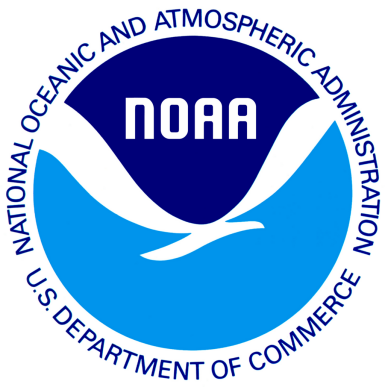

Northeast Fisheries Science Center Reference Document 15-XXXX

Stock Assessment Update of 20 Northeast Groundfish Stocks Through 2014

by Northeast Fisheries Science Center

October 2015

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NOAA, National Marine Fisheries Service,

Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

October 2015

Northeast Fisheries Science Center Reference Documents

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Table of Contents

Contents

1 Executive Summary

Update assessments were conducted for the twenty stocks in the Northeast Multispecies Fishery Management Plan in 2015 (B1). The updates replicated the methods recommended in the most recent benchmark decisions, as modified by any subsequent operational assessments or updates (B2), with the intention of simply adding years of data (B3). However, minor flexibility was allowed to address emerging issues (B4).

Stock status did not change for 15 of the 20 stocks, worsened for two stocks, improved for one stock, and became more uncertain for two stocks (B7).

The number of stocks with retrospective adjustments applied increased from the last assessment from 2 to 7 (B6). The previous Georges Bank cod assessment did apply a retrospective adjustment, however, the assessment model was not approved at the 2015 Updates so it has been excluded from these counts.

While the number of overfished stocks and stocks experiencing overfishing has generally decreased since 2007 (B1), the magnitude of overfishing or depletion for several stocks has worsened considerably (B2 and B3); Gulf of Maine cod, Southern New England/Mid-Atlantic yellowtail flounder, witch flounder and Cape Cod/Gulf of Maine yellowtail flounder). Of those Northeast groundfish stocks for which stock status can be determined, the majority remain below their biomass targets (69%; Figures B1 and B3).

Recent NEFSC survey biomass indices for both the spring and fall surveys are below the long term means. For the majority of stocks the average of the most recent five years are below the time series means (B4 and B5)

Estimates of overall (aggregate) groundfish minimum swept area biomass are at, or near, all-time highs (B6 and B7). 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, and redfish stocks currently make up more than 80% of the overall groundfish biomass (B8).

Table B1: List of stocks included in the groundfish update and the abbreviations used for each in this document.

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-AtlanticYellowtail 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
HALUNIT	Atlantic Halibut
FLDGMGB	Gulf of Maine/Georges Bank Windowpane
FLDSNEMA	Southern New England/Mid-Atlantic Windowpane
OPTUNIT	Ocean Pout
FLWGM	Gulf of Maine Winter Flounder
YELGB	Georges Bank Yellowtail Flounder

Table B2: 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. Update = Operational Update*

Stock	Lead	Forum	Type	Pub.	Term. yr.	Overfished?	Overfishing?	Rebuild status	Reference
CODGM	Michael Palmer	Op. Update	Update	2014	2013	Yes	Yes	By 2024	CRD14-14
CODGB	Loretta O'Brien	SARC 55	Benchmark	2012	2011	Yes	Yes	By 2026	CRD13-11
HADGM	Michael Palmer	SARC 59	Benchmark	2014	2013	No	No	Rebuilt	CRD14-09
HADGB	Liz Brooks	GARM2012	Update	2012	2010	No	No	Rebuilt	CRD12-06
YELCCGM	Larry Alade/Chris Legault	GARM2012	Update	2012	2010	Yes	Yes	By 2023	CRD12-06
YELSNEMA	Larry Alade	SARC 54	Benchmark	2012	2011	No	No	Rebuilt	CRD12-18
FLWGB	Lisa Hendrickson	Op. Update	Update	2015	2013	No	No	By 2017	CRD15-01
FLWSNEMA	Tony Wood/Mark Terciero	SARC 52	Benchmark	2011	2010	Yes	No	By 2023	SARC52
REDUNIT	Brian Linton/Tim Miller	GARM2012	Update	2012	2010	No	No	Rebuilt	CRD12-06
PLAUNIT	Loretta O'Brien	GARM2012	Update	2012	2010	No	No	By 2024	CRD12-06
WITUNIT	Susan Wigley	GARM2012	Update	2012	2010	Yes	Yes	By 2017	CRD12-06
HKWUNIT	Kathy Sosebee	SARC 56	Benchmark	2013	2011	No	No	By 2014	CRD13-10
POLUNIT	Brian Linton	Op. Update	Update	2015	2013	No	No	Rebuilt	CRD15-01
CATUNIT	Chuck Adams/Chad Keith	GARM2012	Update	2012	2010	Yes	No	Unknown	CRD12-06
HALUNIT	Dan Hennen/Jessica Blaylock	GARM2012	Update	2012	2010	Yes	No	By 2055	CRD12-06
FLDGMGB	Toni Chute/Lisa Hendrickson	GARM2012	Update	2012	2010	Yes	Yes	By 2017	CRD12-06
FLDSNEMA	Toni Chute/Lisa Hendrickson	GARM2012	Update	2012	2010	No	No	Rebuilt	CRD12-06
OPTUNIT	Susan Wigley	GARM2012	Update	2012	2010	Yes	No	By 2014	CRD12-06
FLWGM	Paul Nitschke	Op. Update	Update	2015	2013	Unknown	No	Unknown	CRD15-01
YELGB	Chris Legault	TRAC 2015	Update	2015	2014	Unknown	Unknown	By 2032	TRAC2015

Table B3: Data used in each assessment. The column heads are US commercial landings (US c-land), US commercial discards (US c-disc), US recreational landings (US r-land), US recreational discards (US r-disc), Canadian catch (CA catch), NEFSC spring, fall and winter surveys (NEFSC S, NEFSC F and NEFSC 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-land	US c-disc	US r-land	US r-disc	CA Catch	NEFSC S	NEFSC F	NEFSC 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	Yes
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
HALUNIT	Yes	Yes	No	No	Yes	No	Yes	No	No	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 B4: Assessment type and reference points from previous assessment. *Note: sp=stochastic projection.*

