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Assessment of Eastern Georges Bank Haddock for 2014

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ABSTRACT

The total catch of eastern Georges Bank (EGB) haddock in 2013 was 5,066 mt of the 10,400 mt combined Canada/United States of America (USA) quota. The 2013 Canadian catch decreased from 5,064 in 2012 to 4,631 mt while the USA catch in 2013 was 435 mt, a small decrease from the 2012 catch of 569 mt. Haddock discards from the Canadian scallop fishery and the USA groundfish fishery were estimated at 10 and 91 mt, respectively. Under restrictive management measures, combined Canada/USA catches declined from over 6,500 mt in 1991 to a low of 2,150 mt in 1995, averaged about 3,600 mt during 1996 to1999 and have generally increased since then. Catches reached a peak in 2009 at 19,855 mt and have declined since then as the outstanding 2003 year class moved through the fishery.

Adult population biomass (ages 3+) has increased from near an historical low of 10,300 mt in 1993 to 76,500 mt in 2003. It decreased to about 53,000 mt at the beginning of 2005 but subsequently increased to 121,500 mt in 2009, higher than the 1931-1955 maximum of about 90,000 mt. Adult biomass subsequently decreased to 40,600 in 2012 but increased in 2013 and again in 2014 to 160,300 mt. The exceptional 2003 and 2010 year classes, estimated at 243 million and 334 million age-1 fish, respectively, are the largest observed in the assessment time series (1931-1955 and 1969-2013). The preliminary estimate for the 2013 year class is 1,546 million fish at age 1. Except for the strong 2000 and 2011 year classes and the exceptional 2003, 2010 and 2013 year classes, recruitment has fluctuated between 2.1 and 27.3 million since 1990. Fully recruited fishing mortality fluctuated between 0.27 and 0.47 during the 1980s, and increased in 1993 to a high of 0.55, the highest observed. Fully recruited fishing mortality was below F_{ref} = 0.26 during 1995 to 2003, fluctuated around 0.3 during 2004 to 2006, then declined and stayed below F_{ref} and was 0.16 in 2013.

Positive signs of productivity include expanded age structure, broad spatial distribution, large biomass and three exceptional year classes and two strong year classes since 2000. On the negative side, condition has decreased substantially and size at age has declined.

Assuming a 2014 catch equal to the 27,000 mt total quota, a combined Canada/USA catch of 45,500 mt in 2015 results in a neutral risk (50%) that the 2015 fishing mortality rate would exceed F_{ref} = 0.26. A catch of 38,000 mt in 2015 results in a low risk (25%) that the 2015 fishing mortality rate will exceed F_{ref}. The 2010 year class at age 5 is expected to contribute 85% of the catch biomass. The next highest contribution to the 2015 catch biomass of 6% is expected from the 2011 year class at age 4. The probability that the 2016 biomass will not increase by 20% is negligible. Adult biomass is projected to be very high, 568,200 mt at the beginning of 2016 at the F_{ref} catch level.

RÉSUMÉ

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INTRODUCTION

For the purpose of developing a sharing proposal and consistent management by Canada and the United States of America (USA), an agreement was reached that the transboundary management unit for haddock would be limited to the eastern portion of Georges Bank (EGB; DFO statistical unit areas j and m in NAFO sub-division 5Ze; USA statistical areas 551, 552, 561 and 562 in NAFO sub-division 5Ze; Figure 1; DFO 2002). This assessment applies the approach used by Van Eeckhaute *et a*l. (2013) to Canadian and USA fisheries information updated to 2013. Results from the Fisheries and Oceans Canada (DFO) survey, updated to 2014, the USA National Marine Fisheries Service (NMFS) spring survey, updated to 2014 and the NMFS autumn survey, updated to 2013, were incorporated. The NMFS surveys since 2009, which use a new vessel, the NOAA ship *Henry B. Bigelow*, and a new net and protocols, were made equivalent to surveys undertaken by the former NOAA ship *Albatross IV* with length based conversion factors.

FISHERY

Commercial Catches

Haddock on Georges Bank have supported a commercial fishery since the early 1920s (Clark *et al*.1982). Catches from EGB during the 1930s to 1950s ranged between 15,000 mt and 40,000 mt (Figure 2), averaging about 25,000 mt (Schuck 1951, R. Brown *pers. com.*). Records of catches by unit area for 1956 to 1968 have not been located; however, based on records for NAFO Subdivision 5Ze, catches from EGB probably attained record high levels of about 60,000 mt during the early 1960s. Catches in the late 1970s and early 1980s (Table 1) reached a maximum of 23,344 mt and were associated with good recruitment. Substantial quantities of small fish were discarded in those years (Overholtz *et al*. 1983). Catches subsequently declined and fluctuated around 5,000 mt during the mid to late 1980s. Under restrictive management measures (Table 2), combined Canada/USA catches declined from 6,504 mt in 1991 to a low of 2,150 mt in 1995, varied between about 3,000 mt and 4,000 mt until 1999, and increased to 15,256 mt in 2005 (Figure 3). Combined catches varied between 12,510 mt and 19,855 mt from 2006 to 2011 then decreased in 2012 to 5633 mt and in 2013 to 5,066 mt. In 2013, the total catch represented 49% of the combined 10,400 mt quota. Canada caught 72% of its 6,448 mt allocation while the USA caught 11% of its 3,952 mt allocation. The total catch is well below the quota due to reduced availability of haddock and bycatch restrictions on the Canadian and USA fisheries.

Canadian

Some elements of the management measures used on EGB are described in Table 2. Quotas are the principal means used to regulate the Canadian groundfish fisheries on Georges Bank. Quota regulation requires effective monitoring of fishery catch. Weights of all Canadian landings since 1992 have been monitored at dockside. Canadian catches since 1995 have usually been below the quota due to closure of some fleet sectors when the cod quotas were reached. At-sea observer coverage increased from 2011 levels for all gears and represented 32% of otter trawl, 24% of longline and 16% of gillnet landings which amounted to an overall observed level of 31% of the haddock landings in 2013.

Between 1994 and 2004, the Canadian fishery for groundfish on EGB was prohibited from 1 January to 30 May. In 2005, increasing haddock abundance led to permission to conduct an

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exploratory Canadian groundfish fishery in January and February that has continued since that time. Observer coverage for this fishery has been higher than at other times of the year. So as not to adversely affect the rebuilding of cod on EGB, the winter fishery was closed February 4th in 2013, based on when it was determined that cod were actively spawning in the previous year, i.e. when 30% of cod were in the spawning or post-spawning stages from spawning data collected by observers..

Canadian Landings

Canadian landings in 2013 decreased to 4,631 mt from 5,064 mt in 2012. The 2012 and 2013 catches are the lowest since 2000. In recent years, the Canadian fishery has been conducted primarily by vessels using otter trawls and longlines with some handlines and gillnets. In 2013, almost all of the catch was taken by tonnage class 1 to 3 (less than 150 tons) vessels, corresponding roughly to vessels less than 65 ft in overall length. Otter trawl gear accounted for 94% and longline gear accounted for 6% of the haddock landings, and there were minimal landings from gillnet (Table 3). The highest catch occurred in October, followed by September, January, December and November, in that order (Table 4, Figure 4). The January/February winter fishery landed 1,028 mt of haddock, accounting for 22% of the total Canadian landings, somewhat higher than the previous year. Quarter 4 had the highest percentage of total Canadian landings at 45%.

Prior to 1985, Canadian landings include haddock landings reported by the scallop fishery. Landings of haddock by the scallop fleet were low (Table 3) with a maximum of 38 mt reported in 1987.

Canadian Discards

Since 1996, the scallop fishery has been prohibited from landing haddock and this species is therefore discarded. Discards from this fleet ranged between 29 and 186 mt since 1969 (Table 1; Van Eeckhaute *et al*. 2005, 2006, 2010 and 2011, Gavaris *et al*. 2007, 2008 and 2009). In 2013 there were 17 observed scallop trips (Table 5). The monthly discard rates are calculated using a 3-month moving window average. Since 2011, the 3-month moving window used to calculate the discard rate includes December of the previous year for the January discard rate and January of the following year for the December rate (Van Eeckhaute *et al.* 2011). Discards from 2005 onward were recalculated to reflect a change in the effort measure used from freezer trawler hours to hours x meters. The effect on haddock discards was minimal. Discards in 2013 were estimated at 10 mt, the lowest in the time series (Table 6).

Compliance with mandatory retention is thought to be high since at least 1992, so discards in the groundfish fishery are considered to be negligible.

USA

Management measures for the USA fishery have been primarily effort based since 1994; however, in 2004, quota management was introduced to regulate the USA groundfish fishery for EGB haddock (Table 2). From 2008 to 2010, the USA portion of the EGB management area was closed to vessels fishing with trawl gear from May 1 to July 31. From 2011 onwards, the regulation only applies to the common pool which is a miniscule fraction of USA boats that fish on EGB (the common pool received 0.62% and 0.28% of the EGB quota in 2011 and 2012, respectively).

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The minimum size for landed haddock had been reduced to 18 inches (45.7 cm) in October 2007 but reverted back to 19 inches (48.2 cm) in August, 2008. On May 1, 2009, the minimum size was again reduced to 18 inches through a NMFS interim action. This minimum size limit was retained in Amendment 16, which went into effect on May 1, 2010. On September 15, 2008 the Ruhle trawl (previously called the Eliminator Trawl) was authorized for use in the USA portion of EGB management area. The Ruhle trawl is intended to reduce by-catch of cod. Also, beginning on May 1, 2010, many participants in the multispecies groundfish fishery organized into sectors, with each unique sector receiving a portion of the overall quota known as an Annual Catch Entitlement (ACE). Those vessels not joining a sector remained in the common pool, which received a portion of the overall quota. A discard provision went into effect on May 1, 2010 requiring that all legal sized fish be retained by vessels in a sector. On May 11, 2011, the Closed Area II Special Access Permit (SAP) was modified to allow targeting of haddock from August 1 to January 31. Also, on 14 September 2011, the haddock catch cap regulation for the herring midwater trawl fishery increased to 1% of the Georges Bank Annual Biological Catch (ABC).

USA Landings

USA landings of EGB haddock in 2013 were derived from mandatory fishing vessel trip reports (VTRs) and dealer reports. Statistical methodology was applied to allocate unknown landings to statistical area from 1994 to 2013 (Wigley *et al*. 2008a and Palmer 2008). Some of the landings for trawl gear that were reported in 2008 to 2010, during the months when EGB was closed to trawl gear, come from the allocation algorithm which assigns a statistical area when area is missing or there are inconsistencies in reported areas on logbooks. Trawl landings that were allocated to EGB during May to July for 2008-2010 comprised 3% to 5% of total annual US landings.

USA calendar year landings (Table 1) of EGB haddock decreased from 443 mt in 2012 to 344 mt in 2013. The 2013 USA landings peaked in quarter 4 (47%), primarily due to landings in December and February, which represent 24% and 13% of total annual landings (Table 7). As in other years, the otter trawl gear accounted for the majority of the USA landings (331 mt; Table 8). The contribution by other gear, 13 mt, was 4%.

For USA fishing year May 1, 2013 to Apr. 30, 2014, the USA catch quota for sectors was 3,952 mt of which only 8.7% was realized in landings (11.0% of quota, including discards). The catch quota for the common pool was 19 mt, none of which was caught. In recent years, landings have been constrained in part by the low cod quota, the closed area, as well as the delayed opening of the EGB area to trawlers until August 1, in effect from 2008 to 2010 for all USA trawl gear and, since 2011, for the common pool only. The use of the Ruhle and Separator trawls may have reduced interactions with the cod quota.

USA Discards

Discards were estimated from the ratio of discarded haddock to kept of all species, a new methodology that was first applied for the 2009 Eastern Georges Bank haddock assessment. This ratio is calculated by year-quarter (or other suitable time step)-gear-mesh and prorated to the total landings of all species in the same time-gear category to obtain total discards (mt) (Wigley et al. 2008b). Where time steps within the year are sparse, imputation is carried out.

Total discards in 2013 were 91 mt, an decrease from 126 mt in 2012 (Table 1 and 9). Discards were mostly from the second half of the year. USA discards from the large mesh otter trawl

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fishery decreased slightly from 87 mt in 2012 to 84 mt in 2013. Discards from this fleet accounted for 19.3% (by weight) of the USA haddock catch in 2013. Small mesh discards were 6 mt in 2013, a decrease from 38 mt in 2012. The scallop fishery contributed a very small amount of discards in 2013.

Size and Age Composition

Ageing Precision and Accuracy

D. Knox provided ages for the 2013 Canadian fishery and 2014 DFO survey and S.J. Sutherland provided ages for the 2013 US fishery and the NMFS 2013 autumn and 2014 spring surveys. Age testing was conducted between the DFO reader and the NMFS reader and intra-reader testing was conducted at both labs. The NMFS reader also completed two tests against their haddock reference collection which resulted in 91% and 93% agreement. Inter-lab agreement ranged from 84% to 98%. No bias was detected for the exchange. Intra-reader agreement on non-reference collection samples for the NMFS reader ranged between 96% and 99%. For the DFO reader, intra-reader agreement ranged between 93% and 98%. Age determinations at both labs were considered to be reliable for characterizing catch at age (Table 10; http://www.nefsc.noaa.gov/fbp/QA-QC/hd-results.html).

Canadian

The size and age composition of haddock in the 2013 Canadian groundfish fishery was characterized using port and at-sea samples from all principal gears (Table 11). Landings were applied to length samples combined by gear-month, then combined to calendar quarters before applying quarterly age length keys. Canadian fishery weights were derived from fishery lengths using a length-weight relationship which was derived from commercial fishery samples (*round weight* (kg) = 0.0000158 *length* (cm)$^{2.91612}$; Waiwood and Neilson 1985). Gillnet landings were low and no length samples were available. Therefore, gillnet landings were added in at the quarter level. For trips that were sampled by both at-sea observers and port samples, the length frequencies from the two sources were combined with appropriate weighting from each source before using to ensure that samples were used in a consistent manner. The size composition of haddock discards in the 2013 Canadian scallop fishery was characterized by quarter using length samples obtained from 17 observed scallop trips which comprised 15% of the total trips and 12% of the total effort hours. The 2005 to 2012 discards catch at age was updated to reflect changes in estimated amounts due to a change in the effort measure used and changes made to the observer data. The 2013 DFO survey ages, augmented with port samples, were applied to the first quarter landings and discard length compositions. Fishery age samples for quarters 2, 3 and 4 were applied to the corresponding length compositions for both the groundfish fishery and discards.

The modal length of haddock in the 2013 Canadian fishery was 40.5 cm for otter trawlers and 42.5 cm for longliners (Figure 5). Haddock discarded by the scallop fleet had a peak at 14.5 cm and a lesser peak at 36.5 cm.

The 9+ age group, comprised almost exclusively of the 2003 year-class, dominated quarter 1 (48%) Canadian landings, accounted for 25.5% of quarter 2 but decreased in importance for quarters 3 (7%) and 4 (4%). It accounted for 13% in numbers of the total Canadian landings. The 2010 year class (age 3) dominated quarters 3 and 4 at 69% and 86%, respectively (Table 12 and Figure 6). Age 3 (2010 year class) made the highest contribution to the Canadian

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discards (43% by number) followed by the 2013 year class (age 0) at 37%. For the 4th quarter age 0 contributed 76% of the discards.

USA

USA landings of EGB haddock are sorted into “large” and “scrod” market categories at sea and are sampled in port for lengths and ages. Landings of large haddock totaled 28 mt and scrod haddock totaled 269 mt in 2013 (Table 9). Length sampling for USA EGB landings in 2013 was very limited, with no samples in quarters 1 for both market categories, and no samples for large haddock in quarter 4. Length and age samples were pooled to estimate catch at age by half-year rather than by quarter, and were augmented with length and age samples from US statistical area 522 and 525. After augmenting samples, there was a total of 4,090 lengths for EGB commercial landings and a total of 1,803 ages. USA fishery weights were derived from fishery lengths using a length-weight relationship for each half year. For quarters 1 and 2, that equation is (round weight (kg) = 6.07E-06*length (cm)$^{3.10782}$; for quarters 3 and 4, that equation is (round weight (kg) = 7.12E-06*length (cm)$^{3.08054}$.

USA fishermen are required to discard haddock under the legal size limit (18 inches/45.7 cm). A new regulation for the 2010 fishing year required vessels participating in a sector to retain all legal sized haddock. USA discards at age of EGB haddock for calendar year 2013 were estimated by half-year from at-sea observer data. In fishing year 2012, the number of observed trips from the at-sea monitoring program was 148, a decrease from the previous year when there were 202. There were 552 trips to EGB for groundfish gear types, however the fraction of trips sampled varied by gear: 53% of otter trawl trips, 40% of gillnet trips, 14% of scallop trips, and 0% long line trips (out of 16 total long line trips).

As 92% of the discarding was due to the otter trawl fleet, there were few length samples from remaining gears (scallop dredge and midwater trawl). Therefore, length samples were combined across gears. The resulting combined length frequencies by half-year were converted to discarded number at age by applying the age length keys from the NMFS spring bottom trawl survey (821 ages) to quarters 1 and 2 and from the autumn bottom trawl survey (579 ages) to quarters 3 and 4.

The length composition of USA landings in 2013 peaked between 42 and 44 cm (Figure 7). The 2010 year-class dominated the landings but the discards were dominated by age 3 in the first half (2010 year class) and by age 0 (2013 year class) in the second half (Table 12 and Figure 8**)**.. In numbers, discards represented 31% of the US catch.

Combined Canada/USA Catch at Age

The 2013 Canadian and USA landings and discards at age estimates (Table 12) were summed to obtain the combined annual catch at age and appended to the 1969 to 2012 catch at age data (Van Eeckhaute and Brooks 2013; Table 13; Figure 9). The average fishery weights at age are presented in Table 14 and Figure 10 and the average lengths at age in Table 15. The catch at age tracks year classes well. The contribution from older ages in recent years has increased when compared to the 1990s. In comparison to the observed 2013 catch, the age composition of the catch projections in numbers made in 2012 and 2013 for the 2013 catch predicted at least twice the proportion of age group 9+ and a 10% to 16%, respectively, lower proportion of age 3s. (Figure 11). The 2010 year-class (age 3) dominated the fishery in 2013, accounting for 57% by weight and 66% by number.

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Age 2 had contributed a large proportion of the catch during 1969 to 1994 but its contribution decreased dramatically in subsequent years (Figure 12). The increase in the dominant age in the catch is attributable primarily to a change in mesh type by the Canadian fishery, from diamond to square, and an increase in mesh size (Table 2). The combined 2005 to 2012 catch was dominated by ages 5, 6 and 7, a reflection of the domination of the 2000 and 2003 year classes, especially the 2003 year class, which continued to contribute substantially at older ages. The age composition during the 1969 to 1974 period was also atypical since it was dominated by the outstanding 1962 and 1963 year classes which continued to contribute substantially at ages 6 and older.

ABUNDANCE INDICES

Research Surveys

Surveys of Georges Bank have been conducted by DFO each year (February/March) since 1986 and by NMFS each autumn (October/November) since 1963 and each spring (April) since 1968. All surveys use a stratified random design (Figure 13 and 14). The *CCGS Alfred Needler* is the standard vessel used for the DFO Georges Bank survey, but, due to unavailability of the *Needler*, the *CCGS Wilfred Templeman*, a sister ship to the *Needler*, was used in 1993, 2004, 2007 and 2008. No conversion factors are available for the *Templeman*, however, this vessel is considered to be similar in fishing strength to the *Needler*. For the NMFS surveys, two vessels have been employed from 1963 to 2008 and there was a change in the trawl door type in 1985. Vessel and door type conversion factors (Table 16), derived experimentally from comparative fishing, have been applied to the survey results to make the series consistent (Forrester et al. 1997). Additionally, two different trawl nets have been used on the NMFS spring survey, a modified Yankee 41 during 1973-81 and a Yankee 36 in other years, but no conversion factors are available for haddock.

Since spring 2009, the NMFS surveys have been conducted with the NOAA *FSV Henry B. Bigelow*, a new net (4 seam, 3 bridle) and revised protocols. Length based conversion factors have been calculated (Table 17 and Figure 15) and were applied by dividing *Bigelow* catches at length by the length specific conversion value to make the *Bigelow* survey catches equivalent to the FRV *Albatross IV* catches (Brooks *et al.* 2010).

The spatial distributions of catches by age group (1, 2, and 3+ for spring and 0, 1 and 2+ for autumn) for the 2013 NMFS fall survey, the 20134 DFO survey, and the 2014 NMFS spring survey are shown in comparison to the average distribution over the previous 10-year period (Figure 16-18). During the fall, age 0 is spread throughout the 5Zjm area, and age 1 haddock are also spread out over the bank but are more concentrated on the Canadian side than age 0. Older haddock migrate to deeper water along the northern edge and peak and to a lesser extent along the southern edge and so are mainly found on the Canadian side at this time of year. In Feb/March, the DFO survey finds ages 1 and 2 similarly distributed near the bank edges and mostly in the eastern part of the management unit. Ages 3 and older are concentrated on the bank near the northeast peak and edge and also in 5Zm near the Canada/US boundary and spreading north-eastward from there just north of 41°30'. In March/April the NMFS survey finds age 1 concentrated along the southern flank, age 2 is spread throughout the 5Zjm area, similar to the adults, which are now more widely dispersed than they were earlier in the year as observed from the DFO survey.

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The 2013 NMFS fall survey had many very large catches and one exceptionally large catch of 20 thousand along the southern flank on the USA side of age 0 haddock (2013 year class). In comparison, the 2014 DFO survey catches of this year class were generally smaller and very variable. Of note is one exceptionally large tow of 36 thousand near the southern edge on the Canadian side. All except 3 tows from the 2014 NMFS spring survey caught the 2013 year class exhibiting mostly fairly good catches which were widely spread throughout the 5Zjm area. The 3+ (2+ for fall) age group was well represented in all three surveys and they were distributed similarly to past distributions. Catches of the 2012 year class (age 2 in spring surveys and 1 in fall survey) were low for all three surveys (Figure 16-18).

Age-specific, swept area abundance indices show that the three surveys are consistent and track year-class strengths well (Table 18, 19 and 20; Figure 19). Some year effects are evident. For example, low spring catches occurred in 1997 in both the DFO and NMFS surveys and the 2010 year class (age 4) catch in the 2014 DFO survey shows a substantial drop from the catch the previous year. The most recent surveys were dominated by the 2013 and 2010 year classes. Both the DFO and NMFS fall surveys exhibit the highest index values for the 2013 year class in each time series. The fall value is 4.5 times and the DFO value is more than 2 times higher than the next highest value in their respective series. The NMFS spring index value for this year class is the second highest in the time series. The abundance of older ages since about 2000 has increased in comparison to the 1980s and 1990s. Adult biomass indices (ages 2-8 in autumn; 3-8 in spring) peaked during the early 1960s (Figure 20). After declining to a record low in the early 1970s, they peaked again in the late 1970s, although at a lower level, and again during the early 1980s at about half the level of the 1970s peak. Adult biomass generally increased during the late 1990s and reached some record highs since the 2000s, with, however, some substantial drops in between. The NMFS fall survey adult biomass increased in 2012 with the addition of the 2010 year class to the 2-8 age group and increased again in 2013. The NMFS spring and DFO surveys showed decreases in adult biomass from 2013 to 2014. The NMFS spring decrease was small but the DFO index fell substantially from the previous year's value, the series highest. The indices for the 2010 year class at age 3 (fall) and age 4 (DFO and NMFS spring) are among each series' 3 highest values for their respective age (Tables 18, 19 and 20). The recruitment indices for the 2012 year class are similar to but somewhat stronger than the weak 2007 year class (Figure 21).

Georges Bank groundfish fishermen continued to corroborate the findings of the surveys with regard to the high abundance of the 2013 year class and reported that they were catching a relatively large number of small haddock in their catches.

GROWTH

Canadian and USA fishery weights at age show similar trends (Table 14, Figure 10). Low sampling for small year classes at older ages results in increased variability. Except for ages 1 and 2, combined fishery weights at age in 2013 decreased (Table 14). A declining trend is visible starting around 2000. DFO survey weights and lengths at age in 2014 (Table 21 and 22; Figure 22) showed some decreases (ages 1, 4, 5 and 8) and some increases (ages 2, 3, 6 and 7) but the size at age remains low compared to the pre-2000 period. Average size at age for older haddock has declined substantially so that haddock age 3 and older are now at, or smaller, than the size that the next younger age group was in previous years before the declines occurred. Ages 5 to 8 are similar in weight and length indicating that the maximum size at age has decreased substantially as they are now generally less than the size that age 4 was before

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2000. The 2013 year class length and weight at age 1 are similar to the 2010 year class at age 1 which, except for age 3, has lower weights and lengths than to the 2003 year class.

Weights at age from the DFO survey are used as beginning of year population weights and are calculated using the method described in Gavaris and Van Eeckhaute (1998) in which weights observed from the survey are weighted by population numbers at length and age. Canadian fishery weights are derived from fishery lengths using a length-weight relationship (Waiwood and Neilson 1985).

HARVEST STRATEGY

The Transboundary Management Guidance Committee (TMGC) has adopted a strategy to maintain a low to neutral risk of exceeding the fishing mortality limit reference, F_{ref} = 0.26 (TMGC 2003). When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding. The TMGC agreed to a common F strategy at its December 2002 TMGC meeting. The F references used by both countries for "healthy" or "rebuilt" stocks were virtually identical, i.e., 0.25 for Canada and 0.26 for the USA (TMGC Meeting Summary, Oct. 2, 2003).

ESTIMATION OF STOCK PARAMETERS

Calibration of Virtual Population Analysis (VPA)

Calibrated Virtual Population Analysis (VPA) was used to estimate stock parameters. The adaptive framework, ADAPT, (Gavaris 1988) was used to calibrate the VPA with the research survey data. Details of the model formulations and model assumptions can be found in the 1998 benchmark assessment (Gavaris and Van Eeckhaute 1998). Minor changes that were made since 1998 are described in Table 23 and include the updating of the 2005 to 2012 scallop discards catch at age and corrections to the 2011 NFMS fall survey and the 2012 NMFS spring survey.

The VPA was based on an annual catch at age, $C_{a,t}$ for ages a = 0, 1, 2…8, 9+, and time t = 1969, 1970…2013 where t represents the beginning of the time interval during which the catch was taken. Catch discards were included in the catch at age. The population was calculated to the beginning of 2014. The VPA was calibrated to bottom trawl survey abundance indices, $I_{s,a,t}$ for

s = DFO, ages a = 1, 2, 3…8, time t = 1986.17, 1987.17… 2012.17, 2013.17, 2014.00

s = NMFS spring (Yankee 36), ages a = 1, 2, 3…8, time t = 1969.28…1972.28 and 1982.28… 2013.28, 2014.00

s = NMFS spring (Yankee 41), ages a = 1, 2, 3…8, time t = 1973.28, 1974.28…1981.28

s = NMFS autumn, ages a = 0, 1, 2…5, time t = 1969.79, 1970.79… 2013.79.

Since the population is calculated to beginning year 2014, the NMFS and DFO spring surveys in 2014 were designated as occurring at time 2014.00.

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Statistical properties of estimators were determined using conditional non-parametric bootstrapping of model residuals (Efron and Tibshirani 1993, Gavaris and Van Eeckhaute 1998). Population abundance estimates at age 1 and 2 exhibit a large relative error of 59% and 41%, respectively, and a large relative bias at age 1 of 15%. The relative error for other ages is between 24% and 33% with a relative bias for ages 2 and older between 1% and 7% (Table 24). While trends in the three surveys are generally consistent, the survey indices exhibit high variability and the average magnitude of residuals is large relative to other assessments. Although several large residuals are apparent, these do not appear to have a substantial impact on estimates of current abundance (Figure 23 to 27). Some patterns in the residuals (by cohort and by year) suggest year class and/or year effects. Negative residuals are prevalent in the most recent surveys (2013/2014).

Retrospective Analysis

Retrospective analyses were used to detect any trends to consistently overestimate or underestimate biomass, fishing mortality and recruitment relative to the terminal year estimates (Figure 28 and 29). The addition of an extra year's data has caused a bias to appear between the present assessment results and previous assessments. A bias in the estimates of ages 3+ biomass for the years 2006 to 2011 and ages 5-8 F for fishing years 2009 to 2012. This bias is not evident between previous assessments. Recruitment estimates may sometimes change substantially when more data becomes available, e.g., the 2008 year class. The current retrospective analysis indicates a tendency to overestimate initial year class size. The 2010 and 2011 year classes are both estimated about a third smaller than the previous year's retrospective estimates.

A historical retrospective analysis which incorporates all data and model formulation changes by plotting the results from previous assessments back to the last benchmark in 1998 instead of peeling back years from the current assessment is illustrated in Figure 30. This analysis shows that the perception of the stock has remained fairly stable through the data and model changes but is also exhibiting a bias between the results from the current assessment and past assessments..

STATE OF RESOURCE

Evaluation of the state of the resource was based on results from the VPA for the years 1969 to 2014. For each cohort, the terminal population abundance estimates from ADAPT were adjusted for bias estimated from the bootstrap, and used to construct the history of stock status (Table 25, 26 and 27). This approach for bias adjustment was considered preferable to using potentially biased point estimates of stock parameters (O'Boyle 1998). The weights at age from the DFO survey (Table 21) were used to estimate beginning of year population biomass (Table 27). A weight of 2.4 kg, which was midway between the age 6 and 8 weight for that cohort, was used for age 7 in 1995 as no data were available for that age group. The 1986-95 average weight at each age was used for 1969-85.

The adult (ages 3+) population biomass trend reflects the survey adult biomass trends (scaled with catchabilities; Figure 31). Adult biomass increased during the late 1970s and early 1980s to 38,000 mt in 1981. The increase was due to recruitment of the strong 1975 and 1978 year-classes which were both estimated to be above 50 million age-1 fish (Figure 32). However, adult biomass declined rapidly in the early 1980s as these two cohorts were fished intensely at ages 2 and 3 and subsequent recruitment was poor. Improved recruitment in the 1990s and the

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strong 2000 year class (76 million at age 1), lower exploitation, and reduced capture of small fish in the fisheries allowed the biomass to increase from near a historical low of 10,300 mt in 1993 to 76,500 mt in 2003. Adult biomass decreased to 53,000 mt in 2005 but subsequently increased to 121,500 mt in 2009, higher than the 1931-1955 maximum adult biomass of about 90,000 mt. The near tripling of the biomass from 2005 to 2009 was due to the exceptional 2003 year-class, estimated at 243 million age-1 fish. The biomass decreased after the 2009 high and in 2012 the adult biomass was 40,600 mt but increased in 2013, when the 2010 year class joined the 3+ group, to 125,200 mt and again in 2014 to 160,300 (80% confidence interval: 123,500 mt – 206,400 mt, Figure 33). Except for the strong 2000 and 2011 year classes (76 and 51 million fish, respectively) and the exceptional 2003 and 2010 year classes, recruitment has fluctuated between 2.1 and 27.3 million age 1 fish since 1990. The 2001, 2002, 2004, 2006, 2007, 2008 and 2009 year classes, at less than 6 million fish, are below the median of 8.5 million age 1 fish for 1995 to 2014. The preliminary estimate of the 2013 year class at 1,546 million fish is the highest in the time series (1931-1955 and 1969-2014) and is about 3 times the 2010 year class which is the next highest at 334 million fish.

Since 2003, the age at full recruitment to the fishery has been age 5 (rather than age 4 as in previous years) due to a decline in size at age. Comparison of age 4 and 5 fishing mortality (Table 26) and average weights at age from the fishery and survey (Figure 34) indicate that full recruitment to the fishery since 2003 occurs around age 5. Fishery weights are approaching survey (population) weights at age 5, and, when beginning of year to mid-year growth is accounted for, indicate that age 5 fish are fully selected by the fishery. Fully recruited fishing mortality (population weighted average of fully recruited ages) is presented, therefore, for ages 4-8 for pre-2003 and ages 5-8 for 2003 onwards. Fully recruited fishing mortality fluctuated between 0.27 and 0.47 during the 1980s (Figure 35). After reaching a high of 0.55 in 1993, it decreased to well below F_{ref} = 0.26 after 1994, stayed below F_{ref} until 2003, fluctuated around 0.3 during 2004 to 2006, then declined and stayed below F_{ref} and was 0.16 in 2013 (80% confidence interval: 0.14 – 0.20, Figure 33).

Consistent with the increase in age at full recruitment into the fishery, the partial recruitment at age for EGB haddock is normalized to ages 4-8 population weighted F for 1969 to 2002 and to ages 5-8 population weighted F from 2003 onwards (Table 28; Figure 36). Average partial recruitment estimates are less variable when weighted by population numbers and is considered more appropriate than the unweighted average.

Gains in fishable biomass may be partitioned into those associated with somatic growth of haddock which have previously recruited to the fishery, and those associated with new recruitment to the fishery (Rivard 1980). We used age 2 as the age of first recruitment to the fishery. This choice facilitated comparisons with historic stock productivity but may be less representative of the current fishery selectivity. Since 1993, surplus production (biomass gains from growth and from recruitment, decremented by losses due to natural deaths) often exceeded fishery harvest yields, resulting in net population biomass increases (Figure 37). In 2009 to 2011, surplus production decreased substantially as growth of the 2003 year class slowed and gains from recruitment remained low but increased again, well above yield, in 2012 and 2013 due to the recruitment of the outstanding 2010 year class. Growth of fish is the dominant component of the biomass gain but recruitment accounts for significant portions when stronger year classes enter the population, e.g. the 2003 year class in 2005 and the 2010 year class in 2012 and (Figure 38). The biomass contributed by the 2003 and 2010 year classes, both when they recruited at age 2 and through growth during that year was greater than that of any other cohorts since 1969.

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PRODUCTIVITY

Recruitment, as well as age structure, spatial distribution and fish growth reflect changes in the productive potential. Data to approximate the age composition of the catch from unit areas 5Zj and 5Zm during 1931 to 1955 were used to reconstruct a population analysis of EGB that was suitable for comparison of productivity to recent years (Gavaris and Van Eeckhaute 1997, Figure 32).

The catch and survey age structure displays a broad representation of age groups, reflecting improving recruitment and lower exploitation since 1995 (Figure 9 and 19).

Recruitment, while highly variable, has generally been higher when adult biomass has been above 40,000 mt (Figure 39). Since 1969, only the 1975, 1978, 2000, 2003, 2010, 2011 and 2013 year classes have been above the average abundance of 40.5 million age one fish of year classes observed during the period 1931-55. The recruits-per-adult biomass ratio has been highly variable since 1969. It was generally low during the 1980s but higher during the 1990s, comparable to the 1931-1955 period (Figure 40) when the 3+ biomass was above 40,000 mt. Since 2001, with the exception of 2003, 2010, 2011 and 2013, recruits per spawner have again been low. The very high 3+ biomass (greater than about 100,000 mt) observed since 2006 has produced two exceptional year class but has also produced four below average year classes (Figure 39).

The spatial distribution patterns observed during the most recent bottom trawl surveys were similar to the average patterns over the previous ten years for the spring surveys. Consistent with the pattern observed for previous exceptional year-classes, the 2013 year-classwas widely distributed throughout the survey area, especially during the NMFS spring and fall surveys (Figure 16, 17 and 18).

Fish condition as measured by Fulton's K for ages 1 to 9, combined, derived from the DFO survey exhibits a declining trend since about 2001 and declined to its lowest value in 2014 (Figure 41). Except in 2009, the condition factor of haddock has been below the series average since 2003, similar to the trends in condition observed in Eastern Georges Bank cod and Georges Bank yellowtail flounder. Fish condition derived from the NMFS fall survey shows a similar decline (note that weights are available only since 1992 from this survey). The strong 2003 and 2010 year classes sometimes show much lower condition than the ages 1-9 average from the DFO survey. The increase in condition in fall 2008 and spring 2009 coincides with reports from the fishery of high sandlance abundance during this period (Pers. comm. Alain d'Entremont). Fulton's K for the 2013 year class was very low in fall 2013 but improved in late winter of 2014. Condition of the 2010 year class in the fall has been increasing with each subsequent year and was above the series average in 2013.

Both fishery and survey average lengths and weights at age have declined (Figure 10, 22 and 34) and the 2003 year class appears to have reached its maximum growth potential at a smaller size than previous year classes (Table 22 and Figure 42). Some year classes of low abundance like the 2005 and 2007 initially started out with high growth rates but growth rates decreased as they aged. The 2010 year class lengths at age 1 and 2 are less than the 2003 year class but similar at age 3 and 4 (Figure 42).

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Changes in growth in response to changes in stock abundance and episodes of very strong recruitment have been observed throughout this stock's history. Clark *et al.* (1982), reporting on Georges Bank haddock, observed "*a decline in mean weight for all age-groups following every period of very strong recruitment*" and a rapid increase in growth following the late 1960's and early 1970's reduction in stock size. As postulated by Clark *et al.* (1982), increased or decreased availability of food is probably the greatest determining factor for growth increases and decreases, respectively.

In summary, positive signs of productivity include expanded age structure, broad spatial distribution and large biomass and this stock has produced three exceptional and two strong year classes in the last 12 years. On the negative side, condition has decreased, growth has declined and recruitment from the very large biomass has been extremely variable.

PARTIAL RECRUITMENT ON OLDER AGES

Figure 43 illustrates the results of a calculation of total mortality (Z) for ages 3 to 8 and the 9+ group from the DFO survey. Positive values indicate that there has been a decrease in survey abundance and negative values indicate an increase in survey abundance for age 'a' to 'a+1' while zero values indicate no change in abundance. The results for age 8 show that there has been a large increase in Z for about the last 9 years, however, fishing mortality for age 8 has decreased in the last few years. These results support the use of a low PR on the 9+ age group for the catch projection for the 2015 fishing year.

Another indication that a low PR on the 9+ age group should be used for projections is the comparison of predicted versus observed landings for 2013 (Figure 11). Even though a low PR of 0.3 was used, the contribution from the 9+ group was about half what the 2012 and 2013 projections predicted. However, with the reduced importance of the 2003 year class to future catches, specification of the 9+ PR for projected catch is less critical.

OUTLOOK

This outlook is provided in terms of consequences with respect to the harvest reference point for alternative catch quotas in 2015. Uncertainty about standing stock generates uncertainty in forecast results which is expressed here as the risk of exceeding F_{ref}=0.26. The risk calculations assist in evaluating the consequences of alternative catch quotas by providing a general measure of the uncertainties. However, they are dependent on the data and model assumptions and do not include uncertainty due to variations in weight at age, partial recruitment to the fishery, natural mortality, systematic errors in data reporting or the possibility that the model may not reflect stock dynamics closely enough.

