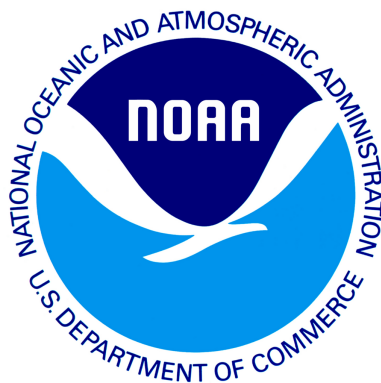


*draft working paper for peer review only*



**Pollock**

*2015 Assessment Update Report*

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

Compiled September 2015

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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 (dome-shaped survey selectivity) model and the flat sel (flat-topped survey selectivity) sensitivity model. The most recent benchmark assessment of the pollock stock was in 2010 as part of the 50<sup>th</sup> 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 1-2). Spawning stock biomass (SSB) in 2014 was estimated to be 198,847 (mt) under the base model and 57,327 (mt) under the flat sel sensitivity model (Table 1) which is 189 and 104% (respectively) of the biomass target, an  $SSB_{MSY}$  proxy of SSB at  $F_{40\%}$  (105,226 and 54,900 (mt); Figure 1). The 2014 age 5 to 7 average fishing mortality (F) was estimated to be 0.051 and 0.133 which is 18 and 53% of the overfishing threshold, an  $F_{MSY}$  proxy of  $F_{40\%}$  (0.277 and 0.252; Figure 2).

Table 1: 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. Model results are from the current base and flat sel models.

	2007	2008	2009	2010	2011	2012	2013	2014
	<i>Data</i>							
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
	<i>Model Results (base)</i>							
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 <i>age1</i>	23331	27177	15360	26638	34890	71958	41112	59953
	<i>Model Results (flat sel)</i>							
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 <i>age1</i>	11029	12879	7384	12954	17235	36001	20880	31234

Table 2: Comparison of biological reference points for pollock estimated in the 2014 assessment and from the current base and flat sel models. An  $F_{MSY}$  proxy of  $F_{40\%}$  was used for the overfishing threshold, and was based on long-term stochastic projections.  $F_{MSY}$  is reported as the age 5 to 7 average F. Recruits represent the median of the predicted recruits. Intervals shown are 5<sup>th</sup> and 95<sup>th</sup> percentiles.

	2014 base	2014 flat sel	base	flat sel
$F_{MSY}$	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
<i>Overfishing</i>	No	Yes	No	No
<i>Overfished</i>	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, maturity ogive, and mean weights at age used in projections are the most recent 5 year averages. Retrospective adjusted age 5 to 7 average F in 2014 (0.07) fell outside the 90% confidence intervals of the unadjusted 2014 value (0.035 to 0.066) under the base model (Figure 2). Retrospective adjusted SSB (32040 (mt)) and age 5 to 7 average F (0.233) in 2014 fell outside the 90% confidence intervals of the unadjusted 2014 values (37,243 to 77,410 (mt) and 0.084 to 0.182, respectively) under the flat sel sensitivity model (Figures 1-2). Therefore, retrospective adjustments were applied in the projections for the base model and the flat sel sensitivity model.

Table 3: Short term projections of median total fishery yield and spawning stock biomass for pollock 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)	$F_{AVG}$
		<i>base</i>			<i>flat sel</i>	
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 selectivity implies the existence of a large cryptic biomass that neither current surveys nor the fishery can confirm. Assuming flat-topped survey selectivity leads to lower estimates of SSB and higher estimates of  $F$  (Figures 1-2). Stock status is insensitive to the shape of the survey selectivity pattern at older ages.*

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major?

*The base model has a major retrospective pattern in  $F$ . Retrospective adjusted age 5 to 7 average  $F$  (Mohn's  $\rho = -0.276$ ) in 2014 fell outside the 90% confidence intervals of the unadjusted 2014 value. The flat sel sensitivity model has a major retrospective pattern in SSB and  $F$ . Retrospective adjusted SSB (Mohn's  $\rho = 0.789$ ) and age 5 to 7 average  $F$  (Mohn's  $\rho = -0.430$ ) in 2014 fell outside the 90% confidence intervals of the unadjusted 2014 values.*

- 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 1-2).*

- 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  $F_{MSY}$  (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.*

