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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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Stock Assessment Update of 20 Northeast Groundfish Stocks Through 2014

by Northeast Fisheries Science Center

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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1 Executive Summary

Note:Working Paper

Update assessments were conducted for the twenty stocks in the Northeast Multispecies Fishery Management Plan in 2015 (Table 1). The updates replicated the methods recommended in the most recent benchmark decisions, as modified by any subsequent operational assessments or updates (Table 2), with the intention of simply adding years of data (Table 3). However, minor flexibility was allowed to address emerging issues (Table 4).

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 (Table 5).

The number of stocks with retrospective adjustments applied increased from the last assessment from 2 to 7 (Table 6). 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 (Figure 1), the magnitude of overfishing or depletion for several stocks has worsened considerably (Figures 2 and 3); 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 1 and 3).

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 (Figures 4 and 5)

Estimates of overall (aggregate) groundfish minimum swept area biomass are at, or near, all-time highs (Figures 6 and 7). However, the current stock diversity of the overall groundfish biomass is less than that seen in the 1960s and 1970s. Current groundfish biomass is dominated by only a few stocks: For example the combined biomass of the Georges Bank haddock, Gulf of Maine haddock, and redfish stocks currently make up more than 80% of the overall groundfish biomass (Figure 8).

Information supplemental to the assessment report for each stock can found on the Stock Assessment Support Information (SASINF) website.

The appendix to this document contains: The letter from the Northeast Regional Coordinating Council providing guidance on the operational assessment procedure (Section 22.1), a summary of the meeting with the Assessment Oversight Panel during which assessment plans were developed (Section 22.2), a summary of NEFSC outreach on 2015 groundfish operational assessments (Section 22.3) and statements from fishing industry members (Section 22.4).

Table 1: 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 2: Lead scientist for each stock (current/previous if different), information about last assessment, including: the forum for review of the last assessment (Forum), the type of assessment done (Type), publication year (Pub.) the terminal year of the catch data included (Term. yr.), overfished/overfishing status, rebuilding status, and reference. *Note: Op. 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 3: 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 4: 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 5: 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

Table 6: 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 7: 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	10,977	12,742 - 16,439	0.08	0.116	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

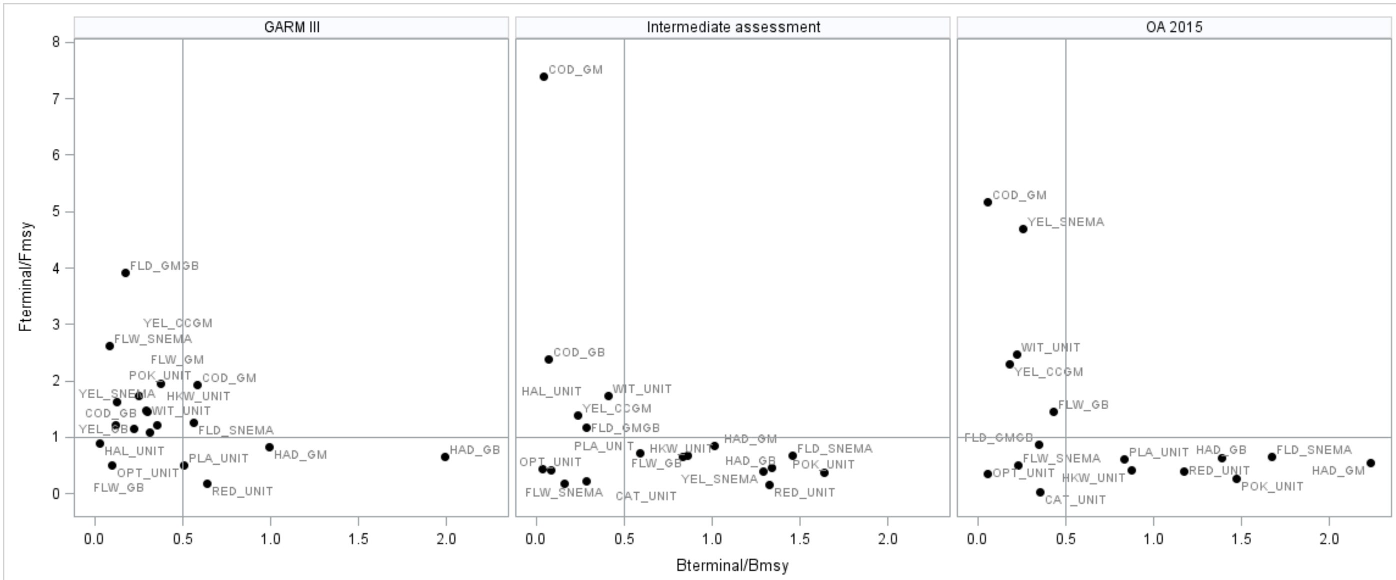

Figure 1: Status of the Northeast Multispecies Fishery Management Plan (groundfish) stocks in 2007 (GARM III) and 2014 (OA 2015) with respect to the F_{MSY} and B_{MSY} proxies. The 'Intermediate assessment' represents the last stock assessment conducted prior to the OA 2015 assessment (year varies by 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.*

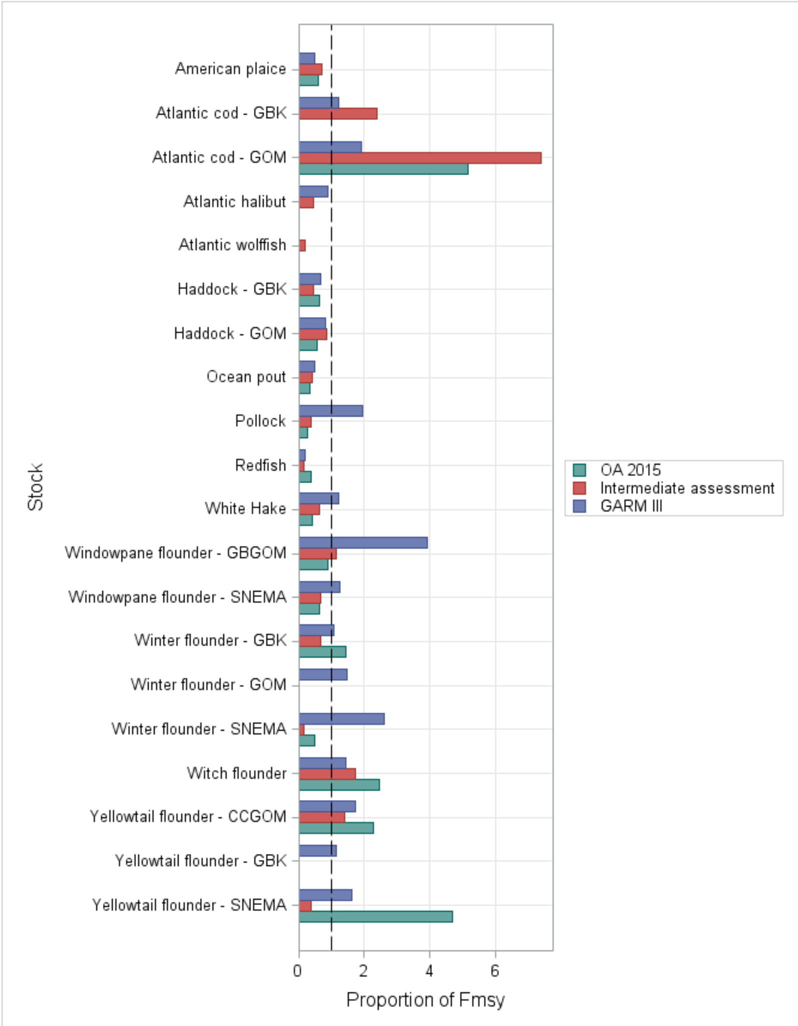

Figure 2: Changes in the ratio of fishing mortality to FMSY proxy from 2007 (GARM III) to 2014 (OA 2015) for the twenty Northeast Multispecies Fishery Management Plan (groundfish) stocks. The results from the assessment prior to the OA 2015 assessment are shown for each stock to provide an 'Intermediate' 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.*

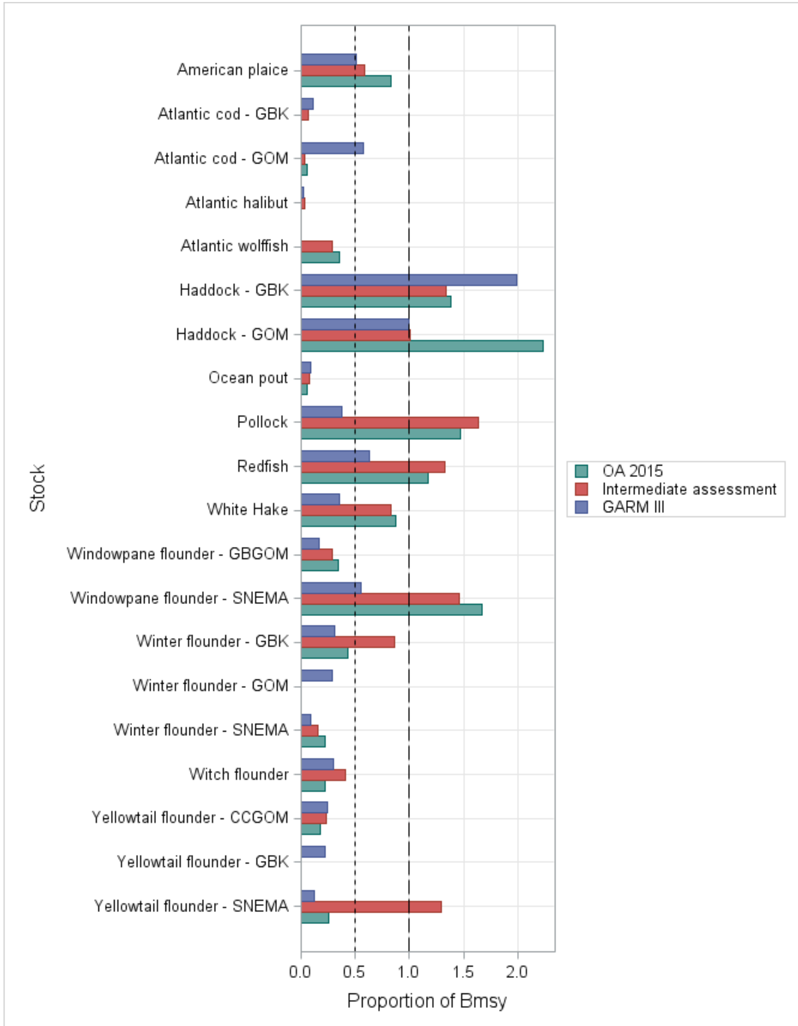

Figure 3: Changes in the ratio of stock biomass to BMSY proxy from 2007 (GARM III) to 2014 (OA 2015) for the twenty Northeast Multispecies Fishery Management Plan (groundfish) stocks. The results from the assessment prior to the OA 2015 assessment are shown for each stock to provide an 'Intermediate' 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 4: 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 5: 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.*

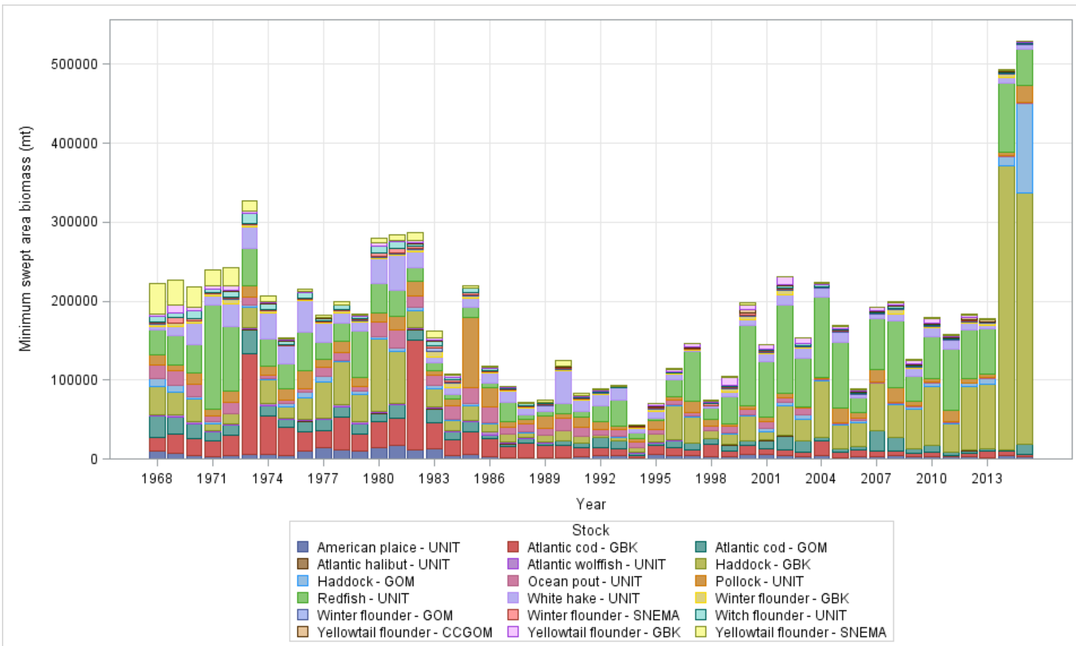

Figure 6: NEFSC spring bottom trawl survey minimum swept area biomass (mt) for the Northeast Multispecies Fishery Management Plan (groundfish) stocks from 1968 to 2015, by stock. Minimum swept area estimates assume a trawl swept area of 0.0112 nm^2) (0.0384 km^2) based on the wing spread of the trawl 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.*

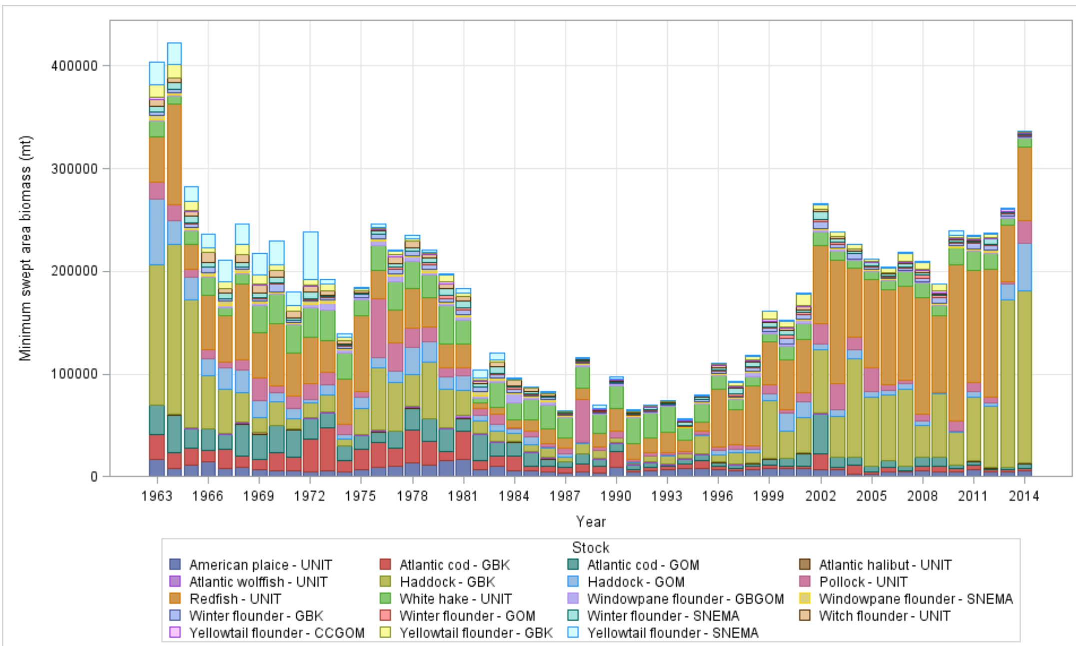

Figure 7: NEFSC fall bottom trawl survey minimum swept area biomass (mt) for for the Northeast Multispecies Fishery Management Plan (groundfish) stocks from 1963 to 2014, by stock. Minimum swept area estimates assume a trawl swept area of 0.0112 nm^2 (0.0384 km^2) based on the wing spread of the trawl 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.*

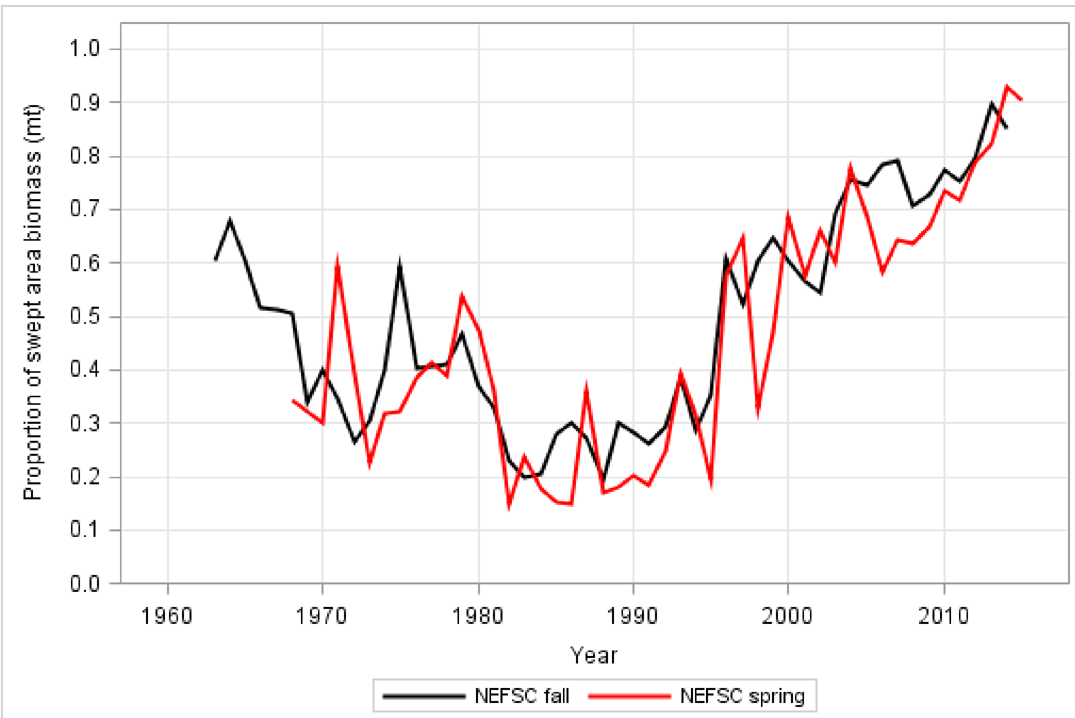

Figure 8: Proportion of the total groundfish swept minimum swept area biomass contributed by Georges Bank and Gulf of Maine haddock and Redfish based on the NEFSC spring and fall bottom trawl surveys.

2 Gulf of Maine Atlantic cod

Michael Palmer

This assessment of the Gulf of Maine Atlantic cod (Gadus morhua) stock is an operational update of the existing 2014 assessment (Palmer 2014). This assessment updates commercial and recreational fishery catch data, research survey indices of abundance, and the analytical ASAPassessment models through 2014. Additionally, stock projections have been updated through 2018. In what follows, there are two population assessment models brought forward from the most recent benchmark assessment (2012), the M=0.2 (natural mortality = 0.2) and the M-ramp (M ramps from 0.2 to 0.4) assessment models (see NEFSC 2013 for a full description of the model formulations).

State of Stock: Based on this updated assessment, the Gulf of Maine Atlantic cod (*Gadus morhua*) stock is overfished and overfishing is occurring (Figures 9-10). Retrospective adjustments were not made to the model results (see Special Comments section of this report). Spawning stock biomass (SSB) in 2014 was estimated to be 2,225 (mt) under the M=0.2 model and 2,536 (mt) under the M-ramp model scenario (Table 8) which is 6 and 4% (respectively) of the biomass target, SSB_{MSY} *proxy* (40,187 (mt) and 59,045 (mt); Figure 9). The 2014 fully selected fishing mortality was estimated to be 0.956 and 0.932 which is 517 and 498% of the F_{MSY} *proxy*($F_{40\%}$; 0.185 and 0.187; Figure 10).

Table 8: Catch and status table for Gulf of Maine Atlantic cod. All weights are in (mt) recruitment is in (000s) and F_{Full} is the fishing mortality on fully selected ages.

	2007	2008	2009	2010	2011	2012	2013	2014
Data								
Recreational discards	154	153	142	188	164	48	69	85
Recreational landings	1,162	1,240	1,399	1,803	1,813	571	705	528
Commercial discards	178	349	752	171	99	93	52	26
Commercial landings	3,990	5,444	5,953	5,356	4,598	2,759	951	832
Catch for Assessment	5,485	7,186	8,247	7,517	6,673	3,472	1,777	1,471
Model Results (M=0.2)								
Spawning Stock Biomass	8608	9716	10088	8638	5617	2954	2064	2225
F_{Full}	0.716	0.926	1.043	1.073	1.563	1.778	1.334	0.956
Recruits $age1$	4407	3087	2035	1281	1615	2269	1030	2042
Model Results (M-ramp)								
Spawning Stock Biomass	11583	12649	12871	10645	6727	3599	2526	2536
F_{Full}	0.564	0.751	0.859	0.908	1.347	1.528	1.185	0.932
Recruits $age1$	9368	6307	4024	2486	3066	4114	1738	3211

Table 9: Comparison of reference points estimated in an earlier assessment and from the current assessment update. The overfishing threshold is the F_{MSY} *proxy* ($F_{40\%}$). The biomass target, (SSB_{MSY} *proxy*) was based on long-term stochastic projections of fishing at the F_{MSY} *proxy*. Median recruitment reflects the median estimated age-1 recruitment from 1982 - 2012. Intervals shown reflect the 5th and 95th percentiles.

	2014 M=0.2	2014 M-ramp	M=0.2	M-ramp
F_{MSY}	0.18	0.18	0.185	0.187
SSB_{MSY} (mt)	47,184 (32,903 - 67,045)	69,621 (53,349 - 89,302)	40,187 (27,551 - 58,228)	59,045 (44,976 - 76,525)
MSY (mt)	7,753 (5,355 - 11,162)	11,388 (8,624 - 14,750)	6,797 (4,608 - 9,990)	10,043 (7,560 - 13,130)
Median recruits age-1) (000s)	4,665 (1,414 - 14,649)	9,173 (2,682 - 16,262)	4,406 (1,458 - 14,450)	8,965 (2,489 - 15,908)
Overfishing	Yes	Yes	Yes	Yes
Overfished	Yes	Yes	Yes	Yes

Projections: Short term projections of median total fishery yield and spawning stock biomass for Gulf of Maine Atlantic cod were conducted based on a harvest scenario of fishing at the FMSY proxy between 2016 and 2018. Catch in 2015 was estimated at 279 mt. Recruitment was sampled from a cumulative distribution function derived from ASAP estimated age-1 recruitment between 1982 and 2012. The projection recruitment model declines linearly to zero when SSB is below 6.3 kmt under the M=0.2 model and 7.9 kmt under the M-ramp model. The 2015 age-1 recruitment was estimated from the geometric mean of the 2010-2014 ASAP recruitment estimates. No retrospective adjustments were applied in the projections as the retrospective patterns are similar to the 2014 update for which no retrospective adjustments were made; however, the 2015 assessment review panel recommended that that M=0.2 projections with retrospective adjustments be brought forward to the SSC for consideration in the evaluation of uncertainty when setting catch advice (provided in the Supplemental Information Report, SASINF). Assumed weights are based on an average of the most recent three years. For the M-ramp model, projections are shown under two assumptions of short-term natural mortality: M=0.2 and M=0.4.

Table 10: Short term projections of total fishery catch and spawning stock biomass for Gulf of Maine Atlantic cod based on a harvest scenario of fishing at the F_{MSY} *proxy* ($F_{40\%}$) between 2016 and 2018. Catch in 2015 has been estimated at 279 (mt).

Year	Catch (mt)	SSB (mt)	F_{Full}	Catch (mt)	SSB (mt)	F_{Full}	Catch (mt)	SSB (mt)	F_{Full}
	M=0.2			*M-ramp(M=0.2)*			*M-ramp(M=0.4)*		
2015	279	3045	0.111	279	3219	0.112	279	3057	0.123
2016	697	4400	0.185	748	4950	0.187	555	3841	0.187
2017	939	5852	0.185	1085	7062	0.187	662	4536	0.187
2018	1211	7601	0.185	1507	9674	0.187	765	5220	0.187

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 is the estimate of natural mortality. Past investigations into changes in natural mortality over time have been inconclusive (NEFSC 2013). Different assumptions about natural mortality affect the scale of the biomass, recruitment, and fishing mortality estimates. Other areas of uncertainty include the retrospective error in the M=0.2 model, residual patterns in the model fits to some of the survey series (e.g., aggregate MADMF spring survey) and stock structure.

- 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} lie outside of the approximate joint confidence region for SSB and F_{Full}).

  The M=0.2 model has a major retrospective pattern (7-year Mohn's rho SSB=0.54, F=-0.31) and the M-ramp model has a minor retrospective pattern (7-year Mohn's rho SSB=0.20, F=-0.08). The 7-year Mohn's rho values from the current assessment are similar to those from the 2014 assessment (M=0.2: SSB=0.53, F=-0.33; M-ramp: SSB=0.17, F=-0.05) where the M=0.2 model had a major retrospective pattern and the M-ramp model had a minor pattern. No retrospective adjustment have been to the terminal model results or in the base catch projections following the recommendations of the SARC 55 and 2014 assessment review panels. The 2015 assessment review panel supported this decision noting that the most recent retrospective 'peel' suggested that an adjustment using the 7-year average may not be appropriate. However, the 2015 review panel highlighted the retrospective error in the M=0.2 model as a source of uncertainty - it should be noted that the retrospective error of the most recent peel is larger for the M-ramp model. Should the retrospective patterns continue then the models may have overestimated spawning stock size and underestimated fishing mortality.

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

  Population projections for Gulf of Maine Atlantic cod are reasonably well determined and projected boimass from the last assessment was within the confidence bounds of the biomass estimated in the current assessment.

- 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.

  This update included several minor changes to model input data including: (1) re-estimation of recreational catch from 2004-2014 to account for recent updates to the MRIP data; (2) a revised assumption on recreational discard mortality from 30% to 15% following a Capizzano et al. 2015 study (unpublished); and (3) re-estimation of 2009-2014 NEFSC spring and fall survey time series using the TOGA station acceptance criterion. Additionally, the ASAP assessment model was run with the likelihood constants option turned off. All of these changes had minimal impacts on model results - summaries of the impacts of these changes are provided in the Supplemental Information Report (SASINF).

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

  There has been no change in stock status since the 2014 udpate assessment.

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

  The Gulf of Maine Atlantic cod assessment could be improved with additional studies on natural mortality and stock structure. Additionally, future assessments should consider possible changes in recent fishery selectivity patterns and exlore alternative methods for estimating recruitment. Potential causes of low stock productivity (i.e., low recruitment) should also be investigated.

- Are there other important issues?

  When setting catch advice careful attention should be given to the retrospective error present in both models, particularly given the poor performance of previous stock projections. Additionally, it is unclear as to which level of natural mortality (M=0.2 or 0.4) to assume for the short-term projections under the M-ramp model.

2.1 Reviewer Comments: Gulf of Maine Atlantic cod

Recommendation: The Panel concluded that the updated assessment with no retrospective adjustment was acceptable as a scientific basis for management advice. The minor changes to survey data and recreational catch statistics were acceptable and the revised assumption of discard mortality for the recreational fishery from 30% to 15% was well justified. The exclusion of likelihood constants from the assessment model's objective function is also reasonable.

The Assessment Oversight Panel recommended that retrospective adjustments should be applied to stock status determination and projections for stocks with major retrospective patterns. However, the SAW55 benchmark assessment did not apply a retrospective adjustment to the M=0.2 model results, and the retrospective pattern in the updated assessment was similar. The most recent retrospective 'peel' (i.e., with a terminal year of 2013) suggests that an adjustment using 7-year average may not be appropriate. On the other hand, the panel noted that unadjusted projections from SAW55 were optimistic in retrospect. Therefore, short-term projections are provided with and without retrospective adjustment, so that they can be considered in the evaluation of uncertainty and catch advice.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: Major sources of uncertainty include the natural mortality assumption and retrospective error in the updated M=0.2 model. A pattern of residuals in fishery age compositions suggests that selectivity may have changed in the last two years, but a longer time series is needed to confirm the pattern. The panel concluded that the survey series are noisy and some residual patterns persist in the model (e.g., MADMF spring survey). The benchmark method cannot consider survey information in the current year (e.g., spring 2015 survey indices), but the two spring surveys have conflicting signals, with a substantial increase in the NEFSC survey (from two large tows in one stratum) and a near record-low index in the MADMF survey. Recently published research suggests that the stock area includes several distinct spawning groups, so stock boundaries may need to be re-considered.

Research Needs: The Panel recommends that the sources of the retrospective pattern in the M=0.2 model need to be addressed. Considering that retrospective patterns are a common problem, the generic problem may be most appropriately addressed in a research track topic, and all possible sources of the retrospective problem should be investigated (misspecified natural mortality, changes in natural mortality, under-reported catch, changes in survey catchability and misspecified selectivity, etc.).

The causes of low productivity, relative to historical productivity should be considered in the next benchmark assessment, including the investigation of ecosystem effects. In particular, information on natural mortality should be investigated. The implicit assumption that natural mortality will return to M=0.2 in the reference points associated with the Mramp model should be examined in the next benchmark assessment. Additional topics to be explored in future benchmark assessments include: alternative methods for estimating recruitment should be explored, possible changes in recent selectivity, and recent information on cod stock structure.

References:

Northeast Fisheries Science Center. 2013. 55^{th} Northeast Regional Stock Assessment Workshop (55^{th} SAW) Assessment Summary Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 13-01; 41 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026

Palmer MC. 2014. 2014 Assessment update report of the Gulf of Maine Atlantic cod stock. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 14-14; 119 p. Available from: National Marine Fisheries Service,166 Water Street, Woods Hole, MA 02543-1026

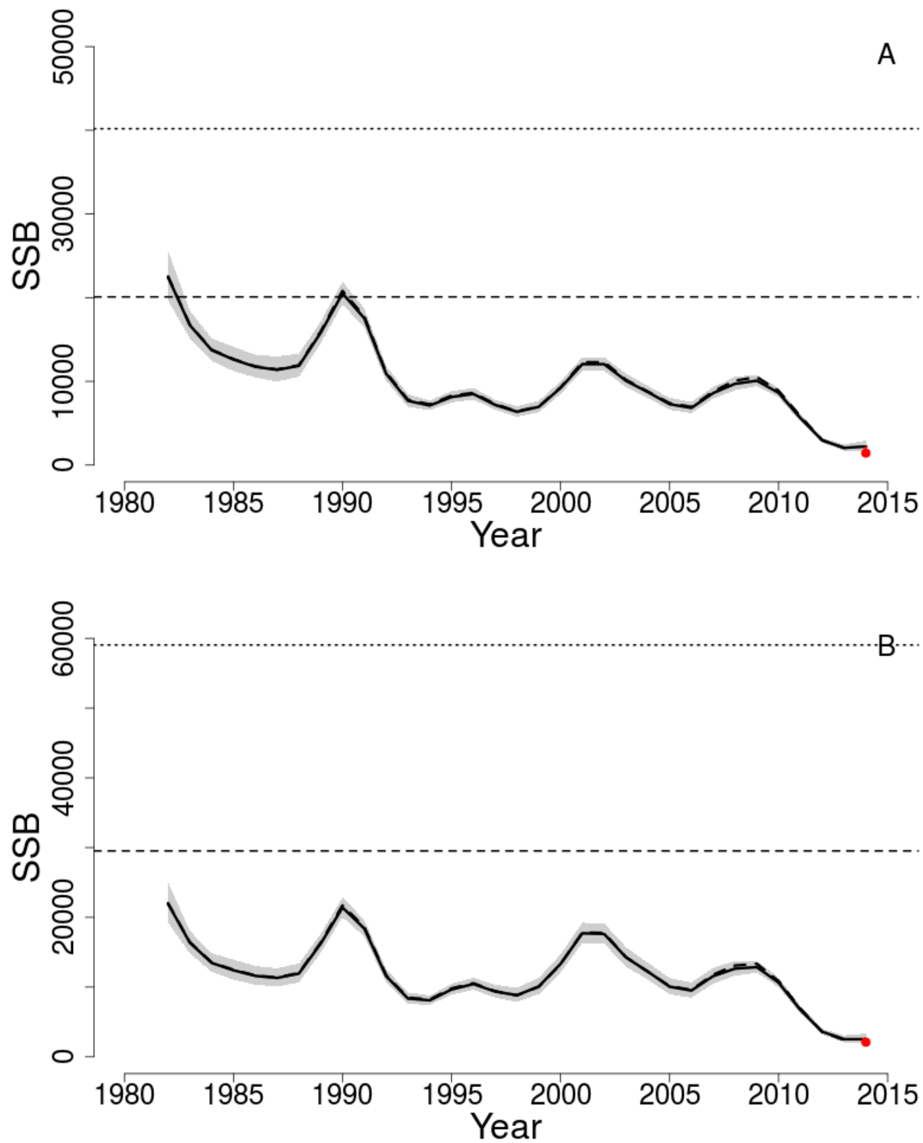

Figure 9: Estimated trends in the spawning stock biomass (SSB) of Gulf of Maine Atlantic cod between 1982 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY}; horizontal dashed line) as well as SSB_{Target} SSB_{MSY}; horizontal dotted line) based on the 2015 M=0.2 (A) and M-ramp (B) assessment models. The 90% lognormal confidence intervals are shown. The red dot indicates the rho-adjusted SSB values that would have resulted had a retrospective adjusment been made to either model (see Special Comments section).

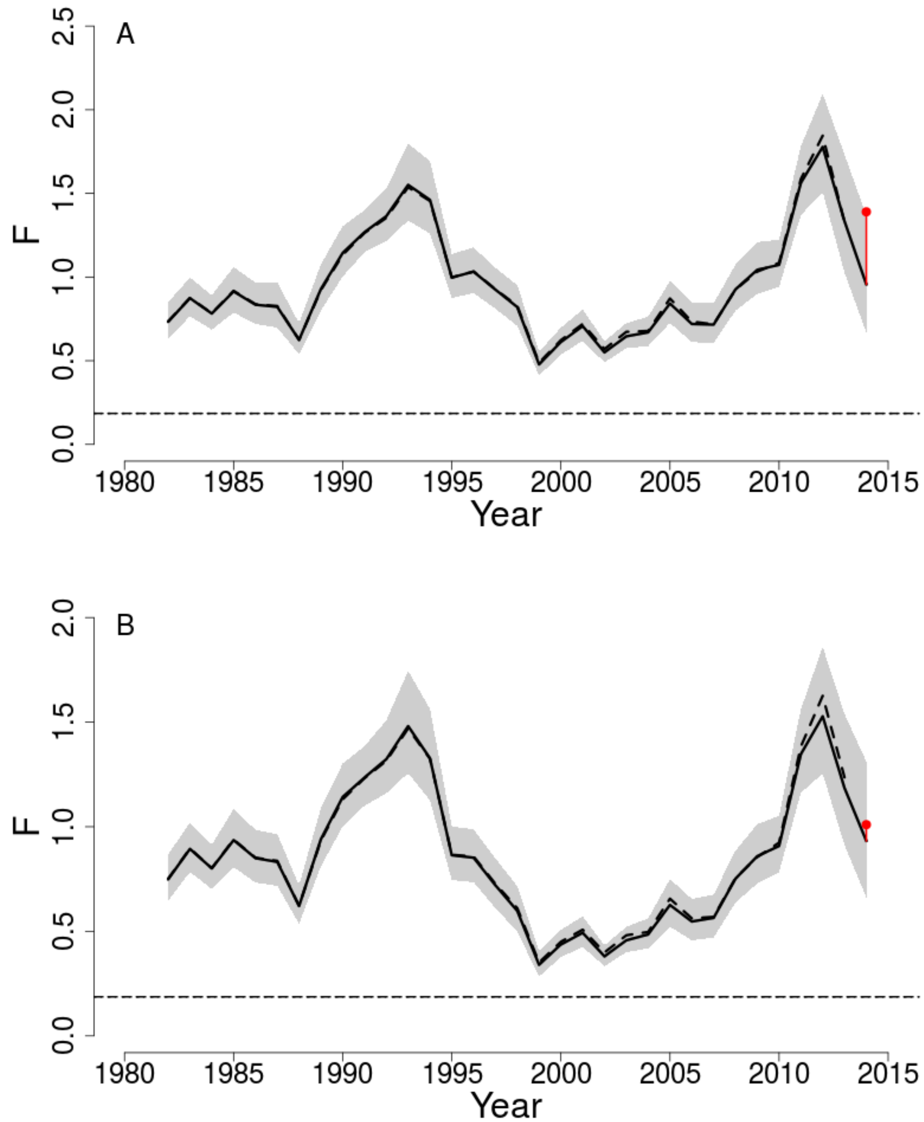

Figure 10: Estimated trends in the fully selected fishing mortality (F) of Gulf of Maine Atlantic cod between 1982 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (0.185 (M=0.2), 0.187 (M-ramp); dashed line) based on the 2015 M=0.2 (A) and M-ramp (B) assessment models. The 90% lognormal confidence intervals are shown. The red dot indicates the rho-adjusted F values that would have resulted had a retrospective adjusment been made to either model (see Special Comments section).

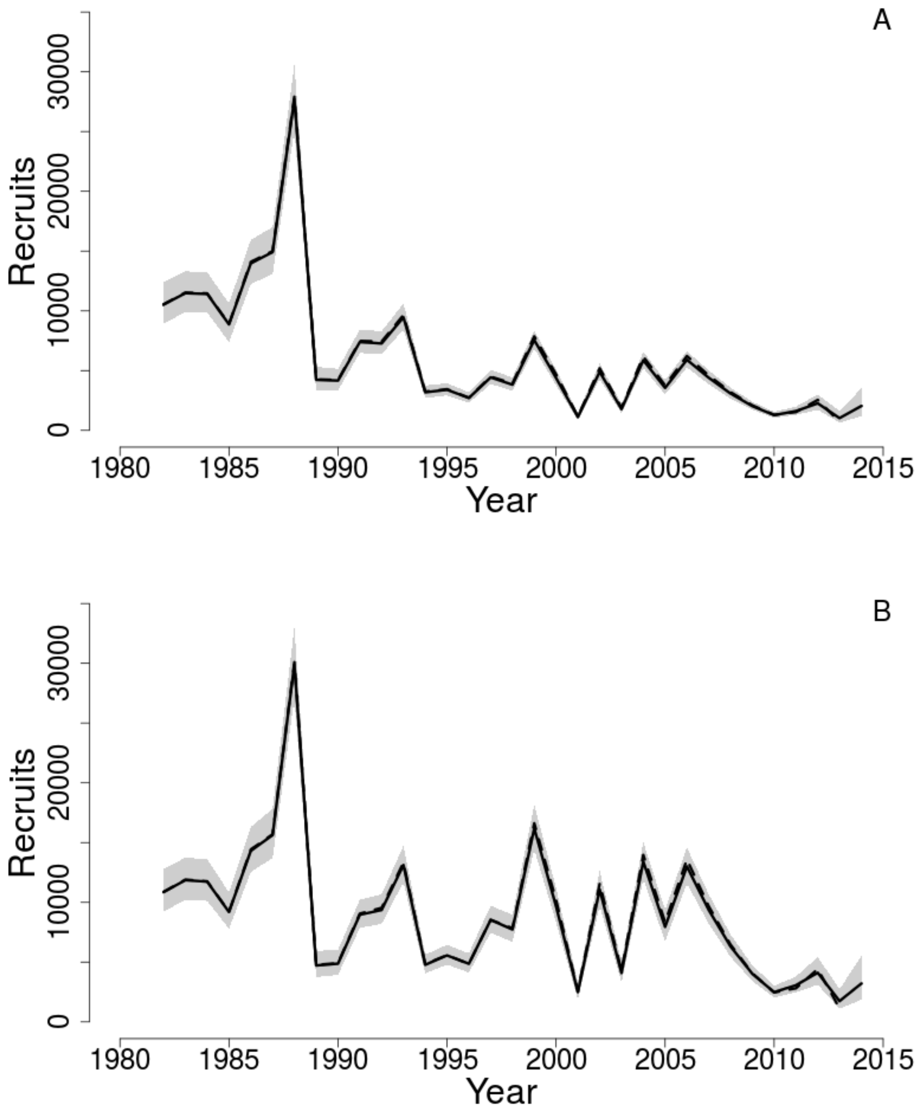

Figure 11: Estimated trends in age-1 recruitment (000s) of Gulf of Maine Atlantic cod between 1982 and 2014 from the current (solid line) and previous (dashed line) M=0.2 (A) and M-ramp (B) assessment models. The 90% lognormal confidence intervals are shown.

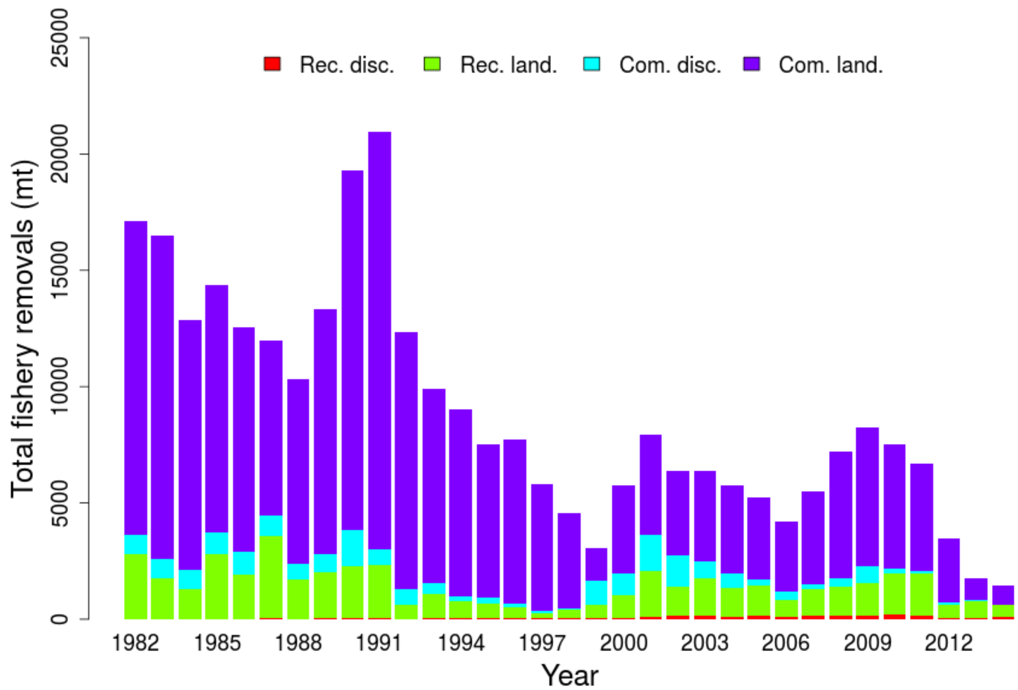

Figure 12: Total catch of Gulf of Maine Atlantic cod between 1982 and 2014 by fleet (commercial and recreational) and disposition (landings and discards).

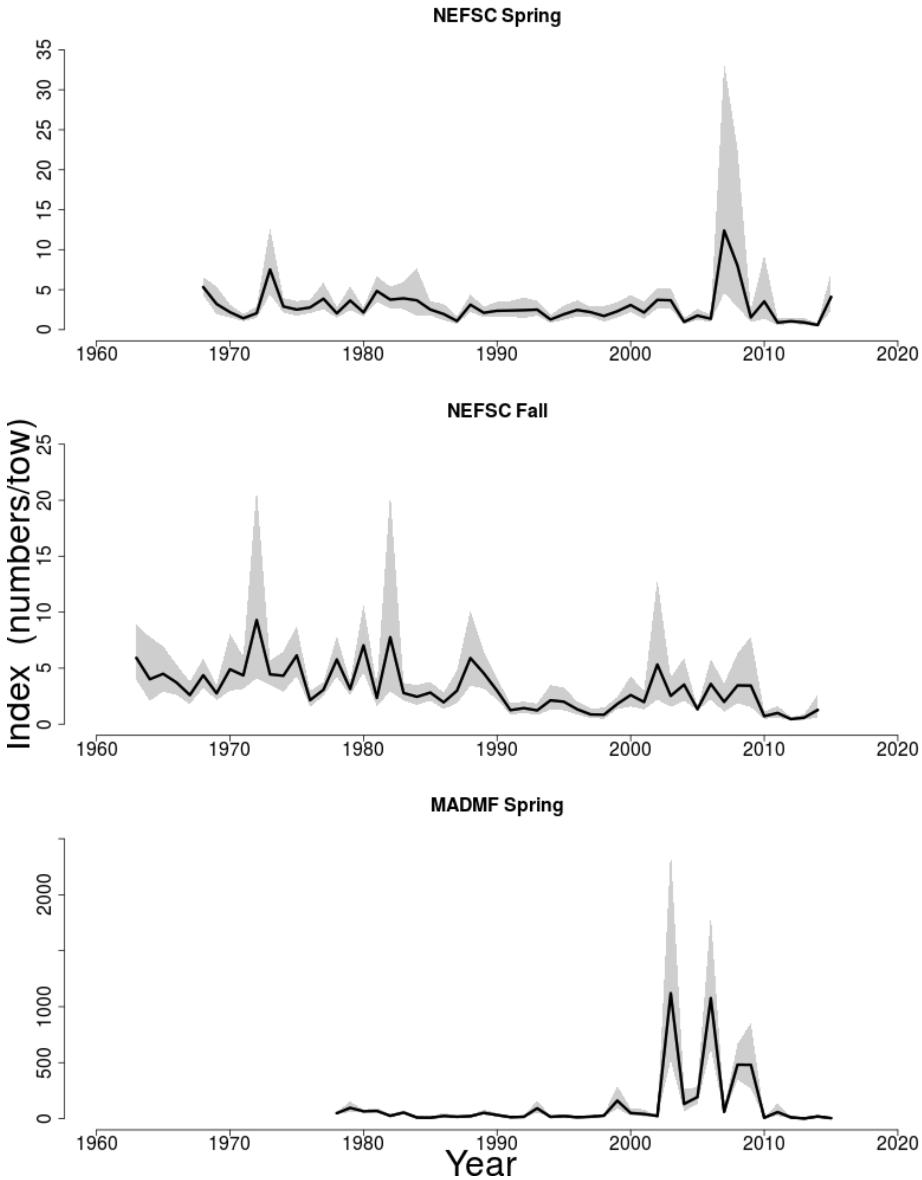

Figure 13: Indices of biomass for the Gulf of Maine Atlantic cod between 1963 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys and Massachusetts Division of Marine Fisheries (MADMF) spring bottom trawl survey. The 90% lognormal confidence intervals are shown.

3 Georges Bank Atlantic cod

Loretta O'Brien

The results from the assessment model were not accepted as a basis for scientific advice for management. Details on this decision may be found in section 3.1. Assessment results that follow reflect conclusions based on the current model configuration but are not used for estimation of overfishing limits in 2016. No attempts were made to refine model configuration to improve model performance. Under the Terms of Reference, such changes were beyond the scope of the Operational Assessment guidelines. Nonetheless these results below provide valuable summaries of fishery-dependent and fishery-independent data, information on model performance, and analyst's insights.

This assessment of the Georges Bank Atlantic cod (Gadus morhua) stock is an operational update of the existing 2012 benchmark assessment (NEFSC 2013). Based on the previous assessment the stock was overfished, and overfishing was ocurring. This 2015 assessment updates commercial fishery catch data, research survey indices of abundance, the analytical ASAP assessment model, and reference points through 2014. Additionally, stock projections have been updated through 2018.

State of Stock: Based on this updated assessment, the Georges Bank Atlantic cod (*Gadus morhua*) stock is overfished and overfishing is occurring (Figures 14-15). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 1,804 (mt) which is 1% of the biomass target for this stock (SSB_{MSY} *proxy* = 201,152; Figure 14). The 2014 fully selected fishing mortality was estimated to be 1.68 which is 994% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.169; Figure 15).

Table 11: Catch and model results for Georges Bank Atlantic cod. All weights are in (mt), recruitment is in (000s), and F_{Full} is the fishing mortality on fully selected ages (ages 5-8). Model results are from the current updated ASAP assessment.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Data										
Commercial landings	2,754	2,700	3,699	3,255	2,999	2,688	3,387	2,007	1,312	1,514
Commercial discards	394	232	728	309	385	253	122	120	83	19
Recreational landings	966	59	11	69	48	153	177	56	6	88
Recreational discards	101	4	3	1	5	23	17	1	1	2
CA landings	630	1,097	1,107	1,390	1,003	748	702	395	384	430
CA discards	226	350	117	140	206	94	43	75	39	28
Catch for Assessment	5,072	4,441	5,665	5,164	4,646	3,959	4,449	2,653	1,824	2,081
Model Results										
Spawning Stock Biomass	9,438	9,362	9,202	7,978	7,672	6,108	5,231	4,066	5,202	6,180
F_{Full}	0.703	0.583	0.825	0.903	0.898	0.916	1.33	1	0.483	0.463
Recruits $age1$	1,298	2,935	3,412	2,214	2,405	1,908	3,248	2,107	929	1,151

Table 12: Comparison of reference points estimated in the previous assessment and from the current assessment update. An $F_{40\%}$ proxy was used for the overfishing threshold and was based on long-term stochastic projections.

	2012	Current
F_{MSY} *proxy*	0.177	0.169
SSB_{MSY} (mt)	186,535	201,152 (157,963 - 247,517)
MSY (mt)	30,622	30,569 (23,910 - 37,712)
Median recruits (age 1) (000s)	8,765	7,118
Overfishing	Yes	Yes
Overfished	Yes	Yes

Projections: Short term projections of biomass were derived by sampling from a two-stage cumulative distribution function of recruitment estimates from ASAP model results, using a 50,000 mt cutpoint. The annual fishery selectivity, maturity ogive, and mean weights at age used in projections are the most recent 5 year averages; retrospective adjustments were applied in the projections.

Table 13: Short term projections of total fishery catch and spawning stock biomass for Georges Bank Atlantic cod based on a harvest scenario of fishing at F_{MSY} *proxy* between 2016 and 2018. Catch in 2015 was assumed to be 1,784 (mt).

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	1,784	1,552 (539 - 3,192)	1.510
2016	135	932 (152 - 2,508)	0.169
2017	263	2,134 (787 - 6,250)	0.169
2018	799	7,001 (3,054 - 24,931)	0.169

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 major source of uncertainty is presumably the estimate of catch or of natural mortality, considering the magnitude of the retrospective bias. These both affect the scale of the biomass, fishing mortality estimates, and the reference point estimates. The catch estimates do not include all discards (e.g., lobster gear) and includes uncertain estimates of recreational landings and discards, and of some commercial discards (e.g., small mesh). Natural mortality (M) of Georges Bank Atlantic cod is not well understood and is assumed constant over time in the model. Other sources of uncertainty include possible changes in *growth parameters in recent years and how this affects fecundity, the viability of eggs/sperm, and the success rate of hatching - all influencing recruitment survival and year class strength.*

- 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 Table 7).

  The 7-year Mohn's ρ, relative to SSB, was 0.68 in the 2012 assessment and was 2.43 in 2014. The 7-year Mohn's ρ, relative to F, was -0.46 in the 2012 assessment and was -0.72 in 2014. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2014 SSB (SSB_ρ=1,804) and 2014 F (F_ρ=1.68) were outside the approximate 90% confidence regions around SSB (3,922 - 10,596) and F (0.251 - 0.815). 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 6,180 to 1,804 and the 2014 F_{Full} from 0.463 to 1.68.

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

  Population projections for Georges Bank Atlantic cod are uncertain and likely optimistic. The projections are based on a biomass cutpoint of 50,000 mt, which has not been produced since 1992. The average recruitment since 1992 has been 4.9 million age 1 fish, whereas during the last 10 years, average recruitment has been about 2.7 million age 1 fish. A sensistivity projection using the most recent 10 years of recruitment was conducted and results presented in the SASINF database.

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

  No major changes, other than the addition of recent years of data, were made to the Georges Bank Atlantic cod assessment for this update. However, recreational catch and commercial discard estimates were revised slightly due to minor changes in the databases, and the application of length frequencies (annual instead of half year) in one instance.

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

  As in recent assessments for Georges Bank Atlantic cod the stock remains in an overfishing and overfished status.

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

  The Georges Bank Atlantic cod assessment could be improved with additional studies on natural mortality, growth, and fecundity. Additionally, more precise estimates of recreational landings and discards, sampling of fish caught by individual recreational anglers, and incorporation of discards in the lobster fishery would decrease uncertainty in the discard esimates.

- Are there other important issues?

  The differences in model assumptions of natural mortality between the SARC GB cod and the TRAC eGB cod assessment is problematic for the recovery of the entire GB cod stock. Model results of the TRAC VPA M=0.8 model are used to determine quota for the eGB management unit, so by default, proportionally more cod are being removed from eastern GB than what the GB cod ASAP model would predict.

3.1 Reviewer Comments: Georges Bank Atlantic cod

Recommendation: The Panel concluded that the updated assessment model (i.e., the SAW55 benchmark configuration) was not acceptable as a scientific basis for management advice. Several diagnostics that indicated problems in the SAW55 benchmark assessment are considerably worse in the updated assessment. The magnitude of retrospective inconsistency in estimates of SSB increased from 70% in the SAW55 assessment to 240% in the update assessment. The SAW55 benchmark assessment accounted for the retrospective pattern using a retrospective adjustment. When the retrospective adjustment was attempted in the update assessment for projections, a substantial number (24.2%) of the projected realizations were not feasible, because they could not support the preliminary estimate of 2015 catch.

The pattern and magnitude of predominantly positive aggregate survey residuals in the last decade also increased, indicating that the updated assessment does not fit survey trends well, and conflicts between information in fishery and survey age composition and survey trends increased. Some alternative model configurations were explored to help understand the problems in the updated assessment. Model explorations suggest that the "M 0.8" scenario assumed for eastern Georges Bank cod (TRAC 2015) and some alternative approaches to recruitment estimation do not resolve the lack-of-fit problems in the updated assessment.

The Panel agreed to provide results from the updated assessment as one interpretation of the available information. However, the panel concluded that stock status and catch advice should be based on an alternative approach. The SAW55 benchmark assessment concluded that the stock was overfished and overfishing continued in 2011. All information available in the update assessment indicates that stock size has not increased. Therefore, the Panel recommends that the SAW55 assessment is the best scientific information available for determining overfishing definitions, and the stock is still overfished. In the absence of an acceptable assessment and fishing mortality estimates that can be compared to the overfishing threshold, the overfishing status is currently unknown.

Alternative Assessment Approach: The Assessment Oversight Panel recommended that the 'fallback' if the updated ASAP is not accepted is to provide the average of recent (3 years) quota or catches. However, the Operational Assessment Panel is concerned that status quo catch may not be appropriate for the current stock status and survey trends. Projections from the updated assessment had indicated that status quo catch would not end overfishing, even taking into account that past projections have been optimistic. Recent catches have not allowed the stock to rebuild. Mean length at age, the proportion of old fish in the fishery and surveys, and recruitment indices all remain relatively low. None of these indicate stock recovery. Therefore, the Operational Assessment Panel recommends that the overfishing limit (OFL) should be a proportion of the most recent 3-year average catch, and that proportion should be determined by recent survey trends.

The Panel considered the use of the TRAC algorithm of smoothing swept-area biomass from surveys for catch allocations. However, incomplete coverage of Georges Bank by the DFO survey in recent years made this algorithm inappropriate. Therefore, the recent survey trend was derived from a combination of NEFSC spring and fall survey indices (methods described below). The recent survey trend (-24% per year), was applied to the status quo catch (2,186 mt per year 2012-2014) to derive the 2016 overfishing limit (1665 mt).

Sources of Uncertainty: The major sources of uncertainty are the retrospective error in the updated assessment, the conflicts in data, and the potential sources of retrospective patterns (mis-specified natural mortality, changes in natural mortality, mis-reported catch, unaccounted catch, changes in survey catchability and mis-specified selectivity). The Canadian survey has not sampled all strata every year and there have been apparent changes in growth rates. The assumed recreational discard mortality rate is considered to be a minor source of uncertainty for the Georges Bank cod stock. The Gulf of Maine cod assessment considered new information on discard mortality from the recreational fishery in that stock area, but the Panel agreed that the new information is less relevant for the Georges Bank cod stock and the assumption should not be revised for the update assessment. The panel also noted that the SAW55 projection method has overestimated recruitment.

Research Needs: The Panel recommends that a new assessment is needed to resolve the problems in the updated assessment model application. This operational assessment process did not allow for many possible revisions to the assessment method. An operational process with broader terms of reference may be able to resolve the problems in the update assessment. However, the data conflicts may require a full benchmark assessment or a research track process. If models cannot reconcile apparent conflicts in data, then empirical approaches may be needed. Recent information on cod stock structure and recommendations from the SAW55 benchmark should be considered in future assessments. Stock assessment approaches for the Georges Bank stock and the eastern Georges Bank management unit should be harmonized. The causes of low productivity, relative to historical productivity should be considered in the next assessment, including the investigation of ecosystem effects. Alternative methods for estimating recruitment and projecting recruitment are needed.

References:

Northeast Fisheries Science Center. 2013. 55^{th} Northeast Regional Stock Assessment Workshop (55^{th} SAW) Assessment Summary Report. Northeast Fisheries Science Center Reference Document 13-01:43.

