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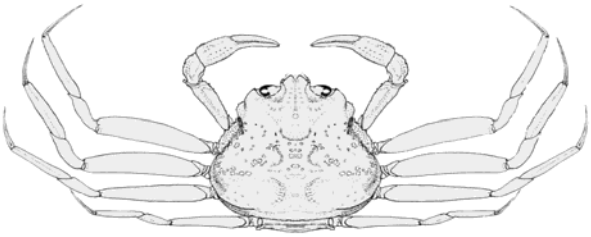
Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
Science Advisory Report 2006/006

ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB



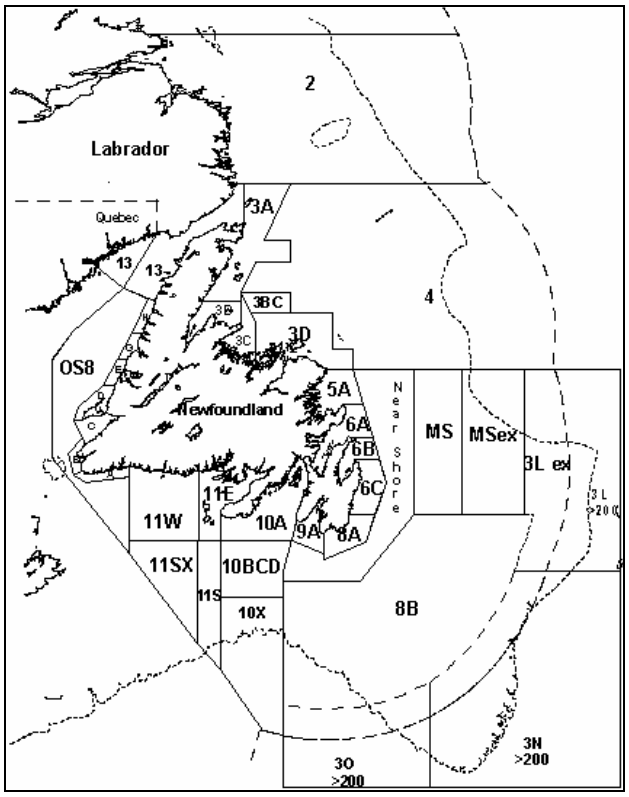


Figure 1: Newfoundland and Labrador Snow Crab Management Areas.

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 but stock structure is unclear. 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.

Crabs grow by molting, in spring. Females cease molting when they achieve sexual maturity between 40 and 75 mm carapace width (CW), whereas males may continue to molt until their terminal molt to adulthood, between about 40 and 115 mm CW.

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

The minimum legal mesh size of traps is 135 mm., to allow small crabs to escape. Under-sized and new-shelled males that are retained in the traps are returned to the sea and an unknown proportion dies.

The fishery began in 1968 and was limited to NAFO Divisions 3KL until the mid 1980's. It has since expanded throughout Divisions 2J3KLNOP4R and is prosecuted by several fleet sectors. Management of the fishery led to the development of multiple quota-controlled management areas (Fig.1) with over 3300 licence holders under enterprise allocation in 2005. Stock status is assessed at the NAFO Division scale. A vessel monitoring system (VMS) was fully implemented in the offshore fleets in 2004.

SUMMARY

- Resource status was evaluated based on trends in fishery catch per unit of effort **(CPUE),** exploitable **biomass**, **recruitment** prospects, and **mortality**. Data were derived from multi-species bottom trawl surveys in Divisions 2J3KLNOP, inshore trap surveys in Divisions 3KL, fishery data from logbooks, and observer catch-effort data, as well as biological sampling data from multiple sources.
- The fall multi-species surveys in Divisions 2J3KLNO indicate a decline in **exploitable biomass** since 1998. **Commercial CPUE** has declined steadily in Division 3K and Subdivision 3Ps over recent years.
- **Recruitment** declined from 1996-2002 and has since remained at a low level, but prospects have improved in the short-term for some divisions (eg. Div. 2J and Subdiv. 3Ps).
- Longer-term recruitment prospects are uncertain.

Division 2J

- Landings declined by 70% from 5400 t in 1999 to 1600 t in 2005 due to reductions in TAC. Meanwhile effort increased by 35% from 2001 to 2002, was unchanged in 2003, and then declined by 48% during 2004-2005.
- The fall survey exploitable biomass index decreased steadily, by 94%, from 1998-2002. It increased during 2003-2005, while remaining below the 2001 level. Commercial CPUE declined steadily by 76% during 1998-2004 to a record low level before increasing slightly in 2005.
- The fall survey pre-recruit index and observer pre-recruit index both decreased from 1998 to a lower level during 1999-2001. The survey index remained low until it increased sharply in 2004 and then decreased in 2005. The observer index increased in 2002 and changed little thereafter.
- Recruitment is expected to increase in 2006.
- The exploitation rate index almost tripled in 2003 but has since declined to the 2001-2002 level.
- The pre-recruit mortality index increased six-fold from 2001 to 2003 and then dropped to the lowest level in the time series in 2005.
- Fishery-induced mortality, on the exploitable as well as the pre-recruit populations, has decreased since 2003.
- Although fishery-induced mortality has decreased, the exploitable biomass remains low. Increase in exploitation in 2006 may impair further recovery.

Division 3K

- **Landings** peaked in 1999 at 21,400 t, but decreased to 15,300-16,500 t in 2000-2004, due to reduction in TAC. The TAC was further reduced by 18% in 2005, whereas landings dropped by 47% to 8,700 t. **Effort** increased by 33% in 2004 and decreased by 41% in 2005.

- The fall survey **exploitable biomass index** decreased by almost half from 2001 to 2004-2005. **Offshore commercial CPUE** has declined since 1998 and is well below the 1990-1998 level. **Inshore commercial CPUE** declined during 2001-2005 and is currently well below the long-term average.
- The fall survey **pre-recruit index** and the observer pre-recruit index declined from 1997 to a lower level during 1999-2002. The survey index changed little since then whereas the observer index increased gradually.
- **Offshore recruitment** should remain unchanged or increase slightly in the short-term. An inshore trap survey index of **immediate pre-recruits** indicates a high level of spatial variability.
- The **exploitation rate index** and **the pre-recruit mortality index** were similar in 2005 to the long-term average.
- The exploitable biomass remains low. Any increase in exploitation in 2006 would further impair recovery.

Division 3L

- **Landings** increased by 15% from 22,600 t in 2000 to 26,000 t in 2003, and decreased to 24,900 t in 2005 due largely to changes in TAC. Meanwhile **effort** increased by 73% during 2000-2004 and decreased by 3% in 2005.
- The fall survey **exploitable biomass index** declined from 1996-2000 and remained relatively low thereafter. **Offshore CPUE** decreased by 22% between 2002 and 2004 and changed little to remain at a high level in 2005 relative to other divisions. **Inshore CPUE** decreased by 21% in 2003 and has changed little since.
- The fall survey **pre-recruit index** has been low since 1999. The observer pre-recruit index declined from 1997-2004 and was unchanged in 2005. **Recruitment** is expected to remain relatively low in the short term.
- The **exploitation rate index** increased from 1996 to 2000 and has since changed little.
- The **pre-recruit mortality index** increased gradually to 2001, doubled to 2003, and then decreased to the 2001 level.
- The effect on **exploitation rate** of maintaining the current catch level remains unclear because trends in the exploitable biomass index and CPUE do not agree. However the current level of fishery removals would not likely result in increased mortality on either the exploitable or the pre-recruit population.

Divisions 3NO

- The fishery has been concentrated along the shelf edge. **Landings** declined by 16% from 5600 t in 2003 to 4700 t in 2005 while effort increased by 17% in 2004 and changed little in 2005.
- Because estimates of the fall survey **exploitable biomass** and **pre-recruit indices**, have wide margins of error, no inferences about trends can be made from these data.

- **Commercial CPUE** has remained high in recent years relative to other areas, but decreased by 31% between 2002 and 2005.
- The observer **pre-recruit** index indicates that **recruitment** has decreased and is expected to remain low in the short term.
- The **exploitation rate index** and **pre-recruit 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 has remained steady during the last 4 years at a low level, implying little wastage of pre-recruits.
- The effects of maintaining the current catch level on fishery-induced mortality are unknown.

Subdivision 3Ps

- Landings declined by 58% from 7600 t in 2002 to 3200 t in 2005, while the TAC was reduced by 46%. **Effort** increased by 59% from 2001-2003 before decreasing by 29% to 2005.
- No **exploitable biomass index** is available as there are insufficient fishery independent data from this area. **Offshore CPUE** declined by 75% from 1999 to its historical low in 2005. **Inshore CPUE** declined by 70% from 2001 to its historical low in 2005.
- The observer discard **pre-recruit index** changed little during 1999-2004 but almost doubled in 2005. **Recruitment** should increase over the next 3 years.
- No **pre-recruit mortality index** is available as there are insufficient fishery independent data from this area. However, the percentage of the total catch discarded in the fishery more than doubled to about 80% in 2005 implying increased wastage of pre-recruits.
- CPUE trends indicate that the exploitable biomass has become depleted. Recruitment prospects have improved. Exploitation, in the short term, would likely impair recovery of the exploitable biomass.

