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An Assessment of Newfoundland and Labrador Snow Crab in 2002

Évaluation du stock de crabe des neiges de Terre-Neuve et du Labrador pour l'année 2002

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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. Survey indices were standardized for effects of crab size and substrate-type on catchability by the survey trawl. 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 2003 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 exploitation rate of maintaining the current catch level is unknown, because trends in biomass indices do not agree. 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 2003, the Div. 4R exploitation rate will likely remain unchanged if the current catch level is maintained. There was no change in the functional sex ratio throughout Div. 2J3KLNO during 1995-1998 as abundance of both legal-sized males and mature females declined throughout the time series. 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 these trends 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 de la ressource en crabe des neiges dans chacune des divisions 2J3KLNO 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 ces divisions, 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 pourra être pêchée l'année suivante. Nous avons normalisé les indices de relevé de sorte à tenir compte des effets de la taille des crabes et du type de substrat sur leur capturabilité au chalut de relevé. Nous avons déduit les tendances de la biomasse dans 2J3KLNO par comparaison des tendances des indices de biomasse exploitable provenant des relevés d'automne aux tendances des prises par unité d'effort (PUE) de pêche hauturière, et les perspectives de recrutement à court terme, par comparaison des 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 distributions normalisées de fréquences des 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 dans les indices de relevé d'automne et les PUE indiquent que la biomasse a diminué 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 2003 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 indiquent que la biomasse s'est récemment stabilisée, mais à un niveau plus bas par rapport à 1998. Les données de relevé côtier au casier semblent indiquer une certaine augmentation récente de l'abondance dans les eaux côtières. Les indices de relevé et de pêche indiquent 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 demeurent incertaines. Le taux d'exploitation dans la division 3K demeurera relativement élevé si le niveau de prises actuel reste le même, quoiqu'il 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 demeurent incertaines. L'effet qu'aura le maintien du niveau des prises au niveau actuel sur le taux d'exploitation dans la division 3L est inconnu parce que les tendances dans les indices de biomasse ne concordent pas. Dans les divisions 3NO, les tendances dans les 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 dans les dernières années et on s'attend à ce que le recrutement varie peu à court terme. Dans l'hypothèse que les PUE reflètent la biomasse exploitable et que la tendance à la baisse continue, 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 dans les dernières années et on s'attend à ce que le recrutement varie peu à court terme. Dans l'hypothèse que les PUE reflètent la

biomasse exploitable et demeurent stables en 2003, le taux d'exploitation dans la division 4R demeurera probablement le même si le niveau de prises actuel ne change pas. Aucun changement dans le rapport des sexes fonctionnel n'a été relevé dans l'ensemble des divisions 2J3KLNO de 1995 à 1998, l'abondance des mâles de taille réglementaire et des femelles adultes ayant diminué tout au long de la série chronologique. Le pourcentage de femelles adultes portant de grosses grappes d'oeufs 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 dans 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 has remained very large throughout the 1990's. 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 hold no relationship with biological units.

The fishery is prosecuted using conical baited traps set in longlines The minimum legal size is 95 mm 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 2002. Data from the fall Div. 2J3KLNO 1995-2002 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. 2002a). 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 2003 and beyond.

Methodology

Fall Multispecies Survey Data

Data on total catch numbers and weight were acquired from the 1995 to 2002 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 2000-2002. 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 (unstandardized) survey data, as well as data that were standardized to account for effects of crab size (CW) and substrate type on catchability by the survey trawl (ie. trawl efficiency). This standardization involved spatial mapping of Roxanne Seabed Classification system data to assign substrate types to each survey set across the 1995-2002 time series. One of two catchability functions was applied depending on bottom type to calculate P, the proportion of crabs in the path of trawl that was caught;

$$P = 0.0019\ (CW) + 0.4746 \qquad (1)$$

and

$$P = 0.00004\ (CW^2) + 0.0002\ (CW) + 0.0159 \qquad (2)$$

These equations were derived from an experiment using secondary trawls (Dawe et al 2002). Equation 1 was applied for sets on the softest bottom type (mud) and equation 2 was applied to all other sets on all other harder substrate types. It must be recognized that even the standardized estimates are indices that underestimate absolute abundance and biomass because the catchability of the secondary trawls (with 8'' diameter footgear) used in the experiment was likely lower than 1.0 (Dawe et al. 2002b). The standardization is considered most reliable for Div. 3L, because Roxanne substrate type data were quite extensive. It was necessary for Div. 2J3K to make assumptions based on scanty Roxanne data. For those divisions the Roxanne data suggested that substrate was softest in the deepest on-shelf strata, so we assigned equation (1) to only the deepest strata and assigned equation (2) to all sets in other strata, including all slope strata.

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 only approximately comparable among years because of annual variation in survey coverage. However survey strata are selected to be comparable for the most-recent two years and, for the 2001 and 2002 fall surveys, all survey strata (including inshore strata) were surveyed in both years.

The ratio of the annual catch to the exploitable biomass index (projected from the survey of the previous year) was calculated using both the unstandardized and standardized exploitable biomass indices. 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 were not included in calculating the ratios for 1996 and 2000, because inshore survey strata were not included in the exploitable biomass indices that were projected for those 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 have been presented by Orr et al. (2003), but annual values for recent years are also used here for comparison with the exploitable biomass indices from fall multispecies surveys. This logbook CPUE index does not include data from inshore areas (small boat fleet, <35 ft.), which were unavailable prior to 1997.

Observer Catch-Effort Data

Data were available from the Observer Program for the same time series as those from the fall multispecies surveys (1995-2002). 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 Div. 3K Trap Survey

Data were available from an inshore Div. 3K trapping survey that has been carried out in White Bay and Notre Dame Bay during 1994-2000 and in 2002. 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.

A catch rate index (kg/trap haul) was calculated by shell category (new-shelled recently-molted versus older-shelled), as an approximate post-fishery (in recent years) index of exploitable biomass (old-shelled) and short-term recruitment (new-shelled).

These local biomass and recruitment indices were compared with observer-based comparable indices (ie. kg/trap haul) for crabs landed and discarded, respectively, from compatible unit areas (Fig. 22).

Results and Discussion

Division 2J3KLNO

Spatial distribution from fall multispecies surveys.

The fall distribution of males (Fig. 1-5) throughout NAFO Div. 2J3KLNO in 2002 was generally similar to the distribution pattern observed throughout 1995-2001, as previously described (Dawe et al. 2002a, 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). Largest (legal-sized) males predominated along the Div. 3LN slope (Fig. 1-2). Largest males were also usually absent from innermost sets at depths <300 m in Div. 2J3K where small males were caught (Fig. 3-5). Snow crabs of both sexes and all sizes were virtually absent over a broad area of the shallow (<100 m) southern Grand Bank (Fig. 1-6). The distribution of mature females (Fig. 6) continued to be similar to that of comparably-sized males (Fig. 4-5).

Trends in distribution over the 1995-2000 period were reviewed by Dawe et al. (2002a) 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). Changes in distribution in 2002 will be described in more detail later, on a divisional basis.

Biomass

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.

Trends in the standardized exploitable biomass index were similar to those in the unstandardized index (Table 1-2, Fig. 7). The unstandardized exploitable biomass index (Table 1, Fig. 7a) from the 2002 survey was about 22% lower than that from the previous year but comparable with that from the 2000 survey. Generally then, the exploitable biomass index has varied little across the 1999-2002 surveys, following a 42% drop in the 2000 survey (Fig. 7a), This suggests a relatively stable exploitable biomass available to the fishery throughout 2000-2003.

Recruitment

Trends in the standardized fall survey pre-recruit index were similar to those in the unstandardized index (Table 3-4, Fig. 7). The unstandardized index from the 2002 survey was 28% lower than that from the previous year This relatively large decline followed relative stability from the 1999-2001 surveys, when this index declined by only 13% over two years (Table 2, Fig. 7a). This index has shown a regular annual decline of 73% overall since the 1996 survey.

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.

Mortality

<u>Exploitation; Ratio of catch to exploitable biomass index.</u>
The unstandardized ratio of the landed catch to the exploitable biomass index (Fig. 8a), 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. 8a), decreased by 31 % in 1997 and then increased steadily, by 166 %, to 2001. It declined by 17% in 2002. The increase above 1.0, to 1.57 in 2001 clearly indicates that this ratio greatly underestimates exploitation rate.

Use of the standardized exploitable biomass indices to calculate this ratio results in much lower values that were consistently lower than 1.0 (Fig. 8b). However this ratio still overestimates true exploitation rate because, as noted above, even the standardized exploitable biomass index underestimates absolute abundance. The maximum standardized ratio was 0.89 in 2001. Trends in the standardized index reflected those in the unstandardized index, both suggesting an increase in exploitation rate during 1997-2001, and a slight decrease in 2002.

<u>Natural Mortality; Bitter crab disease (BCD).</u>
BCD has been observed, based on macroscopic observations, at low levels throughout 1996-2002. 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 1999-2001 (Fig. 9) with highest prevalence having moved from Div. 2J in 1999, to Div. 3K in 2000, and having increased substantially in Div. 3L in 2001. This increase in Div. 3L in 2001 was coincident with a great increase in survey catch rates of smallest males (Dawe et al 2002). The spatial distribution of BCD in 2002 was similar to that in the previous year (Fig. 9), although it appeared to not extend as far offshore in Div. 2J3K in 2002 as it did in 2001. 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

Distribution, Shell Condition, and Size of Legal-sized Males

We examined annual changes in unstandardized abundance indices and size of legal-sized males, by shell condition toward evaluating the internal consistency of the data series (Fig. 10). 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. Trends in the abundance index by shell condition (Fig. 10a) 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. This decline over the past four years, across both shell categories (Fig. 10a), is reflected in the spatial distribution of legal-sized males (Fig. 1-2). Few and small survey catches of legal-sized males were realized in Div. 2J in 2002, contrasting sharply with survey catches in neighbouring Div. 3K.

Size of new-shelled crabs was generally smaller and more variable than that of old-shelled crabs (Fig.10b), but there was no clear trend. However mean CW of new-shelled crabs increased substantially over the past two years, while that of old-shelled crabs declined, resulting in larger mean CW in new-shelled than in old-shelled legal-sized males in 2002. Record large size of new-shelled males in 2002 is consistent with the decrease in catch rate for this group (10c).

Biomass

Trends in the standardized exploitable biomass index were similar to those in the unstandardized index (Table 1-2, Fig. 12). The unstandardized exploitable biomass index increased steadily during 1995-1998 then decreased by 94%, from 1998-2002 (Table 1, Fig. 11a).

Commercial catch rates (CPUE) have declined steadily from 1998-2002, in agreement with the decline in the exploitable biomass index (Fig. 11a), indicating a recent decline in biomass. Trends in both the fall survey index and fishery CPUE indicate that the biomass has declined steadily since 1998.

Production

<u>Short-Term Recruitment</u>
Trends in the standardized fall survey pre-recruit index were similar in those in the unstandardized index (Table 3-4, Fig. 12). The unstandardized index increased steadily from 1995-1998 but then decreased by 66% in 1999 (Table 3, Fig. 12a). The index changed little during 1999-2001 before decreasing in 2002 to its lowest level in the time series.

The observer discard pre-recruit index (kg/trap haul) also increased overall during 1995-1998, dropped by about half in 1999 but has remained stable through 2001 (Fig. 12a). This index doubled in 2002 in contrast to the survey pre-recruit index. The disagreement between the survey pre-recruit index and the observer discard index creates uncertainty about short-term recruitment prospects.

<u>Long-term Recruitment</u>
The size compositions are examined based on the standardized abundance indices-at-CW (Fig. 13). The standardization increased the abundance indices of smallest males (<40 mm CW) by more than an order of magnitude. These smallest males had apparently increased in 2000 and 2001 (Fig. 13a), before dropping sharply in 2002. To view trends in size composition for males larger than about 40 mm CW, it was necessary to truncate the standardized abundance index (Fig 13b). There is very limited evidence of progression of smallest males (< 41 mm CW) to larger sizes, in recent years. Therefore, long-term recruitment prospects are uncertain.

<u>Reproduction</u>
The percent males in the 'functionally' reproductive population (ie. all legal-sized males and all mature females) declined from 87% in 1999 to 35% in 2002 (Fig. 14). This may infer some reduction in mating success because there is some concern that smaller adults may not be effective in mating. The percentage of mature females carrying full clutches of viable eggs remained above 90% until 2000 (excepting the anomalous 1999 value), but declined from 94% in 2000 to 74-78% in 2001-2002. 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>
Trends in the unstandardized exploitation rate index were similar to those in the standardized index (Fig. 15). Each index decreased from 1996-1998, was unchanged in 1999 then increased from 1999-2001 with little change in 2002.The exploitation rate will likely increase in 2003 if the current catch level is maintained.

Indirect fishing mortality

The percentage of the total catch discarded, by weight, in the fishery decreased from 16-18% during 1995-1998 to 11-12% during 1999-2001 (Fig. 16). It increased sharply to 31% in 2002 implying increased handling mortality on pre-recruits in the 2002 fishery. This very high discard rate was related to an increase in the catch rate of new-shelled ('soft') and/or undersized males together with low catch rates of fully-recruited crabs (Fig. 16). Pre-recruit mortality will likely increase in 2003 if the current catch level is maintained.

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 (Fig. 10), and undersized crabs are much smaller.

Natural Mortality; Bitter crab disease (BCD).

BCD has been consistently most prevalent in small crabs of 40-59 mm CW in Div. 2J (Fig. 17). Prevalence 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 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%) (Fig. 17).

There is some uncertainty as to whether the observed BCD prevalence reflects true BCD mortality, because BCD prevalence has a strong seasonal component and the 2002 Div. 2J survey was conducted later than usual (in Jan. 2003). Only once before (1995) was it necessary to complete the survey in the new year (1996), and BCD was not monitored during that initial Campelen survey.

Division 3K

Distribution, Shell Condition and Size of Legal-sized males

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. 18a), as was evident in Div 2J (Fig 10a). 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 (Fig. 1-6), that show consistent relatively low 1999 catch rates across all size groups, and is most evident in small males and in mature females (Fig 5-6).

There were no clear trends in mean size by shell condition (Fig. 18b-c).

Biomass

Trends in the standardized exploitable biomass index were similar to those in the unstandardized index (Tables 1-2, Fig. 19). The unstandardized exploitable biomass index increased sharply in 1996 and remained at a high level during 1996-1998 (Table 1, Fig. 19a). It dropped by more than half in 1999 and has remained relatively stable at a lower level over the past 4 years.

Offshore commercial catch rates (CPUE) declined steadily from 1998-2001 (Fig. 19a) and remained virtually unchanged in 2002, in agreement with relative stability in the exploitable biomass index.

Catch rates from the inshore Div 3K trapping survey (Fig. 20) show that in all three White Bay strata the catch rate of new-shelled legal-sized males increased in 2000 and had consistently increased further by 2002 (Fig. 21). The catch rate of old-shelled males increased later, in either 2001 (when there was no survey) or 2002 (Fig 21). In Notre Dame Bay, the shallow (201-300 m) stratum showed no clear recent change, considering the high variability in that stratum, whereas the deeper (301-400 m) and commercially fished stratum (610) showed lower catch rates of both new-shelled and old-shelled legal-sized males in 2002 than in 2000 (Fig. 21).

There were adequate observer CPUE data from two unit areas (339 and 340, Fig. 22) to compare with our survey results for Notre Dame Bay stratum 610 (Fig. 23). For both of those unit areas observer CPUE had increased from 1998 to 2000 and remained unchanged in 2001. Catch rates in both areas decreased in 2002 (Fig. 23b), as did our survey catch rates in Notre Dame Bay(Fig. 23a).

Production

<u>Immediate Recruitment</u>

Trends in the standardized survey index were similar in those in the unstandardized index (Table 3-4, Fig 24). Both the unstandardized prerecruit index (Table 3) and the observer discard pre-recruit index increased between 1995 and 1997 (Fig.24a), before declining during 1997 – 1999. They have since varied at a lower level. Therefore, recruitment is expected to remain relatively low in the short term.

<u>Long-term Recruitment</u>

The standardized size distributions (Fig. 25 a) were somewhat similar to those of Div. 2J in recent years, in showing an increased abundance of smallest males (<41 mm CW) (in 2000 in Div. 3K) and a drop in 2002. These size distributions, when truncated (Fig. 25b), provide very limited evidence of progression of smallest males (< 41 mm CW) to larger sizes in recent years. Therefore, long-term recruitment prospects are uncertain.

<u>Reproduction</u>

The percent males in the ‘functionally’ reproductive population increased from 26-88% during 1995-1999 (Fig. 26), declined sharply to 35% in 2000, and then increased to 55% in 2002. The percentage of mature females carrying full clutches of viable eggs showed no relationship with changing sex ratio, with the 3 highest values (96-97%) including the two years of lowest percent males (1995 and 2000). Percent females carrying full clutches of viable eggs declined from 96-83% during 2000-2002 (while percent males increased) to remain similar to 1998-1999 levels (83-85%) and above the 1996 minimum of 77%.

Mortality

Exploitation
Trends in the unstandardized exploitation rate index were similar to those in the standardized index (Fig. 27). Each index decreased from 1996-1997, steadily increased from 1997 to 2000, and has remained relatively high over the past 3 years. Exploitation rate will remain relatively high if the current catch level is maintained but would most likely not increase.

The standardized exploitation rate index for 2000, exceeding 1.0 (Fig. 27b), is clearly unrealistically high. This supports our conclusion that the standardized survey biomass indices do not fully account for low catchability of snow crabs by the survey trawl. It also supports our suggestion that snow crab catchability may have been especially low during the 1999 survey.

Indirect fishing mortality
The percentage of the total catch discarded, by weight, in the fishery increased from 18% in 1995 to 31% in 1997 (Fig. 28), comparable to the high discard level seen in Div. 2J in 2002 (Fig 16). As in Div. 2J, this increase in percent discarded was due to an increase in discard (ie. pre-recruit) catch rates while observer CPUE was declining (Fig. 28). Percentage discarded subsequently decreased to 13.5% in 1999, as discard catch rate declined. It again increased to 25% in 2001, as discard catch rates increased slightly while observer CPUE continued to decline. Percent discarded decreased to 19% in 2002 implying decreased handling mortality on pre-recruits in the 2002 fishery.. At current low CPUE levels any substantial increase in pre-recruit abundance, as indicated by discard catch rate, will result in an increase in percentage discarded and handling mortality.

There is considerable small-scale spatial variation in this source of mortality. In adjacent unit areas of Notre Dame Bay (Fig. 22) discard mortality ranged 4-38% in unit area 339 (Fig. 29a) but was much higher, ranging 37-70% in unit area 340 (Fig. 29b). This consistently high discard level (and associated mortality) in unit area 340 (including Green Bay) may account for it's lower observed CPUE level than in adjacent unit area 339 (Fig. 23b).

Natural Mortality; Bitter crab disease (BCD).
BCD has been consistently most prevalent in small crabs of 40-59 mm CW (Fig. 30), as was seen in Div. 2J (Fig. 17). Prevalence, 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. 30). 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 stability at higher levels over the past three years. This suggests a direct density dependent relationship. BCD increased in 2002 in 4 of the 5 male size groups with peak prevalence in 40-59 mm CW males (6.7%) the same as for that size group in 1997. However 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.31) than in the predominately offshore Campelen trawl samples (with peaks of about 5-8%, Fig. 30). 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.

Division 3L

Distribution, Shell Condition and Size of Legal-sized males

Annual changes in the multispecies survey abundance index by shell condition (Fig. 32a) 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.

Annual changes in mean size of new-shelled legal-sized males, while slight, were consistent with the trend in their catch rates. Mean size of new-shelled males increased as their abundance declined (Fig. 32c), likely reflecting declining recruitment and growth of legal-sized, adolescents to maximum-sized adults.

The spatial distribution of legal-sized males changed during 1999-2002 (Fig. 2), with the area of highest density shifting from the eastern-most slope in 1999 to inshore areas in 2002.

Biomass

Trends in the standardized exploitable biomass index were similar to those in the unstandardized index (Table 1-2, Fig. 33). The unstandardized exploitable biomass index declined by 70% from 1996-2000 and has since remained at a low level in contrast with the CPUE trends (Fig.33a). Offshore CPUE decreased in 1996, increased to 2000 and has since remained high. Divergence between the exploitable biomass index and CPUE, since 1996, introduce uncertainty regarding recent trends in biomass.

Production

Immediate Recruitment

Trends in the standardized survey pre-recruit index were similar to those in the unstandardized index (Table 3-4, Fig. 34). These survey pre-recruit indices declined from 1996 - 1999 and have remained at a relatively low level over the past 4 years.
The observer discard pre-recruit index increased from 1995-1997, declined from 1997 – 1999 and has remained at a relatively low level over the past 4 years (Fig. 34a). Recruitment is expected to remain relatively low in the short term.

Long-term Recruitment

The standardized size distributions (Fig. 35a) showed a regular decline in abundance of smallest males during 1995-1998, followed by an increase to 2002. The increase after 1998 was somewhat similar to those of Div. 2J3K in recent years. The truncated size distributions (Fig. 35b) showed very limited evidence of progression of smallest males (< 41 mm CW) to larger sizes, in recent years. Therefore, long-term recruitment prospects are uncertain.

Reproduction

The percent males in the 'functionally' reproductive population declined from 89% in 1998 to 64% in 2001 and 2002 (Fig. 36), which may infer some reduction in mating success. The percentage of mature females carrying full clutches of viable eggs declined overall throughout the time series to 50% in 2001 and 87% in 2002. This decline is similar to that seen in Div. 2J (Fig. 14). Such declines may be related to concurrent decreases in abundance of both sexes, rather than changes in sex ratio.

Mortality

Exploitation

Trends in the unstandardized exploitation rate index were similar to those in the standardized index (Fig. 37). The standardized 2001 and 2002 exploitation rate indices exceeded 1.0 (1.3 and 1.2 respectively, Fig. 37b), indicating that the standardization does not fully account for the low catchability of snow crab by the survey trawl and that even the standardized exploitable biomass index underestimates true biomass. The exploitation rate indices increased from 1997 - 2001 and changed little in 2002. The effect on exploitation rate of maintaining the current catch level is unknown, because trends in biomass indices do not agree.

