5. Assessment of the Greenland turbot stock in the Bering Sea and Aleutian Islands

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Executive Summary

The assessment of Bering Sea and Aleutian Islands (BSAI) Greenland turbot has been moved to a biennial schedule according to the stock assessment prioritization schedule. A partial assessment was done for BSAI Greenland turbot this year. In partial assessment years, an executive summary is presented with recommendations of harvest levels for the next two years. The 2016 full assessment is available online at https://www.afsc.noaa.gov/REFM/Docs/2016/BSAIturbot.pdf. The next full assessment will be conducted in 2018. Updated assessment and projection model results will be presented in next year's SAFE report.

A statistical age-structured model was configured in Stock Synthesis 3 (Methot and Wetzel, 2013) and was used as the primary stock assessment tool for BSAI Greenland turbot, which qualifies as a Tier 3 stock. This assessment consists of a population model to generate historical time series of population estimates and a projection model to predict future population estimates and recommended harvest levels. The data sets used in this assessment included fishery catch data (trawl and longline), survey biomasses from the Eastern Bering Sea shelf and slope surveys and the Auke Bay Laboratory's longline survey, length composition data from the trawl and longline fisheries and the shelf and slope surveys, and mean-size-at-age data from the shelf survey.

For a partial assessment year, we do not re-run the assessment model, but update the projection model with the new catch data. This report incorporates the most current catch information without re-estimating model parameters and biological reference points.

Summary of changes in the assessment inputs

There were no changes made to the assessment model inputs since this was an off-cycle year.

New data added to the projection model included a new estimate of the 2016 catch and estimated catch for 2017 and 2018. The 2016 catch data were updated from 2,186t to 2,238 t. Partial 2017 catch data were also available for the projections. Projected catch to the end of 2017 was determined as the product of the 2017 TAC (4,500 t) and the average fraction of the TAC captured from the past two years (81.1%). The projected 2017 catch was set equal to 3,649.7 t and was lower than the value specified in last year's projections (7,000 t). The 2018 catch value was set equal to 7,000 t rather than assuming catch would be equal to maximum permissible ABC. This follows the catch setting method used for the 2016 projections.

The ABC was apportioned between the Eastern Bering Sea (EBS) and the Aleutian Islands following the methods used in 2016. Based on eastern Bering Sea slope survey estimates and Aleutian Islands surveys, the proportions of the adult biomass in the Aleutian Islands region over the past four surveys (when both areas were covered) were 22.4%, 10.7%, 8.3% and 9.6%. The average 12.7% was applied to the BSAI ABC to apportion the ABC between the EBS and the Aleutian Islands.

Summary of results

Reference values are for BSAI Greenland turbot are summarized in the following table with the recommended ABC and OFL values for 2018 in bold.

Quantity	As estimated or *specified last* year for: 2017	2018	As estimated or *recommended this* year* for: 2018	2019
M (natural mortality rate)	0.112	0.112	0.112	0.112
Tier	3a	3a	3a	3a
Projected total (age 1+)	121,804	122,032	126,417	127,021
Female spawning biomass	50,461	55,347	58,035	61,878
Projected				
$B_{100\%}$	103,097	103,097	103,097	103,097
$B_{40\%}$	41,239	41,239	41,239	41,239
$B_{35\%}$	36,084	36,084	36,084	36,084
F_{OFL}	0.29^{+}	0.29^{+}	0.22	0.22
$maxF_{ABC}$	0.18	0.18	0.18	0.18
F_{ABC}	0.13	0.18	0.18	0.18
OFL (t)	11,615	12,831	**13,148**	13,540
maxABC (t)	9,825	10,864	11,132	11,473
ABC (t)	6,644**	10,864**	11,132	11,473
EBS	5,800	9,484	9,718	10,016
Aleutian Islands	884	1,380	1,414	1,457
Status	As determined *this* year for: 2015	2016	As determined *this* year for: 2016	2017
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No

**Based* on Model 16.4 in the 2016 BSAI Greenland turbot assessment. $^{+}$ This was a typo in the 2016 assessment report and should have been 0.22. **ABC specified by the SSC; the 2016 assessment author recommended a 7,000 t ABC. Plan team recommended the ABC should be set equal to the maxABC for 2018 and 2019.

