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# An Assessment of Newfoundland and Labrador Snow Crab in 2003

# Évaluation du stock de crabe des neiges de Terre-Neuve et du Labrador pour l'année 2003

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## Abstract

Resource status was evaluated, by NAFO Division, based on trends in biomass, recruitment prospects and mortality. Data were derived from the fall Div. 2J3KLNO multi-species bottom trawl survey, an inshore Div. 3K trap survey, and fishery data from logbooks as well as observer data. The fall multispecies survey is conducted near the end of the fishing season and so is considered to provide an index of the exploitable biomass that will be available to the fishery in the following year. Trends in biomass within Div. 2J3KLNO were inferred based on comparison of trends in the fall survey exploitable biomass indices with offshore fishery catch per unit effort (CPUE) trends. Short-term recruitment prospects were inferred from comparison of fall survey pre-recruit indices with an observer-based index of crabs discarded in the fishery. Long-term recruitment trends were based on annual progression of male size groups through standardized fall survey size frequency distributions. Mortality was inferred from exploitation rate indices, a fishery observer-based index of handling mortality and prevalence of Bitter Crab Disease (BCD). No fishery-independent data were available for Subdiv. 3Ps or Div. 4R. In Div. 2J trends in both the fall survey index and fishery CPUE indicate that the biomass has declined steadily since 1998. Both short-term and long-term recruitment prospects are uncertain and the exploitation rate as well as pre-recruit mortality will likely increase in 2004 if the current catch level is maintained. In Div. 3K, trends in both the fall survey indices and offshore CPUE indicate that the biomass has recently stabilized at a lower level relative to 1998. Inshore trap survey data suggest some recent increases inshore. Survey and fishery indices agree that recruitment is expected to remain relatively low in the short term, whereas long-term prospects are uncertain. The Div. 3K exploitation rate will remain relatively high if the current catch level is maintained but would not likely increase. In Div. 3L the trawl survey and the commercial CPUE biomass indices do not agree. Whereas the survey data suggest a decline since 1996, the fishery continues to perform at a high level. Recruitment is expected to remain relatively low in the short term, whereas long-term prospects are uncertain. The effect on the Div. 3L exploitation rate of maintaining the current catch level is unknown, because trends in biomass indices do not agree. In Div. 3NO trends in the exploitable biomass index are unclear, but the fishery continues to perform at a high level. In Subdiv. 3Ps CPUE has declined in recent years and recruitment is expected to change little in the short term. Assuming that CPUE reflects the exploitable biomass, and the declining trend continues, exploitation rate and pre-recruit mortality will likely increase if the current catch level is maintained. In Div. 4R CPUE has remained relatively stable in recent years and recruitment is expected to change little in the short term. Assuming that CPUE reflects the exploitable biomass, and remains stable in 2004, the Div. 4R exploitation rate will likely remain unchanged if the current catch level is maintained. There was a slight decline in the percentage of mature females bearing full clutches of viable eggs in Div. 2J3LN since 1995, but the significance of this trend and implications for future recruitment are unknown. Spatial and temporal trends in the prevalence of BCD are unclear and implications for mortality are unknown.

## Résumé

Nous évaluons l'état des ressources de crabe des neiges dans chacune des divisions de l'OPANO en nous fondant sur les tendances de la biomasse, des perspectives de recrutement et des taux de mortalité. Les données utilisées proviennent du relevé plurispécifique d'automne au chalut de fond effectué dans les divisions 2J3KLNO, d'un relevé au casier effectué dans les eaux côtières de la division 3K, des journaux de bord des pêcheurs et des rapports des observateurs. Le relevé plurispécifique d'automne étant effectué vers la fin de la saison de pêche, il est considéré comme donnant un indice de la biomasse exploitable qui sera disponible l'année suivante. Nous avons déduit les tendances de la biomasse dans 2J3KLNO en comparant les tendances des indices de biomasse exploitable provenant des relevés d'automne aux tendances des prises par unité d'effort (PUE) de la pêche hauturière. Quant aux perspectives de recrutement à court terme, nous les avons déduites en comparant les indices d'abondance des prérecrues provenant des relevés d'automne à un indice du nombre de crabes rejetés à la mer établi par les observateurs. Les tendances à long terme du recrutement reposent sur l'entrée annuelle des groupes de taille des mâles dans les répartitions normalisées des fréquences de tailles provenant des relevés d'automne. Nous avons déduit le taux de mortalité des indices du taux d'exploitation, d'un indice du taux de mortalité due à la manutention établi par les observateurs et de la prévalence de la maladie du crabe amer. Aucune donnée indépendante de la pêche n'était disponible pour la sous-division 3Ps ou la division 4R. Dans la division 2J, les tendances observées dans les indices de relevé d'automne et les PUE indiquent que la biomasse diminue constamment depuis 1998. Les perspectives de recrutement à court et à long terme sont incertaines, et le taux d'exploitation ainsi que le taux de mortalité des prérecrues augmenteront probablement en 2004 si le niveau de prises actuel reste le même. Dans la division 3K, les tendances dans les indices de relevé d'automne et les PUE dans les eaux hauturières révèlent que la biomasse s'est récemment stabilisée, mais à un niveau inférieur à celui de 1998. Les données du relevé côtier au casier laissent croire à une certaine augmentation récente de l'abondance dans les eaux côtières. Les indices de relevé et de pêche montrent tous deux que l'on doit s'attendre à ce que le recrutement demeure relativement faible à court terme, tandis que les perspectives à long terme sont incertaines. Le taux d'exploitation dans la division 3K demeurera relativement élevé si le niveau de prises actuel reste inchangé, mais n'augmentera probablement pas. Dans la division 3L, l'indice de relevé au chalut et l'indice des PUE de la pêche commerciale ne concordent pas; alors que les données de relevé semblent indiquer un déclin de l'abondance depuis 1996, la pêche continue à donner de fortes prises. On s'attend à ce que le recrutement demeure relativement faible à court terme, tandis que les perspectives à long terme sont incertaines. L'effet qu'aura le maintien des prises à leur niveau actuel sur le taux d'exploitation dans la division 3L est inconnu parce que les tendances des indices de biomasse ne concordent pas. Dans les divisions 3NO, les tendances des indices de biomasse exploitable ne sont pas claires, quoique la pêche continue de donner de fortes prises. Dans la sous-division 3Ps, les PUE ont diminué ces dernières années et on s'attend à ce que le recrutement varie peu à court terme. Dans l'hypothèse où les PUE reflètent effectivement la biomasse exploitable et où la tendance à la baisse se poursuit, le taux d'exploitation et le taux de mortalité des prérecrues augmenteront probablement si le niveau de prises actuel ne change pas. Dans la division 4R, les PUE sont demeurées relativement stables ces dernières années et on s'attend à ce que le recrutement varie peu à court terme. Dans l'hypothèse où les PUE reflètent effectivement la biomasse exploitable et demeurent stables en 2004, le taux d'exploitation dans la division 4R demeurera probablement le même si le niveau de prises actuel ne change pas. Le pourcentage de femelles adultes portant de grosses grappes d'œufs viables dans les divisions 2J3LN a légèrement diminué depuis 1995, mais la signification de cette tendance et ses répercussions sur le recrutement futur sont inconnues. Les tendances spatiales et temporelles de la prévalence de la maladie du crabe amer ne sont pas claires et les répercussions sur la mortalité sont inconnues.

# Introduction

The Newfoundland and Labrador snow crab (*Chionoecetes opilio*) fishery began in 1968 and was limited to NAFO Divisions 3KL until the mid 1980's. It has since expanded throughout Divisions 2J3KLNOP4R and is prosecuted by several fleets. The resource declined during the early 1980's but then recovered and remained very large throughout the 1990's. Resource declines have become evident in some areas in recent years (Dawe et al 2003). Management of the increasingly diverse fishery led to the development of 41 quota-controlled areas with over 3500 licence/permit holders under enterprise allocation by 1999. Management areas (Fig. 1) hold no relationship with biological units.

The fishery is prosecuted using conical baited traps set in longlines The minimum legal size is 95 mm carapace width (CW). This regulation excludes females from the fishery while ensuring that a portion of the adult males in the population remain available for reproduction. The minimum legal mesh size of traps is 135 mm., to allow small crabs to escape. Under-sized and soft-shelled males that are retained in the traps are returned to the sea and an unknown proportion of those die.

This document presents research survey data and fishery data toward evaluating the status of the Newfoundland and Labrador snow crab (*Chionoecetes opilio*) resource throughout NAFO Div. 2J3KLNOP4R in 2003. Data from the fall Div. 2J3KLNO 1995-2003 multispecies bottom trawl surveys are presented to provide information on trends in biomass, production, and mortality over the time series. These survey data have been used in annual snow crab assessments since 1997 (Dawe et al. 2003). Multispecies survey indices are compared with other relevant indices derived from fisher logbook data, observer data, and inshore Div. 3K trap survey data, toward inferring changes in resource status for 2004 and beyond.

# Methodology

## Fall Multispecies Survey Data

Data on total catch numbers and weight were acquired from the 1995 to 2003 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 and 1999 surveys. Inshore strata were also surveyed during 2000-2003. These surveys utilized the Campelen 1800 survey trawl in standard tows of 15 min. duration.

Snow crab catches from each set were sorted, weighed and counted by sex. Catches were sampled in their entirety or subsampled by sex. Individuals of both sexes were measured in carapace width (CW, mm) and shell condition was assigned one of three categories: (1) new-shelled - these crab had molted in spring of the current year, have a low meat yield throughout most of the fishing season, and are generally not retained in the current fishery until fall; (2) intermediate-shelled – these crab last molted in the previous year and are fully recruited to the fishery throughout the current fishing season; (3) old-shelled – these crab have been available to the fishery for at least 2 years. Males were also sampled for chela height (CH, 0.1 mm). Maturity status was determined for females and relative fullness and stage of development of egg clutches were assessed. Occurrence of advanced stages of BCD was noted in both sexes based on macroscopic examination. In cases of unclear external characteristics, crabs were dissected and classified based on observation of the hemolymph. Observation of cloudy or milky hemolymph was taken as support for classification of such specimens as infected.

A schematic model of snow crab recruitment (Dawe et al. 1997) was followed in assigning males to population components for subsequent analysis. Based on this model, males 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 males (≥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).

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 ($CW = 0.0806CH^{1.1999}$) was applied to classify each individual as either adult (large-clawed) versus adolescent or juvenile (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 until the following year. Therefore new-shelled legal-sized crabs are not considered to be part of the exploitable biomass, although it is recognized that some of these males are retained by the fishery late in the season (in fall). It is assumed that all males with small chelae molt each spring and so 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.

Spatial distribution was compared among years for Div. 2J3KLNO using the fall survey abundance index data. ACON (G. Black, pers. com.) was used to describe the distribution of each of the four size groups of males described above; 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). Distribution of mature females was also described.

We examined annual changes in abundance indices and size (mean CW) of legal-sized males, by shell condition toward evaluating the internal consistency of the data series. Males enter the legal-size group as new-shelled crabs, after the spring molt, and they begin to contribute to the legal old-shelled group in the following year. Hence we would expect annual changes in abundance to be first seen in new-shelled legal-sized males and to be followed by similar trends in old-shelled males. Trends in mean size are more difficult to interpret than trends in abundance because of confounding effects of exploitation versus recruitment. Increasing mean CW has been interpreted, in other regions (DFO 2002), as reflecting declining recruitment and growth of legal-sized adolescents to maximum size. We feel that such trends would be most evident in new-shelled crabs, that are not targeted by the fishery, although they are affected by discard mortality.

Indices were calculated from post-season fall surveys, using STRAP (Smith and Somerton 1981), to represent the exploitable biomass and pre-recruit biomass in the following year. The exploitable biomass index was calculated as the fall survey biomass index of adult (large-clawed) legal-sized (>95 mm CW) males, regardless of shell condition. Adult males are terminally molted, so that no members of this category would molt in spring and all adults in the fall survey (including new-shelled adults) would be fully recruited to the fishery in the following year. The pre-recruit index was calculated by applying a 19 mm CW growth increment (Hoenig et al. 1994) to all adolescent (small-clawed) males larger than 75 mm CW caught in the fall survey, before applying STRAP. The resultant pre-recruit index represented a component of legal-sized (>95 mm CW) males that would be recently-molted, new-shelled and not recruited to the fishery of the next year, but would begin to recruit (as older-shelled males) in the following year. However, some of these recently-molted males would have remained adolescent, and so would molt one more time before achieving adulthood and subsequently recruiting to the fishery, as older-shelled males, one additional year later (ie. 3 years after the survey year).

These exploitable and pre-recruit biomass indices were calculated using the raw survey data. It is known that catchability of crabs by the survey trawl (ie. trawl efficiency) is lower than 1 and varies with substrate type and crab size (Dawe et al 2002). However trends in raw (‘unstandardized’) indices are comparable to those in ‘standardized’ indices (Dawe et al 2003), that partially account for effects of substrate type and crab size.

Projection of biomass indices from the survey year does not account for annual variability in natural mortality or in the proportion of adolescent males that do not molt in the following spring (skip-molters). Biomass indices are comparable among years because only those survey strata common among all years were included in the analysis. Inshore survey strata were not included in calculating biomass indices because they were not surveyed in some years.

The ratio of the annual catch to the exploitable biomass index (projected from the survey of the previous year) was calculated to provide an index of exploitation rate. It is recognized that annual changes in these ratios may be due to changes in catchability (ie. trawl efficiency) rather than exploitation rate. However we feel that long-term trends (since 1996) provide a useful indication of trends in exploitation rates. Inshore commercial catches and data from inshore survey strata were not included in calculating the ratios because inshore survey strata were not surveyed in all years.

To examine size composition of males, standardized survey catches by carapace widths were grouped into 3 mm CW intervals and adjusted up to total population abundance indices. Each size interval was partitioned, based on chela allometry, between juveniles plus adolescents (small-clawed) versus adults (large-clawed).

**Fishery Logbook Data**

Data on commercial catch (kg) and fishing effort (number of trap hauls) were obtained from vessel logbooks. These data were compiled by the Statistics Divison, Policy and Economics Branch, Newfoundland Region of the Department of Fisheries and Oceans. Catch per unit of effort (CPUE, kg/trap haul) was calculated by year and NAFO Division.

CPUE is used as an index of biomass, but it is unstandardized in that it does not account for variation in catch or effort levels, seasonality of fishing, or other fishing practices (eg. soak time and mesh size). Long-term trends in logbook CPUE are presented here as a fishery-based index of trends in biomass, separately for inshore and offshore areas. Annual offshore values, for recent years, are also used here for comparison with the offshore exploitable biomass indices from fall multispecies surveys. Trends in inshore CPUE are compared with trends in inshore research trap survey catch rate indices.

**Observer Catch-Effort Data**

Data were available from the Observer Program for the same time series as those from the fall multispecies surveys (1995-2003). These observer data included details, for each set observed, of number of traps, landed catch (kg) and discarded catch (kg). An observer-based CPUE index (kg. landed/trap haul) was calculated for comparison with offshore logbook CPUE.

A discard index (kg. discarded/trap haul) was calculated to compare with the pre-recruit index, from fall multispecies surveys.. Although the discard index and the survey pre-recruit biomass index are defined differently, they both include contributions by sub-legal-sized crabs (undersized males versus sub-legal adolescents respectively) as well as by recently-molted legal-sized crabs ('soft'-shelled males versus adolescents). While the catch rate (kg/trap haul) of discarded crabs is viewed as a potentially useful index of recruitment, the percent discarded (by weight) is viewed as a potentially useful index of indirect fishing mortality associated with handling and releasing of pre-recruits.

**Inshore Trap Surveys**

Data were available from an inshore Div. 3K trapping survey that has been carried out in White Bay and Notre Dame Bay during 1994-2003, with the exception of 2001. The survey has consistently been conducted in September and it occupies 5 of the inshore fall multispecies survey strata (Fig. 20) with a target of 8 sets per stratum. Each set includes 6 traps, with crabs sampled from two large-meshed (commercial, 135 mm) traps and two small-meshed (27 mm) traps. Catch rate indices (kg/trap haul) were calculated, for legal-sized males, by shell category (new-shelled recently-molted versus older-shelled), as well as by claw type (small clawed juveniles plus adolescents versus large-clawed adults).

Data were also available from three inshore trap surveys (1979-2003) within Div 3L. These surveys were conducted in different seasons; spring (Northeast Avalon), summer (Bonaviata Bay), and fall (Conception Bay). For each seasonal survey series catch rate indices (kg/trap haul) were calculated, for legal-sized males (excluding new-shelled males) and compared with fishery logbook CPUE trends for the relevant local crab management area.

## Results and Discussion

### The Fishery

The fishery began in Trinity Bay (Management area 6A) in 1968. Initially, crab were taken as gillnet by-catch but within several years there was a directed trap fishery in inshore areas along the northeast coast of Div. 3KL during spring through fall.

Until the early 1980's, the fishery was prosecuted by approximately 50 vessels limited to 800 traps each. In 1981 fishing was restricted to the NAFO division where the licence holder resided. During 1982-1987 there were major declines in the resource in traditional areas in Div. 3K and 3L while new fisheries started in Div. 2J, Subdiv. 3Ps and offshore Div. 3K. Since the late 1980's the resource has increased in these areas. A snow crab fishery began in Div. 4R in 1993.

Licences supplemental to groundfishing were issued in Div. 3K and Subdiv. 3Ps in 1985, in Div. 3L in 1987, and in Div. 2J in the early 1990's. Since 1989 there has been a further expansion in the offshore. Temporary permits for inshore vessels <35 ft., introduced in 1995, were converted to licences in 2003. There are now several fleet sectors and about 3300 licence holders.

In the late 1980's quota control was initiated in all management areas (Fig. 1) of each division. All fleets have designated trap limits, quotas, trip limits, fishing areas within divisions, and differing seasons.

Landings for Div. 2J3KLNOP4R (Table 1, Fig. 2) increased steadily from about 10,000 t annually during the late 1980's to 69,000 t in 1999 largely due to expansion of the fishery to offshore areas. They decreased by 20% to 55,300 t in 2000, in association with a 17% reduction in TAC, before increasing slightly to 59,300 t in 2002. They declined slightly to 58,300 t in 2003, in association with a reduction in TAC.

Effort, as indicated by estimated trap hauls, has approximately tripled throughout the 1990's. It declined in 2000 and increased slightly thereafter. Increasing effort in the 1990's was primarily due to vessels <35 feet with temporary seasonal permits. Effort has been broadly distributed in recent years (Fig. 3).

### Division 2J3KLNO

#### *Spatial distribution from fall multispecies surveys.*

The fall distribution of males (Fig. 4-11) throughout NAFO Div. 2J3KLNO in 2003 was generally similar to the distribution pattern observed throughout 1995-2002, as previously described (Dawe et al. 2003, Dawe and Colbourne 2002). Males of all sizes were absent from the deepest sets (>500 m) along the Div. 3K slope, but they extended to greater depths along the more northern Div. 2J slope and along the more southern Div. 3LN slope. They were virtually absent from the shallow southern Grand Bank (Div. 3LN). Snow crabs of both sexes and all sizes were virtually absent over a broad area of the shallow (<100 m) southern Grand Bank (Fig. 4-13). Largest (legal-sized) males appeared to be most abundant, in 2003, in inshore areas of Div. 3KL and offshore along the northern and eastern Grand Bank (Div 3LN), whereas they appeared to be in lower abundance offshore to the north (Div. 2J3K). (Fig. 4-5). The distribution of smallest males (<60 mm CW) generally shifted south during 2000-2002, and changed little in 2003. (Fig. 11). The distribution of mature females (Fig. 12-13) continued to be similar to that of comparably-sized males (Fig. 8-11).

Trends in distribution over the 1995-2000 period were reviewed by Dawe et al. (2003) and Dawe and Colbourne (2002). These trends included gradual spatial shifts in highest densities of most size groups, but also sharp annual and area-specific changes in survey catch rates. Such sharp area-specific annual changes in density that occur across both sexes and the entire broad male size range imply spatial and annual variability in catchability by the survey trawl (Dawe and Colbourne 2002).

***Biomass and Abundance***

The fall survey is considered to represent a post-fishery survey, although a small proportion of the annual catch was taken during the September-December survey period in some years. Therefore the biomass index from any survey year is considered to represent an index of the exploitable biomass available to the fishery of the following year.

The exploitable biomass index and associated abundance index (Fig. 14) have both declined since 1998, by more than a factor of 3, to their lowest levels in 2003.

***Recruitment***

The fall survey pre-recruit index (Fig 15) declined by 73% from 1996-2002 and was unchanged in 2003. The pre-recruit abundance index similarly declined from 1996-2002 and remained at its lowest level in 2003.

We feel there is higher uncertainty associated with the pre-recruit index than with the exploitable biomass index. This difference in uncertainty is not due to differences in precision of estimates but is primarily related to differences in molt status between the two groups. The exploitable biomass index is comprised exclusively of males that were terminally-molted adults in the fall survey, whereas the pre-recruit index includes a large component of males that were adolescents as small as 76 mm CW during the survey. The projection of the pre-recruit index assumes that all those adolescents will molt, survive, grow by 19 mm CW and subsequently recruit (over the following two years, involving yet an additional molt for those that remained legal-sized adolescents), as older-shelled males. In reality, the biomass of new-shelled pre-recruit crabs is greatly affected by annual variability in natural mortality, growth increment and proportions that fail to molt. These variables currently cannot be predicted and so are not accounted for.

Negative relationships between bottom temperature and snow crab CPUE have been demonstrated at lags of 6-10 years (Fig. 16) suggesting that cold conditions early in the life history are associated with the production of strong year classes. Therefore the recent warm oceanographic regime may have impaired snow crab productivity.

Temperatures on the Newfoundland Shelf were below normal in most years from the mid-1980’s to about 1995. These were years of high crab productivity that led to high commercial catch rates during the 1990’s. Warmer conditions since 1996 might have led to reduced productivity during this more recent period and could negatively impact future commercial catch rates.

Productivity of crab during early life history has also been linked to the winter and spring sea ice cover on the Newfoundland Shelf. The formation and melting of sea ice greatly influences the layering of the water column and, hence, the maintenance of primary and secondary production during spring within the near-surface layer (<50 m). It has been hypothesized that an important mechanism determining snow crab larval survival is a combination of nutrient supply, production of zooplankton, and physical oceanographic processes.

Correlation between the commercial CPUE in Div. 3L and ice cover at a time lag (10 years) approximating the mean age of crabs in the fishery provides a forecast of future fishery performance (Fig. 17). The model predicts a decline in CPUE up to 2006 and gradual recovery thereafter. However uncertainty in the forecast, illustrated in the 95% confidence intervals (C.I.), increases with time.

## *Mortality*

Exploitation; Ratio of catch to exploitable biomass index.

The ratio of the landed catch to the exploitable biomass index (Fig. 18), does not estimate absolute exploitation rate, because the exploitable biomass underestimates absolute biomass and, consequently exploitation rate is overestimated by this ratio. However long-term changes in this ratio may be interpreted as reflecting trends in exploitation rate. This ratio, for the entire survey area (Fig. 18), decreased by 31 % in 1997 and then increased steadily, by 166 %, to 2001. The increase above 1.0, to 1.57 in 2001 clearly indicates that this ratio greatly underestimates exploitation rate. It declined by 17% in 2002 before increasing by 30% in 2003 to the highest level in the time series.

Natural Mortality; Bitter crab disease (BCD).

BCD has been observed, based on macroscopic observations, at low levels throughout 1996-2003. Data on BCD were not collected in 1995, the first multispecies survey year. The prevalence and distribution of this parasitic disease throughout the Newfoundland-southern Labrador Continental Shelf (Div. 2J3KLNO) has been described in detail by Dawe (2002).

BCD appears to have extended southward during 1999-2003 with highest prevalence having moved from Div. 2J in 1999, to Div. 3K in 2000 (Fig. 19), and having much of its distribution shifted from Div. 3K into Div. 3L during 2001-2003 (Fig. 19-20). This shift into Div. 3L, beginning in 2001 was coincident with a great increase in survey catch rates of smallest males in Div. 3L in 2001 (Fig. 11 and Dawe et al 2002). Annual changes in prevalence of BCD will be presented later, on a divisional basis.

BCD occurs in both sexes and all sizes of snow crab. Its prevalence in mature females is comparable to that in males of similar size (Dawe 2002). It is unknown how well disease prevalence in trawl-caught samples, especially based on recognition of external characteristics in chronic cases, represents true prevalence in the population, but it seems likely that our observations underestimate true prevalence. Relationships of prevalence with density are unclear (Dawe 2002) and implications for mortality are unknown.

## Division 2J

### The Fishery

Landings increased slightly from 330 t in 1985 to 600 t in 1990, before increasing to about 3200 t during 1995-1997 (Table 2, Fig 21). They peaked in 1999 at 5400 t but declined to 2500 t in 2003, due to reductions in TAC imposed in 2000 and 2003, while effort increased by about 80%.

### *Biomass*

Commercial catch rates (CPUE) have oscillated over the time series (Table 2, Fig. 22), initially decreasing during 1985-1987, increasing to a peak in 1991, decreasing again to 1995, and increasing to peak again in 1998. CPUE has since declined steadily to its lowest observed value in 2003. This decline was evident across all of Div. 2J, with no substantial change in the spatial distribution of fishing effort (Fig. 23).

The distribution of commercial fishing effort expanded during 1990-1995, (as indicated by the number of spatial cells accounting for 95% of the catch), while the catch increased (Fig. 24). This spatial distribution changed little while the catch remained high but it further expanded after 2000, as the catch declined. This spatial expansion and contraction of the area fished was inversely related to CPUE (Fig. 25).

The logbook CPUE and observed CPUE agreed fairly well (Fig. 26). Trends in CPUE throughout the season (Fig 27 and 28) indicated that initial CPUE decreased during 2001-2003 and that CPUE was lowest in 2003 throughout the fishing season.

The fall multispecies survey exploitable biomass index (Table 3, Fig. 29) increased steadily during 1995-1998, decreased by 94% from 1998-2002, and changed little in 2003. Trends in both the fall survey index and fishery CPUE indicate that the biomass has declined steadily since 1998.

The distribution of the exploitable biomass, based on fall multi-species surveys, contracted during 1998-2002, as indicated by a decrease in the proportion of the survey area accounting for 95% of the exploitable biomass (Fig. 30). There was no further contraction in 2003. This contraction was closely associated with the decline in biomass during 1998-2002 (Fig. 30), and was also reflected in an increase in the percentage of survey sets that caught no male crabs (Fig. 31).

### *Production*

Recruitment

We examined annual changes in abundance indices and of legal-sized males from fall multispecies surveys, by shell condition, toward evaluating the internal consistency of the data series (Fig. 32). Males enter the legal-size group as new-shelled crabs, after the spring moult, and they begin to contribute to the legal old-shelled group in the following year. Trends in the abundance index by shell condition (Fig. 32) reflect this process, in that the abundance index of new-shelled males peaked in 1998 whereas that of old-shelled males peaked one year later, in 1999. The abundance index of new-shelled males dropped sharply (by 72%) in 1999, whereas abundance of old-shelled crabs steadily declined, by 84%, during 1999-2002, and increased marginally in 2003.

The fall survey pre-recruit index (Table 4, Fig. 33) increased steadily from 1995-1998 but then decreased by 66% in 1999. It changed little during 1999-2001, decreased in 2002 to its lowest value in the time series, and remained relatively low in 2003.

The observer discard pre-recruit index (kg/trap haul, Fig. 33) also increased overall during 1995-1998, dropped in 1999, and remained stable through 2001. This index doubled in 2002, in contrast to the survey pre-recruit index, but could not be updated for 2003 due to a low observer coverage level. The disagreement between the pre-recruit indices in 2002 and the especially low level of observer coverage in 2003 create uncertainty about short-term recruitment prospects**.**

The size compositions from fall multispecies surveys are examined initially with the abundance index (ordinate) truncated for smallest males (<50 mm CW), so as to focus on trends in abundance for larger males (Fig. 34). The decline in commercial-sized males, as well as pre-recruits since 1998 is well-reflected in these size frequencies. There is no clear indication of any increase in recruitment in the short term, based on males larger than about 50 mm CW.

The un-truncated size distributions (Fig. 35) suggest that indices of smallest males (<50 mm CW) increased during 1999-2001 and then decreased. However this is unreliable as an indication of long-term recruitment because there has been no evidence of modal groups progressing through the size range over the time series (Fig 35). Therefore, long-term recruitment prospects are unknown.

Size distributions from at-sea sampling by observers (Fig. 36) indicate that modal CW decreased from about 110-113 mm in 2002 to 101 mm in 2003, while catch rates of smaller males increased. Although these observations suggest some increase in recruitment, there is high uncertainty associated with low observer coverage. Because of disagreement between indices of observer and survey pre-recruit biomass, and especially low observer coverage in 2003, recruitment prospects in the short term are uncertain.

<u>Reproduction</u>
The percentage of mature females carrying full clutches of viable eggs (Fig. 37) remained above 90% until 2000 (excepting an anomalous 1999 value), but declined from 94% in 2000 to 74-78% in 2001-2003. It is uncertain whether this apparent decline in mating success is due to the decline in availability of legal-sized males. Also, it is unknown whether declines in fecundity of this apparent level would affect subsequent abundance of settling megalopae.

***Mortality***

<u>Exploitation</u>
The exploitation rate index decreased from 1996-1998 (Fig. 38), was unchanged in 1999, then increased from 1999-2001. It changed little in 2002 but increased sharply in 2003 despite a decrease in landings.

Indirect fishing mortality

The percentage of the total catch discarded, by weight, in the fishery (Fig. 38) decreased from 16-18% during 1995-1998 to 11-12% during 1999-2001. It increased sharply in 2002, implying increased handling mortality on pre-recruits in the 2002 fishery. This index could not be updated for 2003 due to low observer coverage.

The discard rate underestimates true mortality. Deaths in numbers would be much greater than suggested by percentage discarded by weight because new-shelled crabs are generally smaller than older-shelled (recruited) crabs, and undersized crabs are much smaller.

Fishery-induced mortality is expected to remain high in 2004 if the current catch level is maintained and poor handling practices continue.

Natural Mortality; Bitter crab disease (BCD).

BCD has been consistently most prevalent in small crabs of 40-59 mm CW in Div. 2J (Fig. 39). Prevalence, in new-shelled males, has generally been low in this area, usually ranging 2.4-3.1 percent occurrence for that size range, excepting 1999, when 18.2% of new-shelled males in that size group were visibly infected. BCD prevalence increased in 2002, particularly in smallest males of <40 mm CW (from 0.2-3.6%) and in intermediate-sized males of 60-75 mm CW (from 0-2.6%). Overall prevalence changed little in 2003, but shifted to larger sizes, becoming most prevalent in legal-sized new-shelled males (Fig. 39).

**Division 3K**

**The Fishery**

Landings averaged about 3300 t during 1985-1990 then increased to about 21,400 t in 1999 before declining by 29% to 15,300 t in 2001 (Table 5, Fig 40), due to a reduction in TAC imposed in 2000. They increased by 8% to 16,500 t in 2003 due to increases in TAC. Effort decreased during 1999-2001 and increased by 13% during 2001-2003. Inshore landings averaged 18% of the total over the past five years.

**Biomass**

Commercial catch rates oscillated over the time series (Table 5, Fig. 41). Offshore CPUE declined by 32% from 1998-2001 and has since remained at a relatively low level. Inshore CPUE declined from 1993-1999, was unchanged in 2000, increased sharply in 2001, and has since remained relatively high. The spatial distribution of CPUE (Fig 43) reflects the increase in CPUE inshore and decline offshore since 1999. Areas fished changed little over time, with the exception of the virtual disappearance, since 1999, of the fishery east of 51W along the slope and southeast of Funk Island Bank.

The distribution of commercial fishing effort expanded during 1990-1999, (as indicated by the number of spatial cells accounting for 95% of the catch), while the catch increased (Fig. 43). This spatial distribution gradually contracted after 2000, as the catch declined. This spatial expansion and contraction of the area fished was inversely related to CPUE (Fig. 44).

The offshore logbook CPUE and observed CPUE did not agree well, with observed CPUE being much lower than logbook CPUE, since 1998 (Fig. 45). However they agreed that offshore CPUE declined during 1998-2001 and changed little since then. There were no clear annual differences in initial CPUE or trends throughout the season (Fig. 46-47).

The fall multispecies survey exploitable biomass index increased sharply in 1996 (Table Table 6, Fig. 48) and remained at a high level during 1996-1998. It dropped by more than half in 1999, increased slightly during 2000 and 2001 and has since declined by 68%. However there is greater uncertainty in 2003 due to unusually late timing of the survey.

The distribution of the offshore exploitable biomass has contracted during 1998-2001, as indicated by a decrease in the proportion of the survey area accounting for 95% of the exploitable biomass (Fig 49). This index increased slightly in 2002 and was unchanged in 2003. This contraction was closely associated with the decline in biomass during 1998-2001 (Fig. 49), and was also reflected in an increase in the percentage of survey sets that caught no male crabs (Fig. 50).

Catch rates from the inshore Div 3K trapping survey (Fig. 51) show that in all three White Bay strata the catch rate of adult (large-clawed) legal-sized males increased in 2000 and had consistently increased further by 2003 (Fig. 52). In Notre Dame Bay, both strata indicated higher catch rates in 2003 than in 2002, but the deeper (301-400 m) and commercially fished stratum (610) showed low catch rates in the past 2 years relative to 2000 (Fig. 52).

***Production***

<u>Recruitment</u>

Annual changes in the abundance index by shell condition did not show a trend of peaks in new-shelled abundance preceding peaks in old-shelled abundance (Fig. 53), as was evident in Div 2J (Fig 32). This may be due to annual differences, particularly in 1998 and 1999, in catchability of crabs by the survey trawl. Such changes in catchability or trawl efficiency may be related to changes in trawl configuration or changes in distribution of crabs with respect to depth and substrate type (Dawe et al 2002). The decrease in both shell categories in 1999, followed by an increase suggests reduced catchability in the 1999 survey. This is reflected in the spatial distributions, that show consistent relatively low 1999 catch rates across all size groups, and is most evident in small males and in mature females (Fig 10-11).

Both the fall survey pre-recruit index and the observer discard pre-recruit index increased between 1995 and 1997 (Table 7, Fig. 54) before declining during 1997-1999. The observer discard pre-recruit index has since varied at a relatively low level while the survey index declined during 2000-2003. Recruitment is expected to remain relatively low in the short term. However there is greater uncertainty in 2003 due to unusually late timing of the survey.

The size compositions from fall multispecies surveys are examined initially with the abundance index (ordinate) truncated for smallest males (<50 mm CW), so as to focus on trends in abundance for larger males (Fig. 55). The decline in commercial-sized males since 1996, as well as in adolescent pre-recruits since 1997, is well-reflected in these size frequencies. There is no clear indication of any increase in recruitment in the short term, based on males larger than about 50 mm CW.

The un-truncated size distributions (Fig. 56) suggest that indices of smallest males (<50 mm CW) were relatively high during 2000-2001 and decreased thereafter. However this is unreliable as an indication of long-term recruitment because there has been no evidence of modal groups progressing through the size range over the time series (Fig 56). Therefore, long-term recruitment prospects are unknown.

Size distributions from at-sea sampling by observers (Fig. 57) indicate that modal CW decreased from about 110 mm in 1999 to about 101 mm in 2000 as catch rates of small males increased, suggesting some increase in recruitment in 2000. There was little change in 2001, but modal CW increased to 110 mm CW in 2002 and was unchanged in 2003, consistent with the recent decline in the fall survey pre-recruit index (Fig. 54).

Trends in the catch rate of legal-sized males by shell condition (Fig. 58) from the September (post-season) trap survey indicate that the catch rate of new-shelled males (immediate pre-recruits) increased in all 5 strata in 2000. Catch rate of new-shelled males increased further in 2002-2003 in the 3 White Bay strata, suggesting increasing recruitment, whereas they were lower in 2002-2003 than in 2000 in the 2 Notre Dame Bay strata. Size frequencies from these surveys show an increase in catch rate of small males (<95 mm CW) in all 5 strata (Fig. 59-63). Small males that were abundant in White Bay during 1998-2000 achieved legal size during 2000-2003 (Fig 59-61), whereas small males were abundant primarily in 1998 in Notre-Dame Bay, became new-shelled immediate pre-recruits mostly in 2000 (Fig. 62-63). Catch rates of small males remained relatively high in White Bay in 2004 (Fig. 59-61).

Reproduction

The fall multi-species survey percentage of mature females carrying full clutches of viable eggs (Fig. 64) has varied at a high level, exceeding 80% in all years but 1996.

### *Mortality*

Exploitation

The exploitation rate index decreased from 1996-1997 (Fig. 65), steadily increased from 1997 to 2000, and has remained relatively high over the past 4 years.

Indirect fishing mortality

The percentage of the total catch discarded in the fishery decreased from its peak of 45% in 1997 to 17% in 1998. It increased from 1998-2001 (Fig. 65) and remained relatively high, at about 30%, during 2001-2003, implying relatively high handling mortality on pre-recruits during the fishery in 2001-2003. Fishery-induced mortality is expected to remain high in 2004 if the current catch level is maintained and poor handling practices continue.

Natural Mortality; Bitter crab disease (BCD).

Prevalence of BCD, from multispecies trawl samples, has overall been higher in this area than in any other division, with maximum levels during 1996-1998 in the order of 8% in 40-59 mm CW males (Fig. 66). Annual trends in BCD prevalence (across all sizes) were similar to those in the exploitable biomass and prerecruit indices, featuring highest values in 1997-1998, a sharp drop to minimum levels in 1999, and generally lower levels during 2000-2003 than during 1996-1998. The very low prevalence levels, across all sizes, in 1999 may be an artefact related to the lower catchability of BCD-infected crabs by trawl than by traps, together with lower trawl efficiency (in Div. 3K) in 1999 than in other survey years.

BCD has consistently occurred at much higher prevalence levels in the inshore Div. 3K trap survey samples (with peaks of about 15-25%, Fig.67 and 68) than in the predominately offshore Campelen trawl samples (with peaks of about 5-8%, Fig. 66). This, in part, reflects low catchability of diseased animals by the survey trawl (based on comparative trap/trawl sampling), but it may also reflect higher prevalence in inshore than offshore areas. We believe that BCD was not prominent in inshore Div. 3K in the early 1990's because we detected no BCD in 1994, the first year of our survey. Furthermore, in White Bay, it was detected only the shallowest stratum in 1995, especially in smallest males, despite our sampling in both deeper strata as well. Between 1995 and 1999 there was a clear progression of BCD to successively larger crabs and successively greater depths, such that about 12% of legal-sized crabs in the deepest stratum were infected in 1999. This progression with size and depth until 1999 reflects both the observed size-related depth distribution pattern (Dawe and Colbourne 2002), as well as increasing recruitment over that time period. Prevalence increased in 2003 in smallest males within the shallowest White Bay stratum (Fig. 67), and was relatively high within the deeper Notre Dame Bay stratum during 2002-2003 (Fig.68). Implications for mortality are unknown.

**Division 3L**

**The Fishery**
Landings increased from about 1300 t in 1975 to 13,000 t in 1981, before decreasing to 2600 t in 1985 (Table 8, Fig. 69). They increased steadily to peak at 26,200 t in 1999, before declining to 22,600 t in 2000, due to a reduction in TAC. They increased by 11% from 23,500 t in 2001 to 26,200 t in 2003, due to increased TACs, while effort increased by 46%. Inshore landings have averaged 24% of the total over the past 5 years.

**Biomass**
Commercial catch rates (Table 8, Fig. 70) in the offshore increased sharply from 1991-1992 and have since remained high. Inshore CPUE has been consistently lower than offshore CPUE. Both indices were relatively stable during 2000-2002 but declined by 21% inshore and 12% offshore in 2003.

The spatial distribution of CPUE (Fig 71) reflects the decrease in CPUE inshore and offshore in 2003. This spatial distribution has expanded since 2001, and only the far offshore areas fished have changed little over time.

The distribution of commercial fishing effort, (as indicated by the number of spatial cells accounting for 95% of the catch), expanded during 1992-1997 while the catch increased (Fig. 72). This spatial distribution changed little while the catch further increased until 1999 and remained relatively high thereafter. This spatial expansion of the area fished occurred while CPUE remained at a relatively high level (Fig. 73). Further expansion since 2001 (Fig.71) is not reflected in this index (Fig. 72).

The logbook CPUE and observed CPUE agreed fairly well, especially since 1998 (Fig. 74). Trends in CPUE throughout the season (Fig 75 and 76) indicated that CPUE decreased during 2001-2003. CPUE was lowest in 2003 throughout most of the fishing season, but especially late in the season.

The fall multispecies survey exploitable biomass index declined by about 70% from 1996-2000 (Fig. 77) and has since remained at a relatively low level in contrast with the offshore CPUE trend. The distribution of the offshore exploitable biomass has contracted slightly since 1998, as indicated by a decrease in the proportion of the survey area accounting for 95% of the exploitable biomass (Fig. 78) and an increase in the percentage of survey sets catching no male crabs (Fig. 79). Disagreement between the exploitable biomass index and CPUE, since 1996, introduces uncertainty regarding recent trends in biomass.

Inshore Div. 3L spring trap survey catch rates of recruited crabs off Northeast Avalon (Fig. 80) decreased steadily, by about half, from the peak in 1999 until 2003 (Fig 81), while local fishery CPUE remained steady at a relatively high level during 1999-2002 before decreasing sharply in 2003. Summer survey catch rates in Bonavista Bay (Fig. 82) declined by about a factor of 3 during 1997-2003 (Fig. 83), whereas local fishery CPUE changed little during that period. In contrast, fall trap survey catch rates in Conception Bay (Fig. 84) changed little during 1998-2003 while local fishery CPUE declined by more than half. Generally, recent trends in trap survey catch rates from all 3 localized inshore areas did not agree with corresponding commercial CPUE trends. However 2 of the 3 surveys showed a decrease in 2003, consistent with the broader-scale inshore CPUE (Fig. 70).

## Production

<u>Recruitment</u>

Annual changes in the multispecies survey abundance index by shell condition (Fig. 86) reflected greater internal consistency than was evident in Div. 3K. Abundance of new-shelled legal-sized males declined from a peak in 1995 or earlier, whereas old-shelled legal-sized males peaked at least two years later, in 1997. Abundance of new-shelled males continued to decline to 1999 before stabilizing, whereas the decline in old-shelled males extended one year later, to 2000, before stabilizing. These consistent trends show no clear evidence of strong changes in catchability or ‘year effects’, as were suggested in Div. 3K. The catch rates of new-shelled and old-shelled legal-sized males have been equal in the past two years.

The fall survey pre-recruit index declined from 1996-1999 (Fig. 87) and has remained at a relatively low level over the past 5 years. The observer discard pre-recruit index increased from 1995-1997 (Fig. 87), and declined thereafter. Recruitment is expected to remain relatively low in the short term.

The size compositions from fall multispecies surveys are examined initially with the abundance index (ordinate) truncated for smallest males (<50 mm CW), so as to focus on trends in abundance for larger males (Fig. 88). The decline in commercial-sized males, as well as of adolescent pre-recruits since 1996 is well-reflected in these size frequencies. There is no clear indication of any increase in recruitment in the short term, based on males larger than about 50 mm CW.

The un-truncated size distributions (Fig. 89) suggest that indices of smallest males (<50 mm CW) were high during 2001-2002, relative to all earlier years except 1995. However this is unreliable as an indication of long-term recruitment because has been no evidence of modal groups progressing through the size range over the time series (Fig 89). Therefore, long-term recruitment prospects are unknown.

Size distributions from at-sea sampling by observers (Fig. 90) became increasingly platykurtic over the past 5 years. Modal CW increased from 98 mm in 1999 to about 98-101 mm in 2003 as catch rates of small males decreased, suggesting declining recruitment.

Reproduction

The percentage of mature females carrying full clutches of viable eggs remained above 80% for all years except 2001 (Fig. 91) and was about 90% in 2003.

***Mortality***

Exploitation

The exploitation rate index increased from 1997-2001 (Fig. 91), decreased slightly in 2002, and remained unchanged in 2003.

Indirect fishing mortality

The percentage of the total catch discarded in the fishery (Fig. 91) increased from 1995-1997, decreased sharply in 1998, then declined gradually until 2003, implying decreased handling mortality on pre-recruits.

Natural Mortality; Bitter crab disease (BCD).

BCD generally occurs at lower levels in Div. 3L than in Div. 3K, with maximum prevalence, from fall multispecies surveys, of about 4% (Fig. 93), approximately half that in Div. 3K overall. BCD prevalence has been variable at this relatively low level during 1996-2003. It was relatively high in 1997, 2001, and 2003.

**Division 3NO**

**The Fishery**

The fishery began in 1995. Landings peaked in 1999 at 6500 t, then dropped by 35% to 4200 t in 2000, due to a TAC reduction (Table 13, Fig. 94). They increased by 17% from 4700 t in 2001 to 5500 t in 2003, due to increased TACs, while effort increased by 25%.

**Biomass**

Commercial CPUE (Table 13, Fig. 95) increased by about 60% from 1996-2002 but decreased by 10% in 2003.

The resource has been concentrated along the shelf edge in these divisions (Fig. 96). There has been no substantial change in areas fished during 1999-2003.

Observed CPUE was consistently lower than logbook CPUE, but showed a similar trend (Fig. 97).

Estimates of the exploitable biomass index, as determined from the fall multi-species survey data, have wide margins of error (Table 14), and show no clear trend (Fig. 98). Therefore no inferences about biomass can be made from these data.

### *Production*

Recruitment

Wide margins of error (Table 15) introduce uncertainty in interpreting the fall multi-species survey pre-recruit index. However, the survey index (Fig. 99) has shown a declining trend since 1998 while the observer discard pre-recruit index (Fig. 20) has declined since 1999. Recruitment is expected to remain relatively low in the short term.

Longer-term recruitment prospects are unknown. The long-term recruitment indices are especially unreliable for Div. 3NO because of broader confidence intervals about the mean estimates for any size group than in the more northern divisions. Low and variable precision of mean estimates is reflected in the abundance-at-CW data (Dawe et al 2002a) and preclude inferences about long-term recruitment.

Size distributions from at-sea sampling by observers in Div. 3N (Fig. 100) showed a gradual increase in modal CW over the past 5 years. Modal CW increased from 101 mm in 1999 to 113 mm in 2000 and 119 mm in 2003, as catch rates of small males steadily declined, indicating declining recruitment. The trend was not as consistent in Div. 3O (Fig. 101) in that there appeared to be some increase in recruitment during 2000-2002, based on decreasing modal CW and increasing catch rate of sub-legal sized males. However recruitment apparently decreased in 2003, based on an increase in modal CW and decrease in catch rate of small males.

Reproduction

There was no clear trend in the percentage of females carrying full clutches of viable eggs in Div 3N or Div. 3O (Fig. 102). Percent full clutches exceeded 95% in most years. Unusually low percentages may be attributed to low sample sizes, especially in Div. 3O.

### *Mortality*

Exploitation

Trends in exploitation rate are unclear because of uncertainties associated with the exploitable biomass index.

Indirect fishing mortality

The percentage of the total catch discarded in the fishery (Fig. 103) declined by more than half since 1999, implying reduced handling mortality on pre-recruits.

Natural Mortality; Bitter crab disease (BCD).

BCD has been virtually absent from Div. 3NO, based on fall multispecies survey trawl samples.

## Subdivison 3Ps

### The Fishery

The fishery began in 1985 with landings not exceeding 1000 t until 1994 when the offshore fishery began (Table 16, Fig. 104). Landings rose steadily until 1999 due to increased TACs and averaged 7800 t during 1999-2002. They decreased by 20% from 7600 t in 2002 to 6100 t in 2003, due to a reduction in TAC, while effort increased by 9%. Inshore landings have averaged 43% of the total over the past 5 years.

