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Status of Newfoundland and Labrador Snow Crab

by

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Abstract

Data on catch rate, size (carapace width, CW) and molt status (chela allometry) from various sources were presented and used to infer resource status. Trap survey data from commercial grounds in each of three management areas in NAFO Div. 3L were available since the early 1980's, based on sampling with both large-meshed (commercial) traps and small-meshed traps. A model was developed for each area which uses the survey catch rate of legal-sized crabs (including 'soft' crabs) to provide an indication of the commercial catch rate in the following year. The commercial catch rates in all three areas remained high in 1995, as had been predicted from the 1994 surveys. For both trap types, the 1995 survey catch rates indicated that commercial catch rates should generally remain high in Div. 3L in 1996. The survey catch rates of two size groups of prerecruit crabs have been declining over the past 3-4 years especially for small-clawed crabs (which will continue to molt and may begin to recruit in 2-3 years). This suggests that recruitment is declining in Div. 3L. Data from Div. 3K trap surveys, in area 3B (White Bay) in 1994 and 1995 showed no clear difference between years in the catch rates of legal-sized or prerecruit crabs.

Data from the fall NAFO Div. 2J3KLNO bottom trawl survey agreed with those from the trap surveys, for Div. 3L, in suggesting that abundance of prerecruits, relative to that of legal-sized crabs, was low in that division. The trawl data also suggested that crab abundance was low in Div. 2J and 3K. Abundance of prerecruits appeared to be particularly high in virtually unexploited Div. 3N. First estimates of minimum trawlable biomass were generated using STRAP, recognizing that the catchability of the survey trawl for snow crab is unknown. Legal-sized crabs were not caught in deepest trawl sets on the Div. 3KL slope or in shallow areas near the Labrador coast (Div. 2J) and on the Grand Bank (Div. 3LNO). Prerecruit and female crabs extended into shallower areas than did commercial crabs.

Data from sampling by observers aboard commercial vessels were presented for 1994 and 1995. Comparison between years was hampered by yearly differences in distribution of sampling effort by trap type among management areas. However it appeared that catch rates were lowest in Labrador and on the West Coast of the Island.

Résumé

Des données sur le taux de capture, la taille (largeur de carapace, LC) et la mue (allométrie des chélipèdes) obtenues de diverses sources ont été présentées et utilisées pour en déduire l'état de la ressource. Des données de relevés par casiers des fonds commerciaux dans chacune des trois zones de gestion de la division 3L de l'OPANO sont obtenues depuis le début des années 1980 et reposent sur des échantillonnages par casiers à grand maillage (pêche commerciale) et à petit maillage. Un modèle a été élaboré pour chacune des zones en utilisant les taux de capture des relevés de crabes de taille légale (y compris les crabes «mous») afin d'obtenir un indice du taux de capture commercial au cours de l'année suivante. Les taux de capture commerciaux sont demeurés élevés dans les trois zones en 1995, tel que prévu par les relevés de 1994. Pour les deux types de casiers, les taux de capture du relevé de 1995 indiquaient le maintien de taux de capture commerciaux généralement élevés en 1996 dans la division 3L. Les taux de capture des relevés de deux groupes de taille de crabes au stade du prérecrutement ont décliné au cours des 3 ou 4 dernières années, notamment ceux des crabes à petites pinces (qui continueront de muer et commenceront à être recrutés d'ici 2 ou trois ans). Cela porte à croire à une baisse du recrutement en 3L. Les relevés aux casiers dans la division 3K, dans la zone 3B (baie White), en 1994 et 1995 ne montrent pas d'écart interannuel apparent entre les taux de capture des crabes de taille légale ou au stade du prérecrutement.

Les données du relevé d'automne au chalut de fond dans les divisions 2J3KLNO de l'OPANO concordent avec celles des relevés aux casiers de la division 3L, et portent à croire que l'abondance des prérecrues, par rapport à celle des crabes de taille légale, était faible dans cette division. Les données du chalutage portent aussi à croire à une abondance faible en 2J et 3K. Les prérecrues semblaient particulièrement abondantes dans la division 3N, pratiquement inexploitée. Des estimations préliminaires de la biomasse chalutable minimum ont été obtenues par modèle STRAP, car la vulnérabilité du crabe des neiges au chalut des relevés est inconnue. Des crabes de taille légale n'ont pas été capturés aux plus grandes profondeurs chalutées dans la pente des divisions 3KL ni dans les zones peu profondes de la côte du Labrador (2J) ou sur le Grand Banc (3LNO). Les prérecrues et les femelles étaient plus présentes que les crabes de taille commerciale dans les eaux peu profondes.

Les données d'échantillonnage des observateurs se trouvant à bord des bateaux de pêche commerciale ont été présentées pour 1994 et 1995. La possibilité d'effectuer des comparaisons interannuelles se voit réduite par l'existence d'écarts annuels de la distribution de l'effort de pêche par type de casiers dans les zones de gestion. Les taux de capture les plus faibles ont cependant été notés dans les eaux du Labrador et de la côte ouest de l'île.

Introduction

This document presents research data from various sources toward evaluating the status of the Newfoundland and Labrador snow crab resource in 1995 and projecting fishery performance in 1996. Data sources include time series research trap surveys in three crab management areas in NAFO Div. 3L. Data are also presented for the first time from a post-fishery trap survey in White Bay (NAFO Div. 3K) during 1994 and 1995 and from sampling by observers from the commercial fishery in many areas during those years. Data collected during the autumn-winter 1995-96 bottom trawl survey throughout NAFO Div. 2J3KLNO are also utilized.

Methods

Trap Surveys in NAFO Div. 3L

Survey methodology:

Trapping 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 assign crabs to one or 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); 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 50 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 ($CH = 0.0806CW^{1.999}$) was applied to classify each individual as either large-clawed or small-clawed. Data on chela height were available only since 1988.

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 (60-85 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.

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 and 1995 in White Bay (management area 3B, Fig. 1). In the first year sampling was limited to depths of 183 m and greater. A second, shallower stratum (73-182 m) was sampled in the second (1995) survey to investigate the possibility of refugia for juveniles. However those shallower sets will be included in yearly comparisons. Data considered here are from 40 sets in 1994 and 41 sets in 1995.

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 included 2 large-meshed traps, one small-meshed trap and one large-meshed trap equipped with a small-mesh cover. Sets were randomly allocated throughout each of the two depth strata.

Data Collected:

All males were measured in carapace width (mm) and chela height (0.1 mm). Shell condition was assigned one of two categories; new-shelled and old hard-shelled. New-shelled crabs are those which had molted in spring and would represent recruitment to the upcoming fishery, in the following year.

Data Treatment:

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 1994 and 1995 catch rates. Each component was further partitioned into small-clawed and large-clawed sub-groups.

Sampling from the Fishery

Observers sampled trap catches from the commercial fishery before culling in multiple crab management areas during 1994 and 1995 (Table 2). During both years they sampled from commercial traps as well as research traps, deployed with the collaboration of fishermen. Research traps were standard small-meshed traps in 1994, whereas in 1995 they were commercial traps equipped with small-meshed covers (Table 2).

The total catch of each trap was sampled for carapace width. Chela height was determined for total catches or subsamples. Data were summarized by size group and chela allometry (large-clawed versus small-clawed) for comparison of 1994 and 1995 catch rates.

Bottom Trawl Survey

Data Collected:

Data on total catch number and weight were acquired from the autumn-winter stratified random bottom trawl survey which extended from NAFO Div. 2J to 3NO. For most sets, using the Campellen trawl, crabs were sampled (or subsampled) for CW, shell condition (based on Miller and O'Keefe 1979) and chela height.

Data Treatment

Spatial distributions were plotted separately for all crabs (both sexes), all males, and legal-sized males. 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 (ie. all crabs, all males, and legal-sized males. Minimum trawlable biomass was estimated by NAFO Division using the STRAP program (Smith and Somerton 1981). The catchability of the survey trawl for snow crab is unknown.

Carapace widths were grouped into 3 mm intervals and expressed as number per set for comparison among NAFO Divisions. Each size interval was partitioned into small-clawed and large-clawed components. Those crabs ≥ 60 mm CW were also grouped by size category (i.e. legal-size, Prerecruit 1 and Prerecruit 2) and well as claw type for comparison with trap survey data.

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 50-54% of the variation. In contrast, the model, when applied to the small-meshed trap data sets, accounted for 62-81% of the variation (Fig. 4). In both cases, the unexplained variation would likely be due to various sources, including annual variation in methodological factors (eg. sampling 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 has been assumed that they would provide the best predictor of fishery performance (Xu et al. 1992). Furthermore, 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, applied to both trap types, was first used to predict fishery performance for 1995 (Fig. 3-4). For both gear types, the survey catch rate index generally predicted that 1995 catch rates would be comparable to the high catch rates observed during the most recent 2-3 years. The index based on small-meshed trap data predicted record high 1995 catch rates for two of the three areas, Bonavista Bay and Northeast Avalon (Fig. 4).

Fishery performance realized in 1995, when compared to that predicted from both trap types, was comparable for Bonavista Bay, higher for Conception Bay, and lower for Northeast Avalon. Overall, however, commercial CPUE remained high and generally similar to that of the previous two years. This agreed with high CPUE observed throughout Div. 3L in the 1995 fishery (Taylor and O'Keefe, in prep.).

Catch rates from the 1995 surveys indicate that fishery performance for 1996 in Div. 3L should remain at a high level, particularly for Conception Bay and the Northeast Avalon. Record high CPUE is again projected for the Northeast Avalon.

Future refinement of this model 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. Also, survey timing in relation to the fishery has varied considerably within and among areas. Therefore survey catch rates will have to be adjusted for effects of fishery removals within the same year.