This year's projections resulted in an increase in projected 2018 total biomass and spawning biomass, while $B_{100\%}$, $B_{40\%}$, $B_{35\%}$, F_{OFL}, and max F_{ABC} remained the same. This in turn resulted in an increase in 2018 OFL and maxABC. The 2017 catch input in last year's projections was equal to 7,000 t and was reduced to 3,649.7 t leading to the increase.

The recommended 2018 maximum permissible ABC from the updated projection model is 11,132 t. The ABC for Greenland turbot has been set below the maximum permissible estimates in recent years due to concerns about stock structure uncertainty and a lack of recruitment. For example, in 2016 the 2017 maximum permissible ABC (maxABC) was 9,825 t, the author recommended ABC was 7000 t (, and the SSC set the 2017 Greenland turbot ABC to 6,644 t. The SSC's decision was determined as such, "As has been the SSC's practice in the past to address conservation concerns and uncertainties, the SSC recommends a stair-stepped approach to maxABC over the next two years. For 2017, the SSC recommends stepping halfway from the ABC (3,462 t) for 2016 and the maxABC (9,825 t) for 2017. This results in an ABC of 6,644 t for 2017 and 10,864 t (unchanged maxABC) for 2018.". Given that the concerns about continued low recruitment due to warmer ocean conditions have not been alleviated, the authors recommend an ABC of 7,000 t, which is lower than maximum permissible ABC. The Plan Team recommended that the ABC be set equal to the maximum permissible ABC.

The stock is not being subject to overfishing, is not currently overfished, nor is it approaching a condition of being overfished. The tests for evaluating these three statements on status determination require examining the official total catch from the most recent complete year and the current model projections of

spawning biomass relative to $B_{35\%}$. The official total catch for 2016 is 2,238 t which is less than the 2016 OFL of 4,194 t; therefore, the stock is not being subjected to overfishing. The estimates of spawning biomass for 2017 and 2018 from the current year (2017) projection model are 58,035 t and 61,878 t, respectively. Both estimates are above the estimate of $B_{35\%}$ (36,084 t), therefore, the stock is not currently overfished.

Survey trends

The Greenland turbot assessment uses three survey indices; the EBS shelf survey, the EBS slope survey, and the ABL longline survey (Figures 1-3). New data points exist for the EBS shelf survey and the ABL longline survey. The EBS shelf survey biomass estimates declined by 4% after 2016. Conversely the ABL longline survey biomass estimate increased by 132% since 2016 (12,249 t in 2016 and 28,460 t in 2017). The EBS slope survey was not conducted in 2017.

Catch-biomass ratios

A time-series of catch, total biomass, and the catch-biomass ratio are presented in Table 1 and Figure 4. Total biomass increased between 1964 and 1973, generally declined between 1973 and 2010, and has modestly increased since 2011. Catch was more variable over time than total biomass and has been at low levels since 1986. The mean catch-biomass ratio between 1960 and 1983 was approximately 0.09. The mean ratio between 1984 and 2017 was 0.04.

Summaries for Plan Team

Species	Year	Biomass (t)	OFL (t)	ABC (t)	TAC (t)	Catch (t)
Greenland turbot	2015	108,399	3,903	3,172	2,648	2,204
	2016	117,671	4,194	3,462	2,837	2,238
	2017	121,760	11,615	6,644	4,500	3650^{+}
	2018	126,417	13,148	11,132*		

* Reflects the Plan Team's decision. $^{+}$ projected catch to the end of 2017.

