Preliminary assessment of Pacific cod in the ~~Eastern~~ Bering Sea

NOAA FISHERIES
Alaska Fisheries Science Center

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September 20, 2018

Caveats

- Lots of models, some of which are very complicated, and most of which use different data sets
  - I will probably make mistakes during the presentation
- Not many figures
  - Too many lines makes it hard to see differences
  - Ran out of time
- Lots of tables, many of which are too large to read on screen
  - Figure and table numbers will be shown on respective slides
  - Look at the document for values, screen for trends (color scale)
- In order to leave time for discussion, not all features will be described
  - E.g., iterative tuning procedures (see document)
  - Some tables will be abbreviated, or skipped entirely

Team and SSC comments

Comments on assessments in general (1 of 5)

- *SSC1: "The SSC recommends that, for those sets of environmental and fisheries observations that support the inference of an impending severe decline in stock biomass, the issue of concern be brought to the SSC, with an integrated analysis of the indices in future stock assessment cycles. To be of greatest value, to the extent possible, this information should be presented at the October Council meeting...."*
- The Team/AFSC plan for responding to this request begins:
  - "No later than the summer of each year, the lead author of each assessment should review the previous year's ESR and determine whether any factor or set of factors described in that ESR implies an impending severe decline in stock/complex biomass, where "severe decline" means a decline of at least 20% (or any alternative value that may be established by the SSC)...."
  - See "Ecosystem considerations" section for response

Comments on assessments in general (2 of 5)

- *SSC2: "The SSC also recommends explicit consideration and documentation of ecosystem and stock assessment status for each stock ...."*
- This recommendation was subsequently clarified in the minutes of the 12/17 and 6/18 SSC meetings, resulting in the following revised request:
  - *"The SSC retracts its previous request for development of an ecosystem status for each stock/complex. Instead, while considering ecosystem status report information, it may be useful to attempt to develop thresholds for action concerning broad-scale ecosystem changes that are likely to impact multiple stocks/complexes.*
  - *Implementation of these stock and ecosystem determinations will be an iterative process and will require a dialogue between the stock assessment authors, Plan Teams, ecosystem modelers, ESR editors, and the SSC."*
- This request will be addressed upon conclusion of the iterative process

Comments on assessments in general (3 of 5)

- *SSC3: "The SSC reminds authors of the need to balance the desire to improve model fit with increased risk of model misspecification."*
- This recommendation was subsequently clarified in the minutes of the 6/18 SSC meeting as follows:
  - *"In the absence of strict objective guidelines, the SSC recommends that thorough documentation of model evaluation and the logical basis for changes in model complexity be provided in all cases."*
- Model evaluation is documented thoroughly
- In conformity with past practice, this preliminary assessment does not contain a recommendation for a final model, so there are as yet no "changes" in model complexity
- If a more complex model (relative to the current base model) is recommended in the final draft of this assessment, the logical basis for the changes in model complexity will be provided

Comments on assessments in general (4 of 5)

- *SSC4: "Report a consistent metric (or set of metrics) to describe fish condition among assessments and ecosystem documents where possible."*
- The authors of all assessments that reported fish condition in the respective 2017 SAFE report chapters, along with ESR editors and the authors of the groundfish condition sections of the BSAI and GOA ESRs, discussed this recommendation and agreed to adopt the "weight-length residual" method currently used in the ESRs as the standard method
- The index of fish condition used in this preliminary assessment was the same as that reported in last year's BSAI ESR

Comments on assessments in general (5 of 5)

- *SSC5: "Projections ... clearly illustrate the lack of uncertainty propagation in the 'proj' program used by assessment authors. The SSC encourages authors to investigate alternative methods for projection that incorporate uncertainty in model parameters in addition to recruitment deviations.... A two-stage approach that first includes a projection using F to find the catch associated with that F and then a second projection using that fixed catch may produce differing results that may warrant consideration."*
- The Team/AFSC plan for this request includes the following step:
  - "Notify assessment authors that, for the purpose of the standard projection scenarios, the previous requirements for use of the standard Tier 3 projection model and measurement of spawning biomass at the time of peak spawning no longer apply, thereby enabling authors to use SS or other software to make the projections"
- The above should make it possible to respond to this request in Nov.

Comments specific to this assessment (1 of 7)

- *BPT1: "The Team recommends making a direct comparison between the EBS trawl survey length compositions and the NBS survey length compositions for 2010 and 2017, within each year. The NBS survey showed different length compositions between 2010 and 2017, and this comparison would provide a better understanding of the relationship between the stocks in the two areas."*
- This comparison is presented in the "Data" section, under "Northern Bering Sea survey" (see also Figure 2.1.1)
- *BPT2: "The Team recommends presenting in the next assessment document, the fishery CPUE for each of the separate sectors (pot, trawl, longline), as has been done in the past. This information would be useful to compare to estimated trends from the assessment."*
- The requested data will be presented in the final draft

Comments specific to this assessment (2 of 7)

- *BPT3: "The Team recommends reporting the fishery CPUE by area in the NBS areas to provide a context for the genetics proposal. A better understanding of the fishery CPUE in the northern areas would provide insight into population trends in these areas that would supplement the occasional surveys in those areas. The Team leaves it up to the analyst to determine the areas based on personal preference and data availability."*
- The requested data are reported in the "Data" section, under "Northern Bering Sea fishery catch per unit effort"

Comments specific to this assessment (3 of 7)

- *BPT4: "The Team recommends investigating the utility of dropping the first five years in the EBS shelf survey (starting the series in 1987) and thus allowing for the incorporation of the northwest strata (areas 82 and 90) into the survey index time-series. The Pacific cod abundance has potentially increased in the northwest strata, these areas are becoming more important to the fishery, and this change may provide an improved index of abundance for Pacific cod."*
- A model incorporating this suggestion has been included in this preliminary assessment, as described under "Model structures."

Comments specific to this assessment (4 of 7)

- *BPT5: "The Team recommends funding the genetics proposal presented by Ingrid Spies as soon as possible. This proposal will answer questions related to the genetic relationship of Pacific cod caught in the NBS relative to other areas. In addition, the Team would like to understand how the results of this study may affect the assessment and management paradigm, and assumptions of spawning connectivity (or lack thereof) between EBS and NBS Pacific cod."*
- This preliminary assessment only begins to answer the question of how the results of the genetic study may affect the subjects listed above
- *BPT6: "The Team recommends that models 17.2 and 17.6 remain as candidate model structures for continuing to understand the relationships between data and model choices. Models 16.6, 17.2, and 17.6 are structurally different models that represent a range of model uncertainty."*
- Models 17.2 and 17.6 are included here

Comments specific to this assessment (5 of 7)

- *BPT7: "The Team recommends continuing an investigation of why the various models show very different results. This could be accomplished by looking at the effect of model outputs when including individual features (expanding on the evaluation of effects presented).... The effect can be measured with the average difference in spawning biomass, the relative change in the 2016 spawning biomass (not absolute value), the change in the estimate of natural mortality (M), and the unfished equilibrium biomass ($B_{100\%}$). Additionally, and if possible, a look at Mohn's rho for some of the features (at the author's discretion) would be helpful to understand which features affect the retrospective behavior."*
- Average difference in spawning biomass, projected spawning biomass, natural mortality, unfished equilibrium biomass, and Mohn's ρ are presented for all models (see especially Table 2.1.10)
- In addition, a bridging analysis between Models 17.2 and 17.6 is provided in the attachment

Comments specific to this assessment (6 of 7)

- *SSC6: "The SSC has encouraged the additional work on model averaging conducted during 2017, and the author and Plan Teams have made good progress on the topic, even if neither are ready to move forward with it. Remaining concerns include clearly identifying criteria for including models in an ensemble, specifically delineating between alternative plausible hypotheses and sensitivity analyses (which should not be included), as well as continued exploration of specific methods for calculating averaged results. The SSC supports the Plan Team's recommendation to conduct a spring workshop to address these and other issues which would not be limited to just Pacific cod."*
- Once any recommendations resulting from that workshop, or modifications or additions thereto, have been officially adopted, they will be incorporated into the assessment
- In the meantime, this preliminary assessment continues the exploration of specific methods for calculating averaged results

Comments specific to this assessment (7 of 7)

- *SSC7: "Discontinue work on development of empirical weight at age; analysis to date suggests that this may not be a fruitful avenue given data available."*
- Development of empirical weight at age has been discontinued
- *SSC8: "The SSC disagreed with the Plan Team's recommendation to drop the first 5 years of EBS trawl data in order to use the NW strata. Instead it encourages treatment of these data by allowing catchability to change after the first 5 years of the EBS survey in the model, or through geostatistical modelling approaches."*
- A model incorporating this suggestion has been included

Data

2010 and 2011 fishery agecomps

- For the 2010 collection, 411 previously aged otoliths were selected for use, and 589 new otoliths were requested (total = 1000)
- For the 2011 collection, 499 previously aged otoliths were selected for use, and 541 new otoliths were requested (total = 1040)

Year	N	2	3	4	5	6	7	8	9	10	11	12+
2010	6514	0.0145	0.1266	0.4027	0.1993	0.1086	0.0666	0.0556	0.0209	0.0024	0.0019	0.0009
2011	8804	0.0090	0.1777	0.2453	0.3657	0.1247	0.0441	0.0151	0.0109	0.0054	0.0010	0.0011

- The fishery age composition data for 2012 and 2017 are scheduled to be available in time for use in the final draft of this year's assessment
- This will provide a time series stretching from 2010-2017

Partitions in the EBS survey time series (1 of 2)

- The “standard” area covered by the EBS shelf bottom trawl survey was established in 1982
- In 1987, two northwestern strata (82 and 90) were added to the standard area, resulting in an “expanded” survey area that has been covered annually ever since
- Because relatively few Pacific cod were typically found in the two northwestern strata (biomass in the expanded area was 3.2% higher than in the standard area on average over the 1987-2017 time series, while abundance was 2.2% higher on average), and because including data from both survey areas would likely require estimating two catchability coefficients, two sets of selectivity parameters, or both, the EBS Pacific cod assessment has always used data from the standard area only
- However, at the request of the Team and SSC, this preliminary assessment includes two models that include the data from the expanded area

Partitions in the EBS survey time series (2 of 2)

- Another partition in the EBS survey time series that will need to be addressed at some point is the switch from length-stratified to random sampling of otoliths
- Samples were collected using a length-stratified design exclusively through 2014, then both random and stratified samples were collected in 2015 and 2016, and a random design has been in use exclusively since 2017
- This issue was discussed during the June 2017 of the BSAI Team's subcommittee on Pacific cod models, but not included in any of the subcommittee's requested models

EBS survey area index comparison (T2.1.1)

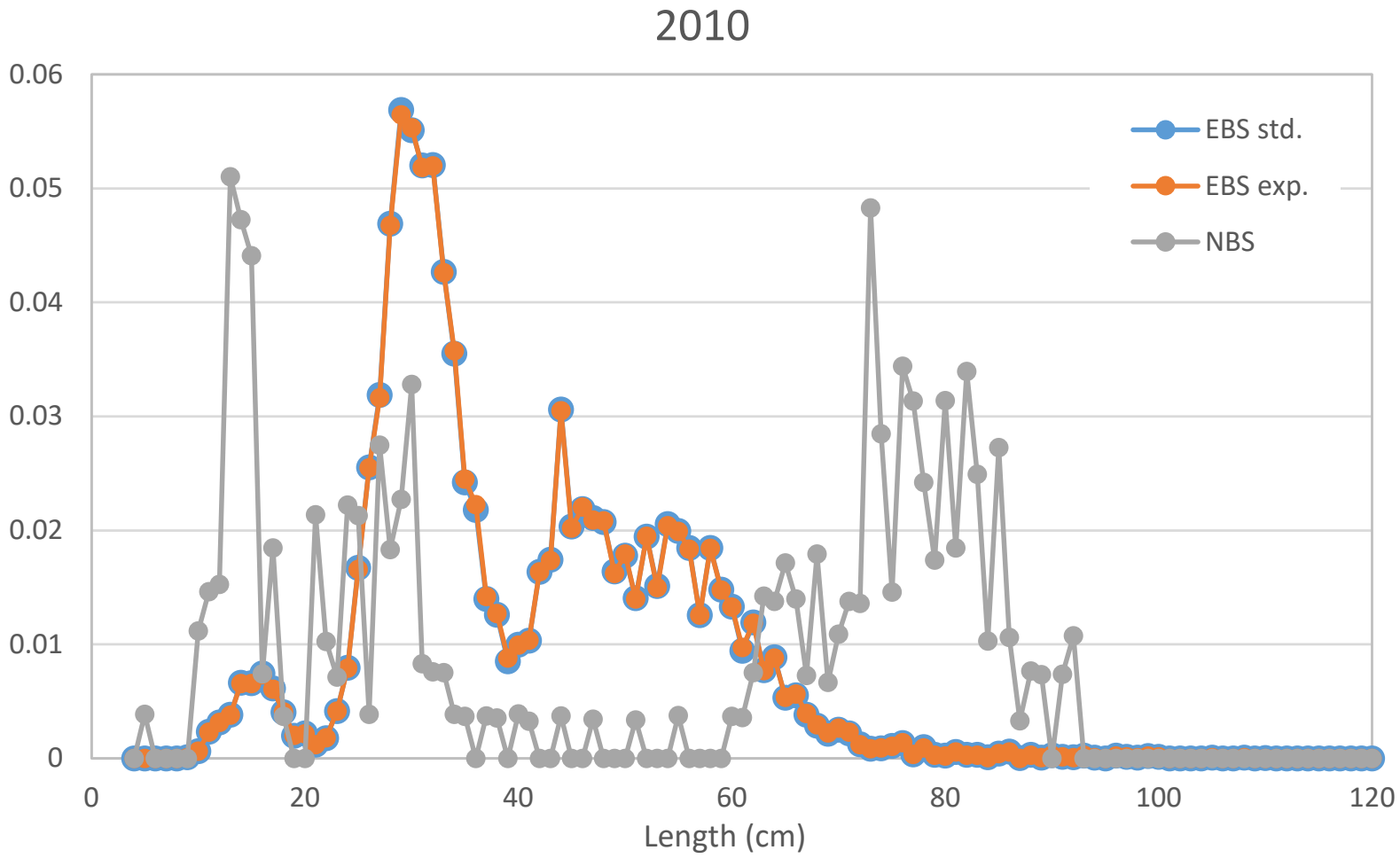
	Standard area				Expanded area			
	Biomass		Abundance		Biomass		Abundance	
Year	Estimate	Sigma	Estimate	Sigma	Estimate	Sigma	Estimate	Sigma
1987	1,027,518	0.062	677,054	0.065	1,064,600	0.060	697,075	0.064
1988	960,962	0.080	507,560	0.070	976,152	0.079	512,095	0.069
1989	833,473	0.075	292,247	0.068	868,804	0.072	301,748	0.066
1990	691,256	0.074	423,835	0.086	728,996	0.072	438,107	0.084
1991	514,407	0.074	488,892	0.104	530,488	0.072	496,765	0.103
1992	529,049	0.084	577,560	0.118	538,862	0.083	585,436	0.117
1993	663,308	0.080	810,608	0.122	669,305	0.079	814,187	0.121
1994	1,360,790	0.181	1,232,175	0.123	1,377,095	0.178	1,255,544	0.121
1995	1,002,961	0.091	757,910	0.099	1,008,293	0.091	761,681	0.099
1996	889,366	0.098	607,198	0.145	909,133	0.096	614,493	0.143
1997	604,439	0.112	485,643	0.145	627,151	0.109	493,660	0.143
1998	534,150	0.080	514,339	0.091	550,504	0.078	522,586	0.090
1999	569,765	0.087	488,337	0.093	618,679	0.091	542,229	0.100
2000	531,171	0.081	483,808	0.091	537,563	0.080	488,605	0.090
2001	811,816	0.090	960,917	0.095	827,176	0.088	974,016	0.094
2002	584,565	0.109	536,342	0.100	597,943	0.106	544,602	0.099
2003	590,973	0.105	498,873	0.124	625,659	0.099	516,468	0.120
2004	562,309	0.060	397,948	0.086	578,064	0.058	404,687	0.085
2005	606,050	0.071	450,705	0.140	638,764	0.068	464,647	0.136
2006	517,698	0.055	394,024	0.060	544,035	0.053	407,584	0.059
2007	423,704	0.082	733,402	0.263	450,337	0.078	753,821	0.256
2008	403,125	0.066	476,697	0.103	427,503	0.065	492,643	0.101
2009	421,291	0.083	716,637	0.087	430,084	0.081	721,812	0.087
2010	860,210	0.119	887,836	0.131	870,639	0.117	896,301	0.130
2011	896,039	0.074	836,840	0.094	911,082	0.073	844,482	0.094
2012	890,665	0.112	987,973	0.093	896,401	0.112	991,342	0.092
2013	791,958	0.093	750,889	0.165	811,667	0.091	760,225	0.163
2014	1,079,712	0.141	1,122,144	0.127	1,095,270	0.139	1,129,255	0.127
2015	1,102,261	0.136	982,470	0.115	1,109,115	0.136	985,698	0.115
2016	944,621	0.081	640,359	0.096	986,013	0.078	660,996	0.093
2017	598,260	0.077	346,693	0.090	643,953	0.077	364,129	0.088

Northern Bering Sea survey

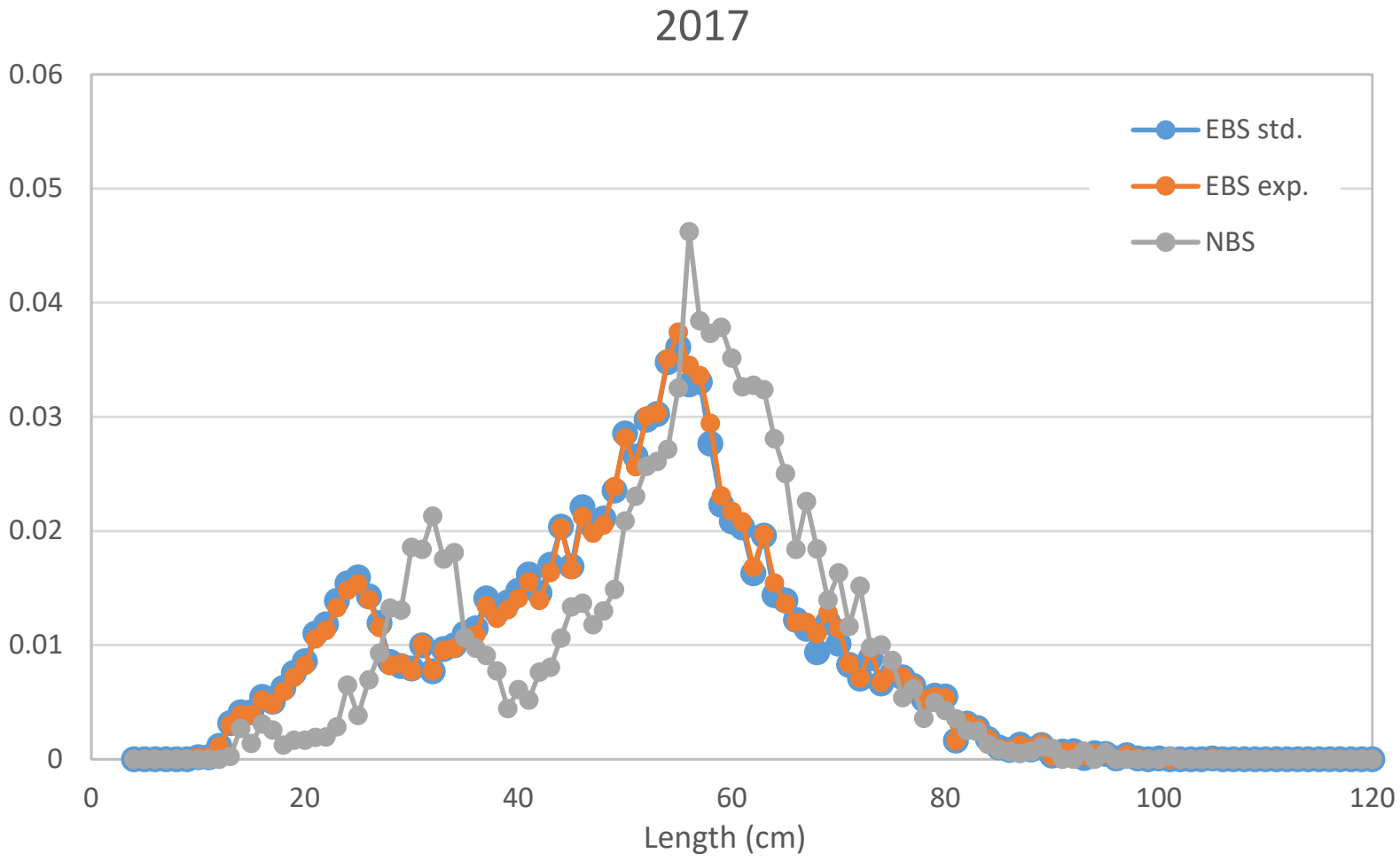
- As discussed in last year's assessment, the time series for the northern Bering Sea (NBS) survey is very short
- As of last year, the survey had been conducted only twice, in 2010 and again in 2017
- Estimates of biomass (t) and abundance (1000s of fish), along with the corresponding lognormal sigma parameters (similar to a coefficient of variation) from those two years are shown below:

