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2006 Assessment of Pollock in 4VWX and 5Zc

Évaluation de la goberge dans 4VWX et 5Zc en 2006

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ABSTRACT

Fishery removals from the Western pollock stock component (4Xopqrs+5Yb+5Zc) averaged 6000 t since 2000 and contributed 92% of total landings in 2005. Mobile gear catch rates in 2006 were at the second lowest level in the time series. Catch rates for 2005 and 2006 were not comparable to those observed earlier in the time series when quotas were not limiting. The 2006 RV biomass index was at the highest observed level in the time series, and although this was an obvious year effect, there has been a general increasing trend since 2003. Other surveys indicated a general trend of increasing rather than decreasing abundance for pollock and supported recent trends from the DFO RV survey. Fishery weights at age, which are used as a proxy for population age 5+ weights at age, have been decreasing since about 1984. RV survey weights at age for these age groups did not show this same declining trend, indicating that the fishery weights may be influenced by changes in fishing patterns. Using a Modified Base VPA (which excludes 2005 and 2006 from the catch rate index), age 4+ biomass has increased from a low of about 7500 t in 2000 to 30000 t in 2006. The 2001 year class is estimated at nearly 15 million recruits and is the strongest since the 1980 year class. Reduced quotas and harvests have contributed to a decline in fishing mortality rates on ages 6-9, which is now just below the F_{ref} of 0.2. The range of harvest strategies in the 2007/2008 fishing year that are risk averse (25% risk of exceeding F_{ref}) to risk neutral (50% risk of exceeding F_{ref}) are about 4400 t to 5300 t.

Landings from the Eastern Component (4Xmn+4VW) traditionally come from the Tonnage Class (TC) 4+ sector, and have been following a declining trend. Since 1993, much of the Eastern Component was closed to cod-directed fishing, which further reduced pollock landings from that area. Research vessel (RV) summer survey biomass, while variable, has been declining since the late 1980s and is now at the third lowest level in the time series. Large scale directed pollock fisheries should not be considered until the Eastern Component rebuilds.

RÉSUMÉ

Les prélèvements de goberge dans le stock de la composante ouest (4Xopqrs+5Yb+5Zc) affichent une moyenne de 6000 t depuis 2000 et ont représenté 92 % des débarquements totaux en 2005. En 2006, les taux de prises pour les engins mobiles ont été les deuxièmes plus faibles de la série chronologique. Les taux de prises de 2005 et de 2006 n'étaient pas comparables à ceux observés précédemment dans la série chronologique, lorsque les quotas ne constituaient pas un facteur limitatif. En 2006, l'indice de la biomasse dérivé des relevés des navires de recherche (NR) a été le plus élevé jamais enregistré dans la série chronologique et, même s'il s'agissait de toute évidence d'un effet propre à cette année-là, on observe une tendance générale à la hausse depuis 2003. D'autres relevés indiquent que l'abondance de la goberge affiche une tendance générale à la hausse plutôt qu'à la baisse et viennent appuyer les tendances récentes observées dans les relevés des NR du MPO. Les poids des prises selon l'âge, lesquels sont utilisés comme valeur approximative pour le poids des individus d'âge 5+, diminuent depuis 1984 environ. Les poids selon l'âge dérivés des relevés des NR pour ces catégories d'âge n'ont toutefois pas montré cette tendance à la baisse, ce qui signifie que le poids des prises peut varier selon les régimes de pêche. Lorsqu'on a utilisé une analyse des populations virtuelles (APV) à base modifiée (qui exclut les années 2005 et 2006 de l'indice du taux de prises), la biomasse de l'âge 4+ est passé d'un creux d'environ 7500 t en 2000 à 30 000 t en 2006. On estime que la classe d'âge de 2001 compte à presque 15 millions de recrues et qu'elle est la plus forte depuis la classe d'âge de 1980. La baisse des quotas et des prises a contribué à la diminution des taux de mortalité par la pêche chez les individus des âges 6 à 9; ce taux est maintenant tout juste inférieur au niveau Fréf. de 0,2. Les stratégies d'exploitation à faible risque (25 % de risque de dépassement du niveau Fréf.) ou à risque neutre (50 % de risque de dépassement du niveau Fréf.) chiffrent les prises entre environ 4400 et 5300 t durant l'année de pêche 2007/2008.

Les débarquements de la composante est (4Xmn+4VW) sont d'ordinaire effectués par la catégorie de jauge (CJ) 4+ et affichent une tendance à la baisse. Depuis 1993, la pêche dirigée à la morue est fermée dans une grande partie de la composante est, ce qui réduit encore davantage les débarquements de goberge en provenance de cette composante. La biomasse dérivée des relevés des NR d'été, quoique variable, diminue depuis la fin des années 1980 et est maintenant la troisième plus faible de la série chronologique. Il ne faut pas envisager la pratique de pêches dirigées à la goberge à grande échelle au sein de la composante est avant que celle-ci se rétablisse.

INTRODUCTION

Pollock in the management unit 4VWX and 5Zc are assessed as a Western (5Zc, 5Yb, 4Xopqrs) and Eastern component (4Xmn, 4VW), following the recommendations of the Framework Assessment completed in 2004 (Neilson et al. 2004) (Fig. 1). This paper updates the last stock assessment for pollock in the Western Component completed by Neilson and Perley (2005) and includes updated information for 2005 (fishery data: Trimester 3) and 2006 (survey data and fishery data: Trimesters 1&2).

Advice was requested by Fisheries and Aquaculture Management on the stock status of pollock to inform management of the 2007/2008 fishery. The Terms of Reference for the Science Advisory Process Scientific Peer Review were to:

- Examine available data from various sources (e.g. surveys, commercial fishery and at-sea observer) for consistency with model predictions on population structure and industry observations, and recommend requirements for new information, monitoring or improved data collection.
- Update the advice using framework methodologies and the latest information from fisheries and research surveys.

THE FISHERY

Landings of pollock for the entire management unit in the fishing year ending March 31, 2006 were 6286 t against a quota of 6500 t (Fig. 2). Landings from April 1 through November 3, 2006 are 2651 t against a quota of 4500 t. Peak landings in 1987 were 46000 t but since 1999 they have been less than 10000 t. The TAC has rarely been restrictive except for a five year period in the late 1980s and more recently since 2004 (Fig. 2). Calendar year landings for 2005 were 7528 t and for 2006 (1 Jan. - 31 Aug.) were 2903 t (Table 1).

The pollock fishery has had significant changes in both area fished and in dominant gear type. The Western Component of the management unit usually contributes the largest proportion of the total landings (92% in 2005) (Fig. 3; Table 2). Landings from the Eastern Component traditionally come from the TC 4+ sector, and have been following a declining trend (Fig. 3; Table 3). Since 1993, much of the Eastern Component was closed to cod-directed fishing, which further reduces pollock landings from that area. Landings from the Western Component now come mostly from three unit areas (4Xp, 4Xq and 5Zc), whereas as recently as 1997, landings were spread among different unit areas to a greater extent (Fig. 4; Table 2). The seasonal pattern of the fishery in 2006 was similar to previous years, with most pollock catches occurring in summer months (Table 4).

Mobile gear catches (OTB 1-3) in 2006 occurred in outer Bay of Fundy, Crowell and Jordan Basins, northeastern Georges Bank and east of La Have Bank,

while gillnet catches were mostly from the Crowell/Jordan Basin areas (Fig. 5). The distribution of catches was similar to last year but with proportionately more catch in 4Xq in 2006. As indicated by Neilson and Perley (2005), the overall distribution of catches in recent years has contracted since the early 1990s.

Since the early 1980s the small mobile gear component (OTB 1-3) has accounted for most of the total landings, with a notable increase after 2001 (Fig. 6; Table 5). The percentage of total landings taken by gillnets has declined since 2000, however, in 2006 the gillnet share increased to 30% while small mobile declined to 63%. The contribution of larger trawlers to total landings (OTB 4+) has been steadily declining since 1988, but showed a modest increase from 2% in 2005 to 6% in 2006. The offshore sector is now using smaller vessels (TC 1-3, under the Temporary Vessel Replacement Program) to catch their allocation. Longline/handline landings continued to represent a small proportion of total catches and in 2006 were < 2%.

Industry Perspectives

The poor status of the pollock resource as described by the 2005 assessment is completely inconsistent with the perception of industry. During the Data Input Review meeting in Yarmouth (Oct. 23, 2006), fishermen reported that all gear sectors were seeing abundant signs of pollock in 2006 throughout the stock area, despite the fact that they were trying to avoid this species due to the low quota. They expressed concern over the usefulness of the commercial catch rate series as an index of abundance. Under current quota restrictions, most fishermen are avoiding pollock as much as possible and recent catch rates (i.e. 2005 and 2006) would not be comparable to those observed earlier in the time series when quotas were not limiting. Fishermen have also indicated that there are very few "pollock directed" trips now compared to the past (possibly only a few vessels actually direct for pollock now) so that not many trips would qualify for inclusion in the catch rate series. Further, they expressed concern over the lack of summer survey coverage on the Canadian portion of Georges Bank, an area that has become increasingly important to the fishery in recent years. There have also been reports of discarding of pollock in 2006, but the extent of this problem is not known.

SAMPLING AND CATCH/WEIGHT AT AGE

Port (shore) and observer (at-sea) sample collections contributed to over 21,000 and 16,000 pollock length measurements in 2005 and 2006 (Jan. 1- Aug. 31), respectively (Table 6). Sampling in 2005 and 2006 was considered adequate to characterize the catch at size and catch at age, with 1287 ages available for the 2005 fishery and 685 ages available to the end of the second trimester in 2006.

Comparisons of port and observer length measurements of pollock were made for months, areas and gear types where both types of samples were

available (Fig. 7). Both sample sources showed similar size compositions of pollock and indicated that discarding of smaller sized fish (high-grading) was not apparent during these trips. Lack of sufficient observer coverage both spatially and seasonally precluded the estimation of discards from the 2006 fishery.

The level of commercial fishery sampling was relatively low in the 1970s in NAFO Division 4X, thus the assessment presented here starts in 1982 when the level of sampling improved to reflect the fishery more accurately. To construct the catch at age (CAA) for 2006 (Trimesters 1 and 2) and update the CAA for 2005 (with data from Trimester 3), data for the Western Component were aggregated to the trimester level by gear type and tonnage class. Area 4Xu was prorated over the Western Component by allocating the proportion of landings attributed to 4Xmn versus the remaining unit areas in 4X. Samples were aggregated on a trimester basis for OTB 1-3 large mesh (cod end mesh > 110mm) and gillnet, and on an annual basis for OTB 1-3 small mesh (cod end mesh ≤ 110mm), OTB 4+, and longline/handline gear because of limited data. Small pollock are caught in the small mesh mobile gear used in the redfish fishery, so this gear type was kept separate in the CAA. Length-weight parameters were calculated from data pooled over the last ten years (1997-2006) from the summer research vessel (RV) survey for strata 474, 476 and 480-495 (the Western Component). Since no surveys were conducted in the spring or fall, the summer value is used for all three trimesters.

In general, larger pollock were captured by gillnet (mean = 66 cm Fork Length (FL)) compared to large and small mesh mobile gear (mean = 58 cm FL) (Fig. 8, upper panel). The small mobile gear captured a greater proportion of fish < 46 cm FL. The age composition of the catch differs among gear types, with predominant ages ranging from 5-8 for gillnet, 4-7 for large mesh mobile and 3-7 for small mesh mobile gear (Fig. 8, lower panel).

Strong and weak year-classes are apparent in the age structure and cohorts are readily tracked (Table 7, Fig. 9). Diminished numbers at age for older ages, a feature which first appeared in the 1990s, continues to the present. However, age 6 in 2005 (1999 year-class) was at its highest value since 1998. This strong year-class was first noted in the 2004 assessment. The 2006 fishery was dominated by ages 5 and 6, the 2001 and 2000 year classes, respectively. Catches up to the end of the second trimester were low due to reduced quota. For the 2006 fishery, ages 5-8 were above the ten year average from 1996-2005, while ages 3-4 were below the ten year average (Fig. 10). Ages 4 and 6 were above what was projected last year for the 2006 catch, and age 5 is close to projected amount.

In 2006, there was a slight increase in Weight at Age (WAA) for ages 4 and 6 and a slight decrease for ages 3, 5 and 7 (Table 8; Fig. 11). At the older ages there was an increase during the late 1990's, followed by a sharp decrease after 2002. In general, fishery weights at age have been decreasing since 1984, especially for ages 3-5 but they may be levelling off now. Fishery weights at age are used as a proxy for population age 5+ weights at age.

INDICES OF ABUNDANCE

Commercial Fishery Catch Rates

Commercial fishery catch rates (CPUE) for small mobile gear (TC 1-3) are used as tuning indices in this assessment and are based on individual standardized catch rates from four areas in the Western Component: NAFO Unit Areas 4Xq, 4Xp/5Zc, Bay of Fundy (4Xrs and 5Yb) and 4Xo. The main criteria for trips included in catch rate analyses is that they must be pollock directed (>50% of total catch is pollock) and the vessel must have five or more consecutive years in the fishery. A multiplicative model (Gavaris 1980, 1988a) with main effects of year (1982-2006), CFV number, month and cod end mesh type (diamond or square) was solved using standard linear regression techniques after *ln* transformation of nominal CPUE (t/hr) data:

$$ln(CPUE_{ijkl}) = \mu + Year_i + Month_j + Vessel_k + Mesh\ Type_l + e_{ijkl}$$

Analysis of variance results indicated that for each area, the overall regression and individual main effects were significant ($P < 0.5$) and that the model explained between 35-49% (multiple r^2) of the variability in the data. A weighting factor was applied to the standardized catch rates for each of the four areas to account for differences in trends, then they were averaged together to generate a single index for the Western Component. The weighting factor for each area was calculated as the number of productive 10' squares in that area in 1992 (a year of high landings) divided by the total number of productive 10' squares in all areas in 1992.

There has been a general declining trend in standardized catch rates for all areas since the early 1980s, followed by an increase in 2002 (Fig. 12; upper panel). The increase for 4Xp/5Zc continued to 2005 and then dropped off in 2006, while for the Bay of Fundy (BOF) and 4Xq, the decline began in 2004. The area-weighted CPUE for all areas combined is now at the second lowest level in the time series, the lowest occurring in 1998 (Fig. 12; lower panel). Catch rates in 2006 were constrained by reduced quotas and changes in fishing practices and appeared to be inconsistent with RV survey indicators.

The age-specific indices of abundance from the mobile gear sector of the fishery indicated a reduction in the abundance of older (ages 7+) fish since 1996 (Table 9; Fig. 13). In recent years, the 1999 year-class has been relatively strong, a trend which continued through to age 7 in 2006. The 2001 year class at age 5 was predominant in the series this year while early indications suggested that the 2003 year-class is weak.

DFO Research Vessel (RV) Survey

Indices from the summer DFO research vessel survey are also used in this assessment. The 2006 RV biomass index was at the highest observed level in the time series and although this was an obvious year effect, there has been a general increasing trend since 2003 (Fig. 14). Several good catches occurred in the Western Component area off southwestern Nova Scotia and in the outer Bay of Fundy, however catches in the Eastern Component continued to be very low (Fig. 15). Stratified area (sq mi) occupied by pollock in the Eastern Component has shown a more dramatic decline than the Western Component, especially after 2001 (60% decrease) (Fig. 16). While there has also been a decline in the Western Component it is not nearly not as pronounced as in the east.

Consistent with the CPUE indices, the DFO RV indices showed that the 1999 year-class was strong in the 2003-2006 surveys and has resulted in improved numbers at age 7 in 2006 (Table 10, Fig. 17). The 2002 year class at age 4 is now much stronger than indicated last year, and the 2000 and 2001 year classes at ages 6 and 5 in 2006, respectively, have reached record high levels. Record high indices at all ages should be interpreted with caution since indices for all year classes are inconsistent with values seen previously.

RV survey weights at age (equivalent to mid-year population WAA) do not appear to have the same declining trend evident in the fishery weights at age for age 5+ (Fig. 18). Fishery WAA may be influenced by changes in fishing patterns.

Other Survey Indicators

The ITQ survey is not used as a tuning index but it provides qualitative information to compare with the DFO summer survey. In 2006 there were several good catches in 4Xpq (similar to the summer RV survey) but lower catches in the outer Bay of Fundy compared to the long term average (Fig. 19). There was also a large catch of small fish near the eastern boundary of the ITQ survey area in 4Xn. Trends in biomass indices for the ITQ and DFO summer surveys show some concurrence (Fig. 20). The ITQ survey biomass index does not show a large increase in 2006 but like the DFO survey biomass index, it gives an indication that biomass may be higher now than it was a few years ago. In contrast, the CPUE series indicates a trend of declining biomass in recent years.

The National Marine Fisheries Service (NMFS) has conducted stratified random surveys during spring and fall in the Gulf of Maine since the1960s'. The 2006 NMFS spring and 2005 NMFS fall surveys show good catches in the western Gulf of Maine and moderate catches on northeastern Georges Bank (Fig. 21). The five year average for both series indicates that catches occur across the international boundary and that there is continuity with the Western Component in 4X. Both series, although not used for tuning indices in this assessment, indicate a trend of

increasing rather than decreasing biomass for pollock and support recent trends from the DFO RV survey (Fig. 22).

ESTIMATION OF CURRENT POPULATION STATE

Two Base VPA runs were conducted using the framework assessment formulation of Neilson et al. (2004) with a few modifications. The Base Model used CAA for ages 2-13 (1982-2006), CPUE indices for age 3-8 (1982-2006, power fit), RV indices for ages 3-8 (1984-2006, proportional fit) and natural mortality of 0.2. The Modified Base Model used the full RV series (1984-2006) but a truncated CPUE series excluding 2005 and 2006, years which had more restrictive quota and fewer pollock-directed trips. The adaptive framework, ADAPT (Gavaris1988b), was used to calibrate the sequential population analysis with the CPUE and RV survey age-specific abundance trend results. For this assessment, age 2 was assigned a fixed value based on recent observed recruitment and fishing mortality at age 9 for 2005 and 2006 was assumed to be equal to the population number weighted average fishing mortality on ages 7 and 8.

During the process of updating the mobile gear CPUE series, it was discovered that the weighting factor was incorrectly applied to the individual standardized series for each of the four areas. The Benchmark assessment method for applying the weighting factor involved *dividing* each area-specific standardized CPUE by the weighting factor for that area, which is not technically correct. The correct method involves *multiplying* the area-specific standardized CPUE by the weighting factor for that area. The end result is slightly lower catch rates prior to 1995, and slightly higher catch rates after 1995 (Fig. 23).

Using the Base VPA formulation, sensitivity runs were carried out to determine the impact that this change in CPUE calculation would have on age 2 recruitment, age 4+ biomass and age 6-9 F. In general, the difference in model results for recruitment, biomass and F are modest (Fig. 24). Age 2 recruitment and 4+ biomass are slightly more optimistic using the corrected method, with age 4+ biomass in 2006 estimated at 20500 t (vs 18500 t using the benchmark CPUE series). There was also a slight reduction in F on ages 6-9 in the VPA run using the corrected CPUE series. For this assessment, both the Base VPA and Modified Base VPA formulations use the corrected area weighting method for the CPUE series.

Comparison of Population Model Results

Age-specific residuals for the Base VPA are shown in Fig. 25. Residuals for the CPUE series were large and negative across all ages in 2006 (model predicts higher abundance than indicated by CPUE series) while for the RV series they were large and positive across all ages (model predicts lower abundance than indicated by survey indices). For the Modified Base VPA, residuals for the CPUE series in 2004 were large and negative for ages 3, 4, 7 and 8 (Fig. 26), but the magnitude was less than the Base VPA. Similarly, for the RV survey, there were large positive residuals on ages 4-6 in 2006, but comparatively not as bad as the Base model.

The population abundance estimates for the Base VPA show greater relative error in model fit and relative bias for ages 3 and 8 while the relative error for ages 4-6 is lower and the bias is smaller (Table 11). The population abundance estimates for the Modified Base VPA show a different pattern with high relative error and relative bias in model fit on ages 3 and 4 (Table 12). Survey calibration constants (q's) for both VPA models increase with age up to age 7, then decline at age 8. While the age-specific estimates of population numbers and calibration constants are sometimes associated with high variance, they are comparable to those reported in the assessment of this resource in 2005.

A comparison of VPA model results indicates that age 2 recruitment for the 1999-2003 year classes is higher for the Modified Base VPA compared to the Base VPA (Fig. 27). Also, age 4+ biomass is higher from 2003 on and shows a steady increase to 2006. The 2006 4+ biomass is estimated at 30000 t (vs 20500 t for Base VPA). Fishing mortality on ages 6-9 is slightly lower in the Modified Base VPA and drops below F_{ref} in 2006. Results for population abundance, F and biomass are given in Tables 13-15, respectively for the Base VPA and in Tables 16-18 for the Modified Base VPA. The Modified Base VPA is considered to be a better approach because it excludes 2005 and 2006 from the catch rates series which are not considered to be comparable to other years in the time series.

