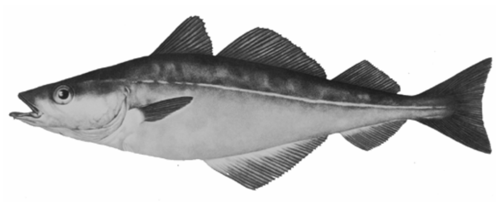
# POLLOCK IN DIV. 4VWX+5



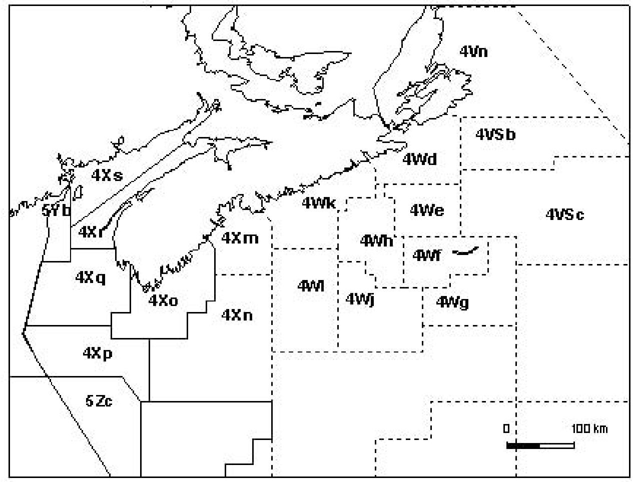



*Figure 1 The pollock management unit, showing unit areas comprising the Western Component (solid lines) and Eastern component (dashed lines).*

## *Context :*

*Significant Canadian fisheries for pollock occur on the Scotian Shelf, eastern Georges Bank, and the Bay of Fundy using primarily otter trawl and gillnets, but also handlines and longlines. Pollock are also caught in the small-mesh redfish fishery.*

*The initial management unit for the western Atlantic pollock resource, established by the International Commission for the Northwest Atlantic Fisheries (ICNAF) in the 1970s, included Division 4X (Western Scotian Shelf/Bay of Fundy) and Subarea 5 (Gulf of Maine/Georges Bank). At the time, it was noted that stock structure was not well understood. In 1974, the management unit was expanded to include divisions 4V and 4W. After the establishment of the International Maritime Boundary between Canada and the USA in 1984, Canada reviewed the stock structure of pollock and concluded that the amount of transboundary movement was not sufficient to affect stock conservation benefits if Canada undertook unilateral management of the resource within its own waters.*

*For Canadian management purposes, the southernmost limit of the stock is considered to include fish in the Canadian portion of Georges Bank and the Gulf of Maine north to the Laurentian Channel. A detailed evaluation of stock structure in 2003 indicated that the management unit is represented by two population components: a slower-growing Eastern Component including divisions 4V and 4W, as well as Unit Areas 4Xm and 4Xn, and a faster-growing Western Component including 4Xopqrs as well as Canadian portions of Subarea 5. The Western Component is currently the main focus of the analytical assessment. For management purposes, DFO still continues to manage the Western Component as all of NAFO Area 4X+5*

*The last comprehensive review of the assessment framework was completed in 2003 and 2004. The last analytical assessment providing management advice on 4VWX+5 pollock was completed in 2006. Advice was requested by Fisheries and Aquaculture Management (FAM) Branch on the current status of the pollock resource.*

# SUMMARY


## Western Component

- Since 2000, fishery removals have averaged 6,000 t. The Western Component of the management unit contributed 87% and 81% of total landings in 2006 and 2007.

- Estimates of Age 4+ (considered spawning stock) biomass declined from about 66,000 t in 1984 to about 7,500 t in 2000. Biomass has been rebuilding since 2000, increasing steadily to about 29,000 t in 2007, but declining to 27,000 t in 2008.

- The 2001 year-class is estimated to be the strongest since the 1988 year-class. Early indications for the 2004 and 2005 year-classes are that they are the lowest in the time series.

- Fishing mortality rates steadily increased from the early 1980s to above 1.0 by the early 1990s and remained high until the early 2000s. Subsequent reduced quotas and harvests as well as increasing population biomass have contributed to a decline in the fishing mortality rate on ages 6-9, which has been below the $F_{ref}$ of 0.2 since 2006.

- The range of harvest strategies in the fishing year that are risk averse (25% risk of exceeding $F_{ref}$) to risk neutral (50% risk of exceeding $F_{ref}$) is about 3,700 to 4,400 t. If fished at $F_{ref}$, the projected 2009/2010 Age 2+ catch biomass is 4,100 t. At this level of harvest, Age 5+ population biomass will decrease from 2009 to 2010.

- If recruitment at Age 2 for the 2004 and 2005 year-classes is not as low as the model estimates and is set to the lowest level in the time series (3.4 million), the range of harvest strategies is about 4,100 to 4,750 t. If fished at $F_{ref}$, the projected 2009/2010 Age 2+ catch biomass is 4,500 t, and at this harvest level, population biomass is expected to stay the same from 2009 to 2010.