	Biomass		Abundance	
Year	Estimate	Sigma	Estimate	Sigma
2010	28,425	0.226	8,881	0.196
2017	286,310	0.131	135,065	0.128

Survey area sizecomps (F2.1.1, upper)



Survey area sizecomps (F2.1.1, lower)



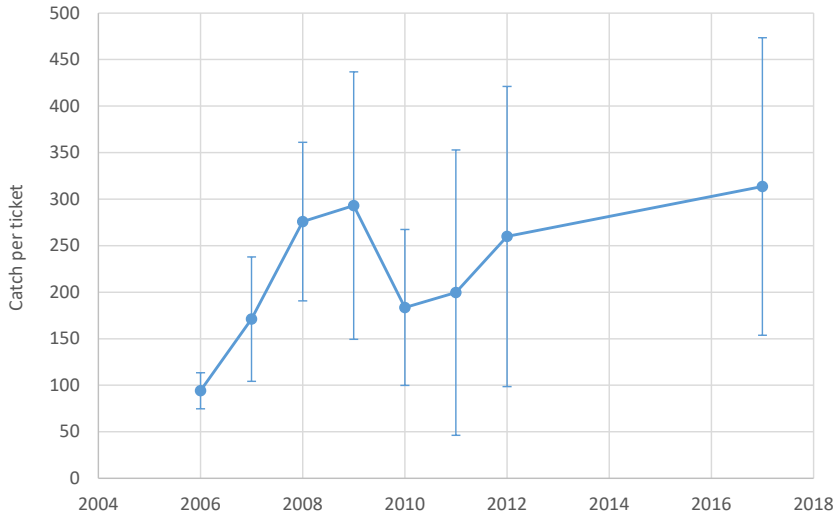
NBS fishery CPUE: observer data

- For the years 1988-2018, the data from longliners targeting Pacific cod in the NBS survey area come from a total of 12 observed hauls
  - There are no years in which hauls from more than two vessels were observed, so confidentiality restrictions prohibit these data from being broken down by year
- If the query is expanded by removing the restriction that the hauls need to have targeted Pacific cod, the sample size increases to 27, but the same confidentiality problems arise with respect to annual reporting

Subarea	N	Mean	Std. Err.	M-2SE	M+2SE
West of 170	15	129.1	26.9	75.3	182.9
East of 170	12	89.2	21.4	46.3	132.0
Overall	27	111.3	17.8	75.7	147.0

NBS fishery CPUE: fish ticket data (1 of 2)

- All records from each ADFG statistical area that was not located predominantly within the NBS survey area were removed, leaving a sample size of 173
- Confidentiality constraints reduced the sample size to 164
- Removing the records from catcher-processors reduced the sample size to 152, resulting in the following time series (F2.1.2):



NBS fishery CPUE: fish ticket data (2 of 2)

- The ADFG fish ticket data were not included in any of the models presented in this preliminary assessment for the following reasons:
  - The time series is short (8 years)
  - The units are catch rather than catch per unit effort
  - The confidence intervals are wide enough that the data may not contain much information
  - Across the time series, the two small ADFG statistical areas just southwest of Nome (#666401 and #666402, which together comprise a half-degree-latitude × one-degree-longitude block) account for between 56% and 92% of the records in each year, so this might not be a good index of the overall NBS
    - All but two of the catches in the time series were delivered to Nome; the other two were delivered to Dutch Harbor

Environmental indices

1. North Pacific Index (“NPI”)
2. Benthic forager biomass (“bnthc_frgr”)
3. St. Paul northern fur seal pups born (“fr_sl_pps”)
4. Ice retreat index (“IRI”)
5. Pelagic forager biomass (“plgc_frgr”)
6. Habitat impacted by trawls (“trwl_mpct”)
7. Euphausiid biomass (“ephsd”)
8. Apex predator biomass (“apx_prd”)
9. Motile epifauna biomass (“mtl_epfn”)
10. Multivariate seabird breeding index (“brd_brdng”)
11. Fish condition (“fsh_cndtn”)
12. Mean bottom temperature in the EBS survey (“bttm_tmp”)
13. Age 1 walleye pollock abundance (“pllck_1”)

Environmental indices (T2.1.5)

Year	NPI	bnthc_frgr	fr_sl_pps	IRI	plgc_frgr	trwl_mpct	ephsd	apx_prd	mtl_epfn	brd_brdng	fsh_cndtn	bttm_tmp	pllck_1
1977	-1.104		1.479										
1978	-0.865		1.733										
1979	0.943		1.708										
1980	-0.333		0.810	-0.507									
1981	-1.779		0.290										
1982	0.965	0.905	0.805	-0.392	-0.743			0.153	0.067			-0.275	-0.412
1983	-2.214	0.607	0.002	-1.150	0.367			1.500	-0.582			0.628	1.936
1984	-0.959	0.412	0.159	-0.147	-0.263			0.280	-1.107		-1.496	-0.199	-0.591
1985	0.700	-1.895	0.350	-0.176	-0.754			0.666	-2.708			-0.157	0.800
1986	-1.620	-1.907	0.039	-0.286	-0.048			1.160	-2.350			-0.766	-0.597
1987	-1.098	-0.508	0.123		-0.395			0.083	-0.544			0.864	-1.052
1988	-0.134	-0.066	0.776	-0.052	1.223			-0.064	0.077			-0.169	-1.183
1989	1.473	-0.310	0.122	-1.027	0.451			-0.425	0.095			0.564	-0.816
1990	1.100	-0.238	0.757	-0.791	1.081			-0.531	0.594			-0.060	1.776
1991	1.251	0.208		-1.076	0.127			-1.408	0.162			0.238	0.166
1992	-0.881	0.498	0.354	0.591	0.269			-1.044	-0.390			-0.580	-0.043
1993	0.142	0.703			3.087			-0.106	-0.340		1.186	0.670	1.595
1994	0.856	2.573	0.560	-0.697	0.694			2.959	-0.502			-1.110	-0.516
1995	0.057	0.165		0.558	1.248			1.152	-0.210			-0.904	-0.853
1996	-0.295	0.233	0.092		-0.790			0.888	-0.609	-0.660		1.108	-0.013
1997	0.105	1.463		-0.020	0.502			-0.404	-0.145	-0.554		0.292	0.561
1998	-1.316	0.401	0.284	-1.091	-1.258			-0.926	-0.612	-1.065	1.833	0.930	-0.525
1999	0.450	-2.190		0.479	-1.065			-1.398	-1.130	-0.150	-1.404	-2.001	-0.445
2000	0.005	-1.279	-0.151		-0.253			-1.296	-0.911	1.301	0.068	-0.408	0.184
2001	-0.601	-0.487			-0.765			0.061	-0.424	0.524	0.380	0.092	0.834
2002	0.339	-0.641	-0.429		-0.275			-1.076	-0.607	0.955	0.385	0.898	0.041
2003	-1.499	-0.070			1.834	0.834		-0.414	-0.068	0.334	1.916	1.574	-0.584
2004	0.058	0.774	-0.917	-1.143	-0.040	0.924	-0.967	-0.336	0.058	0.114	1.361	1.064	-1.126
2005	-0.126	1.480			0.001	0.733		0.139	1.001	-1.108	0.574	1.168	-1.254
2006	0.745	0.971	-1.192	-1.135	-1.194	0.729	-0.155	-0.356	1.064	-0.440	0.103	-0.747	-0.758
2007	0.620	0.267		0.485	-0.900	1.062	0.658	-1.052	0.554	-0.124	0.263	-0.852	0.191
2008	0.387	0.215	-1.347	1.510	-1.251	1.152	0.901	-1.234	-0.098	0.764	-0.180	-1.447	-0.612
2009	2.240	-1.119		1.523	-1.670	0.389	1.586	-1.572	-0.257	0.791	-0.838	-1.335	2.142
2010	-0.865	0.643	-1.540	2.003	-0.417	-0.288	0.674	0.672	0.740	1.070	-0.166	-1.159	-0.085
2011	1.201	0.665		-0.034	-0.747	-0.493		0.789	1.101	-0.030	-0.027	-0.037	-0.697
2012	0.841	-0.350	-1.472	2.342	-0.231	-0.998	-0.475	0.215	1.328	0.702	-1.503	-1.786	-0.816
2013	0.836	-0.380		0.737	0.417	-1.300		-0.067	1.226	0.956	-0.236	-0.749	2.584
2014	0.610	0.176	-1.580		1.153	-1.366	-0.851	1.226	0.738	1.288	-0.287	0.869	1.178
2015	-0.255	-1.676			1.441			1.192	1.274	-0.532	-1.397	1.036	-0.387
2016	-0.822	-0.232	-1.817		-0.353	-1.379	-1.370	0.948	1.708	-2.517	0.252	2.347	-0.319
2017	0.841	-0.010		-0.503	-0.483			-0.376	1.807	-1.618	-0.788	0.400	-0.303

Models

Base model

- Model 16.6 was adopted by the SSC in 2016 as the new base model
- In contrast to the previous base model (Model 11.5, which had been in use since 2011), Model 16.6 is a very simple model
- Its main structural features are as follow:
  - One fishery, one gear type, one season per year
  - Logistic age-based selectivity for both the fishery and survey
  - External estimation of time-varying weight-at-length parameters and the standard deviations of ageing error at ages 1 and 20
  - All parameters constant over time except for recruitment and fishing mortality
  - Internal estimation of all natural mortality, fishing mortality, length-at-age (including ageing bias), recruitment (conditional on Beverton-Holt recruitment steepness fixed at 1.0), catchability, and selectivity parameters

“Minor change” models (1 of 4)

- Models dealing with the use of data from the expanded EBS survey area:
  - Model 16.6a:
    - Structure differences: None
    - Data differences:
      - Exclude 1982-1986 EBS survey data
      - Switch to expanded area data for 1987-2017
  - Model 16.6b
    - Structure difference: Estimate a separate *Q* for the 1982-1986 EBS survey
    - Data difference: Switch to expanded area data for 1987-2017

“Minor change” models (2 of 4)

- Models incorporating an environmental covariate of growth:
  - Model 16.6c
    - Structure difference: Estimate a parameter linking *K* to fish condition
    - Data difference: Include the fish condition time series
  - Model 16.6d
    - Structure difference: Estimate a parameter linking *Lmin* to bottom temperature
    - Data difference: Include the bottom temperature time series

“Minor change” models (3 of 4)

- Models incorporating time-varying catchability, without NBS survey data:
  - Model 16.6e
    - Structure difference: Allow randomly time-varying EBS survey *Q*
    - Data differences: None
  - Model 16.6f
    - Structure difference: Estimate a parameter linking EBS *Q* to the North Pacific Index
    - Data difference: Include the North Pacific Index time series

“Minor change” models (4 of 4)

- Models incorporating time-varying catchability, with NBS survey data:
  - Model 16.6g
    - Structure differences:
      - Allow randomly time-varying EBS survey *Q*
      - Estimate NBS survey selectivity and *Q*
      - Allow randomly time-varying NBS survey *Q*
    - Data differences: Include NBS survey data
  - Model 16.6h
    - Structure differences same as Model 16.6g, plus:
      - Estimate a parameter linking NBS *Q* to the North Pacific Index
    - Data differences same as Model 16.6g, plus:
      - Include the North Pacific Index time series

“Major change” models (1 of 9)

- Previously reviewed models:
  - Model 17.2
    - Structure differences:
      - Adjust timing of fishery and survey per SS V3.30 conventions
      - Include a prior distribution for the natural mortality rate
      - Switch to flat-topped double normal selectivity
      - Allow randomly time-varying fishery selectivity
      - Use harmonic mean weighting of composition data
    - Data differences:
      - Set multinomial input sample size equal to number hauls
      - Include fishery age composition data (with 2011 and 2012)
  - (Continued on next slide)

“Major change” models (2 of 9)

- Previously reviewed models:
  - Model 17.2
    - Structure differences:
      - Adjust timing of fishery and survey per SS V3.30 conventions
      - Include a prior distribution for the natural mortality rate
      - Switch to flat-topped double normal selectivity
      - Allow randomly time-varying fishery selectivity
      - Use harmonic mean weighting of composition data
    - Data differences:
      - Set multinomial input sample size equal to number hauls
      - Include fishery age composition data (with 2011 and 2012)
  - (Continued on next slide)

“Major change” models (3 of 9)

- Previously reviewed models, continued:
  - Model 17.6
    - Structure differences same as Model 17.2, plus:
      - Allow randomly time-varying survey selectivity
      - Allow randomly time-varying *Lmin*
      - Allow randomly time-varying EBS survey catchability
    - Data differences same as Model 17.2

“Major change” models (4 of 9)

- Models incorporating migration:
  - Model 18.1
    - Structure differences:
      - Estimate base values of three migration parameters
      - Allow random variation in migration parameters
    - Data differences:
      - Include NBS survey data
      - Treat EBS and NBS as separate areas
  - (Continued on next slide)

“Major change” models (5 of 9)

- Models incorporating migration, continued:
  - Model 18.2
    - Structure differences:
      - Estimate base values of three migration parameters
      - Estimate three parameters linking migration to covariates
    - Data differences same as Model 18.1, plus:
      - Include North Pacific Index
      - Include benthic forager biomass index
      - Include seabird breeding success index

“Major change” models (6 of 9)

- Models incorporating migration, continued:
  - Model 18.2
    - Structure differences:
      - Estimate base values of three migration parameters
      - Estimate three parameters linking migration to covariates
    - Data differences same as Model 18.1, plus:
      - Include North Pacific Index
      - Include benthic forager biomass index
      - Include seabird breeding success index

“Major change” models (7 of 9)

- Models incorporating an environmental covariate of *M*:
  - Model 18.3
    - Structure difference: Estimate a parameter linking *M* to fish condition
    - Data difference: Include fish condition time series
  - Model 18.4
    - Structure differences:
      - Estimate two additional parameters linking *M* to age
      - Estimate a parameter linking *M* at ages 2-4 to nutrition deficit
    - Data differences: Include nutrition deficit time series

“Major change” models (8 of 9)

- Model incorporating many new features:
  - Model 18.5
    - Structure differences:
      - Estimate a parameter linking EBS *Q* to the North Pacific Index
      - Estimate NBS selectivity and *Q*
      - Estimate base values of three migration parameters
      - Allow random variation in migration parameters
      - Estimate two additional parameters linking *M* to age
      - Estimate a parameter linking *M* to a nutrition deficit index
      - Estimate block-specific Ricker steepness internally
  - (Continued on next slide)

“Major change” models (9 of 9)

- Model incorporating many new features, continued:
  - Model 18.5
    - Data differences:
      - Include NBS survey data
      - Treat EBS and NBS as separate areas
      - Include the North Pacific Index time series
      - Include the nutrition deficit time series

Model structural differences (T2.1.6)

	EBS survey area	EBS survey area	Growth covariates	Growth covariates	Time-vary Q, w/o NBS	Time-vary Q, w/o NBS	Time-vary Q, with NBS	Time-vary Q, with NBS	Previous models	Previous models	Migration	Migration	M covariates	M covariates	Omnibus
Feature	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
Separate Q for EBS survey 1982-1986		x													
K linked to environmental covariate			x												
Lmin linked to environmental covariate				x											
Randomly time-varying EBS Q					x		x			x					
EBS Q linked to environmental covariate						x		x							x
NBS Q and selectivity estimated							x	x							x
Randomly time-varying NBS Q							x	x							
Adjust timing of fishery and survey									x	x					
Prior distribution for M									x	x					
Flat-topped double normal selectivity									x	x					
Randomly time-varying fishery selex									x	x					
Harmonic mean composition weighting									x	x					
Randomly time-varying survey selex										x					
Randomly time-varying *Lmin*										x					
EBS-NBS migration											x	x			x
Randomly time-varying migration											x				x
Migration linked to environ. covariate												x			
M linked to environmental covariate													x	x	x
Age-varying M														x	x
Block-specific steepness estimated															x

Model data sets (T2.1.7)

Category	Model	Comp. N	EBS survey		Fishery ages	NBS	Areas	Env. var. 4	Env. var. 5	Env. var. 6
			1982-1986	1987-2017						
Base model	16.6	mean=300	yes	standard	no	no	1	n/a	n/a	n/a
EBS survey area	16.6a	mean=300	no	expanded	no	no	1	n/a	n/a	n/a
EBS survey area	16.6b	mean=300	yes	expanded	no	no	1	n/a	n/a	n/a
K covariates	16.6c	mean=300	yes	standard	no	no	1	fsh_cndtn	n/a	n/a
K covariates	16.6d	mean=300	yes	standard	no	no	1	bttm_tmp	n/a	n/a
Time-vary *Q*, w/o NBS	16.6e	mean=300	yes	standard	no	no	1	n/a	n/a	n/a
Time-vary *Q*, w/o NBS	16.6f	mean=300	yes	standard	no	no	1	NPI	n/a	n/a
Time-vary *Q*, with NBS	16.6g	mean=300	yes	standard	no	yes	1	n/a	n/a	n/a
Time-vary *Q*, with NBS	16.6h	mean=300	yes	standard	no	yes	1	NPI	n/a	n/a
Previous models	17.2	no. hauls	yes	standard	yes	no	1	n/a	n/a	n/a
Previous models	17.6	no. hauls	yes	standard	yes	no	1	n/a	n/a	n/a
Migration	18.1	mean=300	yes	standard	no	yes	2	n/a	n/a	n/a
Migration	18.2	mean=300	yes	standard	no	yes	2	NPI	bnthc_frgr	brd_brdng
M covariates	18.3	mean=300	yes	standard	no	no	1	fsh_cndtn	n/a	n/a
M covariates	18.4	mean=300	yes	standard	no	no	1	ntrtn_dfct	n/a	n/a
Omnibus	18.5	mean=300	yes	standard	no	yes	2	NPI	ntrtn_dfct	n/a

Why so many models?