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. 5). Although 1995 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 year or two 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 1994 and 1995 (Fig. 6). 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 may not represent good samplers for small-clawed crabs. 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). It is not known whether the catch rate of skip-molters provides an indicator of the abundance of all small-clawed crabs for any size group.

Comparison of catch rates of the Prerecruit 1 size group with indices for legal-sized crabs (Fig. 7) suggests that they were directly related until 1991-92. This is reasonable since these size groups are not necessarily distinct cohorts and annual changes in catchability could affect both groups similarly. However the recent steady decline of Prerecruit 1 catch rates during a period of high commercial crab abundance suggests that current low catch rates of small crabs may in part reflect reduced catchability due to behavioral interactions. Small-clawed males may be especially subject to such effects. This type of relationship may also exist between Prerecruit 2 (60-75 mm CW) and commercial crabs (Fig. 8).

Trap Surveys in NAFO Div. 3K

The catch rate of legal-sized crabs from large-meshed traps was higher in 1995 than in 1994 agreeing with the CPUE trend, whereas the reverse was true for small-meshed and covered traps (Fig. 9). This difference between trap types was also evident for Prerecruit 1 crabs. For both groups however catch rates were generally similar between years. Survey catch rates of Prerecruit 2 crabs, including those with small claws, were clearly higher in 1995 than in 1994 for all three trap types, but especially for traps with small-meshed covers.

Data from the Commercial Fishery

Comparison of years is difficult because the efficiency of small-meshed traps used by observers in 1994 may differ from that of commercial traps with small-meshed covers, used in 1995. Only large-meshed traps were regularly sampled in both years and sampling effort was low for most areas (Table 2). Overall, however, there was no striking difference in catch rates between years for legal-sized crabs (Fig. 10) or Prerecruit 1 crabs (Fig. 11). It appeared that catch rates were generally lowest in northern and western zones.

Bottom Trawl Survey

Legal-sized crabs were broadly distributed throughout the Div. 2J3KLNO survey area (Fig. 12) but were notably absent from deepest sets (mostly >500 m) along the Div. 3KL slope. They were also usually absent from innermost sets <300 m in Div. 2J3K and the shallow (mostly <100 m) southern Grand Bank. The presence of legal-sized crabs on the tail of the Bank contrasts with their absence along the southwest slope. This is probably related to the local oceanographic regime. The distribution of females and sub-legal sized males extended into the inner area of Div. 2J3K, where legal-sized males were seldom encountered (Fig. 13). They were also present at some of those sets where no legal-sized males were caught near the 100 m isobath on the Grand Bank.

Fishing effort was patchily distributed (Fig. 14). It was concentrated in bays, showed some association with the 300 m isobath in offshore Div. 2J3K and was within 100-300 m bottom depths in shallower offshore Div. 3LNOPs. There were extensive areas of the outer Div. 3KL shelf, where the survey had encountered legal-sized crabs, in which little fishing effort was expended (Fig. 14).

Estimates of minimum trawlable biomass are interpreted qualitatively because the catchability of the survey trawl for snow crab is unknown and because areas within bays are not included in the 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 3). This appears to be true for the total population, for all males, and for legal-sized males. Only for Divs. 2J and 3L did legal-sized males represent more than half of the total biomass.

Size frequency distributions differed considerably among NAFO divisions (Fig. 15). They indicated that catch rates were lowest for most sizes (including legal-sized) in Div. 2J3K. In Div. 3L catch rates of legal-sized crabs were high relative to those of the Prerecruit size groups (60-94 mm CW). However in Div. 3L very small crab (14-43 mm CW), also prominent in Div. 2J and 3N, had highest catch rates. Highest catch rates in Div. 3N were for Prerecruit 1 crabs and in Div. 3O were for Prerecruit 2 crabs.

Comparison of Trap and Trawl Survey Data

Comparison of catch rates by size group between trap and trawl surveys in NAFO Div. 3L and 3K shows that the proportion of small-clawed crabs in each size group was considerably higher in trawled samples than in trapped samples (Fig. 16). This supports the contention that traps do not efficiently sample small-clawed crabs. Although it is not valid to compare trap survey catch rates among areas because of seasonal and methodological differences, certain general features are apparent. Most apparent is that the trawl and trap data from Div. 3L consistently show higher catch rates of legal-sized males than of Prerecruit 1's. In contrast, the catch rates of legal-sized males from both trawled and trapped samples were much lower in Div. 3K and were similar to those of Prerecruit 1's. This supports the belief that abundance of commercial crabs has begun to decline in northern areas, as suggested by the decline in commercial CPUE observed in Div. 3K, as well as Div. 2J, over the past two years (Taylor and O'Keefe, in prep.).

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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
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

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

* Indicates period of, and landings from, supplementary as opposed to full-time fisheries.

Table 2. Summary of number of trap hauls by observers during the commercial fishery in 1994 and 1995.

Management area	Large-meshed 1994	Large-meshed 1995	Small-meshed 1994	Covered 1995
2JS	6	12	4	11
2JN	2			
3A		1		
3B		2		2
3C	3	1	4	1
3D	6		2	
4	120	68	20	39
6C	18	3	6	14
7A		4		
7B	39	69	11	21
7C		10	1	2
8B	17		4	
5B1	17	6	21	
5B2	11	6		
3Kg		6		2
3Kc	1	7	3	6
3K6	1	5	1	
7X		5		
10X	23			
40		138		12
41		14		
42		6		
45		15		
51	52			
52	18			
53	12			

Table 3. Minimum trawlable biomass estimates from the 1995 fall bottom trawl survey by NAFO Division for all males, commercial males and all crab (both sexes).

NAFO Div.	Biomass (t)	95% confidence limts Lower	Upper	Mean kg/set
Legal-size males				
2J	2,483	1,234	3,734	1.4
3K	12,577	9,425	15,729	3.1
3L	26,559	18,464	34,653	5.5
3N	2,404	1,115	3,693	1.4
3O	1,506	178	283	0.9
All males				
2J	3,662	2,383	4,940	1.9
3K	28,259	23,361	33,157	6.9
3L	44,111	33,238	54,984	9.1
3N	6,346	464	12,228	3.6
3O	4,089	1,106	7,073	2.4
All crab (males and females)				
2J	3,902	2,674	5,131	2.1
3K	33,004	27,740	38,268	8.0
3L	47,128	37,588	56,669	9.7
3N	6,131	2,452	9,810	3.5
3O	6,813	1,555	12,072	4.0

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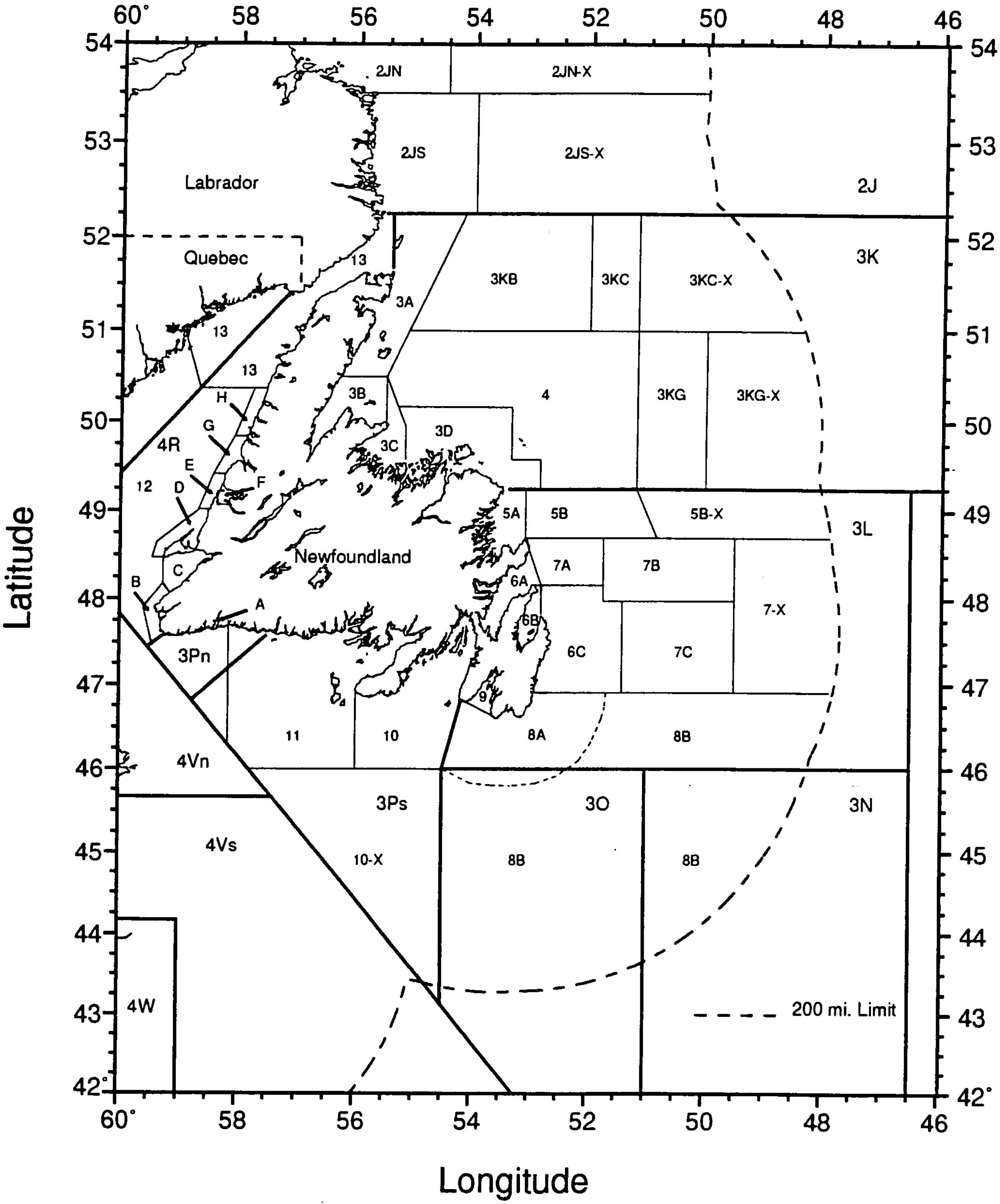


Fig. 1. Snow crab management areas.

