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Status of Newfoundland and Labrador Snow Crab in 1996

by

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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. Data from 1995 and 1996 fall bottom trawl surveys were particularly useful. The more extensive 1996 survey showed that legal-sized males were broadly distributed throughout much of the survey area but were absent north of Div. 2J, as well as on the deep slope of the continental shelf and across most of the shallow southern Grand Bank. All crab sizes generally co-existed offshore, whereas largest crabs tended to be concentrated at greatest depths in inshore areas. Fall bottom trawl surveys indicated a substantial commercial biomass for 1997 throughout Div. 2J3KLN. This was consistent with high 1996 catch rates in two of the three Div. 3L trap surveys and the single Div. 3K trap survey (White Bay). A decline is anticipated in one of the three Div. 3L trap survey areas (Bonavista Bay), probably due to local effects of recruitment and exploitation. The fall bottom trawl surveys indicate no problems with recruitment in the short term throughout Div. 2J3KLN. This contrasts with local Div. 3L trap survey results, especially for Bonavista Bay and Conception Bay. In those areas trap survey catch rates of prerecruits with small claws declined to very low levels. Interpretation of differences in abundance indices of prerecruits between trap and trawl surveys remains unclear because of differences in gear efficiencies and survey design as well as in crab population structure and levels of exploitation between inshore and offshore areas. A great increase in trap survey catch rates of small crabs in White Bay in 1996 suggests that there may be considerable local variation in recruitment dynamics.

RÉSUMÉ

Des données sur les taux de capture, la taille (largeur des carapaces) et le stade de mue (allométrie des chélipèdes) provenant de diverses sources ont été utilisées pour déduire l'état des ressources. Les données provenant de relevés au chalut de fond réalisés à l'automne de 1995 et 1996 ont été particulièrement utiles. Le relevé de 1996, plus important, a révélé que les mâles de taille légale étaient répartis un peu partout dans la majeure partie de la région étudiée mais qu'ils étaient absents au nord de la division 21, ainsi que sur la partie profonde du talus continental et au-dessus de la majeure partie du secteur sud et peu profond du Grand Banc. On a trouvé des crabes de toutes les tailles au large, mais une importante concentration de crabes plus gros aux plus grandes profondeurs dans les régions côtières. Les relevés automnaux au chalut de fond ont indiqué une biomasse commerciale importante pour 1997 dans toute la division 2J3KLN. Ces résultats étaient conformes aux taux de capture élevés de 1996 obtenus dans deux des trois relevés au casier dans la division 3L et dans le relevé au casier de la division 3K (baie White). On prévoit une diminution dans l'un des trois secteurs de relevé au casier de la division 3L (baie Bonavista) qui s'expliquerait probablement par des effets locaux de recrutement et d'exploitation. Les relevés automnaux au chalut de fond ne révèlent aucun problème de recrutement à court terme dans toute la division 2J3KLN. C'est le contraire qui se produit pour certains résultats des relevés au casier dans la division 3L, surtout dans la baie Bonavista et la baie Conception. Dans ces secteurs, les taux de capture de prérecrues à petites pinces étaient très faibles lors des relevés au casier. Il est toutefois difficile d'interpréter les différences dans les indices d'abondance des prérecrues entre les relevés au casier et les relevés au chalut de fond à cause des différences dans l'efficacité des engins de pêche et dans la conception des relevés ainsi que dans la structure et le niveau d'exploitation des populations de crabe entre les régions côtiers et les régions hauturières. L'accroissement important noté dans les taux de capture de petits crabes dans les relevés au casier effectués dans la baie White en 1996 semble montrer qu'il existerait une importante variation locale dans la dynamique de recrutement.

Introduction

This document presents research data from various sources and fishery data toward evaluating the status of the Newfoundland and Labrador snow crab resource in 1996 and projecting fishery performance in 1997. Data sources include time series research trap surveys in three crab management areas in NAFO Div. 3L. Data are also presented from post-fishery trap surveys in White Bay (NAFO Div. 3K) during 1994-96. Data collected during the fall 1995 and 1996 bottom trawl surveys throughout NAFO Div. 2J3KLNO are also utilized.

Methods

Trap Surveys in NAFO Div. 3L

Survey Methodology:

Trap surveys were first conducted in 1979 in Bonavista Bay (Area 5A) and the Northeast Avalon (Area 6C) and in Conception Bay (Area 6B) in 1981 (Fig. 1, Table 1). Initial surveys used only baited commercial Japanese-style conical crab traps. Special small-meshed traps were used in Conception Bay since 1981 and in the other areas since 1982. Small-meshed traps are similar to commercially-used large-meshed traps except that the netting is of 2.5 cm stretched mesh, rather than the 13.3 cm stretched mesh of commercial traps. Small-meshed traps were usually deployed 1-2 per fleet within each fleet of 8 or 12 traps (mostly large-meshed). Traps were separated by 45 m within each fleet and were baited using squid and/or mackerel. Soak time was usually about one day, depending on weather conditions. Within each crab management area surveyed, the depth range and actual area sampled corresponded approximately to the commercial fishery area. Minimum depth for sampling was 170 m for all survey areas.

Surveys were carried out annually in all three areas, with the exception of Conception Bay, for which there were no surveys in three of the years. The timing of surveys varied annually both in the absolute sense, as well as in relation to the time of the fisheries (Table 1).

Data Collected:

All crabs from each trap catch were enumerated by sex. For each male, or for representative sub-samples, carapace width (CW) was determined to the nearest whole mm, using vernier calipers. Carapace condition was assigned one of four categories (Miller and O'Keefe 1981) with respect to relative age and hardness.

1. Claw easily bent with thumb pressure, claw iridescent on the outer edge, shell without calcarious growths and brightly colored.
2. Claw not easily bent by thumb pressure, claw iridescent on the outer edge, shell brightly colored, and shell usually with calcarious growths.
3. As in 2) but shell less brightly colored and claw edge not iridescent.
4. Shell black and soft from decay at some joints, shell colors dull.

Beginning in 1988, individual catches were further subsampled for determination of chela allometry. Height of the right chela (CH), if present and not deformed, was estimated (0.1 mm) using dial calipers. The ratio of chela height to carapace width was subsequently used to partition crabs between two distinct groups with respect to chela allometry; small-clawed or large-clawed.

Treatment of Data:

A schematic model of snow crab recruitment was followed in assigning individuals to population components for subsequent analysis (Fig. 2). 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 ($\geq$95 mm CW); Prerecruit 1, those which would achieve legal size after one molt (76-94 mm CW); and Prerecruit 2, those which would achieve legal size after two molts (60-75 mm CW).

ii) Chela Allometry - males develop enlarged chelae when they undergo a final molt, which 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 ($CH = 0.0806CW^{1.1999}$) was applied to classify each individual as either large-clawed or small-clawed.

iii) Shell Hardness - males which undergo their terminal molt in the spring will remain soft-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 soft-shelled between molts (Fig. 2). In reality, however, an annually-variable proportion of small-clawed males will not molt in any given year ('skip molters') and so will attain hard-shelled condition between molts. For each year that a crab skips a molt, its eventual recruitment is delayed by a year.

The schematic model (Fig. 2) depicts the progression of a molt class of small crabs (60-75 mm CW), with small claws, to eventual recruitment. This component is predominated by a group termed R-3 because they may recruit to the fishery, at about 95-114 mm CW, in three years (i.e. after two molts and an additional year to harden). However a more minor group (R-4) is also represented in this category. This group will remain small-clawed and soft-shelled after two molts and so will molt a third time, recruiting to the fishery, in four years, as very large crabs (115-140 mm). Of course, these simplified recruitment processes and numbers of years involved do not take 'skip-molting' into account, which, as previously noted will further delay recruitment.

Commercial catch per unit of effort (CPUE; kg/trap haul) was used as the index of commercial biomass and the dependent variable in linear regression analysis. CPUE data were subsampled and summarized from vessels' logbooks, maintained by captains as a condition of access to the fishery. Soak time was variable and unstandardized. Where both full-time and supplementary fleet sectors prosecuted the fishery within a management area (i.e. Bonavista Bay and Northeast Avalon, Table 1) only data from the full-time fleet were used to estimate CPUE. In 1996, for the first time, there was no fishery by the full-time fleet in Bonavista Bay so CPUE from the supplementary fleet was used.

The independent variable in the linear model was the survey catch rate of all legal-sized crabs in the previous year. The survey catch rate in kg/trap was calculated from the number of crab per trap, the mean carapace width, and a body weight-carapace width relationship for crabs of carapace condition 2 (Taylor and Warren 1991). This survey catch rate included 'soft-shelled' and 'hard-shelled' crabs, both of which would provide commercially-acceptable meat yield and so be fully recruited and reflected in the CPUE of the next year's fishery. A survey catch rate index was developed separately for each of the data sets from large-meshed and small-meshed traps.

Trap Surveys in NAFO Div. 3K

Survey Methodology:

A survey was carried out during September of 1994-96 in White Bay (management area 3B, Fig. 1). Sampling level was similar among the three years (39-41 sets) at depths of 183 m and greater. Each set was comprised of 6 baited traps separated by 45 m. The catches from end traps (large-meshed) were not sampled. The 4 traps in each set sampled during 1994 and 1995 included 2 large-meshed traps, one small-meshed trap and one large-meshed trap equipped with a small-mesh cover. Traps with small mesh covers are not comparable to small mesh traps with respect to catch rate (Dawe et al.

1996) and so were replaced by small-meshed traps in the 1996 surveys. Sets were randomly allocated.

Data Collected:

All males were measured in carapace width (mm) and chela height (0.1 mm). Shell condition was assigned one of three categories; (1) New-shelled. These crabs had molted in spring and would represent recruitment to the fishery, in the following year. (2) Intermediate-shelled. These crabs last molted in the previous year and represented new recruits to the fishery of the current year. (3) Old-shelled. These crabs have been in the fishery for at least 2 years.

Treatment of Data:

All crabs ≥60 mm CW were assigned to one of the three size groups described above (i.e. legal-size, Prerecruit 1 and Prerecruit 2) for comparison of catch rates among the 3 years. Each component was further partitioned into small-clawed and large-clawed sub-groups.

<u>Bottom Trawl Survey</u>

Data Collected:

Data on total catch number and weight were acquired from the 1995 and 1996 fall stratified random bottom trawl surveys which extended throughout NAFO Divs. 2J3KLNO. The 1996 survey extended to NAFO Divs. 2GH and inshore strata, not included in the 1995 survey. For most sets, using the Campellen 1800 survey trawl, crabs were sampled (or subsampled) for CW, shell condition and chela height. Shell condition data are suspect and will not be described here. This problem relates to the great subjectivity in staging by survey participants with varying levels of experience.

Treatment of Data:

Spatial distributions were compared between years for all crabs (both sexes), all females, all males, and three size groups of males; legal-sized (>94 mm CW), Prerecruit 1 (76-94 mm CW) and Prerecruit 2 (60-75 mm CW). The distribution of legal-sized crabs was also compared with the distribution of commercial fishing effort.

