1 Executive Summary

1.1 Process

Assessments for 19[1] of the 20 groundfish stocks (Table 1) in the New England Fishery Management Council's (NEFMC) Multispecies Groundfish Fisheries Management Plan were updated and reviewed during September 11-15, 2017 at the Northeast Fisheries Science Center (NEFSC), Woods Hole, MA. This represents the fifth assessment of the status of groundfish stocks since 2001. The first three assessments were produced through the Groundfish Assessment Review Meeting (GARM) process (NEFSC 2002, 2005, 2008). Thirteen of the groundfish stocks were updated through the Operational Assessment process in 2012 (NEFSC 2012). All 20 groundfish stocks were updated using operational assessments in 2015 (NEFSC 2015). Operational assessments, first described by the Northeast Regional Coordinating Council (NRCC) in 2011, rely on decisions of previous benchmarks for model formulation and definition of biological reference points (BRPs). The terms of reference for the operational assessments are provided in Section 21.1. The efficiency of the Operational Assessment process increases the frequency of assessments, but reduces the ability to modify model structure either in response to new data or external inputs. Major modifications of the assessment models are restricted to benchmark assessments that can incorporate a much greater range of information but for far fewer stocks. The scope of admissible changes in the assessment is described in Section 21.4 and in guidelines that were initially developed by the NRCC in 2015 and revised in 2017 through collaborative discussions among the NEFSC, NEFMC, and the Assessment Oversight Panel. The Assessment Oversight Panel (AOP) considered those guidelines in its July 24, 2017, review of the plans for each assessment prepared by the individual analysts, making recommendations regarding both planned changes to the assessments as well as plans for how scientific advice would be provided for each stock if the primary analytical assessment was not accepted by the peer review panel (sometimes referred to as "Plan B" assessment advice). See Section 21.3 for a summary of the AOP meeting.

Of particular note this year, newly available cooperative research on survey catchability of flatfish species was incorporated into the process, with modified catchability coefficients applied directly in several assessments that use empirical models and catchability information shared for context and diagnostic consideration for several assessments that use analytical models (Appendix 21.4). Prior to its use in these assessments, the cooperative research study was peer reviewed on July 18, 2017 (summary available online). Those reviewers concluded the cooperative research surveys were well designed, the results well supported, and sample sizes were generally appropriate for use in estimating catchability for flatfish species in the 2017 Operational Assessments. The Peer Review Panel for the Operational Assessments did not repeat this earlier peer review of the catchability studies; rather it considered how the results were applied in relevant empirical assessments and their use in diagnostic evaluations of relevant analytical assessments.

In August and September, 2017 the NEFSC held 8 port-based outreach meetings for fishermen and other stakeholders. These occurred in Maine (Portland), New Hampshire (Portsmouth), Rhode Island (Narragansett), New York (Montauk) and Massachusetts (Gloucester, Plymouth, New Bedford, and Chatham). NEFSC personnel met with attendees at each location to learn more about

[1] Atlantic halibut is being assessed separately

recent observations from the fleet and ports that might help focus future research to improve assessments and interpret patterns in the current assessments. Each meeting started with a brief introduction on the timeline for the assessments, what new information would be considered, and how the results would be reviewed before use in the fishery management process.

A summary report of the outreach meetings discusses relevant insights from those meetings, which were shared during the peer review. Much of the substantive feedback from the outreach meetings focused on future research needs and opportunities as well as stakeholder questions about process, data, and outputs.

Following the established process associated with groundfish operational assessments, the NEFSC provided a data-rich dedicated website to supplement the information provided in individual species assessment reports.

The Peer Review Panel (i.e., Panel) consisted of the following individuals:

- Pat Sullivan (Co-chair), Cornell University, NEFMC Scientific and Statistical Committee
- Patrick Lynch (Co-chair), NMFS Office of Science and Technology, Silver Spring, MD.
- Gary Nelson, Massachusetts Division of Marine Fisheries, Gloucester, MA
- Jim Berkson, NMFS Office of Science and Technology, Silver Spring, MD.

The Panel was responsible for reviewing each of the stock assessments. Primary and supporting documents for each assessment were available prior to the meeting. Each lead assessment scientist (Table 2) prepared a short presentation to describe the past and updated assessment results and address key sources of uncertainty (see agenda). Following the presentation, the Panel was responsible for addressing five terms of reference (TOR):

- Accept/ Not Accept the assessment as a basis for setting Overfishing Limit (OFL).
- If the assessment is not accepted, then recommend an alternative basis for setting OFL.
- Include qualitative written statements about the condition of the stock that will help to inform NOAA Fisheries about stock status.
- Identify key sources of uncertainty.
- Identify important research needs.

If an assessment was not considered suitable for estimation of OFL the Panel was responsible for recommending an alternative basis. Additionally, the Peer Review panel was asked to recommend what the stock status appears to be without reference to analytical assessment results. NOAA Fisheries has final responsibility for making the stock status determination based on best available scientific information, which in the absence of an accepted quantitative assessment, may be qualitative.

The individual assessment sections within this report are standardized and designed to capture the most relevant information for reviewers and fishery managers. The report structure was developed with, and approved by, a subcommittee of the NRCC, followed by NRCC feedback about the report structure. Each assessment is supported by an online set of companion tables, figures and maps, which provide primary users of the assessment information (e.g., Plan Development Teams, Science and Statistical Committee) with necessary details. The online data portal (SASINF) also contains model inputs and outputs that can be used directly in NOAA Fisheries Toolbox applications.

The meeting was broadcast as a webinar using Adobe Connect and all sessions were open to the public. The meeting agenda included a daily public comment period. Members of the audience and individuals on the phone were included in the discussions of the panel at the discretion of the Panel Co-chairs. However, the tight timeline for completing the assessments required a strong adherence to the terms of reference and the description of the operational assessment process developed by the NRCC. Onsite participants in Woods Hole are listed in Section 21.5.

1.2 Data

The groundfish updates used the following standard procedures for updating data from landings, discards and surveys (Table 3). The US commercial landings are estimated by market category from the area allocation ("AA") tables, which combine dealer and vessel trip reports to determine where fish were caught. The US commercial discards are estimated by gear types using the Standardized Bycatch Reporting Methodology (SBRM), which combines observer data (including at-sea monitors) and dealer landings. The US recreational landings and discards come from the Marine Recreational Information Program (MRIP), including recent revisions to historical data. Both commercial and recreational discards have species-specific discard mortality rates applied to the discarded fish. Catch-at-age is estimated using age-length keys applied to expanded length frequency distributions. For white hake, which is landed headed, the age-length key is applied to predicted lengths based on dorsal fin to caudal fin length. Additional sources of catch for some species come from Canadian or other foreign fishing.

The NEFSC spring and fall bottom trawl surveys are the most common source of information for population trends (Table 3). These surveys are calibrated to "Albatross units" in most cases to allow for the longest time series possible. NOAA ship *Henry B. Bigelow* replaced the *Albatross IV* as the primary bottom trawl survey vessel in spring 2009. In some instances the calibration coefficient varies by length but in others a simple scalar adjustment is applied to all length classes. Other surveys used include the Massachusetts Division of Marine Fisheries spring and fall bottom trawl surveys, the Maine-New Hampshire spring and fall bottom trawl surveys, the Canadian Department of Fisheries and Oceans February survey, and some additional state surveys. Catch per unit effort is not typically used as a source of population trends due to the many regulatory changes that have occurred over time in the Northeast that influence fishing behavior and catch rates. All updated assessments used a consistent quality assurance criterion (known as TOGA; Politis et al. 2014) for surveys conducted by the NOAA ship *Henry B. Bigelow*.

1.3 Models

Based on previous 2015 operational assessments (Table 4; NEFSC, 2015), there are 12 stocks assessed with an age-based approach. Eight use the statistical catch-at-age model ASAP while 4 others use virtual population analysis (VPA). For the 4 VPA stocks, the 2017 spring survey information was included in the model. The remaining 7 stocks are assessed with a range of model types including length-based (SCALE), index (AIM), and direct survey expansion. The reference points for the age- and length-based assessments were derived from stochastic projections of the F_{MSY} (or F_{MSY} proxy) for many years (typically 100), while the other assessment types use stock-specific rules for deriving the reference points. Technical descriptions of the biomass, fishing mortality and reference point estimators used for each stock are shown in Table 4. Information from a newly revived industry-based cod survey in the Gulf of Maine was considered for context in a few relevant assessments and discussed with the Peer Review Panel but was not directly included due to limited time series and Operational Assessment guidelines.