The 2014 DFO survey weights at age were used for the projection inputs for the 2014 population weights at age. The 2003 year class survey weights at ages 5 and 6 were used for the 2010 year class population weights for the same ages. Other year classes for 2015 and 2016 were given the 2012 to 2014 average weights at age from the DFO survey. DFO survey 2010 year class average weights at age were used for the 2013 year class population weights and the average of the 2005 and 2009 year class weights were used for the 2011 year class weights at the same ages.
Weights used for catch weights at age were the 2011 to 2013 Canada/USA landings average weights at age except for the 2010 year class where the 2003 year class fishery weights were

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used for the respective ages, the average of the 2005 and 2009 weights for the 2011 year class and 2010 year class weights for the 2013 year class (Table 29).

Partial recruitment inputs were derived from the 2003 to 2013 population weighted values except for age 4 (2010 year class in 2014 and 2011 year class in 2015) where the 2003 observed value at that age was used. This is a deviation from the protocol (i.e., using the average of the last 3 years) but it was observed that not including the 2003 year class values resulted in PRs that were significantly higher than what was observed for the 2003 year class (Table 28). Some of the PRs are suspected to have high error as they come from very small year classes. The 9+ group was given a PR of 0.3 to be consistent with the assessment model results. The 9+ group was not considered to be less catchable by the fishery, but lower availability was observed (Table 28) which was thought to be aliasing unknown processes. Ages 5 to 8 were considered fully recruited to the fishery.

EGB haddock are considered 100% mature at ages 3 and older.

Incorporating the patterns in growth and partial recruitment detailed in Table 29, a deterministic projection and risk assessment was conducted to beginning year 2016 (Table 30) Stock size estimates at the beginning of 2014 were used to start the forecasts. Abundance of the 2014 and 2015 year classes were assumed to be 11.2 million fish at age 1, the 2003 to 2013 median from the 2013 assessment results. Natural mortality was assumed to be 0.2. Assuming a 2014 catch equal to the 27,000 mt total quota, a combined Canada/USA catch of 45,500 mt in 2015 results in a neutral risk (50%) that the 2015 fishing mortality rate would exceed F_{ref} = 0.26 (Figure 44). A catch of 38,000 mt in 2015 results in a low risk (25%) that the 2015 fishing mortality rate will exceed F_{ref}. A catch of 53,000 mt in 2015 results in a high risk (75%) that the 2015 fishing mortality rate will exceed F_{ref}. The 2010 year class at age 5 is expected to contribute 85% of the catch biomass and the 2011 year class at age 4 is expected to contribute the next highest percentage at 6% of the 2015 catch biomass. The 2013 year class at age 2 is expected to contribute 4% of the catch biomass. The probability that the 2016 biomass will not increase by 20% is negligible., Adult biomass is projected to be very high, 568,200 mt, at the beginning of 2016 at the F_{ref} catch level due to the contribution from the 2013 year class.

SPECIAL CONSIDERATIONS

Catch projections for this stock can be highly influenced by outstanding and influential year classes. There is no direct evidence to indicate that age 9 and older haddock should be less available to the fishery than age 8 haddock, however, the domed partial recruitment at age 9 and older that the assessment model produces may be aliasing increased natural mortality, emigration outside of the management area or to areas inaccessible to the fishery, or some other unknown process. Several corroborating factors influenced the decision to use the lower PR produced by the model, e.g. the percent predicted versus percent observed age 9+ in the 2011, 2012 and 2013 assessments. These factors support the use of the lower PR as does the analysis of total mortality from the DFO survey (Figure 43). The highest contribution to the 2012 catch was age 9+ which was dominated by the 2003 year class and it should give a good indication as to whether the 9+ PR of 0.3 from the model should be used for catch projections. The 9+ age group was expected to contribute 69% by numbers in the 2011 projection for the 2012 fishing year which used a 9+ PR of 1.0 (Van Eeckhaute and Brooks 2011). The percent contribution for that age group was well below what was predicted indicating that the PR produced by the model is more appropriate.

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In 2015, most of the exceptional 2013 year class will be below the current minimum size regulation used by the US, which could lead to significant discarding. This is not expected to be an issue in the Canadian fishery due to the different gear types and management measures.

Cod and haddock are often caught together in groundfish fisheries, although their catchabilities to the fisheries differ and they are not necessarily caught in proportion to their relative abundance. With current fishing practices and catch ratios, the achievement of rebuilding objectives for cod may constrain the harvesting of haddock. Modifications to fishing gear and practices, with enhanced monitoring, may mitigate these concerns.

The table in Appendix A summarizes the performance of the management system. It reports the TRAC advice, expected beginning of year 3+ biomass in the year following the catch year, the TMGC quota decision, actual catch, and realized stock conditions for this stock. Fishing mortality and trajectory of age 3+ biomass from the assessment following the catch year are compared to results from this assessment. These comparisons were kindly provided in 2011 by Tom Nies (staff member of the New England Fishery Management Council, NEFMC) and updated for this assessment. The largest differences in expected and actual results occurred when projection inputs for partial recruitment and weights at age for large dominant year classes (i.e., 2000 and 2003) were higher than the realized values. When year class specific input values were used, expected and actual results were similar. These results indicate that stock biomass is being adequately estimated by the model for management purposes, but, misspecification of partial recruitment and weights at age, especially of very large and influential year classes, can result in higher than expected fishing mortality due to catch advice being set too high.

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Table 1. Nominal catches (mt) of haddock from eastern Georges Bank (EGB) during 1969-2013. For "Other" it was assumed that 40% of the total 5Z catch was in EGB. USA landings and 1989 to 2007 USA discards were revised (Van Eeckhaute et al. 2009). Canadian discards are from the scallop fishery and USA discards are from the groundfish fishery.

	Landings			Discards		Totals			Quotas	
Year	Canada	USA	Other	Canada	USA	Canada	USA	Catch	Canadian	USA[2]
1969	3941	6624	695	123		4064	6624	11382		
1970	1970	3154	357	116		2086	3154	5597		
1971	1610	3533	770	111		1721	3533	6024		
1972	609	1551	502	133		742	1551	2795		
1973	1565	1397	396	98		1663	1397	3455		
1974	462	955	573	160	757	622	1712	2907		
1975	1353	1705	29	186		1539	1705	3273		
1976	1355	974	24	160		1515	974	2513		
1977	2871	2428		151	2966	3022	5394	8416		
1978	9968	4725		177	1556	10145	6281	16426		
1979	5080	5213		186		5266	5213	10479		
1980	10017	5615		151	7561	10168	13176	23344		
1981	5658	9081		177		5835	9081	14916		
1982	4872	6286		130		5002	6286	11287		
1983	3208	4453		119		3327	4453	7780		
1984	1463	5121		124		1587	5121	6708		
1985	3484	1684		186		3670	1684	5354		
1986	3415	2201		92		3507	2201	5708		
1987	4703	1418		138		4841	1418	6259		
1988	4046[1]	1694		151		4197	1694	5891		
1989	3060	785		138	137	3198	922	4121		
1990	3340	1189		128	76	3468	1265	4732		
1991	5456	931		117	0	5573	931	6504		
1992	4058	1629		130	9	4188	1638	5826	5000	
1993	3727	424		114	106	3841	530	4371	5000	
1994	2411	24		114	1279	2525	1302	3827	3000	
1995	2065	15		69	0	2134	16	2150	2500	
1996	3663	26		52	5	3715	31	3746	4500	
1997	2749	55		60	1	2809	56	2865	3200	
1998	3371	271		102	0	3473	271	3744	3900	
1999	3681	359		49	5	3729	364	4093	3900	
2000	5402	340		29	3	5431	343	5774	5400	
2001	6774	762		39	22	6813	784	7597	6989	
2002	6488	1090		29	16	6517	1106	7623	6740	
2003	6775	1677		98	96	6874	1772	8646	6933	
2004	9745	1847		93	235	9838	2081	11919	9900	5100
2005	14484	649		49	76	14533	724	15257	15410	7590
2006	11984	313		58	275	12043	588	12630	14520	7480
2007	11890	256[3]		58	306[3]	11948	562	12510	12730	6270
2008	14781	1138[3]		33	52[3]	14814	1190	16003	14950	8050
2009	17595	2152[3]		53	55[3]	17648	2208	19855	18900	11100
2010	16578	2167		15	34	16593	2201	18794	17612	11988
2011	11232	1322		16	87	11248	1409	12656	12540	9460
2012	5034	443		30	126	5064	569	5633	9120	6880
2013	4621	344		10	91	4631	435	5066	6448	3952

[1] 1895 mt excluded because of suspected area misreporting.
[2]The USA quota pertains to the USA fishing year of May 1 to Apr. 30 while the USA catches reported in this table pertain to the calendar year.
[3]USA landings and discards revised in 2011.

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Table 2. Regulatory measures implemented for the 5Z and eastern Georges Bank (EGB) fishery management units by the United States (USA) and Canada, respectively, from 1977, when jurisdiction was extended to 200 miles for coastal states, to the present.

Year	USA	Canada
1977-82	Mesh size of 5 1/8" (140 mm), seasonal spawning closures, quotas and trip limits.	
1982-85	All catch controls eliminated, retained closed area and mesh size regulations, implemented minimum landings size (43 cm).	First 5Ze assessment in 1983.
Oct.1984	Implementation of the 'Hague' line, the boundary between Canada and the USA.	
1985	5 ½" mesh size, Areas 1 and 2 closed February-May.	
1989		Combined cod-haddock-pollock quota for 4X-5Zc
1990		EGB adopted as management unit. For mobile gear (MG) < 65 ft. – trip limits with a 30% by-catch of haddock to a maximum of 8 trips of 35,000 lbs per trip between June 1 and Oct. 31 and minimum square mesh size 130 mm. Fixed gear required to use large hooks until June
1991	Established overfishing definitions for haddock.	MG < 65 ft similar to 1990 but diamond mesh size increased to minimum 145 mm.
1992		Introduction of Individual Transferable Quotas (ITQ) and dockside monitoring. Total allowable catch (TAC) = 5000 mt.
1993	Area 2 closure in effect from Jan 1-June30.	Otter trawl (OT) fishery permitted to operate in Jan. and Feb. Increase in use of square mesh, minimum 130 mm). TAC = 5000 mt.
1994	Jan.: Expanded Area 2 closure to include June and increased extent of area. Area 1 closure not in effect. 500 lb trip limit. Catch data obtained from mandatory log books combined with dealer reports (replaces interview system). May: 6" mesh restriction. Dec.: Area 1,2 closed year-round.	Spawning closure extended to Jan. 1 to May 31. Fixed gear vessels must choose between 5Z or 4X for the period of June to September. Small fish protocol. Increased at sea monitoring. OT > 65 could not begin fishing until July 1. Predominantly square mesh, minimum 130 mm by end of year. TAC = 3000 mt.
1995		All OT vessels using square mesh, mimimum 130 mm. Fixed gear vessels with a history since 1990 of 25t or more for 3 years of cod, haddock, pollock, hake or cusk combined can participate in 5Z fishery. ITQ vessels require at least 2t of cod and 8t of haddock quota to fish Georges. TAC = 2500 mt. Restrictions on catching of cod and haddock under 43 cm (small fish protocol).
1996	July: Additional Days-at-Sea restrictions, trip limit raised to 1000 lbs.	Fixed gear history requirement dropped. TAC = 4500 mt.

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Year	USA	Canada
1997	May: Additional scheduled Days-at-sea restrictions. September: Trip limit raised to 1000 lbs/day, maximum of 10,000 lbs/trip.	All OT vessels using square mesh, mimimum 130 mm. Vessels over 65 ft operated on enterprise allocations, otter trawlers under 65 ft on individual quotas, fixed gear vessels 45-65 ft on self-administered individual quotas and fixed gear vessels under 45 ft on community quotas administered by local boards. TAC = 3,200 mt.
1998	Sept. 1: Trip limit raised to 3000 lbs/day, maximum of 30,000 lbs/trip.	All OT vessels using square mesh, mimimum 130 mm. Fixed gear vessels 45-65 ft operated on individual quotas. TAC = 3,900 mt.
1999	May 1: Trip limit 2,000 lbs/day, max. 20,000 lbs/trip. Square mesh size increased to 6.5" (diamond is 6"). June 15: Scallop exemption fishery in Closed Area II. Nov. 5: Trip limit 5,000 lbs/day, max. 50,000 lbs/trip.	All OT vessels using square mesh, mimimum 130 mm. TAC = 3,900 mt.; mandatory cod separator panel when no observer on board.
2000	October: Daily trip limit suspended to April 2001but retained max. trip limit of 50,000 lbs/trip.	All OT vessels using square mesh, mimimum 130 mm. TAC = 5,400 mt.
2001-2002	Day and trip limit adjustments. Daily trip limit suspended July 5, 2002.	All OT vessels using square mesh, mimimum 130 mm. TAC = 6,989 and 6,740 mt for 2001 and 2002 respectively.
2002-2003	30,000 – 50,000 lb/trip limit. Trip limit suspended in Oct. 2003.	All OT vessels using square mesh, mimimum 130 mm. TAC = 6,933 mt for 2003.
Canada – USA Resource Sharing Agreement on Georges Bank		
2004	May 1, day and trip limits removed. Quota management introduced. TAC[1] = 5,100 mt. Oct. 1: unit areas 561 and 562 closed to groundfish vessels. Nov. 19: Special Access Program (SAP) for haddock opened. Dec. 31: Haddock SAP closed.	All OT vessels using square mesh, mimimum 130 mm. TAC = 9,900 mt.
2005	TAC[1]= 7,590 mt. Jan. 14: separator trawl required. Fishery was closed in August when cod by-catch quota reached.	All OT vessels using square mesh, mimimum 130 mm. TAC = 15,410 mt; exploratory winter fishery Jan. to Feb. 18, 2005.
2006	TAC[1]= 7,480 mt; EGB area closed to USA fishery in first half of year when USA cod quota nearly reached.	All OT vessels using square mesh, mimimum 130 mm. TAC = 14,520 mt; exploratory winter fishery Jan. to Feb. 6, 2006.
2007	TAC[1]=6,270 mt. June 20: EGB area closed to USA fishery due to USA cod catch nearing quota. August 9: Minimum haddock size reduced to 18 inches; October 20: EGB area opened to USA fishery.	All OT vessels using square mesh, mimimum 130 mm. TAC = 12,730 mt; exploratory winter fishery Jan. to Feb. 15, 2007

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Year	USA	Canada
2008	TAC[1]=8,050 mt. Minimum size reverts back to 19 in. in August. Prohibitions on yellowtail flounder fishing Jan 24 to April 30. Trawl fishery opening delayed until Aug. 1. Ruhle trawl (type of separator trawl) approved for use beginning Sept 15. Restrictions on cod catches.	All OT vessels using square mesh, mimimum 130 mm. TAC = 14,950 mt; winter fishery Jan. 1, to Feb. 8, 2008.
2009	TAC[1]=11,100 mt. May 1: Interim action by NMFS set the minimum size at 18 inches.	All OT vessels using square mesh, mimimum 130 mm. TAC = 18,900 mt; winter fishery Jan. 1 to Feb. 7, 2009. Industry test fishery/survey in deep water in February to assess spawning condition of haddock in deep water. Test fishery terminated after 2 trips.
2010	TAC[1]=11,988 mt May 1, 2010: Sector Management with Annual Catch Entitlements (ACEs) and accountability measures implemented (Amendment 16). Minimum haddock size limit set to 18 inches. All legal size fish must be retained by sector vessels.	All OT vessels using square mesh, mimimum 130 mm. TAC = 17,612 mt; winter fishery Jan. 1 to Feb. 7, 2010
2011	TAC[1]=9,460 mt	All OT vessels using square mesh, mimimum 130 mm. TAC = 12,540 mt; winter fishery Jan. 1 to Feb. 6, 2011
2012	TAC[1]=6,880 mt	All OT vessels using square mesh, minimum 130 mm. TAC = 9,120 mt; winter fishery Jan. 1 to Feb. 4, 2012
2013	TAC[1]=3,952 mt July: Minimum size reduced from 18” to 16”	TAC = 10,400 mt; winter fishery Jan. 1 to Feb. 4, 2013. All OT vessels using square mesh, minimum 130 mm.
2014		TAC = 27,000 mt; winter fishery Jan. 1 to Feb. 3, 2014. Experimental use of 145 mm diamond mesh in winter fishery. Starting in June, 145 mm diamond use continued and experimental use of 125 mm square. Continued use of 130 mm square.

[1]For fishing year from May 1 to April 30

Shaded text has not been updated.

Table 3. Canadian landings (mt) of haddock from eastern Georges Bank during 1969-2013 by gear category and tonnage class for principal gears.

Year	Otter Trawl						Longline			Scallop Fishery	Other	Total
	Side	Stern										
		2	3	4	5	Total[1]	2	3	Total[1]			
1969	777	0	1	225	2902	3127	2	21	23	15	0	3941
1970	575	2	0	133	1179	1314	6	72	78	2	1	1970
1971	501	0	0	16	939	955	18	129	151	3	0	1610
1972	148	0	0	2	260	263	23	169	195	1	2	609
1973	633	0	0	60	766	826	23	80	105	0	1	1565
1974	27	0	6	8	332	346	29	59	88	1	0	462
1975	222	0	1	60	963	1024	25	81	107	0	0	1353
1976	217	0	2	59	905	967	48	108	156	0	15	1355
1977	370	92	243	18	2025	2378	43	51	94	1	28	2871
1978	2456	237	812	351	5639	7039	121	47	169	17	287	9968
1979	1622	136	858	627	1564	3185	190	80	271	2	0	5080
1980	1444	354	359	950	6254	7917	129	51	587	4	65	10017
1981	478	448	629	737	2344	4159	331	99	1019	1	1	5658
1982	115	189	318	187	3341	4045	497	187	712	0	0	4872
1983	106	615	431	107	1130	2283	593	195	815	1	3	3208
1984	5	180	269	21	149	620	614	192	835	2	1	1463
1985	72	840	1401	155	348	2745	562	33	626	2	39	3484
1986	51	829	1378	95	432	2734	475	98	594	4	32	3415
1987	48	782	1448	49	1241	3521	854	113	1046	38	50	4703
1988[2]	72	1091	1456	186	398	3183	428	200	695	16	80	4046
1989	0	489	573	376	536	1976	713	175	977	12	95	3060
1990	0	928	890	116	471	2411	623	173	853	7	69	3340
1991	0	1610	1647	81	689	4028	900	271	1309	8	111	5456
1992	0	797	1084	56	645	2583	984	245	1384	4	87	4058
1993	0	535	1179	67	699	2489	794	156	1143	2	93	3727
1994	0	495	911	79	112	1597	498	47	714	9	91	2411
1995	0	523	896	14	214	1647	256	75	390	7	21	2065
1996	1	836	1405	166	270	2689	561	107	947	0	26	3663
1997	0	680	1123	91	96	1991	501	116	722	0	36	2749
1998	0	863	1340	98	71	2422	570	252	921	0	28	3371
1999	0	954	1471	174	145	2761	486	241	887	0	32	3680
2000	0	1313	2269	230	246	4146	619	258	1186	0	70	5402
2001	0	1564	2555	0	757	5112	754	302	1633	0	29	6774
2002	0	1217	2720	0	657	4954	794	151	1521	0	12	6488
2003	0	1186	3246	0	0	4985	806	249	1776	0	14	6775
2004	0	2152	4651	0	67	7744	716	223	2000	0	1	9745
2005	0	2929	7393	326	0	12115	646	78	2368	0	1	14484
2006	0	1805	6076	601	0	10088	491	84	1896	0	1	11984
2007	0	1982	6112	159	0	10034	363	28	1854	0	1	11890
2008	0	2413	7894	0	0	12615	532	0	2164	0	2	14781
2009	0	3112	9884	27	0	15407	585	0	2185	0	3	17595
2010	0	2645	8921	661	0	14100	544	0	2476	0	2	16578
2011	0	1606	6432	113	0	9664	413	0	1566	0	1	11232
2012	0	744	2819	29	0	4201	180	0	832	0	1	5034
2013	0	647	3030	42	0	4348	24	0	272	0	1	4621

[1] Total includes catches for tonnage classes which are not listed.
[2] Catches in 1988 of 26t, 776t, 1091t and 2t for side otter trawlers and stern otter trawlers tonnage classes 2, 3 and 5 respectively were excluded because of suspected area misreporting.

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Table 4. Monthly landings (mt) of haddock by Canada from eastern Georges Bank during 1969-2013.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1969	105	74	6	291	588	691	559	580	551	360	102	34	3941
1970	2	105	0	1	574	345	103	456	242	103	26	12	1970
1971	0	9	1	0	400	132	283	278	97	246	141	21	1610
1972	0	119	2	0	2	111	84	116	98	68	7	2	609
1973	4	10	0	0	0	184	198	572	339	232	22	4	1565
1974	19	0	1	0	0	58	63	53	96	61	92	19	462
1975	4	14	0	0	0	166	256	482	100	166	118	45	1353
1976	0	7	62	68	60	587	152	190	186	26	9	7	1355
1977	102	177	7	0	23	519	1059	835	13	59	56	22	2871
1978	104	932	44	22	21	319	405	85	642	5433	1962	0	9968
1979	123	898	400	175	69	1393	885	396	406	261	53	22	5080
1980	38	134	14	29	223	2956	2300	965	1411	1668	104	176	10017
1981	38	481	568	4	254	1357	1241	726	292	82	378	239	5658
1982	129	309	1	11	46	1060	769	682	585	837	398	44	4872
1983	32	67	29	47	60	1288	387	483	526	195	88	6	3208
1984	3	5	81	88	73	433	219	254	211	71	25	0	1463
1985	1	11	33	99	26	354	392	1103	718	594	61	93	3484
1986	11	28	79	99	40	1339	1059	369	233	139	12	8	3415
1987	24	26	138	70	12	1762	1383	665	405	107	97	14	4703
1988[1]	39	123	67	79	15	1816	1360	315	130	65	13	24	4046
1989	33	94	48	7	20	1398	356	566	141	272	108	18	3060
1990	35	14	50	0	7	1178	668	678	469	199	18	22	3340
1991	144	166	49	26	21	1938	1004	705	566	576	123	137	5456
1992	118	205	97	152	36	1381	619	414	398	401	209	28	4058
1993	468	690	96	78	25	723	505	329	202	198	230	183	3727
1994	3	3	1	2	0	398	693	373	375	220	211	133	2411
1995	5	1	1	1	0	762	327	290	281	109	197	93	2065
1996	0	0	0	0	0	1067	672	706	359	278	191	391	3663
1997	0	0	0	0	0	328	751	772	426	190	116	166	2749
1998	0	0	0	0	0	687	420	580	707	542	164	271	3371
1999	37	0	0	0	0	898	975	562	573	295	269	70	3681
2000	1	0	0	0	0	1368	1175	1026	848	658	175	150	5402
2001	0	0	0	0	0	971	1335	930	1267	1075	647	548	6774
2002	0	0	0	0	0	572	1703	983	1364	820	593	452	6488
2003	0	0	0	0	0	840	1767	1290	930	952	676	320	6775
2004	0	0	0	0	0	1547	2268	2109	1753	1275	556	236	9745
2005	1025	1182	0	0	13	1423	3004	3820	2199	1198	357	266	14484
2006	1176	381	0	0	0	1093	2433	2668	2211	1149	558	316	11984
2007	1100	454	0	0	0	1432	3034	2510	1916	991	231	222	11890
2008	1867	1604	0	0	0	1640	2539	2446	2382	1314	645	343	14781
2009	2977	947	0	0	0	2217	1996	2889	2479	2191	1239	659	17595
2010	2391	574	0	0	0	1861	2893	3809	2257	1572	692	530	16578
2011	1954	466	0	0	0	941	2074	2554	1751	931	299	262	11232
2012	692	634	0	0	0	583	949	1077	490	419	61	128	5034
2013	843	185	0	0	0	193	50	350	939	1004	488	569	4621

[1] Catches in 1988 of 3t, 1846t and 46t for Jan., Feb., and Mar., respectively for otter trawlers were excluded because of suspected area misreporting

Shaded text has not been updated.

Table 5. Prorated discards (kg) and fishing effort (hr) for eastern Georges Bank haddock from the observed trips of the Canadian scallop fishery in December 2012 to January 2014. Note that there were no observed trips in Dec 2012. Effort hours are in hours x meters.

Trip ID	Board Date	Land Date	Proration			Discards (kg)		Effort (hrs x m)
			Dredges					
			Obs.	Total	Prop.	Observed	Prorated	
T2013-01	2013-01-28	2013-02-08	283	498	0.57	53	93	1212
T2013-02	2013-02-11	2013-03-04	678	1270	0.53	43	81	2556
T2013-03	2013-02-16	2013-03-04	502	981	0.51	11	21	1491
T2013-04	2013-03-22	2013-04-04	555	1031	0.54	123	228	1656
T2013-05	2013-03-27	2013-04-04	226	402	0.56	39	69	626
T2013-06	2013-04-04	2013-04-19	581	1192	0.49	115	236	1791
T2013-07	2013-04-17	2013-04-26	232	432	0.54	4	7	969
T2013-08	2013-05-19	2013-05-28	135	261	0.52	2	4	596
T2013-09	2013-05-25	2013-06-05	304	584	0.52	11	21	856
T2013-10	2013-06-18	2013-06-27	174	328	0.53	2	4	768
T2013-11	2013-07-08	2013-07-20	528	998	0.53	0	0	1526
T2013-12	2013-07-21	2013-08-02	616	1138	0.54	4	7	1526
T2013-13	2013-08-21	2013-08-30	261	495	0.53	33	63	1060
T2013-14	2013-08-22	2013-09-05	681	1341	0.51	17	33	1837
T2013-15	2013-10-16	2013-10-31	837	1533	0.55	170	311	1838
T2013-16	2013-10-18	2013-10-24	172	254	0.68	14	21	634
T2013-17	2013-10-20	2013-11-04	521	1028	0.51	77	152	1399
T2014-01	2014-01-24	2014-01-27	37	65	0.57	8	14	207

Shaded text has not been updated.

Table 6. Haddock discards from the Canadian scallop fishery on Georges Bank for 2013 calculated using a 3-month moving window to estimate discard rates. The discard rates for Jan and Dec are calculated by including observed trips from Dec 2012 and Jan 2014, respectively. Note that there were several months with no observed trips. Effort hours are in hours x meters.

Year	Month	Prorated Discards	Observed Effort (hrs x m)	Discard Rate (kg/hr x m)	Fleet Effort (hrs x m)	Discards (mt)	Cumulative Annual Discards (mt)
2012	Dec[1]	0	0				
2013	Jan[1]	0	0	0.037	406	0.015	0.015
	Feb	195	5259	0.065	7800	0.510	0.525
	Mar	298	2282	0.072	12364	0.884	1.409
	Apr	243	2760	0.087	25684	2.240	3.649
	May	25	1452	0.055	26694	1.459	5.108
	Jun	4	768	0.007	18757	0.129	5.236
	Jul	7	3052	0.016	21088	0.337	5.573
	Aug	96	2897	0.017	32794	0.570	6.143
	Sep[1]	0	0	0.086	27609	2.366	8.509
	Oct	484	3871	0.125	11823	1.478	9.987
	Nov[1]	0	0	0.125	2213	0.277	10.264
	Dec[1]	0	0	0.068	733	0.050	10.314
2014	Jan	14	207				

[1]No observed trips in December 2012 and January, September, November and December 2013.

Shaded text has not been updated.

Table 7. Monthly landings (mt) of haddock by the United States from eastern Georges Bank during 1969-2013. An allocation algorithm was applied to landings from 1994 to 2013 to determine area fished (Wigley et al. 2008a).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1969	525	559	976	1826	670	810	204	219	249	226	203	157	6624
1970	169	219	242	375	608	374	324	333	179	219	61	50	3154
1971	155	361	436	483	668	503	338	152	147	165	58	68	3533
1972	150	196	91	90	239	261	97	164	84	63	52	64	1551
1973	90	111	77	85	139	365	217	196	37	3	22	55	1397
1974	135	70	47	70	122	160	165	43	27	6	19	91	955
1975	152	123	32	116	388	489	138	95	57	24	52	39	1705
1976	116	147	84	106	323	162	7	6	5	2	3	13	974
1977	75	211	121	154	374	372	434	191	73	52	146	226	2428
1978	336	437	263	584	752	750	467	221	245	426	194	49	4725
1979	274	329	352	548	766	816	588	659	224	202	282	172	5213
1980	632	1063	742	784	711	461	324	254	221	91	110	222	5615
1981	551	1852	634	628	882	1327	1233	873	321	284	242	255	9081
1982	425	755	502	348	719	1805	757	145	201	216	276	138	6286
1983	492	931	272	181	310	1145	231	178	187	110	227	190	4453
1984	540	961	366	281	627	1047	370	303	250	196	92	89	5121
1985	165	190	254	300	352	206	60	47	1	24	41	43	1683
1986	184	396	334	479	496	221	31	6	12	6	6	29	2201
1987	225	52	43	307	233	342	67	30	24	4	23	68	1418
1988	196	152	207	245	366	316	30	19	6	1	45	110	1694
1989	114	56	47	164	161	145	15	8	1	5	25	46	785
1990	148	21	155	274	214	306	23	3	5	5	16	19	1189
1991	105	28	76	133	89	434	1	20	6	0	19	19	931
1992	253	81	51	149	353	669	20	20	17	3	2	12	1629
1993	15	12	16	55	88	209	6	3	3	7	2	8	424
1994	0	1	1	3	1	1	12	1	0	1	1	2	24
1995	1	1	3	4	2	3	1	0	0	0	1	0	15
1996	2	1	2	3	7	3	3	2	1	1	1	1	26
1997	5	4	3	4	11	6	2	1	9	4	2	6	55
1998	5	19	23	29	31	50	21	17	39	22	1	15	271
1999	35	15	30	52	71	62	23	18	28	0	0	22	359
2000	6	13	89	48	42	22	21	15	24	2	17	42	340
2001	42	9	228	146	81	97	51	12	8	38	21	31	762
2002	92	105	91	150	272	175	66	46	17	42	11	24	1090
2003	94	24	86	506	310	319	57	17	4	51	40	169	1677
2004	97	21	174	725	101	349	256	26	57	5	5	31	1847
2005[1]	2	0	45	34	210	158	103	93	0	0	1	2	649
2006[1]	1	0	0	23	192	87	0	7	0	0	1	3	313
2007[1]	1	0	5	71	43	60	3	0	0	25	47	0	256
2008[1]	0	0	6	26	31	80	47	92	65	153	98	539	1138
2009	13	4	41	677	30	109	38	458	140	31	195	418	2152
2010	130	13	281	503	100	76	16	367	193	118	224	147	2167
2011	75	70	110	341	165	150	76	123	40	34	43	93	1322
2012	50	10	30	112	113	48	17	4	20	18	5	17	443
2013	23	4	9	28	11	9	29	40	29	34	43	84	344

[1]Restrictions placed on USA fishery in eastern Georges Bank due to bycatch limitations.

Shaded text has not been updated.

Table 8. United States landings (mt) of haddock from eastern Georges Bank during 1969-2013 by gear category and tonnage class. An allocation algorithm was applied to landings from 1994 to 2013 to determine area fished (Wigley et al. 2008a).

Year	Otter Trawl		Other	Total
	3	4		
1969	3013	3610	0	6624
1970	1602	1551	0	3154
1971	1760	1768	0	3533
1972	861	690	0	1551
1973	638	759	0	1397
1974	443	512	0	955
1975	1025	679	0	1705
1976	671	303	0	974
1977	1724	703	0	2428
1978	3140	1582	3	4725
1979	3285	1927	1	5213
1980	2654	2955	4	5615
1981	3601	5433	15	9081
1982	2589	3660	37	6286
1983	1162	3276	15	4453
1984	1855	3261	5	5121
1985	857	823	4	1683
1986	993	1207	1	2201
1987	766	651	1	1418
1988	920	768	6	1694
1989	359	419	6	785
1990	488	697	4	1189
1991	404	527	0	931
1992	650	979	0	1629
1993	153	272	0	424
1994	13	11	0	24
1995	4	11	0	15
1996	12	14	0	26
1997	39	15	1	55
1998	123	147	1	271
1999	126	229	4	359
2000	107	233	0	340
2001	248	513	1	762
2002	462	626	2	1090
2003	798	879	0	1677
2004	676	1169	2	1847
2005	255	359	35	649
2006	159	110	44	313
2007	139	101	16	256
2008	284	745	108	1138
2009	632	1395	125	2152
2010	472	1532	162	2167
2011	314	954	53	1322
2012	88	350	5	443
2013	50	281	13	344

Shaded text has not been updated.

Table 9. United States landings and discards of haddock in 2013 by quarter and market category from eastern Georges Bank and National Marine Fisheries Service sampling intensity for lengths and ages. Note that summaries by market category are not possible for discards as the fish are discarded at sea and are not given a market category. Numbers in parentheses refer to sample sizes after augmenting samples from US commercial statistical areas 522 and 525.

Market Category	Large	Scrod	Unclassified	Total
		Landings (mt)		
Quarter 1	11	26	0	37
Quarter 2	8	39	1	48
Quarter 3	3	77	17	98
Quarter 4	6	127	29	161
Total	28	269	47	344
		Number lengths measured		
Quarter 1	0 (394)	0 (368)	0	0 (762)
Quarter 2	183 (726)	209 (510)	0	392 (1236)
Quarter 3	13 (12)	51 (261)	0	64 (273)
Quarter 4	0 (271)	314 (778)	0	314 (1049)
Total	196 (1403)	574 (1917)	0	770 (3320)
		Number aged		
Quarter 1	0 (188)	0 (138)	0	0 (326)
Quarter 2	127 (355)	101 (227)	0	228 (582)
Quarter 3	0 (0)	0 (73)	0	0 (73)
Quarter 4	0 (118)	151 (325)	0	151 (443)
Total	127 (661)	252 (763)	0	379 (1424)
		Discards (mt)		
Quarter 1	N/A	N/A	N/A	
Quarter 2	N/A	N/A	N/A	28
Quarter 3	N/A	N/A	N/A	
Quarter 4	N/A	N/A	N/A	64
Total	N/A	N/A	N/A	91

Shaded text has not been updated.

Table 10. Inter- and intra-reader testing for Georges Bank haddock ageing. (SJS=S. Sutherland (National Marine Fisheries Service, (NMFS)) and DK=D. Knox (Canadian Department of Fisheries and Oceans, DFO), CV=coefficient of variation).

Sample Source	Test Type	Date Completed	Age Reader	Sample Size	CV (%)	Agreement (%)	Bowker's test
DFO/NMFS Exchange:							
2013 US Commercial (Q1&2)	Exchange	Spring 2014	SJS vs DK	88	1.90	84.1	n/s
2013 Can. Commercial (Q2,3,4)	Exchange	Spring 2014	SJS vs DK	66	0.49	95.5	
2014 DFO Survey	Exchange	Spring 2014	SJS vs DK	114	0.47	96.5	
2013 NMFS Autumn Survey	Exchange	Spring 2014	SJS vs DK	105	0.38	98.1	
Combined	Exchange	Spring 2014	SJS vs DK	373	0.79	93.8	
NMFS testing:							
2013 NMFS Autumn Survey	Precision	Feb 2014	SJS	96	0.49	99.0	
2013 US Commercial (Q4)	Precision	Mar 2014	SJS	100	0.16	99.0	
2013 US Commercial (Q3)	Precision	Mar 2014	SJS	100	0.06	99.0	
2013 US Commercial (Q2)	Precision	Feb 2014	SJS	97	0.08	99.0	
2013 US Commercial (Q1)	Precision	Dec 2013	SJS	98	0.38	95.9	
2013 NMFS Spring Survey	Precision	June 2013	SJS	99	0.08	99.0	
Haddock Reference Collection	Accuracy	Apr 2014	SJS	57	1.68	92.7	
Haddock Reference Collection	Accuracy	July 2013	SJS	56	1.69	91.1	
DFO testing:							
2014 DFO survey	Precision	Spring 2014	DK	129	0.68	96.1	
2013 Canadian Commercial (Q4)	Precision	2014	DK	114	0.26	98.2	
2013 Canadian Commercial (Q3)	Precision	2013	DK	104	1.02	93.3	
2013 Canadian Commercial (Q2)	Precision	2013	DK	112	0.69	95.5	

Shaded text has not been updated.

Table 11. Haddock age and length samples for landings from the Canadian groundfish fishery and for discards from the scallop dredge fishery in 2013 from eastern Georges Bank. (OTB=Otter Trawl Bottom, LL=Long Line, GN=Gill Net, DR=Scallop Dredge)

Qtr.	Gear	Month	Landings (kg)	Length Frequency Samples				Ages[3]
				At Sea		Port		
				Trips	Measured	Samples	Measured	
1	OTB	Jan Feb						DFO Survey = 530 Port = 50 At Sea = 0 Total =580
	DR[1]							
2	OTB	June						Port = 134 At Sea = 170 Total = 170
	GN[2]	June						
	DR[1]							
3	OTB	July Aug Sept						
	LL	July Aug Sept						Port = 319 At Sea = 91 Total = 429
	GN[2]	July Aug Sept						
	DR[1]							
4	OTB	Oct Nov Dec						
	LL	Oct Nov						Port = 364 At Sea = 49 Total = 452
	GN[2]	Oct Nov						
	DR[1]							
Totals								1,631

[1]Scallop fishery samples were combined by quarter.

Shaded text has not been updated.

Table 12. Components of the 2013 catch at age in numbers of haddock from eastern Georges Bank by quarter or half year.

	Age Group										
	0	1	2	3	4	5	6	7	8	9+	Total
Canadian Landings											
2013 Q1	0	0	590	134527	68047	29091	63211	32575	44597	343303	715943
2013 Q2	0	1	782	38172	17653	18365	22517	9940	6782	39019	153232
2013 Q3	0	4539	68346	979077	109837	34497	76192	20091	30711	100818	1424110
2013 Q4	99	2460	99721	1946002	25386	21498	65849	5505	16171	85933	2268625
Year total	99	7001	169440	3097779	220925	103451	227770	68111	98262	569074	4561911
United States Landings[1]											
2013 H1	0	0	0	12013	7035	1510	3422	2602	4894	32939	64415
2013 H2	0	0	6262	233899	3218	2048	1234	587	2759	5798	255804
Year total	0	0	6262	245912	10252	3558	4656	3189	7653	38737	320219
Canadian Discards											
2013 Q1	0	49	179	1665	59	9	19	11	20	137	2149
2013 Q2	0	0	235	4394	145	95	72	64	30	357	5393
2013 Q3	1393	2029	527	3104	93	25	49	18	24	59	7320
2013 Q4	7892	279	388	1791	3	1	8	1	1	5	10369
Year total	9286	2357	1330	10954	301	131	148	93	75	557	25232
United States Discards[1]											
2013 H1	0	208	5230	46762	937	356	190	100	208	966	54956
2013 H2	152253	14804	14883	56144	743	115	77	964	116	3700	243798
Year total	152253	15012	20113	102906	1680	470	267	1064	324	4666	298754
Total Catch											
2013	161637	24370	197144	3457550	233157	107610	232842	72457	106314	613034	5206116

[1]United States landings and discards at age were calculated by half year, however, landings and discards occurred in other quarters.

