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**Région de Terre-Neuve et Labrador**

**An assessment of Newfoundland and Labrador Snow Crab (*Chionoecetes opilio*) in 2009**

**Une évaluation du crabe des neiges (*Chionoecetes opilio*) de Terre-Neuve-et-Labrador en 2009**

E. Dawe, D. Mullowney, D. Stansbury, K. Skanes, E. Hynick, D. Fiander, P. Veitch, E. Colbourne, P. O'Keefe, and D. Maddock-Parsons

Science Branch  
Fisheries and Oceans Canada  
P.O. Box 5667  
St. John's NL A1C 5X1

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**ABSTRACT**

Resource status was evaluated throughout NAFO (Northwest Atlantic Fisheries Organization) Divisions 2HJ3KLNOP4R based on trends in biomass, recruitment and mortality. Multiple indices of these metrics were derived from a suite of data sources that include dockside-monitored landings, fisher logbooks, at-sea observer monitoring, pre-and post-season trawl surveys, broad-scale post-season trap surveys, localized inshore trap surveys, a vessel monitoring system (VMS), and biological sampling data from multiple sources. The resource was assessed separately for offshore and inshore areas of each NAFO division, where appropriate (Div. 3KLP4R). Data availability varied among divisions and between inshore and offshore areas within divisions. The 1995-2009 fall post-season multi-species surveys in Div. 2J3KLNO indicate that the exploitable biomass was highest during 1996-98. The more limited time series (1999-2008) from spring multi-species surveys in Div. 3LNOP also indicated a decline in exploitable biomass in the early years of the surveys. The spring and fall surveys both indicate that the exploitable biomass declined from the late 1990's to 2003-04, but has since increased. Recruitment has recently increased overall due to recovery in the south. Longer-term recruitment prospects are uncertain, but the spring and fall surveys indicate that there has been a decline in abundance indices of smallest males (<60 mm CW) in recent years that may indicate reduced biomass in the long-term. Trends in indices are described in detail for each division and conclusions are presented with respect to the anticipated effects of short term changes in removal levels on fishery induced mortality.

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## RÉSUMÉ

L'état des ressources a été évalué dans l'ensemble des divisions 2HJ3KLNOP4R de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO) en fonction des tendances pour la biomasse, le recrutement et la mortalité. On a obtenu de nombreux indices pour ces mesures à partir d'une série de sources de données qui comprennent les débarquements vérifiés à quai, le journal de bord des pêcheurs, la surveillance en mer par un observateur, les relevés au chalut pré et post-saison, les relevés au casier post-saison à grande échelle, les relevés au casier localisés dans les eaux côtières, un système de surveillance des navires (SSN) et les données d'échantillonnage biologique provenant de plusieurs sources. La ressource a été évaluée séparément pour les eaux côtières et du large des côtes pour chaque division de l'OPANO, le cas échéant (div. 3KLP4R). La disponibilité des données variait parmi les divisions et entre les eaux côtières et du large au sein des divisions. Les relevés plurispécifiques post-saison effectués en automne entre 1995 et 2009 dans la div. 2J3KLNO indiquent que la biomasse exploitable a été la plus élevée entre 1996 et 1998. Les relevés plurispécifiques du printemps pour une série chronologique plus limitée (entre 1999 et 2008) dans la div. 3LNOP indiquaient également un déclin de la biomasse exploitable lors des premières années des relevés. Les relevés du printemps et de l'automne indiquent tous deux que la biomasse exploitable a décliné de la fin des années 1990 jusqu'en 2003-2004, mais a depuis augmenté. Le recrutement a récemment augmenté dans l'ensemble en raison du rétablissement dans le sud. Les perspectives de recrutement à plus long terme sont incertaines, mais les relevés du printemps et de l'automne indiquent qu'il y a eu ces dernières années un déclin des indices d'abondance pour les mâles les plus petits ( $LC < 60$  mm), ce qui peut indiquer une diminution de la biomasse à plus long terme. La tendance des indices est décrite en détail pour chaque division et on présente les conclusions relativement aux effets prévus des changements à court terme des niveaux de prélèvement sur la mortalité due à la pêche.

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## INTRODUCTION

This document serves to assess the status of the snow crab (*Chionoecetes opilio*) resource surrounding Newfoundland and Labrador in NAFO Divisions 2HJ3KLNOP4R. The information presented follows from a formal scientific assessment conducted during February 2010, focused upon determining changes in the exploitable biomass of crabs available to the 2010 fishery (commencing in April 2010), as well as the fisheries of succeeding years.

Snow crab are sexually dimorphic, with males normally achieving larger sizes than females. Exploitable crabs consist of large males that have not molted within the past 6-12 months, as recently molted animals do not yield commercially acceptable meat content. The minimum legal size is 95 mm carapace width (CW); this regulation excludes females from the fishery and ensures a portion of the adult males remain available for reproduction.

Snow crab in Newfoundland and Labrador are part of a larger population in Canadian Atlantic waters, from southern Labrador to the Scotian Shelf (Puebla et al. 2008). However, as movements of individuals within the stock are limited, assessments are conducted at the NAFO Division level with inshore and offshore areas considered separately. This is intended to partially conform with management areas (Fig. 1) while accomodating different types and amounts of available information.

The Newfoundland and Labrador snow crab fishery began in 1967 and was limited to NAFO Div. 3KL until the mid 1980's. It has since expanded throughout Div. 2HJ3KLNOP4R and is prosecuted by several fleets. Management of the increasingly diverse fishery led to the development of many quota-controlled areas with about 3200 licence/permit holders under enterprise allocation in 2009. The fishery is prosecuted using conical baited traps set in long-lines. The minimum legal mesh size is 135 mm to allow small crabs to escape. Under-sized and soft-shelled crabs that are captured in traps are returned to the sea and an unknown proportion of those die.

Data from multi-species bottom trawl surveys, conducted during fall in Div. 2HJ3KLNO, spring in SubDiv. 3Ps, and summer in Div. 4R are examined to provide information on trends in biomass, recruitment, production, and mortality over the time series. Multi-species survey indices are compared with other relevant indices derived from data from fisher logbooks, at-sea observers, vessel monitoring system (VMS), dockside monitoring, and inshore and offshore trap surveys, toward inferring changes in resource status for 2010 and beyond.

The snow crab resource declined during the early 1980's but recovered and remained very large throughout the 1990's. The multi-species trawl surveys indicate that the overall exploitable biomass has recently increased due to recovery in the south (Div. 3LNOPs) while the north (Div. 2HJ3K) has decreased (DFO 2010).

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## METHODOLOGY

### MULTI-SPECIES SURVEY DATA

Data on total catch numbers and weight were derived from multi-species bottom trawl surveys conducted during fall in Div. 2HJ3KLNO, spring in SubDiv. 3Ps, and summer in Div. 4R. The trawl used in these surveys was changed to a Campelen 1800 shrimp trawl in the fall of 1995 (Div. 2HJ3KLNO and Subdiv. 3Ps) and in 2004 (Div. 4R). This trawl proved to be more efficient in sampling crabs than the previously used groundfish trawls. The fall post-season trawl survey was conducted annually in all divisions except in Div. 2H, where it was executed during 1996-99, 2004, 2006 and 2008. Snow crab sampling during spring Subdiv. 3LNOPs surveys did not begin until 1999, and data were available from summer trawl surveys conducted in Div. 4R since 2004. The catchability of the survey trawl differs by season; spring (pre-fishery) trawl surveys are considered to be the least reliable because some population components are relatively poorly sampled during spring when mating and molting take place. The fall trawl surveys are thought to have the highest catchability for snow crabs. In previous assessments survey abundance and biomass indices were calculated based on a set of common strata that were sampled in all years for each seasonal survey and NAFO Division. Due to gradual attrition of common strata over time, a set of "core strata" was selected for this assessment which included strata most consistently sampled throughout the time series. This group of core strata captured strata that were common to most years, especially recent years, and does not include inshore strata or deep (>750 m) slope strata that have not been regularly sampled. For the summer trawl survey in Div. 4R, all strata were used to calculate abundance and biomass indices as that survey has suffered less from the attrition of strata over time, than have the spring and fall trawl surveys. The 2006 Div. 3LNOPs spring survey was incomplete and has been omitted from analyses. In divisions where both a spring and a fall survey are conducted (Div. 3LNO), only data from fall surveys are used in this assessment.

Snow crab catches from each survey set were sorted, weighed and counted by sex. Catches were sampled in their entirety or sub-sampled by sex. Individuals of both sexes were measured in carapace width (CW, mm) and in Div. 2HJ3KLNOP shell condition was assigned one of four categories: (1) soft-shelled – These crabs had recently molted, have a high water content and are not retained in the fishery; (2) new-shelled - these crabs 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; (3) intermediate-shelled – these crab last molted in the previous year and are fully recruited to the fishery throughout the current fishing season; (4) old-shelled – these crab have been available to the fishery for at least 2 years. Males that undergo their terminal molt in the spring will remain new-shelled throughout the fishing 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, in the current year, although it is recognized that some of these males may be retained by the fishery if it extends late into the season. 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, its eventual recruitment is delayed by a year.

Males were also sampled for chela height (CH, 0.1 mm). 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 was applied (Dawe et al. 1997) to classify each individual as either adult (large-clawed) versus adolescent or juvenile (small-clawed). This model is defined as:

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$$CW = 0.0806CH^{1.1999}$$

Maturity status was determined for females and relative fullness and stage of development of egg clutches were assessed. Occurrence of advanced stages of Bitter Crab Disease (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 supported the classification of such specimens as infected.

We examined annual changes in biomass indices of legal-sized males, by shell condition, toward evaluating the internal consistency of the data series. Males enter the legal-size group as soft-shelled crabs, after the spring molt and remain as new-shelled immediate pre-recruits for the duration of the current year's fishery. They begin to contribute to the legal-sized intermediate-shelled group in the following year. Hence we would expect annual changes in biomass to be first seen in soft or new-shelled legal-sized males and to be followed by similar trends in intermediate and subsequently old-shelled males.

Indices were calculated from spring and fall surveys using STRAP (Smith and Somerton 1981), to represent the exploitable biomass and pre-recruit biomass. For spring (pre-season) surveys, these indices represent biomass for the immediately upcoming fishery in the current year whereas for summer and fall (post-season) surveys the indices represent biomass for the fishery in the following year. The exploitable biomass index was calculated as the survey biomass index of adult (large-clawed) legal-sized (>94 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 exploitable biomass index generated from spring survey data includes a component of new-shelled males that would not actually be retained by the fishery in the immediately upcoming fishery but would be fully recruited to the fishery in the following year. The offshore exploitable biomass for Div. 4R was calculated based strictly on size, as data on shell condition and chela height are not recorded during these summer trawl surveys. Stations within inshore Div. 4R and CMA 13 were rejected in calculating biomass indices for offshore Div. 4R.

The pre-recruit biomass 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 surveys, before applying STRAP. The resultant pre-recruit index, from fall surveys, represents a component of legal-sized (>94 mm CW) males that would be recently-molted, (soft or 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 intermediate-shelled males, one additional year later (i.e., 3 years after the fall survey year). The pre-recruit biomass index for Div. 4R was calculated based strictly on size, thus it contains an unknown proportion of sub-legal-sized adult crabs that will never recruit to the fishery.

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 (i.e., trawl efficiency) is lower than 1 and varies with substrate type and crab size (Dawe et al. 2010a). 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). It is assumed that all small-clawed males molt each year. The spatial distribution of pre-recruit and exploitable biomass was examined using catch rates (numbers per tow) for each survey set.

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The ratio of the annual landings to the exploitable biomass index (projected from the fall survey of the previous year) was calculated by NAFO Division to provide an index of exploitation rate. This index overestimates absolute exploitation rate because the survey index underestimates absolute biomass. However, long-term changes in these ratios may be interpreted as reflecting trends in exploitation rate within each Division. It is recognized that annual changes in these ratios may be due to changes in catchability (i.e., trawl efficiency) rather than exploitation rate. However, we feel that long-term trends provide a useful indication of trends in exploitation rates. Inshore commercial catches and data from inshore survey strata in Div. 2HJ3KLNOP were not included in calculating the ratios because inshore survey strata were not surveyed in all years. In Div. 4R, inshore strata have been consistently surveyed in some bays, and the catches from these strata have been removed from offshore indices.

To examine size composition of males, trawl survey catches by carapace width were grouped into 3 mm CW intervals and adjusted up to total population abundance indices. In Div. 2HJ3KLNOP, 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 Division, Policy and Economics Branch, Newfoundland Region of Fisheries and Oceans Canada. 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 fishing practices (eg. soak time and mesh size). Long-term trends in logbook CPUE are presented, as a fishery-based index of trends in biomass, for comparison with other fishery based indices and survey indices.

STRAP analysis was applied to logbook data in a fashion similar to its application to the multi-species survey data to calculate exploitable biomass indices for inshore and offshore regions within each NAFO Division. These indices account for variability in area fished across years. An effective area fished of 0.0053 km<sup>2</sup> (Dawe et al. 1993), analogous to the area swept by a single trawl survey tow, was applied to extrapolate trap catch rates across the total fishing area. All comparisons of indices were conducted separately for inshore and offshore regions of each NAFO Division. The offshore logbook-based exploitable biomass indices were used for comparison with the offshore exploitable biomass indices from multi-species surveys, raw logbook CPUE, and in recent years, post-season trap survey catch rate and biomass indices. Similarly, trends in the inshore logbook-based exploitable biomass indices were compared with raw logbook CPUE, inshore research trap survey catch rates, and trap survey exploitable biomass indices.

The spatial extent of annual fishing effort for inshore and offshore areas of each NAFO Division was calculated from commercial logbooks. Sets were assigned to 5' x 5' cells based on logbook coordinates. The annual ratio of the total number of cells with fishing effort ( $\geq 1$  set) to the total number of cells in each area was used as an index of spatial expansion or contraction and compared with trends in fishery CPUE.

To investigate the possible effect of thermal regime on snow crab production or early survival we compared CPUE with lagged (lag of best fit) temperature indices for each of Divisions 2J, 3K, 3L, and Subdivision 3Ps. CPUE was a divisional index, generated from pooled inshore and offshore logbook data. We used two indices of thermal regime, bottom temperature and area of the CIL (Cold Intermediate Layer). Bottom temperatures used for NAFO Div. 3K and 3L were annual mean bottom temperatures from Station 27, located 10 nm off St. John's. Bottom temperatures used for Div. 2J and SubDiv. 3Ps were mean temperatures from bottom trawl survey sets, collected using a trawl-mounted CTD system. Only data from shallow-water sets (<200 m) were used because



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settlement and early benthic stages occur on shallow banks (Dawe and Colbourne 2002). Mean bottom temperatures for Div. 2J were derived using data from fall surveys, whereas those from SubDiv. 3Ps were derived using data from spring surveys. Area of the CIL was the cross-sectional area of the water column occupied by temperatures of <0 °C from oceanographic transects extending across the continental shelf (Colbourne et al. 2010), representing Div. 2J (Hamilton Bank Section), 3K (Bonavista Section) and 3L (Grand Bank Section).

## **OBSERVER CATCH-EFFORT DATA**

Set and catch data were available from the Observer Program for the same time series as those from the multispecies surveys (1995-2009), but at-sea sampling data have only been collected since 1999. Levels of sampling have increased in Div. 3KLNO in recent years due to increased observer coverage in offshore areas (Fig. 2). Sampling has been consistently low in inshore crab management areas and throughout Divisions 2H and 4R.

The observer set-and-catch database included details about number of traps, landed catch (kg) and discarded catch (kg) for each set observed. An observer-based CPUE index (kg. landed/trap haul) was calculated for comparison with inshore and offshore logbook CPUE.

For offshore areas, a pre-recruit fishing mortality index (PFMI) was developed based on the ratio of the observed catch rate of pre-recruits discarded in the fishery to the preceding trawl survey biomass index of pre-recruits. This index is defined as;

$$PFMI = S \left( \frac{DPI_t}{PBI_{t-1}} \right)$$

where DPI is the catch rate (kg/trap haul) of undersized and soft-shelled pre-recruits (and undersized adult males) discarded in the fishery, in year t, calculated from observer data. PBI is an index of the biomass of pre-recruits (and undersized adult males) (t x 1000) from the preceding survey; ie. the fall survey of the previous year for Div. 2HJ3KLNO or the spring survey of the same year for SubDiv. 3Ps. S is a scaling factor to account for incomplete and annually variable levels of observer coverage, defined as:

$$S = \frac{\textit{Total Landings}}{\textit{Observed Landings}}$$

The PFMI overestimates pre-recruit mortality because the PBI underestimates pre-recruit biomass, as a result of low catchability of pre-recruits by the survey trawl. However we feel that long-term trends in this index provide a useful indication of trends in pre-recruit mortality. In both inshore and offshore areas, the percent discarded (by weight) is viewed as an index of wastage in the fishery. It provides an indication of the level of wastage associated with catching and releasing pre-recruits in the fishery, and is not necessarily proportional to the mortality rate on the pre-recruit population.

Data were also examined from at-sea biological sampling by observers. Entire trap catches of males were sampled for carapace width (mm) and shell condition. Shell condition categories differed slightly from those described above for trawl surveys, in that categories of crabs not recently molted (intermediate-shelled and old-shelled in trawl surveys) were pooled into a single category. These biological sampling data were used to identify specific categories of discards (ie 'undersized' and 'soft' legal-sized) for comparison with total discards from observer set-and-catch data. Also, seasonal trends in the percentage of soft-shelled crabs were described. Discarding is believed to impose a high mortality on recently-molted (especially 'soft') immediate pre-recruits. A

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soft-shell protocol was implemented in 2004 to close specific small fishing areas when the percentage of soft-shell crab reached 20 %.

## **VESSEL MONITORING SYSTEM (VMS) AND DOCKSIDE MONITORING PROGRAM (DMP) DATA**

Data on hourly vessel positions (VMS) and landed catch (DMP) were obtained and examined, for offshore areas only (Fig. 1), from the Fisheries Management Branch and the Policy and Economics Branch, Statistics Division, Newfoundland Region of Fisheries and Oceans Canada. These datasets were merged based on vessel registration number (VRN), year, month, and day. A CPUE index (kg/fishing hr.) was calculated by year and NAFO Division, as described by Mullaney and Dawe (2009). Fishing hours were screened based on location and speed from hourly positional signals. Signals occurring at 0.1–3.0 knot speeds were accepted as fishing signals. The VMS dataset consisted of a short (six-year) time series and was limited to offshore fishing fleets.

VMS-based CPUE is used as an index of biomass, but it is unstandardized in that it does not account for variation in fishing practices (eg. soak time and vessel drift) (Mullaney and Dawe 2009). Trends in VMS-based CPUE are presented as a fishery-based index of trends in biomass for offshore areas and compared with commercial logbook and observer-based CPUE indices.

## **TRAP SURVEYS**

Data were available from an inshore Div. 3K trapping survey that was carried out in White Bay and Notre Dame Bay during 1994-2009. There were no surveys in either bay in 2001, and no survey was conducted in Notre Dame Bay in 2009. The survey has consistently occurred in September and occupies 5 of the inshore fall multi-species survey strata 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) of legal-sized males were calculated by shell category (new-shelled recently-molted versus older-shelled), and size distributions were described by claw type (small-clawed juveniles plus adolescents versus large-clawed adults). Mortality was also inferred from levels of BCD observed in these surveys.

Data were also available from two inshore trap surveys (1979-2009) within Div. 3L. These surveys were conducted in different seasons; summer (Bonavista Bay), and fall (Conception Bay). These surveys utilized traps of various mesh sizes for each set, including two small meshed (27 mm) traps. For each survey series, catch rate indices and size distributions were produced as described above for the inshore Div. 3K trapping surveys, and prevalence of BCD was noted.

Data were examined from industry-DFO Collaborative Post-Season (CPS) trap surveys in Div. 2J3KLOPs4R (Fig. 3). These surveys, funded by the Fisheries Science Collaborative Program (FSCP), were examined for the first time in 2006 (Dawe et al. 2008a). They were initiated following the 2003 fishery and have been conducted annually thereafter, beginning Sept. 1st each year. The surveys, conducted by snow crab harvesters accompanied by at-sea observers, focus on commercial fishing grounds within individual CMAs. Survey stations are fixed and generally follow a grid pattern, with maximum station spacing of 5' X 5' (Fig. 3). At each station, 6 (inshore) or 10 (offshore) commercial (135 mm mesh) crab traps are set in a fleet. All crab caught are sexed and counted. Biological sampling of male crab is conducted at-sea, by observers, from two traps at each station. Sampling includes determination of carapace width, shell condition, leg loss and presence of BCD. Small-mesh traps are included at selected stations to collect information on pre-recruits and females.

The CPS trap survey is more spatially limited than the trawl surveys, as it targets only portions of commercial fishing grounds. Stations selected from this survey were changed from common

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stations to a set of core stations (Fig. 3) in the present assessment, due to gradual attrition of common stations. Biomass indices derived from this survey were based on the same stratification scheme as those from the trawl surveys. For the present assessment, strata were chosen to best conform with commercial fishing areas in inshore or offshore zones of each division (Fig. 1). Exploitable and pre-recruit biomass indices were calculated from trap survey catch rates using the method described for the calculation of logbook-derived estimates; ie. using the estimated effective fishing area of a trap to spatially extrapolate catch rates across the entire fishing area. The pre-recruit biomass index is somewhat biased in that it includes undersized adults that will never recruit to the fishery. In the inshore of Div. 3KLPs, exploitation rates were calculated using the ratio of landings to the trap survey-based exploitable biomass estimates of the previous year.

## RESULTS AND DISCUSSION

### THE FISHERY

The fishery began in Trinity Bay (Management area 6A, Fig.1) in 1967. Initially, crabs 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 from 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 1982-87, there were major declines in the resource in traditional areas of 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. Commercial snow crab fisheries began in Div. 4R in 1993 and in Div. 2H in 2004.

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 and exploratory licences in the offshore were converted to full-time licences in 2008. There are now several fleet sectors and about 3200 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. Mandatory use of the electronic vessel monitoring system (VMS) was fully implemented in all offshore fleets in 2004, to ensure compliance with fishing area regulations.

The fishery was delayed in northern divisions (Div. 2J and 3K) in 2009 due to severe ice conditions. Late fishing seasons are believed to contribute to a high incidence of soft-shelled immediate pre-recruits in the catch. Such severe ice conditions can affect the spatial distribution of fishing effort and fishery performance.

Landings for Div. 2HJ3KLNOP4R (Table 1, Fig. 4) increased steadily from 1989 to peak at 69,100 t in 1999, largely due to expansion of the fishery to offshore areas. They decreased by 20 % to 55,400 t in 2000 and changed little until they decreased to 44,000 t in 2005, primarily due to a sharp decrease in Div. 3K where the TAC was not taken. Landings increased by 22 % since 2005 to 53,500 t in 2009, due primarily to increases in Div. 3K. Historically, most of the landings have been from Div. 3KL.

Effort, as indicated by estimated trap hauls, 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 entering into the fishery. Effort has been broadly distributed in recent years (Fig. 5), but there has been a reduction in effort along the shelf slope in Div. 2J3KNOPs since 2003 (Dawe et al. 2004). Since 2007 there has been little effort along the shelf edge of Div. 3O (Dawe et al. 2009), while effort increased greatly in offshore Div. 3K from

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2008 to 2009 (Fig. 5), and effort in inshore areas of 4R has become increasingly contracted and highly aggregated in recent years .

## **DIVISION 2HJ3KLNOs**

### **Spatial distribution from fall multi-species surveys (Div. 2HJ3KLNO)**

The fall distribution of exploitable males (legal-sized adults, Fig. 6) as well as immediate pre-recruits (>75 mm adolescents, Fig. 7) throughout NAFO Div. 2HJ3KLNO in 2009 was generally similar to the distribution pattern observed throughout 1997-2008, as previously described (Dawe et al. 2009, Dawe and Colbourne 2002) with some exceptions. Large males have consistently been virtually absent over a broad area of the shallow (<100m) southern Grand Bank throughout the time series. The abundance of largest males (Fig. 6) has decreased in the northernmost areas (Div. 2J3K) since 2007, while increases occurred in the southernmost areas (Div. 3LNO). Survey catch rates of pre-recruit males (Fig. 7) in 2009 were generally similar to those in 2008, having increased greatly in the southern Divisions (Div. 3LNO) while remaining unchanged in the northern Divisions (Div. 2J3K) since 2007.

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 of 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**

The multi-species trawl surveys indicate that the exploitable biomass declined from the late 1990's to 2003-04, but has since increased. The fall post-season surveys in Div. 2HJ3KLNO (Fig. 8) indicate that the exploitable biomass was highest during 1996-98. The more limited time series from spring multi-species surveys in Div. 3LNOPs (Fig. 9) also indicated a decline in exploitable biomass in the early years of the surveys. The spring and fall surveys both showed decreases in the exploitable biomass indices from 2001 to 2003-04, with little change until the fall index increased in 2007. Most of the increase was due to recovery in the south (Div. 3LNOPs) while the north (Div. 2HJ3K) has decreased, as reflected in the divisional trends. There has been little change overall in both spring and fall indices over the past 3 years.

### **Recruitment**

Recruitment has recently increased overall (Figs. 8-9). The survey abundance and biomass indices of pre-recruits have been increasing since 2005 due to increases in the south (Div. 3LNOPs). Longer-term recruitment prospects are uncertain but the spring and fall surveys indicate that there has been a decline in abundance indices of smallest males (<40 mm CW) that may indicate reduced biomass in the long term (Figs. 10-13). This index for smallest males has been relatively low since 2004.

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 surveys, whereas the pre-recruit index includes a large component of males that were adolescents as small as 76 mm CW during the surveys. 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,

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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.

Low bottom temperatures promote terminal molt at small sizes in snow crab, resulting in relatively low recruitment from a given year class (unpublished data). However recruitment is more strongly affected by the positive effects of a cold regime on year class production than it is on the negative effects of a cold regime on size-at-terminal molt. Negative relationships between bottom temperature and snow crab CPUE have been demonstrated at lags of 6-10 years (Dawe et al. 2005, 2008b) suggesting that cold conditions early in the life history are associated with the production of strong year classes and subsequent strong recruitment. 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. A warm oceanographic regime has persisted over the past decade (Colbourne et al. 2010) implying poor long-term recruitment prospects.

### **Mortality**

BCD has been observed in snow crab, based on macroscopic observations, at low levels throughout 1996-2009. 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).

There had been a broadly-distributed incidence of BCD during 1996-2006, but the distribution became limited to localized aggregations, primarily to Div. 3K and 3L in 2007 (Fig. 14). In 2008, BCD prevalence increased in offshore portions of Div. 2J and Div. 3K, but was virtually absent across most of the survey area in 2009. This disease, which is fatal to crabs, primarily occurs in new-shelled crab of both sexes and appears to be acquired during molting (Dawe 2002).

It is unknown how well apparent disease prevalence in trawl-caught samples represents true prevalence in the population, as diagnosis has been based on recognition of external characteristics in chronic cases. It seems likely that our observations underestimate true prevalence. Prevalence levels in the population appear to be directly related to the density of small to intermediate-sized crabs. Therefore, BCD-induced mortality may moderate initially strong year classes before they recruit to the fishery (Mullowney et al. 2011)

## **DIVISION 2H**

### **The fishery**

There have been exploratory fisheries in Div. 2H since the mid 1990's. A commercial TAC was first established in 2008, and maintained in 2009, at 100 t (Table 2, Fig. 15). Landings increased from 70 to 190 t during 2005-07. They subsequently declined by 53 % to 90 t in 2009, while effort decreased by 24 %.

Prior to becoming commercial, the exploratory fisheries in Div. 2H had been concentrated along the slope edge, east of the Makkovik Bank, as it was during 2006-07 (Fig. 16). However, in 2008 there was a shift with much of the effort occurring west of the Makkovik Bank and closer to shore in the southern portion of the division. Logbook data for 2009 are incomplete, and do not reflect effort that occurred in this near-shore area.

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The fishery has occurred earlier during the past four years than it did in 2005 (Fig. 17). The 2009 fishery began in late June and was complete by mid August. The timing of the fishery in this division is heavily influenced by ice conditions each year.

### **Biomass**

Logbook catch rates (CPUE) were variable and sporadic from 1995-2003, likely reflecting low levels of fishing activity (Dawe et al. 2010b). CPUE increased steadily from 2004 to 2006 (Fig. 18) as total effort increased. CPUE has gradually declined since the 2006 peak, approximating the long-term average in 2009. In 2008, highest catch rates occurred west of the Makkovik Bank in a previously un-fished area (Fig. 16). Unfortunately however, there were no set locations in this area captured in the logbooks in 2009. Offshore CPUE was at a lower level in 2008-2009 than during 2006-07 (Fig. 16). The VMS CPUE index agrees with the logbook index, increasing from 2004 to a peak in 2006, and declining since (Fig. 19).

Since 2005, weekly catch rates have been highly variable in this fishery. However, there is a tendency for CPUE to peak near the middle of the season each year (Fig. 20a). These peak catch rates have occurred after about 40–60 t of removals each year (Fig. 20b).

The exploitable biomass decreased in recent years. The post-season trawl survey exploitable biomass index doubled between 2004 and 2006, but then decreased by 66 % to 2008 (Table 3, Fig. 21). There was no survey in 2009. This recent decline in biomass is consistent with trends observed in the logbook and VMS CPUE indices (Fig. 19).

### **Production**

Recruitment: Recruitment has decreased since 2004 and is expected to be low over the next several years. We examined annual changes in biomass indices of legal-sized males from fall multi-species surveys, by shell condition (Fig. 22), toward evaluating the internal consistency of the data series. Males enter the legal-size group as soft-shelled crabs, after the spring molt, and they begin to contribute to the legal intermediate-shelled group in the following year. Since 2004, new-shelled crabs have dominated the legal-sized population component, suggesting the fishery has been highly dependent upon immediate recruitment.

Size compositions from fall multi-species surveys (Fig. 23) show a clear pattern of modal progression since 2004. A group of large adolescents at about 72-102 mm CW in 2004 were present as legal-sized new-shelled adults in 2006 (Fig. 24). This group of legal-sized crabs was greatly diminished in 2008, with few sub-legal sized crabs captured in the survey. The post-season trawl survey pre-recruit index decreased greatly between 2004 and 2008 (Table 4, Fig. 25); therefore, short-term recruitment is expected to be low.

### **Mortality**

Exploitation: There are no data for 2009 that could be used to predict effects of changes in harvest level on mortality.

## **DIVISION 2J**

### **The fishery**

Landings (Table 5, Fig. 26) peaked in 1999 at 5,420 t, decreased sharply to 3,680 t in 2000 and changed little to 2002, before declining to 2005. They increased by 60 % from 1,500 t in 2005 to 2,410 t in 2008. Effort increased from 2000 to a record high level in 2002-04. It decreased sharply in 2005 and further declined by 18 % to 2008. Landings were virtually unchanged at

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2,300 in 2009 while effort increased by 27 %. Commercial CPUE has oscillated over the time series (Table 5, Fig. 27).

The 2009 fishery was concentrated in Hawke and Cartwright Channels, similar to 2006-08 (Fig. 28). In 2006-08 there was no fishery along the slope edge as there was in earlier years.

The fishery began in late May in 2005, 2006, and 2008, with the bulk of effort expended by the end of June in those years (Fig. 29). However, in 2007 and 2009, the fishery did not commence until early June with more effort extending into the latter parts of July. Among other factors, annual ice conditions can affect the fishery timing in this division, such as occurred in 2009 when severe ice conditions delayed the fishery.

### **Effect of ocean climate variability**

Since the early 1980's, commercial CPUE in Div. 2J has been inversely related to bottom temperature (Fig. 30) and positively related to areal extent of the cold intermediate layer (CIL, Fig. 31) at seven-year lags. Since 2004 however, the relationships have deteriorated, as CPUE has increased in most years while the lagged bottom temperature has remained high and the lagged areal extent of the CIL has been low in most years. This improvement in fishery performance, particularly 2004 to 2008, is not entirely due to change in the exploitable biomass, but also reflects the reduction in fishery removals during 1999-2005 (Fig. 26), a general trend toward earlier fishing seasons since 2003 (Dawe et al. 2010b), and reduced fishing effort since 2004 (Fig. 26), which jointly resulted in reduced fishing mortality on soft-shelled pre-recruits.

### **Biomass**

Commercial catch rate (CPUE) has oscillated over the time series (Table 5, Fig. 27). Initially decreasing from 1991-95, and increasing to a peak in 1998. It declined steadily by 76 % from 1998 to a record low level in 2004. It increased steadily 2004 to 2008 to the long-term average, but decreased in 2009. The increase in CPUE from 2004 to 2008 was attributable to improved catch rates in and around Cartwright Channel in the north and Hawke Channel in the south (Fig. 28). Similarly, decreases in CPUE occurred in both areas in 2009.

The commercial logbook, observer, and VMS CPUE indices all increased from 2004-07 (Fig. 32). However the observer and VMS indices declined in 2008 while logbook CPUE increased. All CPUE indices declined in 2009. Differences between CPUE indices could be related to a greater contribution by small vessels to the logbook datasets than to the other datasets. VMS is exclusive to larger, offshore vessels and observer coverage is generally higher on larger vessels.

The spatial coverage of the fishery has been inversely related to commercial CPUE (Fig. 33). The percentage of available 5' x 5' cells occupied by the fishery declined abruptly from its highest level of 19 % in 2004 to its lowest level of 8 % in 2006 and has gradually increased since. The inverse relationship between spatial coverage of the fishery and commercial CPUE could be a function of fisher searching behaviour. It is likely that some fishers will search for new or alternate fishing grounds when catch rates are low or in decline. Conversely, when catch rates are high, there would be little need to search for alternate fishing grounds.

Seasonal trends in commercial logbook CPUE indicated that initial (week 9) CPUE in 2009 was comparable to initial (week 7) CPUE in the previous two years (Fig. 34a). However CPUE declined sharply throughout the season in 2009 such that mid- to late-season CPUE was considerably lower than in the previous two years. Trends in relation to cumulative catch

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(Fig. 34b) indicated that near the end of the season 2009 CPUE was much lower than that in 2007 and 2008, marginally lower than that in 2006, but higher than that in 2005.

Trends in the logbook-based mean catch rate from the STRAP analysis (Fig. 35) reflected raw logbook CPUE, increasing steadily from 2004 to 2008 and decreasing sharply in 2009. These trends were consistent in both the common strata (strata fished in all years) and all strata (all strata fished in each year) analyses, indicating that differences in strata selected were inconsequential and had little effect on total area surveyed.

Size distributions from at-sea sampling by observers (Fig. 36) showed decreasing catch rates of legal-sized males from 1999 to 2004 (Dawe et al. 2010b), reflecting the trend in CPUE (Fig. 27). Modal CW increased from about 92 mm in 2004 to about 101 mm in 2005, and subsequently to 110 mm in 2008 with an overall increase in abundance of legal-sized animals, reflecting an increase in the exploitable biomass as members of a recruitment pulse molted and grew to large sizes. The primary mode remained at 110 mm in 2009, but abundance of most sizes was marginally lower than in 2008.

The increase in observer catch rate of legal-sized males in 2006 was due to an increase in catch rate of old-shelled crabs (Fig. 37). Further increase in catch rate in 2007-08 was due to a sharp increase in new-hard-shelled crabs, while the catch rate of old-shelled crabs decreased sharply (Fig. 37). This suggests some inconsistency in shell condition classification because an increase in abundance of old-shelled crabs should be preceded by an increase in new-hard-shelled crabs. In 2009, catch rates of both new and old-hard shelled legal-sized crabs decreased. This would not be expected, as catch rates of old-hard shelled crabs should have increased in 2009, following the increase in catch rate of new-hard shelled crab in 2007 and 2008. Shell condition classification is highly subjective and the 3-stage scale used by observers (since 2000) is one that includes the intermediate-shell stage (of the 4-stage scale used during surveys) with the old-shell stage. When the new-hard and old-shelled categories from at-sea sampling are pooled, their combined catch rate agrees well with observed CPUE for most of the time series (Fig. 37). It is unclear to what extent this reflects misclassification of some new-hard-shelled crabs (shell 2) as old-shelled (shell 3) crabs versus retention of some new-hard-shelled crabs by the fishery.

The exploitable biomass has decreased in recent years. The post-season trawl survey exploitable biomass index (Table 6, Fig. 38) decreased steadily by 92 %, from 1998 to 2002. It increased from 2002 to peak in 2006 but remained below pre-2002 levels. It has since declined steadily to 2009. The post-season trap survey index declined sharply from 2007 to 2009 (Fig. 38). However, that index reflects only the southern portion of the division. The increase in the fall survey exploitable biomass index from 2002 to 2006, was small relative to the increase in CPUE indices (Fig. 27). This reflects effects of recent changes in the fishery on fishery performance (CPUE) as described earlier.

The CPS trap survey catch rates of legal-sized crabs decreased markedly from 2007 to 2009 (Fig. 38), with the decline first occurring in new-shelled crabs in 2008, and subsequently in old-shelled crabs in 2009 (Fig. 39).

## **Production**

**Recruitment:** Recruitment has been in decline since 2006 as reflected by the decline in exploitable biomass while landings changed little. Recruitment is expected to remain low in 2010, as reflected by the continued decline in the post-season trawl survey biomass index of legal-sized new-shelled adults to 2009 (Fig. 40). Males enter the legal-size group as soft-shelled crabs, after the spring molt, and they begin to contribute to the legal intermediate-shelled group



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in the following year. Trends in the biomass index by shell condition reflect this process, in that the biomass of new-hard-shelled males peaked in 1997-98 whereas that of intermediate-shelled males peaked in 1998-99. The biomass index of new-hard-shelled males dropped sharply in 1999, whereas biomass of intermediate-shelled crabs declined steadily during 2000-02. The biomass of new-hard-shelled crabs increased steadily from 2002 to 2006 while the biomass of older-shelled crabs remained low. This suggests that the fishery has been highly dependent upon immediate recruitment.

The size compositions from the post-season trap survey (Fig. 41) show a decrease in catch rate throughout most of the size range of sub-legal and legal-sized crabs from 2007 to 2009; most prominent in new-shelled males. The size compositions from fall multi-species surveys (Fig. 42) are examined with the abundance index (ordinate) truncated for smallest males (<50 mm CW), so as to focus on trends in abundance for larger males. The survey data indicate that most of the relatively abundant sub-legal sized adolescent males evident in 2004 achieved legal size in 2005-07, and the abundance of most sizes of legal-sized crabs has since declined. The size distributions (Fig. 42) suggest that indices of smallest males (<50 mm CW) increased during 1999-2001 and remained at a very low level until 2006, before increasing to 2008 and decreasing slightly in 2009. A modal group of 75-92 mm CW pre-recruits in 2004 that progressed into the exploitable biomass during 2005-09 may have been derived from the large modal group of smallest males (<50 mm CW) males in 2001, but there has been no clear evidence of modal progression over the time series. Therefore, long-term recruitment prospects are uncertain. However declining abundance of smallest males during 2003-06 (Fig. 42), together with the persistence of a warm oceanographic regime (Fig. 30), may suggest relatively poor recruitment prospects in the long-term.

The catch rates of sub-legal sized crabs changed little in observer samples since 2007 while total discards decreased substantially in 2008 and remained low in 2009 (Fig. 43), implying a relatively low incidence of discards of soft-shelled crabs in 2008-09.

Recruitment is expected to change little in the short term following 2010. The fall survey pre-recruit index decreased from 1998 to a lower level during 1999-2003 (Table 7, Fig. 44) before increasing sharply to a peak in 2004. It decreased sharply in 2005 and has since fluctuated without trend. The catch rate of under-sized crabs in the post-season trap survey (in the southern portion of the division) decreased 2007-09 (Fig. 44).

Reproduction: The percentage of mature females carrying full clutches of viable eggs (Fig. 45) has varied over the time series, but consistently remained above 75 %, including in the two most recent years. It is unknown to what extent changes in fecundity affect subsequent abundance of settling megalopae.

### **Mortality**

Exploitation: The exploitation rate index declined sharply from 2003 to 2005 (Fig. 46). It continued to decline to 2007 before increasing to 2009. Maintaining the current level of fishery removals while biomass is declining will result in an increase in the exploitation rate in 2010.

Indirect fishing mortality: The pre-recruit fishing mortality index declined sharply from 2003 to 2005 and has remained low since that time (Fig. 46). The percentage of the total catch discarded (Fig. 46) increased from 2001 to a record high level in 2004. It then declined sharply to its lowest level in 2008, implying reduced wastage of under-sized and new-shelled pre-recruits in the fishery. It increased in 2009 to remain relatively low, at about the 1999-2001 level.

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Snow crabs that are caught and released as under-sized or legal-sized soft-shelled males in the fishery are subject to multiple stresses and have unknown survival rates. Time out of water, air temperature, water temperature and shell hardness all influence the mortality level on discarded snow crab (Miller 1977). Other environmental factors such as wind speed, sunlight and size of the crab may also influence survivability (Dufour et al. 1997). Poor handling practices such as prolonged exposure on deck, dropping or throwing crab, as well as inducing limb loss cause increased mortality levels associated with catching and discarding crabs. Recently-molted (soft-shelled) snow crab are subject to more damage and mortality than hard-shelled crab (Miller 1977; Dufour et al. 1997).

Overall, the catch rate of undersized and new-shelled legal-sized crabs discarded in the fishery (Fig. 46) declined sharply from 2004 to 2006 and has since remained relatively low. This implies little wastage of pre-recruit crabs in the 2006-09 fisheries. Due to low levels of observer coverage in this area and seasonal inconsistency among years (Fig. 47) it is not possible to infer annual changes in the percentage of soft-shelled crabs in the fishery.

An area of Hawke Channel (Fig. 28) has been closed to all fisheries except snow crab from 2003 to 2009. CPUE has trended similarly inside and outside the closed area since it's inception (Fig. 48). This implies that other fisheries that do not target snow crab do not represent a major source of snow crab mortality.

Natural mortality; (BCD): BCD occurs almost exclusively in recently-molted crabs (Dawe 2002). BCD in Div. 2J males (Fig. 49) has been most prevalent in small new-shelled crabs of 40-59 mm CW. Prevalence, in new-shelled crabs has generally been low in this area, usually about 2-3 percent occurrence for that size range, excepting 1999 and 2008, when 18 % and 16 % of new-shelled adolescents in that size group were visibly infected. BCD was virtually absent from Div. 2J from 2006 to 2007 and has since increased to remain at the generally low level typical of this area during the past two years.

## **DIVISION 3K**

### **The fishery**

Offshore landings (Table 8, Fig. 50) have generally been higher than inshore landings by a factor of 3-5 (Fig. 50). Offshore landings peaked in 1999 at 17,900 t. They decreased to about 13,000 t in 2000-2004, due to a reduction in the TAC. They decreased sharply in 2005 when the TAC was not fully subscribed because the fishery was closed due to high levels of soft-shelled crabs in the catch (Dawe et al. 2006). Landings more than doubled since 2005 to 13,000 t in 2009. Meanwhile effort declined sharply in 2005 and changed little until it increased by 70 % in 2009. Landings and effort have returned to pre-2005 levels.

Inshore landings (Table 8, Fig. 50) peaked in 1999 at 3,460 t and decreased sharply in 2000 due to a TAC reduction. They increased to 3,340 t in 2003, changed little in 2004, and decreased by 21 % in 2005. Landings increased by 33 % from 2,700 t in 2005 to 3,600 t in 2009. Effort declined from 2004 to 2008 and increased by 42 % in 2009.

Commercial CPUE (Table 4, Fig 51) indicates deterioration of fishery performance in both inshore and offshore areas in 2009. Inshore CPUE has been consistently lower than offshore CPUE. Both offshore and inshore CPUE increased sharply from 2005 to record high levels in 2008 before decreasing in 2009.

Spatially, decreases in CPUE occurred throughout the Division in 2009 (Fig. 52). The level of fishing effort was greatly increased in most areas, and the spatial extent of the fishery

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increased, most notable in the offshore where much of the Funk Island Deep was occupied by the fishery, as it was in 2004. The large increase in offshore fishing effort and decrease in CPUE in 2009 may have been partly due to severe ice conditions early in the fishery and grid closures due to application of the soft-shelled protocol, which altered the spatial distribution of effort and adversely affected fishery performance. These factors may have also contributed to the spatial expansion of fishing effort evident in 2009, and extension to depths greater than those usually fished.

The offshore fishery has occurred later in recent years than it did in 2005-06 (Fig. 53a). These delays are primarily attributable to unfavourable ice conditions off the northeast coast of Newfoundland in the spring of recent years. Despite this, the fishery progressed fairly rapidly in both 2008 and 2009, with most of the total effort expended by weeks 11 and 13 respectively. The timing of the inshore fishery was generally similar to that offshore, with the exception of a more delayed start inshore in 2007 due to severe spring ice conditions (Fig. 53b). The 2009 inshore fishery was late starting relative to previous years (excepting 2007), but as in the offshore, the fishery progressed fairly rapidly with most of the total effort expended by week 15.

### **Effect of ocean climate variability**

Divisional commercial CPUE (inshore and offshore combined) was inversely related to bottom temperature (at Station 27) and positively related to areal extent of the CIL at an eight year lag, since the early 1980's (Figs. 54-55). However, from 2006 to 2008 CPUE increased to a very high level while bottom temperature has remained high and the spatial extent of the CIL has remained low. This improvement in fishery performance is not entirely due to change in the exploitable biomass, but is also partly due to the reduction in fishery removals during 2005-07 (Fig. 50), and a trend toward earlier fishing seasons in those years (Dawe et al 2009).

## **DIVISION 3K OFFSHORE**

### **Biomass**

The commercial logbook, observer, and VMS CPUE indices all decreased sharply in 2009, following increases from since 2005 (Fig. 56). The spatial coverage of the fishery has been inversely related to commercial CPUE since 1995 (Fig. 57). The percentage of available 5' x 5' cells occupied by the fishery increased abruptly in 2009, exceeding 40 % for the first time since 2004.

Commercial logbook CPUE was lower throughout the season in 2009 than during the previous two years. Weekly trends in CPUE showed a general pattern of depletion each year (Fig. 58a), and were at their highest level in 2007 and 2008. CPUE relative to fishery removals showed a large decrease in fishery performance in 2009 (Fig. 58b).

Trends in the logbook-based mean catch rate from the STRAP analysis (Fig. 59) reflected raw logbook CPUE, decreasing abruptly in 2009. These trends were consistent in both the common strata (strata fished in all years) and all strata (all strata fished in a given year) analyses, indicating that differences in method of stratum selection had little effect on the total area surveyed.

Size distributions from at-sea sampling by observers (Fig. 60) show that modal CW has not changed since 2004. Catch rates of most sizes of legal-sized older-shelled animals increased progressively from 2004 to 2007-08, but decreased in 2009. Catch rates of legal-sized new-hard-shelled crabs increased in 2008, before decreasing in 2009 (Fig. 61). Trends in catch rates

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of new-hard and old-shelled legal-sized crabs, when combined, have agreed well with observed CPUE since 1999 (Fig. 61).

The exploitable biomass decreased substantially since 2007, as indicated by both post-season surveys. The post-season trawl survey exploitable biomass index (Table 9, Fig. 62) decreased from its highest level in the late 1990's to its lowest in 2003 before increasing to 2007. The post-season trap survey exploitable biomass index increased in 2006 (Fig. 62). Both indices remained high to 2008 and decreased sharply in 2009.

## **Production**

**Recruitment:** Recruitment decreased in 2009, as reflected by the sharp decrease in the post-season exploitable biomass indices while landings increased little. Recruitment is expected to decrease further in 2010, as reflected by a decrease in biomass indices of legal-sized new-shelled adults in both 2009 post-season surveys (Figs. 63-64). The decrease in recruitment for 2010 is believed to be largely due to high mortality on soft-shelled immediate pre-recruits in the 2009 fishery. The delayed season in 2009 likely contributed to the high incidence of soft-shelled crab in the fishery. Also, the expansion of effort across a broad depth range resulted in greater exposure of soft-shelled immediate pre-recruits to the fishery in 2009 than in previous years.

Size distributions from the CPS survey (Fig. 65) showed little change in modal size since 2005, remaining at 110-113 mm CW. Catch rates decreased across most sizes in 2009, most apparent in legal-sized new-shelled crabs.

Catch rates of most sizes of adolescent and adult males were lower in the 2009 multi-species trawl survey than in 2008 (Fig. 66). A substantial portion of a modal group of adolescents at about 40-60 mm CW in 2006 and 50-80 mm CW in 2007 terminally molted in 2008 (Fig. 66). This likely contributed further to the reduction in recruitment potential for 2010. Longer-term recruitment prospects are uncertain. However relatively low abundance of smallest males (<50 mm CW) in the surveys since 2003 (Fig. 66), together with the persistence of a warm oceanographic regime (Figs. 54-55), suggest relatively poor recruitment prospects in the long term.

The observed catch rates of under-sized crabs closely matched the catch rates of total discards for the fourth consecutive year in 2009 (Fig. 67), implying that most of the discarded catch was comprised of under-sized crabs. This contrasts with 2004 and 2005 when catch rates were much higher for total discards than for under-sized crabs, which implied high prevalence of soft-shelled crabs. Catch rates of undersized crabs have increased marginally since 2006. A sharp increase in total discards relative to undersized crabs in 2009 (Fig. 67) implies an increase in soft-shelled crabs.

The post-season trawl survey pre-recruit index (Table 10, Fig. 68) recently peaked in 2006 and has since fluctuated without trend. The post-season trap survey catch rate of undersized crabs has fluctuated throughout its limited time series (Fig. 68). Recruitment remains uncertain in the short term following 2010.

**Reproduction:** The percentage of mature females carrying full clutches of viable eggs (Fig. 69) varied at a high level from 1995-2004, exceeding 80 % in all years but 1996. It fell to 61 % in 2005, increased steadily to almost 100 % in 2008, but decreased to 75 % in 2009.

## **Mortality**

**Exploitation:** The trawl survey exploitation rate index increased slightly in 2009 following a decline since 2006 (Table 10, Fig. 70). Maintaining the current level of fishery removals would likely increase the exploitation rate in 2010.

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Indirect fishing mortality: The pre-recruit fishing mortality index (Fig. 70) decreased sharply in 2006 and changed little until it more than doubled in 2009, implying an increased mortality on pre-recruits in 2009. The percentage of the total catch discarded in the fishery (Fig. 70) decreased sharply in 2005 and remained low, at about 6-8 % until 2008. However in 2009, the discard percentage doubled, implying an increased wastage of pre-recruits by the fishery in 2009. The observed catch rate of total discards increased sharply in 2009 (Fig. 67) to be higher than that of undersized crabs, for the first time since 2005. This implies there has been an increased level of handing on soft-shelled crabs in the 2009 fisheries relative to previous years. The fishery has been delayed in recent years due to spring ice conditions off northeast Newfoundland. Soft-shelled crab catch rates generally increased around mid June in recent years, likely reflecting seasonality in timing of molting. The delayed fisheries of the past few years have meant that the period of potentially fishing on high levels of soft-shell crab has been prolonged.

During each of the past four years soft-shell crab incidence has generally increased in mid to late June, and commonly fluctuated between 10-20 % per week in the latter parts of the seasons (Fig. 71). However, a high level of spatiotemporal variability in observer coverage creates considerable uncertainty regarding true levels and trends in the incidence of soft-shell crabs

A portion of the Funk Island Deep in the south of Div. 3K offshore (Fig. 52) was closed to gillnet fisheries in 2002 and has been closed to all fisheries except snow crab during 2005-09. CPUE increased both inside and outside of the closed area from 2005 to 2008, before decreasing in 2009 (Fig. 72). The decrease in CPUE in 2009 was particularly substantial inside the closed area, which may be related to the large increase in snow crab fishing effort, especially in deep areas (Fig. 52).

Natural mortality (BCD): Prevalence of BCD, from multi-species trawl samples (Fig. 73), has overall been higher in this division than in any other division, with maximum levels during 1996-98, and 2008, in the order of 8 % in 40-75 mm CW new-shelled males. Annual trends in BCD prevalence (across all sizes) were similar to those in the survey biomass indices, especially for pre-recruits (Fig. 68), featuring highest values in 1996-98, a sharp drop to minimum levels in 1999, generally lower levels during 2000-07, and an increase in 2008. This is consistent with a density-dependent effect on prevalence (Mullowney et al. 2011). The very low prevalence levels, across all sizes for both adolescents and adults in 1999 and 2003 (Fig. 73) coincides with anomalously low survey biomass indices, especially for pre-recruits (Fig. 68). If those anomalously low biomass indices are due to low trawl efficiency, as believed, then this implies that infected crabs have a higher catchability by the survey trawl than healthy crabs.

## **DIVISION 3K INSHORE**

### **Biomass**

The commercial logbook CPUE index increased steadily from 2005 to a record high in 2008, but decreased in 2009 (Table 4, Fig. 74). The observer CPUE index has agreed with logbook CPUE since 2006, increasing sharply in 2007-08 before decreasing in 2009 (Fig. 74). The level of observer coverage has been lower inshore than offshore (Fig. 2) and has been spatially variable among inshore CMAs (Fig. 75). In recent years, the highest numbers of observed sets have occurred in CMA 3C (Green Bay), whereas CMA 3D (Notre Dame Bay) received high levels of observer coverage from 2004 to 2005, but little in the past two years. Low observer coverage and spatiotemporal inconsistencies, account for differences in trends between logbook and

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observer CPUE, particularly prior to 2006 (Fig. 74) Observer CPUE has consistently been higher than logbook CPUE, possibly due to some bias in selection of vessels by observers

The spatial coverage of the fishery has been inversely related to commercial CPUE from 1996 to 2009 (Fig. 76). The area fished has decreased from about 40-45 % of available cells in 2004-05, to about 25-35 % of cells occupied in 2006-09.

Trends in weekly commercial CPUE (Fig. 77a) indicated that the fishery performed more poorly in 2009 than it did in 2007-08. Trends in relation to cumulative catch (Fig. 77b) showed that initial CPUE in 2009 was comparable to that of 2007, but at cumulative catch levels greater than about 400 t, the 2009 CPUE was consistently lower than that in 2007-08. Late-season CPUE in 2008, of about 12 kg/trap, was similar to early-season CPUE in 2009. This could indicate low recruitment to the 2009 fishery. A pattern of depletion occurred throughout the season, and late-season CPUE in 2009 was similar to that in 2006.

Trends in the logbook-based mean catch rate from the STRAP analysis (Fig. 78) reflected raw logbook CPUE, increasing steadily from 2005-2008, and decreasing sharply in 2009. These trends were consistent in both the common strata (strata fished in all years) and all strata (all strata fished in a given year) analyses, as previously noted for other areas.

The exploitable biomass in Div. 3K inshore decreased in 2009. The CPS trap survey exploitable biomass index (Fig. 79) changed little during 2004-08 before decreasing substantially in 2009.

The catch rate of new-shelled legal-sized crab in the CPS trap survey most recently peaked in 2007, and has since declined to its lowest level in 2009 (Fig. 80). This decrease in the new-shelled component of the residual biomass, along with a decrease in legal-sized old-shelled crabs (Fig. 80), implies a greatly reduced exploitable biomass available for the 2010 fishery.

## **Production**

**Recruitment:** Recruitment decreased in 2009 as reflected by the sharp decrease in the post-season exploitable biomass while landings increased little. It is expected to decrease further in 2010. The CPS pre-recruit biomass index of undersized crabs increased from 2005 to 2008 but then decreased in 2009 to about the average level (Fig. 81). Longer term prospects are uncertain.

## **Mortality**

**Exploitation:** The trap survey-based exploitation rate index increased from 2006 to 2008 and decreased slightly in 2009 (Fig. 82). Maintaining the current level of fishery removals would likely increase the exploitation rate in 2010. Data are insufficient to estimate pre-recruit mortality rates.

**Indirect fishing mortality:** The percentage of the total catch discarded in the fishery (Fig. 83) decreased sharply from 2005 to its lowest level in 2007, was unchanged in 2008, and increased slightly in 2009. This implies little wastage of under-sized and new-shelled pre-recruits in the fishery over the past three years. The high wastage in 2004-05 is consistent with a high incidence of soft-shelled pre-recruits in the catch. In 2005, this resulted in a premature closure of the fishery and failure to achieve the TAC (Dawe et al. 2008a). This index is subject to bias associated with spatiotemporal variation in levels and distribution of observer coverage

**Natural mortality (BCD):** BCD prevalence has been monitored by DFO trap surveys in White Bay and Notre Dame Bay (Fig. 84) since 1994. BCD has consistently occurred at much higher

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prevalence levels in these inshore Div. 3K trap survey samples (Figs. 85-88) than in the predominately offshore Div. 3K Campelen trawl samples (Fig. 73). This likely reflects differences in catchability of diseased animals between traps and trawls (based on comparative trap/trawl sampling), but it may also, in part, reflect higher prevalence in inshore than offshore areas. In White Bay, prevalence has been periodic, with two distinct pulses of infection over the time series (Fig. 85). Peaks in prevalence have occurred in successively deeper strata at one to two year time lags. BCD prevalence patterns in White Bay are thought to reflect the relative abundance of small to mid-sized adolescents, and the time lag effect across strata likely reflects migration of crabs to deeper waters over time (Mullowney et al. 2011). In 2009, BCD prevalence in all three White Bay strata was low, which likely indicates that the most recent pulse of adolescents has progressed through the most susceptible size range. This is also apparent on a size-specific analysis for adolescents and adults, with all groups of crabs showing low BCD prevalence rates in all strata in 2009 (Fig. 86). In Notre Dame Bay, there have been two pulses of infection as well (Fig. 87), but no clear difference in timing between strata as seen in White Bay. Prevalence originally peaked in 1996, and most recently in 2004-06. Interestingly, from 2006 to 2008, prevalence was highest in large adolescents in shallow stratum 611, as opposed to smaller adolescents in deeper stratum 610 (Fig. 88). Notre Dame Bay was not surveyed in 2009 due to inclement weather.

### **Spatial variability: Trends by CMA**

**CMA 3A (Canada Bay):** In the north, in CMA 3A (Fig. 1, Canada Bay), CPUE decreased from its highest level in 2009 (Fig. 89), but at about 10 kg/trap, it was higher than in most recent years.

**CMA 3B (White Bay):** In White Bay, CPUE had been in decline since it peaked at a record high in 2004, but increased in 2009 (Fig. 89). Despite annual variability, CPUE has remained relatively high in White Bay in recent years. The DFO post-season trap survey showed that catch rates of legal-sized crabs, both new-shelled and old-shelled, were low in all three survey strata in 2009 in both small-mesh and large-mesh traps (Fig. 90), which suggests a low level of exploitable crabs available for 2010. Size frequencies from this survey (Fig. 91) showed that catch rates of largest legal-sized crabs have declined greatly since 2005 in the commercial strata (614 and 613), such that most legal-sized crabs were <101 mm in 2009. The CPS trap survey agreed with the DFO survey in showing that the catch rate of new-shelled legal sized crabs decreased while that of old-shelled legal-sized crabs was very low in 2009 (Fig. 92). Size frequencies from large-meshed traps in the CPS trap survey (Fig. 93) also agreed with the DFO survey in showing a trend toward smaller legal-sized crabs in recent years. Modal size of legal-sized crabs in the CPS survey has decreased from 113 mm CW in 2005 to the minimum legal size (95 mm CW) in 2008 and 2009. Size frequencies from both post-season surveys (Figs. 91 and 93) have shown large changes in catch rate across a broad size range and all population components, suggesting annual changes in catchability. However, both surveys also show a prominent mode of new-shelled adolescents approaching legal-size since 2007. A scenario of a low residual biomass coupled with a pulse of incoming recruitment could result in increased catches of soft-shelled crabs in the 2010 fishery.

**CMA 3BC (Outer Green Bay/Notre Dame White Bay):** In CMA 3BC, commercial CPUE has been highly variable since 1990 (Fig. 89). CPUE was at its maximum in 2008, but decreased by half in 2009, consistent with adjacent offshore areas.

**CMA 3C (Green Bay):** CPUE in Green Bay has oscillated since the late 1980s (Fig. 89). In 2009, the observed CPUE agreed with logbook CPUE in showing a large decrease in fishery performance relative to the most recent peak in 2008. This decrease in fishery performance may be attributable to a decrease in recruitment in recent years. Observer sampling showed a recent peak in catch rate of legal-sized new-shelled crabs in 2007, which was followed by a

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peak in that of legal-sized old-shelled crabs in 2008 (Fig. 94). The increase in old-shelled crabs in 2008 was for all males smaller than 107 mm, suggesting increased recruitment. A decrease in old-shelled males in 2009 occurred across the full size range of legal-sized crabs (Fig. 95), but did not include sub-legal-sized males. This resulted in a ‘knife-edge’ decrease in catch rate at the minimum legal size, suggesting a high level of exploitation by the 2009 fishery. The percentage of the catch discarded in the fishery nearly doubled in 2009, to exceed 40 % (Fig. 96). This reflects the reduced overall CPUE (of landed crabs), as there was little change in total discards, which at about 20 kg/ trap, were primarily comprised of under-sized crabs (Fig. 96). In 2009, the observed levels of soft-shelled crab were similar to those of 2008, ranging about 10-20 % in June and July, higher than levels observed for the same period of 2007, (Fig. 97). The CPS trap survey was consistent with observer data in showing a reduction in legal-sized old-shelled crabs in 2009 (Fig. 98), attributable to decreases in most sizes of legal-sized crabs, from large-meshed traps (Fig. 99). Small-meshed traps in the CPS survey showed a large mode of new-shelled adolescents at 70 mm CW in 2006 (Fig. 100). However, much of this mode appears to have terminally molted as sub-legal sized crabs from 2007 to 2009, implying that short-term recruitment prospects are not favorable.

CMA 3D (Notre Dame Bay): In Notre Dame Bay (CMA 3D), CPUE peaked at a record high level in 2008 before decreasing sharply in 2009 (Fig. 89). Since 2003 observer CPUE trends have agreed well with logbook CPUE trends (Fig. 89). Observer sampling shows relative consistency in new-shelled and old-shelled legal-sized crabs in the catch throughout the times series (Fig. 101). Decreases in both the new-shelled and old-shelled components of the catch contributed to the large decrease in CPUE in 2009. Size frequencies from at-sea observer sampling (Fig. 102) showed the greatest reductions in catch rates occurred in 101-125 mm CW crabs in 2009. The kept catch has reflected the total of new-shelled and old-shelled legal-size crabs throughout the time series, indicating little wastage in the CMA 3D fishery (Fig. 101). Total discards, and percentage of the catch discarded have remained at a low level and changed little since 2006, as have the catch rates of sub-legal sized crabs (Fig. 103). Soft-shell crab has comprised a minimal amount of the catch in all weeks during all fisheries since 2006 (Fig. 104). The DFO post-season trap survey in Notre Dame was incomplete due to severe weather conditions in 2009, thus no data were available to assess trends in catch rates for legal-sized crabs (Fig. 105) or size-specific abundance (Fig. 106). However, in the closely-timed CPS survey, catch rates of all large-sized crabs decreased in 2009 (Fig. 107), and catch rates of all sizes of commercial-sized crabs were low in 2009 (Fig. 108), especially evident in largest crabs.

## **DIVISION 3LNO**

### **The fishery**

Offshore landings, mostly in Div. 3L, peaked at 27,300 t in 1999 and decreased to about 22,100 t in 2000 due to a reduction in the TAC (Table 11, Fig. 109). Landings remained at 22,000-25,000 t since 2000. Effort increased steadily from 2000 to 2007 and changed little since.

Inshore landings in Div. 3L (Table 11, Fig. 109) peaked in 1996 at 7,900 t. They declined to 4,700 t in 2000, increased to 6,800 t in 2003, and decreased slightly to 6,100 t in 2005 due to changes in the TAC. Landings increased by 15 % from 6,100 t in 2005 to 7,000 t in 2009. Div. 3L inshore effort decreased by 23 % from 2005 to 2008, but increased by 11 % in 2009.

Commercial CPUE (Fig. 110) indicates that fishery performance has deteriorated offshore but improved inshore over recent years. Offshore Div. 3LNO CPUE declined steadily from 2000 to 2008, to the lowest level since 1991, and was unchanged in 2009. The offshore CPUE series is



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considered unreliable in this area due to a high degree of inaccurate reporting. Inshore Div. 3L CPUE increased by 53 % from 2004 to 2008 before decreasing slightly in 2009.

The spatial distribution of fishing effort has remained relatively consistent since 2004 with the exception of a cessation of effort along the Div. 3O slope in 2007 (Fig. 111), when CMA boundaries within Div. 3NO were changed. In most years, dense concentrations of effort occur in the inshore bays, while aggregated pockets of effort occur on the shelf and along the slope of the Grand Bank in the offshore.

The 2009 offshore fishery began early, as in 2006-07 (Fig. 112a), with most effort expended by week 14 (relative to the April 1 opening), 2-4 weeks earlier than in previous years. The 2008 offshore fishery had a delayed start due to ice, but progressed rapidly through the remainder of the season, finishing in week 18. The 2009 inshore fishery was also early, beginning early, as in 2006, and ending early, with most effort expended by week 12 (Fig. 112b). In other recent years, most of the effort had not been expended until week 15-16. Delayed starts in 2007 and 2008 were attributable to heavy ice conditions.

### **Effect of ocean climate variation**

Bottom temperature in Div. 3L, has been inversely related to the divisional commercial CPUE at an eight year lag since the early 1970's (Fig. 113). In recent years, divisional CPUE has declined since 2000, while the lagged bottom temperature has increased to a high level. The spatial extent of the cold intermediate layer on the Grand Bank has been positively related to commercial CPUE, at an eight year lag, since the early 1970's (Fig. 114). Both indices declined to 2007, but the area of the CIL then increased to 2009 while CPUE remained low.

## **DIVISION 3L OFFSHORE**

### **Biomass**

Both the observer CPUE and VMS-based CPUE (Fig. 115) declined from 2004 to 2007, decreased sharply in 2008, and increased in 2009. This trend was not reflected in the unreliable logbook CPUE index.

The spatial coverage of the fishery has generally been inversely related to commercial CPUE since 1995 (Fig. 116). The percentage of available 5' x 5' cells occupied by the fishery reached its highest level, of 25 %, in 2009, while CPUE remained low. Annual changes in the extent of spatial coverage by the Div. 3LNO offshore fishery are less abrupt than in other Divisions as this fishery primarily occurs along the broad slope of the northern portion of the Grand Bank (Fig. 111), whereas in other Divisions effort more commonly occurs at greater depths. Bathymetric and habitat (eg. muddy substrate) limitations in offshore Div. 3LNO may account for the limited annual variation in fishing effort distribution.

Trends in commercial logbook CPUE throughout the season (Fig. 117) indicate that CPUE steadily declined in 2009 to week 8 (Fig. 117a), when, at a cumulative catch of 10,000 t (Fig. 117b) it was lower than in any of the previous 5 years. It subsequently increased in 2009 throughout most of the remaining season, achieving higher late-season values than in 2007 and 2008 (Fig. 117a). This mid-season increase in CPUE was also evident, to a lesser degree in 2007 and 2008, and it may reflect either a seasonal change in the distribution of fishing effort, or the inaccurate reporting of logbook data in this area.

Trends in the logbook-based mean catch rate from the STRAP analysis (Fig. 118) reflected raw logbook CPUE, declining steadily since 2002. However, this trend differs somewhat from

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observer and VMS-cased CPUE, as previously noted, due to unreliability of the logbook data. These trends were generally consistent in both the common strata and all strata analyses, as in other areas.

Size distributions from at-sea sampling by observers (Fig. 119) became increasingly platykurtic from 2004 to 2007. However, in 2008, there was a prominent change in modal CW from 110 mm during 2004-07 to 92-98 mm in 2008. This change was due to a decline in catch rate of largest legal-sized (especially old-shelled) crabs and an increase in smallest new-shelled (including undersized) crabs. This change suggests depletion of the exploitable biomass together with increasing recruitment. The size composition remained similar in 2009 although catch rates of crabs smaller than about 110 mm CW were slightly increased, suggesting increasing recruitment

Observed catch rates of new-shelled legal-sized crabs declined gradually from 2003 to 2007 and since increased slightly to 2009 (Fig. 120), whereas catch rates of old-shelled legal-sized crabs declined steadily from 2006 to 2009. Trends in the levels of new-shelled and old-shelled legal-sized crab, when combined (exploitable crabs), have reflected the observed CPUE in most years throughout the time series.

The exploitable biomass has recently increased. The exploitable biomass index from the trawl survey declined steadily from 2001 to 2007 but has since more than doubled (Table 12, Fig. 121). The CPS survey index declined steadily from 2004 to 2008 but increased in 2009 (Fig. 121).

## **Production**

**Recruitment:** Both post-season surveys indicate that recruitment has been increasing and is expected to increase further over the next two to three years. The recent recruitment increase is reflected by the increase in the post-season exploitable biomass indices (Fig. 121) while landings changed little (Fig. 109). Increased recruitment for 2010 is reflected by an increase in biomass indices of legal-sized new-shelled adults in both 2009 post-season surveys (Figs. 122-123). Catch rates of new-shelled legal-sized crabs from the CPS trap survey have increased gradually in Div. 3L since 2005 (Fig. 122a) while catch rates of old-shelled legal-sized crabs declined steadily to 2008 and were unchanged in 2009. There has been no clear trend in Div. 3O (Fig. 122b). This may be an artifact of spatially limited sampling in Div. 3O however, as the survey is limited to the Whale Deep and Haddock Channel areas of that division. Annual changes in the fall multi-species trawl survey biomass index by shell condition (Fig. 123) showed an increase in legal-sized new-shelled crabs since 2006, which was followed by an increase in intermediate-shelled crabs in 2009.

Size distributions from the CPS trap survey in Div. 3L showed a decline in catch rate of largest legal-sized (especially old-shelled) crabs and an increase in smallest new-shelled (including undersized) crabs from 2004 to 2008, (Fig. 124), as seen in the observer size distributions from the fishery (Fig 119). The increase in the catch rate and proportion of new-shelled (soft and new-hard) crabs in the CPS survey size distributions at sub-legal sizes in 2008 and at larger (small legal) sizes in 2009 (Fig. 124) reflect the increasing recruitment to the fishery. Size distributions from the CPS survey in 3O have shown no discernable trends in catch rates of legal-sized crabs throughout the time series (Fig. 125). Size distributions from the fall multi-species trawl survey show the presence of a group of large adolescents approaching and beginning to enter into the legal-sized group in recent years (Fig. 126). These adolescents should contribute further to the exploitable biomass in the next 2-3 years.

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In Div. 3L, the observed catch rates of under-sized crabs tightly reflected that of total discards from 2003 to 2008 (Fig. 127), but diverged in 2009, as the catch rate of undersized crabs exceeded total discards for the first time since 2000. The reasons for the divergence in trend are unclear, but the increase in catch rate of undersized crabs is consistent with increasing recruitment potential in Div. 3L. In Div. 3NO, observed catch rates of total discards were consistently greater than the catch rates of undersized crabs from 1999 to 2006 (Fig. 128), but the catch rates of undersized crabs have exceeded total discards in recent years, with the disparity most evident in 2009 as in Div. 3L. Again the reasons for this disparity are unclear, but the high level of undersized crabs relative to that of total discards in 2009 likely reflects increasing recruitment potential. It is possible that the recent disparities in both Div. 3L and Div. 3NO are functions of data collection techniques, as total discards are estimated from the total catch whereas catch rates of undersized crabs are from subsamples actually measured by observers.

Recruitment is expected to increase further in the short term following 2010. This is indicated by the continued increase in both post-season survey pre-recruit indices to 2009 (Table 13, Fig. 129).

Reproduction: The percentage of mature females carrying full clutches of viable eggs has exceeded 80 % in both Div. 3L and 3NO since 1995 with little exception (Figs. 130-131), and has been greater than 90 % in both areas for the past four years.

### **Mortality**

Exploitation: Both the exploitation rate index (Fig. 132) and the pre-recruit fishing mortality rate index (Fig. 132) peaked in 2008 but decreased in 2009. The pre-recruit index was at its lowest level in 2009. The anomalously high values of both indices in 2007 reflect the low exploitable biomass (Fig. 121) and pre-recruit biomass (Fig. 129) values from the 2006 survey. Increased removals would not likely increase the exploitation rate in 2010.

Indirect fishing mortality: The percentage of the total catch discarded in the fishery (Fig. 132) increased sharply in 2008 from a low level during 2004-07. It decreased in 2009 implying reduced wastage of pre-recruits, primarily sub-legal sized, in the fishery in 2009.

The prevalence of soft-shelled crab in the catch throughout the season is typically virtually absent until week 12-14 in both Div. 3L (Fig. 133) and Div. 3NO (Fig. 134), about a month later than in Div. 3K (Fig. 71). Soft-shell crab prevalence in 2009 spiked to exceed 20 % in the latter parts of the season; week 15 in Div. 3L (Fig. 133) and week 14 in Div. 3NO (Fig. 134), but these sharp spikes reflect limited fishing activity (Fig. 112). In the three previous seasons, in both Div. 3L and Div. 3NO, soft-shell crab incidence generally increased after week 15, thus the earlier cessation of fishing activity in 2009 may have helped avoid increased levels of mortality on soft-shelled crab.

Natural mortality (BCD): BCD generally occurs at lower levels in Div. 3L than in Div. 3K. Prevalence (in new-shelled males) from offshore Div. 3L fall multi-species trawl surveys (Fig. 135) has been variable with highest incidence during 2003-2005. Maximum prevalence was during 2004, at about 8 % in 40-59 mm CW adolescents and 14 % in 60-75 mm CW adults. Prevalence of infection decreased considerably in 2006, and was non-existent in most groups of crabs in 2007-08. In 2009 levels increased marginally in most sizes of adolescents and adult males. .

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## DIVISION 3L INSHORE

### Biomass

Logbook and observer CPUE indices (Fig. 136) trended together from 2002 to 2006. Both indices showed a decline in catch rates from 2002 to 2004, with a subsequent increase in 2006. However, the trends opposed one another in 2007 as logbook CPUE increased while observer CPUE decreased, and the level of the two indices agreed for the first time. In 2008, the indices again agreed, with both increasing to about 12 kg/trap. The reasons for the disagreement in scale in earlier years are unclear, and there was a similar disparity between the indices in 2009 as observer CPUE increased while logbook CPUE decreased.

Disagreement between logbook and observer CPUE trends since 2006 is due to spatiotemporal variation in observer coverage. Generally, the overall level of observer coverage increased in 2005, and was greatest from 2005 to 2008, before coverage levels decreased in 2009 (Fig. 137). CMA 5A (Bonavista Bay) received consistent, adequate, levels of observer coverage from 2005 to 2008 but none in 2009. Similarly, coverage levels in CMAs 6A (Trinity Bay) and 6B (Conception Bay) decreased in 2009 relative to the preceding years. Observer coverage in CMAs 6C (Northeast Avalon) has remained consistently low over the time series, while CMA 8A (Southern Avalon) received very limited coverage in all years, and none in 2009. Annual coverage levels in CMA 9A (St. Mary's Bay) has been highly variable, and it received a relatively high level of coverage, about 50 observed sets, in 2009.

There has generally been an inverse relationship between spatial distribution of the fishery and commercial CPUE (Fig. 138), as seen in most other divisions, but this relationship has eroded in recent years. The areal extent of the fishery consists of two distinct levels, with about 30-45 % of available 5' x 5' cells occupied each year from 1995 to 2001 and about 70-80 % of cells occupied each year thereafter. This is attributable to localized spatial expansion of effort throughout the inshore of Div. 3L beginning in 2002, which was most pronounced in coastal regions of the Northeast Avalon and the western half of Conception Bay (Dawe et al. 2003). The sharp increase in spatial coverage of the fishery in 2002 was followed one year later by a sharp decrease in CPUE. CPUE increased from 2004 to 2008, and has remained at the pre-2002 level of about 11-12 kg/trap since 2007, while area fished has remained large.

Trends in commercial CPUE throughout the season (Fig. 139a) indicated that CPUE was generally highest throughout the season in 2008, while 2009 values most closely reflected the 2006-07 levels. A pattern of seasonal depletion across weeks was evident in all years, with an increase in CPUE in the mid-portions of the season in some years (eg. 2007). The late-season CPUE, at cumulative removal levels of about 4000 t, was highest in 2008 but the 2009 level was higher than those of 2005-07. End of season CPUE (Fig. 139a) was similar between 2008 and 2009 (at >5500 t cumulative removals), at about the same level as that of the previous 3 years (Fig. 139a) but at a much higher cumulative removal level (Fig. 139b).

Trends in the logbook-based mean catch rate from the STRAP analysis (Fig. 140) reflected raw logbook CPUE (Fig. 136), decreasing slightly in 2009. These trends were similar between the common strata (strata fished in all years) and all strata (all strata fished in a given year) analyses. However the all-strata index has been higher than the common-strata index since 2004, likely due to some change in snow crab distribution in recent years.

The post-season trap survey index (Fig. 141) indicates the exploitable biomass has declined gradually since 2006.

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## **Production**

**Recruitment:** Recruitment is expected to change little for 2010 as reflected by no change in the catch rate of legal-sized new-shelled adults in the CPS trap survey in 2009 (Fig. 142). Overall, recruitment prospects, beyond 2010, have recently improved (Fig. 143), but there is considerable spatial variability.

## **Mortality**

**Exploitation:** The trap survey-based exploitation rate index changed little from 2005 to 2007 but has since increased (Fig. 144). Data are insufficient to estimate pre-recruit mortality rates. Maintaining the current level of fishery removals would likely result in little change in the exploitation rate but may increase mortality on soft-shelled immediate pre-recruits in some areas in 2010.

**Indirect fishing mortality:** The percentage of the total catch discarded in the fishery (Fig. 145) increased in 2008 to about the long-term average and decreased in 2009, implying relatively low wastage of under-sized and new-shelled pre-recruits in the 2009 fishery. However, this index is biased by annual variation in spatial distribution of observer sampling.

**Natural mortality (BCD):** The trend in prevalence of BCD from the DFO trap survey in Conception Bay (Fig. 146) was somewhat similar to that from the multi-species trawl surveys throughout offshore Div. 3L (Fig. 135), but at higher levels of prevalence, with highest prevalence during 2004-05. Trends in prevalence of BCD in trawl surveys in Conception Bay have been similar to those in the trap surveys (Fig. 146), but at lower levels. Prevalence generally increased to 2000 before decreasing sharply in 2001. It increased during 2002-05 before decreasing to 2007 and remaining low in 2008-09. Prevalence in 2008-09 was at its lowest level since 2003 in all sizes of crabs, excepting an anomalously high level in 60-75 mm CW adolescents from traps in both years.

## **Spatial variability: Trends by CMA.**

**CMA 5A (Bonavista Bay):** Commercial CPUE in Bonavista Bay increased steadily from 2004 to 2008, peaking at 17 kg/trap in 2008 (Fig. 147), but decreased to 14 kg/trap in 2009. Observed CPUE closely reflected commercial CPUE in recent years, but there was no observer coverage in 2009. Observer coverage during the 2008 fishery showed the catch primarily consisted of legal-sized old-shelled crabs (Fig. 148), with high catch rates across the full size range of legal-sized crabs (Fig. 149). This high biomass of fully-recruited crabs in 2008 resulted from increased biomass of new-shelled legal sized immediate pre-recruits during 2005-06 (Fig. 148 and 149) and accounted for the strong fishery performance in 2008. The high level of large old-shelled crabs in the population in recent years is reflected in the great decrease in discarding since 2004, to a very low level in 2006 and 2008, with only 1-2 kg/trap discarded in those years (Fig. 150); these discards were almost wholly attributable to undersized crabs in both years (Fig. 150). The overall low level (<10 %) of discarding in recent years (Fig. 150) suggests there has been little wastage of pre-recruits by the fishery, and a low incidence of soft-shelled crab (Fig. 151) in 2006 and 2008. Unfortunately there are no observer data from the 2009 fishery. The DFO post-season trap survey showed that the catch rates of new-shelled legal-sized crabs have been in decline since 2006, while catch rates of old-shelled legal-sized crabs have declined since 2007 (Fig. 152). The catch rates old-shelled legal-sized crabs remained higher than that of new-shelled legal-sized crabs in 2009, suggesting that exploitation has not been excessive. The continued decline in new-shelled immediate pre-recruits in 2009 indicates a slight decrease in recruitment for 2010, but size frequencies from small-meshed traps in the DFO post-season survey show a mode of adolescents approaching legal-size in 2009 (Fig. 153)

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that should contribute to increased recruitment into the fishery in the short term following 2010. The CPS trap survey agreed with the DFO post-season survey in showing a decrease in legal-sized new-shelled crabs since 2006 (Fig. 154), with the 2009 catches consisting almost exclusively of old-shelled crabs across the full range of legal-sizes.

CMA 6A (Trinity Bay): Commercial CPUE changed little from 2001 to 2008, remaining at 6-8 kg/trap, but increased to 10 kg/trap in 2009 (Fig. 147). Trends in observed CPUE were consistent in showing the increase in CPUE in 2009, but at a lower level (Fig. 147). The increase in CPUE in 2009 was attributable to an increase in legal-sized old-shelled crabs that resulted from increased biomass of new-shelled legal-sized immediate pre-recruits in 2008 (Fig. 156). Old-shelled crabs represented most of the 2009 catch (Fig. 156), with their catch rates having increased across the full size range, including sub-legal sizes (Fig. 157). The increased catch rates of legal-sized old-shelled crabs may have contributed to a decrease in both the level and percentage of the catch discarded during the past two years (Fig. 158). The catch rates of sub-legal-sized crabs increased since 2007 (Fig. 158). This was likely a function of increased capture of under-sized terminally molted (i.e., old-shelled) crabs (Fig. 157), especially in 2009. The decline in catch rate of total discards while that of undersized crabs increased, since 2007 (Fig. 158), implies a decline in incidence of soft-shelled crabs. However, this trend can also be accounted for by the progressively earlier seasonal observer coverage over those years (Fig. 159). Annual trends in incidence of soft-shelled crabs are unknown due to seasonal inconsistency in observer coverage and, in particular paucity of data in 2009. However it is clear that soft-shelled crabs were quite prevalent in the fisheries of 2007 and 2008, as percent soft frequently exceeded 20 percent from week 10 (mid-June) onward in both years (Fig. 159). The CPS trap survey showed an increase in the catch rate of old-shelled legal-size crabs since 2006 (Fig. 160), while that of new-shelled legal-sized crabs varied without trend. A 2008 peak in catch rate of new-shelled legal-sized crabs coincided with a modal group of new-shelled crabs at 95mm CW in 2008 that almost fully progressed to legal-size by 2009 (Fig. 161). This reflects increased recruitment recently but reduced recruitment potential in the short-term.