Indirect fishing mortality

The percentage of the total catch discarded, by weight, in the fishery increased from 18% in 1995 to 31% in 1997 (Fig. 38), as it did in Div. 3K (Fig. 28) to reach the same maximum seen in Div. 2J in 2002 (31%). As in Div. 2J and 3K, this increase in percent discarded was due to an increase in discard (ie. prerecruit) catch rates while CPUE was declining (Fig. 28). Percentage discarded decreased sharply in 1998 then declined gradually to about 15% in 2002 (Fig 38), 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 of about 4% (Fig. 39), approximately half that in Div. 3K overall. BCD did not become prevalent in Div. 3L until 1997. It generally declined to 1999 when it virtually disappeared (Fig. 2). It increased from 1999-2001, consistent with increase in abundance of smallest crabs (Fig. 35a), but declined in 2002 despite continued high abundance of smallest crabs (Fig. 35a).

Division 3NO

Distribution, Shell Condition and Size of Legal-sized males

Div. 3N. Annual changes in the multispecies survey abundance index of legal-sized males by shell condition (Fig. 40a) reflected greater internal consistency than was evident in Div. 3K. Abundance of new-shelled legal-sized males increased from 1995 by an order of magnitude to a peak in 1998, before declining steadily by 65% to 2002. The trend for old-shelled males was less clear and there was no clear peak in 1999, as expected, but (excepting the high 2001 value), there was a general decline from 1998-2002.

There was a clear steady increase in mean size of both new-shelled and old-shelled legal-sized males (Fig. 40b). Mean size of new-shelled males increased as their abundance declined (Fig. 40c), likely reflecting declining recruitment and growth of legal-sized adolescents to maximum-sized adults.

Div. 3O.
Abundance of new-shelled legal-sized males declined sharply in 1996 and then increased overall, almost tripling, to 2001, before declining by 26% in 2002 (Fig. 41a). Abundance of old-shelled legal-sized males declined by 72% during 1998-2001. The peak in new-shelled males in 2001 was followed by an increase in old-shelled males in 2002.

Mean size of both shell categories trended together (Fig. 41b). The sharp increase in mean size of new-shelled males from 1995-1997 followed the sharp decline in abundance of new-shelled males in 1996 (Fig. 41c), likely reflecting declining recruitment and growth of legal-sized adolescents to maximum-sized adults. There was no clear trend in recent years.

Biomass

Trends in the standardized exploitable biomass index were similar to those in the unstandardized index (Table 1-2, Fig. 42). These indices for Div 3NO showed no clear trend over the time series (Fig. 42), reflecting low and variable precision of the mean estimates (Tables 1-2). The resource has been concentrated along the shelf edge in these divisions (Fig. 1-2). Because estimates of the exploitable biomass index, as determined from the fall multi-species survey data, have wide margins of error, no inferences about biomass trends can be made from these data. CPUE has remained high in recent years.

Production

Immediate Recruitment
Trends in the standardized survey pre-recruit index were similar to those in the unstandardized index (Table 3-4, Fig. 43). Broad confidence intervals (Tables 3-4)

reflect low and variable precision about the mean estimates. Uncertainties associated with such wide margins of error preclude inferences about short-term recruitment. The observer discard pre-recruit index (Fig. 43a) decreased sharply in 2000 but fluctuated at a relatively low level over the past 3 years suggesting that recruitment will remain low over the short term.

Long-term Recruitment

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 (Tables 1-4) 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.

Reproduction

The percent males in the functionally reproductive population in Div. 3N increased from 1995-1998 and has remained very high since then (Fig. 44). However, there appears to have been some decline in the percentage of females carrying full clutches of viable eggs over the time series, similar to that seen in Div. 2J and 3L. This percentage decreased from 97% in 1998 to 50% in 2002. No females were caught in 2001. As noted earlier, such declines may be related to concurrent decreases in abundance of both sexes, rather than changes in sex ratio.

Neither the functional sex ratio nor the percentage of females carrying full clutches of viable eggs showed any change over the time series in Div. 3O (Fig. 44). Percent full clutches exceeded 95% over the past three years.

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, by weight, in the fishery decreased by about half from a maximum of 17% in 1999 to 8% in 2002 (Fig. 45). m This implies 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 (Fig. 9), and was not encountered in 2001 or 2002.

Subdivison 3Ps

Biomass

No estimates of the exploitable biomass index are available as there are no reliable research survey data from this area. Orr et al. (2003) showed that both offshore and inshore commercial CPUE have declined in recent years. This agrees with the trends in observed CPUE (Fig. 46), which declined steadily during 1997-2001 and dropped sharply in 2002.

Production

Immediate Recruitment

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. 46). It declined slightly in 1999 and has remained stable over the past 4 years. Recruitment is expected to change little in the short term.

Long-term Recruitment

No data.

Mortality

Exploitation

Assuming that CPUE reflects the exploitable biomass, and the declining trend (Orr et al. 2003) continues, exploitation rate will likely increase if the current catch level is maintained.

Indirect fishing mortality

The percentage of the total catch discarded, by weight, in the fishery increased from 11-26% in 1998 as the observer discard catch rate increased (Fig. 46). It remained stable at 20-22% during 1999-2001 before increasing to 32% in 2002. This increase in 2002 was associated with the sharp decrease in observed CPUE, while the discard catch rate was unchanged. 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, probably because it is not externally detectable during spring, when this area is surveyed.

Division 4R and Subdivision 3Pn

Biomass

No estimates of the exploitable biomass index are available as there are no research survey data from this area. Orr et al. (2003) showed that commercial CPUE has remained stable since 1993. This generally agrees with the trends in observed CPUE (Fig. 48), which have been variable, ranging 3.8-8.6 kg/trap haul over the time series, and showing no clear trend. Observed CPUE levels in this area are generally lower than in all other areas, as is also true of logbook CPUE (Orr et al 2003).

Production

Immediate Recruitment

The observed discard pre-recruit index was stable during 1995-1997 before declining by 38% from 3.9 kg/trap haul in 1997 to 2.4 kg/trap haul in 2000 (Fig. 47). It has remained stable during recent years.. Recruitment is expected to change little in the short term.

Long-term Recruitment
No data.

Mortality

Exploitation
Assuming that CPUE reflects the exploitable biomass, and remains stable in 2003 (Orr et al. 2003), exploitation rate will likely remain unchanged if the current catch level is maintained.

Indirect fishing mortality
The percentage of the total catch discarded, by weight, in the fishery was at a very high level of 42-49% during 1995-1997 due to high observed catch rates of discards together with low observed CPUE (Fig. 47). It was variable thereafter, but increased from 27-39% during 2000-2002. This index has generally fluctuated without trend since 1995 but at a higher level than in other divisions, implying high handling mortality on pre-recruits relative to other divisions.

Natural Mortality; Bitter crab disease (BCD).
No data.

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Table 1. Exploitable biomass indices (t) by division, and for the entire fall survey area, by survey year, with 95 % confidence intervals, based on unstandardized data.

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
2J	2,489 +/-43%	5,690 +/-38%	11,615 +/-55%	13,182 +/-45%	6,237 +/-32%	3,549 +/-26%	3,231 +/-25%	798 +/-61%
3K	12,211 +/-46%	20,388 +/-20%	19,370 +/-22%	18,753 +/-24%	8,416 +/-30%	9,966 +/-24%	11,591 +/-39%	9,485 +/-30%
3L	19,527 +/-31%	33,636 +/-21%	23,893 +/-23%	25,068 +/-23%	15,639 +/-23%	10,099 +/-41%	12,148 +/-32%	12,068 +/-43%
3N	1,952 +/-67%	6,405 +/-71%	4,292 +/-91%	10,881 +/-104%	6,681 +/-45%	5,251 +/-65%	8,970 +/-76%	4,075 +/-42%
3O	3,239 +/-96%	1,370 +/-481%	2,476 +/-52%	3,709 +/-76%	4,543 +/-152%	1,104 +/-43%	2,415 +/-56%	3,458 +/-98%
Total	**39,418** **+/-20%**	**67,489** **+/-14%**	**61,646** **+/-13%**	**71,593** **+/-14%**	**41,516** **+/-18%**	**29,969** **+/-17%**	**38,355** **+/-19%**	**29,884** **+/-21%**

Table 2. Exploitable biomass indices (t) by division, and for the entire fall survey area, by survey year, with 95% confidence intervals (in thousands) based on standardized data.

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
2J	5,778 +/-49%	9,610 +/-31%	18,185 +/-42%	24,000 +/-43%	11,133 +/-35%	6,425 +/-28%	5,870 +/-26%	1,495 +/-48%
3K	22,071 +/-67%	36,730 +/-21%	35,173 +/-22%	33,722 +/-21%	15,181 +/-29%	17,560 +/-25%	19,388 +/-38%	16,241 +/-23%
3L	38,807 +/-27%	62,100 +/-21%	47,708 +/-23%	51,290 +/-25%	31,294 +/-21%	19,507 +/-53%	22,510 +/-28%	22,679 +/-43%
3N	3,960 +/-59%	12,071 +/-68%	8,167 +/-91%	17,465 +/-112%	12,132 +/-43%	7,787 +/-72%	15,333 +/-64%	6,938 +/-45%
3O	6,810 +/-95%	2,650 +/-461%	2,609 +/-432%	6,993 +/-80%	4,499 +/-87%	1,891 +/-36%	4,431 +/-60%	6,315 +/-95%
Total	**77,427 +/-18%**	**123,161 +/-13%**	**111,842 +/-13%**	**133,470 +/-14%**	**74,239 +/-13%**	**53,170 +/-22%**	**67,532 +/-16%**	**53,668 +/- 22%**

Table 3. Prerecruit biomass indices (t) by division, and for the entire fall survey area, by survey year, with 95 % confidence intervals, based on unstandardized data.

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
2J	965 +/-30%	2,441 +/-40%	3,331 +/-37%	3,437 +/-32%	1,084 +/-84%	1,171 +/-46%	1,254 +/-147%	547 +/447%
3K	6,988 +/-38%	10,510 +/-35%	13,559 +/-32%	10,341 +/-39%	3,400 +/-41%	9,539 +/-36%	7,377 +/-38%	6,344 +/- 39%
3L	9,062 +/-41%	26,143 +/-61%	16,418 +/-437%	9,307 +/-29%	4,715 +/-48%	5,183 +/-50%	3,784 +/-47%	3,387 +/-27%
3N	2,224 +/-674%	7,515 +/-189%	5,798 +/-702%	9,875 +/-574%	2,917 +/-62%	3,983 +/-92%	4,696 +/-58%	2,029 '/-137%
3O	2,674 +/-83%	831 +/-93%	2,051 +/-92%	2,559 +/-147%	8,905 +/-171%	226 +/-392%	1,075 +/-80%	728 +/-155%
Total	**21,913** **+/-25%**	**47,440** **+/-34%**	**41,157** **+/-72%**	**35,519** **+/-46%**	**21,021** **+/-69%**	**20,102** **+/-24%**	**18,186** **+/-21%**	**13,035** **+/-28%**

Table 4. Prerecruit biomass indices (t) by division, and for the entire fall survey area, by survey year, with 95 % confidence intervals, in thousands, based on standardized data.

	1995	1996	1997	1998	1999	2000	2001	2002
2J	5,118	6,022	7,337	8,809	2,928	3,068	3,546	1,662
	+/-38%	+/-47%	+/-39%	+/-35%	+/-74%	+/-59%	+/-149%	+/-400%
3K	20,431	27,061	32,582	25,299	8,626	21,591	18,275	16,012
	+/-39%	+/-39%	+/-29%	+/-35%	+/-50%	+/-44%	+/-59%	+/-42%
3L	25,431	76,345	38,915	24,476	12,702	11,769	8,409	8,082
	+/-37%	+/-71%	+/-89%	+/-28%	+/-47%	+/-48%	+/-45%	+/-27%
3N	6,750	21,033	14,988	24,688	7,124	9,150	11,067	4,657
	+/-654%	+/-195%	+/-714%	+/-590%	+/-77%	+/-72%	+/-52%	+/-143%
3O	8,152	2.,385	2,900	6,602	10,990	0,504	2,683	1,914
	+/-82%	+/-53%	+/-115%	+/-131%	+/-120%	+/-401%	+/-96%	+/-171%
Total	**65,882**	**132,846**	**96,722**	**89,874**	**42,370**	**46,082**	**43,980**	**32,327**
	+/-24%	**+/-42%**	**+/-36%**	**+/-43%**	**+/-34%**	**+/-27%**	**+/-25%**	**+/-27%**

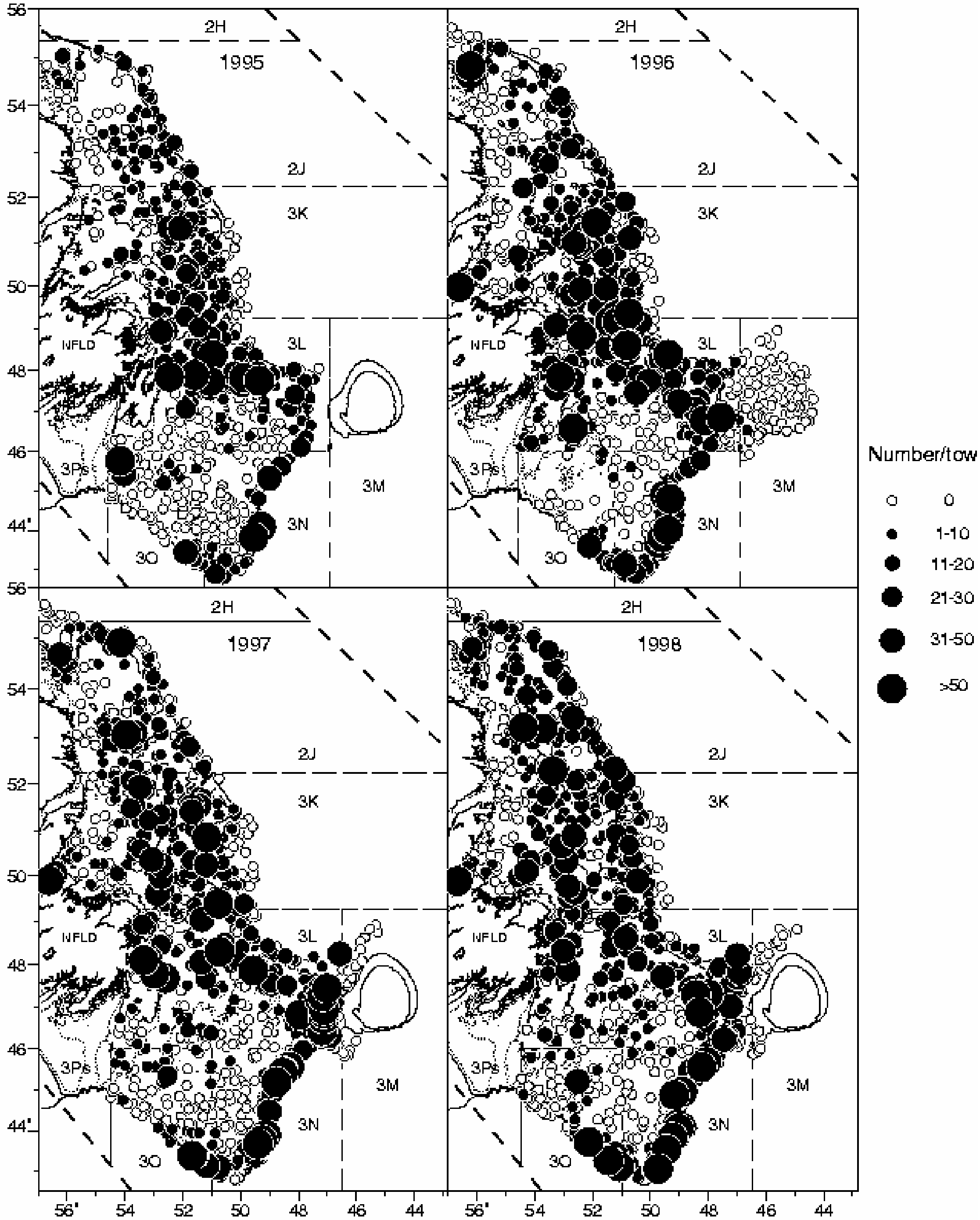


Figure 1: Distribution of Legal-sized males (>94mm CW) from fall Div. 2J3KLNO multispecies surveys from 1995 to 1998.

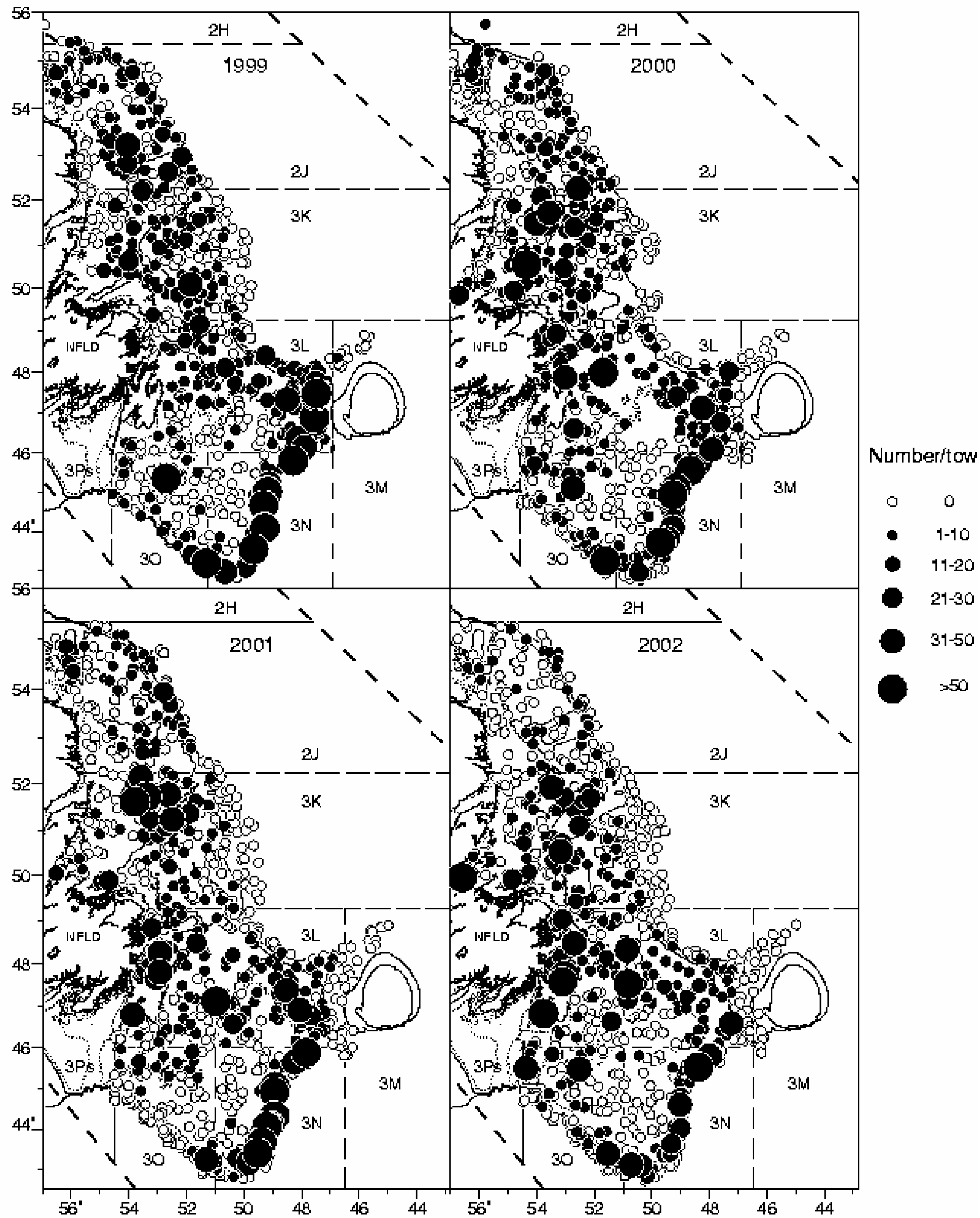


Figure 2: Distribution of legal-sized males (>94mm CW) from fall Div. 2J3KLNO multispecies bottom trawl surveys from 1999 to 2002.

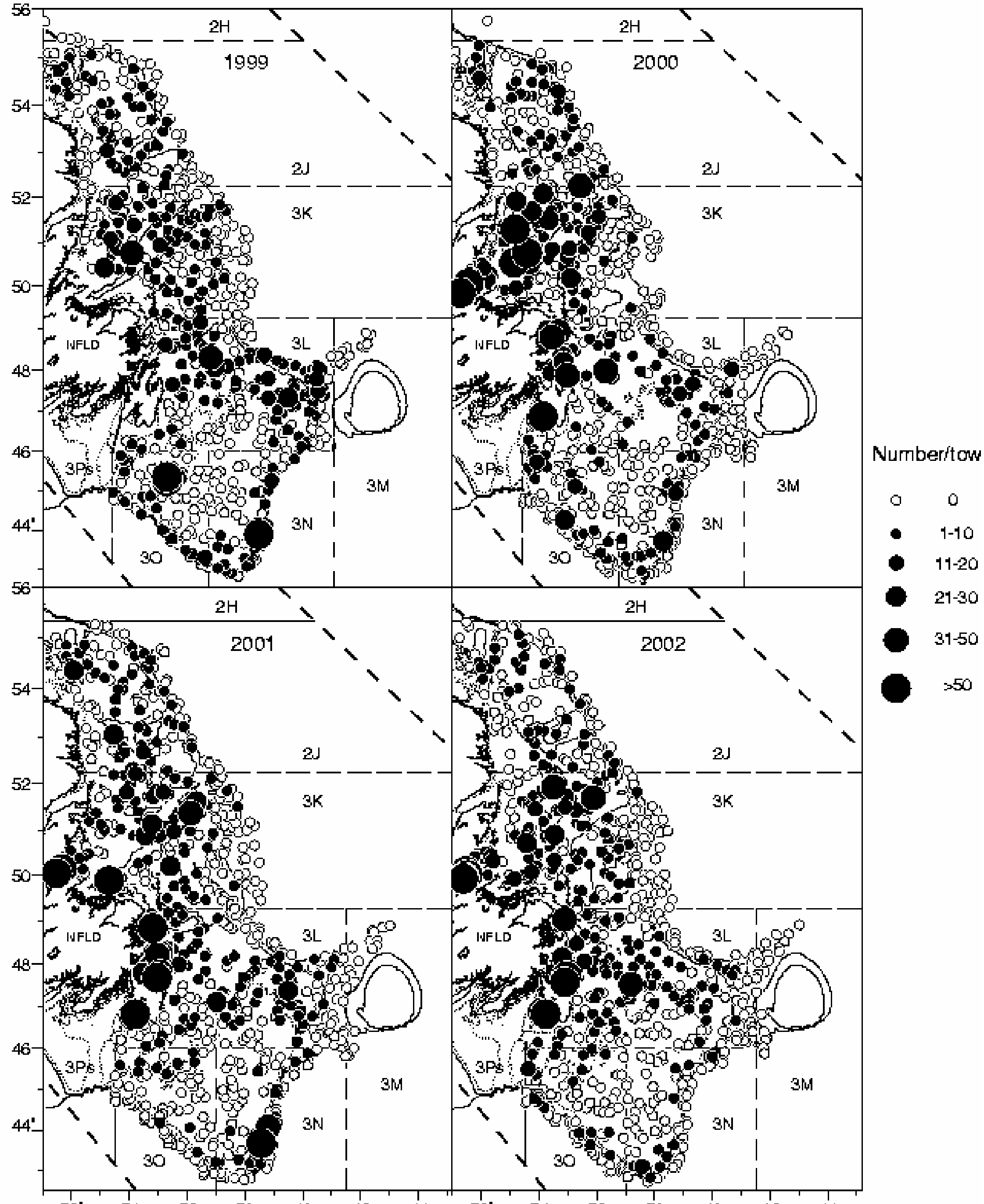


Figure 3: Distribution of Sublegal 1 males (76-94 mm CW) from fall Div. 2J3KLNO multispecies bottom trawl surveys from 1999 to 2002.

