B. GULF OF MAINE WINTER FLOUNDER – REVIEW PANEL SUMMARY

The Panel and workshop participants reviewed a draft report that updated the methods from SAW52 (NEFSC 2011) with fishery data through 2013 and survey data through spring 2014. The panel identified some new research publications that were not available at SAW52. Although those publications were not reviewed by all participants, the Panel evaluated SAW52 data and model decisions in the context of new research. The panel requested minor additions to the report and revisions of the draft text and recommended some topics for the research track.

Terms of Reference

1. Update all fishery-dependent data (landings, discards, catch-at-age, etc.) and all fishery-independent data (research survey information) used as inputs in the baseline model or in the last operational assessment.

The panel confirmed that there were no changes to the data protocols or modeling methods developed for SAW52. Recent catches remain low with a low discard rate and little recreational catch. Although a small portion of the annual catch limit was caught, industry participants reported that the low catch resulted from a large reduction in the inshore fleet and constraints in multispecies effort from catch limits of other species (e.g., yellowtail flounder, American plaice) and changes in mobile gear fishing patterns because of an increase in fixed gear in areas where the fleet would target winter flounder.

There were some conflicting recent survey trends, with general decreases in the NEFSC and MADMF indices (e.g., the 2014 MADMF spring index is the lowest on record), but stable or increasing MENH survey trends (e.g., the 2014 MENH spring index is the highest on record). A recent study documented shifting distributions of Gulf of Maine winter flounder to deeper and more northerly habitats (e.g., Nye et al. 2009). Recent field studies (Fairchild et al. 2009, DeCelles and Cadrin 2010) have also documented more frequent coastal spawning and less estuarine spawning than previously reported. The updated survey and catch data reflect the previous trends in distribution reported by SAW52. For example, the most recent spring survey estimate of biomass is greater than the fall survey biomass estimate, which may have resulted from more of the stock being in coastal waters during the spawning season. The Panel requested information on length distributions from recent surveys to investigate the possibility of more larger, mature fish in coastal strata in spring.

The decline in recreational catch may also result from less availability in estuaries. The recent increase in the MENH survey and decrease in MADMF and NEFSC surveys may have resulted from a continued northward shift. Contrary to the apparent northerly shifts in distribution, the majority of the fishery catch continues to come from statistical area 514 (Massachusetts Bay). The Panel recognized that the apparent shifts in distribution may have resulted from changes in survey timing (e.g., a general trend toward fall surveys extending later into November and the 2014 NEFSC spring survey being the latest ever).

The Panel noted that the survey designs assume random sampling within strata, but sampling may not be truly random because of fixed gear or hard bottom. Some of these issues may be addressed by examining the research vessel logs. The Panel requested information on geographic

distribution of recent survey data. The statistical distribution of the Bigelow survey data should be different than that of the Albatross survey data because of increased catchability. Therefore, the Panel requested distributional information for the entire Bigelow series (2009-2013). Issues of interference from fixed gear and hard bottom avoidance can be examined empirically from the research vessel logs (ie SHG/TOGA codes, failure to sample target sites etc.)

Recently published information on stock structure confirms SAW52 conclusions about stock definition. An interdisciplinary review of winter flounder stock structure (DeCelles and Cadrin 2011) found that the Gulf of Maine stock definition was supported by an examination of life history traits, seasonal movement patterns as indicated by tagging, parasite characteristics and meristics. Wirgin et al. (2014) used microsatellite DNA analysis of young-of-the year and adult winter flounder collected throughout the range of the species to conclude that winter flounder from the Gulf of Maine was marginally distinct from the collections from Georges Bank and Southern New England/Mid-Atlantic stocks, but the genetic differences were less pronounced than would have been expected based on the differences in life history characteristics that have been reported.

Recent publications also confirm the SAW52 method for deriving maturity at age from the time series average of MADMF macroscopic data. McBride et al. (2013) compared maturity assignment by macroscopic and microscopic methods and demonstrated that MADMF data more accurately represents onset of maturity than NEFSC data. McElroy et al. (2013) studied showed skipped spawning of winter flounder, but only found low (2%) incidence of skipped spawning in inshore winter flounder stocks, so that macroscopic maturity is not a biased approach to determining maturity.

2. Estimate fishing mortality and stock size for the current year, and update estimates of these parameters in previous years, if these have been revised.

The panel confirmed that there were no changes to assessment methodology developed for SAW52. This approach derives an estimate of 30+ cm biomass from combined NEFSC, MADMF and MENH fall surveys, assuming a wingspread catchability of 0.6, which is based on the Georges Bank winter flounder VPA. The SAW52 diagnostic test of comparing area-swept biomass estimates from overlapping MADMF and NEFSC inshore strata was updated. Unlike the SAW52 results, which had comparable biomass estimates from the two surveys, the MADMF fall surveys produced significantly greater biomass estimates than NEFSC fall surveys in recent years. Although the survey-based assessment approach may be robust to shifting distributions within the selected survey strata, movement out of the selected strata or to unsampled habitats would not be accounted for. Such shifts would also present problems for analytical stock assessment approaches.

3. Identify and quantify data and model uncertainty that can be considered for setting Acceptable Biological Catch limits.

The Panel confirms that the updated assessment includes the information needed to recommend ABC (e.g., estimates of exploitable biomass and measures of uncertainty). The Panel recommends continued application of the SAW52 approach for determining catch advice.

4. If appropriate, update the values of biological reference points (BRPs).

The SAW52 estimate of $F_{40\%}$ (0.31, 0.23 exploitation rate) from length-based spawner-per-recruit analysis was not revised. The Panel accepted that no new information was available to update the estimate.

5. Evaluate stock status with respect to updated status determination criteria.

The Panel accepts the stock status determined by updated assessment results (2013 exploitable biomass = 2,932 mt and 2013 exploitation rate=0.09) and the SAW52 estimate of $F_{40\%}$ (0.23). Therefore, the stock is not experiencing overfishing. The overfished status is unknown, but the Panel is concerned that recent biomass estimates substantially decreased despite relatively low catch. Reasons for the apparent decline in biomass are not well understood.

6. Perform short-term projections; compare results to rebuilding schedules.

Short-term projections are not possible using the area-swept survey biomass approach.

7. Comment on whether assessment diagnostics—or the availability of new types of assessment input data—indicate that a new assessment approach is warranted (i.e., referral to the research track).

Recent developments in the empirical approach of estimating exploitable biomass from area-swept survey data by the 2014 Transboundary Resources Assessment Committee (TRAC) should be reconciled with the approach developed by SAW52 for Gulf of Maine winter flounder. For example, the TRAC approach uses area swept based on doorspread to account for herding between the trawl doors and wings and an assumed 0.37 whole-net efficiency based on flatfish surveys in other regions. The SAW52 method addresses selectivity by estimating biomass of fully-selected sizes, but the TRAC method does not explicitly address selectivity. The Panel recommends that the empirical approach be considered in a research track assessment to reconcile methodological differences among assessments, consider estimates of catchability from field experiments, and to potentially improve the approach as a basis for fishery management.

The Panel discussed the possibility that catch rates in the commercial and recreational fisheries might help to reflect catch trends, but quantifying fishing effort targeted at winter flounder would be difficult.

8. Should the baseline model fail when applied in the operational assessment, provide guidance on how stock status might be evaluated. Should an alternative assessment approach not be readily available, provide guidance on the type of scientific and management advice that can be.

The panel concluded that the updated assessment is a reliable basis for fishery management and alternative approaches are not necessary at this time.

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B. GULF OF MAINE (GOM) WINTER FLOUNDER OPERATIONAL ASSESSMENT 2014

1.0 Background and Assessment History

Historically the Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) stock was the smallest of the three winter flounder stocks (Figure B1). Gulf of Maine winter flounder was first assessed in SARC 21 (1995) as an index based assessment. It was noted at that assessment that survey indices were low and relatively few large fish were seen in the survey size distributions. Survey Z estimates were high (1978-1993 mean of 1.21), and the stock was thought to be overexploited. The SARC 36/GARM 1 assessment in 2001 was the first analytical assessment (ADAPT VPA) for this stock. The stock was considered rebuilt, and overfishing was not occurring. In GARM II the ADAPT VPA model was updated through 2004 (NEFSC 2005). The GARM II assessment also concluded that the stock is not overfished and overfishing is not occurring. Spawning stock biomass was estimated to be at 3,400 mt and fully recruited F = 0.13 in 2004. SSB at B_{msy} was estimated to be at 4,100 mt and F_{msy} = 0.43. The GARM II VPA developed a severe retrospective pattern in F and a large overestimation of SSB. GARM II concluded that VPA results were too uncertain as a basis for performing projections.

In GARM III the review panel was unable to determine the stock's status relative to the BRPs but stated that trends in the population were very troubling (NEFSC 2008). The review panel generally agreed that the stock biomass was highly likely to be less than the B_{MSY} proxy and that there is a substantial probability that it was below the minimum stock size threshold. The split Virtual Population Analysis (VPA) model estimated spawning stock biomass in 2007 at 1,100 mt or about 29% of the B_{MSY} proxy (3,792 mt), and fishing mortality in 2007 was 0.42 or about 147% of $F_{40\%}$ = 0.28. The base case VPA and a split forward projection model (SCALE) which put higher weight on the recruitment indices suggested that the stock was not overfished and overfishing was not occurring. However the base case VPA had a severe retrospective pattern. The VPA showed greater reductions in biomass than observed in the survey biomass trends. All models had difficulty fitting the relatively flat age 1 and age 2 recruitment indices and the decrease in adult indices with the large decline in the catch at the end of the time series. The models were not accepted as a basis for status determinations. Therefore the stock status was unknown.

The next benchmark assessment occurred at SARC 52 in June 2011. The population models still had difficulty estimating population scale because of the conflicting data trends within the assessment, specifically the large decrease in the catch over the time series with very little change in the indices or age structure in both the catch and surveys. The scaling of the population estimates was sensitive to the weighting imposed on the catch at age compositions. The ASAP model did allow errors in the fit to the catch at age and improved fit to the surveys indices without the split in survey catchability. However, this approach resulted in a lack of fit to the plus group in the catch at age composition. Survey trends possibly may not reflect the population changes in response to the large decline in the catch over time if a greater proportion of the population historically remained within the estuaries in the early 1980s. However, the data are very limited on the extent of estuarine residing populations in the 1980s. The SARC-52 peer review panel concluded that ASAP, VPA, or SCALE models runs were not a suitable basis for management advice. Instead a 30+ cm swept-area biomass method using the MENH, MDMF, and NEFSC surveys was used to estimate exploitable biomass and the exploitation rate. Comparison of this exploitation rate to the estimated length based $F_{40\%}$ F_{MSY} proxy with a knife edge 30+ cm selectivity was used for the development of management advice. Exploitation rates based on 30+ area swept biomass assuming a q=0.6 were low and indicated that overfishing was

not occurring ($F_{2010}/F_{40\%} = 0.13$). Biomass based biological based reference points could not be estimated by using this method and remained unknown.

2.0 Fishery

Landings

Commercial landings were near 1,000 mt from 1964 to the mid-1970s. Thereafter commercial landings increased to a peaked of 2,793 mt in 1982 and then steadily declined to 350 mt in 1999. Landings have been near 650 mt from 2000 to 2004 and about 300 mt from 2005 to 2009. Landings have declined to a record low of 140 mt in 2010 (Table B1, Figure B2). The primary gear used was the otter trawl from 1964-1985 that accounted for an average of 95% of the landings (Table B2, Figure B2). Otter trawl accounted for an average of 80% of the landings from 1986- 2013 with an increase in the proportion of the landings coming from gillnets (20% from 1986-2013) (Table B2). Since 1999 around 95% percent of the landings are taken in Massachusetts from statistical area 514 (Figure B3). GOM winter flounder are landed throughout the year. However, a greater proportion of the landings have been coming from quarter three over the last ten years (Figure B2).

Recreational landings reached a peak in 1981 with 2,554 mt but declined substantially thereafter (Table B3). Recreational landings have generally been less than 100 mt since 1994, with exception of 2008 when the landings were estimated at 103 mt.

Discards

Discards were estimated for the large mesh trawl (1982-2013), gillnet (1986-2013), and northern shrimp fishery (1982-2013). Observer discard to landings of all species ratios were applied to corresponding commercial fishery landings to estimate discards in weight from 2004 to 2013 for the large mesh trawl, gillnet, and shrimp fishery for this assessment update (Table B4). As in the southern New England stock (NEFSC 1999), a 50% mortality rate was applied to all commercial discard data.

A discard mortality of 15% was assumed for recreational discards (B2 category from Marine Recreational Informatio Program [MRIP] data). Discards have been low, about 3,000 fish in 2012 and 2013 (Table B5, Figure B4). Discards in weight have been estimated by using a length weight relationship and a sampled length distribution of 10 fish measured in 2008. Length sampling of the B2 in recent years are inadequate for weight determination.

3.0 RESEARCH SURVEYS

Mean number per tow indices for the Northeast Fisheries Science Center (NEFSC) and the Massachusetts Division of Marine Fisheries (MDMF) spring and fall time series are presented in Table B6 and Figures B5 through B9. In 2009, the *NOAA SHIP Henry B. Bigelow* replaced the *R/V Albatross IV* as the primary vessel for conducting spring and fall annual bottom trawl surveys for the NEFSC. There are many differences in the vessel operation, gear, and towing procedures between the new and old research platforms. For most flatfishes there is evidence for differences in selectivity at length between the two survey vessels. The SARC 52 estimated length based gulf of Maine winter flounder calibration was used to convert the survey indices from 2009 to 2013 into Albatross equivalent units.

All of the indices generally show a slight decrease in the population in the late 1980s from a high in the early 1980s with low abundance remaining through the early 1990s. All of the indices show signs of increase abundance starting in 1998 and 1999. More recently there are decreases in abundance seen in the NEFSC fall, MDMF spring, and MDMF fall surveys while the NEFSC spring survey remained more stable (Figure B5).

Maine and New Hampshire (MENH) have been conducting an inshore bottom trawl survey in the spring since 2001 and in the fall since 2000. These survey indices are relatively flat over the time series with slightly higher abundance in the fall 2010 (Figure B9). However the MENH survey catches relatively few fish over 30 cms (Figure B10).

Gulf of Maine winter flounder inshore and offshore NEFSC survey spatial distribution plots, 30+ cm NEFSC and MDMF length frequency distributions and percent positive tows by strata are shown in appendix B1.

4.0 ASSESSMENT

Gulf of Maine winter flounder exploitation rates using 30+ cm biomass from survey area swept estimates

Direct estimates of exploitable biomass through area swept estimates are now possible with the recent improvements in fishery independent data sources. The NEFSC (RV Bigelow series), MDMF, and MENH surveys catch significant numbers of winter flounder per tow (Figures B5 through B9). The change in the NEFSC survey vessel and gear to the Bigelow in 2009 has resulted in higher catch efficiency relative to the Albatross series. In addition, the sampling intensity has also increased in most of the NEFSC inshore strata for the Gulf of Maine. The MENH survey covers a large area of this stock that was previous missing prior to 2000. Exploitation rates can be estimated from using a range of assumed survey efficiencies (Q) along with consideration of survey stock area coverage. Possible bounds on the likely recent exploitation rate can also be determined. The range of the estimates using different assumptions may help show what the likely exploitation rates are under different catches. A knife edge approximation of exploitable biomass was assumed as legal sized 30+ cm numbers converted to weight from a length-weight equation. Exploitable biomass was estimated as;

Exploitable Biomass = (30+ cm biomass index per tow /1000) x (total survey Area/tow footprint) x (1/q)

and exploitation rate as;

Exploitation rate = catch / 30+ cm biomass

Estimated area swept biomass from nonoverlapping strata from three different surveys (NEFSC, MENH, MDMF) was used to determine the exploitation rate and overfishing status for Gulf of Maine winter flounder (Tables B7 and B8, Figure B11). However, determination on whether the stock is overfished cannot be made since biomass reference points remain unknown.

Exploitable 30+ cm biomass and exploitation rates with the associated error distribution were estimated from 2009 to spring 2014 and fall 2013 (Tables B9 and B10, Figure B12) by using the Survey Area Graphical Analysis (SAGA) and the updated Bigelow Tow Operation Gear Acquisition (TOGA) tow criteria (123x) which considers net performance sensor data for tow evaluation. The 80% confidence intervals were plotted to evaluate the interannual variation for each survey component (Figure B12). An analysis limited to strata which overlapped both the NEFSC Bigelow and MDMF survey was also updated in this assessment. Slightly lower biomass estimates in the NEFSC Fall in 2011 to 2013 are seen relative to the area adjusted (area overlap difference) MDMF biomass estimate (Table B8, Figures B13 - B15). The exact reasons for larger differences between the surveys in recent years are unknown. More recently the MDMF fall survey suggests a higher relative area swept estimate in comparison to the NEFSC fall survey. A comparison of the survey components used in the combined estimate (MDMF, MENH, and

NEFSC surveys) between the spring and the fall surveys shows that a higher proportion of the stock is closer to shore in the spring (Table B9, Figure B16). In SARC 52 the fall 2010 survey estimate was used for exploitation determination since a lower overall 30+ biomass estimates in the spring may be a function of unavailable fish to the surveys that are residing inside the estuaries during the spring spawning season. However, recent reductions in the update fall indices now indicate that total fall 30+ cm biomass indices are similar or lower than the spring estimates. Note that the large reduction in the 2014 MDMF spring index was offset by an increase in the MENH 2014 spring index. Updated surveys show fairly stable spring survey estimates from 2009-2013 relative to the fall indices that showed a larger reduction in biomass since 2010. Also, remember the combined fall 2010 estimate from SARC 52 was based on a different strata set among the surveys since the MDMF strata in Cape Cod Bay were used to account for the missing inshore strata coverage in the NEFSC fall 2010 survey (Table B8).

At the SARC 52 SMAST Fishermen's input meeting, fishermen suggested that herding between the doors and ground cable is important for the catchability of winter flounder. However, questions still remain whether this may be more important in the commercial fishery targeted flatfish tows where tow speeds tend to be about a knot slower than the survey tows (3 knots). Area swept estimates using the doors for the footprint calculation were also done as a sensitivity analysis (Table B10). Area swept estimates coming from the Georges Bank empirical yellowtail benchmark assessment based the area swept estimates on doors spread and an average q estimate taken from the literature (q=0.37) (Somerton et al. 2007; Harden Jones et al. 1977). Gulf of Maine winter flounder area swept estimates using the doors and a q = 0.37 estimate a similar biomass as assuming 100% efficiency on the wing spread (Q=0.37 door spread fall 2013 biomass = 1,852 mt and Q=1.0 wing spread fall 2013 biomass = 1,759 mt) (Tables B9 and B10).

Biological Reference Points

As in SARC 52, biomass based biological reference points remain unknown. The $F_{40\%}$ F_{MSY} poxy was not updated for this assessment because of limited new data to inform the reference points. At SARC 52, a proxy value of the overfishing threshold was derived for the 2011 assessment from a length-based yield per recruit (NFT2011) analysis that assumes all fish above 30 cm are fully recruited to the fishery and that natural mortality is 0.3 (Figure B17). Von Bertalanffy parameters were estimated from the spring and fall NEFSC survey age data (n = 2,035), and the maturity at length information was estimated from the spring MDMF survey (L_{50}=29cm). The reference points were converted to exploitation rates to be consistent with the swept area biomass approach. An $F_{40\%}$ exploitation rate was estimated at 0.23, and 75%$F_{40\%}$ exploitation was 0.17 with M=0.3.

Uncertainty Estimates

Methods

The sampling distributions of biomass and fishing mortality are approximated by integrating over the factors which constitute the primary sources of uncertainty. These factors include the sampling variability in NEFSC, MADMF, and MENH spring and fall bottom surveys updated from 2011 through fall 2013 and spring 2014. The second major source of variability for the survey estimates is the variation in the size of the area swept by an average tow. The sample means and variances for each of these factors were used to parameterize their respective normal distributions. Sampling theory and boot-strapping analyses for other species suggests that the survey means should be asymptotically normal. We exploit this feature to simplify the estimation of the sampling distribution of biomass and exploitation rate.

The estimator of total stock size can be written as

$$B_{Tot} = A_{NEFSC}\frac{I_{NEFSC}}{e\ a_{NEFSC}} + A_{MADMF}\frac{I_{MADMF}}{e\ a_{MADMF}} + A_{MENH}\frac{I_{MENH}}{e\ a_{MENH}} \text{ (Eq. 1)}$$

Where **A** represents the total stratum area, **I** represents the mean index of abundance (kg/tow) for winter flounder greater than 30 cm, **a** represents the average area swept per tow, and **e** represents the trawl efficiency (probability of capture given encounter). Each of the measures of survey abundance and swept area are measured with uncertainty. In this exercise it is assumed that the total stratum area **A** is constant and measured without error. The gear efficiency **e** is unknown but cannot be greater than 1 unless significant herding occurs. If herding does occur, the maximum efficiency is approximately equal to the ratio of the trawl door width to the wing width. For the purposes of this exercise, gear efficiency was examined over a range of values between 0.6 and 1.0. The sampling distribution B_{tot} can be estimated by integrating over all possible sources of variation. In this exercise there are six normally distributed random variables to consider: I_{NEFSC}, I_{MADMF}, I_{MENH}, a_{NEFSC}, a_{MADMF}, and a_{MENH}. The means and variances of these variables are summarized in Table B11. The variance of the footprints for the MADMF and MENH survey were not measured. It was assumed that the CV of these estimates was equal to the estimates for the NEFSC survey. All NEFSC survey estimates were conducted on the FSV Bigelow.

The sampling distribution of each of the Fs described above was evaluated by integrating over each of the normal distributions for average weight I, survey footprint ***a.*** The density **I** and footprint ***a*** parameters were evaluated over 40 equal probability intervals. The full evaluation of the six sources of variability required 40^6 = 4,096,000,000 evaluations. The proposed method is sometimes known as a Latin hypercube approach because it samples each of the distributions over equal probability intervals. In contrast, a parametric bootstrap sampling randomly from each of the component distributions may not adequately characterize the underlying variability. This of course could be tested and compared with the Latin hypercube approach.

Let Φ = Normal cumulative distribution function. The inverse of Φ, denoted as Φ^{-1} , allows the evaluation of a set of values over a specified range, say α_{min} and α_{max} , over equal probability intervals. The value of the random variable X associated with the α level is defined as:

$$I'_{\alpha} = \Phi^{-1}(\alpha \mid \bar{I}, S_I^2) \qquad \text{(Eq. 2)}$$

The step size between successive values of α was set as δ = 1/40 (0.975-0.025), where α_{min} = 0.025 and α_{max} = 0.975. An equivalent approach was used for evaluation of the footprint parameter **a** where a~N(μ_a , σ_a^2).

This property can be illustrated for the biomass estimates by substituting Eq. 2 into Eq. 1 and integrating over all possible step sizes. Let i, j, k, l, m, n represent the indices for survey and footprint components, and let a prime denote the value of each component that is derived by evaluating Eq. 2. corresponding the α probability level.

The expected value of $\boldsymbol{B_{tot}}$ is obtained by summing over the sampling distributions of ***X*** and ***a*** as follows:

$$E[B_{Tot}] = \sum_{i=1}^{40}\sum_{j=1}^{40}\sum_{k=1}^{40}\sum_{l=1}^{40}\sum_{m=1}^{40}\sum_{n=1}^{40}\left[A_{NEFSC}\frac{I'_i}{e\ a'_j} + A_{MADMF}\frac{I'_k}{e\ a'_l} + A_{MENH}\frac{I'_m}{e\ a'_n}\right]\delta^6$$

(Eq .3)

The sampling distribution of ***Btot*** can be constructed by noting that the each element within the right side brackets of Equation 3 has a probability weight of $\delta = (1/40)$.

The sampling distribution of F is simply the assumed value of the quota divided by the estimate of the biomass in Equation 3. This approximation of the multidimensional integration provides reasonable assurance that the sampling distribution of the F and B will be appropriately estimated.

Results of Uncertainty Analyses

Summary statistics for the biomass estimates are provided in Tables B12 and B13 and plotted in Figures B18 and B19. Under the null hypothesis that the distribution is normally distributed, the sample statistics for skewness and kurtosis estimates have expected values of zero. Values of skewness greater than zero indicate positive skewing (i.e., a longer tail on the right or in a positive direction from the mean). Values of kurtosis greater than zero provide evidence that the sampling distribution is more peaked than a normal distribution with a comparable mean and variance.

Exploitation rate distributions relative to exploitation rate biological reference points are shown in Table B14 and Figures B20 - B24. Comparison between the SARC 52 and this operational update of the probability of exceeding candidate biological reference points are provided graphically in Figures B21 - B24.

5.0 Survey Area Swept Biomass and Exploitation Rate Conclusions

At SARC 52 the use of a survey efficiency value (q) of 0.6 was supported by comparison of VPA estimates of efficiency for Georges Bank winter flounder while making the assumption that the same fraction of each stock is available to the respective surveys. The NEFSC fall survey (expressed in Albatross equivalents) had an efficiency estimate of 0.3. Calibration experiments between the FSV Bigelow and the R/V Albatross revealed a biomass conversion coefficient of ~2. Thus, an efficiency estimate for the Bigelow survey estimate in 2010 of 0.6 was supported.

SARC 52 concluded that the best estimate of 30+ cm biomass and recent (2010) exploitation was based on use of the TOGA tow criteria for the most recent fall 2010 surveys assuming an efficiency q of 0.6. In this 2014 operational update, the catch increased slightly from 195 in 2010 to 253 mt in 2013 and the survey based swept area estimate of biomass for winter flounder exceeding 30 cm in length decreased from 6,341 mt in 2010 to 2,932 mt in 2013 based on the fall surveys. Therefore exploitation rate increased from 0.03 (80% CI 0.02 - 0.05) in 2010 to 0.09 (80% CI 0.05 - 0.18) in 2013 (Figure B25). However, overfishing is still not occurring (F_{2013}/F_{40} ratio = 0.32, Figure B26) in 2013 based on a q=0.6 using the wing spread area swept estimates. Estimated exploitation rates would be higher (0.14), but the overfishing status would not have changed if area swept biomass estimates had been based on a q of 0.37 using the door spread which was used for the recent 2014 Georges Bank yellowtail empirical benchmark assessment. In addition, biomass estimates were similar between the spring and fall surveys for both 2012 and 2013 (not statistically different), and therefore the results would not differ greatly between surveys. The difficulty is with the rationale on why recent biomass estimates decreased to less than half of the estimates from 2010 when the catch remained far below the overfishing level of 1,458 mt (F_{40}). Questions remain on why increases in biomass were not realized with the low removals ranging from 217 - 380 mt in the last three years (Figure B26).