1.4 Results

Operational Assessments were conducted in 2017 for 19 of the 20 stocks in the Northeast Multi-species Fishery Management Plan (Table 1). The updates replicated the methods recommended in the most recent benchmark decisions, as modified by any subsequent operational assessments or updates (Table 2). Information supplemental to the assessment report for each stock can be found on the Stock Assessment Support Information (SASINF) website. The Panel accepted all of the assessments as a scientific basis for management and provided catch advice for all 19 stocks. Recommended stock status did not change for 18 of the 19 stocks, and improved for 1 stock (Table 5).

Each of the 19 species chapters contains the assessment results provided to the Panel for peer review followed by a section entitled "Reviewer Comments," which describes final Panel decisions at the conclusion of the peer review. In this Executive Summary, tables and figures related to stock status from the 2017 review reflect the Panel recommendations (Tables 5 - 6; Figures 1 - 2).

The number of stocks with retrospective adjustments (also called rho adjustments) applied increased from the last assessment from 7 to 8 (Table 7). Decisions to apply a retrospective adjustment to estimates of terminal year biomass and fishing mortality rates were based on whether the rho adjusted value was outside the 90% joint confidence region for the model estimates. This principle was supported by the AOP and was applied to adjust biomass estimates for Georges Bank haddock, Southern New England yellowtail flounder, Cape Cod/Gulf of Maine yellowtail flounder, Georges Bank winter flounder, American plaice, white hake, pollock and redfish (Table 8). Gulf of Maine cod was an exception because of earlier guidance from the SARC 55 review panel. Despite the presence of a significant retrospective pattern at that meeting no adjustments were made; the Operational Assessments panel followed that precedent.

Stock status recommendations for the 19 groundfish stocks are summarized in Tables 5 and 6. Four stocks are experiencing overfishing: Southern New England yellowtail flounder, Cape Cod Gulf of Maine yellowtail flounder, Gulf of Maine cod and Georges Bank yellowtail flounder. Ten groundfish stocks are overfished (Table 5). Based on these recommendations, the number of overfished stocks

and stocks experiencing overfishing has generally decreased since GARM III in 2007 (Figure 3), and the magnitude of overfishing or depletion for several stocks has generally decreased (Figures 1 and 2).

Simultaneous assessments of 19 groundfish stocks allowed a comprehensive examination of trends in spring and fall survey indices (Figures 4 and 5, respectively). For the majority of stocks the average of the most recent 5 years is below the time series mean for that stock.

Estimates of overall (aggregate) groundfish minimum swept area biomass are at or near an all-time high (Figures 6 and 7). However, the current stock diversity of the overall groundfish biomass is less than that seen in the 1960s and 1970s. Current groundfish biomass is dominated by only a few stocks. For example, the combined biomass of the Georges Bank haddock, Gulf of Maine haddock, pollock, and redfish stocks currently constitute more than 90% of the overall groundfish biomass observed in NEFSC spring surveys (Figure 6). It is important to note that the minimum swept area biomass estimates assume a common capture efficiency of 1.0 across all years. Actual biomasses, as derived from models, are adjusted for catchability and selectivity estimates and are higher than the minimum swept area estimates. Unfortunately model-based estimates are not available for all stocks over the entire time period of the surveys (i.e. since 1963); the primary limitation is the availability of age information from the commercial catches that would be needed to support full age-based assessments.

For 12 stocks, model-based biomass estimates can be computed from 1985 onward. The striking increase in abundance since 1985 is driven primarily by redfish, Georges Bank haddock, and pollock (Figure 8). Pollock biomass from the stock assessment is much higher than the swept area estimates because of a dome-shaped selectivity pattern in both the survey and catch data. This suggests that a substantial fraction of the stock biomass is unavailable to either the fishery or survey gear. The chapter describing the pollock assessment includes a sensitivity run in which the assumption of dome-shaped selectivity is removed, resulting in a biomass estimate that is about half as large. The increase in model based estimates of overall biomass, with or without pollock, is consistent with the trends revealed in the swept area estimates (Figures 6, 7 and 8).

An advantage of conducting multiple assessments simultaneously is that measures of productivity can be compared over time. Reductions in average weight-at-age, declines in recruitment and shifts in age-at-maturity all influence the estimated biomass at maximum sustainable yield and total MSY. As such, the combined single species stock assessments provide valuable measures of ecosystem productivity, irrespective of the underlying environmental or ecological causes. Reductions in average weights-at-age have occurred for stocks at high abundance, such as Georges Bank haddock, but also for stocks at low abundance, such as witch flounder. Hence, density dependence alone is insufficient to explain this across all stocks. Reductions in recruitment are often associated with declines in stock size but inter-annual variation often masks trends. Aggregate estimates of total B_{MSY} are available for 10 stocks over the past decade (Figure 9). Total B_{MSY} for these stocks declined by 12% between 2008 and 2015 from 668 kt to 521 kt. Estimates further declined by about 7% between 2015 and 2017 to 483 kt (Figure 9).

An ecosystem report provided a climate vulnerability assessment for each of the 19 groundfish species. Current ecosystem considerations were summarized in a risk analysis framework to provide ecological context to the stock status of each species, including condition factor, productivity analyses and habitat modeling as an alternative index of biomass. Potential impacts of the recent

record high fall bottom and sea surface temperatures with subsequent thermal habitat reductions and range shifts were assessed for each stock, taking into account each stock's thermal preferences and vulnerability to climate change.

1.5 Reviewer Comments: Overview

The operational assessment meeting that took place at the Northeast Fisheries Science Center September 11-15 went well and all of the individual operational assessments were approved for use in developing management decisions for the SSC and Council. However, in the process of evaluating the 19 groundfish stocks certain patterns were notable in the data and in the model responses to that data. These patterns would suggest that some higher-level integrated analysis should take place in order to improve the assessment process as a whole while maintaining the integrity of the individual assessments, which meet the requirements for the present. Among the patterns that emerge were the number of assessments that displayed some kind of retrospective pattern and that required a retrospective adjustment. Unfortunately, numerous factors can individually or in union cause retrospective patterns to emerge in assessment estimates. Examples of such influential factors include changes in natural mortality, changes in selectivity, changes in size at age, underreporting of landings or discards, immigration or emigration, as well as factors affecting recruitment.

One recognizes that the Ecosystem Group, who gave a short presentation the afternoon of the first day of the week-long groundfish meeting, are in the position of providing at least some insight on environmental factors that could influence ecosystem health as well as those which might in other ways confound the assessment. The presentations focused on some general metrics likely to influence fish health and behavior, but more proactive approaches might also be considered. During the meeting the review panel noticed general patterns in reductions in size at age across several stocks. And while such changes could be driven by density-dependent effects, these changes may also be precipitated by ecosystem level changes. The management response to these two different determinants could be very different. The panel also noted something that seemed to be common knowledge, namely that 2013 stood out as it was a good year for producing strong recruitment year classes (other years, such as 2007, may also have been conducive to recruitment across stocks). Further, the review panel observed situations where fisheries stocks seemed unable to respond positively to management restrictions on catch.

Broadly, these changes in the biology, in the ecosystem and in contrast to what is happening in management suggest that an integrated approach that not only examines ecosystem trends but also tries to account for other aspects of fisheries systems such as the quality and nature of the survey and catch data, the magnitude of unreported catch, and long term effects on fishing behavior of changing management actions would be highly beneficial. On a related cross-assessment note, working towards assessments that better represent the level of uncertainty in the estimates would also be of value. This will take time as this is an evolving area of research, but the outcome would likely benefit fisheries management as the risk in decision making given constraints in how data are collected and how the ecosystem is changing becomes better known.