- These harvest strategies are for 4Xopqrs+5 and would be conservative if applied to all of 4X+5, which is the current approach used by FAM.

## Eastern Component

- Landings from the Eastern Component, traditionally from the Tonnage Class (TC) 4+ sector, have declined substantially. Since 1993, much of the Eastern Component has been closed to cod and haddock directed fishing, which further reduced pollock landings from this area.

- DFO research vessel (RV) summer survey biomass, while variable, followed a declining trend from the early 1990s to 2006, the third lowest level in the time series. Since then, the index has increased to levels not seen since the mid-1990s. Most of the recent increase is attributed to higher catches from RV survey tows in 4Xmn and not in 4VW. Directed pollock fisheries in the Eastern Component should proceed with caution.

- DFO RV indices for the Eastern Component show a different pattern from the Western Component, with more Age 3 and Age 4 fish present for the past two years.

## Ecosystem Considerations

- The current level of observer coverage in 4X is far too low to provide meaningful bycatch estimates, but spiny dogfish appears to be the most commonly discarded bycatch species, with other species occurring at low levels.

- The habitat over which the directed pollock fishery takes place is highly energetic and of high complexity. The impact of the pollock fishery on the sea floor is currently unknown.

- The diet of pollock from the Scotian Shelf and Bay of Fundy has shown decadal changes, with euphausiids (krill) being the predominant prey in the 1960s and 1980s, less so in the 1990s, but have been predominant again since 2003.

# INTRODUCTION

## Biology

Pollock (*Pollachius virens*) is a gadid fish species found on both sides of the North Atlantic, ranging from Davis Straight to North Carolina in the west and from the Bay of Biscay to the Barents Sea around Iceland and southern Greenland in the east.

The life history of pollock in the Northwest Atlantic involves an offshore spawning and larval phase, recruitment to the coastal environment for a period of one to two years, followed by an offshore migration. On the Scotian Shelf and in the Gulf of Maine, pollock are found at depths ranging from 35 to 380 m with bottom temperatures varying from 5 to $8^{o}$ C. Unlike other cod-like fishes, pollock show strong schooling behaviour and spend less time on the bottom and more time moving freely through the water column than its bottom-living relatives. Tagging studies have shown that pollock are capable of travelling long distances.

Several spawning areas have been identified on the Scotian Shelf, as well as a major spawning area in the western Gulf of Maine. Spawning occurs from November through February. Sexual maturation is essentially complete by Age 6, although more than 50% of fish are mature by ages 3 to 4 (45-50 cm), depending on geographic area. They begin to reach commercial size at Age 3, and are considered fully recruited to the commercial fishery by Age 7. Pollock are relatively long lived, attaining a maximum age of 23 years and may reach lengths of 110 cm and weights of 16 kg.

Juvenile pollock feed on crustaceans, especially small euphausiids and amphipods, although small fishes, especially herring and sand lance are also consumed. Food of adult pollock includes euphausiids, squid and fish such as herring, sand lance, and silver hake. Predators include Atlantic cod, white hake, and monkfish as well as grey and harbour seals.

## Rationale for Assessment

Advice was requested by Fisheries and Aquaculture Management on the stock status of pollock to inform management of the 2007/2008 and 2008/2009 fishery. Specifically:

- Review and evaluate biological and fishery information on 4VWX+5 pollock stock status to be used as the basis for establishing the TAC for the 2009/2010 fishery.

- Update the advice using the 2004 assessment framework and the latest information from fisheries and research surveys.

- Evaluate the impact of pollock and the pollock fishery in an ecosystem context, including:
  - o Descriptions of bycatches
  - o Comment on possible benthic impacts
  - o Update information on pollock predator/prey interactions

## The Fishery

For 2008, landings in the fishery from 4VWX+5 April 1st through December 31st are 4,246 t. Peak landings in 1987 were 46,000 t; landings since 1999 have been less than 10,000 t (Table 1, Figure 2).

Table 1. Landings and TACs (000s t) for pollock in 4VWX5.[1]

| Year | 1970-1979 avg. | 1980-1989 avg. | 1990-1999 avg. | 2000-2003 avg | 2004 | 2005 | 2006 | 2007 | 2008[2] |
|---|---|---|---|---|---|---|---|---|---|
| TAC | | 46.9 | 24.2 | 10.0 | 10.0 | 6.5 | 4.5 | 5.0 | 5.8 |
| EAST | 7.8 | 21.2 | 7.7 | 0.6 | 0.4 | 0.7 | 0.5 | 1.1 | |
| WEST | 14.1 | 17.4 | 11.8 | 5.7 | 8.6 | 5.6 | 3.8 | 4.4 | |
| TOTAL | 21.9 | 38.6 | 19.5 | 6.9 | 9.0 | 6.3 | 4.3 | 5.5 | |

[1]Commencing in 2000, fishing year, landings and TAC refer to the period April 1st of the current year to March 31st of the following year.