CMA 6B (Conception Bay): Commercial CPUE decreased in 2009, following an increase from 2005 to 2008 (Fig. 147). Observed CPUE also increased from 2006 to 2008 (Fig. 147), but data were insufficient in 2009 to calculate a representative catch rate. From 2005 to 2007, the observed catch of legal-sized crabs was comprised of roughly equal proportions of new-shelled and old-shelled crabs (Fig. 162). These trends diverged in 2008, with new-shelled crabs represented the bulk of the legal-sized catch. This was primarily attributable to increased catch rates of small legal-sized (about 95-104 mm CW) new-shelled crabs in 2008 (Fig. 163), which would indicate a pulse of recruitment beginning to contribute to the fishery. This group of pre-recruits (including undersized new-shelled crabs, Fig. 163) likely contributed to a slight increase in the level of discarding in 2008 (Fig. 164), which was primarily attributable to a slight increase in the catch rate of undersized crabs (Fig. 164). Despite this however, the percentage of the catch discarded declined substantially from 2005 to 2008 (Fig. 164), due to the increases in fishery CPUE. The incidence of soft-shelled crabs may exceed 20 percent as early as mid-May in some years (e.g., 2008 Fig. 165). However observed levels of soft-shelled crab in the catch remained low in most weeks of the fishery during 2007-08 (Fig. 165), implying little fishery-induced mortality on immediate pre-recruits. Annual trends in incidence of soft-shelled crabs are unknown due to seasonal inconsistency in observer coverage and, in particular, paucity of data in 2009 (Fig. 165). The DFO post-season trap survey showed a large increase in catch rate of new-shelled legal-sized crabs in 2009 (Fig. 166), which should contribute to an increased exploitable biomass in 2010. This increase in recruitment is related to a prominent group of adolescents first seen in size distributions from small-meshed traps, at a modal size of about 83-95 mm CW in 2007 (Fig. 167). It appears however, that most adolescents of smaller size than this modal group have terminally molted as sub-legal-sized adults in 2008-09 (Fig. 167).

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The CPS trap survey agrees with the DFO post-season survey in showing an increase in catch rates of new-shelled legal-sized crabs (Fig. 168) that should contribute to an increased exploitable biomass in 2010, as well as a high abundance of terminally molted sub-legal-sized crabs in 2009, evident in the catches of small-meshed (Fig. 170) traps. The abundance-at-size of adolescents changed little from 2008 to 2009 (Fig. 170), implying little change in recruitment to the fishery following 2010

CMA 6C (Northeast Avalon): Commercial and observed CPUE have agreed in trend since 2000, although their levels have differed in most years (Fig. 147). Both indices agreed that CPUE increased from 2004 to 2008, peaked in 2008, and decreased in 2009. However, at 14kg/trap in 2008, and 4 kg/trap in 2009, observed CPUE has been much greater and lower than commercial CPUE in each year respectively. Observer data indicate that the large decrease in CPUE in 2009 was primarily a function of decreased catch rates of legal-sized new-shelled (i.e., recently recruited) crabs (Fig. 171), which occurred across the full range of legal sizes (Fig. 172). There is a discrepancy in the observer data which shows undersized crabs have comprised roughly half the discards in the past three years (Fig. 173), which would imply soft-shell crabs have been prevalent in the fishery, yet weekly incidence of soft-shelled crabs has been virtually zero during that time (Fig. 174). The CPS trap survey disagrees with observer data in showing there has been no change in catch rates of legal-sized new-shelled or old-shelled crabs from 2008 to 2009 (Fig. 175), and little change in total catch rates of legal-sized crabs since 2007. This survey shows that there has been little change in shape or magnitude of the size distributions since 2007 (Fig. 176). Similarly, size distributions from small-meshed traps in the CPS survey have changed little since 2007 (Fig. 177). Overall, resource status is uncertain due to conflicting information with fishery logbook and observer CPUE indicating a decrease in fishery performance in 2009, and the CPS trap survey showing little change in recent years.

CMA 8A (Southern Avalon): Commercial CPUE has remained above 15 kg/trap in this CMA since 1995 (Fig. 147), having most recently peaked in 2008. The slight decrease in commercial CPUE in 2009 is consistent with the CPS post season trap survey, which showed decreases in both new and old-shelled legal-sized crabs in 2009 (Fig. 178). Large-mesh trap size frequencies from this survey indicate a gradual reduction across the entire size range of crabs caught during the past two years (Fig. 179). The catch rate of undersized new-shelled crabs has declined during the past two years, which could indicate reduced recruitment for the near future.

CMA 9A (St. Mary's Bay): Commercial CPUE has varied between about 15-23 kg/trap since 1999 (Fig. 147). In 2009 there was a sharp decrease to 15 kg/trap, following the 2008 high of 22 kg/trap. Observer coverage has been limited in most years, however sampling during 2009 indicated the catch was dominated by old-shelled crab (Fig. 180). This is inconsistent with the CPS trap survey, which captured even proportions of new and old-shelled legal-sized crabs in large-meshed pots (Fig. 181), and despite gradual decreases in recent years, have maintained a total catch rate above 30 kg/trap since 2004. Size frequencies from large-meshed traps in the CPS trap survey showed a broad-based distribution of new-shelled crabs centered about the minimum legal-size with highest abundance at 89-104mm CW (Fig. 182), which would suggest a pulse of incoming recruitment. Similarly, small-meshed traps from the CPS survey showed a large pulse of adolescents approaching legal-size, with a mode at 77mm CW (Fig. 183). With a large mode of pre-recruits approaching legal-size, there is potential for a high incidence of soft-shell crab in the fishery in 2010.

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## **SUBDIVISION 3Ps**

### **The Fishery**

The fishery began in 1985 and was limited to the inshore until the early 1990's. Landings (Table 14, Fig. 184) from offshore areas have been about twice as high as those from inshore areas in recent years. Landings from both offshore and inshore areas were at their highest level during 1999-2002. Offshore landings increased by 57 % from 2,300 t in 2006 to 3,600 t in 2009 (Fig. 184). Effort decreased by 26 % in 2008 to its lowest level since 2001 and was unchanged in 2009. Inshore landings more than doubled from 700 t in 2005 to 1,900 t in 2009 while effort declined slightly (Fig. 184).

Commercial CPUE (Table 17, Fig. 185) has consistently been higher offshore than inshore (Fig. 185) with both sectors trending together since 2001. Offshore CPUE has increased by 72 % since 2007 and is approaching the long-term average. Inshore CPUE more than doubled since 2005 to exceed the long-term average. Spatially, increases in CPUE have occurred throughout most of the Subdivision in recent years (Fig. 186). In the offshore, the spatial distribution of fishing effort changed little in recent years, although there has been increased effort along the north-west slope of St. Pierre Bank from 2007 to 2009. In the inshore, the distribution of fishing effort between Fortune and Placentia Bays has varied among years. In 2009 there was a reduction of effort in the inner portions of Fortune Bay.

The management shift toward a spring fishery has been more successful in Subdiv. 3Ps than in any other division. This is likely due in large part to a lack of spring ice cover along the south coast. The fishery has occurred earlier in the past four years than in 2005 in both the inshore and offshore (Fig. 187). In 2009, in both sectors, the fishery began in the first week of April and most of the effort was expended by the end of May (week 8), with the fishery fully completed by the end of June (week 12).

### **Effect of ocean climate variation**

Commercial CPUE in Subdiv. 3Ps has generally been inversely related to bottom temperature seven years earlier since 1985 (Fig. 188). The forward-shifted bottom temperature declined sharply in 2008 while CPUE increased sharply. In 2009 the earlier bottom temperature changed little while CPUE increased further. The spatial extent of the CIL in Subdiv. 3Ps has generally reflected trends in CPUE seven years later (Fig. 189). Most recently, CPUE increased since 2007, while the forward-shifted area of the CIL increased in 2008 and changed little in 2009.

## **SUBDIVISION 3Ps OFFSHORE**

### **Biomass**

The commercial logbook and observer CPUE indices (Fig. 190) have since 1997 agreed (excepting 1998) and have trended together since 1999. Both indices declined steadily from 1999 to 2003, remained at a low level until 2007, and have since increased. The VMS-based CPUE trend (Fig. 190) has agreed with the logbook and observer CPUE trends since 2004, increasing gradually over the past four years following a decrease from 2004 to 2005.

The spatial coverage of the fishery has generally been inversely related to commercial CPUE since 1999 (Fig. 191). The percentage of available 5' x 5' cells occupied by the fishery increased steadily from 1995 to an initial peak in 2002. It then declined gradually in 2003 and 2004 before increasing sharply to its highest level of 75 % in 2005. This is likely attributable to a high incidence of soft-shelled crab in the fishery in 2005 (Dawe et al. 2006). The spatial index



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declined sharply in 2006 and has since changed little, with about 50 % of the available cells occupied by the fishery in 2006-09, while CPUE increased in the past four years, from its lowest level in 2005. The SubDiv. 3Ps offshore fishery primarily occurs around and between St. Pierre and Green Banks (Fig. 186) with smaller amounts of effort along the north-west slope of the St. Pierre Bank in some years.

Logbook CPUE was substantially higher in 2008 throughout the season than in previous years and remained high throughout the season in 2009 (Fig. 192a). A general pattern of decreasing CPUE with time occurs in most years, although CPUE peaked at a high level during weeks 8-10 of the 2009 season. However, this was associated with limited removals (Fig. 192b), as most removals had occurred by week 7.

Trends in the logbook-based mean catch rate from the STRAP-based CPUE index (Fig. 193) were consistent with raw logbook CPUE, as both the 'all strata' and 'common strata' analyses indicated increasing catch rates since 2005.

Size distributions from at-sea sampling by observers (Fig. 194) showed a sharp ('knife-edge') decrease in catch rate at 95 mm CW from 2005 to 2007, suggesting high fishery-induced mortality on legal-sized crabs, including new-shelled immediate pre-recruits, in those years. However, this sharp knife-edge effect was not present in 2008-09, due to a decrease in catch rate of sub-legal sized crabs and an increase in catch rate of legal-sized (especially old-shelled) crabs. This could be due to increased recruitment and/or decreased exploitation rate. Catch rates of crabs from about 89-110 mm CW have increased since 2007 (Fig. 194), likely reflecting the progression and recruitment of a modal group of adolescent pre-recruits observed in spring trawl survey size distributions in 2005 (Dawe et al. 2006). The high catch rates of undersized (<95 mm CW) crabs in most years, and the high proportion of those that were old shelled, suggests that crabs terminally molt to adulthood at small sizes in Subdiv. 3Ps relative to most other areas.

The observed catch rate of legal-sized new-shelled crabs decreased sharply in 2001, followed by a sharp decrease in catch rate of legal-sized old-shelled crabs in 2003 (Fig. 195). Both shell components have been increasing gradually since 2007. Catch rates of old-shelled crabs have consistently been higher than those of new-hard-shelled crabs, and catch rates of soft-shelled crabs have been virtually absent each year after 1999, with the exception of 2005. Trends in the levels of intermediate and old-shelled legal-sized crab, when combined (exploitable crabs), have reflected the retained catch since 2000.

The exploitable biomass has recently increased. The pre-season trawl survey exploitable biomass index (Table 15, Fig. 196) increased since 2007 while the post season trap survey index more than doubled since 2004 (Fig. 196). The 2009 trawl survey index was the highest since 2000.

## **Production**

**Recruitment:** Recruitment has recently increased as reflected by an increase in biomass while landings increased. This is also reflected in the increase in legal-sized old shelled crabs, both in the observer at-sea samples (Figs. 194-195) as well as in the CPS survey samples (Fig. 197). Catch rates of legal-sized old-shelled crabs in the post-season trap survey were at their highest level in 2009 (Fig. 197). Recruitment is expected to remain strong for 2010, as reflected in the slight increase in the CPS survey catch rate of new-shelled legal-sized crabs (Fig. 197).

The biomass index of new-shelled legal-sized crabs in the pre-season trawl survey increased sharply in 2009, to its highest level since 1997 (Fig. 198). The biomass index of legal-sized

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intermediate-shelled crabs has increased during the past two years, while the biomass of legal-sized old-shelled crabs remained low.

Size distributions from the CPS trap survey showed an increase in catch rates of legal-sized and immediately sub-legal-sized new-shelled crabs (>92 mm CW) in 2007 (Fig. 199) that was followed by an increase in catch rate and proportion of old-shelled crabs to 2009 across a broad size range that included all legal sizes. This indicates increasing recruitment since 2007. An increase in catch rate of sub-legal-sized new-shelled crabs in 2009 (Fig. 199) implies an increase in recruitment in the short term following 2010, but it is unknown what portion of these are adolescents. The high catch rates of undersized (<95 mm CW) crabs in most years, and the high proportion of those that were old shelled, supports our earlier suggestion that crabs terminally molt to adulthood at smaller sizes in Subdiv. 3Ps than in other areas.

Size distributions from the spring trawl survey reflect the presence of a modal group of adolescents first observed in 2005 at a modal size of about 65 mm CW (Fig. 200). These adolescents achieved a modal size of about 86 mm CW in 2008 (Fig. 185), and began to achieve legal size in 2008 and 2009, evident by increased abundance of adolescent and adult crabs ranging from 96-108 mm CW.

This represents the only area where the observer catch rate of under-sized discards (from at-sea sampling) commonly exceeds that of total discards (from set and catch data) (Fig. 201). This indicates that either the under-sized discards are over-estimated by the observer or the total discards are under-estimated. As under-sized crabs are physically sampled by observers, and total discards are an estimate, we believe the total discards have been underestimated in recent years (since 2006).

Prospects remain promising for the short-term following 2010. The pre-season trawl survey pre-recruit index has steadily increased since 2007 while the CPS trap survey index has varied without trend (Fig. 202).

Reproduction: The number of females captured increased sharply from 2001 to 2002, and has since declined to a low level during 2007-09 (Fig. 203). There is high annual variability in the percentage of females carrying full clutches of viable eggs (Fig. 189). About 90 % of females carried full clutches of eggs in 2009.

### **Mortality**

Exploitation: Exploitation and pre-recruit mortality rate indices based on the trawl survey have both decreased since 2007 (Fig. 204). The pre-recruit index is at its lowest level since 1996. Fishery removals could likely be marginally increased in 2010 without increasing the exploitation rate.

Indirect fishing mortality: The percentage of the total catch discarded in the fishery (Fig. 204) almost doubled to about 45 % in 2005 and declined markedly to about 20 % in 2009, implying a reduction in wastage of pre-recruits in recent years. The percent discarded in Subdiv. 3Ps is generally higher than in other areas as it includes a larger component of under-sized crabs, an unknown portion of which is comprised of small adults that will never recruit to the fishery.

Soft-shelled crab has been virtually absent in the observed catch since 2006 (Fig. 205). Therefore, mortality resulting from catching and handling soft-shelled crab is assumed to be minimal in recent years.

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Natural mortality (BCD): Small-meshed trap data from the CPS trap survey indicates that BCD has been detected, at low prevalence levels in offshore Subdiv. 3Ps in 2005-06, but not in 2007-09 (unpublished data).

## **SUBDIVISION 3Ps INSHORE**

### **Biomass**

The commercial logbook and observer CPUE indices (Fig. 206) diverged in 2009. The decrease in observed CPUE likely reflects annual spatial inconsistencies in observer coverage. Similarly, the anomalous peak in 2004 in the observer index, inconsistent with the logbook CPUE for that year, is attributable to temporal bias in observer deployments in 2004. Commercial logbook CPUE declined from 2001 to a record low level in 2004-05, but has since recovered, achieving its highest level since 2001 in 2009.

The Subdiv. 3Ps inshore fishery primarily occurs in Placentia Bay to the east, with smaller amounts of effort in Fortune Bay to the west (Fig. 186). The commercial fishery in Fortune Bay has been closed since 2005, with a small-scale monitoring fishery occurring each year since. Observer deployments have been inconsistent amongst the inshore CMAs (Fig. 207), especially in recent years. For example, in 2009 nearly all coverage occurred in Fortune Bay (CMA 11E), whereas from 2006 to 2008 nearly all coverage occurred in Placentia Bay (CMA 10A).

The spatial coverage of the fishery has been inversely related to commercial CPUE since 1995 (Fig. 208). The percentage of available 5' x 5' cells occupied by the fishery has been decreasing in recent years while CPUE has been increasing. About 15-20 % of the available fishing grounds have been targeted each year since 2004.

Trends in commercial CPUE throughout the season (Fig. 209) indicated that CPUE was considerably higher throughout the season in 2009 than in any of the previous 4 years. A pattern of depletion throughout the season was evident during 2005 from the second week of fishing (week 8, Fig. 209a), following the removal of about 200 t (Fig. 209b). No such seasonal depletion has occurred in more recent years. There was little seasonal change in catch rate in both 2008 and 2009 following the first three weeks of fishing (Fig. 209a), despite much higher cumulative removals in those years than in the preceding years (Fig. 209b). This absence of seasonal depletion since 2005 may be related to the generally earlier seasons of recent years (Fig. 187).

Trends in the logbook mean catch rate from the STRAP-based CPUE index (Fig. 210) showed that both the 'all strata' and 'common strata' indices increased from 2005 to 2008 and were unchanged in 2009. This differed from the raw logbook CPUE, which increased considerably in 2009 (Fig. 206).

The exploitable biomass appears to have peaked. The CPS trap survey exploitable biomass index increased substantially from 2006 to 2008 but decreased slightly in 2009 (Fig. 211).

### **Production**

Recruitment: Recruitment has decreased for 2010, as reflected in a decrease in the CPS survey catch rate of new-shelled legal-sized adults (Fig. 212). However, prospects remain promising in the short term following 2010. The CPS trap survey pre-recruit biomass index peaked in 2007 and has since decreased, to remain above the 2004-06 level (Fig. 213). The pre-recruit biomass indices for this subdivision include a high proportion of small adults that will never recruit to the fishery.

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Reproduction: no data

### **Mortality**

Exploitation: The CPS trap survey-based exploitation rate index (Fig. 214) fluctuated without trend during 2005 to 2009. Data are insufficient to estimate a pre-recruit fishing mortality indices. Maintaining the current level of fishery removals would likely result in a slight increase in the exploitation rate in 2010.

Indirect fishing mortality: The percentage of the total catch discarded in the fishery (Fig. 215) was at its highest, about 60%, in 2005 and 2006. It has since decreased substantially to about 30% in 2008 implying reduced wastage of pre-recruits in the fishery. It increased slightly in 2009.

Natural mortality (BCD): Small-meshed trap data from the collaborative post-season trap survey indicates that BCD has occasionally been detected, at low prevalence levels, in inshore Subdiv. 3Ps.

### **Spatial variability: trends by CMA.**

CMA 10A (Placentia Bay): Commercial CPUE (Fig. 216) has steadily increased from its lowest level during 2004-06 to approach the 2002 level in 2009. The increased CPUE in recent years has resulted from increases in both the new-shelled and old-shelled components of crabs in the legal-size range, but particularly the old-shelled component, as indicated from observer sampling (Fig. 217). Unfortunately observer data were insufficient in 2009, but size frequencies from 2005 to 2008 (Fig. 218) show consistent increases in both sub-legal and legal-sized crabs, indicating that recruitment has been increasing to 2008. This is consistent with the increase in sub-legal-sized crabs, and consequently total crabs, discarded in recent years (Fig. 219). The decreased percentage of the catch discarded reflects the steady increase in catch rates of crabs kept and landed. Observed soft-shell crab incidence in the catch has been virtually zero since 2006 (Fig. 220), indicating little wastage by the fishery. The CPS trap survey agrees with the observer data that recent increases in the exploitable biomass have occurred from 2006 to 2008 due to a steady increase in abundance of both new-shelled and old-shelled legal-sized crabs (Fig. 221). However the CPS trap survey shows a decrease in catch rate of legal-sized crabs in 2009, due to a decrease in new-shelled legal-sized crabs. This suggests a decrease in recruitment to the exploitable biomass for the 2010 fishery. The decreases in new-shelled (including soft-shelled) legal-sized animals in the survey primarily occurred in crabs ranging about 95-102 mm CW (Fig. 222); crabs which would have most recently molted into the legal-size group.

CMA 11E (Fortune Bay): Fishery CPUE increased from 2003 to 2006 and has since changed little, remaining below 6 kg/trap (Fig. 216). Observer sampling shows that the catch in 2009 was comprised of roughly equal components of new and old-shelled legal-sized crabs, along with a high catch rate of undersized old-shelled crabs (Fig. 223). Trends in catch rates of new-shelled and old-shelled legal-sized crabs in the CPS trap survey have been synchronous since 2004 (Fig. 224), and similar to observer data, been composed of a roughly even split in catch rates by shell condition during 2008 and 2009. The CPS trap survey showed a decrease in total catch rate of legal-sized crabs in 2009 (Fig. 224), that occurred across all sizes of legal-sized crabs (Fig. 225). Small-meshed trap size distributions from this survey show that the majority of a large modal group of adolescents centered at about 58 mm CW in 2006 terminally molted as undersized adults from 2007 to 2009 (Fig. 226). The decreased catch rates of undersized

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adolescents from 2007 to 2009 implies reduced recruitment prospects for the fishery over the next few years.

CMA 11W (Pass Islands): Commercial CPUE initially peaked at 8 kg/trap in 1998, and declined to a low of 2 kg/trap in 2003 (Fig. 216). It has since increased steadily, to a high of 11k g/trap in 2009. There is no available information from which to infer recruitment prospects.

## **DIVISION 4R AND SUBDIVISION 3Pn**

### **The fishery**

Landings (Table 17, Fig. 227) have generally been comparable between inshore and offshore areas; TACs have not been taken since 2002. Offshore landings and effort have been variable in recent years after reaching historical lows in 2006. Inshore landings and effort have steadily declined since 2004, to historical lows in 2009.

Commercial CPUE (Table 17, Fig. 228) has been higher in inshore than in offshore areas but low relative to other divisions. Offshore CPUE has remained below the long-term average since 2003. Inshore CPUE has steadily declined since 2002 to its lowest level in 2009. CPUE was very low throughout most of the Division in 2009 (Fig. 229).

Offshore fishery distribution patterns have changed little since 2007, whereas the spatial distribution of inshore effort has been highly variable in recent years (Fig. 229). The fishery in offshore Div. 4R3Pn has been small in scale in recent years. The timing of the offshore fishery has changed little since 2006 (Fig. 230a), starting in early April and ending in early July. The temporal pattern of the inshore fishery has changed little since 2005 (Fig. 230b), starting in early April and finishing in late July, and the level of recorded logbook effort has been similar each year with the exception of 2006, when more of the fishing effort was captured in logbooks.

## **DIVISION 4R AND SUBDIVISION 3Pn OFFSHORE**

### **Biomass**

The exploitable biomass is low as reflected by poor fishery performance since 2004. Logbook CPUE has remained below 4 kg/trap since 2003, while VMS-based CPUE has gradually declined since 2004 (Fig. 231).

In contrast to other areas, CPUE and the spatial extent of the fishery have generally been directly related over most of the time series (Fig. 232). The spatial extent of the fishery has been in decline since 2000. In other areas, this is normally opposed by an increase in fishery performance, however in this case the continued poor fishery performance coupled with the spatial contraction of effort likely reflects the low exploitable biomass.

Commercial CPUE throughout the season (Fig. 233a) and in relation to the cumulative catch (Fig. 233b), have remained low since 2005; rarely exceeding 4 kg/trap. There was no evidence of seasonal depletion in 2009, as opposed to in previous years.

The exploitable biomass index from the summer trawl survey (Fig. 234) increased since 2007 to its highest level in 2009. Most of the largest survey catches are not included in this offshore biomass index because they occur within the inshore region (Fig. 235). Catch rates of legal-sized crabs from the CPS post-season trap survey (Fig. 236) decreased from 2007 to 2009 (Fig. 236), with a sharp reduction in catch rates of legal-sized old-shelled crabs from 2008 to 2009.

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## **Production**

**Recruitment:** Recruitment has been low in recent years, as reflected in the prolonged low exploitable biomass. The catch rate of legal-sized new-shelled crabs has not exceeded 1 kg./trap during each of the past three years (Fig. 236).

Size frequencies from large-meshed traps in the CPS survey (Fig. 237) and from offshore strata in the summer trawl survey (Fig. 238) show no clear trend in catch rates of undersized crabs. The pre-recruit biomass index from the summer trawl survey (Figs. 239 and 240) has remained unchanged since 2006.

Longer-term recruitment prospects are unknown.

**Reproduction:** No data.

## **Mortality**

**Exploitation:** Trends in fishing mortality on either the exploitable or pre-recruit population are unknown. The effect of maintaining the current level of fishery removals on the exploitation rate is unknown

**Indirect fishing mortality:** The observer data are insufficient to estimate the percentage of the catch discarded in the fishery or to infer wastage of pre-recruits.

**Natural mortality (BCD):** No data.

## **DIVISION 4R AND SUBDIVISION 3Pn INSHORE**

### **Biomass**

Annual trends in CPUE are influenced by the spatial variation of the fishery. Both CPUE and the spatial extent of the fishery increased sharply in 2002 before steadily declining to 2008 and 2007 respectively (Fig. 241). The spatial extent of the fishery increased in 2009, likely reflecting increased levels of effort in Bay St. George (Fig. 229). CPUE in 2009 was unchanged from the previous year.

Commercial logbook CPUE throughout the season and in relation to cumulative catch (Fig. 219) showed very limited seasonal depletion in 2009, as opposed to in most previous years.

Post-season trap survey catch rates show that the exploitable biomass has remained generally low over the time series (Fig. 243).

### **Production**

**Recruitment:** Recruitment is expected to remain low for 2010, as reflected in a low catch rate of new-shelled legal-sized crabs in the 2009 CPS trap survey (Fig. 244). It is expected to increase in the short term following 2010, but there is considerable spatial variability. The CPS trap survey catch rate of undersized crabs (Fig. 245) increased substantially in 2009. This increase was mostly due to one southern area.

**Reproduction:** No data.

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## **Mortality**

**Exploitation:** Trends in fishing mortality on either the exploitable or pre-recruit population are unknown. Maintaining the current level of fishery removals would have an unknown effect on the exploitation rate but may increase mortality on soft-shelled immediate pre-recruits in some areas in 2010.

**Indirect fishing mortality:** The observer data are insufficient to estimate the percentage of the catch discarded in the fishery or to infer wastage of pre-recruits.

**Natural mortality (BCD):** No data.

**Spatial variability:** Trends by CMA.

**CMA 12C + BSG (Bay St. George):** Commercial CPUE peaked at 14 kg./trap in 2002, but quickly declined to 3kg./trap by 2005 (Fig. 246). CPUE has since increased marginally, but remains low, at 3-4 kg/trap each year. The CPS trap survey catch rates of new-shelled legal-sized crabs peaked in 2008 (Fig. 247), which was followed by an increase in old-shelled legal-sized crabs in 2009. The relatively high catch rate of new-shelled crabs in 2008 was apparent across the full size range of legal-sized crabs, as well as undersized crabs (Fig. 248). Small-mesh trap data from this survey show a mode of adolescents approaching legal-size (Fig. 249), with the primary mode having progressed from 54 mm CW in 2008 to 70 mm CW in 2009. Similarly, the summer trawl survey captured high catch rates of 68-92 mm CW males in 2009 (Fig. 250). Short-term recruitment prospects appear promising. However, there is potential for an increased incidence of soft-shelled crab in the 2010 fishery, under the current scenario of low catch rates of large-sized crabs and increasing recruitment into the fishery.

**CMA 12E (Outer Bay of Islands):** Commercial CPUE peaked at 11 kg/trap in 2002 and has declined since, to a low of 3 kg/trap in 2009 (Fig. 246). The CPS survey catch rate of legal-sized crabs has declined since 2005, to a low in 2008-09 (Fig. 251). This reflects decreased catch rates of both new-shelled and old-shelled legal-size crabs of all sizes (Fig. 252).

**CMA 12F + BOI (Bay of Islands):** Commercial CPUE peaked at 12 kg/trap in 2004 and has since steadily declined, to about 4 kg/trap in 2009 (Fig. 246). The catch rate of new-shelled legal-sized crabs in the CPS survey has varied without trend since 2004, while the catch rate of old-shelled legal-sized crabs has decreased since 2005 (Fig. 253). Total catch rate of legal-sized crabs in the CPS was at its lowest in 2009, at less than 2 kg/trap. This reflects low catch rates of all sizes of legal-sized crabs (Fig. 254). Small-meshed trap data from the CPS survey have shown increased catch rates of a broad size range of sub-legal-sized crabs in 2008, followed by a decrease in 2009 (Fig. 255). Such sharp changes across a broad size range may be due to changes in the capture efficiency of traps.

**CMA 12D, CMA 12G, CMA 12H:** There are inadequate data to assess resource status. CMA 12G was under a voluntary fishing moratorium in 2009 (Fig. 246).

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Table 1. TAC (t) and Landings (t) by year for Division 2HJ3KLNOPs4R.

Year	TAC	Landings
1995	27,875	32,334
1996	34,864	37,967
1997	42,015	45,726
1998	49,225	52,677
1999	61,806	69,131
2000	51,169	55,434
2001	52,267	56,727
2002	56,981	59,418
2003	56,250	58,362
2004	53,590	55,675
2005	49,978	43,958
2006	46,233	47,238
2007	47,663	50,207
2008	54,338	52,775
2009	54,110	53,451

Table 2. TAC (t), Landings (t), Effort (trap hauls), and CPUE (kg/trap) by year for Division 2H.

Year	TAC	Landings	Effort	CPUE
2004		10	5,000	2
2005		67	9,306	7.2
2006		152	11,014	13.8
2007		193	16,083	12
2008	100	141	12,703	11.1
2009	100	86	9,663	8.9

Table 3. Fall trawl survey Exploitable Biomass Index by year for Division 2H, with 95% confidence intervals and mean catch rate.

Year	Biomass (t)	Confidence intervals (+/-)		Mean (kg/set)
		Upper	Lower	
1999	12	159	-136	0.02
2001	0	0	0	0
2004	138	321	-46	0.09
2006	315	1,037	-407	0.21
2008	103	472	-266	0.08

Table 4. Fall trawl survey Pre-recruit Biomass Index by year for Division 2H, with 95% confidence intervals and mean catch rate.

Year	Biomass (t)	Confidence intervals (+/-)		Mean (kg/set)
		Upper	Lower	
1999	0	0	0	0
2001	0	0	0	0
2004	421	980	-138	0.29
2006	142	285	-1	0.10
2008	67	320	-187	0.05

Table 5. TAC (t), Landings (t), Effort (trap hauls), and CPUE (kg/trap) by year for Division 2J.

Year	TAC	Landings	Effort	CPUE
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	284,583	14.4
1999	4,655	5,416	401,185	13.5
2000	3,411	3,682	304,298	12.1
2001	3,340	3,754	426,591	8.8
2002	3,381	3,520	577,049	6.1
2003	2,265	2,510	583,721	4.3
2004	1,780	1,915	531,944	3.6
2005	1,425	1,509	284,717	5.3
2006	1,425	1,987	242,317	8.2
2007	1,570	2,330	258,889	9.1
2008	2,366	2,408	231,538	10.7
2009	2,366	2,301	295,000	7.8

Table 6. Fall trawl survey Exploitable Biomass Index by year for Division 2J, with 95% confidence intervals and mean catch rate.

Year	Biomass	Confidence intervals (+/-)		Mean kg/set
	(t)	Upper	Lower	
1995	2,859	3,915	1,804	0.89
1996	6,283	8,454	4,112	1.85
1997	11,240	17,309	5,171	3.31
1998	11,097	16,734	5,460	3.27
1999	5,447	7,473	3,420	1.61
2000	3,734	4,750	2,717	1.11
2001	3,357	4,219	2,496	0.99
2002	878	1,389	367	0.26
2003	1,062	1,762	362	0.31
2004	1,406	2,068	743	0.41
2005	2,125	11,455	-7,204	0.63
2006	3,177	11,145	-4,791	0.94
2007	2,867	4,103	1,631	0.85
2008	2,034	3,022	1,046	0.60
2009	1,524	2,677	371	0.45

Table 7. Fall trawl survey Pre-recruit Biomass Index by year for Division 2J, with 95% confidence intervals and mean catch rate.

Year	Biomass	Confidence intervals (+/-)		Mean kg/set
	(t)	Upper	Lower	
1995	1,812	2,704	920	0.57
1996	3,047	4,439	1,654	0.90
1997	3,121	4,399	1,843	0.92
1998	3,113	4,500	1,727	0.92
1999	1,043	2,122	-36	0.31
2000	1,334	1,979	690	0.40
2001	1,334	3,239	-571	0.39
2002	616	3,068	-1,837	0.18
2003	966	1,382	550	0.28
2004	4,661	35,288	-25,965	1.37
2005	1,750	3,883	-383	0.52
2006	2,253	4,963	-457	0.66
2007	1,331	3,063	-400	0.39
2008	1,219	4,912	-2,474	0.36
2009	1,730	11,920	-8,460	0.51

Table 8. TAC (t), Landings (t), Effort (trap hauls), and CPUE (kg/trap) by year for Division 3K inshore and offshore.

Year	TAC inshore	Landings inshore	Effort inshore	CPUE inshore	TAC offshore	Landings offshore	Effort offshore	CPUE offshore
1995	1,950	1,950	237,805	8.2	9,500	10,376	741,143	14.0
1996	3,450	3,267	510,469	6.4	9,500	10,943	835,344	13.1
1997	3,450	3,122	538,276	5.8	10,850	11,674	871,194	13.4
1998	3,040	2,781	487,895	5.7	12,700	14,103	946,510	14.9
1999	3,242	3,460	865,000	4.0	14,950	17,898	1,345,714	13.3
2000	2,275	2,328	485,000	4.8	11,218	13,056	1,186,909	11.0
2001	2,475	2,757	306,333	9.0	11,218	12,519	1,251,900	10.0
2002	3,195	3,481	429,753	8.1	12,183	12,870	1,191,667	10.8
2003	3,425	3,585	535,075	6.7	12,183	12,922	1,242,500	10.4
2004	3,410	3,527	665,472	5.3	12,183	12,943	1,703,026	7.6
2005	3,115	2,707	575,957	4.7	9,745	5,972	853,143	7.0
2006	2,635	2,728	426,250	6.4	7,795	7,984	694,261	11.5
2007	2,820	3,056	315,052	9.7	8,930	9,215	626,871	14.7
2008	3,455	3,456	300,522	11.5	11,620	11,612	699,518	16.6
2009	3,695	3,585	426,786	8.4	12,780	12,599	1,188,585	10.6

Table 9. Fall trawl survey Exploitable Biomass Index by year for Division 3K, with 95% confidence intervals and mean catch rate.

Year	Biomass (t)	Confidence intervals (+/-)		Mean kg/set
		Upper	Lower	
1995	11,620	14,496	8,744	2.65
1996	20,956	25,214	16,697	4.78
1997	19,635	23,862	15,409	4.48
1998	19,693	24,138	15,248	4.49
1999	9,011	11,764	6,258	2.05
2000	10,345	13,099	7,591	2.51
2001	12,006	16,575	7,437	2.74
2002	9,369	12,111	6,627	2.14
2003	3,808	4,796	2,820	0.87
2004	5,918	7,530	4,306	1.35
2005	7,274	9,299	5,250	1.66
2006	11,268	13,841	8,695	2.68
2007	17,584	23,655	11,513	4.01
2008	16,472	21,758	11,186	3.76
2009	8,192	10,577	5,808	1.87

Table 10. Fall trawl survey Pre-recruit Biomass Index by year for Division 3K, with 95% confidence intervals and mean catch rate.

Year	Biomass (t)	Confidence intervals (+/-)		Mean kg/set
		Upper	Lower	
1995	7,307	9,912	4,701	1.67
1996	10,954	14,721	7,187	2.50
1997	14,086	18,710	9,462	3.21
1998	10,343	14,364	6,323	2.36
1999	3,655	5,115	2,195	0.83
2000	9,948	13,703	6,194	2.42
2001	6,930	9,199	4,662	1.58
2002	5,372	7,620	3,123	1.22
2003	2,538	4,144	932	0.58
2004	5,729	9,580	1,877	1.31
2005	6,060	8,296	3,823	1.38
2006	10,197	15,250	5,145	2.43
2007	5,506	7,557	3,456	1.26
2008	8,448	12,646	4,250	1.93
2009	5,919	8,146	3,692	1.35

Table 11. TAC (t), Landings (t), Effort (trap hauls) and CPUE (kg/trap) by year for Division 3LNO inshore and offshore.

Year	TAC inshore	Landings inshore	Effort inshore	CPUE inshore	TAC offshore	Landings offshore	Effort offshore	CPUE offshore
1995	6,475	6,795	471,875	14.4	5,175	7,212	389,577	18.5
1996	7,675	7,922	665,714	11.9	7,100	8,494	536,437	15.9
1997	5,850	6,398	627,255	10.2	13,075	14,293	899,861	15.9
1998	7,225	6,882	583,220	11.8	13,250	15,111	872,436	17.3
1999	5,350	5,453	482,566	11.3	24,275	27,329	1,515,188	18
2000	4,633	4,731	407,845	11.6	20,502	22,083	1,148,688	19.2
2001	5,615	5,543	518,037	10.7	20,465	22,630	1,198,624	18.9
2002	6,540	6,524	582,500	11.2	22,333	23,528	1,258,622	18.7
2003	6,774	6,814	841,235	8.1	23,703	24,828	1,451,403	17.1
2004	6,255	6,421	823,205	7.8	23,703	24,676	1,702,536	14.5
2005	6,045	6,114	745,610	8.2	23,703	23,557	1,691,310	14
2006	6,095	6,229	648,854	9.6	23,703	24,514	1,778,564	13.8
2007	6,105	6,485	600,463	10.8	23,703	24,405	2,062,439	11.8
2008	7,033	6,823	573,361	11.9	24,148	23,375	2,117,352	11
2009	7,210	7,091	638,829	11.1	21,769	21,942	1,961,724	11.2

Table 12. Fall trawl survey Exploitable Biomass Index by year for Division 3LNO, with 95% confidence intervals and mean catch rate (Survey was incomplete in 2004).

Year	Biomass	Confidence intervals (+/-)		Mean
	(t)	Upper	Lower	kg/set
1995	30,394	39,110	21,678	2.77
1996	38,069	45,814	30,325	3.50
1997	25,693	31,731	19,654	2.34
1998	35,008	43,799	26,217	3.19
1999	21,663	26,221	17,105	1.99
2000	16,036	20,462	11,611	1.48
2001	24,310	31,040	17,580	2.21
2002	20,015	26,369	13,661	1.82
2003	16,053	20,720	11,386	1.46
2004				
2005	16,570	28,758	4,381	1.51
2006	5,235	6,815	3,654	0.48
2007	10,018	14,918	5,118	0.91
2008	15,501	20,008	10,994	1.41
2009	23,046	32,661	13,431	2.10

Table 13. Fall trawl survey Pre-recruit Biomass Index by year for Division 3LNO, with 95% confidence intervals and mean catch rate (Survey was incomplete in 2004).

Year	Biomass	Confidence intervals (+/-)		Mean
	(t)	Upper	Lower	kg/set
1995	15,948	21,312	10,584	1.45
1996	26,948	37,286	16,610	2.48
1997	16,583	62,496	-29,330	1.51
1998	20,984	41,200	767	1.91
1999	11,445	16,510	6,380	1.05
2000	10,731	14,463	6,999	0.99
2001	9,488	12,470	6,506	0.86
2002	5,854	8,940	2,769	0.53
2003	8,617	14,855	2,379	0.79
2004				
2005	4,805	7,486	2,124	0.44
2006	2,752	4,044	1,460	0.25
2007	8,368	11,476	5,259	0.76
2008	17,000	24,025	9,976	1.55
2009	19,678	27,294	12,061	1.80

Table 14. TAC (t), Landings (t), Effort (trap hauls) and CPUE (kg/trap) by year for Subdivision 3Ps inshore and offshore.

Year	TAC inshore	Landings inshore	Effort inshore	CPUE inshore	TAC offshore	Landings offshore	Effort offshore	CPUE offshore
1995	1,200	1,035	161,719	6.4	525	894	45,846	19.5
1996	1,350	1,309	73,955	17.7	1,700	1,665	99,701	16.7
1997	2,400	2,305	187,398	12.3	2,200	2,370	117,910	20.1
1998	2,500	3,367	333,366	10.1	3,700	3,257	134,033	24.3
1999	3,701	3,598	342,667	10.5	4,298	4,307	177,975	24.2
2000	3,300	3,501	350,100	10	4,400	4,386	212,913	20.6
2001	3,200	3,436	279,350	12.3	4,400	4,403	271,790	16.2
2002	3,200	3,280	410,000	8	4,400	4,357	360,083	12.1
2003	2,520	2,369	415,614	5.7	3,565	3,750	451,807	8.3
2004	1,630	1,302	372,000	3.5	2,765	3,418	421,975	8.1
2005	1,300	705	207,353	3.4	2,800	2,468	398,065	6.2
2006	975	781	200,256	3.9	2,070	2,324	309,867	7.5
2007	975	1,146	216,226	5.3	2,270	2,816	375,467	7.5
2008	1,128	1,426	171,807	8.3	3,230	3,097	279,009	11.1
2009	1,500	1,939	164,322	11.8	3,780	3,620	280,620	12.9

Table 15. Spring trawl survey Exploitable Biomass Index by year for Subdivision 3Ps, with 95% confidence intervals and mean catch rate (Survey was incomplete in 2006).

Year	Biomass	Confidence intervals (+/-)		Mean
	(t)	Upper	Lower	kg/set
1996	4,677	8,127	1,227	1.81
1997	1,161	1,759	562	0.45
1998	1,548	2,395	700	0.60
1999	2,563	4,471	654	0.99
2000	932	1,404	459	0.36
2001	516	820	212	0.20
2002	442	643	241	0.17
2003	443	1176	-291	0.12
2004	223	325	120	0.09
2005	523	830	216	0.20
2006				
2007	252	418	87	0.10
2008	396	592	199	0.15
2009	965	1,689	242	0.37



Table 16. Spring trawl survey Pre-recruit Biomass Index by year for Subdivision 3Ps, with 95% confidence intervals and mean catch rate (survey was incomplete in 2006).

Year	Biomass (t)	Confidence intervals (+/-)		Mean kg/set
		Upper	Lower	
1996	1,908	3,751	66	0.74
1997	303	544	63	0.12
1998	624	1,140	108	0.24
1999	328	469	188	0.13
2000	223	434	13	0.09
2001	328	651	5	0.13
2002	326	506	147	0.13
2003	99	198	0	0.03
2004	222	357	87	0.09
2005	452	646	257	0.18
2006				
2007	803	1,805	-199	0.31
2008	1,085	2,996	-827	0.42
2009	1,453	2,416	490	0.56

Table 17. TAC (t), Landings (t), Effort (trap hauls) and CPUE (kg/trap) by year for Division 4R3Pn inshore and offshore.

Year	TAC inshore	Landings inshore	Effort inshore	CPUE inshore	TAC offshore	Landings offshore	Effort offshore	CPUE offshore
1998	1,310	1,067	197,593	5.4				3.7
1999	690	988	161,967	6.1	645	629	149,762	4.2
2000	785	954	190,800	5	645	674	134,800	5
2001	909	1,026	190,000	5.4	635	649	147,500	4.4
2002	904	878	100,920	8.7	845	977	195,400	5
2003	1,050	954	117,778	8.1	845	608	168,889	3.6
2004	1,016	877	139,206	6.3	838	584	182,500	3.2
2005	1,000	511	81,111	6.3	845	348	108,750	3.2
2006	860	460	85,185	5.4	675	79	22,571	3.5
2007	750	368	85,581	4.3	540	194	77,600	2.5
2008	718	250	65,789	3.8	540	131	37,429	3.5
2009	483	199	53,784	3.7	419	88	31,429	2.8

Table 18. Summer trawl survey Exploitable Biomass Index by year for Division 4R3Pn, with 95% confidence intervals and mean catch rate.

Year	Biomass (t)	Confidence intervals (+/-)		Mean kg/set
		Upper	Lower	
2004	111	292	-70	0.14
2005	82	273	-109	0.13
2006	180	431	-72	0.21
2007	92	261	-77	0.11
2008	177	555	-202	0.2
2009	229	1,099	-640	0.26

Table 19. Summer trawl survey Pre-recruit Biomass Index by year for Division 4R3Pn, with 95% confidence intervals and mean catch rate.

Year	Biomass (t)	Confidence intervals (+/-)		Mean kg/set
		Upper	Lower	
2004	195	917	-527	0.24
2005	14	74	-46	0.02
2006	46	116	-24	0.05
2007	54	260	-151	0.06
2008	52	121	-17	0.06
2009	74	337	-189	0.08

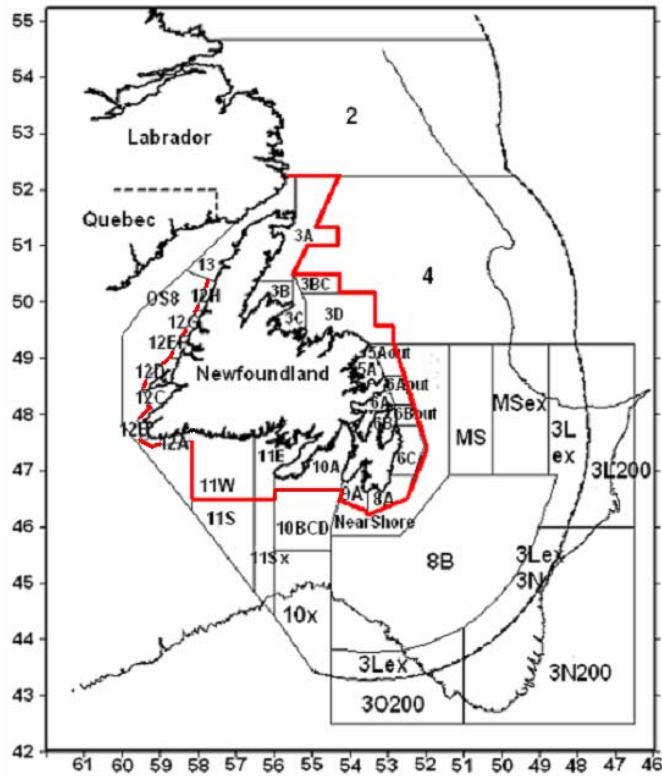


Figure 1. Newfoundland and Labrador Snow Crab Management areas. (Red line shows division of inshore vs. offshore CMAs.)

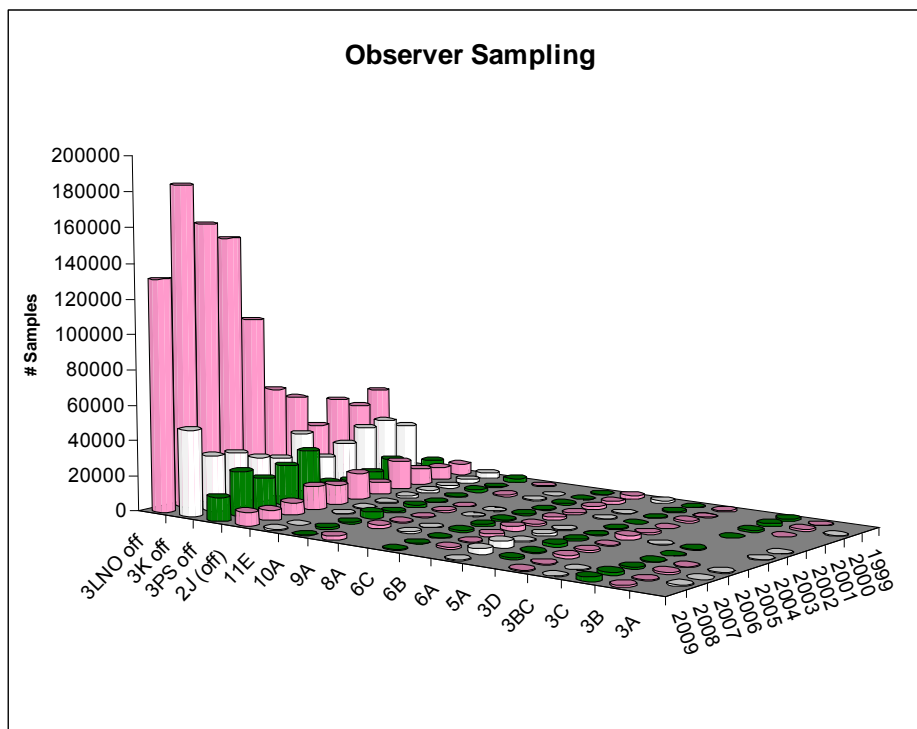


Figure 2. Observer sampling by crab management area (CMA) and year. Data pooled for offshore crab management areas in each Division.

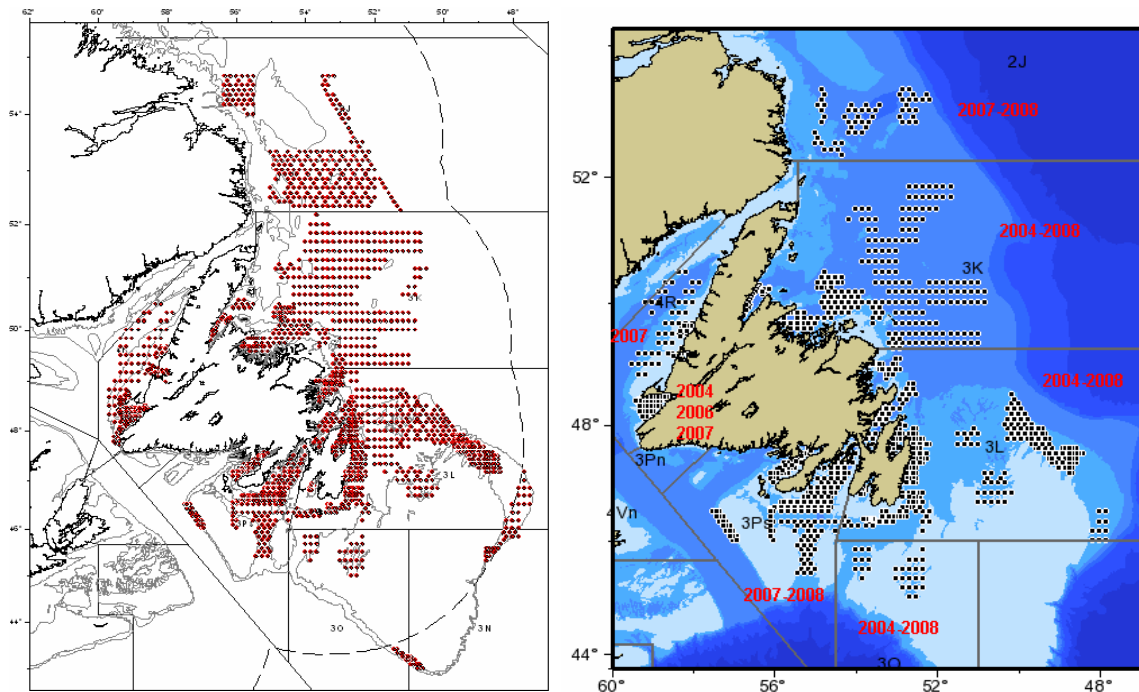


Figure 3. Industry – DFO Collaborative Post-Season trap survey design (left) and core stations used for data analyses (right). The years upon which core stations in each area were based are shown in red.

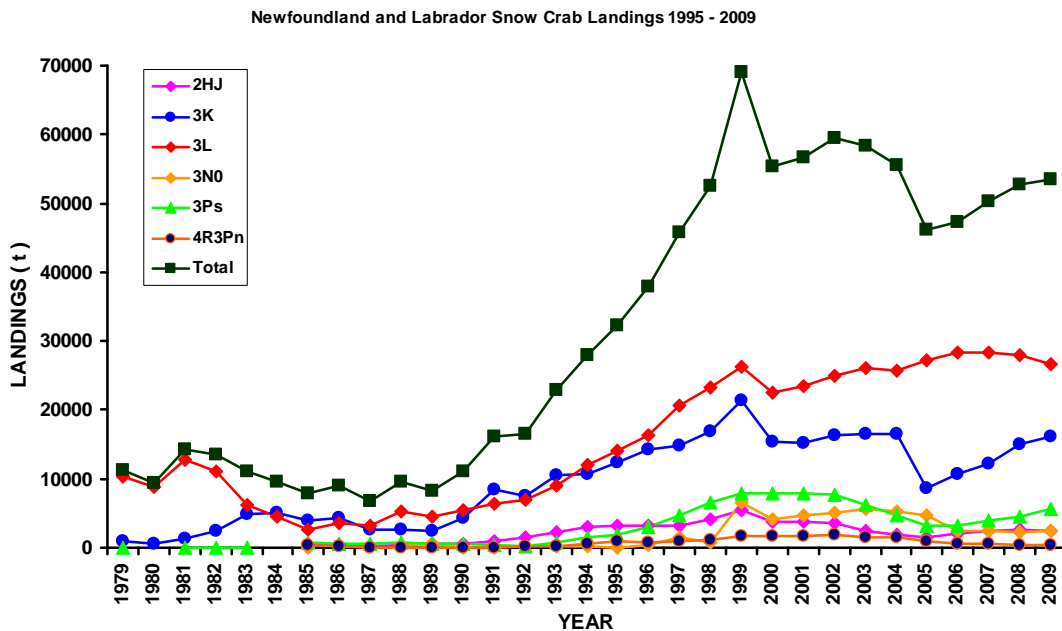


Figure 4. Trends in landings by NAFO Division and in total.

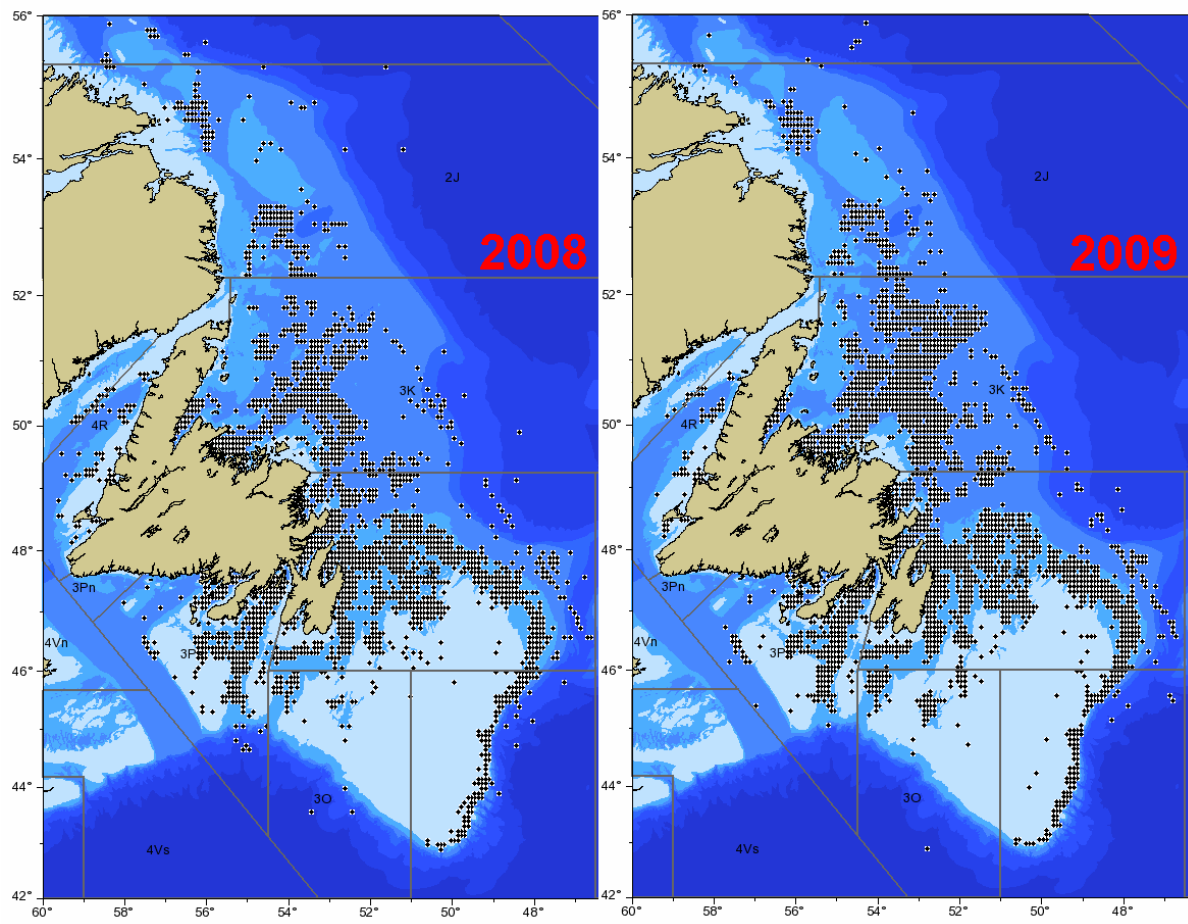


Figure 5. Spatial distribution of commercial fishing effort (set locations) during 2008 (left) and 2009 (right).

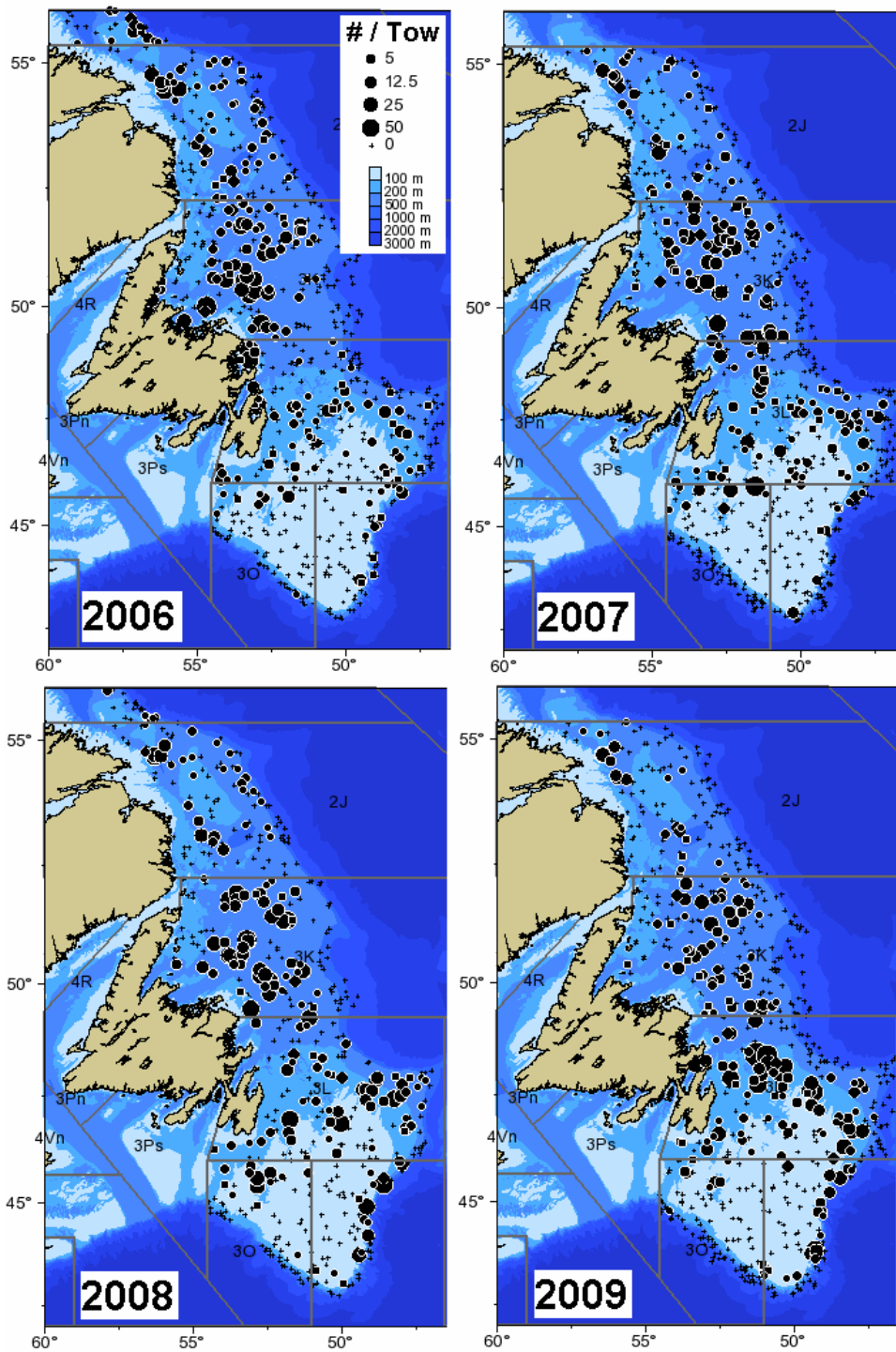


Figure 6. Distribution of exploitable males (>94 mm CW adults) from fall Division 2HJ3KLNO bottom trawl surveys from 2006 to 2009.

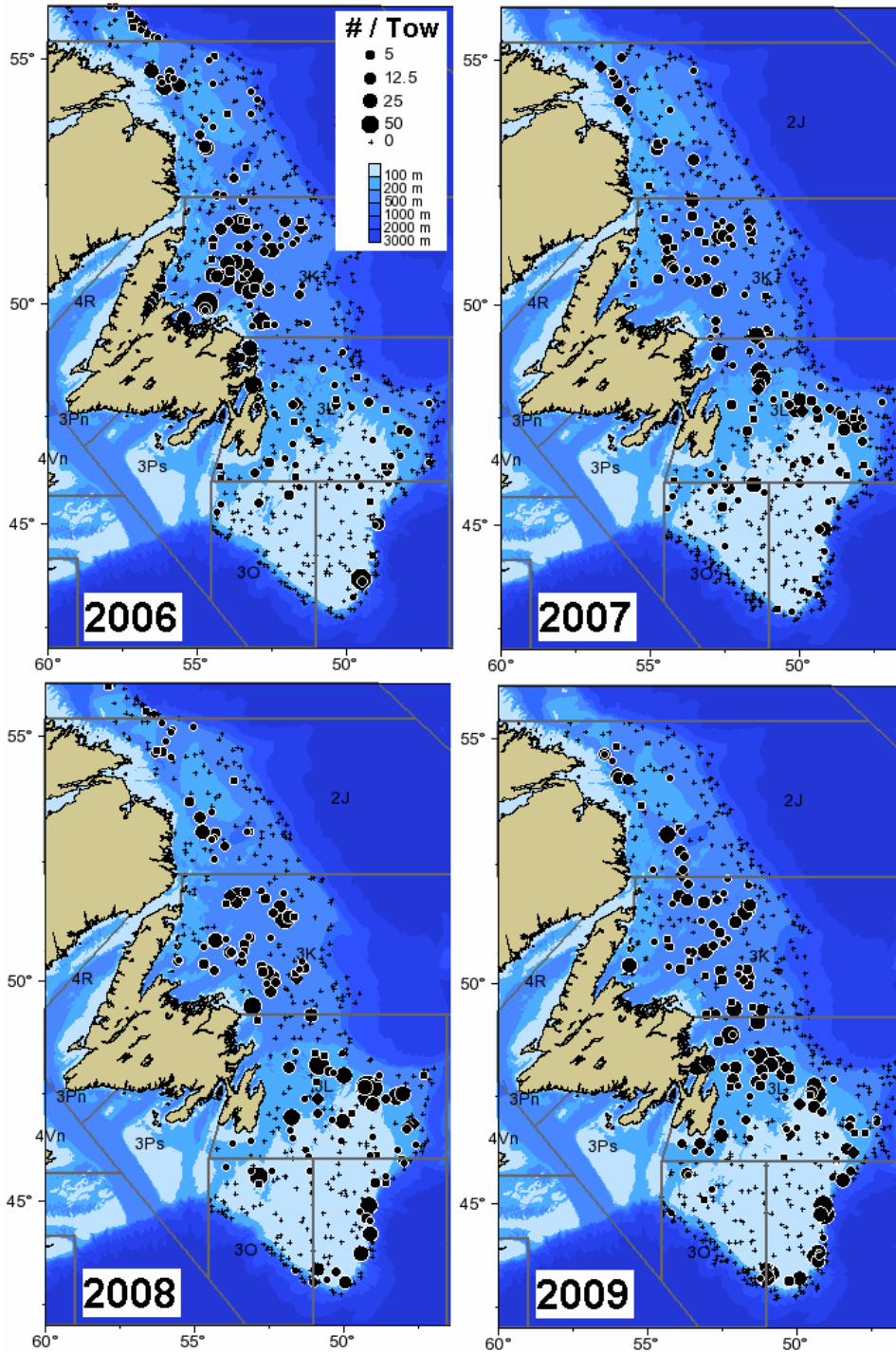


Figure 7. Distribution of pre-recruit males (>75 mm CW adolescents) from fall Division 2HJ3KLNO bottom trawl surveys from 2006 to 2009.

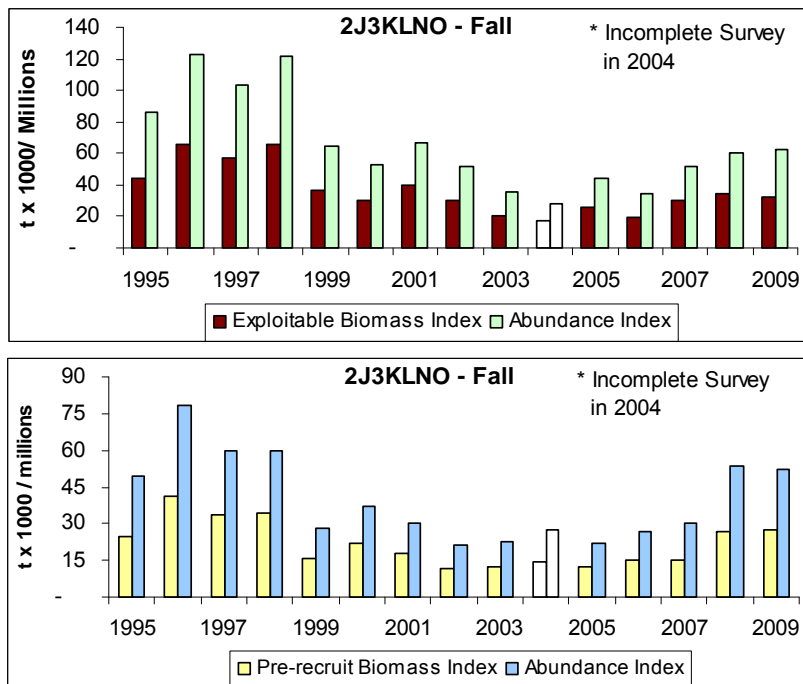


Figure 8. Trends in the fall trawl survey exploitable biomass and abundance indices (above) and pre-recruit biomass and abundance indices (below), for Division 2J3KLNO.

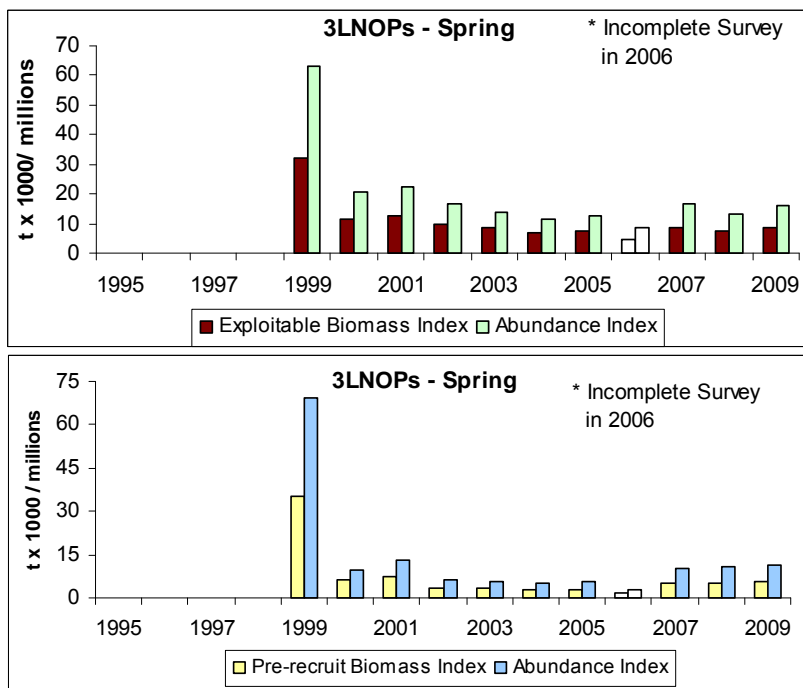


Figure 9. Trends in the spring trawl survey exploitable biomass and abundance indices (above) and pre-recruit biomass and abundance indices (below), for Division 3LNOPs.



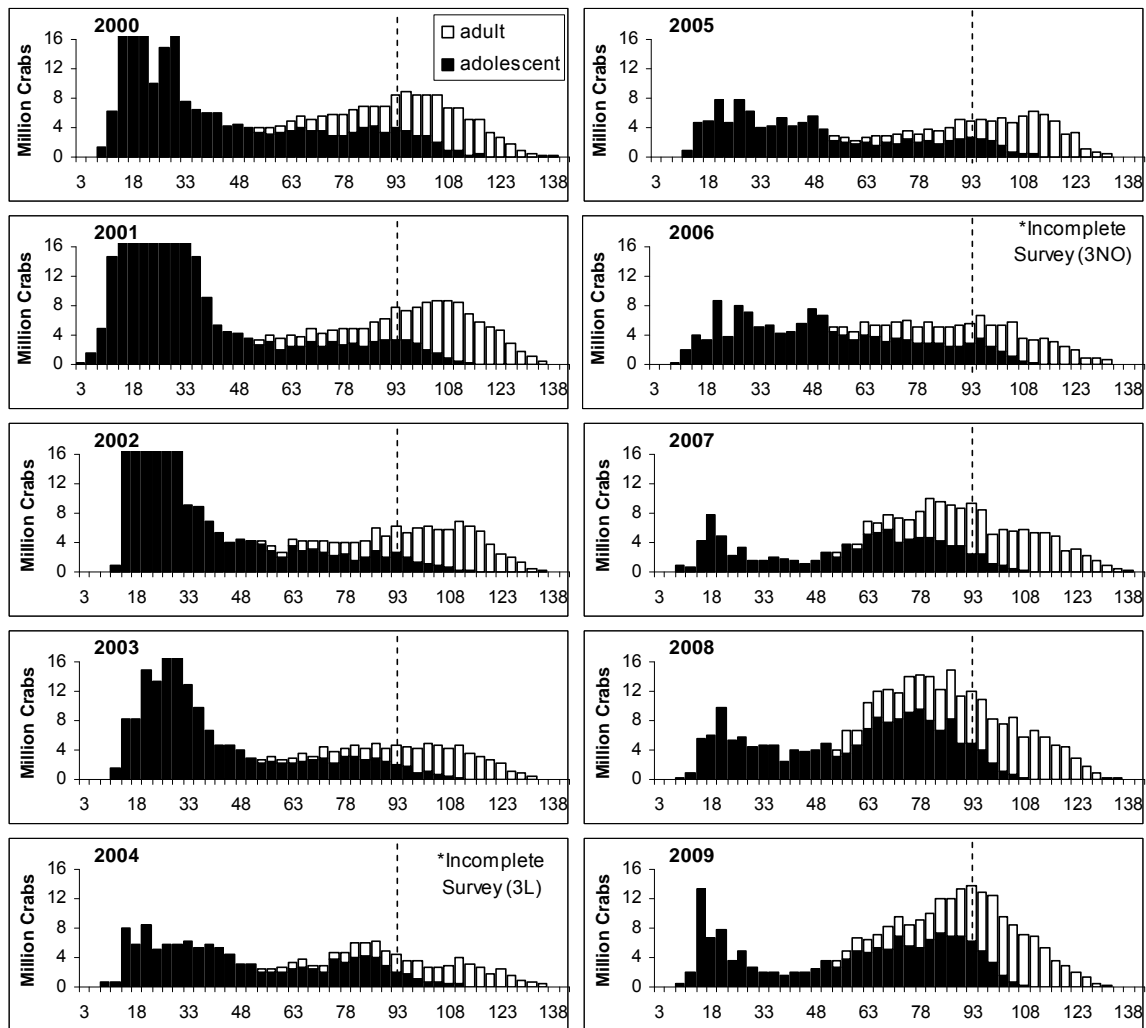


Figure 10. Distribution of abundance (index) by carapace width for Division 2J3KLNO juveniles plus adolescents (dark bars) versus adults (open bars) from fall trawl surveys. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line.

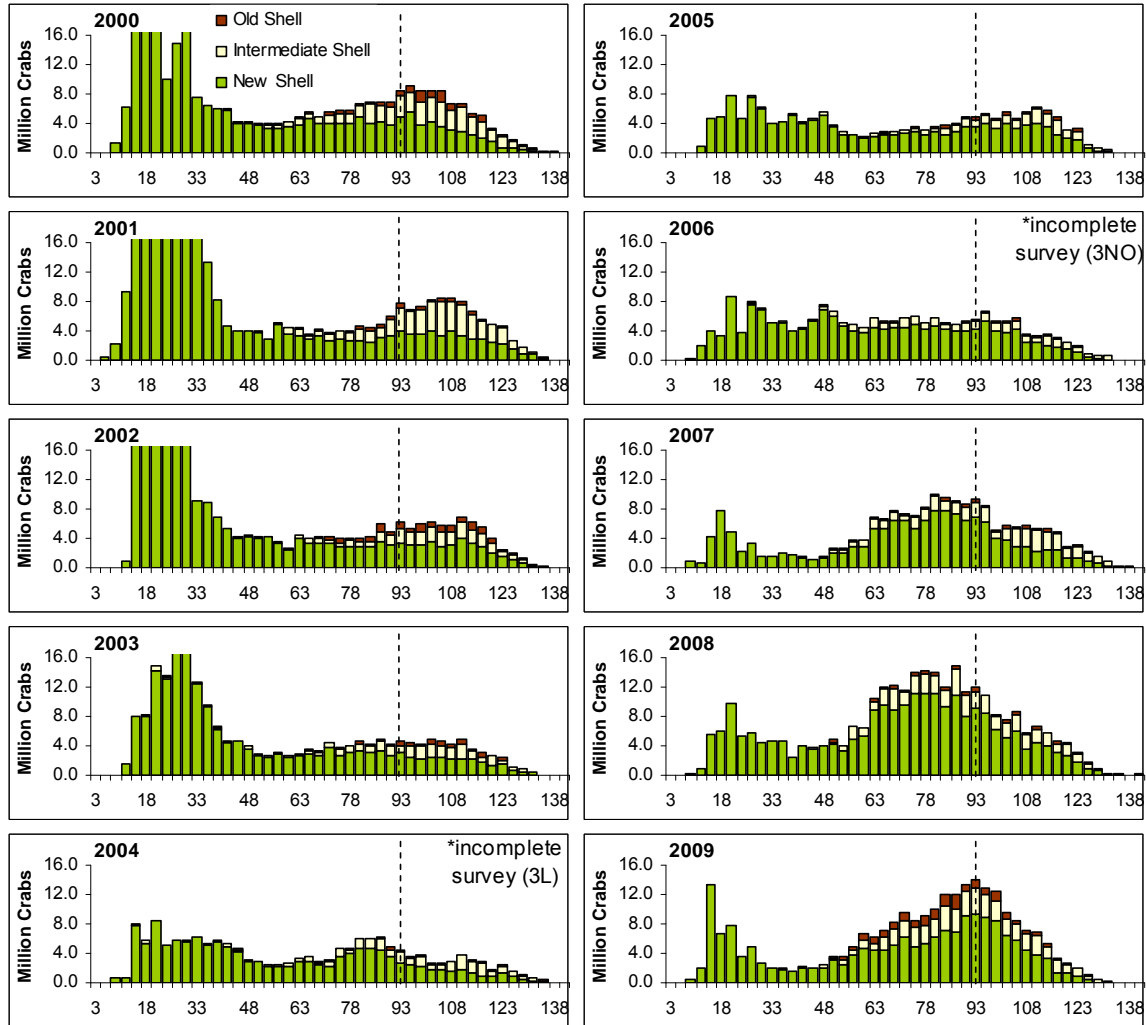


Figure 11. Distribution of abundance (index) by carapace width and shell condition from fall trawl surveys for Division 2J3KLNO. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line.

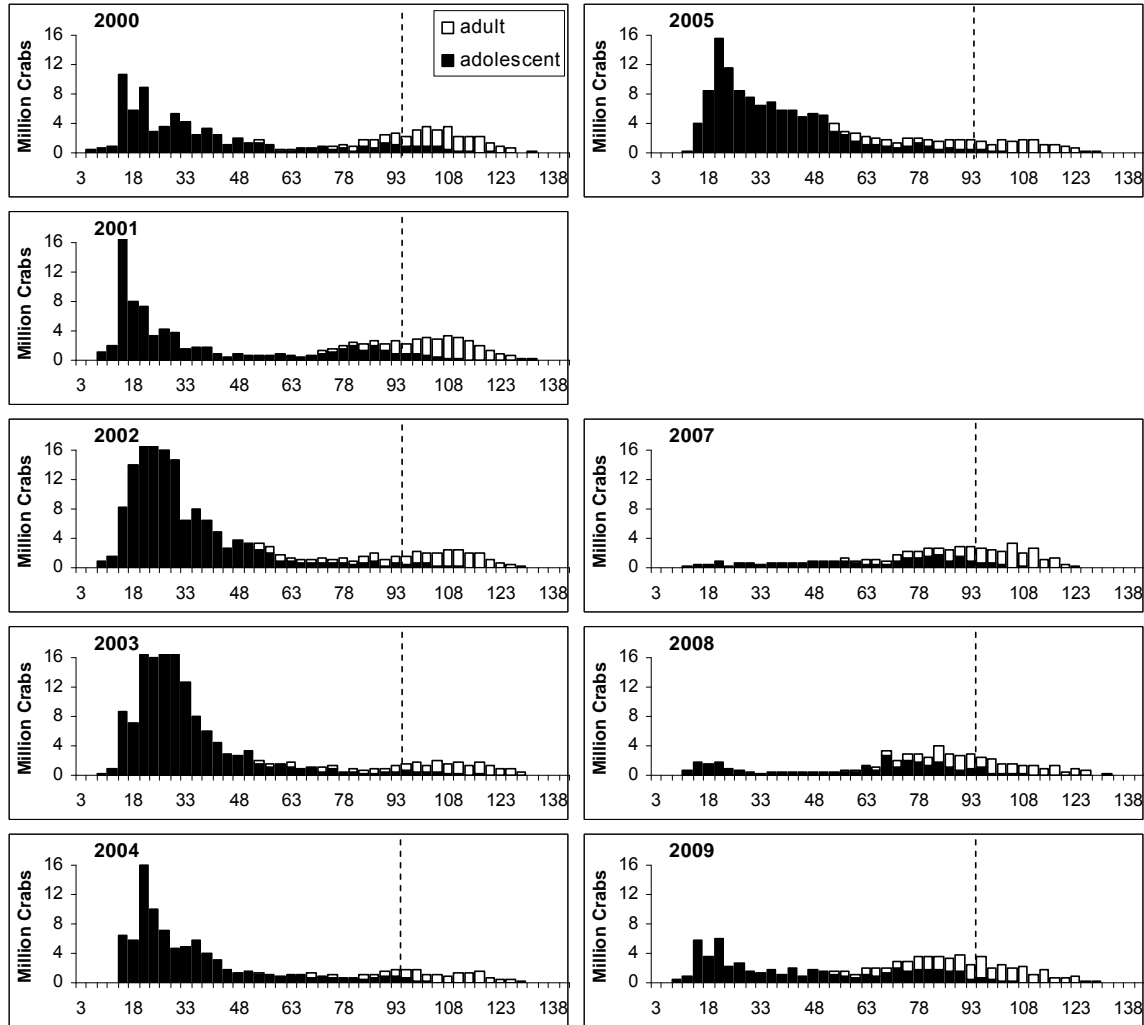


Figure 12. Distribution of abundance (index) by carapace width for Division 3LNOPs juveniles plus adolescents (dark bars) versus adults (open bars) from spring trawl surveys. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line. The survey was incomplete in 2006.

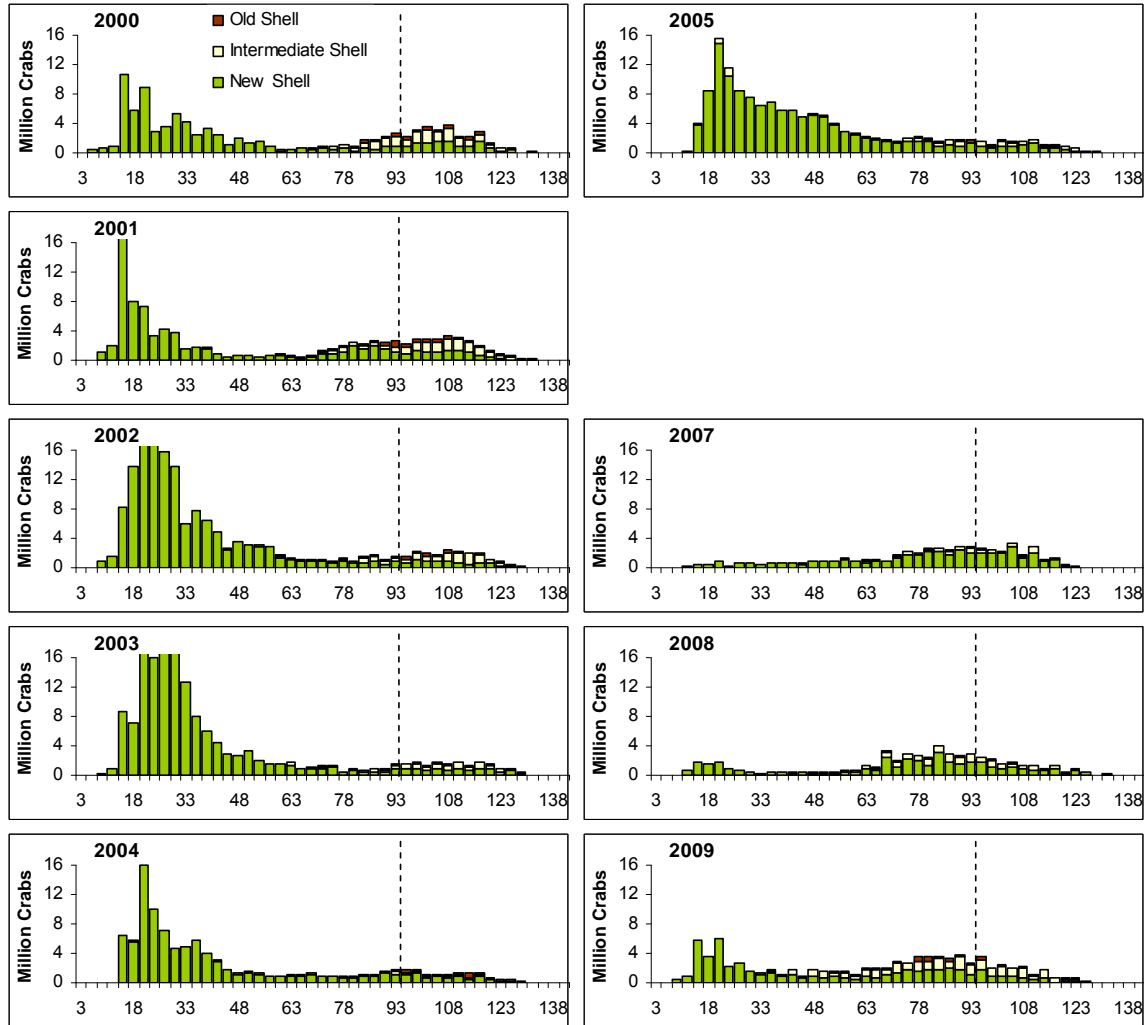


Figure 13. Distribution of abundance (index) by carapace width and shell condition from spring trawl surveys for Division 3LNOPs. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line. The survey was incomplete in 2006.