The review panel was pleased to see the work coming out of the Cooperative Research Survey Program. In this review, the data were used to help validate existing model-based trends as well as provide direct input into catchability estimates for empirical approaches when no integrated model

was available for use. The assessment community is encouraged to continue to use these data for such purposes. One must recognize, however, that such data are most useful when considered in the longer term. More specifically, the review panel notes that individual surveys must be viewed in the context of long-term data collection efforts and extensive integrated assessment that undergo ongoing review. One should not expect that a single experiment should overturn years of systematic analysis, but should be instrumental in providing validation and by contrast challenges to the existing methods. Such studies should also point to where additional work is needed.

References

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Table 1: List of stocks included in the 2017 groundfish operational assessment and the abbreviations used for each in tables and figures in this document. Atlantic halibut has been excluded from this document because it is being reviewed in a separate forum.

Stock Abbrev	Stock Name
CODGM	Gulf of Maine cod
CODGB	Georges Bank cod
HADGM	Gulf of Maine haddock
HADGB	Georges Bank haddock
YELCCGM	Cape Cod/Gulf of Maine yellowtail flounder
YELSNEMA	Southern New England/Mid-Atlantic yellowtail flounder
FLWGB	Georges Bank winter flounder
FLWSNEMA	Southern New England/Mid-Atlantic winter flounder
REDUNIT	Acadian redfish
PLAUNIT	American plaice
WITUNIT	Witch flounder
HKWUNIT	White hake
POLUNIT	Pollock
CATUNIT	Wolffish
FLDGMGB	Gulf of Maine/Georges Bank windowpane flounder
FLDSNEMA	Southern New England/Mid-Atlantic windowpane flounder
OPTUNIT	Ocean pout
FLWGM	Gulf of Maine winter flounder
YELGB	Georges Bank yellowtail flounder

Table 2: Lead scientist for each stock (current/previous if different), information about last assessment, including: the forum for review of the last assessment (Forum), the type of assessment done (Type), publication year (Pub.), the terminal year of the catch data included (Term. yr.), overfished/overfishing status, rebuilding status, and reference. *Note: Op. Assess = Operational Assessment*

Stock	Lead	Forum	Type	Pub.	Term. yr.	Overfished?	Overfishing?	Rebuild status	Reference
CODGM	Palmer	Op. Assess	Update	2015	2014	Yes	Yes	By 2024	CRD15-24
CODGB	Legault/O'Brien	Op. Assess	Update	2015	2014	Yes	Unknown	By 2026	CRD15-24
HADGM	Palmer	Op. Assess	Update	2015	2014	No	No	Rebuilt	CRD15-24
HADGB	Brooks	Op. Assess	Update	2015	2014	No	No	Rebuilt	CRD15-24
YELCCGM	Alade	Op. Assess	Update	2015	2014	Yes	Yes	By 2023	CRD15-24
YELSNEMA	Alade	Op. Assess	Update	2015	2014	Yes	Yes	Rebuilt	CRD15-24
FLWGB	Hendrickson	Op. Assess	Update	2015	2014	Yes	Yes	By 2017	CRD15-24
FLWSNEMA	Wood	Op. Assess	Update	2015	2014	Yes	No	By 2023	CRD15-24
REDUNIT	Linton	Op. Assess	Update	2015	2014	No	No	Rebuilt	CRD15-24
PLAUNIT	Terceiro/O'Brien	Op. Assess	Update	2015	2014	No	No	By 2024	CRD15-24
WITUNIT	Wigley	SARC 62	Benchmark	2017	2016	Yes	Unknown	By 2017	CRD17-03
HKWUNIT	Sosebee	Op. Assess	Update	2015	2014	No	No	By 2014	CRD15-24
POLUNIT	Linton	Op. Assess	Update	2015	2014	No	No	Rebuilt	CRD15-24
CATUNIT	Adams	Op. Assess	Update	2015	2014	Yes	No	Unknown	CRD15-24
FLDGMGB	Chute	Op. Assess	Update	2015	2014	Yes	No	By 2017	CRD15-24
FLDSNEMA	Chute	Op. Assess	Update	2015	2014	No	No	Rebuilt	CRD15-24
OPTUNIT	Wigley	Op. Assess	Update	2015	2014	Yes	No	By 2014	CRD15-24
FLWGM	Nitschke	Op. Assess	Update	2015	2014	Unknown	No	Unknown	CRD15-24
YELGB	Legault	TRAC 2017	Update	2017	2016	Yes	Unknown	By 2032	TRAC2017

Table 3: Data used in each assessment. The column heads are US commercial landings (US c-lnd), US commercial discards (US c-dis), US recreational landings (US r-lnd), US recreational discards (US r-dis), Canadian catch (CA cat), Northeast Fisheries Science Center spring, fall and winter surveys (NE S, NE F and NE W), Massachusetts spring and fall surveys (MA S and MA F), Maine/New Hampshire spring and fall surveys (ME/NH S and ME/NH F) and Canadian Department of Fisheries and Oceans February survey (DFO S).

	Catch					**Surveys**							
Stock	US c-lnd	US c-dis	US r-lnd	US r-dis	CA Cat	NE S	NE F	NE W	MA S	MA F	ME/NH S	ME/NH F	DFO S
CODGM	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	No	No	No
CODGB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No
HADGM	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	No	No
HADGB	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	Yes
YELCCGM	Yes	Yes	No	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No
YELSNEMA	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No	No	No	No
FLWGB	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	Yes
FLWSNEMA	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	No
REDUNIT	Yes	Yes	No	No	No	Yes	Yes	No	No	No	No	No	No
PLAUNIT	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	No	No	No
WITUNIT	Yes	Yes	No	No	No	Yes	Yes	No	No	No	No	No	No
HKWUNIT	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No
POLUNIT	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	No	No
CATUNIT	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	No	No	No	No
FLDGMGB	Yes	Yes	No	No	No	No	Yes	No	No	No	No	No	No
FLDSNEMA	Yes	Yes	No	No	No	No	Yes	No	No	No	No	No	No
OPTUNIT	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No	No
FLDWGM	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No
YELGB	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	Yes

Table 4: Assessment type and reference points from 2015 operational assessment CRD15-24. Biomass and yield values are in metric tons. *Note: sp=stochastic projection and surv. B = survey biomass.*

Stock	Assess.	Type	F def.	B def.	F_{MSY} type	F_{MSY} value	B_{MSY} type	B_{MSY} value	MSY type	MSY value
CODGM(M=.2)	ASAP	age-based	F_{Full}	SSB	$F_{40\%SPR}$	0.18	sp	40,187	sp	6,797
CODGM(M_{ramp})	ASAP	age-based	F_{Full}	SSB	$F_{40\%SPR}$	0.18	sp	59,045	sp	10,043
CODGB	empirical	smoothed survey	$\frac{catch}{surv.B}$	surv. B	NA	NA	NA	NA	NA	NA
HADGM	ASAP	age-based	F_{Full}	SSB	$F_{40\%SPR}$	0.468	sp	4,623	sp	1,083
HADGB	VPA	age-based	avg F ages 5-7	SSB	$F_{40\%SPR}$	0.39	sp	108,300	sp	24,900
YELCCGOM	VPA	age-based	avg F ages 4-6	SSB	$F_{40\%SPR}$	0.279	sp	5,259	sp	1,285
YELSNEMA	ASAP	age-based	avg F ages 4-5	SSB	$F_{40\%SPR}$	0.349	sp	1,959	sp	541
FLWGB	VPA	age-based	avg F ages 4-6	SSB	Fmsy	0.536	sp	6,700	sp	2,840
FLWSNEMA	ASAP	age-based	avg F ages 4-5	SSB	Fmsy	0.325	sp	26,928	sp	7,831
REDUNIT	ASAP	age-based	F_{Full}	SSB	$F_{50\%SPR}$	0.038	sp	281,112	sp	10,466
PLAUNIT	VPA	age-based	avg F ages 6-9	SSB	$F_{40\%SPR}$	0.196	sp	13,107	sp	2,675
WITUNIT	empirical	survey expansion	$\frac{catch}{surv.B}$	surv. B	NA	NA	NA	NA	NA	NA
HKWUNIT	ASAP	age-based	F_{Full}	SSB	$F_{40\%SPR}$	0.188	sp	32,550	sp	5,422
POLUNIT(base)	ASAP	age-based	avg F ages 5-7	SSB	$F_{40\%SPR}$	0.27	sp	105,22	sp	19,67
POLUNIT(flat)	ASAP	age-based	avg F ages 5-7	SSB	$F_{40\%SPR}$	0.25	sp	54,90	sp	10,99
CATUNIT	SCALE	length-based	F_{Full}	SSB	$F_{40\%SPR}$	0.243	sp	1,663	sp	244
FLDGMGB	AIM	index	$\frac{catch}{surv.B}$	surv. B	replacement ratio	0.450	$\frac{MSY\,proxy}{F_{MSY\,proxy}}$	1.554	median catch 1995-2001	700
FLDSNEMA	AIM	index	$\frac{catch}{surv.B}$	surv. B	replacement ratio	2.027	$\frac{MSY\,proxy}{F_{MSY\,proxy}}$	0.247	median catch 1995-2001	500
OPTUNIT	index	index	$\frac{catch}{surv.B}$	surv. B	med. $F_{1977-1985}$	0.76	med. surv. $B_{1977-1985}$	4.94	F_{MSY} * B_{MSY}	3,754
FLWGM	empirical	survey expansion	$\frac{catch}{B_{30+cm}}$	surv. B	$F_{40\%}$ from YPR	0.23	NA	NA	NA	NA
YELGB	empirical	survey expansion	$\frac{catch}{surv.B}$	surv. B	NA	NA	NA	NA	NA	NA