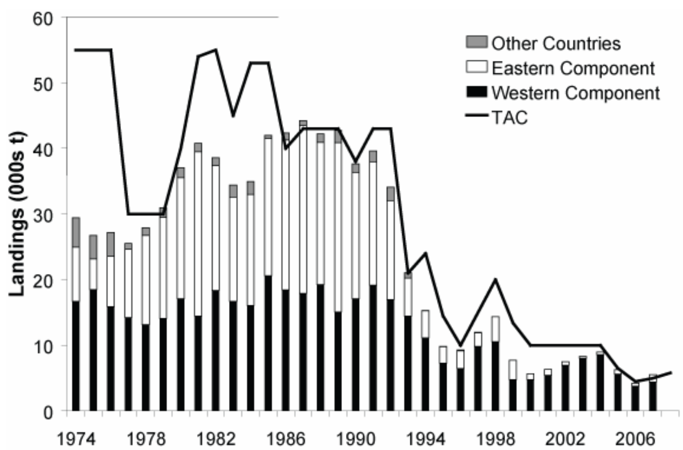



*Figure 2. Landings[1] and TACs for pollock in 4VWX+5, for the Eastern and Western components. Foreign landings are also included.*

The pollock fishery has had significant changes in both area fished and in dominant gear type. Landings from the Eastern Component, traditionally from the Tonnage Class (TC) 4+ sector, have declined substantially. Since 1993, much of the Eastern Component has been closed to cod and haddock directed fishing, which further reduced pollock landings from that area. In the fall of 2007 and 2008, the mobile gear sector was allowed to participate in a test fishery in 4VsW which resulted in landings of 586 t and 373 t, respectively.

Since 2000, fishery removals have averaged 6,000 t. The Western Component of the management unit contributed 87% and 81% of total landings in 2006 and 2007. The contribution of larger trawlers (TC 4+) to total landings has been steadily declining since 1988 and in 2008 there were no vessels of this tonnage class (Figure 3). The offshore sector uses smaller vessels (TC 1-3) to catch their allocation. Since the early 1980s, the small mobile gear component has accounted for most of the total landings. The percentage of total landings taken by gillnets has declined since 2000.

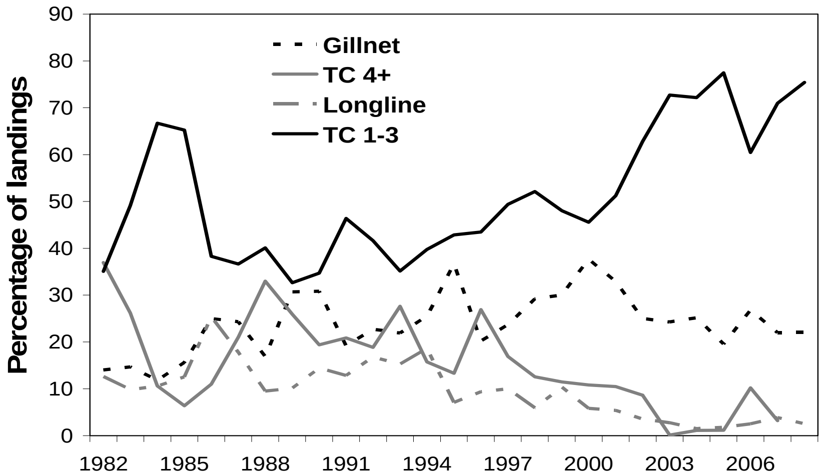



*Figure 3. Percentage of landings by gear type for the Western Component, 1982-2008.*

Landings from the Western Component now come mostly from Unit areas 4Xpq and have declined substantially from all other areas, i.e., Bay of Fundy, Georges Bank, and 4Xo (Figure 4).

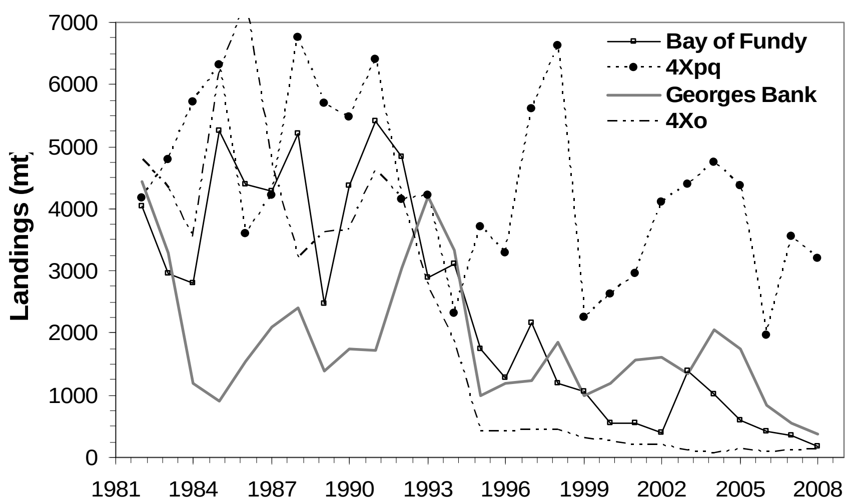



*Figure 4. Pollock landings by area for the Western Component, 1982-2008.*

# ASSESSMENT

## Stock Trends and Current Status

### Western Component

**Mobile gear catch rates** (CPUE; TC 1-3) have generally declined from a peak in 1984 to a low in 1999, then increased again in 2002, but declined to the second lowest level in the time series in 2006 (Figure 5). Since 2006, catch rates have been higher but variable. Catch rates from 2005 to 2008 were constrained by reduced quotas and changes in fishing practices and are not comparable to those earlier in the time series. The current view is that since 2004, this series may no longer reflect trends in relative abundance.

