2. Assessment of the Pacific Cod Stock in the Eastern Bering Sea

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EXECUTIVE SUMMARY

Summary of Changes in Assessment Inputs

Relative to the November edition of last year's BSAI SAFE report, the following substantive changes have been made in the eastern Bering Sea (EBS) Pacific cod stock assessment.

Changes in the Input Data

- For all models:
  - Catches for 1991-2018 were updated, and a preliminary catch estimate for 2019 was incorporated.
  - Commercial fishery size compositions for 1991-2018 were updated, and a preliminary size composition from the 2019 commercial fishery was incorporated.
  - Size composition from the 2019 EBS shelf bottom trawl survey was incorporated.
- For the base model (Model 16.6i):
  - The design-based estimate of numeric abundance from the 2019 EBS shelf bottom trawl survey was incorporated.
  - The design-based estimate of age composition from the 2018 EBS shelf bottom trawl survey standard area was incorporated.
  - The design-based estimates of numeric abundance and size composition from the 2010 and 2017 northern Bering Sea (NBS) shelf bottom trawl surveys were recalibrated to reflect the "standard" NBS survey area.
  - The design-based estimates of numeric abundance and size composition from the 2018 "rapid response" NBS survey were removed.
  - The design-based estimates of numeric abundance and size composition from the 2019 northern Bering Sea (NBS) shelf bottom trawl survey were incorporated.
- For all models other than the base model:
  - VAST estimates of the time series of numeric abundance and age composition from the respective survey or surveys (either EBS by itself, EBS and NBS combined into a single survey, or EBS and NBS modeled separately) were incorporated.

Changes in the Assessment Methodology

Many changes have been made or considered in the stock assessment model since the 2018 assessment (Thompson 2018). Seven models (including the current base model) were presented in this year's preliminary assessment (Appendix 2.1). After reviewing the preliminary assessment, the SSC and Team requested that all of the models from the preliminary assessment be presented in this final assessment. In addition, the SSC requested three more new models. Following further explorations by the senior author and consultation with the SSC co-chairs and the Team and SSC rapporteurs assigned to this assessment, a compromise set of ten models (including the current base model) are included here. The nine new models are treated both individually and as an ensemble, with results for the latter presented as both weighted and unweighted averages. For details regarding model structures, see "Responses to SSC and Plan Team Comments Specific to this Assessment" in this section (specifically comments BPT12, BPT14, SSC13, SSC14, and SSC15), and also the "Description of Alternative Models" subsection of the "Analytic Approach" section.

Summary of Results

The principal results of the present assessment, **based on the ensemble weighted average**, are listed in the table below (biomass and catch figures are in units of t) and compared with the corresponding quantities from last year's assessment as specified by the SSC (note that the 2020 OFL of 183,000 t specified last year was an error; it should have been 164,000 t, as estimated in last year's assessment):

Quantity	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
	2019	2020	2020*	2021*
M (natural mortality rate)	0.34	0.34	0.35	0.35
Tier	3a	3b	3b	3b
Projected total (age 0+) biomass (t)	824,000	683,000	751,708	716,581
Projected female spawning biomass (t)	290,000	246,000	259,509	211,410
$B_{100\%}$	658,000	658,000	666,506	666,506
$B_{40\%}$	263,000	263,000	266,602	266,602
$B_{35\%}$	230,000	230,000	233,277	233,277
F_{OFL}	0.38	0.35	0.41	0.34
$maxF_{ABC}$	0.31	0.29	0.34	0.28
F_{ABC}	0.31	0.29	0.34	0.28
OFL (t)	216,000	183,000	185,650	123,331
maxABC (t)	181,000	137,000	155,873	102,975
ABC (t)	181,000	137,000	155,873	102,975
Status	As determined *last* year for:		As determined *this* year for:	
	2017	2018	2018	2019
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

*Projections are based on assumed catches of 176,847 t, and 155,873 t in 2019 and 2020, respectively.

Note that the 2020 and 2021 F_{ABC} and ABC values listed above may be subject to modification following consideration by the SSC of the newly required "risk table" (see "Risk Table" subsection in the "Harvest Recommendations" section). The summarized results of the risk analysis are shown below:

Assessment-related considerations	*Population dynamics considerations*	*Environmental/ ecosystem considerations*	*Fishery Performance considerations*	*Overall score (highest of the individual scores)*
Level 1: Normal	Level 1: Normal	Level 2: Substantially increased concerns	Level 1: Normal	Level 2: Substantially increased concerns

In the event that the 2020 F_{ABC} or ABC values are changed from those shown above, projected 2021 values of other non-constant quantities would need to change in response.

Responses to SSC and Plan Team Comments on Assessments in General

Since last year's assessment was completed, the SSC has made two comments on assessments in general. One of these (comment SSC1) was addressed provisionally in the preliminary assessment (Appendix 2.1), but that response merits some elaboration here. In addition, the SSC made one new comment on assessments in general at its October 2019 meeting, which is addressed here as well. Note that numbering of new comments here is continuous with numbering of comments in the preliminary assessment.

Comments from the December 2018 SSC meeting
SSC1: "The SSC requests that all authors fill out the risk table in 2019, and that the PTs provide comment on the author's results in any cases where a reduction to the ABC may be warranted (concern levels 2-4). The author and PT do not have to recommend a specific ABC reduction, but should provide a complete evaluation to allow for the SSC to come up with a recommendation if they should choose not to do so." *Response*: The risk table is included here (see "Risk Table" subsection in the "Harvest Recommendations" section). No specific ABC reduction is recommended, but a complete evaluation is provided in order to allow the SSC to come up with a reduction if it chooses to do so.

Comments from the October 2019 SSC meeting
SSC12: "The SSC recommends the authors complete the risk table and note important concerns or issues associated with completing the table." *Response*: As noted in response to SSC1, the risk table is included here. Some concerns and issues associated with completing the table are noted in the subsection where the table appears.

Responses to SSC and Plan Team Comments Specific to this Assessment

Since last year's assessment was completed, the BSAI Plan Team and the SSC have made several comments specific to this assessment. Ten Team comments and nine SSC comments specific to this assessment were addressed in the preliminary assessment (Appendix 2.1), of which the responses to four Team comments (comments BPT3, BPT5, BPT8, and BPT9) merit some elaboration here. In addition, the Team made eight new comments specific to this assessment at its September 2019 meeting and the SSC made six new comments specific to this assessment at its October 2019 meeting. Note that numbering of new comments here is continuous with numbering of comments in the preliminary assessment.

Comments from the November 2018 Team meeting
"For next year's assessment, the Team recommended that...

BPT3: "...a model-based survey time-series be developed that can predict combined abundance of the expanded EBS survey area and the Northern Bering Sea survey area for all years.... Validate the predictions using various methods as well as consistency with observations from other external surveys (e.g., BASIS)." *Response*: As reported in the preliminary assessment, a model-based survey time series for the combined EBS and Northern Bering Sea (NBS) areas, based on the vector autoregressive spatio-temporal (VAST) method developed by Thorson et al. (2015), has been developed. It was used in two of the models presented in the preliminary assessment, and is used in all nine of the new models presented here. While validation of the estimates using comparison for consistency with *other surveys* has not yet been attempted, comparison of the estimates with those obtained under the traditional design-based approach was provided in Figure 2.1.1 and Tables 2.1.1 and 2.1.2 from the preliminary assessment and in Tables 2.8 and 2.9 here.

BPT5: "...Pacific cod fishery catches and Pacific cod survey data in Russia be researched and summarized." *Response*: A small amount of data on Russian catches of Pacific cod from the Western Bering Sea is reported here in a text table in the "Fishery" section.

BPT8: "...the author considers bringing forward an ensemble of models to capture structural uncertainty with a justifiable weighting as well as a "null" approach with equal weights...." *Response*: An ensemble of models is included here, with results reported for both weighted and unweighted averages.

BPT9: "...the authors coordinate with Council staff to augment the fishery information section of the assessment for next year. Council staff will be providing a cod allocation review in 2019 and will work with the author to provide pertinent summary sections over the summer." *Response*: The requested augmentation will be included once it has been provided by Council staff.

Comments from the September 2019 Team meeting

BPT11: "The Team recommends that the authors break out the NBS VAST vs empirical in November. (Show separate indices for EBS and NBS using VAST and design-based estimators, along with the combined estimates)." *Response*: Separate EBS and NBS estimates, along with combined EBS and NBS estimates, are provided for the design-based method in Table 2.8 and for the VAST method in Table 2.9.

BPT12: "The Team recommends that the simple and complex versions of models associated with the 3 developed hypotheses should move forward." *Response*: See responses to comments SSC13 and SSC15.

BPT13: "The Team recommends that, if possible, the authors leave out areas of the NBS (for 2017-2019) for cross-validation of VAST models 19.3 and 19.4 and areas of the EBS. Specifically leaving out the northern portion could be valuable, dependent on the time available." *Response*: Sufficient time was not available to complete the requested exercise. See also response to comment SSC16.

BPT14: "The Team recommends that the 6 19.X models be brought forward in November and the author choose an ensemble if time allows along with appropriate weighting." *Response*: Regarding the six models in the 19.x series presented in September, see responses to comments SSC13 and SSC15. An ensemble is chosen here, with appropriate weighting.

BPT15: "The Team recommends that, if time does not allow, bring back six 19.X models and an equal weighting average may be attempted by the Team during the Plan Team meeting with the set or a subset of the available models (using code developed for SS ensemble averaging developed by Allan Hicks)." *Response*: An option for equal weighting of the models in the proposed ensemble is presented here.

BPT16: "The Team recommends that the author provide measures of uncertainty for all models so that it would be possible to select ensemble elements and integrate them into a single assessment model." *Response*: Measures of uncertainty associated with all parameter estimates and with some key derived quantities such as spawning biomass, relative spawning biomass, ABC, and OFL are provided for all models as well as for the ensemble (both weighted and unweighted averages).

BPT17: "The Team recommends that [the authors] present retrospective estimates of specific parameters that show retrospective patterns." *Response*: The retrospective behaviors of the estimates of all time-invariant parameters is summarized in Table 2.23a, and the retrospective behavior of the four time-invariant parameters with the highest median correlation with respect to retrospective "peels" is detailed in Table 2.23b.

BPT18: "The Team recommends continuing investigation of the CCDA model averaging method, realizing it is unlikely to be implemented this year. The Team is very enthusiastic about this approach. The Team will discuss with the author whether additional input would be useful in further testing and developing the method." *Response*: Investigation of model averaging by cross-conditional decision analysis will continue although, as anticipated, it was not possible to implement the method this year.

Comments from the October 2019 SSC meeting

SSC13: "The SSC generally supports the PT recommendations to bring forward the six models and hypothesis testing framework for PT and SSC evaluation in November/December. However, the SSC requests that the PT strongly consider not carrying forward hypothesis 1 given many indicators are certainly pointing to strong interaction between the NBS and EBS. Genetic information shows the NBS and EBS to be a single stock. Additionally, the 2019 trawl survey showed evidence of younger fish in the NBS and EBS, and recent trawl surveys have consistently shown higher aggregations on northern edge of the EBS. Tagging information will further help inform the relationship of the cod stock between the EBS and NBS." *Response*: This request consists of two parts, which could be viewed as inconsistent. The first is to "bring forward" the models presented in the preliminary assessment, including those associated with Hypothesis 1 (in which the NBS survey data are ignored). The second involves "not carrying forward" the models associated with Hypothesis 1. In an attempt to reconcile these parts, models associated with Hypothesis 1 are included in the ensemble but given very little weight (see Table 2.22 and Figure 2.14).

SSC14: "The GPT suggested that Mohn's rho may not be a useful statistic given the different hypotheses and data. The SSC disagrees with this statement because one of the main reasons retrospective analysis is conducted is to identify model misspecification, of which ignoring population closure is an important one. Thus, the SSC is concerned about the high values of Mohn's rho in some of the proposed set of models." *Response*: Both the Team and the SSC requested that the six models from the preliminary assessment be included in the final assessment (see comments BPT12, BPT14, and SSC13), but five of those models were associated with extremely high values of ρ, which would appear to render them unacceptable to the SSC. The only new model from the preliminary assessment that was not associated with an extremely high value of ρ was one of the models associated with Hypothesis 1, which, given comment SSC13, would appear to render it unacceptable to the SSC. See also response to comment SSC15.

SSC15: "The SSC suggests that the 'simple model' should only compare the three biological hypotheses with the accepted model (but with the VAST estimated indices) and allow the 'complex models' to incorporate the additional structural and statistical changes of interest. Thus, at the authors' discretion, models that are similar to 16.6i from last year that use the VAST indices testing the three biological hypotheses could be substituted for models 19.1, 19.3, 19.5 and would be preferable to the SSC. However, if time constraints only permit fewer models, a model that only examines hypothesis 2 (combined EBS and NBS) that is the same as model 16.6i with the VAST estimates would be satisfactory as well." *Response*: The three new requested models are included here. They were not substituted for the "simple" models, however, in an attempt to satisfy the various requests for inclusion of those models (see comments BPT12, BPT14, SSC13, and SSC14). Nevertheless, with comment SSC14 also in mind, one or two adjustments to both the "simple" and "complex" models were made in order to keep the level of retrospective bias within acceptable levels (see "Description of Alternative Models" subsection in the "Analytic Approach" section).

SSC16: "The GPT suggested that cross validating the VAST results by selectively removing different strata from the data and considering the results would be a useful exercise to test the model's ability to fill in missing data would be a useful exercise. The SSC agrees with this recommendation, but we do suggest that this may not be in the purview of the assessment author, but better suited for the survey analysis team." *Response*: In light of this recommendation (with time limitations also a factor), comment BPT13 will be left for the survey analysis team to address.

SSC17: [The senior author] "requested that the SSC affirm their general statements on how the EBS Pacific cod should proceed in terms of modeling guidelines, including such things as avoiding 'complexity creep' and the SSC reiterates their recommendations which spanned between 2013 and the present." *Response*: As a minor clarification, the senior author did not "request that the SSC affirm" the model evaluation criteria; rather, he asked, "Should last year's model evaluation criteria ... be modified and, if so, how?" Given the SSC's response, last year's four model evaluation criteria are retained here (although not given equal emphasis), along with five others (see Table 2.22 and Figure 2.14).

SSC18: "Finally, the SSC remains concerned about doing ensemble 'on the fly' during the Plan Team. Time allowing, the SSC requests the authors bring forward an ensemble set for the PT to evaluate. However, should the PT do an ensemble analysis, the SSC recommends they use the standardized code that the Plan Team discussed to work from." *Response*: An ensemble is brought forward here.

INTRODUCTION

General

Pacific cod (*Gadus macrocephalus*) is a transoceanic species, ranging from Santa Monica Bay, California, northward along the North American coast; across the Gulf of Alaska and Bering Sea north to Norton Sound; and southward along the Asian coast from the Gulf of Anadyr to the northern Yellow Sea; and occurring at depths from shoreline to 500 m (Ketchen 1961, Bakkala et al. 1984). The southern limit of the species' distribution is about 34° N latitude, with a northern limit of about 65° N latitude (Lauth 2011). Pacific cod is distributed widely over the eastern Bering Sea (EBS) as well as in the Aleutian Islands (AI) area. Tagging studies (e.g., Shimada and Kimura 1994) have demonstrated significant migration both within and between the EBS, AI, and Gulf of Alaska (GOA). However, recent research indicates the existence of discrete stocks in the EBS and AI (Canino et al. 2005, Cunningham et al. 2009, Canino et al. 2010, Spies 2012). Research conducted in 2018 indicates that the genetic samples from the NBS survey in 2017 are very similar to those from the EBS survey area, and quite distinct from samples collected in the Aleutian Islands and the Gulf of Alaska (Spies et al. 2019).

Although the resource in the combined EBS and AI (BSAI) region had been managed as a single unit from 1977 through 2013, separate harvest specifications have been set for the two areas since the 2014 season.

Pacific cod are not known to exhibit any special life history characteristics that would require it to be assessed or managed differently from other groundfish stocks in the BSAI.

Review of Life History

Spawning, eggs, and larvae

Pacific cod in the EBS form large spawning aggregations, and typically spawn once per year (Sakurai and Hattori 1996, Stark 2007), from late February or early March through early to mid-April (Neidetcher et al. 2014). Shimada and Kimura (1994) identified major spawning areas between Unalaska and Unimak Islands, and seaward of the Pribilof Islands along the shelf edge. Neidetcher et al. (2014) identified spawning concentrations north of Unimak Island, in the vicinity of the Pribilof Islands, at the shelf break near Zhemchug Canyon, and adjacent to islands in the central and western Aleutian Islands along the continental shelf. In their tagging study, Shimada and Kimura observed a few travel distances in excess of 500 nmi, with a large number of travel distances in excess of 100 nmi, which they inferred to be part of an annual migration between summer feeding grounds and winter spawning grounds. Shimada and Kimura and Neidetcher et al. speculated that variations in spawning time may be temperature-related.

In a laboratory study, eggs hatched between 16-28 days after spawning, with peak hatching occurring on day 21 (Abookire et al. 2007). Settlement in the Gulf of Alaska is reported to occur from July onward (Blackburn and Jackson 1982, Abookire et al. 2007, Laurel et al. 2007), which, given a mean spawning date of mid-March (Neidetcher et al. 2014), and assuming that settlement occurs immediately after transformation, and subtracting about 20 days for the egg stage, implies that the larval life stage might last about 90 days. In the laboratory study by Hurst et al. (2010), postflexion larvae were all younger than 106 days post-hatching, and juveniles were all older than 131 days post-hatching, so it might be inferred that transformation typically takes place between 106 and 131 days after hatching.

Several studies have demonstrated an impact of temperature on survival and hatching of eggs and development of embryos and larvae (e.g., Laurel et al. 2008, Hurst et al. 2010, Laurel et al. 2011, Laurel et al. 2012, Bian et al. 2014, Bian et al. 2016). Temperature has been (negatively) related to recruitment of Pacific cod (e.g., Doyle et al. 2009, Hurst et al. 2012).

Pacific cod eggs are demersal (Thomson 1963), but Pacific cod larvae move quickly to surface waters after hatching (Rugen and Matarese 1988, Hurst et al. 2009), and appear to be capable of traveling considerable distances. Rugen and Materese concluded that larval Pacific cod were transported from waters near the Kenai peninsula and Kodiak Island to locations as far as Unimak Island. In the Gulf of Alaska, it is thought that movement of larvae has a significant shoreward component (Rugen and Materese, Abookire et al. 2001 and 2007, Laurel et al. 2007), but it is not obvious that this is always the case elsewhere in the species' range (Hurst et al. 2012), although Hurst et al. (2015) found that age 0 Pacific cod in the EBS were most abundant in waters along the Alaska peninsula to depths of 50 m.

Laurel et al. (2011) investigated the match-mismatch hypothesis for Pacific cod in the Gulf of Alaska. Their results showed that cold environments allow Pacific cod larvae to bridge gaps in prey availability (i.e., timing and magnitude), but negatively impact survival over longer periods. Under warmer conditions, mismatches in prey significantly impacted growth and survival. However, both yolk reserves and compensatory growth mechanisms reduced the severity of mismatches occurring in the first 3 weeks of development.

Doyle et al. (2009) found that larval retention of Pacific cod during the month of April was key to late spring abundance in the Gulf of Alaska, but it is unknown whether this result holds elsewhere in the species' range. Neidetcher et al. (2014) speculated that spawning locations in the EBS are the product of "an accumulation of conditions beneficial to Pacific cod productivity," with no consistent basis in topography, current structure, or water column hydrology.

Juveniles

Juveniles usually tend to settle near the seafloor (Abookire et al. 2007, Laurel et al. 2007).

