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
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National Marine Fisheries Service
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Northeast Fisheries Science Center Reference Documents

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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* / $F_{MSY proxy}$	1.60	median catch 1995-2001	700
FLDSNEMA	AIM	index	relative F (catch/survey biomass)	surv. B	replacement ratio	2.09	MSY *proxy* / $F_{MSY proxy}$	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
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

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

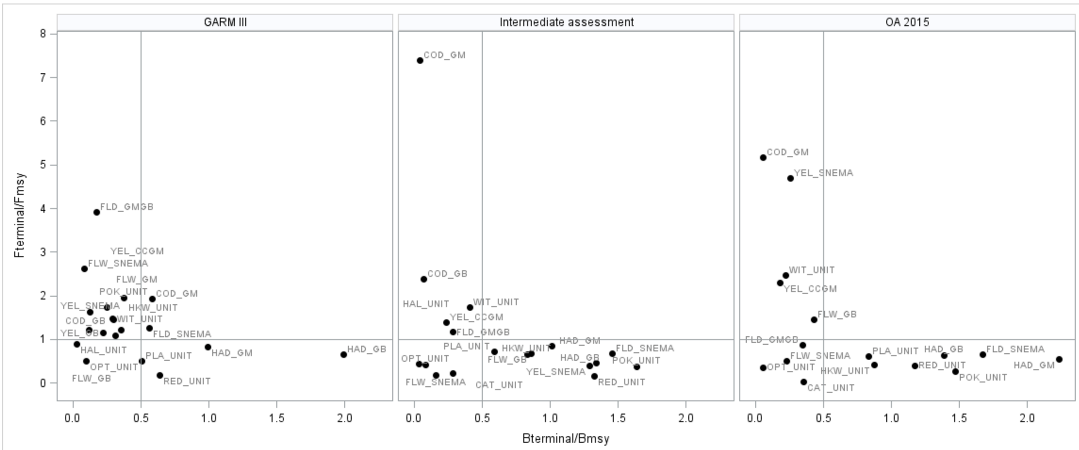

Figure B1: Status of the Northeast Multispecies Fishery Management Plan (groundfish) stocks in 2007 (GARM III) and 2014 (OA 2015) with respect to the F_{MSY} and B_{MSY} proxies. The 'Intermediate assessment' represents the last stock assessment conducted prior to the OA 2015 assessment (year varies by stock). Stocks on which overfishing is occurring are those where the $\frac{F_{terminal}}{F_{MSY proxy}}$ ratio is greater than 1 and overfished stocks are those where the $\frac{B_{terminal}}{B_{MSY proxy}}$ 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.*

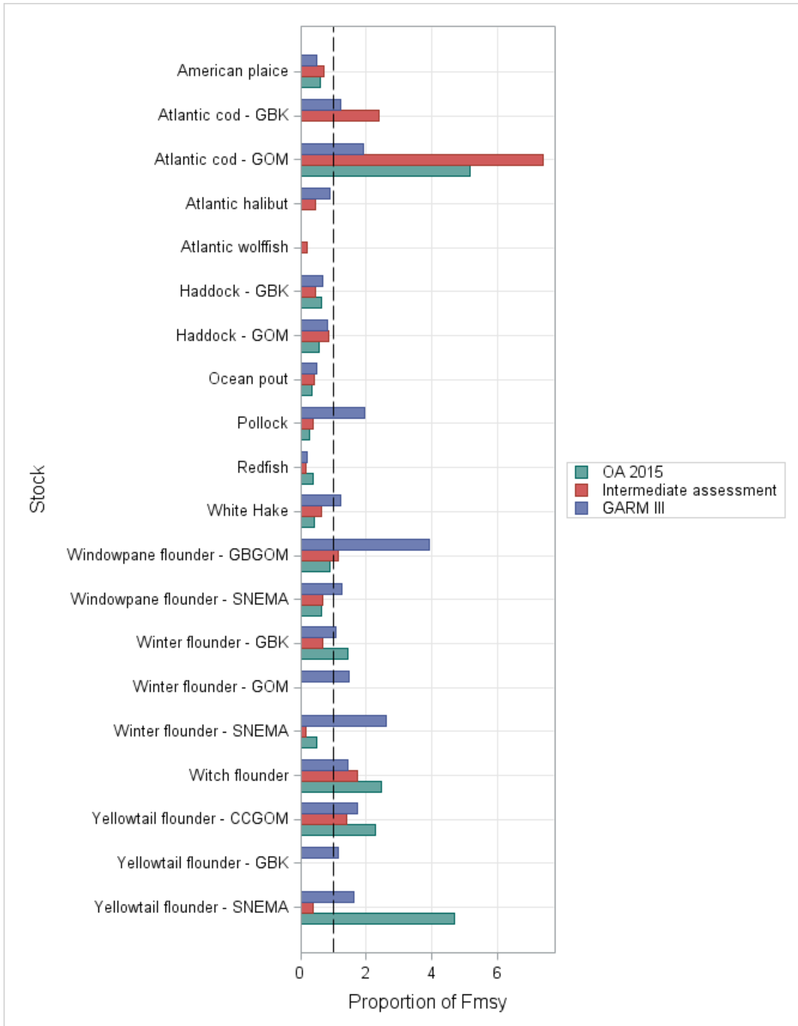

Figure B2: Changes in the ratio of fishing mortality to FMSY proxy from 2007 (GARM III) to 2014 (OA 2015) for the twenty Northeast Multispecies Fishery Management Plan (groundfish) stocks. The results from the assessment prior to the OA 2015 assessment are shown for each stock to provide an 'Intermediate' value. Stocks on which overfishing is occurring are those where the $\frac{F_{terminal}}{F_{MSY proxy}}$ 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.*

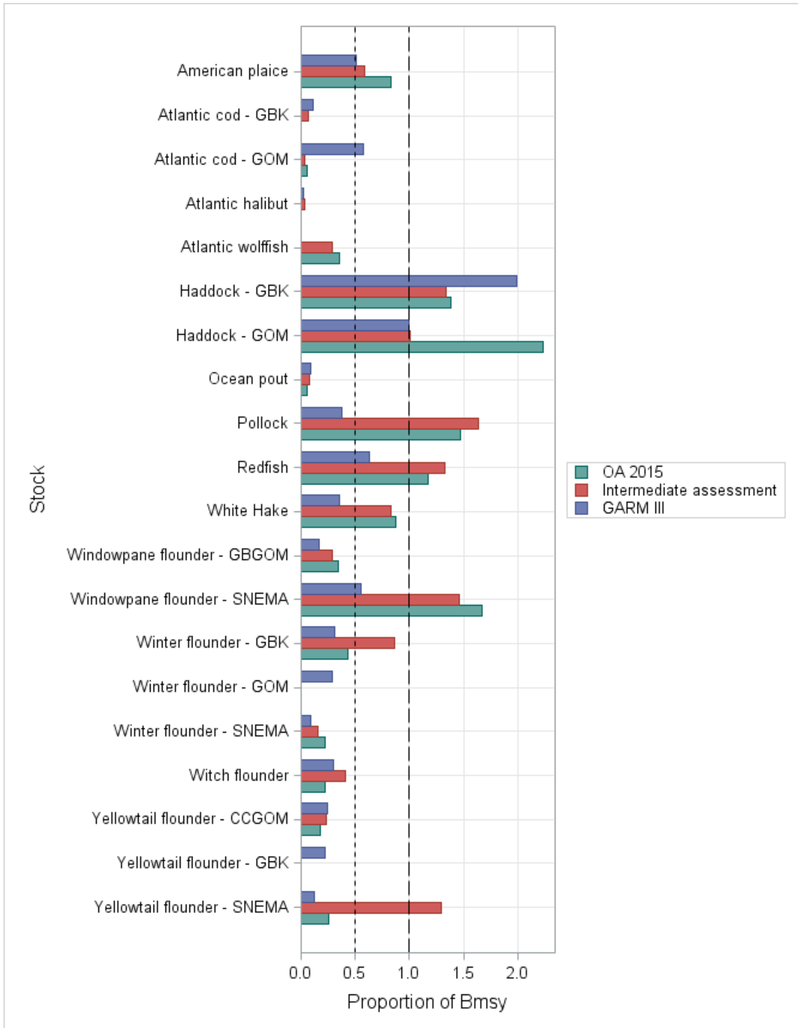

Figure B3: Changes in the ratio of stock biomass to BMSY proxy from 2007 (GARM III) to 2014 (OA 2015) for the twenty Northeast Multispecies Fishery Management Plan (groundfish) stocks. The results from the assessment prior to the OA 2015 assessment are shown for each stock to provide an 'Intermediate' value. Stocks that are overfished stocks are those where the $\frac{B_{terminal}}{B_{MSY proxy}}$ 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.*

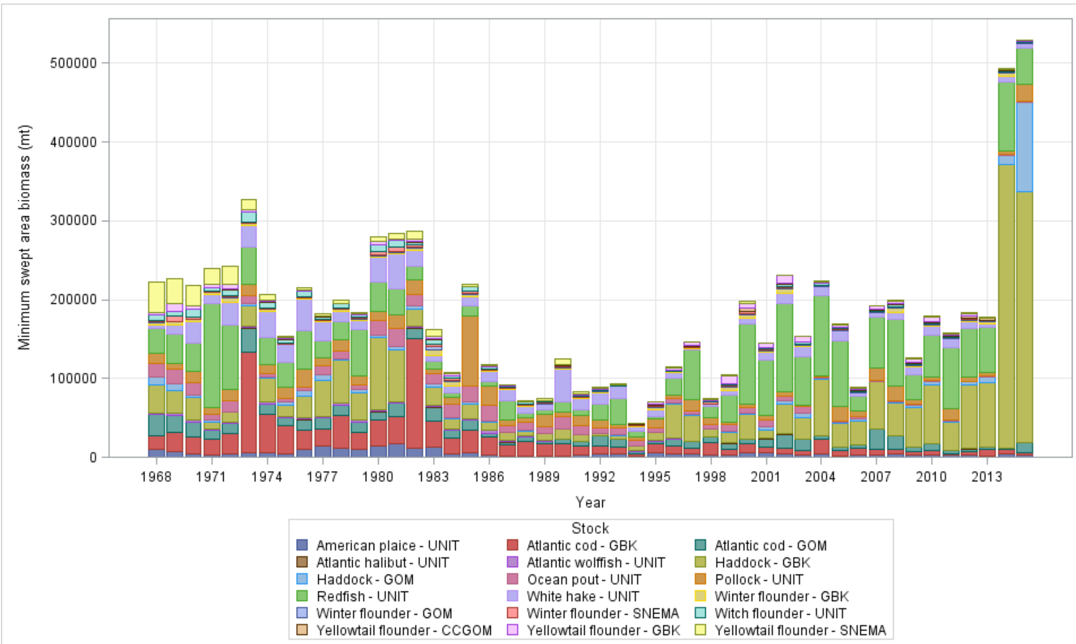

Figure B6: NEFSC spring bottom trawl survey minimum swept area biomass (mt) for the Northeast Multispecies Fishery Management Plan (groundfish) stocks from 1968 to 2015, by stock. Minimum swept area estimates assume a trawl swept area of 0.0112 nm^2) (0.0384 km^2) based on the wing spread of the trawl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

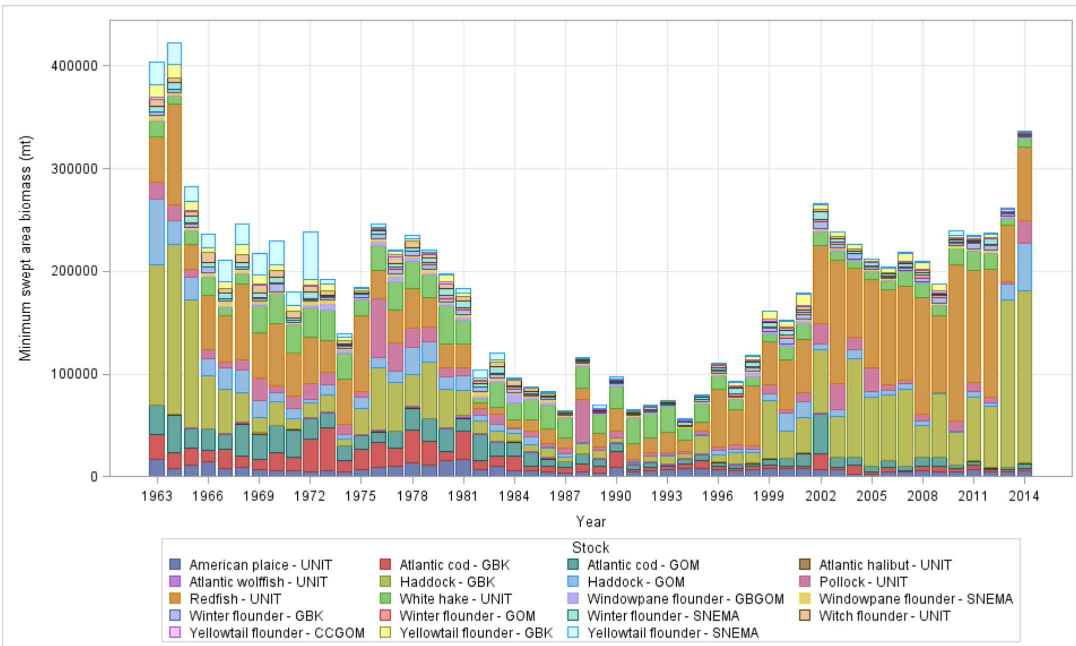

Figure B7: NEFSC fall bottom trawl survey minimum swept area biomass (mt) for for the Northeast Multispecies Fishery Management Plan (groundfish) stocks from 1963 to 2014, by stock. Minimum swept area estimates assume a trawl swept area of 0.0112 nm^2 (0.0384 km^2) based on the wing spread of the trawl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