The summer **RV survey** biomass index, while variable, has been showing a general increasing trend since 2002 (Figure 5). Strong year-effects are apparent in the time series (i.e. 1988, 1990, 1996, 2006) and reflect the semi-pelagic schooling behaviour of pollock and changes in catchability. **Bottom trawl surveys** conducted by the US National Marine Fisheries Service (NMFS) in the Gulf of Maine/Georges Bank region (NMFS Spring, NMFS Fall) also indicate a general trend of increasing biomass for pollock and support recent trends from the DFO survey (Figure 6).

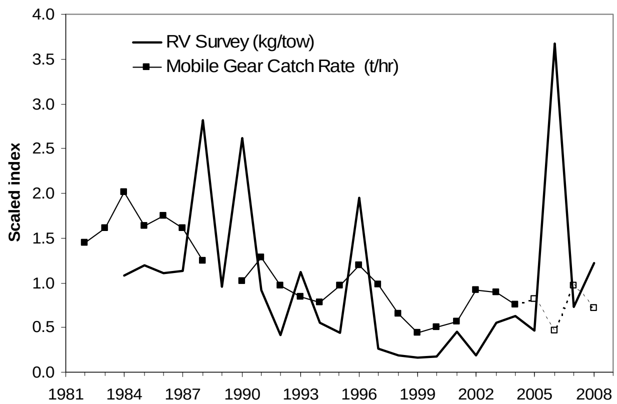



Figure 5. Mobile gear (TC 1-3) catch rates (kg/hr) and DFO summer survey biomass index (kg/tow).

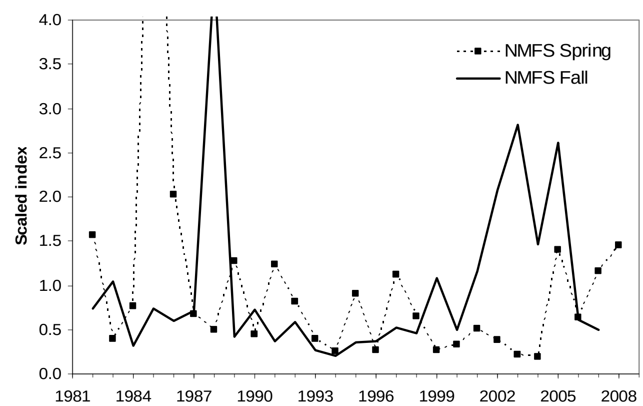



Figure 6. NMFS Spring and NMFS Fall survey biomass indices (kg/tow).

Age-specific **indices of abundance** from the mobile gear sector of the fishery indicate a reduction in the abundance of older (Age 7+) fish since 1996 with a modest expansion of the age composition since 2006. In recent years, the 1999 and 2001 year-classes have been relatively strong, and have made significant contributions to the landings. The 2002 (Age 6) and 2003 (Age 5) year-classes were predominant in the series this year, notwithstanding problems with the time series for 2005-2008 (Figure 7).

Consistent with the CPUE indices, the DFO RV indices also show that the 1999 and 2001 year-classes were strong (Figure 8). While more older fish are present now than in the past (ages 7 and 8), incoming recruitment (i.e. the 2004 and 2005 year-classes at Age 3) appears to have been very weak for the past two years.

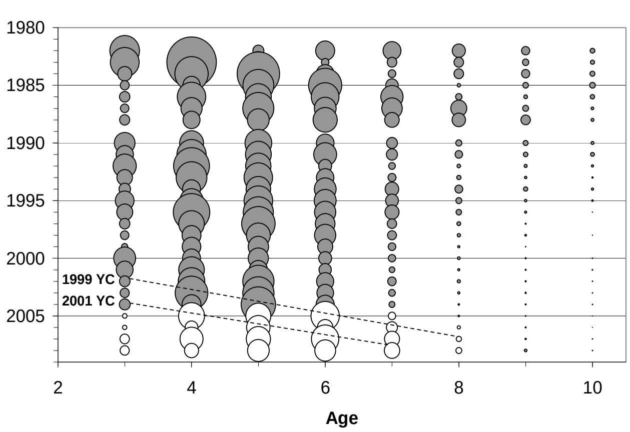



Figure 7. Mobile gear (TC 1-3) standardized catch rates at age. The index value is proportional to bubble area. (White bubbles represent years that were not included in the population model).