Stock Trends and Current Status

The final assessment results were based on the Modified Base age-structured population model for the Western Component that incorporated indices of abundance from both the DFO summer research vessel survey (1984-2006) and standardized CPUE from the commercial fishery excluding the most recent two years (1982-2004). The 2001 year-class was estimated to be slightly higher than indicated last year and was the strongest at age 2 since 1980, followed by the 1999 year class (Fig. 28). Initial indications for both the 2002 and 2003 year-classes are that they are of moderate strength. Age 2 recruitment estimates for both the 2002 and 2003 year classes are at about 5 million recruits while the 2001 year class is estimated at 15 million.

Estimates of age 4+ (considered spawning stock) biomass declined from about 66000 t in 1984 to about 7500 t in 2000. Biomass has been rebuilding since 2000, increasing steadily to about 30000 t in 2006 (Fig. 28). 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 have contributed to a decline in the fishing mortality rate on ages 6-9, which is now just below the F_{ref} of 0.2 (Fig. 29). The overall prognosis is considerably better than indicated from last year's assessment.

PROJECTIONS OF CATCH AND POPULATION BIOMASS

Projections were done using the Modified Base VPA results and used a 3-year average (2004-2006) for partial recruitment, fishery WAA and beginning of year WAA. The partial year (2006) was included in the calculations because in previous years, the increment of growth observed in the final trimester was inconsequential. Recruitment was set at 5 million for 2007 and 2008. It was assumed that removals for the remainder of quota year (March 31, 2007) would be about 1500 t with removals at F_{ref} for the next fishing year (2007/2008). The projected 4+ population biomass is estimated at 33402 t for 2007 and 36150 t for 2008. The projected 4+ yield in 2007 is estimated at 4887 t (Table 19) with the 2001 year class at age 6 representing 52% of the catch biomass.

For the Western Component, 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}) are about 4400 t to 5300 t (Fig. 30). The population has a 50% likelihood of achieving a 10% increase in biomass over the 2007/2008 fishing year with removals as high as about 4400 t.

EASTERN COMPONENT

While most of the fishery now occurs within the Western Component, there remains a need to provide advice on the status of the resource on the Eastern Component. The distribution of catches from the 2006 RV survey is shown in Fig. 31. Only a few good catches of pollock occurred in 2006, all near the western boundary of the Eastern Component in 4Xn. The proportion of biomass from the eastern component in 2006 is about 2% of the total (Fig. 32) and total stratified biomass is now at the third lowest level in the time series since 1970. Smoothed estimates of total mortality from the RV survey remain high and have followed an increasing trend despite minimal landings (Fig. 33).

SOURCES OF UNCERTAINTY

The results of the assessment depend, in part, on indices of abundance from the commercial fishery. Trends in catch rates for 2005 and 2006 appear to be confounded by changes in the fishery and management practices not associated with trends in abundance. Further examination of this time series is required to ensure its future utility. Fishermen have also indicated that there are very few "pollock directed" trips now compared to the past (i.e. where pollock represent > 50% of catch by weight) so that not many trips would qualify for inclusion in the catch rate series. 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. There is a concern over the lack of summer survey coverage on the Canadian portion of Georges Bank, an area that has become increasingly important to the fishery in recent years. If the proportion of the population on Georges Bank has increased in recent years, the survey would underestimate the recent biomass series. Survey weights-at-age do not display the recent decline seen in fishery weights. The selection of weights at age is influential in population biomass estimates and recent trends are impacting on the calculation of biomass trends and reference points. Using survey weights at age could result in a greater proportional increase in biomass since 2000.

CONCLUSIONS AND ADVICE

For the Western Component, 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}) are about 4400 t to 5300 t. This risk analyses does not incorporate the uncertainties as noted above and overstates the precision of the estimates of F_{ref} yield outcomes. Recommendations for the Eastern Component are the same as last year: "Large scale directed pollock fisheries should not be considered until the Eastern Component rebuilds".

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Table 1. Landings of pollock by country in 4VWX5Zc. The landings for 2006 represent a partial year (Jan. 1 to Aug. 31).

	Canada	Japan	France	Fed. Rep. Germany	German Dem. Rep.	Cuba	USSR (Russia)	USA	Spain	Other	Total
1974	24975	40		149			2301	435	1500	61	29461
1975	26548			236	95		2004	403	708	124	30118
1976	23565			994	24		1466	443	303	385	27180
1977	24653	1		368			182	325		53	25582
1978	26801	110	33			141	502	451			28038
1979	29967	19	23			50	1025	391		7	31482
1980	35986	81	99			32	950	443			37591
1981	40270	15	90				358	918			41651
1982	38029	3	44			84	297	1107			39564
1983	32749	6	22			261	226	1854			35118
1984	33465	1	46			123	97	2272		1	36005
1985	43300	17	77			66	336	152			43948
1986	43249	51	77			387	564	234		4	44566
1987	45330	82	28			343	314	102			46199
1988	41831	1				225	1054	60			43171
1989	41112	1				99	1782	35			43029
1990	36178					261	1040	213			37692
1991	37931	38				459	1177	68			39673
1992	32002	72	9			1015	1006	57			34161
1993	20253					644	176				21073
1994	15240					10					15250
1995	9781					58					9839
1996	9145					129	6				9280
1997	11927					64					11991
1998	14371					9	1				14381
1999	7738					6					7744
2000	5672										5672
2001	6318										6318
2002	7090										7090
2003	8090										8090
2004	8353										8353
2005	7528										7528
2006	2903										2903

Table 2. Pollock landings (t) by area in the western component, (4Xopqrs, 5Yb in Canadian waters and 5Zc). The landings for 2006 represent a partial year (Jan 1 to Aug. 31).

	4Xo	4Xp	4Xq	4Xr	4Xs	4Xu	5Yb	5Zc	Total
1982	4781	1499	2675	2508	1345	183	925	4430	18347
1983	4337	1146	3635	1170	461	1319	1079	3301	16448
1984	3536	1189	4541	716	163	1933	2015	1199	15291
1985	6179	595	5718	1284	696	3275	853	911	19511
1986	7326	1073	2531	1046	1287	2066	654	1538	17520
1987	4734	2329	1893	508	1209	2571	1120	2096	16460
1988	3194	3417	3333	307	790	4110	345	2403	17899
1989	3619	3373	2334	332	374	1777	531	1385	13724
1990	3668	2523	2953	1042	693	2629	346	1740	15595
1991	4621	3745	2665	2465	2105	831	456	1715	18602
1992	4174	1528	2626	2175	1793	865	443	3036	16639
1993	2754	1985	2226	1605	941	337	368	4193	14410
1994	1860	1097	1213	1453	866	784	236	3327	10836
1995	429	1158	2552	676	393	683	250	1004	7144
1996	419	1478	1811	686	412	179	256	1200	6441
1997	446	1574	4030	1112	607	447	311	1231	9759
1998	437	3495	3134	564	469	153	425	1857	10534
1999	313	879	1372	648	380	37	135	996	4760
2000	257	1086	1531	264	249	47	136	1197	4768
2001	207	1191	1774	301	186	68	104	1569	5400
2002	201	1482	2628	189	159	52	157	1616	6485
2003	114	1823	2578	403	665	316	594	1347	7839
2004	58	2404	2342	321	557	147	137	2047	8012
2005	126	3397	970	221	324	43	108	1740	6928
2006	79	968	589	60	138	41	101	529	2504

Table 3. Pollock landings (t) by area in the eastern component, (4Xmn, 4W 4V). The landings for 2006 represent a partial year (Jan 1 to Aug. 31).

	4Vn	4Vs	4Vu	4Wd	4We	4Wf	4Wg	4Wh	4Wj	4Wk	4Wl	4Wm	4Wu	4Xm	4Xn	Total
1982	149	2216	162	4	89	8	230	904	3181	1987	2469	25	69	4341	3154	18987
1983	104	5214	13	7	189	24	621	1577	235	1725	702	7	191	2713	2532	15855
1984	351	4598	101	5	60	9	207	1699	252	2061	1406		106	2251	3805	16912
1985	839	9375	7	79	80	6	1002	198	32	1156	247		43	4803	3014	20882
1986	1379	11639	138	202	30	2	658	289	454	986	239		220	4124	2448	22808
1987	915	9680	303	70	26	0	416	92	659	2302	29		154	4947	5987	25583
1988	1448	9307	224	128	85	10	746	124	44	934	841		165	5020	2599	21674
1989	4465	7542		253	79	30	313	253	272	1394	931	6	309	4239	5689	25774
1990	2124	6065		90	20	80	769	160	300	1172	1093	46	350	3078	3886	19233
1991	1043	3009		193	42	7	2146	132	477	1329	2229	106	72	2824	5172	18779
1992	284	2129		149	98	13	990	101	162	1064	2695	44	387	1594	5357	15066
1993	86	743		81	470	1	114	6	5	588	272	1	63	739	2563	5731
1994	437	329		19	434	0	69	11	4	787	60		6	878	1128	4161
1995	397	665		36	3	0	108	31	1	130	188	6	135	220	592	2513
1996	30	432		35	0	0	19	44	0	747	67	1	81	305	898	2660
1997	10	135		7	1	0	1	94	0	606	66	1	73	305	770	2071
1998	155	171		11	16	0	36	63	2	149	1160	1	20	257	1767	3806
1999	29	422		0	0		80	61	1	1067	248	0	3	247	803	2963
2000	6	234		0	0		20	2	0	145	85	0	7	153	239	891
2001	0	94		0	0		7	2	0	128	151	2	15	146	336	882
2002	0	39			0		0	2	0	37	39	0	1	77	317	513
2003	0	4		0	0		1	5	0	15	37	0	4	24	152	243
2004	0	9						2	0	25	135		1	25	144	340
2005	8	4			0		0	1	0	81	75		7	44	379	599
2006	0	13	0	0			0	5	0	41	46	19	0	32	242	399

Table 4. Pollock landings (t) by month in the western component, (4Xopqrs, 5Yb in Canadian waters and 5Zc). The landings for 2006 represent a partial year (Jan 1 to Aug. 31).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1982	766	667	258	196	1555	2789	3413	2510	2317	2085	1140	620	18317
1983	1147	805	477	495	1814	4650	3272	1659	1207	568	172	77	16344
1984	167	170	362	753	1413	3922	3818	1619	1325	1090	346	91	15076
1985	114	681	841	1892	981	4503	5243	1885	1556	1048	357	222	19323
1986	1023	682	758	452	2221	3015	3678	2649	2069	664	169	23	17404
1987	1428	648	643	34	2212	3686	2797	1905	1431	490	114	836	16224
1988	1043	563	140	375	912	4213	4534	1241	1159	409	151	2561	17301
1989	645	1473	329	459	712	3740	1682	1230	1140	561	1317	320	13607
1990	244	233	44	132	1039	3199	3465	2944	2002	1182	465	923	15874
1991	1091	884	433	1235	1884	3435	3189	2136	1750	1335	729	681	18783
1992	432	625	222	783	1744	2916	3073	2414	1813	1572	817	232	16644
1993	1089	654	633	385	1202	2725	2741	1684	1172	550	900	629	14363
1994	36	244	228	517	801	1931	2950	1350	1061	903	473	489	10981
1995	106	217	206	472	319	2013	1406	255	1472	255	300	180	7200
1996	277	199	222	223	470	786	1226	914	544	606	387	604	6457
1997	56	458	508	681	597	1482	1917	1392	1209	661	560	282	9802
1998	285	624	807	711	953	1872	2193	1109	986	789	165	51	10544
1999	64	59	174	236	348	781	1112	825	666	215	180	111	4771
2000	135	272	301	98	318	738	850	684	553	506	184	140	4778
2001	231	46	417	224	418	775	1180	566	610	534	261	146	5410
2002	139	268	328	415	947	1346	1266	599	505	345	221	121	6501
2003	39	235	941	643	893	1171	1205	901	877	450	374	116	7845
2004	48	514	871	527	676	1806	1547	764	560	367	245	85	8012
2005	398	1065	547	448	536	1460	835	543	371	302	404	19	6928
2006	220	143	342	161	250	533	421	434					2504

Table 5. Pollock landings(t) by gear in the western component, (4Xopqrs, 5Yb in Canadian waters and 5Zc). The landings for 2006 represent a partial year (Jan 1 to Aug 31).

	Gillnet	OTB 4+	Longline	Misc	OTB 1-3	Total
1982	2574	6782	2315	241	6435	18347
1983	2416	4307	1618	25	8081	16448
1984	1809	1623	1615	39	10204	15291
1985	3045	1246	2443	52	12725	19511
1986	4378	1928	4447	55	6712	17519
1987	4003	3465	2934	26	6032	16460
1988	3021	5904	1704	93	7177	17899
1989	4217	3558	1391	78	4480	13724
1990	4810	3027	2252	95	5411	15595
1991	3572	3884	2387	132	8627	18602
1992	3784	3135	2789	3	6928	16639
1993	3159	3983	2199	1	5067	14410
1994	2760	1703	2019	44	4310	10836
1995	2620	951	506	4	3062	7144
1996	1301	1733	605	3	2799	6441
1997	2312	1648	978	1	4820	9759
1998	3076	1323	621	21	5492	10534
1999	1431	546	494	5	2286	4761
2000	1796	516	278	5	2172	4768
2001	1776	564	291	1	2765	5398
2002	1621	559	229	1	4074	6484
2003	1902	11	217	9	5699	7839
2004	2017	90	121	1	5782	8012
2005	1356	80	125	0	5365	6926
2006	732	145	42	0	1552	2471

Table 6. Summary of Pollock sampling in 2005 and 2006 (Trimesters 1&2) from port (dockside) and observer (at sea) collections. “Ages” refers to the number of ages used in catch at age calculations.

Year	Number measured/aged			Landings (t)
	Port Samples	Observer Samples	Ages	
2005	12,773 (57)	8,480 (47)	1287	6,926
2006 **(Trim 1&2)**	6,725 (28)	9,981 (107)	685	2,474

Table 7. Total catch at age (000s) for pollock in the western component (4Xopqrs 5Yb in Canadian waters and 5Zc). The catch at age for 2006 includes January 1 to August 31.

	2	3	4	5	6	7	8	9	10	11	12
1982	95	1618	1352	371	1031	838	425	145	45	33	13
1983	45	1283	3966	854	179	314	291	138	59	17	19
1984	4	370	1832	2751	465	85	148	114	41	19	2
1985	5	195	621	1806	2142	328	38	100	99	62	30
1986	1	162	1410	1136	1329	876	88	37	37	41	15
1987	5	104	628	1622	883	786	490	68	17	15	28
1988	19	425	990	1126	1281	519	424	242	22	14	20
1989	93	386	1533	1129	576	463	147	129	65	6	7
1990	47	776	1102	1621	873	429	174	138	49	23	10
1991	58	1013	1900	1506	1395	347	157	56	49	25	10
1992	46	1250	2678	1651	675	314	124	96	61	14	12
1993	4	551	1989	2125	1143	318	92	27	10	7	6
1994	51	259	675	1327	1151	494	166	59	14	8	2
1995	24	263	537	949	676	294	63	17	4	1	1
1996	14	202	949	710	473	256	55	15	0	0	1
1997	6	151	900	1654	780	217	54	4	0	1	0
1998	7	228	829	1368	1262	307	47	16	2	1	0
1999	13	89	496	621	426	173	22	4	1	2	0
2000	86	581	404	592	319	139	27	6	1	0	0
2001	15	335	814	571	314	91	14	5	2	1	1
2002	7	191	787	1073	416	127	20	6	1	0	0
2003	2	111	1302	1331	513	120	18	5	1	1	0
2004	2	173	542	1876	696	118	13	4	2	1	0
2005	0	37	842	759	1160	170	13	5	1	0	0
2006	1	22	119	364	268	149	11	2	0	0	0

Table 8. Mean weights at age (kg) for pollock from the commercial landings in the Western Component, (4Xopqrs, 5Yb in Canadian waters and 5Zc).

	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12
1982	0.000	0.943	1.427	2.529	3.462	4.211	4.772	5.681	6.239	7.687	8.622	10.621
1983	0.000	0.881	1.349	1.983	3.373	4.367	5.105	5.651	6.624	7.220	8.381	8.886
1984	0.000	0.914	1.635	2.331	3.005	4.078	5.401	6.062	6.208	6.661	7.230	9.725
1985	0.000	0.974	1.615	2.462	3.169	3.695	4.296	6.022	7.315	7.185	7.968	9.343
1986	0.000	0.738	1.554	2.306	3.095	3.929	4.530	5.791	6.651	7.161	7.322	8.698
1987	0.000	0.943	1.475	2.266	3.046	3.564	4.315	4.907	5.300	6.794	7.482	7.909
1988	0.000	1.195	1.549	2.240	3.096	3.807	4.191	4.979	5.886	7.073	8.169	8.454
1989	0.000	0.880	1.313	2.095	3.068	3.885	4.491	4.869	6.012	6.334	8.911	7.133
1990	0.000	0.571	1.263	2.055	2.894	3.657	4.766	5.818	6.371	6.966	7.625	9.770
1991	0.000	0.906	1.344	2.153	2.866	3.736	4.730	5.711	6.460	6.815	8.060	9.030
1992	0.000	1.033	1.271	1.831	2.615	3.509	4.614	5.466	6.141	6.864	8.164	9.189
1993	0.000	0.761	1.110	1.666	2.312	3.143	3.754	4.723	5.492	6.704	7.704	8.131
1994	0.000	0.805	1.250	1.586	2.163	3.058	3.765	4.219	4.854	6.268	6.082	7.846
1995	0.000	0.671	1.132	1.806	2.296	3.038	3.941	4.796	5.389	7.348	8.573	8.781
1996	0.000	0.896	1.336	1.795	2.353	3.057	3.665	5.205	6.296	8.502	9.561	11.422
1997	0.000	0.915	1.388	1.938	2.446	3.288	3.976	5.101	7.763	10.058	6.737	11.915
1998	0.000	0.867	1.103	1.720	2.361	3.144	4.219	5.159	5.640	8.615	8.833	12.063
1999	0.000	0.806	1.193	1.682	2.419	3.245	4.288	5.659	7.057	9.939	9.943	0.000
2000	0.000	0.757	1.247	1.796	2.478	3.166	4.168	5.412	5.745	9.003	9.821	0.000
2001	0.105	0.453	1.039	1.987	2.929	3.734	4.775	6.532	8.118	8.539	9.026	10.788
2002	0.062	0.280	0.931	1.592	2.528	3.714	4.829	6.328	6.936	8.663	10.872	11.081
2003	0.000	0.675	0.990	1.535	2.376	3.528	4.780	6.289	7.427	9.267	10.079	8.875
2004	0.000	0.475	0.873	1.621	2.210	3.125	4.290	6.509	7.369	8.699	9.077	12.027
2005	0.000	0.000	0.939	1.446	2.126	2.624	3.753	5.341	6.356	9.300	14.277	14.277
2006	0.309	0.668	0.894	1.609	2.081	2.998	3.644	5.020	5.799	9.096	9.885	10.851

Table 9. Small mobile gear (TC 1-3) age-disaggregated catch rates for the Western Component, 1982-2006, calculated using the area-weighting factor (t/hr X 100).

	Age3	Age4	Age5	Age6	Age7	Age8
1982	1.2934	0.7871	0.1863	0.5333	0.4755	0.2584
1983	1.1912	3.5019	0.6117	0.0877	0.1388	0.1400
1984	0.2800	1.5556	2.5221	0.4505	0.0814	0.1334
1985	0.1203	0.4313	1.3677	1.5713	0.2249	0.0190
1986	0.1503	1.1112	0.9017	1.0499	0.6773	0.0576
1987	0.1069	0.6392	1.3871	0.6835	0.6019	0.3683
1988	0.1247	0.3556	0.5786	0.7013	0.2607	0.2198
1989	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1990	0.6272	0.8276	1.0397	0.4583	0.1721	0.0567
1991	0.4391	1.2248	0.9511	0.7537	0.1828	0.0878
1992	0.7933	1.8634	0.9446	0.2491	0.0688	0.0210
1993	0.3313	1.2960	1.1088	0.4140	0.0907	0.0274
1994	0.2007	0.4796	0.8718	0.6945	0.2702	0.0917
1995	0.5189	0.7957	1.2165	0.7055	0.2501	0.0540
1996	0.3512	1.7982	1.2346	0.6152	0.2701	0.0421
1997	0.1498	0.8942	1.5318	0.5393	0.1256	0.0213
1998	0.1071	0.5094	0.8051	0.6330	0.1147	0.0175
1999	0.0599	0.4968	0.5969	0.3316	0.0873	0.0083
2000	0.6979	0.4685	0.5868	0.2450	0.0798	0.0144
2001	0.3978	0.9046	0.4654	0.2127	0.0481	0.0082
2002	0.1718	1.0610	1.4612	0.4446	0.1124	0.0177
2003	0.1303	1.5941	1.4718	0.4151	0.0681	0.0088
2004	0.1638	0.4856	1.5732	0.4405	0.0508	0.0044
2005	0.0303	0.9156	0.8538	1.0906	0.0773	0.0042
2006	0.0299	0.2755	0.7891	0.3794	0.1585	0.0103

Table 10. DFO summer research vessel survey age-disaggregated numbers per tow for the Western Component, 1984-2006.

