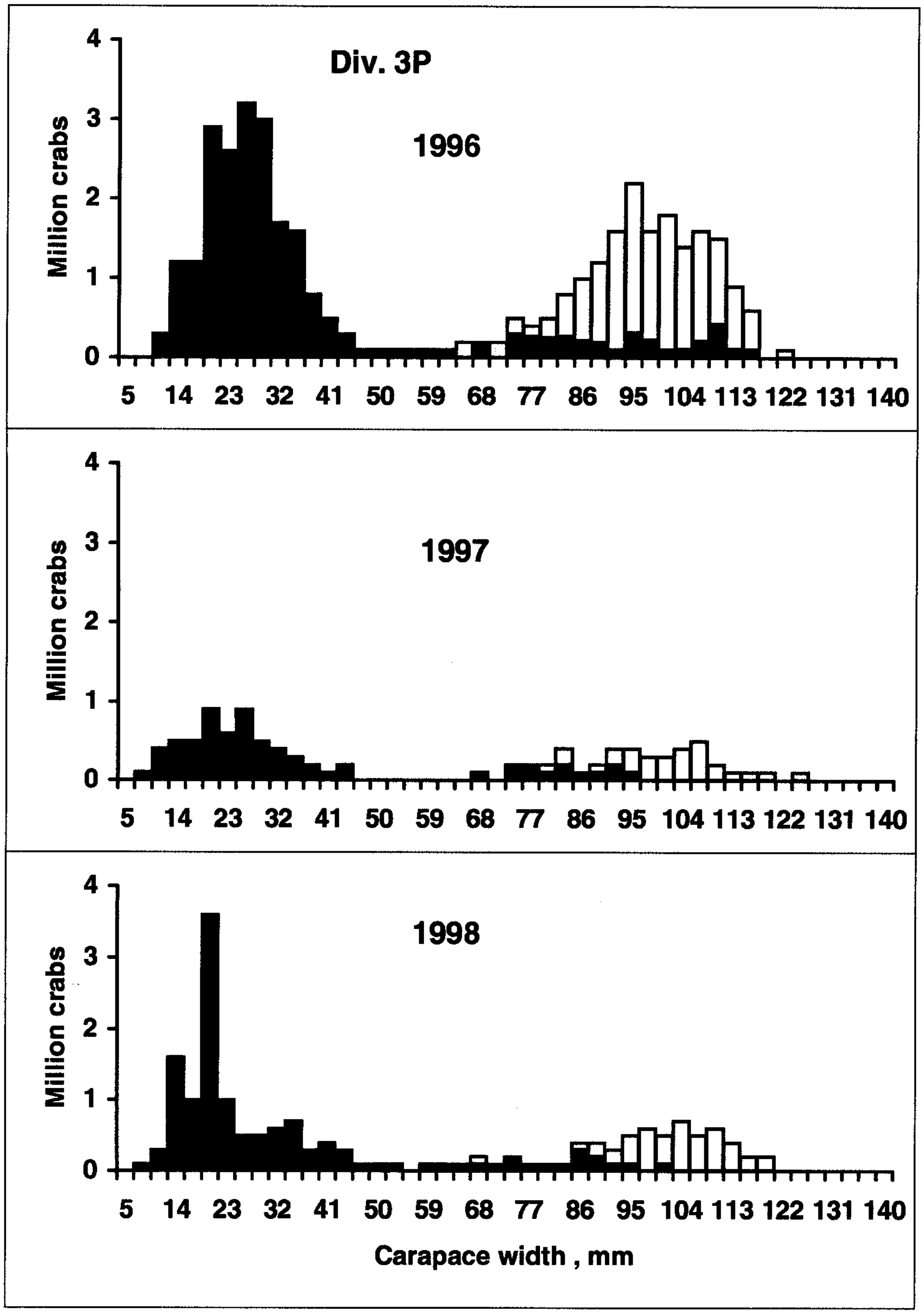

Figure 5. Size distributions by claw type and year from spring Div. 3P surveys.