- Model 16.6 is required
- Models 16.6a, 16.6b, 17.2, and 17.6 requested by Team or SSC
- Models 16.6e, 16.6f, 16.6g, 16.6h, 18.1 and 18.2 address these issues:
  - Can the NBS survey data be used in a meaningful way?
  - Is a model with time-varying *Q* acceptable?
    - If yes, does time-varying *Q* require an environmental covariate?
    - If no, is a migration model an acceptable alternative?
      - If yes, does migration require an environmental covariate?
- Models 16.6c, 16.6d, 18.3, 18.4, and 18.5 requested by AFSC scientists

Performance of nutrition deficit indices (T2.1.9)

Color coding for positive and negative correlations

Type	Index	1	2	3	4	5	6	7	8	9	10	11	12	13
Population	Placeholder	0.118	-0.030	0.573	0.350	-0.004	-0.105	0.082	-0.022	0.204	-0.094	0.189	-0.360	0.049
Population	consumedG	-0.118	0.124	0.472	0.041	0.022	-0.081	-0.025	0.002	0.008	-0.331	-0.309	0.052	-0.379
Population	meanPreyED	-0.091	-0.087	0.078	-0.113	-0.315	-0.086	-0.576	-0.016	0.198	-0.047	-0.131	0.001	0.153
Population	RFR	0.006	0.145	0.410	-0.060	0.140	-0.027	-0.023	-0.003	-0.078	-0.265	-0.452	0.094	-0.489
Population	Cmax	-0.215	0.006	-0.136	0.206	-0.137	-0.095	0.023	-0.112	0.176	-0.117	0.287	-0.225	0.276
Population	maxG	-0.142	0.081	-0.016	0.110	-0.211	-0.181	-0.272	-0.285	0.241	-0.248	0.178	-0.372	0.275
Population	Gpotential	0.004	0.129	0.435	-0.051	-0.108	-0.104	-0.226	-0.157	0.159	-0.182	-0.170	-0.085	-0.062
Age-specific	consumedG	-0.236	0.351	-0.044	-0.147	0.154	0.173	0.188	0.172	0.011	-0.159	-0.381	-0.247	-0.070
Age-specific	meanPreyED	0.090	0.167	-0.147	0.020	0.136	0.245	0.167	0.353	0.171	0.257	-0.318	0.042	0.154
Age-specific	RFR	-0.168	0.354	-0.060	-0.203	0.193	0.220	0.167	0.177	0.013	-0.102	-0.436	-0.251	-0.011
Age-specific	Cmax	-0.019	0.177	-0.191	0.111	0.189	0.245	0.311	0.346	0.150	0.241	-0.184	-0.084	0.052
Age-specific	maxG	-0.158	0.068	-0.204	0.087	0.038	0.112	0.072	0.187	0.127	0.063	-0.196	-0.015	-0.016
Age-specific	Gpotential	-0.081	0.141	-0.347	-0.038	0.008	0.097	0.083	0.085	0.002	-0.160	-0.277	-0.219	0.031

Color coding for within-age performance

Type	Index	1	2	3	4	5	6	7	8	9	10	11	12	13
Population	Placeholder	0.118	-0.030	0.573	0.350	-0.004	-0.105	0.082	-0.022	0.204	-0.094	0.189	-0.360	0.049
Population	consumedG	-0.118	0.124	0.472	0.041	0.022	-0.081	-0.025	0.002	0.008	-0.331	-0.309	0.052	-0.379
Population	meanPreyED	-0.091	-0.087	0.078	-0.113	-0.315	-0.086	-0.576	-0.016	0.198	-0.047	-0.131	0.001	0.153
Population	RFR	0.006	0.145	0.410	-0.060	0.140	-0.027	-0.023	-0.003	-0.078	-0.265	-0.452	0.094	-0.489
Population	Cmax	-0.215	0.006	-0.136	0.206	-0.137	-0.095	0.023	-0.112	0.176	-0.117	0.287	-0.225	0.276
Population	maxG	-0.142	0.081	-0.016	0.110	-0.211	-0.181	-0.272	-0.285	0.241	-0.248	0.178	-0.372	0.275
Population	Gpotential	0.004	0.129	0.435	-0.051	-0.108	-0.104	-0.226	-0.157	0.159	-0.182	-0.170	-0.085	-0.062
Age-specific	consumedG	-0.236	0.351	-0.044	-0.147	0.154	0.173	0.188	0.172	0.011	-0.159	-0.381	-0.247	-0.070
Age-specific	meanPreyED	0.090	0.167	-0.147	0.020	0.136	0.245	0.167	0.353	0.171	0.257	-0.318	0.042	0.154
Age-specific	RFR	-0.168	0.354	-0.060	-0.203	0.193	0.220	0.167	0.177	0.013	-0.102	-0.436	-0.251	-0.011
Age-specific	Cmax	-0.019	0.177	-0.191	0.111	0.189	0.245	0.311	0.346	0.150	0.241	-0.184	-0.084	0.052
Age-specific	maxG	-0.158	0.068	-0.204	0.087	0.038	0.112	0.072	0.187	0.127	0.063	-0.196	-0.015	-0.016
Age-specific	Gpotential	-0.081	0.141	-0.347	-0.038	0.008	0.097	0.083	0.085	0.002	-0.160	-0.277	-0.219	0.031

Results

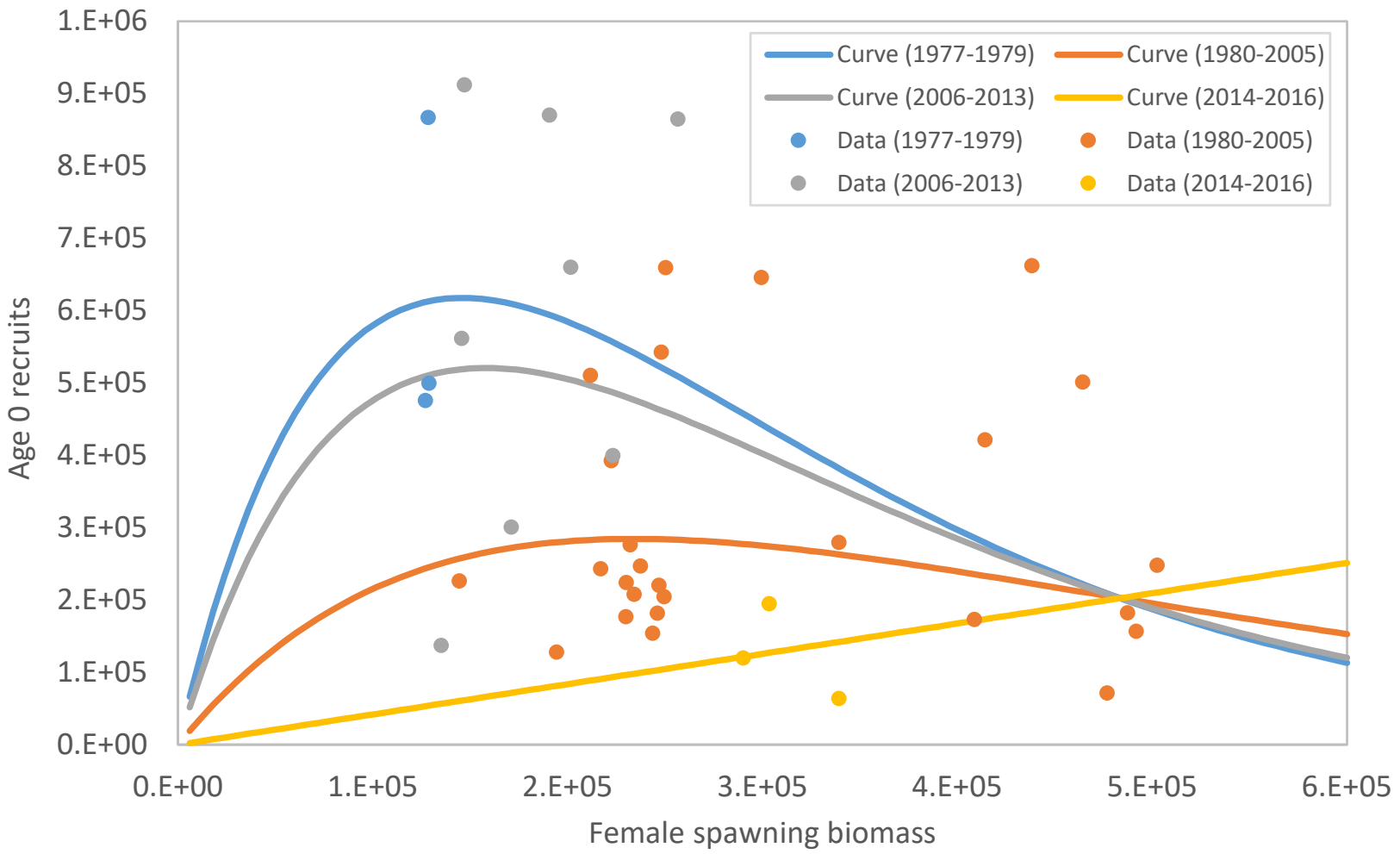
Overview of major results (T2.1.10)

Dimensions	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
EBS exp. area data used?	no	yes	yes	no	no	no	no	no	no	no	no	no	no	no	no	no
NBS data used?	no	no	no	no	no	no	no	yes	yes	no	no	yes	yes	no	no	yes
Separate area for NBS?	no	no	no	no	no	no	no	no	no	no	no	yes	yes	no	no	yes
Diagnostics	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
ADSB	n/a	0.102	0.098	0.070	0.043	0.034	0.065	0.031	0.054	0.117	0.174	1.076	0.595	0.185	0.145	1.106
Mohn's ρ	0.243	0.202	0.217	0.304	0.222	0.323	0.291	0.359	0.319	0.309	0.069	0.452	0.370	0.118	0.451	0.724
Base values	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
Natural mortality rate	0.359	0.348	0.347	0.354	0.363	0.361	0.354	0.353	0.348	0.374	0.312	0.305	0.331	0.349	0.381	0.294
EBS std. area catchability	0.929		0.995	0.943	0.913	0.917	0.952	0.954	0.980	1.043	1.200	1.240	1.074	1.008	0.816	1.286
EBS exp. area catchability		0.994	0.990													
NBS catchability								0.058	0.060			0.457	1.030			0.526
Unfished equil. sp. biom.	629	645	645	637	627	631	638	640	645	604	703	753	684	626	619	484
2019 quantities	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
Depletion	0.424	0.392	0.401	0.418	0.431	0.443	0.424	0.448	0.428	0.356	0.208	0.529	0.481	0.327	0.461	0.741
EBS spawning biomass												199	239			188
NBS spawning biomass												199	90			170
Spawning biomass	267	253	259	266	270	279	270	287	276	215	147	399	329	205	285	358
EBS age 0+ biomass												589	690			541
NBS age 0+ biomass												483	220			409
Age 0+ biomass	775	731	746	774	797	810	781	813	782	657	488	1,072	910	614	835	950
OFL	209	186	196	206	214	220	209	220	208	155	53	197	212	133	237	179
maxABC	175	156	165	173	180	185	175	185	175	130	45	170	180	111	199	154

Survey fits in units of –lnL change (T2.1.12b)

Year	Obs. abund.	Negative log likelihood minus row minimum															
		16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
1982	583781	0.283		0.188	0.188	0.322	0.051	0.000	0.023	0.030	0.106	0.217	2.468	1.132	0.179	1.039	1.272
1983	752456	0.409		0.458	0.458	0.383	0.074	0.009	0.108	0.000	0.520	0.705	0.133	0.273	0.444	0.131	0.006
1984	651058	0.398		0.320	0.320	0.434	0.032	1.095	0.000	0.894	0.346	0.026	0.367	0.317	0.367	1.310	0.687
1985	841108	0.278		0.310	0.310	0.265	0.000	0.614	0.027	0.680	0.384	0.014	0.335	0.350	0.252	0.019	0.349
1986	838217	0.391		0.437	0.437	0.416	0.072	0.000	0.087	0.006	0.448	0.389	0.460	0.474	0.331	0.065	0.093
1987	677054	0.411	0.912	0.446	0.446	0.453	0.023	0.000	0.024	0.001	0.000	0.001	0.643	0.564	0.260	0.146	0.198
1988	507560	0.220	0.186	0.212	0.212	0.245	0.001	0.131	0.000	0.115	0.279	0.057	0.310	0.334	0.097	0.284	0.293
1989	292247	8.533	9.981	8.911	8.911	8.143	0.053	4.766	0.000	4.843	17.846	0.078	6.740	7.020	9.553	6.535	4.600
1990	423835	1.134	1.164	1.269	1.269	1.075	0.173	0.464	0.135	0.390	1.852	0.130	0.243	0.479	1.318	0.659	0.000
1991	488892	1.753	1.811	1.878	1.878	1.703	0.305	0.803	0.235	0.699	1.545	0.000	0.946	1.137	1.850	1.414	0.445
1992	577560	0.058	0.063	0.092	0.092	0.055	0.008	0.352	0.000	0.314	0.025	0.528	0.014	0.014	0.069	0.013	0.049
1993	810608	0.719	0.549	0.583	0.583	0.700	0.257	0.712	0.263	0.747	1.134	0.000	0.568	0.706	0.778	0.768	0.525
1994	1E+06	5.994	6.269	5.425	5.425	6.110	0.061	7.411	0.000	7.526	8.118	1.262	5.732	6.003	6.554	5.652	5.819
1995	757910	1.878	1.527	1.438	1.438	2.069	0.016	1.790	0.000	1.818	3.408	0.078	1.431	1.794	2.497	1.691	1.095
1996	607198	0.439	0.368	0.195	0.195	0.557	0.003	0.248	0.000	0.262	1.215	0.218	0.131	0.355	0.851	0.454	0.017
1997	485643	0.371	0.429	0.604	0.604	0.335	0.187	0.377	0.168	0.352	0.000	0.016	0.388	0.341	0.050	0.353	0.404
1998	514339	0.858	0.958	1.364	1.364	0.836	0.170	2.257	0.140	2.131	0.130	0.000	0.897	0.777	0.326	0.902	1.343
1999	488337	0.308	0.062	0.760	0.760	0.260	0.073	0.172	0.064	0.157	0.765	0.000	0.402	0.292	0.039	0.367	0.430
2000	483808	1.712	2.206	2.858	2.858	1.446	0.234	1.869	0.213	1.847	3.310	0.516	1.725	1.596	0.000	2.328	2.668
2001	960917	7.832	7.454	6.249	6.249	8.409	0.836	6.217	0.739	6.174	6.343	0.000	8.829	8.444	15.560	5.820	5.824
2002	536342	0.221	0.292	0.502	0.502	0.128	0.000	0.140	0.008	0.171	0.288	0.140	0.091	0.129	0.180	0.687	0.537
2003	498873	0.029	0.000	0.031	0.031	0.038	0.027	0.227	0.026	0.272	0.028	0.032	0.033	0.037	0.408	0.028	0.144
2004	397948	0.429	0.646	0.532	0.532	0.381	0.000	0.515	0.027	0.672	0.640	0.328	0.146	0.236	0.288	0.219	0.253
2005	450705	0.888	0.864	0.918	0.918	0.835	0.403	0.719	0.321	0.597	0.661	0.000	1.208	1.120	0.522	1.502	1.393
2006	394024	2.083	2.132	2.671	2.671	1.533	0.055	3.029	0.002	2.410	2.666	0.000	2.653	2.805	0.305	5.424	5.131
2007	733402	0.908	0.900	1.090	1.090	0.795	0.670	1.000	0.644	0.984	1.507	0.000	0.850	0.929	0.431	1.306	1.169
2008	476697	2.323	2.204	1.409	1.409	2.797	0.067	2.142	0.000	2.005	0.976	0.166	0.841	3.997	6.198	1.128	0.195
2009	716637	0.921	1.196	0.381	0.381	1.176	0.200	0.014	0.161	0.000	0.267	0.853	0.113	2.013	3.923	0.393	0.305
2010	887836	0.180	0.152	0.455	0.455	0.128	0.046	0.000	0.057	0.015	0.629	0.243	0.592	0.041	0.003	0.315	0.474
2011	836840	0.773	0.603	1.392	1.392	0.665	0.146	1.516	0.132	1.515	1.641	0.054	0.509	4.853	0.000	1.215	0.827
2012	987973	0.635	0.459	1.087	1.087	0.633	0.101	1.022	0.078	0.954	1.706	0.012	0.307	0.006	0.000	0.569	0.261
2013	750889	0.358	0.365	0.179	0.179	0.288	0.133	0.184	0.197	0.263	0.155	0.000	1.157	1.247	0.684	0.684	1.295
2014	1E+06	1.087	0.970	1.325	1.325	1.193	0.338	1.271	0.223	1.005	1.391	0.817	0.025	0.149	0.748	0.626	0.000
2015	982470	0.982	0.907	1.131	1.131	1.062	0.245	0.654	0.162	0.494	1.354	0.934	0.001	0.084	1.303	0.580	0.000
2016	640359	0.134	0.266	0.174	0.174	0.163	0.009	0.010	0.000	0.045	0.240	0.243	0.893	0.222	0.734	0.153	0.803
2017	346693	3.821	2.690	3.749	3.749	4.158	0.977	3.207	0.931	3.008	3.000	0.398	0.035	1.670	1.445	2.926	0.000
0s:		0	1	0	0	0	3	3	9	2	2	9	0	0	3	0	4
Max:		8.533	9.981	8.911	8.911	8.409	0.977	7.411	0.931	7.526	17.846	1.262	8.829	8.444	15.560	6.535	5.824

Ricker stock-recruitment in M18.5 (F2.1.3)



Common time-invariant parameters (T2.1.14a)

Quantity	Model 16.6		Model 16.6a		Model 16.6b		Model 16.6c		Model 16.6d		Model 16.6e		Model 16.6f		Model 16.6g	
	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.
Natural mortality (M)	0.359	0.012	0.348	0.014	0.347	0.014	0.354	0.012	0.363	0.012	0.361	0.014	0.354	0.012	0.353	0.014
Length at age 1.5 (cm)	16.418	0.088	16.312	0.093	16.375	0.088	16.407	0.088	16.695	0.092	16.419	0.088	16.422	0.088	16.409	0.088
Asymptotic length (cm)	99.64	1.921	102.30	2.388	100.14	2.014	100.00	1.919	100.10	1.936	99.48	1.930	100.06	1.959	98.55	1.796
Brody growth coefficient (K)	0.198	0.012	0.184	0.013	0.196	0.012	0.198	0.012	0.195	0.012	0.198	0.012	0.196	0.012	0.208	0.012
Richards growth coefficient	1.038	0.048	1.084	0.050	1.038	0.048	1.029	0.048	1.053	0.048	1.043	0.048	1.044	0.048	1.000	0.047
SD of length at age 1 (cm)	3.438	0.058	3.410	0.061	3.429	0.058	3.431	0.058	3.427	0.056	3.439	0.058	3.439	0.058	3.440	0.058
SD of length at age 20 (cm)	9.789	0.277	9.751	0.312	9.754	0.279	9.679	0.276	9.712	0.278	9.751	0.278	9.784	0.280	9.515	0.264
Ageing bias at age 1	0.332	0.012	0.334	0.013	0.332	0.012	0.331	0.012	0.335	0.012	0.333	0.012	0.331	0.012	0.331	0.012
Ageing bias at age 20	0.281	0.142	0.264	0.144	0.259	0.142	0.233	0.143	0.284	0.141	0.254	0.142	0.261	0.143	0.262	0.144
ln(mean post-1976 recruits)	13.123	0.100	13.031	0.110	13.040	0.110	13.092	0.101	13.151	0.100	13.149	0.111	13.091	0.101	13.089	0.110
SD of ln(recruitment) devs	0.644	0.066	0.616	0.069	0.647	0.066	0.644	0.066	0.631	0.065	0.636	0.065	0.646	0.066	0.655	0.068
ln(pre-1977 recruits offset)	-1.122	0.212	-1.068	0.255	-1.144	0.207	-1.126	0.209	-1.108	0.212	-1.093	0.214	-1.133	0.209	-1.118	0.213
Initial fishing mortality rate	0.180	0.069	0.162	0.071	0.186	0.073	0.180	0.069	0.174	0.066	0.168	0.063	0.182	0.070	0.173	0.066
ln(EBS std. area catchability)	-0.074	0.061			-0.005	0.099	-0.058	0.062	-0.091	0.062	-0.086	0.071	-0.050	0.062	-0.047	0.070
Select. inflection (fishery)	4.349	0.045	4.360	0.047	4.361	0.045	4.355	0.045	4.338	0.045	4.353	0.046	4.354	0.045	4.308	0.044
Select. 95% width (fishery)	1.164	0.032	1.179	0.032	1.173	0.032	1.169	0.031	1.171	0.031	1.167	0.032	1.168	0.032	1.158	0.031
Select. inflection (EBS sur.)	1.009	0.006	1.003	0.006	1.006	0.006	1.007	0.006	1.008	0.006	1.010	0.006	1.007	0.006	1.007	0.006
Select. 95% width (EBS sur.)	0.287	0.052	0.288	0.052	0.287	0.052	0.287	0.052	0.288	0.051	0.287	0.052	0.287	0.052	0.287	0.051