Biomass and exploitation rate estimates are sensitive to the assumed survey q (Figure B27). Therefore the estimated Overfishing Limits (OFLs) and ABC will also be sensitive to this

assumption. Updated OFLs and ABCs based strictly on the SARC 52 method (q=0.6 on the wing spread) decreased from 1,458 mt to 688 mt and from 1,078 mt to 510 mt respectively using the 2010 and 2013 fall surveys. Survey efficiency studies are needed to better determine the true efficiency (Q) in the surveys. The Q assumption that was used in the Georges Bank yellowtail assessment would translate into a higher efficiency on the wing spread and lower biomass than what was used in the SARC 52 GOM winter flounder assessment. However, catch advice (ABCs) would still have resulted in high catch limits than the removals that occurred if the SARC 52 catch advice was instead based on the Georges Bank yellowtail Q assumption.

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Table B1. Winter flounder (*Pseudopleuronectes americanus*) commercial landings (metric tons) for the Gulf of Maine stock (US statistical reporting areas 511 - 515). Landings from 1964-1977 are taken from SARC 21, 1982-1993 are estimated from the WODETS data, 1994-2013 is estimated using the trip based allocated AA tables.

Year	metric tons	Year	Metric tons
1964	1,081	1990	1,116
1965	665	1991	1,008
1966	785	1992	825
1967	803	1993	611
1968	864	1994	543
1969	975	1995	707
1970	1,092	1996	606
1971	1,113	1997	569
1972	1,085	1998	643
1973	1,080	1999	350
1974	885	2000	535
1975	1,181	2001	700
1976	1,465	2002	694
1977	2,161	2003	755
1978	2,194	2004	623
1979	2,021	2005	336
1980	2,437	2006	201
1981	2,407	2007	254
1982	2,793	2008	288
1983	2,096	2009	283
1984	1,699	2010	140
1985	1,582	2011	173
1986	1,188	2012	348
1987	1,140	2013	218
1988	1,250		
1989	1,253		

Table B2. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) commercial landings (metric tons) by gear.

Year	Trawl	Shrimp	Gillnet	Other	Total
1982	2,485	151	59	99	2,793
1983	1,819	142	54	80	2,096
1984	1,438	139	26	96	1,699
1985	1,446	62	16	59	1,582
1986	912	69	164	42	1,188
1987	848	97	135	60	1,140
1988	1,016	61	161	12	1,250
1989	1,008	58	138	48	1,253
1990	857	25	214	21	1,116
1991	868	22	94	25	1,008
1992	632	17	160	16	825
1993	460	1	138	13	611
1994	438	0	100	5	543
1995	511	1	184	10	706
1996	464	0	135	6	606
1997	426	0	134	9	569
1998	461	0	176	6	643
1999	248	0	101	1	350
2000	412	0	122	1	535
2001	531	0	160	9	700
2002	596	0	82	15	694
2003	565	0	185	5	755
2004	427	0	137	59	623
2005	230	0	67	38	336
2006	133	0	47	21	201
2007	163	0	53	38	254
2008	196	0	57	35	288
2009	202	0	67	14	283
2010	83	0	49	7	139
2011	112	0	50	12	173
2012	248	0	57	43	348
2013	177	0	32	9	218

Table B3. Estimated number (in thousands) and weight for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) caught, landed, and discarded in the recreational fishery. Marine Recreational Fisheries Statistics Survey (MRFSS) estimates from 1981-2003 and Marine Recreational Information Program (MRIP) estimates from 2004-2013.

	Numbers (000's)				Metric tons
	Catch	Landed	Released	15% Release	Landed
year	A+B+B2	A+B1	B2	Mortality	A+B1
1981	6,200	5,433	767	115	2,554
1982	8,207	7,274	933	140	1,876
1983	2,169	1,988	181	27	868
1984	2,477	2,285	191	29	1,300
1985	3,694	3,220	474	71	1,896
1986	946	691	255	38	523
1987	3,070	2,391	679	102	1,809
1988	953	841	111	17	345
1989	1,971	1,678	294	44	620
1990	786	652	134	20	370
1991	213	154	59	9	91
1992	186	137	48	7	90
1993	398	249	150	22	140
1994	232	145	88	13	83
1995	150	83	67	10	40
1996	183	98	86	13	56
1997	192	64	129	19	43
1998	109	65	44	7	30
1999	109	65	44	7	33
2000	146	59	87	13	32
2001	173	72	102	15	45
2002	101	61	40	6	42
2003	86	52	34	5	32
2004	62	46	16	2	29
2005	82	40	42	6	23
2006	75	50	25	4	34
2007	75	49	26	4	28
2008	249	179	70	10	124
2009	190	97	94	14	60
2010	154	88	65	10	40
2011	138	80	58	9	37
2012	66	47	19	3	22
2013	63	42	20	3	28

Table B4. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) estimated large mesh trawl, shrimp, and gillnet discard ratios (discard/sum all species kept), estimated discard CVs, and estimated discards in metric tons.

	Discard Ratio			CV			Metric Tons		
	trawl			trawl			trawl		
year	lg mesh	shrimp	gillnet	lg mesh	shrimp	gillnet	lg mesh	shrimp	gillnet
2004	0.0022	0.0035	0.0011	0.28	0.27	0.27	60.61	3.83	7.65
2005	0.0025	0.0063	0.0003	0.27	0.41	0.22	46.95	5.52	2.21
2006	0.0019	0.0012	0.0001	0.32	0.33	0.42	20.89	1.49	0.85
2007	0.0032	0.0010	0.0002	0.33	0.33	0.39	29.73	2.08	1.33
2008	0.0015	0.0018	0.0002	0.24	0.26	0.43	17.12	3.40	1.76
2009	0.0015	0.0046	0.0003	0.19	0.33	0.29	16.19	5.62	2.31
2010	0.0004	0.0016	0.0001	0.26	0.42	0.16	4.80	5.61	0.82
2011	0.0005	0.0001	0.0001	0.11	0.00	0.09	5.95	0.36	0.90
2012	0.0013	0.0008	0.0002	0.11	0.29	0.08	17.08	1.41	1.16
2013	0.0009	0.0070	0.0001	0.17	0.32	0.18	9.74	1.36	0.45

Table B5. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) composition of the catch by weight (mt). A 50% mortality rate is assumed on gillnet, large mesh, and shrimp discards while a 15% mortality rate is assumed on recreational discards.

	Landings		Dead Discards				
year	recreational	commercial	recreational	gillnet	lg mesh	shrimp	Total
1981	2,270						
1982	3,024	2,793	11		343	7	6,178
1983	817	2,096	2		112	8	3,035
1984	1,103	1,699	3		67	12	2,883
1985	1,629	1,582	8		93	14	3,327
1986	411	1,188	5	12	63	16	1,696
1987	1,443	1,140	12	12	81	25	2,713
1988	537	1,250	2	12	106	19	1,927
1989	1,035	1,253	6	4	11	5	2,315
1990	344	1,116	3	22	5	21	1,511
1991	86	1,008	1	3	17	21	1,136
1992	77	825	1	12	7	24	947
1993	134	611	3	19	4	7	777
1994	77	543	2	6	6	6	640
1995	40	707	1	12	8	8	777
1996	52	606	2	6	2	7	675
1997	32	569	3	38	5	14	660
1998	27	643	1	7	7	4	690
1999	34	350	1	4	9	1	399
2000	31	535	2	12	3	3	587
2001	37	700	3	3	14	2	759
2002	35	694	1	5	17	0	752
2003	29	755	1	3	13	2	803
2004	29	623	1	4	30	2	689
2005	23	336	2	1	23	3	388
2006	34	201	1	0	10	1	248
2007	28	254	1	1	15	1	300
2008	124	288	3	1	9	2	426
2009	60	283	4	1	8	3	359
2010	40	140	3	0	2	3	188
2011	37	173	2	0	3	0	217
2012	22	348	1	1	9	1	380
2013	28	218	1	0	5	1	253

Table B6. Northeast Fisheries Science Center (NEFSC) and Massachusetts Division of Marine Fisheries (MDMF) survey indices of abundance for Gulf of Maine (GOM) winter flounder (*Pseudopleuronectes americanus*). Indices are stratified mean number and mean weight (kg) per tow. NEFSC indices are for inshore strata (58, 59, 60 ,61, 65, 66) and offshore strata (26, 27, 38, 39, 40). NEFSC indices are calculated with trawl door conversion factors where appropriate. NEFSC GOM Length based conversions were applied from 2009-2014. NEFSC fall 2010 (bold) did not sample Cape Cod Bay. MDMF uses strata 25-36.

	NEFSC spring		NEFSC fall		MA spring		MA fall	
year	number	weight	number	weight	number	weight	number	Weight
1978					98.258	20.430	57.454	12.217
1979	4.487	1.730	6.003	2.602	71.834	15.787	134.251	32.837
1980	5.586	2.391	13.141	6.553	72.142	19.108	83.805	17.868
1981	6.461	2.122	4.179	3.029	106.341	30.383	50.847	13.595
1982	7.670	3.022	4.201	1.924	61.612	14.713	108.203	24.418
1983	12.367	5.653	10.304	3.519	112.487	28.984	76.658	15.143
1984	5.155	1.979	7.732	3.106	68.949	16.716	39.541	12.212
1985	3.469	1.418	7.638	2.324	54.210	15.302	48.677	8.288
1986	2.342	0.998	2.502	0.938	68.984	16.352	44.646	6.920
1987	5.609	1.503	1.605	0.488	85.180	18.640	54.434	8.018
1988	6.897	1.649	3.000	1.030	54.039	11.266	38.419	8.237
1989	3.717	1.316	6.402	2.013	64.696	13.940	39.249	8.602
1990	5.415	2.252	3.527	1.177	82.125	14.375	67.661	13.218
1991	4.517	1.436	7.035	1.467	46.630	11.513	101.716	17.580
1992	3.932	1.160	10.447	3.096	79.000	15.356	87.581	15.089
1993	1.556	0.353	7.559	1.859	78.018	12.051	93.527	15.109
1994	3.481	0.891	4.870	1.319	72.578	9.779	67.789	13.246
1995	12.185	3.149	4.765	1.446	89.361	14.960	76.736	15.092
1996	2.736	0.732	10.099	3.116	70.494	12.082	77.006	13.144
1997	2.806	0.664	10.008	2.950	85.396	12.959	78.402	14.438
1998	2.001	0.527	3.218	0.987	77.771	13.473	98.450	15.454
1999	6.510	1.982	10.921	3.269	80.776	14.957	125.742	23.204
2000	10.383	2.885	12.705	5.065	162.190	34.160	99.953	25.100
2001	5.242	1.663	8.786	3.133	89.743	24.510	81.072	17.743
2002	12.066	3.692	10.691	4.003	91.083	22.391	65.812	16.264
2003	7.839	2.544	10.182	4.315	83.693	17.323	90.477	15.801
2004	3.879	1.103	2.763	0.867	79.115	11.201	107.591	14.091
2005	6.920	2.056	8.807	2.314	94.044	11.980	78.591	11.812
2006	4.173	1.211	7.117	2.346	85.548	14.434	86.985	15.463
2007	2.500	0.717	6.378	1.820	53.583	10.060	76.669	11.599
2008	11.543	2.177	13.319	4.692	46.863	8.424	90.919	18.085
2008	11.543	2.177	13.319	4.692	46.863	8.424	90.919	18.086
2009	6.846	1.528	13.176	3.163	71.316	12.277	108.996	22.677
2010	5.023	1.178	**12.046**	**2.561**	68.235	13.676	104.672	18.612
2011	3.345	0.767	10.352	2.714	66.492	9.134	152.607	25.434
2012	7.237	1.509	8.111	1.845	71.541	10.876	83.228	14.090
2013	5.465	1.157	4.533	1.287	58.518	10.415	47.838	9.610
2014	7.877	1.690			30.879	5.348		

Table B7. Survey total area coverage, average tow footprint, expansion factors, tow duration, and average numbers per tow for nonoverlapping strata used in the combined estimate. NEFSC = Northeast Fisheries Science Center. MDMF = Massachusetts Division of Marine Fisheries. MENH = Maine and New Hampshire

	Combined Survey Estimate		
	NEFSC	MDMF	MENH
survey area (nm2)	2,990	309	3,475
Avg tow (wing area swept)	0.00700	0.00385	0.00462
Total area/tow footprint	427,143	80,343	752,154
Tow duration	20 min	20 min	20 min
Numbers per tow	34-65	80	35

Table B8. Survey total area coverage, average tow footprint, kg/tow expansion factors and tow during for the different surveys and survey nonoverlapping components (Northeast Fisheries Science Center [NEFSC] combined, Massachusetts Division of Marine Fisheries [MDMF] near shore, Maine and New Hampshire [MENH] state waters). NEFSC combined (offshore (39, 40 ,26) = 2322 nm^2 + NEFSC inshore overlap (59 ,60, 61, 64, 65, 66) = 668 nm^2), MDMF overlap (27, 28, 29, 30, 34, 35, 36) = 484 nm^2, MDMF near shore (25, 26, 31, 32, 33) = 309 nm^2.

A. Wing spread

	NEFSC (Bigelow)			Gloria Michele (MDMF)			MENH
	inshore overlap	Fall 2010	combined	overlap	Fall 2010	near shore	state waters
survey area (nm2)	668	2,638	2,990	484	633	309	3,475
Avg tow (area swept)	0.0070	0.0070	0.0070	0.0038	0.0038	0.0038	0.0046
Total area/tow footprint	95,429	376,857	427,143	125,845	164,587	80,343	752,165
Tow duration	20 min	20 min	20 min	20 min	20 min	20 min	20 min

B. Door spread

	NEFSC (Bigelow)			Gloria Michele (MDMF)			MENH
	inshore overlap	Fall 2010	combined	overlap	Fall 2010	near shore	state waters
survey area (nm2)	668	2,638	2,990	484	633	309	3,475
Avg tow (area swept)	0.0173	0.0173	0.0173	0.0125	0.0125	0.0125	0.0123
Total area/tow footprint	38,657	152,662	173,032	38,758	50,690	24,744	282,469
Tow duration	20 min	20 min	20 min	20 min	20 min	20 min	20 min

Table B9. A range of estimated 30+ cm biomass based on WING spread and exploitation rates for the combined survey estimate using Bigelow spring 2009 to 2014 and Bigelow fall 2009 to 2013 data with a range of qs assumptions (0.6, 0.8, & 1.0) and a range of assumed catch (mt) (2013=253, 2012=380, SARC 52 ABC=1078, OFL=1,458) based on a Tow Operation Gear Acquisition (TOGA) criterion of 132x. The proportion of the biomass in each survey area is also shown. * Fall 2010 estimate is based on a different strata set since the Northeast Fisheries Science Center (NEFSC) fall survey did not cover Cape Cod bay strata. MDMF = Massachusetts Division of Marine Fisheries. MENH = Maine and New Hampshire. ABC = Acceptable Biological Catch. OFL = Overfishing Limit.

Q = 1.0				Total	2013	2012	abc	OFL
	NEFSC	MDMF	MENH	30+ biomass	253	380	1078	1458
Spring 2009	0.56	0.25	0.19	3,212	0.08	0.12	0.34	0.45
Spring 2010	0.45	0.33	0.21	2,594	0.10	0.15	0.42	0.56
Spring 2011	0.40	0.33	0.28	1,536	0.16	0.25	0.70	0.95
Spring 2012	0.66	0.21	0.13	2,336	0.11	0.16	0.46	0.62
Spring 2013	0.51	0.33	0.16	1,931	0.13	0.20	0.56	0.75
Spring 2014	0.58	0.12	0.30	2,533	0.10	0.15	0.43	0.58
2012-2014 avg	0.58	0.22	0.20	2,267	0.11	0.17	0.48	0.65
Fall 2009	0.90	0.06	0.03	4,567	0.06	0.08	0.24	0.32
Fall 2010*	0.69	0.26	0.05	3,804	0.07	0.10	0.28	0.38
Fall 2011	0.81	0.14	0.05	3,999	0.06	0.10	0.27	0.36
Fall 2012	0.82	0.09	0.09	2,002	0.13	0.19	0.54	0.73
Fall 2013	0.73	0.11	0.16	1,759	0.14	0.22	0.61	0.83
2011-2013 avg	0.79	0.11	0.10	1,881	0.13	0.20	0.57	0.78

Q = 0.8				Total	2013	2012	abc	OFL
	NEFSC	MDMF	MENH	30+ biomass	253	380	1078	1458
Spring 2009	0.56	0.25	0.19	4,015	0.06	0.09	0.27	0.36
Spring 2010	0.45	0.33	0.21	3,243	0.08	0.12	0.33	0.45
Spring 2011	0.40	0.33	0.28	1,920	0.13	0.20	0.56	0.76
Spring 2012	0.66	0.21	0.13	2,920	0.09	0.13	0.37	0.50
Spring 2013	0.51	0.33	0.16	2,414	0.10	0.16	0.45	0.60
Spring 2014	0.58	0.12	0.30	3,166	0.08	0.12	0.34	0.46
2012-2014 avg	0.58	0.22	0.20	2,833	0.09	0.14	0.39	0.52
Fall 2009	0.90	0.06	0.03	5,709	0.04	0.07	0.19	0.26
Fall 2010*	0.69	0.26	0.05	4,756	0.05	0.08	0.23	0.31
Fall 2011	0.81	0.14	0.05	4,999	0.05	0.08	0.22	0.29
Fall 2012	0.82	0.09	0.09	2,503	0.10	0.15	0.43	0.58
Fall 2013	0.73	0.11	0.16	2,199	0.12	0.17	0.49	0.66
2011-2013 avg	0.79	0.11	0.10	2,351	0.11	0.16	0.46	0.62

Q = 0.6				Total	2013	2012	abc	OFL
	NEFSC	MDMF	MENH	30+ biomass	253	380	1078	1458
Spring 2009	0.56	0.25	0.19	5,354	0.05	0.07	0.20	0.27
Spring 2010	0.45	0.33	0.21	4,324	0.06	0.09	0.25	0.34
Spring 2011	0.40	0.33	0.28	2,559	0.10	0.15	0.42	0.57
Spring 2012	0.66	0.21	0.13	3,894	0.06	0.10	0.28	0.37
Spring 2013	0.51	0.33	0.16	3,219	0.08	0.12	0.33	0.45
Spring 2014	0.58	0.12	0.30	4,221	0.06	0.09	0.26	0.35
2012-2014 avg	0.58	0.22	0.20	3,778	0.07	0.10	0.29	0.39
Fall 2009	0.90	0.06	0.03	7,612	0.03	0.05	0.14	0.19
Fall 2010*	0.69	0.26	0.05	6,341	0.04	0.06	0.17	0.23
Fall 2011	0.81	0.14	0.05	6,666	0.04	0.06	0.16	0.22
Fall 2012	0.82	0.09	0.09	3,337	0.08	0.11	0.32	0.44
Fall 2013	0.73	0.11	0.16	2,932	0.09	0.13	0.37	0.50
2011-2013 avg	0.79	0.11	0.10	3,135	0.08	0.12	0.34	0.47

Table B10. A range of estimated 30+ cm biomass based on DOOR spread and exploitation rates for the combined survey estimate using Bigelow spring 2009 to 2014 and Bigelow fall 2009 to 2013 with an assumed q=0.37 (literature value used for Georges Bank yellowtail) and a range of assumed catch (mt) (2013=253, 2012=380, SARC 52 ABC=1078, OFL=1,458) based on a Tow Operation Gear Acquisition (TOGA) criterion of 132x. The proportion of the biomass in each survey area is also shown. * Fall 2010 estimate is based on a different strata set since the NEFSC fall survey did not cover Cape Cod bay strata. NEFSC = Northeast Fisheries Science Center. MDMF = Massachusetts Division of Marine Fisheries. MENH = Maine and New Hampshire. ABC = Acceptable Biological Catch. OFL = Overfishing Limit.

	NEFSC	MDMF	ME/NH	Total 30+ biomass	2013 253	2012 380	abc 1078	OFL 1458
Spring 2009	0.60	0.21	0.19	3,255	0.08	0.12	0.33	0.45
Spring 2010	0.50	0.28	0.22	2,569	0.10	0.15	0.42	0.57
Spring 2011	0.44	0.28	0.29	1,516	0.17	0.25	0.71	0.96
Spring 2012	0.70	0.17	0.13	2,403	0.11	0.16	0.45	0.61
Spring 2013	0.56	0.27	0.17	1,923	0.13	0.20	0.56	0.76
Spring 2014	0.61	0.10	0.29	2,630	0.10	0.14	0.41	0.55
2012-2014 avg	0.62	0.18	0.19	2,319	0.11	0.16	0.46	0.63
Fall 2009	0.92	0.05	0.03	4,912	0.05	0.08	0.22	0.30
Fall 2010*	0.74	0.21	0.05	3,893	0.06	0.10	0.28	0.37
Fall 2011	0.84	0.11	0.05	4,216	0.06	0.09	0.26	0.35
Fall 2012	0.85	0.07	0.08	2,132	0.12	0.18	0.51	0.68
Fall 2013	0.76	0.09	0.15	1,852	0.14	0.21	0.58	0.79
2011-2013 avg	0.82	0.09	0.09	1,992	0.13	0.19	0.54	0.73

Table B11. Summary of uncertainty model input data for estimation of updated swept area biomass estimates for Gulf of Maine winter flounder **(***Pseudopleuronectes americanus***)**. NEFSC = Northeast Fisheries Science Center. MADMF = Massachusetts Division of Marine Fisheries. MENH = Maine and New Hampshire. ABC = Acceptable Biological Catch. OFL = Overfishing Limit.

Survey	Season	Year	Total Survey Area in	Area per tow in nm^2 (SE)	Survey in kg/tow (SE)
NEFSC	Fall	2011	2990	0.006974755 0.000835526	7.58160 1.89494
MADMF			309	0.003846 0.0004607	6.95300 1.36203
ME-NH			3475	0.00462 0.000553443	0.26902 0.03428
NEFSC	Fall	2012	2990	0.006974755 0.000835526	3.86460 0.51401
MADMF			309	0.003846 0.0004607	2.22835 0.86196
ME-NH			3475	0.00462 0.000553443	0.22957 0.04138
NEFSC	Fall	2013	2990	0.006974755 0.000835526	3.00956 1.91193
MADMF			309	0.003846 0.0004607	2.47407 0.42430
ME-NH			3475	0.00462 0.000553443	0.36564 0.05090
NEFSC	spring	2011	2990	0.006974755 0.000835526	1.42612 0.43308
MADMF			309	0.003846 0.0004607	6.23390 1.29496
ME-NH			3475	0.00462 0.000553443	0.56596 0.24210
NEFSC	spring	2012	2990	0.006974755 0.000835526	3.60241 1.00922
MADMF			309	0.003846 0.0004607	6.23518 1.34671
ME-NH			3475	0.00462 0.000553443	0.39419 0.14960
NEFSC	spring	2013	2990	0.006974755 0.000835526	2.29905 0.37989
MADMF			309	0.003846 0.0004607	7.87736 1.12588
ME-NH			3475	0.00462 0.000553443	0.42051 0.08807
NEFSC	spring	2014	2990	0.006974755 0.000835526	3.42422 1.20931
MADMF			309	0.003846 0.0004607	3.90166 0.70399
ME-NH			3475	0.00462 0.000553443	1.00579 0.68373

Table B12. Summary of estimated sampling distribution of biomass estimates for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) for spring surveys from 2011 to 2014 under assumed efficiency estimates of 1.0, 0.8, and 0.6.

	Spring 2011			Spring 2012			Spring 2013			Spring 2014		
	Q=1.0	Q=0.8	Q=0.6	Q=1.0	Q=0.8	Q=0.6	Q=1.0	Q=0.8	Q=0.6	Q=1.0	Q=0.8	Q=0.6
Minimum	760	960	1300	1210	1530	2060	1300	1630	2200	730	940	1290
Maximum	2530	3150	4170	3930	4880	6470	2780	3460	4590	4850	6020	7820
Range	1770	2190	2870	2720	3350	4410	1480	1830	2390	4120	5080	6530
Mean	1553.6	1945.7	2599.3	2369.8	2965.9	3959.0	1945.1	2435.0	3251.7	2587.588	3238.1	3509.5
Std Dev	264.2	329.8	439.1	440.4	549.7	731.6	216.3	270.1	359.6	665.777	830.9	639.2
C.V.	0.17	0.169	0.169	0.186	0.185	0.185	0.111	0.111	0.111	0.257	0.257	0.182
Skewness(G1)	0.172	0.171	0.169	0.263	0.262	0.259	0.246	0.244	0.242	0.165	0.162	-0.621
Kurtosis(G2)	-0.172	-0.181	-0.19	-0.266	-0.274	-0.284	-0.113	-0.124	-0.134	-0.26	-0.27	0.078
Percentiles												
1%	990	1240	1660	1490	1870	2500	1490	1870	2500	1180	1480	1830
5%	1130	1420	1900	1680	2110	2820	1610	2010	2690	1520	1910	2310
10%	1220	1520	2040	1810	2260	3020	1670	2090	2800	1730	2170	2590
20%	1320	1660	2220	1980	2480	3310	1760	2200	2940	2010	2510	2950
25%	1370	1710	2290	2050	2570	3430	1790	2240	3000	2110	2650	3090
30%	1410	1760	2350	2110	2650	3530	1820	2280	3050	2210	2770	3210
40%	1480	1850	2470	2230	2790	3730	1880	2350	3140	2390	3000	3420
50%	1550	1940	2590	2350	2940	3920	1940	2420	3240	2570	3210	3610
60%	1610	2020	2700	2470	3090	4120	1990	2490	3330	2740	3430	3790
70%	1690	2120	2830	2590	3250	4330	2050	2570	3430	2930	3670	3950
75%	1730	2170	2890	2670	3340	4450	2090	2610	3490	3040	3800	4030
80%	1780	2230	2970	2750	3440	4590	2130	2660	3560	3160	3950	4110
90%	1900	2380	3180	2960	3700	4940	2230	2790	3730	3470	4340	4270
95%	2000	2510	3350	3130	3920	5230	2320	2900	3870	3720	4650	4350
99%	2190	2740	3660	3450	4310	5740	2480	3100	4140	4180	5220	4410

Table B13. Summary of estimated sampling distribution of biomass estimates for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) for fall surveys from 2011 to 2013 under assumed efficiency estimates of 1.0, 0.8, and 0.6.