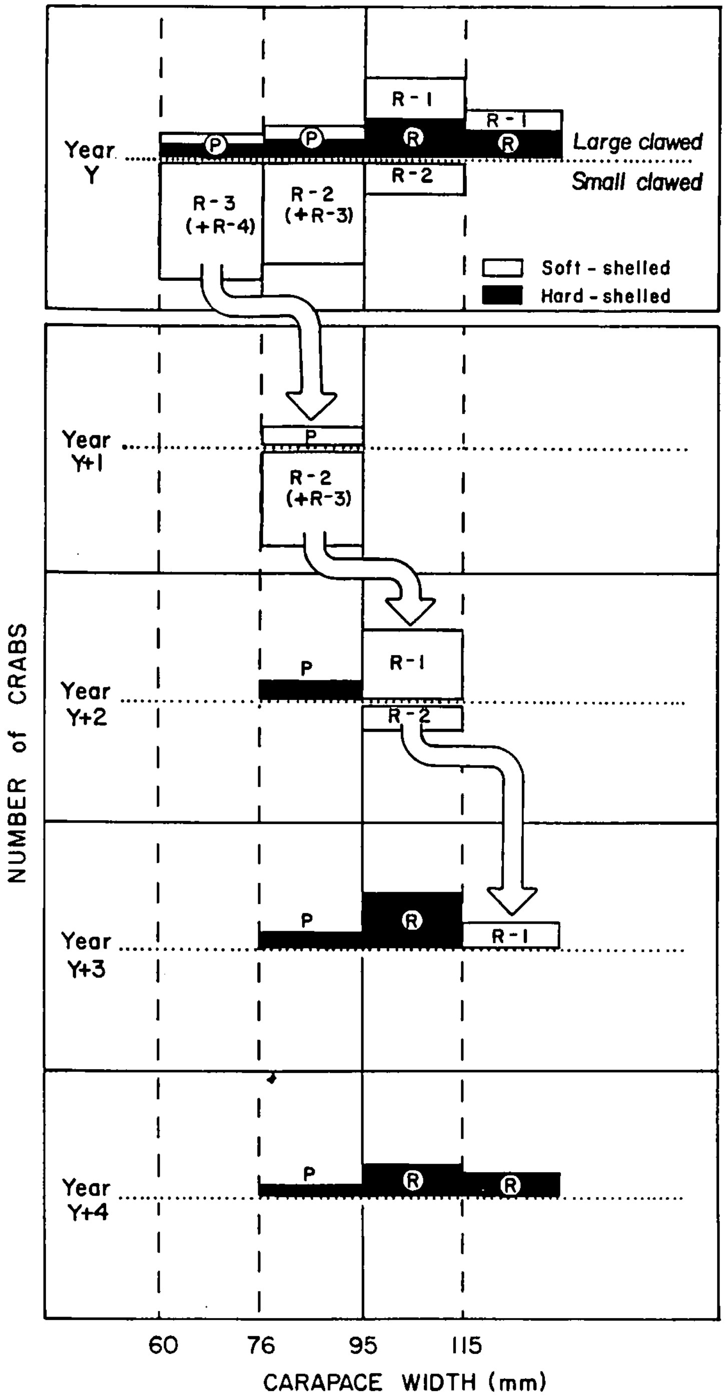


Fig. 2. Schematic representation of snow crab population components relevant to recruitment for males ≥60 mm CW (top panel) and depiction of the recruitment process for the molt class of smallest (60-74 mm CW) crabs with small claws (all panels). Arrows represent molting. 'P' represents 'Pygmy' crabs - 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.

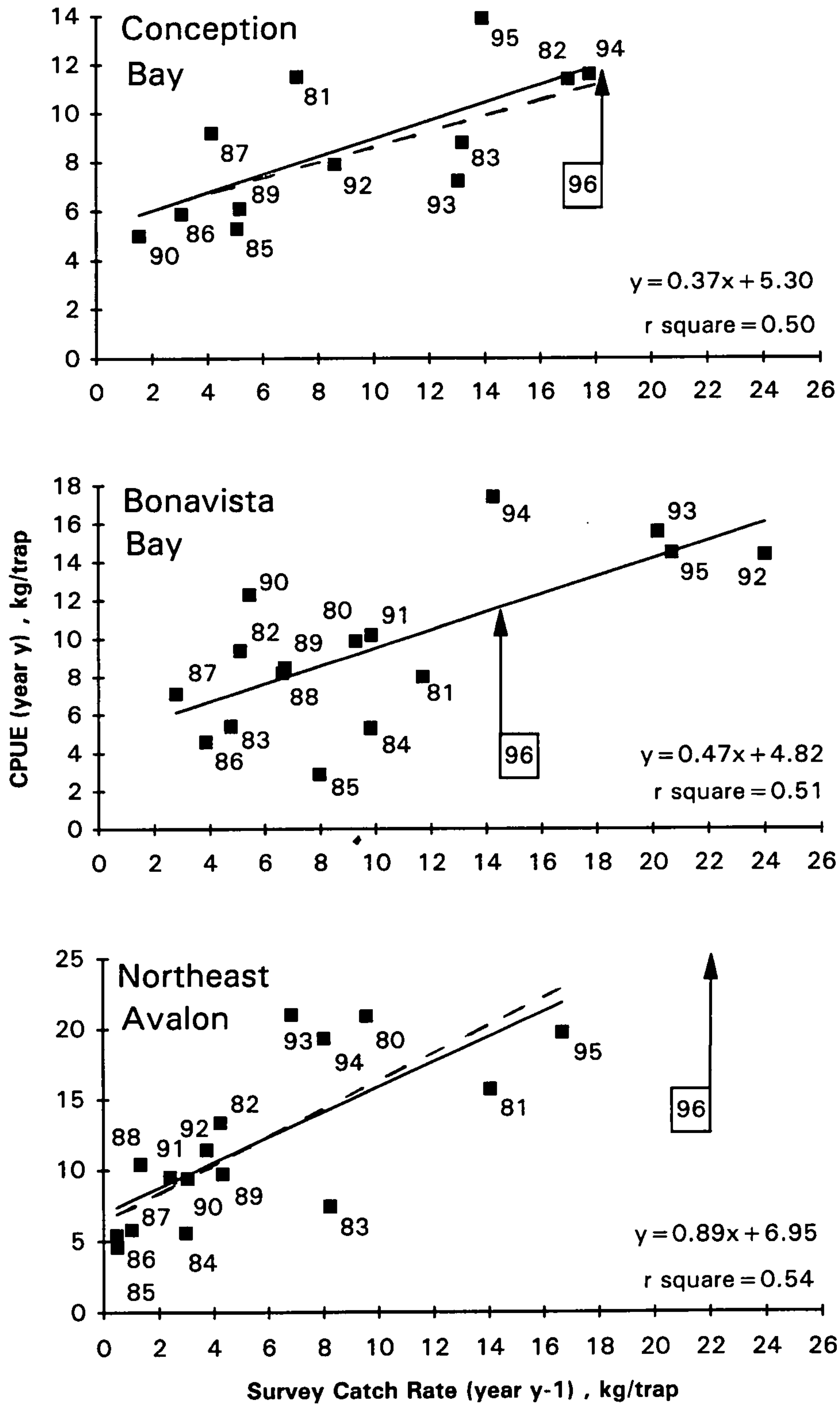


Fig. 3. Relationship of commercial CPUE in any year to the survey catch rate of legal-sized crabs from large-meshed traps in the previous year, by survey area. Dashed lines represent regressions which did not include 1995 data. Arrows show projected CPUE's for 1996.