Some studies of Pacific cod in the Gulf of Alaska, and also some studies of Atlantic cod, suggest that young-of-the-year cod are dependent on eelgrass, but this may not be the case elsewhere in the species' range. In contrast to other parts of the range of Pacific cod, where sheltered embayments are key nursery grounds, Hurst et al. (2015) found that habitat use of age 0 Pacific cod in the EBS occurs along a gradient from coastal-demersal (bottom depths < 50 m) to shelf-pelagic (bottom depths 60-80 m), with densities near the coastal waters of the Alaska peninsula much higher than elsewhere. Hurst et al. (2012) and Parker-Stetter et al. (2013) also observed age 0 Pacific cod in the shelf-pelagic zone. Hurst et al. (2012) found evidence of density-dependent habitat selection at the local scale, but no consistent shift in distribution of juvenile Pacific cod in response to interannual climate variability. Hurst et al. (2015) state, "The ability to utilize a mosaic of habitats as nursery areas may contribute to the persistence of the Pacific cod population in the Bering Sea."

Hurst et al. (2015) suggested that habitat use by age 0 Pacific cod in the EBS is related to temperature and the distribution of large-bodied demersal predators. Gotceitas et al. (1997) found that the habitat distribution of age 0 Atlantic cod was influenced by predators.

Leslie matrix analysis of a Pacific cod stock occurring off Korea estimated the instantaneous natural mortality rate of 0-year-olds at 2.49% per day (Jung et al. 2009). This may be compared to a mean estimate for age 0 Atlantic cod (*Gadus morhua*) in Newfoundland of 4.17% per day, with a 95% confidence interval ranging from about 3.31% to 5.03% (Robert Gregory, DFO, *pers. commun.*); and age 0 Greenland cod (*Gadus ogac*) of 2.12% per day, with a 95% confidence interval ranging from about 1.56% to 2.68% (Robert Gregory and Corey Morris, DFO, *pers. commun.*).

Adults

Adult Pacific cod in the EBS are strongly associated with the seafloor (Nichol et al. 2007), suggesting that fishing activity has the potential to disturb habitat. Nichol et al. (2013) observed frequent diel vertical migration. Patterns varied significantly by location, bottom depth, and time of year, with daily depth changes averaging 8 m.

Although little is known about the likelihood of age-dependent natural mortality in adult Pacific cod, it has been suggested that Atlantic cod may exhibit increasing natural mortality with age (Greer-Walker 1970).

At least one study (Ueda et al. 2006) indicates that age 2 Pacific cod may congregate more, relative to age 1 Pacific cod, in areas where trawling efficiency is reduced (e.g., areas of rough substrate), causing their selectivity to decrease. Also, Atlantic cod have been shown to dive in response to a passing vessel (Ona and Godø 1990, Handegard and Tjøstheim 2005), which may complicate attempts to estimate catchability (Q) or selectivity. It is not known whether Pacific cod exhibit a similar response.

As noted above, Pacific cod are known to undertake seasonal migrations, the timing and duration of which may be variable (Savin 2008).

FISHERY

Description of the Directed Fishery

During the early 1960s, a Japanese longline fishery harvested EBS Pacific cod for the frozen fish market. Beginning in 1964, the Japanese trawl fishery for walleye pollock (*Gadus chalcogrammus*) expanded and cod became an important bycatch species and an occasional target species when high concentrations were detected during pollock operations. By the time that the Magnuson Fishery Conservation and Management Act went into effect in 1977, foreign catches of Pacific cod had consistently been in the 30,000-70,000 t range for a full decade. In 1981, a U.S. domestic trawl fishery and several joint venture fisheries began operations in the EBS. The foreign and joint venture sectors dominated catches through 1988, but by 1989 the domestic sector was dominant and by 1991 the foreign and joint venture sectors had been displaced entirely.

Presently, the Pacific cod stock is exploited by a multiple-gear fishery, including trawl, longline, pot, and jig components (although catches by jig gear are very small in comparison to the other three main gear types, with an average annual catch of less than 200 t since 1992). The breakdown of catch by gear during the most recent complete five-year period (2014-2018) is as follows: longline gear accounted for an average of 52.4% of the catch, trawl gear accounted for an average of 29.4%, and pot gear accounted for an average of 18.2%.

In the EBS, Pacific cod are caught throughout much of the continental shelf, with National Marine Fisheries Service (NMFS) statistical areas 509, 513, 517, 519, 521, and 524 each accounting for at least 5% of the total catch over the most recent 5-year period (2014-2018).

Catches of Pacific cod taken in the EBS for the periods 1964-1980, 1981-1990, and 1991-2019 are shown in Tables 2.1a, 2.1b, and 2.1c, respectively; and the time series for the overall fishery (1977-2019) and by gear type (1988-2019) are shown in Figure 2.1. The catches in Tables 2.1a and 2.1b are broken down by fleet sector (foreign, joint venture, domestic annual processing). The catches in Table 2.1b are also broken down by gear to the extent possible. The catches in Table 2.1c are broken down by gear.

Figure 2.2 shows the geographic distribution of observed catch for 2016-2019. The distribution exhibits a notable northerly expansion in 2018 and 2019.

Appendix 2.2 contains an economic performance report on the BSAI Pacific cod fishery.

The extent to which catches of Pacific cod in Russian waters affect the EBS stock are unknown, and the available catch data from the Western Bering Sea (shown below) are likely not comprehensive:

Year:	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Catch (t):	11124	16252	16260	15397	18065	23068	19799	21420	31664	45793

(Source: S. Barbeaux, AFSC, *pers. commun*., March 8, 2019.)

Effort and CPUE

Catch-per-unit-effort (CPUE) data from the 1991-2019 fisheries are shown in Table 2.2, with trawl fishery data shown in Table 2.2a, longline fishery data shown in Table 2.2b, and pot fishery data shown in Table 2.2c. Data in each panel have been normalized to an overall mean of 1.0.

Beginning with the 2017 assessment (Thompson 2017), the time series of catch-per-unit-effort (CPUE) data from the longline fishery have been analyzed in each assessment using a model that estimates a time series of year and month effects. This enables the average (across months) CPUE for 2019 to be estimated even though data for the last few months of the year are not yet available. The estimated year and month effects are shown in the two upper panels of Figure 2.1 and the overall fit to the time series (inverse-variance-weighted R_2 = 0.91) is shown in the lower panel. The CPUE for 2019 is estimated to be almost exactly equal to the average for the time series, and about 9% above the CPUE for 2018.

Discards

The catches shown in Tables 2.1b and 2.1c include estimated discards. Discards of Pacific cod in the EBS Pacific cod fisheries are shown for each year 1991-2019 in Table 2.3. Amendment 49, which mandated increased retention and utilization of Pacific cod, was implemented in 1998. From 1991-1997, discard rates in the Pacific cod fishery averaged about 4.9%. Since then, they have averaged about 1.3%.

Management History

The history of acceptable biological catch (ABC), overfishing level (OFL), and total allowable catch (TAC) levels is summarized and compared with the time series of aggregate (i.e., all-gear, combined area) commercial catches in Table 2.4. Note that, prior to 2014, this time series pertains to the combined BSAI region, so the catch time series differs from that shown in Table 2.1, which pertains to the EBS only.

From 1980 through 2018 TAC averaged about 85% of ABC (ABC was not specified prior to 1980), and from 1980 through 2018, commercial catch averaged about 93% of TAC. In 10 of these 39 years, TAC equaled ABC exactly, and in 11 of these 39 years, catch exceeded TAC (by an average of 3.6%). However, six of those overages occurred in 2007, 2008, 2010, 2016, 2017, and 2018, when TAC was reduced by various proportions to account for a small, State-managed fishery inside State of Alaska waters (such reductions have been made in all years since 2006; see text table below for recent formulae); thus, while the combined Federal and State catch exceeded the Federal TAC in 2007, 2008, 2010, 2016, 2017, and 2018 by up to 6.3%, the overall target catch (Federal TAC plus State GHL) was *not* exceeded.

Total catch has been less than OFL in every year since 1993 (inclusive).

Changes in ABC over time are typically attributable to three factors: 1) changes in resource abundance, 2) changes in management strategy, and 3) changes in the stock assessment model. Assessments conducted prior to 1985 consisted of simple projections of current survey numbers at age. In 1985, the assessment was expanded to consider all survey numbers at age from 1979-1985. From 1985-1991, the assessment was conducted using an *ad hoc* separable age-structured model. In 1992, the assessment was conducted using the Stock Synthesis modeling software (Methot 1986, 1990) with age-based data. All assessments from 1993 through 2003 continued to use the Stock Synthesis modeling software, but with length-based data. Age data based on a revised ageing protocol were added to the model in the 2004 assessment. At about that time, a major upgrade in the Stock Synthesis architecture resulted in a substantially new product, at that time labeled "SS2" (Methot 2005). The assessment was migrated to SS2 in 2005. Changes to model structure were made annually through 2011, then the base model remained constant through 2015, and new base models were adopted in both 2016 and 2017 (see Appendix 2.3). A note on software nomenclature: The label "SS2" was dropped in 2008. Since then, the program has been known simply as "Stock Synthesis" or "SS," with several versions typically produced each year, each given a numeric or alpha-numeric label.

The time series shown in Table 2.4 can be used to estimate a statistical relationship between ABC and realized catch, which can be helpful for making multi-year forecasts. The relationship was re-estimated for the 2018 assessment (Thompson 2018), yielding the following segmented linear model: For ABC≥198,000 t, catch = 89,000 t + 0.55×ABC; for ABC<198,000 t, catch = ABC (Figure 2.2). The root-mean-squared relative error from this model was 4%.

Beginning with the 2014 fishery, the Board of Fisheries for the State of Alaska has established guideline harvest levels (GHLs) in State waters between 164 and 167 degrees west longitude in the EBS subarea (these have supplemented GHLs that had been set aside for the Aleutian Islands subarea since 2006). The table below shows the formulas that have been used to set the State GHL for the EBS (including the formula anticipated for setting the 2020 GHL):

Year	Formula
2014	0.030 × (EBS ABC + AI ABC)
2015	0.030 × (EBS ABC + AI ABC)
2016	0.064 × EBS ABC
2017	0.064 × EBS ABC
2018	0.064 × EBS ABC
2019	0.080 × EBS ABC
2020	0.090 × EBS ABC

For 2020 and 2021, the Board of Fisheries established an additional GHL of 45 t for vessels using jig gear within State waters.

Table 2.5 lists all implemented amendments to the BSAI Groundfish FMP that reference Pacific cod explicitly. In addition to those already implemented, Amendments 120/108, if approved by the Secretary of Commerce, will soon be added to the list. Those amendments would require that a C/P acting as a mothership receiving deliveries of BSAI non-CDQ Pacific cod from CVs engaged in directed fishing with trawl gear be designated on a groundfish LLP license with a "BSAI Pacific cod trawl mothership endorsement." Passage of the amendment was motivated by an increase in mothership activity since 2016 in the BSAI non-CDQ Pacific cod trawl CV directed fishery, which was linked to trawl CVs delivering to C/Ps operating as motherships, thereby decreasing Pacific cod landings at BSAI shoreside processing facilities. Only two groundfish LLP licenses will currently qualify for the BSAI Pacific cod trawl mothership endorsement. The proposed rule for Amendments 120/108 has already been published (84 FR 51092, September 27, 2019), and the final rule is expected to be published in time to be implemented for the 2020 A season trawl catcher vessel Pacific cod fishery in the BSAI (https://www.federalregister.gov/documents/2019/09/27/2019-20552/fisheries-of-the-exclusive-economic-zone-off-alaska-pacific-cod-management-in-the-groundfish).

DATA

The first two subsections below describe fishery and survey data that are used in the current stock assessment models. The third subsection describes survey data that are not used in the current stock assessment models, but that may help to provide some context for the survey data that are used.

The following table summarizes the sources, types, and years of data included in the data file for at least one of the stock assessment models:

Source	Type	Years
Fishery	Catch biomass	1977-2019
Fishery	Catch size composition	1977-2019
EBS shelf trawl survey	Survey numerical abundance	1982-2019
EBS shelf trawl survey	Survey size composition	1982-2019
EBS shelf trawl survey	Survey age composition	1994-2018
NBS shelf trawl survey	Survey numerical abundance	1982, 1985, 1988, 1991, 2010, 2017-2019
NBS shelf trawl survey	Survey size composition	1982, 1985, 1988, 1991, 2010, 2017-2019
NBS shelf trawl survey	Survey age composition	2010, 2017-2019
EBS+NBS trawl survey	Survey numerical abundance	1982-2019
EBS+NBS trawl survey	Survey size composition	1982-2019
EBS+NBS trawl survey	Survey age composition	1994-2019

Fishery Data Used in the Models

Catch Biomass

Catch estimates for the period 1977-2019 are shown Tables 2.1a, 2.1b, and 2.1c. However, the estimate for 2019 is complete only through October 27. To obtain an estimate of the year-end catch for 2019, the method developed in the 2014 assessment was used (Thompson 2014). After comparing 12 alternative estimators in that assessment, it turned out that the best choice was simply to set the current year's catch during August-December equal to the previous year's catch during those same months, unless this would cause the catch to exceed the ABC, in which case the year-end catch was set equal to the ABC. This procedure resulted in an estimated year-end 2019 catch of 176,847 t, slightly less than the 2019 ABC of 181,000 t.

The catches shown in Tables 2.1a, 2.1b, and 2.1c consist of "official" data from the NMFS Alaska Region. However, other removals of Pacific cod are known to have occurred over the years, including removals due to subsistence fishing, sport fishing, scientific research, and fisheries managed under other FMPs. Estimates of such other removals are shown in Appendix 2.4.

The catch estimates for the years 1977-1980 shown in Table 2.1a may or may not include discards.

Size Composition
Fishery size compositions are presently available from 1977 through the first part of 2019, and are parsed into 1-cm bins for use in the assessment models.

The size composition data in the current base model (Model 16.6i) and three of the alternative models are based on the data used in Model 11.5, which was the base model from 2011-2015. Model 11.5 was structured with respect to both gear and season, whereas Model 16.6i is structured with only a single gear and a single season. When Model 16.6, the immediate precursor to Model 16.6i was being developed during the 2016 assessment (Thompson 2016), the gear-and-season-specific catch proportions in each year were used to create a weighted average size composition from the size composition data used in Model 11.5, in an attempt to make the data files for the two models as comparable as possible. The same procedure was retained for updating the size composition data used this year in Model 16.6i, resulting in the values shown in Table 2.6a. The values in each row (year) of this table sum to the number of fish measured in that year.

The 1991-2019 size composition data used in the other models (Table 2.6b) were compiled differently, with each year's record computed by using the month/gear/area catch proportions to create the weighted average, roughly similar to the approach described in the 2017 preliminary assessment (Appendix 2.1 of Thompson 2017). The units in Table 2.6b are proportions rather than number of measured fish, because the models that use these data specify different sets of input sample sizes.

Nominal sample sizes for the fishery size composition data, in units of both measured fish and sampled hauls, are shown in Table 2.7.

Survey Data Used in the Models

Overview of Survey Areas and Frequency
The areas covered by the EBS shelf and NBS bottom trawl surveys are shown in Figure 2.4. In the EBS, strata 10-62 have been surveyed annually since 1982 and strata 82 and 90 have been surveyed annually since 1987. Strata 70, 71, and 81 in the NBS have been surveyed in 2010, 2017, and 2019. Less extensive surveys of the NBS were conducted in 1982, 1985, 1988, 1991, and 2018.

Abundance
Design-based, area-swept estimates of abundance (in 1000s of fish) obtained from the EBS, NBS, and combined EBS and NBS are shown in Table 2.8, together with their respective log-scale standard deviations ("Sigma"). Abundance estimates and 95% confidence intervals for the same four time series are shown in Figure 2.5. The 2019 estimate for the EBS was up 112% from the 2018 estimate and up 44% from the 2017 estimate. The 2019 estimate for the NBS was up 47% from the 2017 estimate (the 2018 "rapid response" survey did not cover the entire NBS survey area, and is not included in the design-based estimates). The 2019 estimate for the combined EBS and NBS surveys was up 45% from 2017.

This year, alternative sets of survey abundance estimates based on the VAST approach of Thorson et al. (2015) became available, and were used in all models other than the base model. More specifically, four sets of estimates (each covering the EBS, NBS, and combined EBS and NBS) were developed, following a 2×2 factorial design, where the first factor was whether the location and extent of the "cold pool" was included as a covariate or not, and the second factor was whether the estimates were bias corrected or not. All four sets of estimates are shown in Table 2.9, and are illustrated for the EBS, NBS, and combined EBS and NBS in Figure 2.6. All settings used to generate the VAST estimates followed the recommendations given by Thorson (2019). As Figure 2.6 shows, the results for the EBS are extremely similar across the four datasets, although some differences are visually discernible for the NBS. The set of estimates with the cold pool covariate included and bias corrected was chosen for use in this assessment, because: 1) the SSC has previously expressed a preference for mechanistic models over mere correlation and use of the cold pool as a covariate for changes in the distribution of Pacific cod in particular (SSC minutes, October 2018, and 2) bias is generally something to be avoided (all else being equal). The estimates for the EBS, NBS, and combined EBS and NBS from this dataset are consolidated in Figure 2.7. Broadly speaking, this set of estimates is similar to the design-based estimates shown in Table 2.8. The 2019 EBS estimate is up 95% from 2018 and up 46% from 2017, the 2019 NBS estimate is down 13% from 2018 but up 58% from 2017, and the 2019 EBS+NBS estimate is up 44% from 2018 and up 49% from 2017.

Size and Age Composition

Design-based estimates of the size compositions (in 1-cm bins) from the bottom trawl surveys for the years 1982-2019 are shown in Table 2.10 (VAST estimates of size composition are not yet available, so design-based estimates were used for all models). Each row sums to unity. Nominal sample sizes for the survey size composition data, in units of both measured fish and sampled hauls, are shown in Table 2.11.

Recent size compositions, up to 80 cm, are compared in Figure 2.8. The size compositions from the nine most recent surveys of the EBS are shown in Figure 2.8a along with the 1987-2019 mean size composition. While the size compositions from 2011-2014 show clear indications of incoming year classes that are larger than the long-term mean, the 2015-2018 size compositions indicate a string of poor recruitments. The 2019 size composition shows that the 2018 year class may break that string. Figure 2.8b shows the size compositions from the 2010, 2017, and 2019 NBS surveys. As in the 2019 EBS survey, the 2019 NBS survey indicates that the 2018 year class may be large. However, it should be noted that bottom temperatures near shore in both the EBS and NBS were extremely high in 2019, and it is possible that the apparent large size of the 2018 year class may be due in part or entirely to a change in selectivity, if age 1 fish that might normally reside largely in waters close to shore and outside the survey areas were pushed into the survey areas by the high temperatures near shore.

Age compositions from the 1994-2018 EBS surveys are shown in Table 2.12, where the values in each row sum to unity. Table 2.12a shows the design-based estimates of age composition for the EBS. Table 2.12b shows the VAST estimates of age composition for the EBS, NBS, and EBS and NBS combined. Nominal sample sizes for the survey age composition data, in units of both measured fish and sampled hauls, are shown in Table 2.13.

Survey Data Provided for Context Only

Other results from the EBS and NBS shelf bottom trawl surveys, or results from other surveys, may provide some helpful context for the results provided in the previous section. These include estimates of biomass from the EBS shelf and NBS bottom trawl surveys and results from the International Pacific Halibut Commission (IPHC) longline survey.