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

Northeast Fisheries Science Center. 2010. 50<sup>th</sup> Northeast Regional Stock Assessment Workshop (50<sup>th</sup> 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/>

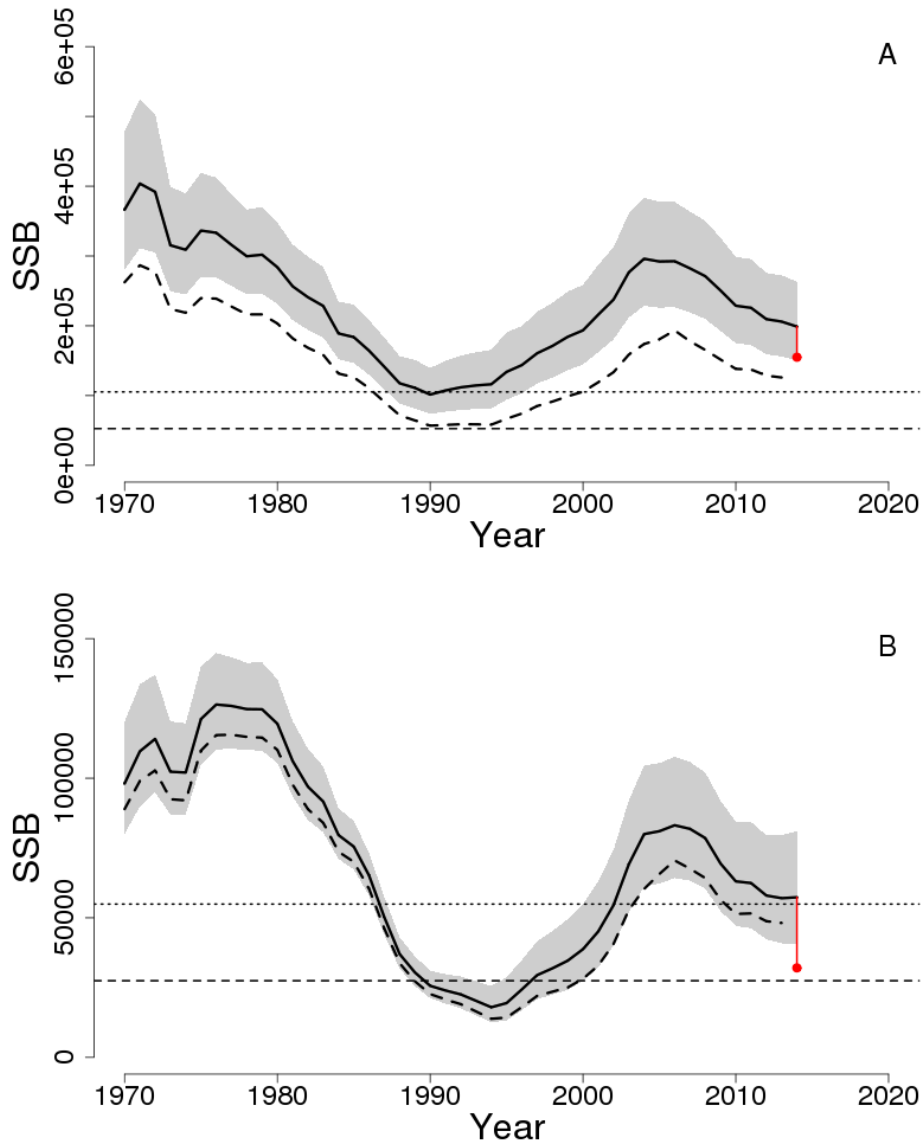


Figure 1: Estimated trends in the spawning stock biomass of pollock between 1970 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding  $SSB_{Threshold}$  ( $0.5 * SSB_{MSY}$ ; horizontal dashed line) as well as  $SSB_{Target}$  ( $SSB_{MSY}$ ; horizontal dotted line) based on the 2015 assessment models base (A) and flat sel (B). Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