	Fall 2011			Fall 2012			Fall 2013		
	Q=1.0	Q=0.8	Q=0.6	Q=1.0	Q=0.8	Q=0.6	Q=1.0	Q=0.8	Q=0.6
Minimum	2160	2720	3660	1280	1610	2170	250	320	440
Maximum	6830	8490	11200	3030	3780	5010	4130	5160	6850
Range	4670	5770	7540	1750	2170	2840	3880	4840	6410
Mean	4060.211	5077.898	6774.045	2018.999	2527.355	3374.759	1799.57	2252.689	3007.586
Std Dev	799.455	997.124	1325.803	271.025	338.508	450.829	735.99	919.321	1223.498
C.V.	0.197	0.196	0.196	0.134	0.134	0.134	0.409	0.408	0.407
Skewness(G1)	0.308	0.304	0.299	0.331	0.329	0.328	0.217	0.217	0.212
Kurtosis(G2)	-0.287	-0.298	-0.314	-0.133	-0.139	-0.147	-0.467	-0.468	-0.476
Percentiles									
1%	2520	3150	4210	1480	1850	2470	380	480	640
5%	2820	3540	4720	1600	2010	2680	620	780	1050
10%	3040	3800	5080	1680	2100	2810	830	1050	1400
20%	3340	4180	5590	1780	2230	2980	1130	1420	1900
25%	3470	4340	5790	1820	2280	3050	1260	1570	2100
30%	3590	4490	5990	1860	2330	3110	1370	1710	2290
40%	3800	4760	6350	1930	2420	3230	1570	1970	2630
50%	4010	5020	6700	2000	2510	3350	1770	2220	2960
60%	4230	5290	7060	2070	2590	3460	1970	2470	3290
70%	4470	5580	7450	2150	2690	3600	2190	2740	3660
75%	4600	5750	7670	2200	2750	3670	2310	2890	3860
80%	4750	5930	7910	2250	2810	3760	2440	3060	4080
90%	5140	6420	8560	2380	2980	3980	2800	3500	4660
95%	5460	6820	9090	2500	3120	4170	3070	3840	5120
99%	6030	7530	10030	2700	3380	4510	3530	4410	5870

Table B14. Summary of estimated probabilities of exceeding reference points in 2013, based on fall survey for alternative quotas.

	Efficiency = 0.6		Efficiency = 0.8		Efficiency = 1.0	
Quota	P(F>0.17)	P(F>0.23)	P(F>0.17)	P(F>0.23)	P(F>0.17)	P(F>0.23)
100	0.003781	0.000023	0.021372	0.003293	0.039872	0.016458
200	0.063437	0.028328	0.125578	0.06142	0.208417	0.104862
217	0.077379	0.035885	0.15144	0.074986	0.24953	0.126734
253	0.111159	0.053915	0.214021	0.107824	0.346014	0.179886
300	0.164444	0.081777	0.309905	0.159633	0.483373	0.262422
380	0.277783	0.141996	0.495235	0.270059	0.707052	0.427969
400	0.309905	0.159633	0.542411	0.301441	0.754741	0.471812
500	0.483373	0.262422	0.754741	0.471812	0.922046	0.681964
600	0.655255	0.384643	0.897895	0.642626	0.987622	0.843385
700	0.797832	0.515677	0.970956	0.786553	0.99967	0.940382
800	0.897895	0.642626	0.995716	0.889487	1	0.985183
900	0.958225	0.754150	0.999982	0.952958	1	0.99821
1000	0.987622	0.843385	1	0.985183	1	1
1078	0.996547	0.896309	1	0.995504	1	1
1100	0.997786	0.908775	1	0.99704	1	1
1200	0.999982	0.952958	1	0.999907	1	1
1300	1	0.979511	1	1	1	1
1400	1	0.992872	1	1	1	1
1458	1	0.996634	1	1	1	1
1500	1	0.998210	1	1	1	1

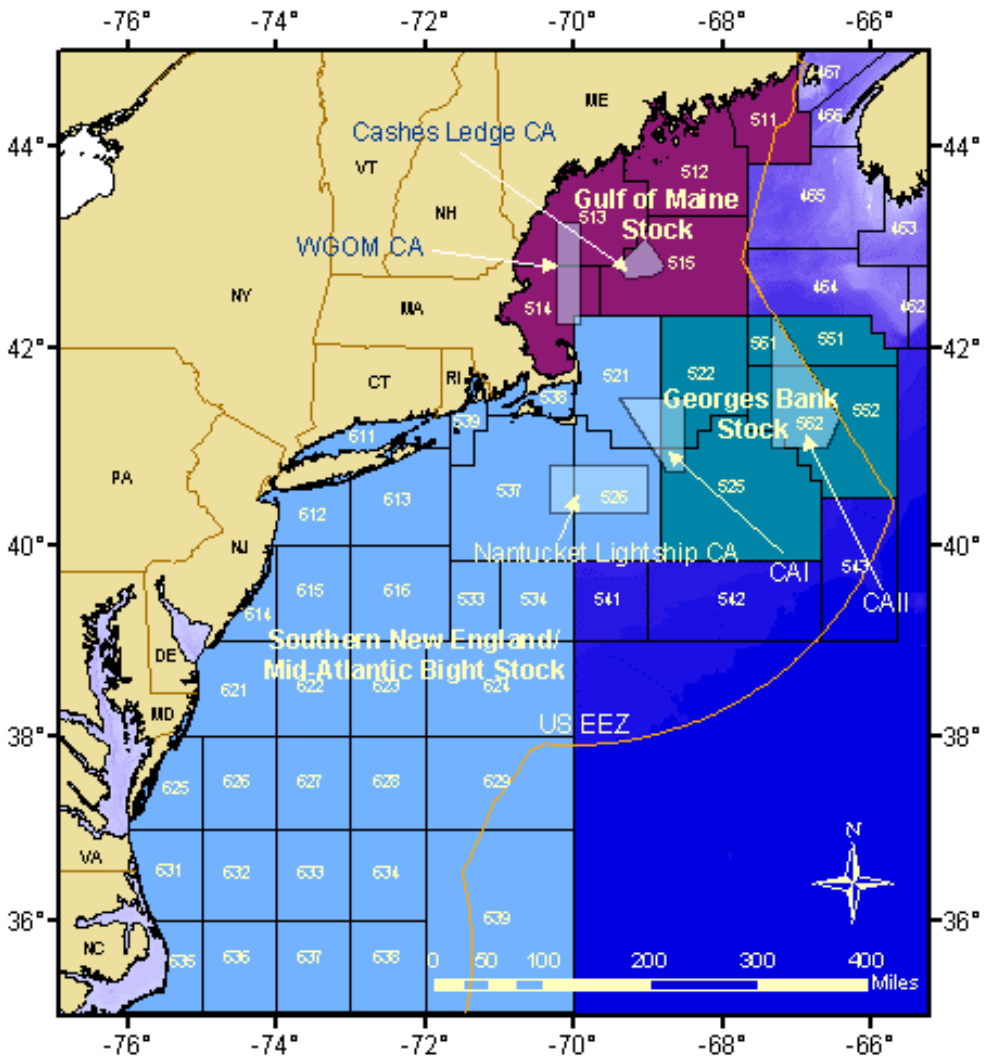


Figure B1. Statistical areas used to define winter flounder (*Pseudopleuronectes americanus*) stocks. The Gulf of Maine stock includes area 511-515.

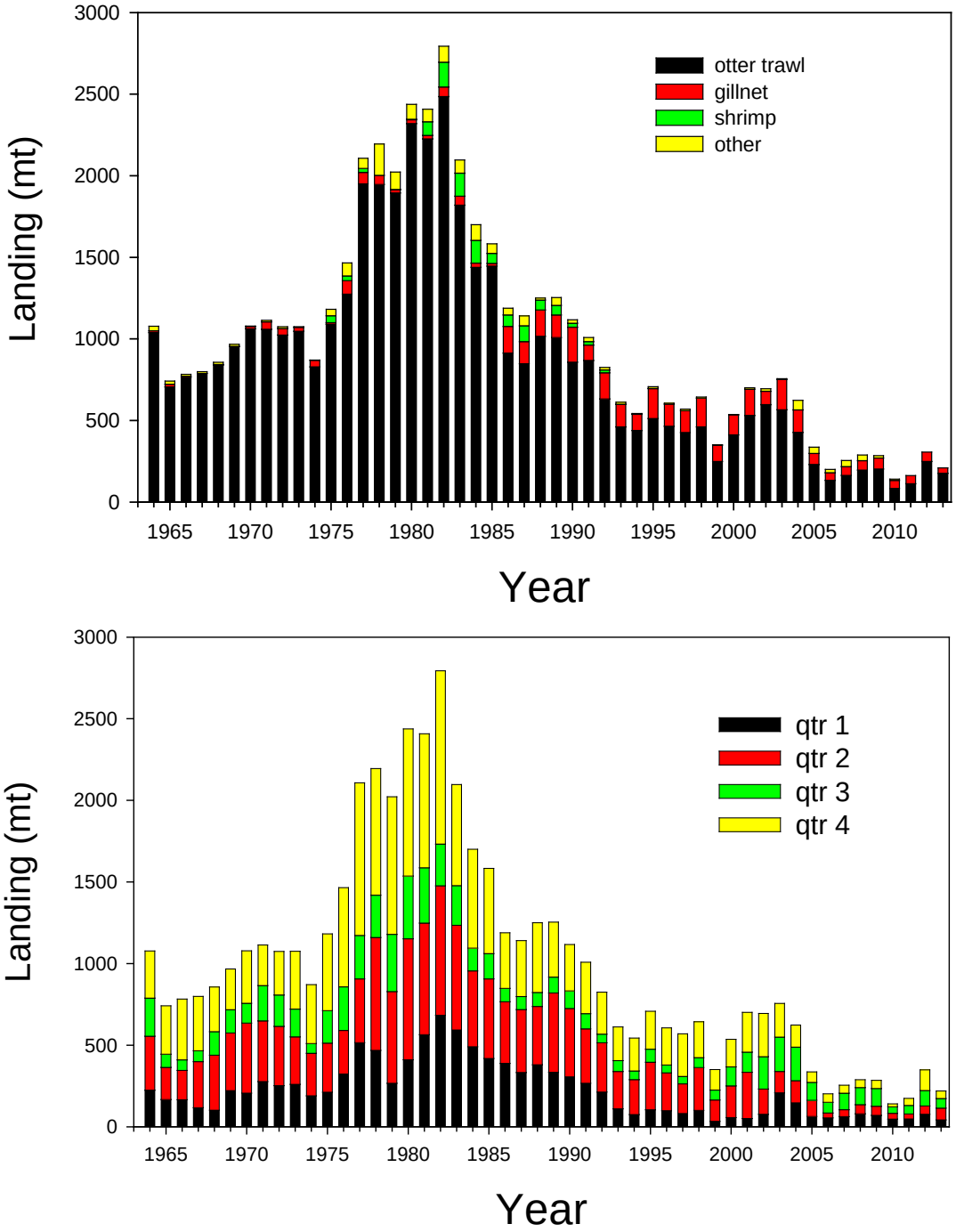


Figure B2. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) commercial landings by gear (top) and quarter (bottom) 1964-2013.

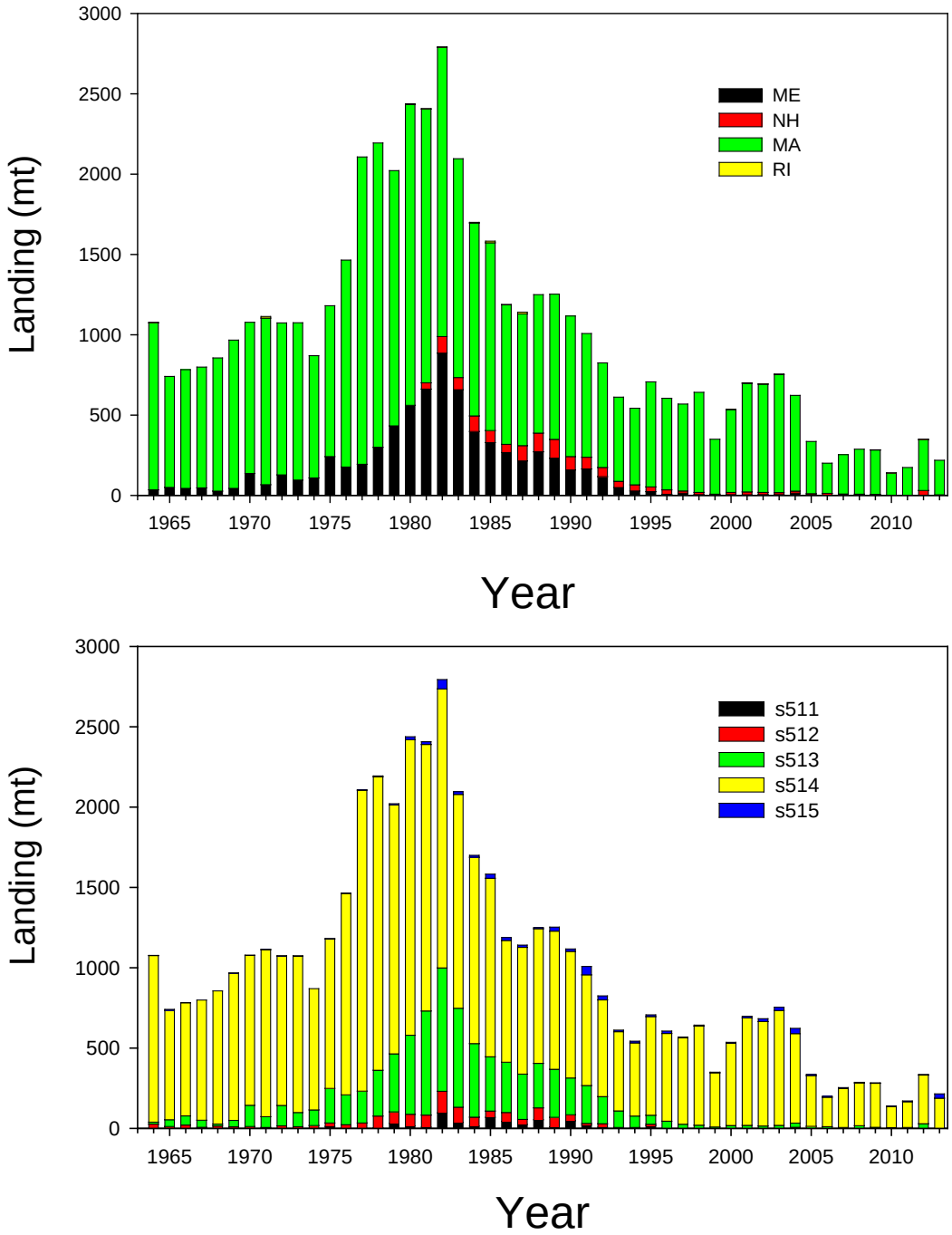


Figure B3. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) commercial landings by state (top) and statistical area (bottom) 1964-2013.

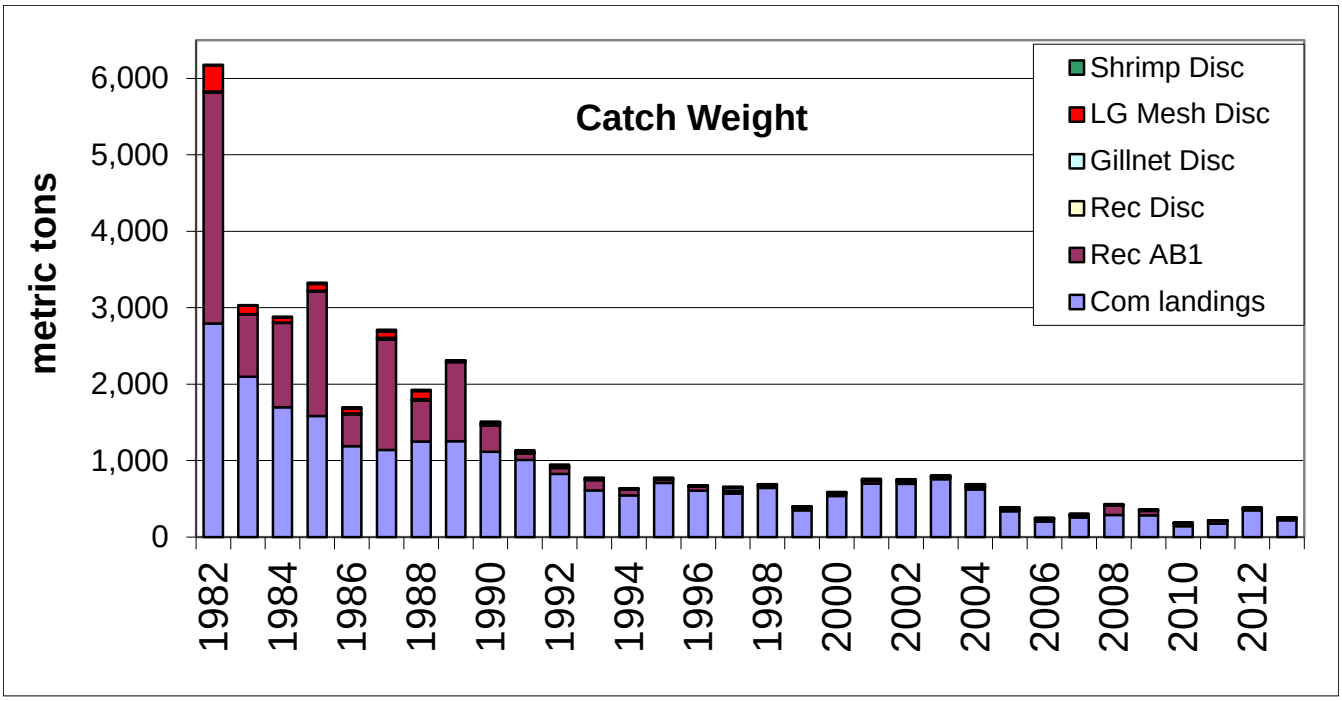


Figure B4. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) composition of the catch by weight 1982-2013.

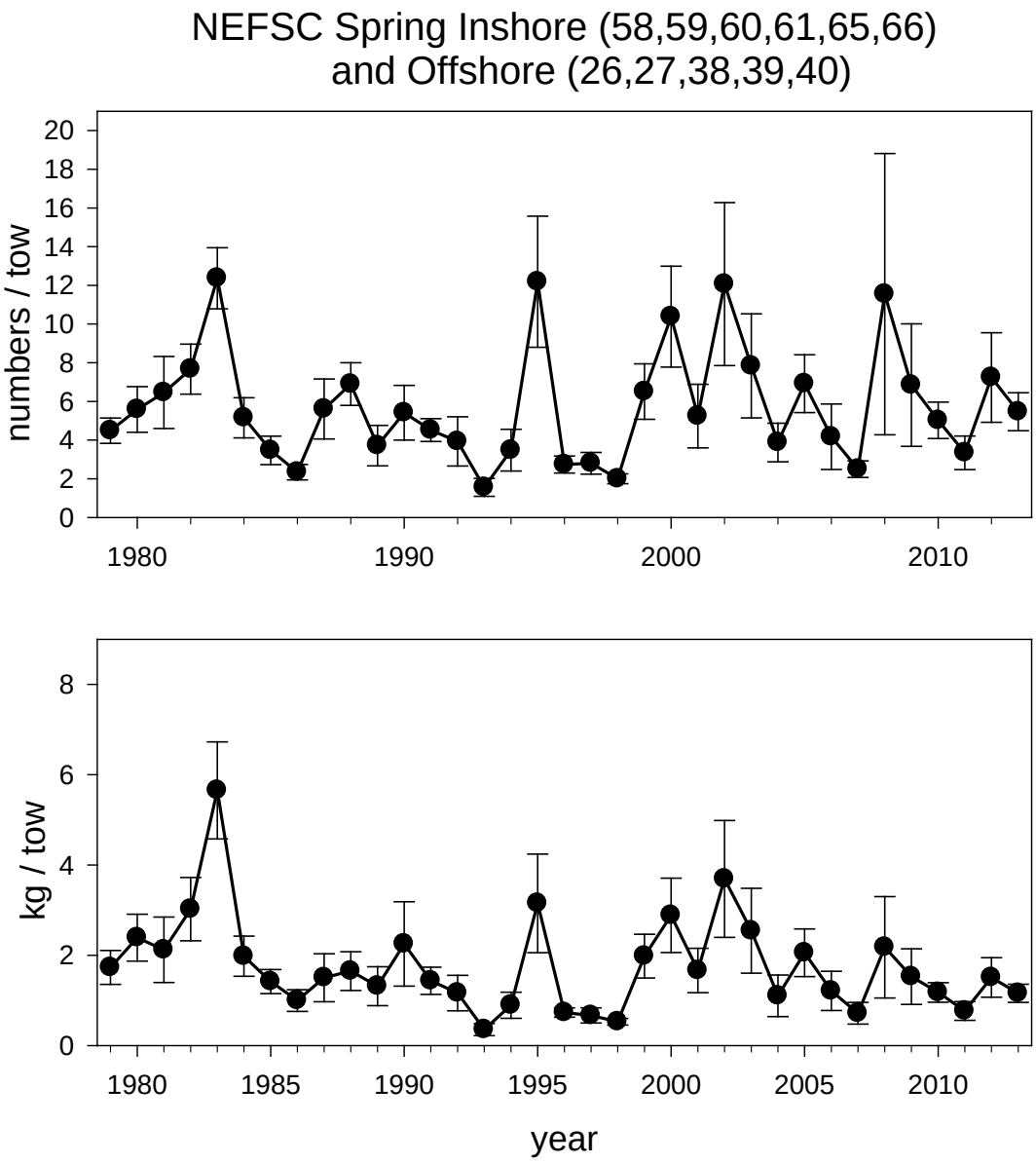


Figure B5. Northease Fisheries Science Center (NEFSC) spring survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*). Estimated standard error is also shown. Trawl door and FV Bigelow conversion factors are used where appropriate.

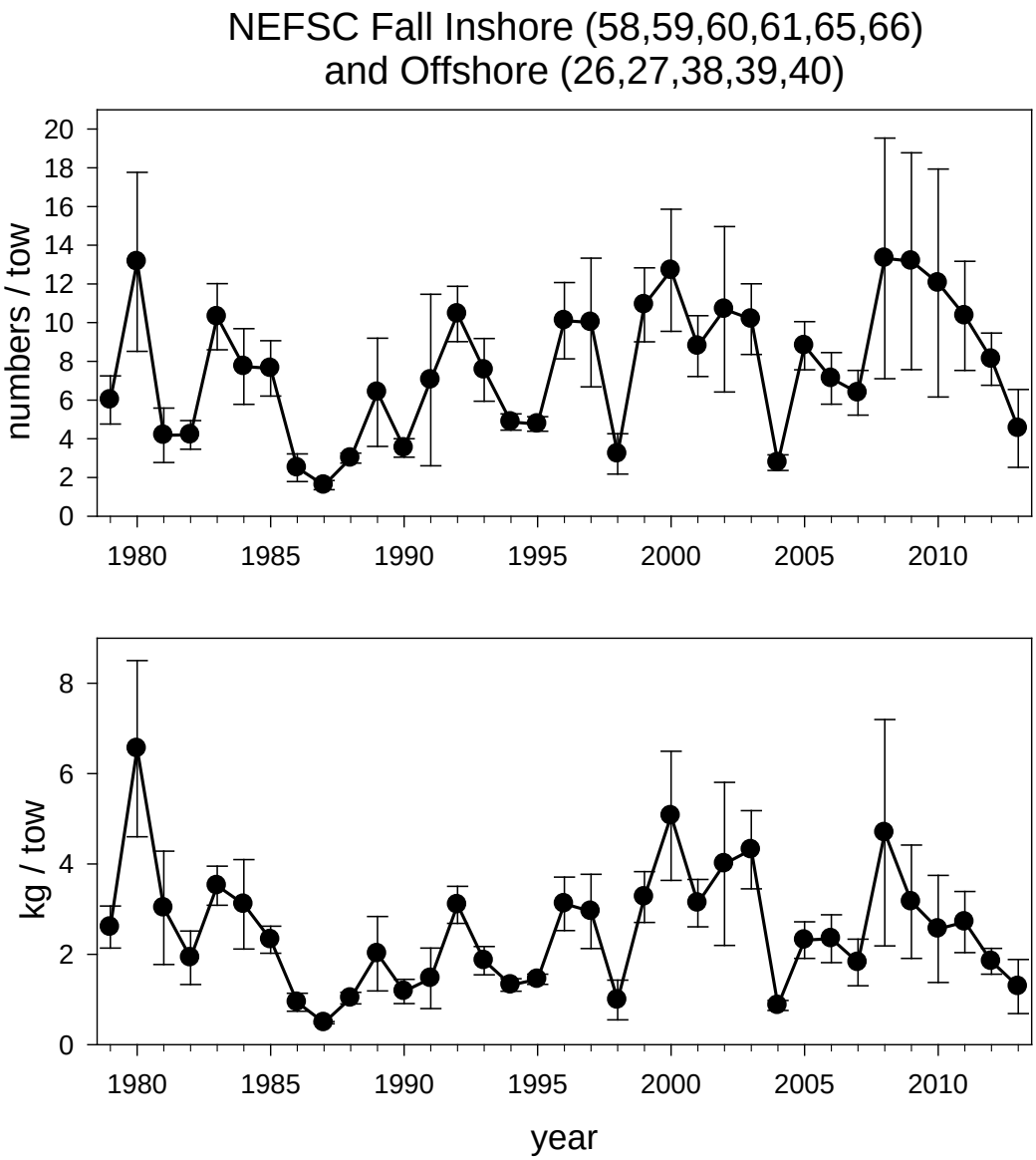


Figure B6. NEFSC fall survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*). Estimated standard error is also shown. Trawl door and FV Bigelow conversion factors are used where appropriate.