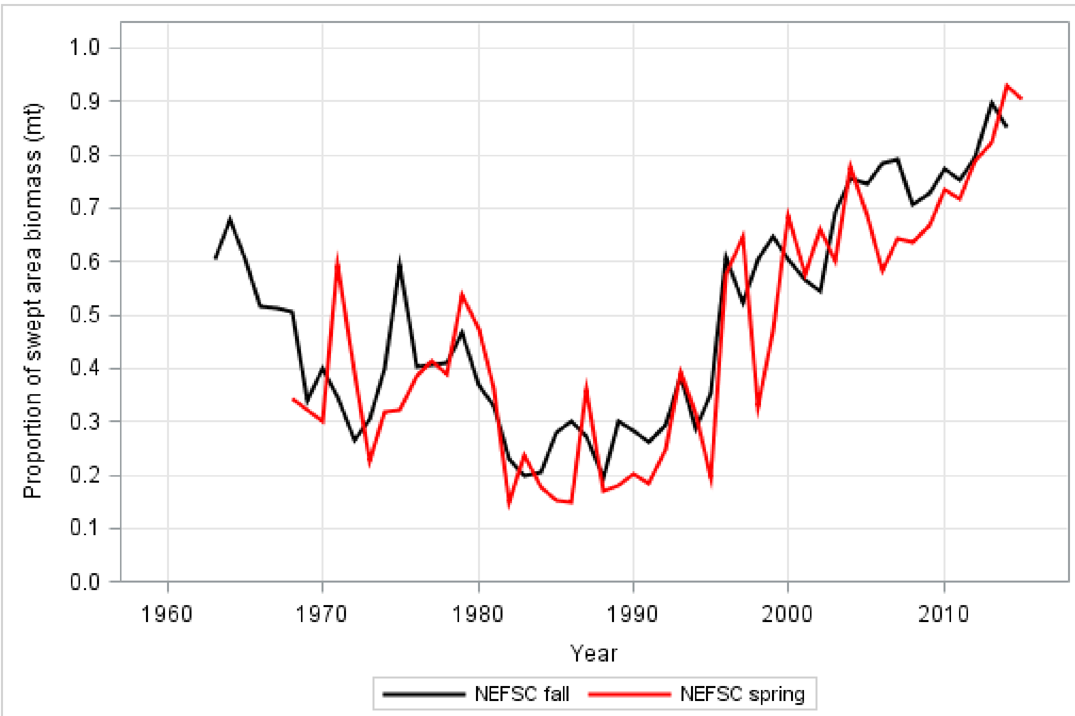

Figure B8: Proportion of the total groundfish swept minimum swept area biomass contributed by Georges Bank and Gulf of Maine haddock and Redfish based on the NEFSC spring and fall bottom trawl surveys.

2 Acadian redfish

Brian Linton

This assessment of the Acadian redfish (Sebastes fasciatus) stock is an update of the existing 2012 operational assessment (NEFSC 2012). This assessment updates commercial fishery catch data, research survey indices of abundance, the ASAP analytical model, and biological reference points through 2014. Additionally, stock projections have been updated through 2018. The most recent benchmark assessment of the Acadian redfish stock was in 2008 as part of the 3rd Groundfish Assessment Review Meeting (GARM III; NEFSC 2008), which includes a full description of the model formulations.

State of Stock: Based on this updated assessment, the Acadian redfish (*Sebastes fasciatus*) stock is not overfished and overfishing is not occurring (Figures B9-B10). Retrospective adjustments were made to the model results. Retrospective adjusted spawning stock biomass (SSB) in 2014 was estimated to be 330,004 (mt) which is 117% of the biomass target (SSB_{MSY} *proxy* of SSB at $F_{50\%}$ = 281,112; Figure B9). The retrospective adjusted 2014 fully selected fishing mortality (F) was estimated to be 0.015 which is 39% of the overfishing threshold (F_{MSY} *proxy* of $F_{50\%}$ = 0.038; Figure B10).

Table B8: Catch and status table for Acadian redfish. All weights are in (mt), and F_{Full} is the fishing mortality on fully selected ages. Unadjusted SSB and F estimates are reported. Model results are from the current updated ASAP assessment.

	2007	2008	2009	2010	2011	2012	2013	2014
Data								
Commercial landings	787	1,193	1,461	1,646	2,011	3,844	3,550	4,573
Commercial discards	373	180	206	206	212	302	424	513
Catch for Assessment	1,160	1,373	1,667	1,852	2,223	4,146	3,974	5,086
Model Results								
Spawning Stock Biomass	205,903	228,151	252,149	278,878	309,190	342,567	377,993	414,544
F_{Full}	0.006	0.006	0.007	0.007	0.008	0.012	0.011	0.012
Recruits $age1$	177,255	274,310	142,068	46,308	63,366	72,633	126,756	108,697

Table B9: Comparison of biological reference points for Acadian redfish estimated in the 2012 assessment and from the current assessment update. An F_{MSY} *proxy* of $F_{50\%}$ was used for the overfishing threshold, and was based on long-term stochastic projections. Recruits represent the median of the predicted recruits from 1969 to the final assessment year. Intervals shown are 5th and 95th percentiles.

	2012	Current
F_{MSY} *proxy*	0.038	0.038
SSB_{MSY} (mt)	238,480	281,112 (201,740 - 376,533)
MSY (mt)	8,891	10,466 (7,458 - 14,081)
Median recruits (age 1) (000s)	22,477	31,391
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of median total fishery yield and spawning stock biomass for Acadian redfish were conducted based on a harvest scenario of fishing at the F_{MSY} *proxy* between 2016 and 2018. Catch in 2015 has been estimated at 5,204 (mt). Recruitments were sampled from a cumulative distribution function derived from ASAP estimated age 1 recruitment between 1969 and 2014. The annual fishery selectivity, natural mortality, maturity ogive, and mean weights used in projections are the same as those used in the assessment model. Retrospective adjusted SSB and fully selected F in 2014 fell outside the 90% confidence intervals of the unadjusted 2014 values. Therefore, retrospective adjustments were applied in the projections.

Table B10: Retrospective adjusted short term projections of median total fishery yield and spawning stock biomass for Acadian redfish based on a harvest scenario of fishing at an F_{MSY} *proxy* of $F_{50\%}$ between 2016 and 2018. Catch in 2015 has been estimated at 5,204 (mt). F_{Full} is the fully selected F.

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	5,204	343,190	0.015
2016	13,723	367,307	0.038
2017	14,541	382,319	0.038
2018	15,007	393,124	0.038

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 largest source of uncertainty in the Acadian redfish assessment is the lack of age data, particularly from the commercial fishery. Age measurements from landings halted after 1985, due to relatively low landings. Current landings have increased to levels seen in the mid-1980s. If landings continue to increase, then age data from the fishery will become increasingly important. Dimorphic growth is another source of uncertainty in this assessment, with females growing faster than males. The use of female weights at age in the stock projections may lead to overestimation of stock productivity, as well as having an unknown effect on biological reference points.

- 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 7-year Mohn's ρ, relative to SSB, was 0.036 in the 2012 assessment and was 0.256 in 2014. The 7-year Mohn's ρ, relative to F, was -0.035 in the 2012 assessment and was -0.190 in 2014. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2014 SSB (SSB_ρ=330,004) and 2014 F (F_ρ=0.015) were outside the approximate 90% confidence regions around SSB (368,906 - 465,828) and F (0.011 - 0.014). A retrospective adjustment was made for both the determination of stock status and for projections of catch in 2016. The retrospective adjustment changed the 2014 SSB from 414,544 to 330,004 and the 2014 F_{Full} from 0.012 to 0.015.

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

  Population projections for Acadian redfish appear to be reasonably well determined.

- 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.

  Only one major change was made to the Acadian redfish assessment as part of this update. Likelihood constants were excluded from likelihood calculations to avoid potential bias caused by one of the recruitment likelihood constants, which is the sum of the log-scale predicted recruitments, and therefore not a constant. Inclusion of this likelihood constant allows the assessment model to minimize the negative log likelihood by estimating lower recruitments. Exclusion of the likelihood constants led to slightly higher estimates of SSB in recent years.

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

  There has been no change in the stock status of Acadian redfish since the previous assessment.

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

  The Acadian redfish assessment could be improved by 1) including additional age data, particularly from the commercial fishery, and 2) investigating the sensitivity of biological reference points and stock projections to the mean weights at age.

- Are there other important issues?

  Northeast Fisheries Science Center (NEFSC) fall bottom trawl index values for 2013 and 2014 are lower than in previous years (Figure B13), but the current assessment model continues to predict an increase in SSB for the last two years (Figure B9). If future index values remain low (i.e., if the index is responding to a change in abundance, rather than interannual variability), then the predicted trend in SSB may change abruptly in a future assessment. Such an abrupt change may lead to an increase in the retrospective pattern.

2.1 Reviewer Comments: Acadian redfish

Generic reviewer comments.
Reviewer 1

Things and stuff.
Reviewer 2

Blah blah
Reviewer 3

References:

Northeast Fisheries Science Center. 2008. Assessment of 19 Northeast Groundfish Stocks through 2007: Report of the 3^{rd} Groundfish Assessment Review Meeting (GARM III), Northeast Fisheries Science Center, Woods Hole, Massachusetts, August 4-8, 2008. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/

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://www.nefsc.noaa.gov/nefsc/publications/

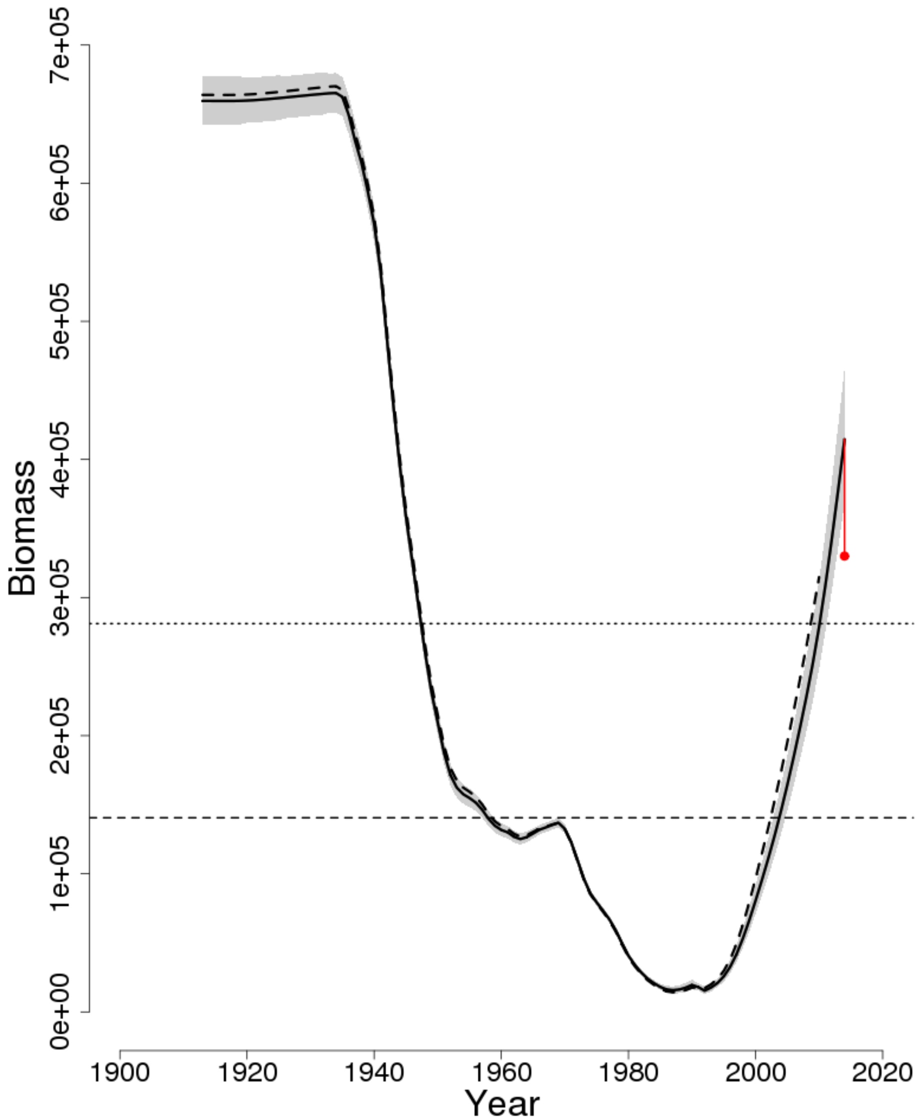

Figure B9: Trends in spawning stock biomass of Acadian redfish between 1913 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ (0.5 * SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