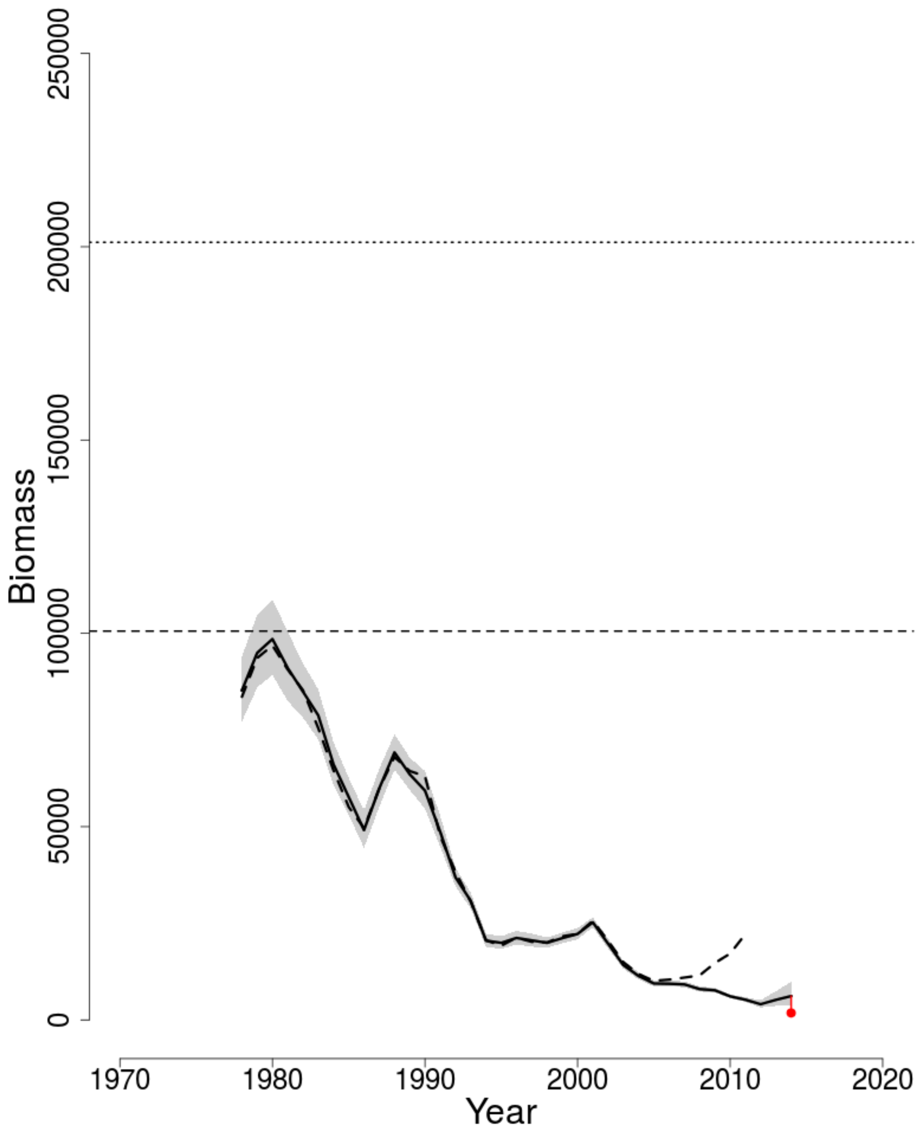

Figure 14: Trends in spawning stock biomass of Georges Bank Atlantic cod between 1978 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

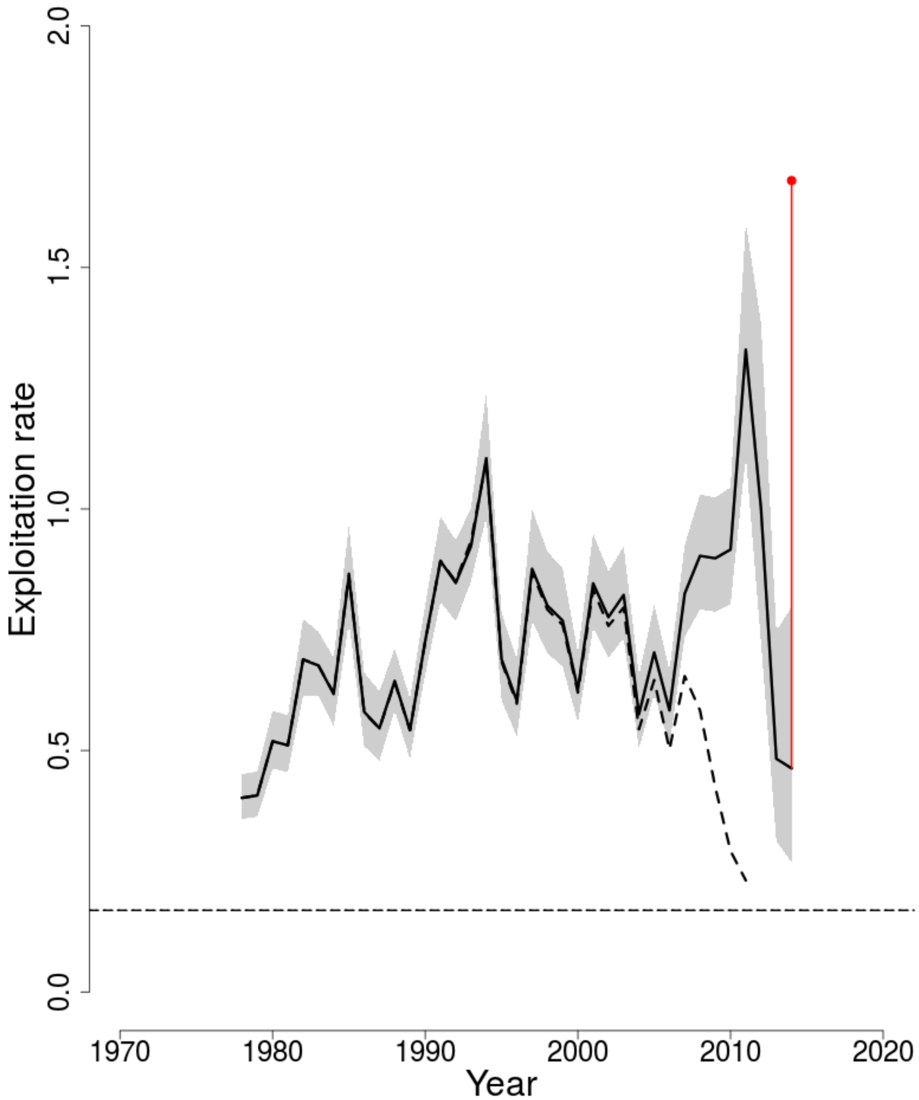

Figure 15: Trends in the fully selected fishing mortality (F_{Full}) of Georges Bank Atlantic cod between 1978 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.169; horizontal dashed line). F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red, based on the 2015 assessment. The approximate 90% lognormal confidence intervals are shown.

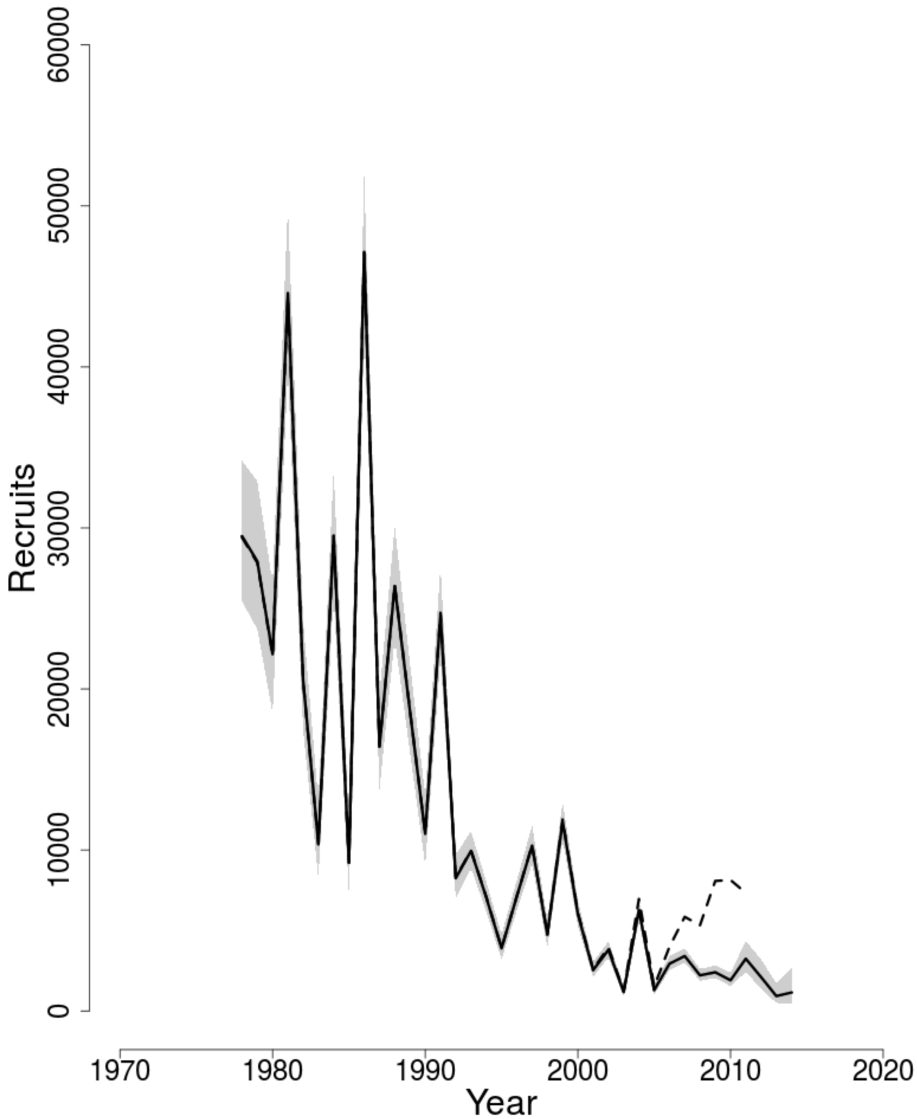

Figure 16: Trends in Recruits (age 1) (000s) of Georges Bank Atlantic cod between 1978 and 2014 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

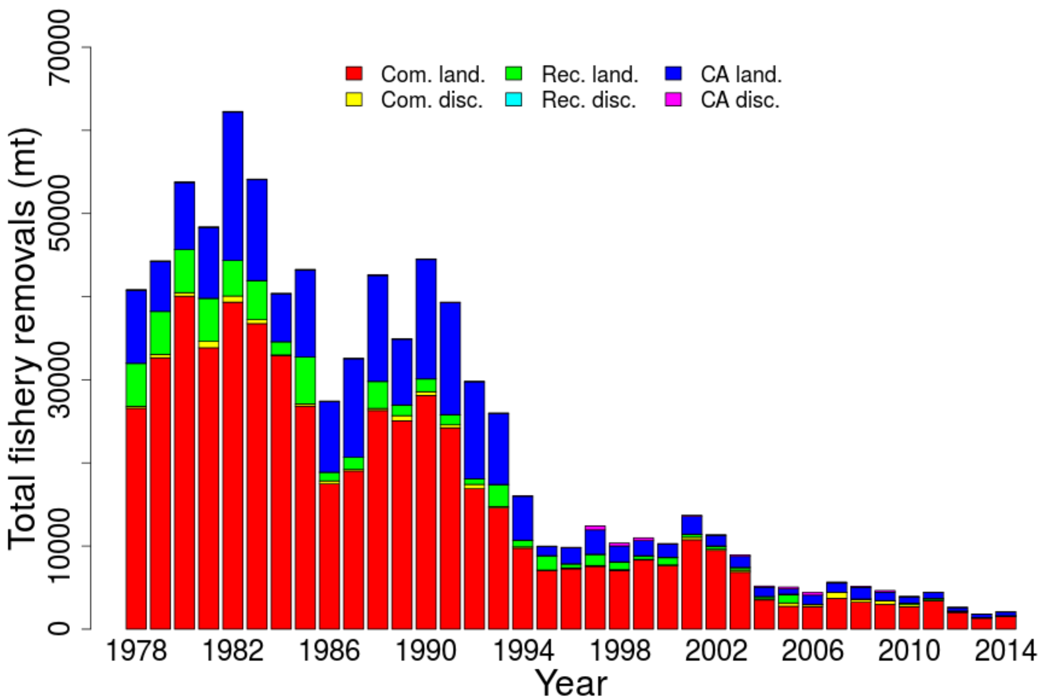

Figure 17: Total catch of Georges Bank Atlantic cod between 1978 and 2014 by fleet (US commercial, US recreational, or Canadian) and disposition (landings and discards).

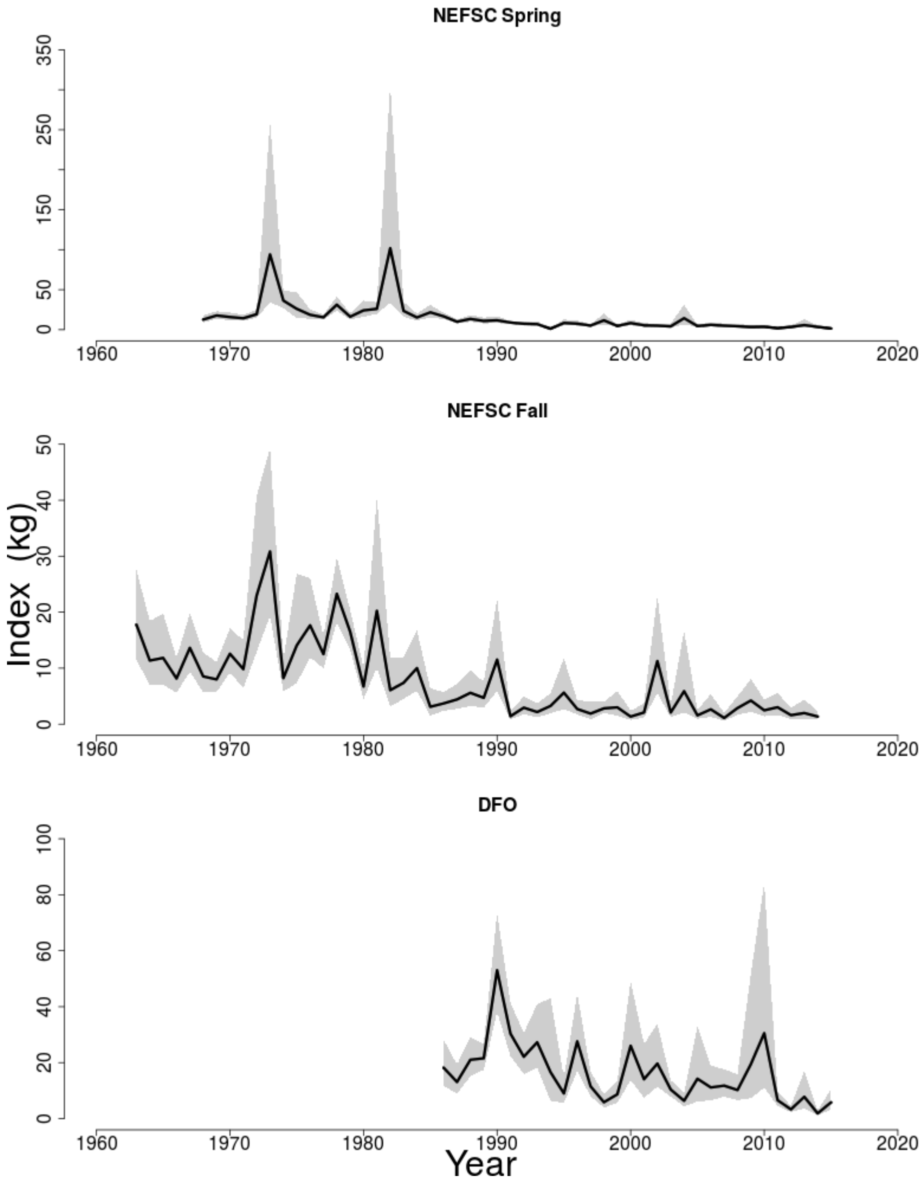

Figure 18: Indices of biomass for the Georges Bank Atlantic cod between 1963 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall, and the DFO research bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.

4 Georges Bank haddock

Liz Brooks

This assessment of the Georges Bank haddock (Melanogrammus aeglefinus) stock is an operational update of the existing 2012 update VPA assessment (Brooks et al., 2012). The last benchmark for this stock was in 2008 (Brooks et al., 2008). Based on the previous assessment in 2012, the stock was not overfished, and overfishing was not ocurring. This assessment updates commercial fishery catch data, research survey indices of abundance, weights and maturity at age, and the analytical VPA assessment model and reference points through 2014. Additionally, stock projections have been updated through 2018.

State of Stock: Based on this updated assessment, the Georges Bank haddock (*Melanogrammus aeglefinus*) stock is not overfished and overfishing is not occurring (Figures 19-20). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 150,053 (mt) which is 139% of the biomass target (SSB_{MSY} *proxy* = 108,300; Figure 19). The 2014 fully selected fishing mortality was estimated to be 0.241 which is 62% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.39; Figure 20).

Table 14: Catch and status table for Georges Bank haddock. All weights are in (mt), recruitment is in (000s), and F_{Full} is the average fishing mortality on ages 5 to 7. Model results are from the current updated VPA assessment. A rho adjustment was not applied to values in this Table.

	2007	2008	2009	2010	2011	2012	2013	2014
Data								
US Commercial discards	1,968	389	196	144	212	321	538	1,409
US Commercial landings	14,837	20,632	22,930	25,759	5,210	1,550	1,659	4,240
Canadian Catch	10	0	0	0	11,248	5,064	4,631	12,953
Catch for Assessment	16,815	21,021	23,126	25,903	16,670	6,935	6,828	18,601
Model Results								
Spawning Stock Biomass	182,528	166,726	140,278	103,889	71,076	65,848	162,078	225,080
F_{Full}	0.241	0.183	0.195	0.308	0.266	0.258	0.16	0.159
Recruits $age1$	5,826	6,488	3,574	7,696	399,497	70,916	29,655	3,406,466

Table 15: Comparison of reference points estimated in an earlier assessment and from the current assessment update. An $F_{40\%}$ proxy was used for the overfishing threshold. The medians and 90% probability intervals are reported for MSY, SSBMSY, and RMSY, based on long-term stochastic projections with fishing mortality fixed at $F_{40\%}$.

	2012	Current
F_{MSY} proxy	0.39	0.39
SSB_{MSY} (mt)	124,900	108,300 (58,200 - 167,900)
MSY (mt)	28,000	24,900 (13,600 - 38,400)
Median recruits (age 1) (000s)	54,200	53,400 (3,500 - 130,000
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of biomass were derived by sampling from a cumulative distribution function of recruitment estimates from ADAPT VPA (corresponding to SSB>75,000 mt and dropping the extremely large 1963, 2003, and 2010 year classes, as well as the two final year class estimates for 2013 and 2014). The annual fishery selectivity, maturity ogive, and mean weights at age used in this projection are the most recent 5 year averages; retrospective adjustments were applied to the starting numbers at age (2015) in the projections.

Table 16: Short term projections of total fishery catch and spawning stock biomass for Georges Bank haddock based on a harvest scenario of fishing at F_{MSY} *proxy* between 2016 and 2018. Catch in 2015 was assumed to be 20,686 mt.

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	20,686	450,644 (295,863 - 677,103)	0.100 (0.073 - 0.139)
2016	160,385 (98,994 - 255,087)	1,171,481 (636,247 - 1,997,691)	0.390
2017	242,187 (132,381 - 414,260)	1,226,513 (655,530 - 2,109,738)	0.390
2018	293,033 (155,255 - 506,597)	962,959 (525,327 - 1,647,905)	0.390

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 is the estimate of 2013 recruitment, which accounts for a substantial portion of catch and SSB in projections. The rho adjusted projections reduce all starting numbers at age to 67% of unadjusted values (i.e., all 2015 numbers at age are multiplied by 0.667). Two other exceptionally large year classes were observed in 2003 and 2010. The 2003 year class is now estimated to be only 28% of its initial model estimate, while the 2010 year class is now estimated to be 63% of it's initial estimate. Given that only 5 years of data are available to estimate the 2010 year class, it is possible that there may be further revisions to the magnitude of this year class estimate with more years of data. Therefore, it remains uncertain if the scalar applied to all age classes in these projections (0.667, based on Mohn's rho for SSB) is sufficient to account for future revisions to the 2013 *year class estimate. In addition, the median recruitment in the projections (the proxy for recruitment at MSY) is 53.4 million, which is greater than 7 of the last 10 recruitments even though SSB is above the SSBMSY proxy (Table 1). While projections of catch and SSB in the near-term are mostly driven by the 2013 year class, it is worth noting the magnitude of median projected recruitment relative to recent recruitment observations.*

- 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 Table 7).

  The 7-year Mohn's ρ, relative to SSB, was 0.20 in the 2012 assessment and was 0.50 in 2014. The 7-year Mohn's ρ, relative to F, was -0.15 in the 2012 assessment and was -0.34 in 2014. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2014 SSB (SSB_ρ=150,053) and 2014 F (F_ρ=0.241) were outside the approximate 90% confidence regions around SSB (171,911 - 301,282) and F (0.13 - 0.203). 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 225,080 to 150,053 and the 2014 F_{Full} from 0.159 to 0.241.

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

  As noted above, population projections for Georges Bank haddock are uncertain due to uncertainty about the size of the 2013 year class. Two sensitivity projections were conducted. The first sensitivity used biological parameters and fishery selectivity values from the 2010 year class for the 2013 year class. A second sensitivity projection was made that used the same biological and selectivity parameters as the first sensitivity, and in addition it doubled the rho-adjustment on the 2013 year class (age 2 at the start of 2015) by multiplying it by 0.33. These sensitivity runs are available on the Stock Assessment Supplementary Information website (SASINF), in the sensitivity slides appended to the end of the background presentation.

- 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.

  No changes, other than the incorporation of new data were made to the Georges Bank haddock assessment for this update. However, the criterion for determining acceptable tows on NEFSC surveys used the TOGA protocol rather than the SHG protocol (TOGA=132x).

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

  The stock status of Georges Bank haddock has not changed.

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

  Projection advice and reference points for Georges Bank haddock are strongly dependent on recruitment. A decade ago, extremely large year classes were considered anomalies (e.g., 1963 and 2003). However, since 2003, there have been two more extremely large (2010 and 2013) and one very large (2012) year classes. Future work could focus on recruitment forecasting and providing robust catch advice.

- Are there other important issues?

  The Georges Bank haddock assessment has recently developed a major retrospective *pattern. This stock assessment has historically performed very consistently. This should continue to be monitored. Density-dependent responses in growth should also continue to be monitored. The switch from SHG to TOGA was ruled out as the cause of the retrospective pattern.*

4.1 Reviewer Comments: Georges Bank haddock

Recommendation: The Panel concluded that the updated assessment with retrospective adjustment was acceptable as a scientific basis for management advice. The minor revisions of survey data and maturity schedule were acceptable. The Assessment Oversight Panel decided that the base case projection excluded the few dominant year classes from the recruitment distribution, but a sensitivity analysis provided to the PDT included them.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: The major sources of uncertainty are the retrospective pattern, estimation of recent recruitment, and the expectation of density-dependent effects. The 2013 year class is not well estimated, and estimates of previous dominant year classes changed substantially as assessments were updated. Based on recent observations from dominant year classes in the fishery and surveys, density dependent growth should be expected. However, the expected changes in growth and selectivity are not accounted for in projections.

Research Needs: The Panel recommends that the sources of the retrospective pattern need to be addressed. Considering that retrospective patterns are a common problem, the generic problem may be most appropriately addressed in a research track topic, and all possible sources of the retrospective problem should be investigated (misspecified natural mortality, changes in natural mortality, under-reported catch, changes in survey catchability and misspecified selectivity, etc.). Specific research recommendations include monitoring of abundance and growth of the 2013 year class, investigation of recruitment processes to help improve recruitment forecasting, and methods to estimate MSY reference points for a stock with episodic recruitment.

References:

Brooks, E.N, M.L. Traver, S.J. Sutherland, L. Van Eeckhaute, and L. Col. 2008. In. 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 Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii.
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Brooks, E.N, S.J. Sutherland, L. Van Eeckhaute, and M. Palmer. 2012. In. Northeast Fisheries Science Center. 2012. Assessment or Data Updates of 13 Northeast Groundfish Stocks through 2010. US Dept Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 12-06.; 789 p.
http://nefsc.noaa.gov/publications/crd/crd1206/

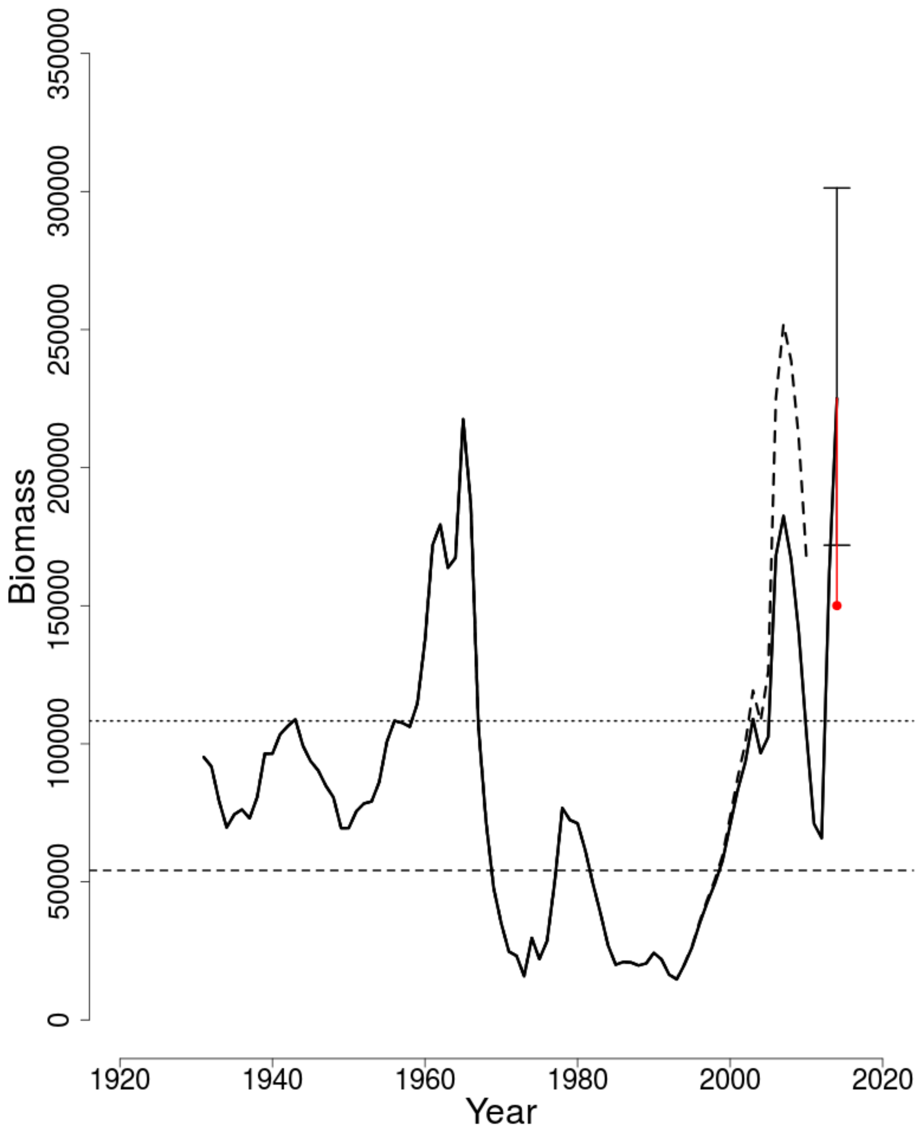


Figure 19: Trends in spawning stock biomass of Georges Bank haddock between 1931 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The 90% bootstrap probability intervals are shown.

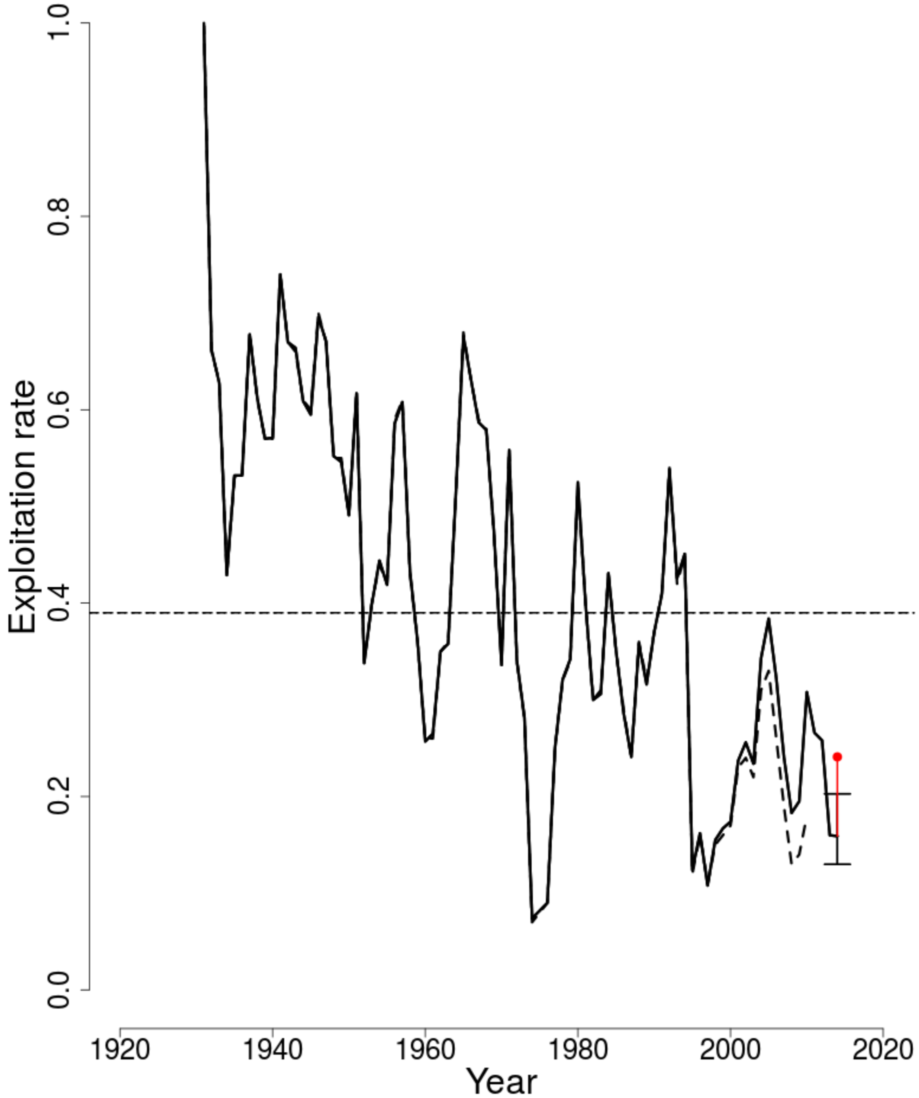


Figure 20: Trends in the fully selected fishing mortality (F_{Full}) of Georges Bank haddock between 1931 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.39; horizontal dashed line) based on the 2015 assessment. F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red. The 90% bootstrap probability intervals are shown.

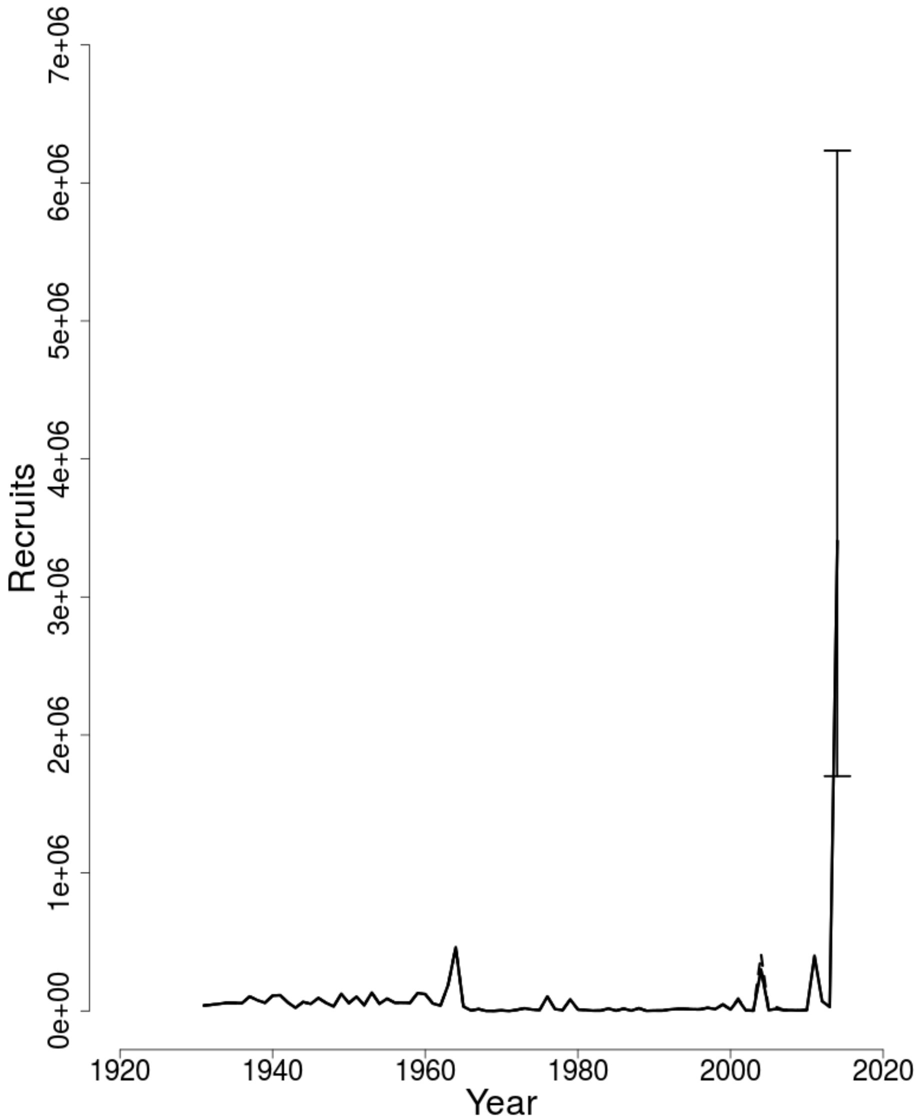


Figure 21: Trends in Recruits (age 1) (000s) of Georges Bank haddock between 1931 and 2014 from the current (solid line) and previous (dashed line) assessment. The 90% bootstrap probability intervals are shown.

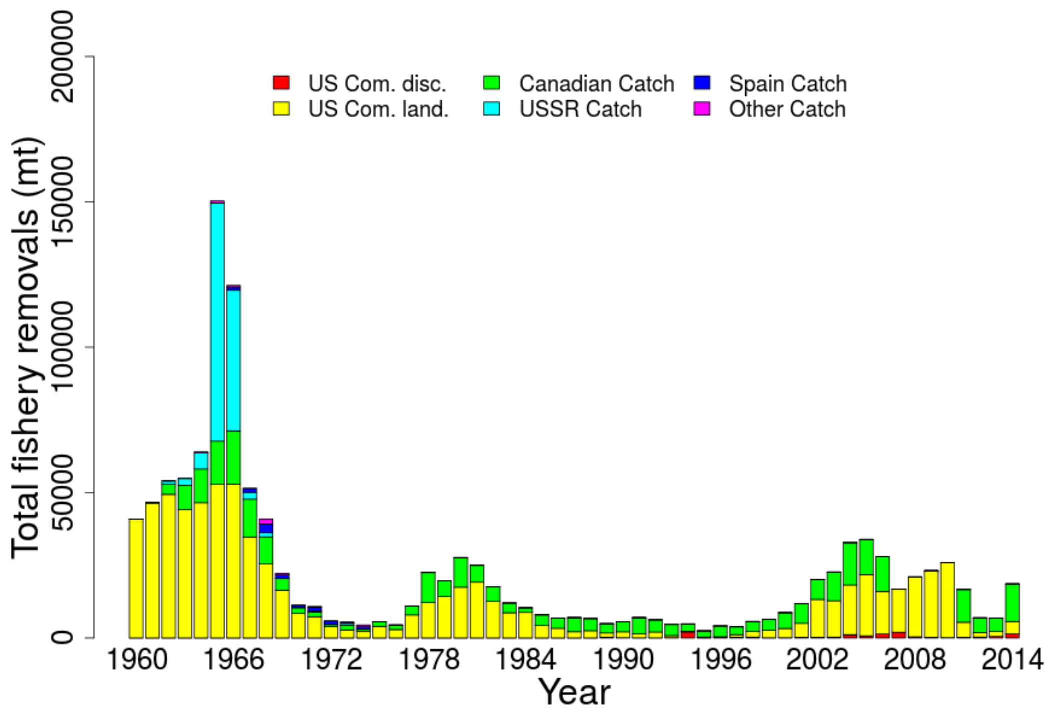


Figure 22: Total catch of Georges Bank haddock between 1931 and 2014 by fleet (US Commercial, Canadian, or foreign fleet) and disposition (landings and discards).

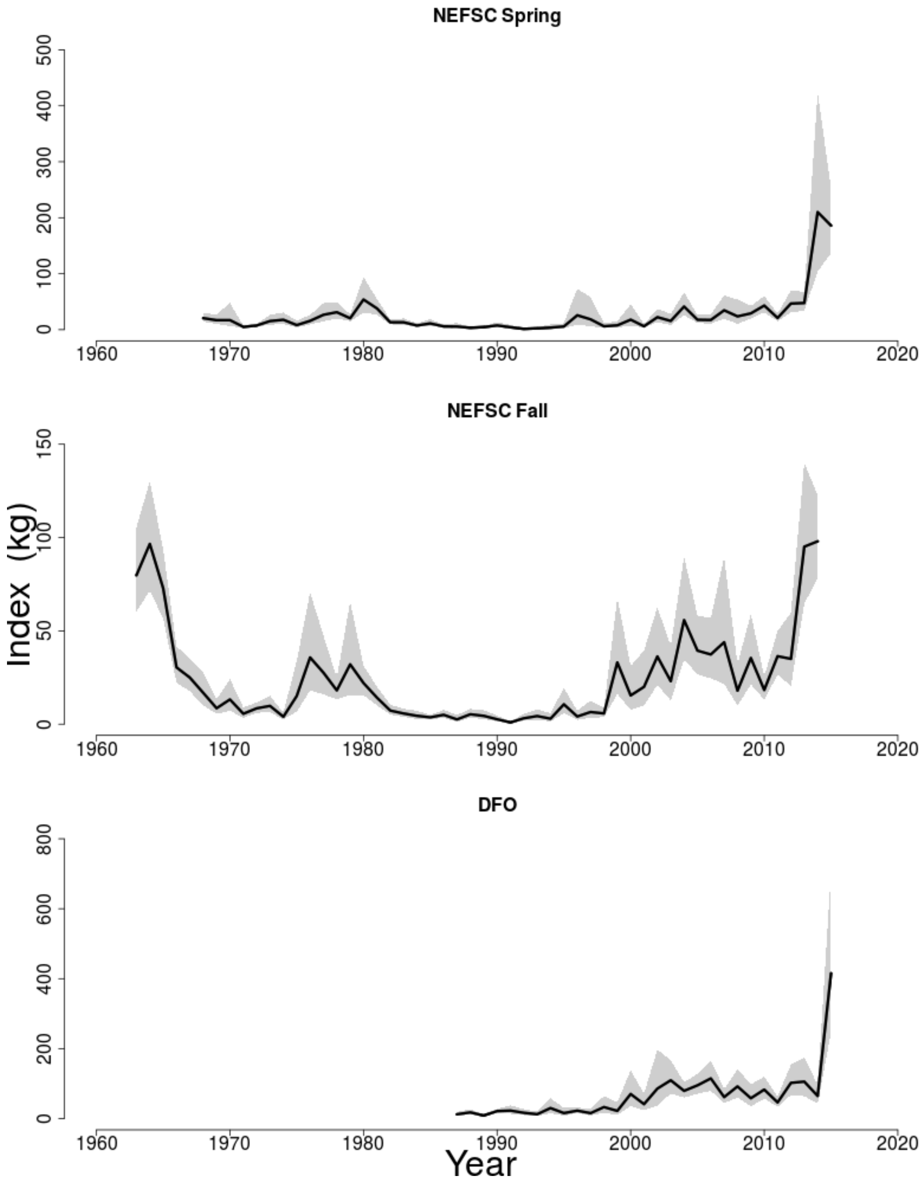


Figure 23: Indices of biomass (Mean kg/tow) for the Georges Bank haddock stock between 1963 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys and the DFO winter bottom trawl survey. The approximate 90% lognormal confidence intervals are shown.

5 Gulf of Maine haddock

Michael Palmer

This assessment of the Gulf of Maine haddock (Melanogrammus aeglefinus) stock is an operational update of the existing 2014 benchmark assessment (NEFSC 2014). Based on the previous assessment, the stock was not overfished, and overfishing was not ocurring. This assessment updates commercial and recreational fishery catch data, research survey indices of abundance, and the analytical ASAP assessment model and reference points through 2014. Additionally, stock projections have been updated through 2018

State of Stock: Based on this updated assessment, the Gulf of Maine haddock (*Melanogrammus aeglefinus*) stock is not overfished and overfishing is not occurring (Figures 24-25). Retrospective adjustments were not made to the model results (see Special Comments section of this report). Spawning stock biomass (SSB) in 2014 was estimated to be 10,325 (mt) which is 223% of the biomass target (SSB_{MSY} *proxy* = 4,623; Figure 24). The 2014 fully selected fishing mortality was estimated to be 0.257 which is 55% of the overfishing threshold proxy (F_{MSY} *proxy* = $F_{40\%}$ = 0.468; Figure 25).

Table 17: Catch and status table for Gulf of Maine haddock. All weights are in (mt) recruitment is in (000s) and F_{Full} is the fully selected fishing mortality. Model results are from the current updated ASAP assessment.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
					Data					
Recreational discards	36	66	46	72	24	19	11	54	250	371
Recreational landings	538	447	573	537	409	314	229	251	299	314
Commercial discards	25	32	47	10	12	3	6	18	32	22
Commercial landings	978	622	678	543	500	623	499	417	212	314
Foreign landings	0	0	0	0	0	0	0	0	0	0
Catch for Assessment	1,577	1,167	1,343	1,162	946	958	744	739	793	1,021
					Model Results					
Spawning Stock Biomass	8,848	8,219	7,271	6,369	5,735	4,877	4,086	4,551	6,907	10,325
F_{Full}	0.264	0.226	0.322	0.298	0.247	0.287	0.26	0.337	0.296	0.257
Recruits $age1$	451	1,325	1,541	279	438	1,345	11,547	3,930	18,186	26,457

Table 18: Comparison of reference points estimated in an earlier assessment and from the current assessment update. The overfishing threshold is the F_{MSY} *proxy* ($F_{40\%}$). The biomass target, (SSB_{MSY} *proxy*) was based on long-term stochastic projections of fishing at the F_{MSY} *proxy*. Median recruitment reflects the median estimated age-1 recruitment from 1977 - 2012. Intervals shown reflect the 5th and 95th percentiles.

	2014	Current
F_{MSY} *proxy*	0.46 (0.36 - 0.54)	0.468 (0.391 - 0.547)
SSB_{MSY} (mt)	4,108 (1,774 - 7,861)	4,623 (2,036 - 9,283)
MSY (mt)	955 (421 - 1,807)	1,083 (489 - 2,148)
Median recruits (age 1) (000s)	1,121 (205 - 6,500)	1,335 (253 - 8,198)
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of median total fishery yield and spawning stock biomass for Gulf of Maine haddock 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 885 mt. Recruitment was sampled from a cumulative distribution function of model estimated age-1 recruitment from 1977-2012. The age-1 estimate in 2015 was generated from the geometric mean of the 1977-2014 recruitment series. The annual fishery selectivity, maturity ogive, and mean weights at age used in the projections were estimated from the most recent 5 year averages; retrospective adjustments were not applied in the projections. Given the uncertainty in the size of the 2012 and 2013 year classes and the model's tendency to overestimate large terminal year classes, the 2015 assessment review panel recommended that a sensitivity projection scenario which constrains terminal recruitment ('Constrain terminal R') be brought forward to the New England Fishery Management Council's Scientific and Statistical Committee (NEFMC SSC) for consideration when setting catch advice; these sensitivity projections are provided in the Supplemental Information Report (SASINF).

Table 19: Short term projections of total fishery catch and spawning stock biomass for Gulf of Maine haddock based on a harvest scenario of fishing at F_{MSY} *proxy* ($F_{40\%}$) between 2016 and 2018. Catch in 2015 was assumed to be 885 (mt).

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	885	18,026	0.131
2016	4,717	25,352	0.468
2017	5,614	24,623	0.468
2018	5,642	20,371	0.468

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 assessment is the estimated size of the 2012 and 2013 year classes. Based on the estimated selectivity patterns, these year classes are projected to be 30% selected to the fishery in 2016 and 2017 respectively. However, recent changes to the commercial and recreational minimum retention size may result in these year classes recruiting to the fishery sooner than projected. The abundance and growth of the 2012 and 2013 year classes should be monitored and frequent model updates would be expected to improve the estimates of year class size and validate projection assumptions.

- 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} lie outside of the approximate joint confidence region for SSB and F_{Full}).

  This assessment does not exhibit a retrospective pattern and therefore no retrospective adjustments were made to the terminal model results or the short-term catch projections. The 7-year Mohn's rho values on SSB (-0.04) and F (0.03) are small and there were no consistent patterns in the directionality of the retrospective 'peels' (see the Supplemental Information Report, SASINF).

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

  Population projections for Gulf of Maine haddock, are reasonably well determined. The projected boimass from the last assessment is below the confidence bounds of the biomass estimated in the current assessment; however, this is primarily due to the positive rescaling of the population size that occured from turning the ASAP model likelihood constants option off (see next Special Comment).

- 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.

  Recreational catch estimates from 2004-2014 were re-estimated as part of this update to account for updates to the MRIP data. Additionally, the ASAP model was revised by turning the likelihood constants off; sensitivity runs on SAW/SARC 59 model suggest minor positive rescaling of recruitment and SSB, negative rescaling of F (sensitivity results are provided in the Supplemental Information Report, SASINF).

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

  There has been no change in stock status since the previous SAW/SARC 59 assessment (2014).

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

  Currently the assessment assumes 50% survival of haddock discarded in the recreational fishery - directed field research would improve this estimate. Additionally, a better understanding of recruitment processes may help to improve recruitment forecasting.

- Are there other important issues?

  None.

5.1 Reviewer Comments: Gulf of Maine haddock

Recommendation: The Panel concluded that the updated assessment was acceptable as a scientific basis for management advice. The minor revisions to the recreational catch statistics are justified. The Assessment Oversight Panel recommended that the likelihood function should be revised. The assessment results are somewhat sensitive to the revised likelihood function, but the revision is reasonable. There was no retrospective pattern in the update assessment.

Alternative Assessment Approach: Not Applicable

Sources of Uncertainty: The major source of uncertainty is the estimation of recent recruitment; the abundance of the 2012 and 2013 year classes is not well estimated. A sensitivity analysis of the SAW59 benchmark method that includes a constraint on the estimate of recruitment in the last year of the assessment, which limits the abundance estimate of the 2013 year class was also provided in the update assessment. The method was performance tested in SAW59 but the Panel noted that the model does not fit the surveys well in the last two years. Although density-dependent growth has not been observed for this stock, there have been strong density-dependent effects for haddock in other areas from dominant year classes. Recreational discard mortality is also uncertain.

Research Needs: The Panel recommends that abundance of 2012 and 2013 year classes should be monitored. Model updates are expected to improve the estimates of abundance. As noted for Georges Bank haddock, a better understanding of recruitment process may help to improve the estimation and projection of recruitment. Importantly, the estimation of MSY reference points for a stock with episodic recruitment should be reconsidered. When experimental results become available, estimates of recreational discard mortality should be considered in future assessments. Projections from the sensitivity analysis with recruitment constraints should be considered for catch advice.

References:

Northeast Fisheries Science Center. 2014. 59^{th} Northeast Regional Stock Assessment Workshop (59^{th} SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 14-09; 782 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026

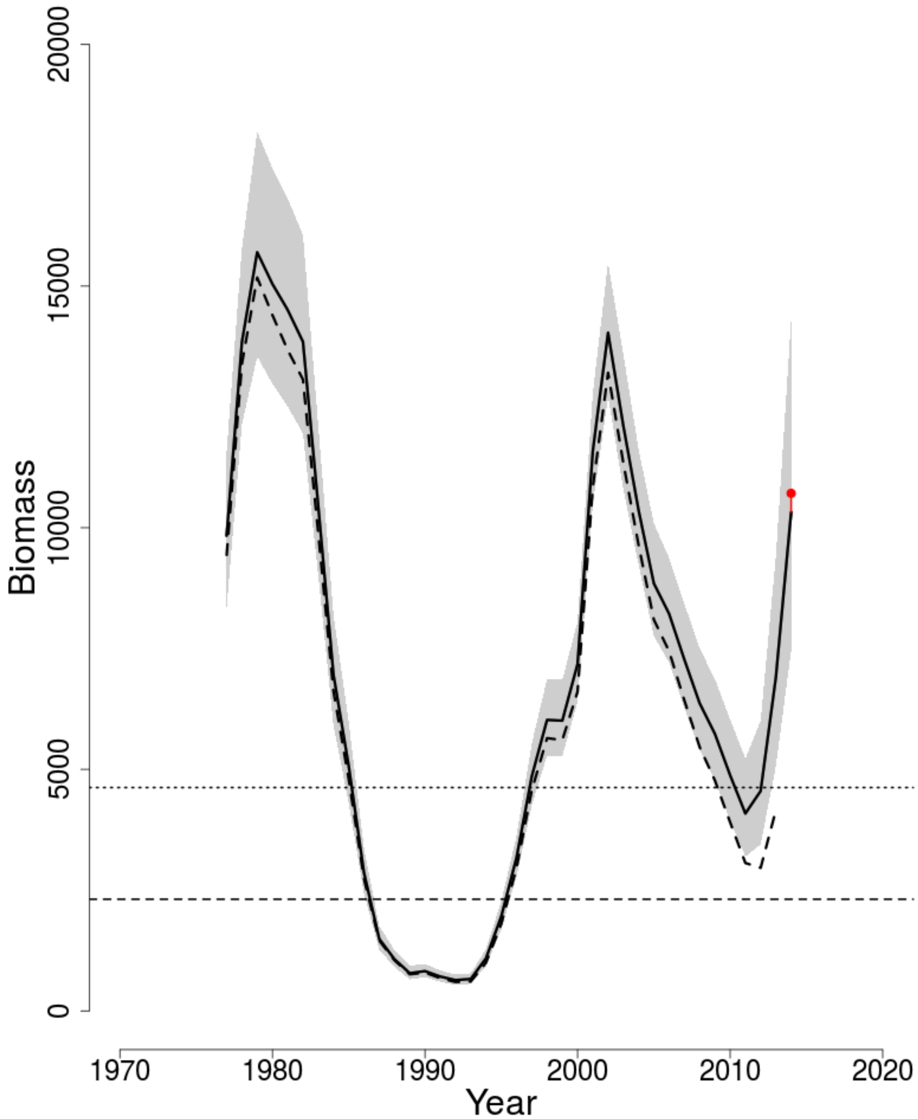


Figure 24: Trends in spawning stock biomass (SSB) of Gulf of Maine haddock between 1977 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment. The approximate 90% lognormal confidence intervals are shown. The red dot indicates the rho-adjusted SSB values that would have resulted had a retrospective adjusment been made to either model (see Special Comments section).

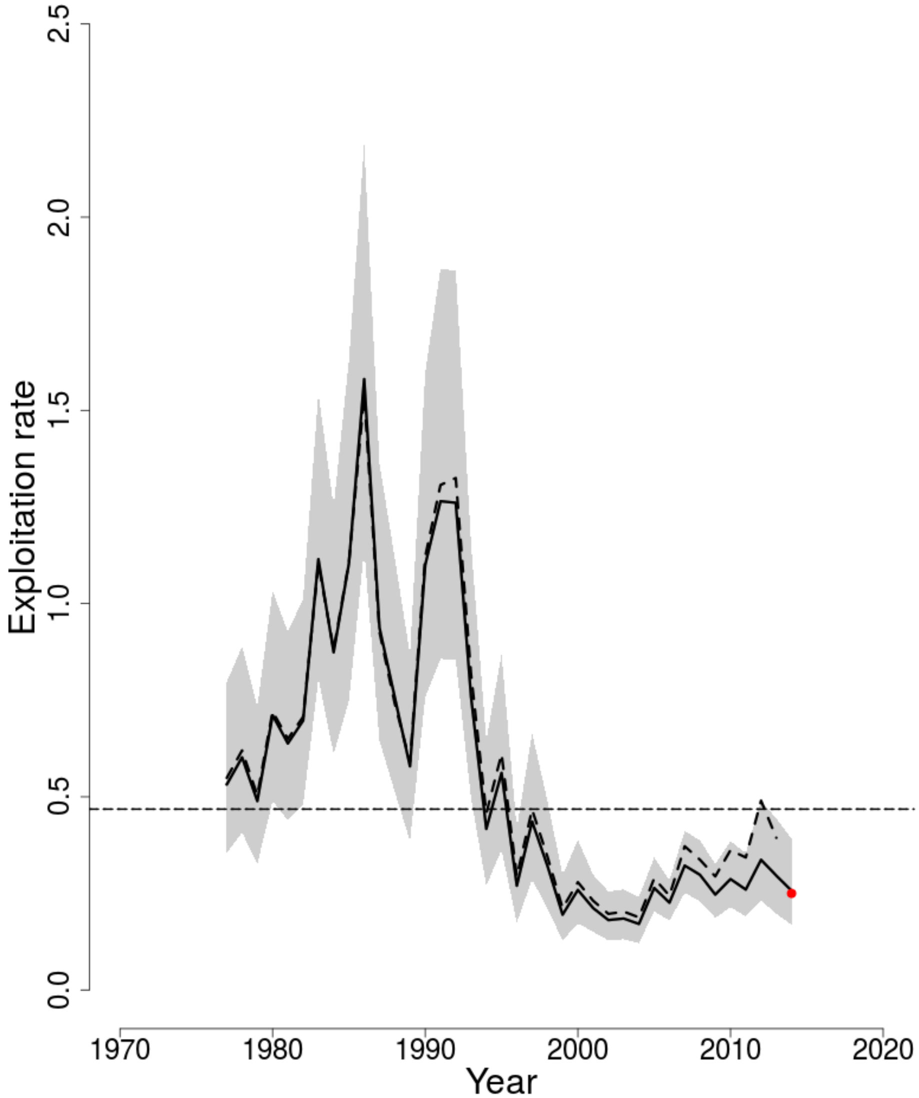


Figure 25: Trends in the fully selected fishing mortality (F) of Gulf of Maine haddock between 1977 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.468; horizontal dashed line) from the 2015 assessment model. The approximate 90% lognormal confidence intervals are shown. The red dot indicates the rho-adjusted F values that would have resulted had a retrospective adjusment been made to either model (see Special Comments section).

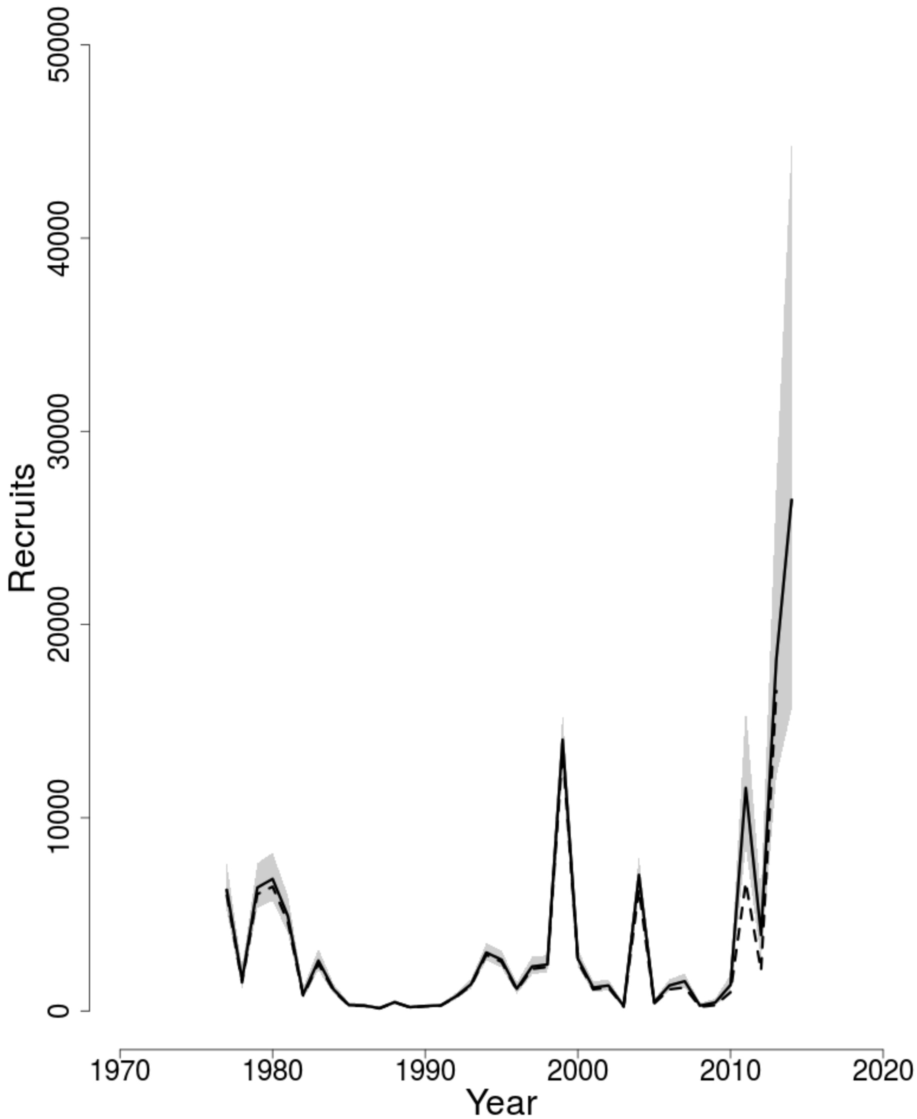


Figure 26: Trends in Recruits (age 1) (000s) of Gulf of Maine haddock between 1977 and 2014 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

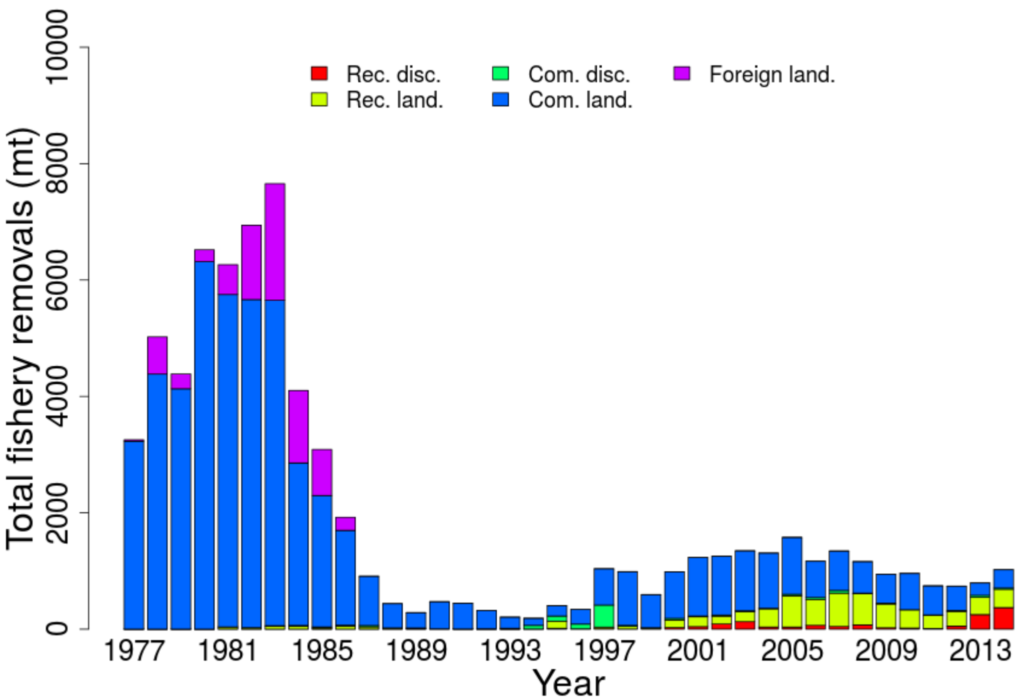


Figure 27: Total catch of Gulf of Maine haddock between 1977 and 2014 by fleet (commercial, recreational, or foreign) and disposition (landings and discards).

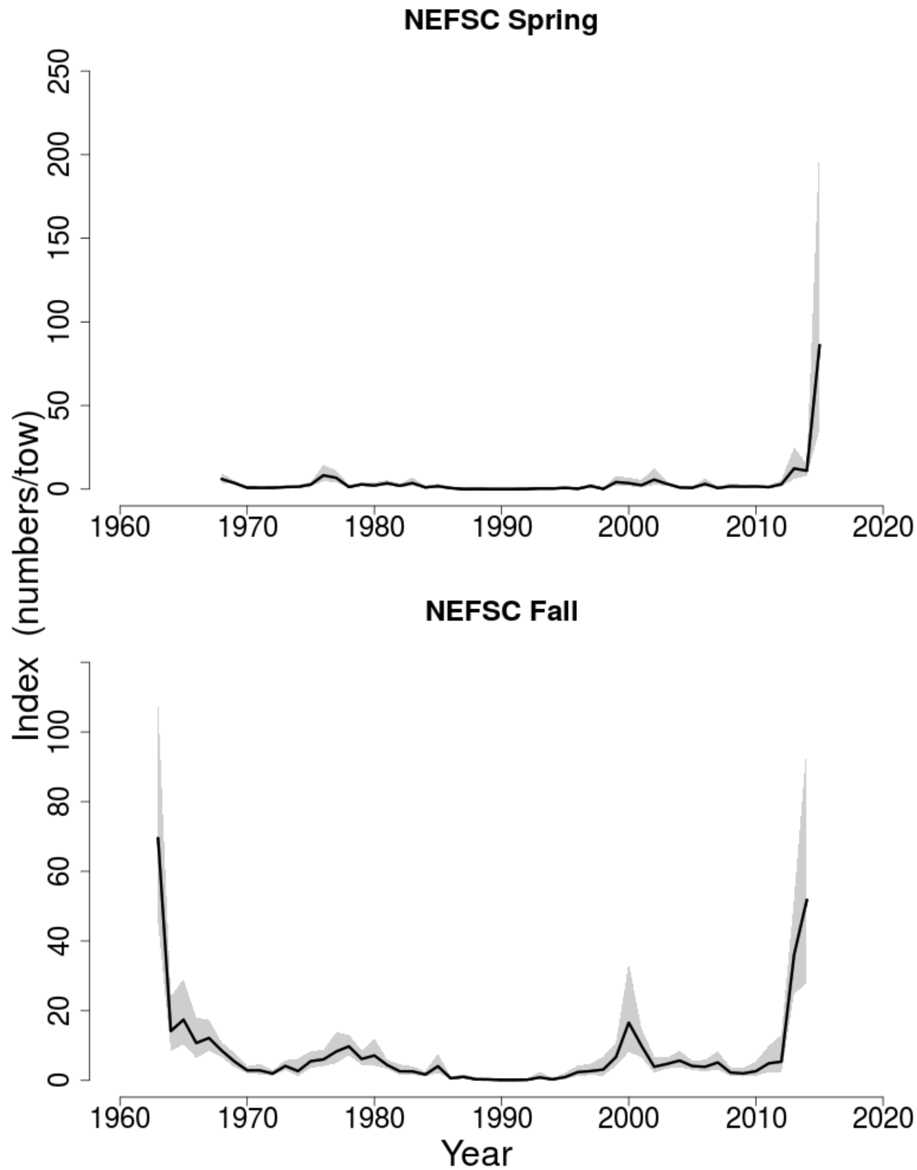


Figure 28: Indices of biomass for the Gulf of Maine haddock between 1963 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.