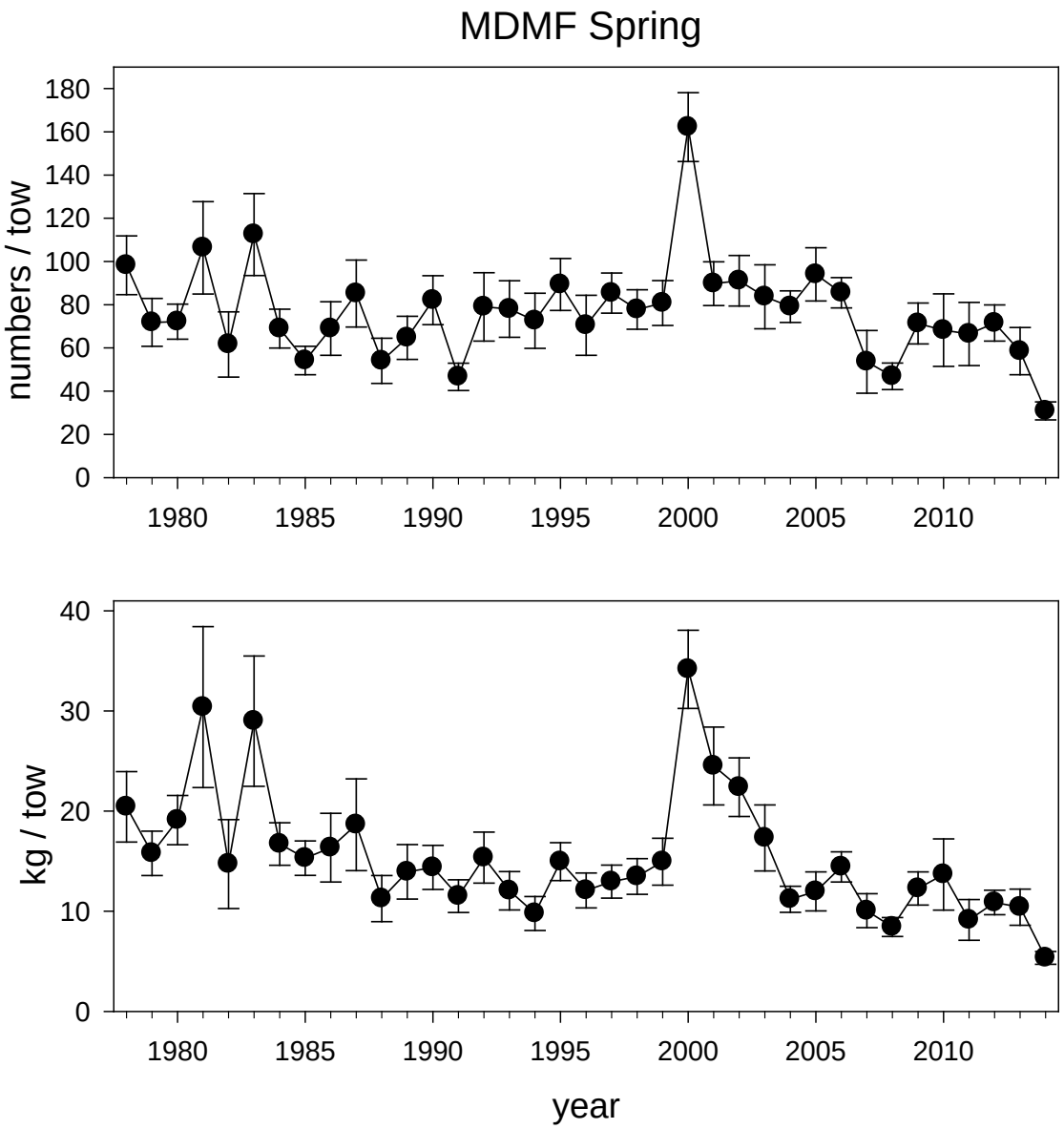


Figure B7. Massachusetts Division of Marine Fisheries (MDMF) spring survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*). Estimated standard error is also shown.

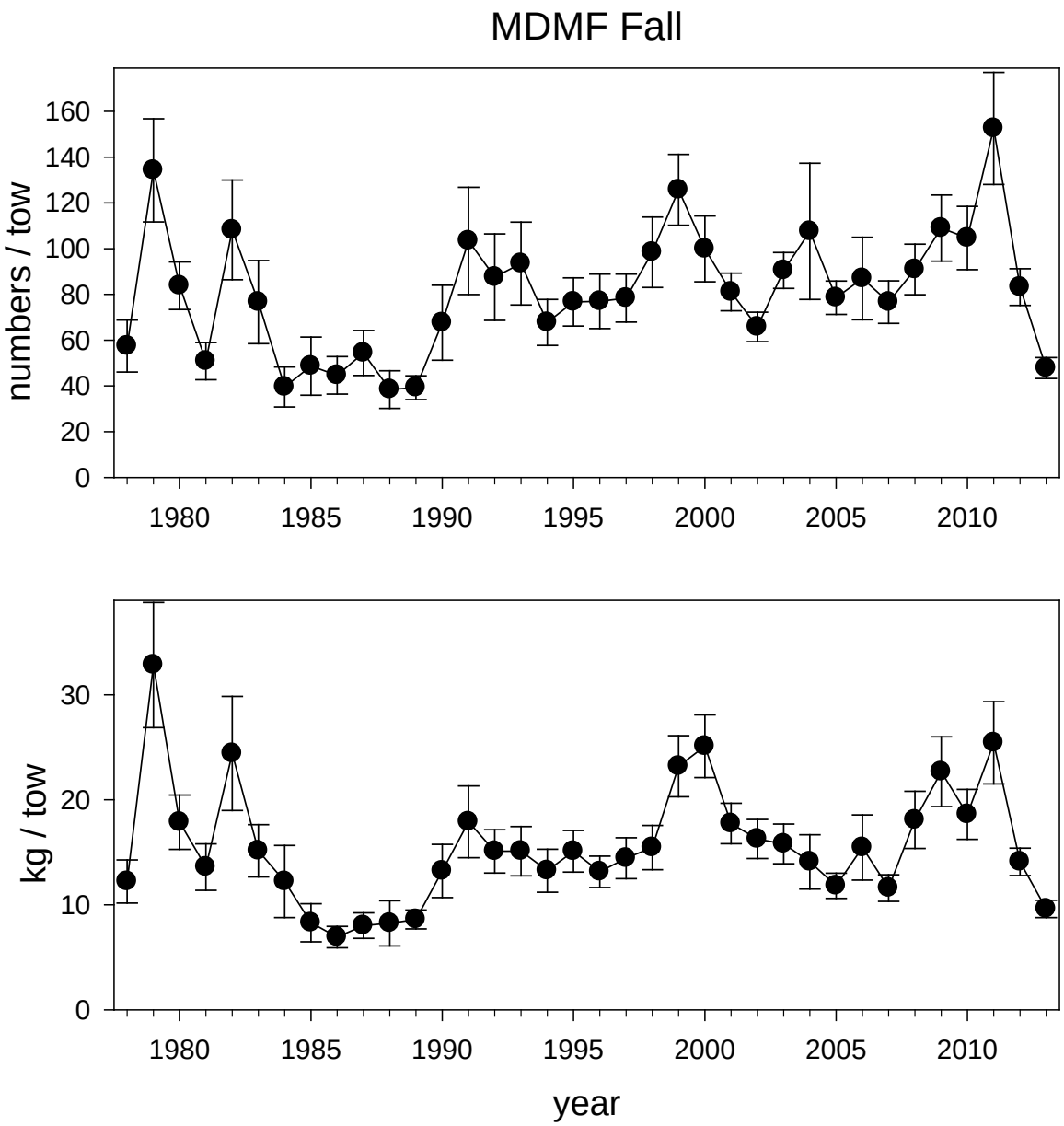
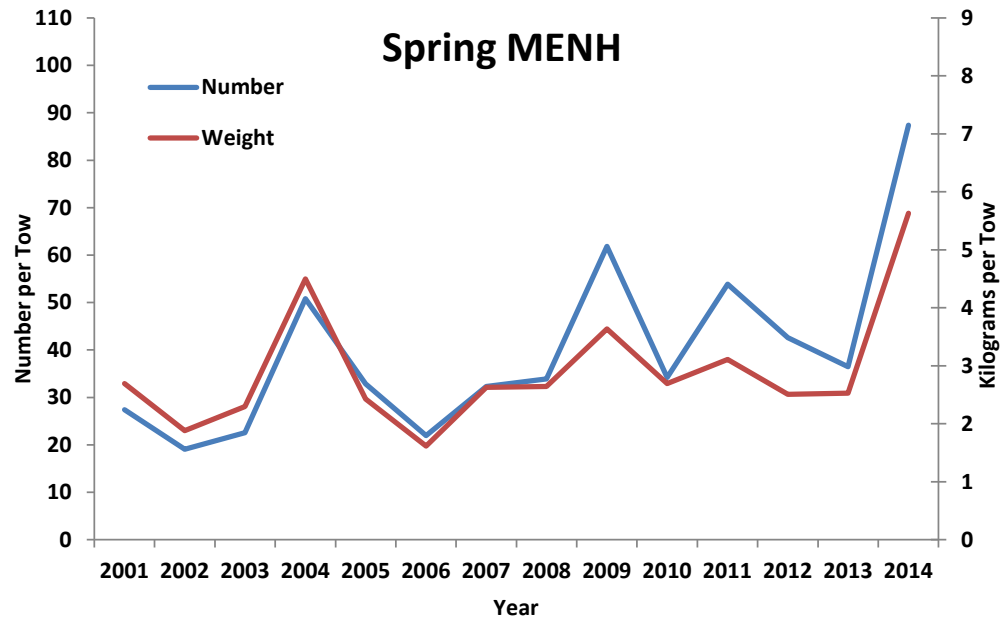


Figure B8. Massachusetts Division of Marine Fisheries (MDMF) fall survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*). Estimated standard error is also shown.



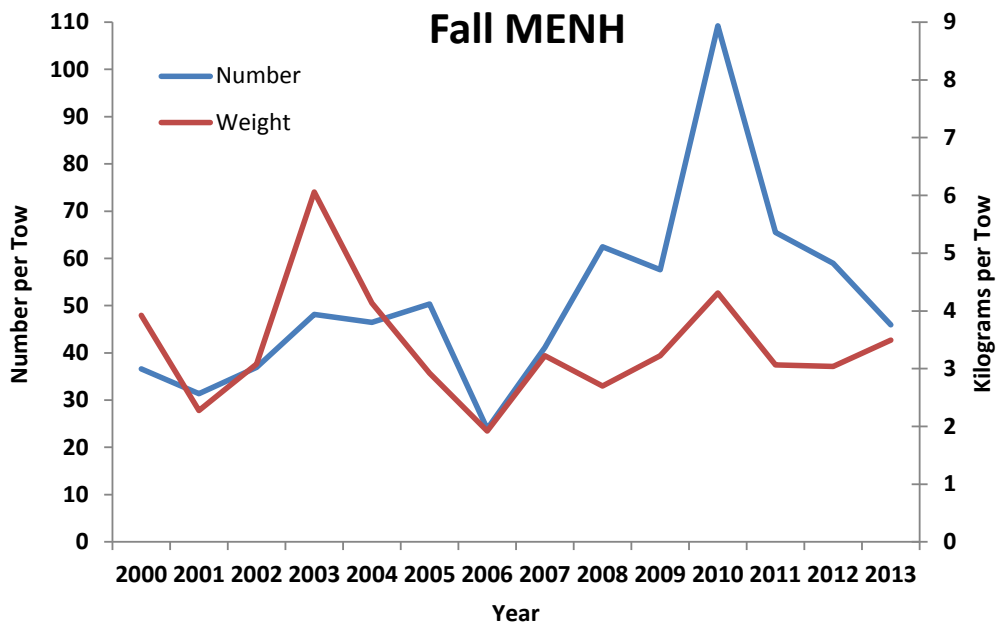


Figure B9. Maine and New Hampshire (MENH) spring and fall survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*).

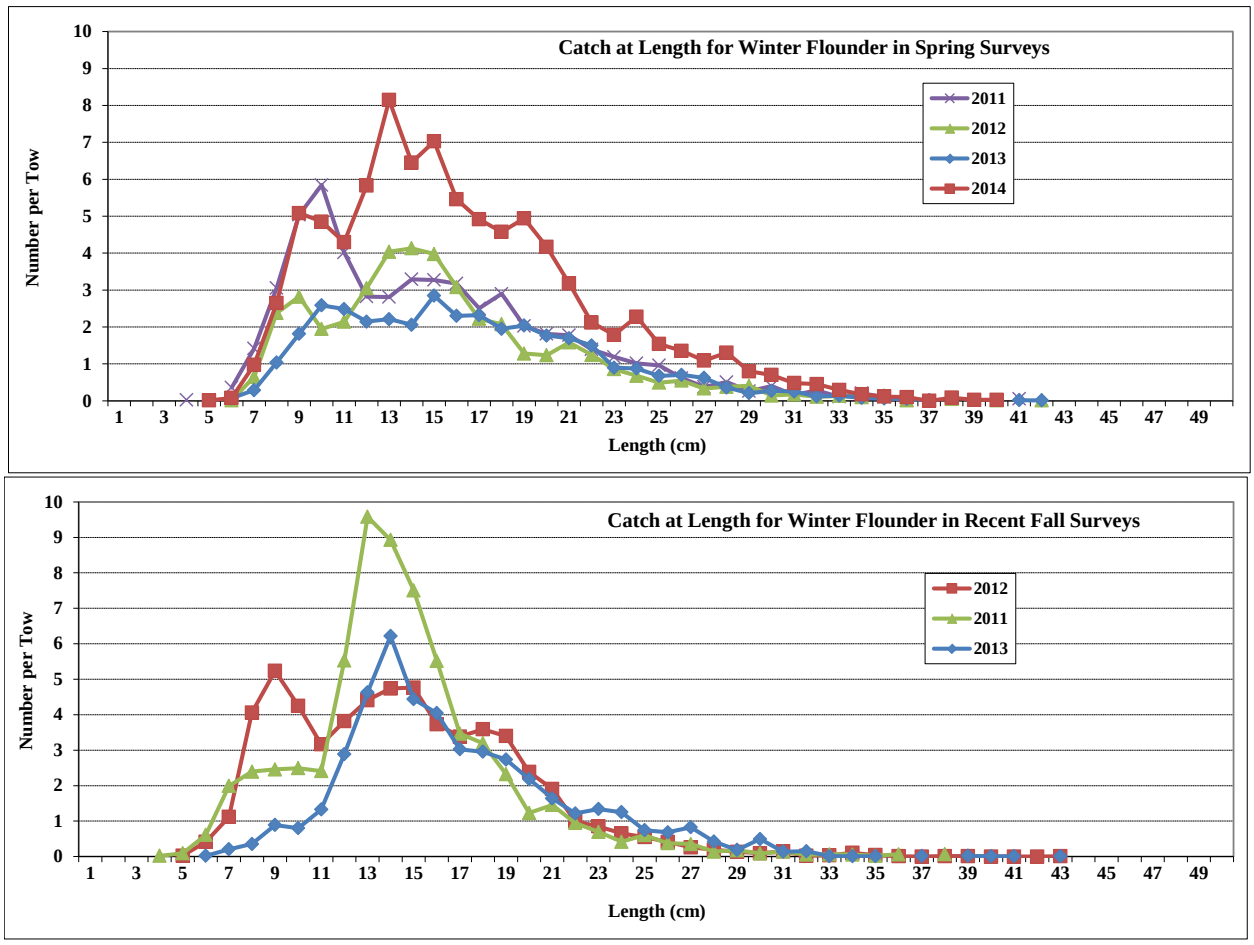


Figure B10. Numbers per tow at length from the inshore Maine and New Hampshire (MENH) survey. Relatively few fish 30 cm and greater are caught in the MENH survey.

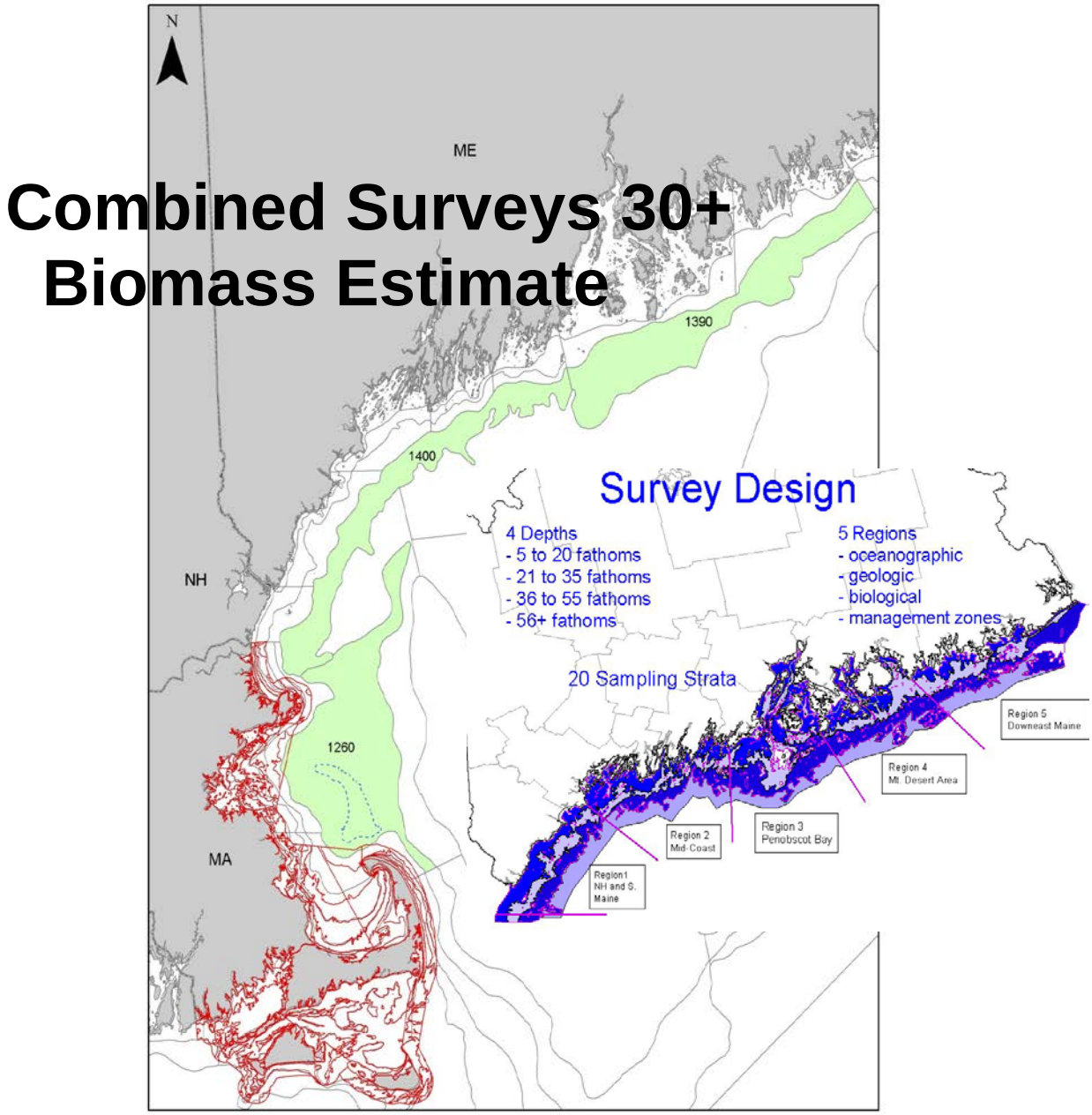
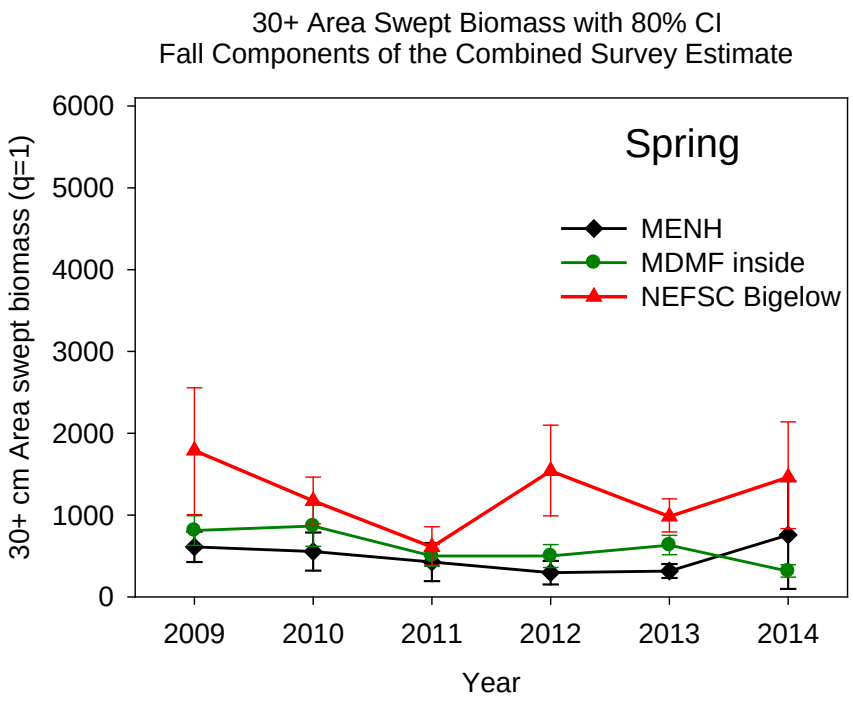


Figure B11. Northeast Fisheries Science Center (NEFSC), Massachusetts Division of Marine Fisheries (MDMF), and Maine-New Hampshire (MENH) survey areas used in the combined survey 30+ cm biomass estimate. Green shaded areas are the NEFSC offshore strata used for the 30+ biomass estimate.



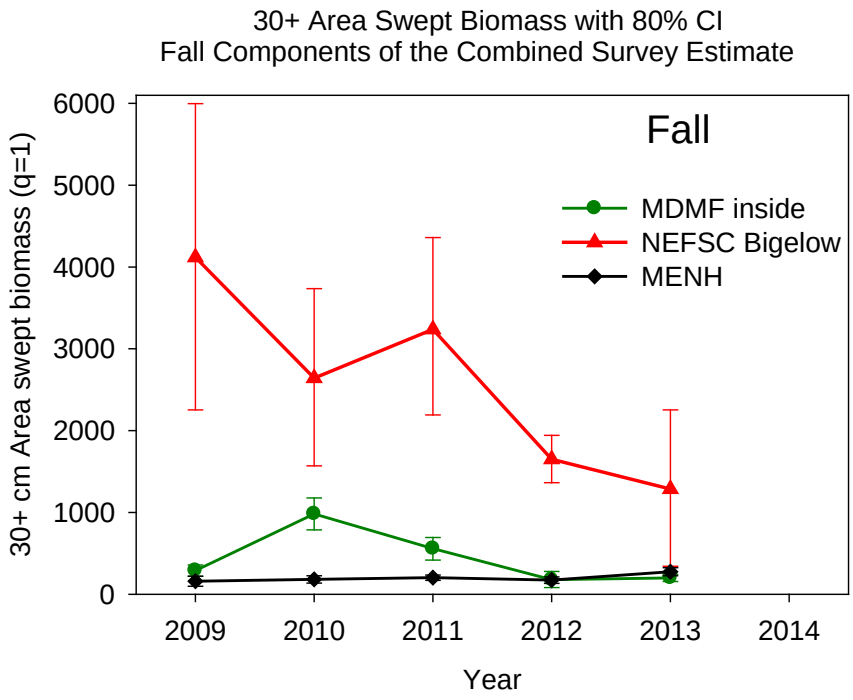


Figure B12. Bigelow spring and fall area swept (Q=1) exploitable biomass (30+cm) estimates by year with the associated 80% confidence intervals (CI)for the nonoverlapping strata used in the combine biomass estimate. NEFSC = Northeast Fisheries Science Center. MDMF = Massachusetts Division of Marine Fisheries. MENH = Maine and New Hampshire.

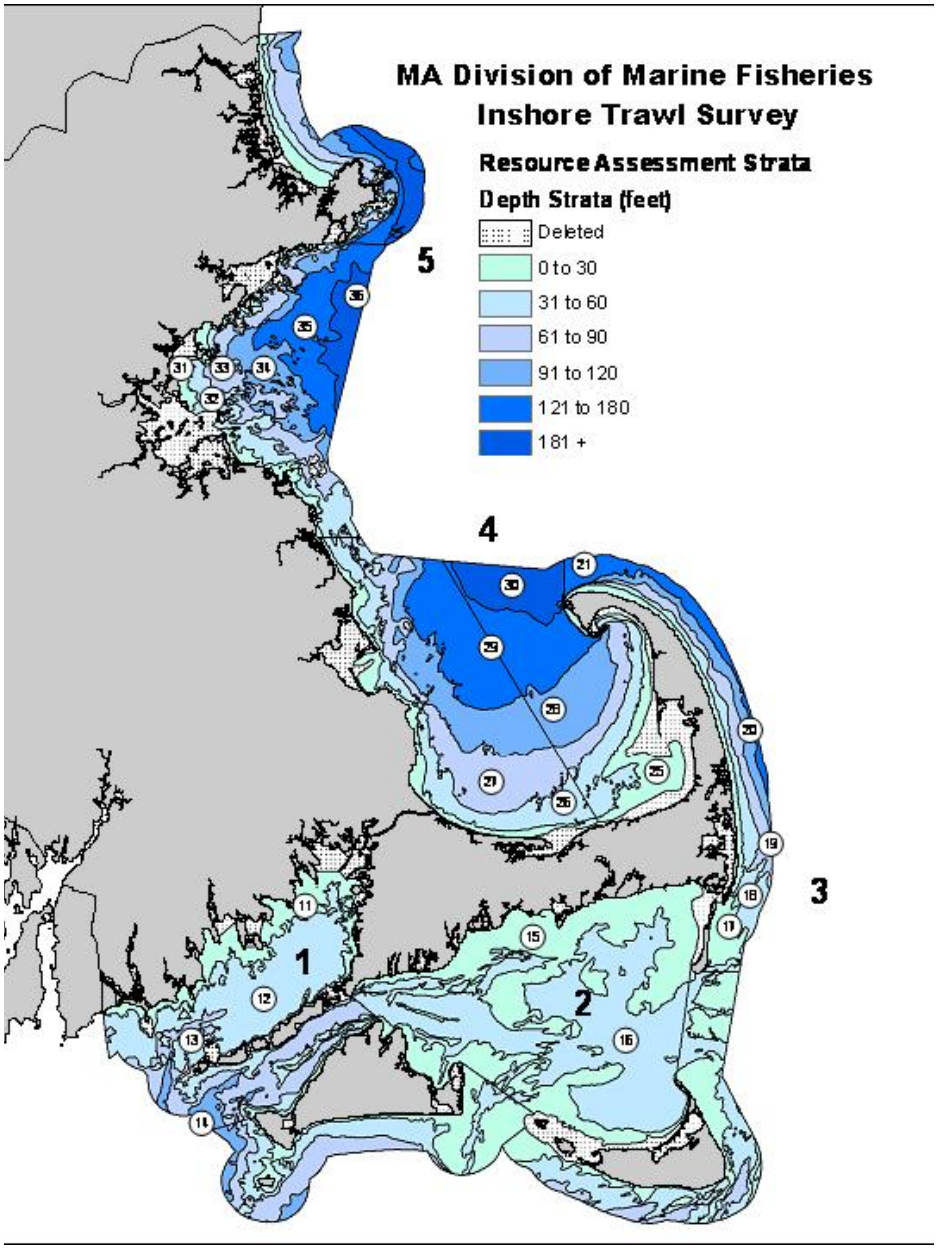


Figure B13. Massachusetts Division of Marine Fisheries (MDMF) survey strata. The gulf of Maine winter flounder (*Pseudopleuronectes americanus*) stock uses strata north of Cape Cod. Strata 25, 26, 31, 32, and 33 are used for the combined nonoverlapping biomass estimate.