### *Biomass*

Inshore and offshore commercial CPUE have declined from 1999-2003 (Fig. 105) by 40% and 67% respectively. This decline was evident across all of Subdivision 3Ps, with no substantial change in the areas fished (Fig. 106).

The distribution of offshore commercial fishing effort expanded steadily during 1992-1999, (as indicated by the number of spatial cells accounting for 95% of the catch), while the catch increased (Fig. 107). Expansion continued until 2002, as the catch remained high (Fig. 107) and CPUE declined steadily (Fig. 108).

The logbook CPUE and observed CPUE did not agree closely (Fig 109) Observed CPUE was generally lower than logbook CPUE. They did agree, however, that CPUE declined since 1999.

Trends in CPUE throughout the season (Fig 110 and 111) indicated that initial CPUE decreased during 2001-2003 and that CPUE was lowest in 2003 throughout the fishing season. An increase in CPUE to peak during week 8 in 2001, week 9 in 2002 and week 10 in 2003 suggests either an increase in catchability in general, or landing of new-shelled crabs.

No estimates of the exploitable biomass index are available as there are no reliable research survey data from this area.

### *Production*

<u>Immediate Recruitment</u>
The observer pre-recruit index more than doubled from a low level of 2.6-3.2 kg/trap haul in 1995-1997 to 6.9 kg/trap haul in 1998 (Fig. 112). It declined slightly in 1999 and has remained stable over the past 5 years (1999-2003). Recruitment is expected to change little in the short term.

Size distributions from at-sea sampling by observers (Fig.113) showed a decrease in catch rate of legal-sized males as well as smaller males during 2000-2002, and no change in 2003.

<u>Long-term Recruitment</u>
No data.

### *Mortality*

Exploitation
Assuming that CPUE reflects the exploitable biomass, and the declining trend continues, exploitation rate will likely increase if the current catch level is maintained.

Indirect fishing mortality
The percentage of the total catch discarded in the fishery (Fig. 24) increased from 26% in 2001 to 48% in 2002 and remained at that level in 2003, implying high handling mortality on pre-recruits during the 2002 and 2003 fisheries.

Assuming that CPUE reflects the exploitable biomass, and the declining trend continues, pre-recruit mortality will likely increase if the current catch level is maintained.

Natural Mortality; Bitter crab disease (BCD).
There are no data on BCD in this area.

## Division 4R and Subdivision 3Pn

### The Fishery

The fishery began in the early 1990's with landings not exceeding 1000 t until 1998 (Table 17, Fig. 115). They increased by 88% from 930-1750 t during 1997-2002, due to increases in TAC, and dropped by 10% to 1570 t in 2003, despite a further increase in TAC. Effort increased steadily until 2001 and then decreased by 24% to 2003.

### *Biomass*

There are no reliable fishery independent data from this area. It is not possible to infer trends in biomass from CPUE data because of recent changes in the spatial distribution of fishing effort**.** Effort has shifted from north to south in recent years (Fig. 116). CPUE is consistently low relative to other divisions (Table 17, Fig. 117).

Observed CPUE and logbook CPUE differed greatly and showed no common trend (Fig. 118), due to inadequate observer coverage.

### *Production*

Immediate Recruitment
Observer coverage levels have been low for this area. New analysis showed that the data were not representative of the seasonal distribution of effort. Therefore the observer data are considered insufficient to estimate a reliable pre-recruit index and short-term recruitment prospects are unknown.

Long-term Recruitment
No data.

### *Mortality*

The effects of maintaining the current catch level on the exploitation rate and pre-recruit mortality are unknown.

There are no Data on BCD from this area.

## Literature Cited


Colbourne, E. 2002. Physical Oceanographic conditions on the Newfoundland and Labrador Shelves during 2001. DFO Can. Sci. Advis. Sec. Res. Doc. 2002/023, 27pp.

Dawe, E. G. 2002. Trends in Prevalence of Bitter Crab Disease Caused by *Hematodinium* sp. in Snow Crab (*Chionoecetes opilio*) throughout the Newfoundland and Labrador Continental Shelf. pp. 385-400 *In*: Crabs in Cold Water Regions: Biology, Management, and Economics. Edited by A.J. Paul, E.G. Dawe, R. Elner, G.S. Jamieson, G.H. Kruse, R.S. Otto, B. Sainte-Marie, T.C. Shirley, and D. Woodby University of Alaska Sea Grant, AK-SG-02-01, Fairbanks, 786 pp.

Dawe, E.G., and E.B. Colbourne. 2002. Distribution and demography of snow crab (*Chionoecetes opilio*) males on the Newfoundland and Labrador shelf. pp. 577-594 *In*: Crabs in Cold Water Regions: Biology, Management, and Economics. Edited by A.J. Paul, E.G. Dawe, R. Elner, G.S. Jamieson, G.H. Kruse, R.S. Otto, B. Sainte-Marie, T.C. Shirley, and D. Woodby University of Alaska Sea Grant,AK-SG-02-01, Fairbanks, 876 p.

Dawe, E.G., H.J. Drew, P.J. Veitch, R.Turpin, P. G. O'Keefe, and P. C. Beck. 2002a. An assessment of Newfoundland and Labrador snow crab in 2001. DFO Can. Sci. Advis. Sec. Res. Doc. 2002/050, 51 p.

Dawe, E. G., B. R. McCallum, S. J. Walsh, P. C. Beck, H. J. Drew and E. M Seward. 2002b. A study of the catchability of snow crab by the Campelen 1800 survey trawl. DFO Can. Sci. Advis. Sec. Res. Doc. 2002/051. 16 pp.

Dawe, E.G., H.J. Drew, P.J. Veitch, R.Turpin, E. Seward and P. C. Beck. 2003. An assessment of Newfoundland and Labrador snow crab in 2002. DFO Can. Sci. Advis. Sec. Res. Doc. 2002/050, 51 p.

DFO, 2002. Snow crab of the Estuary and Northern Gulf of St. Lawrence (Areas 13 to 17). DFO Science Stock Status Report C4-01 (2002), 13 p.

Hoenig, J.M., E.G. Dawe, and P.G. O'Keefe. 1994. Molt indicators and growth per molt for male snow crabs (*Chionoecetes opilio*). J. Crust. Biol. 14(2): 273-279.

Lovrich, G. A., and B. Sainte-Marie. 1997. Cannibalism in the snow crab, *Chionoecetes opilio* (O. Fabricus) (Brachyura: Majidae), and its potential importance to recruitment. J. Exp. Mar. Biol. Ecol. 211: 225-245.

Moriyasu, M., G.Y. Conan, P. Mallet, Y.J. Chiasson, and H. Lacroix. 1987. Growth at molt, molting season and mating of snow crab (*Chionoecetes opilio*) in relation to functional and morphometric maturity. ICES C.M. 1987/K:21, p. 1-44.

Orr, D., E. Dawe, D. Taylor, P. Veitch, J. Drew, P. O'Keefe, and R. Turpin. 2003. Development of standardized Snow Crab (*Chionoecetes opilio*) Catch-Per-Unit Effort (CPUE) models, as well as, comparisons between commercial logbook and multi-species trawl data. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/029

Sainte-Marie, B., S. Raymond, and J.-C. Brêthes. 1995. Growth and maturation of the benthic stages of male snow crab, *Chionoecetes opilio* (Brachyura, Majidae). Can. J. Fish. Aquat. Sci. 52: pp. 903-924.

Sainte-Marie, B., J-M. Sévigny, B. D. Smith, and G. A. Lovrich. 1996. Recruitment variability in snow crab *Chionoecetes opilio*: pattern, possible causes, and implications for fishery management. pp. 451-478 *In*: Proceedings of the International Symposium on the Biology, Management, and Economics of Crabs from High Latitude Habitats. Edited by B. Baxter, Lowell Wakefield Fish. Symp. Ser., Alaska Sea Grant Rep. No. 96-02, 713 p.

Smith, S.J., and G.D. Somerton. 1981. STRAP: A user-oriented computer analysis system for groundfish research trawl survey data. Can. Tech. Rep. Fish. Aquat. Sci. 1030: 66 p.

Taylor, D.M., and J.M. Hoenig. 1990. Growth per molt of male snow crab, *Chionoecetes opilio*, from Conception and Bonavista Bays, Newfoundland. Fish Bull., United States. 88: 753-760.

**Table 1 : TAC (t) and Landings (t) by Year for division 2J3KLNOPs4R**

| Year | TAC | Landings |
|---|---|---|
| 1981 | | 14,196 |
| 1982 | | 13,498 |
| 1983 | | 11,113 |
| 1984 | | 9,555 |
| 1985 | | 7,974 |
| 1986 | 8,825 | 8,968 |
| 1987 | 8,325 | 6,680 |
| 1988 | 8,526 | 9,588 |
| 1989 | 9,970 | 8,326 |
| 1990 | 12,800 | 11,026 |
| 1991 | 15,670 | 16,162 |
| 1992 | 14,470 | 16,437 |
| 1993 | 18,550 | 22,922 |
| 1994 | 23,650 | 27,917 |
| 1995 | 27,875 | 32,334 |
| 1996 | 34,864 | 37,967 |
| 1997 | 42,015 | 45,726 |
| 1998 | 46,525 | 52,609 |
| 1999 | 61,761 | 68,825 |
| 2000 | 51,169 | 55,279 |
| 2001 | 52,252 | 56,594 |
| 2002 | 56,981 | 59,295 |
| 2003 | 56,330 | 58,327 |

**Table 2 : TAC (t), Landings (t), Effort (trap hauls), and CPUE (Kg/trap) by year for Div. 2J.**

| Year | TAC | Landings | Effort | CPUE Total |
|---|---|---|---|---|
| 1985 | | 332 | 24,776 | 13.4 |
| 1986 | 925 | 468 | 38,361 | 12.2 |
| 1987 | 925 | 232 | 25,778 | 9 |
| 1988 | 926 | 456 | 50,667 | 9 |
| 1989 | 920 | 483 | 39,917 | 12.1 |
| 1990 | 920 | 602 | 47,031 | 12.8 |
| 1991 | 1,420 | 1,003 | 68,231 | 14.7 |
| 1992 | 1,420 | 1,494 | 121,463 | 12.3 |
| 1993 | 2,300 | 2,267 | 190,504 | 11.9 |
| 1994 | 2,900 | 2,971 | 330,111 | 9 |
| 1995 | 3,050 | 3,189 | 393,704 | 8.1 |
| 1996 | 2,800 | 3,102 | 326,526 | 9.5 |
| 1997 | 2,800 | 3,183 | 286,757 | 11.1 |
| 1998 | 3,500 | 4,098 | 276,892 | 14.8 |
| 1999 | 4,655 | 5,428 | 399,118 | 13.6 |
| 2000 | 3,411 | 3,673 | 301,066 | 12.2 |
| 2001 | 3,340 | 3,738 | 420,000 | 8.9 |
| 2002 | 3,381 | 3,521 | 567,903 | 6.2 |
| 2003 | 2,265 | 2,532 | 562,667 | 4.5 |

**Table 3: Fall multi- species survey exploitable biomass index by year for Div. 2J.**

| YEAR | BIOMASS (t) | CONFIDENCE INTERVALS (+/-) | MEAN kg/set |
|---|---|---|---|
| 1995 | 3415 | 41% | 1.14 |
| 1996 | 5609 | 38% | 1.87 |
| 1997 | 10294 | 59% | 3.44 |
| 1998 | 12510 | 46% | 4.18 |
| 1999 | 6117 | 33% | 2.04 |
| 2000 | 3505 | 26% | 1.18 |
| 2001 | 3176 | 26% | 1.06 |
| 2002 | 820 | 59% | 0.27 |
| 2003 | 945 | 69% | 0.31 |

**Table 4: Fall multi - species survey pre-recruit index by year for Div. 2J.**

| YEAR | BIOMASS (t) | CONFIDENCE INTERVALS (+/-) | MEAN kg/set |
|---|---|---|---|
| 1995 | 2096 | 84% | 0.70 |
| 1996 | 2410 | 47% | 0.80 |
| 1997 | 2813 | 50% | 0.94 |
| 1998 | 3476 | 35% | 1.16 |
| 1999 | 1082 | 85% | 0.36 |
| 2000 | 1211 | 45% | 0.41 |
| 2001 | 1254 | 147% | 0.42 |
| 2002 | 547 | 447% | 0.18 |
| 2003 | 861 | 49% | 0.28 |

**Table 5: TAC (t), Landings (t), Effort (trap hauls), and CPUE (Kg/trap) by year for Div. 3K.**

| Year | TAC | Landings | Effort | CPUE Offshore | CPUE Inshore |
|---|---|---|---|---|---|
| 1981 | | 1,303 | 110,424 | | |
| 1982 | | 2,443 | 294,337 | | |
| 1983 | | 4,898 | 612,250 | | |
| 1984 | | 5,031 | 606,145 | | |
| 1985 | | 4,001 | 689,828 | | |
| 1986 | 4,000 | 4,277 | 1,069,250 | | |
| 1987 | 4,000 | 2,678 | 723,784 | | |
| 1988 | 2,550 | 2,681 | 570,426 | | |
| 1989 | 2,350 | 2,346 | 418,929 | | |
| 1990 | 4,380 | 4,309 | 398,981 | 14.7 | 6.7 |
| 1991 | 7,650 | 8,353 | 673,629 | 14.9 | 9.3 |
| 1992 | 6,650 | 7,543 | 633,866 | 13.3 | 9.5 |
| 1993 | 8,575 | 10,463 | 721,586 | 16.2 | 10.5 |
| 1994 | 9,800 | 10,724 | 794,370 | 15.3 | 9.1 |
| 1995 | 11,450 | 12,326 | 1,018,678 | 13.7 | 8.3 |
| 1996 | 12,950 | 14,210 | 1,280,180 | 13 | 6.4 |
| 1997 | 14,300 | 14,796 | 1,395,849 | 13.4 | 5.8 |
| 1998 | 15,740 | 16,839 | 1,347,120 | 15.1 | 5.7 |
| 1999 | 18,192 | 21,386 | 2,117,426 | 13.4 | 4 |
| 2000 | 13,493 | 15,390 | 1,691,209 | 11.2 | 4.4 |
| 2001 | 13,693 | 15,288 | 1,513,663 | 10.2 | 8.9 |
| 2002 | 15,378 | 16,352 | 1,587,573 | 10.8 | 8.3 |
| 2003 | 15,608 | 16,493 | 1,736,105 | 10.4 | 7.2 |

**Table 6 : Fall multi-species survey exploitable biomass index for Div. 3K**

| YEAR | BIOMASS (t) | CONFIDENCE INTERVALS (+/-) | MEAN kg/set |
|---|---|---|---|
| 1995 | 10938 | 24% | 2.10 |
| 1996 | 21958 | 21% | 4.21 |
| 1997 | 18905 | 22% | 3.63 |
| 1998 | 18578 | 24% | 3.61 |
| 1999 | 8455 | 30% | 1.62 |
| 2000 | 9796 | 25% | 1.98 |
| 2001 | 11162 | 41% | 2.14 |
| 2002 | 8730 | 30% | 1.68 |
| 2003 | 3594 | 27% | 0.70 |

**Table 7: Fall multi-species survey pre-recruit index by year for Div. 3K.**

| YEAR | BIOMASS (t) | CONFIDENCE INTERVALS (+/-) | MEAN kg/set |
|---|---|---|---|
| 1995 | 7340 | 49% | 1.41 |
| 1996 | 10704 | 38% | 2.05 |
| 1997 | 13070 | 34% | 2.51 |
| 1998 | 9790 | 42% | 1.90 |
| 1999 | 3419 | 41% | 0.66 |
| 2000 | 8954 | 38% | 1.81 |
| 2001 | 6299 | 35% | 1.21 |
| 2002 | 4838 | 42% | 0.93 |
| 2003 | 2340 | 79% | 0.45 |

**Table 8: TAC (t), Landings (t), Effort (trap hauls) and CPUE (Kg/trap) by year for Div. 3L.**

| Year | TAC | Landings | Effort | CPUE Offshore | CPUE Inshore |
|---|---|---|---|---|---|
| 1981 | | 12,855 | 851,325 | | |
| 1982 | | 11,041 | 716,948 | | |
| 1983 | | 6,211 | 627,374 | | |
| 1984 | | 4,524 | 706,875 | | |
| 1985 | | 2,638 | 507,308 | | |
| 1986 | 3,300 | 3,506 | 480,274 | | |
| 1987 | 2,800 | 3,133 | 352,022 | | |
| 1988 | 4,450 | 5,319 | 625,765 | | |
| 1989 | 6,000 | 4,423 | 614,306 | | |
| 1990 | 6,800 | 5,394 | 719,200 | 8.1 | 7.4 |
| 1991 | 5,900 | 6,430 | 803,750 | 9.7 | 7.7 |
| 1992 | 5,900 | 6,992 | 568,455 | 18.1 | 11.4 |
| 1993 | 7,175 | 9,074 | 677,164 | 16.7 | 12.9 |
| 1994 | 10,100 | 11,944 | 785,789 | 16.9 | 15.2 |
| 1995 | 11,650 | 14,007 | 828,817 | 18.9 | 15.6 |
| 1996 | 14,775 | 16,416 | 1,124,384 | 16.4 | 13.1 |
| 1997 | 18,925 | 20,691 | 1,477,929 | 17.3 | 11.6 |
| 1998 | 19,975 | 23,289 | 1,464,717 | 17.7 | 11.4 |
| 1999 | 26,375 | 26,220 | 1,618,519 | 17.7 | 11.4 |
| 2000 | 22,710 | 22,600 | 1,215,054 | 19.4 | 11.7 |
| 2001 | 23,655 | 23,469 | 1,341,086 | 18.9 | 10.7 |
| 2002 | 26,448 | 25,026 | 1,564,125 | 18.6 | 11.2 |
| 2003 | 27,807 | 26,159 | 1,952,164 | 16.3 | 8.8 |

**Table 9: Fall multi - species surevy exploitable biomass index by year for Div. 3L.**

| YEAR | BIOMASS (t) | CONFIDENCE INTERVALS (+/-) | MEAN kg/set |
|---|---|---|---|
| 1995 | 22194 | 38% | 3.73 |
| 1996 | 31955 | 30% | 5.37 |
| 1997 | 20163 | 37% | 3.37 |
| 1998 | 23205 | 32% | 3.88 |
| 1999 | 12718 | 25% | 2.13 |
| 2000 | 9109 | 25% | 1.56 |
| 2001 | 11734 | 22% | 1.96 |
| 2002 | 11387 | 32% | 1.9 |
| 2003 | 9696 | 31% | 1.62 |

**Table 10: Fall multi – species exploitable biomass index by year for Div. 3L.**

| YEAR | BIOMASS (t) | CONFIDENCE INTERVALS (+/-) | MEAN kg/set |
|---|---|---|---|
| 1995 | 44547 | 32% | 7.49 |
| 1996 | 63999 | 22% | 10.75 |
| 1997 | 40657 | 35% | 6.80 |
| 1998 | 47785 | 27% | 7.99 |
| 1999 | 25281 | 26% | 4.23 |
| 2000 | 18362 | 49% | 3.15 |
| 2001 | 21870 | 29% | 3.66 |
| 2002 | 21588 | 46% | 3.61 |
| 2003 | 18141 | 41% | 3.03 |

**Table 11: Fall multi - species survey pre-recruit biomass index by year for Div. 3L.**

| YEAR | BIOMASS (t) | CONFIDENCE INTERVALS (+/-) | MEAN kg/set |
|---|---|---|---|
| 1995 | 11135 | 55% | 0.97 |
| 1996 | 25683 | 48% | 1.98 |
| 1997 | 8437 | 42% | 0.67 |
| 1998 | 9000 | 35% | 0.72 |
| 1999 | 4492 | 99% | 1.30 |
| 2000 | 4623 | 47% | 0.62 |
| 2001 | 2935 | 102% | 0.69 |
| 2002 | 2218 | 34% | 0.31 |
| 2003 | 4296 | 42% | 0.55 |

**Table 12: Fall multi - species survey pre-recruit biomass index by year for Div. 3L.**

| YEAR | BIOMASS (t) | CONFIDENCE INTERVALS (+/-) | MEAN kg/set |
|---|---|---|---|
| 1995 | 31010 | 58% | 5.21 |
| 1996 | 77018 | 66% | 12.94 |
| 1997 | 23990 | 34% | 4.01 |
| 1998 | 23786 | 31% | 3.98 |
| 1999 | 12146 | 49% | 2.03 |
| 2000 | 11769 | 52% | 2.02 |
| 2001 | 6908 | 52% | 1.15 |
| 2002 | 5875 | 35% | 0.98 |
| 2003 | 11691 | 63% | 1.95 |

**Table 13: TAC (t), landings (t), Effort (trap hauls) and CPUE (kg/trap) by year for Div. 3NO**

| Year | TAC | Landings | Effort | CPUE Total |
|---|---|---|---|---|
| 1985 | | 7 | | |
| 1986 | | | | |
| 1987 | | | | |
| 1988 | | 327 | | |
| 1989 | | 531 | | |
| 1990 | | 78 | | |
| 1991 | | 19 | | |
| 1992 | | | | |
| 1993 | | 148 | | |
| 1994 | | 106 | | |
| 1995 | | 14 | 615 | 22.76 |
| 1996 | | 427 | 33,126 | 12.89 |
| 1997 | | 1,454 | 99,385 | 14.63 |
| 1998 | | 730 | 40,176 | 18.17 |
| 1999 | 3,250 | 6,506 | 337,098 | 19.3 |
| 2000 | 2,425 | 4,173 | 214,440 | 19.46 |
| 2001 | 2,425 | 4,703 | 233,748 | 20.12 |
| 2002 | 2,425 | 5,006 | 241,253 | 20.75 |
| 2003 | 2,670 | 5,468 | 293,348 | 18.64 |

**Table 14: Fall multispecies survey exploitable biomass index by year for Div. 3NO.**

| YEAR | BIOMASS (t) 3NO | 3N CONFIDENCE INTERVALS (+/-) | 3O CONFIDENCE INTERVALS (+/-) | 3N MEAN kg/set | 3O MEAN kg/set |
|---|---|---|---|---|---|
| 1995 | 3039 | 45% | 179% | 0.77 | 0.60 |
| 1996 | 9203 | 90% | 146% | 3.03 | 0.78 |
| 1997 | 6110 | 55% | 87% | 1.72 | 0.95 |
| 1998 | 14274 | 64% | 72% | 4.19 | 1.96 |
| 1999 | 8518 | 41% | 77% | 2.79 | 0.75 |
| 2000 | 5739 | 43% | 35% | 1.78 | 0.65 |
| 2001 | 10699 | 45% | 64% | 3.63 | 0.76 |
| 2002 | 4988 | 31% | 124% | 1.56 | 0.54 |
| 2003 | 4613 | 36% | 59% | 1.65 | 0.22 |

**Table 15: Fall multi - species survey pre - recruit index by year for Div. 3NO.**

| YEAR | BIOMASS (t) | 3N CONFIDENCE INTERVALS (+/-) | 3O CONFIDENCE INTERVALS (+/-) | 3N MEAN kg/set | 3O MEAN kg/set |
|---|---|---|---|---|---|
| 1995 | 2902 | 736% | 100% | 0.79 | 0.38 |
| 1996 | 9535 | 102% | 90% | 1.54 | 0.18 |
| 1997 | 7071 | 175% | 96% | 1.14 | 0.36 |
| 1998 | 12150 | 113% | 123% | 2.01 | 0.44 |
| 1999 | 4484 | 70% | 143% | 1.61 | 0.54 |
| 2000 | 4340 | 46% | 96% | 1.15 | 0.21 |
| 2001 | 5146 | 46% | 81% | 1.41 | 0.16 |
| 2002 | 2115 | 80% | 91% | 0.56 | 0.06 |
| 2003 | 2133 | 52% | 114% | 0.50 | 0.08 |

**Table 16: TAC (t), Landings (t), Effort (trap hauls) and CPUE (kg/trap) by year for Div. 3Ps.**

| Year | TAC | Landings | Effort | CPUE Offshore | CPUE Inshore |
|---|---|---|---|---|---|
| 1981 | | 38 | 2,533 | | |
| 1982 | | 14 | 9,333 | | |
| 1983 | | 4 | 263 | | |
| 1984 | | | | | |
| 1985 | | 705 | 110,156 | | |
| 1986 | 600 | 584 | 166,857 | | |
| 1987 | 600 | 587 | 195,667 | | |
| 1988 | 600 | 723 | 133,889 | | |
| 1989 | 700 | 528 | 96,000 | | |
| 1990 | 700 | 597 | 124,375 | | 4.8 |
| 1991 | 700 | 309 | 67,174 | | 4.7 |
| 1992 | 500 | 170 | 16,832 | | 11.8 |
| 1993 | 500 | 829 | 74,685 | | 11.2 |
| 1994 | 850 | 1,538 | 103,919 | 19.5 | 15.5 |
| 1995 | 1,725 | 1,929 | 158,115 | 15.5 | 2.3 |
| 1996 | 3,050 | 2,974 | 177,024 | 16.3 | 18.8 |
| 1997 | 4,600 | 4,675 | 286,810 | 19.1 | 12.5 |
| 1998 | 6,000 | 6,619 | 398,735 | 24.1 | 11.2 |
| 1999 | 7,959 | 7,905 | 510,000 | 24.5 | 10.4 |
| 2000 | 7,700 | 7,887 | 559,362 | 20.7 | 9.9 |
| 2001 | 7,600 | 7,830 | 518,543 | 16.3 | 12.2 |
| 2002 | 7,600 | 7,637 | 756,139 | 12.1 | 7.9 |
| 2003 | 6,085 | 6,110 | 825,676 | 8.2 | 6.2 |

**Table 17: TAC(t), Landings (t), Effort(trap hauls) and CPUE(kg/trap) by year for Div. 4R3Pn.**

| Year | TAC | Landings | Effort | CPUE Offshore | CPUE Inshore |
|---|---|---|---|---|---|
| 1985 | | 291 | | | |
| 1986 | | 133 | | | |
| 1987 | | 50 | | | |
| 1988 | | 82 | | | |
| 1989 | | 15 | | | |
| 1990 | | 46 | | | |
| 1991 | | 48 | | | |
| 1992 | | 238 | | | |
| 1993 | | 141 | 28,776 | | 4.9 |
| 1994 | | 634 | 112,411 | | 5.6 |
| 1995 | | 869 | 145,805 | 5.3 | 7.4 |
| 1996 | 1,289 | 838 | 180,603 | 3.9 | 5.3 |
| 1997 | 1,390 | 927 | 221,770 | 3.3 | 5.8 |
| 1998 | 1,310 | 1,034 | 242,723 | 3.7 | 5.5 |
| 1999 | 1,330 | 1,380 | 275,449 | 4.5 | 6.2 |
| 2000 | 1,430 | 1,556 | 311,824 | 5 | 4.8 |
| 2001 | 1,539 | 1,566 | 344,934 | 4.4 | 5.3 |
| 2002 | 1,749 | 1,753 | 273,053 | 5.3 | 8.8 |
| 2003 | 1,895 | 1,565 | 261,269 | 3.9 | 9.4 |

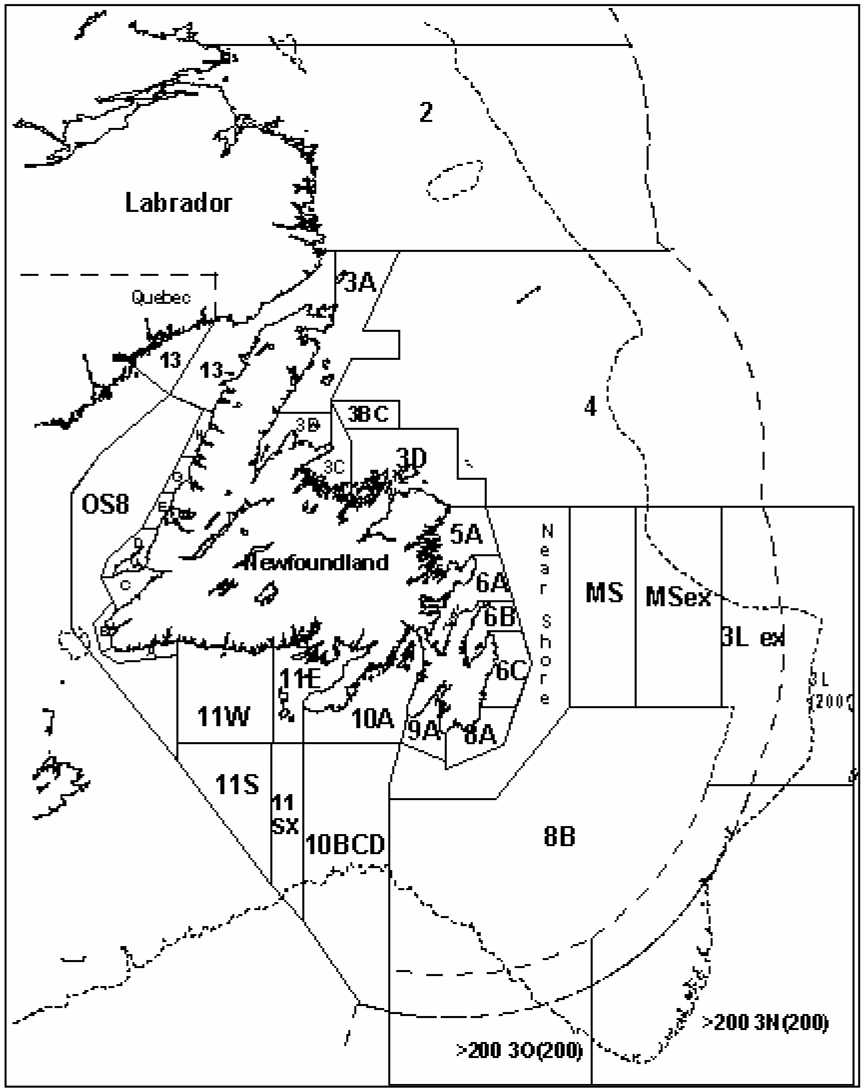



**Figure 1: Newfoundland and Labrador Snow Crab Management areas.**

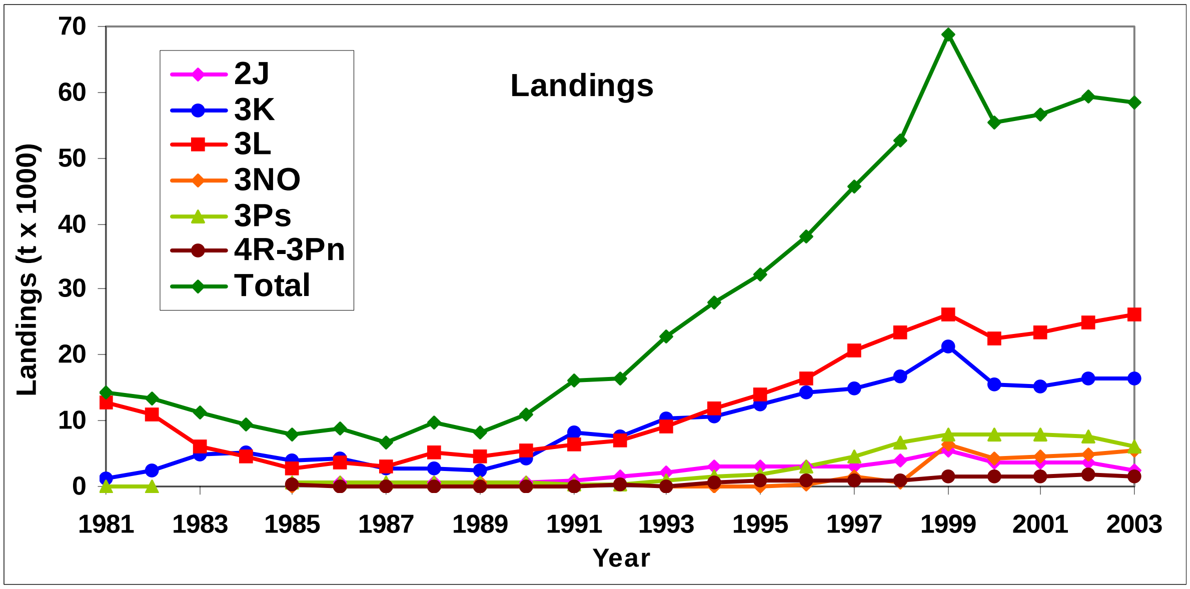



**Figure 2 : Trends in annual landings by NAFO Division.**

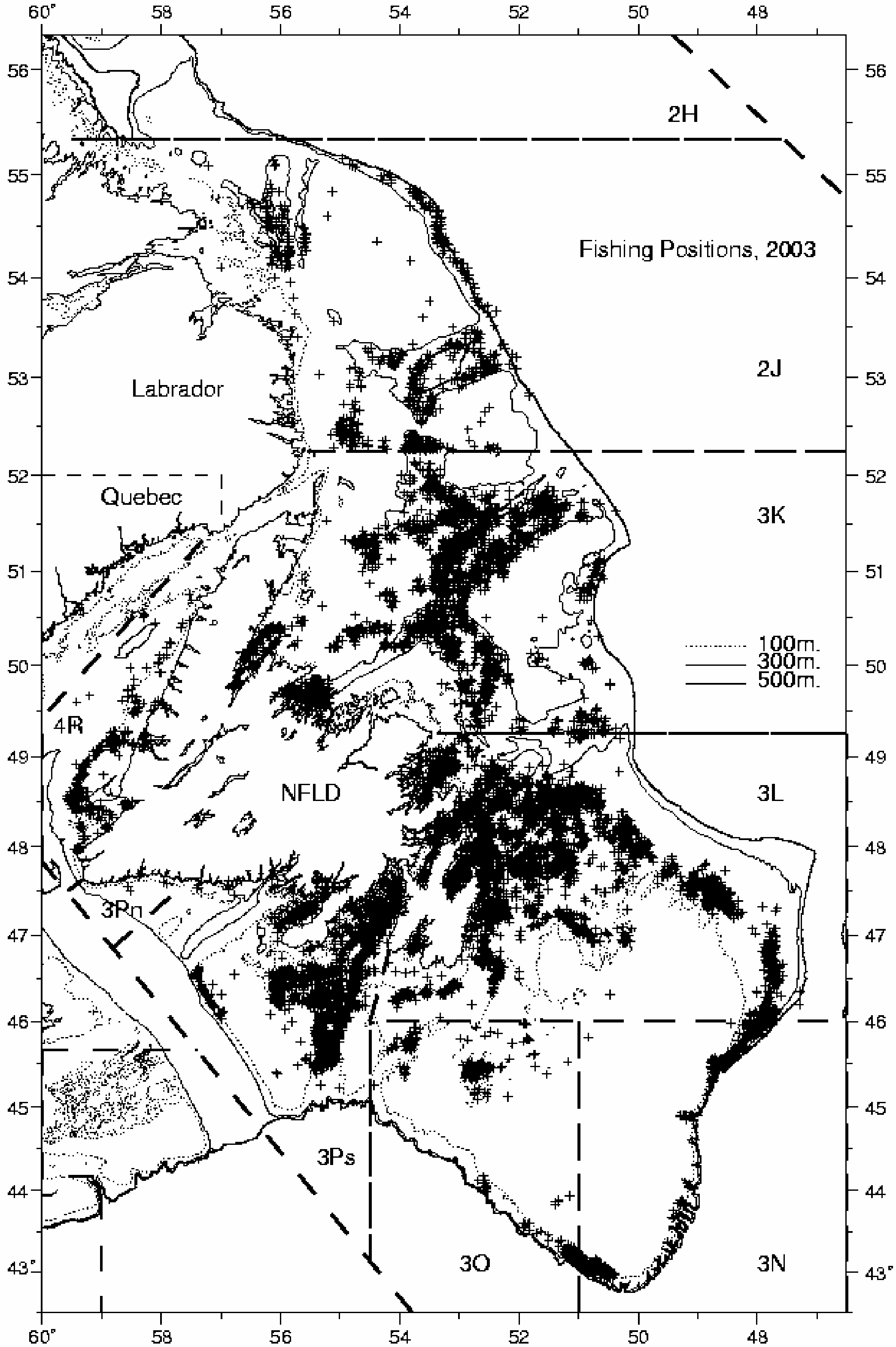



**Figure 3: Spatial distribution of commercial fishing effort during 2003.**

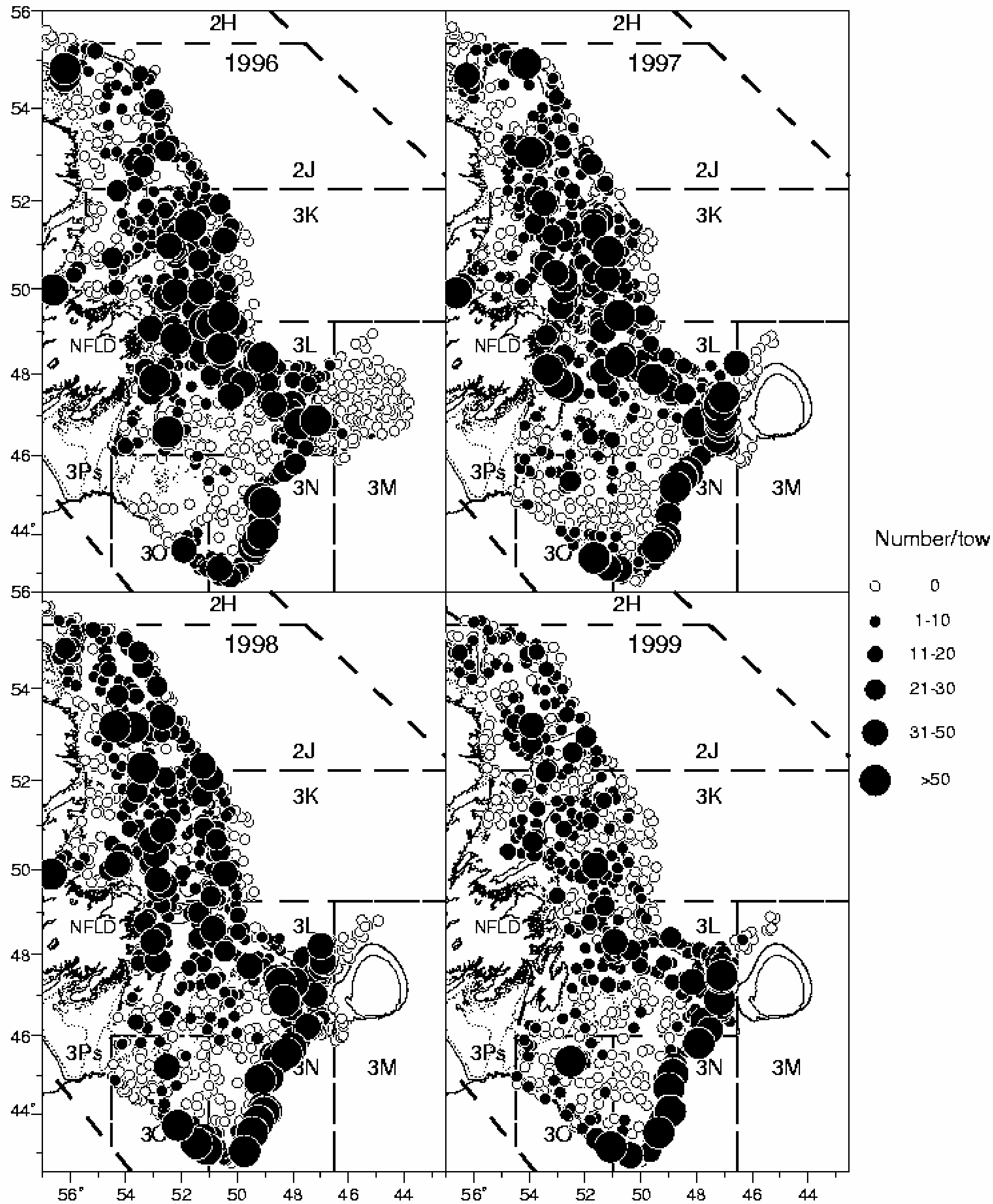



**Figure 4: Distribution of Legal - sized males (> 94mm CW) from fall Div. 2J3KLNO multi – species surveys from 1996-1999.**

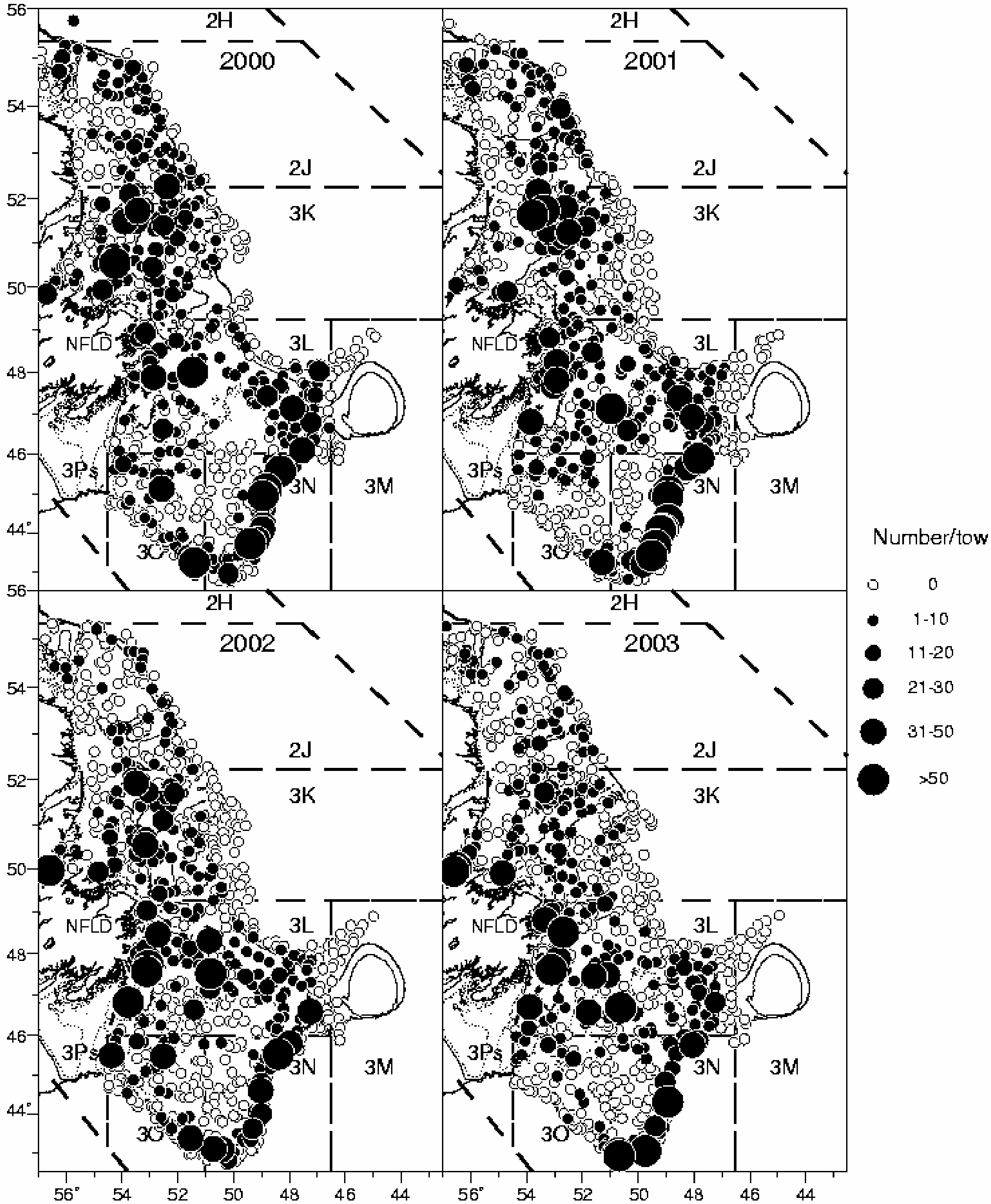



**Figure 5: Distribution of Legal - sized males (> 94mm CW) from fall Div. 2J3KLNO multi - species surveys from 2000-2003.**

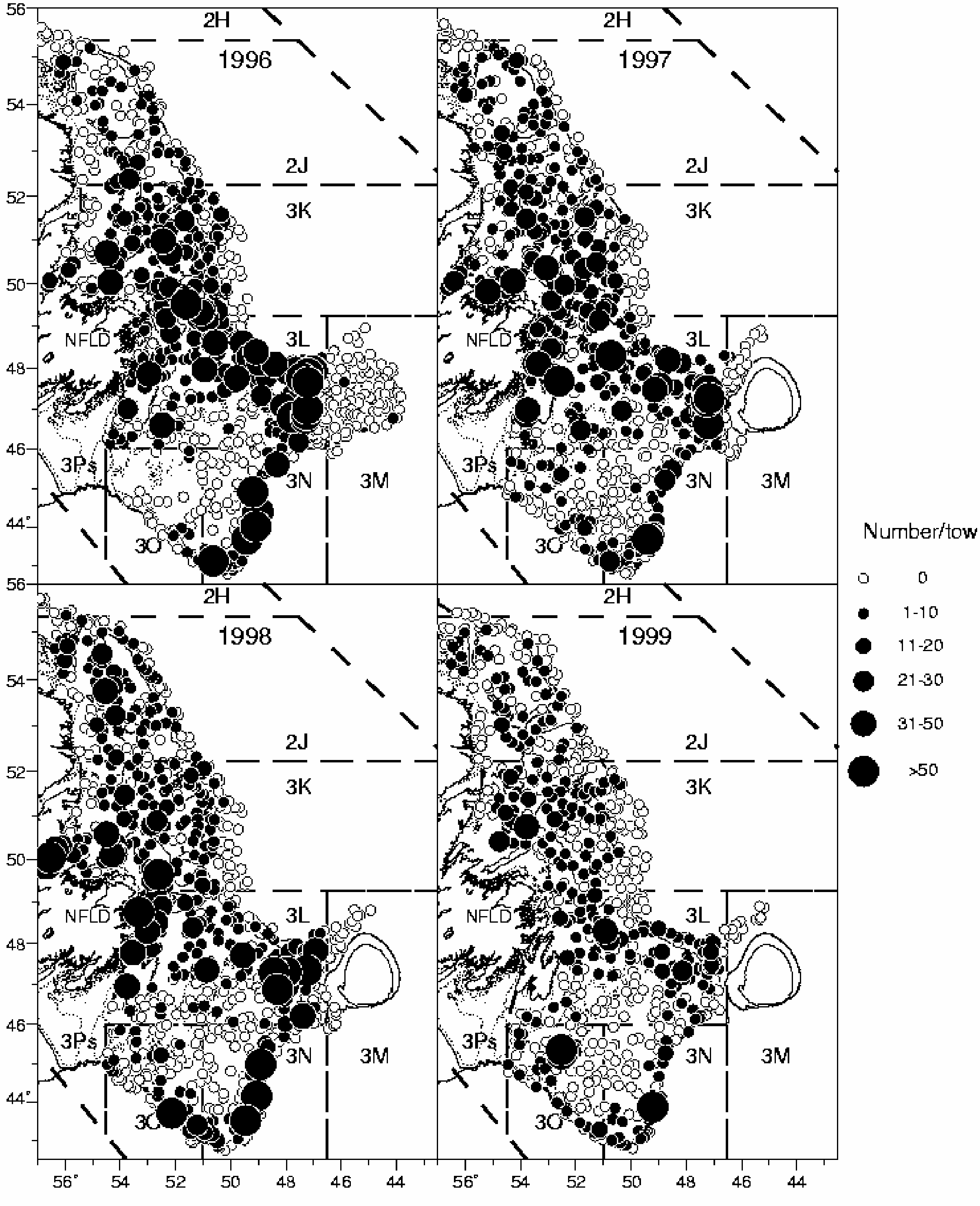



**Figure 6: Distribution of Sublegal 1 males (76-94 mm CW) from fall Div. 2J3KLNO multi - species bottom trawl surveys from 1996-1999**