Biomass estimates were generated separately for each of the above groups (i.e. all crabs, all females, all males, and 3 size groups of males. Minimum trawlable biomass, with 95% confidence limits, was estimated by NAFO Division. The catchability of the survey trawl for snow crab is unknown. Only those strata sampled in both years were included for comparison.

Carapace widths were grouped into 3 mm intervals and adjusted up to total population abundance for comparison between years and among NAFO Divisions. Each size interval was partitioned by claw type.

Results and Discussion

Trap Surveys in NAFO Div. 3L

For all three survey areas positive relationships were found using the large-meshed trap data (Fig. 3), but the linear model explained only 54-63% of the variation. In contrast, the model, when applied to the small-meshed trap data sets, accounted for 69-75% of the variation (Fig. 3). In both cases, the unexplained variation would likely be due to various sources, including annual variation in methodological factors (eg. sampling time and intensity, fishing patterns) or biological variables (eg. changes in molting season, proportions molting and other factors which affect catchability).

It is surprising that the survey catch rate index based on small-meshed trap data represents a more reliable predictor of commercial CPUE than that based on large-meshed trap data. It is recognized that large-meshed traps are size selective and are biased samplers even for legal-sized crabs but, because they are used in the commercial fishery, it had been assumed that they would provide the best predictor of fishery performance (Xu et al. 1992). Furthermore, the time series are longer for large-meshed traps and most of the sampling at each station has historically utilized large-meshed traps so catch rate has probably been more precisely estimated by those traps.

This model for both gear types generally predicted that 1996 catch rates would be comparable to the high catch rates observed during the most recent 2-3 years. The index based on both trap types predicted record high 1996 CPUE for two of the three areas, Conception Bay and Northeast Avalon (Fig. 3).

Fishery performance realized in 1996, when compared to that predicted from both trap types, was comparable for Conception Bay but considerably lower for Northeast Avalon. Commercial CPUE remained high and generally similar to that of the previous two years for Conception Bay and Northeast Avalon. The predicted record high CPUE was realized in Conception Bay. CPUE declined for Bonavista Bay, as predicted by large-meshed traps better than by small-meshed traps.

Catch rates from the 1996 surveys indicate that fishery performance for 1997 in Div. 3L should remain at a high level for Conception Bay and the Northeast Avalon although catch rates were consistently lower than in 1996. A considerable decline in CPUE is projected for Bonavista Bay (Fig. 3).

Reliability of the predictive models differs among survey areas, due to area differences in timing of surveys relative to fisheries (Table 1). The models are overall most reliable for Conception Bay (considering that there were no surveys for three of the years) because surveys were conducted in the fall, often after the single (supplementary) fishery was completed (eg. 1991-95). Predictability was overall poorest for Northeast Avalon, especially for recent years (1993-96) because surveys (in spring) preceded much of the spring full-time fishery and the entire fall supplementary fishery of the same year. Trends in survey catch rates best track CPUE in the same year for Northeast Avalon. Bonavista Bay surveys (August) were usually timed between these two fisheries during 1990-95, but it was executed during the single supplementary/temporary fishery in 1996.

Future refinement of these models will focus on standardizing commercial CPUE for effects of annually variable fishing effort. In a refined model some standardized early-season CPUE would be used as the dependent variable.

The survey catch rate of the immediate prerecruit size group (Prerecruit 1; 76-94 mm) peaked in either 1991 (Bonavista Bay) or 1992 (Conception Bay and Northeast Avalon) and has been generally declining since (Fig. 4). Although 1996 catch rates for this size group remain higher than those prior to 1988 (for two areas), the catch rate of the small-clawed component of this group declined especially sharply beginning in 1992 and 1993. Since only the small-clawed component of this Prerecruit 1 size group will actually molt and subsequently recruit to the fishery (in as little as two years) this suggests that recruitment has declined in the past 2-3 years in Div. 3L.

The small-clawed component of a size group of smaller crabs (Prerecruit 2; 60-74 mm CW) has also declined regularly in recent years, achieving very low catch rates in 1996 (Fig. 4). Since this component requires at least three years before it begins to recruit to the fishery (as hard-shelled crabs) it suggests that relatively poor recruitment will persist for several years.

This interpretation of future recruitment should be considered with caution, however, because baited traps do not efficiently sample small-clawed crabs (Hoenig and Dawe 1991). Small-clawed males do not feed or enter traps for a rather extended time period including their molt. Annually-molting small-clawed males are assumed to not harden fully between molts. Therefore it is possible that the predominantly hard-shelled small-clawed males sampled in the trap surveys may represent the annually-variable proportion which did not molt during the most recent spring (i.e. skip-molters). However, a decline in catch rates of legal-sized crabs is evident for Bonavista Bay only (Fig. 3) reflecting an early decline in Prerecruit 1 crab from that area relative to the other two survey areas (Fig. 4).

Trap Surveys in NAFO Div. 3K

The catch rate of legal-sized crabs from both trap types increased slightly in 1996 agreeing with the CPUE trend (Fig. 5). Catch rates of Prerecruit 1 crabs generally remained high in 1996. Survey catch rates of Prerecruit 2 crabs, including those with small claws, increased considerably in 1996 for both trap types, but especially for small-meshed traps (Fig. 5). Size frequency distributions from small-meshed traps (Fig. 6) also show a great increase in catch rate of smaller crabs (<60 mm CW). This may indicate increased recruitment beginning in about 3 years, but it may also reflect increased catchability or local immigration of small crabs.

Bottom Trawl Surveys

Both sexes and all sizes of males were broadly distributed throughout the Div. 2J3KLNO survey area (Fig. 7-10) but were notably absent from most of the deepest sets (mostly >500 m) along the Div. 3KL slope and most of the Southern Grand Bank (Div. 3LNO). Largest males (legal-size and Prerecruit 1) were also usually absent from innermost sets <300 m in Div. 2J3K (Fig. 7-8) where Prerecruit 2 (Fig. 9) and smaller males, as well as females (Fig. 10), were caught. On the Grand Bank, Prerecruit 2's and larger crabs were prevalent on the tail and eastern edge, whereas smaller crabs were also caught in some sets on the Southwest Slope. The 1996 survey extended north into NAFO Div. 2GH, but no crabs were caught in those areas.

Comparison of the distribution of legal-sized crabs with that of commercial fishing effort indicates that portions of the resource are as yet unexploited (Fig. 11).

A summary of the fall 1996 depth distribution of all male size groups in Div. 3L and 3K (Fig. 12) shows that all size groups are sympatric, with considerable difference between divisions. Catch rates of legal-size crabs, and other size groups generally, were highest at 50-200 m in Div. 3L versus 250-400 m in Div. 3K. The partial spatial segregation of smallest males in inshore areas noted earlier (Fig. 7-8) is likely related to bottom substrate.

Biomass estimates are interpreted qualitatively because the catchability of the survey trawl for snow crab is unknown and because areas within bays are not included in these estimates. Biomass estimates and mean catch/set suggest that biomass and density were highest in Div. 3L and much lower in all other divisions except 3K (Table 2). This appears to be true for the total population, for all males, and for legal-sized males.

Comparison of biomass estimates between years, for common strata, suggests that total crab biomass has increased (Table 2). This is due to an increase in biomass of largest males (legal-size and Prerecruit 1) in all Divisions except 3O. The estimated biomass of commercial males approximately quadrupled in 3N, doubled in 2J3K, and increased by 32% in 3L. Increase in Prerecruit 1's was greatest in 3LN. Prerecruit 2's also increased considerably in 3L but decreased elsewhere. Biomass of all females (mature plus immature) declined in all divisions, but especially in 3L.

Size frequency distributions (Fig. 13) show that abundance of these size groups increased as well between years. The large increase in 2J commercial biomass was due to increased abundance of especially large crabs. A great increase in abundance of Prerecruit 1's was apparent in 3L, especially for those with small claws. Comparison of chela allometry between years for each size group (Fig. 14) indicates that a much higher proportion of each of the two Prerecruit groups was small-clawed in 1996 than in 1995 throughout 3LNO. Future recruitment overall seems especially promising in 3LN. The 1996 size frequencies suggest that abundance of about 35-65 mm CW crabs is low in all areas (Fig. 13). This 'recruitment trough' could begin to enter the fishery in about 4 years.

<u>Offshore Trawl Versus Inshore Trap Data</u>

Trends from these two data sources are in conflict. Although they both predict a continuing high level of fishery performance for 1997 overall, trap data suggest either comparable CPUE (3K) or a slight decline (3L) in 1996 whereas trawl data indicate considerable increases in commercial biomass across 2J3KLN. Most conflicting is that trap catch rates of Prerecruit 1's (and especially those with small claws) declined in 1996 in all three Div. 3L trap survey areas whereas the offshore trawl catch rate for Div. 3L increased by 73% for this group in 1996, due to a great increase in small-clawed crabs. Increase in biomass of Prerecruit 1 crabs from trawl data was also evident across 2J3KLN. The two data sets also disagree in trends for Prerecruit 2's in Div. 3L as well as in Div. 3K. In 3K the comparison is reversed; the trap survey indicates an increase in Prerecruit 2's in White Bay whereas the trawl survey indicated a decline offshore.

We are unable to fully resolve these conflicts, but we offer three likely (and probably interacting) contributing factors:

(1) Sampling Gear Effects (traps versus trawl):

Traps may indicate general abundance level for largest crabs, but at unusually high abundance levels 'trap saturation' may occur. Trap indices for smaller crabs (eg. Prerecruit 1 and 2) are even more subject to density dependent effects on catchability. It is clear that traps do not sample small-clawed crabs well (Hoenig and Dawe 1991), and these intermolt crabs represent most of both Prerecruit size groups. Catchability of such small crabs (especially with small claws) is likely further reduced by behavioral interactions when abundance of larger crabs is very high.

(2) Habitat Effects (offshore versus inshore):

In offshore areas all male size groups are sympatric whereas in inshore areas there appears to be partial segregation; largest males are most abundant on deepest muddy bottoms within bays whereas smaller crabs may be more abundant on other substrates at lesser depths. Hence catch rates of prerecruit size groups are lowest in Conception Bay and Bonavista Bay where surveys target the deep commercial fishing grounds. Catch rates for these groups remain higher in the offshore Northeast Avalon trap survey area. The 3K trap survey in the White Bay area is not limited to the deepest commercial fishing area (within the Bay), probably accounting for sustained and increasing catch rates of Prerecruit 1 and smaller crabs respectively. The great increase in catch rate of White Bay Prerecruit 2 crabs in 1996 is in conflict with the decrease apparent in offshore 3K; this suggests local effects such as immigration of small crabs into the trap survey area (Management Area 3B, Fig. 1).

(3) Effects of Fishing Effort Distribution (offshore versus inshore):

The apparent considerable increase in commercial biomass offshore in 1996 relative to inshore may be related to relatively low effort allocation. The decline in Bonavista Bay trap catch rates in particular may be related to locally high exploitation.