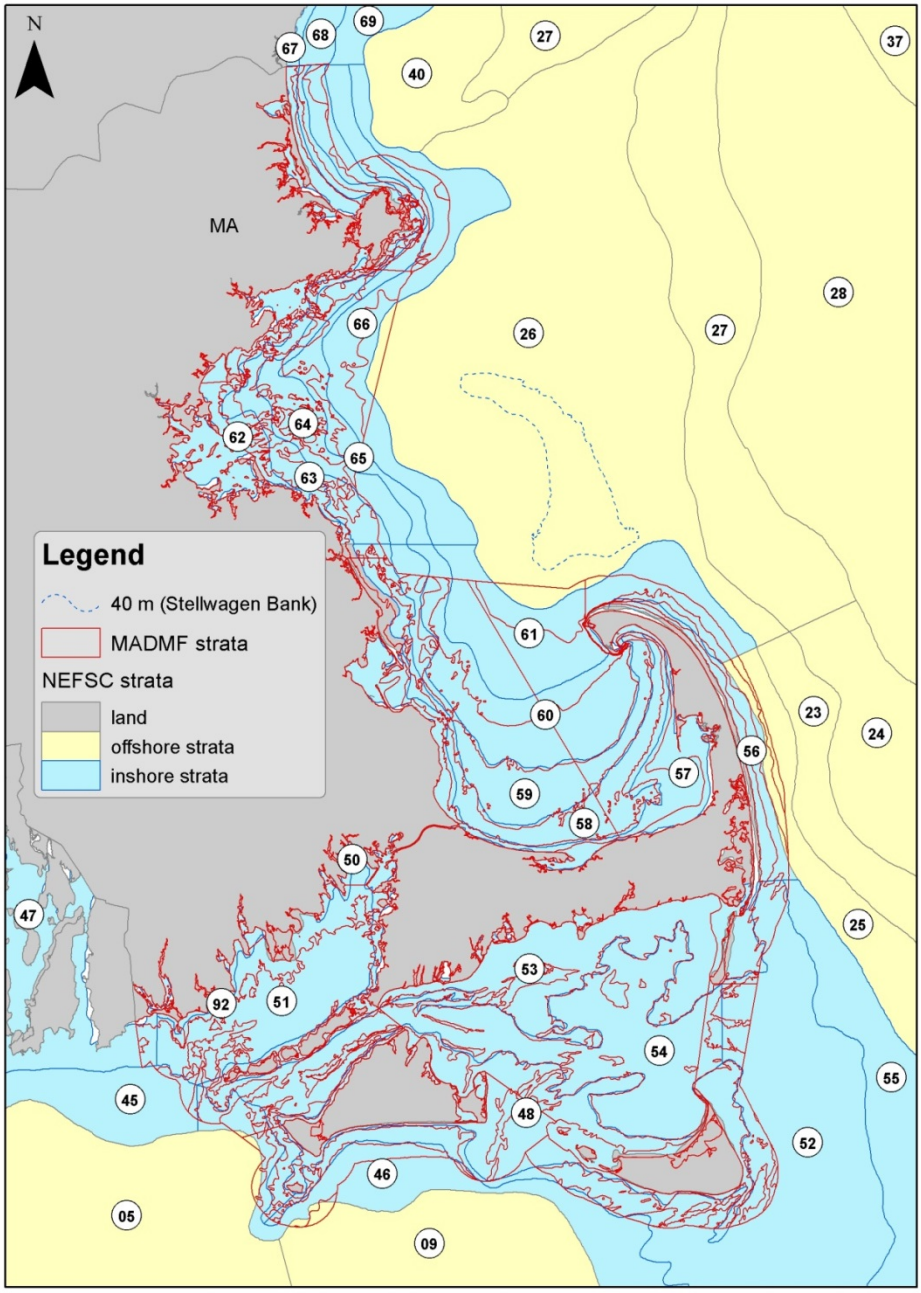


Figure B14. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) inshore survey overlap between the Northeast Fisheries Science Center NEFSC and Massachusetts Division of Marine Fisheries (MDMF) surveys.

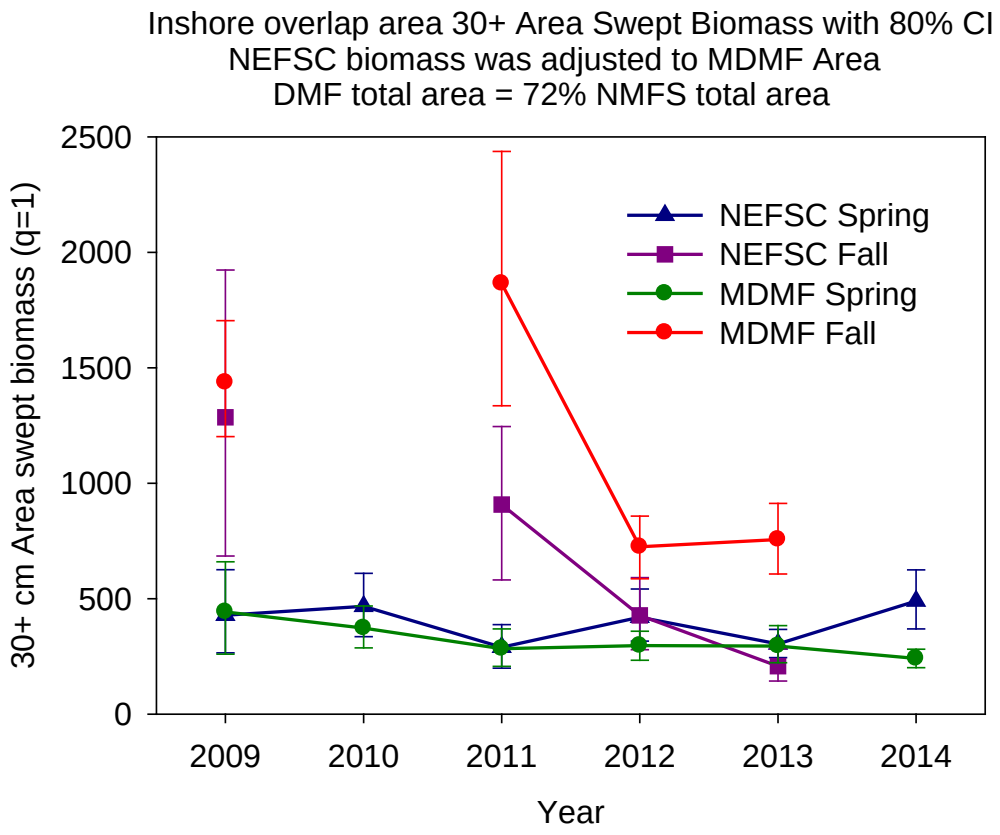


Figure B15. Minimum area adjusted area swept (q=1.0) exploitable biomass (30+cm) estimates by year with the associated 80% confidence intervals limited to the overlap strata between the NEFSC and MDMF surveys. NEFSC overlap strata equals 72% of the total DMF overlap area. NEFSC fall 2010 is missing because of lack of coverage for Cape Cod bay inshore strata. NEFSC = Northeast Fisheries Science Center. MDMF = Massachusetts Division of Marine Fisheries.

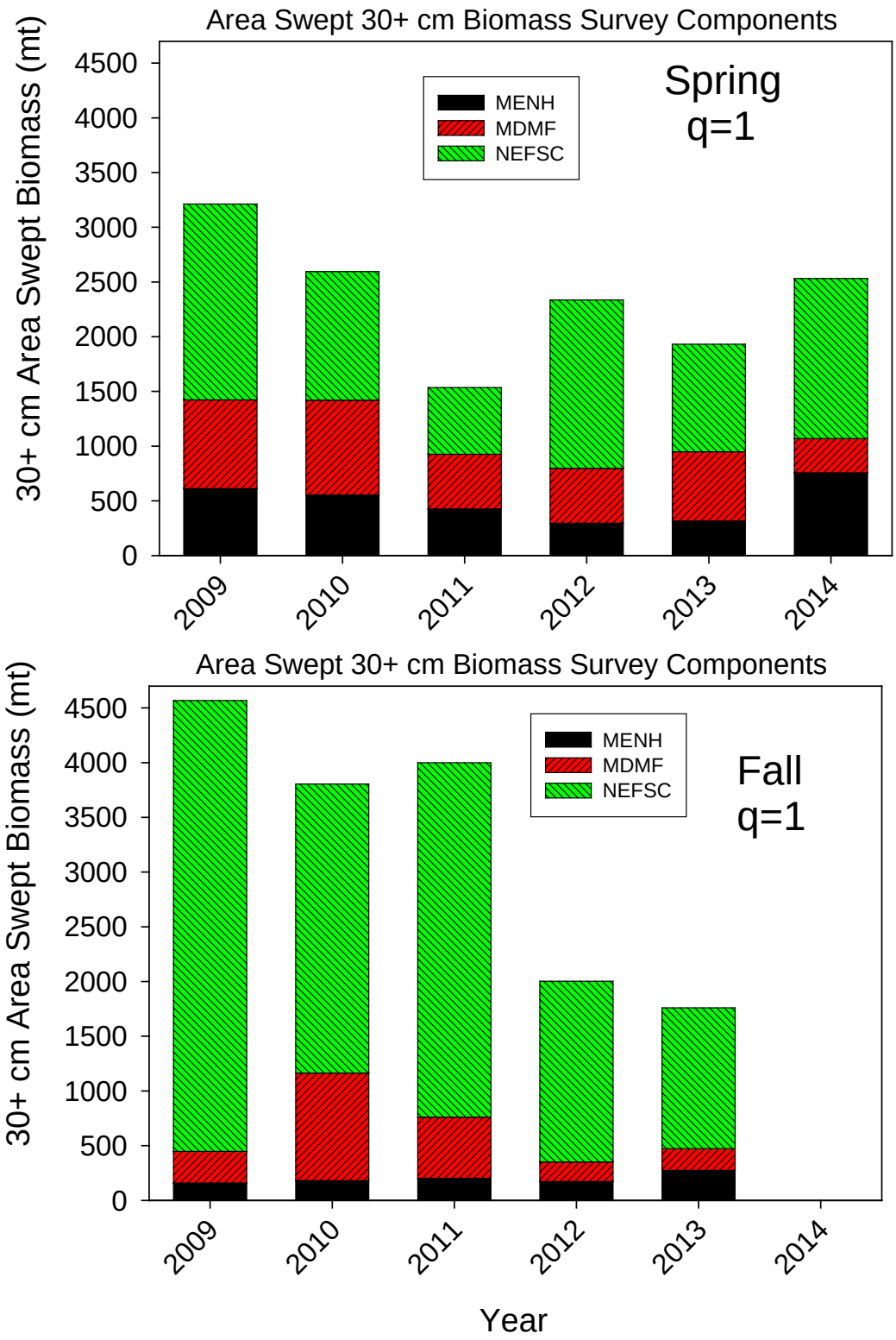


Figure B16. 30+ cm area swept biomass estimates for each survey (MENH, MDMF, NEFSC) for the spring (top; 2009-2014) and fall (bottom; 2009-2013) surveys assuming q=1.0. NEFSC = Northeast Fisheries Science Center. MDMF = Massachusetts Division of Marine Fisheries. MENH = Maine and New Hampshire.

Figure B17. SARC 52 length based yield per recruit of Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) analysis using updated von Bertalanffy parameters estimated from the spring and fall 2006-2010 Northeast Fisheries Science Center NEFSC surveys, maturity at length from the Massachusetts Division of Marine Fisheries (MDMF) survey and assuming a natural mortality of 0.3. F40% was estimated at 0.31.

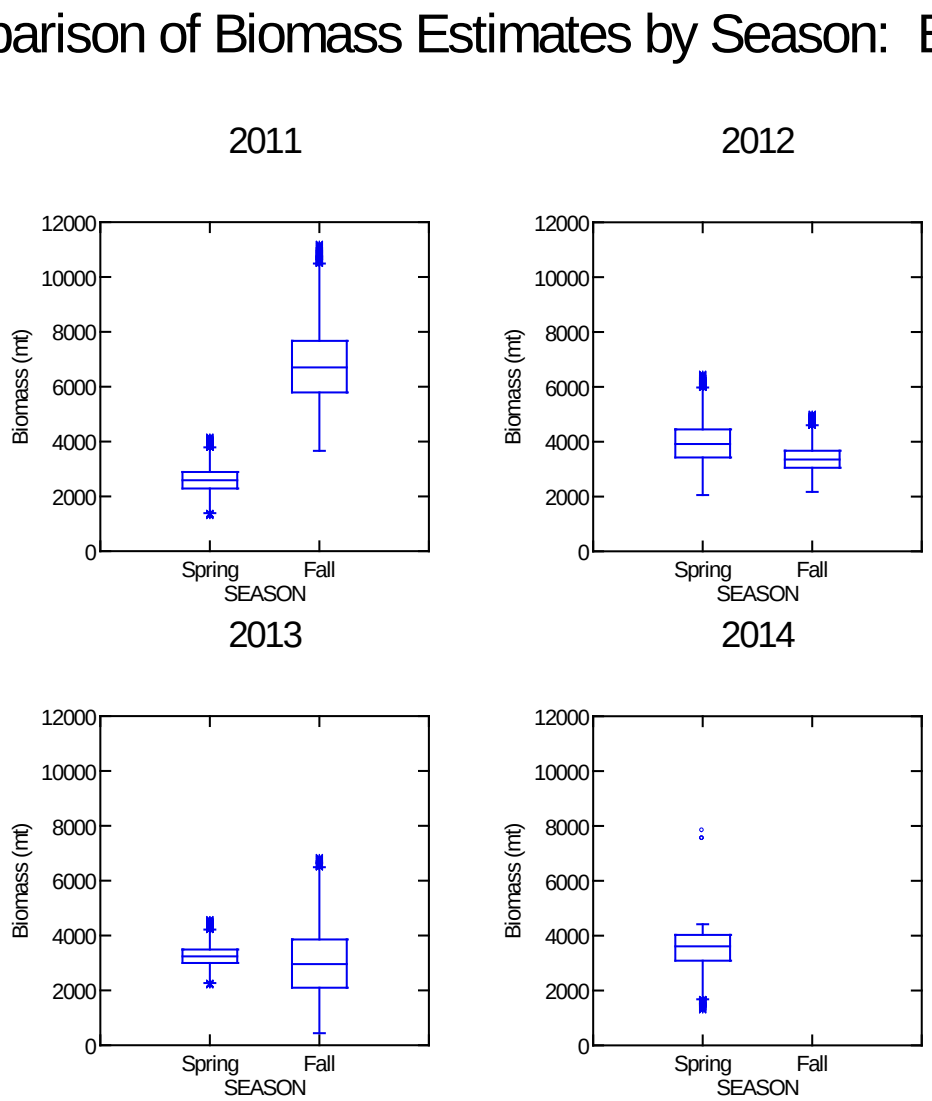
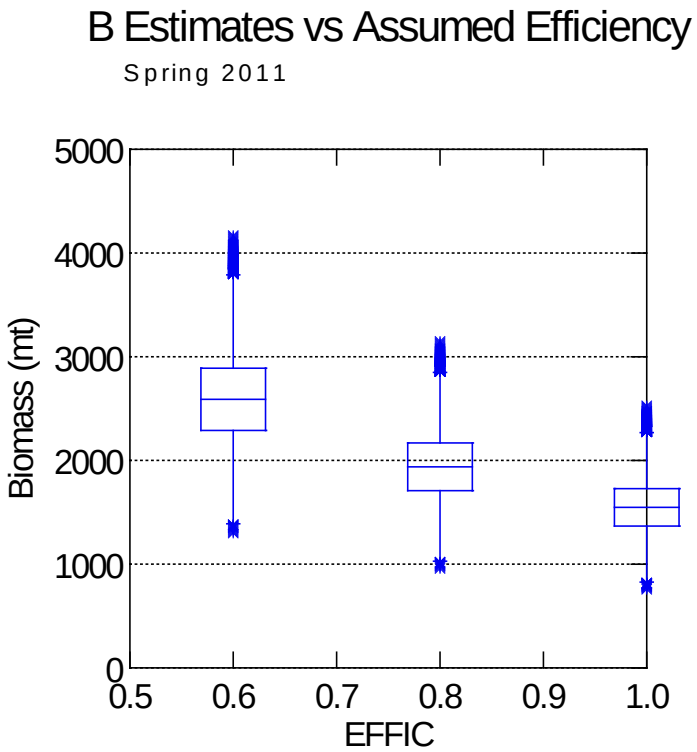


Figure B18. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) seasonal (spring and fall) swept area biomass estimates comparison assuming trawl efficiency = 0.6.



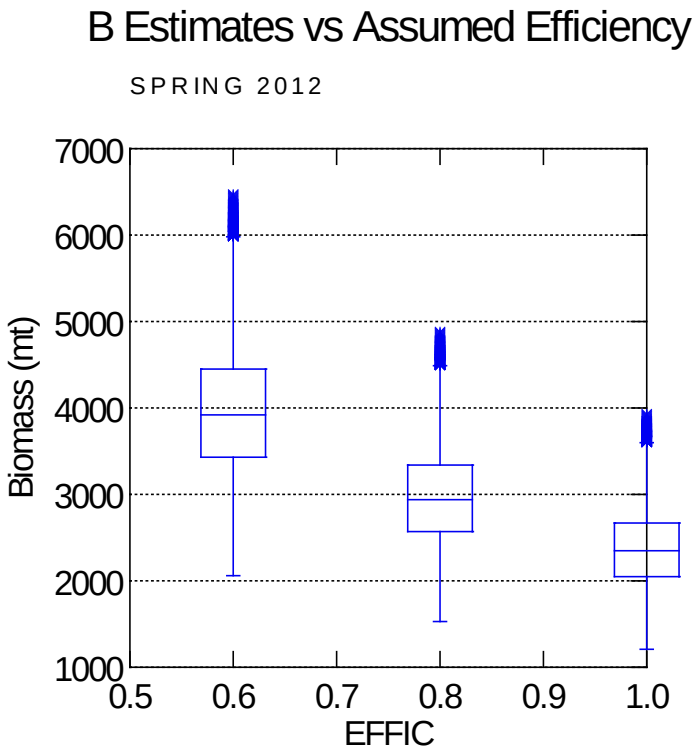
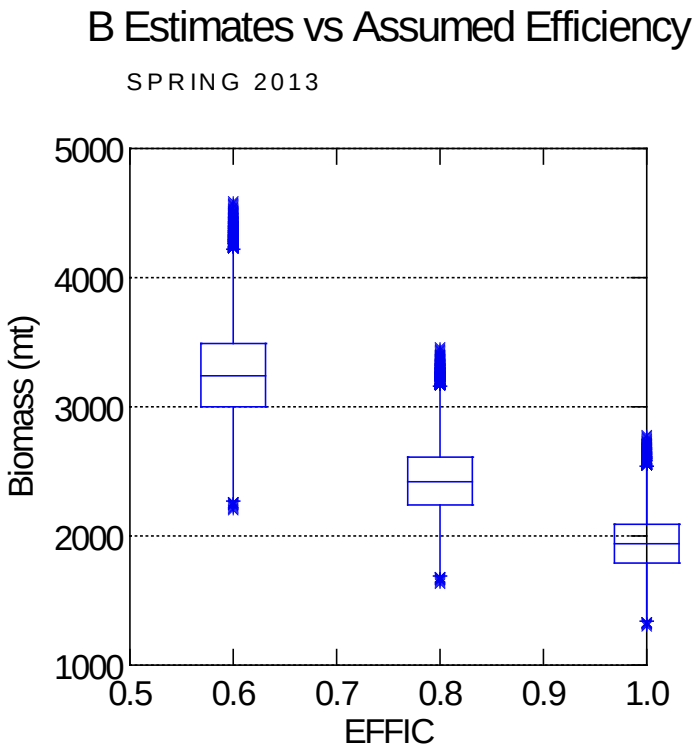


Figure B19. Swept area biomass estimates for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) for varying seasons (spring and fall) and years under three alternative assumed values of trawl efficiency (0.6, 0.8, and 1.0).



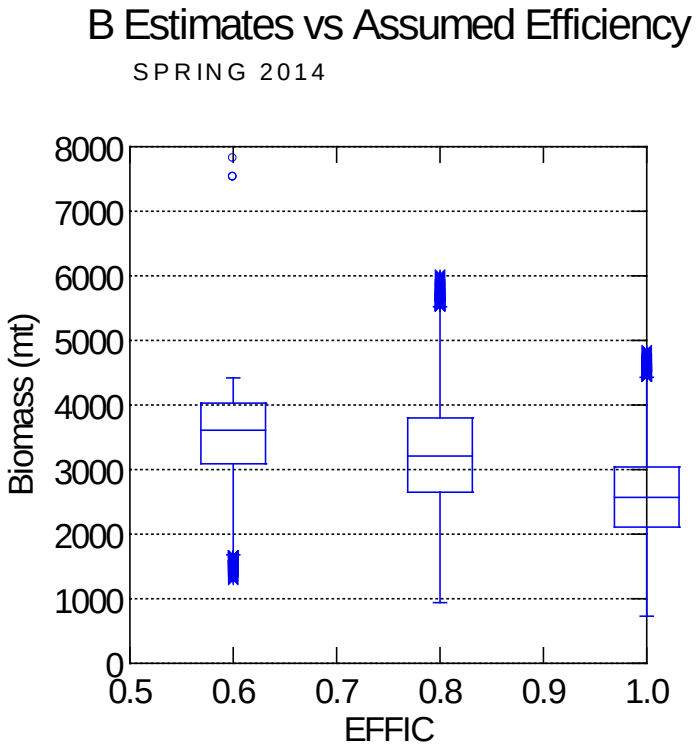
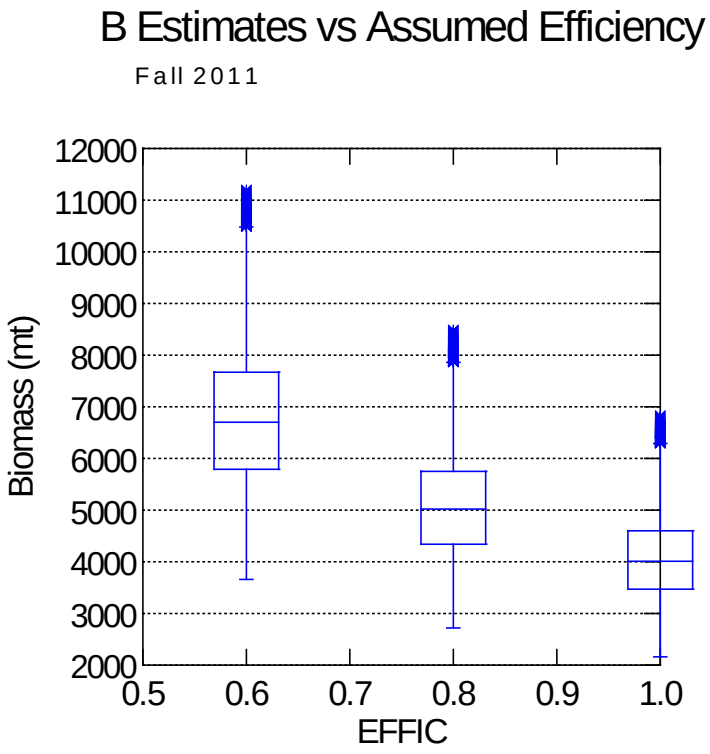


Figure B19, continued. Swept area biomass estimates for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) for varying seasons (spring and fall) and years under three alternative assumed values of trawl efficiency (0.6, 0.8, and 1.0).



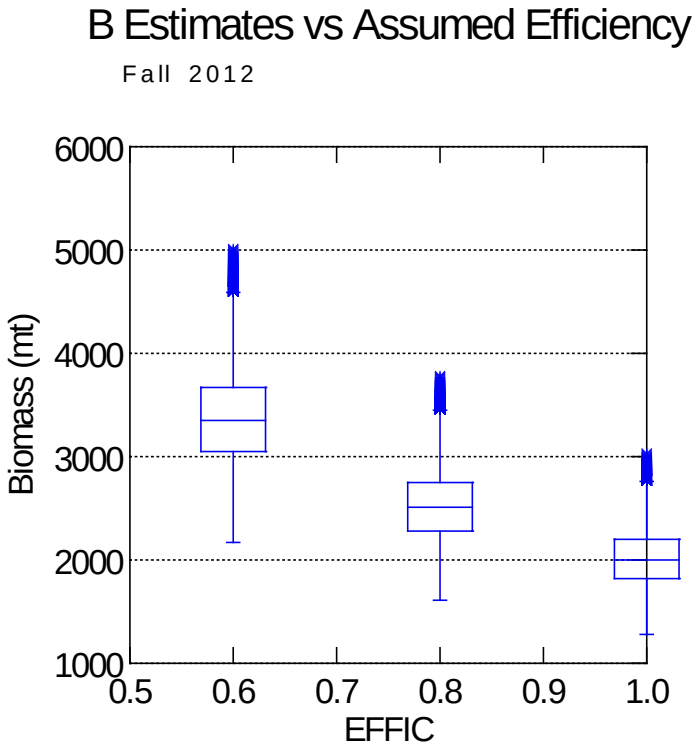


Figure B19, continued. Swept area biomass estimates for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) for varying seasons (spring and fall) and years under three alternative assumed values of trawl efficiency (0.6, 0.8, and 1.0).