Responses to SSC and Plan Team Comments on Assessments in General

In this section, we list new or outstanding comments on assessments in general from the last full assessment in 2016. Since this is an off-cycle year we only respond to priority comments in the executive summary. We will respond to remaining and future comments in the next full assessment.

"*The SSC supports the PT recommendations for the assessment authors to: 1. Explore the consistency of time blocks across surveys, 2. Complete a stock structure template, 3. Explore the use of age composition data in the model, and 4. Contact Auke Bay Laboratory survey staff about getting sex-specific lengths collected during future surveys."*

These recommendations will be addressed during the next assessment cycle.

Literature Cited

Methot, R., Wetzel, C. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research 142: 86-99.

Tables

Table 1. Time series of catch and biomass in tons and exploitation rate (F=C/B).

Year	Catch	Biomass	F	Year	Catch	Biomass	F
1960	27632	297969	0.09	2000	6974.39	124808	0.06
1961	43011	279059	0.15	2001	5312.43	110722	0.05
1962	43670	244270	0.18	2002	3635.54	99510	0.04
1963	23679	210540	0.11	2003	3111.44	91593.1	0.03
1964	25675	204343	0.13	2004	2258.75	85626.6	0.03
1965	7535	211649	0.04	2005	2608.06	81533.1	0.03
1966	9829	263044	0.04	2006	1989.31	77519	0.03
1967	18197	341600	0.05	2007	2004.18	74333.7	0.03
1968	26584	432434	0.06	2008	2911.18	71293.4	0.04
1969	27193	521194	0.05	2009	4514.69	68243.1	0.07
1970	19976	603596	0.03	2010	4123.03	66197.3	0.06
1971	42214	680673	0.06	2011	3668.15	68773	0.05
1972	77384	717632	0.11	2012	4715.70	75910.9	0.06
1973	63946	697595	0.09	2013	1741.88	84526	0.02
1974	78442	672438	0.12	2014	1655.69	96830.1	0.02
1975	67789	618718	0.11	2015	2203.53	108399	0.02
1976	62590	569068	0.11	2016	2238.30	117671	0.02
1977	30161	526159	0.06	2017	3649.72	121760	0.03
1978	42189	524819	0.08				
1979	41409	519434	0.08				
1980	52552	518606	0.10				
1981	57321	504094	0.11				
1982	52122	477165	0.11				
1983	47558	445485	0.11				
1984	23120	408702	0.06				
1985	14731	389377	0.04				
1986	9864	373056	0.03				
1987	9585	357813	0.03				
1988	7108	340305	0.02				
1989	8822	323640	0.03				
1990	12696	303638	0.04				
1991	7863.36	278867	0.03				
1992	3752.35	260042	0.01				
1993	8469.59	246344	0.03				
1994	10272.33	227834	0.05				
1995	8194.25	206921	0.04				
1996	6555.85	188566	0.03				
1997	7199.74	172359	0.04				
1998	8757.33	155960	0.06				
1999	5852.69	138581	0.04				