Shaded text has not been updated.

Table 13. Total annual commercial catch at age numbers (000's) of haddock from eastern Georges Bank during 1969-2013. Estimates of discards are included.

Year	Age Group										
	0	1	2	3	4	5	6	7	8	9+	0+
1969	6	0	18	1451	262	334	2909	831	91	283	6184
1970	0	66	84	7	351	151	130	1153	372	193	2508
1971	43	0	1201	251	31	252	159	161	774	412	3284
1972	118	346	1	390	72	21	94	39	16	451	1547
1973	7	1119	1758	6	364	38	10	39	8	169	3517
1974	9	37	2257	276	0	32	3	0	29	63	2706
1975	553	18	279	1504	216	5	36	2	2	31	2645
1976	1	402	157	173	834	135	0	19	0	18	1739
1977	0	1	8028	66	182	307	164	0	15	15	8778
1978	110	6	291	9956	164	173	306	80	10	9	11105
1979	12	212	17	208	4307	364	201	217	43	14	5597
1980	31	32	17701	343	302	2425	193	130	52	12	21220
1981	6	55	693	6773	400	497	1243	119	33	7	9826
1982	1	2	731	1057	2848	205	379	730	62	65	6080
1983	75	11	149	663	554	1653	208	104	409	35	3860
1984	1	72	100	259	350	270	1131	186	166	318	2854
1985	353	9	2147	386	182	199	128	381	53	117	3954
1986	0	89	39	2586	175	143	124	119	174	42	3492
1987	19	0	2081	131	1536	100	58	83	70	111	4190
1988	1	53	53	2199	124	894	111	39	46	100	3619
1989	8	2	1274	86	776	143	347	34	23	47	2740
1990	18	31	8	1346	133	770	73	168	43	43	2633
1991	35	22	466	91	2076	89	391	72	146	61	3450
1992	151	49	249	324	129	1466	90	320	26	91	2895
1993	4	80	283	357	291	91	667	41	157	76	2049
1994	13	36	423	870	186	73	101	190	89	48	2028
1995	4	8	79	534	414	53	25	3	52	16	1188
1996	6	4	32	489	864	419	60	18	3	72	1967
1997	1	29	94	73	535	484	195	13	8	34	1466
1998	19	18	195	292	260	541	448	114	12	35	1932
1999	2	27	44	752	319	249	347	256	99	25	2119
2000	1	6	320	449	1268	264	213	217	186	67	2991
2001	0	22	65	1733	533	847	263	204	232	204	4105
2002	0	1	333	218	1891	379	671	115	110	289	4008
2003	486	7	10	1831	288	1487	426	479	110	234	5358
2004	4	332	26	75	3646	605	1498	519	421	263	7388
2005	0	14	241	29	224	6891	526	823	128	157	9034
2006	1	20	16	2515	44	289	4544	234	551	154	8367
2007	0	2	39	181	7345	148	168	1431	136	187	9637
2008	0	4	30	273	268	9721	102	85	708	95	11288
2009	3	17	125	192	741	261	11222	73	58	379	13074
2010	15	31	56	391	314	844	382	9849	50	210	12142
2011	1	243	107	181	515	228	676	108	6233	75	8366
2012	3	75	638	174	126	351	174	379	138	2055	4112
2013	162	24	197	3458	233	108	233	72	106	613	5206

Shaded text has not been updated.

Table 14. Average weight at age (kg) of haddock from the combined Canadian and USA commercial groundfish fishery landings on eastern Georges Bank during 1969-2013. From 1969 to 1973 only USA fishery sampling for lengths and ages was available. Between 1974 and 1984 a mix of USA and Canadian samples were used. No USA fishery weights were available for 1997, 1998. For age 1 missing weights (**bold),** an average of 0.600 kg was used. Missing weights for older haddock were extrapolated within year class.

Year	Age Group								
	1	2	3	4	5	6	7	8	9+
1969	**0.600**	0.763	1.282	1.531	1.649	1.836	2.298	2.879	3.354
1970	0.721	1.067	0.812	1.653	1.886	2.124	2.199	2.841	3.150
1971	**0.600**	0.928	1.059	1.272	2.011	2.255	2.262	2.613	3.047
1972	0.759	**0.983**	1.562	1.750	2.147	2.505	2.411	2.514	2.989
1973	0.683	1.002	1.367	1.804	2.202	1.631	2.885	3.295	3.192
1974	**0.600**	1.052	1.491	**1.683**	2.017	3.760	**2.583**	3.145	3.735
1975	**0.600**	0.877	1.557	2.085	1.999	2.429	4.107	3.534	3.429
1976	0.610	0.984	1.292	1.853	2.417	**2.247**	2.774	**4.484**	3.807
1977	**0.600**	0.970	1.442	1.810	2.336	2.807	**2.494**	3.094	4.150
1978	0.619	1.158	1.432	2.067	2.602	2.926	2.971	2.741	4.334
1979	**0.600**	0.966	1.288	1.823	2.214	2.791	3.214	3.206	4.041
1980	0.405	0.889	1.035	1.703	2.094	2.606	3.535	3.584	3.109
1981	**0.600**	0.888	1.270	1.650	2.310	2.627	3.545	4.086	4.455
1982	**0.600**	0.964	1.370	1.787	2.332	2.550	2.957	3.528	3.426
1983	**0.600**	1.028	1.327	1.755	2.132	2.475	2.895	3.125	4.010
1984	**0.600**	0.872	1.338	1.798	2.151	2.577	2.842	3.119	3.411
1985	**0.600**	0.950	1.230	1.915	2.227	2.702	2.872	3.180	3.696
1986	0.452	0.981	1.352	1.866	2.367	2.712	2.969	3.570	3.908
1987	**0.600**	0.833	1.431	1.984	2.148	2.594	2.953	3.646	3.880
1988	0.421	0.974	1.305	1.708	2.042	2.350	3.011	3.305	3.693
1989	**0.600**	0.868	1.450	1.777	2.183	2.522	3.012	3.411	3.751
1990	0.639	0.999	1.419	1.787	2.141	2.509	2.807	3.002	3.668
1991	0.581	1.197	1.241	1.802	2.086	2.597	2.913	3.010	3.362
1992	0.538	1.163	1.622	1.654	2.171	2.491	2.988	3.388	3.524
1993	0.659	1.160	1.724	2.181	2.047	2.623	2.386	3.112	3.486
1994	0.405	1.141	1.669	2.244	2.662	2.454	2.837	3.253	3.449
1995	0.797	1.055	1.511	2.032	2.549	2.762	2.978	3.012	3.535
1996	0.576	1.026	1.441	1.796	2.296	2.490	3.331	2.220	3.620
1997	0.685	1.216	1.336	1.747	2.121	2.476	3.034	3.367	3.927
1998	0.568	1.131	1.573	1.697	1.983	2.312	2.864	3.395	3.657
1999	0.678	1.094	1.568	1.907	1.893	2.216	2.577	2.816	3.743
2000	0.664	1.104	1.470	1.917	2.242	2.132	2.518	2.829	3.170
2001	0.394	1.102	1.461	1.742	2.100	2.364	2.187	2.554	3.114
2002	0.405	1.010	1.400	1.739	1.905	2.352	2.742	2.550	2.895
2003	0.475	0.758	1.377	1.577	1.845	1.913	2.389	2.859	2.909
2004	0.482	0.589	1.100	1.502	1.610	1.872	1.993	2.307	2.558
2005	0.056[1]	0.697	0.988	1.429	1.678	1.842	2.005	2.055	2.419
2006	0.335	0.514	0.977	0.977	1.598	1.776	1.861	2.021	2.216
2007	0.464	0.584	0.990	1.187	1.385	1.658	1.833	1.671	2.122
2008	0.458	0.791	1.003	1.230	1.390	1.610	1.572	1.912	2.434
2009	0.551	0.864	0.987	1.255	1.422	1.531	1.740	2.245	2.248
2010	0.436	0.739	1.063	1.231	1.338	1.503	1.594	1.728	2.220
2011	0.346	1.027	1.024	1.217	1.319	1.360	1.556	1.630	2.125
2012	0.256	0.646	1.027	1.222	1.310	1.437	1.477	1.559	1.705
2013	0.323	0.660	0.848	1.205	1.254	1.301	1.469	1.547	1.692
Low	0.256	0.514	0.812	0.977	1.254	1.301	1.469	1.547	1.692
High	0.797	1.216	1.724	2.244	2.662	3.760	4.107	4.086	4.455
Median	0.538	0.972	1.338	1.749	2.094	2.442	2.807	3.006	3.426
Average	0.529	0.938	1.300	1.679	1.996	2.281	2.590	2.829	3.253
2011-13 Avg	0.308	0.778	0.966	1.215	1.294	1.366	1.501	1.579	1.841

[1]One haddock measured. [2]Excludes 2005 value.

Shaded text has not been updated.

Table 15. Average lengths at age (cm) of haddock from the combined Canadian and USA commercial groundfish fishery landings on eastern Georges Bank during 1969-2013.

Year	Age Group									
	0	1	2	3	4	5	6	7	8	9+
1969			42.5	50.2	53.4	54.9	56.6	61.2	66.7	70.6
1970		40.1	47.0	43.4	54.9	57.4	60.0	60.4	66.4	68.6
1971			44.7	46.6	50.0	58.4	61.3	61.9	64.2	68.1
1972		40.6		53.3	55.4	59.4	63.3	63.5	62.0	67.3
1973		39.2	45.2	52.5	55.4	60.3	54.7	65.8	69.2	69.0
1974			45.6	52.1		59.6	72.5		69.2	73.3
1975			42.5	52.8	59.7	59.8	63.7	75.8	72.7	71.7
1976		37.4	44.6	49.5	57.1	62.3		65.8		72.6
1977			44.1	51.2	55.9	61.1	65.4		68.8	76.7
1978		37.6	46.4	50.5	57.3	63.5	65.8	65.9	66.1	76.1
1979			44.3	49.0	55.3	59.3	64.7	68.4	67.8	74.0
1980		32.5	42.5	44.9	54.3	58.6	63.1	71.6	71.0	67.0
1981			42.9	48.8	53.2	60.4	63.4	70.7	75.5	76.3
1982			44.4	50.1	55.1	60.6	63.1	66.3	71.5	70.9
1983			45.0	49.2	54.4	58.8	62.0	65.4	67.6	73.4
1984			44.1	50.5	55.8	59.8	63.6	66.5	68.2	70.3
1985			43.3	47.5	55.8	59.2	63.6	65.9	67.9	70.8
1986		33.7	43.8	49.6	55.1	60.1	63.7	66.3	70.8	72.0
1987			41.4	50.3	56.5	58.0	62.2	66.3	71.3	71.9
1988		32.8	43.7	48.6	53.7	58.0	60.6	67.1	68.5	69.3
1989			41.9	50.0	54.1	59.2	61.9	66.6	70.3	70.0
1990		37.9	44.2	50.0	55.4	58.2	63.4	63.7	64.9	69.4
1991		36.2	47.0	48.3	54.2	58.3	62.2	66.7	64.9	66.6
1992		35.7	46.4	52.7	53.9	58.2	63.2	65.5	71.6	67.8
1993		38.3	46.4	53.3	58.0	57.0	61.7	62.4	65.2	67.9
1994		32.5	46.1	52.6	58.1	61.6	59.7	62.9	65.6	67.4
1995		40.2	45.0	50.9	56.3	60.8	62.5	64.1	64.2	67.9
1996		36.4	44.6	50.0	53.9	58.6	60.1	66.7	58.1	68.4
1997		38.7	47.2	48.8	53.4	57.0	60.2	64.4	66.9	70.5
1998		36.5	46.1	51.6	52.8	55.7	58.7	63.3	67.2	68.8
1999		38.7	45.6	51.5	55.1	54.9	57.9	61.0	63.0	69.3
2000		38.5	45.7	50.4	55.2	58.3	57.1	60.4	62.9	65.3
2001		32.1	45.5	50.4	53.5	56.9	59.2	57.6	60.3	64.5
2002		32.5	44.3	49.6	53.5	55.2	59.2	62.6	60.7	63.5
2003		34.2	40.2	49.3	51.8	54.7	55.3	59.7	63.8	64.0
2004		34.5	36.9	45.6	50.8	52.3	54.7	55.9	58.3	60.1
2005		16.5[1]	38.8	44.1	49.9	52.8	54.5	56.1	56.5	59.2
2006		30.4	35.2	43.7	43.9	51.9	53.8	54.7	56.1	57.8
2007		34.0	36.7	43.9	46.8	49.3	52.5	54.3	52.3	57.1
2008		33.3	40.7	44.3	47.6	49.6	52.0	51.3	55.0	59.6
2009		36.0	42.0	44.4	47.9	49.7	51.4	52.9	57.7	57.8
2010		33.1	39.9	45.1	47.6	49.1	50.9	52.1	53.3	58.4
2011		30.7	44.0	44.7	47.4	48.9	49.5	51.8	52.5	57.8
2012		27.7	37.9	44.8	47.4	48.6	50.2	50.7	51.5	53.2
2013	22.8	30.0	38.2	41.8	47.2	47.8	48.4	50.5	51.4	53.0
Low	22.8	27.7[2]	35.2	41.8	43.9	47.8	48.4	50.5	51.4	53.2
High	22.8	40.6[2]	47.2	53.3	59.7	63.5	72.5	75.8	75.5	76.7
Median	22.8	35.7[2]	44.1	49.6	54.1	58.2	60.4	63.5	65.4	68.4
Average	22.8	35.2[2]	43.3	48.7	53.3	56.8	59.5	62.2	64.0	66.9
Avg. 2011-13	22.8	29.5	40.0	43.7	47.3	48.4	49.4	51.0	51.8	54.7

[1]One haddock measured. [2]Excludes 16.5 cm value in 2005.

Shaded text has not been updated.

Table 16. Conversion factors used to adjust for changes in door type and survey vessel in the National Marine Fisheries Service surveys during 1968-2014.

Year	Door	Spring		Fall	
		Vessel	Conversion	Vessel	Conversion
1968	BMV	Albatross IV	1.49	Albatross IV	1.49
1969	BMV	Albatross IV	1.49	Albatross IV	1.49
1970	BMV	Albatross IV	1.49	Albatross IV	1.49
1971	BMV	Albatross IV	1.49	Albatross IV	1.49
1972	BMV	Albatross IV	1.49	Albatross IV	1.49
1973	BMV	Albatross IV	1.49	Albatross IV	1.49
1974	BMV	Albatross IV	1.49	Albatross IV	1.49
1975	BMV	Albatross IV	1.49	Albatross IV	1.49
1976	BMV	Albatross IV	1.49	Albatross IV	1.49
1977	BMV	Albatross IV	1.49	Delaware II	1.2218
1978	BMV	Albatross IV	1.49	Delaware II	1.2218
1979	BMV	Albatross IV	1.49	Delaware II	1.2218
1980	BMV	Albatross IV	1.49	Delaware II	1.2218
1981	BMV	Delaware II	1.2218	Delaware II	1.2218
1982	BMV	Delaware II	1.2218	Albatross IV	1.49
1983	BMV	Albatross IV	1.49	Albatross IV	1.49
1984	BMV	Albatross IV	1.49	Albatross IV	1.49
1985	Polyvalent	Albatross IV	1	Albatross IV	1
1986	Polyvalent	Albatross IV	1	Albatross IV	1
1987	Polyvalent	Albatross IV	1	Albatross IV	1
1988	Polyvalent	Albatross IV	1	Albatross IV	1
1989	Polyvalent	Delaware II	0.82	Delaware II	0.82
1990	Polyvalent	Delaware II	0.82	Delaware II	0.82
1991	Polyvalent	Delaware II	0.82	Delaware II	0.82
1992	Polyvalent	Albatross IV	1	Albatross IV	1
1993	Polyvalent	Albatross IV	1	Delaware II	0.82
1994	Polyvalent	Delaware II	0.82	Albatross IV	1
1995	Polyvalent	Albatross IV	1	Albatross IV	1
1996	Polyvalent	Albatross IV	1	Albatross IV	1
1997	Polyvalent	Albatross IV	1	Albatross IV	1
1998	Polyvalent	Albatross IV	1	Albatross IV	1
1999	Polyvalent	Albatross IV	1	Albatross IV	1
2000	Polyvalent	Albatross IV	1	Albatross IV	1
2001	Polyvalent	Albatross IV	1	Albatross IV	1
2002	Polyvalent	Albatross IV	1	Albatross IV	1
2003	Polyvalent	Delaware II	0.82	Delaware II	0.82
2004	Polyvalent	Albatross IV	1	Albatross IV	1
2005	Polyvalent	Albatross IV	1	Albatross IV	1
2006	Polyvalent	Albatross IV	1	Albatross IV	1
2007	Polyvalent	Albatross IV	1	Albatross IV	1
2008	Polyvalent	Albatross IV	1	Albatross IV	1
2009 – 2014	3 bridle, 4 seam	Henry B Bigelow	See Table 17	Henry B Bigelow	See Table 17

Shaded text has not been updated.

Table 17. Conversion factors for Georges Bank haddock used to adjust for changes in net, doors, survey vessel and protocols for the National Marine Fisheries Service surveys during 2009 to 2013 when the *Henry B. Bigelow* was the research vessel used. *Bigelow* catches are divided by the conversion factor to equate to *Albatross IV* catches.

Length (cm)	Conversion factor
1 – 18	2.626169
19	2.580551
20	2.534933
21	2.489315
22	2.443697
23	2.398079
24	2.352462
25	2.306844
26	2.261226
27	2.215608
28	2.169990
29	2.124372
30	2.078754
31	2.033136
32	1.987518
33	1.941900
34	1.896283
35	1.850665
36	1.805047
37	1.759429
38	1.713811
39	1.668193
40	1.622575
41	1.576957
42	1.531339
43	1.485721
44	1.440104
45	1.394486
46	1.348868
47	1.303250
48	1.257632
49	1.212014
50	1.166396
51 and greater	1.163990

Shaded text has not been updated.

Table 18. Total swept area estimates of abundance at age (numbers in 000's) of eastern Georges Bank haddock from the Canadian Department of Fisheries and Oceans (DFO) surveys during 1986-2014.

Year	Age Group									
	1	2	3	4	5	6	7	8	9+	Total
1986	5057	306	8176	997	189	348	305	425	401	16205
1987	46	4286	929	3450	653	81	387	135	1132	11099
1988	971	49	12714	257	4345	274	244	130	686	19670
1989	48	6664	991	2910	245	526	40	34	265	11724
1990	726	108	12300	168	4466	299	1370	144	389	19968
1991	383	2163	134	10819	114	1909	117	505	225	16368
1992	1914	3879	1423	221	4810	18	1277	52	656	14249
1993	3448	1759	545	431	34	1186	19	281	147	7849
1994	4197	15163	5332	549	314	20	915	18	356	26864
1995	1231	3224	6236	3034	720	398	0	729	849	16422
1996	1455	2290	4784	5305	3113	303	274	38	684	18247
1997	1033	1550	1222	2742	2559	1397	150	65	372	11090
1998	2379	10626	5348	3190	5312	5028	2248	348	601	35080
1999	24593	4787	10067	3104	1963	1880	1764	448	174	48780
2000	3177	15865	7679	12108	2900	2074	2726	1591	813	48932
2001	23026	3519	14633	4255	5608	1808	1426	1963	2299	58536
2002	732	28174	5977	12660	2981	2646	648	529	2423	56769
2003	1682	1503	82161	5533	15105	3675	2355	1106	1986	115107
2004	91843	539	2682	54882	5001	9695	1654	954	634	167883
2005	1669	20958	531	1557	25559	3403	4815	1087	548	60125
2006	9130	5817	178604	2521	2251	15695	764	1633	261	216675
2007	3051	9541	3289	67311	984	154	3584	251	652	88816
2008	3832	1219	4647	5025	103874	1006	191	8553	724	129071
2009	2001	3977	2668	5989	652	43838	637	125	1568	61456
2010	868	606	3005	2335	4855	1433	42302	314	1071	56788
2011	209508	1892	1649	3079	1329	2974	741	29157	535	250864
2012	20047	353084	4108	746	1061	410	684	401	4454	384995
2013	2988	33059	320949	5319	786	1390	588	969	5442	371491
2014	474896	8419	17468	51849	654	88	28	183	548	554132

Shaded text has not been updated.

Table 19. Total swept area estimated abundance at age (numbers in 000's) of eastern Georges Bank haddock from the National Marine Fisheries Service spring surveys during 1968-2014. From 1973-81, a 41 Yankee trawl was used while a 36 Yankee trawl was used in other years up to and including 2008. Since 2009 a new net, vessel and protocols were used and conversion factors to equate to *Albatross IV* catches were applied. Note that the 2012 survey results have been revised.

Year	Age Group									
	1	2	3	4	5	6	7	8	9+	Total
1968	0	3254	68	679	4853	2045	240	123	234	11496
1969	17	35	614	235	523	3232	1220	358	489	6724
1970	478	190	0	560	998	441	3165	2491	769	9092
1971	0	655	261	0	144	102	58	1159	271	2650
1972	2594	0	771	132	25	47	211	27	1214	5020
1973	2455	5639	0	1032	154	0	276	0	1208	10763
1974	1323	20596	4084	0	354	0	43	72	322	26795
1975	528	567	6016	1063	0	218	127	45	208	8773
1976	8228	402	424	1127	532	0	0	0	22	10735
1977	126	26003	262	912	732	568	0	22	102	28727
1978	0	743	20859	641	880	1163	89	23	116	24516
1979	10496	441	1313	9764	475	72	445	42	9	23056
1980	4355	66450	1108	1086	5761	613	371	693	360	80797
1981	3281	2823	27085	2906	751	2455	347	56	21	39725
1982	584	3703	1658	7802	767	455	697	0	0	15666
1983	238	770	686	359	2591	30	0	798	58	5529
1984	1366	1414	1046	910	847	1189	133	73	490	7469
1985	40	8911	1396	674	1496	588	1995	127	483	15709
1986	3334	280	3597	246	210	333	235	560	159	8953
1987	122	5480	144	1394	157	231	116	370	0	8013
1988	305	61	1868	235	611	203	218	178	0	3678
1989	84	6665	619	1343	267	791	58	92	47	9966
1990	1654	70	10338	598	1042	110	182	0	0	13995
1991	740	2071	432	3381	192	203	66	87	25	7198
1992	529	287	205	158	602	32	46	46	0	1905
1993	1870	1116	197	232	195	717	77	35	43	4480
1994	1025	4272	1487	269	184	118	278	28	84	7745
1995	921	2312	4184	1727	265	152	51	272	214	10099
1996	912	1365	3789	3190	1905	237	36	0	496	11931
1997	1635	1226	380	595	470	343	24	44	20	4736
1998	549	6046	2005	1281	1184	303	58	15	122	11562
1999	6286	1914	3655	661	1128	1062	468	476	46	15696
2000	2675	2131	3399	1624	636	564	438	305	165	11938
2001	10503	1186	3304	1232	374	294	113	20	20	17047
2002	231	40432	10938	4044	1492	473	287	229	236	58362
2003	125	1105	16915	2245	3773	476	200	82	286	25206
2004	195013	4724	2644	45872	3544	5261	960	1245	842	260104
2005	540	32911	257	614	5818	671	1196	240	67	42313
2006	2961	1247	48882	213	949	6650	325	574	187	61988
2007	1468	11383	2055	95882	180	441	2168	222	312	114110
2008	3402	1671	4332	240	38569	836	371	1739	480	51639
2009	2896	2758	1589	5126	801	23985	563	483	1259	39462
2010	481	644	3326	1461	3785	517	20735	0	600	31548
2011	16812	1319	834	707	551	1052	303	6751	155	28484
2012	19701	99410	1372	362	725	657	908	43	3532	126709
2013	2583	9575	60096	1197	506	411	349	292	1101	76111
2014	91436	4429	8306	28732	291	65	78	49	153	133540

Shaded text has not been updated.

Table 20. Total swept area estimated abundance at age (numbers in 000's) of eastern Georges Bank haddock from National Marine Fisheries Service fall surveys during 1963-2013. Since 2009 a new net, vessel and protocols were used and conversion factors to equate to *Albatross IV* catches were applied. Note that the 2011 survey has been revised.

Year	Age Group									
	0	1	2	3	4	5	6	7	8+	Total
1963	105993	40995	10314	3378	5040	4136	1477	451	276	172061
1964	1178	123976	46705	4358	807	1865	477	211	167	179742
1965	259	1503	51338	8538	479	302	142	148	208	62918
1966	9325	751	1742	20323	3631	671	138	133	84	36798
1967	0	3998	73	327	1844	675	141	88	88	7233
1968	55	113	800	28	37	2223	547	177	313	4293
1969	356	0	0	509	62	30	739	453	108	2257
1970	0	6400	336	16	415	337	500	902	578	9483
1971	2626	0	788	97	0	265	27	73	594	4471
1972	4747	2396	0	232	0	0	53	0	275	7702
1973	1223	16797	1598	0	168	0	0	8	16	19809
1974	151	234	961	169	0	6	0	0	70	1589
1975	30365	664	192	1042	239	0	0	0	28	32530
1976	738	121717	431	25	484	71	0	17	37	123521
1977	47	238	26323	445	125	211	84	4	4	27480
1978	14642	547	530	7706	56	42	94	0	0	23617
1979	1598	21605	14	335	1489	45	12	0	0	25098
1980	3556	2788	5829	0	101	1081	108	25	4	13492
1981	596	4617	2585	2748	89	136	318	0	15	11103
1982	62	0	673	465	2508	153	97	528	42	4527
1983	3609	444	236	501	289	402	17	12	86	5598
1984	45	3775	856	233	194	45	262	0	41	5451
1985	12148	381	1646	199	70	68	46	30	21	14611
1986	30	7471	109	961	52	50	72	24	23	8793
1987	508	0	843	28	152	38	22	0	0	1592
1988	122	3983	184	2348	155	400	142	140	38	7513
1989	167	83	2645	112	509	68	73	0	0	3656
1990	1217	1041	36	1456	65	196	24	5	0	4040
1991	705	331	267	52	289	25	10	0	0	1679
1992	3484	1052	172	110	0	95	0	18	18	4948
1993	687	6656	3601	585	0	87	96	30	0	11742
1994	625	782	927	419	96	32	0	24	0	2905
1995	892	1436	5993	3683	550	30	0	0	53	12637
1996	1742	453	570	2302	963	167	0	0	0	6196
1997	217	5738	3368	592	690	385	0	0	13	11004
1998	2566	2966	4214	1085	705	526	722	0	0	12784
1999	3268	1236	5364	5060	837	2825	148	1150	991	20879
2000	1368	5284	6226	3712	622	229	0	146	97	17684
2001	659	16626	1382	6939	3000	1586	306	127	58	30684
2002	172	1864	44602	6040	5120	1660	863	457	354	61131
2003	196182	60	285	3415	655	739	20	99	158	201613
2004	2864	116289	322	775	17200	1034	2410	416	528	141837
2005	4981	3114	95159	340	532	3631	347	242	155	108502
2006	930	8752	1040	65817	1083	82	796	0	16	78517
2007	1264	1922	11764	965	52456	955	562	244	0	70132
2008	1902	1865	1162	2564	477	21289	0	74	484	29818
2009	2010	862	1352	1082	2504	388	20906	88	237	29430
2010	172390	1154	585	1069	393	1166	589	9909	172	187428
2011	14019	106939	349	225	281	331	650	219	3673	126686
2012	3493	10311	72573	237	151	83	102	80	754	87784
2013	909714	3149	6643	52237	445	106	21	0	360	972675

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Table 21. Average weight at age (kg) of eastern Georges Bank haddock from the Canadian Department of Fisheries and Oceans surveys during 1986-2014. These weights are used to represent beginning of year population weights. 9+ weights are population weighted averages. Highlighted cells indicated exceptionally strong year classes.

Year	Age Group								
	1	2	3	4	5	6	7	8	9+
1986	0.135	0.451	0.974	1.445	3.044	2.848	3.598	3.376	3.918
1987	0.150	0.500	0.716	1.672	2.012	2.550	3.148	3.151	3.629
1988	0.097	0.465	0.931	1.795	1.816	1.918	2.724	3.264	3.871
1989	0.062	0.474	0.650	1.392	1.995	2.527	2.158	2.859	3.141
1990	0.149	0.525	0.924	1.181	1.862	2.073	2.507	2.815	3.472
1991	0.120	0.685	0.800	1.512	1.695	2.434	2.105	3.122	3.432
1992	0.122	0.602	1.118	1.061	2.078	2.165	2.709	2.284	3.440
1993	0.122	0.481	1.227	1.803	1.274	2.332	2.343	2.739	3.280
1994	0.107	0.469	1.047	1.621	1.927	2.154	3.154	2.688	3.084
1995	0.086	0.493	0.963	1.556	2.222	2.445	2.4[1]	2.991	3.184
1996	0.139	0.495	0.919	1.320	1.932	2.555	2.902	2.611	3.588
1997	0.132	0.506	0.782	1.205	1.664	2.176	2.454	2.577	3.158
1998	0.107	0.535	1.035	1.161	1.570	1.954	2.609	3.559	3.462
1999	0.130	0.474	0.911	1.290	1.259	1.869	2.131	2.722	2.992
2000	0.116	0.543	0.949	1.478	1.871	1.789	2.298	2.508	2.901
2001	0.093	0.524	1.005	1.371	1.798	2.165	2.250	2.593	2.928
2002	0.096	0.332	0.778	1.138	1.494	1.965	2.177	2.206	2.708
2003	0.080	0.369	0.846	1.063	1.477	1.645	2.208	2.229	2.487
2004	0.064	0.310	0.781	1.151	1.306	1.558	1.622	1.956	2.216
2005	0.028	0.218	0.493	0.696	1.226	1.321	1.531	1.600	2.444
2006	0.059	0.171	0.389	0.657	0.870	1.366	1.591	1.742	2.355
2007	0.077	0.246	0.405	0.709	0.992	1.745	1.559	1.671	1.862
2008	0.107	0.329	0.573	0.795	0.927	1.254	1.729	1.476	1.897
2009	0.114	0.387	0.775	0.999	0.987	1.258	1.482	2.680	2.228
2010	0.072	0.385	0.749	0.960	1.120	1.207	1.333	1.772	2.066
2011	0.038	0.322	0.612	0.900	0.953	1.018	1.120	1.371	1.721
2012	0.070	0.186	0.457	0.506	0.997	1.104	1.084	1.190	1.346
2013	0.070	0.261	0.412	0.789	1.092	0.972	1.100	1.142	1.457
2014	0.042	0.323	0.537	0.648	0.911	1.214	1.214	0.953	1.432
Low	0.028	0.171	0.389	0.506	0.870	0.972	1.084	0.953	1.346
High	0.150	0.685	1.227	1.803	3.044	2.848	3.598	3.559	3.918
Median	0.097	0.465	0.782	1.161	1.494	1.918	2.167	2.577	2.928
Average	0.096	0.416	0.785	1.168	1.530	1.848	2.101	2.339	2.748
Avg. 1991-2000	0.118	0.528	0.975	1.401	1.749	2.187	2.523	2.780	3.252
Avg. 2012-2014	0.061	0.257	0.469	0.648	1.000	1.097	1.133	1.095	1.412

[1]The weight midway between the age 6 and 8 weight for that cohort was used as data were not available for this age group.

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Table 22. Average lengths at age (cm) of eastern Georges Bank haddock from the Canadian Department of Fisheries and Oceans surveys during 1986-2014. Highlighted cells indicated exceptionally strong year classes.

Year	Age Group								
	1	2	3	4	5	6	7	8	9+
1986	22.9	36.2	45.4	51.0	63.7	61.9	67.8	66.0	70.7
1987	24.2	36.3	39.7	53.4	57.1	61.1	65.1	65.8	69.6
1988	22.3	36.4	45.1	55.7	55.9	58.0	62.4	65.8	71.5
1989	19.5	35.9	39.1	50.4	56.8	61.3	58.0	64.6	66.3
1990	24.7	35.8	44.4	48.0	55.9	58.7	61.6	63.1	67.5
1991	23.1	40.7	42.7	51.7	52.9	60.2	58.3	65.1	67.8
1992	23.2	39.2	47.7	46.8	57.7	62.5	63.9	60.3	68.1
1993	23.6	36.6	49.7	55.5	50.0	60.4	59.3	63.7	67.3
1994	22.3	35.8	45.8	53.8	57.6	58.5	65.9	66.5	65.4
1995	20.2	36.3	45.1	52.7	59.0	62.5		65.0	66.0
1996	24.2	36.2	44.4	50.1	56.9	62.7	66.2	61.8	68.4
1997	23.6	37.1	42.1	48.9	54.2	59.5	62.4	63.5	66.8
1998	21.8	37.6	46.4	47.3	52.9	57.2	62.5	69.3	68.7
1999	23.7	35.9	44.8	49.8	48.9	56.1	58.9	63.6	66.6
2000	22.7	37.6	44.3	52.1	56.4	54.7	59.6	61.7	64.7
2001	21.7	37.5	46.1	51.1	56.2	60.0	59.0	62.5	65.5
2002	21.5	31.8	42.1	47.5	52.0	58.1	60.3	59.2	64.4
2003	20.2	34.0	43.3	46.8	52.0	53.8	61.2	61.3	63.3
2004	19.1	31.8	42.0	47.9	50.6	53.3	55.3	59.1	60.2
2005	15.1	29.1	37.2	41.1	49.7	51.6	53.8	54.3	62.7
2006	18.7	27.0	34.0	40.2	42.6	51.8	52.8	55.7	62.2
2007	20.6	29.6	34.2	41.0	46.7	55.0	53.5	54.1	55.4
2008	23.1	33.1	39.4	43.0	45.7	50.5	56.3	52.9	57.9
2009	23.2	34.7	42.6	45.8	44.9	49.3	51.9	61.7	59.4
2010	20.3	34.8	43.0	46.3	48.3	50.5	51.4	55.7	59.8
2011	16.6	32.5	40.1	45.8	47.5	47.6	49.3	52.3	56.9
2012	19.9	26.7	36.2	37.1	47.0	48.7	48.6	50.1	52.0
2013	19.8	30.0	35.0	43.9	48.3	48.2	49.4	50.4	53.5
2014	16.4	32.4	37.9	40.5	46.8	49.2	50.5	47.8	54.0
Low	15.1	26.7	34.0	37.1	42.6	47.6	48.6	47.8	52.0
High	24.7	40.7	49.7	55.7	63.7	62.7	67.8	69.3	71.5
Median	21.8	35.8	42.7	47.9	52.0	57.2	59.0	61.7	65.4
Average	21.3	34.4	42.1	47.8	52.2	56.0	58.0	60.1	63.5

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Table 23. Data and model changes to the eastern Georges Bank haddock assessment framework from 1998 to 2013.

Assessment Year	Change
1998	Framework: Random error in catch at age negligible. Errors in abundance indices assumed independent and identically distributed after taking the natural logarithms. Annual natural mortality rate (M) = 0.2. Fishing mortality (F) on age 8 = weighted F on ages 4 to 7. 9+ age group calculated but not calibrated to indices. In Q1 of first year, 9+ based on assumption that F9+ = popn weighted F4-8. In Q1 of subsequent years, 9+ abundance calculated as sum of age 8 and 9+ at end of last quarter of previous year. Quarterly catch at age: 0,1,2…8,9+; 1969.0, 1969.25, 1969. 75, 1970.0…1996.75. DFO survey: ages 1,2,3…8; 1986.16, 1987.16…1998.0. NMFS spring (Yankee 36): age 1,2,3…8; 1969.29, 1970.29…1997.29. NMFS spring (Yankee 41): age 1,2,3…8; 1973.29, 1974.29…1981.29. NMFS fall: 0,1,2…5, 1969.69, 1970.69…1997.69. Zero survey observations treated as missing data.
1999	Minor differences in the handling of zero terminal catches for a year class were implemented as a refinement to the software to afford more flexibility.
2003	NMFS spring (Yankee 36): age 1,2,3…8; 1969.29, 1970.29…2003.25. (In previous years, the last survey available was the same year as the last catch at age year.) Catch of 0 was assumed for the 1st quarter of 2003 and the population calculated to beginning of 2003.25.
2005	Discards ages 1 and older from Canadian scallop fishery included in catch at age but age 0 set to zero. Population calculated to beginning year 2005. NMFS and DFO spring surveys in 2005 set to time=2005.00.
2007	Discards at age 0 included in catch at age.
2008	1) an annual catch at age instead of a quarterly catch at age. 2) revised survey timing: DFO spring from 0.16 to 0.17, NMFS spring from 0.29 to 0.28 and the NMFS fall survey from 0.69 to 0.79. 3) a change from ages 4 to 7 to 5 to 7 (weighted by population numbers) used to estimate oldest age F from 2003 to present.
2009	USA 2007 catch corrected from previous year (calculation error). The landings at age for 2006 to 2007 were recalculated. USA landings for 1994 to 2007 revised using new methodology. (Effect was negligible.) USA landings at age from 1991 to 2005 were revised to reflect the recalculated landings using a scalar adjustment. USA discards recalculated using ratio of discarded haddock to kept of all species for 1989 to 2007. Discards at age were not revised for 1989 to 2000 as amounts were low, except for 1994 (old=258 vs new=1,021 mt). No adjustment to the 1994 discards at age was made due to the uncertainty of this estimate. Discard at age estimates for 2001 to 2007 were revised by a scalar. 2009 NMFS spring survey not used (no conversion factors).
2010	9+ group in catch at age expanded to 9 to 16+; ages 15 and 16 dropped; 9+ group reconstructed from ages 9 to 14. Revisions made to USA landings, Canadian scallop discards and USA groundfish fishery discards at age. Largest change for 1994 discards from 258 mt to 1279 mt.
2011 - 2013	No additional changes. Note that the 2010 fall survey was used at twice its actual value in the 2011 and 2012 assessments. The effect on the 2012 assessment results are as follows:

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	• 2010 yc declined from 589 M to 532 M • 1+ population declined from 644,586 K to 597,434 K • 3+ population declined from 57,745 to 55,964 K • 3+ biomass declined from 70,679 mt to 68,521 mt • risk analysis for 2013 F_{ref} catch declined by 700 mt from 10,400 mt to 9,700 mt
2014	NMFS 2012 spring survey: For the 2012 and 2013 assessments the survey results did not incorporate some lengths for which there were no ages. The numbers involved were small. Updated values also reflect an increase in the number of tows, changes to the numbers per tow and a large increase in the numbers aged. NMFS 2011 fall survey: The NMFS 2011 fall survey used incorrect stratum area values for strata 5Z3 and 5Z4 for the 2012 and 2013 assessments. Updated values also reflect changes to the numbers per tow. Canadian scallop discards: Revised 2005 to 2012 to reflect updated values due to change from freezer trawler equivalents to hours x meters as new effort measure and other data changes. Largest percent difference from previous values for age/year was 19%. Largest annual change was 7%. Canadian scallop discards contribute a very small amount to the total catch.