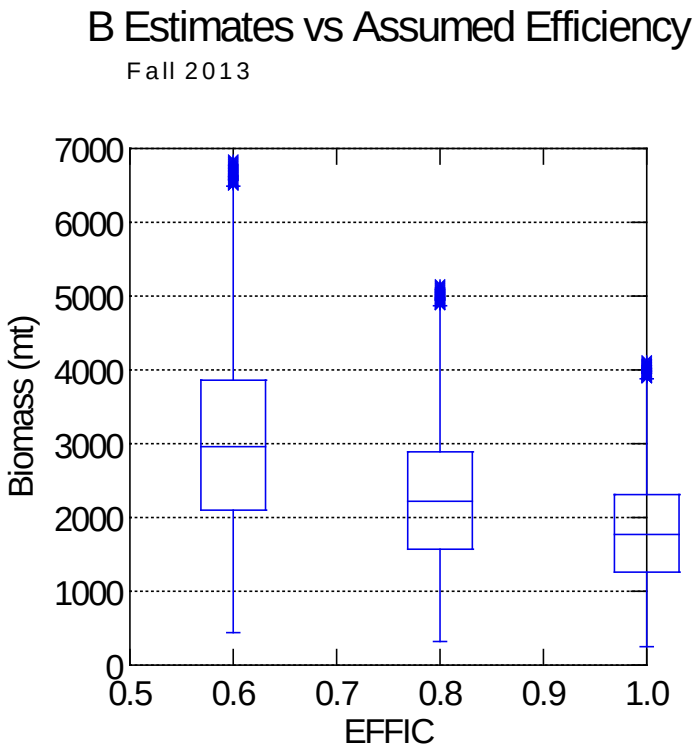
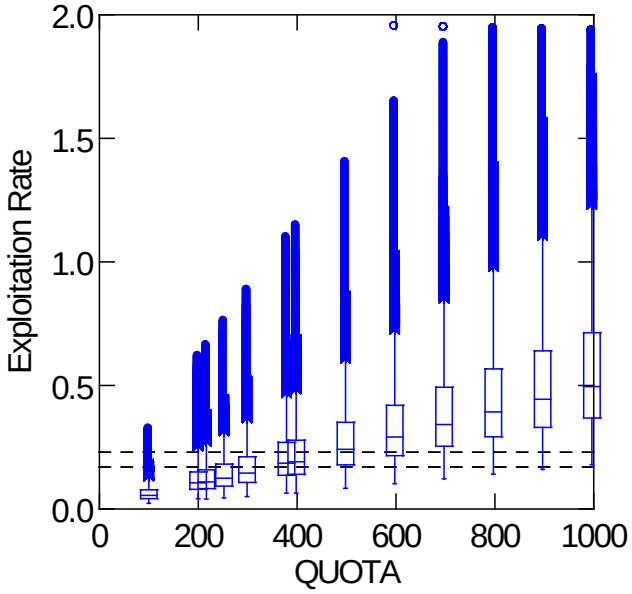


Figure B19, continued. Swept area biomass estimates for Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) for varying seasons (spring and fall) and years under three alternative assumed values of trawl efficiency (0.6, 0.8, and 1.0).

Exploitation Estimates: Fall 2013, Efficiency=1.0



Exploitation Estimates: Fall 2013, Efficiency=0.8

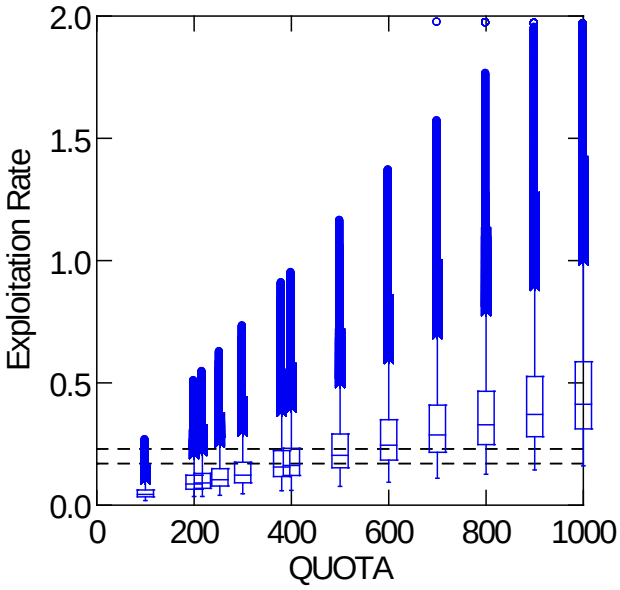


Figure B20. Estimated exploitation rates for Gulf of Maine (GOM) winter flounder (*Pseudopleuronectes americanus*) for fall 2009 based on three assumed estimates of gear efficiency (0.6, 0.8, and 1.0) under various quotas. Dashed lines represent length based estimates of F40% (0.19) and 75% of F40% (0.1425). SSB per recruit is derived by using GOM winter flounder growth and maturation relationships and an assumed knife edge selection curve at 30 cm.

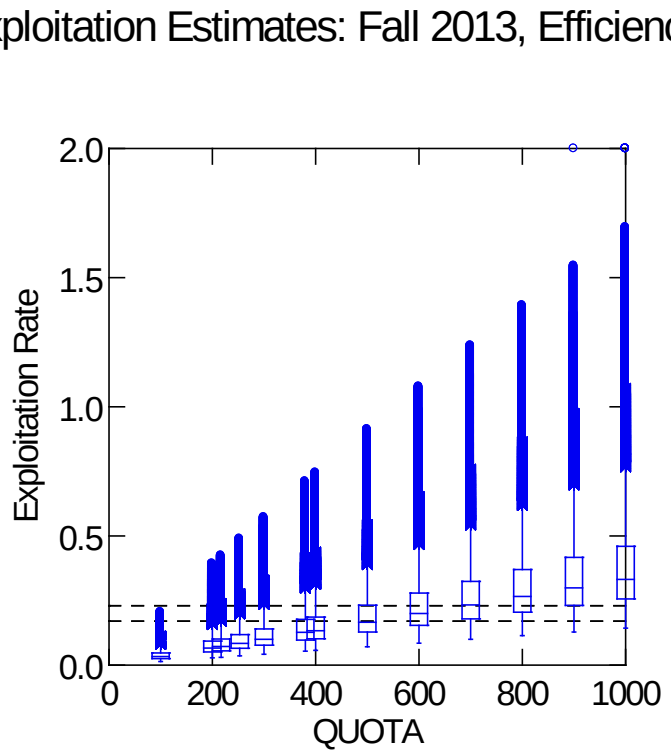


Figure B20, continued. Estimated exploitation rates for Gulf of Maine(GOM) winter flounder (*Pseudopleuronectes americanus*) for fall 2009 based on three assumed estimates of gear efficiency (0.6, 0.8, and 1.0) under various quotas. Dashed lines represent length based estimates of F40% (0.19) and 75% of F40% (0.1425). SSB per recruit is derived by using GOM winter flounder growth and maturation relationships and an assumed knife edge selection curve at 30 cm.

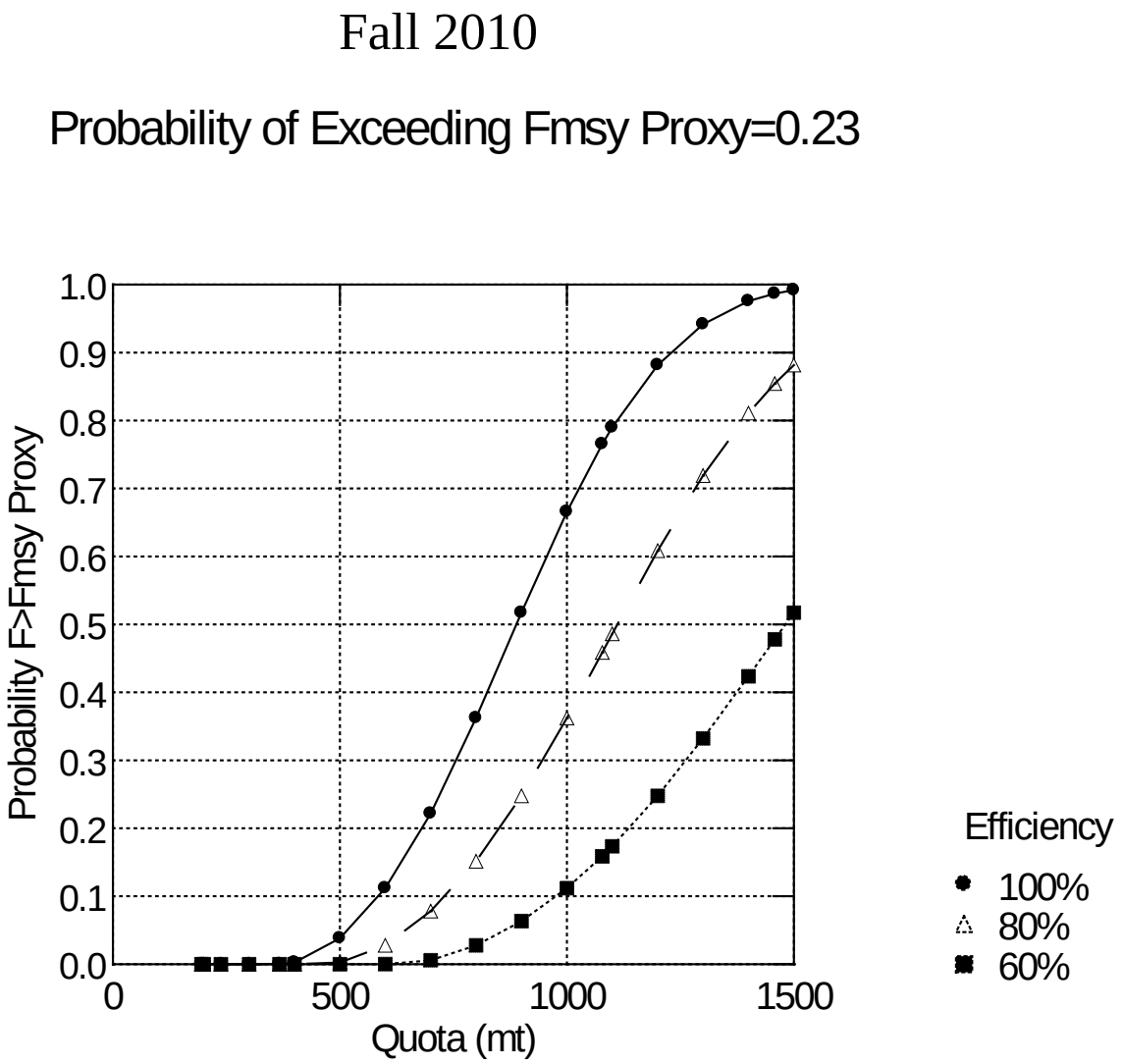


Figure B21. Estimated probability of exceeding F_{MSY} proxy (F40%), expressed as an exploitation rate of 0.23 and assuming efficiencies of 60%, 80%, and 100% from SARC 52 based on the fall 2010 survey across a range of quotas.

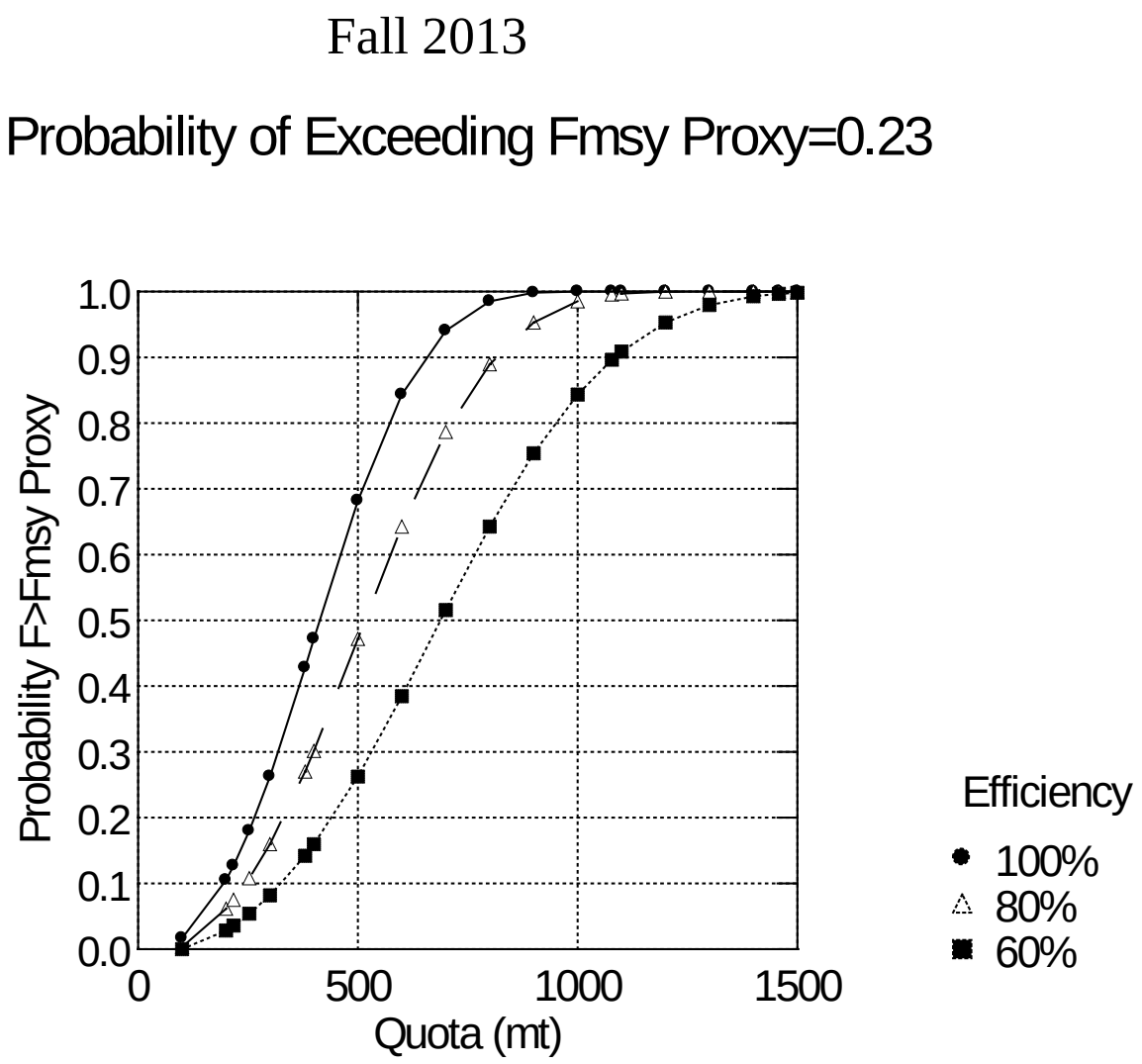


Figure B22. Updated estimated probability of exceeding F_{MSY} proxy (F40%), expressed as an exploitation rate of 0.23 and assuming efficiencies of 60%, 80%, and 100% based on the fall 2013 survey across a range of quotas.

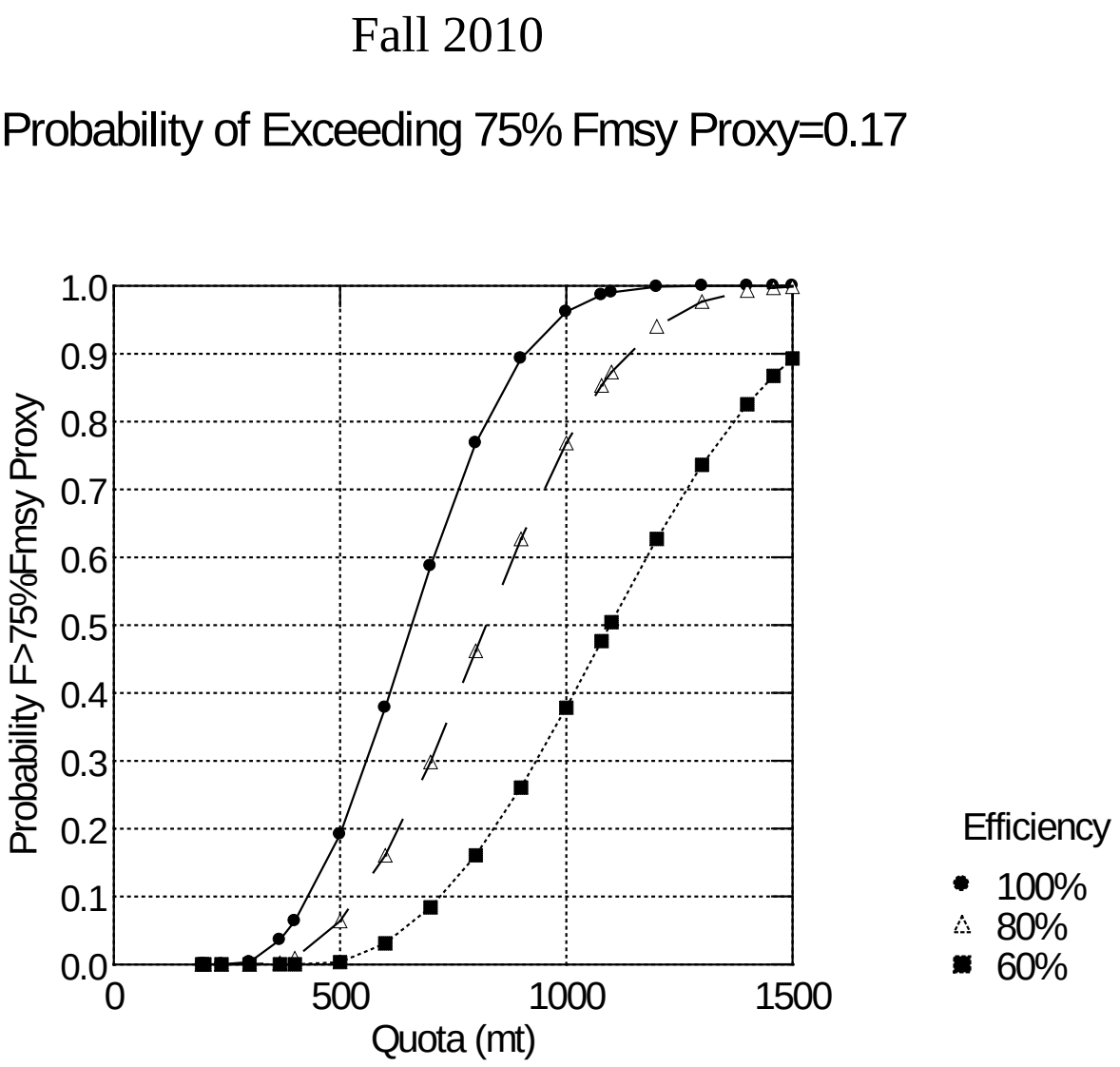


Figure B23. Estimated probability of exceeding 75% of F_{MSY} proxy (F40%), expressed as an exploitation rate of 0.17 and assuming efficiencies of 60%, 80%, and 100% from SARC 52 based on the fall 2010 survey across a range of quotas.

Fall 2013

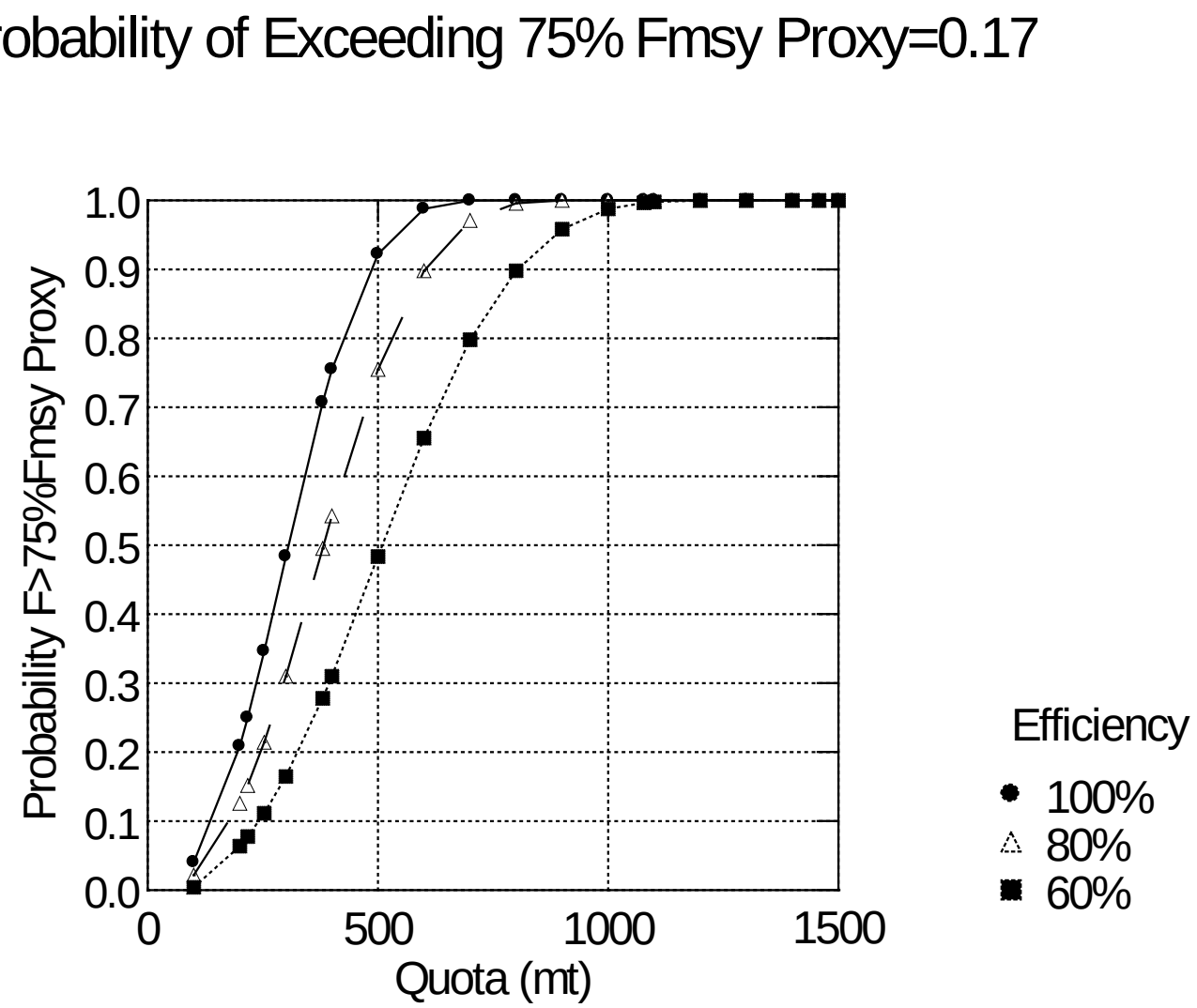


Figure B24. Updated estimated probability of exceeding 75% of F_{MSY} proxy (F40%), expressed as an exploitation rate of 0.17 and assuming efficiencies of 60%, 80%, and 100% based on the fall 2013 survey across a range of quotas.

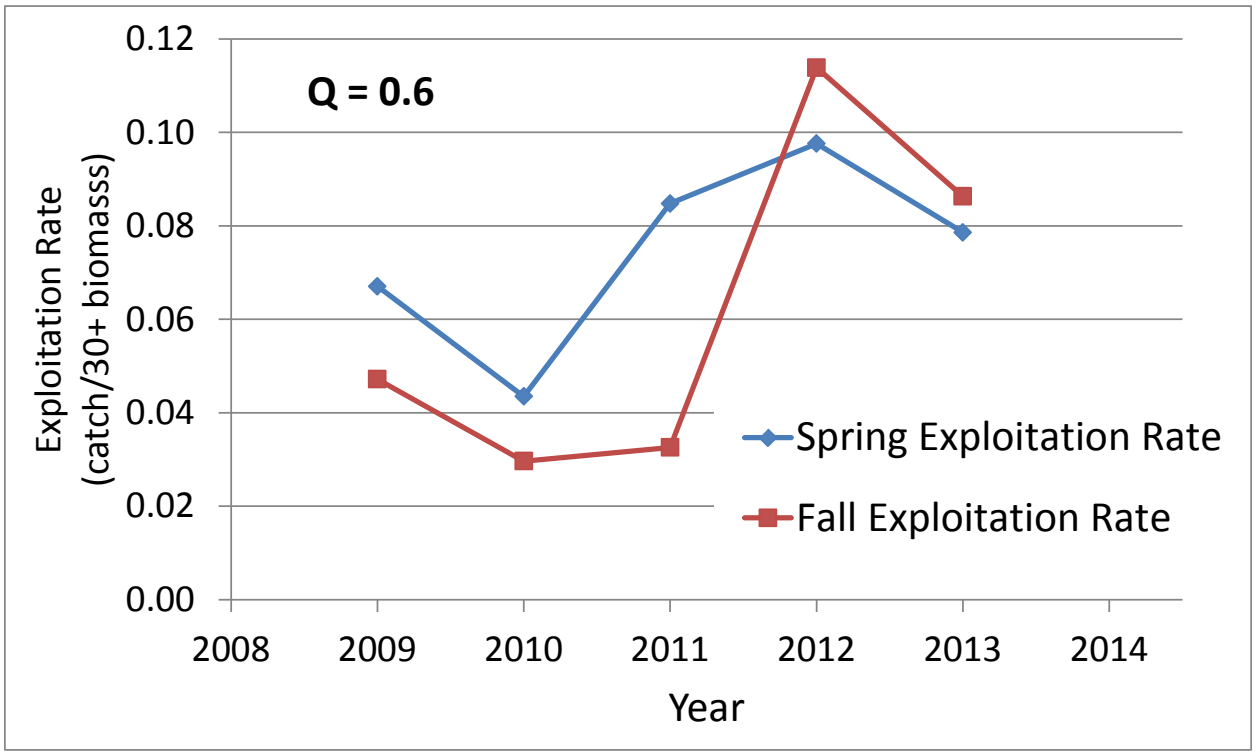


Figure B25. Estimated exploitation rates (catch/ 30+ cm biomass) from 2009-2013 using the spring and fall surveys assuming q=0.6 on wing spread.