Biomass Estimates from the EBS Shelf and NBS Bottom Trawl Surveys

Design-based, area-swept estimates of biomass for the EBS, NBS, and EBS and NBS combined are shown in Table 2.14, together with their respective standard errors. Biomass estimates and 95% confidence intervals are shown in Figure 2.9. The 2019 estimate for the EBS was up 2% from the 2018 estimate, but down 20% from the 2017 estimate. The 2019 estimate for the NBS was up 29% from the 2017 estimate (the 2018 "rapid response" survey did not cover the entire NBS survey area, and is not included in the design-based estimates). The 2019 estimate for the combined EBS and NBS surveys was down 5% from 2017.

IPHC Longline Survey
Figuer 2.10a shows the locations of BSAI stations sampled by the IPHC longline survey. The time series (1997-2019) of relative population numbers (RPN) is shown in Figure 2.10b. The 2019 estimate was up 32% from the 2018 estimate, and is almost identical to the mean value for the time series.

ANALYTIC APPROACH

General Model Structure

Although Pacific cod in the EBS and AI were managed on a BSAI-wide basis through 2013, the stock assessment model has always been configured for the EBS stock only. Since 1992, the assessment model has always been developed under some version of the SS modeling framework (technical details given in Methot and Wetzel 2013; see especially Appendix A to that paper). Beginning with the 2005 assessment, the EBS Pacific cod models have all used versions of SS based on the ADMB software package (Fournier et al. 2012). A history of previous model structures, including all SS-based models that have been fully vetted since 2005, is given in Appendix 2.3.

SS V3.30.12.00 (beta release, including various minor incremental upgrades through August 3, 2018) was used to run the base model in last year's assessment. SS V3.30.14.00 was used to run all of the models in this final assessment, except that V3.30.12.00 was used to run the projections for Scenario 3 in the standard harvest scenarios (see "Harvest REcommendations" section).

Description of Alternative Models

List of Models
Beginning with the final 2015 assessment (Thompson 2015), model numbering has followed the protocol given by Option A in the SAFE chapter guidelines. Names of all final models adopted between the 2005 assessment (when an ADMB-based version of SS was first used) and the 2015 assessment were translated according to that protocol in Table 2.11 of the 2015 assessment. The goal of the protocol is to make it easy to distinguish between major and minor changes in models and to identify the years in which major model changes were introduced. Names of models constituting *major* changes get linked to the year that they are introduced (e.g., the *original version* of the current base model, Model 16.6, was one of several models introduced in 2016 that constituted a major change from the then-current base model), while names of models constituting *minor* changes from the original form of the current base model get linked to the name of that model (e.g., the name of the current base model, Model 16.6i, refers to a model that constitutes a minor change from Model 16.6, regardless of the year in which it was introduced).

This year's preliminary assessment (Appendix 2.1) included Model 16.6i, which was newly adopted as the base model in 2018 (it replaced Model 16.6, which had been the base model since 2016), and six new models, labeled 19.1-19.6. Models 19.1-19.6 spanned a 3×2 factorial design. The first factor consisted of three "hypotheses" posed by the Team:

1. Pacific cod in the NBS are insignificant to the managed stock, so the assessment should include data from the EBS only.
2. Pacific cod in the EBS and NBS comprise a single stock, and the EBS and NBS surveys can be modeled in combination.
3. Pacific cod in the EBS and NBS comprise a single stock, but the EBS and NBS surveys should be modeled separately.

The second factor consisted of two sets of structural changes (relative to the base model), which were modified from two sets of structural changes suggested by the SSC (see comment SSC3 in Appendix 2.1). The two sets of structural modifications were the same across hypotheses, except that an additional set of survey parameters was required for Hypothesis 3 (to allow for separate modeling of the NBS survey). In addition to structural differences, the models for the various hypotheses also involved different data or data weightings.

The first (smaller) set of structural modifications was as follows:

- Set input sample size for compositional data equal to the number of hauls, rescaled to an average of 300 for each component (Model 16.6i sets input sample size equal to the number of *observations*, rescaled to an average of 300 for each component).
- Include the available fishery age composition data (Model 16.6i ignores those data).
- Use age-based, double-normal selectivity, potentially dome-shaped for the fishery but forced asymptotic for the survey (Model 16.6i uses age-based, logistic survey for both fleets).
- Tune the input standard deviation of log-scale recruitment deviations (σ_R) to match the square root of the variance of the estimates plus the sum of the estimates' variances (Methot and Taylor 2011; Model 16.6i estimates σ_R internally).
- Use size-based maturity (Model 16.6i uses age-based maturity).

The second (larger) set of structural modifications was as follows:

- Set input sample size for compositional data equal to raw number of hauls rather (than rescaled to an average of 300 for each component).
- Reweight compositional data internally using the Dirichlet-multinomial distribution (Thorson et al. 2017).
- Use size-based double-normal selectivity rather than age-based (but keeping the assumption of asymptotic survey selectivity).
- Allow mean ageing bias at ages 1 and 20 to differ between the pre-2008 and post-2007 periods in order to compensate for an apparent change in ageing criteria (Beth Matta, AFSC Age and Growth Program, *pers. commun.*, 6/27/2019) .
- Allow yearly random variation in survey selectivity (two parameters), with the input standard deviation of the deviations tuned to set the variance of the estimates plus the sum of the estimates' variances equal to unity.
- Allow yearly random variation in survey catchability, with the input standard deviation of the deviations tuned to set the variance of the estimates plus the sum of the estimates' variances equal to unity.
- Allow yearly random variation in mean length at age 1.5, with the input standard deviation of the deviations tuned to set the variance of the estimates plus the sum of the estimates' variances equal to unity, in order to address the significant amount of time-variability in growth documented by Puerta et al. (2019) and Ciannelli et al. (2019).
- Allow yearly random variation in fishery selectivity (three parameters), with the input standard deviation of the deviations tuned to set the variance of the estimates plus the sum of the estimates' variances equal to unity.

(Note that the method for tuning the input standard deviations of log-scale recruitment deviations is slightly different than the method for tuning the input standard deviations of all other deviation vectors. This is because SS treats log-scale recruitment deviations differently from all other deviation vectors.)

Referring to models conforming to the first set of structural modifications as "simple" and models conforming to the second (larger) set of structural modifications as "complex," the set of alternative models can be summarized as follows:

Hypothesis	Structure	Model
2: EBS+NBS	Basic	M16.6i
1: EBS only	Simple	M19.1
	Complex	M19.2
2: EBS and NBS combined	Simple	M19.3
	Complex	M19.4
3: EBS and NBS separated	Simple	M19.5
	Complex	M19.6

Both the Team and SSC requested that Models 16.6i and 19.1-19.6 be included in this year's final assessment. Additionally, the SSC requested three other new models (see comment SSC15), bringing the total of requested models to ten. However, this set of models was rendered problematic by some of the Team and SSC comments from the September 2019 and October 2019 meetings, respectively:

- Although the SSC asked that the authors "bring forward" all six of the new models (including the two models corresponding to Hypothesis 1), it also requested that the Team "strongly consider not carrying forward Hypothesis 1," implying that Models 19.1 and 19.2 would have very little chance of being adopted by the SSC (see comment SSC13).
- In contrast to the Team's perspective, the SSC reaffirmed its view that retrospective bias should be among the model evaluation criteria (comments SSC14 and SSC17), but Models 19.2-19.6 all exhibited very high levels of retrospective bias. Taken together with the preceding item, this implies that none of the new models would likely be adopted by the SSC.
- Overall, there seemed to be considerable interest by both the Team and the SSC in seeing VAST estimates of survey abundance and age composition used in the new models (see comments BPT3, BPT11, BPT13, SSC3, SSC6, and SSC15), but only two of the new models (19.3 and 19.4) actually used those data. If VAST-based analogues of Models 19.1, 19.2, 19.5, and 19.6 were to be developed, it would bring the total number of models to 14, which would likely prove impractical, and it seems likely that at least three of those analogues would suffer the same problem with retrospective bias as their respective original versions.

Rather than produce a large number of models that would seem to have very little chance of being either adopted or given substantial weight in an ensemble, attention was turned instead to investigating the issue of the large retrospective biases exhibited by Models 19.2-19.6. Although the time available for this investigation was extremely limited, the results suggested that the retrospective biases of at least some of the new models might be reduced to acceptable levels by making the following changes to the simple and complex models, both of which result in model structures closer to that of all recent base models:

- For both the simple and complex models, eliminate the fishery age composition data that were added as part of the first set of structural modifications (note that no base model since 1992 has included fishery age composition data).
- For the complex models, reduce the average input sample size of the fishery size composition data so that it equals the average input sample size of the survey size composition data (note that this has been the practice for all base models since 2007).

The above modifications resulted in six new models, following the original 3×2 factorial design. The three new models requested by the SSC (see comment SSC15) have the same structure as the base model and will therefore be referred to as having a "basic" structure, which results in a 3×3 factorial design. Together with the base model, this brings the total number of models to ten, where the nine new models are labeled 19.7-19.15. The relationships of Models 19.7-19.15 to each other and to those presented in the preliminary assessment (Models 19.1-19.6) are shown below:

Hypothesis	Structure	Preliminary	Final	Changes (from preliminary to final)
2: EBS+NBS	Basic	M16.6i	M16.6i	none
1: EBS only	Basic	n/a	M19.7	n/a
	Simple	M19.1	M19.8	fishery: no agecomps
	Complex	M19.2	M19.9	fishery: no agecomps, downweighted sizecomps
2: EBS and NBS combined	Basic	n/a	M19.10	n/a
	Simple	M19.3	M19.11	fishery: no agecomps
	Complex	M19.4	M19.12	fishery: no agecomps, downweighted sizecomps
3: EBS and NBS separated	Basic	n/a	M19.13	n/a
	Simple	M19.5	M19.14	fishery: no agecomps
	Complex	M19.6	M19.15	fishery: no agecomps, downweighted sizecomps

Convergence Behavior

As in previous assessments, development of the final versions of all models included calculation of the Hessian matrix and a requirement that all models pass a "jitter" test of 50 runs. Following the procedure established in the 2016 assessment (Thompson 2016), when running a jitter test, the bounds for each parameter in the model were adjusted to match the 99.9% confidence interval (based on the normal approximation obtained by inverting the Hessian matrix). A jitter rate (equal to half the standard deviation of the logit-scale distribution from which "jittered" parameter values are drawn) was set at 1.0 for all models. Standardizing the jittering process in this manner will not explore parameter space as thoroughly as possible; however, it makes the jitter rate more interpretable, and shows the extent to which the identified minimum (local or otherwise) is well behaved.

In the event that a jitter run produced a non-negligibly better value for the objective function than the base run (specifically, an improvement of more than 0.01 units), then:

1. The model was re-run starting from the final parameter file from the best jitter run.
2. The resulting new control file, with the parameter estimates from the best jitter run incorporated as starting values, became the new base run.
3. The entire process (starting with a new set of jitter runs) was repeated until no jitter run produced a better value for the objective function than the most recent base run.

For models with several time-varying parameters and iteratively tuned sigma terms, previous experience with the above method has shown that a jitter run with a slightly better value for the objective function can sometimes be misleading, in that the iteratively tuned sigma terms are no longer in equilibrium with the results, and that starting from the "better" jitter run and retuning the sigma terms simply returns the model to the configuration of the base run. Therefore, for the three models with "complex" structure, the definition of "non-negligibly better" was liberalized slightly.

Parameters Estimated Outside the Assessment Model

Variability in Estimated Age

Variability in estimated age in the assessment models is based on the standard deviation of estimated age between "reader" and "tester" age determinations (note that this is not the same as ageing *bias*, which is estimated internally). Weighted least squares regression, without an intercept, has been used in the past several assessments to estimate a proportional relationship between standard deviation and age. The regression has traditionally been computed over ages 1 through 13, yielding a slope parameter that is used to estimate standard deviation at age as the product of slope and age. To maintain consistency between models, only survey age data were used to estimate the slope parameter.

For the survey-only data, the estimated slope was 0.083, giving a weighted R^2 of 0.97. This regression corresponds to a standard deviation at age 1 of 0.083 and a standard deviation at age 20 of 1.668.

Weight at Length

Using the functional form weight = $\alpha \times \text{length}^{\beta}$, where weight is measured in kg and length is measured in cm, the long-term base values for the parameters were estimated this year (using fishery data from 1974 through 2019) as α = 5.55906E-06 (mean-unbiased) and β = 3.189727.

All of the models allow inter-annual, externally estimated, variability in weight-length parameters. Values of annual additive offsets from the base α and β values are shown in Table 2.15. Although values were calculated for 1977 (the initial year in the model), they were not used in the data files, because SS computes $B_{100\%}$ on the basis of the biology in the initial year, and it seemed more important to have $B_{100\%}$ represent a long-term average than to get the weight-length relationship in 1977 exactly right.

Maturity

A detailed history and evaluation of parameter values used to describe the maturity schedule for BSAI Pacific cod was presented in the 2005 assessment (Thompson and Dorn 2005). A length-based maturity schedule was used for many years. The parameter values used for the length-based maturity schedule in the 2005 and 2006 assessments were set on the basis of a study by Stark (2007) at the following values: length at 50% maturity = 58 cm and slope of linearized logistic equation = –0.132. However, in 2007, changes in SS allowed for use of either a length-based or an age-based maturity schedule. Beginning with the 2007 assessment, the accepted model has used an age-based schedule with intercept = 4.88 years and slope = –0.965 (Stark 2007). The use of an age-based rather than a length-based schedule followed a recommendation from the maturity study's author (James Stark, AFSC, *pers. commun.*), and the age-based parameters were retained for the base model (16.6i) in the present assessment. However, because all assessments since 2009 have estimated some amount of ageing bias, the new models in the present assessment (19.7-19.15) all use the length-based parameters.

Stock-Recruitment "Steepness"

Following the standard Tier 3 approach, all models assume that there is no relationship between stock and recruitment, so the "steepness" parameter is set at 1.0 in each.

Parameters Estimated Inside the Assessment Model

A total of 80 parameters were estimated inside SS for Model 16.6i. These consist of the following:

1. instantaneous natural mortality rate (*M*)
2. all three von Bertalanffy growth parameters, plus the Richards growth parameter
3. standard deviation of length at ages 1 and 20
4. mean ageing bias at ages 1 and 20
5. log mean recruitment since the 1976-1977 regime shift
6. offset for log-scale mean recruitment before the 1976-1977 regime shift
7. standard deviation of the log-scale recruitment deviations (σ_R)
8. initial (equilibrium) fishing mortality
9. log catchability for the trawl survey

10. deviations for log-scale initial (i.e., 1977) abundance, ages 1-20
11. log-scale recruitment deviations, 1977-2018
12. base values of both selectivity parameters for both the fishery and survey

The three new models with "basic" model structure (Models 19.7, 19.10, and 19.13) estimate the same set of parameters as the base model, except that Model 19.13 also estimates catchability and two selectivity parameters for the NBS bottom trawl survey.

The three new models with "simple" model structure (Models 19.8, 19.11, and 19.14) each estimate two parameters in addition to their respective "basic" counterparts, representing the more flexible form of the fishery selectivity curve (note that the definitions of the selectivity parameters also differ between the "basic" and "simple" models, owing to the difference in functional form).

The three new models with "complex" model structure (Models 19.9, 19.12, and 19.15) each estimate the same parameters as their respective "simple" counterparts, except that:

- two additional ageing bias parameters are also estimated (to allow for the change in ageing criteria that occurred in 2008)
- one fewer fishery selectivity parameter (top width) is estimated, as it always ended up being bound low and so was fixed at a very low value
- three parameters representing the Dirichlet-multinomial weights are also estimated
- an additional 247 constrained deviations for length at age 1.5, three fishery selectivity parameters (peak, ascending standard deviation, and selectivity at 120 cm), two survey selectivity parameters (peak and ascending standard deviation), and survey catchability are also estimated, except that:
    - an additional 40 constrained deviations for NBS survey catchability are also estimated for Model 19.15, but only 8 of those are fit to data (the remaining 32 have estimated values of zero with standard deviations of unity, conforming to the underlying normal(0,1) distributional assumption)

In all models, uniform prior distributions were used for all parameters. It should also be noted that vectors of deviations were constrained by input standard deviations, which are somewhat analogous to a joint prior distribution.

For all parameters estimated within individual SS runs, the estimator used was the minimum negative log likelihood.

In addition to the above, the full set of fishing mortality rates were also estimated internally, but not in the same sense as the above parameters. The fishing mortality rates are determined (almost) exactly as functions of other model parameters, because SS assumes that the input total catch data are true values rather than estimates, so the fishing mortality rates can be computed algebraically given the other parameter values and the input catch data. An option does exist in SS for treating the fishing mortality rates as full parameters, but previous explorations have indicated that adding these parameters has almost no effect on other model output (Methot and Wetzel 2013).

Objective Function Components

All models in this assessment include likelihood components for catch, initial (equilibrium) catch, trawl survey relative abundance, recruitment, initial recruitment, "softbounds" (analogous to a very weak prior distribution designed to keep parameters from hitting bounds), fishery and survey size composition, and survey age composition (although the identity and number of surveys differ between models). In addition, the three "complex" models (19.9, 19.12, and 19.15) include a component for parameter deviations.

In SS, emphasis factors are specified to determine which likelihood components receive the greatest attention during the parameter estimation process. As in previous assessments, all likelihood components were given an emphasis of 1.0 here.

Use of Size Composition Data in Parameter Estimation

Size composition data are assumed to be drawn from a multinomial distribution specific to a particular year and fleet (fishery or survey). In the parameter estimation process, SS weights a given size composition observation according to the emphasis associated with the respective likelihood component and the sample size specified (and perhaps adjusted by a multiplier) for the multinomial distribution from which the data are assumed to be drawn. In developing the model upon which SS was originally based, Fournier and Archibald (1982) suggested truncating the multinomial sample size at a value of 400 in order to compensate for contingencies which cause the sampling process to depart from the process that gives rise to the multinomial distribution. For many years, the Pacific cod assessments assumed a multinomial sample size equal to the square root of the true length sample size, rather than the true length sample size itself. Given the true length sample sizes observed in the EBS Pacific cod data, this procedure tended to give values somewhat below 400 while still providing SS with usable information regarding the appropriate effort to devote to fitting individual length samples.

Although the "square root rule" for specifying multinomial sample sizes gave reasonable values, the rule itself was largely *ad hoc*. In an attempt to move toward a more statistically based specification, the 2007 assessment used the harmonic means from a bootstrap analysis of the available fishery length data from 1990-2006 (Thompson et al. 2007). The harmonic means were smaller than the actual sample sizes, but still ranged well into the thousands. A multinomial sample size in the thousands would likely overemphasize the size composition data. As a compromise, the harmonic means were rescaled proportionally in the 2007 assessment so that the average value (across all samples) was 300. However, the question then remained of what to do about years not covered by the bootstrap analysis (2007 and pre-1990) and what to do about the survey samples. The solution adopted in the 2007 assessment was based on an observed consistency in the ratios between the harmonic means (the raw harmonic means, not the rescaled harmonic means) and the actual sample sizes: Whenever the actual sample size exceeded about 400 fish, for the years prior to 1999 the ratio was very consistently close to 0.16, and for the years after 1998 the ratio was very consistently close to 0.34.

This consistency was used to specify the missing values as follows: For fishery data, records with actual sample sizes less than 400 were omitted. Then, the sample sizes for fishery length compositions from years prior to 1999 were tentatively set at 16% of the actual sample size, and the sample sizes for fishery length compositions from 2007 were tentatively set at 34% of the actual sample size. For the pre-1982 trawl survey, length compositions were tentatively set at 16% of an assumed sample size of 10,000. For the post-1981 trawl survey length compositions, sample sizes were tentatively set at 34% of the actual sample size. Then, with sample sizes for fishery length compositions from 1990-2007 tentatively set at their bootstrap harmonic means (not rescaled), all sample sizes were adjusted proportionally so that the average was 300.