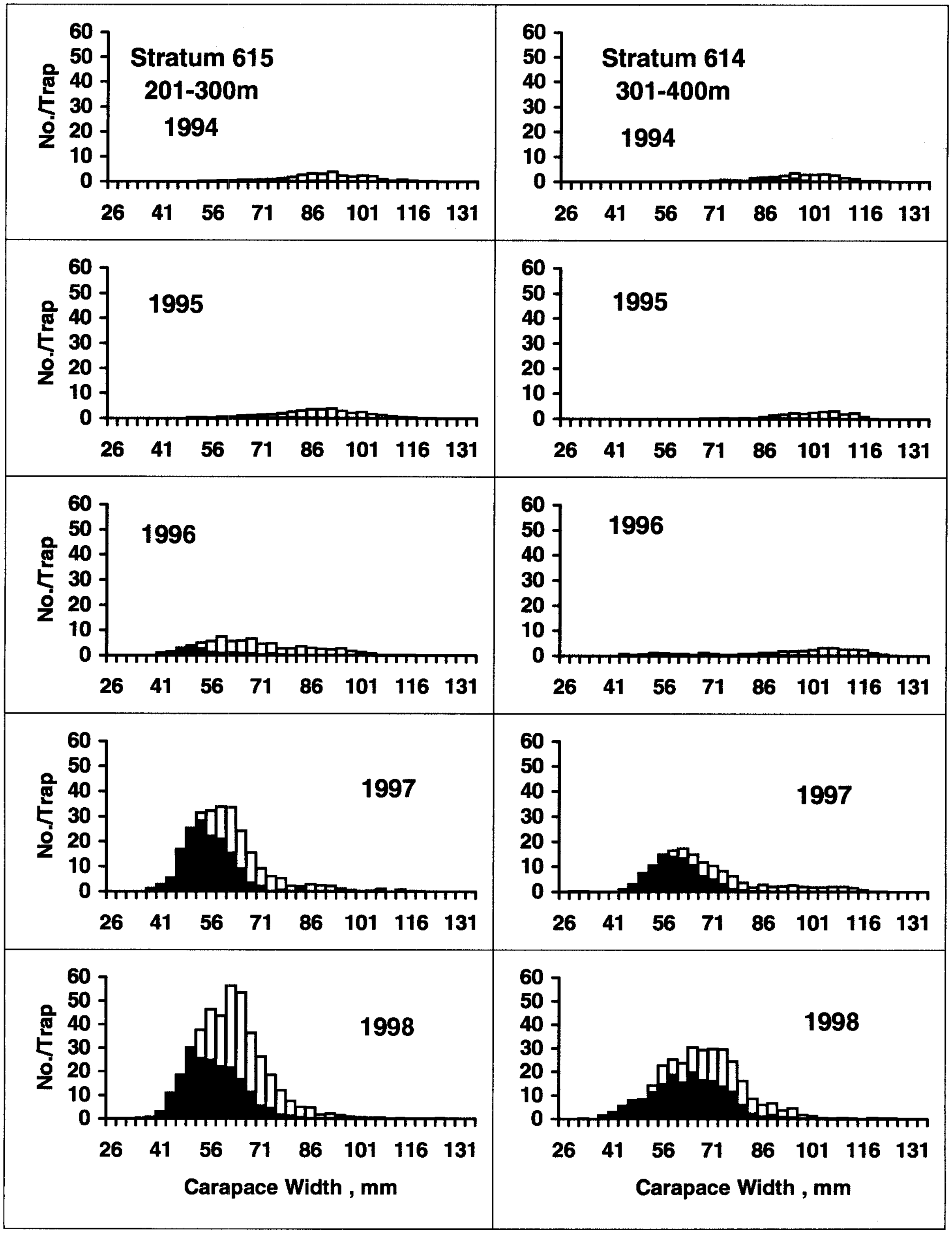

Figure 6. Size distributions from small-meshed traps by year for each of three White Bay dept strata.