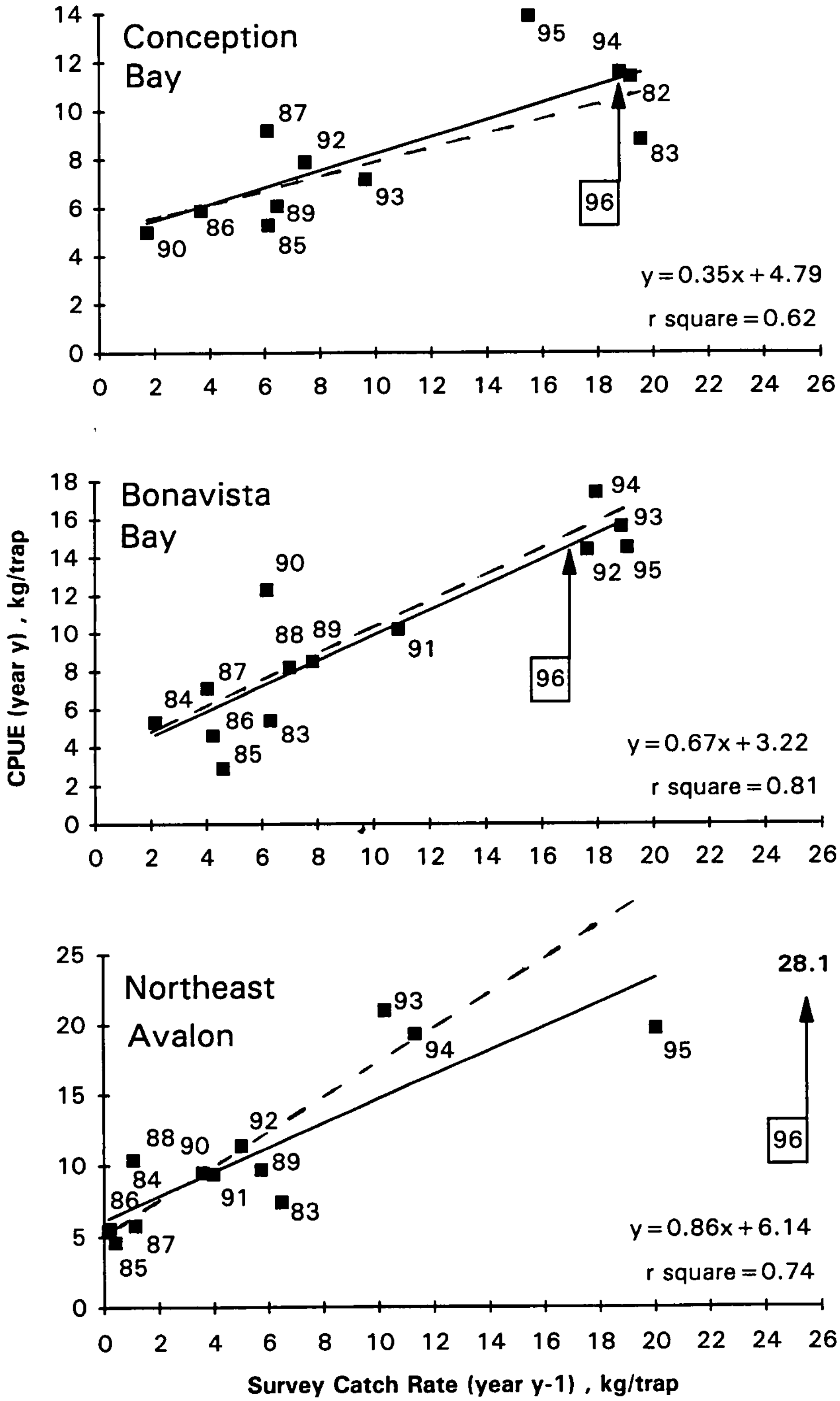


Fig. 4. Relationship of commercial CPUE in any year to the survey catch rate of legal-sized crabs from small-meshed traps in the previous year, by survey area. Dashed lines represent regressions which did not include 1995 data. Arrows show projected CPUE's for 1996.

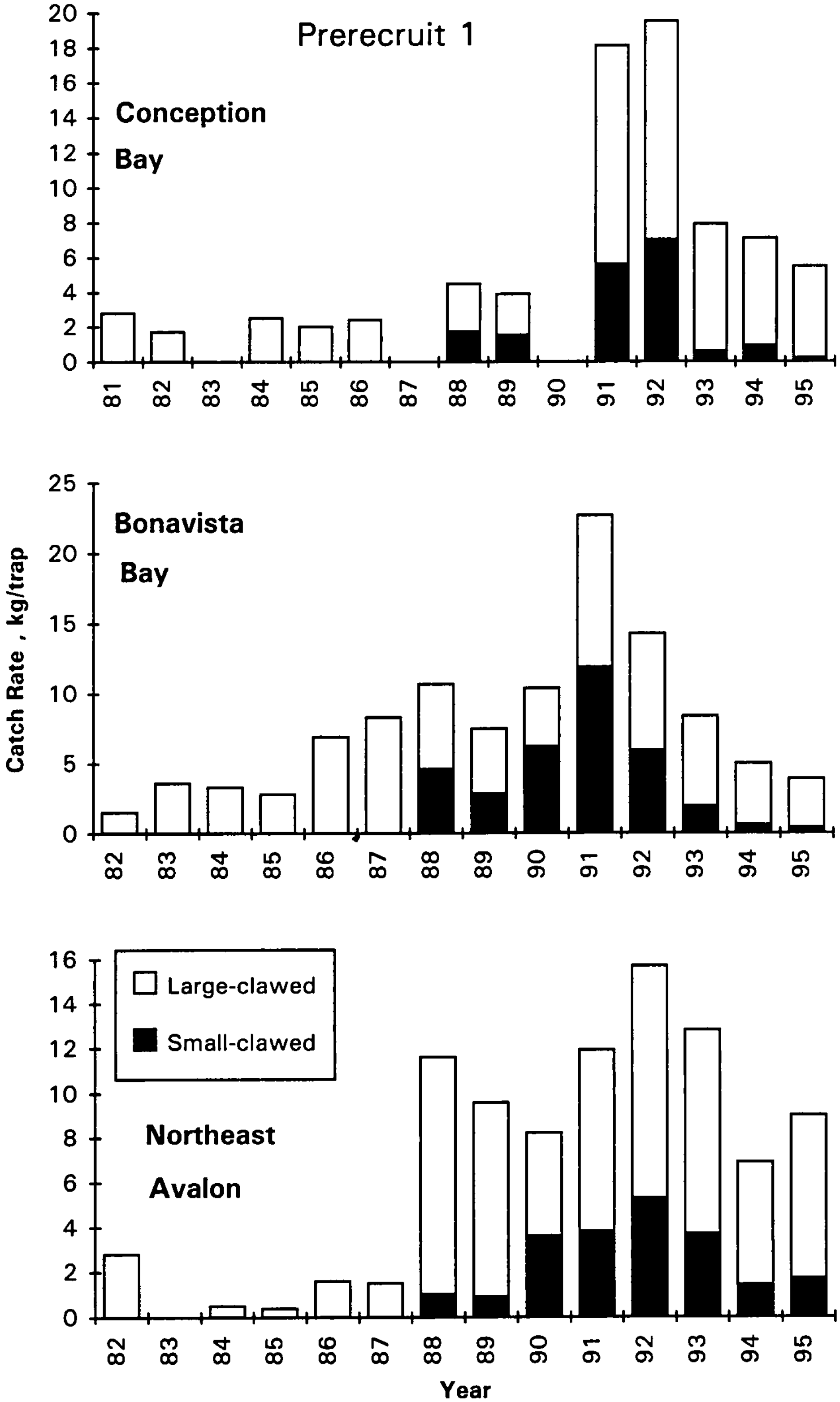


Fig. 5. Yearly trends in survey catch rate of Prerecruit 1 crabs (76-94 mm CW) from small-meshed traps, by survey area. Catch rates are partitioned by chela morphometry since 1987 (dark area represents small-clawed crabs).

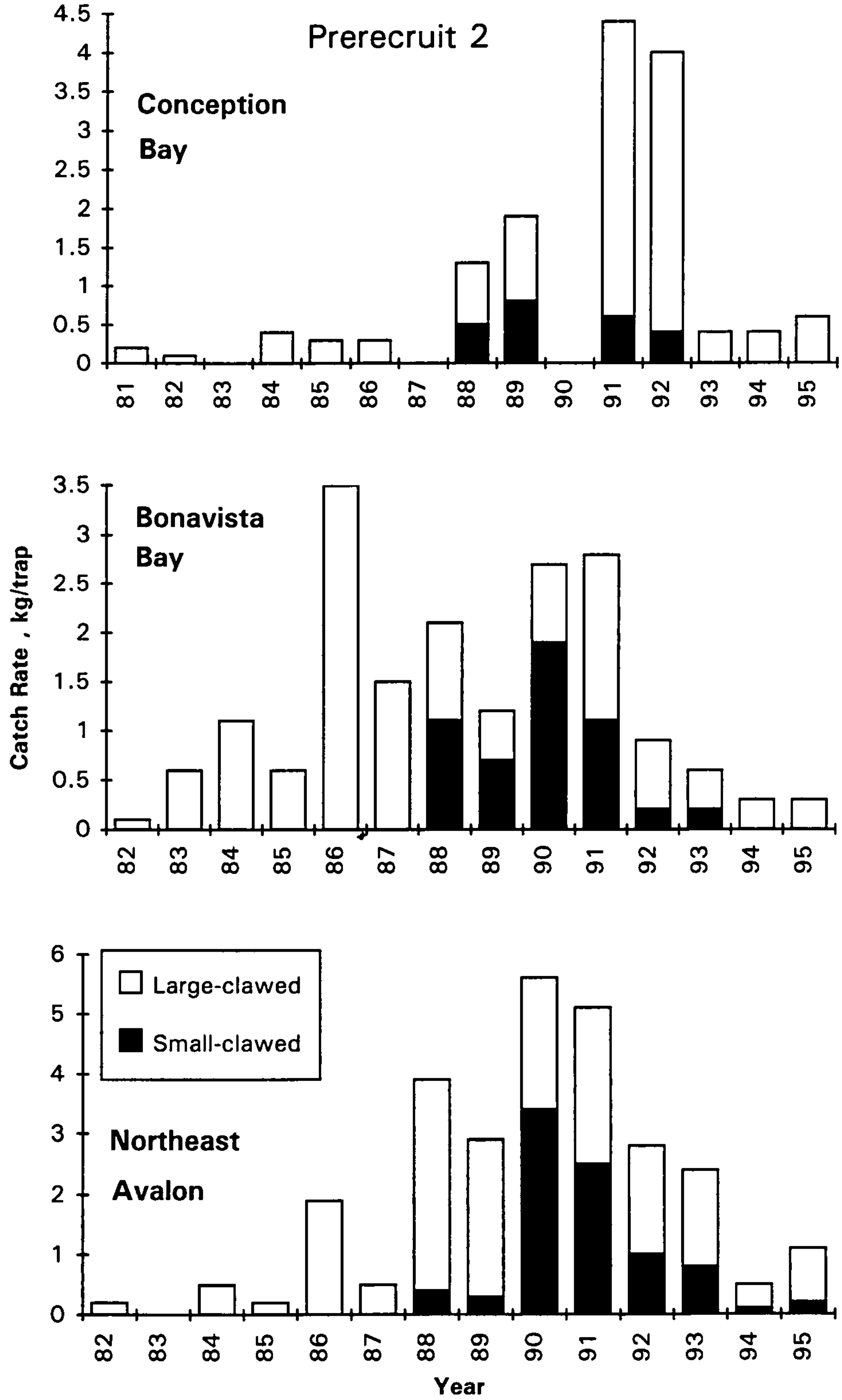


Fig. 6. Yearly trends in survey catch rate of Prerecruit 2 crabs (60-75 mm CW) from small-meshed traps, by survey area. Catch rates are partitioned by chela morphometry since 1987 (dark area represents small-clawed crabs).

