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Science / Sciences
Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
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ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB

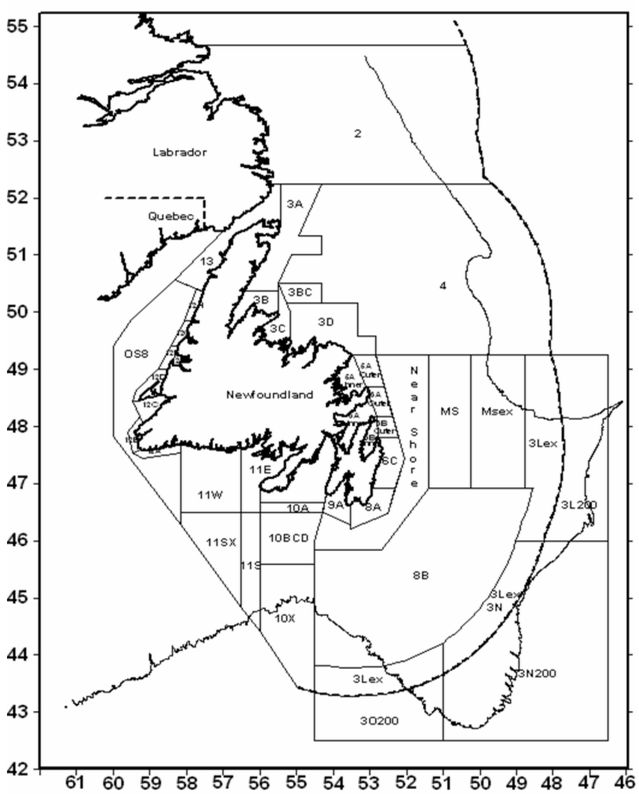

Figure 1: Newfoundland and Labrador Snow Crab Management Areas.

Context

Snow crab (Chionoecetes opilio) occur over a broad depth range in the Northwest Atlantic from Greenland to the Gulf of Maine. Distribution in waters off Newfoundland and southern Labrador is widespread and continuous.

Crab harvesters use fleets of conical baited traps. The minimum legal size is 95 mm carapace width (CW). This regulation excludes females from the fishery while ensuring that a portion of the adult males in the population remain available for reproduction.

Total Allowable Catch (TAC) management was initiated in the late 1980's. This led to the development of multiple TAC-controlled management areas (Fig. 1) with over 3300 licence holders across several vessel fleets under enterprise allocation in 2006. All fleets have designated trap limits, quotas, trip limits, fishing areas within divisions, and differing seasons. Stock status is assessed at the NAFO Division scale. A vessel monitoring system (VMS) was fully implemented in the offshore fleets in 2004.

The resource is managed under a 3-year integrated fisheries management plan, but the status of the resource is assessed annually.

Resource status is evaluated based on trends in fishery catch per unit of effort (CPUE), exploitable biomass indices, recruitment prospects, and mortality indices. Data are derived from multi-species bottom trawl surveys in Div. 2J3KLNOP, inshore trap surveys in Div. 3KL, fishery data from logbooks, observer catch-effort data, post-season trap survey data, as well as biological sampling data from multiple sources.

A meeting of the Regional Advisory Process was held Feb. 27-Mar. 9, 2007 in St. John's, NL to assess the status of the snow crab resource. Participants included DFO scientists, fisheries managers, and representatives from industry, the provincial government and Memorial University.

SUMMARY

- The fall multi-species surveys in Div. 2J3KLNO indicate a decline in **exploitable biomass** since 1998. However both the survey indices and commercial **CPUE** agree that the exploitable biomass has increased in the north (Div. 2J3K) in 2006 but continued to decline in the south.
- **Recruitment** has increased overall in 2006 due to increases in the north, while prospects have improved in the south.
- Longer-term recruitment prospects are uncertain but the persistence of a warm oceanographic regime implies poor prospects relative to the strong recruitment of the late 1990's.

Division 2J

- **Landings** increased by 25% from 2005 to 2000 t following a decline since 2002. **Effort** has declined by 58% from the 2002-2004 level.
- The fall survey **exploitable biomass index** has increased over the past four years but remains below levels observed prior to 2002. Commercial **CPUE** doubled from a record low level in 2004 to about the long-term average in 2006.
- **Recruitment** has increased since 2004 and prospects remain promising for 2007.
- The **exploitation rate index** has declined since 2003 while the **pre-recruit fishing mortality index** decreased to a very low level.
- An increase in exploitation rate in the short term that results in increased pre-recruit mortality could impair further recovery.

Division 3K

- **Landings** increased by 23% to 10,700 t in 2006 following a sharp decrease in 2005. **Effort** declined by half since 2004.
- The fall survey **exploitable biomass index** has increased since 2003 to the long-term average. Both **offshore and inshore** commercial **CPUE** increased in 2006 to their long-term averages.
- **Recruitment** has increased in 2006 and prospects remain promising for 2007.
- The **exploitation rate index** was unchanged from 2005 at about the long-term average whereas the **pre-recruit fishing mortality index** decreased sharply to its lowest level.
- Any increase in exploitation rate in the short term that results in increased pre-recruit mortality could impair recovery of the exploitable biomass.

Division 3L

- **Landings**, totaling 26,500 t in 2006, and **effort** remained at consistently high levels over the past 3 years.
- The fall survey **exploitable biomass index** was at its lowest level in 2006. **Offshore**

commercial **CPUE** has changed little in the past 3 years and remains below the long-term average but high relative to other divisions. **Inshore CPUE** increased in 2006, approaching the long-term average.

- **Recruitment** is expected to remain low in the short-term.
- The **exploitation rate index** has changed little since 2001 while the **pre-recruit fishing mortality index** was about average.
- Maintaining the current level of fishery removals in the short term will likely result in some increase in the fishery-induced **mortality** rate.

Division 3NO

- The fishery has been concentrated along the shelf edge. **Landings**, totaling 4200 t in 2006, and **effort** have declined by about 20% since 2004.
- Survey indices are unreliable. Commercial **CPUE** has changed little over the past 3 years and remains high relative to other areas.
- **Recruitment** has been low in recent years and short term prospects are uncertain.
- The effects of maintaining the current catch level on the fishery-induced **mortality** rate are unknown.

Subdivision 3Ps

- **Landings** changed little at 3100t in 2006, following a 59% decline from 2002-2005. **Effort** decreased by 40% since 2003.
- **Offshore and inshore** commercial **CPUE** increased slightly in 2006 from record low levels in 2005.
- **Recruitment** should increase over the next three years.
- Increased removals, in the short term, would likely impair recovery of the exploitable biomass.

Division 4R

- **Landings** declined by 71% since 2002 to their historic low of 540 t in 2006. **Effort** decreased to its lowest level since 1995.
- There are **insufficient data** to assess resource status.

BACKGROUND

Species Biology

The snow crab life cycle features a planktonic larval period, following spring hatching, involving several stages before settlement. Benthic juveniles of both sexes molt frequently, but at about 40 mm CW (~ 4 years of age) they may become sexually mature.

Crabs grow by molting, in spring. Females cease molting after sexual maturity is achieved at about 40-75 mm CW and so do not contribute to the exploitable biomass. However sexually mature (adolescent) males may continue to molt annually until their terminal molt, when they develop enlarged claws (adults), which enhances their mating ability. Males may molt to adulthood within a size range of about 40-115 mm CW, and so only a portion of any cohort will recruit to the fishery at 95 mm CW (~ 8 years of age).

Adult legal-sized males remain new-shelled with low meat yield throughout the remainder of the year of their terminal molt. They are considered to be pre-recruits until the following year when they begin to contribute to the exploitable biomass as older-shelled adults. Males may live about 5-6 years as adults after the terminal molt.

Large males are most common on mud or mud/sand, while smaller crabs are common on harder substrates. Snow crab diet includes fish, clams, polychaete worms, brittle stars, shrimp, snow crab, and other crustaceans. Predators include various groundfish, other snow crabs, and seals.

Effects of temperature differ throughout the life cycle. Cold conditions in early life favour survival while in later life they promote early terminal molt, thereby reducing the proportion that will recruit to the fishery. Negative relationships between bottom temperature and snow crab CPUE have been demonstrated at lags of 6-10 years suggesting that the positive effects on recruitment of cold conditions early in the life history are stronger than the negative effects in later life. A warm oceanographic regime has persisted over the past decade implying poor long-term recruitment prospects relative to the strong recruitment of the late 1990's.

The Fishery

The fishery began in Trinity Bay (Management area 6A, Fig. 1) in 1968. Initially, crab were taken as gillnet by-catch but within several years a directed trap fishery developed in inshore areas along the northeast coast of Div. 3KL. The minimum legal mesh size of traps is 135 mm, to allow small crabs to escape. Under-sized and new-shelled males that are retained in the traps are returned to the sea and an unknown proportion dies.

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

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

In the late 1980's quota control was initiated in all management areas of each division. All fleets have designated trap limits, quotas, trip limits, fishing areas within divisions, and differing seasons. Fishing seasons have become progressively earlier and have recently been prosecuted predominately in spring, resulting in reduced incidence of soft-shelled crabs. A protocol was initiated in 2004 that results in closure of localized areas when the percent soft-shelled crabs within the legal-sized catch exceeds 20%.

Mandatory use of the electronic vessel monitoring system (VMS) was fully implemented in all offshore fleets in 2004, to ensure compliance with regulations regarding area fished.

Landings for Div. 2J3KLNOP4R (Fig. 2) increased steadily from 1989 to peak at 69,000 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 43,900 t in 2005, primarily due to a sharp decrease in Div. 3K where the TAC was not taken. Landings increased to 47,100 t in 2006, achieving the reduced TAC, due primarily to increases in Div. 3KL. Historically, most of the landings have been from Div. 3KL.