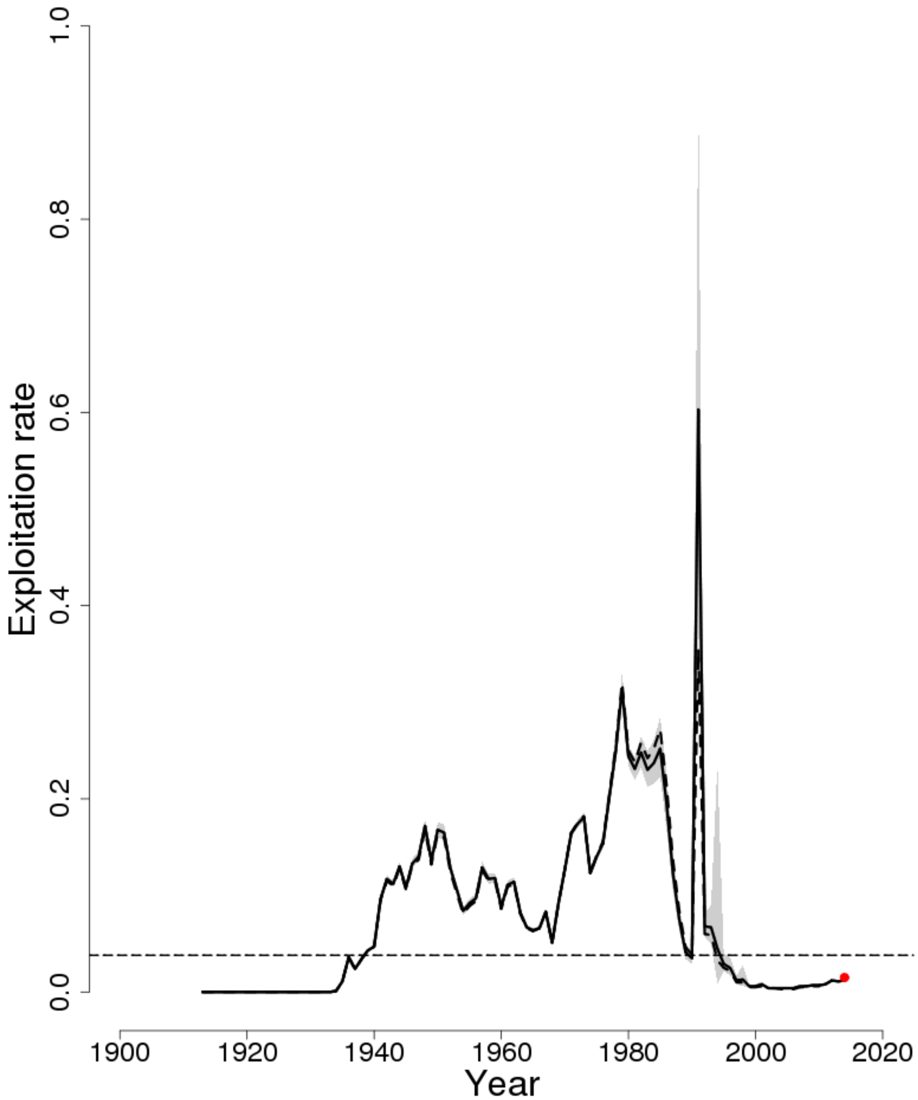

Figure B10: Trends in the fully selected fishing mortality (F_{Full}) of Acadian redfish between 1913 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.038; horizontal dashed line) based on the 2015 assessment. F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

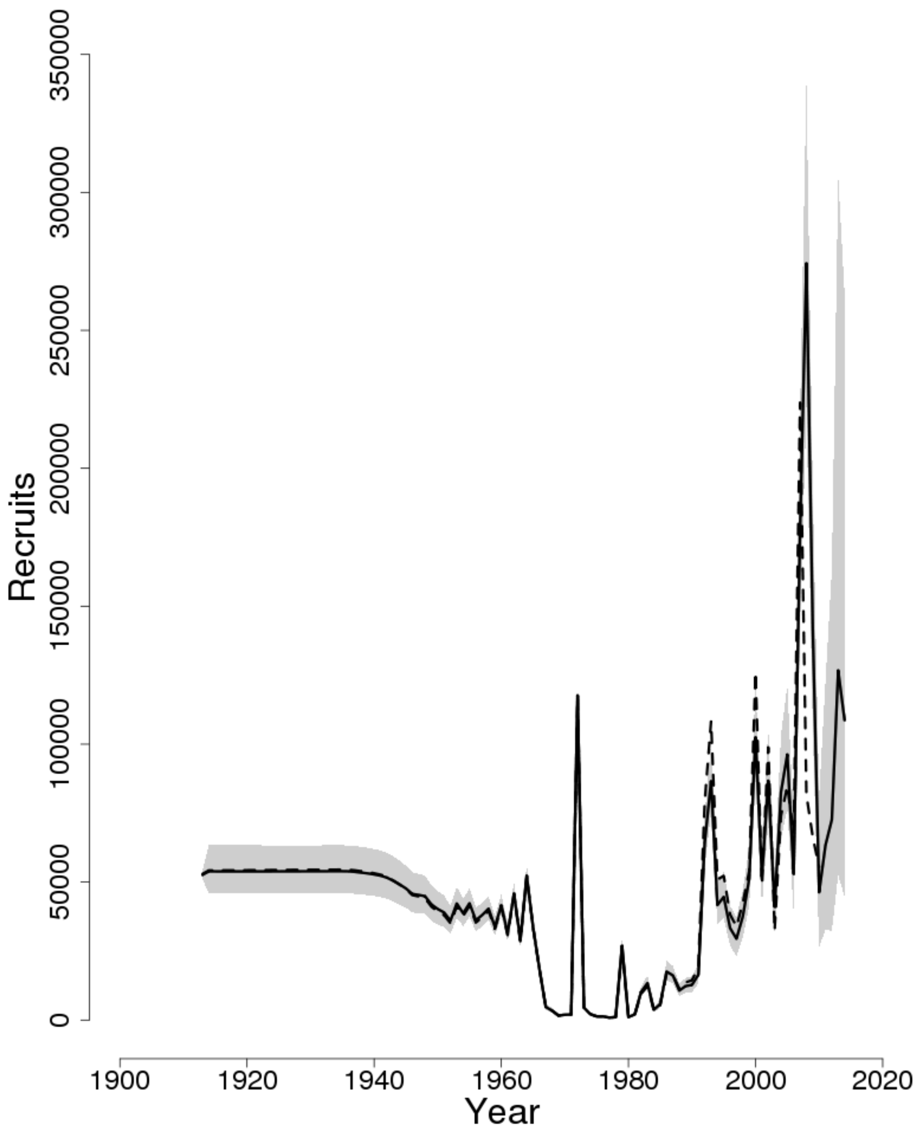

Figure B11: Trends in Recruits (age 1) (000s) of Acadian redfish between 1913 and 2014 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

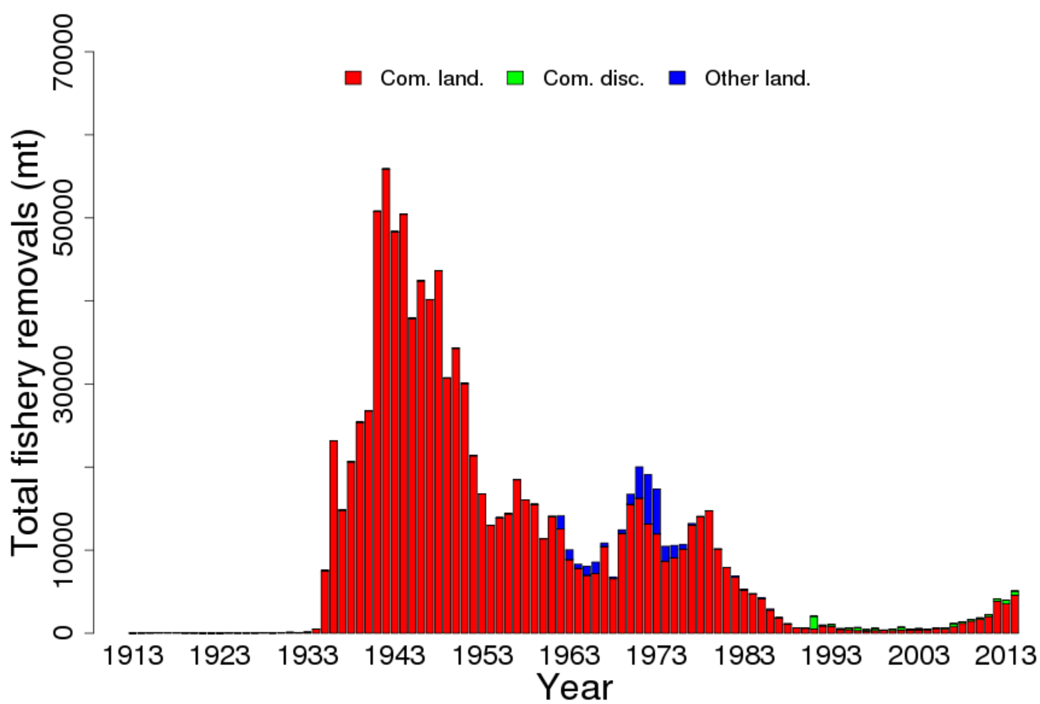

Figure B12: Total catch of Acadian redfish between 1913 and 2014 by fleet (commercial and other) and disposition (landings and discards).

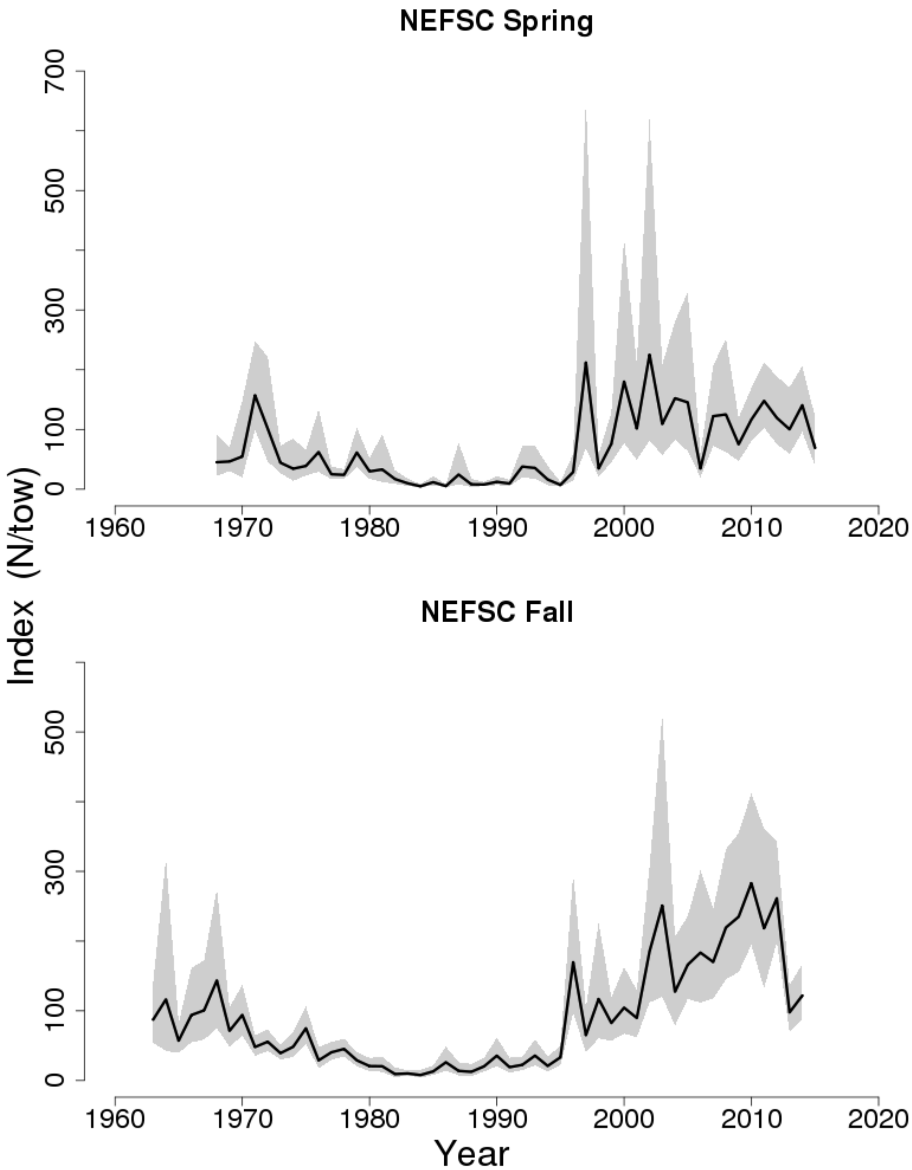

Figure B13: Indices of abundance for Acadian redfish from the Northeast Fisheries Science Center (NEFSC) spring (1963 to 2015) and fall (1963 to 2014) bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.