Table 5: Synopsis of recommended status by stock from the 2017 peer review. These recommendations will be considered by NMFS in making final status determinations.

		Recommended Status	
Stock	Stock Name	Overfishing?	Overfished?
CODGM	Gulf of Maine cod	Yes	Yes
CODGB	Georges Bank cod	Unknown	Yes
HADGM	Gulf of Maine haddock	No	No
HADGB	Georges Bank haddock	No	No
YELCCGM	Cape Cod/Gulf of Maine yellowtail flounder	Yes	Yes
YELSNEMA	S. New Eng./Mid-Atl. yellowtail flounder	Yes	Yes
FLWGB	Georges Bank winter flounder	No	No
FLWSNEMA	S. New Eng./Mid-Atl. winter flounder	No	Yes
REDUNIT	Acadian redfish	No	No
PLAUNIT	American plaice No	No	No
WITUNIT	Witch flounder	Unknown	Yes
HKWUNIT	White hake	No	No
POLUNIT	Pollock	No	No
CATUNIT	Wolffish	No	Yes
FLDGMGB	Gulf of Maine/Georges Bank windowpane flounder	No	Yes
FLDSNEMA	S. New Eng./Mid-Atl. windowpane flounder	No	No
OPTUNIT	Ocean pout	No	Yes
FLWGM	Gulf of Maine winter flounder	No	Unknown
YELGB	Georges Bank yellowtail flounder	Yes	Yes

Table 6: Summary of Operational Assessment estimates of biomasses and fishing mortality rates in 2016 and biological reference points for groundfish stocks. Reference points are not estimable for some stocks. Terminal biomass estimates for CODGB and YELGB are for 2017 rather than 2016.

Stock	Model type	B_{2016} (mt)	B_{MSY} (mt)	$\frac{B_{2016}}{B_{MSY}}$	F_{2016}	F_{MSY}	$\frac{F_{2016}}{F_{MSY}}$	MSY (mt)	ρ adj?	Comments
CODGM	ASAP (M=0.2)	3,046	40,604	0.08	0.228	0.17	1.31	7,049	No	
CODGM	ASAP (M-ramp)	3,262	59,714	0.05	0.237	0.18	1.34	10,502	No	
CODGB	Empirical	7.237			0.174				No	Smoothed survey indices used to estimate biomass
HADGB	VPA	290,324	104,312	2.78	0.309	0.35	0.88	24,372	Yes	
HADGM	ASAP	47,821	6,769	7.06	0.137	0.46	0.30	1,547	No	
YELCCGM	VPA	1,191	4,640	0.26	0.314	0.27	1.15	1,154	Yes	
YELSNEMA	ASAP	152	1,860	0.08	1.09	0.34	3.20	511	Yes	
FLWGB	VPA	3,946	7,600	0.52	0.117	0.52	0.22	3,500	Yes	
FLWSNEMA	ASAP	4,360	24,687	0.18	0.21	0.34	0.62	7,532	No	
PLAUNIT	VPA	13,351	13,503	0.99	0.111	0.22	0.51	2,924	Yes	
WITUNIT	Empirical	14,563			0.035				No	Average survey biomass, exploitation ratio used
REDUNIT	ASAP	359,970	247,918	1.45	0.011	0.04	0.29	9,318	Yes	
HKWUNIT	ASAP	21,276	30,948	0.69	0.066	0.18	0.36	4,867	Yes	
POLUNIT	ASAP (base)	183,907	105,510	1.74	0.036	0.26	0.14	19,427	Yes	Flat top selectivity model was used for sensitivity testing
POLUNIT	ASAP (flat top)	72,889	60,738	1.20	0.079	0.25	0.32	11,692	Yes	see above
CATUNIT	SCALE	652	1,612	0.40	0.002	0.22	0.01	232	No	
FLDGMGB	AIM	0.36	2.06	0.17	0.222	0.34	0.65	700	No	Biomass in kg/tow. F values reflect exploitation rate
FLDSNEMA	AIM	0.329	0.253	1.30	1.733	1.92	0.90	500	No	Biomass in kg/tow. F values reflect exploitation rate
OPTUNIT	Index-based	0.223	4.94	0.05	0.221	0.76	0.29	3,754	No	Biomass in kg/tow. F values reflect exploitation rate
FLWGM	Empirical	2,585			0.086	0.23	0.37		No	30+ cm biomass, exploitation ratio used
YELGB	Empirical	3,118			0.009				No	Average survey biomass, exploitation ratio used

Table 7: Comparison of biomass (B) and fishing mortality rate (F) Mohn's rho values (ρ) by stock between the previous assessment (ρ_{last}) and the 2017 (ρ_{2016}) updates. The biomass (B_{2016}) and fishing mortality rate (B_{2016}) point estimates and ρ adjusted values (Adj.) are provided for the 2017 operational assessments. Stocks using ρ adjusted values in the last assessment and the 2017 assessments (ρ adj. vs. pt. est. for those stocks that did not use the ρ adjustment) are identified, along with the type of ρ adjustment used in the 2017 assessment (NAA=numbers at age, SSB=spawning stock biomass applied to all ages), are also provided. Only age-based and length-based stocks that could exhibit retrospective patterns are included in this table. Missing ρ values indicate a minor retrospective pattern was found and no retrospective adjustments were made.

Stock	Model type	ρ_{last}	ρ_{2016}	B_{2016}	Adj.	ρ_{last}	ρ_{2016}	F_{2016}	Adj.	Last Assess.	2017	Proj. Adj.
CODGM	ASAP (M=0.2)	0.54	0.53	3046	1,997	-0.31	-0.31	0.23	0.33	pt. est.	pt. est.	none
CODGM	ASAP (M-ramp)	0.20	0.30	3262	2,502	-0.08	-0.17	0.24	0.28	pt. est.	pt. est.	none
HADGM	ASAP	-0.04		47821	NA	0.03		0.14		pt. est.	pt. est.	none
HADGB	VPA	0.50	0.89	549938	290,324	-0.34	-0.63	0.11	0.31	ρ adj.	ρ adj.	SSB
YELCCGM	VPA	0.98	0.76	2093	1,191	-0.45	-0.39	0.19	0.31	ρ adj.	ρ adj.	NAA
YELSNEMA	ASAP	1.06	0.97	300	152	-0.53	-0.47	0.58	1.09	pt. est.	ρ adj.	NAA
FLWGB	VPA	0.83	0.54	6083	3,946	-0.51	-0.31	0.08	0.12	ρ adj.	ρ adj.	SSB
FLWSNEMA	ASAP	0.21		4360	NA	-0.25		0.21		pt. est.	pt. est.	none
REDUNIT	ASAP	0.26	0.21	435852	359,970	-0.19	-0.18	0.01	0.01	ρ adj.	ρ adj.	NAA
PLAUNIT	VPA	0.32	0.14	15148	13,351	-0.32	-0.32	0.07	0.11	ρ adj.	ρ adj.	NAA
HKWUNIT	ASAP	0.18	0.20	25638	21,276	-0.13	-0.12	0.06	0.07	pt. est.	ρ adj.	NAA
POLUNIT	ASAP (base)	0.28	0.23	226371	183,907	-0.28	-0.28	0.03	0.04	ρ adj.	ρ adj.	NAA
POLUNIT	ASAP (flat)		0.41	102571	72,889		-0.35	0.05	0.08	ρ adj.	ρ adj.	NAA

Table 8: The biomass (B) and exploitation rate (F) values used for status determination may be adjusted to account for a retrospective pattern in some stocks. In general, when the B or F values adjusted for restrospective pattern (B_ρ and F_ρ) were outside of the approximate 90% confidence interval (Conf. limits) of the model-estimated B_{2016} and F_{2016}, the adjusted values were used to determine stock status (Adj. = Yes). There can be exceptions however, such as YELSNEMA and CODGM(M=0.2) in OA 2017 and details regarding each decision can be found in the report and reviewer comments sections for each stock in OA 2017. Only stocks that had both an estimable 7-year Mohn's ρ for B and F and estimable approximate 90% confidence limits on terminal year B and F values are included here.