Stock	Assess.	Type	F def.	B def.	F_{MSY} type	F_{MSY} value	B_{MSY} type	B_{MSY} value	MSY type	MSY value
CODGM	ASAP	age-based	F_{Full}	SSB	$F_{40\%SPR}$	0.18	sp	47,184 (M=0.2) or 69,621 (Mramp)	sp	7,753 (M=0.2) or 11,388 (Mramp)
CODGB	ASAP	age-based	F_{Full}	SSB	$F_{40\%SPR}$	0.18	sp	186,535	sp	30,622
HADGM	ASAP	age-based	F_{Full}	SSB	$F_{40\%SPR}$	0.46	sp	4,108	sp	955
HADGB	VPA	age-based	avg F ages 5-7	SSB	$F_{40\%SPR}$	0.39	sp	124,900	sp	28,000
YELCCGOM	VPA	age-based	avg F ages 4-6	SSB	$F_{40\%SPR}$	0.26	sp	7,080	sp	1,600
YELSNEMA	ASAP	age-based	avg F ages 4-5	SSB	$F_{40\%SPR}$	0.32	sp	2,995	sp	773
FLWGB	VPA	age-based	avg F ages 4-6	SSB	Fmsy	0.44	sp	8,100	sp	3,200
FLWSNEMA	ASAP	age-based	avg F ages 4-5	SSB	Fmsy	0.29	sp	43,661	sp	11,728
REDUNIT	ASAP	age-based	F_{Full}	SSB	$F_{50\%SPR}$	0.04	sp	238,000	sp	8,891
PLAUNIT	VPA	age-based	avg F ages 6-9	SSB	$F_{40\%SPR}$	0.18	sp	18,398	sp	3,385
WITUNIT	VPA	age-based	avg F ages 8-11	SSB	$F_{40\%SPR}$	0.27	sp	10,051	sp	2,075
HKWUNIT	ASAP	age-based	F_{Full}	SSB	$F_{40\%SPR}$	0.20	sp	32,400	sp	5,630
POLUNIT	ASAP	age-based	avg F ages 5-7	SSB	$F_{40\%SPR}$	0.27	sp	76,900	sp	14,800
CATUNIT	SCALE	length-based	F_{Full}	SSB	$F_{40\%SPR}$	0.33	sp	1,756	sp	261
HALUNIT	RYM	surplus production	biomass wted F	B	F0.1	0.07	deterministic	49,000	deterministic	3,500
FLDGMGB	AIM	index	relative F (catch/survey biomass)	surv. B	replacement ratio	0.44	MSY *proxy* / $F_{MSYproxy}$	1.60	median catch 1995-2001	700
FLDSNEMA	AIM	index	relative F (catch/survey biomass)	surv. B	replacement ratio	2.09	MSY *proxy* / $F_{MSYproxy}$	0.24	median catch 1995-2001	500
OPTUNIT	index	index	relative F (catch/survey biomass)	surv. B	median relative F 1977-1985	0.76	median surv. B 1977-1985	4.94	F_{MSY} * B_{MSY}	3,754
FLWGM	empirical	survey expansion	exploitation rate (catch/30+cm biomass)	surv. B	exploitation rate ($F_{40\%}$ from YPR)	0.23	NA	NA	NA	NA
YELGB	empirical	survey expansion	NA	surv. B	NA	NA	NA	NA	NA	NA

Table B5: The biomass (B) and exploitation rate (F) values used for status determination were 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), the ρ adjusted values were used to determine stock status (Adj. = Yes). There were exceptions however, such as YELSNEMA and CODGM(M=0.2) and details regarding each decision can be found in the report and reviewer comments sections for each stock. 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.

Stock	B_{2014}	B_ρ	Conf. limits	F_{2014}	F_ρ	Conf. limits	Adj?
CODGM(M=0.2)	2,225	1,443	1,942 - 2,892	0.956	1.39	0.654 - 1.387	No
CODGM(M ramp)	2,536	2,106	1,921 - 3,298	0.932	1.01	0.662 - 1.304	No
HADGB	225,080	150,053	171,911 - 301,282	0.159	0.241	0.13 - 0.203	Yes
HADGM	10,325	10,712	7,229 - 14,453	0.257	0.25	0.164 - 0.373	No
YELSNEMA	502	243	355 - 739	1.64	3.53	1.053 - 2.348	No
YELCCGM	1,695	857	1,375 - 2,111	0.355	0.64	0.25 - 0.52	Yes
FLWSNEMA	6,151	5,105	5,045 - 7,500	0.16	0.21	0.12 - 0.213	No
FLWGB	5,275	2,883	3,783 - 6,767	0.379	0.778	0.254 - 0.504	Yes
PLAUNIT	14,543	10,915	12,742 - 16,439	0.08	0.118	0.069 - 0.093	Yes
WITUNIT	3,129	2,077	2,643 - 3,864	0.428	0.687	0.321 - 0.603	Yes
HWKUNIT	28,553	24,197	24,351 - 33,480	0.076	0.086	0.063 - 0.092	No
POLUNIT	198,847	154,919	37,243 - 255,097	0.051	0.07	0.084 - 0.066	Yes
REDUNIT	414,544	330,004	368,906 - 465,828	0.012	0.015	0.011 - 0.014	Yes

Table B6: Comparison of biomass (B) and fishing mortality (F) rate Mohn's rho values (ρ) by stock between the previous assessment and the 2015 updates. The biomass and fishing mortality rate point estimates and ρ adjusted values (Adj.) are provided for the 2015 update assessments. The total number of stocks using ρ adjusted values in the last assessment and the 2015 assessments (ρ adj. vs. pt. est. for those stocks that did not use the ρ adjustment), along with the type of ρ adjustment used in the 2015 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. *Note: Because the Georges Bank cod assessment was rejected at the 2015 OA Update it has been excluded from this table.*