3 Pollock

Brian Linton

This assessment of the pollock (Pollachius virens) stock is an update of the existing 2014 operational assessment (Hendrickson et al. 2015). This assessment updates commercial and recreational fishery catch data, research survey indices of abundance, the ASAP analytical models, and biological reference points through 2014. Additionally, stock projections have been updated through 2018. In what follows, there are two population assessment models brought forward from the 2014 operational assessment, the base model (dome-shaped survey selectivity) , which is used to provide management advice, and the flat sel sensitivity model (flat-topped survey selectivity), which is included for the sole purpose of demonstrating the sensitivity of assessment results to survey selectivity assumptions. The most recent benchmark assessment of the pollock stock was in 2010 as part of the 50th Stock Assessment Review Committee (SARC 50; NEFSC 2010), which includes a full description of the model formulations.

State of Stock: The pollock (*Pollachius virens*) stock is not overfished and overfishing is not occurring (Figures B14-B15). Retrospective adjustments were made to the model results. Retrospective adjusted spawning stock biomass (SSB) in 2014 was estimated to be 154,919 (mt) under the base model and 32,040 (mt) under the flat sel sensitivity model which is 147 and 58% (respectively) of the biomass target, an SSB_{MSY} proxy of SSB at $F_{40\%}$ (105,226 and 54,900 (mt); Figure B14). Retrospective adjusted 2014 age 5 to 7 average fishing mortality (F) was estimated to be 0.07 under the base model and 0.233 under the flat sel sensitivity model which is 25 and 92% (respectively) of the overfishing threshold, an F_{MSY} proxy of $F_{40\%}$ (0.277 and 0.252; Figure B15).

Table B11: Catch and status table for pollock. All weights are in (mt), recruitment is in (000s), and F_{AVG} is the age 5 to 7 average F. Unadjusted SSB and F estimates are reported. Model results are from the current base model and flat sel sensitivity model.

	2007	2008	2009	2010	2011	2012	2013	2014
			Data					
Commercial landings	8,373	10,040	7,504	5,153	7,211	6,742	5,058	4,545
Commercial discards	157	355	280	97	174	108	168	135
Recreational landings	570	918	576	1,326	1,436	582	1,727	612
Recreational discards	181	903	395	797	917	845	1,641	779
Catch for Assessment	9,281	12,216	8,755	7,373	9,738	8,277	8,594	6,071
			Model Results (base)					
Spawning Stock Biomass	282294	271102	250598	228732	225714	209493	205977	198847
F_{AVG}	0.047	0.075	0.066	0.064	0.085	0.072	0.073	0.051
Recruits $age1$	23331	27177	15360	26638	34890	71958	41112	59953
			Model Results (flat sel sensitivity)					
Spawning Stock Biomass	81862	78556	69440	63044	62441	57973	57020	57327

F_{AVG}	0.119	0.188	0.168	0.163	0.223	0.192	0.2	0.133
Recruits $age1$	11029	12879	7384	12954	17235	36001	20880	31234

Table B12: Comparison of biological reference points for pollock estimated in the 2014 assessment and from the current base model and flat sel sensitivity model. An F_{MSY} proxy of $F_{40\%}$ was used for the overfishing threshold, and was based on long-term stochastic projections. F_{MSY} is reported as the age 5 to 7 average F. Recruits represent the median of the predicted recruits. Intervals shown are 5^{th} and 95^{th} percentiles.

	2014 base	2014 flat sel sensitivity	base	flat sel sensitivity
F_{MSY}	0.273	0.245	0.277	0.252
SSB_{MSY} (mt)	76,879	51,140	105,226 (81,994 - 139,721)	54,900 (40,655 - 74,922)
MSY (mt)	14,791	10,491	19,678 (14,443 - 28,533)	10,995 (7,757 - 15,975)
Median recruits (age 1) (000s)	17,622	10,806	25,299	12,879
Overfishing	No	Yes	No	No
Overfished	No	No	No	No

Projections: Short term projections of median total fishery yield and spawning stock biomass for pollock were conducted based on a harvest scenario of fishing at an F_{MSY} proxy of $F_{40\%}$ between 2016 and 2018. Catch in 2015 has been estimated at 5,208 (mt). Recruitments were sampled from a cumulative distribution function derived from ASAP estimated age 1 recruitment between 1970 and 2012. Recruitments in 2013 and 2014 were not included due to uncertainty in those estimates. The annual fishery selectivity, natural mortality, maturity ogive, and mean weights used in projections are the most recent 5 year averages. Retrospective adjusted age 5 to 7 average F in 2014 fell outside the 90% confidence intervals of the unadjusted 2014 value under the base model (Figure B15). Retrospective adjusted SSB and age 5 to 7 average F in 2014 fell outside the 90% confidence intervals of the unadjusted 2014 values under the flat sel sensitivity model (Figures B14-B15). Therefore, retrospective adjustments were applied in the projections for the base model and the flat sel sensitivity model.

Table B13: Retrospective adjusted short term projections of median total fishery yield and spawning stock biomass for pollock from the current base model and flat sel sensitivity model based on a harvest scenario of fishing at an F_{MSY} proxy of $F_{40\%}$ between 2016 and 2018. Catch in 2015 has been estimated at 5,208 (mt). F_{AVG} is the age 5 to 7 average F.

Year	Catch (mt)	SSB (mt)	F_{AVG}	Catch (mt)	SSB (mt)	F_{AVG}

		base			*flat sel sensitivity*	
2015	5,208	160,581	0.056	5,208	42,924	0.167
2016	27,668	178,534	0.277	9,154	51,426	0.252
2017	30,704	176,077	0.277	11,303	56,807	0.252
2018	31,327	168,611	0.277	12,572	58,890	0.252

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 largest source of uncertainty in the pollock assessment is selectivity, as the base model with dome-shaped survey and fishery selectivities implies the existence of a large cryptic biomass that neither current surveys nor the fishery can confirm. Assuming flat-topped survey selectivities leads to lower estimates of SSB and higher estimates of F (Figures B14-B15). Stock status is insensitive to the shape of the survey selectivity patterns at older ages.

- 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_{AVG} lies outside of the approximate joint confidence region for SSB and F_{AVG}; see Figure B5).

  The 7-year Mohn's ρ, relative to SSB, was 0.291 under the base model and 0.66 under the flat sel sensitivity model in the 2014 assessment and was 0.284 and 0.789, respectively, in 2014. The 7-year Mohn's ρ, relative to F, was -0.252 under the base model and -0.359 under the flat sel sensitivity model in the 2014 assessment and was -0.276 and -0.43, respectively, in 2014. There was a major retrospective pattern for the base model because the ρ adjusted estimate of 2014 F (F_ρ=0.07) was outside the approximate 90% confidence regions around F (0.035 - 0.066). There was a major retrospective pattern for the flat sel sensitivity model because the ρ adjusted estimates of 2014 SSB (SSB_ρ=32,040) and 2014 F (F_ρ=0.233) were outside the approximate 90% confidence regions around SSB (37,243 - 77,410 (mt)) and F (0.084 - 0.182). A retrospective adjustment was made for both the determination of stock status and for projections of catch in 2016. The base model retrospective adjustment changed the 2014 SSB from 198,847 to 154,919 and the 2014 F_{AVG} from 0.051 to 0.07. The flat sel sensitivity model retrospective adjustment changed the 2014 SSB from 57,327 to 32,040 and the 2014 F_{AVG} from 0.133 to 0.233.

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

  Population projections for pollock, appear to be reasonably well determined for both the base model and the flat sel sensitivity 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.

  Only one major change was made to the pollock assessment as part of this update.

Likelihood constants were excluded from likelihood calculations to avoid potential bias caused by one of the recruitment likelihood constants, which is the sum of the log-scale predicted recruitments, and therefore not a constant. Inclusion of this likelihood constant allows the assessment model to minimize the negative log likelihood by estimating lower recruitments. Exclusion of the likelihood constants led to higher estimates of SSB and lower estimates of F (Figures B14-B15).

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

  Stock status based on the base model has not changed since the previous assessment. Stock status based on the flat sel sensitivity model has changed from 'overfishing is occurring' in the previous assessment to 'overfishing is not occurring' in the current assessment. Though, the retrospective adjusted 2014 age 5 to 7 average fishing mortality from the flat sel sensitivity model (0.233) is close to the F_{MSY} *proxy (0.252). This change in status likely is due to a decline in predicted F from 2013 to 2014, as well as to the exclusion of the likelihood constants, which led to higher predicted stock productivity.*

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

  The pollock assessment could be improved with additional studies on gear selectivity. These studies could cover topics such as physical selectivity (e.g., multi-mesh gillnet), behavior (e.g., swimming endurance, escape behavior), geographic and vertical distribution by size and age, tag-recovery at size and age, and evaluating information on length-specific selectivity at older ages.

- Are there other important issues?

  As in the previous assessment, the pollock assessment models had difficulty converging on a solution in some of the retrospective peels. One possible explanation for this convergence issue is that the model may be overparameterized, because the commercial and recreational fleets are modeled separately in this assessment. The possibility of combining the two fleets into a single fleet should be explored during the next benchmark assessment.

3.1 Reviewer Comments: Pollock

Generic reviewer comments.
Reviewer 1

Things and stuff.
Reviewer 2

Blah blah
Reviewer 3

References:

Hendrickson L, Nitschke P, Linton B. 2015. 2014 Operational stock assessments for Georges Bank winter flounder, Gulf of Maine winter flounder, and pollock. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 15-01; 228 p. Available from: NationalMarine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/publications/

Northeast Fisheries Science Center. 2010. 50^{th} Northeast Regional Stock Assessment Workshop (50^{th} SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 10-17; 844 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/