Division 4R and Subdivision 3Pn

- **Landings** peaked in 2002 at 1850 t and then declined, by 54%, to 860 t in 2005, while the TAC changed little. Meanwhile, **effort** increased by 13% to 2004 and dropped by 42% in 2005.
- Fishery independent data from this area are insufficient to assess resource status.
- It is not possible to infer trends in **exploitable biomass** from **commercial CPUE** data because of recent changes in the spatial distribution of fishing effort**.**
- The observer data for this area are insufficient to estimate a reliable **pre-recruit index** or the percentage of the catch discarded.
- The effects of maintaining the current catch level on the **exploitation rate** or **pre-recruit mortality** are unknown.

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.

Females cease molting after sexual maturity is achieved at about 40-75 mm CW and so they 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.

Negative relationships between bottom temperature and snow crab CPUE have been demonstrated at lags of 6-10 years suggesting that cold conditions early in the life history are associated with the production of strong year classes.

A warm oceanographic regime has persisted over the past decade implying poor long-term recruitment prospects.

The Fishery

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

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

Licences supplemental to groundfishing were issued in Division 3K and Subdivision 3Ps in 1985, in Division 3L in 1987, and in Division 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.

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 Divisions 2J3KLNOP4R (Fig. 2) increased steadily from about 10,000 t annually during the late 1980's to 69,000 t in 1999 largely due to expansion of the fishery to offshore areas. They decreased by 20% to 55,400 t in 2000, increased slightly to 59,400 t in 2002 and 2003 and declined to 55,700 t in 2004, due to changes in TAC's. They decreased by 21% to 43,900 t in 2005, primarily due to a sharp decrease in Division 3K, where the TAC was not taken. Historically, most of the landings have been from Divisions 3KL.

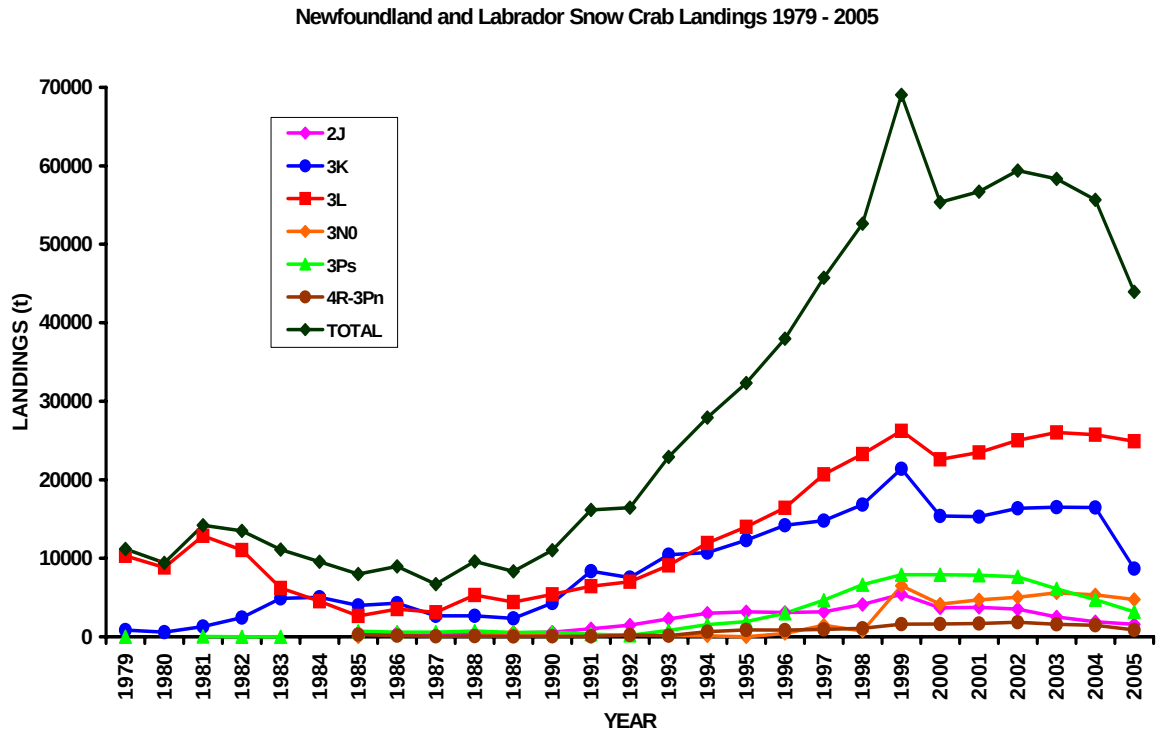


Figure 2: Trends in annual total landings and by NAFO Division.

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

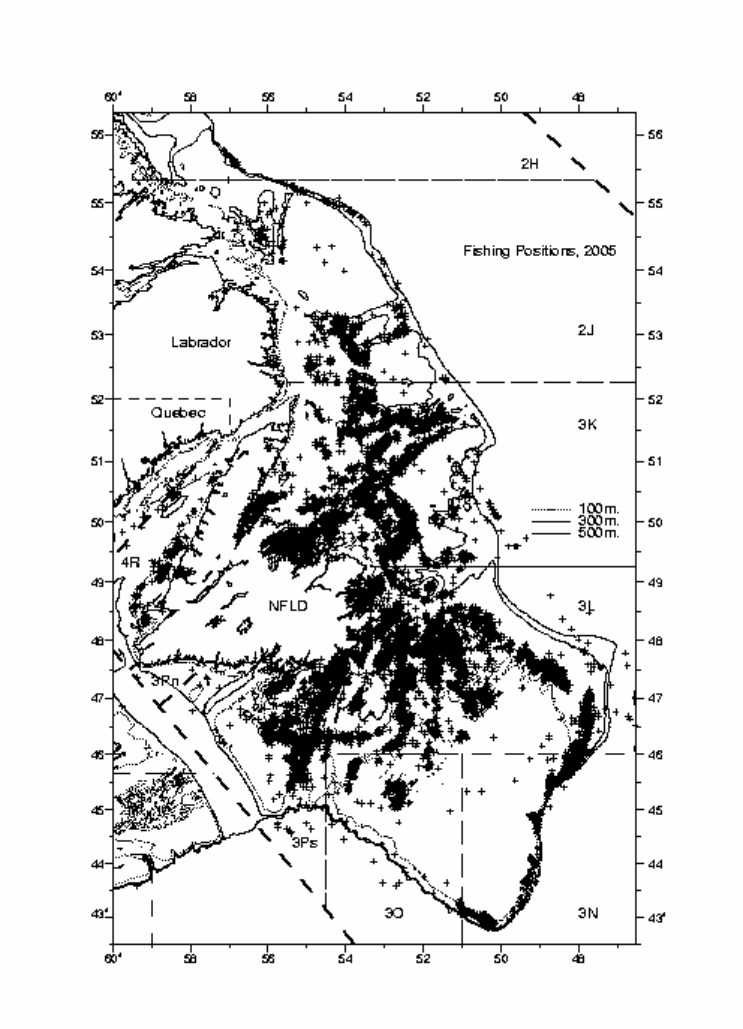


Figure 3: Spatial distribution of commercial fishing effort during 2005.

ASSESSMENT

Resource status was evaluated based on trends in fishery **CPUE**, exploitable **biomass**, **recruitment** prospects and **mortality**. Data were derived from multi-species bottom trawl surveys in Divisions 2J3KLNOP, inshore trap surveys in Divisions 3KL, fishery data from logbooks, and observer catch-effort data, 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 Divisions 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.

Fall bottom trawl surveys also provide data on adolescents larger than 75 mm that are used to calculate an index of pre-recruit legal-sized males that would result from imminent molting in spring. These new-shelled crabs would begin to recruit to the fishery, as older-shelled adults, one year later.

This survey index is compared to observer-based catch rates (kg/trap haul) of total crabs discarded. Both the survey pre-recruit index and the observer discard pre-recruit index reflect catch rates of undersized and new-shelled legal-sized pre-recruits.

Evidence of progression of smallest males (< 41 mm CW) to larger sizes from size frequency data is lacking. Therefore, longer-term (> 3 years) recruitment prospects are uncertain.

Fishery induced mortality is a function of the proportion of the exploitable population that dies as landed crabs 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 commercial catch 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 exploitation rate index reflects a known (100%) mortality on recruited crabs, whereas the pre-recruit mortality index reflects an unknown (but likely high) mortality on released pre-recruits. Pre-recruit mortality is greatly affected by fishing practices, including how under-sized and new-shelled pre-recruits are handled. Handling practices have reportedly improved in recent years.

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 2J3KLNOP4R

The fall multi-species surveys in Divisions 2J3KLNO indicate a decline in **exploitable biomass** since 1998 (Fig. 4). **Commercial CPUE** has declined steadily in Division 3K and Subdivision 3Ps over recent years.