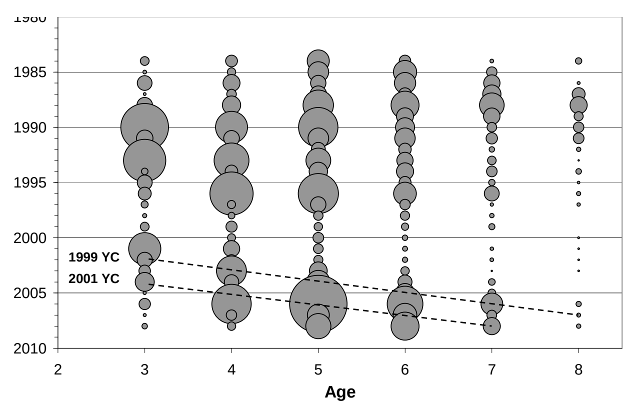



Figure 8. RV survey indices at age for the Western Component. The index value is proportional to bubble area.

The following results are based on an age-structured population model developed for the Western Component that incorporate indices of abundance from both the DFO summer research vessel survey (1984-2008) and standardized CPUE from the commercial fishery (1982-2004), excluding the most recent four years.

Concerning **recruitment**, the 2001 year-class was estimated to be slightly lower than indicated from the 2006 assessment, was the strongest at Age 2 since the 1988 year-class, and the third highest in the time series (Figure 9). Early indications for the 2004 and 2005 year-classes are that they are the lowest in the time series, while the 2002 and 2003 year-classes are about average.

Estimates of Age 4+ (considered spawning stock) **biomass** declined from about 66,000 t in 1984 to about 7,500 t in 2000. Biomass has been rebuilding since 2000, increasing steadily to about 29,000 t in 2007 then declining to 27,000 t in 2008 (Figure 9). (During the framework review, it was concluded that the probability of good recruitment is higher when adult biomass is > $B_{ref}$ = 30,000 t.) The current estimate of 2006 Age 4+ biomass (23,000 t) is lower than indicated from the 2006 assessment (30,000 t) which was influenced by the overly optimistic 2006 survey indices for several year-classes.

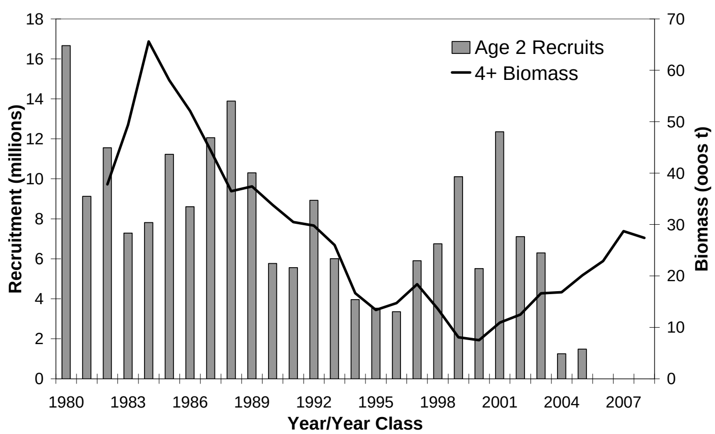



*Figure 9. Trends in Age 4+ biomass and Age 2 recruitment of pollock for the Western Component.*

The fishery **weights at age**, which are used as a proxy for population weights at age for ages 5 and older, had been decreasing since the early 1980s, but seem to be levelling off or increasing now (Figure 10). RV survey weights at age (Figure 11) are much more variable, but generally exhibit similar trends.

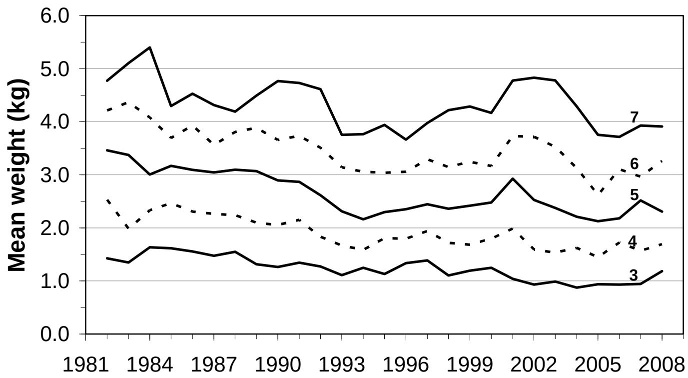



*Figure 10. Commercial fishery weights at age for pollock in the Western Component.*

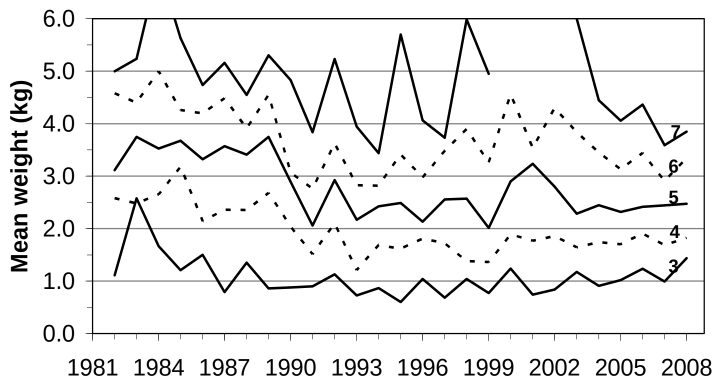



*Figure 11. Research vessel survey weights at age for pollock Western Component.*

**Fishing mortality** rates steadily increased from the early 1980s to above 1.0 by the early 1990s and remained high until the early 2000s. Subsequent reduced quotas and harvests, as well as increasing population biomass, have contributed to a decline in the fishing mortality rate on ages 6-9, which has been below the $F_{ref}$ of 0.2 since 2006 (Figure 12).