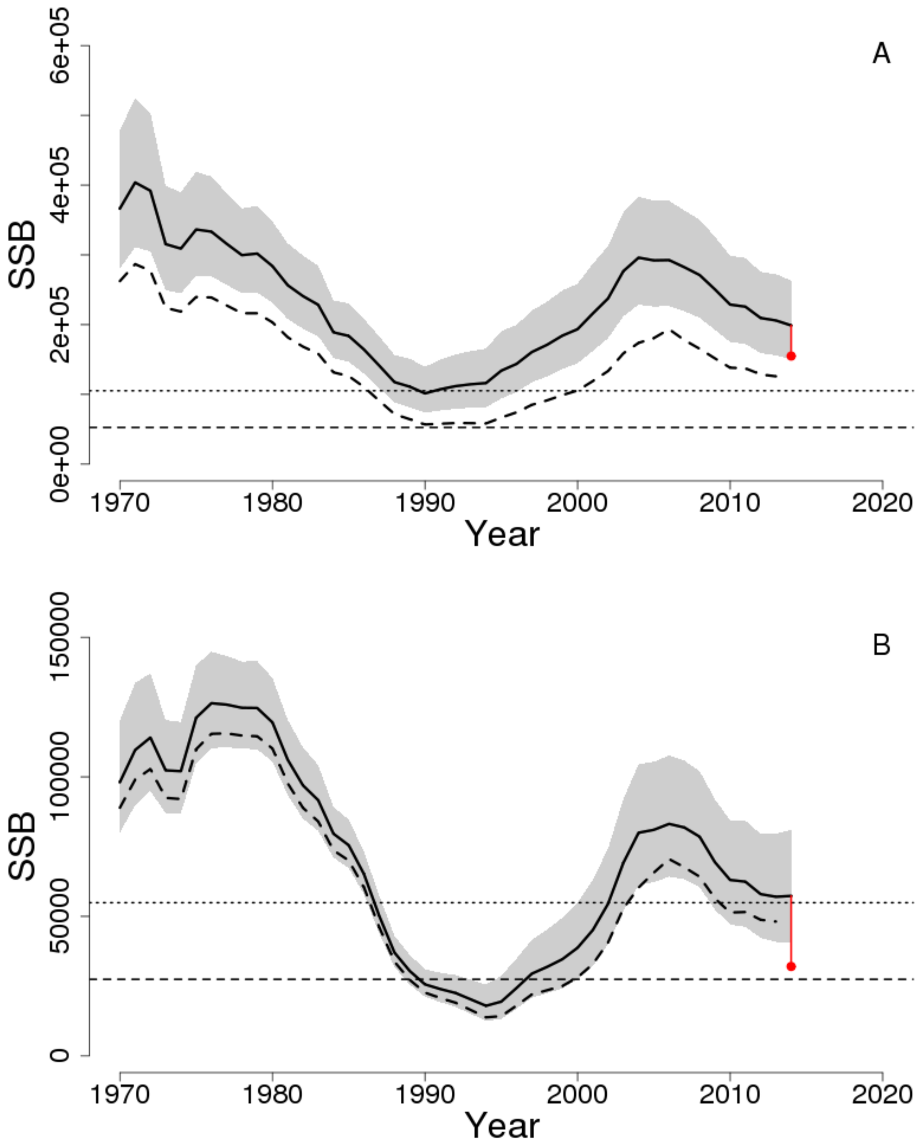

Figure B14: Estimated trends in the spawning stock biomass of pollock between 1970 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ (0.5 * SSB_{MSY} proxy; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} proxy; horizontal dotted line) based on the 2015 assessment models base (A) and flat sel sensitivity (B). Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

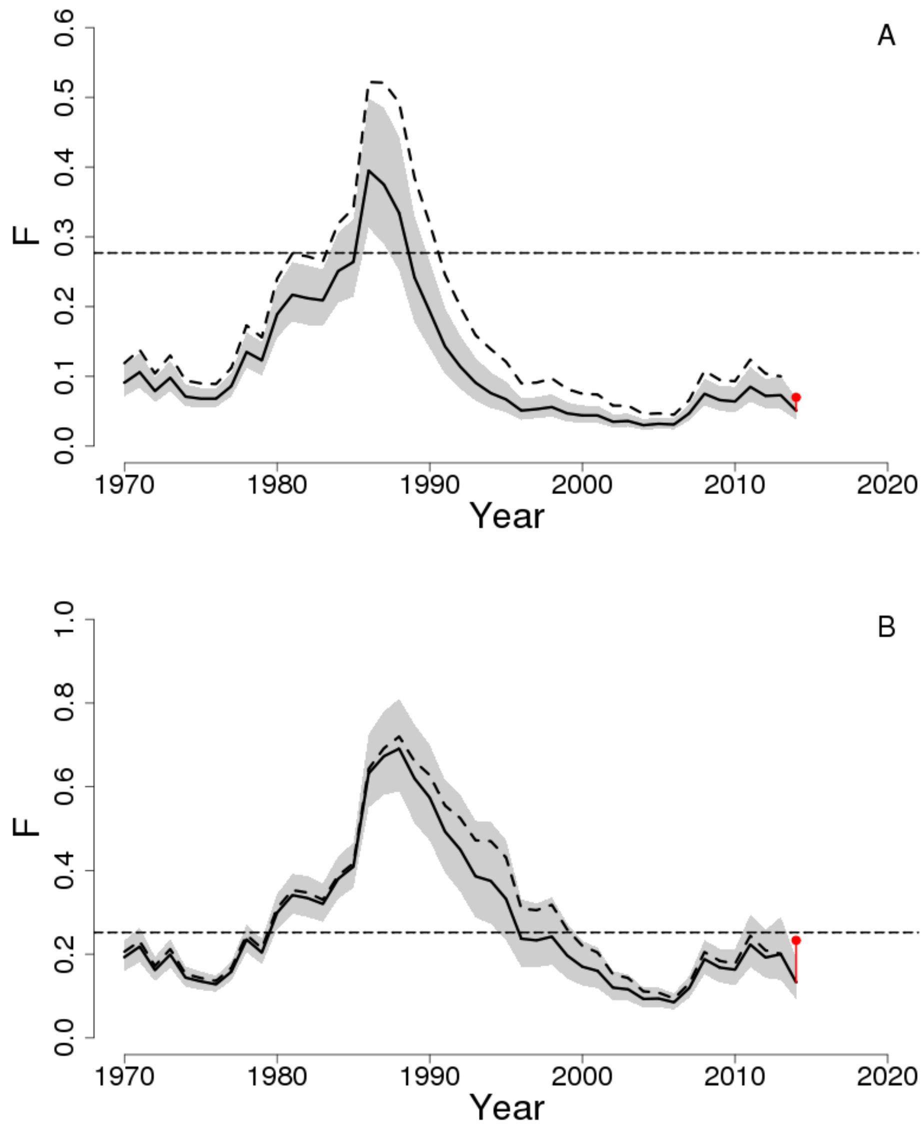

Figure B15: Estimated trends in age 5 to 7 average F (F_{AVG}) of pollock between 1970 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} proxy; dashed line) based on the 2015 assessment models base (A) and flat sel sensitivity (B). F_{AVG} was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

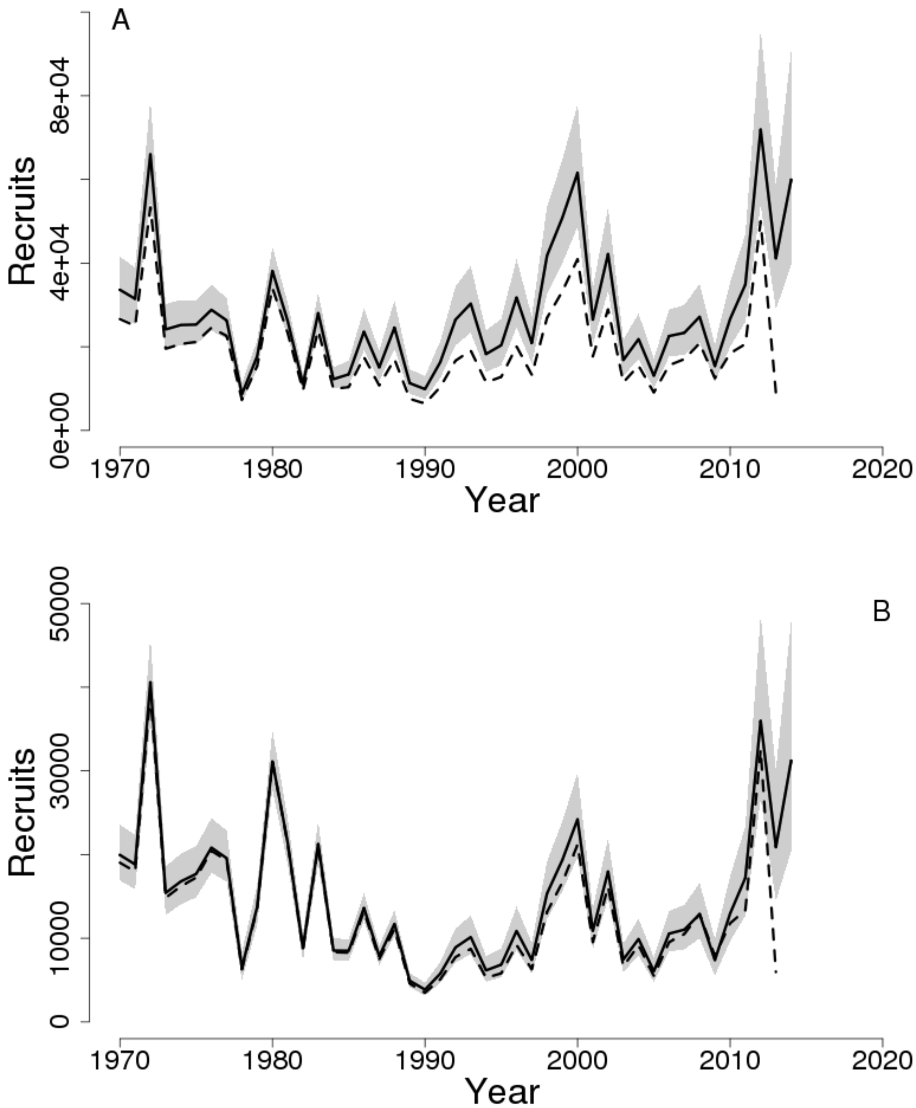

Figure B16: Estimated trends in age 1 recruitment (000s) of pollock between 1970 and 2014 from the current (solid line) and previous (dashed line) assessment for the assessment models base (A) and flat sel sensitivity (B). The approximate 90% lognormal confidence intervals are shown.

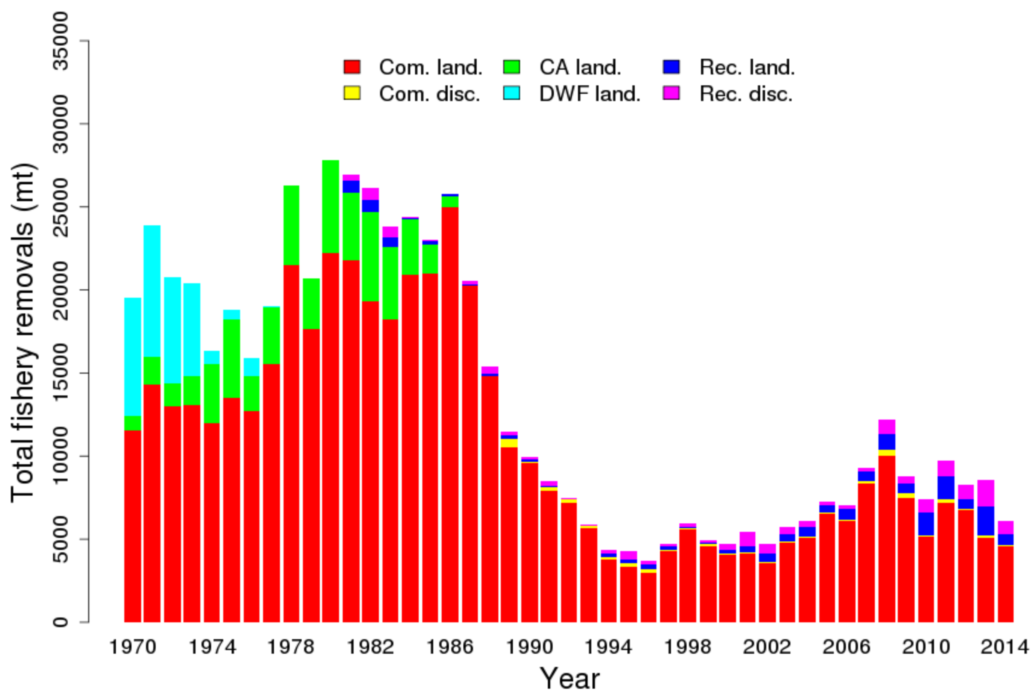

Figure B17: Total catch of pollock between 1970 and 2014 by fleet (commercial, Canadian, distant water fleet, and recreational) and disposition (landings and discards).

