Summary of Stock Assessment Prospectuses
Population Dynamics Branch
Northeast Fisheries Science Center
Last Update: July 24, 2015

Contents

The following statements have been prepared by the lead assessment scientists for each stock to summarize the most recent assessments and the utility of new benchmarks. Key strengths and weaknesses of the assessment are summarized, and research necessary to obtain major breakthroughs are identified. In many instances, completion of these research topics is a prerequisite for conducting new benchmarks. In the meantime, update assessments may be the best approach for providing management advice and allowing adequate research time to address critical topics.

1.0 New England Fishery Management Council

1.1 Northeast Multispecies (Groundfish)

1.1.1 Gulf of Maine cod: Gadus morhua

Mike Palmer
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2014 update, SSC review
Model Type: age-based, ASAP

The Gulf of Maine cod stock has been assessed three times since 2011, with the last assessment occurring in 2014. The 2014 assessment updated commercial and recreational fishery catch data, research survey indices of abundance, and the analytical assessment models through 2013 using the data preparation and modelling approaches adopted for the 2012 SARC 55 benchmark assessment. Additionally, reference points and stock projections were updated through 2017. There are two accepted population assessment models for this stock, the M=0.2 (natural mortality, M=0.2) and the M-ramp (M ramps from 0.2 to 0.4) assessment models. The Gulf of Maine Atlantic cod stock is overfished and overfishing is occurring. Spawning stock biomass (SSB) in 2013 is estimated to be below 2,500 mt under both the M=0.2 and M-ramp model scenarios. The 2013 spawning biomass levels are the lowest ever estimated and are at 4% or 3% of the SSB_{MSY} proxy (47,184 mt or 69,621 mt) in the M=0.2 or M-ramp models, respectively. The 2013 fully selected fishing mortality is estimated to be greater than 1.2 under both models which is more than 6 times greater than the F_{MSY} proxy (0.18 for both models). Fishing mortality is near all time highs despite the fact that fishery catches are at the lowest levels in the time series. The Gulf of Maine cod stock is in poor condition.

The both the M=0.2 and the M-ramp assessment models exhibit retrospective patterning, with the M-ramp model categorized as minor and the M=0.2 model as major (rho adjusted SSB and F terminal values fall outside of the 90% confidence intervals). The review panel for the 2014

update recommended that a retrospective adjustment not be made for either model. Should the retrospective patterns continue then the models may have overestimated spawning stock size and underestimated fishing mortality. Additionally, declining spawning stock biomass and truncation of the age-structure could compromise the future recruitment success and rebuilding potential of this stock. Recruitment over the last five years (2009-2013) was well below the long-term recruitment levels. If recent weak recruitment of Gulf of Maine cod continues, productivity and rebuilding of the stock will be low.

A future benchmark assessment should include a thorough analysis of the empirical evidence for changes in natural mortality, including any observations on changes to life history parameters. Discussions on natural mortality should also extent to reference point considerations and how best to develop reference points when/if there are changes in the underlying biological parameters over time. Additionally, there are several outstanding research recommendations with this stock which should be addressed before another benchmark assessment is conducted, most notably: stock structure, estimates of bycatch in the inshore lobster fishery and discard mortality in the recreational fishery.

1.1.2 Georges Bank Cod: Gadus morhua

Loretta O'Brien
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2012 SARC 55
Model Type: age based, forward projecting, ASAP

This stock was last assessed at the SARC 55 (2012) benchmark review where the historically applied VPA model was replaced by a forward projecting age-structured model, ASAP. In 2012, the Georges Bank Atlantic cod stock was overfished and overfishing was occurring. The 2012 ASAP results (1978-2011) indicated a strong retrospective bias such that retrospective adjusted population numbers were applied in the catch projections. Sources of uncertainty, besides the retrospective bias and the adjustment, include seasonal movements of the stock, the magnitude of recent natural mortality, and the effect of recent declining trends in mean weights at age and truncated age structure on the estimation of SSB (i.e. productivity of spawners and the viability of offspring from 1st and 2nd time spawners). Research needed to be done before another benchmark assessment is conducted would include the resolution of cod stock structure vs. cod management units in New England waters and investigations related to natural mortality, e.g., analysis of historical tagging data combined with more recent tagging experiment, or how changing condition factor affects survivability. Several more recommendations for further research were outlined by the SARC 55 review panel.

1.1.3 Gulf of Maine haddock: Melanogrammus aeglefinus

Mike Palmer
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2014 benchmark, SARC 59
Model Type: age-based, ASAP

A benchmark assessment for Gulf of Maine haddock was conducted at SARC 59 in July 2014. A new statistical catch at age model (ASAP) was developed and accepted for use. The new model incorporated estimates of recreational discards (assumed survival of 50%) which had not been estimated in previous assessments. Prior to SARC 59, Gulf of Maine haddock was assessed using a VPA model in 2012 as part of the 2012 NE Groundfish Updates Integrated Peer Review and a benchmark assessment of Gulf of Maine haddock occurred in 2008 as part of the Third Groundfish Assessment Review Meeting (GARM III). The existing ASAP assessment model generally has good diagnostics and little retrospective patterning. The stock is currently not overfished, and overfishing is not occurring. Reference points and stock projections were updated through 2017.

The SARC 59 assessment included an in depth examination of the hypothesis that "spill over" of large year classes of Georges Bank haddock into the Gulf of Maine was occurring. All available information and analyses suggest that mixing from Georges Bank to the Gulf of Maine is low (<0.8% of Georges Bank fish), though the mixing scenarios have similar plausibility to that of an isolated stock. The largest source of uncertainty in the 2014 assessment was the estimated size of the 2012 year class. Based on the estimated selectivity patterns, this year class is predicted to be 50% selected by the fishery in 2017 at age-5. Recent changes to the commercial minimum retention size may result in this year class recruiting to the fishery sooner.

1.1.4 Georges Bank haddock: Melanogrammus aeglefinus

Liz Brooks
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2012 Operational Assessment
Model Type: Age-based VPA

The last benchmark assessment of Georges Bank haddock occurred in 2008 as part of the Third Groundfish Assessment Review Meeting (GARM III). An update of the Georges Bank haddock stock was conducted in 2012 as part of the 2012 NE Groundfish Updates Integrated Peer Review. The stock is currently not overfished, and no overfishing is occurring. The existing VPA assessment model generally has good diagnostics; however, future assessment efforts should explore the use of statistical catch at age models to better account for the uncertainty in the underlying data. The 2012 assessment indicated that the incoming 2010 year class was

exceptionally large, albeit uncertain. Forecasted allowable catch will be sensitive to the assumed magnitude of this year class. Also, the presence of another large year class in the population could continue the current trend for smaller size at age. This impacts the magnitude of discards (hard to avoid such a large year class), and the probability of discarding due to slower growth and the minimum size. The reduced size at age also impacted the fully selected age, which impacted reference points. If the Georges Bank stock is benchmarked in the future, it should be done in concert with the Gulf of Maine stock to permit an evaluation of hypotheses that could impact both haddock stocks. There is an eastern management unit of Georges Bank (statistical areas 551-552 and 561-562) that is jointly managed by the U.S. and Canada through the TRAC and TMGC. This eastern management unit comprises only the eastern portion of the full Georges Bank management unit. To the extent practicable, alterations to model formulation or assessment method should be compatible between the two assessments (Georges Bank and the eastern Georges Bank management unit).

1.1.5 Yellowtail flounder stocks: Limanda ferruginea

Larry Alade, Chris Legault,
Fishery Management Plan: NEFMC Multispecies
Last Assessment: ***2012 Operational Assessment (Cape Cod/Gulf of Maine)***
2015 TRAC (Georges Bank)
2012 Benchmark (Southern New England/Mid-Atlantic)
Model Type: age-based, VPA (CCGOM), Empirical (GB), age-based, ASAP (SNEMA)

The three stocks of yellowtail flounder, CCGOM, GB, and SNEMA, are currently not producing significant catches relative to their historic amounts. The CCGOM assessment currently suffers from strong retrospective patterns. A wide range of possible "fixes" have been examined, but none have been embraced by reviewers or the fishing industry. Somewhat similar to CCGOM, the GB assessment also underwent an extensive evaluation of several model formulations but all resulted in undesirable model outcomes for setting catch advice due to a strong retrospective pattern. In 2014, an empirical approach was adopted for GB yellowtail and is currently used for setting catch advice for the stock. Giving the analytical challenges associated with the GB and CCGOM assessments, both of these stocks will require either a strong field program to demonstrate there are not many yellowtail flounder in the sea or else an extensive forensic accounting to determine the cause of the missing old fish. Simply running more models does not appear to be a fruitful approach for these stocks. The SNEMA yellowtail flounder is a "success" story because it no longer exhibits a retrospective pattern and was recently reclassified as not overfished and not overfishing. However, this reclassification was due to a major lowering of the bar due to extended poor recruitment in this stock. Without an increase in recruitment, catches will remain low despite its "success" status.