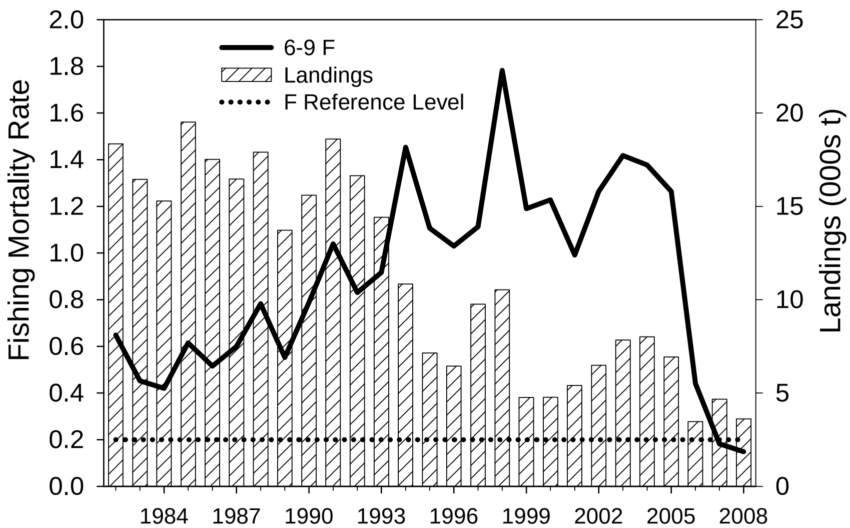



*Figure 12. Trends in fishing mortality and landings of pollock for the Western Component.*

## Eastern Component

DFO RV summer survey biomass, while variable, followed a declining trend from the early 1990s to 2006, the third lowest level in the time series. Since then, the index has increased to levels not seen since the mid-1990s (Figure 13). Biomass declined in the east in 2008, but was still relatively high compared to the past decade. Most of the increase over the past two years is attributed to higher catches from RV survey tows in 4Xmn, and not in 4VW. There have been relatively few tows with good catches from the Eastern Scotian Shelf region since the mid-1990s.

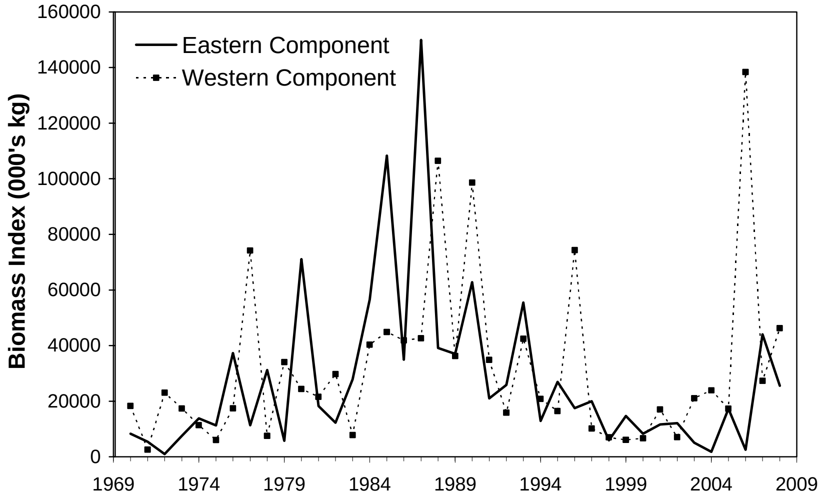



*Figure 13. Trends in survey biomass indices for pollock from the Eastern and Western components.*

DFO RV indices for the Eastern Component show a different pattern from the Western Component, with more Age 3 and Age 4 fish present for the past two years (Figure 14). The 2004 year-class (Age 4) is predominant in 2008, while the 2002 year-class (Age 5) is strong in 2007, a pattern that is consistent with the age composition from fall test fisheries in 4W. This implies that there may be a linkage between 4Xmn and 4W, with an eastward movement of pollock from July through October.

For the Eastern Component, relative fishing mortality (landings/survey biomass) for all fisheries in 4W and 4Xmn is currently low at 3% and 2% for 2007 and 2008, respectively.