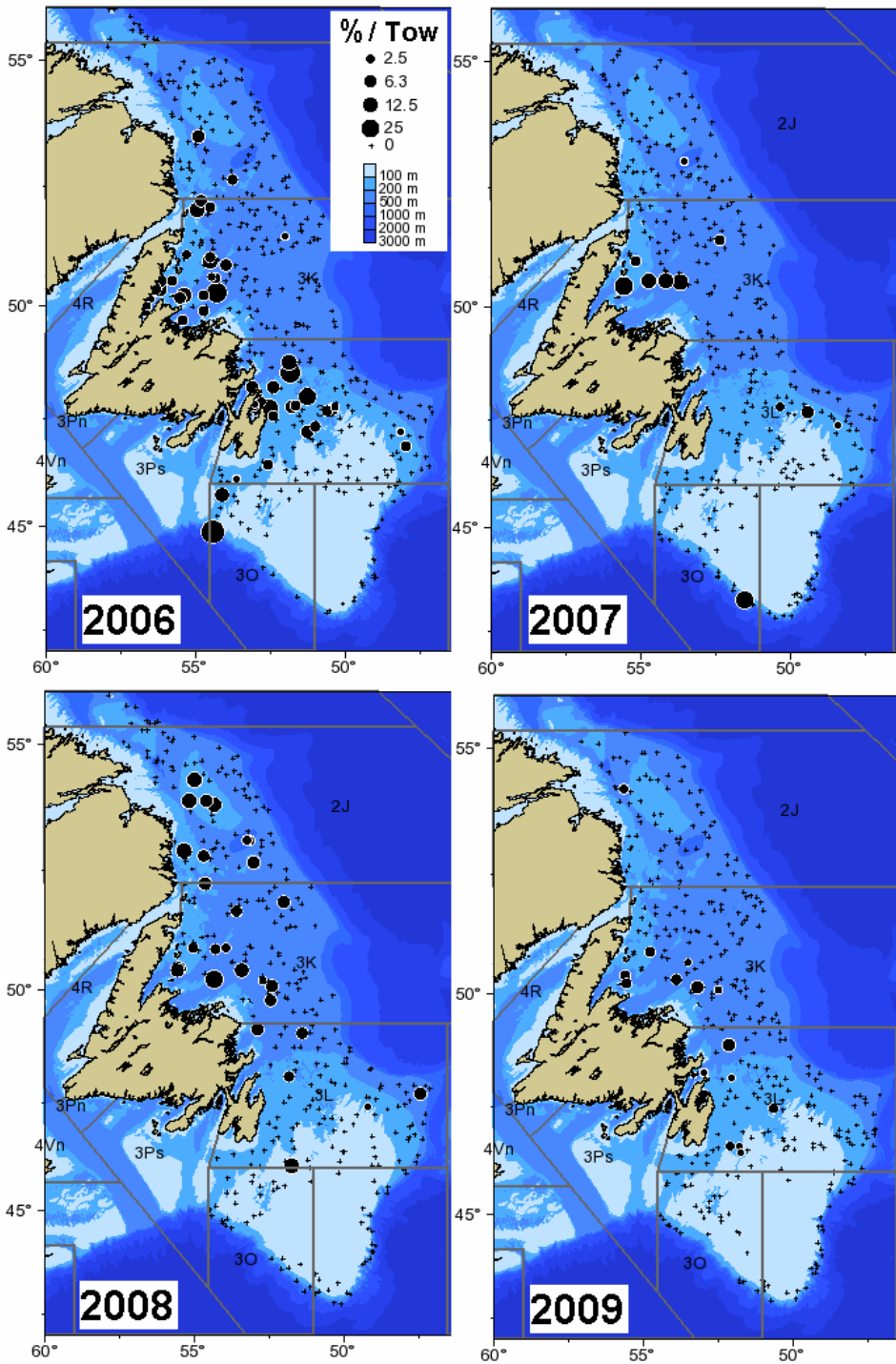


Figure 14: Distribution by year of fall trawl survey sets where BCD was encountered (closed circles) versus all other sets (+ symbols) from 2006 to 2009.

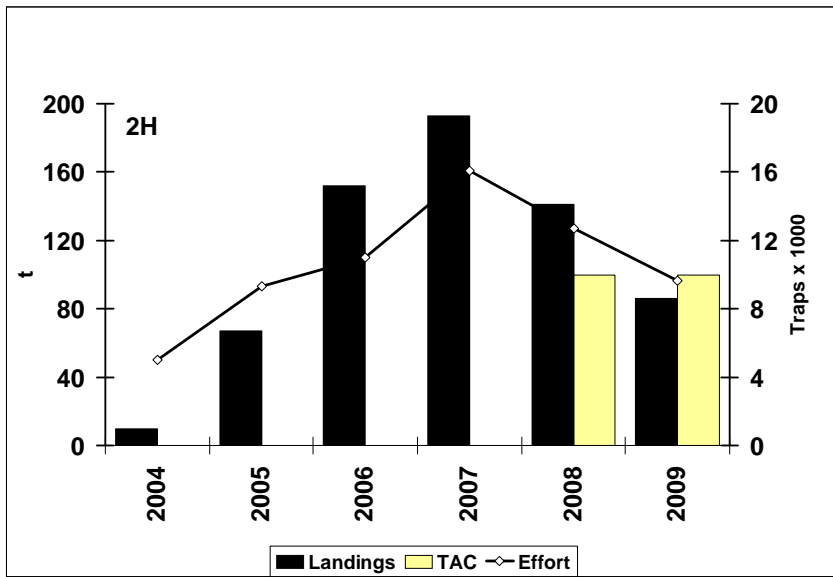


Figure 15. Trends in Division 2H landings, TAC, and fishing effort.

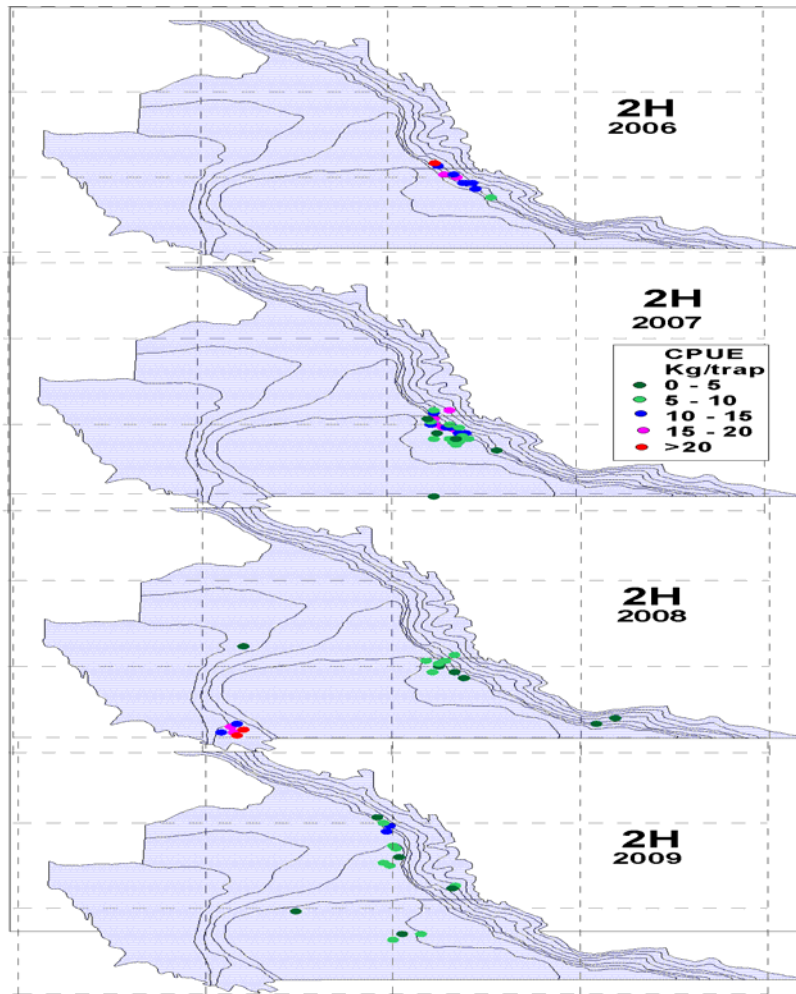


Figure 16. Spatial distribution of Division 2H commercial CPUE by year.

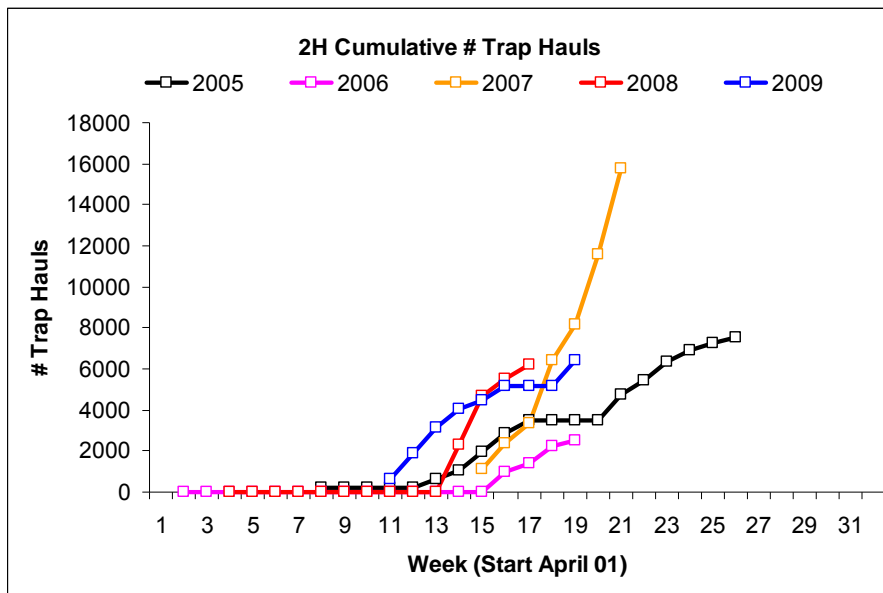


Figure 17. Seasonal trends in weekly fishing effort for Division 2H during 2005-09.

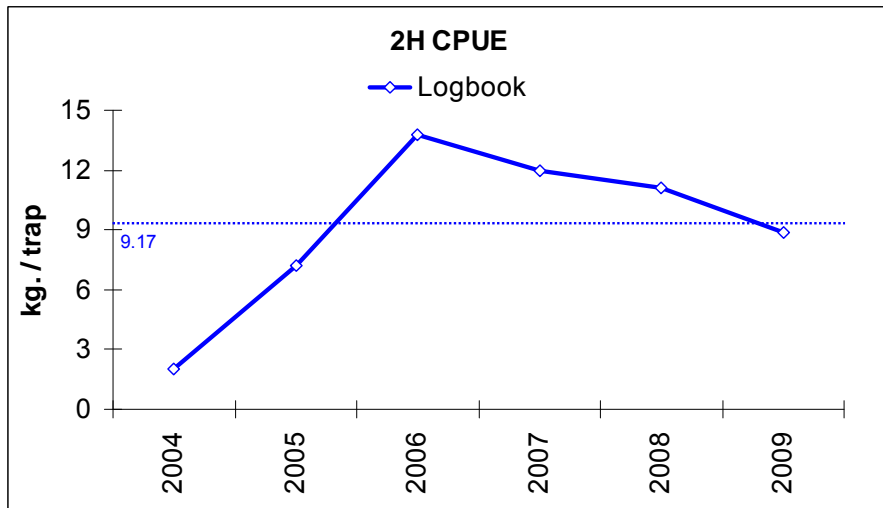


Figure 18: Trends in Division 2H commercial CPUE in relation to the long-term average (dotted line).

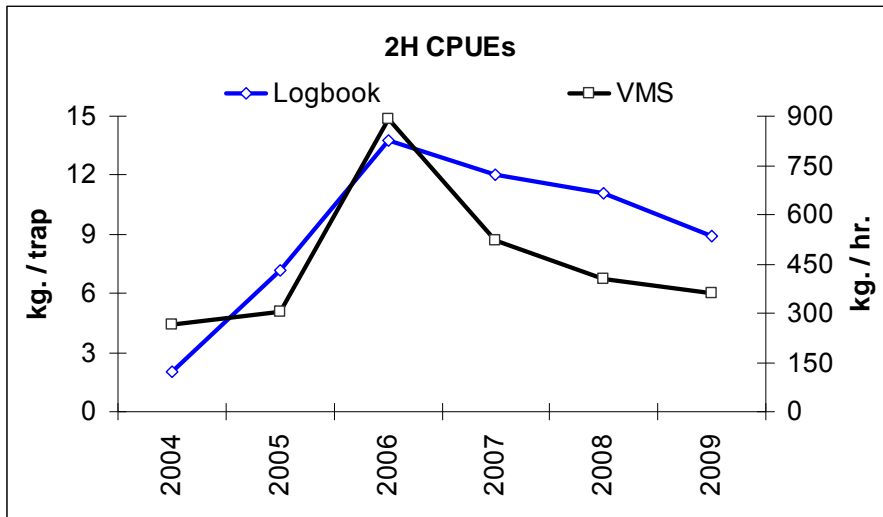


Figure 19. Trends in commercial logbook-based and VMS-based CPUE in the Division 2H fishery.

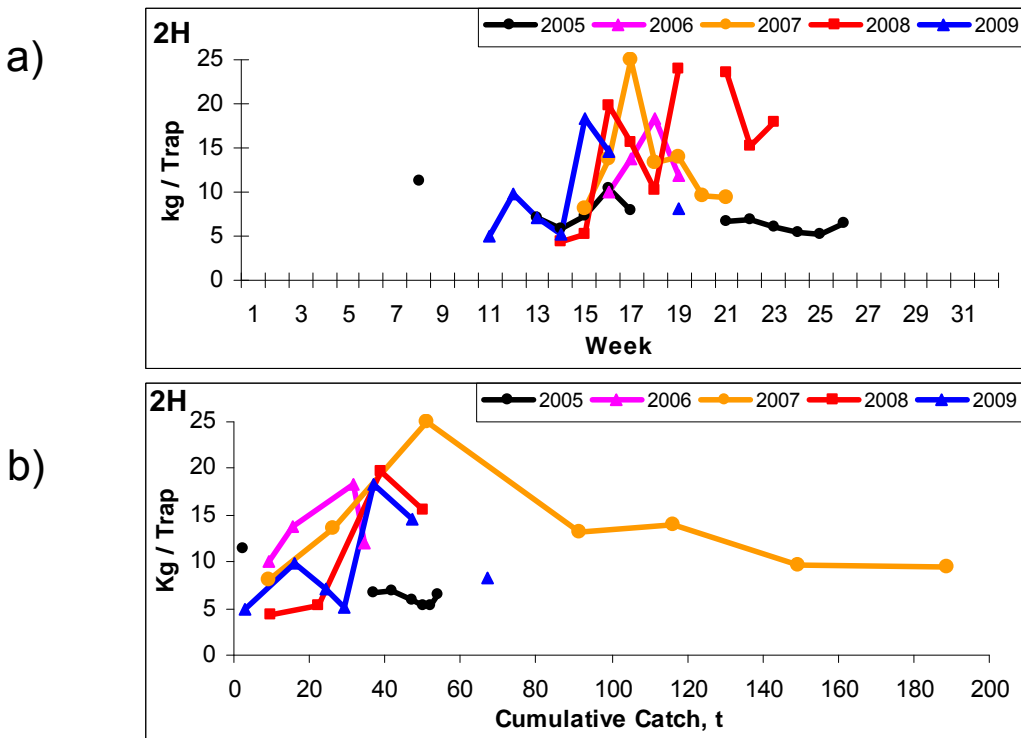


Figure 20. Seasonal trends in logbook-based CPUE for Division 2H during 2005-2009; (a) by week, and (b) in relation to cumulative catch.



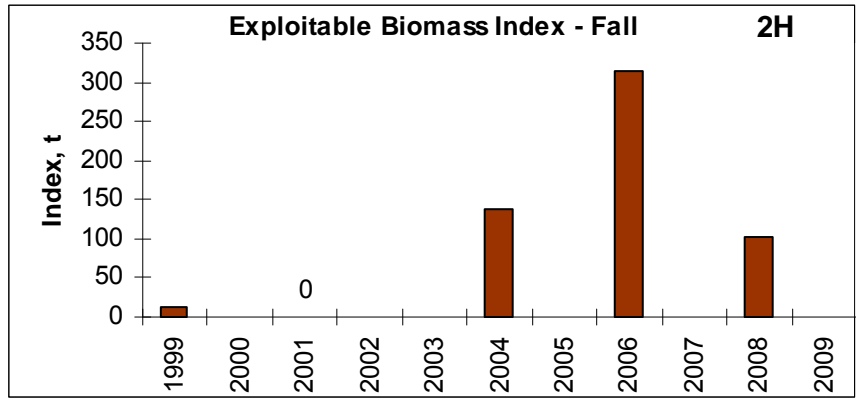


Figure 21. Trends in the Division 2H fall trawl survey exploitable biomass index.

a

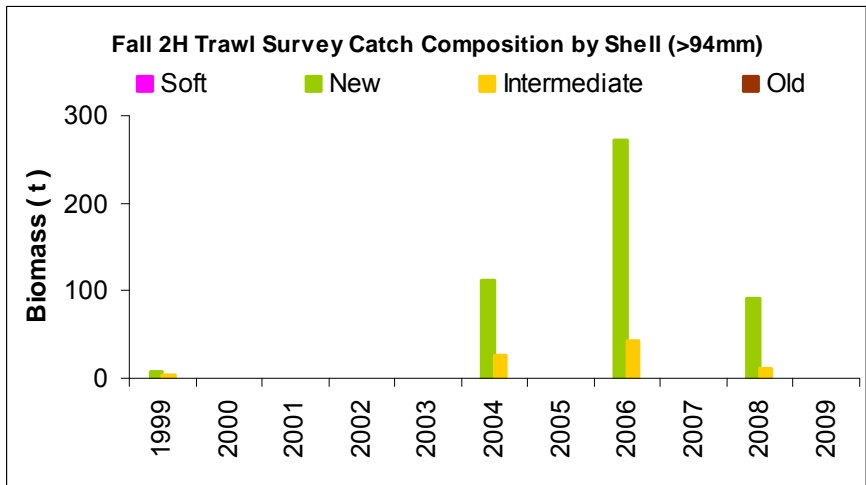


Figure 22. Trends, by shell condition, in legal-sized males for Division 2H from fall trawl surveys.

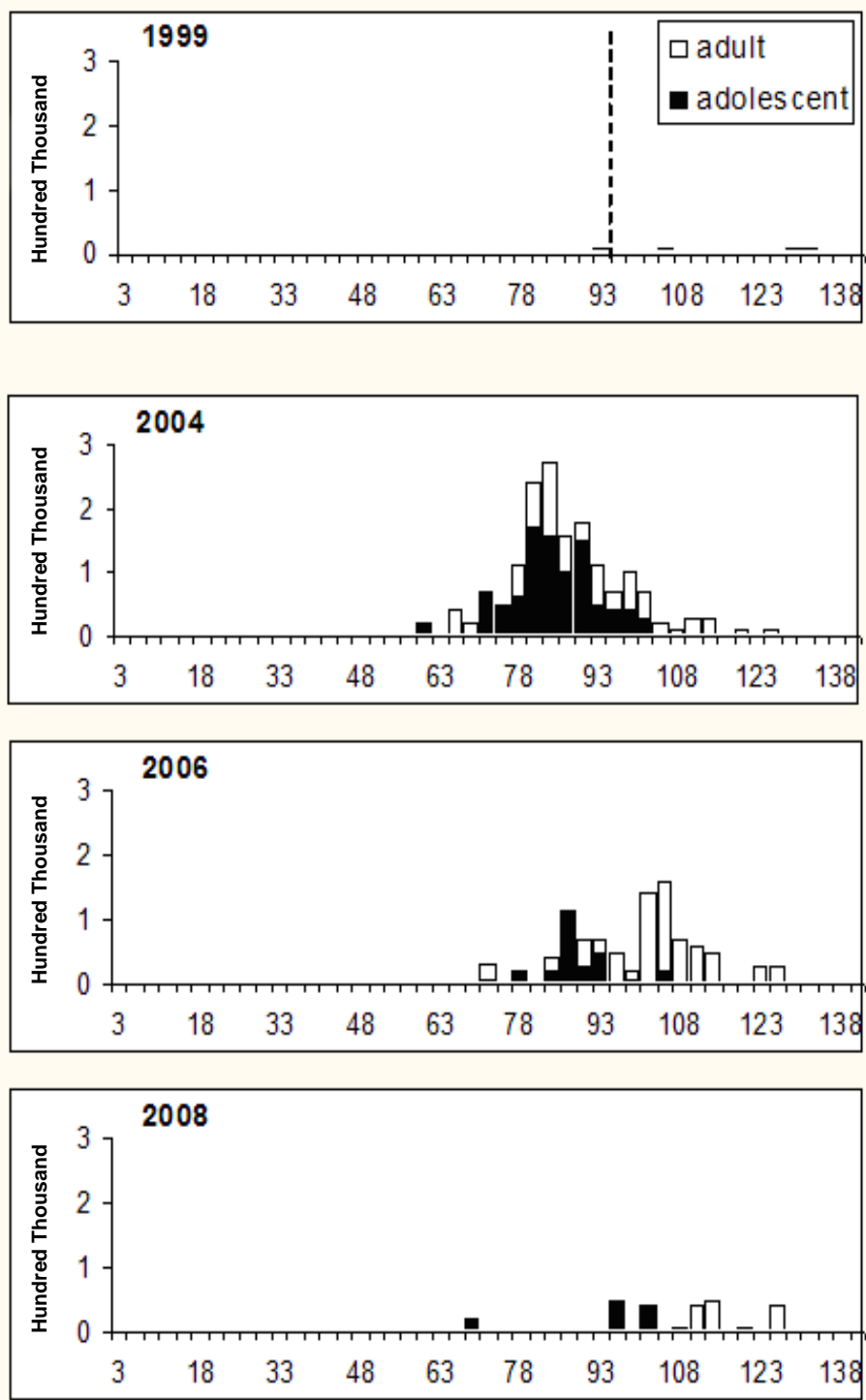


Figure 23. Distribution of abundance (index) by carapace width for Division 2H juveniles plus adolescents (dark bars) versus adults (open bars) from fall trawl surveys. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line.

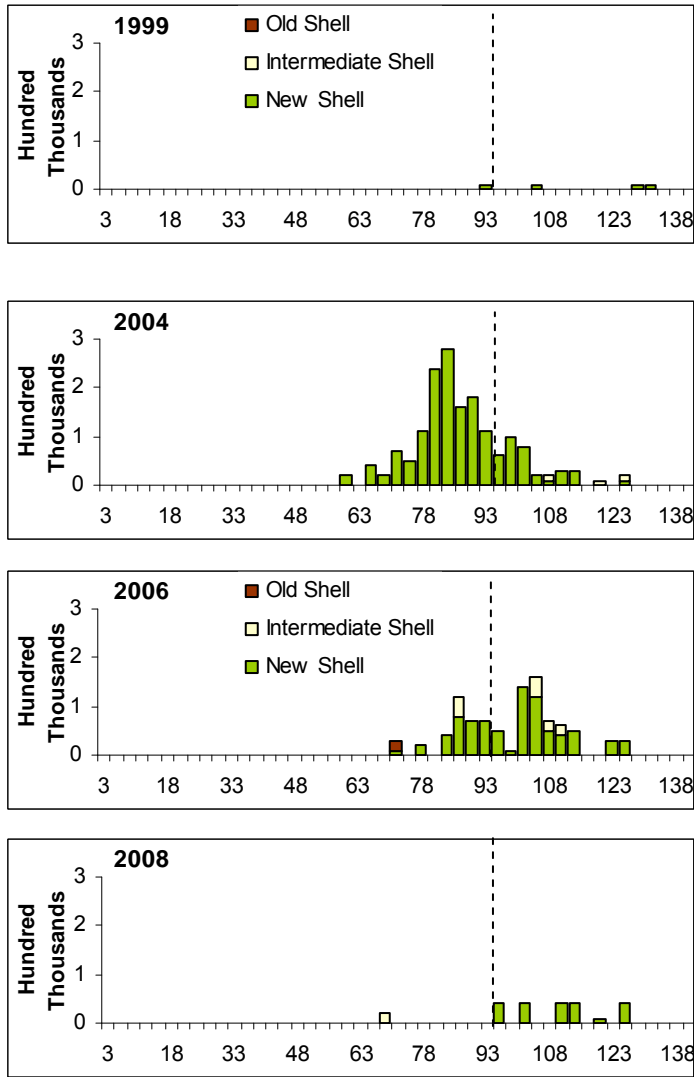


Figure 24. Distribution of abundance (index) by carapace width and shell condition from fall trawl surveys for Division 2H. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line.

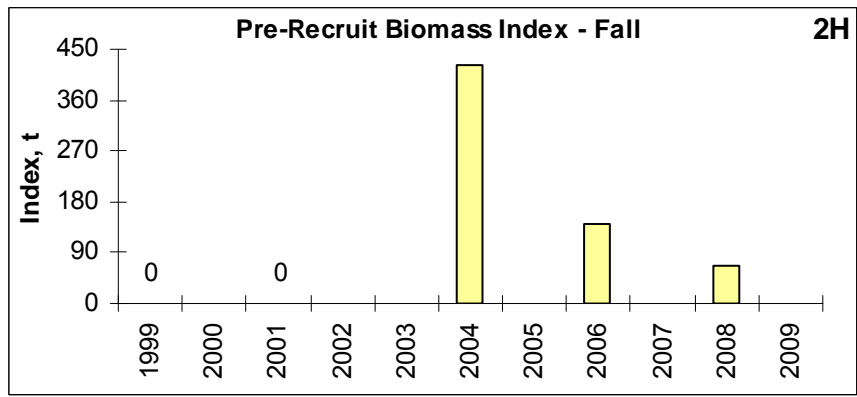


Figure 25. Trends in the Division 2H fall trawl survey pre-recruit biomass index.

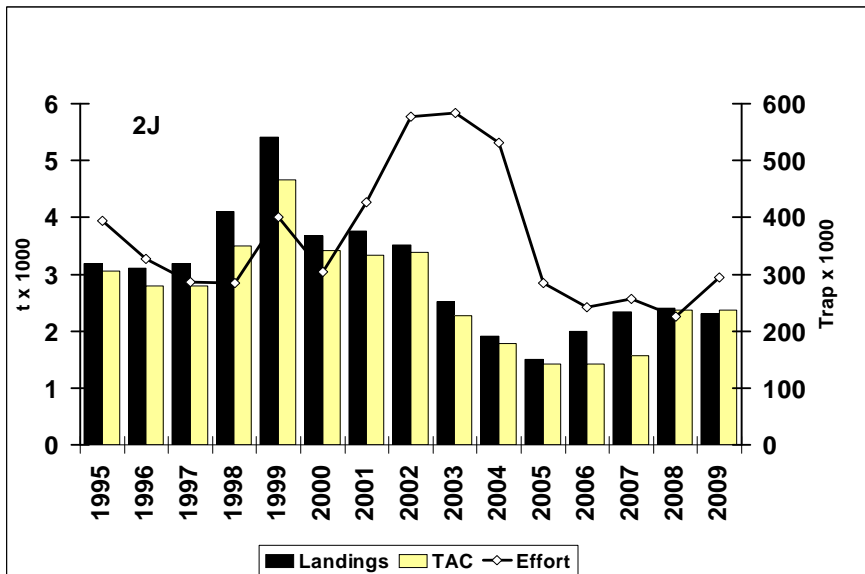


Figure 26. Trends in Division 2J landings, TAC, and fishing effort.

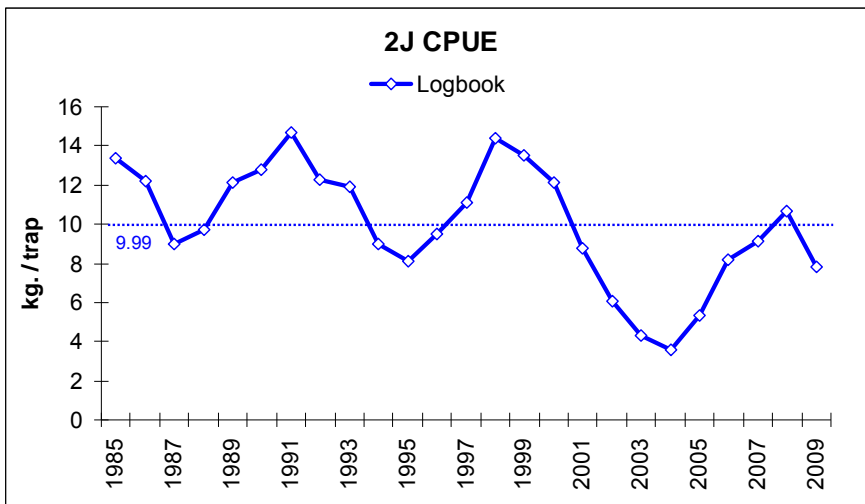


Figure 27: Trends in Division 2J commercial CPUE in relation to the long-term average (dotted line).

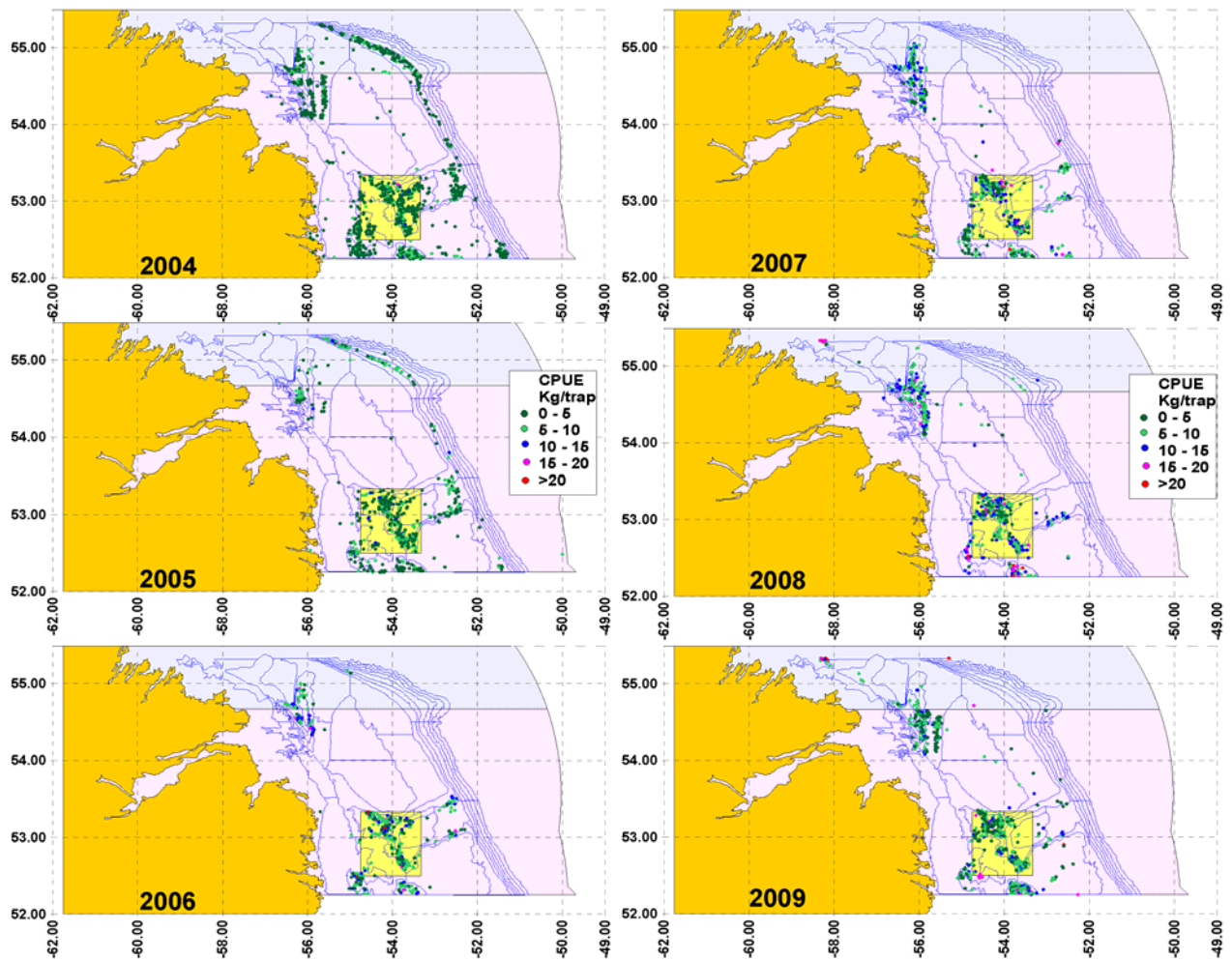


Figure 28. Spatial distribution of Division 2J commercial CPUE by year showing the Hawke channel closed area.

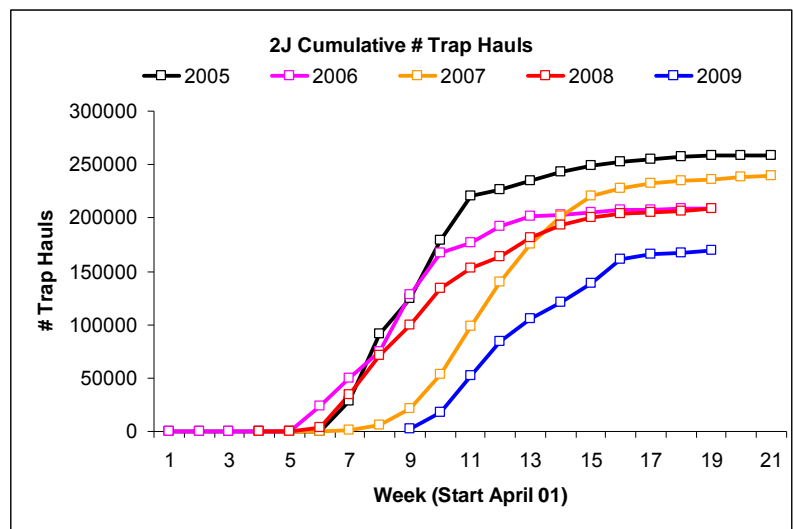


Figure 29. Seasonal trends in weekly fishing effort for Division 2J during 2005-09.

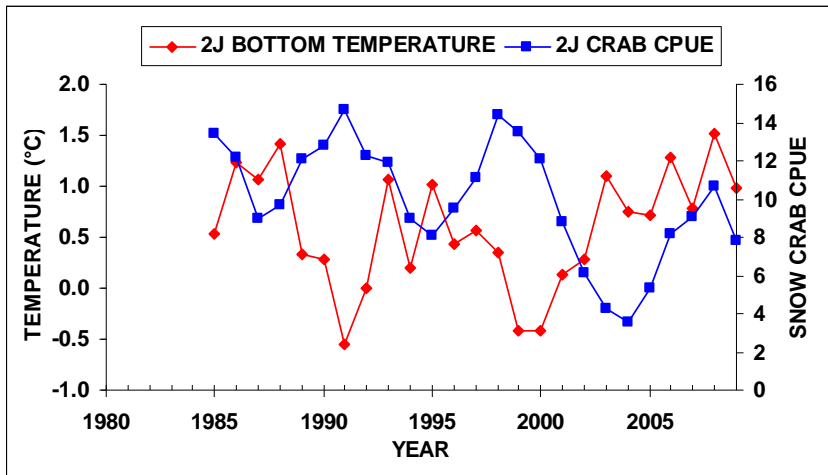


Figure 30. Trends in commercial CPUE in the Division 2J fishery vs. bottom temperature seven years earlier.

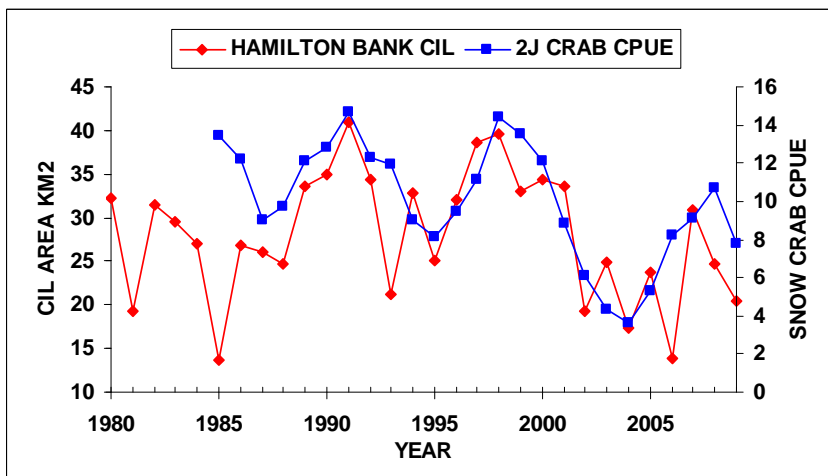


Figure 31. Trends in commercial CPUE in the Division 2J fishery vs. spatial extent of the cold intermediate layer seven years earlier.

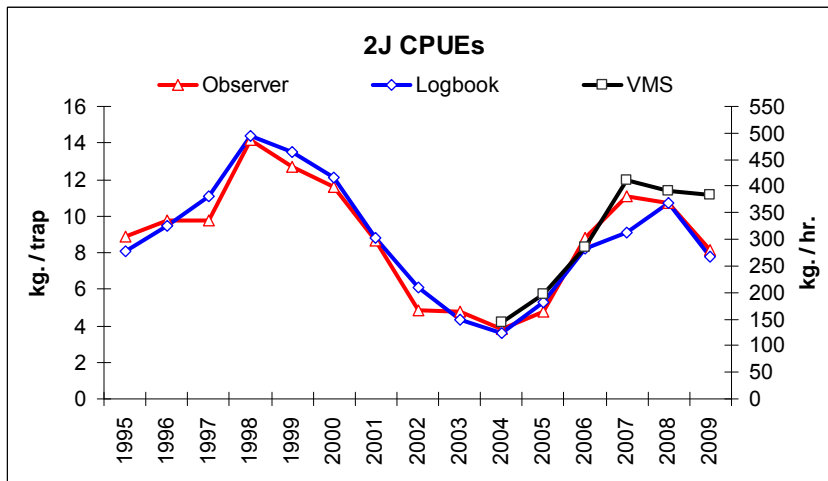


Figure 32. Trends in commercial logbook-based CPUE, observer-based CPUE, and VMS-based CPUE in the Division 2J fishery.

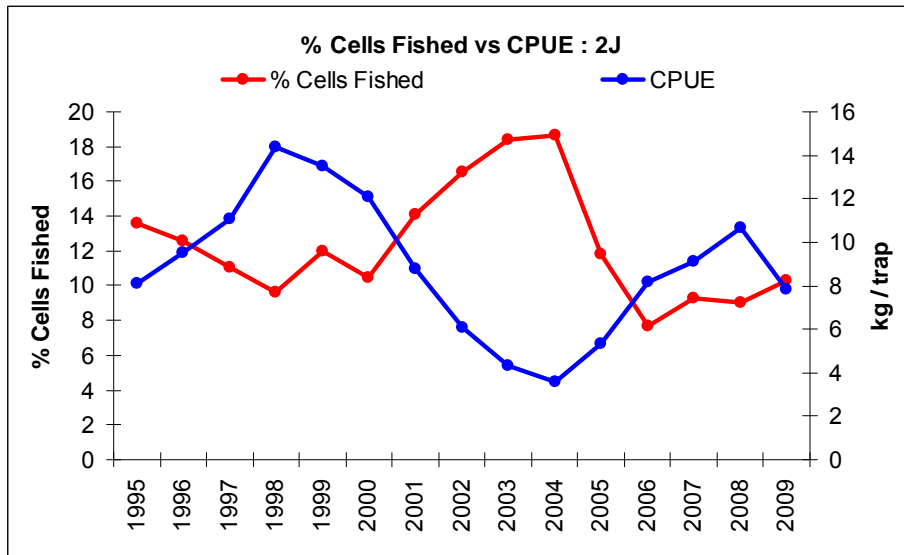


Figure 33: Trends in Division 2J commercial CPUE vs. the percentage of 5' x 5' cells fished.

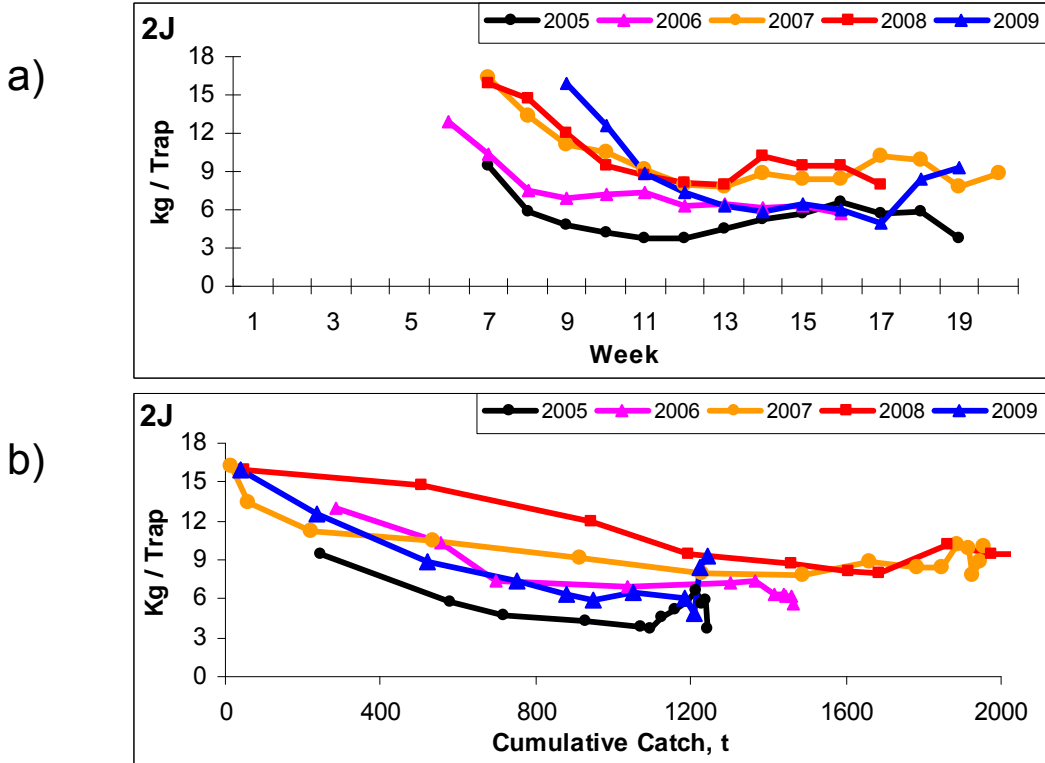


Figure 34. Seasonal trends in logbook-based CPUE for Division 2J during 2005-09; (a) by week, and (b) in relation to cumulative catch.

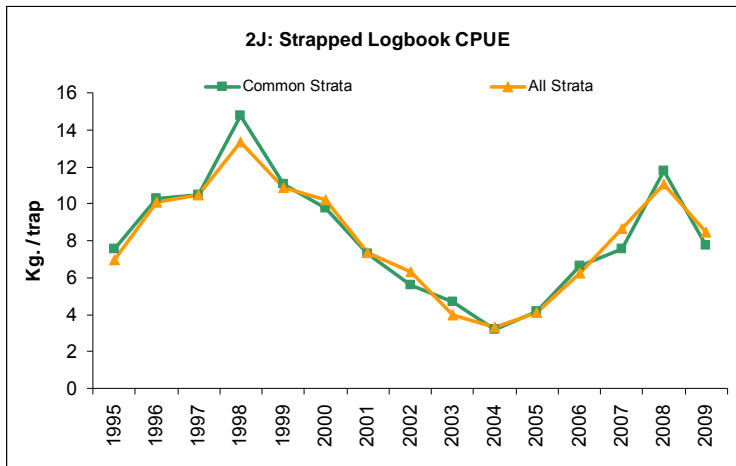


Figure 35. Trends in mean catch rates in the Division 2J fishery based on spatially-expanded logbook STRAP analysis.

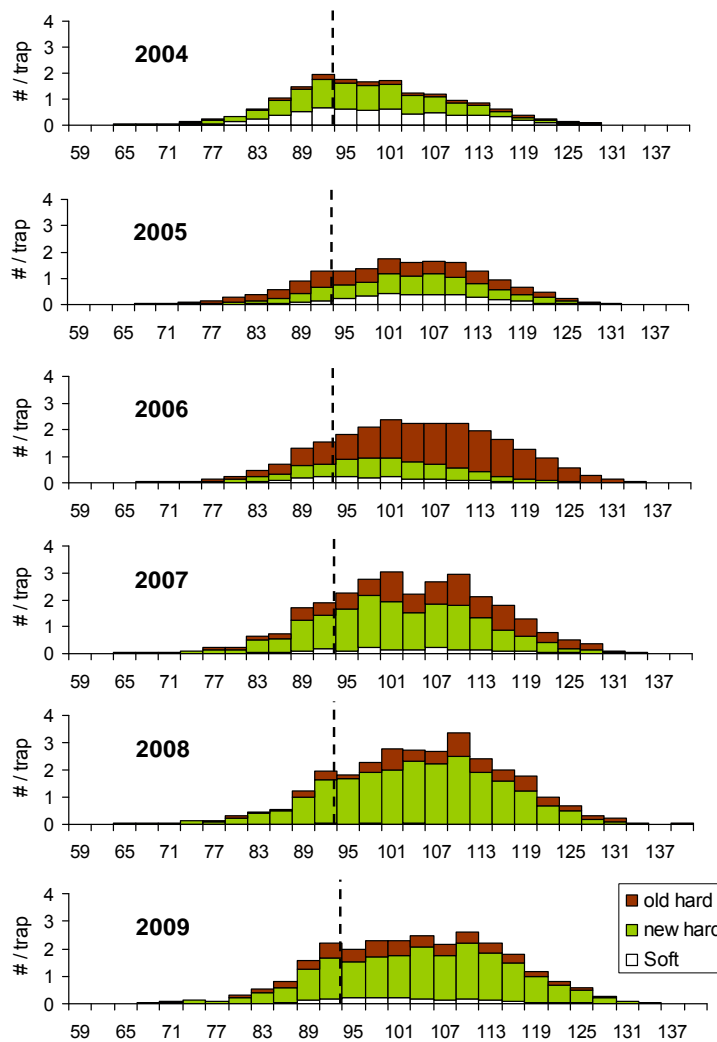


Figure 36. Trends in male carapace width distributions by shell condition from observer at-sea sampling for Division 2J. The vertical dashed line indicates the minimum legal size.



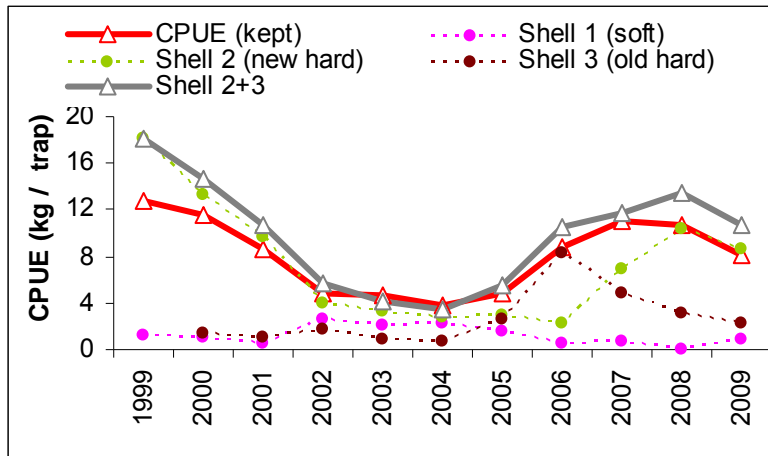


Figure 37. Trends in Division 2J observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

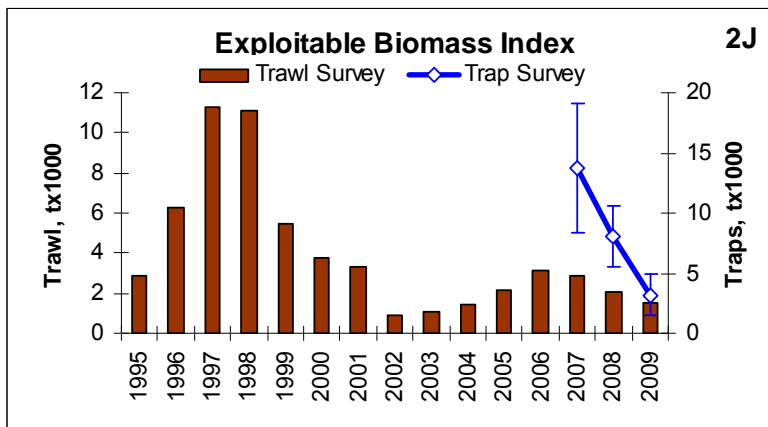


Figure 38. Trends in the Division 2J fall trawl survey exploitable biomass index and the CPS trap survey biomass index.

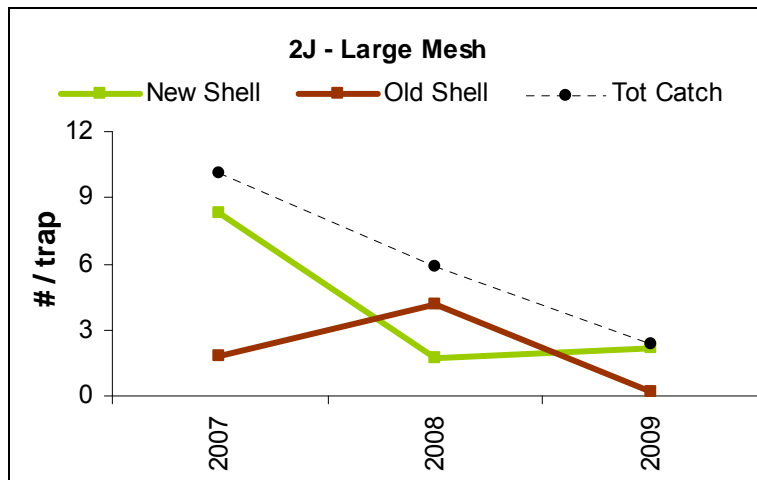


Figure 39. Trends in CPUE by shell condition for legal-sized crabs from core stations in the Division 2J CPS trap survey.

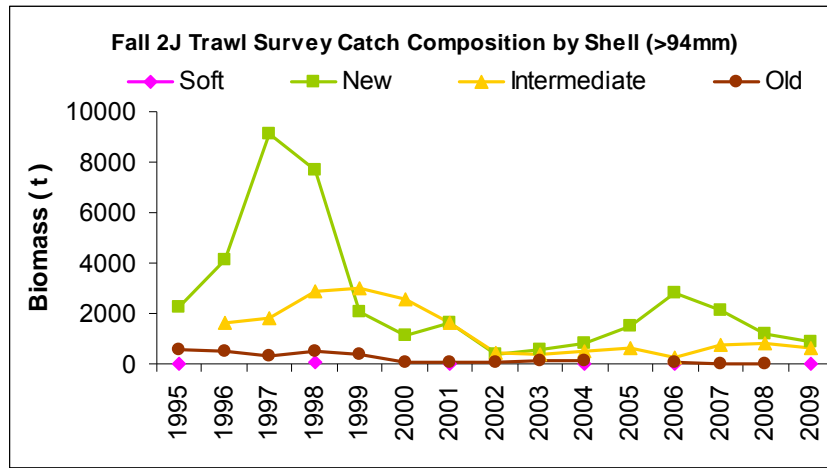


Figure 40. Trends, by shell condition, in the biomass index of legal-sized males for Division 2J from fall trawl surveys.

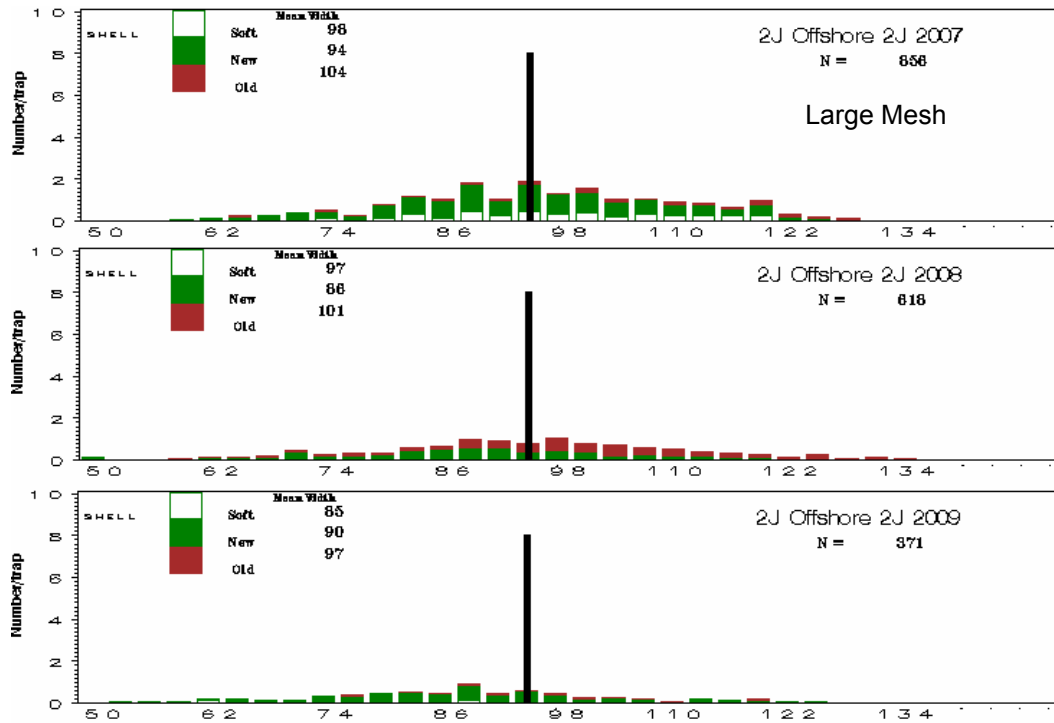


Figure 41. Trends in male carapace width distributions from core stations in the Division 2J CPS trap survey. The vertical solid line indicates the minimum legal size.

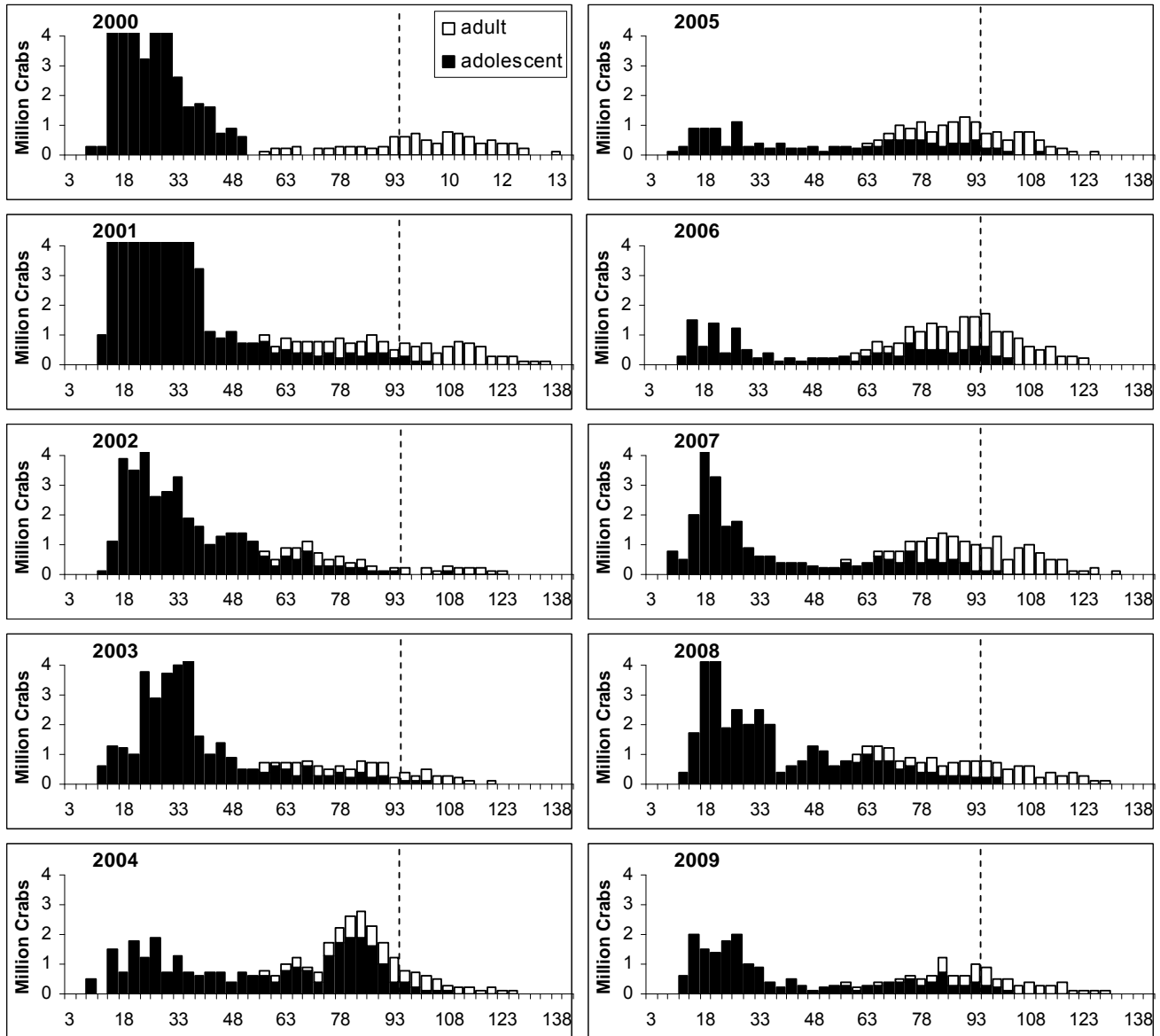


Figure 42. Distribution of abundance (index) by carapace width for Division 2J juveniles plus adolescents (dark bars) versus adults (open bars) from fall trawl surveys. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line.

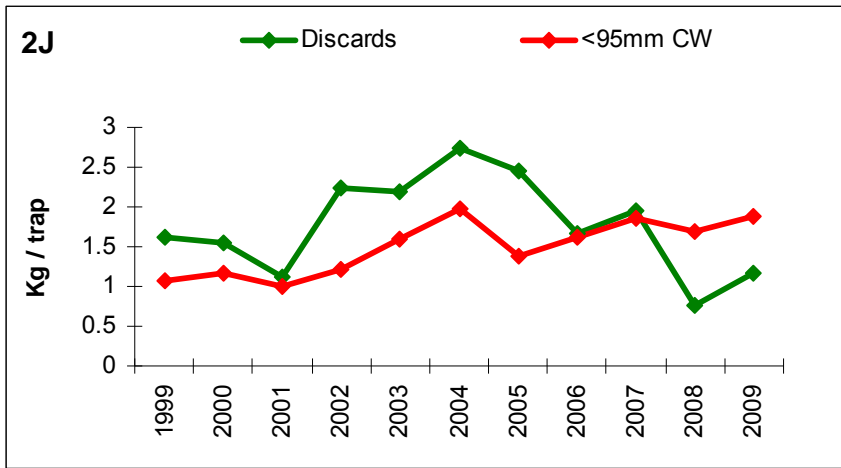


Figure 43: Trends in Division 2J observer catch rates of total discards from set and catch records and of sub-legal sized crabs from at-sea sampling.

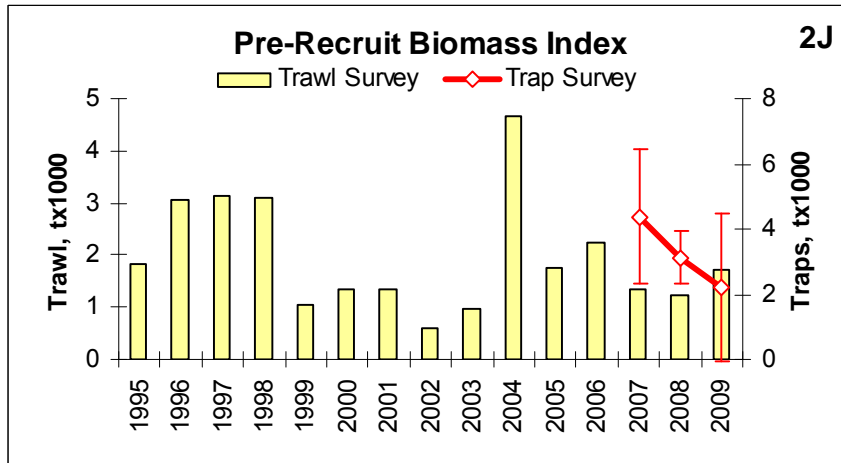


Figure 44. Trends in the Division 2J fall trawl survey pre-recruit biomass index and the CPS trap survey biomass index.

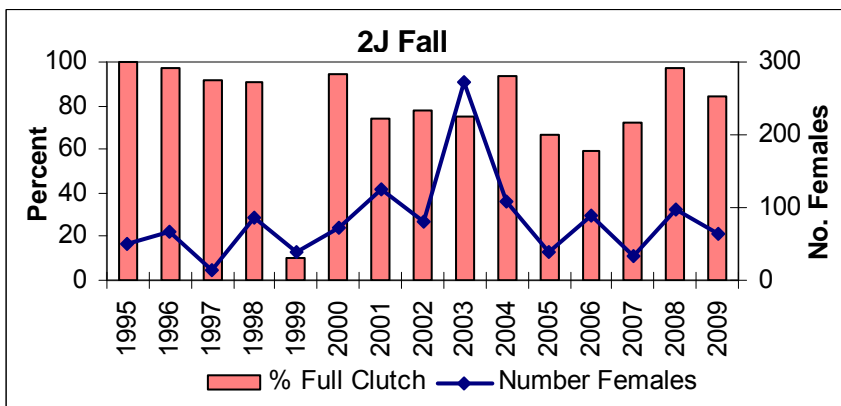


Figure 45. Trends in percent of mature females bearing full clutches of viable eggs and samples sizes in Division 2J from fall multi-species surveys.

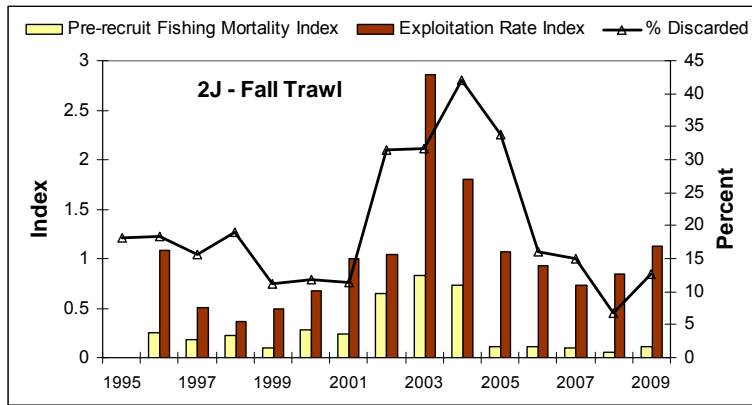


Figure 46. Trends in Division 2J mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery.

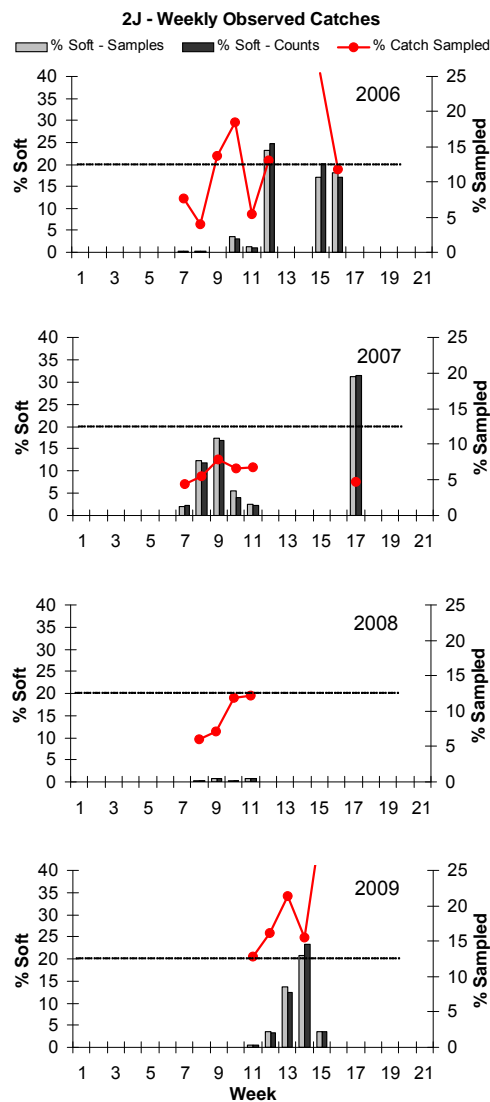


Figure 47. Trends in weekly percentages of soft-shell crab monitored and sampled in Division 2J from 2006 to 2009. Red lines show percentage of the catch sampled each week.

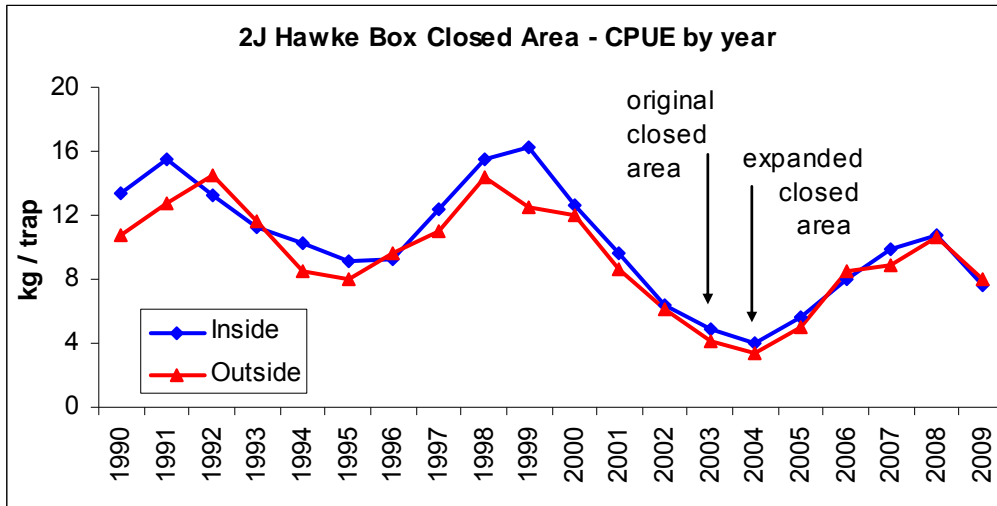


Figure 48. Division 2J commercial CPUE; inside vs. outside the Hawke Channel closed area.

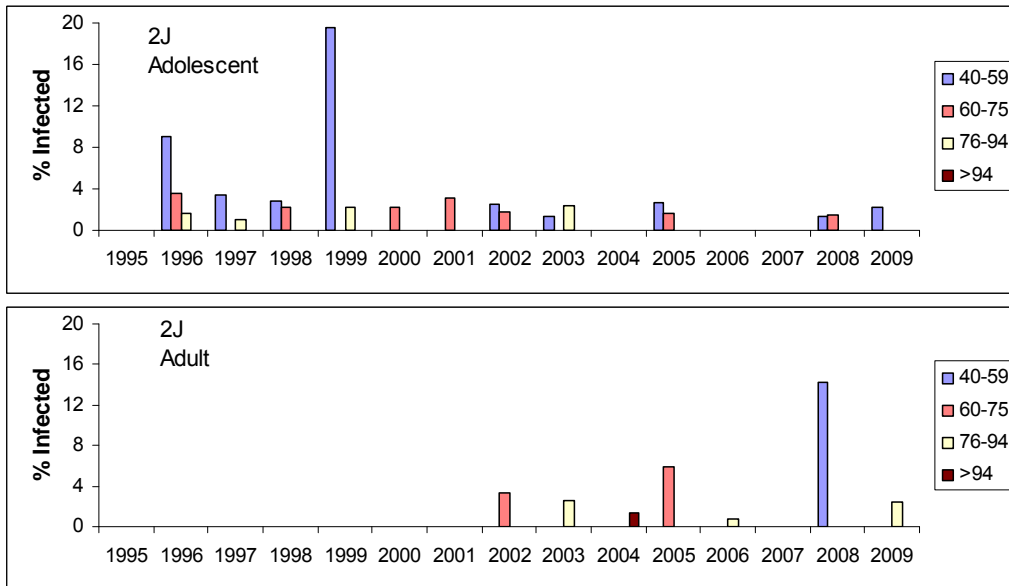


Figure 49. Trends in prevalence of BCD in new-shelled adolescents (above) and adults (below) by male size group from Division 2J fall trawl surveys.

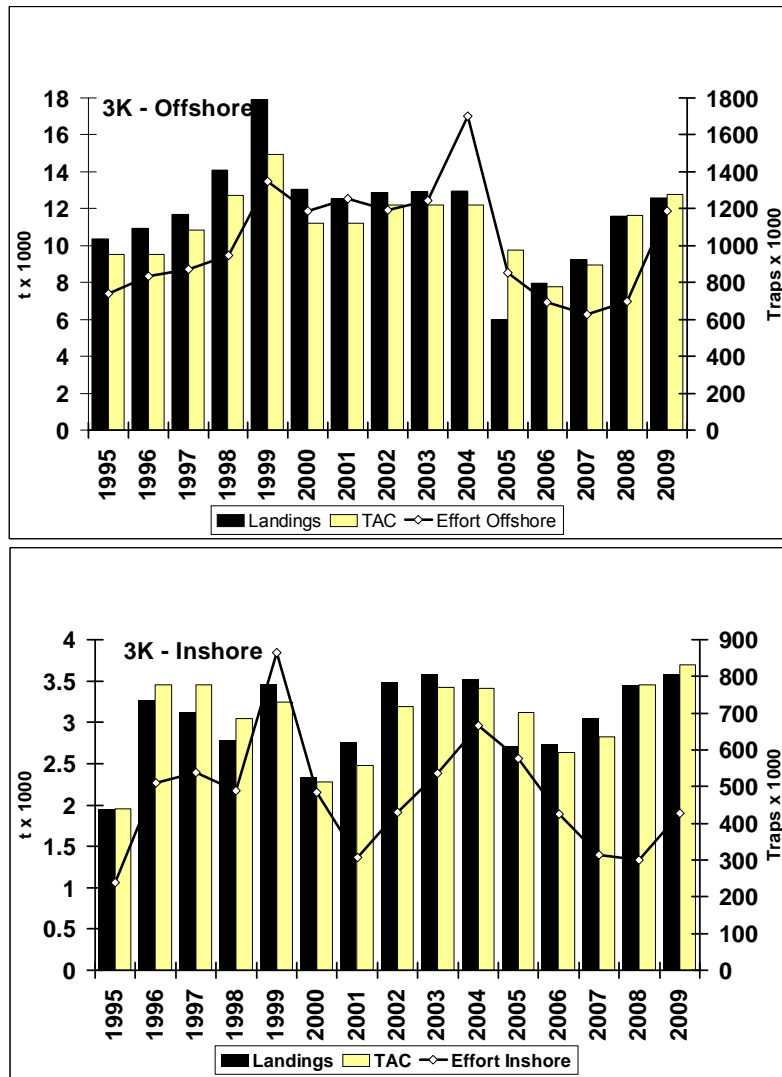


Figure 50. Trends in Division 3K landings, TAC, and fishing effort for the offshore (above) and inshore (below).

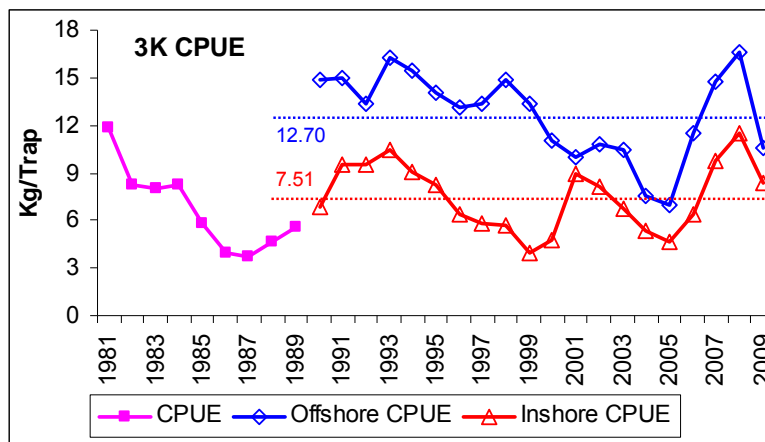


Figure 51: Trends in Division 3K offshore and inshore commercial CPUE in relation to their long-term averages (dotted lines).

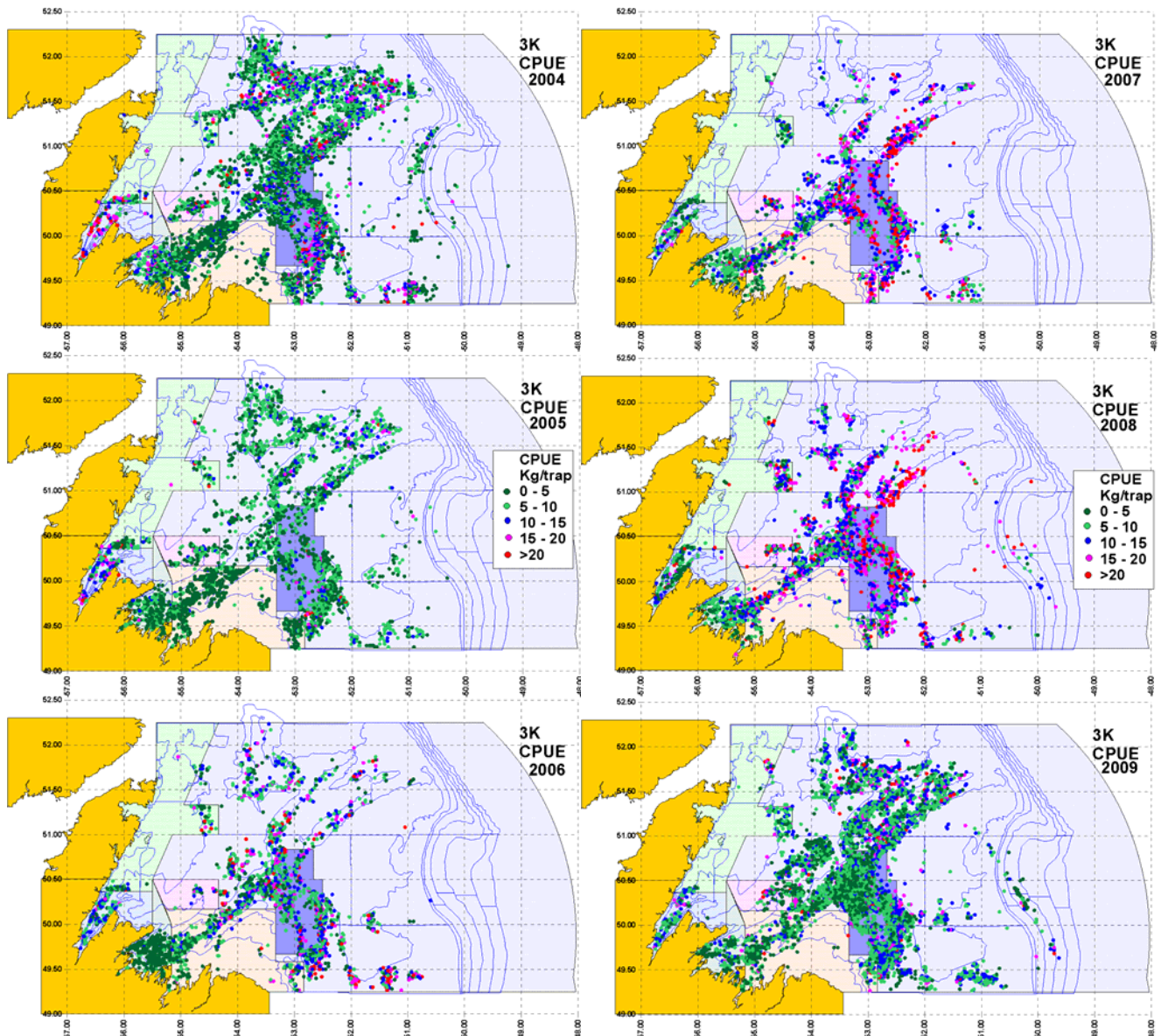
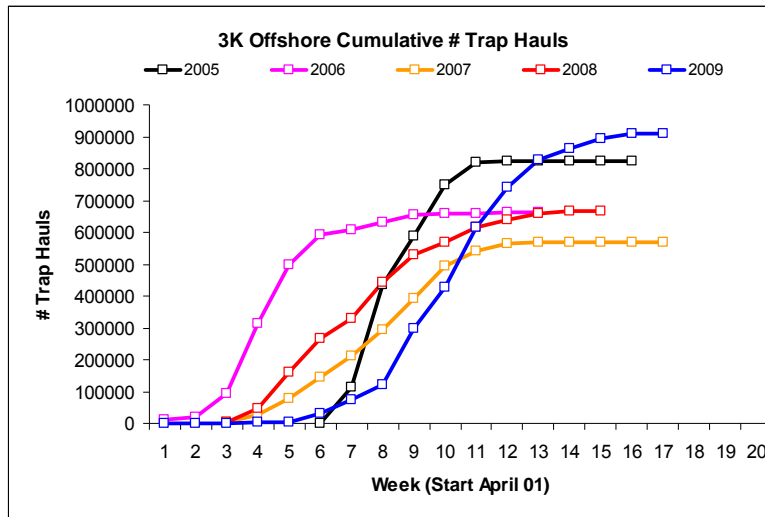


Figure 52. Spatial distribution of Division 3K commercial CPUE by year showing the Funk Island Deep closed area.



a)



b)

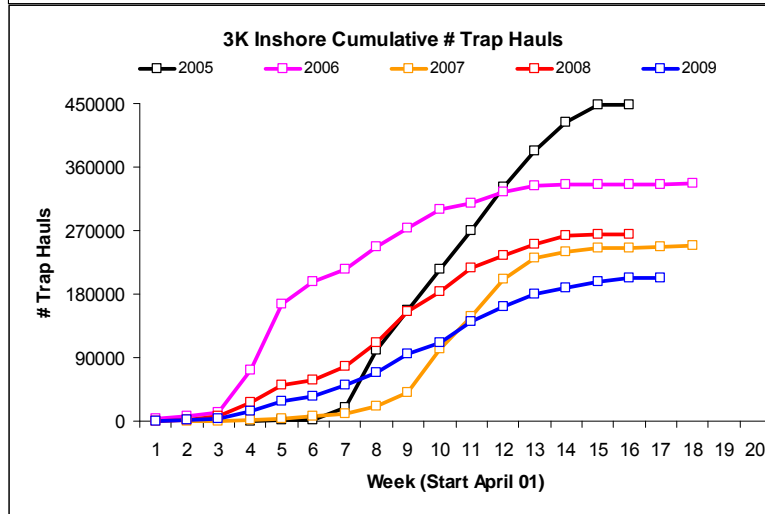


Figure 53. Seasonal trends in fishing effort for Division 3K during 2005-09 for (a) the offshore and (b) the inshore.

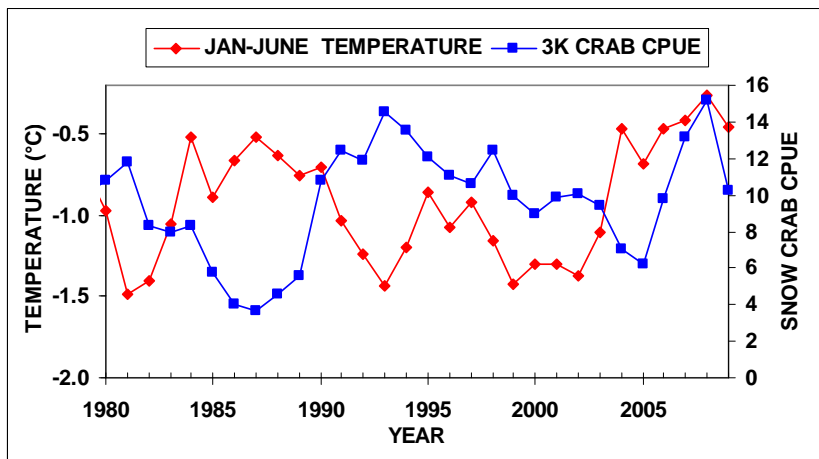


Figure 54. Trends in commercial CPUE in the Division 3K fishery (offshore and inshore combined) vs. Station 27 bottom temperature eight years earlier.

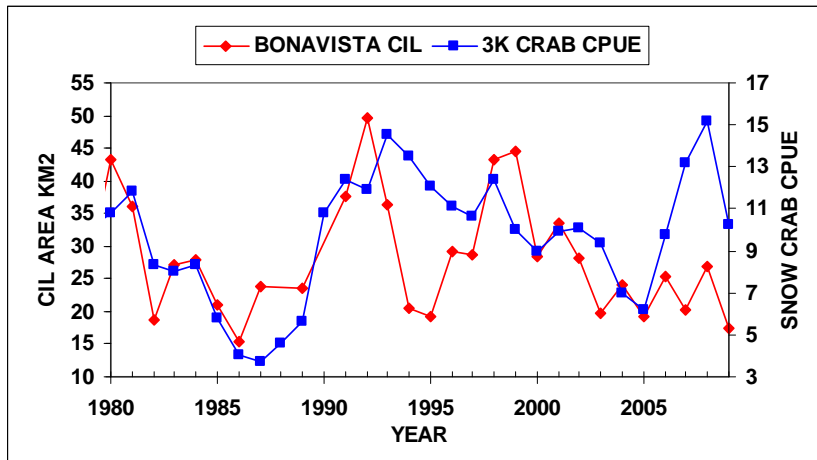


Figure 55. Trends in commercial CPUE in the Division 3K fishery (offshore and inshore combined) vs. spatial extent of the cold intermediate layer eight years earlier.

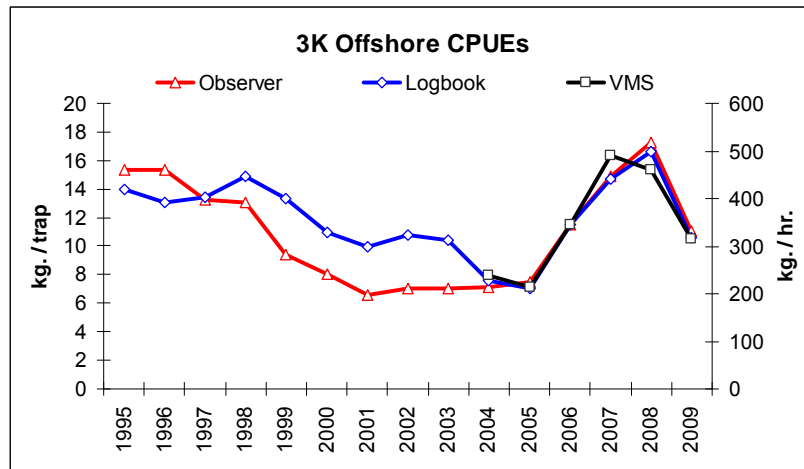


Figure 56. Trends in commercial logbook-based CPUE, observer-based CPUE, and VMS-based CPUE in the Division 3K offshore fishery.