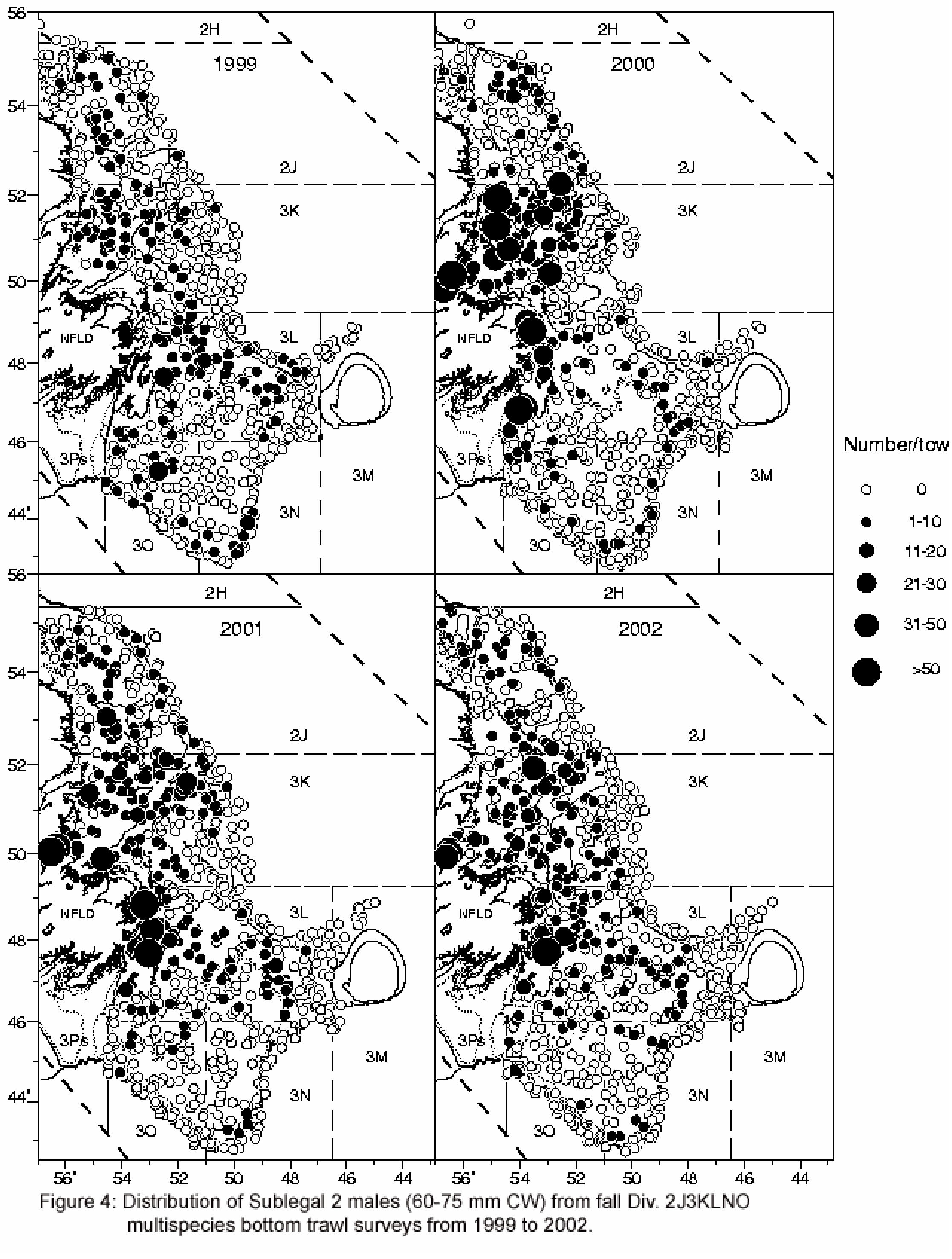


Figure 4: Distribution of Sublegal 2 males (60-75 mm CW) from fall Div. 2J3KLNO multispecies bottom trawl surveys from 1999 to 2002.

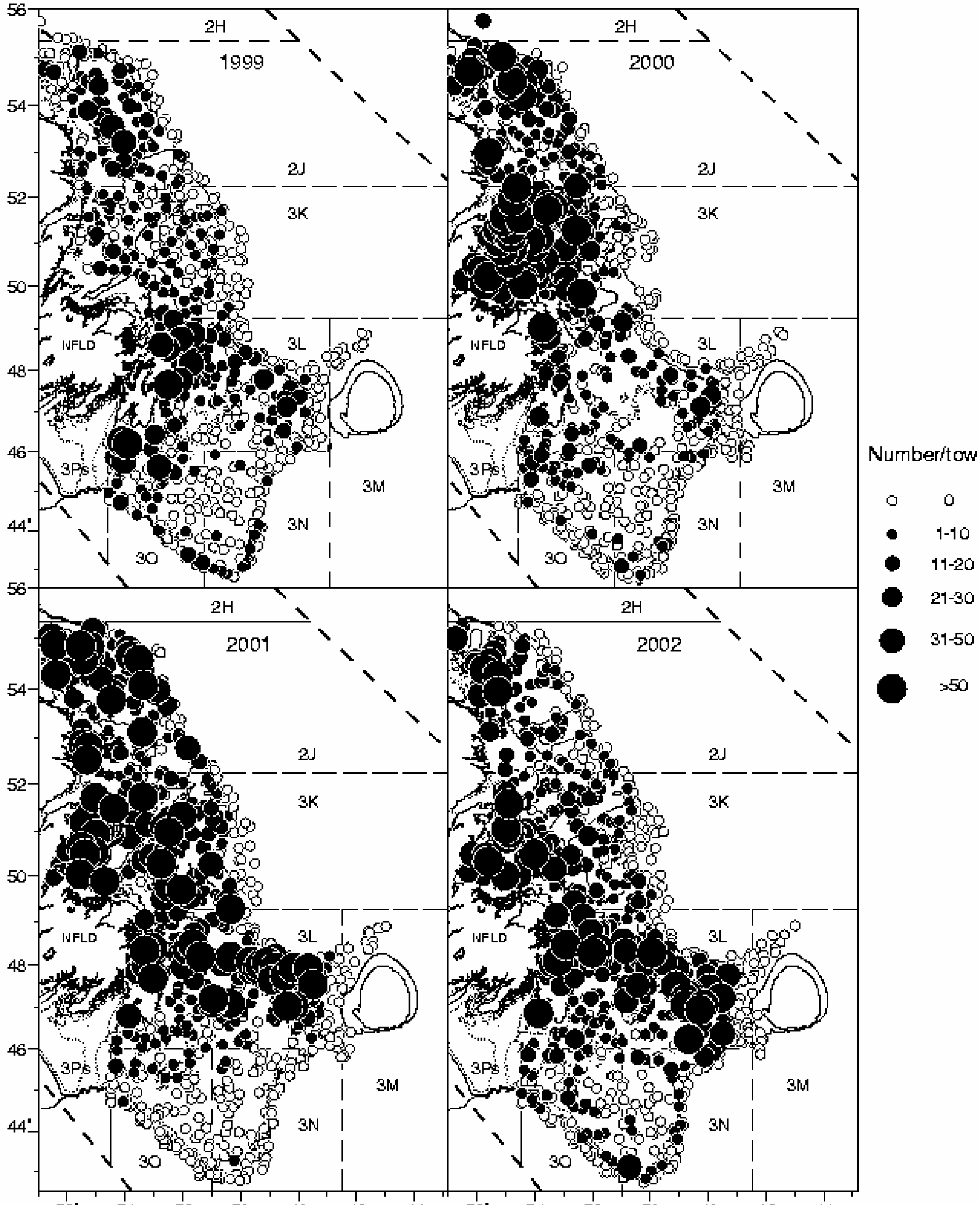


Figure 5: Distribution of smallest males (<60 mm CW) from fall Div. 2J3KLNO multispecies Bottom trawl surveys from 1999-2002.

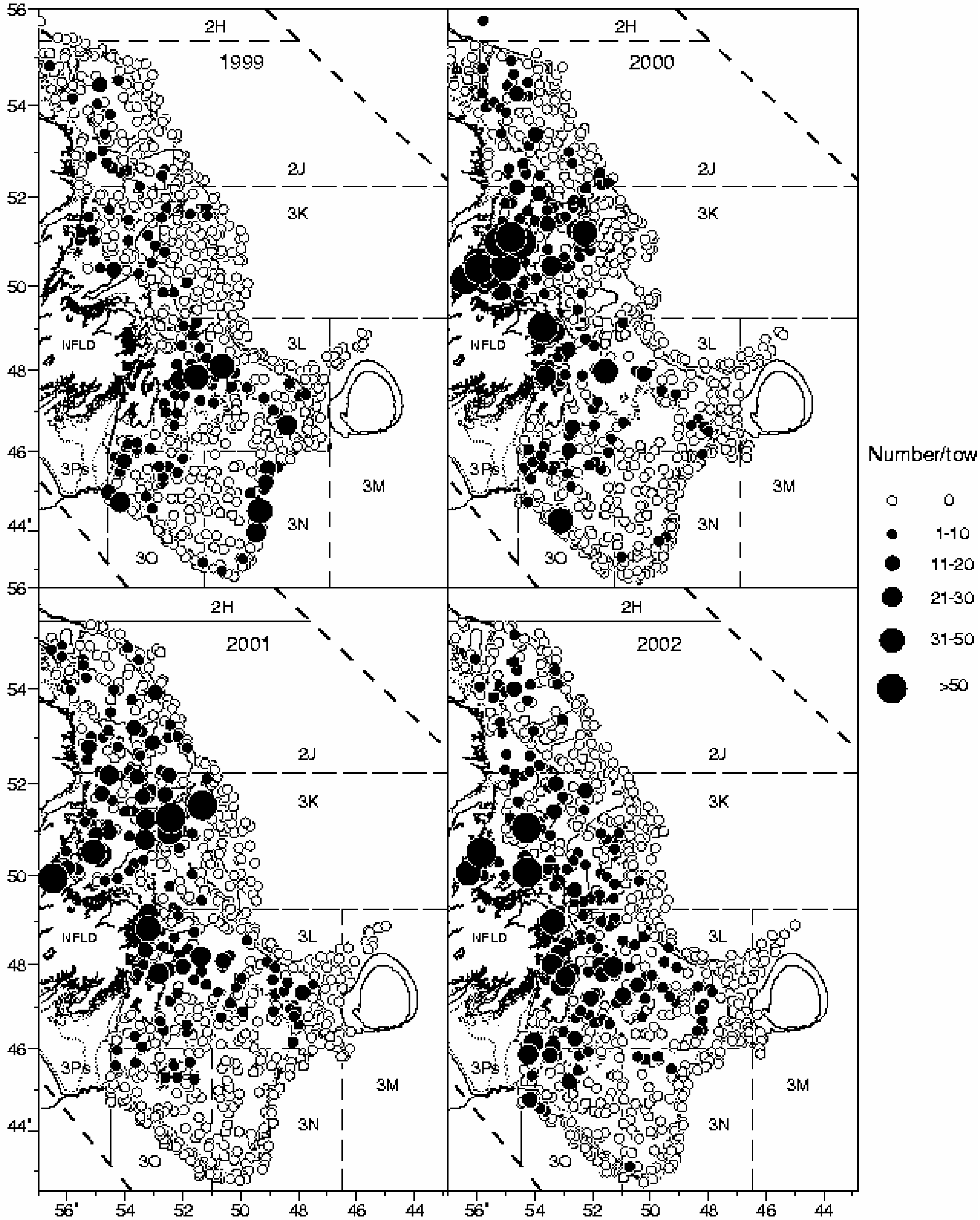
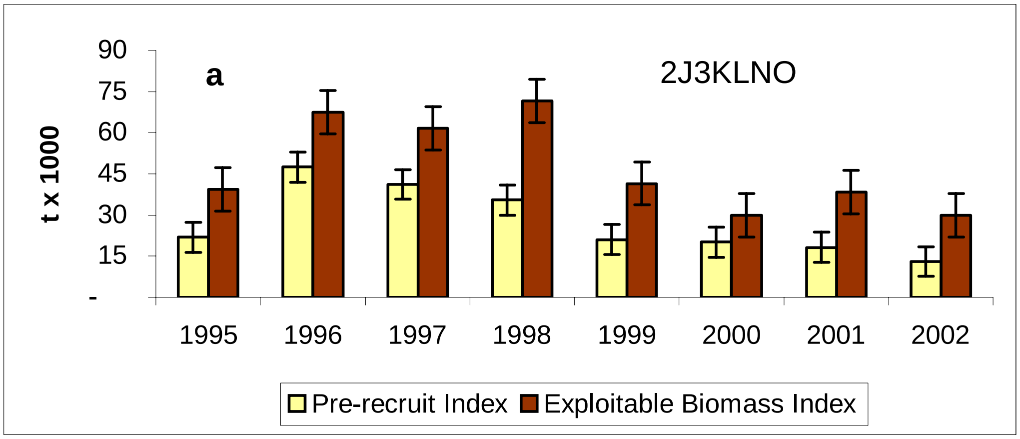


Figure 6: Distribution of mature females from fall Div. 2J3KLNO multispecies bottom trawl surveys from 1999 to 2002.



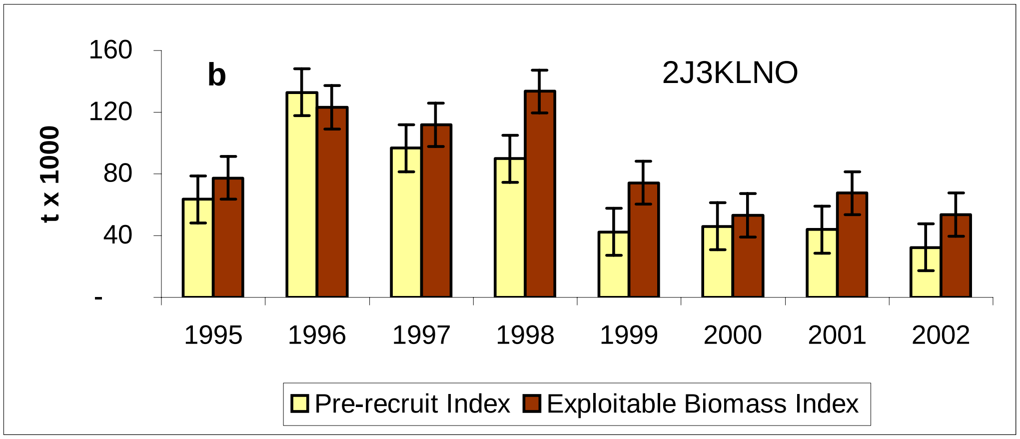


Fig. 7. Projected exploitable biomass and prerecruit indices by year across the entire fall survey area, with 95% confidence intervals, based on unstandardized (a) and standardized (b) data.

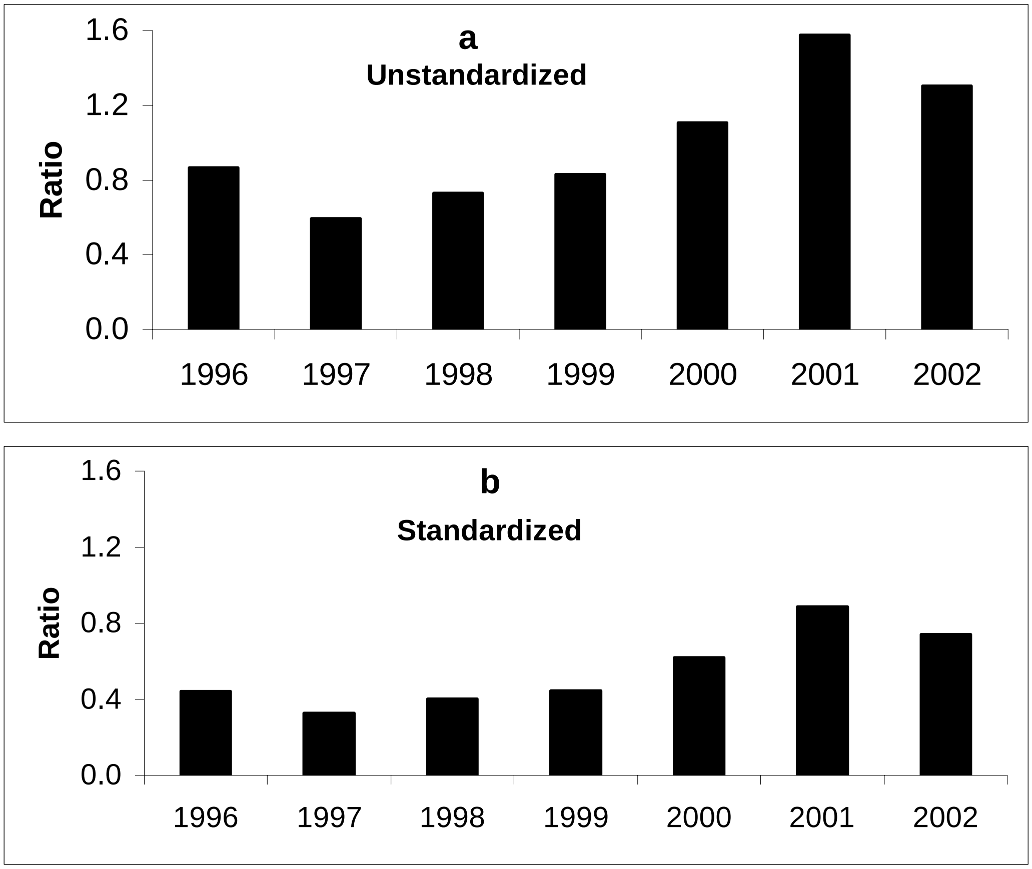


Fig. 8. Ratio of landed catch to the exploitable biomass index by year across the entire fall survey area. Div. 3KL inshore catch and survey strata are not included in estimates for 1996 and 2000; estimated using unstandardized (a) and standardized (b) exploitable biomass indices

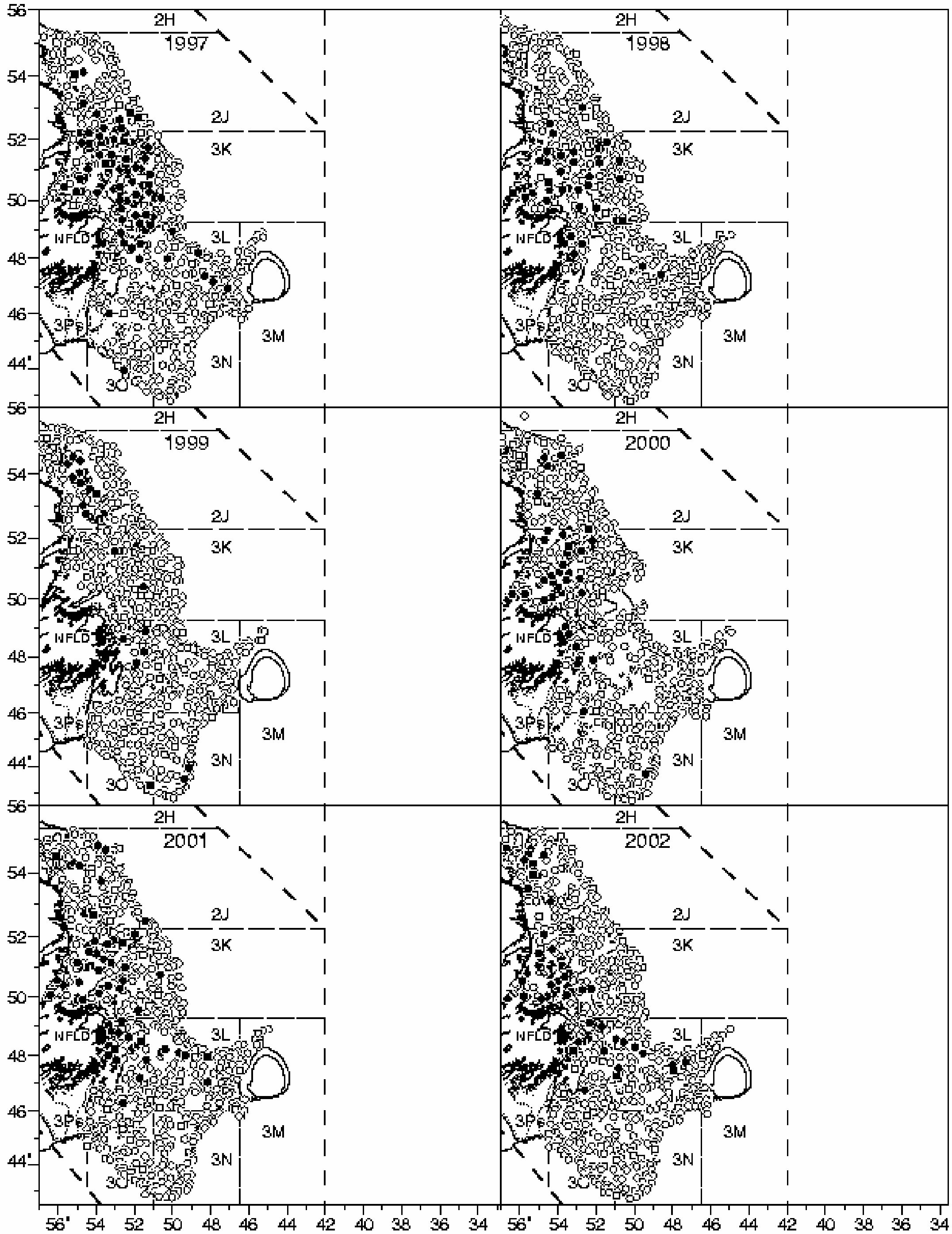


Figure 9 : Distribution of sets in which BCD was encountered (closed circles) versus sets in which BCD was not observed (open circles), from 1997-2002 fall multispecies surveys.