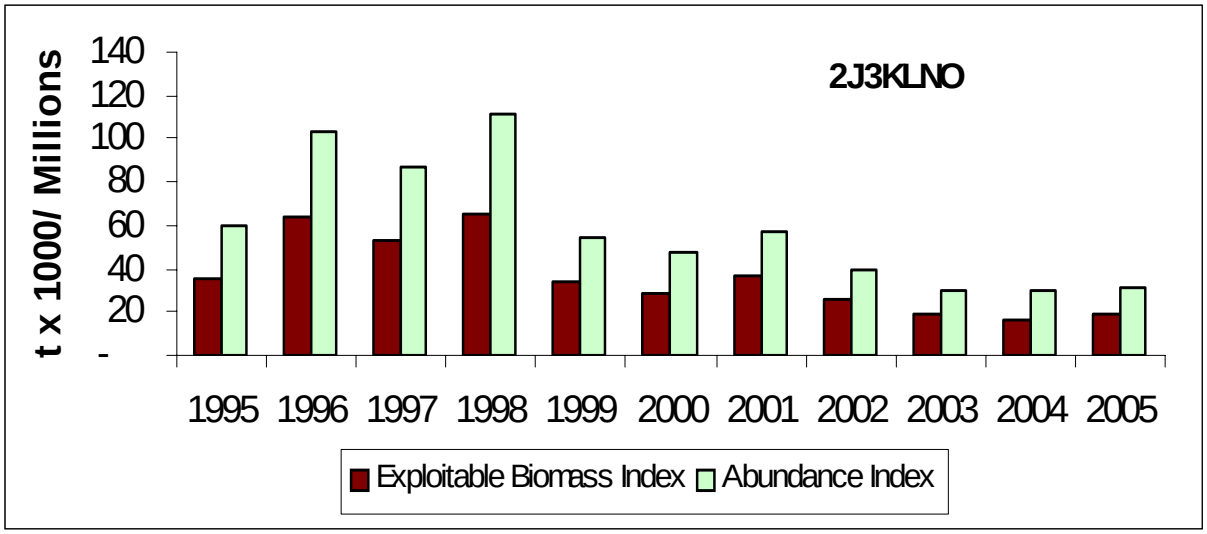


Figure 4: Annual trends in the fall multi-species survey exploitable biomass and abundance indices, for Div. 2J3KLNO.

Recruitment declined from 1996-2002 and has since remained at a low level (Fig. 5), but prospects have improved in the short-term for some divisions (eg. Div. 2J and Subdiv. 3Ps).

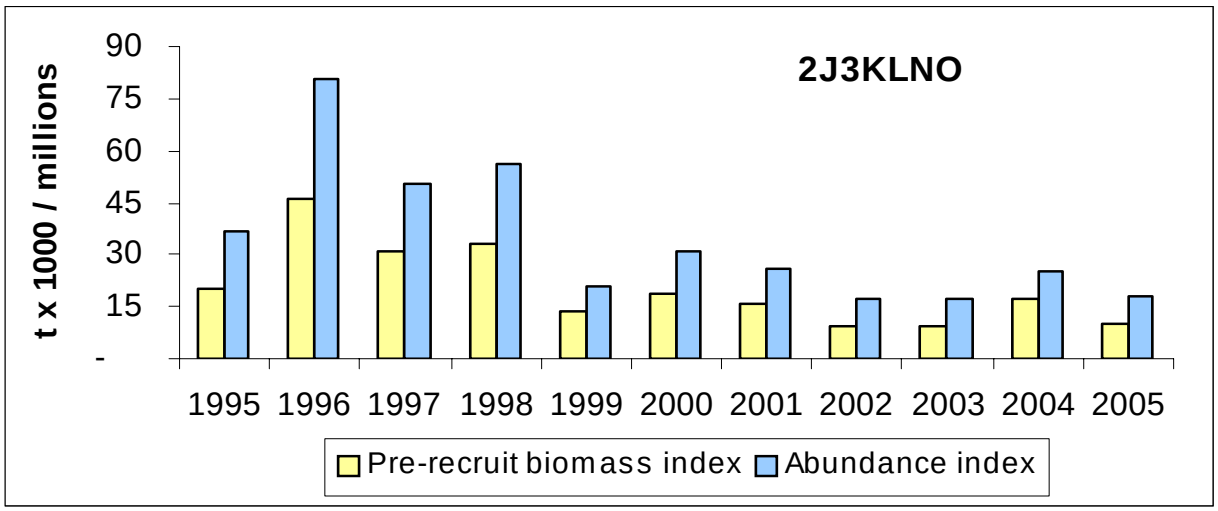


Figure 5: Annual trends in the fall multi-species survey pre-recruit biomass and abundance indices for Div. 2J3KLNO.

Longer-term recruitment prospects are uncertain.

Trends in fishery-induced mortality have varied among divisions.

Resource Status, Division 2J

Commercial Fishery

Landings (Fig. 2) increased slightly from 330 t in 1985 to 600 t in 1990, before increasing to about 3200 t during 1995-1997 and peaking in 1999 at 5400 t. They declined by 70% to 1600 t in 2005 due to reductions in TAC. Effort increased by 35%

from 2001 to 2002, was unchanged in 2003, and then declined by 48% during 2004-2005.

Commercial catch rates (CPUE) have oscillated over the time series (Fig. 6), 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 increasing slightly in 2005.

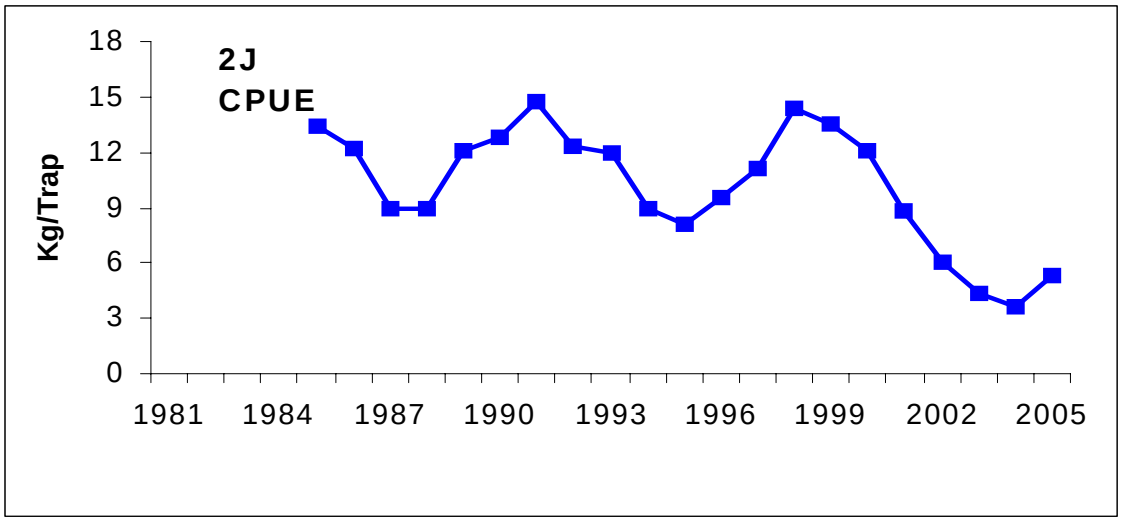


Figure 6: Annual trends in Div. 2J commercial CPUE.

Biomass

The fall survey **exploitable biomass index** (Fig. 7) decreased steadily, by 94%, from 1998-2002. It increased during 2003-2005, while remaining below the 2001 level.

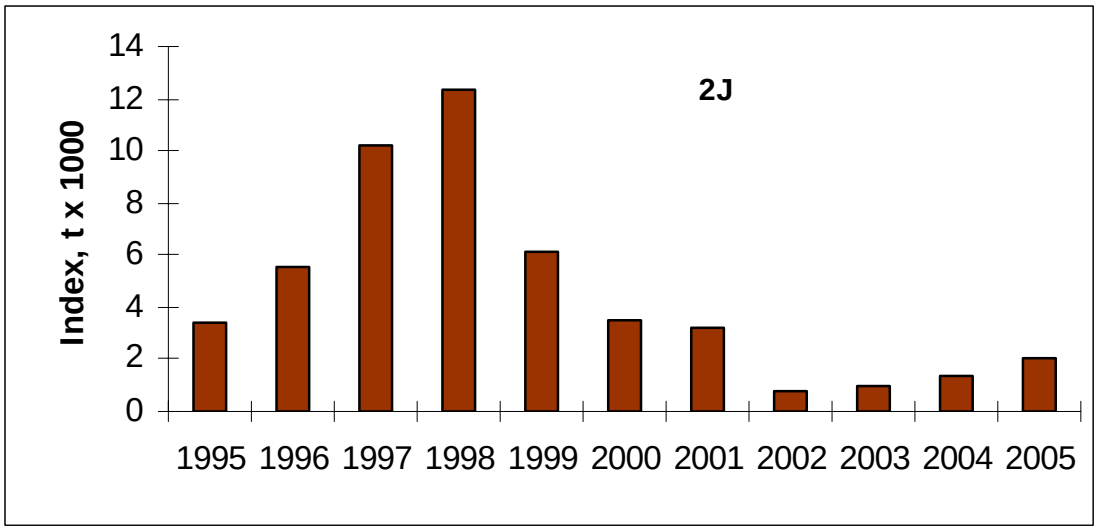


Figure 7: Annual trends in the Div. 2J fall multi-species survey exploitable biomass index.

Commercial catch rates (CPUE) declined steadily by 76% during 1998-2004 to a record low level, before increasing slightly in 2005 (Fig. 6).

Recruitment Prospects

The fall survey pre-recruit index and observer pre-recruit index both decreased from 1998 to a lower level during 1999-2001. The survey index remained low until it increased sharply in 2004 and then decreased in 2005. The observer index increased in 2002 and changed little thereafter.

Recruitment is expected to increase in 2006.