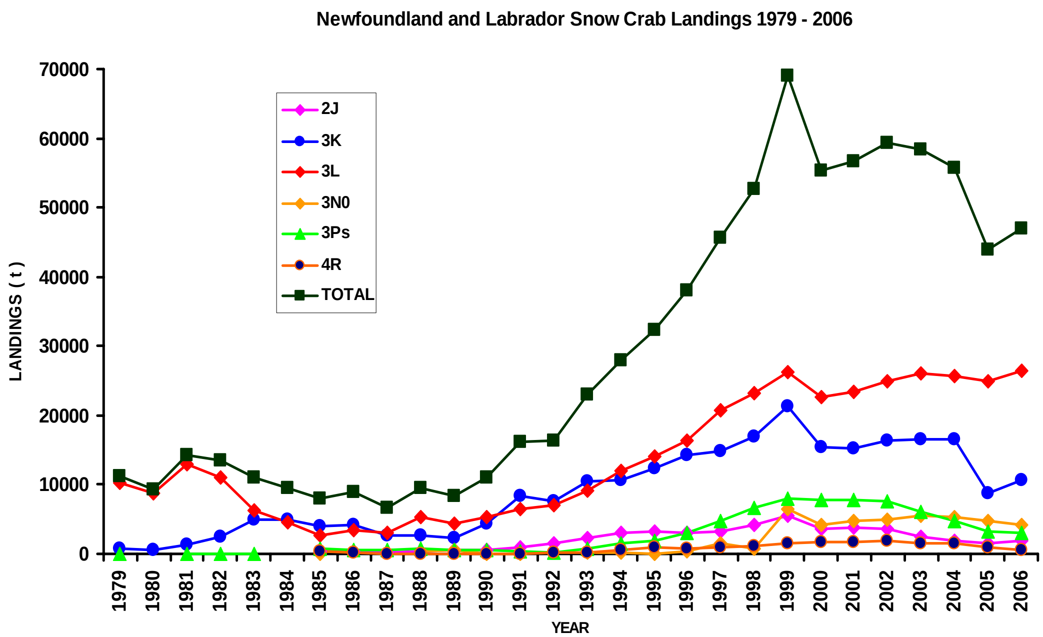

Figure 2: Trends in landings by NAFO Division and in total.

Effort has increased since the 1980's and has been broadly distributed in recent years (Fig. 3).

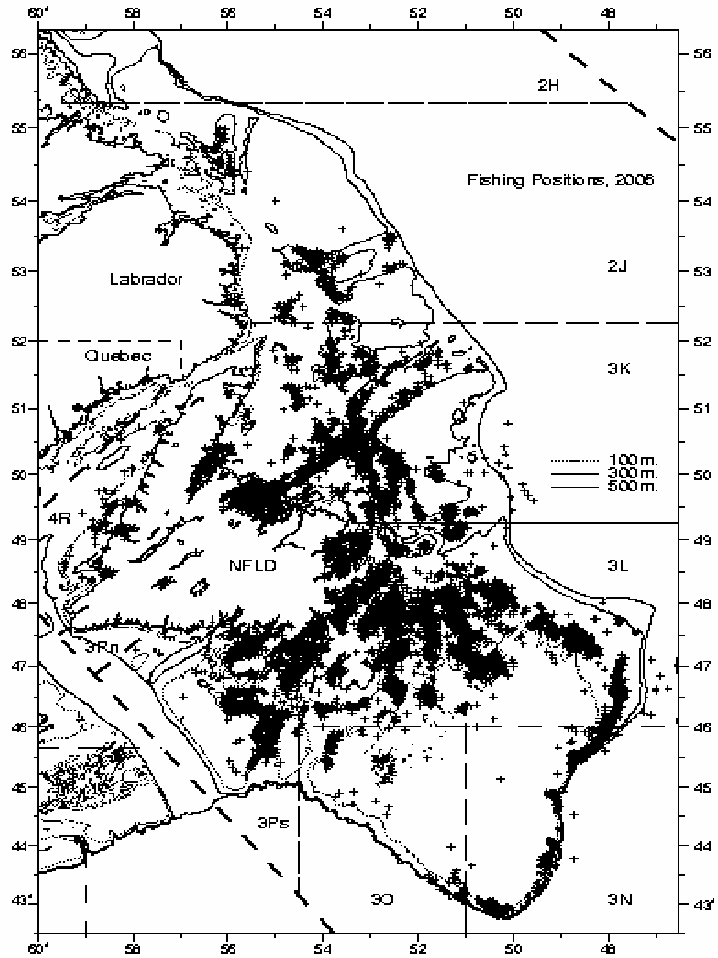

Figure 3: Spatial distribution of commercial fishing effort during 2006.

ASSESSMENT

Resource status was evaluated based on trends in fishery **CPUE**, **exploitable biomass indices**, **recruitment** prospects and **mortality indices**. Information was derived from multi-species bottom trawl surveys in Div. 2J3KLNOP, inshore trap surveys in Div. 3KL, fishery data from logbooks, observer catch-effort data, and data from industry-DFO collaborative post-season trap surveys, as well as biological sampling data from multiple sources.

Fall multi-species bottom trawl surveys (post-fishery surveys with respect to snow crab) provide an index of the exploitable biomass (older-shelled adults of legal size) that is expected to be available for the fishery in the following year for Div. 2J3KLNO. This index, based on offshore survey strata, is used together with offshore commercial CPUE to evaluate trends in the exploitable biomass.

Inshore commercial CPUE is compared with catch rates from inshore trap surveys, where available. These indices are also compared with inshore and offshore biomass indices (catch rate of legal-sized crabs) from a very limited (4-year) time series of industry-DFO post-season trap surveys.

Fall bottom trawl surveys also provide data on adolescents larger than 75 mm that are used to calculate an index of pre-recruit males that would begin to recruit to the fishery 2 years later, as older-shelled adults. This index is compared to observer-based catch rates (kg/trap haul) of total crabs discarded. Both the survey and the observer pre-recruit indices reflect catch rates of undersized and new-shelled legal-sized pre-recruits. These indices are also compared with inshore and offshore pre-recruit indices from industry-DFO post-season trap surveys.

There is little evidence of progression of smallest males (< 41 mm CW) to larger sizes from fall multispecies survey size frequency data. Therefore, longer-term recruitment prospects are uncertain.

Fishery-induced mortality is a function of the proportion of the exploitable population that is harvested and the proportion of the pre-recruit population that dies as a result of being caught and released. Trends in exploitation rate are inferred from changes in the ratio of landings to the exploitable biomass index from the previous year's fall multi-species survey. Trends in pre-recruit mortality are inferred from changes in the ratio of the estimated total catch of pre-recruits (from observer data) to the survey pre-recruit biomass index of the previous year.

The pre-recruit fishing mortality index reflects an unknown (but likely high) mortality on released pre-recruits. Pre-recruit mortality is reduced by increasing trap mesh size and soak time, as well as by careful handling and quick release of pre-recruits.

The percentage discarded by weight of the total catch, as estimated from observer data, is interpreted as an index of wastage of pre-recruits. Mortalities on pre-recruits, including wastage, will impact short-term (about 1-3 years) recruitment. Also, mortality on small (<95 mm CW) males may adversely affect insemination of females, especially when abundance of larger males is low.

Overall Resource Status, Divisions 2J3KLNO

The fall multi-species surveys in Div. 2J3KLNO indicate a decline in **exploitable biomass** since 1998 (Fig. 4). However both the survey indices and commercial **CPUE** agree that the exploitable biomass has increased in the north (Div. 2J3K) in 2006 but continued to decline in the south (described later).

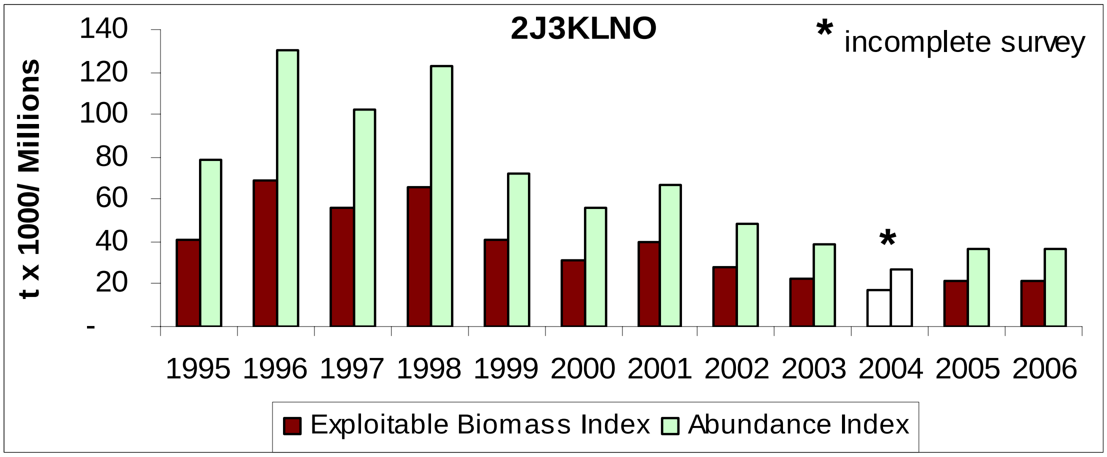

Figure 4: Trends in the fall multi-species survey exploitable biomass and abundance indices, for Div. 2J3KLNO.

Recruitment has increased overall in 2006 (Fig. 5), due to increases in the north while prospects have improved in the south.

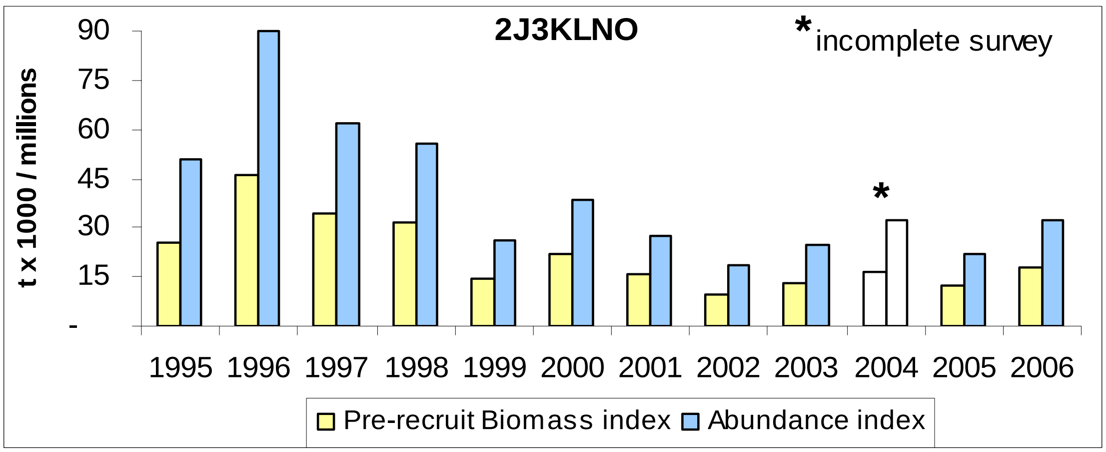

Figure 5: Trends in the fall multi-species survey pre-recruit biomass and abundance indices for Div. 2J3KLNO.

Longer-term recruitment prospects are uncertain but the persistence of a warm oceanographic regime implies poor prospects relative to the strong recruitment of the late 1990's.

Fishery-induced **mortality** has decreased in the north (Div. 2J3K).