	Age3	Age4	Age5	Age6	Age7	Age8
1984	0.545	0.951	3.308	0.913	0.097	0.284
1985	0.101	0.498	2.844	3.613	0.747	0.000
1986	1.468	1.929	1.599	3.027	1.821	0.072
1987	0.064	0.633	1.851	1.119	2.268	1.159
1988	1.651	2.277	6.218	5.278	4.043	1.984
1989	0.098	0.488	1.358	1.957	1.868	0.568
1990	15.197	6.864	10.383	2.456	0.619	0.755
1991	1.872	1.656	2.877	2.862	0.890	0.800
1992	0.364	0.989	1.341	1.061	0.223	0.143
1993	11.941	8.135	4.141	1.815	0.514	0.016
1994	0.301	1.086	2.306	1.980	0.784	0.219
1995	1.501	1.216	1.957	0.986	0.297	0.050
1996	1.142	12.519	10.772	3.475	1.531	0.133
1997	0.351	0.477	1.616	0.763	0.081	0.090
1998	0.126	0.306	0.616	0.609	0.143	0.000
1999	0.538	0.849	0.492	0.378	0.271	0.000
2000	0.480	0.439	0.795	0.216	0.000	0.029
2001	6.976	1.824	0.652	0.177	0.093	0.022
2002	1.583	0.731	0.580	0.200	0.106	0.024
2003	0.904	6.055	2.146	0.491	0.021	0.024
2004	2.462	1.438	3.659	1.347	0.313	0.000
2005	0.082	1.228	1.349	2.412	0.419	0.000
2006	0.896	10.378	22.111	8.642	3.219	0.201

Table 11. Bias adjusted statistical properties of estimates for population abundance and survey calibration constants for pollock in the Western Component using the Base VPA model formulation.

		Bootstrap			
Age	Estimate	Standard Error	Relative Error	Bias	Relative Bias
Population Abundance					
3	2048	1511.020	0.738	283.117	0.138
4	1652	893.721	0.541	161.014	0.097
5	4402	2092.063	0.475	330.784	0.075
6	1415	740.954	0.524	96.392	0.068
7	943	518.736	0.550	91.395	0.097
8	62	43.703	0.705	10.523	0.170
RV Survey Calibration Constants					
1984-2006 (Ages 3-8)					
3	0.00015	0.00002	0.16875	0.00000	0.01373
4	0.00039	0.00006	0.16280	0.00000	0.01182
5	0.00098	0.00015	0.15101	0.00001	0.00557
6	0.00148	0.00025	0.16740	0.00002	0.01095
7	0.00172	0.00031	0.17717	0.00002	0.01064
8	0.00154	0.00028	0.18134	0.00003	0.01946
CPUE Calibration Constants					
1982-2006 (Ages 3-8)					
3	0.00000	0.00002	323.83251	0.00000	39.27215
4	0.00001	0.00117	228.16662	0.00014	26.99740
5	0.00012	0.00890	76.75215	0.00152	13.09720
6	0.00010	0.00087	8.78665	0.00022	2.20242
7	0.00007	0.00015	2.10120	0.00004	0.57235
8	0.00001	0.00001	0.76413	0.00000	0.00000
CPUE Power Coefficients					
1982-2006 (Ages 3-8)					
3	1.24566	0.31550	0.25328	0.00124	0.00099
4	0.89556	0.31499	0.35173	0.00075	0.00084
5	0.57228	0.28806	0.50335	-0.01141	-0.01994
6	0.57963	0.22328	0.38521	0.00234	0.00403
7	0.54928	0.16359	0.29784	0.00063	0.00114
8	0.84933	0.12518	0.14738	0.00007	0.00008

Table 12. Bias adjusted statistical properties of estimates for population abundance and survey calibration constants for pollock in the Western Component using the Modified Base VPA model formulation with 2005 and 2006 omitted from the CPUE series.

		Bootstrap			
Age	Estimate	Standard Error	Relative Error	Bias	Relative Bias
Population Abundance					
3	6534	12539.856	1.919	2654.669	0.406
4	3696	3045.833	0.824	719.509	0.195
5	6536	3725.649	0.570	667.359	0.102
6	1749	1048.361	0.599	186.679	0.107
7	1534	834.087	0.544	84.234	0.055
8	124	90.523	0.728	17.514	0.141
RV Survey Calibration Constants					
1984-2006 (Ages 3-8)					
3	0.00013	0.00002	0.16330	0.00000	0.00819
4	0.00037	0.00006	0.16181	0.00000	0.01008
5	0.00094	0.00015	0.16386	0.00002	0.01850
6	0.00143	0.00024	0.16727	0.00004	0.02647
7	0.00163	0.00029	0.18030	0.00004	0.02475
8	0.00148	0.00027	0.18432	0.00003	0.02193
CPUE Calibration Constants					
1982-2006 (Ages 3-8)					
3	0.00000	0.00122	507.84796	0.00013	52.40813
4	0.00001	0.00898	1117.94872	0.00062	77.73245
5	0.00007	0.01658	234.21882	0.00138	19.50755
6	0.00009	0.00172	19.78159	0.00034	3.94559
7	0.00006	0.00011	1.84075	0.00003	0.54539
8	0.00001	0.00001	0.79367	0.00000	0.19139
CPUE Power Coefficients					
1982-2006 (Ages 3-8)					
3	0.80538	0.32679	0.40576	-0.00408	-0.00507
4	0.84384	0.34207	0.40538	-0.02783	-0.03298
5	0.64046	0.27331	0.42674	0.00937	0.01464
6	0.60020	0.25006	0.41663	-0.01368	-0.02279
7	0.58854	0.16136	0.27416	-0.00297	-0.00504
8	0.81189	0.12529	0.15432	0.00038	0.00047

Table 13. Beginning of year population abundance numbers (000's) for pollock in the Western Component from the Base VPA model formulation using bootstrap bias adjusted population abundance.

	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13
1982	16664	20867	4653	1119	2248	1991	947	404	87	102	34	1
1983	9119	13557	15625	2597	583	920	881	396	200	31	54	16
1984	11558	7425	9943	9230	1361	317	472	460	200	111	10	27
1985	7287	9459	5745	6492	5088	697	183	253	274	127	74	6
1986	7818	5962	7569	4144	3694	2250	278	116	118	136	49	34
1987	11224	6400	4735	4928	2372	1834	1057	149	62	63	74	26
1988	8603	9185	5146	3311	2580	1151	799	428	61	35	38	36
1989	12062	7027	7137	3323	1702	970	479	276	135	30	16	13
1990	13888	9791	5404	4465	1708	877	381	260	111	52	19	7
1991	10304	11328	7316	3433	2204	620	335	157	90	47	22	7
1992	5769	8384	8361	4283	1465	568	199	134	78	30	16	9
1993	5556	4682	5738	4444	2029	597	186	54	25	11	12	3
1994	8927	4545	3337	2915	1742	644	206	70	20	11	3	4
1995	6012	7263	3487	2125	1201	407	93	23	6	3	2	1
1996	3957	4900	5709	2371	892	381	75	20	4	2	2	1
1997	3527	3227	3830	3819	1305	309	86	13	3	3	1	1
1998	3355	2882	2505	2327	1648	375	62	23	7	2	1	1
1999	5942	2741	2154	1308	690	240	39	9	4	4	1	1
2000	6888	4854	2164	1317	517	187	44	13	4	2	1	1
2001	12052	5562	3450	1408	550	140	30	12	5	3	2	1
2002	6558	9853	4251	2093	642	171	34	13	6	2	1	1
2003	10810	5363	7895	2773	758	157	28	10	5	4	1	1
2004	2785	8848	4290	5292	1082	167	23	7	4	3	2	1
2005	2494	2278	7088	3024	2651	269	32	8	2	1	1	1
2006	5000	2042	1832	5044	1794	1133	70	14	2	1	1	1
2006.67	4372	1765	1491	4071	1319	852	51	11	2	1	1	1

Table 14. Bias adjusted fishing mortality rate for pollock in the Western Component from the Base VPA model formulation.

	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	4-9 F	6-9 F	Landings
1982	0.006	0.089	0.383	0.452	0.694	0.616	0.673	0.501	0.834	0.440	0.539	0.000	0.521	0.648	18317
1983	0.005	0.110	0.326	0.446	0.410	0.468	0.449	0.482	0.391	0.942	0.476	0.000	0.358	0.452	16344
1984	0.000	0.057	0.226	0.396	0.469	0.351	0.422	0.318	0.253	0.203	0.285	0.000	0.321	0.419	15076
1985	0.001	0.023	0.127	0.364	0.616	0.718	0.256	0.566	0.504	0.763	0.578	0.000	0.375	0.615	19323
1986	0.000	0.030	0.229	0.358	0.500	0.555	0.423	0.426	0.418	0.408	0.417	0.000	0.359	0.515	17404
1987	0.000	0.018	0.158	0.447	0.523	0.631	0.704	0.693	0.357	0.311	0.529	0.000	0.411	0.600	16224
1988	0.002	0.052	0.237	0.466	0.778	0.676	0.861	0.954	0.501	0.581	0.876	0.000	0.495	0.783	17301
1989	0.009	0.063	0.269	0.465	0.463	0.734	0.410	0.712	0.745	0.249	0.690	0.000	0.386	0.553	13607
1990	0.004	0.091	0.254	0.506	0.813	0.762	0.689	0.863	0.659	0.665	0.785	0.000	0.472	0.789	15874
1991	0.006	0.104	0.335	0.652	1.157	0.935	0.718	0.492	0.888	0.877	0.675	0.000	0.579	1.039	18783
1992	0.009	0.179	0.432	0.547	0.698	0.918	1.113	1.494	1.775	0.737	1.490	0.000	0.528	0.831	16644
1993	0.001	0.139	0.477	0.736	0.947	0.865	0.781	0.799	0.624	1.082	0.786	0.000	0.662	0.916	14363
1994	0.006	0.065	0.251	0.687	1.253	1.734	1.992	2.275	1.530	1.571	0.905	0.000	0.753	1.453	10981
1995	0.004	0.041	0.186	0.668	0.947	1.498	1.323	1.647	1.077	0.415	0.407	0.000	0.542	1.107	7200
1996	0.004	0.046	0.202	0.398	0.859	1.292	1.565	1.604	0.104	0.042	0.438	0.000	0.371	1.029	6457
1997	0.002	0.053	0.298	0.640	1.047	1.412	1.128	0.462	0.132	0.478	0.049	0.000	0.587	1.112	9802
1998	0.002	0.091	0.450	1.016	1.726	2.068	1.674	1.458	0.403	0.475	0.107	0.000	1.045	1.783	10544
1999	0.002	0.036	0.292	0.729	1.107	1.489	0.923	0.647	0.354	0.882	0.000	0.000	0.618	1.189	4771
2000	0.014	0.141	0.230	0.674	1.108	1.613	1.097	0.772	0.285	0.086	0.000	0.000	0.546	1.226	4778
2001	0.001	0.069	0.300	0.585	0.967	1.213	0.679	0.531	0.513	0.331	0.427	0.000	0.463	0.995	5410
2002	0.001	0.021	0.227	0.816	1.210	1.596	0.995	0.703	0.271	0.253	0.185	0.000	0.523	1.271	6501
2003	0.000	0.022	0.196	0.739	1.313	1.712	1.184	0.869	0.287	0.541	0.198	0.000	0.422	1.370	7845
2004	0.001	0.019	0.140	0.473	1.172	1.423	0.904	1.063	0.721	0.607	0.352	0.014	0.427	1.199	8012
2005	0.000	0.015	0.123	0.288	0.580	1.031	0.542	0.987	0.332	0.006	0.006	0.000	0.274	0.622	6928
2006	0.000	0.012	0.088	0.101	0.213	0.173	0.193	0.182	0.120	0.048	0.003	0.000	0.129	0.197	2474

Table 15. Beginning of year biomass (t) for pollock in the Western Component from the Base VPA formulation using the bootstrap bias adjusted population abundance at the beginning of 2006.

	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	2+	3+	4+
1982	4725	16922	7878	3344	8585	8927	4930	2405	602	831	325	10	59483	54759	37837
1983	2761	16743	25941	7659	2268	4266	4575	2426	1345	248	471	162	68864	66103	49360
1984	4158	7007	26001	25197	5046	1539	2625	2725	1328	802	89	274	76792	72634	65627
1985	2350	7625	13219	18824	16953	2918	1042	1686	1830	926	610	61	68043	65693	58068
1986	3310	5362	12167	12995	13035	9203	1389	733	852	983	404	341	60773	57463	52101
1987	2075	4107	8917	12586	7878	7551	4985	827	416	465	562	262	50630	48555	44448
1988	4920	6388	7018	8952	8786	4449	3702	2301	374	264	303	356	47814	42894	36506
1989	4418	5270	13565	8931	5901	4012	2164	1513	824	241	124	130	47092	42674	37404
1990	3519	6428	7149	12429	5722	3773	1949	1450	718	365	180	67	43748	40229	33801
1991	3771	6684	8442	8296	7246	2579	1748	961	593	352	183	72	40928	37157	30473
1992	1909	6504	11491	8525	4646	2357	1014	792	522	226	138	92	38216	36307	29803
1993	2467	2620	6705	9786	5816	2166	867	294	158	79	97	30	31085	28618	25998
1994	2766	3151	3696	4713	4632	2216	819	333	116	69	23	44	22579	19813	16662
1995	1278	3499	4127	4179	3078	1414	396	110	35	26	13	10	18165	16887	13388
1996	791	3005	5947	4626	2363	1273	338	112	25	14	19	10	18521	17730	14725
1997	721	3143	5130	8030	3629	1079	371	81	27	20	14	10	22254	21533	18390
1998	1259	1743	2433	4693	4572	1397	279	122	54	23	12	10	16596	15337	13594
1999	1315	1664	2565	2391	1909	882	190	57	32	33	11	10	11060	9745	8081
2000	1816	3384	2614	2421	1430	686	214	72	32	25	12	10	12716	10900	7516
2001	3779	2919	5104	3313	1672	543	159	80	33	23	19	10	17655	13876	10956
2002	1690	5958	4986	4427	2117	726	187	85	49	23	15	10	20273	18583	12625
2003	2382	3799	9277	5824	2262	661	156	71	41	34	15	10	24531	22150	18350
2004	571	5010	6133	10088	2949	648	129	48	28	29	19	10	25663	25092	20082
2005	666	1360	8808	5716	6536	955	151	46	16	16	16	10	24295	23629	22269
2006	1302	1314	2551	9490	4451	3586	315	79	15	11	14	14	23142	21840	20526

Table 16. Beginning of year population abundance numbers (000's) for pollock in the Western Component from the Modified Base VPA model formulation with 2005 and 2006 omitted from the CPUE series, using bootstrap bias adjusted population abundance.

	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13
1982	16664	20867	4653	1119	2248	1991	947	404	87	102	34	1
1983	9119	13557	15625	2597	583	920	881	396	200	31	54	16
1984	11558	7425	9943	9230	1361	317	472	460	200	111	10	27
1985	7287	9459	5745	6492	5088	697	183	253	274	127	74	6
1986	7818	5962	7569	4144	3694	2250	278	116	118	136	49	34
1987	11224	6400	4735	4928	2372	1834	1057	149	62	63	74	26
1988	8603	9185	5146	3311	2580	1151	799	428	61	35	38	36
1989	12062	7027	7137	3323	1702	970	479	276	135	30	16	13
1990	13888	9791	5404	4465	1708	877	381	260	111	52	19	7
1991	10304	11328	7316	3433	2204	620	335	157	90	47	22	7
1992	5769	8384	8361	4283	1465	568	199	134	78	30	16	9
1993	5556	4682	5738	4444	2029	597	186	54	25	11	12	3
1994	8927	4545	3337	2915	1742	644	206	70	20	11	3	4
1995	6012	7263	3487	2125	1201	407	93	23	6	3	2	1
1996	3957	4900	5709	2371	892	381	75	20	4	2	2	1
1997	3527	3227	3830	3819	1305	309	86	13	3	3	1	1
1998	3365	2882	2505	2327	1648	375	62	23	7	2	1	1
1999	5981	2749	2154	1308	690	240	39	9	4	4	1	1
2000	7109	4886	2170	1317	517	187	44	13	4	2	1	1
2001	13926	5743	3476	1414	550	140	30	12	5	3	2	1
2002	7179	11388	4399	2115	646	171	34	13	6	2	1	1
2003	14555	5871	9151	2894	775	160	28	10	5	4	1	1
2004	5318	11915	4707	6320	1180	180	26	7	4	3	2	1
2005	5448	4352	9599	3365	3490	348	43	10	2	1	1	1
2006	5000	4460	3530	7099	2072	1817	133	23	4	1	1	1
2006.67	4372	3880	2976	5869	1562	1450	107	19	3	1	1	1

Table 17. Bias adjusted fishing mortality rate for pollock in the Western Component from the Modified Base VPA model formulation with 2005 and 2006 omitted from the CPUE series.

	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9	Age10	Age11	Age12	Age13	4-9 F	6-9 F	Landings
1982	0.006	0.089	0.383	0.452	0.694	0.616	0.673	0.501	0.834	0.440	0.539	0.000	0.521	0.648	18317
1983	0.005	0.110	0.326	0.446	0.410	0.468	0.449	0.482	0.391	0.942	0.476	0.000	0.358	0.452	16344
1984	0.000	0.057	0.226	0.396	0.469	0.351	0.422	0.318	0.253	0.203	0.285	0.000	0.321	0.419	15076
1985	0.001	0.023	0.127	0.364	0.616	0.718	0.256	0.566	0.504	0.763	0.578	0.000	0.375	0.615	19323
1986	0.000	0.030	0.229	0.358	0.500	0.555	0.423	0.426	0.418	0.408	0.417	0.000	0.359	0.515	17404
1987	0.000	0.018	0.158	0.447	0.523	0.631	0.704	0.693	0.357	0.311	0.529	0.000	0.411	0.600	16224
1988	0.002	0.052	0.237	0.466	0.778	0.676	0.861	0.954	0.501	0.581	0.876	0.000	0.495	0.783	17301
1989	0.009	0.063	0.269	0.465	0.463	0.734	0.410	0.712	0.745	0.249	0.690	0.000	0.386	0.553	13607
1990	0.004	0.091	0.254	0.506	0.813	0.762	0.689	0.863	0.659	0.665	0.785	0.000	0.472	0.789	15874
1991	0.006	0.104	0.335	0.652	1.157	0.935	0.718	0.492	0.888	0.877	0.675	0.000	0.579	1.039	18783
1992	0.009	0.179	0.432	0.547	0.698	0.918	1.113	1.494	1.775	0.737	1.490	0.000	0.528	0.831	16644
1993	0.001	0.139	0.477	0.736	0.947	0.865	0.781	0.799	0.624	1.082	0.786	0.000	0.662	0.916	14363
1994	0.006	0.065	0.251	0.687	1.253	1.734	1.992	2.275	1.530	1.571	0.905	0.000	0.753	1.453	10981
1995	0.004	0.041	0.186	0.668	0.947	1.498	1.323	1.647	1.077	0.415	0.407	0.000	0.542	1.107	7200
1996	0.004	0.046	0.202	0.398	0.859	1.292	1.565	1.604	0.104	0.042	0.438	0.000	0.371	1.029	6457
1997	0.002	0.053	0.298	0.640	1.047	1.412	1.128	0.462	0.132	0.478	0.049	0.000	0.587	1.112	9802
1998	0.002	0.091	0.450	1.016	1.726	2.068	1.674	1.458	0.403	0.475	0.107	0.000	1.045	1.783	10544
1999	0.002	0.036	0.292	0.729	1.107	1.489	0.923	0.647	0.354	0.882	0.000	0.000	0.618	1.189	4771
2000	0.013	0.140	0.229	0.674	1.108	1.613	1.097	0.772	0.285	0.086	0.000	0.000	0.545	1.226	4778
2001	0.001	0.066	0.297	0.582	0.967	1.213	0.679	0.531	0.513	0.331	0.427	0.000	0.460	0.995	5410
2002	0.001	0.018	0.218	0.804	1.194	1.596	0.995	0.703	0.271	0.253	0.185	0.000	0.508	1.258	6501
2003	0.000	0.019	0.164	0.691	1.254	1.613	1.184	0.869	0.287	0.541	0.198	0.000	0.367	1.307	7845
2004	0.000	0.014	0.123	0.371	0.984	1.199	0.741	1.063	0.721	0.607	0.352	0.014	0.348	1.007	8012
2005	0.000	0.007	0.084	0.246	0.392	0.638	0.363	0.618	0.332	0.006	0.006	0.000	0.193	0.414	6928
2006	0.000	0.003	0.038	0.067	0.176	0.104	0.086	0.109	0.057	0.048	0.003	0.000	0.080	0.140	2474

Table 18. Beginning of year biomass (t) for pollock in the Western Component from the Modified Base VPA model formulation with 2005 and 2006 omitted from the CPUE series, using the bootstrap bias adjusted population abundance at the beginning of 2006.