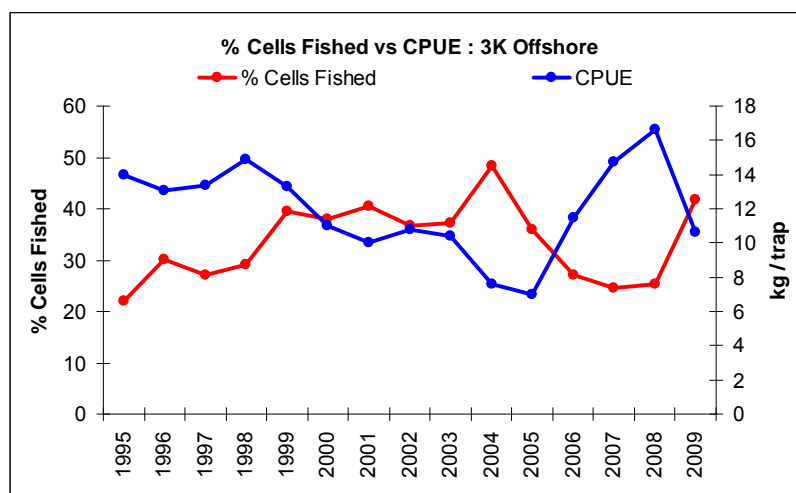


Figure 57: Trends in Division 3K offshore commercial CPUE vs. the percentage of 5' x 5' cells fished.

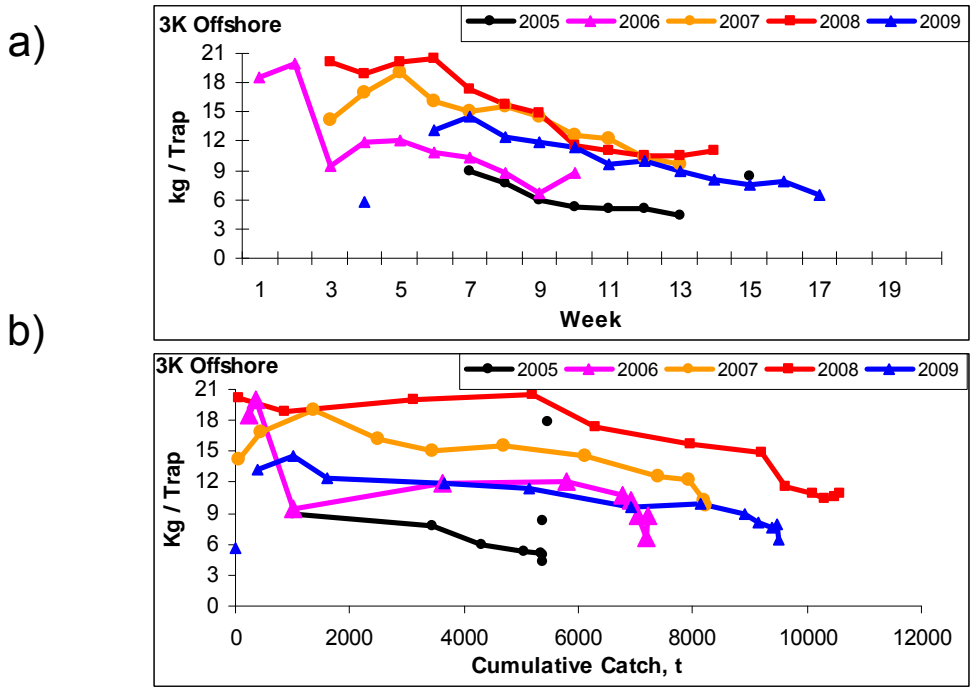


Figure 58: Seasonal trends in logbook-based CPUE for Division 3K offshore during 2005-09; (a) by week, and (b) in relation to cumulative catch.

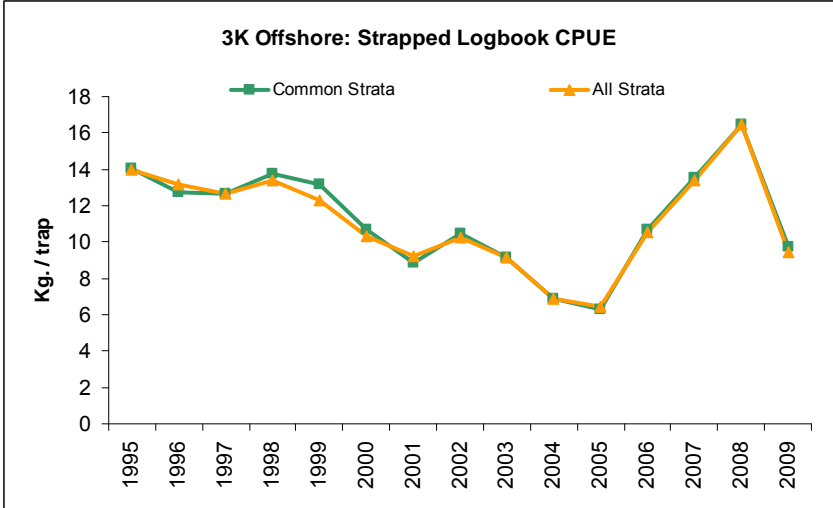


Figure 59. Trends in mean catch rates in the Division 3K offshore fishery based on spatially-expanded logbook STRAP analysis.

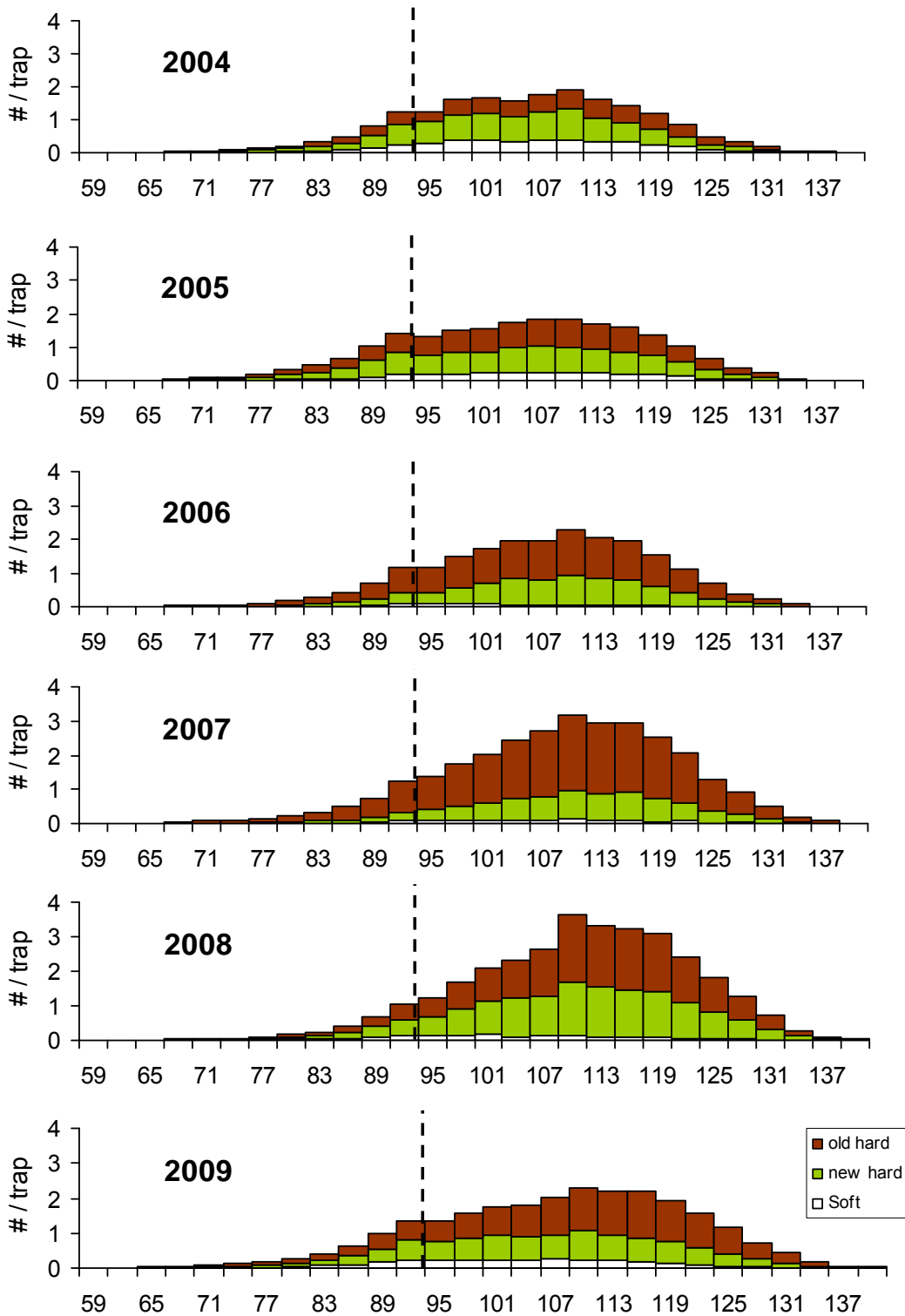


Figure 60. Trends in male carapace width distributions by shell condition from observer at-sea sampling for Division 3K offshore. The vertical dashed line indicates the minimum legal size.

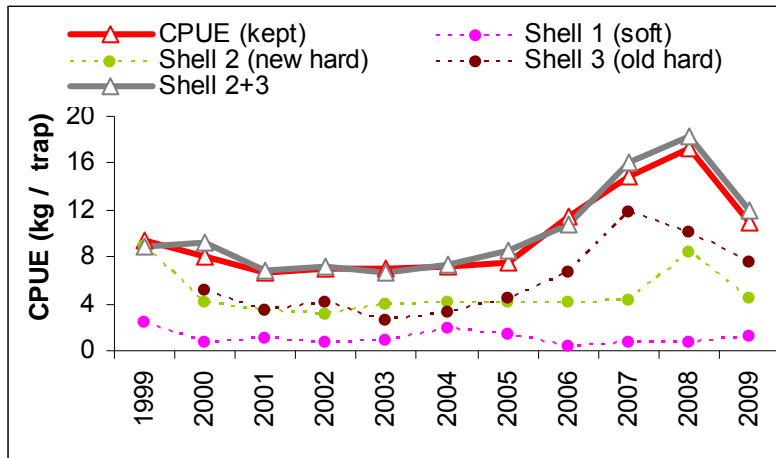


Figure 61. Trends in Division 3K offshore observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

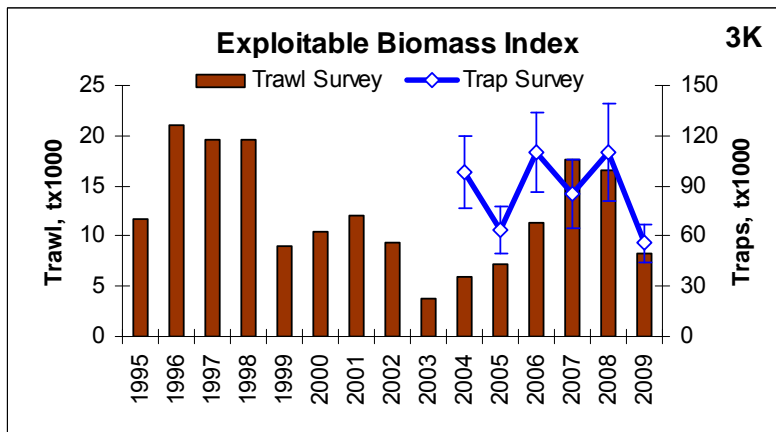


Figure 62. Trends in the Division 3K offshore fall trawl survey exploitable biomass index and the CPS trap survey biomass index.

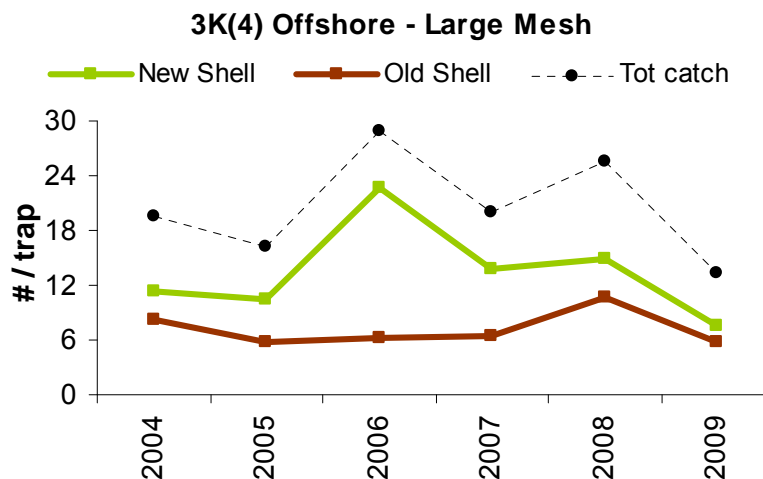


Figure 63. Trends in CPUE by shell condition for legal-sized crabs from core stations in the Division 3K offshore CPS trap survey.

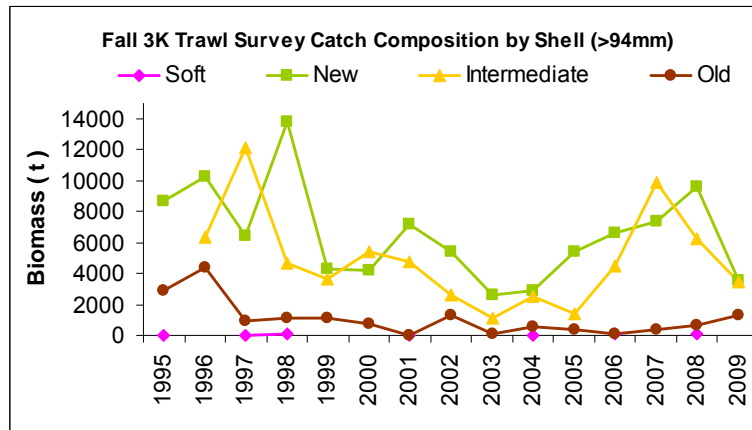


Figure 64. Trends, by shell condition, in legal-sized males for Division 3K offshore from fall trawl surveys.

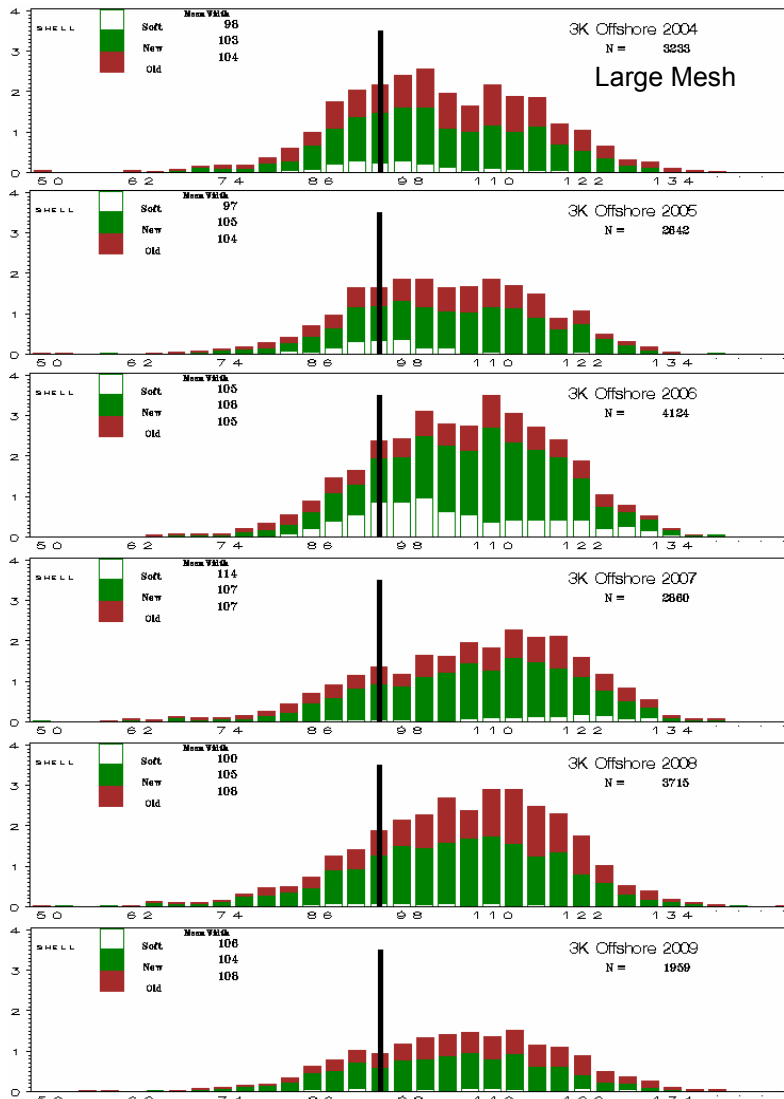


Figure 65. Trends in male carapace width distributions from core stations in the Division 3K offshore CPS trap survey. The vertical solid line indicates the minimum legal size.

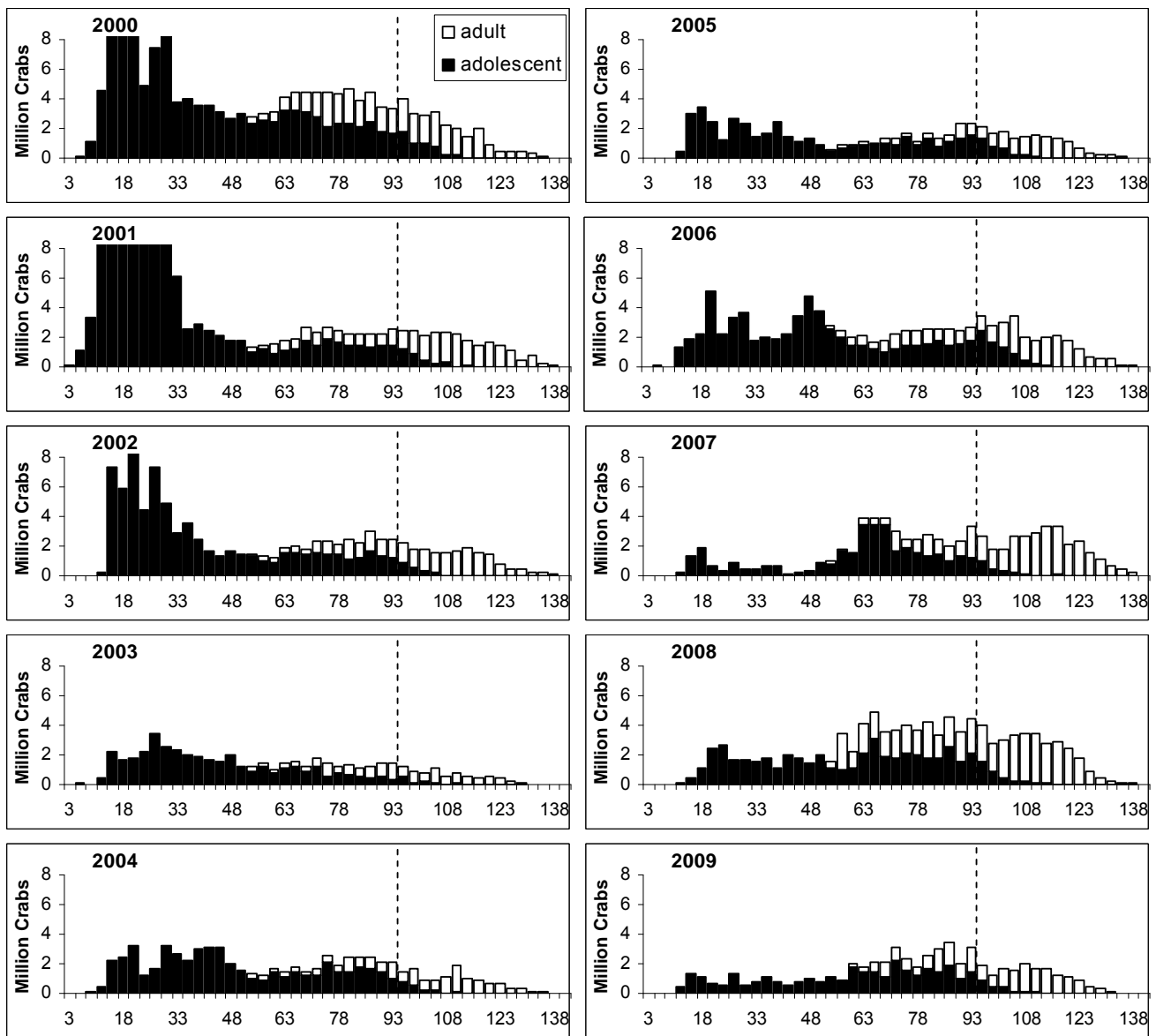


Figure 66. Distribution of abundance (index) by carapace width for Division 3K juveniles plus adolescents (dark bars) versus adults (open bars) from fall trawl surveys. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line.

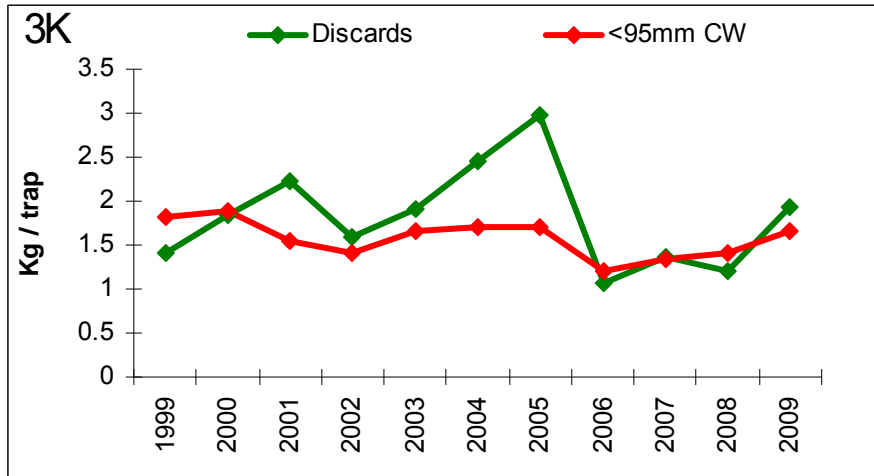


Figure 67. Trends in Division 3K offshore observer catch rates of total discards from set and catch records and of sub-legal sized crabs from at-sea sampling.

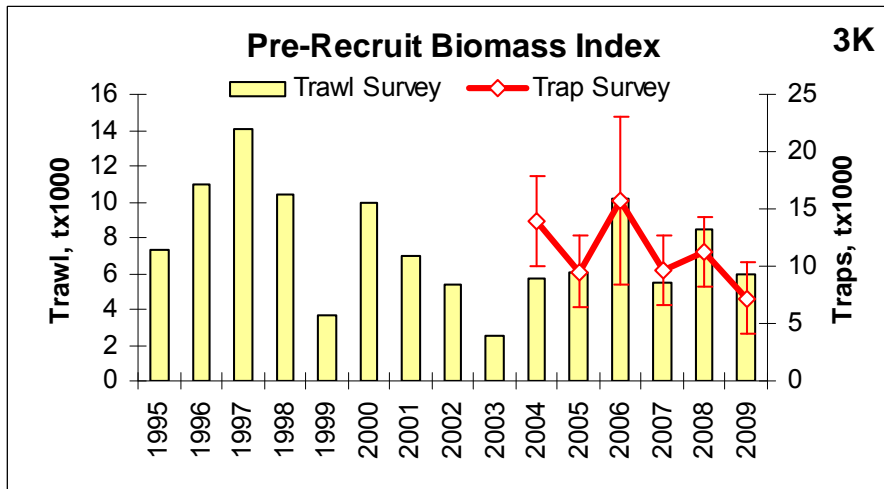


Figure 68. Trends in the Division 3K fall trawl survey pre-recruit biomass index and the CPS trap survey biomass index.

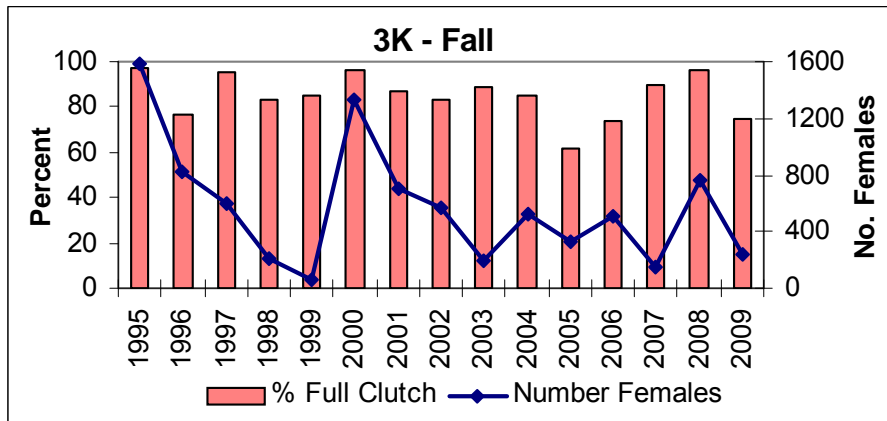


Figure 69. Trends in percent of mature females bearing full clutches of viable eggs and sample sizes in Division 3K from fall multi-species surveys.



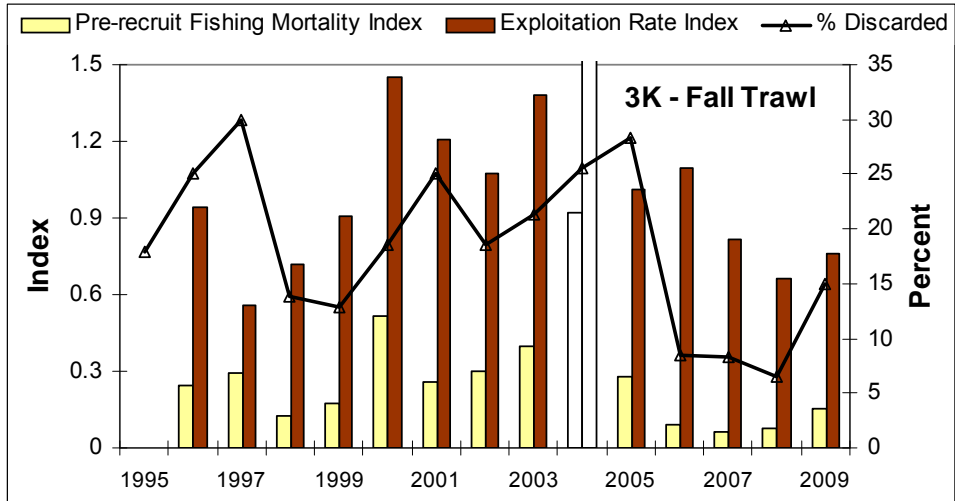


Figure 70. Trends in Division 3K offshore mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery (anomalously high 2004 values are attributable to low catch rates in 2003 trawl survey).

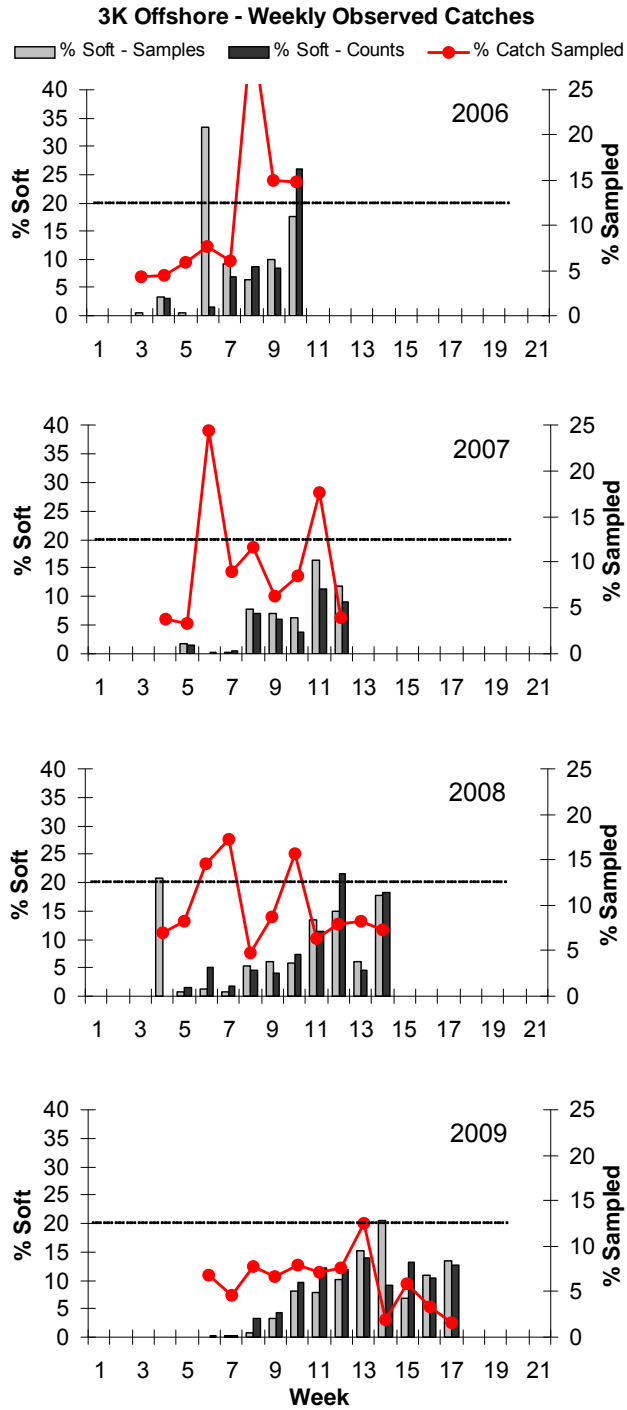


Figure 71. Trends in weekly percentages of soft-shell crab monitored and sampled in Division 3K Offshore from 2006 to 2009. Red lines show percentage of the catch sampled each week.

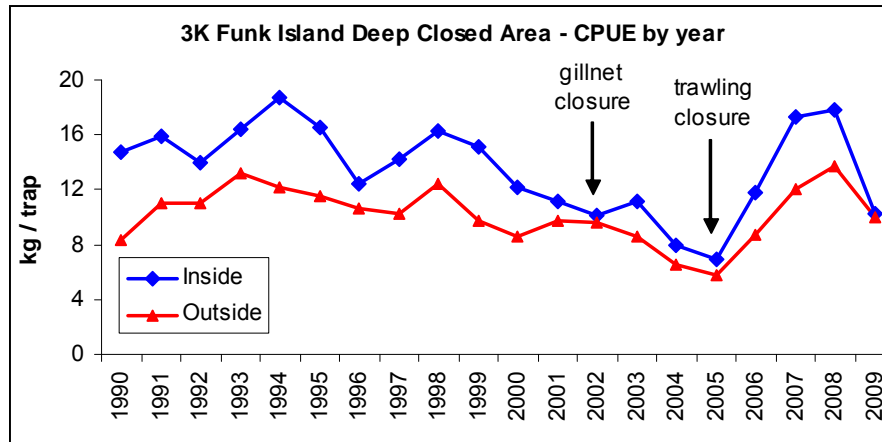


Figure 72. Division 3K offshore commercial CPUE; inside vs. outside the Funk Island Deep closed area.

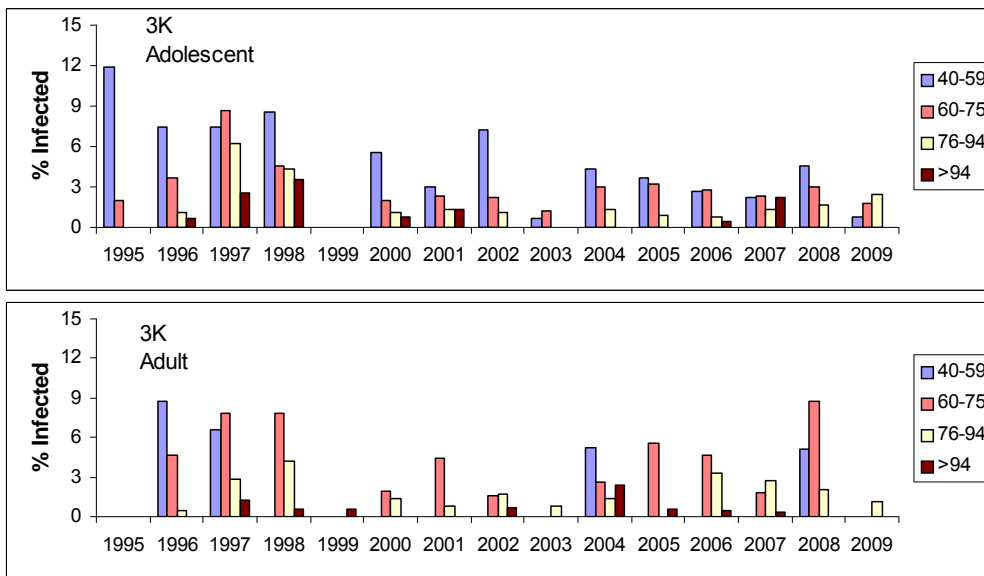


Figure 73. Trends in prevalence of BCD in new-shelled adolescents (above) and adults (below) by male size group from Division 3K fall trawl surveys.

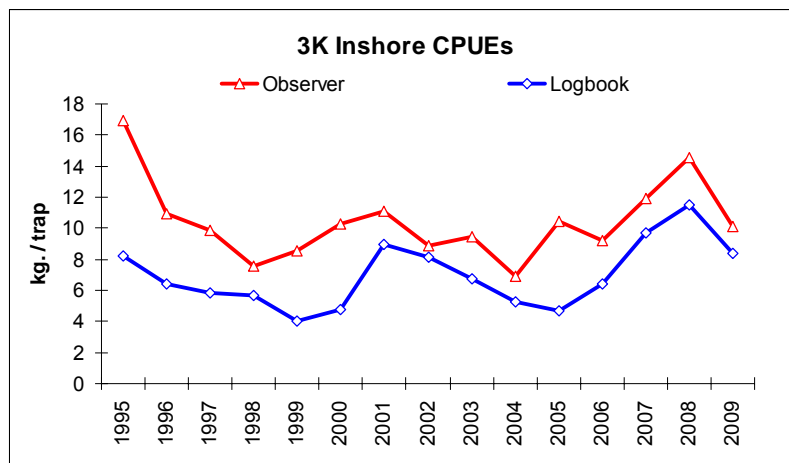


Figure 74. Trends in commercial logbook-based CPUE and observer-based CPUE in the Division 3K inshore fishery.

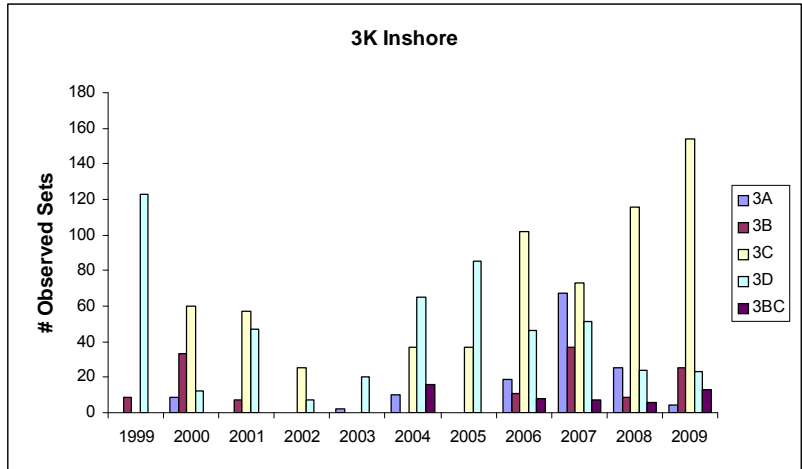


Figure 75. Trends in number of observed sets by Crab Management Areas and year in Division 3K inshore.

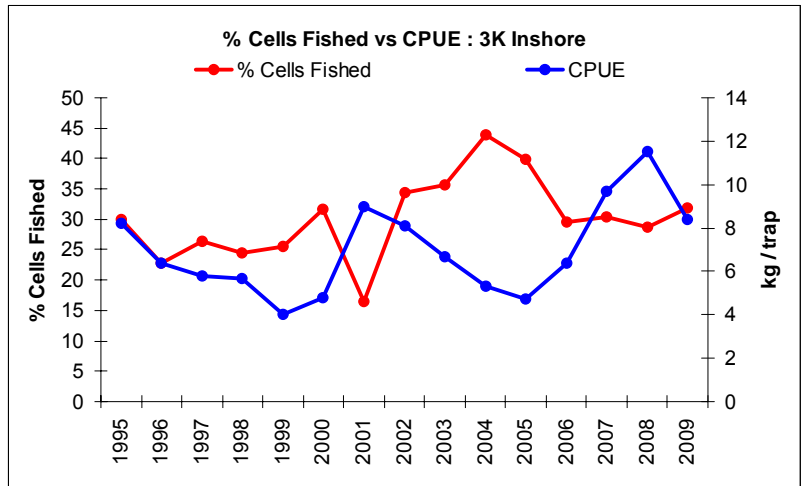


Figure 76: Trends in Division 3K inshore commercial CPUE vs. the percentage of 5' x 5' cells fished.

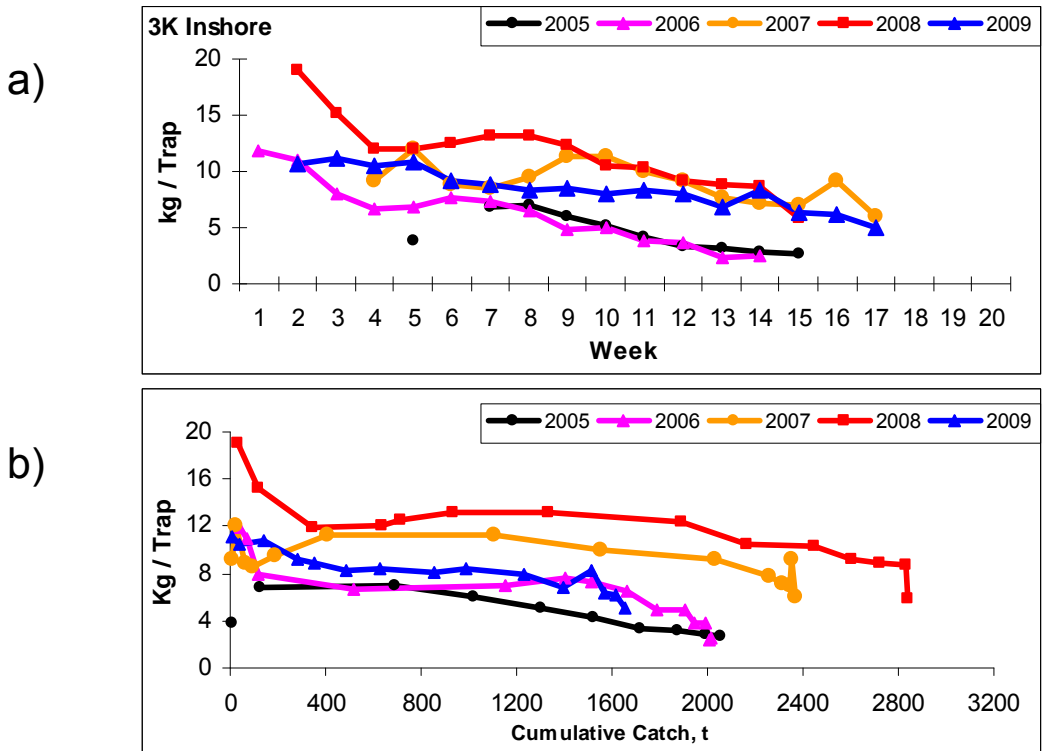


Figure 77. Seasonal trends in logbook-based CPUE for Division 3K inshore during 2005-09; (a) by week, and (b) in relation to cumulative catch.

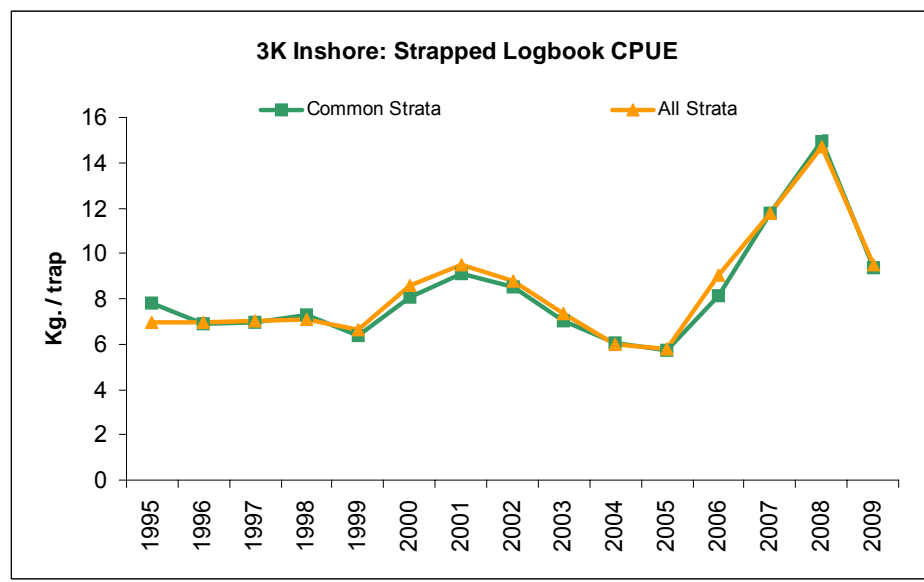


Figure 78. Trends in mean catch rates in the Division 3K inshore fishery based on spatially-expanded logbook STRAP analysis.

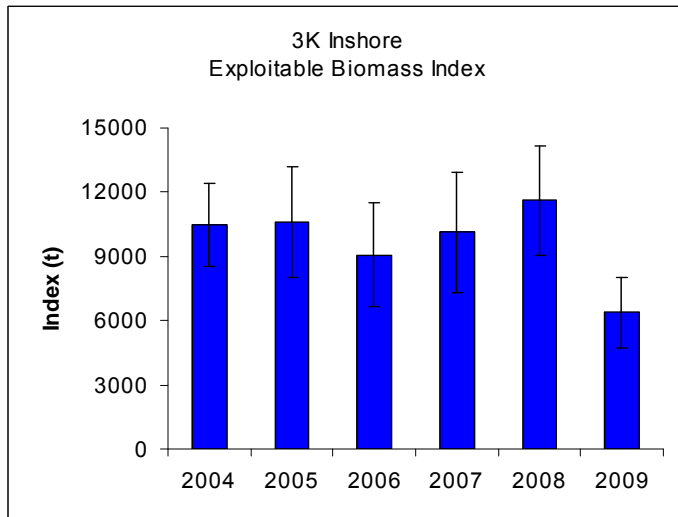


Figure 79. Exploitable biomass index based on the CPS trap survey in Division 3K inshore.

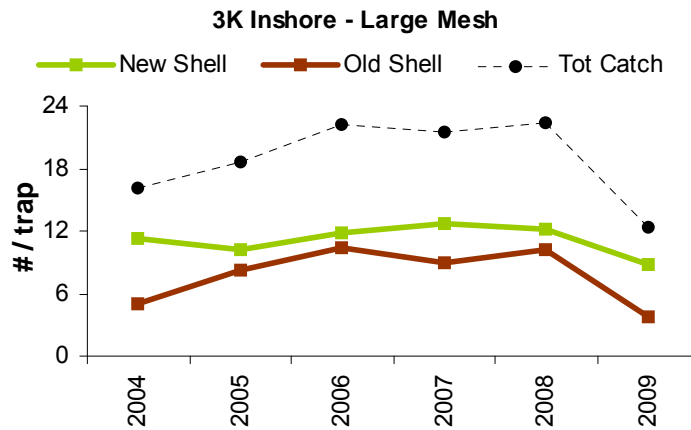


Figure 80. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CPS trap survey in Division 3K inshore.

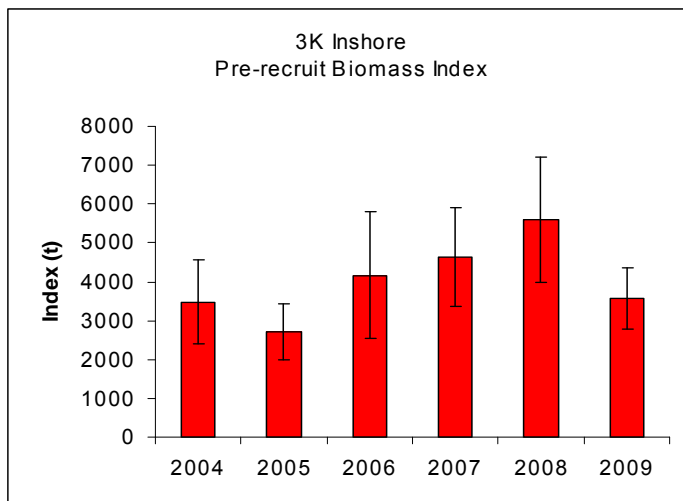


Figure 81. Pre-recruit biomass index based on the CPS trap survey in Division 3K inshore.

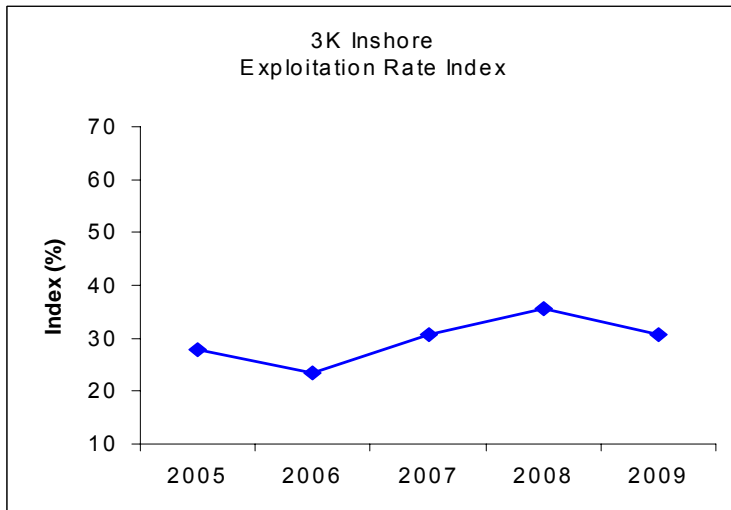


Figure 82. Trends in Division 3K inshore exploitation rate.

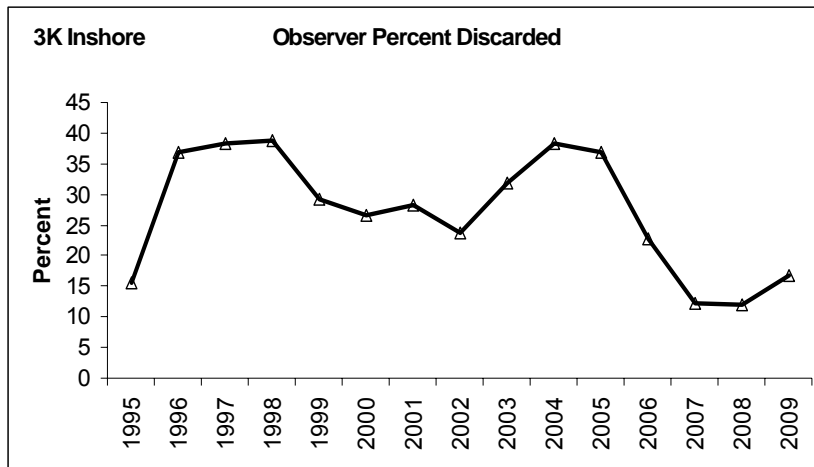


Figure 83. Trends in Division 3K inshore percentage of the catch discarded in the fishery.

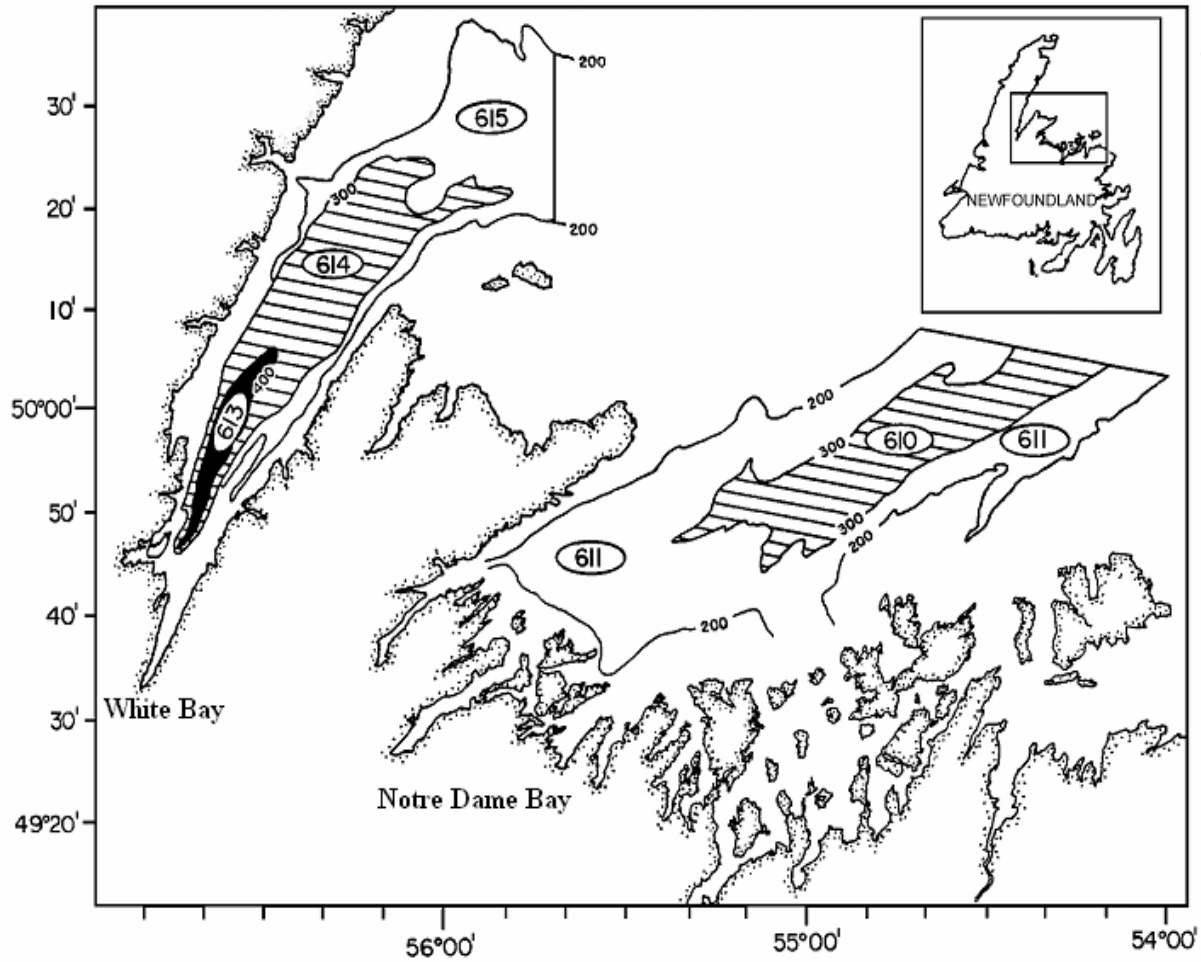


Figure 84. Location map showing inshore Division 3K strata sampled during fall trap surveys in White Bay and Notre Dame Bay.

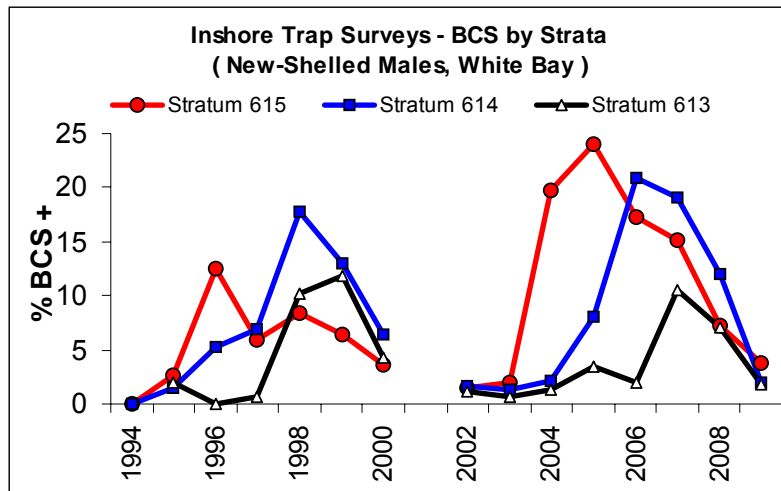


Figure 85. Prevalence of BCD in new-shelled males from Division 3K DFO inshore trap surveys by stratum in White Bay.



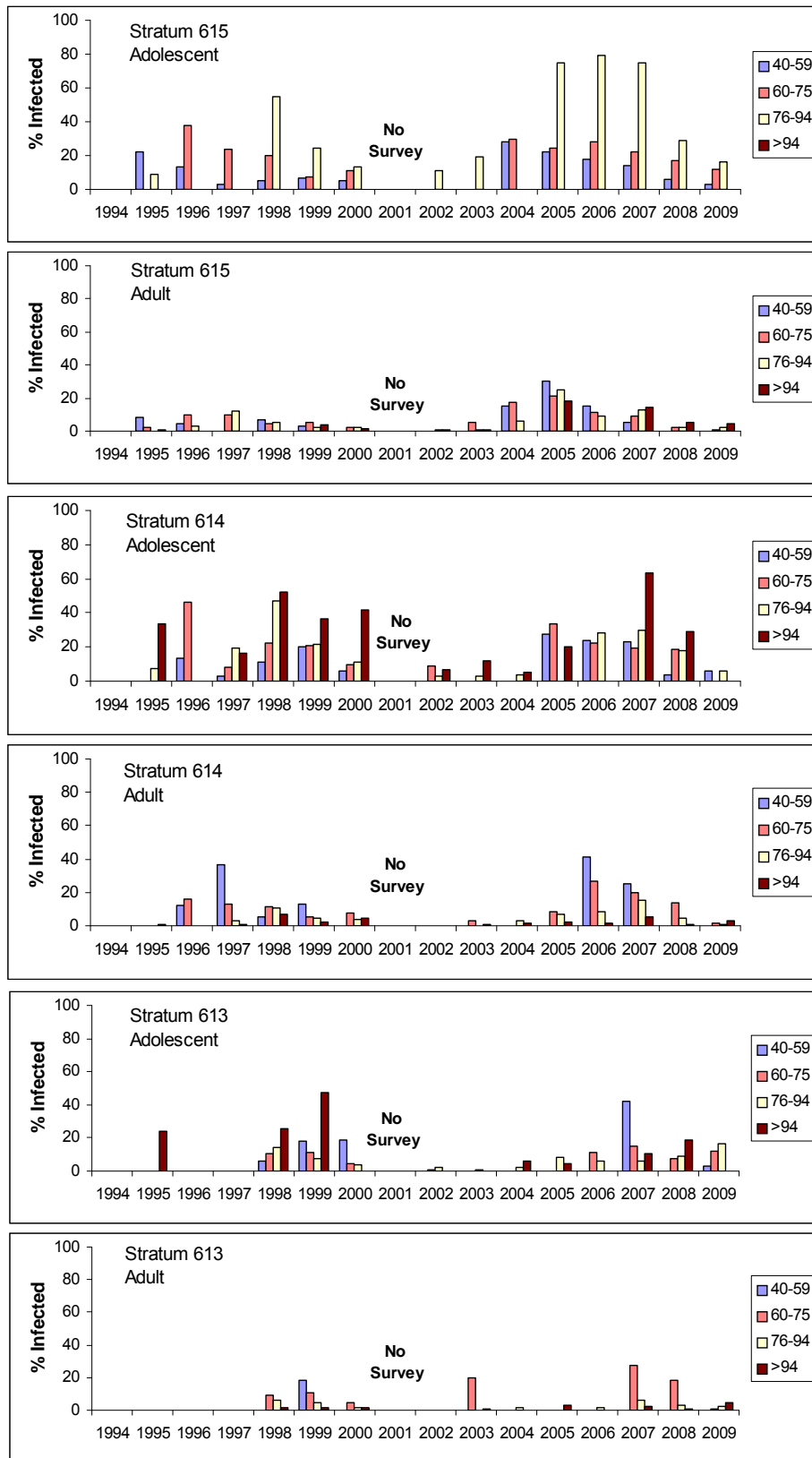


Figure 86. Trends of prevalence of BCD in new-shelled males by stratum, year and size group from DFO trap surveys in White Bay; adolescents (above) and adults (below).

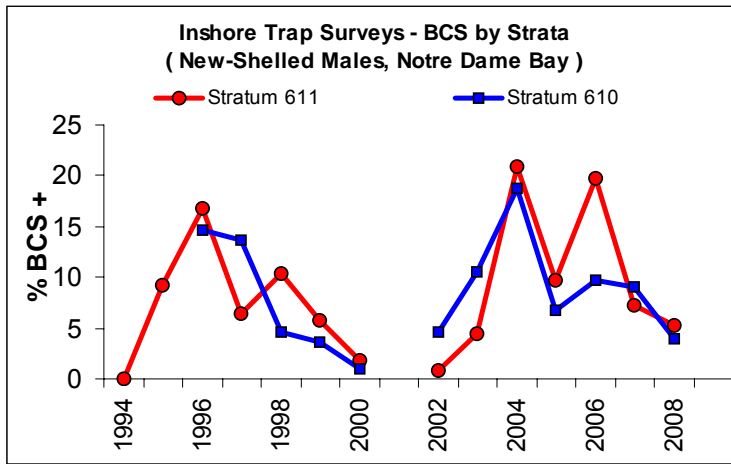


Figure 87. Prevalence of BCD in new-shelled males from Division 3K DFO inshore trap surveys by stratum in Notre Dame Bay.

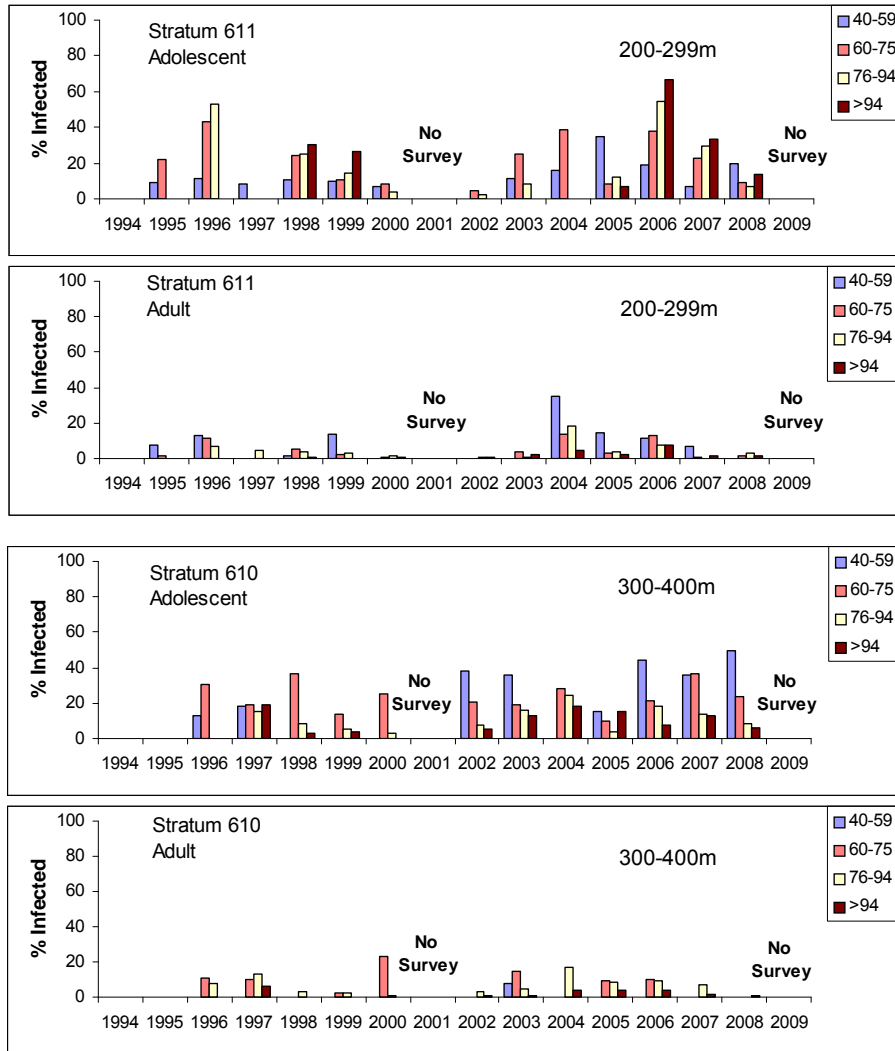


Figure 88. Trends of prevalence of BCD in new-shelled males by stratum, year and size group from DFO trap surveys in Notre Dame Bay; adolescents (above) and adults (below).

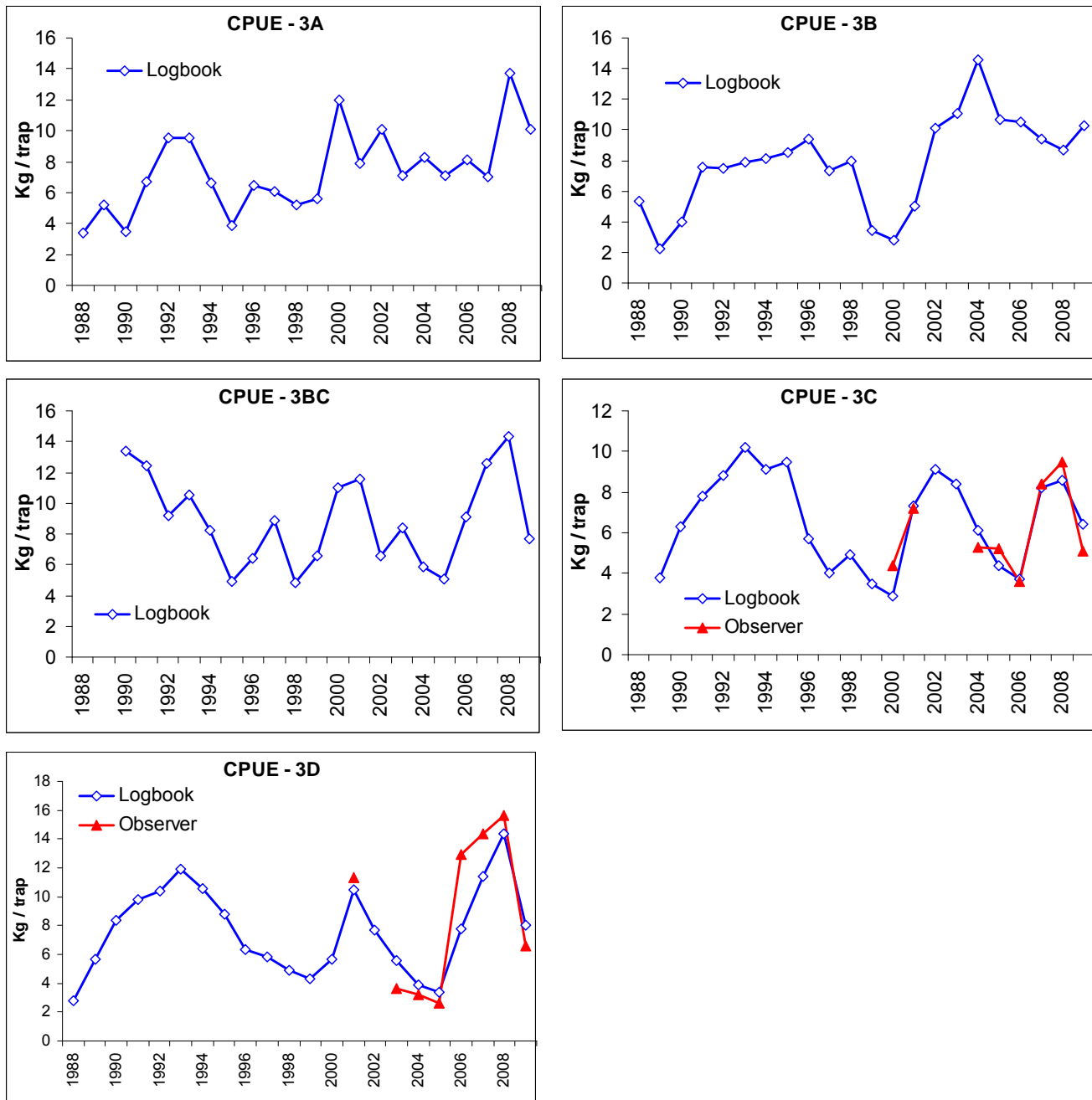


Figure 89. Trends in Division 3K inshore logbook CPUE and observer CPUE by Crab Management Area.

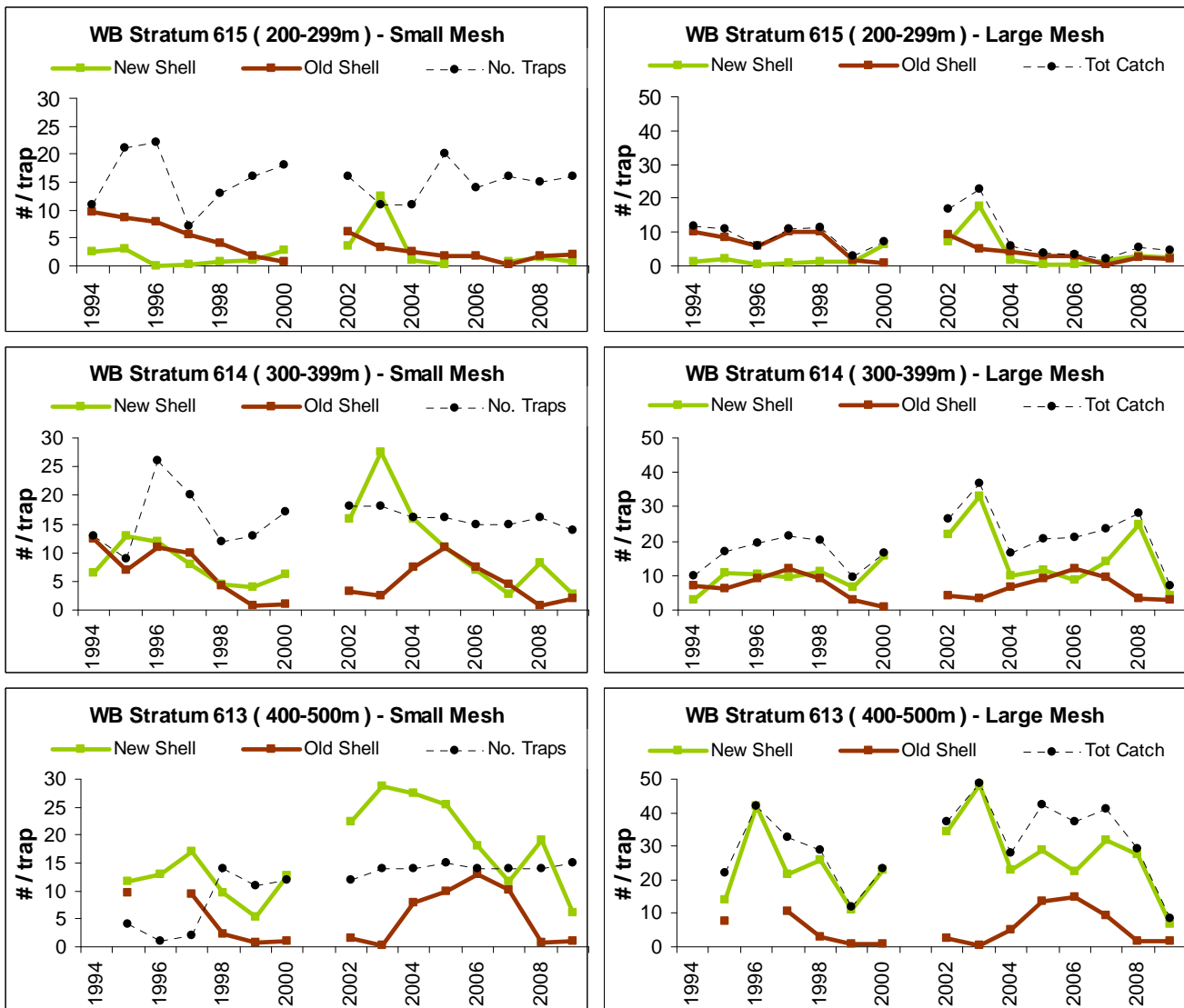


Figure 90. Trends in catch rate by shell condition of legal-sized males from small-mesh and large-mesh traps in the DFO survey by stratum in White Bay, 1994-2009; no survey was conducted in 2001.

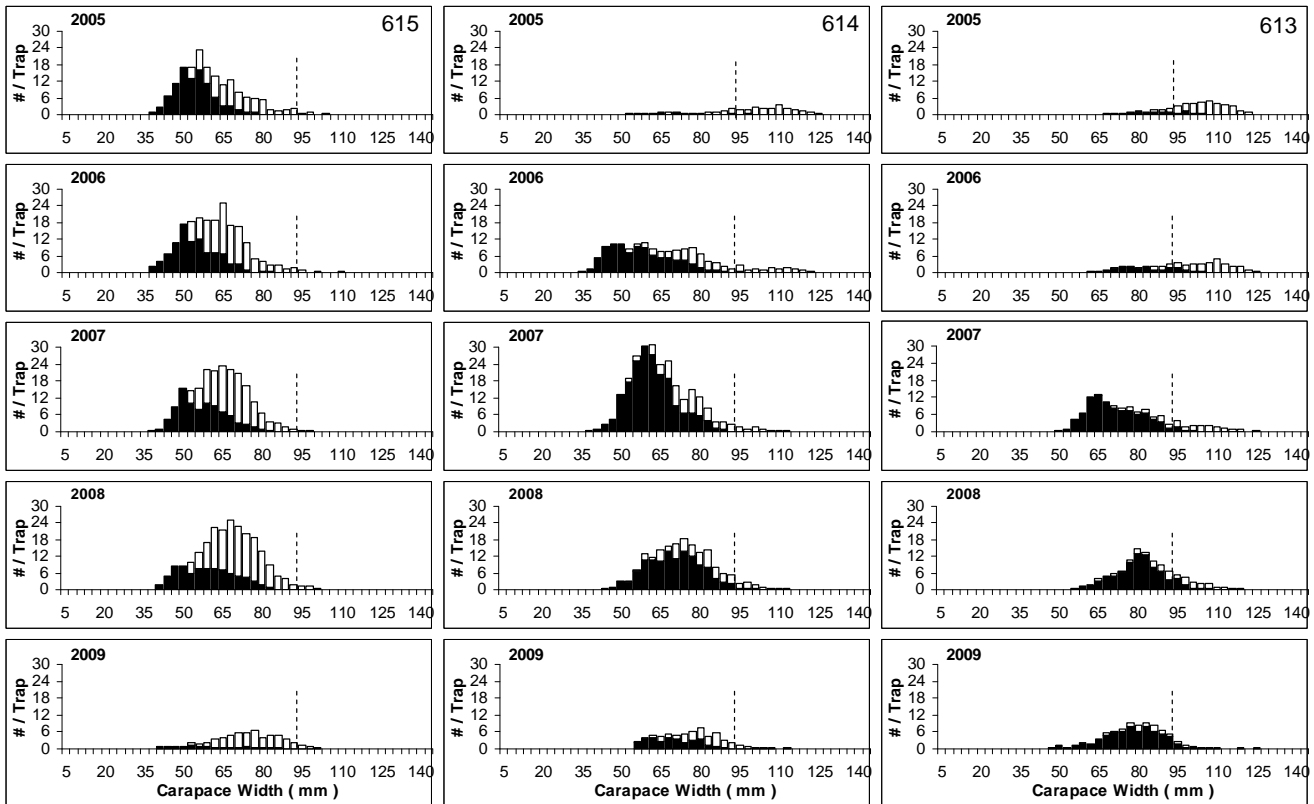


Figure 91. Distribution of adolescent (dark bars) vs. adult (open bars) male catch rates by size year and stratum from small-mesh traps in the DFO survey in White Bay from 2005 to 2009.

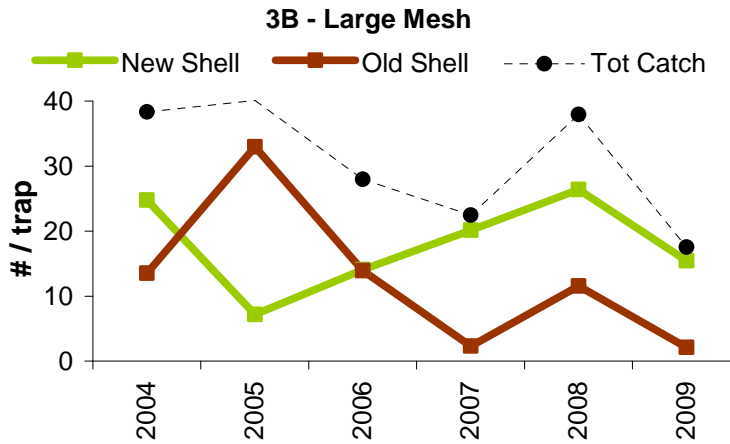


Figure 92. Trends in CPUE by shell condition for legal-sized crabs from core stations in the Division 3K inshore CPS trap survey in White Bay.

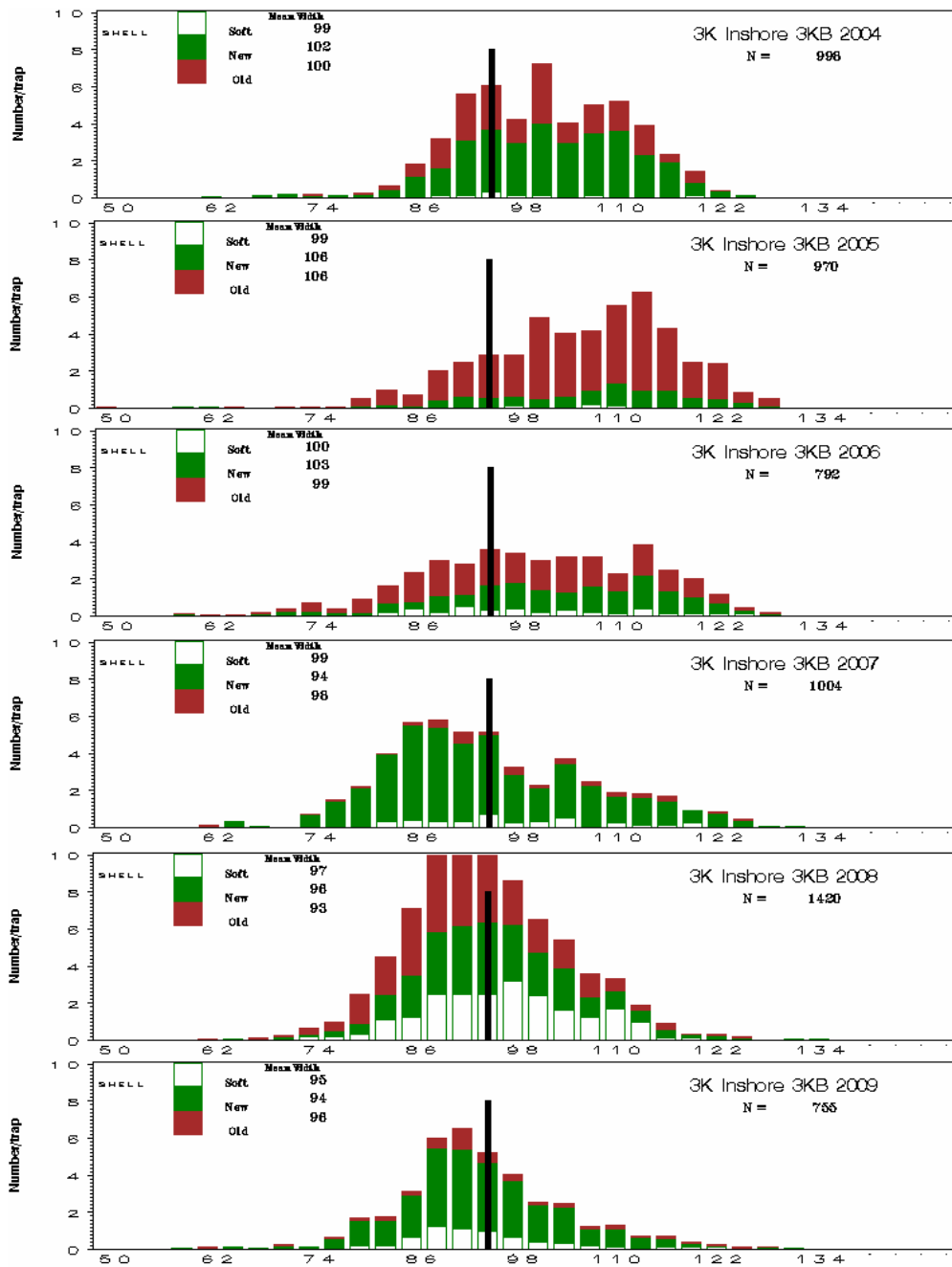


Figure 93. Trends in male carapace width distributions from core stations in the Division 3K inshore CPS trap survey. The vertical solid line indicates the minimum legal size.

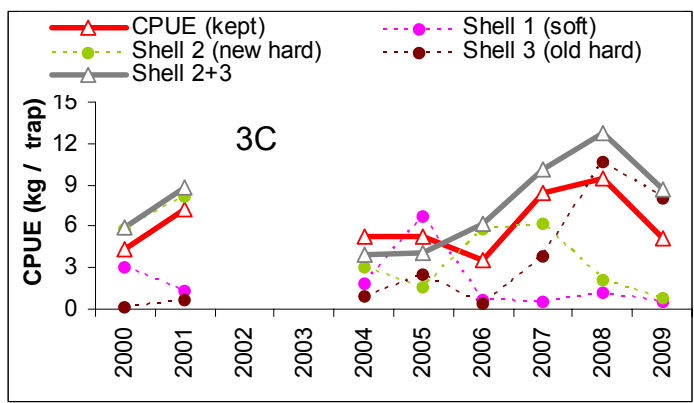


Figure 94. Trends in CMA 3C observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

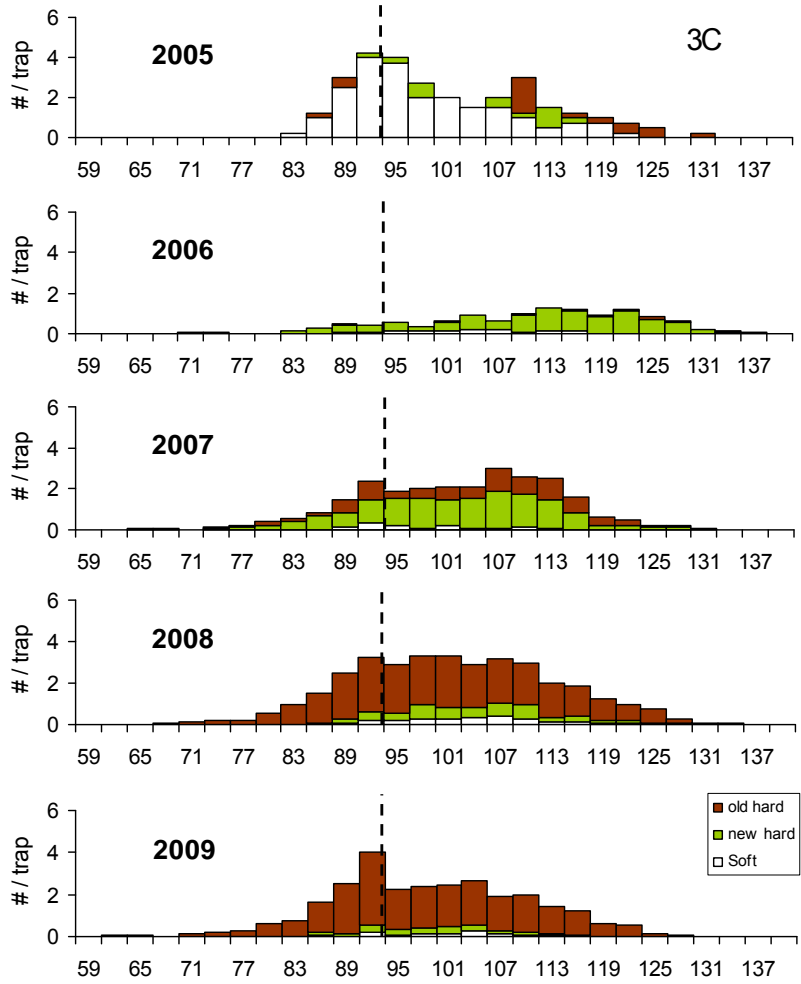


Figure 95. Trends in male carapace width distributions by shell condition from observer at-sea sampling for CMA 3C. The vertical dashed line indicates the minimum legal size.

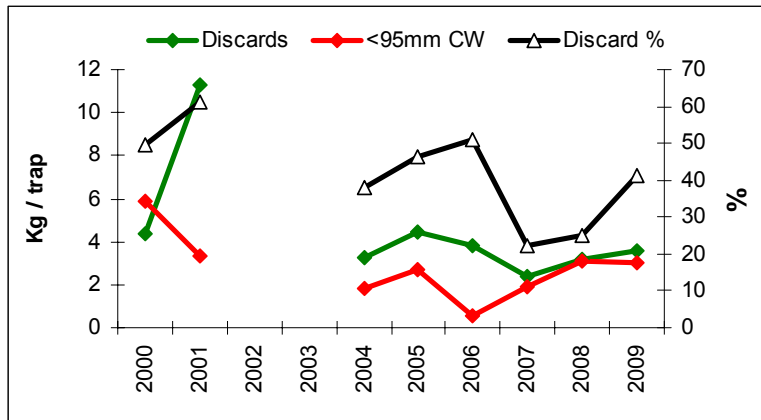


Figure 96. Trends in CMA 3C observer catch rates of total discards and percent discarded and percent discarded from set and catch records and of sub-legal sized crabs from at-sea sampling.

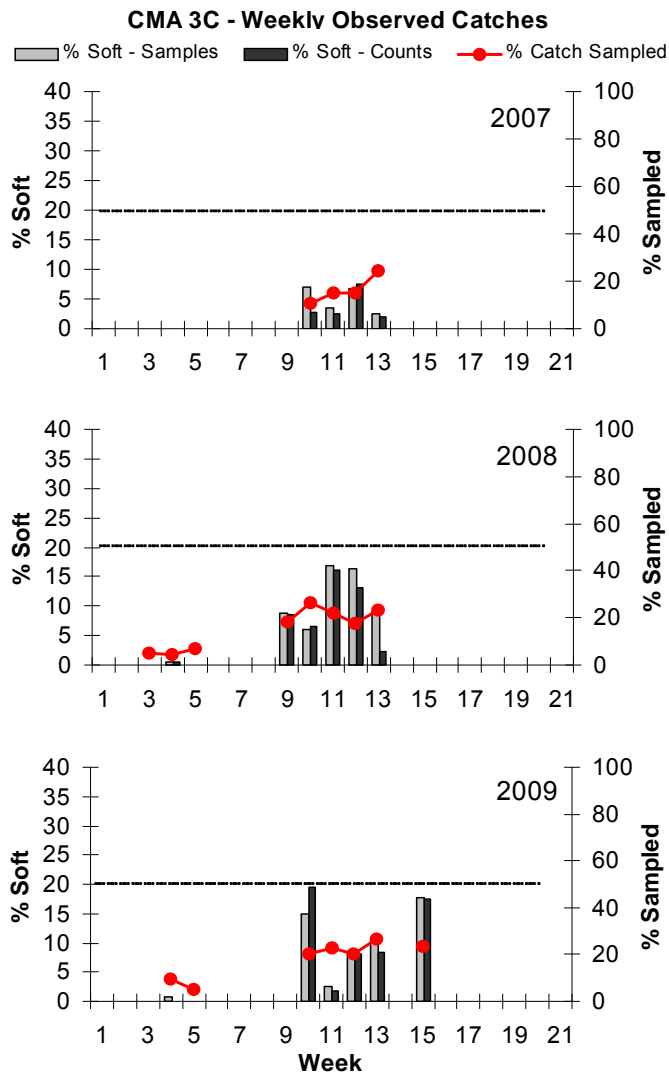


Figure 97. Trends in weekly percentages of soft-shell crab monitored and sampled in CMA 3C from 2007 to 2009. Red lines show percentage of the catch sampled each week.