Resource Status, Division 2J

Commercial Fishery

Landings (Fig. 6) peaked in 1999 at 5400 t. They then declined by 70% to 1600 t in 2005 due to reductions in TAC and increased by 25% in 2006 to 2000 t. **Effort** increased to a record high level in 2002-2004 before declining by 58% to 2006.

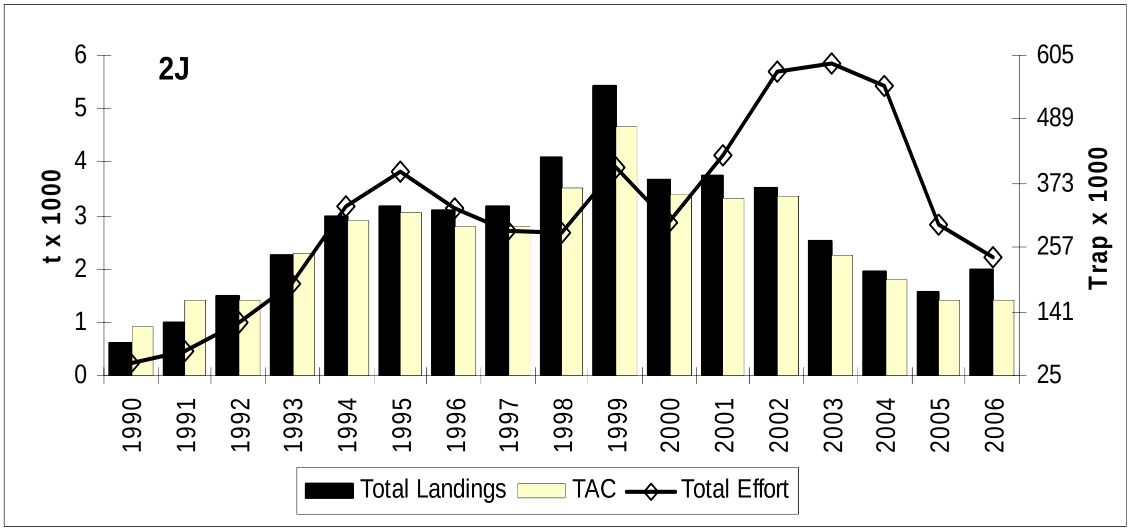

Figure 6: Trends in TAC, landings, and fishing effort in Div. 2J.

The fishing season has occurred progressively earlier in recent years, especially in 2005 and 2006.

<u>Biomass</u>

Commercial catch rates (**CPUE**) have oscillated over the time series (Fig. 7), initially decreasing during 1985-1987, increasing to a peak in 1991, decreasing again to 1995, and increasing to peak again in 1998. They declined steadily by 76% during 1998-2004 to a record low level before doubling to about the long-term average in 2006.

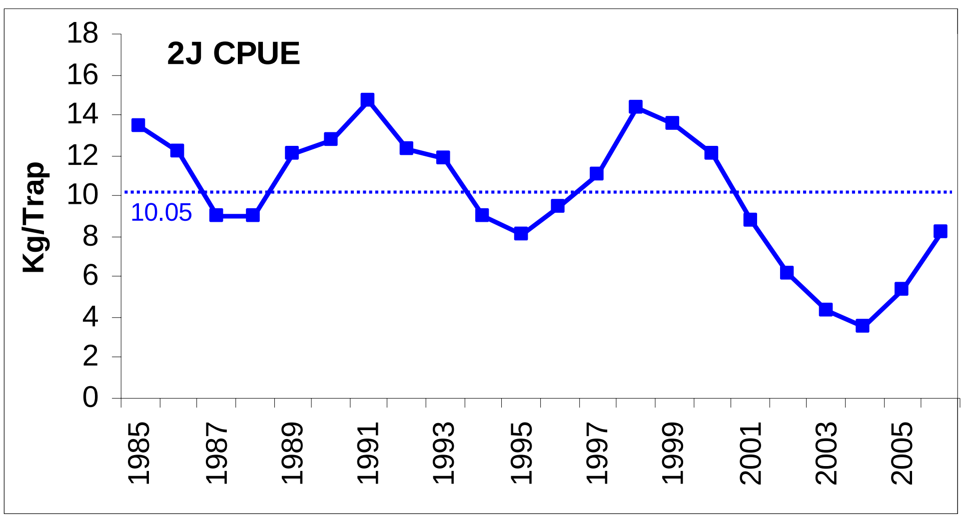

Figure 7: Trends in Div. 2J commercial CPUE in relation to the long-term average (dotted line).

The fall survey **exploitable biomass index** (Fig. 8) decreased steadily, by 94%, from 1998-2002. It has increased over the past four years but remains below levels observed prior to 2002.

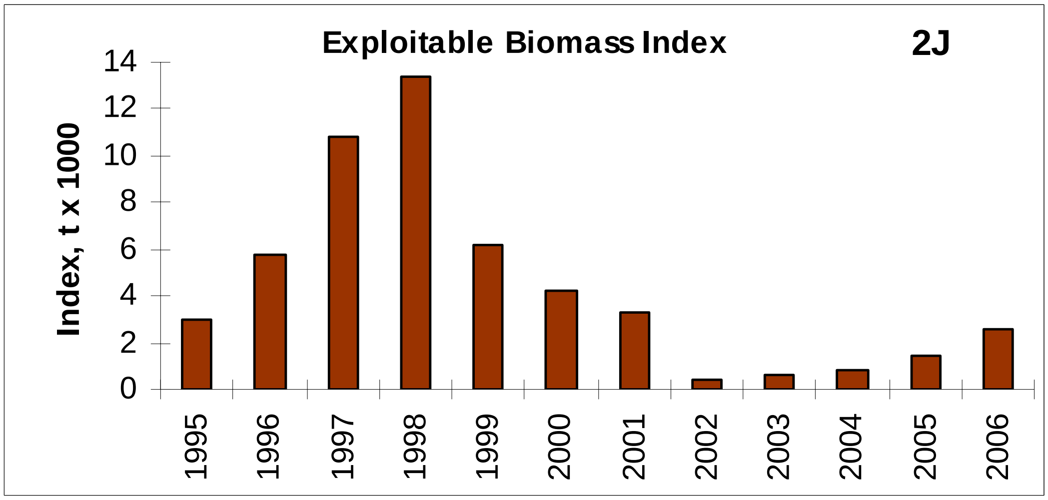

Figure 8: Trends in the Div. 2J fall multi-species survey exploitable biomass index.

<u>Recruitment Prospects</u>

The fall survey **pre-recruit index** and observer discard **pre-recruit index** both decreased from 1998 to a lower level during 1999-2001 (Fig. 9). Both indices increased to peak in 2004 and decreased in 2005. The observer index decreased further while the survey index almost doubled in 2006. The decline in the observer discard index in the past 2 years is related to a very early fishing seasons in those years that resulted in reduced catches of new-shelled immediate pre-recruits.

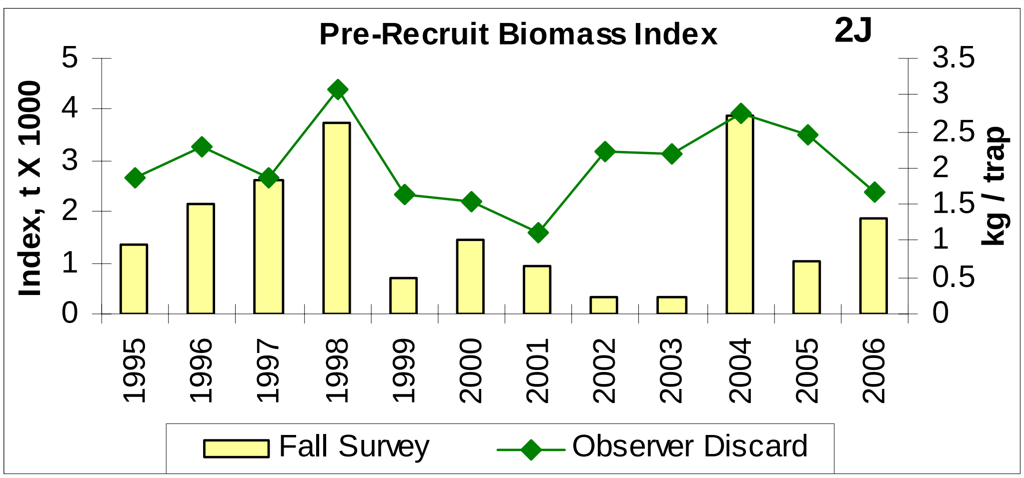

Figure 9: Trends in two Div. 2J pre-recruit indices.

Data from at-sea sampling during the fishery indicated an increase in catch rate of small new-shelled crabs in 2004, which was followed by increased recruitment, as reflected by increasing CPUE during 2005-2006. This catch rate of small new-shelled crabs decreased in 2005 but increased slightly again in 2006 suggesting another increase in recruitment in the short term. While this is uncertain, it is consistent with an increase in the proportion of the legal-sized males that were new-shelled in the 2006 post-season multi-species survey.

Recruitment has increased since 2004 and prospects remain promising for 2007.

Mortality

The **exploitation rate index** (Fig. 10) was low during 1996-2002, increased sharply in 2003, and has since declined to 2006.

The **pre-recruit fishing mortality index** (Fig. 10) increased sharply from 2001 to 2004, decreased to the 1996-2001 level in 2005, and remained at a very low level in 2006.

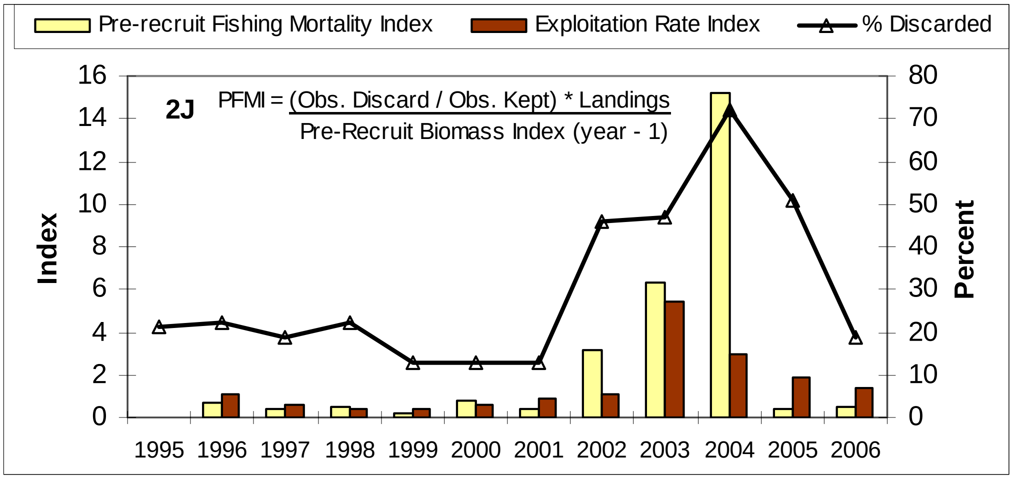

Figure 10: Trends in two Div. 2J mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery.