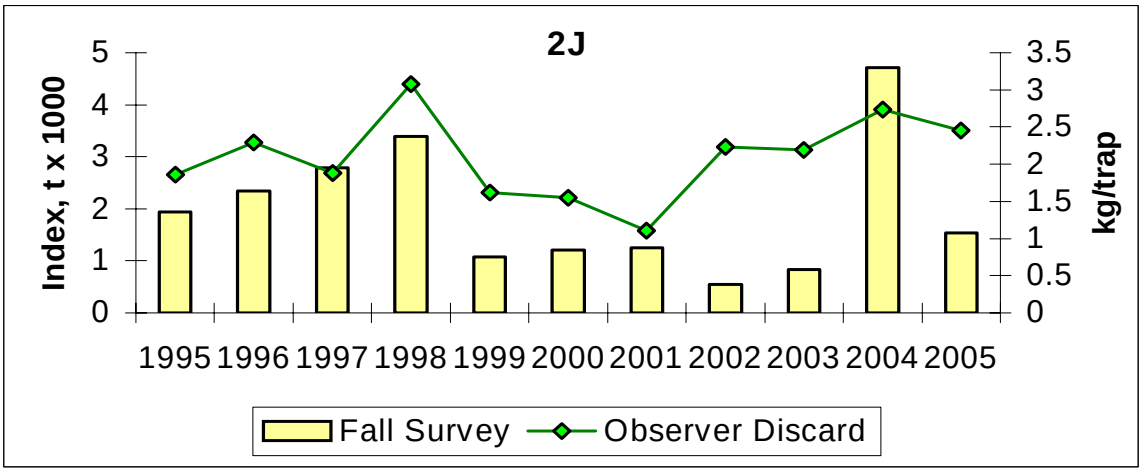


Figure 8: Annual trends in two Div. 2J pre-recruit indices.

The survey data indicate that most of the relatively abundant sub-legal sized adolescent males evident in 2004 achieved legal size in 2005, as new-shelled immediate pre-recruits. These will be recruited to the fishery as older-shelled crabs in 2006.

Mortality

The **exploitation rate index** (Fig. 9) increased from 1999-2001, changed little in 2002 and almost tripled in 2003, but has since declined to the 2001-2002 level.

The pre-recruit mortality index (Fig. 9) increased six-fold from 2001 to 2003 and then dropped to the lowest level in the time series in 2005.

The percentage of the total catch discarded (Fig. 9) increased sharply in 2002, was unchanged in 2003, and further increased to a record high level in 2004. It decreased to the second highest level in 2005, implying continued high wastage of under-sized and new-shelled pre-recruits in the 2005 fishery.

Although wastage of pre-recruits (percent discarded) remained high in the 2005 fishery (Fig. 9), overall pre-recruit mortality decreased sharply due to increase in the pre-recruit biomass in 2004 and reduced landings in 2005. The total number of pre-recruits discarded (not shown) decreased more sharply than did the percent discarded in 2005 due to reduction in landings.

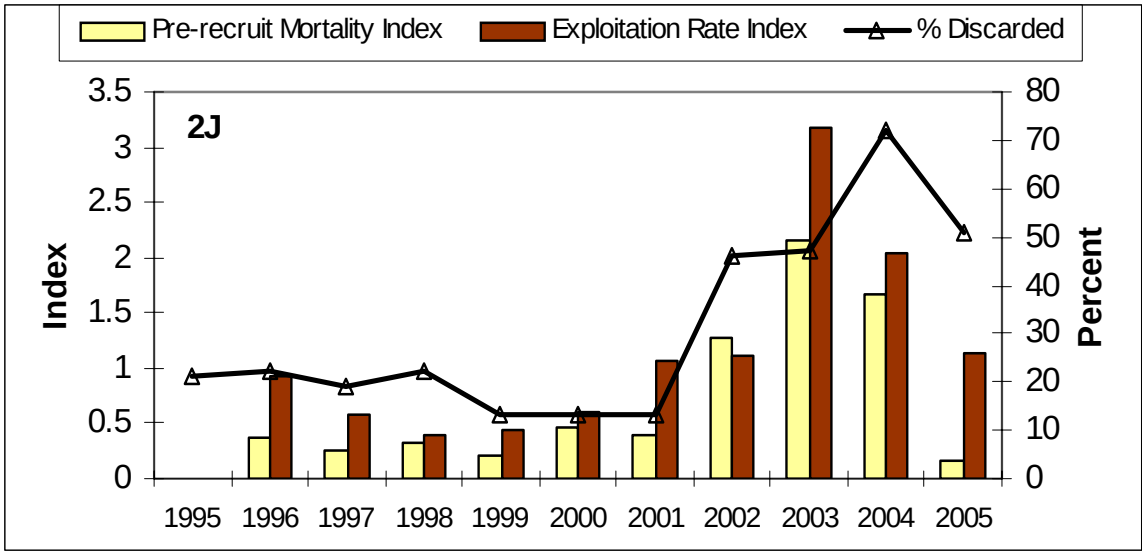


Figure 9: Annual trends in two Div. 2J mortality indices, (exploitation rate index and pre-recruit mortality index) and in the percentage of the catch discarded in the fishery.

An area of the Hawke Channel has been closed to all fisheries except snow crab during 2002-2005. It would be premature to draw any conclusions regarding the impact of this closure on the snow crab resource. However, it is noted that the CPUE increased similarly inside and outside the closed area in 2005. Also, the increase in the survey pre-recruit index in 2004 occurred predominately well north of the closed area, around Cartwright Channel.

Resource Status, Division 3K

Commercial Fishery

Landings (Fig. 2) averaged about 3300 t during 1985-1990 then increased to peak in 1999 at 21,400 t. They decreased to 15,300-16,500 t in 2000-2004, due to reduction in TAC. The TAC was further reduced by 18% in 2005, whereas landings dropped by 47% to 8,700 t. **Effort** increased by 33% in 2004 and decreased by 41% in 2005.

Commercial catch rates have oscillated over the time series (Fig. 10). **Offshore CPUE** has declined since 1998 and is well below the 1990-1998 level. **Inshore commercial CPUE** declined during 2002-2005 and is currently well below the long-term average

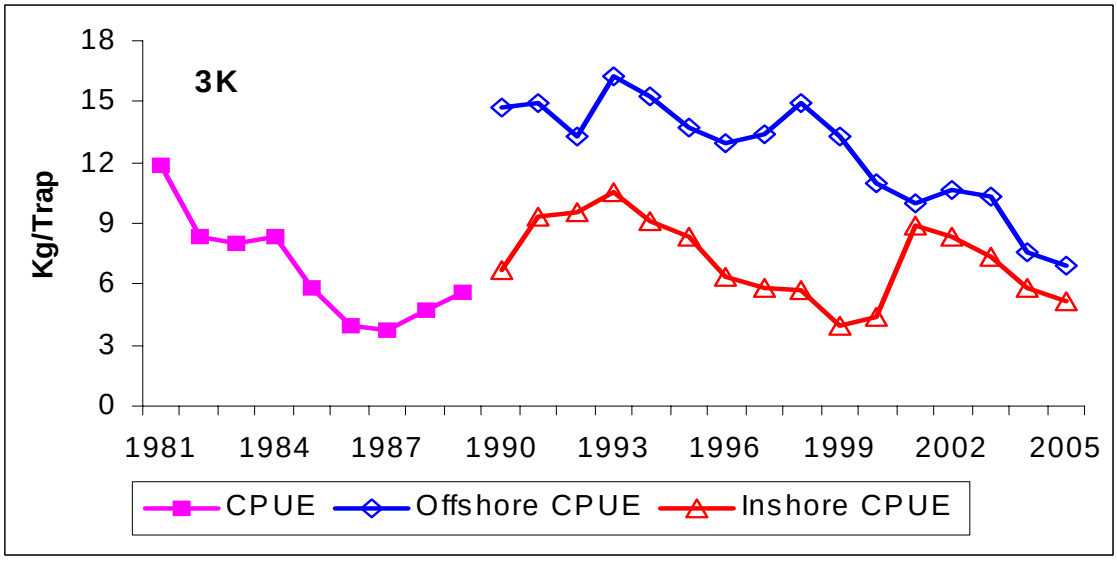


Figure 10: Annual trends in Div. 3K commercial CPUE.

Biomass

The fall survey **exploitable biomass index** increased sharply in 1996 (Fig. 11) and remained at a high level during 1996-1998. It dropped by more than half in 1999 and increased slightly during 2000 and 2001. It decreased by almost half from 2001 to 2004-2005.

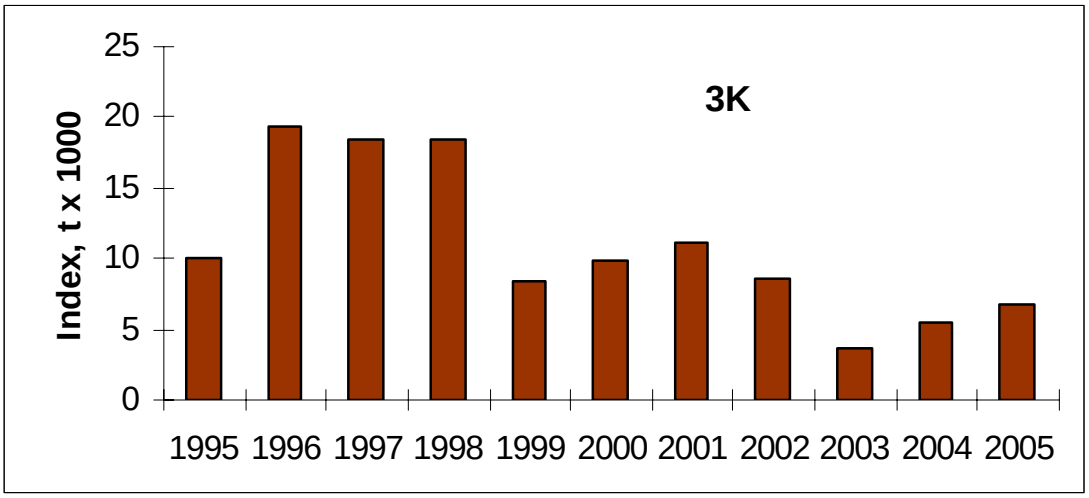


Figure 11: Annual trends in the Div. 3K fall multi-species survey exploitable biomass index.