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Table 1. Details pertaining to research surveys and fisheries, by year and survey area.

Year	Period	No. stations	No. of trap hauls: Large meshed	No. of trap hauls: Small meshed	Fishery: Period	Fishery: Catch (t)
Conception Bay						
1979						
1980						
1981	Sept. 25-30	13	143	24	Feb. 22-Nov. 28	502
1982	Nov. 4-17	16	170	24	Mar. 22-July 17	694
1983	NO SURVEY				Jan. 3-Dec. 3	564
1984	Oct. 2-11	32	375	12	Jan. 22-Nov. 17	333
1985	Nov. 5-14	23	235	44	Apr. 21-Oct. 26	139
1986	Oct. 31-Nov. 6	24	264	20	Apr. 20-Dec. 6	193
1987	NO SURVEY				May 3-June 13	227
1988	Oct. 3-14	25	249	45	Apr. 24-May 21	499
1989	Oct. 9-13	9	85	18	Sept. 3-Oct. 14*	*476
1990	NO SURVEY				Sept. 9-Oct. 6*	*314
1991	Nov. 2-13	35	382	42	May 19-June 22/	
					Aug. 18-Sept. 14*	*383
1992	Nov. 2-16	23	247	24	May 17-June 27/	
					Sept. 1-Oct. 3*	*304
1993	Oct. 11-22	25	271	24	June 5-8/Aug. 1-13*	*309
1994	Sept. 27-Oct. 7	31	266	103	May 30-June 3/Sept. 6-9*	*416
1995	Sept. 25-Oct. 6	40	350	120	June 11-16/Sept. 19-24*	*516
1996	Sept. 23-Oct. 4	27	218	80	July 11-Aug. 22*/Oct. 3-14*	*599
Bonavista Bay						
1979	June 15-July 4	41	327	0	May 7-Nov. 24	1586
1980	Mar. 24-Apr. 15	16	188	0	Apr. 7-Nov. 30	1905
1981	May 5-18	27	325	0	Mar. 2-Dec. 5	1376
1982	May 3-14	25	253	48	Apr. 5-Nov. 20	905
1983	Aug. 10-26	25	264	44	Apr. 24-Dec. 3	1101
1984	Aug. 6-20	33	361	37	May 13-Dec. 15	1327
1985	Aug. 5-18	31	316	51	May 5-Nov. 9	728
1986	Aug. 4-14	22	249	15	Apr. 27-Aug. 2	648
1987	Aug. 4-19	30	329	25	May 3-June 20	602
1988	Aug. 8-24	22	277	30	May 2-June 5	735
						*109
1989	Aug. 1-15	29	317	34	May 14-June 10	639
						*320
1990	Aug. 2-14	24	260	26	Apr. 15-May 12	656
					Sept. 9-25*	*416
1991	Aug. 5-16	30	329	32	May 12-June 1	623
					Aug. 11-24*	*479
1992	Aug. 3-15	30	332	28	May 17-June 6	692
					Sept. 1-10*	*468
1993	Aug. 2-25	27	291	34	May 15-June 25	905
					Aug. 1-6*	*526
1994	Aug. 8-19	29	234	112	Apr. 25-May 3	566
					May 30-June/Sept. 6-9*	*984
1995	Aug. 7-18	26	181	71	May 21-June 4	370
					May 22-June 19/Sept. 6-27*	*736
1996	Aug. 9-16	32	225	87	July 10-Aug. 19*	*1003

Table 1. Continued ...

Year	Period	No. stations	No. of trap hauls: Large meshed	No. of trap hauls: Small meshed	Fishery: Period	Fishery: Catch (t)
Northeast Avalon						
1979	Apr. 9-May 9	32	260	0	Apr. 2-Dec. 24	7632
1980	Mar. 24-Apr. 15	14	162	0	Apr. 7-Dec. 13	5065
1981	Mar. 23-Apr. 15	12	142	0	Mar. 2-Dec. 19	7607
1982	Mar. 31-Apr. 20	20	187	47	Apr. 1-Dec. 11	3368
1983	May 4-12	13	144	10	May 1-Dec. 10	801
1984	May 26-31	12	129	20	May 22-Nov. 17	312
1985	June 11-15	10	103	17	May 26-Oct. 5	113
1986	May 29-June 12	13	129	20	Aug. 10-Oct. 25	144
1987	July 15-24	23	256	16	May 3-Aug. 8	172
1988	June 2-22	26	203	60	May 1-July 16	751
1989	May 1-10	20	211	22	May 7-July 1	661
1990	June 7-18	27	266	63	Apr. 1-June 30	619
					Sept. 16-Nov. 10*	*231
1991	June 3-17	24	259	26	May 12-July 6	699
					May 12-June15/Sept. 1-21*	*391
1992	June 1-12	26	278	29	May 17-June 6	650
					May 17-June 6/Sept. 1-26*	*428
1993	May 4-14	12	126	15	May 22-July 1/Aug. 1-20	702
					June 5-18/Aug. 1-20*	*839
1994	May 11-20	16	119	70	Apr. 25-May 11	633
					Apr. 25-May 1/ May 30-June 2/Sept. 6-9*	*566
1995	May 29-June 9	27	191	79	May 21-June 5	470
					May 21-June 23/Sept. 5-30*	*1658
1996	May 29-June 14	29	170	72	June 24-Nov. 15	264
					June 20-Dec. 18*	*2136

* Indicates period of, and landings from, supplementary as opposed to full-time fisheries. 'Temporary' included in 1996.

Table 2. Minimum trawlable biomass estimates from the 1995 and 1996 (**highlighted figures**) fall bottom trawl surveys by NAFO Division and population component.

NAFO Div.	Biomass (t)	95% confidence limits Lower	Upper	Mean kg/set
Legal-size males (> 95 mm CW)				
2J	4,267	2,668	5,866	1.4
	8,023	**5,396**	**10,650**	**2.6**
3K	12,692	9,650	15,733	2.4
	24,611	**20,003**	**29,219**	**4.7**
3L	27,457	18,840	36,073	4.5
	36,378	**28,302**	**44,454**	**5.8**
3N	2,222	888	3,557	0.8
	9,056	**2,671**	**15,441**	**3.3**
3O	4,494	-925	9,913	1.6
	1,689	**-9,428**	**12,806**	**0.6**
Prerecruit 1 (76-94 mm CW)				
2J	978	659	1,297	0.3
	1,191	**547**	**1,835**	**0.4**
3K	7,069	5,309	8,828	1.4
	7,868	**6,125**	**9,612**	**1.5**
3L	11,169	8,047	14,291	1.8
	19,278	**11,350**	**27,206**	**3.1**
3N	2,584	-12,055	17,224	1.0
	3,892	**-988**	**8,772**	**1.4**
3O	2,986	645	5,327	1.1
	261	**-61**	**584**	**0.1**
Prerecruit 2 (60-75 mm CW)				
2J	2,324	1231	3,417	0.1
	188	**75**	**301**	**0.1**
3K	3,566	2,444	4,688	0.7
	2,419	**1,665**	**3,173**	**0.5**
3L	2,999	2,078	3,920	0.5
	4,361	**741**	**7,981**	**0.7**
3N	782	-339	1,952	0.3
	546	**30**	**1,063**	**0.2**
3O	1,745	-275	3,766	0.6
	70	**-17**	**157**	**0.02**

Table 2. Continued ...

NAFO Div.	Biomass (t)	95% confidence limits Lower	Upper	Mean kg/set
Small males (< 60 mm CW)				
2J	117	-19	252	0.04
	75	**49**	**101**	**0.02**
3K	2,349	1,533	3,165	0.5
	1,368	**957**	**1,778**	**0.3**
3L	3,790	2,646	4,934	0.6
	1,623	**1,096**	**2,150**	**0.3**
3N	262	50	474	0.1
	167	**-708**	**1,041**	**0.1**
3O	336	-91	763	0.1
	16	**-9**	**42**	**0.01**
All males				
2J	5,594	3,920	7,268	1.8
	9,478	**6,481**	**12,474**	**3.0**
3K	29,586	24,706	34,466	5.7
	36,264	**30,115**	**42,413**	**7.0**
3L	45,415	34,109	56,921	7.4
	61,640	**48,190**	**75,090**	**9.9**
3N	5,850	-12,023	23,723	2.2
	14,458	**3,219**	**25,697**	**5.3**
3O	9,559	194	18,925	3.4
	2,365	**-9,331**	**14,061**	**0.8**
All females				
2J	151	67	236	0.1
	136	**78**	**194**	**0.04**
3K	4,266	5,608	2,924	0.8
	2,364	**1,401**	**3,327**	**0.5**
3L	10,920	8,333	13,507	1.8
	3,233	**910**	**5,556**	**0.5**
3N	991	254	1,727	0.4
	576	**270**	**882**	**0.2**
3O	391	177	605	0.1
	73	**21**	**125**	**0.03**
All crab				
2J	5,745	4,080	7,410	1.8
	9,613	**6,611**	**12,616**	**3.1**
3K	33,851	28,585	39,118	6.5
	38,600	**32,094**	**45,107**	**7.4**
3L	56,852	45,284	68,419	9.3
	64,877	**50,980**	**78,774**	**10.4**
3N	6,841	551	13,130	2.5
	15,034	**4,310**	**25,759**	**5.6**
3O	10,065	520	19,609	3.6
	3,880	**-823**	**8,583**	**1.4**