The percentage of the total catch discarded (Fig. 10) increased sharply in 2002, was unchanged in 2003, and further increased to a record high level in 2004. It declined sharply over the past two years to the pre-2002 level, implying reduced wastage of under-sized and new-shelled pre-recruits in the fishery. The sharp decline over the past two years is related to very early fishing seasons in those years that resulted in reduced catches of new-shelled immediate pre-recruits.

Fishery and multi-species survey data suggest that the **exploitable biomass** has become increasingly dependent upon immediate recruitment. An increase in exploitation rate in the short term that results in increased pre-recruit mortality could impair further recovery.

An area of the Hawke Channel has been closed to all fisheries except snow crab during 2003-2006. The CPUE increased similarly inside and outside the closed area since 2004.

Resource Status, Division 3K

Commercial Fishery

Landings (Fig. 11) peaked in 1999 at 21,400 t. They decreased to 15,400-16,500 t in 2000-2004, due to reduction in TAC. Landings decreased by half to 8,700 t in 2005, not meeting the 12,900 t TAC. They increased by 23% to 10,700 t in 2006, achieving a reduced TAC. **Effort** increased by 33% in 2004 and then declined by half to 2006.

The TAC was not fully subscribed in 2005 because the fishery was closed prematurely due to high levels of soft-shelled crabs in the catch. The fishing season occurred especially early in 2006 and most effort was concentrated in the southern portion of the Division.

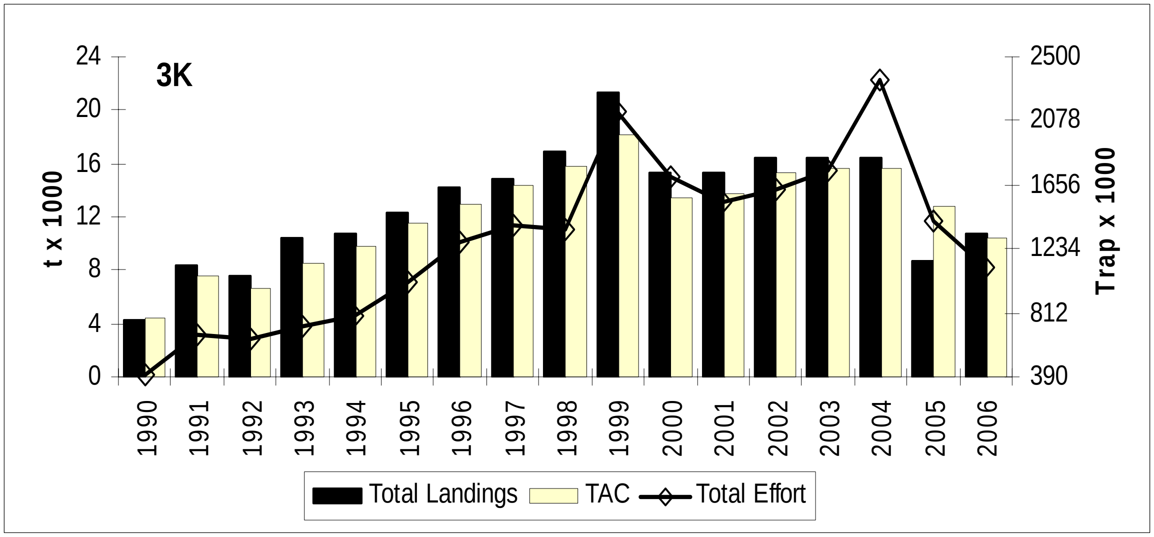

Figure 11: Trends in TAC, landings, and fishing effort in Div. 3K.

Biomass

Offshore CPUE declined since 1998 to its lowest level in 2005 before increasing sharply in 2006 to the long-term average. (Fig. 12).

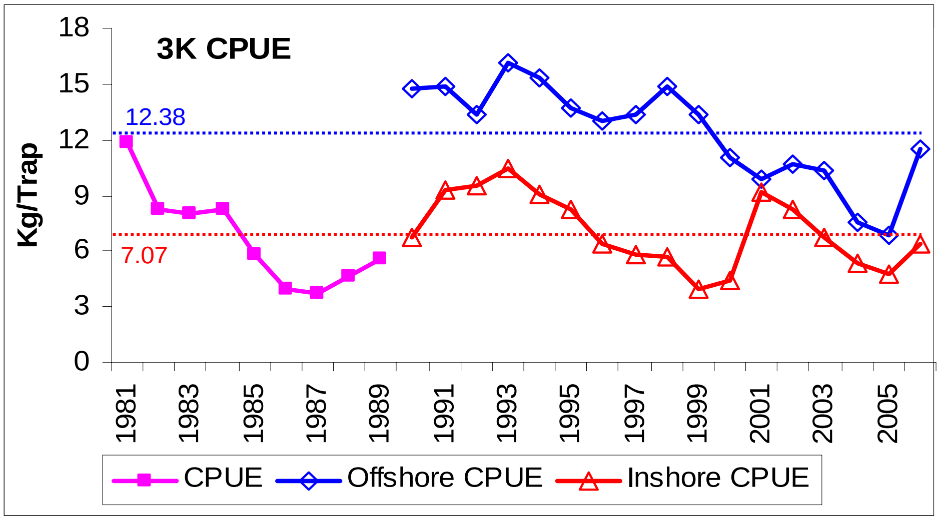

Figure 12: Trends in Div. 3K inshore and offshore commercial CPUE in relation to their long-term averages (dotted lines).

The fall survey **exploitable biomass index** (Fig. 13) decreased from its highest level by almost half in 1999. It changed little until it decreased again from 2001 to its lowest level in 2003 and has since increased to the long-term average. The industry-DFO **offshore** post-season trap survey showed that the catch rate of legal-sized crabs increased in 2006.

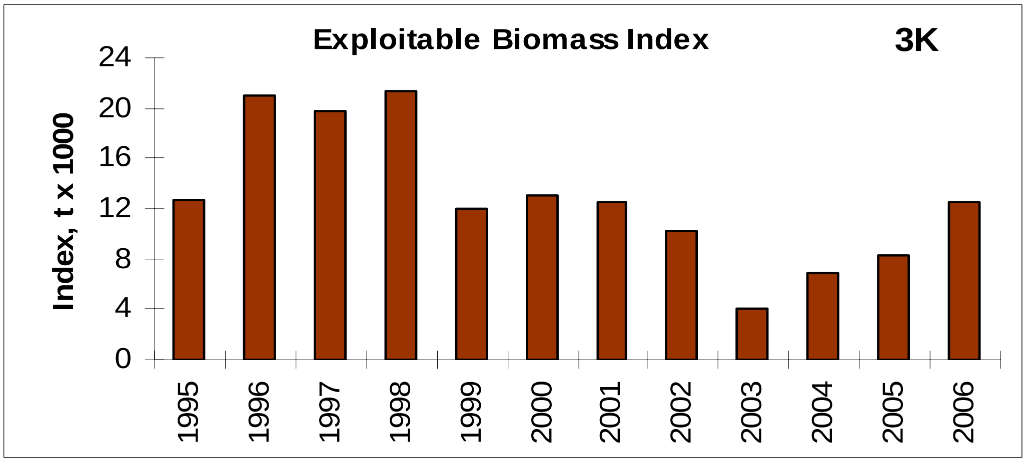

Figure 13: Trends in the Div. 3K fall multi-species survey exploitable biomass index.

Inshore commercial **CPUE** declined during 2002-2005 and increased in 2006 to the long-term average (Fig. 12). The industry-DFO **inshore** post-season trap survey showed that the catch rate of legal-sized crabs increased during 2004-2006. Inshore commercial CPUE has been consistently lower than offshore CPUE.

Recruitment Prospects

Both the fall survey **pre-recruit index** and the observer discard **pre-recruit index** (Fig. 14) declined from 1997 to a lower level during 1999-2002. The survey index doubled since 2002, whereas the observer index doubled to 2005 before decreasing by more than half in 2006. The sharp decrease in the observer discard index in 2006 is related to a very early fishing season that resulted in reduced catches of new-shelled pre-recruits.

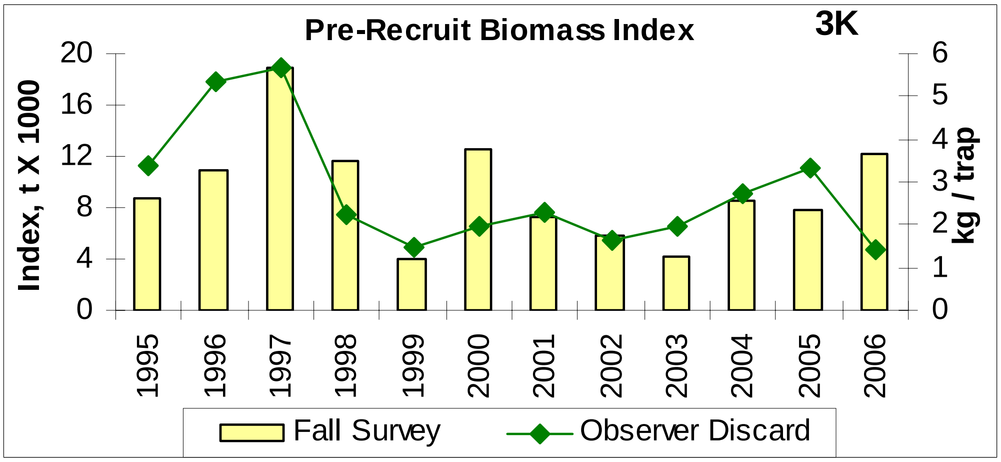

Figure 14: Trends in two Div. 3K pre-recruit indices.

Both **offshore** post-season surveys (industry-DFO trap and multispecies trawl) indicate an increase in catch rate of new-shelled legal-sized crabs in 2006 that should result in increased recruitment in the short term. These pre-recruits include a substantial portion of large adolescents that will begin to recruit in 2008. Both surveys indicated that the post-season catch rate of older-shelled legal-sized crabs changed little in 2006, and was lower than that of the new-shelled pre-recruits.

The industry-DFO **inshore** post-season trap survey showed that the catch rate of legal-sized older-shelled crabs increased during 2004-2006 but the catch rate of new-shelled legal-sized crabs remained higher. Similar trends were evident from a more localized DFO **inshore** post-season trap survey.

Recruitment has increased in 2006 and prospects remain promising for 2007.