Offshore commercial CPUE (Fig. 10) has declined since 1998 and is well below the 1990-1998 level.

Inshore commercial CPUE has been consistently lower than offshore CPUE (Fig. 10). Inshore CPUE declined during 1993-2000 and increased sharply in 2001. It declined during 2002-2005 and is currently well below the long-term average.

Recruitment Prospects

Both the fall survey pre-recruit index and the observer discard pre-recruit index increased between 1995 and 1997 (Fig. 12), and declined to a lower level during 1999-2002. The survey index changed little since then whereas the observer index increased gradually.

Offshore recruitment should remain unchanged or increase slightly in the short term.

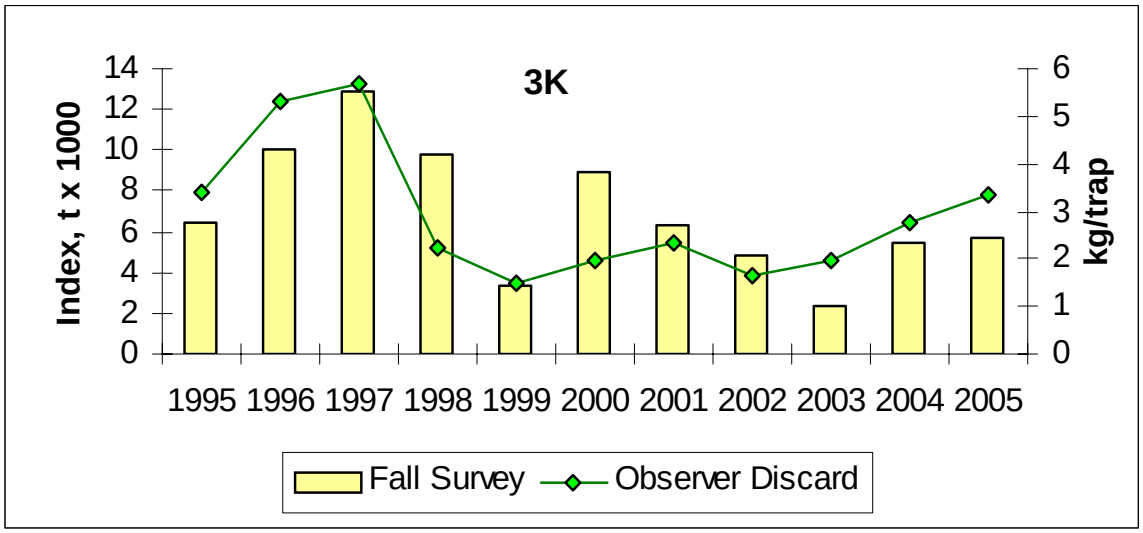


Figure 12: Annual trends in two Div. 3K pre-recruit indices.

An inshore trap survey index of **immediate pre-recruits** indicates a high level of spatial variability.

Mortality

The **exploitation rate index** decreased from 1996-1997 (Fig. 13) and increased steadily from 1997 to 2000. The **pre-recruit mortality index** decreased from 1996-1998 and increased to 2000. Both indices have since varied at this higher level. The **exploitation rate index** and **the pre-recruit mortality index** were similar in 2005 to the long-term average.

The percentage of the total catch discarded in the fishery (Fig. 13) increased since 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 immediate pre-recruits in the catch, which resulted in a premature closure of the fishery and failure to achieve the TAC. Because of the greatly reduced landings, and associated catch of pre-recruits, fishery-induced mortality, on either the exploitable or pre-recruit population, did not increase in 2005.

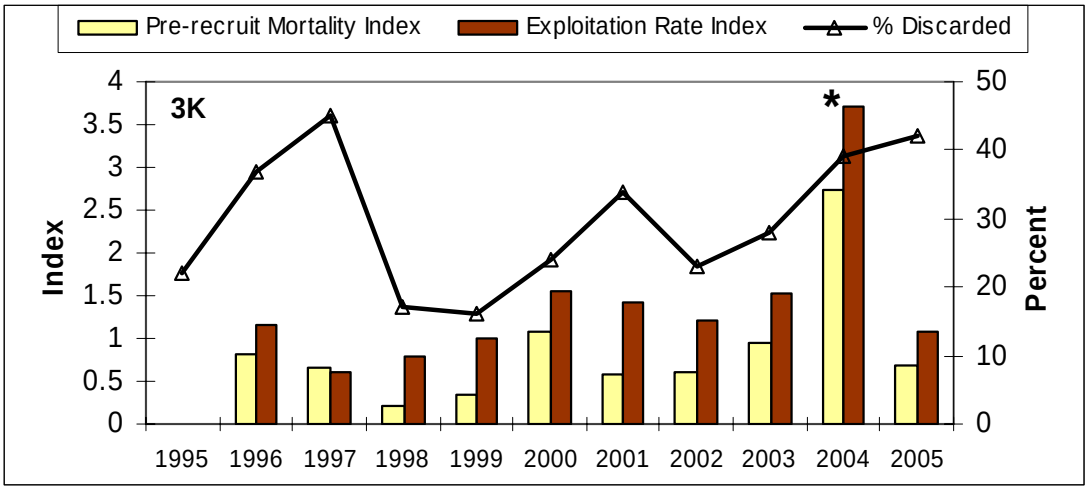


Figure 13: Annual trends in two Div. 3K mortality indices (the exploitation rate index and the pre-recruit mortality index) and in the percentage of the catch discarded in the fishery.
**Note: high mortality indices for 2004 may be due to anomalously low biomass indices from the 2003 survey.*

Resource Status, Division 3L

Commercial Fishery

Landings (Fig. 2) increased from about 1300 t in 1975 to 13,000 t in 1981, before decreasing to 2600 t in 1985. They increased steadily to peak at 26,200 t in 1999 before declining to 22,600 t in 2000. They then increased by 15% to 26,000 t in 2003, and decreased to 24,900 t in 2005 due largely to changes in TAC. Meanwhile **effort** increased by 73% during 2000-2004 and decreased by 3% in 2005.

Commercial catch rates (Fig. 14) in the offshore decreased by 22% between 2002 and 2004 and changed little in 2005. **Offshore CPUE** remains at a high level relative to other divisions. **Inshore CPUE** has been consistently lower than **offshore CPUE**. **Inshore CPUE** decreased by 21% in 2003 and has changed little since.

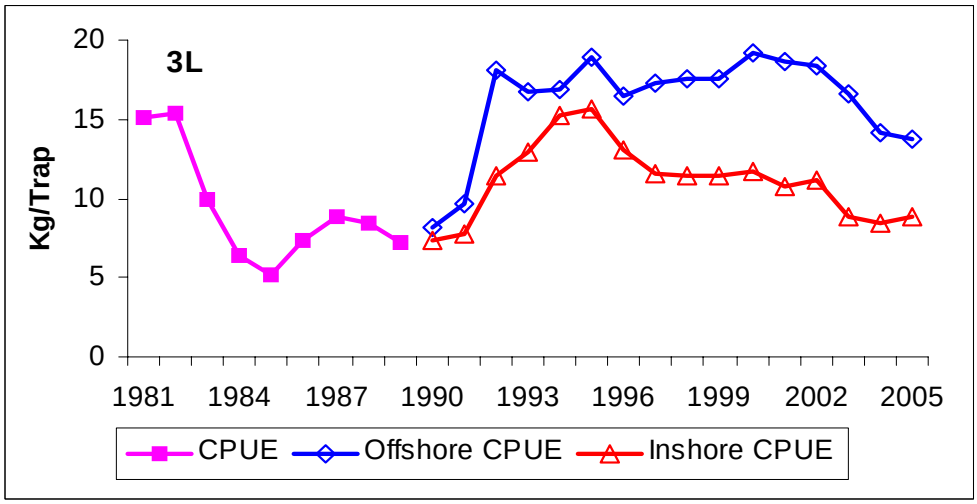


Figure 14: Annual trends in Div. 3L commercial CPUE.

Biomass

The fall survey **exploitable biomass index** (Fig. 15) declined from 1996-2000 and remained relatively low thereafter. **Offshore CPUE** (Fig. 14) decreased by 22% between 2002 and 2004 and changed little to remain at a high level in 2005 relative to other divisions. Disagreement between the exploitable biomass index and CPUE throughout most of the time series introduces uncertainty regarding trends in biomass.