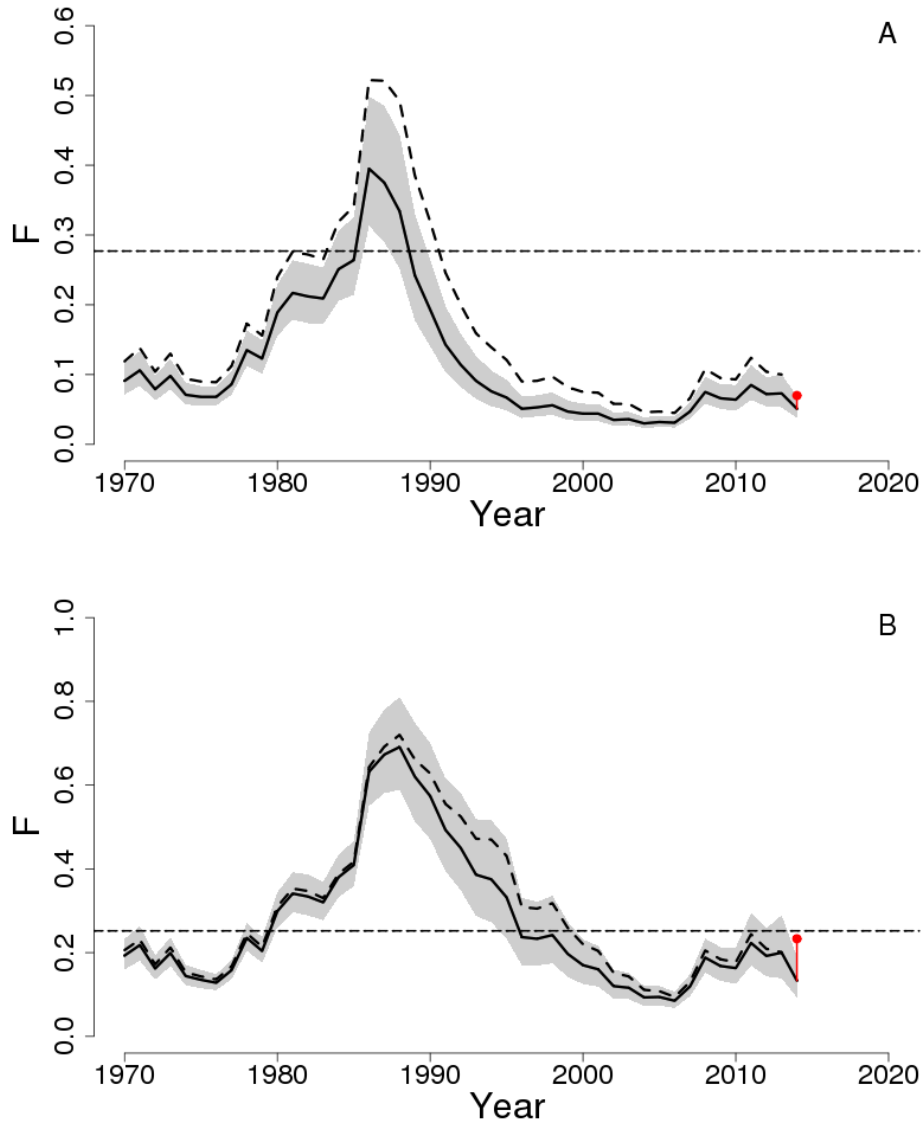


Figure 2: Estimated trends in age 5 to 7 average  $F$  ( $F_{AVG}$ ) of pollock between 1970 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding  $F_{Threshold}$  ( $F_{MSY}$ ; dashed line) based on the 2015 assessment models base (A) and flat sel (B).  $F_{AVG}$  was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