The same procedure was used in the 2008 and 2009 assessments. For the 2010 assessment, however, this procedure had to be modified somewhat, because the bootstrap values for the 1990-2006 size composition data did not match the new bin and seasonal structures. To be as consistent as possible with the approach used to set sample sizes in the 2008 and 2009 assessments, the 2010 and 2011 assessments set sample sizes by applying the 16/34% rule for *all* size composition records with actual sample sizes greater than 400 (not just those lying outside the set of 1990-2006 fishery data), then rescaling proportionally to achieve an average sample size of 300. The same procedure was used for the 2012-2018 assessments, except that, beginning in 2017, the pre-1982 trawl survey data were no longer used. The four models with “basic” structure in the present assessment (16.6i, 19.7, 19.10, and 19.13) continue to use this approach.

The three models with “simple” structure (19.8, 19.11, and 19.14) set input sample size equal to the number of sampled hauls, in either the fishery or the respective survey, rescaled to a mean of 300.

The three models with “complex” structure (19.9, 19.12, and 19.15) set input sample size for the survey equal to the number of sampled hauls from that survey (not rescaled), and they set input sample size for the fishery equal to the number of sampled hauls from the fishery, rescaled to a mean equal to the mean number of sampled hauls from the respective survey.

Input sample sizes for fishery size composition data are shown in Table 2.16 and for survey size composition data in Table 2.17. The left half of each table shows the data or calculations used to generate the various sample size vectors, and the right half of each table maps those vectors into the relevant model(s). Color coding shows relationships between the two halves of a given table (color coding is not consistent between tables, however).

In Table 2.16:

- Under “Survey,” the columns labeled “EBS” and “E+N” represent the EBS and combined EBS and NBS surveys.
- Under “Fishery:”
    - Under “Lengths:”
        - The column labeled “Nadj” shows the adjustment used to approximate the harmonic mean described above for the models with “basic” structure
        - The column labeled “300” shows values of the column labeled “Nadj” rescaled to a mean of 300
    - Under “Hauls:”
        - The column labeled “300” shows values of the column labeled “N” rescaled to a mean of 300
        - The column labeled “EBS” shows values of the column labeled “N” rescaled to a mean equal to the mean of the column labeled “EBS” under “Survey”
        - The column labeled “E+N” shows values of the column labeled “N” rescaled to a mean equal to the mean of the column labeled “E+N” under “Survey”

In Table 2.17, each column labeled “300” shows values of the column immediately to the left rescaled to a mean of 300.

Use of Age Composition Data in Parameter Estimation
Like the size composition data, the age composition data are assumed to be drawn from a multinomial distribution specific to a particular year and fleet (fishery or survey). The models with “basic” structure (16.6i, 19.7, 19.10, and 19.13) set input sample size equal to the number of measured fish in the respective survey, rescaled to a mean of 300. The models with “simple” structure (19.8, 19.11, and 19.14) set input sample size equal to the number of hauls in the respective survey, rescaled to a mean of 300. The models with “complex” structure (19.9, 19.12, and 19.15) set input sample size equal to the number of hauls in the respective survey (not rescaled).

Input sample sizes for survey age composition data are shown for all models in Table 2.18, which follows the same formatting conventions as Table 2.17.

Note that the age compositions are used in the marginal forms, not in conditional-age-at-length form.

Use of Survey Relative Abundance Data in Parameter Estimation
For the survey, each year's survey abundance estimate is assumed to be drawn from a lognormal distribution specific to that year. The model's estimate of survey abundance in a given year serves as the geometric mean for that year's lognormal distribution, and the ratio of the survey abundance estimate's standard error to the survey abundance estimate itself serves as the distribution's coefficient of variation, which is then transformed into the "sigma" parameter of the lognormal distribution.

The "sigma" parameters for the design-based estimates are shown in Table 2.8 and for the VAST estimates in Table 2.9a.

Use of Recruitment Deviation "Data" in Parameter Estimation
The likelihood component for recruitment is different from traditional likelihoods because it does not involve "data" in the same sense that traditional likelihoods do. Instead, the log-scale recruitment deviation plays the role of the datum in a normal distribution with mean zero and specified (or estimated) standard deviation; but, of course, the deviations are parameters, not data.

RESULTS

Note: Some tables referenced in this section employ red-to-green color scales. In all cases, the scale ranges from red=low to green=high, and can extend across a row, a column, or the entire table, depending on the context.

Model Evaluation

Individual Model Goodness of Fit
Table 2.19 shows the objective function value for each data component in each model, along with the number of parameters in each model, where the latter is broken down into "true" (unconstrained) parameters and constrained deviations. With few exceptions, objective function values are not truly comparable across models, and attempts to apply information-theoretic statistics such as the Akaike information criterion may be misleading, because:

- The total parameter counts overestimate the number of "effective" parameters, because these counts include parameters with prior distributions and constrained deviations.
- The models use different data files.
- The data are often weighted differently between models.

The root-mean-squared-standardized-residual (RMSSR) is shown for all models in Table 2.20. Ideally values should equal unity. The desired result is obtained for all of the "complex" models, but all other models have RMSSR values far in excess of unity, ranging from 1.789 (Model 16.6i) to 7.059 (Model 19.13). Note that the standard errors of the survey data differ depending on which survey is involved and whether design-based estimates (Model 16.6i) or VAST estimates (Models 19.7-19.15) are used, with EBS survey standard errors for the VAST estimates being notably smaller than those for the design-based estimates. Fits to the trawl survey abundance data are shown for all models in Figure 2.11.

Effective sample sizes implied by the models' fits to the size composition and age composition data are compared with the corresponding input sample sizes in Table 2.21. Input sample sizes are expressed as arithmetic means. Two formulations of effective sample size are shown:

- The formulation popularized by McAllister and Ianelli (1997), which has been used in many previous assessments, is shown for all models, expressed as a harmonic mean. Ideally, the harmonic mean of this formulation of effective sample size should equal the arithmetic mean of the input sample size, which typically requires iterative tuning.

- The formulation of Thorson et al. (2017) is shown for the “complex” models, which use the Dirichlet-multinomial distribution to model compositional data. In this formulation, the effective sample size is a function of an internally estimated parameter (“theta” in Table 2.21), so iterative tuning is not required. However, in the case of size composition data, the estimated parameter was constrained by the upper bound for both the fishery and survey (or surveys) in all of the “complex” models. For the age composition data, the effective sample sizes for the Thorson et al. formulation were of the same magnitude as, but smaller than, the effective sample sizes for the McAllister-Ianelli formulation.

Residual plots for the size and age composition data are shown in Figures 2.12 and 2.13, respectively.

Choice of Ensemble and Model Weights
The models used in this assessment are described under “Description of Alternative Models” above.

For the last few years, the Team and SSC have expressed interest in using an ensemble (model averaging) approach for the EBS Pacific cod assessment. For this year’s assessment, the Team and SSC again recommended consideration of an ensemble approach (see comments BPT7, BPT8, BPT14, BPT15, BPT16, and SSC 18).

Of the ten models presented in this assessment Models 19.7-19.15 appear to represent a reasonable ensemble. It seems advisable to exclude Model 16.6i, because:

- Model 16.6i does not account for the changes in the sampling design of the NBS bottom trawl survey over the years or gaps in the time series (it simply sums the results from the two surveys, and treats missing years in the NBS survey as though the NBS abundance in those years was 0).
- Although Model 16.6i was adopted as the base model last year, “the Team expressed many caveats” about this model, with seven “significant concerns” listed in the 11/18 minutes.
- The results of Model 16.6i are sufficiently similar to those of Model 19.10 that inclusion of both models would tend to double-count the results of Model 19.10.
- Inclusion of Model 16.6i would spoil the 3×3 factorial design of the ensemble.

Once an ensemble has been identified, it is necessary to assign weights to the included models. This has proven to be a challenging task in previous assessments, as a large number of alternative model weightings were presented in both the 2017 assessment and the preliminary 2018 assessment, but none were adopted.

For the present assessment, the Team requested “a justifiable weighting as well as a ‘null’ approach with equal weights” (comment BPT8). In response to the Team’s request, nine criteria were chosen upon which to base a system of model weighting. These include the four criteria used in the 2018 assessment, which the SSC has asked to be retained for the present assessment (comment SSC17). The criteria are as follow (last year’s criteria are shaded):

1. Are the catchability estimates plausible?
2. Is the retrospective bias within the acceptable range?
3. Is the associated “hypothesis” plausible?
4. Is the model complexity similar to that of other BSAI groundfish Tier 3 assessments?
5. Are input standard deviations of “dev” vectors estimated appropriately?
6. Are fits to the data consistent with the variances specified for those data?
7. Are changes from the base model, if any, suitably incremental?
8. Is an objective criterion used to specify input sample sizes for compositional data?
9. Is the apparent change in ageing criteria (pre-2008 and post-2007) addressed?

The decision rules used to evaluate each model in the ensemble with respect to the above criteria follow.

1. Estimates of catchability for the years 2017-2019 (time-varying in the cases of Models 19.9, 19.12, and 19.15) are shown below:

	Hypothesis 1			Hypothesis 2		
	M19.7	M19.8	M19.9	M19.10	M19.11	M19.12
Year	EBS	EBS	EBS	EBS+NBS	EBS+NBS	EBS+NBS
2017	1.05	0.88	0.88	1.14	0.95	0.93
2018	1.05	0.88	0.97	1.14	0.95	1.18
2019	1.05	0.88	0.97	1.14	0.95	1.11
Mean	1.05	0.88	0.94	1.14	0.95	1.07

	Hypothesis 3								
	M19.13			M19.14			M19.15		
Year	EBS	NBS	EBS+NBS	EBS	NBS	EBS+NBS	EBS	NBS	EBS+NBS
2017	1.18	0.41	1.59	0.98	0.56	1.54	0.86	0.70	1.57
2018	1.18	0.41	1.59	0.98	0.56	1.54	0.92	1.47	2.39
2019	1.18	0.41	1.59	0.98	0.56	1.54	0.95	1.44	2.40
Mean	1.18	0.41	1.59	0.98	0.56	1.54	0.91	1.21	2.12

Note that, because Models 19.13-19.15 lack explicit spatial structure, the estimates of catchability for those models apply to the *entire stock*, not just the portion of the stock with the respective survey area. Thus, for example, the results of Model 19.15 suggest that, in 2019, the EBS survey observed 95% of the fully selected fish in the combined EBS and NBS stock, while, at the same time, the NBS survey observed 144% of the fully selected fish in the combined EBS and NBS stock. Given that field studies (e.g., Somerton 2004) have indicated that catchability of Pacific cod in the EBS survey is unlikely to be much greater than unity, estimates of catchability greater than 1.2, either for the EBS by itself (Hypothesis 1) or for the EBS and NBS combined (Hypotheses 2 and 3) were deemed implausible.

2. Retrospective behavior will be addressed in detail in the next subsection, but values of ρ (Mohn 1999, equation corrected in the 2013 Retrospective Working Group report) for spawning biomass are shown below, together with lower and upper bounds on acceptable levels defined as a function of *M*, based on results reported by Hurtado-Ferro et al. (2015):

Hypothesis	2	1			2			3		
Model	16.6i	19.7	19.8	19.9	19.10	19.11	19.12	19.13	19.14	19.15
M	0.33	0.35	0.42	0.36	0.33	0.40	0.35	0.32	0.41	0.36
Mohn's ρ	0.22	0.13	0.22	0.04	0.06	0.14	-0.06	0.20	1.51	0.11
ρmin	-0.20	-0.20	-0.23	-0.21	-0.20	-0.22	-0.20	-0.19	-0.23	-0.21
ρmax	0.27	0.28	0.31	0.28	0.27	0.30	0.27	0.26	0.31	0.28

All values of ρ within the model-specific range (above) were deemed acceptable.

3. Given comment SSC13, all models associated with Hypothesis 1 were deemed implausible.

4. All "basic" and "simple" models were deemed to have levels of complexity similar to that of other BSAI groundfish Tier 3 assessments.

5. All “simple” and “complex” models were deemed to have appropriately estimated input standard deviations for their associated “dev” vectors.

6. All “complex” models were deemed to exhibit fits to the data that were consistent with the variances specified for those data.

7. All “basic” models were deemed to exhibit suitably incremental changes from the base model.

8. All “complex” models were deemed to use an objective criterion to specify input sample sizes for compositional data.

9. All “complex” models were deemed to have addressed the apparent change in ageing criteria.

The above decision rules were used to assign a score (*S*) of either 0 or 1 to each model *j*=1,2,...,9 for each criterion *i*=1,2,...,9.

The next step in the development of model weights was to assign an emphasis (*E*) to each criterion. Criteria 1-3 were assigned an emphasis of 3, criteria 4-6 were assigned an emphasis of 2, and criteria 7-9 were assigned an emphasis of 1. These assignments were based on the subjective judgement of the senior author.

The next step was to compute an “exponential average emphasis” (*EAE*) for each model *j*=1,2,...,9, defined as:

$$EAE_j = exp\left(\sum_{i=1}^{9} E_i\, S_{i,j} - \sum_{i=1}^{9} E_i\right)$$

The final step was to scale the *EAE* values proportionally so that the resulting vector summed to unity.

The entire procedure, including the resulting model weights, is summarized in Table 2.22. Model 19.12 received the highest weight by far (0.7712), followed by Model 19.11 (0.1044). The cumulative distribution of model weights (ranked from largest to smallest) is shown in Figure 2.14. Five models (19.12, 19.9, and 19.10, and 19.15) account for just over 99% of the total weight.

Per request of the Team (see comment BPT8), ensemble results will be reported, where applicable, both as weighted averages (using the weights in Table 2.22) and unweighted averages.

Retrospective Performance

Retrospective analyses of all models, along with retrospective analyses of the weighted and unweighted ensemble averages, are shown in Figure 2.15. The text table of ρ values from the previous subsection is repeated below, but with values for the weighted and unweighted ensemble averages included:

Hypothesis	2	1			2			3			Ensemble	
Model	16.6i	19.7	19.8	19.9	19.10	19.11	19.12	19.13	19.14	19.15	wtd	unw
M	0.33	0.35	0.42	0.36	0.33	0.40	0.35	0.32	0.41	0.36	0.35	0.37
Mohn's ρ	0.22	0.13	0.22	0.04	0.06	0.14	-0.06	0.20	1.51	0.11	-0.02	0.27
ρmin	-0.20	-0.20	-0.23	-0.21	-0.20	-0.22	-0.20	-0.19	-0.23	-0.21	-0.20	-0.21
ρmax	0.27	0.28	0.31	0.28	0.27	0.30	0.27	0.26	0.31	0.28	0.28	0.28

The weighted ensemble average exhibits the value closest to zero (-0.02), followed by Model 19.9 (0.04) and Models 19.10 and 19.12 (0.06 and -0.06, respectively). As noted previously, the value for Model 19.14 falls far outside the acceptable range. The value for the unweighted ensemble average is within the acceptable range, but just barely.

In addition to the standard retrospective plots, the Team requested an analysis of the retrospective behavior of "specific parameters" (comment BPT17). The results of this analysis are shown in Table 2.23. Table 2.23a shows the correlation between the value of each time-invariant parameter (in any model) and retrospective "peel" (color scales in this figure are column-specific). The four parameters with the highest median correlation (across models) were mean ageing bias at age 20 (0.916); standard deviation of length at age 20 (0.900); natural mortality rate (0.892); and the log of EBS survey catchability, or combined EBS and NBS survey catchability, in the case of Models 19.10-19.12 (0.863). Peel-specific values of those four parameters are shown for each model in Table 2.23b, along with the value:peel correlation and the slope of the value:peel regression.

Parameter Estimates
Table 2.24 displays the values of all parameters (except fishing mortality rates, because these are functions of other parameters and are therefore shown separately) estimated either internally or iteratively in any of the models, along with the standard deviations of internally estimated parameters. Standard deviations are based on the inverse of the Hessian matrix, and assume a normal distribution. Weighted and unweighted ensemble means and standard deviations are also shown. However, it should be noted that the distributions for the ensemble, being averages of normal distributions, are themselves *not* normal, meaning that, while the standard deviations are correct, the 95% confidence intervals may or may not be well approximated by +/– two standard deviations. In the case of any parameter that is not used in all models, the weights for the models that do use that were rescaled to sum to unity. A blank cell in Table 2.24 indicates that the respective parameter (row) is not used in the respective model (column), and a parameter with an estimate (Est.) but no standard deviation (SD) means either that that the respective parameter was estimated iteratively rather than internally or that the parameter ended up at a bound.

Table 2.24a shows time-invariant parameters other than selectivity parameters (color scales are row-specific). Natural mortality ranges from 0.32 (Model 19.13) to 0.42 (Model 19.8). There appears to be a tradeoff between the Brody growth coefficient (*K*) and the Richards growth coefficient, in that all of the "basic" and "simple" models all estimate roughly similar values for those two parameters, while all of the "complex" models estimate substantially lower values for the Brody coefficient and substantially higher values for the Richards coefficient. When ageing bias is permitted to vary between the pre-2008 and post-2007 eras, the sign of the bias flips from almost all positive (pre-2008) to almost all negative (post-2007). Initial fishing mortality ranges from 0.13 (Model 19.12) to 0.21 (Model 19.13). Baseline log catchability for the EBS survey (or the combined EBS and NBS surveys in the case of Models 16.6i, 19.10, 19.11, or 19.12) ranges from -0.13 (Model 19.8) to 0.16 (Model 19.13).

Table 2.24b shows log recruitment deviations for the initial numbers-at-age vector, and Table 2.24c shows log recruitment deviations for the time series (color scales are column-specific). Table 2.24d shows selectivity parameters (not counting deviations).

Tables 2.24e-2.24k apply to the "complex" models only (Models 19.2, 19.4, and 19.6).

Table 2.24e shows input standard deviations for deviation vectors other than log recruitment (all estimated iteratively) and the coefficients governing compositional data weighting in the Dirichlet-multinomial approach (Thorson et al. 2017). The Dirichlet coefficients for the fishery size composition data and the EBS survey size composition data (EBS+NBS in the case of Model 19.4) were all bound high (upper bound = 10.0), but estimation of those parameters was not disabled (unlike other bound parameters).

Table 2.24f shows deviations for mean length at age 1.5.

Table 2.24g shows deviations for log catchability.

Tables 2.24h-2.24k show deviations for the time-varying selectivity parameters.

Derived Quantities
Figure 2.16 shows selectivity for all models. Figure 2.16a pertains to the "basic" and "simple" models, and Figure 2.16b pertains to the "complex" models.

Table 2.25 shows back-transformed EBS catchability (or combined EBS and NBS catchability, as appropriate) for all models (including weighted and unweighted ensemble averages) and years.

Table 2.26 and Figure 2.17 show the time series of female spawning biomass for all models (including weighted and unweighted ensemble averages).

Table 2.27 and Figure 2.18 show the time series of female spawning biomass relative to $B_{100\%}$ for all models (including weighted and unweighted ensemble averages).

Table 2.28 and Figure 2.19 show the time series of age 0 recruitment for all models (including weighted and unweighted ensemble averages).

Table 2.29 and Figure 2.20 show the time series of fishing mortality for all models (including weighted and unweighted ensemble averages).