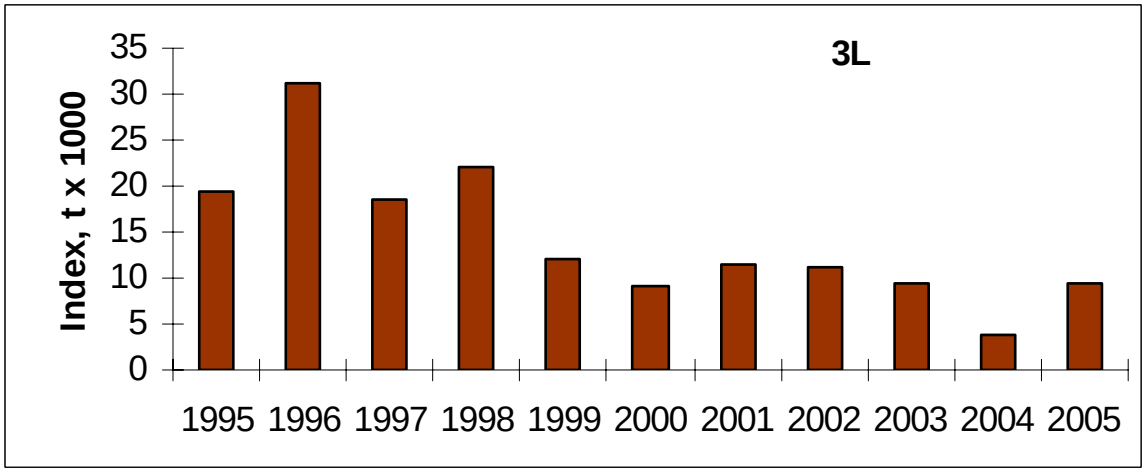


Figure 15: Annual trends in the Div. 3L fall multi-species survey exploitable biomass index.

Inshore CPUE decreased by 21% in 2003 and has changed little since (Fig. 14).

Catch rates from **trap surveys** in 3 localized inshore areas have declined since the 1990's.

Recruitment Prospects

The fall survey **pre-recruit index** has been low since 1999. The observer pre-recruit index declined from 1997-2004 and was unchanged in 2005 (Fig. 16). **Recruitment** is expected to remain relatively low in the short term.

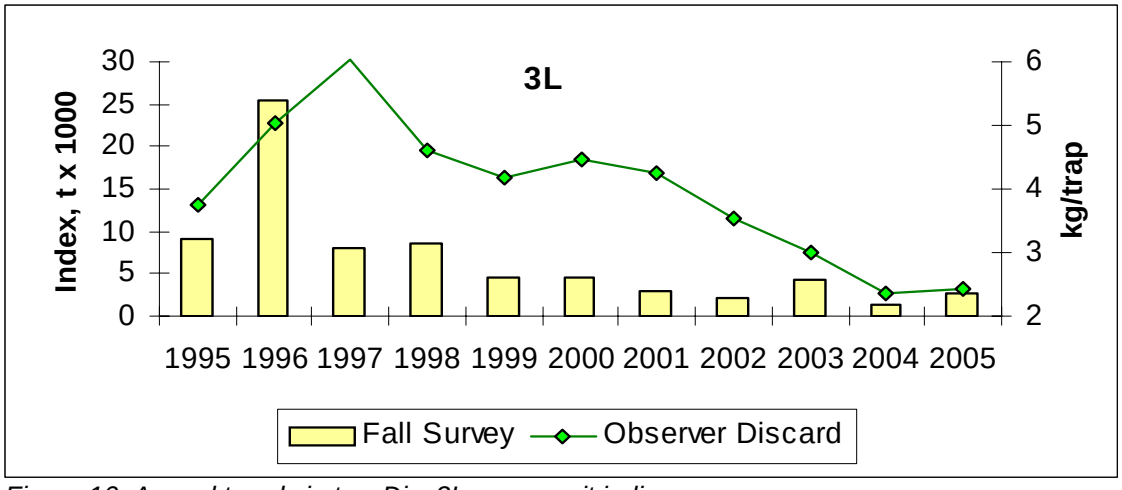


Figure 16: Annual trends in two Div. 3L pre-recruit indices.

Mortality

The **exploitation rate index** (Fig. 17) increased from 1996 to 2000 and has since changed little.

The **pre-recruit mortality index** (Fig. 17) increased gradually to 2001, doubled to 2003, and then decreased to the 2001 level.

The percentage of the total catch discarded in the fishery (Fig. 17) 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.

The survey mortality indices (Fig. 17) and landings have changed little in recent years, Therefore the stable low pre-recruit wastage index, to 2005, implies that fishery-induced mortality has remained relatively low in recent years. However, unreliability of 2005 mortality indices introduces uncertainty.

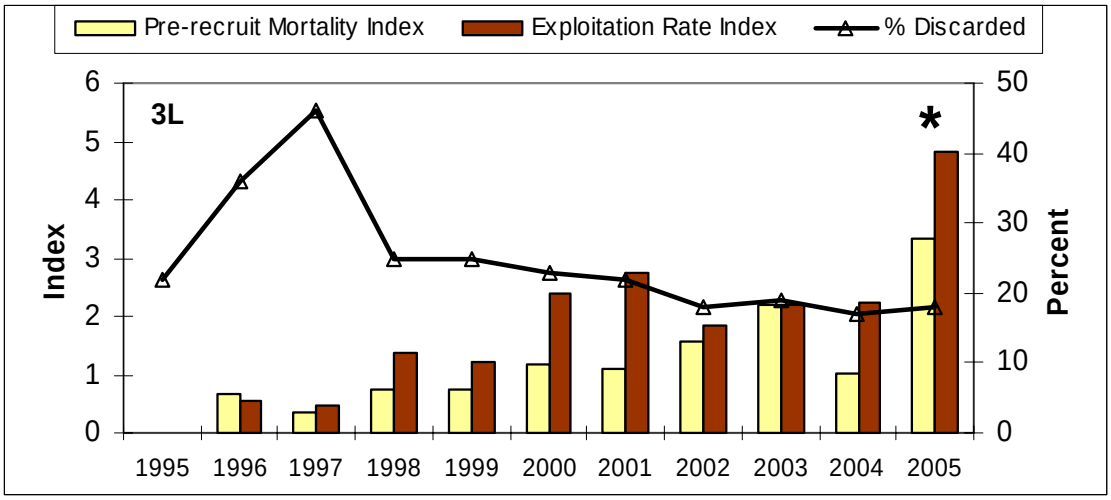


Figure 17: Annual trends in two Div. 3L mortality indices (the exploitable biomass index and the pre-recruit mortality index) and in the percentage of the catch discarded in the fishery.
**Note: anomalously high mortality indices for 2005 reflect low catchability in the 2004 survey.*

Resource Status, Divisions 3NO

Commercial Fishery

The fishery began in the mid-1980's in Division 3O and expanded along the shelf edge in 1999. It has since been concentrated along the shelf edge, and mostly in Div. 3N. **Landings** (Fig. 2) increased sharply in 1999 and changed little to 2003. They declined by 16% from 5600 t in 2003 to 4700 t in 2005 while effort increased by 17% in 2004 and changed little in 2005.

Commercial **CPUE** (Fig. 18) has remained high in recent years relative to other areas. It decreased by 26% between 2002 and 2004.

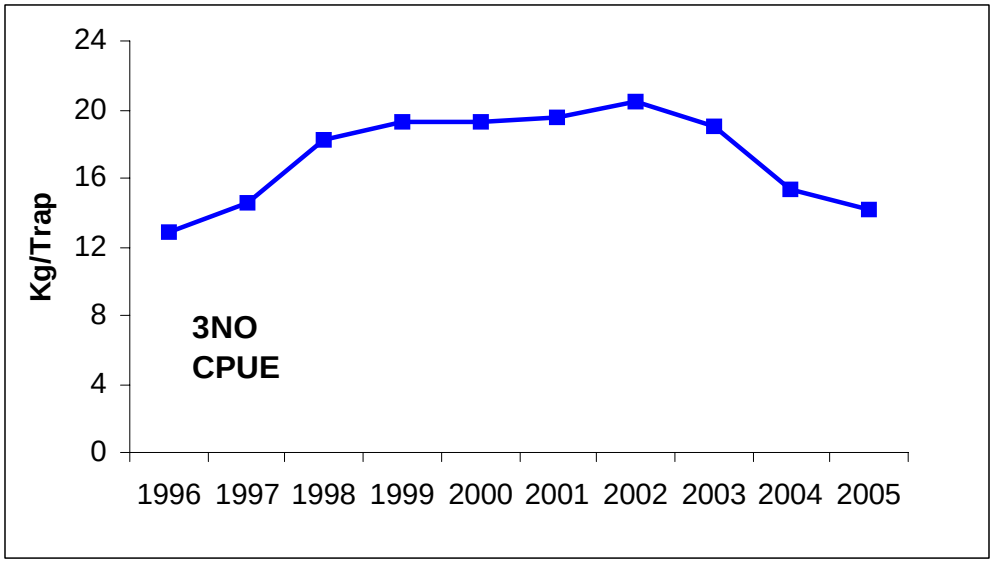


Figure 18: Annual trends in Div. 3NO commercial CPUE.

Biomass

The resource has been concentrated along the shelf edge in these divisions. Estimates of the fall survey biomass indices have wide margins of error and show no clear trend. Therefore no inferences about biomass can be made from these data. **CPUE** has remained high in recent years relative to other areas, but decreased by 31% between 2002 and 2005.

Recruitment Prospects

The observer **pre-recruit** index indicates that **recruitment** has decreased and is expected to remain low in the short term (Fig. 19).