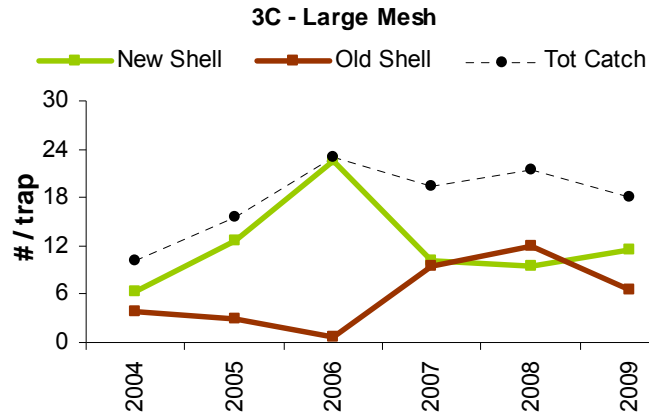


Figure 98. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 3C CPS trap survey.

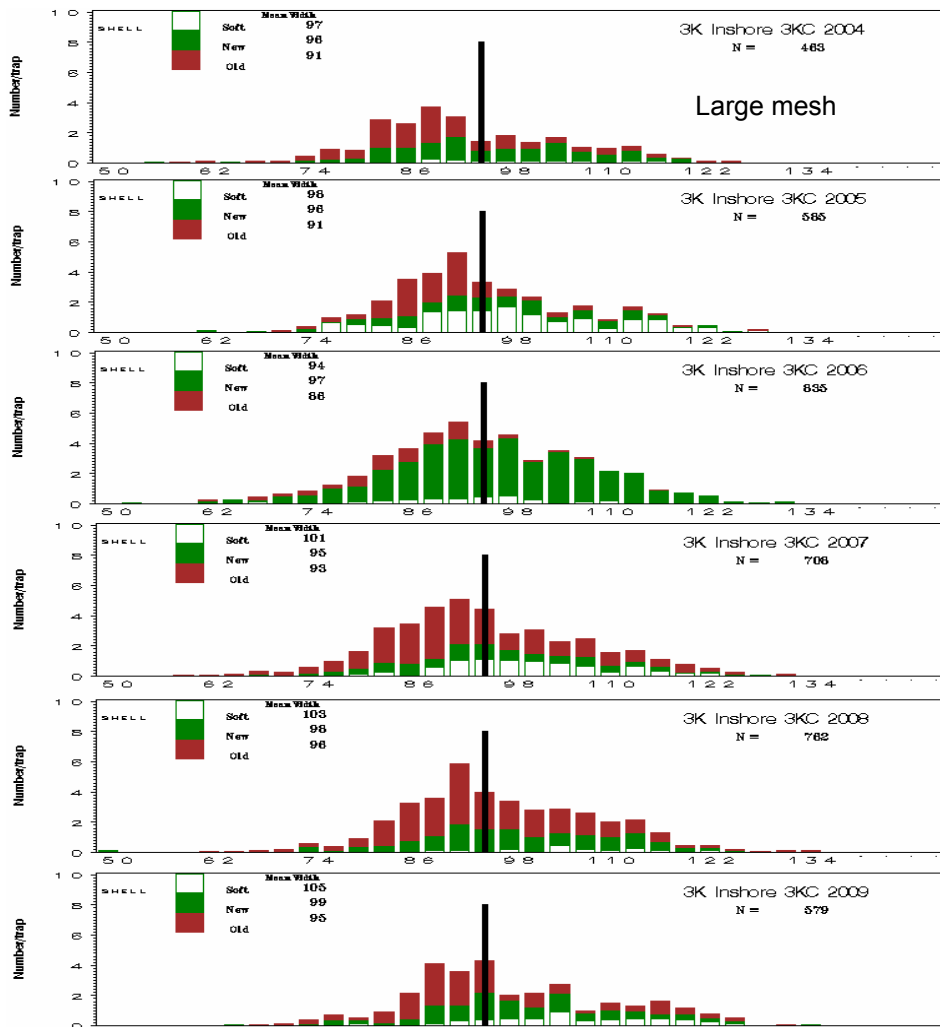


Figure 99. Trends in male carapace width distributions from core stations in the CMA 3C CPS trap survey. The vertical solid line indicates the minimum legal size.

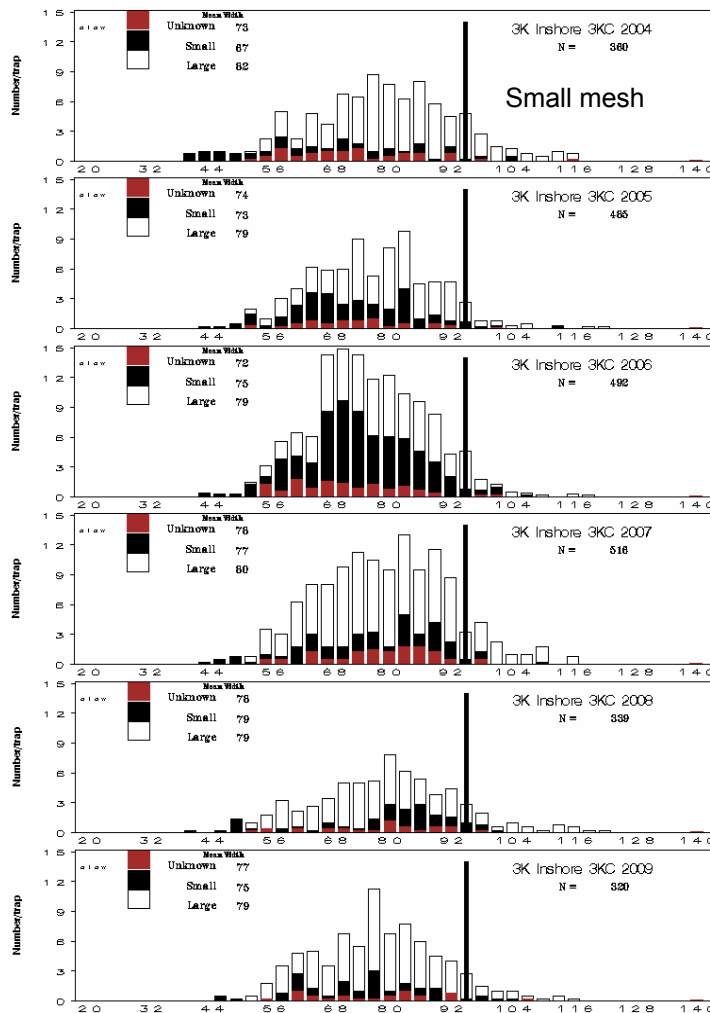


Figure 100. Trends in male carapace width distributions by chela type from small-mesh traps at core stations in the CMA 3C CPS trap survey. The vertical solid line indicates the minimum legal size.

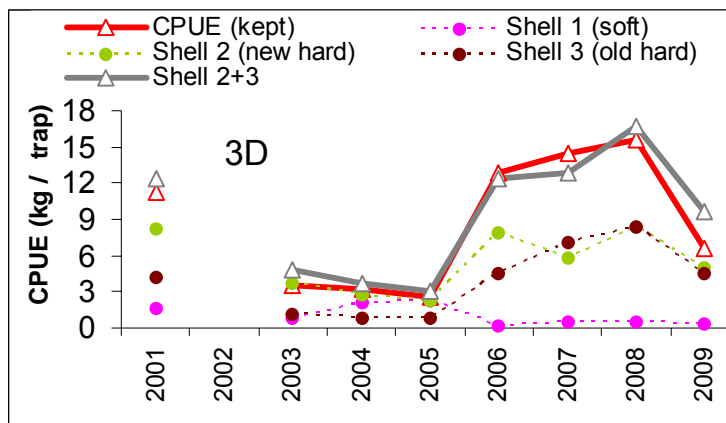


Figure 101. Trends in CMA 3D observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

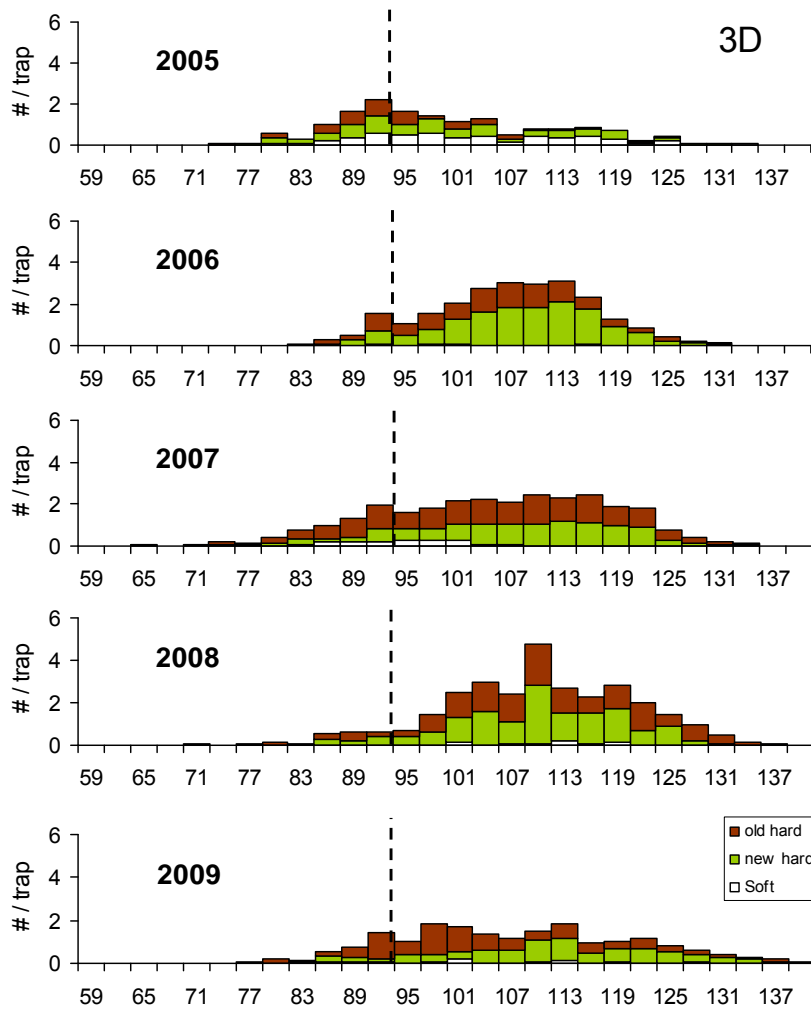


Figure 102. Trends in male carapace width distributions by shell condition from observer at-sea sampling for CMA 3D. The vertical dashed line indicates the minimum legal size.

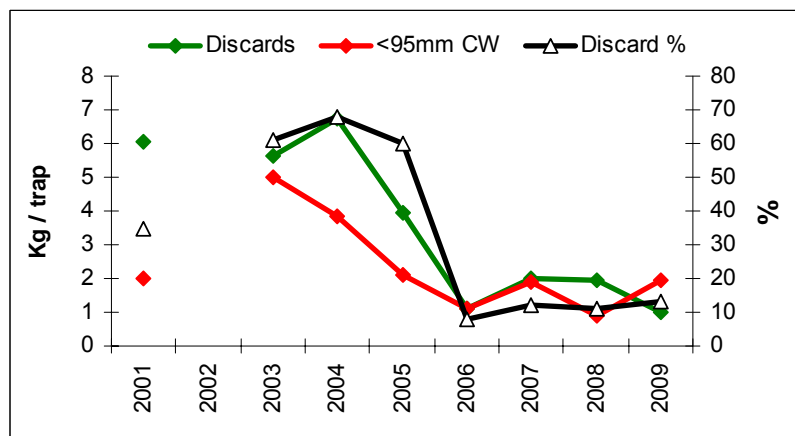


Figure 103. Trends in CMA 3D observer catch rates of total discards and percent discarded from set and catch records and of sub-legal sized crabs from at-sea sampling.

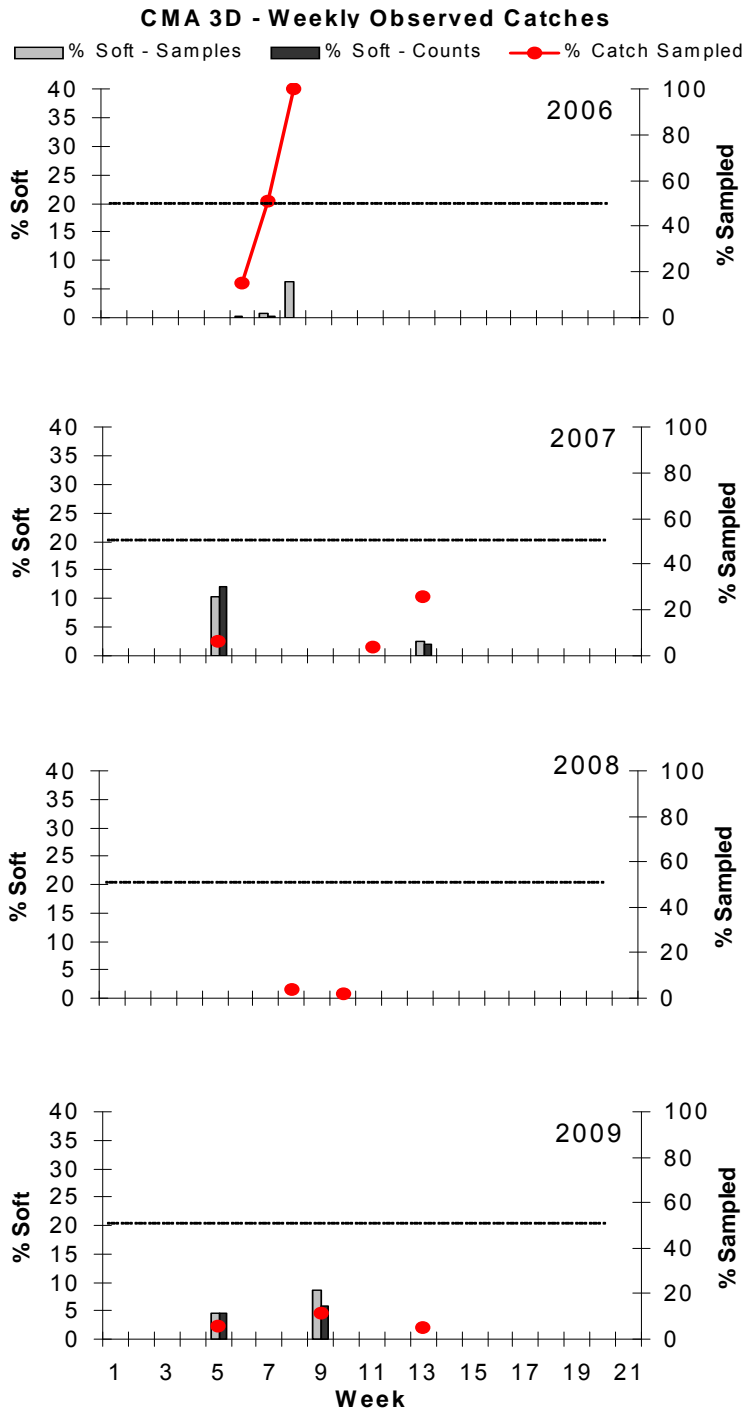


Figure 104. Trends in weekly percentages of soft-shell crab monitored and sampled in CMA 3D from 2006 to 2009. Red lines show percentage of the catch sampled each week.

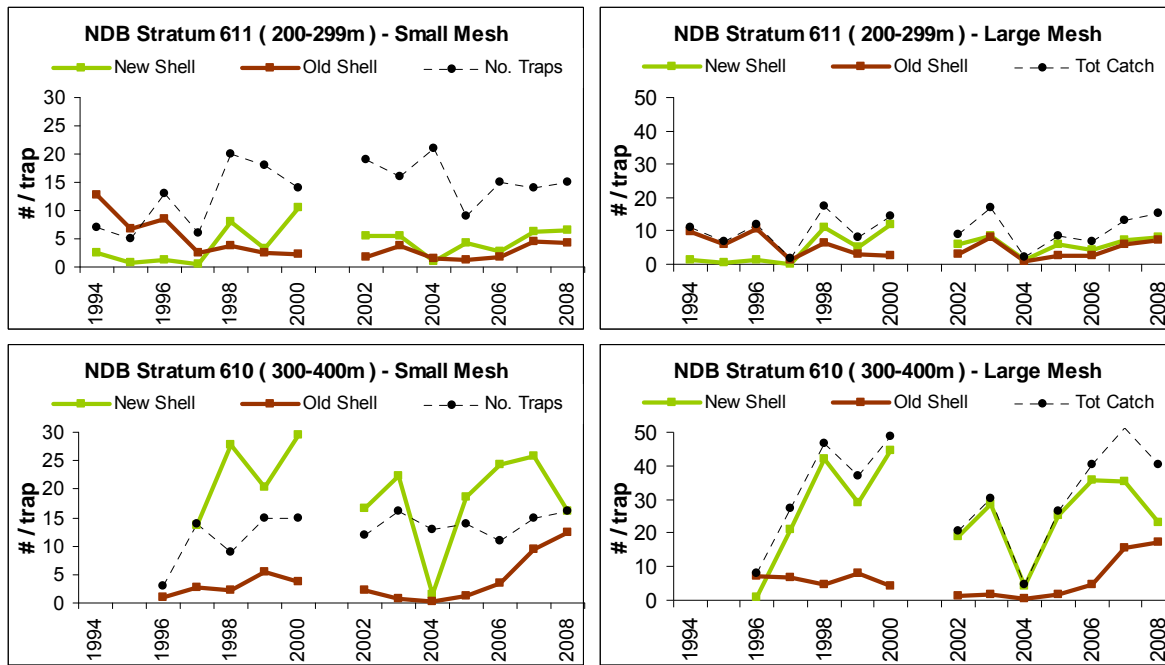


Figure 105: Trends in catches by shell condition of legal-sized males from small-mesh and large-mesh traps in the DFO survey by stratum in Notre Dame Bay, 1994-2009; no survey was conducted in 2001 and 2009.

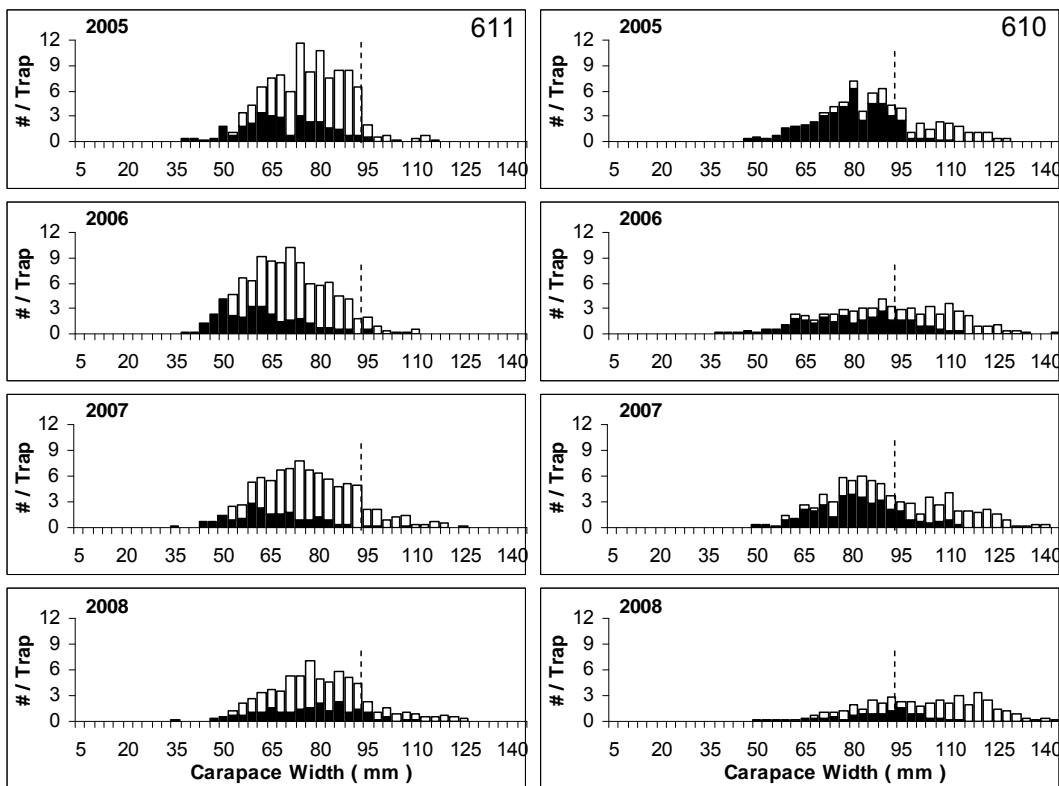


Figure 106. Distributions of small-claw (adolescent) vs. large-claw (adult) male catch rates by size from small-mesh traps in DFO survey in Notre Dame Bay from 2005 to 2008. No survey in 2009.

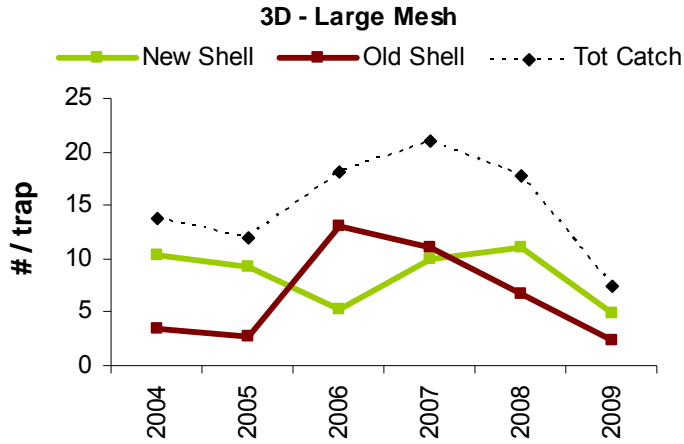


Figure 107. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 3D CPS trap survey.

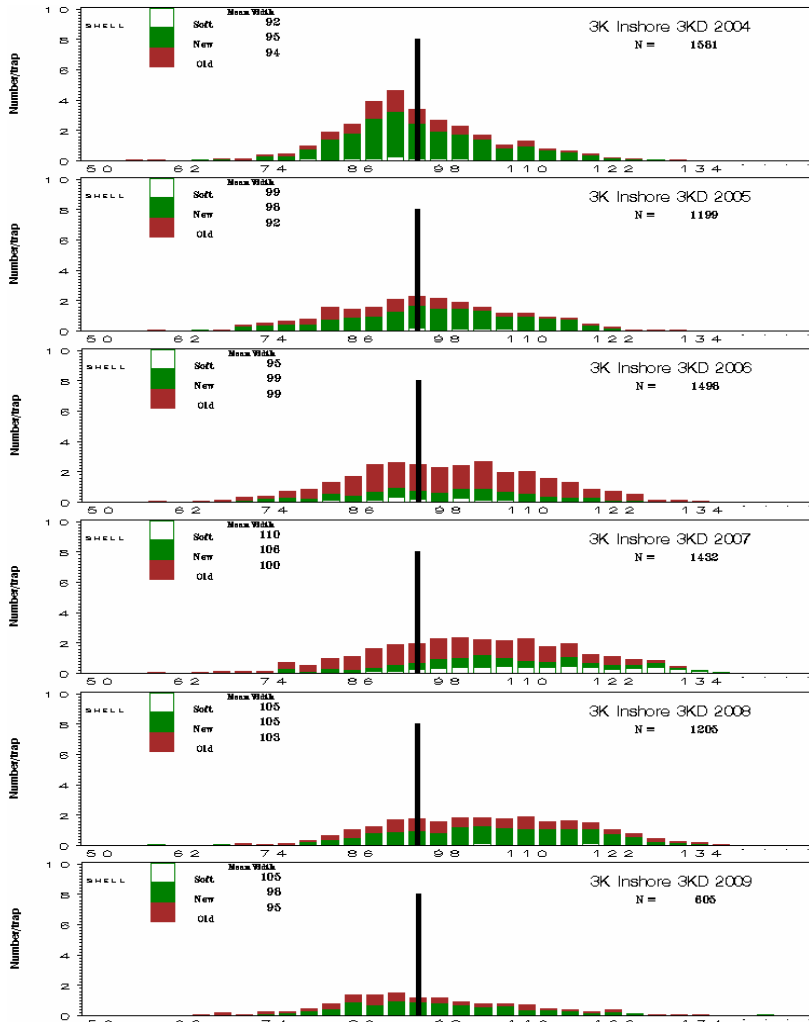


Figure 108. Trends in male carapace width distributions from core stations in the CMA 3D CPS trap survey. The vertical solid line indicates the minimum legal size.

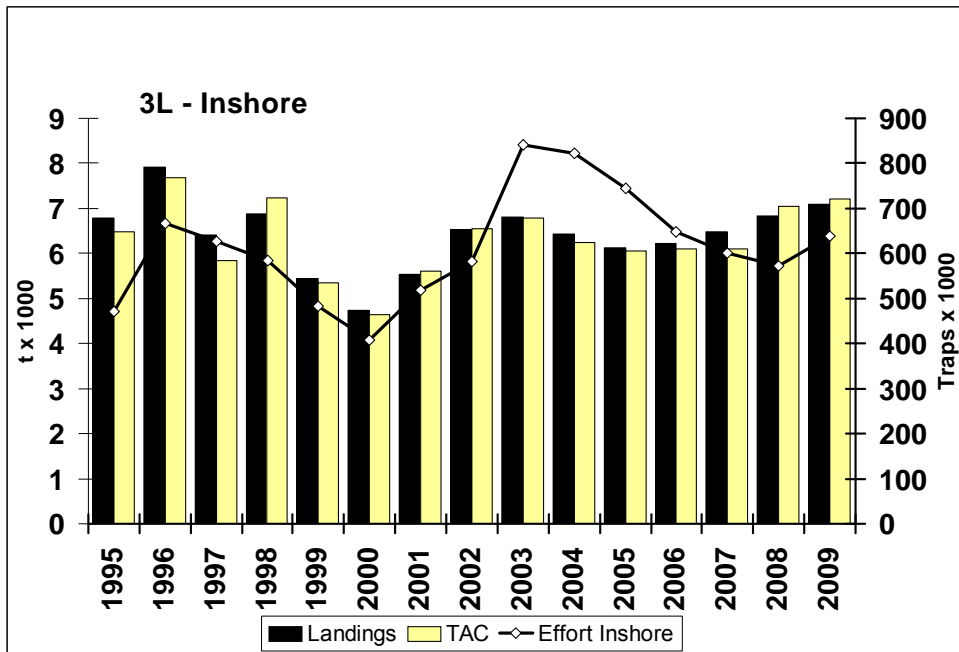
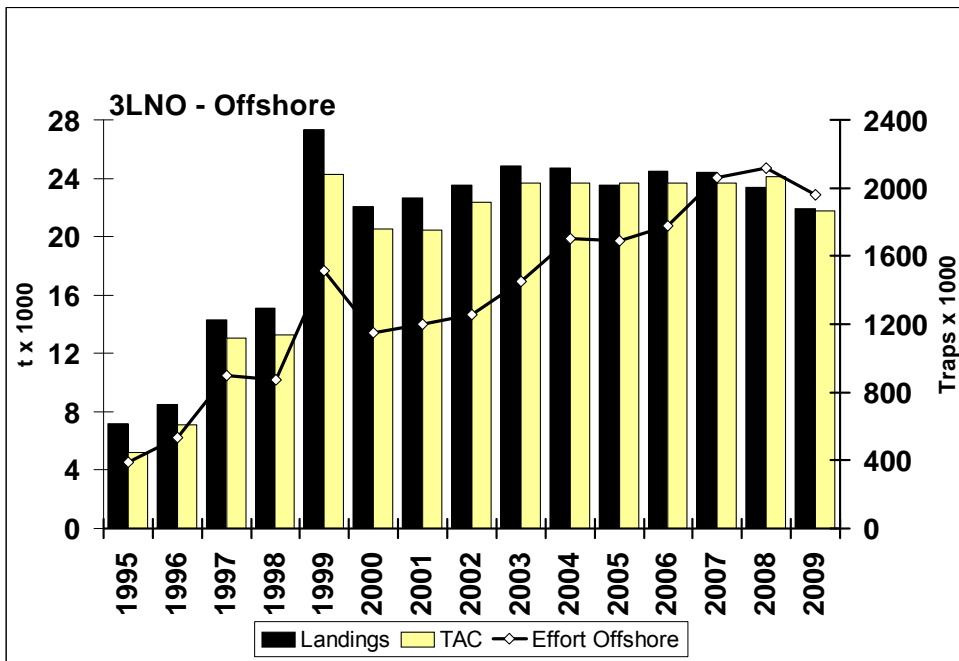


Figure 109. Trends in Division 3LNO landings, TAC, and fishing effort for Division 3LNO offshore (above) and Division 3L inshore (below).

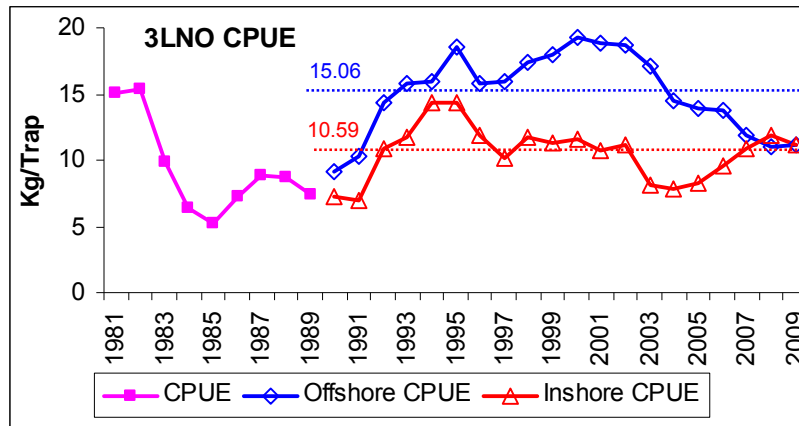


Figure 110. Trends in Division 3LNO offshore and Division 3L inshore commercial CPUE in relation to their long-term averages (dotted lines).

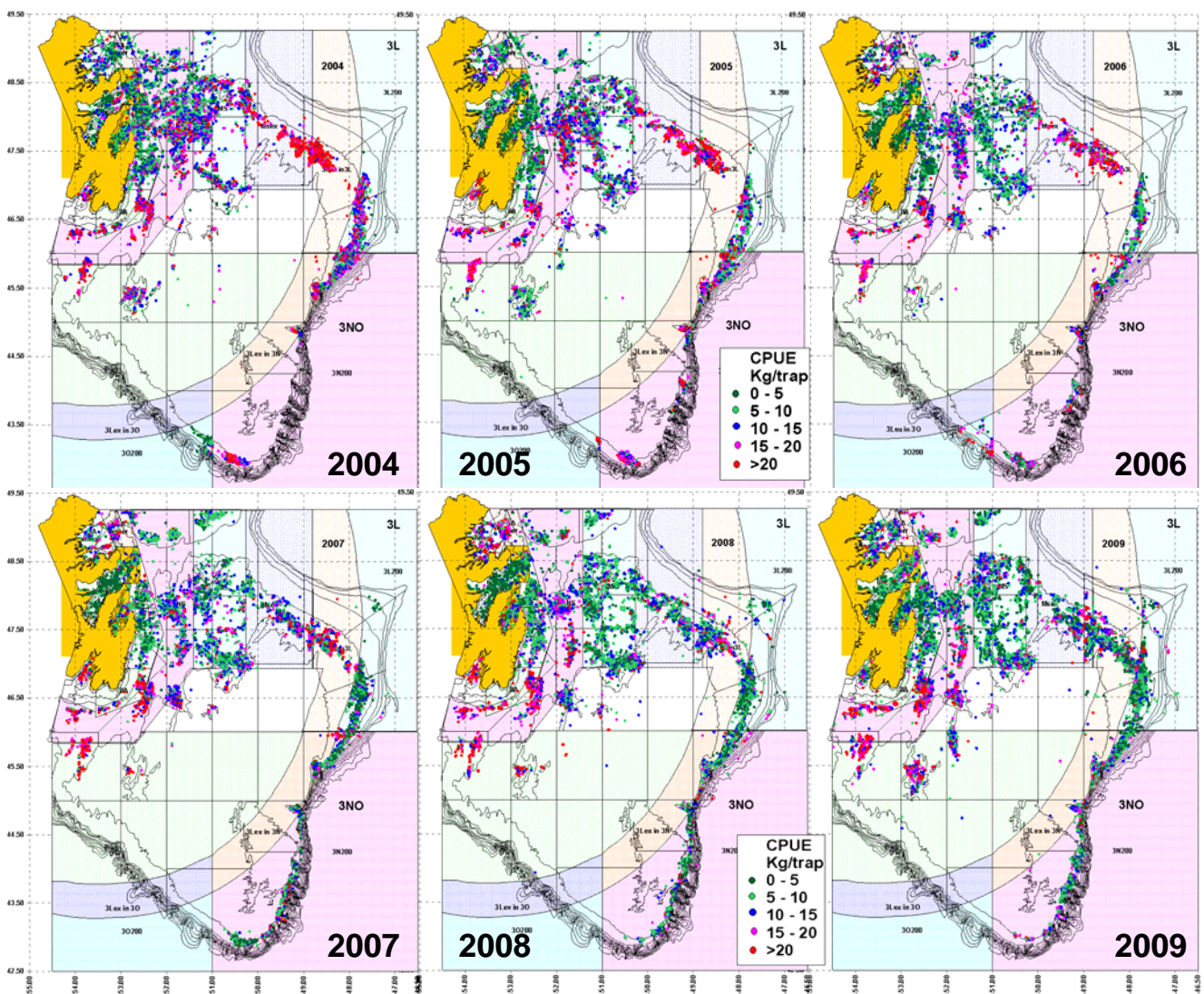
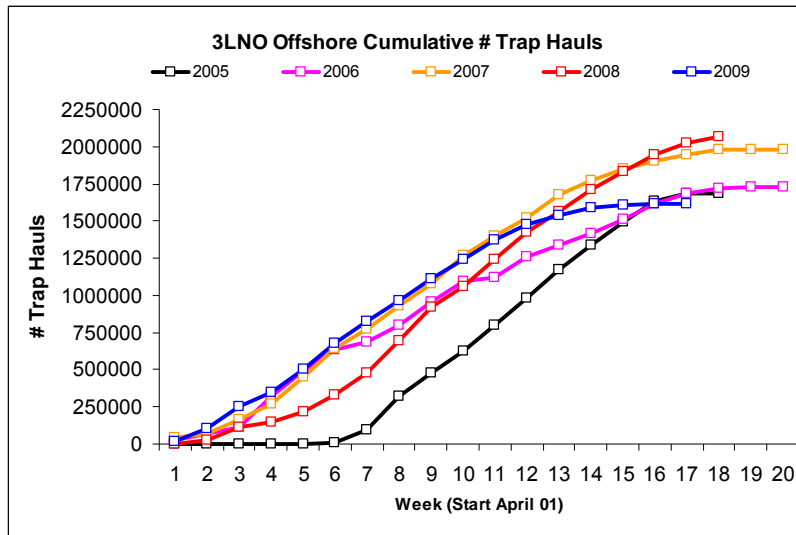


Figure 111. Spatial distribution of Division 3LNO commercial CPUE by year.



a)



b)

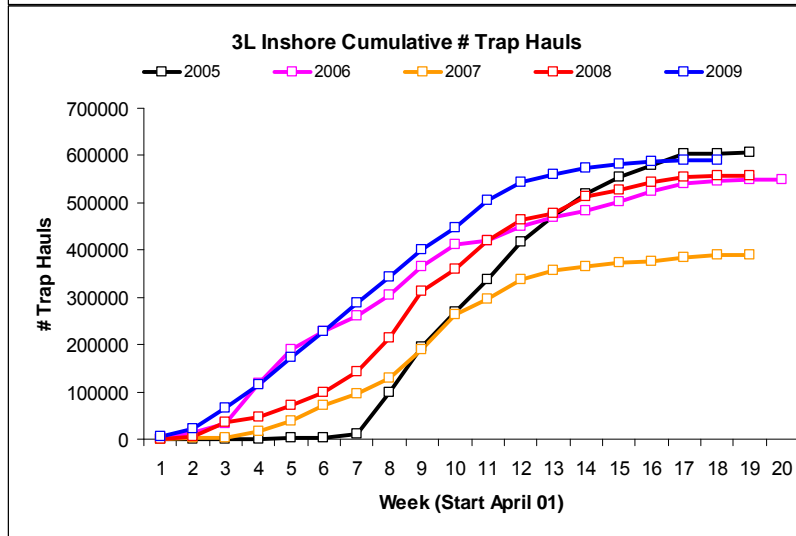


Figure 112. Seasonal trends in fishing effort for Division 3LNO during 2005-09 for (a) Division 3LNO offshore and (b) Division 3L inshore.

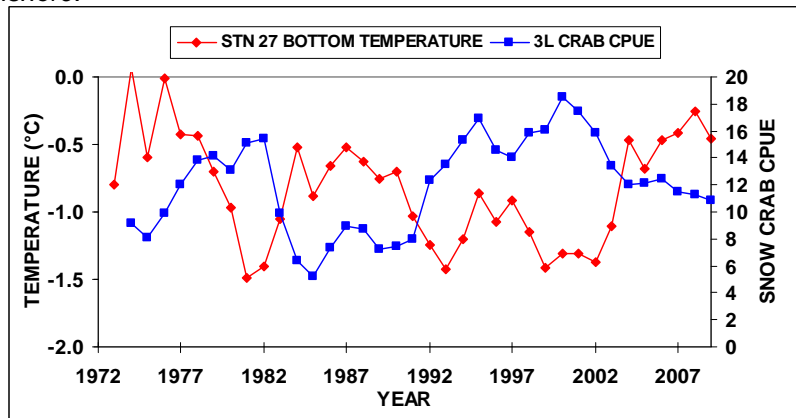


Figure 113. Trends in commercial CPUE in the Division 3LNO fishery (offshore and inshore combined) vs. bottom temperature eight years earlier.

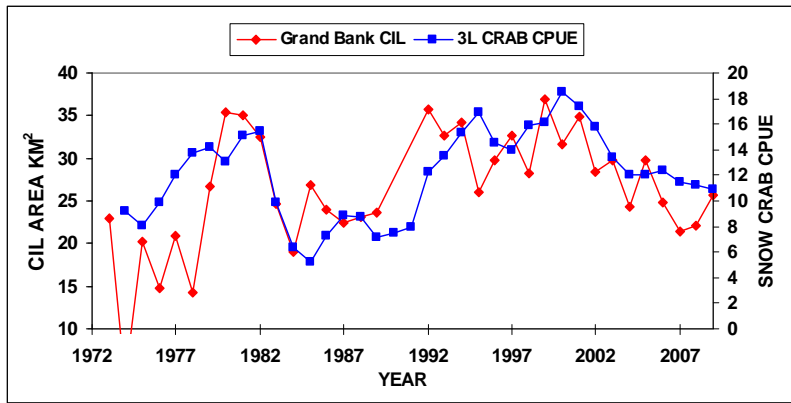


Figure 114. Trends in commercial CPUE in the Division 3LNO fishery (offshore and inshore combined) vs. spatial extent of the cold intermediate layer eight years earlier.

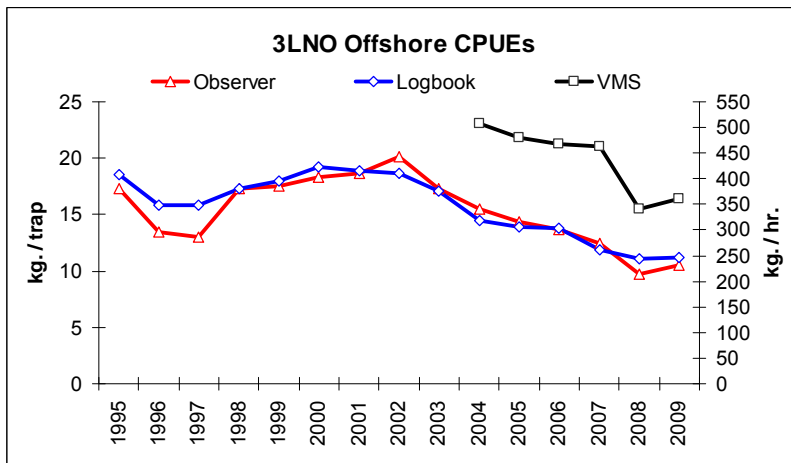


Figure 115. Trends in commercial logbook-based CPUE, observer-based CPUE, and VMS-based CPUE in the Division 3LNO offshore fishery.

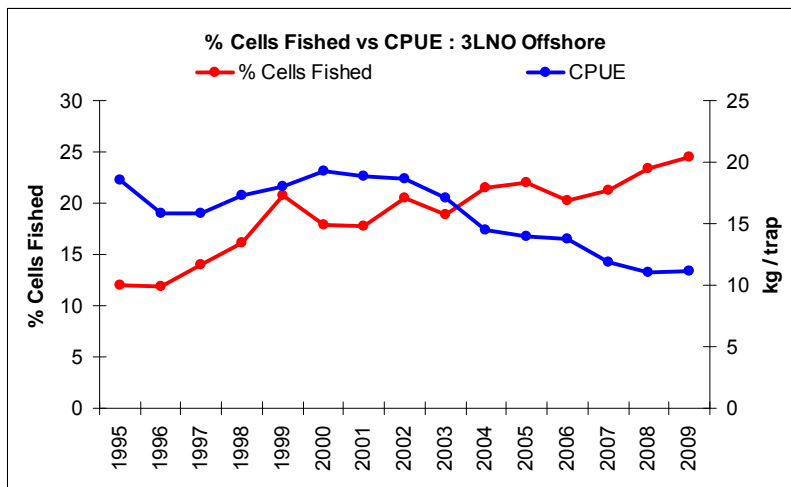


Figure 116. Trends in Division 3LNO offshore commercial CPUE vs. the percentage of 5' x 5' cells fished.

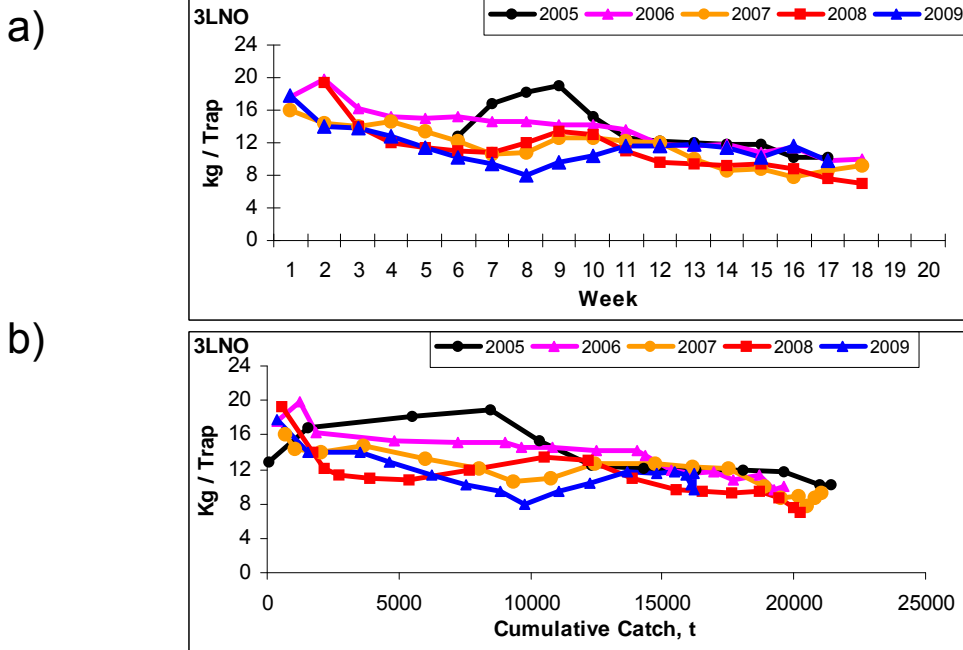


Figure 117. Seasonal trends in logbook-based CPUE for Division 3LNO offshore during 2005-09; (a) by week, and (b) in relation to cumulative catch.

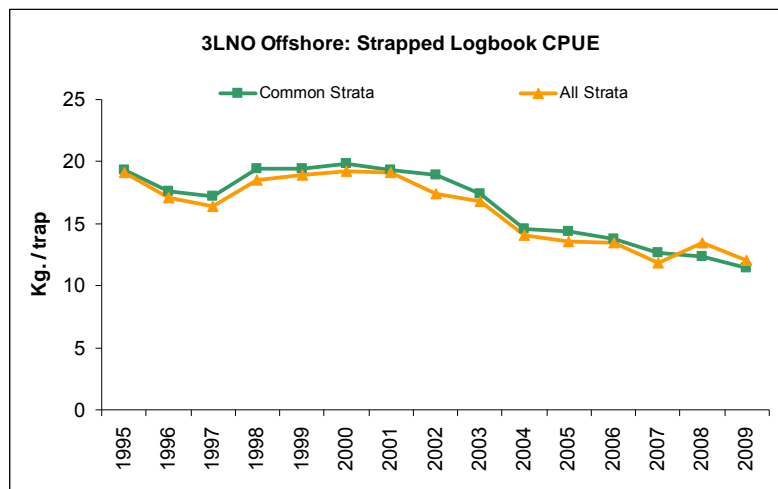


Figure 118. Trends in mean catch rates in the Division 3LNO offshore fishery based on spatially-expanded logbook STRAP analysis.

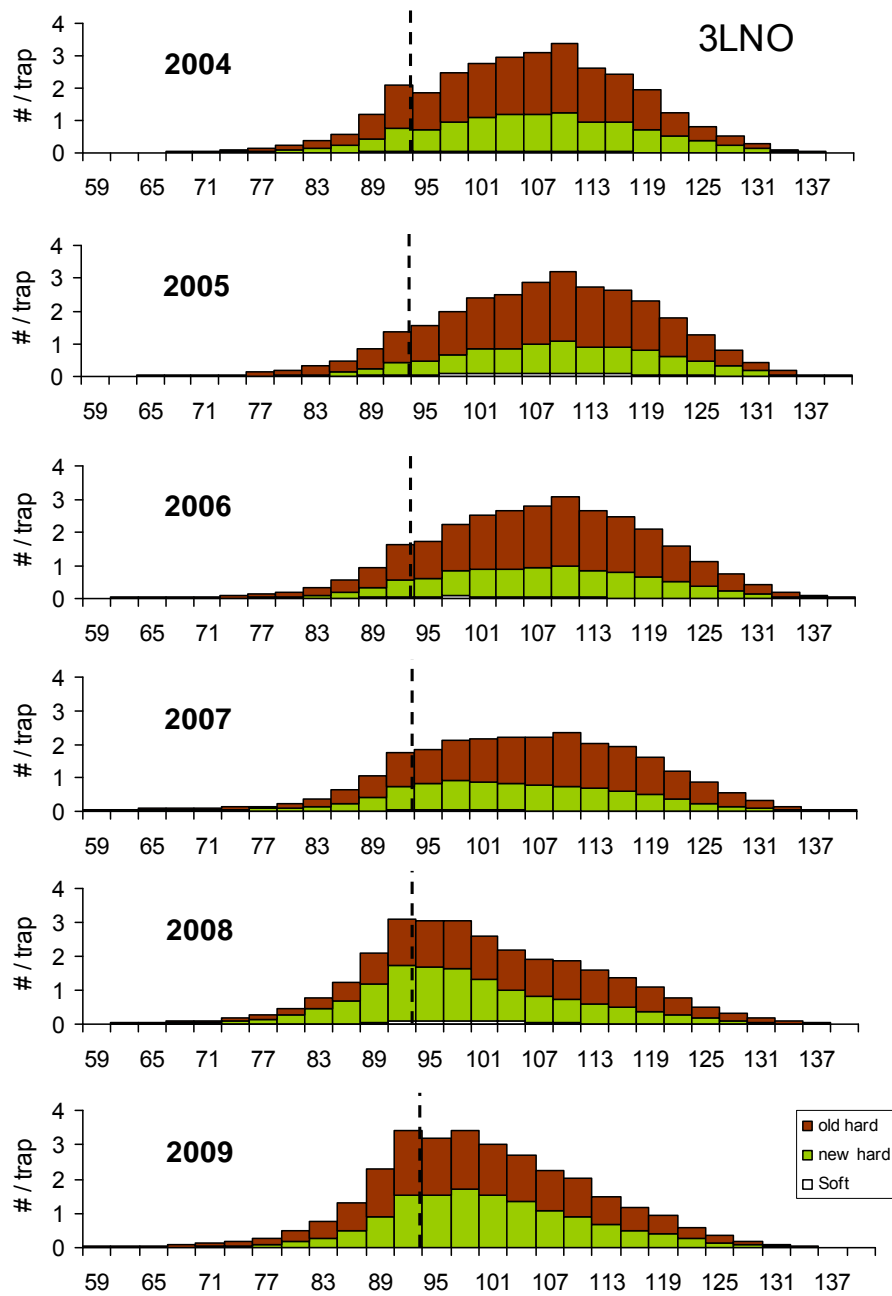


Figure 119. Trends in male carapace width distributions by shell condition from observer at-sea sampling for Division 3LNO offshore. The vertical dashed line indicates the minimum legal size.

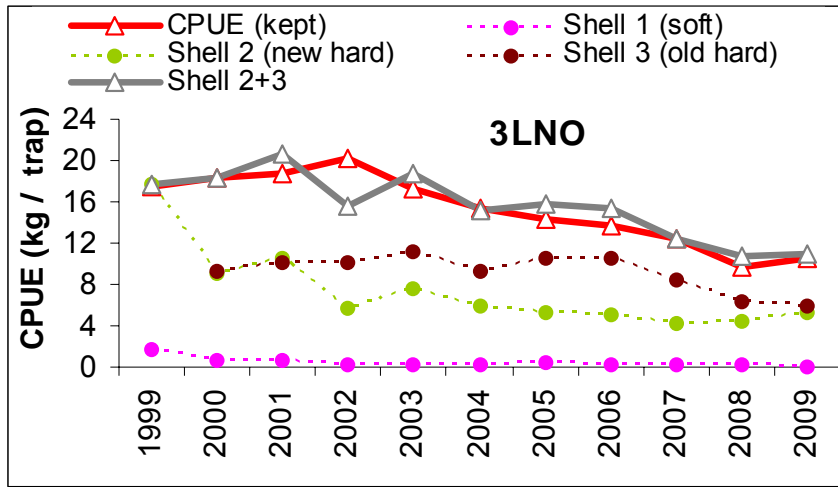


Figure 120. Trends in Division 3LNO observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

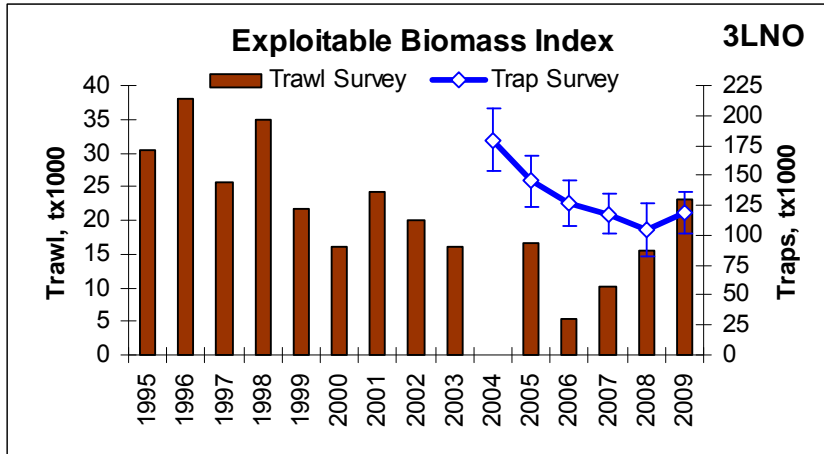


Figure 121. Trends in the Division 3LNO fall trawl survey exploitable biomass index and the CPS trap survey biomass index. The survey was incomplete in 2004.

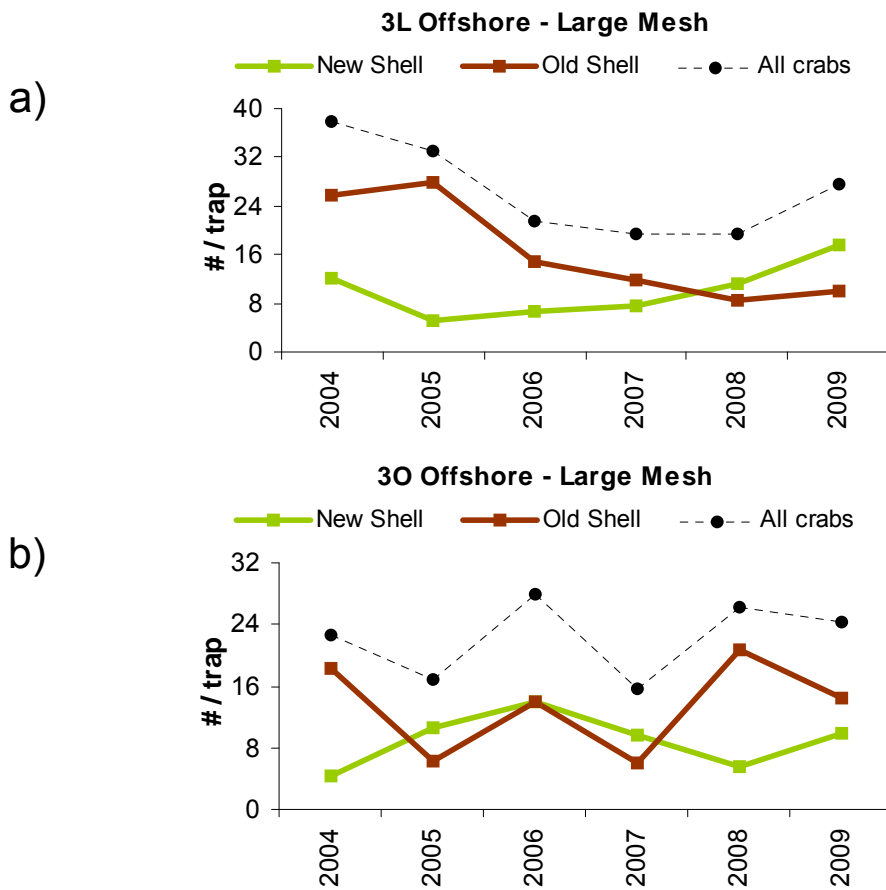


Figure 122. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CPS trap survey in (a) Division 3L offshore and (b) Division 3O offshore.

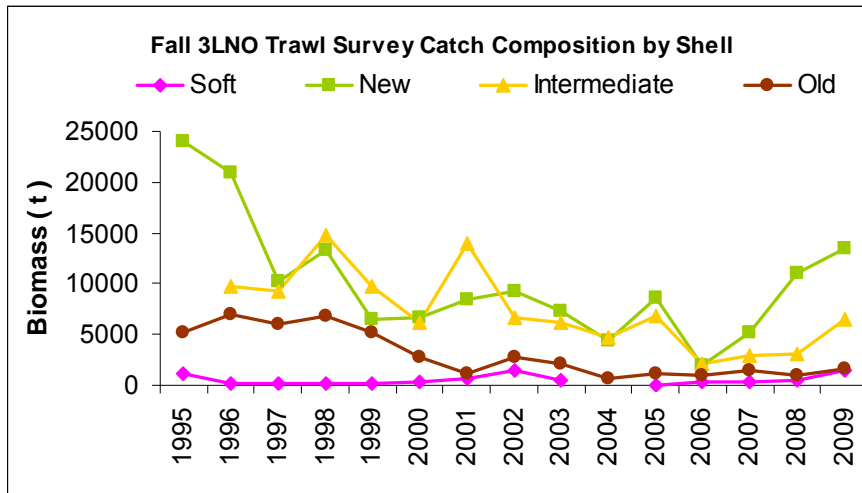


Figure 123. Trends, by shell condition, in legal-sized males for Division 3LNO offshore from fall trawl surveys.

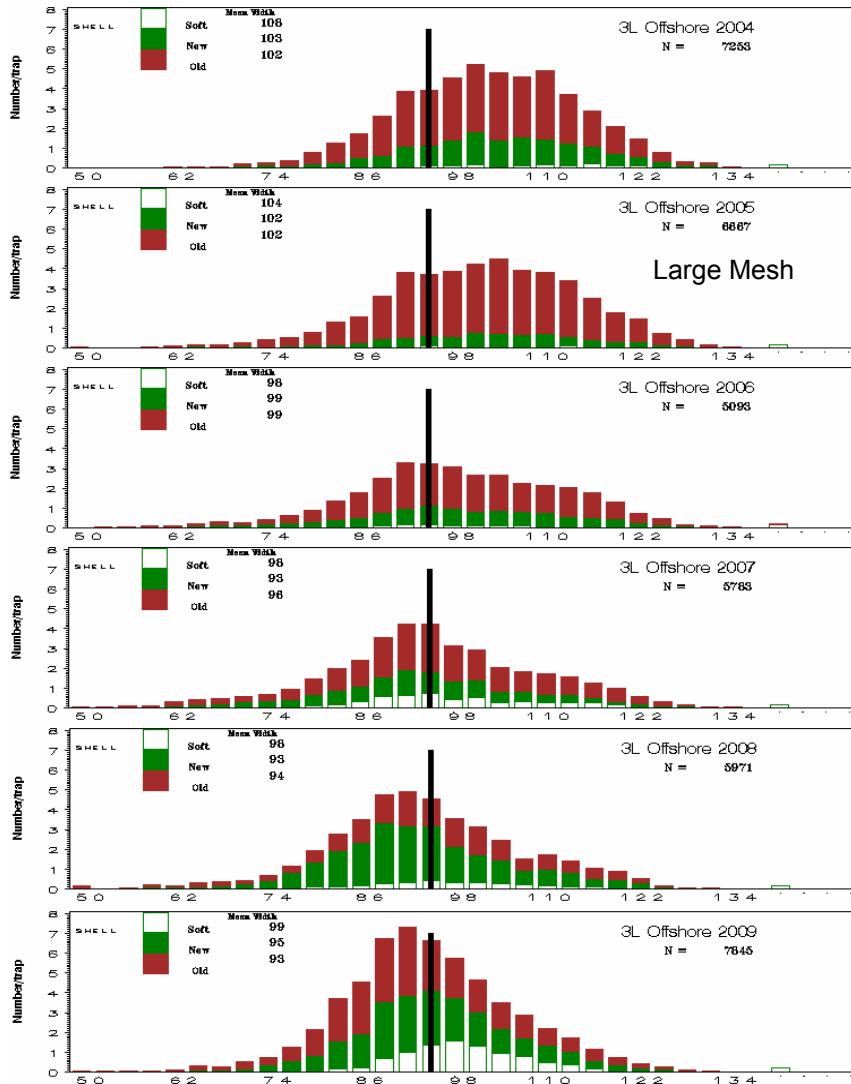


Figure 124. Trends in male carapace width distributions from core stations in the Division 3L CPS trap survey. The vertical solid line indicates the minimum legal size.

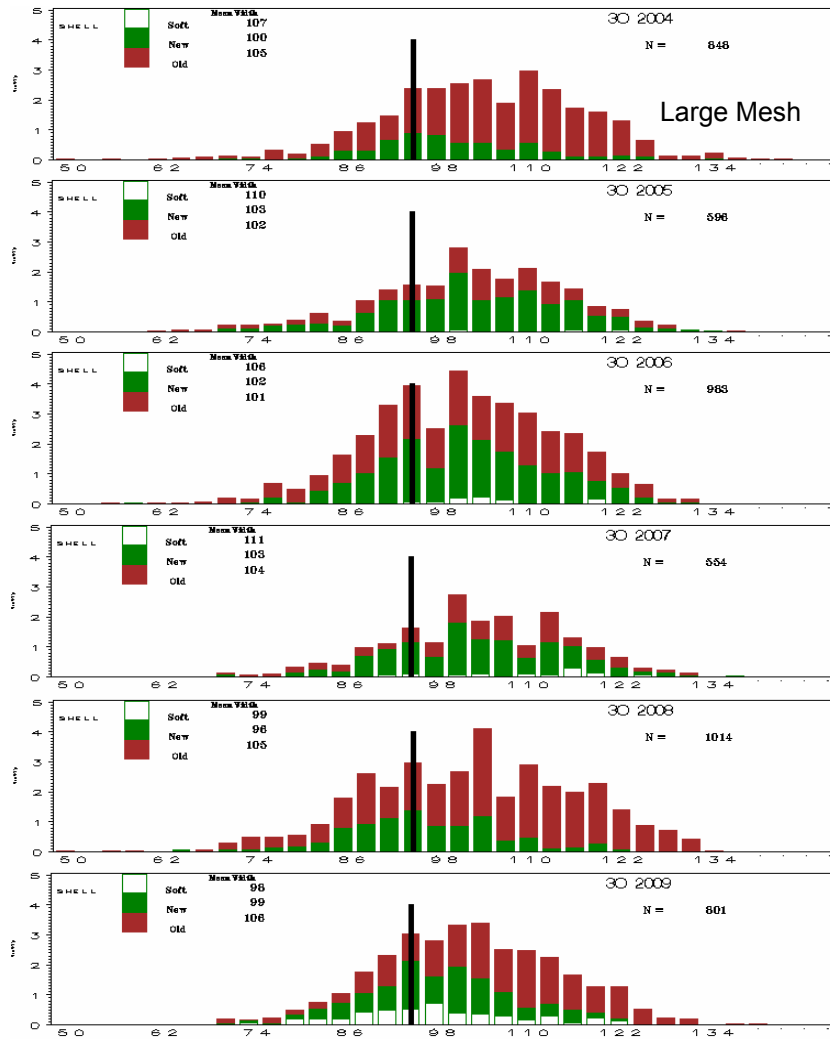


Figure 125. Trends in male carapace width distributions from core stations in the Division 30 CPS trap survey. The vertical solid line indicates the minimum legal size.



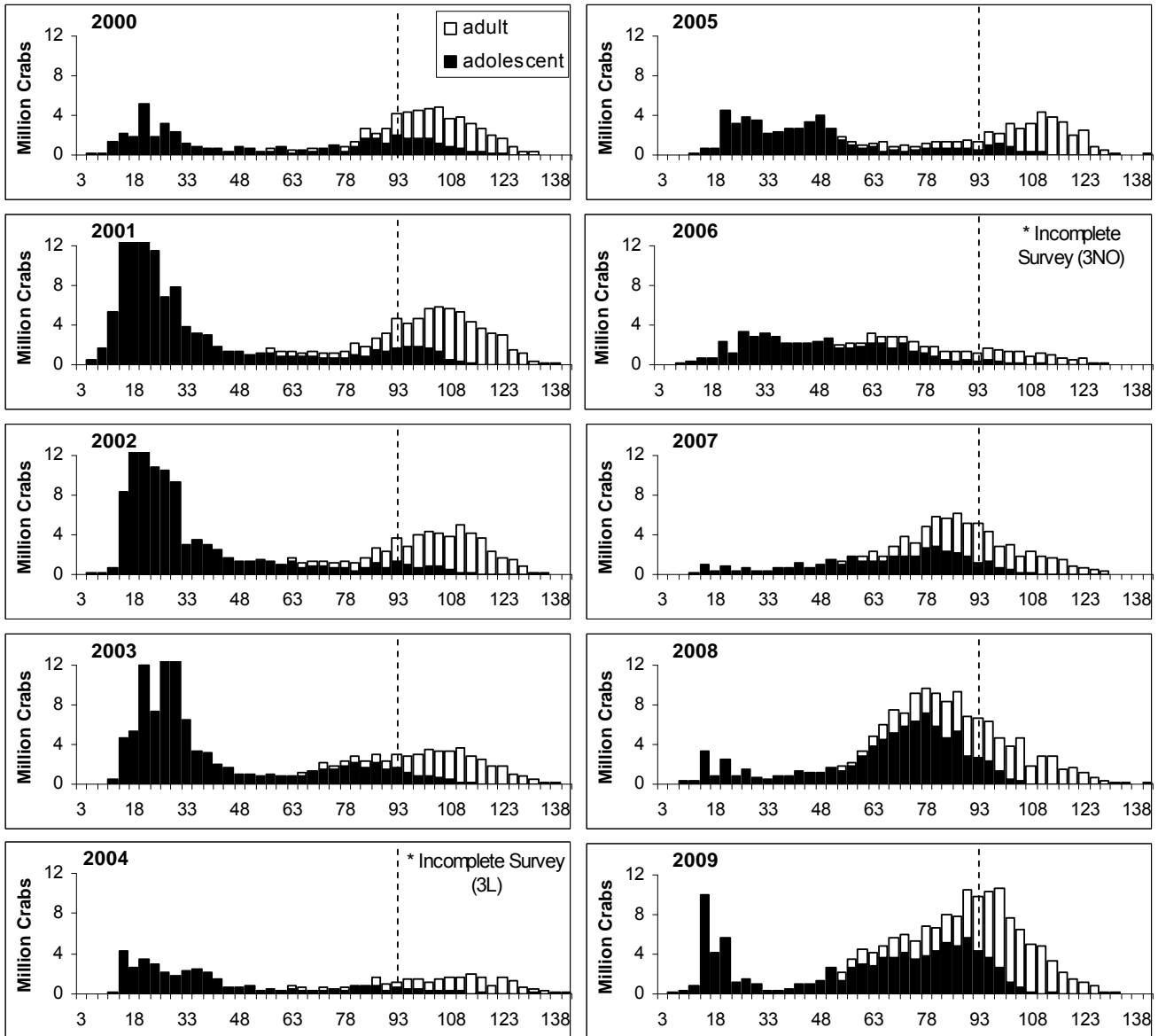


Figure 126. Distribution of abundance (index) by carapace width for Division 3LNO juveniles plus adolescents (dark bars) versus adults (open bars) from fall trawl surveys. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line.

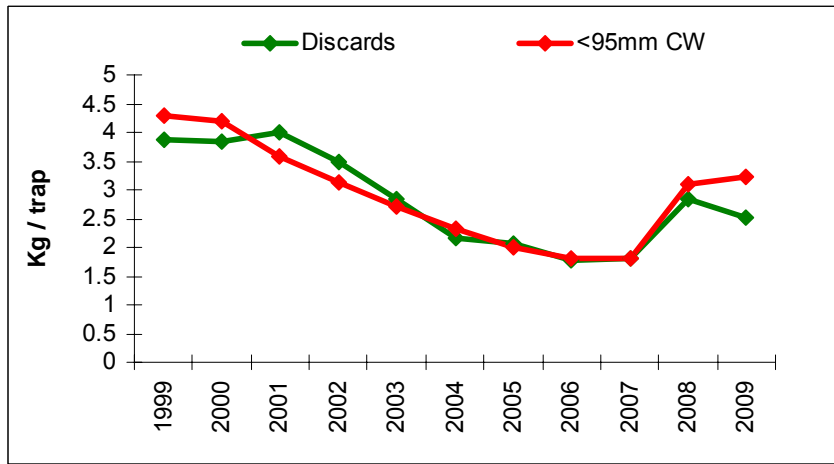


Figure 127. Trends in Division 3L observer catch rates of total discards from set and catch records and of sub-legal sized crabs from at-sea sampling.

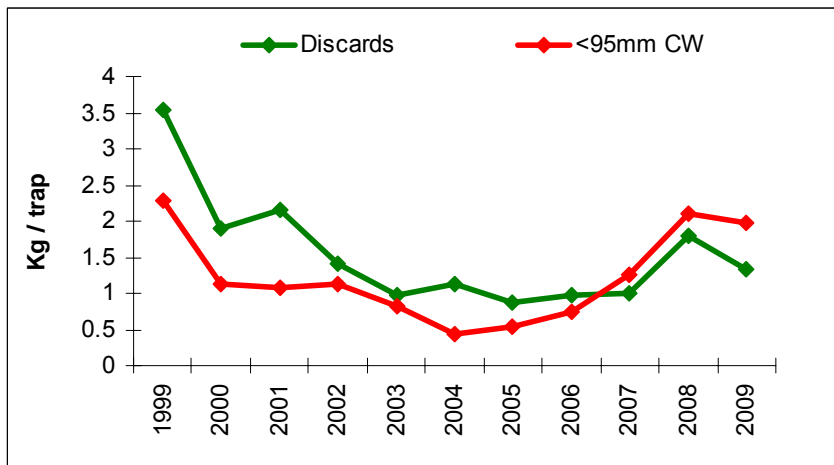


Figure 128. Trends in Division 3NO observer catch rates of total discards from set and catch records and of sub-legal sized crabs from at-sea sampling.

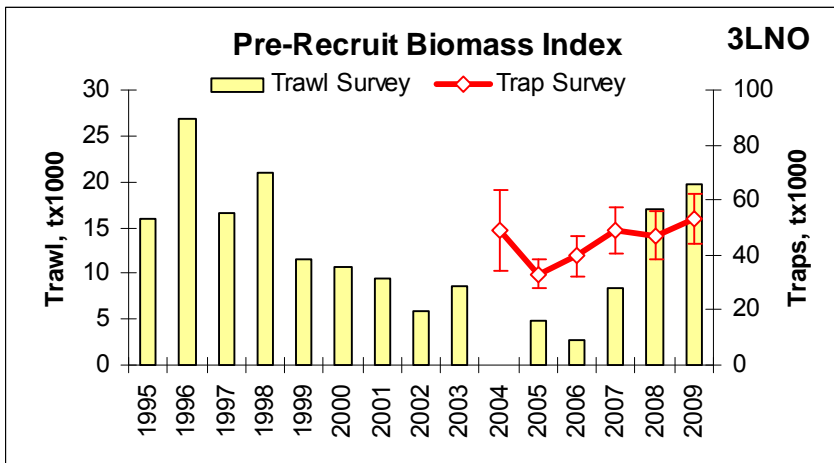


Figure 129. Trends in the Division 3LNO fall trawl survey pre-recruit biomass index and the CPS trap survey biomass index. The survey was incomplete in 2004.

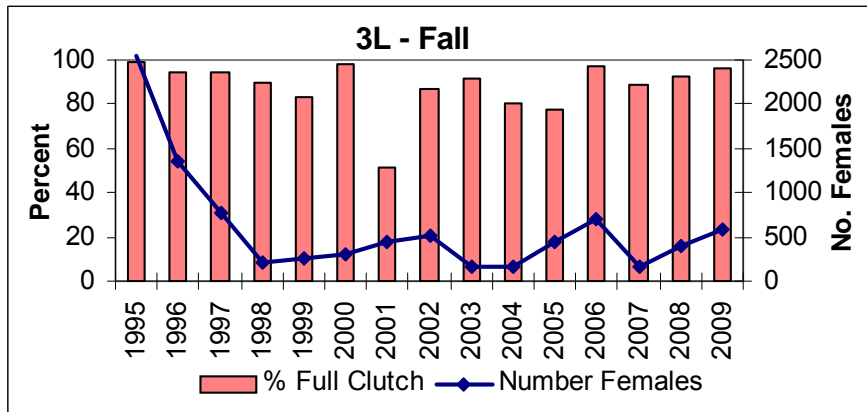


Figure 130. Trends in percent of mature females bearing full clutches of viable eggs and samples sizes in Division 3L from fall multi-species surveys.

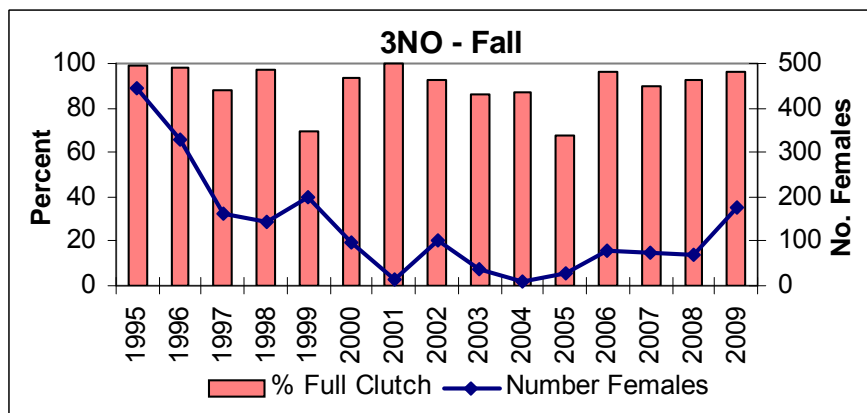


Figure 131. Trends in percent of mature females bearing full clutches of viable eggs and samples sizes in Division 3L from fall multi-species surveys.

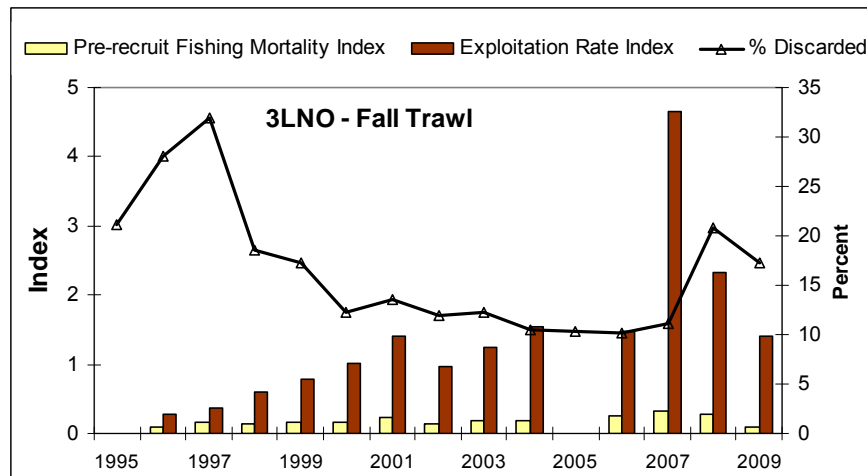


Figure 132. Trends in Division 3LNO offshore mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery. (No 2005 exploitation rate or pre-recruit fishing mortality indices because of an incomplete 2004 survey).

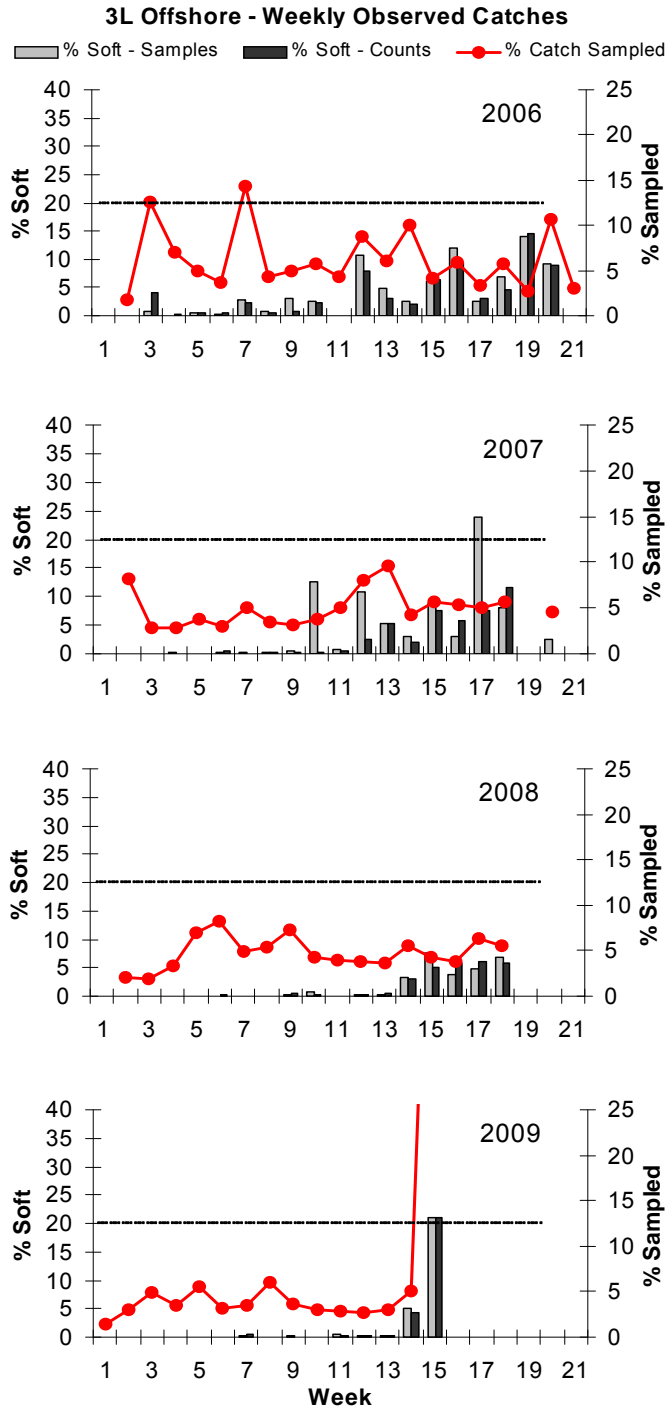


Figure 133. Trends in weekly percentages of soft-shell crab monitored and sampled in Division 3L offshore from 2006 to 2009. Red lines show percentage of the catch sampled each week.

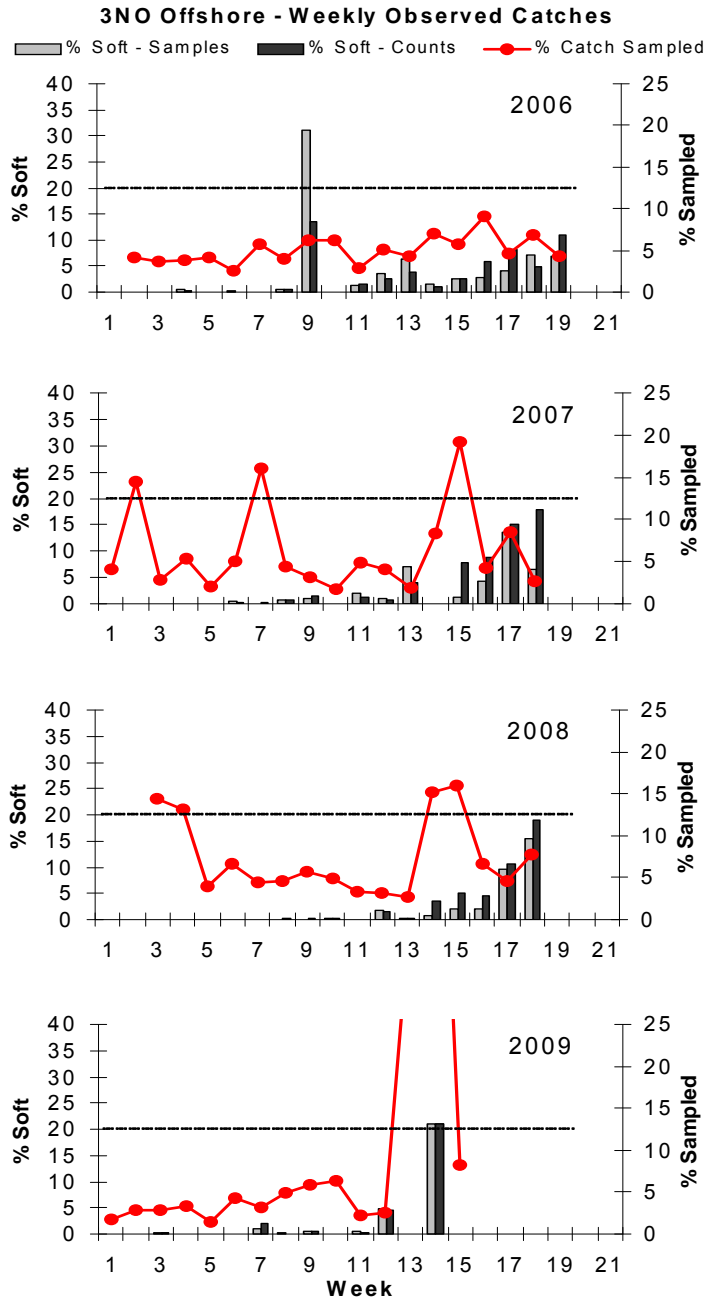


Figure 134. Trends in weekly percentages of soft-shell crab monitored and sampled in Division 3NO offshore from 2006 to 2009. Red lines show percentage of the catch sampled each week.

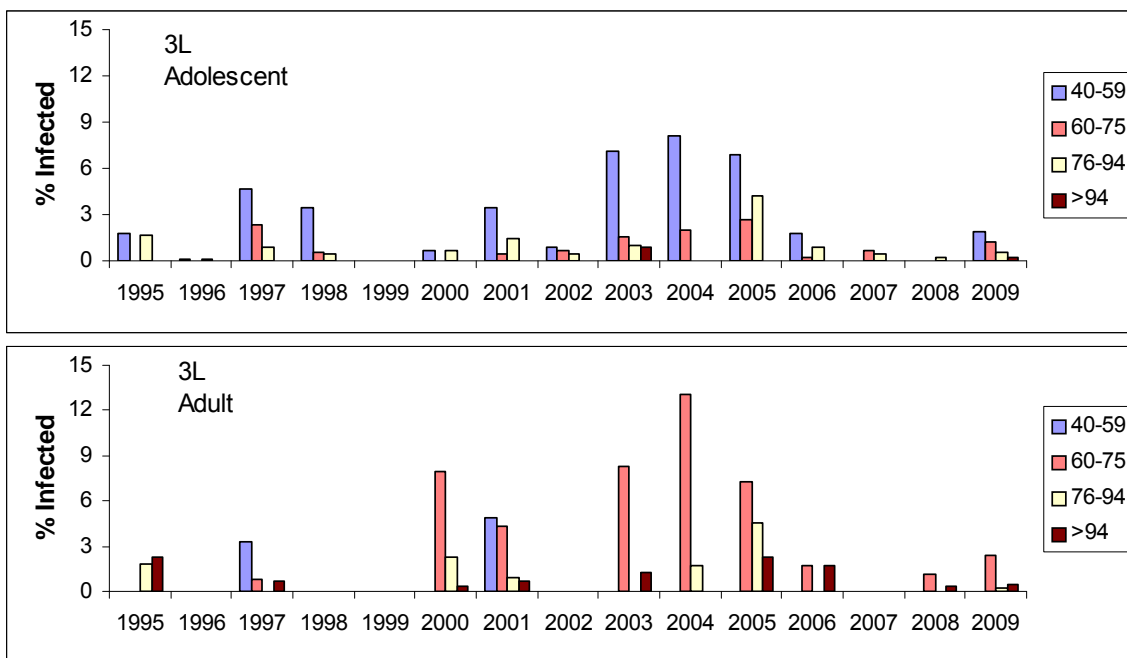


Figure 135. Trends in prevalence of BCD in new-shelled adolescents (above) and adults (below) by male size group from Division 3L fall trawl surveys.