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Table 24. Statistical properties of estimates of population abundance (numbers in 000's) at beginning of year 2014 and survey calibration constants (unitless, survey:population) for eastern Georges Bank haddock obtained from a bootstrap with 1000 replications.

Age	Estimate	Standard Error	Relative Error	Bias	Relative Bias
		Population Abundance (000's)			
1	1811316	1071226	0.591	265143	0.146
2	13012	5268	0.405	967	0.074
3	34989	11186	0.320	1350	0.039
4	186702	49466	0.265	6955	0.037
5	1496	391	0.261	51	0.034
6	711	189	0.266	18	0.025
7	630	209	0.331	19	0.030
8	797	191	0.240	11	0.014
		Survey Calibration Constants			
Canadian Department of Fisheries and Oceans Survey					
1	0.277	0.046	0.166	0.004	1.307
2	0.493	0.084	0.171	0.010	0.020
3	0.897	0.147	0.163	0.009	0.010
4	0.907	0.146	0.161	0.009	0.010
5	0.916	0.157	0.171	0.009	0.010
6	0.762	0.128	0.168	0.013	0.017
7	0.797	0.136	0.171	0.015	0.019
8	0.827	0.140	0.169	0.005	0.006
National Marine Fisheries Service (NMFS) Spring Survey – Yankee 36 – 1969-72/1982-2014					
1	0.146	0.022	0.150	0.003	0.020
2	0.355	0.053	0.149	0.000	0.001
3	0.451	0.070	0.155	0.001	0.003
4	0.414	0.059	0.143	0.003	0.007
5	0.471	0.067	0.142	0.005	0.011
6	0.403	0.057	0.142	0.005	0.012
7	0.401	0.058	0.145	0.005	0.012
8	0.387	0.061	0.158	0.007	0.017
NMFS Spring Survey – Yankee 41 – 1973-81					
1	0.228	0.071	0.312	0.009	0.038
2	0.534	0.165	0.309	0.022	0.042
3	0.652	0.202	0.310	0.028	0.044
4	0.806	0.257	0.319	0.039	0.049
5	0.895	0.287	0.321	0.031	0.035
6	0.811	0.306	0.378	0.065	0.080
7	1.488	0.541	0.363	0.125	0.084
8	0.724	0.238	0.329	0.036	0.050
NMFS Fall Survey					
0	0.157	0.022	0.137	0.002	0.012
1	0.321	0.046	0.144	0.003	0.009
2	0.255	0.034	0.133	0.002	0.009
3	0.246	0.033	0.134	0.002	0.009
4	0.207	0.029	0.138	0.001	0.006
5	0.170	0.023	0.137	0.001	0.007

Shaded text has not been updated.

Table 25. Beginning of year population abundance (numbers in 000's) for eastern Georges Bank haddock during 1969-2014 from a virtual population analysis using the bootstrap bias adjusted population abundance at the beginning of 2014. Highlighted cells follow three recent large year classes, the 2000, 2003 and 2010.

Year	Age Group											
	1	2	3	4	5	6	7	8	9+	1+	2+	3+
1969	804	193	3639	872	911	7650	2497	250	776	17592	16789	16596
1970	3593	658	141	1681	479	447	3659	1299	506	12463	8870	8212
1971	235	2881	463	109	1061	256	249	1961	971	8187	7952	5071
1972	5303	192	1285	155	62	642	69	61	1340	9109	3806	3614
1973	11637	4029	157	702	63	32	441	21	728	17811	6174	2144
1974	3082	8519	1728	123	251	18	17	327	454	14517	11436	2917
1975	3448	2490	4947	1166	100	176	12	14	557	12910	9462	6973
1976	54074	2807	1787	2701	761	78	112	8	437	62765	8691	5884
1977	6038	43909	2157	1307	1463	501	64	74	348	55862	49824	5914
1978	4057	4942	28725	1706	906	922	263	52	319	41893	37836	32894
1979	52344	3317	3784	14595	1249	587	480	144	287	76785	24441	21125
1980	6238	42664	2700	2910	8084	695	300	199	301	64091	57853	15189
1981	4616	5078	19099	1901	2111	4443	396	130	352	38124	33508	28431
1982	2096	3730	3533	9569	1197	1281	2521	217	358	24501	22406	18676
1983	2553	1714	2396	1944	5278	796	708	1409	356	17155	14602	12887
1984	16098	2081	1269	1367	1094	2838	465	486	1047	26744	10646	8565
1985	1639	13115	1614	806	804	652	1312	214	821	20977	19338	6223
1986	13906	1334	8805	974	496	480	419	731	694	27841	13935	12601
1987	2188	11305	1057	4888	640	278	282	237	973	21846	19659	8354
1988	16040	1791	7383	747	2624	434	176	156	828	30178	14138	12347
1989	1021	13085	1419	4071	500	1347	255	109	674	22481	21459	8375
1990	2381	834	9565	1083	2635	281	791	178	578	18326	15945	15111
1991	2064	1921	676	6618	767	1466	164	497	542	14715	12651	10730
1992	8107	1670	1154	471	3556	548	849	71	664	17090	8983	7313
1993	12144	6593	1143	654	270	1600	368	408	496	23677	11532	4939
1994	11429	9870	5142	616	276	139	714	264	531	28981	17552	7681
1995	5723	9324	7700	3427	337	160	25	414	528	27638	21915	12591
1996	5644	4678	7563	5822	2433	228	108	18	709	27205	21561	16882
1997	16814	4618	3801	5751	3989	1615	133	72	528	37321	20507	15889
1998	8188	13740	3696	3046	4225	2830	1146	97	454	37423	29235	15495
1999	27252	6688	11074	2763	2259	2972	1913	836	409	56167	28915	22227
2000	8776	22288	5436	8388	1974	1626	2121	1336	907	52852	44077	21789
2001	75893	7179	17959	4045	5726	1379	1139	1541	1609	116470	40577	33397
2002	3670	62116	5819	13140	2832	3924	893	749	2186	95329	91659	29543
2003	2132	3003	50556	4568	9055	1977	2609	628	2043	76569	74438	71434
2004	243376	1739	2450	39738	3480	6075	1235	1705	1876	301675	58298	56559
2005	5750	198960	1401	1938	29247	2304	3628	547	2317	246092	240342	41382
2006	10551	4695	162677	1121	1385	17752	1413	2231	2088	203911	193361	188665
2007	5519	8620	3830	130917	877	874	10452	947	2901	164938	159419	150798
2008	5429	4517	7023	2972	100557	585	564	7268	2860	131776	126347	121830
2009	2794	4441	3671	5504	2192	73565	387	385	7567	100505	97711	93270
2010	4148	2272	3523	2832	3838	1559	50124	251	6116	74662	70514	68242
2011	334338	3368	1810	2532	2036	2384	933	32176	4978	384554	50216	46848
2012	50532	273513	2661	1318	1610	1461	1345	667	24743	357851	307319	33806
2013	14738	41305	223357	2022	966	1002	1040	761	18827	304018	289280	247975
2014	1546172	12045	33639	179747	1445	694	611	786	15388	1790528	244355	232310

Shaded text has not been updated.

Table 26. Fishing mortality rates for eastern Georges Bank haddock during 1969-2013 from a virtual population analysis using the bootstrap bias adjusted population abundance at the beginning of 2013. The aggregated rates are weighted by population numbers. The rates for ages 4 to 8 and 5 to 8 are also shown as exploitation rate (%). Highlighted cells follow two recent large year classes, the 2000 and 2003.

Year	Age Group												
	1	2	3	4	5	6	7	8	9+	4-8	4-8(%)	5-8	5-8(%)
1969	0.000	0.111	0.572	0.399	0.512	0.538	0.453	0.508	0.508	0.508	36.4	0.516	36.9
1970	0.021	0.152	0.057	0.261	0.425	0.383	0.424	0.377	0.538	0.377	28.7	0.410	30.7
1971	0.000	0.608	0.892	0.369	0.302	1.114	1.202	0.564	0.623	0.564	39.5	0.570	39.8
1972	0.075	0.005	0.404	0.705	0.468	0.175	0.973	0.342	0.460	0.342	26.4	0.275	21.9
1973	0.112	0.647	0.045	0.830	1.056	0.410	0.101	0.571	0.294	0.571	39.8	0.245	19.7
1974	0.013	0.343	0.193	0.000	0.154	0.181	0.015	0.103	0.164	0.103	8.9	0.124	10.6
1975	0.006	0.132	0.405	0.227	0.051	0.255	0.218	0.218	0.063	0.218	17.8	0.184	15.3
1976	0.008	0.064	0.113	0.413	0.217	0.000	0.208	0.000	0.046	0.357	27.3	0.197	16.2
1977	0.000	0.224	0.035	0.166	0.262	0.444	0.000	0.247	0.048	0.247	19.9	0.297	23.4
1978	0.002	0.067	0.477	0.112	0.235	0.452	0.405	0.244	0.033	0.244	19.7	0.349	26.9
1979	0.004	0.006	0.062	0.391	0.385	0.471	0.679	0.401	0.056	0.401	30.2	0.464	33.9
1980	0.006	0.604	0.151	0.121	0.399	0.363	0.639	0.335	0.046	0.335	26.0	0.402	30.2
1981	0.013	0.163	0.491	0.263	0.299	0.366	0.401	0.330	0.024	0.330	25.6	0.348	26.8
1982	0.001	0.242	0.398	0.395	0.208	0.393	0.382	0.377	0.224	0.377	28.7	0.344	26.6
1983	0.005	0.101	0.361	0.375	0.420	0.338	0.176	0.383	0.114	0.383	29.0	0.385	29.1
1984	0.005	0.054	0.254	0.330	0.317	0.572	0.577	0.467	0.405	0.467	34.1	0.505	36.2
1985	0.006	0.198	0.305	0.285	0.316	0.242	0.384	0.320	0.170	0.320	25.0	0.330	25.6
1986	0.007	0.033	0.389	0.221	0.379	0.333	0.372	0.303	0.069	0.303	23.8	0.341	26.4
1987	0.000	0.226	0.147	0.422	0.189	0.259	0.391	0.389	0.135	0.389	29.4	0.275	21.9
1988	0.004	0.033	0.395	0.201	0.467	0.331	0.277	0.394	0.143	0.394	29.7	0.436	32.3
1989	0.002	0.113	0.070	0.235	0.378	0.332	0.158	0.265	0.079	0.265	21.2	0.319	24.9
1990	0.014	0.010	0.168	0.145	0.386	0.335	0.266	0.309	0.085	0.309	24.2	0.355	27.2
1991	0.012	0.310	0.161	0.421	0.137	0.346	0.646	0.389	0.132	0.389	29.4	0.315	24.6
1992	0.007	0.179	0.367	0.356	0.599	0.198	0.531	0.527	0.164	0.527	37.4	0.543	38.3
1993	0.007	0.049	0.419	0.665	0.462	0.607	0.132	0.546	0.185	0.546	38.5	0.517	36.9
1994	0.003	0.048	0.206	0.401	0.344	1.509	0.345	0.458	0.105	0.458	33.6	0.483	35.0
1995	0.002	0.009	0.079	0.143	0.190	0.191	0.119	0.149	0.035	0.149	12.5	0.170	14.2
1996	0.001	0.008	0.074	0.178	0.210	0.342	0.201	0.192	0.119	0.192	15.9	0.220	18.0
1997	0.002	0.023	0.021	0.108	0.143	0.143	0.111	0.125	0.073	0.125	10.7	0.142	12.0
1998	0.002	0.016	0.091	0.099	0.152	0.191	0.116	0.144	0.088	0.144	12.2	0.160	13.5
1999	0.001	0.007	0.078	0.136	0.129	0.137	0.159	0.139	0.071	0.139	11.8	0.140	11.9
2000	0.001	0.016	0.095	0.182	0.159	0.155	0.119	0.166	0.085	0.166	13.9	0.148	12.5
2001	0.000	0.010	0.112	0.157	0.178	0.235	0.219	0.181	0.151	0.181	15.1	0.191	15.8
2002	0.000	0.006	0.042	0.172	0.159	0.208	0.152	0.176	0.157	0.176	14.7	0.183	15.2
2003	0.004	0.004	0.041	0.072	0.199	0.270	0.225	0.214	0.135	0.180	15.0	0.214	17.6
2004	0.002	0.016	0.034	0.106	0.212	0.315	0.613	0.316	0.167	0.157	13.2	0.316	24.7
2005	0.003	0.001	0.023	0.136	0.299	0.288	0.286	0.297	0.078	0.289	22.8	0.297	23.4
2006	0.002	0.004	0.017	0.045	0.260	0.329	0.200	0.316	0.085	0.303	23.8	0.316	24.7
2007	0.000	0.005	0.053	0.064	0.204	0.237	0.163	0.171	0.073	0.073	6.4	0.171	14.3
2008	0.001	0.007	0.044	0.104	0.112	0.213	0.181	0.113	0.037	0.113	9.7	0.113	9.7
2009	0.007	0.031	0.058	0.160	0.140	0.183	0.231	0.182	0.057	0.180	15.0	0.182	15.1
2010	0.008	0.027	0.128	0.127	0.275	0.311	0.242	0.246	0.038	0.240	19.4	0.246	19.8
2011	0.001	0.034	0.112	0.246	0.127	0.370	0.134	0.237	0.017	0.237	19.2	0.237	19.2
2012	0.001	0.002	0.071	0.106	0.261	0.134	0.364	0.254	0.095	0.221	18.0	0.251	20.2
2013	0.002	0.005	0.016	0.128	0.123	0.269	0.076	0.163	0.036	0.147	12.4	0.157	13.2

Shaded text has not been updated.

Table 27. Beginning of year biomass (mt) for eastern Georges Bank haddock during 1969-2014. Weights at age from the DFO survey were applied to the virtual population analysis bootstrap bias adjusted population numbers at age at the beginning of 2013 to determine biomass. Highlighted cells follow two recent large year classes, the 2000, 2003 and 2010.

Year	Age Group											
	1	2	3	4	5	6	7	8	9+	1+	2+	3+
1969	92	99	3402	1311	1816	17938	6702	733	2674	34768	34676	34577
1970	413	339	132	2528	954	1048	9823	3805	1743	20784	20371	20032
1971	27	1483	433	164	2113	600	670	5745	3346	14580	14553	13071
1972	610	99	1201	234	123	1506	185	180	4616	8752	8143	8044
1973	1338	2073	146	1056	125	74	1185	62	2509	8569	7231	5158
1974	354	4383	1615	184	499	42	46	956	1565	9646	9292	4909
1975	396	1281	4626	1754	200	412	33	41	1918	10660	10264	8983
1976	6216	1444	1671	4062	1516	183	299	24	1507	16921	10705	9261
1977	694	22593	2016	1965	2915	1175	171	217	1200	32947	32253	9661
1978	466	2543	26856	2565	1805	2162	706	153	1100	38358	37892	35348
1979	6017	1706	3538	21949	2489	1375	1289	421	987	39772	33754	32048
1980	717	21952	2524	4377	16107	1631	805	584	1036	49732	49015	27063
1981	531	2613	17856	2859	4205	10417	1063	380	1212	41135	40605	37992
1982	241	1919	3303	14390	2385	3004	6768	636	1232	33879	33638	31719
1983	293	882	2240	2923	10517	1866	1902	4127	1226	25976	25683	24801
1984	1851	1071	1186	2056	2179	6655	1247	1424	3606	21275	19424	18354
1985	188	6748	1509	1212	1603	1530	3521	626	2830	19765	19577	12829
1986	1872	602	8579	1407	1510	1367	1509	2469	2720	22036	20164	19562
1987	329	5647	757	8175	1287	709	886	746	3530	22066	21738	16090
1988	1560	832	6870	1341	4766	832	479	509	3204	20392	18832	18000
1989	63	6204	922	5669	998	3404	550	312	2116	20237	20174	13970
1990	355	437	8840	1280	4906	582	1984	502	2006	20892	20537	20100
1991	247	1316	541	10004	1301	3568	346	1550	1860	20731	20484	19169
1992	991	1006	1290	500	7391	1186	2299	161	2285	17109	16118	15112
1993	1481	3172	1402	1180	344	3732	862	1119	1625	14918	13437	10265
1994	1219	4631	5383	998	531	300	2251	710	1637	17660	16441	11810
1995	493	4601	7415	5333	750	391	61	1237	1681	21963	21469	16868
1996	782	2315	6950	7686	4699	584	314	48	2546	25924	25142	22827
1997	2222	2339	2971	6931	6638	3514	326	187	1667	26796	24573	22235
1998	879	7356	3826	3538	6633	5529	2991	347	1572	32670	31791	24435
1999	3533	3168	10086	3563	2844	5555	4077	2274	1225	36325	32792	29624
2000	1016	12110	5157	12401	3693	2909	4875	3350	2633	48145	47129	35019
2001	7085	3759	18054	5546	10293	2985	2564	3997	4710	58993	51908	48149
2002	351	20596	4527	14950	4231	7711	1943	1653	5918	61879	61528	40932
2003	171	1109	42774	4855	13375	3252	5761	1399	5081	77777	77605	76496
2004	15551	539	1915	45748	4545	9466	2004	3335	4156	87259	71708	71169
2005	160	43324	690	1350	35860	3044	5554	876	5663	96521	96361	53037
2006	619	804	63259	737	1205	24249	2248	3885	4917	101923	101304	100501
2007	422	2116	1551	92826	870	1525	16299	1582	5401	122592	122170	120053
2008	581	1486	4026	2362	93246	734	976	10724	5424	119559	118978	117492
2009	319	1718	2845	5497	2163	92553	574	1032	16859	123560	123242	121523
2010	301	875	2638	2718	4300	1882	66799	445	12638	92595	92294	91420
2011	12852	1084	1108	2277	1940	2427	1045	44107	8568	75408	62557	61473
2012	3554	50829	1217	667	1605	1614	1458	794	33294	95031	91477	40648
2013	1032	10786	92095	1596	1054	974	1144	869	27434	136983	135952	125165
2014	65000	3891	18059	116506	1317	842	742	749	22040	229147	164147	160256

Shaded text has not been updated.

Table 28. Partial recruitment of haddock normalized to ages 4 to 8 for 1969 to 2002 and to ages 5 to 8 for 2003 to 2013 from the eastern Georges Bank Canadian commercial fishery. Average F's used to normalize the partial recruitment were weighted by population numbers. [1]Weighted by population.

	Age Group								
Year	1	2	3	4	5	6	7	8	9+
1969	0.00	0.22	1.13	0.79	1.01	1.06	0.89	1.00	1.00
1970	0.05	0.40	0.15	0.69	1.13	1.02	1.12	1.00	1.43
1971		1.08	1.58	0.65	0.53	1.97	2.13	1.00	1.10
1972	0.22	0.01	1.18	2.06	1.37	0.51	2.84	1.00	1.34
1973	0.20	1.13	0.08	1.45	1.85	0.72	0.18	1.00	0.51
1974	0.11	2.78	1.56		1.24	1.46	0.12	0.83	1.33
1975	0.03	0.60	1.85	1.04	0.24	1.17	1.00	1.00	0.29
1976	0.02	0.17	0.31	1.13	0.59		0.57		0.13
1977	0.00	0.91	0.14	0.67	1.06	1.80	0.00	1.00	0.19
1978	0.01	0.28	1.95	0.46	0.96	1.85	1.66	1.00	0.14
1979	0.01	0.01	0.16	0.97	0.96	1.17	1.69	1.00	0.14
1980	0.02	1.80	0.45	0.36	1.19	1.08	1.91	1.00	0.14
1981	0.04	0.49	1.49	0.80	0.91	1.11	1.22	1.00	0.07
1982	0.00	0.64	1.05	1.05	0.55	1.04	1.01	1.00	0.60
1983	0.01	0.26	0.94	0.98	1.10	0.88	0.46	1.00	0.30
1984	0.01	0.12	0.54	0.71	0.68	1.23	1.24	1.00	0.87
1985	0.02	0.62	0.95	0.89	0.99	0.76	1.20	1.00	0.53
1986	0.02	0.11	1.28	0.73	1.25	1.10	1.23	1.00	0.23
1987	0.00	0.58	0.38	1.09	0.49	0.67	1.01	1.00	0.35
1988	0.01	0.08	1.00	0.51	1.19	0.84	0.70	1.00	0.36
1989	0.01	0.43	0.26	0.89	1.43	1.25	0.60	1.00	0.30
1990	0.05	0.03	0.54	0.47	1.25	1.08	0.86	1.00	0.27
1991	0.03	0.80	0.41	1.08	0.35	0.89	1.66	1.00	0.34
1992	0.01	0.34	0.70	0.68	1.14	0.38	1.01	1.00	0.31
1993	0.01	0.09	0.77	1.22	0.85	1.11	0.24	1.00	0.34
1994	0.01	0.11	0.45	0.88	0.75	3.29	0.75	1.00	0.23
1995	0.01	0.06	0.53	0.96	1.28	1.28	0.80	1.00	0.23
1996	0.00	0.04	0.39	0.93	1.09	1.78	1.05	1.00	0.62
1997	0.01	0.18	0.17	0.86	1.14	1.14	0.89	1.00	0.59
1998	0.02	0.11	0.63	0.69	1.06	1.33	0.81	1.00	0.61
1999	0.01	0.05	0.56	0.98	0.93	0.99	1.14	1.00	0.51
2000	0.00	0.10	0.57	1.09	0.96	0.93	0.72	1.00	0.51
2001	0.00	0.06	0.62	0.86	0.98	1.30	1.21	1.00	0.83
2002	0.00	0.03	0.24	0.98	0.90	1.18	0.86	1.00	0.89
2003	0.016	0.02	0.19	0.34	0.93	1.26	1.05	1.00	0.63
2004	0.005	0.05	0.11	0.34	0.67	1.00	1.94	1.00	0.53
2005	0.009	0.004	0.08	0.46	1.01	0.97	0.96	1.00	0.26
2006	0.006	0.01	0.05	0.14	0.82	1.04	0.63	1.00	0.27
2007	0.002	0.03	0.31	0.37	1.19	1.38	0.95	1.00	0.43
2008	0.008	0.06	0.39	0.92	0.99	1.88	1.60	1.00	0.33
2009	0.036	0.17	0.32	0.88	0.77	1.01	1.27	1.00	0.31
2010	0.033	0.11	0.52	0.52	1.12	1.26	0.98	1.00	0.16
2011	0.003	0.14	0.47	1.04	0.54	1.56	0.57	1.00	0.07
2012	0.006	0.01	0.28	0.42	1.04	0.54	1.45	1.01	0.38
2013	0.010	0.03	0.10	0.82	0.78	1.72	0.48	1.04	0.23
Avg 1998-02[1]	0.004	0.06	0.55	0.97	0.98	1.15	0.94	1.00	0.76
Avg 2009-13[1]	0.004	0.02	0.12	0.78	0.89	1.03	0.98	1.00	0.28
Avg 2011-13[1]	0.004	0.01	0.11	0.82	0.76	1.28	0.90	1.00	0.29
Avg 2003-13[1]	0.005	0.01	0.11	0.40	0.98	1.04	0.99	1.00	0.30

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Table 29. Input for projections and risk analyses of eastern Georges Bank haddock for the 2015 fishery. A catch of 27,000 mt in 2014 and natural mortality = 0.2 were assumed for the forecasts. The 2010 and 2013 year classes are highlighted.

Year	Age Group								
	1	2	3	4	5	6	7	8	9+
Population Numbers (000s)									
2014	1546172	12045	33639	179747	1445	694	611	786	15388
Partial Recruitment to the Fishery[1]									
2014	0.005	0.01	0.11	0.37[2]	1	1	1	1	0.3
2015	0.005	0.01	0.11	0.37[2]	1	1	1	1	0.3
Weight at beginning of year for population (kg)[3]									
2014	0.04[4]	0.32[4]	0.54[4]	0.65[4]	0.91[4]	1.21[4]	1.21[4]	0.95[4]	1.43[4]
2015	0.06	0.19[5]	0.47	0.89[6]	0.93[7]	1.1	1.13	1.1	1.41
2016	0.06	0.26	0.41[5]	0.65	1.01[6]	1.26[7]	1.13	1.1	1.41
Weight at age for catch (kg)[8]									
2014	0.35[9]	0.78	1.01[10]	1.19[11]	1.29	1.37	1.5	1.58	1.84
2015	0.31	0.65[9]	0.97	1.23[10]	1.39[11]	1.37	1.5	1.58	1.84
Maturity									
2014	0	0	1	1	1	1	1	1	1
2015	0	0	1	1	1	1	1	1	1

[1]Based on 2003 to 2013 weighted average except where indicated and ages 5 to 8 assumed fully recruited.
[2]Based on observed values from 2003 year class.
[3]2012-2014 average weights at age from the Canadian Department of Fisheries and Oceans (DFO) survey unless indicated otherwise.
[4]2014 average weights at age from DFO survey.
[5]2010 year class average weights at age from DFO survey used for 2013 year class.
[6]Average of 2005 and 2009 year class average weights at age from DFO survey used for 2011 year class.
[7]2003 year class average weights at age from DFO survey used for 2010 year class.
[8]2011 to 2013 average weights at age from Canadian/USA landings except where indicated.
[9]2010 year class average weights at age from Canadian/USA landings used for 2013 year class..
[10]2005 and 2009 year class average weights at age from Canadian/USA landings used for 2011 year class.
[11]2003 year class average weights at age from Canadian/USA landings used for 2010 year class.

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Table 30. Bias adjusted deterministic projection results for eastern Georges Bank haddock for the 2015 fishery using 11.2 million age 1 recruits (2003 to 2013 median from 2013 assessment results) for the 2014 and 2015 year classes, the input values detailed in Table 29 and assuming that the 2014 quota of 27,000 mt is caught. Natural mortality was assumed to be 0.2. Highlighted values indicate the 2013 and 2010 year classes.

Year	Age Group											
	1	2	3	4	5	6	7	8	9+	1+	2+	3+
Population Numbers (000s)												
2014	1546172	12045	33639	179747	1445	694	611	786	15388	1790527	244355	232310
2015	11177	1263883	9830	26593	130795	860	413	364	11918	1455833	1444656	180773
2016	11177	9139	1032093	7821	19775	82569	543	261	9255	1172633	1161456	1152317
Population Biomass (mt)												
2014	65000	3891	18059	116506	1317	842	742	749	22040	229147	164147	160256
2015	682	235082	4610	23774	121247	944	468	399	16828	404033	403352	168269
2016	682	2349	425222	5068	20032	103871	615	285	13068	571194	570512	568163
Fishing mortality												
2014	0.002	0.003	0.035	0.118	0.319	0.319	0.319	0.319	0.096			
2015	0.001	0.003	0.029	0.096	0.26	0.26	0.26	0.26	0.078			
Projected Catch Numbers (000s)												
2014	2231	35	1051	18157	359	172	152	195	1274	23626	21395	21360
2015	13	2975	251	2214	27258	179	86	76	812	33864	33851	30876
Catch Biomass (mt)												
2014	772	27	1067	21552	465	236	228	309	2345	27000	26228	26201
2015	4	1922	243	2726	37889	245	129	120	1494	44771	44767	42845

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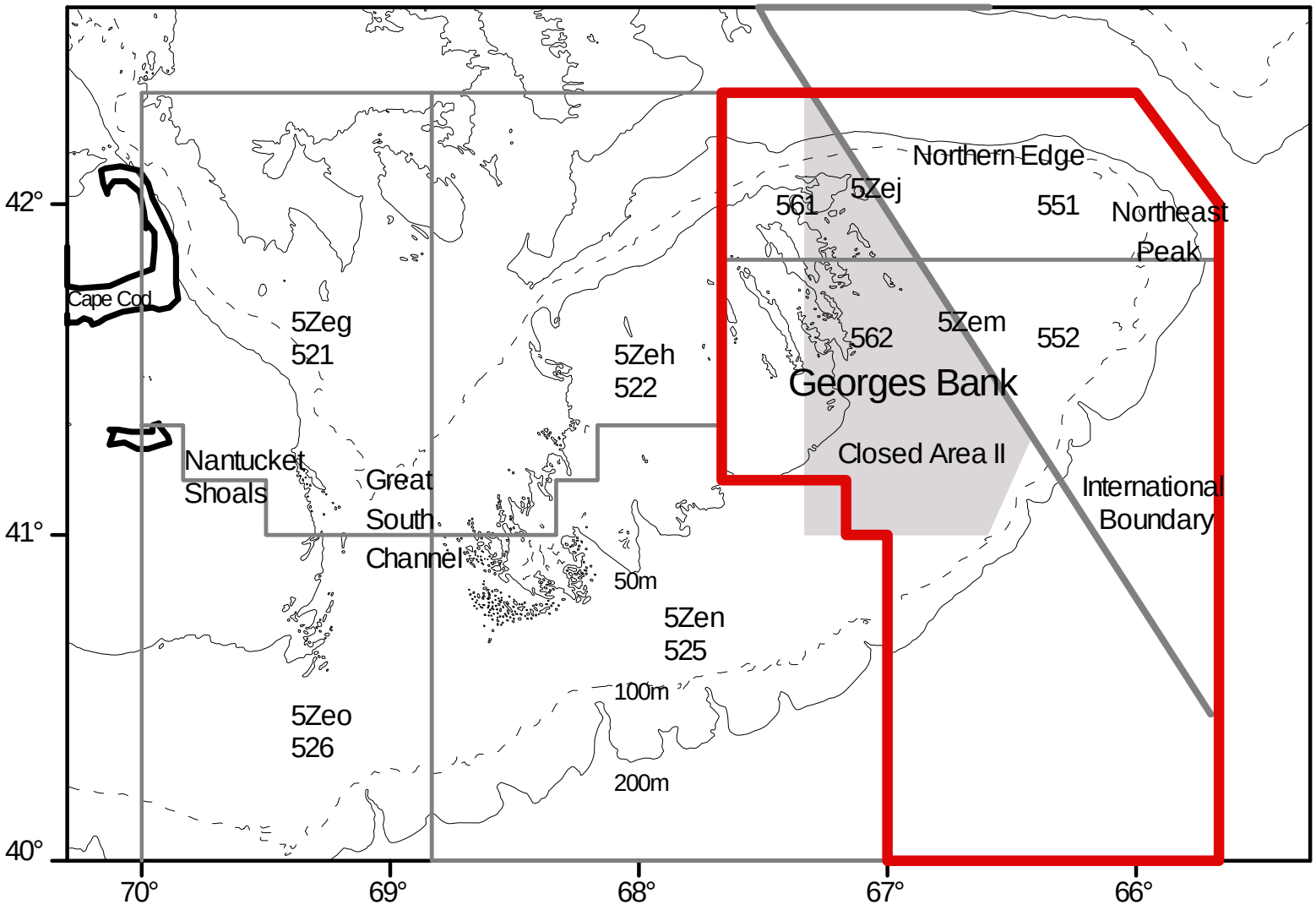

Figure 1. Fisheries statistical unit areas in North Atlantic Fisheries Organization Subdivision 5Ze. Alpha-numeric codes, e.g. 5Zej, are the Canadian Department of Fisheries and Oceans designations and numeric codes, e.g. 561, are National Marine Fisheries Service designations. The eastern Georges Bank management unit is outlined by a heavy red line..

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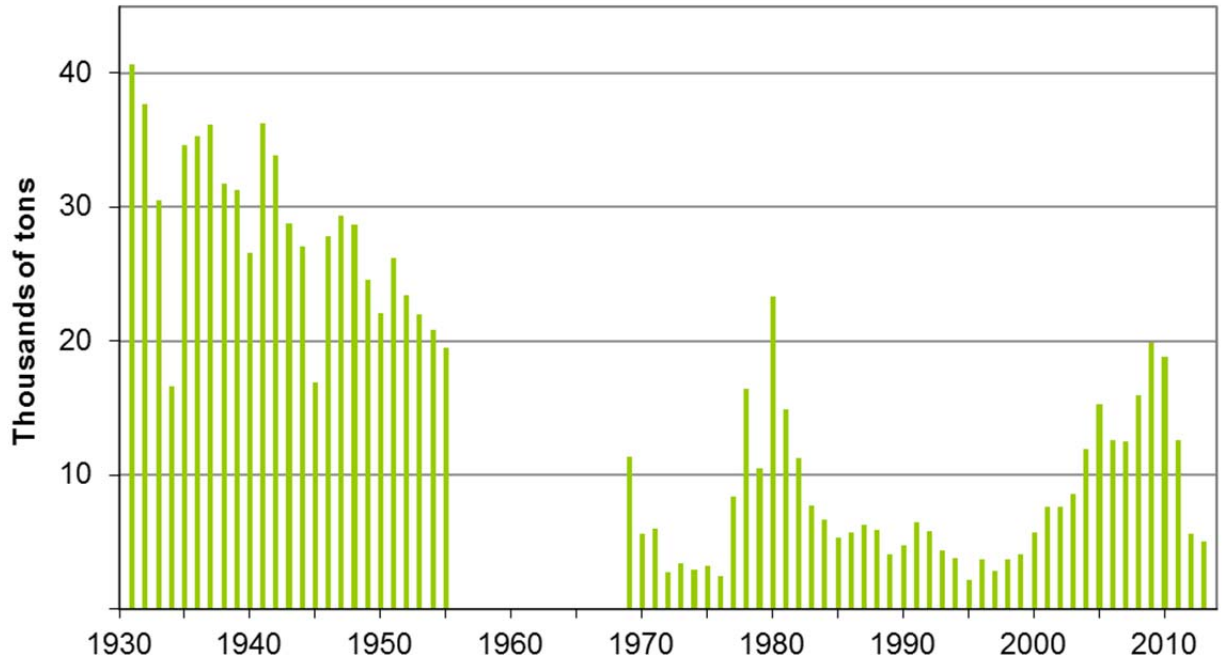

Figure 2. Historical catch of eastern Georges Bank haddock during 1931-1955 (Gavaris and Van Eeckhaute 1997) compared to recent catches during 1969-2013. Catch data for 1956 to 1968 were not available by unit area.

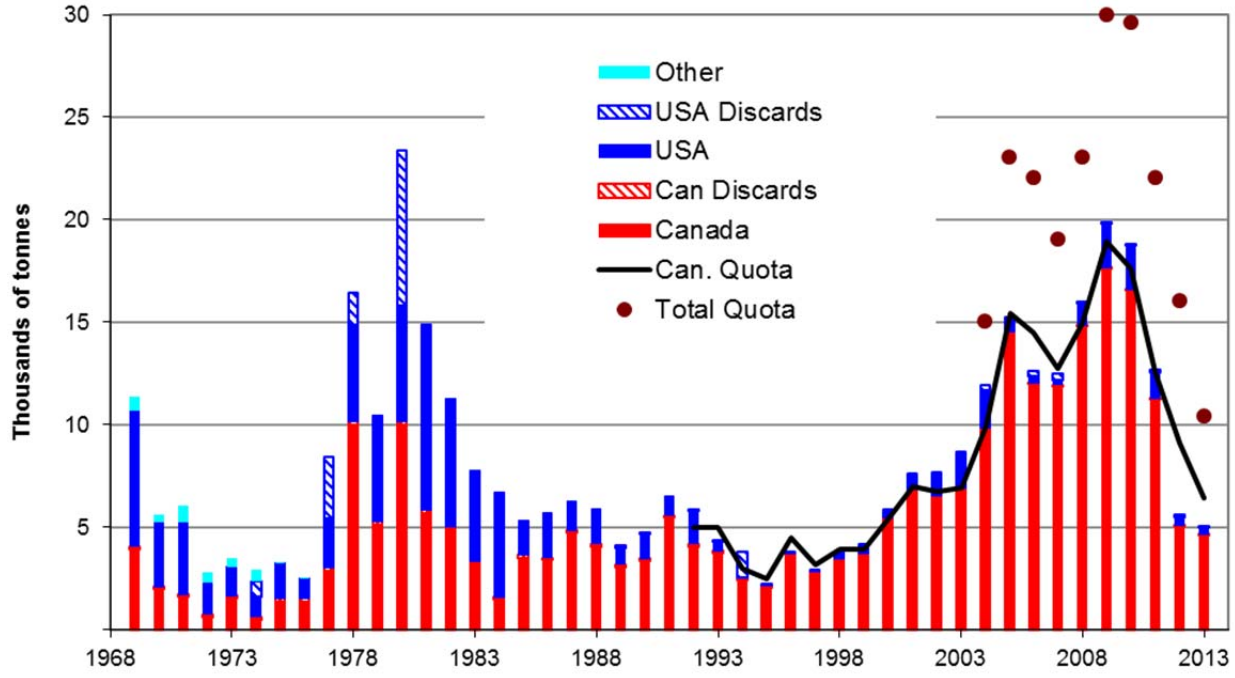

Figure 3. Nominal catches of eastern Georges Bank haddock during 1969-2013.

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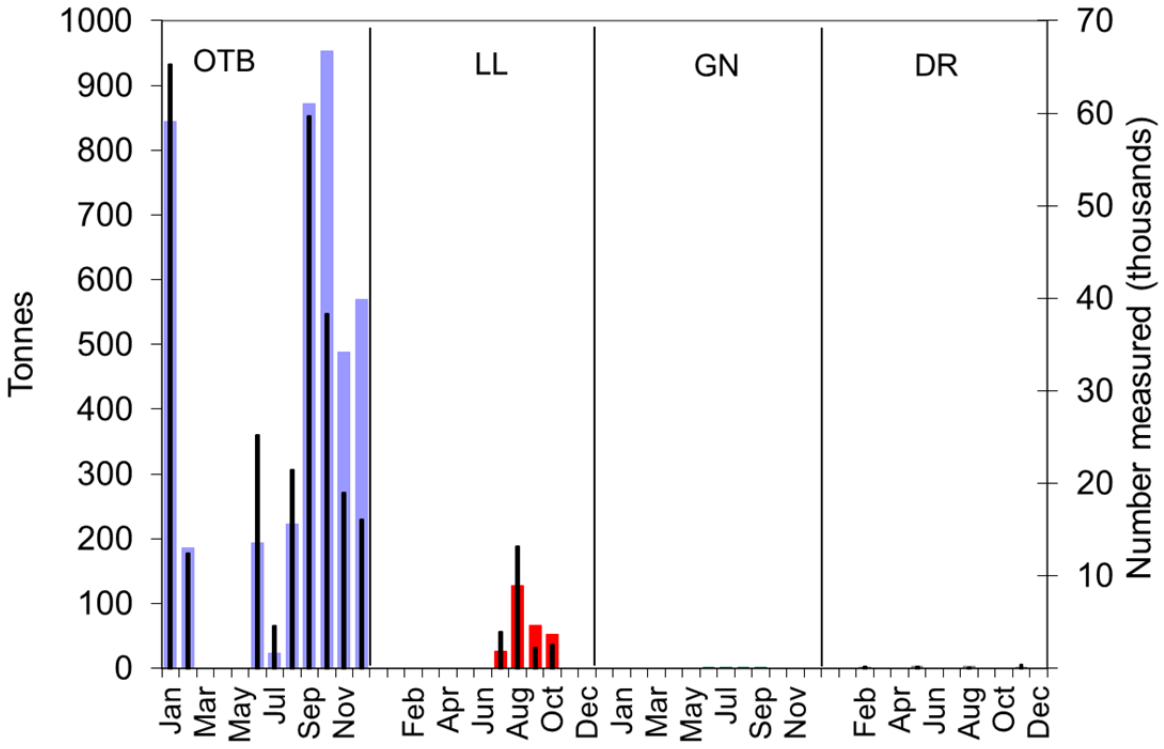

Figure 4. Haddock landings by the Canadian commercial groundfish fishery and discards from the scallop fishery from eastern Georges Bank by month and gear in 2013 (wide bars) with sampling levels (narrow bars). Landings from the gillnet fishery were very low and no samples were available. OTB=otter trawl bottom, LL= longline, GN=gill net, DR=scallop dredge.