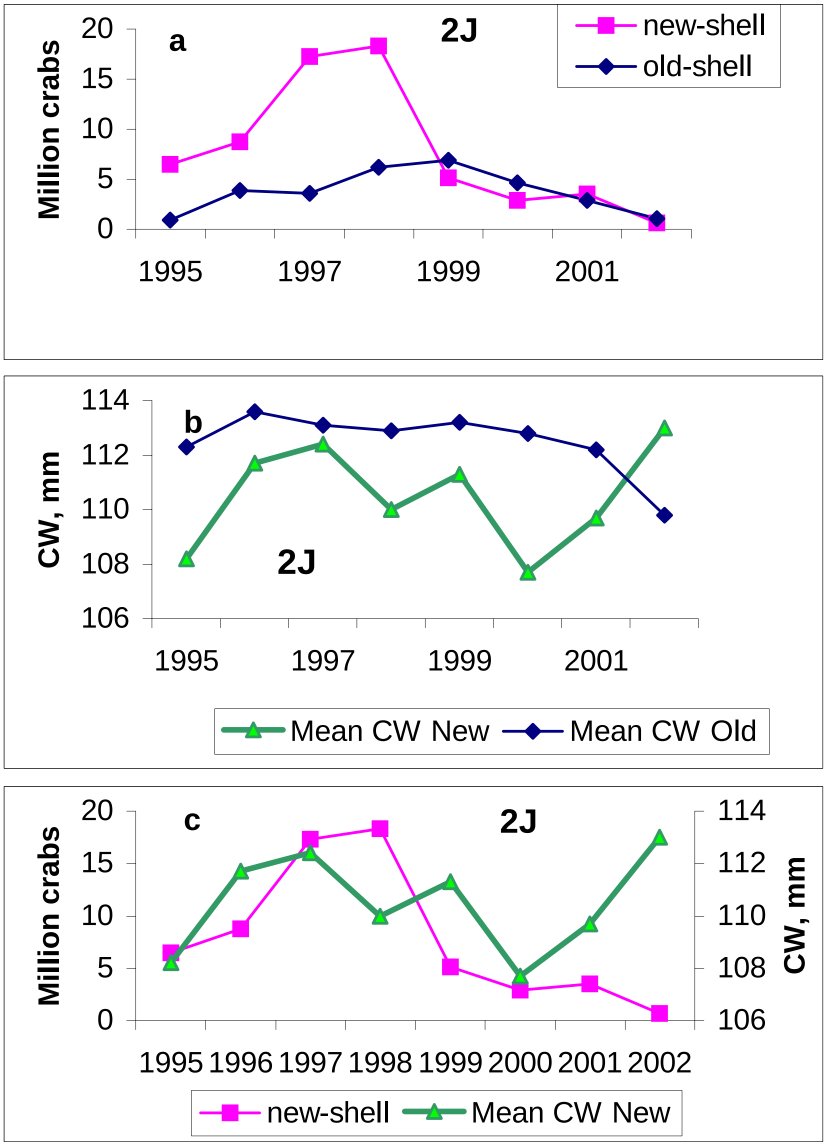
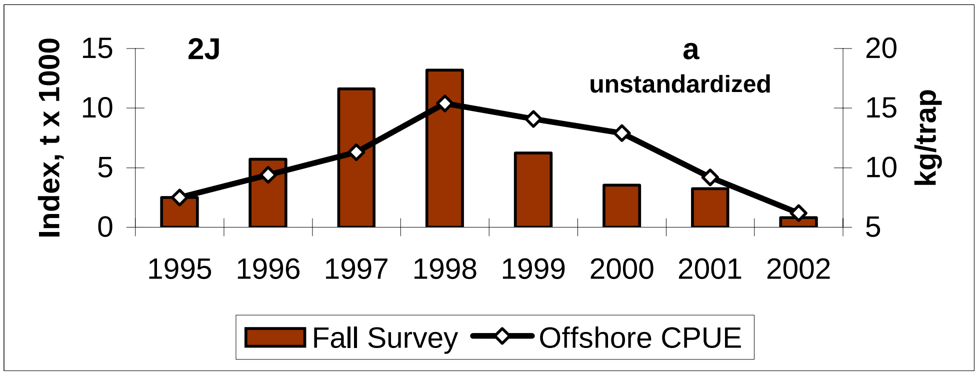


Fig. 10. Annual trends, by shell condition, in abundance indices (a) and mean size (b) of legal-sized males from fall multispecies surveys, with comparison of abundance and size indices for new-shelled crabs (c) in Div. 2J; based on unstandardized data



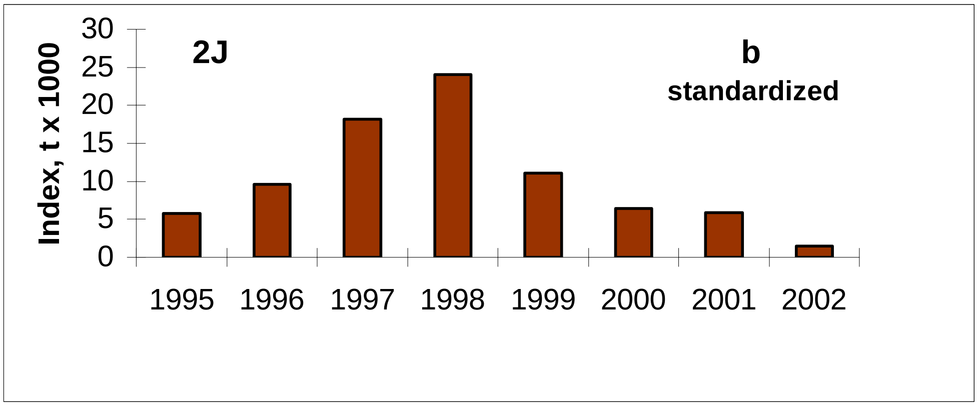


Fig. 11. Annual trends in the Div. 2J fall survey unstandardized exploitable biomass index and commercial CPUE (a) and in the standardized survey index (b).

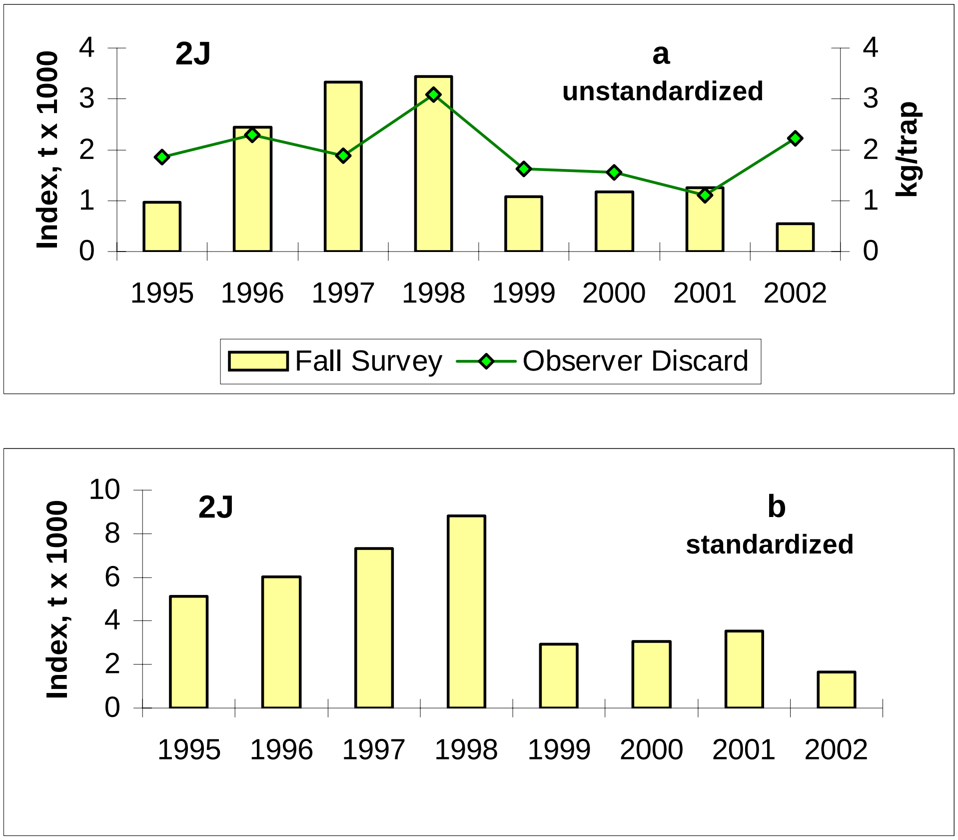


Fig. 12. Annual trends in the Div. 2J fall survey unstandardized prerecruit biomass index and the observer discard catch rate index (a) and in the standardized survey index (b).

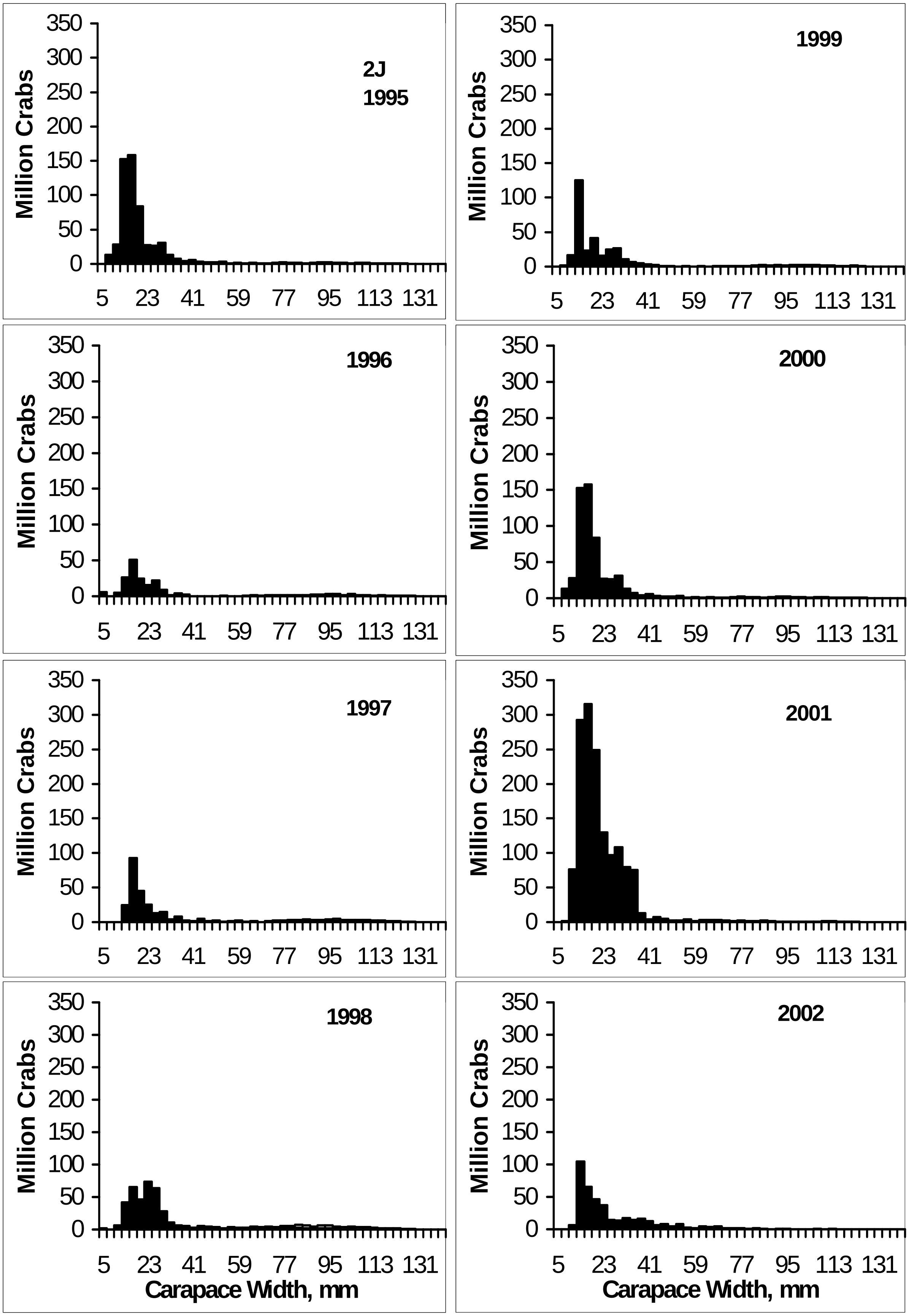


Fig. 13a.Distribution of Div. 2J male abundance (standardized index) by carapace width from fall multispecies surveys, for juveniles plus adolescents (dark bars) versus adults (light bars).

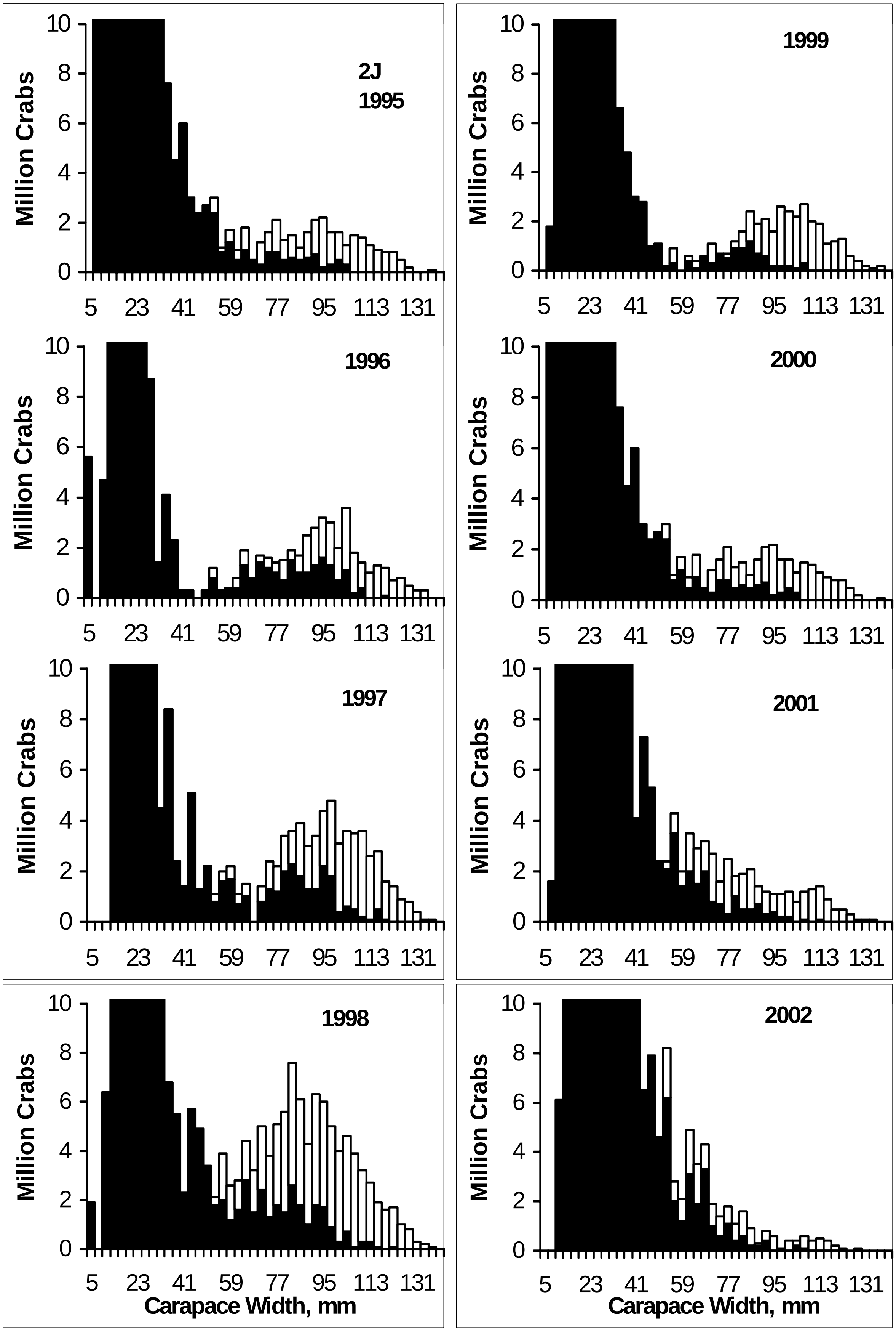


Fig. 13b.Truncated distribution of Div. 2J male abundance (standardized index) by carapace width from fall multispecies surveys, for juveniles plus adolescents (dark bars) versus adults (light bars).

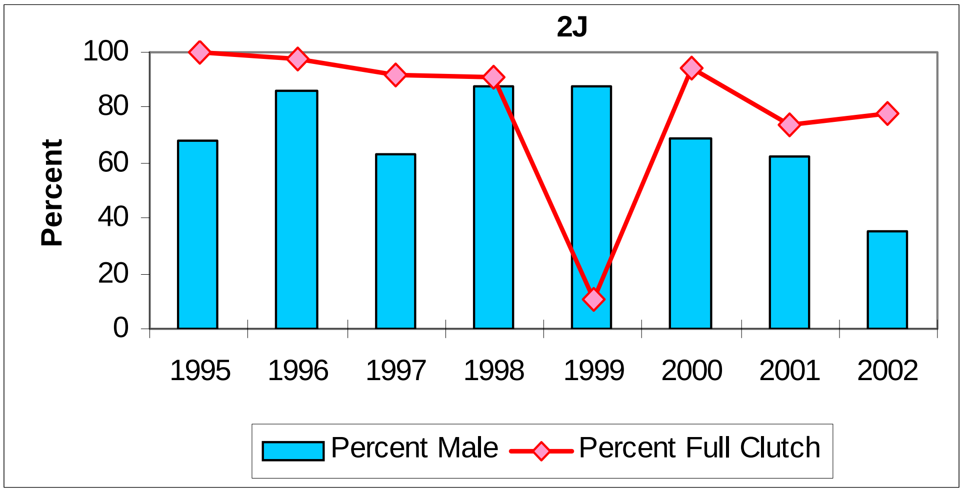
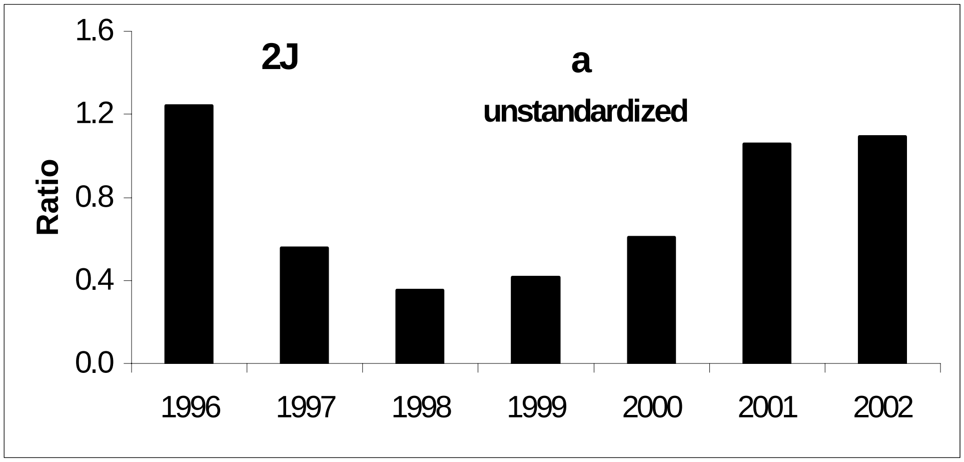


Fig. 14. Annual trends in sex ratio, expressed as the ratio of legal-sized males to mature females, and in percent of mature females bearing full clutches of viable eggs, in Div. 2J, from unstandardized survey data



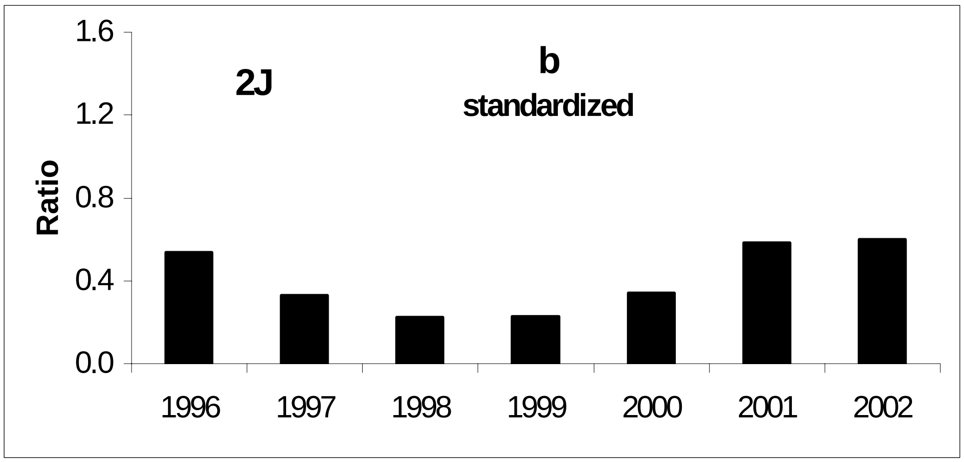


Fig. 15. Ratio of landed catch to the projected exploitable biomass index by year for Div. 2J, using the unstandardized survey index (a) and using the standardized survey index (b)

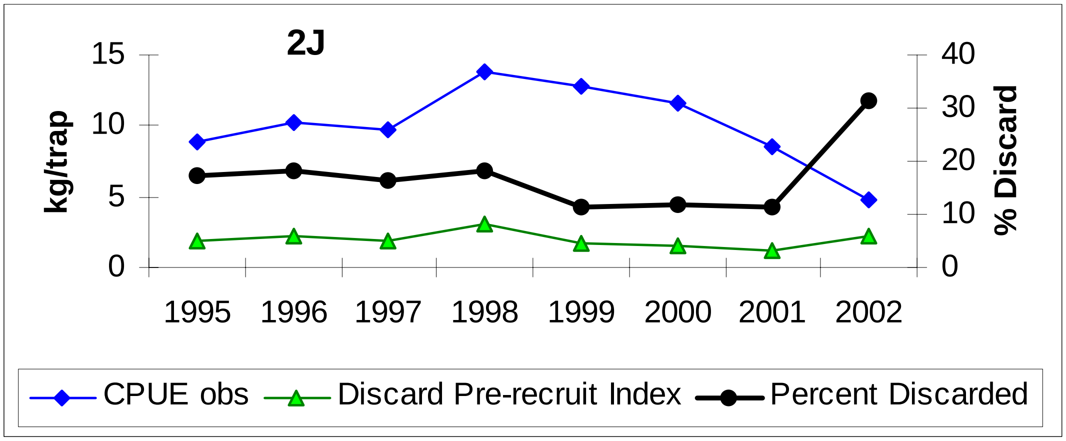


Fig. 16. Annual trends in observer-based CPUE, discard catch rate, and percentage discarded by weight in the Div. 2J fishery.