Table 2.30 contains selected management reference points. Static quantities include $B_{100\%}$, $B_{40\%}$, $B_{35\%}$, $F_{40\%}$, and $F_{35\%}$. Quantities shown for each of the first two projection years (2020 and 2021) consist of female spawning biomass, relative spawning biomass, the probability that the ratio of spawning biomass to $B_{100\%}$ will fall below 0.2, $maxF_{ABC}$, maxABC, catch, F_{OFL}, OFL, and the probability that maxABC exceeds the true-but-unknown OFL.

Choice of Final Model
The weighted average ensemble is chosen as the final model. Both the Team and SSC have encouraged adoption of an ensemble approach for this assessment for some time now, and the SSC has asked that the models associated with Hypothesis 1 be down-weighted, implying that the unweighted average would not be an appropriate choice. Nevertheless, because the Team has expressed interest in the unweighted average, values for that option will be presented in the following sections as well. One downside is that running all the models in the ensemble and performing all of the calculations necessary to implement the ensemble approach fully is so time-consuming that it may not be possible to include any alternatives to the present ensemble in future assessments. Model 19.12 would be another reasonable choice, as it has the highest weight and gives results that are very similar to those of the weighted average ensemble.

Final Parameter Estimates and Associated Schedules
Final parameter estimates for the ensemble weighted average are shown in Table 2.24, as are estimates for the unweighted average, given that the Team has expressed interest in the unweighted average.

Table 2.31 shows length at age by year.

Table 2.32 shows fishery weight at age by year.

Table 2.33 shows survey weight at age by year. Table 2.33a pertains to the EBS survey and the sub-ensemble consisting of all Hypothesis 1 and Hypothesis 3 models, Table 2.33b pertains to the combined EBS and NBs surveys and the sub-ensemble consisting of all Hypothesis 2 models, and Table 2.33c pertains to the NBS survey and the sub-ensemble consisting of all Hypothesis 3 models.

Table 2.34 shows fishery selectivity at age by year.

Table 2.35 shows survey selectivity at age by year. Table 2.35a pertains to the EBS survey and the sub-ensemble consisting of all Hypothesis 1 and Hypothesis 3 models, Table 2.35b pertains to the combined EBS and NBs surveys and the sub-ensemble consisting of all Hypothesis 2 models, and Table 2.35c pertains to the NBS survey and the sub-ensemble consisting of all Hypothesis 3 models.

Time Series Results

The biomass estimates presented here will be defined in two ways: 1) age 0+ biomass, consisting of the biomass of all fish aged 0 years or greater in January of a given year; and 2) spawning biomass, consisting of the biomass of all spawning females in January of a given year. The recruitment estimates presented here will be defined as numbers of age 0 fish in a given year.

Table 2.36 shows the time series of age 0+ and female spawning biomass (t) since 1977 as estimated last year in the model accepted by the SSC and this year (both weighted and unweighted averages). The estimated spawning biomass time series are accompanied by their respective standard deviations.

Table 2.37 shows the time series of recruitment (1000s of fish) for the years since 1977 as estimated last year in the model accepted by the SSC and this year (both weighted and unweighted averages). The estimated time series are accompanied by their respective standard deviations. The correlation between last year's estimated recruitment time series and this year's is 0.99, for both the weighted and unweighted averages.

For the time series as a whole, the largest year class appears to have been the 2008 cohort, and the 2006, 2010, 2011, 2013 are also estimated to have been well above average. In contrast, the 2014-2017 year classes are all estimated to be well below average, with the 2016 and 2017 year classes being two of the three smallest year classes of all time (1987 being the third member of that group). However, the 2018 year class may break that string. The weighted and unweighted average estimates of the 2018 year class are 56% and 95% above average, respectively.

The coefficients of autocorrelation for this year's estimated recruitment time series are –0.15 (weighted average) and -0.14 (unweighted average).

Table 2.38 shows the time series of numbers at age (both weighted and unweighted averages).

Figure 2.21 shows the time series of female spawning biomass, with error bars representing plus-or-minus two standard deviations (both unweighted and unweighted averages).

Figure 2.22 shows the time series of female spawning biomass relative to $B_{100\%}$, with error bars representing plus-or-minus two standard deviations (both unweighted and unweighted averages).

Figure 2.23 shows the time series of recruitment, with error bars representing plus-or-minus two standard deviations (both unweighted and unweighted averages).

Figure 2.24 shows the time series of full-selection fishing mortality, with error bars representing plus-or-minus two standard deviations (both unweighted and unweighted averages).

Figure 2.25 plots the estimated/projected trajectory of relative fishing mortality ($F/F_{35\%}$) and relative female spawning biomass ($B/B_{35\%}$) from 1977 through 2021 based on full-selection fishing mortality, overlaid with the current harvest control rules (weighted average in Figure 2.25a, unweighted average in Figure 2.25b). In 2016, the base model changed from Model 11.5 (which had served as the base model from 2011-2015) to Model 16.6, which generally gave lower estimates of relative spawning biomass than either Model 11.5 or previous models. In 2018, the base model changed to Model 16.6i, which likewise gives lower estimates than Model 11.5, to the extent that, in hindsight, the stock was being subjected to fishing mortality rates in excess of the retroactively calculated F_{OFL} values (but not the official F_{OFL} values that were calculated at the time) in all years from the early 1990s through 2017, a conclusion which continues to hold in the present assessment.

Harvest Recommendations

The results presented in this section are based primarily on the ensemble weighted average (although results for the unweighted average are also presented in many cases). Because the ensemble weighted average differs from Model 16.6i (the current base model), a set of parallel results for the items in this section, but based on Model 16.6i, is provided in Appendix 2.5.

Amendment 56 Reference Points

Amendment 56 to the BSAI Groundfish Fishery Management Plan (FMP) defines the "overfishing level" (OFL), the fishing mortality rate used to set OFL (F_{OFL}), the maximum permissible ABC, and the fishing mortality rate used to set the maximum permissible ABC. The fishing mortality rate used to set ABC (F_{ABC}) may be less than this maximum permissible level, but not greater. Because reliable estimates of reference points related to maximum sustainable yield (MSY) are currently not available but reliable estimates of reference points related to spawning per recruit are available, Pacific cod in the EBS have generally been managed under Tier 3 of Amendment 56. Tier 3 uses the following reference points: $B_{40\%}$, equal to 40% of the equilibrium spawning biomass that would be obtained in the absence of fishing; $F_{35\%}$, equal to the fishing mortality rate that reduces the equilibrium level of spawning per recruit to 35% of the level that would be obtained in the absence of fishing; and $F_{40\%}$, equal to the fishing mortality rate that reduces the equilibrium level of spawning per recruit to 40% of the level that would be obtained in the absence of fishing. The following formulae apply under Tier 3:

3a) Stock status: $B/B_{40\%} > 1$

$F_{OFL} = F_{35\%}$

$F_{ABC} \leq F_{40\%}$

3b) Stock status: $0.05 < B/B_{40\%} \leq 1$

$F_{OFL} = F_{35\%} \times (B/B_{40\%} - 0.05) \times 1/0.95$

$F_{ABC} \leq F_{40\%} \times (B/B_{40\%} - 0.05) \times 1/0.95$

3c) Stock status: $B/B_{40\%} \leq 0.05$

$F_{OFL} = 0$

$F_{ABC} = 0$

The ensemble weighted average estimates of $F_{35\%}$ and $F_{40\%}$ are 0.43 and 0.35, respectively (Table 2.30).

The ensemble weighted average estimates of $B_{100\%}$, $B_{40\%}$, and $B_{35\%}$ are 666,506 t, 266,602 t, and 233,277 t, respectively (Table 2.30).

Means and standard deviations of the ABC and OFL distributions for 2020 and 2021 are shown for each model and for the weighted and unweighted average ensemble in Table 2.39 (along with medians for the weighed and unweighted ensemble distributions), and the distributions are shown in Figure 2.26.

Specification of OFL and Maximum Permissible ABC
Given the assumptions of Scenario 2 (below), female spawning biomass for 2020 and 2021 is estimated by ensemble weighted average to be 259,509 t and 211,410 t, respectively, of which are below the $B_{40\%}$ value of 266,602 t, thereby placing Pacific cod in Tier 3b for both 2020 and 2021. Given this, the ensemble weighted average estimates OFL, maximum permissible ABC, and the associated fishing mortality rates for 2020 and 2021 as follows (Table 2.30):

Year	Overfishing Level	Maximum Permissible ABC
2020	OFL = 185,650 t	maxABC = 155,873 t
2021	OFL = 123,331 t	maxABC = 102,975 t
2020	*FOFL* = 0.41	*maxFABC* = 0.34
2021	*FOFL* = 0.34	*maxFABC* = 0.28

The age 0+ biomass projections for 2020 and 2021 from the ensemble weighted average are 751,708 t and 716,581 t, respectively.

Standard Harvest Scenarios, Projection Methodology, and Projection Results
A standard set of projections is required for each stock managed under Tiers 1, 2, or 3 of Amendment 56. This set of projections encompasses seven harvest scenarios designed to satisfy the requirements of Amendment 56, the National Environmental Policy Act, and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). Prior to the 2018 assessment, the standard harvest scenarios were made using the AFSC's "Proj" program. Beginning with the 2018 assessment, however, the projections have been made within SS. Year-end catch for 2020 was estimated to be 176,847 t (slightly lower than the 2020 ABC of 181,000 t), using the method described under "Catch Biomass" in the "Data" section. In the event that catch is likely to be less than the recommended ABC in either of the first two projection years, Scenario 2 must be conducted, using the best estimates of catch in those two years (otherwise, Scenario 2 can be omitted if the author's recommended ABCs for the next two years are equal to the maximum permissible ABCs). The following relationship between ABC and catch was described under "Management History" in the "Fishery" section: For ABC≥198,000 t, catch = 89,000 t + 0.55×ABC; for ABC<198,000 t, catch = ABC. Because the recommended ABCs for both of the first two projection years are less than 198,000 t, no adjustment is necessary.

In each subsequent year, the fishing mortality rate is prescribed on the basis of the spawning biomass in that year and the respective harvest scenario.

Five of the seven standard scenarios are sometimes used in an Environmental Assessment prepared in conjunction with the final SAFE. These five scenarios, which are designed to provide a range of harvest alternatives that are likely to bracket the final TACs for 2020 and 2021, are as follow ("*max* F_{ABC}" refers to the maximum permissible value of F_{ABC} under Amendment 56):

> *Scenario 1*: In all future years, *F* is set equal to *max* F_{ABC}. (Rationale: Historically, TAC has been constrained by ABC, so this scenario provides a likely upper limit on future TACs.)
>
> *Scenario 2*: In all future years, *F* is set equal to a constant fraction ("author's F") of *max* F_{ABC}, where this fraction is equal to the ratio of the F_{ABC} value for 2020 recommended in the assessment to the *max* F_{ABC} for 2020, and where catches for 2020 and 2021 are estimated at their most likely values given the 2020 and 2021 recommended ABCs under this scenario. (Rationale: When F_{ABC} is set at a value below *max* F_{ABC}, it is often set at the value recommended in the stock assessment; also, catch tends not to equal ABC exactly.)

Scenario 3: In all future years, *F* is set equal to the 2014-2018 average *F*. (Rationale: For some stocks, TAC can be well below ABC, and recent average *F* may provide a better indicator of F_{TAC} than F_{ABC}.)

Scenario 4: In all future years, the upper bound on F_{ABC} is set at $F_{60\%}$. (Rationale: This scenario provides a likely lower bound on F_{ABC} that still allows future harvest rates to be adjusted downward when stocks fall below reference levels.)

Scenario 5: In all future years, *F* is set equal to zero. (Rationale: In extreme cases, TAC may be set at a level close to zero.)

Two other scenarios are needed to satisfy the MSFCMA's requirement to determine whether a stock is currently in an overfished condition or is approaching an overfished condition. These two scenarios are as follow (for Tier 3 stocks, the MSY level is defined as $B_{35\%}$):

Scenario 6: In all future years, *F* is set equal to F_{OFL}. (Rationale: This scenario determines whether a stock is overfished. If the stock is 1) above its MSY level in 2019 or 2) above 1/2 of its MSY level in 2019 and expected to be above its MSY level in 2029 under this scenario, then the stock is not overfished.)

Scenario 7: In 2020, *F* is set equal to *max* F_{ABC}, and in all subsequent years, *F* is set equal to F_{OFL}. (Rationale: This scenario determines whether a stock is approaching an overfished condition. If the stock is 1) above its MSY level in 2021 or 2) above 1/2 of its MSY level in 2021 and expected to be above its MSY level in 2031 under this scenario, then the stock is not approaching an overfished condition.)

Projections (means and standard deviations) of female spawning biomass (B), full selection fishing mortality (F), and catch (C) corresponding to the standard scenarios are shown for all models and both the weighted and unweighted ensemble averages in Table 2.40.

In addition to the seven standard harvest scenarios, Amendments 48/48 to the BSAI and GOA Groundfish Fishery Management Plans require projections of the likely OFL two years into the future. While Scenario 6 gives the best estimate of OFL for 2020, it does not provide the best estimate of OFL for 2021, because the mean 2021 catch under Scenario 6 is predicated on the 2020 catch being equal to the 2020 OFL, whereas the actual 2020 catch will likely be less than the 2020 OFL. Table 2.30 contains the appropriate one- and two-year ahead projections for both ABC and OFL.

Risk Table

<u>Should the ABC be Reduced Below the Maximum Permissible ABC?</u>

The SSC, in its December 2018 minutes, recommended that all assessment authors use the risk table when determining whether to recommend an ABC lower than the maximum permissible. The SSC also requested the addition of a fourth column on fishery performance, which has been included in the table below.

	Assessment-related considerations	*Population dynamics considerations*	*Environmental/ecosystem considerations*	*Fishery Performance*
Level 1: Normal	Typical to moderately increased uncertainty/minor unresolved issues in assessment.	Stock trends are typical for the stock; recent recruitment is within normal range.	No apparent environmental/ecosystem concerns	No apparent fishery/resource-use performance and/or behavior concerns
Level 2: Substantially increased concerns	Substantially increased assessment uncertainty/ unresolved issues.	Stock trends are unusual; abundance increasing or decreasing faster than has been seen recently, or recruitment pattern is atypical.	Some indicators showing an adverse signals relevant to the stock but the pattern is not consistent across all indicators.	Some indicators showing adverse signals but the pattern is not consistent across all indicators
Level 3: Major Concern	Major problems with the stock assessment; very poor fits to data; high level of uncertainty; strong retrospective bias.	Stock trends are highly unusual; very rapid changes in stock abundance, or highly atypical recruitment patterns.	Multiple indicators showing consistent adverse signals a) across the same trophic level as the stock, and/or b) up or down trophic levels (i.e., predators and prey of the stock)	Multiple indicators showing consistent adverse signals a) across different sectors, and/or b) different gear types
Level 4: Extreme concern	Severe problems with the stock assessment; severe retrospective bias. Assessment considered unreliable.	Stock trends are unprecedented; More rapid changes in stock abundance than have ever been seen previously, or a very long stretch of poor recruitment compared to previous patterns.	Extreme anomalies in multiple ecosystem indicators that are highly likely to impact the stock; Potential for cascading effects on other ecosystem components	Extreme anomalies in multiple performance indicators that are highly likely to impact the stock

The table is applied by evaluating the severity of four types of considerations that could be used to support a scientific recommendation to reduce the ABC from the maximum permissible. These considerations are stock assessment considerations, population dynamics considerations, environmental/ecosystem considerations, and fishery performance. Examples of the types of concerns that might be relevant include the following:

1. Assessment considerations—data-inputs: biased ages, skipped surveys, lack of fishery-independent trend data; model fits: poor fits to fits to fishery or survey data, inability to simultaneously fit multiple data inputs; model performance: poor model convergence, multiple minima in the likelihood surface, parameters hitting bounds; estimation uncertainty: poorly-estimated but influential year classes; retrospective bias in biomass estimates.

2. Population dynamics considerations—decreasing biomass trend, poor recent recruitment, inability of the stock to rebuild, abrupt increase or decrease in stock abundance.

3. Environmental/ecosystem considerations—adverse trends in environmental/ecosystem indicators, ecosystem model results, decreases in ecosystem productivity, decreases in prey abundance or availability, increases or increases in predator abundance or productivity.

4. Fishery performance—fishery CPUE is showing a contrasting pattern from the stock biomass trend, unusual spatial pattern of fishing, changes in the percent of TAC taken, changes in the duration of fishery openings.

Assessment Considerations
Recent range expansion of the stock into the NBS has made assessment modeling more difficult. On one hand, detailed investigation of multiple models gives some confidence that relevant uncertainties have been explored. Use of an ensemble approach likewise gives some confidence that alternative explanations of the data are considered. Moreover, an ensemble approach mitigates, at least to some extent, concerns that may exist regarding any individual model. On the other hand, wide ranges of key quantities such as 2021 ABC (54,138 t to 201,257 t) tend to temper such confidence. Retrospective behavior of nearly all models is within the acceptable range, but the fact that this was achieved, at least in part, by continuing to exclude the fishery age composition data is disappointing. Ageing bias has long been suspected to exist, but this has been estimated within, and accounted for by, the assessment models for over a decade now, including (as of the present assessment) a change in the amount and direction of ageing bias during the time series. This is a fairly data-rich assessment, with annual surveys covering a substantial portion of the stock's range and extensive observer coverage. Assessment considerations were rated as level 1 (normal).

Population Dynamics Considerations
Looking at the EBS in isolation, survey biomass has been undergoing a pronounced decline since 2015. However, when examined from the perspective of the combined EBS and NBS, the decline is much less dramatic. Moreover, numerical abundance took a sharp upturn this year in both the EBS and NBS, due apparently to a strong 2018 year class. On the other hand, nearshore temperatures were very high during this year's surveys, and it has been suggested that some of the 2018 cohort's apparent strength may actually represent a change in selectivity, as age 1 fish that would normally reside outside the survey areas in nearshore waters were forced to move into the survey areas. This is corroborated to some extent by the "complex" models, which allow for time-varying selectivity, and which estimate lower relative values for the 2018 year class than the "basic" or "simple" models (although all models agree that the 2018 year class is well above average). Also of note is the string of four very poor year classes spawned in 2014-2017, two of which are among the three worst of all time. However, these considerations are already incorporated into the assessment models and are also addressed by the harvest control rules. Population dynamics considerations were rated as level 1 (normal).

Environmental/Ecosystem Considerations
Appendix 2.6 provides a detailed look at environmental/ecosystem considerations. These may be summarized as follows:

- Pacific cod continue to expand their range into the northern Bering Sea.
- Based on conditions metrics, both juvenile and adult Pacific cod were able to find sufficient prey resources in 2018 and 2019.
- However, low abundances of euphausiids were observed in 2018 (MACE acoustic survey) and 2019 (RPA RZA).

- Effects of cannibalism might be mediated by spatial mismatch between juvenile and adult cod.
- The 2019 gray whale unusual mortality event reflects poor 2018 NBS feeding conditions.
- Shearwater die-off events in 2019 could also reflect feeding conditions in the NBS in 2018.
- The abundance time series for Pacific cod and walleye pollock appear to decouple after 2010, suggesting a shift in drivers of survival in these two populations, and mechanistic understanding of recruitment drivers is less well-known for cod than for pollock.

Environmental/ecosystem considerations were rated as level 2 (substantially increased concern).

Fishery Performance Considerations
Mean longline fishery CPUE has increased for the last two years, and is now equal to the time series mean. Recent expansion of the fishery into the NBS is noteworthy, but not necessarily a concern. Fishery performance considerations were rated as level 1 (normal).