	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	2+	3+	4+
1982	4725	16922	7878	3344	8585	8927	4930	2405	602	831	325	10	59483	54759	37837
1983	2761	16743	25941	7659	2268	4266	4575	2426	1345	248	471	162	68864	66103	49360
1984	4158	7007	26001	25197	5046	1539	2625	2725	1328	802	89	274	76792	72634	65627
1985	2350	7625	13219	18824	16953	2918	1042	1686	1830	926	610	61	68043	65693	58068
1986	3310	5362	12167	12995	13035	9203	1389	733	852	983	404	341	60773	57463	52101
1987	2075	4107	8917	12586	7878	7551	4985	827	416	465	562	262	50630	48555	44448
1988	4920	6388	7018	8952	8786	4449	3702	2301	374	264	303	356	47814	42894	36506
1989	4418	5270	13565	8931	5901	4012	2164	1513	824	241	124	130	47092	42674	37404
1990	3519	6428	7149	12429	5722	3773	1949	1450	718	365	180	67	43748	40229	33801
1991	3771	6684	8442	8296	7246	2579	1748	961	593	352	183	72	40928	37157	30473
1992	1909	6504	11491	8525	4646	2357	1014	792	522	226	138	92	38216	36307	29803
1993	2467	2620	6705	9786	5816	2166	867	294	158	79	97	30	31085	28618	25998
1994	2766	3151	3696	4713	4632	2216	819	333	116	69	23	44	22579	19813	16662
1995	1278	3499	4127	4179	3078	1414	396	110	35	26	13	10	18165	16887	13388
1996	791	3005	5947	4626	2363	1273	338	112	25	14	19	10	18521	17730	14725
1997	721	3143	5130	8030	3629	1079	371	81	27	20	14	10	22254	21533	18390
1998	1263	1743	2433	4693	4572	1397	279	122	54	23	12	10	16600	15337	13594
1999	1324	1669	2565	2391	1909	882	190	57	32	33	11	10	11074	9750	8081
2000	1874	3406	2622	2421	1430	686	214	72	32	25	12	10	12804	10930	7524
2001	4367	3014	5143	3326	1672	543	159	80	33	23	19	10	18389	14022	11008
2002	1850	6886	5160	4472	2132	726	187	85	49	23	15	10	21594	19744	12858
2003	3207	4160	10753	6078	2314	676	156	71	41	34	15	10	27514	24307	20147
2004	1091	6746	6728	12047	3217	701	144	48	28	29	19	10	30810	29719	22973
2005	1455	2598	11927	6360	8603	1233	202	60	16	16	16	10	32496	31041	28444
2006	1302	2869	4916	13356	5142	5750	599	127	28	11	14	14	34130	32828	29959

Table 19. Deterministic projection results for pollock in the Western Component from the Modified Base VPA formulation using the bootstrap bias adjusted population abundance at the beginning of 2006.

Projected Population Numbers

	2	3	4	5	6	7	8	9	10	11	12	13
2006.67	4372	3880	2976	5869	1562	1450	107	19	3	1	1	1
2007.25	5000	3892	3449	2602	5015	1263	1177	89	15	3	1	1
2008.25	5000	4092	3176	2713	1948	3332	847	842	60	11	2	1

Fishing Mortality

	2	3	4	5	6	7	8	9	10	11	12	13
2006.67	0.000	0.003	0.032	0.071	0.166	0.159	0.107	0.154	0.089	0.052	0.017	0.001
2007.25	0.000	0.003	0.040	0.089	0.209	0.200	0.135	0.193	0.112	0.065	0.022	0.001

PR

	2	3	4	5	6	7	8	9	10	11	12	13
2006.67	0.00	0.02	0.20	0.45	1.00	1.00	0.67	0.97	0.56	0.33	0.11	0.00
2007.25	0.00	0.02	0.20	0.45	1.00	1.00	0.67	0.97	0.56	0.33	0.11	0.00

BegWt

	2	3	4	5	6	7	8	9	10	11	12	13
2006.67	0.27	0.62	1.36	1.89	2.56	3.53	4.93	6.14	7.79	9.90	11.62	10.84
2007.25	0.27	0.62	1.36	1.89	2.56	3.53	4.93	6.14	7.79	9.90	11.62	10.84
2008.25	0.27	0.62	1.36	1.89	2.56	3.53	4.93	6.14	7.79	9.90	11.62	10.84

Projected Population Biomass

	2	3	4	5	6	7	8	9	10	11	12	13	2+	3+	4+	5+
2006.67	1198	2413	4033	11109	3995	5121	527	114	25	10	12	11	28567	27370	24956	20923
2007.25	1370	2421	4674	4925	12823	4464	5804	549	117	27	10	10	37193	35823	33402	28728
2008.25	1370	2545	4303	5135	4981	11772	4176	5172	470	109	25	8	40065	38695	36150	31847

Projected Catch Numbers

	2	3	4	5	6	7	8	9	10	11	12	13
2006.67	1	6	52	224	136	121	6	1	0	0	0	0
2007.25	2	12	123	202	859	208	135	14	1	0	0	0
2008.25												

AvgWt

	2	3	4	5	6	7	8	9	10	11	12	13
2006.67	0.51	0.91	1.56	2.15	2.98	4.01	5.67	6.38	9.00	11.08	12.39	11.00
2007.25	0.51	0.91	1.56	2.15	2.98	4.01	5.67	6.38	9.00	11.08	12.39	11.00

Projected Catch Biomass

	2	3	4	5	6	7	8	9	10	11	12	13	2+	3+	4+	5+
2006.67	0	5	80	481	403	484	34	10	1	0	0	0	1500	1500	1494	1414
2007.25	1	11	192	434	2557	835	763	91	13	2	0	0	4898	4897	4887	4695

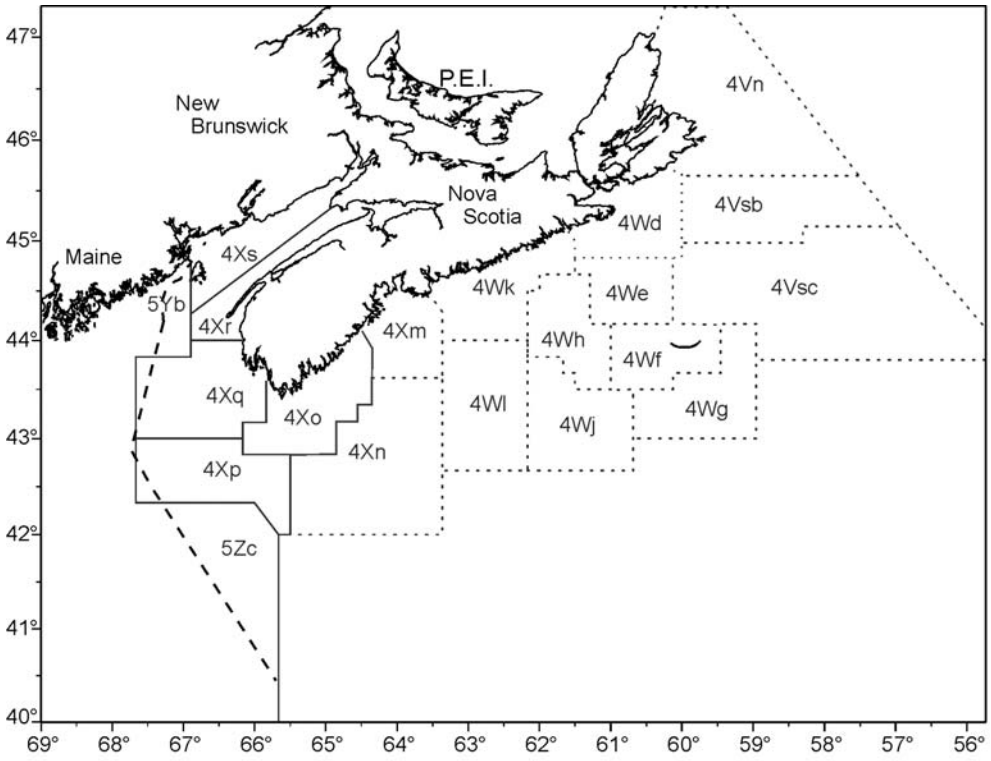

Fig. 1. DFO Statistical Unit Areas in the Scotian Shelf and Bay of Fundy and NAFO SubDivision 5Zc. Those areas forming the western component of pollock on the Scotian Shelf, Bay of Fundy and Georges Bank are outlined as solid lines, and those comprising the eastern component are shown dashed lines.

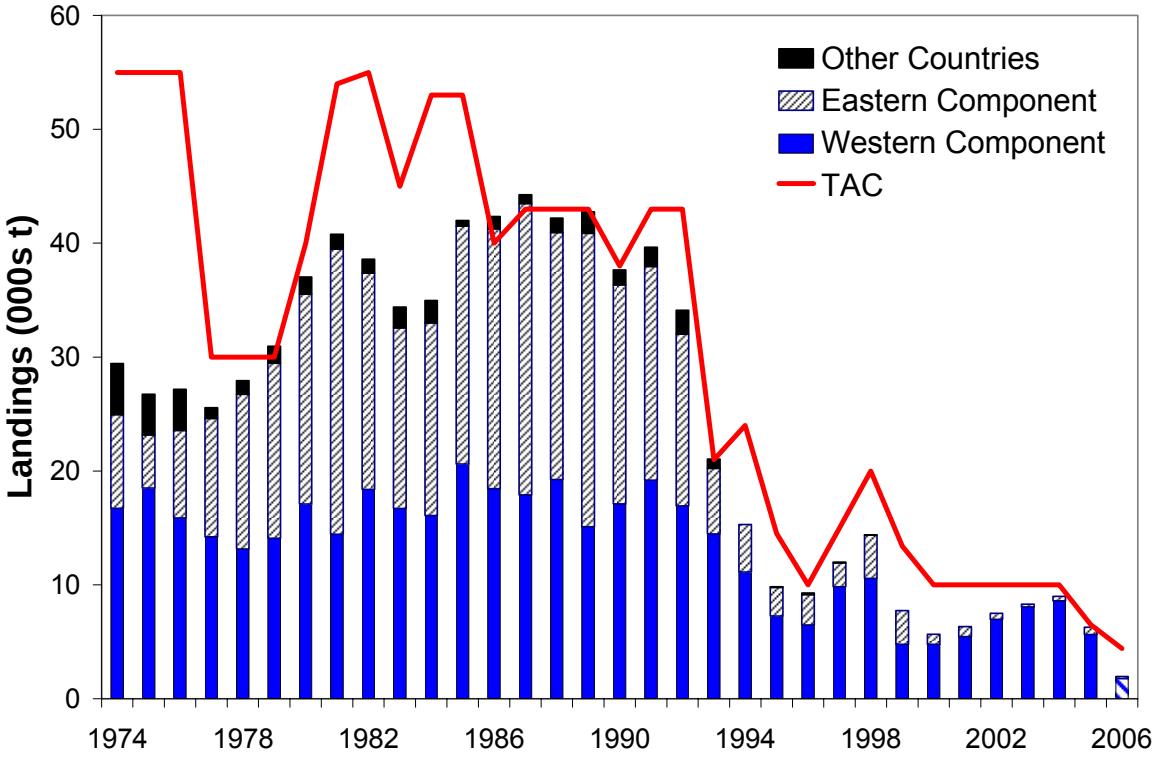

Fig. 2. Landings of 4VWX5Zc pollock, shown with respect to the Total Allowable Catch (TAC). The striped bar in 2006 signifies incomplete landings. Prior to 1999, the quota year was Jan. 1 to Dec. 31. In 1999, the quota year was Jan. 1, 1999 to Mar. 31, 2000. Subsequently, it is Apr 1 to Mar. 31. All landings are shown for quota years.

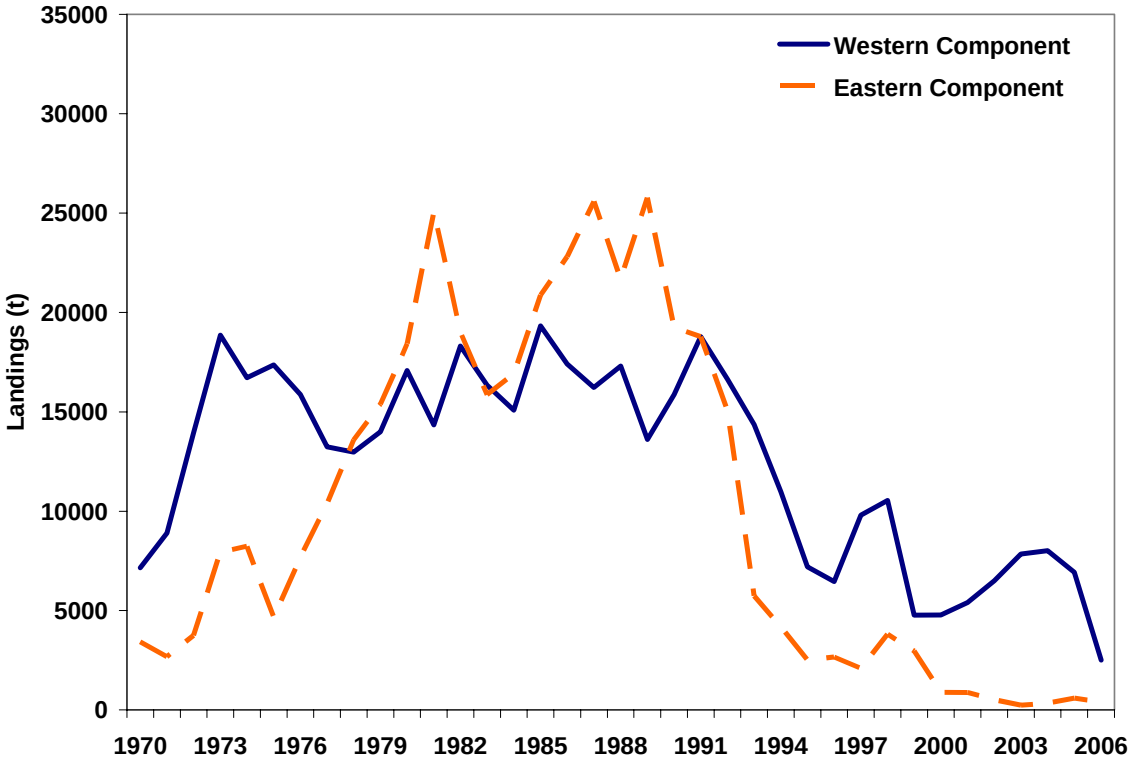

Fig. 3. Landings of pollock from the Eastern and Western Components, 1970-2006.

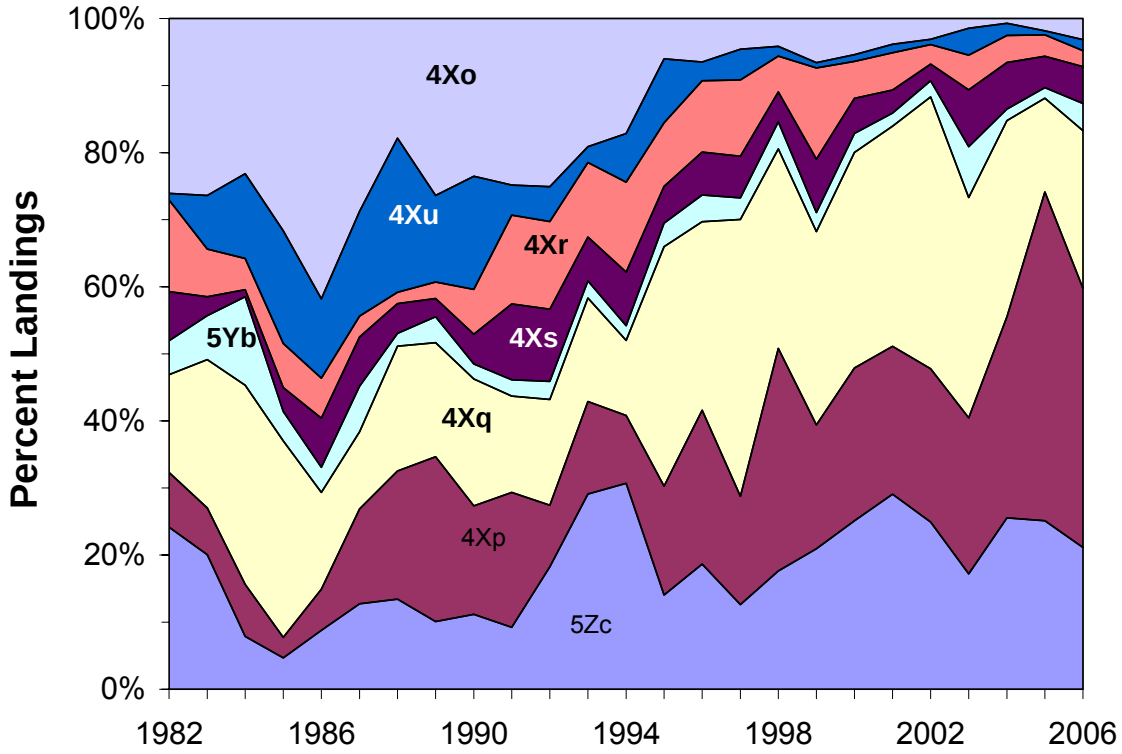

Fig. 4. Proportional landings of pollock by statistical Unit Area from the Western Component, 1982-2006.

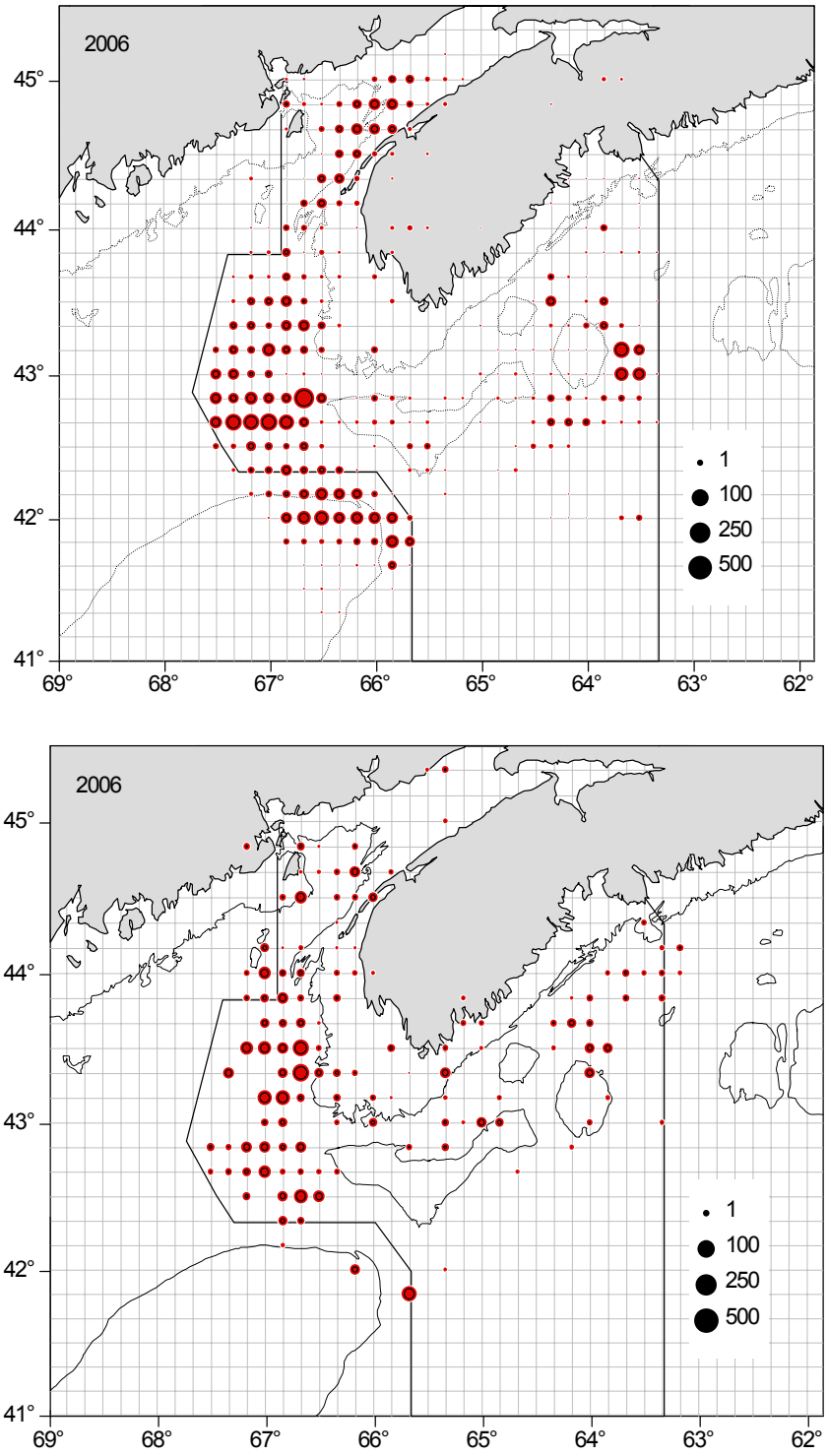

Fig. 5. Spatial distribution of pollock catches for small mobile otter trawl (TC 1-3) (upper panel) and gillnet (lower panel) by 10 minute squares for 2006 (1 Jan - 31 Aug).