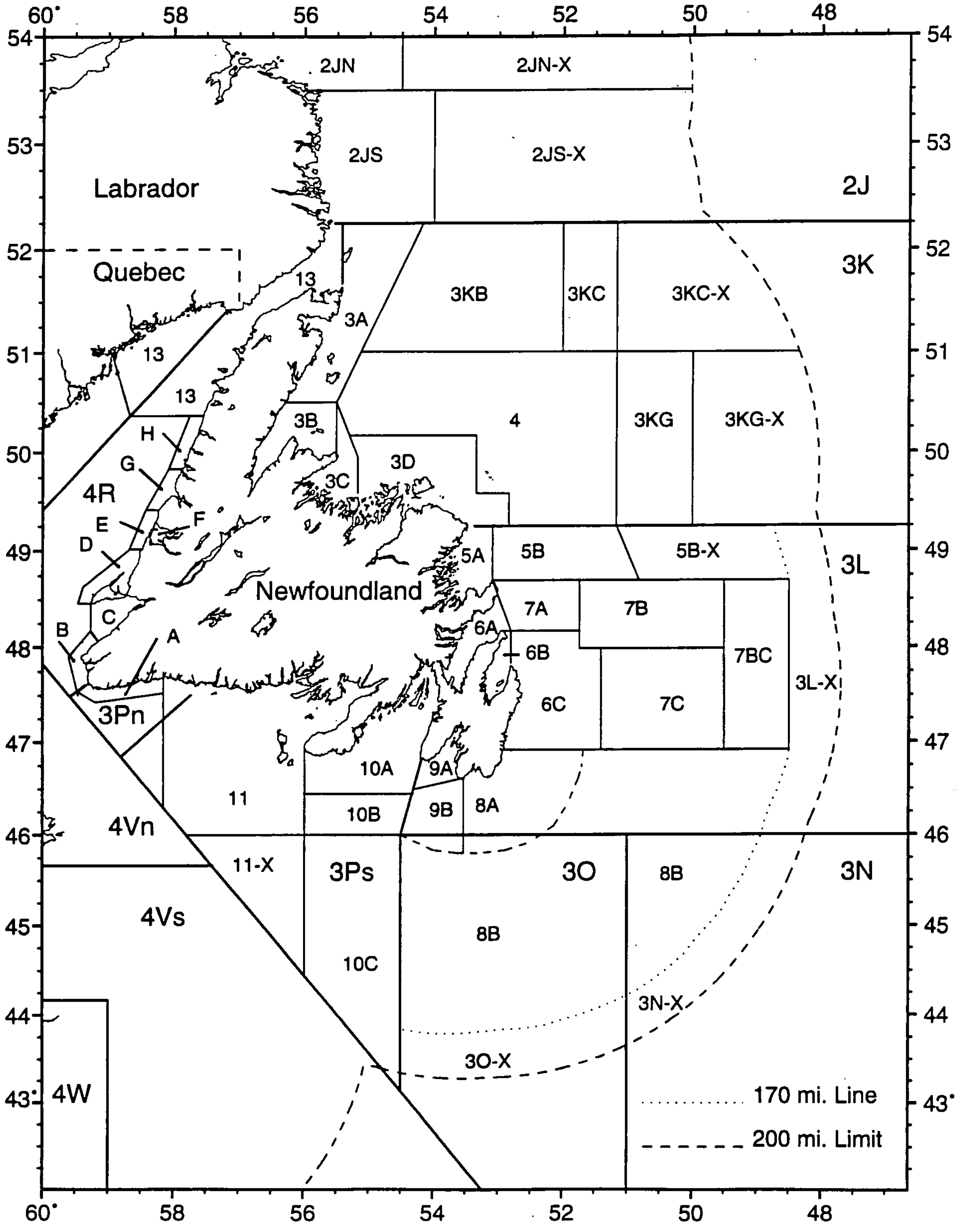

Fig. 1. Snow crab management areas.

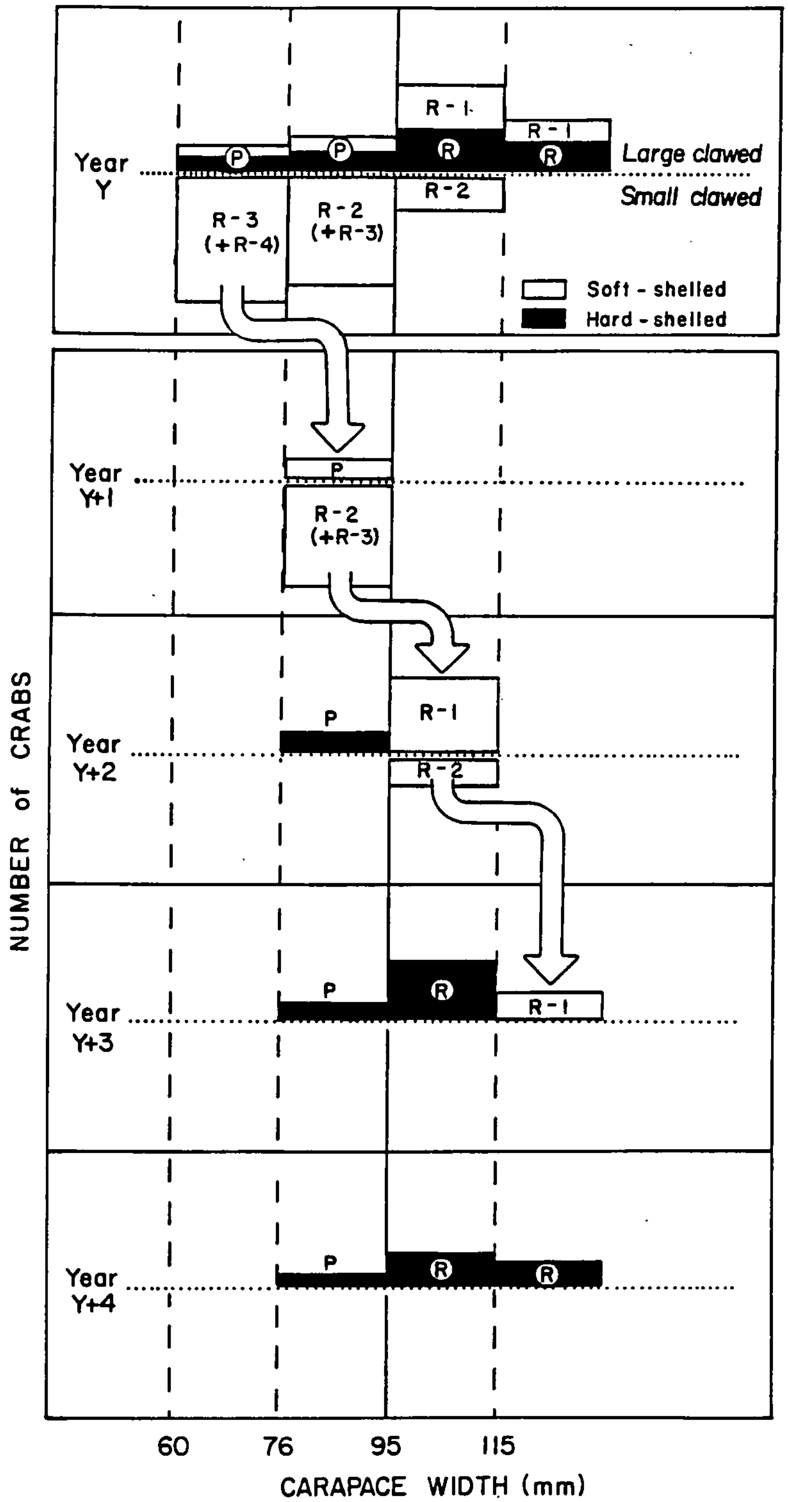

Fig. 2. Schematic representation of snow crab population components relevant to recruitment for males ³60 mm CW (top panel) and depiction of the recruitment process for the molt class of smallest (60-74 mm CW) crabs with small claws (all panels). Arrows represent molting. 'P' represents 'Pygmy' crabs - males which have attained large-clawed status at sub-legal size (<95 mm CW) and are assumed to have molted for the last time. R represents hard-shelled males which have recruited to the fishery. This model does not include skip-molters.

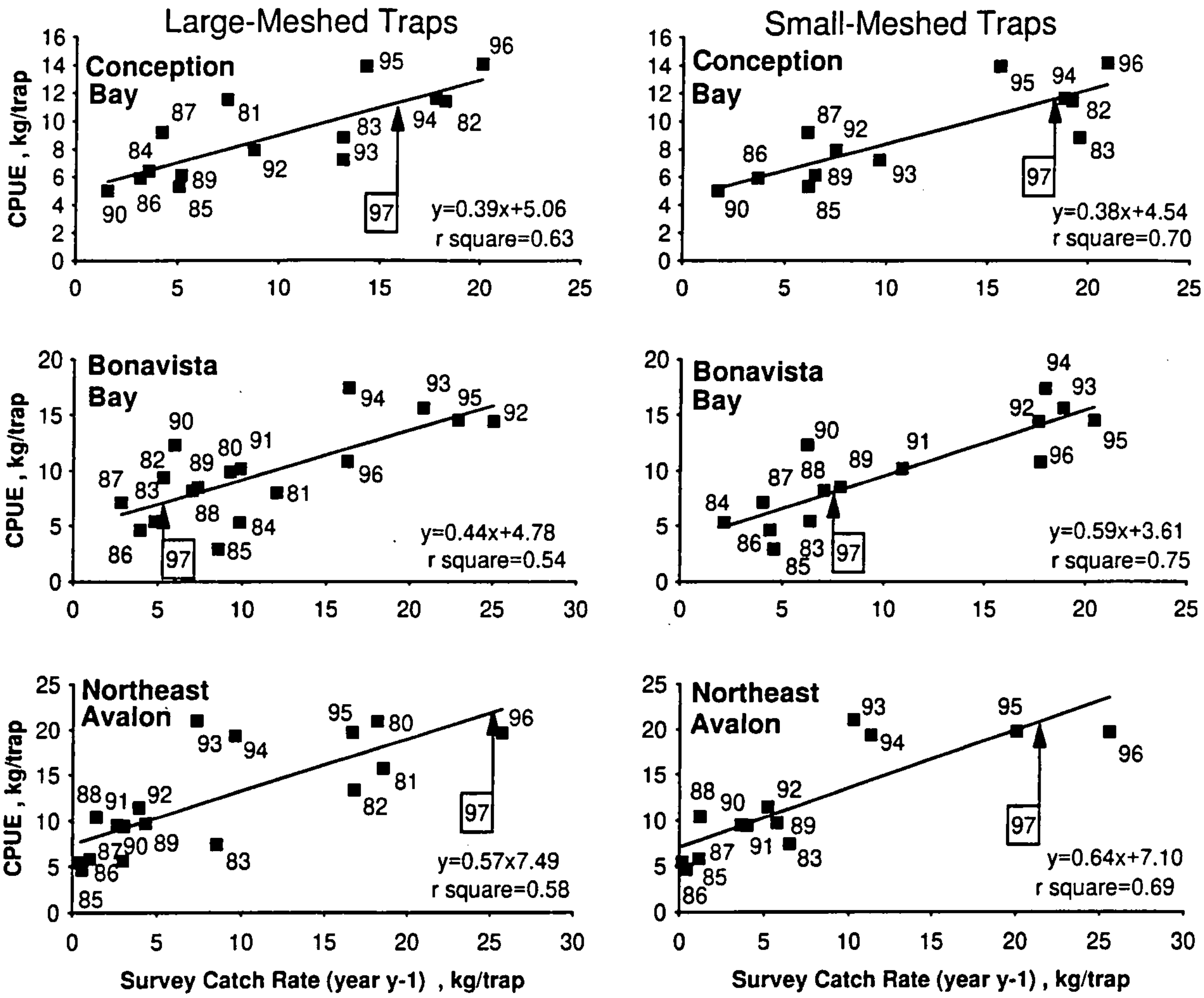

Fig. 3. Relationship of commercial CPUE in any year to the survey catch rate of legal-sized crabs in the previous year, by trap type and survey area. Arrows show projected CPUE's for 1997.