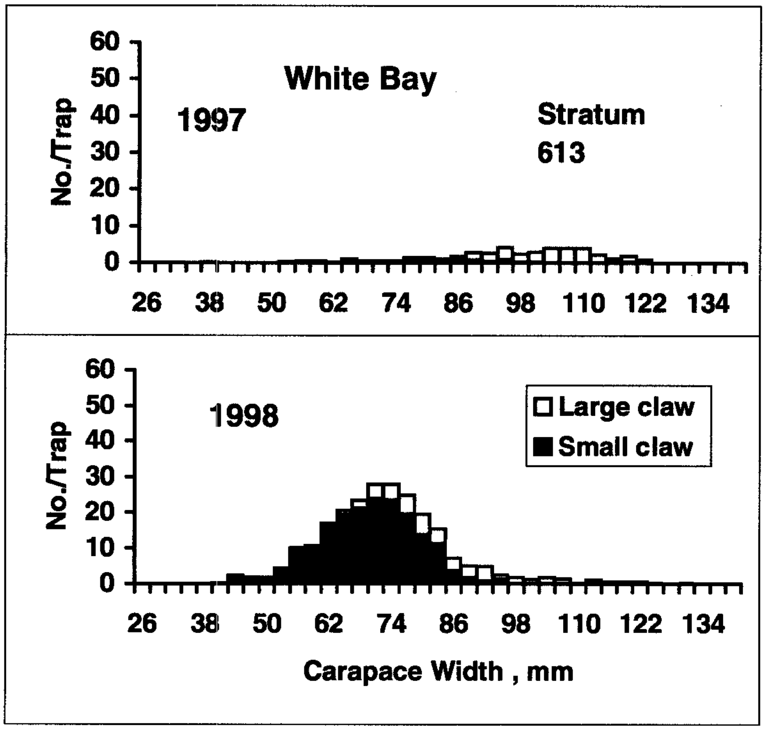

Figure 6. Continued

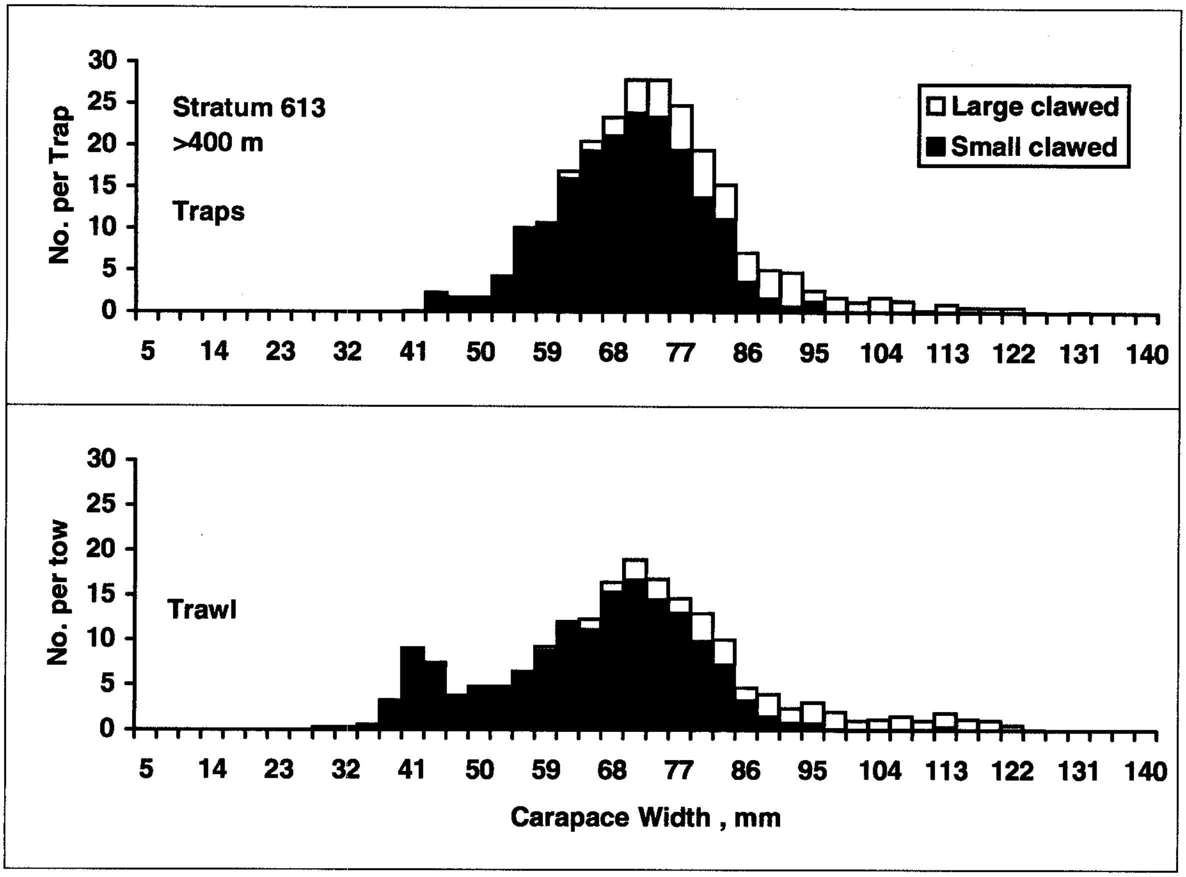

Figure 7. Comparison of size distributions between small-meshed traps and Campelen trawl for the deepest stratum in White Bay in 1998, from comparative sampling.