<u>Mortality</u>

The **exploitation rate index** (Fig. 15) has changed little throughout the time series and was unchanged in 2006 from the previous year at about the long-term average.

The **pre-recruit fishing mortality index** (Fig. 15) decreased sharply to its lowest level in 2006.

The percentage of the total catch discarded in the fishery (Fig. 15) increased from 2002 to about 40% in 2005, reflecting increased wastage of under-sized and new-shelled pre-recruits. The high wastage in 2005 is consistent with a high incidence of soft-shelled pre-recruits in the catch, which resulted in a premature closure of the fishery and failure to achieve the TAC. The percentage discarded decreased sharply in 2006 to its lowest level due to a very early fishing season that resulted in reduced catches of new-shelled pre-recruits. This implies greatly reduced wastage of pre-recruits in the 2006 fishery.

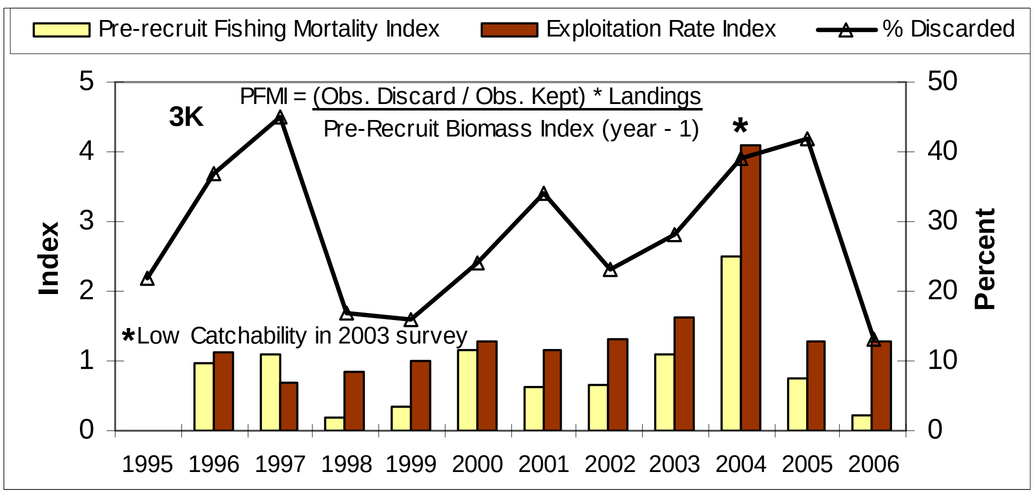

Figure 15: Trends in two Div. 3K mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery.

Post-season trap surveys (industry-DFO and DFO) show that the residual component of the inshore exploitable biomass has increased during 2004-2006 and the **inshore exploitable biomass** has become less dependent upon immediate recruitment.

Both **offshore** post-season surveys (industry-DFO trap and multispecies trawl) indicate that the **offshore exploitable biomass** has become increasingly dependent upon immediate recruitment. Any increase in exploitation rate in the short term that results in increased pre-recruit mortality could impair recovery of the exploitable biomass.

An area of southern Div. 3K was closed to gillnet fisheries in 2002 and has been closed to all fisheries except snow crab during 2005-2006. It would be premature to draw any conclusions regarding the impact of this closure on the snow crab resource but it is noted that the CPUE increased both inside and outside the closed area in 2006.

Resource Status, Division 3L

Commercial Fishery

Landings (Fig. 16) peaked at 26,200 t in 1999 and decreased to 22,600 t in 2000 due to a reduction in TAC. They then increased to 26,000 t in 2003 due to TAC increases and changed little since, totaling 26,500 t in 2006. **Effort** increased by 73% during 2000-2004 and remained at that high level over the past 3 years.

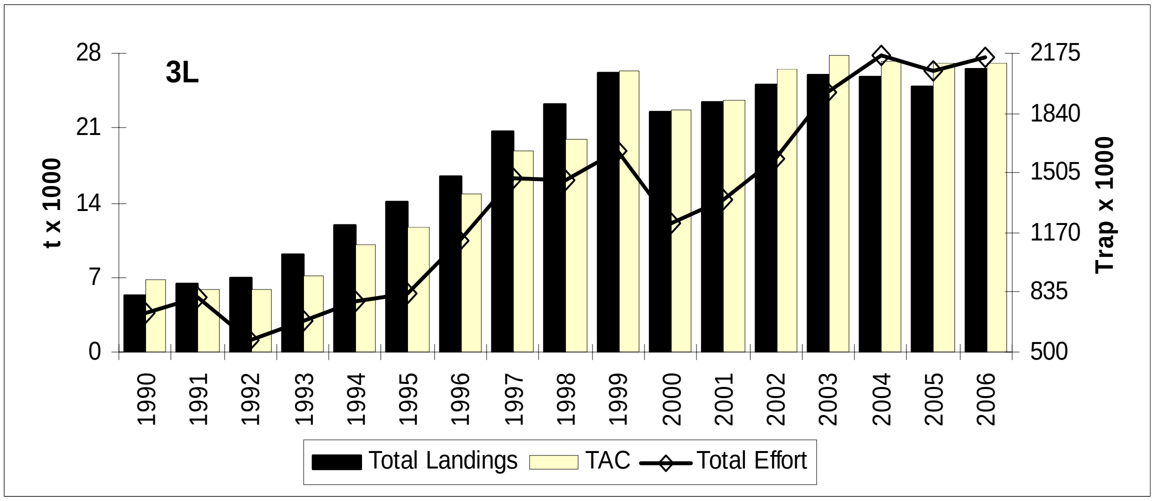

Figure 16: Trends in TAC, landings, and fishing effort in Div. 3L.

Biomass

Offshore CPUE (Fig. 17) decreased by 22% between 2002 and 2004 and has changed little in the past 3 years to remain below the long-term average but high relative to other divisions.

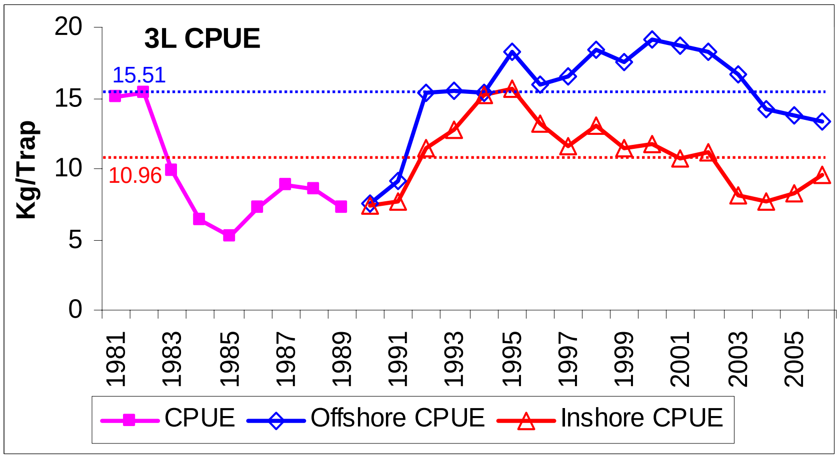

Figure 17: Trends in Div. 3L inshore and offshore commercial CPUE in relation to their long-term averages (dotted lines).

The fall survey **exploitable biomass index** (Fig. 18) declined from 1996-2000 and remained at that lower level until it further decreased to its lowest level in 2006. The industry-DFO **offshore** post-season trap survey catch rates of legal-sized crabs declined during 2004-2006.

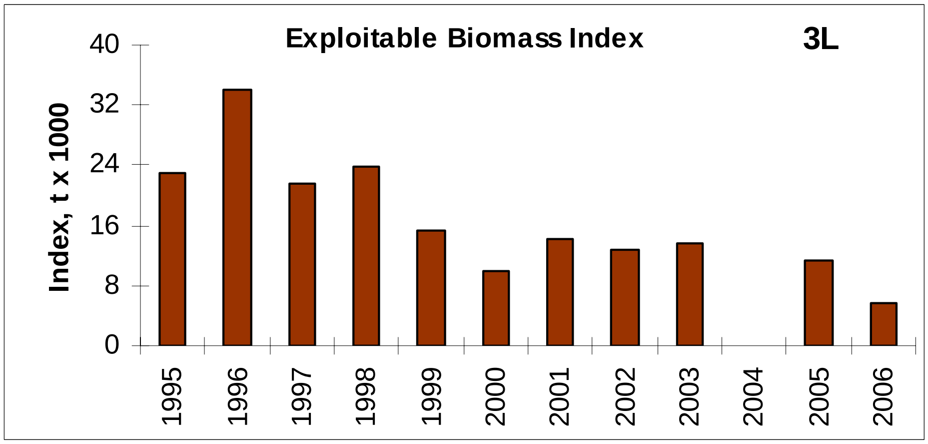

Figure 18: Trends in the Div. 3L fall multi-species survey exploitable biomass index; the survey was incomplete in 2004.

Inshore CPUE decreased by 21% in 2003, changed little to 2005, and increased in 2006, approaching the long-term average (Fig. 17). Industry-DFO **inshore** post-season trap survey catch rates of legal-sized crabs increased during 2004-2006. Commercial **CPUE** (Fig. 17) has been consistently higher in the offshore than in the inshore.

<u>Recruitment Prospects</u>

The fall survey **pre-recruit index** has been low since 1999. The observer discard **pre-recruit index** declined from 1997-2004 and has changed little since (Fig. 19).

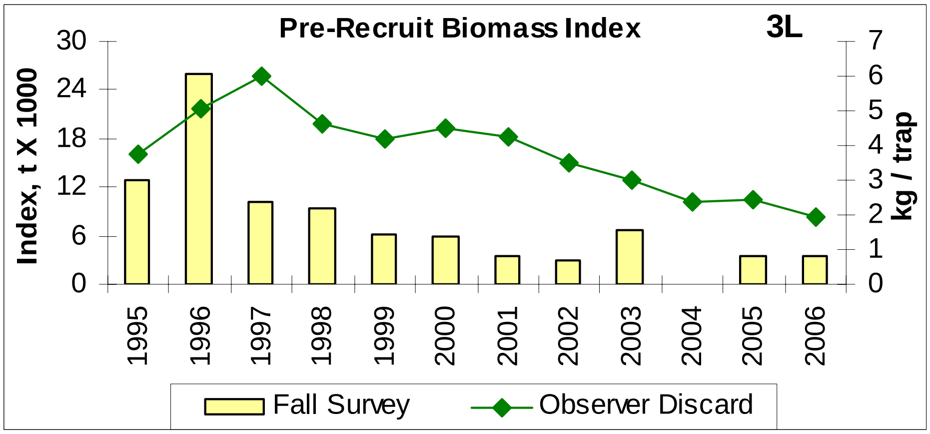

Figure 19: Trends in two Div. 3L pre-recruit indices; the survey was incomplete in 2004.