Quantity	Model 16.6h		Model 17.2		Model 17.6		Model 18.1		Model 18.2		Model 18.3		Model 18.4		Model 18.5	
	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.
Natural mortality (M)	0.348	0.012	0.374	0.018	0.312	0.012	0.305	0.014	0.331	0.013	0.349	0.012				
Length at age 1.5 (cm)	16.411	0.088	16.445	0.092	16.946	0.288	16.415	0.088	16.415	0.089	16.410	0.088	16.422	0.089	16.422	0.088
Asymptotic length (cm)	98.987	1.811	109.18	1.867	108.41	2.022	93.32	1.308	95.26	1.511	99.89	1.983	99.60	2.148	93.74	1.509
Brody growth coefficient (K)	0.206	0.012	0.171	0.009	0.170	0.009	0.241	0.011	0.229	0.012	0.200	0.012	0.194	0.012	0.238	0.012
Richards growth coefficient	1.002	0.047	1.071	0.037	1.017	0.037	0.899	0.045	0.934	0.047	1.020	0.049	1.067	0.048	0.909	0.045
SD of length at age 1 (cm)	3.440	0.058	3.492	0.058	3.130	0.039	3.438	0.057	3.437	0.058	3.430	0.058	3.454	0.058	3.445	0.057
SD of length at age 20 (cm)	9.545	0.266	8.675	0.227	9.459	0.232	9.049	0.247	9.319	0.252	9.915	0.281	9.576	0.290	8.943	0.252
Ageing bias at age 1	0.330	0.013	0.337	0.030	0.357	0.017	0.316	0.014	0.323	0.013	0.325	0.013	0.337	0.011	0.315	0.014
Ageing bias at age 20	0.269	0.144	-0.405	0.212	-0.327	0.161	0.407	0.151	0.394	0.146	0.321	0.143	0.274	0.141	0.388	0.153
ln(mean post-1976 recruits)	13.048	0.101	13.113	0.129	12.735	0.085	12.874	0.112	12.997	0.106	13.015	0.101	13.337	0.090	12.346	0.199
SD of ln(recruitment) devs	0.664	0.068					0.632	0.067	0.646	0.068	0.659	0.063	0.632	0.065	0.504	0.055
ln(pre-1977 recruits offset)	-1.148	0.208	-1.442	0.135	-0.977	0.201	-0.693	0.197	-0.908	0.214	-1.337	0.192	-1.006	0.224	-0.471	0.155
Initial fishing mortality rate	0.183	0.072	0.469	0.316	1.691	0.886	0.129	0.033	0.150	0.046	0.313	0.173	0.144	0.051	0.178	0.054
ln(EBS std. area catchability)	-0.021	0.062	0.042	0.063	0.182	0.056	0.215	0.080	0.072	0.068	0.008	0.059	-0.204	0.082	0.251	0.118
Select. inflection (fishery)	4.309	0.043					4.420	0.049	4.386	0.048	4.347	0.045	4.349	0.045	4.426	0.049
Select. 95% width (fishery)	1.159	0.031					1.200	0.033	1.184	0.032	1.158	0.032	1.168	0.031	1.212	0.033
Select. inflection (EBS sur.)	1.005	0.006					1.009	0.006	1.008	0.006	1.007	0.006	1.017	0.005	1.005	0.005
Select. 95% width (EBS sur.)	0.287	0.051					0.300	0.055	0.296	0.055	0.287	0.051	0.288	0.052	0.299	0.055

Recruitment deviations (T2.1.14e, 1 of 2)

Quantity	Model 16.6		Model 16.6a		Model 16.6b		Model 16.6c		Model 16.6d		Model 16.6e		Model 16.6f		Model 16.6g	
	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.
ln(recruits) dev 1977	0.959	0.210	0.777	0.307	0.909	0.211	0.928	0.209	0.946	0.208	0.971	0.214	0.937	0.209	0.913	0.213
ln(recruits) dev 1978	0.503	0.252	0.520	0.357	0.464	0.248	0.493	0.245	0.498	0.249	0.510	0.256	0.490	0.250	0.507	0.244
ln(recruits) dev 1979	0.515	0.143	0.082	0.329	0.483	0.143	0.503	0.140	0.521	0.140	0.520	0.146	0.499	0.143	0.510	0.141
ln(recruits) dev 1980	-0.256	0.138	-0.705	0.402	-0.284	0.139	-0.261	0.137	-0.254	0.135	-0.246	0.140	-0.258	0.137	-0.242	0.137
ln(recruits) dev 1981	-0.851	0.142	0.461	0.165	-0.873	0.143	-0.846	0.142	-0.840	0.140	-0.847	0.144	-0.867	0.143	-0.848	0.142
ln(recruits) dev 1982	0.819	0.051	0.297	0.195	0.798	0.054	0.813	0.051	0.809	0.051	0.820	0.054	0.794	0.051	0.810	0.054
ln(recruits) dev 1983	-0.545	0.126	-0.006	0.229	-0.562	0.126	-0.548	0.125	-0.514	0.122	-0.546	0.127	-0.558	0.126	-0.532	0.124
ln(recruits) dev 1984	0.808	0.050	0.636	0.102	0.803	0.050	0.801	0.050	0.791	0.051	0.800	0.052	0.797	0.050	0.797	0.052
ln(recruits) dev 1985	-0.159	0.090	-0.041	0.108	-0.211	0.096	-0.161	0.089	-0.165	0.089	-0.162	0.091	-0.172	0.090	-0.138	0.090
ln(recruits) dev 1986	-0.563	0.102	-0.678	0.122	-0.623	0.119	-0.562	0.101	-0.555	0.100	-0.554	0.103	-0.557	0.101	-0.538	0.102
ln(recruits) dev 1987	-1.436	0.180	-1.202	0.177	-1.216	0.184	-1.416	0.178	-1.418	0.175	-1.389	0.179	-1.407	0.179	-1.371	0.177
ln(recruits) dev 1988	-0.414	0.095	-0.354	0.099	-0.332	0.100	-0.403	0.095	-0.447	0.096	-0.359	0.096	-0.390	0.095	-0.363	0.095
ln(recruits) dev 1989	0.578	0.057	0.532	0.057	0.552	0.057	0.583	0.056	0.573	0.056	0.566	0.059	0.581	0.056	0.559	0.058
ln(recruits) dev 1990	0.378	0.063	0.370	0.061	0.383	0.062	0.386	0.063	0.364	0.063	0.359	0.064	0.372	0.063	0.370	0.063
ln(recruits) dev 1991	-0.069	0.076	-0.085	0.075	-0.070	0.076	-0.051	0.076	-0.058	0.075	-0.092	0.077	-0.074	0.076	-0.085	0.077
ln(recruits) dev 1992	0.783	0.038	0.774	0.038	0.788	0.037	0.802	0.038	0.774	0.038	0.763	0.039	0.782	0.038	0.768	0.039
ln(recruits) dev 1993	-0.099	0.057	-0.111	0.057	-0.098	0.057	-0.080	0.057	-0.129	0.058	-0.119	0.058	-0.104	0.057	-0.105	0.058
ln(recruits) dev 1994	-0.302	0.062	-0.317	0.061	-0.304	0.061	-0.275	0.062	-0.323	0.062	-0.312	0.062	-0.305	0.061	-0.305	0.062
ln(recruits) dev 1995	-0.391	0.069	-0.409	0.069	-0.391	0.069	-0.327	0.069	-0.424	0.070	-0.395	0.070	-0.392	0.069	-0.391	0.069
ln(recruits) dev 1996	0.627	0.037	0.625	0.037	0.642	0.037	0.650	0.038	0.626	0.037	0.625	0.038	0.621	0.037	0.626	0.038
ln(recruits) dev 1997	-0.177	0.059	-0.186	0.060	-0.178	0.060	-0.157	0.060	-0.175	0.059	-0.184	0.060	-0.182	0.059	-0.170	0.060
ln(recruits) dev 1998	-0.212	0.063	-0.216	0.063	-0.201	0.063	-0.124	0.063	-0.251	0.064	-0.219	0.064	-0.208	0.063	-0.207	0.063
ln(recruits) dev 1999	0.523	0.039	0.519	0.039	0.535	0.039	0.558	0.040	0.494	0.039	0.507	0.041	0.520	0.039	0.517	0.040
ln(recruits) dev 2000	0.255	0.043	0.243	0.043	0.253	0.043	0.256	0.043	0.248	0.043	0.237	0.044	0.252	0.043	0.258	0.044
ln(recruits) dev 2001	-0.542	0.066	-0.552	0.066	-0.539	0.066	-0.535	0.066	-0.567	0.066	-0.553	0.067	-0.542	0.066	-0.527	0.066
ln(recruits) dev 2002	-0.263	0.052	-0.260	0.052	-0.250	0.052	-0.296	0.054	-0.250	0.051	-0.277	0.054	-0.262	0.052	-0.250	0.053
ln(recruits) dev 2003	-0.431	0.056	-0.425	0.055	-0.412	0.055	-0.453	0.056	-0.433	0.055	-0.449	0.057	-0.427	0.056	-0.419	0.057
ln(recruits) dev 2004	-0.604	0.061	-0.603	0.061	-0.593	0.061	-0.635	0.062	-0.561	0.060	-0.630	0.063	-0.596	0.061	-0.596	0.062
ln(recruits) dev 2005	-0.306	0.055	-0.320	0.055	-0.304	0.055	-0.340	0.055	-0.291	0.054	-0.324	0.056	-0.297	0.055	-0.302	0.056
ln(recruits) dev 2006	0.827	0.034	0.821	0.034	0.838	0.034	0.782	0.035	0.837	0.034	0.829	0.035	0.832	0.034	0.828	0.034
ln(recruits) dev 2007	-0.003	0.056	-0.015	0.055	0.000	0.056	-0.036	0.056	-0.005	0.057	-0.002	0.057	0.004	0.056	-0.007	0.056
ln(recruits) dev 2008	1.138	0.031	1.117	0.031	1.134	0.031	1.096	0.032	1.138	0.032	1.133	0.032	1.143	0.031	1.124	0.032
ln(recruits) dev 2009	-0.927	0.114	-0.919	0.109	-0.917	0.110	-0.966	0.114	-0.904	0.113	-0.942	0.115	-0.925	0.114	-0.814	0.105
ln(recruits) dev 2010	0.607	0.044	0.594	0.044	0.613	0.044	0.585	0.044	0.593	0.044	0.602	0.047	0.616	0.044	0.613	0.046
ln(recruits) dev 2011	0.986	0.043	0.965	0.042	0.985	0.042	0.970	0.042	0.964	0.043	0.987	0.048	0.992	0.043	1.017	0.046
ln(recruits) dev 2012	0.132	0.066	0.119	0.067	0.141	0.067	0.105	0.067	0.077	0.068	0.135	0.072	0.140	0.066	0.206	0.069
ln(recruits) dev 2013	0.933	0.051	0.913	0.052	0.934	0.052	0.940	0.051	0.935	0.051	0.941	0.061	0.939	0.052	0.982	0.061
ln(recruits) dev 2014	-0.943	0.107	-0.976	0.107	-0.958	0.107	-0.914	0.105	-0.939	0.107	-0.928	0.113	-0.937	0.107	-1.022	0.112
ln(recruits) dev 2015	-0.662	0.105	-0.713	0.107	-0.684	0.107	-0.668	0.106	-0.645	0.104	-0.628	0.114	-0.650	0.105	-0.592	0.096
ln(recruits) dev 2016	-1.220	0.225	-1.270	0.229	-1.253	0.234	-1.196	0.222	-1.040	0.208	-1.148	0.230	-1.200	0.225	-1.580	0.284

Recruitment deviations (T2.1.14e, 2 of 2)

Quantity	Model 16.6h		Model 17.2		Model 17.6		Model 18.1		Model 18.2		Model 18.3		Model 18.4		Model 18.5	
	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.
ln(recruits) dev 1977	0.893	0.209	0.461	0.152	0.505	0.160	1.058	0.219	1.012	0.215	0.975	0.198	1.050	0.217	0.347	0.319
ln(recruits) dev 1978	0.497	0.239	0.503	0.137	0.471	0.133	0.544	0.245	0.536	0.250	0.479	0.251	0.546	0.259	-0.205	0.348
ln(recruits) dev 1979	0.499	0.139	0.485	0.101	0.432	0.088	0.483	0.143	0.513	0.142	0.522	0.141	0.548	0.145	-0.253	0.305
ln(recruits) dev 1980	-0.246	0.134	-0.280	0.120	-0.786	0.158	-0.247	0.135	-0.248	0.136	-0.253	0.138	-0.234	0.138	-0.128	0.196
ln(recruits) dev 1981	-0.861	0.141	-0.367	0.102	-0.609	0.117	-0.870	0.142	-0.856	0.142	-0.851	0.143	-0.810	0.142	-0.783	0.178
ln(recruits) dev 1982	0.789	0.051	0.724	0.053	0.766	0.050	0.781	0.052	0.802	0.051	0.826	0.051	0.857	0.052	0.853	0.092
ln(recruits) dev 1983	-0.540	0.123	-0.333	0.103	-0.375	0.103	-0.564	0.124	-0.547	0.125	-0.533	0.126	-0.492	0.126	-0.311	0.150
ln(recruits) dev 1984	0.796	0.050	0.669	0.049	0.661	0.052	0.781	0.051	0.796	0.051	0.823	0.050	0.857	0.052	1.089	0.120
ln(recruits) dev 1985	-0.148	0.088	0.085	0.064	0.102	0.065	-0.195	0.089	-0.168	0.089	-0.138	0.090	-0.133	0.089	0.245	0.177
ln(recruits) dev 1986	-0.543	0.101	-0.389	0.076	-0.440	0.080	-0.636	0.103	-0.597	0.102	-0.542	0.102	-0.582	0.102	-0.239	0.182
ln(recruits) dev 1987	-1.391	0.176	-0.949	0.100	-1.254	0.135	-1.475	0.175	-1.462	0.177	-1.417	0.181	-1.460	0.178	-1.063	0.212
ln(recruits) dev 1988	-0.393	0.094	-0.333	0.067	-0.186	0.072	-0.494	0.097	-0.458	0.096	-0.400	0.095	-0.436	0.095	-0.099	0.184
ln(recruits) dev 1989	0.575	0.056	0.458	0.044	0.496	0.048	0.535	0.058	0.553	0.058	0.589	0.056	0.549	0.058	0.864	0.154
ln(recruits) dev 1990	0.383	0.062	0.345	0.047	0.403	0.052	0.362	0.063	0.377	0.063	0.390	0.062	0.350	0.064	0.591	0.123
ln(recruits) dev 1991	-0.066	0.076	-0.153	0.061	-0.243	0.075	-0.073	0.076	-0.072	0.076	-0.068	0.076	-0.074	0.077	0.059	0.096
ln(recruits) dev 1992	0.787	0.038	0.698	0.034	0.718	0.037	0.778	0.040	0.782	0.039	0.766	0.037	0.788	0.039	0.843	0.083
ln(recruits) dev 1993	-0.090	0.057	-0.225	0.059	-0.158	0.060	-0.094	0.058	-0.090	0.058	-0.128	0.057	-0.088	0.059	-0.029	0.103
ln(recruits) dev 1994	-0.297	0.061	-0.417	0.054	-0.338	0.057	-0.297	0.062	-0.300	0.062	-0.357	0.062	-0.299	0.062	-0.239	0.106
ln(recruits) dev 1995	-0.388	0.068	-0.464	0.057	-0.355	0.062	-0.385	0.068	-0.390	0.069	-0.462	0.069	-0.404	0.070	-0.329	0.100
ln(recruits) dev 1996	0.623	0.037	0.454	0.036	0.618	0.038	0.605	0.039	0.619	0.038	0.524	0.041	0.617	0.039	0.647	0.085
ln(recruits) dev 1997	-0.168	0.059	0.084	0.045	0.001	0.058	-0.204	0.060	-0.184	0.060	-0.300	0.063	-0.173	0.061	-0.142	0.100
ln(recruits) dev 1998	-0.198	0.062	-0.002	0.048	-0.144	0.067	-0.247	0.063	-0.230	0.063	-0.356	0.067	-0.198	0.066	-0.155	0.113
ln(recruits) dev 1999	0.530	0.039	0.546	0.035	0.576	0.040	0.475	0.041	0.503	0.040	0.446	0.041	0.570	0.046	0.589	0.107
ln(recruits) dev 2000	0.272	0.043	0.160	0.046	0.170	0.048	0.209	0.045	0.240	0.044	0.052	0.057	0.307	0.050	0.323	0.101
ln(recruits) dev 2001	-0.518	0.065	-0.728	0.067	-0.691	0.076	-0.577	0.066	-0.555	0.066	-0.757	0.077	-0.524	0.069	-0.476	0.105
ln(recruits) dev 2002	-0.237	0.052	-0.204	0.048	-0.036	0.047	-0.311	0.053	-0.287	0.053	-0.472	0.065	-0.285	0.054	-0.254	0.090
ln(recruits) dev 2003	-0.399	0.055	-0.335	0.051	-0.146	0.051	-0.473	0.057	-0.451	0.056	-0.613	0.065	-0.498	0.059	-0.449	0.094
ln(recruits) dev 2004	-0.566	0.061	-0.647	0.061	-0.675	0.061	-0.623	0.062	-0.616	0.061	-0.660	0.062	-0.683	0.064	-0.614	0.100
ln(recruits) dev 2005	-0.279	0.054	-0.477	0.065	-0.428	0.058	-0.307	0.055	-0.309	0.055	-0.253	0.055	-0.393	0.059	-0.313	0.103
ln(recruits) dev 2006	0.829	0.034	0.665	0.042	0.794	0.040	0.851	0.037	0.839	0.035	0.950	0.041	0.753	0.041	0.269	0.151
ln(recruits) dev 2007	-0.003	0.056	0.161	0.057	0.081	0.070	0.043	0.059	0.028	0.057	0.149	0.063	-0.055	0.059	-0.547	0.174
ln(recruits) dev 2008	1.132	0.031	0.993	0.037	1.073	0.036	1.155	0.035	1.166	0.033	1.336	0.048	1.094	0.035	0.562	0.187
ln(recruits) dev 2009	-0.802	0.105	-0.960	0.129	-1.021	0.144	-0.772	0.105	-0.784	0.109	-0.712	0.121	-0.979	0.116	-1.322	0.213
ln(recruits) dev 2010	0.622	0.044	0.543	0.053	0.525	0.053	0.636	0.047	0.614	0.046	0.770	0.053	0.601	0.045	0.078	0.189
ln(recruits) dev 2011	1.017	0.042	0.935	0.049	0.876	0.047	1.042	0.045	1.030	0.043	1.152	0.052	1.030	0.046	0.532	0.158
ln(recruits) dev 2012	0.203	0.064	0.211	0.075	0.009	0.083	0.251	0.067	0.204	0.065	0.300	0.073	0.176	0.069	-0.197	0.148
ln(recruits) dev 2013	0.973	0.051	0.869	0.060	0.778	0.072	1.055	0.056	0.995	0.051	0.999	0.052	0.959	0.052	0.647	0.134
ln(recruits) dev 2014	-1.038	0.105	-0.905	0.137	-0.792	0.127	-0.884	0.107	-0.971	0.105	-0.888	0.107	-0.944	0.106	-0.015	0.172
ln(recruits) dev 2015	-0.611	0.086	-0.745	0.126	-1.016	0.147	-0.390	0.092	-0.519	0.086	-0.623	0.106	-0.682	0.105	0.425	0.169
ln(recruits) dev 2016	-1.639	0.278	-1.135	0.206	-0.360	0.470	-1.524	0.279	-1.518	0.304	-1.262	0.226	-1.227	0.223	-0.803	0.288