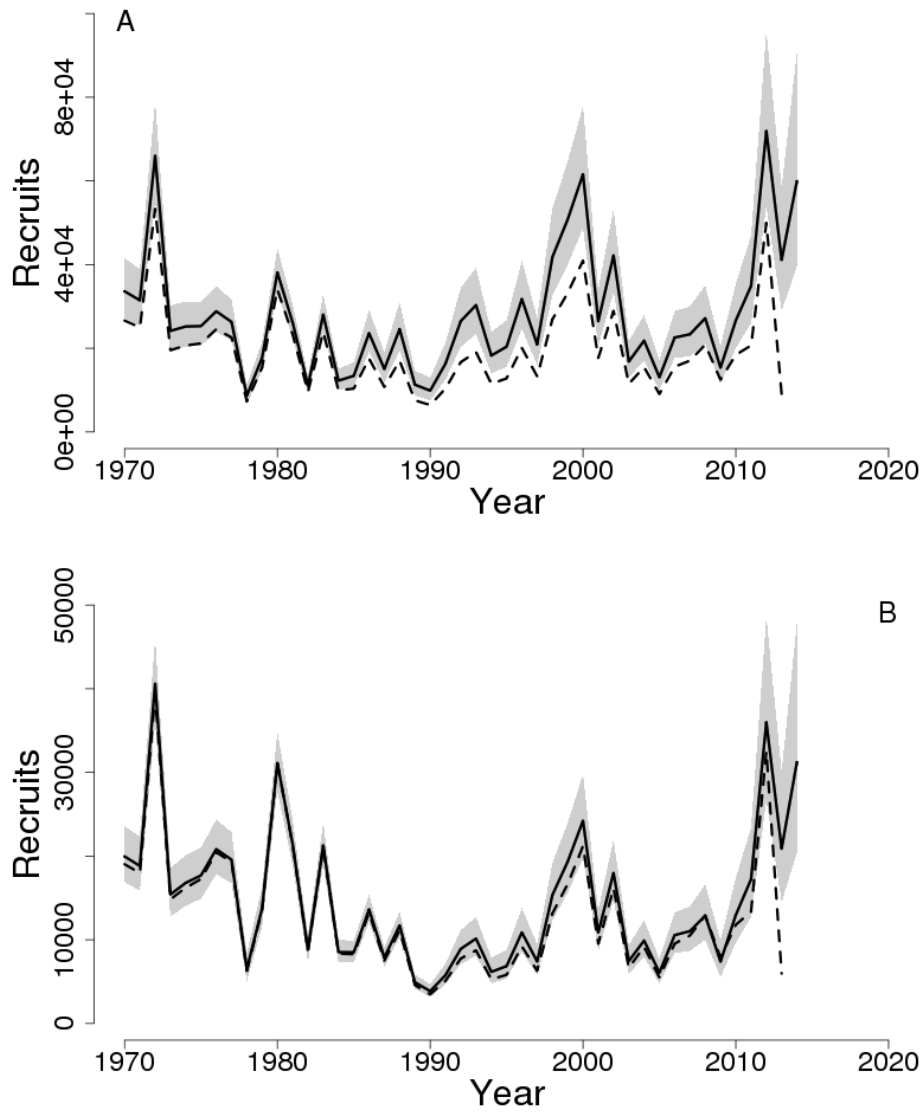


Figure 3: Estimated trends in age 1 recruitment (000s) of pollock between 1970 and 2014 from the current (solid line) and previous (dashed line) assessment for the assessment models base (A) and flat sel (B). The approximate 90% lognormal confidence intervals are shown.