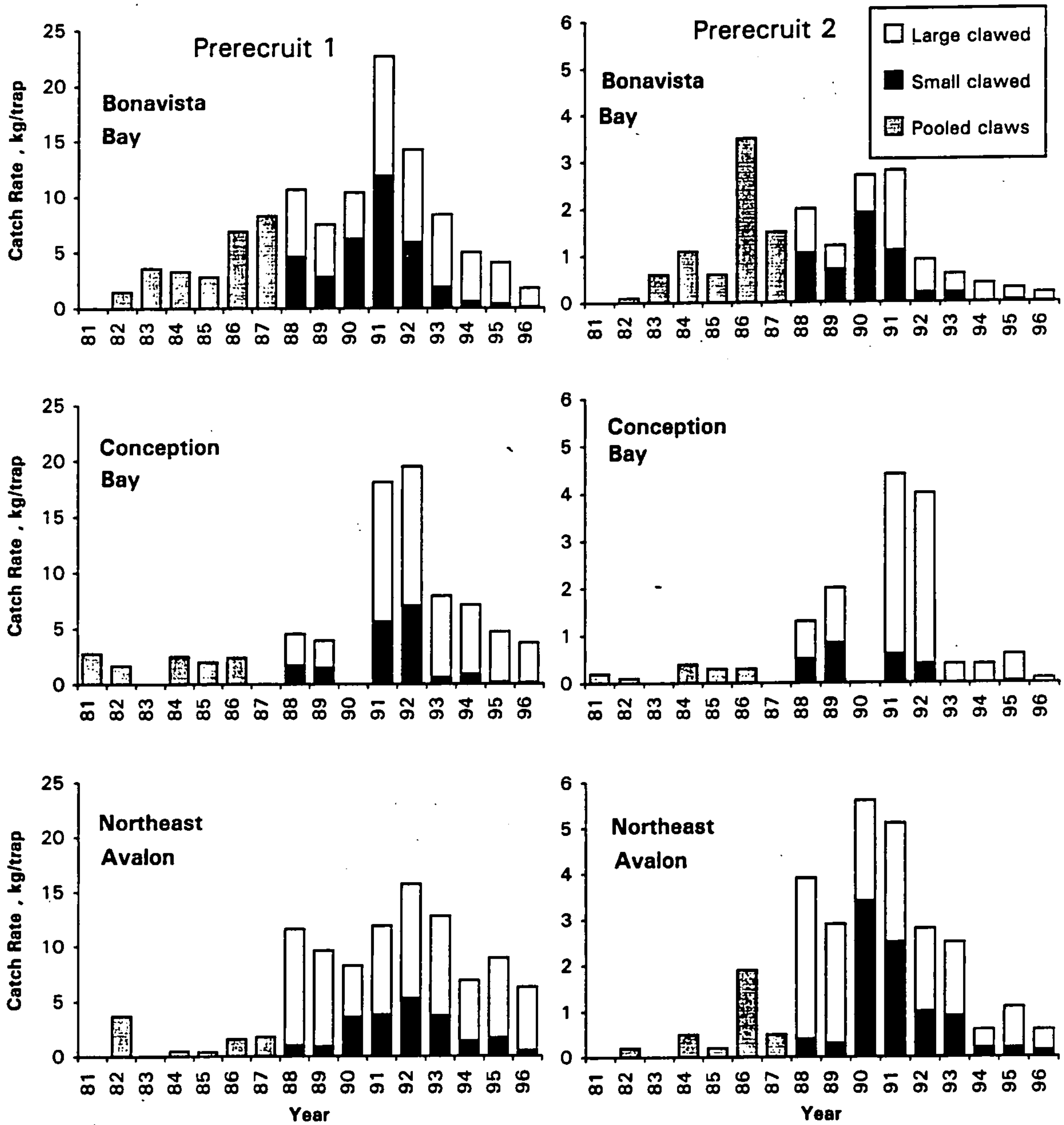

Fig. 4. Yearly trends in survey catch rate of Prerecruit crabs from small-meshed traps, by size group and survey area. Catch rates are partitioned by chela allometry since 1988.

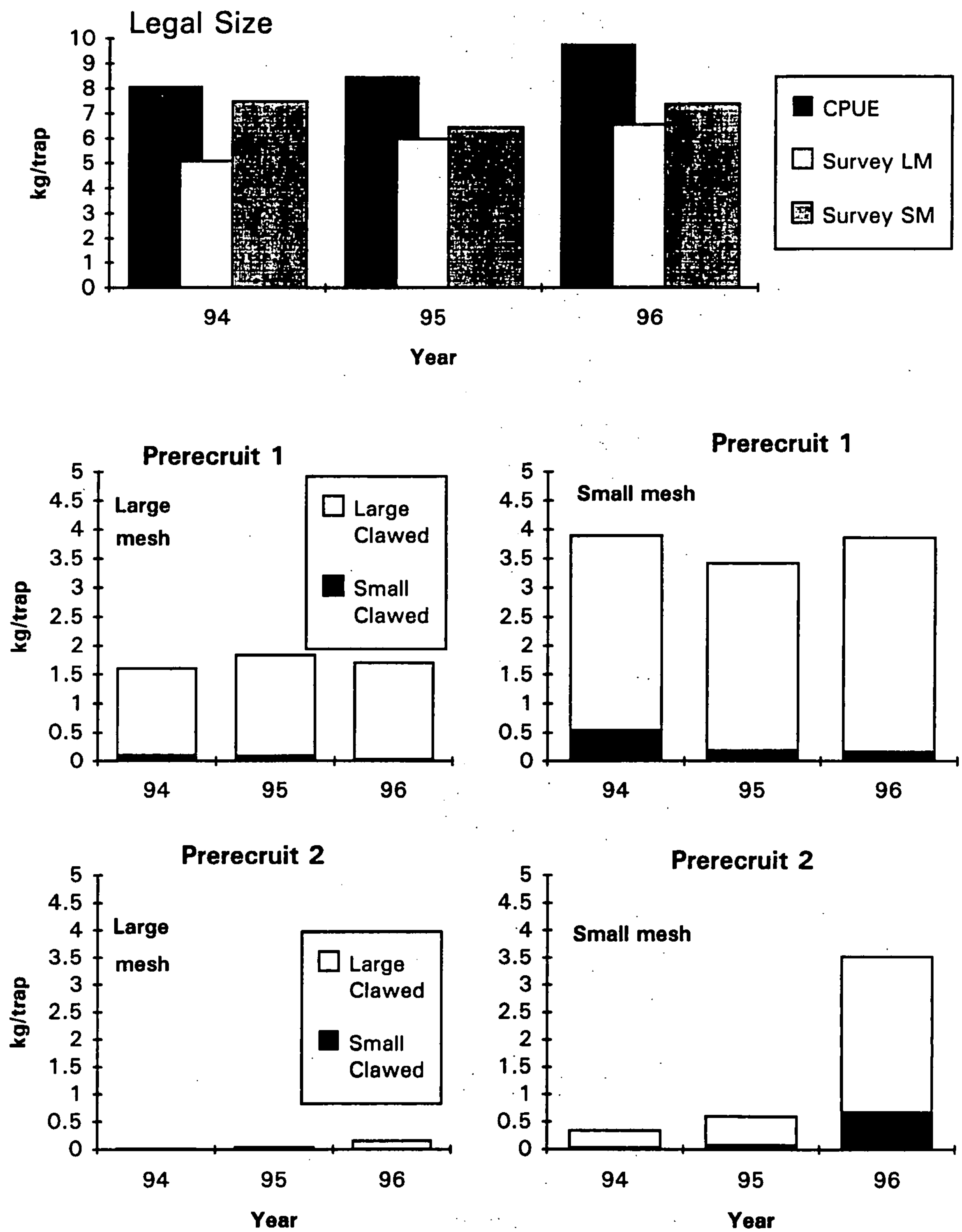

Fig. 5. Comparison of 1994-96 survey catch rates from White Bay (area 3B) for each of three population components by trap type.

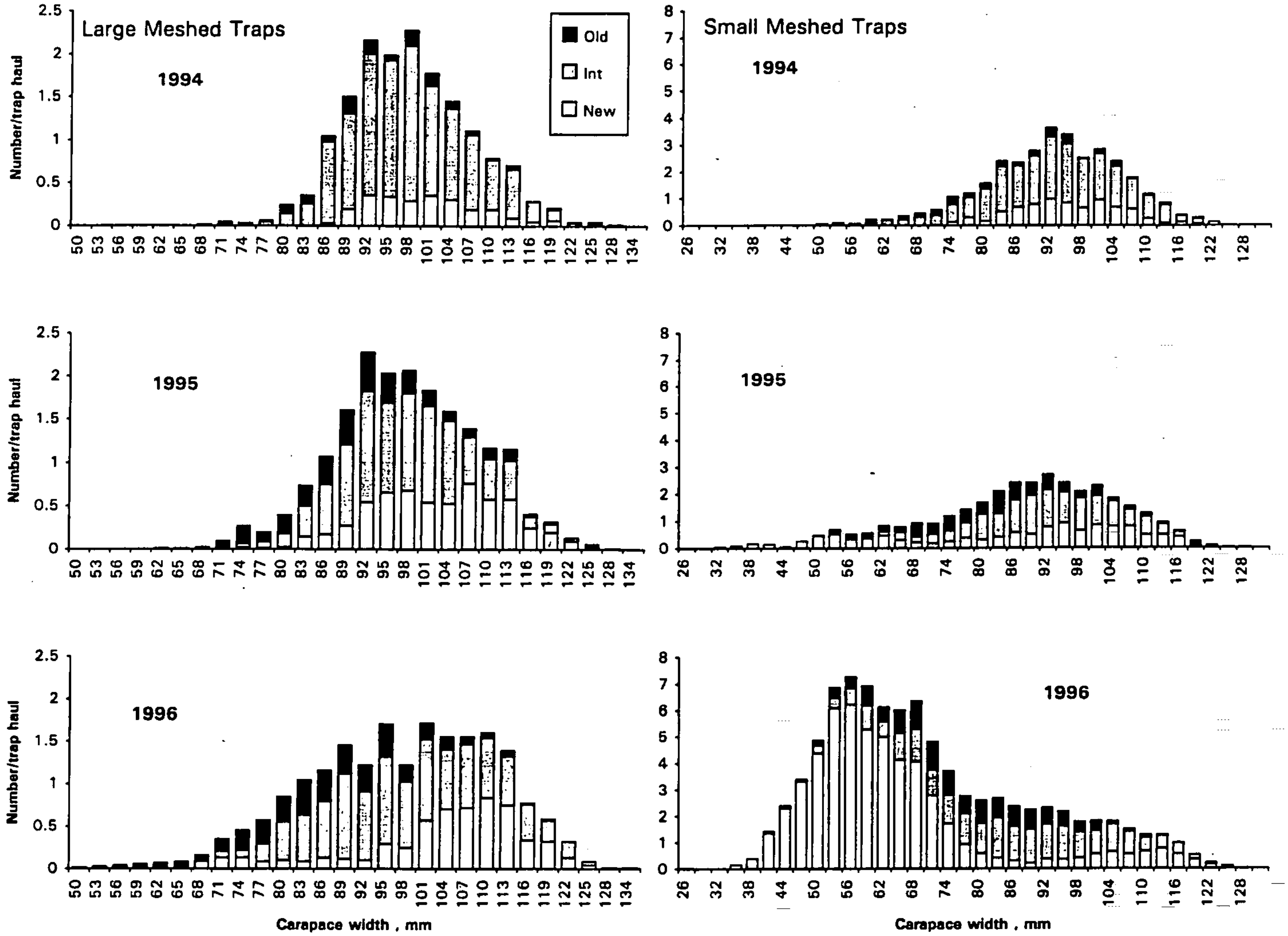

Fig. 6. Carapace width distributions and shell condition for White Bay by survey year and trap type.