Migration rates in Model 18.1 (T2.1.17a)

Year	Source	Dest.	0	1	2	3	4	5	6	7	8	9	10	11	12
2007	EBS	EBS	0.712	0.712	0.712	0.712	0.712	0.601	0.478	0.358	0.254	0.254	0.254	0.254	0.254
2007	EBS	NBS	0.288	0.288	0.288	0.288	0.288	0.399	0.522	0.642	0.746	0.746	0.746	0.746	0.746
2007	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.663	0.663	0.663	0.663	0.663
2007	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.337	0.337	0.337	0.337	0.337
2008	EBS	EBS	0.572	0.572	0.572	0.572	0.572	0.472	0.374	0.286	0.211	0.211	0.211	0.211	0.211
2008	EBS	NBS	0.428	0.428	0.428	0.428	0.428	0.528	0.626	0.714	0.789	0.789	0.789	0.789	0.789
2008	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.545	0.545	0.545	0.545	0.545
2008	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.455	0.455	0.455	0.455	0.455
2009	EBS	EBS	0.975	0.975	0.975	0.975	0.975	0.915	0.749	0.453	0.186	0.186	0.186	0.186	0.186
2009	EBS	NBS	0.025	0.025	0.025	0.025	0.025	0.085	0.251	0.547	0.814	0.814	0.814	0.814	0.814
2009	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.560	0.560	0.560	0.560	0.560
2009	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.440	0.440	0.440	0.440	0.440
2010	EBS	EBS	0.792	0.792	0.792	0.792	0.792	0.685	0.554	0.415	0.288	0.288	0.288	0.288	0.288
2010	EBS	NBS	0.208	0.208	0.208	0.208	0.208	0.315	0.446	0.585	0.712	0.712	0.712	0.712	0.712
2010	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.610	0.610	0.610	0.610	0.610
2010	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.390	0.390	0.390	0.390	0.390
2011	EBS	EBS	0.753	0.753	0.753	0.753	0.753	0.628	0.483	0.341	0.223	0.223	0.223	0.223	0.223
2011	EBS	NBS	0.247	0.247	0.247	0.247	0.247	0.372	0.517	0.659	0.777	0.777	0.777	0.777	0.777
2011	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.552	0.552	0.552	0.552	0.552
2011	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.448	0.448	0.448	0.448	0.448
2012	EBS	EBS	0.823	0.823	0.823	0.823	0.823	0.681	0.494	0.309	0.170	0.170	0.170	0.170	0.170
2012	EBS	NBS	0.177	0.177	0.177	0.177	0.177	0.319	0.506	0.691	0.830	0.830	0.830	0.830	0.830
2012	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.531	0.531	0.531	0.531	0.531
2012	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.469	0.469	0.469	0.469	0.469
2013	EBS	EBS	0.853	0.853	0.853	0.853	0.853	0.724	0.542	0.349	0.195	0.195	0.195	0.195	0.195
2013	EBS	NBS	0.147	0.147	0.147	0.147	0.147	0.276	0.458	0.651	0.805	0.805	0.805	0.805	0.805
2013	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.474	0.474	0.474	0.474	0.474
2013	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.526	0.526	0.526	0.526	0.526
2014	EBS	EBS	0.837	0.837	0.837	0.837	0.837	0.707	0.530	0.346	0.198	0.198	0.198	0.198	0.198
2014	EBS	NBS	0.163	0.163	0.163	0.163	0.163	0.293	0.470	0.654	0.802	0.802	0.802	0.802	0.802
2014	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.496	0.496	0.496	0.496	0.496
2014	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.504	0.504	0.504	0.504	0.504
2015	EBS	EBS	0.843	0.843	0.843	0.843	0.843	0.696	0.494	0.294	0.151	0.151	0.151	0.151	0.151
2015	EBS	NBS	0.157	0.157	0.157	0.157	0.157	0.304	0.506	0.706	0.849	0.849	0.849	0.849	0.849
2015	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.530	0.530	0.530	0.530	0.530
2015	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.470	0.470	0.470	0.470	0.470
2016	EBS	EBS	0.484	0.484	0.484	0.484	0.484	0.383	0.291	0.213	0.152	0.152	0.152	0.152	0.152
2016	EBS	NBS	0.516	0.516	0.516	0.516	0.516	0.617	0.709	0.787	0.848	0.848	0.848	0.848	0.848
2016	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.630	0.630	0.630	0.630	0.630
2016	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.370	0.370	0.370	0.370	0.370

Migration rates in Model 18.2 (T2.1.17b)

Year	Source	Dest.	0	1	2	3	4	5	6	7	8	9	10	11	12
2007	EBS	EBS	0.959	0.959	0.959	0.959	0.959	0.917	0.838	0.709	0.535	0.535	0.535	0.535	0.535
2007	EBS	NBS	0.041	0.041	0.041	0.041	0.041	0.083	0.162	0.291	0.465	0.465	0.465	0.465	0.465
2007	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.890	0.890	0.890	0.890	0.890
2007	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.110	0.110	0.110	0.110	0.110
2008	EBS	EBS	0.943	0.943	0.943	0.943	0.943	0.894	0.811	0.685	0.524	0.524	0.524	0.524	0.524
2008	EBS	NBS	0.057	0.057	0.057	0.057	0.057	0.106	0.189	0.315	0.476	0.476	0.476	0.476	0.476
2008	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.768	0.768	0.768	0.768	0.768
2008	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.232	0.232	0.232	0.232	0.232
2009	EBS	EBS	0.996	0.996	0.996	0.996	0.996	0.980	0.909	0.663	0.281	0.281	0.281	0.281	0.281
2009	EBS	NBS	0.004	0.004	0.004	0.004	0.004	0.020	0.091	0.337	0.719	0.719	0.719	0.719	0.719
2009	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.763	0.763	0.763	0.763	0.763
2009	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.237	0.237	0.237	0.237	0.237
2010	EBS	EBS	0.725	0.725	0.725	0.725	0.725	0.697	0.668	0.638	0.606	0.606	0.606	0.606	0.606
2010	EBS	NBS	0.275	0.275	0.275	0.275	0.275	0.303	0.332	0.362	0.394	0.394	0.394	0.394	0.394
2010	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.708	0.708	0.708	0.708	0.708
2010	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.292	0.292	0.292	0.292	0.292
2011	EBS	EBS	0.982	0.982	0.982	0.982	0.982	0.958	0.903	0.792	0.610	0.610	0.610	0.610	0.610
2011	EBS	NBS	0.018	0.018	0.018	0.018	0.018	0.042	0.097	0.208	0.390	0.390	0.390	0.390	0.390
2011	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.880	0.880	0.880	0.880	0.880
2011	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120	0.120	0.120	0.120	0.120
2012	EBS	EBS	0.970	0.970	0.970	0.970	0.970	0.926	0.827	0.649	0.415	0.415	0.415	0.415	0.415
2012	EBS	NBS	0.030	0.030	0.030	0.030	0.030	0.074	0.173	0.351	0.585	0.585	0.585	0.585	0.585
2012	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.779	0.779	0.779	0.779	0.779
2012	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.221	0.221	0.221	0.221	0.221
2013	EBS	EBS	0.970	0.970	0.970	0.970	0.970	0.925	0.825	0.644	0.410	0.410	0.410	0.410	0.410
2013	EBS	NBS	0.030	0.030	0.030	0.030	0.030	0.075	0.175	0.356	0.590	0.590	0.590	0.590	0.590
2013	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.731	0.731	0.731	0.731	0.731
2013	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.269	0.269	0.269	0.269	0.269
2014	EBS	EBS	0.958	0.958	0.958	0.958	0.958	0.914	0.832	0.697	0.517	0.517	0.517	0.517	0.517
2014	EBS	NBS	0.042	0.042	0.042	0.042	0.042	0.086	0.168	0.303	0.483	0.483	0.483	0.483	0.483
2014	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.661	0.661	0.661	0.661	0.661
2014	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.339	0.339	0.339	0.339	0.339
2015	EBS	EBS	0.866	0.866	0.866	0.866	0.866	0.742	0.561	0.363	0.202	0.202	0.202	0.202	0.202
2015	EBS	NBS	0.134	0.134	0.134	0.134	0.134	0.258	0.439	0.637	0.798	0.798	0.798	0.798	0.798
2015	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.924	0.924	0.924	0.924	0.924
2015	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.076	0.076	0.076	0.076	0.076
2016	EBS	EBS	0.738	0.738	0.738	0.738	0.738	0.671	0.597	0.518	0.438	0.438	0.438	0.438	0.438
2016	EBS	NBS	0.262	0.262	0.262	0.262	0.262	0.329	0.403	0.482	0.562	0.562	0.562	0.562	0.562
2016	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.989	0.989	0.989	0.989	0.989
2016	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.011	0.011	0.011	0.011

Migration rates in Model 18.5 (T2.1.17c)

Year	Source	Dest.	0	1	2	3	4	5	6	7	8	9	10	11	12
2007	EBS	EBS	0.737	0.737	0.737	0.737	0.737	0.631	0.510	0.389	0.280	0.280	0.280	0.280	0.280
2007	EBS	NBS	0.263	0.263	0.263	0.263	0.263	0.369	0.490	0.611	0.720	0.720	0.720	0.720	0.720
2007	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.711	0.711	0.711	0.711	0.711
2007	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.289	0.289	0.289	0.289	0.289
2008	EBS	EBS	0.643	0.643	0.643	0.643	0.643	0.536	0.426	0.323	0.235	0.235	0.235	0.235	0.235
2008	EBS	NBS	0.357	0.357	0.357	0.357	0.357	0.464	0.574	0.677	0.765	0.765	0.765	0.765	0.765
2008	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.610	0.610	0.610	0.610	0.610
2008	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.390	0.390	0.390	0.390	0.390
2009	EBS	EBS	0.978	0.978	0.978	0.978	0.978	0.925	0.772	0.482	0.203	0.203	0.203	0.203	0.203
2009	EBS	NBS	0.022	0.022	0.022	0.022	0.022	0.075	0.228	0.518	0.797	0.797	0.797	0.797	0.797
2009	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.598	0.598	0.598	0.598	0.598
2009	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.402	0.402	0.402	0.402	0.402
2010	EBS	EBS	0.818	0.818	0.818	0.818	0.818	0.712	0.578	0.430	0.295	0.295	0.295	0.295	0.295
2010	EBS	NBS	0.182	0.182	0.182	0.182	0.182	0.288	0.422	0.570	0.705	0.705	0.705	0.705	0.705
2010	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.653	0.653	0.653	0.653	0.653
2010	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.347	0.347	0.347	0.347	0.347
2011	EBS	EBS	0.793	0.793	0.793	0.793	0.793	0.674	0.527	0.375	0.245	0.245	0.245	0.245	0.245
2011	EBS	NBS	0.207	0.207	0.207	0.207	0.207	0.326	0.473	0.625	0.755	0.755	0.755	0.755	0.755
2011	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.598	0.598	0.598	0.598	0.598
2011	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.402	0.402	0.402	0.402	0.402
2012	EBS	EBS	0.842	0.842	0.842	0.842	0.842	0.711	0.532	0.345	0.195	0.195	0.195	0.195	0.195
2012	EBS	NBS	0.158	0.158	0.158	0.158	0.158	0.289	0.468	0.655	0.805	0.805	0.805	0.805	0.805
2012	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.583	0.583	0.583	0.583	0.583
2012	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.417	0.417	0.417	0.417	0.417
2013	EBS	EBS	0.861	0.861	0.861	0.861	0.861	0.735	0.555	0.359	0.201	0.201	0.201	0.201	0.201
2013	EBS	NBS	0.139	0.139	0.139	0.139	0.139	0.265	0.445	0.641	0.799	0.799	0.799	0.799	0.799
2013	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.527	0.527	0.527	0.527	0.527
2013	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.473	0.473	0.473	0.473	0.473
2014	EBS	EBS	0.847	0.847	0.847	0.847	0.847	0.719	0.542	0.354	0.203	0.203	0.203	0.203	0.203
2014	EBS	NBS	0.153	0.153	0.153	0.153	0.153	0.281	0.458	0.646	0.797	0.797	0.797	0.797	0.797
2014	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.539	0.539	0.539	0.539	0.539
2014	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.461	0.461	0.461	0.461	0.461
2015	EBS	EBS	0.846	0.846	0.846	0.846	0.846	0.703	0.504	0.305	0.159	0.159	0.159	0.159	0.159
2015	EBS	NBS	0.154	0.154	0.154	0.154	0.154	0.297	0.496	0.695	0.841	0.841	0.841	0.841	0.841
2015	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.552	0.552	0.552	0.552	0.552
2015	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.448	0.448	0.448	0.448	0.448
2016	EBS	EBS	0.514	0.514	0.514	0.514	0.514	0.415	0.322	0.241	0.176	0.176	0.176	0.176	0.176
2016	EBS	NBS	0.486	0.486	0.486	0.486	0.486	0.585	0.678	0.759	0.824	0.824	0.824	0.824	0.824
2016	NBS	EBS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.689	0.689	0.689	0.689	0.689
2016	NBS	NBS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.311	0.311	0.311	0.311	0.311

Catchability (T2.1.18)

Area	Year	M16.6	M16.6a	M16.6b	M16.6c	M16.6d	M16.6e	M16.6f	M16.6g	M16.6h	M17.2	M17.6	M18.1	M18.2	M18.3	M18.4	M18.5
EBS	1982	0.929		0.995	0.943	0.913	0.872	0.904	0.920	0.931	1.043	1.316	1.240	1.074	1.008	0.816	1.260
EBS	1983	0.929		0.995	0.943	0.913	0.951	1.070	0.998	1.101	1.043	1.334	1.240	1.074	1.008	0.816	1.348
EBS	1984	0.929		0.995	0.943	0.913	0.867	1.001	0.911	1.030	1.043	1.244	1.240	1.074	1.008	0.816	1.312
EBS	1985	0.929		0.995	0.943	0.913	0.954	0.917	0.997	0.944	1.043	1.276	1.240	1.074	1.008	0.816	1.267
EBS	1986	0.929		0.995	0.943	0.913	0.954	1.037	0.997	1.067	1.043	1.288	1.240	1.074	1.008	0.816	1.331
EBS	1987	0.929	*0.994*	*0.990*	0.943	0.913	0.948	1.008	0.988	1.038	1.043	1.207	1.240	1.074	1.008	0.816	1.316
EBS	1988	0.929	*0.994*	*0.990*	0.943	0.913	0.937	0.958	0.974	0.986	1.043	1.145	1.240	1.074	1.008	0.816	1.290
EBS	1989	0.929	*0.994*	*0.990*	0.943	0.913	0.734	0.880	0.760	0.906	1.043	0.984	1.240	1.074	1.008	0.816	1.246
EBS	1990	0.929	*0.994*	*0.990*	0.943	0.913	0.836	0.898	0.872	0.924	1.043	1.012	1.240	1.074	1.008	0.816	1.256
EBS	1991	0.929	*0.994*	*0.990*	0.943	0.913	0.824	0.891	0.858	0.917	1.043	1.051	1.240	1.074	1.008	0.816	1.252
EBS	1992	0.929	*0.994*	*0.990*	0.943	0.913	0.897	0.997	0.935	1.026	1.043	1.115	1.240	1.074	1.008	0.816	1.310
EBS	1993	0.929	*0.994*	*0.990*	0.943	0.913	0.973	0.944	1.015	0.972	1.043	1.274	1.240	1.074	1.008	0.816	1.282
EBS	1994	0.929	*0.994*	*0.990*	0.943	0.913	1.134	0.909	1.188	0.936	1.043	1.499	1.240	1.074	1.008	0.816	1.263
EBS	1995	0.929	*0.994*	*0.990*	0.943	0.913	1.026	0.949	1.071	0.977	1.043	1.455	1.240	1.074	1.008	0.816	1.284
EBS	1996	0.929	*0.994*	*0.990*	0.943	0.913	0.973	0.966	1.014	0.995	1.043	1.359	1.240	1.074	1.008	0.816	1.294
EBS	1997	0.929	*0.994*	*0.990*	0.943	0.913	0.879	0.946	0.915	0.974	1.043	1.242	1.240	1.074	1.008	0.816	1.283
EBS	1998	0.929	*0.994*	*0.990*	0.943	0.913	0.854	1.020	0.890	1.050	1.043	1.178	1.240	1.074	1.008	0.816	1.322
EBS	1999	0.929	*0.994*	*0.990*	0.943	0.913	0.878	0.929	0.913	0.957	1.043	1.152	1.240	1.074	1.008	0.816	1.274
EBS	2000	0.929	*0.994*	*0.990*	0.943	0.913	0.831	0.951	0.863	0.979	1.043	1.124	1.240	1.074	1.008	0.816	1.286
EBS	2001	0.929	*0.994*	*0.990*	0.943	0.913	1.133	0.982	1.182	1.011	1.043	1.251	1.240	1.074	1.008	0.816	1.302
EBS	2002	0.929	*0.994*	*0.990*	0.943	0.913	0.883	0.935	0.915	0.962	1.043	1.151	1.240	1.074	1.008	0.816	1.277
EBS	2003	0.929	*0.994*	*0.990*	0.943	0.913	0.921	1.030	0.954	1.060	1.043	1.127	1.240	1.074	1.008	0.816	1.328
EBS	2004	0.929	*0.994*	*0.990*	0.943	0.913	0.873	0.949	0.899	0.977	1.043	1.074	1.240	1.074	1.008	0.816	1.284
EBS	2005	0.929	*0.994*	*0.990*	0.943	0.913	0.978	0.958	1.013	0.986	1.043	1.102	1.240	1.074	1.008	0.816	1.289
EBS	2006	0.929	*0.994*	*0.990*	0.943	0.913	1.010	0.915	1.036	0.942	1.043	1.073	1.240	1.074	1.008	0.816	1.266
EBS	2007	0.929	*0.994*	*0.990*	0.943	0.913	0.959	0.921	0.999	0.948	1.043	1.084	1.240	1.074	1.008	0.816	1.269
EBS	2008	0.929	*0.994*	*0.990*	0.943	0.913	0.805	0.932	0.837	0.960	1.043	1.017	1.240	1.074	1.008	0.816	1.275
EBS	2009	0.929	*0.994*	*0.990*	0.943	0.913	0.853	0.845	0.891	0.870	1.043	1.036	1.240	1.074	1.008	0.816	1.226
EBS	2010	0.929	*0.994*	*0.990*	0.943	0.913	0.942	0.996	0.983	1.025	1.043	1.178	1.240	1.074	1.008	0.816	1.310
EBS	2011	0.929	*0.994*	*0.990*	0.943	0.913	0.972	0.893	1.010	0.919	1.043	1.230	1.240	1.074	1.008	0.816	1.253
EBS	2012	0.929	*0.994*	*0.990*	0.943	0.913	0.965	0.910	1.000	0.937	1.043	1.244	1.240	1.074	1.008	0.816	1.263
EBS	2013	0.929	*0.994*	*0.990*	0.943	0.913	0.871	0.910	0.900	0.937	1.043	1.247	1.240	1.074	1.008	0.816	1.263
EBS	2014	0.929	*0.994*	*0.990*	0.943	0.913	0.980	0.921	1.009	0.948	1.043	1.351	1.240	1.074	1.008	0.816	1.269
EBS	2015	0.929	*0.994*	*0.990*	0.943	0.913	0.975	0.964	1.005	0.993	1.043	1.375	1.240	1.074	1.008	0.816	1.293
EBS	2016	0.929	*0.994*	*0.990*	0.943	0.913	0.930	0.994	0.956	1.023	1.043	1.300	1.240	1.074	1.008	0.816	1.309
EBS	2017	0.929	*0.994*	*0.990*	0.943	0.913	0.785	0.910	0.815	0.937	1.043	1.171	1.240	1.074	1.008	0.816	1.263
NBS	2010								0.013	0.013			0.457	1.030			0.526
NBS	2017								0.261	0.272			0.457	1.030			0.526