Figures

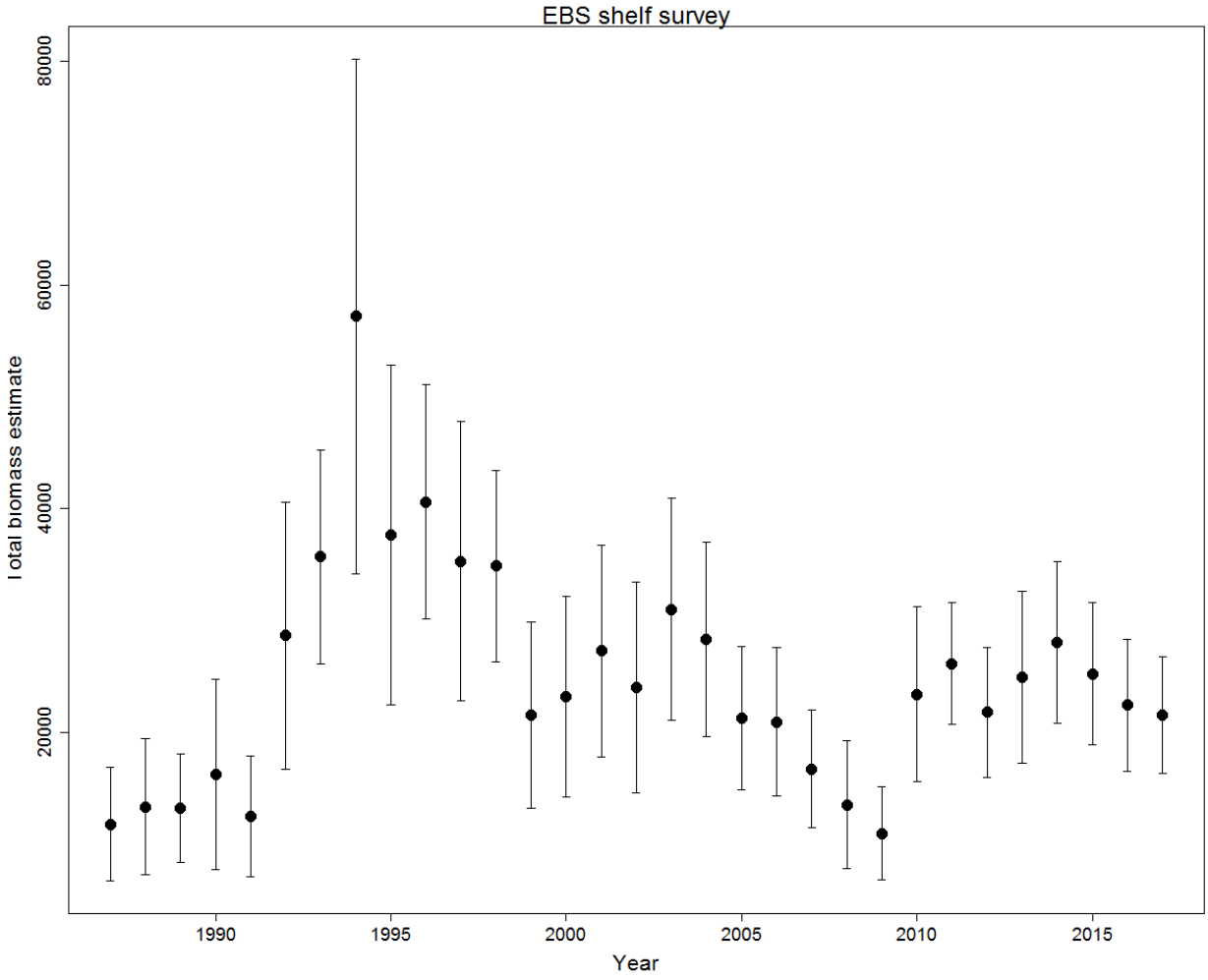


Figure 1. The Eastern Bering Sea shelf survey biomass estimates (1987-2017).