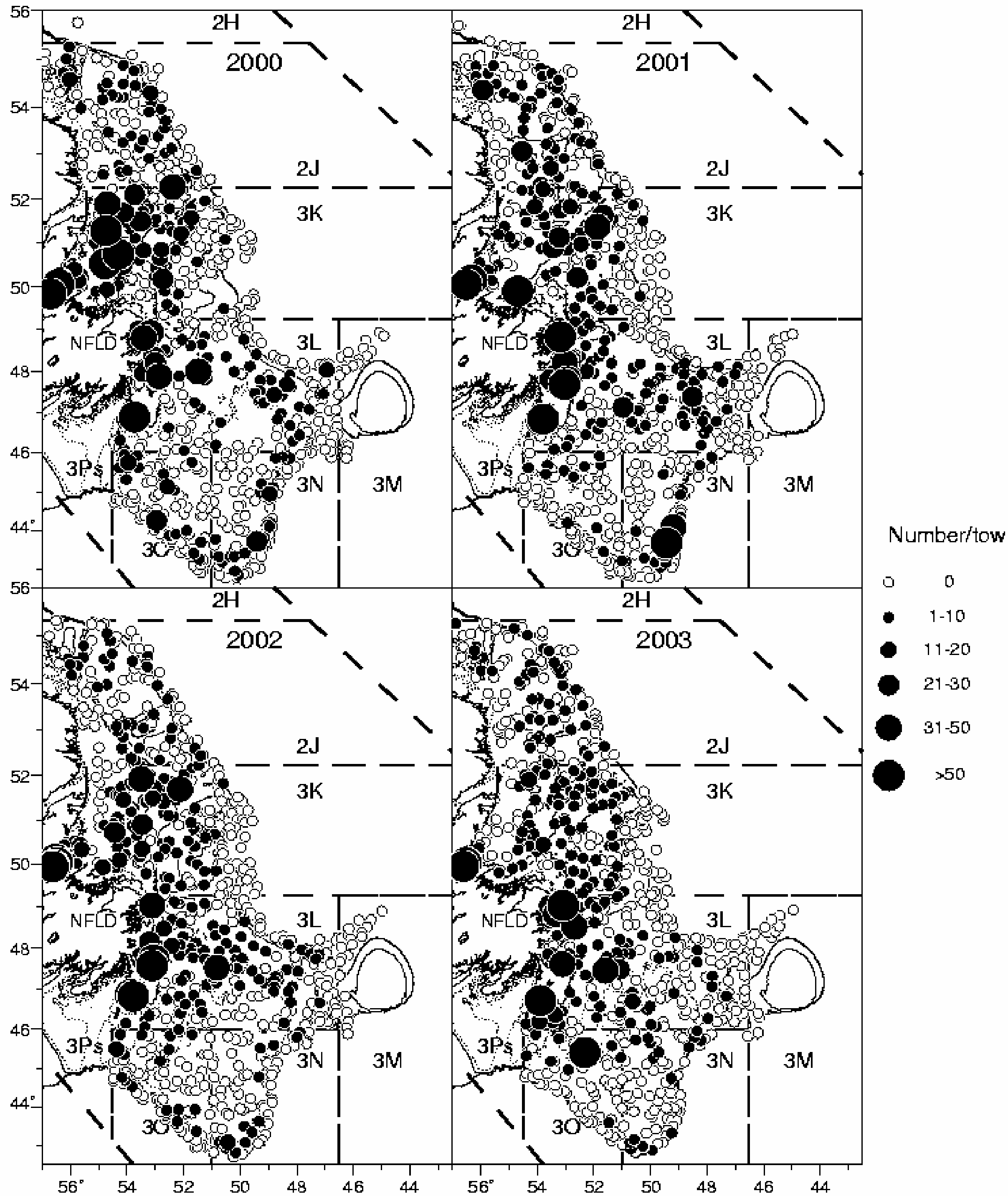



**Figure 7: Distribution of Sublegal 2 males (76-94 mm CW) from fall multi - species bottom trawl surveys from 2000-2003.**

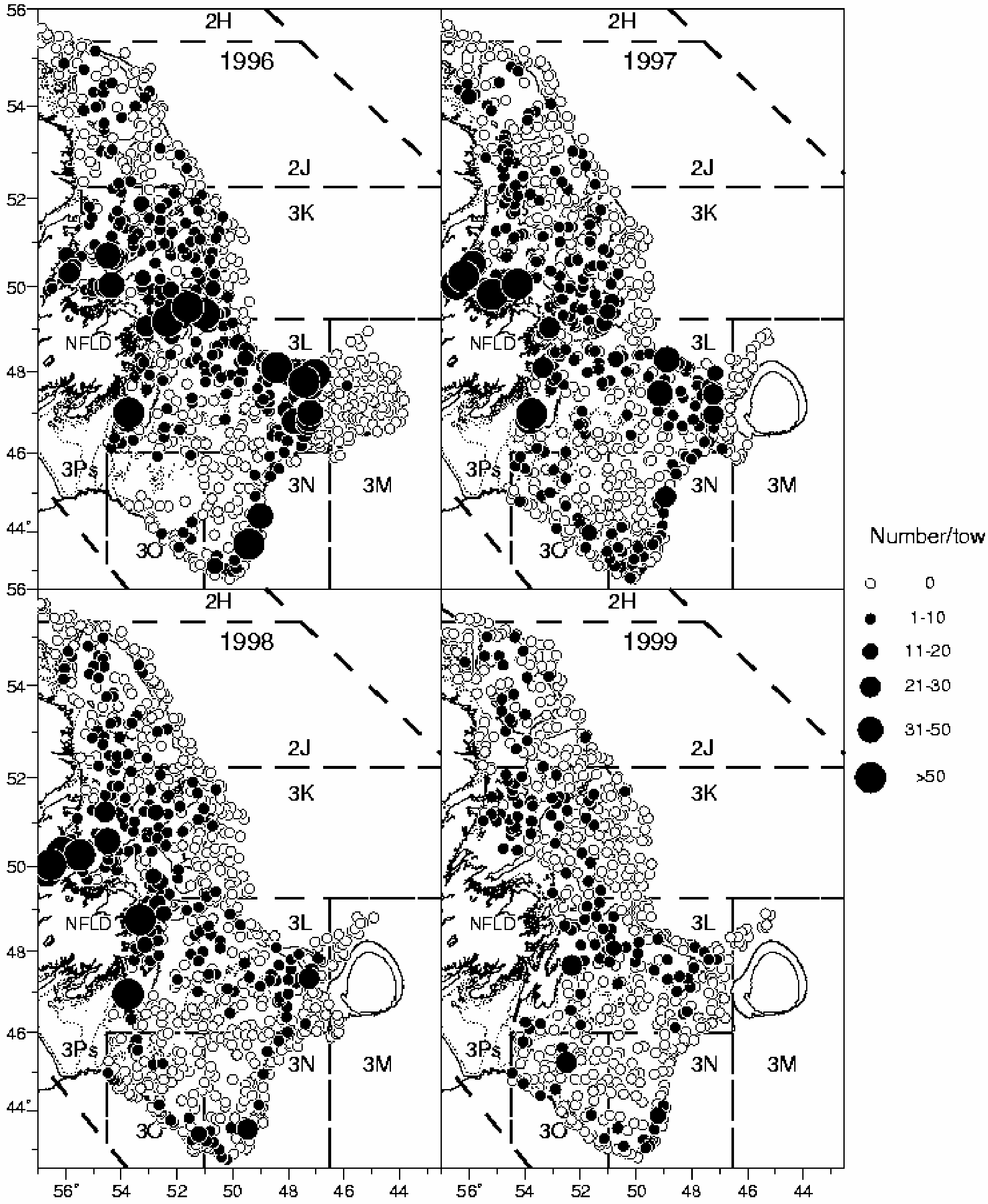



**Figure 8: Distribution of Sublegal 2 males (60-75 mm CW) from fall Div. 2J3KLNO multi - species bottom trawl surveys from 1996-1999.**

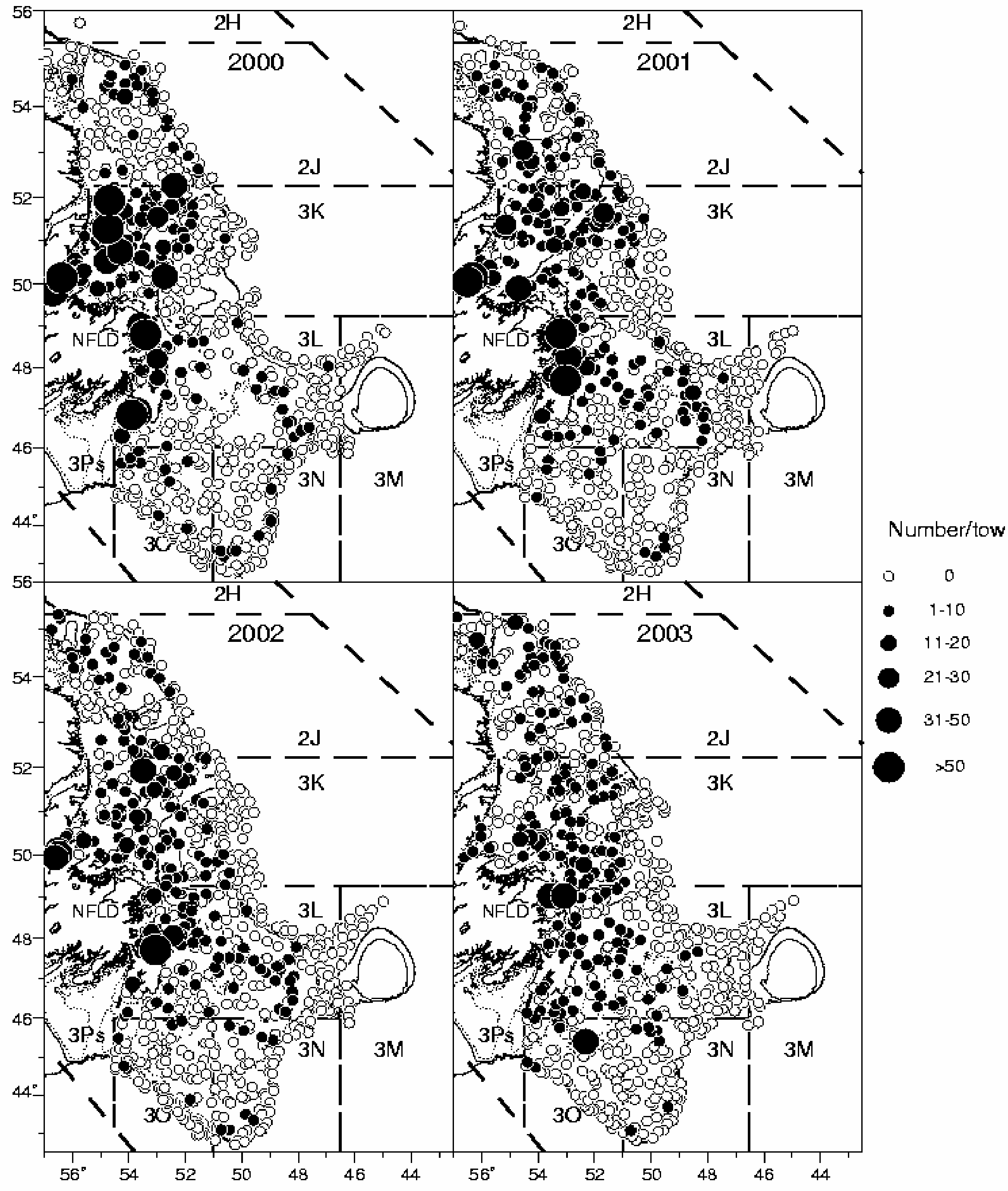



**Figure 9: Distribution of Sublegal 2 males (60-75mm CW) from fall Div. 2J3KLNO multi - species bottom trawl surveys from 2000-2003.**

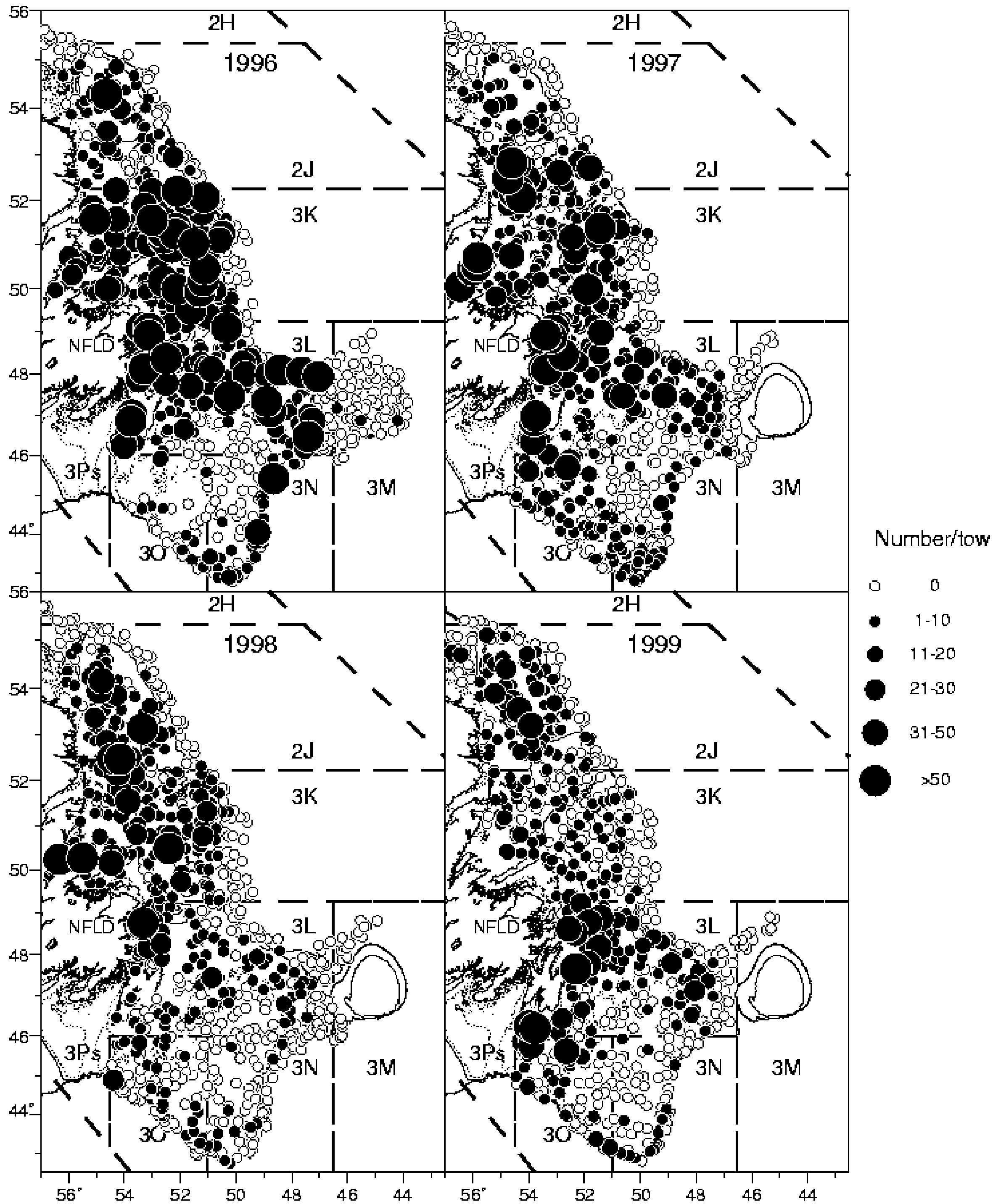



**Figure 10: Distribution of Sublegal 3 males (<60 mm CW) from fall Div. 2J3KLNO multi - species bottom trawl surveys from 1996-1999.**

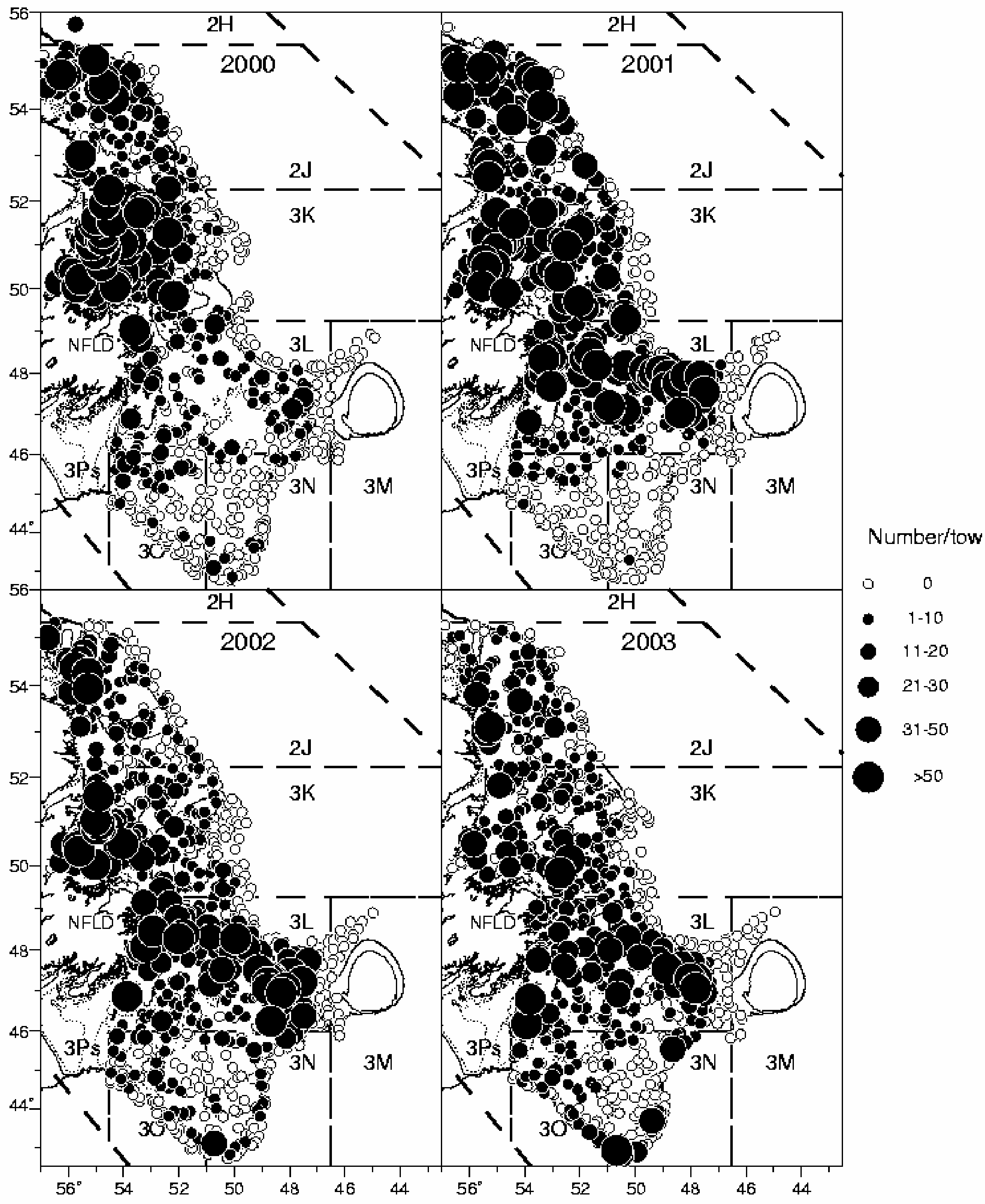



**Figure 11: Distribution of Sublegal 3 males (<60 mm CW) from fall Div. 2J3KLNO multi - species bottom trawl surveys from 2000-2003.**

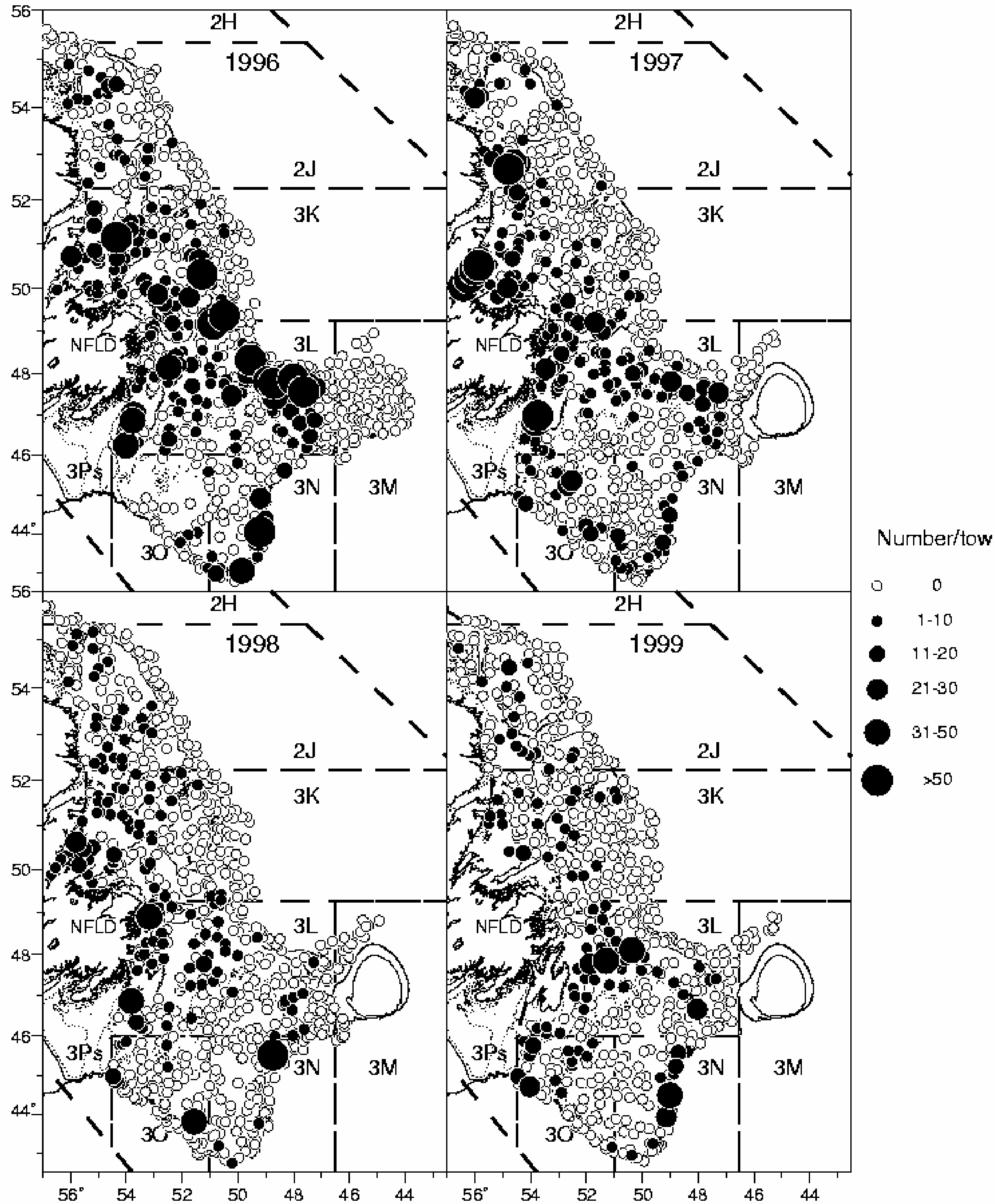



**Figure 12: Distribution of mature females from fall Div. 2J3KLNO multi - species bottom trawl surveys from 1996-1999.**

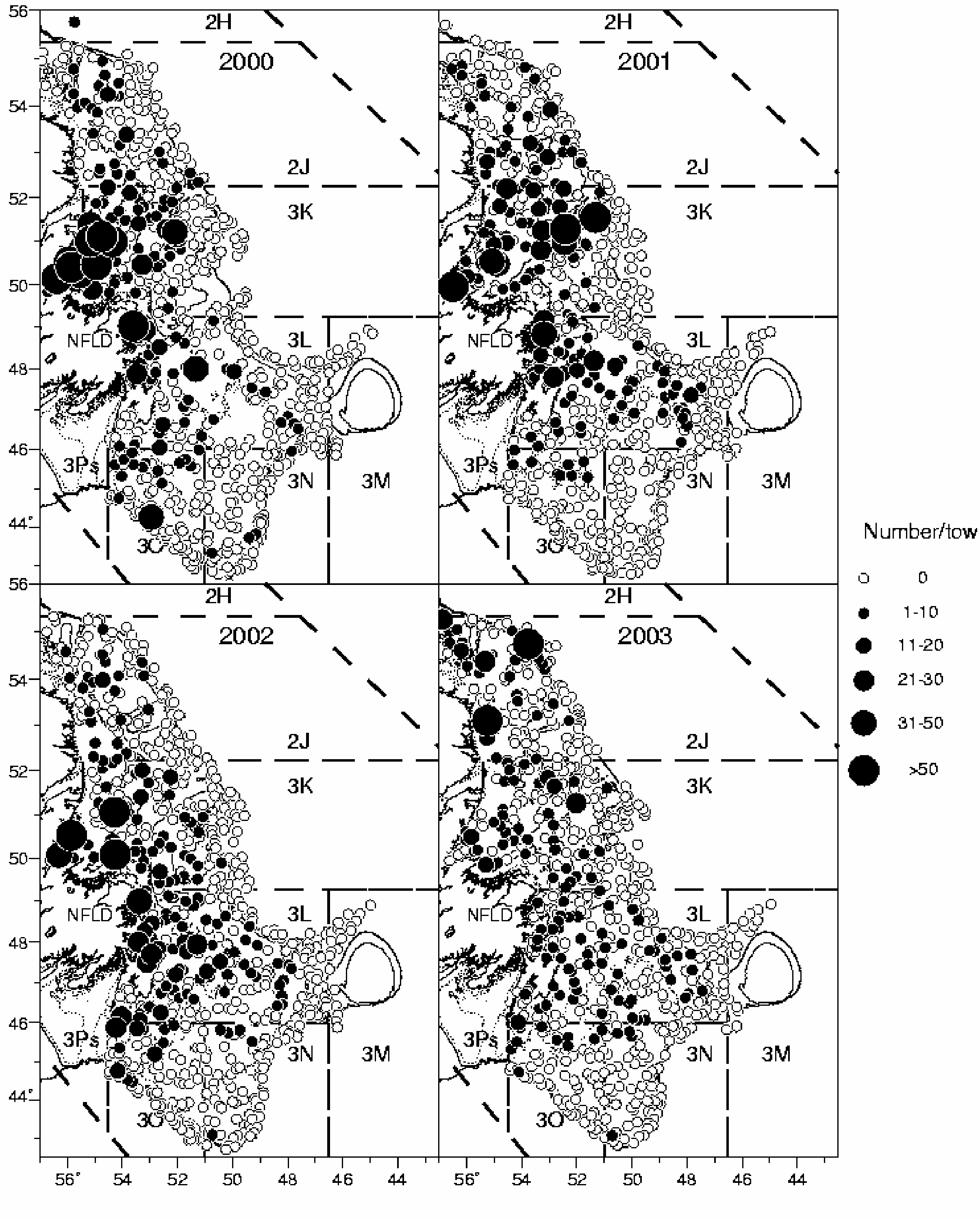



**Figure 13: Distribution of mature females from fall Div. 2J3KLNO multi - species bottom trawl surveys from 2000-2003.**

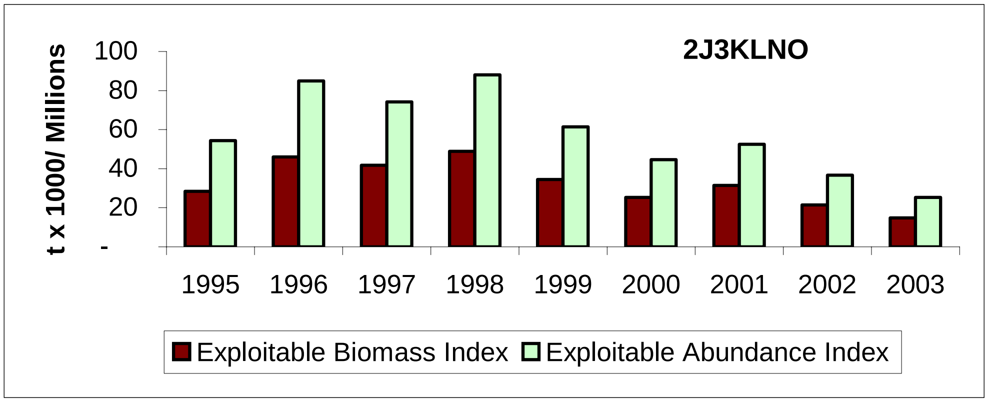



**Figure 14: Annual trends in the fall multi-species survey exploitable biomass and abundance indices, for Div. 2J3KLNO.**

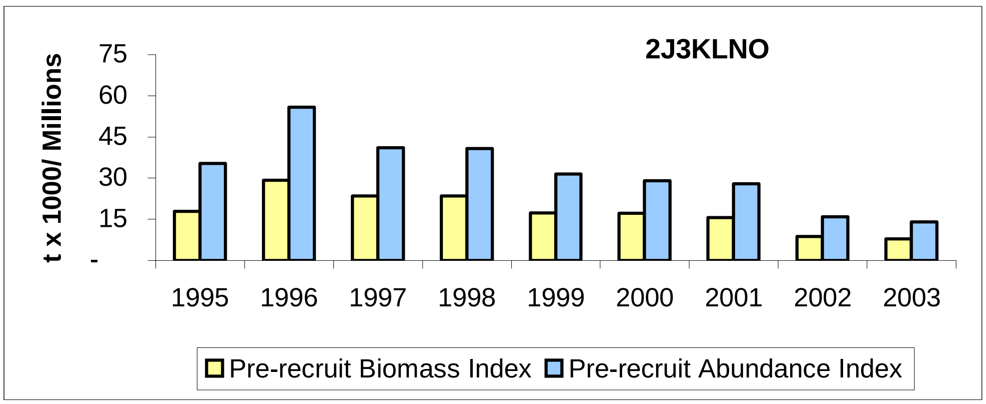



**Figure 15: Annual trends in the fall multi-species survey pre-recruit biomass and abundance indices, for Div. 2J3KLNO.**

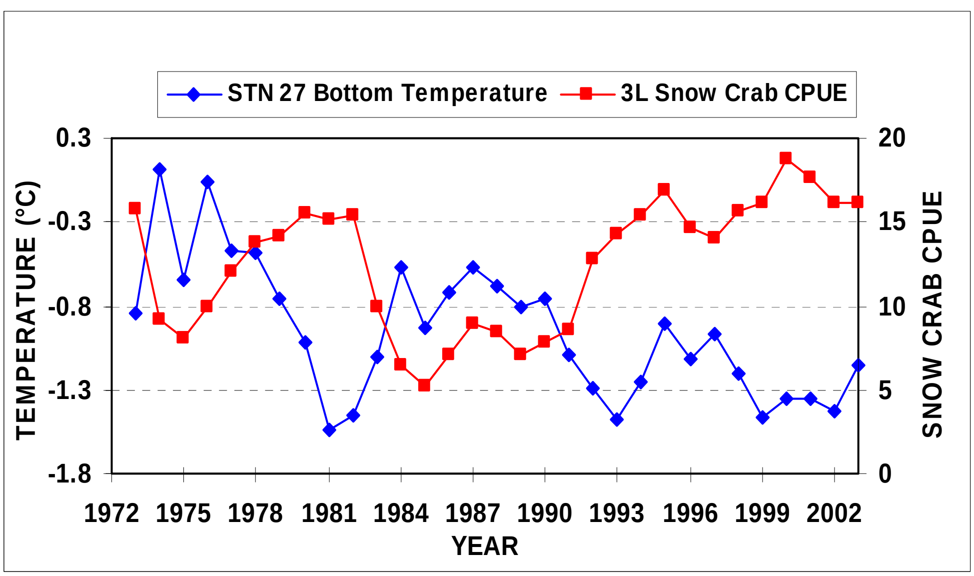



**Figure 16: Trends in Div. 3L CPUE and lagged (8 years) Station 27 bottom temperature.**

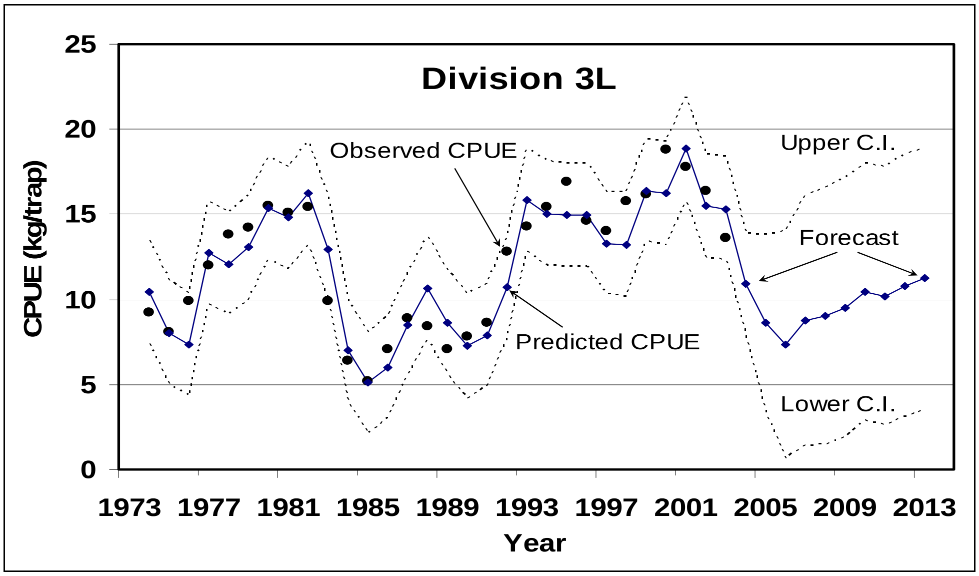



**Figure 17: Comparison of observed Div. 3L CPUE values with those predicted by a model that includes ice cover 10 years earlier as an explanatory variable.**

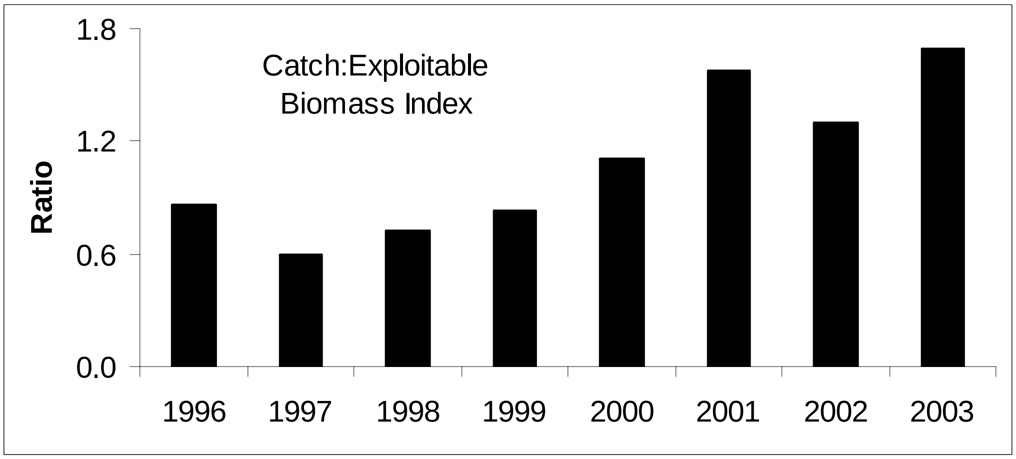



**Figure 18: Ratio of the landed catch to the exploitable biomass index from fall Div. 2J3KLNO multi-species surveys**

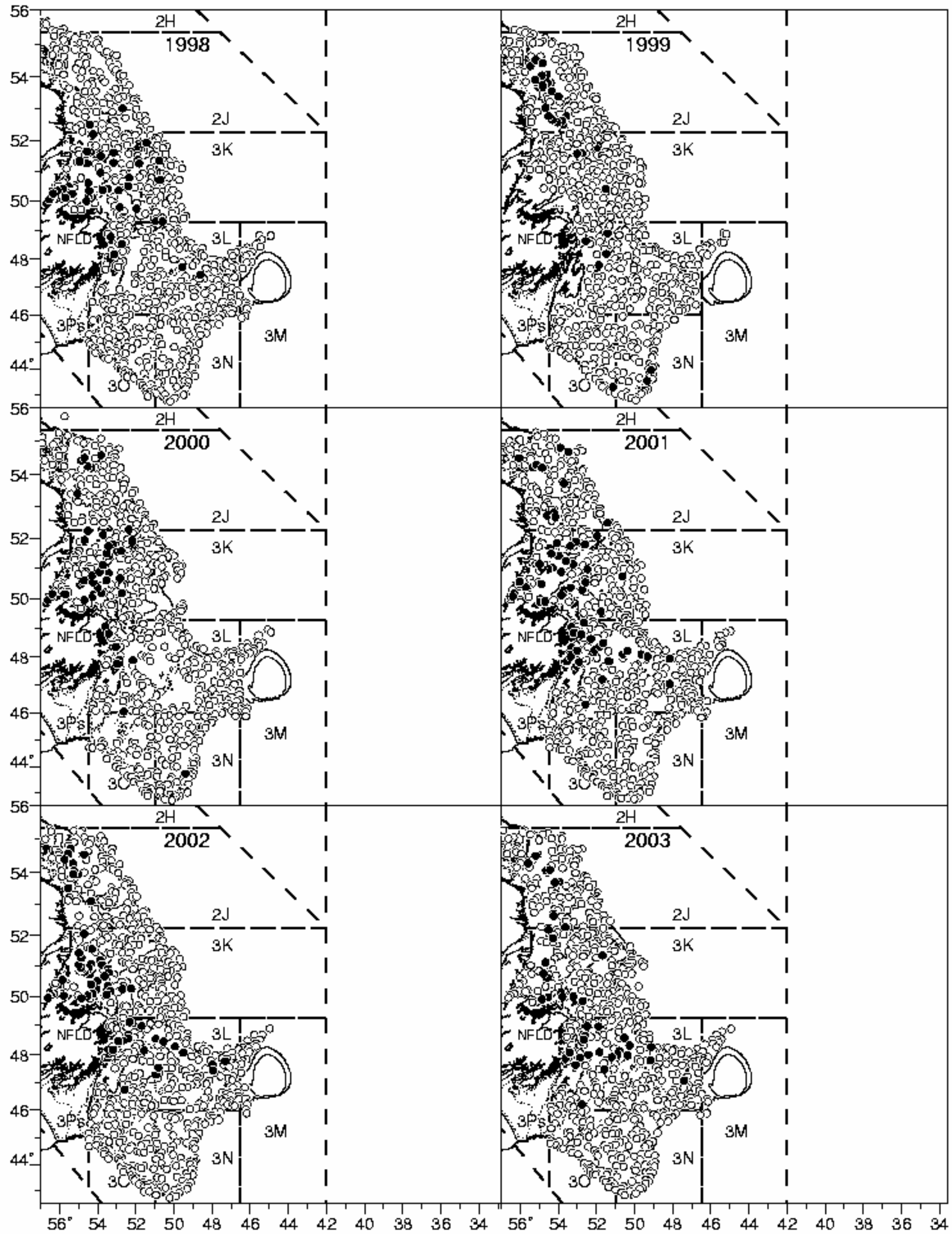



**Figure 19: Distribution by year of survey sets where BCD was encountered (closed circles) versus all other sets (open circles) during 1998-2003.from fall Div. 2J3KLNO multi-species surveys**

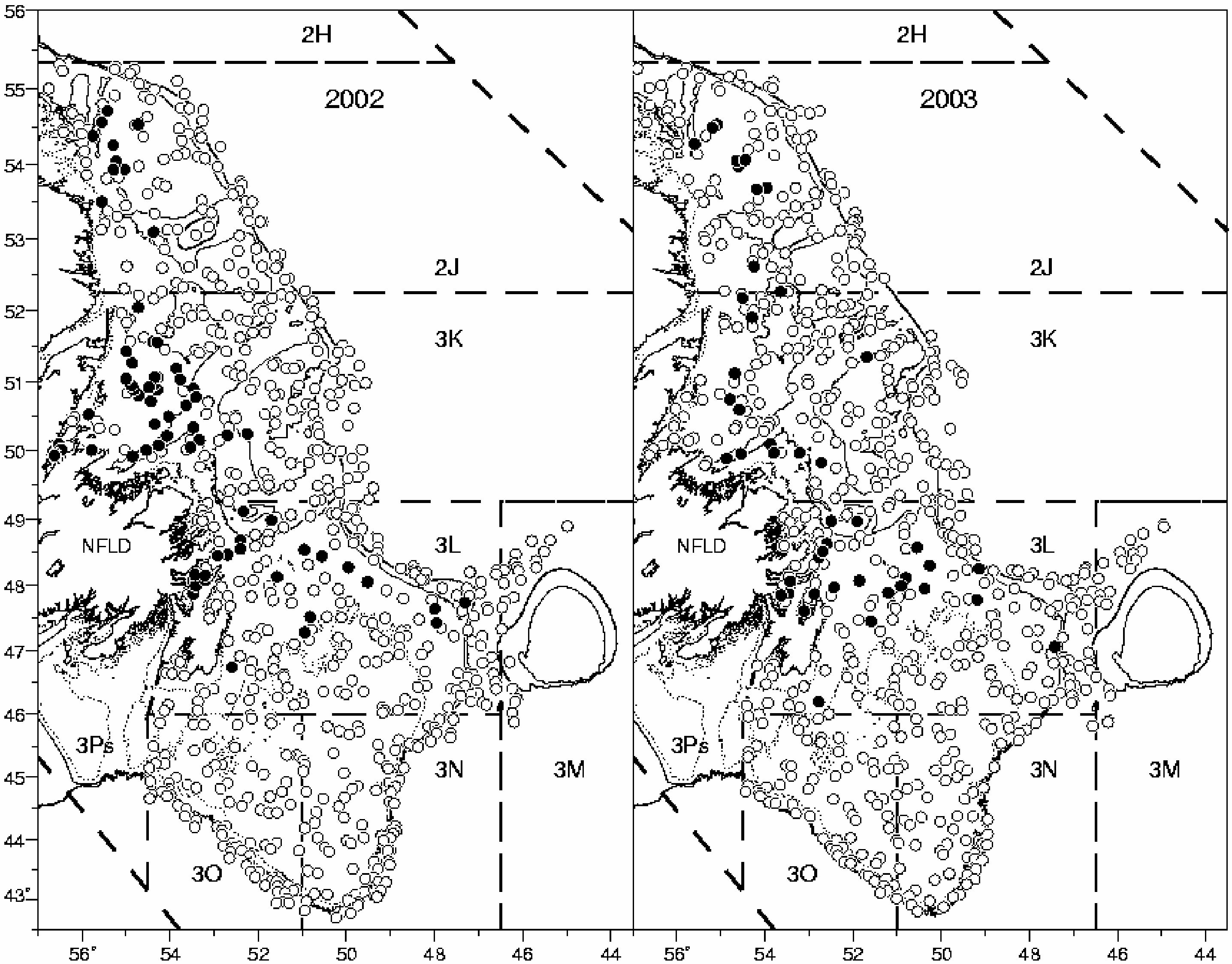



**Figure 20: Distribution of sets in which BCD was encountered (closed circles) versus sets in which BCD was not observed (open circles), for years 2002 and 2003 from fall multi –species surveys.**