6 Cape Cod-Gulf of Maine yellowtail flounder

Larry Alade

This assessment of the Cape Cod-Gulf of Maine yellowtail flounder (Limanda ferruginea) stock is an operational update of the existing 2012 VPA assessment (Legault et al., 2012). The last benchmark for this stock was in 2008 (Legault et al., 2008). Based on the previous assessment the stock was overfished, and overfishing was ocurring. This assessment updates commercial fishery catch data, research survey indices of abundance, weights at age, and the analytical VPA assessment model and reference points through 2014. Additionally, stock projections have been updated through 2018

State of Stock: Based on this updated assessment, Cape Cod-Gulf of Maine yellowtail flounder (*Limanda ferruginea*) stock is overfished and overfishing is occurring (Figures 29-30). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 857 (mt) which is 16% of the biomass target (SSB_{MSY} $proxy$ = 5,259; Figure 29). The 2014 fully selected fishing mortality was estimated to be 0.64 which is 229% of the overfishing threshold proxy (F_{MSY} $proxy$ = 0.279; Figure 30).

Table 20: Catch and model results for Cape Cod-Gulf of Maine yellowtail flounder. All weights are in (mt), recruitment is in (000s) and F_{Full} is the average fishing mortality on ages (ages 4 and 5). Model results are from the current updated VPA assessment without any retrospective adjustment.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Data										
Commercial discards	282	85	141	156	175	87	74	146	86	54
Commercial landings	715	534	492	543	464	546	684	946	590	421
Total Catch for Assessment	997	620	633	699	639	633	758	1,092	676	475
Model Results										
Spawning Stock Biomass	687	668	789	944	1,120	1,474	1,659	1,285	1,179	1,695
F_{Full}	1.685	1.48	1.056	1.163	0.745	0.491	0.645	0.977	0.818	0.355
Recruits $age1$	2,927	3,593	3,458	3,816	4,151	3,542	3,332	4,666	8,013	10,268

Table 21: Comparison of reference points estimated in an earlier assessment and from the current assessment update. An $F_{40\%}$ proxy was used for the overfishing threshold and was based on long-term stochastic projections. The medians and 90% probability intervals are reported for MSY and SSB_{MSY}. The median recruits are descriptive and do not reflect the R_{MSY} proxy.

	2012	Current

F_{MSY} proxy	0.259	0.279
SSB_{MSY} (mt)	7,080	5,259 (3,950 - 7,412)
MSY (mt)	1,720	1,285 (968 - 1,806)
Median recruits (age 1) (000s)	7,279	6,562
Overfishing	Yes	Yes
Overfished	Yes	Yes

Projections: Short term projections of biomass were derived by sampling from a cumulative distribution function of recruitment estimates from ADAPT VPA. Recruitment estimates were hindcast based on a simple linear regression between the NEFSC Fall survey abundance at age 1 and the VPA estimate at age 1. The most recent two years (2013 and 2014) were not included in the series of values due to high uncertainty in these estimates. This resulted in a total of 36 recruitment values: 8 from the hindcast predictions (years 1977-1984) and 28 from the VPA (years 1985-2012). The annual fishery selectivity, maturity ogive, and mean weights at age used in projection are the most recent 5 year averages; retrospective adjustments were applied in the projections.

Table 22: Short term projections of total fishery catch and spawning stock biomass for Cape Cod-Gulf of Maine yellowtail flounder based on a harvest scenario of fishing at F_{MSY} *proxy* between 2017 and 2018. Catch in 2015 was assumed to be 376 (mt).

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	376	1,762 (1,364 - 2,300)	0.276
2016	555 (426 - 750)	2,429 (1,846 - 3,341)	0.279
2017	680 (542 - 892)	2,847 (2,313 - 3,656)	0.279
2018	814 (645 - 1,075)	3,518 (2,706 - 4,832)	0.279

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 is the source of the retrospective pattern. This pattern has persisted for a number of years causing SSB estimates to decrease and F estimates to increase as more years of data are added.

- 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 RhoDecisionTab.ref).

  The 7-year Mohn's ρ, relative to SSB, was 0.68 in the 2012 assessment and was 0.98 in

2014. The 7-year Mohn's ρ, relative to F, was -0.19 in the 2012 assessment and was -0.45 in 2014. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2014 SSB (SSB_ρ=857) and 2014 F (F_ρ=0.64) were outside the approximate 90% confidence regions around SSB (1,375 - 2,111) and F (0.25 - 0.52). 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 1,695 to 857 and the 2014 F_{Full} from 0.355 to 0.64.

- Based on this stock assessment, are population projections well determined or uncertain?
  Population projections for Cape Cod-Gulf of Maine yellowtail flounder, are uncertain as projected biomass from the last assessment was above the confidence bounds of the biomass estimated in the current assessment.

- 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.
  No changes, other than the incorporation of new data were made to the Cape Cod-Gulf of Maine yellowtail flounder assessment for this update.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  The 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.
  Extensive studies have examined the causes of the retrospective patterns with no definitive conclusions other than a change in model did not resolve the issue.

- Are there other important issues?
  No.

6.1 Reviewer Comments: Cape Cod-Gulf of Maine yellowtail flounder

Recommendation: The Panel concluded that the updated assessment with retrospective adjustment was acceptable as a scientific basis for management advice. The GARMIII benchmark stock assessment had a minor retrospective pattern (i.e., retrospective differences were within the confidence limits of the estimate). The 2012 update assessment had a major retrospective pattern (i.e., SSB rho=68% which was outside the confidence limits of the SSB estimate), so a retrospective adjustment was applied for stock status determination and projections. The 2015 update assessment has a stronger retrospective pattern (SSB rho=98%, which is outside the confidence limits). Despite the major retrospective pattern, the update assessment generally fits the data and is currently considered the most appropriate basis for status determination and projection.

Alternative Assessment Approach: Not applicable.

Sources of Uncertainty: The major source of uncertainty is the retrospective pattern. Misspecification of the assumed rate of natural mortality (M) was considered as a potential source of the retrospective pattern. The assumed M (0.2) is inconsistent with the recently revised assumptions for other New England yellowtail flounder stocks (M=0.4), which is based on life history attributes and equilibrium age distributions (SAW54, TRAC 2014). Although an exploratory analysis that assumed M=0.4 had less of a retrospective pattern, the pattern was still 'major' (outside the confidence limits). The apparent shift to deeper water may produce changes in fishery selectivity or survey catchability.

Research Recommendations: The Panel recommends that the sources of the retrospective pattern need to be addressed. Considering that retrospective patterns are a common problem, the generic problem may be most appropriately addressed in a research track topic, and all possible sources of the retrospective problem should be investigated (misspecified natural mortality, changes in natural mortality, under-reported catch, changes in survey catchability and misspecified selectivity, etc.). If analytical models cannot resolve the source of the retrospective pattern, empirical assessment approaches and simulation-based performance testing may be needed.

References:

Legault, C, L. Alade, S.Cadrin, J. King, and S. Sherman. 2008. In. 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 Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii. http://www.nefsc.noaa.gov/publications/crd/crd0815/

Legault, C, L. Alade, S.Emery, J. King, and S. Sherman. 2012. In. Northeast Fisheries Science Center. 2012. Assessment or Data Updates of 13 Northeast Groundfish Stocks through 2010. US Dept Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 12-06.; 789 p. http://nefsc.noaa.gov/publications/crd/crd1206/

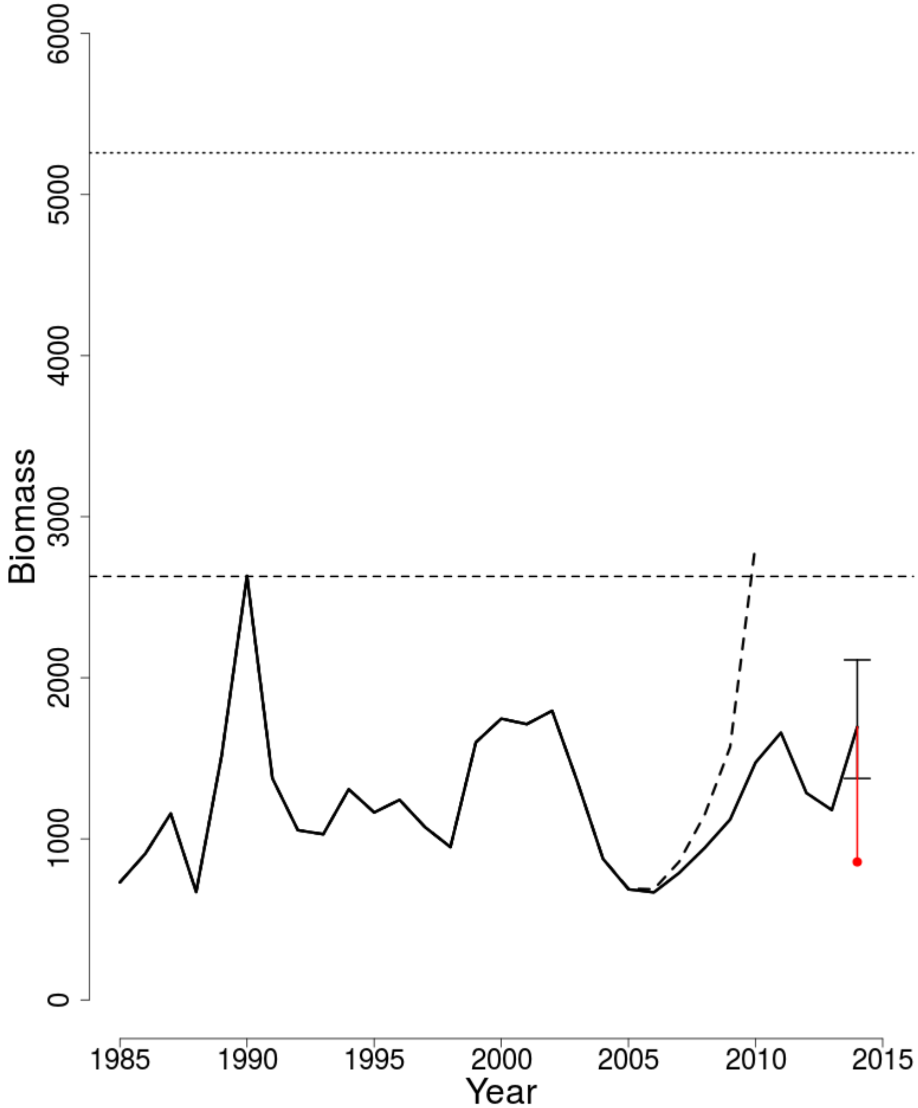


Figure 29: Trends in spawning stock biomass of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The 90% bootstrap probability intervals are shown.

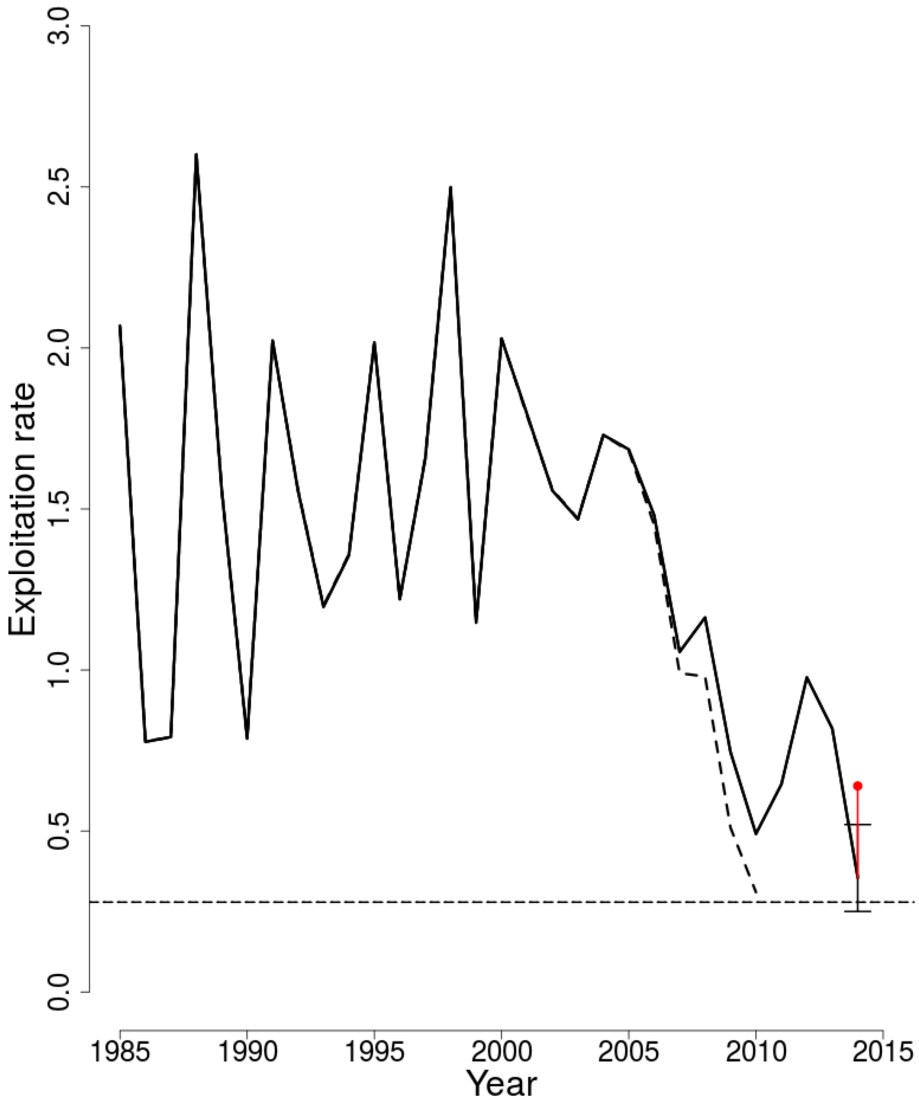


Figure 30: Trends in the fully selected fishing mortality (F_{Full}) of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.279; horizontal dashed line). F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red based on the 2015 assessment. The 90% bootstrap probability intervals are shown.

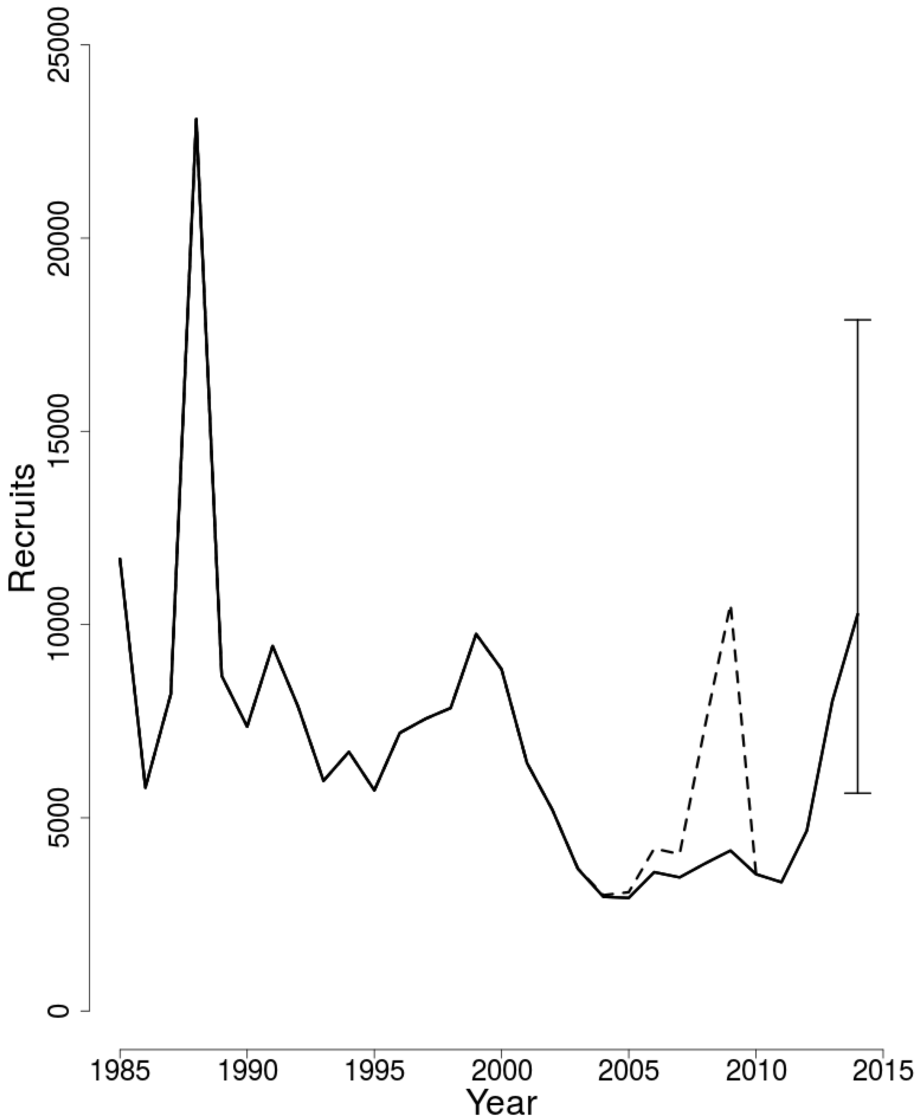


Figure 31: Trends in Recruits (age 1) (000s) of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2014 from the current (solid line) and previous (dashed line) assessment. The 90% bootstrap probability intervals are shown.

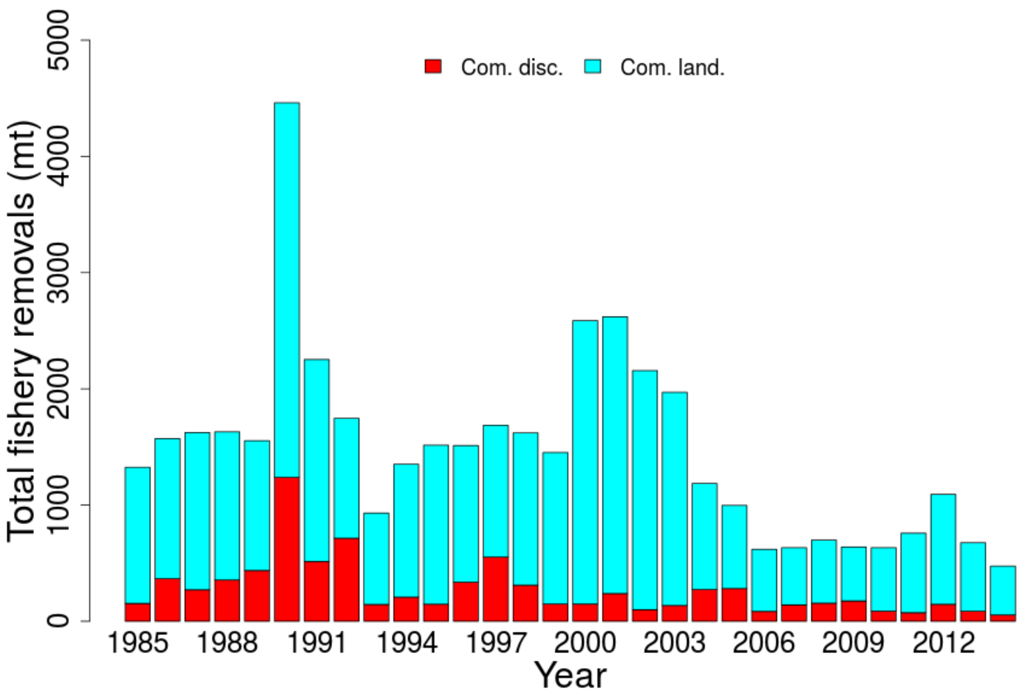


Figure 32: Total catch of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2014 by disposition (landings and discards).

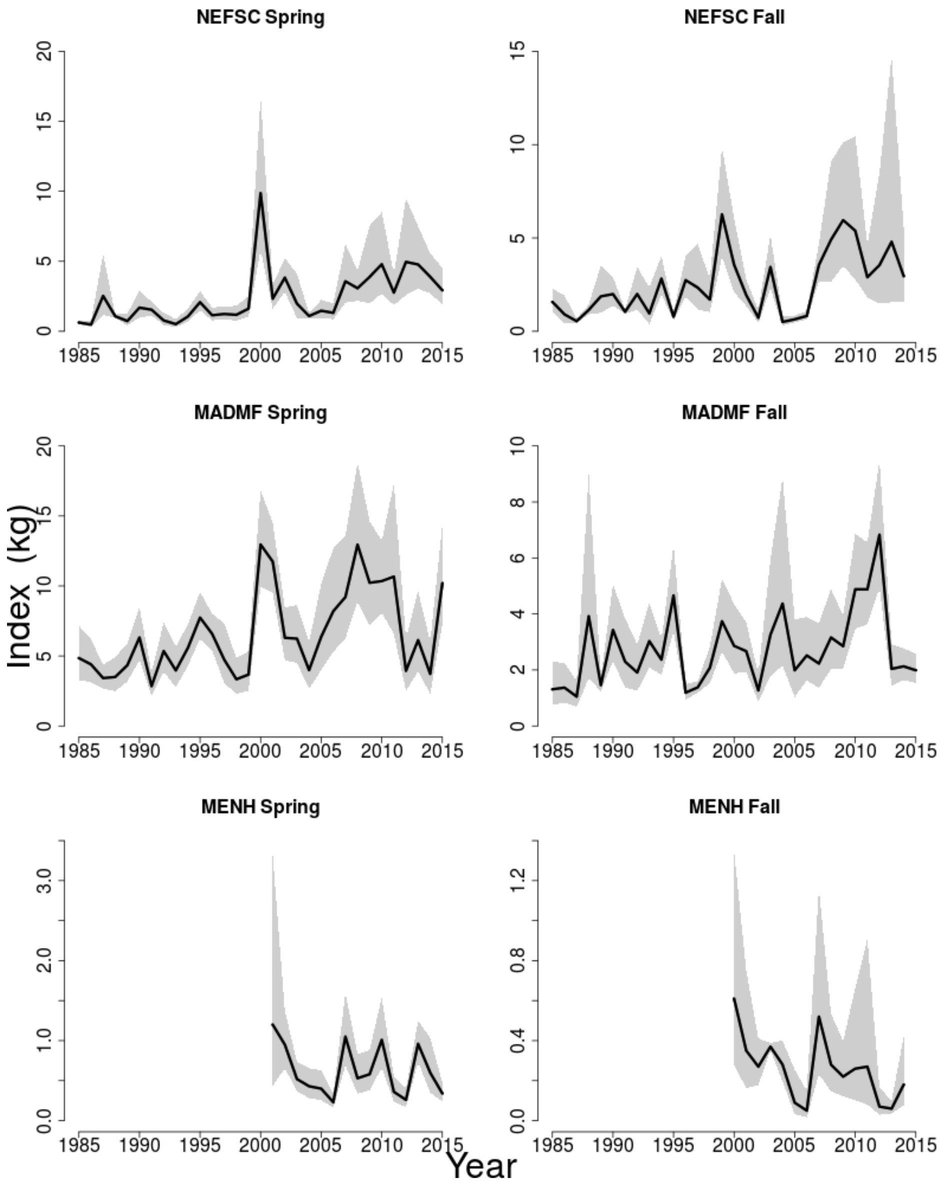


Figure 33: Indices of biomass for the Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys, Massachusetts Department of Marine Fisheries (MADMF) inshore state spring and fall bottom trawl surveys,and the Maine New Hampshire inshore state spring and fall state surveys The 90% bootstrap probability intervals are shown.

7 Southern New England-Mid Atlantic yellowtail flounder

Larry Alade

This assessment of the Southern New England-Mid Atlantic yellowtail flounder (Limanda ferruginea) stock is an operational update of the existing 2012 benchmark ASAP assessment (NEFSC 2012). Based on the previous assessment the stock was not overfished, and overfishing was not ocurring. This assessment updates commercial fishery catch data, research survey indices of abundance, weights at age and the analytical ASAP assessment model and reference points through 2014. Additionally, stock projections have been updated through 2018

State of Stock: Based on this updated assessment, Southern New England-Mid Atlantic yellowtail flounder (*Limanda ferruginea*) stock is overfished and overfishing is occurring (Figures 34-35). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 502 (mt) which is 26% of the biomass target (SSB_{MSY} $proxy$ = 1,959; Figure 34). The 2014 fully selected fishing mortality was estimated to be 1.64 which is 469% of the overfishing threshold proxy (F_{MSY} $proxy$ = 0.35; Figure 35).

Table 23: Catch and model results for Southern New England-Mid Atlantic yellowtail flounder. All weights are in (mt) recruitment is in (000s) and F_{Full} is the average fishing mortality on ages (ages 4 and 5). Model results are from the current updated ASAP assessment. Note: Terminal year estimates of SSB and F reflect the unadjusted values for retrospective error.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
			Data							
Commercial discards	104	187	296	391	268	177	145	221	185	109
Commercial landings	242	209	205	192	185	113	243	342	461	516
Foreign Catch	0	0	0	0	0	0	0	0	0	0
Total Catch for Assessment	346	396	502	583	453	291	388	563	646	625
			Model Results							
Spawning Stock Biomass	603	896	1,350	1,390	1,277	1,342	1,367	1,204	893	502
F_{Full}	0.81	0.82	0.66	0.59	0.46	0.3	0.41	0.72	1.01	1.64
Recruits $age1$	7,463	5,363	2,315	3,450	3,009	2,695	4,467	1,221	1,925	435

Table 24: Comparison of reference points estimated in an earlier assessment and from the current assessment update. An $F_{40\%}$ proxy was used for the overfishing threshold and was based on long-term stochastic projections.

	2012	Current

F_{MSY} *proxy*	0.32	0.35
SSB_{MSY} (mt)	2,995	1,959 (1,298 - 2,840)
MSY (mt)	773	541 (361 - 776)
Median recruits (age 1) (000s)	9,652	7,634
Overfishing	No	Yes
Overfished	No	Yes

Projections: Short term projections of biomass were derived by sampling from a cumulative distribution function of recruitment estimates from ASAP. Following the previous and accepted benchmark formulation, recruitment was based on the more recent estimates of the model time series (i.e. corresponding to year classes 1990 through 2013) to reflect the low recent pattern in recruitment. The annual fishery selectivity, maturity ogive, and mean weights at age used in projection are the most recent 5 year averages; retrospective adjustments were not applied in the projections.

Table 25: Short term projections of total fishery catch and spawning stock biomass for Southern New England-Mid Atlantic yellowtail flounder based on a harvest scenario of fishing at F_{MSY} *proxy* between 2017 and 2018. Catch in 2015 was assumed to be 478 (mt). Note: The numbers-at-age used in the short-term projections for Southern New England-Mid Atlantic yellowtail were not adjusted for retrospective error.

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	478	597 (444 - 798)	1.018
2016	130 (89 - 193)	477 (324 - 715)	0.349
2017	162 (111 - 233)	647 (408 - 1,020)	0.349
2018	234 (146 - 382)	1,062 (611 - 1,799)	0.349

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 is the emergence of the retrospective pattern in this updated assessment. This retrospective bias has resulted in the reduction of SSB estimates and caused F estimates to increase with additional years of data. Further, the basis for the recruitment assumption used in stock status determination and population forecast (i.e. the inclusion of historical recruitment values versus contemporary basis of recruitment) is another source of uncertainty. Although recent estimated recruitments likely reflect realistic conditions for the stock, the basis for recruitment selection is not clearly understood.

- 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 RhoDecisionTab.ref).

  The 7-year Mohn's ρ, relative to SSB, was 0.14 in the 2012 assessment and was 1.06 in 2014. The 7-year Mohn's ρ, relative to F, was -0.16 in the 2012 assessment and was -0.53 in 2014. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2014 SSB (SSB_ρ=502) and 2014 F (F_ρ=1.64) were outside the approximate 90% confidence regions around SSB (355 - 739) and F (1.053 - 2.348). However, a retrospective adjustment was not made for both the determination of stock status and for projections of catch because of the large proportion of unfeasible projections (assumed 2015 catch required a fishing mortality rate greater than 5). This implies the retrospective adjustment was too large or the assumed 2015 catch was too high. The review panel decided to use the unadjusted projections as an upper bound for OFL with the strong suggestion that the OFL estimates were too high (meaning the ABC buffer should be larger than normal - see Reviewer Comments below).

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

  Population projections are uncertain with projected biomass from the last assessment above the confidence bounds of the biomass estimate in the current assessment. Further, the short-term projections which incorporated the retropective adjustment in initial numbers-at-age were unrelaible due to the low percentage of feasible solutions (33%) encountered durring the simulation. The feasibility problem in the projections was caused by the retrospective adjustment, which led to the assumed 2015 projected catch exceeding the population biomass in several of the iterations. Evaluation of the the estimated January-1 2015 biomass from the few feasbile projections indicated that the assumed 2015 catch was approximately 98% of the stock biomass. This suggests that the assumed 2015 catch is not sustainable given the low starting abundance in the forecast. Alternatively, the unadjusted (for retrospective pattern) projections performed well, but are likely to result in an overly optimistic projection of the fishery yield and population biomass.

- 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.

  There were no major changes to the current stock assessment formulation. However, the criterion for determining acceptable tows on the NEFSC surveys were revised the Bigelow years (i.e. 2009-2011) and carried foreward to ensure consistency between the assessment and deck operations. The influence of the revised protocol on the survey indices was inconsequential.

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

  The overfishing and biomass stock status have changed since the previous assessment due to increased catches relative to the stock biomass and the very low recruitment of young fish, which are contributing very little to the adult biomass.

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

  The emergence of retrospective bias in this assessment is not clearly understood and may result from a variety of sources. Future studies should further investigate the source of this *retrospective pattern to help improve the underlying diagnostics of the model for providing catch advice for this stock. Recruitment for Southern New England-Mid Atlantic yellowtail flounder continues to be weak and it is likely that the stock is in a new productivity regime. Should this pattern of poor recruitment continue into the future, the ability of the stock to recover will be impeded. Therefore, future studies should build on current knowledge to further understand the underlying ecological mechanisms of poor recruitment in the stock as it may relate to the physical environment.*

- Are there other important issues?
  None.

7.1 Reviewer Comments: Southern New England-Mid Atlantic yellowtail flounder

Recommendation: The Panel concluded that the updated assessment with no retrospective adjustment was acceptable as a scientific basis for management advice. The SAW54 benchmark stock assessment had a minor retrospective pattern (i.e., SSB rho=16% which was within the confidence limits of the SSB estimate), and no retrospective adjustment was applied for stock status determination or projections. There is a major retrospective pattern in the updated assessment (SSB rho=106%, which is outside the confidence limits). The Assessment Oversight Panel recommended that retrospective adjustments should be applied to stock status determination and projections for stocks with major retrospective patterns. However, when the retrospective adjustment was applied to starting stock size for projections, a substantial portion (67%) of the projected realizations were not feasible, because they could not support the preliminary estimate of 2015 catch. The Operational Assessment Panel concluded that the retrospective adjustment was not acceptable, because of the high frequency of infeasible projections. The unadjusted update assessment generally fits the data, and is currently considered to be the most appropriate basis for status determination and projection.

Alternative Assessment Approach: Not applicable.

Sources of Uncertainty: The major sources of uncertainty are the change in productivity and the retrospective pattern. Because of the high frequency of infeasible projections in the retrospective adjusted projections and the decision to project catches with no retrospective adjustment, the retrospective pattern should be considered to be a source of scientific uncertainty in catch advice. There is some concern with the estimation of stock size, because some estimates of survey catchability are greater than one. Considering the low estimate of stock biomass, the preliminary estimate of 2015 catch should be updated for projections.

Research Needs: The Panel recommends that the decrease in productivity should be explored. Although previous studies have identified linkages between climate and recruitment success of yellowtail flounder, little is known about the underlying ecological mechanism. The explorations of environmental effects from SAW54 should be continued. The sources of the retrospective pattern need to be addressed. Considering that retrospective patterns are a common problem, the generic problem may be most appropriately addressed in a research track topic. All possible sources of the retrospective problem should be investigated (misspecified natural mortality, changes in natural mortality, under-reported catch, changes in survey catchability and misspecified selectivity, etc.).

References:

Alade, L, C. Legault, S.Cadrin. 2008. In. 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 Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii. http://www.nefsc.noaa.gov/publications/crd/crd0815/

Northeast Fisheries Science Center. 2012. 54^{th} Northeast Regional Stock Assessment Workshop (54^{th} SAW) Assessment Report. US Dept Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 12-18.; 600 p. http://nefsc.noaa.gov/publications/crd/crd1218/

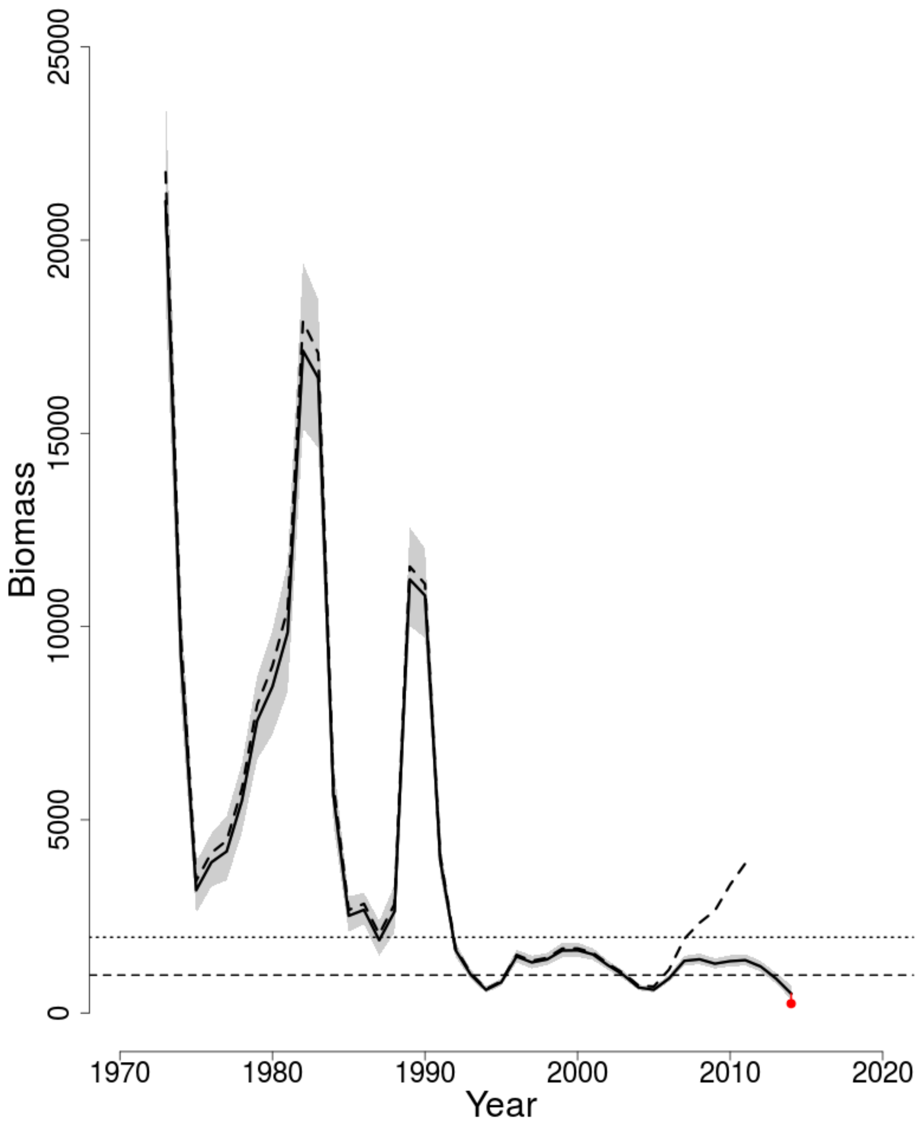


Figure 34: Trends in spawning stock biomass of Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

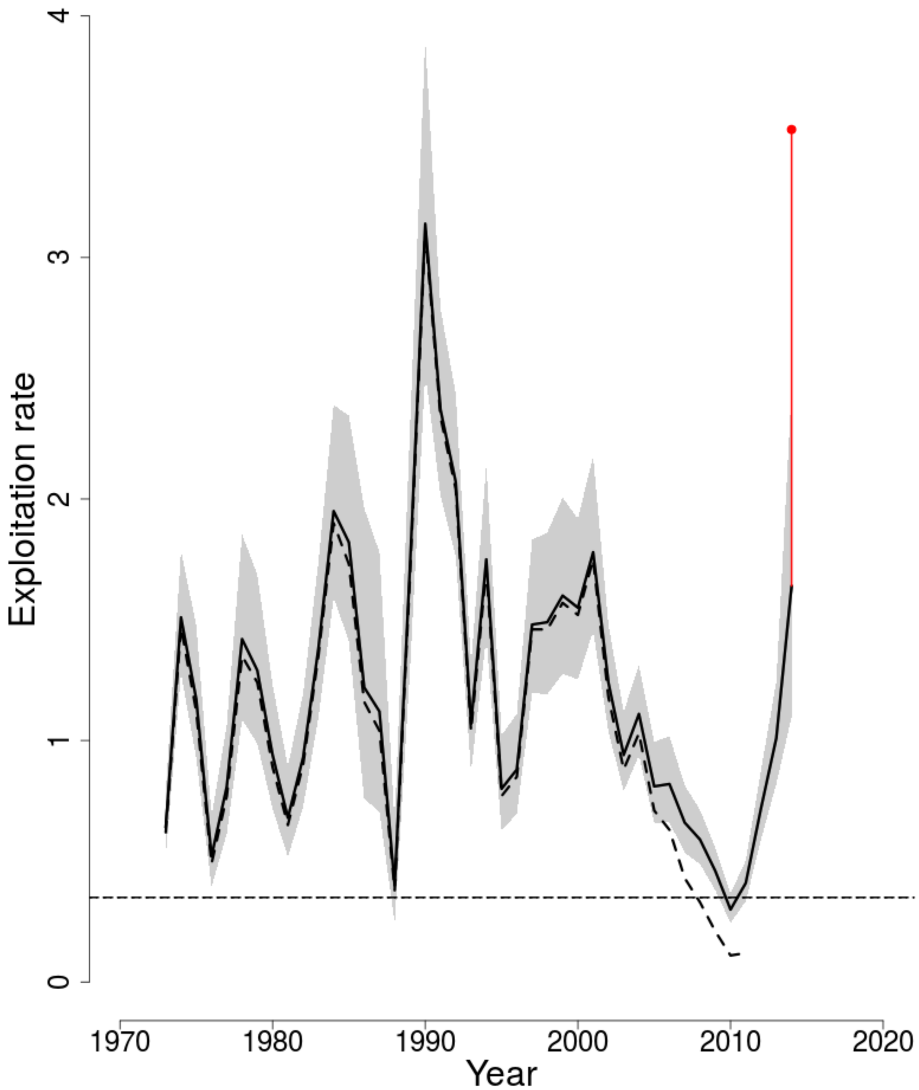


Figure 35: Trends in the fully selected fishing mortality (F_{Full}) of Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.35; horizontal dashed line). F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red based on the 2015 assessment. The approximate 90% lognormal confidence intervals are shown.

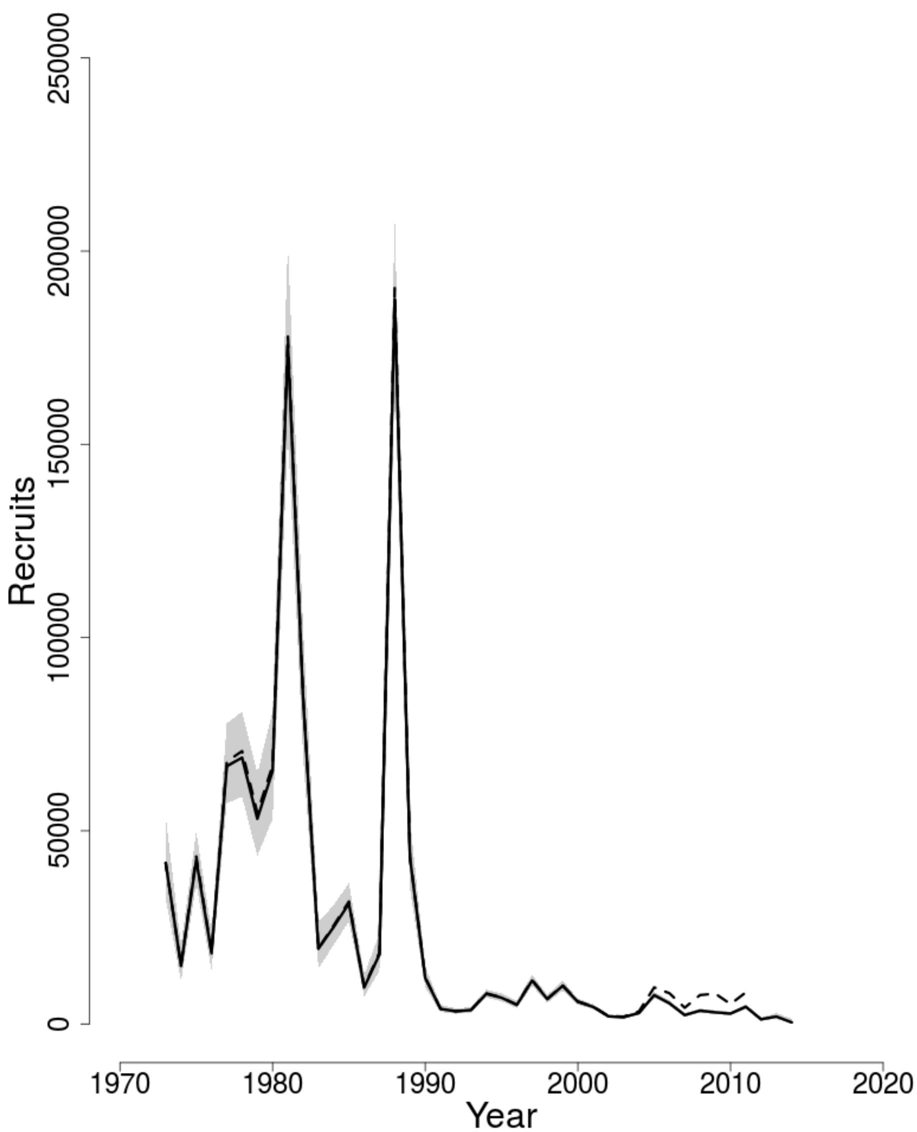


Figure 36: Trends in Recruits (age 1) (000s) of Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2014 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

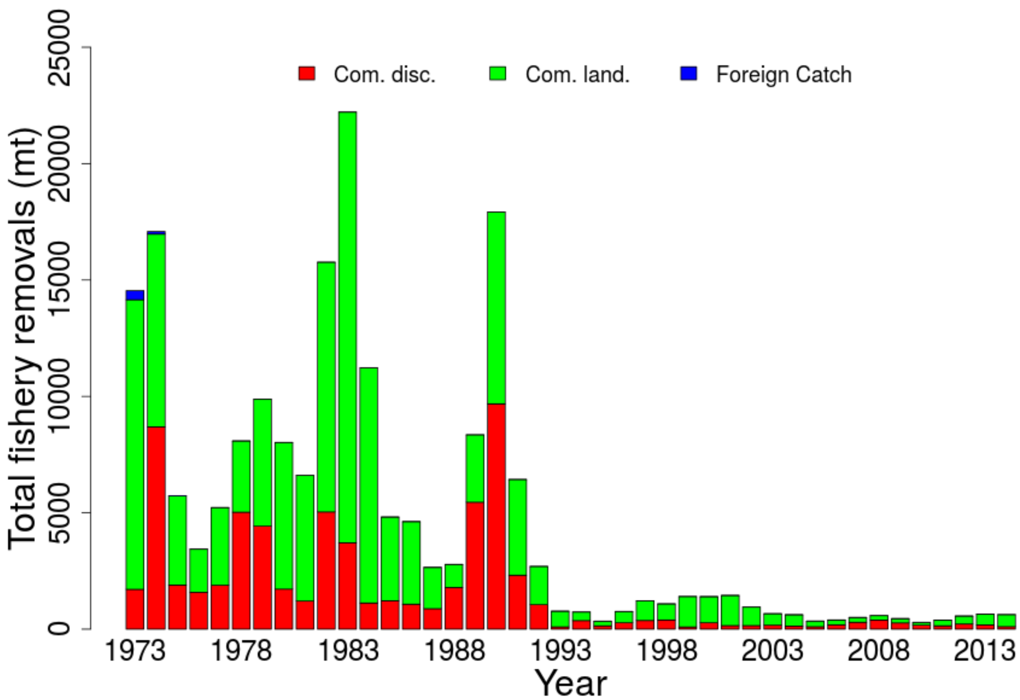


Figure 37: Total catch of Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2014 by fleet (US domestic and foreign catch) and disposition (landings and discards).

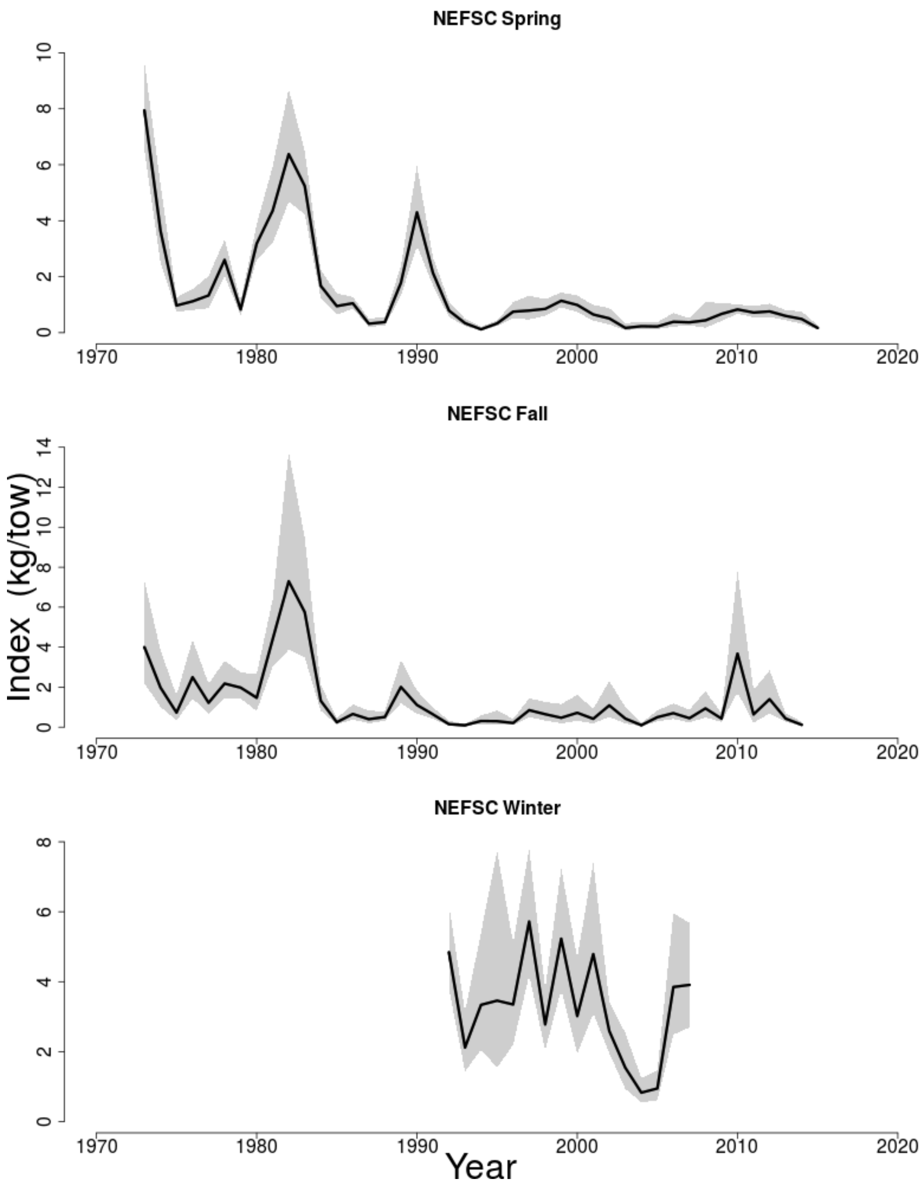


Figure 38: Indices of biomass for the Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring, fall and winter bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown. Note: Larval index was also used in this assessment and is available in the supplemental documentation

8 Georges Bank winter flounder

Lisa Hendrickson

This assessment of the Georges Bank winter flounder (Pseudopleuronectes americanus) stock is an operational update of the existing 2014 operational VPA assessment which included data for 1982-2013 (Hendrickson et al. 2015). Based on the previous assessment the stock was not overfished and overfishing was not ocurring. This assessment updates commercial fishery catch data, research survey biomass indices, and the analytical VPA assessment model and reference points through 2014. Additionally, stock projections have been updated through 2018.

State of Stock: Based on this updated assessment, the Georges Bank winter flounder (*Pseudopleuronectes americanus*) stock is overfished and overfishing is occurring (Figures 39-40). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 2,883 (mt) which is 43% of the biomass target for an overfished stock (SSB_{MSY} = 6,700 with a threshold of 50% of SSBMSY; Figure 39). The 2014 fully selected fishing mortality (F) was estimated to be 0.778 which is 145% of the overfishing threshold (F_{MSY} = 0.536; Figure 40).

Table 26: Catch input data and VPA model results for Georges Bank winter flounder. All weights are in (mt), recruitment is in (000s) and F_{Full} is the average fishing mortality on ages (ages 4-6). Catch and model results are only for the most recent years (2005-2014) of the current updated VPA assessment.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
				Data						
US landings	2,012	825	795	947	1,658	1,252	1,801	1,911	1,675	1,114
CA landings	73	55	12	20	12	45	52	83	12	12
US discards	118	110	188	143	91	138	129	113	47	46
CA scall dr discards	145	135	44	69	252	109	88	79	29	47
Catch for Assessment	2,348	1,125	1,039	1,179	2,013	1,544	2,070	2,186	1,763	1,219
				Model Results						
Spawning Stock Biomass	4,426	4,478	4,316	3,931	4,282	4,997	5,157	4,829	4,645	5,275
F_{Full}	0.679	0.265	0.309	0.371	0.459	0.365	0.507	0.5	0.533	0.379
Recruits $age1$	3,840	6,106	9,566	12,874	11,355	5,789	7,650	6,519	6,217	6,575

Table 27: Comparison of reference points estimated in the 2014 assessment and the current assessment update and stock status during 2013 and 2014, respectively. An estimate of F_{MSY} was used for the overfishing threshold and was based on long-term stochastic projections.

	2014	Current
F_{MSY}	0.44	0.536
SSB_{MSY} (mt)	8,100	6,700 (4,370 - 10,610)
MSY (mt)	3,200	2,840 (1,850 - 4,480)
Median recruits (age 1) (000s)	13,235	9,880
Overfishing	No	Yes
Overfished	No	Yes

Projections: Short-term projections of biomass were derived by sampling from a cumulative distribution function of recruitment estimates (1982-2013 year classes) from the final run of the ADAPT VPA model. The annual fishery selectivity, maturity ogive, and mean weights-at-age used in the projection are the most recent 5 year averages (2010-2014). An SSB retrospective adjustment factor of 0.546 was applied in the projections.

Table 28: Short-term projections of catch (mt) and spawning stock biomass (mt) for Georges Bank winter flounder based on a harvest scenario of fishing at 75% of F_{MSY} between 2016 and 2018. Catch in 2015 was assumed to be 1,150 (mt).

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	1,150	2,623 (1,802 - 3,813)	0.362
2016	755	2,295 (1,472 - 3,482)	0.402
2017	830	2,595 (1,894 - 3,594)	0.402
2018	1,110	3,581 (2,390 - 5,948)	0.402

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 is the estimate of natural mortality based on longevity (max. age = 20 for this stock), which is not well studied in Georges Bank winter flounder, and assumed constant over time. Natural mortality affects the scale of the biomass and fishing mortality estimates. Other sources of uncertainty include the underestimation of catches. Discards from the Canadian bottom trawl fleet were not provided by the CA DFO and the precision of the Canadian scallop dredge discard estimates, with only 1-2 trips per month, are uncertain. The lack of age data for the Canadian spring survey catches requires the use of the US spring survey age/length keys despite selectivity differences. In addition, there are no length or age composition data from the Canadian landings or discards of Georges Bank winter flounder.

- 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 Table 7).

  The 7-year Mohn's ρ, relative to SSB, was 0.26 in the 2014 assessment and was 0.83 in 2014. The 7-year Mohn's ρ, relative to F, was -0.16 in the 2014 assessment and was -0.51 in 2014. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2014 SSB (SSB_ρ=2,883) and 2014 F (F_ρ=0.778) were outside the approximate 90% confidence region around SSB (3,783 - 6,767) and F (0.254 - 0.504). 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 5,275 to 2,883 and the 2014 F_{Full} from 0.379 to 0.778.

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

  Population projections for Georges Bank winter flounder are 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.

  The only change made to the Georges Bank winter flounder assessment, other than the incorporation of an additional year of data, involved fishery selectivity. During the 2014 assessment update, stock size estimates of age 1 and age 2 fish were not estimable in the VPA during year t + 1 (CVs near 1.0). When age 2 stock size is not estimated in year t + 1, the VPA model calculates the stock size of age 1 fish (i.e., recruitment) in the terminal year by using the age 1 partial recruitment (PR) value to derive the F at age 1 in the terminal year. The age 1 PR value used in the 2014 assessment update was 0.001. However, when this same age 1 PR value was used in a VPA run for the current assessment update, the low PR value combined with the low age 1 catch in 2014 resulted in an unlikely high stock size estimate for age 1 recruitment in 2014 (i.e., 41,587,000 fish) when compared to survey observations of the same cohort (i.e., age 1 in 2014 and age 2 in 2015). In order to obtain a more realistic estimate of age 1 recruitment in 2014, I allowed the VPA model to estimate age 2 stock size in 2015 (and thereby avoided the use of an age 1 PR value in the age 1 stock size calculation for 2014) and used the back-calculated PR values from this VPA run to derive a new PR-at-age vector which was used in the final 2015 VPA run. Similar to the 2014 assessment update, the final 2015 VPA run did not include the estimation of age 2 stock size and the new PR-at-age vector was computed using the same methods as in the 2014 assessment. Full selectivity occurs at age 4. For the 2015 assessment update, fishery selectivity for ages 1-3 was changed from the 2014 assessment values of 0.001, 0.10 and 0.43, respectively, to 0.01, 0.08 and 0.55, respectively. Differences between estimates of F, SSB and R values from the final 2015 VPA run, with the new PR vector, and a 2015 VPA run that utilized the PR vector from the 2014 assessment are shown in Table G30 (see SASINF).

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

  The overfished and overfishing status of Georges Bank winter flounder has changed in the current assessment update due to a worsening of the retrospective error associated with fishing mortality and SSB.

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

The Georges Bank winter flounder assessment could be improved with discard estimates from the Canadian bottom trawl fleet and age data from the Canadian spring bottom trawl surveys.

- Are there other important issues?
  None.

8.1 Reviewer Comments: Georges Bank winter flounder

Recommendation: The Panel concluded that the updated assessment with retrospective adjustment was acceptable as a scientific basis for management advice. The revised partial recruitment assumption for VPA calibration was well justified.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: The major source of uncertainty is the retrospective pattern. The magnitude of the retrospective pattern is substantially greater than the 2014 update assessment. The decrease in estimates of stock size from the previous update is largely influenced by updated survey indices. The natural mortality assumption was revised in the SAW52 benchmark assessment, but the assumption is based on limited longevity information. The catch is underestimated and uncertain, because the magnitude of Canadian trawl discards is unknown. The Panel also noted that age composition of the Canadian survey and fishery is not sampled, and that weight at age and maturity at age have declined since 2008. The MSY reference point is conditional on an assumed steepness value.

Research Needs: The Panel recommends that the sources of the retrospective pattern need to be addressed. Considering that retrospective patterns are a common problem, the generic problem may be most appropriately addressed in a research track topic, and all possible sources of the retrospective problem should be investigated (misspecified natural mortality, changes in natural mortality, under-reported catch, changes in survey catchability and misspecified selectivity, etc.). Survey data should be updated to monitor rebuilding or persistent decreases and better sampling of the magnitude and age composition of Canadian discards is needed. Dedicated age samples are needed for the Canadian survey and fishery.

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.

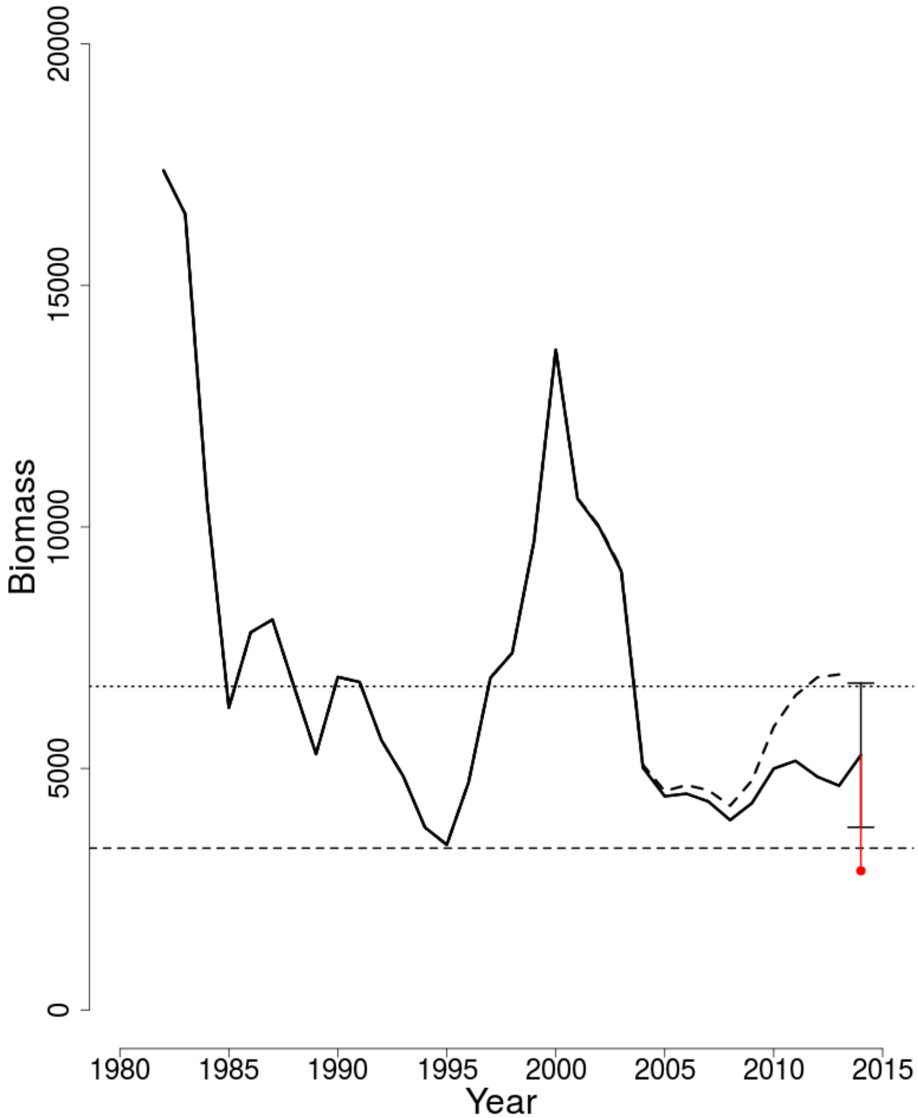


Figure 39: Trends in spawning stock biomass (mt) of Georges Bank winter flounder between 1982 and 2014 from the current (solid line) and previous (dashed line) assessments and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY}; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY}; horizontal dotted line) based on the 2015 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% normal confidence intervals are shown.