Base selectivity at age (T2.1.19, partial)

Fishery:

Age	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000
2	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.008	0.012	0.003	0.003	0.003	0.003	0.003
3	0.032	0.032	0.032	0.032	0.034	0.032	0.032	0.035	0.035	0.063	0.067	0.030	0.031	0.031	0.032	0.030
4	0.292	0.289	0.288	0.290	0.300	0.291	0.290	0.314	0.313	0.322	0.297	0.263	0.277	0.292	0.293	0.262
5	0.838	0.832	0.833	0.835	0.841	0.837	0.836	0.853	0.852	0.796	0.743	0.806	0.822	0.840	0.838	0.801
6	0.985	0.984	0.984	0.984	0.985	0.985	0.984	0.987	0.987	0.982	0.976	0.980	0.982	0.985	0.985	0.979
7	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	1.000	0.999	0.998	0.999	0.999	0.999	0.998
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

EBS survey:

Age	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.477	0.493	0.484	0.481	0.479	0.475	0.482	0.482	0.487	0.414	0.467	0.479	0.479	0.482	0.455	0.489
2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.907	1.000	1.000	1.000	1.000	1.000	1.000

NBS survey:

Age	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
0								0.000	0.000			0.001	0.002			0.002
1								0.294	0.311			0.577	0.406			0.552
2								0.999	0.999			1.000	0.996			0.999
3								1.000	1.000			1.000	1.000			1.000

Depletion (T2.1.21, 1 of 2)

	16.6		16.6a		16.6b		16.6c		16.6d		16.6e		16.6f		16.6g	
Year	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.
1977	0.098	0.037	0.107	0.051	0.091	0.035	0.096	0.036	0.103	0.038	0.105	0.040	0.095	0.036	0.097	0.037
1978	0.095	0.037	0.105	0.052	0.088	0.034	0.093	0.036	0.101	0.038	0.103	0.040	0.092	0.035	0.095	0.037
1979	0.097	0.035	0.105	0.051	0.088	0.033	0.094	0.034	0.102	0.037	0.105	0.039	0.093	0.034	0.095	0.036
1980	0.129	0.037	0.131	0.053	0.116	0.035	0.125	0.036	0.135	0.038	0.138	0.040	0.123	0.035	0.125	0.037
1981	0.210	0.042	0.198	0.058	0.189	0.041	0.203	0.040	0.217	0.043	0.222	0.047	0.201	0.040	0.202	0.043
1982	0.365	0.054	0.325	0.070	0.329	0.056	0.351	0.053	0.374	0.055	0.381	0.063	0.349	0.053	0.350	0.058
1983	0.523	0.066	0.452	0.080	0.475	0.070	0.503	0.064	0.533	0.067	0.543	0.076	0.502	0.064	0.502	0.072
1984	0.558	0.062	0.473	0.073	0.510	0.069	0.539	0.061	0.568	0.063	0.577	0.073	0.537	0.061	0.539	0.069
1985	0.634	0.067	0.536	0.079	0.581	0.075	0.614	0.066	0.645	0.067	0.655	0.078	0.611	0.066	0.615	0.075
1986	0.614	0.061	0.537	0.075	0.564	0.070	0.596	0.061	0.625	0.061	0.634	0.072	0.592	0.060	0.597	0.070
1987	0.598	0.056	0.542	0.070	0.552	0.064	0.583	0.055	0.609	0.056	0.617	0.066	0.577	0.055	0.584	0.064
1988	0.634	0.055	0.580	0.069	0.588	0.064	0.619	0.055	0.644	0.055	0.652	0.065	0.611	0.055	0.619	0.064
1989	0.614	0.052	0.563	0.063	0.570	0.060	0.600	0.052	0.622	0.051	0.630	0.060	0.591	0.051	0.601	0.059
1990	0.559	0.044	0.513	0.053	0.520	0.051	0.547	0.045	0.565	0.044	0.573	0.051	0.538	0.044	0.548	0.051
1991	0.447	0.034	0.414	0.040	0.418	0.039	0.439	0.034	0.452	0.034	0.460	0.039	0.432	0.034	0.442	0.039
1992	0.317	0.026	0.295	0.030	0.297	0.029	0.312	0.026	0.321	0.026	0.329	0.030	0.307	0.026	0.315	0.029
1993	0.294	0.025	0.276	0.029	0.277	0.028	0.290	0.026	0.299	0.025	0.308	0.029	0.286	0.025	0.294	0.029
1994	0.308	0.025	0.289	0.029	0.291	0.028	0.304	0.025	0.313	0.025	0.321	0.029	0.300	0.025	0.306	0.028
1995	0.342	0.027	0.321	0.031	0.323	0.030	0.340	0.028	0.348	0.027	0.353	0.031	0.334	0.027	0.337	0.030
1996	0.342	0.028	0.319	0.032	0.322	0.031	0.341	0.029	0.347	0.028	0.350	0.031	0.333	0.028	0.334	0.031
1997	0.329	0.027	0.307	0.031	0.310	0.030	0.330	0.028	0.333	0.027	0.335	0.030	0.320	0.027	0.320	0.029
1998	0.291	0.026	0.270	0.029	0.273	0.028	0.295	0.027	0.294	0.025	0.295	0.028	0.282	0.025	0.281	0.027
1999	0.283	0.026	0.263	0.029	0.265	0.028	0.283	0.026	0.285	0.025	0.286	0.028	0.274	0.025	0.272	0.027
2000	0.293	0.027	0.273	0.030	0.276	0.029	0.300	0.028	0.297	0.027	0.298	0.029	0.284	0.026	0.283	0.028
2001	0.304	0.027	0.285	0.030	0.288	0.029	0.313	0.028	0.308	0.027	0.309	0.029	0.295	0.027	0.295	0.029
2002	0.325	0.027	0.306	0.031	0.309	0.030	0.336	0.029	0.329	0.027	0.331	0.030	0.315	0.027	0.316	0.029
2003	0.324	0.027	0.306	0.030	0.309	0.029	0.337	0.028	0.327	0.027	0.330	0.029	0.315	0.027	0.316	0.029
2004	0.329	0.026	0.312	0.030	0.314	0.029	0.335	0.027	0.332	0.026	0.334	0.028	0.320	0.026	0.322	0.028
2005	0.326	0.025	0.310	0.029	0.312	0.028	0.325	0.025	0.329	0.025	0.330	0.027	0.317	0.025	0.319	0.027
2006	0.288	0.022	0.274	0.025	0.276	0.024	0.283	0.022	0.291	0.022	0.290	0.024	0.280	0.022	0.282	0.024
2007	0.243	0.019	0.232	0.022	0.234	0.021	0.236	0.019	0.248	0.020	0.245	0.020	0.237	0.019	0.240	0.021
2008	0.207	0.017	0.198	0.019	0.200	0.018	0.198	0.016	0.213	0.017	0.209	0.018	0.202	0.017	0.205	0.018
2009	0.191	0.016	0.182	0.018	0.183	0.018	0.179	0.015	0.198	0.017	0.192	0.017	0.186	0.016	0.189	0.017
2010	0.205	0.018	0.194	0.020	0.196	0.019	0.192	0.017	0.214	0.019	0.207	0.019	0.201	0.018	0.203	0.019
2011	0.271	0.023	0.256	0.026	0.258	0.025	0.253	0.022	0.281	0.023	0.275	0.025	0.266	0.023	0.267	0.025
2012	0.322	0.028	0.302	0.031	0.305	0.030	0.297	0.027	0.332	0.028	0.328	0.030	0.316	0.028	0.316	0.030
2013	0.363	0.032	0.338	0.035	0.342	0.034	0.339	0.031	0.373	0.033	0.371	0.035	0.357	0.033	0.356	0.035
2014	0.374	0.035	0.347	0.037	0.351	0.036	0.348	0.034	0.383	0.035	0.383	0.038	0.368	0.036	0.368	0.038
2015	0.378	0.037	0.349	0.039	0.354	0.038	0.353	0.036	0.385	0.037	0.388	0.042	0.373	0.038	0.376	0.041
2016	0.425	0.043	0.392	0.045	0.398	0.044	0.407	0.043	0.430	0.043	0.437	0.049	0.420	0.044	0.429	0.048
2017	0.461	0.049	0.425	0.050	0.433	0.049	0.443	0.049	0.466	0.049	0.476	0.056	0.457	0.050	0.474	0.056
2018	0.464	0.051	0.428	0.052	0.437	0.051	0.454	0.052	0.470	0.051	0.482	0.060	0.462	0.052	0.485	0.060
2019	0.424	0.050	0.392	0.050	0.401	0.049	0.418	0.051	0.431	0.050	0.443	0.061	0.424	0.051	0.448	0.060

Depletion (T2.1.21, 2 of 2)

	16.6h		17.2		17.6		18.1		18.2		18.3		18.4		18.5	
Year	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.	Est.	StD.
1977	0.090	0.034	0.049	0.020	0.018	0.004	0.201	0.063	0.141	0.050	0.084	0.032	0.129	0.047	0.266	0.078
1978	0.087	0.033	0.055	0.019	0.031	0.006	0.200	0.064	0.138	0.050	0.081	0.032	0.130	0.048	0.266	0.079
1979	0.087	0.032	0.066	0.019	0.042	0.008	0.197	0.061	0.138	0.048	0.082	0.031	0.135	0.048	0.263	0.078
1980	0.115	0.033	0.098	0.022	0.066	0.011	0.223	0.061	0.167	0.049	0.112	0.032	0.178	0.050	0.299	0.077
1981	0.188	0.038	0.162	0.028	0.117	0.017	0.299	0.064	0.245	0.053	0.190	0.037	0.280	0.060	0.402	0.080
1982	0.328	0.050	0.284	0.041	0.212	0.028	0.449	0.075	0.400	0.065	0.338	0.050	0.464	0.081	0.619	0.092
1983	0.476	0.062	0.410	0.053	0.312	0.038	0.602	0.084	0.557	0.075	0.491	0.062	0.639	0.098	0.845	0.101
1984	0.512	0.060	0.452	0.054	0.345	0.040	0.624	0.076	0.591	0.070	0.529	0.059	0.678	0.092	0.906	0.093
1985	0.586	0.064	0.528	0.060	0.399	0.045	0.710	0.082	0.670	0.075	0.603	0.064	0.760	0.095	1.039	0.098
1986	0.569	0.059	0.534	0.057	0.399	0.044	0.685	0.074	0.646	0.068	0.585	0.059	0.735	0.086	1.017	0.089
1987	0.556	0.054	0.543	0.054	0.407	0.043	0.656	0.066	0.626	0.062	0.572	0.054	0.713	0.077	0.986	0.081
1988	0.590	0.055	0.589	0.054	0.448	0.044	0.679	0.064	0.653	0.060	0.608	0.054	0.730	0.074	1.008	0.078
1989	0.573	0.051	0.584	0.051	0.452	0.043	0.652	0.059	0.630	0.056	0.590	0.050	0.694	0.069	0.960	0.072
1990	0.523	0.044	0.537	0.044	0.425	0.038	0.591	0.051	0.574	0.049	0.538	0.044	0.610	0.058	0.857	0.063
1991	0.421	0.034	0.441	0.034	0.355	0.030	0.481	0.041	0.463	0.038	0.430	0.034	0.488	0.044	0.702	0.051
1992	0.298	0.026	0.327	0.026	0.265	0.023	0.357	0.032	0.334	0.029	0.302	0.025	0.349	0.032	0.517	0.039
1993	0.276	0.025	0.312	0.025	0.251	0.022	0.331	0.031	0.309	0.029	0.277	0.024	0.328	0.032	0.480	0.038
1994	0.290	0.025	0.319	0.024	0.260	0.021	0.323	0.029	0.312	0.027	0.291	0.024	0.347	0.034	0.476	0.036
1995	0.323	0.027	0.341	0.024	0.278	0.021	0.345	0.030	0.340	0.029	0.323	0.026	0.391	0.038	0.516	0.039
1996	0.322	0.028	0.324	0.024	0.262	0.020	0.341	0.030	0.340	0.030	0.318	0.027	0.395	0.040	0.513	0.040
1997	0.310	0.027	0.293	0.021	0.235	0.018	0.330	0.030	0.329	0.029	0.301	0.025	0.375	0.039	0.491	0.039
1998	0.273	0.025	0.243	0.019	0.193	0.015	0.302	0.029	0.296	0.028	0.257	0.023	0.336	0.037	0.449	0.037
1999	0.265	0.025	0.224	0.018	0.181	0.015	0.299	0.030	0.290	0.028	0.273	0.024	0.323	0.036	0.438	0.037
2000	0.274	0.026	0.229	0.020	0.188	0.016	0.311	0.031	0.301	0.029	0.258	0.024	0.341	0.038	0.460	0.039
2001	0.285	0.026	0.241	0.021	0.200	0.018	0.316	0.030	0.310	0.029	0.261	0.024	0.358	0.038	0.476	0.040
2002	0.306	0.027	0.277	0.023	0.228	0.020	0.331	0.030	0.328	0.029	0.277	0.025	0.388	0.040	0.511	0.041
2003	0.305	0.027	0.300	0.025	0.242	0.020	0.327	0.029	0.325	0.028	0.270	0.025	0.388	0.038	0.509	0.041
2004	0.312	0.026	0.318	0.025	0.255	0.021	0.328	0.028	0.329	0.028	0.297	0.026	0.385	0.037	0.504	0.040
2005	0.310	0.026	0.315	0.023	0.256	0.020	0.324	0.027	0.325	0.027	0.317	0.026	0.364	0.034	0.484	0.037
2006	0.275	0.023	0.271	0.019	0.226	0.017	0.289	0.025	0.289	0.024	0.291	0.024	0.307	0.029	0.417	0.033
2007	0.234	0.020	0.224	0.016	0.194	0.015	0.250	0.022	0.247	0.021	0.250	0.021	0.256	0.025	0.354	0.029
2008	0.201	0.017	0.189	0.014	0.170	0.013	0.215	0.020	0.211	0.018	0.220	0.019	0.220	0.022	0.304	0.025
2009	0.186	0.017	0.172	0.014	0.154	0.012	0.198	0.019	0.194	0.018	0.204	0.018	0.206	0.022	0.280	0.025
2010	0.199	0.018	0.178	0.016	0.150	0.012	0.207	0.021	0.206	0.019	0.213	0.019	0.233	0.026	0.301	0.027
2011	0.261	0.023	0.236	0.020	0.191	0.014	0.266	0.025	0.268	0.024	0.282	0.024	0.312	0.034	0.394	0.035
2012	0.307	0.028	0.281	0.025	0.223	0.016	0.318	0.031	0.321	0.030	0.340	0.030	0.361	0.041	0.462	0.042
2013	0.346	0.032	0.303	0.028	0.232	0.017	0.365	0.037	0.367	0.035	0.357	0.031	0.410	0.048	0.530	0.051
2014	0.357	0.035	0.310	0.030	0.234	0.018	0.388	0.041	0.387	0.039	0.363	0.033	0.459	0.055	0.600	0.059
2015	0.364	0.038	0.310	0.033	0.221	0.018	0.404	0.045	0.397	0.042	0.360	0.034	0.471	0.059	0.628	0.066
2016	0.414	0.044	0.353	0.040	0.235	0.020	0.460	0.052	0.450	0.048	0.370	0.037	0.515	0.066	0.701	0.075
2017	0.456	0.050	0.389	0.047	0.245	0.024	0.518	0.060	0.499	0.055	0.398	0.043	0.523	0.070	0.749	0.084
2018	0.465	0.052	0.388	0.050	0.231	0.029	0.542	0.064	0.510	0.058	0.373	0.044	0.512	0.071	0.766	0.091
2019	0.428	0.051	0.356	0.049	0.208	0.033	0.529	0.065	0.481	0.057	0.327	0.044	0.461	0.066	0.741	0.093

Spawning biomass in 2-area models (T2.1.23)

- Rows between 1985 and 2005 deleted for presentation purposes

	18.1		18.2		18.5	
Year	EBS	NBS	EBS	NBS	EBS	NBS
1977	84,092	67,563	71,949	24,717	75,116	53,295
1978	75,356	74,958	67,595	27,023	67,468	61,345
1979	84,237	63,865	71,419	22,775	75,099	52,047
1980	99,464	68,778	89,025	25,089	87,427	56,983
1981	145,770	79,107	137,431	30,496	130,049	64,365
1982	218,659	119,801	222,946	50,586	199,665	99,830
1983	280,485	172,608	299,982	81,171	260,102	148,728
1984	275,148	195,028	304,387	99,920	265,669	172,701
1985	277,616	257,017	326,641	131,974	270,355	232,316
2005	150,209	93,861	172,765	49,976	146,985	87,148
2006	132,721	85,202	151,275	46,618	125,412	76,177
2007	111,412	76,991	128,089	40,905	104,855	66,293
2008	100,294	61,866	118,085	26,638	95,337	51,815
2009	86,409	62,529	105,539	27,024	83,850	51,405
2010	128,431	27,704	122,738	17,933	122,298	23,461
2011	130,475	69,491	127,761	55,675	129,066	61,688
2012	172,560	67,220	208,052	11,609	165,084	58,211
2013	187,620	87,470	209,568	41,693	179,341	77,225
2014	191,907	100,465	215,295	49,708	194,187	95,945
2015	202,601	101,516	224,201	47,714	205,605	97,925
2016	215,334	131,085	202,467	105,191	210,917	128,304
2017	206,622	183,581	259,319	82,466	202,227	159,855
2018	283,818	124,452	272,200	76,782	257,827	112,871
2019	199,474	199,108	239,224	89,999	188,490	169,726

Mohn's ρ "acceptability" test (text table)

Model:	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g
M:	0.359	0.348	0.347	0.354	0.363	0.361	0.354	0.353
Min ρ:	-0.206	-0.202	-0.201	-0.204	-0.207	-0.206	-0.204	-0.204
Max ρ:	0.279	0.274	0.274	0.277	0.282	0.280	0.277	0.277
ρ:	0.243	0.202	0.217	0.304	0.222	0.323	0.291	0.359

Model:	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
M:	0.348	0.374	0.312	0.305	0.331	0.349	0.381	0.294
Min ρ:	-0.202	-0.211	-0.189	-0.187	-0.196	-0.202	-0.213	-0.183
Max ρ:	0.274	0.287	0.256	0.252	0.266	0.274	0.290	0.247
ρ:	0.319	0.309	0.069	0.452	0.370	0.118	0.451	0.724

Bridging from M17.2 to M17.6 (1 of 4)

- Features that distinguish Model 17.6 from Model 17.2:
  - M17.6 has time-varying *Lmin*; M17.2 does not
  - M17.6 has ln(recruitment) σ = 0.5928; M17.2 has 0.5771
  - M17.6 has time-varying *Q*; M17.2 does not
  - M17.6 has time-varying survey selectivity peak age; M17.2 does not
  - M17.6 has time-varying survey selectivity asc. width; M17.2 does not
  - M17.6 has fishery peak age deviation σ = 0.1187, M17.2 has 0.1155
  - M17.6 has fishery asc. width deviation σ = 0.4088, M17.2 has 0.4123
  - M17.6 has fishery sizecomp emphasis = 0.1475; M17.2 has 0.2416
  - M17.6 has survey sizecomp emphasis = 1.6603; M17.2 has 0.8665
  - M17.6 has fishery agecomp emphasis = 0.0217; M17.2 has 0.0225
  - M17.6 has survey agecomp emphasis = 0.3172; M17.2 has 0.1353

Bridging from M17.2 to M17.6 (2 of 4)