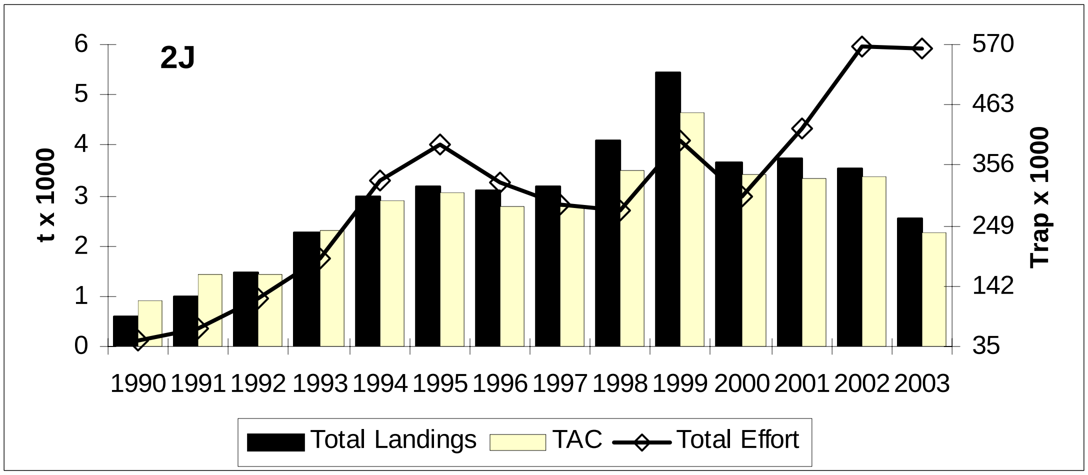



**Figure 21: Annual trends in Div. 2J landings, TAC and fishing effort.**

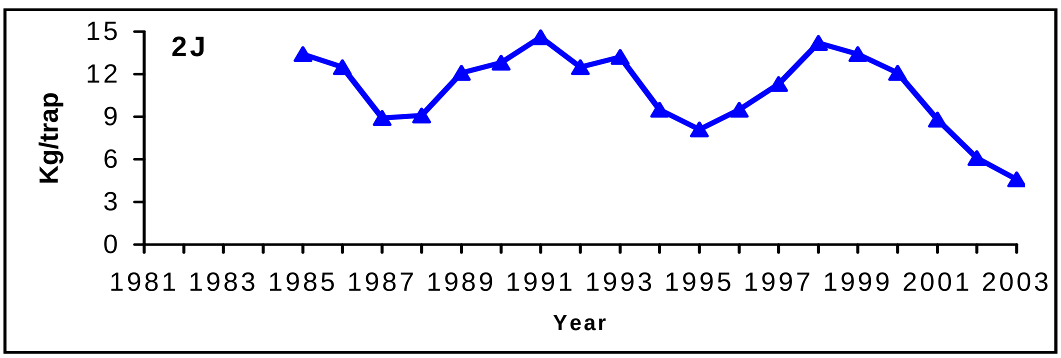



**Figure 22: Annual trends in Div. 2J commercial CPUE**

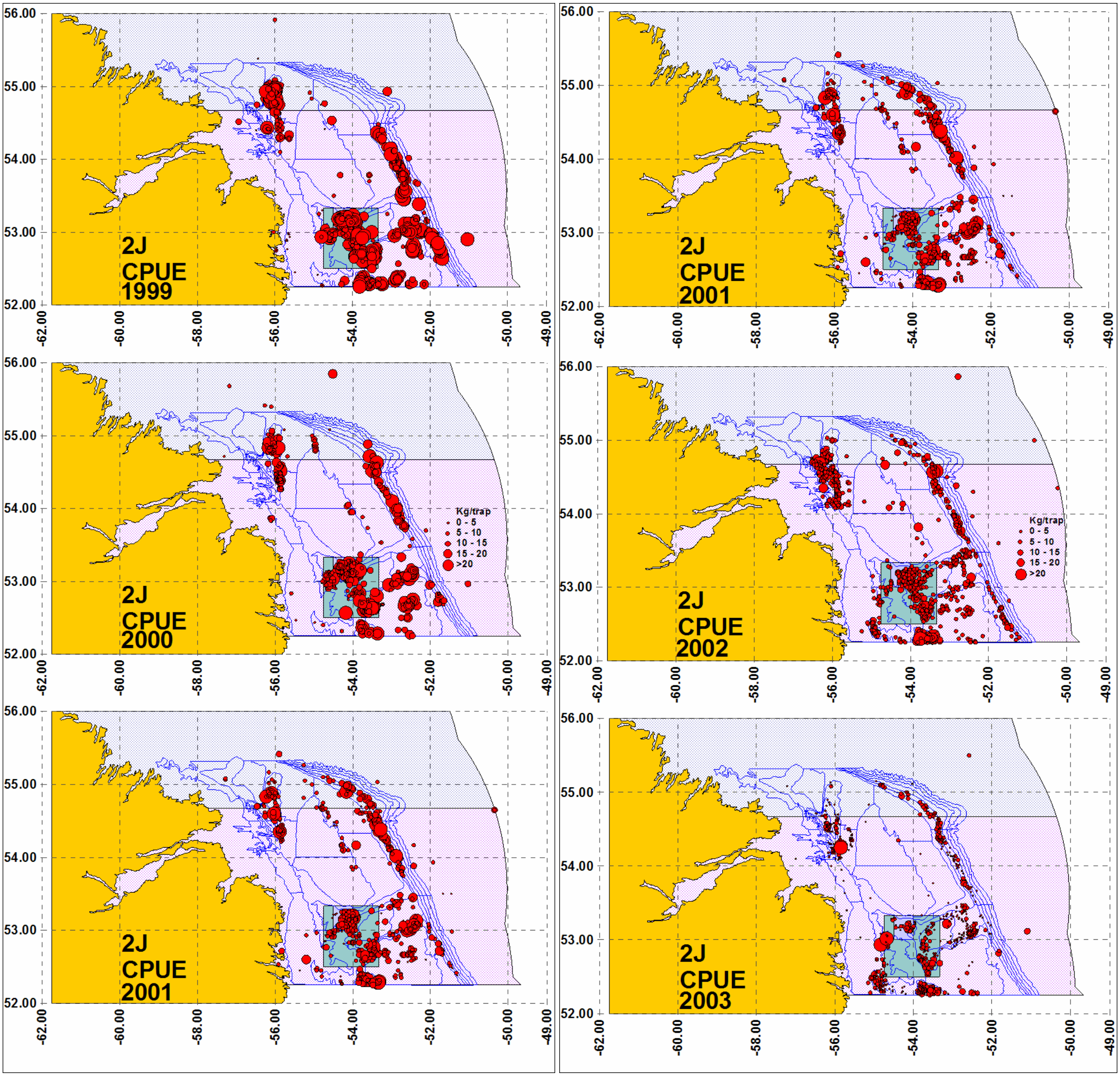



**Figure 23: Spatial distribution of commercial CPUE within Div. 2J during 1999 – 2003.**

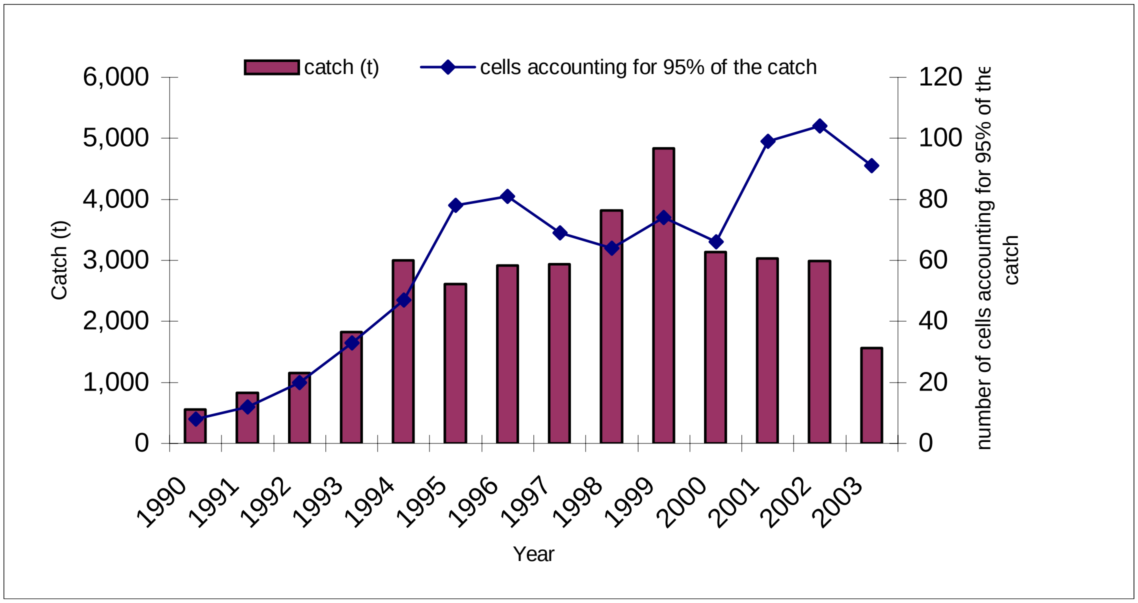



**Figure 24: Annual trends in commercial catch versus spatial distribution of the fishery within Div. 2J.**

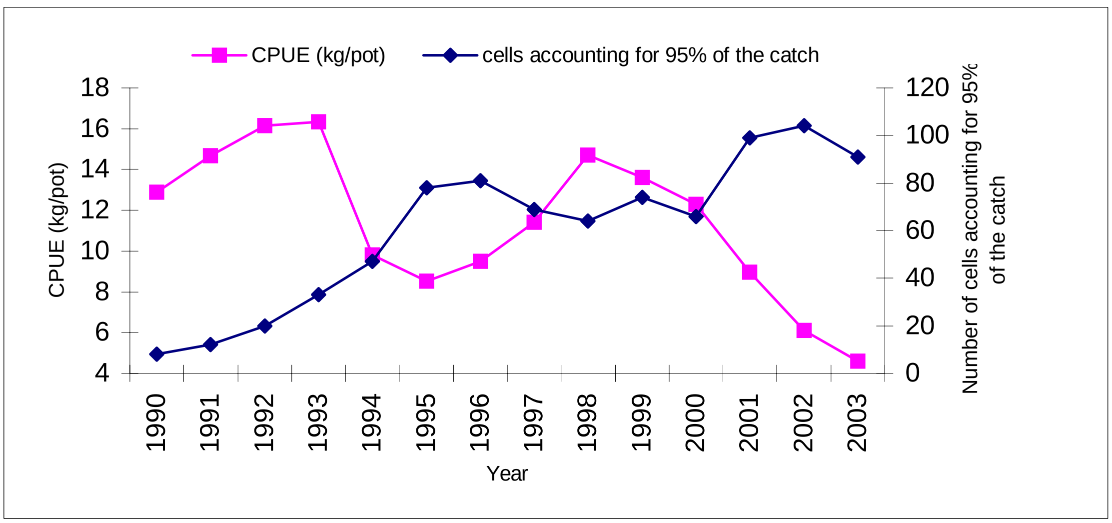



**Figure 25: Annual trends in commercial CPUE versus spatial distribution of the fishery within Div. 2J.**

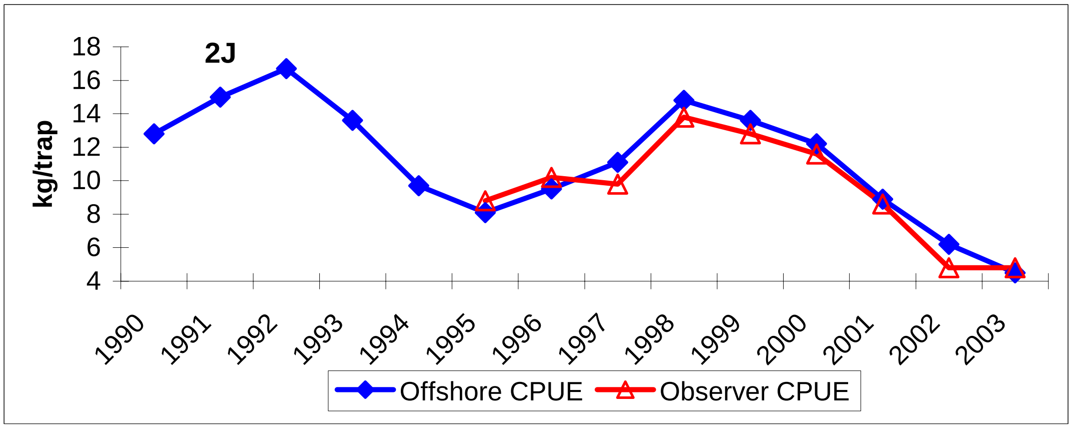



**Figure 26: Annual trends in logbook- based CPUE vs. observer - based CPUE in the Div. 2J fishery.**

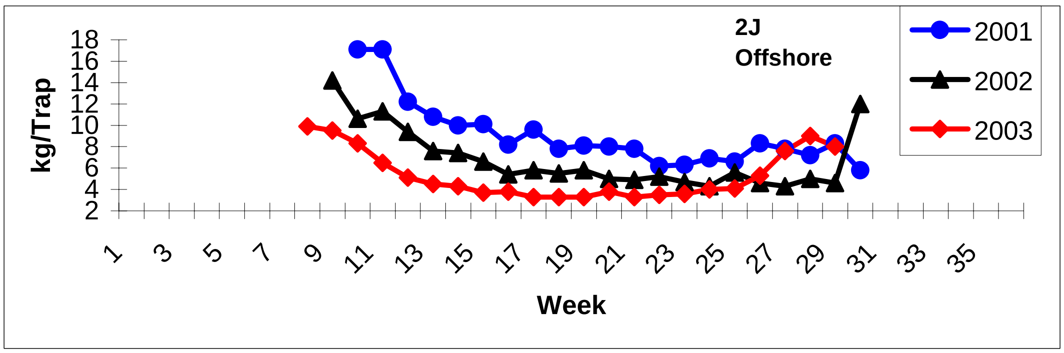



**Figure 27: Seasonal trend in CPUE, by week, for Div. 2J during 2001-2003**

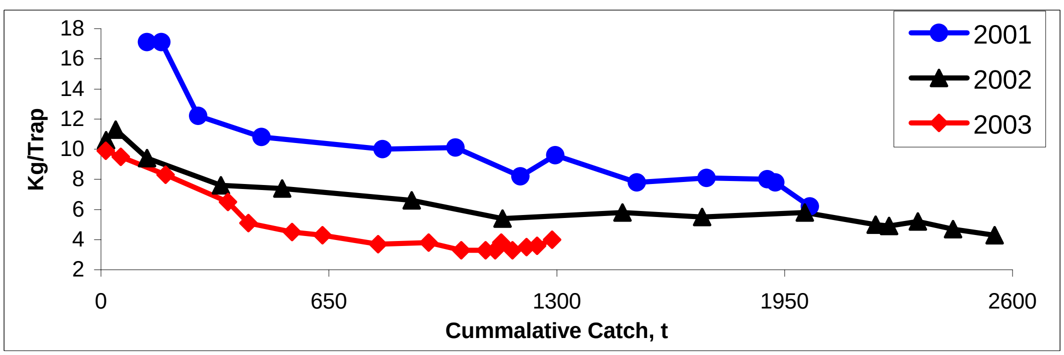



**Figure 28: Seasonal trend in CPUE, in relation to cumulative catch, for Div. 2J during 2001-2003.**

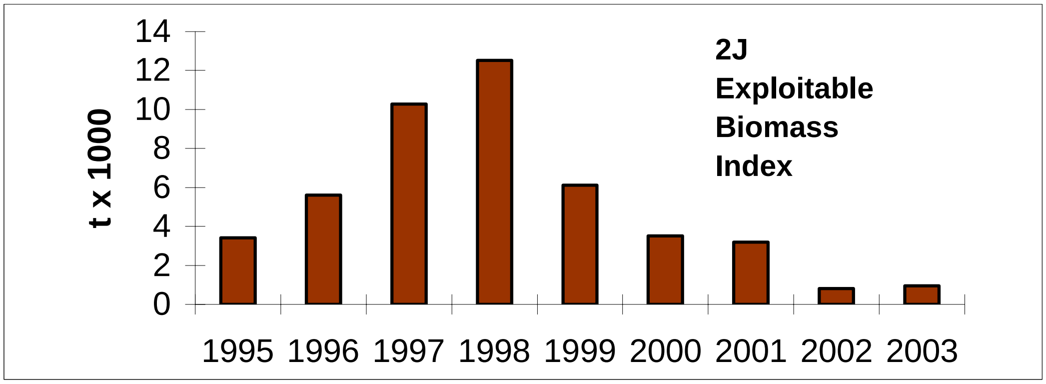



**Figure 29: Annual trends in the Div. 2J fall survey exploitable biomass index.**

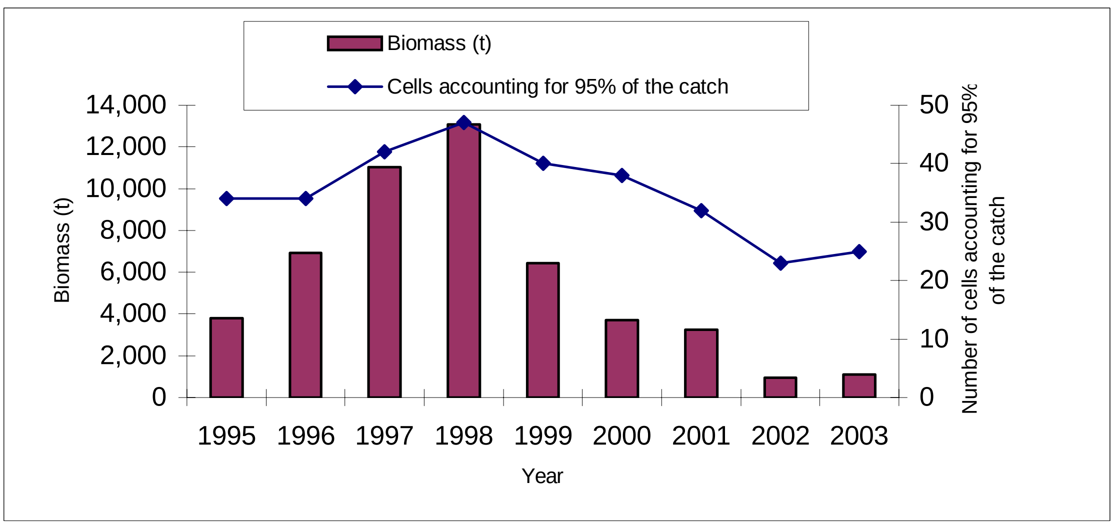



**Figure 30: Annual trends in the spatial distribution of male snow crabs and in the exploitable biomass index in Div. 2J based on fall multi-species bottom trawl survey).**

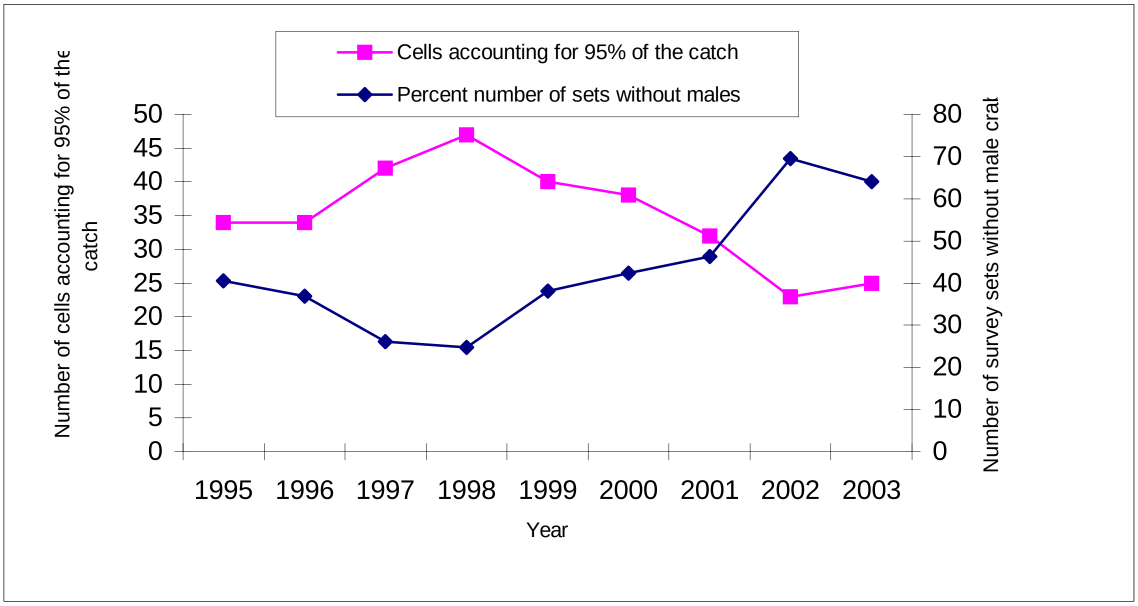



**Figure 31: Area accounting for 95% of the fall multi-species survey catch of legal-sized crabs, within the Div. 2J, and the number of sets without legal-sized males.**

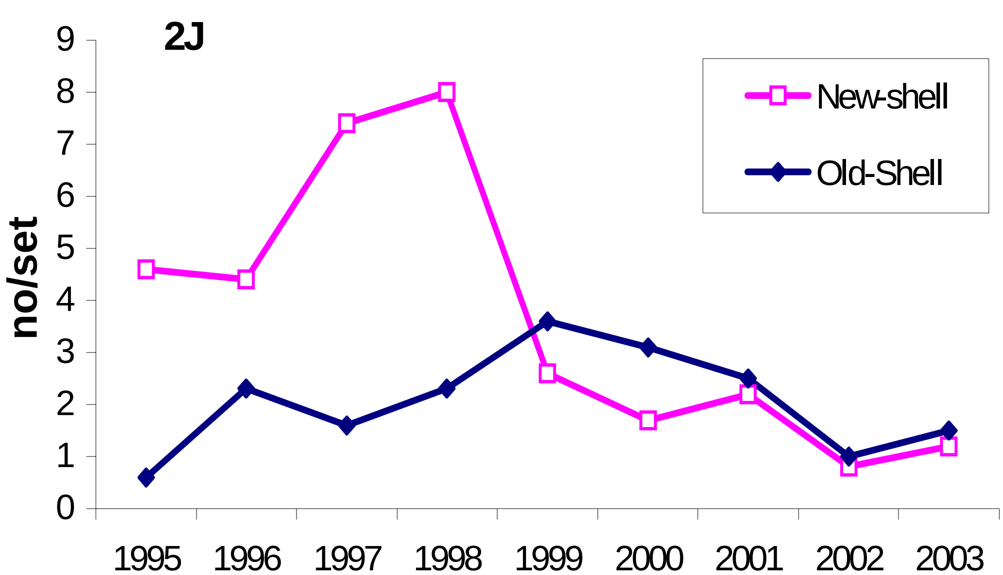



**Figure 32: Annual trends, by shell condition, in abundance indices of legal-sized males for Div. 2J from fall multi-species surveys.**

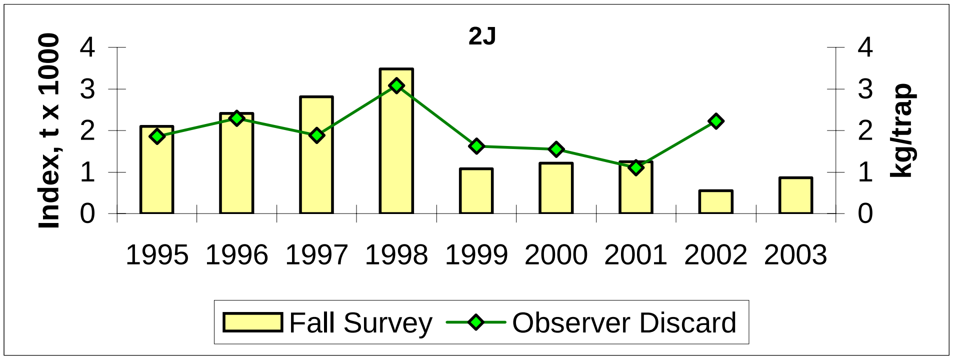



**Figure 33: Annual trends in the Div. 2J fall multi-species survey pre-recruit biomass index and the observer discard catch rate index.**

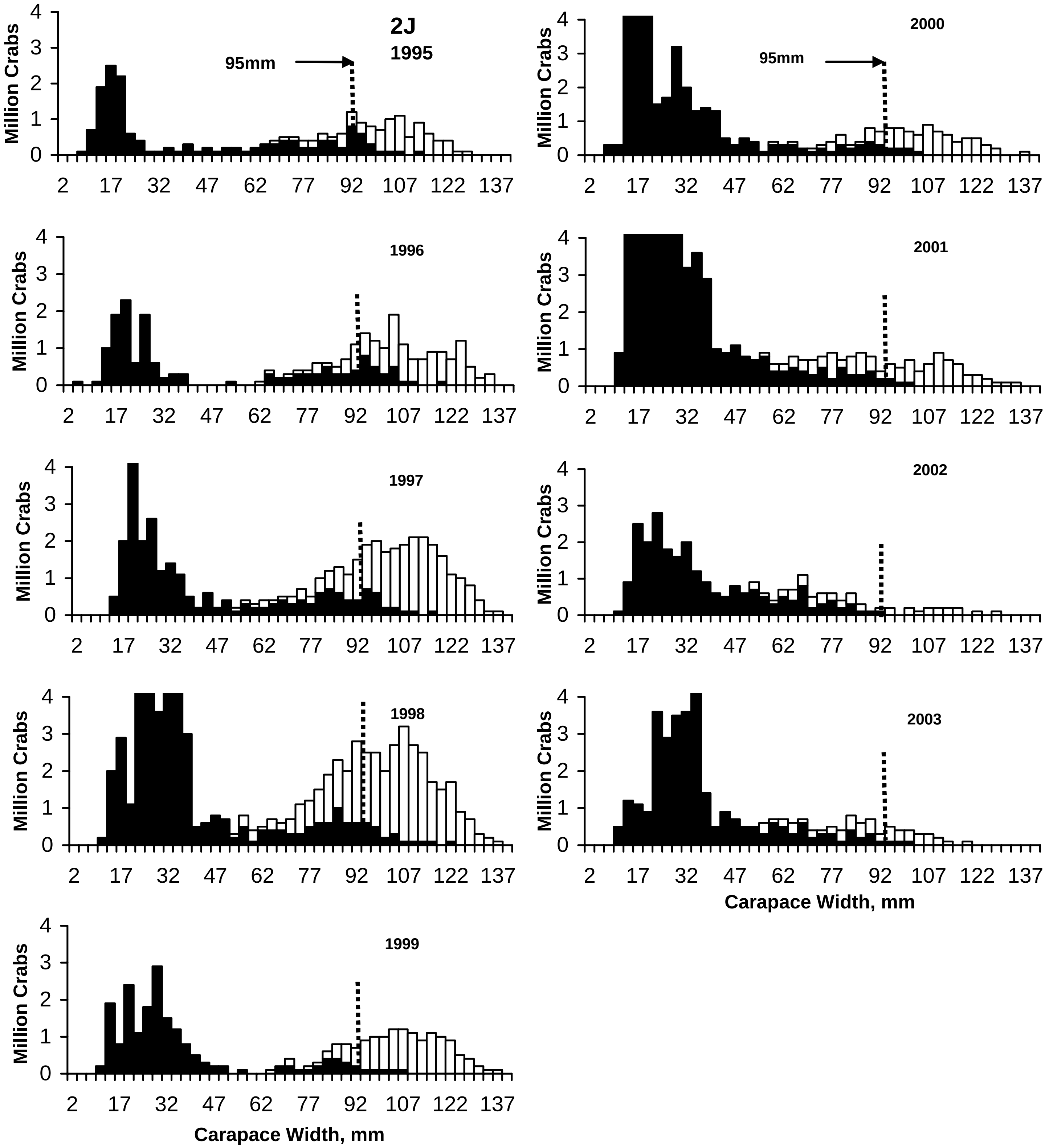



**Figure 34: Truncated distribution of abundance (index) by carapace width for Div. 2J juveniles plus adolescents (dark bars) versus adults (open bars) from fall multi - species surveys**

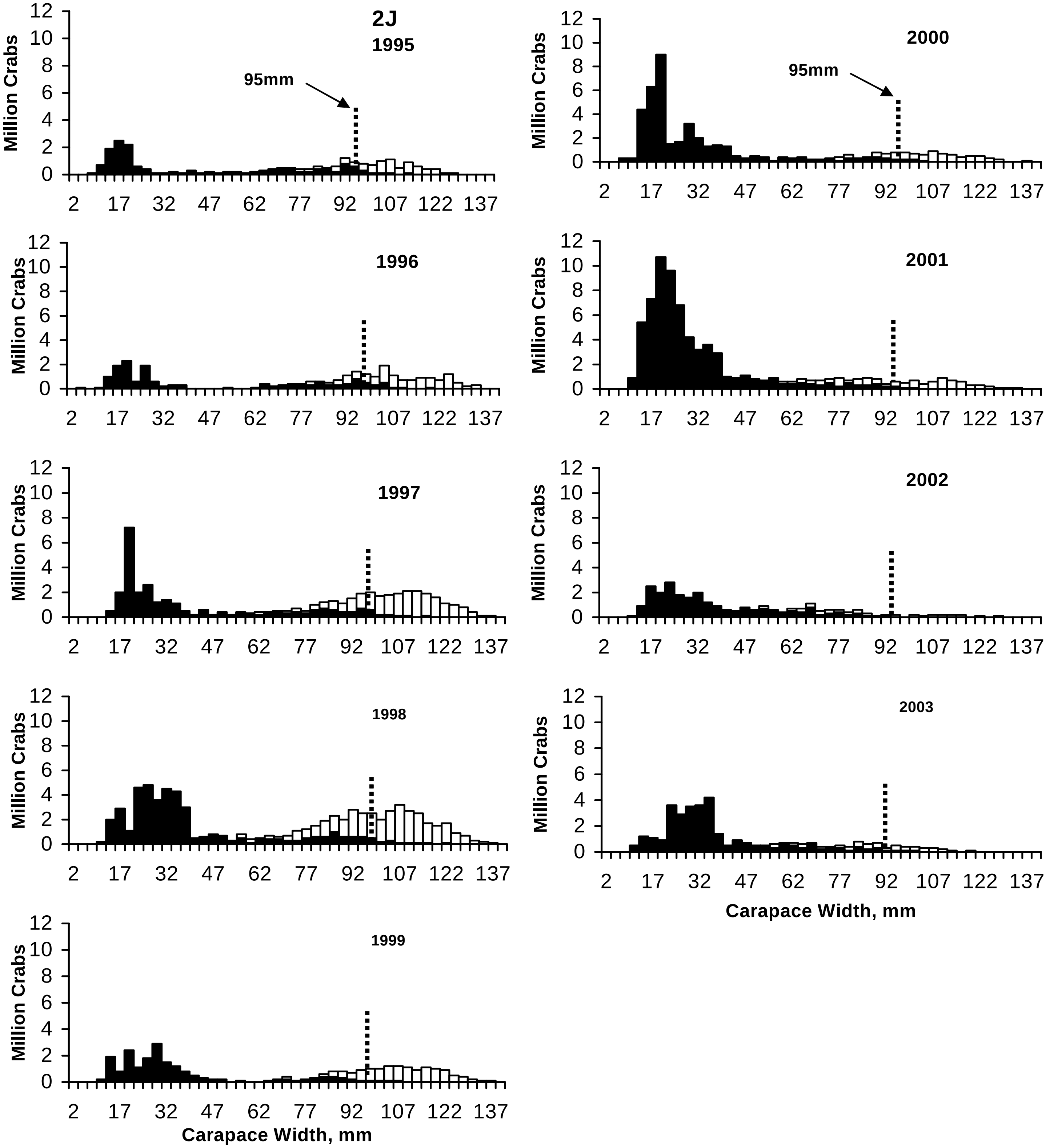



**Figure 35: Distribution of abundance (index) by carapace width for Div. 2J juveniles plus adolescents (dark bars) versus adults (open bars) from fall multi-species surveys.**

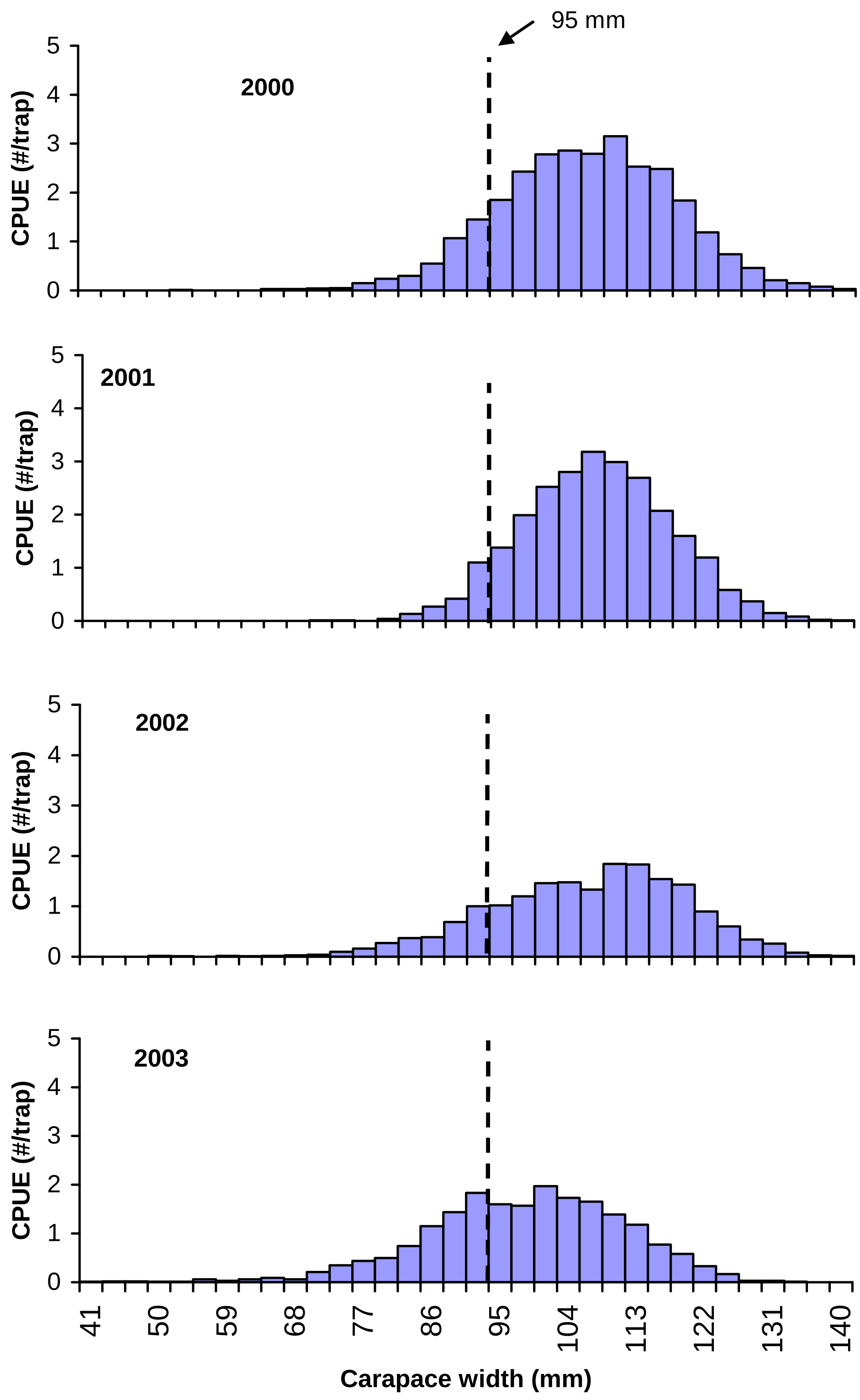



**Figure 36: Annual trends in male carapace width distributions from observer at-sea sampling for Div. 2J.**

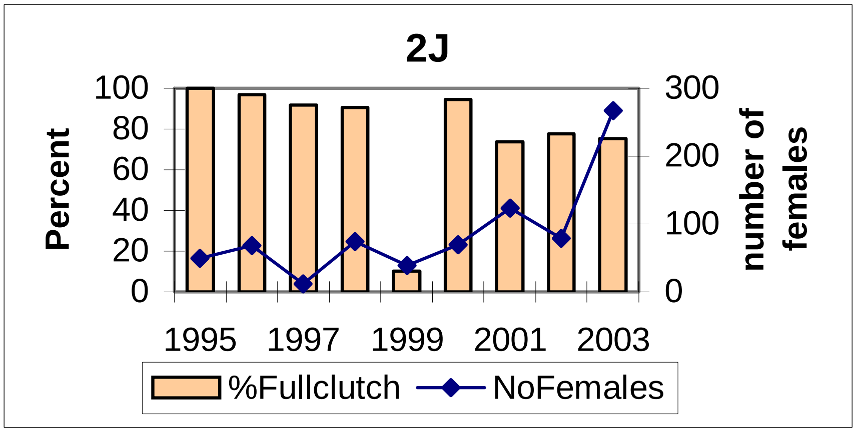



**Figure 37: Annual trend in percent of mature females bearing full clutches of viable eggs and sample sizes, in Div 2J from fall multi-species surveys.**