Risk Summary
The ratings of the four categories are summarized below:

Assessment-related considerations	*Population dynamics considerations*	*Environmental/ ecosystem considerations*	*Fishery Performance considerations*	*Overall score (highest of the individual scores)*
Level 1: Normal	Level 1: Normal	Level 2: Substantially increased concerns	Level 1: Normal	Level 2: Substantially increased concerns

Because the overall score is greater than level 1, ABC may need to be reduced from the maximum permissible value. However, it should be noted that the overall score of level 2 is due entirely to the identification of “some indicators showing adverse signals” even though “the pattern is not consistent across all indicators.” It seems likely that, given sufficient effort, it would almost always be possible to identify one or more indicators showing adverse signals, and it is not obvious how this is to be reconciled with the SSC’s stated intent that “reductions from the maximum ABC are intended to be an infrequent action to respond to substantial unquantified risk” (SSC minutes, December 2018). Rather than having each assessment author determine the appropriate reduction in isolation, the SSC has volunteered to take responsibility for determining those reductions. This seems a preferable course of action, as it should tend to increase consistency across assessments. Therefore, no reduction is recommended here.

ABC Recommendation
The recommended ABCs for 2020 and 2021 are 155,873 t (Tier 3b) and 102,975 t (Tier 3b), respectively, representing the maximum permissible levels under the ensemble weighted average (but see paragraph immediately above).

Area Allocation of Harvests
No recommendations are made regarding area allocation of harvests.

Status Determination
Under the MSFCMA, the Secretary of Commerce is required to report on the status of each U.S. fishery with respect to overfishing. This report involves the answers to three questions: 1) Is the stock being subjected to overfishing? 2) Is the stock currently overfished? 3) Is the stock approaching an overfished condition?

Is the stock being subjected to overfishing? The official catch estimate for the most recent complete year (2018) is 199,881 t. This is less than the 2018 OFL of 238,000 t. Therefore, the EBS Pacific cod stock is not being subjected to overfishing.

Harvest Scenarios #6 and #7 are intended to permit determination of the status of a stock with respect to its minimum stock size threshold (MSST). Any stock that is below its MSST is defined to be *overfished*. Any stock that is expected to fall below its MSST in the next two years is defined to be *approaching* an overfished condition. Harvest Scenarios #6 and #7 are used in these determinations as follows:

Is the stock currently overfished? This depends on the stock's estimated spawning biomass in 2019:

a. If spawning biomass for 2019 is estimated to be below ½ $B_{35\%}$, the stock is below its MSST.

b. If spawning biomass for 2019 is estimated to be above $B_{35\%}$, the stock is above its MSST.

c. If spawning biomass for 2019 is estimated to be above ½ $B_{35\%}$ but below $B_{35\%}$, the stock's status relative to MSST is determined by referring to harvest Scenario #6 (Table 2.40f). If the mean spawning biomass for 2029 is below $B_{35\%}$, the stock is below its MSST. Otherwise, the stock is above its MSST.

Is the stock approaching an overfished condition? This is determined by referring to harvest Scenario #7 (Table 2.40g):

a. If the mean spawning biomass for 2021 is below ½ $B_{35\%}$, the stock is approaching an overfished condition.

b. If the mean spawning biomass for 2021 is above $B_{35\%}$, the stock is not approaching an overfished condition.

c. If the mean spawning biomass for 2021 is above 1/2 $B_{35\%}$ but below $B_{35\%}$, the determination depends on the mean spawning biomass for 2031. If the mean spawning biomass for 2031 is below $B_{35\%}$, the stock is approaching an overfished condition. Otherwise, the stock is not approaching an overfished condition.

Based on the above criteria and Tables 2.40f and 2.40g, the stock is not overfished and is not approaching an overfished condition.

ECOSYSTEM CONSIDERATIONS

Ecosystem Effects on the Stock

A primary ecosystem phenomenon affecting the Pacific cod stock seems to be the occurrence of periodic "regime shifts," in which central tendencies of key variables in the physical environment change on a scale spanning several years to a few decades (Zador, 2011). One well-documented example of such a regime shift occurred in 1977, and shifts occurring in 1989 and 1999 have also been suggested (e.g., Hare and Mantua 2000). As in previous assessments, an attempt was made in the present assessment to estimate the change in mean recruitment of EBS Pacific cod associated with the 1977 regime shift. According to the ensemble weighted average, pre-1977 mean recruitment was only about 38% of post-1976 mean recruitment. Establishing a link between environment and recruitment within a particular regime is more difficult. In the 2004 assessment (Thompson and Dorn 2004), for example, the correlations between age 1 recruits spawned since 1977 and monthly values of the Pacific Decadal Oscillation (Mantua et al. 1997) were computed and found to be very weak.

In the 2012 assessment, annual log-scale recruitment deviations estimated by the assessment model were regressed against each of several environmental indices summarized by Zador (2011). The highest univariate correlation was obtained for the spring-summer North Pacific Index (NPI), which was developed by Trenberth and Hurrell (1994). The NPI is the area-weighted sea level pressure over the region 30°N-65°N, 160°E-140°W. Further investigations were conducted with monthly NPI data from the Climate Analysis Section of the National Center for Atmospheric Research. The best univariate model obtained in the 2012 analysis was a linear regression of recruitment deviations from 1977-2011 against the October-December average NPI (from the same year). Vestfals et al. (2014) have also noted a positive correlation between Pacific cod recruitment and the NPI, although not the October-December average NPI in particular. In each assessment from 2012-2018, the regression analysis was updated. However, the performance of the estimator in both 2017 and 2018 was so poor that the analysis was not updated this year.

The prey and predators of Pacific cod have been described or reviewed by Albers and Anderson (1985), Livingston (1989, 1991), Lang et al. (2003), Westrheim (1996), and Yang (2004). The composition of Pacific cod prey varies to some extent by time and area. In terms of percent occurrence, some of the most important items in the diet of Pacific cod in the BSAI and GOA have been polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, some of the most important dietary items have been euphausids, miscellaneous fishes, and amphipods. In terms of weight of organisms consumed, some of the most important dietary items have been walleye pollock, fishery offal, yellowfin sole, and crustaceans. Small Pacific cod feed mostly on invertebrates, while large Pacific cod are mainly piscivorous. Predators of Pacific cod include Pacific cod, halibut, salmon shark, northern fur seals, Steller sea lions, harbor porpoises, various whale species, and tufted puffin. Major trends in the most important prey or predator species could be expected to affect the dynamics of Pacific cod to some extent.

Abookire et al. (2007) found that young-of-the-year Pacific cod near Kodiak Island fed mainly on small calanoid copepods, mysids, and gammarid amphipods. Moss et al. (2016) found that age 0 Pacific cod in the central Gulf of Alaska consumed mostly copepods and amphipods. Poltev and Stominok (2008) found that young-of-the-year walleye pollock played a major role in the diet of juvenile Pacific cod near the Kuril Islands and Kamchatka. Strasburger et al. (2014) found that age 0 (juvenile) Pacific cod in the southeastern Bering Sea consumed primarily euphausiids, snow and Tanner crab larvae, amphipods, sea snails, and arrow worms. Farley et al. (2016) found that diet of age 0 (juvenile) Pacific cod in the EBS varied with temperature, with high proportions of age 0 walleye pollock during warm years and a shift to euphausiids and large copepods during cool years.

Fishery Effects on the Ecosystem

Potentially, fisheries for Pacific cod can have effects on other species in the ecosystem through a variety of mechanisms, for example by relieving predation pressure on shared prey species (i.e., species which serve as prey for both Pacific cod and other species), by reducing prey availability for predators of Pacific cod, by altering habitat, by imposing bycatch mortality, or by "ghost fishing" caused by lost fishing gear.

Incidental Catch Taken in the Pacific Cod Fisheries

Incidental catches taken in the Pacific cod fisheries, expressed as proportions of total incidental EBS catches (i.e., across all targets) for the respective species, are summarized in Tables 2.41-2.44. Catches for 2019 in each of these tables are incomplete. Table 2.41 shows incidental catch of FMP species taken from 1991-2019 by each of the three main gear types. Table 2.42 shows incidental catch of certain species of squid and members of the former "other species" complex taken from 2003-2019, aggregated across gear types. Table 2.43 shows incidental catch of prohibited species taken from 1991-2019, aggregated across gear types. Table 2.44 shows incidental catch of non-target species groups taken from 2003-2019, aggregated across gear types.

Steller Sea Lions

Sinclair and Zeppelin (2002) showed that Pacific cod was one of the four most important prey items of Steller sea lions in terms of frequency of occurrence averaged over years, seasons, and sites, and was especially important in winter. Pitcher (1981) and Calkins (1998) also showed Pacific cod to be an important winter prey item in the GOA and BSAI, respectively. Furthermore, the size ranges of Pacific cod harvested by the fisheries and consumed by Steller sea lions overlap, and the fishery has operated to some extent in the same areas used by Steller sea lion as foraging grounds (Livingston (ed.), 2002).

One of the main research emphases of the AFSC Fisheries Interaction Team (now disbanded) was to determine the effectiveness of management measures designed to mitigate the impacts of the Pacific cod fisheries (among others) on Steller sea lions. A study conducted in 2002-2005 using pot fishing gear demonstrated that the local concentration of cod in the Unimak Pass area is very dynamic, so that fishery removals did not create a measurable decline in fish abundance (Conners and Munro 2008). A preliminary tagging study in 2003–2004 showed some cod remaining in the vicinity of the release area in the southeast Bering Sea for several months, while other fish moved distances of 150 km or more north-northwest along the shelf, some within a matter of two weeks (Rand et al. 2015).

Seabirds

The following is a summary of information provided by Livingston (ed., 2002): In both the BSAI and GOA, the northern fulmar (*Fulmarus glacialis*) comprises the majority of seabird bycatch, which occurs primarily in the longline fisheries, including the hook and line fishery for Pacific cod. Shearwater (*Puffinus* spp.) distribution overlaps with the Pacific cod longline fishery in the Bering Sea, and with trawl fisheries in general in both the Bering Sea and GOA. Black-footed albatross (*Phoebastria nigripes*) is taken in much greater numbers in the GOA longline fisheries than the Bering Sea longline fisheries, but is not taken in the trawl fisheries. The distribution of Laysan albatross (*Phoebastria immutabilis*) appears to overlap with the longline fisheries in the central and western Aleutians. The distribution of short-tailed albatross (*Phoebastria albatrus*) also overlaps with the Pacific cod longline fishery along the Aleutian chain, although the majority of the bycatch has taken place along the northern portion of the Bering Sea shelf edge (in contrast, only two takes have been recorded in the GOA). Some success has been obtained in devising measures to mitigate fishery-seabird interactions. For example, on vessels larger than 60 ft. LOA, paired streamer lines of specified performance and material standards have been found to reduce seabird incidental take significantly.

Fishery Usage of Habitat

The following is a summary of information provided by Livingston (ed., 2002): The longline and trawl fisheries for Pacific cod each comprise an important component of the combined fisheries associated with the respective gear type in each of the three major management regions (BS, AI, and GOA). Looking at each gear type in each region as a whole (i.e., aggregating across all target species) during the period 1998-2001, the total number of observed hauls/sets was as follows:

Gear	BS	AI	GOA
Trawl	240,347	43,585	68,436
Longline	65,286	13,462	7,139

In the BS, both longline and trawl effort was concentrated north of False Pass (Unimak Island) and along the shelf edge represented by the boundary of areas 513, 517 (in addition, longline effort was concentrated along the shelf edge represented by the boundary of areas 521-533). In the AI, both longline and trawl effort were dispersed over a wide area along the shelf edge. The catcher vessel longline fishery in the AI occurred primarily over mud bottoms. Longline catcher-processors in the AI tended to fish more over rocky bottoms. In the GOA, fishing effort was also dispersed over a wide area along the shelf, though pockets of trawl effort were located near Chirikof, Cape Barnabus, Cape Chiniak and Marmot

Flats. The GOA longline fishery for Pacific cod generally took place over gravel, cobble, mud, sand, and rocky bottoms, in depths of 25 fathoms to 140 fathoms.

Impacts of the Pacific cod fisheries on essential fish habitat were further analyzed in an environmental impact statement by NMFS (2005), followed by "5-year reviews" in 2010 and 2017 (NMFS 2010 and 2017, respectively).

DATA GAPS AND RESEARCH PRIORITIES

Significant improvements in the quality of this assessment could be made if future research were directed toward closing certain data gaps. At this point, the most critical needs pertain to the effects of the large and potentially unprecedented movements of Pacific cod from the EBS and NBS that appear to have taken place in the last few years, including: 1) to understand the factors determining these movements, 2) to understand whether/how these movements change over time, 3) to obtain accurate estimates of these movements, 4) to understand the extent to which reciprocal movements occur, and 5) to understand the spawning contribution of NBS fish to the overall stock. Additional surveys of the NBS are strongly encouraged, as are genetic analyses and tagging studies. Ageing also continues to be an issue, as the assessment models consistently estimate a positive ageing bias, at least for otoliths read prior to 2008. Longer-term research needs include improved understanding of: 1) the ecology of Pacific cod in the EBS, including spatial dynamics, trophic and other interspecific relationships, and the relationship between climate and recruitment; 2) ecology of species taken as bycatch in the Pacific cod fisheries, including estimation of biomass, carrying capacity, and resilience; and 3) ecology of species that interact with Pacific cod, including estimation of interaction strengths, biomass, carrying capacity, and resilience.

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Ongoing contributions: Rick Methot continues to make improvements to Stock Synthesis. Numerous AFSC personnel and countless fishery observers collected nearly all of the raw data that were used in this assessment.

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TABLES

Table 2.1a—Summary of 1964-1980 catches (t) of Pacific cod in the EBS by fleet sector. "For." = foreign, "JV" = joint venture processing, "Dom." = domestic annual processing. Catches by gear are not available for these years. Catches may not always include discards.

Year	For.	JV	Dom.	Total
1964	13,408	0	0	13,408
1965	14,719	0	0	14,719
1966	18,200	0	0	18,200
1967	32,064	0	0	32,064
1968	57,902	0	0	57,902
1969	50,351	0	0	50,351
1970	70,094	0	0	70,094
1971	43,054	0	0	43,054
1972	42,905	0	0	42,905
1973	53,386	0	0	53,386
1974	62,462	0	0	62,462
1975	51,551	0	0	51,551
1976	50,481	0	0	50,481
1977	33,335	0	0	33,335
1978	42,512	0	31	42,543
1979	32,981	0	780	33,761
1980	35,058	8,370	2,433	45,861

Table 2.1b—Summary of 1981-1990 catches (t) of Pacific cod in the EBS by fleet sector, and gear type. All catches include discards. "LLine" = longline, "Subt." = sector subtotal. Breakdown of domestic annual processing by gear is not available prior to 1988.

	Foreign			Joint Venture		Domestic Annual Processing				
Year	Trawl	LLine	Subt.	Trawl	Subt.	Trawl	LLine	Pot	Subt.	Total
1981	30,347	5,851	36,198	7,410	7,410	n/a	n/a	n/a	12,899	56,507
1982	23,037	3,142	26,179	9,312	9,312	n/a	n/a	n/a	25,613	61,104
1983	32,790	6,445	39,235	9,662	9,662	n/a	n/a	n/a	45,904	94,801
1984	30,592	26,642	57,234	24,382	24,382	n/a	n/a	n/a	43,487	125,103
1985	19,596	36,742	56,338	35,634	35,634	n/a	n/a	n/a	51,475	143,447
1986	13,292	26,563	39,855	57,827	57,827	n/a	n/a	n/a	37,923	135,605
1987	7,718	47,028	54,746	47,722	47,722	n/a	n/a	n/a	47,435	149,903
1988	0	0	0	106,592	106,592	93,706	2,474	299	96,479	203,071
1989	0	0	0	44,612	44,612	119,631	13,935	145	133,711	178,323
1990	0	0	0	8,078	8,078	115,493	47,114	1,382	163,989	172,067

Table 2.1c—Summary of 1991-2019 catches (t) of Pacific cod in the EBS by gear type. The small catches taken by "other" gear types have been merged proportionally with the catches of the gear types shown. Pot catches for 2014-2019 include the State-managed fishery. Catches for 2019 are through October 27.

Year	Trawl	Longline	Pot	Total
1991	129,393	77,505	3,343	210,241
1992	77,276	79,420	7,514	164,210
1993	81,792	49,296	2,098	133,186
1994	85,294	78,898	8,071	172,263
1995	111,250	97,923	19,326	228,498
1996	92,029	88,996	28,042	209,067
1997	93,995	117,097	21,509	232,601
1998	60,855	84,426	13,249	158,529
1999	51,939	81,520	12,408	145,867
2000	53,841	81,678	15,856	151,376
2001	35,670	90,394	16,478	142,542
2002	51,118	100,371	15,067	166,555
2003	46,717	108,769	19,957	175,443
2004	57,866	108,618	17,264	183,748
2005	52,638	113,190	17,112	182,940
2006	53,236	96,613	18,969	168,818
2007	45,700	77,181	17,248	140,129
2008	33,497	88,936	17,368	139,802
2009	36,959	96,606	13,609	147,174
2010	41,301	81,819	19,725	142,845
2011	64,088	117,077	28,064	209,229
2012	75,536	128,508	28,738	232,782
2013	81,619	124,824	30,263	236,705
2014	72,262	127,271	39,195	238,728
2015	66,680	128,217	37,942	232,838
2016	72,598	127,937	47,086	247,621
2017	68,906	122,768	46,184	237,858
2018	59,982	100,212	39,686	199,881
2019	46,618	66,126	36,469	149,213

Table 2.2a—Trawl fishery mean CPUE by year (row) and month (column), normalized to an overall mean of 1.0. Year-month combinations with fewer than 3 distinct vessels not shown. Color scale applies to the entire matrix, and extends from red=low to green=high.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1991	1.049	1.388	1.483	1.293	0.688	0.518	0.739					
1992	1.480	1.317	1.335	0.918	0.561	0.422		1.465				
1993	1.201	1.327	1.348	1.016	0.787	1.226		1.202	0.778	1.117	0.776	
1994	0.653	1.284	1.539	0.866	0.613	0.685		1.056	0.931	1.349		
1995	1.224	2.156	1.451	1.103			1.380	1.205		0.981		
1996	0.814	1.249	0.927	0.678	0.625	0.816		1.073		0.786	0.687	
1997	1.539	1.746	1.351	0.837	0.516		0.722	0.593	0.202		0.728	
1998	1.225	1.442	0.859	0.479	0.430	0.691	0.748	0.571	0.657	1.139	0.393	
1999	0.585	1.192	0.888	0.696	0.379		0.344	0.444	0.661	0.398	0.302	
2000	0.769	0.817	0.963	0.521	0.954	0.316	0.359	0.308	0.466			
2001	0.409	0.634	0.681	0.367	0.444	1.630	1.342	0.452	0.324	0.219		
2002	0.691	0.876	0.857	0.404	0.643	1.284	0.850	0.319	0.335	0.456		
2003	0.577	0.570	0.846	0.497	0.372	1.507	1.211	0.420	0.492			
2004	1.597	1.488	1.305	0.645	0.781	0.770	0.759	0.562	0.424	0.264		
2005	0.797	1.090	1.496	0.523	0.662	0.528	0.342					
2006	0.816	0.825	1.061	1.526	0.717		0.466	0.616				
2007	0.486	0.771	1.204	0.985	0.846	1.096	0.537	0.358				
2008	0.372	0.655	0.946	0.990	0.553	0.285	1.846	1.609	0.588	1.429		
2009	0.408	0.928	1.285	1.481	0.258	0.756	1.075	1.264	1.086	1.321	0.659	
2010	0.762	0.962	1.360	0.753	0.382	1.090	0.676	1.841	1.817	1.436	0.931	
2011	1.342	1.128	2.091	0.924	1.279	0.684	1.219	1.398	1.303	1.275	0.490	
2012	2.937	2.157	2.834	1.246	3.046	1.292	0.336	1.129	0.980	1.327		1.225
2013	1.915	1.445	1.009	2.049	1.031	0.609	1.281	1.526	2.250	1.348	0.399	
2014	1.321	1.327	1.399	1.505	1.538	0.569	0.561	1.206	1.448		0.564	
2015	0.435	1.351	1.792	1.360	1.398	1.257	0.879	2.272	0.535	1.093		
2016	1.129	1.588	2.414	1.061	0.579	0.741	0.823	0.629	0.623	0.752	1.303	
2017	0.945	2.125	1.973	1.394	0.678	0.806	0.540	0.348	0.223			
2018	1.269	1.800	6.087	4.107	0.480	0.590	0.323	0.359	0.432	0.592	0.322	
2019	1.512	1.825	5.091	4.762	0.542	0.215	0.416		0.278			