Data from at-sea sampling during the fishery and industry-DFO **offshore** post-season trap survey data show no change in catch rate of pre-recruits since 2004. **Recruitment** is expected to remain relatively low in the short term.

Industry-DFO **inshore** post-season trap survey catch rates of older-shelled crabs have increased during 2004-2006 but are lower than catch rates of new-shelled crabs. Recent increases in catch rates of legal-sized crabs from DFO trap surveys in two of three localized inshore areas suggest improved recruitment prospects.

Mortality

The **exploitation rate index** (Fig. 20) increased from 1996 to 2001 and has since changed little.

The **pre-recruit fishing mortality index** (Fig. 20) increased gradually to 2001, doubled to 2003, and has been lower since. It was about average in 2006.

The percentage of the total catch discarded in the fishery (Fig. 20) increased from 1995-1997 and decreased sharply in 1998. It then declined gradually until 2002, and changed little since, implying relatively little wastage of under-sized and new-shelled pre-recruits in the fishery in recent years.

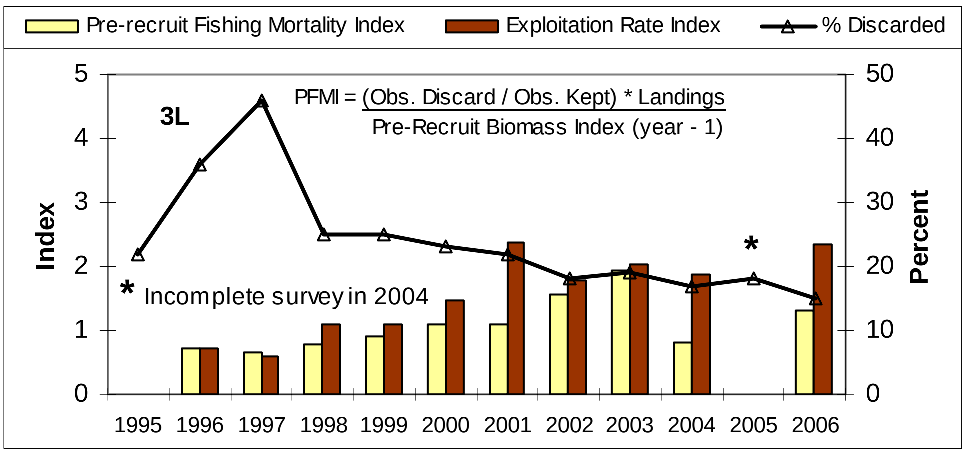

Figure 20: Trends in two Div. 3L mortality indices (the exploitation rate index and the pre-recruit fishing mortality index) and in the percentage of the catch discarded in the fishery.

Maintaining the current level of fishery removals in the short term will likely result in some increase in the fishery-induced **mortality** rate.

Resource Status, Divisions 3NO

Commercial Fishery

The fishery has been concentrated along the shelf edge, mostly in Div. 3N. **Landings** (Fig. 21) decreased from 5600 t in 2003 to 4200 t in 2006. **Effort** has declined by about 20% since 2004.

Landings have consistently exceeded the TAC because some management areas extend into Div. 3L, and all landings from those areas are attributed to Div. 3NO.

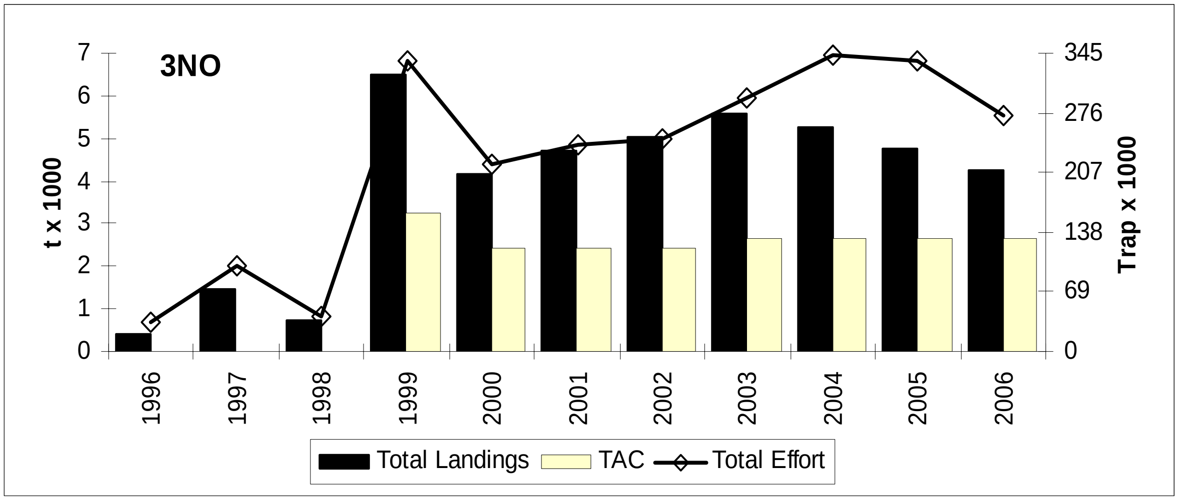

Figure 21: Trends in TAC, landings, and fishing effort in Div. 3NO.

Biomass

Commercial **CPUE** (Fig. 22) decreased by 26% between 2002 and 2004. It has changed little over the past 3 years and remains high relative to other divisions.

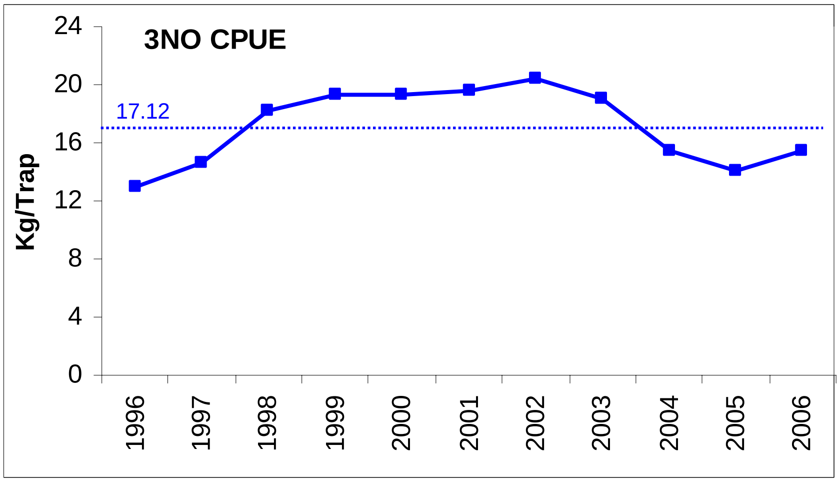

Figure 22: Trends in Div. 3NO commercial CPUE in relation to the long-term average (dotted line).

Fall trawl survey indices are unreliable because of a limited spatial distribution of the resource within these divisions that is poorly sampled by the multi-species survey.

Recruitment Prospects

The observer discard **pre-recruit index** (Fig. 23) declined during 1999-2003 and has been unchanged since.

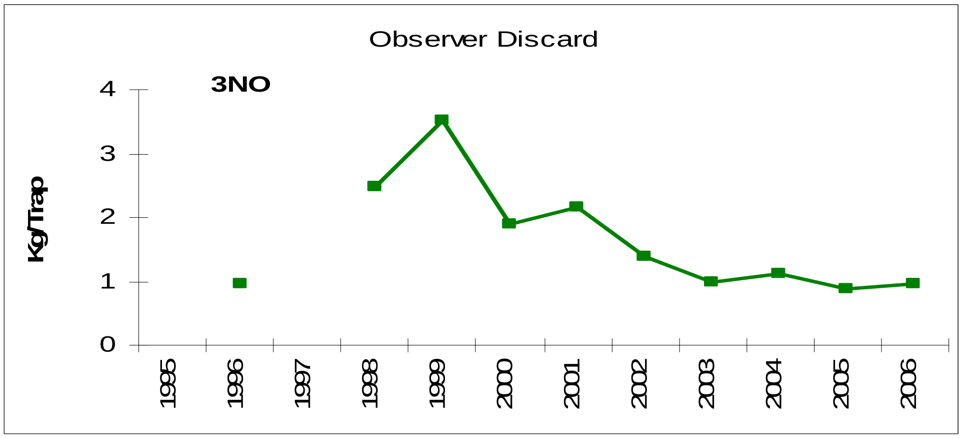

Figure 23: Trends in the Div. 3NO observer discard pre-recruit index.

Data from at-sea sampling during the fishery show little change in catch rate of legal-sized new-shelled pre-recruits since 2003 suggesting little change in recruitment in the short term.

Recruitment has been low in recent years and short term prospects are uncertain.

Mortality

The **exploitation rate index** and **pre-recruit fishing mortality index** are not informative because of uncertainties associated with the survey biomass indices. Trends in fishery-induced mortality are unknown.

The percentage of the total catch discarded in the fishery (Fig. 24) declined by more than half from 1999-2002. It has remained steady during the last 5 years at a low level, implying little wastage of pre-recruits in the fishery in recent years.

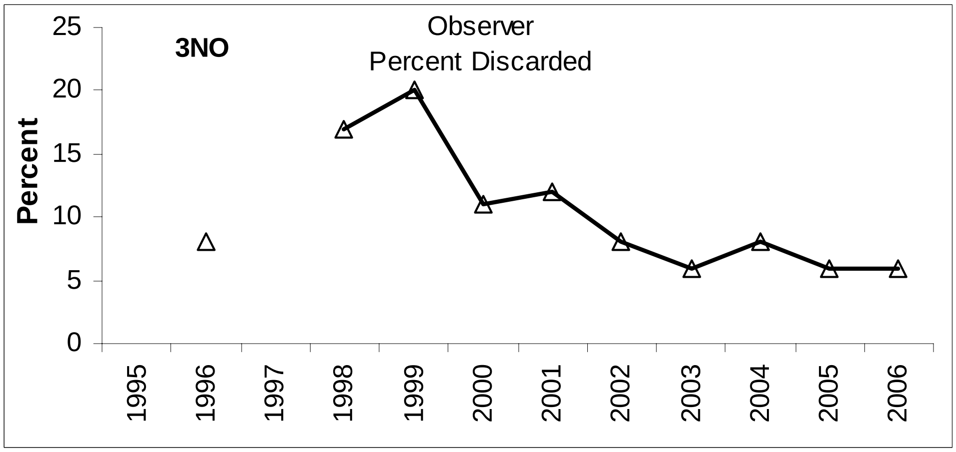

Figure 24: Trends in the percentage of the catch discarded in the Div. 3NO fishery.