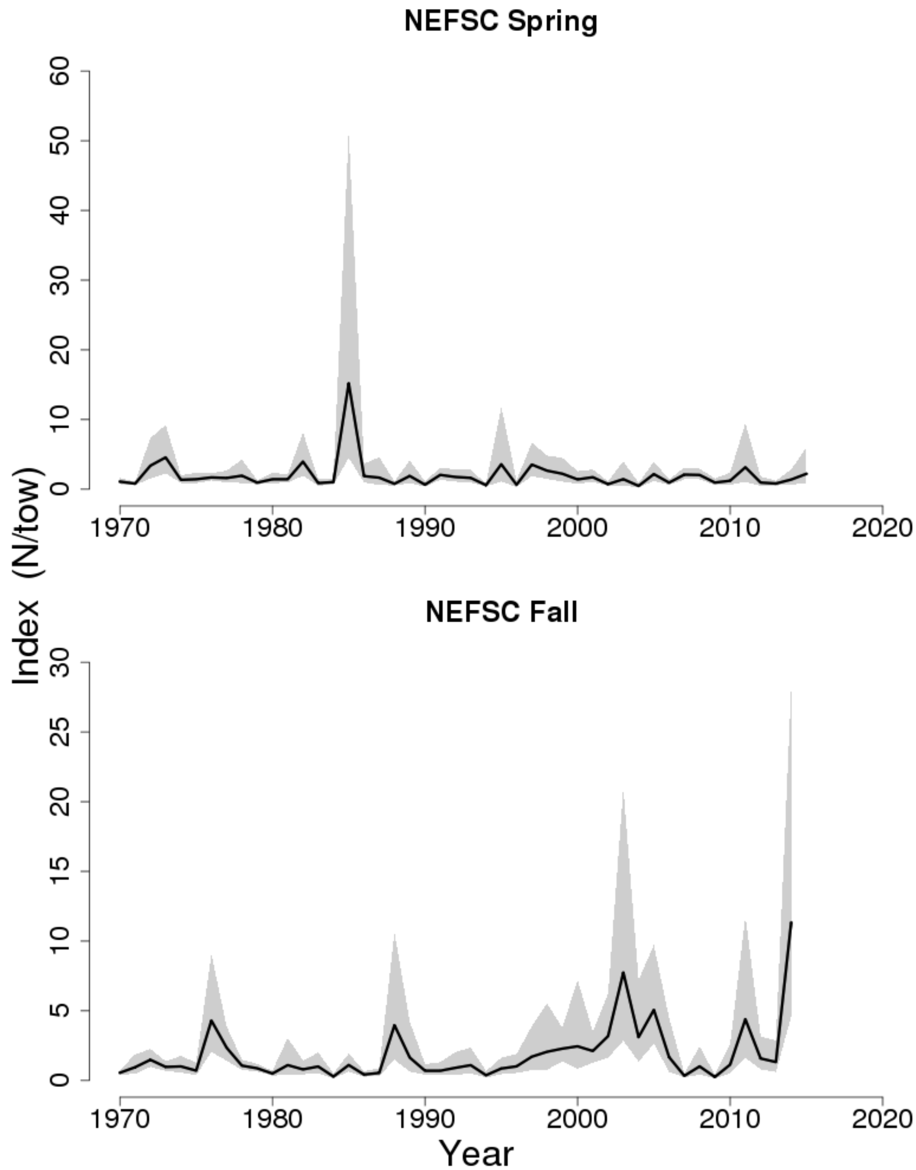

Figure B18: Indices of abundance for pollock from the Northeast Fisheries Science Center (NEFSC) spring (1970 to 2015) and fall (1970 to 2014) bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.

4 Atlantic wolffish

Charles Adams

This assessment of the Atlantic wolffish (Anarhichas lupus) stock is an update of the existing 2012 operational assessment (NEFSC 2012). Based on the previous assessment the stock was overfished, but overfishing was not occurring. This assessment updates commercial fishery catch data, research survey indices of abundance, and the analytical assessment models and reference points through 2014.

State of Stock: Based on this updated assessment, the Atlantic wolffish (*Anarhichas lupus*) stock is overfished and overfishing is not occurring (Figures B19-B20). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 638 (mt) which is 38% of the biomass target (SSB_{MSY} $proxy$ = 1,663; Figure B19). The 2014 fully selected fishing mortality was estimated to be 0.003 which is 1% of the overfishing threshold proxy (F_{MSY} $proxy$ = 0.243; Figure B20).

Table B14: Catch and status table for Atlantic wolffish. All weights are in (mt) recruitment is in (mt) and F_{Full} is the fully selected fishing mortality. Model results are from the current updated SCALE assessment, assuming 8% discard mortality. Note that a no possession limit was put in place in May 2010.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
				Data						
Commercial landings	114	80	63	49	33	3	0	0	0	0
Commercial discards	0	0	0	0	0	1	3	2	2	1
Recreational landings	13	18	12	14	7	1	2	0	0	0
Catch for Assessment	127	99	75	64	40	5	5	2	2	1
				Model Results						
Spawning Stock Biomass	594	496	417	389	356	369	433	498	564	638
F_{Full}	0.571	0.577	0.431	0.488	0.266	0.023	0.018	0.008	0.004	0.003
Recruits $age1$	59	83	88	68	78	154	298	298	298	298

Table B15: Comparison of reference points from the previous assessment and the current assessment update, assuming 8% discard mortality. An $F_{40\%}$ proxy was used for the overfishing threshold and was based on yield per recruit calculations within the SCALE model.

	2012	Current
F_{MSY} $proxy$	0.334	0.243
SSB_{MSY} (mt)	1,756	1,663

MSY (mt)	261	244
Median recruits (age 1) (mt)	300	252
Overfishing	No	No
Overfished	Yes	Yes

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 primary sources of uncertainty are the use of the ocean pout calibration coefficient, and the change to a no possession limit in May 2010. The ocean pout calibration coefficient (4.575) is one of the largest for any species (Miller et al. 2010), and results in lower biomass estimates. The change to a no possession limit places greater importance on discard mortality. Additionally, it is unclear whether the lack of a recruitment index since 2004 is due to an actual decrease in recruitment, or a change in catchability resulting from the increase in liner mesh size associated with the switch to the Bigelow. Other sources of uncertainty were identified in previous Atlantic wolffish assessments (NDPSWG 2009, NEFSC 2012): the surveys may have reached the limit of wolffish detectability due to the decline in abundance; and the lack of commercial length information results in model estimation difficulties for fishery selectivity.

- 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).

  This assessment has retrospective patterns with Mohn's rho = 0.83 for SSB and -0.36 for F. Confidence intervals are not available because MCMC is not fully developed for the SCALE model. Thus, retrospective adjustments were not done for this assessment.

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

  Population projections for Atlantic wolffish were not done. Due to the uncertainties in the assessment, the Northeast Data Poor Stocks Working Group (NDPSWG 2009) concluded that stock projections would be unreliable and should not be conducted.

- 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.

  Commercial discards for the entire time series were revised assuming 8% discard mortality based on a recent study by Grant and Hiscock (2014). A sensitivity run with the revised discard estimates was presented to the Peer Review Panel during the 2015 Operational Assessments. This became the accepted run. There was no change in stock status resulting from the adoption of the 8% discard mortality run.

  Recreational landings for the entire time series were revised due to an updated grand mean, and the MRFSS/MRIP calibration for 1981-2003. This had a negligible effect on the assessment, and there was no change in stock status.

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

  Stock status has not changed since the previous assessment.

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

  The Atlantic wolffish maturity study in the Gulf of Maine is ongoing. Increased sample size since the previous assessment allowed the use of a revised knife edge maturity of 50 cm in this assessment. Continued histological sampling over the next several years should allow for the development of a definitive maturity ogive that can be used in the next assessment.

- Are there other important issues?

  Recruitment at the end of the time series increases toward the initial recruitment estimate (Table 1; Figure 3) because there is no information in the model to inform these estimates. There is no indication in the data that recruitment has increased recently.

  Approximate 90% lognormal confidence intervals are not shown in Figures 1-3 because MCMC is not fully developed for the SCALE model.

4.1 Reviewer Comments: Atlantic wolffish

Generic reviewer comments.
Reviewer 1

Things and stuff.
Reviewer 2

Blah blah
Reviewer 3

References:

Grant SM, Hiscock W. 2014. Post-capture survival of Atlantic wolffish (*Anarhichas lupus*) captured by bottom otter trawl: Can live release programs contribute to the recovery of species at risk? Fish Res 151:169-176

Miller TJ, Das C, Politis PJ, Miller AS, Lucey SM, Legault CM, Brown RW, Rago PJ. 2010. Estimation of Albatross IV to Henry B. Bigelow calibration factors. US Dep Commer, Northeast Fish Sci Cent Ref Doc. 10-05; 233 p. http://www.nefsc.noaa.gov/publications/crd/crd1005/

Northeast Fisheries Science Center (NEFSC). 2012. Assessment or Data Updates of 13 Northeast Groundfish Stocks through 2010. US Dep Commer, Northeast Fish Sci Cent Ref Doc. 12-06; 789 p. http://www.nefsc.noaa.gov/publications/crd/crd1206/

Northeast Data Poor Stocks Working Group (NDPSWG). 2009. The Northeast Data Poor Stocks Working Group Report, December 8-12, 2008 Meeting. Part A. Skate species complex, deep sea red crab, Atlantic wolffish, scup, and black sea bass. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 09-02; 496 p. http://www.nefsc.noaa.gov/publications/crd/crd0902/

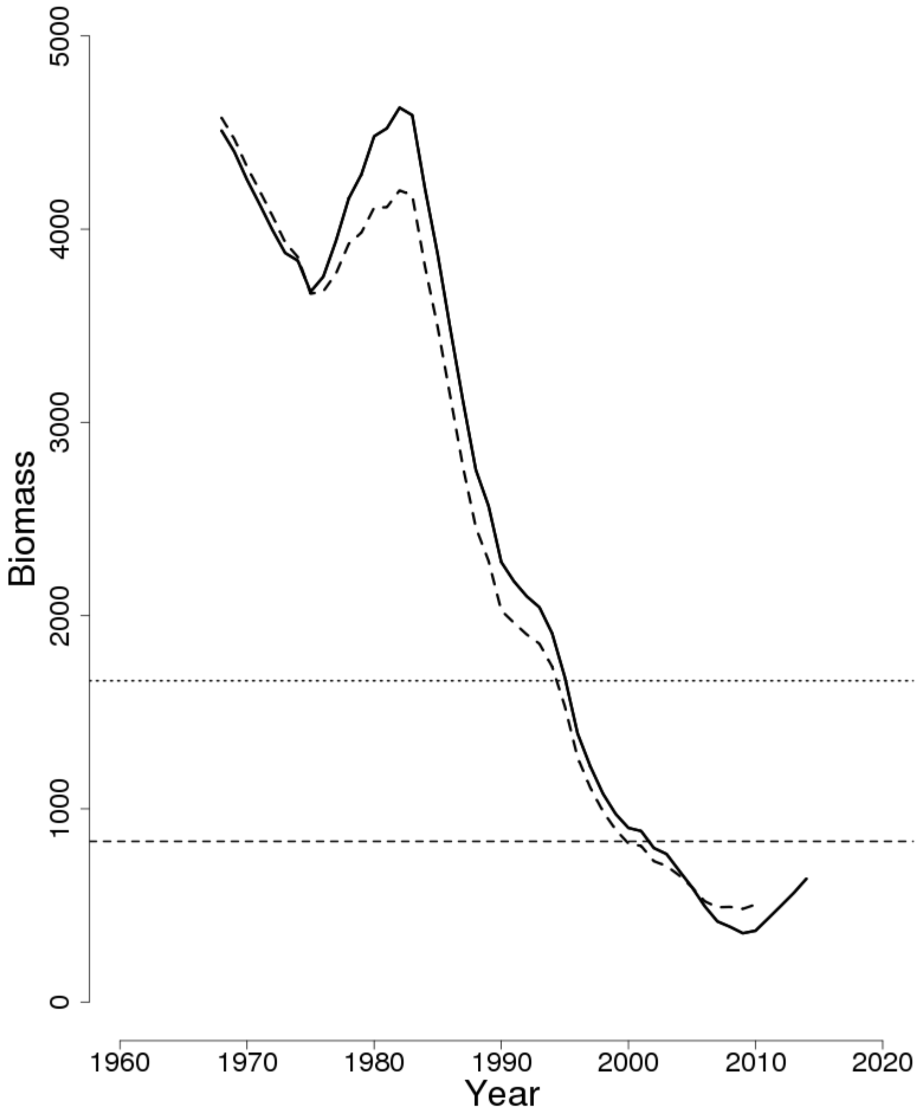

Figure B19: Trends in spawning stock biomass of Atlantic wolffish between 1968 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the current assessment.