1.1.6 American plaice: Hippoglossoides platessoides

Loretta O'Brien
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2012 Operational Assessment
Model Type: age based, VPA

This stock was last assessed at the 2012 Northeast Groundfish Update meeting applying the benchmark formulation agreed upon at the 2008 Groundfish Assessment Review Meeting (GARM III). In 2012 the American plaice Gulf of Maine-Georges Bank stock was not overfished and overfishing was not occurring. The 2012 VPA results (1980-2010) indicated a strong retrospective bias such that retrospective adjusted population numbers were applied in the catch projections. Sources of uncertainty include growth differences between the Gulf of Maine and Georges Bank fish, the estimation of historical discards prior to 1989, and the estimation of small mesh fishery discards, given the lack of length frequency samples. Future benchmark assessments could explore 1) the possibility of two stocks; however, there may not be sufficient data to support a Georges Bank assessment, 2) the apparent survey dome selectivity relative to catch selectivity due to larger fish in offshore waters being less available to survey gear than the younger fish in inshore waters and 3) the application of length based conversion factors between the *Bigelow* and *Albatross IV* survey catches (or alternatively, break the survey time series between 2008-2009).

1.1.7 Gulf of Maine Winter Flounder: Pseudopleuronectes americanus

Paul Nitschke
Fishery Management Plan: NEFMC Multispecies
Last Assessment: 2014 Operational Assessment
Model Type: Swept Area biomass

The last benchmark assessment for Gulf of Maine winter flounder (GOM WF) was done at SARC 52 in 2011. This assessment was last updated in 2014. Modeling of this stock suffered from a severe retrospective pattern in GARM III and in SARC 52. Models have difficulty with the apparent lack of a relationship between a large decrease in the catch with little change in the indices and age and/or size structure over time. Stock assessment models were deemed too unreliably as a basis for the stock status determination. Like with the GB yellowtail retrospective issue, simply running more models will likely not be very informative. The stock assessment and overfishing status was determined using a 30+ cm area swept estimate from combining non-overlapping strata in three different surveys to cover the stock area. Direct estimates of stock abundance are sensitive to survey gear efficiency assumptions for the assumed survey footprint based on either wing or door spread. Survey gear studies could answer

questions regarding possible herding between the doors and inform the assumptions surrounding gear efficiency. This method can be easily updated and should be monitored if greater confidence could be obtained surrounding the gear efficiency. However, the overfished status could not be determined using this method for GOM winter flounder.

1.1.8 Georges Bank winter flounder: Pseudopleuronectes americanus

Lisa Hendrickson
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2014 Operational Assessment
Model Type: Age-based VPA

An operational assessment was conducted during 2014 using an ADAPT VPA model that included US and Canadian catches-at-age and US and Canadian survey indices-at-age for 1982-2013 as input data. In 2013, the stock was not overfished (SSB = 6,947 mt) and overfishing was not occurring (F = 0.30) based on updated estimates of FMSY (= 0.44) and ½ SSBMSY (= 4,050 mt). Terminal year estimates of F and SSB were fairly precise. Retrospective patterns for F and SSB, based on a seven-year peel, were minor and did not require adjustments. Trends in the residuals patterns were evident for a number of ages within each of the three sets of VPA calibration indices, with variability by age and year. Results from the 2014 assessment indicated that the stock was overfished during 1994 and 1995 and that spawning stock biomass has been increasing since 2008, but has remained below the new SSBMSY target of 8,100 mt. In 2007, the stock was deemed overfished, but major changes made to the 2011 benchmark assessment, including an increase in M from 0.2 to 0.3 and from %MSP-based to MSY-based BRPs, changed the perception of the stock's status. Stochastic projections for 2015-2017 indicated that the stock will be rebuilt, with at least 75% probability, by the 2017 deadline when fished at Freb = 0.27 and a 2015 assumed catch of 2,155 mt. The next benchmark assessment should investigate the utility of a statistical catch-at-age model to better account for the uncertainty in the underlying data, similar to that used for the SNE-MAB winter flounder stock. Also, the precision of the FMSY reference point is unknown because it was necessary to fix the steepness value in order to fit a Beverton-Holt stock-recruit model. Therefore, the next benchmark assessment should explore improving the S-R model fit by including large-scale, environmental forcing variables (e.g., temperature, circulation, NAO) in the model runs.

1.1.9 SNEMA Winter flounder: Pseudopleuronectes americanus

Tony Wood
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2011 SARC 52
Model Type: age-based, forward projection ASAP

The southern New England—Mid-Atlantic winter flounder stock went through a benchmark assessment at SARC52, which covered data updated through 2010. The SNE/MA winter flounder stock was overfished but overfishing was not occurring. The assessment provided a new assessment model (ASAP instead of ADAPT VPA), a new assumption for the instantaneous

natural mortality rate (M=0.3 instead of 0.2), and new biological reference points. The recommended biological reference points were FMSY = Fthreshold = 0.290, SSBMSY = Btarget = 43,661 mt, 1/2 SSBMSY = Bthreshold = 21,831 mt, and MSY = 11,728 mt. The 2010 estimate of Spawning Stock Biomass (SSB) was 7,076 mt, 16% of Btarget and 32% of Bthreshold. The 2010 estimate of fishing mortality (F, ages 4-5) was 0.051, 18% of Fthreshold. A considerable source of vulnerability for SNE/MA winter flounder is the continued weak recruitment and low reproductive rate (e.g., recruits per spawner). Recruitment estimates for the last decade are lower than those predicted by the stock recruitment model. If the weak recruitment and low reproductive rate continues, productivity and rebuilding of the stock will be less than projected. In addition, Stock-recruit modeling suggests that warm winter temperatures can have a negative effect on recruitment of SNE/MA winter flounder. Future assessments should work towards incorporating environmental indices relating to temperature and other important factors into the assessment.

1.1.10 Witch flounder: Glyptocephalus cynoglossus

Susan Wigley
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2012 Operational Assessment
Model Type: age based, VPA

The last benchmark assessment of witch flounder occurred at the 2008 Groundfish Assessment Review Meeting (GARM III). An update of the assessment was conducted in the 2012 Northeast Groundfish Update (an integrated peer review). In 2010, witch flounder was overfished and overfishing was occurring. The VPA assessment model has been used and retrospective patterns have been evident. The combination of: 1) the contraction of the age structure observed in the survey indices at age and the commercial catch at age; 2) the low NEFSC survey abundance and biomass indices in recent years; and 3) the magnitude of the 2004 year class at age 3 relative to the age 3 abundance indices over the entire time series indicating a strong 2004 cohort but not exceptional year class, all seem to suggest that the VPA with a split time series more accurately characterizes the witch flounder population. Sources of uncertainty identified in recent assessments include: (1) low frequency of samples across market category and quarter results in imprecise mean weights at age and estimates of numbers at age in some years; (2) lack of data to support direct estimates of discards at age requires use of various surrogate survey-based methods; (3) the research bottom trawl survey catches very few witch flounder; in many years, the stratified mean number per tow of witch flounder is less than 5 fish. Abundance of witch flounder in the late 1980s and early 1990's may have gone below levels that provide reliable estimates of trends in abundance and biomass. Future assessment efforts should explore the use of statistical catch at age models to better account for the uncertainty in the underlying data.