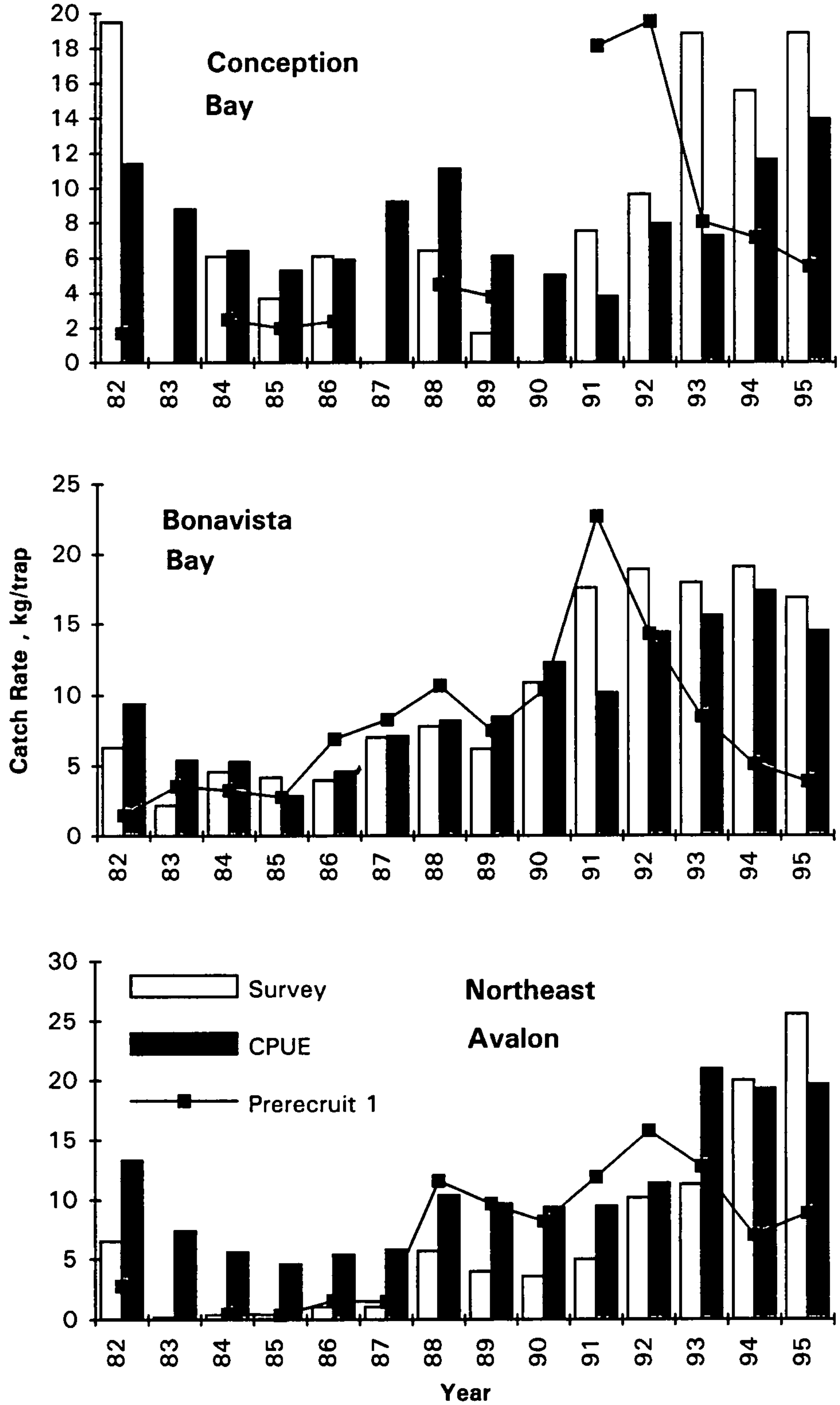


Fig. 7. Comparison of yearly trends in indices of standing stock based on research surveys (survey) and the commercial fishery (CPUE) with the survey index for the Prerecruit 1 size group.

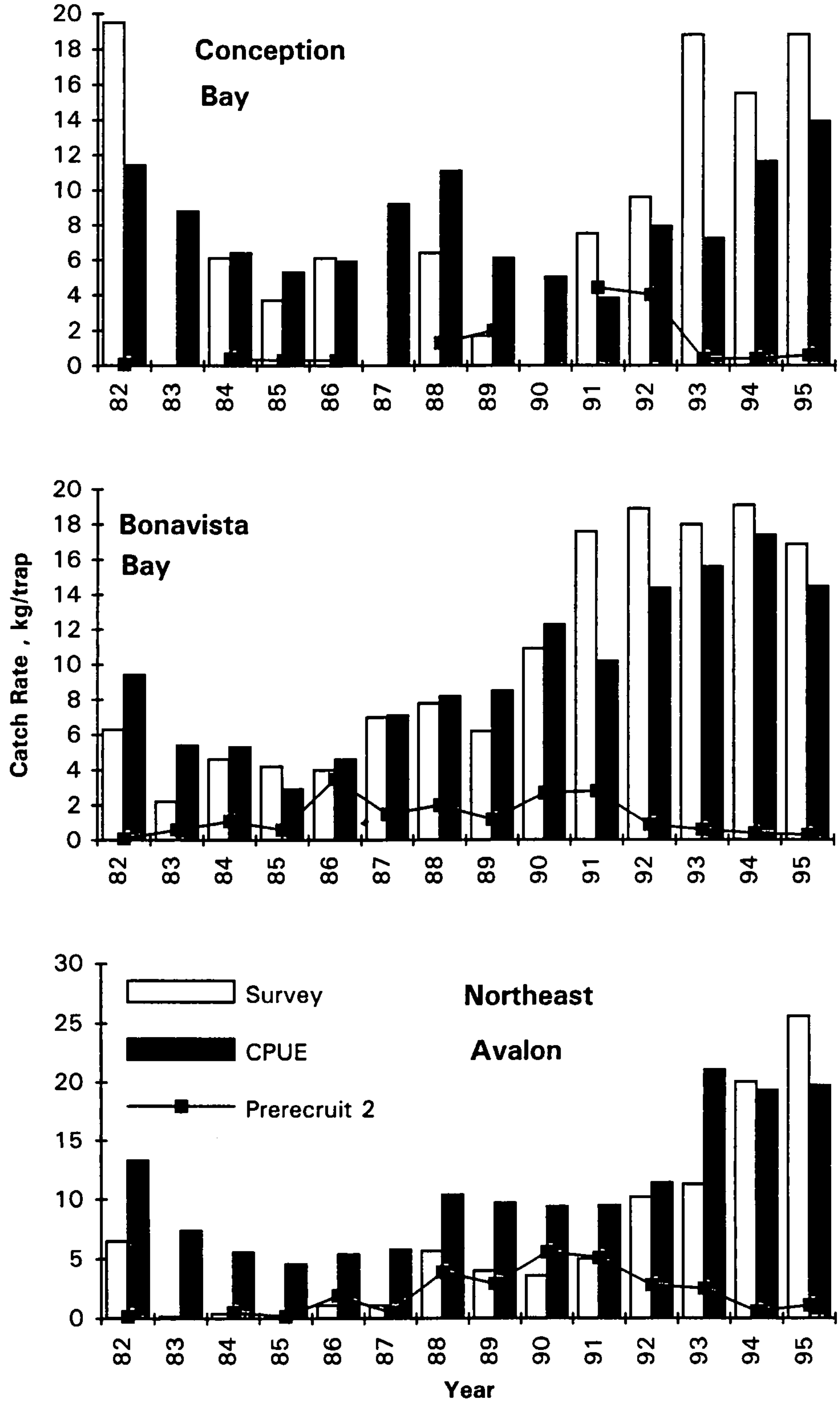


Fig. 8. Comparison of yearly trends in indices of standing stock based on research surveys (survey) and the commercial fishery (CPUE) with the survey index for the Prerecruit 2 size group.