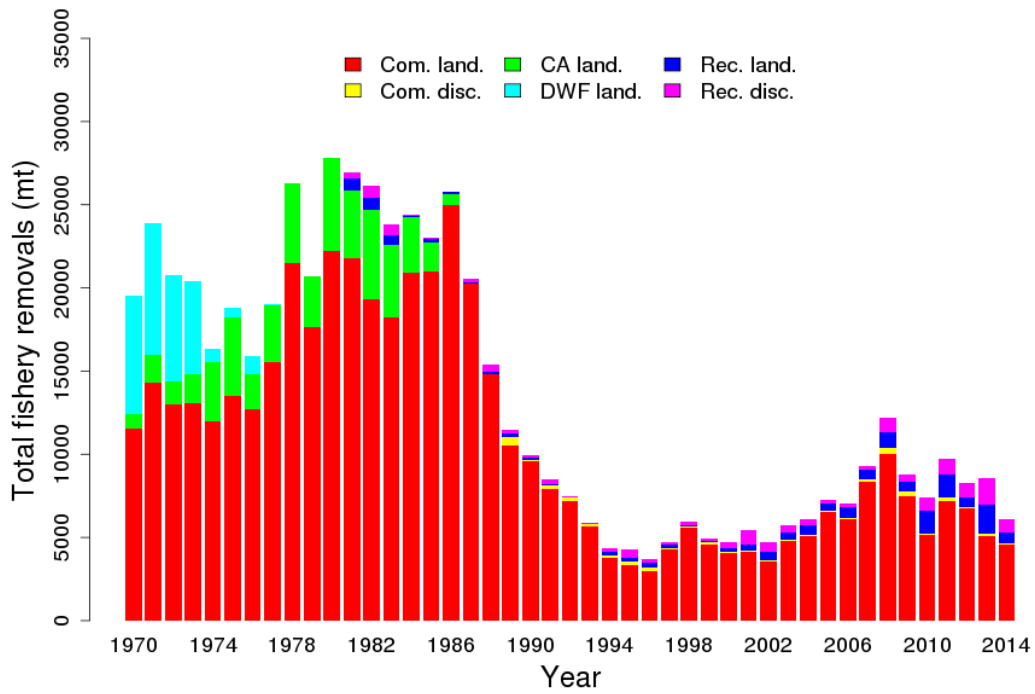


Figure 4: Total catch of pollock between 1970 and 2014 by fleet (commercial, Canadian, distant water fleet, and recreational) and disposition (landings and discards).

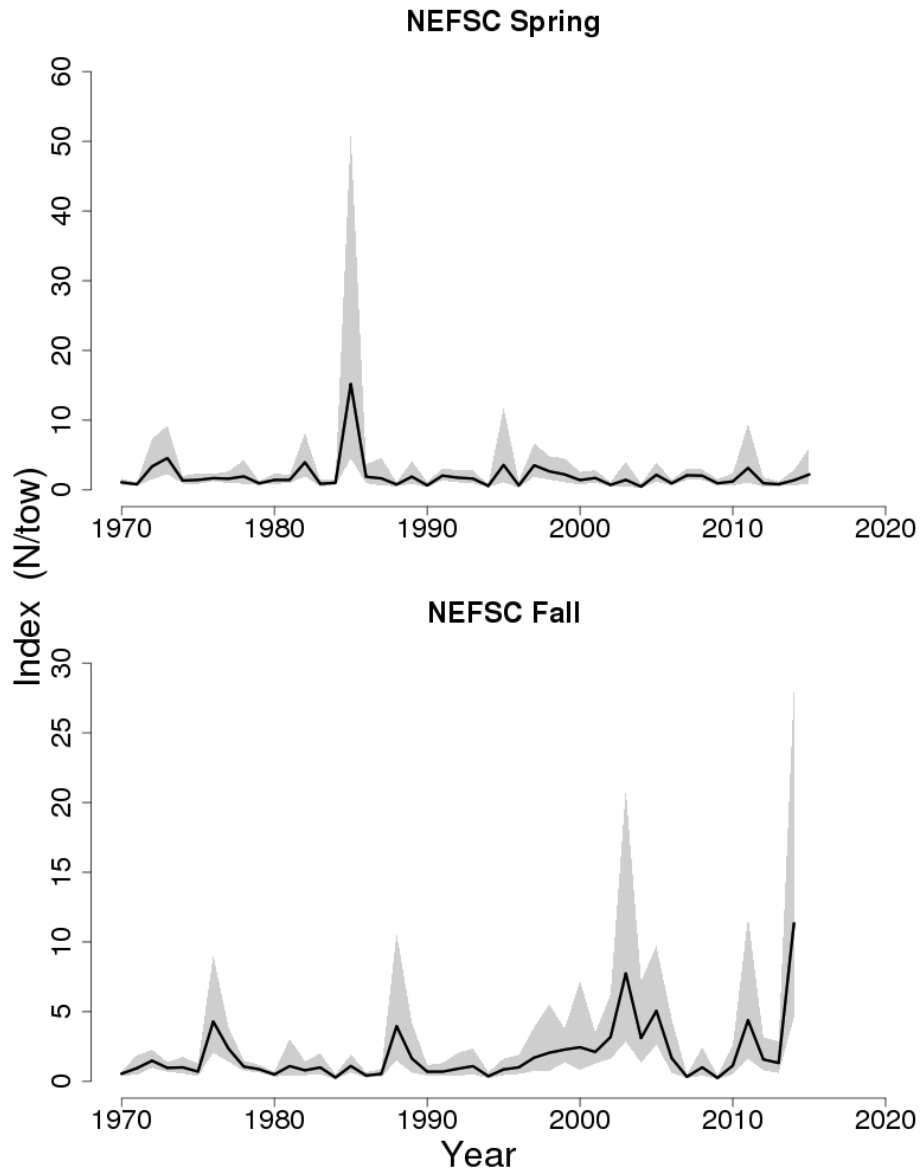


Figure 5: Indices of biomass for pollock between 1970 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.