1.1.11 Gulf of Maine-Georges Bank Acadian redfish, Sebastes fasciatus:

Brian Linton

Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2012 Operational Assessment
Model Type: age based forward projection ASAP

The last benchmark assessment of Acadian redfish occurred in 2008 as part of the Third Groundfish Assessment Review Meeting (GARM III). An update of the Acadian redfish stock was conducted in 2012 as part of the 2012 NE Groundfish Updates Integrated Peer Review. Stock size has increased dramatically in recent years and it is currently not overfished, nor is overfishing occurring. The existing ASAP assessment model generally has good diagnostics including a lack of any strong retrospective pattern at the last update. Survey age composition data were not available for the last assessment update, but this will be important for the next benchmark assessment. Since the stock has been rebuilt recent annual catches are rising and associated age composition data will also become more important for the assessment. The dimorphic growth of this species would also be an important consideration in a new assessment model

1.1.12 Pollock: Pollachius virens

Brian Linton
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2014 Operational Assessment
Model Type: Age-based forward projecting ASAP

The last benchmark assessment of pollock occurred in 2010 as part of the SARC 50. Operational assessments of pollock occurred in 2012 and 2014. The existing ASAP assessment model generally has good diagnostics. However, there was considerable uncertainty about the degree of doming in both the survey and fishery selectivities. A consequence analysis was performed to highlight the risk associated with assuming a dome when in fact selectivities were flat-topped, which showed that stock status is sensitive to the shape of survey selectivity at older ages. Management advice was based on the dome. Additional research should focus on model selection techniques to help resolve the difficulty of estimating selectivity at the oldest ages. Another source of uncertainty involved the lack of a calibration factor between the Albatross IV and Bigelow time series—pollock samples were infrequent, and the number of observations did not meet the minimum requirements specified by reviewers of the vessel calibration work. In the absence of an estimated calibration factor, the null hypothesis was adopted that the calibration factor=1. Since that initial work, alternative models have been fit to the data, and suggest that the null hypothesis was reasonable. One could consider applying a calibration estimate derived from this new work, simply to quiet any concerns that the original assumption was highly influential.

1.1.13 Gulf of Maine –Georges Bank white hake: Urophycis tenuis

Katherine Sosebee

Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2013 SARC 56
Model Type: Age-based forward projecting ASAP

The Gulf of Maine-Georges Bank white hake stock was last assessed in 2013 at SARC 56 using ASAP. The stock is currently not overfished and overfishing is not occurring. The assessment appears to be stable (very little retrospective) so benchmarks may not be needed in the near future. A benchmark should examine the new market category implemented by dealers around 2011 and added to the ITIS codes in June 2014. Any benchmark assessment should also include any new information on maturity that is currently being analyzed by the POPBIO group. If the age structures from the commercial fishery, the ME/NH survey and the shrimp survey become available, these should be included as well. Information on stock structure for this species is minimal and any new information on genetics or other studies should be incorporated.

1.1.14 Gulf of Maine-Georges Bank windowpane flounder : Scophthalmus aquosus

Lisa Hendrickson (Toni Chute)
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2012 Operational Assessment
Model Type: Index

The stock was last assessed at the 2012 GARM using "An Index-based Model" (AIM) with NEFSC fall survey biomass indices and catch data for 1975-2010 as input data. The assessment was intended to be an update, but instead, the entire catch and survey time series had to be revised, resulting in the need to re-estimate the biological reference points (BRPs) for data consistency purposes. In 2010, the stock was overfished and overfishing was occurring. A benchmark assessment that utilizes a model other than AIM is needed because the correlation between the **ln(replacement ratio)** and **ln(relative F) was only marginally significant (p = 0.090)**. One reason for poor model fit may be the underestimation of catches, which have been dominated by discards during the past decade. There has been a "no possession" regulation in effect since May of 2010. Discards from the Canadian scallop dredge and groundfish bottom trawl fleets were not available from the Canada DFO, but an attempt to estimate these discards should be made during the next benchmark assessment.

1.1.15 Southern New England-Mid-Atlantic Bight windowpane flounder : Scophthalmus aquosus

Lisa Hendrickson (Toni Chute)
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2012 Operational Assessment

Model Type: Index

The stock was last assessed at the 2012 GARM using "An Index-based Model" (AIM) with NEFSC fall survey biomass indices and catch data for 1975-2010 as input data. The assessment was intended to be an update, but instead, the entire catch and survey time series had to be revised, resulting in the need to re-estimate the biological reference points (BRPs) for data consistency purposes. In 2010, the stock was not overfished (and was rebuilt as of 2009) and overfishing was not occurring. Similar to the GOM-GB windowpane flounder stock, catches are dominated by discards. There has been a "no possession" regulation in effect since May of 2010. Although the correlation between the **ln(replacement ratio)** and **ln(relative F) was significant (*p* = 0.006)**, the next benchmark assessment should consider the utility of a length-based model and/or area-swept survey biomass estimates using both NEFSC and NEAMAP survey data. The NEAMAP survey covers strata less than 18 m deep which is important habitat for this species and can no longer be sampled by the NEFSC research vessel as of 2009.

1.1.16 Atlantic Halibut Assessment: Hippoglossus hippoglossus

Jessica Blaylock (Dan Hennen)
Fishery Management Plan: NEFMC Multispecies
Last Assessment: 2012 Operational Assessment
Model Type: Replacement Yield Model (Butterworth)

Atlantic halibut was last assessed in 2012 using a Replacement Yield Model. The stock was determined to be overfished (½ BMSY proxy =24,000 mt, B2010 = 1,700 mt) but overfishing was not occurring (FMSY proxy = 0.073, F_{2010} = 0.032). The main strength of this assessment is the existence of a long catch time series (1893-present). Weaknesses include uncertainty in growth, maturity at age, natural mortality (M), intrinsic growth rate (r), and stock boundary, as well as high interannual variability in the NEFSC bottom trawl surveys due to the low current abundance. Importantly, this stock was fished down in the late 1800s and has not rebuilt since. While addressing current research recommendations would improve the assessment of Atlantic halibut, the very low abundance of the stock relative to its target means no breakthroughs are expected in this assessment in the near future. It will take a long time for this stock to rebuild, even under no fishing.

1.1.17 Ocean Pout: Zoarces americanus

Susan Wigley
Fishery Management Plan: NEFMC Multispecies Groundfish
Last Assessment: 2012 Operational Assessment
Model Type: Index Assessment

The last benchmark assessment of ocean pout occurred at the 2008 Groundfish Assessment Review Meeting (GARM III). An update of the assessment occurred at the 2012 Northeast

Groundfish Update (an integrated peer review). In 2010, ocean pout was overfished and overfishing was not occurring. An index assessment was used where the three year average of NEFSC spring survey indices and the exploitation ratio (2010 catch /average of 2009, 2010, 2011 spring survey biomass indices) are used as proxies for biomass and fishing mortality, respectively. This index assessment revealed that catch, survey indices and exploitation ratios remain at, or near, record low levels and the annual estimates of discards exceed the landings. Although exploitation has been low, stock size has not increased suggesting that this stock may be in a depensatory state. Discards are estimated to be an important component of catch and may be sufficiently high to hinder recovery of the stock. Sources of uncertainty identified in recent assessments include: (1) due to the lack of commercial length samples (13 samples since 1997), the size composition of the commercial landings could not be characterized; (2) biological reference points are based on catch; the estimated discards used in catch are based on a mix of direct and indirect methods. The catch used to determine MSY is based on indirect methods.

1.1.18 Atlantic Wolffish: Anarhichas lupus

Charles Adams (Paul Nitschke)
Fishery Management Plan: NEFMC Multispecies
Last Assessment: 2012 Operational Assessment
Model Type: age-length based forward projection SCALE

The last benchmark assessment for Atlantic wolffish was done at the Northeast Data Poor Stocks Working Group in 2008. The wolffish assessment was updated as part of the groundfish updates in 2012. Wolffish was assessed in both instances using the forward projecting SCALE model, which tunes to length information, total removals, and abundance indices using an overall growth model, since production aging does not exist for this species. There are several major sources of uncertainty with this stock assessment. The lack of length information results in model estimation difficulties for fishery selectivity. Maturation data for wolffish in US waters is limited, which produces uncertainty in the BRPs. However, a histological maturity study has been initiated to reduce the uncertainty in the maturation schedule. The low biomass of the stock at the end of the Albatross survey series was near the detection limits of the survey with very few fish being caught in the survey. The Bigelow does seem to catch greater numbers of fish but due to the low numbers in the Albatross survey a conversion factor could not be estimated. Major uncertainty surrounds the use of the ocean pout conversion factor for wolffish in the 2012 updated assessment. There has been no recruitment index since 2004, which results in lower biomass at the end of the time series. There was little evidence that biomass was directly reduced by removals since there were large reductions in catch and little evidence of size truncation over time. Biomass appears to be at a time series low but fishing mortality also appears to be low with low catch at the end of the time series. Uncertainties in this assessment will likely not be reduced until an adequate histological sample size is collected from the surveys

and perhaps when the Bigelow series is long enough so that it can be treated as a separate survey index of abundance in the modeling.