		Biomass				**Fishing Mortality Rate**				**Used**		
Stock	Model	ρ_{last}	ρ_{2015}	B_{2015}	Adj.	ρ_{last}	ρ_{2015}	F_{2015}	Adj.	Last assess.	2015	Proj. adj.
CODGM	ASAP(M=0.2)	0.53	0.54	2225	1445	-0.33	-0.31	0.956	1.386	pt. est.	pt. est.	none
CODGM	ASAP(M-ramp)	0.17	0.2	2536	2113	-0.05	-0.08	0.932	1.013	pt. est.	pt. est.	none
HADGM	ASAP	-0.15	-0.04	10325	10755	0.3	0.03	0.257	0.25	pt. est.	pt. est.	none
HADGB	VPA	0.2	0.5	225080	150053	-0.15	-0.34	0.159	0.241	pt. est.	ρ adj.	SSB
YELCCGM	VPA	0.68	0.98	1695	857	-0.19	-0.45	0.35	0.64	ρ adj.	ρ adj.	NAA
YELSNEMA	ASAP	0.14	1.06	502	243	-0.16	-0.53	1.64	3.53	pt. est.	pt. est.	none
FLWGB	VPA	0.26	0.83	5275	2883	-0.16	-0.51	0.379	0.778	pt. est.	ρ adj.	SSB
FLWSNEMA	ASAP	0.35	0.21	6151	5105	-0.31	-0.25	0.16	0.214	pt. est.	pt. est.	none
REDUNIT	ASAP	0.04	0.26	414544	330004	-0.04	-0.19	0.012	0.015	pt. est.	ρ adj.	NAA
PLAUNIT	VPA	0.62	0.32	14439	10915	-0.35	-0.32	0.08	0.12	ρ adj.	ρ adj.	NAA
WITUNIT	VPA	0.61	0.51	3129	2077	-0.33	-0.38	0.428	0.687	pt. est.	ρ adj.	SSB
HKWUNIT	ASAP	0.15	0.18	28553	24197	-0.13	-0.12	0.076	0.086	pt. est.	pt. est.	none
POLUNIT	ASAP	0.29	0.28	198847	154865	-0.25	-0.28	0.051	0.07	pt. est.	ρ adj.	NAA
CATUNIT	SCALE	0.96	0.83	592	324	-0.55	-0.36	0.003	0.005	pt. est.	pt. est.	none

Table B7: Synopsis of status by stock.

Stock	Last Assessment	Status Change?	Overfishing?	Overfished?
CODGM	2014	Same	Yes	Yes
CODGB	2012	More uncertain	Unknown	Yes
HADGM	2012	Same	No	No
HADGB	2014	Same	No	No
YELCCGM	2012	Same	Yes	Yes
YELSNEMA	2012	Worse	Yes	Yes
FLWGB	2014	Worse	Yes	Yes
FLWSNEMA	2011	Same	No	Yes
REDUNIT	2012	Same	No	No
PLAUNIT	2012	Same	No	No
WITUNIT	2012	Same	Yes	Yes
HKWUNIT	2013	Same	No	No
POLUNIT	2014	Same	No	No
CATUNIT	2012	Same	No	Yes
HALUNIT	2012	More uncertain	Unknown	Yes
FLDGMGB	2012	Better	No	Yes
FLDSNEMA	2012	Same	No	No
OPTUNIT	2012	Same	No	Yes
FLWGM	2014	Same	No	Unknown
YELGB	2014	Same	Unknown	Unknown

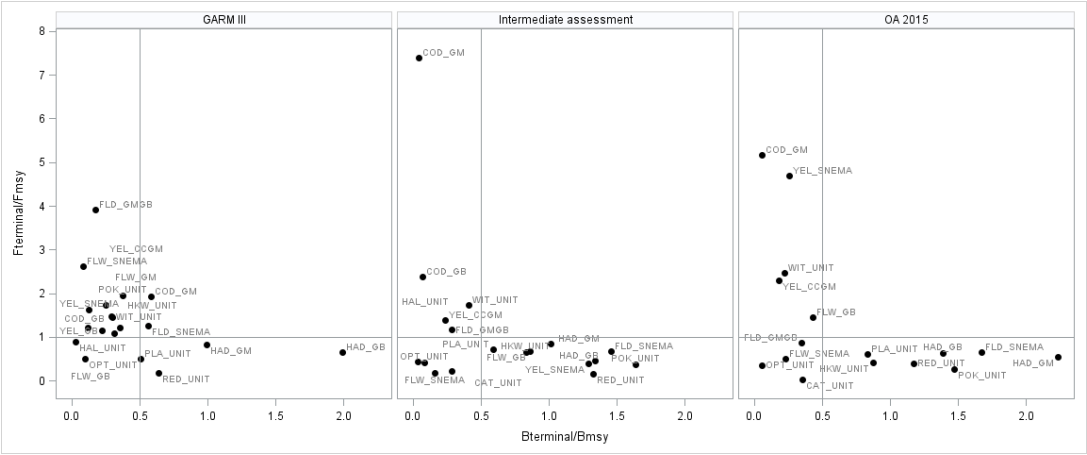

Figure B1: Status of the Northeast Multispecies Fishery Management Plan (groundfish) stocks in 2007 (GARM III) and 2014 (OA 2015) with respect to the F_{MSY} and B_{MSY} proxies. The 'Intermediate assessment' represents the last stock assessment conducted prior to the OA 2015 assessment (year varies 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. *Notes: (1) the GARM III assessments did not include wolfish; (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 Atlantic halibut, Gulf of Maine winter flounder and Georges Bank yellowtail flounder. In the OA 2015 assessment, the stock status for Georges Bank cod remained overfished and overfishing is occurring; however, since the assessment was rejected, ratios of terminal conditions to reference points cannot be determined. Species codes: COD-Atlantic cod, HAD-haddock, POL-pollock, RED-redfish, WHK-white hake, OPT-ocean pout, CAT-wolffish, PLA-American plaice, FLW-winter flounder, YEL-yellowtail flounder, WIT-witch flounder, FLD-windowpane flounder, HAL-Atlantic halibut.*