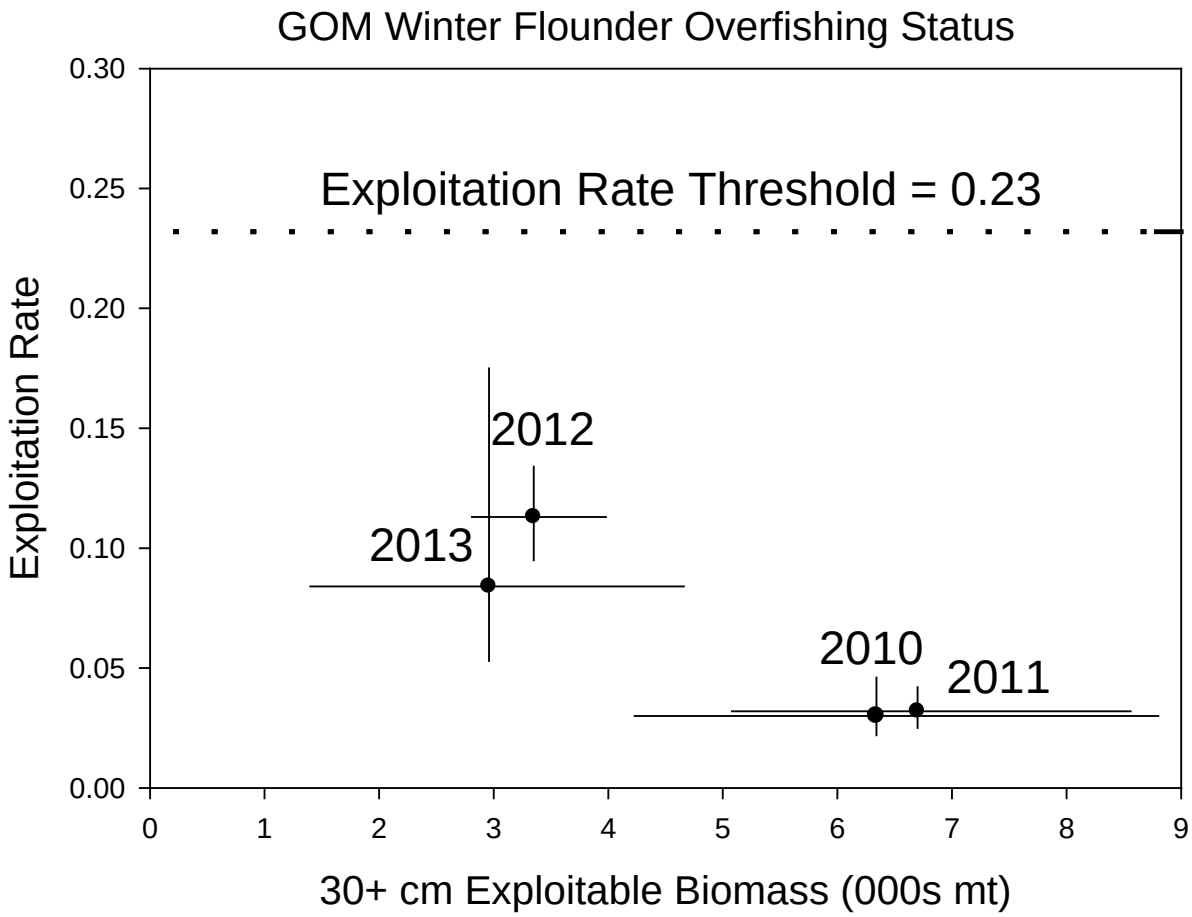


Figure B26. Stock status for Gulf of Maine (GOM) winter flounder (*Pseudopleuronectes americanus*) from 2010 through 2013 with respect to the F_{MSY} proxy. 80% confidence intervals are shown for biomass and exploitation rate from 2010 and 2013. F40% = 0.31, which corresponds to an exploitation rate of 0.23.

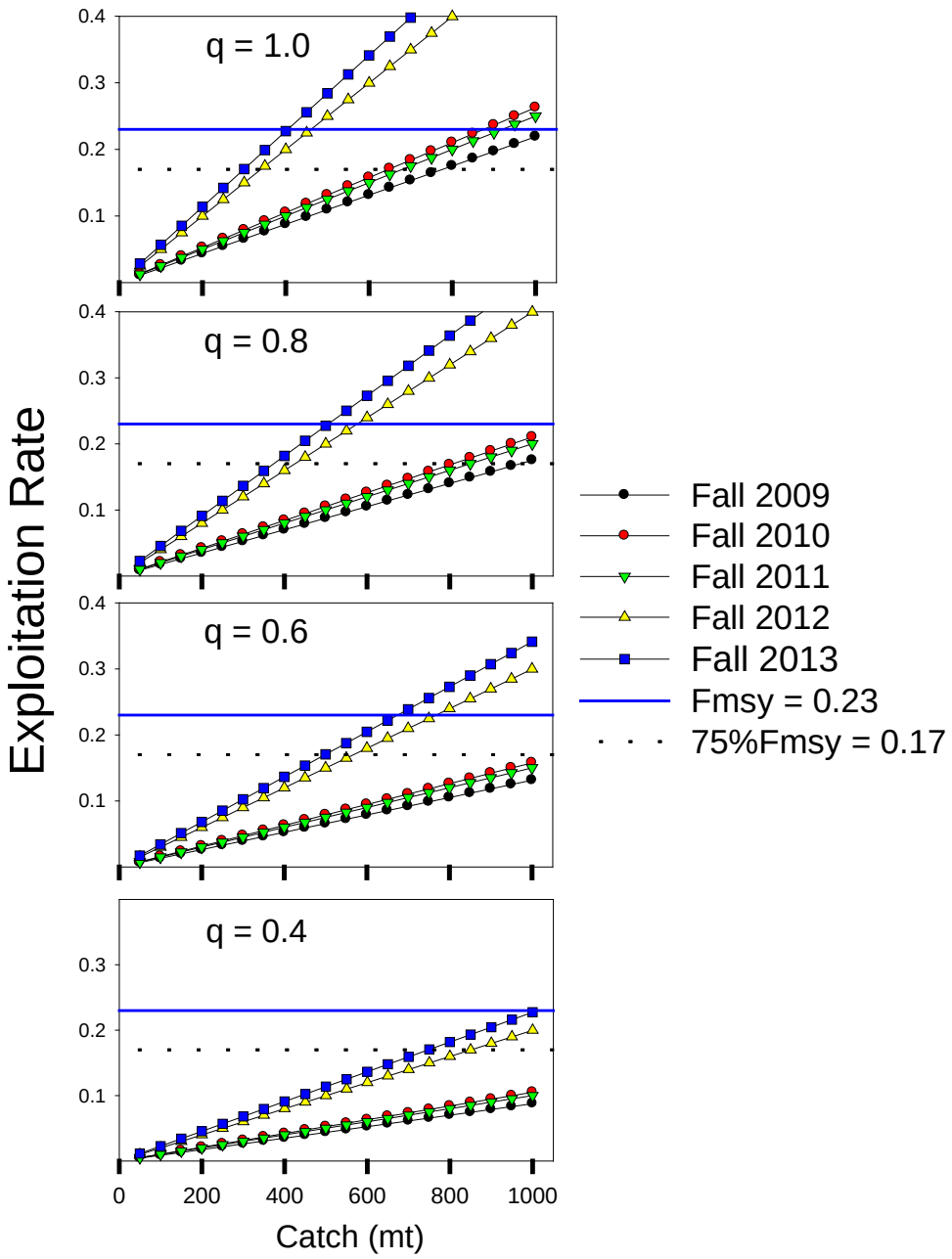
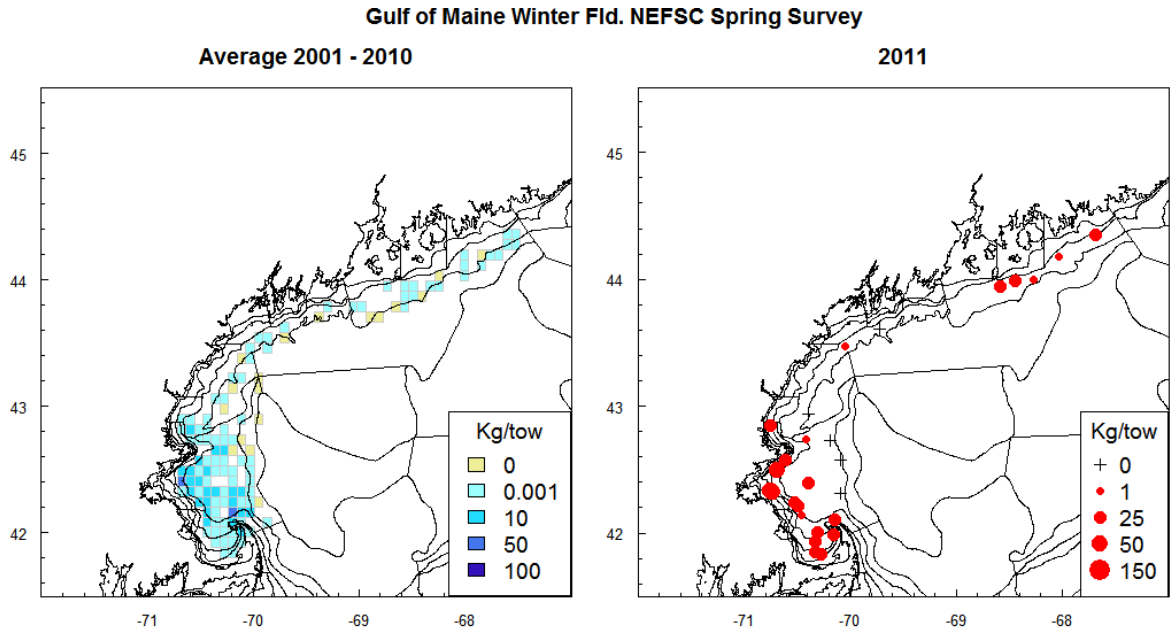
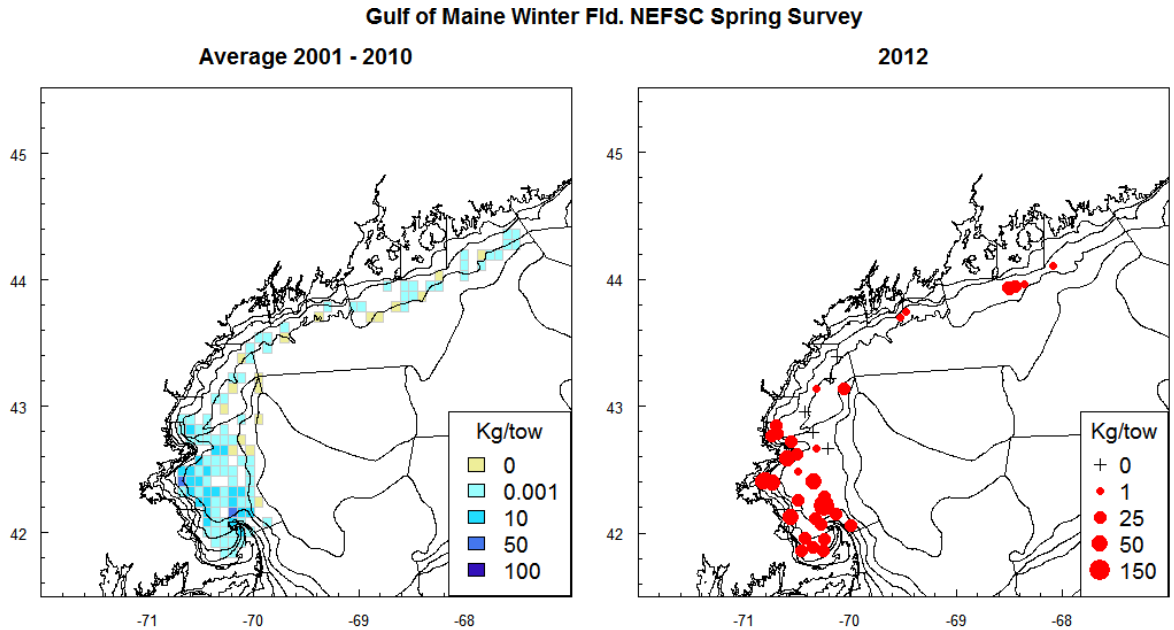


Figure B27. Exploitation rate (catch over survey biomass) for a range of catches using the combined fall surveys from 2009 through 2013 assuming different efficiencies (0.4, 0.6, 0.8 1.0) using wing spread. Solid blue line is exploitation rate at F_{MSY} = 0.23 proxy, and the dashed black line is the exploitation rate at 75% F_{MSY} = 0.17.

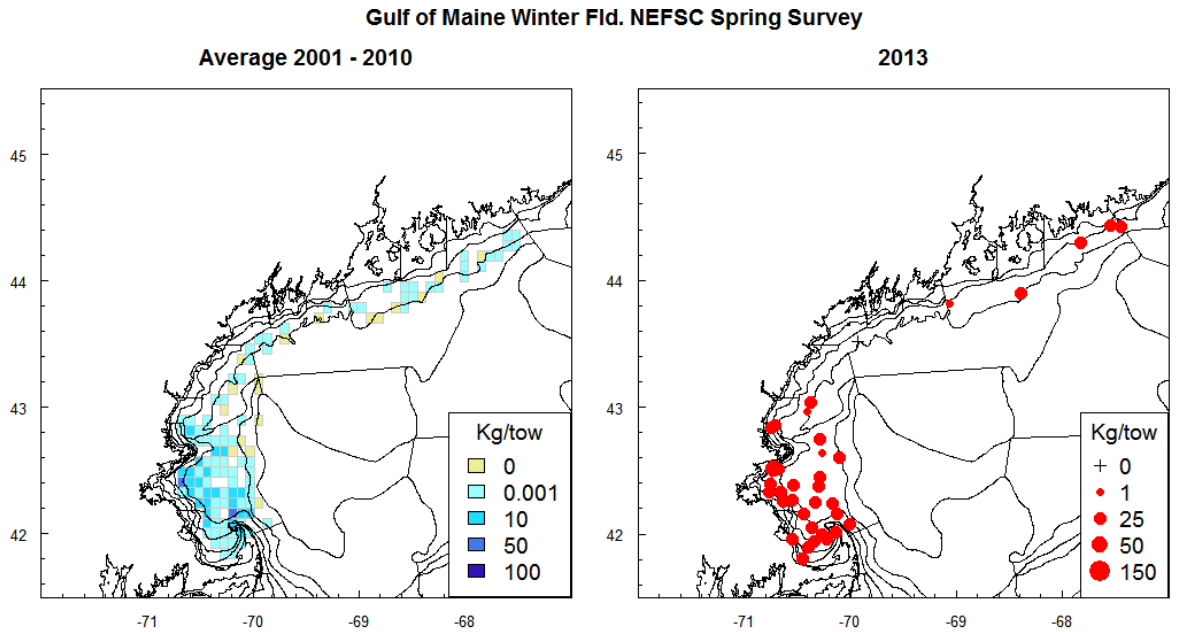
Appendix B1. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*)

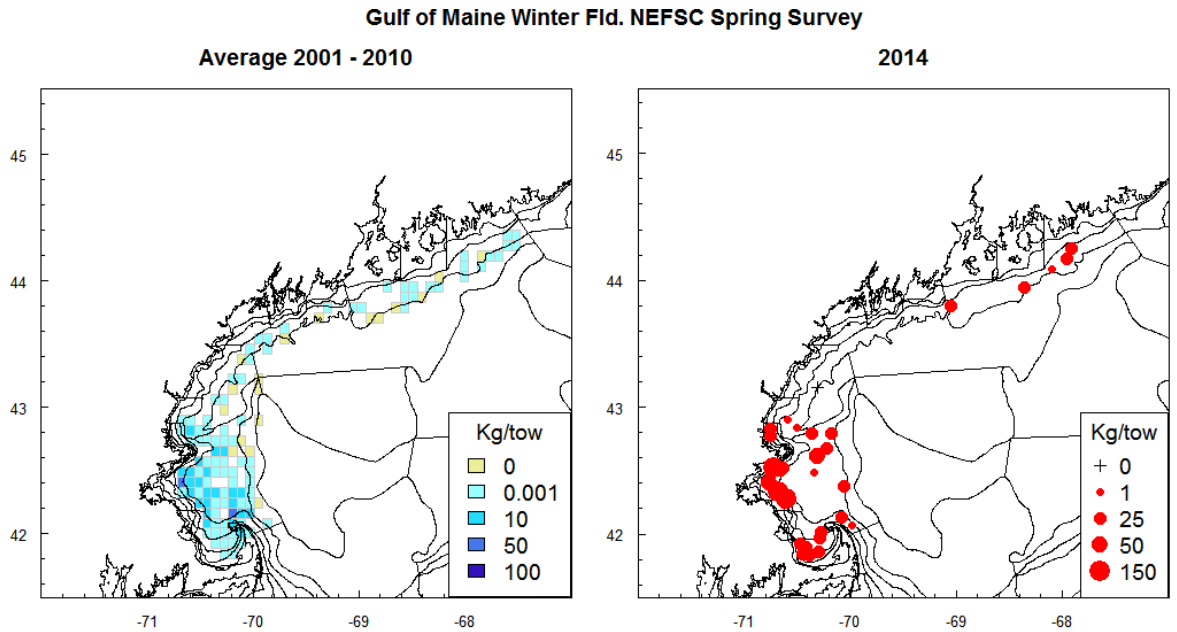
Survey distribution plots, length frequency distributions, and percent positive tows by strata plots



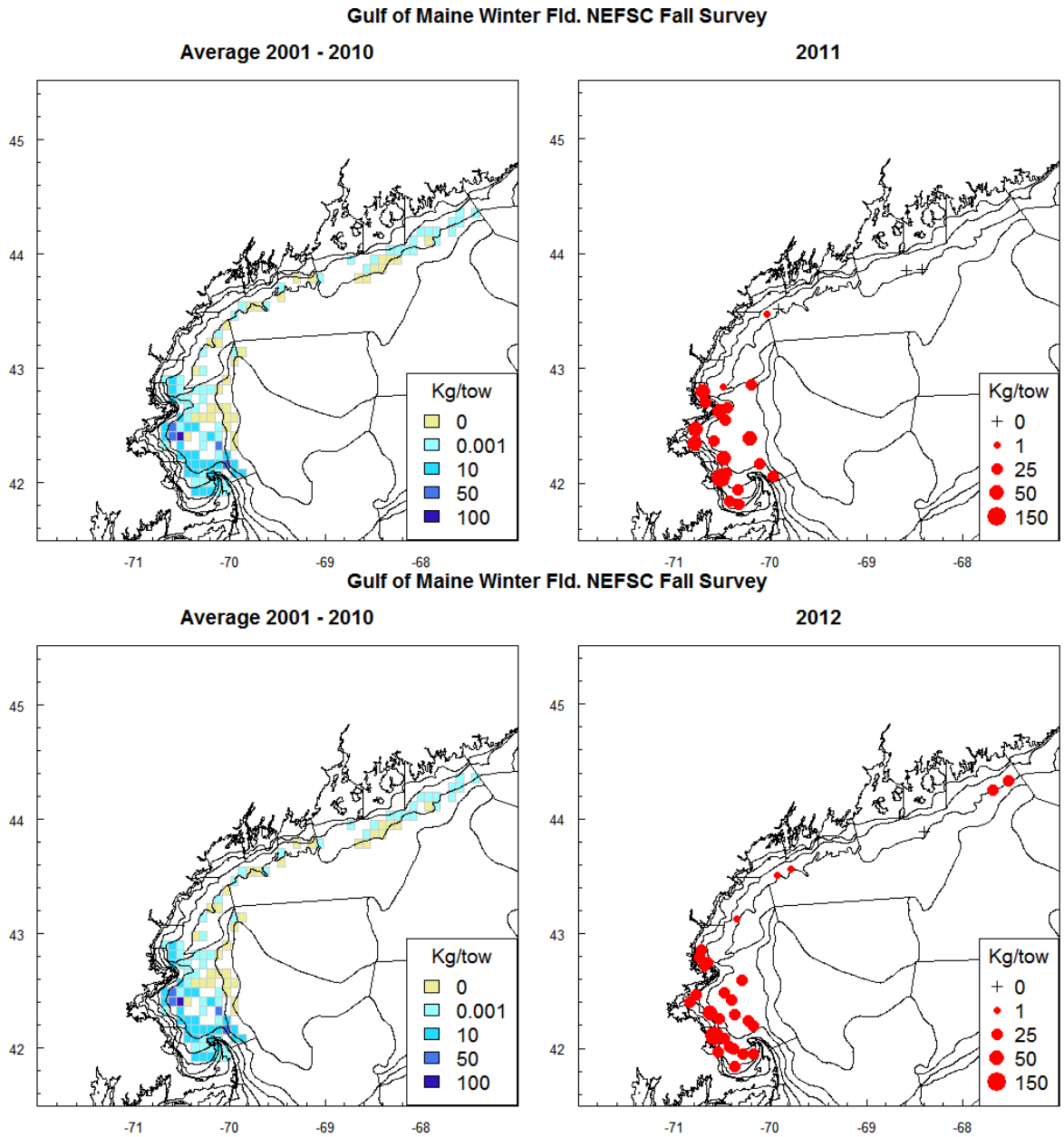


Appendix B1 Figure B1. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) Northeast Fisheries Science Center (NEFSC) spring 2011-2014 and fall 2011-2013 spatial survey distributions in Kg/tow (right panel). Plots on the left show the kg/tow average from 2001 to 2010.

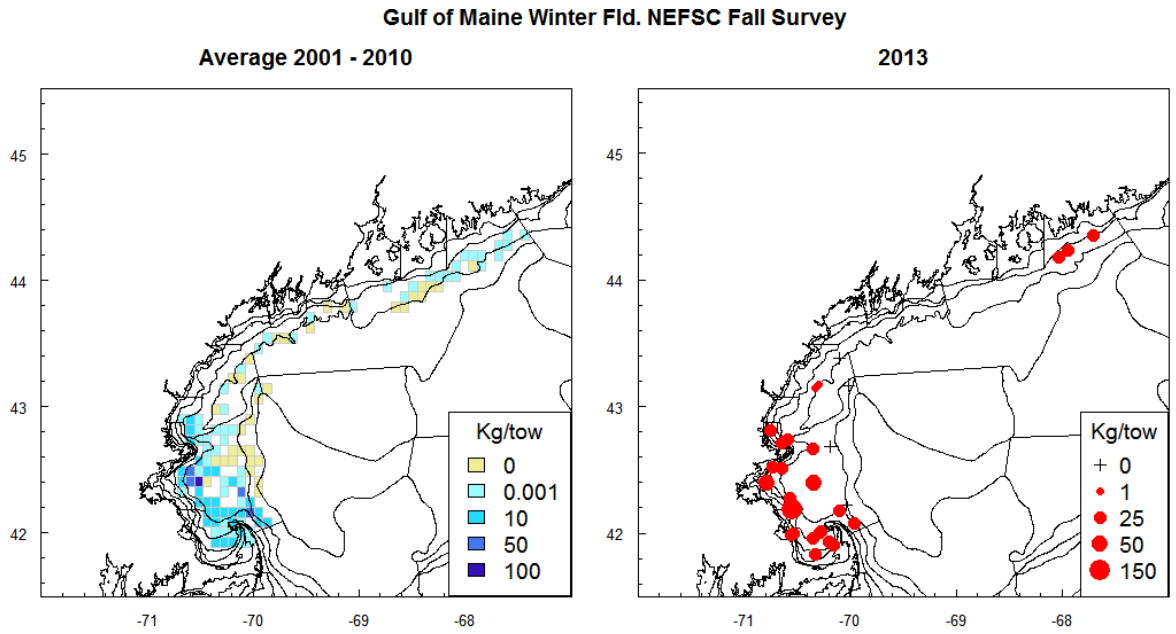




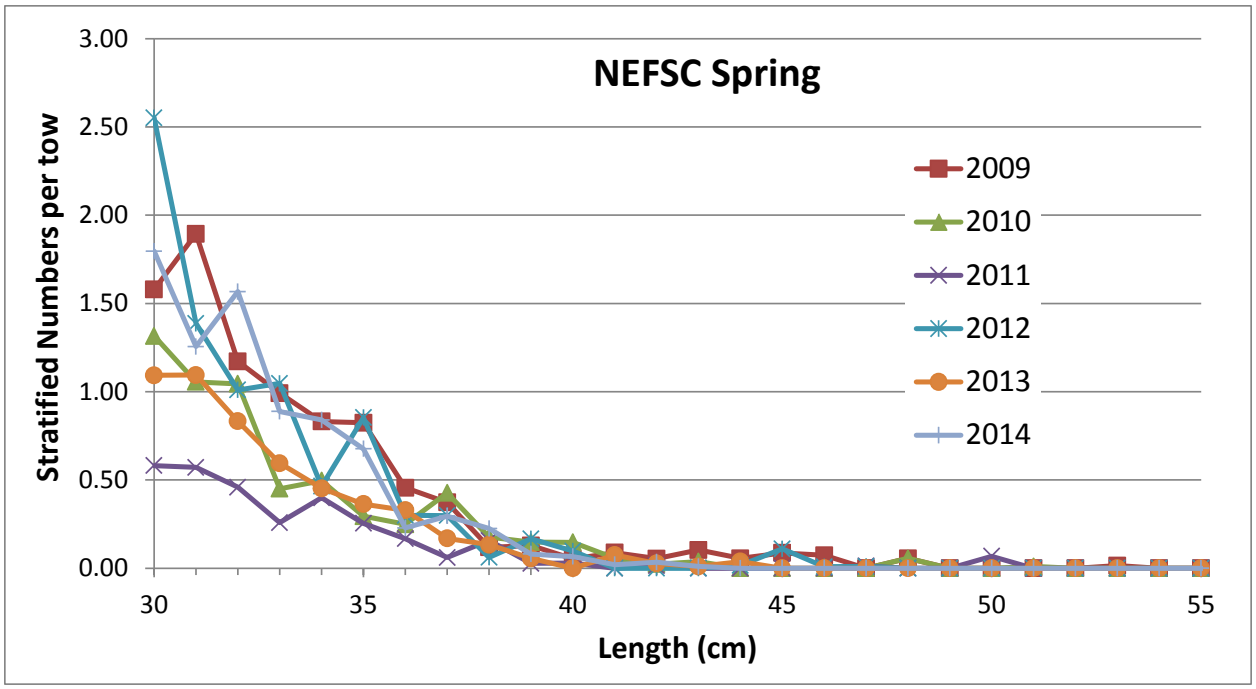
Appendix B1 Figure B1, continued. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) Northeast Fisheries Science Center (NEFSC) spring 2011-2014 and fall 2011-2013 spatial survey distributions in Kg/tow (right panel). Plots on the left show the kg/tow average from 2001 to 2010.