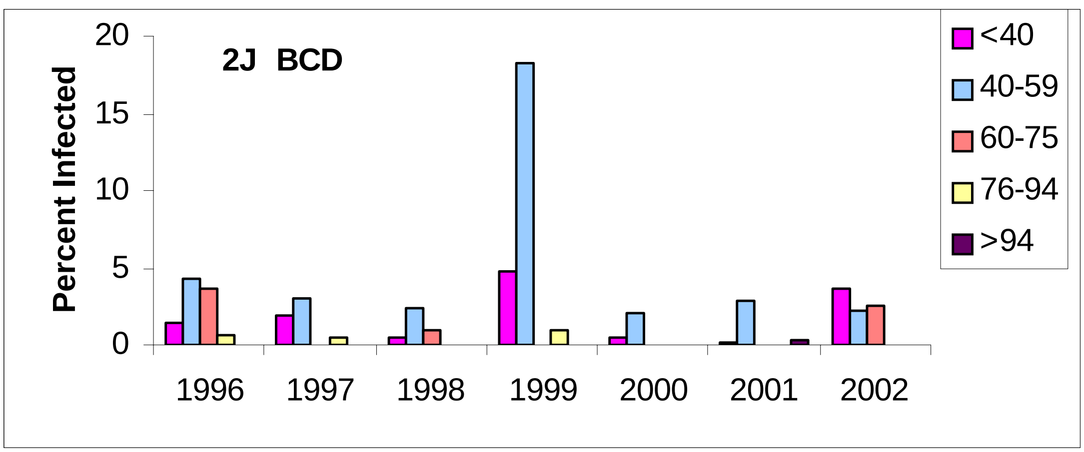


Fig. 17. Yearly trends in prevalence of BCD in Div. 2J by male size group from fall multispecies surveys.

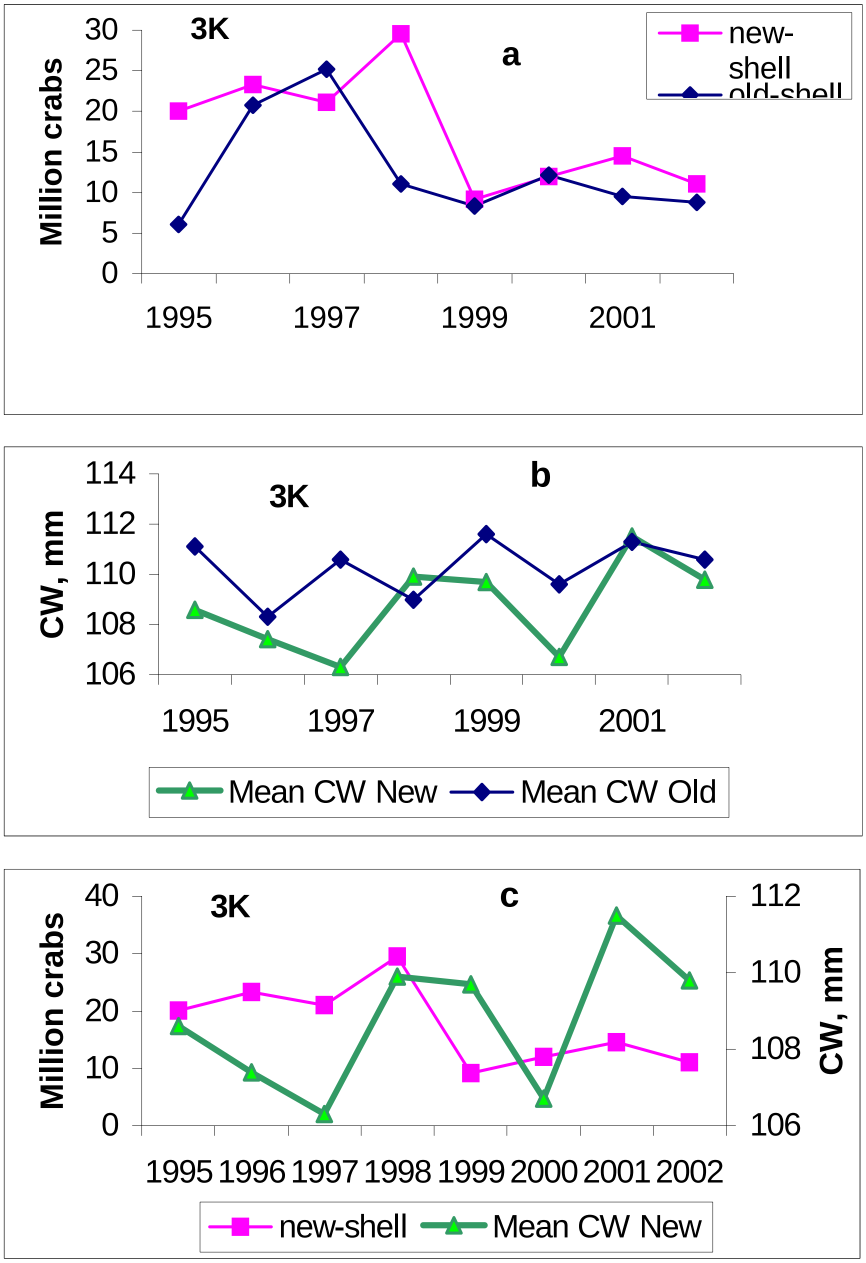
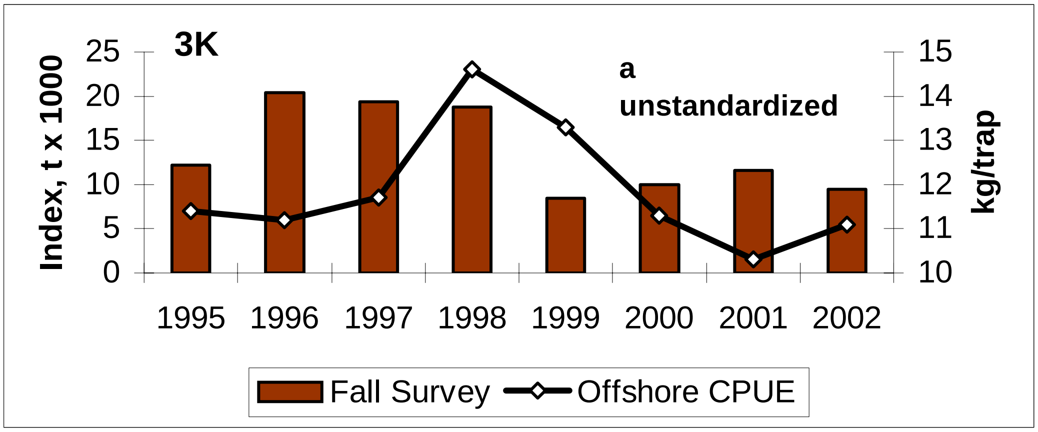


Fig. 18. Annual trends, by shell condition, in abundance indices (a) and mean size (b) of legal-sized males from fall multispecies surveys, with comparison of abundance and size indices for new-shelled crabs (c) in Div. 3K; based on unstandardized data



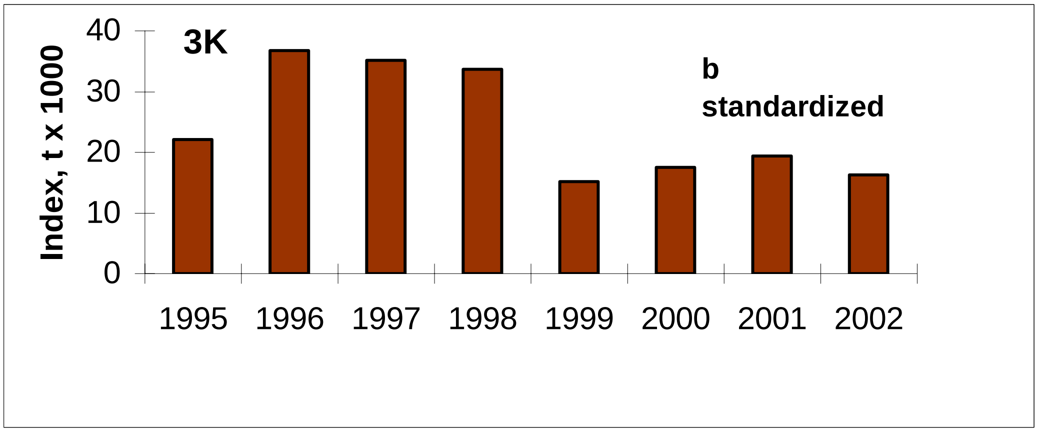


Fig. 19. Annual trends in fall survey projected exploitable biomass indices and commercial CPUE for Div. 3K, using unstandardized (a) and standardized (b) survey data

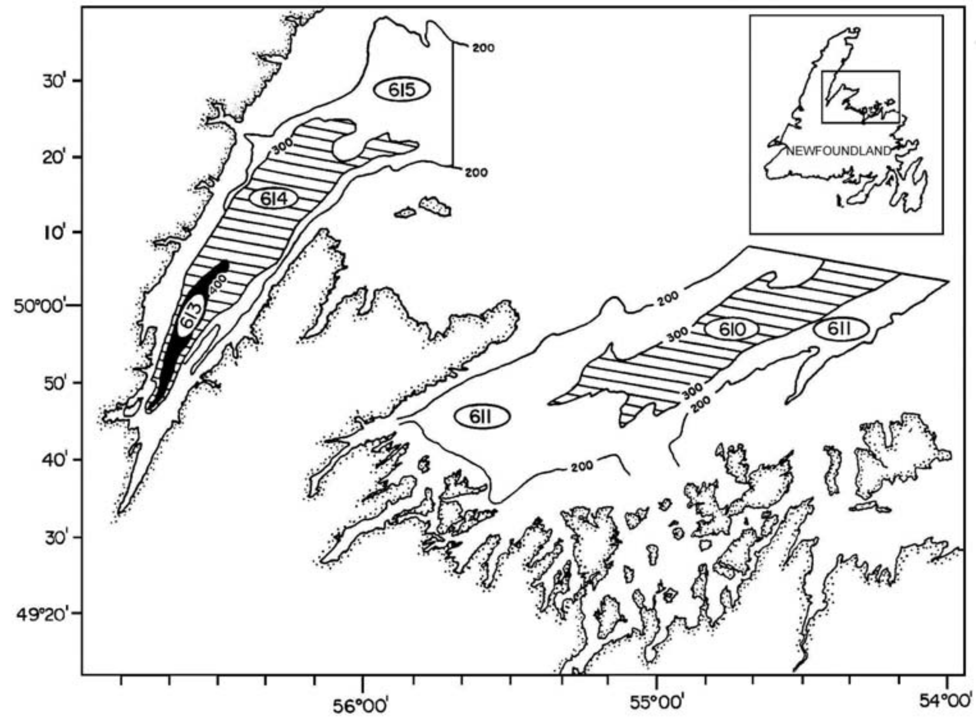


Figure 20: Location map showing inshore Division 3K strata sampled during White Bay / Notre Dame Bay September trapping surveys.

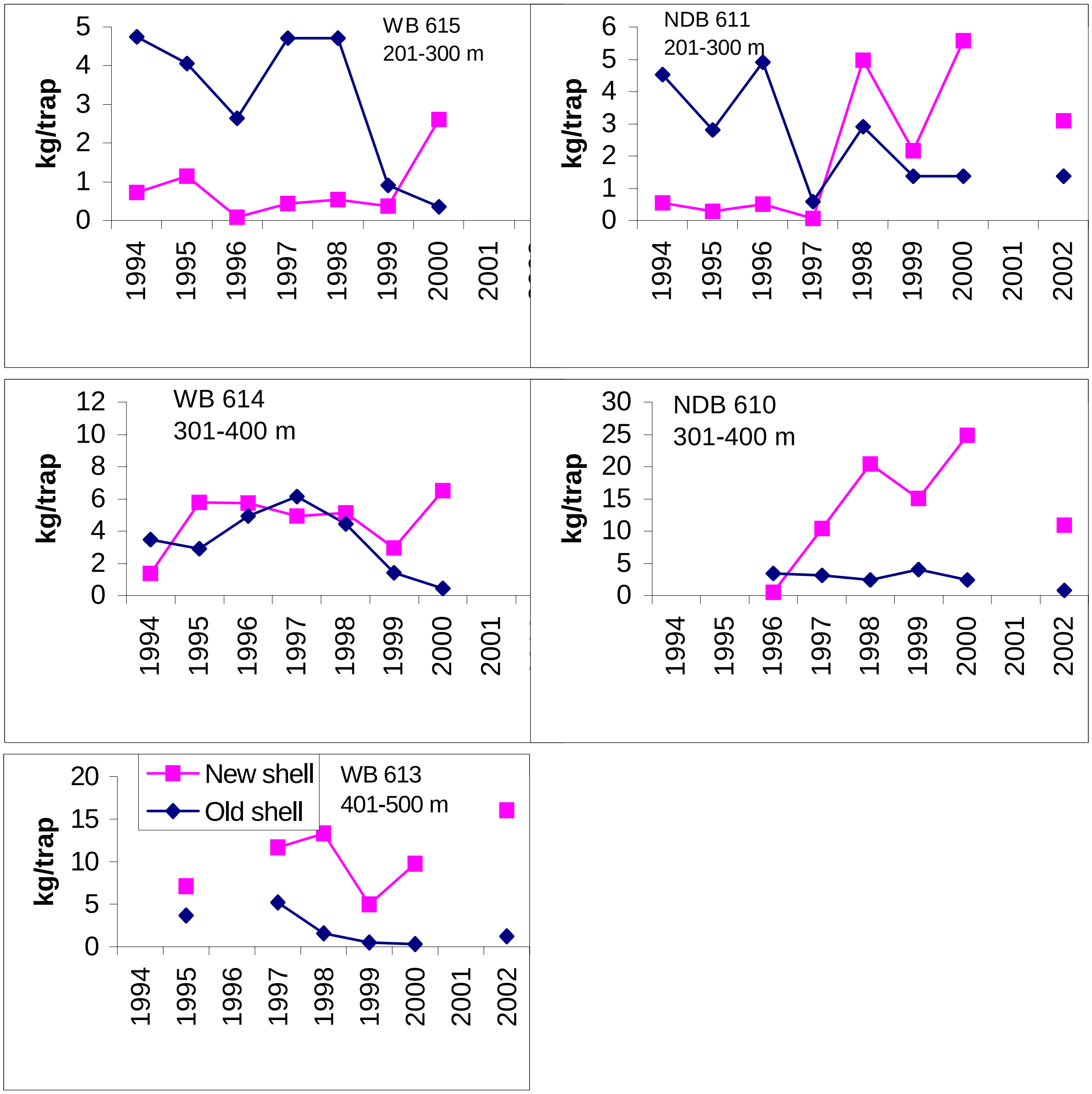


Fig. 21. Annual trends in catch rates by shell category from inshore Div 3K trap surveys in Whie Bay and Notre Dame Bay, 1994-2002.

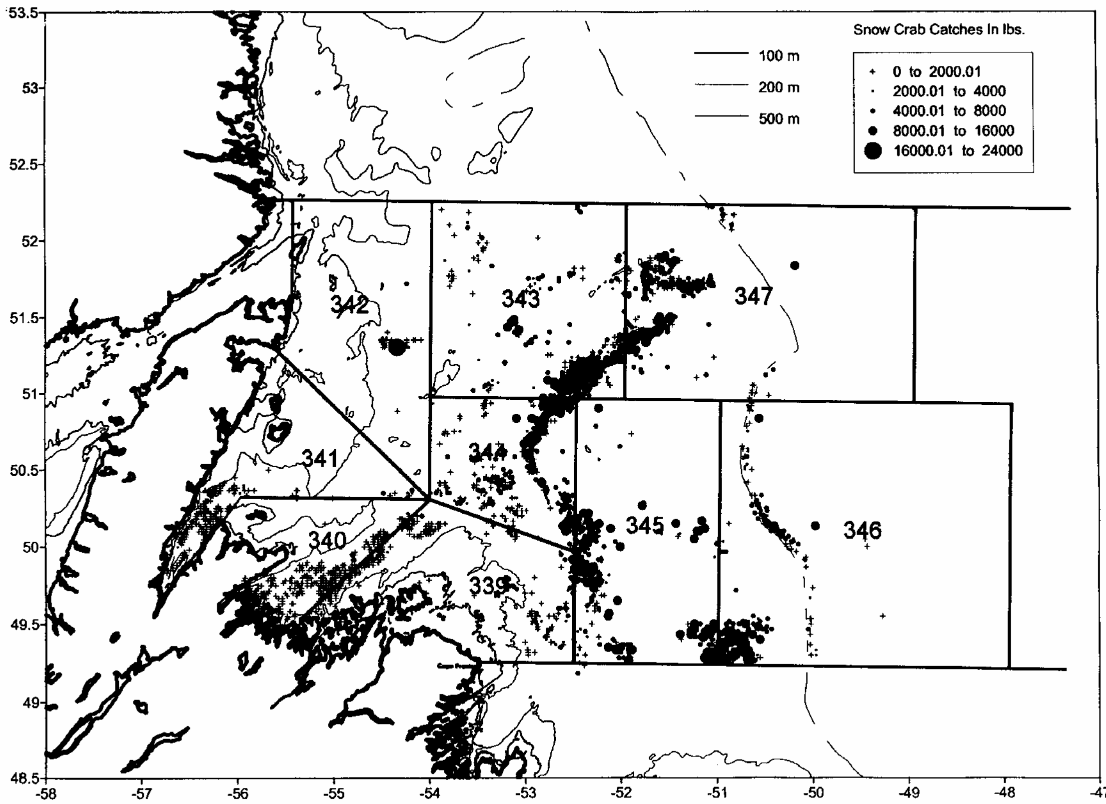


Figure 22: Distribution of Snow Crab catches during 1997 in NAFO division 3K unit areas.

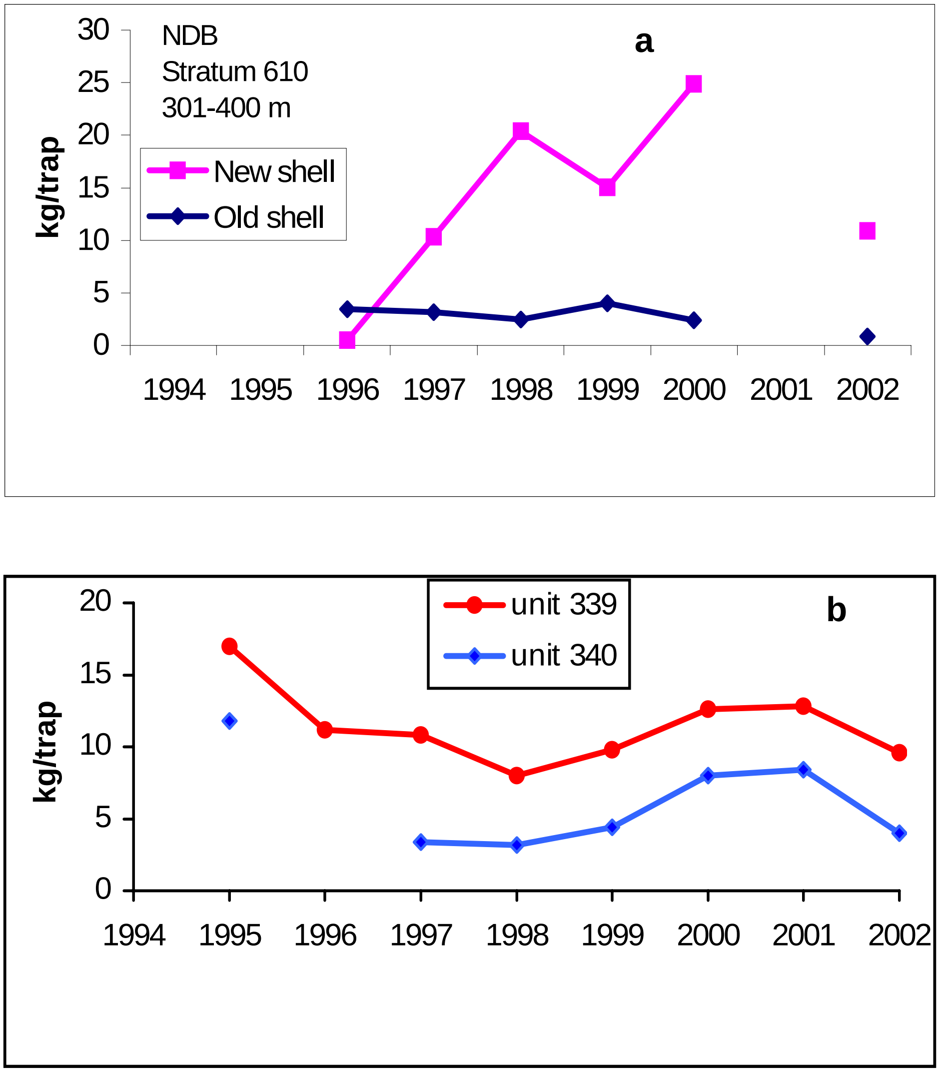


Fig. 23. Comparsion of Inshore Div. 3K trap survey catch rates in Stratum 610 (Notre Dame Bay), by shell category (a), with observer CPUE in two Notre Dame Bay unit areas (b).