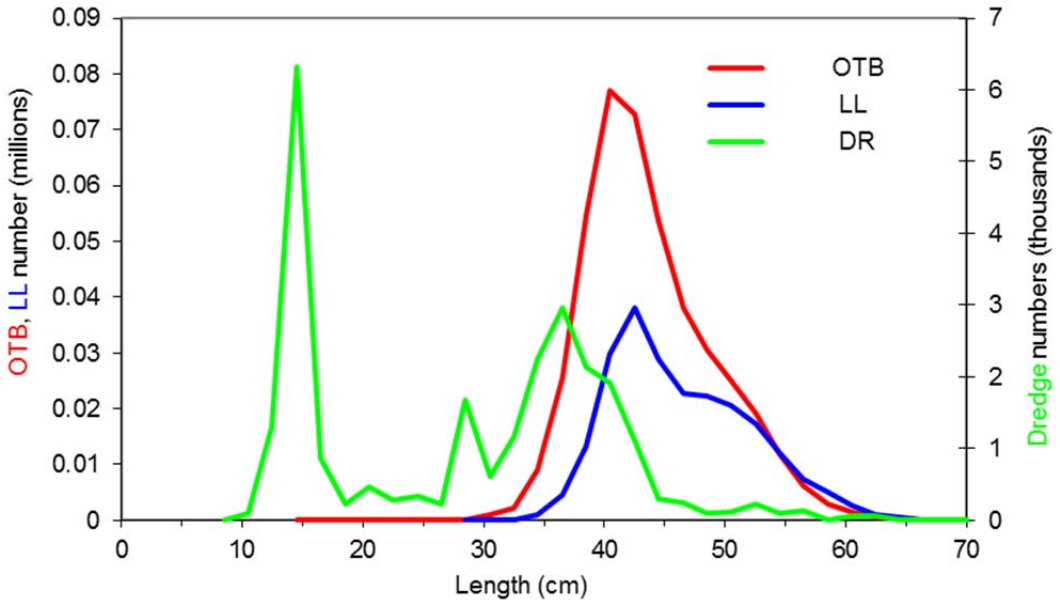

Figure 5. Haddock numbers at length landed by components of the Canadian commercial groundfish fisheries and haddock discards at length from the Canadian scallop fishery on eastern Georges Bank in 2013. The scallop dredge length frequencies are expanded according to the axis on the right. OTB=otter trawl bottom, LL=longline, DR=scallop dredge. Landings and sampling from the gillnet fishery were very low.

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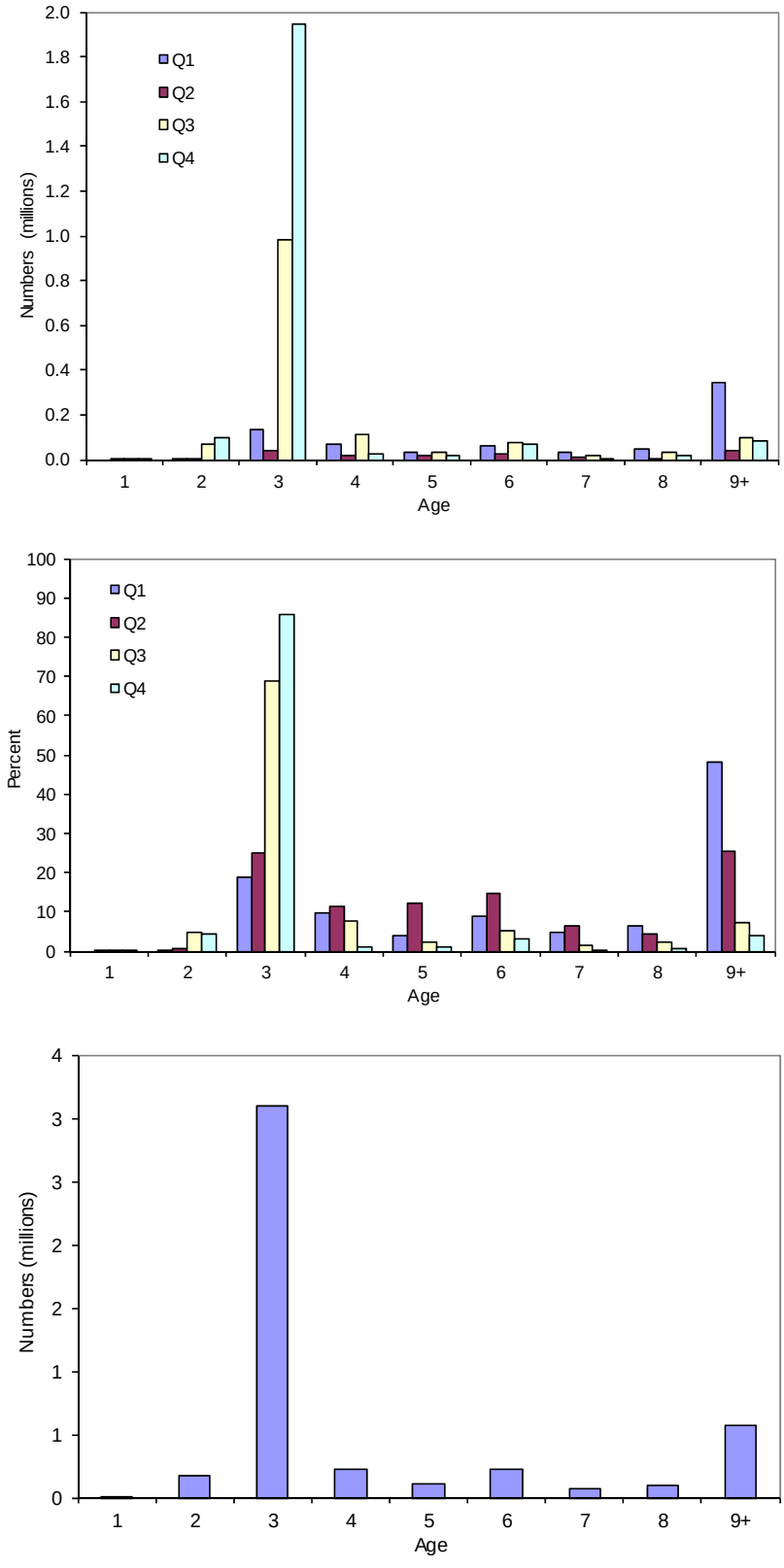

Figure 6. Numbers (top panel) and percent (middle panel) of haddock landings at age by quarter and numbers for the year by the Canadian groundfish fishery on eastern Georges Bank in 2013.

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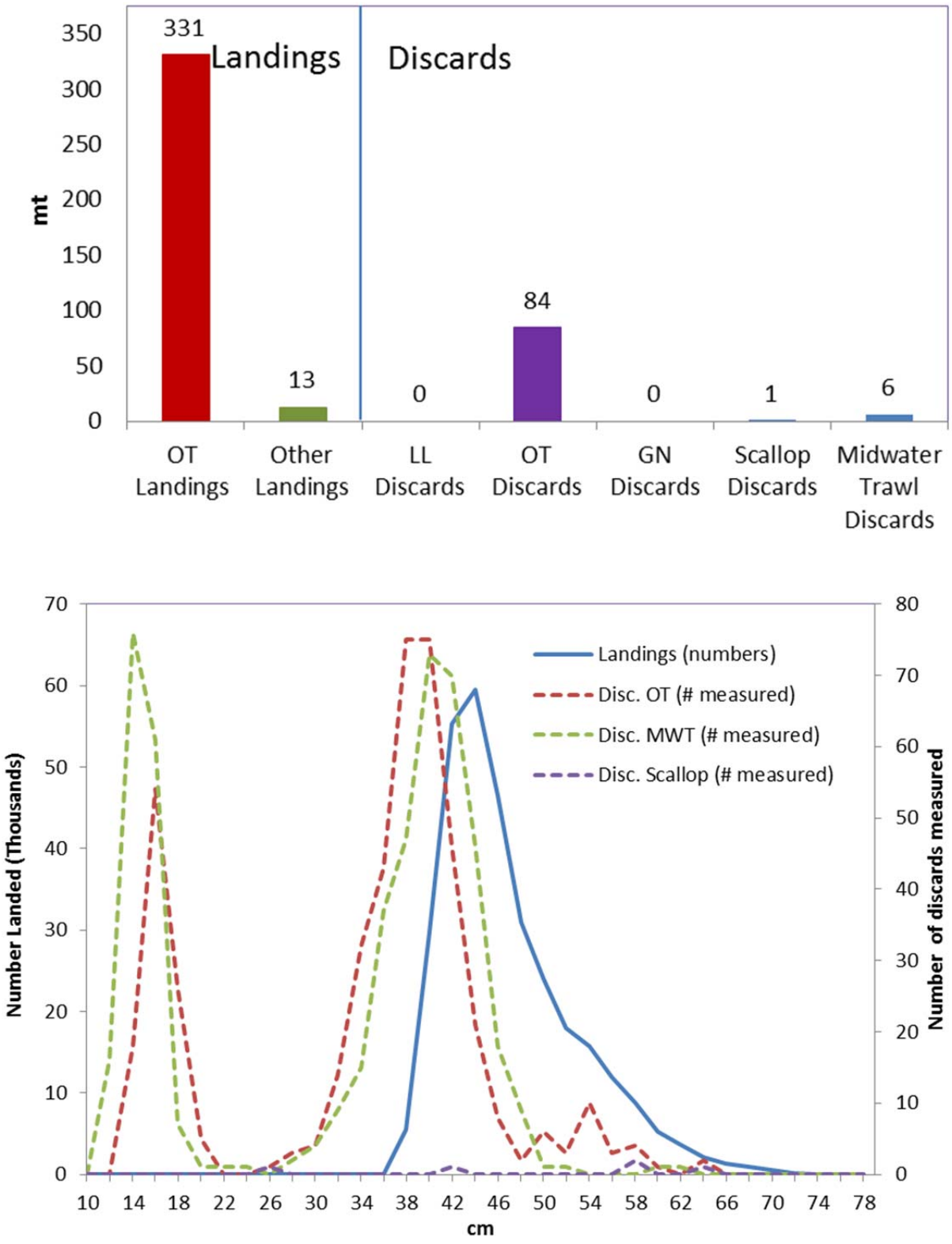

Figure 7. Haddock landings and discards by gear in metric tonnes (upper) and length composition (lower; total numbers for landings and numbers measured for discards) by the United States from eastern Georges Bank in 2013.

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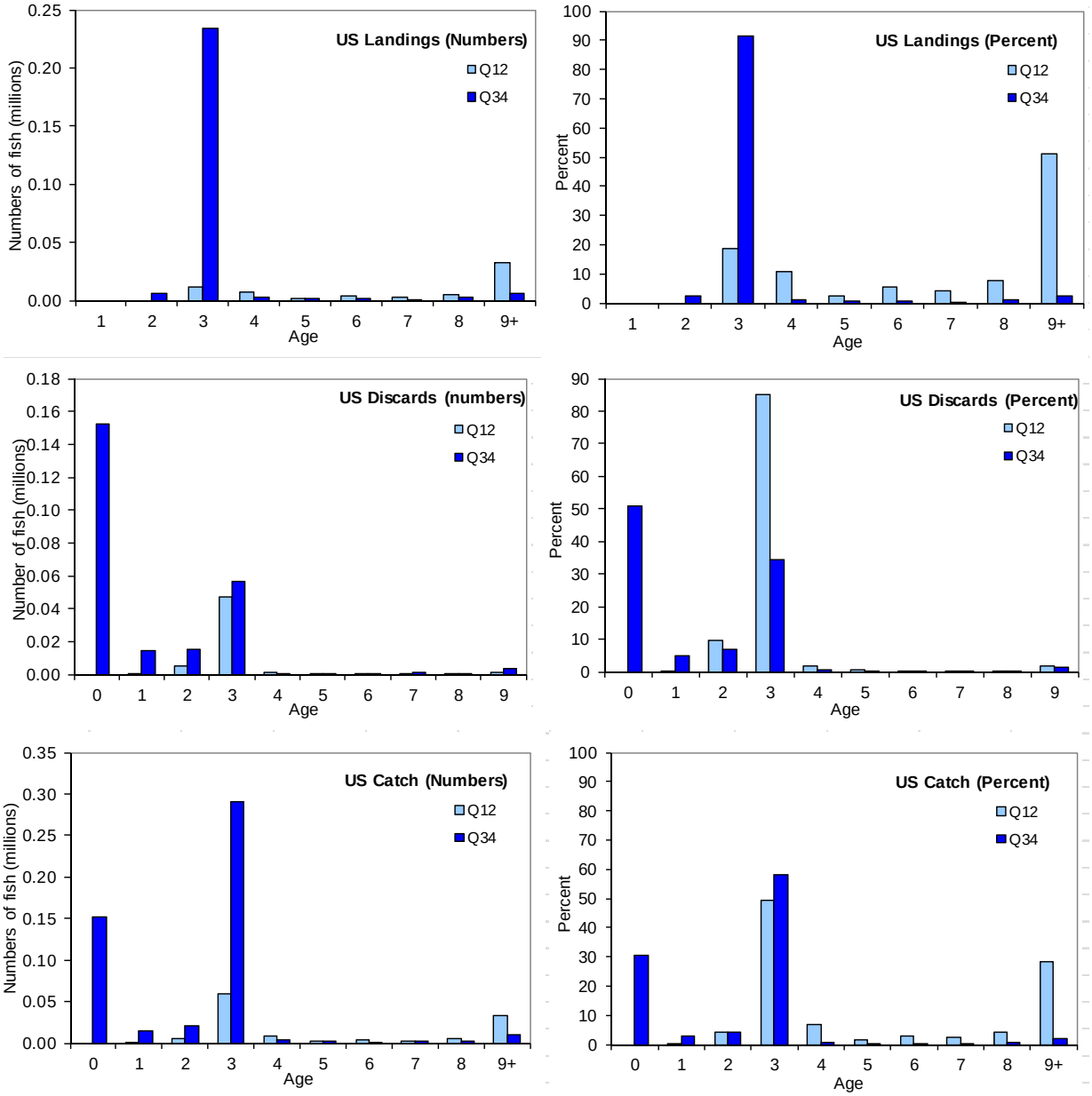

Figure 8. Haddock landings and discards at age in numbers and percent by half year from the USA eastern Georges Bank groundfish fisheries in 2013.

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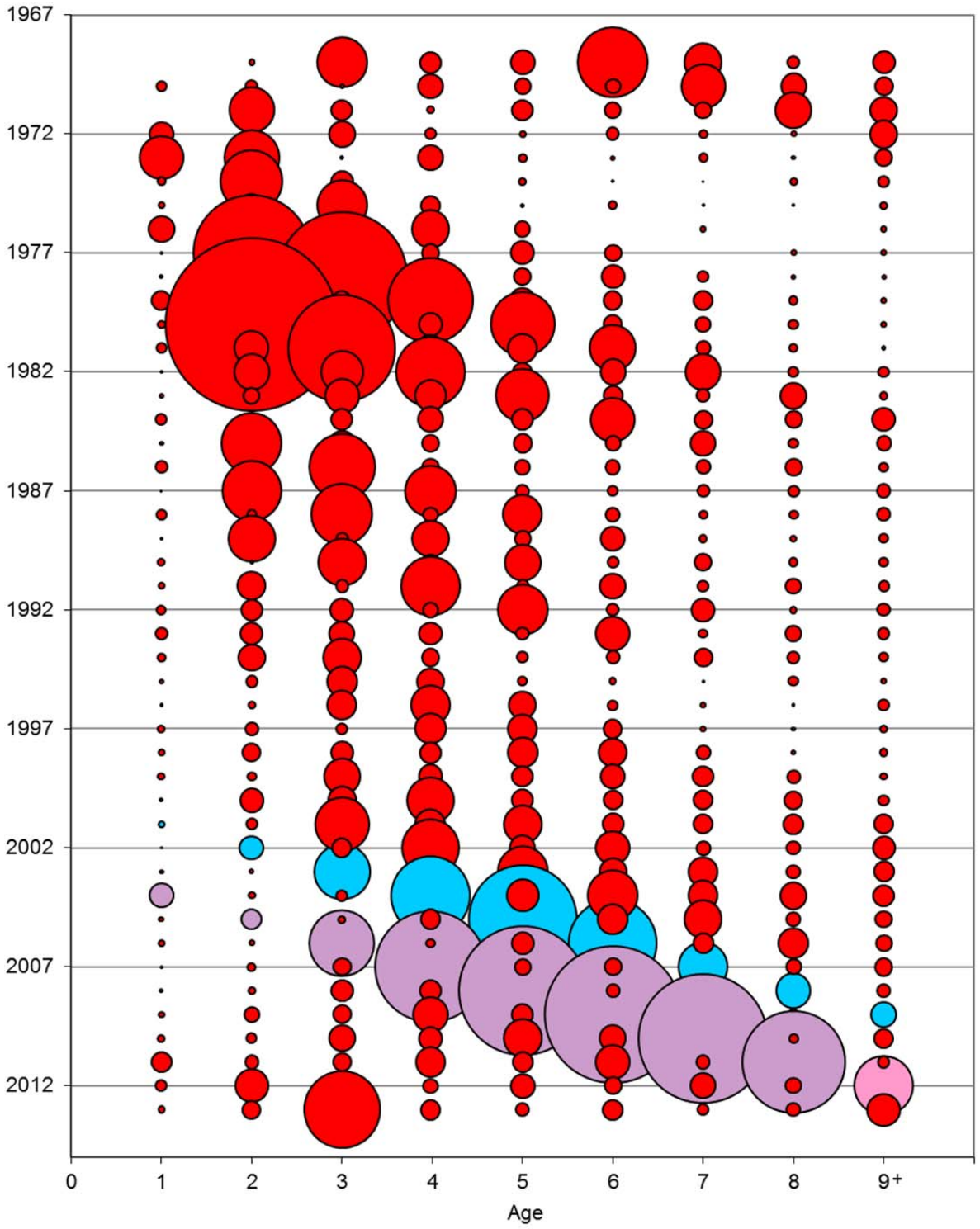

Figure 9. Total commercial catch at age (numbers) of eastern Georges Bank haddock during 1969-2013. The 2000 and 2003 year classes are indicated in blue and purple, respectiviely. The bubble area is proportional to catch magnitude.

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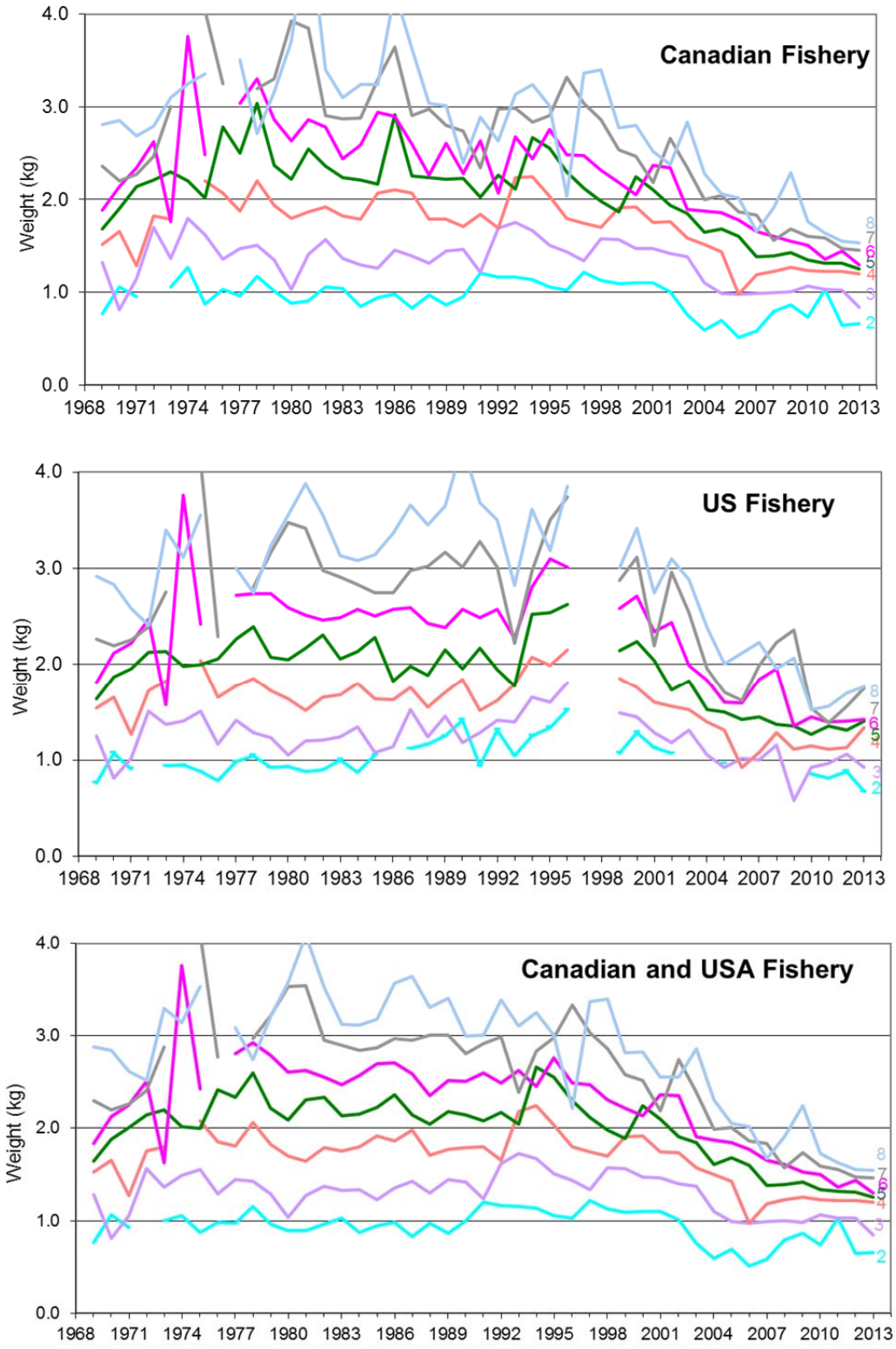

Figure 10. Average weights at age for eastern Georges Bank haddock from the Canadian, USA and combined commercial groundfish fishery during 1969-2013. From 1969 to 1973 only USA fishery sampling for lengths and ages was available. Between 1974 and 1984 a mix of USA and Canadian samples was used (Gavaris and Van Eeckhaute 1990).

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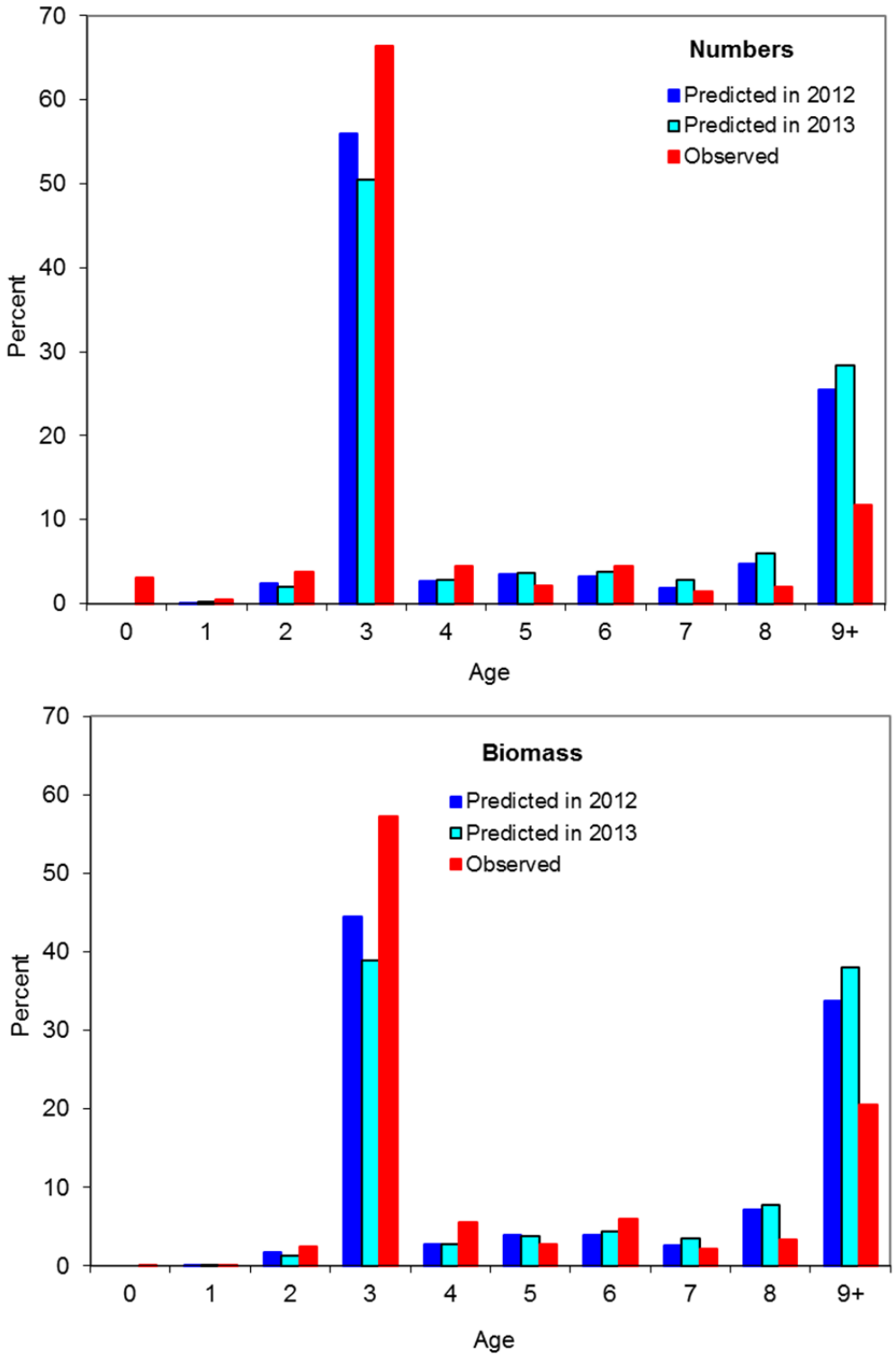

Figure 11. Percent compostion in numbers and biomass of 2013 observed eastern Georges Bank haddock landings projected in 2012, upon which the quota was based, and in 2013.

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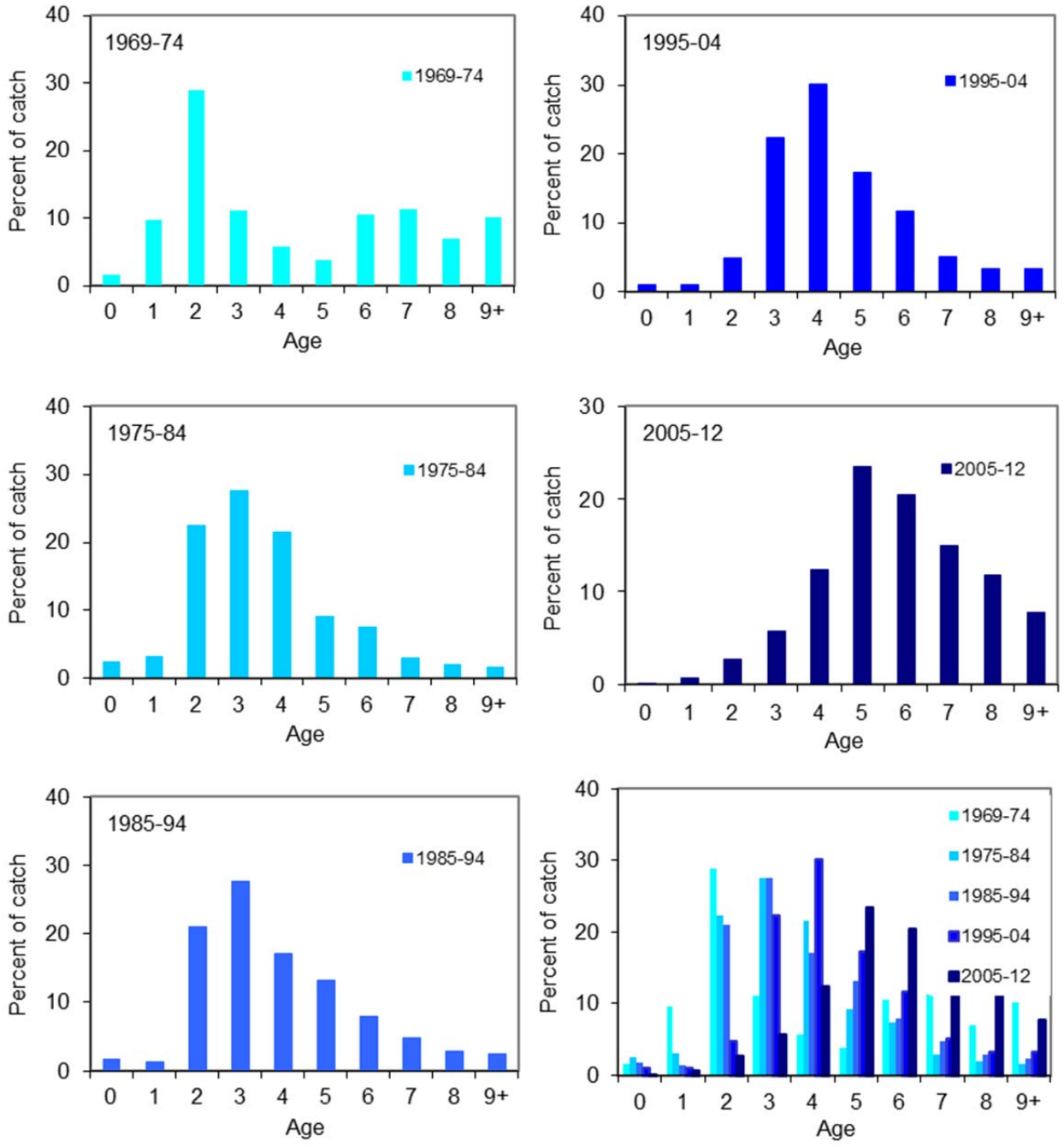

Figure 12. Age composition of the haddock catch for the eastern Georges Bank commercial fishery during 1969-1974, 1975-1984, 1985-1994, 1995-2004, and 2005-2012. Note: This figure not updated.

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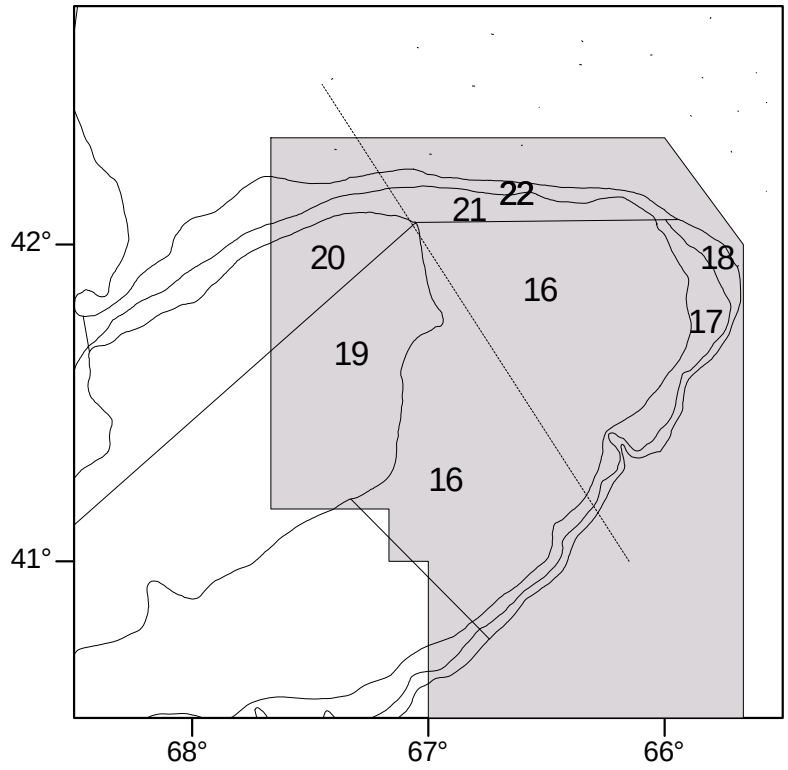

Figure 13. Stratification scheme used for National Marine Fisheries Service surveys. The eastern Georges Bank management area is indicated by shading.

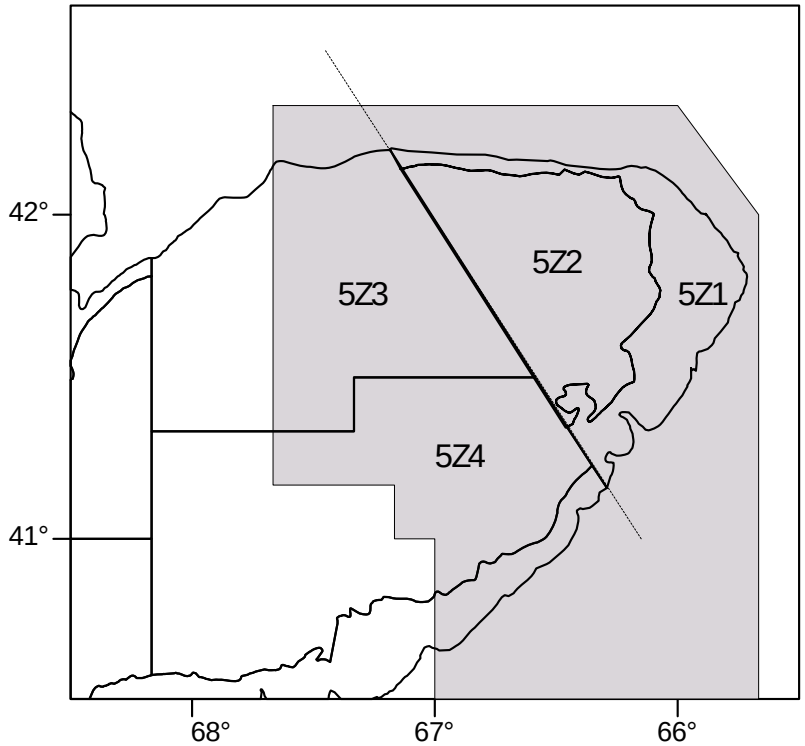

Figure 14. Stratification scheme used for the Canadian Department of Fisheries and Oceans survey. The eastern Georges Bank management area is indicated by shading.

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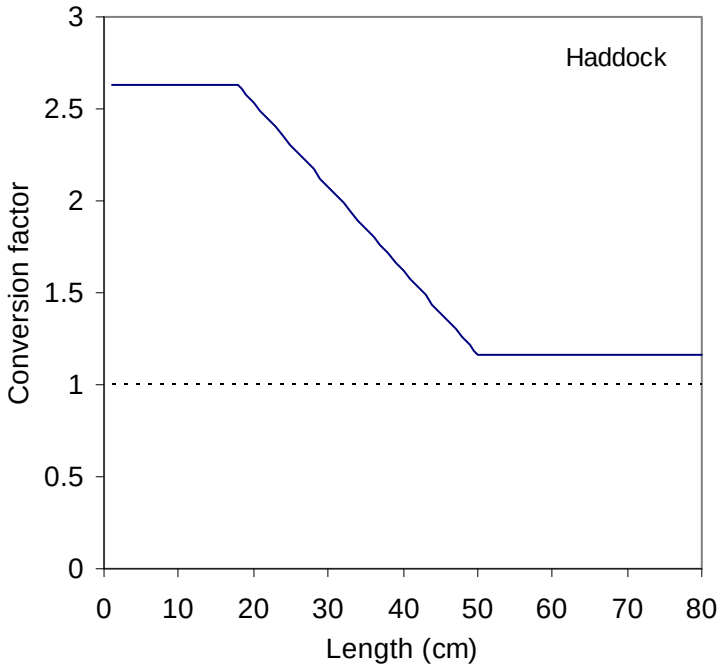

Figure 15. Conversion factors for NMFS surveys conducted by the *Henry B. Bigelow* since 2009. Factors are applied by dividing the *Bigelow* catch at length by the length specific conversion factor to make them equivalent to *Albatross IV* catches.