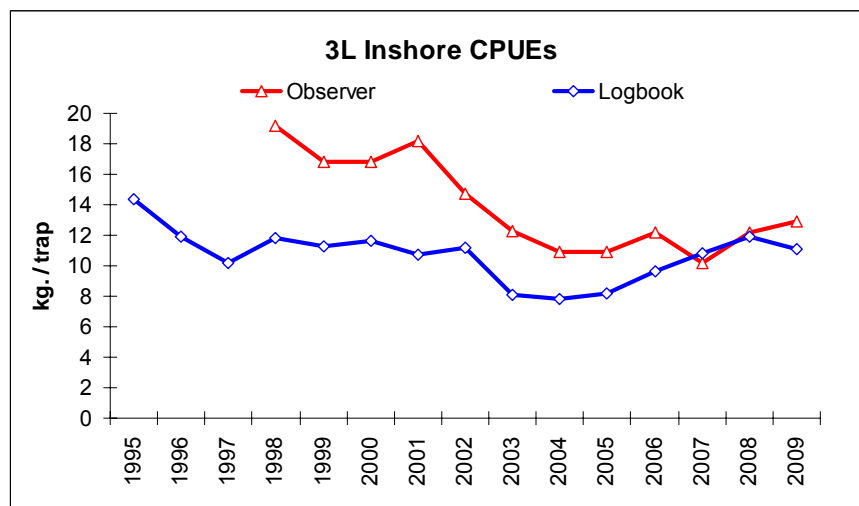


Figure 136. Trends in commercial logbook-based CPUE and observer-based CPUE in the Division 3L inshore fishery.

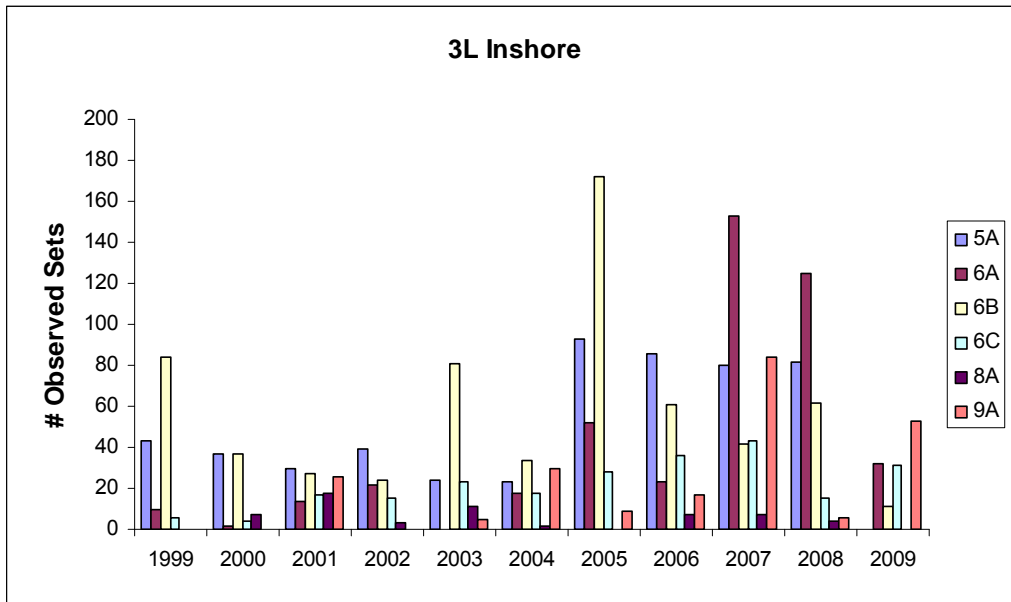


Figure 137. Trends in number of observed sets by Crab Management Areas and year in Division 3L inshore.

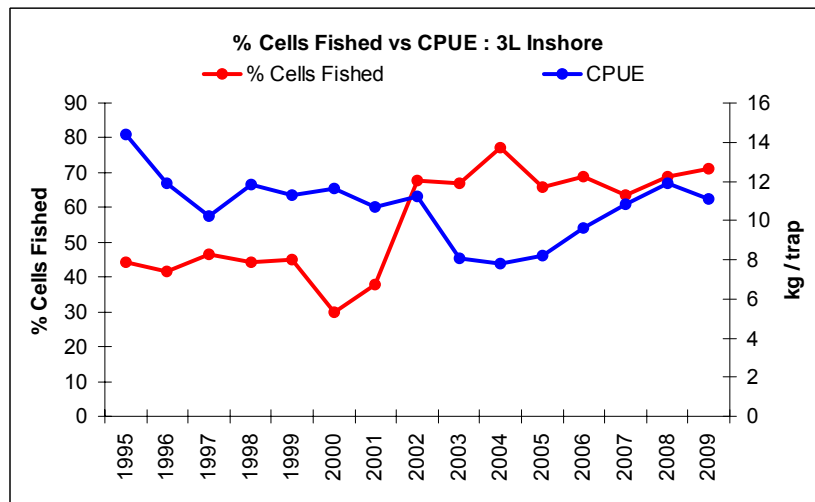


Figure 138. Trends in Division 3L inshore commercial CPUE vs. the percentage of 5' x 5' cells fished.

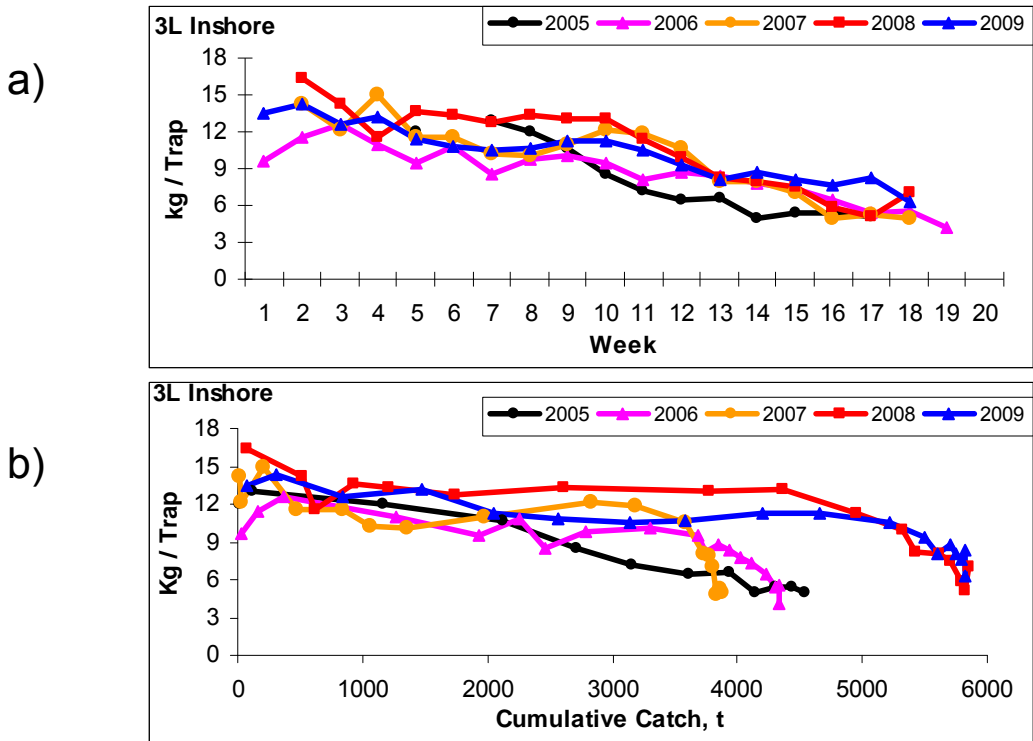


Figure 139. Seasonal trends in logbook-based CPUE for Division 3L inshore during 2005-09; (a) by week, and (b) in relation to cumulative catch.

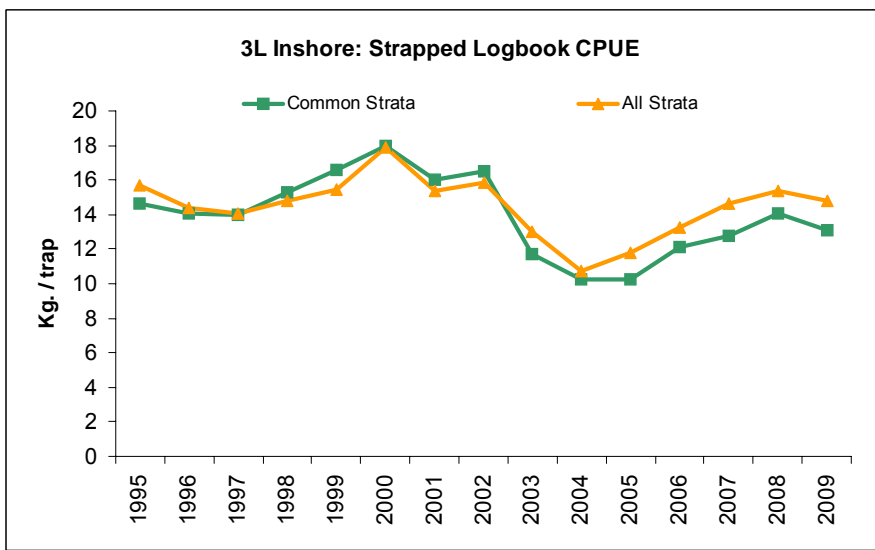


Figure 140. Trends in mean catch rates in the Division 3L inshore fishery based on spatially-expanded logbook STRAP analysis.



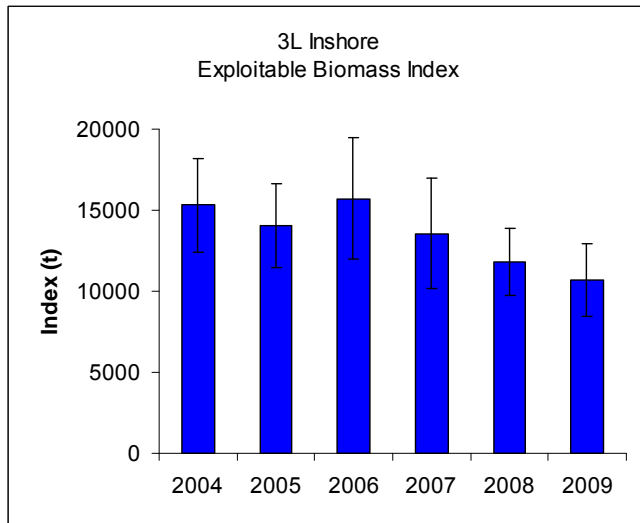


Figure 141. Exploitable biomass index based on the CPS trap survey in Division 3L inshore.

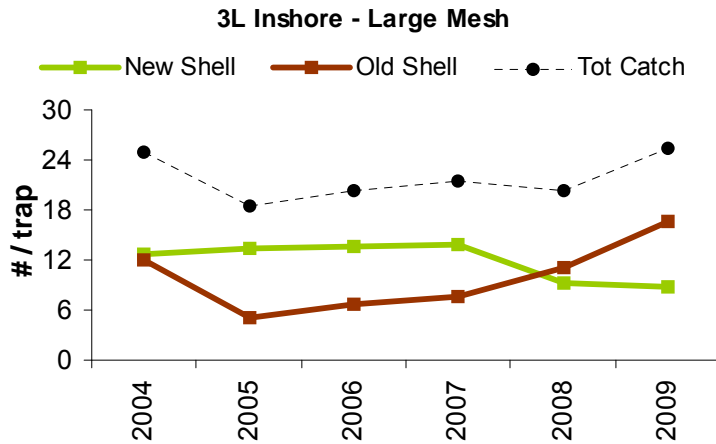


Figure 142. Trends in CPUE by shell condition for legal-sized crabs from core stations in the Division 3L inshore CPS trap survey.

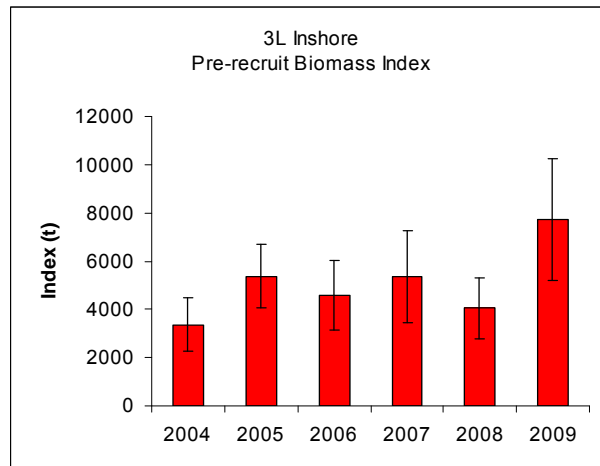


Figure 143. Pre-recruit biomass index based on the CPS trap survey in Division 3L inshore.

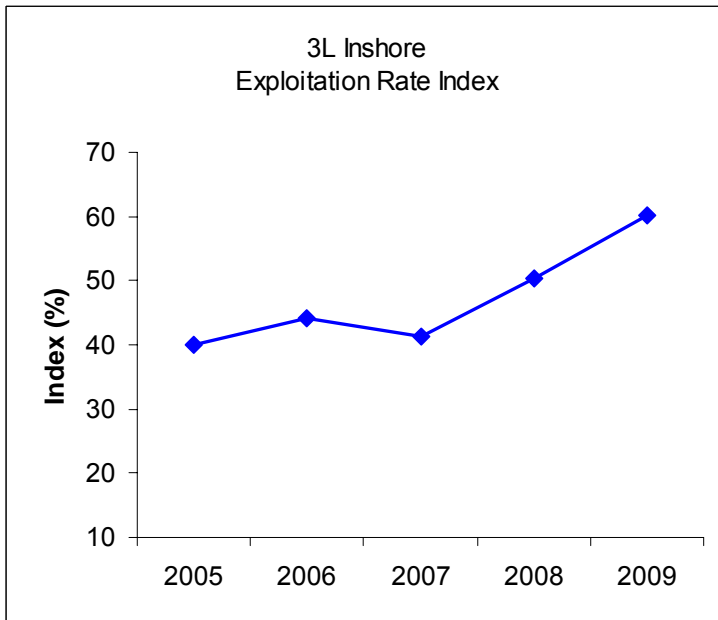


Figure 144. Trends in Division 3L inshore exploitation rate.

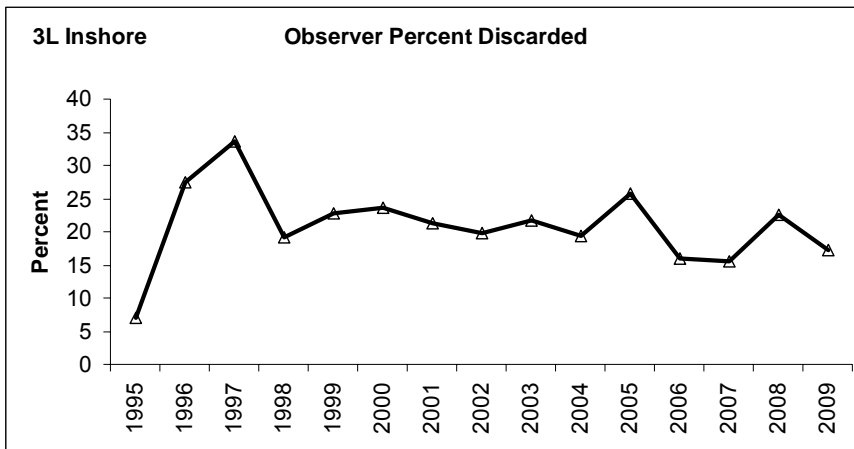
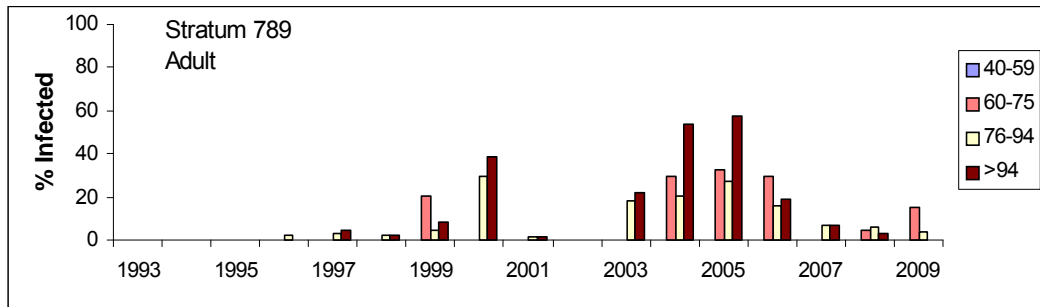
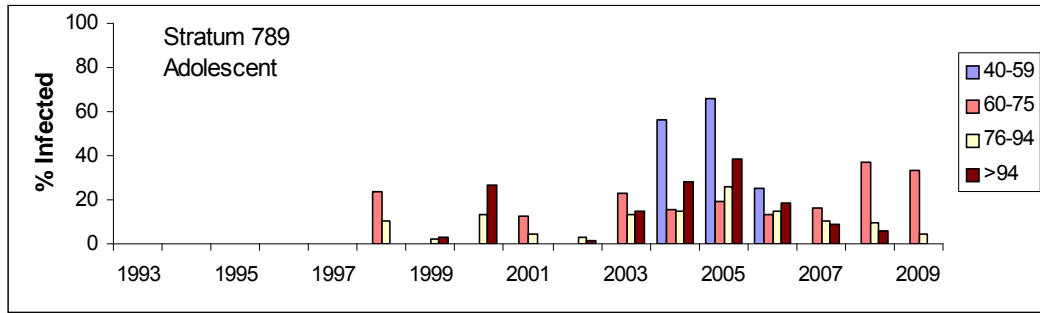


Figure 145. Trends in Division 3L inshore percentage of the catch discarded in the fishery.

**Traps**



**Trawls**

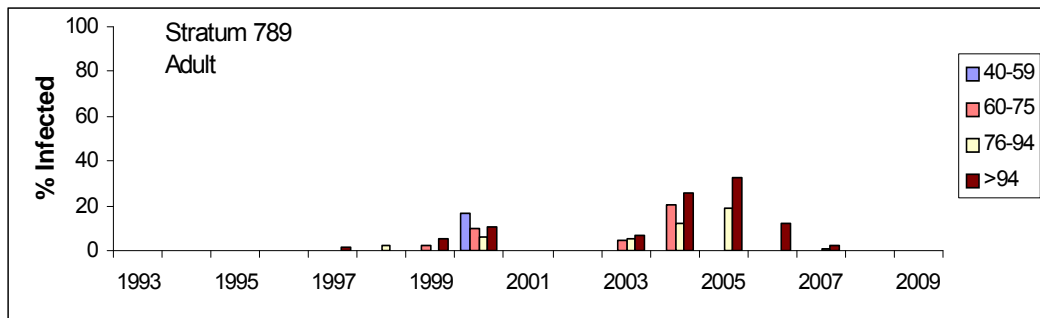
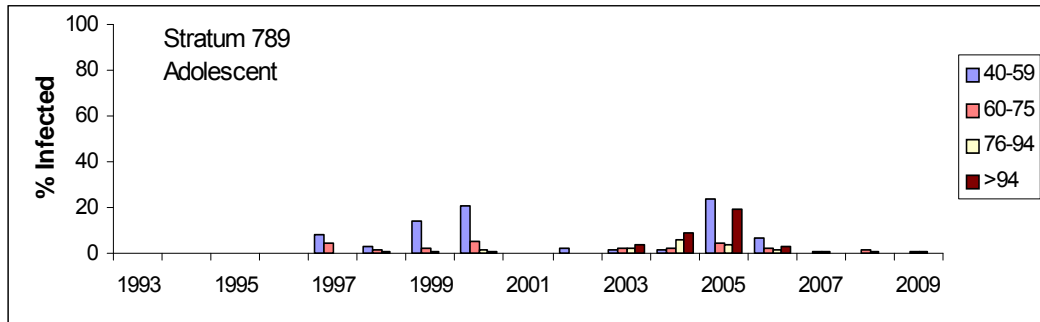


Figure 146. Trends in prevalence of BCD in new-shelled males by stratum, year and size group from DFO trap and trawl surveys in Conception Bay; adolescents (above) and adults (below).

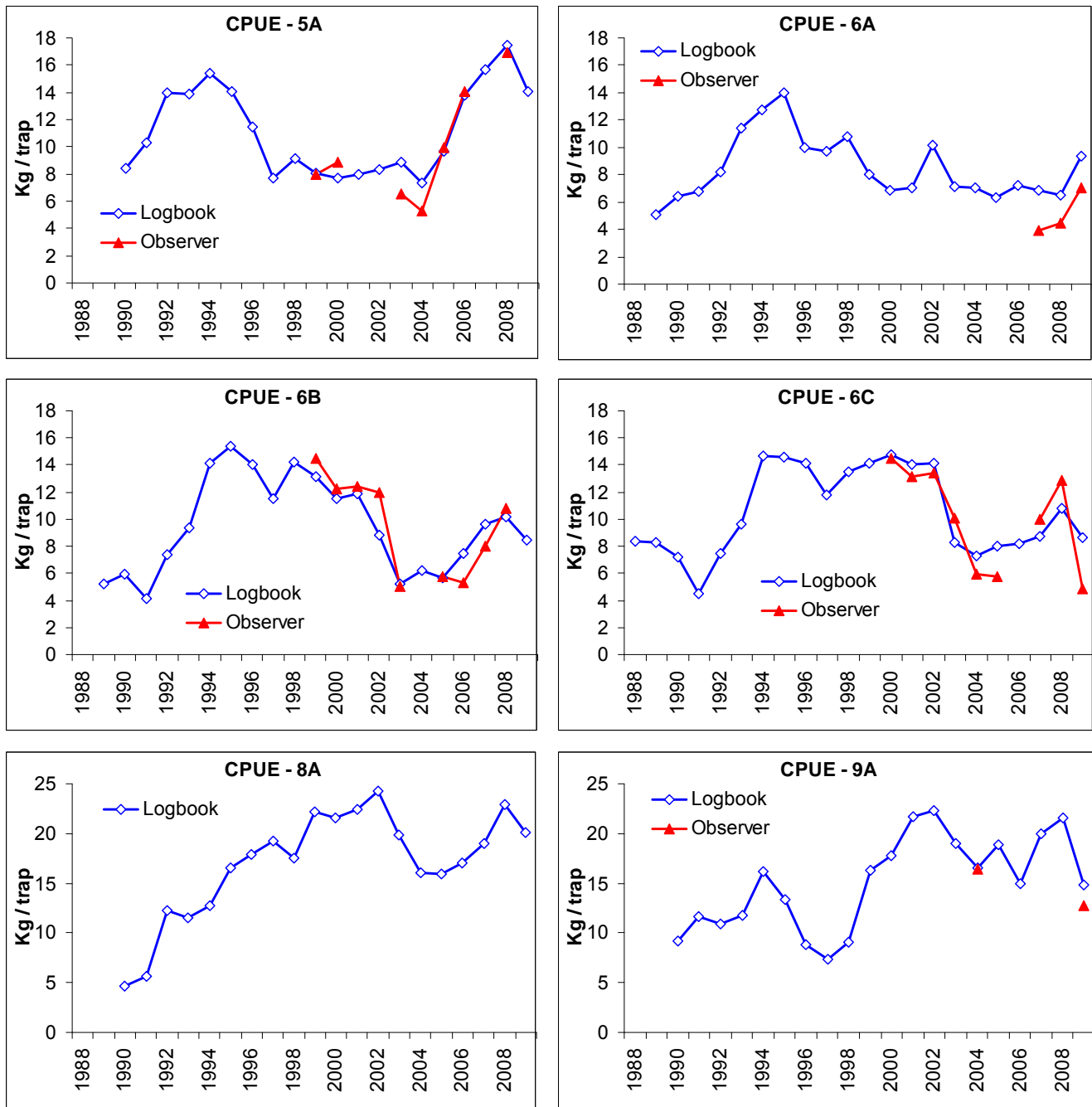


Figure 147. Trends in Division 3L inshore logbook CPUE and observer CPUE by Crab Management Area.

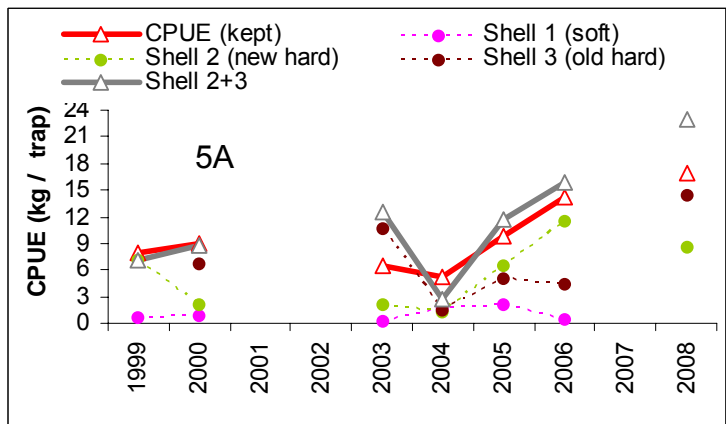


Figure 148. Trends in CMA 5A observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

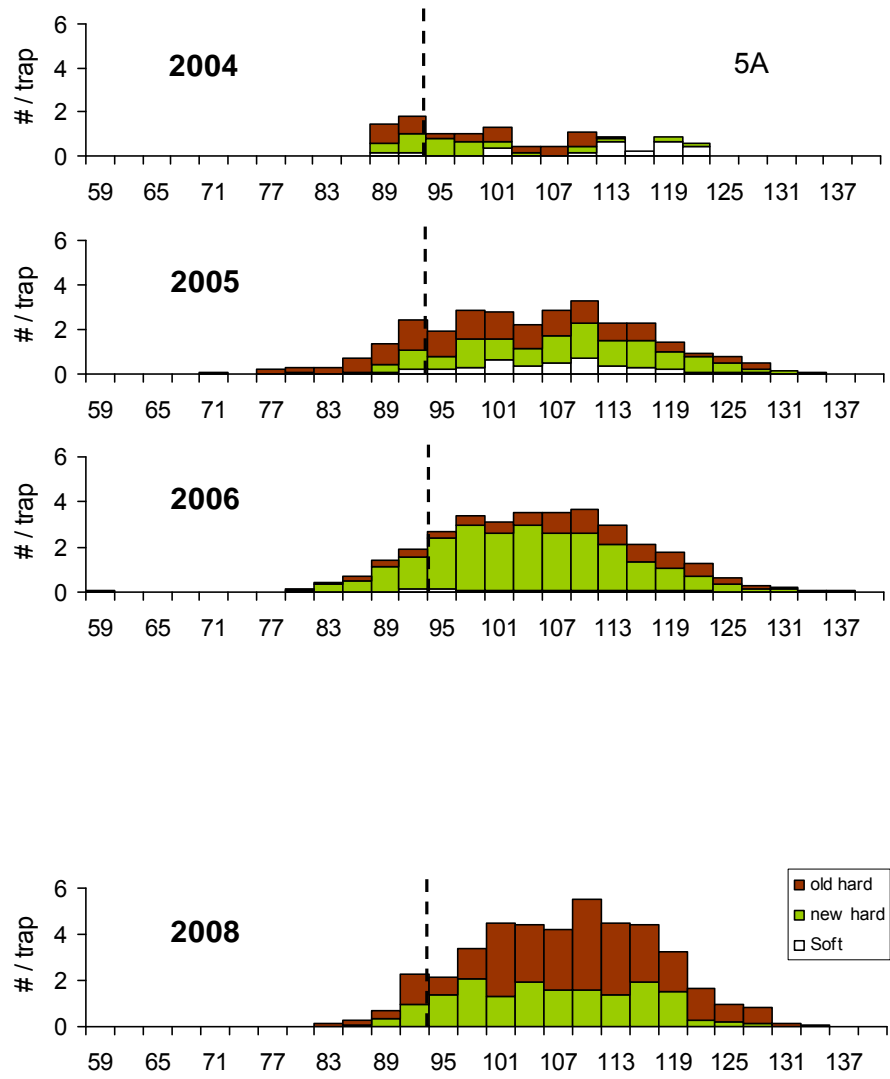


Figure 149. Trends in male carapace width distributions by shell condition from observer at-sea sampling for CMA 5A. The vertical dashed line indicates the minimum legal size.

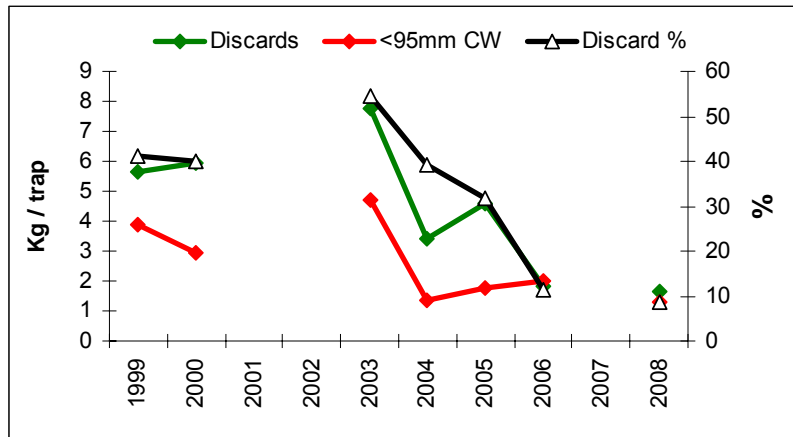


Figure 150. Trends in CMA 5A observer catch rates of total discards and percent discarded from set and catch records and of sub-legal sized crabs from at-sea sampling.

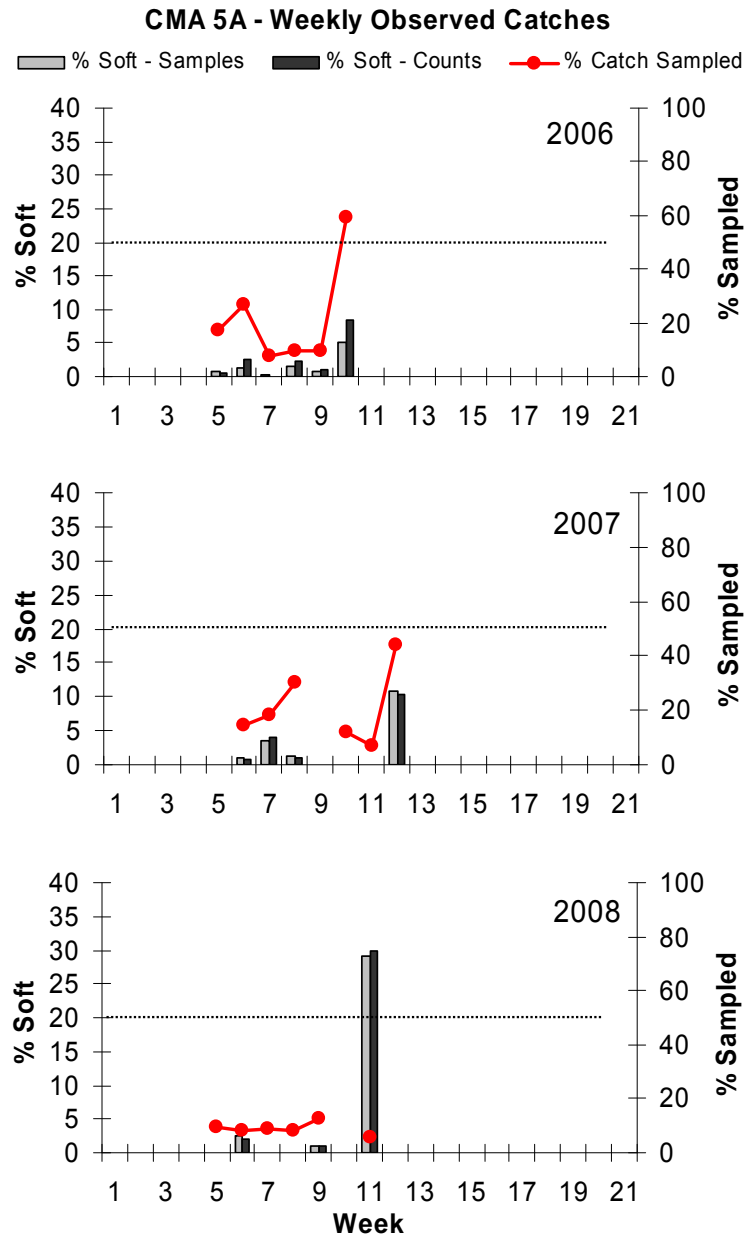


Figure 151. Trends in weekly percentages of soft-shell crab monitored and sampled in CMA 5A from 2006 to 2009. Red lines show percentage of the catch sampled each week.

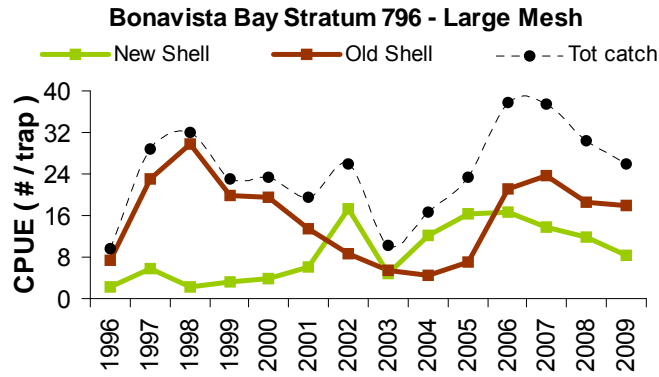


Figure 152. Trends in catches by shell condition of legal-sized males from large-mesh traps in the DFO survey in Bonavista Bay, 1996-2009.

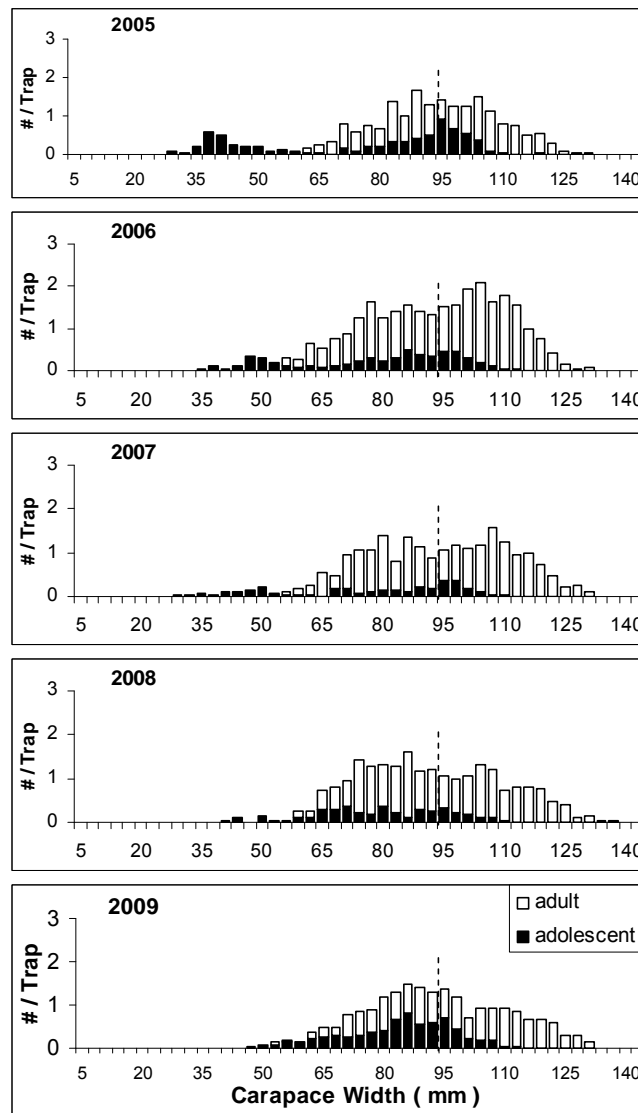


Figure 153. Distribution of small-claw (adolescent) vs. large-claw (adult) male catch rates by size from small-mesh traps in DFO survey in Bonavista Bay from 2005 to 2009.



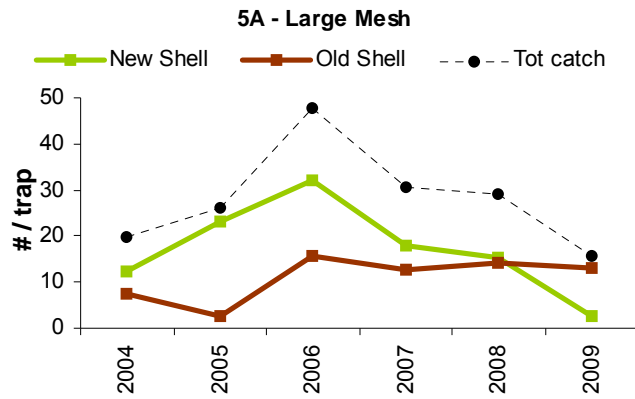


Figure 154. Trends in catch rate by shell condition for legal-sized crabs from core stations in the CMA 5A CPS trap survey.

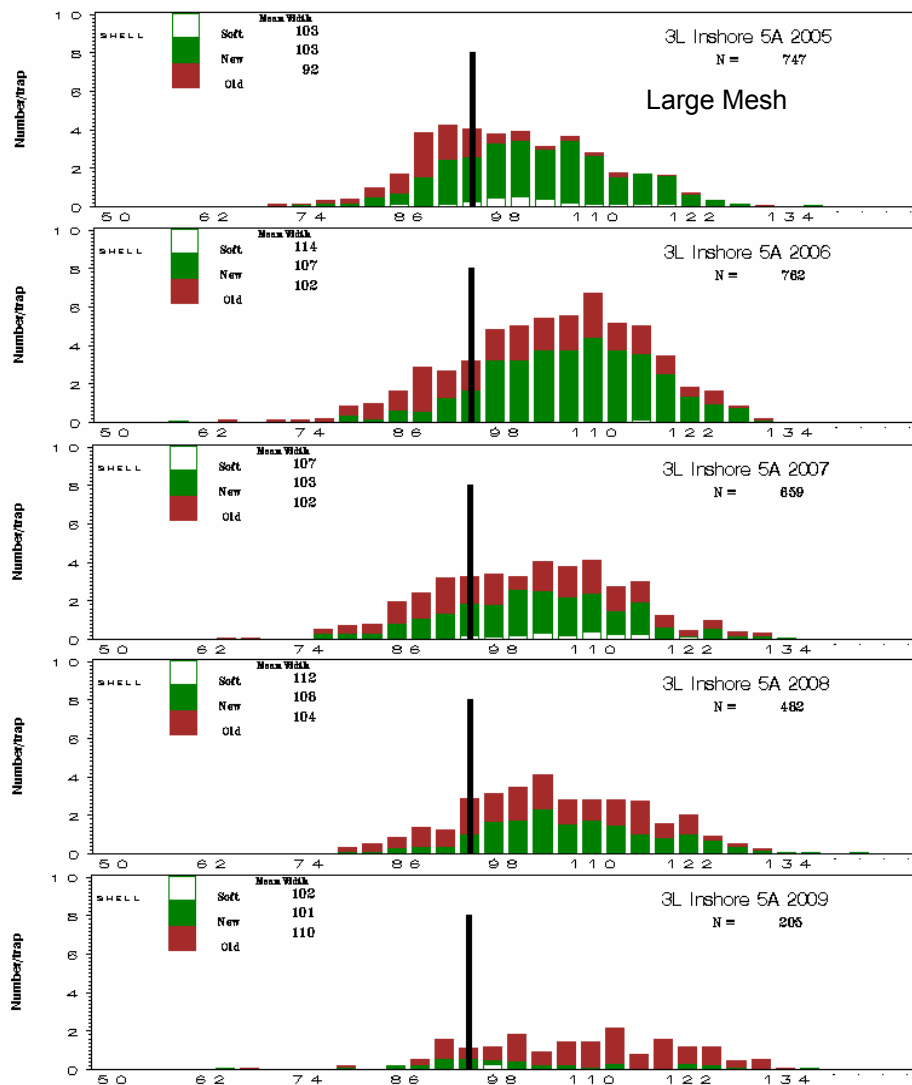


Figure 155. Trends in male carapace width distributions from core stations in the CMA 5A CPS trap survey. The vertical solid line indicates the minimum legal size.

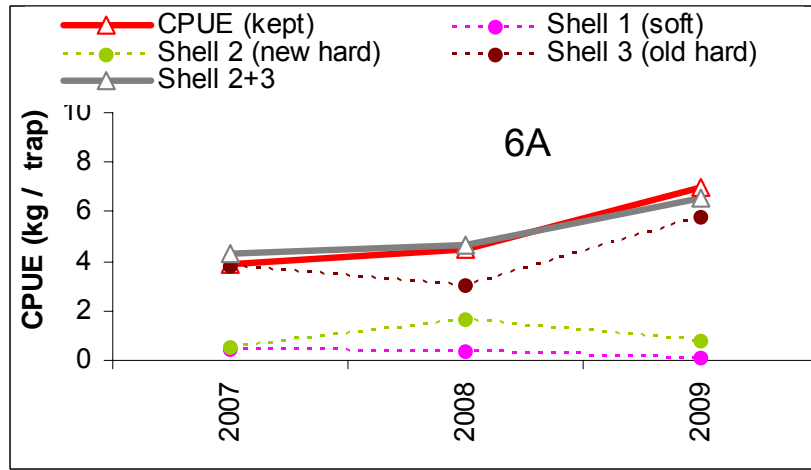


Figure 156. Trends in CMA 6A observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

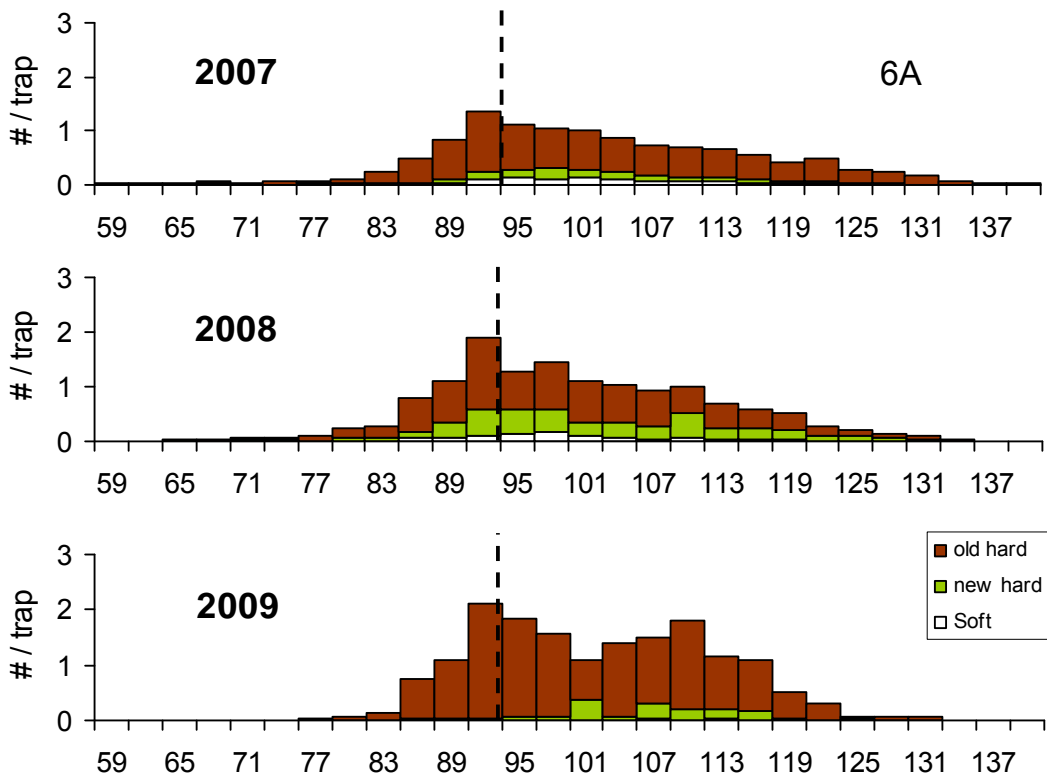


Figure 157. Trends in male carapace width distributions by shell condition from observer at-sea sampling for CMA 6A. The vertical dashed line indicates the minimum legal size.

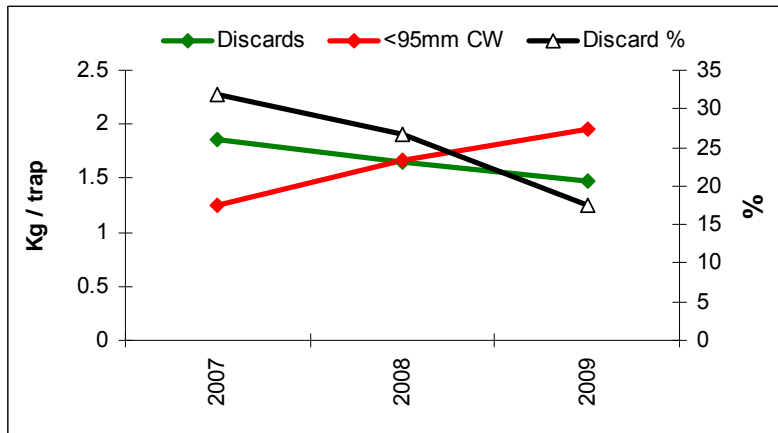


Figure 158. Trends in CMA 6A observer catch rates of total discards and percent discarded from set and catch records and of sub-legal sized crabs from at-sea sampling.

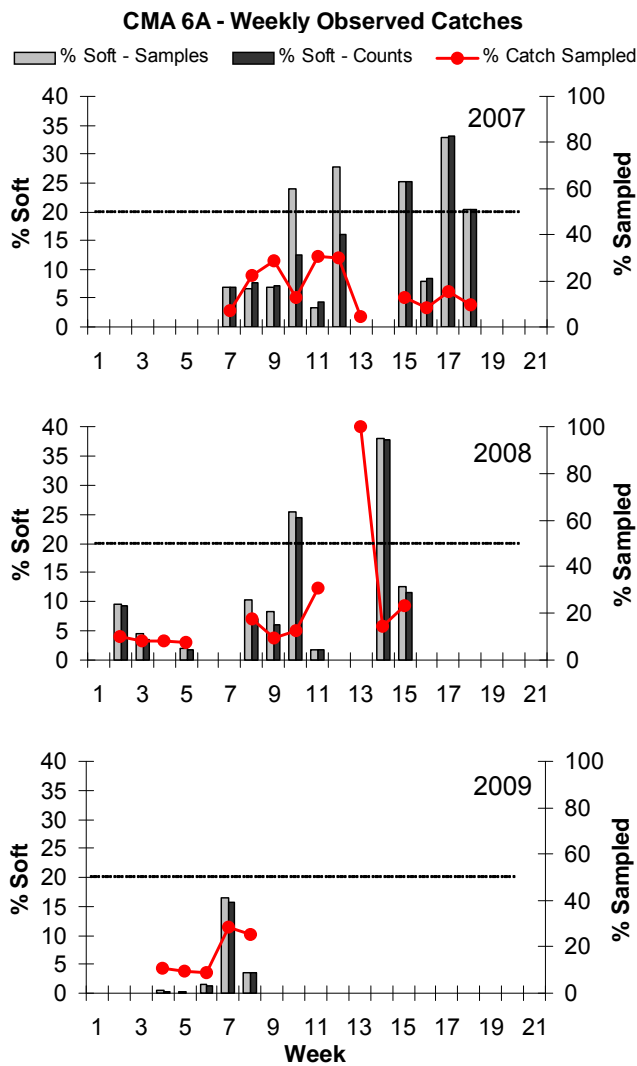


Figure 159. Trends in weekly percentages of soft-shell crab monitored and sampled in CMA 6A from 2007 to 2009. Red lines show percentage of the catch sampled each week.

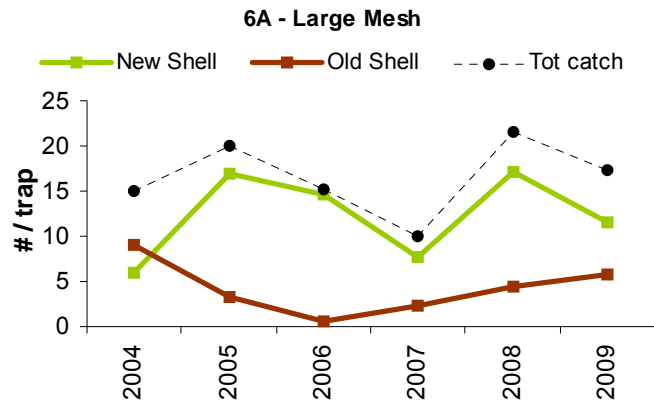


Figure 160. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 6A CPS trap survey.

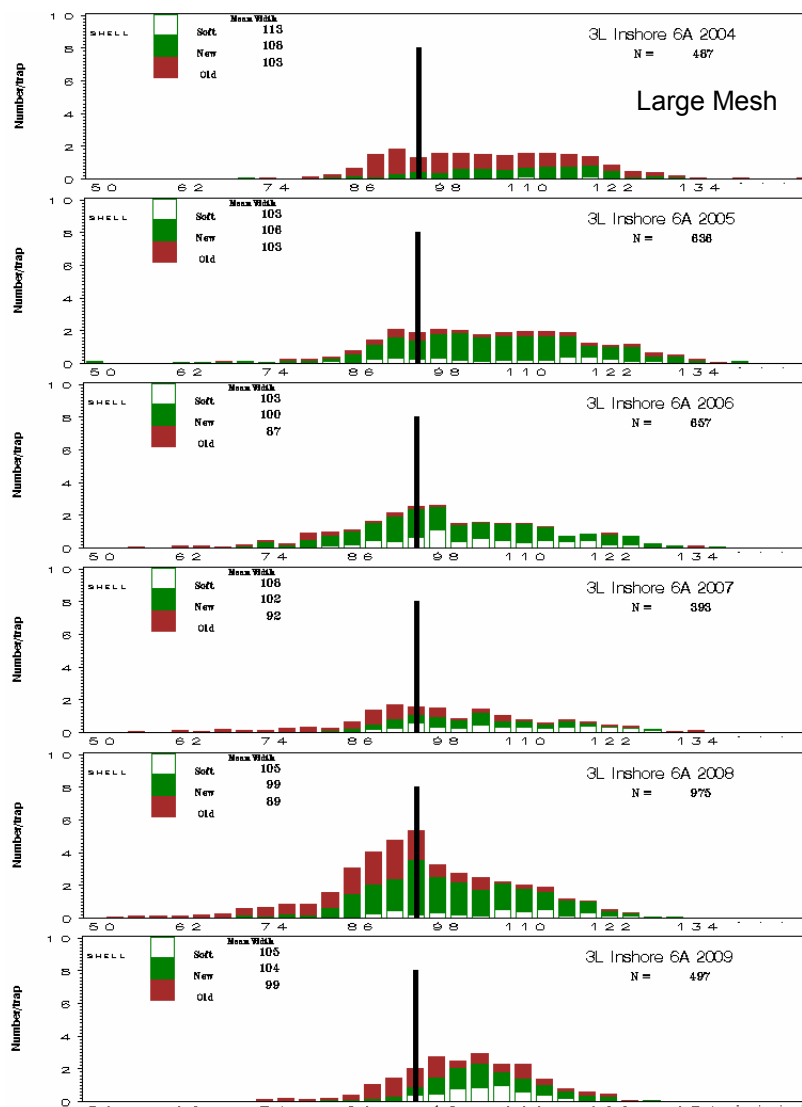


Figure 161. Trends in male carapace width distributions from core stations in the CMA 6A CPS trap survey. The vertical solid line indicates the minimum legal size.

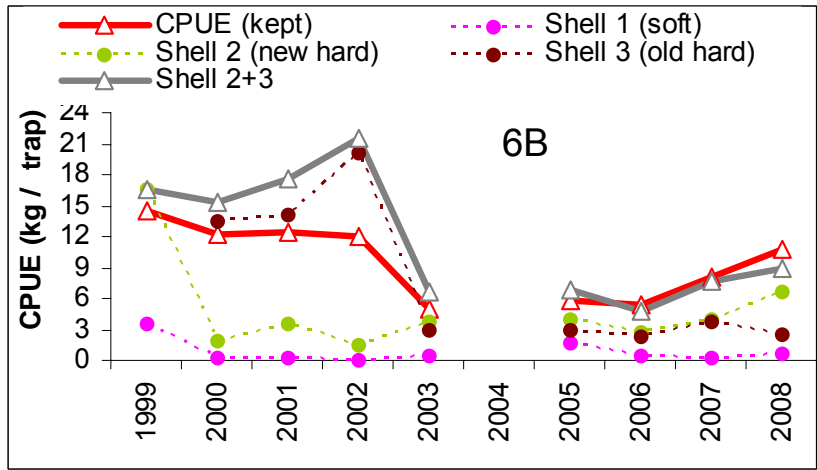


Figure 162. Trends in CMA 6B observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

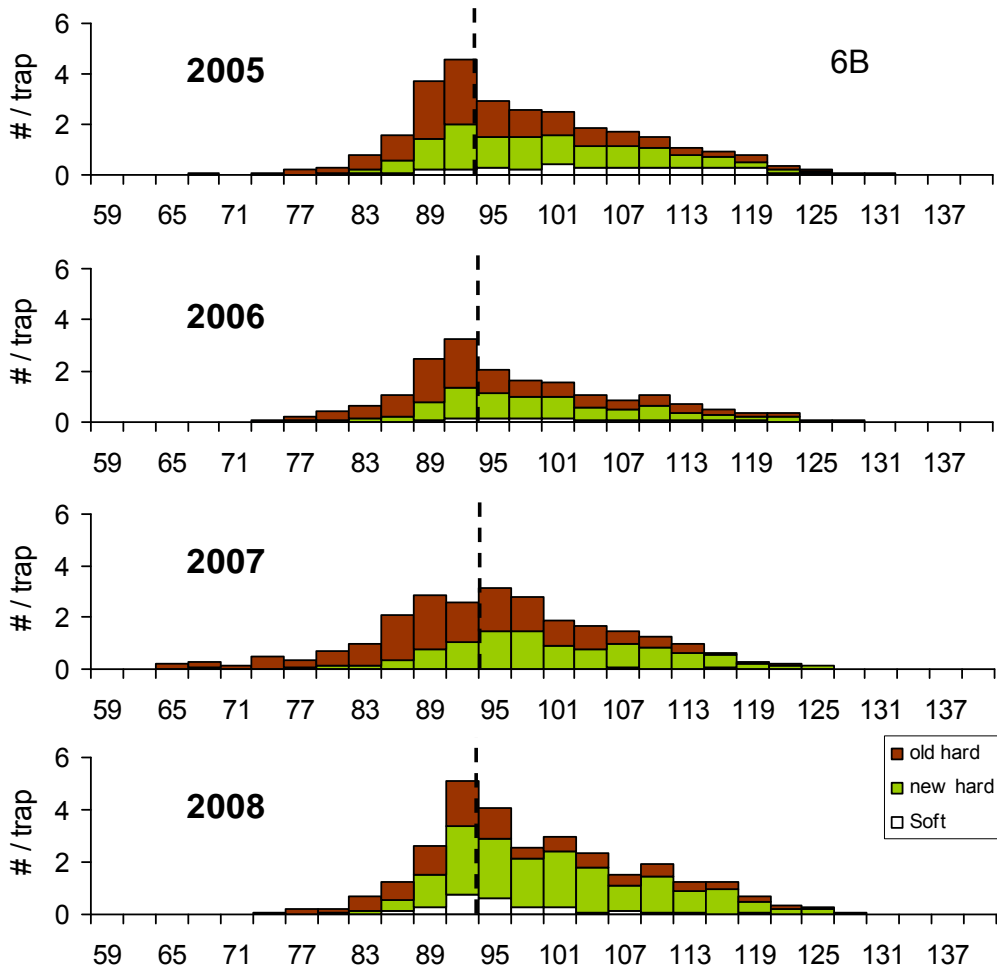


Figure 163. Trends in male carapace width distributions by shell condition from observer at-sea sampling for CMA 6B. The vertical dashed line indicates the minimum legal size.

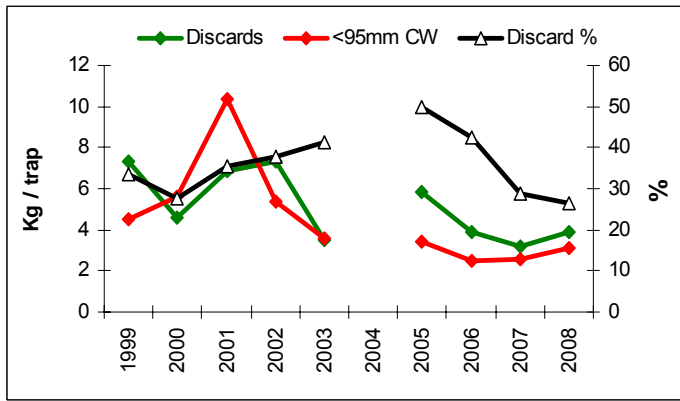


Figure 164. Trends in CMA 6B observer catch rates of total discards and percent discarded from set and catch records and of sub-legal sized crabs from at-sea sampling.

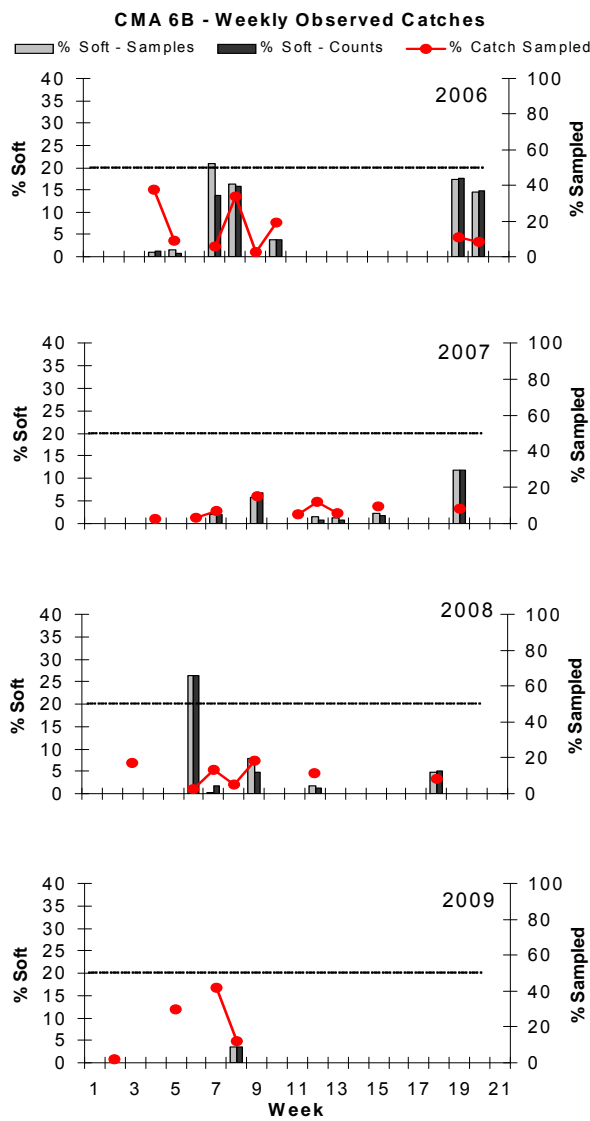


Figure 165. Trends in weekly percentages of soft-shell crab monitored and sampled in CMA 6B from 2006 to 2009. Red lines show percentage of the catch sampled each week.

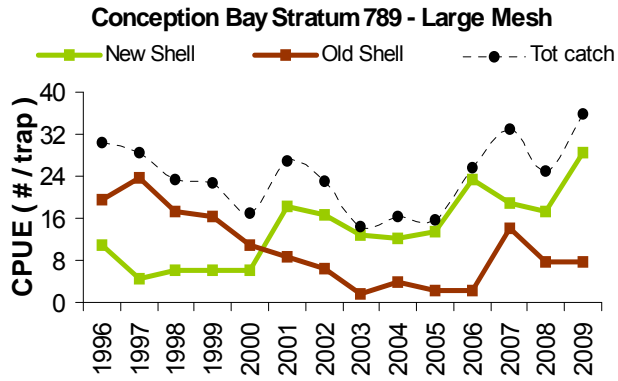


Figure 166. Trends in catch rate by shell condition of legal-sized males from large-mesh traps in the DFO survey in Conception Bay, 1996-2009.

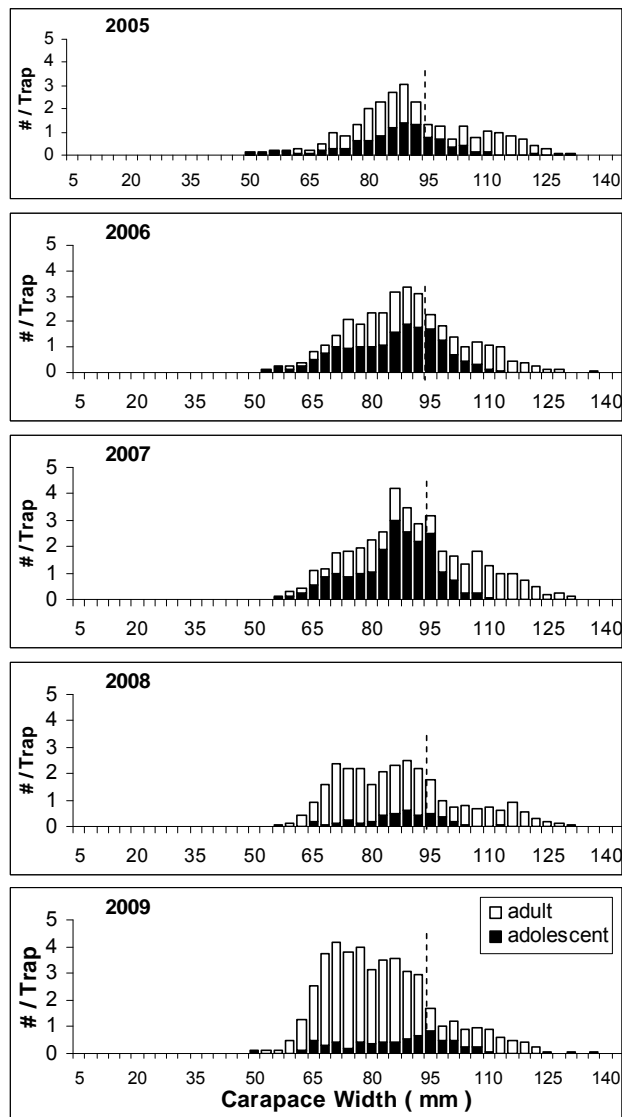


Figure 167. Distribution of small-claw (adolescent) vs. large-claw (adult) male catch rates by size from small-mesh traps in DFO survey in Conception Bay from 2005 to 2009.

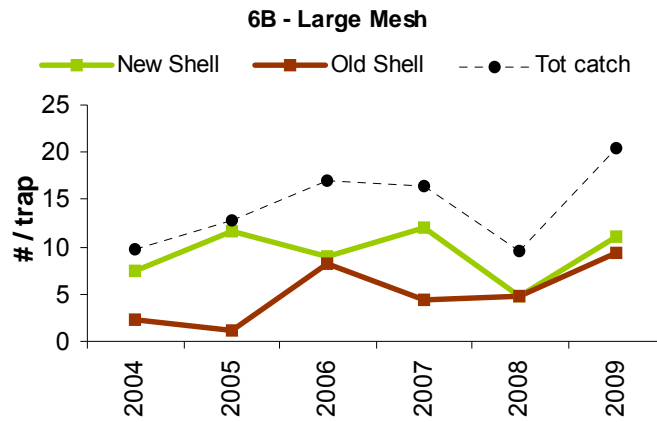


Figure 168. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 6B CPS trap survey.

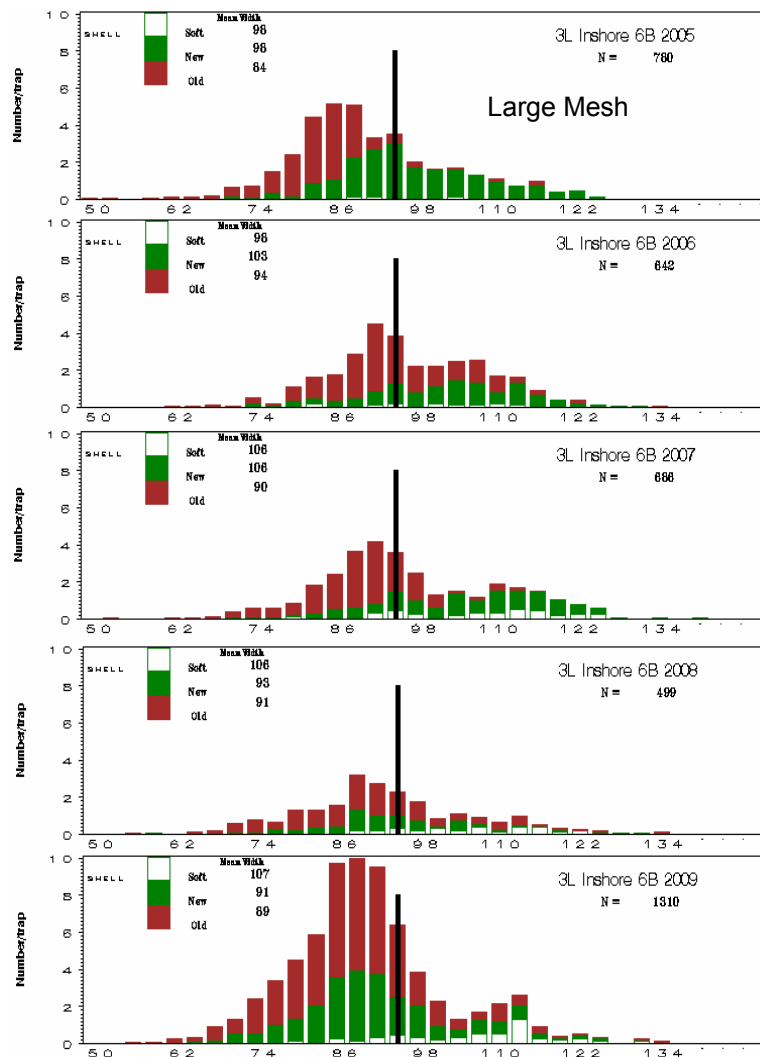


Figure 169. Trends in male carapace width distributions from large-meshed traps from core stations in the CMA 6B CPS trap survey. The vertical solid line indicates the minimum legal size.



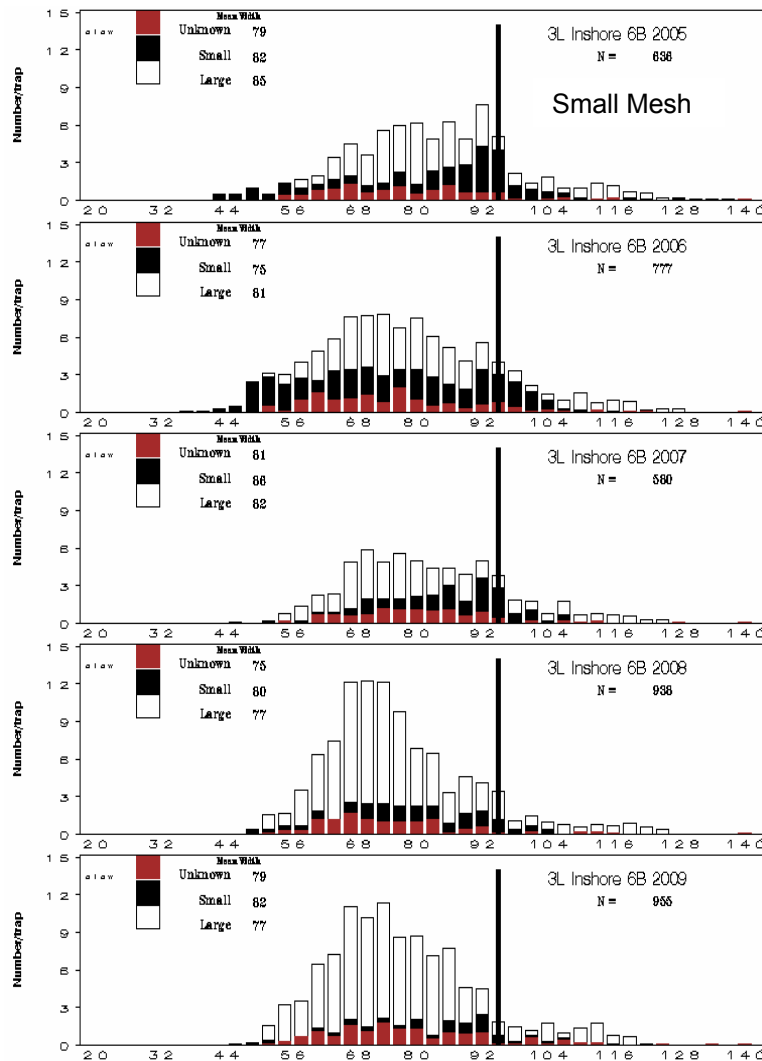


Figure 170. Trends in male carapace width distributions by chela type from small-mesh traps at core stations in the CMA 6B CPS trap survey. The vertical solid line indicates the minimum legal size.

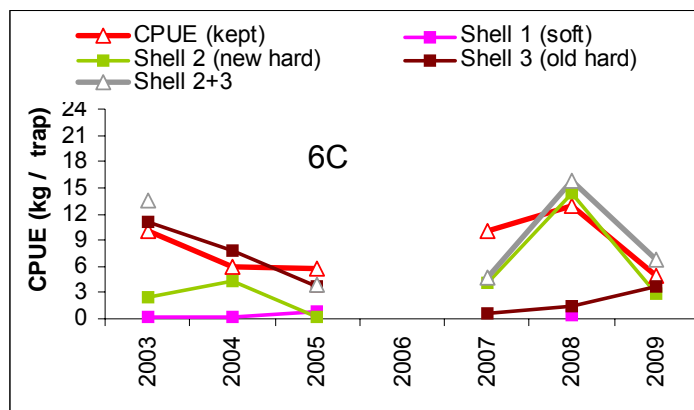


Figure 171. Trends in CMA 6C observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

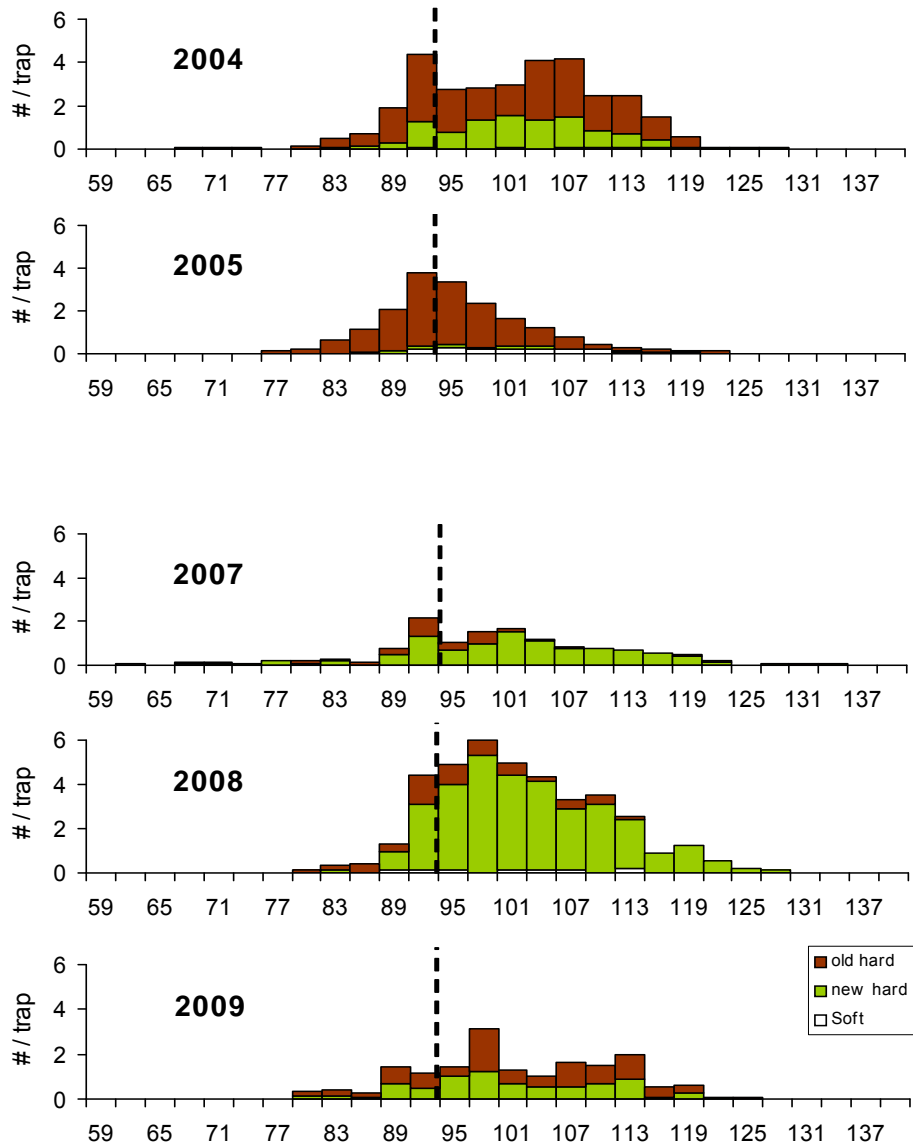


Figure 172. Trends in male carapace width distributions by shell condition from observer at-sea sampling for CMA 6C. The vertical dashed line indicates the minimum legal size.

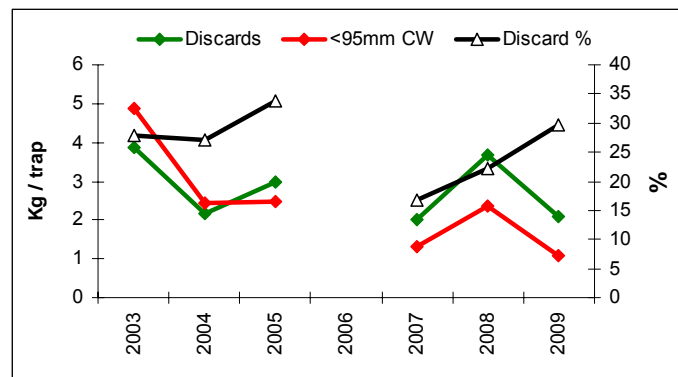


Figure 173. Trends in CMA 6C observer catch rates of total discards and percent discarded from set and catch records and of sub-legal sized crabs from at-sea sampling.

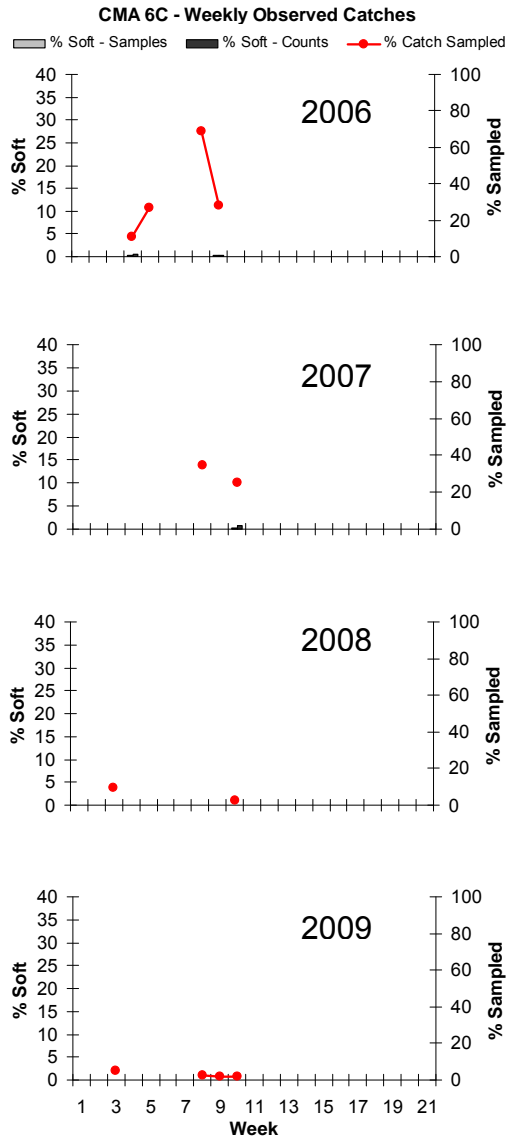


Figure 174. Trends in weekly percentages of soft-shell crab monitored and sampled in CMA 6C from 2006 to 2009. Red lines show percentage of the catch sampled each week.

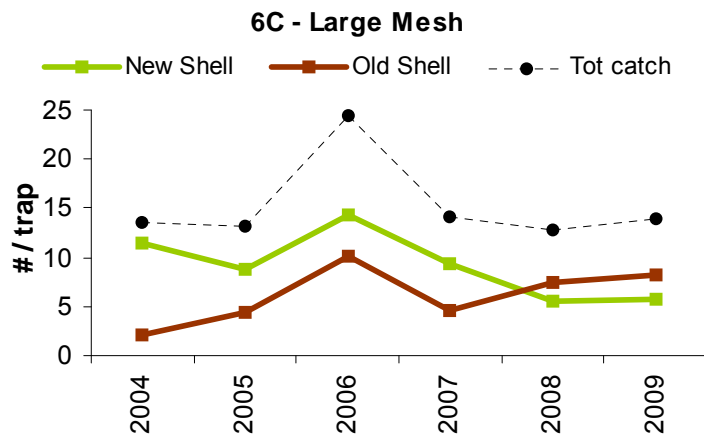


Figure 175. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 6C CPS trap survey.

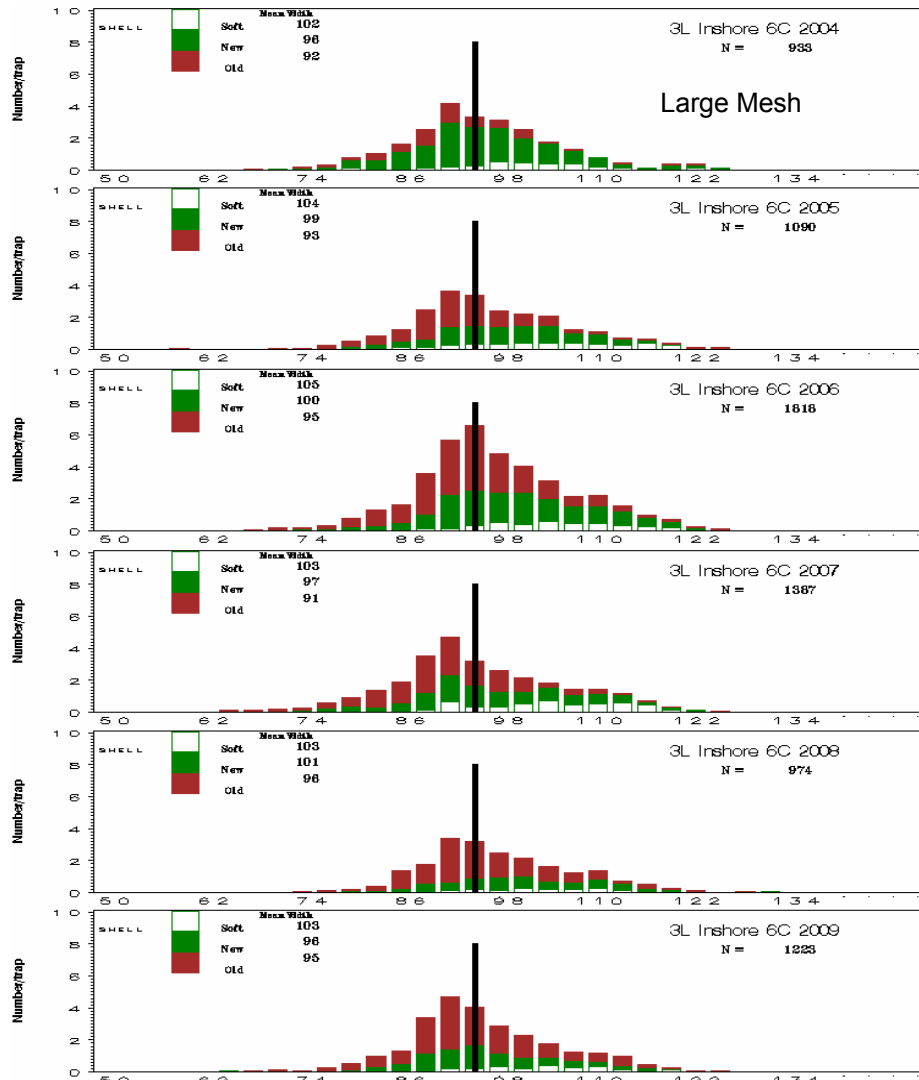


Figure 176. Trends in male carapace width distributions from core stations in the CMA 6C CPS trap survey. The vertical solid line indicates the minimum legal size.

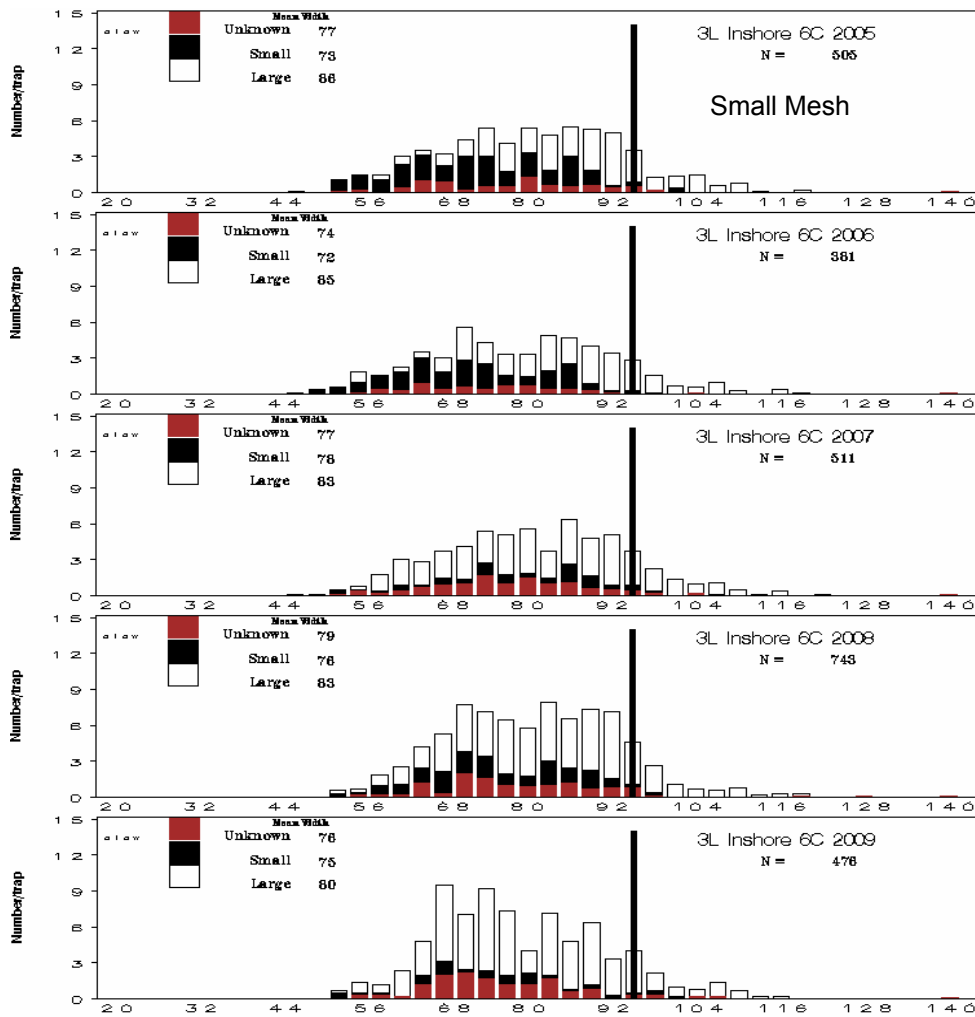


Figure 177. Trends in male carapace width distributions by chela type from small-mesh traps at core stations in the CMA 6C CPS trap survey. The vertical solid line indicates the minimum legal size.