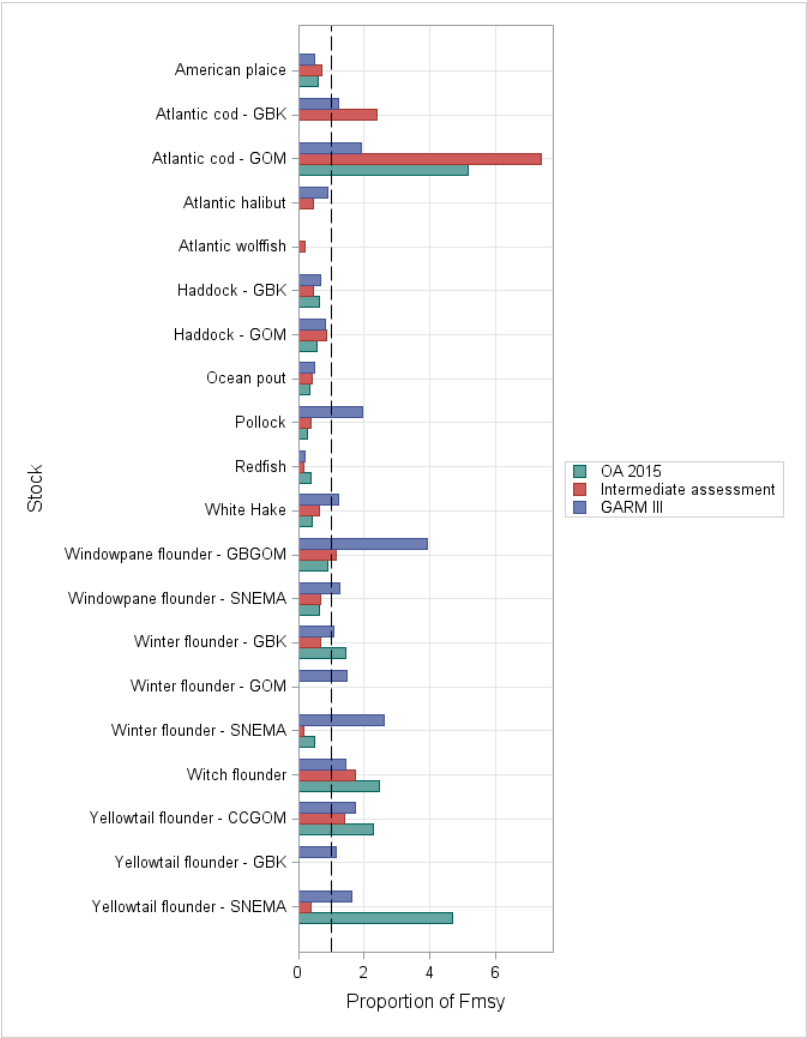

Figure B2: Changes in the ratio of fishing mortality to FMSY proxy from 2007 (GARM III) to 2014 (OA 2015) for the twenty Northeast Multispecies Fishery Management Plan (groundfish) stocks. The results from the assessment prior to the OA 2015 assessment are shown for each stock to provide an 'Intermediate' value. 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 wolfish; (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 Atlantic halibut, Gulf of Maine winter flounder and Georges Bank yellowtail flounder. In the OA 2015 assessment, the stock status for Georges Bank cod remained overfished and overfishing is occurring; however, since the assessment was rejected, ratios of terminal conditions to reference points cannot be determined.*

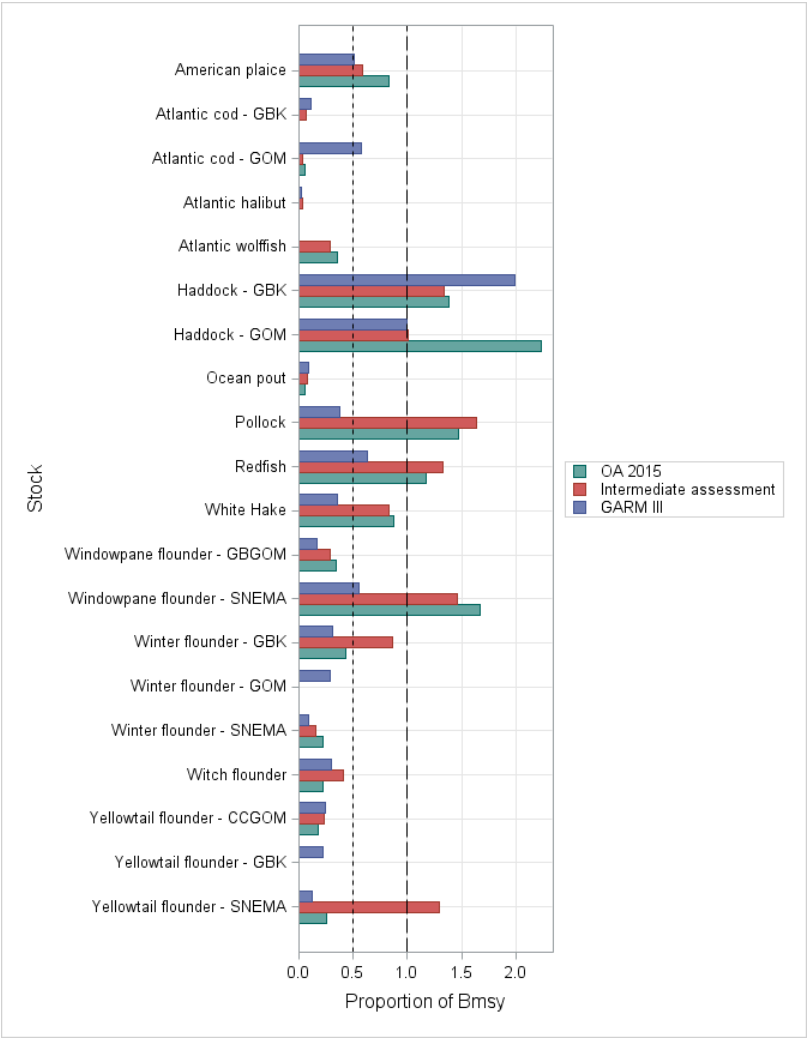

Figure B3: Changes in the ratio of stock biomass to BMSY proxy from 2007 (GARM III) to 2014 (OA 2015) for the twenty Northeast Multispecies Fishery Management Plan (groundfish) stocks. The results from the assessment prior to the OA 2015 assessment are shown for each stock to provide an 'Intermediate' value. 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 wolfish; (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 Atlantic halibut, Gulf of Maine winter flounder and Georges Bank yellowtail flounder. In the OA 2015 assessment, the stock status for Georges Bank cod remained overfished and overfishing is occurring; however, since the assessment was rejected, ratios of terminal conditions to reference points cannot be determined.*

Figure B4: NEFSC spring bottom trawl survey index standardized anomalies (Z-score) for the Northeast Multispecies Fishery Management Plan (groundfish) stocks from 1968 to 2015. *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 B5: NEFSC fall bottom trawl survey index standardized anomalies (Z-score) for the Northeast Multispecies Fishery Management Plan (groundfish) stocks from 1963 to 2014. *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.*