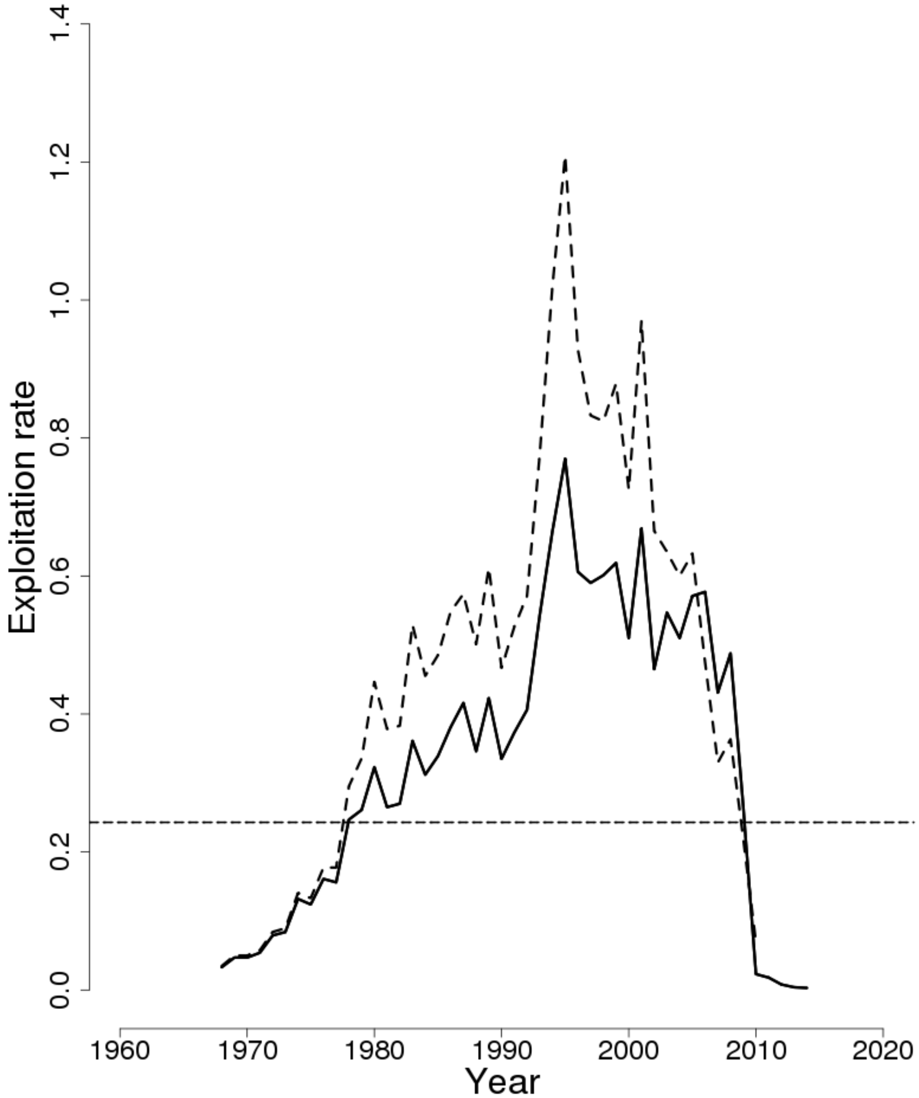

Figure B20: Trends in the fully selected fishing mortality (F_{Full}) of Atlantic wolffish between 1968 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.243; horizontal dashed line).

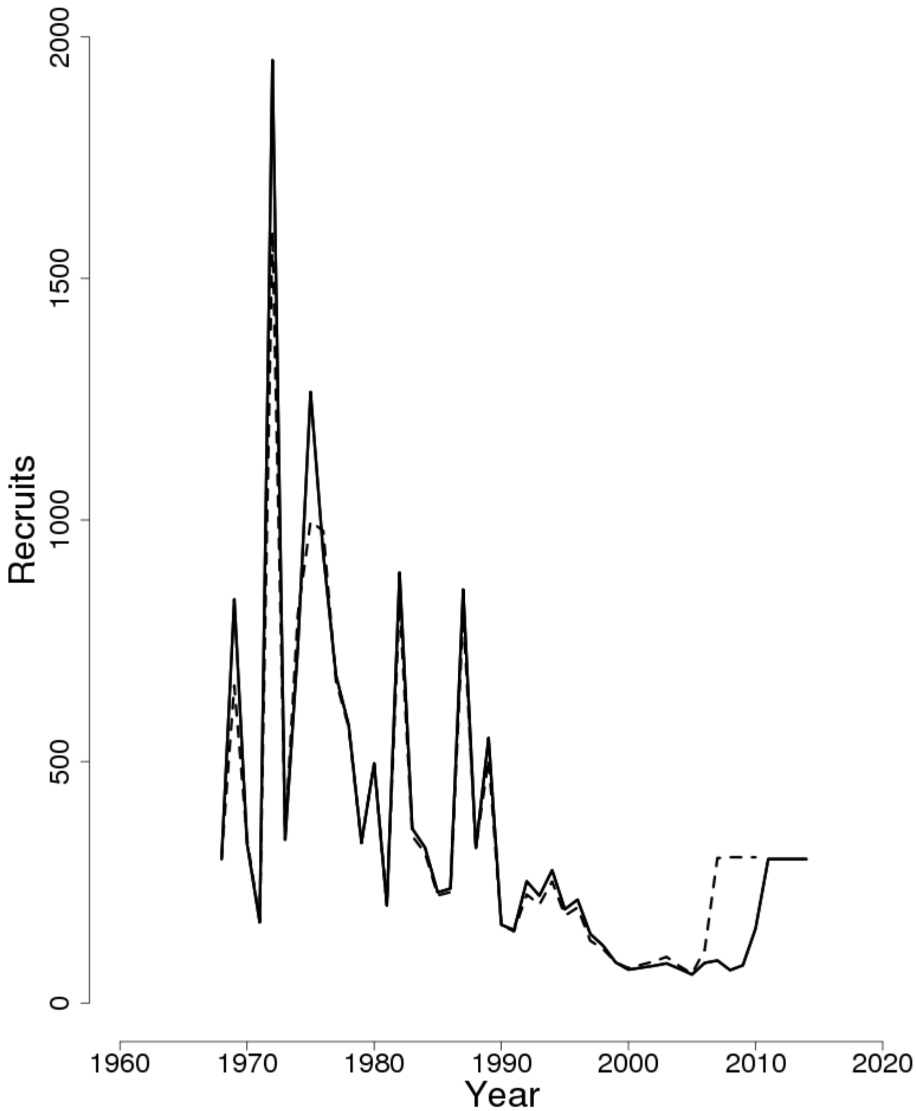

Figure B21: Trends in age 1 recruits of Atlantic wolffish between 1968 and 2014 from the current (solid line) and previous (dashed line) assessment.

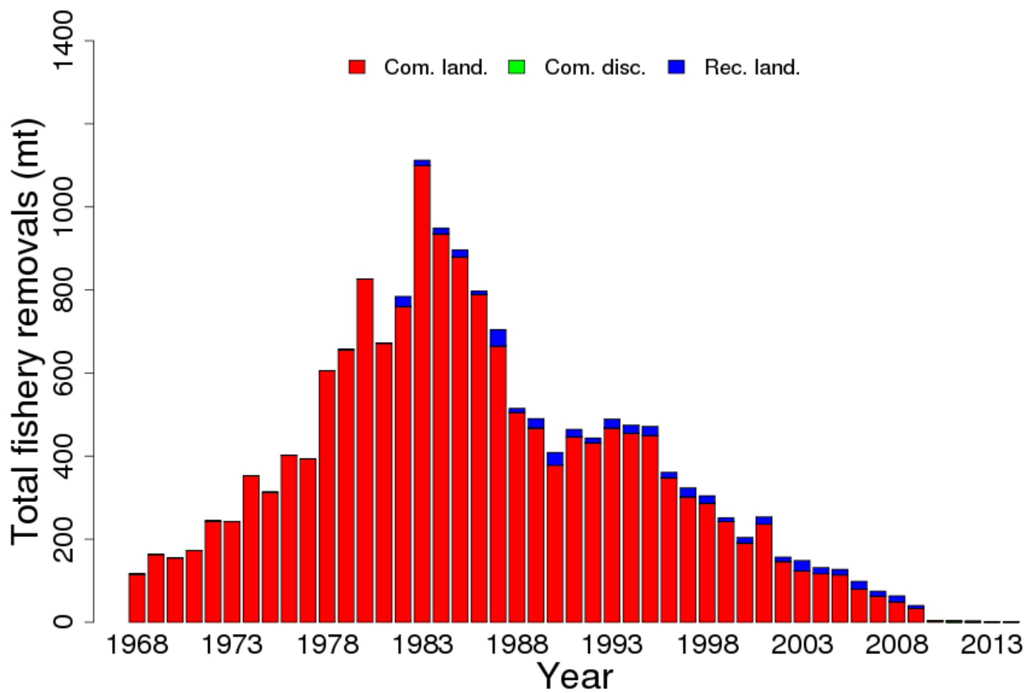

Figure B22: Total catch of Atlantic wolffish between 1968 and 2014 by fleet (commercial and recreational) and disposition (landings and discards). Note that a no possession limit was put in place in May 2010.

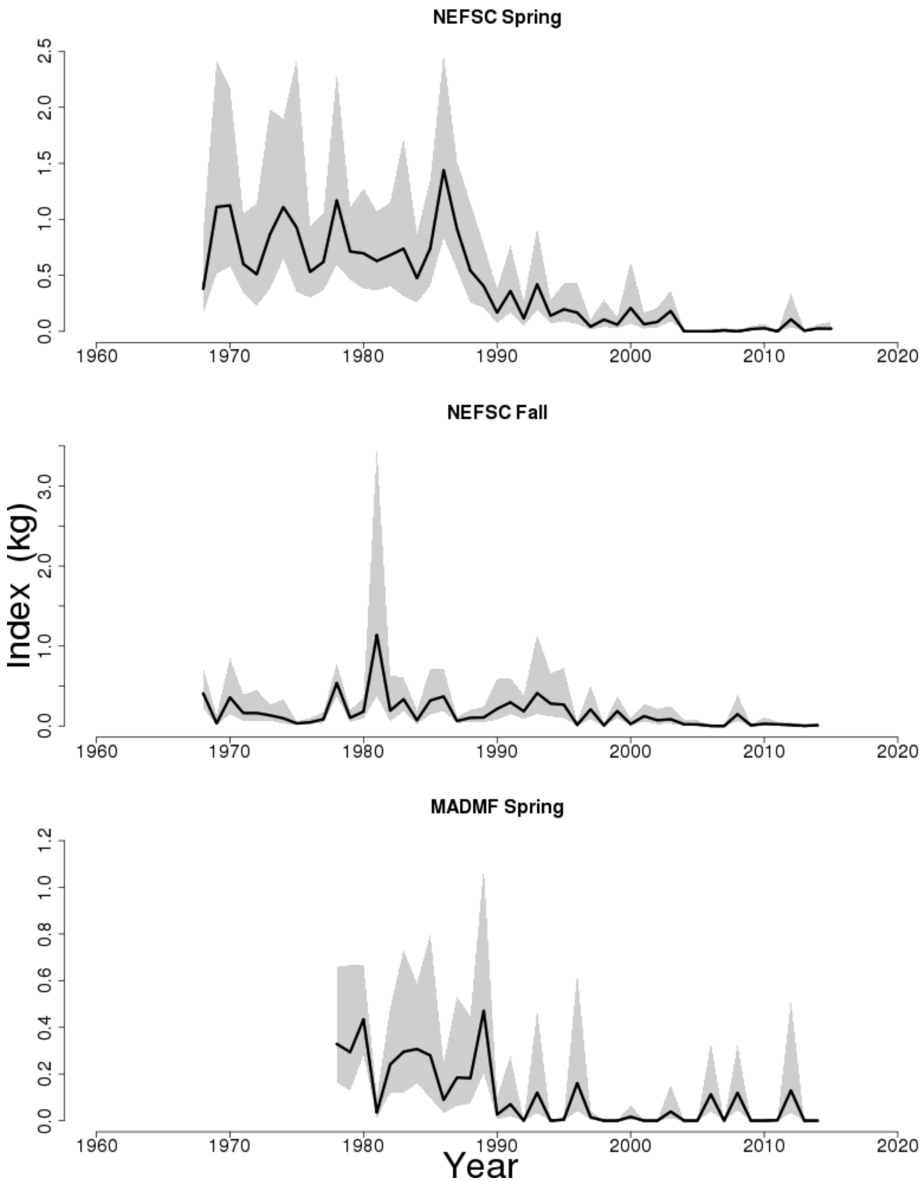

Figure B23: Indices of biomass for the Atlantic wolffish between 1968 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys, and the Massachusetts Division of Marine Fisheries (MADMF) spring bottom trawl survey. The approximate 90% lognormal confidence intervals are shown. NEFSC indices for 2009-2015 are calibrated using the ocean pout coefficient from Miller et al. (2010).

5 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 B24-B25). 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 B24). 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 B25).

Table B16: 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 B17: 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 B18: 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.