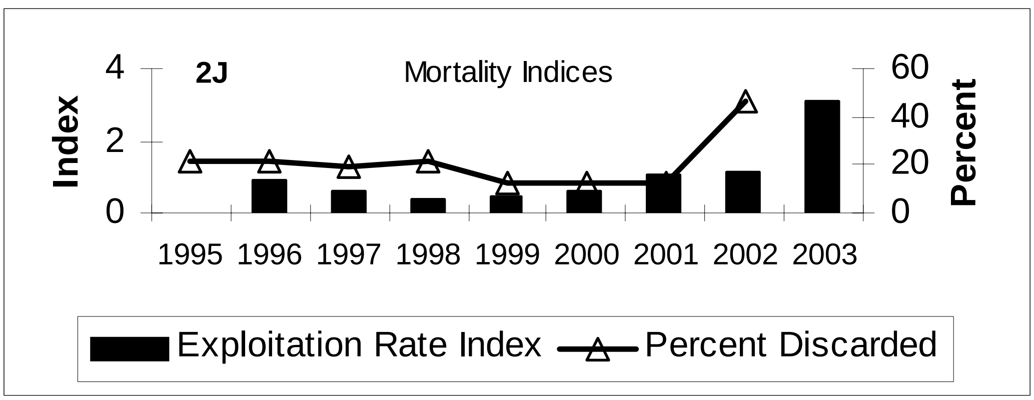



**Figure 38: Annual trends in two Div. 2J mortality indices.**

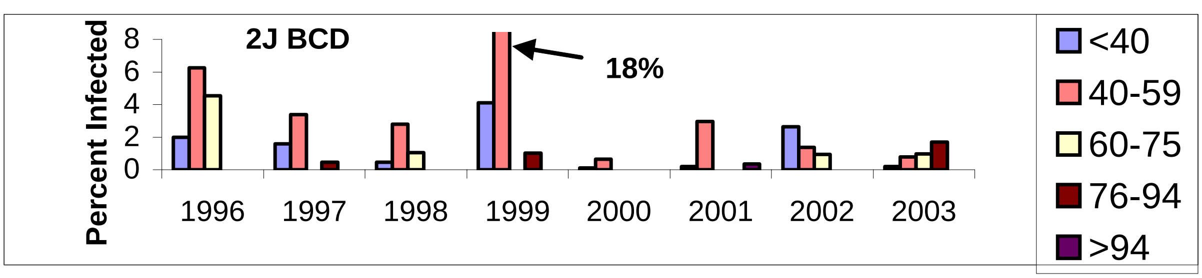



**Figure 39: Annual trends in prevalence of BCD in Div. 2J by male size group from fall multi-species surveys.**

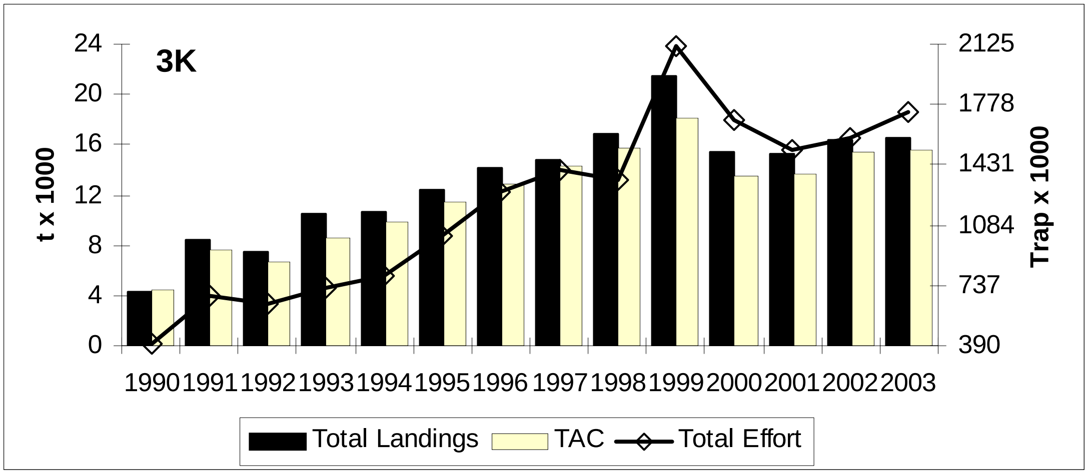



**Figure 40: Annual trends in Div. 3K landings, TAC and fishing effort.**

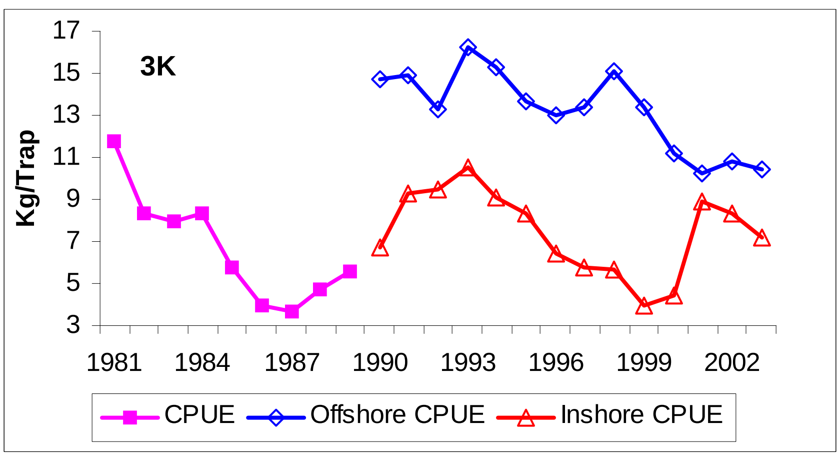



**Figure 41: Annual trends in Div. 3K commercial CPUE.**

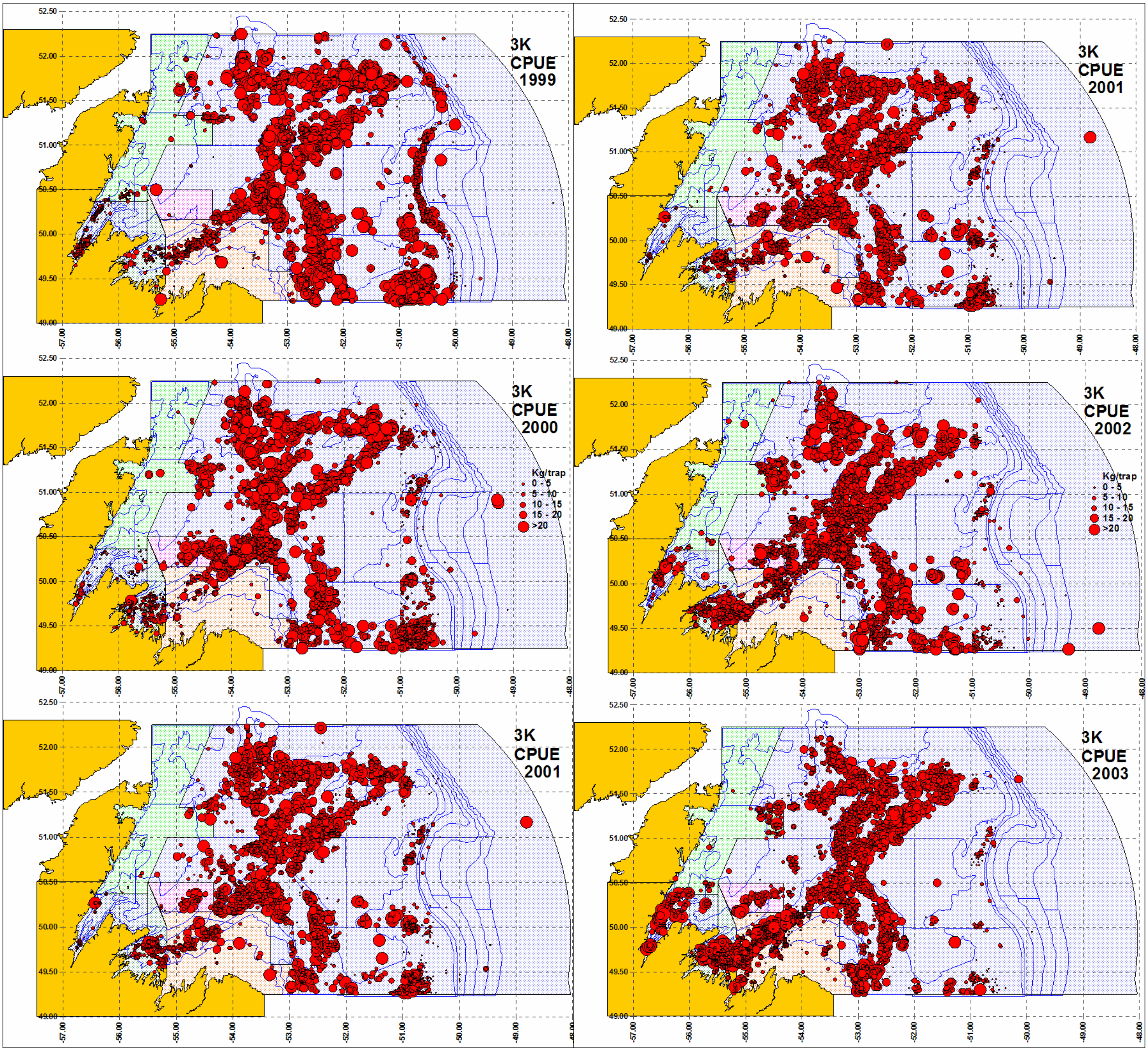



**Figure 42: Spatial distribution of commercial CPUE within Div. 3K during 2000-2003.**

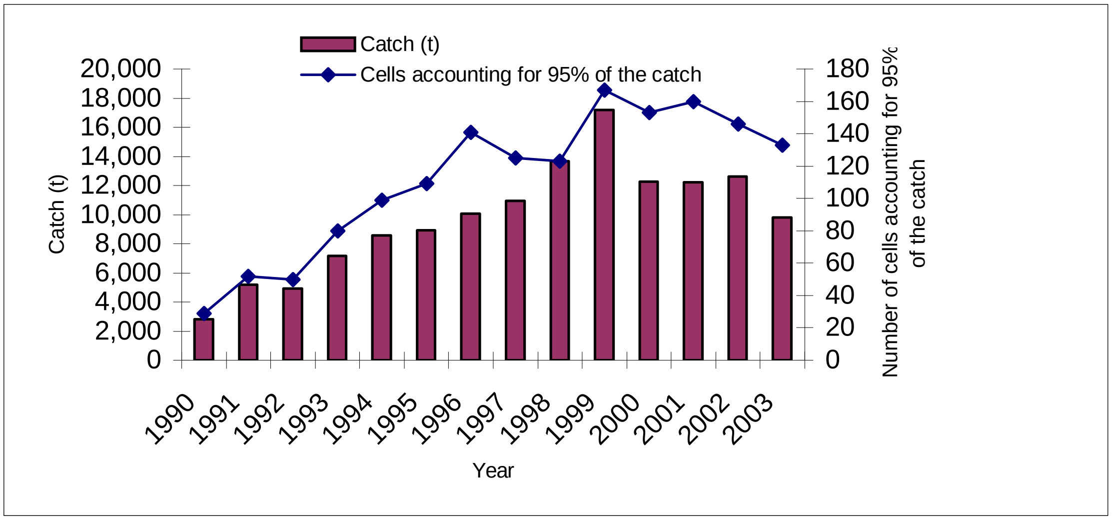



**Figure 43: Annual trends in commercial catch versus spatial distribution of the fishery within offshore Div. 3K.**

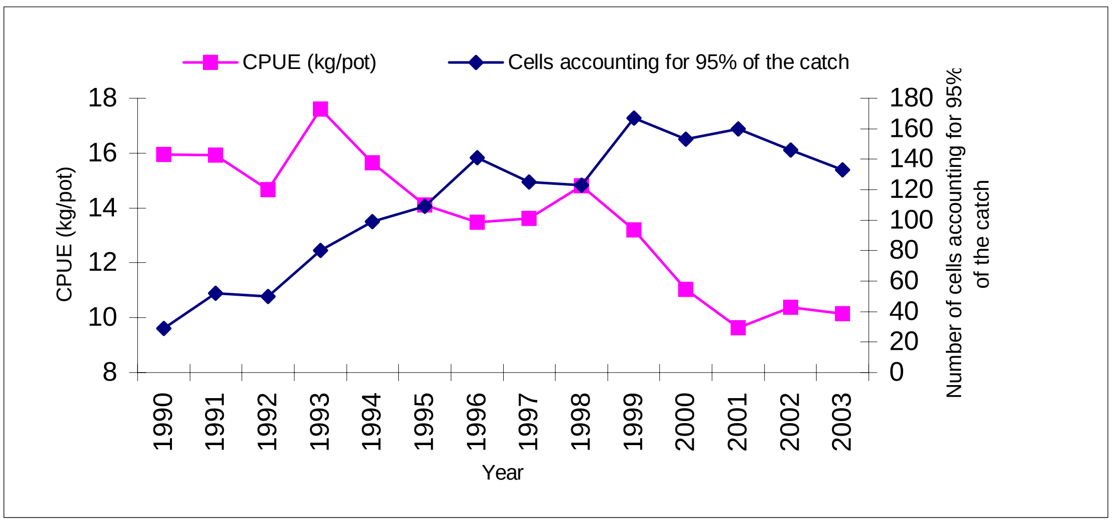



**Figure 44: Annual trends in commercial CPUE versus spatial distribution of the fishery within offshore Div. 3K.**

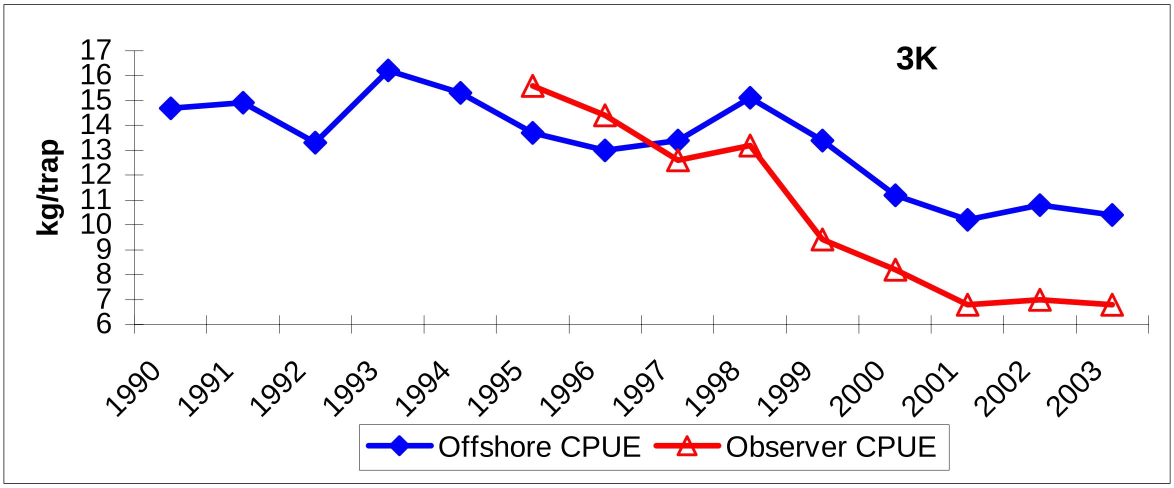



**Figure 45: Annual trends in logbook- based CPUE vs. observer - based CPUE in the Div. 3K offshore fishery.**

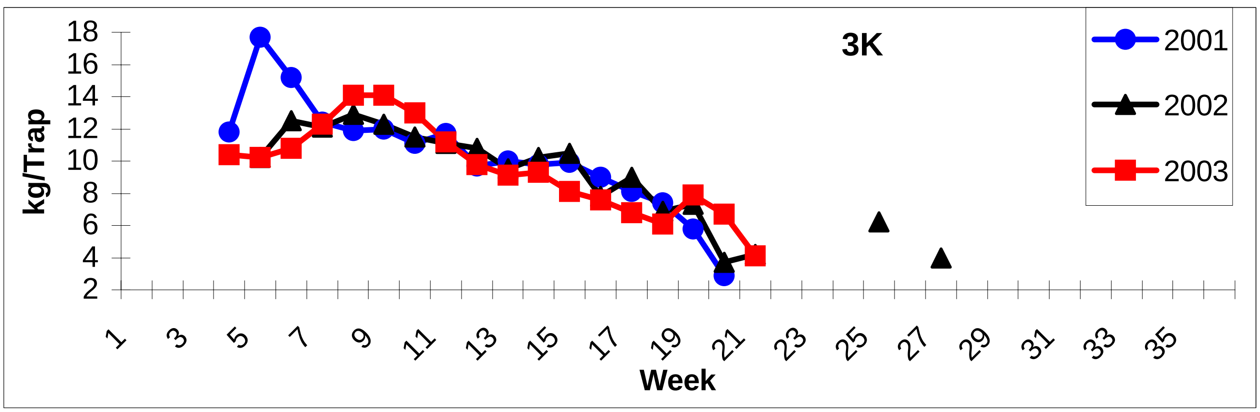



**Figure 46: Seasonal trends in CPUE, by week, for Div. 3K during 2001-2003.**

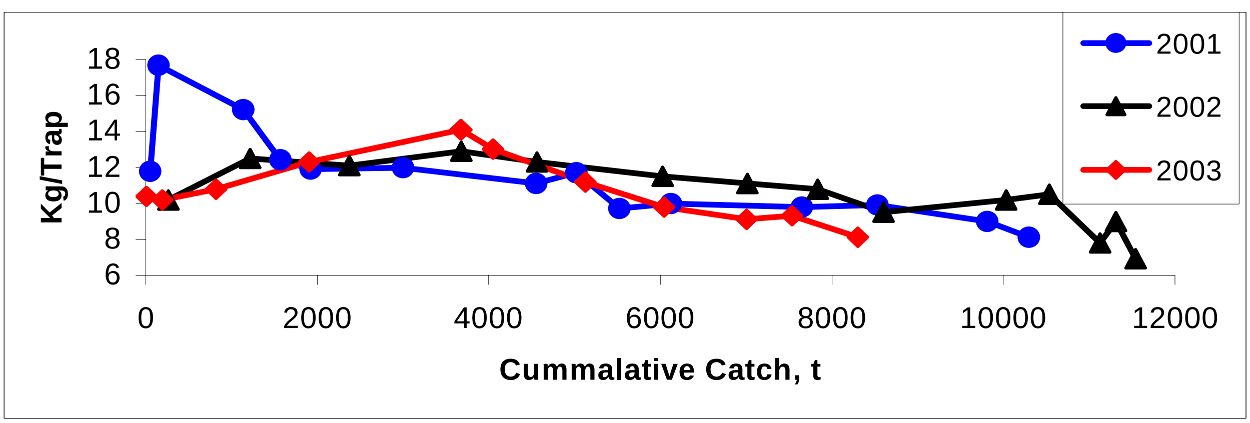



**Figure 47: Seasonal trends in CPUE, in relation to, cumulative catch for Div. 3K.**

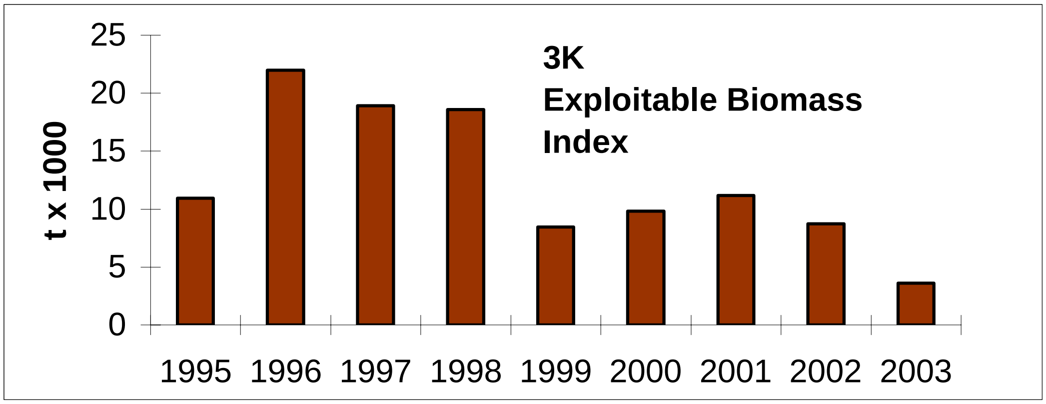



**Figure 48: Annual trends in Div. 3K fall multi-species survey exploitable biomass index.**

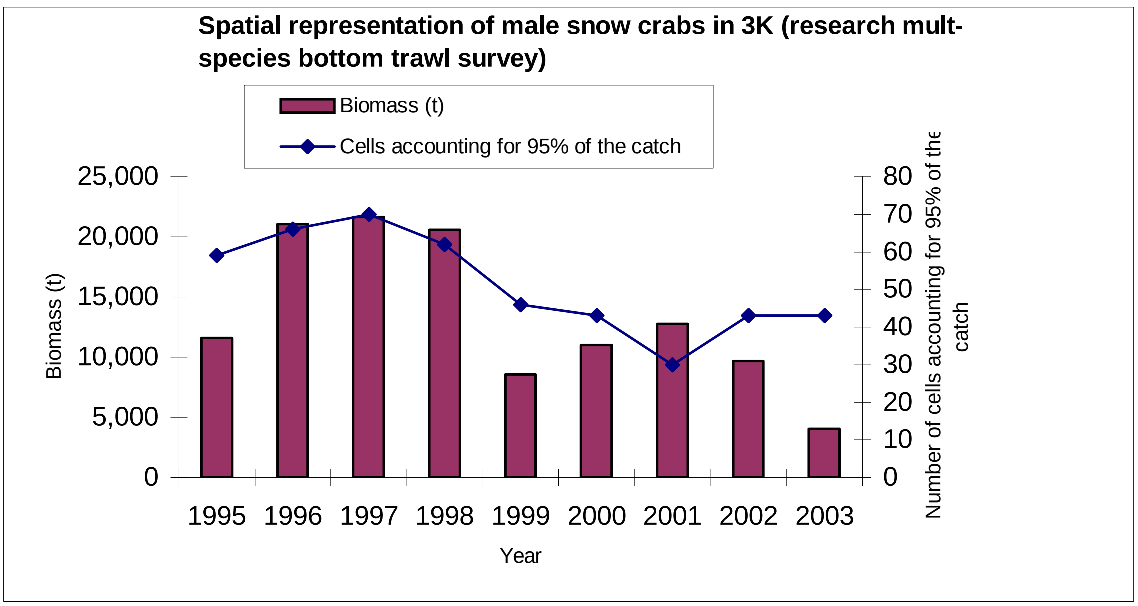



**Figure 49: Annual trends in the spatial distribution of male snow crabs and in the exploitable biomass index in Div. 3K based on fall multi-species bottom trawl survey.**

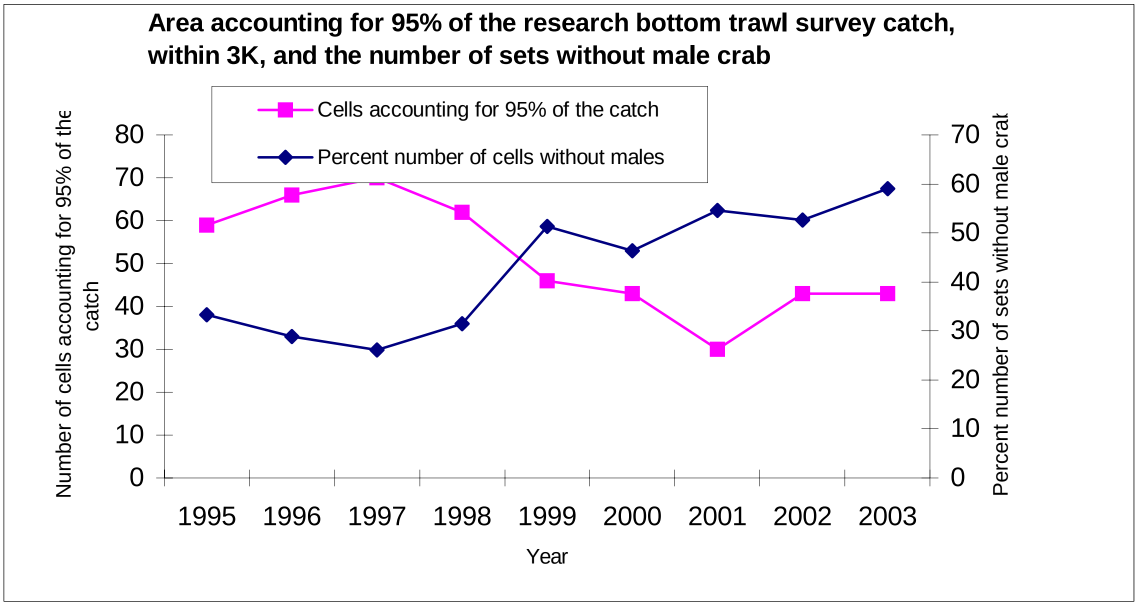



**Figure 50: : Area accounting for 95% of the fall multi-species survey catch of legal-sized crabs, within the Div. 3K, and the number of sets without legal-sized males.**

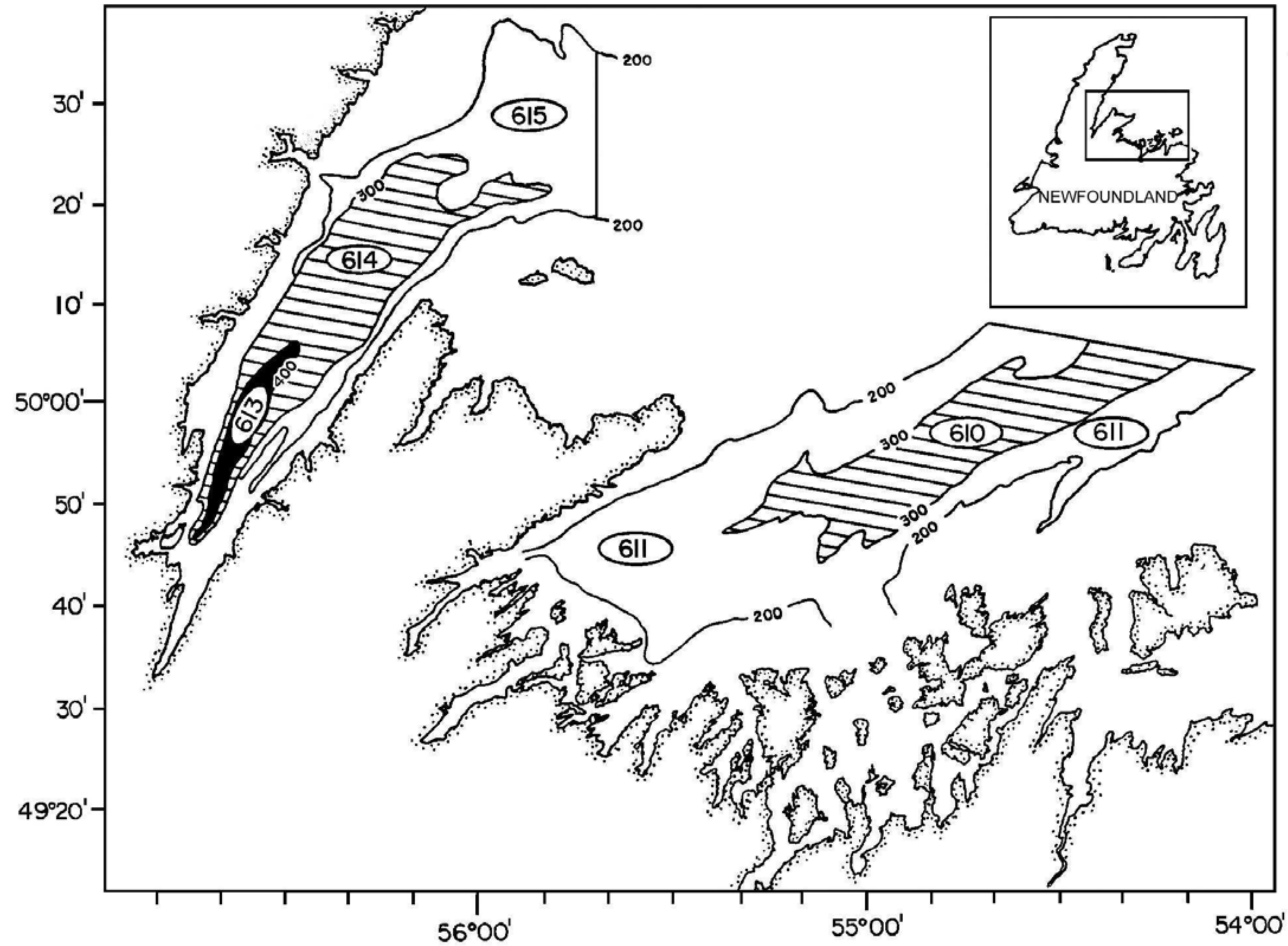



**Figure 51: Location map showing inshore Div. 3K strata sampled during White Bay / Notre Dame Bay September trapping surveys.**

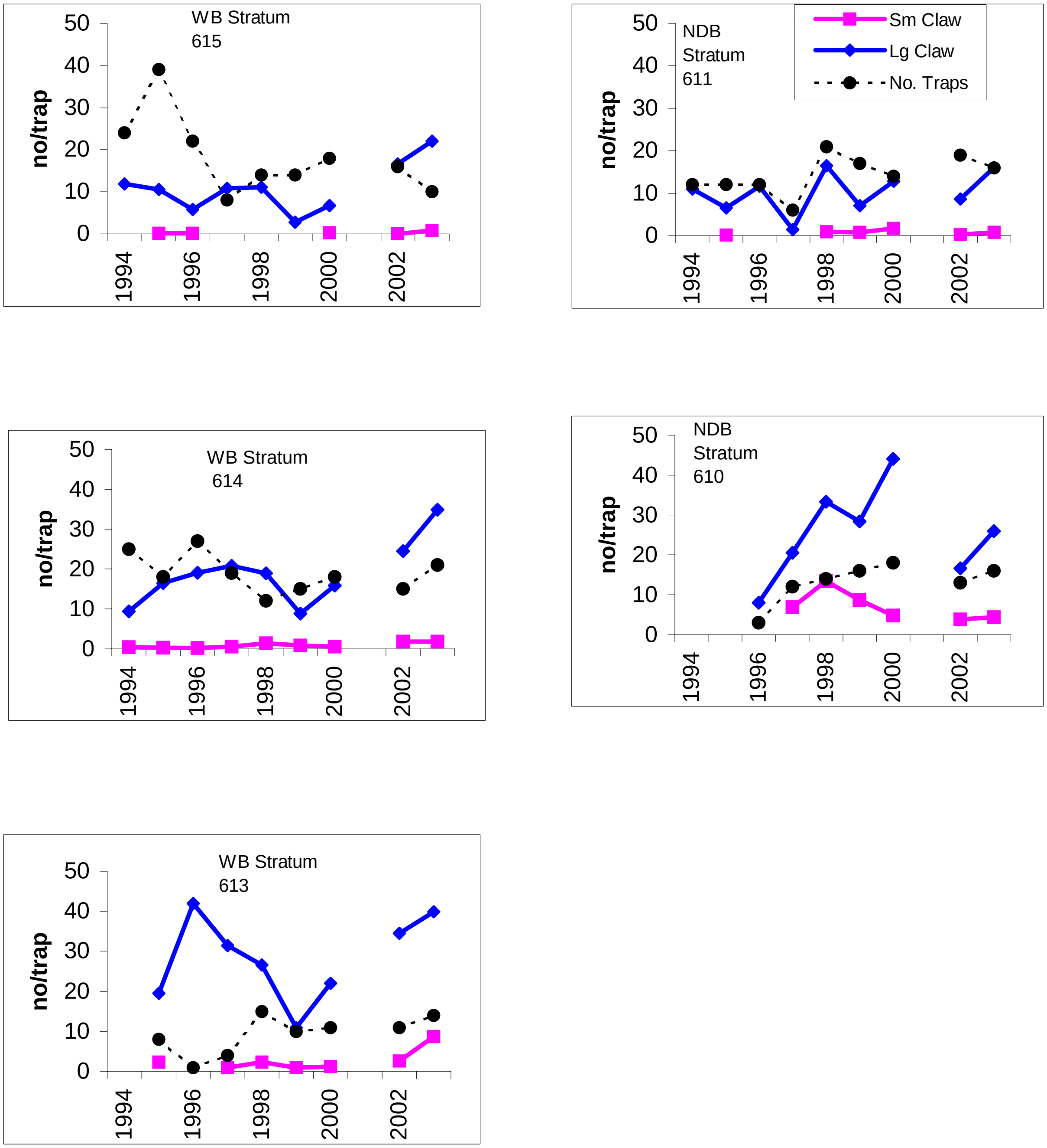



**Figure 52: Annual trends in catch rates of legal-sized males, in relation to chela morphometry, from inshore Div. 3K trap surveys in White Bay and Notre Dame Bay, 1994-2003.**

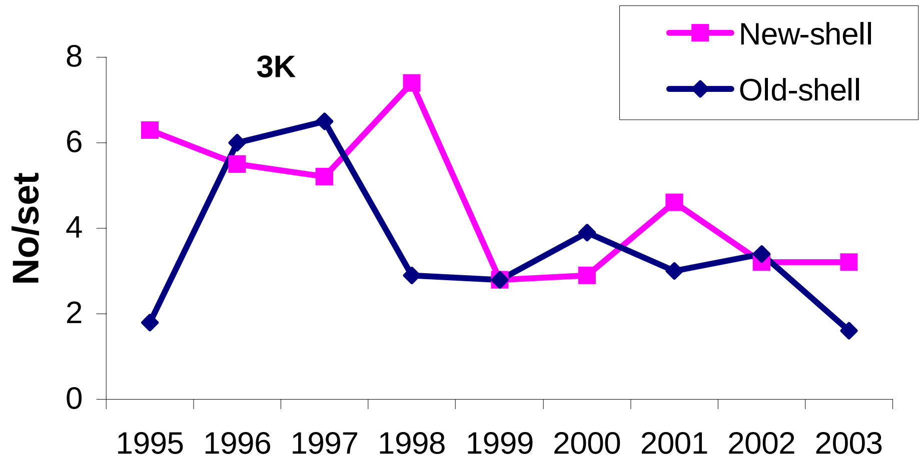



**Figure 53: Annual trends in catch rate of legal-sized males by shell condition from fall multi - species surveys in Div. 3K.**

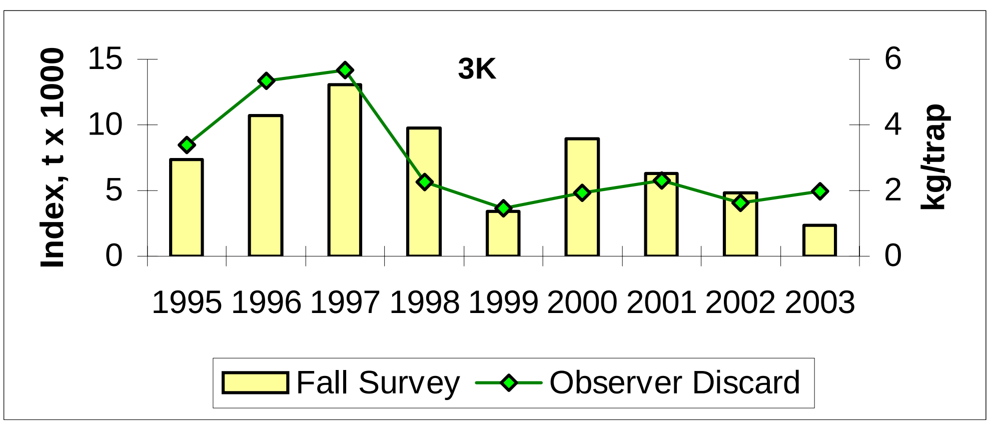



**Figure 54: Annual trends in the fall multi-species survey pre-recruit index and the observer discard pre-recruit index for Div. 3K.**

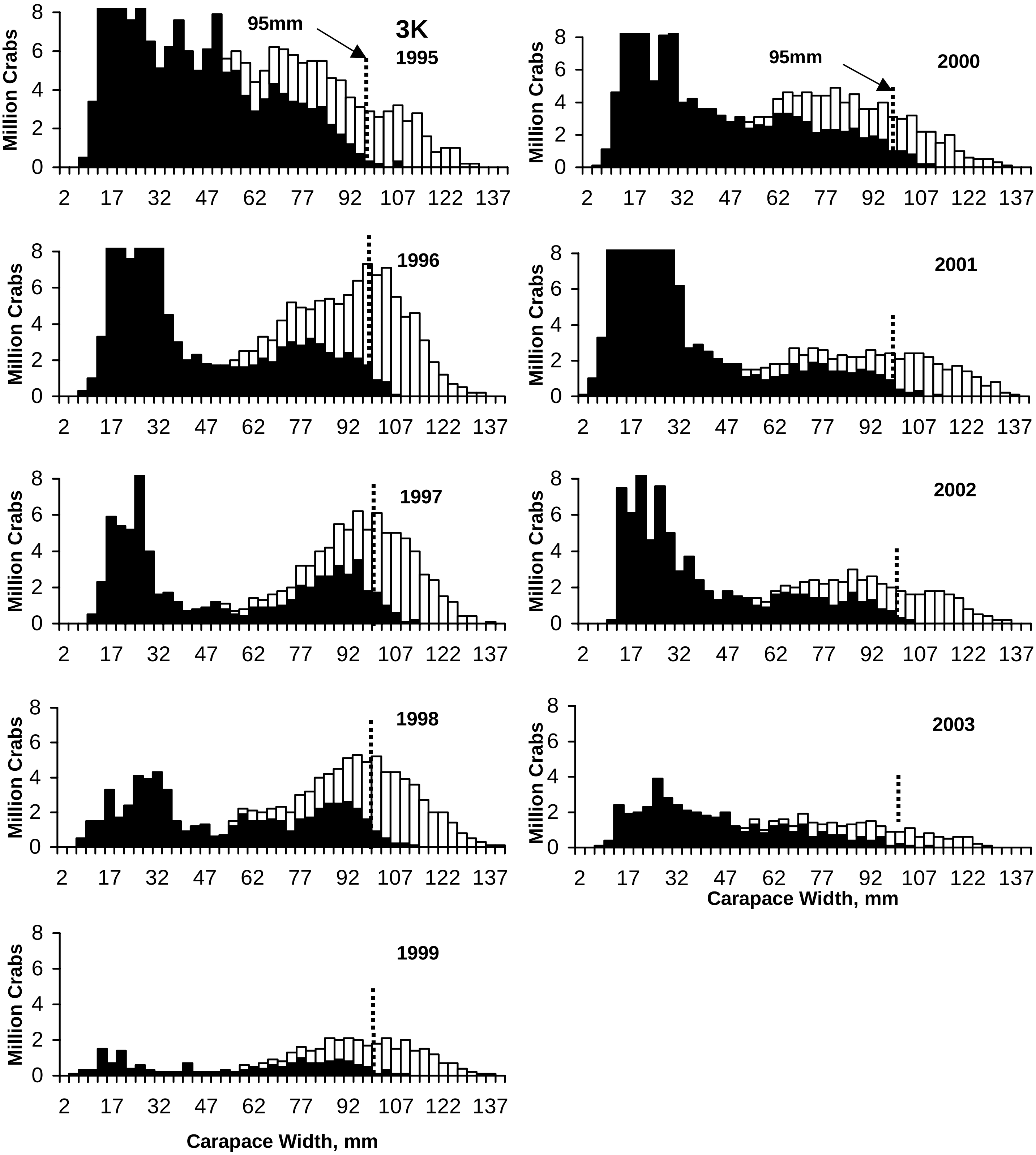



**Figure 55: Truncated distribution of abundance (index) by carapace width for juveniles plus adolescents (dark bars) versus adults (open bars) for Div. 3K from fall multi-species surveys.**

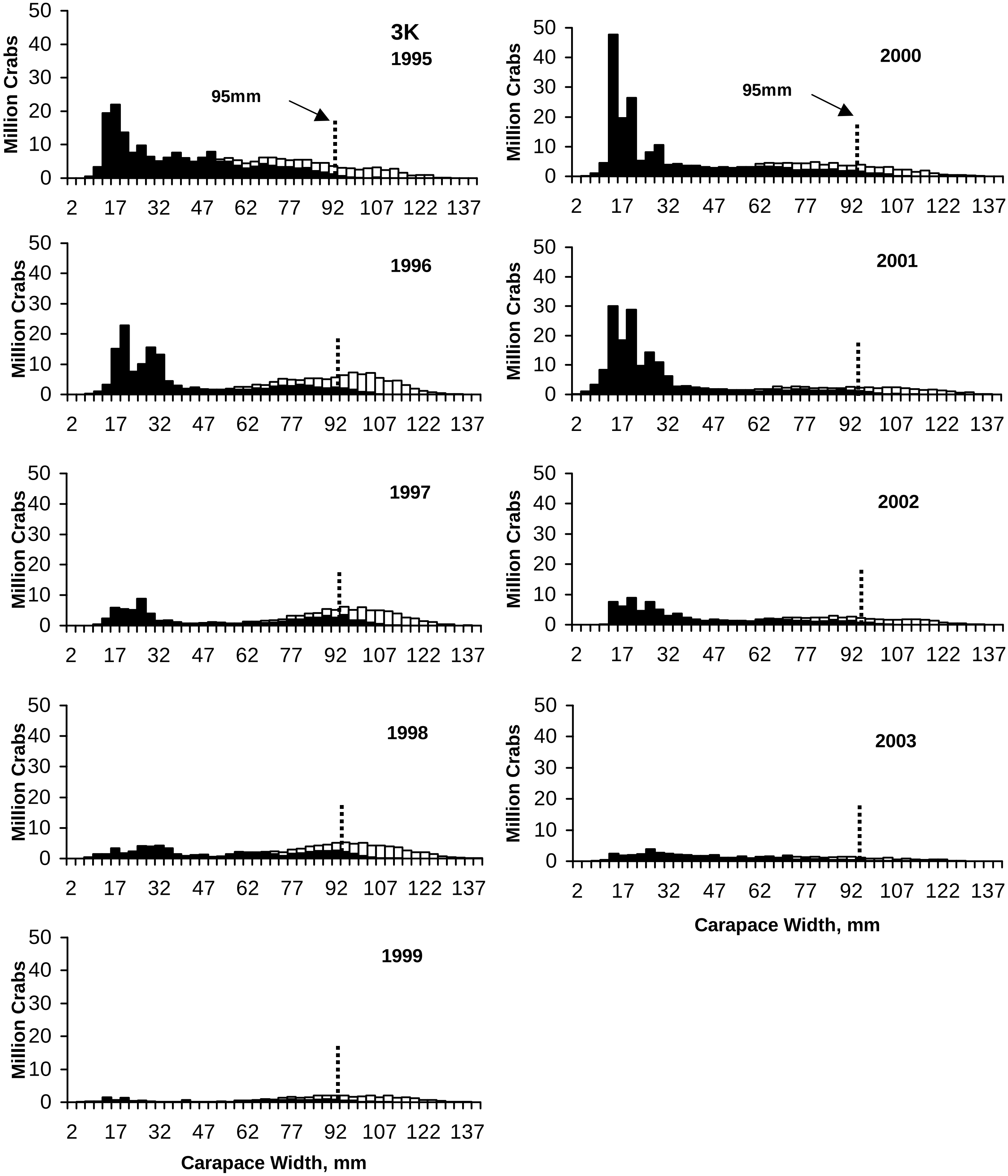



**Figure 56: Distribution of abundance (index) by carapace width for juveniles plus adolescents (dark bars) versus adults (open bars) from Div. 3K fall multi-species surveys.**

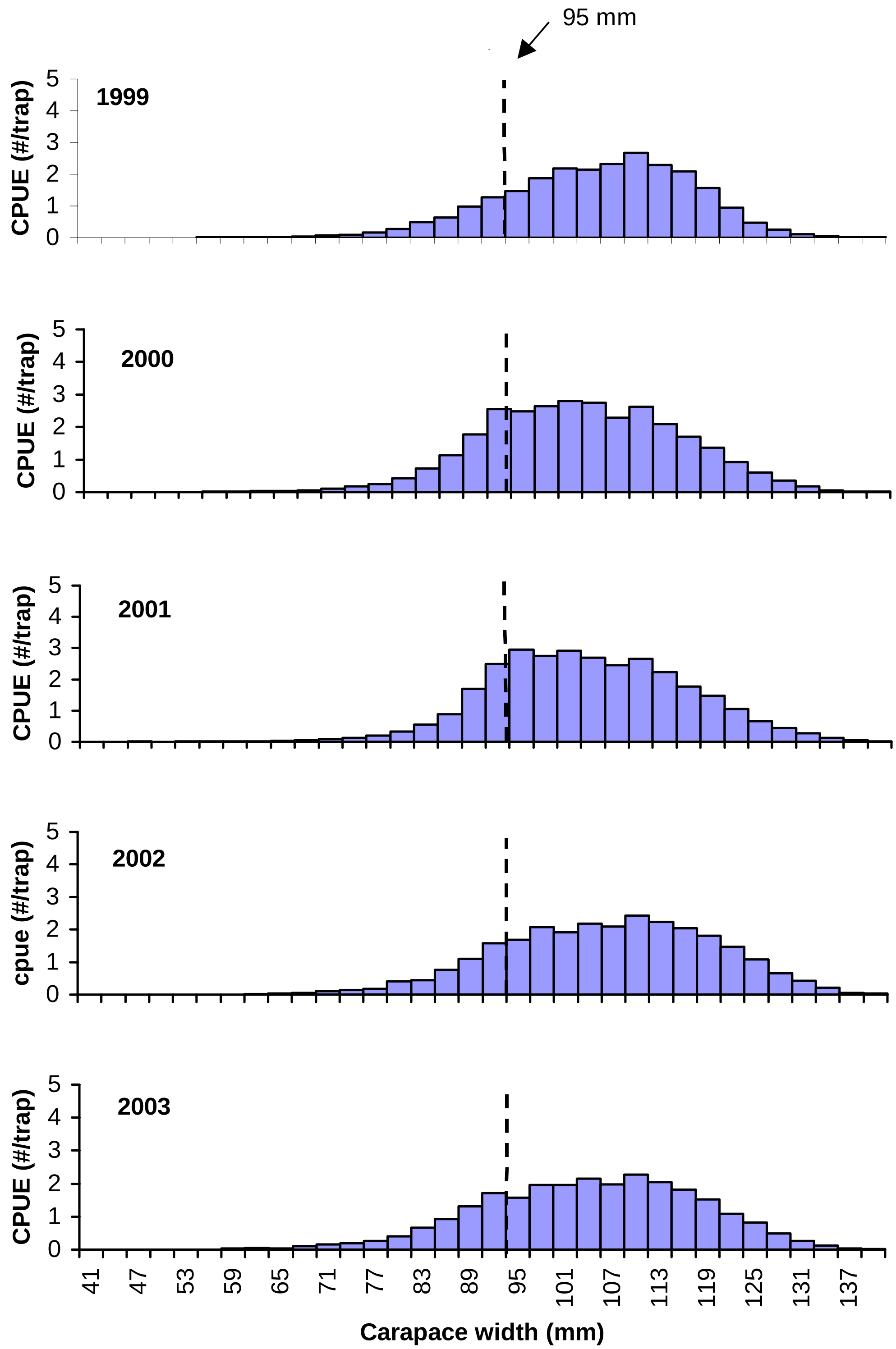



**Figure 57: Annual trends in male size distributions from observer at-sea sampling for Div. 3K.**

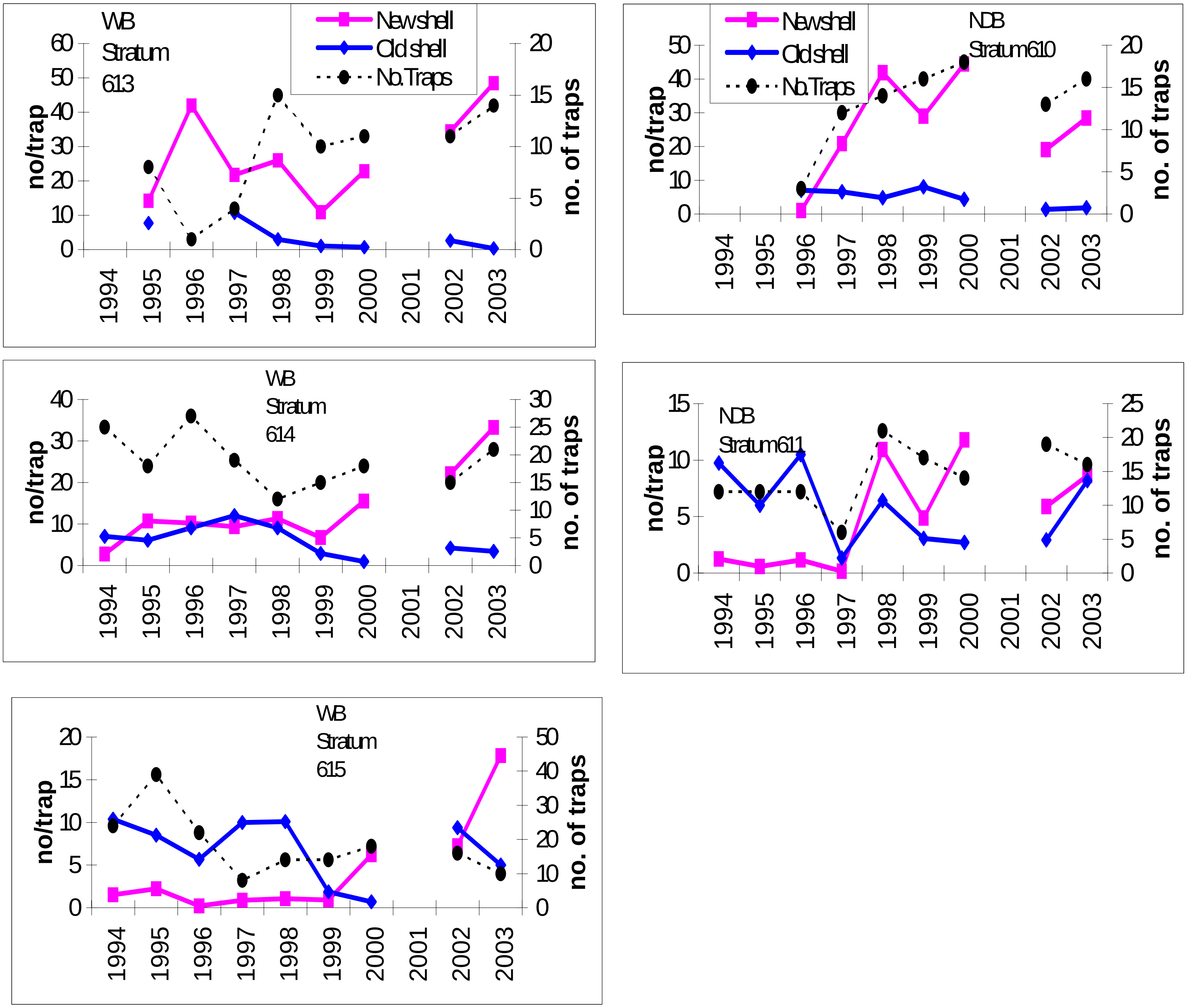



**Figure 58: Annual trends in trap survey catch rates of legal-sized males by shell condition , from inshore Div. 3K trap surveys in White Bay and Notre Dame Bay, 1994-2003.**

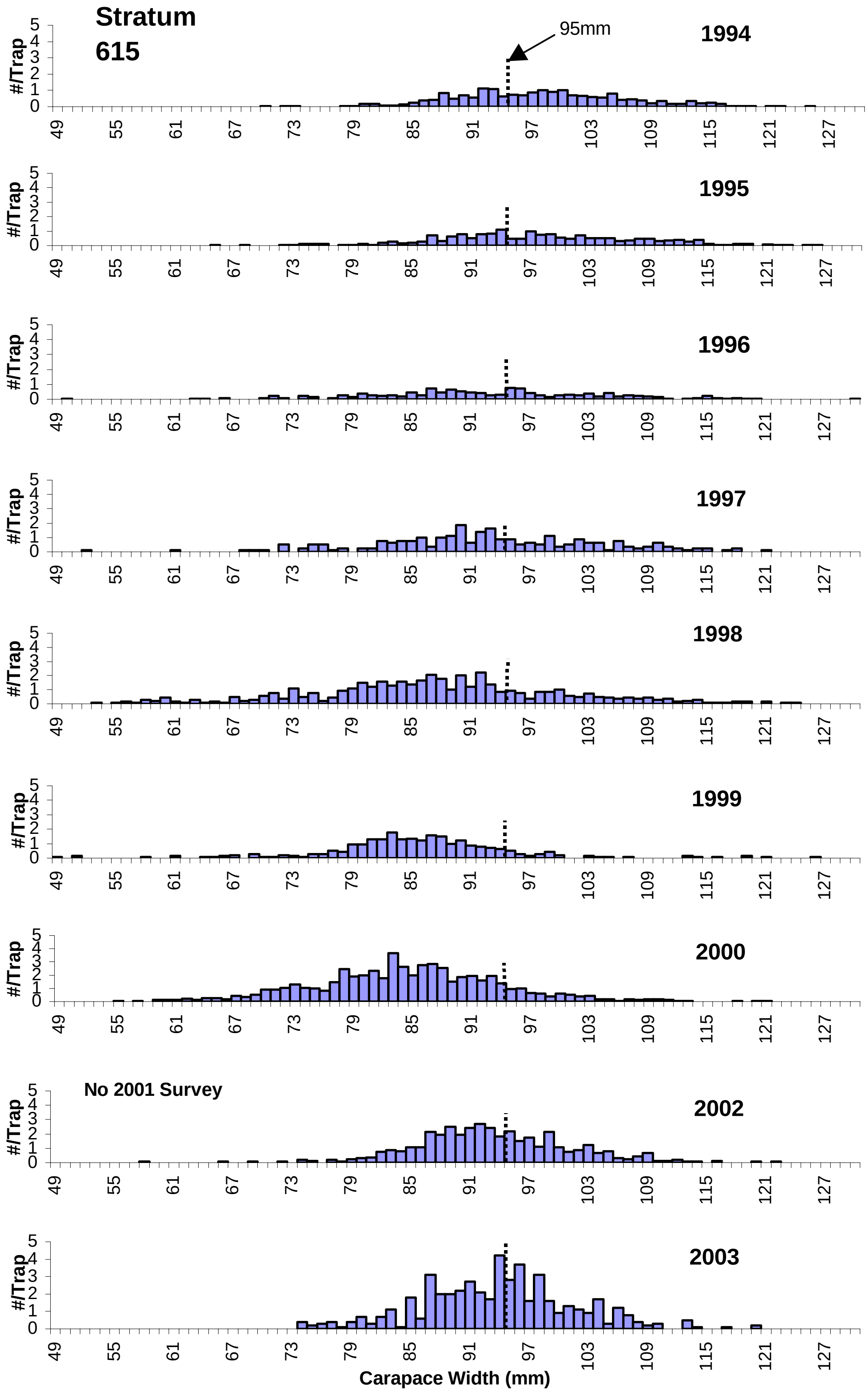



**Figure 59: Annual trends in male size composition, from inshore Div. 3K trap survey catches of small-meshed traps in White Bay stratum 615**

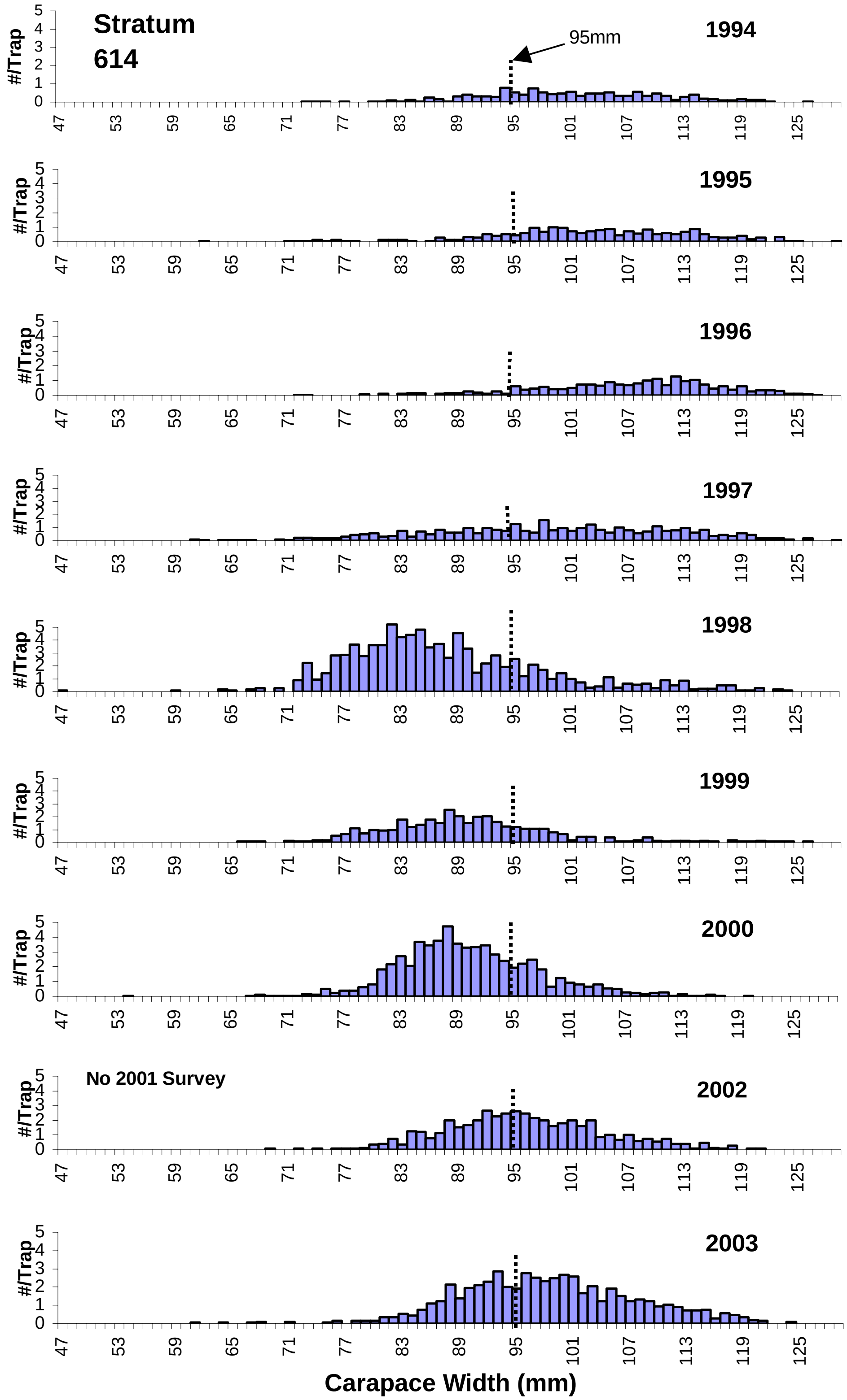



**Figure 60: Annual trends in male size composition, from inshore Div. 3K trap survey catches of small-meshed traps in White Bay stratum 614.**

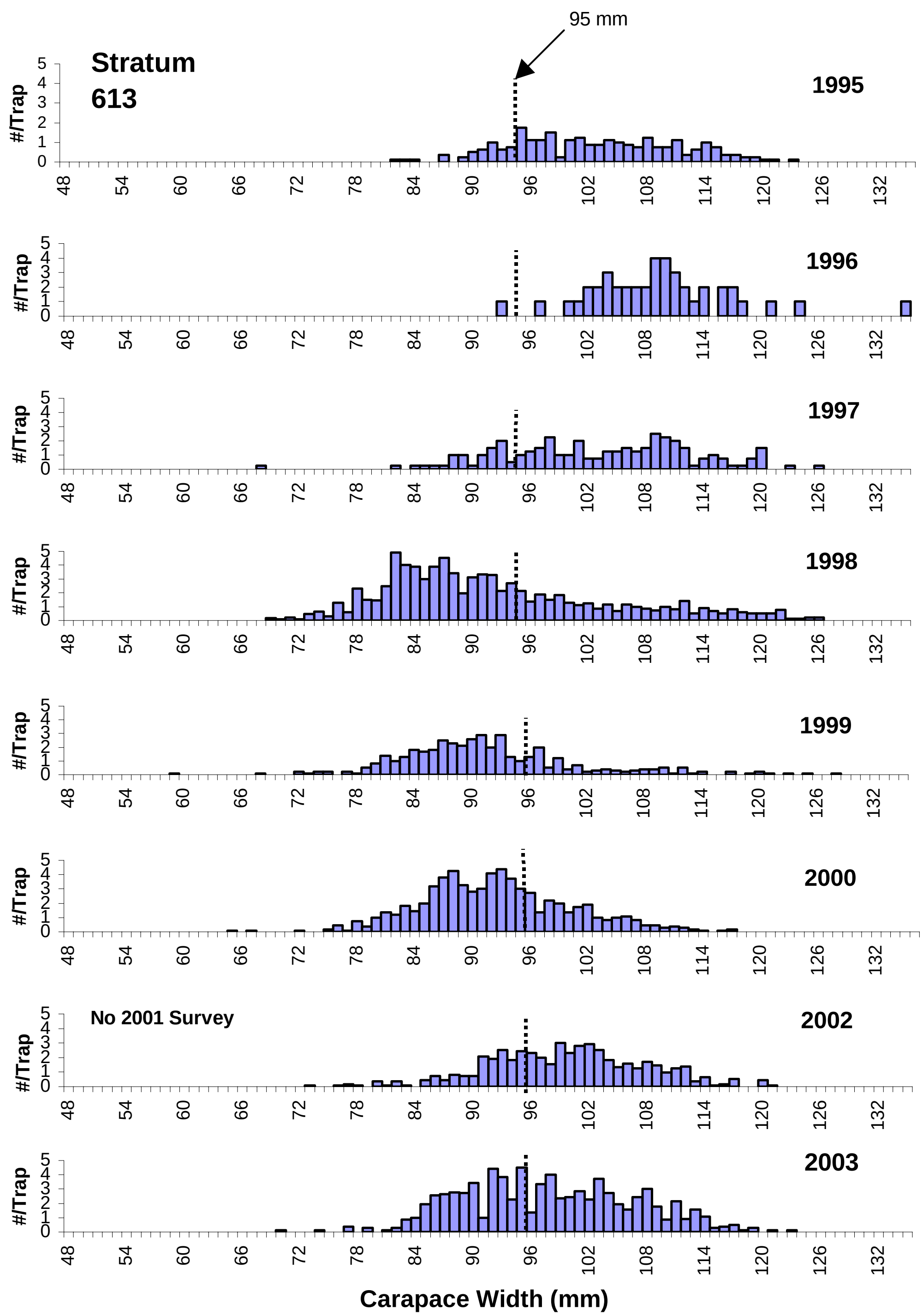



**Figure 61: Annual trends in male size composition, from inshore Div. 3K trap survey catches of small-meshed traps in White Bay stratum 613.**