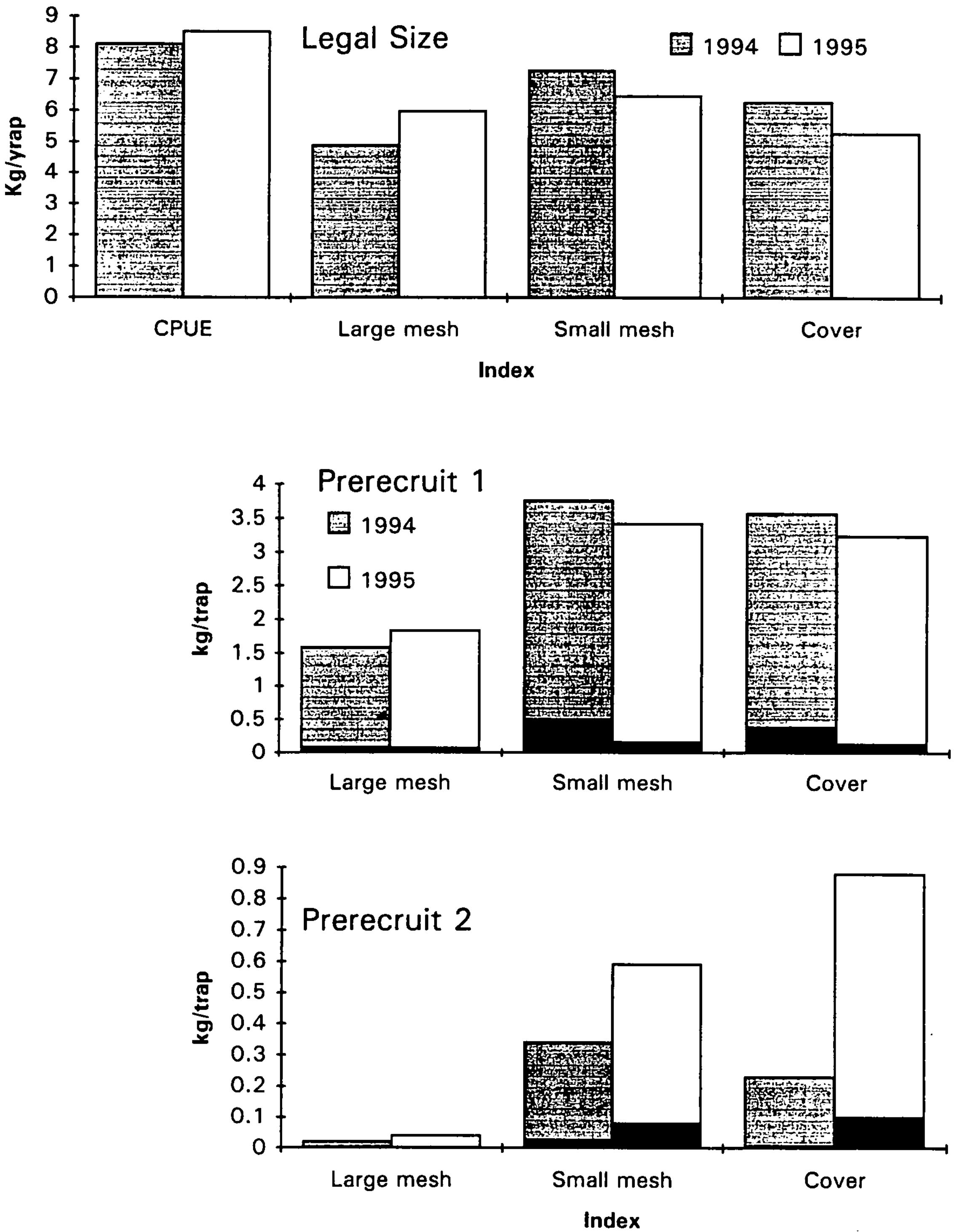
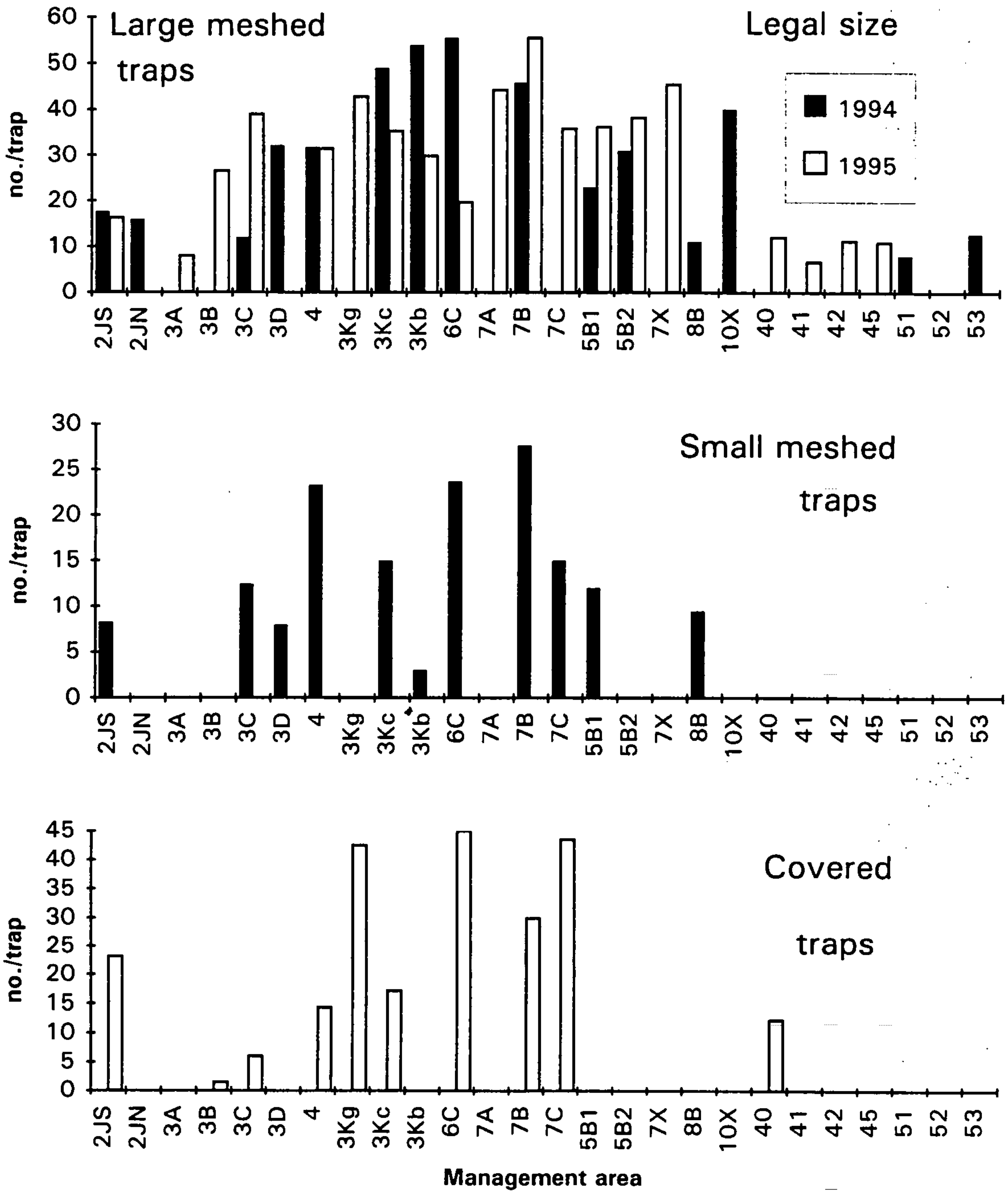


Fig. 9. Comparison of 1994 and 1995 survey catch rates from White Bay (area 3B) for each of three population components and trap types. Darkest areas at the base of bars represents small-clawed crabs.



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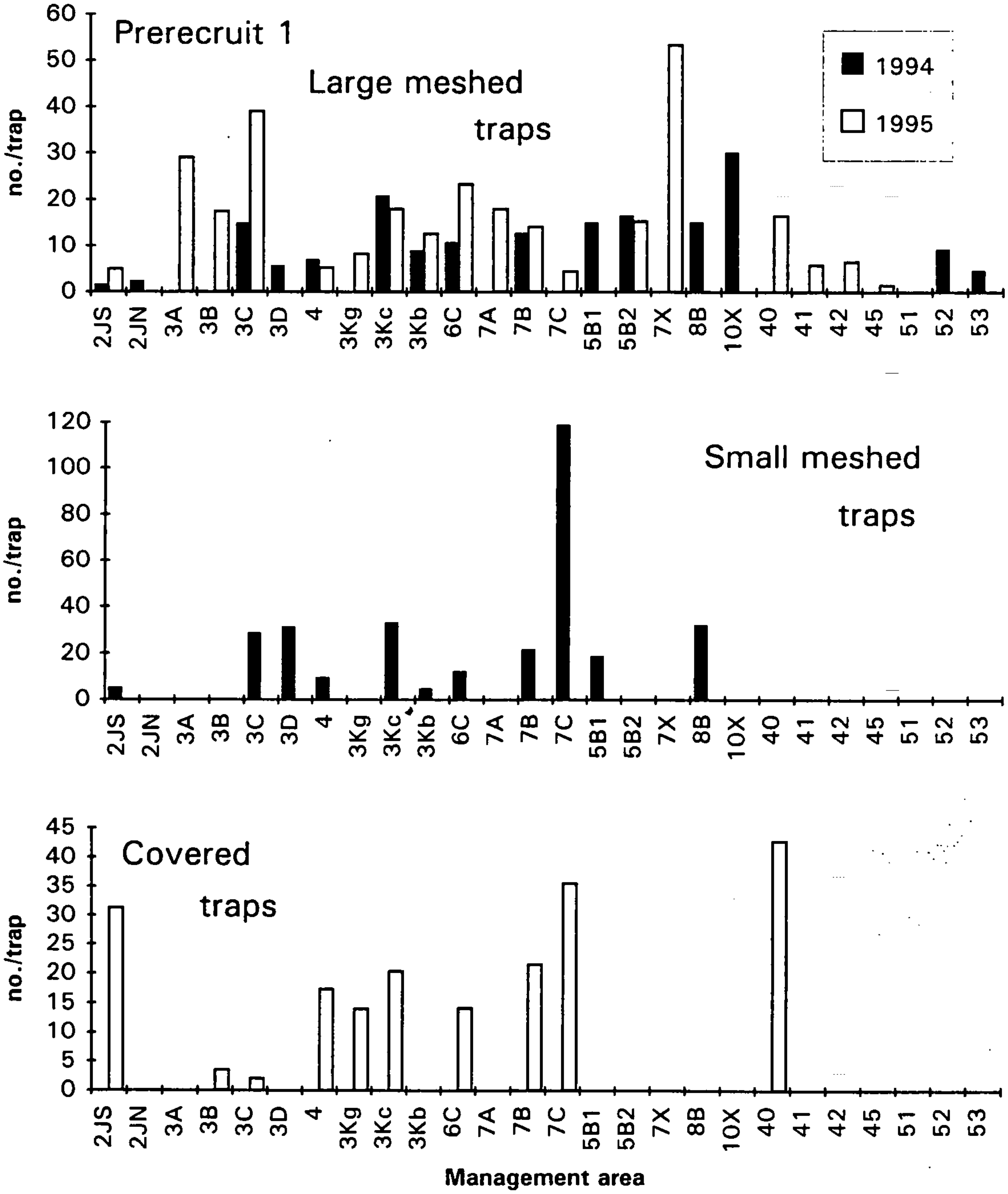