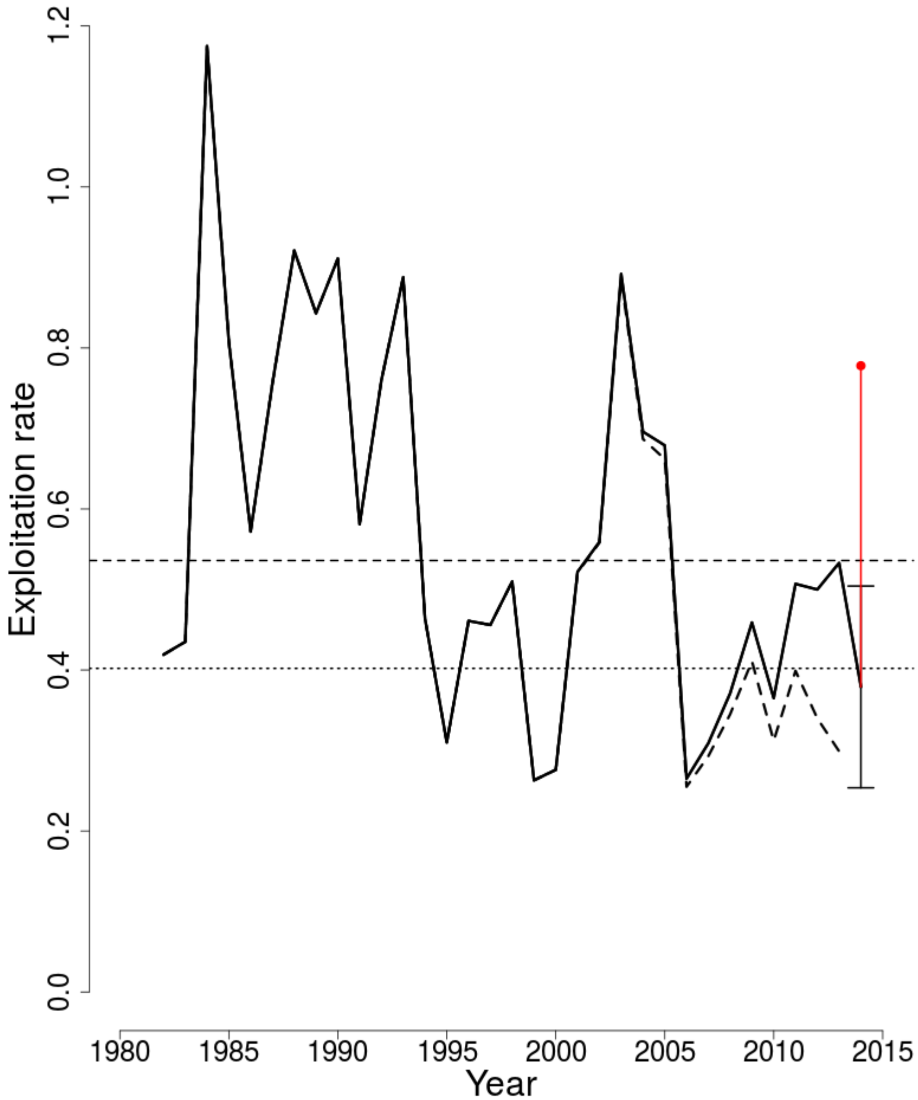


Figure 40: Trends in fully selected fishing mortality (F_{Full}) of Georges Bank winter flounder between 1982 and 2014 from the current (solid line) and previous (dashed line) assessments and the corresponding $F_{Threshold}$ (F_{MSY}=0.536; horizontal dashed line) as well as (F_{Target}= 75% of FMSY; horizontal dotted line). F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% normal confidence intervals are also shown.

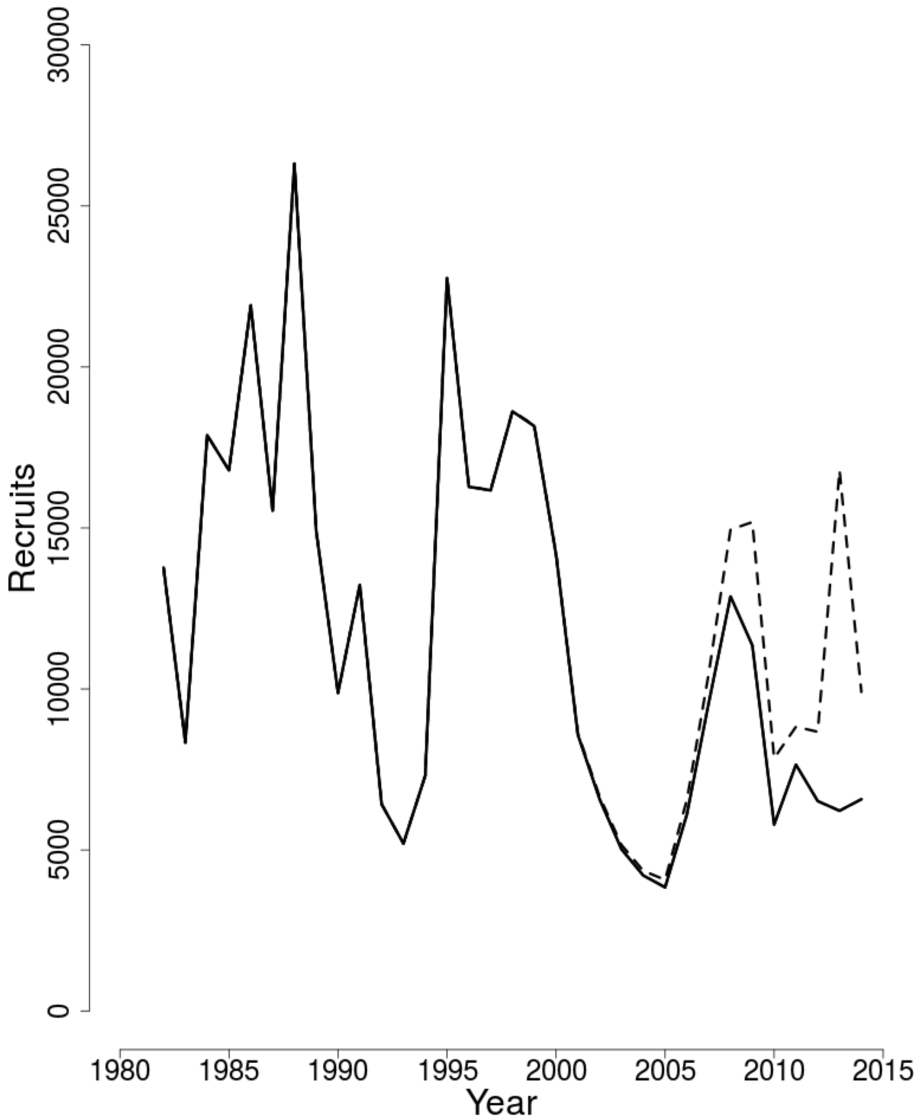


Figure 41: Trends in Recruits (age 1) (000s) of Georges Bank winter flounder between 1982 and 2014 from the current (solid line) and previous (dashed line) assessments. The approximate 90% normal confidence intervals are shown.

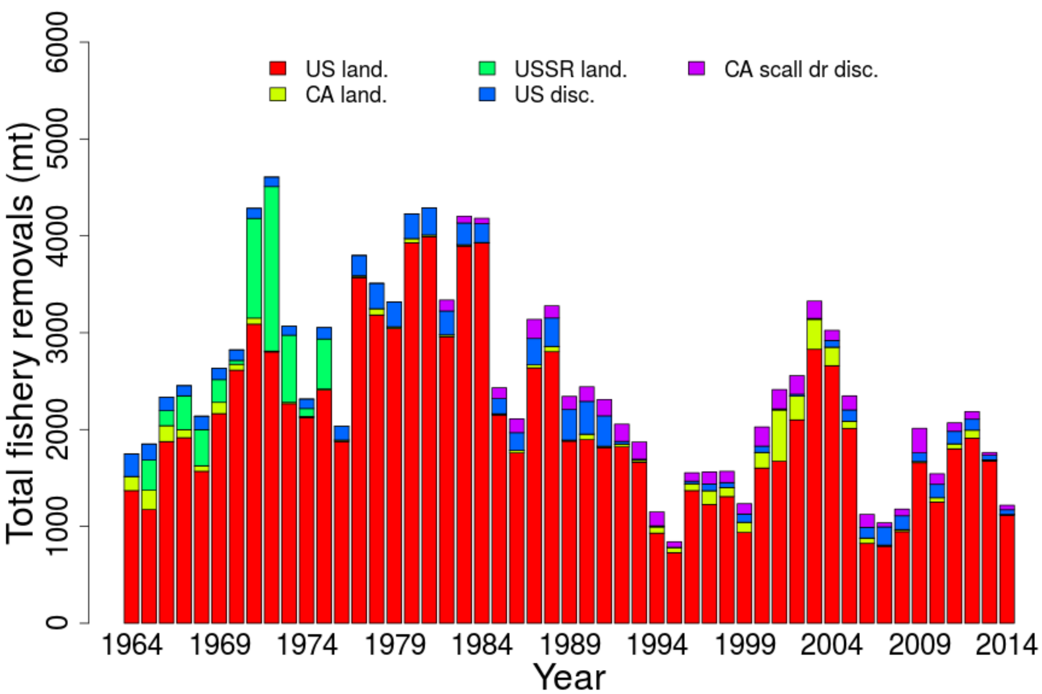


Figure 42: Total catches (mt) of Georges Bank winter flounder between 1982 and 2015 by country and disposition (landings and discards).

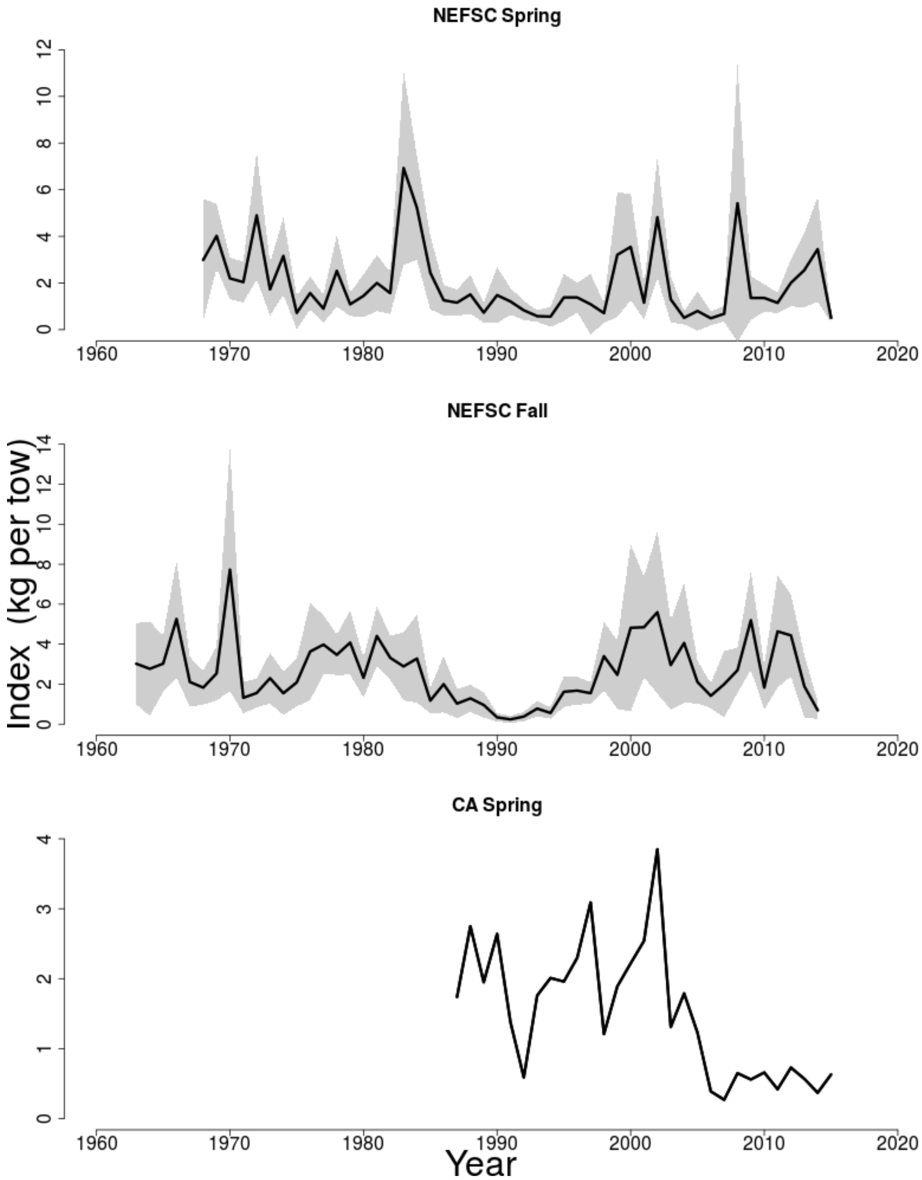


Figure 43: Indices of biomass for the Georges Bank winter flounder for the Northeast Fisheries Science Center (NEFSC) spring (1968-2015) and fall (1963-2014) bottom trawl surveys and the Canadian DFO spring survey (1987-2015). The approximate 90% normal confidence intervals are shown.

9 Southern New England Mid-Atlantic winter flounder

Anthony Wood

This assessment of the Southern New England Mid-Atlantic winter flounder (Pseudopleuronectes americanus) stock is an operational update of the existing 2011 benchmark ASAP assessment (NEFSC 2011). Based on the previous assessment the stock was overfished, but overfishing was not ocurring. This assessment updates commercial fishery catch data, recreational fishery catch data, and research survey indices of abundance, and the analytical ASAP assessment models and reference points through 2014. Additionally, stock projections have been updated through 2018

State of Stock: Based on this updated assessment, the Southern New England Mid-Atlantic winter flounder (*Pseudopleuronectes americanus*) stock is overfished but overfishing is not occurring (Figures 44-45). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 6,151 (mt) which is 23% of the biomass target (26,928 mt), and 23% of the biomass threshold for an overfished stock ($SSB_{Threshold} = 13464$ (mt); Figure 44). The 2014 fully selected fishing mortality was estimated to be 0.16 which is 49% of the overfishing threshold ($F_{MSY} = 0.325$; Figure 45).

Table 29: Catch and status table for Southern New England Mid-Atlantic winter flounder. All weights are in (mt) recruitment is in (000s) and F_{Full} is the fishing mortality on fully selected ages (ages 4 and 5). Model results are from the current updated ASAP assessment.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Data										
Recreational discards	14	16	5	3	9	8	18	2	4	1
Recreational landings	124	136	116	73	87	28	65	31	7	30
Commercial discards	105	151	118	109	165	153	298	483	206	64
Commercial landings	1,320	1,720	1,628	1,113	271	174	150	134	857	658
Catch for Assessment	1,563	2,023	1,867	1,298	532	363	531	650	1,074	753
Model Results										
Spawning Stock Biomass	5,021	5,517	6,338	5,552	5,038	5,806	6,946	7,116	7,077	6,151
F_{Full}	0.35	0.41	0.36	0.28	0.11	0.07	0.09	0.11	0.19	0.16
Recruits $age1$	13,244	7,368	6,212	9,422	7,416	7,070	5,365	5,281	2,633	4,906

Table 30: Comparison of reference points estimated in an earlier assessment and from the current assessment update. F_{MSY} was generated assuming a Beverton-Holt S-R relationship and an SSB_{MSY} proxy was used for the overfished threshold and was based on long-term stochastic projections. Recruitment estimates are median values of the time-series. 90% CI are shown in parentheses.

	2011	Current
F_{MSY}	0.290	0.325
SSB_{MSY} (mt)	43,661	26,928 (18,488 - 39,847)
MSY (mt)	11,728	7,831 (5,237 - 11,930)
Median recruits (age 1) (000s)	19,256	16,448
Overfishing	No	No
Overfished	Yes	Yes

Projections: Short term projections of biomass were derived by sampling from a cumulative distribution function of recruitment estimates assuming a Beverton-Holt stock recruitment relationship. The annual fishery selectivity, maturity ogive, and mean weights at age used in projection are the most recent 5 year averages; The model exhibited minor retrospective pattern in F and SSB so no retrospective adjustments were applied in the projections.

Table 31: Short term projections of total fishery catch and spawning stock biomass for Southern New England Mid-Atlantic winter flounder based on a harvest scenario of fishing at F_{MSY} between 2016 and 2018. Catch in 2015 was assumed to be 717 (mt), a value provided by GARFO (Dan Caless pers. comm.). 90% CI are shown next to SSB estimates.

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	717	5,439 (4,423 - 6,607)	0.183
2016	1,041	4,732 (3,827 - 5,774)	0.325
2017	973	3,782 (3,057 - 4,645)	0.325
2018	1,515	4,612 (3,267 - 7,339)	0.325

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).

  A large source of uncertainty is the estimate of natural mortality based on longevity, which is not well studied in Southern New England Mid-Atlantic winter flounder, and assumed constant over time. Natural mortality affects the scale of the biomass and fishing *mortality estimates. Natural mortality was adjusted upwards from 0.2 to 0.3 during the last benchmark assessment assuming a max age of 16. However, there is still uncertainty in the true max age of the population and the resulting natural mortality estimate. Other sources of uncertainty include length distribution of the recreational discards. The recreational discards, are a small component of the total catch, but the assessment suffers from very little length information used to characterize the recreational discards (1 to 2 lengths in recent years).*

- 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 Table 7).
  No retrospective adjustment of spawning stock biomass or fishing mortality in 2014 was required.

- Based on this stock assessment, are population projections well determined or uncertain?
  Population projections for Southern New England Mid-Atlantic winter flounder are reasonably well determined. There is uncertainty in the estimates of M. In addition, while the retrospective pattern is considered minor (within the 90% CI of both F and SSB) the rho adjusted terminal value is very close to falling outside of the bounds, becoming a major retrospective pattern. This would lead to retrospective adjustments being needed for the projections.

- 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.
  No changes, other than the incorporation of new data were made to the Southern New England Mid-Atlantic winter flounder assessment for this update.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  The stock status of Southern New England Mid-Atlantic winter flounder has not changed since the previous benchmark in 2011.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  The Southern New England Mid-Atlantic winter flounder assessment could be improved with additional studies on maximum age, as well additional recreational discard lengths. In addition, further investigation into the localized struture/genetics of the stock is warranted. Also, a future shift to ASAP version 4 will provide the ability to model envirionmental factors that may influence both survey catchability and the modeled S-R relationship

- Are there other important issues?
  None.

9.1 Reviewer Comments: Southern New England Mid-Atlantic winter flounder

Recommendation: The Panel concluded that the updated assessment was acceptable as a scientific basis for management advice.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: The major sources of uncertainty are the change in productivity and poor fit to some survey data. There are residual patterns for some surveys (e.g., NEFSC fall and CTDEP) and the retrospective magnitude is close to the confidence limits of the estimates. The natural mortality assumption was revised in the SAW52 benchmark, but the assumption is based on limited longevity information. The Panel noted that the size composition of recreational catch, particularly discards, is poorly sampled.

Research Needs: The Panel recommends that the decrease in productivity should be explored, including environmental effects on recruitment. The potential for depletion of stock components should be considered and information on natural mortality should be investigated. The next benchmark assessment should investigate the weighting of multiple surveys. Recent investigations of maturity should be considered in the next assessment.

References:

Smith, A. and S. Jones. 2008. In. 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 Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii. http://www.nefsc.noaa.gov/publications/crd/crd0815/

Northeast Fisheries Science Center. 2011. 52^{nd} Northeast Regional Stock AssessmentWorkshop (52^{nd} SAW) Assessment Report. US Dept Commer, Northeast Fish SciCent Ref Doc. 11-17; 962 p. Available from: National Marine Fisheries Service, 166Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/

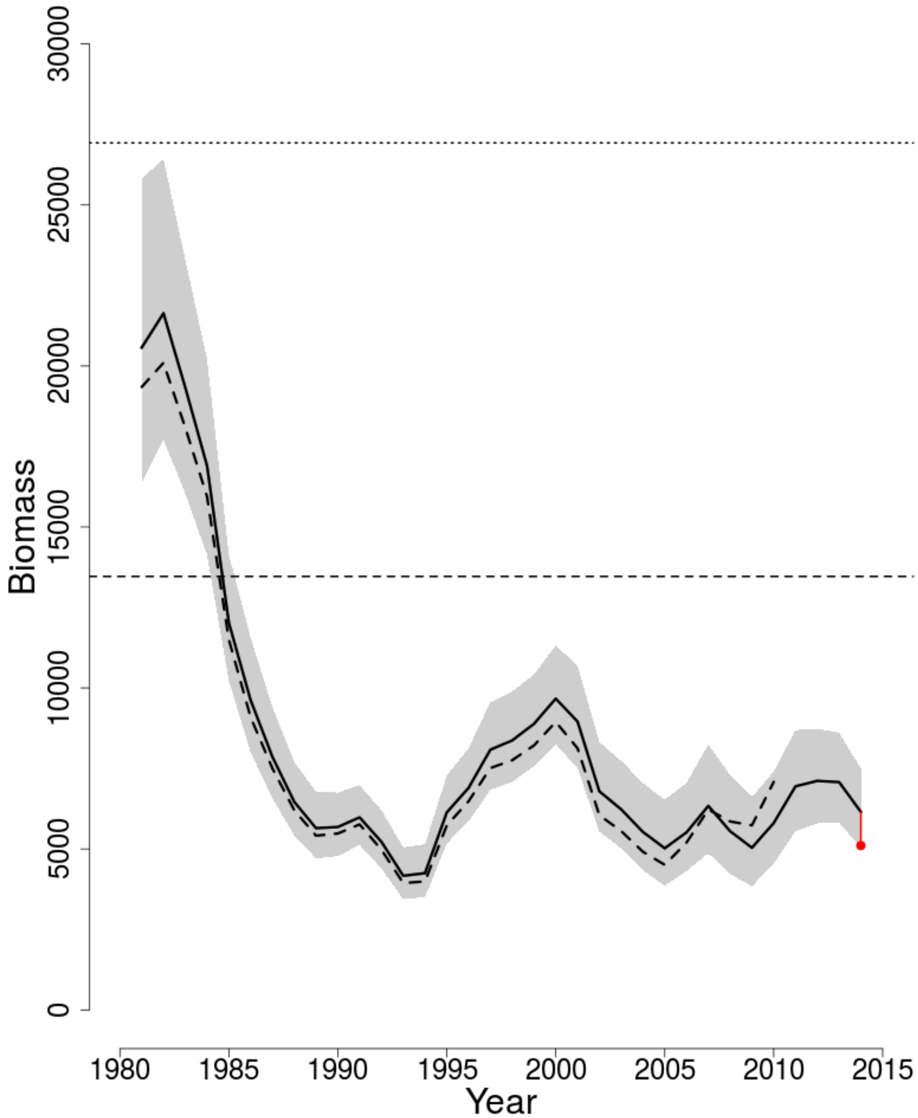


Figure 44: Trends in spawning stock biomass of Southern New England Mid-Atlantic winter flounder between 1981 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment. The approximate 90% lognormal confidence intervals are shown.

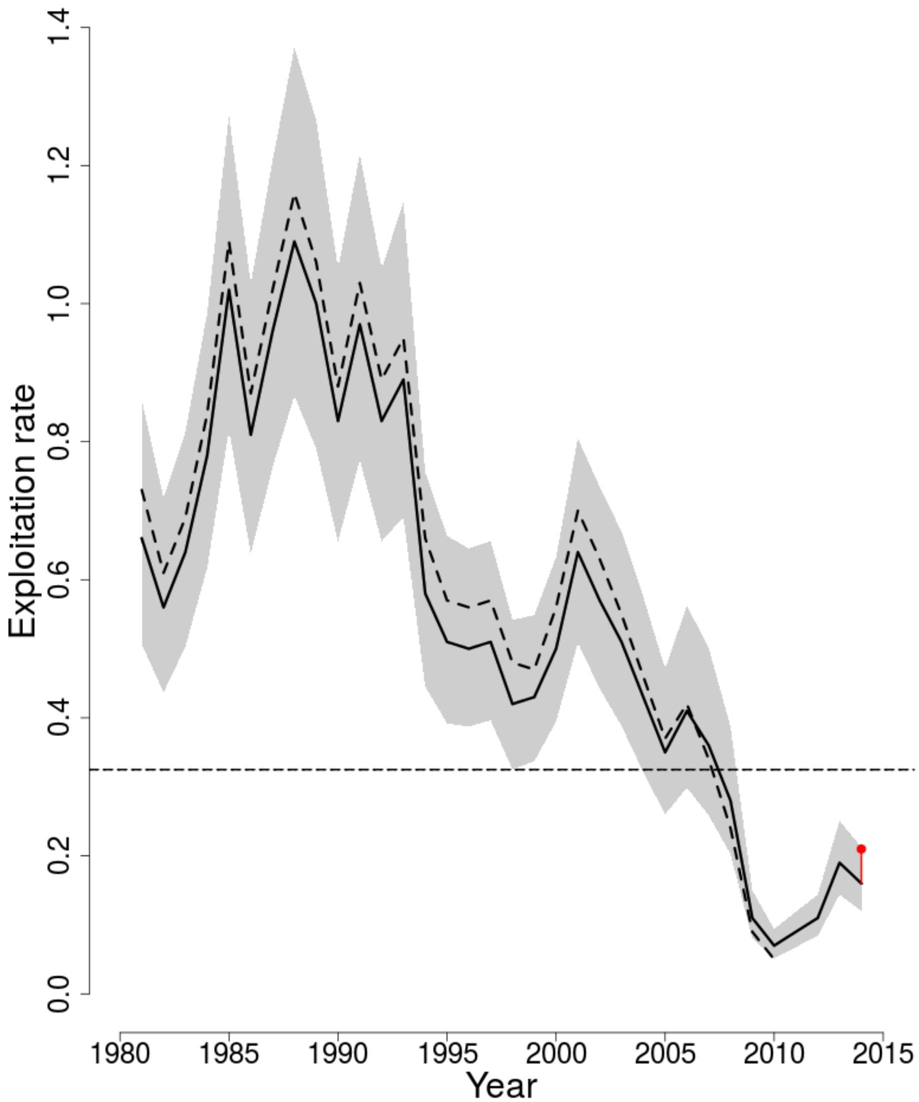


Figure 45: Trends in the fully selected fishing mortality (F_{Full}) of Southern New England Mid-Atlantic winter flounder between 1981 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY}=0.325; horizontal dashed line) based on the 2015 assessment. The approximate 90% lognormal confidence intervals are shown.

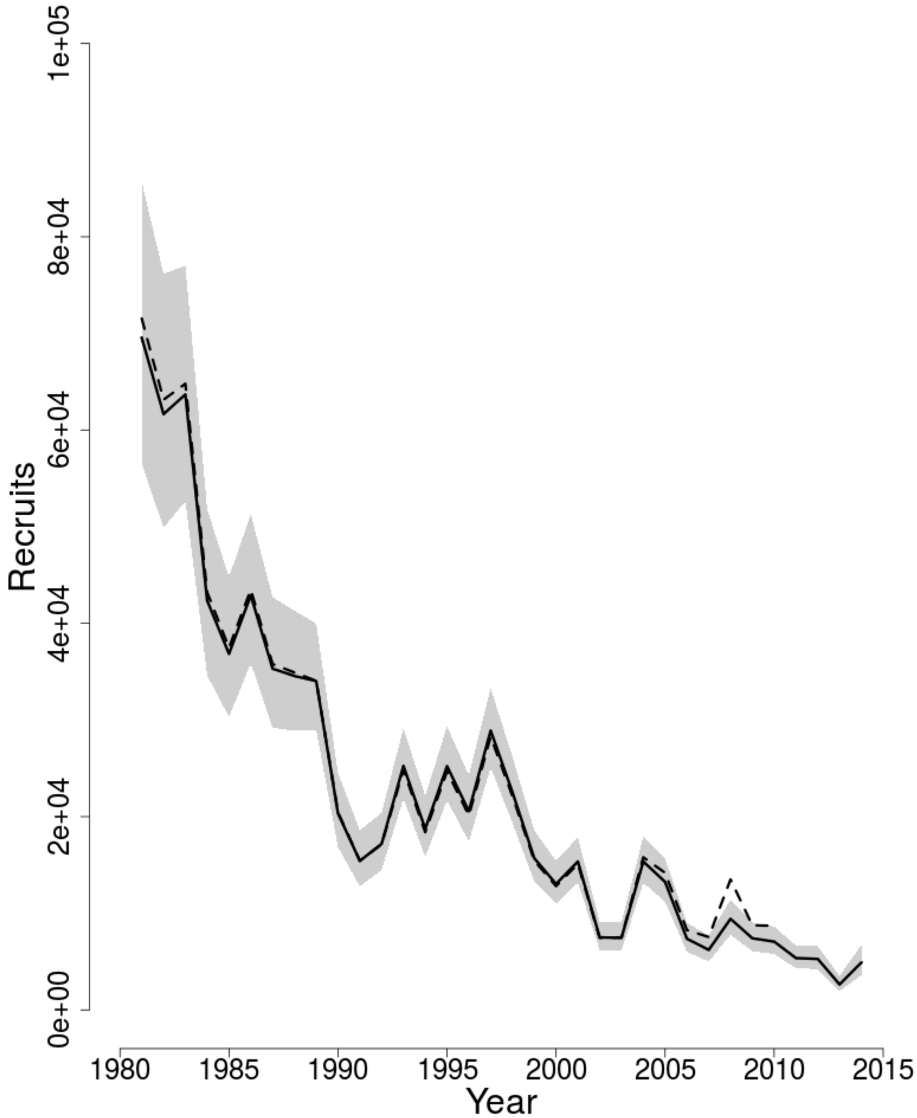


Figure 46: Trends in Recruits (age 1) (000s) of Southern New England Mid-Atlantic winter flounder between 1981 and 2014 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

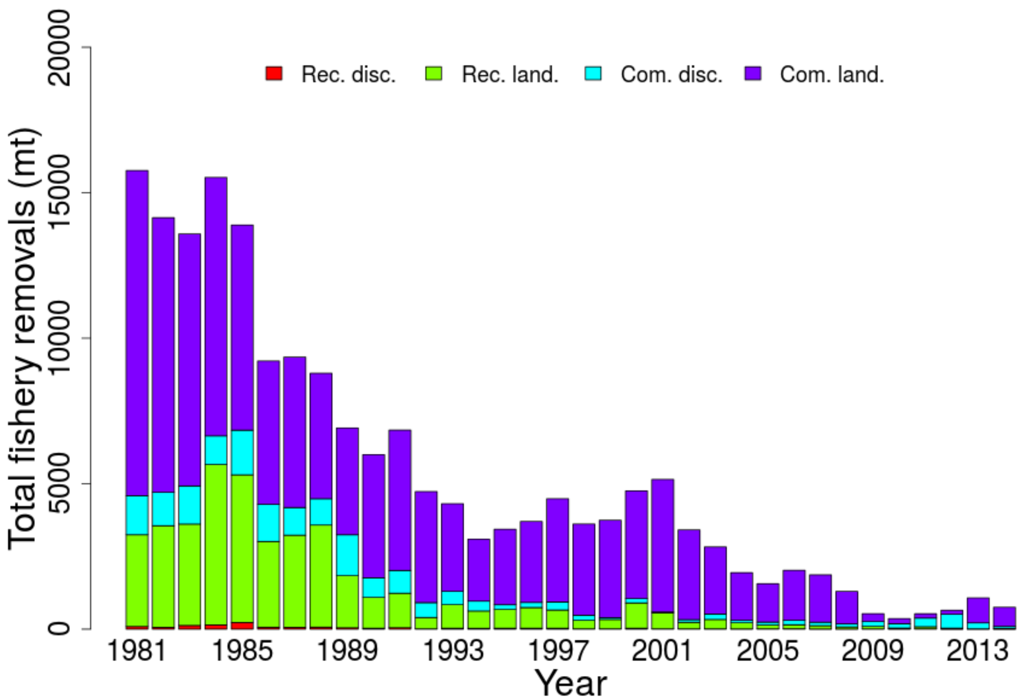


Figure 47: Total catch of Southern New England Mid-Atlantic winter flounder between 1981 and 2014 by fleet (commercial, recreational) and disposition (landings and discards).

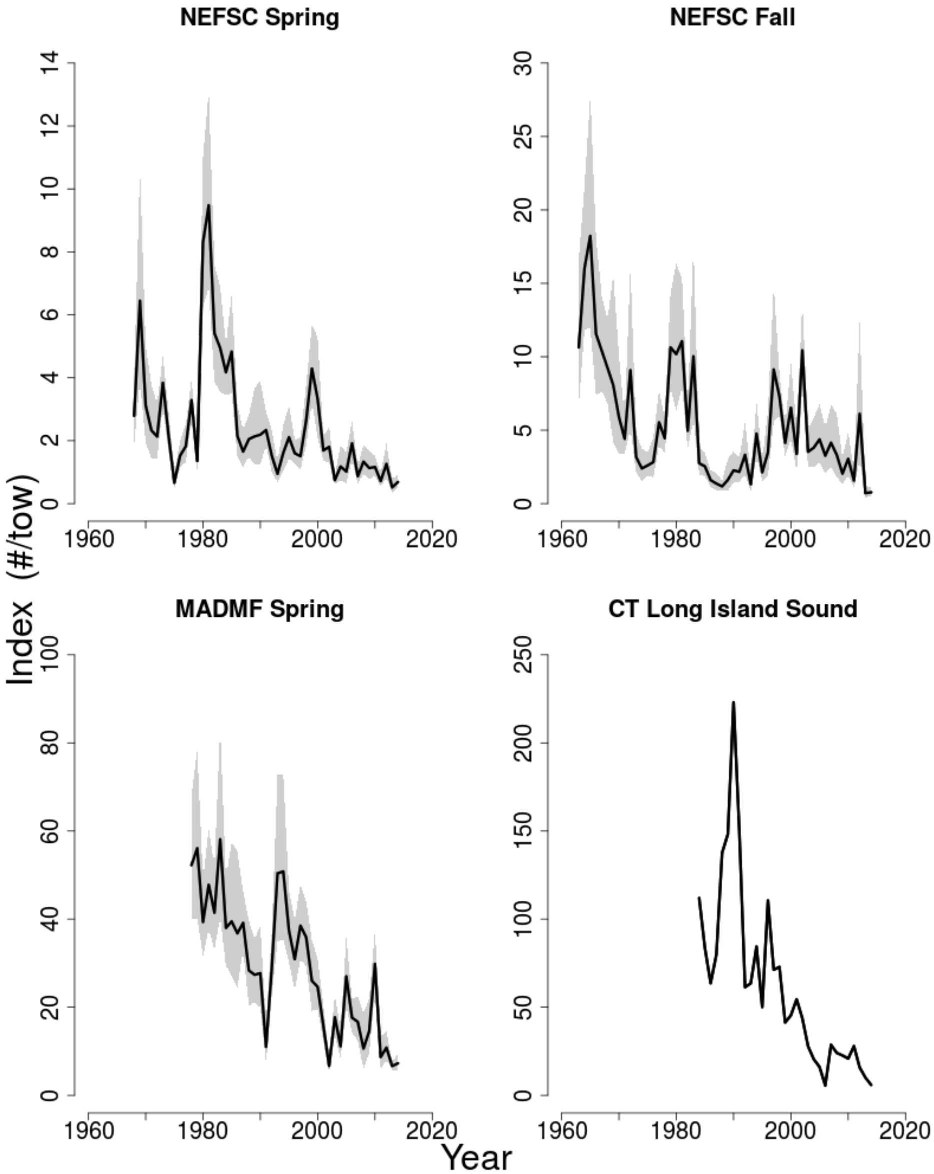


Figure 48: Indices of biomass for the Southern New England Mid-Atlantic winter flounder between 1963 and 2014 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys, the MADMF spring survey, and the CT LISTS survey The approximate 90% lognormal confidence intervals are shown.

10 Gulf of Maine-Georges Bank American plaice

Loretta O'Brien

This assessment of the Gulf of Maine-Georges Bank American plaice (Hippoglossoides platessoides) stock is an operational update of the existing 2012 benchmark assessment (O'Brien et al. 2012). Based on the previous assessment the stock was not overfished, and overfishing was not ocurring. This 2015 assessment updates commercial fishery catch data, research survey indices of abundance, the analytical VPA assessment model, and reference points through 2014. Additionally, stock projections have been updated through 2018.

State of Stock: Based on this updated assessment, the Gulf of Maine-Georges Bank American plaice (*Hippoglossoides platessoides*) stock is not overfished and overfishing is not occurring (Figures 49-50). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 10,977 mt which is 84% of the biomass target for this stock (SSB_{MSY} *proxy* = 13,107; Figure 49). The 2014 fully selected fishing mortality was estimated to be 0.116 which is 59% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.196; Figure 50).

Table 32: Catch and model results for Gulf of Maine-Georges Bank American plaice. All weights are in (mt), recruitment is in (000s), and F_{Full} is the average fishing mortality on ages (ages 6-9). Model results are from the current updated VPA assessment.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
					Data					
GM Commercial landings	752	583	601	703	866	901	771	762	764	738
GM Commercial discards	213	142	82	113	115	239	96	161	88	36
GB Commercial landings	574	504	377	388	501	492	595	699	528	498
GB Commercial discards	76	144	164	144	274	154	0	0	0	0
SNE landings	16	18	12	9	13	11	3	1	5	3
CA landings	5	11	2	0	0	0	1	0	0	0
Catch for Assessment	1,636	1,402	1,239	1,357	1,770	1,797	1,467	1,624	1,385	1,275
					Model Results					
Spawning Stock Biomass	5,145	6,118	8,079	11,193	12,988	13,990	14,937	14,811	14,427	14,543
F_{Full}	0.33	0.28	0.13	0.17	0.2	0.14	0.11	0.13	0.1	0.08
Recruits $age1$	29,643	40,420	16,684	23,538	14,199	8,655	12,495	9,184	11,302	30,333

Table 33: Comparison of reference points estimated in the previous assessment and from the current assessment update. An $F_{40\%}$ proxy was used for the overfishing threshold and was based on long-term stochastic projections.

	2012	Current
F_{MSY} *proxy*	0.179	0.196
SSB_{MSY} (mt)	18,398	13,107 (10,142-16,951)
MSY (mt)	3,385	2,675 (2,071 - 3,456)
Median recruits (age 1) (000s)	24,504	22,514
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of biomass were derived by sampling from an empirical cumulative distribution function of 34 recruitment estimates from VPA model results. The annual fishery selectivity, maturity ogive, and mean weights at age used in projections are the most recent 5 year averages; retrospective adjustments were applied in the projections.

Table 34: Short term projections of total fishery catch and spawning stock biomass for Gulf of Maine-Georges Bank American plaice based on a harvest scenario of fishing at F_{MSY} *proxy* between 2016 and 2018. Catch in 2015 was assumed to be 1,395 (mt).

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	1,395	8,948 (7,858 - 10,160)	0.156
2016	1,695	8,645 (7,506 - 9,863)	0.196
2017	1,686	8,325 (7,163 - 9,697)	0.196
2018	1,722	8,710 (7,136 - 11,184)	0.196

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).

  Sources of uncertainty in this assessment are the estimates of historical landings at age, prior to 1984, and the magnitude of historical discards, prior to 1989. Both of these affect the scale of the biomass and fishing mortality estimates, and influence reference point estimations.

- 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 Table 7).

  The 7-year Mohn's ρ, relative to SSB, was 0.63 in the 2012 assessment and was 0.325 in 2014. The 7-year Mohn's ρ, relative to F, was -0.35 in the 2012 assessment and was -0.324 in 2014. There was a major retrospective pattern for this assessment because the ρ

adjusted estimates of 2014 SSB (SSB_ρ=10,977) and 2014 F (F_ρ=0.116) were outside the approximate 90% confidence regions around SSB (12,742 - 16,439) and F (0.069 - 0.093). 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 14,543 to 10,977 and the 2014 F_{Full} from 0.08 to 0.116.

- Based on this stock assessment, are population projections well determined or uncertain?
  Population projections for Gulf of Maine-Georges Bank American plaice are reasonably well determined.

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.
  No major changes, other than the addition of recent years of data, were made to the Gulf of Maine-Georges Bank American plaice assessment for this update. A new version of VPA was used (V3.3.0) which gave very similar results to the 2012 VPA 3.1.0 run, with the same F and slightly lower SSB. The MADMF spring and autumn survey indices were re-estimated for the time series, accounting for revised stratum areas. The revision occurred in 2007, but was overlooked in the 2012 assessment. A comparison of 2010 terminal year VPAs indicated minimal differences in 2010 SSB (now slightly lower) and no change in F.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  As in recent assessments for Gulf of Maine-Georges Bank American plaice the stock status remains as not overfished and overfishing not occurring.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  The Gulf of Maine-Georges Bank American plaice assessment could be improved with updated studies on growth of Georges Bank and Gulf of Maine fish.

- Are there other important issues?
  A difference in growth between GM and GB fish has been documented, however, historical catch data for GB may not be sufficient to conduct a separate assessment. Also, the growth difference may not persist in the most recent years. This could all be explored further in a benchmark review.

10.1 Reviewer Comments: Gulf of Maine-Georges Bank American plaice

Recommendation: The Panel concluded that the updated stock assessment with retrospective adjustment was acceptable as a scientific basis for management advice and agreed with the status determination that the stock is not overfished and overfishing is not occurring. The Panel accepted the current projections as basis for the 2016-2018 overfishing limits. All data updates and minor survey revisions were accepted by the Panel.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: A major source of uncertainty is the retrospective pattern. The current assessment model underestimates fishing mortality and overestimates spawning stock biomass. However, compared to the 2012 assessment, the magnitude of the retrospective pattern has declined slightly. Other sources of uncertainty include the age composition of catch during 1980-1984, discards estimates prior to 1989, age composition of discards in the small mesh fishery, and the mixed stock composition of age data.

Research Needs: For the next benchmark assessment, the Panel recommended that a statistical catch-at-age model, which can potentially handle the observed conflict between offshore and inshore surveys, should be explored. In addition, the assessment team should consider the inclusion of the Maine-New Hampshire survey as another calibration index.

References:

O'Brien, L. and J. Dayton (2012). E. Gulf of Maine - Georges Bank American plaice Assessment for 2012 in 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. http://www.nefsc.noaa.gov/publications/crd/crd1206/.

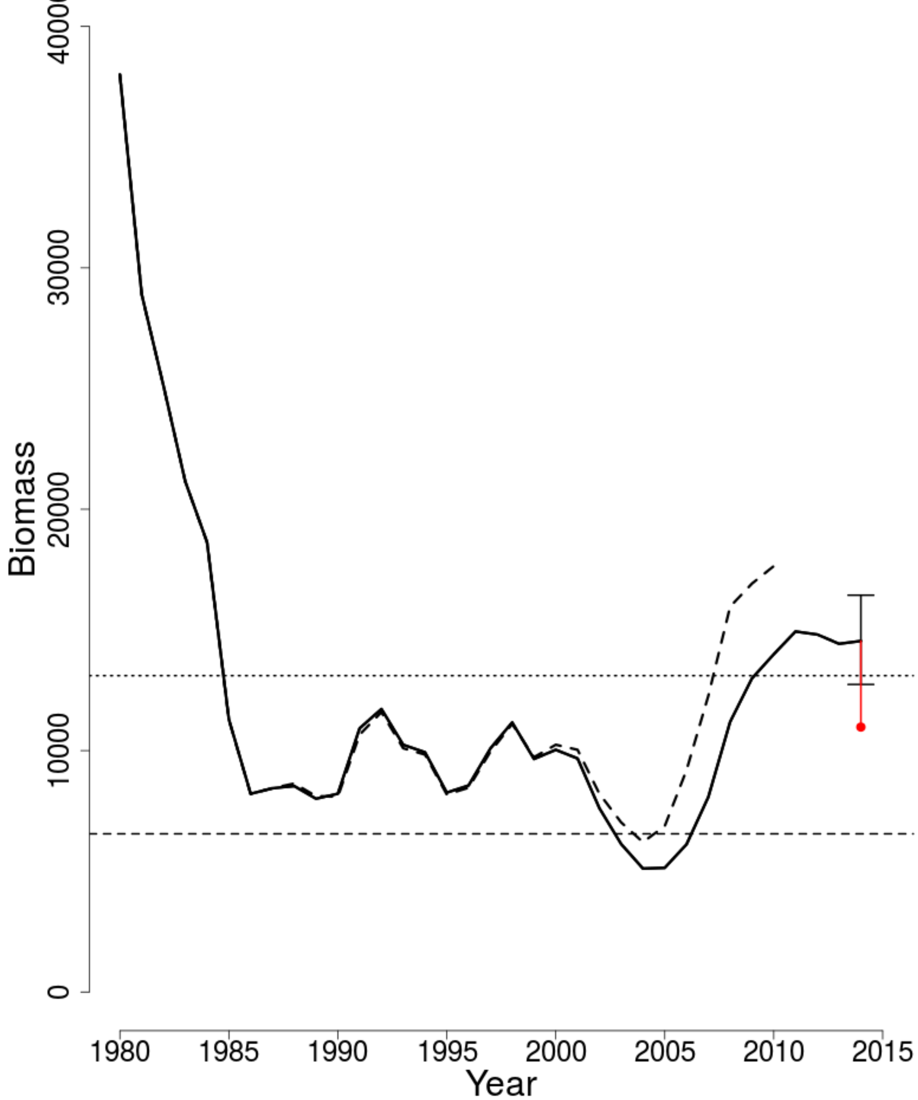


Figure 49: Trends in spawning stock biomass of Gulf of Maine-Georges Bank American plaice between 1980 and 2015 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% normal confidence intervals are shown.

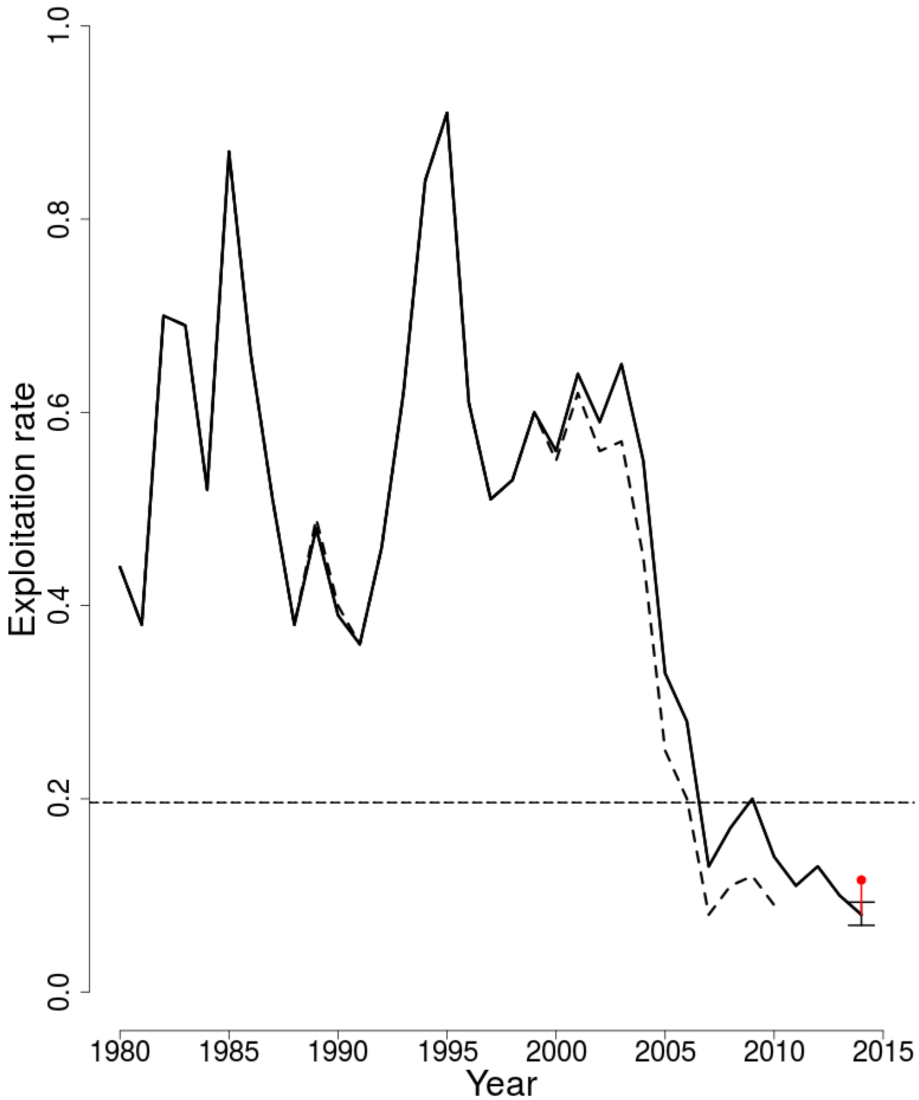


Figure 50: Trends in the fully selected fishing mortality (F_{Full}) of Gulf of Maine-Georges Bank American plaice between 1980 and 2015 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.196; horizontal dashed line). F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red, based on the 2015 assessment. The approximate 90% normal confidence intervals are shown.

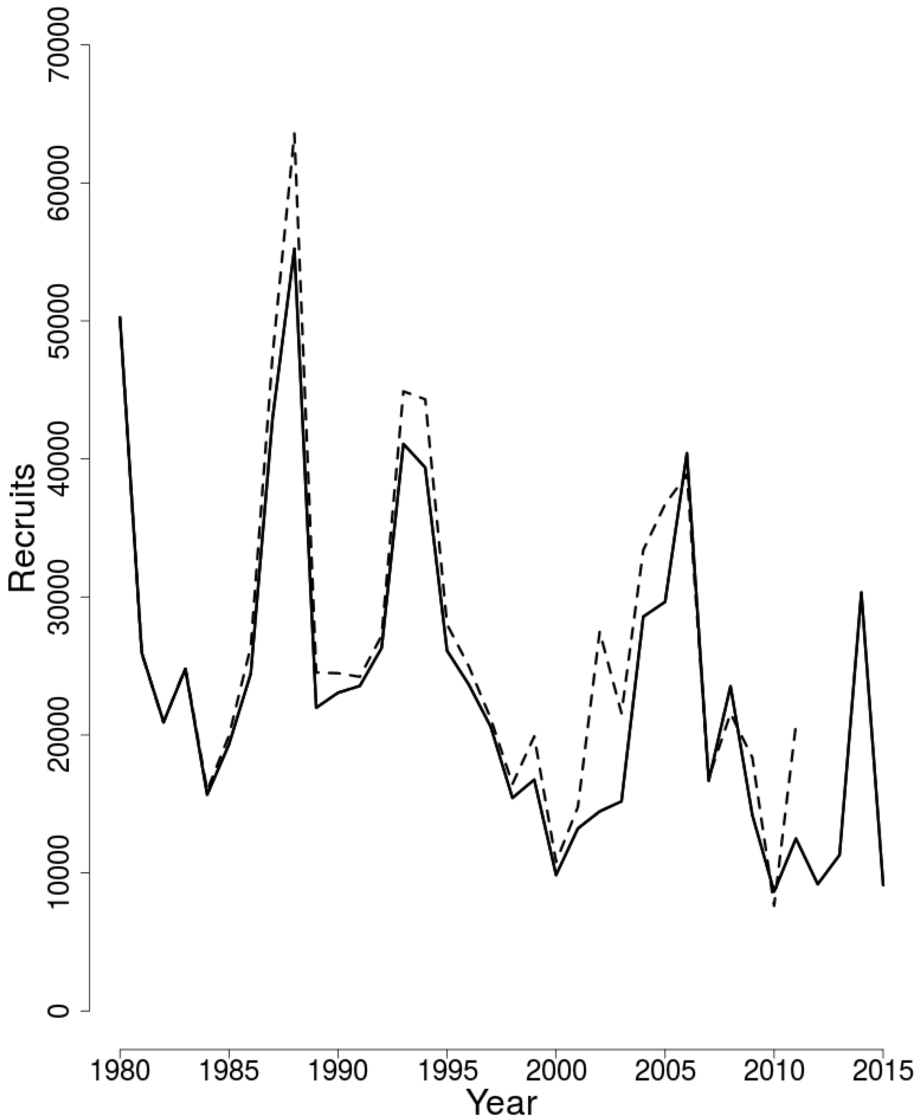


Figure 51: Trends in Recruits (age 1) (000s) of Gulf of Maine-Georges Bank American plaice between 1980 and 2015 from the current (solid line) and previous (dashed line) assessment.

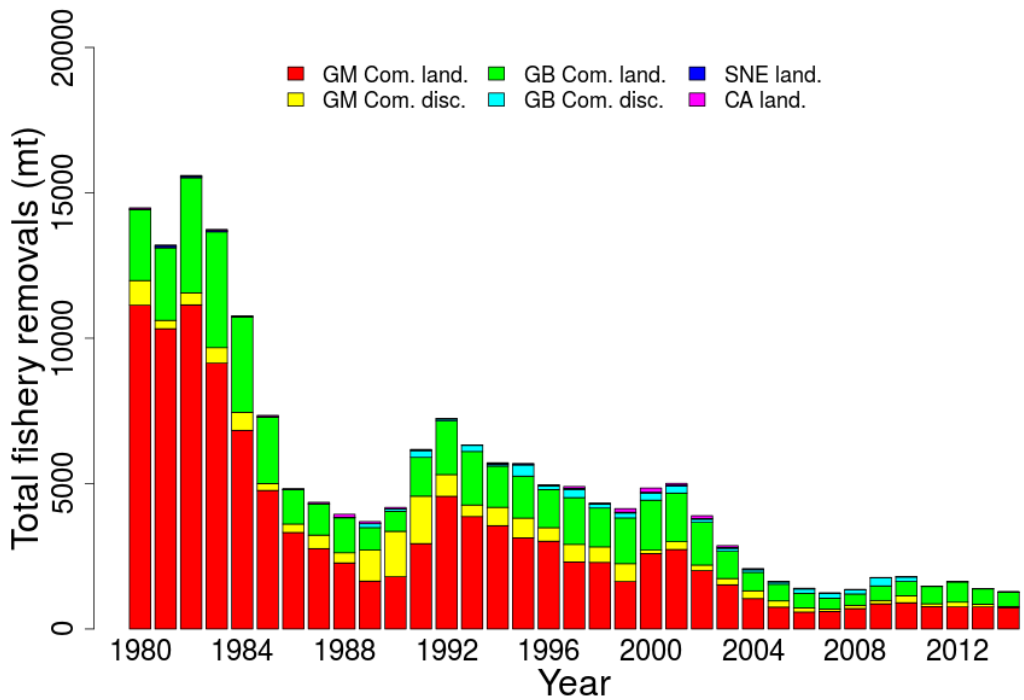


Figure 52: Total catch of Gulf of Maine-Georges Bank American plaice between 1980 and 2015 by fleet (Gulf of Maine, Georges Bank, Southern New England, and Canadian) and disposition (landings and discards).

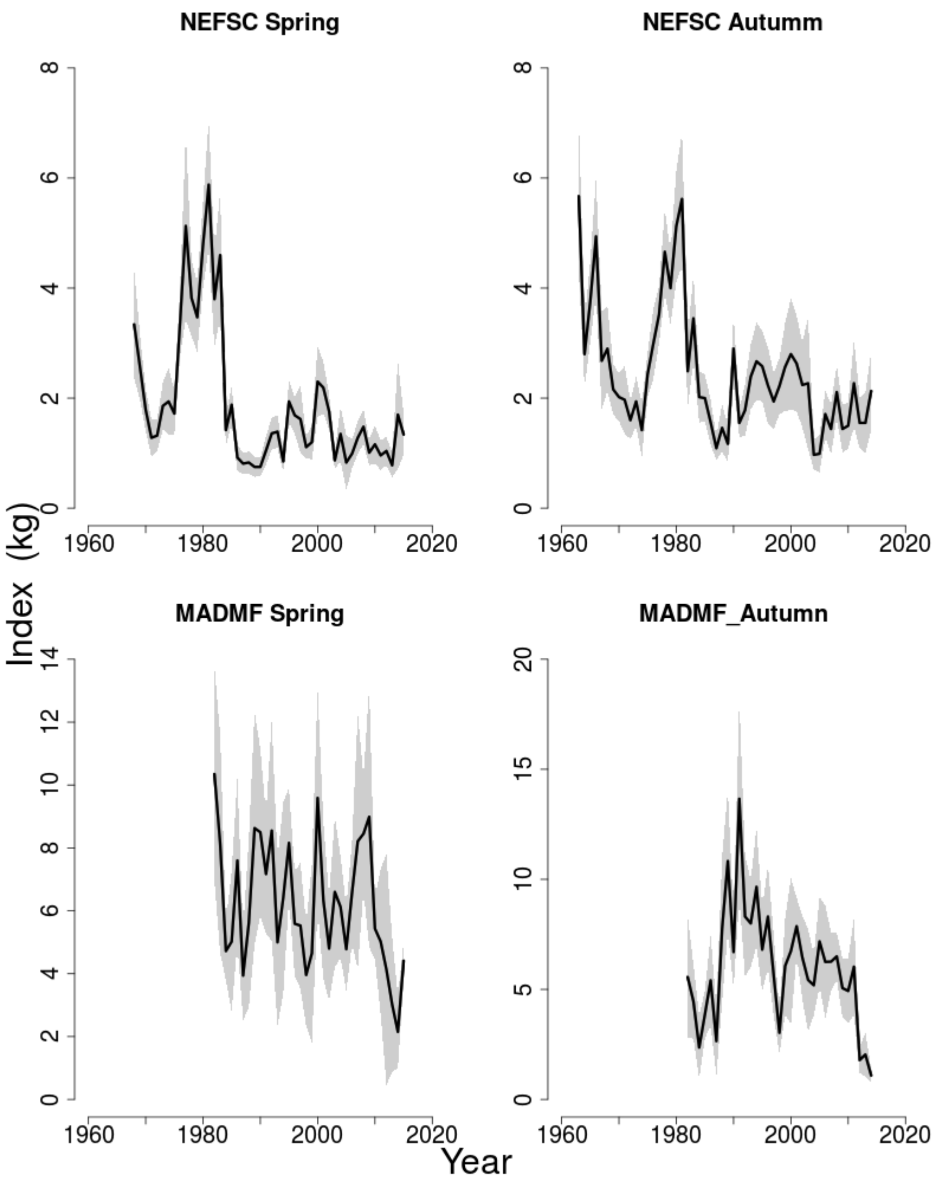


Figure 53: Indices of biomass for the Gulf of Maine-Georges Bank American plaice between 1963 and 2015 for the Northeast Fisheries Science Center (NEFSC) and Massachusetts Division of Marine Fisheries (MADMF) spring and autumn research bottom trawl surveys. The approximate 90% normal confidence intervals are shown.

11 Witch flounder

Susan Wigley

This assessment of the witch flounder (Glyptocephalus cynoglossus) stock is an operational update of the 2012 assessment (NEFSC 2012) and the 2008 benchmark assessment (NEFSC 2008). This assessment updates commercial fishery catch data, research survey indices, and the analytical assessment model through 2014. Additionally, stock projections have been updated through 2018. Reference points have been updated.

State of Stock: witch flounder (*Glyptocephalus cynoglossus*) stock is overfished and overfishing is occurring (Figures 54-55). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 2,077 (mt) which is 22% of the SSB_{MSY} proxy (9,473; Figure 54). The 2014 fully selected fishing mortality was estimated to be 0.687 which is 246% of the F_{MSY} proxy (0.279; Figure 55). A retrospective adjustment to F_{Full} and SSB in 2014 was required but did not lead to a change in status.

Table 35: Catch and model results table for witch flounder. All weights are in (mt), recruitment is in (000s). In this report, F_{Full} is defined as the average fishing mortality on ages 8 and 9 (unweighted). The 2014 retrospective adjusted values for F_{Full} and SSB are 0.687 and 2,077, respectively.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
					Data						
Commercial Landings	2,917	2,652	1,863	1,076	1,009	954	759	870	1,038	686	570
Commercial Discards	312	148	86	89	63	105	90	74	70	50	35
Catch for Assessment	3,229	2,800	1,949	1,165	1,072	1,059	850	944	1,108	737	604
					Model Results						
Spawning Stock Biomass	4,167	3,642	2,592	2,395	2,571	2,653	2,363	2,309	2,477	2,494	3,129
F_{Full}	0.936	0.859	0.899	0.568	0.658	0.583	0.671	0.633	0.78	0.637	0.428
Recruits $Age3$	4,268	3,546	3,619	4,992	4,713	3,730	3,229	5,388	7,740	3,876	10,160

Table 36: Biological references points for witch flounder from the previous and current assessments are given. An $F_{40\%}$ proxy was used for the overfishing threshold and biomass and catch proxies were based on long-term stochastic projections.