Stock	B_{2016}	B_ρ	Conf. limits	F_{2016}	F_ρ	Conf. limits	Adj?
CODGM(M=0.2)	3,046	1,997	2,464 - 4,025	0.228	0.332	0.169 - 0.316	No
CODGM(M ramp)	3,262	2,502	2,487 - 4,270	0.237	0.285	0.172 - 0.331	No
HADGB	549,938	290,324	383,166 - 801,643	0.113	0.309	0.079 - 0.164	Yes
YELSNEMA	300	152	217 - 459	0.58	1.09	0.362 - 0.843	Yes
YELCCGM	2,093	1,191	1,722 - 2,626	0.193	0.314	0.15 - 0.26	Yes
FLWGB	6,083	3,946	4,898 - 7,812	0.081	0.117	0.064 - 0.106	Yes
PLAUNIT	15,148	13,351	13,582 - 17,009	0.075	0.111	0.065 - 0.088	Yes
HKWUNIT	25,638	21,276	21,466 - 30,052	0.058	0.066	0.048 - 0.07	Yes
POLUNIT(base)	226,371	183,907	76,914 - 293,256	0.026	0.036	0.037 - 0.034	Yes
REDUNIT	435,852	359,970	394,927 - 481,018	0.009	0.011	0.008 - 0.01	Yes

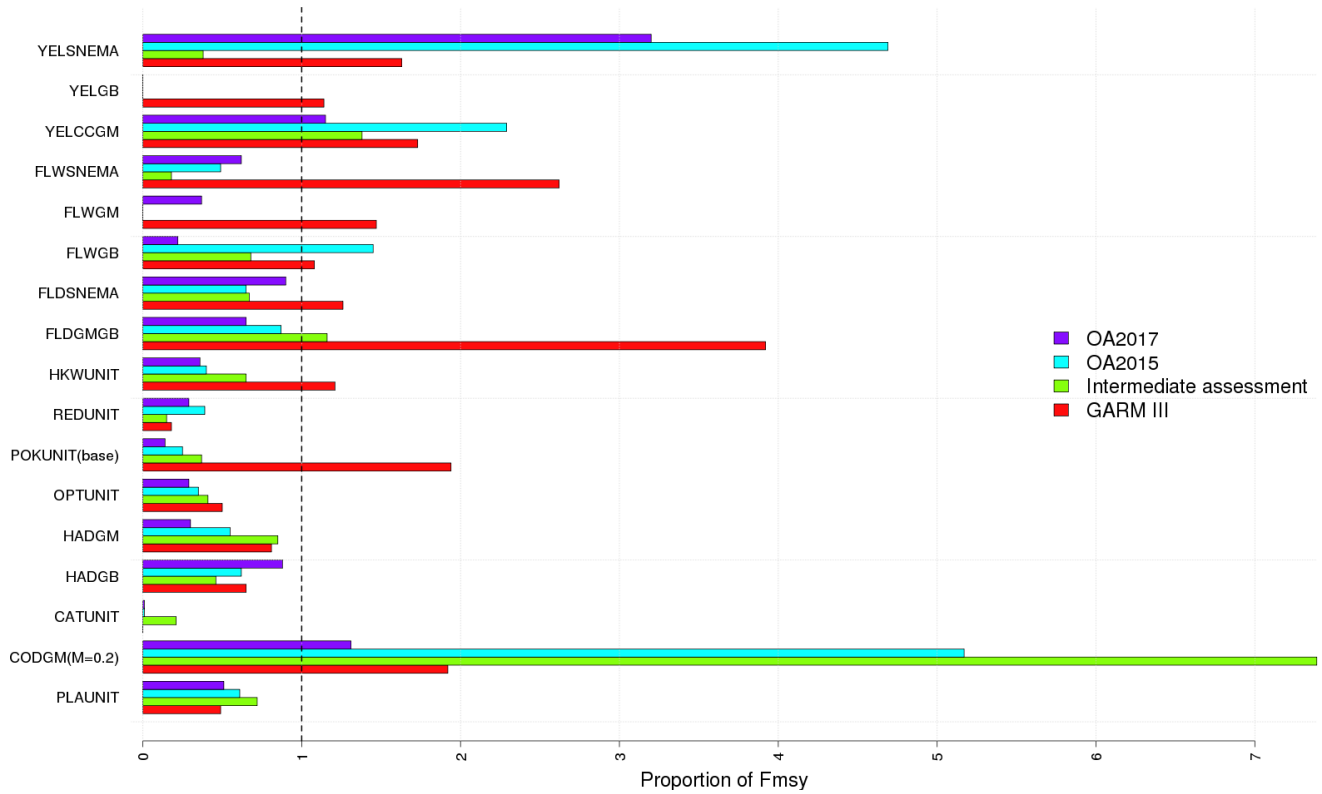

Figure 1: Changes in the ratio of fishing mortality to FMSY proxy from 2007 (GARM III) to 2016 (OA 2017) for selected Northeast Multispecies Fishery Management Plan groundfish stocks. The results from the assessment prior to the OA 2015 assessment are shown for each stock to provide 'Intermediate' values. Stocks on which overfishing is occurring are those where the $\frac{F_{terminal}}{F_{MSYproxy}}$ ratio is greater than 1. *Notes: (1) the GARM III assessments did not include wolffish; (2) stock status in the 'Intermediate' assessment could not be determined for Gulf of Maine winter flounder or Georges Bank yellowtail flounder; and, (3) based on the OA 2015 assessments stock status could not be determined for Gulf of Maine winter flounder, Georges Bank yellowtail flounder and Georges Bank cod; (4) the Gulf of Maine cod assessment values shown here are for the M=0.2 model. (5) based on the SARC 62 benchmark assessment, status for witch flounder status could not be determined.* Because current overfishing status for Georges Bank cod and witch flounder are unknown, they were not included in this figure.