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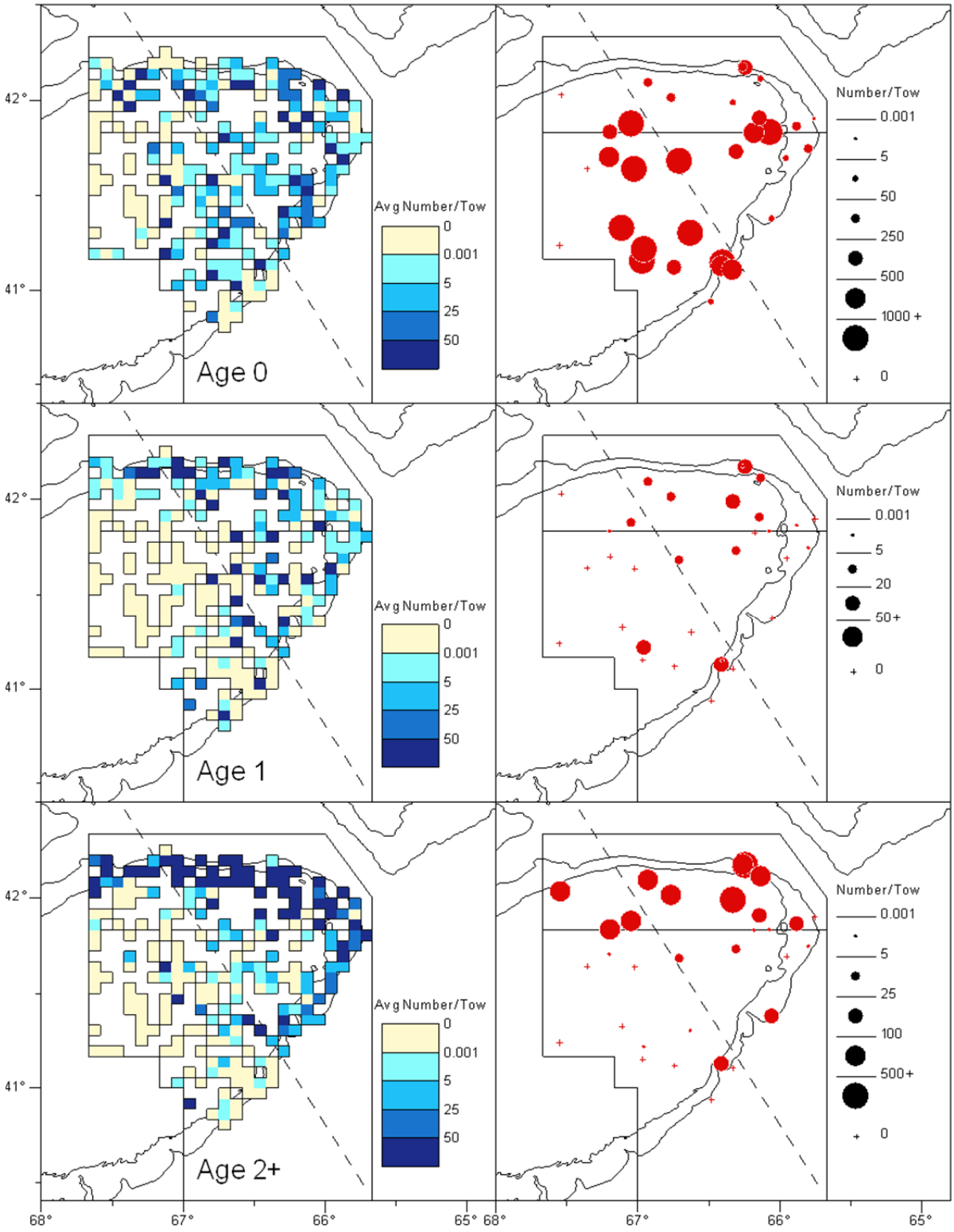

Figure 16. Distribution of eastern Georges Bank haddock abundance (number/tow) as observed from the National Marine Fisheries Service **fall** survey. The squares (left panels) are shaded relative to the average survey catch for 2003 to 2012. The expanding symbols (right panels) represent the **2013** survey catches. Length based conversion coefficients have been applied since the 2009 survey to make them comparable to surveys undertaken by the *Albatross IV*.

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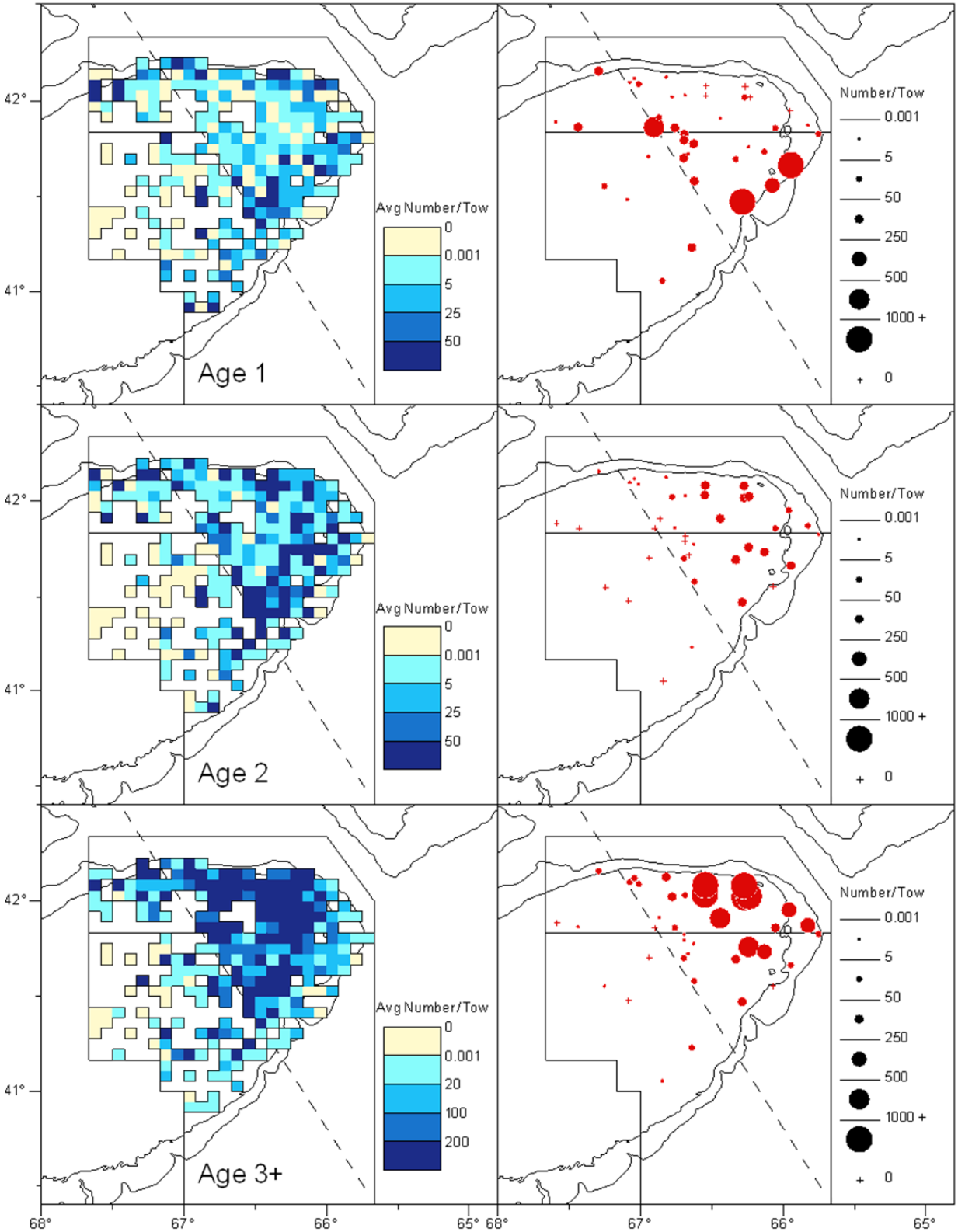

Figure 17. Distribution of eastern Georges Bank haddock abundance (number/tow) as observed from the Canadian Department of Fisheries and Oceans survey. The squares (left panels) are shaded relative to the average survey catch for 2004 to 2013. The expanding symbols (right panels) represent the **2014** survey catches.

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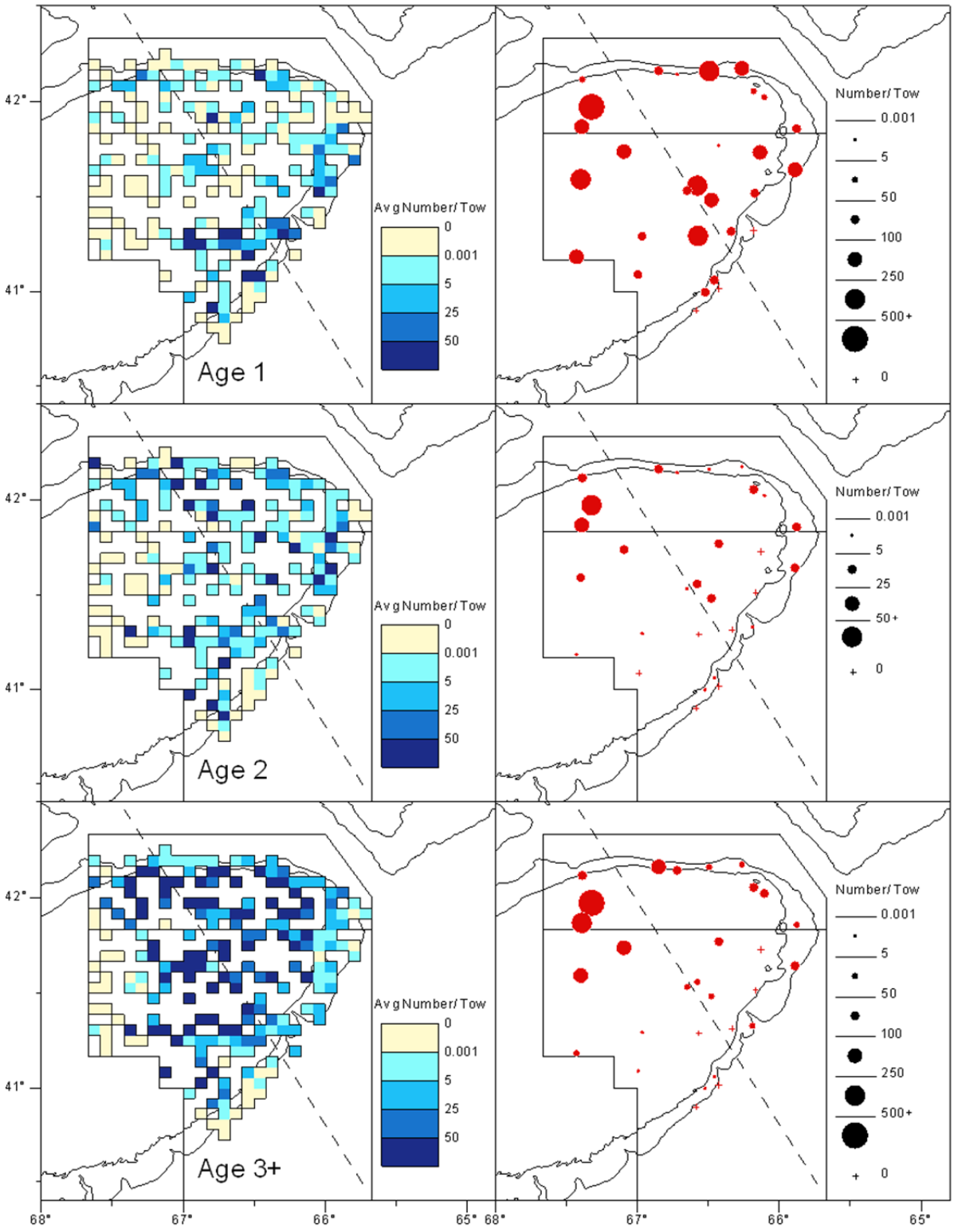

Figure 18. Distribution of eastern Georges Bank haddock abundance (number/tow) as observed from the National Marine Fisheries Service **spring** survey. The squares (left panels) are shaded relative to the average survey catch for 2004 to 2013. The expanding symbols (right panels) represent the **2014** survey catches. Length based conversion coefficients have been applied since the 2009 survey to make them comparable to surveys undertaken by the *Albatross IV*.

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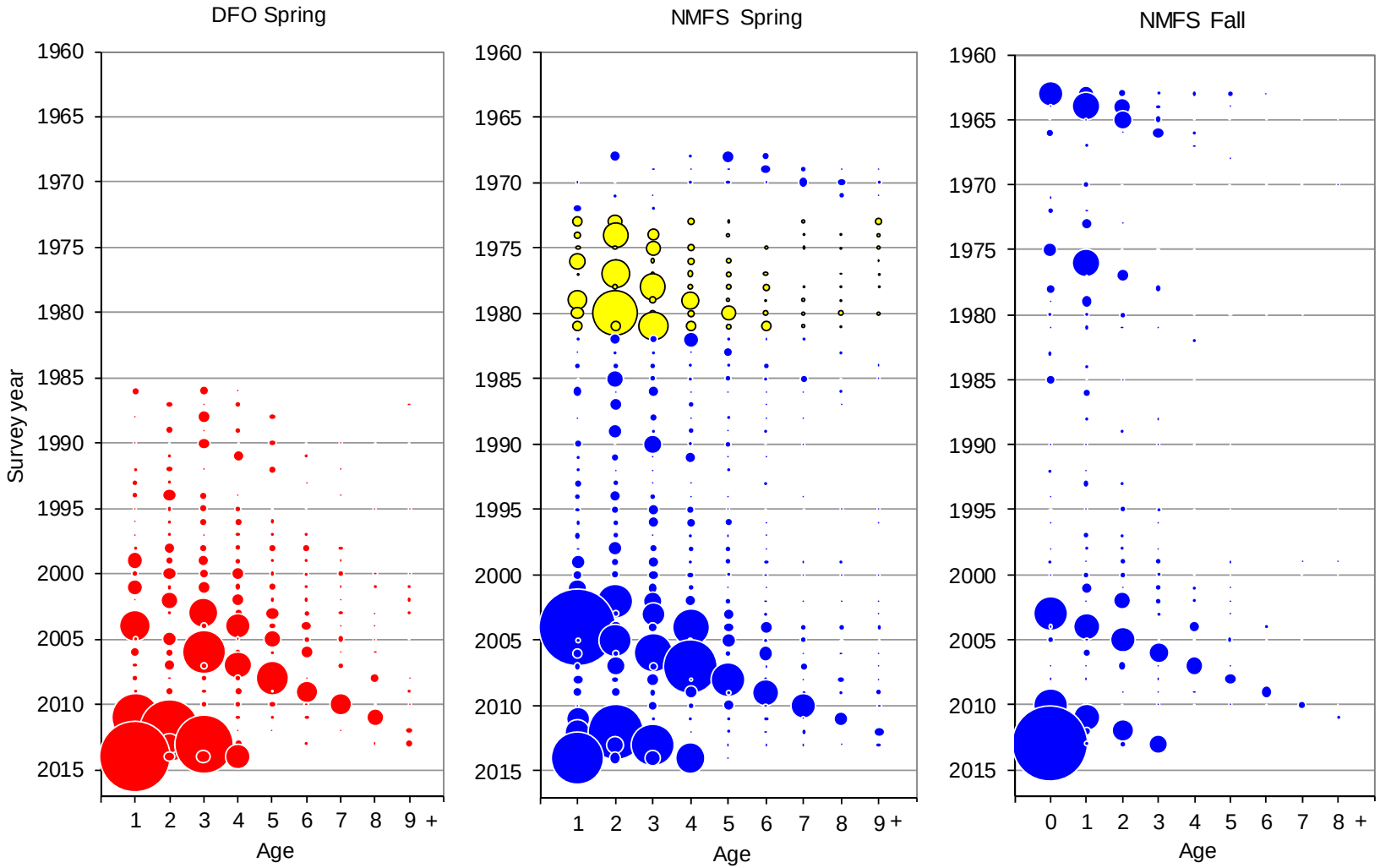

Figure 19. Estimated abundance at age (numbers in 000's) of eastern Georges Bank haddock for the Canadian Department of Fisheries and Oceans (DFO) for 1986 to 2014, the National Marine Fisheries Service (NMFS) spring survey for 1968 to 2014 and the NMFS fall survey for 1963 to 2013. Bubble area is proportional to magnitude (see Tables 18-20). Conversion factors to adjust for changes in door type and survey vessel were applied to the NMFS surveys. From 1973-81 (yellow circles), a 41 Yankee trawl was used for the NMFS spring survey while a 36 Yankee was used in the other years. Length based conversion coefficients have been applied to the NMFS surveys since the 2009 survey to make them comparable to surveys undertaken by the *Albatross IV*. Symbol size has not been adjusted between surveys for the catchability of the survey.

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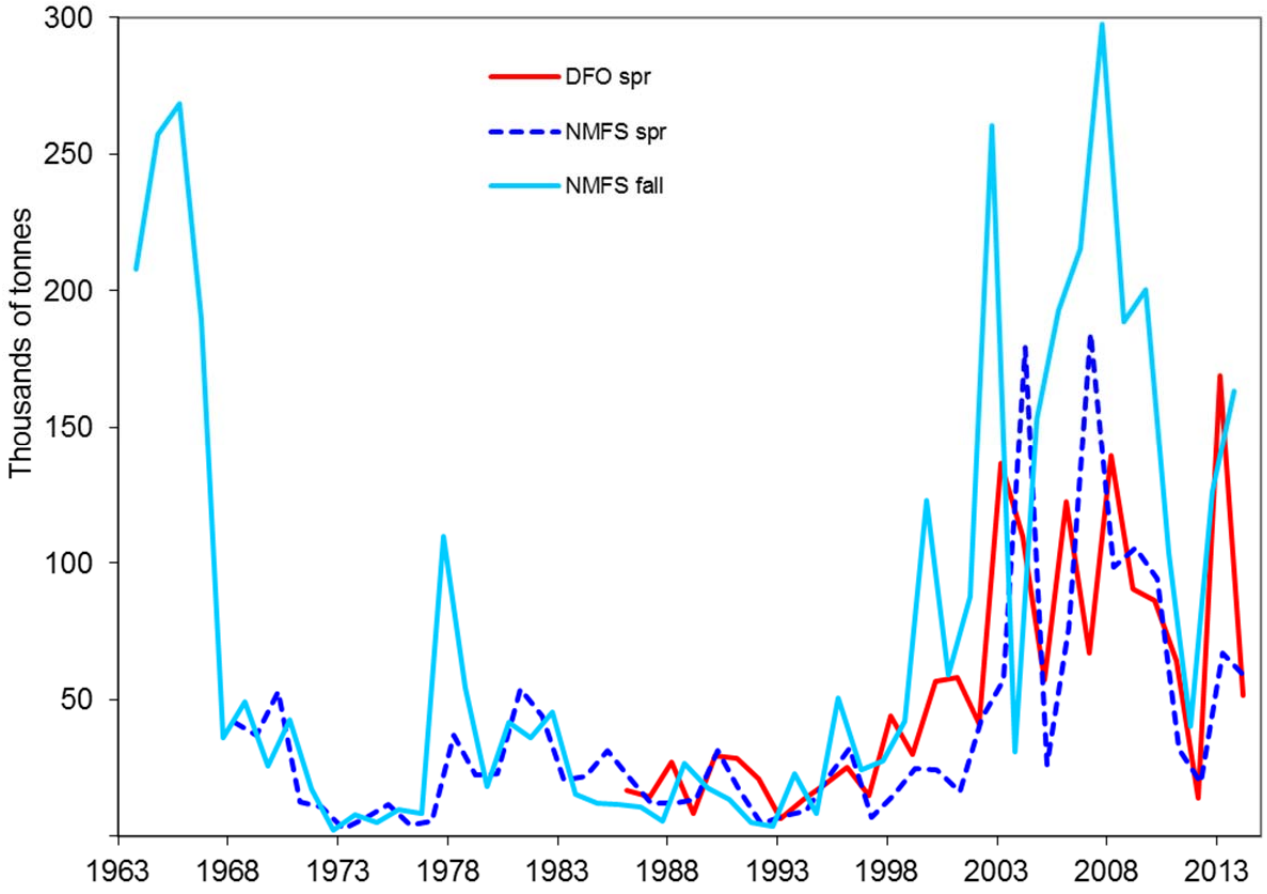

Figure 20. Biomass from National Marine Fisheries Service (NMFS) fall (ages 2-8), NMFS spring (ages 3-8) and Canadian Department of Fisheries and Oceans (DFO) (ages 3-8) research surveys for eastern Georges Bank haddock during 1963-2013, 1968-2014, 1986-2014, respectively (scaled by calibration constants). Conversion factors to adjust for changes in door type and survey vessel were applied to the NMFS surveys. From 1973-81 a 41 Yankee trawl was used for the NMFS spring survey while a 36 Yankee was used in the other years. Length based conversion coefficients have been applied to the NMFS surveys since the 2009 survey to make them comparable to surveys undertaken by the *Albatross IV*.

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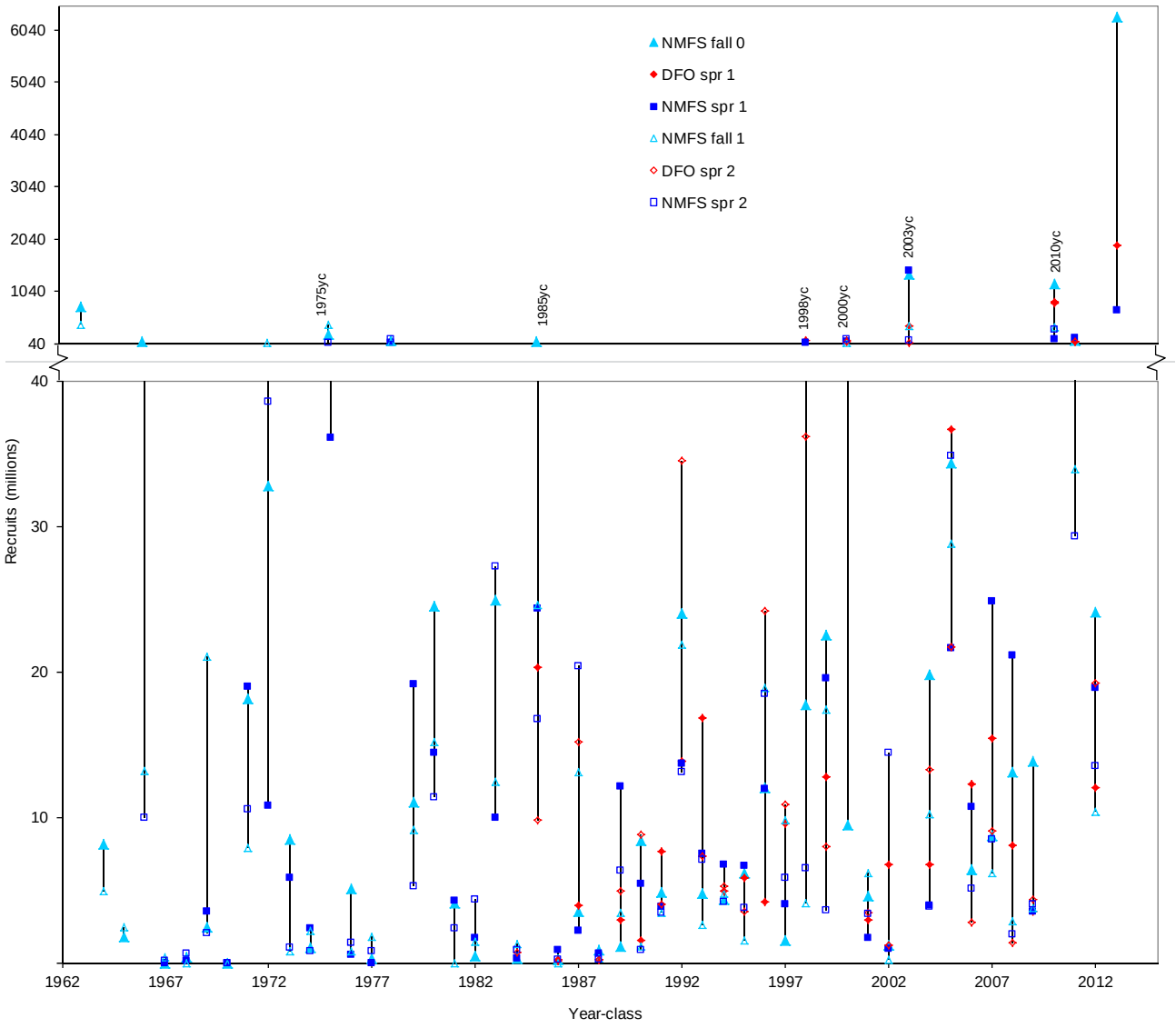

Figure 21. Year-class abundance for ages 0 and 1 from the National Marine Fisheries Service (NMFS) fall survey for 1963-2013 and ages 1 and 2 from the NMFS spring survey for 1968-2014 and the Canadian Department of Fisheries and Oceans (DFO) research survey for 1986-2014 (scaled by calibration constants) for eastern Georges Bank haddock. Conversion factors to adjust for changes in door type and survey vessel were applied to the NMFS surveys. From 1973-81 a 41 Yankee trawl was used for the NMFS spring survey while a 36 Yankee was used in the other years. Length based conversion coefficients have been applied to the NMFS surveys since the 2009 survey to make them comparable to surveys undertaken by the *Albatross IV*.

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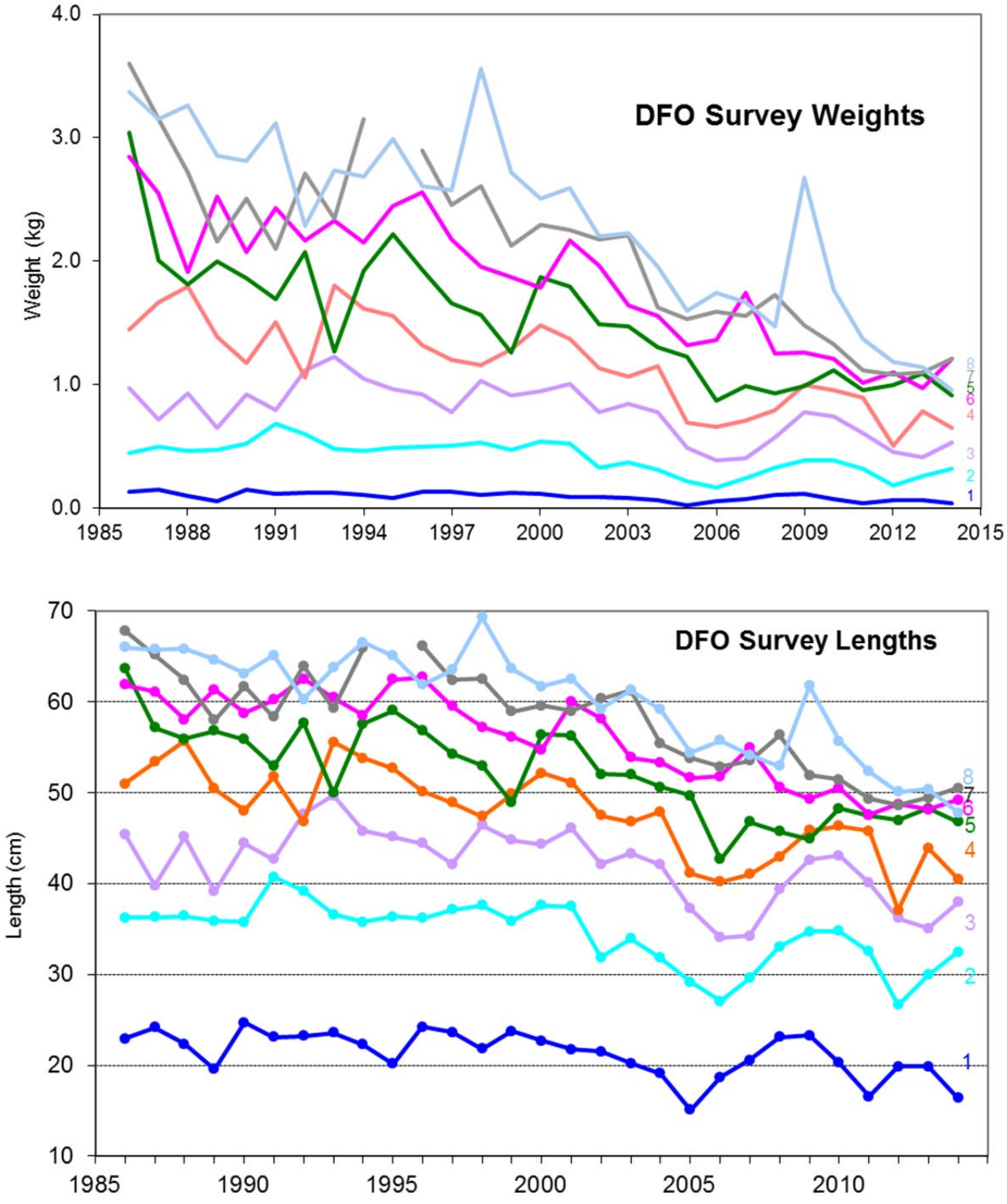

Figure 22. Average weights (upper panel) and lengths (lower panel) at age for eastern Georges Bank haddock derived from Canadian Department of Fisheries and Oceans surveys during 1986-2014.

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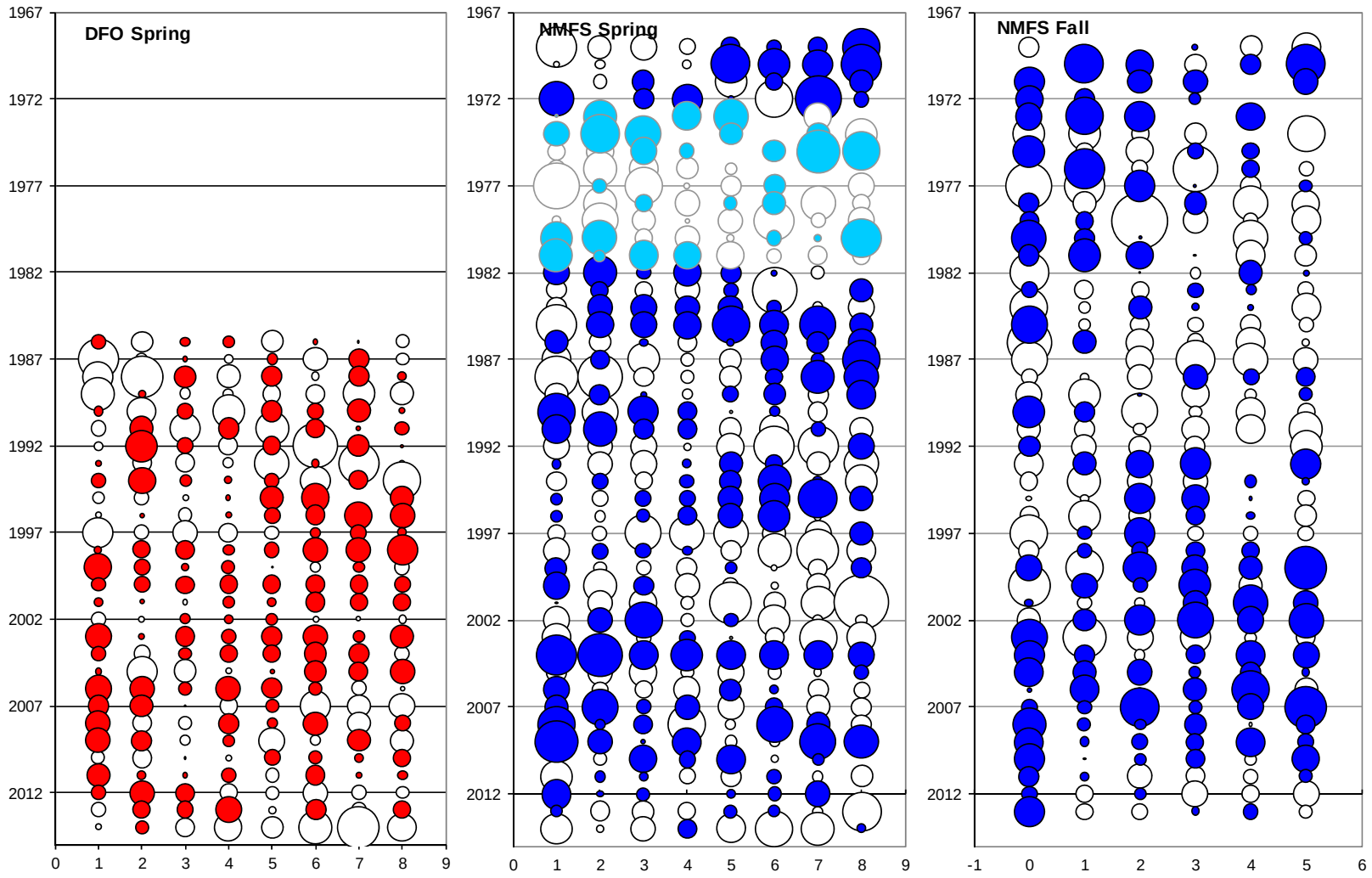

Figure 23. Residuals of survey abundance indices, by year and age group, from the Canadian Department of Fisheries and Oceans (DFO) research survey 1986 to 2014 and the National Marine Fisheries Service (NMFS) spring and autumn surveys during 1969 to 2014 and 1969 to 2013, respectively, for eastern Georges Bank haddock. Solid symbols indicate positive values, open symbols indicate negative values. Bubble area is proportional to magnitude. From 1973-81 (light blue circles), a Yankee 41 trawl was used for the NMFS spring survey while a Yankee 36 trawl was used in the other years.

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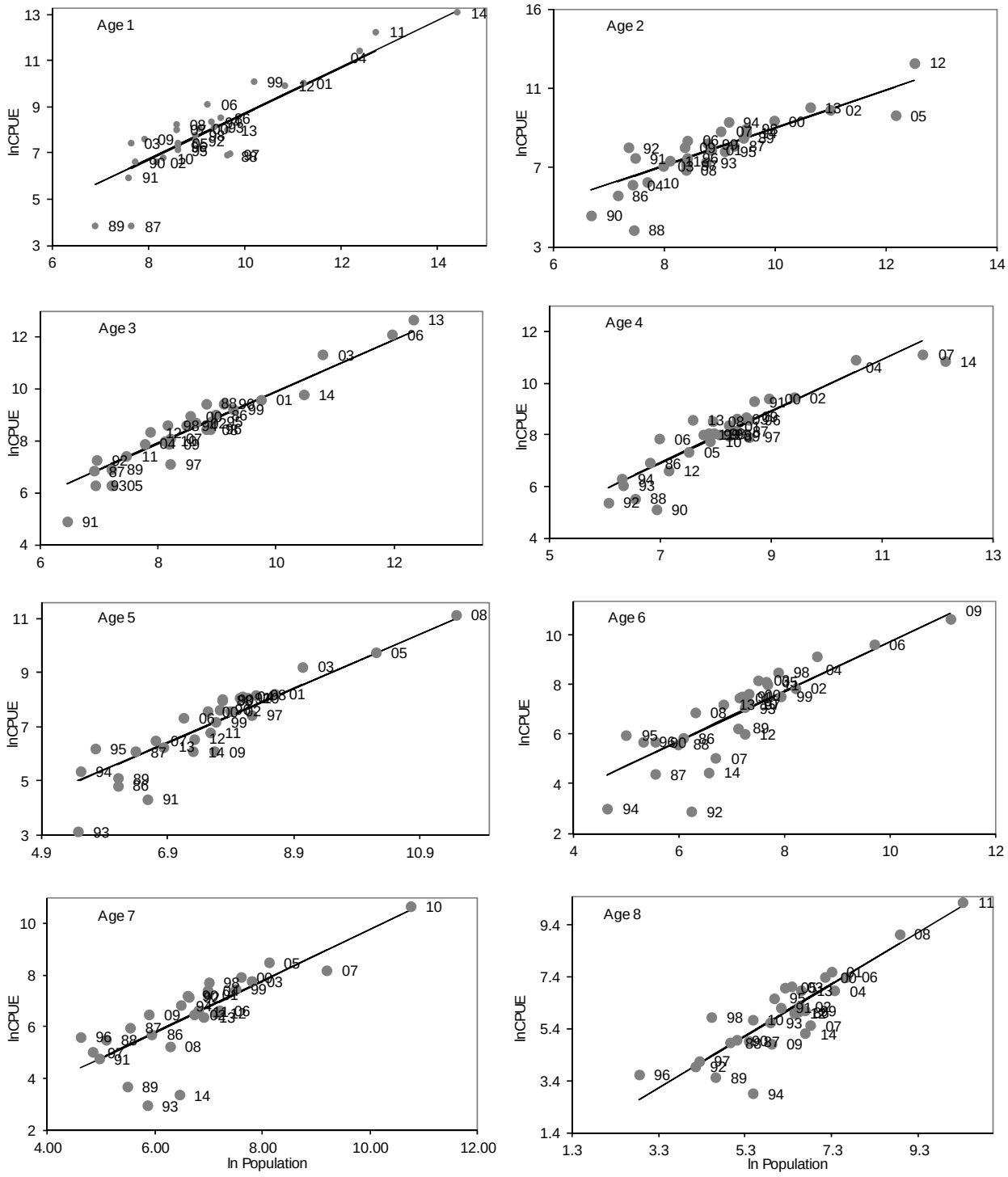

Figure 24. Age by age plots of the observed and predicted ln abundance index versus ln population numbers for eastern Georges Bank haddock from the Department of Fisheries and Oceans survey during 1986-2014.

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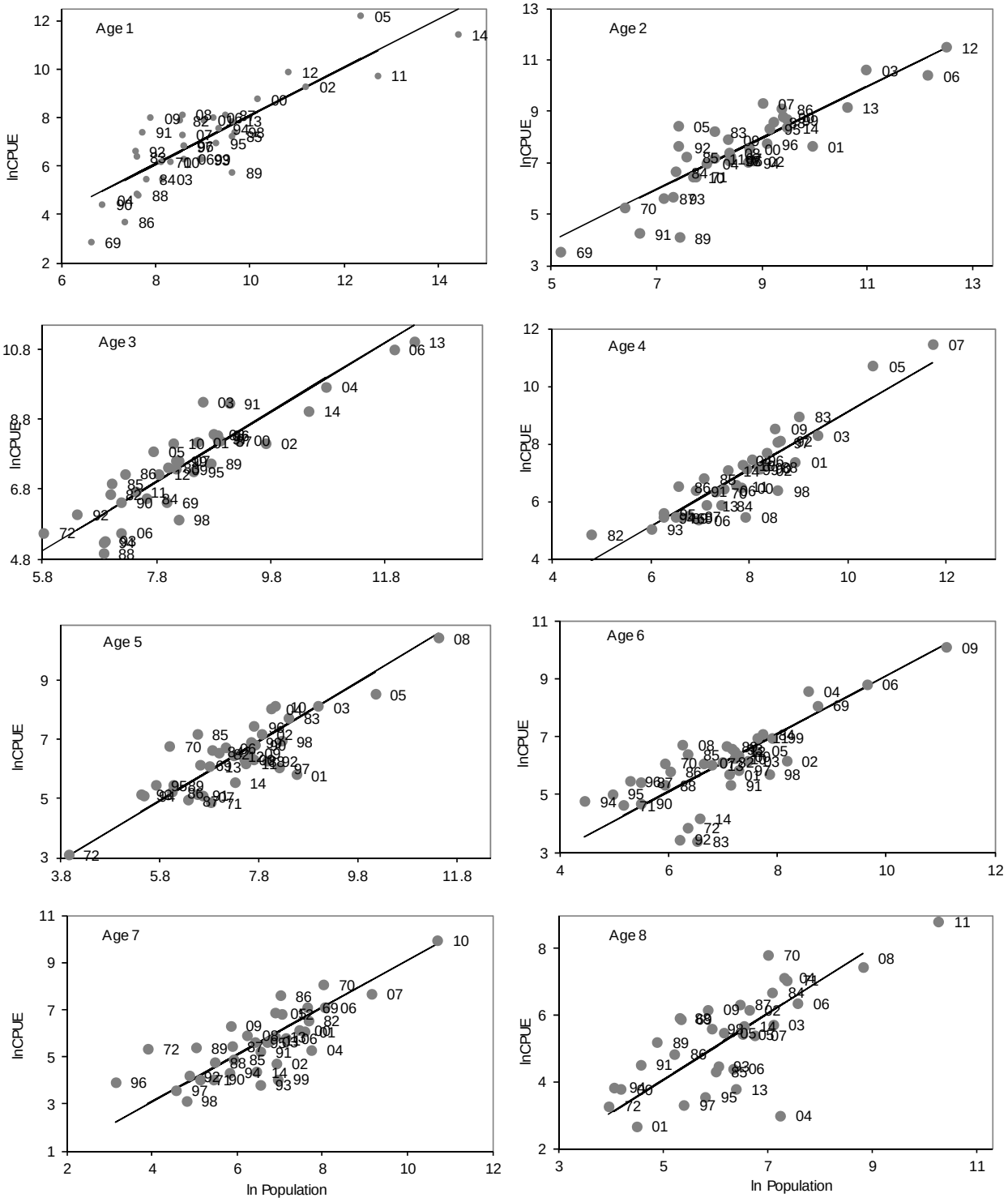

Figure 25. Age by age plots of the observed and predicted ln abundance index versus ln population numbers for eastern Georges Bank haddock from the National Marine Fisheries Service **spring** survey with a Yankee 36 net during 1969-1972 and 1982-2014.