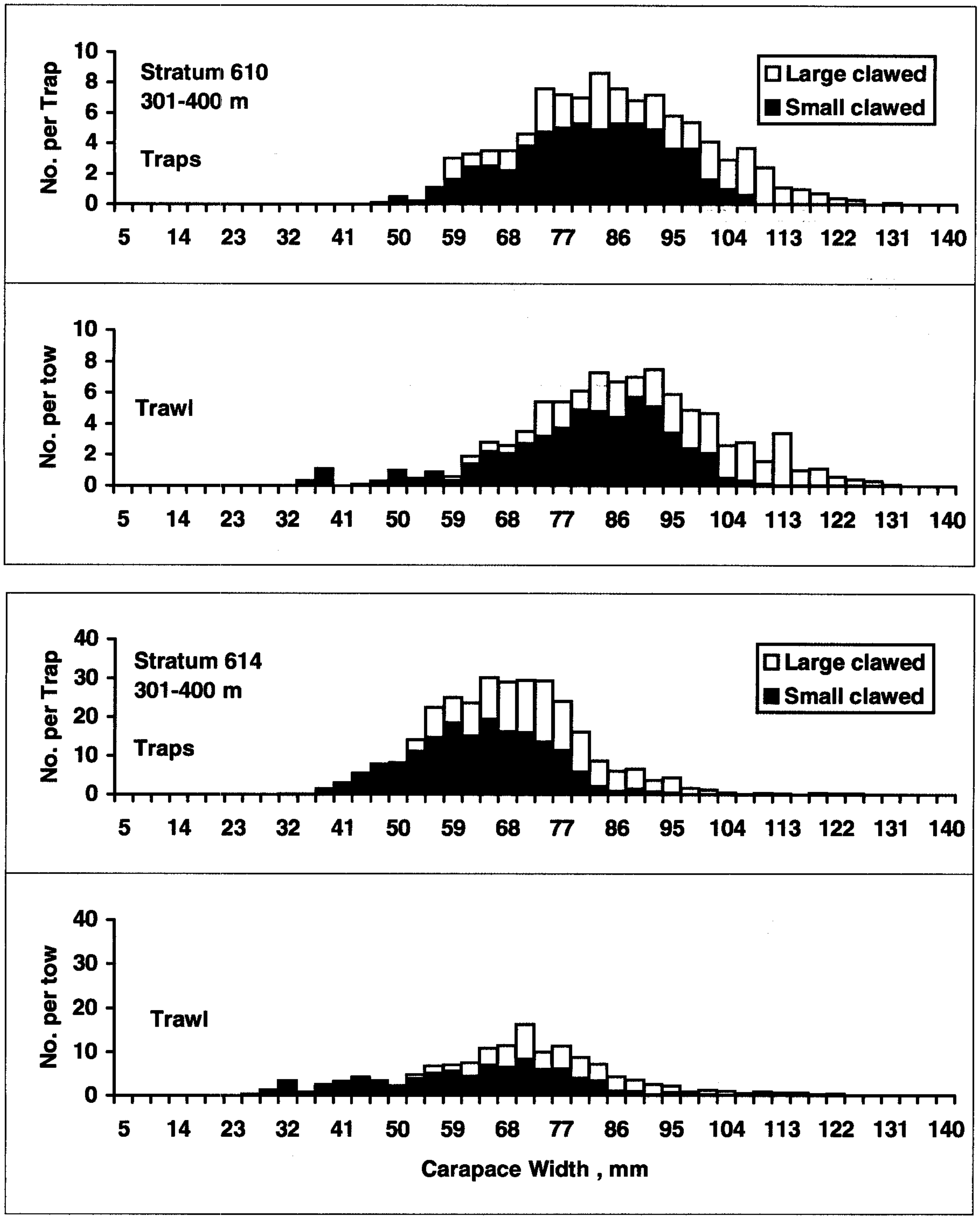

Figure 8. Comparison of size distributions between small-meshed traps and Campelen trawl for the intermediate depth strata of White Bay and Notre Dame Bay in 1998, from comparative sampling.