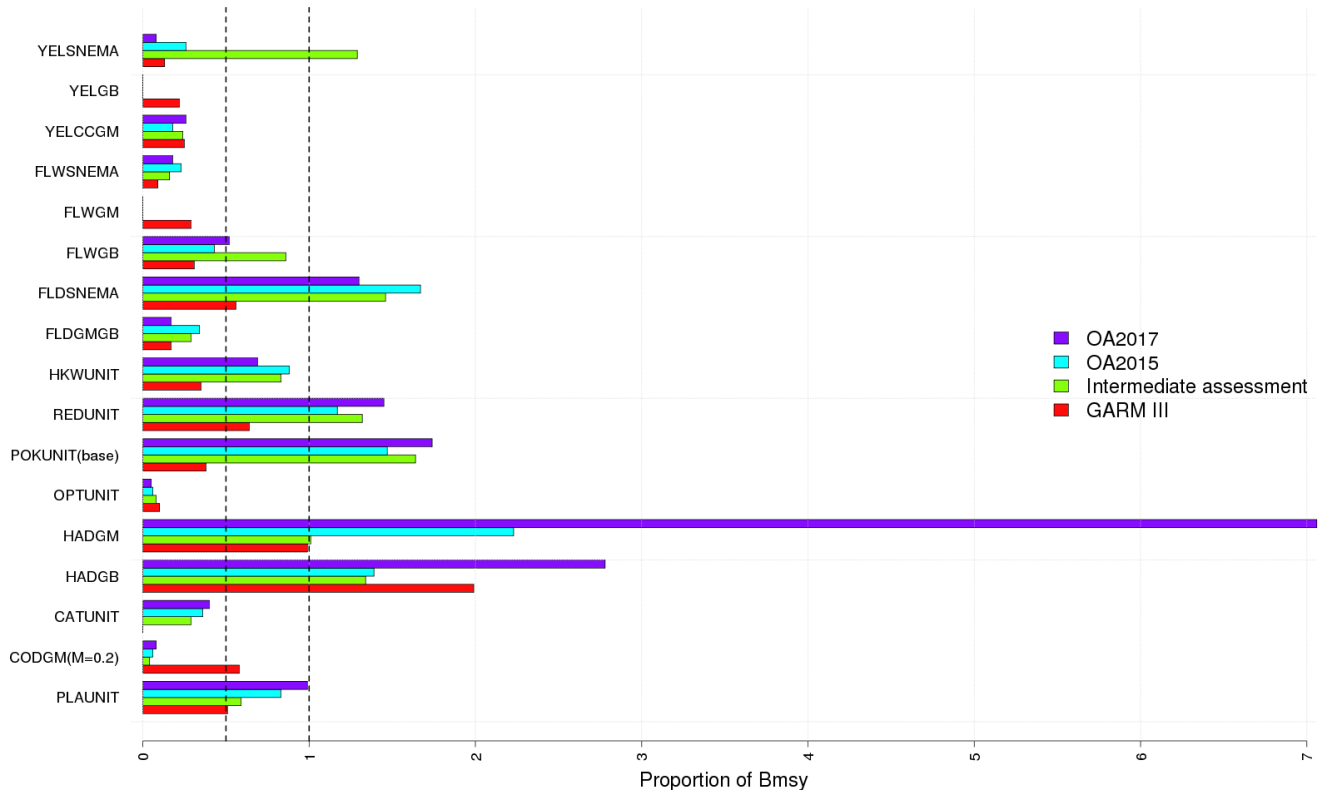

Figure 2: Changes in the ratio of stock biomass to B_{MSY} proxy from 2007 (GARM III) to 2016 (OA 2017) for selected Northeast Multispecies Fishery Management Plan groundfish stocks. The results from the assessment prior to the OA 2015 assessment are shown for each stock to provide 'Intermediate' values. Stocks that are overfished stocks are those where the $\frac{B_{terminal}}{B_{MSYproxy}}$ ratio is less than 0.5. *Notes: (1) the GARM III assessments did not include wolffish; (2) stock status in the 'Intermediate' assessment could not be determined for Gulf of Maine winter flounder or Georges Bank yellowtail flounder; and, (3) based on the OA 2015 assessments stock status could not be determined for Gulf of Maine winter flounder, Georges Bank yellowtail flounder and Georges Bank cod; (4) the Gulf of Maine cod assessment values shown here are for the M=0.2 model. (5) based on the SARC 62 benchmark assessment, status for witch flounder status could not be determined.* Because Georges Bank cod and witch flounder do not currently have quantitative biomass reference points, they were not included in this figure.

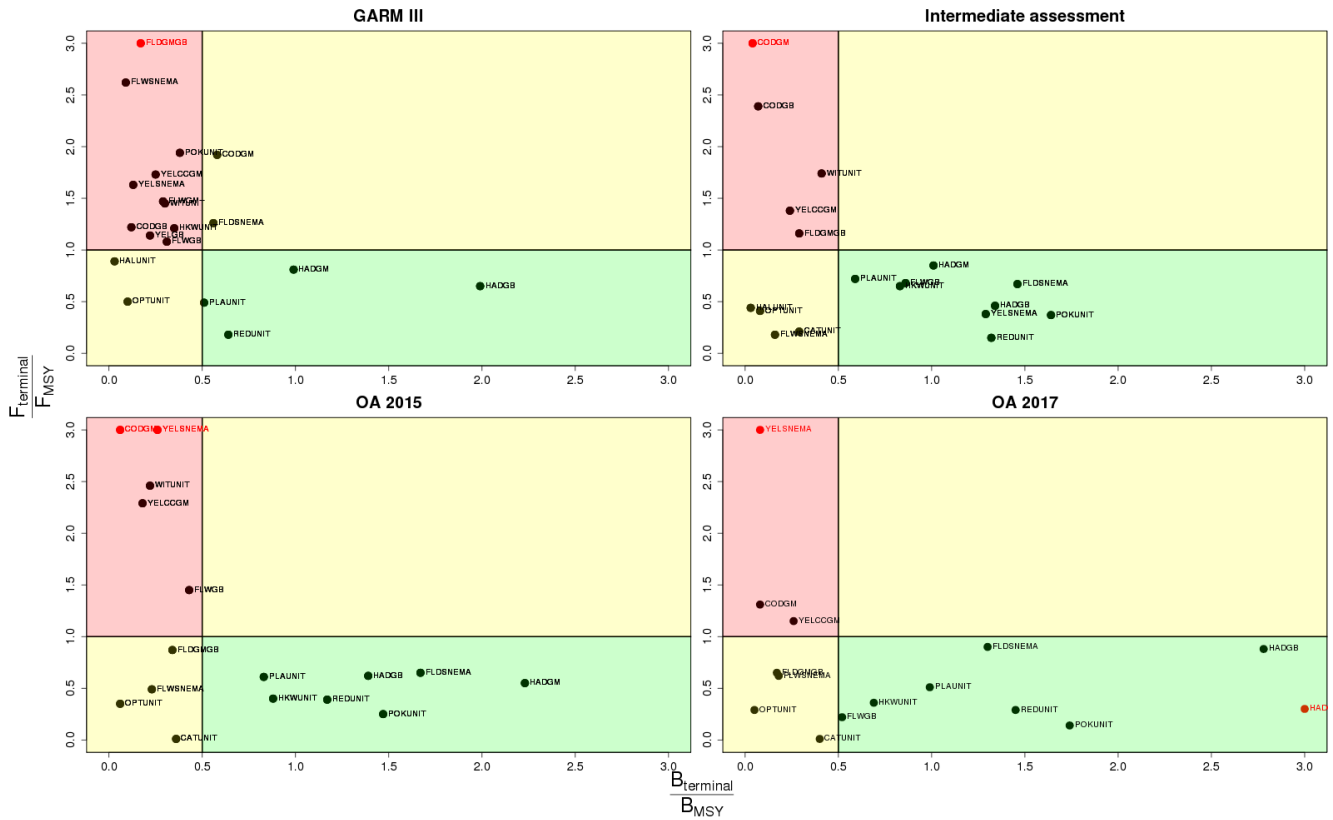

Figure 3: Status of the Northeast Multispecies Fishery Management Plan groundfish stocks in 2007 (GARM III) and 2016 (OA 2017) with respect to the F_{MSY} and B_{MSY} proxies. The 'Intermediate assessment' represents the last stock assessment conducted prior to the OA 2015 assessment (year varies by stock). Stocks on which overfishing is occurring are those where the $\frac{F_{terminal}}{F_{MSYproxy}}$ ratio is greater than 1 and overfished stocks are those where the $\frac{B_{terminal}}{B_{MSYproxy}}$ ratio is less than 0.5. The scale of the axes was restricted to allow for comparison between years. Stocks with red markers and text exceeded these limits (values are available in Table 6). *Notes: (1) the GARM III assessments did not include wolffish; (2) for the intermediate assessments stock status could not be determined for Gulf of Maine winter flounder (OA 2014) or Georges Bank yellowtail (TRAC 2015); and, (3) based on the OA 2015 assessments stock status could not be determined for Gulf of Maine winter flounder and Georges Bank yellowtail flounder; (4) the Gulf of Maine cod assessment values shown here are for the M=0.2 model. In the OA 2015 assessment, the stock status for Georges Bank cod remained overfished and overfishing is occurring; however, since the assessment was not accepted, ratios of terminal conditions to reference points cannot be determined.* Only stocks with known reference points are included in this figure.