5.1 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/

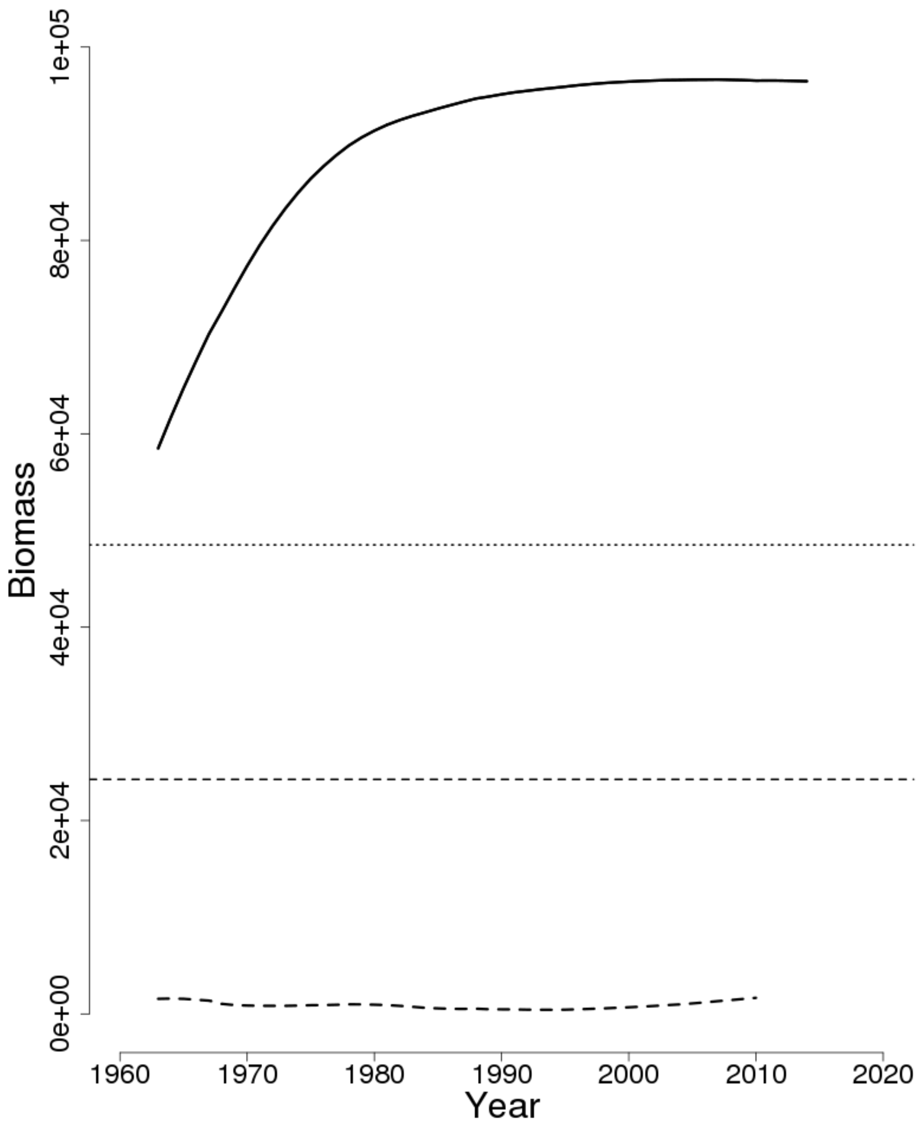

Figure B24: Estimated trends in the biomass of Atlantic halibut between 1963 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $B_{Threshold} = \frac{1}{2}\ B_{MSY}$ *proxy*(horizontal dashed line) as well as B_{Target} (B_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment.

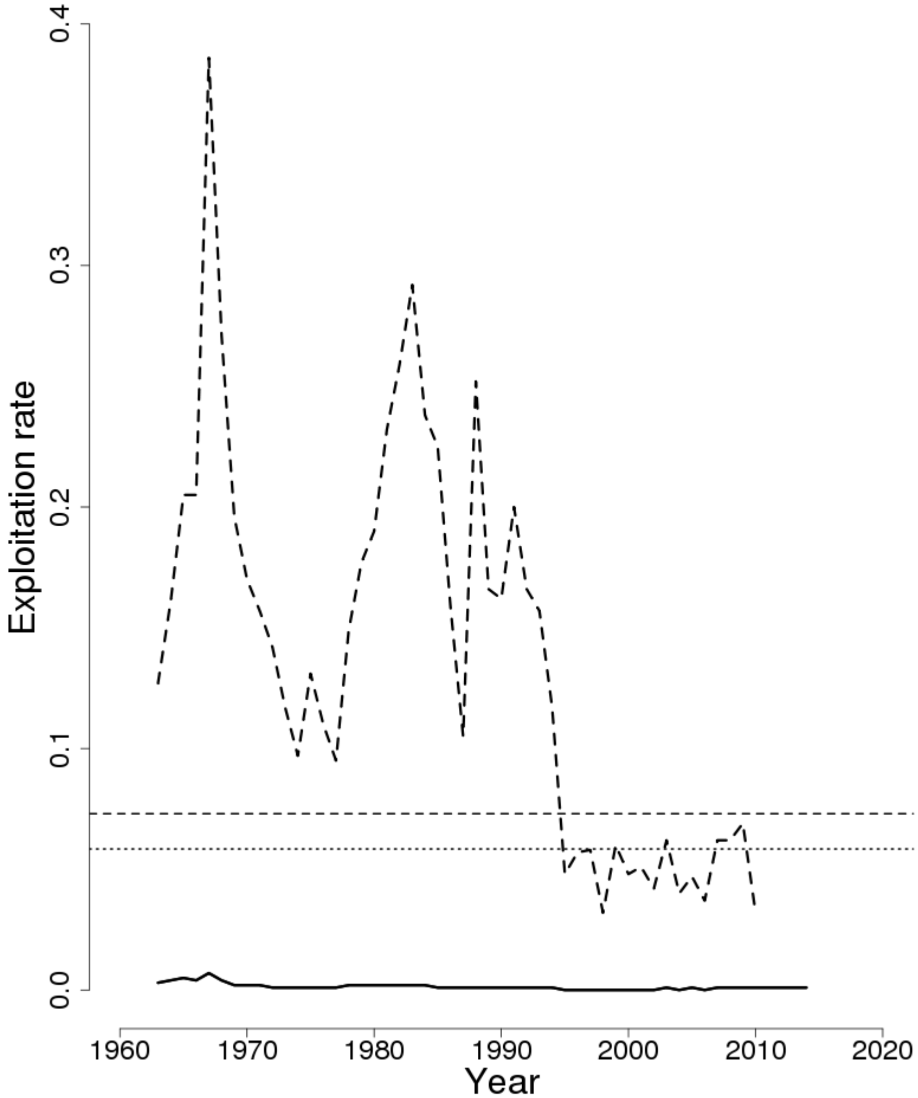

Figure B25: Estimated trends in the fully selected fishing mortality (F_{Full}) of Atlantic halibut between 1963 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (0.073; horizontal dashed line) as well as F_{Target} (0.8 * F_{MSY} *proxy*; dotted line) based on the 2015 assessment.

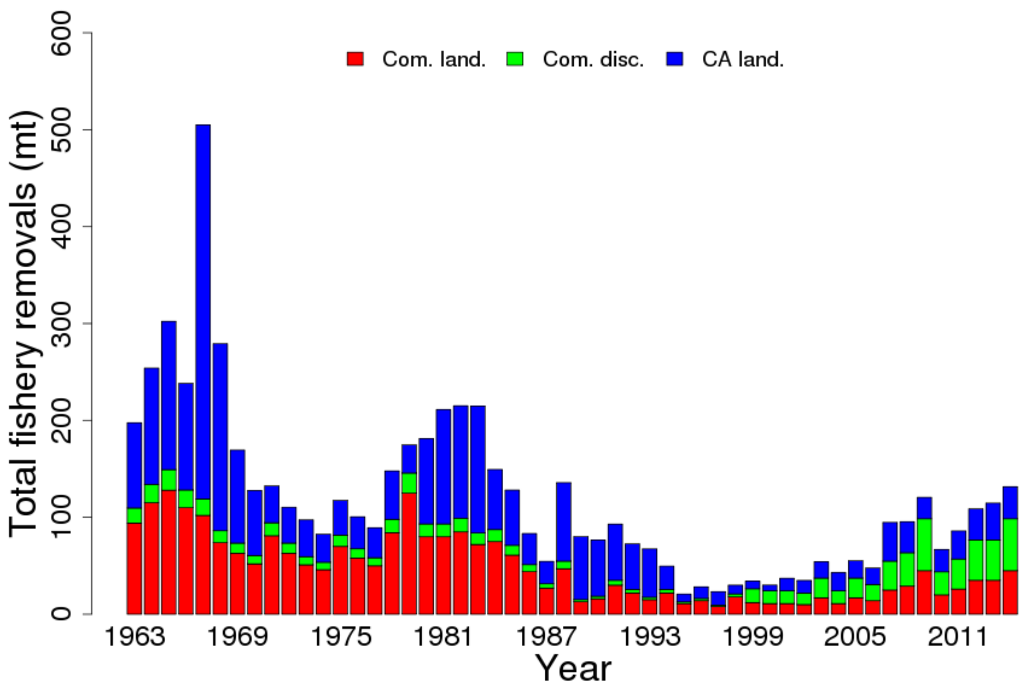

Figure B26: Total catch of Atlantic halibut between 1963 and 2014 by disposition (landings and discards).

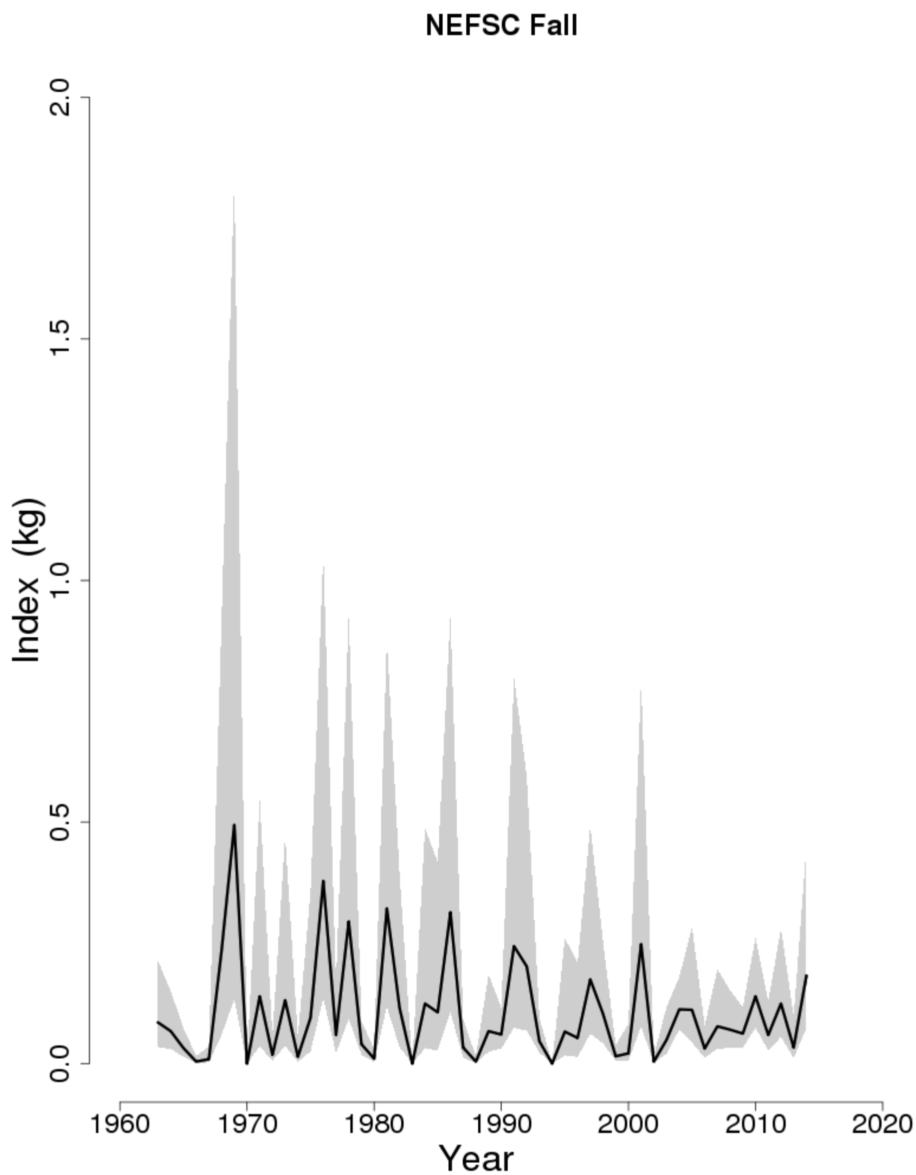

Figure B27: Indices of biomass for the Atlantic halibut between 1963 and 2014 for the Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey. The 90% lognormal confidence intervals are shown.