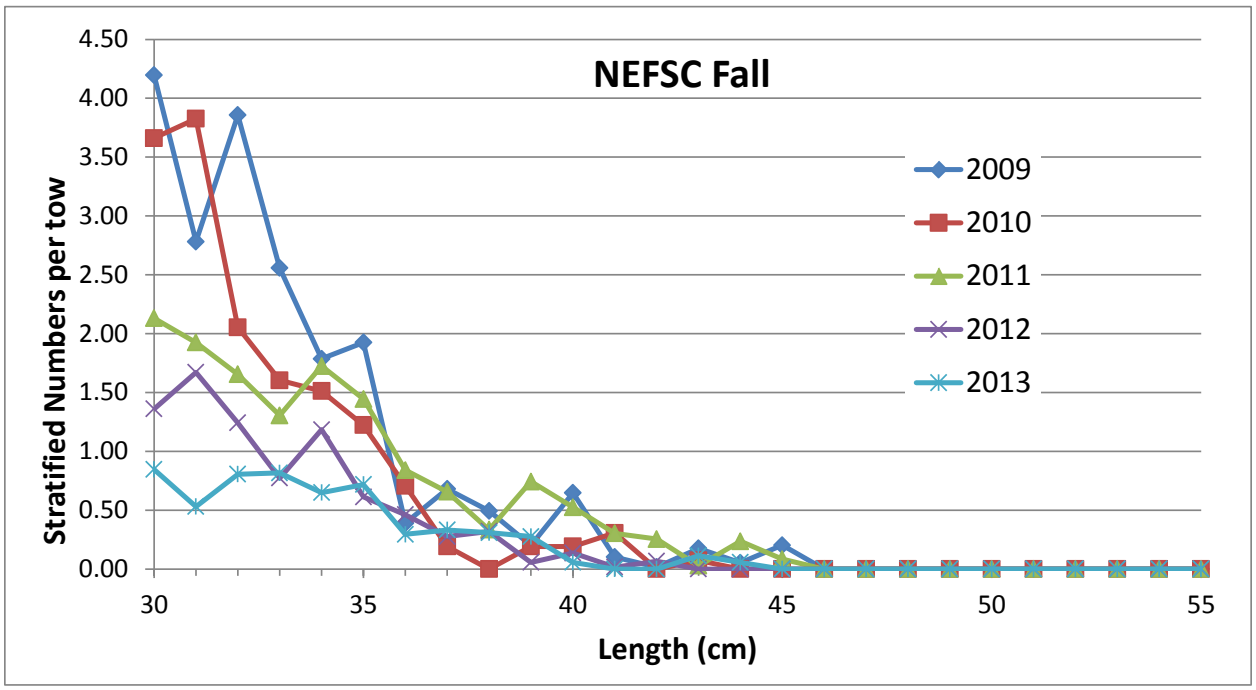


Appendix B1 Figure B1, continued. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) Northeast Fisheries Science Center (NEFSC) spring 2011-2014 and fall 2011-2013 spatial survey distributions in Kg/tow (right panel). Plots on the left show the kg/tow average from 2001 to 2010.

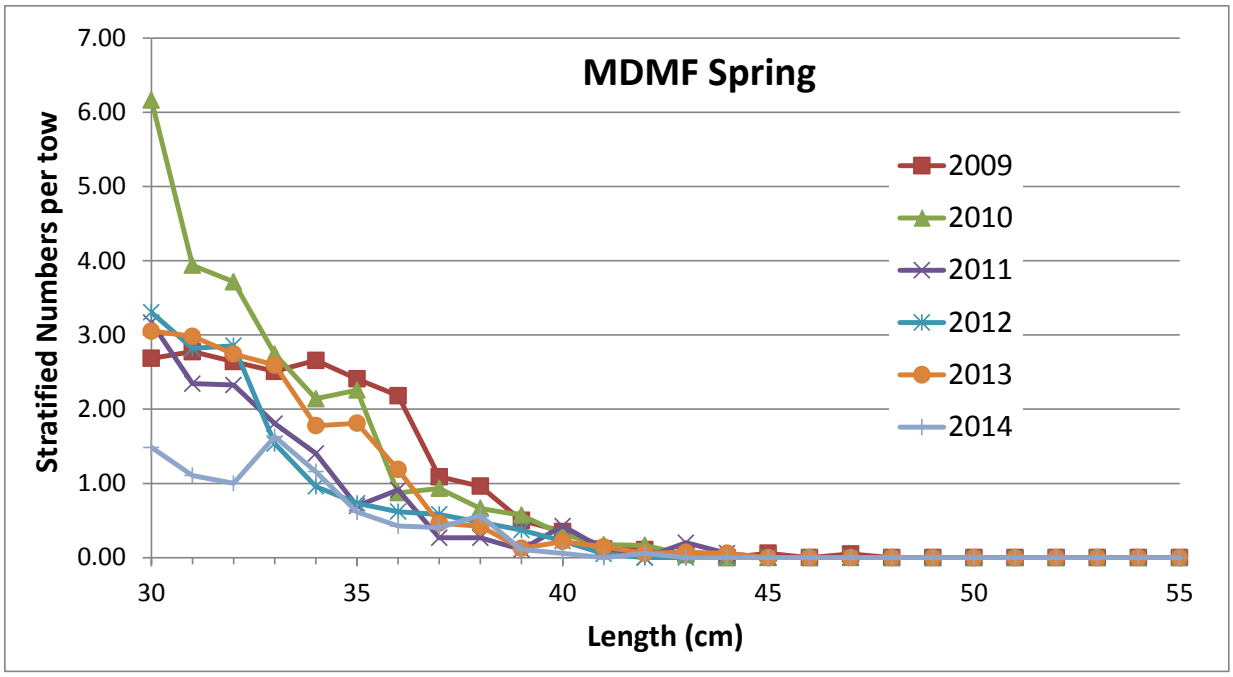


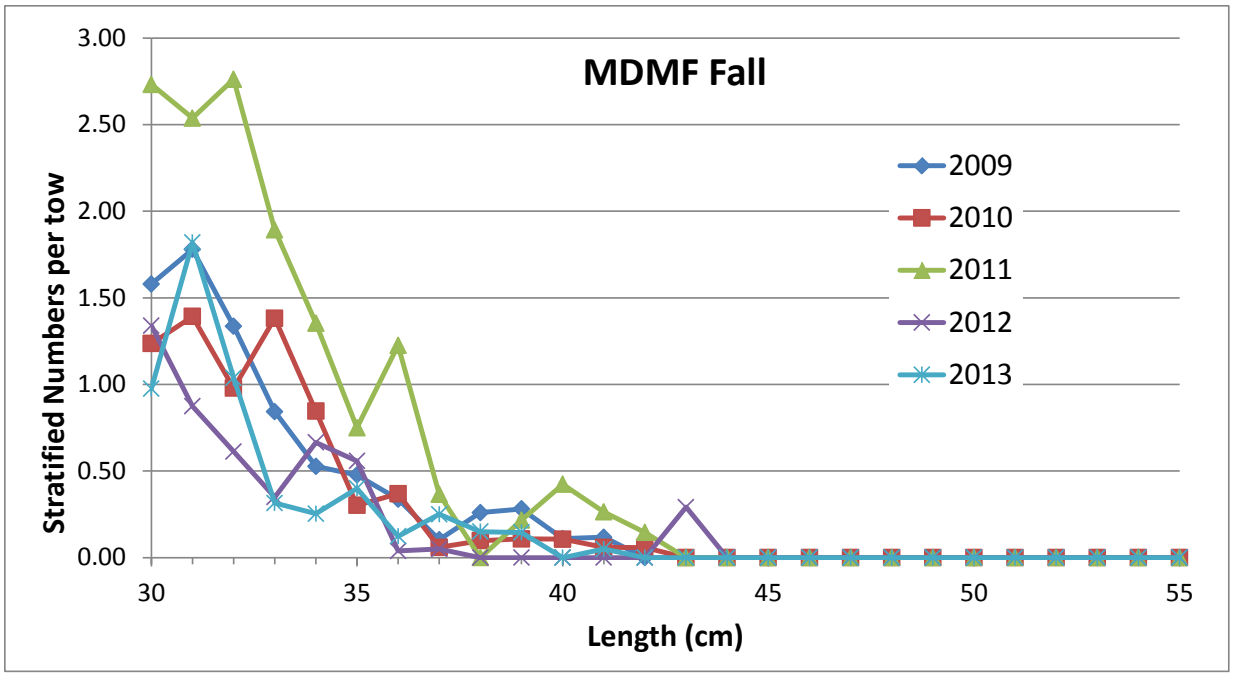
Appendix B1 Figure B1, continued. Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) Northeast Fisheries Science Center (NEFSC) spring 2011-2014 and fall 2011-2013 spatial survey distributions in Kg/tow (right panel). Plots on the left show the kg/tow average from 2001 to 2010.



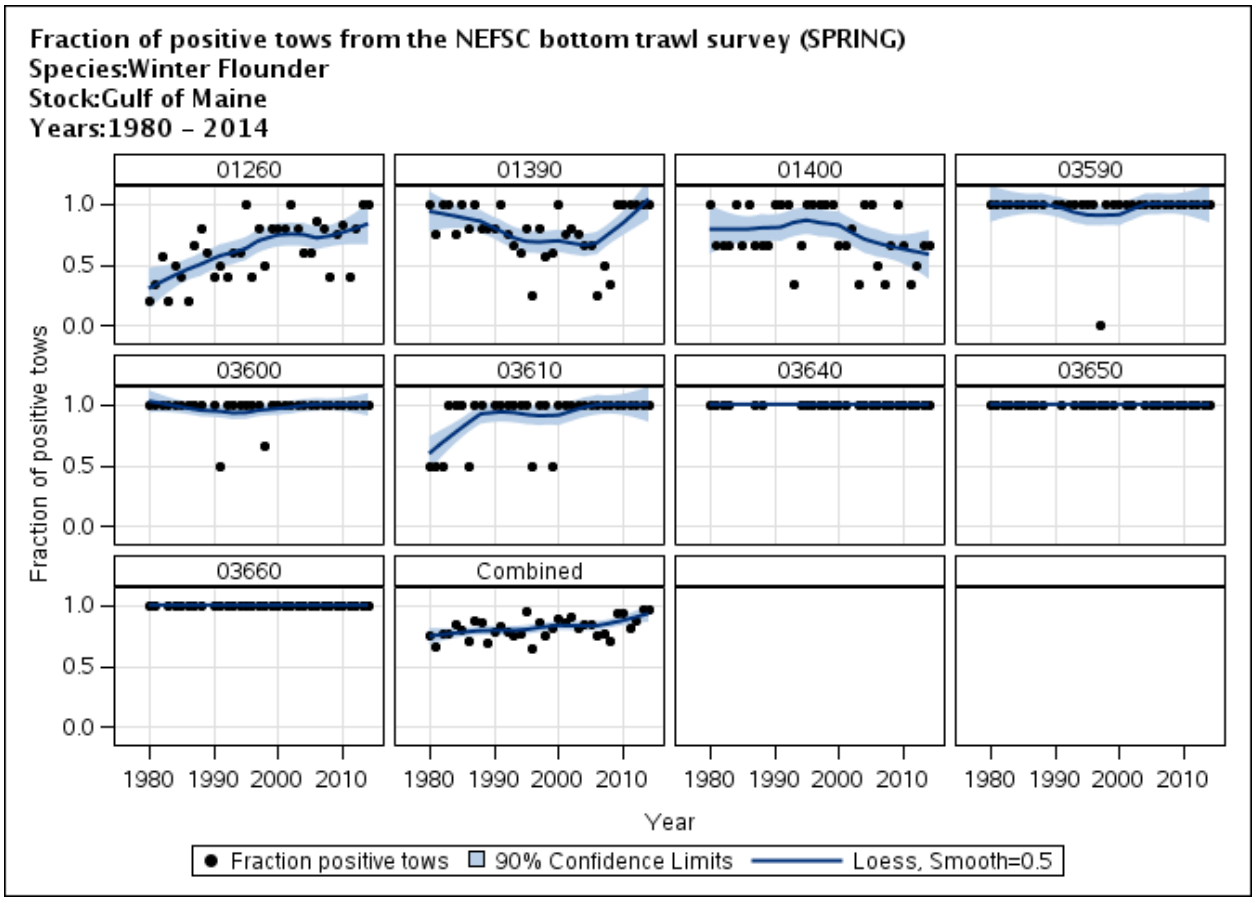


Appendix B1 Figure B2. Northeast Fisheries Science Center (NEFSC) 30+ cm stratified numbers per tow size distribution for the spring 2009 to 2014 and the fall 2009 to 2013 surveys (offshore strata 39, 40, 26 and inshore strata 59, 60, 61, 64, 65, 66).

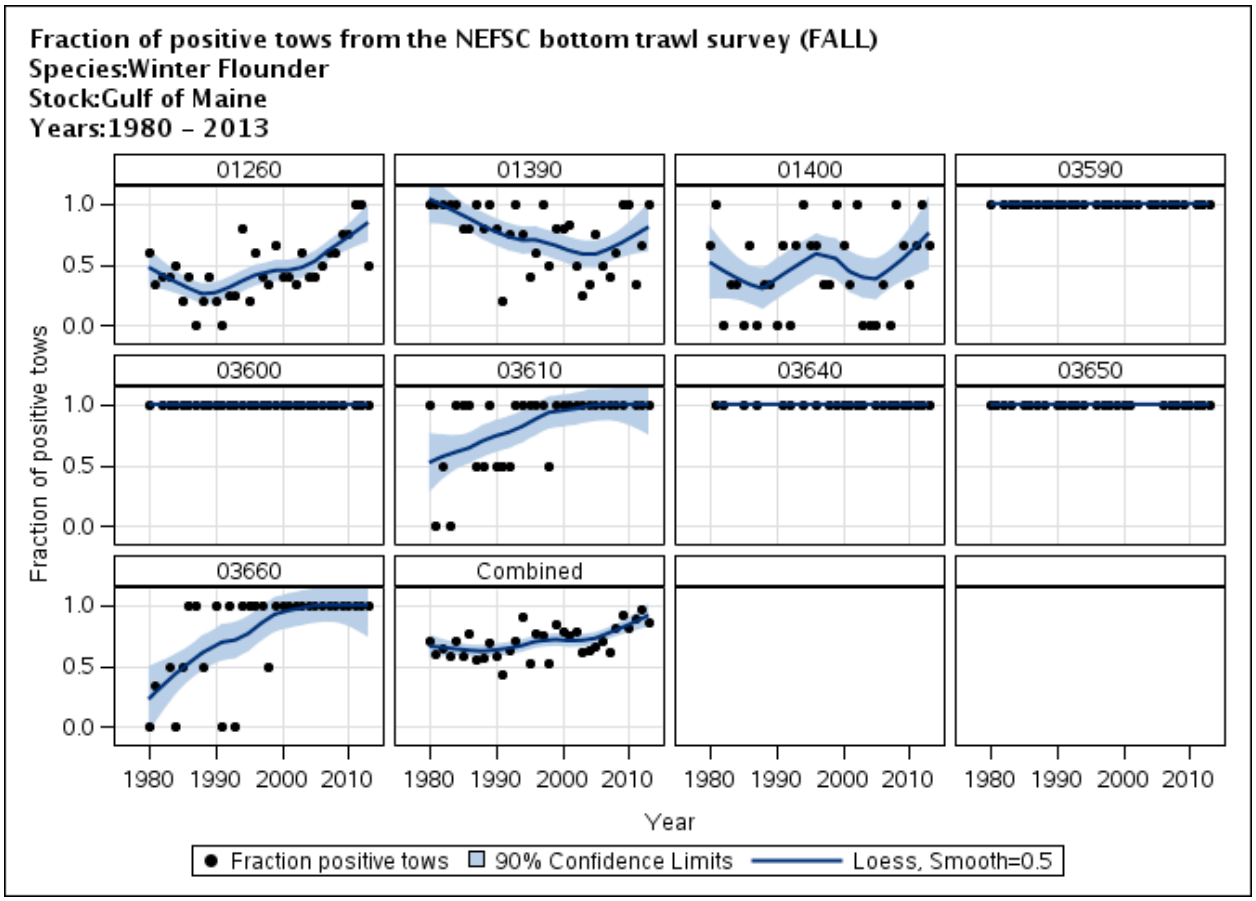




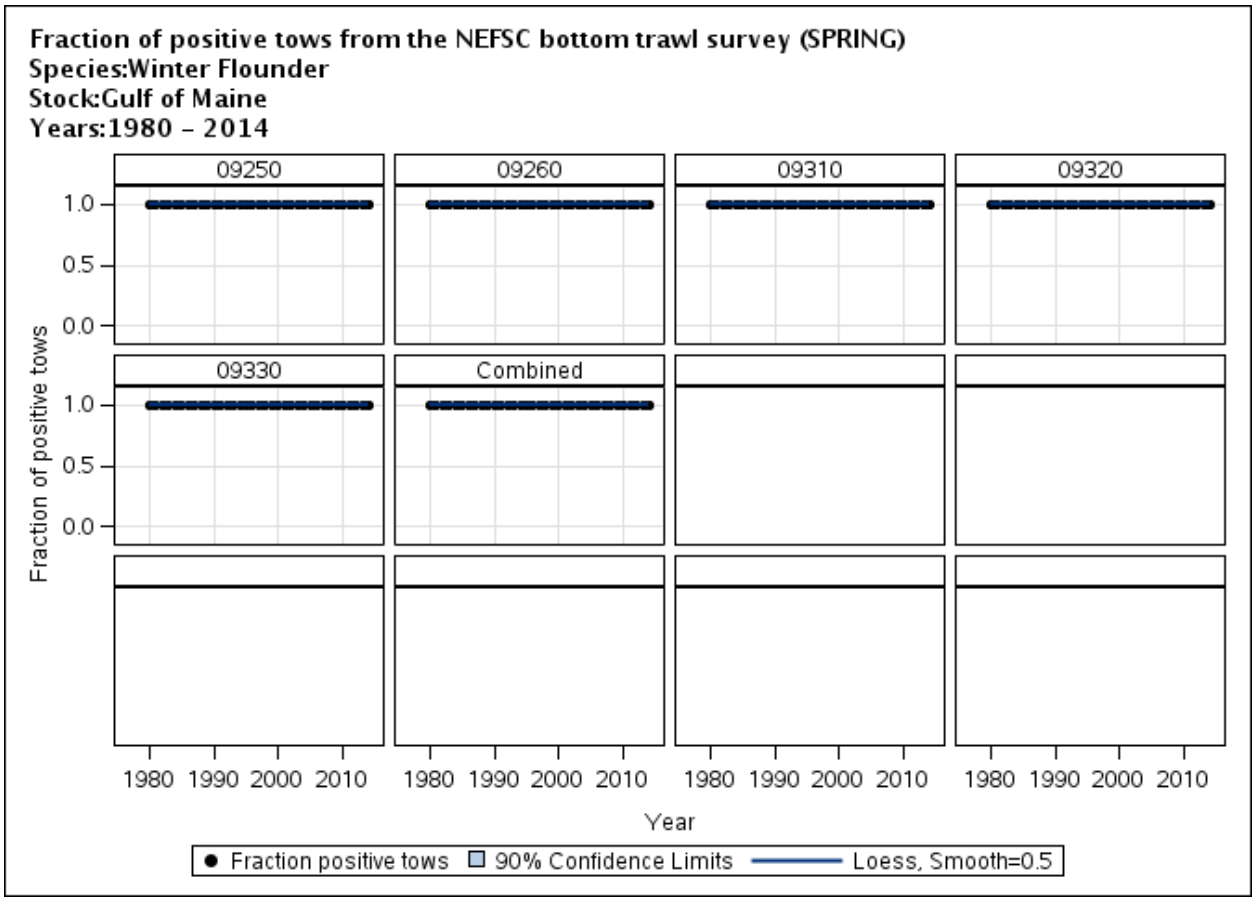
Appendix B1 Figure B3. Massachusetts Division of Marine Fisheries (MDMF) 30+ cm stratified numbers per tow size distribution for the spring 2009 to 2014 and the fall 2009 to 2013 surveys (strata 25, 26, 31, 32, 33).



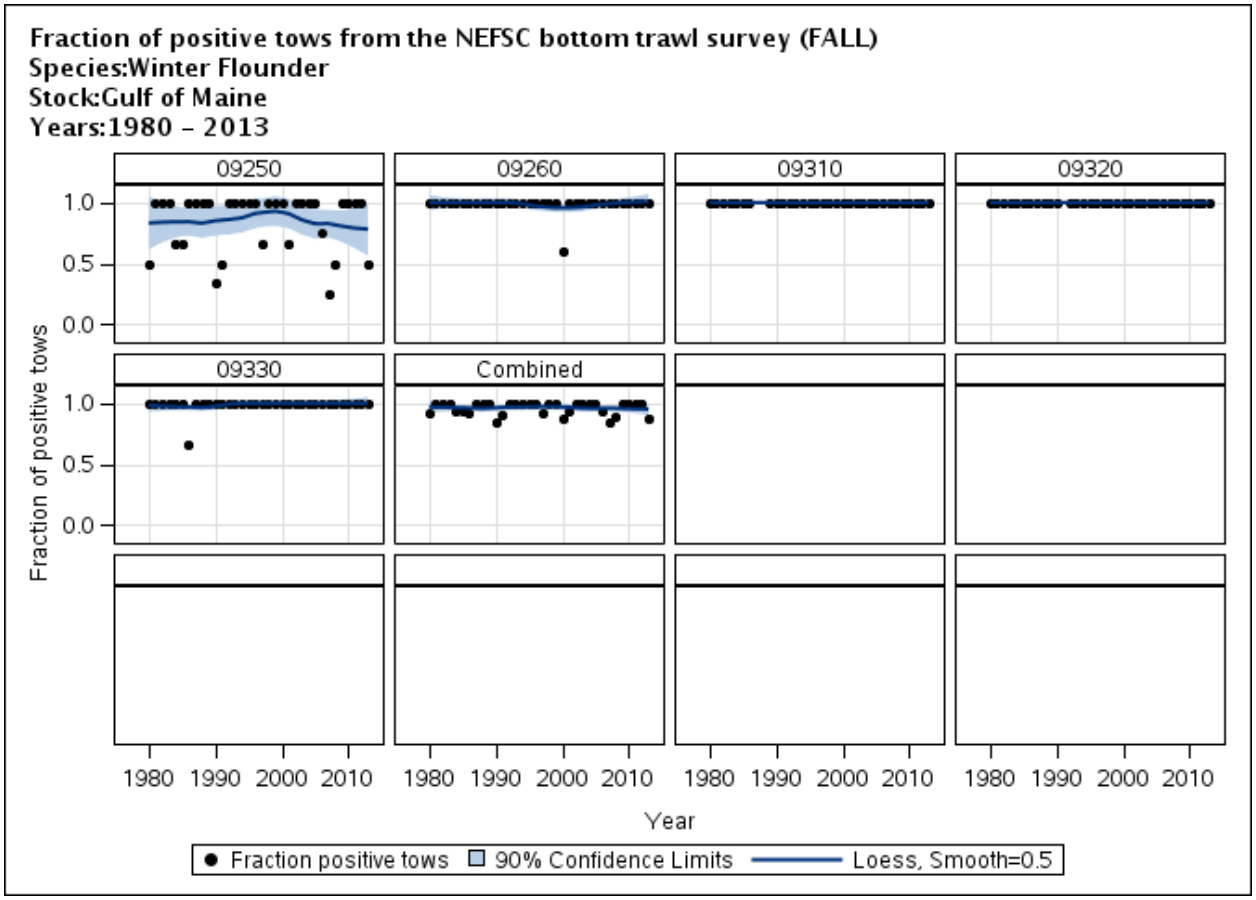
Appendix B1 Figure B4. Northeast Fisheries Science Center (NEFSC) and Massachusetts Division of Marine Fisheries (MDMF) spring 1980 to 2014 and fall 1980 to 2013 percent of positive winter flounder (*Pseudopleuronectes americanus*) tows by strata. A combined strata and loess smooth is also shown.



Appendix B1 Figure B4, continued. Northeast Fisheries Science Center (NEFSC) and Massachusetts Division of Marine Fisheries (MDMF) spring 1980 to 2014 and fall 1980 to 2013 percent of positive winter flounder (*Pseudopleuronectes americanus*) tows by strata. A combined strata and loess smooth is also shown.



Appendix B1 Figure B4, continued. Northeast Fisheries Science Center (NEFSC) and Massachusetts Division of Marine Fisheries (MDMF) spring 1980 to 2014 and fall 1980 to 2013 percent of positive winter flounder (*Pseudopleuronectes americanus*) tows by strata. A combined strata and loess smooth is also shown.



Appendix B1 Figure B4, continued. Northeast Fisheries Science Center (NEFSC) and Massachusetts Division of Marine Fisheries (MDMF) spring 1980 to 2014 and fall 1980 to 2013 percent of positive winter flounder (*Pseudopleuronectes americanus*) tows by strata. A combined strata and loess smooth is also shown.

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