Table 2.2b—Longline fishery mean CPUE by year (row) and month (column), normalized to an overall mean of 1.0. Year-month combinations with fewer than 3 distinct vessels not shown. Color scale applies to the entire matrix, and extends from red=low to green=high.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1991	1.912	2.141	1.918	1.736	1.773	1.541	1.173	1.286	1.122	0.883	0.929	1.100
1992	1.384	1.735	1.551	1.573	1.143	0.895	0.883	0.960	0.892			
1993	1.157	1.231	1.310	1.137	1.008	0.629						
1994	1.316	1.336	1.428	1.266	1.299				1.063	1.026		
1995	1.520	1.733	1.597	1.467	1.384				1.128	0.978	1.166	1.199
1996	1.612	1.580	1.417	1.332	1.222				0.952	1.024	1.073	
1997	1.740	1.860	1.495	1.533	1.197				1.077	1.045	0.999	1.130
1998	1.555	1.691	1.258	0.998	0.907				0.690	0.744	0.902	0.934
1999	1.320	1.388	1.160	1.073	1.222	0.928		0.832	0.918	0.846	0.942	1.082
2000	1.536	1.103	1.195	0.968	1.099			0.860	0.750	0.674	0.718	0.831
2001	1.073	1.061	1.028	0.921	0.949	1.022	0.798	0.766	0.706	0.720	0.713	0.914
2002	1.241	1.235	1.227	1.247	0.994		0.701	0.712	0.678	0.644	0.694	0.769
2003	0.913	0.972	1.039	0.835	0.789	0.666	0.655	0.630	0.610	0.631	0.624	0.732
2004	0.945	1.118	1.084	1.008	0.702	0.607	0.664	0.592	0.552	0.564	0.716	0.965
2005	1.131	1.152	1.232	1.255		0.689	0.701	0.623	0.580	0.600	0.643	0.808
2006	1.307	1.456	1.492	1.172			0.664	0.809	0.707	0.614	0.780	0.807
2007	1.302	1.387	1.262				0.723	0.852	0.675	0.652		1.154
2008	1.426	1.497	1.369	1.512		0.440	0.637	0.661	0.546	0.489	0.636	1.246
2009	1.580	1.736	2.111			0.675	0.700	0.671	0.624	0.608	0.660	1.031
2010	1.351	1.585	1.664				0.731	0.700	0.621	0.604	0.752	0.941
2011	1.255	1.342	1.381	1.141	0.827	0.723	0.601	0.636	0.675	0.702	0.752	0.889
2012	1.424	1.400	1.080	1.095	0.910	0.923	0.667	0.602	0.555	0.597	0.702	1.044
2013	1.380	1.299	1.214	1.167	0.929	0.676	0.734	0.665	0.628	0.649	0.781	0.991
2014	1.013	1.183	0.947	0.959	0.783	0.662	0.581	0.628	0.648	0.697	0.773	0.833
2015	0.951	1.158	1.102	0.961	0.884	0.780	0.835	0.718	0.643	0.672	0.773	0.938
2016	1.134	1.299	1.048	0.982	0.926	0.757	0.764	0.755	0.739	0.692	0.790	0.930
2017	1.011	1.352	1.184	1.054	0.899	0.791	0.673	0.554	0.581	0.672	0.885	1.017
2018	1.506	1.551	1.298	1.278	0.847	0.692	0.546	0.588	0.809	0.772	0.688	0.998
2019	1.631	1.635	1.341	1.305	0.882	0.829	0.664	0.602	0.658			

Table 2.2c—Pot fishery mean CPUE by year (row) and month (column), normalized to an overall mean of 1.0. Year-month combinations with fewer than 3 distinct vessels not shown. Color scale applies to the entire matrix, and extends from red=low to green=high.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1991							0.873	0.966	1.714	1.305		1.009
1992					1.028	0.791	0.823	0.434	0.367			
1993				1.162	1.236							
1994			1.077	1.262	1.054				1.410	1.303		
1995			1.117	1.338	1.015	0.900	0.966	1.012	0.604	0.778	0.828	0.703
1996			0.973	1.024	0.766	0.801	0.715	0.672	0.681	0.683	0.735	
1997			1.027	1.291	0.640	0.654	0.594	0.692	0.458	0.725	0.525	0.583
1998				1.058	0.703	0.587	0.754	0.484	0.464	0.410	0.407	0.693
1999			0.666	0.930	0.655	0.547			0.469	0.545		
2000		0.773	0.618									
2001		0.985	0.885						0.614	0.690	0.524	
2002		1.117	0.840						0.585	0.571	0.682	
2003		1.007							0.787	0.854	0.837	
2004	0.849	1.092	0.928						0.663	0.696	0.905	
2005	1.329	1.121							0.648	0.587		
2006	1.137	1.117		1.742					0.668	0.918	0.517	
2007	0.862	1.102							0.850	1.267		
2008	1.113								0.842	0.598		
2009	1.253											
2010	1.174								1.157	1.030	1.432	
2011	1.796								1.132	1.049		
2012	1.954								0.782	1.161		
2013	1.776	1.700							1.302	1.114	1.225	
2014	1.335	1.736							1.232	0.893	0.779	1.411
2015	1.257	1.845	1.878	1.389					1.310	1.039	0.903	1.182
2016	1.210	1.505	1.580	1.645					1.373	1.000	0.981	1.083
2017	1.278	2.348							0.968	0.960	1.004	0.757
2018	1.233		2.481						1.238	1.301	1.052	1.169
2019	1.366		2.780									

Table 2.3—Discards (t) and discard rates (%) of Pacific cod in the Pacific cod fishery, by area, gear, and year for the period 1991-2019 (2019 data are current through September 29). The small amounts of discards taken by other gear types have been merged proportionally into the gear types shown. Note that Amendment 49, which mandated increased retention and utilization, was implemented in 1998.

	Discard amount (t)				Discard rate (%)			
Year	Trawl	Longline	Pot	Total	Trawl	Longline	Pot	All
1991	1,278	1,493	4	2,774	4.11	2.62	0.26	3.10
1992	3,314	1,768	59	5,141	8.68	2.23	0.78	4.12
1993	5,449	2,234	25	7,708	12.89	4.54	1.21	8.24
1994	4,599	2,917	161	7,677	9.98	3.71	2.01	5.79
1995	7,987	3,669	222	11,877	12.24	3.77	1.15	6.54
1996	2,971	2,833	391	6,194	5.12	3.19	1.39	3.54
1997	3,327	3,183	79	6,590	5.42	2.72	0.37	3.30
1998	102	2,456	52	2,610	0.27	2.92	0.39	1.94
1999	353	1,285	52	1,691	0.95	1.58	0.42	1.29
2000	207	2,267	71	2,546	0.56	2.78	0.45	1.90
2001	142	1,531	52	1,726	0.76	1.70	0.32	1.38
2002	557	2,066	91	2,715	1.73	2.06	0.61	1.84
2003	240	1,771	159	2,170	0.79	1.63	0.80	1.36
2004	158	1,814	48	2,019	0.41	1.67	0.28	1.23
2005	86	2,599	61	2,747	0.26	2.30	0.36	1.68
2006	193	1,528	63	1,784	0.54	1.58	0.33	1.18
2007	238	1,373	45	1,656	0.74	1.78	0.26	1.31
2008	13	1,280	156	1,449	0.09	1.44	0.90	1.20
2009	126	1,503	16	1,645	1.02	1.56	0.12	1.34
2010	147	1,402	3	1,552	1.04	1.72	0.02	1.35
2011	86	1,853	8	1,947	0.30	1.59	0.03	1.12
2012	93	1,761	26	1,880	0.26	1.37	0.09	0.98
2013	97	3,060	33	3,190	0.26	2.46	0.11	1.66
2014	149	2,893	119	3,161	0.39	2.28	0.30	1.55
2015	119	2,374	29	2,522	0.36	1.85	0.08	1.27
2016	80	2,547	27	2,654	0.20	1.99	0.06	1.23
2017	65	1,934	32	2,031	0.17	1.58	0.07	0.98
2018	117	1,540	21	1,677	0.33	1.54	0.05	0.96
2019	131	870	28	1,029	0.56	1.32	0.08	0.82

Table 2.4—History of BSAI (1977-2013) and EBS (2014-2019) Pacific cod catch, TAC, ABC, and OFL (t). Catch for 2019 is through October 27. Note that specifications through 2013 were for the combined BSAI region, so BSAI catch is shown rather than the EBS catches from Table 2.1 for the period 1977-2013. Source for historical specifications: NPFMC staff.

Year	Catch	TAC	ABC	OFL
1977	36,597	58,000	-	-
1978	45,838	70,500	-	-
1979	39,354	70,500	-	-
1980	51,649	70,700	148,000	-
1981	63,941	78,700	160,000	-
1982	69,501	78,700	168,000	-
1983	103,231	120,000	298,200	-
1984	133,084	210,000	291,300	-
1985	150,384	220,000	347,400	-
1986	142,511	229,000	249,300	-
1987	163,110	280,000	400,000	-
1988	208,236	200,000	385,300	-
1989	182,865	230,681	370,600	-
1990	179,608	227,000	417,000	-
1991	220,038	229,000	229,000	-
1992	207,278	182,000	182,000	188,000
1993	167,391	164,500	164,500	192,000
1994	193,802	191,000	191,000	228,000
1995	245,033	250,000	328,000	390,000
1996	240,676	270,000	305,000	420,000
1997	257,765	270,000	306,000	418,000
1998	193,256	210,000	210,000	336,000
1999	173,998	177,000	177,000	264,000
2000	191,060	193,000	193,000	240,000
2001	176,749	188,000	188,000	248,000
2002	197,356	200,000	223,000	294,000
2003	207,907	207,500	223,000	324,000
2004	212,618	215,500	223,000	350,000
2005	205,635	206,000	206,000	265,000
2006	193,025	194,000	194,000	230,000
2007	174,486	170,720	176,000	207,000
2008	171,277	170,720	176,000	207,000
2009	175,756	176,540	182,000	212,000
2010	171,875	168,780	174,000	205,000
2011	220,109	227,950	235,000	272,000
2012	250,899	261,000	314,000	369,000
2013	250,274	260,000	307,000	359,000
2014	238,728	246,897	255,000	299,000
2015	232,838	240,000	255,000	346,000
2016	247,621	238,680	255,000	390,000
2017	237,858	223,704	239,000	284,000
2018	199,881	188,136	201,000	238,000
2019	149,213	166,475	181,000	216,000

Table 2.5 (page 1 of 2)—Amendments to the BSAI Fishery Management Plan (FMP) that reference Pacific cod explicitly (excerpted from Appendix A of the FMP, except that Amendment 113, which is listed in Appendix A of the FMP, is omitted here, due to the fact that the final rule implementing that amendment was vacated by the U.S. District Court for the District of Columbia on March 21, 2019).

Amendment 2, implemented January 12, 1982:

For Pacific cod, decreased maximum sustainable yield to 55,000 t from 58,700 t, increased equilibrium yield to 160,000 t from 58,700 t, increased acceptable biological catch to 160,000 t from 58,700 t, increased optimum yield to 78,700 t from 58,700 t, increased reserves to 3,935 t from 2,935 t, increased domestic annual processing (DAP) to 26,000 t from 7,000 t, and increased DAH to 43,265 t from 24,265 t.

Amendment 4, implemented May 9, 1983, supersedes Amendment 2:

For Pacific Cod, increased equilibrium yield and acceptable biological catch to 168,000 t from 160,000 t, increased optimum yield to 120,000 t from 78,700 t, increased reserves to 6,000 t from 3,935 t, and increased TALFF to 70,735 t from 31,500 t.

Amendment 10, implemented March 16, 1987:

Established Bycatch Limitation Zones for domestic and foreign fisheries for yellowfin sole and other flatfish (including rock sole); an area closed to all trawling within Zone 1; red king crab, C. bairdi Tanner crab, and Pacific halibut PSC limits for DAH yellowfin sole and other flatfish fisheries; a C. bairdi PSC limit for foreign fisheries; and a red king crab PSC limit and scientific data collection requirement for U.S. vessels fishing for Pacific cod in Zone 1 waters shallower than 25 fathoms.

Amendment 24, implemented February 28, 1994, and effective through December 31, 1996:

1. Established the following gear allocations of BSAI Pacific cod TAC as follows: 2 percent to vessels using jig gear; 44.1 percent to vessels using hook-and-line or pot gear, and 53.9 percent to vessels using trawl gear.
2. Authorized the seasonal apportionment of the amount of Pacific cod allocated to gear groups. Criteria for seasonal apportionments and the seasons authorized to receive separate apportionments will be set forth in regulations.

Amendment 46, implemented January 1, 1997, superseded Amendment 24:

Replaced the three year Pacific cod allocation established with Amendment 24, with the following gear allocations in BSAI Pacific cod: 2 percent to vessels using jig gear; 51 percent to vessels using hook-and-line or pot gear; and 47 percent to vessels using trawl gear. The trawl apportionment will be divided 50 percent to catcher vessels and 50 percent to catcher processors. These allocations as well as the seasonal apportionment authority established in Amendment 24 will remain in effect until amended.

Amendment 49, implemented January 3, 1998:

Implemented an Increased Retention/Increased Utilization Program for pollock and Pacific cod beginning January 1, 1998 and rock sole and yellowfin sole beginning January 1, 2003.

Amendment 64, implemented September 1, 2000, revised Amendment 46:

Allocated the Pacific cod Total Allowable Catch to the jig gear (2 percent), fixed gear (51 percent), and trawl gear (47 percent) sectors.

Amendment 67, implemented May 15, 2002, revised Amendment 39:

Established participation and harvest requirements to qualify for a BSAI Pacific cod fishery endorsement for fixed gear vessels.

Amendment 77, implemented January 1, 2004, revised Amendment 64:

Implemented a Pacific cod fixed gear allocation between hook and line catcher processors (80%), hook and line catcher vessels (0.3%), pot catcher processors (3.3%), pot catcher vessels (15%), and catcher vessels (pot or hook and line) less than 60 feet (1.4%).

(Continued on next page.)

Table 2.5 (page 2 of 2)—Amendments to the BSAI Fishery Management Plan (FMP) that reference Pacific cod explicitly (excerpted from Appendix A of the FMP).

Amendment 85, partially implemented March 5, 2007, superseded Amendments 46 and 77:

Implemented a gear allocation among all non-CDQ fishery sectors participating in the directed fishery for Pacific cod. After deduction of the CDQ allocation, the Pacific cod TAC is apportioned to vessels using jig gear (1.4 percent); catcher processors using trawl gear listed in Section 208(e)(1)-(20) of the AFA (2.3 percent); catcher processors using trawl gear as defined in Section 219(a)(7) of the Consolidated Appropriations Act, 2005 (Public Law 108-447) (13.4 percent); catcher vessels using trawl gear (22.1 percent); catcher processors using hook-and-line gear (48.7 percent); catcher vessels ≥60' LOA using hook-and-line gear (0.2 percent); catcher processors using pot gear (1.5 percent); catcher vessels ≥60' LOA using pot gear (8.4 percent); and catcher vessels <60' LOA that use either hook-and-line gear or pot gear (2.0 percent).

Amendment 99, implemented January 6, 2014 (effective February 6, 2014):

Allows holders of license limitation program (LLP) licenses endorsed to catch and process Pacific cod in the Bering Sea/Aleutian Islands hook-and-line fisheries to use their LLP license on larger newly built or existing vessels by:

1. Increasing the maximum vessel length limits of the LLP license, and
2. Waiving vessel length, weight, and horsepower limits of the American Fisheries Act.

Amendment 103, implemented November 14, 2014:

Revise the Pribilof Islands Habitat Conservation Zone to close to fishing for Pacific cod with pot gear (in addition to the closure to all trawling).

Amendment 109, implemented May 4, 2016:

Revised provisions regarding the Western Alaska CDQ Program to update information and to facilitate increased participation in the groundfish CDQ fisheries (primarily Pacific cod) by:

1. Exempting CDQ group-authorized catcher vessels greater than 32 ft LOA and less than or equal to 46 ft LOA using hook-and-line gear from License Limitation Program license requirements while groundfish CDQ fishing,
2. Modifying observer coverage category language to allow for the placement of catcher vessels less than or equal to 46 ft LOA using hook-and-line gear into the partial observer coverage category while groundfish CDQ fishing, and
3. Updating CDQ community population information, and making other miscellaneous editorial revisions to CDQ Program-related text in the FMP.

Table 2.6a (page 1 of 6)—Fishery size composition data (Model 16.6i weighting, units = measured fish).

Year	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1984	0	0	0	0	0	0	0	0	2	0	2	0	3	6	8	13	47	77	86	95
1985	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	4	4
1986	0	0	0	0	0	0	0	0	2	2	5	5	12	21	4	6	12	26	24	35
1987	0	0	0	0	0	0	0	0	0	0	2	1	2	8	18	21	15	15	33	14
1988	0	1	0	0	0	1	0	0	0	0	0	0	1	1	2	2	1	3	1	4
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	4	6	3	3
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	2	1	6	2	15
1991	0	0	0	0	0	0	0	0	0	2	0	2	2	6	1	6	6	10	8	11
1992	0	0	0	0	0	0	0	0	2	0	3	5	6	3	12	2	13	8	16	16
1993	0	0	0	0	1	0	0	0	0	0	0	1	3	4	1	4	5	10	13	9
1994	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	6	7	17	9
1995	0	0	0	0	0	0	0	0	0	0	0	0	9	12	14	16	22	23	22	28
1996	0	0	0	0	0	2	0	0	3	3	3	5	11	5	16	16	8	23	12	5
1997	0	2	2	0	8	0	2	0	2	5	0	2	8	17	29	50	49	59	47	53
1998	0	0	0	0	0	1	0	0	0	1	0	3	3	4	4	1	1	11	11	15
1999	0	2	3	2	0	1	1	2	0	0	0	0	1	0	2	5	3	4	0	4
2000	0	1	2	1	2	1	0	2	0	9	0	0	0	0	1	0	1	1	1	0
2001	0	1	6	0	1	0	0	0	0	0	0	0	1	1	0	0	2	3	4	2
2002	0	4	5	4	0	4	0	0	0	0	2	2	0	4	2	3	6	8	5	8
2003	0	4	7	7	0	0	1	0	0	0	0	3	1	0	0	1	1	3	2	0
2004	0	0	1	1	1	1	0	0	0	1	1	0	0	0	0	0	2	0	0	4
2005	0	4	2	5	0	1	0	0	0	0	0	0	1	1	2	2	0	4	3	3
2006	0	0	2	4	1	0	0	0	0	0	0	0	0	0	2	0	1	4	4	6
2007	0	0	2	1	1	1	0	0	0	0	1	2	1	0	3	3	2	4	2	6
2008	0	3	0	0	0	0	0	0	0	0	0	0	1	1	0	3	2	1	4	3
2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1
2011	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2
2013	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1
2014	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	1	0	2	0
2015	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
2017	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	1	0	1	1
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2

Table 2.6a (page 2 of 6)—Fishery size composition data (Model 16.6i weighting, units = measured fish).