1.1.19 Cusk Brosme brosme:

Loretta O'Brien
Fishery Management Plan: none
Last Assessment: no formal assessment to Council
Model Type: age-length based, SCALE

This stock was first assessed in 2009 in response to a request from the Protected Resources at the Regional Office to provide an estimate of cusk biomass for status determination under NOAA ESA. The length based model, SCALE was applied, and the assessment reviewed internally by the Population Dynamics Branch since cusk is not a managed species. The model was not accepted because of poor diagnostics, in part due to the conflict of lower catches in the fishery with the slow truncation of older fish in the commercial fishery, and to the low survey abundance indices. A more representative index of abundance and a more accurate accounting of discards in the recreational and lobster fisheries would likely improve the model diagnostics. A recently conducted pilot longline survey that sampled the rocky habitat preferred by cusk had high catch rates indicating that longline gear would provide a better index of abundance, particularly at low biomasses, compared to the research bottom trawl survey. Recent recreational (party charter) data collection has improved and NEFSC observer coverage of the lobster fishery has increased since 2012; both of these initiatives will help improve the discard estimation of cusk.

1.2 Small Mesh Multispecies Groundfish

1.2.1 Silver hake (Northern and Southern Stocks): Merluccius bilinearis

Larry Alade
Fishery Management Plan: NEFMC Small Mesh Multispecies
Last Assessment: 2012 Operational Assessment
Model Type: index AIM

The northern and southern stocks of Silver hake were last assessed in the 2010 benchmark assessment during SARC 51. The stock was considered not overfished with overfishing not occurring. The silver hake assessments should be considered "model resistant" due to conflicting signals in the fishery and survey data inputs into the model which has contributed to the lack of an analytical assessment for over ten years. The last benchmark assessment made significant advances to provide an analytical assessment by extensively exploring a statistical catch at age model for the first time that included consumption as an independent fleet based on food habits data. The SARC review panel however did not accept the adequacy of the model due

to inconsistent interpretation of the steep age profiles in the fishery and survey data. Additionally, there was considerable uncertainty about the resulting dome in the model, as there is no biological justification for such pattern relative to the known behavior of silver hake. Other sources of uncertainty in the assessment include the mis-specification of both silver and offshore hake in the fishery catch data, estimates of predatory consumption which is likely to be conservative due to data limitation to only groundfish predator species and not including estimates on highly migratory species, marine mammals and seabirds. The silver hake assessment is also faced with uncertainty in stock structure and in particular the extent of mixing between the northern and southern adult spawning contingents. Stock status determinations for both stocks of silver hake are currently based on survey and exploitation rate trends. If silver hake is benchmarked in the future, further progress on silver hake distribution, stock structure, and consumption estimates and reconciliation of conflicting signals in the underlying fishery and survey data will be necessary for any improvements in the 2010 assessment to be realized.

1.2.2 Red hake (Northern and Southern Stocks): Urophycis chuss

Katherine Sosebee/Michele Traver
Fishery Management Plan: NEFMC Small Mesh Multispecies
Last Assessment: 2010 SARC 51
odel Type: Index, AIM

The assessments for red hake (GOM-NGBK and SGBK-MA stock areas) are currently index-based as there has been no ageing of this species since 1985. These stocks were last assessed at SARC 51 in 2010. Both stocks were not overfished and overfishing was not occurring on either stock. Any benchmark would have to include at least some updated age information to determine if growth has remained constant. The red hake assessments should be considered "model resistant" due to conflicting signals in the fishery and survey data inputs as is silver hake. No stock assessment model will be able to adequately explain this unless growth has changed (silver hake growth has not changed) or other removals (consumption) can be adequately described. The red hake assessment is also faced with uncertainty in stock structure and in particular the extent of mixing between the northern and southern adult spawning contingents. For red hake, the stock structure is largely based on similarity to silver hake, and not any direct evidence.

1.2.3 Offshore hake: Merluccius albidus

Michele Traver
Fishery Management Plan: NEFMC Small Mesh Multispecies
Last Assessment: 2010 SARC 51
Model Type: Index

Offshore hake is considered a data-poor stock with very little known about its biology and life history. This stock was last assessed at SARC 51 during the fall of 2010. Two assessment models were attempted, An Index Method (AIM) and Survival Estimation in Non-Equilibrium

Situations Model (SEINE). Neither model was considered adequate because the fishery data was insufficient and the survey data were not considered to reflect stock trends. Consequently, biological reference points could not be updated. However, based on reference points that were developed prior to SARC 51, offshore hake is not overfished and overfishing is unknown. The current definition for an overfished stock is: "Offshore hake is in an overfished condition when the three year moving average weight per individual in the fall survey falls below the 25th percentile of the average weight per individual from the fall survey time series 1963-1997 (0.236) **AND** when the three year moving average of the abundance of immature fish less than 30 cm falls below the median value of the 1963-1997 fall survey abundance of fish less than 30 cm (0.33)." Clearly, more modeling efforts will not help for this stock since the survey index likely does not cover the stock area and changes in the survey indices are more reflective of changes in distribution along the slope than abundance. It is unlikely that any more useful data will ever become available in the near future. If offshore hake were to be benchmarked in the future, it should be done in collaboration with silver hake to allow a consistent evaluation of the mixed-species composition in the fishery catch data, which is also another major source of uncertainty in the assessment.

1.3 Atlantic Herring FMP

Atlantic Herring *Clupea harengus*

Jon Deroba

Fishery Management Plan: NEFMC Herring

Last Assessment: 2012 SARC 54

Model Type: age based ASAP

Atlantic herring were last assessed in a benchmark assessment in 2012 during SARC 54. The 2012 assessment reconsidered nearly all data inputs and model settings from previous assessments. Some major model features are summarized here. Natural mortality rates varied among years with a 50% increase during 1996-2011 that resolved a retrospective pattern and ensured that the implied levels of consumption were consistent with observed increases in estimated consumption of herring. Consumption estimates were based on food habits data primarily for groundfish, but also informed by consumption estimates from marine mammals, highly migratory species, and seabirds. Catches and selectivity for two aggregate gear types, fixed and mobile gears, were modeled separately. This assessment also estimated selectivity for any survey with age composition data. Finally, maturity at age varied through time. The conclusion of the assessment was that the Atlantic herring stock was not overfished and overfishing was not occurring. Time varying natural mortality was considered a major uncertainty in this assessment. This feature of the assessment had significant implications for estimates of stock productivity and reference points. More research should be conducted on the topic of reference point calculation in the presence of time varying life history parameters. Current stock status was also largely driven by the 2008 cohort, which was estimated to be the largest on record. The strength of large cohorts, however, is often overestimated in the short-term, and so this was considered a major uncertainty. Steepness of the stock-recruitment relationship, which directly affects reference point calculations, was not well estimated and this

parameter should be carefully reconsidered in future assessments. Atlantic herring also have a complex sub-stock structure that was ignored in the stock assessment, but accounting for this feature may reduce retrospective patterns and address some stakeholder concerns.