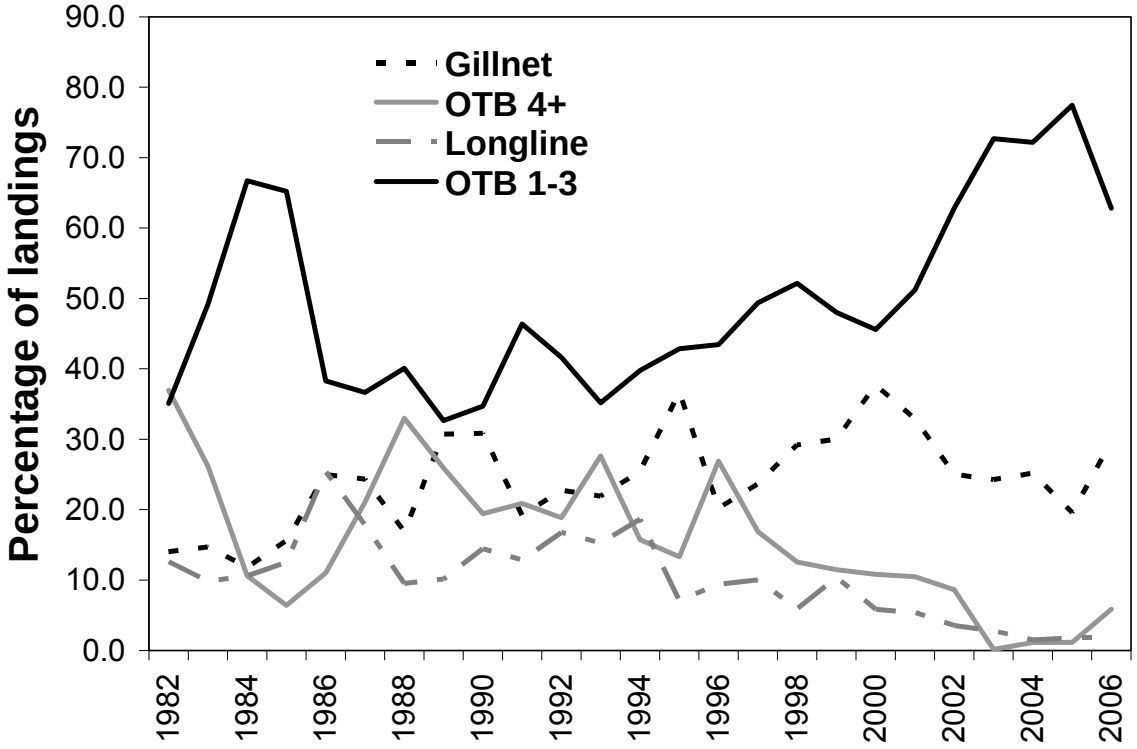

Fig. 6. Proportional landings of pollock by gear type from the Western Component, 1982 -2006.

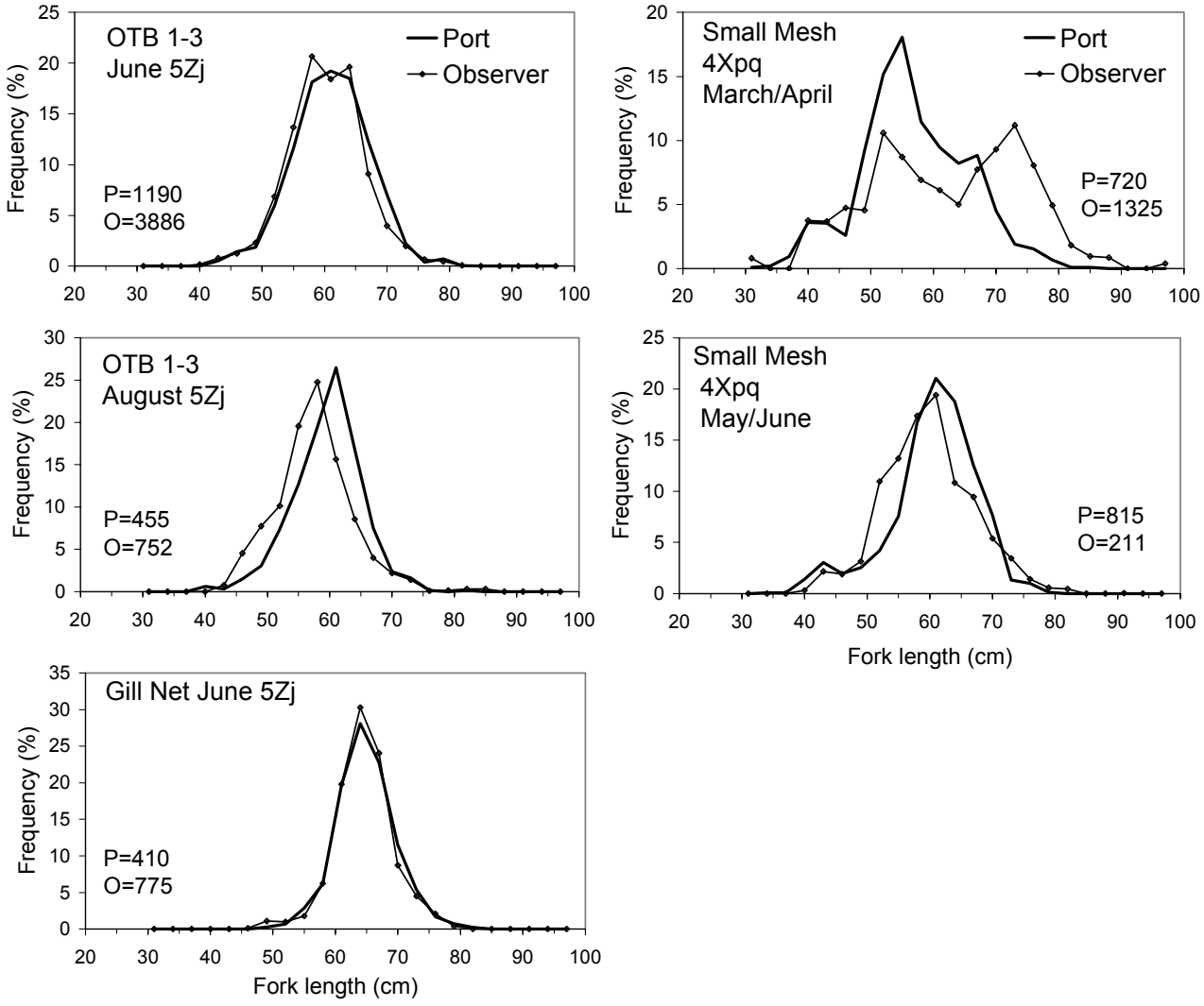

Fig. 7. Comparisons of 2006 port (dockside) and observer (at-sea) sample length measurements of pollock by area, month and gear type from the Western Component. Number of fish measured is shown for port (P) and observer (O) samples.

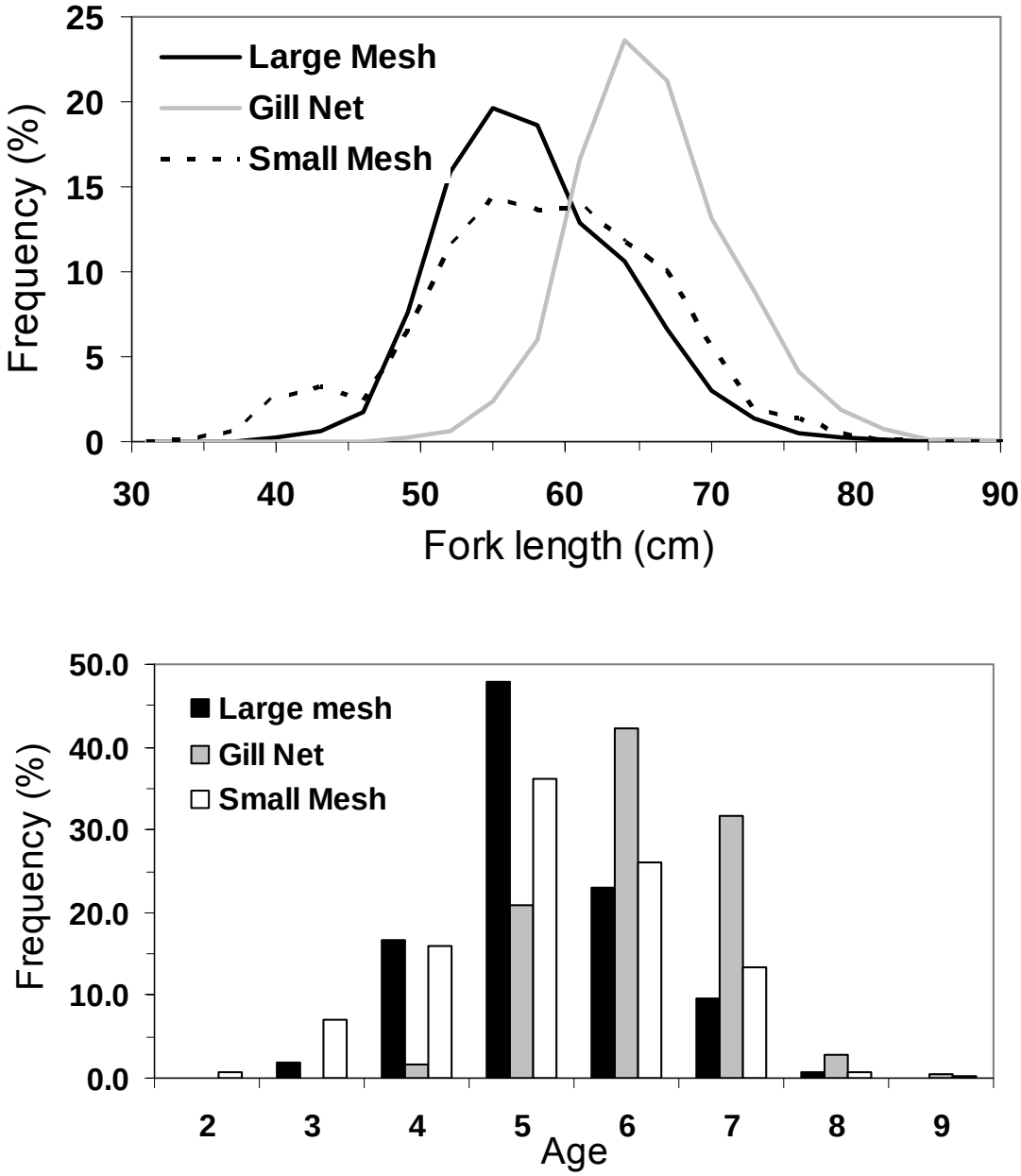

Fig. 8. Catch at size (upper panel) and age (lower panel) of pollock from gill net, large mesh otter trawl (cod end mesh >110mm) and small mesh otter trawl (cod end mesh ≤ 110mm) from the 2006 fishery (Jan. 1 - Aug. 31) in the Western Component area.

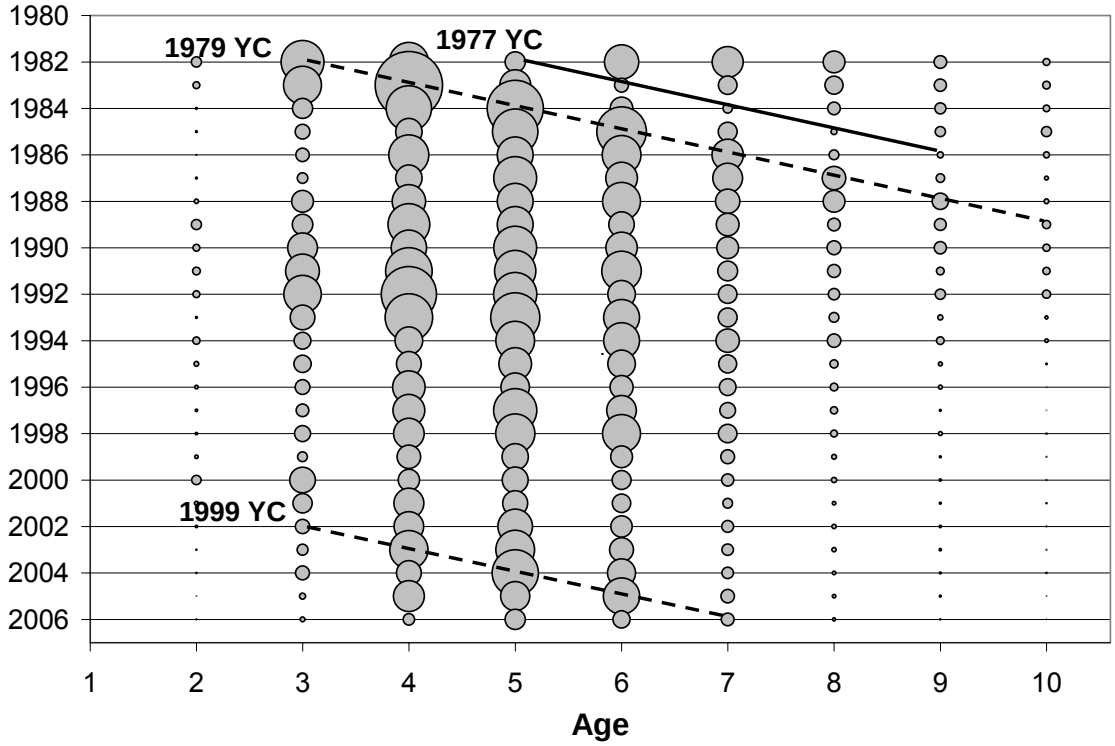

Fig. 9. Catch at age for pollock from the Western Component, 1982-2006. The area of the circle is proportional to the catch at that age and year. Two examples of strong cohorts are highlighted with a dashed line, and a weak cohort is indicated by the solid line.

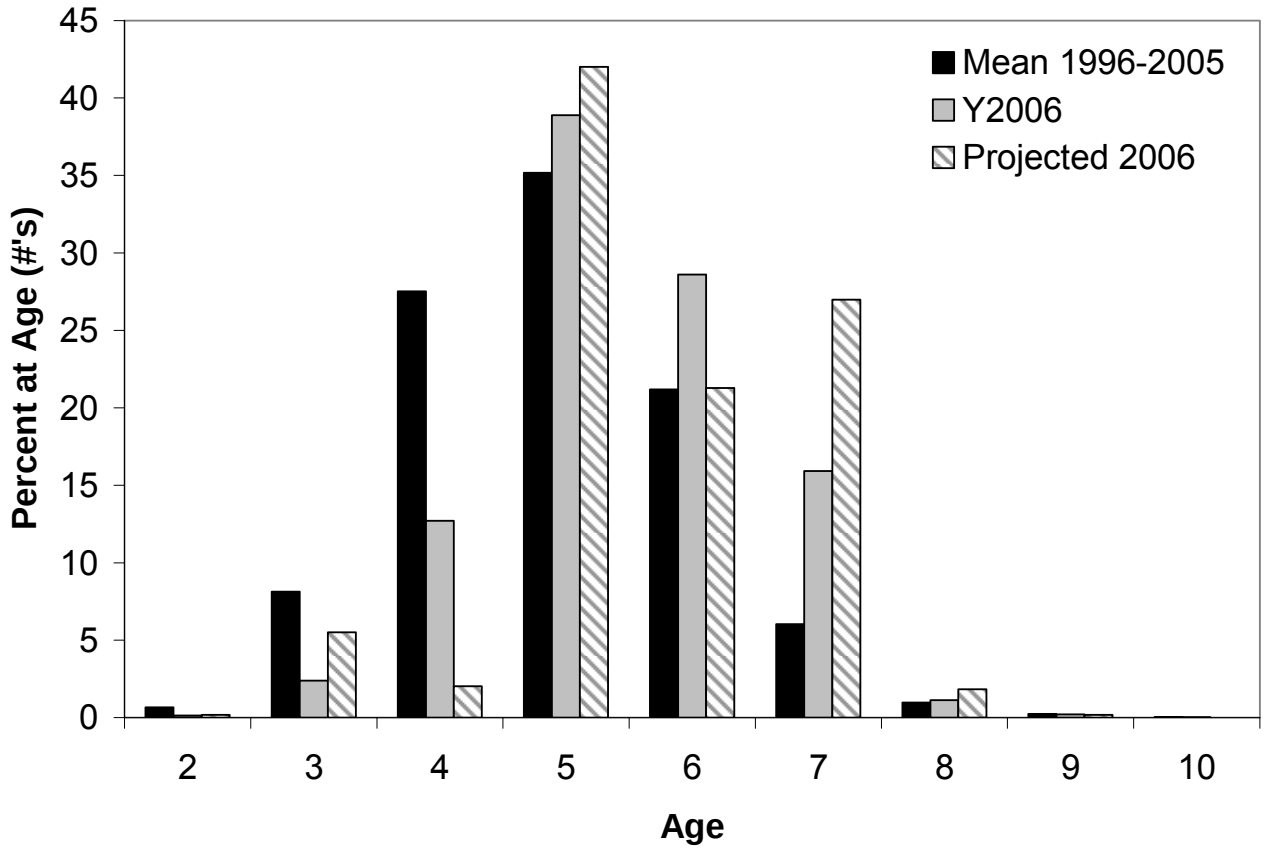

Fig. 10. Age composition of Western Component pollock catch in 2006 compared with the 10 year average from 1996-2005 and the projected catch for 2006 from last years' assessment.

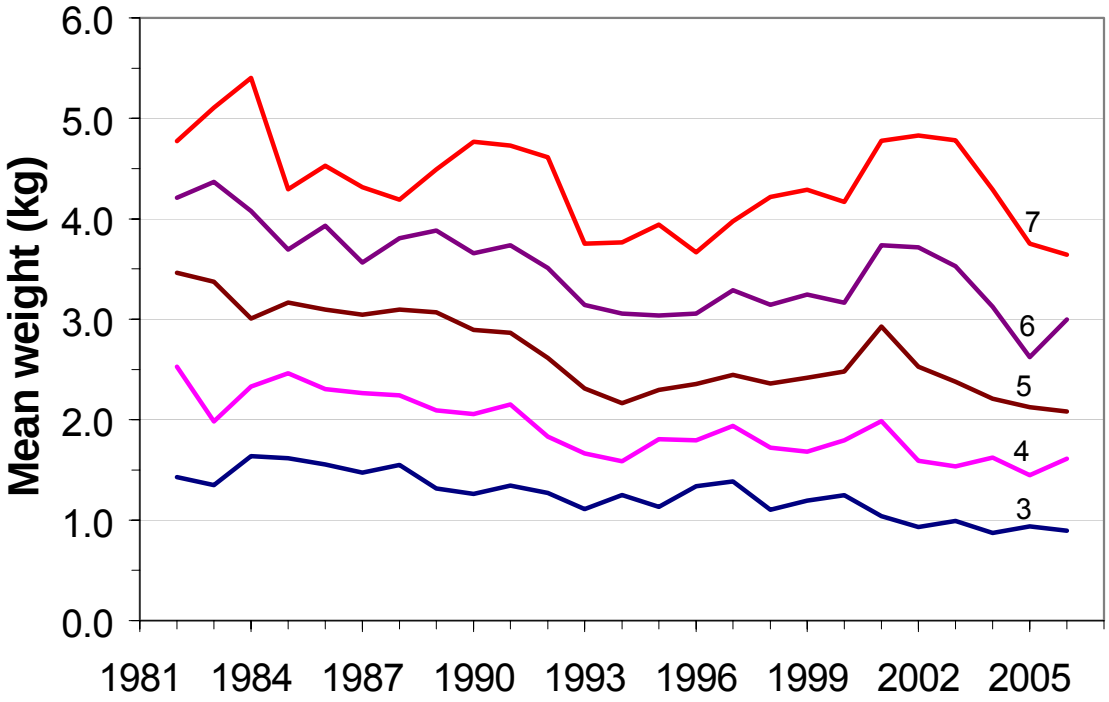

Fig. 11. Trends in fishery weights at age (kg) for pollock aged 3-7 from the Western Component, 1982-2006.