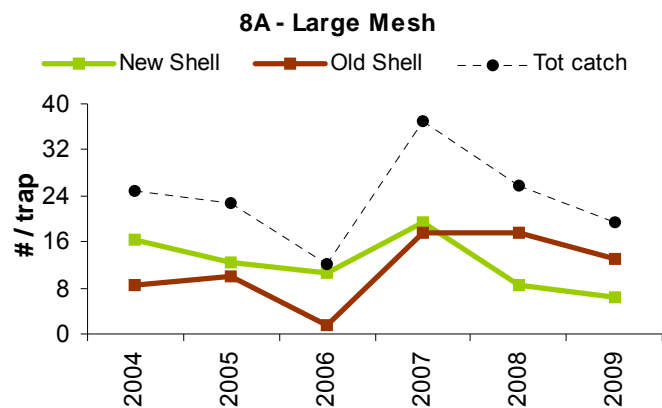


Figure 178. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 8A CPS trap survey.

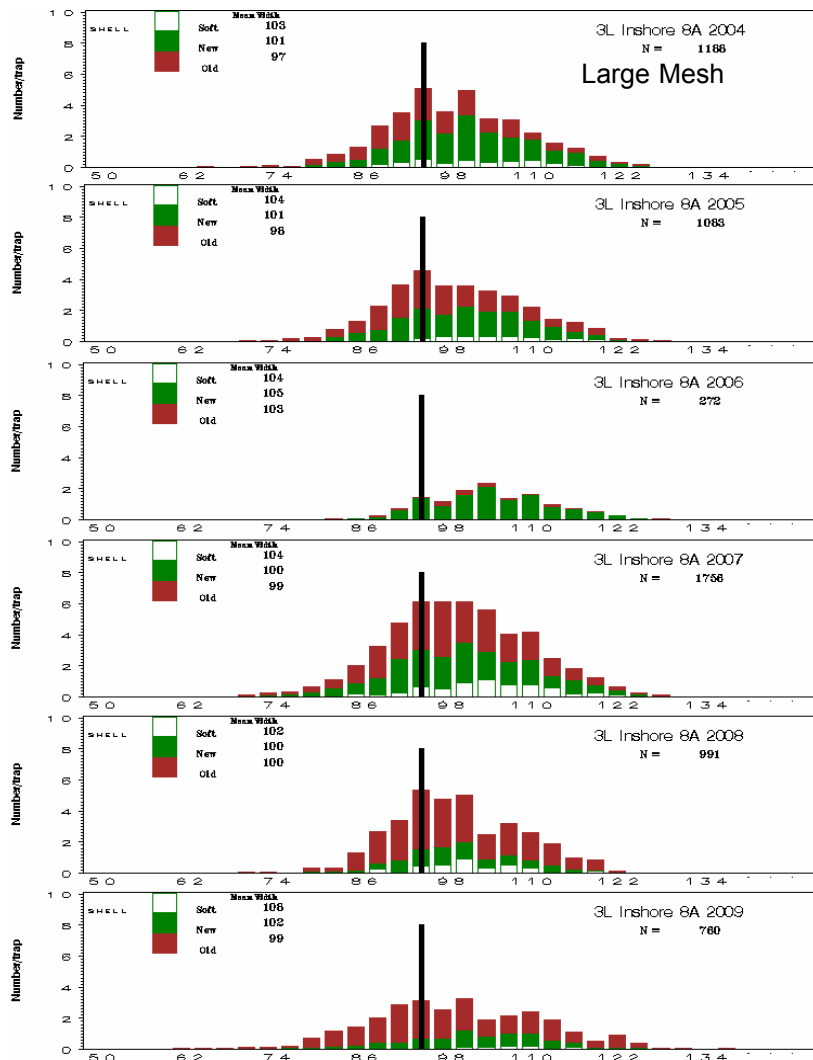


Figure 179. Trends in male carapace width distributions from core stations in the CMA 8A CPS trap survey. The vertical solid line indicates the minimum legal size.

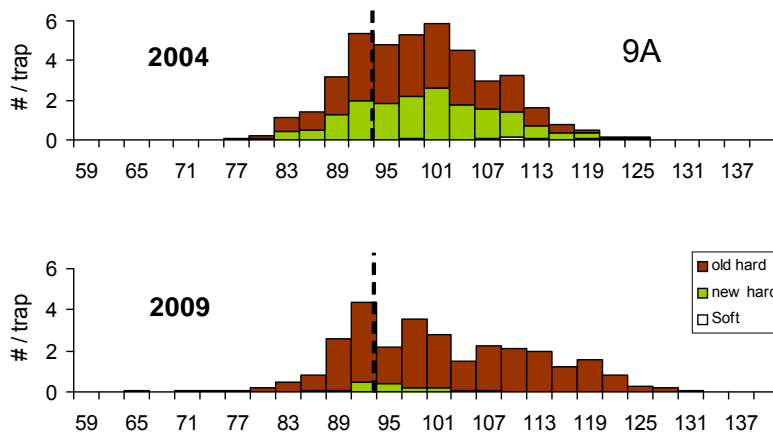


Figure 180. Trends in male carapace width distributions by shell condition from observer at-sea sampling for CMA 9A. The vertical dashed line indicates the minimum legal size.

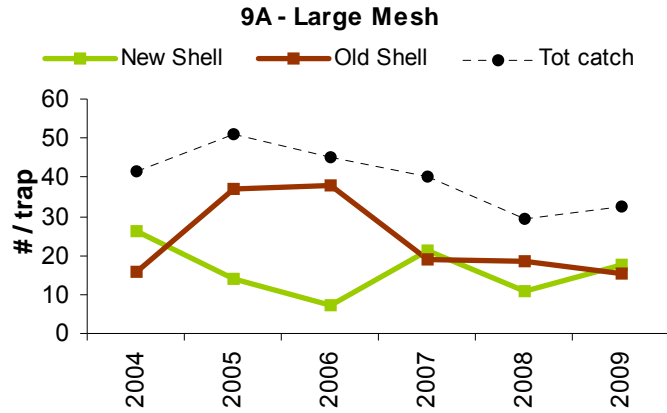


Figure 181. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 9A CPS trap survey.

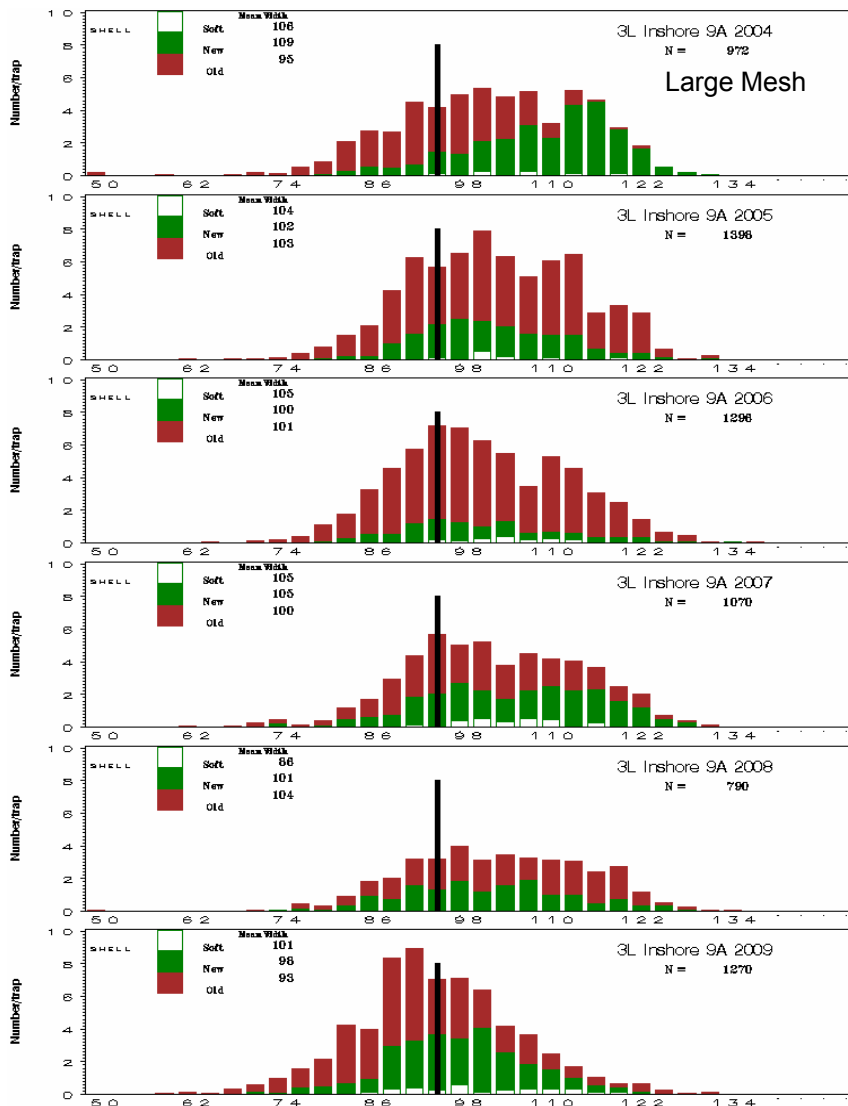


Figure 182. Trends in male carapace width distributions from core stations in the CMA 9A CPS trap survey. The vertical solid line indicates the minimum legal size.

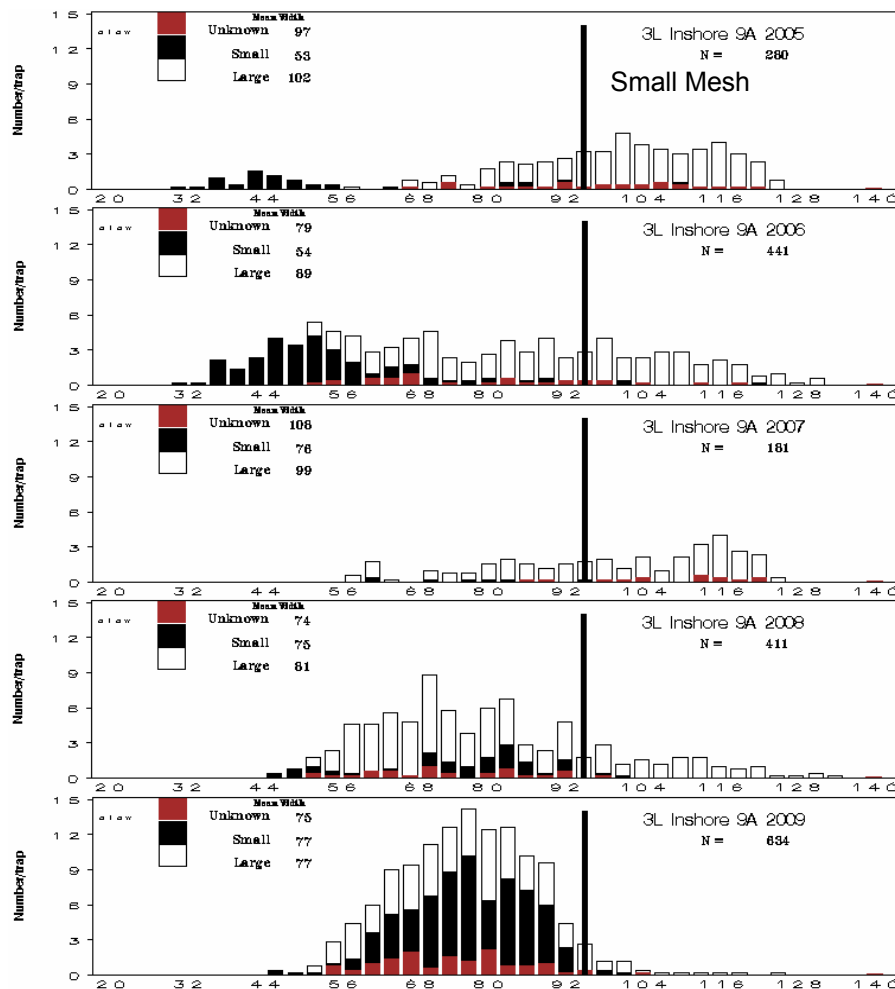


Figure 183. Trends in male carapace width distributions by chela type from small-mesh traps at core stations in the CMA 9A CPS trap survey. The vertical solid line indicates the minimum legal size.



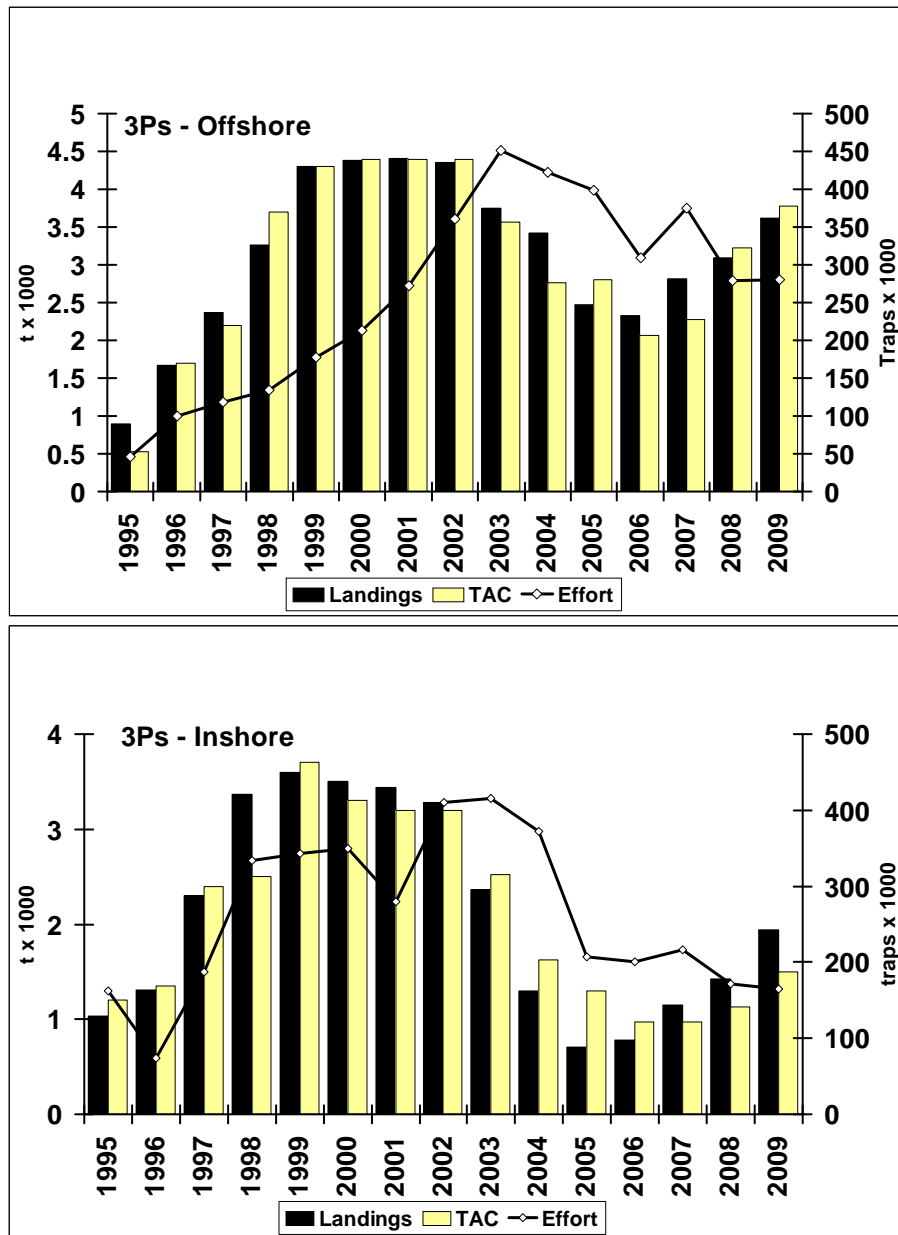


Figure 184. Trends in Subdivision 3Ps landings, TAC, and fishing effort for the offshore (above) and inshore (below).

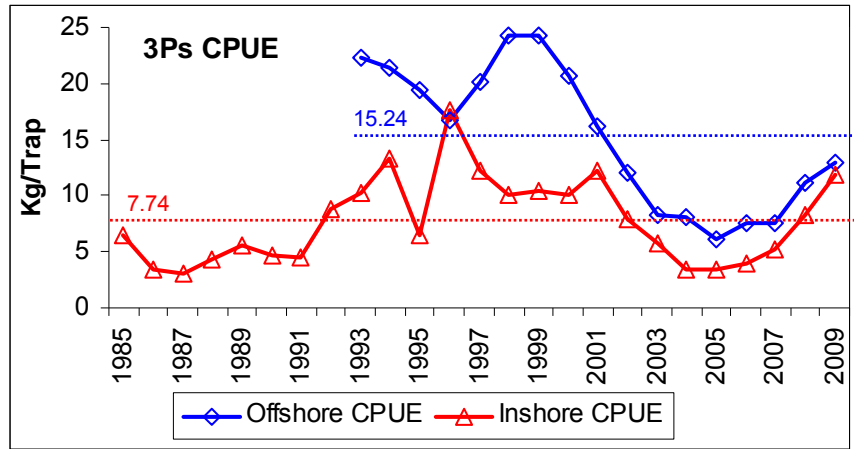


Figure 185. Trends in Subdivision 3Ps offshore and inshore commercial logbook CPUE in relation to their long-term averages (dotted lines).

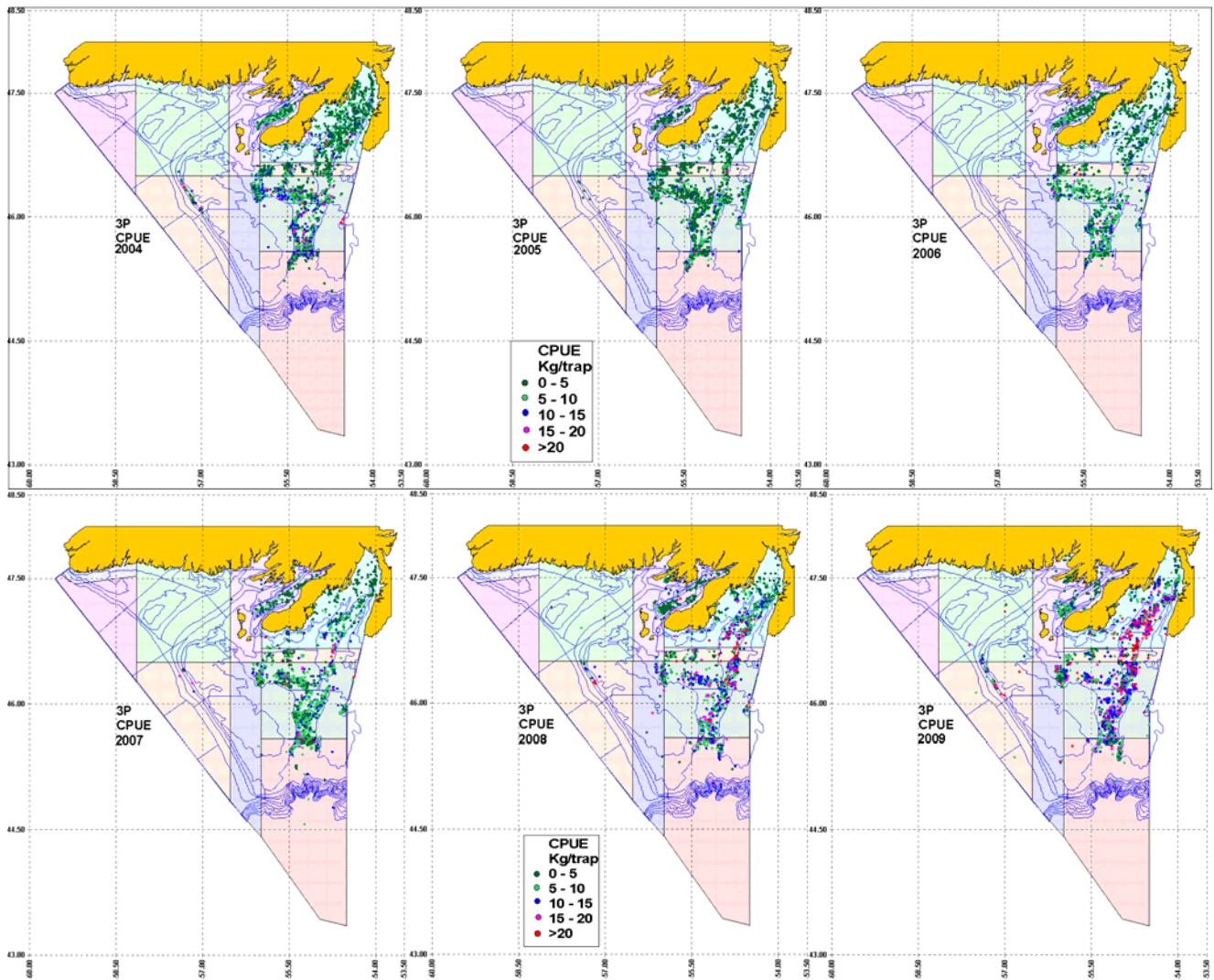
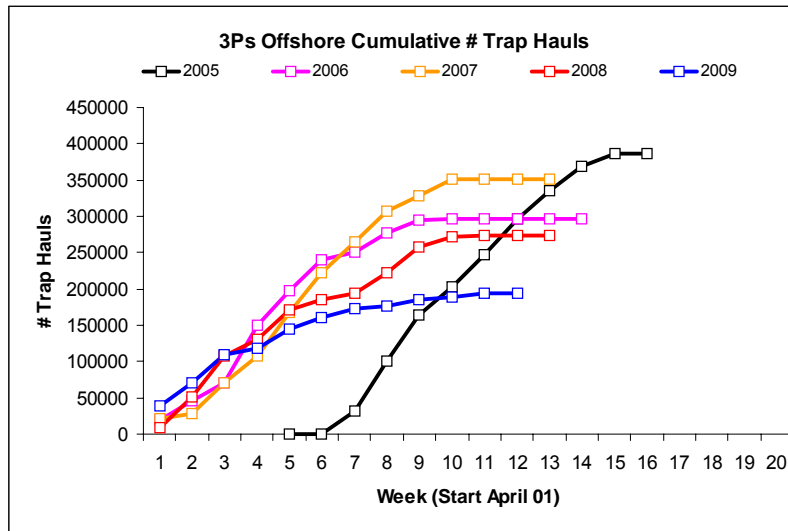


Figure 186. Spatial distribution of Subdivision 3Ps commercial logbook CPUE by year.

a)



b)

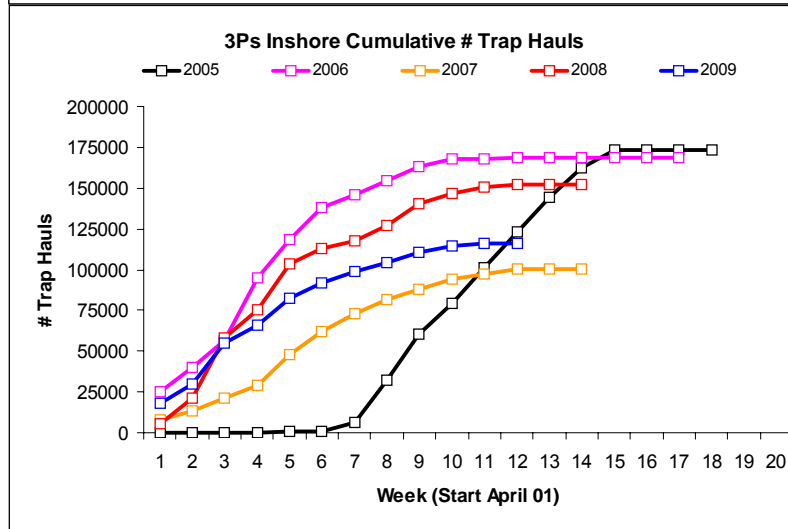


Figure 187. Seasonal trends in fishing effort for Subdivision 3Ps during 2005-09 for (a) the offshore and (b) the inshore.

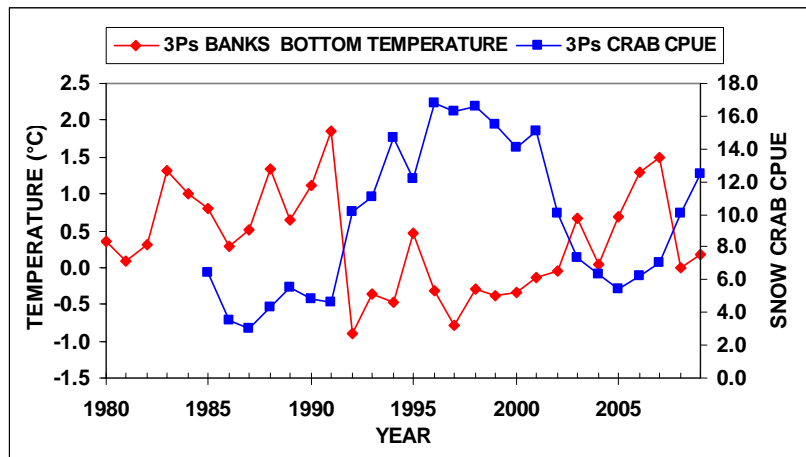


Figure 188. Trends in commercial logbook CPUE in the Subdivision 3Ps fishery (offshore and inshore combined) vs. bottom temperature seven years earlier.

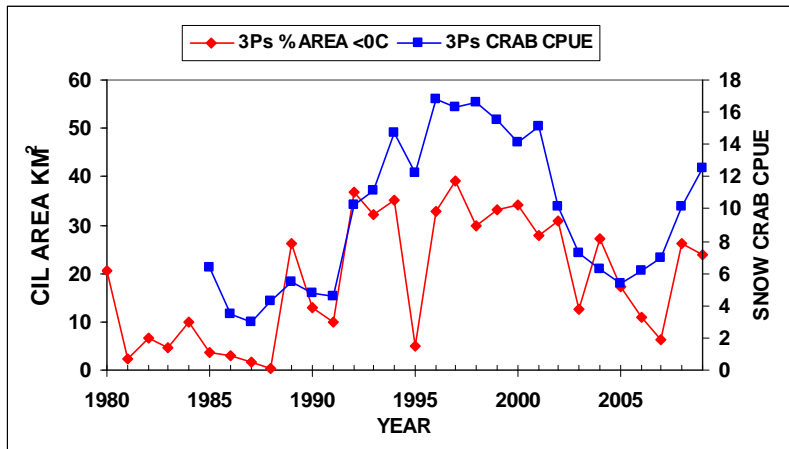


Figure 189. Trends in commercial logbook CPUE in the Subdivision 3Ps fishery (offshore and inshore combined) vs. the spatial extent of the cold intermediate layer seven years earlier.

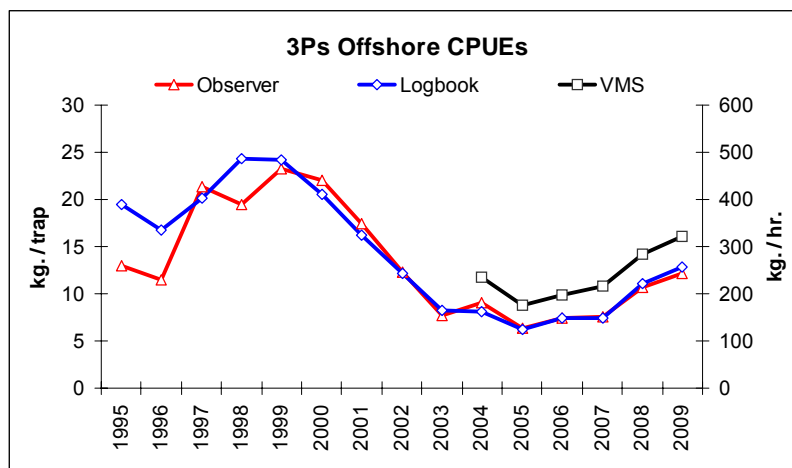


Figure 190. Trends in commercial logbook-based CPUE, observer-based CPUE, and VMS-based CPUE in the Subdivision 3Ps offshore fishery.

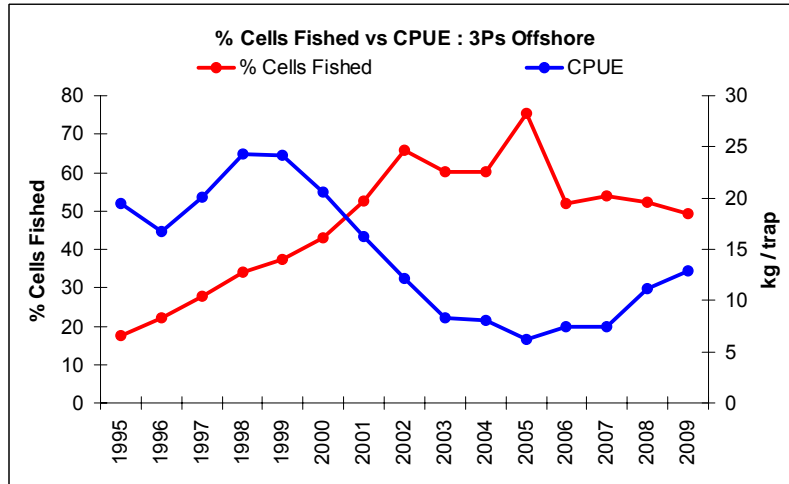


Figure 191. Trends in Subdivision 3Ps offshore commercial CPUE vs. the percentage of 5' x 5' cells fished.

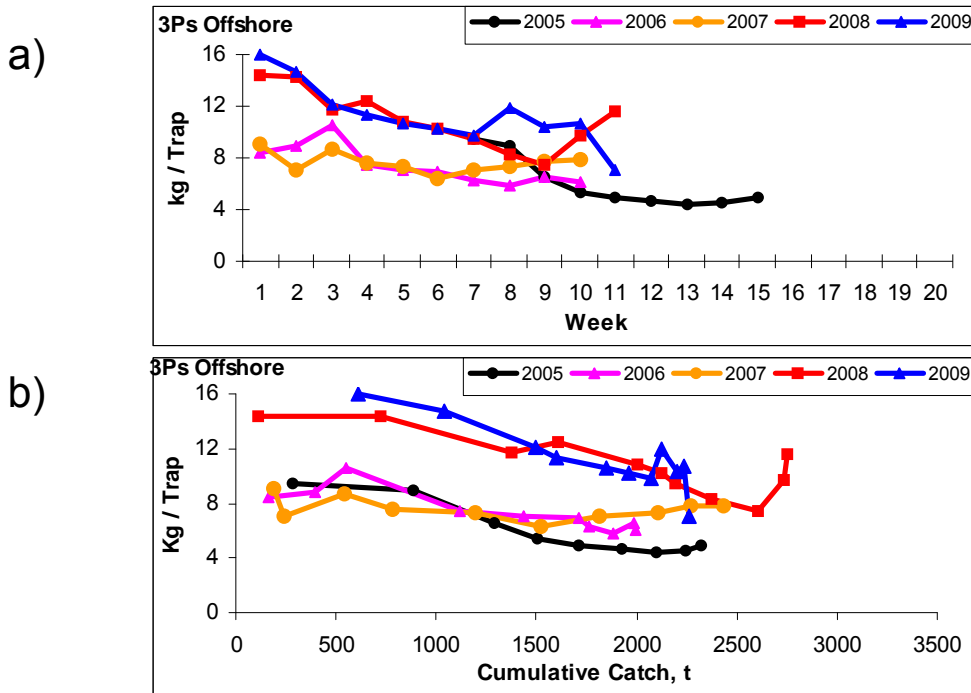


Figure 192. Seasonal trends in logbook-based CPUE for Subdivision 3Ps offshore during 2005-09; (a) by week, and (b) in relation to cumulative catch.

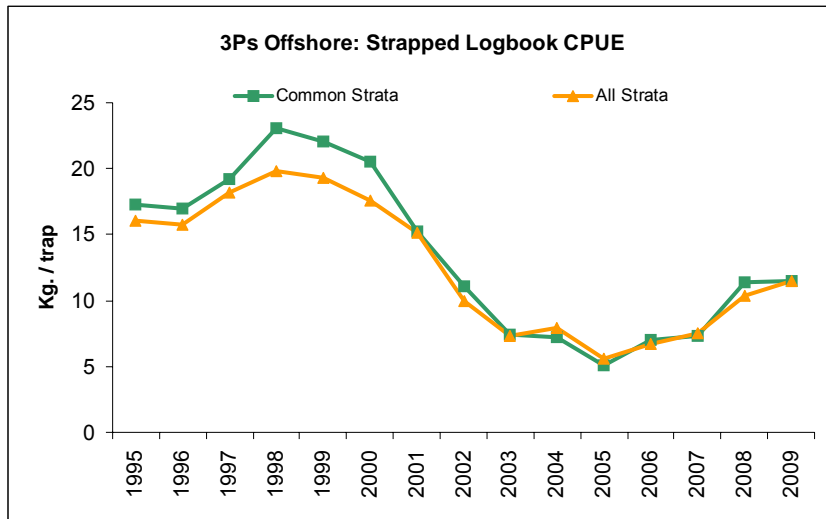


Figure 193. Trends in mean catch rates in the Subdivision 3Ps offshore fishery based on spatially-expanded logbook STRAP analysis.

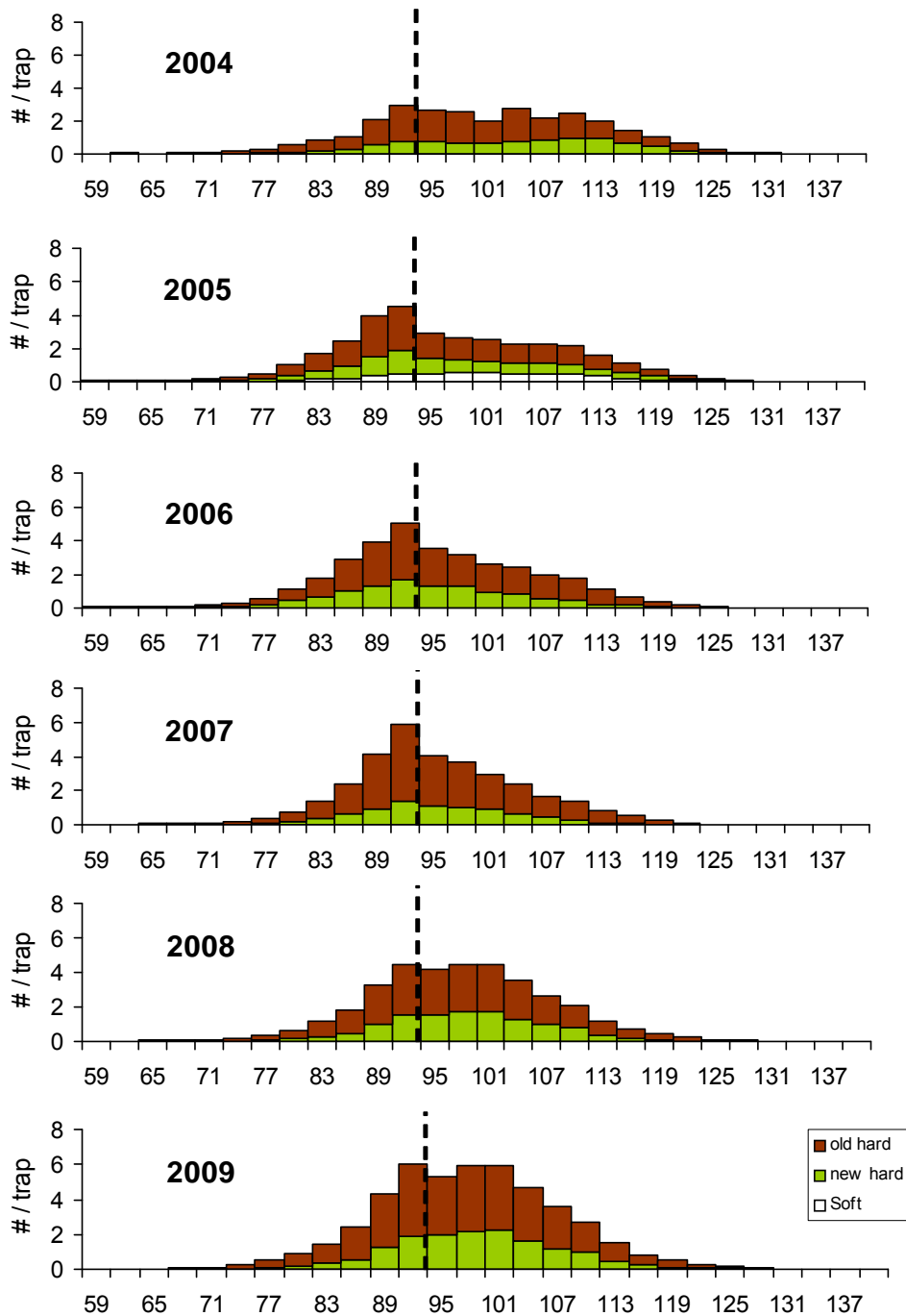


Figure 194. Trends in male carapace width distributions by shell condition from observer at-sea sampling for Subdivision 3Ps offshore. The vertical dashed line indicates the minimum legal size.

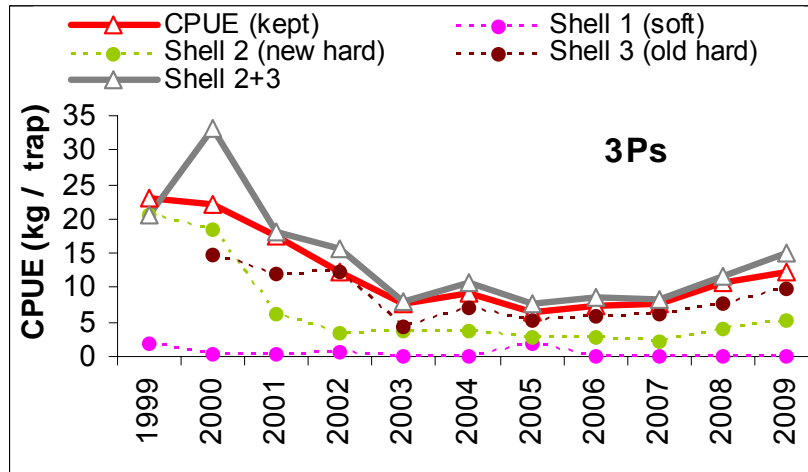


Figure 195. Trends in Subdivision 3Ps offshore observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

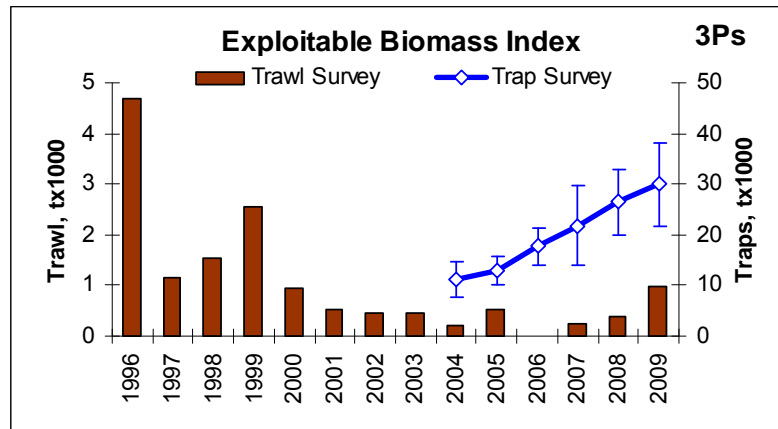


Figure 196. Trends in the Subdivision 3Ps offshore fall trawl survey exploitable biomass index and the CPS trap survey biomass index. The survey was incomplete in 2006.

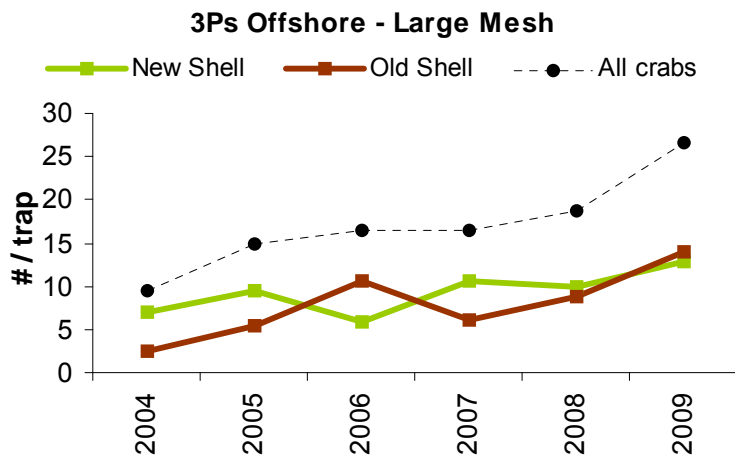


Figure 197. Trends in CPUE by shell condition for legal-sized crabs from core stations in the Subdivision 3Ps offshore CPS trap survey.



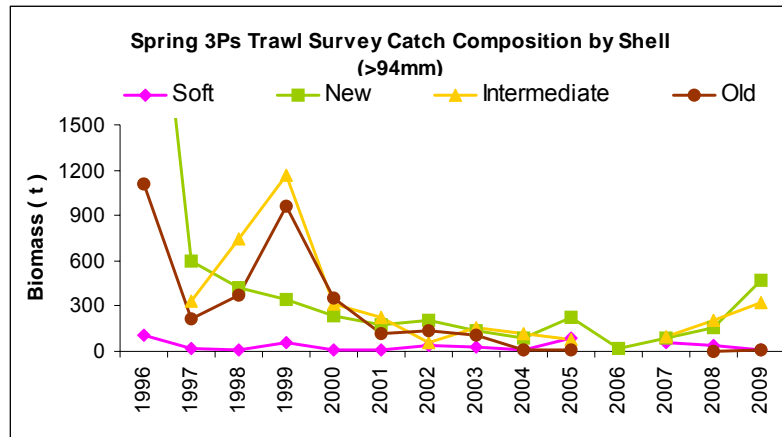


Figure 198. Trends, by shell condition, in legal-sized males for Subdivision 3Ps offshore from spring trawl surveys.

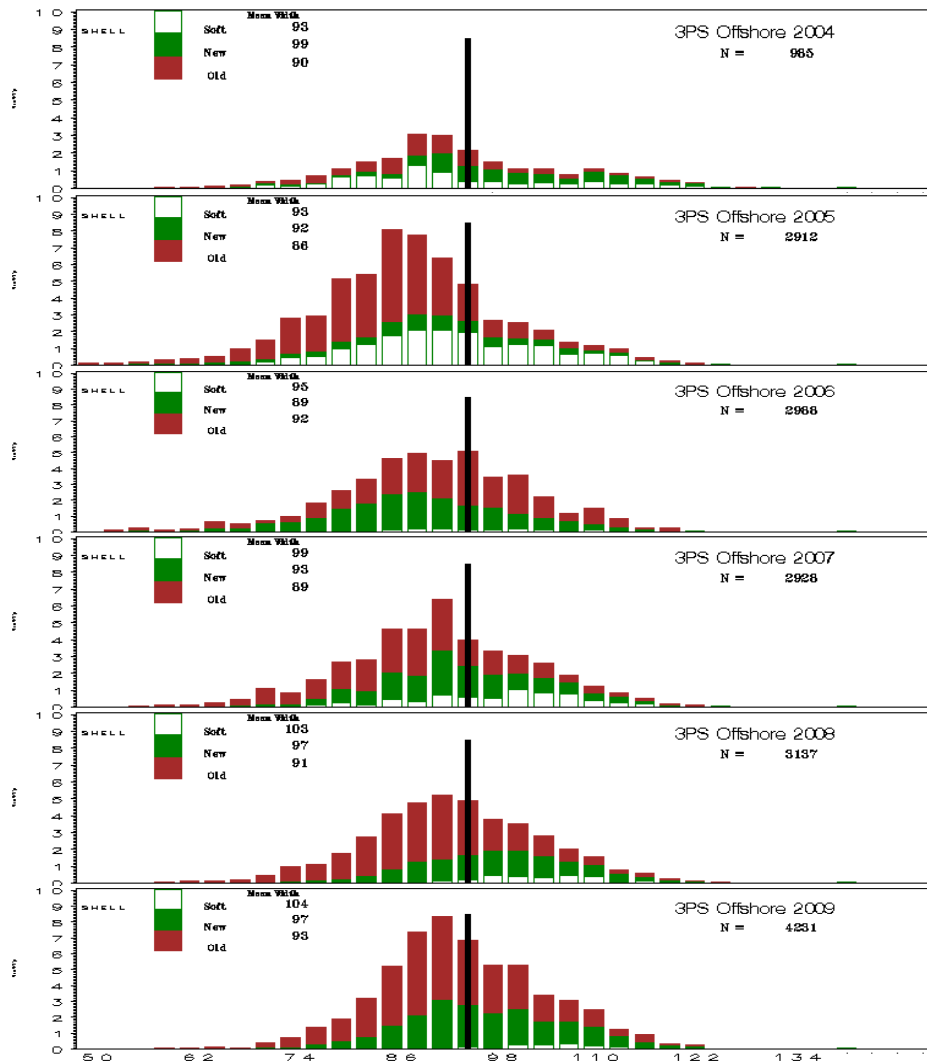


Figure 199. Trends in male carapace width distributions from core stations in the Subdivision 3Ps offshore CPS trap survey. The vertical solid line indicates the minimum legal size.

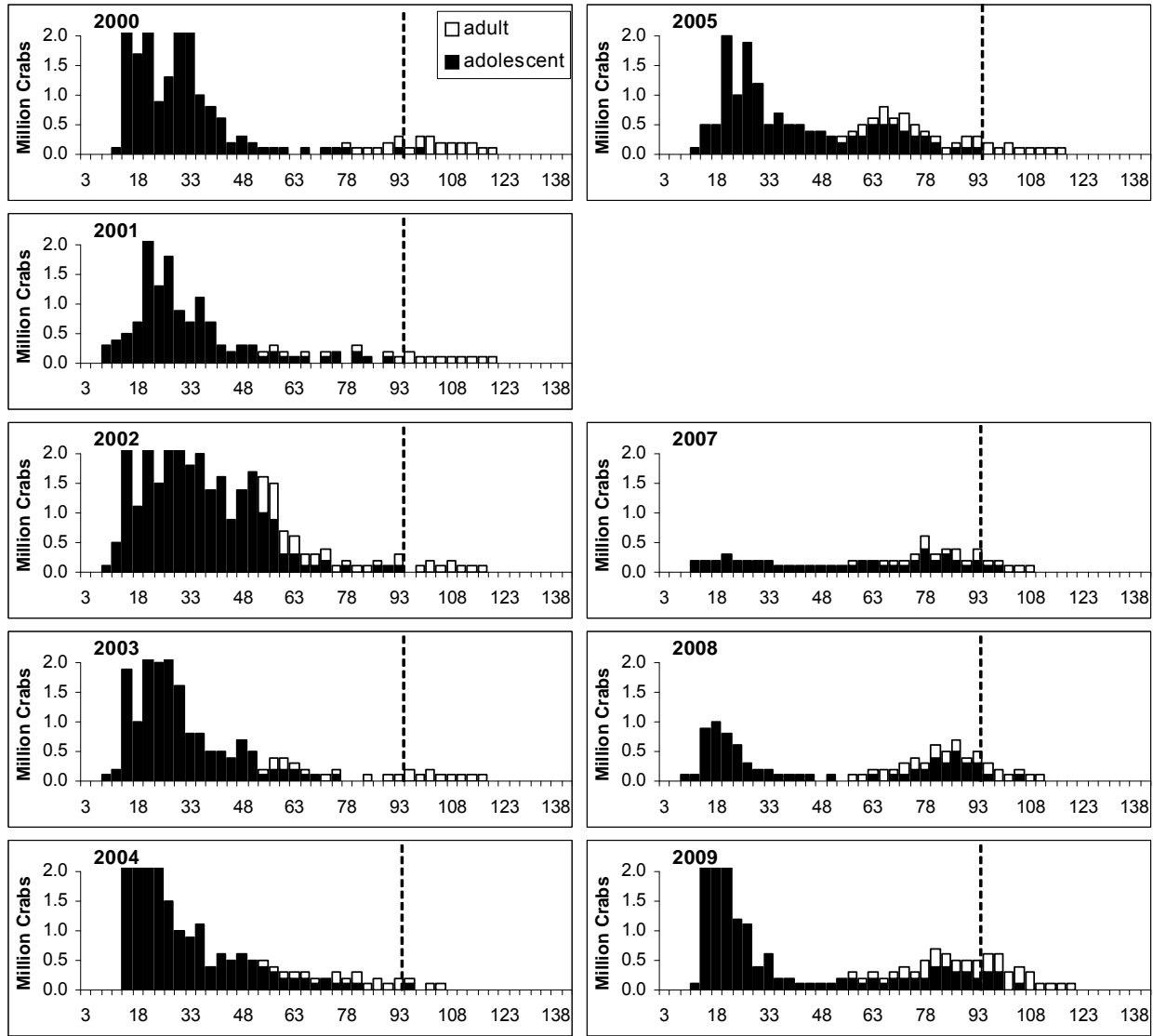


Figure 200. Distribution of abundance (index) by carapace width for Subdivision 3Ps juveniles plus adolescents (dark bars) versus adults (open bars) from spring trawl surveys. Abundance is truncated for smallest crabs (<50 mm CW). The minimum legal size is indicated by a vertical dashed line. The survey was incomplete in 2006.

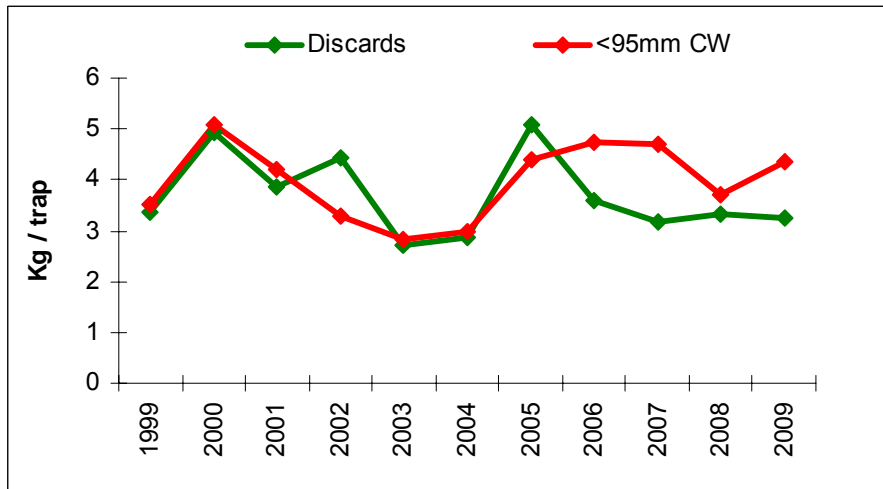


Figure 201. Trends in Subdivision 3Ps offshore observer catch rates of total discards from set and catch records and of sub-legal sized crabs from at-sea sampling.

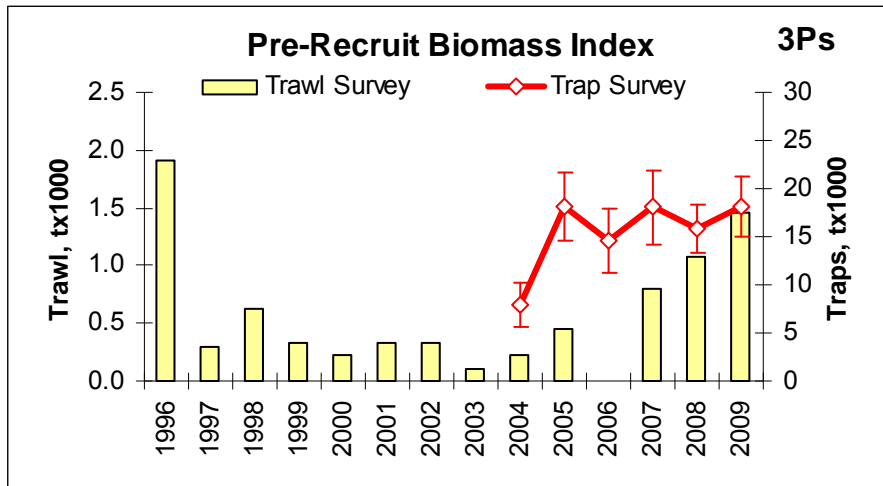


Figure 202. Trends in the Subdivision 3Ps trawl survey pre-recruit biomass index and the CPS trap survey biomass index. The trawl survey was incomplete in 2006.

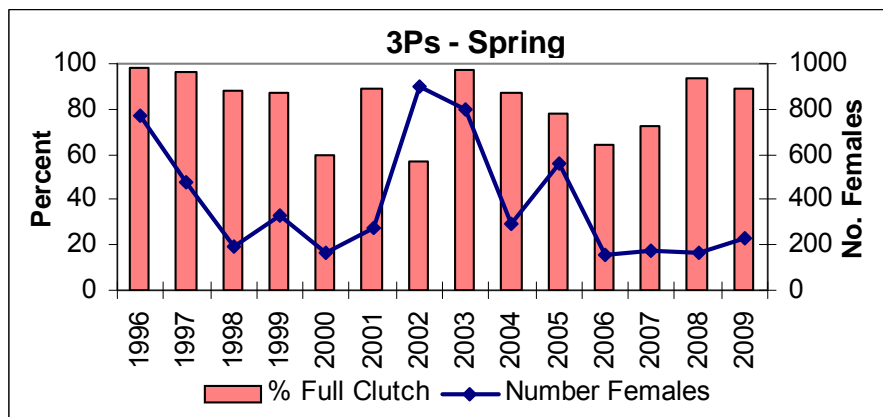


Figure 203. Trends in percent of mature females bearing full clutches of viable eggs and samples sizes in Subdivision 3Ps from fall multi-species surveys.

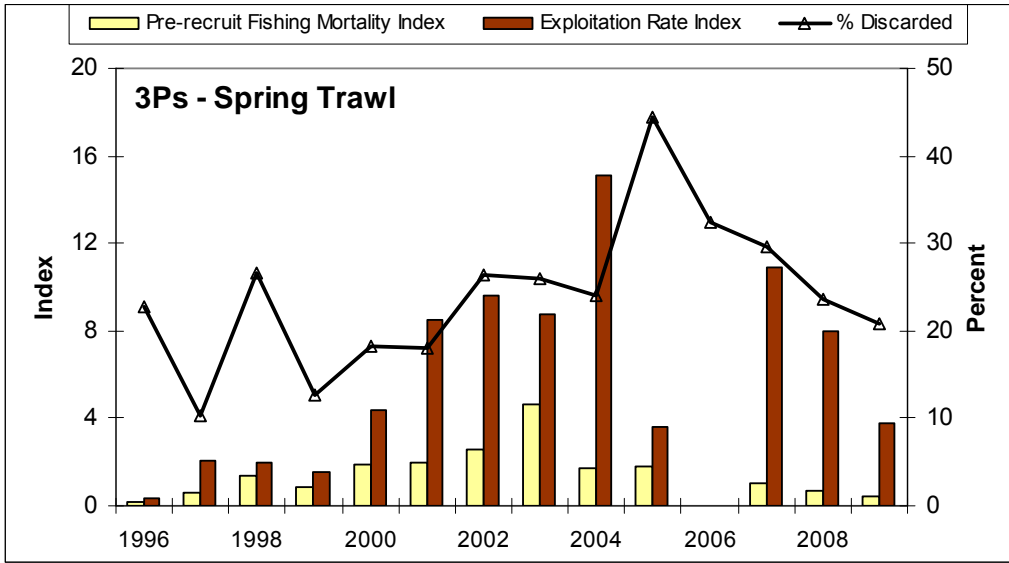


Figure 204. Trends in Subdivision 3Ps offshore mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery. (No 2006 exploitation rate or pre-recruit fishing mortality indices because of an incomplete 2006 survey).

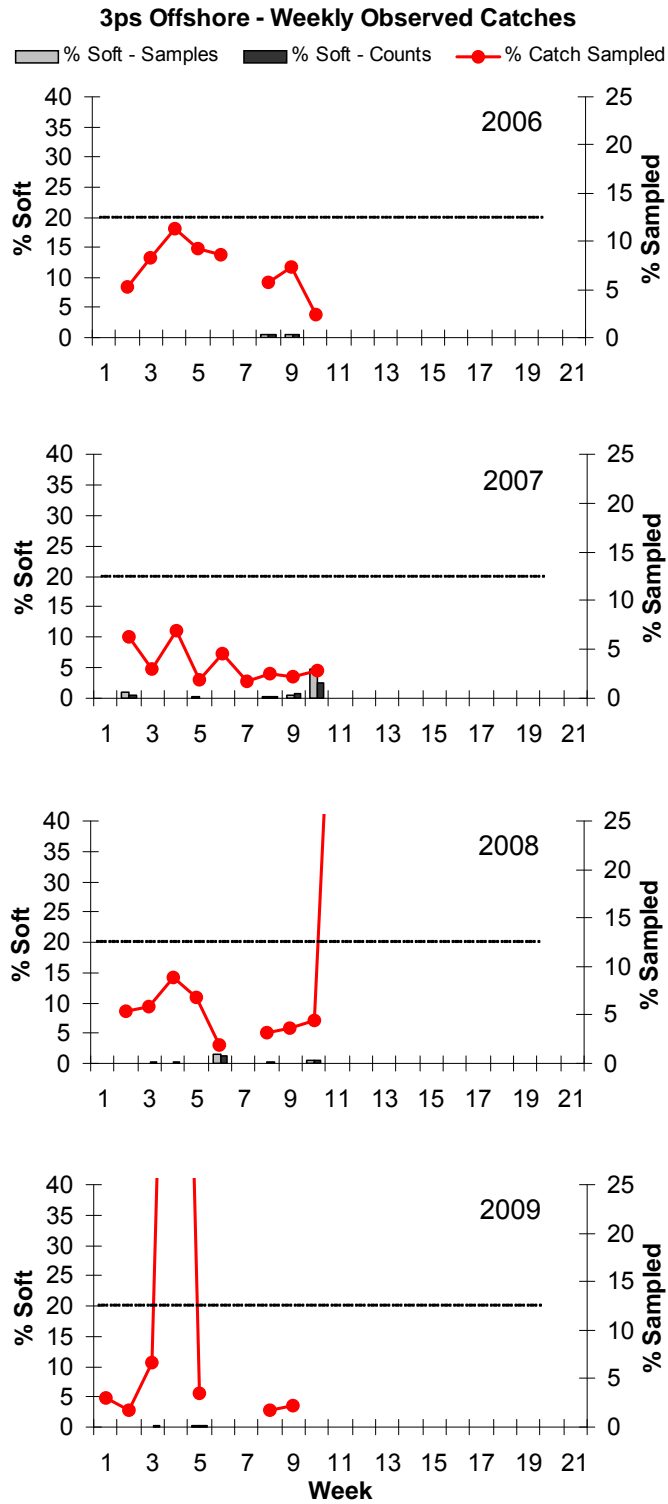


Figure 205. Trends in weekly percentages of soft-shell crab monitored and sampled in Subdivision 3Ps Offshore from 2006 to 2009. Red lines show percentage of the catch sampled each week.

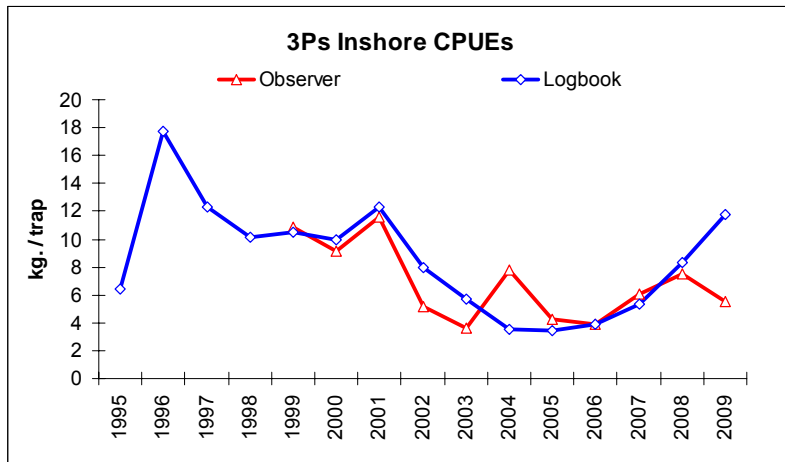


Figure 206. Trends in commercial logbook-based CPUE and observer-based CPUE in the Subdivision 3Ps inshore fishery.

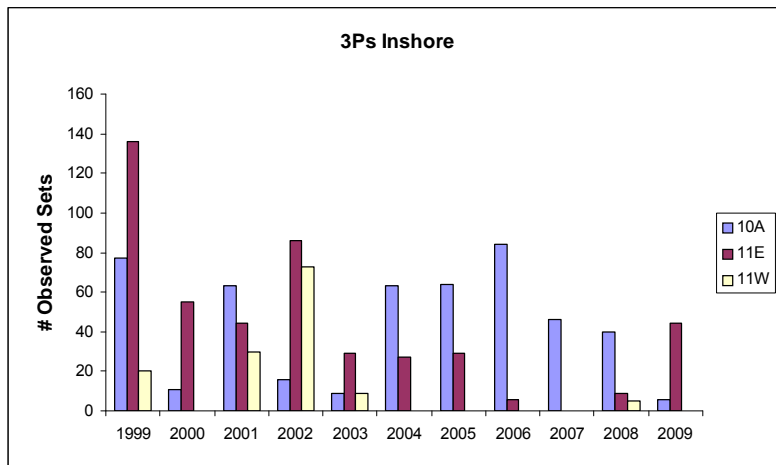


Figure 207. Trends in number of observed sets by Crab Management Areas and year in Subdivision 3Ps inshore.

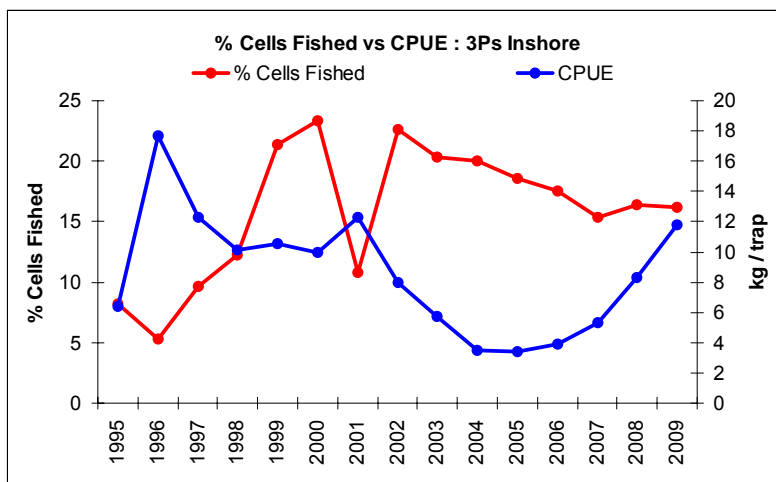


Figure 208. Trends in Subdivision 3Ps inshore commercial CPUE vs. the percentage of 5' x 5' cells fished.

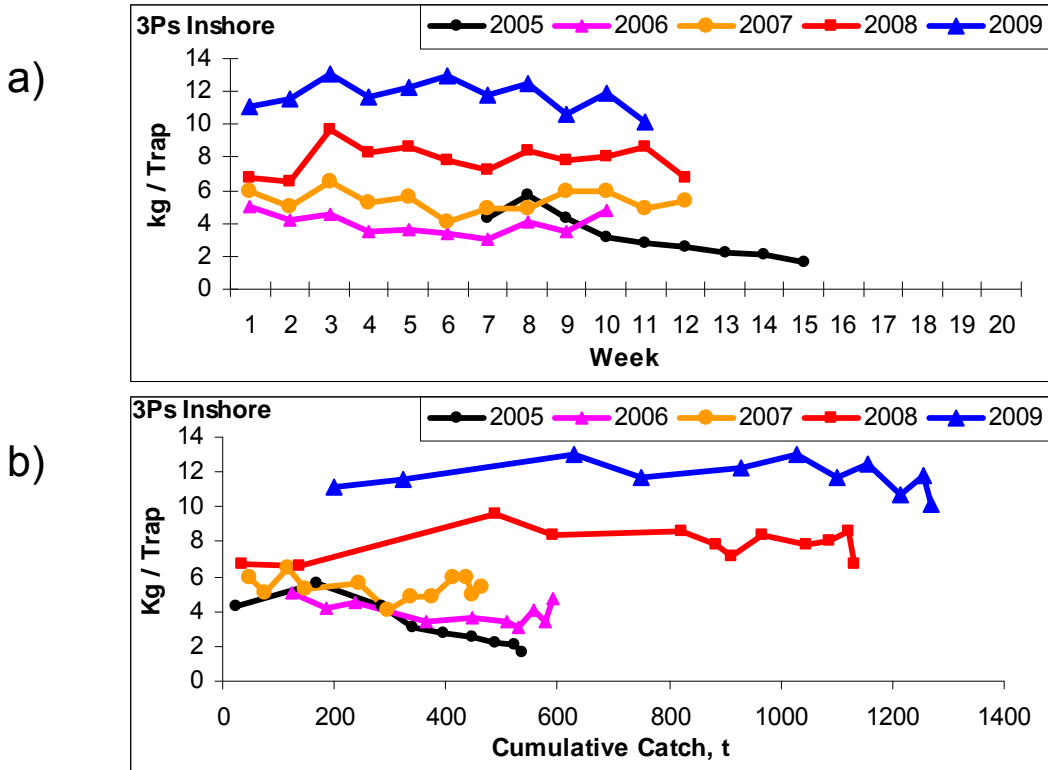


Figure 209. Seasonal trends in logbook-based CPUE for Subdivision 3Ps inshore during 2005-09; (a) by week, and (b) in relation to cumulative catch.

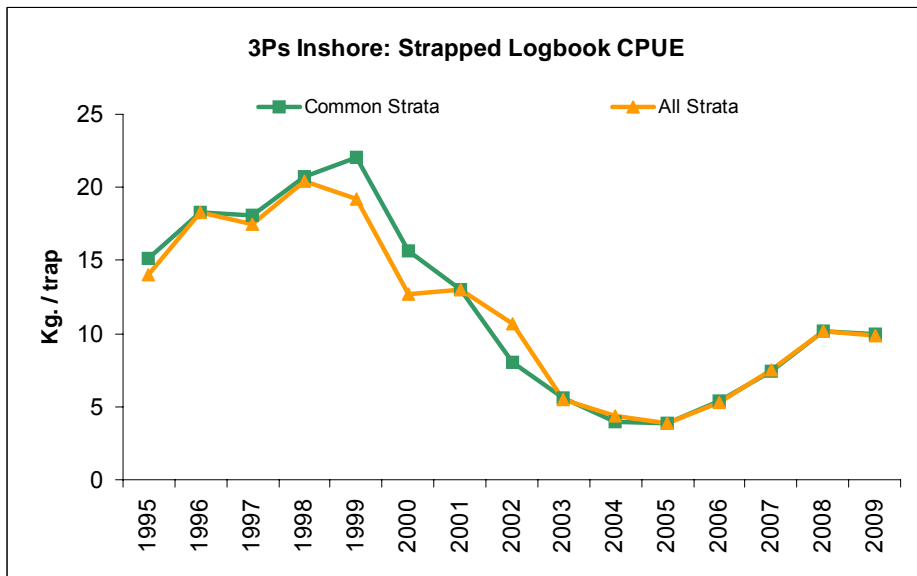


Figure 210. Trends in mean catch rates in the Subdivision 3Ps inshore fishery based on spatially-expanded logbook STRAP analysis.

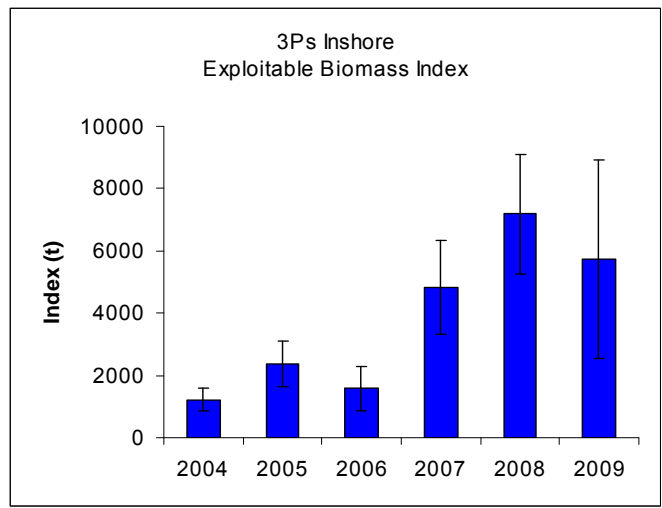


Figure 211. Exploitable biomass index based on the CPS trap survey in Subdivision 3Ps inshore.

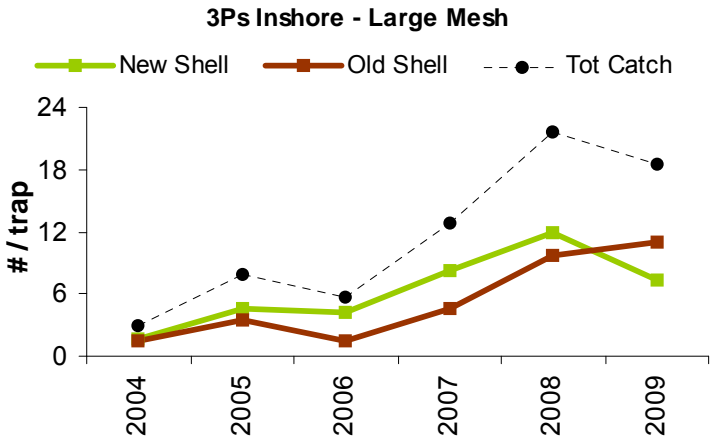


Figure 212. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CPS trap survey in Subdivision 3Ps inshore.

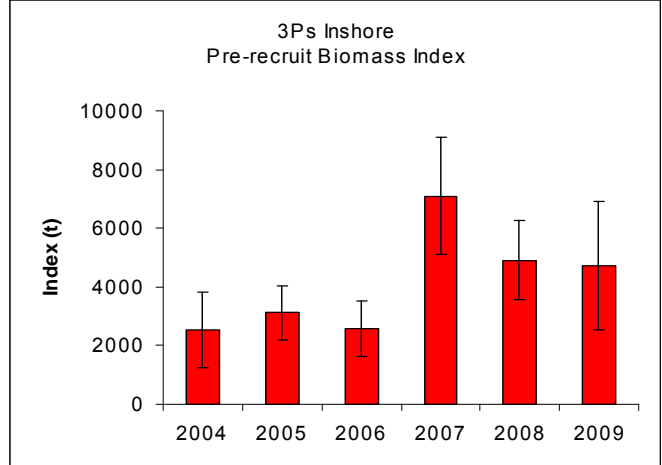


Figure 213. Pre-recruit biomass index based on the CPS trap survey in Subdivision 3Ps inshore.



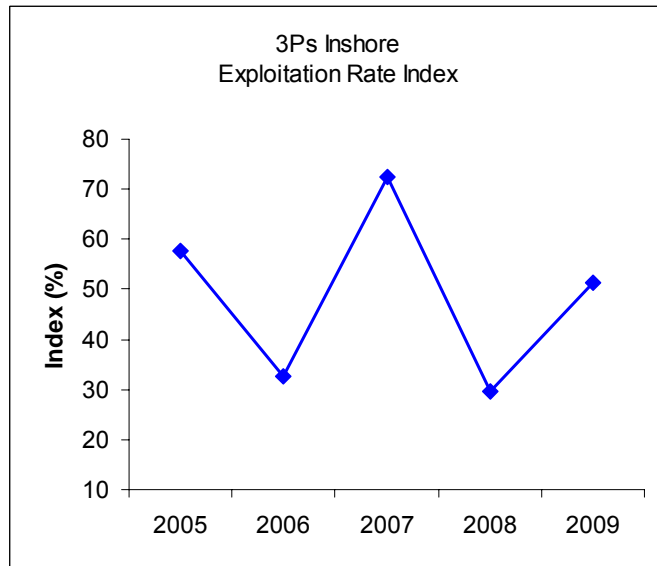


Figure 214. Trends in Subdivision 3Ps inshore exploitation rate.

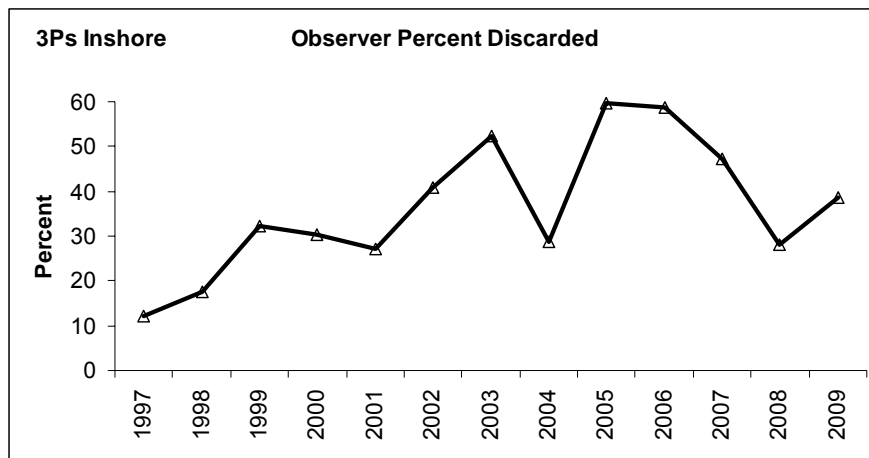


Figure 215. Trends in Subdivision 3Ps inshore percentage of the catch discarded in the fishery.

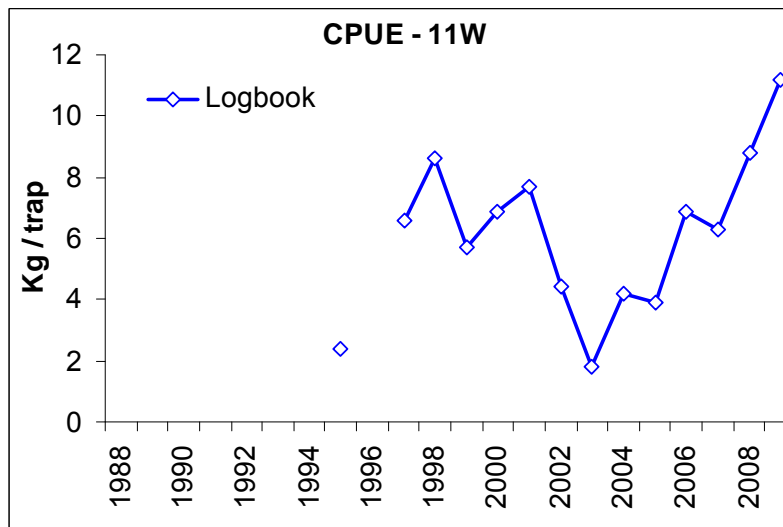
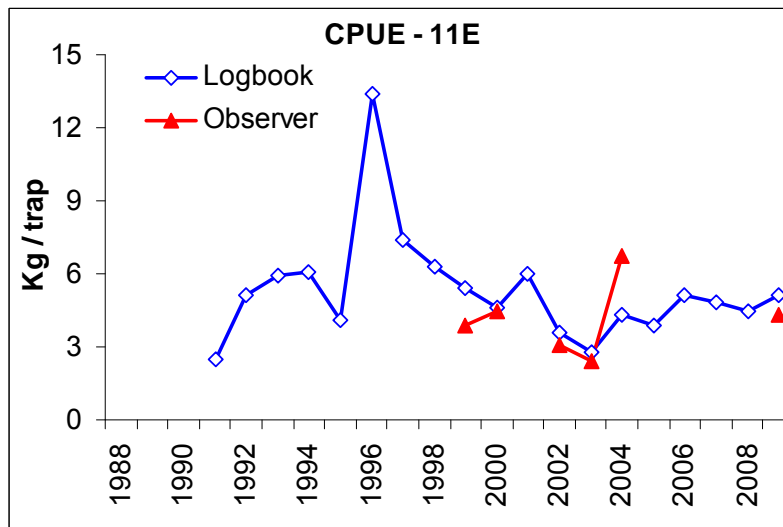
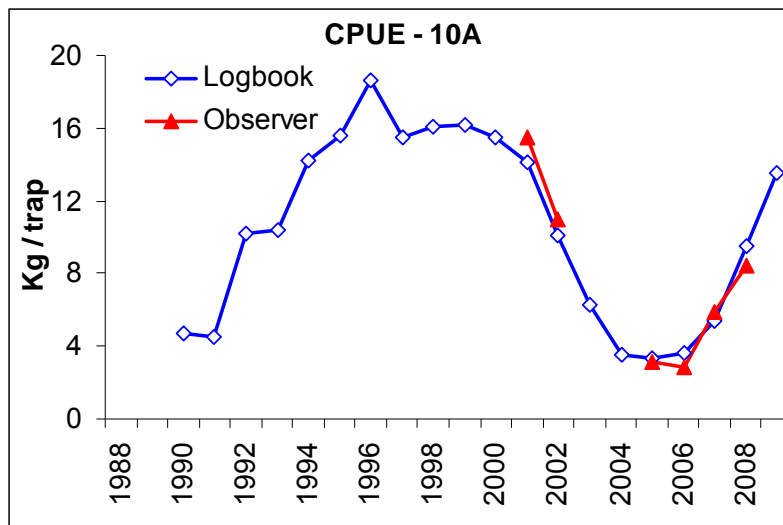


Figure 216. Trends in Subdivision 3Ps inshore logbook CPUE and observer CPUE by Crab Management Area.

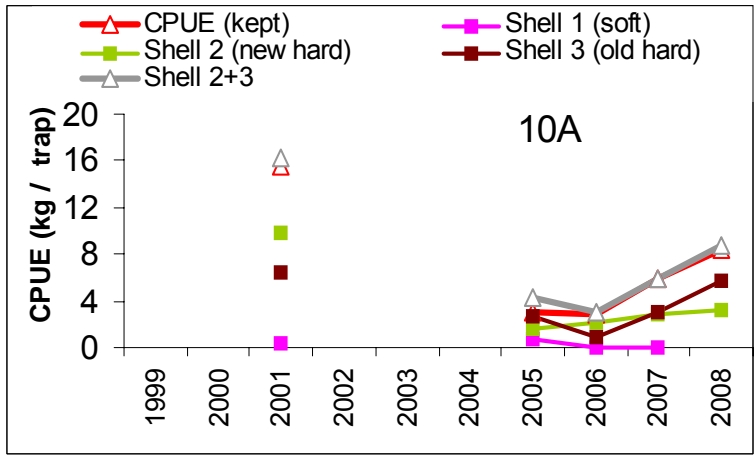


Figure 217. Trends in CMA 10A observer catch rates of exploitable crabs from set and catch records (kept) versus catch rates of sampled legal-sized crabs by shell condition category.

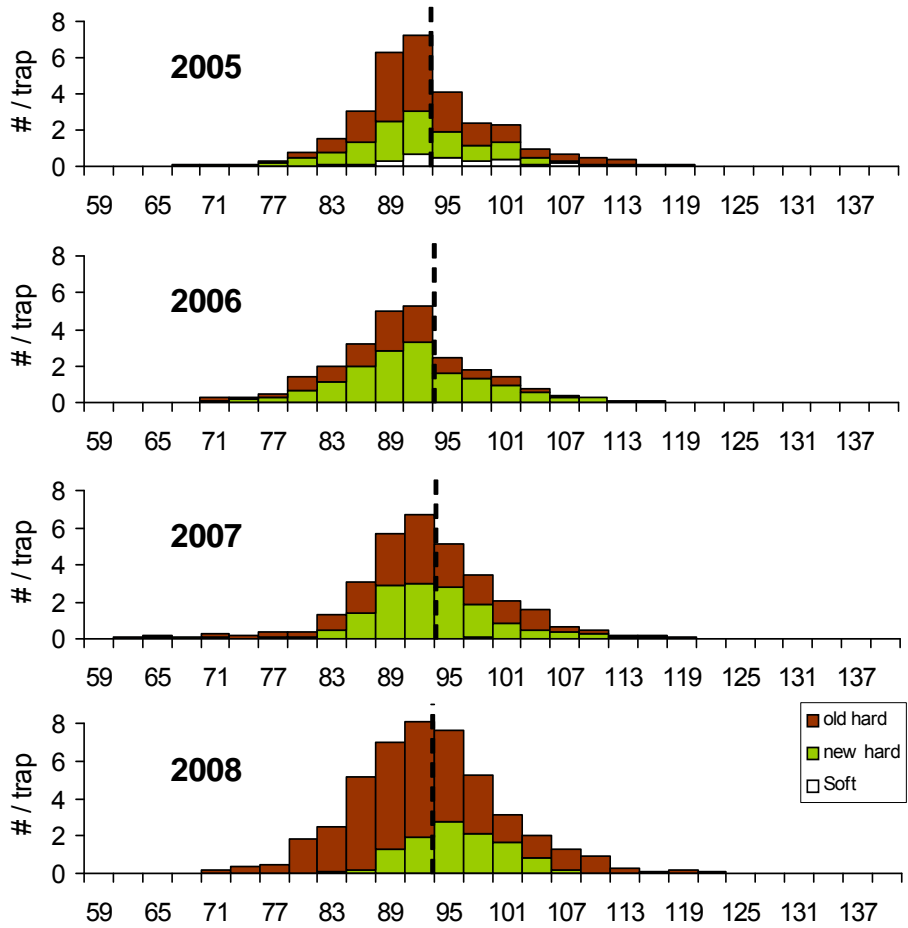


Figure 218. Trends in male carapace width distributions by shell condition from observer at-sea sampling for CMA 10A. The vertical dashed line indicates the minimum legal size.

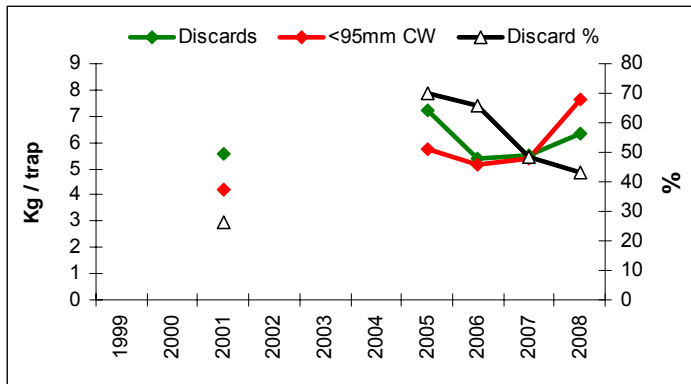


Figure 219. Trends in CMA 10A observer catch rates of total discards and percent discarded from set and catch records and of sub-legal sized crabs from at-sea sampling.