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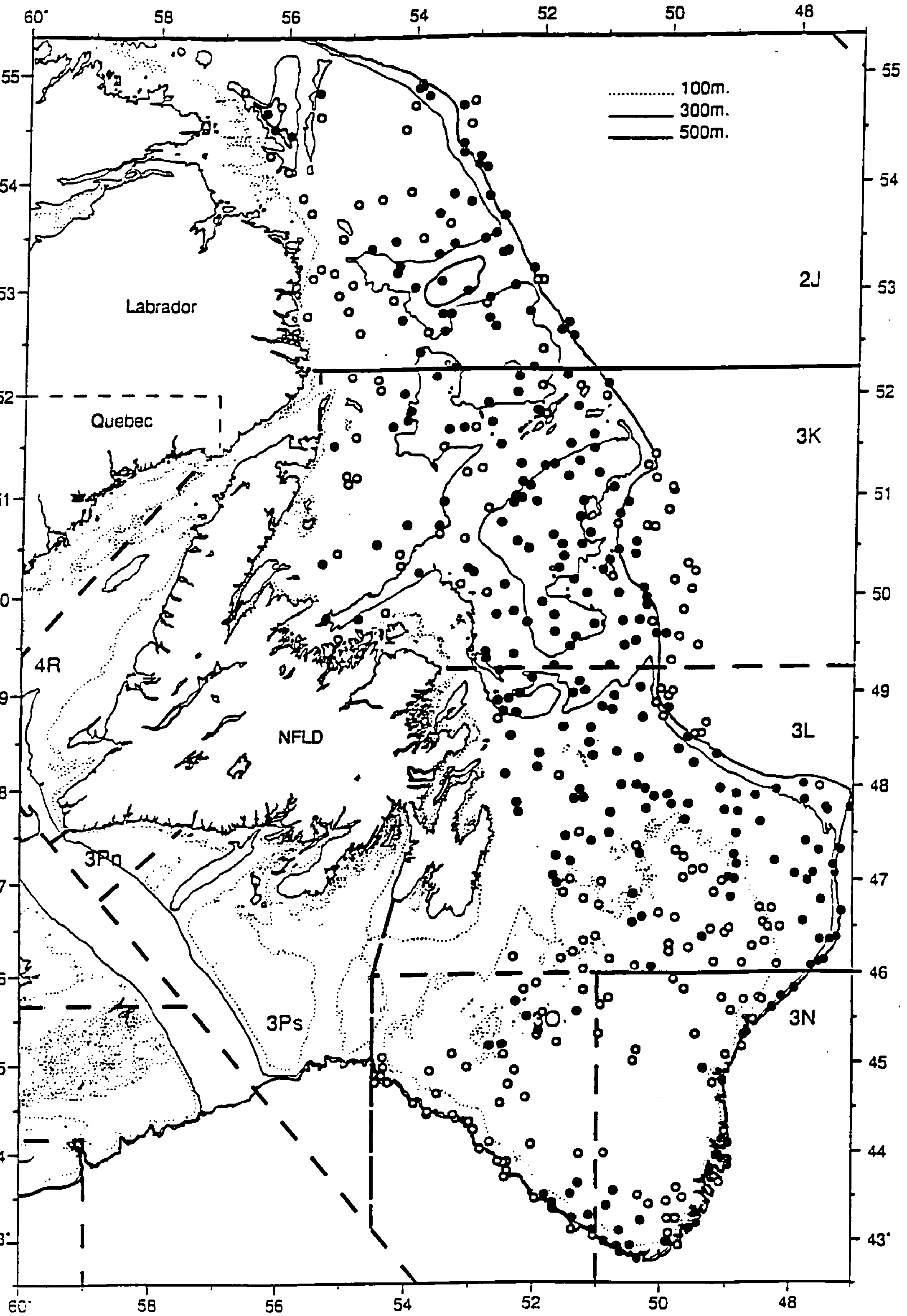

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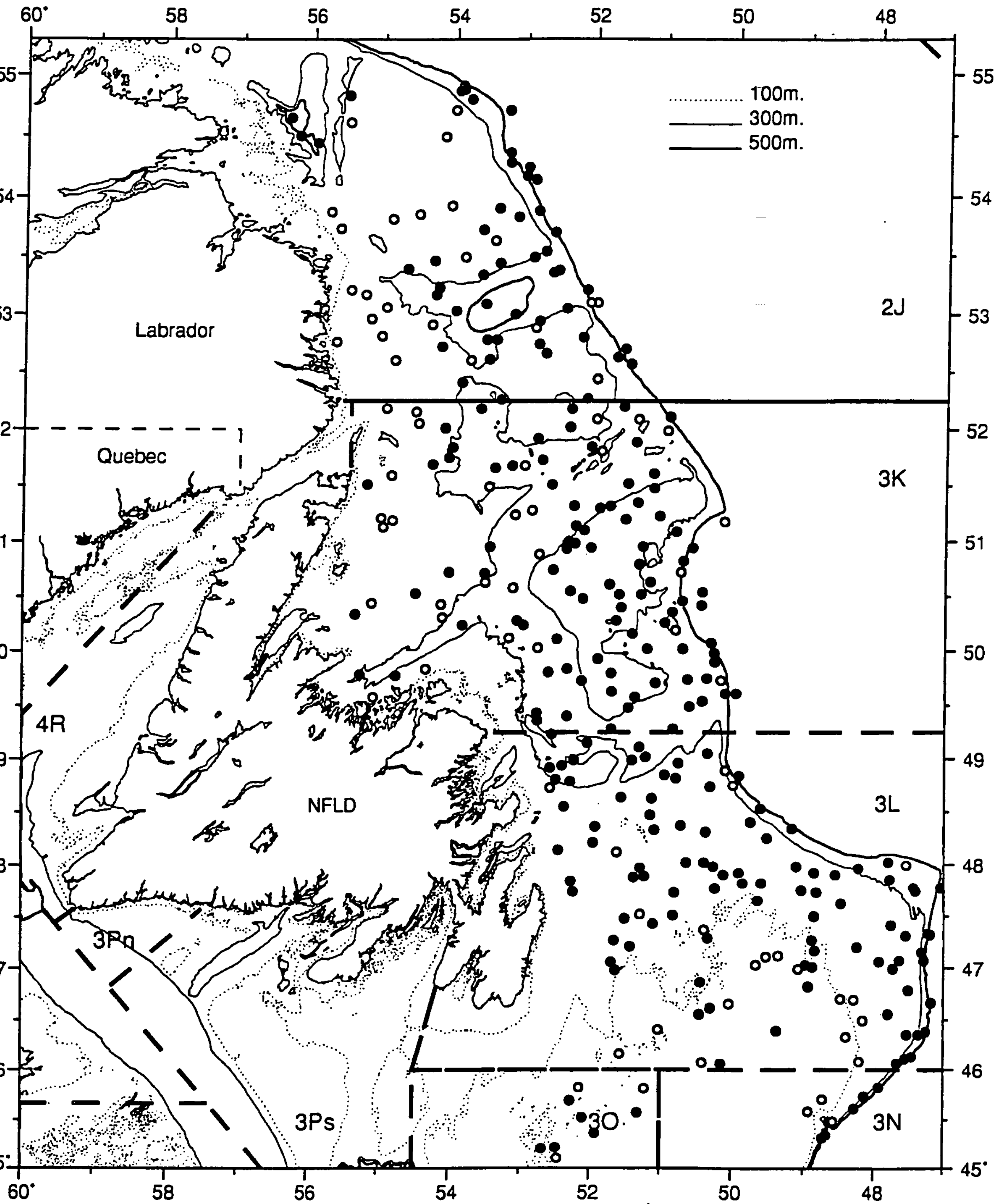