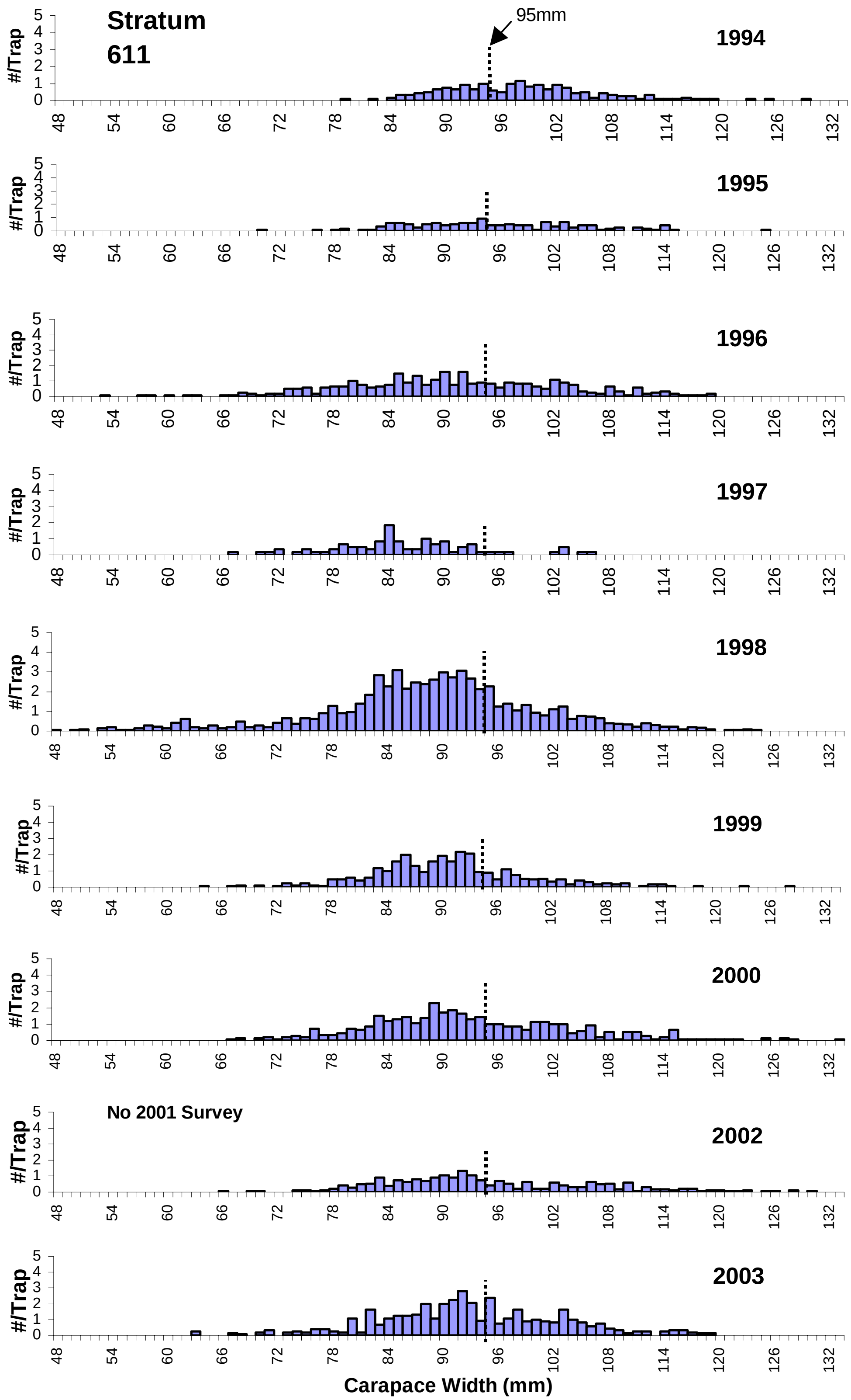



**Figure 62: Annual trends in male size composition, from inshore Div. 3K trap survey catches of small-meshed traps in Notre Dame Bay stratum 611.**

**Stratum 610**

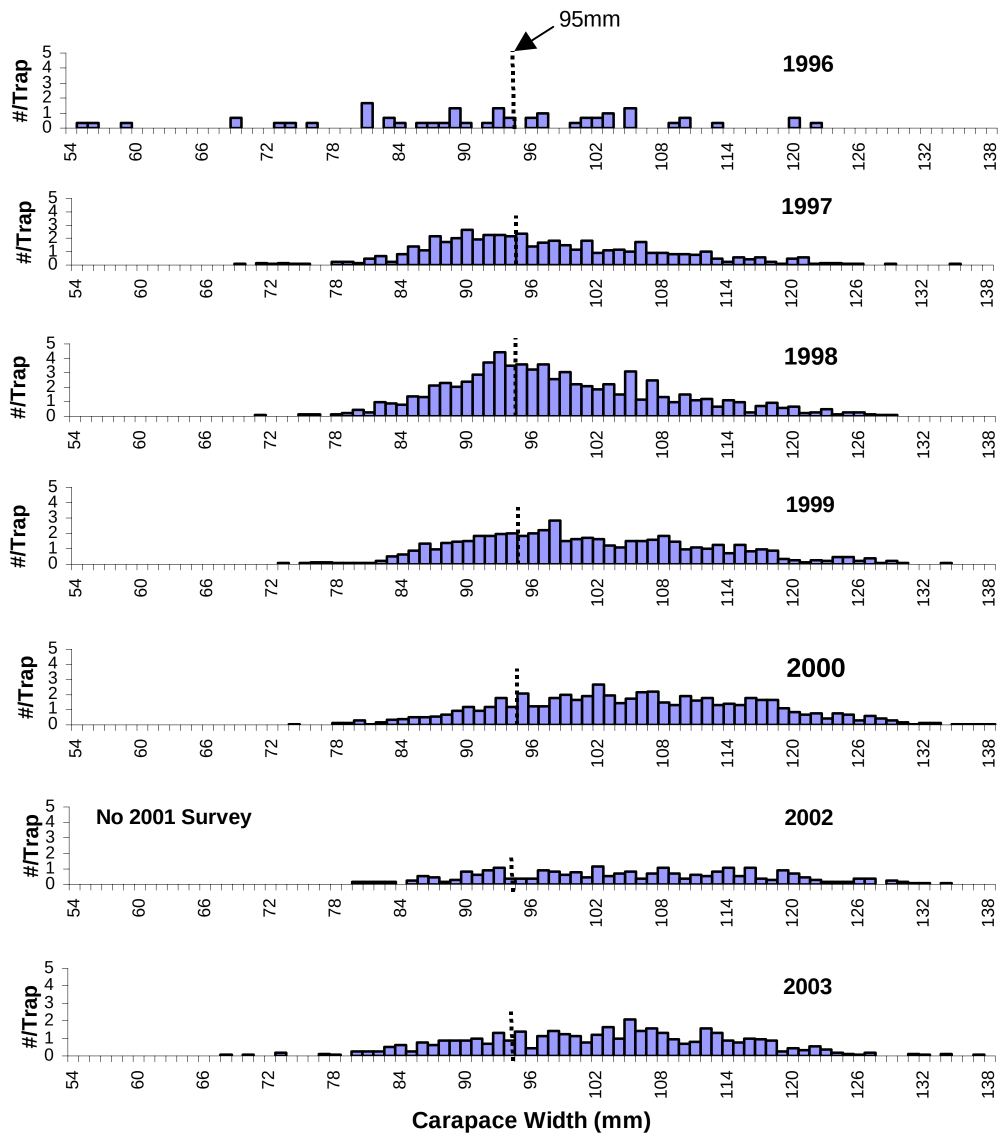



**Figure 63: Annual trends in male size composition, from inshore Div. 3K trap survey catches of small-meshed traps in White Bay stratum 610.**

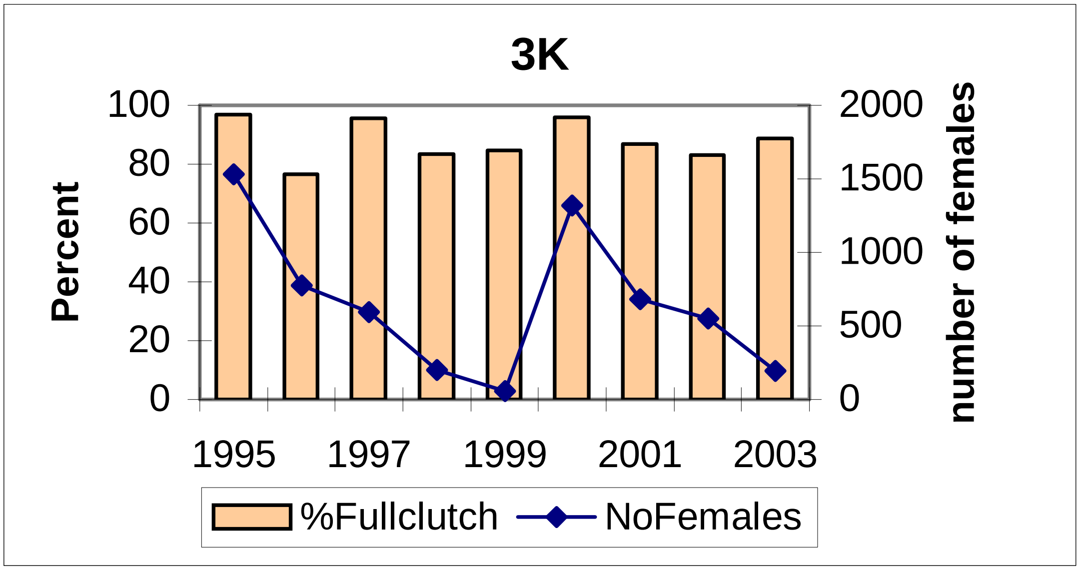



**Figure 64: Annual trend in percent of mature females bearing full clutches of viable eggs and sample sizes from Div 3K fall multi-species surveys.**

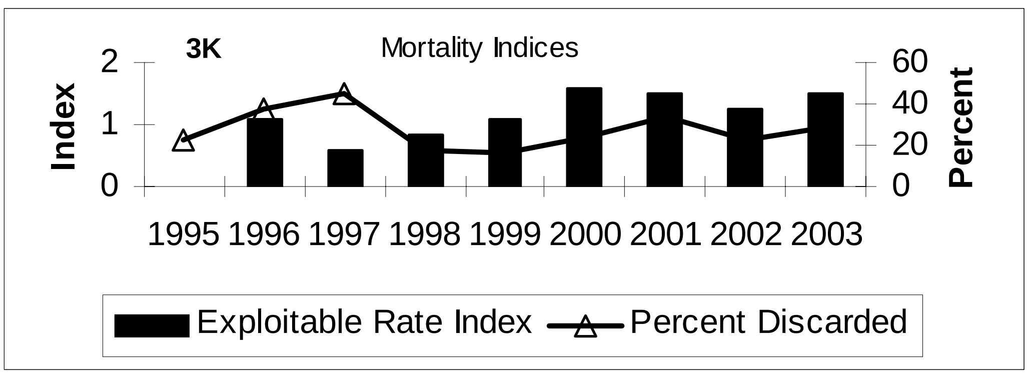



**Figure 65: Annual trends in two Div. 3K mortality indices.**

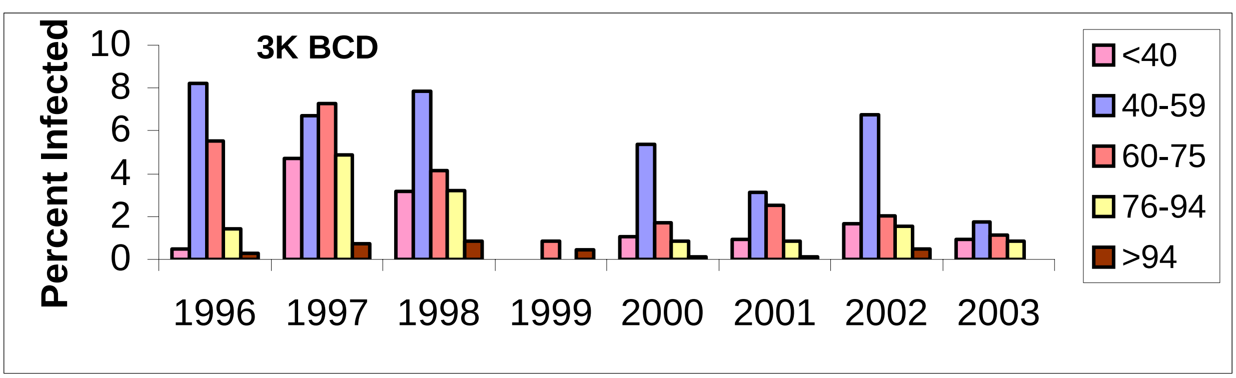



**Figure 66: Annual trends in prevalence of BCD in Div. 3K by male size group from fall multi-species surveys.**

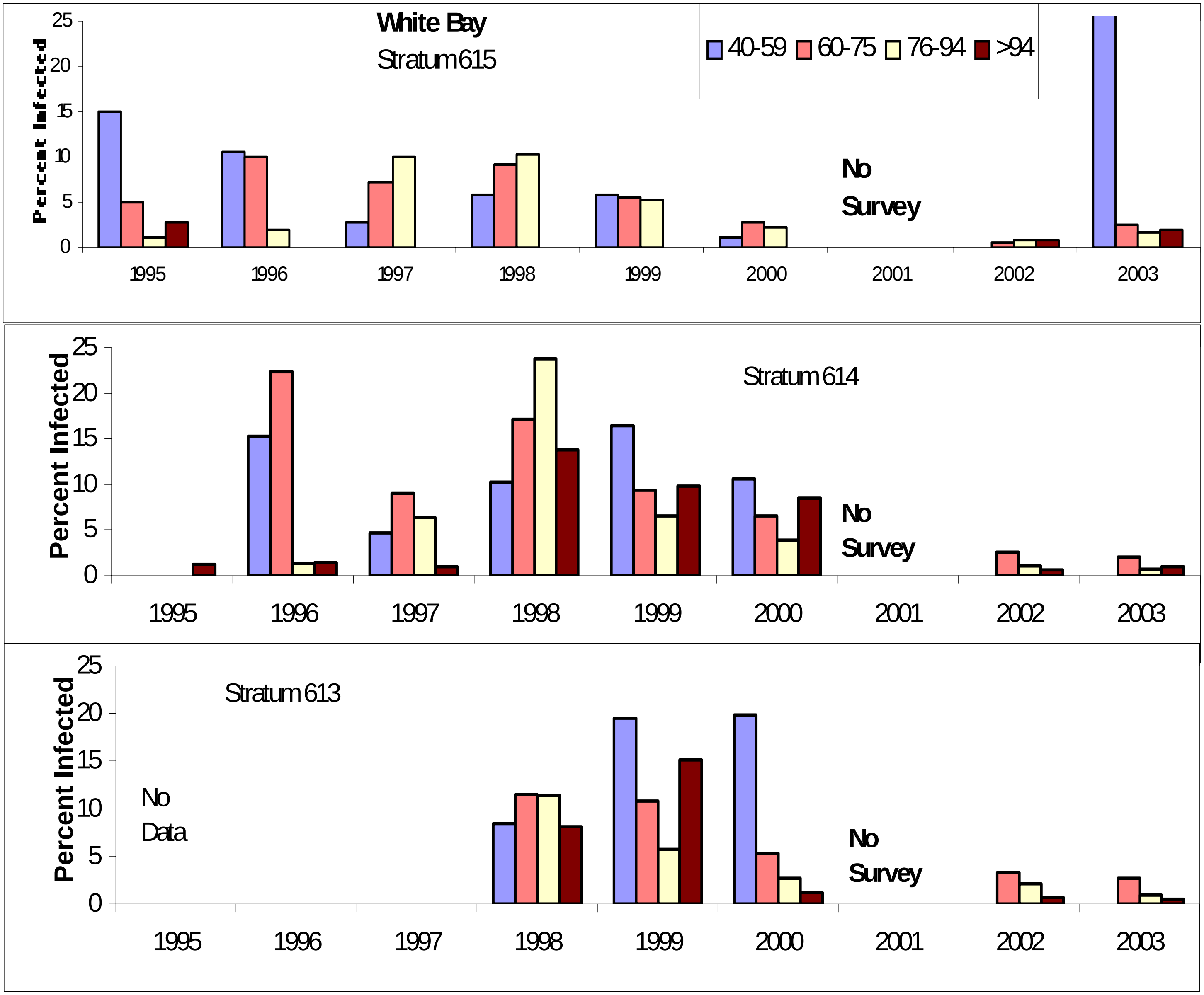



**Figure 67: Annual trends in prevalence of BCD from inshore Div. 3K trap survey catches of small-meshed traps, by male size group, in 3 White Bay strata.**

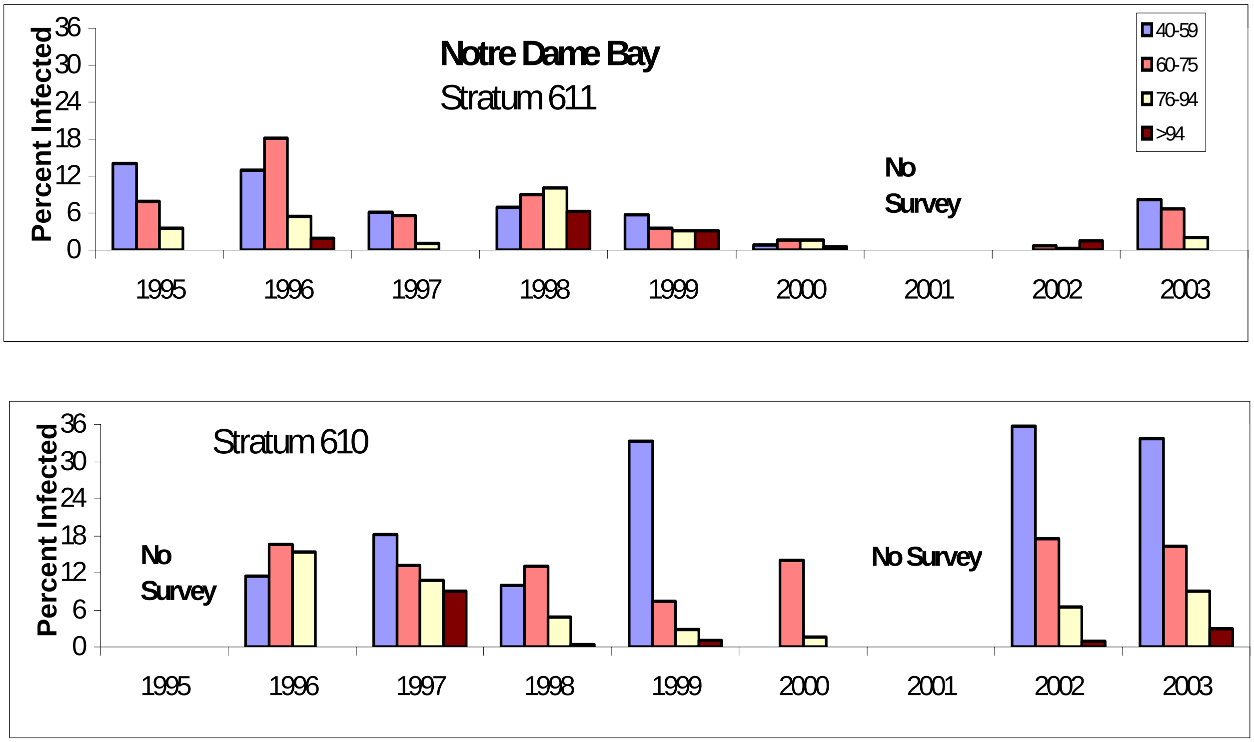



**Figure 68: : Annual trends in prevalence of BCD from inshore Div. 3K trap survey catches of small-meshed traps, by male size group, in 2 Notre Dame Bay strata.**

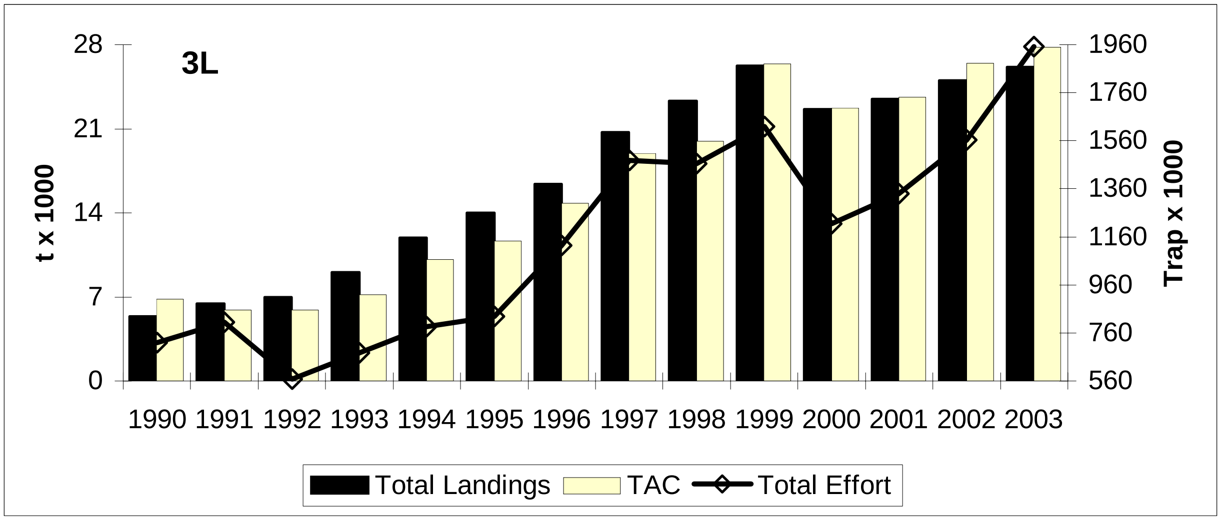



**Figure 69: Annual trends in Div. 3L landings, TAC and fishing effort.**

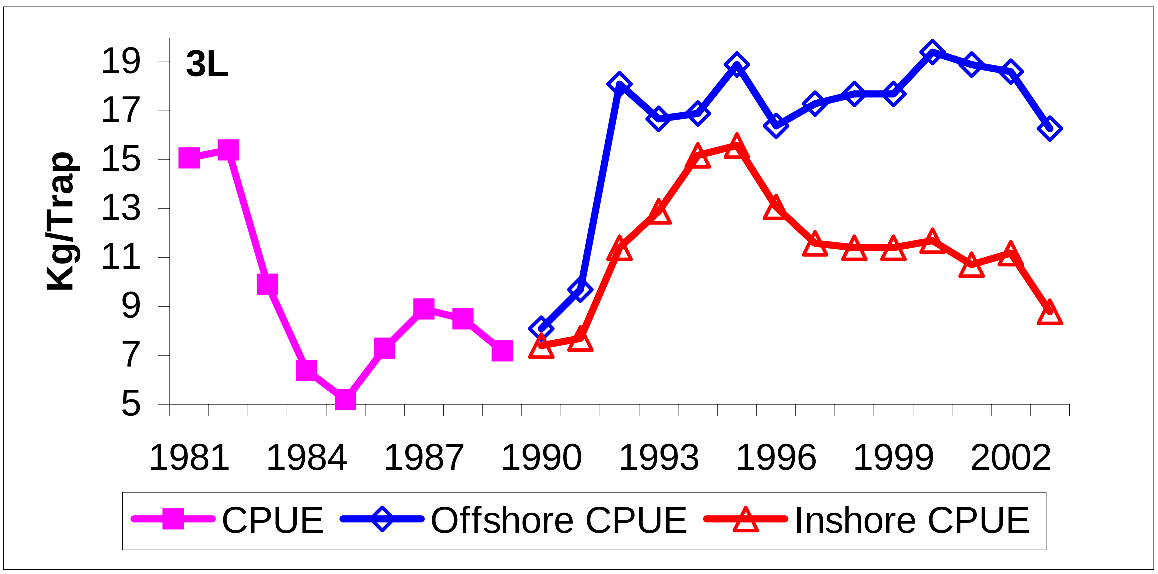



**Figure 70: Annual trends in Div. 3L commercial CPUE.**

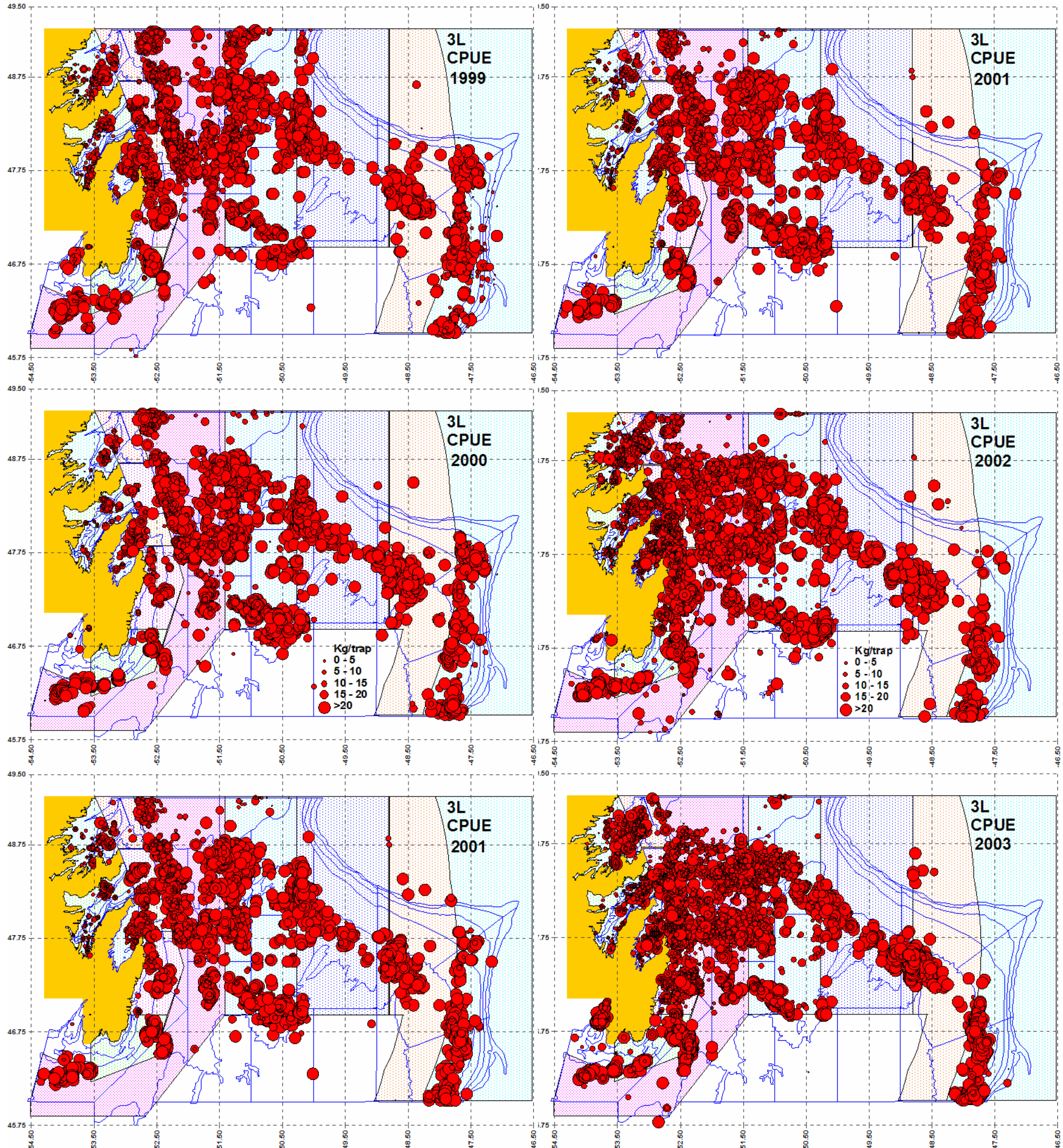



**Figure 71: Trends in spatial distribution of Div. 3L commercial CPUE for 1999-2003.**

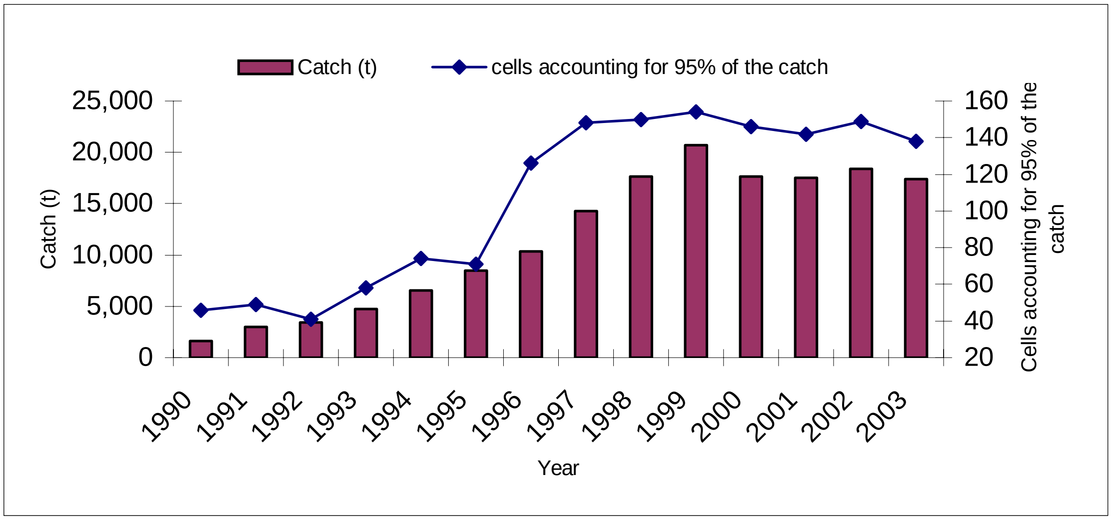



**Figure 72: Annual trends in commercial catch versus spatial distribution of the offshore fishery in Div. 3L.**

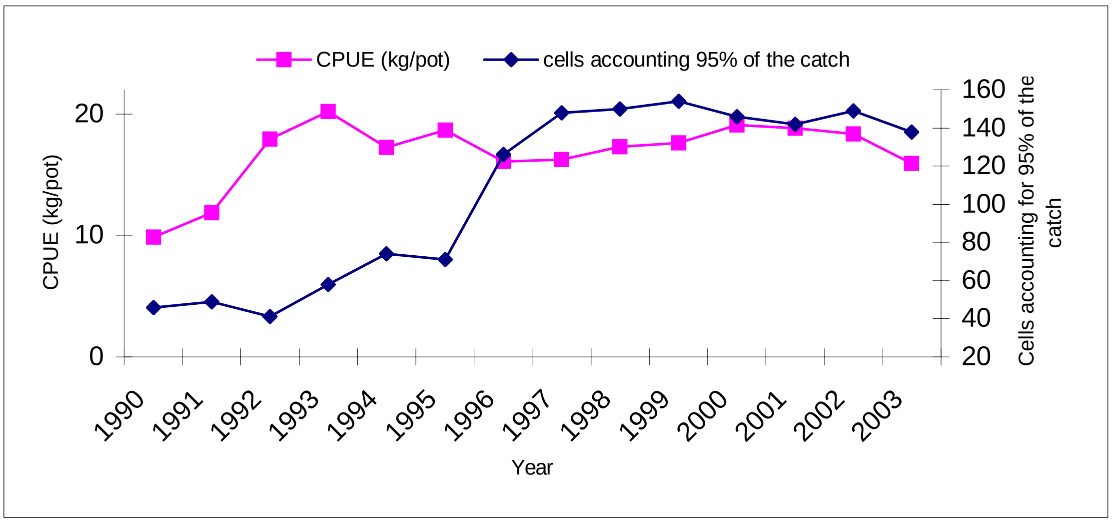



**Figure 73: Annual trends in CPUE versus spatial distribution within the offshore fishery in Div. 3L.**

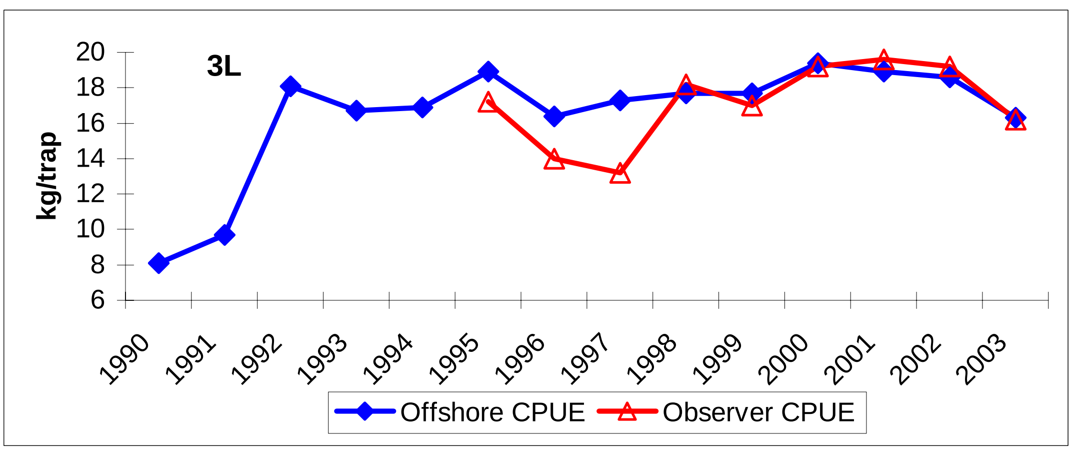



**Figure 74: Annual trends in logbook based CPUE versus observer based CPUE in the Div. 3L offshore fishery.**

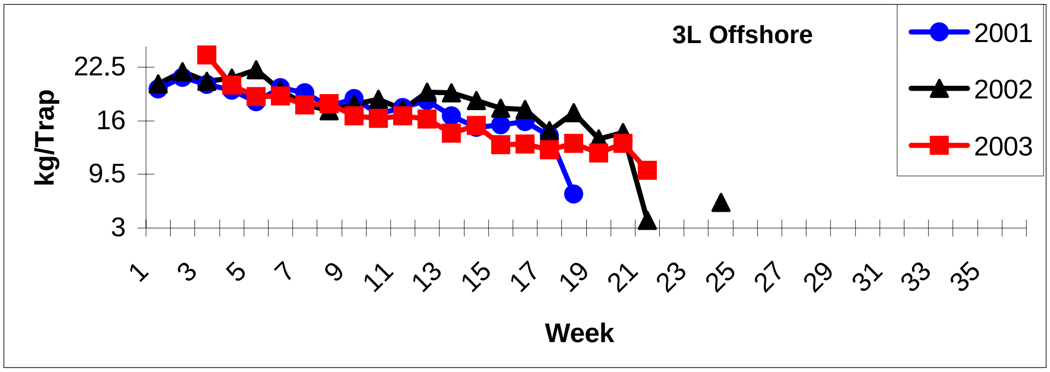



**Figure 75: Seasonal trend in CPUE, by week, for recent years for Div. 3L during 2001-2003**

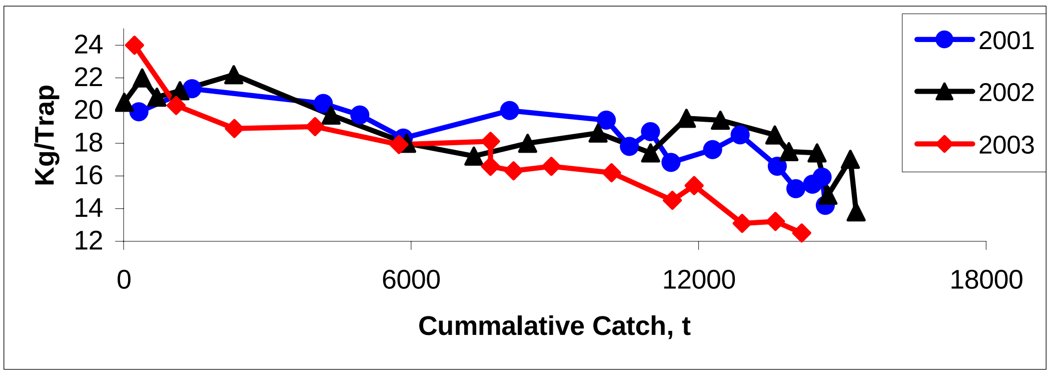



**Figure 76: Seasonal trend in CPUE, in relation to cumulative catch, for Div. 3L during 2002-2003.**

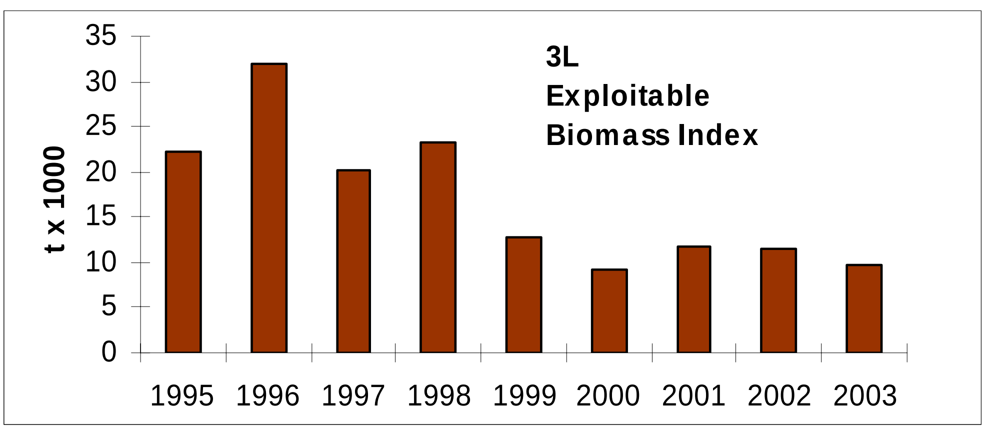



**Figure 77: Annual trends in the Div. 3L fall multi-species survey exploitable biomass index.**

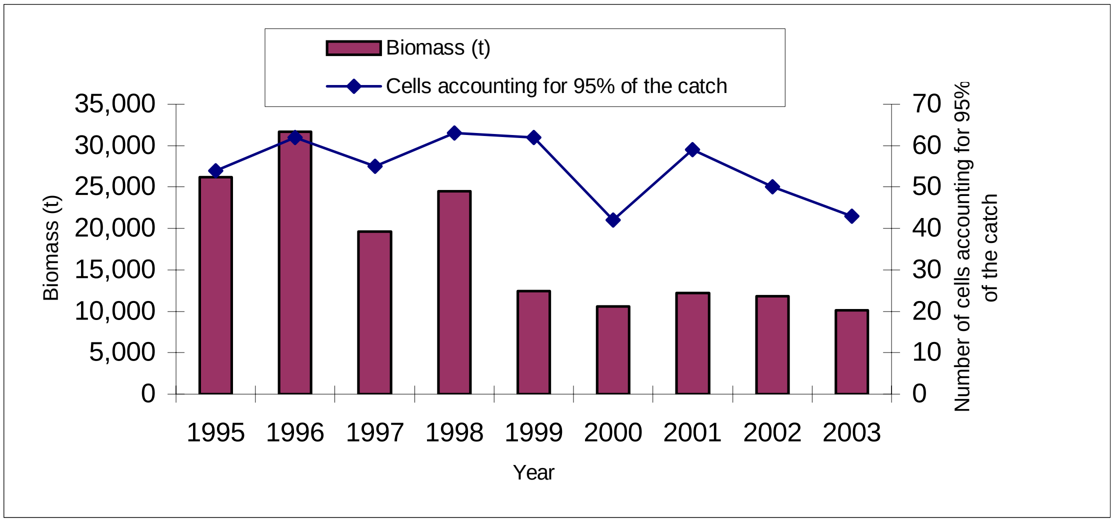



**Figure 78: Annual trends in the spatial distribution of male snow crabs and in the exploitable biomass index in Div. 3L based on fall multi-species bottom trawl survey.**

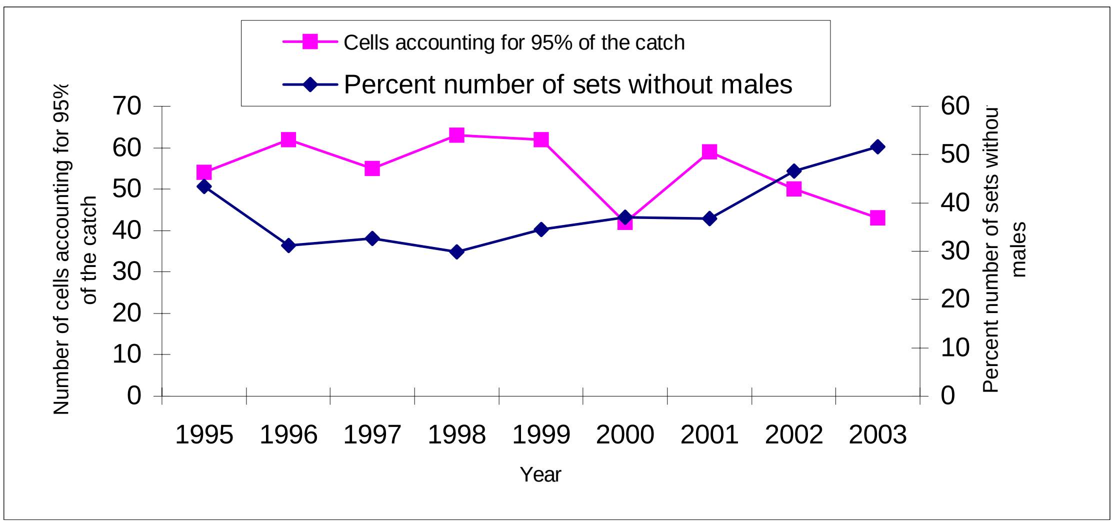



**Figure 79: Area accounting for 95% of the multi-species bottom trawl survey catch of legal-sized crabs and, within Div. 3L, and the number of sets without legal-sized males.**

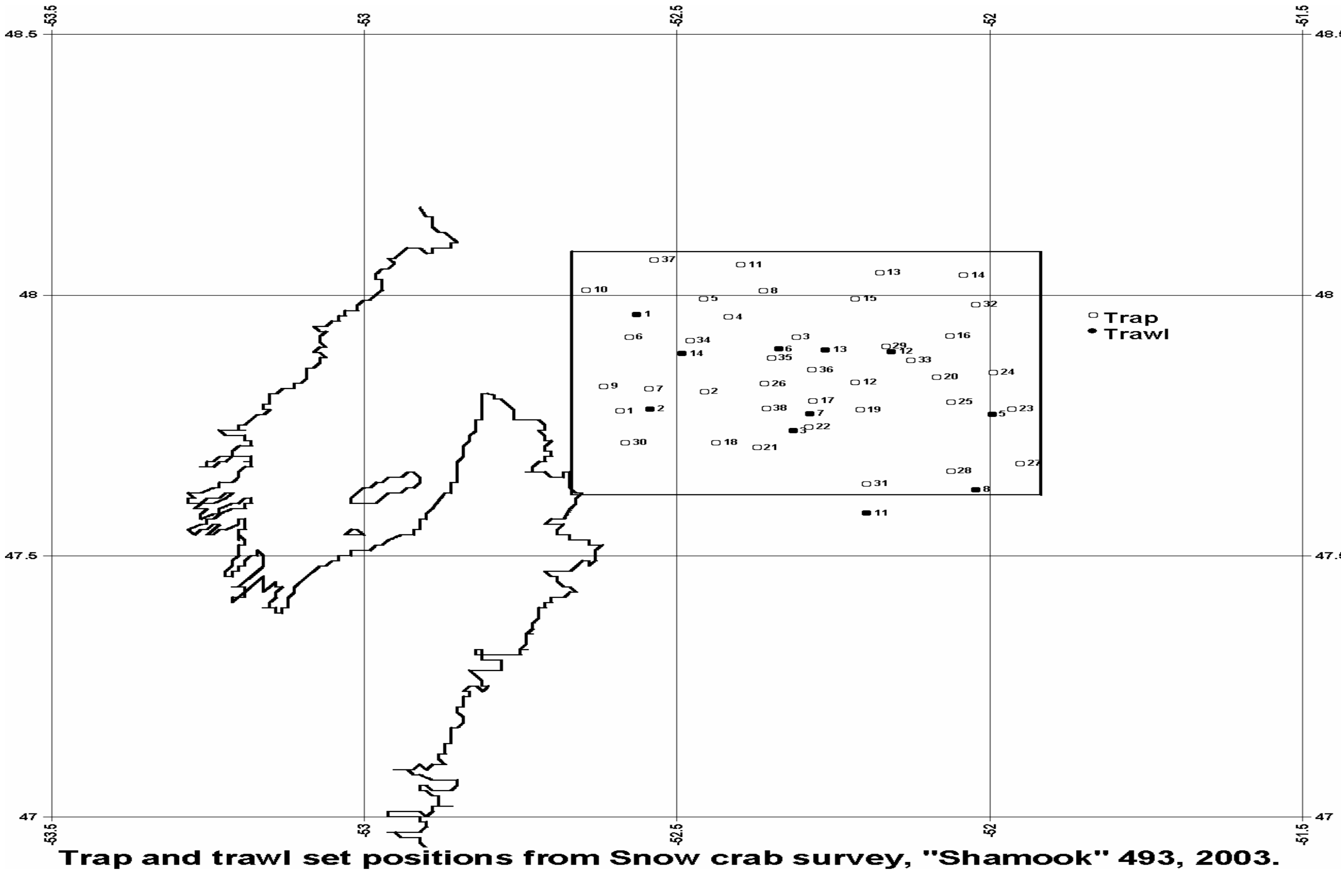



**Figure 80: Station locations for the 2003 Div. 3L inshore spring trap survey for Northeast Avalon (NEA).**

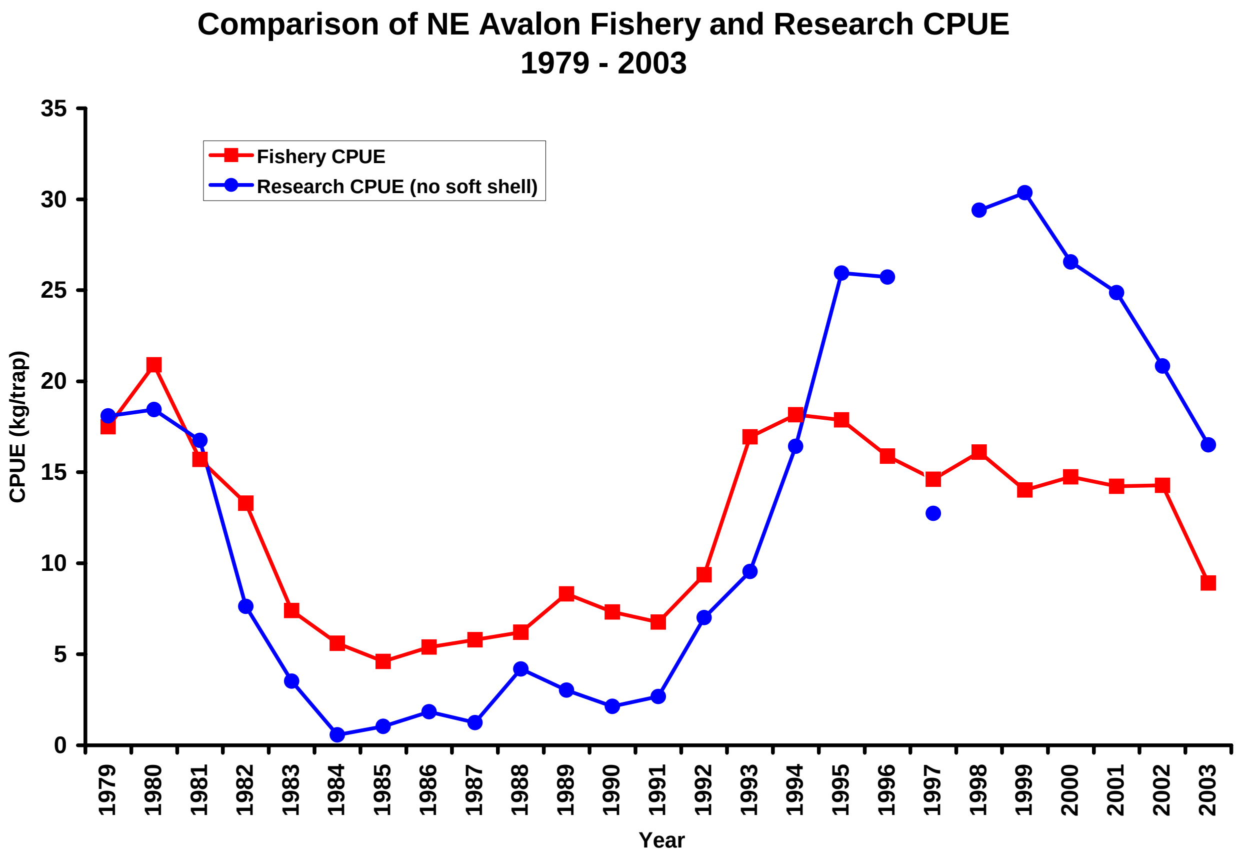



**Figure 81: Annual trends in commercial CPUE versus spring trap survey CPUE for Northeast Avalon, inshore Div. 3L, 1979-2003.**