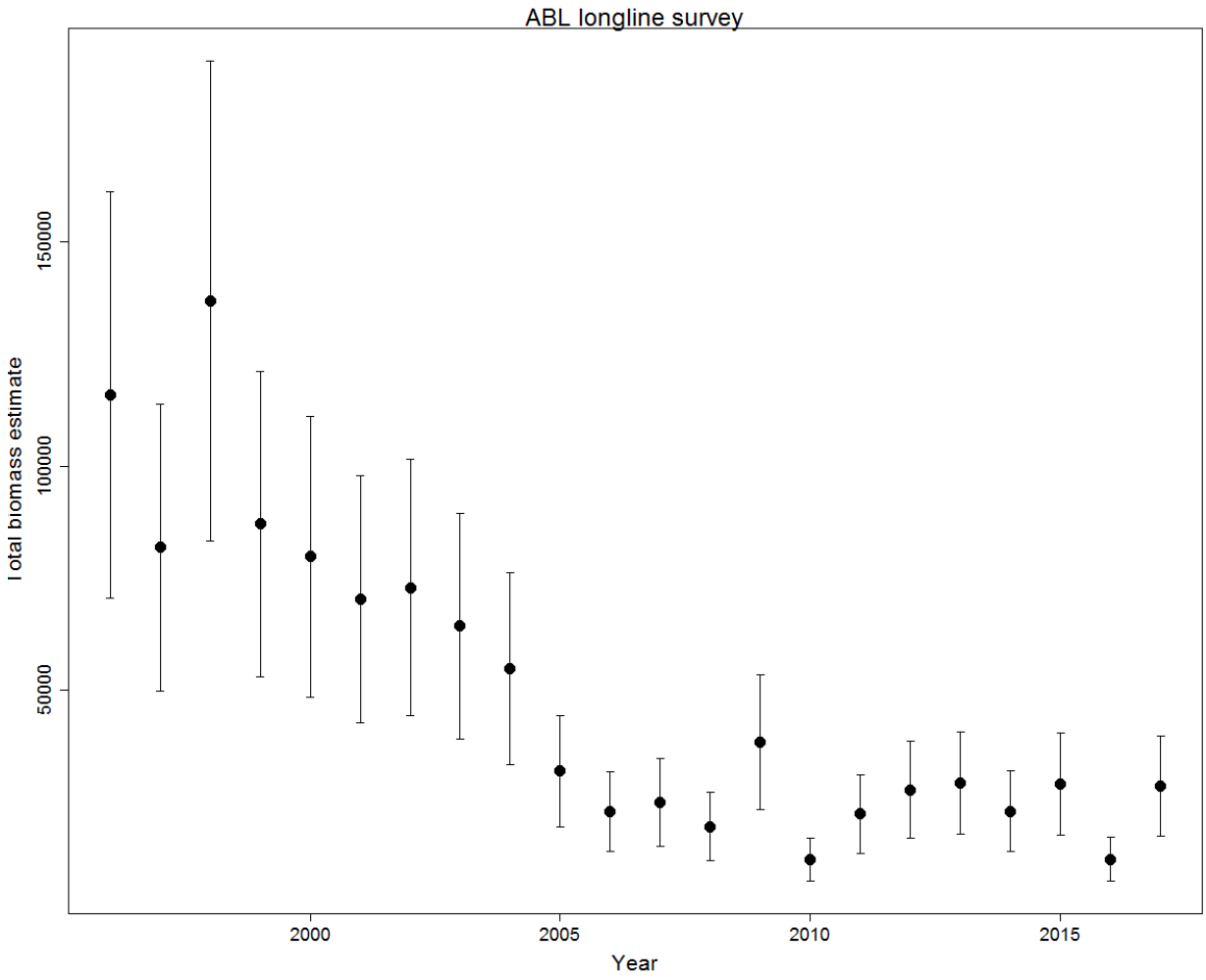


Figure 2. The Auke Bay Laboratory longline survey total biomass estimates (1996-2017).