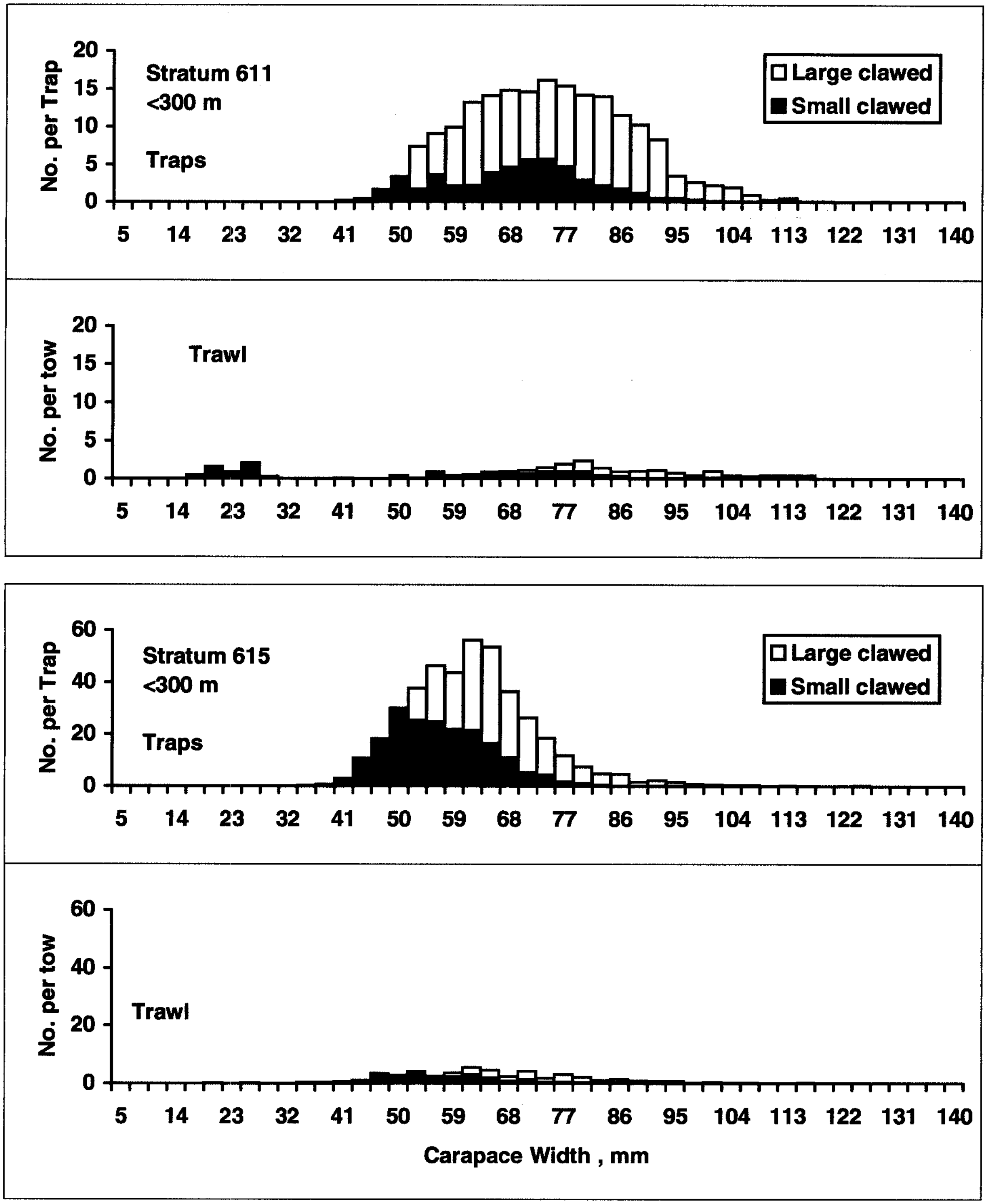

Figure 9. Comparison of size distributions between small-meshed traps and Campelen trawl for the shallowest depth strata of White Bay and Notre Dame Bay in 1998, from comparative sampling.