	2012	Current
F_{MSY}	0.27	0.279
SSB_{MSY} (mt)	10,051	9,473
MSY (mt)	2,075	1,957
Median Recruits Age 3 (000s)	9,301	8,517

Overfishing	Yes	Yes
Overfished	Yes	Yes

Projections: Short term projection recruitment was sampled from a cumulative distribution function derived from ADAPT VPA (with split time series between 1994 and 1995) estimated age 3 recruitment between 1982 and 2013. Average 2010-2014 partial recruitment, average 2010-2014 mean weights, and maturation ogive representing 2011-2015 maturity data were used.

Table 37: Short term projections of median total fishery yield and spawning stock biomass for witch flounder based a harvest scenario of fishing at F_{MSY} between 2016 and 2018. Catch in 2015 has been estimated at 637 mt; initial 2015 stock sizes for ages 3 to 11+. The SSB retrospective adjustment factor (0.6638) was applied to all ages.

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	637	2556	0.437
2016	513	3201	0.279
2017	712	4143	0.279
2018	879	5163	0.279

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).
  An important source of uncertainty is the retrospective pattern where fishing mortality is underestimated and spawning stock biomass and recruitment are overestimated.

- 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}).
  The 7-year Mohn's ρ, relative to SSB, was 0.61 in the 2012 assessment and was 0.51 in 2014. The 7-year Mohn's ρ, relative to F, was -0.33 in the 2012 assessment and was -0.38 in 2014. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2014 SSB (SSB_ρ=2,077) and 2014 F (F_ρ=0.687) were outside the approximate 90% confidence regions around SSB (2,643 - 3,864) and F (0.321 - 0.603). 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 3,129 to 2,077 and the 2014 F_{Full} from 0.428 to 0.687.

- Based on this stock assessment, are population projections well determined or uncertain?
  Population projections for witch flounder appear to be optimistic; the projected rho adjusted biomass from the last assessment was above the upper confidence bounds of the projected rho adjusted biomass estimated in the current assessment.

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.
  TOGA (Type, Operation, Gear, Acquisition) values were used for haul criteria for NEFSC surveys for 2009 onward and minor changes in the use of observer data for discard estimates were made to the current witch flounder assessment. These changes had negligible effect on the assessment and stock status.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  No change in stock status has occurred for witch flounder 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.
  Extensive studies have examined the causes of retrospective patterns with no definitive conclusions other than a change in model does not resolve the issue.

- Are there other important comments?
  The VPA analysis was performed with survey time series split between 1994 and 1995. This time split corresponds to changes in the commercial reporting methods as well as other regulatory management changes.

11.1 Reviewer Comments: Witch flounder

Recommendation: The Panel concluded that the updated stock assessment with retrospective adjustment was acceptable as a scientific basis for management advice and agreed with the status determination that the stock is overfished and overfishing is occurring. The Panel accepted the current rho-adjusted projections as basis for the 2016-2018 overfishing limits but these limits may be optimistic. All data updates and survey revisions were accepted by the Panel.

Alternative Assessment Approach: Not applicable

Source of Uncertainty: A major source of uncertainty is the retrospective pattern. The current assessment model underestimates fishing mortality and overestimates spawning stock biomass. Compared to the 2012 assessment, the magnitude of the retrospective pattern has increased slightly for F and decreased slightly for SSB.

Research Needs: The Panel recommends that the sources of the retrospective pattern need to be addressed. Considering that retrospective patterns are a common problem, the generic problem may be most appropriately addressed in a research track topic, and all possible sources of the retrospective problem should be investigated (misspecified natural mortality, changes in natural mortality, under-reported catch, changes in survey catchability and misspecified selectivity, etc.).

For the next benchmark assessment, the Panel recommended exploring a statistical catch-at-age model to investigate possible doming in the catch selectivity.

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 Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii. http://www.nefsc.noaa.gov/publications/crd/crd0815/

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

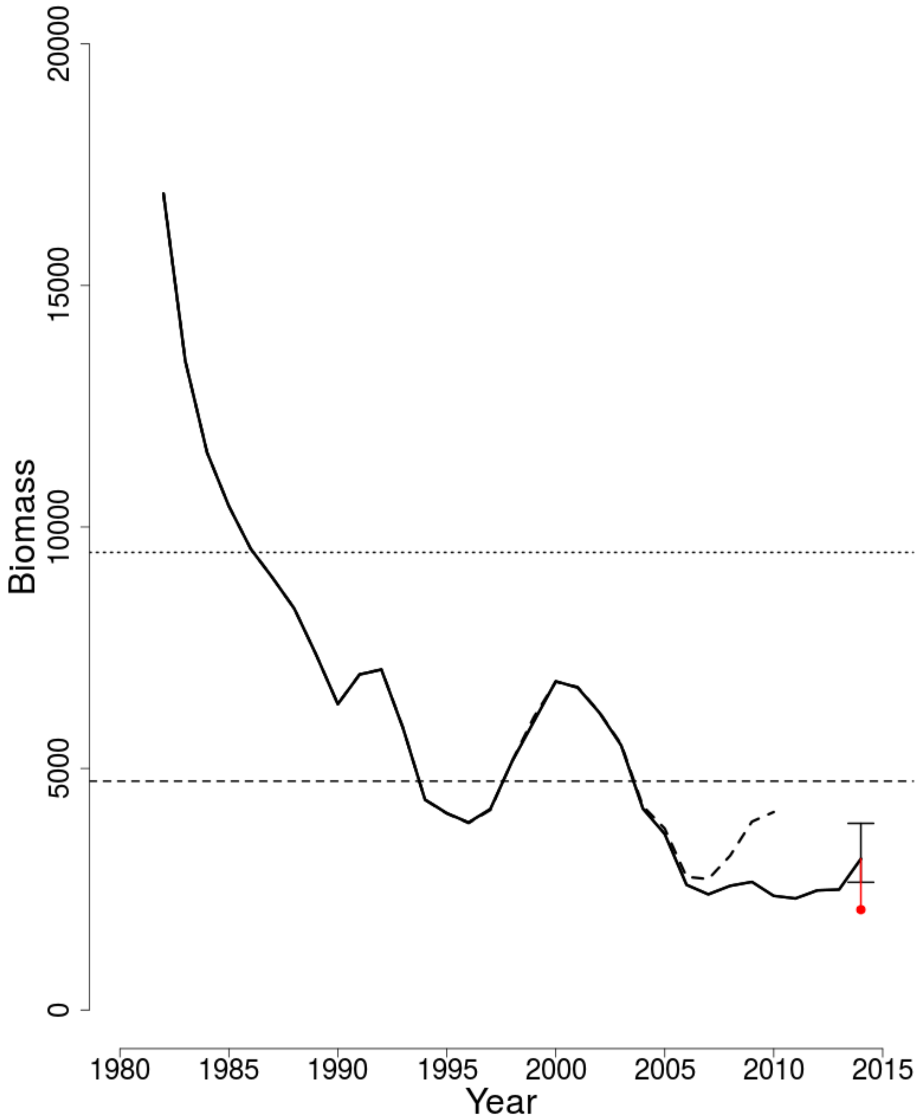


Figure 54: Trends in spawning stock biomass (mt) of witch flounder between 1982 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY}; horizontal dashed line) as well as SSB_{Target} SSB_{MSY}; horizontal dotted line) based on the current assessment. Red solid vertical line indicates rho adjusted SSB. Black solid vertical line indicates 90% confidence interval for 2014.

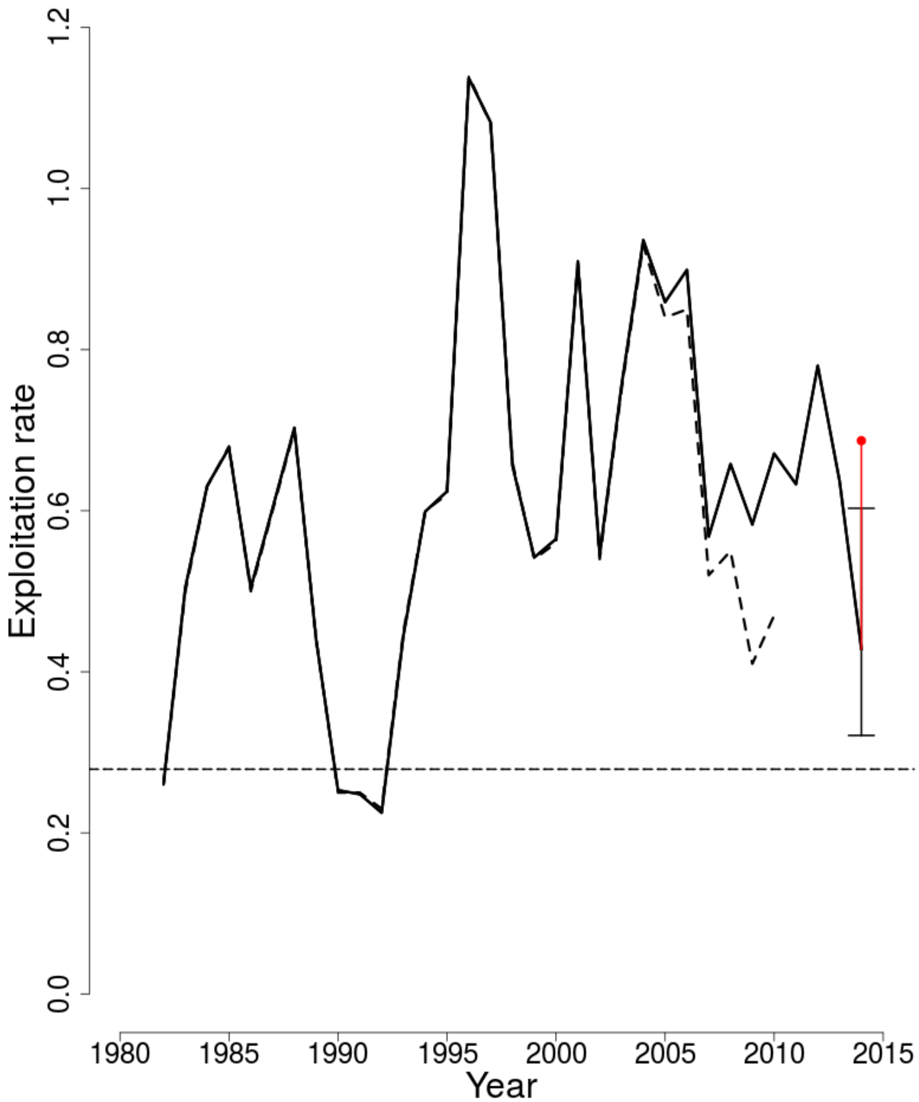


Figure 55: Trends in the fully selected fishing mortality (F_{Full}) of witch flounder between 1982 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY}=0.279; horizontal dashed line) based on the current assessment. Red solid vertical line indicates rho adjusted F_{Full}. Black solid vertical line indicates 90% confidence interval for 2014.

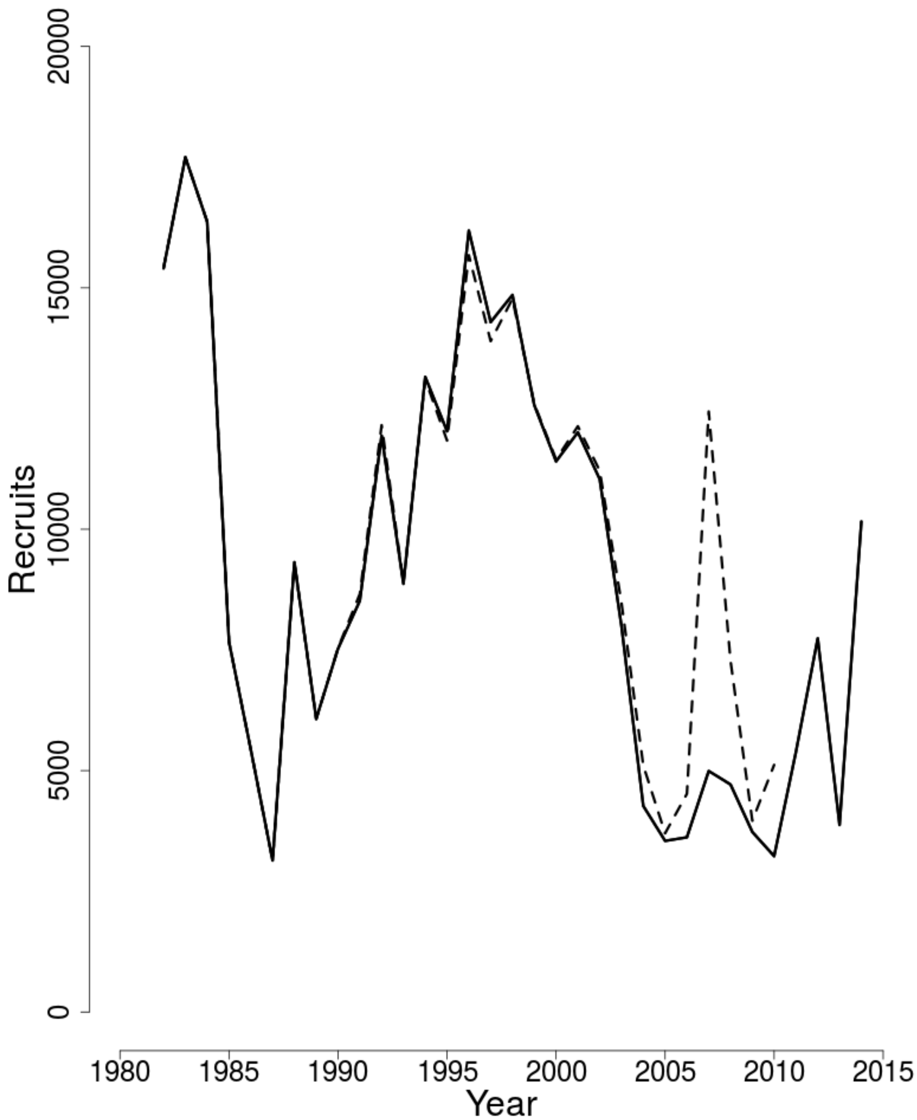


Figure 56: Trends in Age 3 (000s) of witch flounder between 1982 and 2014 from the current (solid line) and previous (dashed line) assessment.

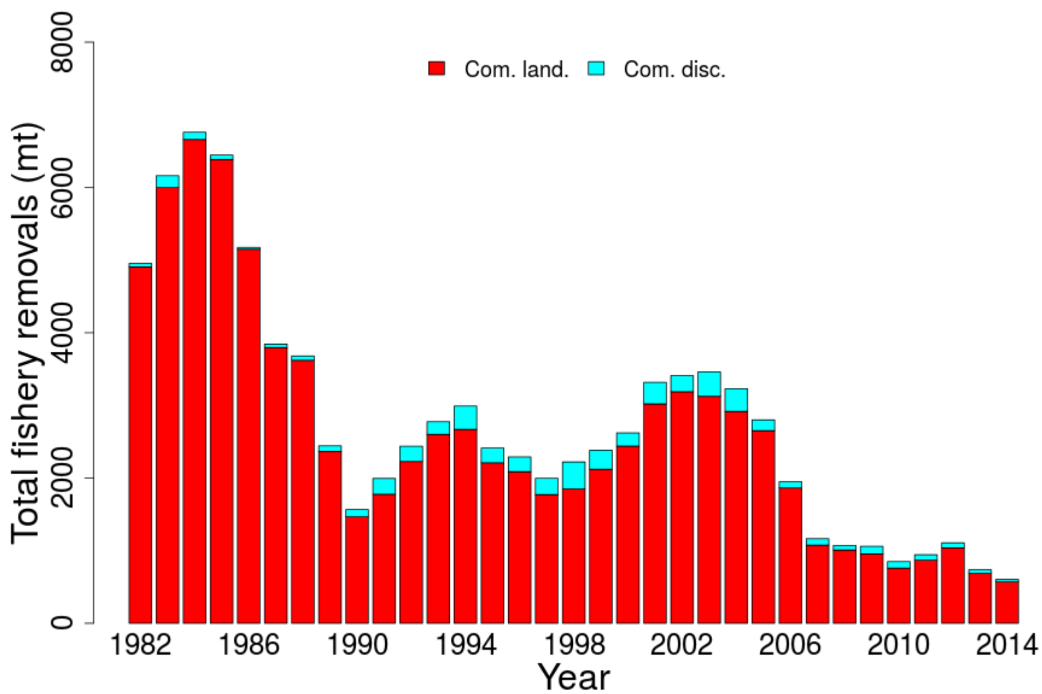


Figure 57: Total catch of witch flounder between 1982 and 2014 by fleet (commercial) and disposition (landings and discards).

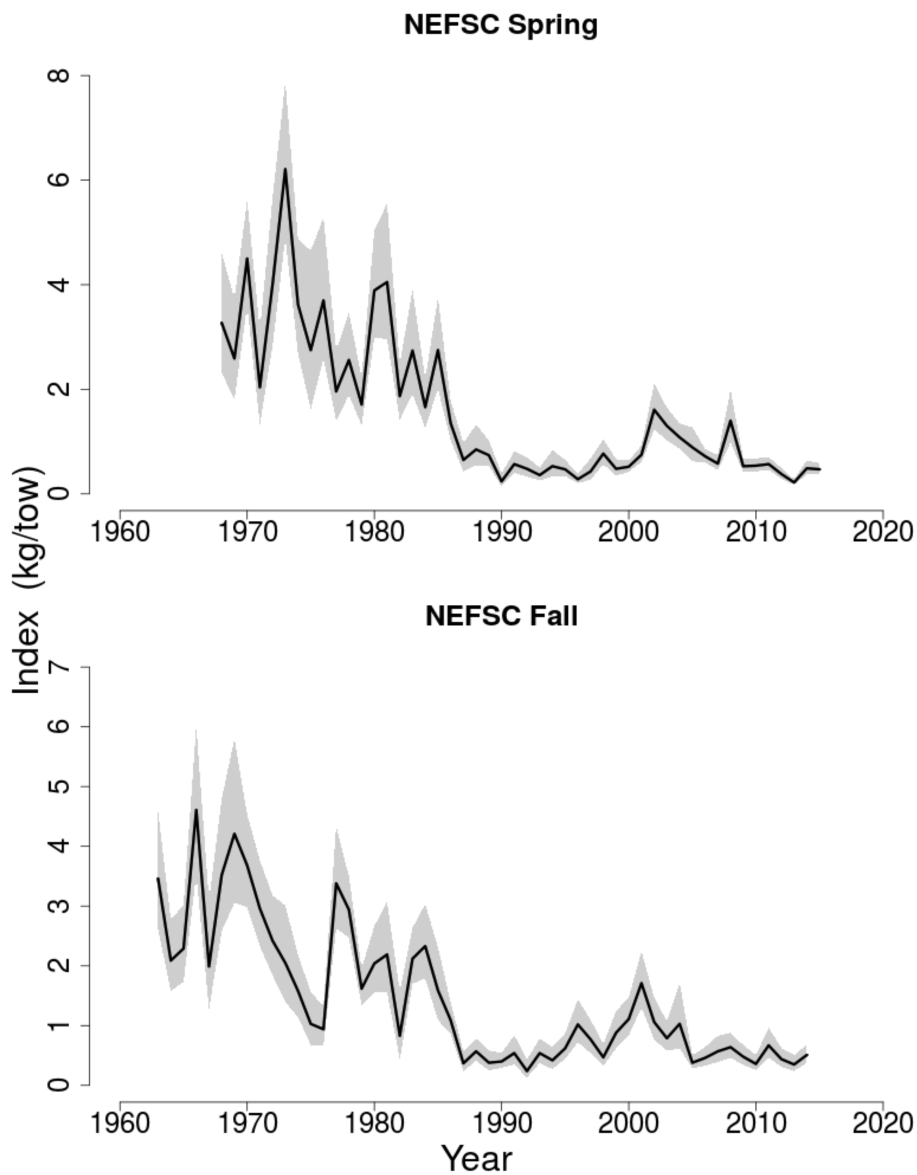


Figure 58: Indices of biomass (kg/tow) for the witch flounder between 1963 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys. The 90% lognormal confidence intervals are shown.

12 Acadian redfish

Brian Linton

This assessment of the Acadian redfish (Sebastes fasciatus) stock is an operational 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 59-60). 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 59). 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 60).

Table 38: 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 39: 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 5^{th} and 95^{th} 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 40: 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 Table 7).

  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 63), but the current assessment model continues to predict an increase in SSB for the last two years (Figure 59). 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.

12.1 Reviewer Comments: Acadian redfish

Recommendation: The Panel concluded that the updated stock assessment with retrospective adjustment was acceptable as a scientific basis for management advice and agreed with the status determination that the stock is not overfished and overfishing is not occurring. The Panel accepted the current projections as basis for the 2016-2018 overfishing limits. All data updates and model change (removal of likelihood constants) were accepted by the Panel.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: Major sources of uncertainty are the retrospective pattern, lack of age samples from the commercial fishery, historical discard estimates and model inconsistencies. The current assessment model underestimates fishing mortality and overestimates spawning stock biomass, and compared to the 2012 assessment, the magnitude of the retrospective pattern has increased slightly. The current retrospective pattern is similar in magnitude to the retrospective pattern from the GARM III benchmark assessment. No age measurements from the commercial fishery have been made since 1985. There is dimorphic growth of sexes and the current use of female weights-at-age in the stock projections may lead to overestimation of stock productivity and have unknown effects on the biological reference points. The relatively high uncertainty in the 1991 discard estimate (CV = 76%) led to an overestimation of total removals and a spike in predicted F in that year. The shift in peak recruitment from 2006 in the last assessment to 2007 in the current assessment, and lack of fit to the fall survey values in 2013-2014 suggests potential model/data inconsistencies.

Research Needs: For the next benchmark assessment, the Panel recommended that processing of historical samples and age sampling of the current commercial fishery should occur since the landings of redfish are increasing, and age data will better inform the model. In addition, they suggested work should focus on ageing samples from select years (since the ASAP does not require ages for every year) or targeting years where there are problems. Since redfish are long-lived, errors in ageing should be investigated and quantified.

References:

Northeast Fisheries Science Center. 2008. Assessment of 19 Northeast Groundfish Stocks through 2007: Report of the 3rd 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/

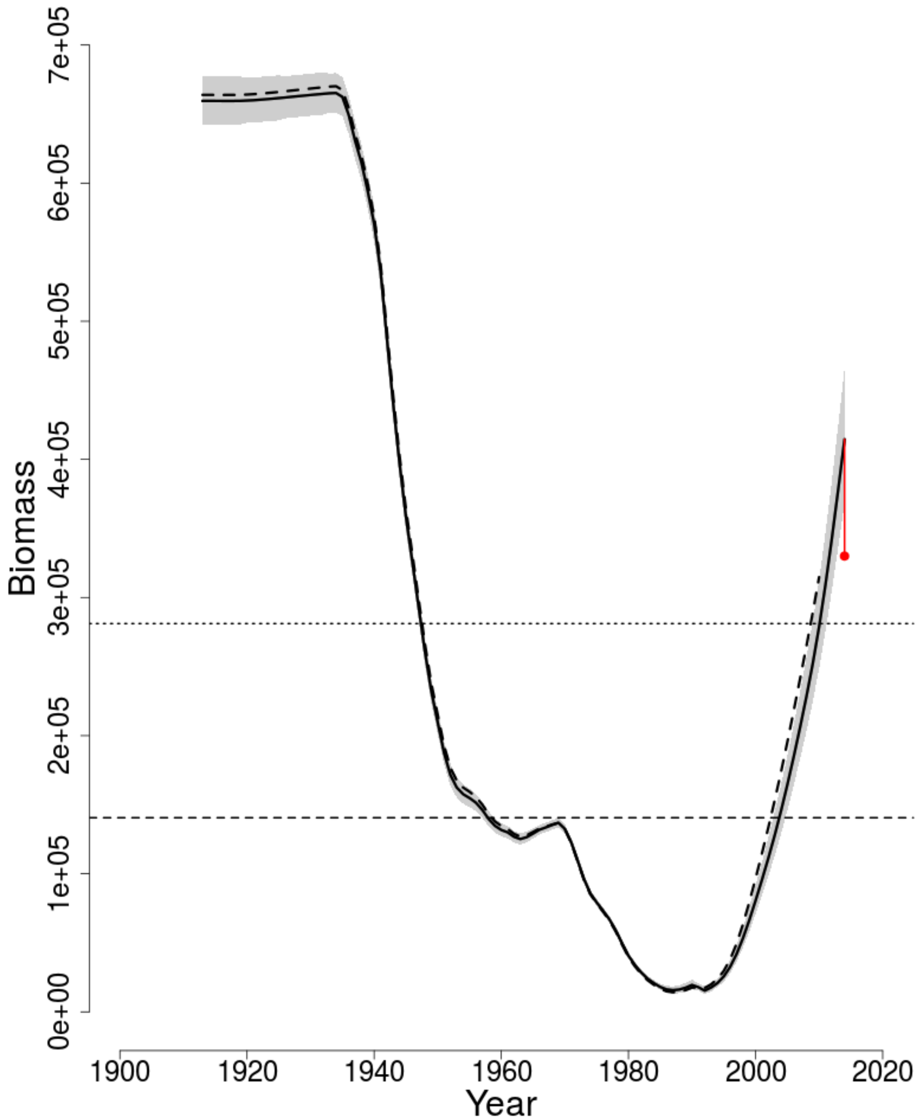


Figure 59: Trends in spawning stock biomass of Acadian redfish between 1913 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ (0.5 * SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted 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.

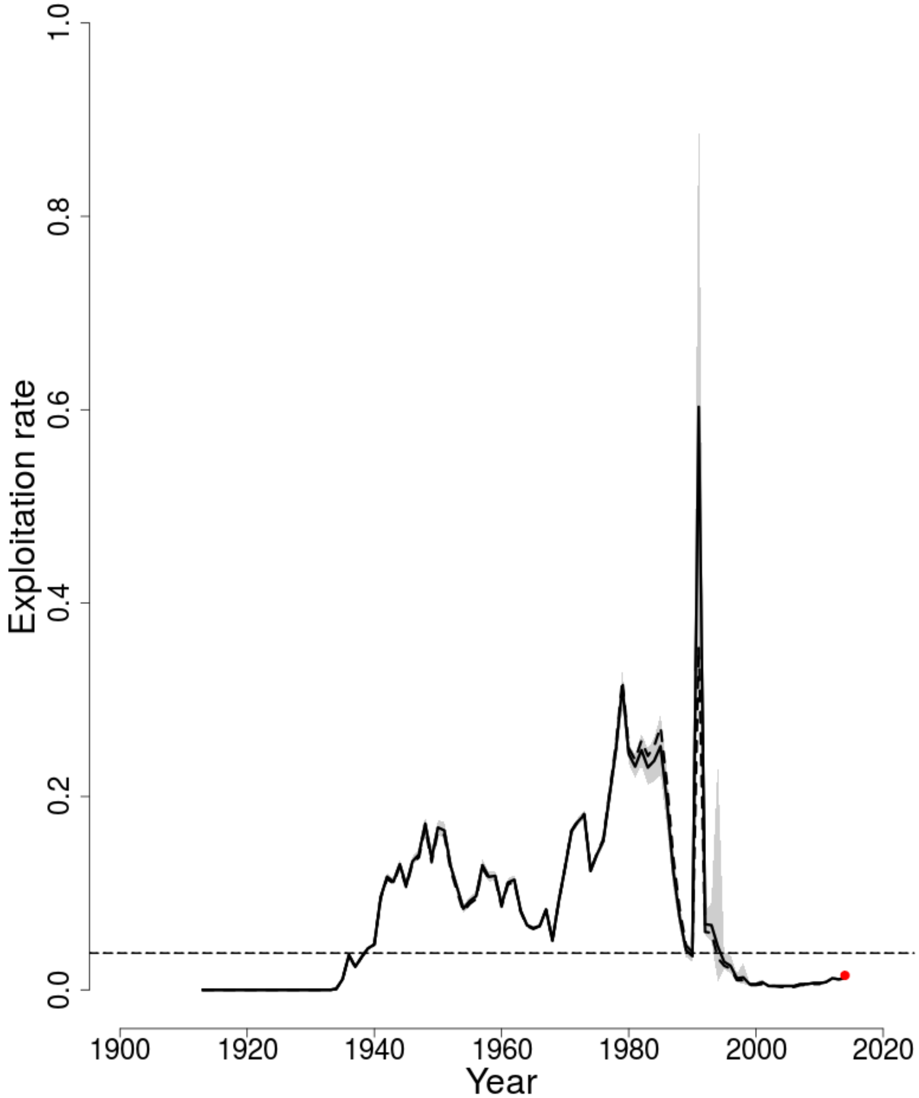


Figure 60: Trends in the fully selected fishing mortality (F_{Full}) of Acadian redfish between 1913 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.038; horizontal dashed line) based on the 2015 assessment. F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

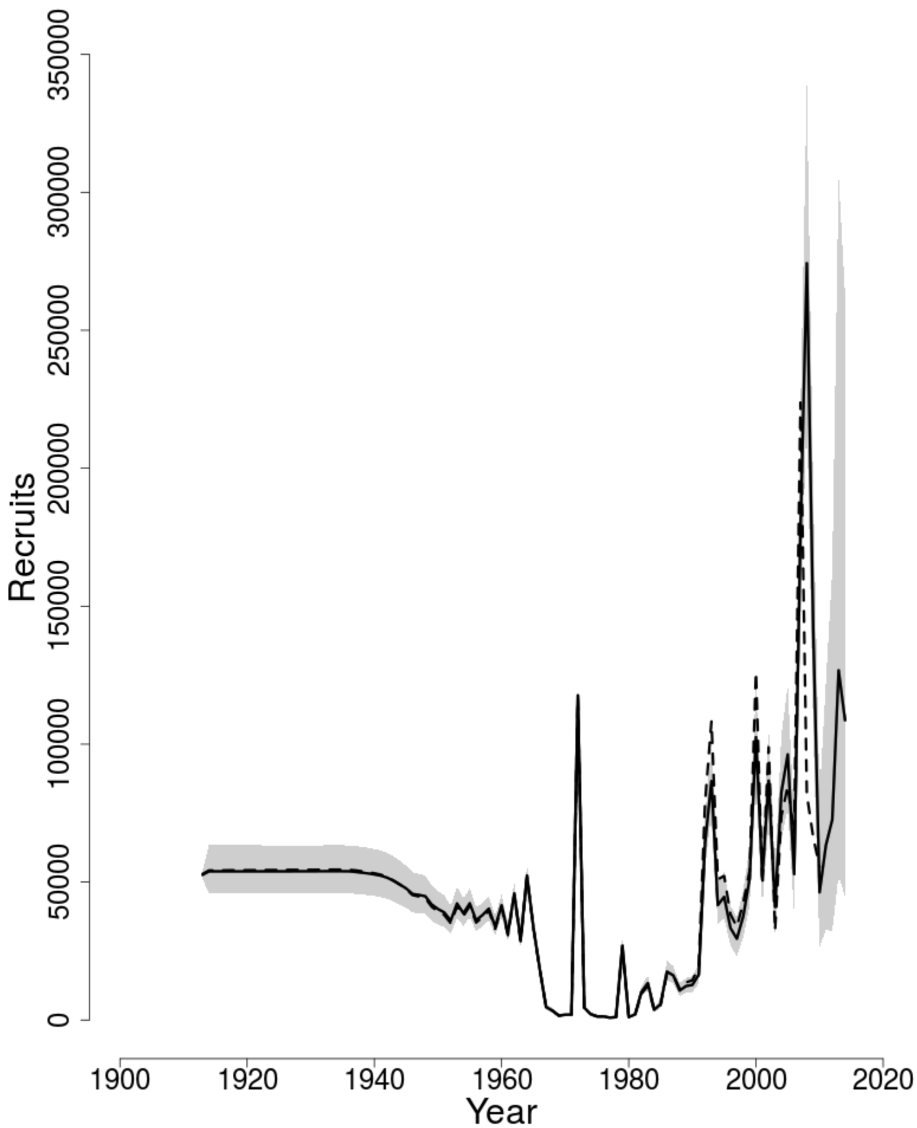


Figure 61: Trends in Recruits (age 1) (000s) of Acadian redfish between 1913 and 2014 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

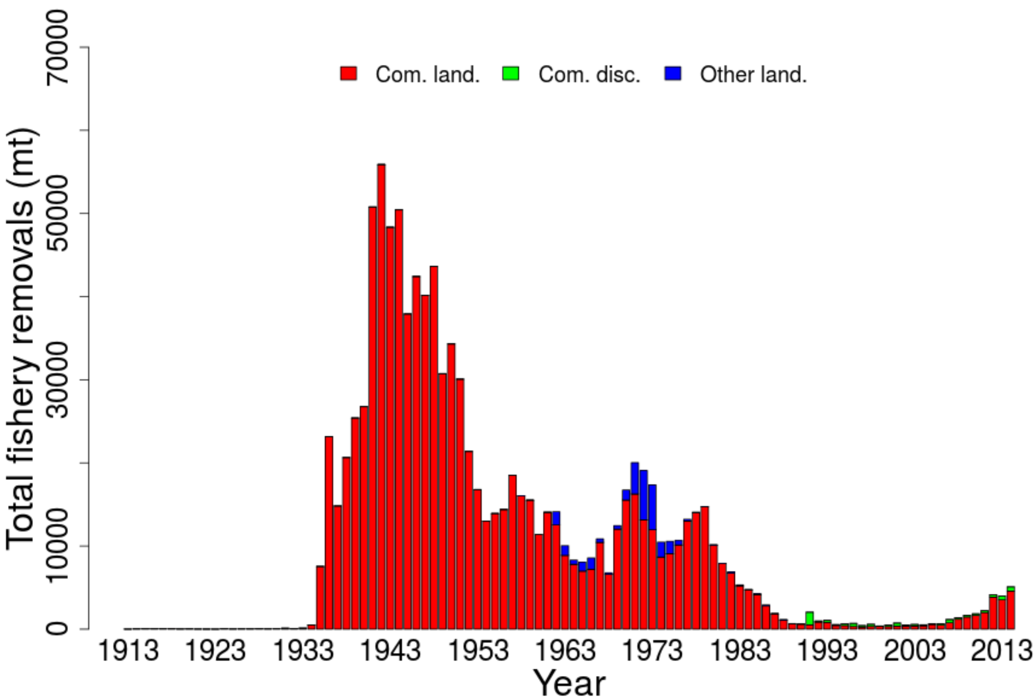


Figure 62: Total catch of Acadian redfish between 1913 and 2014 by fleet (commercial and other) and disposition (landings and discards).

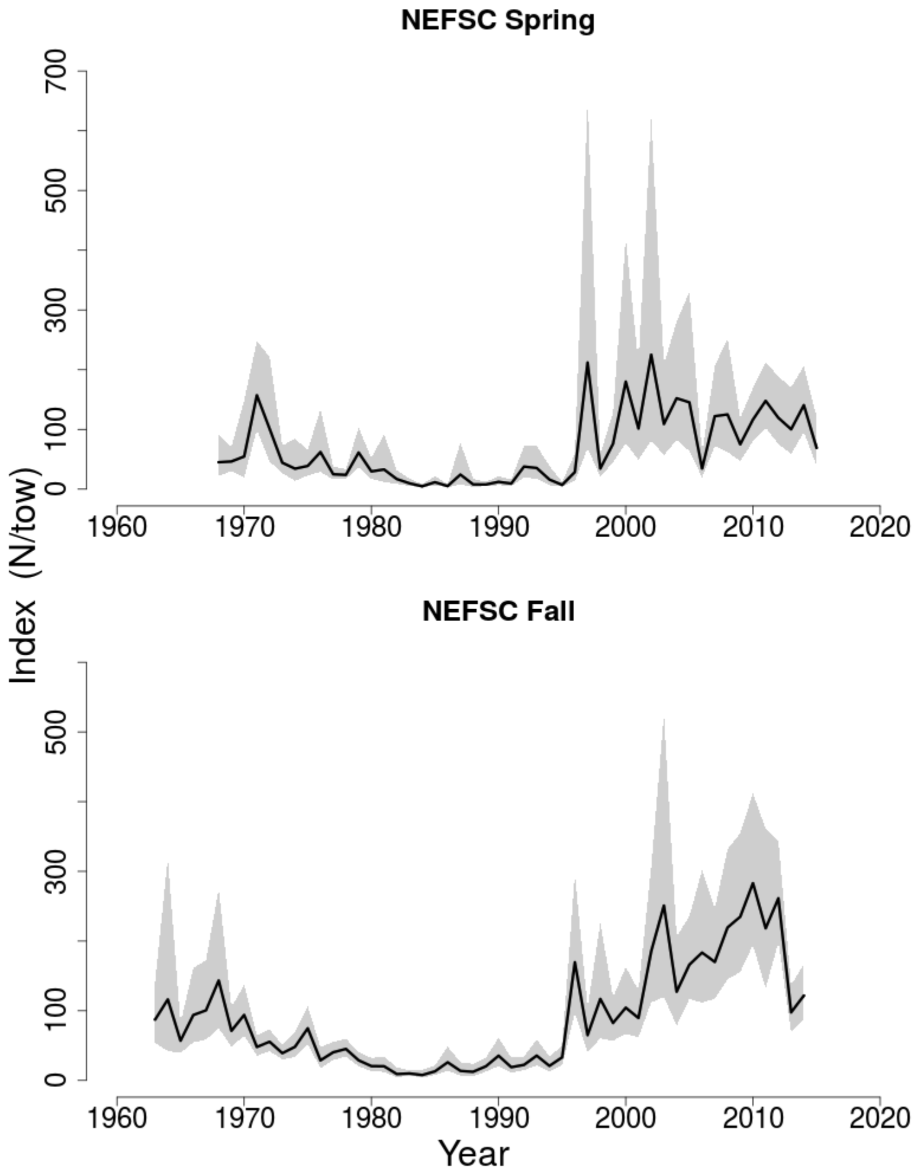


Figure 63: Indices of abundance for Acadian redfish from the Northeast Fisheries Science Center (NEFSC) spring (1963 to 2015) and fall (1963 to 2014) bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.

13 White hake

Katherine Sosebee

This assessment of the white hake (Urophycis tenuis) stock is an operational update of the existing 2013 benchmark ASAP assessment (NEFSC 2013). Based on the previous assessment the stock was not overfished, and overfishing was not ocurring. This assessment updates commercial fishery catch data, research survey indices of abundance, and the ASAP assessment model and reference points through 2014. Additionally, stock projections have been updated through 2018.

State of Stock: Based on this updated assessment, white hake (*Urophycis tenuis*) stock is not overfished and overfishing is not occurring (Figures 64-65). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 28,553 (mt) which is 88% of the biomass target (SSB_{MSY} *proxy* = 32,550; Figure 64). The 2014 fully selected fishing mortality was estimated to be 0.076 which is 40% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.188; Figure 65).

Table 41: Catch and status table for white hake. All weights are in (mt) recruitment is in (000s) and F_{Full} is the fishing mortality on fully selected ages (ages 6 - 9+). Model results are from the current updated ASAP assessment.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
					Data					
Commercial discards	93	62	36	171	83	91	54	34	28	33
Commercial landings	2,671	1,703	1,530	1,340	1,712	1,820	2,899	2,771	2,235	1,888
Canadian landings	85	89	56	39	79	104	86	83	43	59
Other landings	0	0	0	0	0	0	0	0	0	0
Catch for Assessment	2,849	1,851	1,621	1,543	1,859	2,002	3,039	2,887	2,306	1,980
					Model Results					
Spawning Stock Biomass	10,752	11,000	13,721	14,988	14,662	18,782	22,824	24,156	25,092	28,553
F_{Full}	0.306	0.19	0.126	0.123	0.149	0.118	0.151	0.136	0.103	0.076
Recruits $age1$	3,523	4,356	3,533	4,013	3,925	3,505	3,409	3,000	3,674	1,343

Table 42: Comparison of reference points estimated in the 2013 assessment and from the current assessment update. An $F_{40\%}$ proxy was used for the overfishing threshold and was based on long-term stochastic projections which sampled from a cumulative distribution function of recruitment estimates from ASAP from 1963-2012. The annual fishery selectivity, maturity ogive, and mean weights at age used in the projection are the most recent 5 year averages.

	2013	Current
F_{MSY} *proxy*	0.200	0.188
SSB_{MSY} (mt)	32,400	32,550 (26,323 - 40,771)
MSY (mt)	5,630	5,422 (4,589 - 6,470)
Median recruits (age 1) (000s)	4,948	4,608
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of catch and SSB were derived by sampling from a cumulative distribution function of recruitment estimates from ASAP from 1995-2012. The annual fishery selectivity, maturity ogive, and mean weights at age used in the projection are the most recent 5 year averages.

Table 43: Short term projections of total fishery catch and spawning stock biomass for white hake based on a harvest scenario of fishing at F_{MSY} *proxy* between 2016 and 2018. Catch in 2015 was assumed to be 1,759 (mt) and is also the 2015 OFL.

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	1,759	28,829 (24,458 - 33,954)	0.066
2016	4,985	29,304 (24,851 - 34,376)	0.188
2017	4,627	27,320 (23,386 - 31,685)	0.188
2018	4,393	26,119 (22,742 - 29,940)	0.188

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).

  1. Catch at age information is not well characterized due to possible mis-identification of species in the commercial and sea sampling data, particularly in early years, low sampling of commercial landings in some years, and sparse discard data particularly in early years.

  2. Since the commercial catch is aged primarily with survey age/length keys, there is considerable augmentation required, mainly for ages 5 and older. The numbers at age and mean weights at age in the catch for these ages may therefore not be well specified.

  3. White hake may move seasonally into and out of the defined stock area.

  4. There are no commercial catch at age data prior to 1989 and the catchability of older ages in the surveys is very low. This results in a large uncertainty in starting numbers at age.

  5. Since 2003, dealers have been culling very large fish out of the large market category. However, there was no market category to input into the landings until June 2014. The *length compositions are distinct from large and have been identified since 2011. This may bias the age composition of the landings, particularly in 2014 when 2000 of the 5000 large samples were these extra-large fish.*

6. A pooled age/length key is used for 1963-1981, fall 2003 (second half of commercial key) and 2014. Age data were not available for 2014 in time for this assessment. The same pooled key that was used for 1963-1981 was used for 2014.

- 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 Table 7).

  No retrospective adjustment of spawning stock biomass or fishing mortality in 2014 was required. The pattern in this assessment is considered minor (Mohns rho of 0.18 on SSB, Mohns rho of 0.12 on F) with the adjusted SSB within the 90% CI of the MCMC. However, the Mohns rho for Age 1 estimates is 0.54. This may have an impact on projections if this continues into the future.

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

  Population projections for white hake, are not well determined and projected biomass from the last assessment was outside the confidence bounds of the biomass estimated in the current assessment.

- 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 2011 catch-at-length and age were re-estimated for both landings and discards. For the landings, two samples were adjusted for dorsal length to total length that had been missed in the previous assessment.

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

  While stock status of white hake has not changed, the stock has not rebuilt as the projections from the last assessment indicated. This is due to the retrospective pattern in recruitment. The numbers for the 2005-2009 year classes, which were included in the age 2-6 starting numbers in the projections, were over-estimated which led to over-estimating SSB in 2014.

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

  Age structures from the observer program are available and should be aged to augment the survey keys. There is a also a new market category for heads and age structures could be acquired from these as an otolith length/total length relationship can be established.

- Are there other important issues?

  None.

13.1 Reviewer Comments: White hake

Recommendation: The Panel concluded that the updated stock assessment without retrospective adjustment was acceptable as a scientific basis for management advice and agreed with the status determination that the stock is not overfished and overfishing is not occurring. The Panel accepted the current projections as basis for the 2016-2018 catch advice. All data updates and revisions were accepted by the Panel.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: Major sources of uncertainty are the commercial catch, age data, and stock dynamics. The magnitude of the SSB retrospective pattern was less than but near the upper bound of the confidence interval and is a source of uncertainty. The previous assessment overestimated abundance of ages 2-5, which do not contribute much to the estimate of SSB. Therefore, previous projections were overly optimistic. There are two large residuals at the end of the fall survey time series. The spring 2015 survey is not included in the updated benchmark method, but the index is less than the 2014 index. There is possible mis-identification of hake species during commercial and at-sea sampling and sparse discard data. The recent addition of an extra-large market category and the mis-match between samples and landings statistics may bias the age composition of landings. Age/length data from surveys are used to estimate commercial catch age composition and pooled age/length keys were used for 1963-1981, fall 2003 and 2014. Numbers and weights of ages 5 and older are likely the most uncertain due to low sample sizes. There are also potential seasonal movements in and out of the stock area that are not accounted for in the current assessment model.

Research Needs: For the next benchmark assessment, the Panel recommended that more age samples be processed, particularly for large sizes, and that staff should investigate the appropriate way to estimate age composition of fish in the extra-large market category. In addition, methods to account for size structure information without pooling age/length keys should be explored. Given that the last two years of survey data were not fit well in the model, the Panel recommended monitoring the model predictions of survey trends closely for major deviations in the future.

References:

NEFSC. 2013. 56^{th} Northeast Regional Stock Assessment Workshop (56^{th} SAW) Assessment Report.US Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 13-10; 868 p. http://www.nefsc.noaa.gov/publications/crd/crd1310/

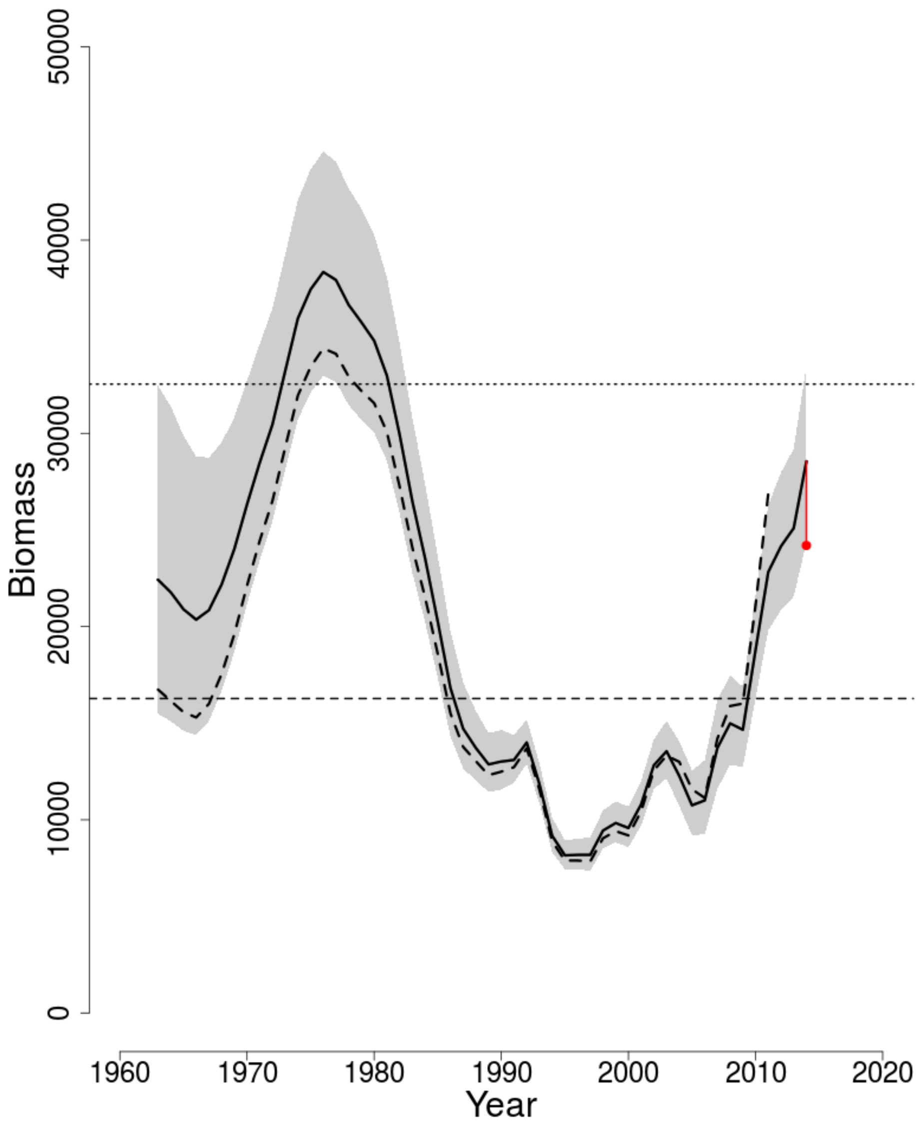


Figure 64: Trends in spawning stock biomass of white hake between 1963 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2014 assessment. The red dot indicates the rho-adjusted SSB values that would have resulted had a retrospective adjusment been made (see Special Comments section). The approximate 90% lognormal confidence intervals are shown.

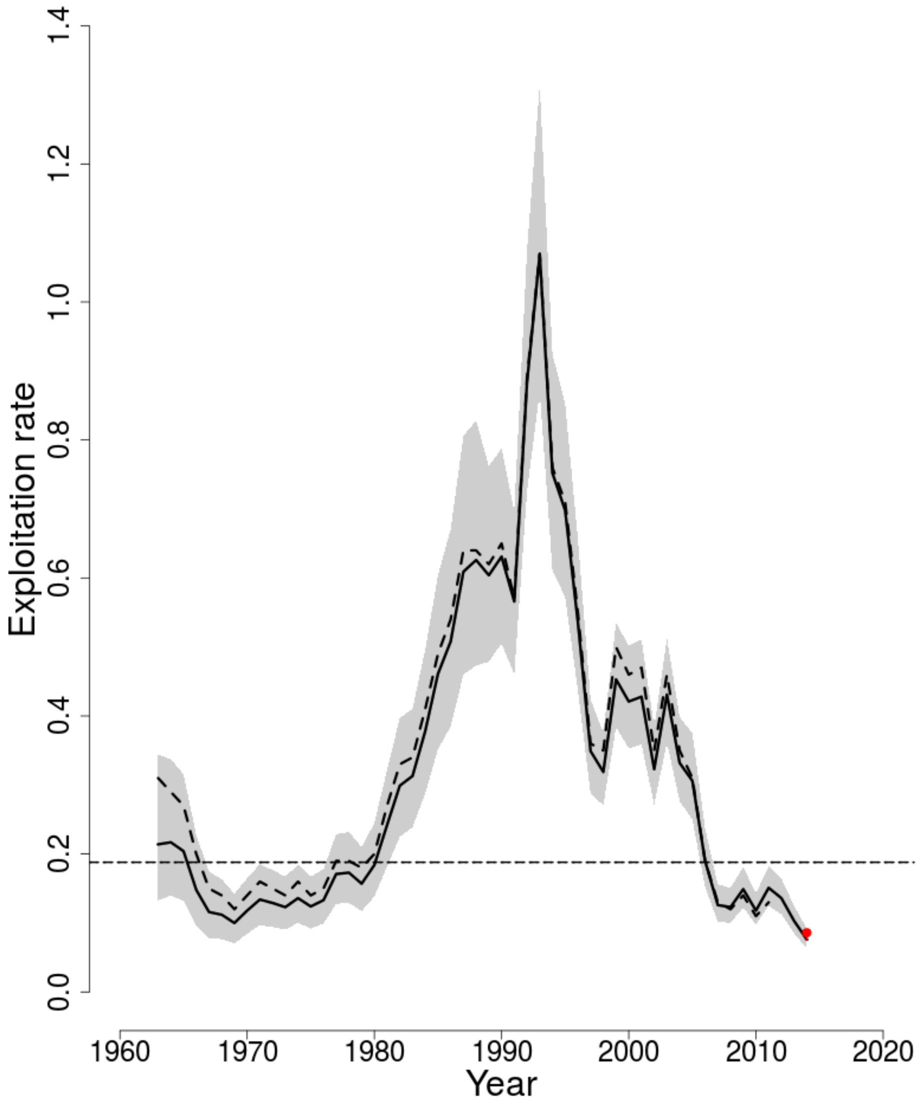


Figure 65: Trends in the fully selected fishing mortality (F_{Full}) of white hake between 1963 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.188; horizontal dashed line). The red dot indicates the rho-adjusted SSB values that would have resulted had a retrospective adjusment been made (see Special Comments section). The approximate 90% lognormal confidence intervals are shown.

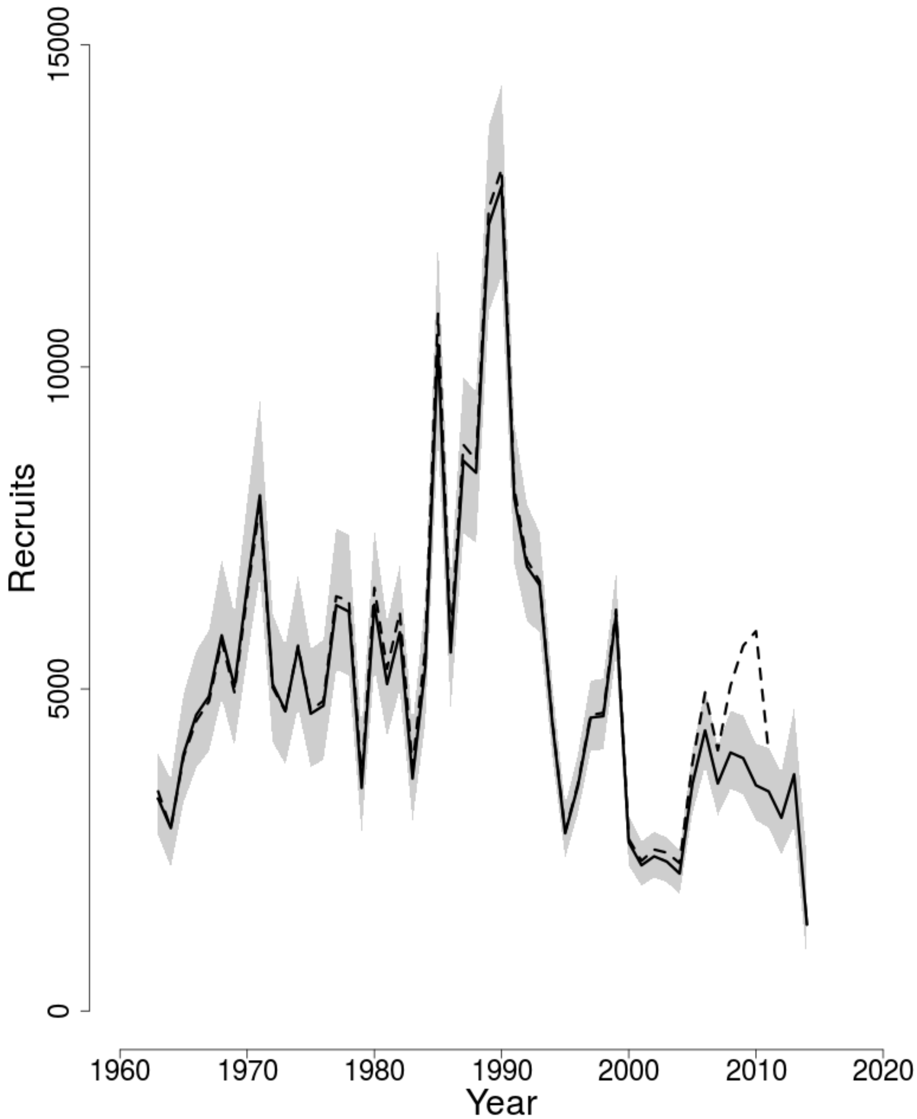


Figure 66: Trends in Recruits (age 1) (000s) of white hake between 1963 and 2014 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

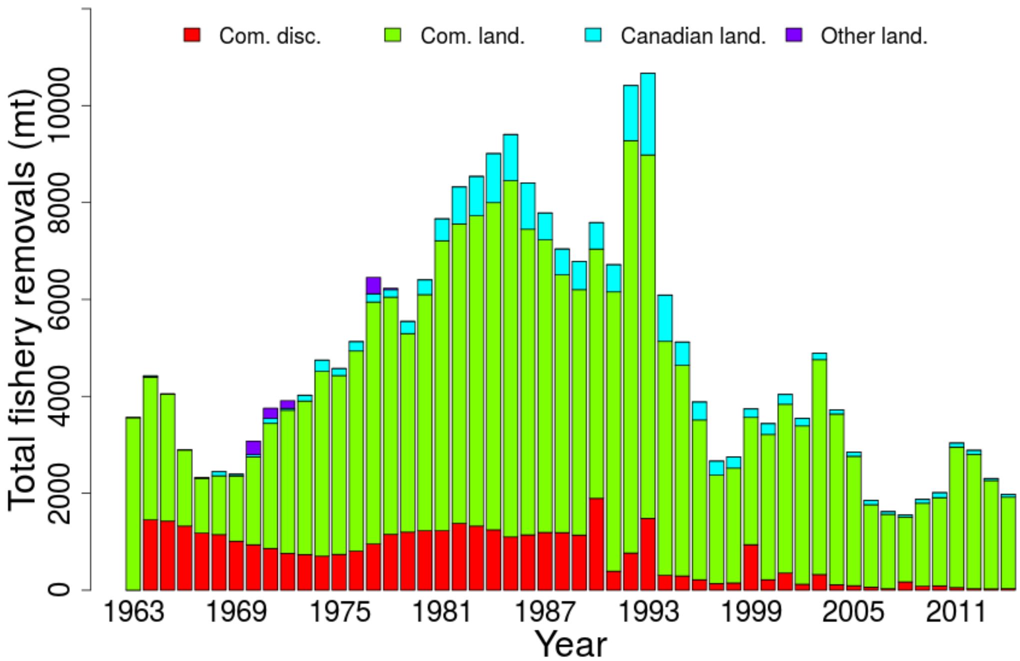


Figure 67: Total catch of white hake between 1963 and 2014 by fleet (commercial, recreational, or Canadian) and disposition (landings and discards).

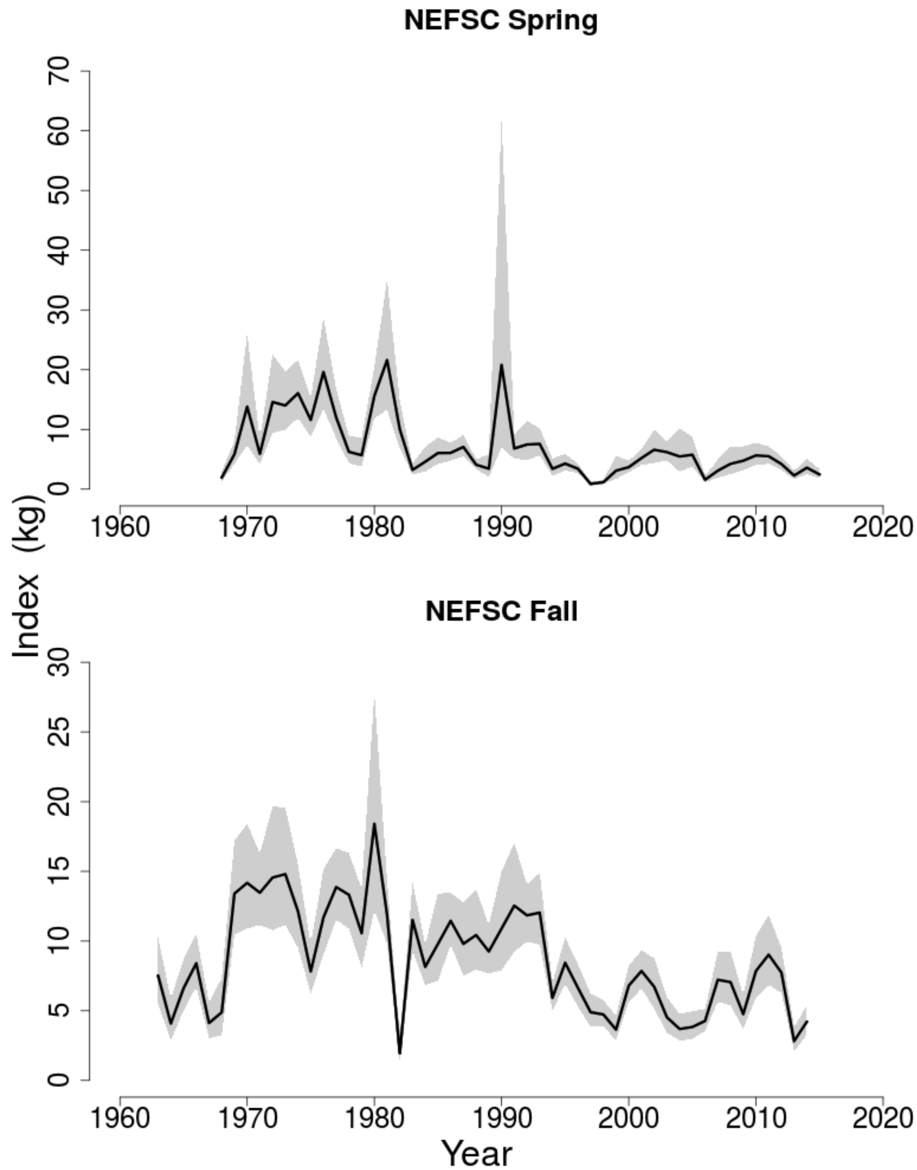


Figure 68: Indices of biomass for the white hake between 1963 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.