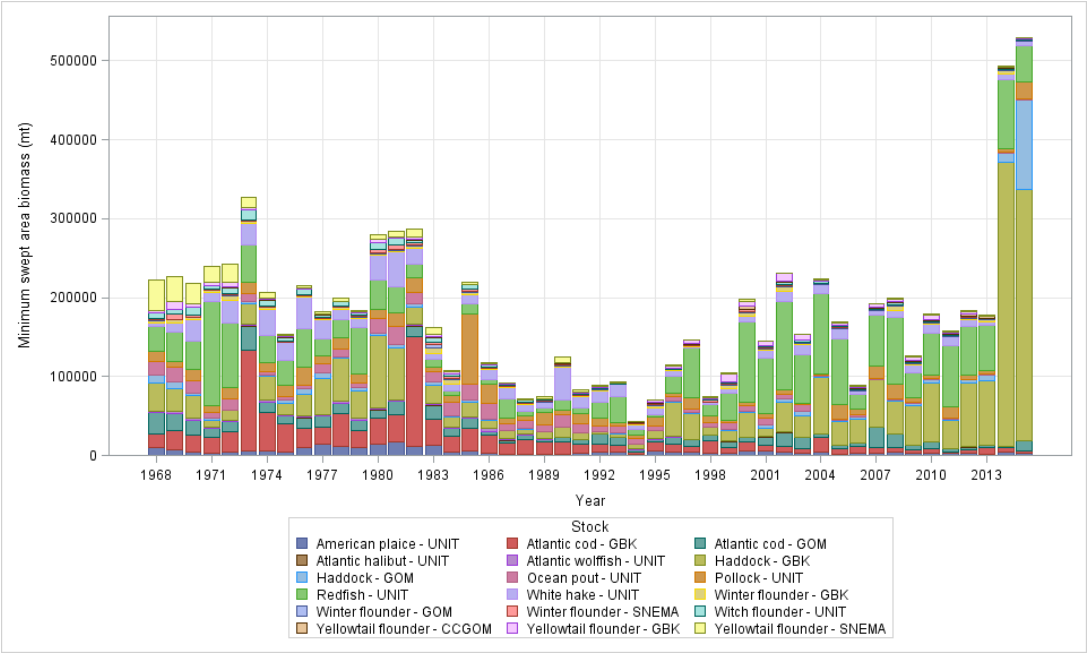

Figure B6: NEFSC spring bottom trawl survey minimum swept area biomass (mt) for the Northeast Multispecies Fishery Management Plan (groundfish) stocks from 1968 to 2015, by stock. Minimum swept area estimates assume a trawl swept area of 0.0112 nm^2) (0.0384 km^2) based on the wing spread of the trawl 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.*

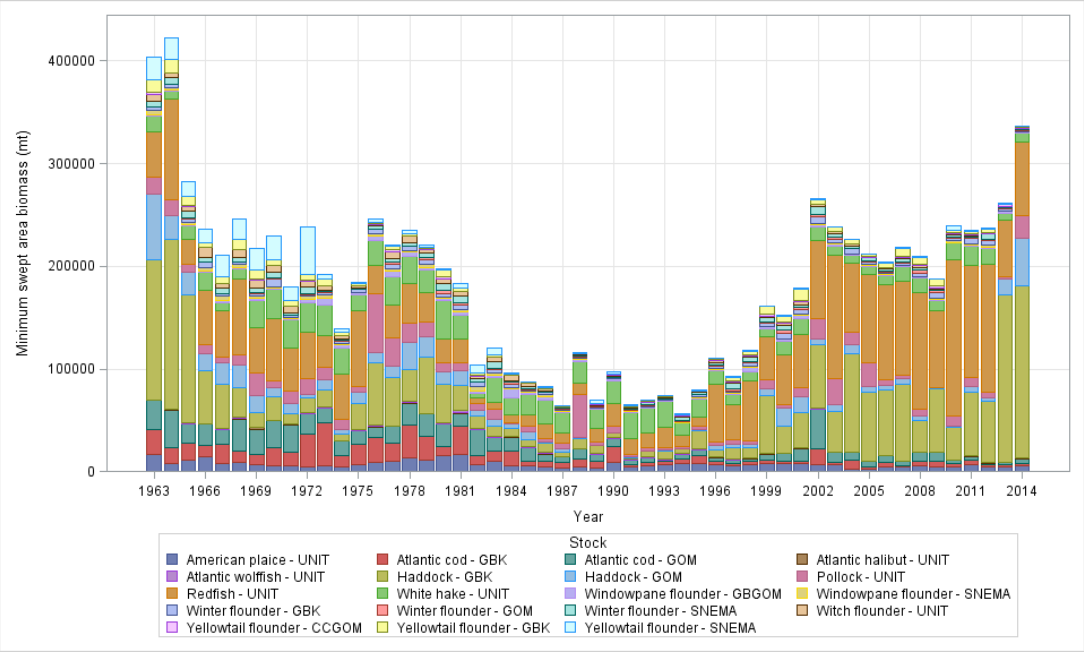

Figure B7: NEFSC fall bottom trawl survey minimum swept area biomass (mt) for for the Northeast Multispecies Fishery Management Plan (groundfish) stocks from 1963 to 2014, by stock. Minimum swept area estimates assume a trawl swept area of 0.0112 nm^2 (0.0384 km^2) based on the wing spread of the trawl 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.*