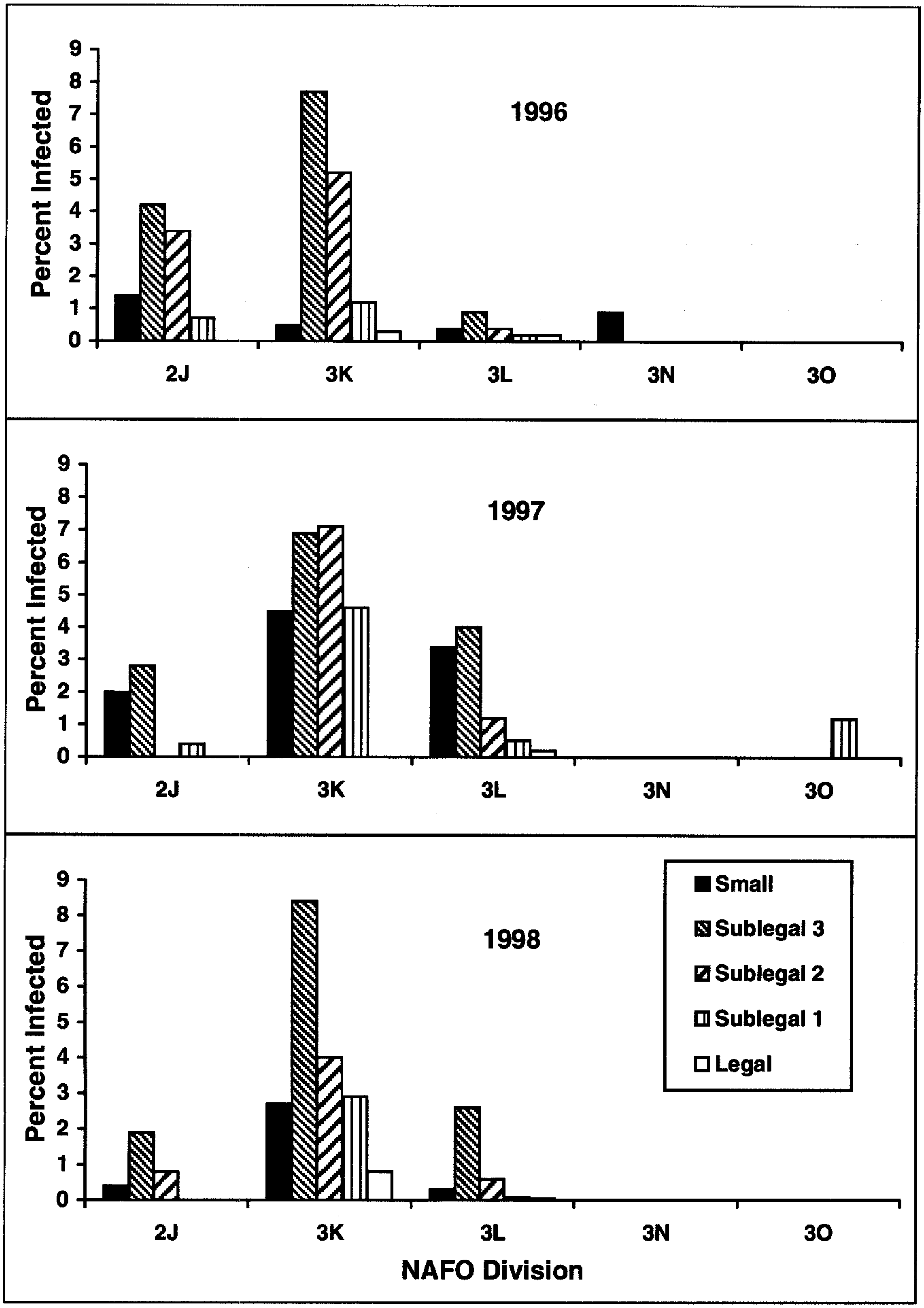

Figure 10. Incidence of BCD by year, male size group, and NAFO Division from fall bottom trawl surveys