1.4 Atlantic sea scallops : Placopecten magellanicus

Debora Hart

Fishery Management Plan: NEFMC Atlantic Sea Scallop

Last Assessment: 2014 SARC 59 (in progress)

Model Type: size based, forward projection, CASA

The last sea scallop benchmark assessment was in the spring of 2010 (SARC 50). The scallop assessment employs size-based models that can use shell height data from surveys, observers and port sampling. These include CASA (Catch-at-Size Analysis) that estimates biomass and fishing mortality from past years, an area-based projection methodology (SAMS – Scallop Area Management Simulator) and a stochastic reference point model that takes into account uncertainty in parameter estimates (SYM – Scallop Yield Model). Updates of the CASA and SAMS models are provided to the NEFMC during their Framework specification development. The SYM model is used to estimate reference points, including a risk-based methodology in setting the ACL and target fishing mortality rates.

1.5 Deep sea red crab: Chaceon quinquedens

Toni Chute

Fishery Management Plan: MAFMC Fluke, Scup, and Black Sea Bass

Last Assessment: 2008 Data Poor Working Group

Model Type: Index, Mass Balance

Records of deep sea red crab harvests have been recorded since 1982 but resource has been managed federally only since 2002. Only two surveys designed especially for deep sea red crab have been conducted. These surveys, in 1974 and 2003-2005, were followed by assessments in 1974 and 2006 (SAW 43). Red crab is considered a data poor species and was included in the Northeast Data Poor Stocks Working Group (DPSWG) in 2008. Reliable Biological Reference Points have not been developed because relatively little is known about the biology of deep sea red crab biology, the directed fishery is little more than a decade old, and only two surveys have been conducted. Until the time series of reliable landings data lengthens and more is known about red crab biology, BRPs are likely to remain unreliable. Sources of uncertainty include 1) natural mortality is unknown 2) maximum age is unknown; 3) growth rates are unknown; 4) discard mortality is uncertain; 5) indices of abundance such as LPUE are difficult to interpret due to fishery patterns. With more biological information for red crab, it might be possible to model this stock reasonably. An MSY proxy is currently used to determine overfishing where if landings exceed the MSY proxy than overfishing is occurring. The MSY proxy was lowered by emergency action after the DPSWG. Since the FMP was established in 2002, overfishing has not occurred.

1.6 Skate Complex *:*

Katherine Sosebee
Fishery Management Plan: NEFMC Skate
Last Assessment: 2013 Update
Model Type: Index

The skate complex consists of seven species of skates: winter, *Leucoraja ocellata* little, *Leucoraja erinacea*, barndoor, *Dipturus laevis*, thorny, *Amblyraja radiata*, smooth, *Malacoraja senta*, clearnose, *Raja eglanteria*, and rosette, *Leucoraja garmani*. The last benchmark assessment of the skate complex was completed at the Data Poor Stocks Working Group in 2008 and updates have since occurred annually mostly through the PDT process, the most recent in 2013. The current stock status for three of the species (winter, little, and clearnose) is above Bmsy. Three species (barndoor, smooth and rosette) are between Bthreshold and Bmsy while one (thorny skate) is well below the biomass threshold. Overfishing is occurring on two of the species (winter and thorny), while the other five are not experiencing overfishing. The biological reference points for these stocks are based completely on survey data, since catch data by species is unreliable, although efforts have been made to separate the catch into species components. Various models have been attempted (ASPIC, SEINE, AIM) but none have been successful. Discard mortality for most of the species is assumed to be 0.5 for all gear types, although work in underway to develop gear/species specific rates. The ABC is set using these uncertain catches by species, even though the relationship between the change in survey abundance from year to year does not appear to be related to the catch estimates. Therefore there is no relationship between the overfishing definitions, which are based on the change in the survey index from one three-year time period to the next, and the quota-setting process. This has led to the 2012 and 2013 fisheries likely not taking the quota while overfishing is occurring on the main species. A benchmark assessment should examine a way to bring these two methods together. An examination of environmental processes on the various species should also be included in a benchmark, since thorny skate does not appear to be responding to any management regulations.

1.7 Monkfish: Lophius americanus

Anne Richards
Fishery Management Plan: NEFMC Monkfish
Last Assessment: 2013 Operational Assessment
Model Type: Age-Length- based (SCALE)

The assessments for monkfish (Northern and Southern management areas) are subject to high levels of uncertainty due to weaknesses in input data including under-reported landings and unknown discards during the 1980s, incomplete understanding of key biological parameters such as age and growth, longevity, natural mortality, sex ratios, stock structure and migration patterns, and the relatively short reference time frame (1980-2011) of the models. Although the models allow integration of several sources of data, the models for both management areas have

difficulty fitting the catch length frequencies in many years, with substantial overestimates of the numbers of large fish in the stock. These undesirable patterns could be due to misspecification of growth and natural mortality, and other poorly understood biological parameters. Until growth in particular is better understood, improvements to the assessment are unlikely, and the models' results should be viewed with extreme caution. Annual indicators of stock status (e.g. survey results) and fishery performance should be monitored until further biological research can be completed and improve the basis for modeling efforts.

1.8 US Atlantic Salmon Salmo salar Gulf of Maine DPS, Central New England, and Long Island Sound:

John Kocik and Tim Sheehan

FMP: NEFMC Atlantic Salmon

Last Assessment: 2013 ICES North Atlantic Salmon Working Group and US Atlantic Salmon Stock Assessment Committee

Model Type: Prefishery Abundance Model

US Atlantic salmon populations are divided into four discrete stock complexes: (i) Long Island Sound complex; (ii) Central New England complex; (iii) Gulf of Maine distinct population segment (DPS- endangered - US Endangered Species Act), and (iv) the Outer Bay of Fundy designatable unit (proposed as Endangered under Canada Species At Risk Act- transboundary stock assessed by Canada). The three US complexes are assessed by the US Atlantic Salmon Assessment Committee (USASAC), a team of state and federal biologists tasked with compiling data on the species throughout New England and reporting population status. Currently, population status of salmon is determined by counting returning adults either directly (traps and weirs) or indirectly (redd surveys). Some mortality can and does occur between trap counts and actual spawning—the actual number of spawners is termed "spawning escapement" and is not estimated for many US populations. However, redd counts provide a reasonable proxy for rivers with populations surveyed with that method. Adult assessment is strong with relatively high accuracy, the USASAC is continuing its efforts to develop metrics to examine juvenile production of large parr (pre-smolts) and emigrating smolts to better understand and partition mortality across habitats. The USASAC will start to report specific returns for salmon habitat recovery units in the Gulf of Maine starting in 2014. Adult assessments are used in ESA status updates and added to North American Stock complex for international assessments in support of NASCO.

1.9 Hagfish, *Myxine glutinosa*

Alicia Miller.

Fishery Management Plan: NEFMC none

Last Assessment: 2003 SARC 37

Model Type: none

Despite the ubiquity and recognized ecological importance of hagfish, there is still limited knowledge of their life history,adaptability and role in benthic marine ecosystems. Hagfish are poorly represented in traditional trawl surveys because of their morphology and burrowing behavior. The sample size of hagfish collected during trawl and shrimp surveys is not large enough to distinguish noise in the survey data from true changes in the population or to determine changes in localized populations over the period of the surveys. Specialized hagfish survey using standardized, baited traps deployed in random sampling locations are recommended. There are substantial gaps in basic information on fishery performance, and many fundamental unanswered questions on its biology and life history. The paucity of crucial data makes assessments problematic. Hagfish fisheries around the world have not been sustained and some have a history of overexploitation followed by fishery collapse. The level of a potentially sustainable fishery on Atlantic hagfish is uncertain. Developing a comprehensive understanding of the hagfish fishery and resource will require new scientific and fishery-dependent research and data collection efforts.

2.0 Mid Atlantic Fishery Management Council

2.1_ Summer Flounder, Scup and Black Sea Bass

2.1.1 Summer Flounder : Paralichthys dentatus

Mark Terceiro
Fishery Management Plan: MAFMC Fluke, Scup, and Black Sea Bass
Last Assessment: 2013 SARC 57
Model Type: age-based, forward projecting ASAP

The summer flounder stock was last assessed as a benchmark assessment in 2013 (data through 2012). The fishing mortality rate has decreased to below 1.000 since 1997 and was estimated to be 0.285 in 2012, below the FMSY proxy = F35% = 0.309. SSB was estimated to be 51,238 mt in 2012, about 82% of the SSBMSY proxy = SSB35% = 62,394 mt. The summer flounder stock assessment has historically exhibited a consistent retrospective pattern of underestimation of F and overestimation of SSB; the causes of this previous pattern have not been determined. In the current assessment model, however, no persistent retrospective patterns are evident. The 2013 benchmark assessment includes several new research survey time series. The URI GSO trawl, NY trawl, VIMS ChesMMAP trawl, VIMS NEAMAP spring and fall trawl, and the NEFSC MARMAP and ECOMON larval surveys are now tabulated in the assessment and used in the population model calibration. Future research that is needed to improve the assessment include a) continued evaluation of sex-specific natural mortality, including efforts to estimate natural mortality through mark-recapture programs, and telemetry, and b) continued efforts to improve understanding of sexually dimorphic mortality and growth patterns, including the monitoring of

sex ratios and associated biological information in the fisheries and research surveys to allow development of sex-structured models in the future.