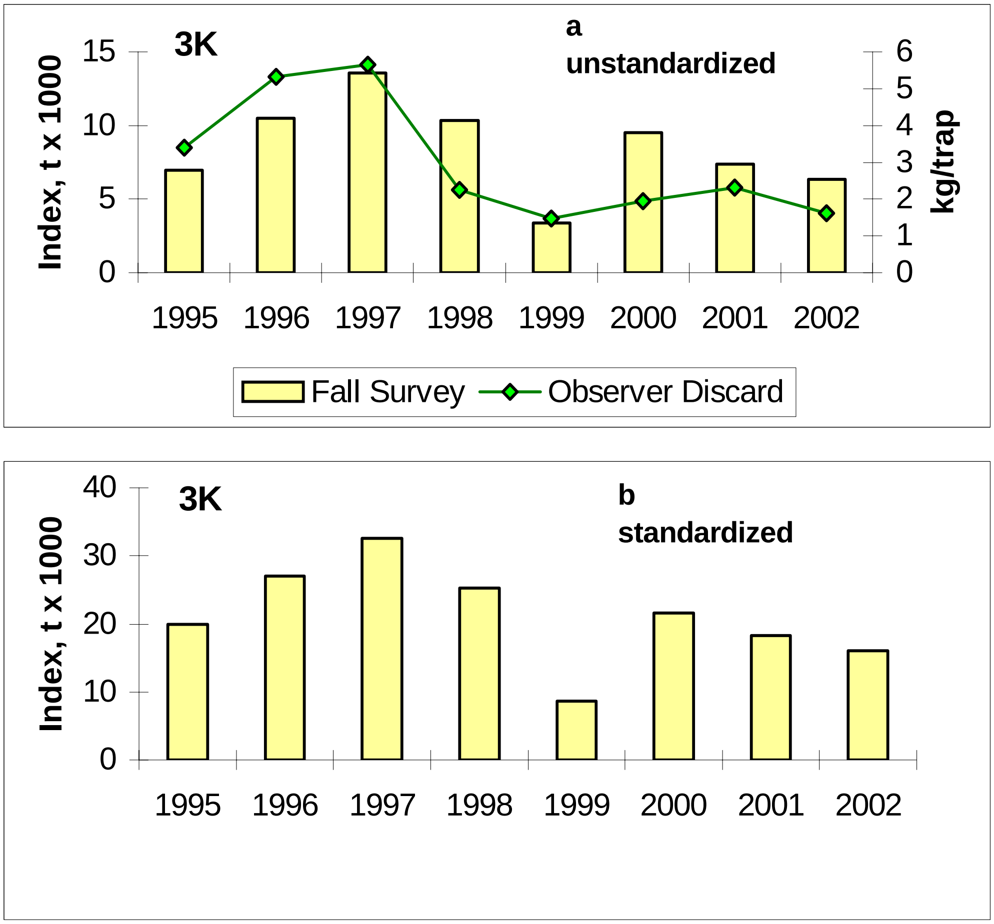


Fig. 24. Annual trends in the Div. 3K fall survey unstandardized prerecruit biomass index and the observer discard catch rate index (a) and in the standardized survey index (b).

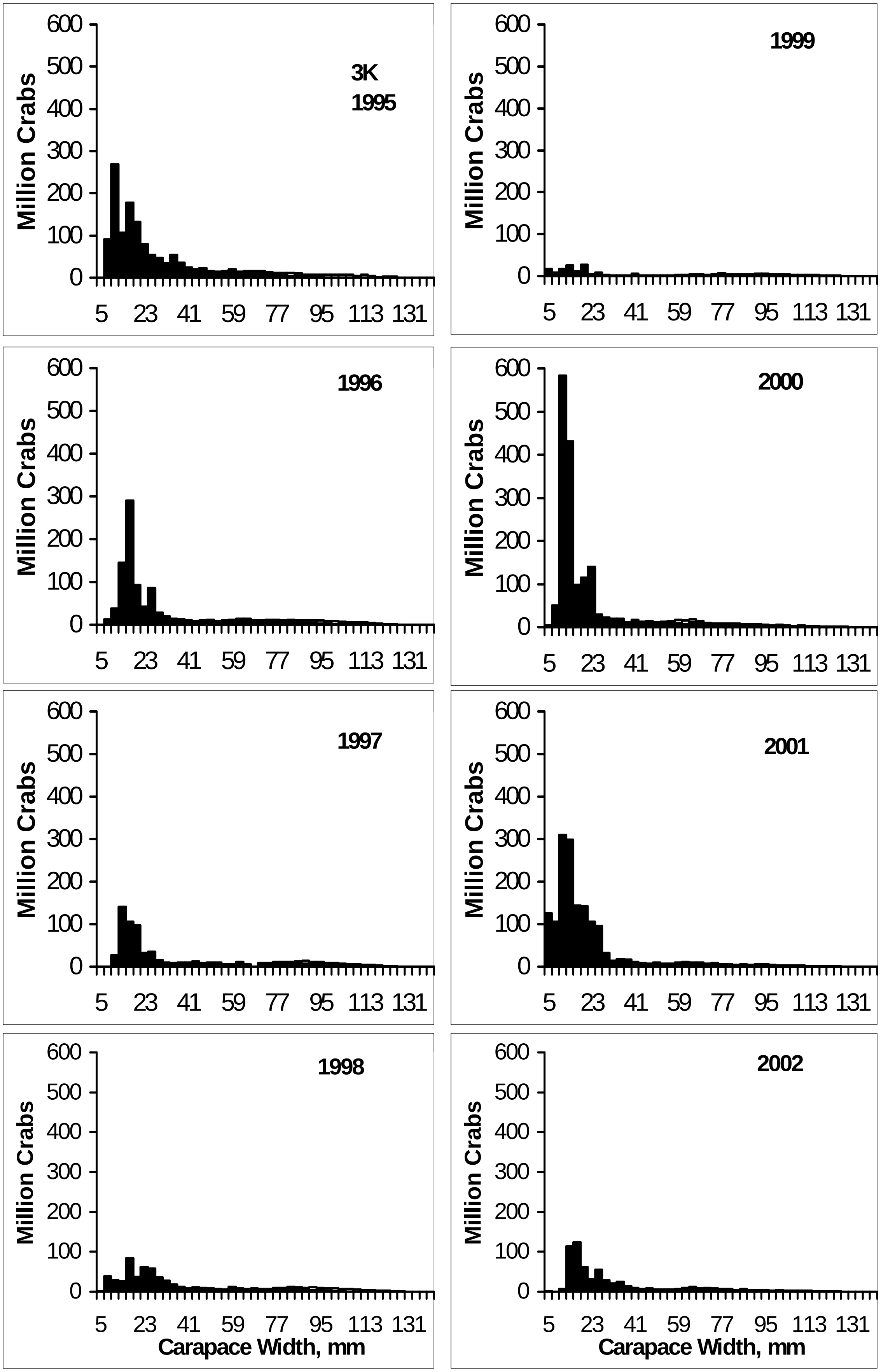


Fig. 25a.Distribution of Div. 3K male abundance (standardized index) by carapace width from fall multispecies surveys, for juveniles plus adolescents (dark bars) versus adults (light bars).

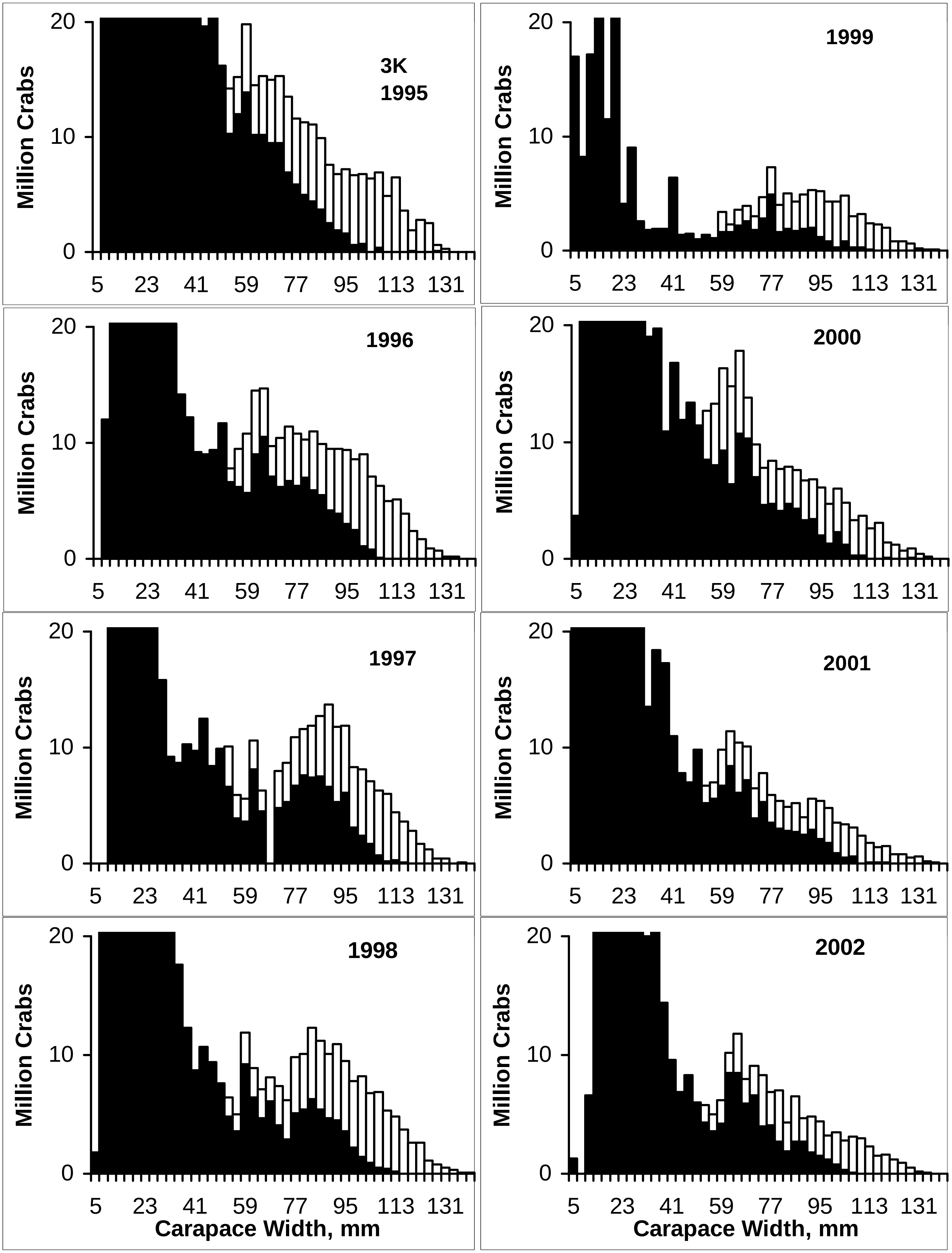


Fig. 25b.Truncated distribution of Div. 3K male abundance (standardized index) by carapace width from fall multispecies surveys, for juveniles plus adolescents (dark bars) versus adults (light bars).

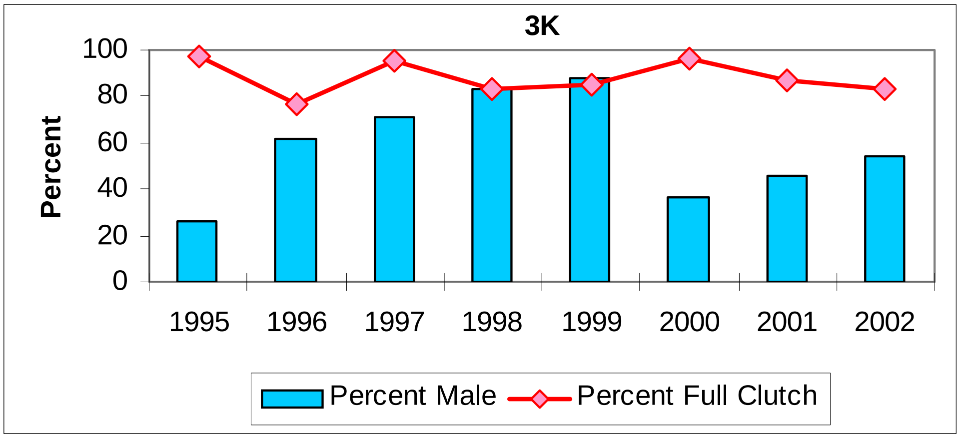


Fig. 26. Annual trends in sex ratio, expressed as the ratio of legal-sized males to mature females, and in percent of mature females bearing full clutches of viable eggs, in Div. 3K.

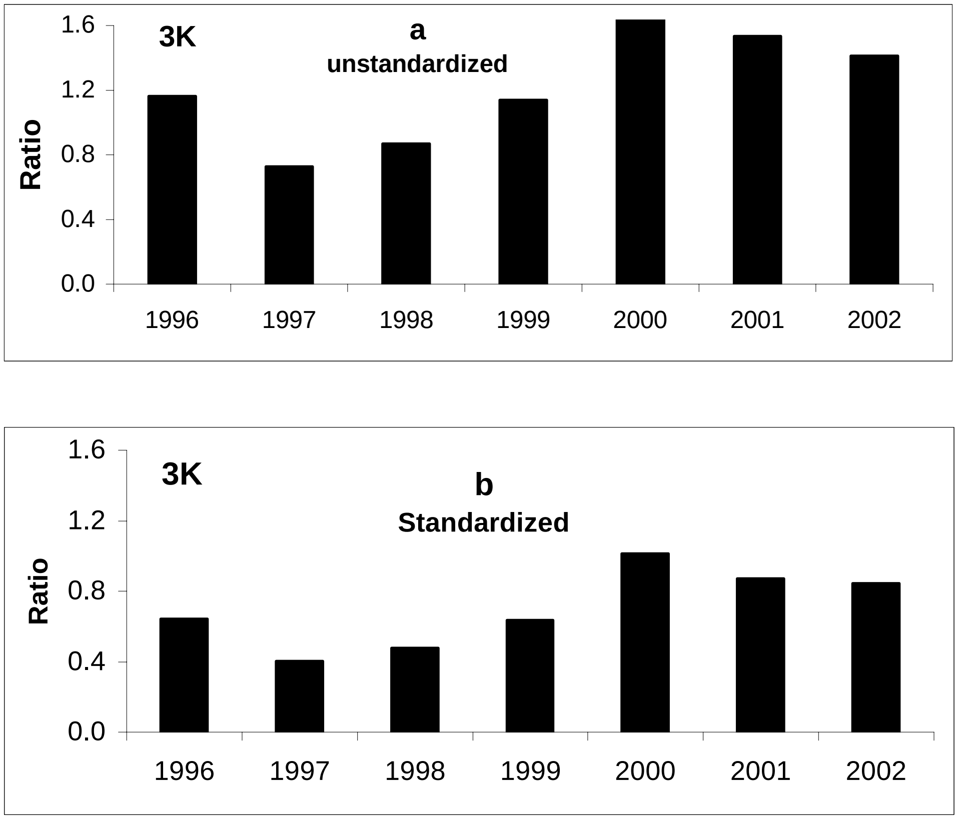


Fig. 27. Ratio of landed catch to the projected exploitable biomass index by year for Div. 3K, using the unstandardized survey index (a) and using the standardized survey index (b)

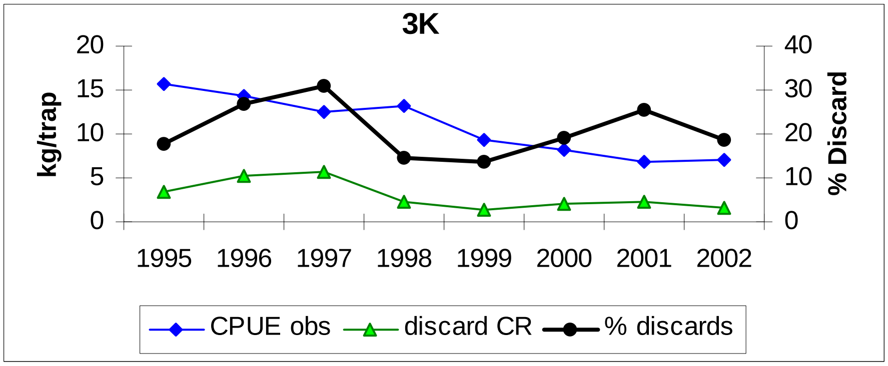


Fig. 28. Annual trends in observer-based CPUE, discard catch rate, and percentage discarded by weight in the Div. 3K fishery.

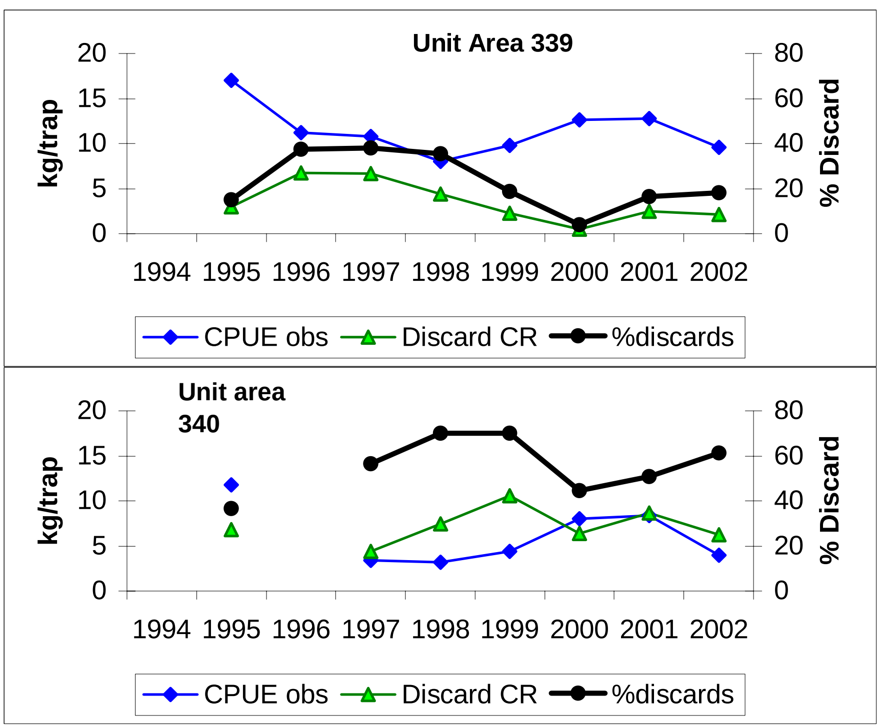


Fig. 29. Annual trends in observer-based CPUE, discard catch rate, and percentage discarded by weight in the Div. 3K fishery in each of two Notre Dame Bay unit areas.

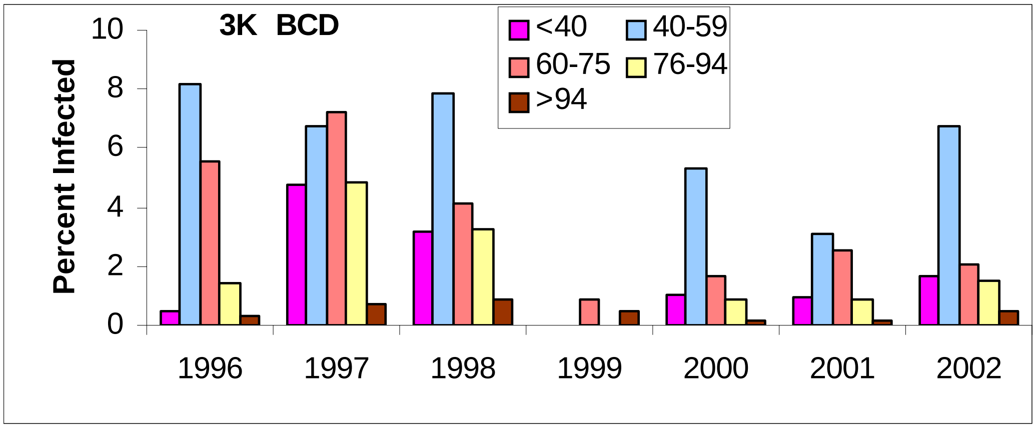


Fig. 30. Yearly trends in prevalence of BCD in Div. 3K by male size group from fall multispecies surveys.

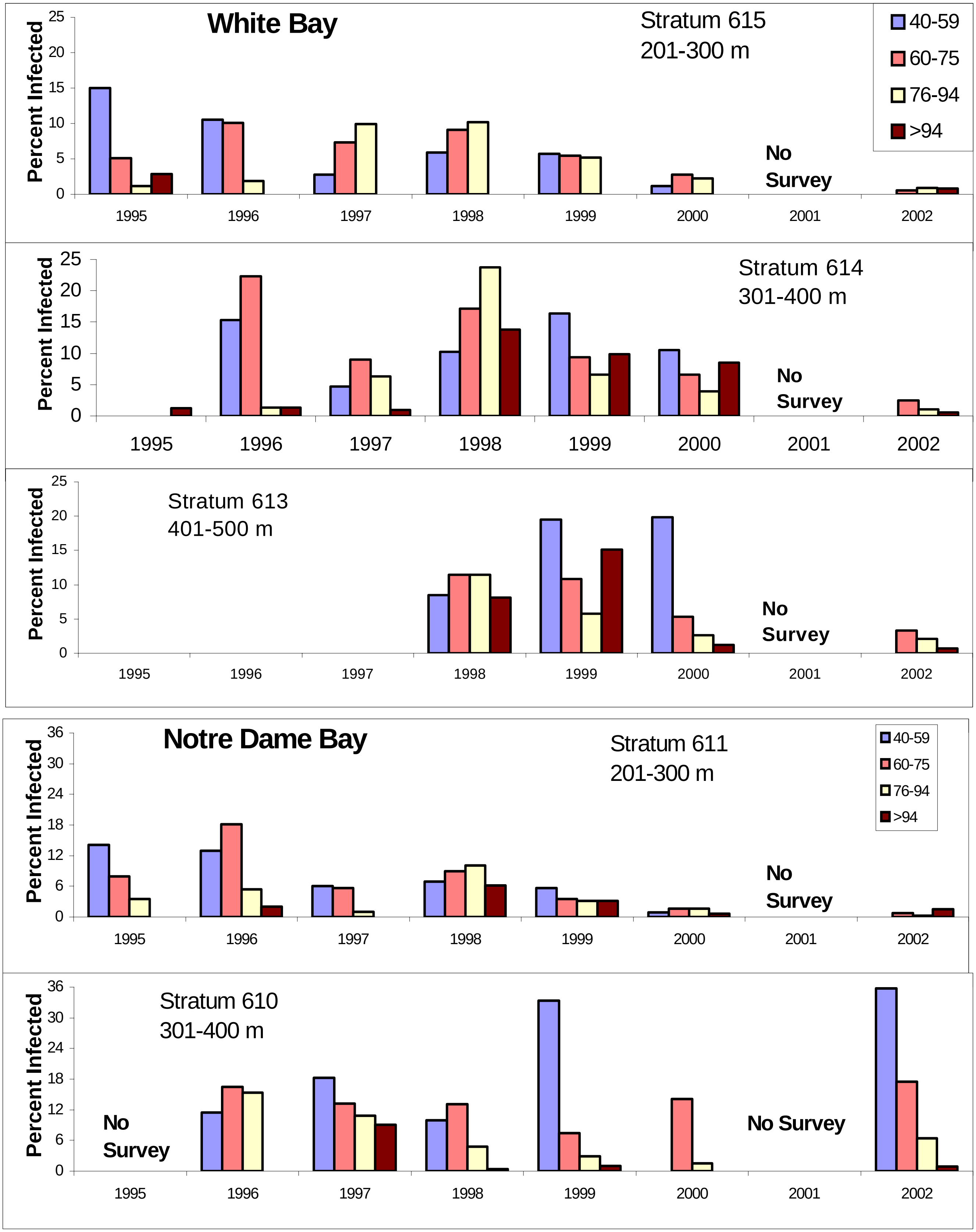


Fig. 31 Yearly trends in prevalence of BCD in Div. 3K by male size group and depth stratum from fall inshore Div. 3K trap surveys in White Bay and Notre Dame Bay.