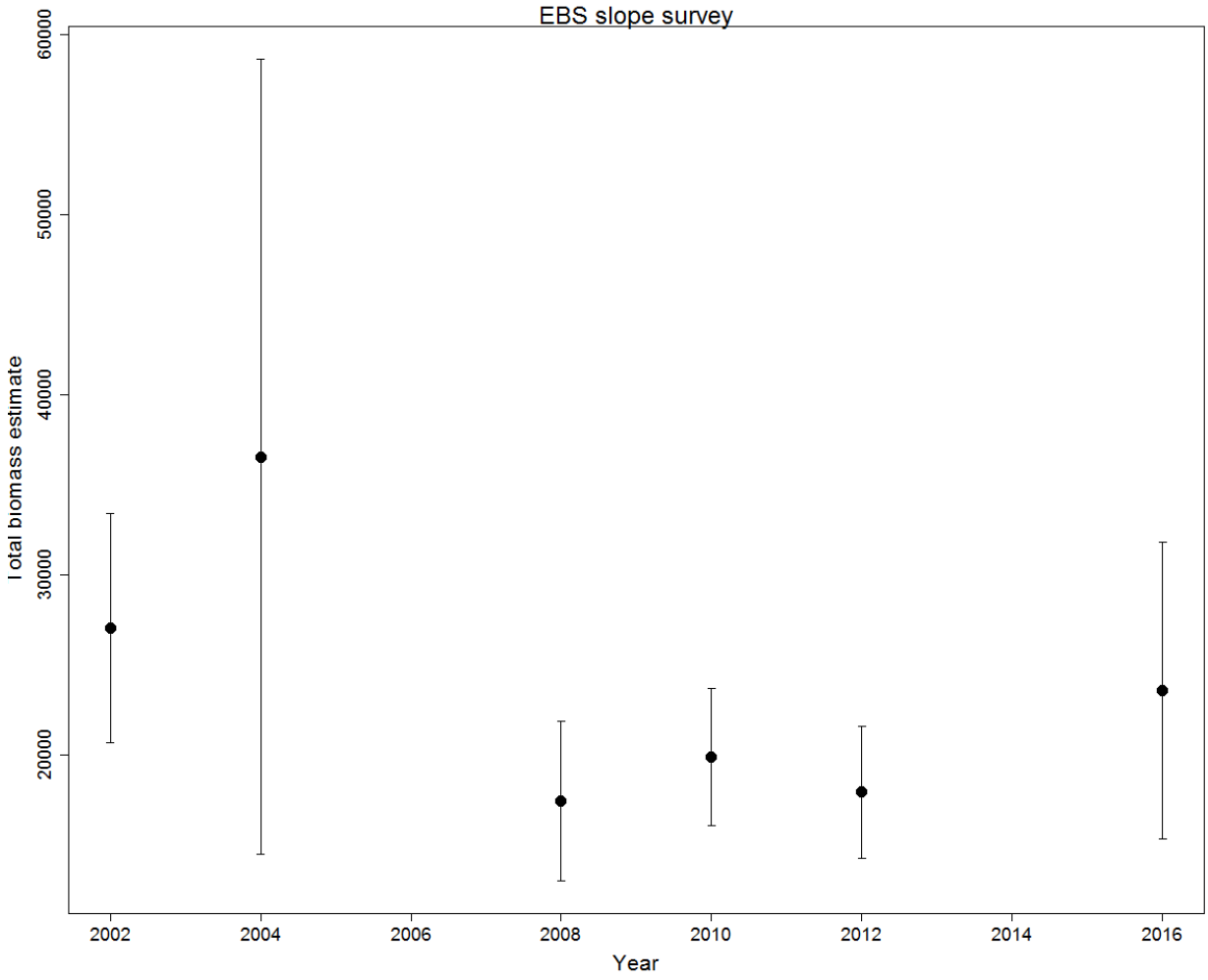
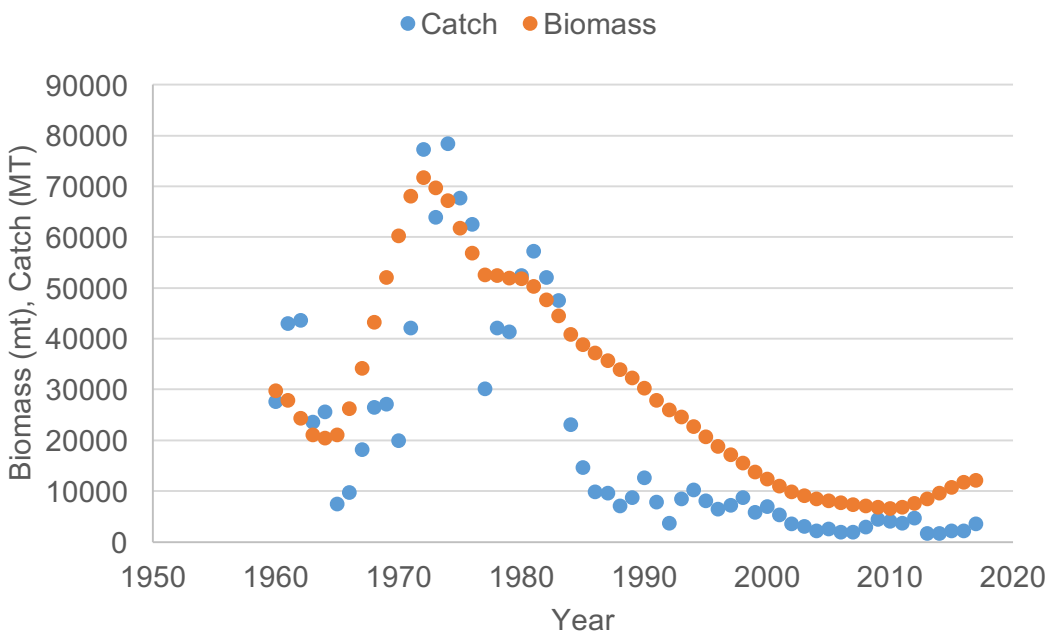