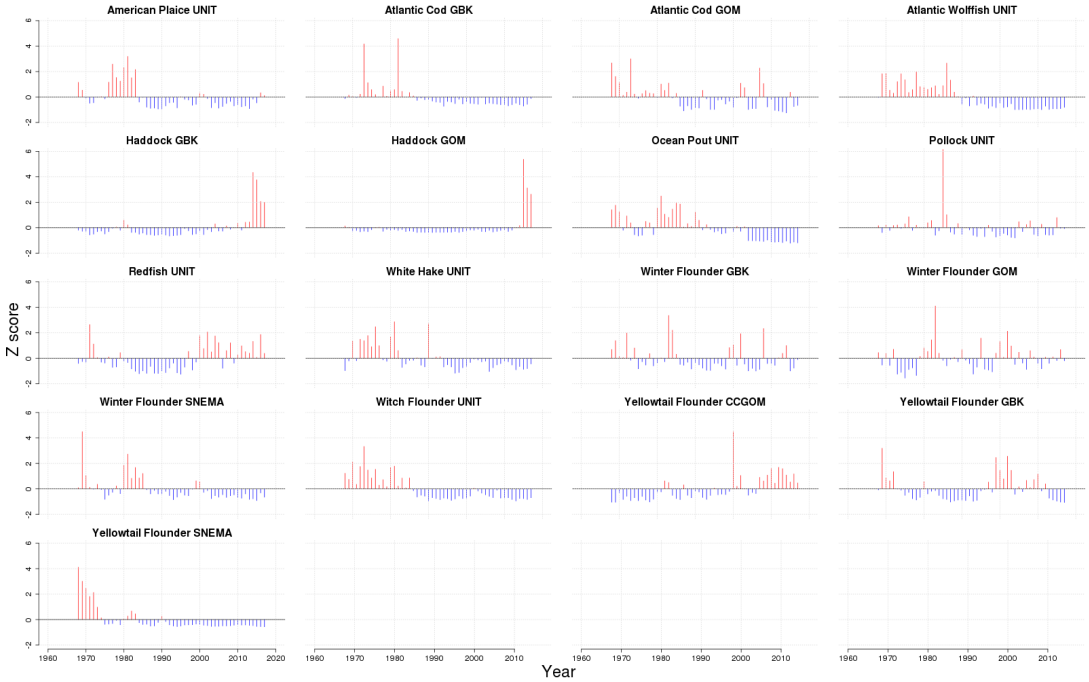

Figure 4: NEFSC spring bottom trawl survey index standardized anomalies (Z-score) for the Northeast Multispecies Fishery Management Plan groundfish stocks from 1968 to 2017. *Note that both the Georges Bank/Gulf of Maine and Southern New England/Mid-Atlantic windowpane flounder stocks are not included since the spring survey is uninformative as an index of abundance and not used in the stock assessment.*

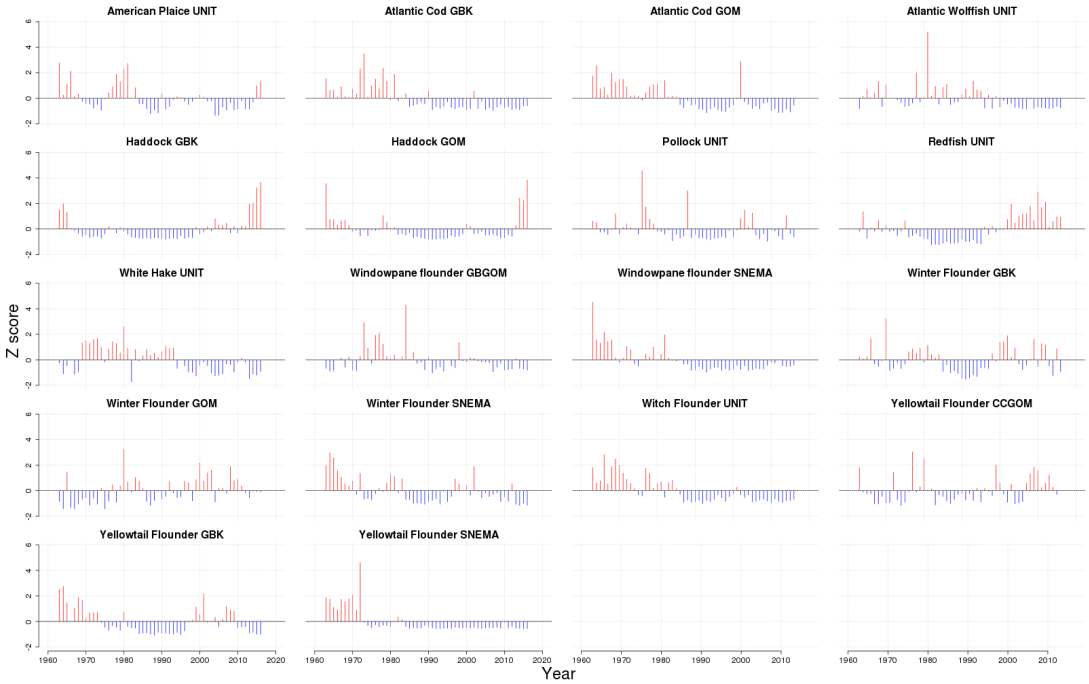

Figure 5: NEFSC fall bottom trawl survey index standardized anomalies (Z-score) for the Northeast Multispecies Fishery Management Plan groundfish stocks from 1963 to 2016. *Note that ocean pout is not included since the fall survey is uninformative as an index of abundance and not used in the stock assessment.*

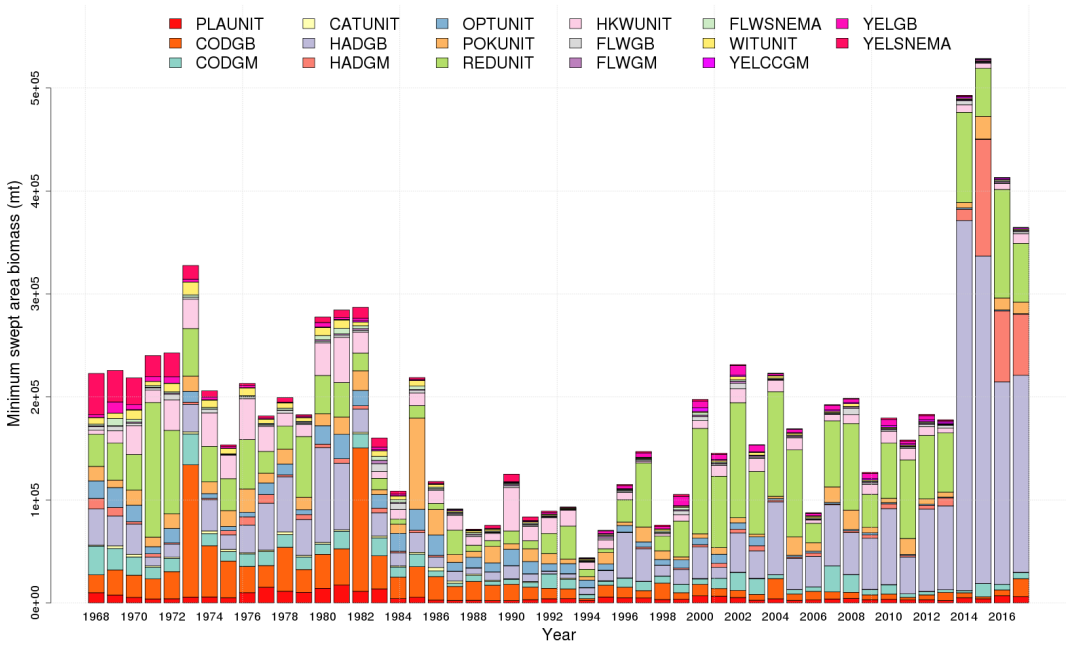

Figure 6: NEFSC spring bottom trawl survey minimum swept area biomass (mt) for the Northeast Multispecies Fishery Management Plan groundfish stocks from 1968 to 2017, by stock. Minimum swept area estimates assume a trawl swept area of 0.0112 nm^2) (0.0384 km^2) based on the wing spread of the trawl net. *Note that both the Georges Bank/Gulf of Maine and Southern New England/Mid-Atlantic windowpane flounder stocks are not included since the spring survey is uninformative as an index of abundance and not used in the stock assessment.*