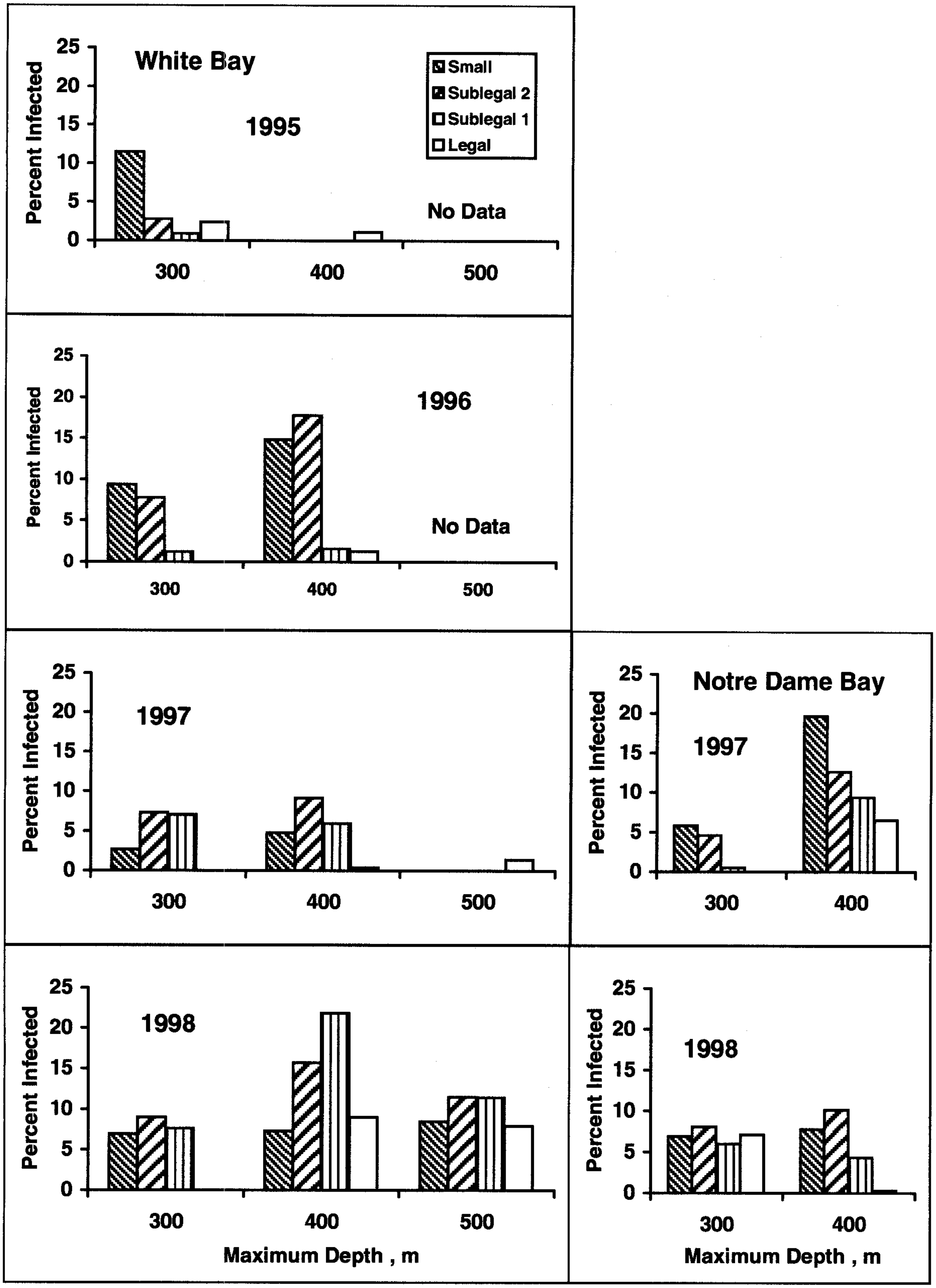

Figure 11. Incidence of BCD by year, male size group, and stratum from small-meshed traps in White Bay and Notre Dame Bay.