The effects of maintaining the current catch level on the fishery-induced **mortality** rate are unknown.

Resource Status, Subdivision 3Ps

Commercial Fishery

Landings (Fig. 25) were at their highest level of 7600-8000 t during 1999-2002. They declined by 59% to 3200 t in 2005, while the TAC was reduced by 46%. Landings changed little, at 3100 t, in 2006, achieving the reduced TAC. **Effort** peaked in 2003 before declining by 40% to 2006.

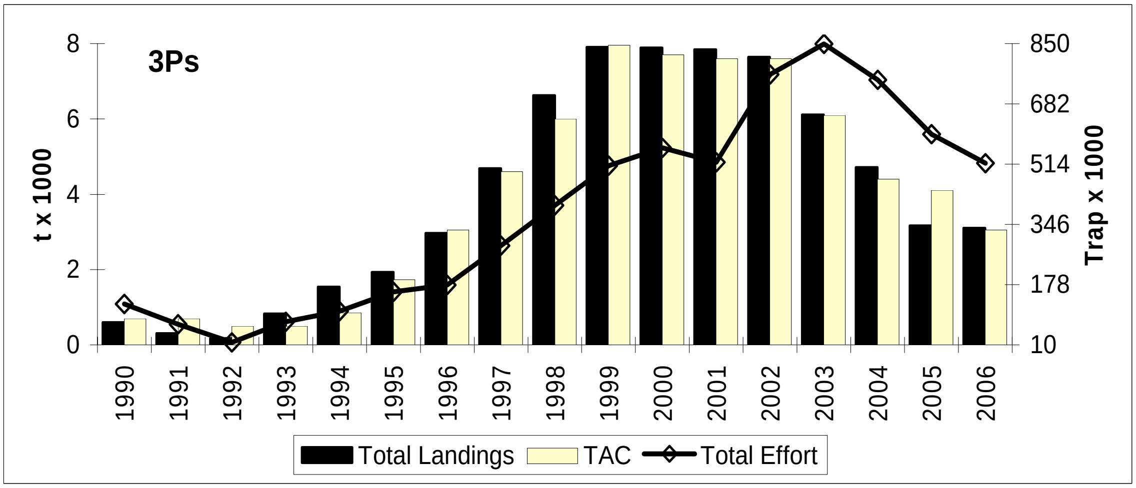

Figure 25: Trends in TAC, landings, and fishing effort in Subdiv. 3Ps.

Biomass

Offshore CPUE declined by 75% from 1999 to its historical low in 2005 (Fig. 26) and increased slightly in 2006.

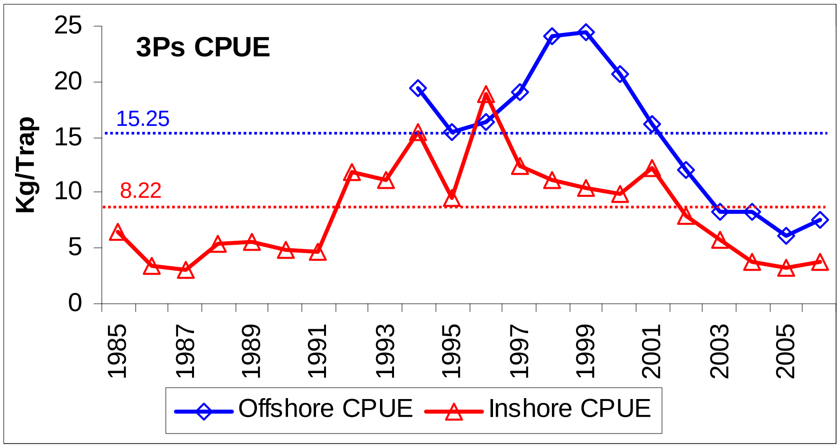

Figure 26: Trends in Subdiv. 3Ps inshore and offshore commercial CPUE in relation to their long-term averages (dotted lines).

No multispecies survey **exploitable biomass index** is available as the fall survey is not conducted in this area and indices from spring surveys are highly variable, for unknown reasons. Industry-DFO **offshore** post-season trap survey indices of legal-sized crabs showed a slight increase in catch rate since 2004.

Inshore CPUE declined by 70% from 2001 to its historical low in 2005 (Fig. 26) and increased slightly in 2006. Industry-DFO **inshore** post-season trap survey indices of legal-sized crabs showed no trend.

Recruitment Prospects

The observer discard **pre-recruit index** (Fig. 27) changed little during 1999-2004 but almost doubled in 2005. It decreased in 2006, largely due to an early fishing season in 2006 that resulted in greatly reduced catches of soft-shelled crabs. Although spring survey biomass indices are considered unreliable, size distributions from these surveys agreed with observer data in 2005 in suggesting that recruitment should increase over the next 3 years. However a spring survey was not conducted in this area in 2006 due to vessel breakdown.

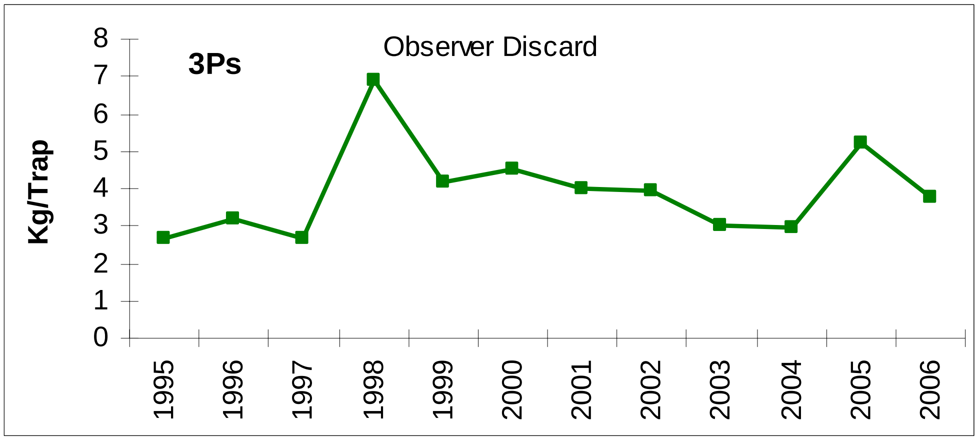

Figure 27: Trends in the Subdiv. 3Ps observer discard pre-recruit index.

Data from at-sea sampling during the fishery showed an increase in catch rate of small legal-sized new-shelled crabs during 2005 and 2006 that is expected to result in increased recruitment. Industry-DFO **offshore** post-season trap survey catch rates of sub-legal-sized crabs increased sharply in 2005 and were followed by an increase in catch rate of legal-sized new-shelled crabs in 2006, suggesting an increase in recruitment in the short term. **Recruitment** should increase over the next three years.

Industry-DFO **inshore** post-season trap survey indices of pre-recruit crabs showed no convincing trend.

Mortality

No **pre-recruit fishing mortality index** is available as there are insufficient fishery independent data from this area.

The percentage of the total catch discarded in the fishery (Fig. 28) more than doubled to about 80% in 2005 and decreased to its second highest level in 2006 largely due to an early fishing season in 2006 that resulted in greatly reduced catches of soft-shelled crabs.

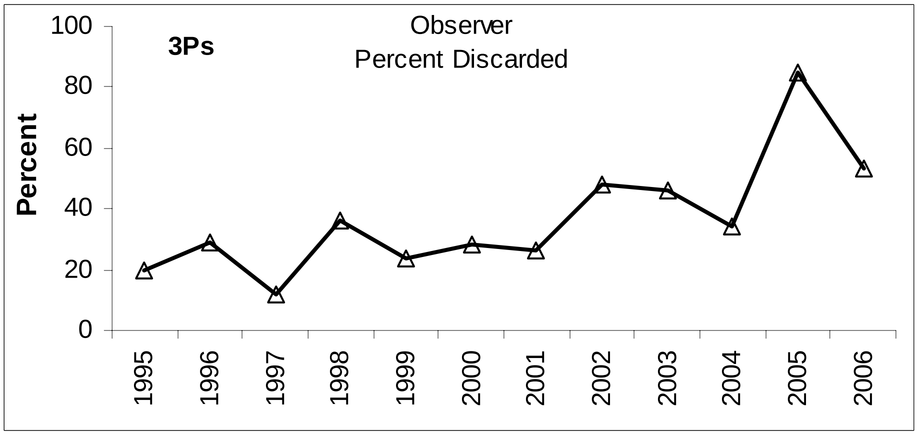

Figure 28: Trends in the percentage of the catch discarded in the Subdiv. 3Ps fishery.

Increased removals, in the short term, would likely impair recovery of the exploitable biomass.

Resource Status, Division 4R

Commercial Fishery

Landings (Fig. 29) peaked in 2002 at 1850 t and since declined by 71% to their historic low of 540 t in 2006, while the TAC remained high. **Effort** decreased during 2005-2006 to its lowest level since 1994.

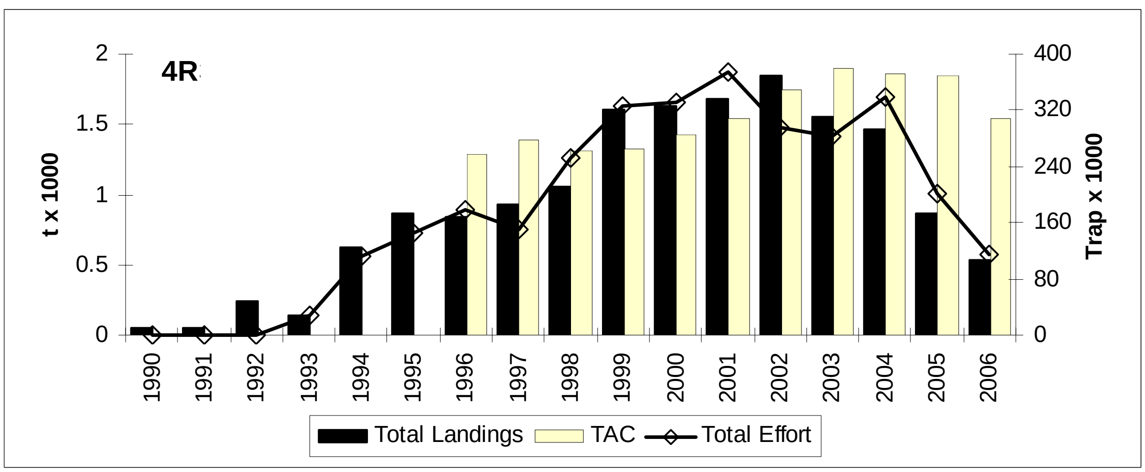

Figure 29: Trends in TAC, landings, and fishing effort in Div. 4R.