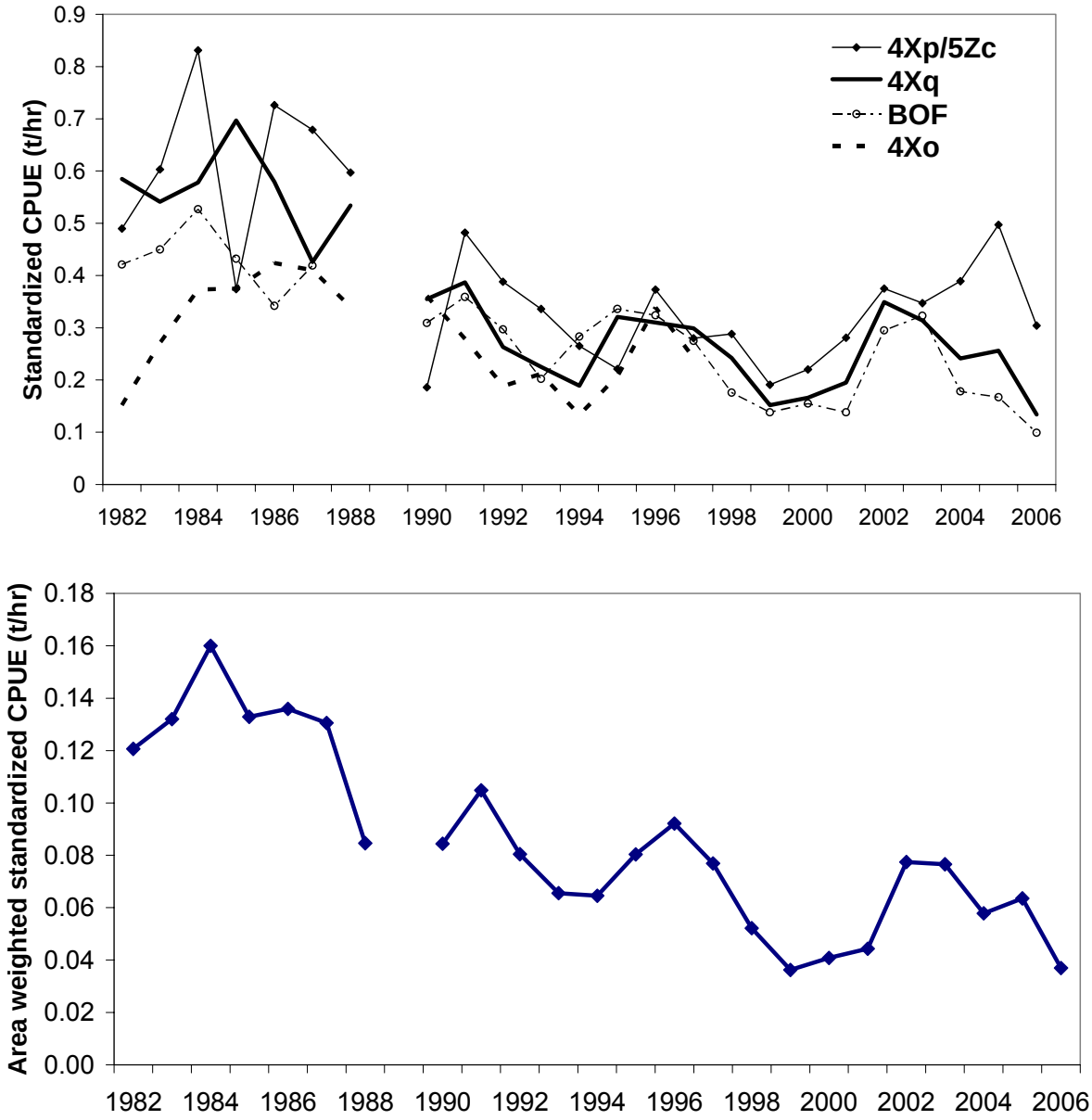

Fig. 12. Standardized mobile gear (OTB 1-3) catch rate series (t/hr) for pollock for the Western Component, 1982-2006. Upper panel: CPUE by area; Lower Panel: area weighted CPUE for combined areas.

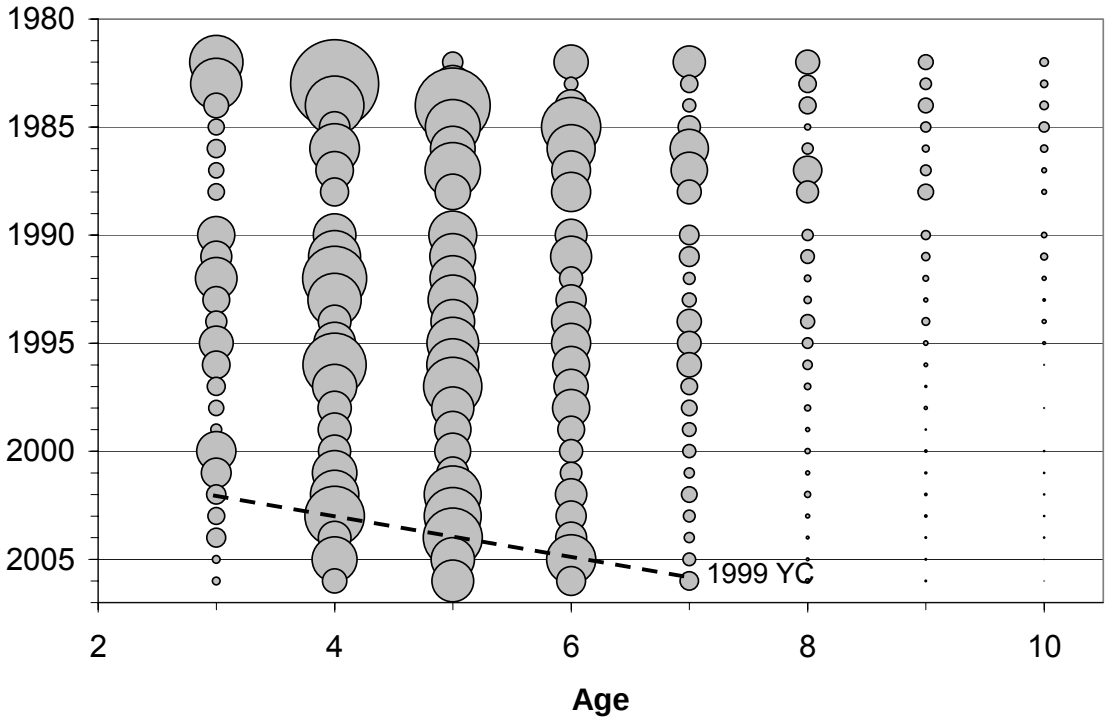

Fig. 13. Age-disaggregated catch rates for small mobile gear operating in the western component, 1982-2006.

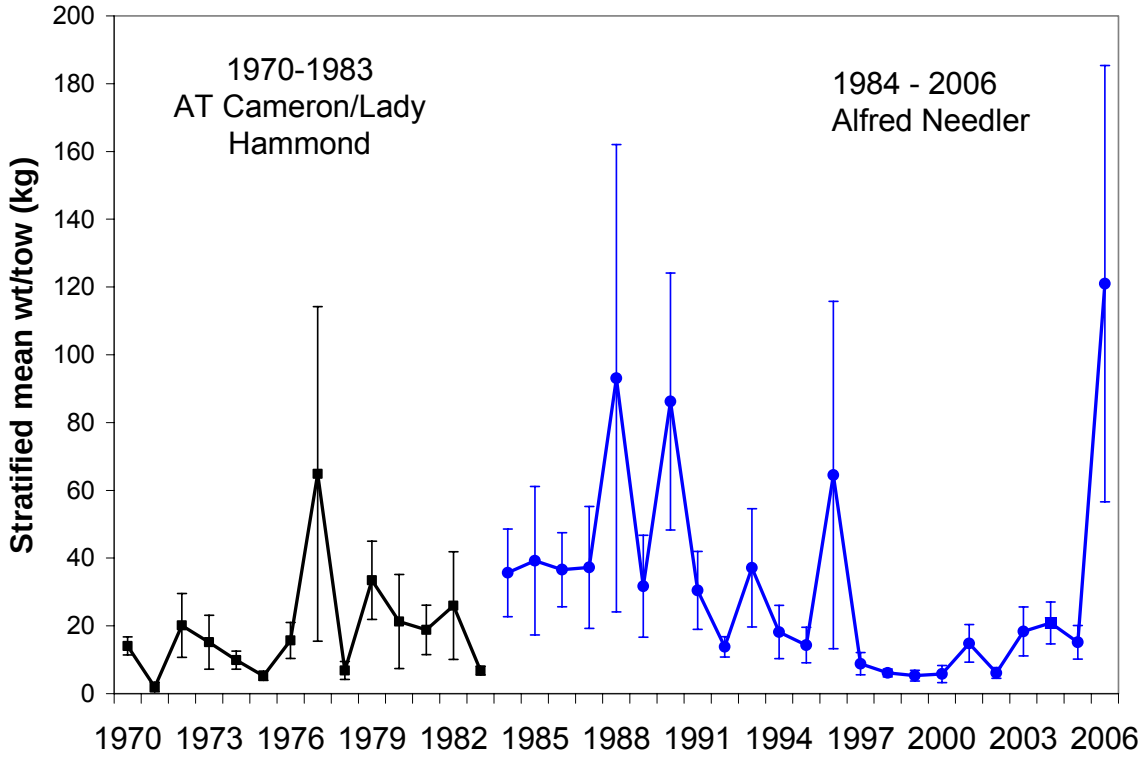

Fig. 14. Stratified mean catch per tow (kg) of pollock from the DFO summer research vessel survey in 4X strata (strata 474, 476 and 480-495) corresponding to the Western Component, 1970-2006. Data from 1984 until the present is the input data used in the VPA.

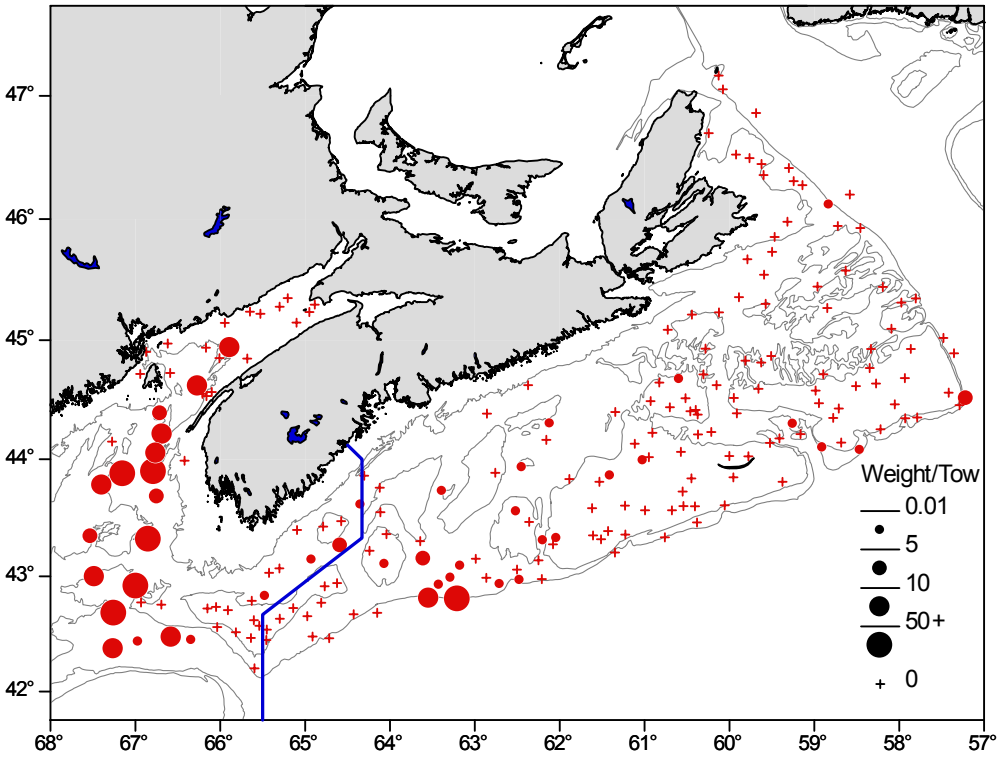

Fig. 15. Pollock biomass distribution (kg/tow) from the 2006 DFO summer survey. The solid line separates the Eastern and Western Components.

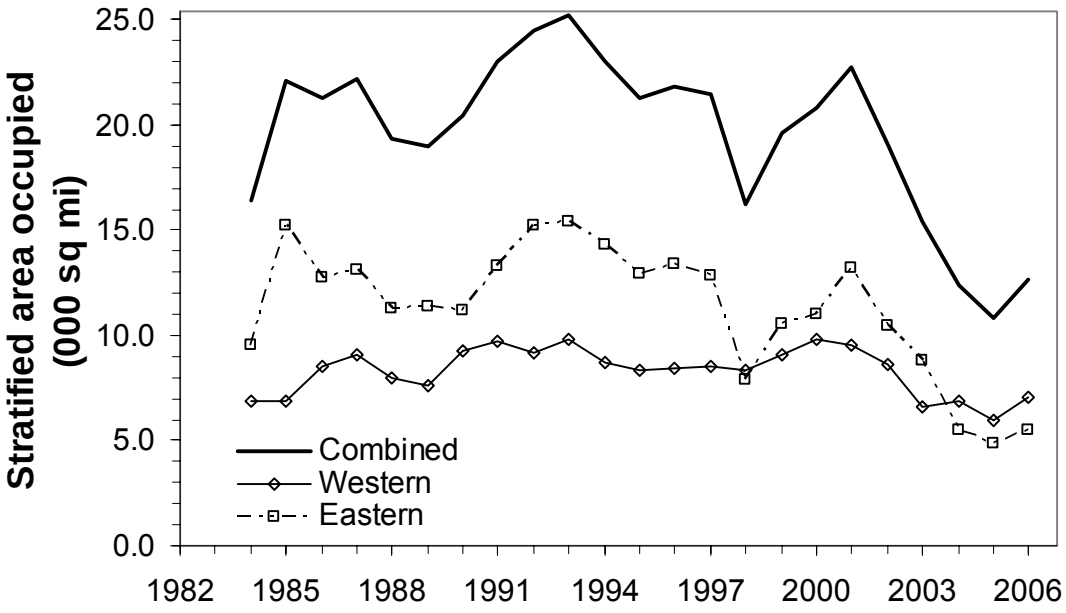

Fig.16. Stratified area occupied (000s sq mi) by pollock in the Eastern and Western component strata from the DFO summer RV survey, 1984-2006.

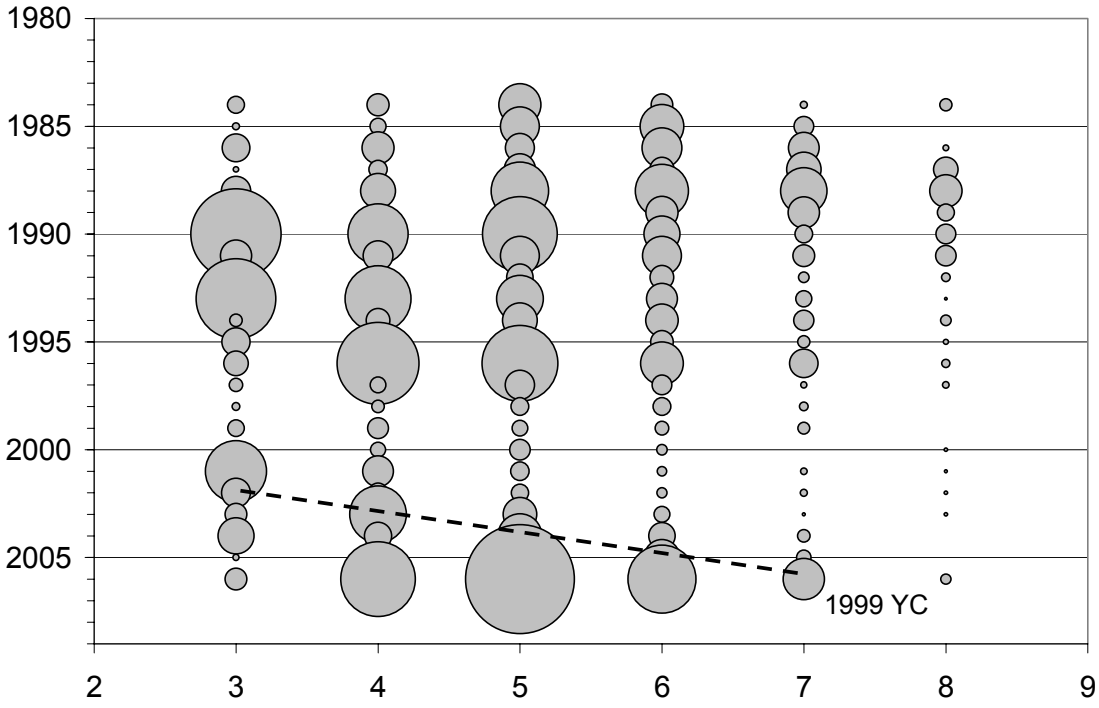

Fig. 17. Stratified mean number per tow at age of pollock from the DFO summer research vessel survey in 4X strata corresponding to the Western Component, 1984-2006.

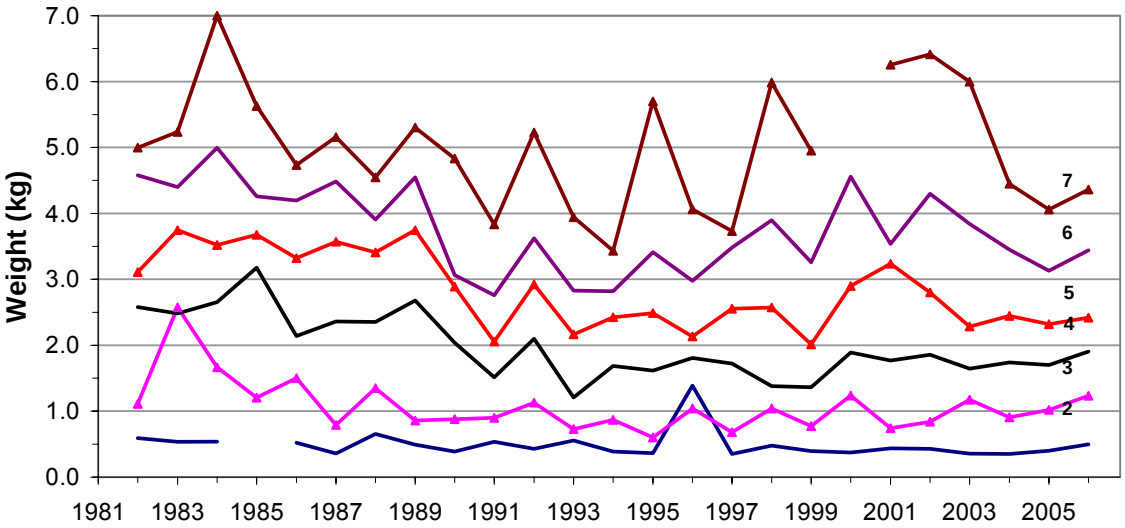

Fig. 18. Weight at age for pollock ages 2-7 from the DFO summer research vessel survey in 4X strata corresponding to the Western Component, 1982-2006.

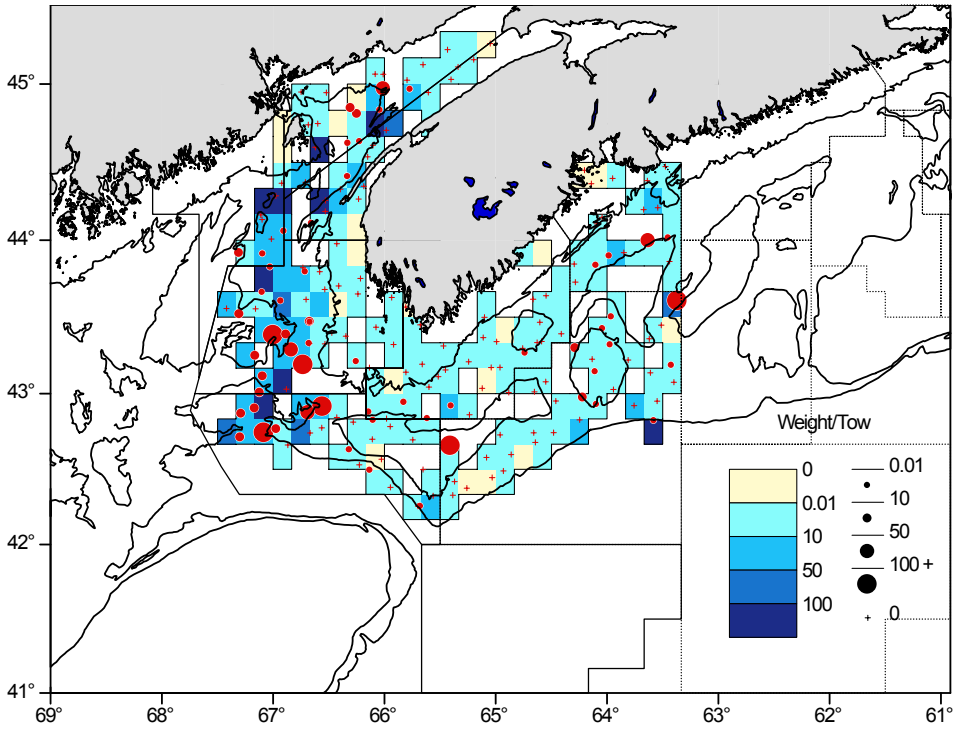

Fig. 19. ITQ survey pollock biomass (kg/tow) distribution for 2006 (solid circles), shown with respect to the average catch over the past ten years (shaded rectangles).