2.1.2 Scup: Stenotomus chrysops

Mark Terceiro
Fishery Management Plan: MAFMC Fluke, Scup, and Black Sea Bass
Last Assessment: 2012 Update
Model Type: age-based, forward projecting ASAP

The scup stock was last assessed as an update in 2012 (data through 2011). The last benchmark assessment was conducted in 2008. Fishing mortality was estimated to be 0.034 in 2011, below the FMSY proxy = F40% = 0.177. SSB was estimated to be 190,424 metric tons (mt) in 2011, above the SSBMSY proxy = SSB40% = 92,044 mt. There is no consistent internal retrospective pattern in F, SSB, or recruitment evident in the 2012 updated assessment model. Future research that is needed to improve the assessment include a) improve estimates of discards and discard mortality for commercial and recreational fisheries, b) evaluate indices of stock abundance from new surveys, and c) explore the utility of incorporating ecological relationships, predation, and oceanic events that influence scup population size on the continental shelf and its availability to resource surveys into the stock assessment model.

2.1.3 Black sea bass: Centropristis striata

Gary Shepherd
Fishery Management Plan: MAFMC Fluke, Scup and Black Sea Bass
Last Assessment: 2012 SARC 53
Model Type: Age-length based forward projection SCALE

A black sea bass benchmark stock assessment was reviewed in December 2012 at SARC 53 and the analytical model was not accepted. The stock was last updated in July 2012 at the request of the MAFMC. However, the MAFMC SSC deemed the uncertainty in the results as excessive and not suitable for use in management decisions. Consequently the ABC was based on historic landings and trends. The cause of the uncertainty was related to the atypical life history of sea bass (a protogynous hermaphrodite), concerns about geographic mixing of stock components, natural mortality, and trawl calibration coefficients. ASMFC sponsored a black sea bass workshop in April 2013 to discuss issues with the assessment. The workshop concluded that conducting a stock assessment (update or benchmark) would be inappropriate until such time as additional work could be conducted to resolve the issues related to the uncertainty, possibly 2016 or later. The workshop report highlighted some areas of research which should be prioritized, such as spatial modeling and evaluation of alternative survey methods.

2.2 Surfclam and Ocean Quahog

2.2.1 Atlantic surfclam : Spisula solidissima

Dan Hennen, Larry Jacobson, Toni Chute
Fishery Management Plan: MAFMC Surfclam and Ocean Quahog
Last Assessment: 2013 SARC 56
Model Type: Stock Synthesis

A benchmark assessment for Atlantic surfclam was conducted in 2013 (SARC 56). The stock is not overfished and overfishing is not occurring. This population is relatively stable due to low fishing pressure and a market limited fishery. In 2013, for the first time, there may be substantial catches (about 1/3 of the total) on GBK but the productivity of GBK has not been characterized. The most important current threat to the stock is habitat loss in southern regions due to increasing ocean temperatures. The stock is currently modeled as two separate areas with results combined to provide management advice and fishing mortality and biomass estimates for determining status relative to (proxy) biological reference points. The next benchmark stock assessment of Atlantic surfclam should evaluate the productivity of Georges Bank, estimate new empirical reference points and include a deeper examination of natural mortality. These goals are possible given the data already being collected.

2.2.2 Ocean quahog Arctica islandica

Toni Chute, Dan Hennen, Larry Jacobson
Fishery Management Plan: MAFMC Surfclam and Ocean Quahog
Last Assessment: 2013 Update
Model Type: forward projecting, delay difference, KLAMZ

A benchmark assessment for Ocean quahog was last conducted in 2009 (SARC 48). An update assessment was completed in 2013. The stock is not overfished and overfishing is not occurring. This population is relatively stable due to low fishing pressure and a market limited fishery. The stock is relatively unproductive, and depends on infrequent regional recruitment events. The current biomass represents accumulation over the last century or more. The biggest challenge for assessing quahog is finding suitable harvest policies given the productivity and long generation time (quahogs frequently live over 200 years and mature late). Survey and fishery data are available since the late-1970's and cover a time period shorter than a single generation. The current reference points and harvest policies need to be re-examined and the next benchmark stock assessment should incorporate length structure because age data for ocean quahogs are not available. The reference point work will require significant research prior to the next assessment. Both goals are achievable without additional data sources.

2.3 Squid, Mackerel and Butterfish

2.3.1 Longfin Squid Doryteuthis (Amerigo) pealeii *:*

Lisa Hendrickson
Fishery Management Plan: MAFMC Squid, Mackerel and Butterfish
Last Assessment: 2010 SARC 51
Model Type: Swept Area

The stock was last assessed in 2010 at SARC 51 using a catchability-adjusted area-swept biomass estimates and consumption estimates for the two primary seasonal cohorts during 1976-2009. In 2009, the stock was not overfished, but the overfishing status was unknown because the previous threshold was deemed inappropriate and a revised overfishing threshold was not recommended because there was no clear statistical relationship between the annual catch and annualized biomass estimates (mean of spring and fall surveys). Furthermore, annual catches were low relative to preliminary, annual estimates of minimum consumption by a subset of fish predators. Future assessments should account for the species' complex life history (i.e., semelparous, sub-annual lifespan, year-round recruitment with seasonal peaks that result in multiple, overlapping seasonal microcohorts), implying that stock sizes and reference points should be estimated separately for the spring and fall microcohorts so they can be managed based on their respective productivity levels. The 2010 assessment represented an advance over previous assessments because spawning mortality, consumption, biomass indices, and relative exploitation indices were estimated for each of the microcohorts. However, seasonal empirical estimates of the catch efficiency of the survey trawl are needed to further improve upon this work. Ideally, real-time, in-season assessment and management would be implemented to avoid foregone yield during high abundance years and to reduce recruitment overfishing during low abundance years. However, industry support for this type of management would be necessary because squid fishermen and processors would need to actively participate in the data collection program. Research is currently being conducted to determine if the spatial and temporal resolution of the existing fishery databases are sufficient to support a weekly, multi-fleet, catch dynamics model. A benchmark assessment should not occur until this research is complete. This type of model will likely require intensive fishery data collection in near real-time (similar to the real-time data collection program implemented for the much smaller *Illex* fleet during 1999-2002). New regulations in 2014 will improve the temporal resolution of the logbook (VTR) data because weekly reporting by the *Doryteuthis* fleet will be required.

2.3.2 Shortfin Squid Illex illecebrosus

Lisa Hendrickson
Fishery Management Plan: MAFMC Squid, Mackerel and Butterfish
Last Assessment: 2005 SARC 42
Model Type: Life History

The stock was last assessed in 2005 at SARC 42 using a weekly, depletion-type model that included fishery data from a pilot study pertaining to real-time, at-sea data reporting by the *Illex* fleet. In 2004, stock status was unknown because the in-season assessment model was deemed preliminary so there were no reliable estimates of stock biomass and fishing mortality rate. Future assessments should continue to account for the species' complex life history (i.e.,

semelparous, sub-annual lifespan, year-round recruitment with seasonal peaks that result in multiple, overlapping seasonal microcohorts), implying that stock sizes and reference points should be estimated separately each seasonal microcohort so they can be managed based on their respective productivity levels. In addition, this transboundary species migrates between US and Canadian waters and supports international fisheries between Newfoundland and Cape Hatteras. Although assumed to represent a unit stock, the southern and northern stock components are assessed and managed by the US and NAFO, respectively. The NAFO component is assessed annually and the US component is assessed irregularly. The 2005 assessment represented an advance over previous assessments because growth rate and size-at-maturity data for the winter microcohort were included in models with weekly time steps which estimated spawning mortality and stock size for the winter microcohort. A weekly per-recruit model was also used to estimate %MSP-based reference point proxies that would allow for sufficient spawner escapement. However, age and maturity data for the other seasonal cohorts are needed to further improve upon this work. Industry support for this type of real-time assessment and management would be necessary because squid fishermen and processors would need to actively participate in the data collection program. Research similar to that being conducted for the Doryteuthis stock should also be investigated for the southern *Illex* stock component. A benchmark assessment should not occur until this research is complete. This type of model will likely require intensive fishery data collection in near real-time (similar to the real-time data collection program implemented for the *Illex* fleet during 1999-2002). New regulations in 2014 will improve the temporal resolution of the logbook (VTR) data because weekly reporting by the US *Illex* fleet will be required.