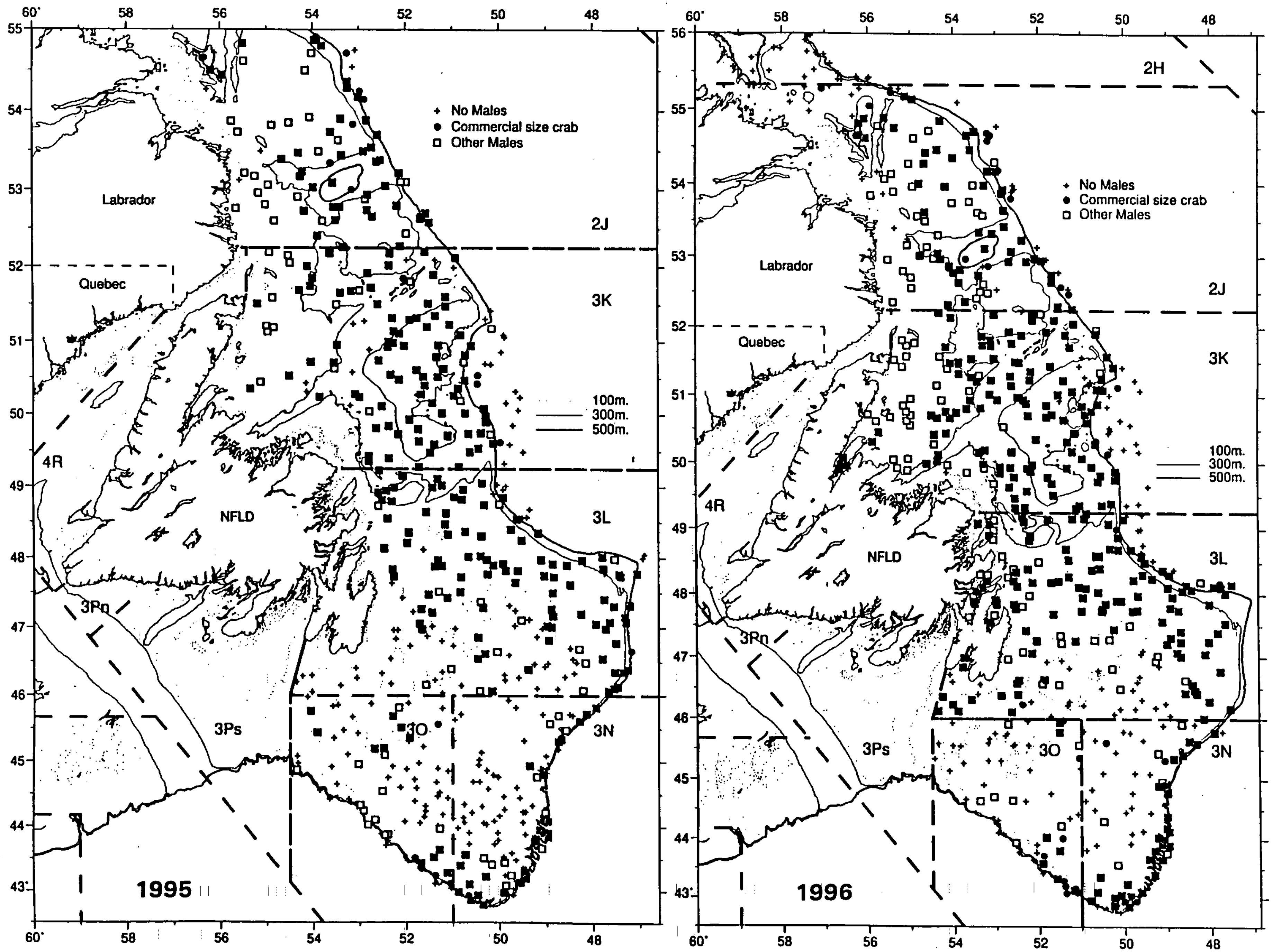

Fig. 7. Spatial distribution of those sets where legal-sized crabs were caught in relation to sets which caught other males or no males, by year.

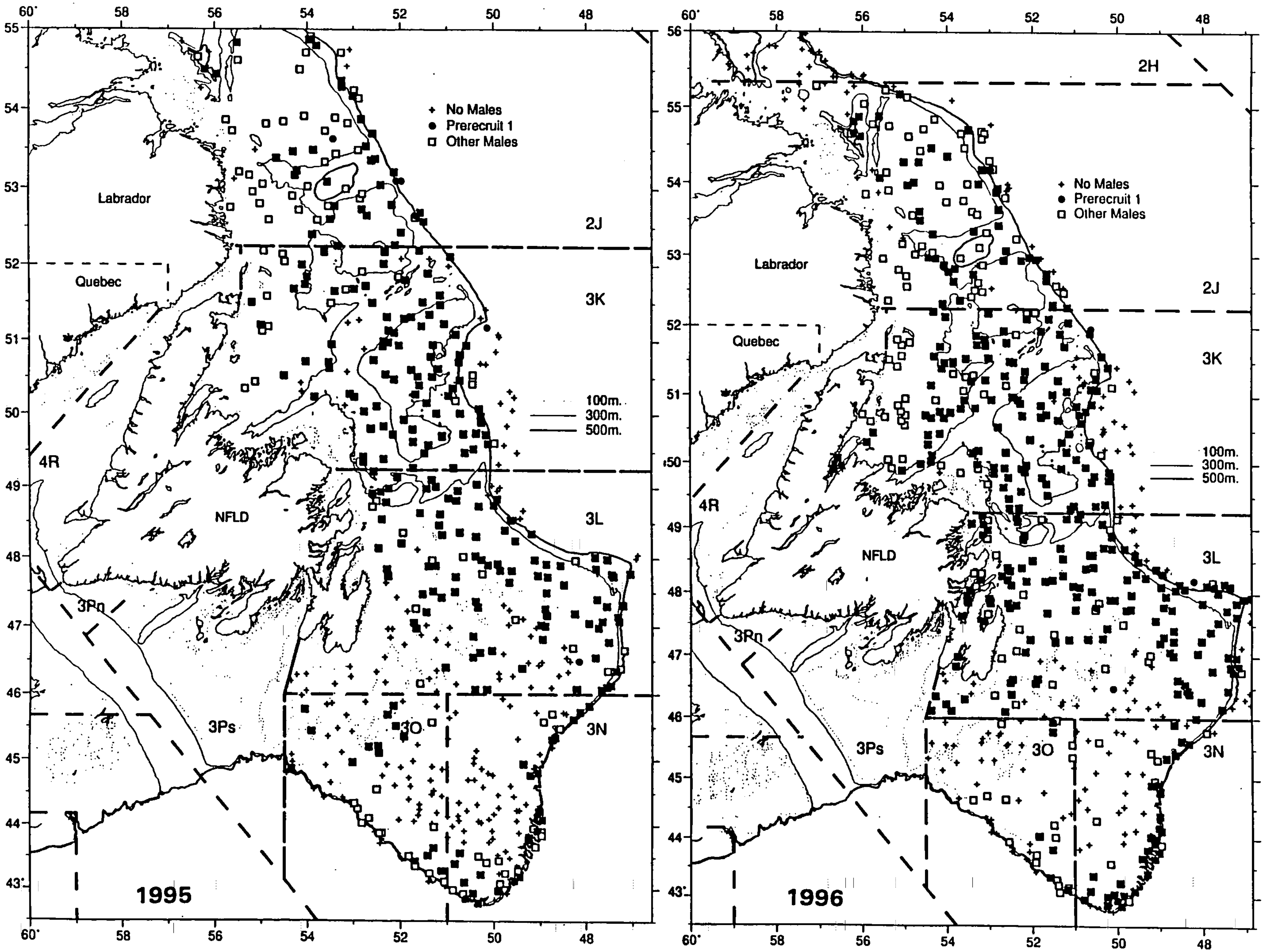

Fig. 8. Spatial distribution of those sets where Prerecruit 1 crabs were caught in relation to sets which caught other males or no males, by year.