Figure 3. The Eastern Bering Sea slope survey biomass estimates (2002, 2004, 2008, 2010, 2012, 2016).

a)



b)

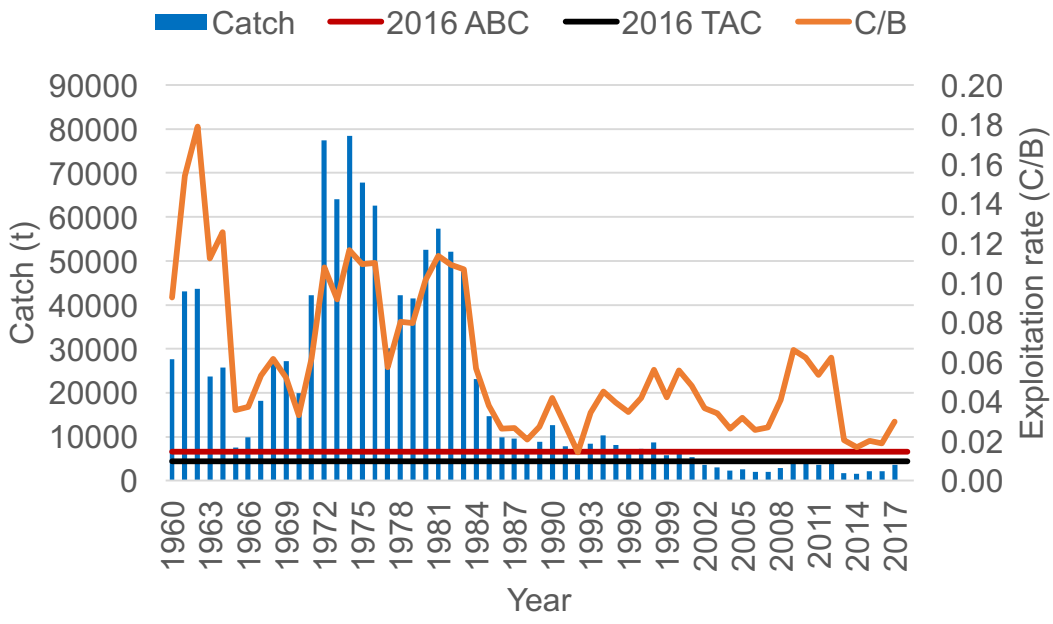


Figure 4. Time series of a) total biomass (10s of tons), catch (tons), and b) the catch-biomass ratio and from 1960 – 2017 and the 2016 ABC and TAC.