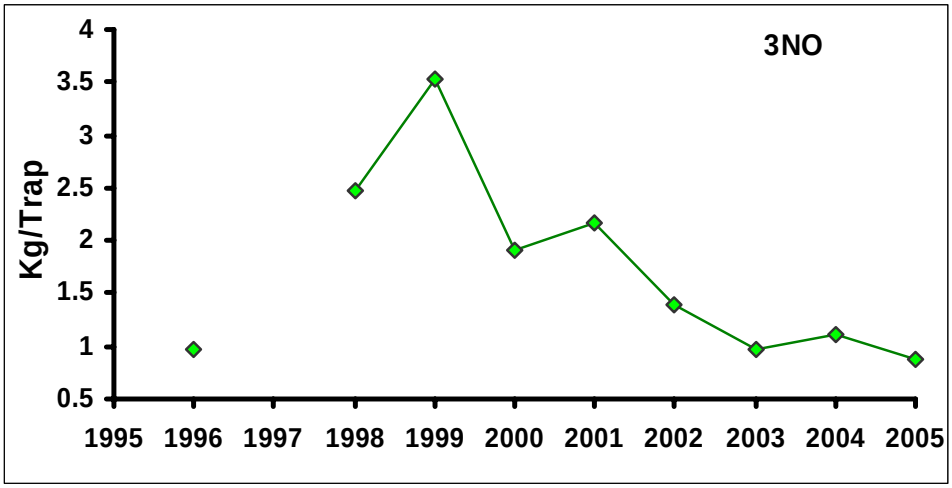


Figure 19: Annual trends in the Div. 3NO observer pre-recruit index.

Mortality

The **exploitation rate index** and **pre-recruit 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. 20) declined by more than half from 1999-2002. It has remained steady during the last 4 years at a low level, implying little wastage of pre-recruits.

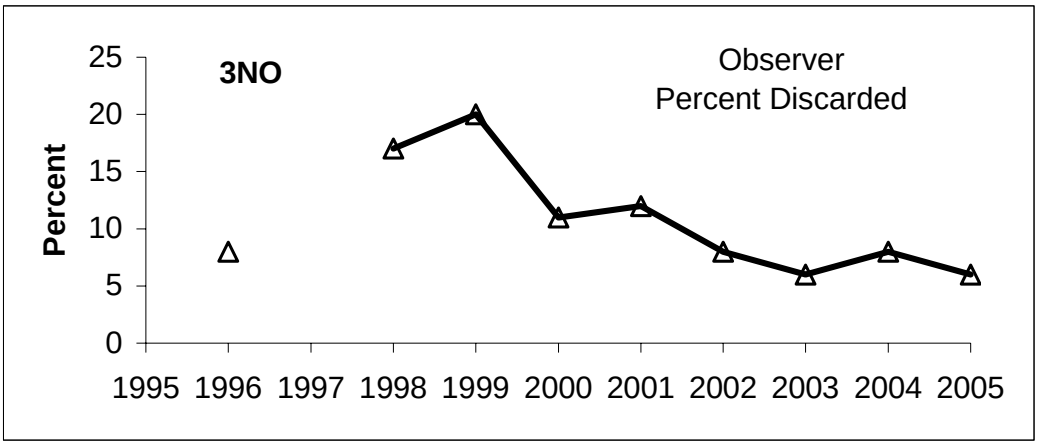


Figure 20: Annual trends in the percentage of the catch discarded in the Div. 3NO fishery.

Resource Status, Subdivision 3Ps

Commercial Fishery

The fishery began in 1985 with **landings** (Fig. 2) not exceeding 1000 t until 1994 when the offshore fishery began. Landings rose steadily until 1999 due to increased TACs and averaged 7800 t during 1999-2002. They declined by 58% from 7600 t in 2002 to 3200 t in 2005, while the TAC was reduced by 46%. **Effort** increased by 59% from 2001-2003 before decreasing by 29% to 2005.

Offshore CPUE declined by 75% from 1999 to its historical low in 2005. **Inshore CPUE** declined by 70% from 2001 to its historical low in 2005 (Fig. 21).

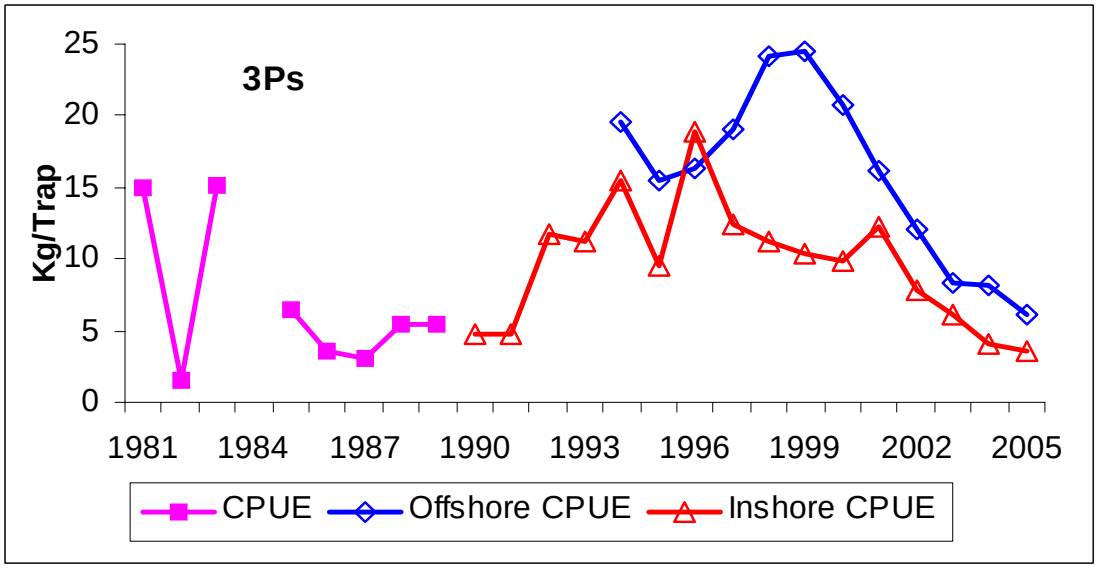


Figure 21: Annual trends in Subdiv. 3Ps commercial CPUE.

Biomass

No **exploitable biomass index** is available as there are insufficient fishery independent data from this area. For unknown reasons, indices from spring surveys are highly variable. **Offshore CPUE** declined by 75% from 1999 to its historical low in 2005 (Fig. 21). **Inshore CPUE** declined by 70% from 2001 to its historical low in 2005 (Fig. 21).

Recruitment Prospects

The observer discard **pre-recruit index** (Fig. 22) changed little during 1999-2004 but almost doubled in 2005. Although spring survey biomass indices are considered unreliable, biological data from these surveys agree with observer data and suggest that **recruitment** should increase over the next 3 years.

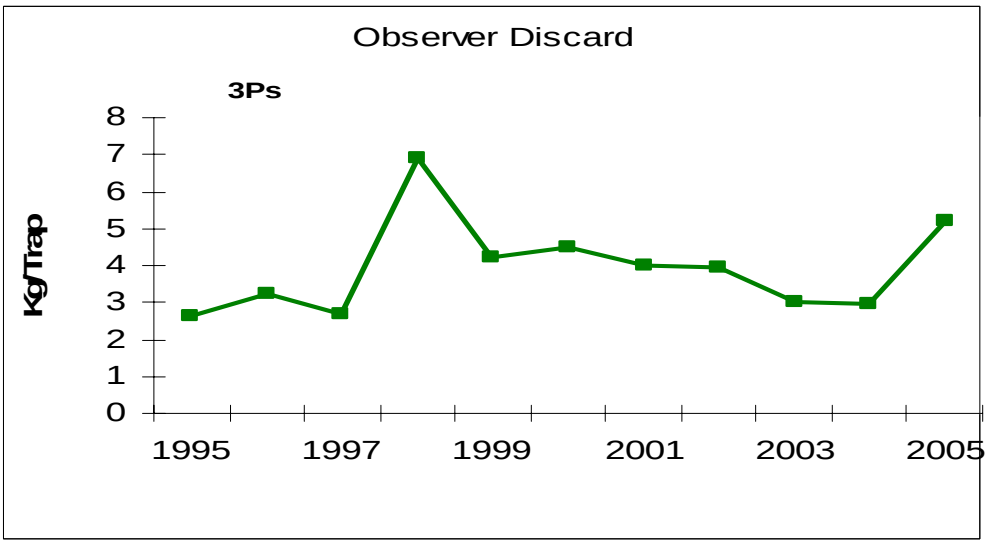


Figure 22: Annual trends in the Subdiv. 3Ps observer discard pre-recruit index.

Mortality

No **pre-recruit 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. 23) more than doubled to about 80% in 2005 implying increased wastage of pre-recruits.

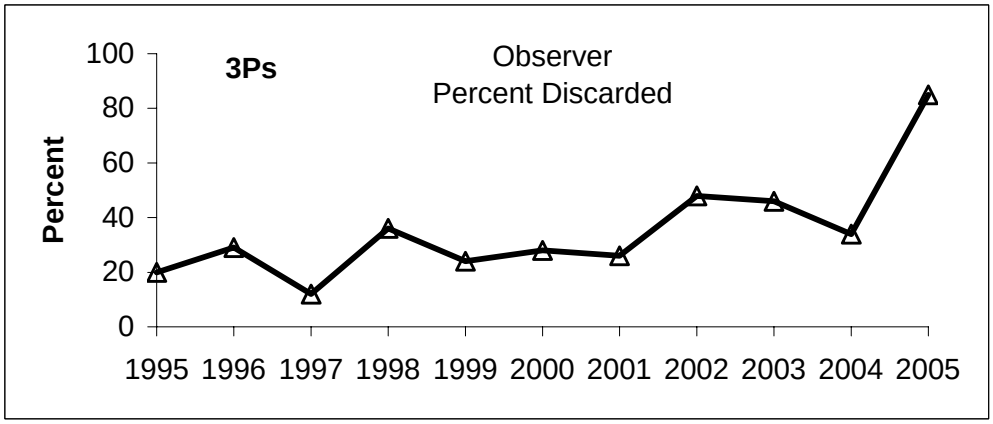


Figure 23: Annual trends in the percentage of the catch discarded in the Subdiv. 3Ps fishery.