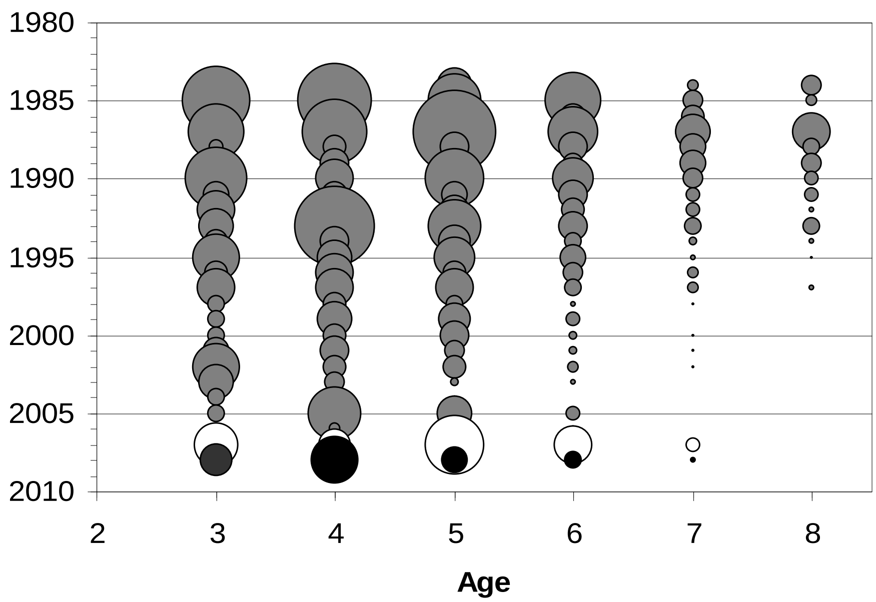



*Figure 14. RV survey indices at age for the Eastern Component. The index value is proportional to bubble area. The 2007 and 2008 survey values are shaded white and black, respectively.*

## Ecosystem Considerations

### Bycatch

With the exception of the 2007/2008 4W test fisheries and to a lesser extent 5Z, the current level of observer coverage for pollock directed mobile gear fisheries in 4X is low and may not be representative of fishing activities in this area, Notwithstanding these limitations, most of the total catch (82-99%) is landed and counted against respective quotas for these species. Spiny dogfish appears to be the most commonly discarded bycatch species, with other species occurring at low levels.

Pollock are also caught in the small mesh redfish fishery, particularly in Crowell, Jordan, and LaHave basins, and represent 22% of the observed total catch weight for 2006-2008. Based on comparisons of port (dockside) and observer (at sea) size compositions, pollock < 40 cm may be discarded at sea.

Bycatch discards may also occur in the 4X pollock gillnet fishery, but observer coverage is far too low (i.e. two trips for 2006-2008) to make any conclusions.

### Habitat Impacts

Offshore pollock aggregations are associated with hard bottom topographic features such as rises, ridges or mounts, and the location of mobile and fixed gear fisheries are often in close proximity to these features. Some of these are areas of high complexity and high energy (currents generated by tides, wind, and storms). The physical effects on the bottom from pollock fisheries using mobile and fixed gear, and subsequent effects on benthic communities are unknown. While some information exists on the effects of bottom trawl fisheries (DFO, 2006), very specific studies would be required to assess the impact of pollock fisheries on benthic communities.

### Food and Feeding Habits

The diet of pollock from the Scotian Shelf and Bay of Fundy has shown decadal changes, with euphausiids (krill) being the predominant prey in the 1960s and 1980s, less so in the 1990s, but has been predominant again since 2003. The decline in the 1990s was associated with changes in euphausiid abundance. Concurrent with the decrease in krill and other crustaceans in the diet during the 1990s was an increase in the consumption of fish prey, especially by large pollock.

While euphausiids are a main component of the diet overall, pollock increase their consumption of fish prey as they grow, with silver hake, herring, and sand lance being the largest contributors. Pollock show daily and seasonal feeding patterns, with stomach fullness being highest during early evening, especially during summer, autumn, and winter. The proportion of empty stomachs is generally highest during spring, and may be due to a post spawning recovery period. Condition (plumpness) of pollock in 4VWX has declined through to the late 1990s, but since then it has been variable but stable.

Pollock are prey to several species including cod, white hake and silver hake, as well as grey and harbour seals.

## Sources of Uncertainty

Including the mobile gear CPUE time series (1982-2004) as a tuning index improved the model fit, but catch rates since 2004 are not included because they may no longer reflect abundance.

Pollock, being a semi-pelagic, schooling species, are less well sampled by the summer RV survey than other gadids. This creates high variability in the RV abundance index from year to year.

The Virtual Population Analysis (VPA) model results showed high relative error for the current population abundance estimates of ages 3 and 4 and generated low estimates for population abundance at Age 2 (recruitment) for 2004 and 2005, which were beyond the range of past model predictions. If the lowest observed level of predicted recruitment for the VPA time series (3.4 million recruits) is used for projections and risk analyses, harvest strategies are more optimistic.

There is a concern over the lack of summer survey coverage on the Canadian portion of Georges Bank, which is part of the Western Component. Excluding this area from the survey indices could make a difference to the assessment results if the pollock biomass on Georges Bank was increasing or decreasing more than the biomass in 4X.