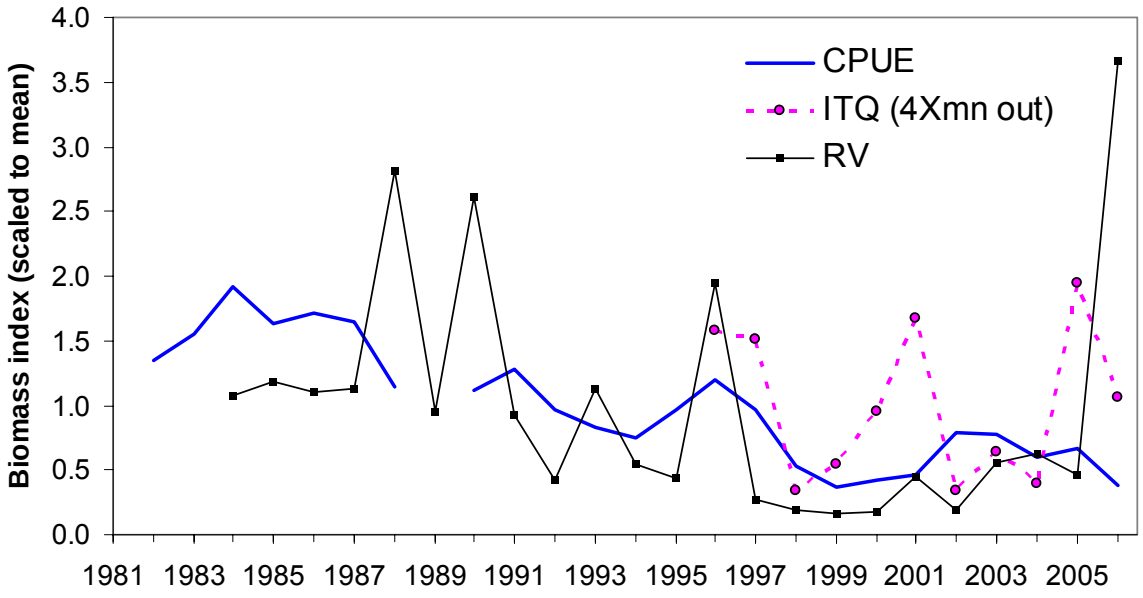

Fig. 20. Trends in pollock biomass indices from the mobile gear CPUE series (1982-2006), DFO research vessel survey (1984-2006) and the ITQ survey (1996-2006) for the Western Component area.

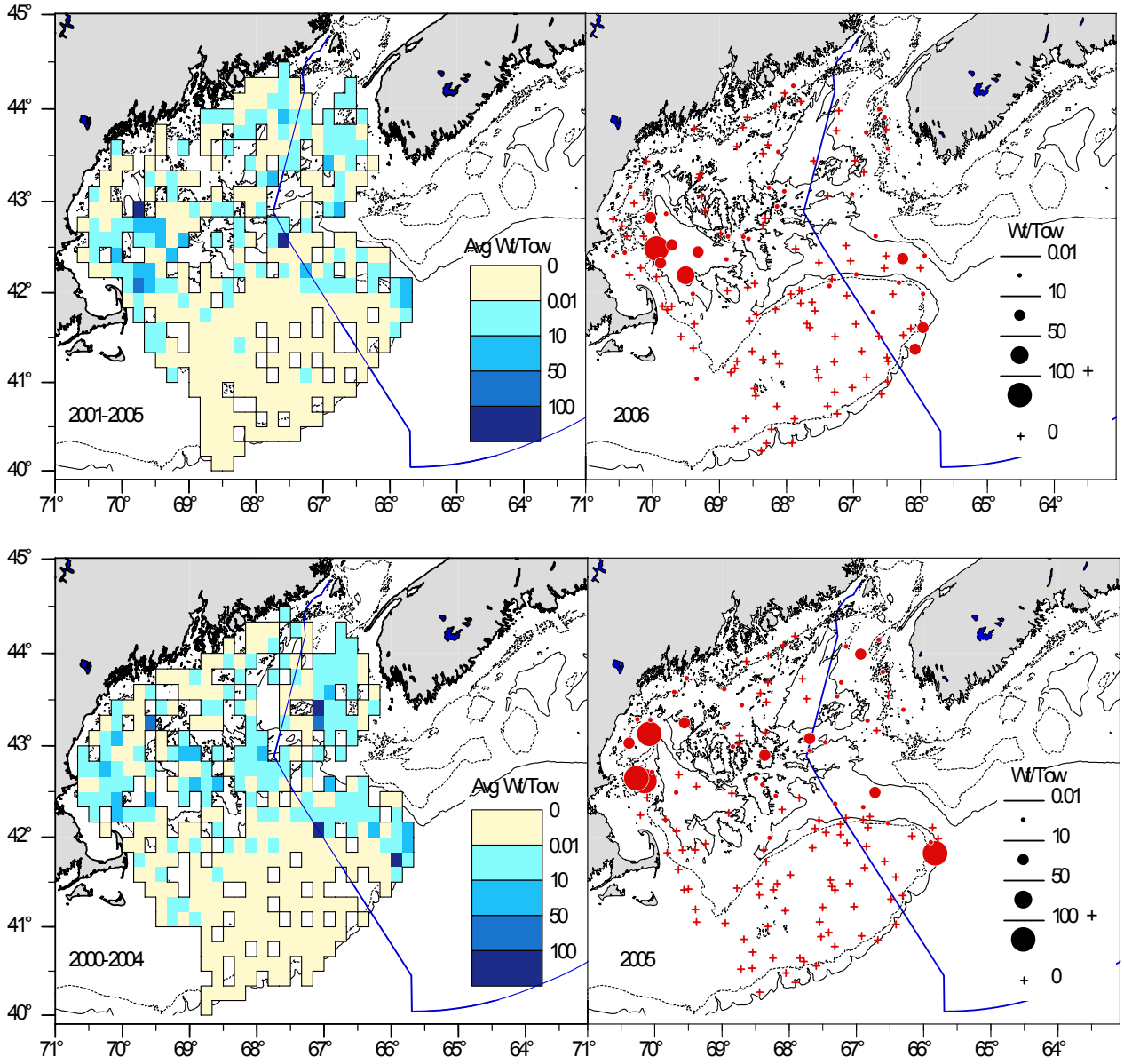

Fig. 21. National Marine Fisheries Service (NMFS) bottom trawl survey biomass distribution (kg/tow) for spring (upper panel) and fall (lower panel) surveys conducted in 2006 and 2005, respectively (solid circles) compared with the average for the previous five years (shaded rectangles). The solid line indicates the International Boundary.

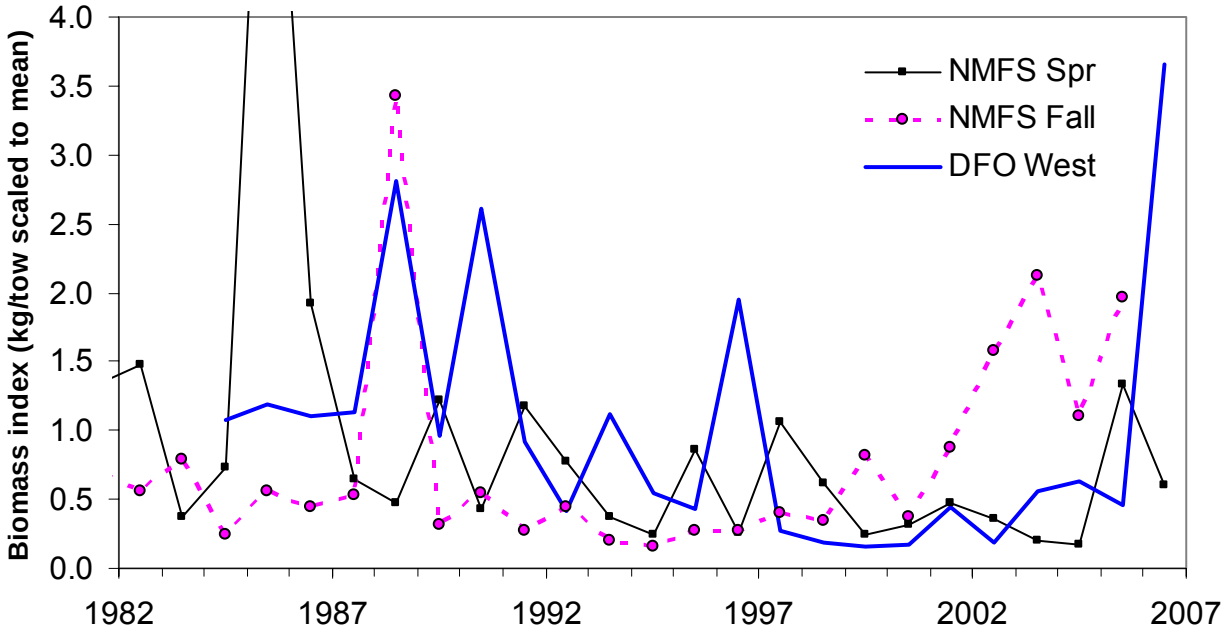

Fig. 22. Comparison of biomass indices (kg/tow, scaled to mean of series) from the NMFS Spring, NMFS Fall and DFO RV surveys.

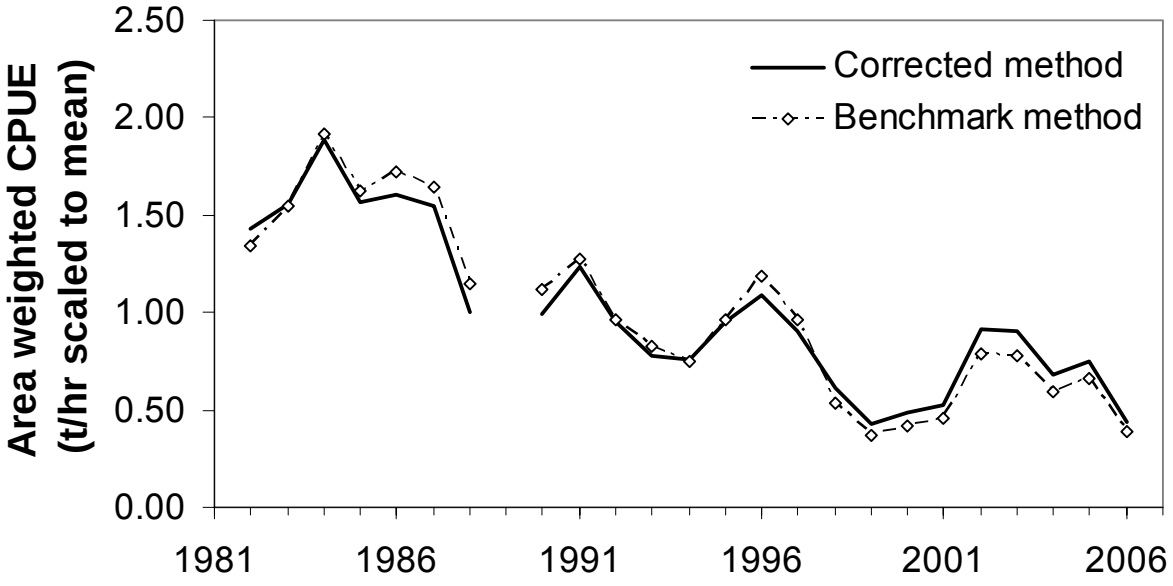

Fig. 23. Comparison area combined CPUE calculated using the Benchmark method (by dividing) and the corrected method (by multiplying) for applying the weighting factor to area specific standardized CPUE series.

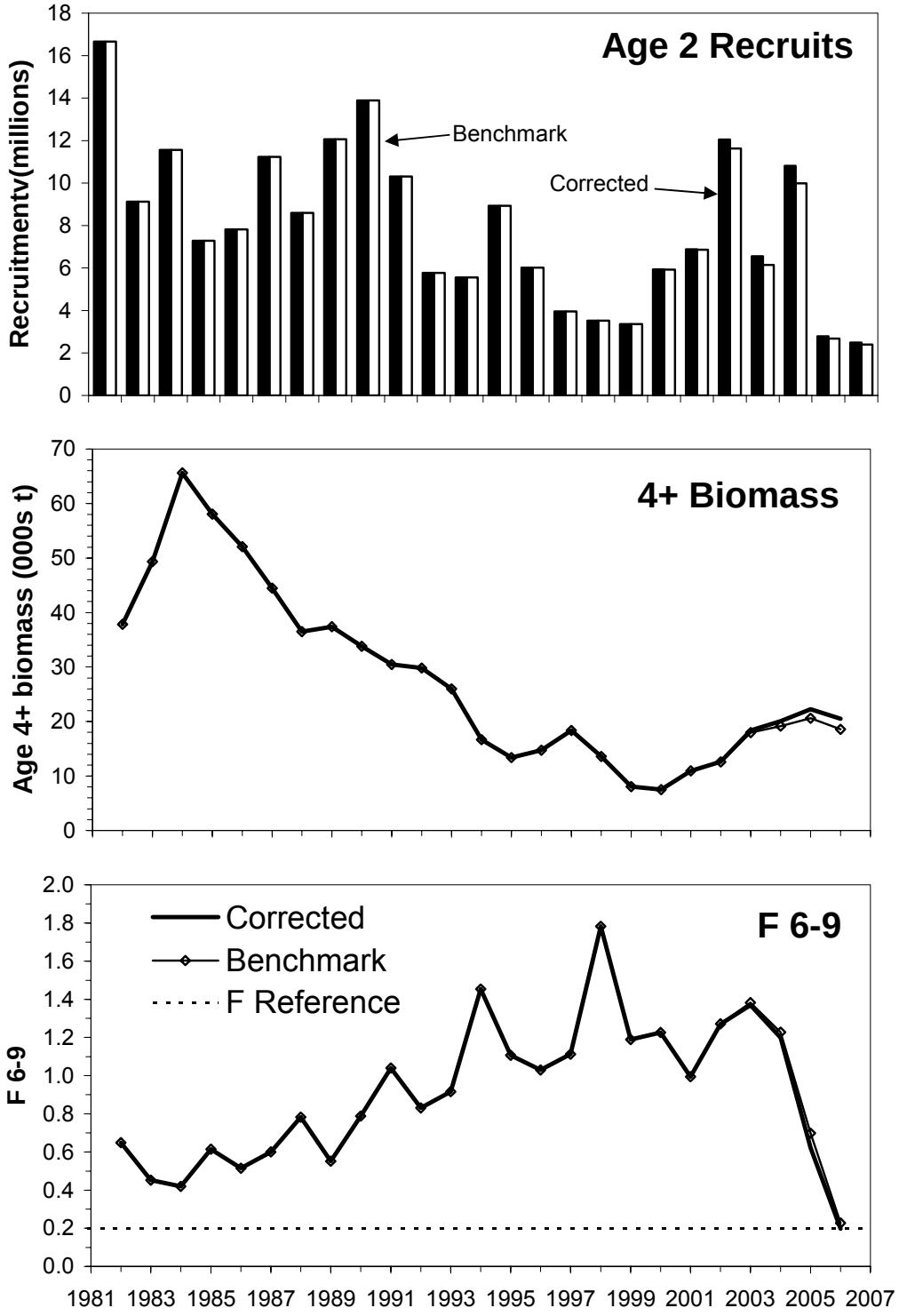

Fig. 24. Comparison area combined CPUE calculated using the Benchmark method (by dividing) and the corrected method (by multiplying) for applying the weighting factor to area specific standardized CPUE series.

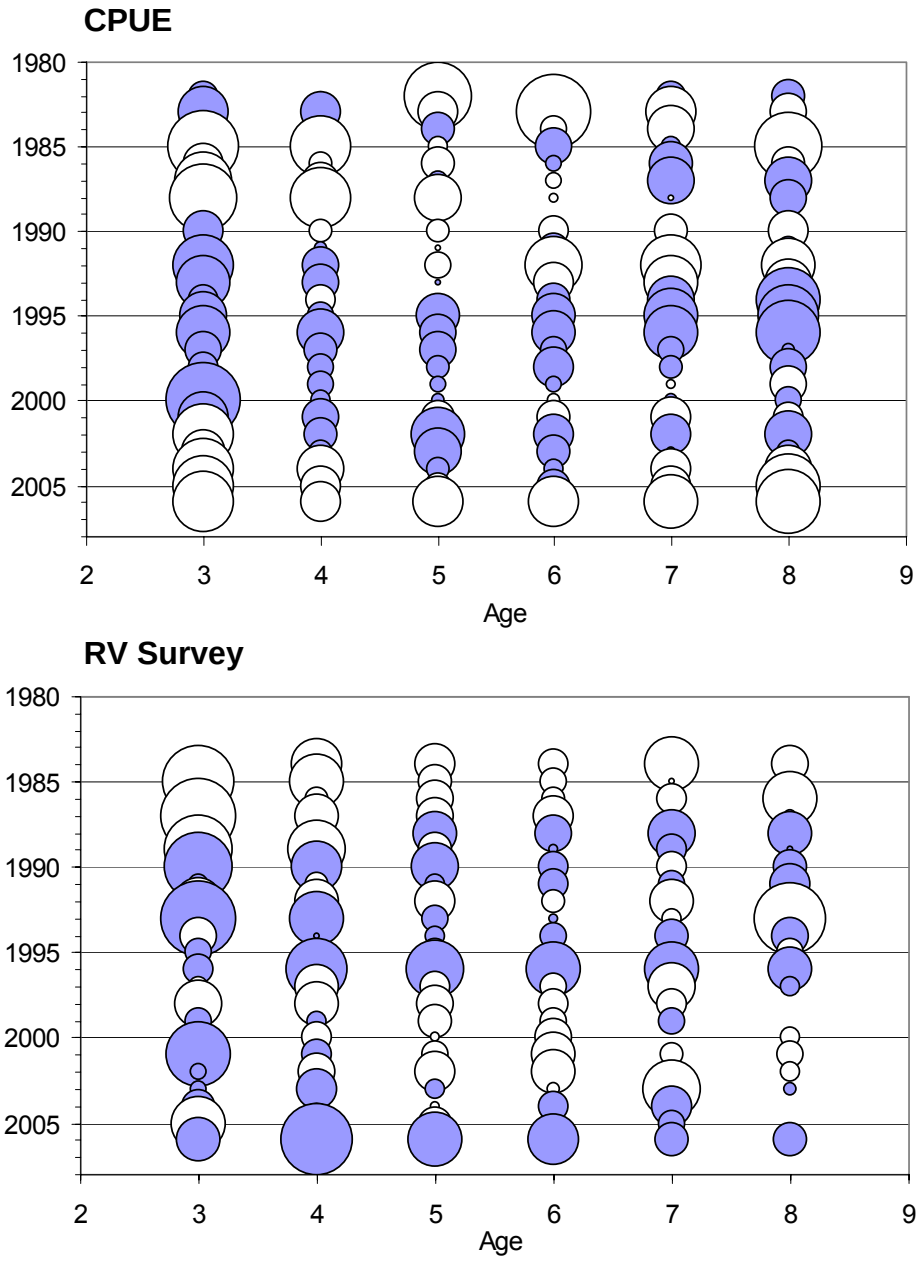

Fig. 25. Age-specific residuals for the Base VPA formulation, Western Component pollock, for the relationships between *ln* abundance index versus *ln* population numbers for the CPUE series (upper panel) and the RV series (lower panel). Closed circles denote positive residuals and open circles denote negative residuals. (Bubble size is proportional to magnitude).