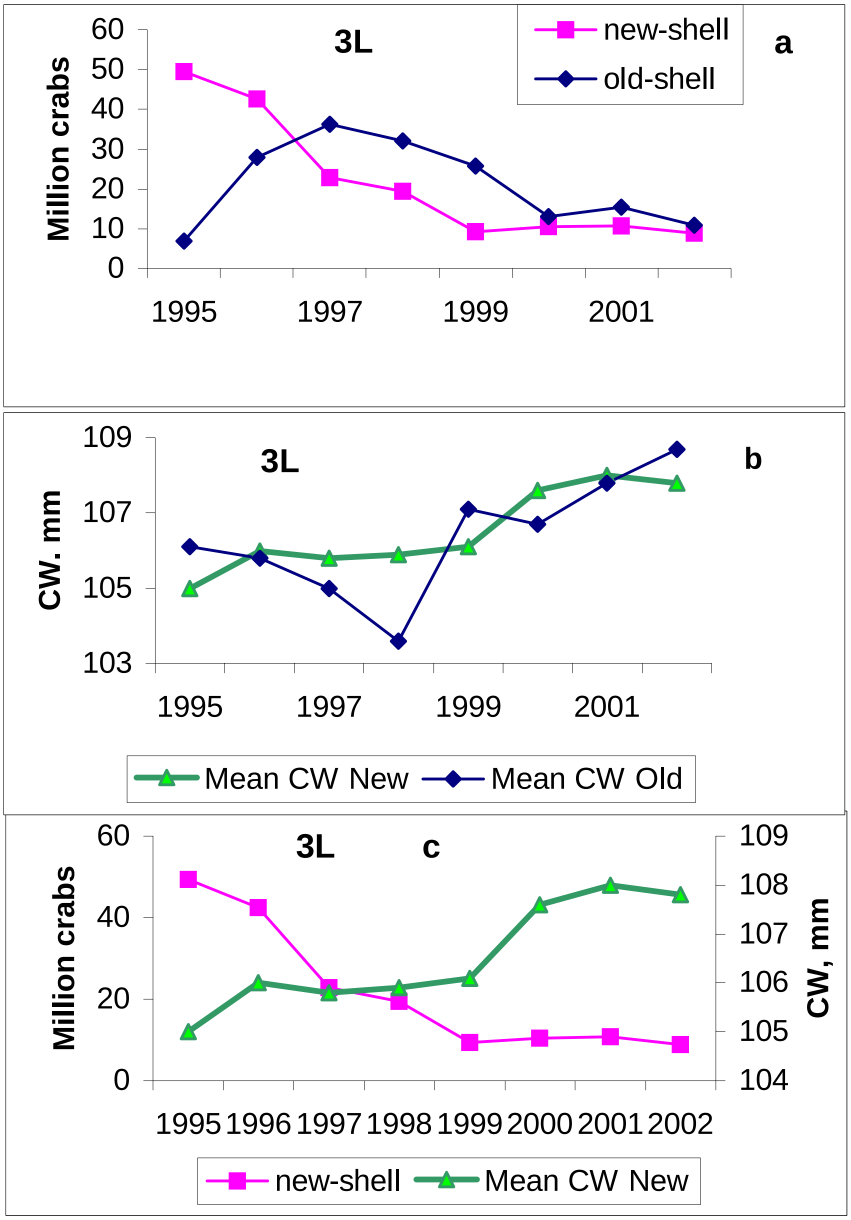


Fig. 32. Annual trends, by shell condition, in abundance indices (a) and mean size (b) of legal-sized males from fall multispecies surveys, with comparison of abundance and size indices for new-shelled crabs (c) in Div. 3L, based on unstandardized data

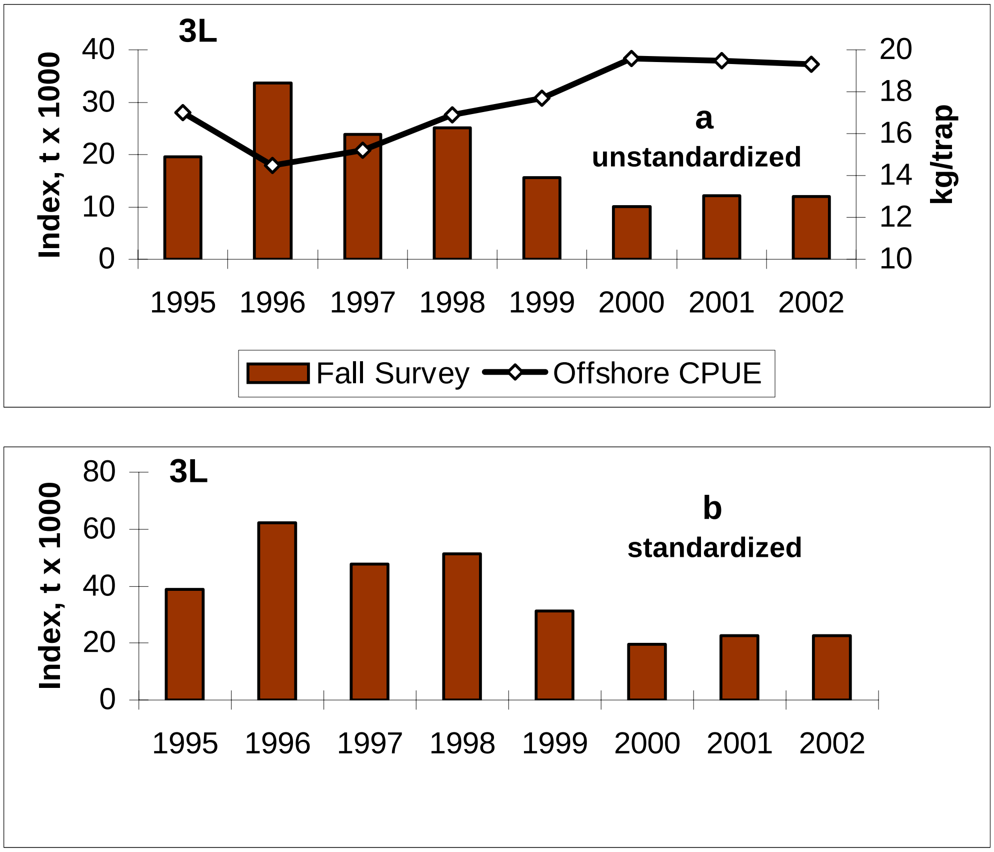
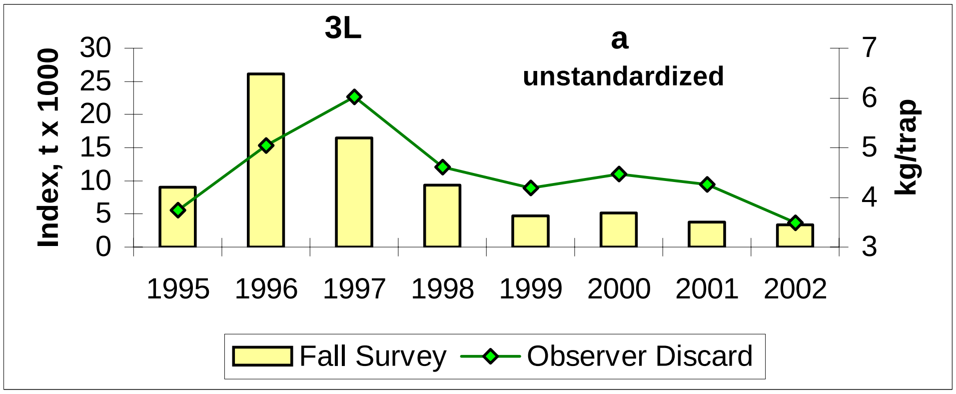


Fig. 33. Annual trends in the Div. 3L fall survey unstandardized exploitable biomass index and commercial CPUE (a) and in the standardized survey index (b).



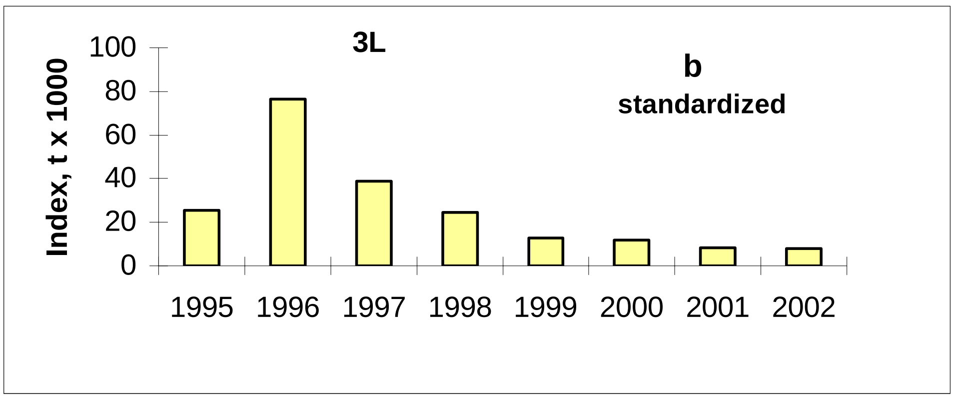


Fig. 34. Annual trends in the Div. 3L fall survey unstandardized prerecruit biomass index and the observer discard catch rate index (a) and in the standardized survey index (b).

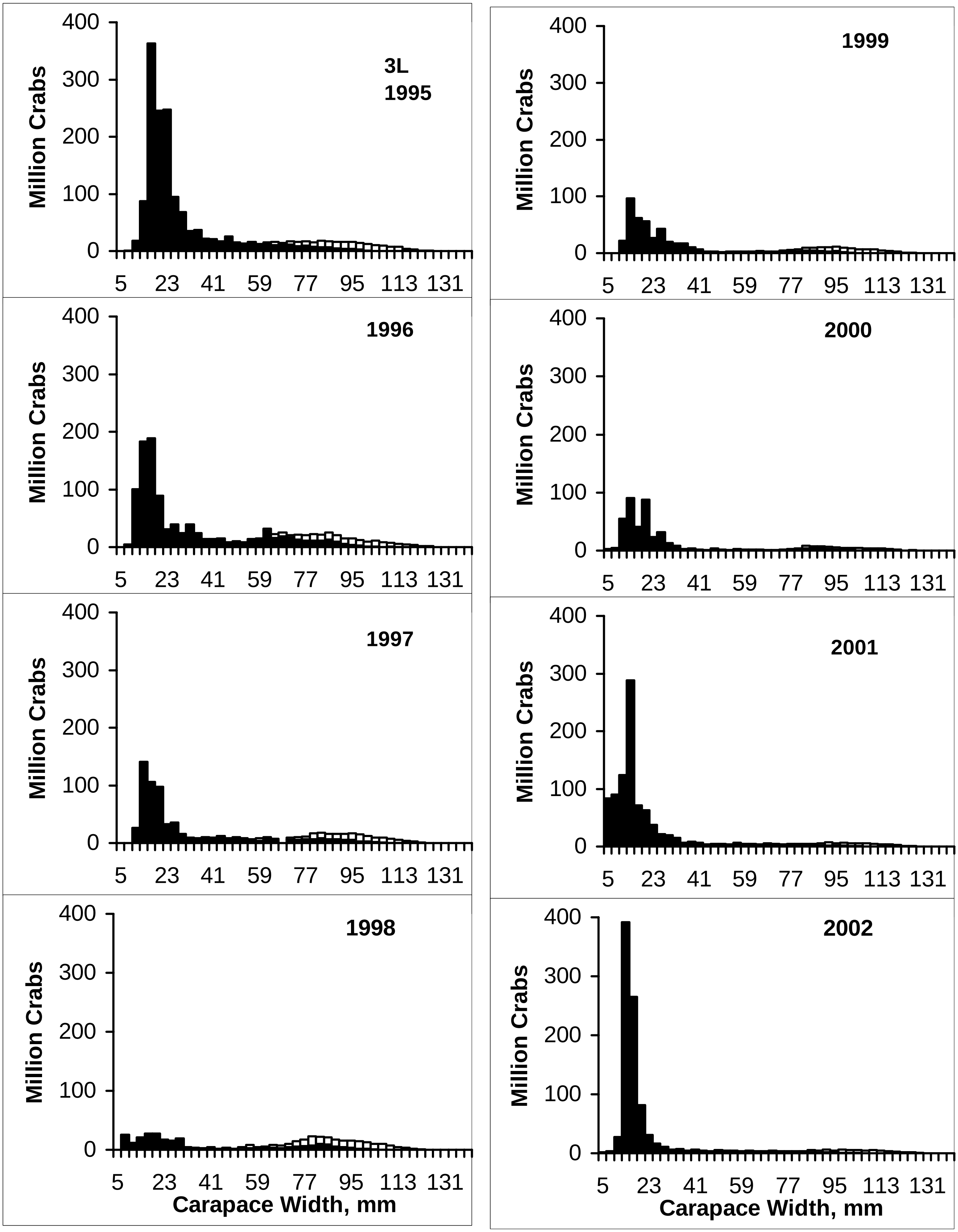


Fig. 35a.Distribution of Div. 3L male abundance (standardized index) by carapace width from fall multispecies survey, for juveniles plus adolescents (dark bars) versus adults (light bars).

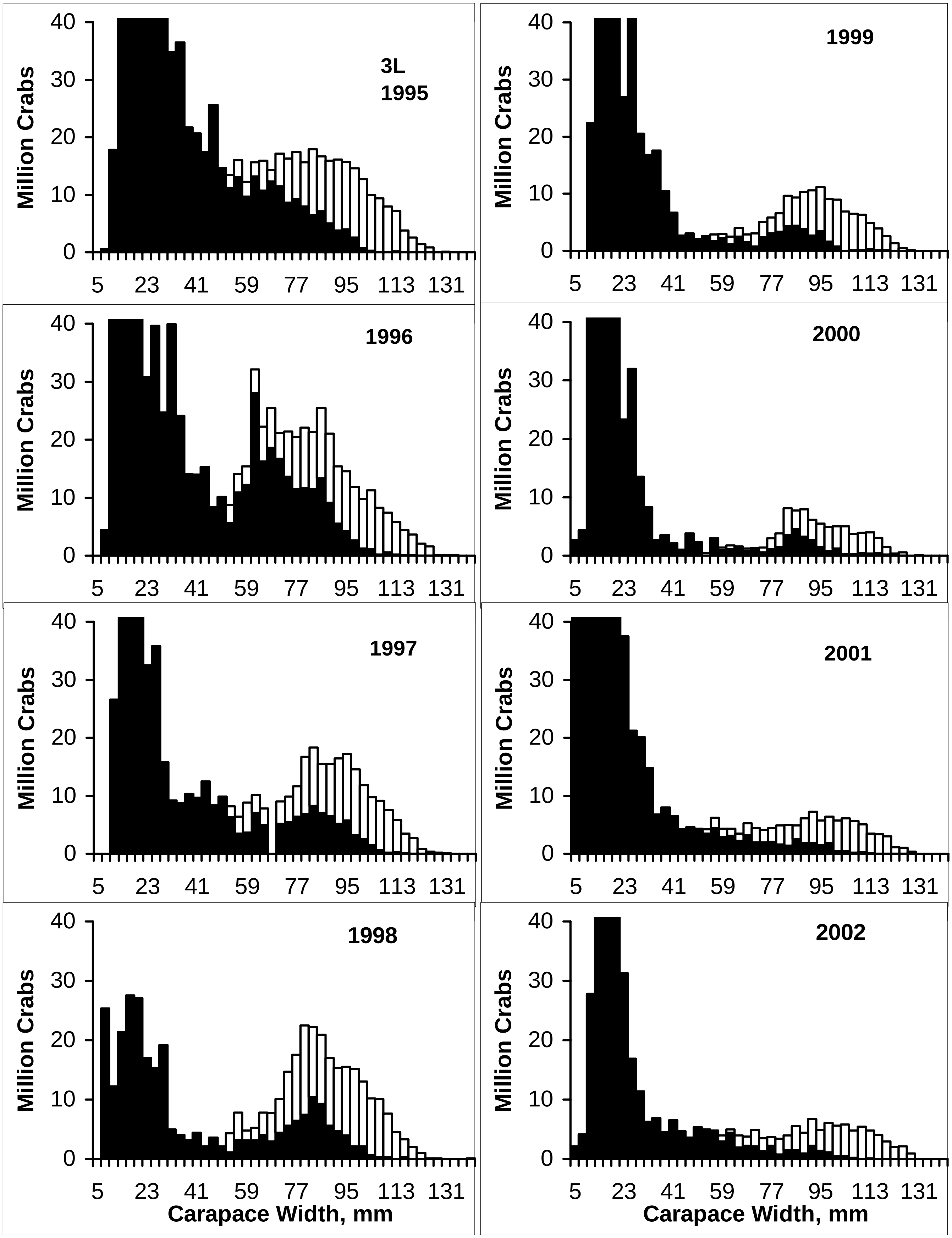


Fig. 35b.Truncated distribution of Div. 3L male abundance (standardized index) by carapace width from fall multispecies survey, for juveniles plus adolescents (dark bars) versus adults (light bars).

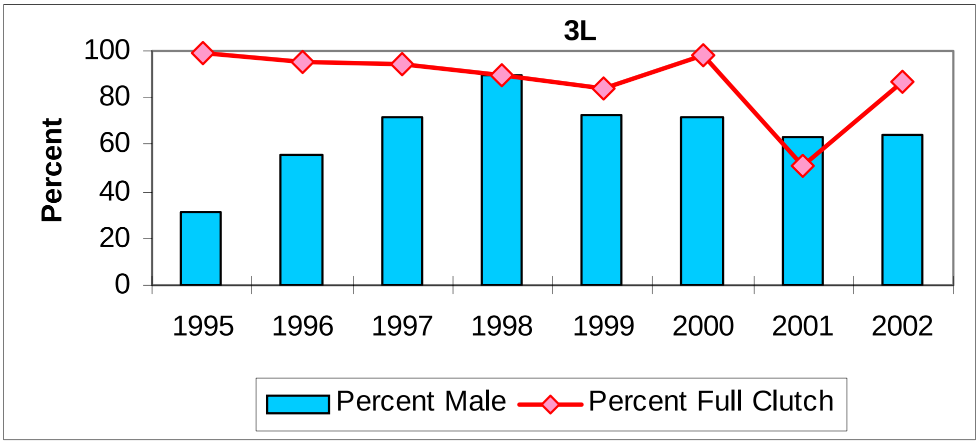


Fig. 36. Annual trends in sex ratio, expressed as the ratio of legal-sized males to mature females, and in percent of mature females bearing full clutches of viable eggs, in Div. 3L.

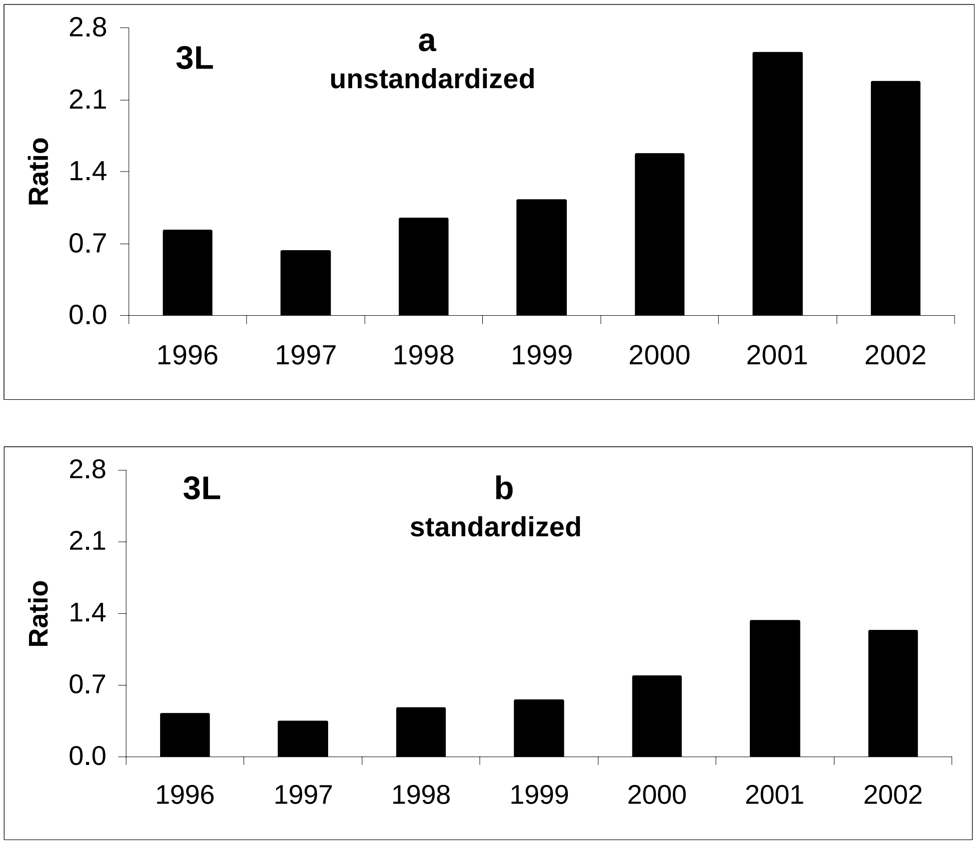


Fig. 37. Ratio of landed catch to the projected exploitable biomass index by year for Div. 3L, using the unstandardized survey index (a) and using the standardized survey index (b)

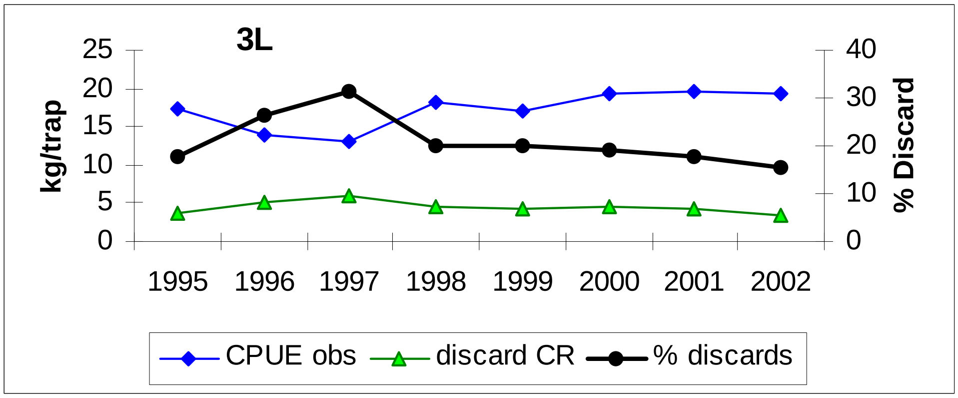


Fig. 38. Annual trends in observer-based CPUE, discard catch rate, and percentage discarded by weight in the Div. 3L fishery.