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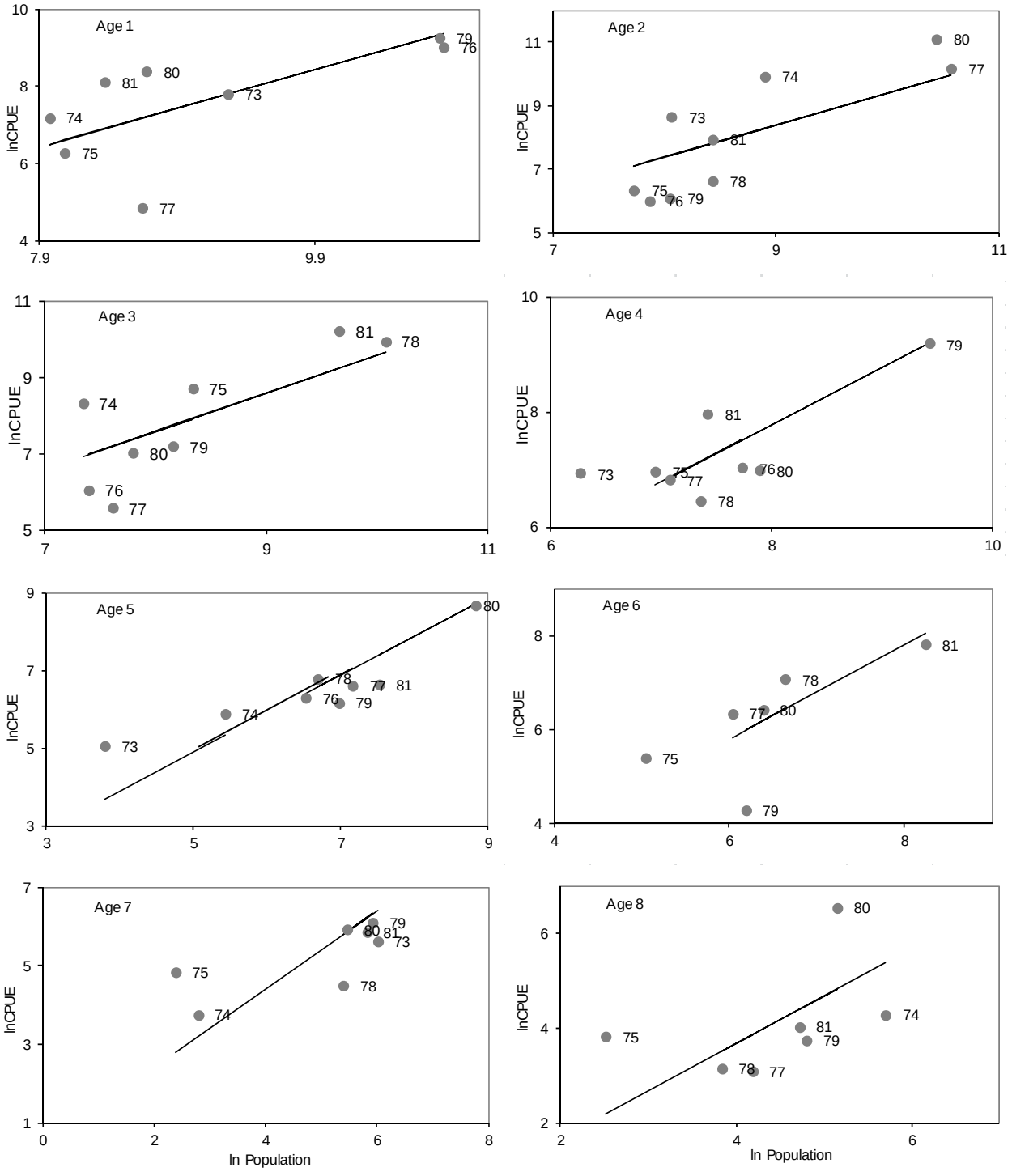

Figure 26. Age by age plots of the observed and predicted ln abundance index versus ln population numbers for eastern Georges Bank haddock from the National Marine Fisheries Service **spring** survey with a Yankee 41 net during 1973-1981.

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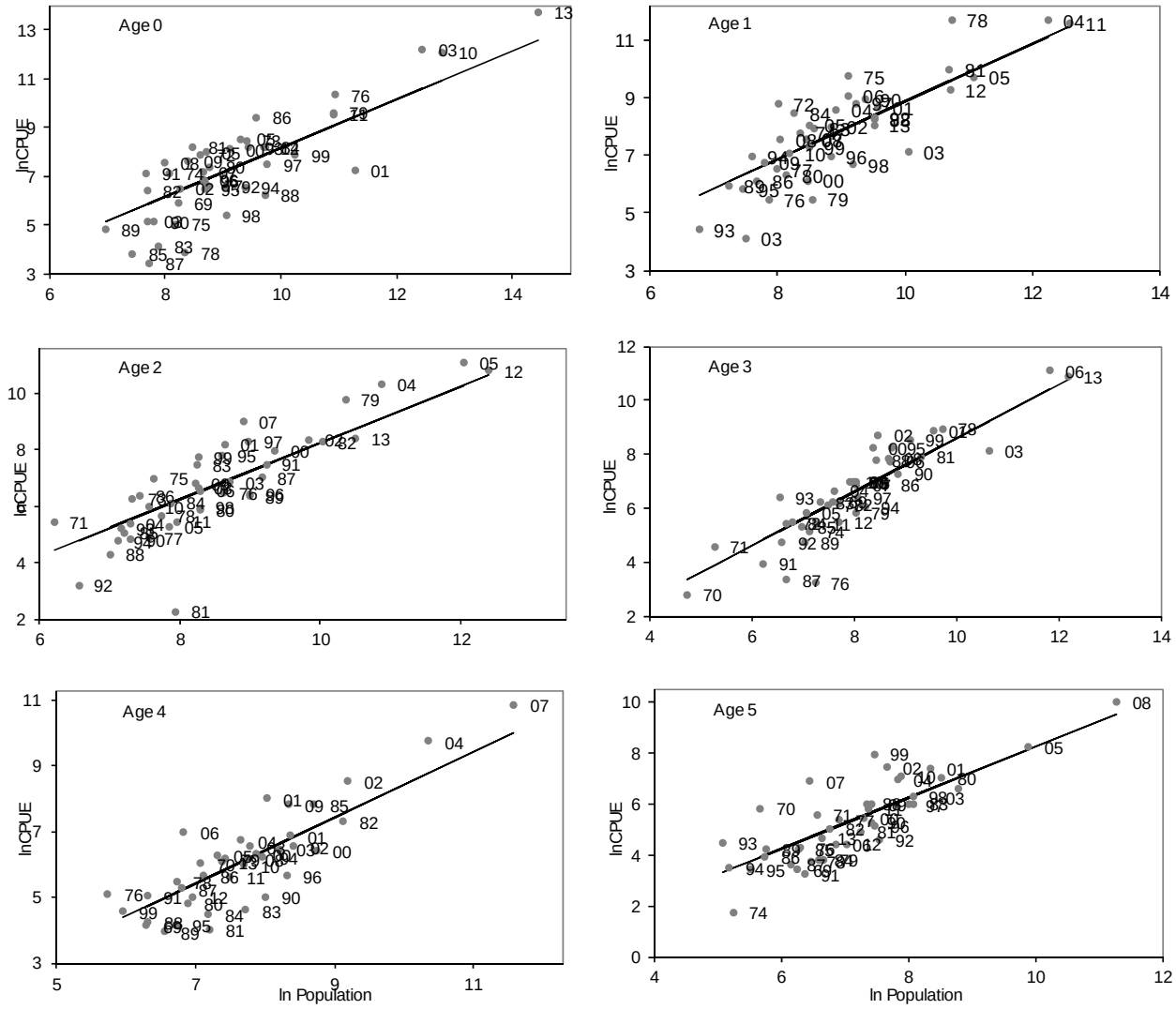

Figure 27. Age by age plots of the observed and predicted ln abundance index versus ln population numbers for eastern Georges Bank haddock from the National Marine Fisheries Service **fall** survey 1969-2013.

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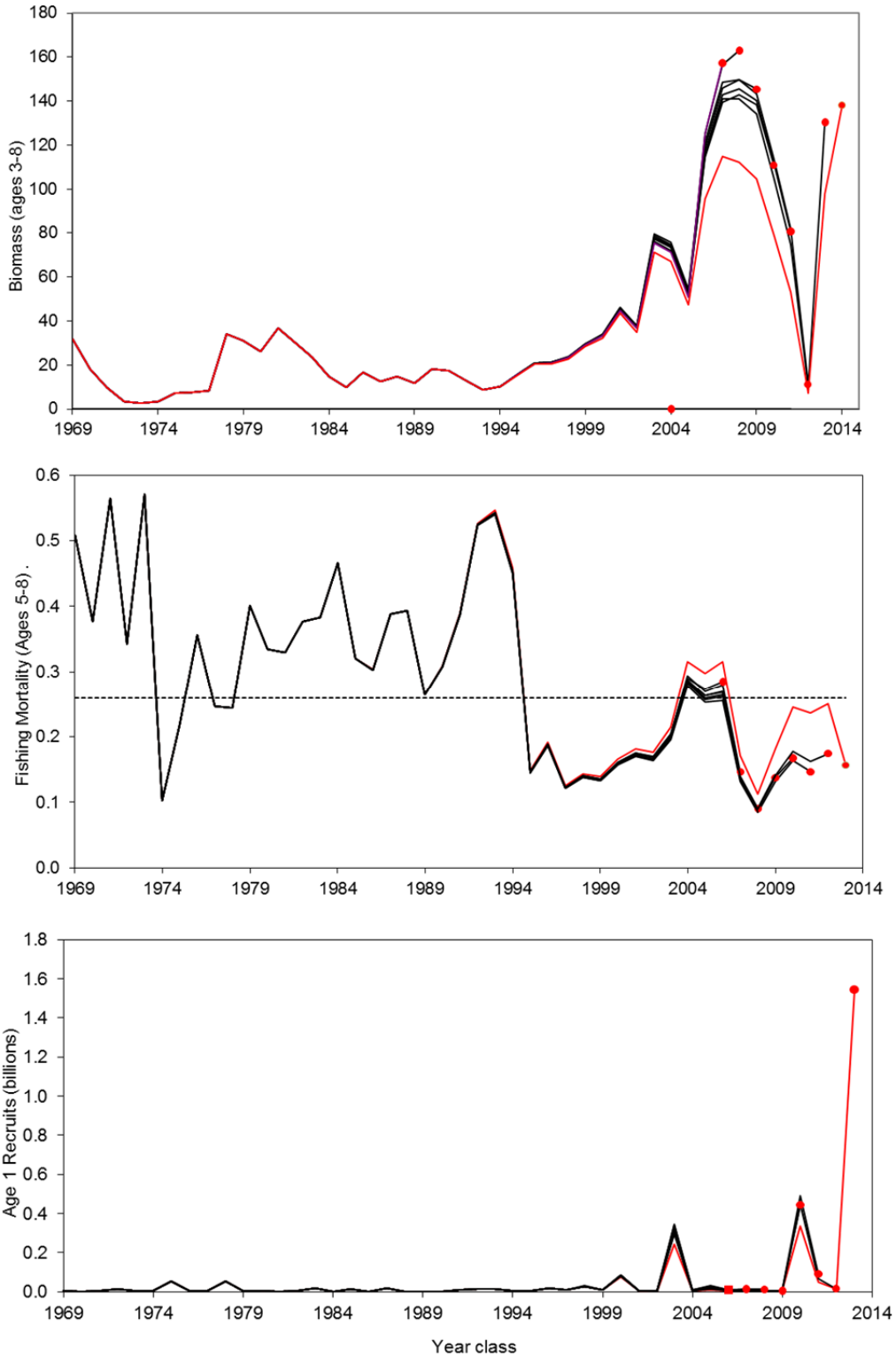

Figure 28. Retrospective results from virtual population analysis of eastern Georges Bank haddock for biomass (ages 3-8), fishing mortality (ages 5-8) and recruits (age 1) as successive years of data are excluded in the assessment. The present assessment (2014) is indicated in red.

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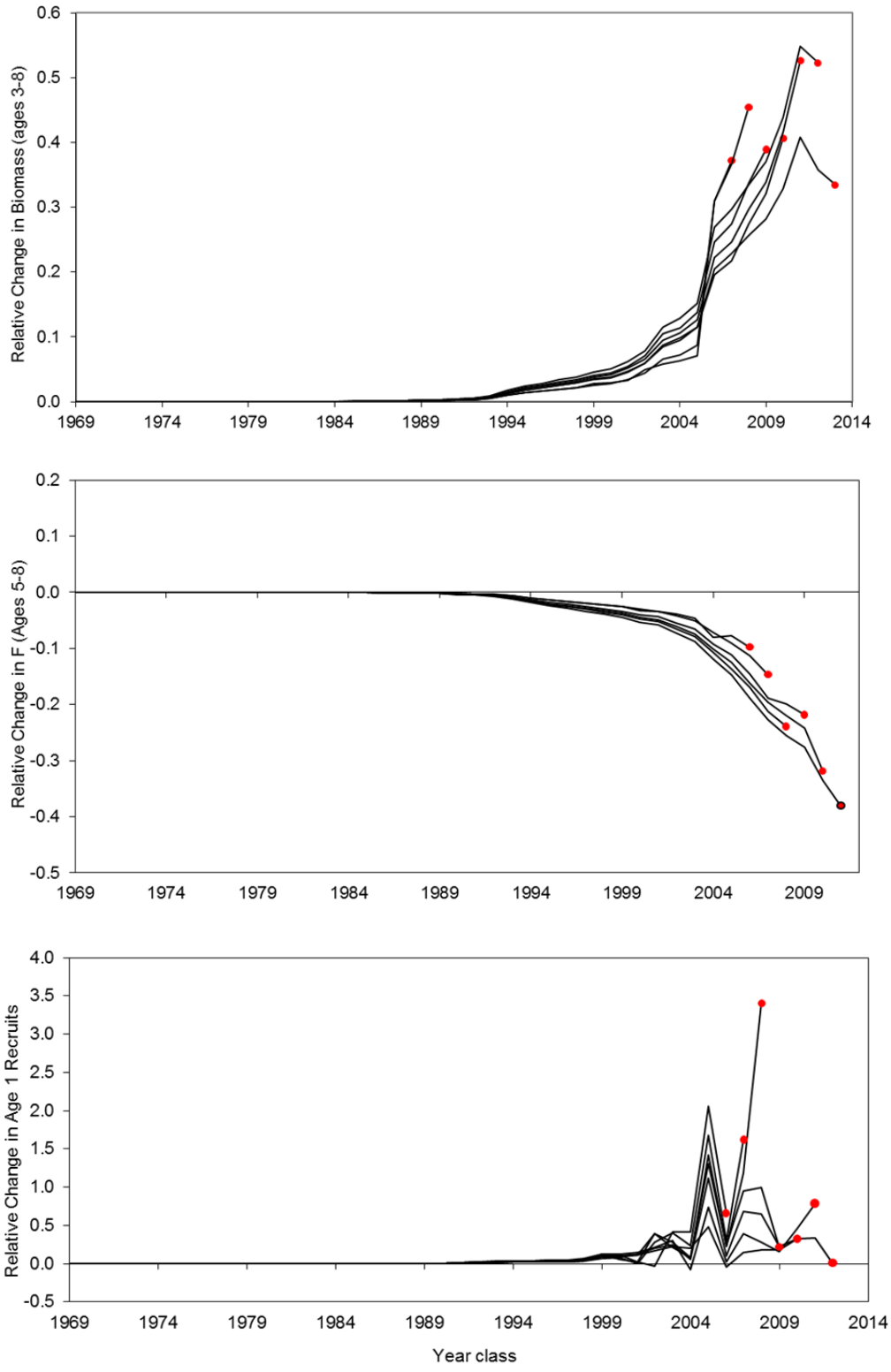

Figure 29. Relative retrospective results from virtual population analysis of eastern Georges Bank haddock for biomass (ages 3-8), fishing mortality (ages 5-8) and recruits (age 1) as successive years of data are excluded in the assessment. Changes are relative to the 2014 assessment.

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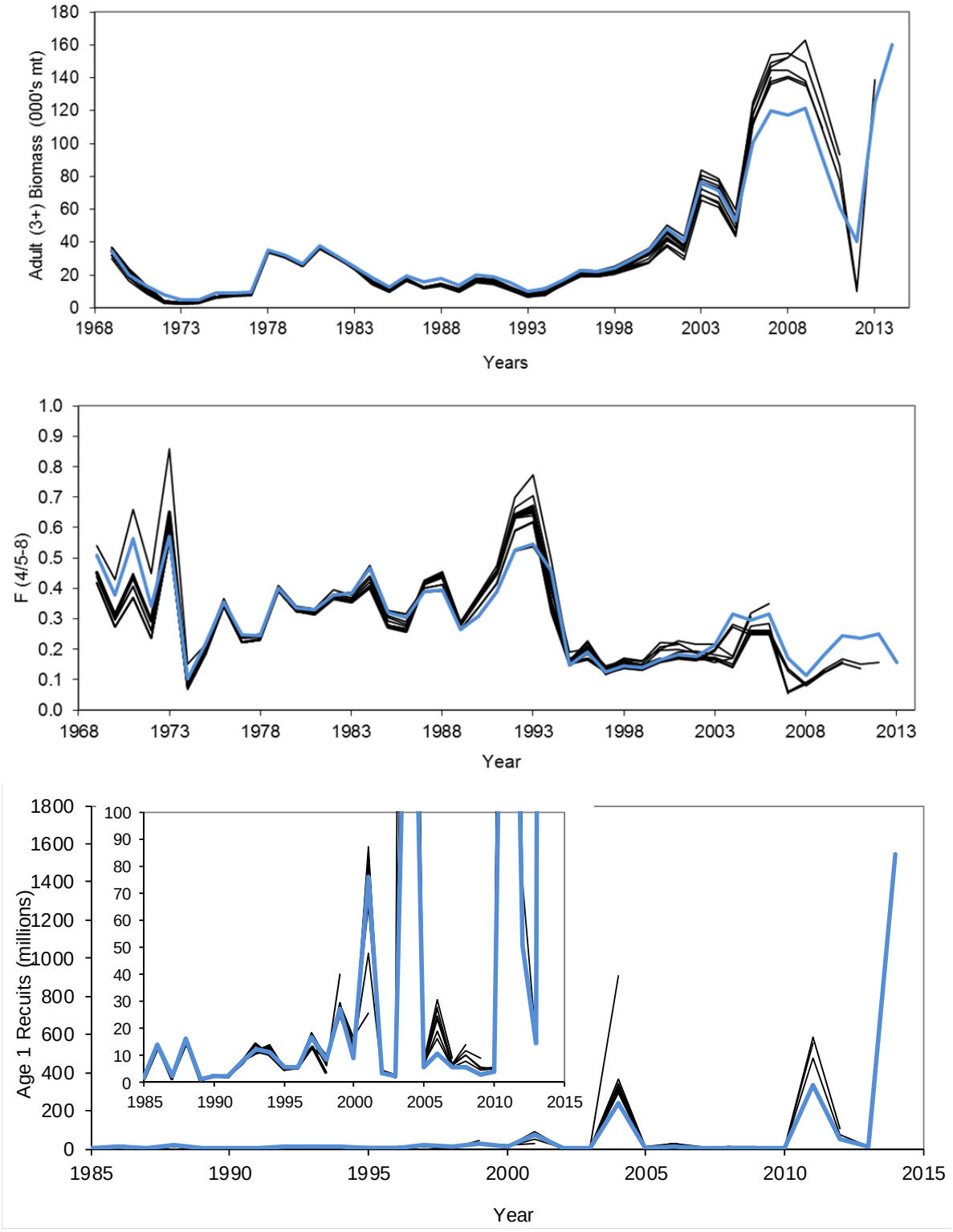

Figure 30. Historical retrospective analysis of 1969 to 2014 3+ biomass (top panel), age 4/5-8 population weighted fishing mortality (middle panel) and 1984 to 2013 recruitment (lower panel) from the 1998 to 2014 eastern Georges Bank haddock assessments. The insert in the lower panel is an expansion of the 0 to 100 million recruitment axis. The 1998 assessment is the last benchmark. The 2014 assessment is indicated in blue.

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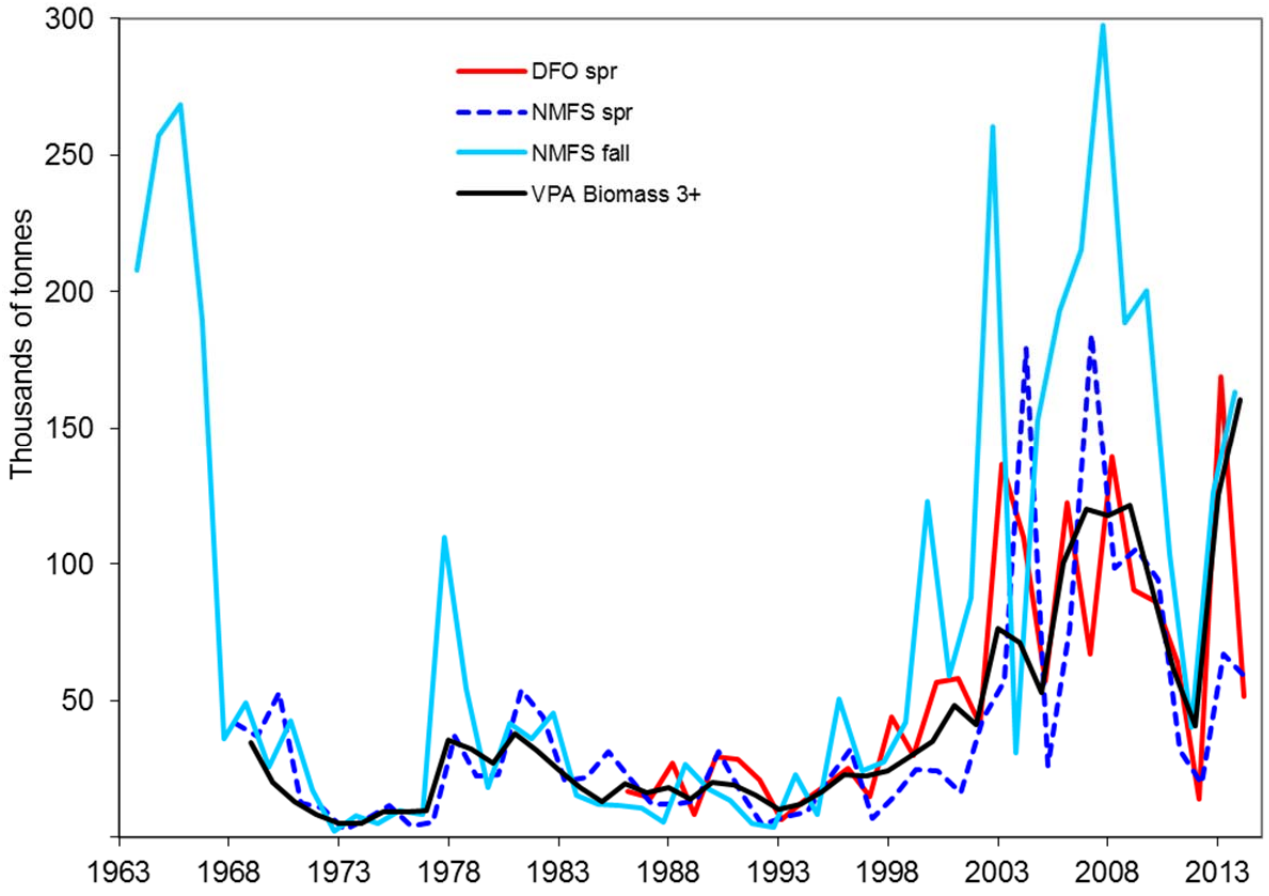

Figure 31. The 1969 to 2014 eastern Georges Bank adult haddock (ages 3+) biomass trend from virtual population analysis compared with the survey adult biomass (scaled with catchabilities) trends.

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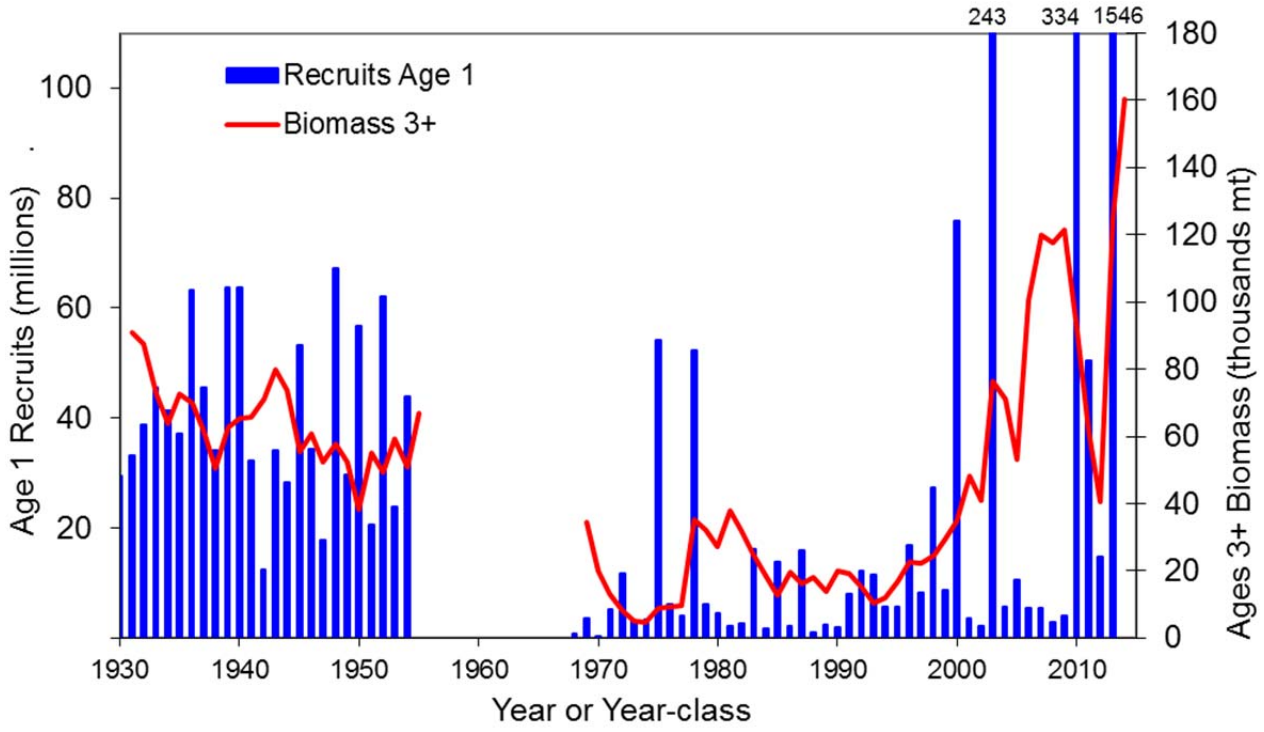

Figure 32. Beginning of year adult (3+) biomass and number of age 1 recruits for eastern Georges Bank haddock during 1931-1955 and 1969-2014.

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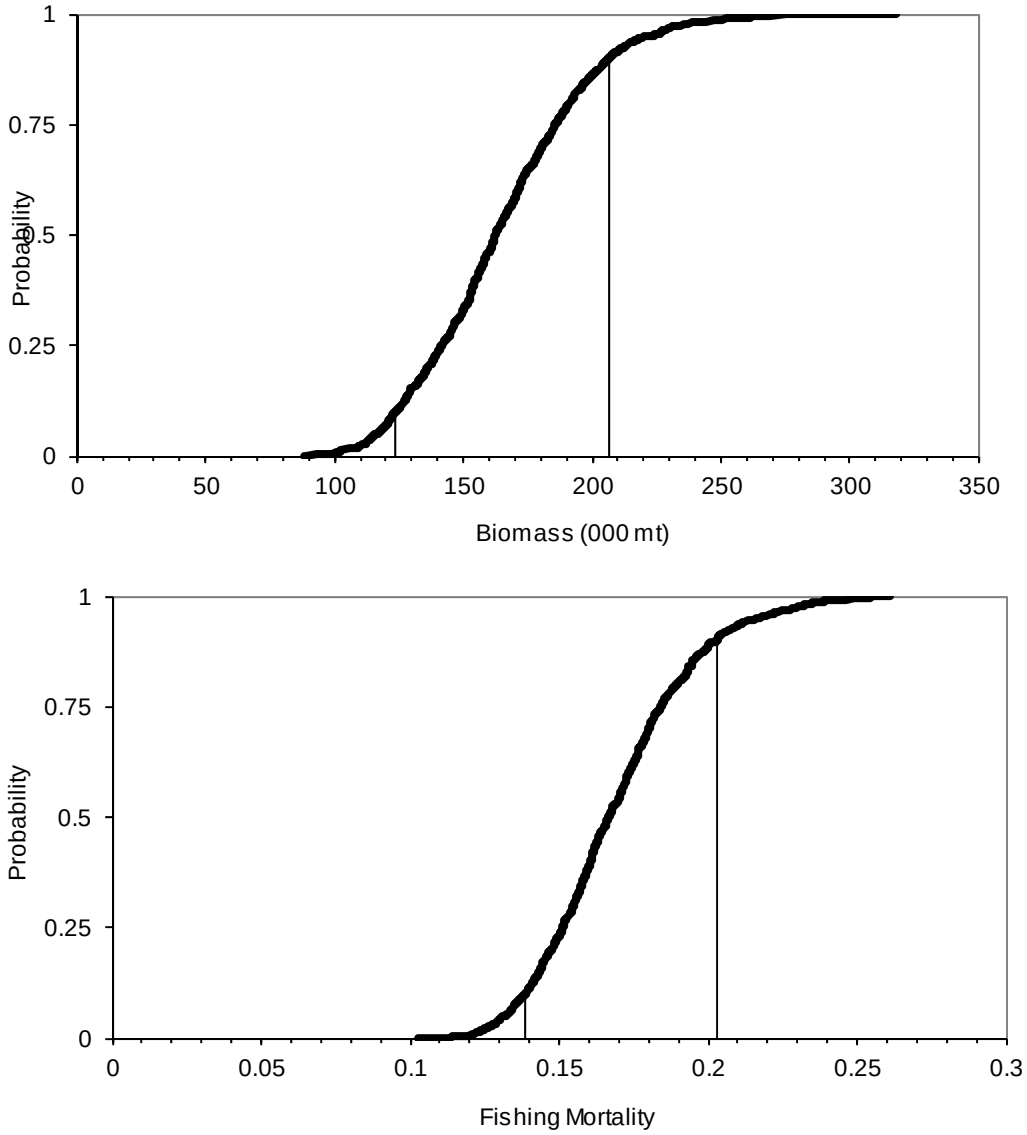

Figure 33. Cumulative probability distribution with 80% confidence intervals for 2014 age 3+ biomass (000 mt) and 2013 age 5-8 fishing mortality for eastern Georges Bank haddock.

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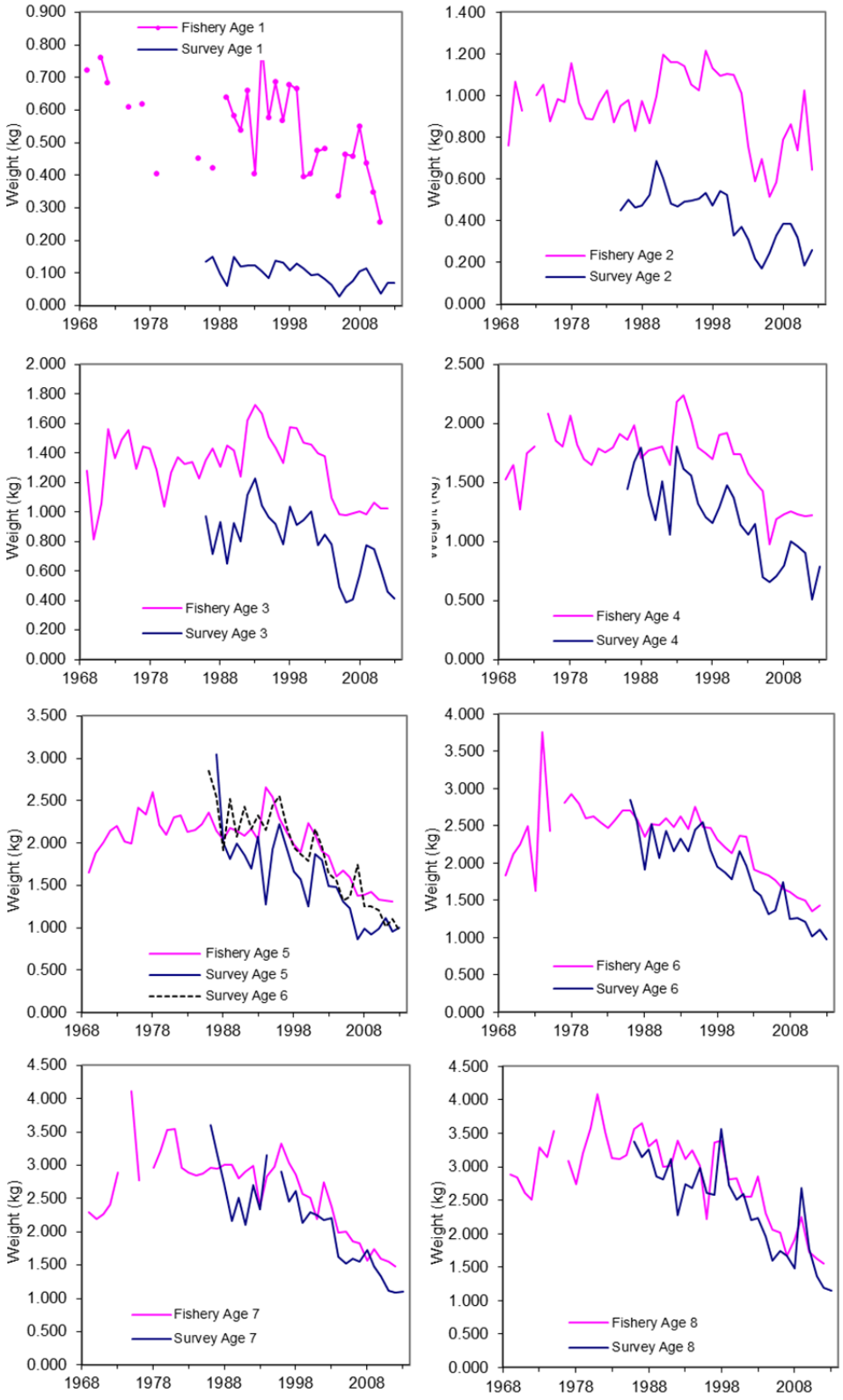

Figure 34. Average weights at age for eastern Georges Bank haddock from the Canada/USA commercial groundfish fishery during 1969-2012 and from the Canadian Department of Fisheries and Oceans survey during 1986-2013. Note: This figure has not been updated for 2014.

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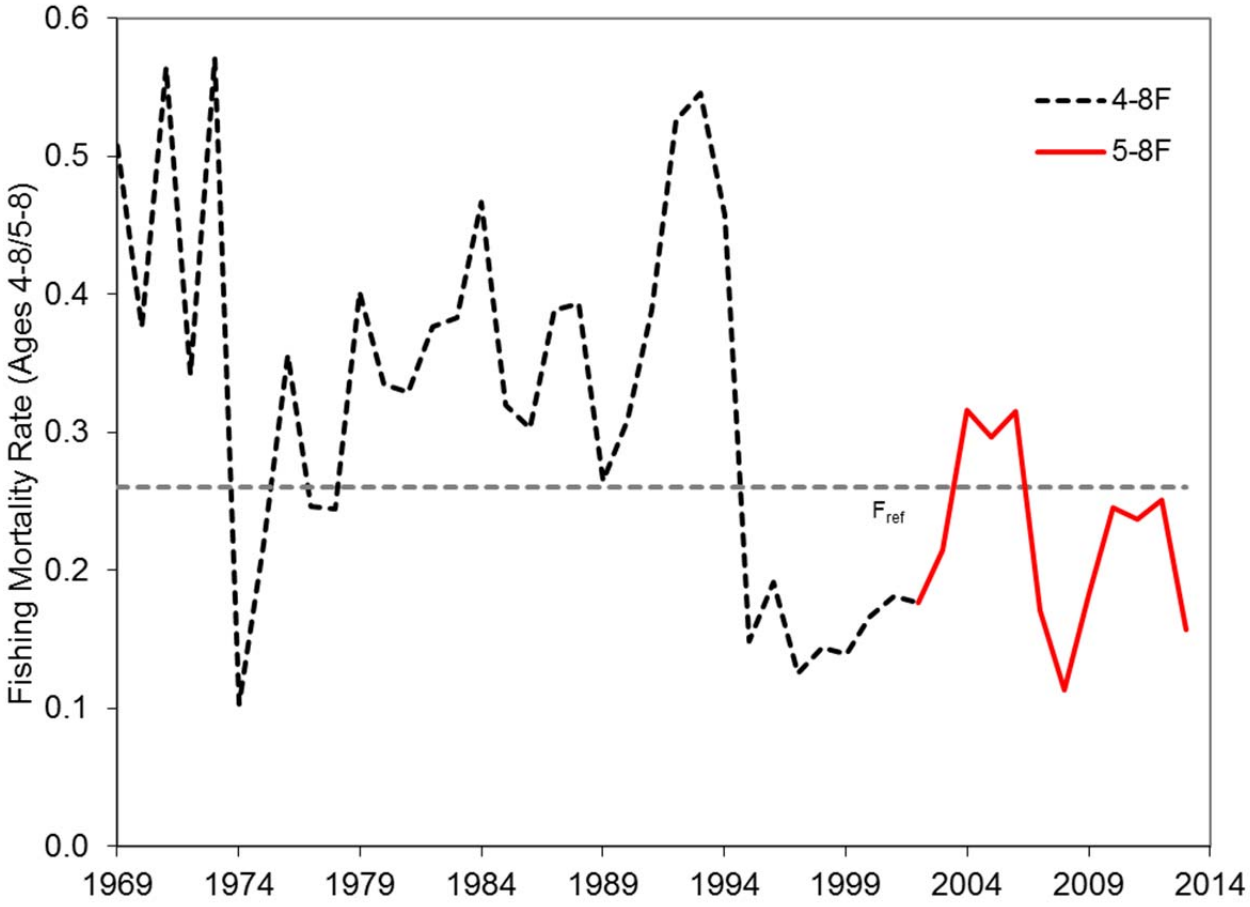

Figure 35. Fishing mortality rate (weighted by population) for eastern Georges Bank haddock ages 4+ and 5+ during 1969-2013 and the fishing mortality threshold reference established at F_{ref} = 0.26.