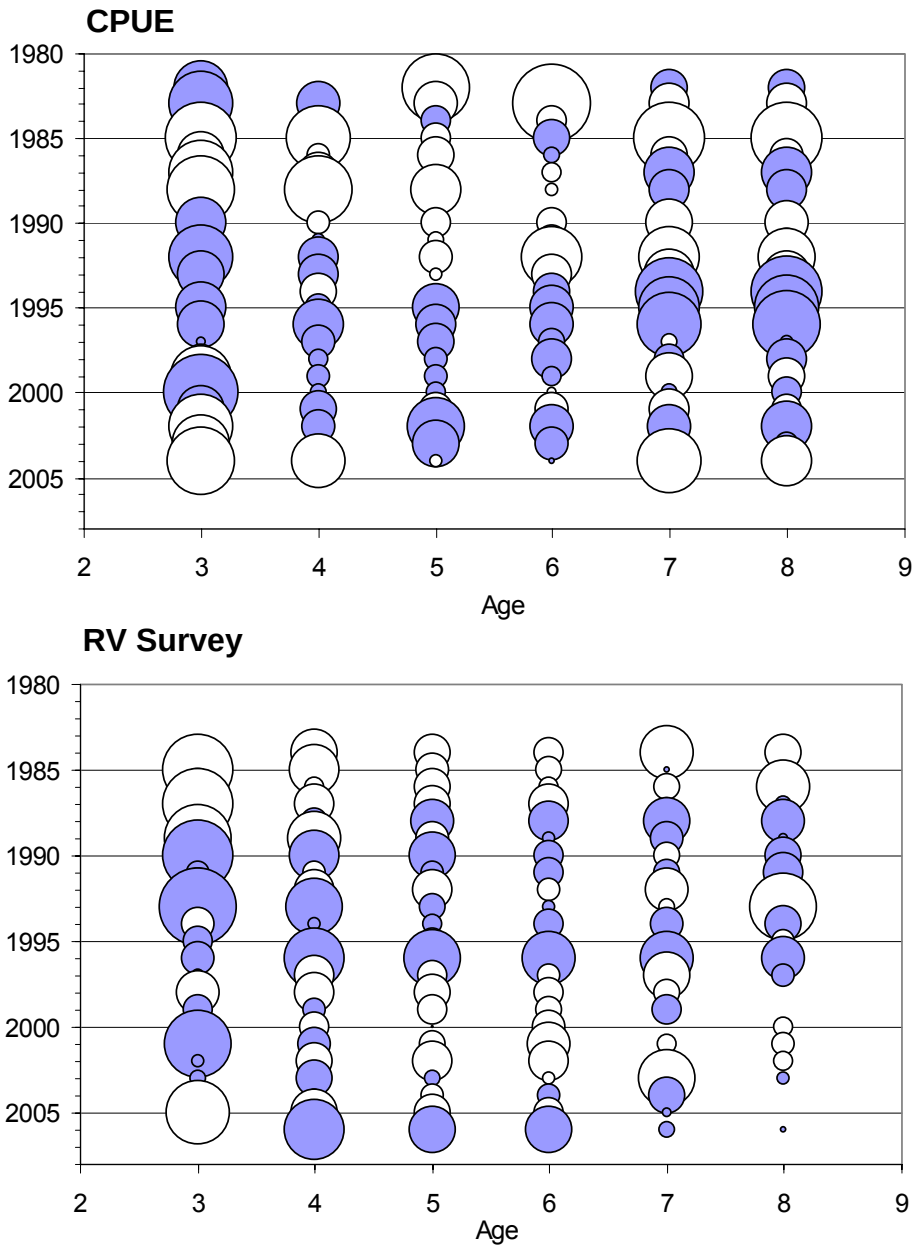

Fig. 26. Age-specific residuals for the Modified Base VPA formulation, Western Component pollock, for the relationships between *ln* abundance index versus *ln* population numbers for the CPUE series (upper panel) and the RV series (lower panel). Closed circles denote positive residuals and open circles denote negative residuals. (Bubble size is proportional to magnitude).

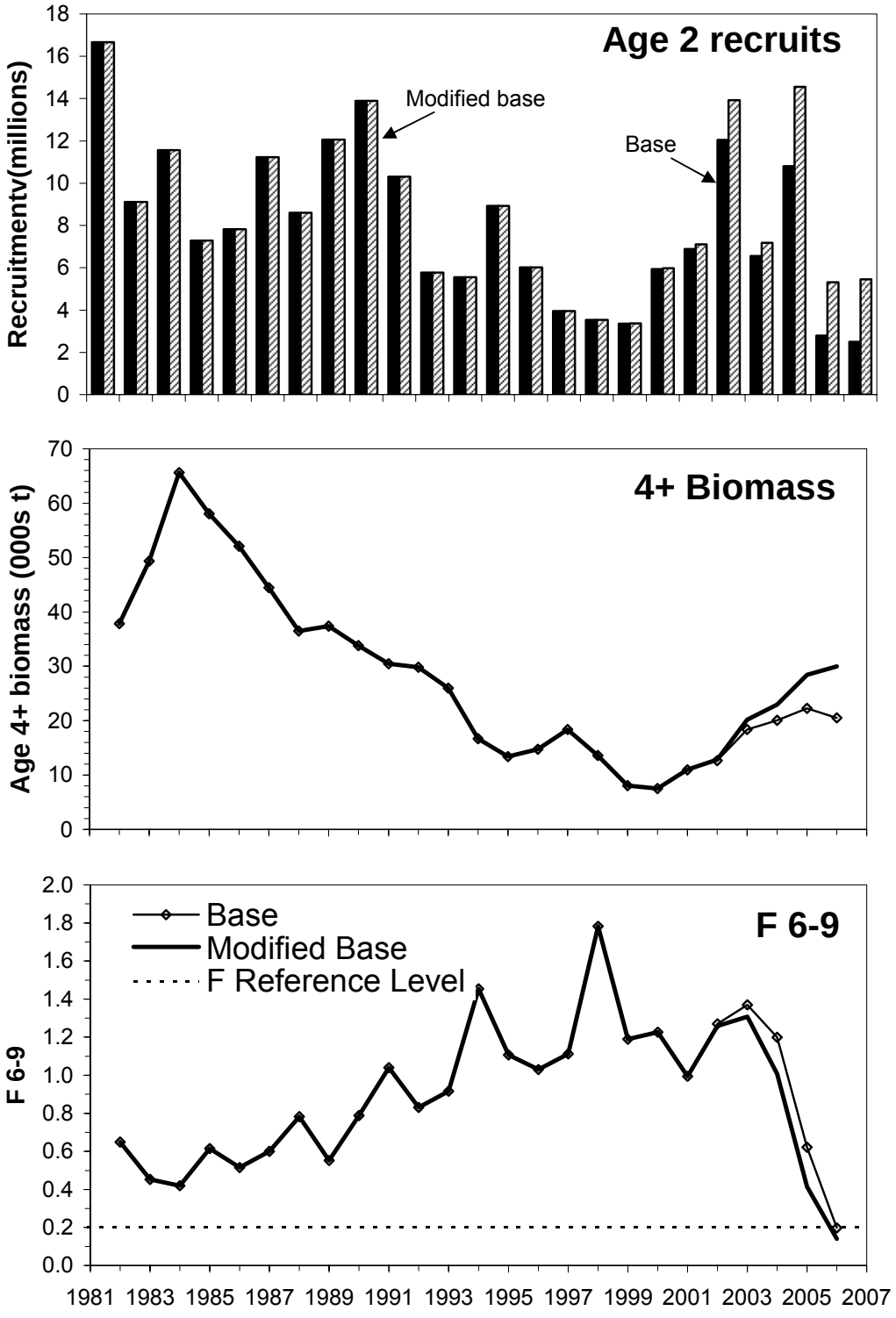

Fig. 27. Comparison of trends in age 2 recruitment, 4+ biomass and age 6-9 fishing mortality for the Western Component from the Base VPA and the Modified Base VPA with 2005 and 2006 removed from the CPUE series.

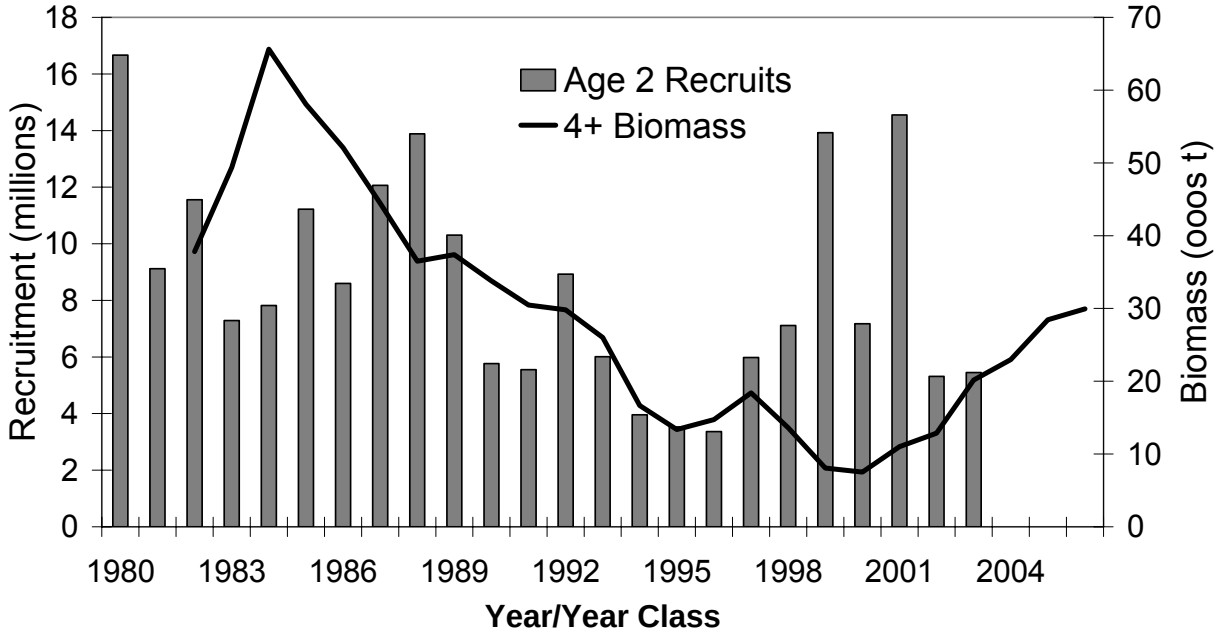

Fig. 28. Trends in age 4+ biomass and age 2 recruitment of pollock in the Western Component from the Modified Base VPA formulation.

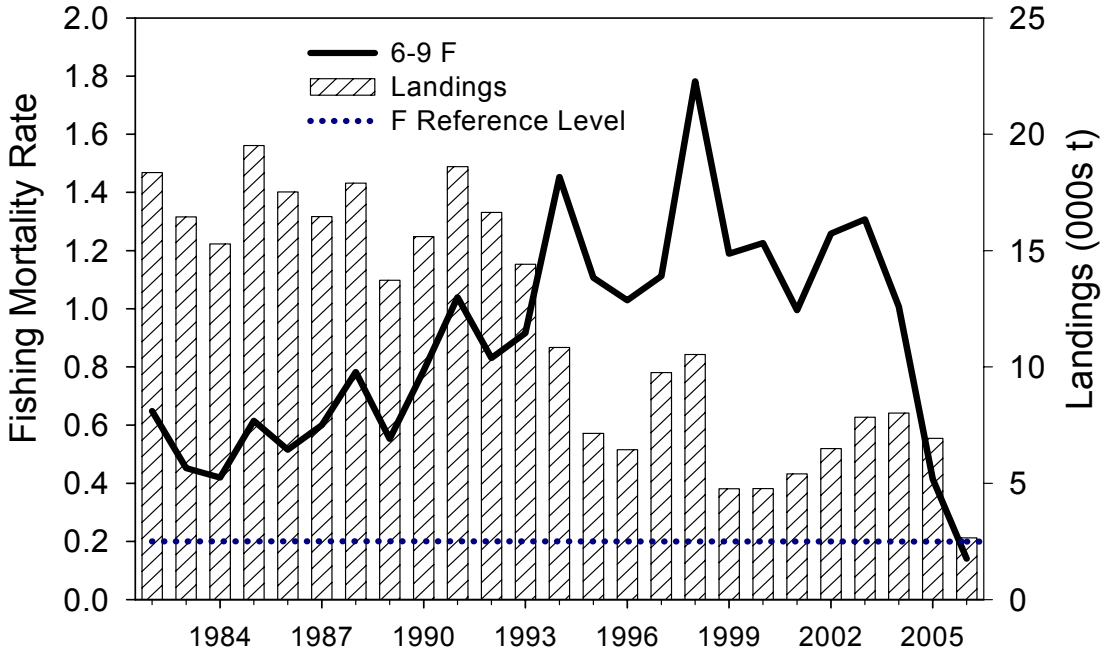

Fig. 29. Trends in fishing mortality and landings of pollock for the Western Component from the Modified Base VPA formulation.

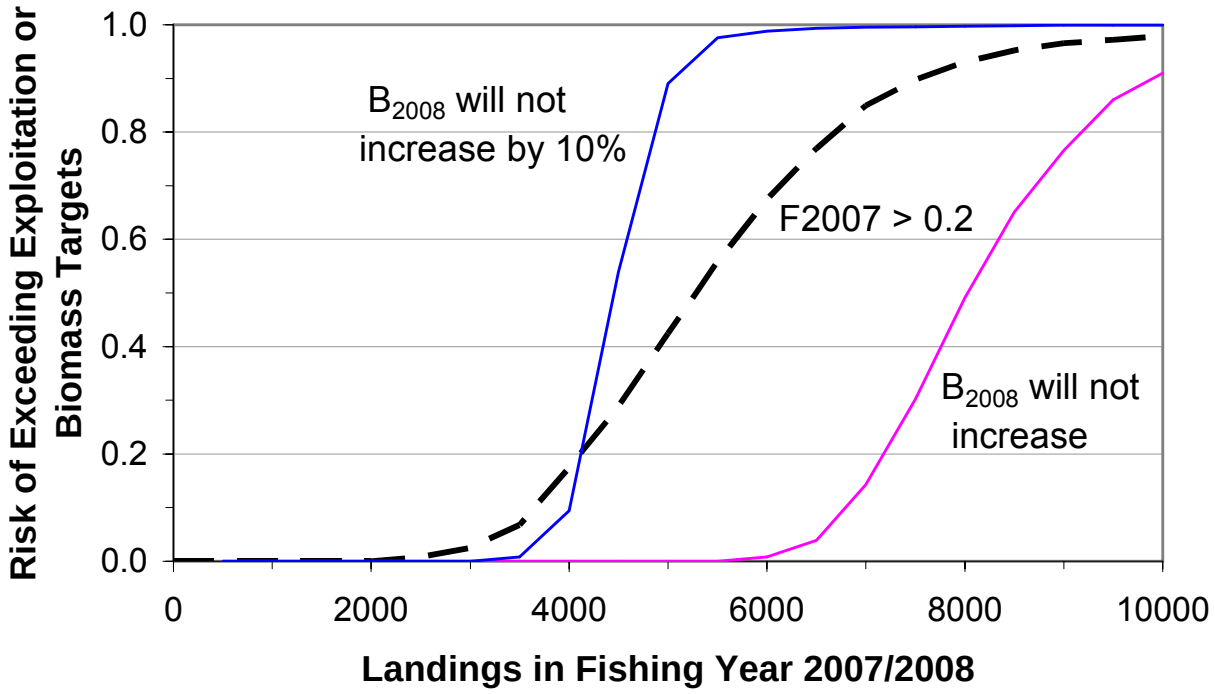

Fig. 30. Risk of exceeding exploitation or biomass rebuilding targets for Western Component from the Modified Base VPA formulation.

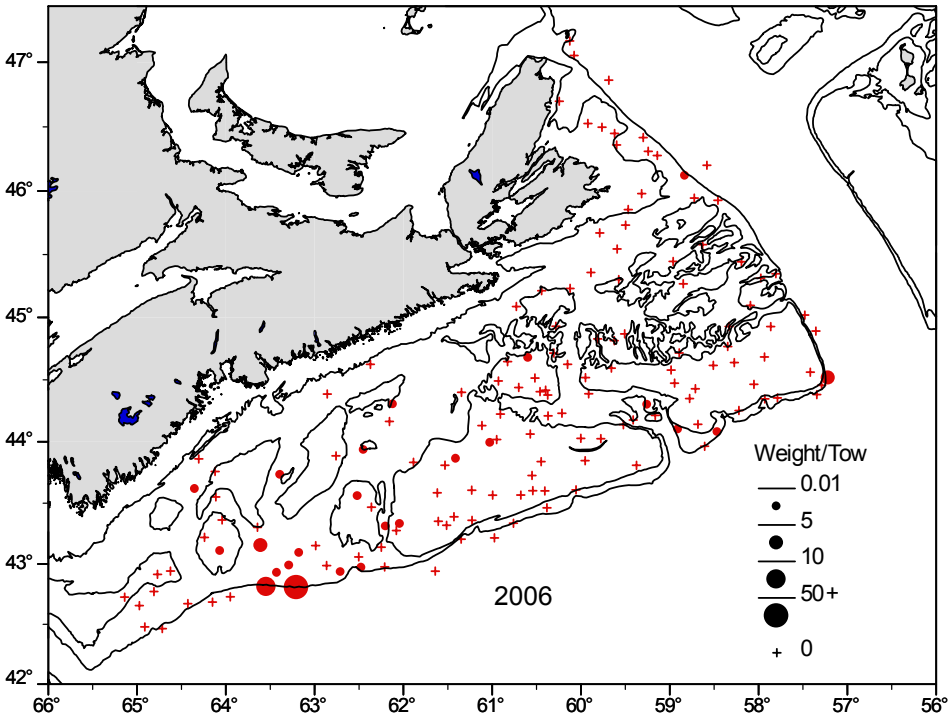

Fig. 31. Spatial distribution of pollock catches during the 2006 RV survey in the Eastern Component.

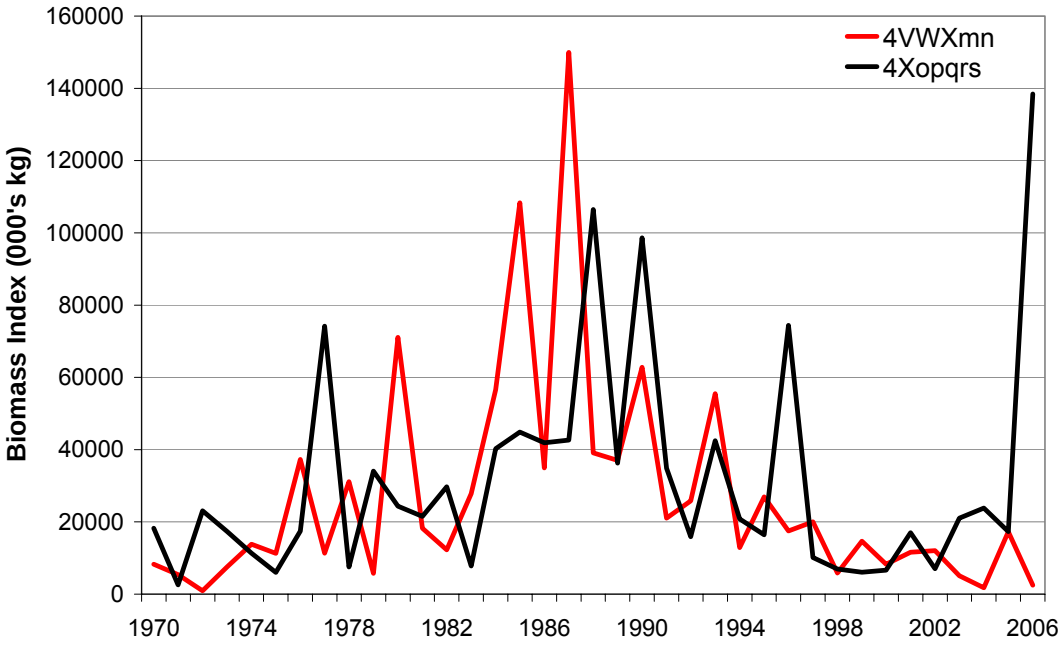

Fig. 32. RV survey biomass indices from the Eastern and Western components, 1970-2006.

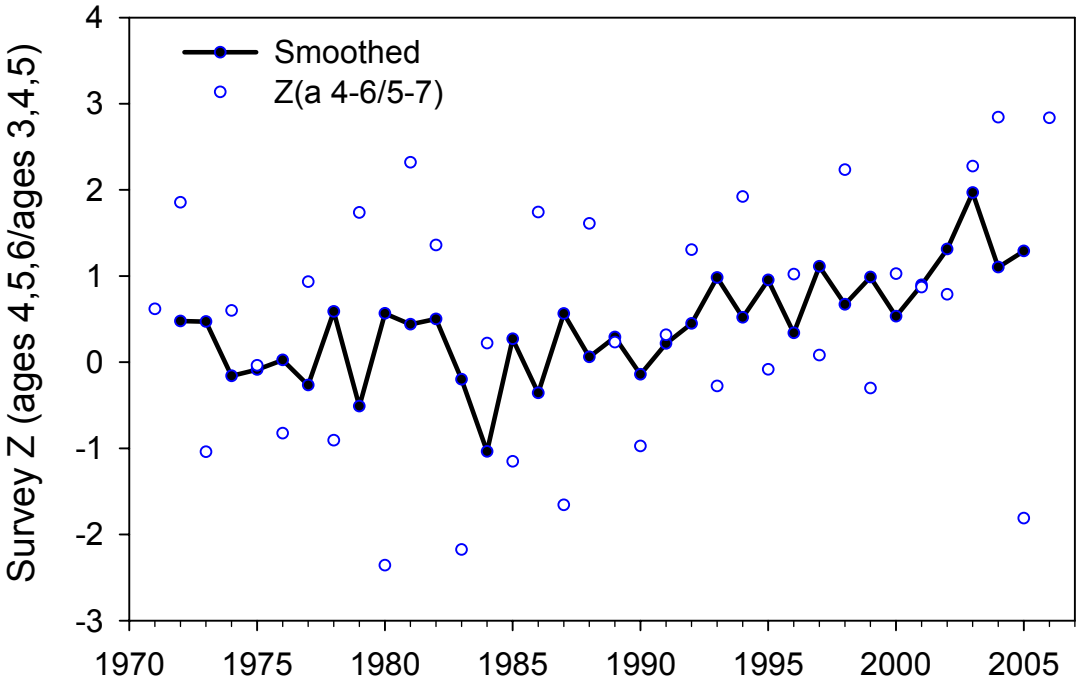

Fig. 33. Smoothed (running average of three year) estimates of total mortality from RV surveys, eastern component pollock. Annual estimates of total mortality (unsmoothed) are shown as open circles.