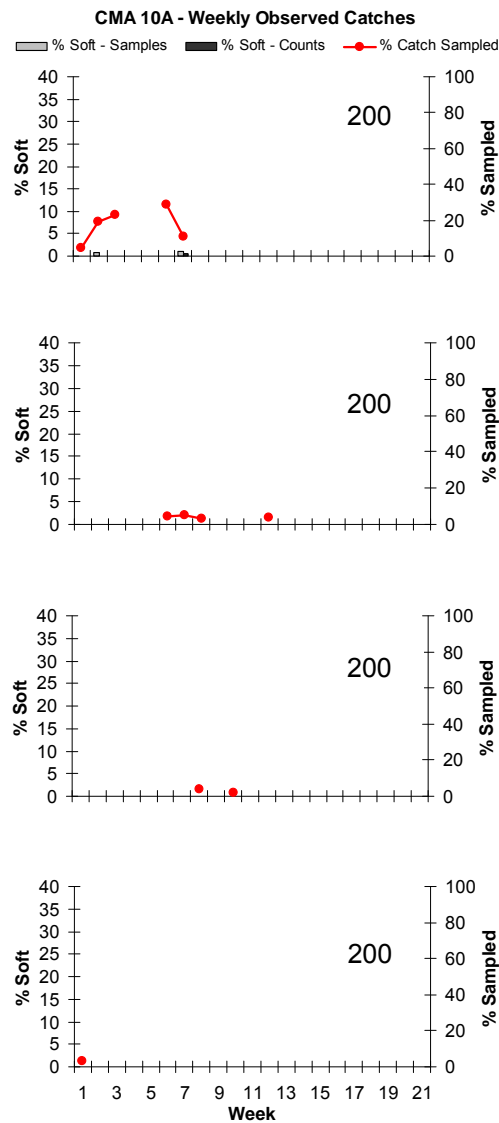


Figure 220. Trends in weekly percentages of soft-shell crab monitored and sampled in CMA 10A from 2006 to 2009. Red lines show percentage of the catch sampled each week.

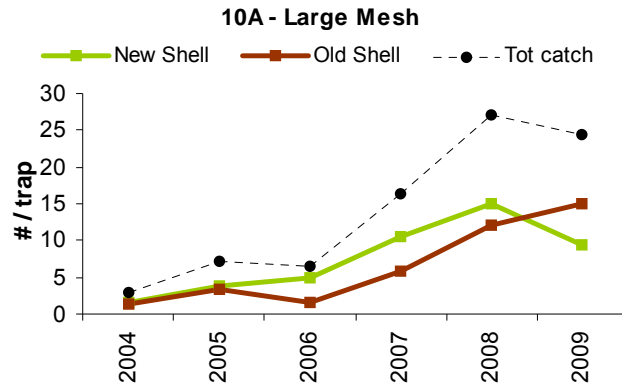


Figure 221. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 10A CPS trap survey.

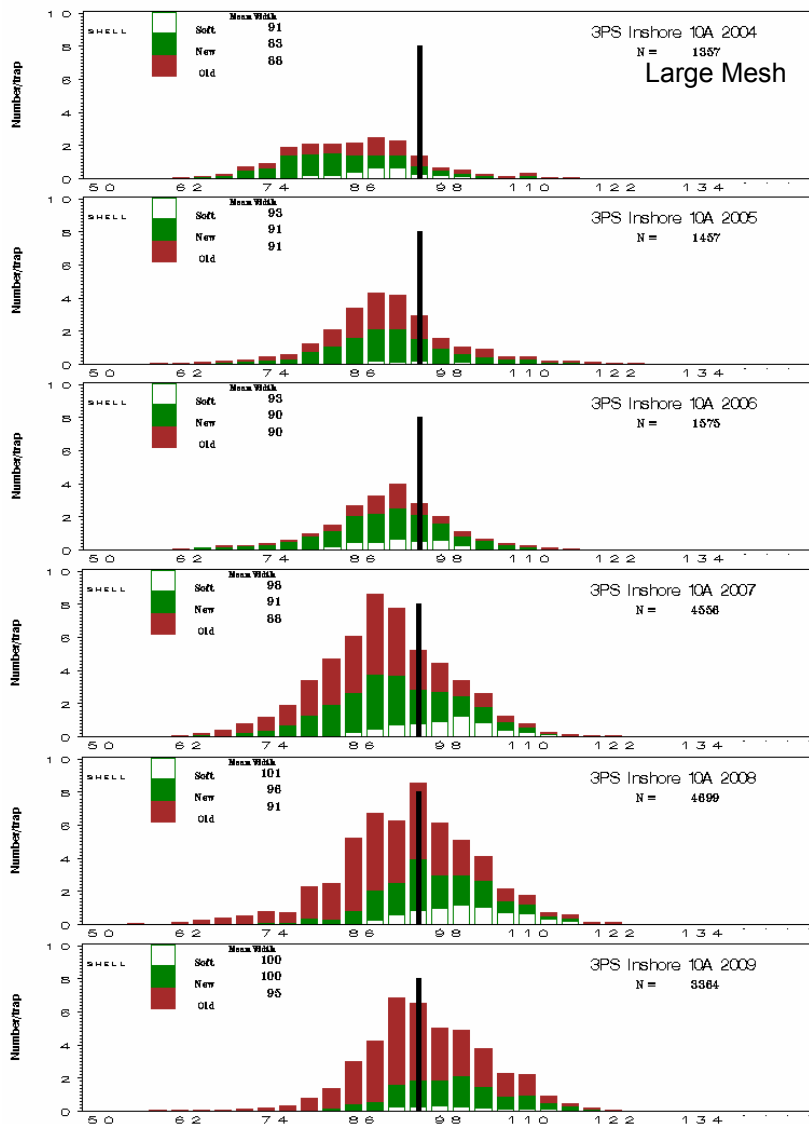


Figure 222. Trends in male carapace width distributions from core stations in the CMA 10A CPS trap survey. The vertical solid line indicates the minimum legal size.

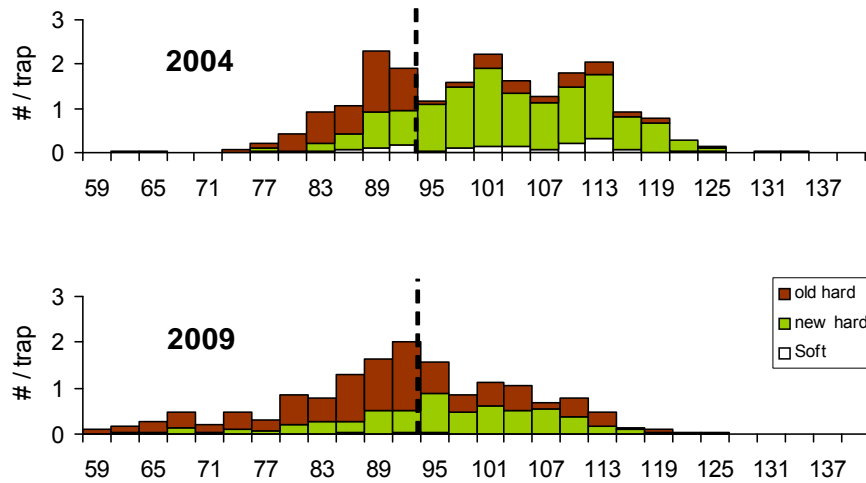


Figure 223. In male carapace width distributions by shell condition from observer at-sea sampling for CMA 11E. The vertical dashed line indicates the minimum legal size.

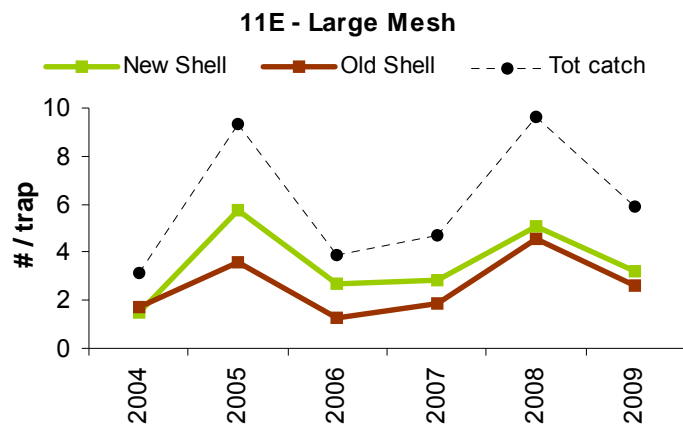


Figure 224. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 11E CPS trap survey.

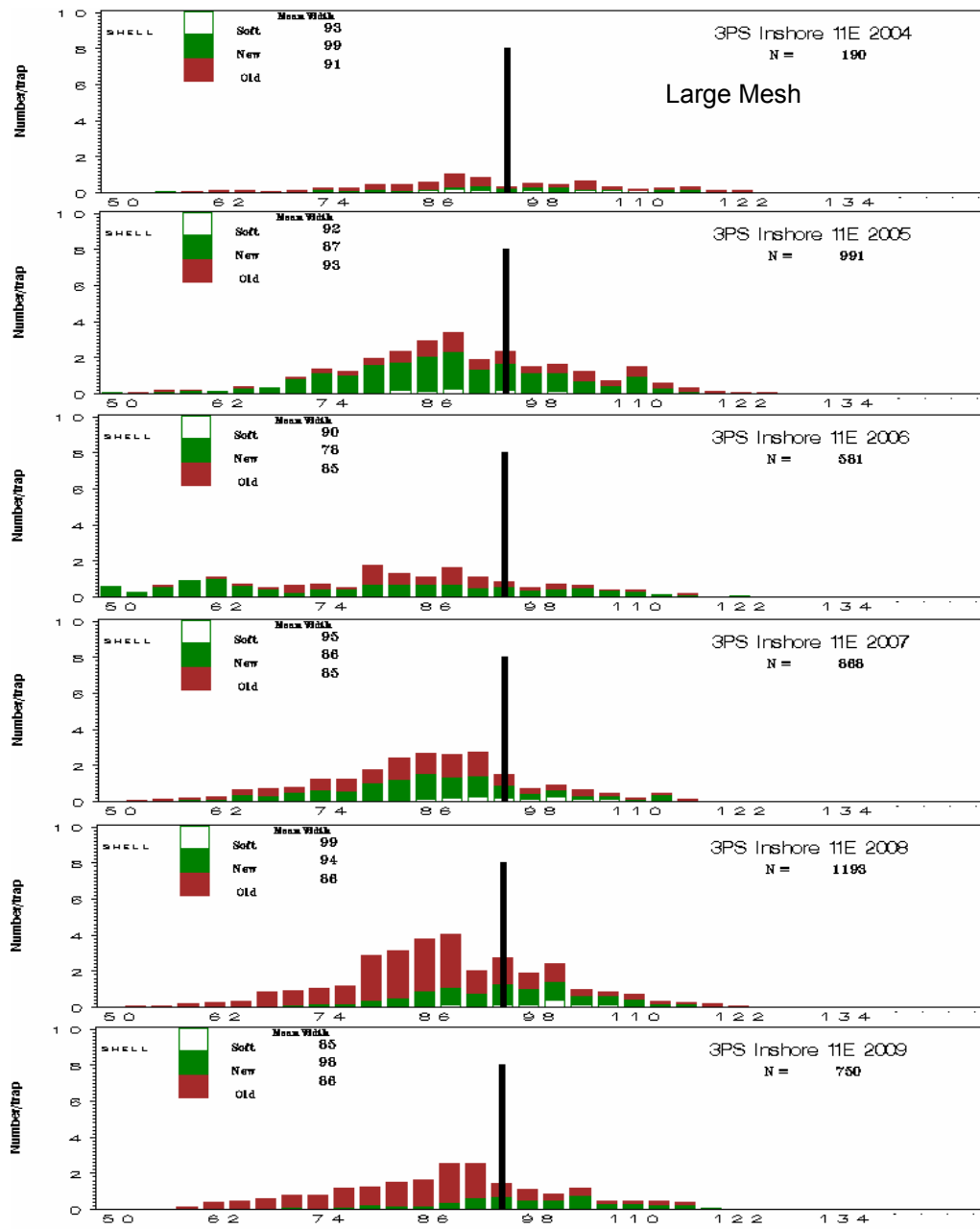


Figure 225. Trends in male carapace width distributions from core stations in the CMA 11E CPS trap survey. The vertical solid line indicates the minimum legal size.

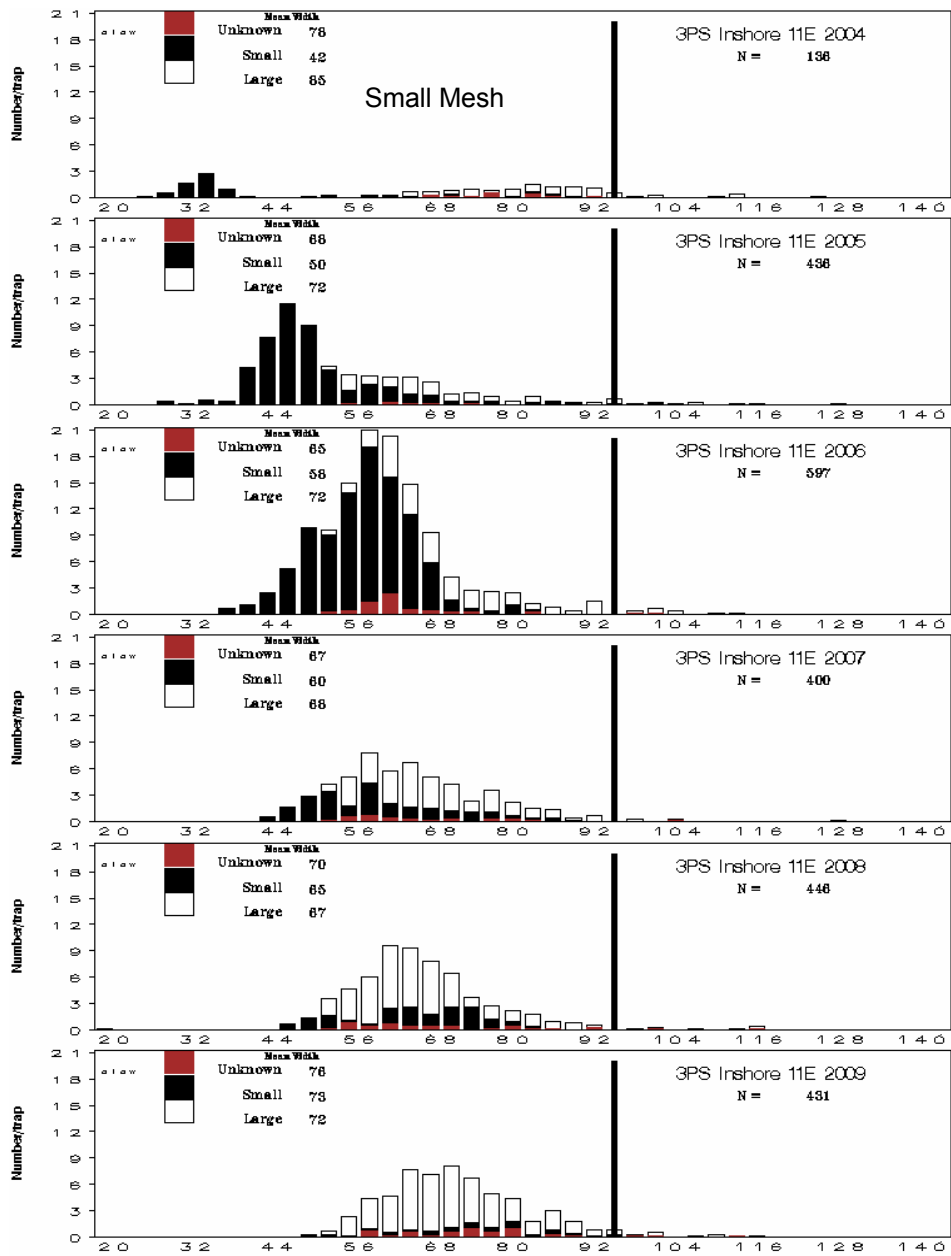


Figure 226. Trends in male carapace width distributions by chela type from small-mesh traps at core stations in the CMA 11E CPS trap survey. The vertical solid line indicates the minimum legal size.



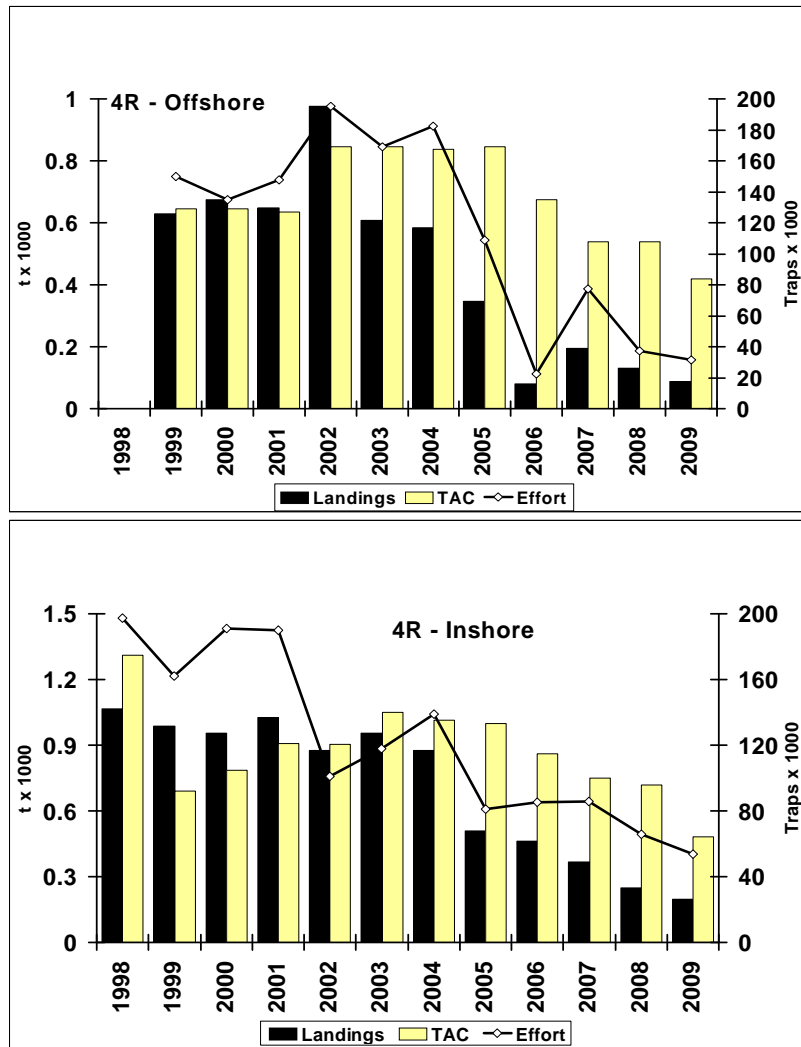


Figure 227. Trends in Division 4R3Pn landings, TAC, and fishing effort for the offshore (above) and inshore (below).

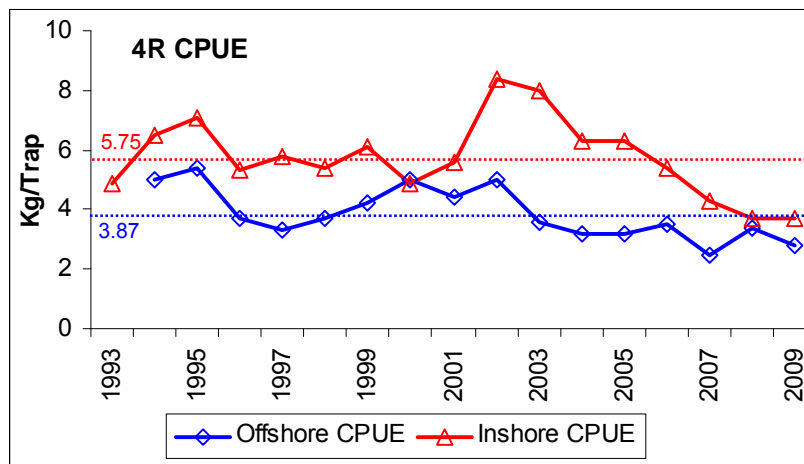


Figure 228. Trends in Division 4R3Pn offshore and inshore commercial CPUE in relation to their long-term averages (dotted lines).

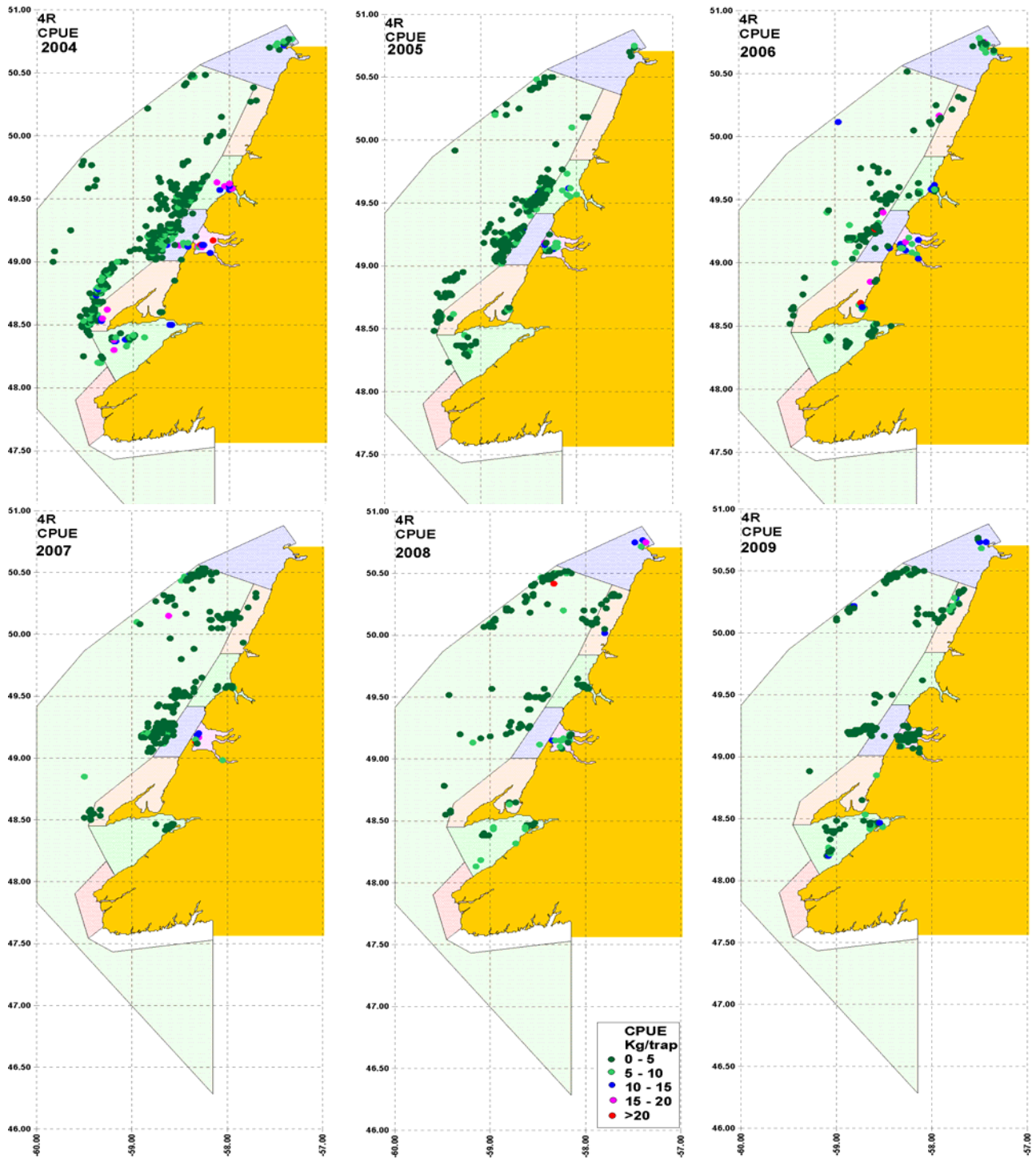
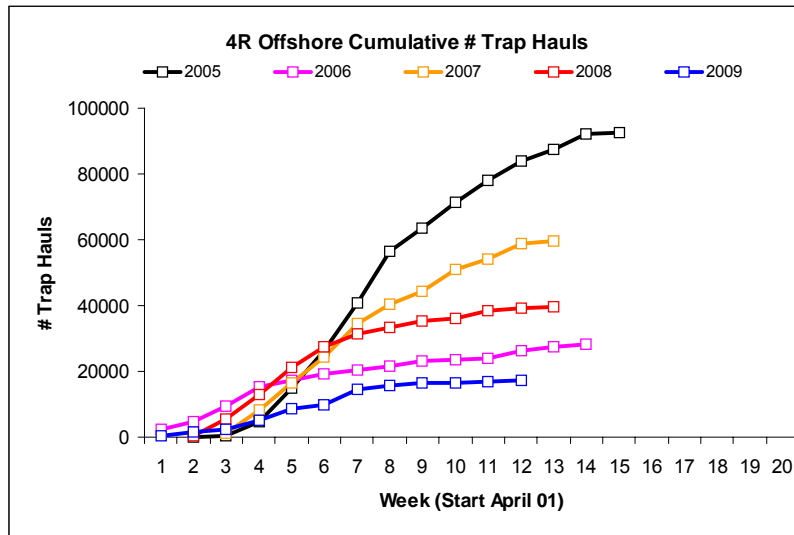


Figure 229. Spatial distribution of Division 4R commercial CPUE by year.

a)



b)

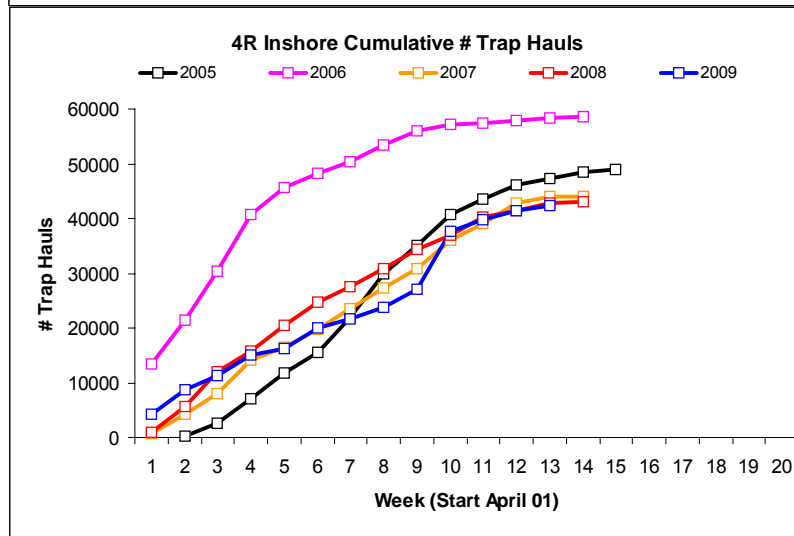


Figure 230. Seasonal trends in cumulative fishing effort for Division 4R3Pn during 2005-09 for (a) the offshore and (b) the inshore.

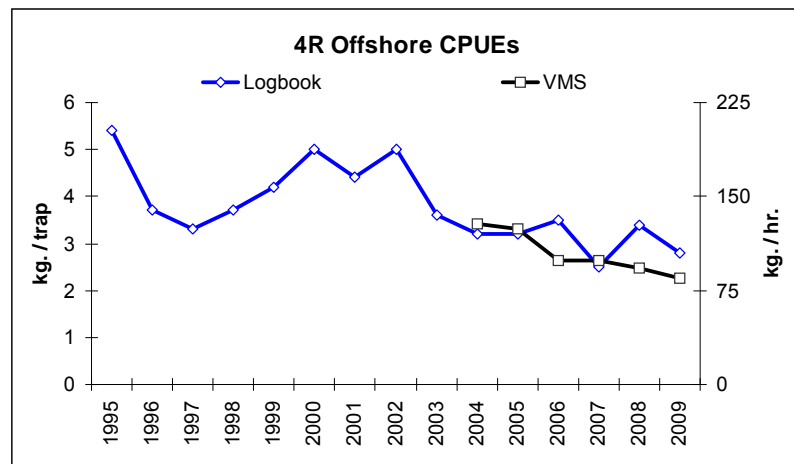


Figure 231. Trends in commercial logbook-based CPUE and VMS-based CPUE in the Division 4R3Pn offshore fishery.

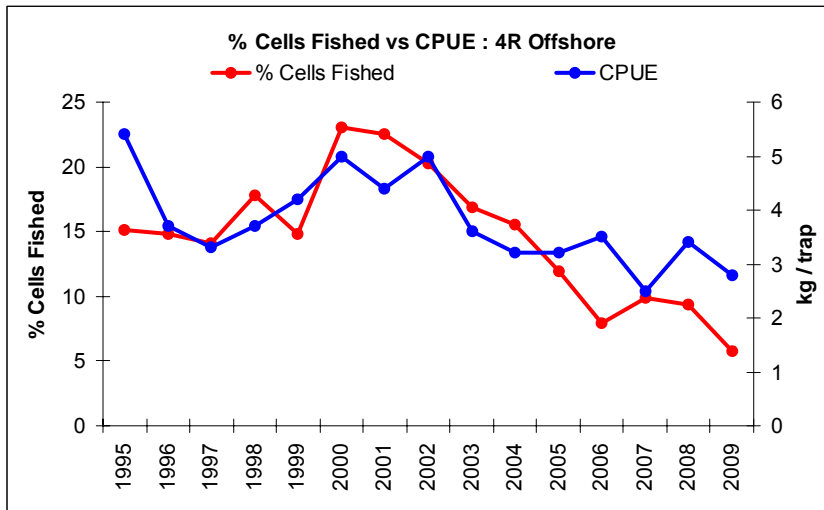


Figure 232. Trends in Division 4R3Pn offshore commercial CPUE vs. the percentage of 5' x 5' cells fished.

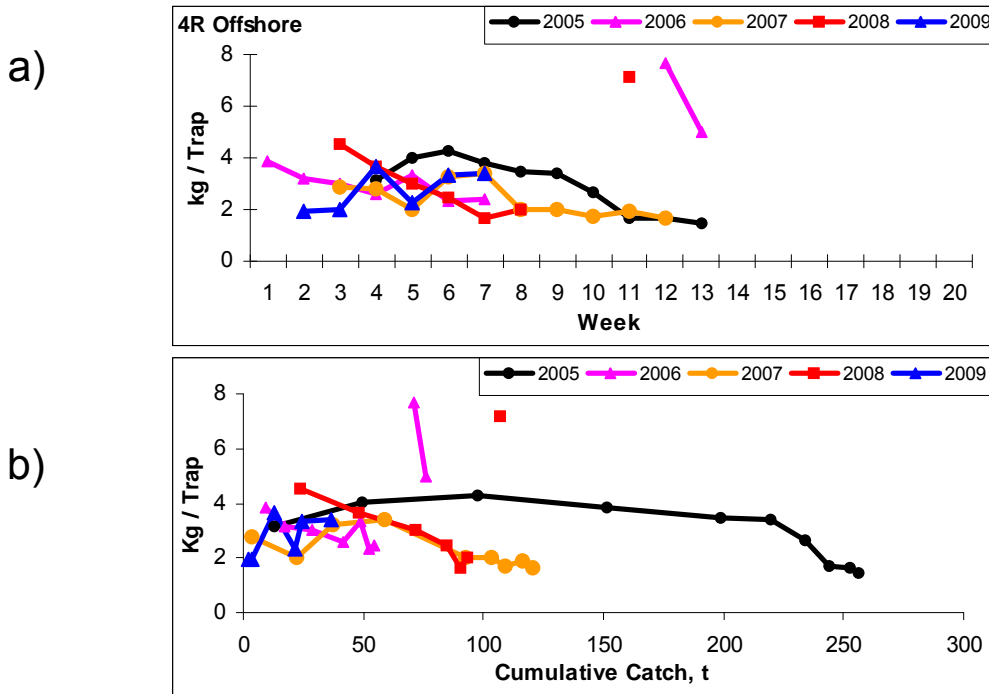


Figure 233. Seasonal trends in logbook-based CPUE for Division 4R3Pn offshore during 2005-09; (a) by week, and (b) in relation to cumulative catch.

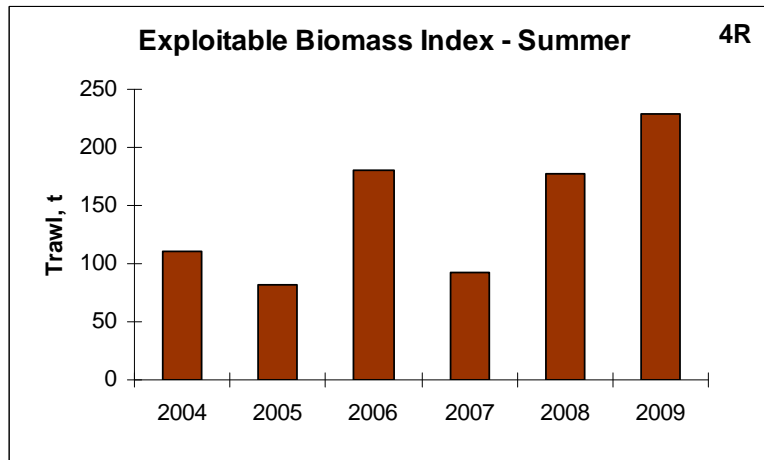


Figure 234. Trends in the Division 4R offshore summer trawl survey exploitable biomass index.

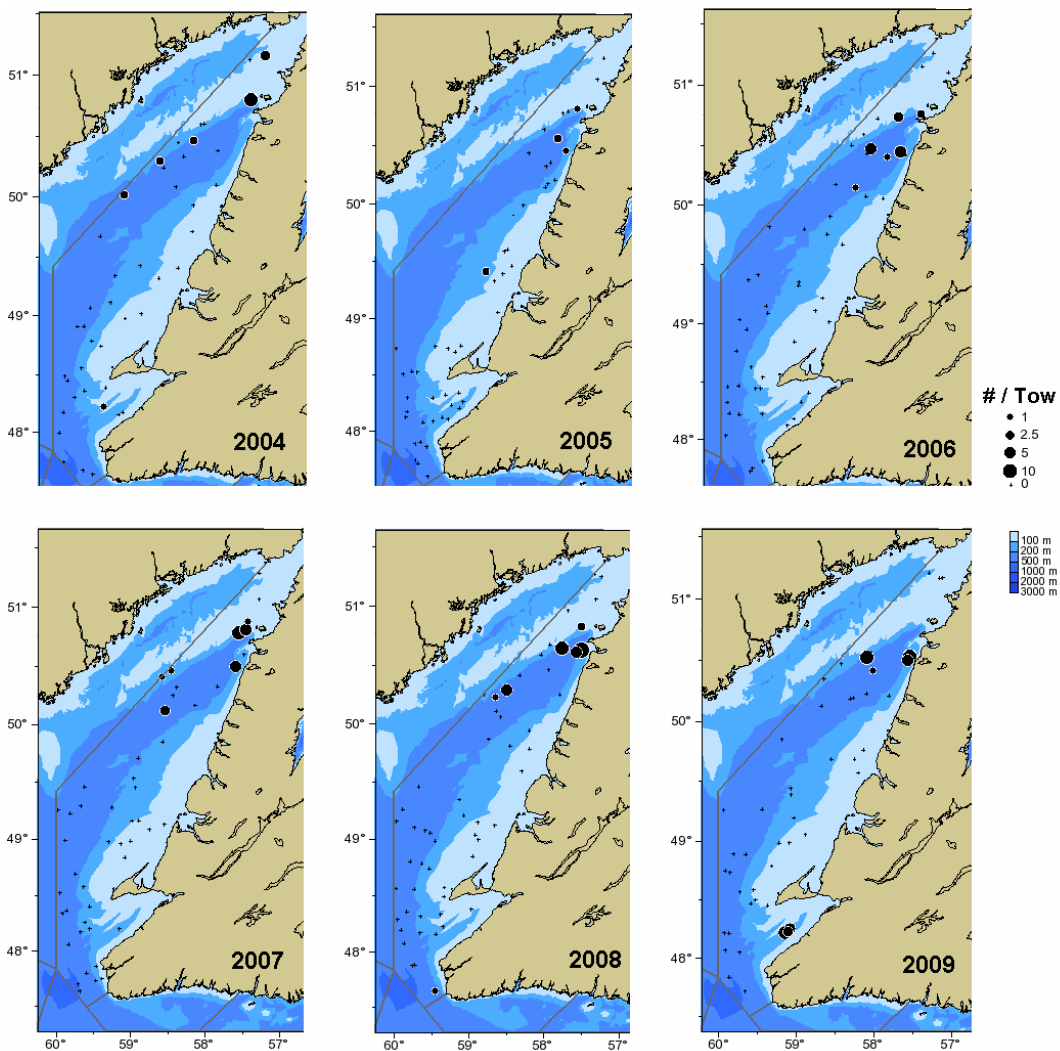


Figure 235. Spatial distribution of catches of legal-sized males in the Division 4R summer trawl survey.

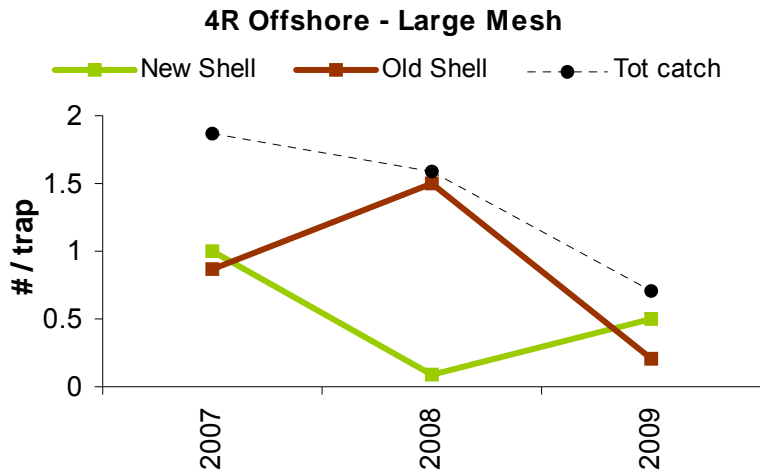


Figure 236. Trends in CPUE by shell condition for legal-sized crabs from core stations in the Division 4R CPS trap survey.

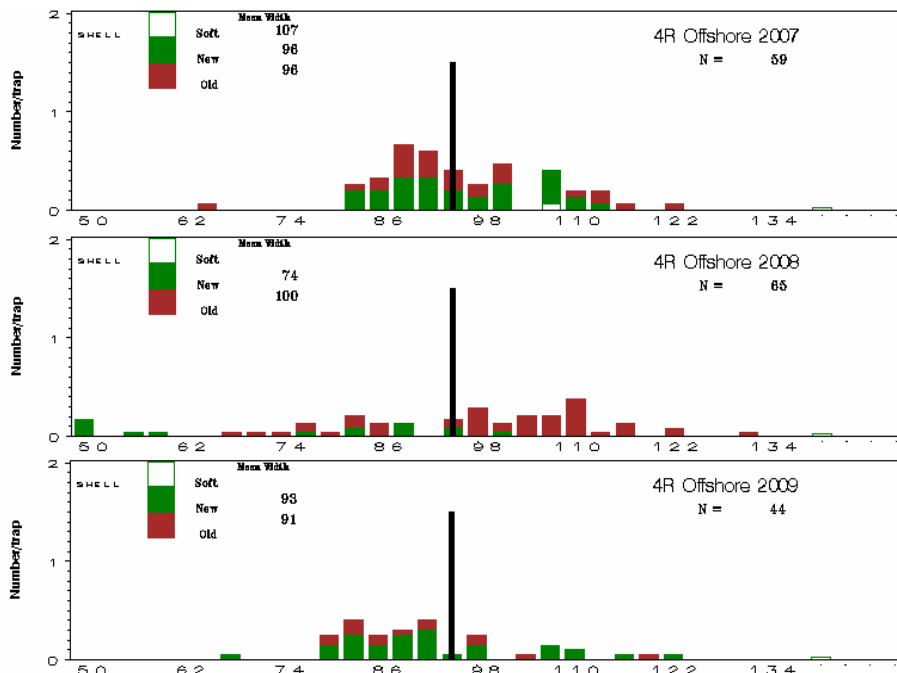


Figure 237. Trends in male carapace width distributions from core stations in the Division 4R3Pn CPS trap survey. The vertical solid line indicates the minimum legal size.

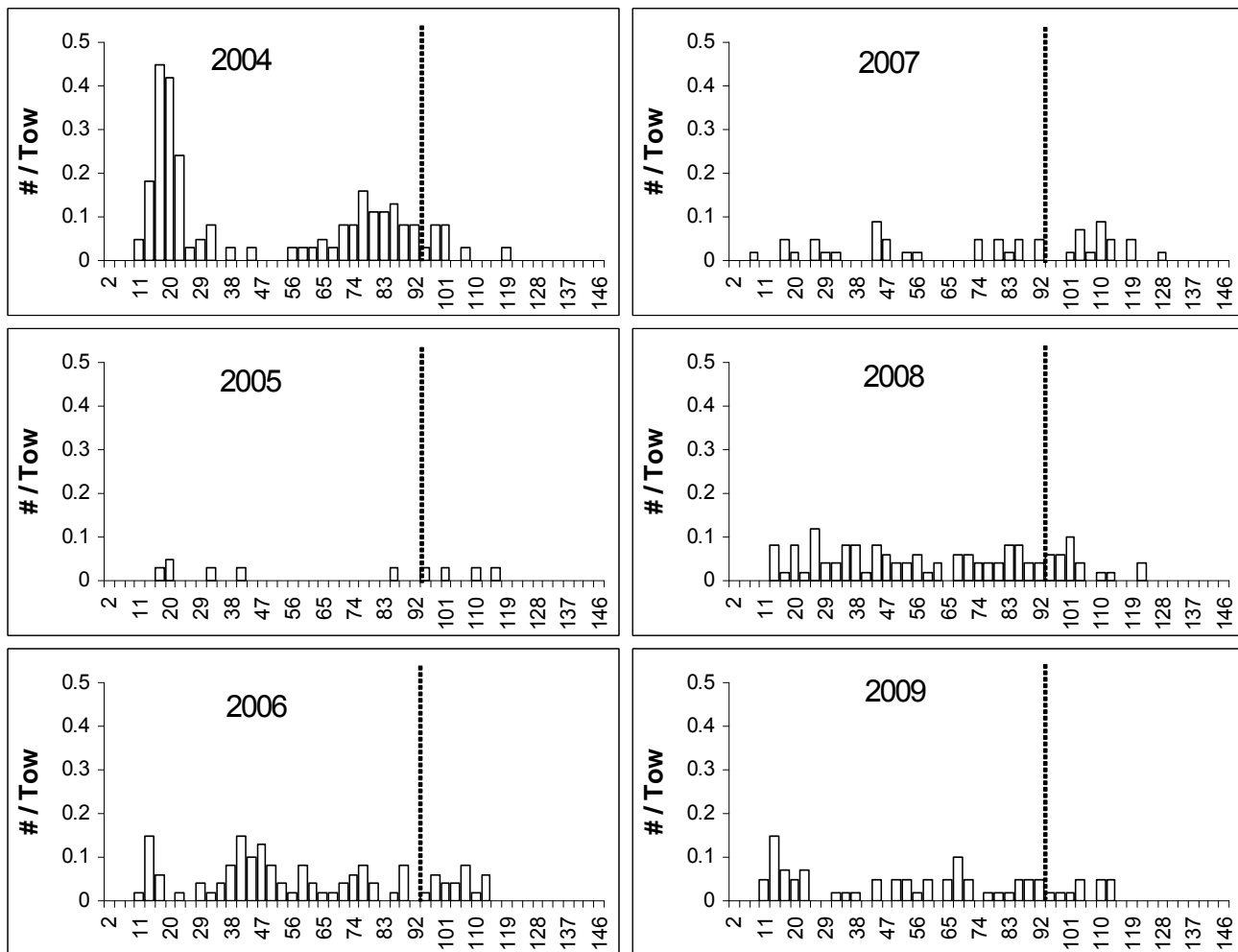


Figure 238. Distribution of abundance (index) by carapace width for Division 4R offshore males from fall trawl surveys. The minimum legal size is indicated by a vertical dashed line.

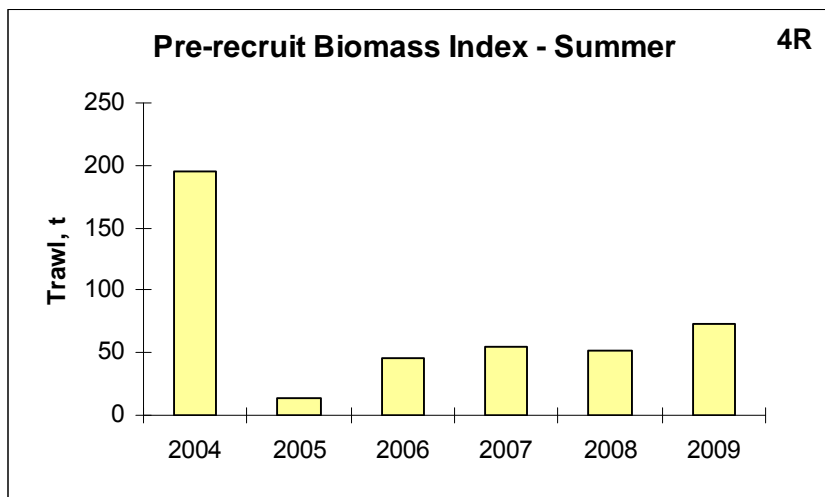


Figure 239. Trends in the Division 4R offshore summer trawl survey pre-recruit biomass index.

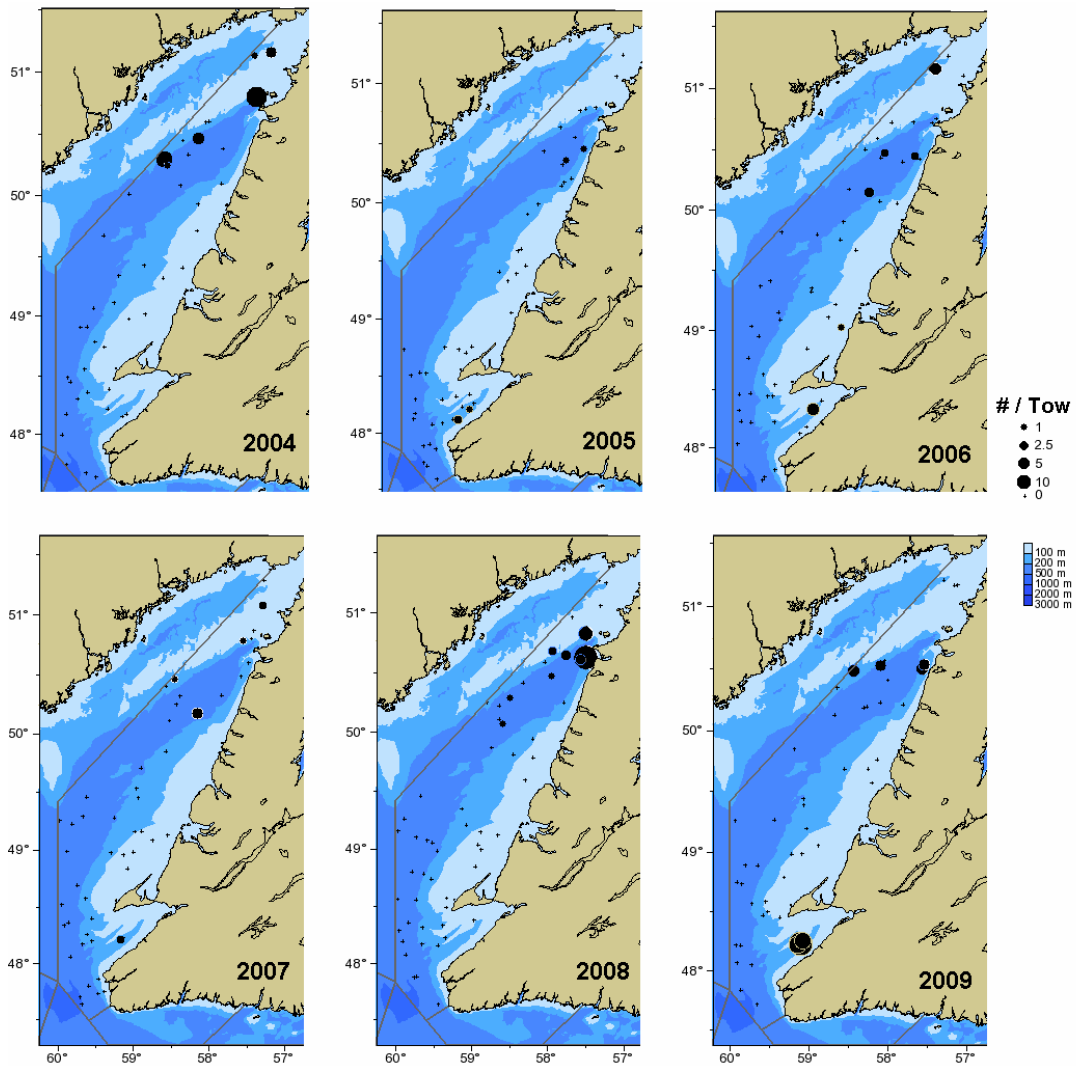


Figure 240. Spatial distribution of catches of pre-recruit-sized males in the Division 4R summer trawl survey.

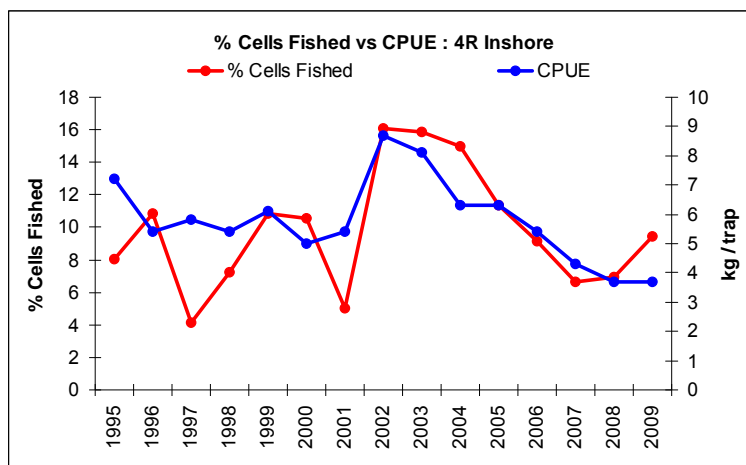


Figure 241. Trends in Division 4R3Pn inshore commercial CPUE vs. the percentage of 5' x 5' cells fished.



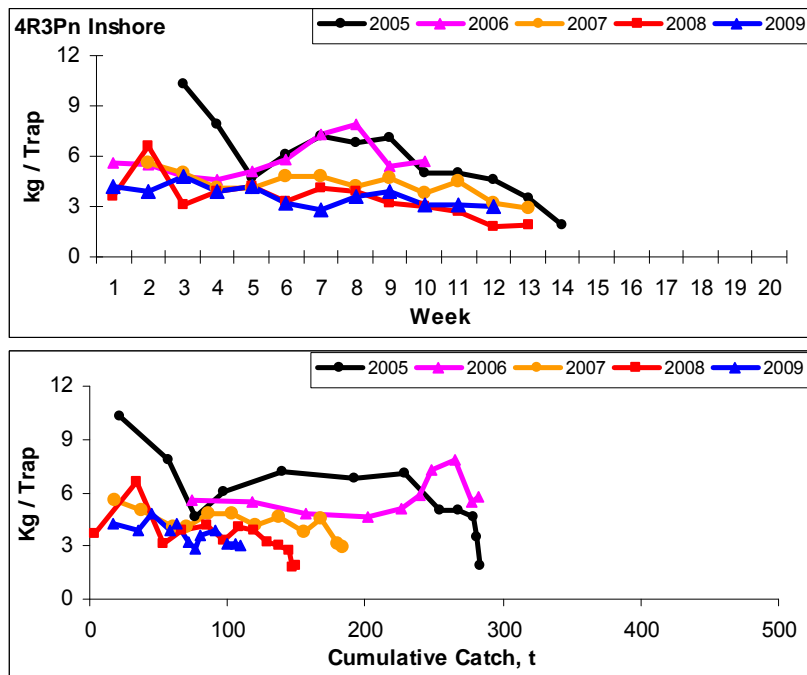


Figure 242. Seasonal trends in logbook-based CPUE for Division 4R3Pn inshore during 2005-09; (a) by week, and (b) in relation to cumulative catch.

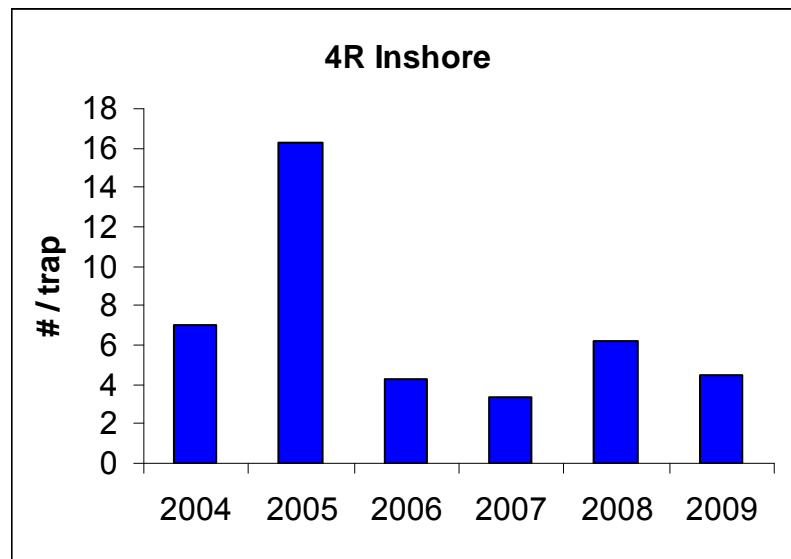


Figure 243. Catch rates of legal-sized crabs from the CPS trap survey in Division 4R inshore.

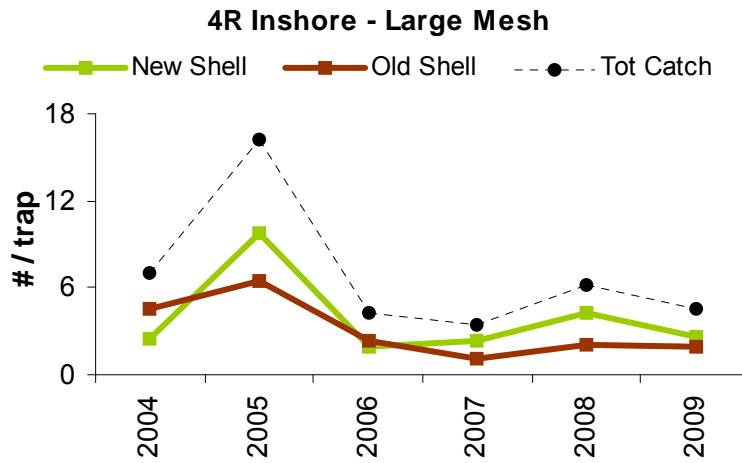


Figure 244. Trends in CPUE by shell condition for legal-sized crabs from core stations in the industry-DFO collaborative post-season trap survey in Division 4R inshore.

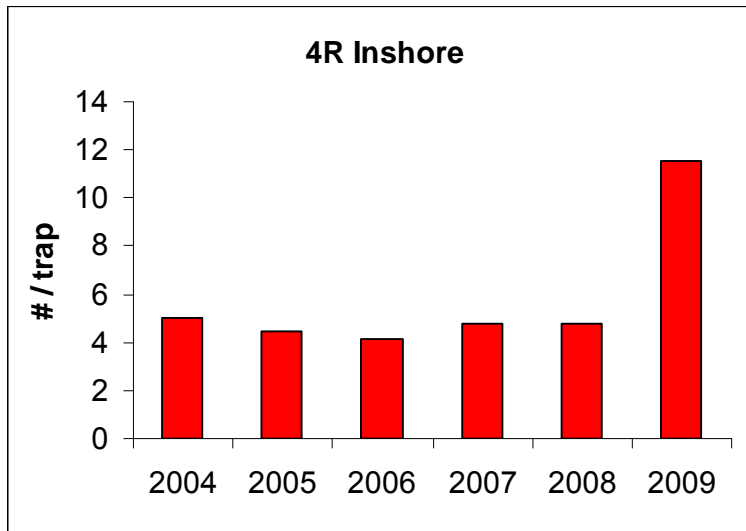


Figure 245. Catch rates of undersized (<95 mm CW) crabs from the CPS trap survey in Division 4R inshore.

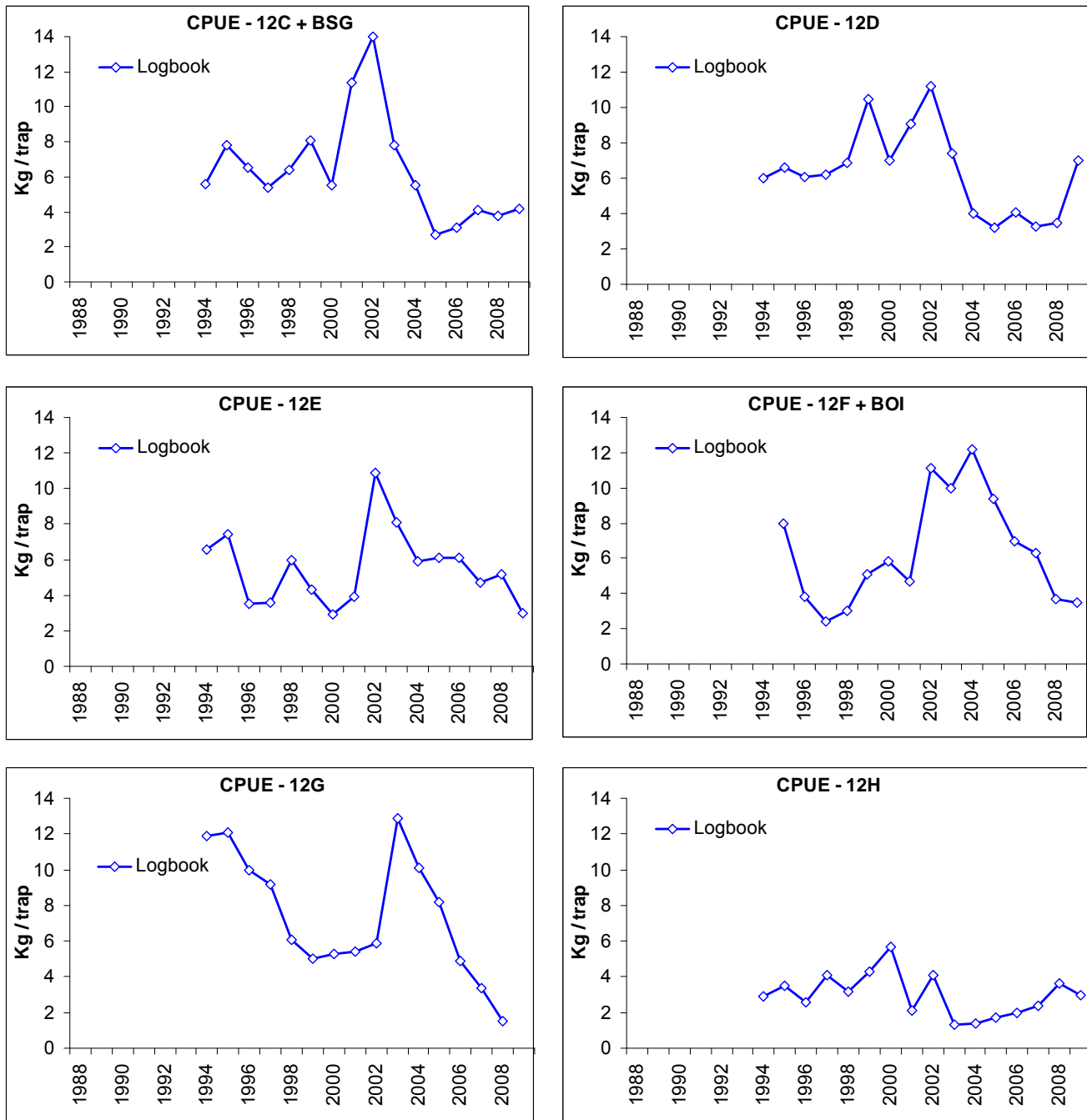


Figure 246. Trends in Division 4R inshore logbook CPUE and observer CPUE by Crab Management Area.

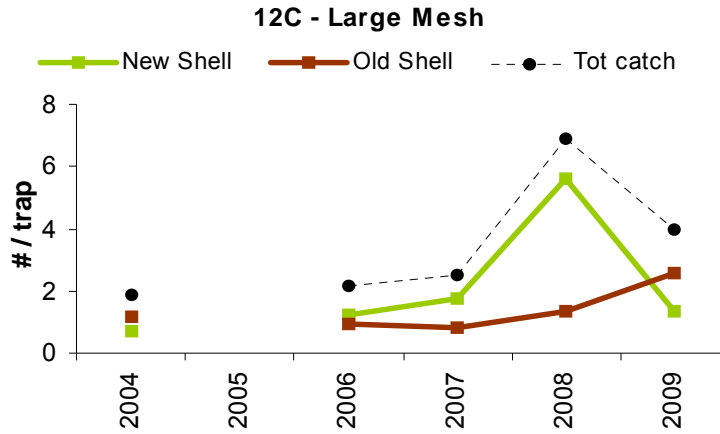


Figure 247. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 12C inshore CPS trap survey.

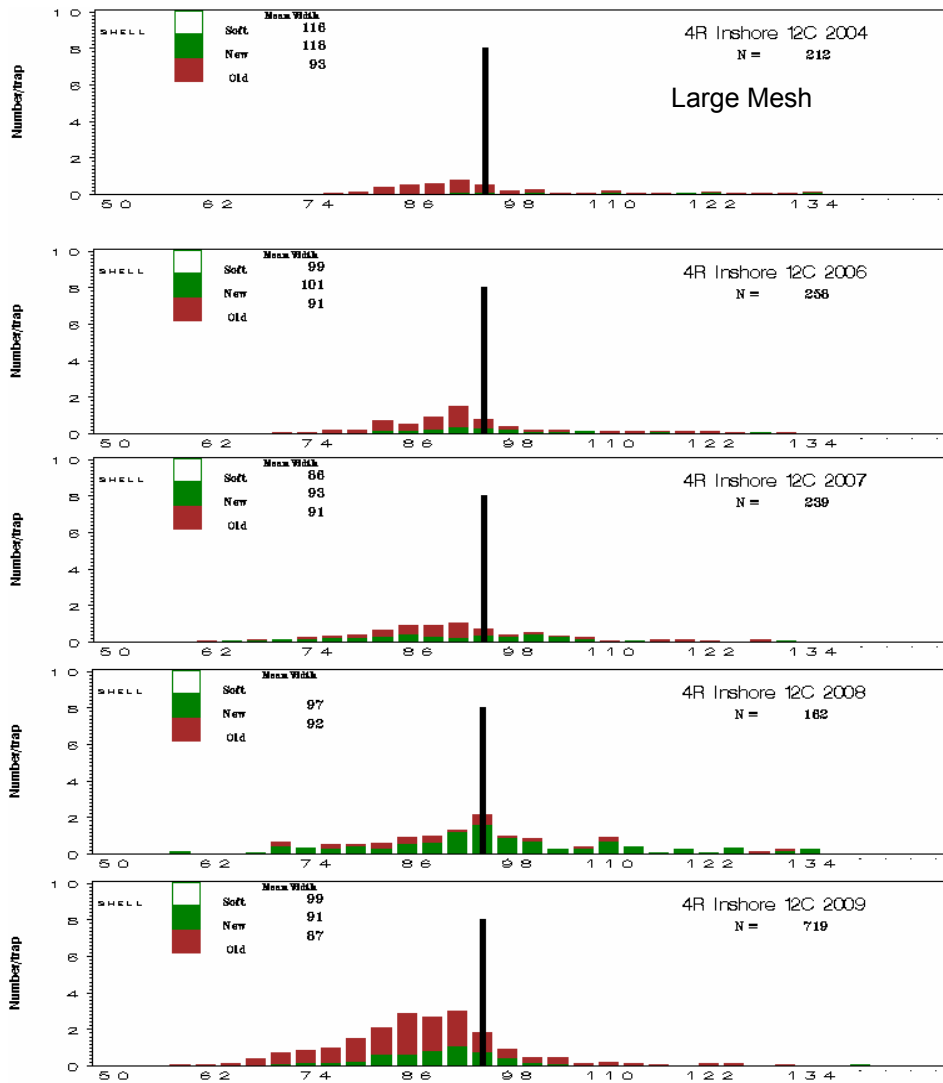


Figure 248. Trends in male carapace width distributions from core stations in the CMA 12C CPS trap survey. The vertical solid line indicates the minimum legal size.

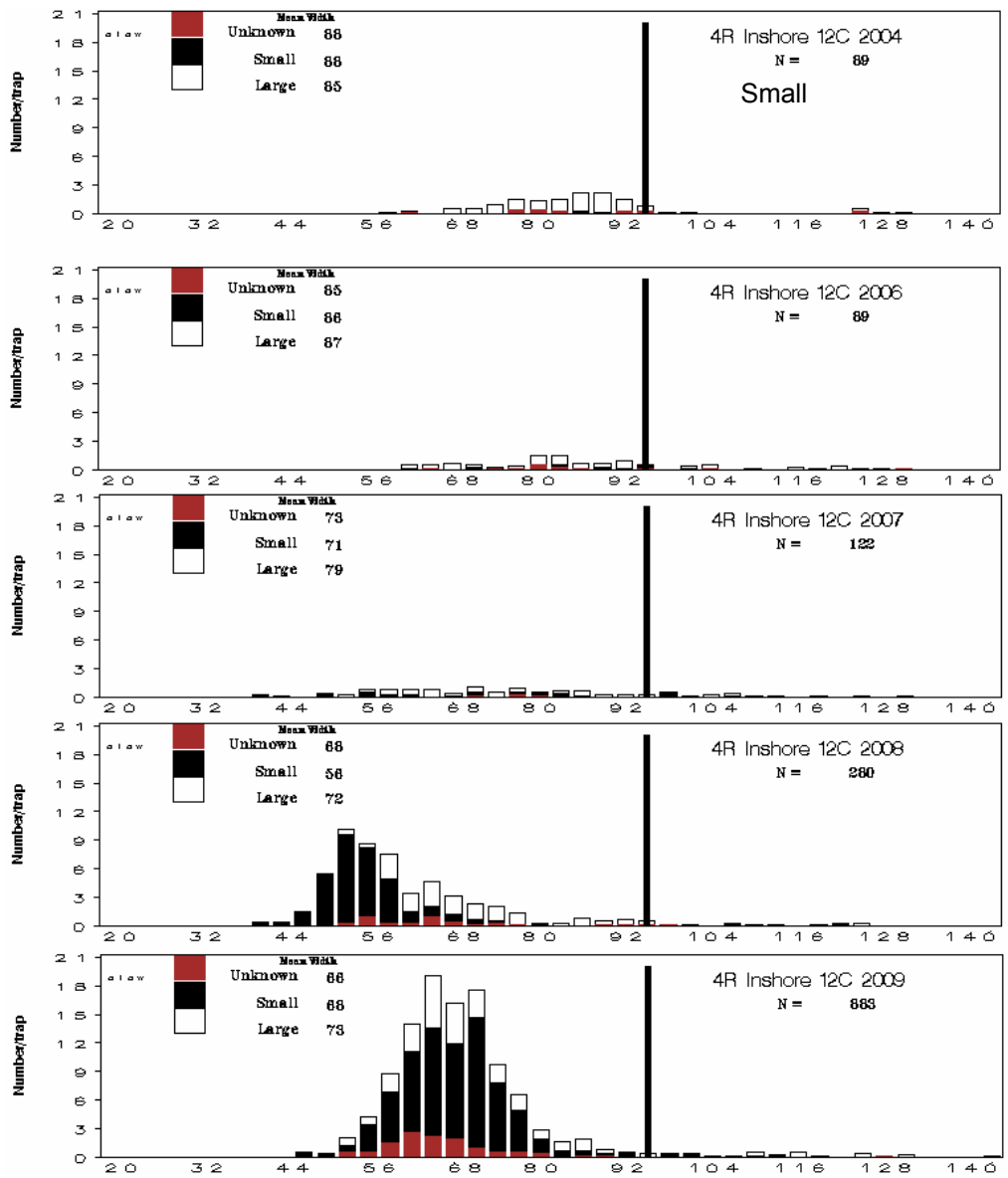


Figure 249. Trends in male carapace width distributions by chela type from small-mesh traps at core stations in the CMA 12C CPS trap survey. The vertical solid line indicates the minimum legal size.

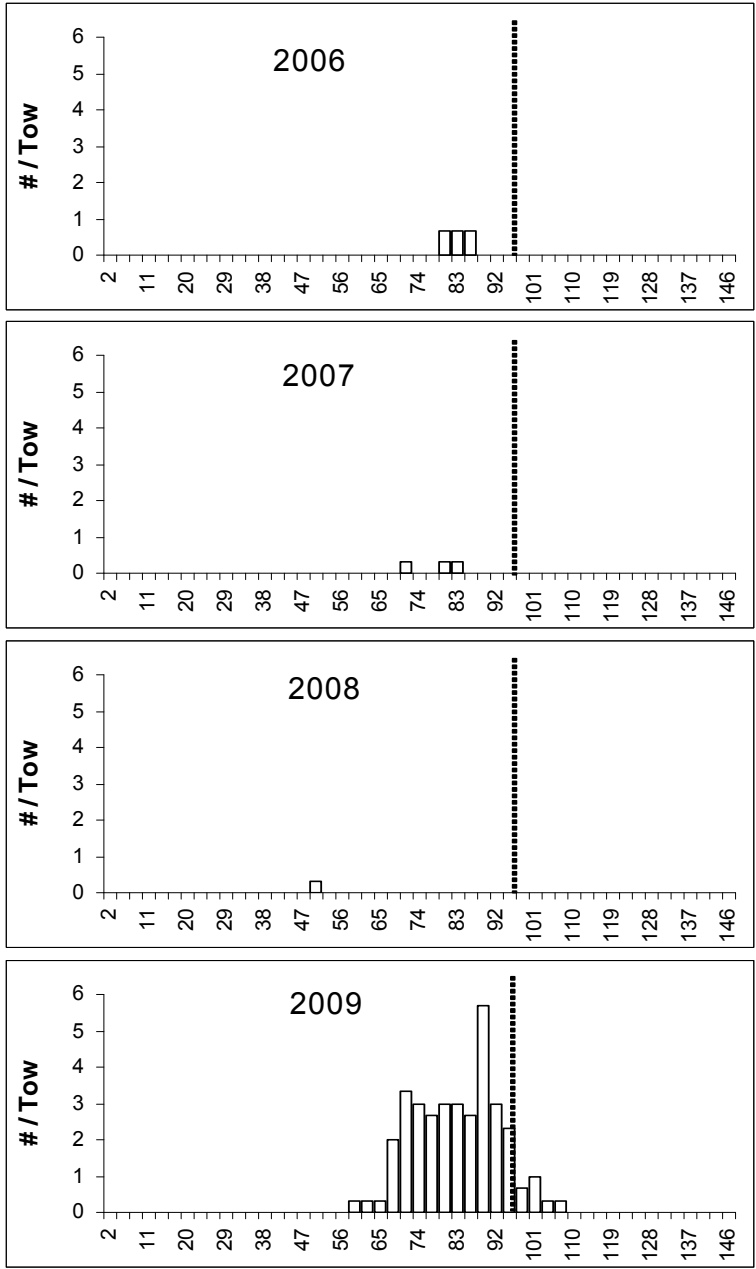


Figure 250. Distribution of abundance (index) by carapace width for CMA 12C males from fall trawl surveys. The minimum legal size is indicated by a vertical dashed line.

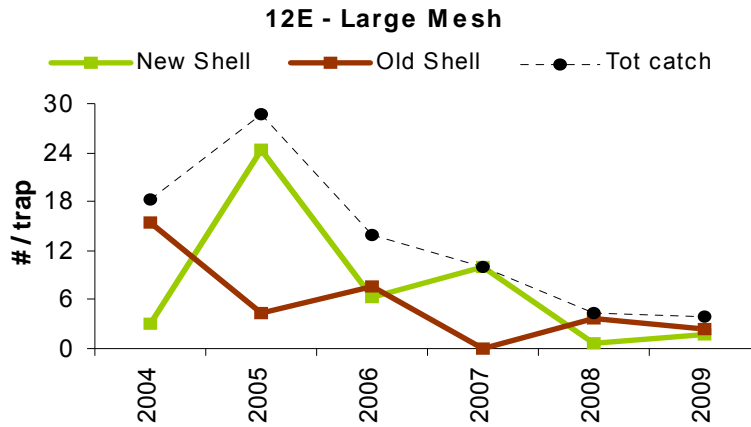


Figure 251. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 12E CPS trap survey.

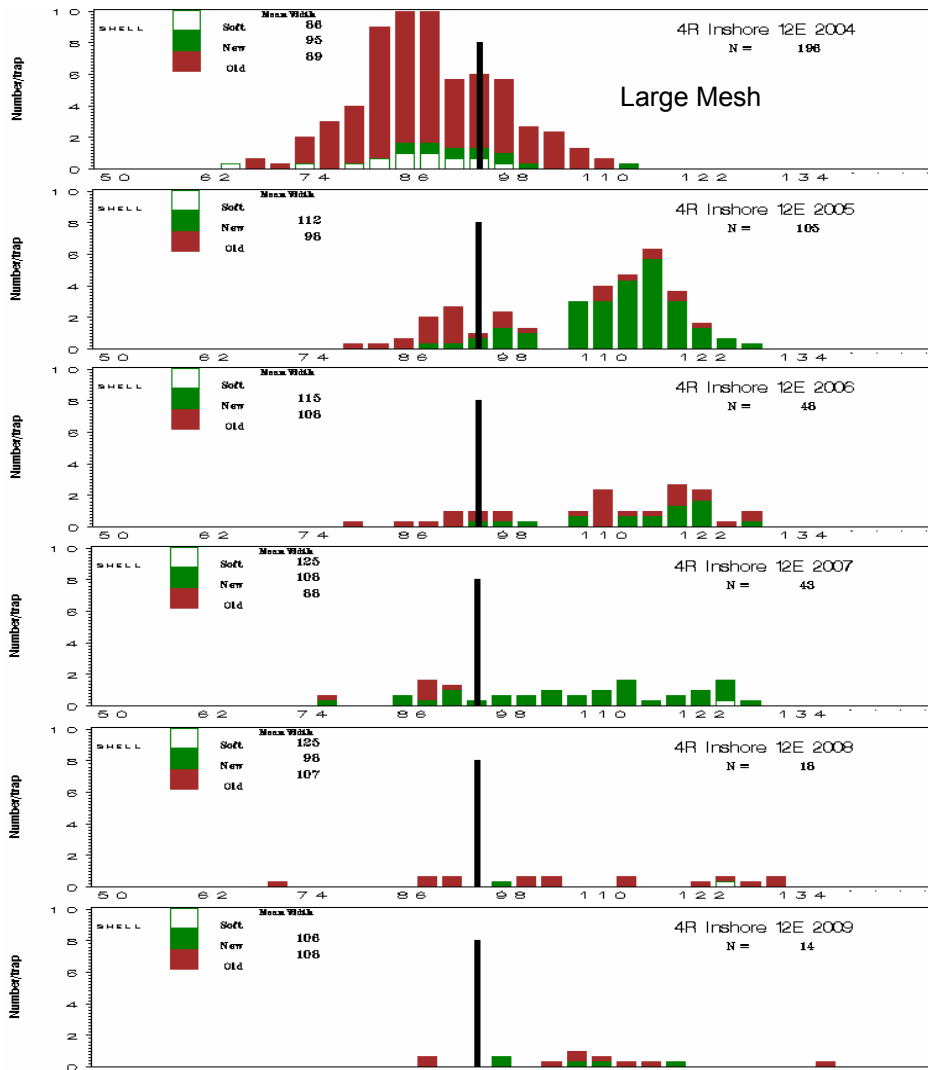


Figure 252. Trends in male carapace width distributions from core stations in the CMA 12E CPS trap survey. The vertical solid line indicates the minimum legal size.

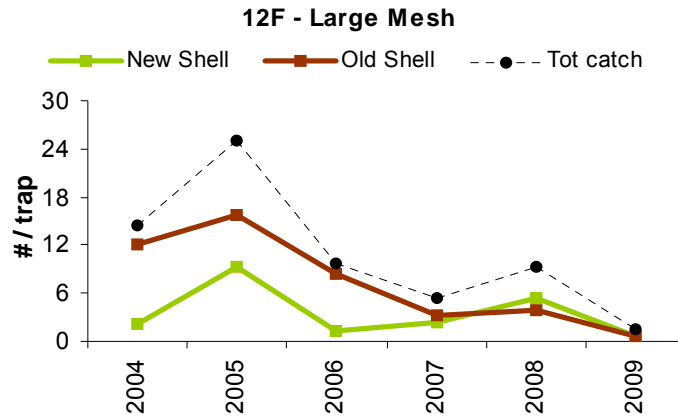


Figure 253. Trends in CPUE by shell condition for legal-sized crabs from core stations in the CMA 12F CPS trap survey.

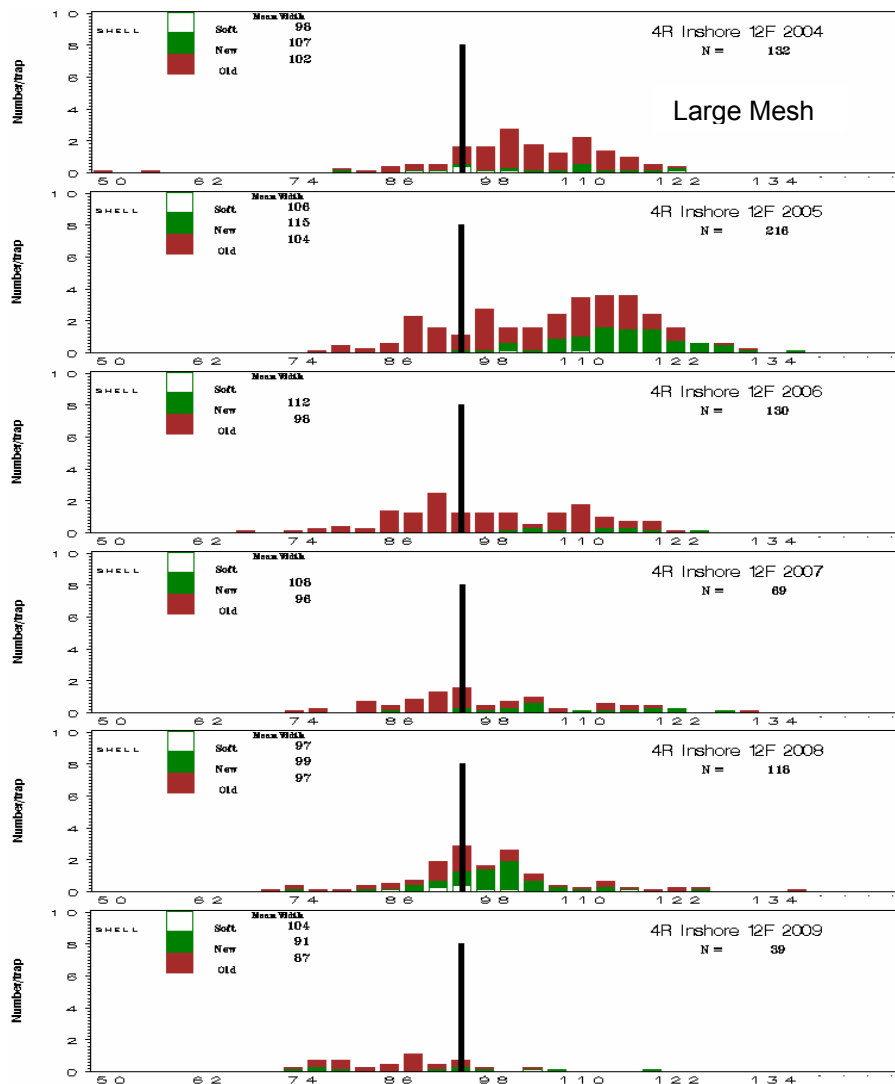


Figure 254. Trends in male carapace width distributions from core stations in the CMA 12F CPS trap survey. The vertical solid line indicates the minimum legal size.



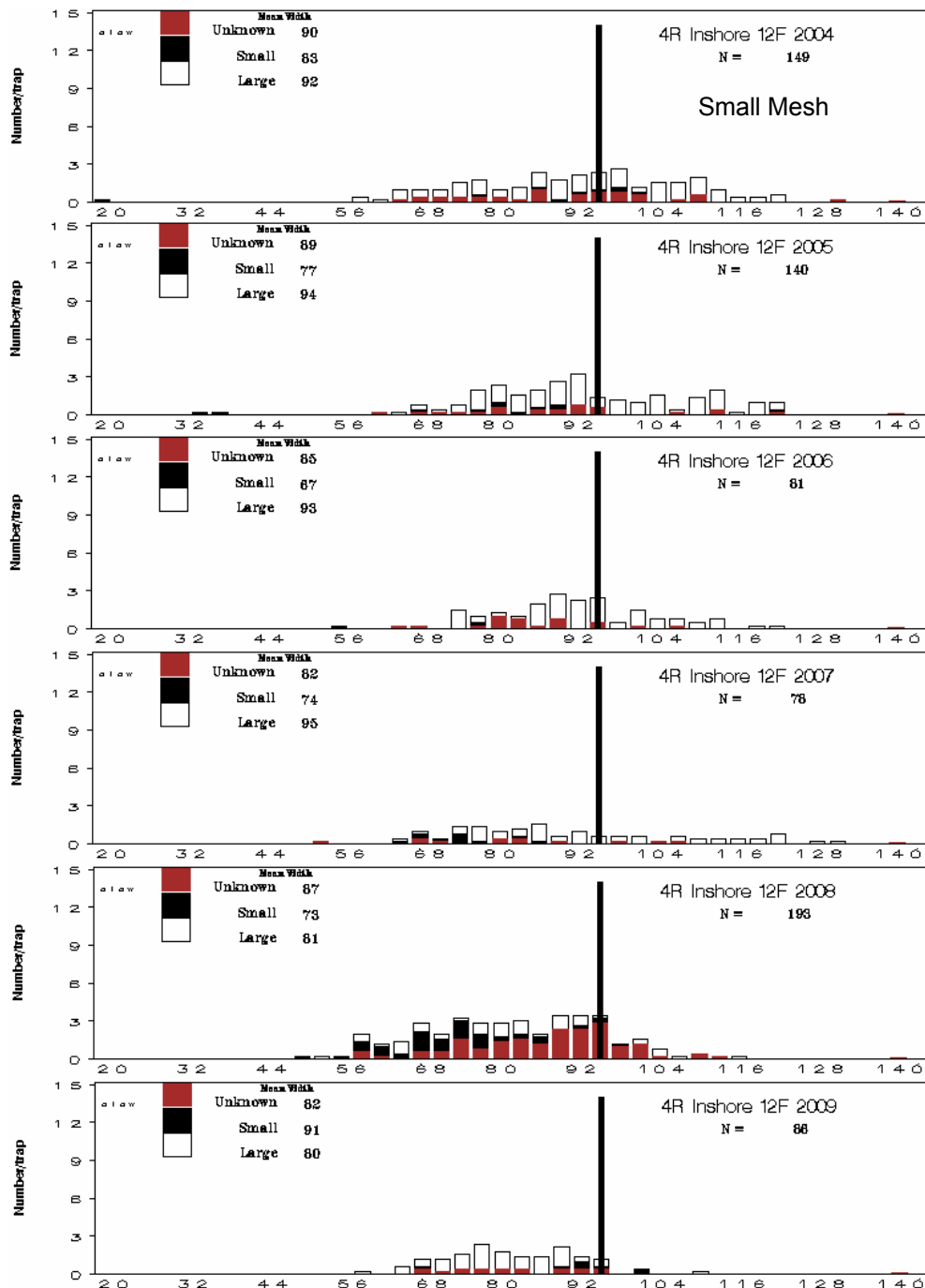


Figure 255. Trends in male carapace width distributions by chela type from small-mesh traps at core stations in the CMA 12F CPS trap survey. The vertical solid line indicates the minimum legal size.