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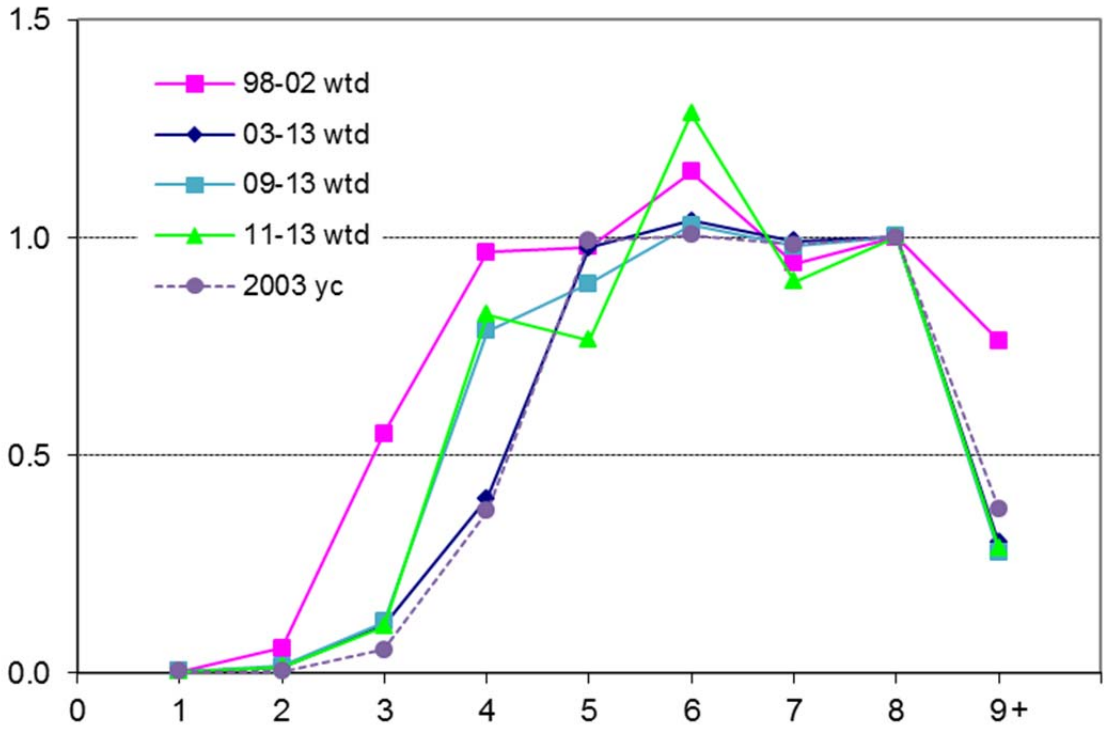

Figure 36. Partial recruitment of eastern Georges Bank haddock for the population weighted average of 1998 to 2002, 2003 to 2013, 2009 to 2013 and 2011 to 2013 and for the 2003 year class. The partial recruitment is normalized to ages 4-8 for years before 2003 and to ages 5-8 for years after 2002.

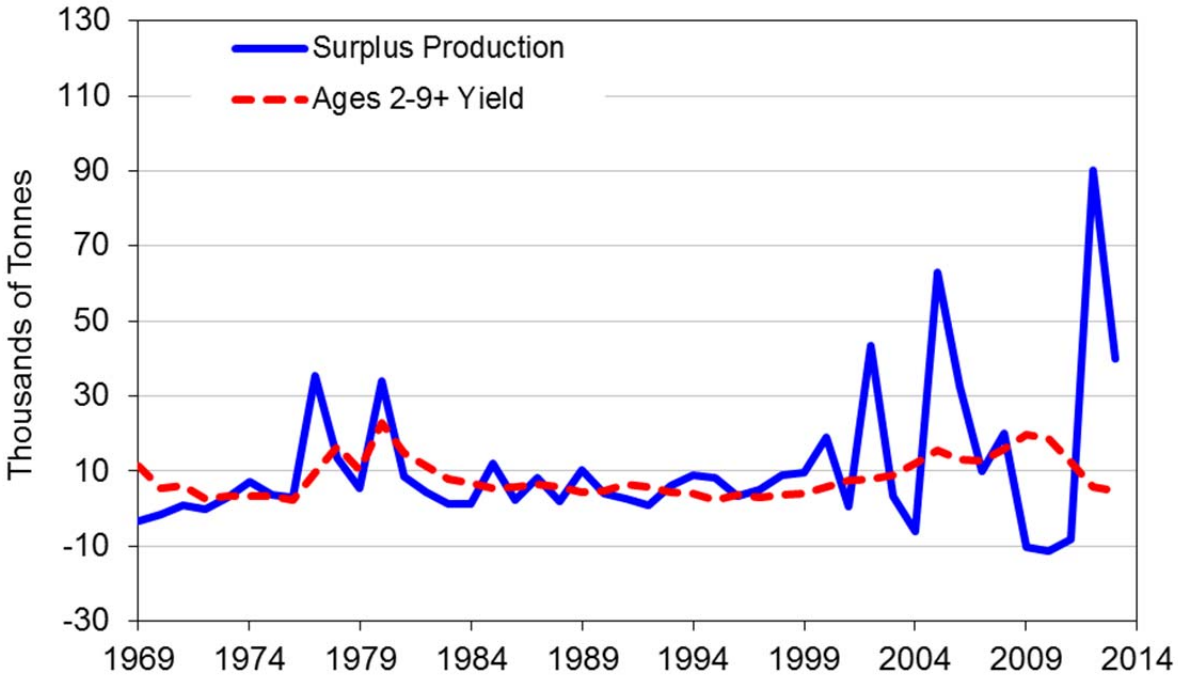

Figure 37. Surplus production of eastern Georges Bank haddock available to the commercial fishery compared to the harvested yield during 1969-2013.

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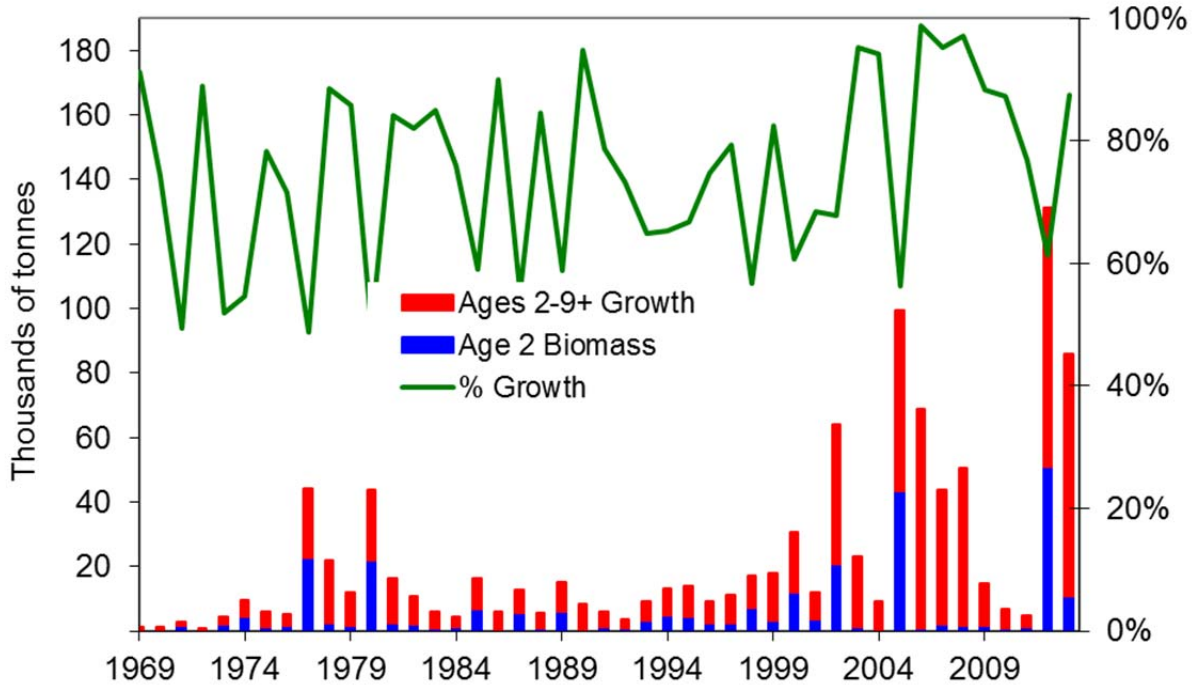

Figure 38. Amount of productivity attributible to growth (ages 2 to 9+) of eastern Georges Bank haddock and the amount contributed by recruitment (age 2) during 1969-2012.

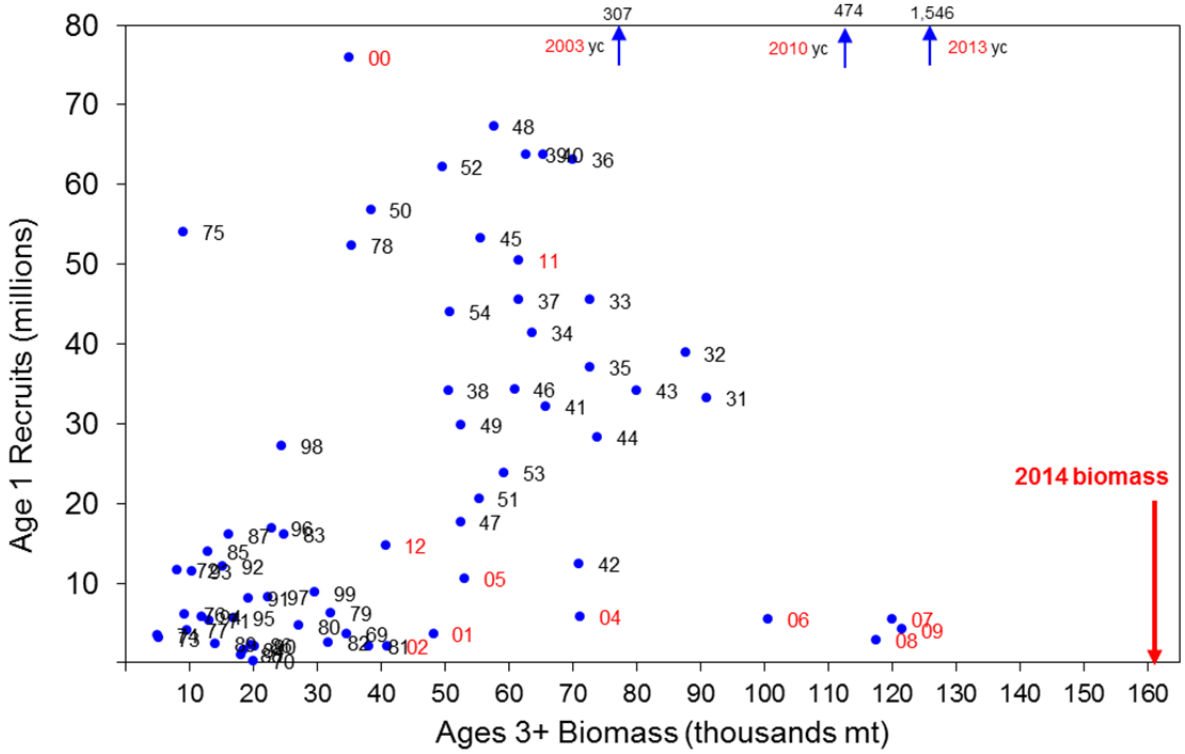

Figure 39. Relationship between eastern Georges Bank adult (ages 3+) haddock biomass during 1931-1955 and 1969-2013 and recruits at age 1. The year classes since the 2000 are labeled in red font.

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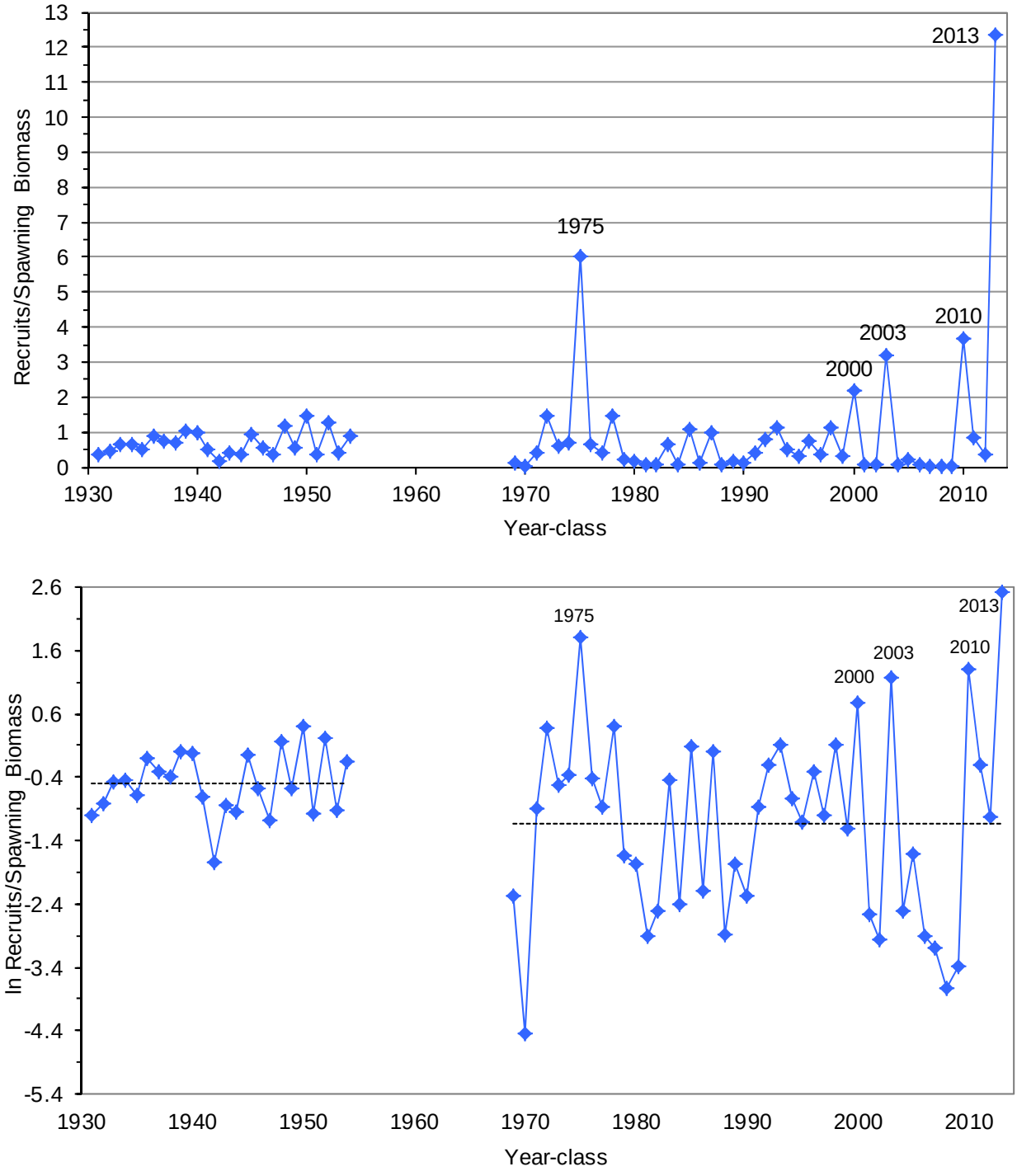

Figure 40. Ratio of recruits (numbers at age 1) to spawning biomass (kg) for eastern Georges Bank haddock during 1931-1955 and during 1969-2013. Upper graph is in absolute numbers, lower graph is on a ln scale. Dotted lines in lower graph indicate averages over the two periods.

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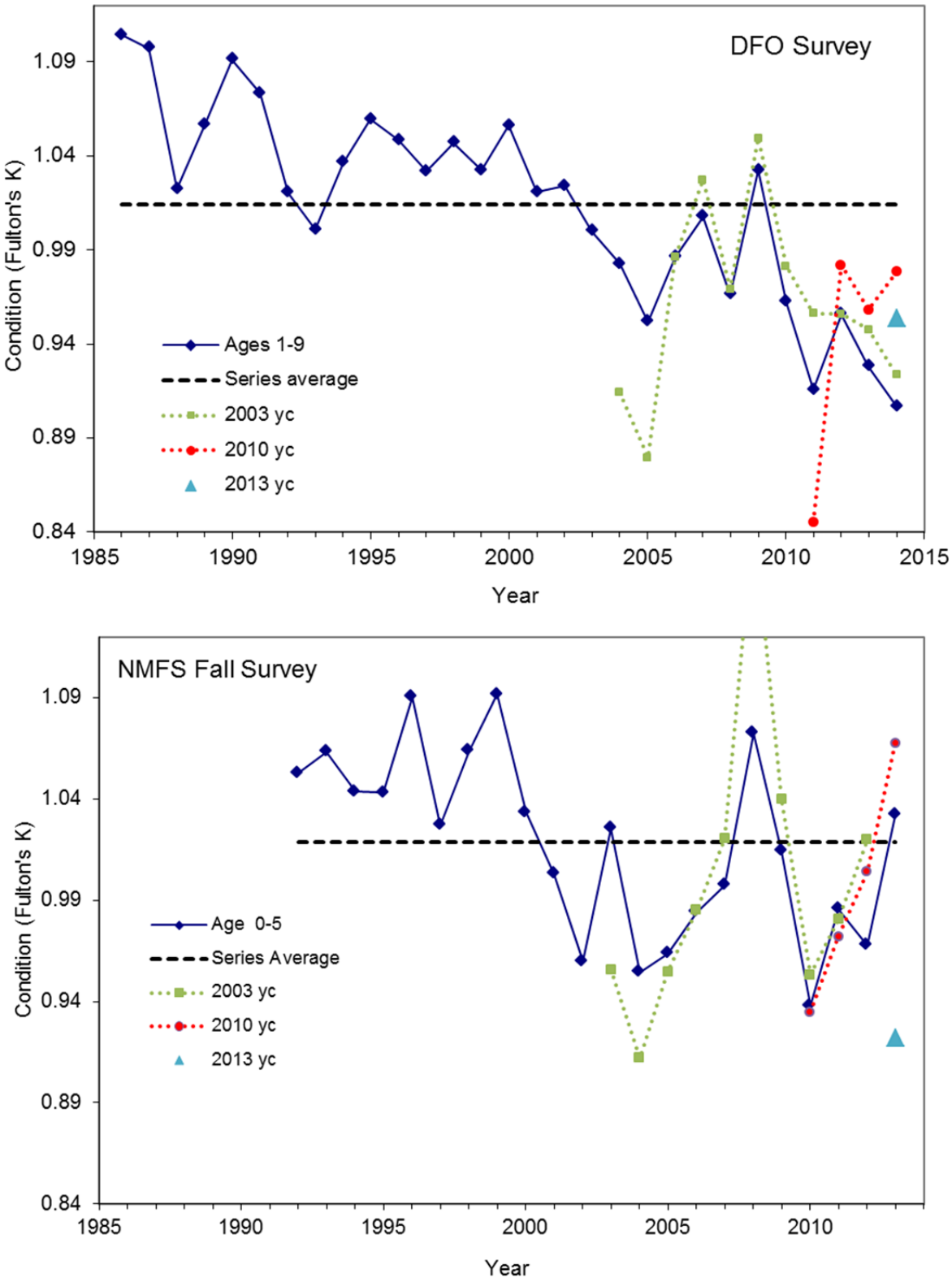

Figure 41. Condition as indicated by Fulton's K for eastern Georges Bank haddock from the Canadian Department of Fisheries and Oceans survey for age group 1-9 during 1986-2014 (upper) and from the NMFS fall survey for ages 0-5 (lower) compared to the average for each time series. The 2003, 2010 and 2013 year classes are also shown.

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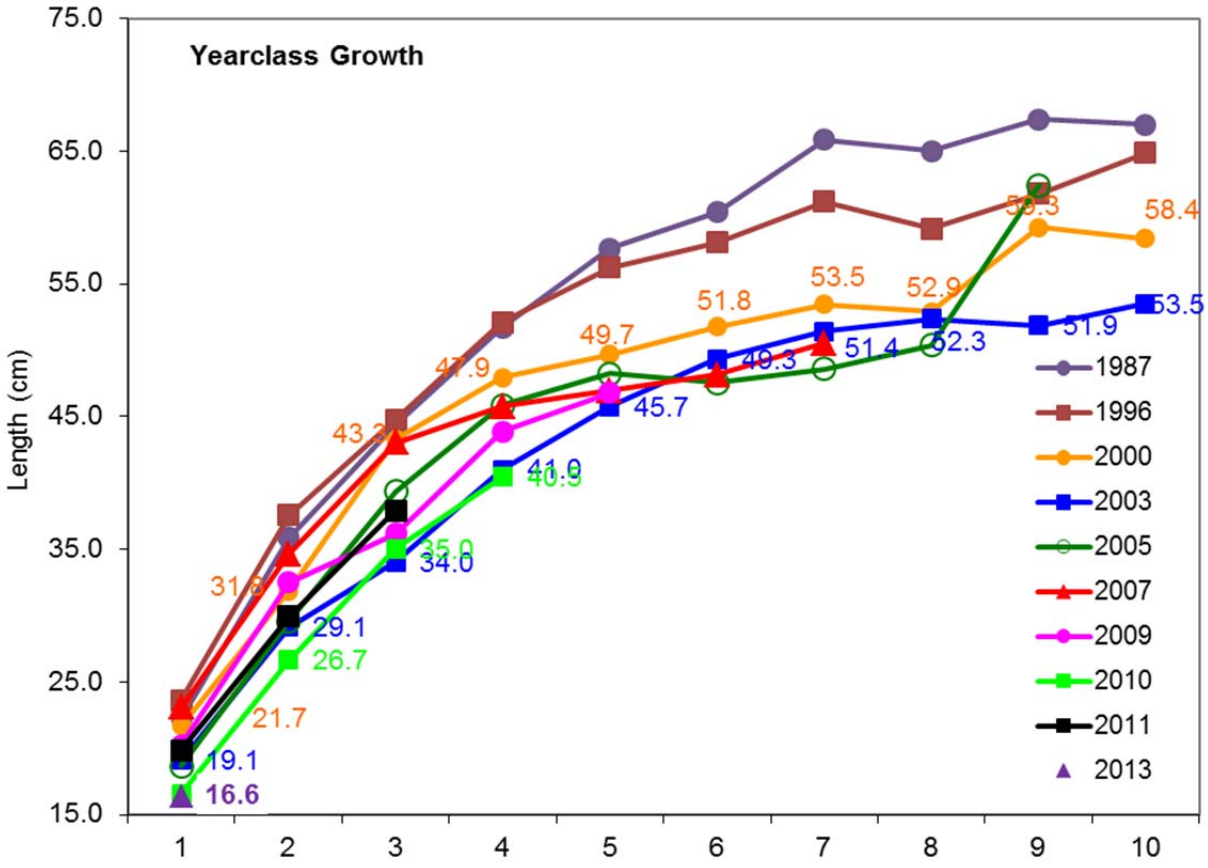

Figure 42. Length at age of eastern Georges Bank haddock year classes from the DFO survey.

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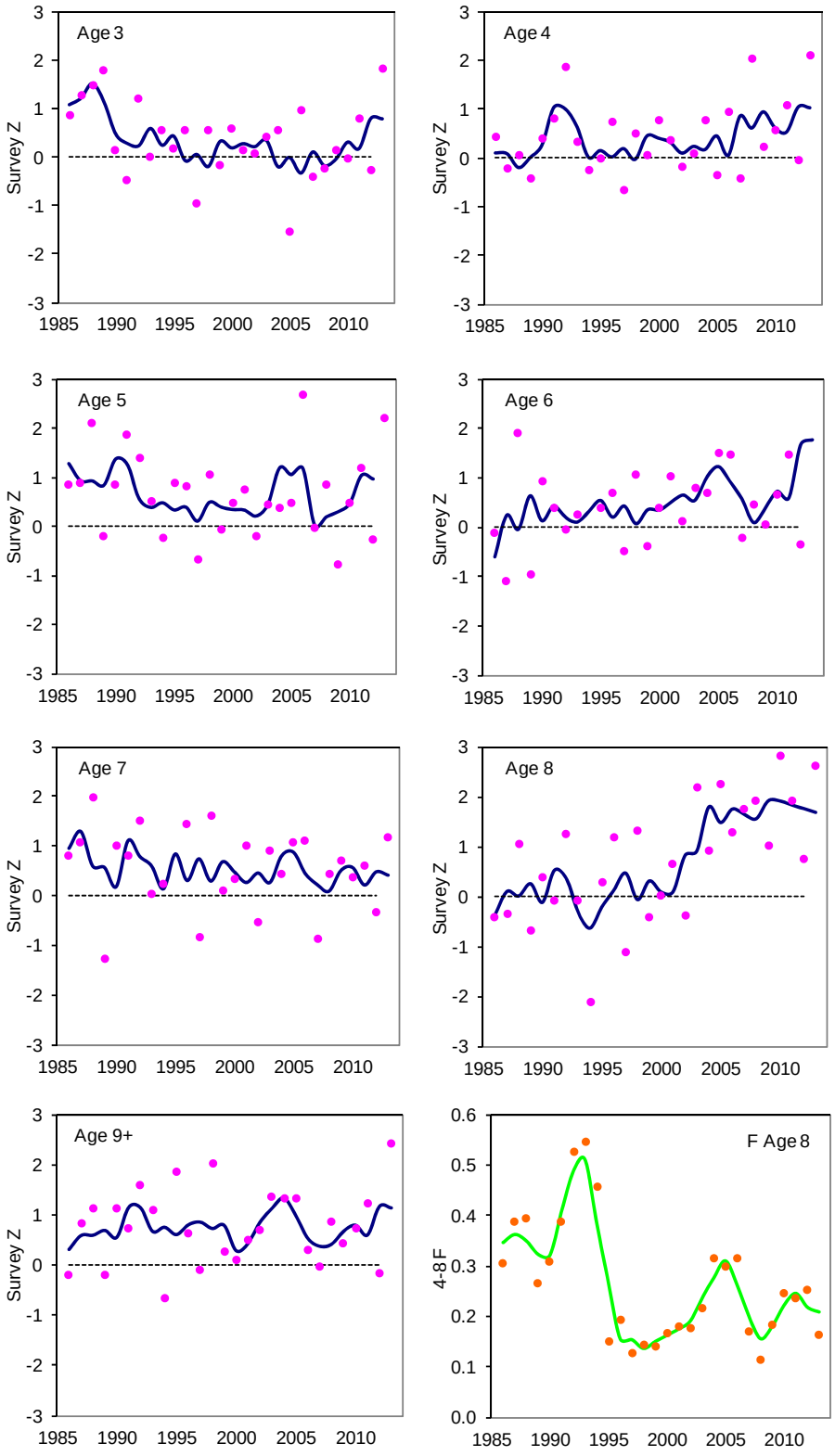

Figure 43. Eastern Georges Bank haddock total mortality (Z's) for ages 3 to 9+ for 1986 to 2013 from the Canadian Department of Fisheries and Oceans survey and the age 8 fishing mortality from VPA (bottom right).

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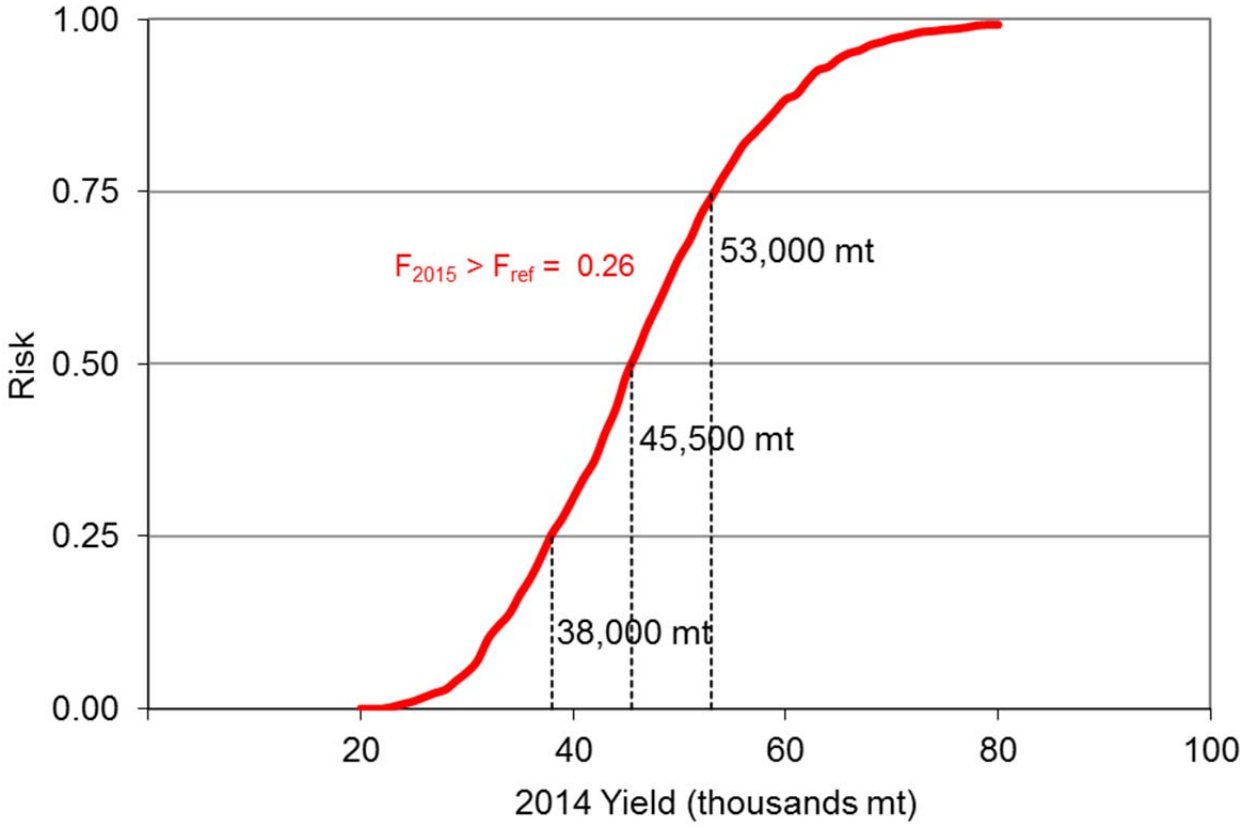

Figure 44. Risk of 2015 fishing mortality exceeding F_{ref} = 0.26 for eastern Georges Bank haddock for increasing catch quotas.

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Appendix A. Note: This table has not been updated for 2014.

Comparison of EGB haddock TRAC catch advice, TMGC quota decision, actual catch, resulting fishing mortality and biomass changes. All catches are calendar year catches. In the "Results" column, values in italics are assessment results in the year immediately following the catch year; values in normal font are results from the 2013 assessment. This table was kindly provided by Tom Nies (New England Fisheries Management Council) in 2011 and updated to the 2013 assessment.

TRAC	Catch Year	TRAC Analysis/Recommendation		TMGC Decision		Actual Catch/ Compared to Risk Analysis	Results	Comments[2]
		Amount	Rationale/Biomass	Amount	Rationale			
1999[1]	1999	6,300 mt	$F_{0.1}$	NA	NA	4,000 mt	*Below $F_{0.1}$*	
2000[1]	2000	8,800 mt	$F_{0.1}$	NA	NA	5,600 mt	*Below $F_{0.1}$*	
2001[1]	2001	9,700 mt	$F_{0.1}$	NA	NA	7,300 mt	*Below $F_{0.1}$*	
2002[1]	2002	10,700 mt	$F_{0.1}$	NA	NA	7,500 mt	*Below Fref = 0.26*	
Transition to TMGC process in following year; note catch year differs from TRAC year in following lines F's below are based on Age 5+								
2003	2004	(1) 20,000 mt (2) 8,000 mt	(1) Low risk of exceeding F_{ref} (2) Neutral risk of biomass decline	15,000 mt	Low risk of exceeding F_{ref} and reduction in biomass > 10%	11,800 mt Low risk of exceeding F_{ref}	*F = 0.17 Age 3+ biomass decrease of 27% 2004 to 2005* F = 0.283 Age 3+ biomass decreased 24% 2004 to 2005	In projection, PR on age 4 (2000 year class) was set to 1. Realized was 0.3. Fully recruited ages now 5 – 8.
2004	2005	26,000 mt	Neutral risk of exceeding F_{ref} Adult biomass will increase substantially 3+ B_{2006}=513,700 mt	23,000 mt	Low risk of exceeding F_{ref} Adult biomass will increase substantially	15,100 mt Low risk of exceeding F_{ref}	*F = 0.29 Age 3+ biomass increase of 142% 2005 to 2006* F = 0.258 Age 3+ biomass increased 106% 2005 to 2006 3+ B_{2006}=123,300 mt	Higher F due to lower realized PR and weights at age for 2003 year class and lower weights for 2000 year class. Large biomass increase due to 2003 year class.
2005	2006	22,000 mt/18,000 mt	Neutral/low risk of exceeding F_{ref} 3+ B_{2007}=157,400 mt	22,000 mt	Neutral risk of exceeding F_{ref}	12,642 mt Low risk of exceeding F_{ref}	*F = 0.36 Age 3+ biomass increase of 26% 2006 to 2007* F = 0.262 Age 3+ biomass increased 22% 2006 – 2007 3+ B_{2007}=150,900 mt	Higher F due to lower realized PR and weights at age for 2003 year class and lower weights for 2000 year class.

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TRAC	Catch Year	TRAC Analysis/Recommendation		TMGC Decision		Actual Catch/ Compared to Risk Analysis	Results	Comments[2]
		Amount	Rationale	Amount	Rationale			
2006	2007	19,000 mt/16,000 mt	Neutral/low risk of exceeding F_{ref} 3+ B_{2008}=161,900 mt	19,000 mt	Neutral risk of exceeding F_{ref}	12,680 mt Low risk of exceeding F_{ref}	*F = 0.14* *Age 3+ biomass increase of 4% 2007 – 2008* F = 0.136 Age 3+ biomass increased <1% 2007 to 2008 3+ B_{2008}=151,300 mt	2003 year class specific values for projection inputs.
2007	2008	26,700 mt/ 23,000 mt	Neutral/low risk of exceeding F_{ref} 3+ B_{2009}=145,700 mt	23,000 mt	Low risk of exceeding F_{ref}	15,995 mt Low risk of exceeding F_{ref}	*F = 0.09* *Age 3+ biomass increase of 7% 2008 to 2009* F = 0.087 Age 3+ biomass increased 6% 2008 to 2009 3+ B_{2009}=159,900 mt	2003 year class specific values for projection inputs.
2008	2009	33,000 mt /28,000 mt	Neutral/low risk of exceeding F_{ref} 3+ $B_{2010=}$125,500 mt	30,000 mt	Low to neutral risk of exceeding F_{ref}	19,707 mt Low risk of exceeding F_{ref}	*F = 0.13* *Age 3+ biomass decrease of 21% 2009 to 2010* F = 0.133 Age 3+ biomass decreased 22% 2009 to 2010 3+ B_{2010}=125,000 mt	2003 year class specific values for projection inputs.
2009	2010	29,600 mt/ 25,900 mt	Neutral/low risk of exceeding F_{ref} 3+ $B_{2011=}$94,700 mt	29,600 mt	Low to neutral risk of exceeding F_{ref}	18,794 mt Low risk of exceeding F_{ref}	*F = 0.148* *Age 3+ biomass decrease of 28% 2010 to 2011* F = 0.168 Age 3+ biomass decreased 29% 2010 to 2011 3+ B_{2011}=89,100 mt	2003 and 2005 year class specific values for projection inputs.
2010	2011	22,000 mt/ 19,000 mt	Neutral/low risk of exceeding F_{ref} 3+ $B_{2012=}$67,800 mt	22,000 mt	Neutral risk of exceeding F_{ref}	12,655 mt Low risk of exceeding F_{ref}	*F = 0.135* *Age 3+ biomass decrease of 29% 2011 to 2012* F = 0.152 Age 3+ biomass decreased 30% 2011 to 2012 3+ B_{2012}=62,700 mt	2003 and 2005 year class specific values for projection inputs.
2011	2012	16,000 mt/ 13,900 mt	Neutral/low risk of exceeding F_{ref} Adult biomass will increase substantially from 2012 to 2013 (2010 year class) 3+ $B_{2013=}$188,700 mt	16,000mt	Neutral risk of exceeding F_{ref}	5,631 mt Low risk of exceeding F_{ref}	*F = 0.157* *Age 3+ biomass increased 193% 2012 to 2013* *3+ B_{2013}=183,600 mt*	2003, 2005 and 2010 year class specific values for projection inputs. PR_{9+} for projection higher than model

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TRAC	Catch Year	TRAC Analysis/Recommendation		TMGC Decision		Actual Catch/ Compared to Risk	Results	Comments[2]
								estimate.
2012	2013	10,400 mt/ 9,300 mt	Neutral/low risk of exceeding F_{ref} Adult biomass will increase substantially from 2012 to 2013 (growth of 2010 year class) $3+B_{2014=}$ 306,000mt	10,400 mt	Neutral risk of exceeding F_{ref}	N/A	N/A	2003 year class values for 2010 year class inputs. Model estimate for PR_{9+} used for projection.
2013	2014	31,500 mt/ 27,000 mt	Neutral/low risk of exceeding F_{ref} Adult biomass will decrease slightly from series maximum projected for 2014. $3+B_{2015=}$240,000 mt	N/A	N/A	N/A	N/A	2003 year class values for 2010 year class inputs. Model estimate for PR_{9+} used for projection.

[1] Prior to implementation of US/CA Understanding
[2] Comments by L. Van Eeckhaute