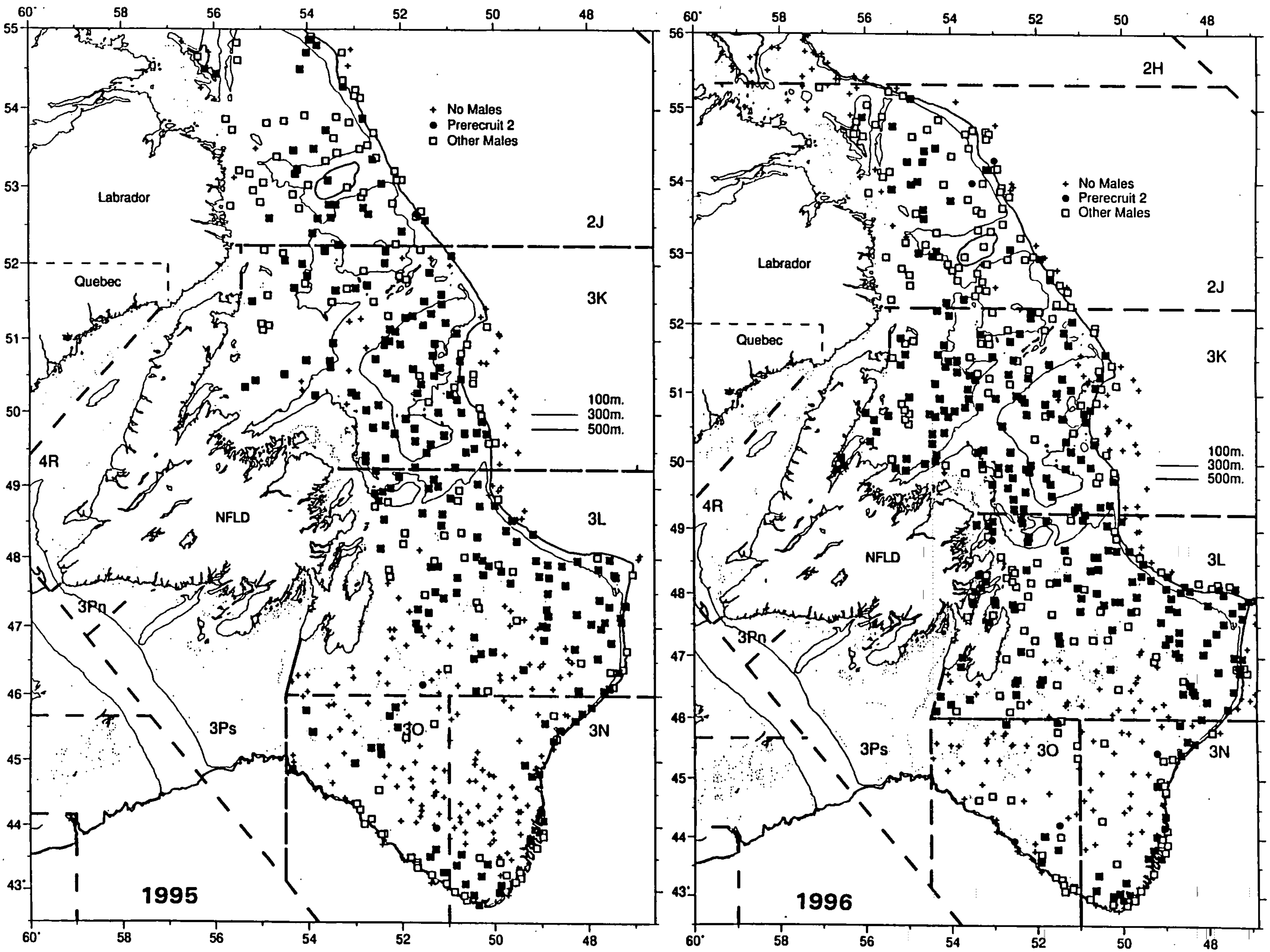

Fig. 9. Spatial distribution of those sets where Prerecruit 2 crabs were caught in relation to sets which caught other males or no males, by year.

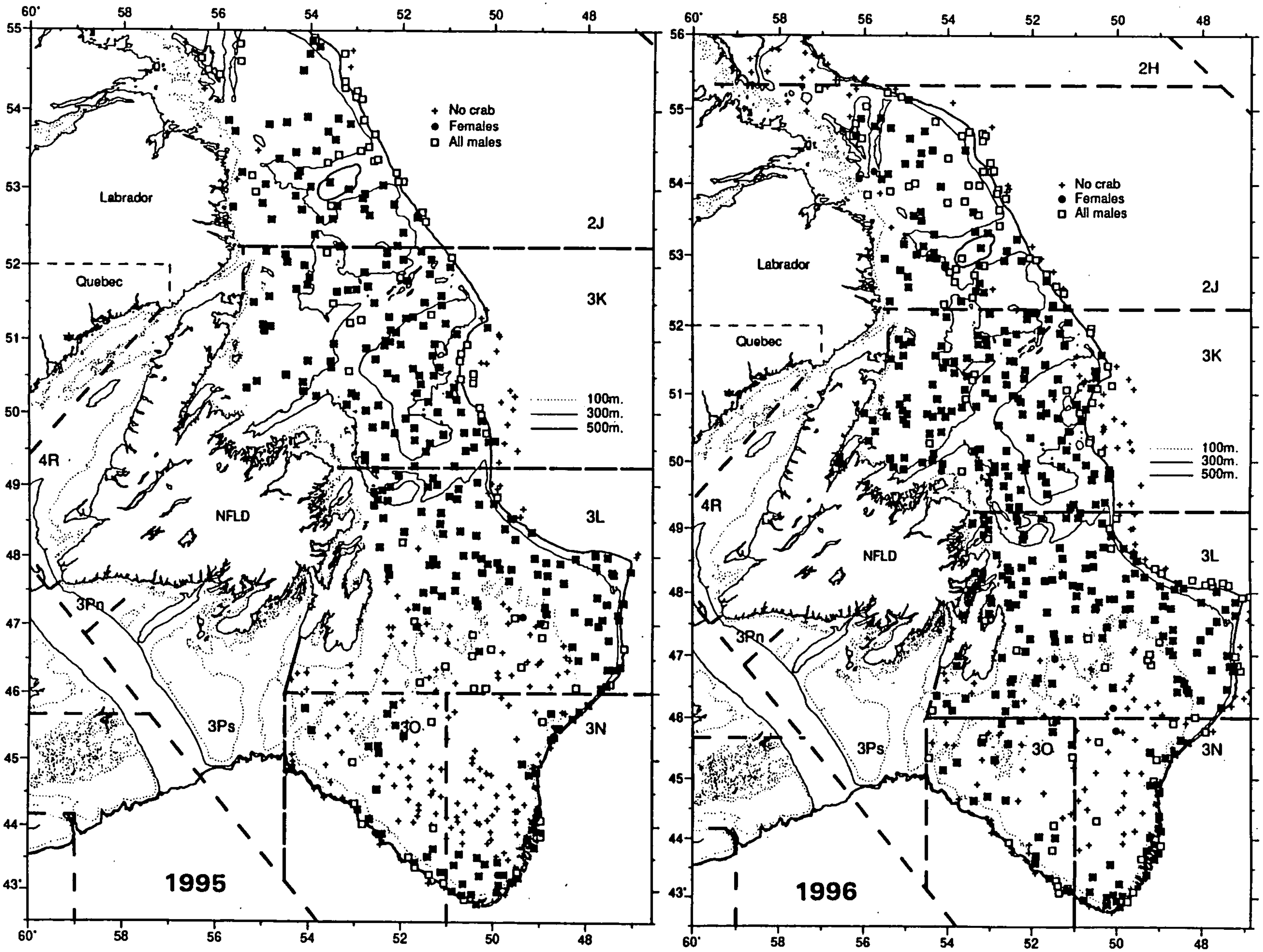

Fig. 10. Spatial distribution of those sets where female crabs were caught in relation to sets which caught males and no crabs at all, by year.

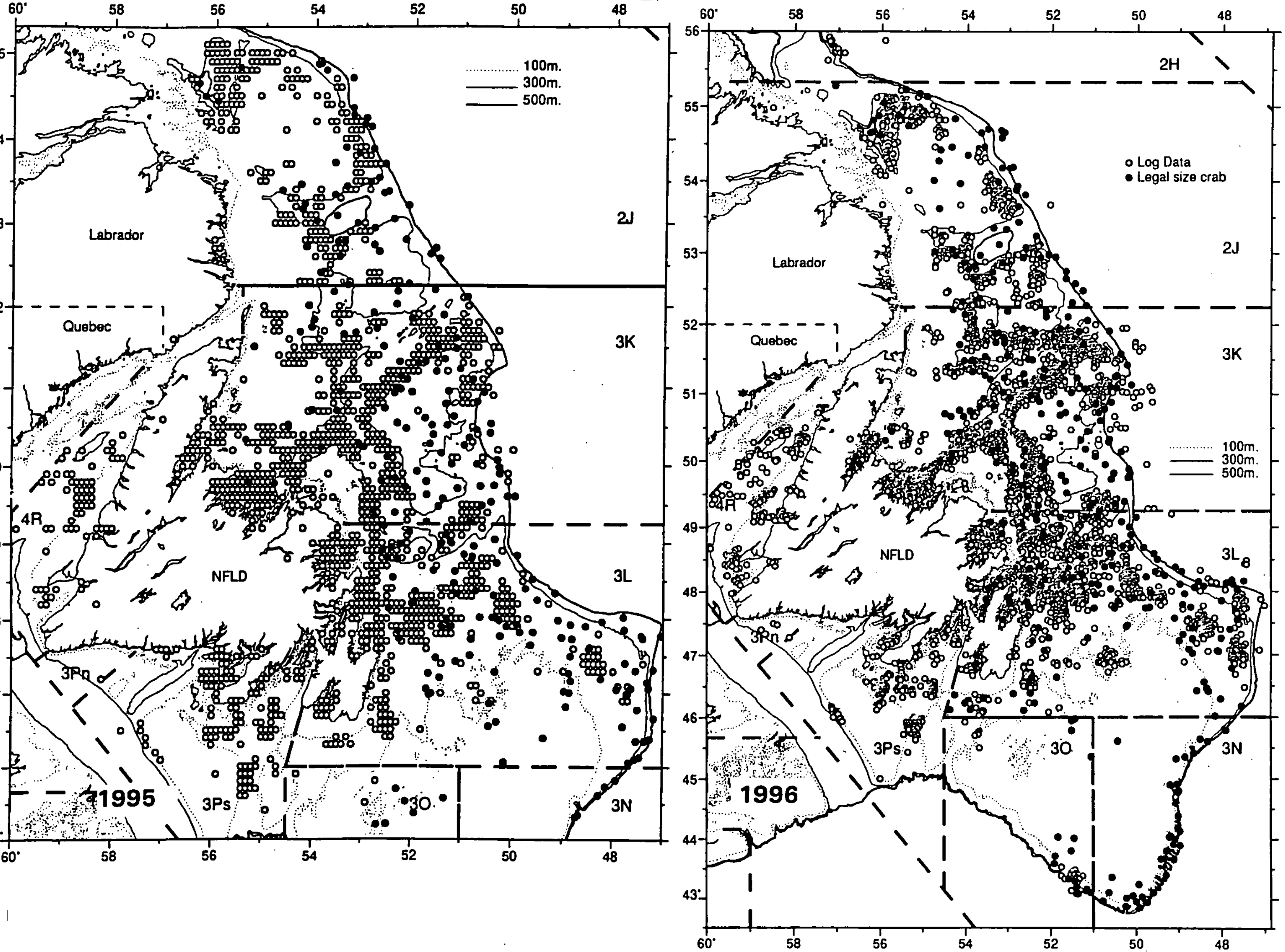

Fig. 11. Spatial distribution of those sets where legal-sized crabs were caught in fall bottom trawl surveys in relation to the spatial distribution of commercial fishing effort, by year.