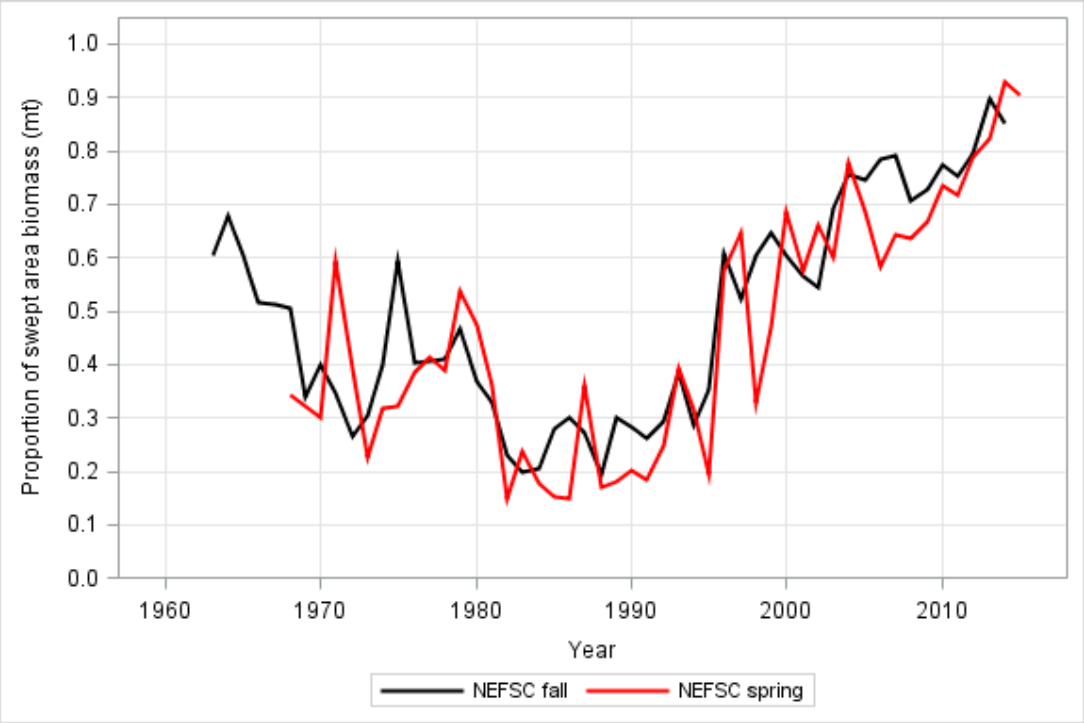

Figure B8: Proportion of the total groundfish swept minimum swept area biomass contributed by Georges Bank and Gulf of Maine haddock and Redfish based on the NEFSC spring and fall bottom trawl surveys.

2 Atlantic halibut

Daniel Hennen

This assessment of the Atlantic halibut (Hippoglossus hippoglossus) stock is an update of the existing 2012 benchmark assessment (NEFSC 2010) and the last update assessment (NEFSC 2012). This assessment updates commercial fishery catch data, research survey indices of abundance, and the replacement yield assessment model through 2014. Additionally, stock projections have been updated through 2018. Reference points have not been updated.

State of Stock: Based on this updated assessment, Atlantic halibut (*Hippoglossus hippoglossus*) stock is unknown and unknown (Figures B9-B10). Retrospective adjustments were not made to the model results. Biomass (SSB) in 2014 was estimated to be 96,464 (mt) which is 199% of the biomass target (SSB_{MSY} *proxy* = 48,509; Figure B9). The 2014 fully selected fishing mortality was estimated to be 0.001 which is 1% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.073; Figure B10).

Table B8: Catch and status table for Atlantic halibut. All weights are in (mt) and F_{Full} is the fishing mortality on fully selected ages.

	2007	2008	2009	2010	2011	2012	2013	2014
				Data				
Commercial landings	25	29	45	20	26	35	35	45
Commercial discards	30	34	54	24	31	42	42	54
CA landings	40	32	22	23	29	32	38	33
Catch for Assessment	95	96	121	67	86	109	115	132
				Model Results				
Biomass	96,641	96,607	96,578	96,527	96,538	96,528	96,497	96,464
F_{Full}	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Table B9: An F_{MSY} *proxy* ($F_{0.1}$) was used for the overfishing threshold. The biomass target and threshold were based on the B_{MSY} *proxy* (estimated carrying capacity), B_{Target}= B_{MSY} *proxy* and $B_{Threshold}$= $\frac{1}{2}$ B_{MSY} *proxy*.

	2012	Current
F_{MSY} *proxy*	0.073	0.073
SSB_{MSY} (mt)	48,509	48,509
MSY (mt)	3,546	3,546
Overfishing	No	Unknown
Overfished	Yes	Unknown

Projections: Short term projections were based on a constant F = F_{MSY} *proxy* = 0.073. Projections use the assessment model (replacement yield) and maintain all other model assumptions.

Table B10: Short term projections of catch and biomass for Atlantic halibut based on a harvest scenario of fishing at F_{MSY} *proxy*=0.073 between 2016 and 2018.

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	124	96147	0.001
2016	7025	96156	0.073
2017	6521	89262	0.073
2018	6121	83788	0.073

Special Comments:

- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results (such as estimates of biomass, F, recruitment, and population projections).

  The assessment model used for Atlantic halibut is highly uncertain. It estimates one parameter, the initial biomass, and proceeds deterministically from 1800 to 2014. The model is highly sensitive to the initial biomass. The model is tuned to the survey index, which is inefficient for Atlantic halibut, catches very few animals and is therefore noisy. The RYM model assumes no immigration or emmigration and that the population both began, and tends to, equilibrium. These assumptions are unlikely to be true for Atlantic halibut. The model estimates a biomass that is approximately equal to unfished biomass, which is not credible. Catch has been very low for at least 100 years relative to the landings reported early in the time series, despite a strong market and high value relative to other groundfish. The low catch throughout the century implies that the Atlantic halibut stock is very likely depleted relative to it's unfished condition and is therefore likely to be overfished, even if its current biomass is unknown.

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted SSB or F_{Full} lies outside of the approximate joint confidence region for SSB and F_{Full}; see Figure B5).

  The model used to determine the status of this stock does not allow estimation of a retrospective pattern.

- Based on this stock assessment, are population projections well determined or uncertain?

  Population projections for Atlantic halibut are uncertain because biomass cannot be reasonably determined using the current assessment model.

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the affect these changes had on the assessment and stock status.

  The catch data were slightly altered due to the exclusion of catch made in international waters and the re-estiamtion of average discard ratio after 1998 (due to the incorporation of more years of data).

- If the stock status has changed a lot since the previous assessment, explain why this occurred.

  The overfishing and overfished status of Atlantic halibut cannot be determined using the current assessment. This occurred because diagnostics showed the model was unreliable.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.

  The Atlantic halibut assessment could be improved with additional studies on stock structure, additional age and length data, a more precise and accurrate survey, and an investigation of alternate assessment models.

- Are there other important issues?

  Atlantic halibut are clearly depleted relative to their unfished state. Catches have been far below historical landings for more than 100 years, despite a lack of regulation before 1999 and a strong commercial market. The current assessment model implies that Atlantic halibut is near or above its unfished biomass and could support removals commensurate with MSY. The current assessment should probably not be used to inform management decisions.