14 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 69-70). 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 69). 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 70).

Table 44: 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 45: 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 5th and 95th 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 70). 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 69-70). Therefore, retrospective adjustments were applied in the projections for the base model and the flat sel sensitivity model.

Table 46: 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 69-70). 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 Table 7).
  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 69-70).

- 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.

14.1 Reviewer Comments: Pollock

Recommendation: The Panel concluded that the updated stock assessment with retrospective adjustment was acceptable as a scientific basis for management advice and agreed with the status determination that the stock is not overfished and overfishing is not occurring. The Panel accepted the current projections as basis for the 2016-2018 overfishing limits. All data updates and changes to survey indices and model (removal of likelihood constants) were accepted by the Panel.

Alternative Assessment Approach: Not applicable

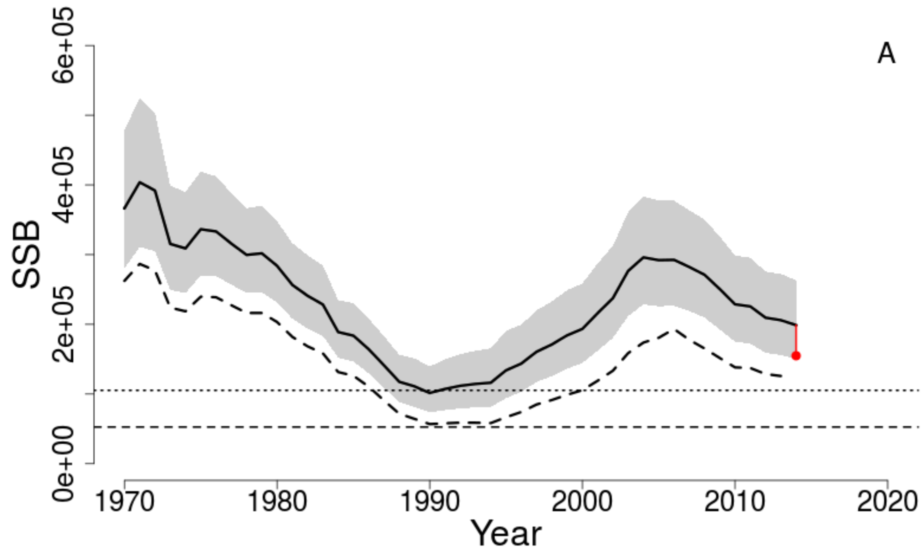
Sources of Uncertainty: The major sources of uncertainty are the selectivity of the fisheries-independent surveys and the retrospective pattern. The base model assumes dome-shaped survey selectivity and results from the model imply that a large portion of the stock biomass is unavailable to the fishery and survey. If a flat-topped selectivity is assumed, less biomass is estimated. However, stock status was insensitive to the shape of the selectivity form. The current retrospective pattern rescales the entire time series of F and SSB estimates unlike other assessments viewed in the session and reviewers were concerned about the general accept/reject criteria for retrospective adjustment used during the meeting.

Research Needs: For the next benchmark assessment, the Panel recommended that the ASAP model be explored to find a more stable configuration. Convergence issues occurred with the retrospective peels of the model (but were fixed with changes in phase estimation) and modeling the data as a combined fleet was suggested as a possible fix. Additionally, knowledge of selectivity shape of fisheries-independent surveys could be improved with additional studies on gear selectivity. Another research recommendation included investigating alternative fitting algorithms in the model (e.g., 'robustified maximum likelihood estimation') that may perform well given highly variable survey tuning indices.

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/



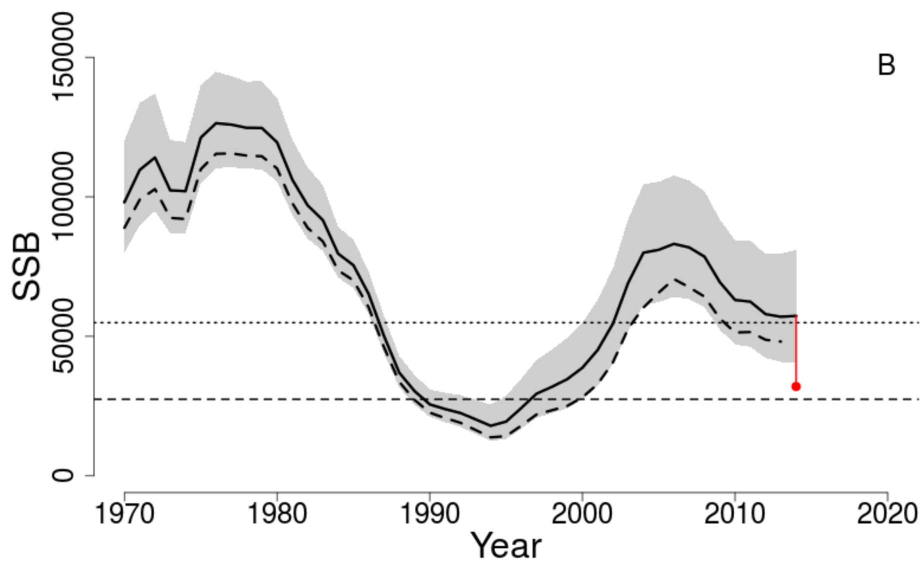


Figure 69: Estimated trends in the spawning stock biomass of pollock between 1970 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ (0.5 * SSB_{MSY} proxy; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} proxy; horizontal dotted 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.

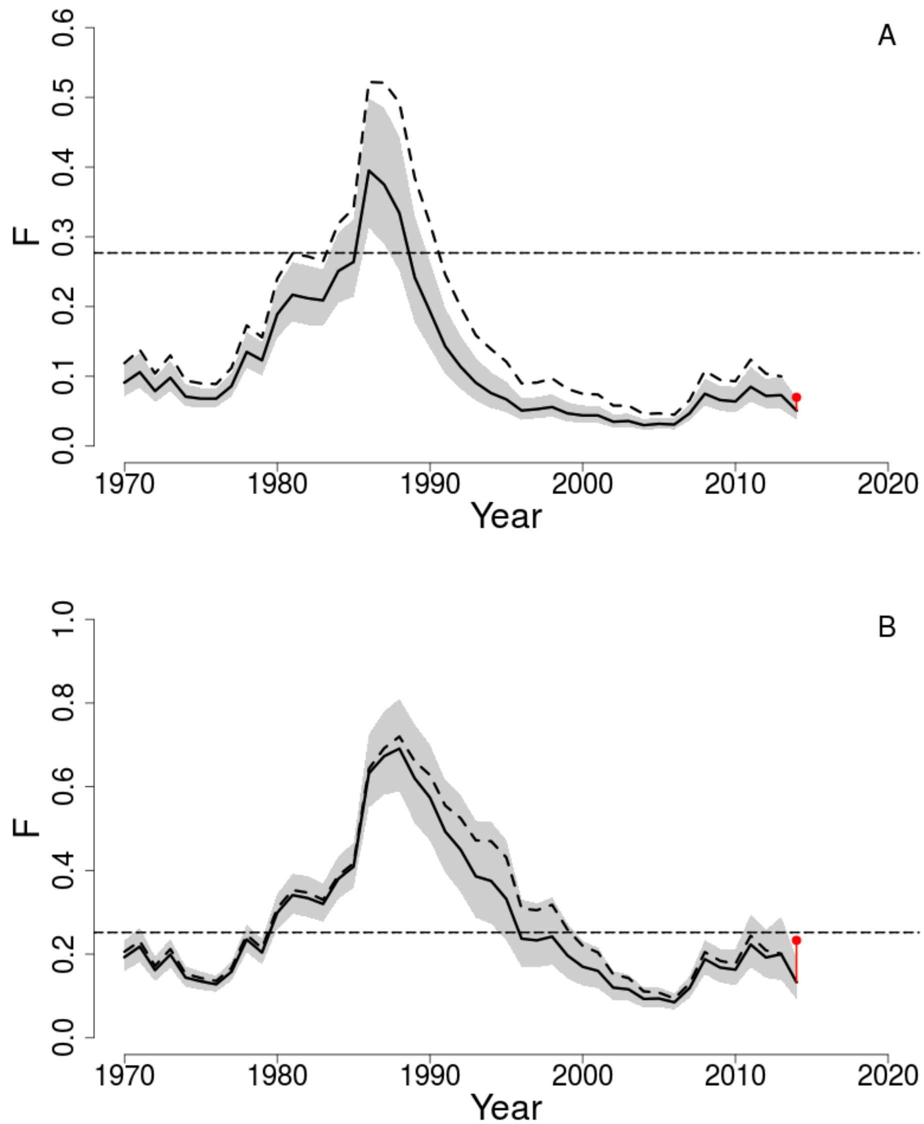


Figure 70: Estimated trends in age 5 to 7 average F (F_{AVG}) of pollock between 1970 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} proxy; dashed line) based on the 2015 assessment models base (A) and flat sel sensitivity (B). F_{AVG} was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

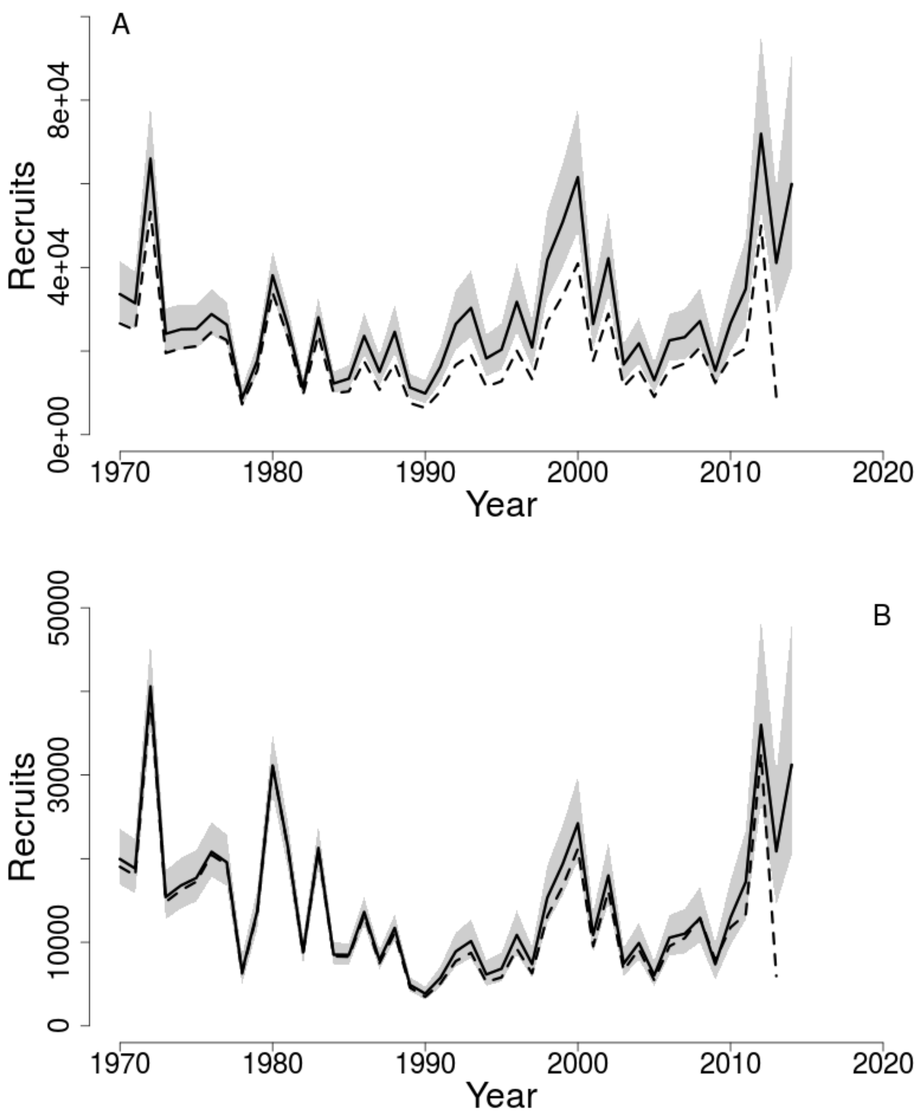


Figure 71: Estimated trends in age 1 recruitment (000s) of pollock between 1970 and 2014 from the current (solid line) and previous (dashed line) assessment for the assessment models base (A) and flat sel sensitivity (B). The approximate 90% lognormal confidence intervals are shown.

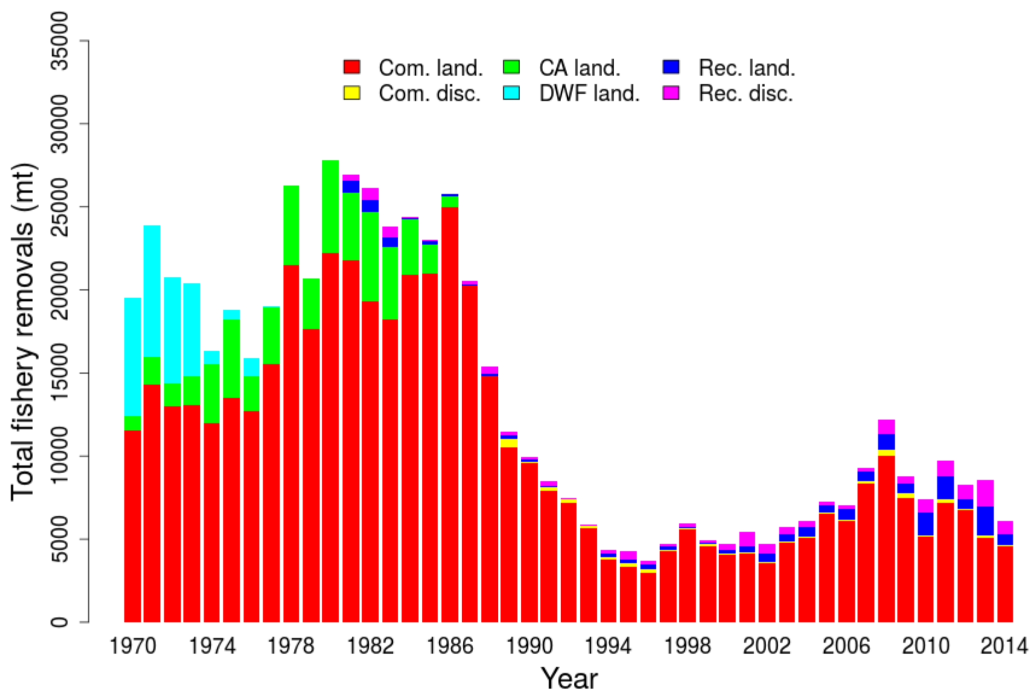


Figure 72: Total catch of pollock between 1970 and 2014 by fleet (commercial, Canadian, distant water fleet, and recreational) and disposition (landings and discards).

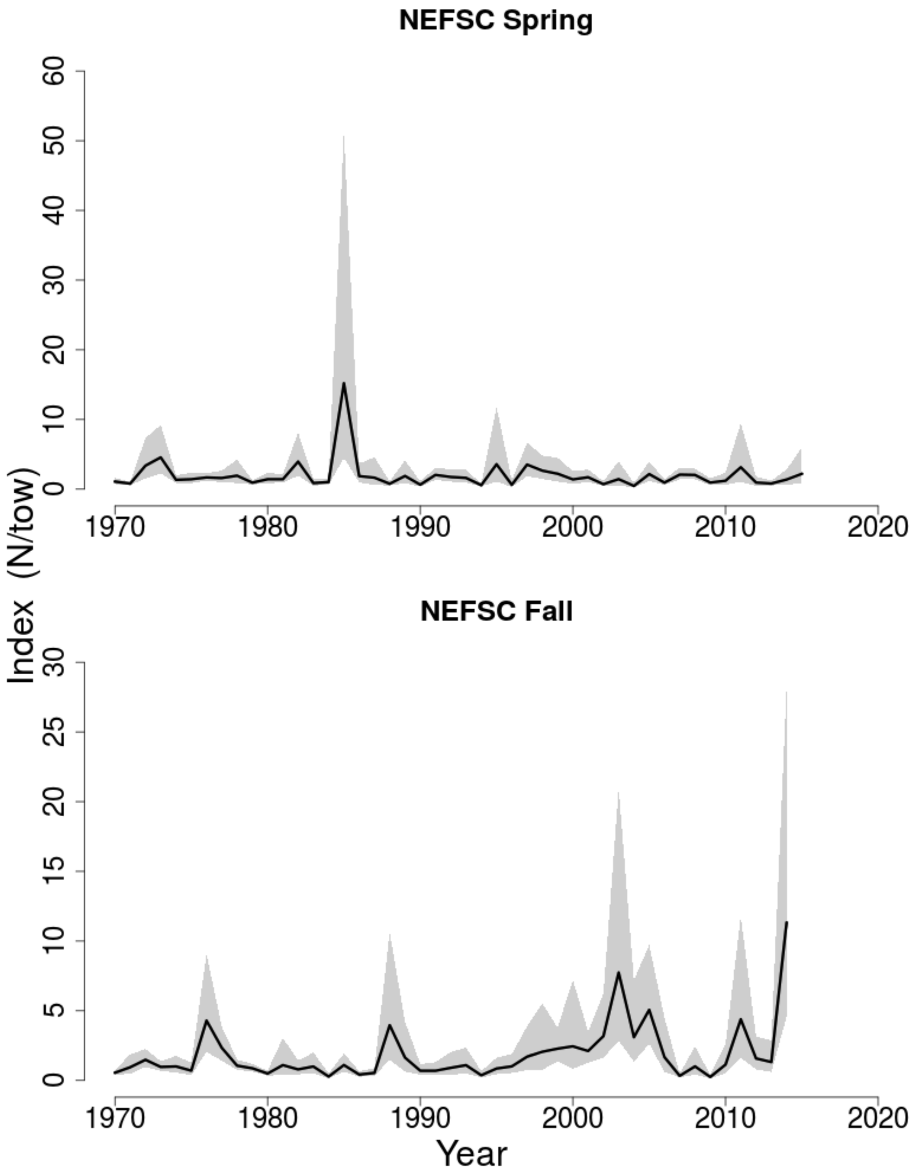


Figure 73: Indices of abundance for pollock from the Northeast Fisheries Science Center (NEFSC) spring (1970 to 2015) and fall (1970 to 2014) bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.

15 Atlantic wolffish

Charles Adams

This assessment of the Atlantic wolffish (Anarhichas lupus) stock is an operational 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 74-75). 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 74). 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 75).

Table 47: 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 48: 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 Table 7).

  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.

15.1 Reviewer Comments: Atlantic wolffish

Recommendation: The panel concluded that the revised assessment, based on 50cm size-at-maturity and 8% discard mortality, was acceptable as a scientific basis for management advice. 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.

New studies provided information on the values of L50 and discard mortality. The 2012 assessment used two values for length-at-maturity: 40 and 65cm. The 2015 assessment presented to the Panel used a value of 50cm based on Richard McBride's (NEFSC) ongoing work, which was accepted for the base case by the Panel. The 2012 assessment assumed 100% discard mortality rate. Research by Grant and Hiscock (2014) indicates that discard mortality is 8%. The panel discussed this research, in particular the applicability of the research given its location in colder Newfoundland waters. The panel agreed to use the 8% mortality rate for the base case.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: The retrospective pattern is a major source of uncertainty. The revised assessment has retrospective patterns with Mohn's rho = 0.83 for SSB and -0.36 for F. The cause of the retrospective pattern is unknown. Confidence intervals are not available because MCMC is not fully developed for the SCALE model, making it impossible to classify the patterns as major or minor. Therefore, a retrospective adjustment was not applied to the stock status determination, but the status determination is robust to that decision. Due to uncertainties in a prior assessment, the Northeast Data Poor Stocks Working Group (NDPSWG 2009) concluded that stock projections would be unreliable and should not be conducted.

Another source of uncertainty is the use of a calibration coefficient for the change from the Albatross to Bigelow bottom trawl surveys. A calibration coefficient for another species (ocean pout) has been used for the wolfish assessment since 2009, because the calibration coefficient for wolfish is unknown. The change to a no possession limit in 2010 places greater importance on the discard mortality assumption. There has been no catch of recruits in the surveys since 2004. Surveys may have reached the limit of wolffish detectability due to the decline in abundance. The lack of commercial length information results in model estimation difficulties for fishery selectivity. Recruitment at the end of the time series increases toward the initial recruitment estimate because there is no information in the model to inform these estimates. There is no indication in the data that recruitment has increased recently. Maturity and growth need to be better understood.

Research Needs: The Atlantic wolffish maturity study in the Gulf of Maine is ongoing and should be beneficial. 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. It may be possible to use a likelihood profile to apply the criterion for a retrospective adjustment. Further studies on growth parameters would be helpful. A tagging study could provide information on stock structure and movement. Post-capture nest site fidelity needs to be studied.

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/

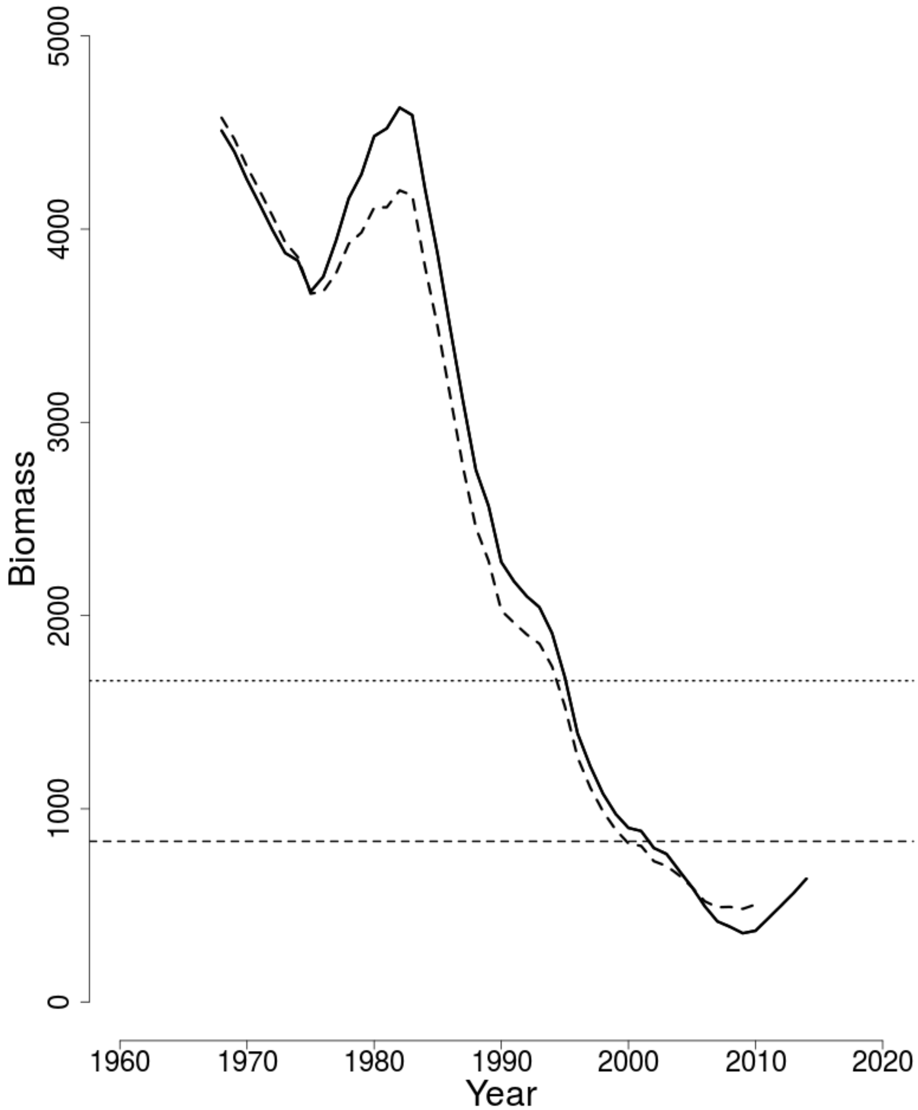


Figure 74: Trends in spawning stock biomass of Atlantic wolffish between 1968 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the current assessment.

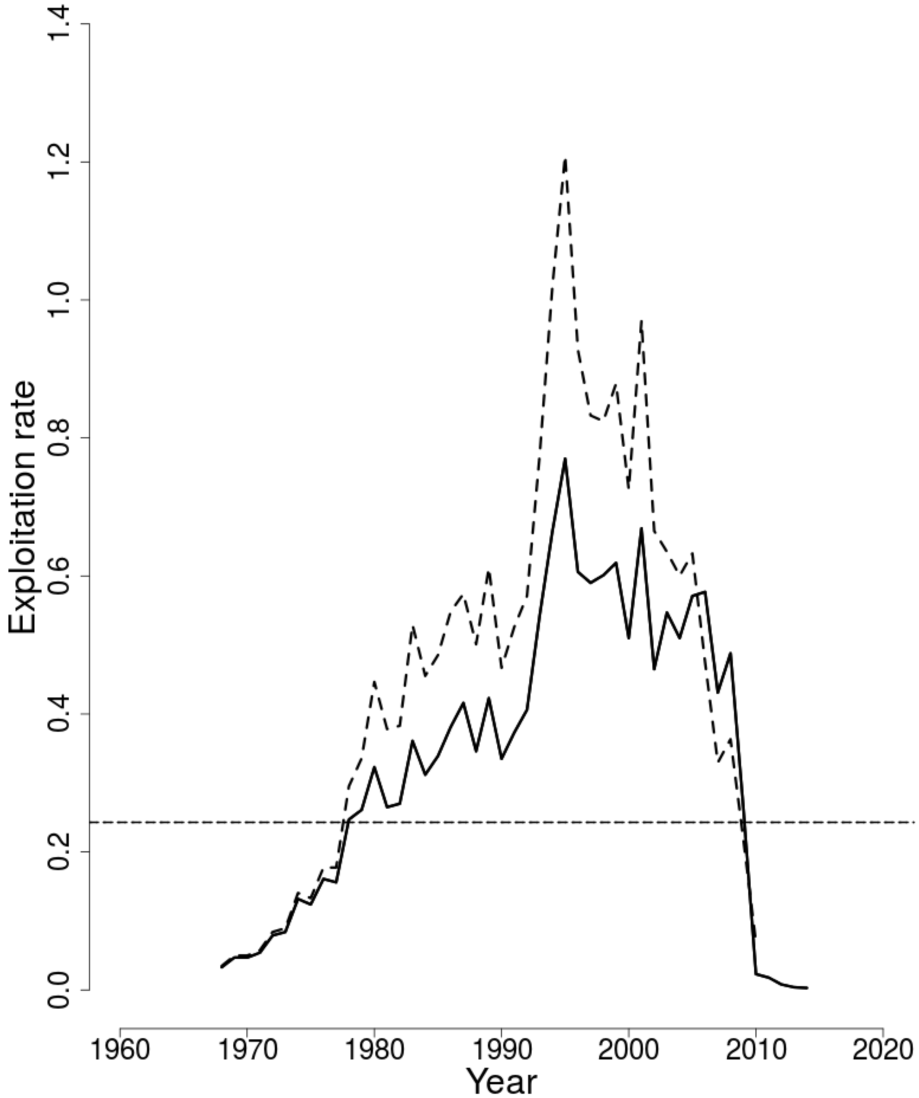


Figure 75: Trends in the fully selected fishing mortality (F_{Full}) of Atlantic wolffish between 1968 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.243; horizontal dashed line).

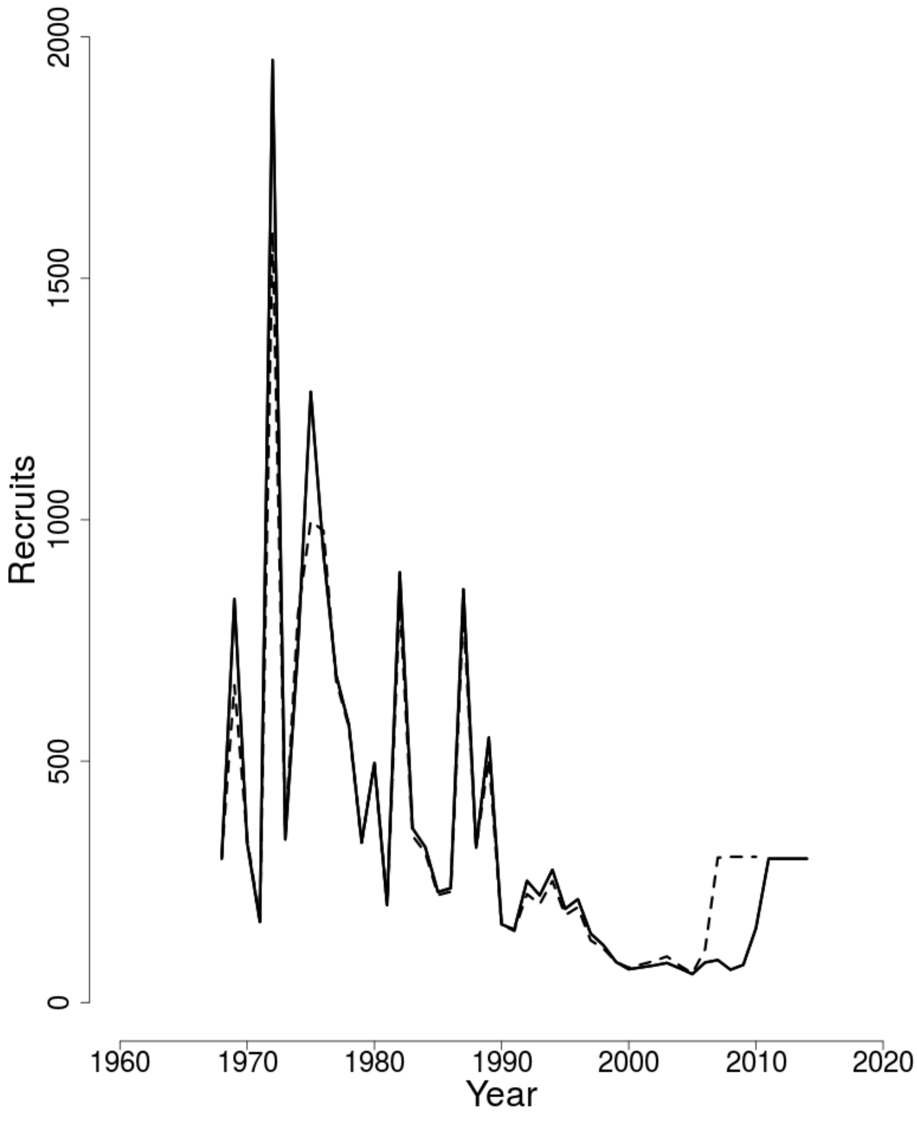


Figure 76: Trends in age 1 recruits of Atlantic wolffish between 1968 and 2014 from the current (solid line) and previous (dashed line) assessment.

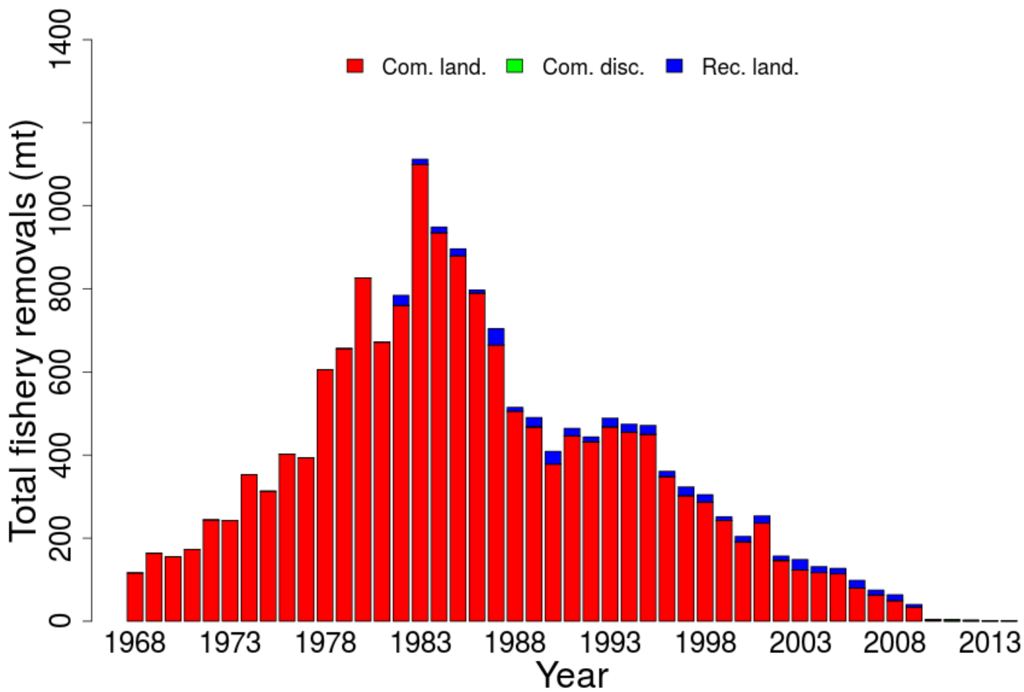


Figure 77: Total catch of Atlantic wolffish between 1968 and 2014 by fleet (commercial and recreational) and disposition (landings and discards). Note that a no possession limit was put in place in May 2010.

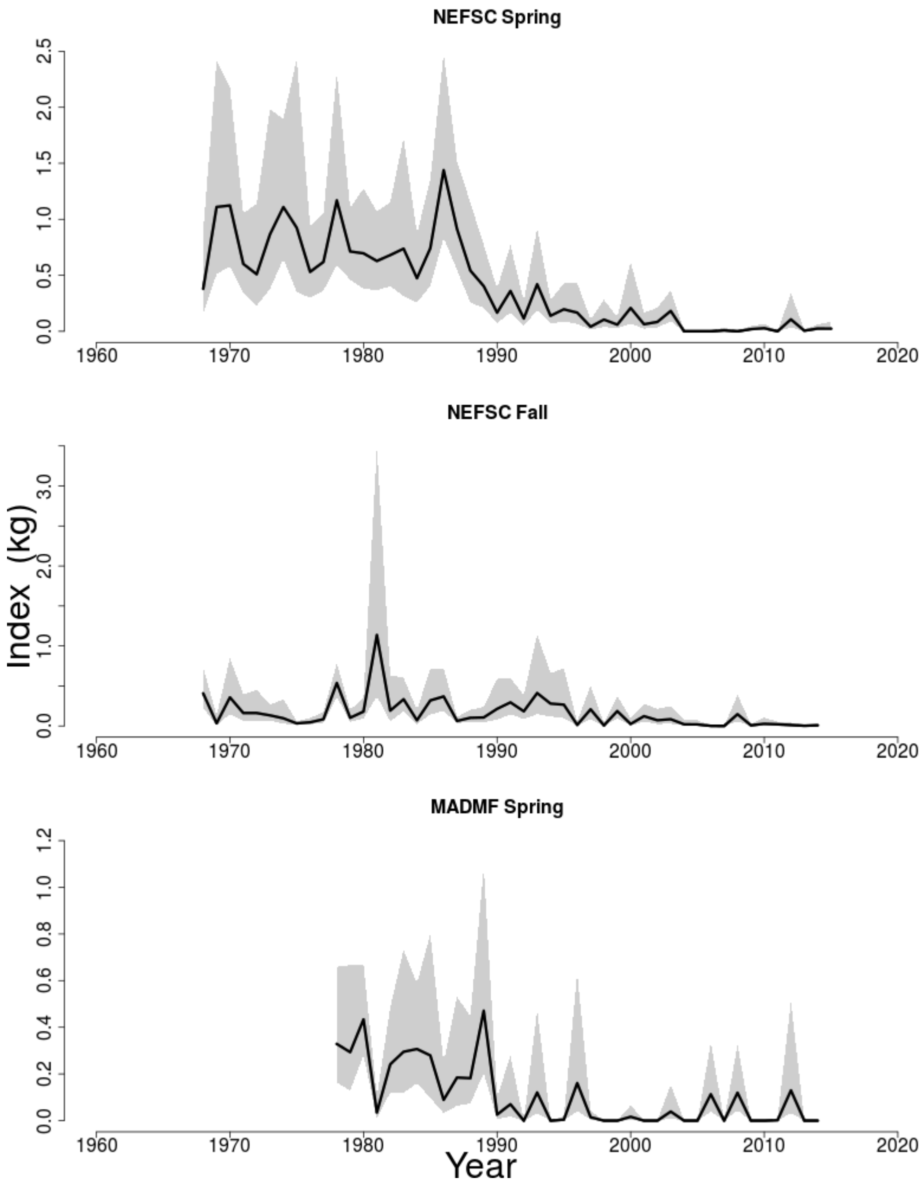


Figure 78: Indices of biomass for the Atlantic wolffish between 1968 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys, and the Massachusetts Division of Marine Fisheries (MADMF) spring bottom trawl survey. The approximate 90% lognormal confidence intervals are shown. NEFSC indices for 2009-2015 are calibrated using the ocean pout coefficient from Miller et al. (2010).

16 Atlantic halibut

Daniel Hennen

The results from the assessment model were not accepted as a basis for scientific advice for management. Details on this decision may be found in section 16.1. Assessment results that follow reflect conclusions based on the current model configuration but are not used for estimation of overfishing limits in 2016. No attempts were made to refine model configuration to improve model performance. Under the Terms of Reference, such changes were beyond the scope of the Operational Assessment guidelines. Nonetheless these results below provide valuable summaries of fishery-dependent and fishery-independent data, information on model performance, and analyst's insights.

This assessment of the Atlantic halibut (Hippoglossus hippoglossus) stock is an operational 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 status is unknown and unknown (Figures 79-80). 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 79). 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 80).

Table 49: 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 50: 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 51: 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 Table 7).

  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.

16.1 Reviewer Comments: Atlantic halibut

Recommendation: The Panel concluded that the updated assessment was not acceptable as a scientific basis for management advice. The updated assessment produced an unstable and unrealistic solution. Estimates of current stock size were highly sensitive to initial conditions and slight changes in assumed parameter values. The Panel agreed that the exclusion of distant water catches and revised discard estimates were acceptable.

The GARMIII benchmark assessment and the 2012 update assessment concluded that the stock was overfished but overfishing was not occurring. All information available in the update assessment indicates that stock size has not substantially increased. Therefore, based on the long-term exploitation history and survey trends, the Panel concludes that the stock is still overfished. However, the overfishing status is unknown. Considering the instability of the assessment model, the overfishing threshold was not updated.

Alternative Assessment Approach: The Assessment Oversight Panel recommended that the alternative basis for catch advice should be status quo catch. However, considering that status quo catch was produced with low trip limits, and the increase in recent discards suggest greater availability, the Operational Assessment Panel recommends that the overfishing limit be based on status quo OFL (198 mt) rather than status quo catch.

Sources of Uncertainty: The major sources of uncertainty are limited information available for stock assessment and stock identity. The surveys catch few halibut, there is limited contrast in survey time series, and there are insufficient data to estimate survey conversion coefficients. Connectivity with the much larger stock in the northwest Atlantic has been documented, but stock identity is unknown. The omission of Canadian catches from the eastern Gulf of Maine (area 5Y) in previous assessments and the estimate of OFL is also a source of uncertainty.

Research Needs: The Panel recommends that a new benchmark assessment is needed to determine stock identity, to develop a new stock assessment model and to reconsider the overfishing definition. All information on stock identity should be considered, and new information should be collected if necessary. If the US resource is a portion of the larger northwest Atlantic resource, a transboundary assessment should be developed. If the US resource is self-sustaining stock, a data-limited assessment should be developed that considers all information available. New information on discard mortality of Atlantic halibut should be considered in future assessments.

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/

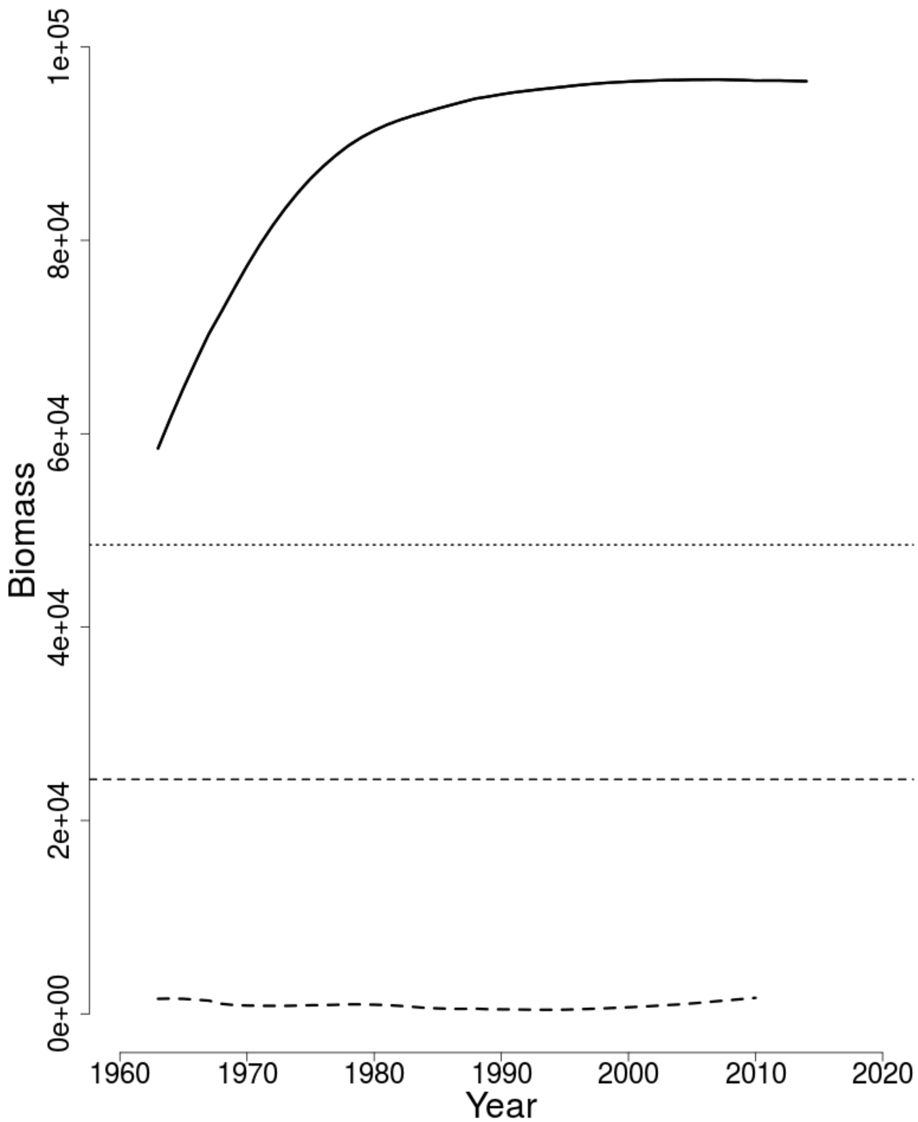


Figure 79: Estimated trends in the biomass of Atlantic halibut between 1963 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $B_{Threshold}= \frac{1}{2}\, B_{MSY}$ *proxy*(horizontal dashed line) as well as B_{Target} (B_{MSY} *proxy*; horizontal dotted line) based on the 2015 assessment.

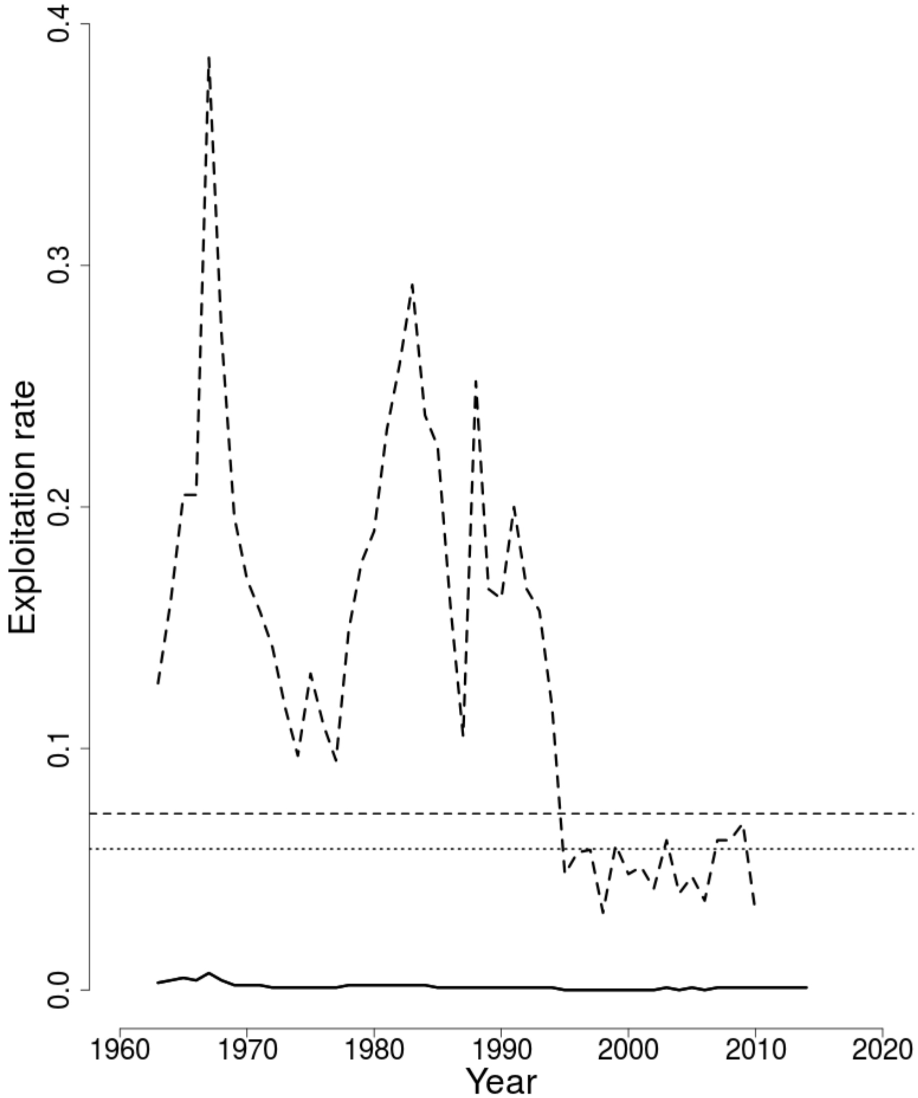


Figure 80: Estimated trends in the fully selected fishing mortality (F_{Full}) of Atlantic halibut between 1963 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (0.073; horizontal dashed line) as well as F_{Target} (0.8 * F_{MSY} *proxy*; dotted line) based on the 2015 assessment.

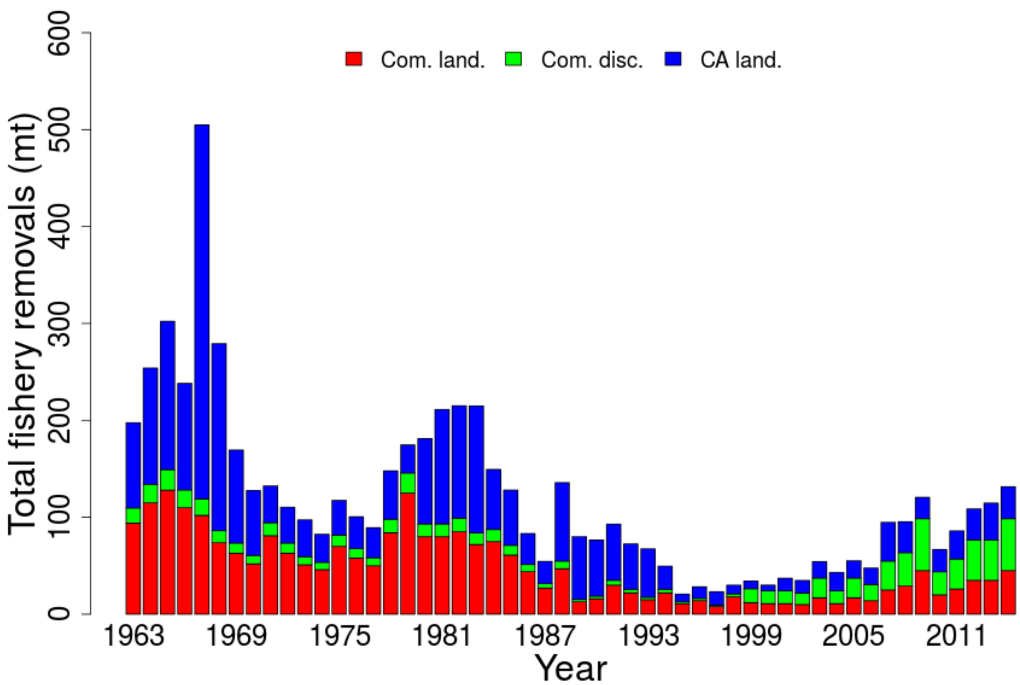


Figure 81: Total catch of Atlantic halibut between 1963 and 2014 by disposition (landings and discards).

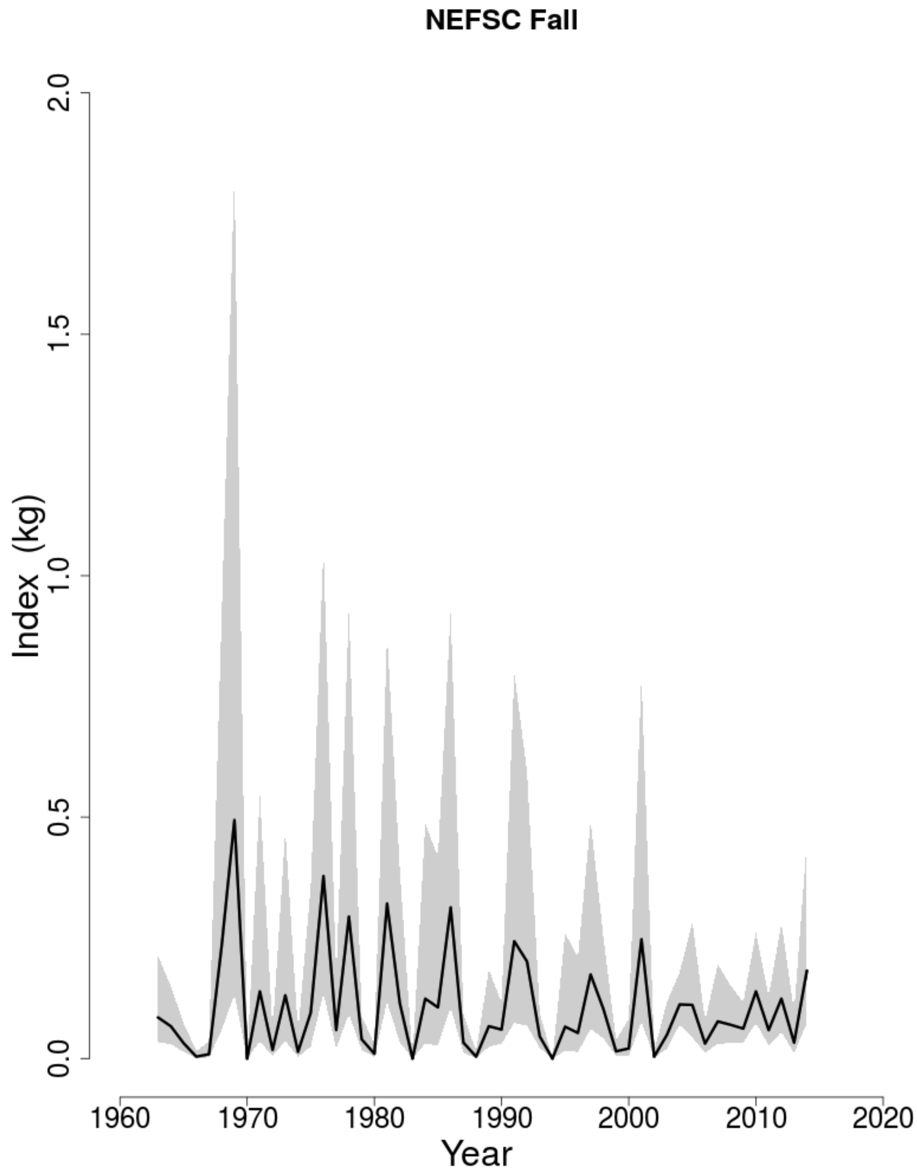


Figure 82: Indices of biomass for the Atlantic halibut between 1963 and 2014 for the Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey. The 90% lognormal confidence intervals are shown.

17 Northern windowpane flounder

Toni Chute

This assessment of the northern windowpane flounder (Scophthalmus aquosus) stock is an operational update of the 2012 assessment which included updates through 2010 (NEFSC 2012). Based on the 2012 assessment the stock was overfished, and overfishing was ocurring. This assessment updates commercial fishery catch data, survey indices of abundance, AIM model results, and reference points through 2014.

State of Stock: Based on this updated assessment, the northern windowpane flounder (*Scophthalmus aquosus*) stock is overfished but overfishing is not occurring (Figures 83-84). Retrospective adjustments were not made to the model results. The mean NEFSC fall bottom trawl survey index from years 2012, 2013 and 2014 (a 3-year moving average is used as a biomass index) was 0.535 kg/tow which is lower than the $B_{Threshold}$ of 0.777 kg/tow. The 2014 relative fishing mortality was estimated to be 0.393 kt per kg/tow which is lower than the F_{MSY} *proxy* of 0.450 kt per kg/tow.

Table 52: Catch and model results table for northern windowpane flounder. All landings and discard weights are rounded to the nearest metric ton. Biomass index is in units of kg/tow, and relative F is in units of kt per kg/tow.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Data										
Commercial landings	51	46	117	46	28	0	0	1	0	0
Commercial discards	917	637	974	329	412	235	180	198	355	215
Total catch	967	683	1,092	376	440	236	180	199	355	215
Model Results										
Biomass index	0.7	0.67	0.52	0.45	0.44	0.47	0.43	0.34	0.52	0.54
Relative F	1.39	1.02	2.08	0.85	1	0.51	0.42	0.58	0.68	0.393

Table 53: Reference points estimated in the 2012 assessment and in the current assessment update. F_{MSY} *proxy* is in units of kt per kg/tow.

	2012	Current
F_{MSY} *proxy*	0.44	0.450 (0.020 - 0.765)
B_{MSY} *proxy* (kg/tow)	1.60	1.554
MSY proxy (mt)	700	700
Overfishing	Yes	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 main source of uncertainty in this assessment is the lack of windowpane discard estimates from Canadian fisheries to add to the catch component of model input. Discard estimates were from the U.S. only. There is overlap between the survey area and Canadian fishing grounds (Van Eeckhaute et al. 2010), which means catch from within the stock area was likely underestimated.

- 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 Table 7).

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

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

  N/A

- 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.

  No changes were made to the northern windowpane flounder assessment for this update other than the incorporation of four years of new NEFSC fall bottom trawl survey data and four years of new U.S. commercial landings and discard data (2011 - 2014).

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

  The stock status of northern windowpane flounder changed from 'overfished and overfishing is occurring' to 'overfished and overfishing is not occurring' due to stable-to-decreasing catch since 2008, and an increasing trend in the survey index since 2010.

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

  The northern windowpane flounder assessment could be improved by estimating the Canadian windowpane removals and, although to a lesser degree, the 'general category' scallop dredge fleet discards from within the stock area and using them as additional catch input to the AIM model. While the model fit now is reasonable (the relationship between ln(relative F) and ln(replacement ratio), a measure of the relationship between catch and survey index values, has a p-value of 0.079) there are probably removals unaccounted for in the model and the fit can likely be improved.

- Are there other important issues?

  None.

17.1 Reviewer Comments: Northern windowpane flounder

Recommendation: The panel concluded that the updated assessment was acceptable as a scientific basis for management advice. Four new years of fall bottom trawl survey data and U.S commercial landings and discard data were added (2011-2014). The criteria for survey tow quality changed from SHG to TOGA having a small impact on the biomass index for 2014. The benchmark GARM III recommended that no projections be made.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: Uncertainties include the unavailability of Canadian catches for the assessment. The "general category" scallop dredge fleet discards from within the stock area could be used as additional catch input to the AIM model. The model was run using the spring survey; trends were the same but fits were worse. The F_{MSY} proxy (=0.45) is imprecise (confidence interval 0.02-0.76). The GARM benchmark indicated that projections should not be made based on discards. This is a data-limited assessment, and as such, the results are limited.

Research Needs: Research needs include ageing and the development of a more advanced, analytical model.

References:

Most recent assessment update:
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 online at http://nefsc.noaa.gov/publications/

Most recent benchmark assessment:
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 Dep Commer, NOAA FIsheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii.

Van Eeckhaute, L., Sameoto, J., and A. Glass. 2010. Discards of Atlantic cod, haddock and yellowtail flounder from the 2009 Canadian scallop fishery on Georges Bank. TRAC Ref. Doc. 2010/10. 7p.

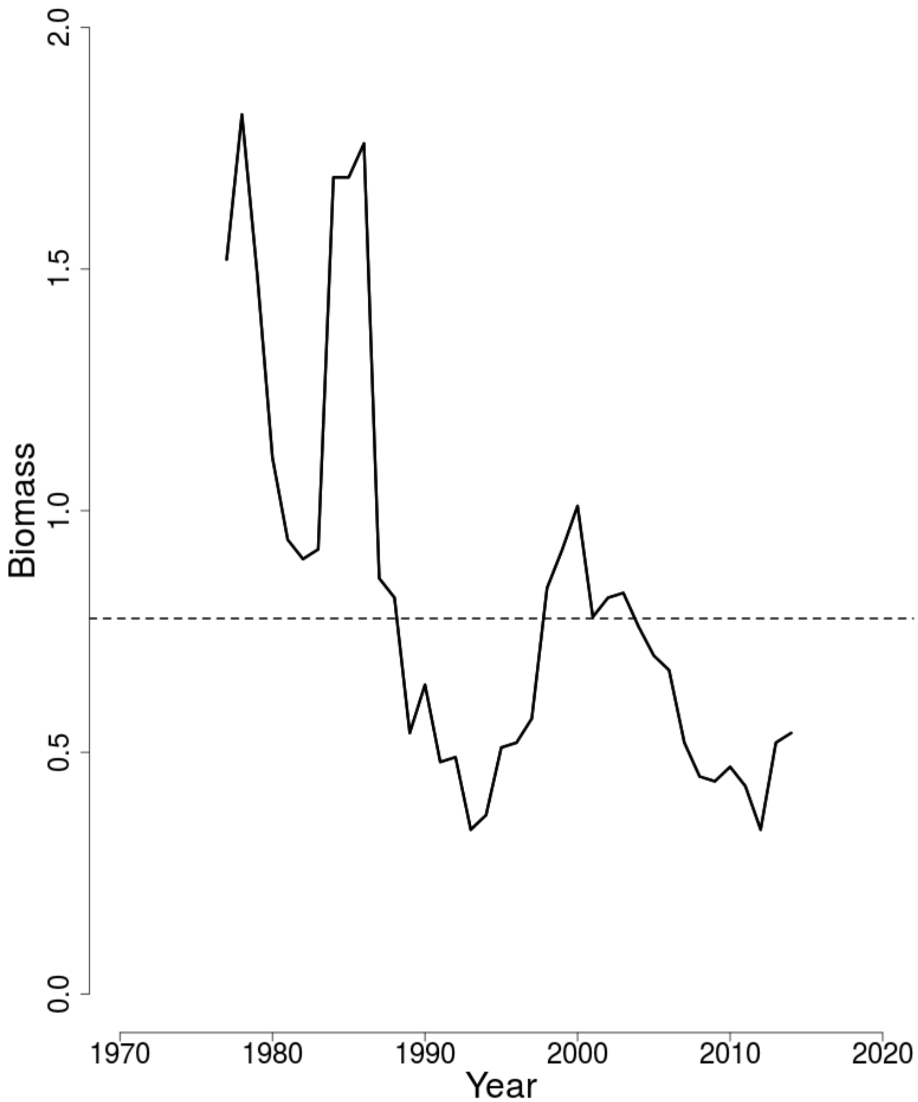


Figure 83: Trends in the biomass index (a 3-year moving average of the NEFSC fall bottom trawl survey index) of northern windowpane flounder between 1975 and 2014 from the current assessment, and the corresponding $B_{Threshold} = \frac{1}{2}\ B_{MSY}$ *proxy* = 0.777 kg/tow (horizontal dashed line).