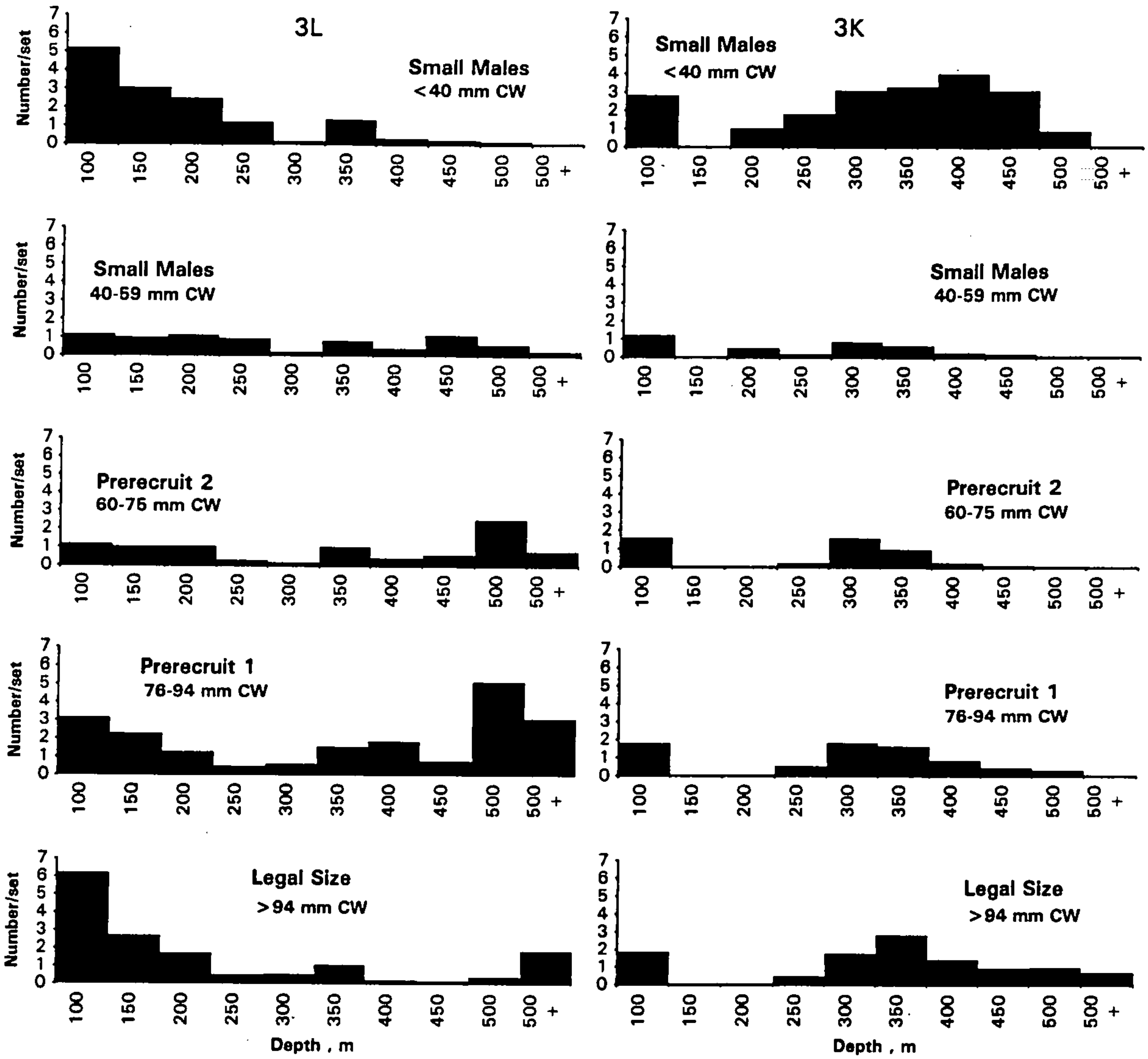

Fig. 12. Distribution of 5 size groups of males by depth interval for Div. 3L and 3K, from the 1996 fall bottom trawl survey.

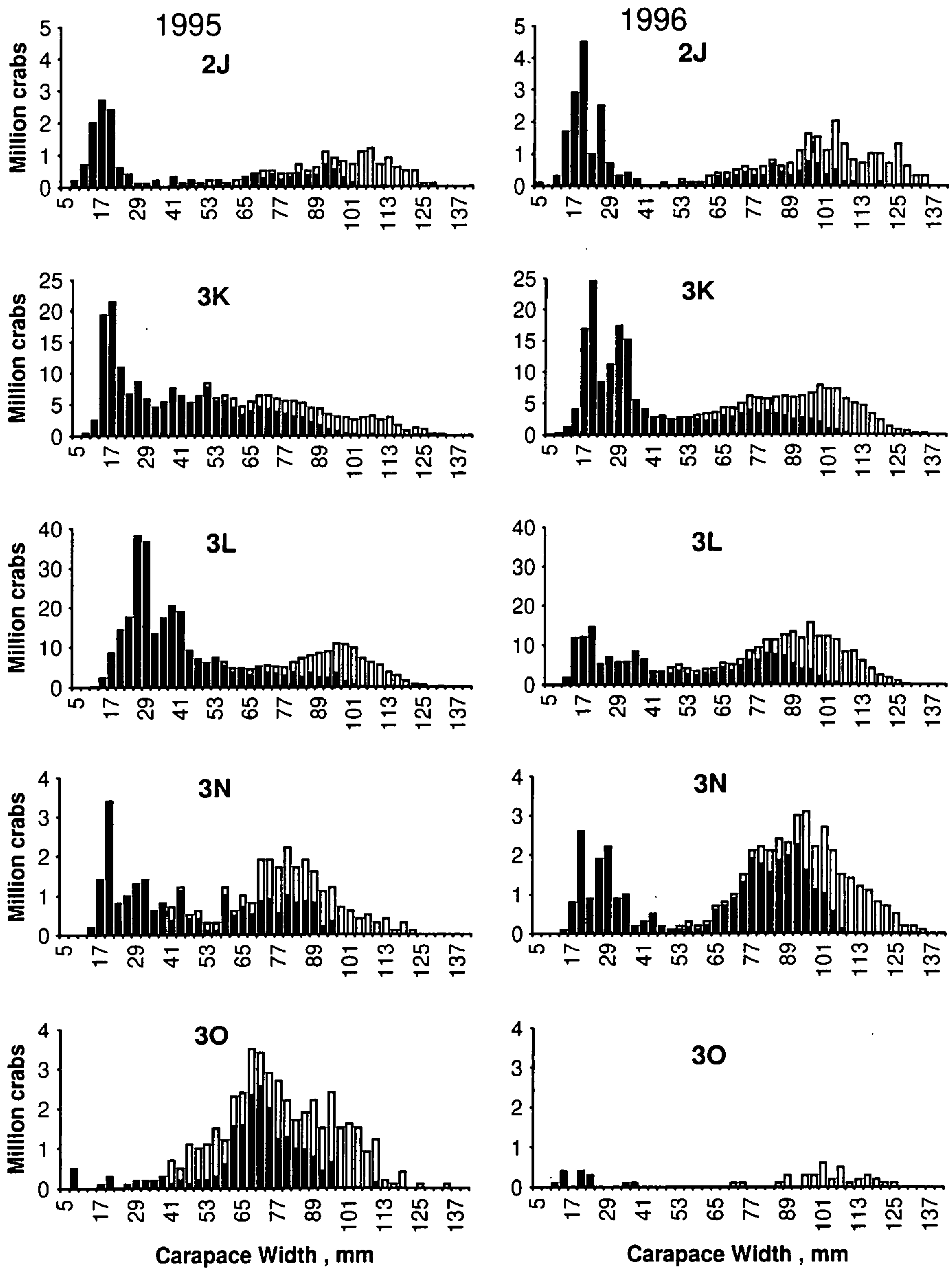

Fig. 13. Size distributions adjusted up to total population abundance from fall bottom trawl surveys by Division, year and chela allometry (small-clawed as dark bars and large-clawed as open bars).

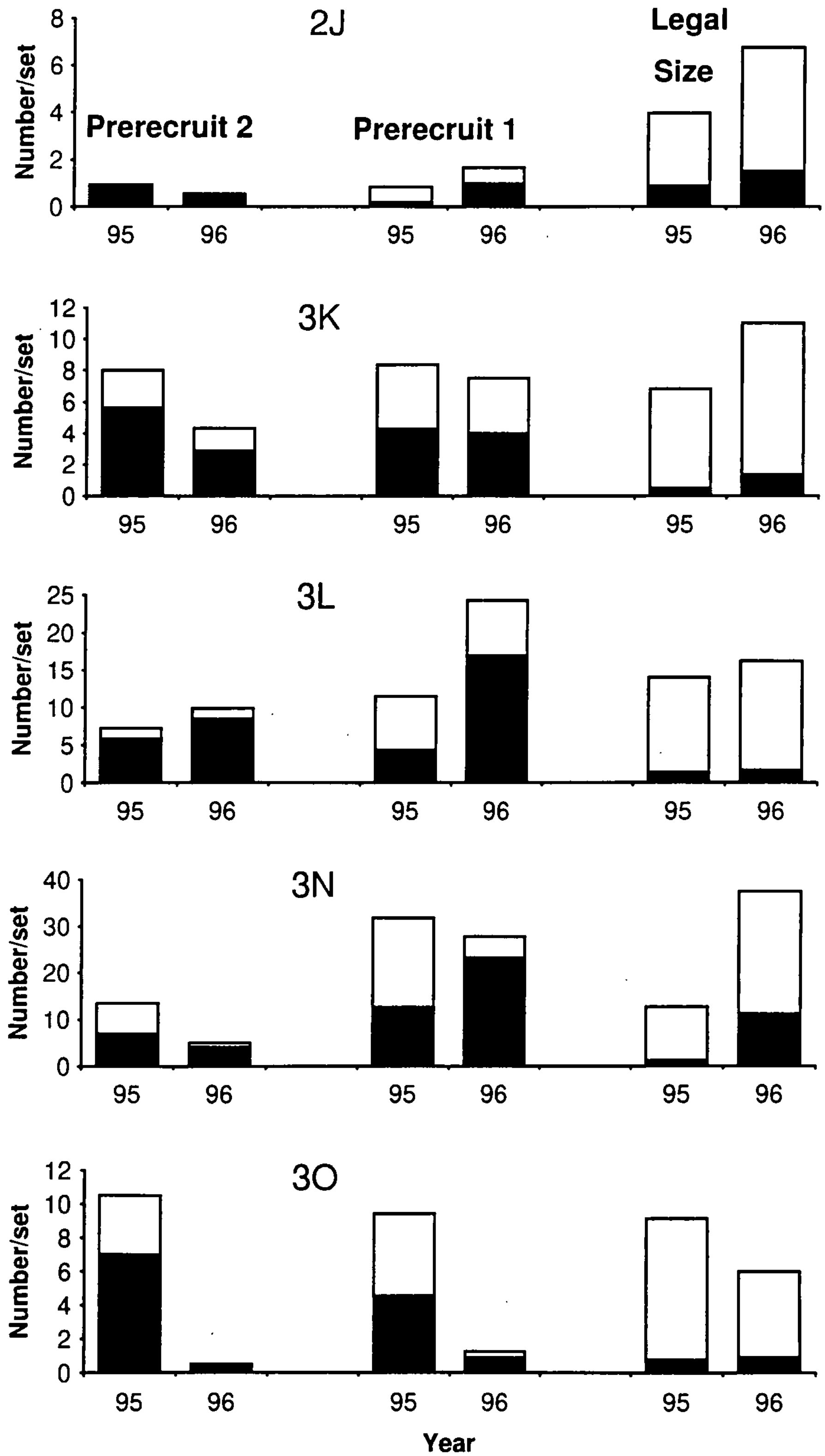

Fig. 14. Yearly comparison of fall bottom trawl survey catch rates (based on only those sets which caught crabs) for the three size groups of largest males by Division and chela allometry (small-clawed as dark bars and large-clawed as open bars).