2.1 Reviewer Comments: Atlantic halibut

The halibut assessment was truly awful
Reviewer 1

The halibut assessment should be used as toilet paper because it has no other purpose I can find.
Reviewer 2

At least the GOM Cod assessment was pretty good.
Reviewer 3

References:

Northeast Fisheries Science Center. 2012. Assessment or Data Updates of 13 Northeast Groundfish Stocks through 2010. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 12-06; 789 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://nefsc.noaa.gov/publications/

Col, L.A., Legault, C.M. 2009. The 2008 Assessment of Atlantic halibut in the Gulf of Maine Georges Bank region. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 09-08; 39 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/

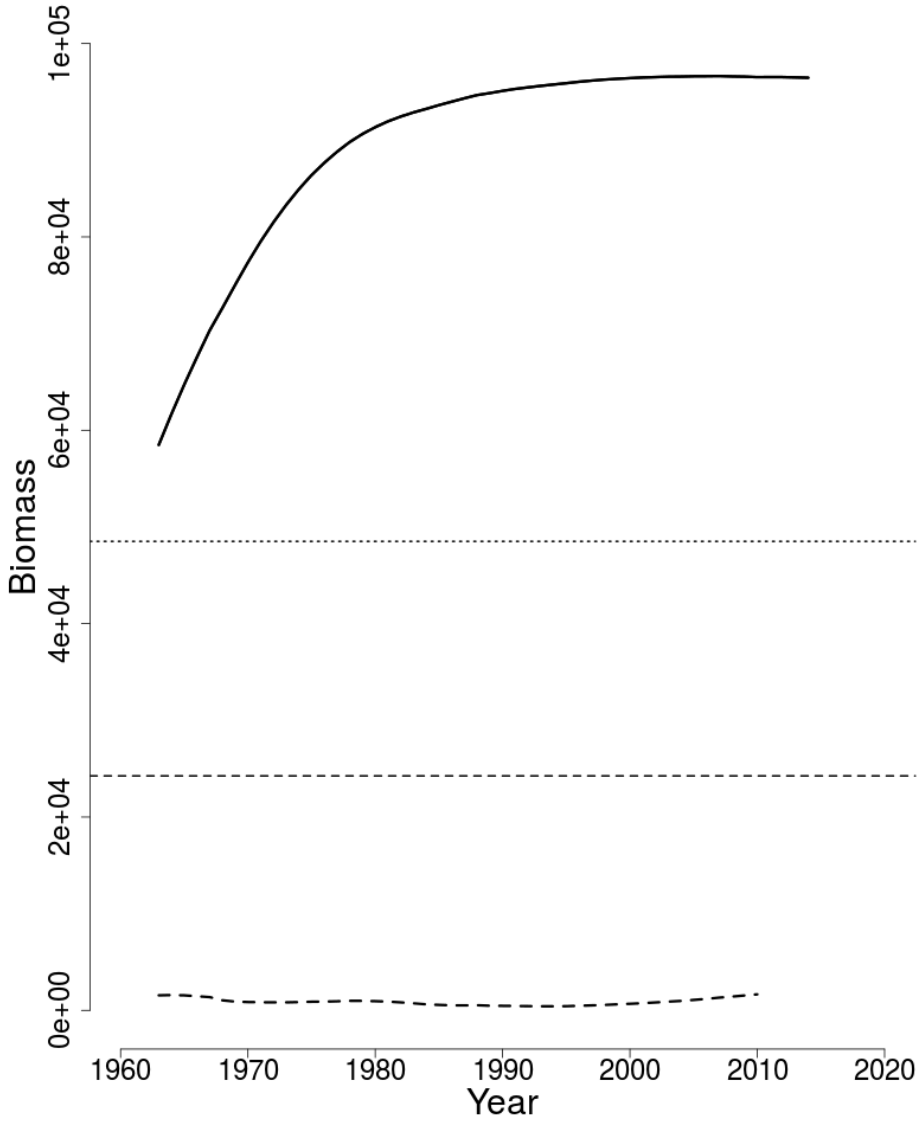

Figure B9: Estimated trends in the biomass of Atlantic halibut between 1963 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $B_{Threshold}$= $\frac{1}{2}$ B_{MSY} *proxy*(horizontal dashed line) as well as B_{Target} (B_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment.

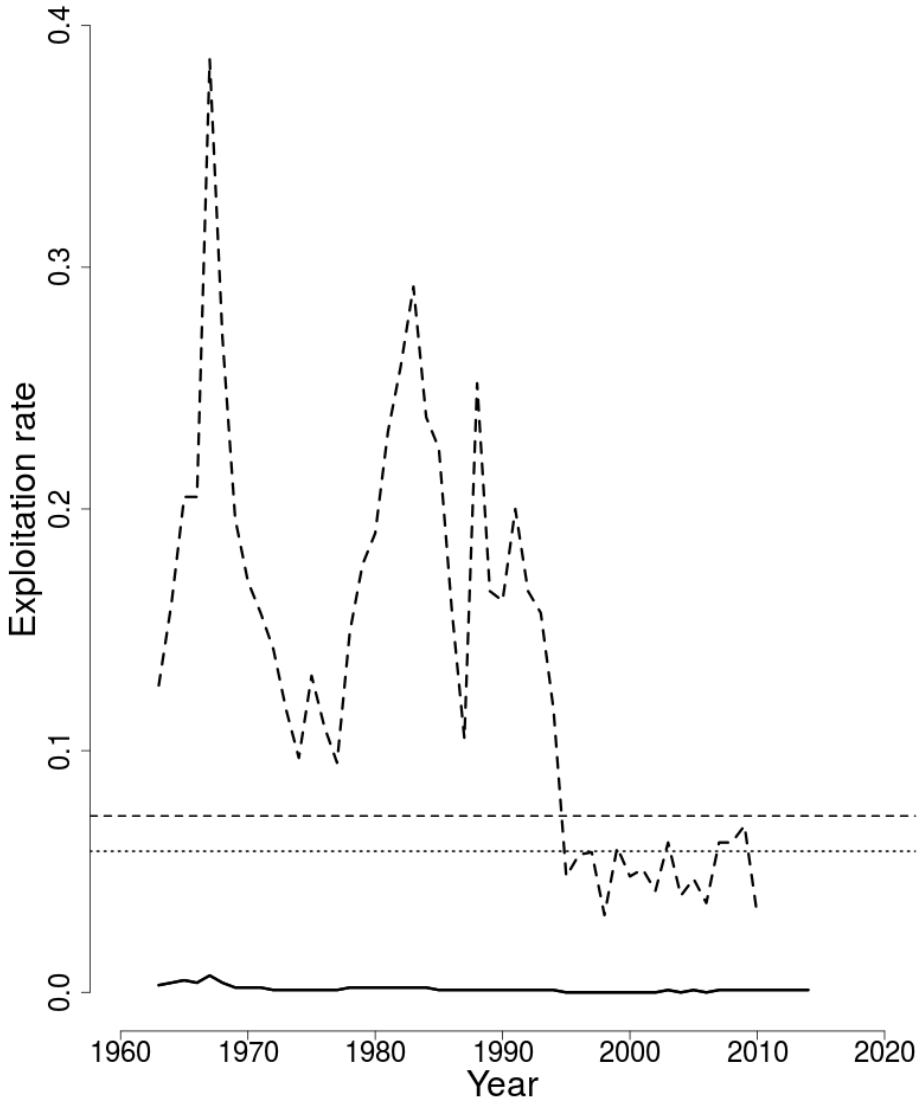

Figure B10: Estimated trends in the fully selected fishing mortality (F_{Full}) of Atlantic halibut between 1963 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (0.073; horizontal dashed line) as well as F_{Target} (0.8 * F_{MSY} *proxy*; dotted line) based on the 2015 assessment.