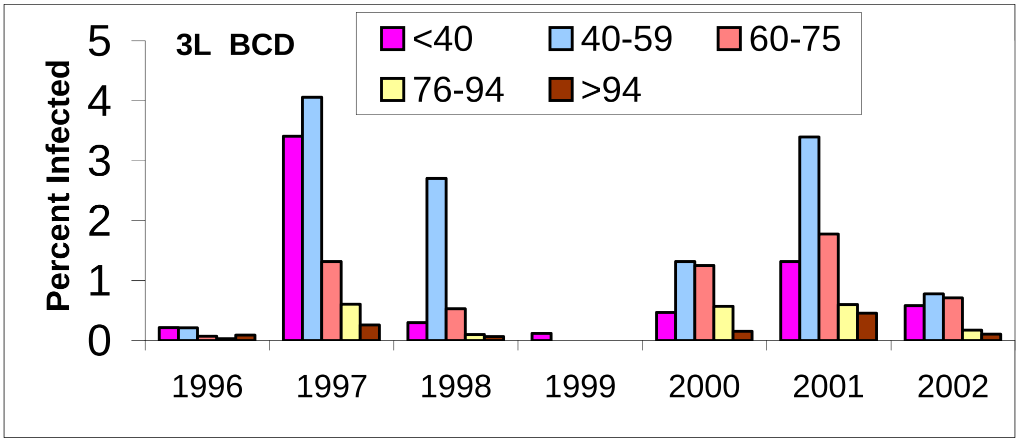


Fig. 39. Yearly trends in prevalence of BCD in Div. 3L by male size group from fall multispecies surveys.

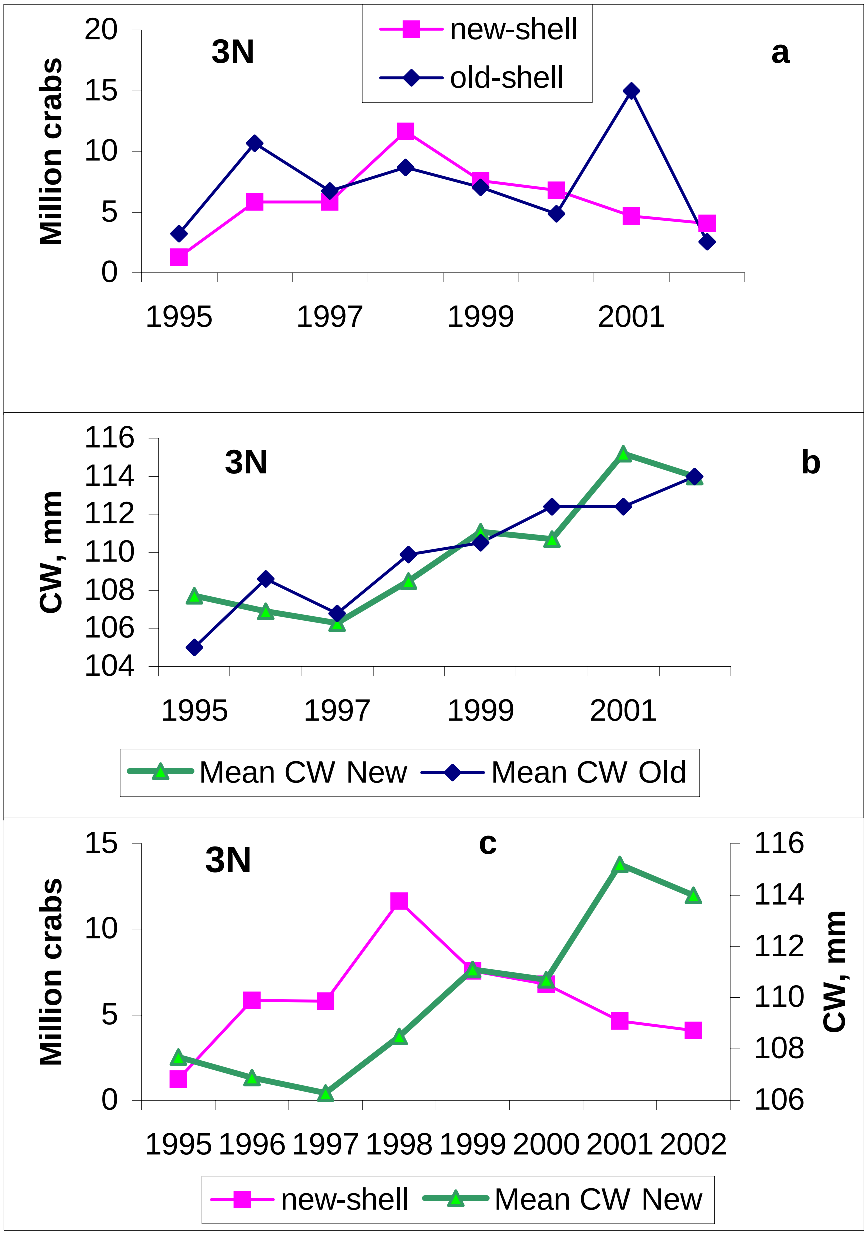


Fig. 40. Annual trends, by shell condition, in abundance indices (a) and mean size (b) of legal-sized males from fall multispecies surveys, with comparison of abundance and size indices for new-shelled crabs (c) in Div. 3N, based on unstandardized data

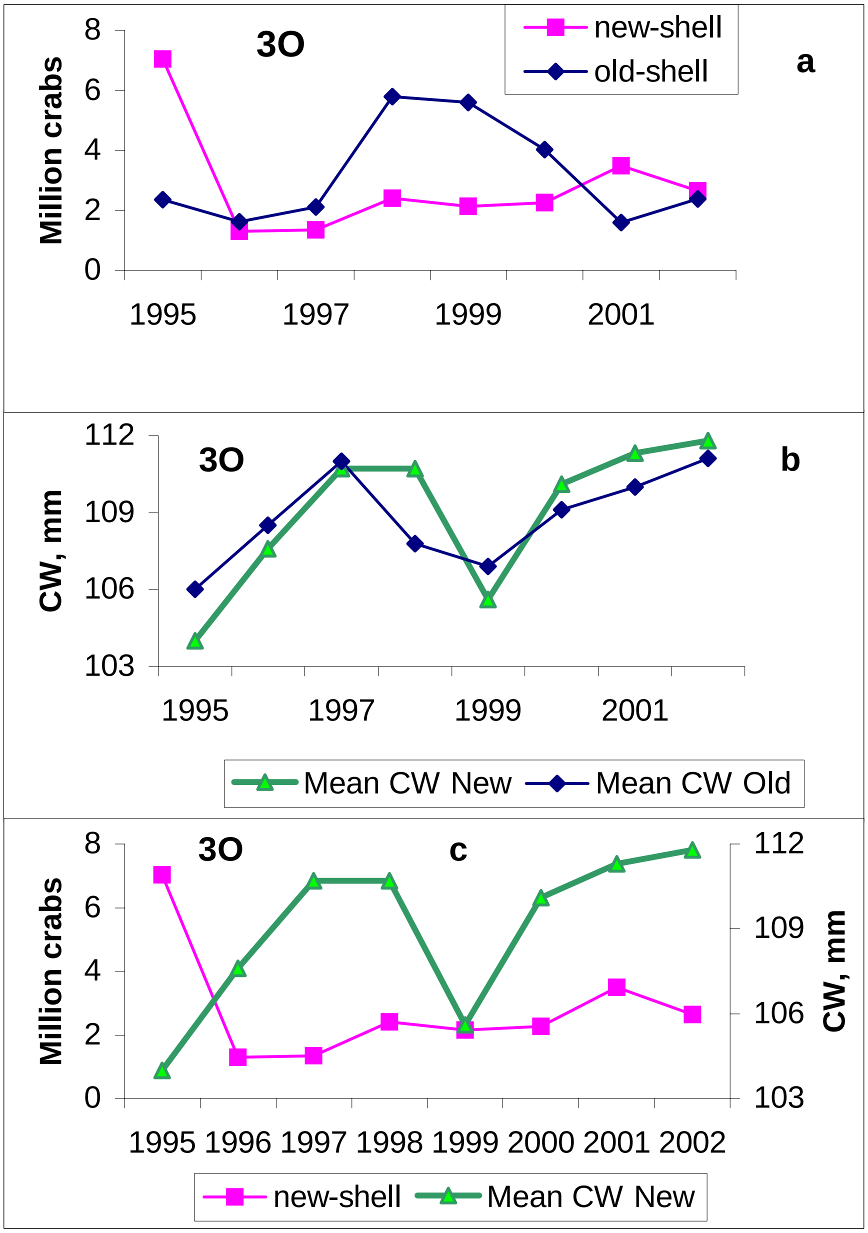
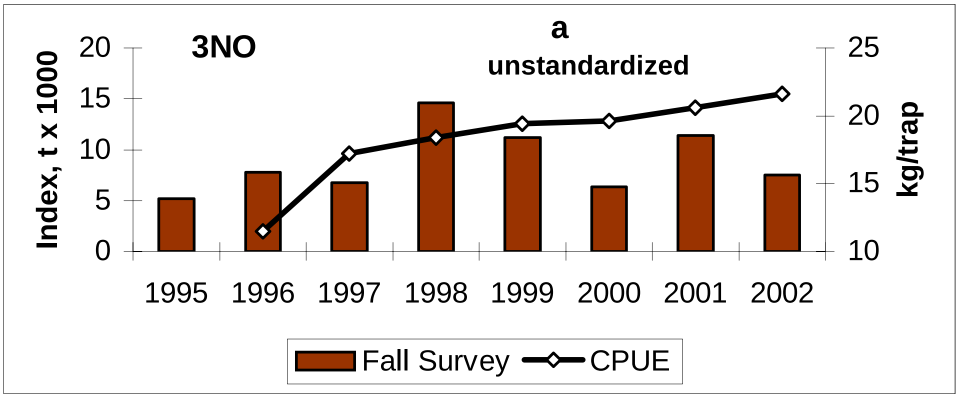


Fig. 41. Annual trends, by shell condition, in abundance indices (a) and mean size (b) of legal-sized males from fall multispecies surveys, with comparison of abundance and size indices for new-shelled crabs (c) in Div. 3O, based on unstandardized data



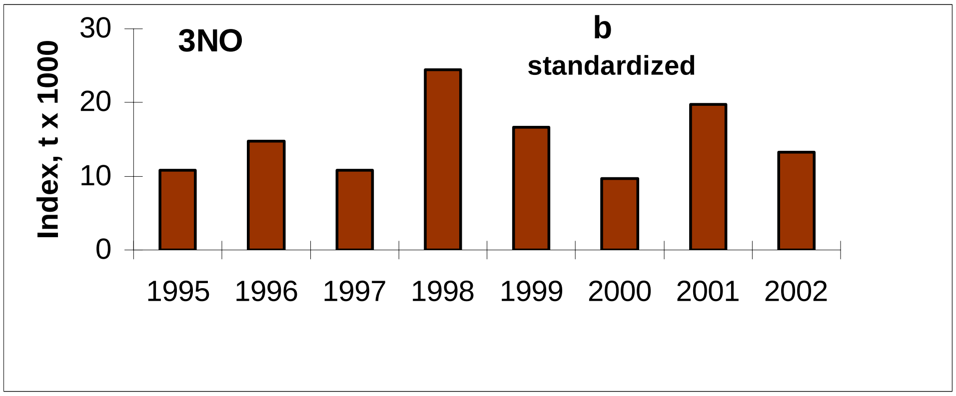


Fig. 42. Annual trends in the Div. 3NO fall survey unstandardized exploitable biomass index and commercial CPUE (a) and in the standardized survey index (b).

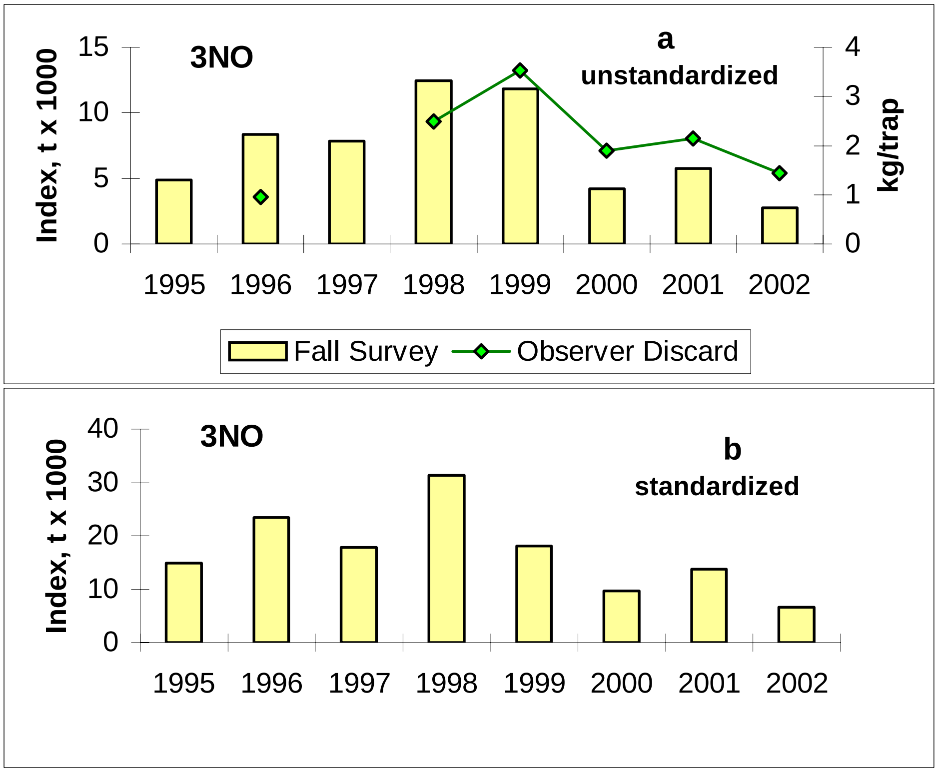


Fig. 43. Annual trends in the Div. 3NO fall survey unstandardized prerecruit biomass index and the observer discard catch rate index (a) and in the standardized survey index (b).

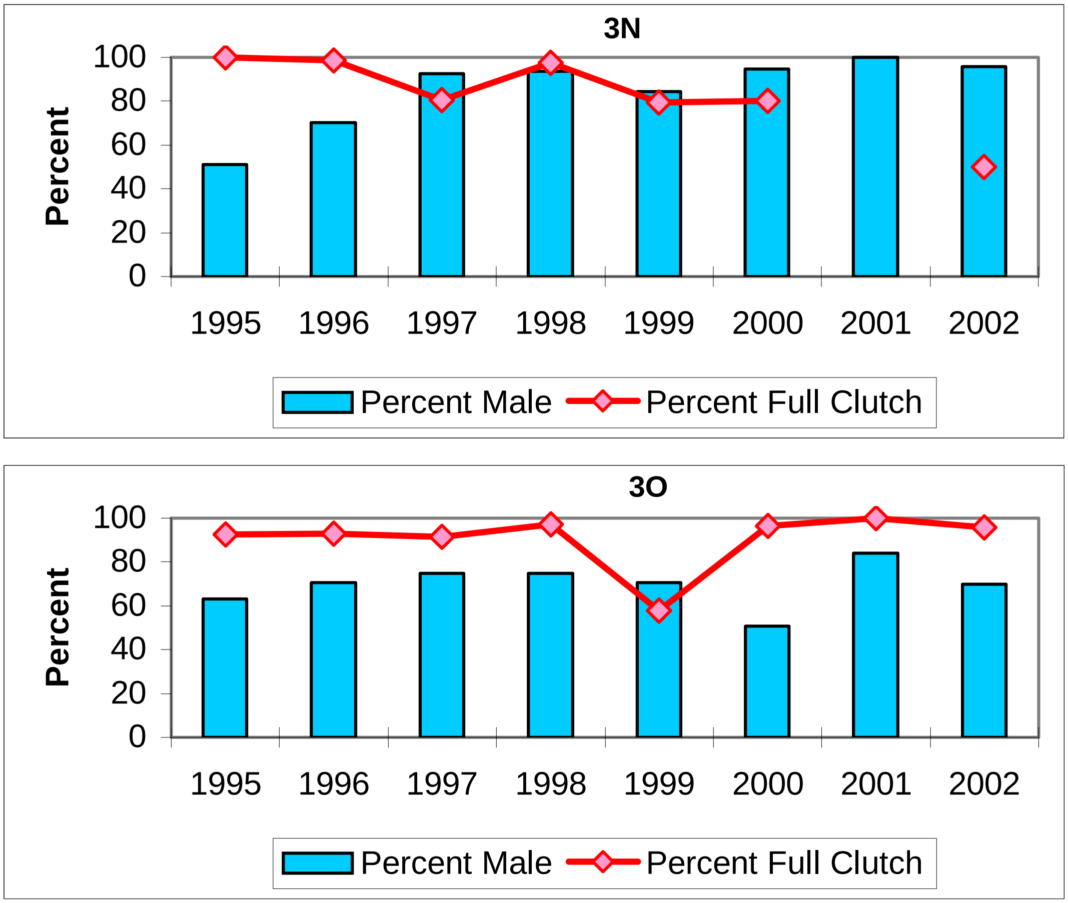


Fig. 44. Annual trends in sex ratio, expressed as the ratio of legal-sized males to mature females, and in percent of mature females bearing full clutches of viable eggs, in Div. 3N and 3O

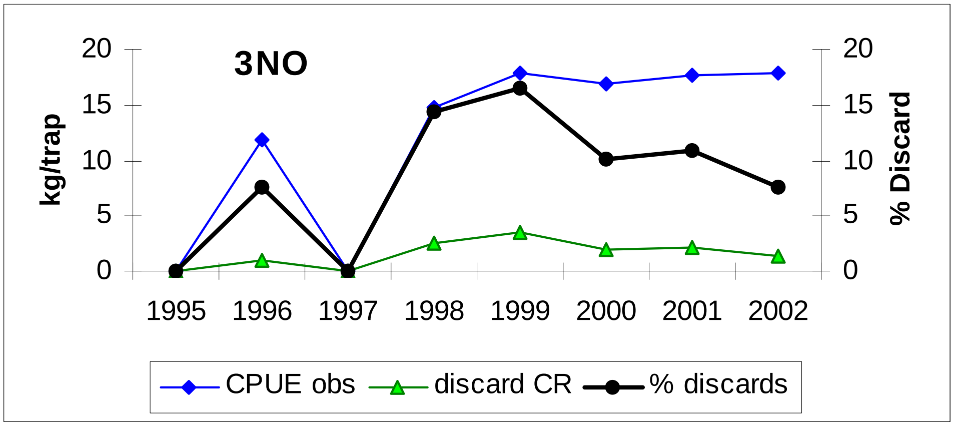


Fig. 45. Annual trends in observer-based CPUE, discard catch rate, and percentage discarded by weight in the Div. 3NO fishery.

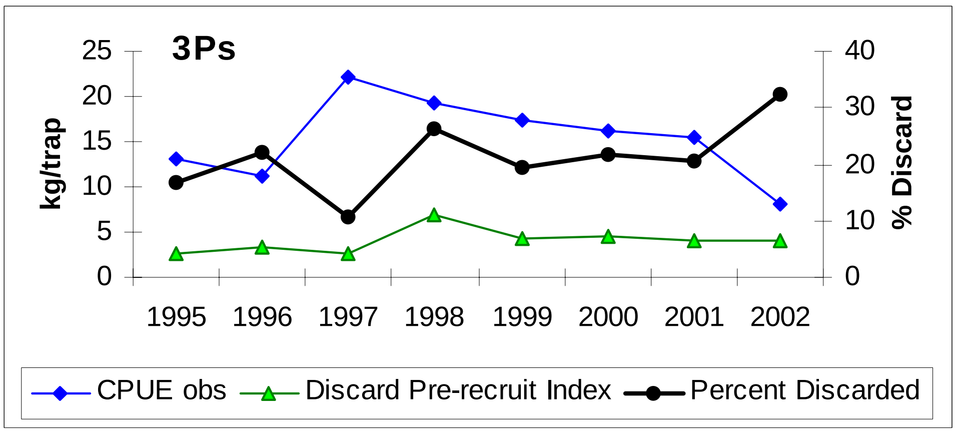


Fig. 46. Annual trends in observer-based CPUE, discard catch rate, and percentage discarded by weight in the Subdivision 3Ps fishery.

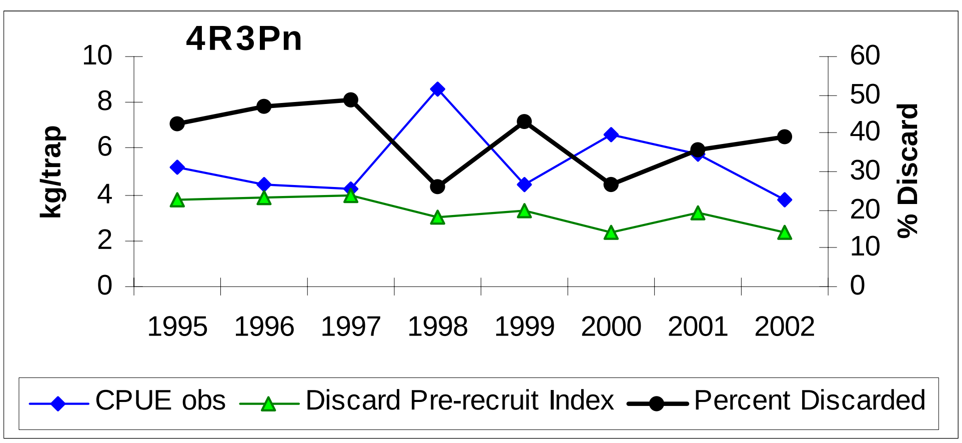


Fig. 47. Annual trends in observer-based CPUE, discard catch rate, and percentage discarded by weight in the Div. 4R3Pn fishery.