- Starting from Model 17.2, 11 exploratory runs were made, with one of the 11 features changing from the respective Model 17.2 version to its Model 17.6 counterpart in each
- From this first batch of exploratory runs, the run that resulted in the largest proportional change (absolute value) in 2018 spawning biomass relative to Model 17.2 was denoted “Bridging run 1”
- Bridging run 1 was then used as the starting point for a second batch of exploratory runs, with one of the remaining 10 features changing from the respective Model 17.2 version to its Model 17.6 counterpart in each
- From this batch of exploratory runs, the run that resulted in the largest proportional change (absolute value) in 2018 spawning biomass relative to Bridging run 1 was denoted “Bridging run 2.”
- The above procedure was repeated until all 11 features had been changed from their respective Model 17.2 versions to their Model 17.6 counterparts

Bridging from M17.2 to M17.6 (3 of 4)

- The above procedure resulted in features being added as follows:

Run	Feature changed from preceding run	SB2018	Change
Model 17.2	None (starting point = Model 17.2)	234,705	n/a
Bridging run 1	Turn on time-varying survey selectivity asc. width	191,298	-0.185
Bridging run 2	Change survey sizecomp emphasis	261,465	0.367
Bridging run 3	Turn on time-varying Lmin	179,454	-0.314
Bridging run 4	Turn on time-varying Q	169,748	-0.054
Bridging run 5	Change survey agecomp emphasis	193,042	0.137
Bridging run 6	Turn on time-varying survey selectivity peak age	159,586	-0.173
Bridging run 7	Change fishery sizecomp emphasis	170,705	0.070
Bridging run 8	Change fishery agecomp emphasis	161,866	-0.052
Bridging run 9	Change fishery peak age dev sigma	170,752	0.055
Bridging run 10	Change sigmaR	162,491	-0.048
Model 17.6	Change fishery asc. width dev sigma	162,198	-0.003

Bridging from M17.2 to M17.6 (4 of 4)

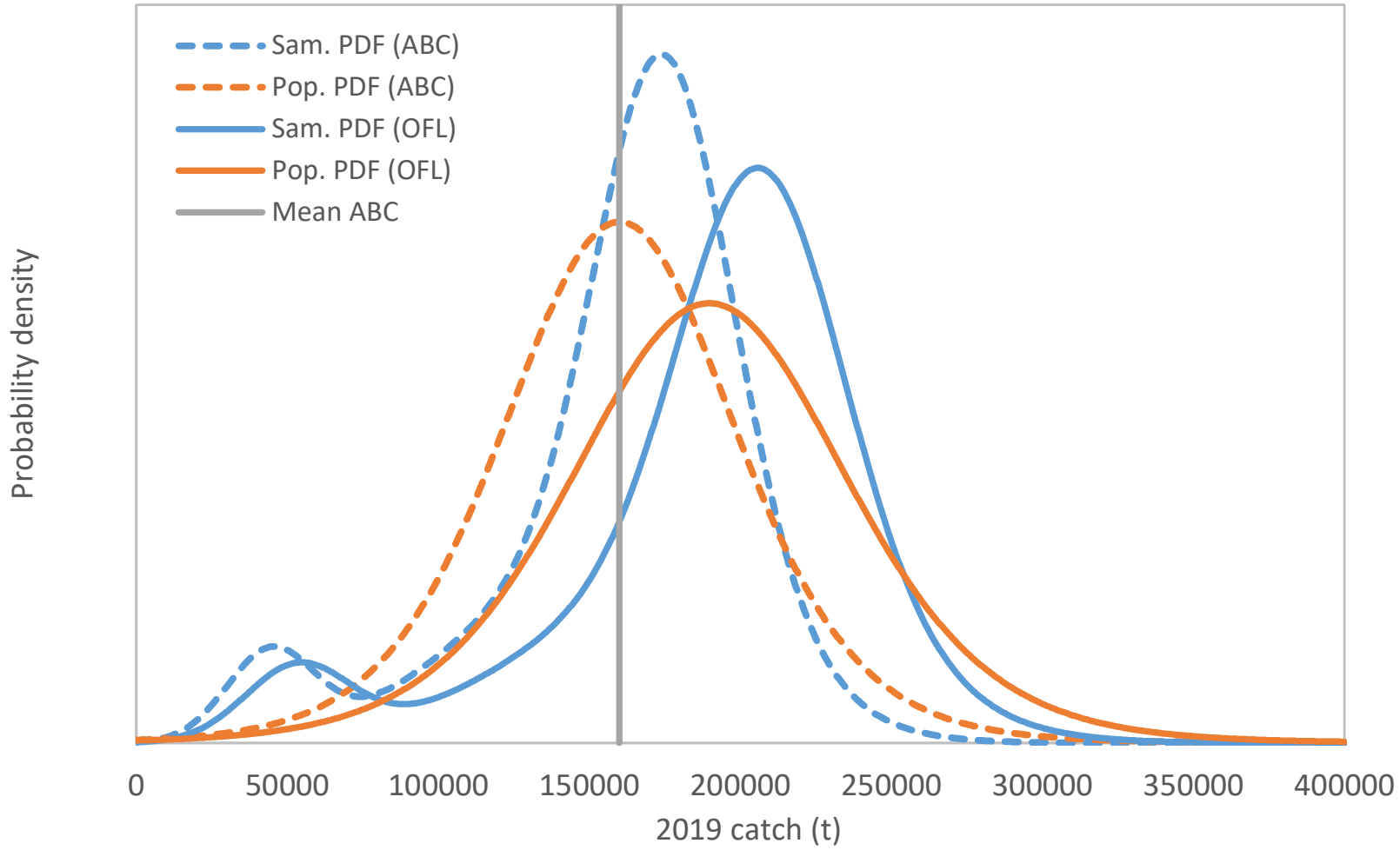
Parameter	Model (17.2, 17.6) or bridging run (BR_#)											
	17.2	BR_1	BR_2	BR_3	BR_4	BR_5	BR_6	BR_7	BR_8	BR_9	BR_10	17.6
Natural mortality (M)	0.3744	0.2073	0.3710	0.2035	0.1927	0.3489	0.3135	0.3376	0.3121	0.3350	0.3134	0.3123
Length at age 1.5 (cm)	16.4454	0.0000	0.0000	0.9297	0.9361	3.8434	16.9604	16.9647	16.9443	16.9647	16.9408	16.9457
Asymptotic length (cm)	109.1790	94.7823	102.7290	88.7880	89.1908	95.6643	109.0650	106.9510	108.4370	107.0670	108.3680	108.4180
Brody growth coefficient (K)	0.1714	0.3094	0.2105	0.3982	0.3954	0.2845	0.1702	0.1743	0.1706	0.1732	0.1707	0.1704
Richards growth coefficient	1.0706	0.4480	0.9078	0.1681	0.1705	0.5946	1.0155	1.0190	1.0167	1.0227	1.0170	1.0180
SD of length at age 1 (cm)	3.4923	2.1786	2.4389	1.5907	1.6042	2.1398	3.1440	3.1363	3.1298	3.1353	3.1298	3.1296
SD of length at age 20 (cm)	8.6749	9.0800	8.7923	9.7222	9.7114	9.0068	9.2613	9.3403	9.4556	9.3526	9.4550	9.4591
Ageing bias at age 1	0.3366	-1.9230	-0.7634	-1.9291	-1.9380	-0.7862	0.3543	0.3605	0.3565	0.3609	0.3567	0.3567
Ageing bias at age 20	-0.4049	-1.6124	-1.1629	-1.5518	-1.5248	-0.7048	-0.3184	-0.3429	-0.3233	-0.3442	-0.3227	-0.3262
ln(mean post-1976 recruits)	13.1126	12.3566	13.4167	12.2750	12.1885	13.1847	12.7322	12.9068	12.7262	12.8926	12.7456	12.7372
ln(pre-1977 recruits offset)	-1.4416	-0.2365	-1.2555	-0.2216	-0.1969	-1.3121	-1.1225	-1.2648	-0.9496	-1.2662	-0.9852	-0.9794
Initial fishing mortality rate	0.4688	1.5970	0.2765	1.8701	1.8781	0.3648	1.4953	0.2676	1.7148	0.2676	1.6817	1.6882
ln(EBS std. area catchability)	0.0418	0.5806	0.0506	0.6239	0.6746	0.2014	0.1948	0.0836	0.1834	0.0877	0.1784	0.1810
Select. peak age (fishery)	5.7405	7.3879	6.5985	7.2167	7.2295	6.3808	5.8968	5.8439	5.8842	5.8530	5.8826	5.8845
Select. asc. wid. (fishery)	0.9224	0.6942	0.8097	0.5418	0.5519	0.6745	1.0246	0.9748	1.0151	0.9804	1.0130	1.0144
Select. peak age (EBS sur.)	2.5308	2.9902	2.3055	2.9904	2.9906	2.2967	1.0354	1.0270	1.0383	1.0398	1.0437	1.0366
Select. asc. wid. (EBS sur.)	1.2279	-9.9999	-2.3387	-10.0000	-10.0000	-2.3273	-7.5042	-8.8091	-7.3322	-7.2893	-6.8926	-7.4939
Select. asc. wid. σ (EBS sur.)	n/a	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594	0.1594
Sizecomp emphasis (EBS sur.)	0.8665	0.8665	1.6603	1.6603	1.6603	1.6603	1.6603	1.6603	1.6603	1.6603	1.6603	1.6603
Length at age 1.5 σ	n/a	n/a	n/a	0.0973	0.0973	0.0973	0.0973	0.0973	0.0973	0.0973	0.0973	0.0973
ln(EBS std. area Q) σ	n/a	n/a	n/a	n/a	0.0889	0.0889	0.0889	0.0889	0.0889	0.0889	0.0889	0.0889
Agecomp emphasis (EBS sur.)	0.1353	0.1353	0.1353	0.1353	0.1353	0.3172	0.3172	0.3172	0.3172	0.3172	0.3172	0.3172
Select. peak age σ (EBS sur.)	n/a	n/a	n/a	n/a	n/a	n/a	0.0544	0.0544	0.0544	0.0544	0.0544	0.0544
Sizecomp emphasis (fishery)	0.2416	0.2416	0.2416	0.2416	0.2416	0.2416	0.2416	0.1475	0.1475	0.1475	0.1475	0.1475
Agecomp emphasis (fishery)	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0217	0.0217	0.0217	0.0217
Select. peak age σ (fishery)	0.1155	0.1155	0.1155	0.1155	0.1155	0.1155	0.1155	0.1155	0.1155	0.1187	0.1187	0.1187
SD of ln(recruitment) devs	0.5771	0.5771	0.5771	0.5771	0.5771	0.5771	0.5771	0.5771	0.5771	0.5771	0.5928	0.5928
Select. asc. wid. σ (fishery)	0.4123	0.4123	0.4123	0.4123	0.4123	0.4123	0.4123	0.4123	0.4123	0.4123	0.4123	0.4088

Model averaging

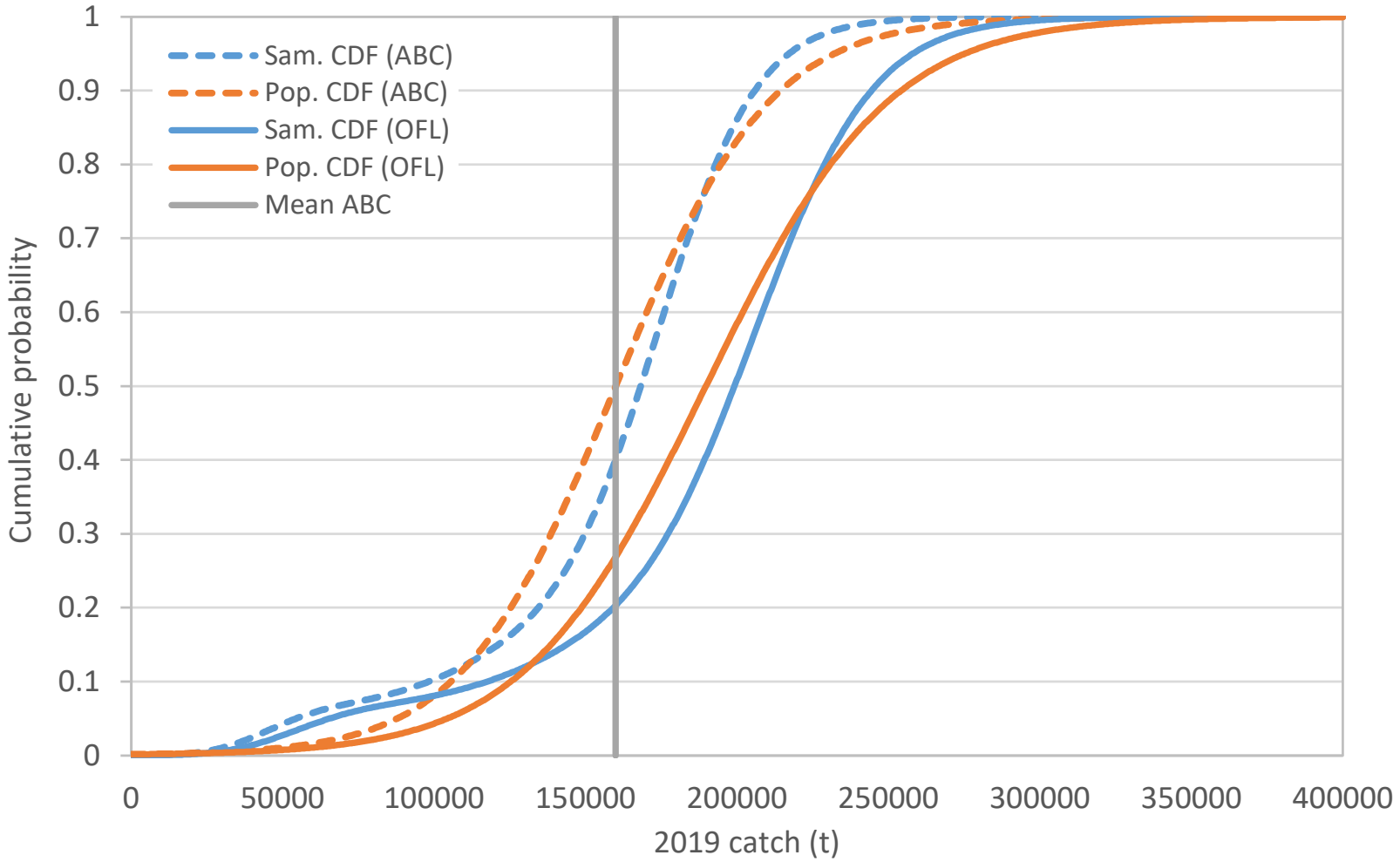
OFL and ABC distribution parameters (T2.1.26)

Model	2019 OFL			2019 maxABC			Pr(ABC>OFL)	
	Mean	SDev	CV	Mean	SDev	CV	Sam.	Pop.
16.6	208,725	25,907	0.124	175,394	21,705	0.124	0.287	0.381
16.6a	186,345	44,764	0.240	156,497	38,104	0.243	0.189	0.245
16.6b	195,995	24,755	0.126	164,711	20,736	0.126	0.225	0.300
16.6c	206,168	26,255	0.127	173,237	21,998	0.127	0.273	0.364
16.6d	214,405	26,410	0.123	180,120	22,121	0.123	0.321	0.419
16.6e	220,429	32,303	0.147	185,156	27,067	0.146	0.363	0.460
16.6f	208,647	26,222	0.126	175,316	21,967	0.125	0.286	0.380
16.6g	219,645	31,185	0.142	184,787	26,172	0.142	0.359	0.457
16.6h	208,201	25,457	0.122	175,189	21,357	0.122	0.286	0.379
17.2	154,825	42,277	0.273	129,953	35,909	0.276	0.120	0.114
17.6	53,480	17,399	0.325	44,529	14,564	0.327	0.019	0.004
18.1	197,498	24,185	0.122	169,944	20,693	0.122	0.253	0.339
18.2	211,915	24,892	0.117	180,412	21,137	0.117	0.323	0.421
18.3	133,196	34,616	0.260	111,286	29,251	0.263	0.092	0.061
18.4	237,280	39,559	0.167	199,107	33,130	0.166	0.499	0.576
18.5	178,873	30,100	0.168	153,757	25,702	0.167	0.179	0.228
Average	189,727	52,872	0.279	159,962	44,672	0.279	0.203	0.267

Model averaging PDFs (F2.1.4, upper)



Model averaging CDFs (F2.1.4, lower)



Effective sample size summary (T2.1.27)

Type	Fleet	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g
Size	Fish.	23,850	23,439	23,779	24,015	23,389	23,606	23,835	23,899
Size	Std.	11,086	n/a	2,264	11,171	11,546	11,088	11,078	11,056
Size	Exp.	n/a	9,427	9,373	n/a	n/a	n/a	n/a	n/a
Size	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	105
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	1,395	n/a	n/a	1,392	1,384	1,408	1,399	1,392
Age	Exp.	n/a	1,452	1,443	n/a	n/a	n/a	n/a	n/a
Index	Std.	3,978	n/a	2,161	3,895	3,966	11,782	4,119	12,332
Index	Exp.	n/a	3,177	3,166	n/a	n/a	n/a	n/a	n/a
Index	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	177
	Sum:	40,309	37,496	42,185	40,473	40,285	47,885	40,431	48,960

Type	Fleet	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
Size	Fish.	24,110	45,671	27,866	22,152	22,741	25,802	23,640	22,373
Size	Std.	11,045	10,471	20,062	11,334	11,239	11,155	11,118	11,326
Size	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	NBS	106	n/a	n/a	206	269	n/a	n/a	208
Age	Fish.	n/a	1,339	1,293	n/a	n/a	n/a	n/a	n/a
Age	Std.	1,383	1,068	2,506	1,511	1,454	1,496	1,367	1,490
Age	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	Std.	4,201	3,215	12,246	4,487	3,814	3,580	4,021	4,552
Index	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	NBS	175	n/a	n/a	176	2,216	n/a	n/a	176
	Sum:	41,020	61,763	63,973	39,866	41,732	42,033	40,146	40,124

SSC model weight adjustments (T2.1.28)

Model:	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
abs(ρ):	0.243	0.202	0.217	0.304	0.222	0.323	0.291	0.359	0.319	0.309	0.069	0.452	0.370	0.118	0.451	0.724
Adjust (α=1.0):	0.841	0.875	0.863	0.791	0.858	0.776	0.801	0.748	0.779	0.787	1.000	0.682	0.740	0.952	0.683	0.520
Adjust (α=0.8):	0.870	0.899	0.888	0.829	0.885	0.817	0.838	0.793	0.819	0.826	1.000	0.736	0.786	0.961	0.737	0.593
Adjust (α=0.6):	0.901	0.923	0.915	0.869	0.912	0.859	0.876	0.840	0.861	0.866	1.000	0.795	0.835	0.971	0.795	0.675
Adjust (α=0.4):	0.933	0.948	0.943	0.911	0.941	0.904	0.915	0.890	0.905	0.909	1.000	0.858	0.887	0.981	0.858	0.770
Adjust (α=0.2):	0.966	0.974	0.971	0.954	0.970	0.951	0.957	0.944	0.951	0.953	1.000	0.926	0.942	0.990	0.927	0.877

Model:	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
Jitter score:	0.000	0.000	0.000	0.000	2.110	0.000	0.000	0.000	0.004	0.001	0.125	0.000	0.000	0.000	0.000	0.000
Adjust (α=1.0):	1.000	1.000	1.000	1.000	0.121	1.000	1.000	1.000	0.996	0.999	0.883	1.000	1.000	1.000	1.000	1.000
Adjust (α=0.8):	1.000	1.000	1.000	1.000	0.185	1.000	1.000	1.000	0.997	1.000	0.905	1.000	1.000	1.000	1.000	1.000
Adjust (α=0.6):	1.000	1.000	1.000	1.000	0.282	1.000	1.000	1.000	0.998	1.000	0.928	1.000	1.000	1.000	1.000	1.000
Adjust (α=0.4):	1.000	1.000	1.000	1.000	0.430	1.000	1.000	1.000	0.998	1.000	0.951	1.000	1.000	1.000	1.000	1.000
Adjust (α=0.2):	1.000	1.000	1.000	1.000	0.656	1.000	1.000	1.000	0.999	1.000	0.975	1.000	1.000	1.000	1.000	1.000