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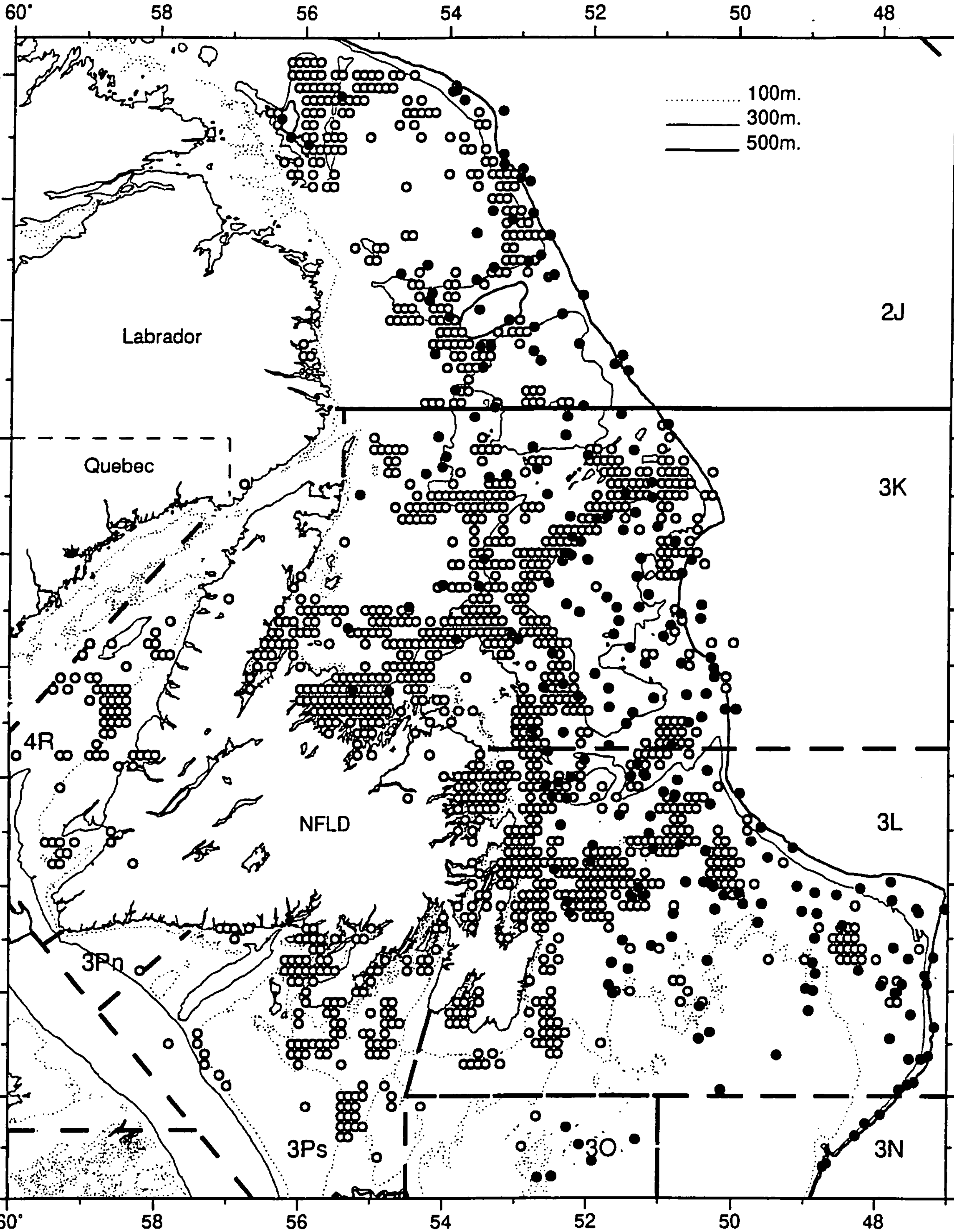

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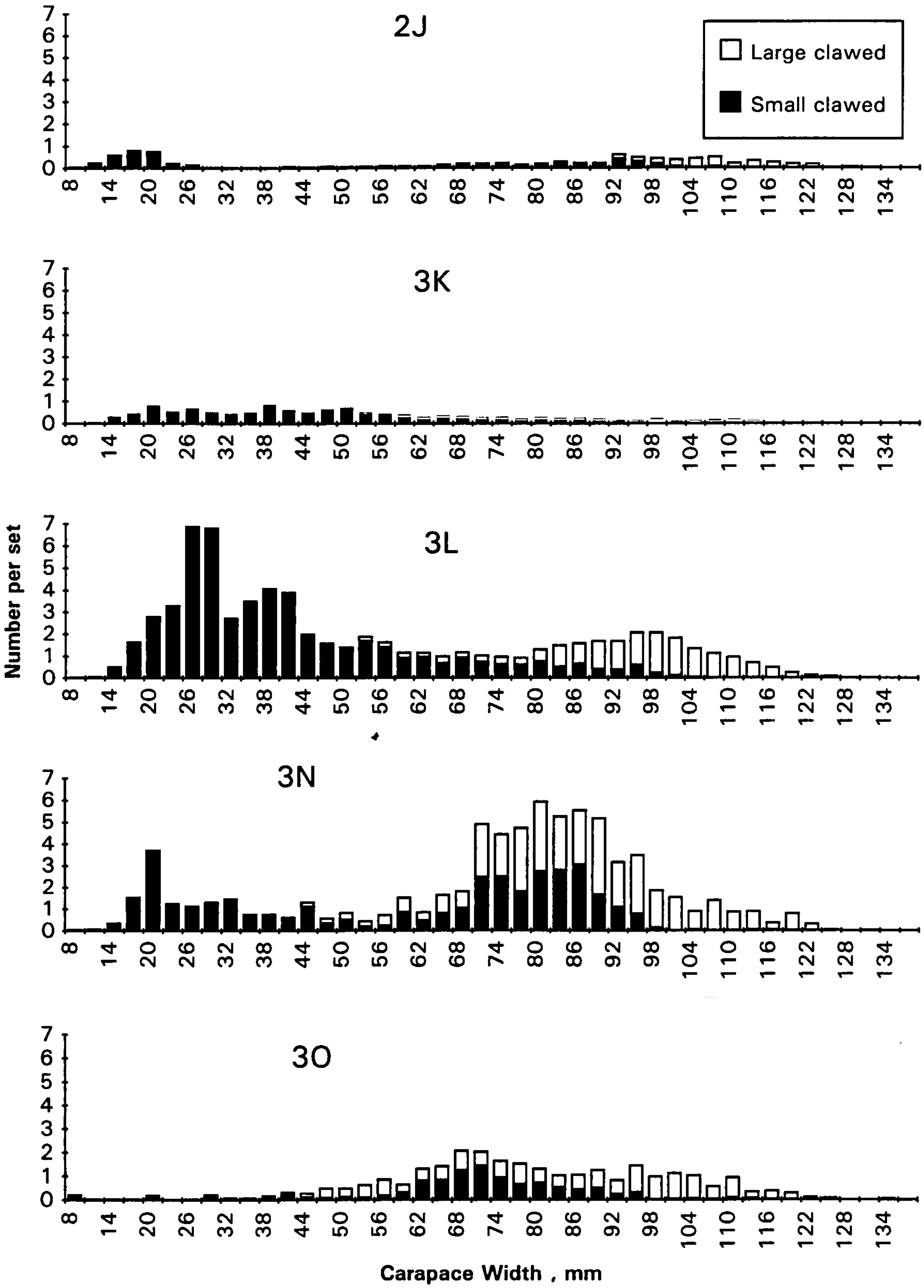

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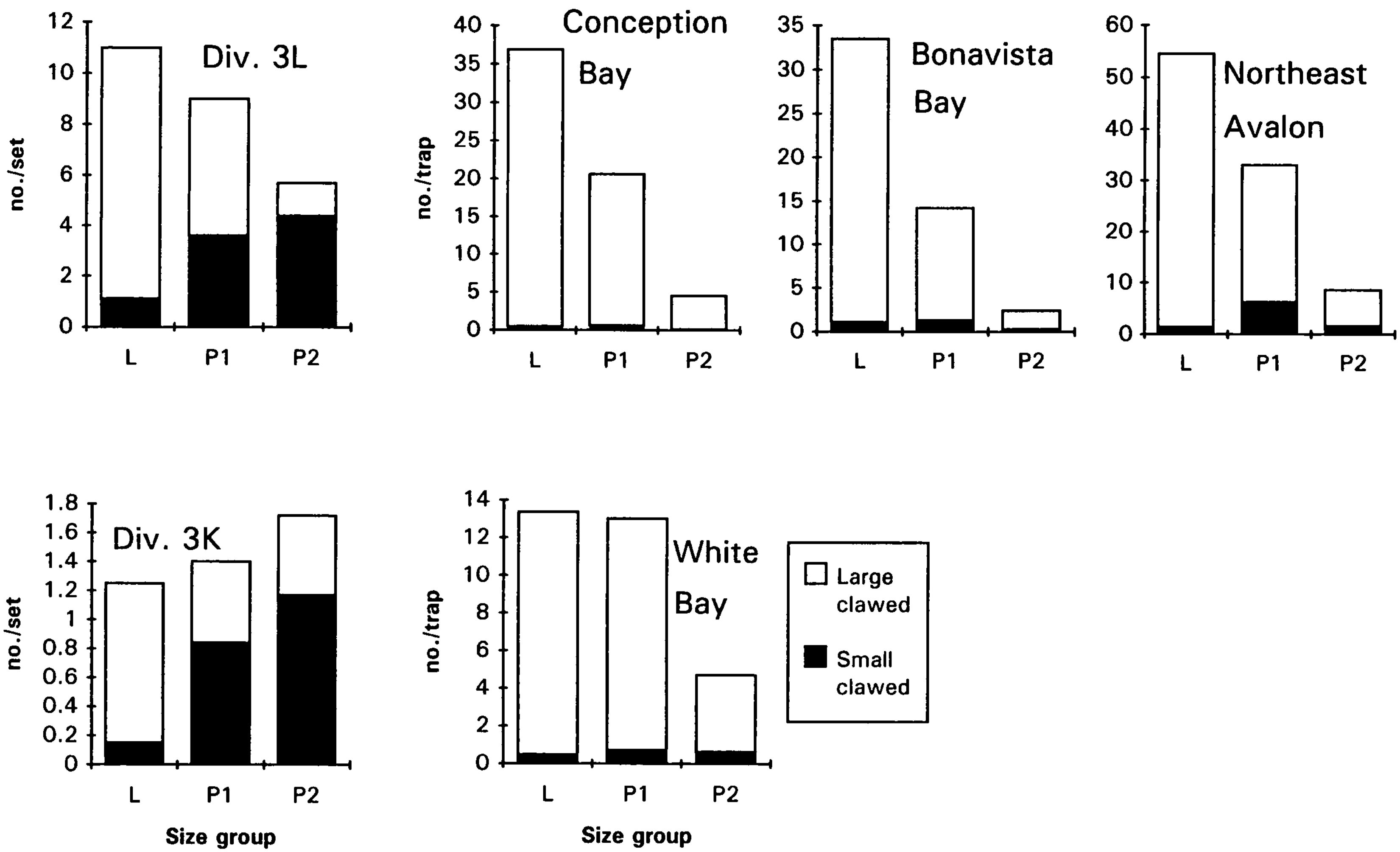

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