Resource Status, Division 4R and Subdivision 3Pn

Commercial Fishery

Landings (Fig. 2) increased by 88% from 930 t in 1997 to peak in 2002 at 1850 t. They then declined, by 54%, to 860 t in 2005, while the TAC changed little. **Effort** increased by 13% during 2002-2004 and dropped by 42% in 2005. CPUE is consistently low relative to other divisions (Fig. 24).

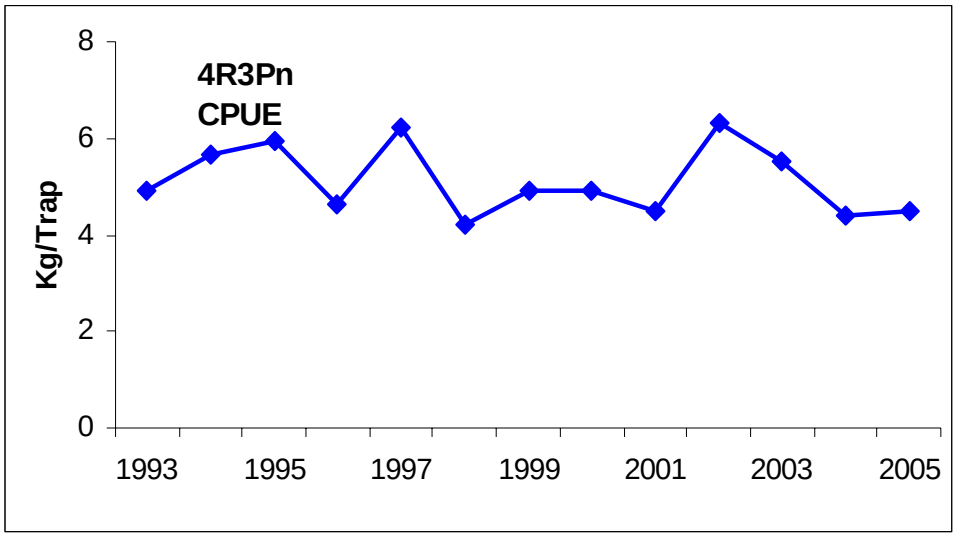


Figure 24: Annual trends in Div. 4R and Subdiv. 3Pn commercial CPUE.

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**.**

Fishery independent data from this area are insufficient to assess resource status.

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 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.

ADDITIONAL STAKEHOLDER PERSPECTIVES

Division 2J

Based on catch rates there appeared to be improvement in the status of the resource in 2005. While harvesters are optimistic about the improvement continuing in 2006 they want to take a cautious approach and do not recommend an increase in TAC. Harvesters recommend no changes in the 2005 Conservation Harvesting Plan (CHP) and recommend the TAC remains unchanged and the snow crab working group continue for the 2006 fishing season.

Division 3K

The commercial fishery and the commercial CPUE would have reflected a higher level of fishery performance, had the fishery been allowed to start earlier. Harvesters have improved handling practices significantly during the last few years and the soft-shell protocol they helped put in place for the 2005 season further reduced mortality by closing the fishery 4 weeks early. If the fishery is opened early and the 2005 CHP is again implemented for 2006, harvesters feel there will be no reason to reduce the 2006 TAC below what it was for 2005.

Division 3LNO

Quotas were caught in 2005, CPUE remained about the same as it was during 2004 and there were no significant occurrences of soft-shelled crabs. Harvesters have significantly improved handling practices in the last few years and are attempting to keep mortality to a minimum.

The implementation of a vessel monitoring system (VMS) has resulted in improved tracking of vessels and, as a result, logbook information since 2003 represents a more accurate picture of fishing activity. CPUE data is also more reflective of biomass by crab management area (CMA).

CPUE and total landings from some areas have been affected by economic factors. To reduce travel cost between CMAs, fishing activity sometimes takes place along a boundary between two areas. Where harvesting is now occurring is sometimes not where abundance is highest or where past fishing activity had taken place and as a result logbook data may show a decline in CPUE. Recent increases in operating costs and the implementation of trip limits have combined to cause portions of IQs to remain uncaught. As a result, there has been a decline in landings for some areas.

Harvesters feel that the 2005 fishery was positive from a resource status perspective and recommend the TAC for 2006 remain unchanged from 2005.

Sub-division 3Ps

Harvesters feel that the 2005 fishery was severely impacted by the late start date. Early results from the 2005 fishery were very positive and if the fishery had opened earlier the TAC could have been harvested prior to encountering soft-shelled crabs. Harvesters have observed good recruitment prospects. They feel that an earlier start date to the 2006 fishery will produce far more positive results and provide a more accurate and optimistic view of the status of this stock. Harvesters recommend the TAC for 2006 remain unchanged from 2005.

Division 4R

Despite an overall decrease in landings in 2005, the fishery remained strong in inshore areas 12E and 12F (Bay of Islands) and 12G (Bonne Bay). There were some good catches reported in the offshore zone (OS8), and this fishery was primarily concentrated in an area adjacent to the Bay of Islands. While landings were down in other inshore zones, all fleets attributed the late start to the season as being an important factor in this result. In areas where catches have declined, harvesters are confident that an earlier start to the fishery will result in improved landings in 2006.

CONCLUSIONS AND ADVICE

Division 2J

Trends in both the fall survey exploitable biomass index and fishery CPUE indicate that the **biomass** declined steadily during 1998-2004 and increased slightly in 2005. Landings decreased over the past three years, and the exploitation rate index has declined in the past two years. **Recruitment** is expected to increase in 2006.

Although fishery-induced mortality has decreased, the exploitable biomass remains low. Increase in exploitation in 2006 may impair further recovery.

Division 3K

Trends in both the fall survey exploitable biomass index and fishery CPUE indicate that the **biomass** has declined over recent years. Both offshore and inshore CPUE decreased in 2005 despite a substantial reduction in landings. **Recruitment** is expected to remain unchanged or

increase slightly in the short term. Fishery-induced **mortality** in 2005 was similar to the long-term average.

The exploitable biomass remains low. Any increase in exploitation in 2006 would further impair recovery.

Division 3L

The effect on exploitation rate of maintaining the current catch level remains unclear because trends in the exploitable biomass index and CPUE do not agree. However, offshore CPUE remains high relative to other areas and there has been a low level of wastage of pre-recruits.

Stability of the observer-based percentage of the total catch discarded (pre-recruit wastage index) in recent years, while landings and survey mortality indices have changed little, suggest that fishery-induced mortality has remained stable. Therefore the current level of fishery removals would not likely result in increased mortality on either the exploitable or the pre-recruit population.

Divisions 3NO

Survey indices are unreliable. Although the fishery continues to perform at a high level relative to other areas, CPUE has declined since 2002. **Recruitment** is expected to remain relatively low in the short term.

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

Subdivision 3Ps

CPUE trends indicate that the exploitable biomass has become depleted. Recruitment prospects have improved. Exploitation, in the short term, would likely impair recovery of the exploitable biomass.

Division 4R and Subdivision 3Pn

The fishery has contracted spatially in recent years, which compromises interpretation of CPUE trends.

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

OTHER CONSIDERATIONS

Reproductive Biology

The percentage of mature females carrying full clutches of viable eggs has remained high throughout the time series, despite reduced abundance of legal sized adults.

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 1996-2005. This disease, which is fatal to crabs, occurs in new-shelled crab of both sexes and appears to be acquired during molting. Prevalence increases with size in new-shelled adolescent (i.e., non-terminally molted) males. It is uncommon in Divisions 3NOP4R and has been most prevalent in Division 3K. Prevalence has recently increased, particularly in Division 3L.

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 Divisions 2J3K. 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 2002-2005. It would be premature to draw any conclusions regarding the impact of this closure on the snow crab resource. An area of 3K, in the Funk Island Deep, was first closed to gillnetting in 2002 and then closed to bottom trawling in 2005.

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, but the implications for mortality are unknown. **Cannibalism** is known to occur but there are no data on spatial or annual variation in its prevalence.

Management Considerations

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.

SOURCES OF UNCERTAINTY

There is uncertainty regarding the effects of changes in some fishing practices (e.g. 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. The full implementation of VMS in 2004 should improve reliability in the future.

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, as well as biological parameters such as proportion molting, growth rate, and natural mortality. There is additional uncertainty in the indices for Divisions 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 Division 3L were not surveyed in 2004.

Recruitment, pre-recruit mortality, and wastage 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. Furthermore, handling imposes a high mortality on discarded crabs. It is uncertain how handling practices have changed over time, although they have reportedly improved recently.

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ISSN 1480-4913 (Printed)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO, 2006. Assessment of Newfoundland and Labrador Snow Crab. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/006.