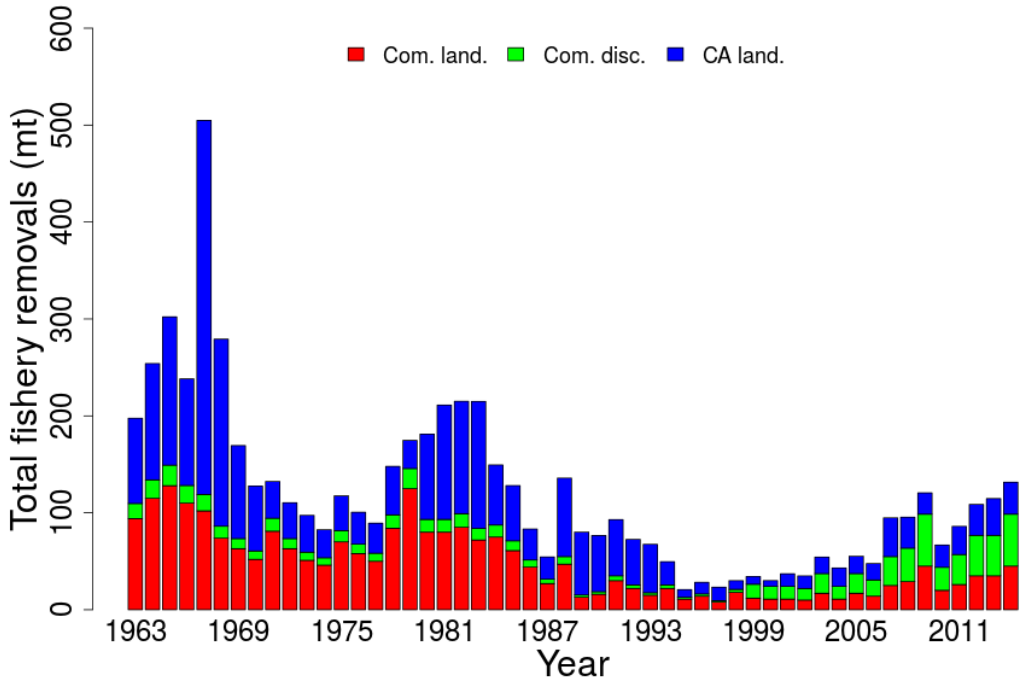

Figure B11: Total catch of Atlantic halibut between 1963 and 2014 by disposition (landings and discards).

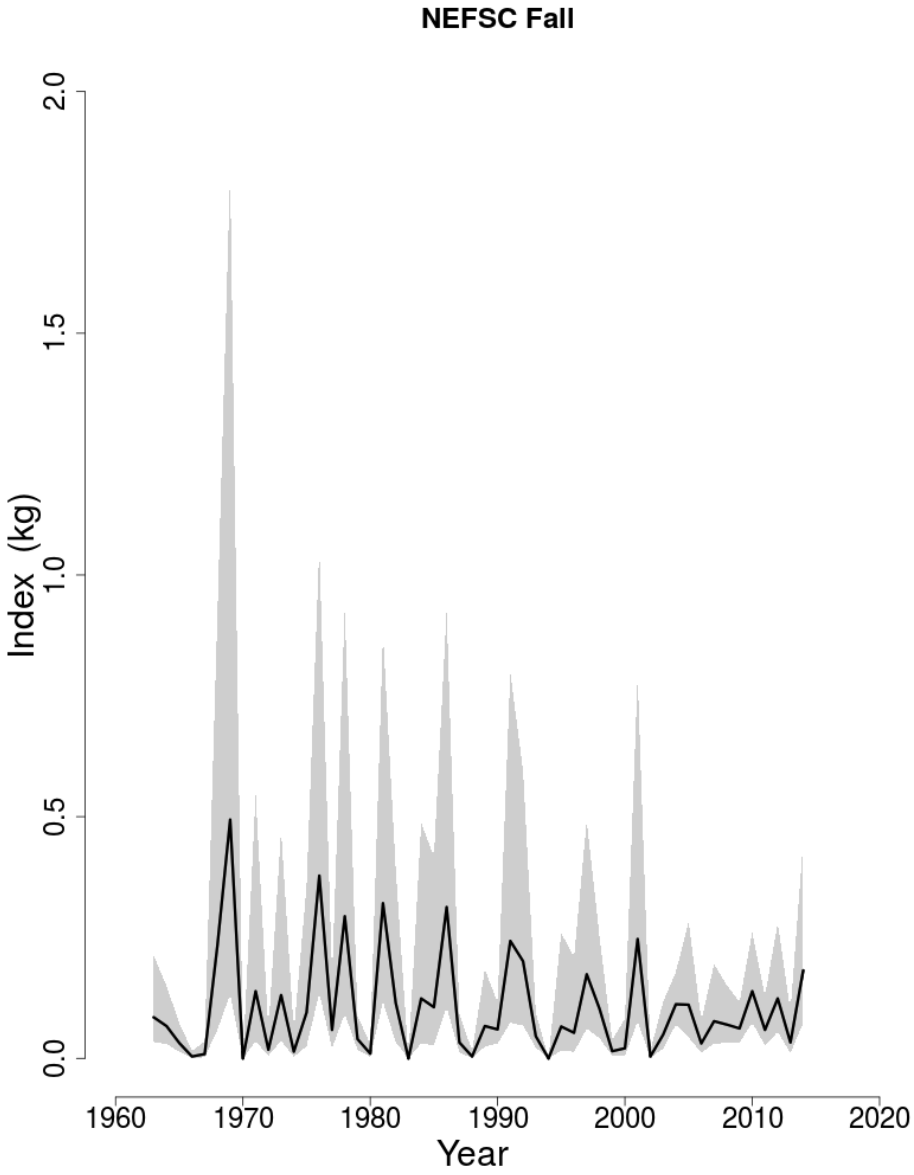

Figure B12: Indices of biomass for the Atlantic halibut between 1963 and 2014 for the Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey. The 90% lognormal confidence intervals are shown.