Biomass

It is not possible to infer trends in **exploitable biomass** from commercial CPUE data because of recent changes in the spatial distribution (steady contraction) of fishing effort**. CPUE** (Fig. 30) is higher in inshore than in offshore areas but is low relative to other divisions.

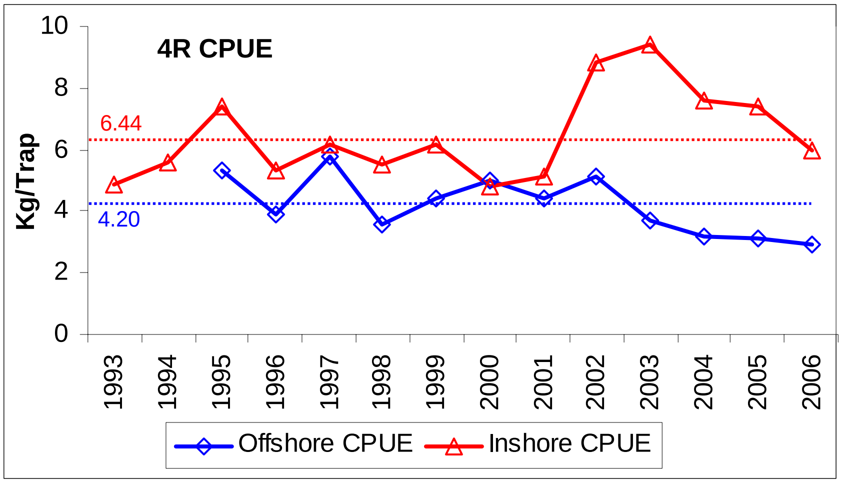

Figure 30: Trends in Div. 4R inshore and offshore commercial CPUE in relation to their long-term averages (dotted lines).

Recruitment Prospects

The observer data for this area are insufficient to estimate a reliable **pre-recruit index.** Therefore, short-term recruitment prospects are unknown.

Mortality

Trends in fishing mortality on either the exploitable or pre-recruit population are unknown.

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

There are **insufficient data** to assess resource status.

Sources of Uncertainty

A major source of uncertainty is a lack of reliable fishery-independent indices, or limited time series, in some divisions.

The CPUE series are not standardized. There is uncertainty regarding the effects of changes in some fishing practices (e.g. seasonality, soak time, trap mesh size, bait quality, and high-grading) on catch rates and their interpretation as indicators of resource status. The reliability of the logbook data is uncertain with respect to reported effort and areas fished.

Exploitable biomass and recruitment indices from multi-species trawl surveys are affected by uncertainties associated with variation in catchability of crabs by the survey trawl. There is additional uncertainty in the indices for Div. 3KL due to unusually late timing of the survey in 2002-2005 and unknown seasonal effects on catchability of crabs by the survey trawl. Furthermore, important strata in Div. 3L were not surveyed in 2004.

Recruitment and pre-recruit fishing mortality indices that are estimated using observer data are uncertain due to low observer coverage and, more importantly, seasonal variation in the distribution of observer coverage.

There is uncertainty in interpreting trends in exploitable biomass and recruitment from the short time series of industry-DFO collaborative trap survey data. There is additional uncertainty related to inconsistent spatial coverage, especially in Div. 4R.

ADDITIONAL STAKEHOLDER PERSPECTIVES

Division 2J

CPUE improved significantly over the past 2 years in all areas of 2J. Harvesters feel that this improvement can be attributed to measures taken in recent years including but not exclusive to reductions in TAC. Harvesters are optimistic that this stock is improving and that future prospects are promising.

Division 3K

2006 CPUE improved significantly in the offshore while remaining stable for the inshore areas with a dramatic increase in areas 3BC and 3D. Soft-shell was not a problem in 2006, which can be attributed to an early start to the fishery resulting in low pre-recruit mortality. For the offshore area, harvesters maintain that the abundance of crab remains high.

Division 3LNO

The TAC was reached in 2006 and CPUE have been stable since 2004. Harvesters have continued to improve handling practices, which observer data supports. Harvesters have gradually been moving to 5.5 inch mesh from 5.25 inch mesh pots since the late 1990s, which has resulted in less undersize crab being observed in commercial pots. This is clearly a reflection of improved fishing practices and not necessarily less recruitment. There were no significant occurrences of soft-shelled animals.

2006 CPUE and total landings were affected by economic factors. To reduce travel cost between CMAs, fishing activity sometimes takes place along a boundary between two areas. A large proportion of harvesting occurred where abundance was not highest, resulting in a lower CPUE, which in turn did not give an accurate indication of exploitable biomass. These practices were more exaggerated during the 2006 season due to high fuel prices and extremely low prices paid for raw material. Overall, harvesters felt the 2006 season was positive from a resource status perspective.

Subdivision 3Ps

The 2006 TAC was caught and CPUEs improved compared to the previous season. Harvesters feel the early start to the fishery had positive impacts as very few soft-shelled animals were encountered. Harvesters continue to see exceptional recruitment prospects in the form of animals under the legal size.

Division 4R

Landings have declined in this area in recent years, however the fishery still remains strong in inshore areas 12E and F (Bay of Islands) and 12G (Bonne Bay). Landings were low in other inshore zones including the offshore (OS8) area. Economic factors such as higher fuel cost and lower price have resulted in very little fishing effort being applied to these areas and in turn have contributed significantly to an overall reduction in landings.

CONCLUSIONS AND ADVICE

Division 2J

Recruitment and the **exploitable biomass** have recently increased. The fishery-induced **mortality** rate has decreased. Recruitment prospects remain promising for 2007.

Fishery and multi-species survey data suggest that the exploitable biomass has become increasingly dependent upon immediate recruitment.

An increase in exploitation rate in the short term that results in increased pre-recruit mortality could impair further recovery.

Division 3K

Recruitment increased in 2006 and the **exploitable biomass** has increased in both inshore and offshore areas. The fishery-induced **mortality** rate on the exploitable biomass was unchanged in 2006 whereas that on the pre-recruit population decreased to its lowest level.

The proportion of the exploitable biomass represented by immediate recruitment has increased in the **offshore** but decreased in the **inshore.** The **offshore** fishery has become increasingly dependent upon immediate recruitment.

Most of the exploitable biomass is distributed offshore. Any increase in exploitation rate in the short term that results in increased pre-recruit mortality could impair recovery of the exploitable biomass.

Division 3L

Recruitment and the **exploitable biomass** have decreased **offshore** since the late 1990's, but the exploitable biomass remains high relative to other divisions. **Recruitment** is expected to remain low in the short-term.

Recruitment and the **exploitable biomass** increased **inshore** in 2006 and recruitment prospects appear promising for 2007.

The fishery-induced **mortality** rate has changed little offshore in recent years.

Most of the exploitable biomass is distributed offshore. Maintaining the current level of fishery removals in the short term will likely result in some increase in the fishery-induced **mortality** rate.

Divisions 3NO

Survey indices are unreliable. Commercial **CPUE** has changed little over the past 3 years and remains high relative to other areas. **Recruitment** has been low in recent years and short term prospects are uncertain.

The effects of maintaining the current catch level on the fishery-induced **mortality** rate are unknown.

Subdivision 3Ps

The **exploitable biomass** changed little in 2006 and remains very low.

Recruitment should increase over the next three years.

Increased removals, in the short term, would likely impair recovery of the exploitable biomass.

Division 4R

The fishery has become concentrated in two localized **inshore** areas and industry-DFO post-season trap surveys indicate decreasing catch rates in those areas.

There are **insufficient data** to assess overall resource status.

OTHER CONSIDERATIONS

Reproductive Biology

The percentage of mature females carrying full clutches of viable eggs has remained high throughout the time series.

Fishery-induced mortality on undersized males may adversely affect insemination of females, especially when abundance of larger adults is low.

Bitter Crab Disease (BCD)

There has been a broadly-distributed incidence of **bitter crab disease** during 1996-2006. This disease, which is fatal to crabs, occurs in new-shelled crab of both sexes and appears to be acquired during molting. The distribution of infected crabs appears to have extended southward recently.

Indirect Effects of Fishing

Gillnet fisheries for groundfish impose an unquantified fishing mortality on snow crab. Snow crab and shrimp fisheries occur on common grounds in Div. 2J3KL. Preliminary results of a 2005 study indicated that bottom trawling is associated with an increased incidence of leg loss. However there is no evidence that shrimp trawling imposes a substantial mortality on snow crab.

An area of the Hawke Channel has been closed to all fisheries except snow crab during 2003-2006. The CPUE increased similarly inside and outside the closed area since 2004. An area of southern 3K, in the Funk Island Deep, was first closed to gillnetting in 2002 and then closed to all fisheries except snow crab during 2005-2006. It would be premature to draw any conclusions regarding the impact of this closure on the snow crab resource but it is noted that the CPUE increased both inside and outside the closed area in 2006.

Ghost fishing by lost gillnets and crab traps has been reported but the associated snow crab mortality is unquantified.

Predation

The abundance of **predatory groundfish** species has remained low since the early 1990's, implying low predation mortality. **Cannibalism** is known to occur but there are no data on spatial or annual variation in its prevalence.

Management Considerations

Longer-term recruitment prospects are uncertain but the persistence of a warm oceanographic regime over the past decade implies poor prospects relative to the strong recruitment of the late 1990's. The increase in recruitment in the north and improved prospects in the south may be largely attributable to reduced effort and removals as well as early seasons that interact to reduce pre-recruit mortality. There is little evidence of increase in the residual component of the exploitable biomass and the fishery remains highly dependent upon annual recruitment. Allowing the residual component to increase would promote greater stability in the fishery.

Reproductive potential is largely protected by conservation measures that exclude females and males smaller than 95 mm CW, including a portion of the adult (large-clawed) males, from the fishery. Therefore exploitation has been considered to have minimal impact on reproductive potential. However fishery-induced mortality on small (< 95 mm CW) males may adversely affect insemination of females, especially when abundance of larger adults is low.

Fishery-induced mortality on pre-recruits can impair future recruitment. Options for reducing this mortality include early fishing seasons, increasing mesh size and soak time, improving handling practices, and reducing high-grading, as well as trap modifications such as escape mechanisms and biodegradable panels.

Wastage of pre-recruits in the fishery would increase sharply as a recruitment pulse begins to enter the legal size range as new-shelled immediate pre-recruits, especially when the exploitable biomass is low. This wastage negatively affects recruitment and future yield. It increases as the exploitable biomass declines due to an increase in both the relative abundance of pre-recruits and their catchability by traps. Recruitment could be promoted by not allowing the exploitable biomass to become critically low.

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