2.3.3 Atlantic mackerel *: Scomber scombrus*

Kiersten Curti
Fishery Management Plan: MAFMC Squid, Mackerel and Butterfish
Last Assessment: 2010
Model Type: age-based backward projection VPA/ADAPT

Atlantic mackerel was last assessed in 2010 through the joint Canada/US Transboundary Resources Assessment Committee (TRAC). The TRAC assessment could not determine overfishing and overfished status, and the status of the stock is currently unknown. The assessment model exhibited strong retrospective patterns, which were in part attributable to disparate trends between the NEFSC spring survey and fishery landings. The 2010 TRAC assessment also reviewed the findings of the previous U.S. assessment (2005) and rejected those findings because the 2005 model had a severe retrospective pattern that was not taken into account, making the reference points inappropriate. Consequently, the ABC was based on recent landings and trends. The mackerel assessment is also faced with uncertainty in stock structure and in particular the extent of mixing between the northern and southern spawning contingents in the northwest Atlantic. In 2012, DFO assessed the Canadian contingent of Atlantic mackerel in NAFO Subareas 3 and 4, which indicated a decline in estimated mackerel spawning stock biomass since approximately 2006 that was attributable to low recruitment and high fishing mortality rates. An Icelandic project is currently underway to investigate Atlantic mackerel

stock structure in the North Atlantic and both the U.S. and Canada have contributed samples for this project. However, at this time no additional information is available regarding Atlantic mackerel stock structure in the northwest Atlantic and in particular whether the U.S. and Canadian contingents should be classified as two distinct mackerel stocks or one unit stock. Until further progress is made on mackerel distribution, stock structure and the influence of environmental factors such as temperature, improvements to the 2010 assessment are unlikely.

2.3.4 Butterfish: Peprilus triacanthus

Chuck Adams and Tim Miller
Fishery Management Plan: MAFMC Squid, Mackerel and Butterfish
Last Assessment: 2014 SARC 58
Model Type: age based, forward projecting ASAP

Butterfish are relatively short-lived and have a high natural mortality rate (M = 1.22) which results in the spawning stock biomass (SSB) being strongly dependent on recruitment. Overfishing is not occurring and the stock is not overfished and is rebuilt. The most recent assessment benefited from a broad interaction with ecologists, oceanographers and fishermen. Together, their work improved understanding of thermal habitat and overall catchability. Research on estimation of catchability provided an improved basis for understanding the stock history and allowed estimation of BRP. There were three improvements to the basic ASAP model: 1)catchability was reparameterized as the product of availability and efficiency with the former specified using the availability estimates based on bottom water temperature; 2) length-based calibration of bottom trawl survey data in 2009-2012 was performed internal to the model; and 3) estimation of natural mortality. For the NEFSC fall offshore survey, an average measure of availability based on a bottom temperature was used and the efficiency was based on relative efficiency of the FRV *Albatross IV* to the FSV *Henry B. Bigelow* and an assumption that the *Bigelow* was 100% efficient for daytime tows. An important conclusion of the habitat modeling was there were was NOT significant inter-annual variation in availability. Ability to estimate parameters within the new model framework was confirmed through simulation. Validity of ASAP model estimates of biomass and fishing mortality was supported by the application of a simple envelope analysis method that established a feasible range for biomass. Estimates of consumption by the top six finfish predators appear to be very low and similar in magnitude to historic fishing mortality but well below the estimated natural mortality rate.

2.4 Bluefish Pomatomus saltatrix

Tony Wood
Fishery Management Plan: MAFMC Bluefish
Last Assessment: 2012 Update to MAFMC SSC
Model Type: Age based forward projection ASAP

The Atlantic coast bluefish stock was last assessed as an update assessment in 2012 (data through 2011). The last benchmark for this species occurred in 2005 at SARC41 and a new benchmark assessment is planned for Spring 2014 at SARC 59. Total mean biomass in 2011

equaled 132,890 mt, a slight decrease from the 2010 estimate of 136,371 mt. Corresponding spawning stock biomass (SSB) in 2011 was 123,107 mt, also a slight decrease from the 2010 estimate of 124,601 mt and still below B_{MSY} (147,052 mt). Fishing mortality steadily declined from 0.34 in 1987 to 0.12 in 1999 and has remained steady since 2000 with an average F=0.14. The 2011 F_{MULT} value was equal to 0.114, which remained below F_{MSY} (0.19). The bluefish stock is not currently overfished or experiencing overfishing. Uncertainty remains in several aspects of the assessment input data. Age data continues to be limited to one age key built from a limited set of samples. The assumption that this age information is applicable to all areas remains untested. Length samples from recreational discards are limited and contribute to the uncertainty as does the lack of commercial discard estimates. Changes in the NEFSC inshore survey series, from both vessel changes and sample area adjustments, significantly alter indices. Strata inshore of 15 fathoms are currently sampled as part of the NEMAP survey, but the time series is not yet adequate to provide a tuning index. In addition, the highly migratory nature of bluefish populations and the recruitment dynamics of the species create a unique modeling situation. Future assessments should include any additional information that could index seasonal abundance of incoming recruitment.

2.5 Golden Tilefish Assessment: Lopholatilus chamaeleonticeps

Paul Nitschke
Fishery Management Plan: MAFMC Tilefish
Last Assessment: 2014 SARC 58
Model Type: age and length based, forward projection SCALE

Golden tilefish was last assessed as a benchmark in 2009 using the ASPIC surplus production model. The Golden tilefish assessment is considered a data poor stock due to the lack of a fishery independent measure of abundance. Commercial CPUE based on a simple effort metric of day absent suggests there has been an increase in stock abundance since a constant harvest TAC (905 mt) was implemented by the FMP in 2001. Subsequent cyclical fluctuations in the commercial CPUE can be explained by year class effects which track through the catch at length data. However these year class effects result in process error in a simple surplus production model which assumes constant recruitment. The general lack of tilefish data available did not fully support the stock status determination using a more data intensive forward projecting (SCALE) model which unlike the surplus production model suggests the stock has not yet rebuilt. Uncertainty surrounds the ability to determine whether the stock has rebuilt is likely due to the lack of survey and growth information. Perhaps the aging of commercial port samples for the next assessment will help determine the appropriate size/age structure of a rebuilt population. Nevertheless, stock conditions appear to be improving with the present removals of about 900 mt annually over the last 12 years. It is questionable whether it is worth the investment in resources and time to conduct a specialized tilefish survey for a relatively small and highly targeted fishery that may or may not fine tune the assessment. Perhaps the simple monitoring of stock conditions

through CPUE and landings size structure in conjunction with a relatively stable management system which only allows for small changes over longer periods of time could prove to be the optimal method forward for this stock.