There is uncertainty as to whether the pollock observed in 4Xmn during the summer survey are the same fish captured in the 4W fall test fisheries (although the size and age composition appears to be similar).

There is a lack of fishery size/age composition data for fixed gear fisheries in the Eastern Component.

Discarding of small pollock from the 4Xpq redfish fishery may compromise catch at age calculations.

The current level of observer coverage in 4X is far too low to provide meaningful bycatch estimates.

# CONCLUSIONS AND ADVICE

The range of harvest strategies for 4Xopqrs+5 in the 2009/2010 fishing year that is risk averse (25% risk of exceeding $F_{ref}$ of 0.2) to risk neutral (50% risk of exceeding $F_{ref}$) are about 3,700 to 4,400 t (Figure 15). If fished at $F_{ref}$, the projected 2009/2010, Age 2+ catch biomass is 4,100 t, 83% of which will be represented by ages 6-8. At this level of harvest, Age 5+ population biomass will decrease from 2009 to 2010.

Alternatively, if recruitment at Age 2 for the 2004 and 2005 year-classes is not as low as the model estimate and is set to the lowest observed level in the time series (3.4 million), then the range of harvest strategies (risk averse to risk neutral) is about 4,100 to 4,750 t (Figure 16). If fished at $F_{ref}$, the projected 2009/2010, Age 2+ catch biomass is 4,500 t, and at this harvest level, population biomass is expected to remain the same from 2009 to 2010.

These harvest strategies would be conservative if applied to all of 4X+5, which is the current approach used by FAM. This risk analyses does not incorporate the uncertainties as noted above and overstates the precision of the estimates of $F_{ref}$ yield outcomes.

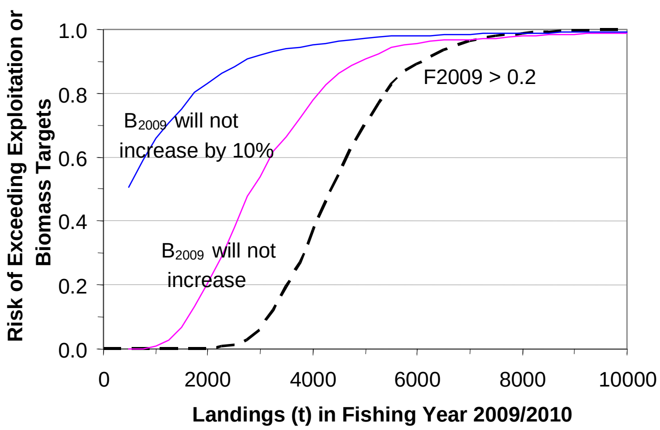



*Figure 15. Risk of exceeding Age 5+ exploitation or biomass rebuilding targets for the Western Component from the Base VPA model which estimates recruitment for all years.*

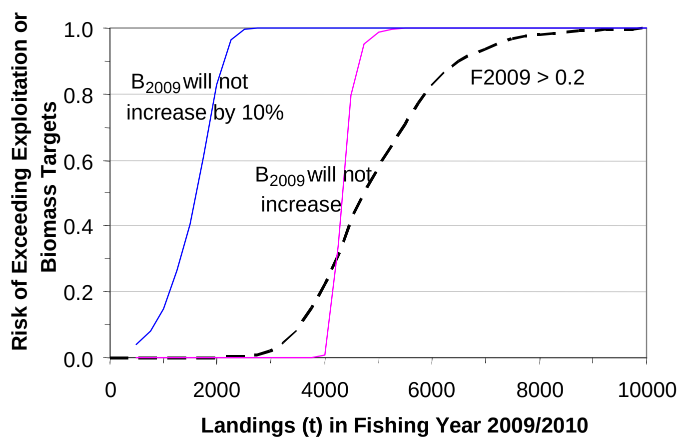



*Figure 16. Risk of exceeding Age 5+ exploitation or biomass rebuilding targets for the Western Component from the Base VPA model with assigned recruitment (3.4 million) at age 2 for 2006-2008.*

While the current level of removals in the Eastern Component has allowed for some rebuilding (i.e. in 4Xmn), this population has not rebuilt yet, especially in 4V. Therefore, directed pollock fisheries for the Eastern Component should proceed with caution.

## SOURCES OF INFORMATION

DFO, 2009. Proceedings of the Maritimes Region Science Peer Review on the 4VWX+5 Pollock Stock; 19-20 January 2009. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2009/017.

DFO, 2006. Impacts of Trawl Gears and Scallop Dredges on Benthic Habitats, Populations and Communities. DFO Ca. Sci. Advis. Sec. Sci. Advis. Rep. 2006/25.

DFO, 2004. Proceedings of the Pollock Framework Assessment: 1 May 2003, 16-18 June 2003 and 6-8 April 2004. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2004/030.

Stone H.H., C. Nelson, D. Clark, and A. Cook. 2009. 2008 Assessment of Pollock in 4VWX+5. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/001.

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