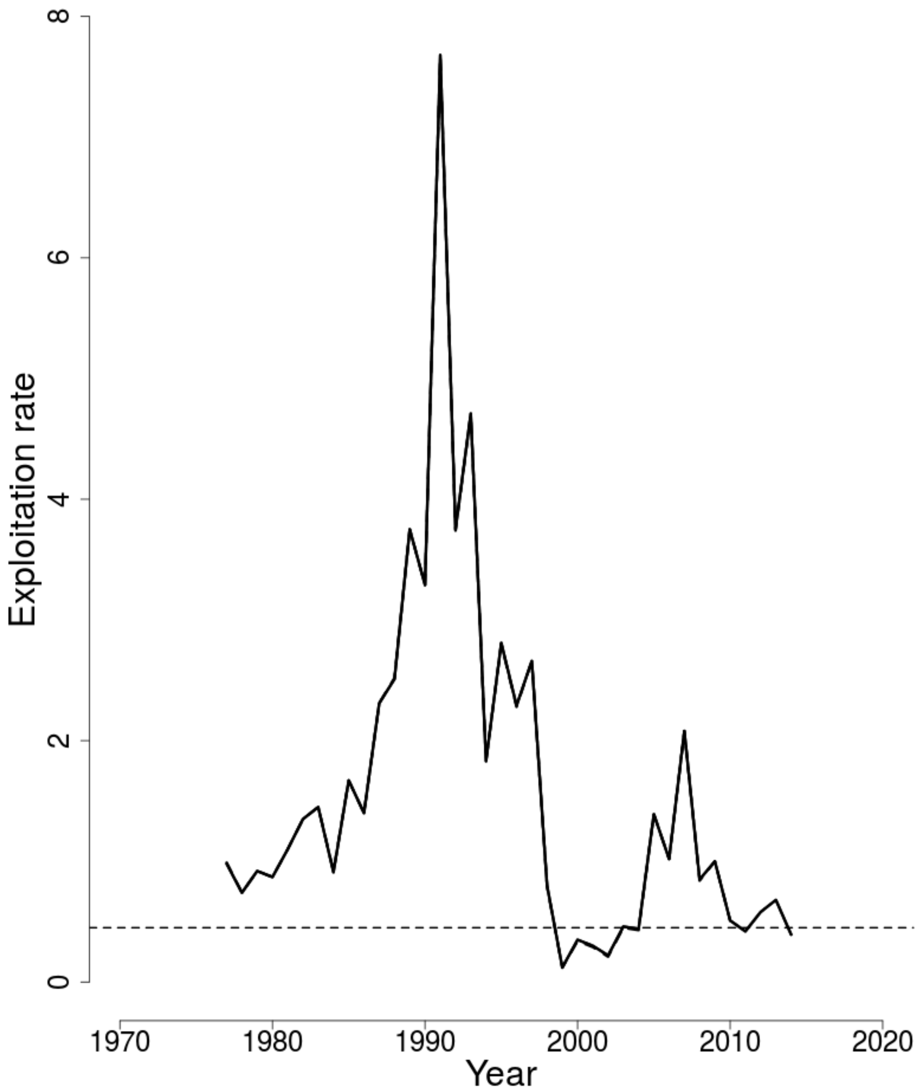


Figure 84: Trends in relative fishing mortality of northern windowpane flounder between 1975 and 2014 from the current assessment, and the corresponding F_{MSY} *proxy*=0.45 (horizontal dashed line).

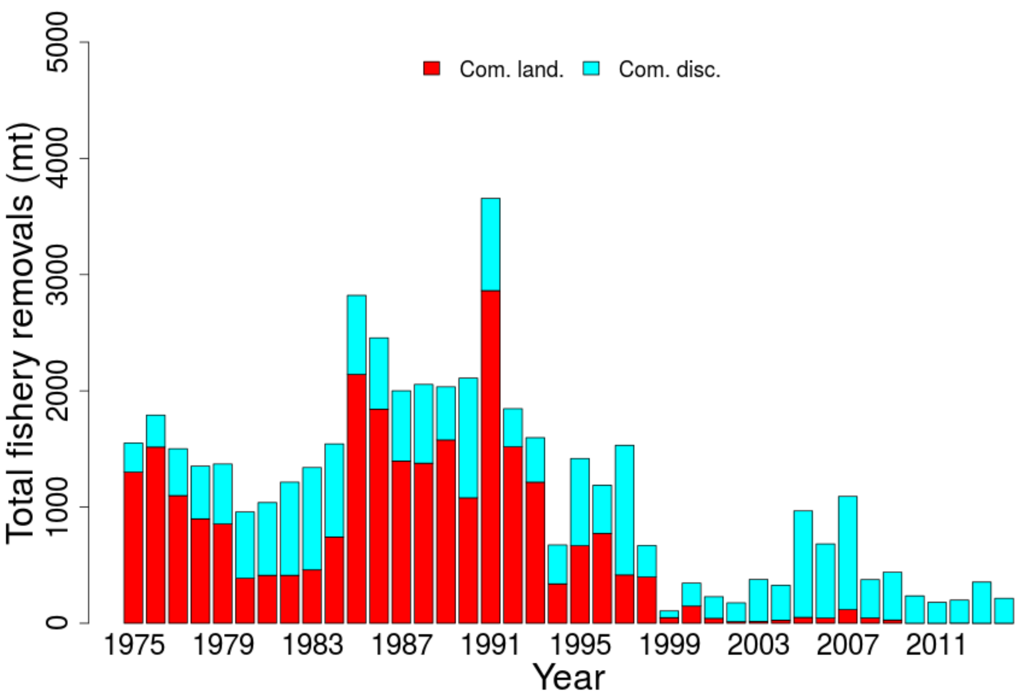


Figure 85: Total catch of northern windowpane flounder between 1975 and 2014 by disposition (landings and discards).

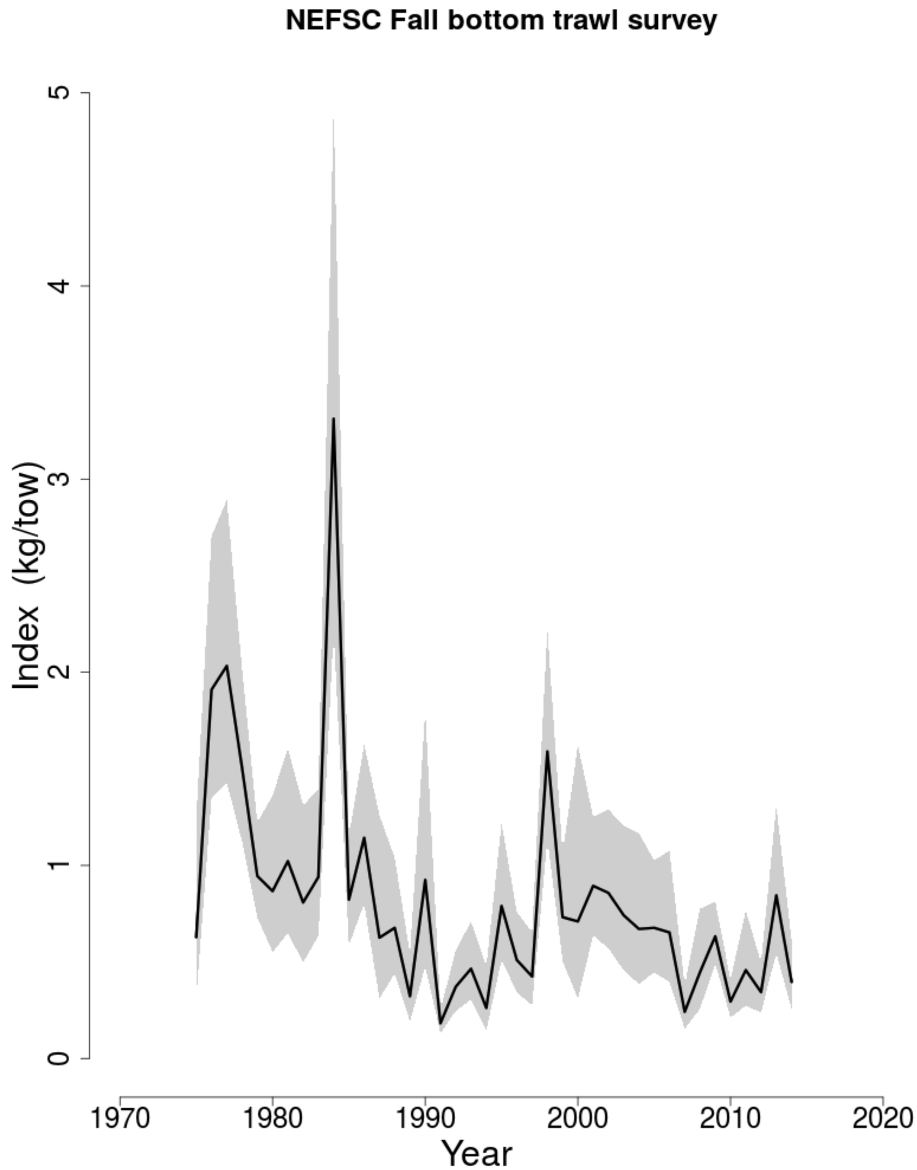


Figure 86: NEFSC fall bottom trawl survey indices in kg/tow for northern windowpane flounder between 1975 and 2014 The approximate 90% lognormal confidence intervals are shown.

18 Southern windowpane flounder

Toni Chute

This assessment of the southern windowpane flounder (Scophthalmus aquosus) stock is an operational update of the 2012 assessment which included updates through 2010 (NEFSC 2012). Based on the 2012 assessment the stock was not overfished, and overfishing was not ocurring. This assessment updates commercial fishery catch data, survey indices of abundance, AIM model results, and reference points through 2014.

State of Stock: Based on this updated assessment, the southern windowpane flounder (*Scophthalmus aquosus*) stock is not overfished and overfishing is not occurring (Figures 87-88). Retrospective adjustments were not made to the model results. The mean NEFSC fall bottom trawl survey index from years 2012, 2013, and 2014 (a 3-year moving average is used as a biomass index) was 0.413 (kg/tow) which is higher than the $B_{Threshold}$ of 0.123 (kg/tow). The 2014 relative fishing mortality was estimated to be 1.308 (kt per kg/tow) which is lower than the F_{MSY} *proxy* of 2.027 (kt per kg/tow).

Table 54: Catch and model results table for southern windowpane flounder. All landings and discard weights are rounded to the nearest metric ton. Biomass index is in units of kg/tow, and relative F is in units of kt per kg/tow.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Data										
Commercial landings	38	57	83	74	53	53	32	29	22	14
Commercial discards	293	374	266	246	405	435	445	701	681	525
Total catch	330	431	349	321	458	489	477	730	703	539
Model Results										
Biomass index	0.21	0.17	0.19	0.2	0.24	0.35	0.44	0.52	0.46	0.41
Relative F	1.6	2.53	1.83	1.57	1.88	1.42	1.1	1.41	1.51	1.31

Table 55: Reference points estimated in the 2012 assessment and in the current assessment update. F_{MSY} *proxy* is in units of kt per kg/tow.

	2012	Current
F_{MSY} *proxy*	2.088	2.027 (1.131 - 2.576)
B_{MSY} *proxy* (kg/tow)	0.240	0.247
MSY proxy (mt)	500	500
Overfishing	No	No
Overfished	No	No

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).

  A source of uncertainty for this assessment is missing commercial discard estimates from the general category scallop dredge fleet that should be added to the catch time series for model input.

- 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 Table 7).

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

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

  N/A

- 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.

  No changes were made to the southern windowpane flounder assessment for this update other than the incorporation of four years of new NEFSC fall bottom trawl survey data and four years of new U.S. commercial landings and discard data (2011 - 2014).

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

  The stock status of southern windowpane flounder 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.

  Estimates of discards from the general category scallop dredge fleet should be added to the catch time series for model input. However, the model fit is presently good with a randomization test indicating the correlation between ln(relative F) and ln(replacement ratio), a measure of the relationship between catch and survey index values, is significant (p = 0.002.)

- Are there other important issues?

  None.

18.1 Reviewer Comments: Southern windowpane flounder

Recommendation: The panel concluded that the updated assessment was acceptable as a scientific basis for management advice. Four new years of fall bottom trawl survey data and U.S commercial landings and discard data were added (2011-2014). The criteria for survey tow quality changed from SHG to TOGA, which had no impact on the biomass index for 2014. The model fit is presently good. A randomization test suggests that the negative relationship between the replacement ratio (survey indices) and relative F (catch/survey) due to chance alone is less than 0.002.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: Since 2000, an average of 8% additional estimated discards (1% 19%, 5 65mt) has come from the general category scallop dredge fleet. These should be added to the catch for model input. The general category dredge fleet is more active in the southern windowpane stock area. The GARM III benchmark indicated that projections should not be made based on discards. This is a data-limited assessment, and as such, results are limited.

Research Needs: Research needs include the addition of the estimated discards from the general category scallop dredge fleet into the next update or benchmark for consistency with management, ageing data, and the development of a more advanced, analytical model.

References:
Most recent assessment update:
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 online at http://nefsc.noaa.gov/publications/

Most recent benchmark assessment:
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, MA, August
4-8, 2008. US Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii.

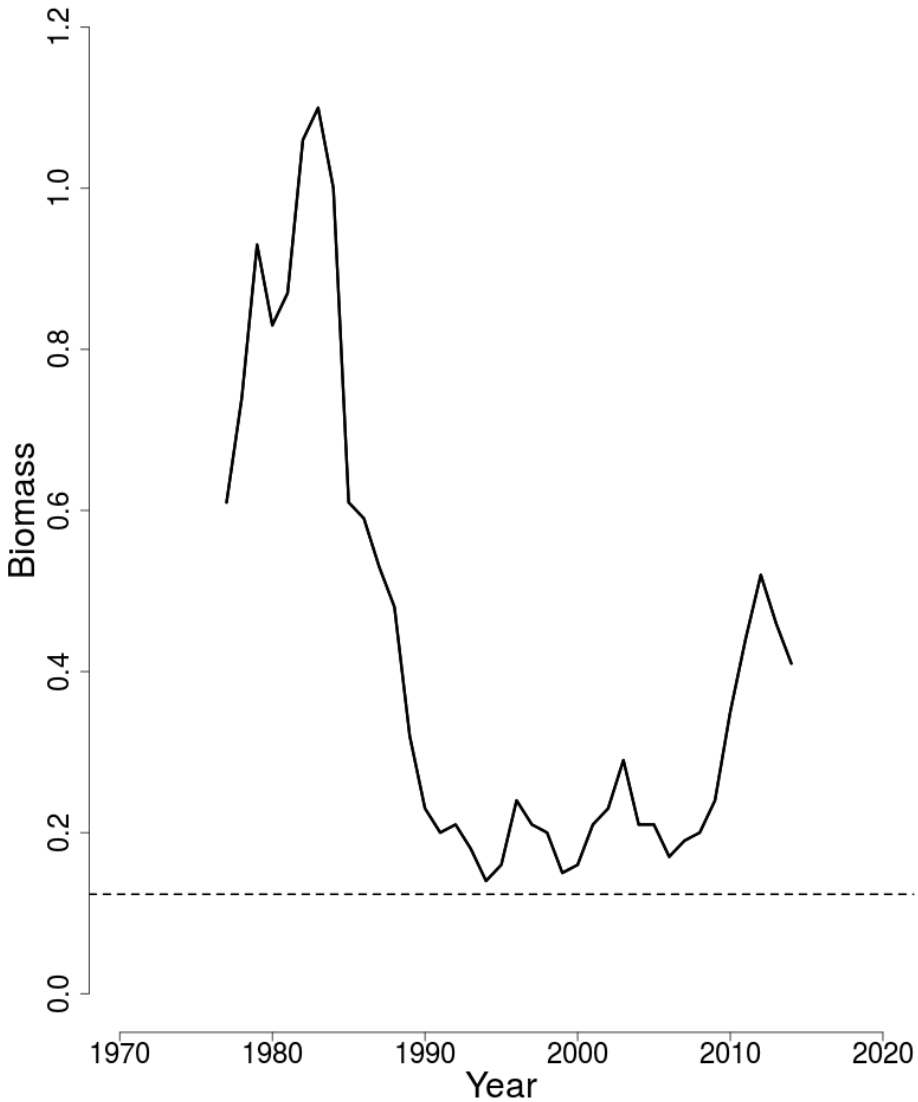


Figure 87: Trends in the biomass index (a 3-year moving average of the NEFSC fall bottom trawl survey index) of southern windowpane flounder between 1975 and 2014 from the current assessment, and the corresponding $B_{Threshold} = \frac{1}{2}\ B_{MSY}$ *proxy* = 0.123 kg/tow(horizontal dashed line).

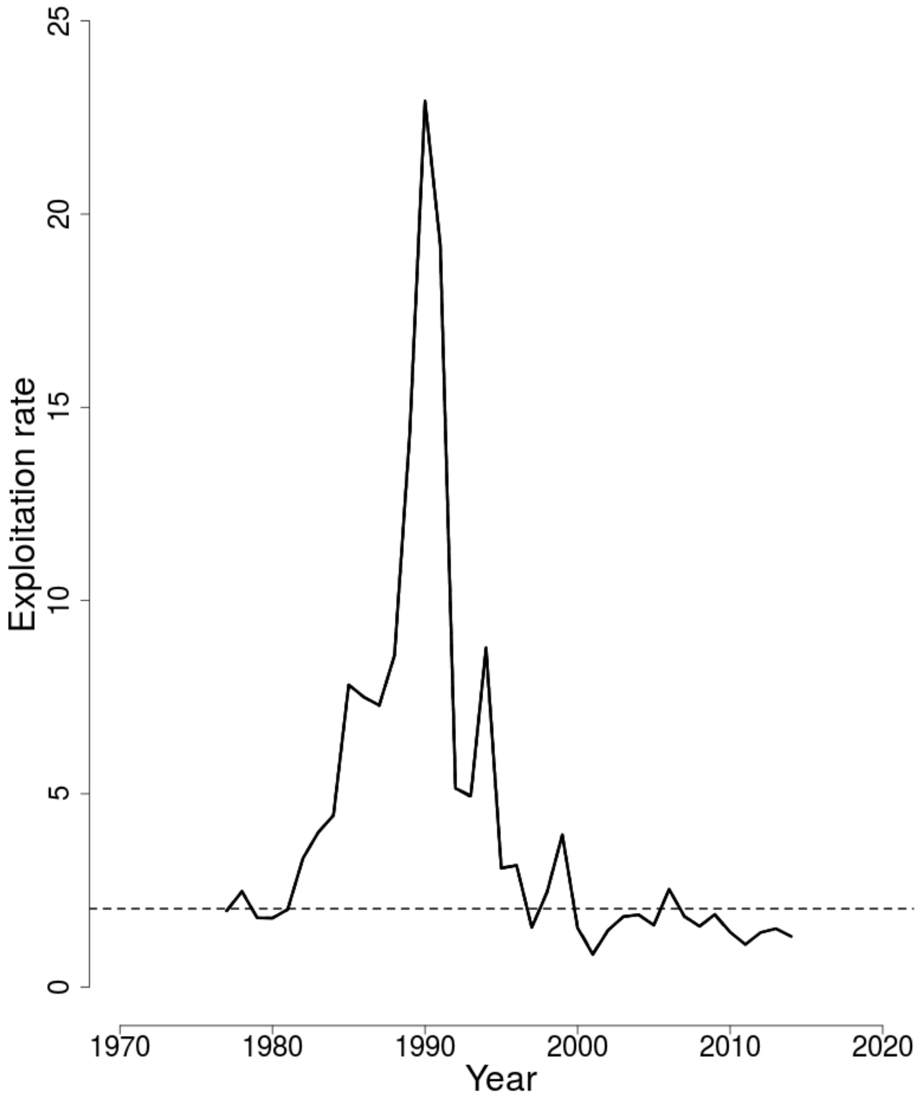


Figure 88: Trends in relative fishing mortality of southern windowpane flounder between 1975 and 2014 from the current assessment, and the corresponding F_{MSY} *proxy*=2.027 (horizontal dashed line).

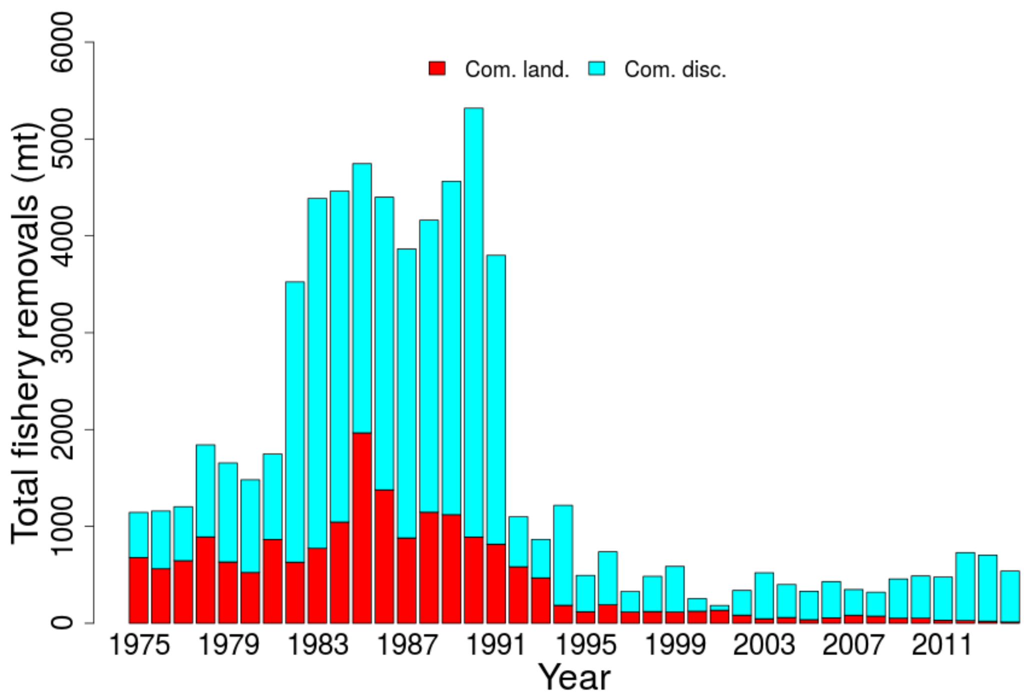


Figure 89: Total catch of southern windowpane flounder between 1975 and 2014 by disposition (landings and discards).

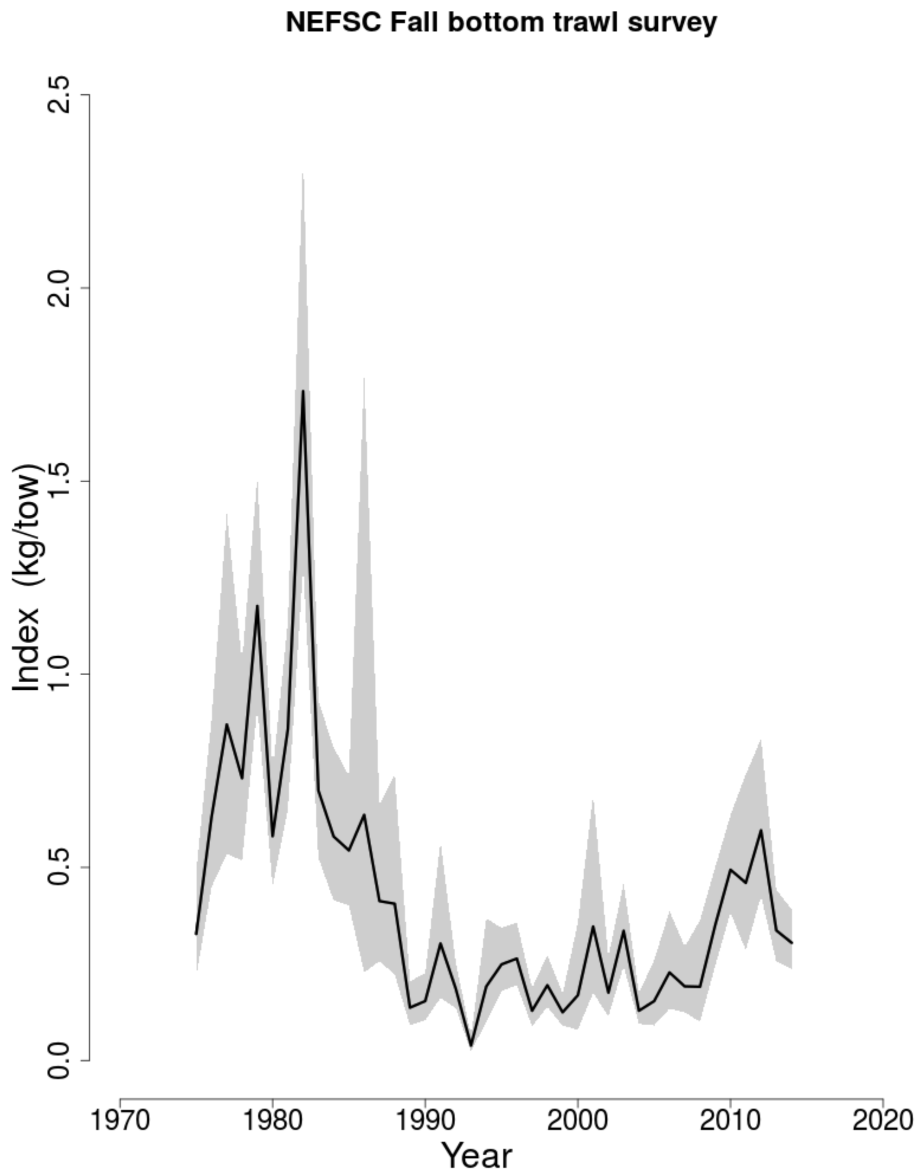


Figure 90: NEFSC fall bottom trawl survey indices in kg/tow for southern windowpane flounder between 1975 and 2014. The approximate 90% lognormal confidence intervals are shown.

19 Ocean pout

Susan Wigley

This assessment of the ocean pout (Zoarces americanus) stock is an operational update of the 2012 assessment (NEFSC 2012) and the 2008 benchmark assessment (NEFSC 2008). Based on the 2012 assessment, the stock was overfished but overfishing was not ocurring. This assessment updates commercial fishery catch data, research survey indices and the exploitation ratios through 2014. There are no stock projections.

State of Stock: Based on the current assessment, the ocean pout (*Zoarces americanus*) stock is overfished and overfishing is not occurring (Figures 91-92). Retrospective adjustments were not made to the model results. Biomass proxy (B) in 2014 was estimated to be 0.29 (kg/tow) which is 6% of the biomass target (B_{MSY} *proxy* $= 4.94$; Figure 91). The 2014 fully selected fishing mortality was estimated to be 0.269 which is 35% of the overfishing threshold proxy (F_{MSY} *proxy* $= 0.76$; Figure 92).

Table 56: Catch and model results table for ocean pout. Catch weights are in (mt), survey biomass is in (kg/tow), and the relative exploitation ratio is the total catch / NEFSC 3 year average spring biomass index. Model results are from the current updated index assessment. Note: The 2014 landings were investigated; it was found that the species associated with the 2 mt was mis-reported (a database error). A database correction has not yet occurred. When 2 mt of landings are removed, the 2014 ocean pout catch will become 76 mt and the 2014 relative exploitation ratio will become 0.262. The revisions do not change the 2014 stock status.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
					Data					
US Commercial discards	197	180	164	118	164	125	76	90	68	76
US Commercial landings	4	5	4	7	3	0	0	0	0	2
Other landings	0	0	0	0	0	0	0	0	0	0
Catch for Assessment	201	184	167	126	168	126	77	90	68	78
					Model Results					
NEFSC 3 yr average Spring Survey	0.533	0.51	0.475	0.513	0.479	0.44	0.343	0.298	0.357	0.29
Relative Exploitation Ratio	0.377	0.361	0.352	0.246	0.351	0.287	0.225	0.302	0.19	0.269

Table 57: Comparison of reference points estimated in an earlier assessment and from the current updated assessment. For ocean pout, median NEFSC 3 year average Spring survey biomass and median exploitation ratio during 1977-1985 are used as B_{MSY} and F_{MSY} proxies, respectively.

	2012	Current
F_{MSY} *proxy*	0.76	0.76
B_{MSY} *proxy* (kg/tow)	4.94	4.94
MSY (mt)	3,754	3,754
Overfishing	No	No
Overfished	Yes	Yes

Projections: The index-based assessment approach does not support catch projections; catch advice for ocean pout has been based on the target exploitation rate and the most recent centered 3-year average biomass index from the NEFSC spring survey.

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).

  An important source of uncertainty is the stock has not responded to low catch as expected.

- 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 Table 7).

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

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

  N/A

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

  TOGA (Type, Operation, Gear, Acquisition) values were used for haul criteria for NEFSC surveys for 2009 onward and minor changes in the use of observer data for discard estimates were made to the current assessment. These changes had a negligible effect on the assessment and stock status. Recreational landings were updated and found to be negligible (time series average of recreational landings to total catch was less than 1%) and therefore not included in this assessment.

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

  Ocean pout 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 ocean pout assessment could be improved with studies that explore why this stock is not rebuilding as expected.

- Are there other important comments?

  Biological reference points are based on catch; the estimated discards used in the catch are based on a mix of direct (1989 onward) and indirect (1988 and back) methods. The catch used to determine MSY is based on indirect methods.

19.1 Reviewer Comments: Ocean pout

Recommendation: The panel concluded that the updated assessment was acceptable as a scientific basis for management advice.

All data updates and survey revisions made in this assessment were accepted by the Panel. The base run includes a known error in the database indicating 2 mt of landings. This error has not yet been corrected in the database. A sensitivity run that removed those landings had a negligible effect on results and no effect on stock status. The Panel agreed to use the data as it currently appears in the database.

Projections are not possible for this stock. This is a data-limited assessment, and as such, results are limited.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: One of the greatest sources of uncertainty is that the stock has not responded to low catch as expected.

Research Needs: Research needs are focused on understanding why the stock has not responded to low catch as expected and whether alternative biological reference points need to be explored.

References:

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

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 Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii. http://www.nefsc.noaa.gov/publications/crd/crd0815/

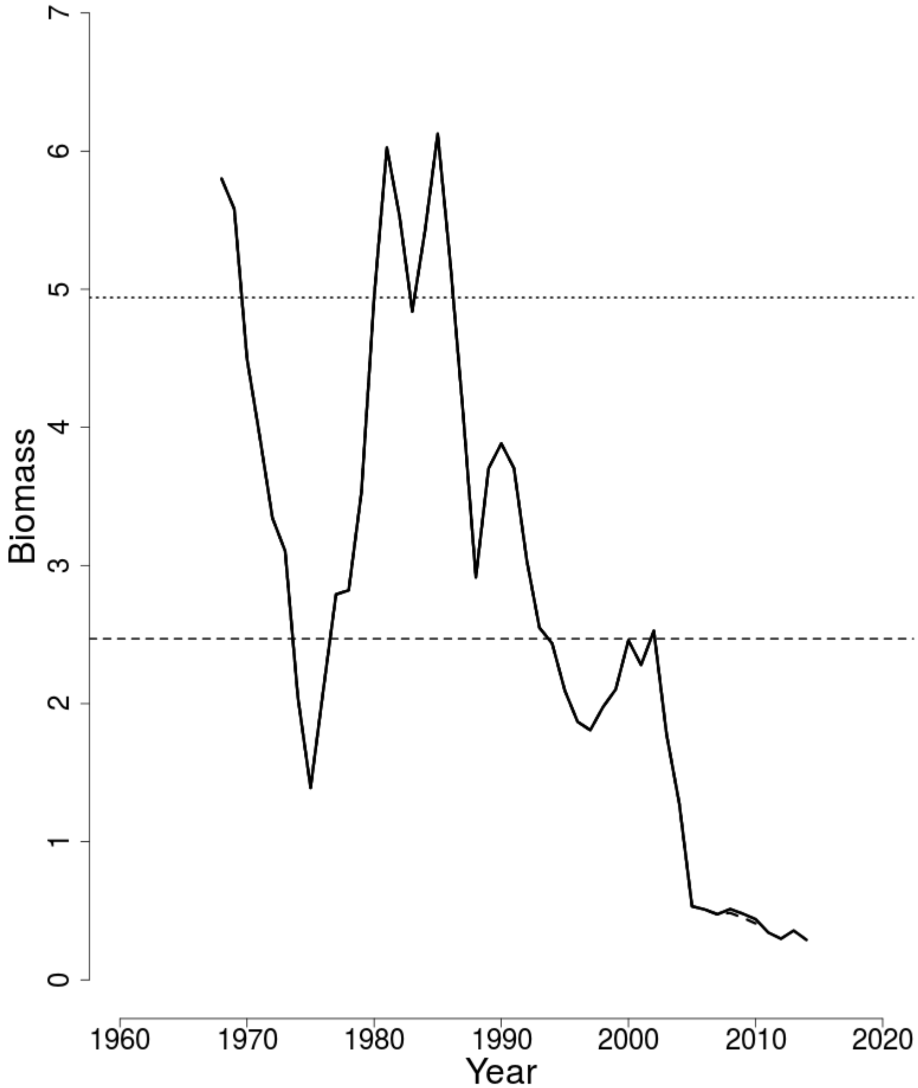


Figure 91: Trends in biomass (kg/tow) of ocean pout between 1968 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $B_{Threshold}$ ($\frac{1}{2}$ B_{MSY} *proxy*; horizontal dashed line) as well as B_{Target} (B_{MSY} *proxy*; horizontal dotted line) based on the current assessment.

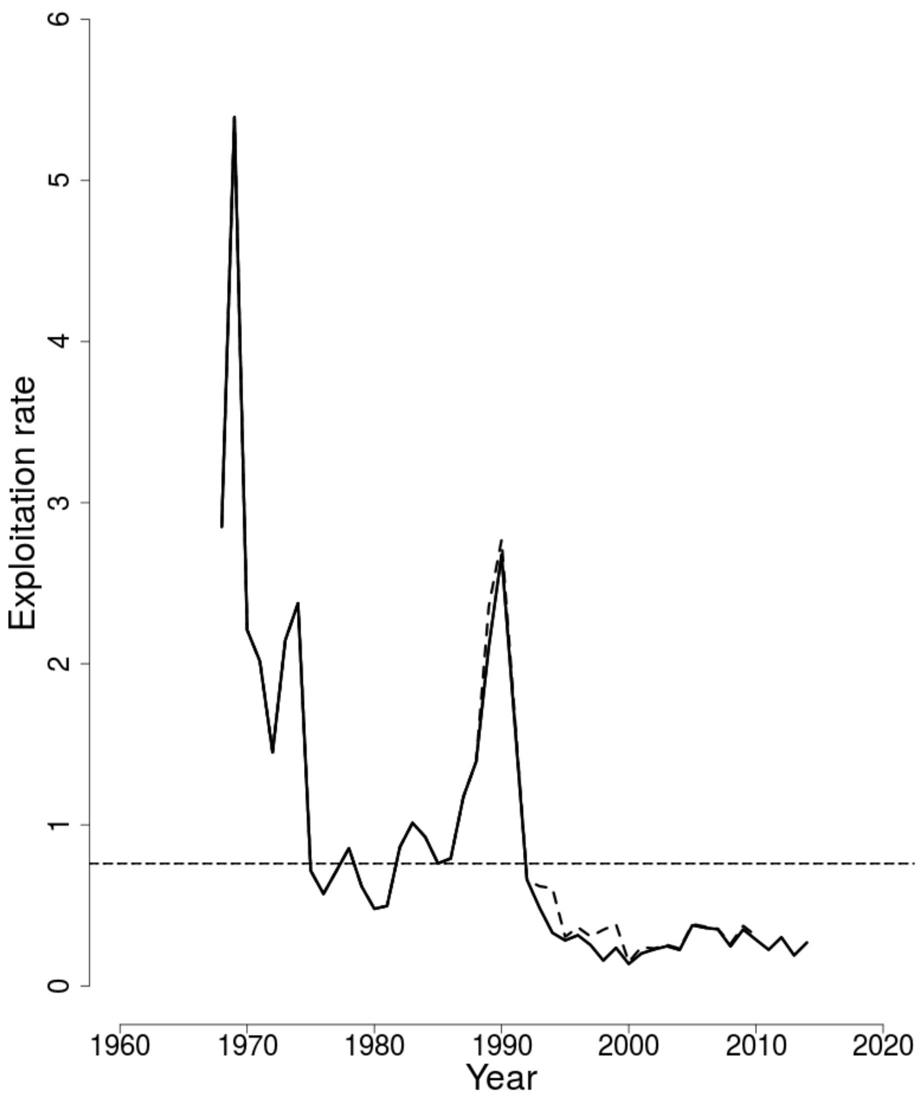


Figure 92: Trends in the exploitation rate of ocean pout between 1968 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.76; horizontal dashed line) based on the current assessment.

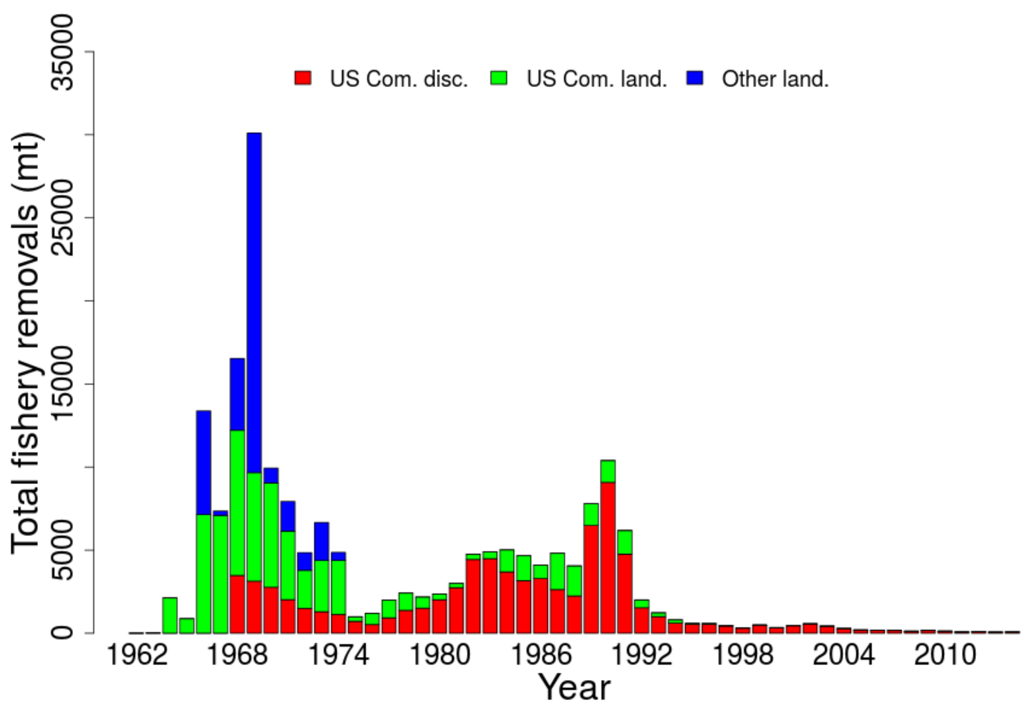


Figure 93: Total catch of ocean pout between 1968 and 2014 by fleet (US and Other) and disposition (landings and discards).

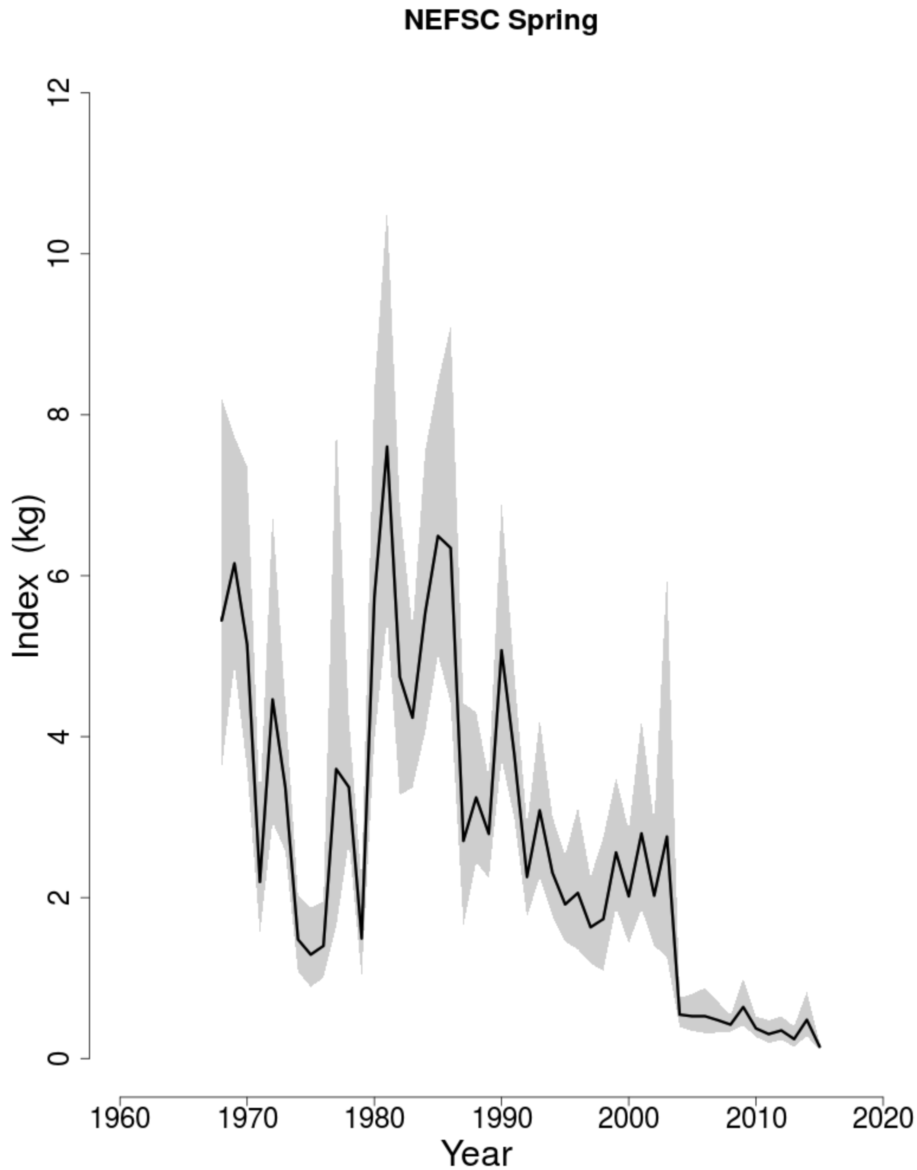


Figure 94: Indices of biomass (kg/tow) for ocean pout between 1968 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring survey. The approximate 90% lognormal confidence intervals are shown.

20 Gulf of Maine winter flounder

Paul Nitschke

This assessment of the Gulf of Maine winter flounder (Pseudopleuronectes americanus) stock is an operational update of the existing 2014 operational update area-swept assessment (NEFSC 2014). Based on the previous assessment the biomass status is unknown but overfishing was not occurring. This assessment updates commercial and recreational fishery catch data, research survey indices of abundance, and the area-swept estimates of 30+ cm biomass based on the fall NEFSC, MDMF, and MENH surveys.

State of Stock: Based on this updated assessment, the Gulf of Maine winter flounder (*Pseudopleuronectes americanus*) stock biomass status is unknown and overfishing is not occurring (Figures 95-96). Retrospective adjustments were not made to the model results. Biomass (30+ cm mt) in 2014 was estimated to be 4,655 mt (Figure 95). The 2014 30+ cm exploitation rate was estimated to be 0.06 which is 26% of the overfishing exploitation threshold proxy (E_{MSY} $proxy = 0.23$; Figure 96).

Table 58: Catch and status table for Gulf of Maine winter flounder. All weights are in (mt) and E_{Full} is the exploitation rate on 30+ cm fish. Biomass is estimated from survey area-swept for non-overlaping strata from three different fall surveys (MENH, MDMF, NEFSC) using a q=0.6 assumption on the wing spread.

	2009	2010	2011	2012	2013	2014
Data						
Recreational discards	4	3	4	1	1	2
Recreational landings	60	40	38	22	29	55
Commercial discards	12	6	4	10	6	5
Commercial landings	283	139	173	348	218	213
Catch for Assessment	359	187	219	381	254	275
Model Results						
30+ cm Biomass	7,612	6,341	6,666	3,337	2,932	4,655
E_{Full}	0.05	0.03	0.03	0.11	0.09	0.06

Table 59: Comparison of reference points estimated in an earlier assessment and from the current assessment update. An $E_{40\%}$ exploitation rate proxy was used for the overfishing threshold and was based on a length based yield per recruit model from the 2011 SARC 52 benchmark assessment.

	2014	Current

E_{MSY} proxy	0.23	0.23
B_{MSY}	Unkown	Unkown
MSY (mt)	Unkown	Unkown
Overfishing	No	No
Overfished	Unknown	Unknown

Projections: Projections are not possible with area-swept based assessments. Catch advice was based on 75% of $E_{40\%}$(75% E_{MSY} *proxy*) using the fall area-swept estimate assuming q=0.6 on the wing spread. Updated 2014 fall 30+ cm area-swept biomass (4,655 mt) implies an OFL of 1,080 mt based on the E_{MSY} *proxy* and a catch of 810 mt for 75% of the E_{MSY} *proxy*.

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 with the direct estimates of stock biomass from survey area-swept estimates originate from the assumption of survey gear catchability (q). Biomass and exploitation rate estimates are sensitive to the survey q assumption (0.6 on wing spread). The 2014 empirical benchmark assessement of Georges bank yellowtail flounder based the area-swept q assumption on an average value taken from the literature for west coast flatfish (0.37 on door spread). The yellowtail q assumption corresponds to a value close to 1 on the wing spread which would result in a lower estimate of biomass (2,995 mt). Another major source of uncertainty with this method is that biomass based reference points cannot be determined and overfished status 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 Table 7).

  The model used to determine status of this stock does not allow estimation of a retrospective pattern. An analytical stock assessment model does not exist for Gulf of Maine winter flounder. An analytical model was no longer used for stock status determination at SARC 52 (2011) due to concerns with a strong retrospective pattern. Models have difficulty with the apparent lack of a relationship between a large decrease in the catch with little change in the indices and age and/or size structure over time.

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

  Population projections for Gulf of Maine winter flounder, do not exist for area-swept assessments. Catch advice from area-swept estimates tend to vary with interannual variability in the surveys.

- 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.
  No changes, other than the incorporation of new data were made to the Gulf of Maine winter flounder assessment for this update. However, stabilizing the catch advice may be desired and could be obtained through the averaging of the area-swept fall and spring survey estimates.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  The overfishing status of Gulf of Maine winter flounder has not changed.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  Direct area-swept assessment could be improved with additional studies on survey gear efficiency. Quantifying the degree of herding between the doors and escapement under the footrope and/or above the headrope for each survey is needed since area-swept biomass estimates and catch advice are sensitive to the assumed catchability.

- Are there other important issues?
  The general lack of a response in survey indices and age/size structure is the primary source of concern with catches remaining far below the overfishing level.

20.1 Reviewer Comments: Gulf of Maine winter flounder

Recommendation: The panel concluded that the updated assessment was acceptable as a scientific basis for management advice. Trends were updated for the NEFSC, MDMF, and MENH surveys. The 2015 catch was estimated including commercial and recreational landings; and the recreational, large mesh trawl, and gillnet discards. Analytic models used previously were deemed inappropriate by the SARC 52 benchmark due to concerns with a large retrospective pattern. The lack of an apparent relationship between a large decrease in catch and little change in indices and age or size structure cause poor fit in models that have been used. Currently the assessment is based on a 30+ cm area swept biomass estimated directly from the surveys. Projections are not possible with area-based assessments.

Alternative Assessment Approach: Not applicable

Sources of Uncertainty: The largest source of uncertainty originates from the assumption of survey gear catchability (q). Biomass and exploitation rate estimates are sensitive to the survey q assumption. Another major source of uncertainty is that biomass-based reference points cannot be determined and overfished status is unknown. The lack of a relationship between the large decrease in catch with little changes in the indices and age and/or size structure over time is perplexing. Catch advice from area-swept estimates tend to vary with interannual variability in the surveys. The lack of an analytical model contributes to uncertainty. It is unknown why the stock is not responding to low catches and low exploitation rates. This is a data-limited assessment, and as such, the results are limited.

Research Needs: Direct area-swept assessment could be improved with additional studies on survey gear efficiency. Inclusion of the spring survey into the assessment should be considered.

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: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://nefsc.noaa.gov/publications/

Northeast Fisheries Science Center. 2011. 52^{nd} Northeast Regional Stock AssessmentWorkshop (52^{nd} SAW) Assessment Report. US Dept Commer, Northeast Fish SciCent Ref Doc. 11-17; 962 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/

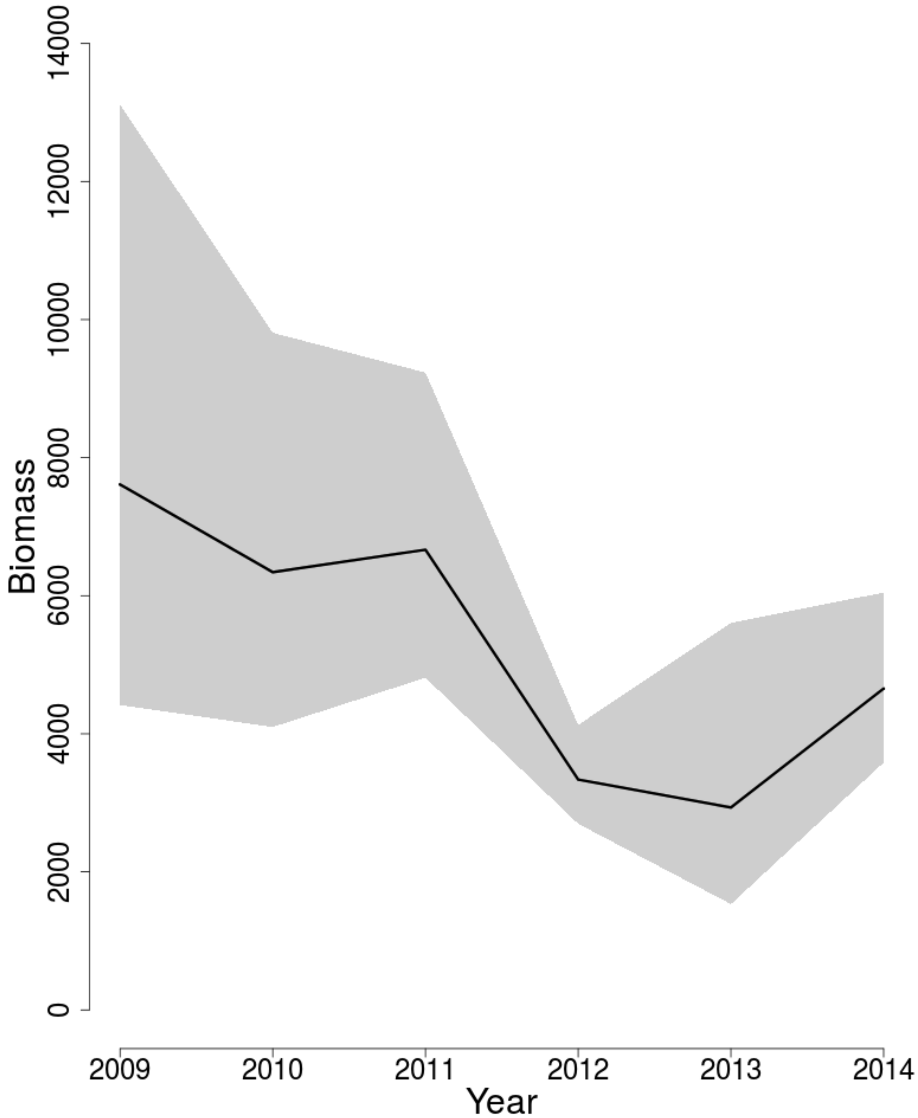


Figure 95: Trends in 30+ cm area-swept biomass of Gulf of Maine winter flounder between 2009 and 2014 from the current assessment based on the fall (MENH, MDMF, NEFSC) surveys. The approximate 90% lognormal confidence intervals are shown.

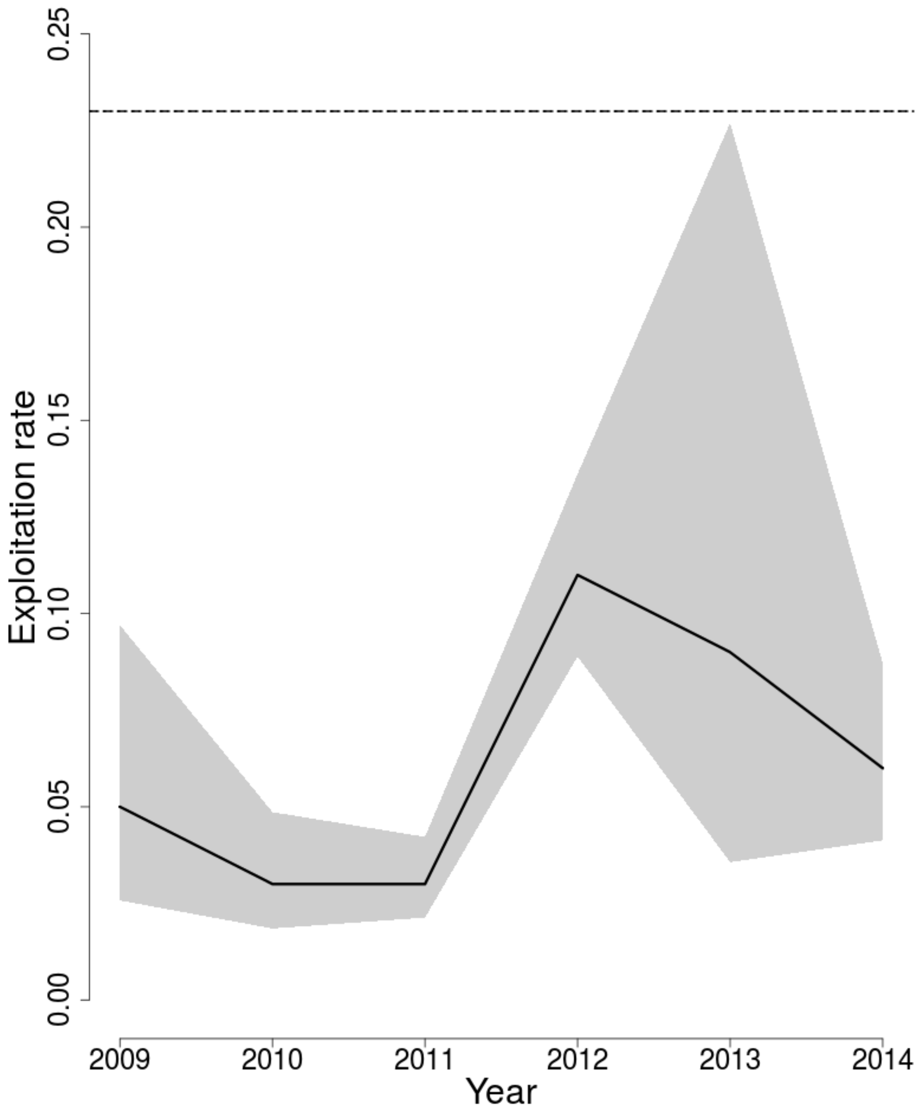


Figure 96: Trends in the exploitation rates (E_{Full}) of Gulf of Maine winter flounder between 2009 and 2014 from the current assessment and the corresponding $F_{Threshold}$ (E_{MSY} *proxy*=0.23; horizontal dashed line). The approximate 90% lognormal confidence intervals are shown.

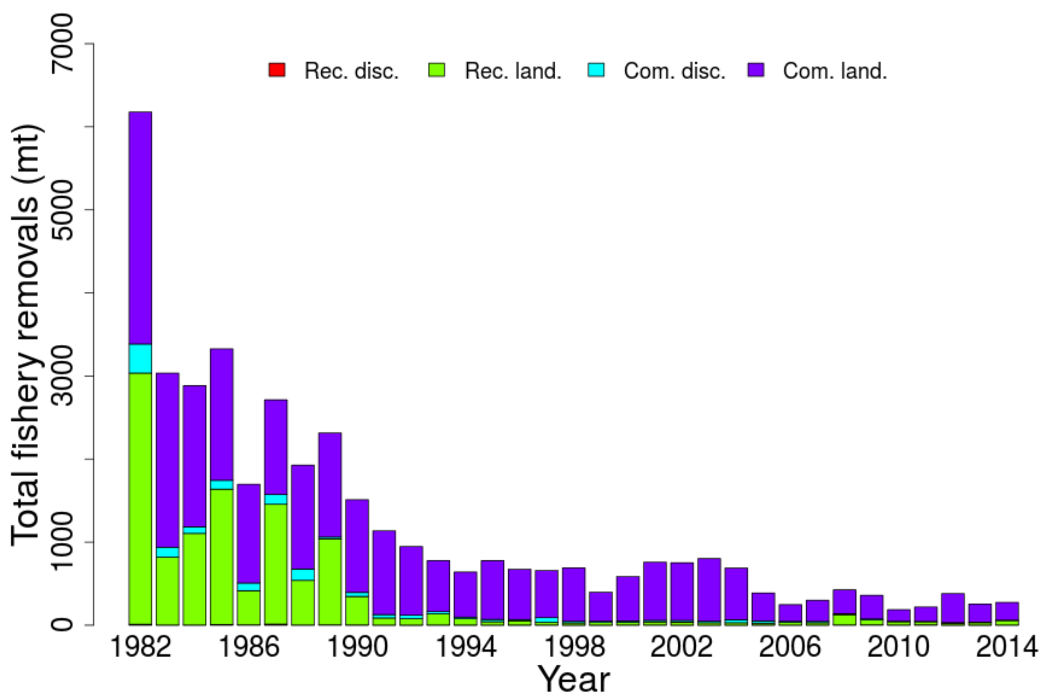


Figure 97: Total catch of Gulf of Maine winter flounder between 2009 and 2014 by fleet (commercial and recreational) and disposition (landings and discards). A 15% mortality rate is assumed on recreational discards and a 50% mortality rate on commercial discards.

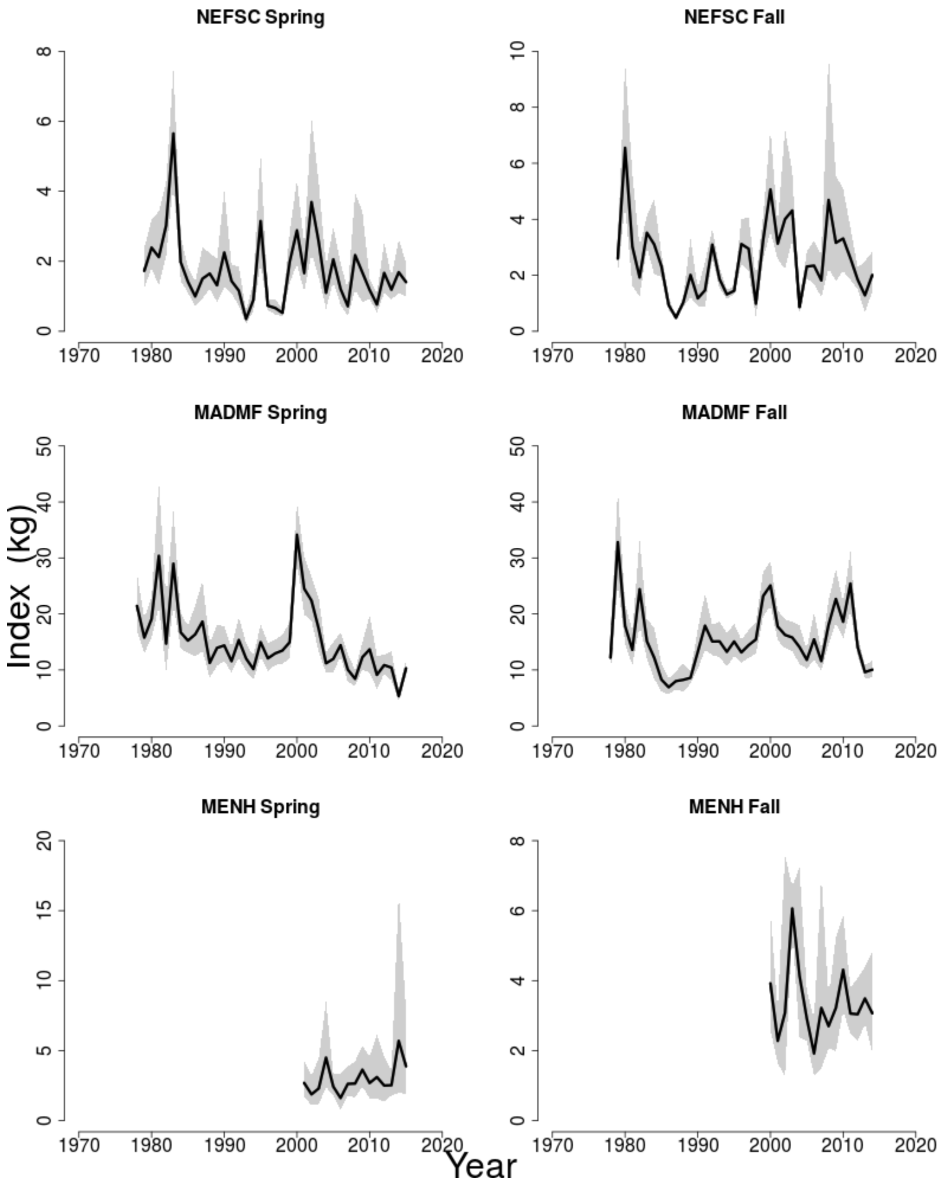


Figure 98: Indices of biomass for the Gulf of Maine winter flounder between 1978 and 2015 for the Northeast Fisheries Science Center (NEFSC), Massachusetts Division of Marine Fisheries (MDMF), and the Maine New Hampshire (MENH) spring and fall bottom trawl surveys. NEFSC indices are calculated with gear and vessel conversion factors where appropriate. The approximate 90% lognormal confidence intervals are shown.