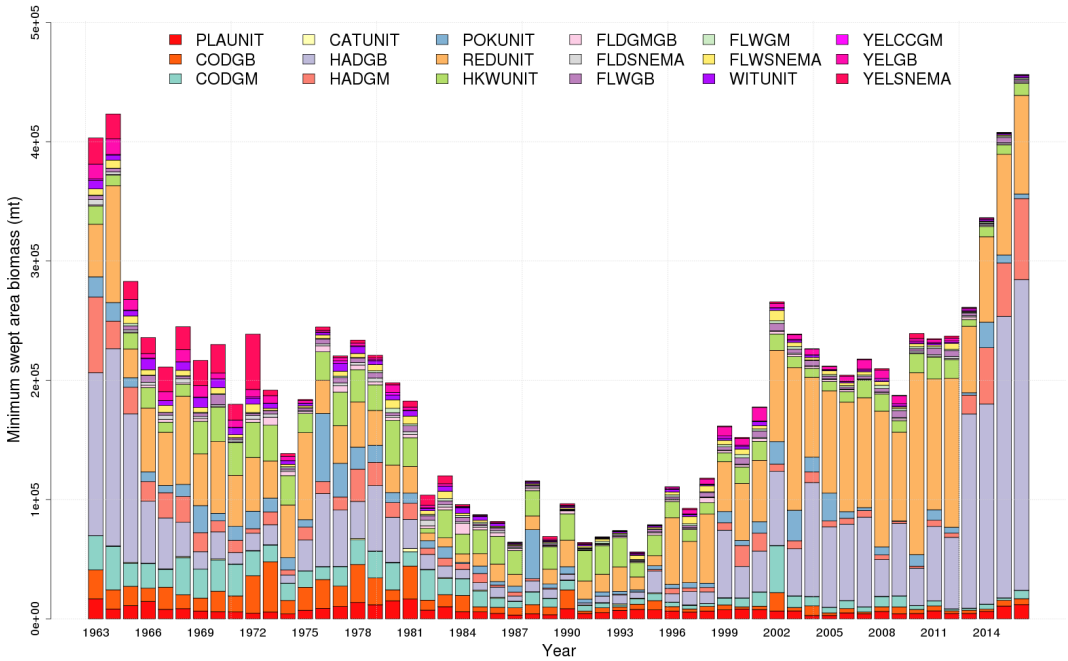

Figure 7: NEFSC fall bottom trawl survey minimum swept area biomass (mt) for for the Northeast Multispecies Fishery Management Plan groundfish stocks from 1963 to 2016, by stock. Minimum swept area estimates assume a trawl swept area of 0.0112 nm^2 (0.0384 km^2) based on the wing spread of the trawl net. *Note that ocean pout is not included since the fall survey is uninformative as an index of abundance and not used in the stock assessment.*

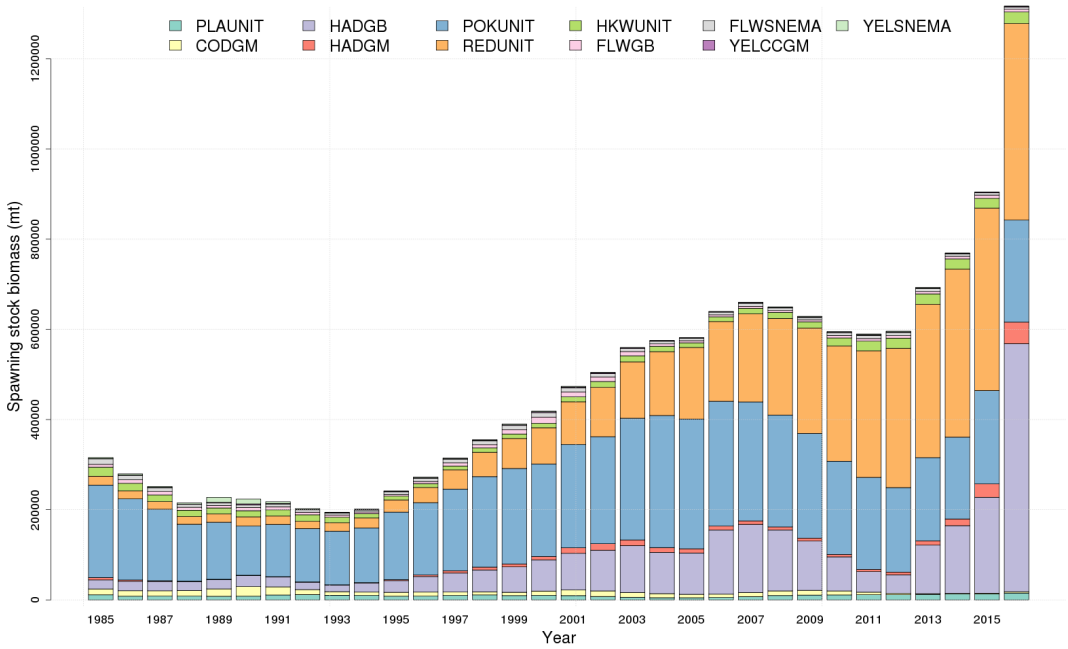

Figure 8: Model-based spawning stock biomass estimates for 11 groundfish stocks, 1985-2016 based on the Operational Assessments in 2017. Models without model-based biomass estimates are excluded.

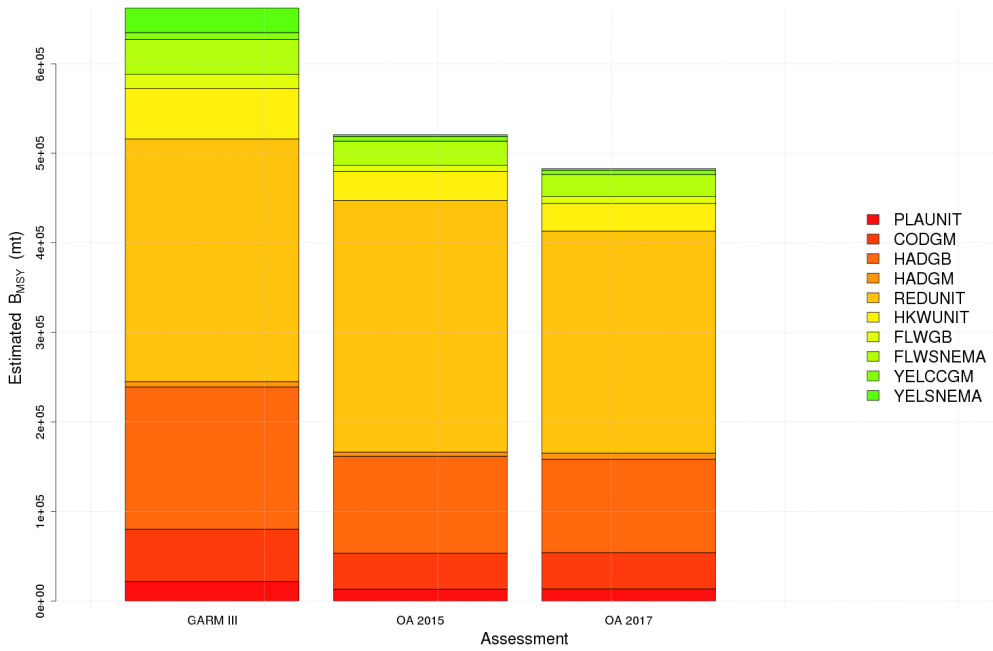

Figure 9: Sum of B_{MSY} estimates for nine stocks which had B_{MSY} estimates in 2008 (662,166 mt), 2015 (520,725 mt) and 2017 (482,841 mt) assessments. Pollock is not included since biomass targets not established until 2010 at SARC 50. B_{MSY} estimates for Gulf of Maine winter flounder, witch flounder and Georges Bank yellowtail flounder are not available as both stock assessments are based on swept area expansions. The assessment model for Georges Bank cod was not accepted for catch advice in 2015 and is currently based on smoothed survey estimates.