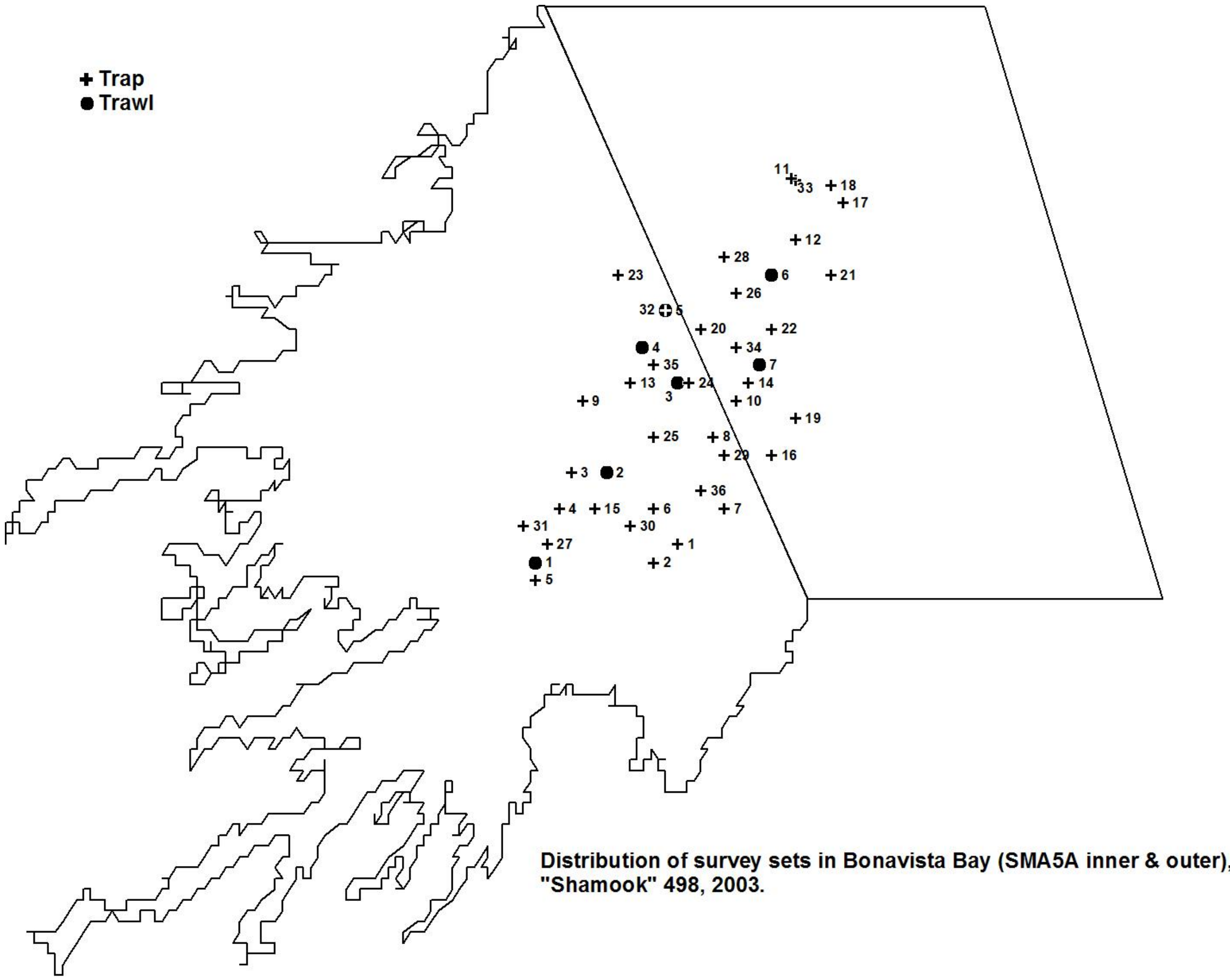



**Figure 82: Station locations for the 2003 Div. 3L inshore summer trap survey in Bonavista Bay (BB).**

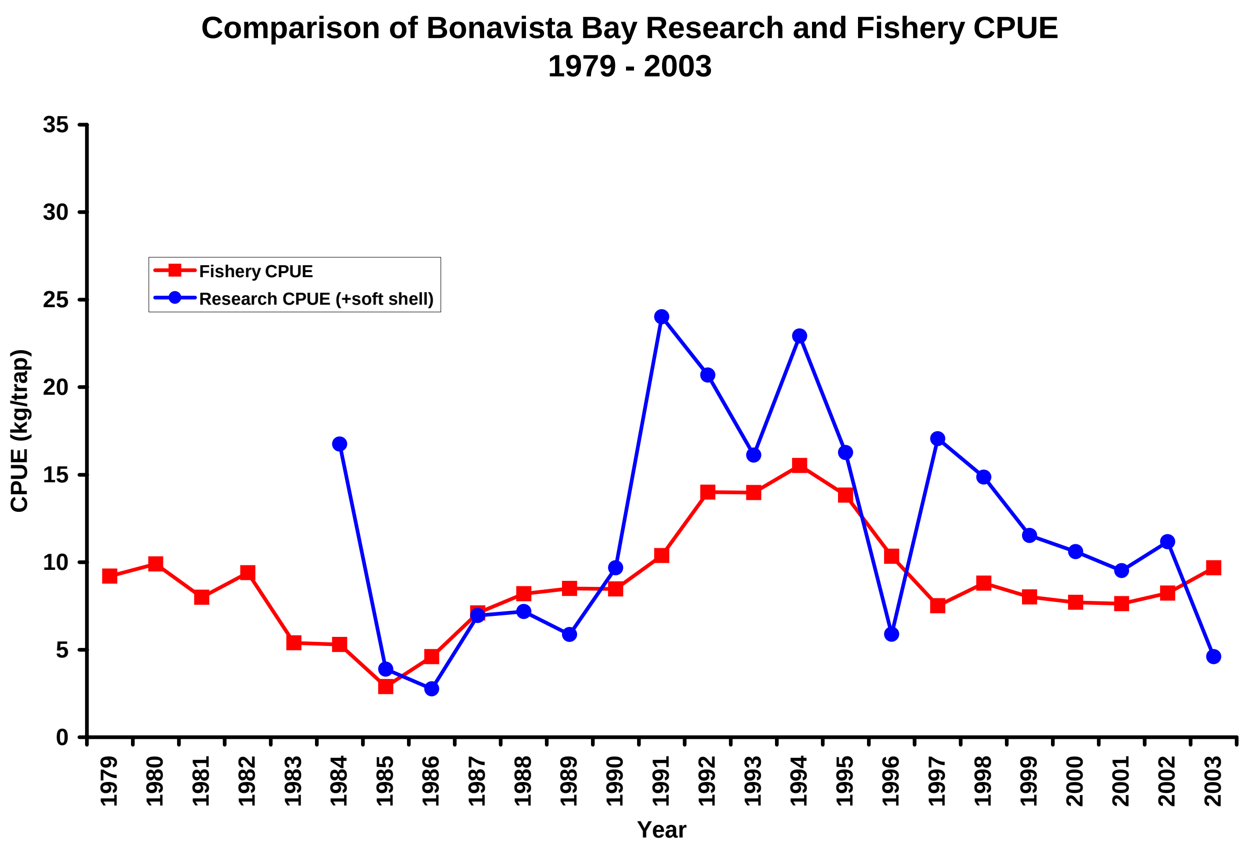



**Figure 83: Annual trends in commercial CPUE versus summer trap survey CPUE for Bonavista Bay, 1979-2003.**

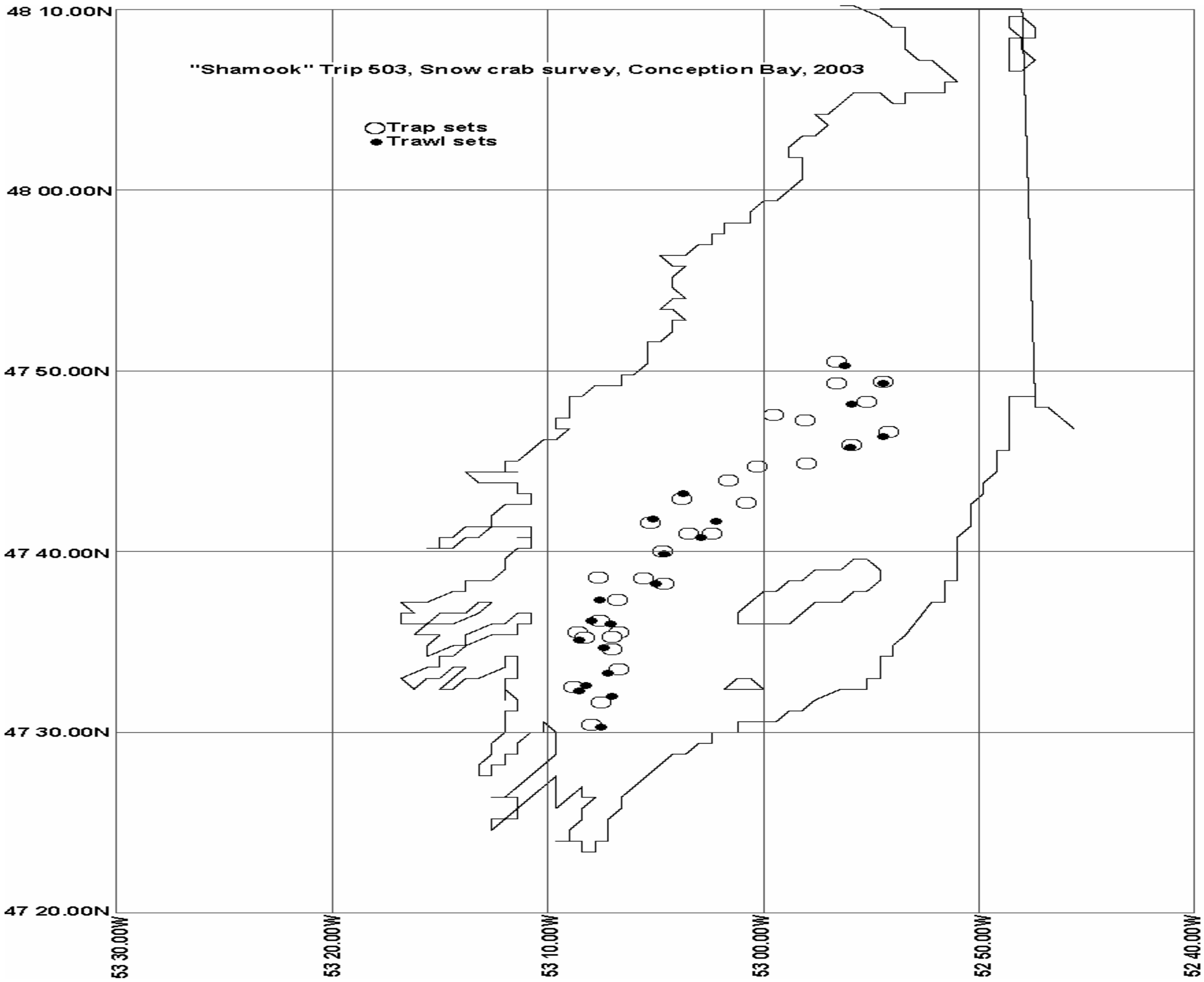



**Figure 84: Station locations for the 2003 Div. 3L inshore fall trap survey in Conception Bay (CB).**

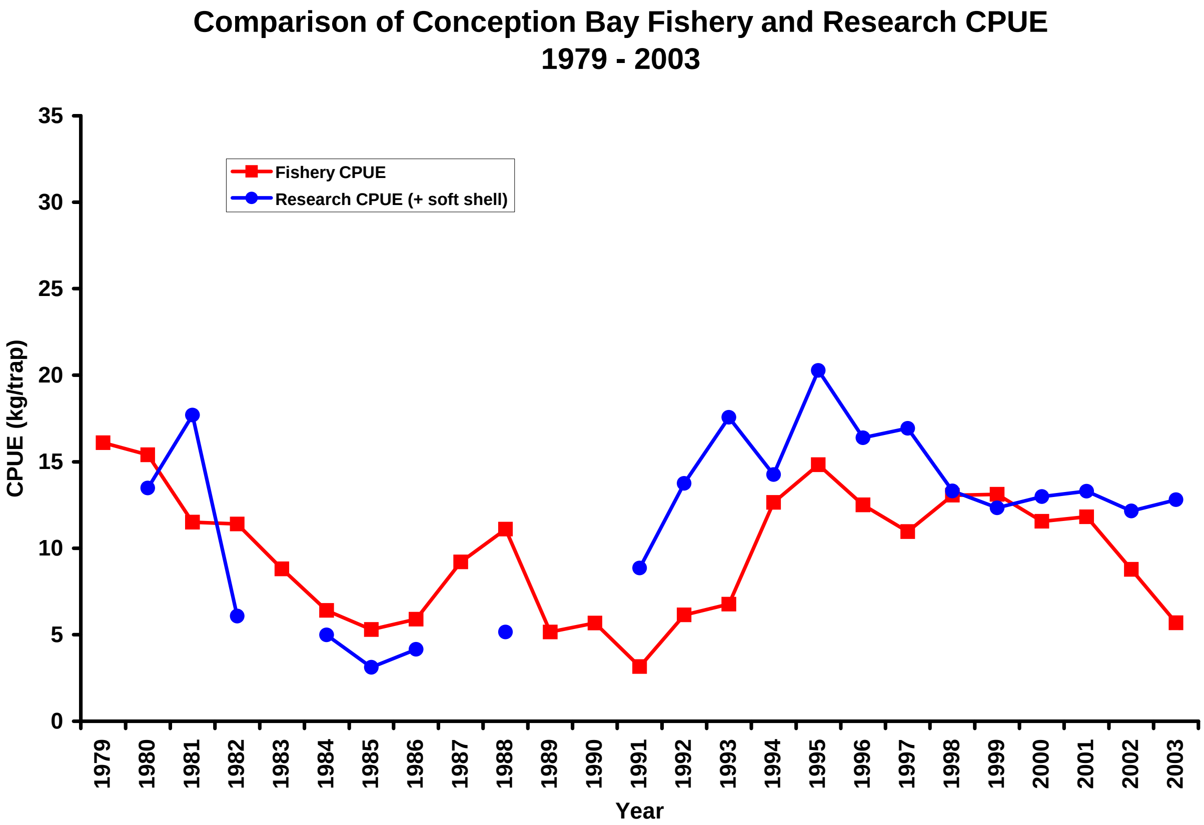



**Figure 85: Annual trends in commercial CPUE versus fall trap survey CPUE for Conception Bay, 1979-2003.**

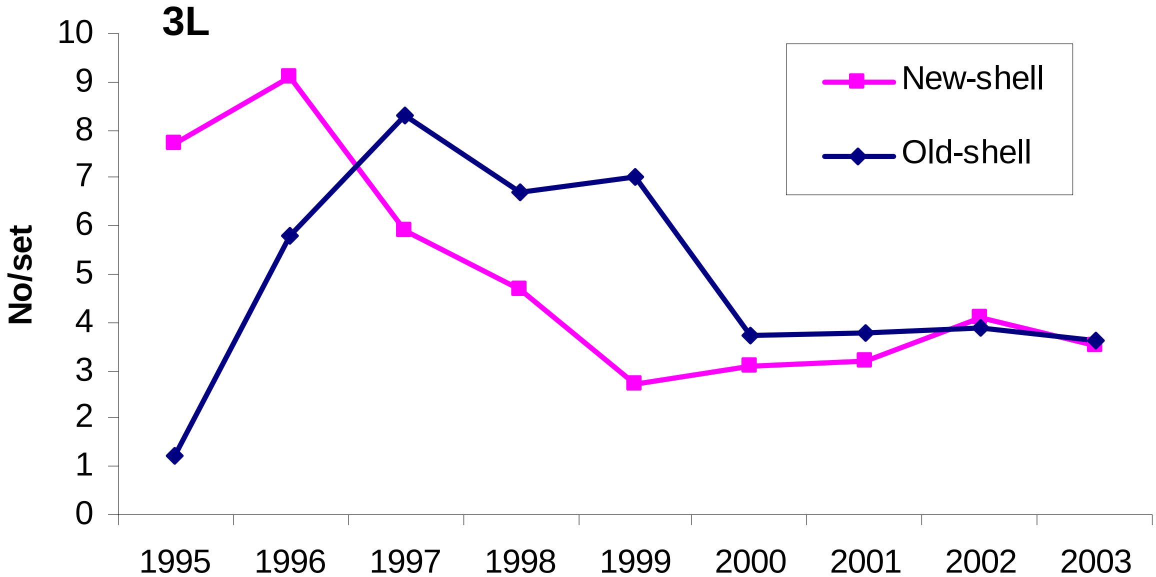



**Figure 86: Annual trends in Div. 3L fall multi - species survey catch rates of legal-sized males by shell condition.**

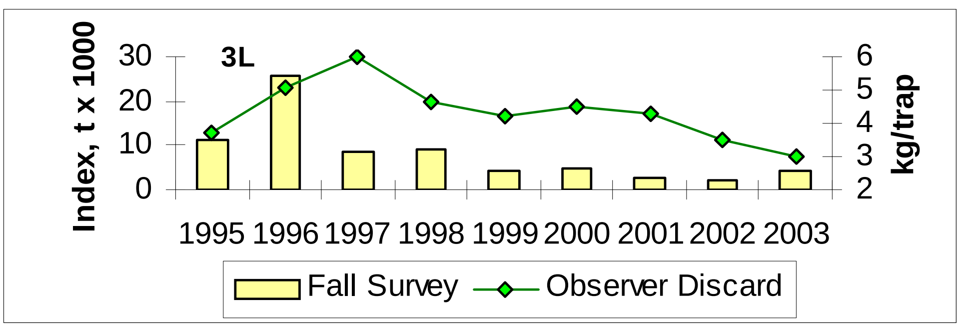



**Figure 87: Annual trends in the fall multi-species survey pre-recruit index and the observer discard pre-recruit index for Div. 3L.**

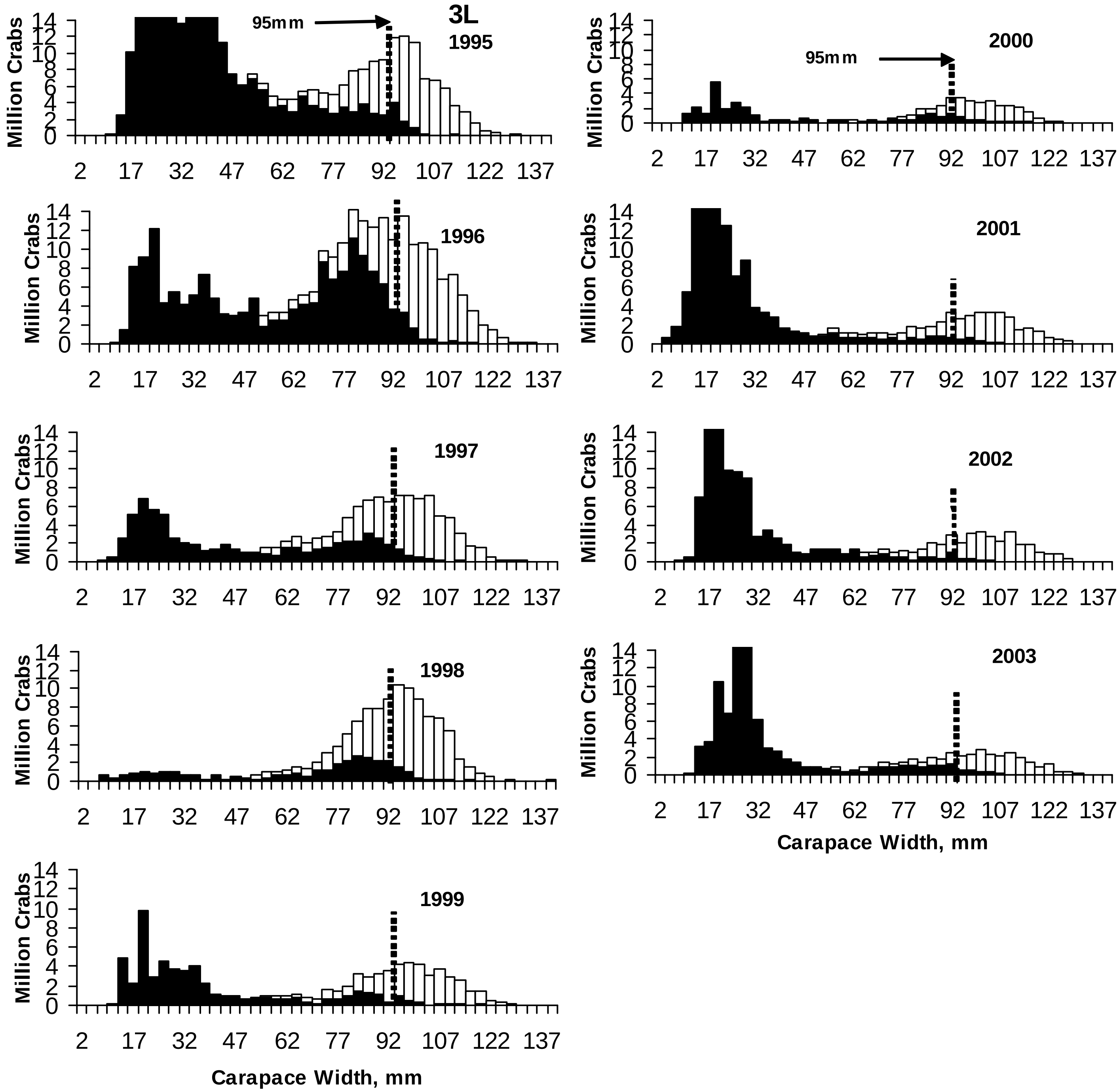



**Figure 88: Truncated distribution of Div. 3L male abundance (index) by carapace width for juveniles plus adolescents (dark bars) versus adults (open bars) from fall multi-species surveys.**

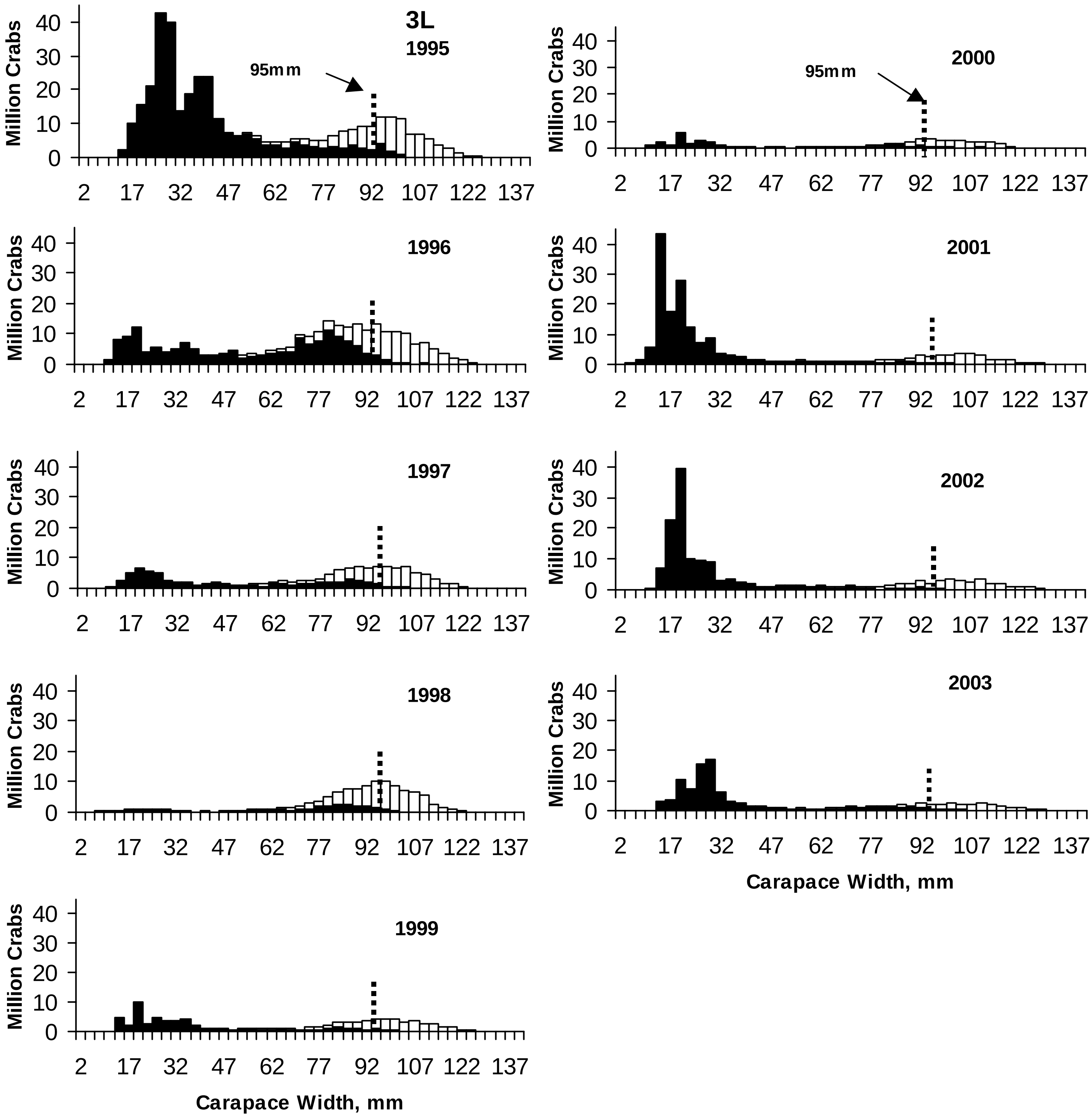



**Figure 89: Distribution of Div. 3L male abundance (index) by carapace width for juveniles plus adolescents (dark bars) versus adults (open bars) from fall multi-species surveys.**

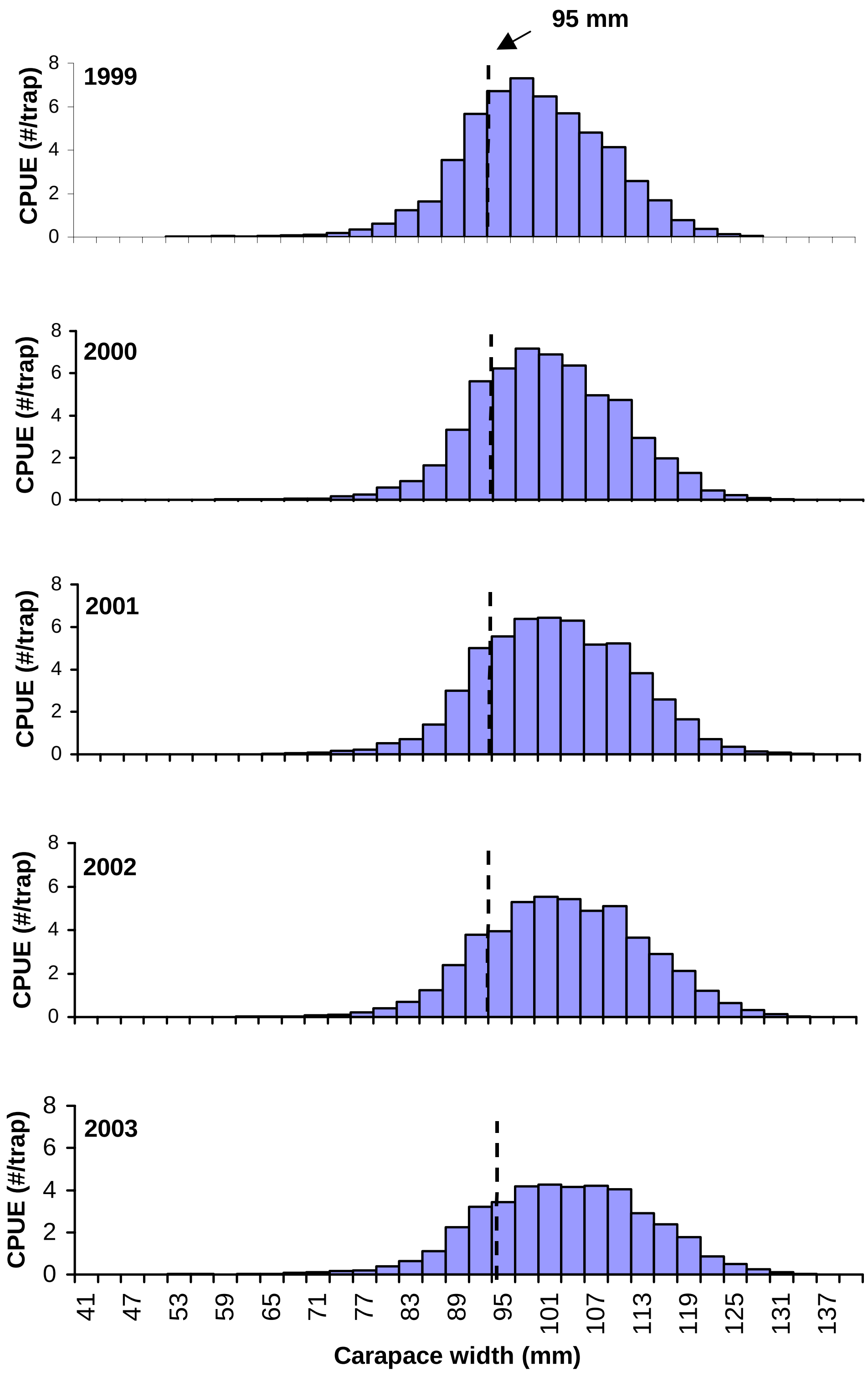



**Figure 90: Annual trends in offshore Div. 3L male size composition from observer at sea sampling for 1999-2003.**

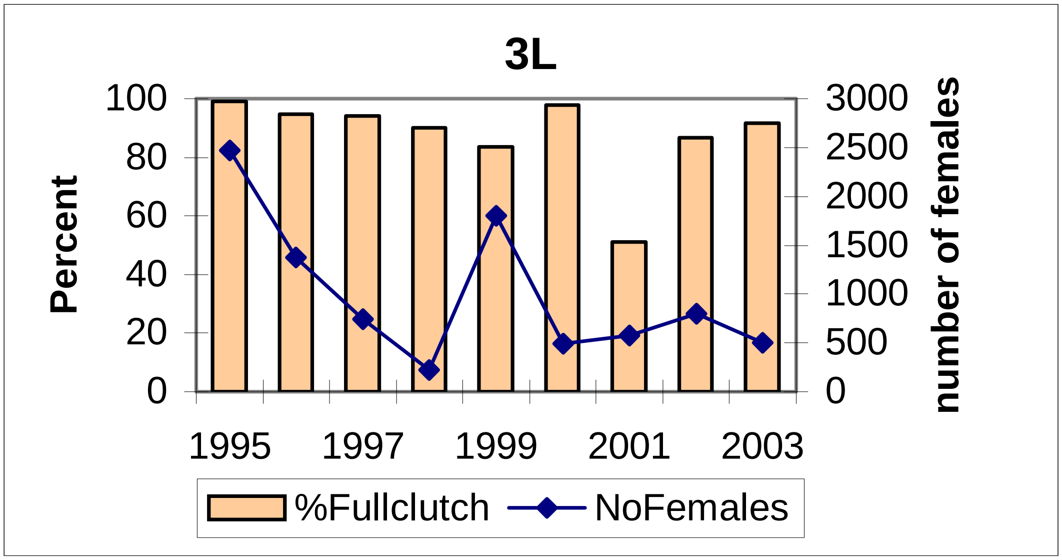



**Figure 91: Annual trends in the Div. 3L percentage of females carrying full clutches of viable eggs and sample sizes, from fall multi-species surveys.**

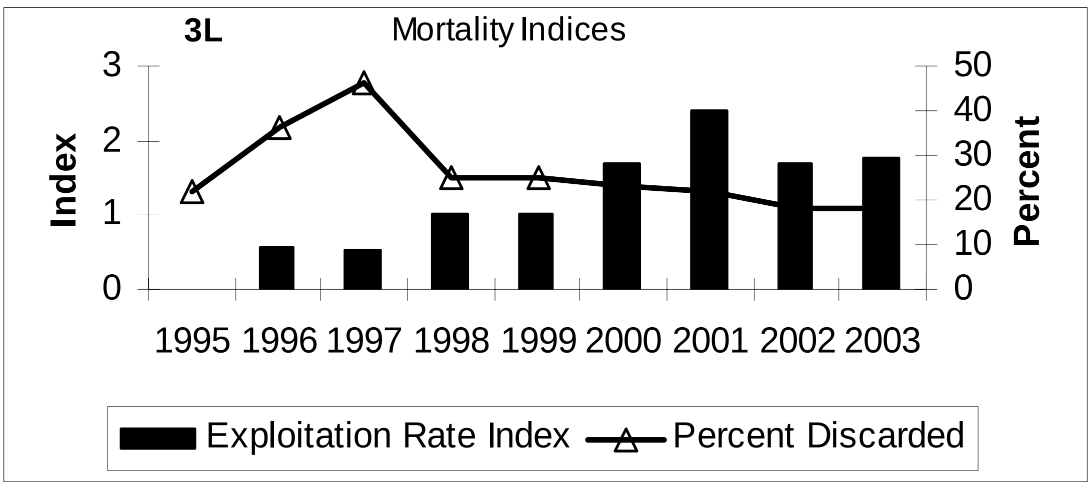



**Figure 92: Annual trends in two mortality indices for Div. 3L.**

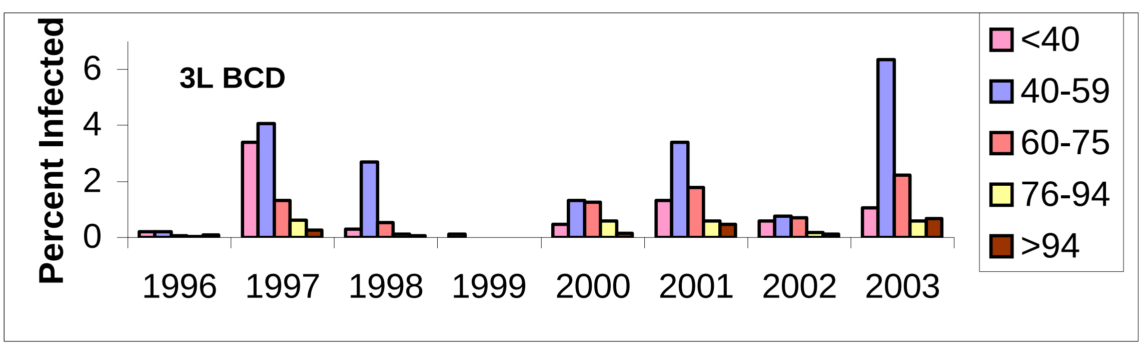



**Figure 93: Annual trends in prevalence of BCD in Div. 3L by male size group from fall multi-species surveys.**

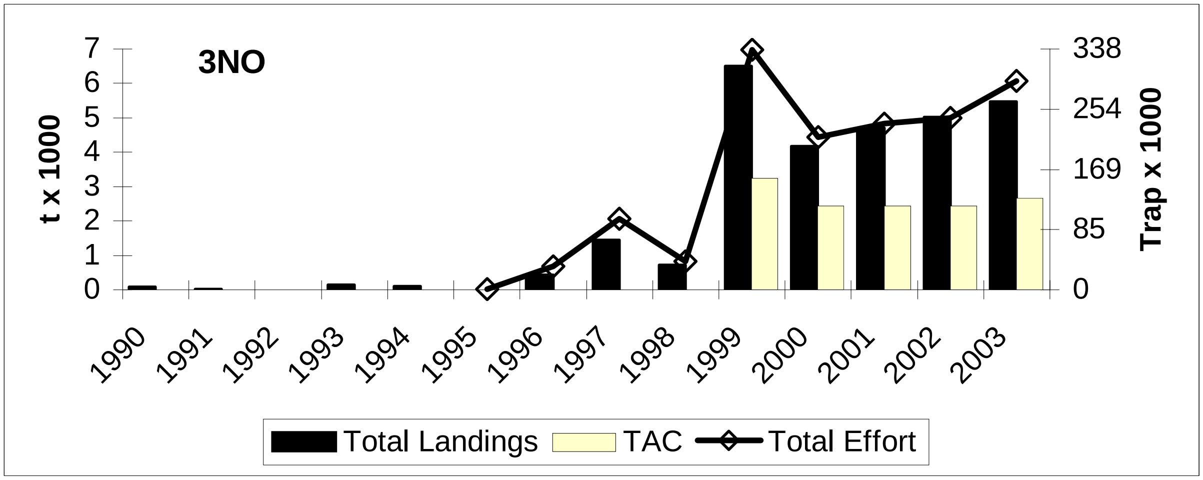



**Figure 94: Annual trends in Div. 3NO landings, TAC and fishing effort.**

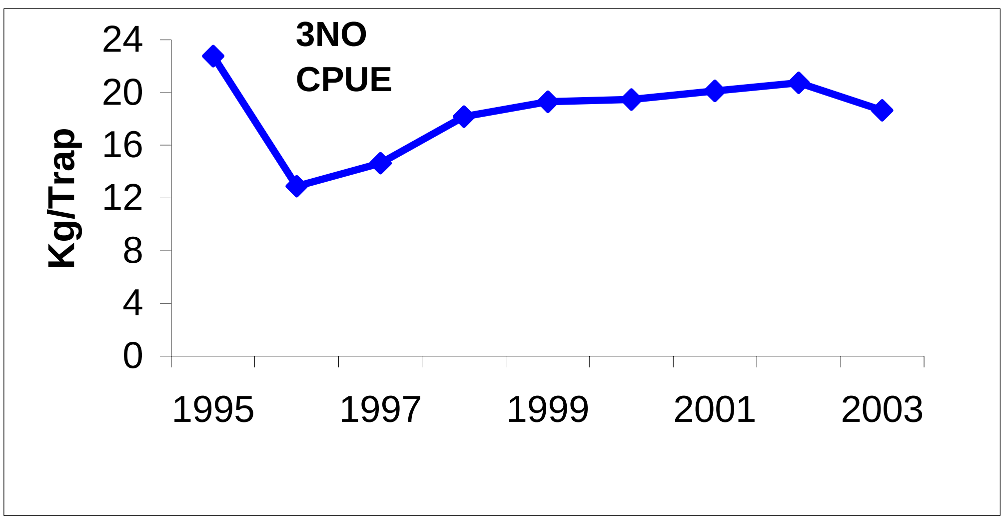



**Figure 95: Annual trends in Div. 3NO commercial CPUE.**

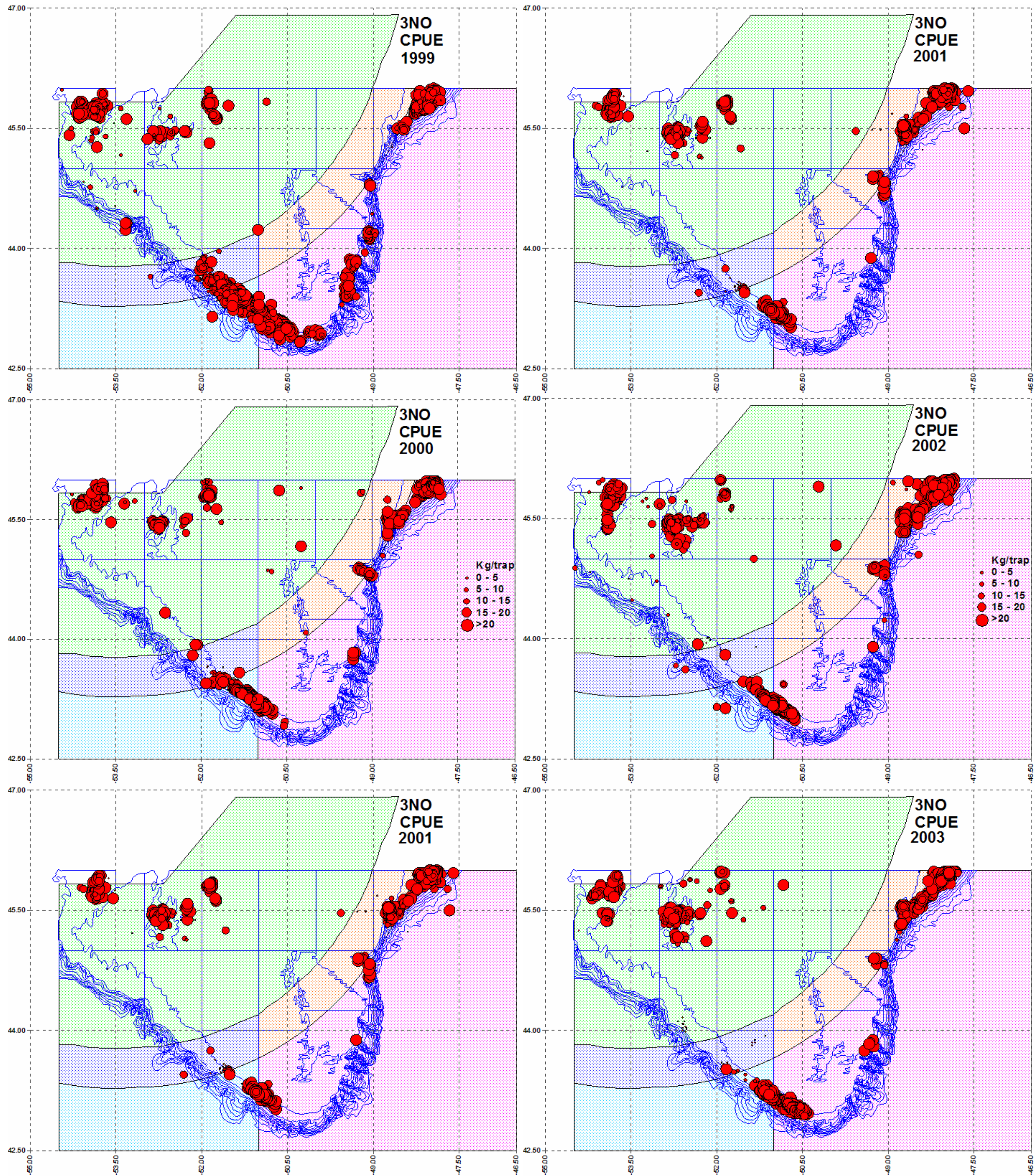



**Figure 96: Annual trends in the spatial distribution of commercial CPUE within Div. 3NO during 1999-2003.**

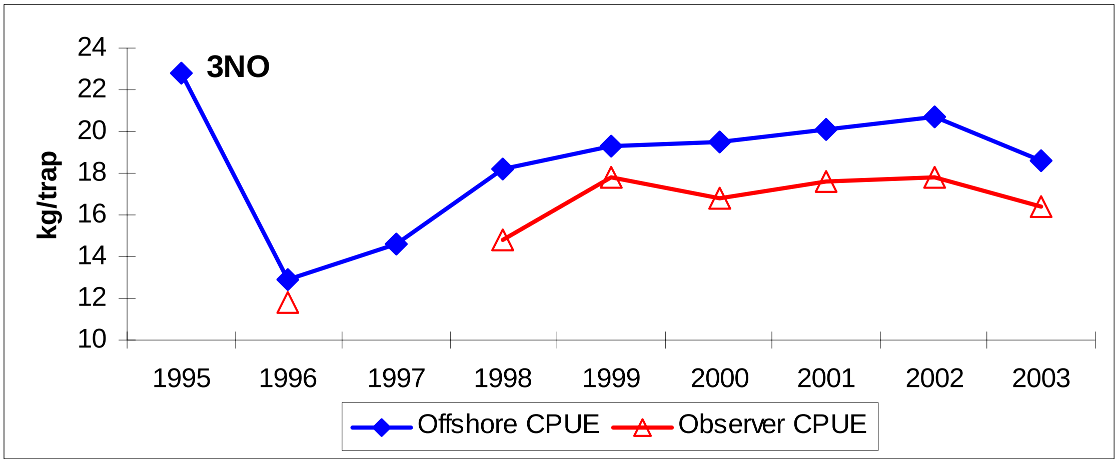



**Figure 97: Annual trends of logbook versus observer CPUE in Div. 3NO.**

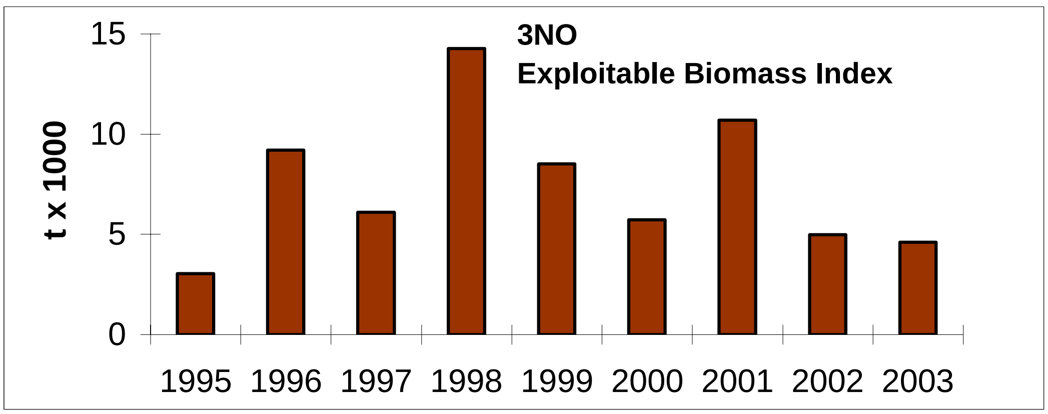



**Figure 98: Annual trends in the Div. 3NO fall multi - species survey exploitable biomass index.**

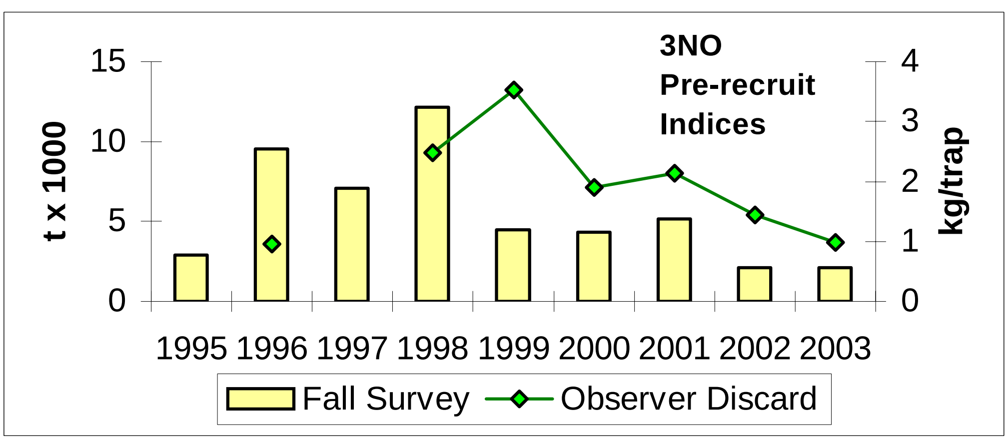



**Figure 99: Annual trends in the fall multi-species survey pre-recruit index and the observer discard pre-recruit index for Div. 3NO.**