21 Georges Bank yellowtail flounder

Chris Legault

This assessment of the Georges Bank yellowtail flounder (Limanda ferruginea) stock was reviewed during the July 2015 TRAC meeting (Legault et al. 2015). It is an operational update of the existing 2014 update assessment (Legault et al. 2014). Based on the previous assessment the stock status was unknown, but stock condition was poor. This assessment updates commercial fishery catch data through 2014 (Table 60, Figure 101), and updates research survey indices of abundance and the empirical approach assessment through 2015 (Figure 102). No stock projections can be computed using the empirical approach.

State of Stock: Based on this updated assessment, Georges Bank yellowtail flounder (*Limanda ferruginea*) stock status is unknown due to a lack of biological reference points associated with the empirical approach, but stock condition is poor. Retrospective adjustments were not made to the model results. The average survey biomass in 2015 (the arithmetic average of the 2015 DFO, 2015 NEFSC spring, and 2014 NEFSC fall surveys) was estimated to be 2,240 (mt) (Figure 99). The 2014 exploitation rate (2014 catch divided by 2014 average survey biomass) was estimated to be 0.071 (Figure 100).

Table 60: Catch and model results table for Georges Bank yellowtail flounder. All weights are in (mt). The average survey biomass in year y is the arithmetic average of the year y DFO, year y NEFSC spring, and year y-1 NEFSC fall surveys. The exploitation rate is the catch divided by the average survey biomass. Model results are from the current updated empirical approach assessment.

	2010	2011	2012	2013	2014
Data					
US landings	654	904	443	130	70
US discards	289	192	188	49	74
Canadian landings	17	22	46	1	1
Canadian discards	210	53	48	39	14
Other catch	0	0	0	0	0
Catch for Assessment	1,170	1,171	725	218	159
Model Results					
Average Survey Biomass	19,117	7,328	9,921	4,938	2,240
Exploitation Rate	0.061	0.16	0.073	0.044	0.071

Table 61: Comparison of reference points estimated in an earlier assessment and from the current assessment update.

	2014	Current
F_{MSY} *proxy*	NA	NA
SSB_{MSY} (mt)	NA	NA
MSY (mt)	NA	NA
Overfishing	Unknown	Unknown
Overfished	Unknown	Unknown

Projections: Short term projections cannot be computed using the empirical approach. Application of an exploitation rate of 2% to 16% to the 2015 average survey biomass (2,240 mt) results in catch advice for 2016 of 45 mt to 359 mt.

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 is the estimate of survey catchability, which currently relies on literature values for other species in other regions of the world using different gear. The survey catchability affects the expansion of the stratified mean catch per tow for each survey and is inversely related to the catch advice. Other sources of uncertainty include the appropriate exploitation rate to apply to this stock, which has seen continued decrease in survey biomass despite low exploitation rates.

- 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 RhoDecisionTab.ref).
  The model used to estimate 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 Georges Bank yellowtail flounder are not computed. Catch advice is derived from applying an exploitation rate to the current estimate of survey biomass.

- 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 2014 NMFS spring survey value was changed from 2,684 mt to 2,763 mt due to using preliminary data during the 2014 TRAC meeting. However, this has no impact on the 2015 stock status or 2016 catch advice in this update assessment.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  The stock status of Georges Bank yellowtail flounder remains unknown and stock condition continues to be poor.

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

  The Georges Bank yellowtail flounder assessment could be improved with studies on NMFS and DFO survey catchability for flatfish.

- Are there other important issues?

  None.

21.1 Reviewer Comments: Georges Bank yellowtail flounder

Recommendation: The 2014 update assessment was reviewed by the Transboundary Resource Assessment Committee (TRAC), and catch advice was developed by the New England Fishery Management Council's Scientific and Statistical Committee as well as the Transboundary Management Guidance Committee.

A summary of the assessment is included in this report to provide 2014 update assessments for all groundfish stocks.

References:

Legault, C.M., L. Alade, W.E. Gross, and H.H. Stone. 2014. Stock Assessment of Georges Bank Yellowtail Flounder for 2014. TRAC Ref. Doc. 2014/01. 214 p.

Legault, C.M., L. Alade, D. Busawon, and H.H. Stone. 2015. Stock Assessment of Georges Bank Yellowtail Flounder for 2015. TRAC Ref. Doc. 2015/01. 66 p.

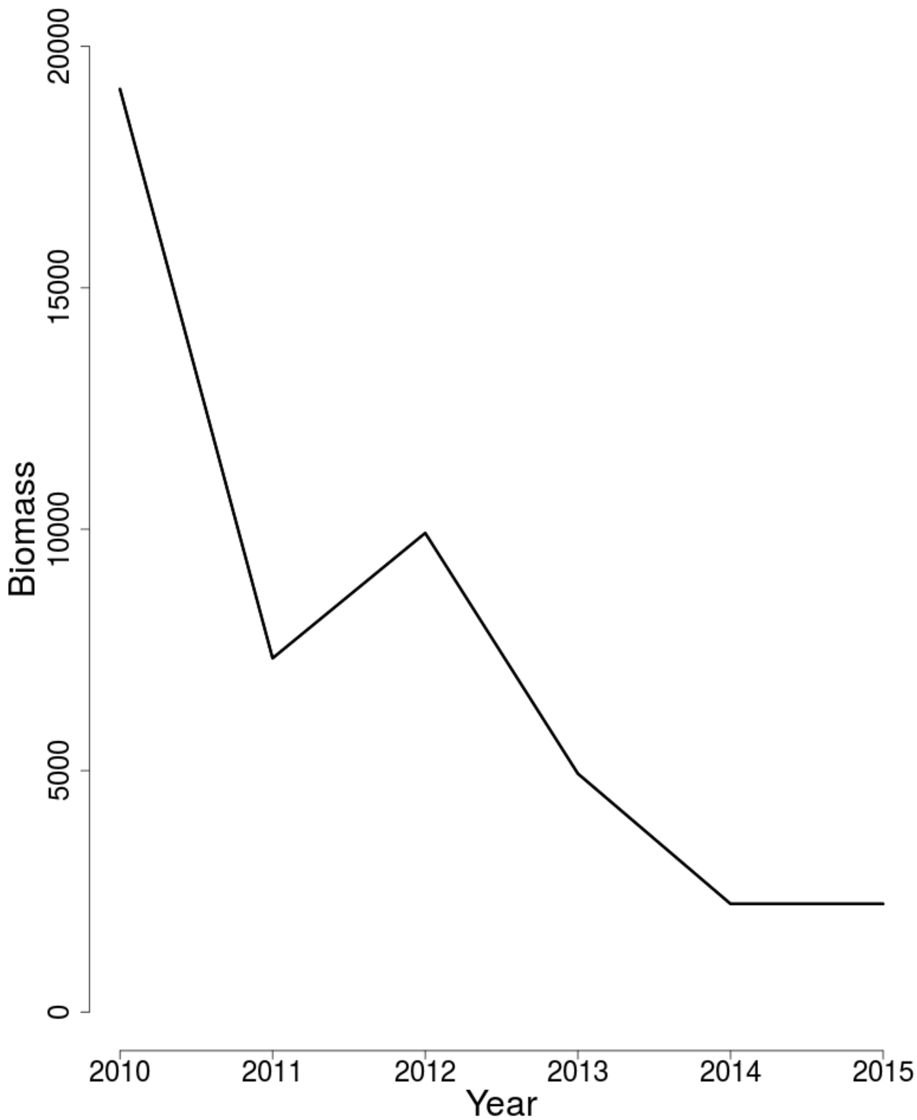


Figure 99: Trends in average survey biomass (mt) of Georges Bank yellowtail flounder between 2010 and 2015 from the current assessment.

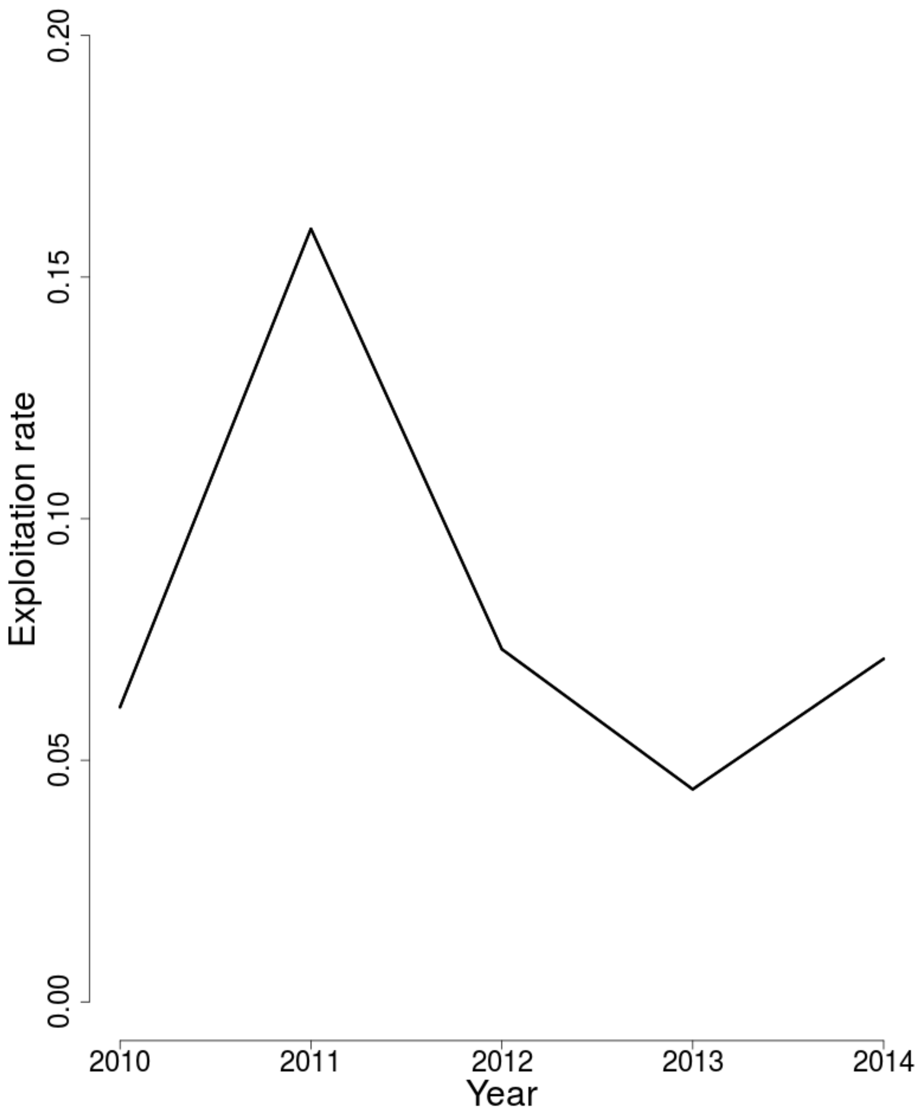


Figure 100: Trends in the exploitation rate (catch/average survey biomass) of Georges Bank yellowtail flounder between 2010 and 2014 from the current assessment.

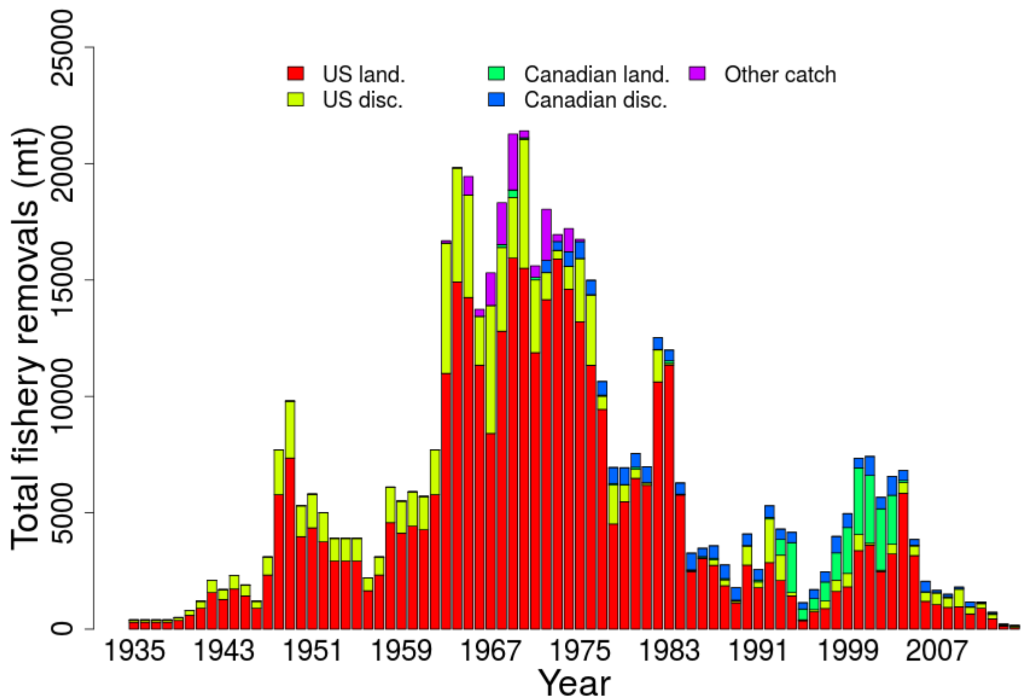


Figure 101: Total catch of Georges Bank yellowtail flounder between 1935 and 2014 by fleet (US, Canadian, or Other) and disposition (landings or discards).

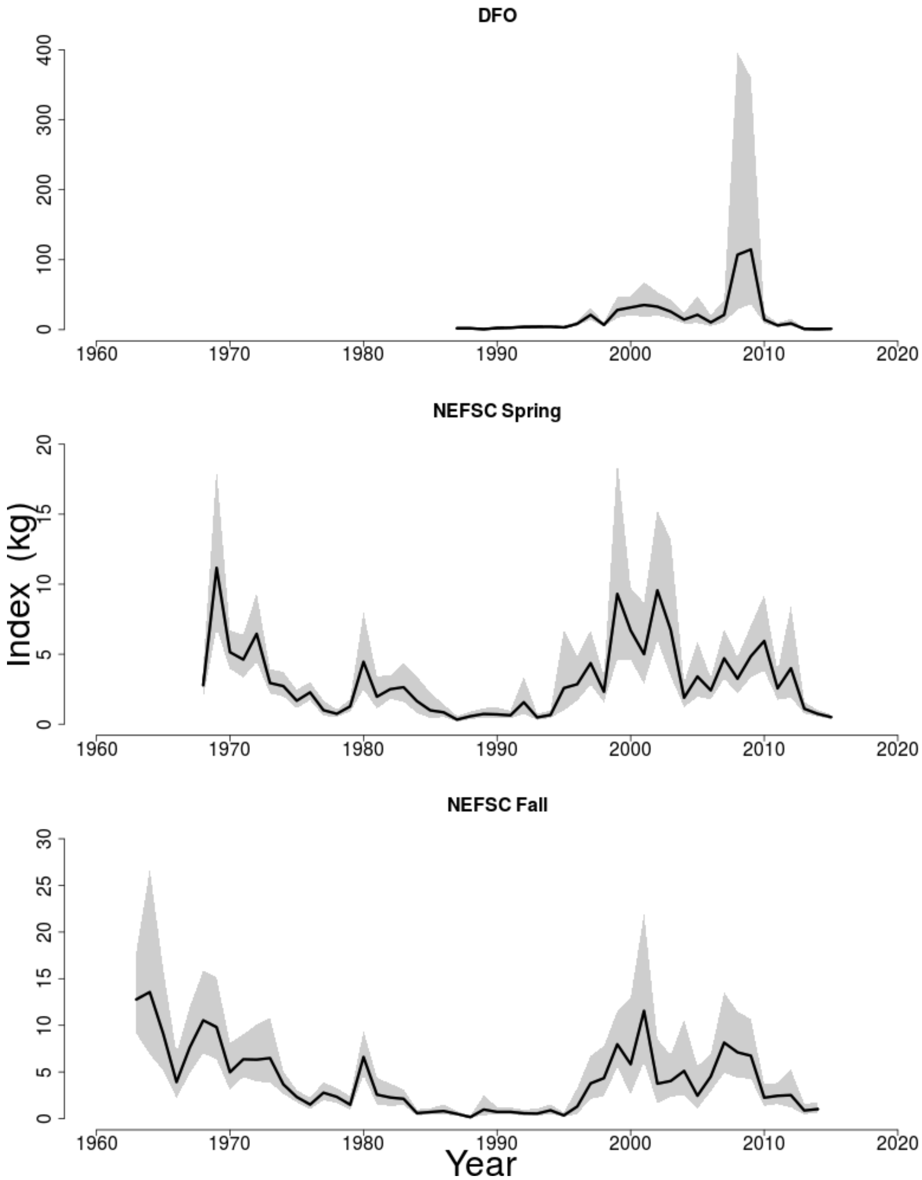


Figure 102: Indices of biomass for the Georges Bank yellowtail flounder between 1963 and 2015 for the Canadian DFO and Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.

22 Appendix

22.1 Northeast Regional Coordinating Council letter

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northeast Fisheries Science Center
166 Water Street
Woods Hole, MA 02543-1026

June 30, 2015

Dear NRCC Partners:

At our May 2015 meeting, we discussed the upcoming suite of Operational Assessments for 20 New England groundfish stocks. The NRCC recognized the value in this operational approach, in that it provides information useful to making fishery management decisions for a larger number of stocks and more rapidly and frequently. However, the NRCC also understood that trade-offs are inherent with this approach.

To provide more rapid assessments, these Operational Assessments are conducted using the existing, peer-reviewed assessment model for each stock, updated with new data collected since the last assessment. There is little to no scope for revising the underlying assessment model, as any such changes would require significant analytical work and would also require expanded peer review and discussion. This additional analytical work and peer review are typical of Benchmark Assessments, which are conducted for stocks that require incorporation of significant new information or a different analytical approach.

The NRCC supported completion of the upcoming 20 Operational Assessments and also recognized the importance of setting clear constraints on modifications to the existing models and data streams for each Operational Assessment. These constraints are essential to avoid the possibility for greatly increasing the complexity of each assessment, with resultant delays and reduction in our capacity to complete such a large number of assessments. Communication of these constraints is necessary to discourage external scientists or stakeholders from investing in developing new approaches or data streams that could not be accommodated within the Operational Assessment framework.

In the interest of setting and communicating these constraints, the NRCC reviewed a comprehensive list of types of modifications and agreed whether each type of modification could be accommodated within an Operational Assessment or if the modification could only be considered within a Benchmark Assessment. Since efficiency is essential to the success of the Operational Assessment concept, the majority of modifications could not be accommodated. However, in addition to incorporating new data from existing data streams to update current parameters in the existing assessment models, the NRCC felt that Operational Assessments could make minor adjustments to account for (a) updated information on growth and maturation of fish; (b) changes in values of reference points, but not the underlying basis for the reference points; and (c) introduction or modification of retrospective adjustments for biomass or fishing mortality. Modifications to the discard mortality data stream would be beyond the scope of an Operational Assessment in most cases, but, given recent changes to discard mortality data used for management of the cod recreational fishery, the NRCC agreed that modifications to discard mortality data streams could be considered for the Operational Assessment for Gulf of Maine cod and for other stocks with similar significant changes to discard mortality data.

Other modifications to existing assessment models or data streams would require more extensive analysis consistent with Benchmark Assessments. Modifications of this sort include: (a) changes to the abundance and trend data streams (e.g., changes to surveys, survey indices, LPUE); (b) changes to measures of scale (e.g., new or revised measures of catchability, new catch estimate data streams); (c) changes to the bases for reference points (e.g., updated priors on steepness, incorporation of regime changes); (d) changes in model configuration (e.g., changes in selectivity function, differential weighting of likelihood components, down-weighting of information such as specific year classes, splitting surveys and modeling data separately, new models); and (e) changes in biological information (e.g., changes in natural mortality). None of the modifications in items (a) to (e) will be considered in the Operational Assessments of groundfish in September 2015.

We provide this summary of our discussion for your review and feedback, and seek your concurrence in communicating these guidelines to the public, on behalf of the NRCC.

John K. Bullard
Regional Administrator
Greater Atlantic Regional Fisheries Office

William Karp

William A. Karp, Ph.D.
Science and Research Director
Northeast Fisheries Science Center

cc: R. Beal, ASMFC
C. Moore, MAFMC
T. Nies, NEFMC

22.2 Assessment Oversight Panel summary

Summary of Assessment Oversight Panel Meeting
July 27, 2015
Woods Hole MA 02543
Draft--September 13, 2015

As part of the Operational Assessment process for the 20 Groundfish stock assessments, the Assessment Oversight Panel (AOP) met in Woods Hole to review the assessment plans for each stock. The meeting was also broadcast as a Webinar.

The AOP consisted of:

Jake Kritzer, Environmental Defense Fund, Boston, MA
Jean Jacques Maguire, Sillery, Quebec
Steve Cadrin, SMAST, University of Massachusetts
Paul Rago, Northeast Fisheries Science Center, Woods Hole

In addition to lead scientists for each stock and other staff from the Population Dynamics Branch, participants included: Tom Nies (NEFMC Exec Director), Jonathan Peros (NEFMC staff), Terry Alexander (NEFMC member), Mike Simpkins (NEFSC) and Jim Weinberg(NEFSC). Participants on the webinar included Aja Szumylo (GARFO), Amanda Helwig, Chris Kellogg (NEFMC), Erica Fuller, Katie Almeida (GARFO), Sally Sherman (MEDMR), Sarah Robinson, Vito Giacalone, Jackie O'Dell, and Doug Butterworth.

The following reports and presentations were reviewed or served as background for the meeting.

- Individual presentations by stock, combined in the file= "AOP 7-27-2015 All Presentations. Pdf"
- Overview of NEFMC Multispecies Groundfish: Data and Model Configuration Summary, in the file "Model-Data-Summary.pdf"
- Summary of Stock Assessment Prospectuses for all stocks assessed by the NEFSC in the file "Stock Prospectus.pdf"
- Memo of June 30, 2015 from Regional Administrator John Bullard and Science and Research Director William Karp to NRCC on guidance for Operational Assessments. File = "nrcc-memo.pdf"

The meeting began at 10:00 am. Lead scientists for each stock gave a series of presentations on the data to be used, model specifications, evaluation of model performance, the process for updating the biological reference points, and the basis for catch projections. Presentations ranged from 10 to 25 minutes and we were able to address all 20 stocks before 4:30pm. Three background documents were provided to the Panel. The first was an updated prospectus for each stock. The second was an overview summary all the salient data and model information for each stock. The third was the NRCC Guidance memo on the Operational Assessments. The NRCC guidance memo was recognized as particularly relevant to the deliberations of the AOP.

The meeting served as a valuable forum for standardizing methods across assessments and resolving a number of potentially contentious issues. The overarching issues addressed included:

- A 90% confidence interval for fishing mortality and spawning stock biomass will be used as an objective way of applying a retrospective adjustment to terminal year stock size estimates. When the Mohn's rho adjusted F and SSB lie outside the joint confidence region of the terminal year estimates, the terminal year abundance estimates will be adjusted by the SSB rho estimate for stock status determination and catch advice projections.

- The likelihood function for the ASAP stock recruitment relationship will not include the constants as part of the function. This precedent was established at the most recent Operational Assessment of Atlantic herring and will be continued here.

- Projections for stock size and catches will be based on the Fmsy proxy and 75% Fmsy (or Frebuild if this rate is already in effect as the default for management (e.g. witch flounder).

- Estimates of catch in 2015 will be provided by the GARFO and will be used in all projections.

- The data quality assurance filter for tows from the FSV Bigelow bottom trawl survey will be based on TOGA criteria rather than SHG, an earlier filter used for the R/V Albatross.

- Values of all assessment reference points will be updated and based on updated growth and maturation values for reference point determination. Biological information will be averaged over the same time period (e.g., 3 or 5 years) as in last assessment. However, there will be no adjustments to the basis of biological reference points (e.g., change from F40% to F30%).

- Changes to natural mortality rate will not be allowed per the NRCC memo.

- For only a few stocks with issues identified in the table below, sensitivity runs will be presented to the Review Panel.

- The AOP provided a review of a study discard mortality rates of GOM cod that is currently in review for the ICES journal. The AOP agreed that the results of the study were sufficient for use in the September Operational Assessments for both the GOM and GB cod stocks.

- The NRCC guidance memo noted the possibility of changing other discard mortality rates if appropriate, and scientifically sound studies were available. In particular, consideration will be given to studies for wolffish and Atlantic halibut.

- The SSC will determine the most appropriate method for determining the OFL and ABC. In the absence of an approved model, this would likely utilize recent average catch over a number of years to be determined based on the trends observed in the stock. If an ABC has already been approved by the Council under Framework 53 for the 2016 fishing year, it might be utilized in the event the updated model is an insufficient basis for catch determination.[1]

- No alternative dynamic models will be applied in the event that the operational model for a given stock that was approved in the most recent benchmark assessment does not pass the upcoming peer review. Development and application of an alternative model for assessment generally requires a benchmark assessment with a greater scope for review and participation than is feasible in an Operational Assessment.

One of the general conclusions from the meeting was that recommendations for benchmark assessments should be expected for assessments that reveal either revised status or poor agreement between data and models (i.e. lack of fit or strong retrospective patterns). Decisions on benchmarks and their timing will be made by the Northeast Regional Coordinating Council.

Specific recommendations for each assessment were summarized in the attached set of Powerpoint presentations. In general the AOP approved these plans but highlighted a number of clarifications as summarized below:

Stock Name	***Lead Scientist***	***Major Comments***
Overview of Process	Paul Rago	Terms of Reference listed in presentation will be used.
Gulf of Maine Cod	Michael Palmer	Results for both the Mramp and constant M will be presented. Discard mortality for recreationally caught fish will be reduced from 30% to 15%.
Georges Bank Cod	Loretta O'Brien	Discard mortality for recreationally caught fish will be reduced from 30% to 15%. The M=0.8 VPA and associated consequence analysis developed by the TRAC for EGB cod are outside the scope of the update, and any inconsistency between the GB cod update, and EGB cod assessment methods or TMGC decisions will need to be reconciled in the Council process.
Gulf of Maine Haddock	Michael Palmer	Base run should turn the likelihood constants OFF but should be turned on for a sensitivity run.
Georges Bank Haddock	Liz Brooks	Base case model will omit certain strong recruitments from bootstraps but a sensitivity analysis will include them. Results are relevant to estimation of 2013 year class.
Cape Cod/Gulf of Maine Yellowtail Flounder	Larry Alade	No comments
Southern New England/Mid-Atlantic	Larry Alade	Split survey run will not be included. Confirm that recent recruitment is low vis-à-vis projection assumptions.

[1] Subsequent to the meeting NEFMC staff noted that the 2016 ABCs for GM haddock and GOM cod were approved by the SSC only with the understanding that new ABCs would be adopted in the 2015 assessments. Hence it may not be appropriate to use the existing ABCs as “Plan B” alternatives. The AOP did not comment on this.

Yellowtail Flounder		
Georges Bank Winter Flounder	Lisa Hendrickson	Do not use AIM as Plan B. Discard mortality =100% because no satisfactory alternative is available for this stock.
Southern New England/Mid-Atlantic Winter Flounder	Tony Wood	Do not use scaled Q as Plan B for this stock
Acadian Redfish	Brian Linton	No Comments
American Plaice	Loretta O'Brien	No Comments.
Witch Flounder	Susan Wigley	This VPA assessment has a split series. If a significant retrospective pattern is observed, the rho adjustment factor will be applied.
White Hake	Kathy Sosebee	Per the SARC 56 benchmark, a truncated CDF of recruitment will be used for catch projections (1995-2012). Reference points will be based on recruitments from 1963-2012. Plan B = catch for 2016 per Framework Adjustment.
Pollock	Brian Linton	Perform sensitivity analysis with flat-topped selectivity assumption. This sensitivity run has been useful to SSC for setting ABC in the past.
Wolffish	Chuck Adams	Recent average catch will be used as basis for Plan B. Updated maturation data will be used in model formulation. This is additional information collected in same manner as used in previous assessment.
Atlantic Halibut	Dan Hennen	The current model for Atlantic halibut sensitive to initial conditions. The final determination of the model's utility will be determined by the review panel in September. AOP recommended sensitivity analysis of model to assumed discard mortality rate. Plan B = recent average catch.
Gulf of Maine/Georges Bank Windowpane	Toni Chute	Recent average catch will be used for Plan B if assessment model fails. Canadian catches have not been reported in recent years and cannot be used in this assessment. The use of projections was questioned, noting that the PDT has chosen not to use these in recent years. However, the AIM projection method is part of original assessment benchmark and should not be changed.
Southern New England/Mid-Atlantic Windowpane	Toni Chute	As above
Ocean Pout	Susan Wigley	No changes
Gulf of Maine Winter Flounder	Paul Nitschke	No changes to BRPs values expected because no changes in growth rates observed. Empirical model only uses data from Bigelow surveys.
Georges Bank Yellowtail Flounder	Chris Legault	This assessment was updated as part of the TRAC. No further revisions will be done at the Operational Assessment.

The meeting concluded at 4:30 pm. Assessment reports will be prepared by the lead scientists and uploaded to the following website http://www.nefsc.noaa.gov/groundfish/operational-assessments-2015/. Draft assessment reports will be made available approximately two weeks before the Peer Review Panel meets September 14-18. In addition to the short summary reports, all of the model inputs and outputs, and supporting tables, figures and graphs will be made available via a web-based tool.

22.3 Outreach on 2015 groundfish operational assessments

Outreach on 2015 Groundfish Operational Assessments

Given the relatively new process associated with these operational assessments, the NEFSC made an extra effort to promote understanding of the process ahead of the peer review meeting. These efforts included a webinar/seminar for in-house outreach staff, sector managers, and New England fishery Management Council groundfish and recreational fishing advisors on July 20, and a data-rich dedicated website:
http://www.nefsc.noaa.gov/groundfish/operational-assessments-2015/

On July 22, 2015 the NEFSC also held five port-based outreach meetings for fishermen and other stakeholders. These occurred in Maine (Portland), New Hampshire (Hampton), and Massachusetts (Gloucester, Woods Hole, New Bedford.) Assessment analysts met with attendees at each location to learn more about recent observations from the fleet and ports that might help focus future research to improve assessments. Each meeting started with a brief introduction on the timeline for the assessments, what new information would be considered, and how the results would be reviewed before use in the fishery management process.

Although not the first time that outreach meetings have been held for industry ahead of an assessment, this is the first time that summaries of the meetings are included in the assessment report and provided to peer reviewers. The summaries were prepared from notes taken by NEFSC communications staff, then provided to meeting attendees for comment before they were finalized for publication.

2015 Groundfish Operational Assessment Industry Outreach Meeting—Portland Maine
22 July 2015

Observations

Scientific surveys are unreliable indicators of fish abundance: Many attendees were concerned that there will be decreases in their quotas because of survey data, which they do not believe reflects fish abundance. They're concerned that the timing of the survey cruises and the sparse coverage of areas where fishermen are seeing the most fish do not give a complete representation of the fish population. In particular, two fishermen noted that they avoid fishing Platt's/New Ledge because there is an abundance of cod there, yet three NEFSC tows that occurred in that area caught zero cod in the spring. Overall, they worry that the survey is "too thin" because of the variability in the movement of fish. For example, there may be an area where fishermen don't catch anything for weeks, but then after a month or so that same area is flooded with fish. If the survey only covers that area on one day, and that day happens to be an off day, then the scientists won't know that sometimes that area is full of fish. A participant at the meeting noted that all these characteristics would be expected to increase the variability of the survey, but not create bias, meaning the long term trends should be representative.

Concerns that reduced landings of a species are interpreted as lower abundance: Some fishermen stated that they are under their quota on some fish (such as monkfish) simply because they are trying to avoid species such as dabs and gray soles. They would like a higher quota on the dabs and gray soles so that they can take their quota on monkfish. The fact that they aren't catching as many monkfish as allowed is not because that stock is low, but because fishermen are trying to avoid other fish that occur with monkfish. There is concern that the way this appears in the landings data suggests that there are fewer fish in the water than are really there. An NEFSC analyst noted that low catch is not assumed to mean low population abundance.

Fishermen report large numbers of cod in pocketed areas they are avoiding or can't access: The fishermen and charter boats aggregate in one area in order to avoid catching "choke" stocks. They see pockets of cod everywhere and are afraid to fish in those areas because they don't want to go over their quotas. They are hearing from scallopers that there are cod on Georges Bank and near Canada. Lobstermen tell them they are seeing young cod in their lobster traps.

Cod populations, while not at high levels, are in better condition than the assessments indicate: Many fishermen said they simply do not see evidence on the water of what the science is finding. They feel that cod is recovering, perhaps not at record highs, but it is not as low as the assessment.

Revised Gulf of Maine cod recreational discard mortality rates will lower quotas: Some fishermen are worried that the fact that revised recreational discard rates allowed in the upcoming assessments will lead to a lower quota overall. There is concern that their quotas will only drop as a result of these assessments. An analyst noted this was not the case; quotas could increase if the updated assessments indicate increased stock abundance.

Early warning of a changing trend in the population or quota allocation would be welcome: A seafood processor raised the issue of stability and predictability. He cannot always buy the fish that come in locally because he might be set up to process something different. If he had some advance warning about which species would be allowed more catch, then he could be prepared to process what comes in. Overall, industry members indicated that they would like some advance notice of what to expect from these assessments and that more stability would be helpful. But one participant noted that stability at low catch amounts is not desirable.

Are Gulf of Maine cod and gray sole being out-competed? The fishermen had questions about fish that swim together possibility out-competing depleted stocks for resources. For example, monkfish might be outcompeting gray soles and haddock might be outcompeting cod. Other ecological concerns were raised, such as red tide. An NEFSC analyst noted the difficulty in trying to find a direct link between two species in such a complex ecosystem with many species and interactions.

Fishermen would like to take a more active role in the assessments: Fishermen would like to communicate with the assessment scientists and relay them what they are seeing on the water. The fishermen feel that the scientists should be able to reach out to them if they come across data that doesn't add up and perhaps they could explain something that's happening at sea that would factor into what the science seems to be showing.

Scientific surveys should better track fishery practices: Some felt it would be better if the survey used the same kind of gear, same trawl speed, and go to the same places as the fishermen. Let the fishermen show the scientists where the fish are and what they are seeing. Side by side tows with the survey vessel and the commercial fishing vessels might provide useful information and would help improve credibility in the survey. An analyst noted this is exactly what is done during cooperative research projects when catching fish for a particular study is the goal, scientists rely on the fishermen's knowledge to find the fish. However, multispecies surveys require sampling in all the habitats, some of which will not be suited for a particular species.

Fishermen's feedback needs to be reflected in assessments: Several fishermen felt that the cooperative research programs were useful in bridging the gap between the fishing industry and the assessment scientist. Most importantly, if NEFSC shows that it is using fishermen's feedback in the assessment process, then there will be more willingness for future collaboration and continued dialog. An NEFSC analyst noted that these meetings were the first step towards doing exactly that.

Potential Areas for Further Examination or Research

- Consider fine-scale surveys of areas where fishermen expect large cod are occurring, or other ways of increasing survey stations in these areas
- Investigate occurrence of cod and gray sole in lobster gear and whether this significant enough to warrant further sampling or monitoring.
- Interrogate food habits data regarding competition among monkfish, cod, haddock, and gray sole in the Gulf of Maine
- Seek a way to turn the kinds of observations obtained in industry outreach meetings like this one into data that can inform assessments
- Find ways to more effectively use cooperative research to bridge the gap between the fishing industry and the assessment scientist

2015 Groundfish Operational Assessment Industry Outreach Meeting—Hampton, NH
22 July 2015

Observations

Scientific surveys are unreliable indicators of fish abundance and vary too much: There was a general frustration in what was called the "inconsistency" of the survey. If fishermen could see reliable, consistent results from the survey, results that match up with what they are seeing on the water, then they would believe the survey is consistent. Because they feel the results are not reliable, some are calling for a complete overhaul of the trawl data and how scientists are collecting it. Those present were concerned about the small number of surveys per year, the number of stations (too few), the tow protocols, the timing, the reluctance to change the survey to account for changing water temperatures, and so on. There were also concerns about trawl gear bottom contact, and avoiding survey stations where other fishing activity is occurring (particularly lobster pots). An analyst noted more tows in each survey would increase the precision of the survey, but would not be expected to change the mean.

Seasonality is an overlooked parameter in the scientific surveys: The fishermen feel the time of year when the survey occurs is even more important than location. The research survey tows in the spring, but cod swim in certain areas a certain times of the season. It doesn't make sense to tow when the fish aren't around, so of course the survey isn't going to catch anything at the beginning of May. Still location remains a factor. There's the concern that the areas the research cruises tow are not a representative sample.

Closed areas should be better surveyed: There were concerns the closed areas don't get surveyed at all on any given year. It was suggested that the strata need to be redrawn to ensure sampling occurs in each closed area during each survey.

Fish are present in relatively large numbers in areas fishermen are avoiding or can't access: Fishermen are concerned that the assessments are not going to capture the numbers of fish and their location in the areas fishermen are avoiding because they contain an abundance of cod. They worry that the scientists will assume they are catching less fish because there are fewer fish available, not because they are avoiding going over their quotas. An NEFSC analyst noted that reduced catch by the fishery is not assumed to mean fewer few in the population, and that fishery models relate the annual amounts of catch to changes in the survey to estimate the size of the population.

Surveys should cover the line of areas where fishermen expect to catch cod: The fishermen worry that the population of several stocks is increasing but this is not reflected in assessments because the research vessels are not capturing that information. As a result, the fishermen are not taking quotas of healthier stocks because they are avoiding the ones with lower quotas. They are frustrated that research vessels do not survey along a line of areas where they expect to catch cod, and then the scientists could note the differences from year to year in the places where cod are typically caught. An NEFSC analyst noted that the Maine-New Hampshire originally included fixed stations but that these were abandoned after a number of years because they were not providing additional information.

Are changing environmental factors (climate variability and change) and competition among species being considered in establishing survey stations and in assessments? If the water temperatures have been rising, fish that like colder water might be swimming deeper to stay in those ideal temperatures. Many of these fish are now living at deeper depth than they used to according to some participants. NEFSC analysts noted that the surveys do sample in these deeper waters as well. Fishermen also asked about competition for resources among different species. For example, is it possible that the abundant numbers of haddock are outcompeting cod because they occur together? The fishermen were concerned about maximum sustainable yield of all stock simultaneously when they compete at the same niche. Many species compete in pairs, e.g., cod and haddock, witch flounder and American plaice, yellowtails and blackbacks. All the species compete, but it is most fishermen's experience that when one of the species in the pairs listed is abundant, the other species is less abundant. So when, for example, haddock is abundant cod is less abundant. Fishermen would like to have this observation investigated.

An NEFSC analyst noted that there are many species in the region that are generalist feeders, making it hard to directly relate the change in abundance of one species to that of another.

Spring and summer 2015 conditions should be used in operational assessments: Some seemed discouraged that the data being used for the upcoming assessments will not reflect the population dynamics found in the water this spring and summer. An NEFSC analyst noted that one goals of the operational assessments is to reduce the lag between the most recent data that can be included and the most recent data collected. Data from spring and fall 2015 will be included n the next update. To include these data in the 2015 operational assessment would delaying the analyses until these most recent data collected are ready for use.

Fishery-dependent data does not accurately reflect abundance: From Gloucester to Maine, some suggested, all the charter party boats are huddled in a ten mile spot, and VTRs will show that they are in the one same area to avoid catching cod. This is problematic because there won't be much fishery-dependent data on the many areas where the fishermen are seeing high numbers of cod.

Fishermen want more opportunities to talk to assessment scientists, but worry about the risks of doing so: Fishermen are reluctant to say exactly where the fish are because they're worried NOAA will then close those areas. Industry members would like more opportunities to interact with the scientists. They'd like to review the assessment reports before they are public, and if there's an FAQ section on the website, they'd like the ability to respond so that there's more of a dialogue and exchange happening, rather than information only flowing one way. An NEFSC analyst noted his participation in cooperative research aboard a commercial boat was a positive experience and suggested that meetings like these would also help. The participants were asked if there were other ways of communicating between scientists and the fishing industry that could be tried. Google hangout was mentioned as a possibility.

Something doesn't add up if the fishermen are seeing cod at the same rate they have been for 10 years, but the scientists are saying that the population is only at 3%: Many said they could not believe that the stock size of cod is what the assessments indicate because they are catching so many. Some fishermen said there was a dip five years ago, but this year they are seeing the healthiest levels that they've seen in 7 years. They are finding cod higher up in the water column. One fisherman works on research projects and has no trouble targeting cod of any age or size. In addition, lobstermen are seeing age 1 cod in their traps, more than they've seen before.

Potential Areas for Further Examination or Research

- Consider fine-scale surveys of areas where fishermen expect large cod or other fish believed to be scarce are occurring, or other ways of increasing survey stations in these areas
- Investigate occurrence of cod and wolfish in lobster gear and whether this significant enough to warrant further sampling or monitoring.
- Interrogate food habits data regarding competition among monkfish, cod, haddock, and gray sole in the Gulf of Maine
- Seek a way to turn the kinds of observations obtained in industry outreach meetings like this one into data that can inform assessments

2015 Groundfish Operational Assessment Industry Outreach Meeting—Gloucester, MA
22 July 2015

Observations

Catch rates for Gulf of Maine cod are increasing: Fishermen observed that their catch rates for cod are increasing. They contended that, after a few years of decline, the cod are back and are plentiful, much more so than in the 1990s. Several said that they are easily filling the current quota and fear they cannot avoid all of the cod that are out there, even by using cod-end sensors to try to avoid large catches of cod, as many in the Gloucester fleet have been doing since 2009. Participants questioned how, if GOM cod is at 3% of the SSB target, they could be consistently finding Gulf of Maine cod throughout the range (inshore and offshore) and be spending so much time avoiding cod. By way of example, some fishermen noted that during the 2014 fishing year they were actively staying away from areas where they knew Gulf of Maine cod would be located because of the 2014 reduction in ACL (1,500 mt). But, when word of a pending Emergency Action became known, more GOM cod were caught (easily) in the weeks leading up to the Emergency Action than during the prior 5-6 months of the 2014 fishing year to date. These observations do not comport with the Gulf of Maine cod assessment, which indicates that the stock is at historic lows.

The Gulf of Maine cod population has significant numbers of large fish that are not available to the fishery and therefore not showing up in logbooks or landings: Participants were concerned about the reported "age truncation" of the stock. Their belief is that there has been a consistent supply of Gulf of Maine cod of many sizes (scrod, market and large) being caught and landed. Several fishermen reported that large fish are showing up in their catch. There was discussion of what was meant by "large" and a range of views on that. Among the measures discussed were relative size (large or small), absolute length (measured in inches or centimeters), market category (scrod, market, large), and age structure (i.e., what ages are considered "old" and what length does that represent? Are those "old" fish associated primarily with the large market category?) Many felt that these large cod are sheltering in areas that are no longer fished because vessels are too small to reach them, or where they are too numerous to avoid (thereby risking quota overage or opportunities to fish for other species), or in closed areas. Some of the areas mentioned as harboring the large cod are: Cash's Ledge, Whaleback, deeper waters, and the mid-western portion of Gulf of Maine closure. The reported presence of significant numbers of large cod is at odds with the assessment finding that the age structure of the population is truncated.

Recreational fishermen are catching large cod inside the western Gulf of Maine closure: Several commercial fishermen asserted that this is the case. The reported presence of significant numbers of large cod in recreational catch is at odds with catch data collected from the recreational fishery that reflect a truncated size structure, similar to data from the commercial catch.

The Gulf of Maine cod population has significant numbers of large fish that are not available to the research surveys: The fishermen have numerous concerns about the scientific resource surveys. These include the density of sampling (too sparse), the frequency of sampling (not often enough), and not in the right place (where cod do not occur).

Prevalence of lobster gear inshore prevents detection of cod that are present in these areas: Several people expressed concern that important areas of the Gulf of Maine are not being surveyed by scientists or fished by groundfishermen because of the density of lobster traps. There's a perception that those unsampled areas are providing a refuge for cod and gray sole that are not being counted in the assessment. Fishermen also referenced anecdotal reports of lobstermen seeing lots of cod. Scientists from the Northeast Fisheries Science Center (NEFSC) and from Massachusetts Division of Marine Fisheries (MADMF) indicated that the MADMF survey is consistently able to make tows along inshore areas where lobster gear occur, and that a review of their database indicated very few occurrences where a planned tow was moved due to presence of gear.

Undocumented discarding in the 1990s may be skewing abundance estimates: Fishermen acknowledged that there was undocumented discarding of cod in the 1990s when the restrictive trip limits were introduced. The result was discarded cod unaccounted for in catch data, and a skewed picture of age composition based on landings because of high grading, both of which could still be affecting the population abundance trend in the assessment.

Survey data have too much influence on population estimates, while commercial data have too little: This was a widely held view.

Potential Areas for Further Examination or Research

- Seek a way to turn the kinds of observations obtained in industry outreach meetings into data that can inform assessments.
- To better explain perceived inconsistencies between fishermen's observations and assessment results, conduct work to:
    - Better document fishing patterns and how they have changed under sectors and in response to management measures. This could be characterized both spatially and temporally, including maps of fishing grounds, and geographic distribution of landings by statistical area and port. This could also include an examination of seasonal oceanographic conditions relative to well-defined fishing grounds over time. Input from fishermen as well as analysis of VTRs could help identify well-defined fishing grounds over time.
    - Examine the implications of 1990s unreported discarding and high grading on assessments. This could take the form of a limited set of sensitivity analyses to bound the scale of unreported catch.
- Examine density of survey tows by strata over time, and spatial distribution of tows within strata over time, to address concerns that the survey sampling is inadequate. This could be compared with reported areas of fishery landings over time from VTRs and observer data.
- Investigate the effects of closed areas and fishing patterns on port sampling data (age, length and market category)

- Investigate occurrence of cod and gray sole in lobster gear and whether this is significant enough to warrant further sampling or monitoring. It was noted by NEFSC scientists that there is now increased observer coverage on lobster trips. Sampling and monitoring of this fishery will likely evolve over time based on reviewing annual patterns of bycatch.

2015 Groundfish Operational Assessment Industry Outreach Meeting--Woods Hole, MA July 22, 2015

The NEFSC Woods Hole Laboratory hosted guests from the Nature Conservancy and the Mass. Fisherman's Partnership. Roughly a dozen fishermen and fishery managers participated in the conference call/webinar, which was also open to the meeting held in New Bedford. Following the presentation and Q&A, New Bedford exited the conference call, and each location hosted its own discussion. Some callers remained on the phone to participate in the Woods Hole meeting. Most discussion points were covered in conjunction with New Bedford, but Woods Hole-specific topics are highlighted below.

Many attendees expressed appreciation for the opportunity to talk with the NEFSC, though there were requests that future meetings be held in the late afternoon/early evening to accommodate fishing schedules.

OBSERVATIONS

(WH, NB)

Timing of Operational Assessments: The idea was floated by one caller to conduct the more thorough benchmark assessments more frequently. NEFSC staff explained why conducting large-scale benchmarks every year is not efficient, and does not result in a better picture of stock status. Benchmarks are best used to consider significant new data or methods, things that fundamentally change the patterns of scale and that are not available on an annual basis. Because of their complexity, expense, and required analyst time, doing more benchmarks also means fewer annual updates and operational assessments and more time between assessments for each species.

Assessment Process Data Sharing: Several participants and callers wanted specific timing for when the data portal associated with the groundfish operational assessments would be available for use. NEFSC staff indicated that the database will be functional by the time reports are delivered to the reviewers, currently expected to be at least one week, but possibly two weeks ahead of the assessment meetings.

Assessment Meeting Reviews: There was a question about the groundfish operational assessment process. Would the peer reviewers have the authority to reject a stock review outright? NEFSC staff said the peer reviewers can recommend changes similar to those that occurred with the 2015 Herring Operational Assessments, which incorporated retrospective adjustments. NEFSC staff noted that biological reference points used in the last assessments for these species are being retained, but reference point values may change based on new data, which could actually result in a change in stock status if systematic trends in weight and age are found.

Assessment Meeting Logistics: Callers requested the names of the panel as well as schedule details for September's meetings. NEFSC replied that the report would include text written by peer review panel, and short summary statements on all 20 stocks. Monday through Thursday would be used to present and discuss assessment results for each species/stock. Friday will be used for synthesis and report writing. NEFSC staff reiterated that brief, detailed feedback would be welcomed throughout the entire process.

Assessment Meeting—Stock Prioritization: Several participants wanted to know how we currently prioritize future benchmark studies, and wondered how we will prioritize them going forward. NEFSC staff explained that it was a long-term issue with many components, but this may represent an opportunity for further developing a process.

Observer Monitoring : Several callers expressed considerable reluctance to embrace the fishery monitoring process. Many were concerned about relying on fishery monitoring data, given the significant changes happening and the level of turmoil in the process. The controversy over funding the monitors continues to be a challenge, with several callers voicing strong opinions on whether the presence/absence of an at-sea monitor affects observation bias. Specific comments are as follows:

"Trip duration and landing quantities are measures of bias induced by monitoring."

"Monitoring reduces scope for normal behavior. "

"I haven't changed my fishing limits based on observer status. I don't have the time or bank account to change anything I do to accommodate a monitor. But I think I'm in the minority, because I know a lot of other fishermen who will change their behavior to skew the data."

A related discussion at the Woods Hole meeting centered on random selection of trips for fishery monitoring. Some participants felt strongly that the selection is not as random as it should be. The perception is that observers only seem to want certain boats. One caller asked what the effect would be if at-sea monitoring is eliminated, with NEFSC staff replying that discard estimates would be less precise due to a smaller sample size. The NEFSC may have an opportunity here to assist the fishing community by offering as much info on the fishery monitoring program as possible—one example being an online tutorial on the program.

Data usage and assessment cut-off dates: One caller requested an explanation of how NEFSC incorporates fishery and fishing data into its operational and benchmark Assessments. NEFSC staff attempted to explain how fishermen's data is used, noting that vessel trip reports are key to estimating abundance and catch, and biological samples taken from catch on observed trips as well as from landed fish are important for determining the characteristics of fish removed by harvesting.

There was a question about cutoff dates for data for September's assessment. NEFSC staff reported that data collected though calendar year 2014 would be used for landings, discards and survey data but several species may incorporate Spring 2015 survey data. Gulf of Maine cod, specifically, will **not** use Spring 2015 data.

WH only: It was pointed out that Spring 2014 and Spring 2015 were polar opposites in GOM, one very warm and one unseasonably frigid. Is there an opportunity for scientific discussion regarding stock status in temperature extremes?

Potential Areas for Further Examination or Research

- Work to develop a wider common understanding of assessment prioritization and process, and how industry generated data enter the assessments
- Work to better characterize observer bias in the data, and account for it as needed in the assessments
- Work to better explain the Northeast Fishery Observer Program goals and operations
- Examination of stock performance in years when water temperatures have been unusually high or low

2015 Groundfish Operational Assessment Industry Outreach Meeting--New Bedford, MA
July 22, 2015

Observations

Concerns from industry that reduced landings are interpreted as lower abundance and the Total Allowable Catches (TAC) are being lowered: Fishermen are landing 20-25 percent of their TAC and feel like the TACs, other than for haddock, are being lowered because of the lower landings. Mention of yellowtail as an example. Some fishermen believe predation is causing poor recruitment, that places like Nantucket Lightship have not seen yellowtail in years, while others question numbers and believe there is more yellowtail out there. An analyst noted that yellowtail recruitment was poor despite low fishing pressure, that lack of young fish recruited to the population results in lack of adult biomass to support higher catches. Analyst also noted that while predation may be part of the equation, there is no evidence of that and predation is not believed to be a primary source hindering population productivity.

Scientific surveys aboard the *Bigelow* do not match what fishermen are seeing and are therefore unreliable indicators of what is really happening: Industry representatives questioned where the *Bigelow* goes and the lack of a station match with where fish are being caught. They felt only a few stations, maybe six, were useful. They suggested they provide guidance for where the Bigelow could go at certain times of the year to get a more accurate picture of what they believe is going on. They don't understand why the *Bigelow* goes to areas where there are no fish, or why all the zero tows are included in assessments from these areas when they are catching plenty of fish in other areas. An analyst noted that we need to know where the fish are not as well as where they are, that the survey shows trends in the populations, while the commercial data provides information on the scale of the populations.

Changing fishing patterns in response to regulatory mandates makes it difficult to interpret the use of CPUE in the assessments. Industry was concerned about how assessments take into account changing fishery effort patterns in response to regulatory mandates. Reviewers have not accepted CPUE as a measure of abundance. Fishing industry wants to know if there is a baseline of effort expected, and if industry does not hit that, are they penalized in the assessment model. An analyst replied that their job is not to penalize fishermen for not achieving a baseline level; they are interested in population levels and harvest,. Vessel trip reports and dealer data are important sources for getting information on fishery removals, along with survey data to monitor population trends over time.

Industry felt their discard rates are low, and want to know how discard rates are applied since each sector has a different rate. Several said their rates are low, about 10%, while scientists see higher rates. Questions on what impact observers have on how the rates are applied to all trips, and what is the discard rate for the industry as a whole. An analyst noted there is variability from one sector to another, that it depends on gear types across many trips, and explained the discard estimate procedure and how it is applied.

Climate change needs to be factored into assessments. A study and evidence in the cold pool area regarding temperature related to recruitment success was extensively studied to explain yellowtail recruitment patterns in recent decades. Evidence that reduced suitable habitat may have contributed to low recruitment trends was not considered strong enough and required further research. Analyst noted that Stony Brook University is working with NEFC to look at this issue. Better information is needed.

Fishermen/the fishing industry wants to be more involved in the assessments. Fishermen don't come to these meetings because they are tired and frustrated with the process. They are fishing at about 25 percent capacity, perceive they have lost market share and wonder how/if they will get it back. They want to have more input to the assessments, suggest digging into the data from past side-by side tows (i.e. a dedicated Georges Bank yellowtail survey with industry to compare catches at different times of the year). They would like to know how to get more information to and from fishermen and scientists about what each is seeing. They feel their information is not being used in assessments and should be. Multiple offers were made extending an invitation to NEFSC scientists to come down to the boats to see them and talk in an informal way, face to face. An analyst noted that the meeting was a first step in bridging that gap.

Industry wants to know what they can do to help improve the situation. They mentioned they are providing a lot of information now and want to know what else they could do. An analyst stated the need for consistent, accurate vessel trip report data, that it has improved over time but could be better. The analysts noted the data is being used now and is the basis of any assessment, that their data is invaluable and is used with the survey data.

Retrospective patterns in models are biased toward lower estimates and are a concern. A question arose about how uncertainty from the government shutdown, Bigelow breakdowns, and other interruptions is incorporated in stock assessments since an analytical assessment can place certain weight on these factors. An analyst explained that the government shutdown did not affect the completion of the Bigelow survey, that not all stocks were affected by the Bigelow breakdowns but due diligence would be applied to understand the effects of a truncated survey, and these uncertainties would be presented or accounted for in a modeling context for the reviewers. The analyst explained how models are adjusted within confidence levels, that uncertainties will be flagged and carried forward in a systematic way to inform future benchmarks.

Potential Areas for Further Examination or Research

- Consider guidance from fishermen as to where the *Bigelow* could go (survey stations) at certain times of the year to get a more accurate view of where fish are and when
- Take fishermen and scientists out together on a one-day *Bigelow* survey to show how the nets and sensors work
- Find a way to turn industry observations into data that can inform assessments
- Create more face-to-face opportunities for fishermen and scientists to talk informally about what each is seeing
- Find ways to more effectively use cooperative research, such as comparison tows and other joint projects with industry, to bridge the gap between the fishing industry and assessment scientists

22.4 Industry statements

I begin my comment with an open invitation to Loretta O Brian and Mike Palmer to come out on a fishing trip with me anytime. in the past Steve Murawski and John Brodsiak made trips with me and found them enlightening.

My name is Mike Russo, I am the owner operator of the FV GULF VENTURE. The Gulf Venture Is a 40' gillnetter currently enrolled in the Trip Gillnet category. undoubtedly the smallest trip netter in New England. We make 3 to 5 day trips anywhere inside the US Canadian line.We fish between 48 to 96 nets daily depending on location and conditions. Soak times typically under 16 hrs.

I have been groundfishing as a crew and Captain for 30 years now,primarily with tub trawl and gillnet. Most of my experience is from fishing east of the Cape but in recent years have expanded my range thru out the Gulf of Maine and out to the Eastern area on GB.

After last year's GOM cod assessment and the subsequent quota reduction ,I had to bring my boat back to the Cape to fish on GB. There's more cod in the GOM than what nmfs says and the quota is very difficult to lease.Now we're going to be up against the same situation on GB.

This summer I've made 9 trips in the EGB and WGB stock sreas. In the eastern area I have no experience, I found cod in 25 to 30 fathom and had hauls over 10000lbs in one day. On my last trip there I fished in 100 to 110 fathom and found cod ,I left the because I was looking for pollock and hake. Day 2 and 3 of that same trip Was spent on Franklin Swell . By day 3 I had found fish and it was primarily cod in 90 to 100 fathoms. I made 3 more trips to Franklin and had good catches with 50% of the Catch being cod. In my past experience I've never had that kind of cull deeper than 65 fathom. Also my catch of cod has been averaging 25% large cod,the best %s being up to 50% in 95 fathom. That's an indication to me that there's some large cod around ,large cod tend to bounce off 6.5 in gear ,the ones you catch are usually rolled up in the net. Same trend I have been experiencing in the GOM . I feel the cod stock has shifted to the deep water in the WGB area. .Grey Seals,dogfish and water temps I believe are the biggest reasons.

If a 150 mt TAC were in place this year my wgb my landings would have accounted for close to 8% of the quota in 9 days. I can't stress enough that this is the SMALLEST boat currently groundfishing in New England In the trip gillnet catagory. I have been working without the benefit of a network on GB. I steam 18 hrs and not see another groundfish boat. I'm finding cod in various quantity everywhere I go beyond the inshore bottom off the Cape.

I do not believe the trawl survey is finding the fish in the deep water on GB and GOM. If the stock is so low ,why am I finding them from 25 to 110 fathom and over a wide geographic range? I will not accept the excuse that I'm seeing the last aggregation of cod .

However there are problems inside of 50 miles from the Cape .that's why I shifted offshore. The Grey seals And dogfish have destroyed the inshore fishing . I have little hope that I'll be able to catch a trip of cod within sight of the Cape for the rest of my career. Cutting the WGB cod quota will do nothing to solve those issues. It's not a problem caused by commercial fisherman and I feel we shouldn't be penalized for it.

sincerely

Michael A Russo

Michael A Russo