Model:	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
Finit - M:	-0.179	-0.186	-0.161	-0.174	-0.189	-0.192	-0.172	-0.180	-0.165	0.094	1.379	-0.176	-0.182	-0.036	-0.237	-0.116
Adjust (α=1.0):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.910	0.252	1.000	1.000	1.000	1.000	1.000
Adjust (α=0.8):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.927	0.332	1.000	1.000	1.000	1.000	1.000
Adjust (α=0.6):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.945	0.437	1.000	1.000	1.000	1.000	1.000
Adjust (α=0.4):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.963	0.576	1.000	1.000	1.000	1.000	1.000
Adjust (α=0.2):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.981	0.759	1.000	1.000	1.000	1.000	1.000

Model:	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
ln(EBS *Q*):	-0.074	-0.006	-0.005	-0.058	-0.091	-0.086	-0.050	-0.047	-0.021	0.042	0.182	0.215	0.072	0.008	-0.204	0.251
Adjust (α=1.0):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.959	0.833	0.807	0.931	0.992	1.000	0.778
Adjust (α=0.8):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.967	0.864	0.842	0.944	0.994	1.000	0.818
Adjust (α=0.6):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.975	0.896	0.879	0.958	0.995	1.000	0.860
Adjust (α=0.4):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.983	0.930	0.918	0.972	0.997	1.000	0.904
Adjust (α=0.2):	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.992	0.964	0.958	0.986	0.998	1.000	0.951

Xval time series results (T2.1.29b)

Year	16.6	16.6a	16.6b	16.6c	16.6d	16.6e	16.6f	16.6g	16.6h	17.2	17.6	18.1	18.2	18.3	18.4	18.5
1982	0.6654		0.4215	0.5677	0.7810	1.0029	0.1554	0.4786	0.0000	0.2767	0.8883	6.6821	3.0958	0.3302	3.3752	6.1172
1983	0.4601		0.4388	0.4944	0.4343	0.3053	0.0000	0.4815	0.4855	0.3469	1.3391	0.2065	0.3671	0.6418	0.1340	0.1275
1984	0.6370		0.2898	0.5489	0.6650	1.1677	0.5730	0.6607	0.3091	0.0000	0.1901	0.5020	1.0594	0.4762	2.2951	0.6967
1985	0.3376		0.1692	0.3872	1.7547	0.2958	0.4400	0.3986	0.5035	0.1559	0.0000	0.3347	0.3694	0.3152	0.0363	0.2356
1986	0.3596		0.7345	0.3906	0.4298	0.2104	0.3863	0.2944	0.4565	0.5664	1.0271	0.5086	0.4077	0.2918	0.0000	0.4609
1987	0.5283	0.8920	0.6974	0.5704	0.5546	0.3378	0.1515	0.3587	0.3865	0.0011	0.0000	0.9032	0.7540	0.4070	0.2904	0.6036
1988	0.1847	0.1491	0.0720	0.1461	0.2445	0.0155	0.1472	0.0000	0.1158	0.0344	0.2364	0.2974	0.3493	0.1508	0.2220	0.1364
1989	2.4197	6.1377	6.7846	2.8030	1.8648	2.5852	2.4536	2.5509	2.4944	14.3925	8.4531	0.1960	0.9774	3.3646	0.1192	0.0000
1990	0.8993	1.4218	1.4687	1.0293	0.8721	1.2046	1.1018	1.0828	0.9894	0.5701	0.2353	0.1279	0.3814	1.1905	0.5060	0.0000
1991	1.0863	2.3839	1.3645	1.1975	1.1810	1.2399	1.2083	1.0162	1.0235	0.8057	0.1035	0.1706	0.4594	1.1649	0.8364	0.0000
1992	0.1092	0.0792	0.2244	0.1210	0.1231	0.1305	0.1799	0.0965	0.1483	0.0000	0.6635	0.0663	0.0664	0.1658	0.1005	0.0518
1993	0.4974	0.5387	0.3133	0.4754	0.4580	0.5097	0.3737	0.5590	0.4099	1.1443	0.0000	0.3170	0.4302	0.3927	0.5535	0.2588
1994	7.4072	6.1204	6.8897	6.9206	0.0000	7.4647	7.3313	7.6405	7.4617	10.7194	8.8381	7.3730	7.4816	7.9525	7.3531	7.0615
1995	0.8655	0.2551	0.4381	0.4460	1.0740	0.8277	0.7362	0.8652	0.7401	1.7206	0.0000	0.4157	0.6653	1.4025	0.9195	0.2920
1996	0.3953	0.1270	0.1990	0.1259	0.5148	0.4138	0.3394	0.4320	0.3597	1.1048	0.3587	0.0408	0.2895	0.9957	0.5500	0.0000
1997	0.2689	0.4328	0.4797	0.4256	0.2637	0.2978	0.2944	0.2633	0.2734	0.0059	0.0000	0.2841	0.2604	0.0643	0.2607	0.3268
1998	1.4088	0.8841	1.9910	1.7729	1.4378	1.5162	1.5043	1.3310	1.3572	0.0000	0.1130	1.6967	1.4755	1.2170	1.5182	1.6946
1999	0.4231	0.7377	0.6285	1.3517	0.3505	0.5889	0.5063	0.5048	0.4494	0.7812	0.0000	0.4753	0.2822	0.0396	0.4578	0.9573
2000	1.5886	2.2429	2.1714	2.6372	1.3266	1.6416	1.7075	1.6035	1.8550	0.8818	0.4840	1.8446	1.6202	0.0000	2.2925	2.9693
2001	6.0950	6.3673	4.9490	4.2604	6.8349	6.0309	5.8708	5.8805	5.7612	4.3196	0.0000	7.0897	6.8044	17.2964	5.9939	4.5040
2002	0.2220	0.4874	0.4481	0.5320	0.1479	0.2323	0.2647	0.2962	0.3204	0.5585	0.7365	0.1364	0.1769	0.0000	1.0781	1.1933
2003	0.0029	0.0266	0.0073	0.0157	0.0107	0.0008	0.0000	0.0018	0.0048	0.0319	0.1275	0.0112	0.0230	0.2866	0.0435	0.1054
2004	0.4295	0.7096	1.0941	0.4678	0.3804	0.2187	0.4883	0.4537	0.7113	0.3385	1.0879	0.0000	0.0224	0.6726	0.0784	0.1821
2005	0.7267	0.6583	0.4696	0.7115	0.6837	0.7043	0.6182	0.5352	0.4858	0.7151	0.0000	0.9260	0.8513	0.5314	1.4209	1.2108
2006	6.7258	2.0099	4.6499	7.4814	5.6012	6.3365	5.9525	4.4471	4.1926	4.2691	0.0000	7.3123	7.3344	1.4984	15.1821	8.1481
2007	0.9113	0.8535	0.7702	1.0153	0.7934	0.8900	0.8336	0.8695	0.8246	1.2733	0.0000	0.8453	0.9441	0.5108	1.1412	1.0586
2008	0.9505	2.5982	1.4012	0.0356	1.1984	1.1626	1.3016	0.9653	1.1066	0.7208	2.7854	1.9485	2.6798	5.5218	0.0000	1.1354
2009	0.6912	1.6459	1.3192	0.3969	1.1821	0.9946	0.9403	0.6811	0.6788	0.1330	4.4920	0.4774	2.0564	2.5424	0.0000	3.2790
2010	0.0580	0.1737	0.0035	0.2875	0.0213	0.0320	0.0151	0.0641	0.0557	0.2999	0.2448	0.6375	0.0000	0.0145	0.1878	0.3785
2011	0.5176	0.3575	0.1882	0.7831	0.2988	0.3294	0.3394	0.3607	0.3577	2.6366	0.1141	1.0321	7.9550	0.0000	1.0592	2.1043
2012	1.1233	0.4593	0.7207	1.2385	1.0959	0.7746	0.8486	0.6622	0.7979	2.1335	0.8993	2.7585	0.0000	0.2024	0.9872	2.5524
2013	0.4368	0.6600	0.5306	0.2166	0.3543	0.4805	0.5581	0.7645	0.7449	0.1654	0.0000	1.8152	1.7789	0.6570	1.1374	2.1841
2014	1.4772	1.0850	1.1263	1.5153	1.5601	1.1033	1.2574	0.7377	0.9688	1.7750	2.9490	0.1159	0.3502	1.5947	0.7432	0.0000
2015	1.3543	1.2455	1.0465	1.5622	1.4129	1.0107	1.1168	0.6866	0.8424	1.4888	2.0363	0.0291	0.6437	1.7303	0.8624	0.0000
2016	0.3175	0.4193	0.1845	0.4799	0.3263	0.1258	0.0650	0.0078	0.0000	0.2760	0.4584	4.9660	0.4540	1.3301	0.4132	3.7715
2017	9.5708	9.0841	10.0071	9.5103	10.3823	9.5399	10.3206	10.8548	9.3463	11.1213	2.8460	0.6653	2.8676	3.4322	7.6031	0.0000
No. 0s:	0	0	0	0	1	0	2	1	2	3	11	1	2	3	3	7
Max:	9.5708	9.0841	10.0071	9.5103	10.3823	9.5399	10.3206	10.8548	9.3463	14.3925	8.8381	7.3730	7.9550	17.2964	15.1821	8.1481

Xval model weights (T2.1.30)

Sorted in order of model number					Sorted in order of negative log likelihood				
Model	-lnL	Δ(-lnL)	Exp(-Δ)	Weight	Model	-lnL	Δ(-lnL)	Exp(-Δ)	Weight
16.6	-0.1254	10.4446	0.0000	0.0000	17.6	-10.5700	0.0000	1.0000	0.9868
16.6a	9.7917	20.3617	0.0000	0.0000	16.6g	-3.3902	7.1798	0.0008	0.0008
16.6b	2.4149	12.9849	0.0000	0.0000	16.6f	-1.8964	8.6736	0.0002	0.0002
16.6c	0.6439	11.2139	0.0000	0.0000	16.6e	-0.5542	10.0158	0.0000	0.0000
16.6d	-5.6623	4.9077	0.0074	0.0073	16.6	-0.1254	10.4446	0.0000	0.0000
16.6e	-0.5542	10.0158	0.0000	0.0000	16.6c	0.6439	11.2139	0.0000	0.0000
16.6f	-1.8964	8.6736	0.0002	0.0002	18.1	0.9316	11.5016	0.0000	0.0000
16.6g	-3.3902	7.1798	0.0008	0.0008	18.5	1.5202	12.0902	0.0000	0.0000
16.6h	-5.2589	5.3111	0.0049	0.0049	16.6b	2.4149	12.9849	0.0000	0.0000
17.2	13.4868	24.0568	0.0000	0.0000	16.6d	-5.6623	4.9077	0.0074	0.0073
17.6	-10.5700	0.0000	1.0000	0.9868	16.6h	-5.2589	5.3111	0.0049	0.0049
18.1	0.9316	11.5016	0.0000	0.0000	18.2	3.4571	14.0271	0.0000	0.0000
18.2	3.4571	14.0271	0.0000	0.0000	18.3	6.1074	16.6774	0.0000	0.0000
18.3	6.1074	16.6774	0.0000	0.0000	18.4	7.4747	18.0447	0.0000	0.0000
18.4	7.4747	18.0447	0.0000	0.0000	16.6a	9.7917	20.3617	0.0000	0.0000
18.5	1.5202	12.0902	0.0000	0.0000	17.2	13.4868	24.0568	0.0000	0.0000

Ecosystem considerations

Relative spawning biomass change (text table)

- Task: Determine if any of the ESR time series indicates that the 2018 spawning biomass that will be estimated by the base model as updated for November will be at least 20% than the 2018 spawning biomass projected by the base model last November
- Time series of relative spawning biomass changes (from Model 16.6):

Year:	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Δ(SB):	-0.024	0.011	0.332	0.633	0.736	0.433	0.067	0.136	-0.032	-0.025
Year:	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Δ(SB):	0.060	-0.032	-0.090	-0.199	-0.291	-0.073	0.047	0.112	-0.001	-0.038
Year:	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Δ(SB):	-0.116	-0.028	0.038	0.038	0.068	-0.003	0.016	-0.010	-0.118	-0.156
Year:	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Δ(SB):	-0.147	-0.080	0.076	0.324	0.187	0.127	0.030	0.011	0.124	0.086

ESR variables as predictors of ΔSB (text table)

- Change in spawning biomass was regressed against each of the environmental variables in T2.1.5 in a set of cross-validation analyses
- Each univariate model with a positive cross-validation R^2 was retained
- The cross-validation R2 values were used to weight the model-specific means and standard deviations as follows:

Variable	nlags	R^2	weight	2018 μ	2018 σ
Benthic forager biomass	6	0.193	0.134	0.039	0.096
Pelagic forager biomass	4	0.062	0.043	0.002	0.102
Euphausiid biomass	3	0.342	0.237	-0.078	0.185
Apex predator biomass	1	0.033	0.023	0.080	0.127
Motile epifauna biomass	6	0.531	0.368	0.122	0.075
Multivariate seabird breeding	2	0.139	0.096	0.119	0.098
Mean bottom temperature	3	0.141	0.098	0.039	0.101
R^2-weighted mean	n/a	n/a	n/a	0.049	0.119

- The results imply a 25.8% chance that the 2018 spawning biomass will decline, but only a 0.2% chance that it will decline by more than 20%

Extra slides

Effective sample sizes (T2.1.13, 1 of 6)

Base model

				Model 16.6				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	41	300	1.0000	300	582	12299	23850
Size	Std.	36	300	1.0000	300	308	10798	11086
Size	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	23	343	1.0000	343	61	7889	1395
Age	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					SEave	RMSE		
Index	Std.	36	341	n/a	0.1074	0.1886	12260	3978
Index	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a
						Sum:	43246	40309

Effective sample sizes (T2.1.13, 2 of 6)

Minor change models that use data from the expanded EBS survey area

				Model 16.6a				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	41	300	1.0000	300	572	12299	23439
Size	Std.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	Exp.	31	300	1.0000	300	304	9298	9427
Size	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Exp.	23	343	1.0000	343	63	7889	1452
					SEave	RMSE		
Index	Std.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	Exp.	31	341	n/a	0.1080	0.1969	10557	3177
Index	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a
						Sum:	40043	37496

				Model 16.6b				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	41	300	1.0000	300	580	12299	23779
Size	Std.	5	331	1.0000	331	453	1653	2264
Size	Exp.	31	295	1.0000	295	302	9149	9373
Size	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Exp.	23	343	1.0000	343	63	7889	1443
					SEave	RMSE		
Index	Std.	5	341	n/a	0.0956	0.0849	1703	2161
Index	Exp.	31	341	n/a	0.1080	0.1973	10557	3166
Index	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a
						Sum:	43250	42185

Effective sample sizes (T2.1.13, 3 of 6)

Minor change models with growth covariates

				Model 16.6c					Model 16.6d				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	41	300	1.0000	300	586	12299	24015	1.0000	300	570	12299	23389
Size	Std.	36	300	1.0000	300	310	10798	11171	1.0000	300	321	10798	11546
Size	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	23	343	1.0000	343	61	7889	1392	1.0000	343	60	7889	1384
Age	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					SEave	RMSE				SEave	RMSE		
Index	Std.	36	341	n/a	0.1074	0.1906	12260	3895	n/a	0.1074	0.1889	12260	3966
Index	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
						Sum:	43246	40473			Sum:	43246	40285

Effective sample sizes (T2.1.13, 4 of 6)

Minor change models with time-varying Q, without NBS survey data

				Model 16.6e					Model 16.6f				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	41	300	1.0000	300	576	12299	23606	1.0000	300	581	12299	23835
Size	Std.	36	300	1.0000	300	308	10798	11088	1.0000	300	308	10798	11078
Size	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	23	343	1.0000	343	61	7889	1408	1.0000	343	61	7889	1399
Age	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					SEave	RMSE				SEave	RMSE		
Index	Std.	36	341	n/a	0.1074	0.1096	12260	11782	n/a	0.1074	0.1853	12260	4119
Index	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
						Sum:	43246	47885			Sum:	43246	40431

Minor change models with time-varying Q, with NBS survey data

				Model 16.6g					Model 16.6h				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	41	300	1.0000	300	583	12299	23899	1.0000	300	588	12299	24110
Size	Std.	36	300	1.0000	300	307	10798	11056	1.0000	300	307	10798	11045
Size	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	NBS	2	300	1.0000	300	52	600	105	1.0000	300	53	600	106
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	23	343	1.0000	343	61	7889	1392	1.0000	343	60	7889	1383
Age	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					SEave	RMSE				SEave	RMSE		
Index	Std.	36	341	n/a	0.1074	0.1071	12260	12332	n/a	0.1074	0.1835	12260	4201
Index	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	NBS	2	88	n/a	0.1620	0.1617	176	177	n/a	0.1620	0.1626	176	175
						Sum:	44022	48960			Sum:	44022	41020

Effective sample sizes (T2.1.13, 5 of 6)

Previous major change models

				Model 17.2					Model 17.6				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	35	5400	0.2416	1305	1305	45662	45671	0.1475	797	796	27878	27866
Size	Std.	36	336	0.8665	291	291	10470	10471	1.6603	557	557	20061	20062
Size	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Fish.	6	9948	0.0225	224	223	1343	1339	0.0217	216	215	1295	1293
Age	Std.	23	343	0.1353	46	46	1067	1068	0.3172	109	109	2502	2506
Age	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					SEave	RMSE				SEave	RMSE		
Index	Std.	36	341	n/a	0.1074	0.2098	12260	3215	n/a	0.1074	0.1075	12260	12246
Index	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
						Sum:	70802	61763			Sum:	63996	63973

Major change models with migration

				Model 18.1					Model 18.2				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	41	300	1.0000	300	540	12299	22152	1.0000	300	555	12299	22741
Size	Std.	36	300	1.0000	300	315	10798	11334	1.0000	300	312	10798	11239
Size	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	NBS	2	300	1.0000	300	103	600	206	1.0000	300	135	600	269
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	23	343	1.0000	343	66	7889	1511	1.0000	343	63	7889	1454
Age	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					SEave	RMSE				SEave	RMSE		
Index	Std.	36	341	n/a	0.1074	0.1776	12260	4487	n/a	0.1074	0.1926	12260	3814
Index	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	NBS	2	88	n/a	0.1620	0.1619	176	176	n/a	0.1620	0.0457	176	2216
						Sum:	44022	39866			Sum:	44022	41732

Effective sample sizes (T2.1.13, 6 of 6)

Major change models with M covariates

				Model 18.3					Model 18.4				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	41	300	1.0000	300	629	12299	25802	1.0000	300	577	12299	23640
Size	Std.	36	300	1.0000	300	310	10798	11155	1.0000	300	309	10798	11118
Size	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	23	343	1.0000	343	65	7889	1496	1.0000	343	59	7889	1367
Age	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					SEave	RMSE				SEave	RMSE		
Index	Std.	36	341	n/a	0.1074	0.1988	12260	3580	n/a	0.1074	0.1876	12260	4021
Index	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	NBS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
						Sum:	43246	42033			Sum:	43246	40146

Major change omnibus model

				Model 18.5				
Type	Fleet	Yrs	N	Mult	N×Mult	Har	ΣNeff1	ΣNeff2
Size	Fish.	41	300	1.0000	300	546	12299	22373
Size	Std.	36	300	1.0000	300	315	10798	11326
Size	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Size	NBS	2	300	1.0000	300	104	600	208
Age	Fish.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age	Std.	23	343	1.0000	343	65	7889	1490
Age	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
					SEave	RMSE		
Index	Std.	36	341	n/a	0.1074	0.1763	12260	4552
Index	Exp.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Index	NBS	2	88	n/a	0.1620	0.1620	176	176
						Sum:	44022	40124