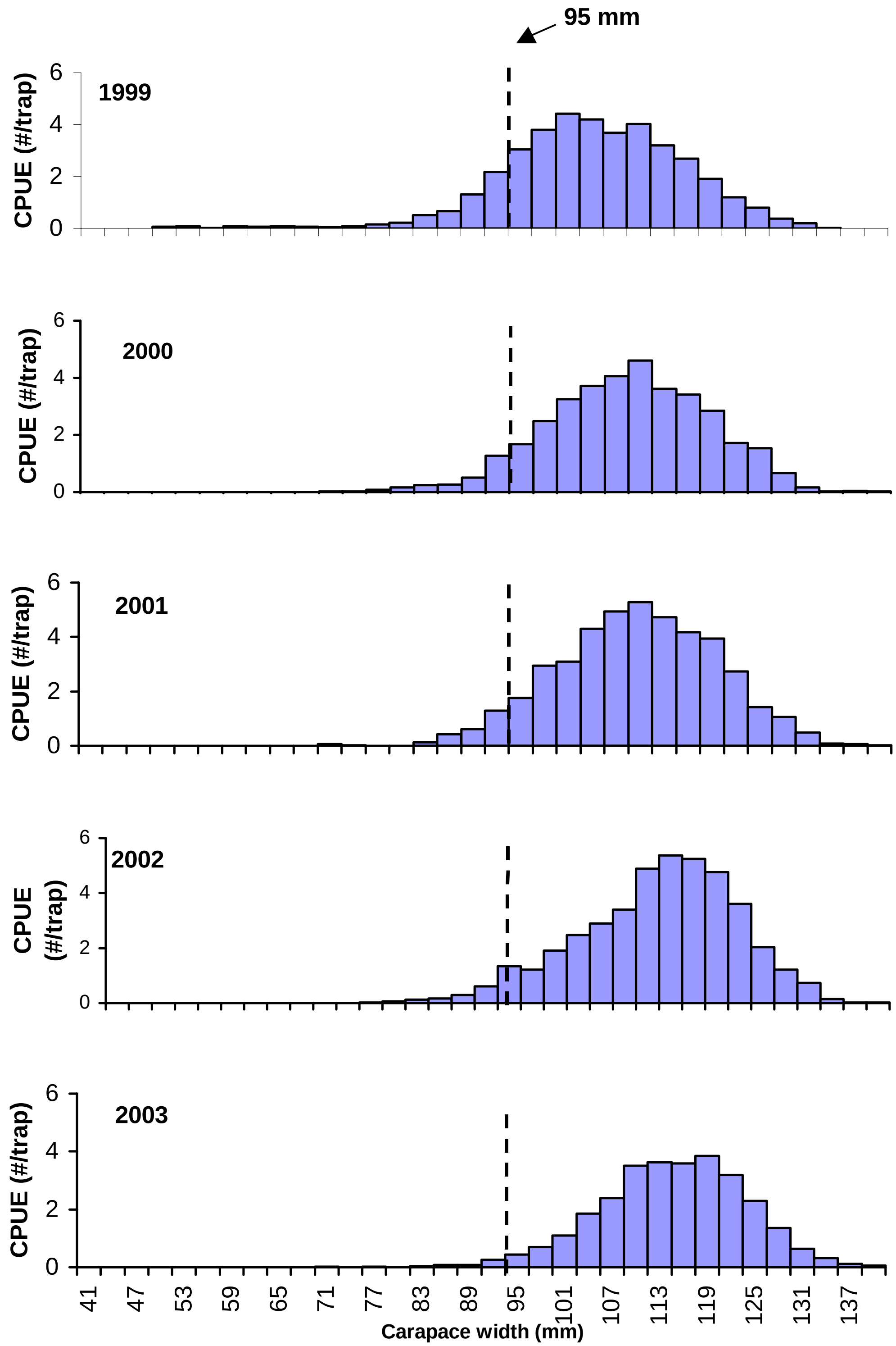



**Figure 100: Annual trends in offshore Div. 3N male size composition from observer at sea sampling for 1999-2003.**

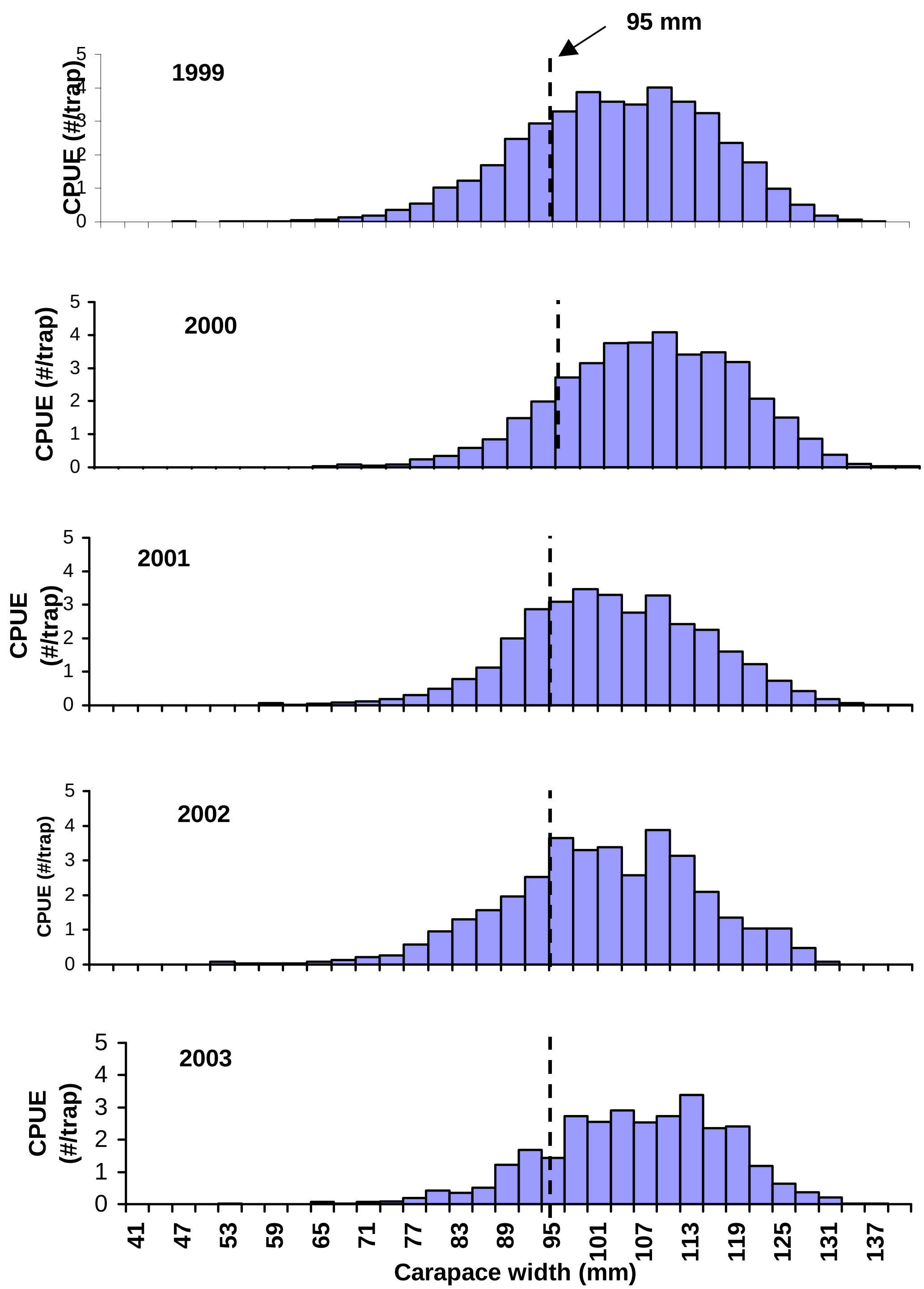
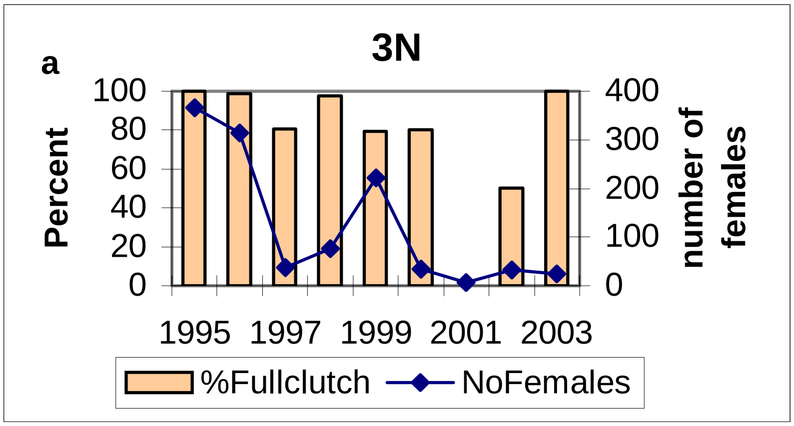



**Figure 101: Annual trends in offshore Div. 3O male size composition from observer at sea sampling for 1999-2003.**



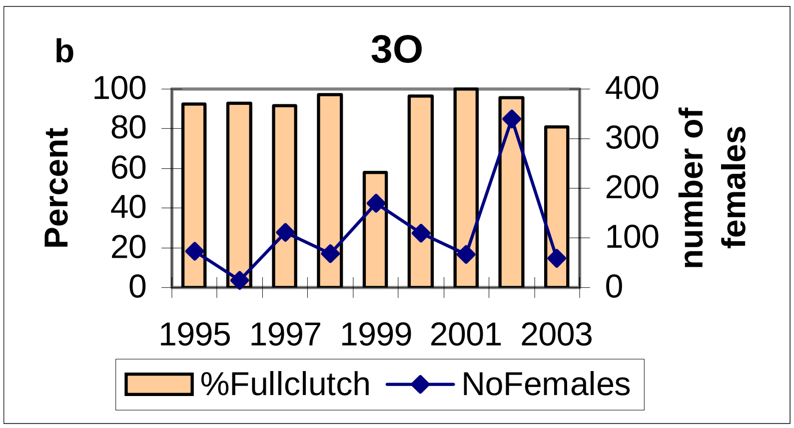




**Figure 102: Percentage of females carrying full clutch of viable eggs and sample sizes for a) Div. 3N and b) Div. 3O, from fall multi-species surveys.**

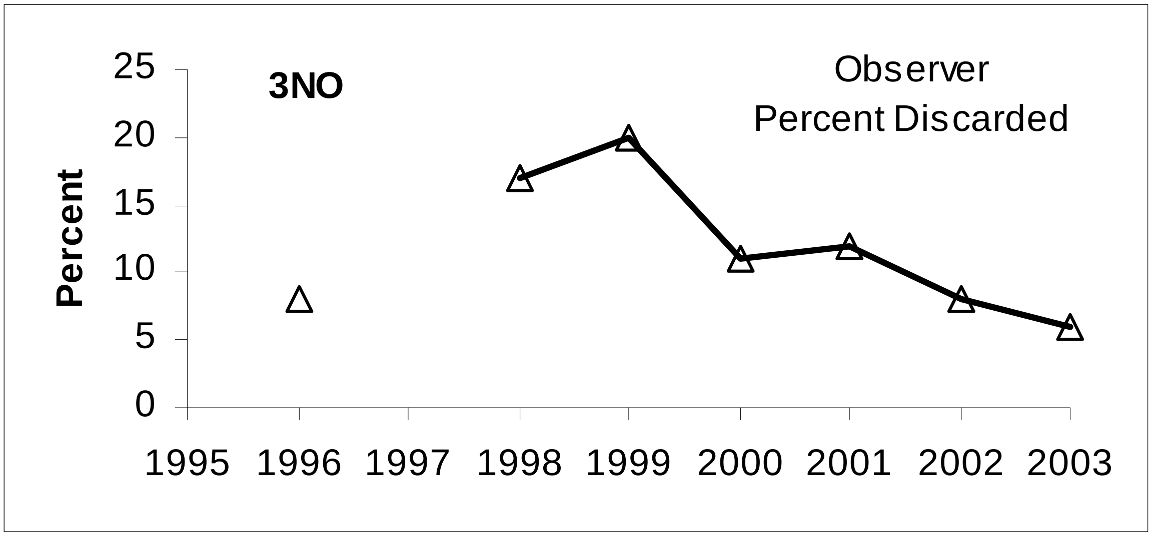



**Figure 103: Annual trends in observer-based percent discarded in the Div. 3NO fishery.**

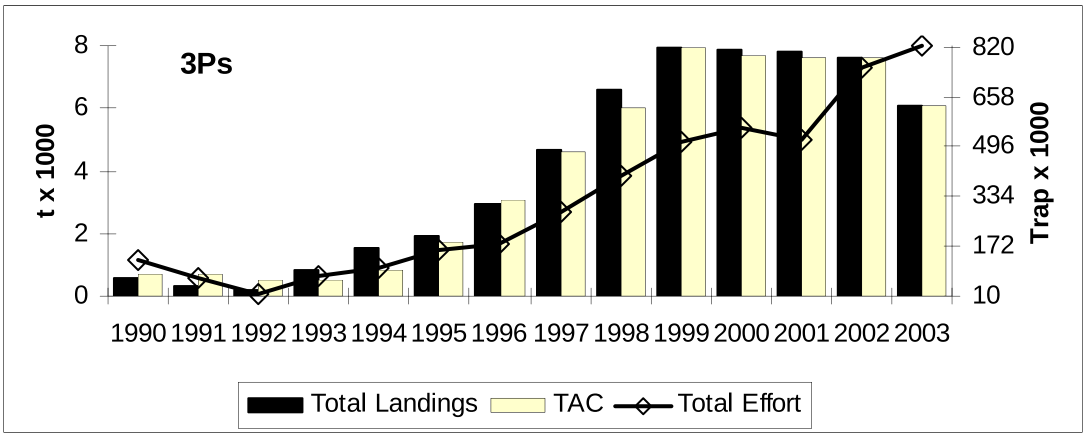



**Figure 104: Annual trends in landings, TAC and fishing ffort for Subdiv. 3Ps.**

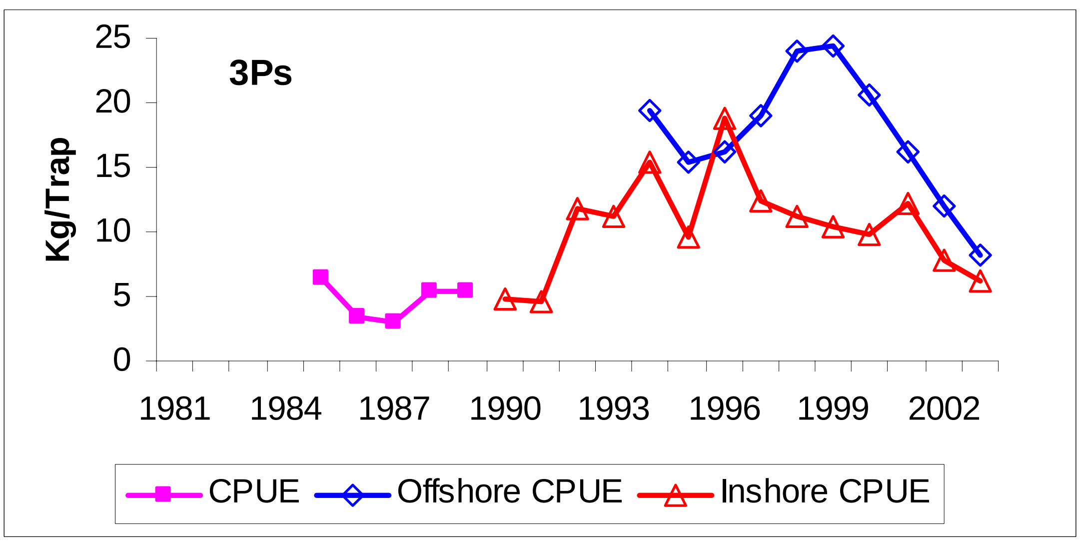



**Figure 105: Annual trends in CPUE for Subdiv. 3Ps.**

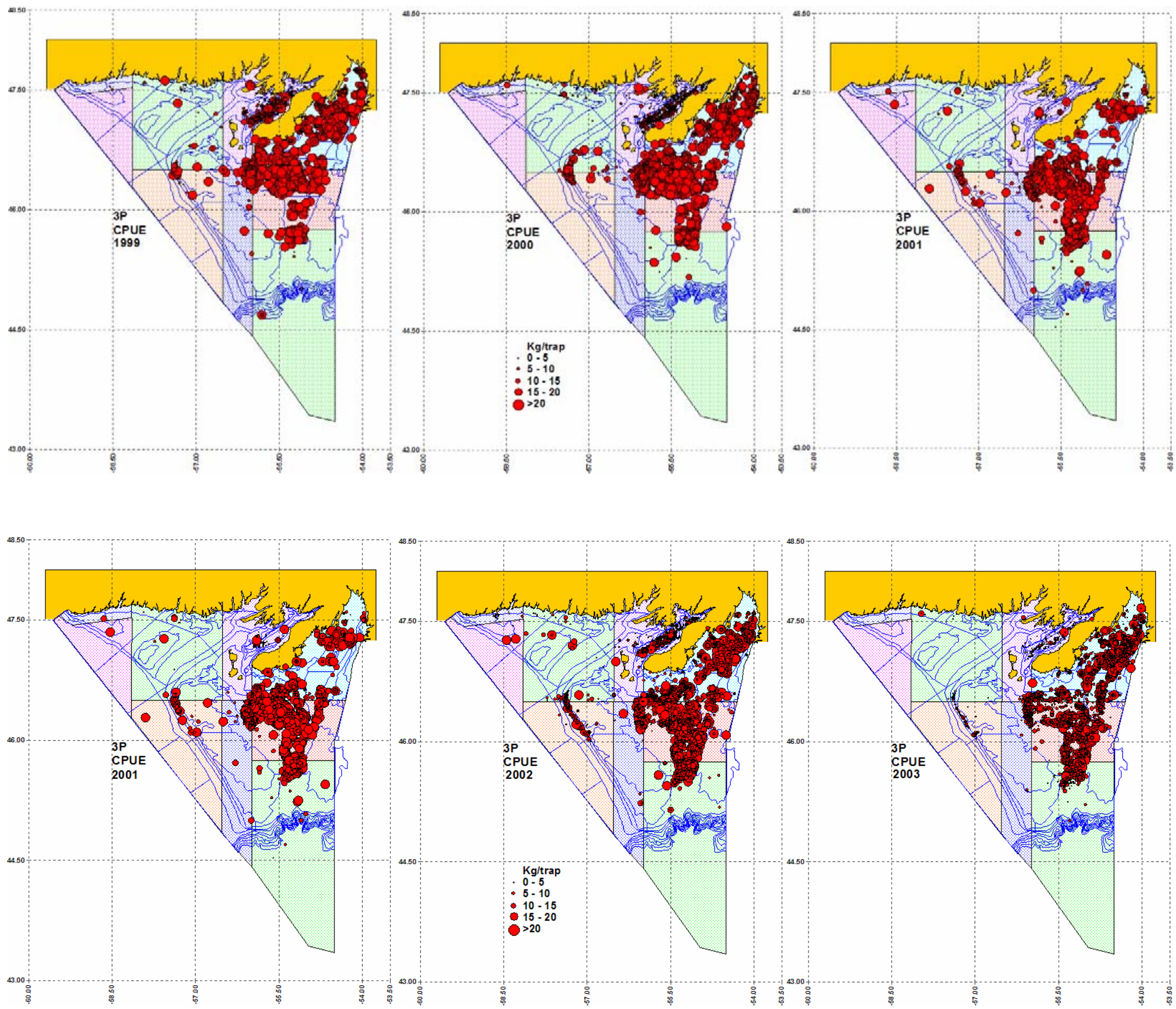



**Figure 106: Annual trends in the spatial distribution of commercial CPUE within Subdiv. 3Ps during 1999-2003.**

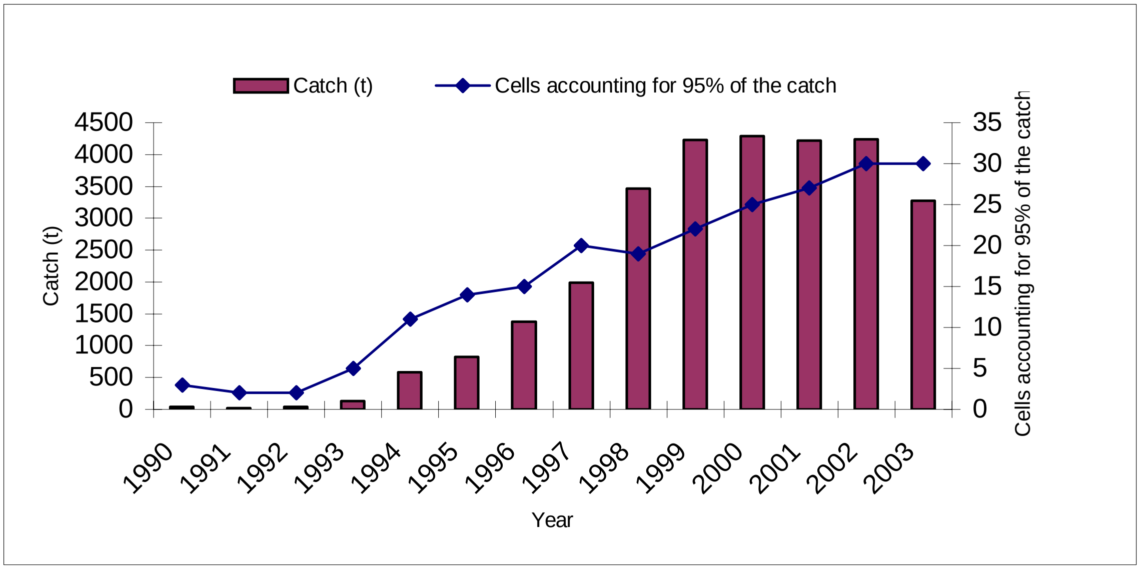



**Figure 107: Annual trends in commercial catch versus spatial distribution of the offshore fishery in Subdiv. 3Ps.**

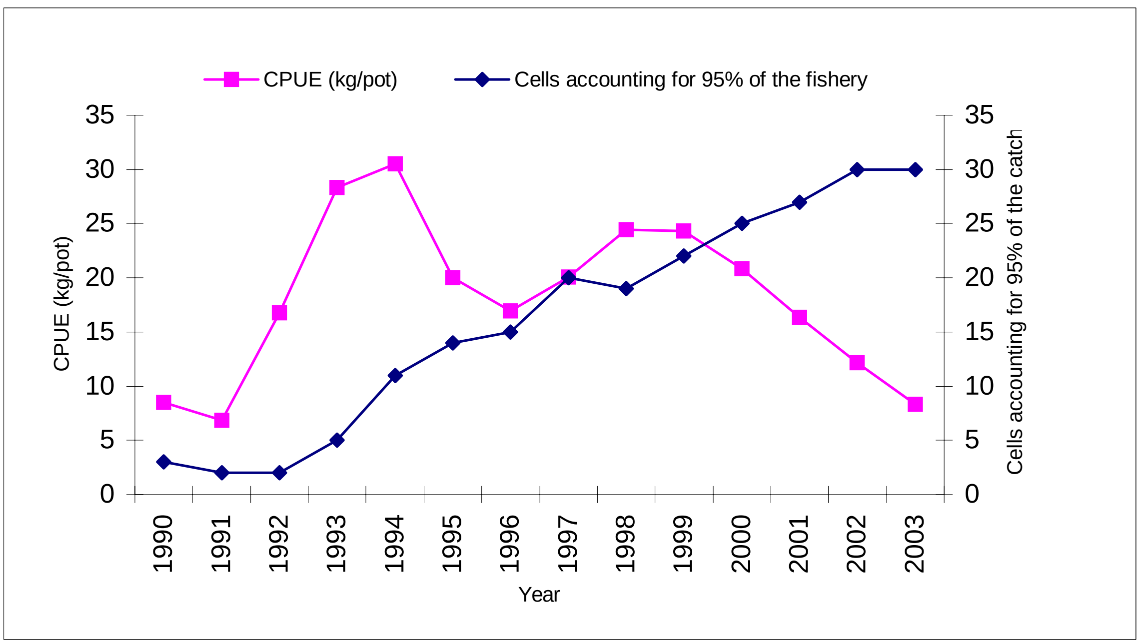



**Figure 108: Annual trends in CPUE versus spatial distribution of the offshore fishery in 3Ps.**

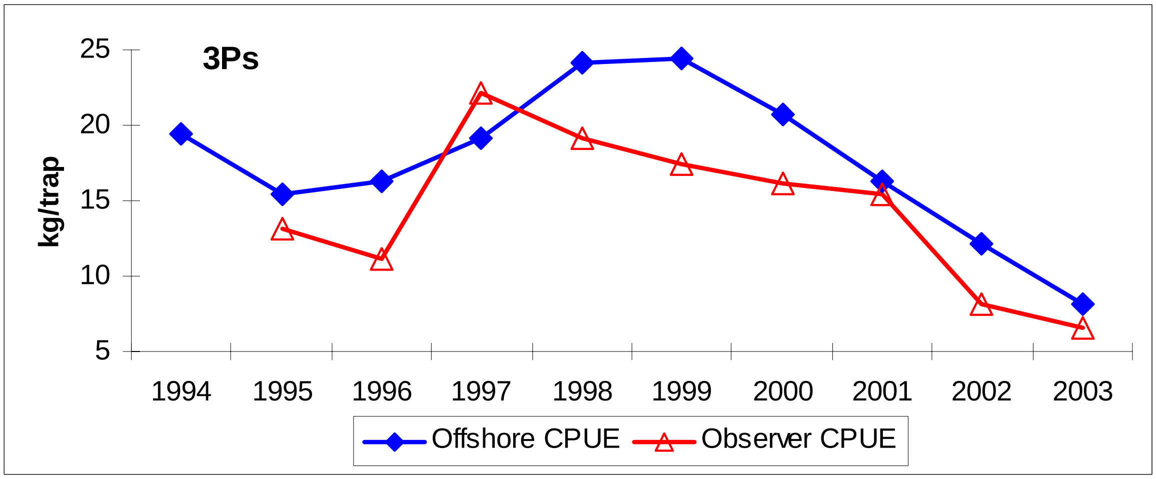



**Figure 109: Annual trends in offshore Subdiv. 3Ps logbook versus observer CPUE.**

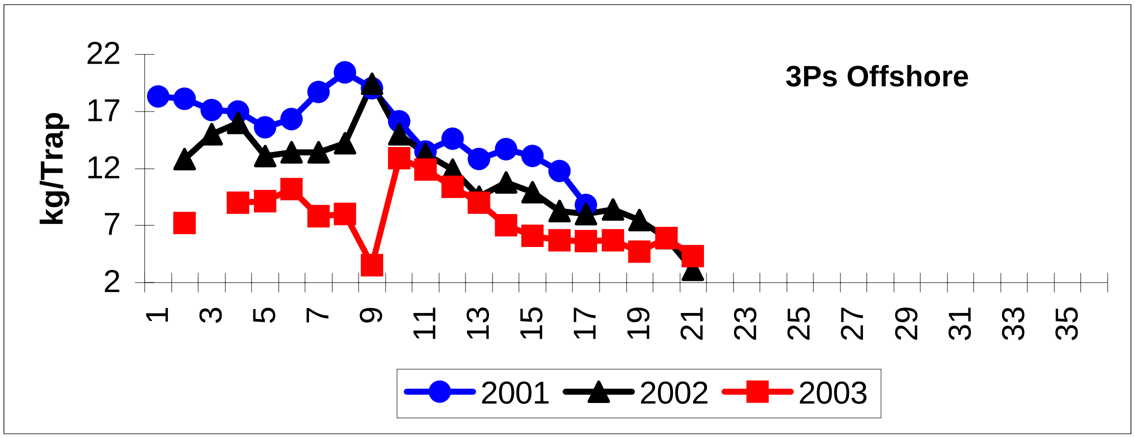



**Figure 110: Seasonal trends in CPUE, by week, for Subdiv. 3Ps during 2001-2003.**

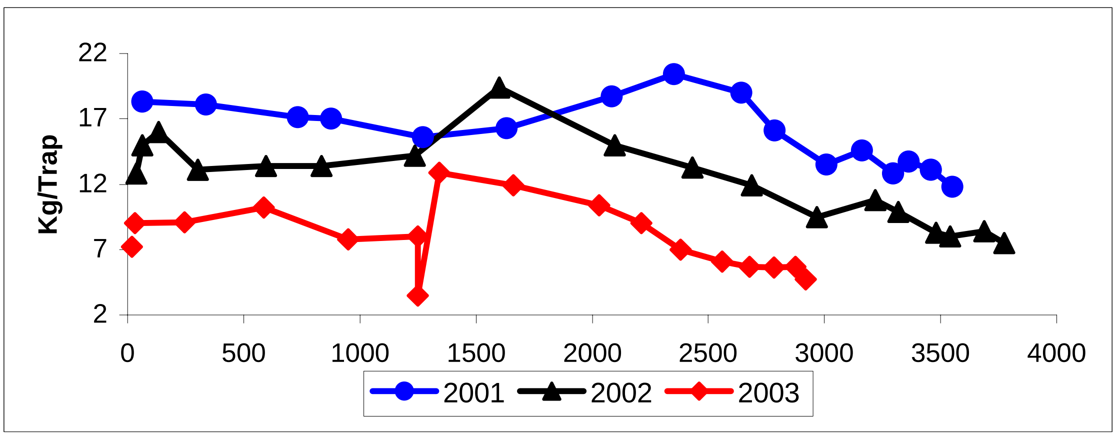



**Figure 111: Seasonal trends in CPUE, in relation to cumulative catch, for Subdiv. 3Ps during 2001-2003.**

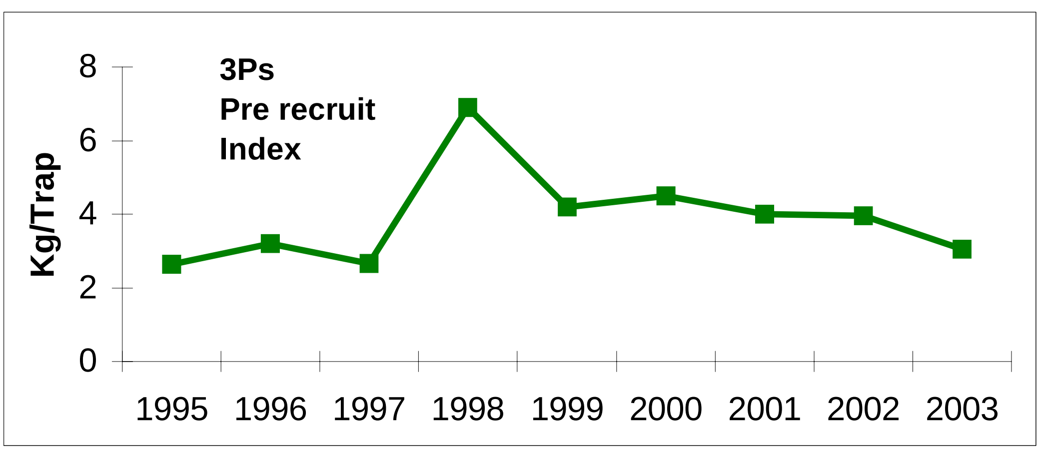



**Figure 112: Annual trends in the Subdiv. 3Ps observer discard pre-recruit index.**

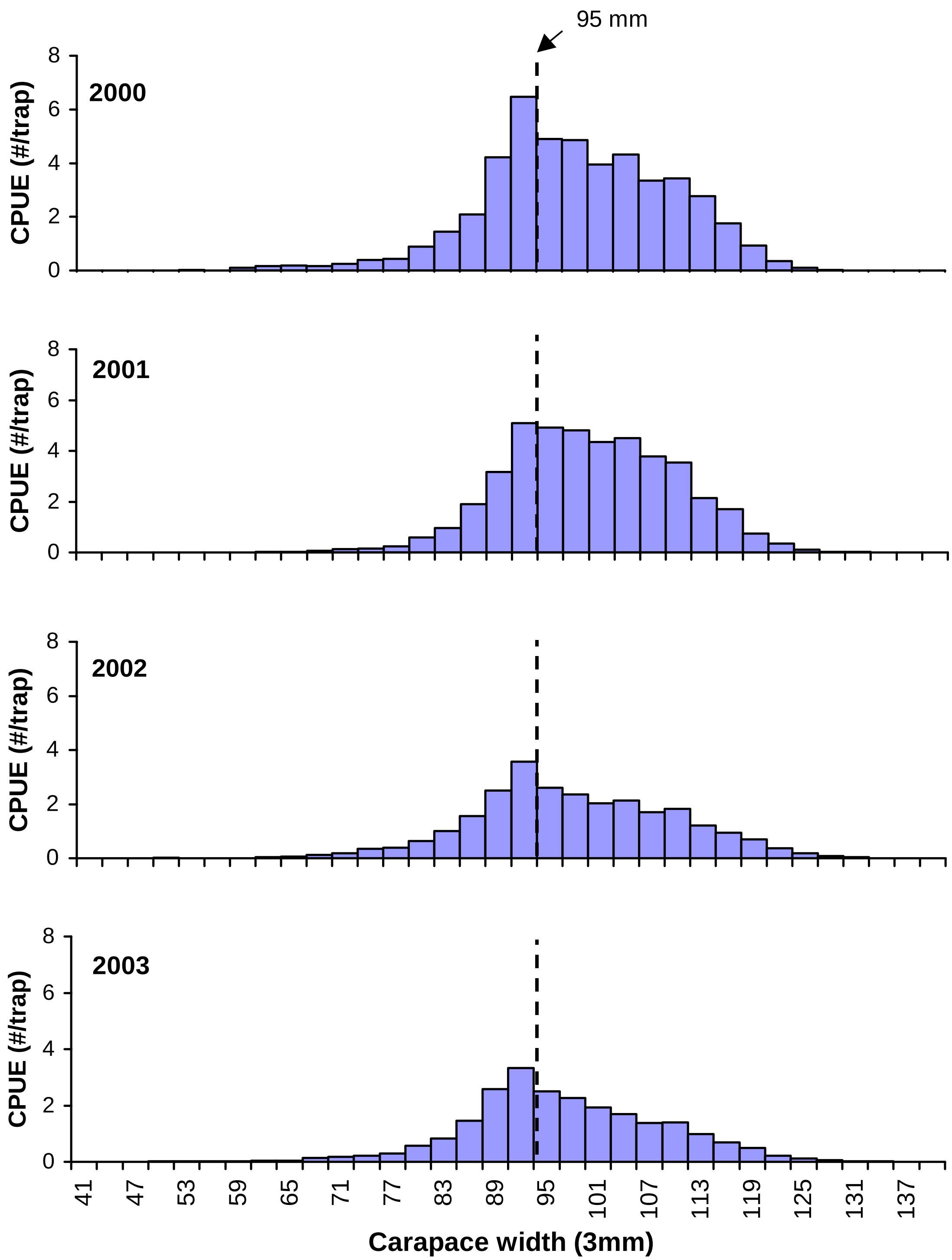



**Figure 113: Annual trends in offshore Subdiv. 3Ps male size composition from observer at sea sampling for 2000-2003.**

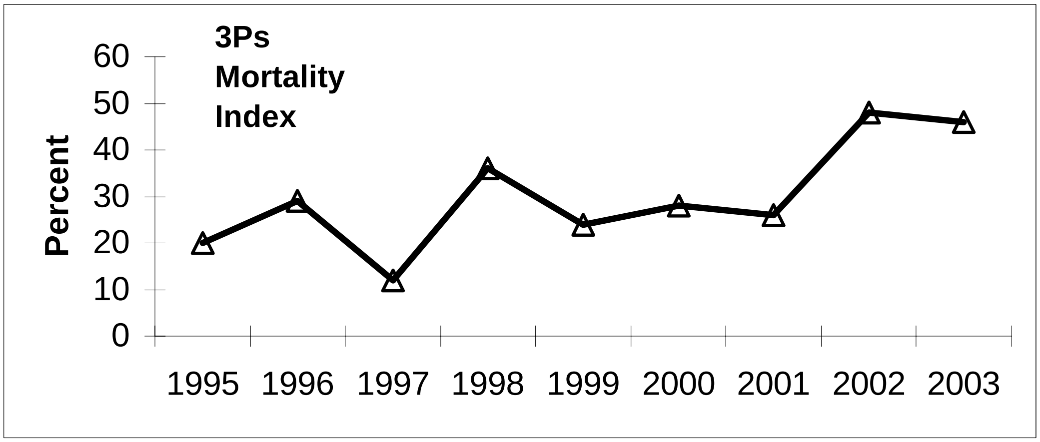



**Figure 114: Annual trends in the Subdiv. 3Ps observer-based percent discarded.**

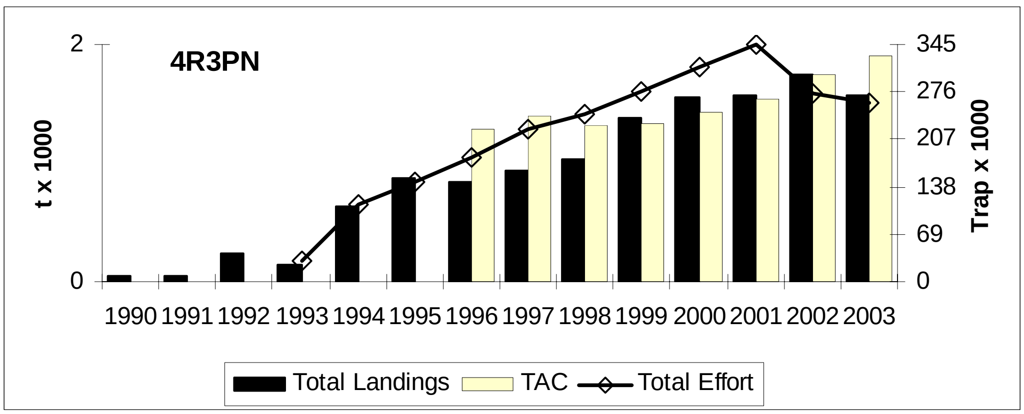



**Figure 115: Annual trends in landings, TAC, and fishing effort for Div. 4R3Pn.**

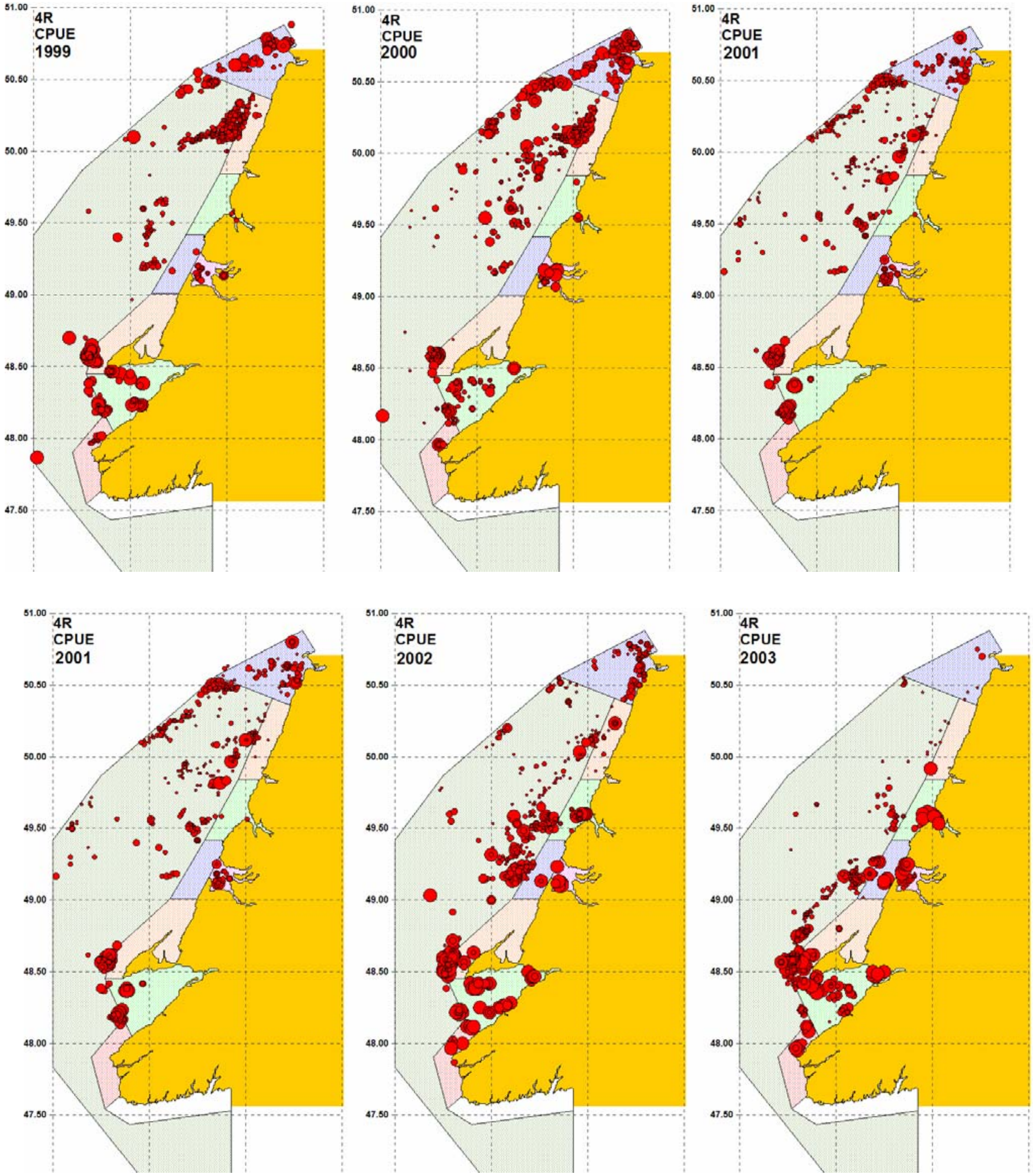



**Figure 116: Annual trends in the spatial distribution of commercial CPUE for Div. 4R.**

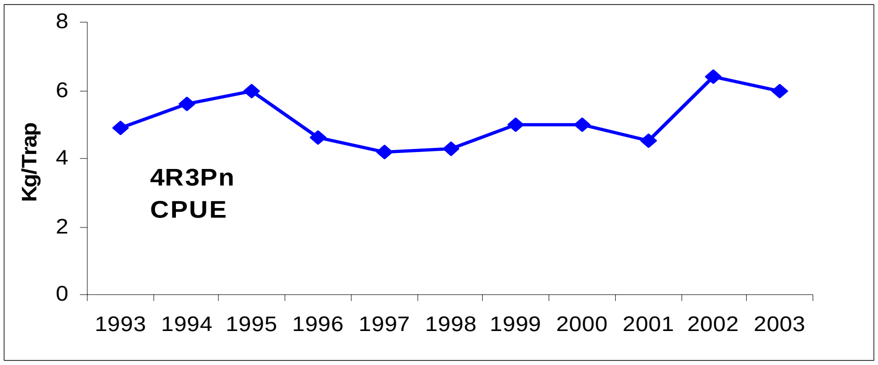



**Figure 117: Annual trends in Div. 4R and subdiv. 3Pn commercial CPUE.**

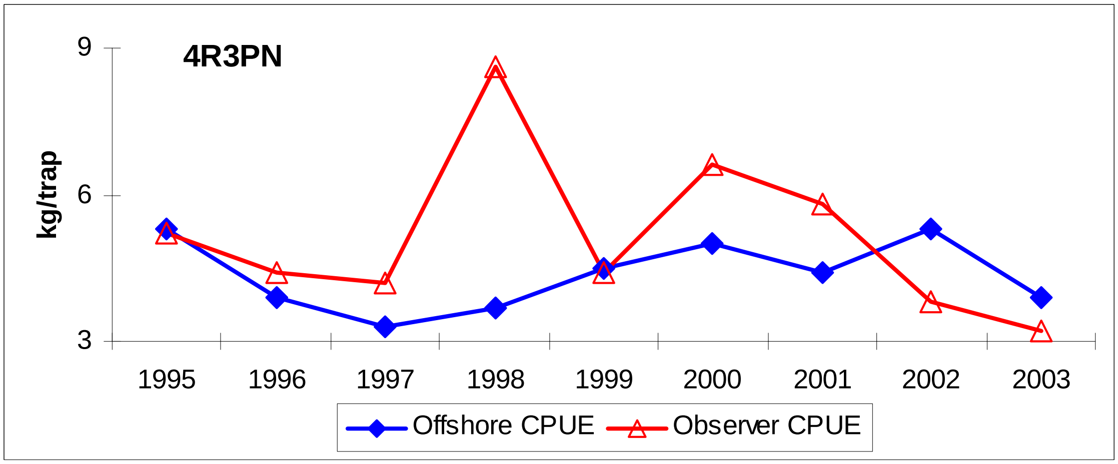



**Figure 118: Annual trends in offshore logbook versus observer CPUE for Div. 4R3Pn.**