2.6 Spiny Dogfish: Squalus acanthias

Paul Rago/Katherine Sosebee
Fishery Management Plan: MAFMC Spiny Dogfish (also joint with NEFMC, ASMFC)
Last Assessment: 2013 Update
Model Type: Index, Length and Sex based projection model

The last benchmark assessment of the spiny dogfish stock was conducted at the TRAC in 2009/2010. At that time, no models were accepted. An update of the existing biological reference points (from SARC 43) was conducted in the summer of 2010 and reviewed by the SSC. The modification to the existing BRP was in adding pup size as a covariate to the spawner-recruit relationship to help explain the years of lower recruitment. In 2012, spiny dogfish were above SSBmsy and overfishing was not occurring. Any benchmark would require development of models that deal with elasmobranch biology (live birth, 2-year gestation) better than existing models that analyze time series. The current model incorporates uncertainty of discards and the survey index into estimating fishing mortality and projects using growth information from the early 1980s. Contemporary aging studies for spiny dogfish age structures (e.g., fins, spines) obtained from all sampling programs (include additional age validation and age structure exchanges) should be continued, and an aging workshop for spiny dogfish, encouraging participation by NEFSC, Canada DFO, other interested state agencies, academia, and other international investigators with an interest in dogfish aging (US and Canada Pacific Coast, ICES) should be conducted. Both of these should occur before any benchmark assessment.

3.0 Atlantic States Marine Fisheries Commission

3.1 Striped bass: Morone saxatilis

Gary Shepherd
Fishery Management Plan: ASMFC Striped Bass
Last Assessment: 2013 SARC 57
Model Type: age-based forward projecting SCA by MADMF

Striped bass is managed by the Atlantic States Marine Fisheries Commission in cooperation with NMFS and USFWS. Assessment updates are conducted every two years and benchmark stock assessments conducted and reviewed every five years. The striped bass management unit is

comprised of several stocks (Hudson, Delaware and Chesapeake stocks) and is assessed using a statistical catch at age model, with additional input from tag model results. The most recent benchmark assessment will undergo review at SARC 57 in July 2013. The FMP has management actions required if the stock is found to be approaching or exceeding threshold values for SSB and F. The information contained in the assessment, in addition to a variety of abundance indices, determines if action is required. If management action is required, the demands on the Striped bass technical committee is likely to increase in the short term.

3.2 American Lobster *Homarus americanus*

Burton Shank and Larry Jacobson
Fishery Management Plan: ASMFC American Lobster
Last Assessment: ASMFC Peer Review 2009, SNE CIE review 2010
Model Type: U. Maine Length-based Model

American Lobster stocks are managed by ASMFC and assessed every five years. The last assessment was in 2008 with an assessment currently ongoing in 2013. Lobsters are divided into three stocks: Gulf of Maine, Georges Bank, and Southern New England, each of which is assessed with a statistical catch-at-length model with separate sexes that was developed at the University of Maine with help from federal, ASMFC and state biologists. Primary survey indices for the assessments come from federal and state bottom trawl surveys. State ventless trap surveys are being incorporated into the current assessment for the first time. Warming waters in coastal habitats over the last two decades are correlated with increased recruitment, abundance and productivity in the north with decreases in the south.

Gulf of Maine Lobster

The Gulf of Maine lobster stock is the largest of the three fisheries and fished primarily in state waters. The stock is not depleted and overfishing is not occurring. Lobster densities and recruitment rates are at record highs and the stock has increased its geographic extent along the east along the coast of Maine. Females are moderately more abundant than males, particularly in offshore areas, possibly due to conservation measures that include prohibition of landing egg-bearing lobsters, V-notching and maximum size limits for harvested females.

Georges Bank Lobster

The Georges Bank lobster stock is the smallest of the three fisheries and with landings primarily from federal waters. The stock is not depleted, overfishing is not occurring. Densities are at a record high and recruitment has been high for the past 15 years. Females became substantially more abundant than males during this time due to conservation measures and female immigration from adjacent stocks.

Southern New England Lobster

The Southern New England lobster stock is the second largest of the three fisheries and fished primarily in state waters. The stock is depleted but overfishing is not occurring. Landings remained near a time-series high until 1999, declined rapidly and are now near the lowest on record. Survey data indicate that abundance is relatively stable in offshore habitats but declining and low in inshore habitats. Declines in abundance are attributed to recent recruitment failure and shell disease due to warming water temperatures along with possible increases in adult mortality and heavy fishing.

3.3 River herring : Alosa pseudoharengus/Alosa aestivalis

Kiersten Curti
Fishery Management Plan: none yet but MAFMC Squid, Mackerel and Butterfish and NEFMC Atlantic herring are candidates for inclusion
Last Assessment: 2013
Model Type: Depletion Based Stock Reduction Analyses plus State Space for trends

River herring (alewife and blueback herring) are managed by the Atlantic States Marine Fisheries Commission in cooperation with NMFS and USFWS. A benchmark assessment was conducted in 2012 and concluded that the coastwide meta-complex of river herring stocks is depleted. The stock complex was classified as depleted instead of overfished/overfishing because there was evidence for abundance declines but the relative contribution of each factor (including directed and incidental fishing, habitat loss, predation, climate change) to the declines could not be determined. Assessment of the status of river herring was impeded by a lack of data and as a consequence, estimates of abundance and fishing mortality could not be developed. Statistical catch-at-age models were developed for three rivers with sufficient data; otherwise, trend analyses were used to identify patterns in available fishery dependent and independent datasets. A coastwide model was developed using Depletion-Based Stock Reduction Analysis, a modeling approach available for data-poor stocks. However, the peer review panel concluded that resulting biomass, fishing mortality and reference point estimates were not credible, with the model requiring further development before it was appropriate for use in management. Several data needs were indentified, including 1) expanded observer and portside sampling coverage to improve total catch estimates, 2) determination of population stock structure along the coast and quantification of which stocks are impacted by mixed stock fisheries, 3) improved age determination through validation of ageing techniques and regular ageing workshops, and 4) implementation of monitoring programs to determine population responses for rivers undergoing restoration as well as to quantify and improve fish passage efficiency. The ASMFC plans to update the trend analyses in 5 years and complete another benchmark assessment in 10 years (finalized in 2022).

3.4 Northern shrimp Pandalus borealis

Anne Richards
Fishery Management Plan: ASMFC Northern Shrimp
Last Assessment: 2014 SARC 58
Model Type: Catch-survey

Northern shrimp is managed by the Atlantic States Marine Fisheries Commission. The stock is assessed annually, with benchmark assessments reviewed by the SARC approximately every 5 years. None of the models presented for the 2014 benchmark assessment was accepted by the SARC. The model currently used for management (catch-survey analysis reviewed by the 2007 SARC) was extended to improve the statistical basis; however, this revealed uncertainties that were not previously recognized and led the panel to reject the updated model formulation. There are several sources of high quality survey data for northern shrimp; however, extreme fluctuations in abundance in recent years have posed difficulties for the modeling efforts. Most recently, severe declines in biomass and recruitment indices led to a moratorium on fishing during 2014. The annual assessment will be updated in October 2014.

3.5 Atlantic sturgeon: Acipenser oxyrhynchus

Christine Lipsky
Fishery Management Plan: ASMFC Sturgeon
Last Assessment: NA
Model Type: NA

Atlantic sturgeon are managed by the ASMFC, and the last assessment, which occurred in 1998, was a stock assessment peer review report based on a report on stock status of Atlantic sturgeon of Atlantic coast estuaries. The stock has not had a formal assessment, however. The species was divided into five distinct population segments in the US (Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic), based on genetic analysis, four of which were listed as endangered under the Endangered Species Act (New York Bight, Chesapeake Bay, Carolina, and South Atlantic), and the Gulf of Maine was listed as threatened in 2012. The Maritimes Designatable Unit of Atlantic sturgeon was evaluated as Threatened by the Committee on the Status of Endangered Wildlife in Canada in 2011. Because a fishing moratorium has been in place in the US since 1998, available catch data are from observed bycatch events. The only other available data are from researchers conducting mark-recapture and telemetry studies. A formal stock assessment has been initiated and should be completed by 2015.

3.6 Shortnose sturgeon: Acipenser brevirostrum

Christine Lipsky
Fishery Management Plan: ASMFC Sturgeon
Last Assessment: NA

Model Type: NA

Shortnose sturgeon has not had a formal stock assessment. It was listed as an endangered species under the Endangered Species act in 1967, and a status review was conducted in 2010. Due to its endangered status, there is no directed fishery on shortnose sturgeon. River-specific population estimates have been made using limited mark-recapture data, and these data are housed in a USFWS database. Anecdotal evidence shows that sturgeon numbers are greater than previously thought. A stock assessment is needed to determine if the population has reached a point where it no longer needs ESA protection.