Year	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1977	0	0	0	0	0	0	0	2	2	5	9	14	9	24	25	28	20	15	27	20
1978	2	6	2	6	9	39	46	39	39	25	18	16	6	7	22	19	15	9	13	20
1979	0	0	0	3	0	0	9	24	44	32	71	105	149	178	281	388	380	495	566	560
1980	0	0	0	2	0	2	15	13	31	35	33	54	87	110	182	214	374	451	526	582
1981	2	2	3	2	9	7	21	46	56	125	230	320	356	420	363	277	266	177	167	212
1982	1	1	0	0	3	1	2	2	4	10	29	56	66	56	73	66	42	30	43	81
1983	8	12	14	4	18	28	25	47	88	120	131	114	87	84	73	102	99	161	250	320
1984	112	83	109	179	246	375	475	518	499	494	480	502	515	528	613	547	507	508	532	640
1985	0	0	1	0	1	2	13	30	36	50	72	140	165	170	297	349	553	814	1144	1549
1986	45	59	47	89	129	147	179	306	437	606	723	762	852	820	766	735	821	718	776	910
1987	23	36	77	84	131	222	309	380	391	431	504	513	507	536	583	705	963	1244	1526	1969
1988	13	11	7	14	27	59	113	218	303	436	527	648	727	678	745	667	808	895	1170	1496
1989	2	1	1	2	9	22	58	113	96	190	203	266	339	322	411	379	309	344	340	383
1990	49	36	66	132	166	343	363	595	485	574	545	554	547	529	420	467	443	398	359	389
1991	14	40	86	153	281	424	619	808	904	875	836	808	827	797	802	846	872	1017	1127	1423
1992	29	28	68	76	117	167	306	379	463	669	784	921	1001	1040	1248	1445	1974	2584	3480	4098
1993	21	20	37	63	100	179	375	536	642	747	754	782	783	828	1052	1657	2406	3230	4071	4489
1994	19	45	75	128	220	416	620	948	1167	1473	1687	1740	1743	1459	1214	1098	1037	1189	1565	2087
1995	40	46	80	77	111	119	151	167	213	239	222	288	344	450	705	1251	2202	3227	4486	5539
1996	14	11	53	81	199	289	443	582	684	716	724	729	693	663	614	674	809	1048	1504	2044
1997	23	42	55	78	154	266	393	665	902	1136	1236	1443	1432	1362	1279	1230	1240	1416	1633	2096
1998	9	55	107	212	316	474	613	637	685	699	659	625	603	701	664	843	1217	1607	2095	2585
1999	2	4	4	24	43	76	144	204	211	182	197	206	181	253	365	608	1061	1547	2320	2876
2000	2	3	1	4	18	31	51	51	68	60	59	85	106	143	216	305	505	749	980	1323
2001	2	1	3	6	4	9	11	21	37	45	73	102	152	233	279	441	531	833	1036	1271
2002	10	10	21	18	38	45	92	134	196	226	294	342	399	490	518	739	1002	1382	1865	2378
2003	1	1	2	3	3	11	13	40	66	121	162	226	291	331	411	564	800	1124	1591	2203
2004	2	0	4	5	8	9	25	31	40	70	104	125	172	192	240	251	369	439	621	821
2005	5	3	8	10	5	15	35	55	63	78	126	156	185	205	236	309	376	649	727	940
2006	1	1	3	2	7	2	10	20	37	54	78	98	107	168	198	221	275	373	467	605
2007	6	7	11	6	19	20	34	65	57	72	94	103	114	111	145	193	219	245	310	424
2008	6	18	27	26	45	42	49	43	45	49	65	68	107	146	209	355	556	722	884	1125
2009	0	0	2	1	2	4	4	14	9	9	18	26	43	54	151	233	443	638	737	1017
2010	3	4	3	5	12	13	15	23	10	20	26	32	57	76	125	199	335	436	552	638
2011	0	2	3	2	4	19	24	28	0	41	39	39	64	100	168	314	564	791	1061	1428
2012	0	1	3	24	29	42	38	48	60	52	80	83	77	97	106	129	207	383	527	693
2013	8	4	9	28	39	59	82	76	127	149	156	236	256	355	366	499	663	941	1242	1599
2014	0	0	5	10	18	32	40	47	93	106	109	104	96	131	232	377	689	1070	1514	1962
2015	0	1	3	3	5	18	28	52	81	96	103	154	143	157	176	194	239	360	489	787
2016	1	0	0	0	1	4	3	4	17	21	20	39	49	69	72	101	173	309	503	785
2017	3	4	0	0	0	1	0	4	1	7	5	14	16	35	59	52	89	96	136	181
2018	0	0	0	0	0	0	0	4	6	9	12	14	13	38	49	60	113	135	190	207
2019	1	0	0	1	0	0	2	3	1	1	5	7	9	15	15	33	65	63	79	86

Table 2.6a (page 3 of 6)—Fishery size composition data (Model 16.6i weighting, units = measured fish).

Year	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
1977	10	14	10	6	14	21	35	54	94	80	95	91	77	73	69	62	72	74	79	79
1978	30	46	68	88	124	155	197	274	321	390	505	587	670	759	709	737	724	655	604	506
1979	495	490	472	409	383	284	265	257	307	322	351	372	392	432	482	483	509	540	578	569
1980	545	575	526	561	470	466	384	425	401	373	378	407	404	372	357	394	354	364	288	255
1981	256	305	364	456	421	410	405	392	400	396	358	298	306	263	248	241	224	211	176	178
1982	104	153	123	175	155	155	198	156	257	234	342	344	329	308	339	374	350	391	440	443
1983	380	386	449	435	469	459	414	512	580	677	866	1176	1251	1470	1507	1757	1818	2022	2157	1931
1984	730	875	858	807	841	867	926	957	1040	1028	1350	1568	1861	2341	2448	2764	3150	3530	3898	4142
1985	1782	1829	1994	2249	2384	2816	3143	3428	3799	4000	4120	3936	3616	3478	3218	2995	3030	2966	3117	3620
1986	1098	1383	1376	1639	1864	2084	2333	2733	3020	3122	3822	4008	4318	4724	4923	5037	5280	5373	5681	5652
1987	2203	2461	3040	3266	3450	3864	4497	4863	5769	6518	7352	8110	8385	8803	9046	9110	9390	8970	9075	9318
1988	1979	2220	2432	2588	2537	2378	2395	2168	2338	2396	2435	2331	2345	2294	2272	2099	2190	2135	1935	1903
1989	495	549	677	778	783	948	1028	973	1095	1125	1164	1162	1162	1186	1203	1225	1282	1386	1356	1496
1990	387	386	506	639	657	951	1091	1662	1787	2081	2300	2682	3137	3553	4006	4604	5057	5616	6618	6885
1991	1782	2148	2805	3162	3446	4116	3862	3821	4129	3971	4053	4106	4392	4428	4905	5206	5906	6331	7227	7937
1992	5186	6016	6236	6613	7094	7309	7687	7506	7760	7670	7535	7703	7387	7599	7546	7671	8136	8081	8769	8721
1993	4941	4973	5205	5038	4940	5282	5574	6022	6632	7078	7476	7720	7867	7797	7538	7180	7198	6611	6333	5941
1994	2615	3673	3995	4805	5622	6408	7799	8180	9370	9922	10571	11707	11662	12491	12553	12456	14184	13134	13285	13223
1995	6571	6618	6785	6507	6124	5989	6248	6181	6746	7423	8288	9013	9707	10160	10881	11531	12136	12354	13073	13374
1996	2882	3832	4625	5611	6770	8236	9810	10937	12031	12968	13520	14183	14219	14293	14292	14216	14156	13776	13773	13961
1997	2839	3874	4501	5348	5836	6577	7136	7552	8159	9096	10485	11672	12372	13731	14636	16243	17601	17907	19064	19352
1998	3207	3948	4342	4655	5178	5569	6089	6624	6992	7612	8152	9143	9411	10132	10689	11163	12626	13107	14087	15017
1999	3247	3716	3851	3977	4108	4047	4199	4084	4240	4396	4228	4596	4605	4410	4615	4640	5067	4884	5314	5598
2000	1523	1916	2271	2741	3181	3631	4119	4725	5206	5598	6014	6293	6725	6818	6946	7187	7472	7557	7655	7612
2001	1557	1817	2196	2620	2851	3342	3620	4052	4667	5193	5838	6438	6817	7368	7518	7820	8310	8324	8395	8693
2002	2662	3141	3458	4019	4298	4796	5163	5416	5747	6002	6370	6619	6750	7092	7420	7491	8020	8193	8400	8426
2003	2848	3635	3985	4790	5421	5968	6823	7324	8599	8858	9525	9734	10056	10132	9933	9785	10164	9786	9728	9893
2004	1102	1492	1931	2400	2759	3372	4028	4620	5114	5898	6414	7098	7739	8288	8455	9132	9869	9817	9822	9937
2005	1236	1648	2026	2309	2632	3047	3291	3643	4127	4423	4855	5278	5835	6087	6328	6547	7162	7314	7552	7866
2006	693	969	1273	1577	1967	2324	2820	3178	3667	4033	4398	4813	5038	5203	5274	5199	5551	5298	5488	5443
2007	481	697	870	1055	1315	1538	1949	2129	2465	2741	3024	3351	3590	3837	4128	4249	5015	4732	4904	4804
2008	1181	1490	1603	1806	1955	2257	2671	2866	3376	3811	4052	4515	4741	5027	5244	5477	5935	5870	5731	6142
2009	1232	1641	2039	2474	3294	3794	4683	5172	5444	5682	5225	4930	4779	4412	4206	4080	4385	4360	4487	4689
2010	779	871	998	1226	1547	2012	2544	3016	3516	4057	4276	4758	4791	5078	5313	5378	5747	5737	5922	5892
2011	1709	2096	2398	2847	3490	4074	4440	4686	4747	4877	4810	4857	4810	5135	5392	5758	6331	6505	6894	7259
2012	817	1139	1221	1444	1822	2559	3648	4571	5428	6162	7003	7609	7791	7961	7930	8278	8833	8156	8018	8145
2013	1962	2316	2536	2866	3185	3353	4126	4823	5403	5905	6378	6919	7299	7580	7868	8489	9308	9582	10016	10248
2014	2221	2418	2563	2701	3026	3541	4573	4831	5350	5871	6369	6717	6926	7317	7461	7697	8488	8183	8320	8820
2015	966	1327	1622	2004	2419	2712	3442	4189	4872	5675	6529	7177	8002	8373	8826	8836	9107	8930	8949	8812
2016	1153	1585	2024	2404	2717	2929	3317	3580	3683	3948	4103	4474	4792	5114	5481	5976	6693	6632	7299	7870
2017	222	377	429	620	861	1210	1645	2151	2643	3306	4064	4620	5079	5373	5874	5888	6292	6272	6380	6471
2018	292	329	441	525	656	769	950	996	1261	1522	1707	2035	2323	2742	3256	3693	4315	4736	5292	5773
2019	88	127	169	189	300	398	534	611	662	747	855	923	851	989	960	1071	1282	1306	1502	1728

Table 2.6a (page 4 of 6)—Fishery size composition data (Model 16.6i weighting, units = measured fish).

Year	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
1977	87	86	99	72	59	55	48	46	35	25	18	28	21	20	20	11	12	8	7	2
1978	452	364	266	210	212	193	179	146	119	135	122	92	91	75	69	48	40	25	46	36
1979	601	593	578	518	493	372	373	347	254	230	208	154	116	122	84	57	44	48	41	22
1980	244	227	178	192	215	205	252	236	225	240	216	209	196	192	152	130	107	90	74	54
1981	133	143	136	107	105	93	92	76	72	63	56	49	50	35	25	24	14	17	6	12
1982	466	517	503	483	503	476	519	482	512	404	374	338	284	289	198	198	150	169	87	86
1983	2064	2147	2228	2022	2008	2058	1958	1791	1722	1601	1550	1443	1300	1294	1236	1154	1060	912	714	628
1984	4662	4730	4782	5030	5250	5148	5105	4997	4921	4802	4519	4215	4103	3772	3462	3243	2872	2589	2366	2199
1985	4129	4872	5353	6162	6694	7257	7928	7753	8034	7786	7471	7099	6625	6201	5544	4910	4668	3919	3638	3155
1986	5836	5687	5381	5546	4977	4473	4102	3989	3928	3892	4017	4077	3766	3866	3750	3680	3522	3227	2890	2827
1987	9746	9626	10088	10242	10313	9949	10298	9905	9665	9720	9205	9010	8061	7867	7265	6348	6167	5208	4814	4675
1988	2017	2135	2125	2143	2451	2358	2629	2628	2651	2698	2590	2758	2320	2296	2092	1877	1728	1504	1198	1054
1989	1571	1622	1635	1647	1772	1870	2008	1963	1933	2065	2028	2157	1864	1903	1811	1741	1668	1541	1456	1291
1990	7328	8015	8401	8516	8576	9101	8913	8845	9097	8656	8773	8567	8258	7802	7310	7000	6290	6013	5461	5035
1991	8735	9464	9865	10601	11000	11416	11644	11314	11903	11148	11422	11459	10707	9878	9570	9045	8551	7700	7487	6817
1992	9306	9994	9599	9976	10170	9912	9981	8789	9055	8219	8085	8097	7129	6853	6653	6136	6318	5252	5035	4772
1993	5371	5014	4629	4491	4231	3972	3957	3584	3614	3422	3291	3171	2998	2711	2728	2503	2448	2164	1969	1935
1994	13298	13378	12484	12655	12002	10739	10961	8449	7744	7138	6205	5913	4678	4344	3794	3144	3338	2647	2468	2201
1995	12997	13854	13029	13192	12691	11914	11667	9681	8940	7894	7100	6388	5378	4789	4160	3644	3282	2640	2509	2212
1996	13948	14225	13818	13699	13352	13133	13690	11934	11601	10765	10453	9858	8704	8035	7300	6571	6212	5336	4850	4313
1997	19804	19896	19353	18877	18329	17416	16958	14269	13415	12175	10942	10341	8909	8026	7127	6520	5705	4660	4275	4055
1998	15734	16331	16696	17257	16947	16647	17092	15108	14732	13818	12526	11319	10119	8929	7889	6906	6209	5107	4621	4189
1999	5319	5620	5549	5621	5645	5345	5666	5067	5261	4595	4341	4007	3690	3134	2981	2626	2535	2107	1881	1663
2000	7331	6791	6575	6350	5794	5403	5170	4314	4245	3891	3642	3270	2966	2690	2544	2298	2091	1870	1637	1533
2001	8447	8440	8033	7913	7531	7240	7075	5977	5247	4588	4086	3505	2921	2413	2052	1849	1644	1397	1159	974
2002	8462	8161	8068	7955	7931	7263	6971	6159	5640	4753	4410	3703	3296	2833	2501	2122	1764	1560	1299	1120
2003	9362	9428	9048	8768	8807	7942	8359	6967	6593	5965	5587	5023	4452	3905	3460	3035	2895	2371	2001	1731
2004	9724	9319	8820	8333	7954	7367	7209	6113	5429	4806	4505	3855	3564	2990	2820	2459	2336	2036	1732	1567
2005	8039	8118	8013	8285	8294	7912	8395	7086	6742	6282	5813	5434	4943	4394	4238	3574	3504	3066	2673	2342
2006	5457	5350	5303	5347	5347	5051	5605	4635	4631	4424	4439	4068	3843	3549	3513	3211	3137	2778	2737	2551
2007	4956	4789	4504	4512	4509	3969	4316	3591	3331	3123	2930	2908	2507	2450	2285	2069	2229	2014	1831	1825
2008	6046	5971	6195	5947	5813	5243	5287	4557	4161	3848	3440	2950	2640	2291	2099	1802	1836	1529	1393	1359
2009	4756	4775	4615	4670	4652	4335	4506	3649	3435	3164	2813	2400	2178	1797	1741	1362	1197	1086	926	707
2010	5666	5273	4835	4481	4088	3530	3524	2800	2619	2333	2139	1916	1757	1375	1263	1085	1053	868	639	608
2011	7275	7444	6684	6417	6043	5600	5255	4056	3558	3024	2739	2372	1921	1508	1384	1185	1155	923	759	638
2012	7697	7589	6843	6592	6213	5778	6123	4688	3924	3594	3095	2765	2130	1753	1548	1236	1106	849	731	566
2013	10584	10589	10150	9834	9035	8521	8248	6722	6170	5366	4561	3896	3156	2561	2195	1688	1415	1157	993	719
2014	8760	9107	8904	9015	8770	8487	8425	7270	6592	6153	5455	4772	3990	3276	2856	2389	2061	1582	1257	1055
2015	8887	8510	7966	7868	7529	6762	6894	5544	5125	4753	4219	3739	3247	2822	2411	2100	1924	1516	1398	1161
2016	8027	8314	8235	8051	7753	7080	7076	5946	5227	4804	4534	3763	3249	2703	2531	2077	1734	1420	1243	987
2017	6454	6420	6514	6255	6189	6059	6333	5188	5002	4738	4369	3949	3630	2977	2685	2171	2001	1464	1315	1082
2018	6047	6367	6195	6118	5958	5578	5424	4513	4235	4009	3499	3134	2712	2350	2150	1807	1741	1460	1249	1092
2019	1860	2031	2148	2414	2483	2623	2751	2595	2642	2470	2276	2058	1599	1393	1301	1028	901	720	622	508

Table 2.6a (page 5 of 6)—Fishery size composition data (Model 16.6i weighting, units = measured fish).

Year	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
1977	7	1	5	2	0	0	1	0	3	0	0	2	0	1	0	0	0	0	0	0
1978	27	25	16	15	14	9	5	2	4	3	4	4	1	0	0	1	1	0	0	0
1979	22	25	11	13	9	9	6	8	8	4	8	2	2	2	3	0	2	1	1	0
1980	39	36	38	33	34	14	29	17	18	15	5	10	8	5	3	2	2	2	0	2
1981	5	7	7	6	4	2	5	2	2	0	3	0	0	1	0	2	0	0	0	0
1982	75	42	31	43	30	31	37	18	25	12	20	26	12	12	7	10	1	6	0	6
1983	550	490	437	352	296	212	202	159	137	112	62	53	46	37	36	24	24	19	17	5
1984	1899	1655	1307	1230	1053	784	689	504	437	318	258	196	130	122	76	54	47	42	33	22
1985	2803	2608	2161	1782	1607	1406	1235	929	805	697	596	469	327	265	210	197	114	101	66	63
1986	2411	2200	1885	1579	1347	1084	968	750	612	556	444	391	284	240	175	152	148	113	76	56
1987	4025	3786	3417	3130	2758	2484	2338	1980	1703	1562	1194	1135	746	731	551	461	398	283	260	200
1988	921	890	783	623	557	477	534	406	321	323	245	304	191	141	126	112	103	99	79	49
1989	1227	1090	944	903	807	669	593	485	378	413	321	310	197	211	190	177	133	131	73	70
1990	4599	4342	3915	3448	3149	3102	2434	2352	2206	2075	1704	1675	1367	1234	1067	891	606	557	463	466
1991	6402	6014	5336	4767	4393	4216	3686	3020	2851	2403	2123	1936	1702	1480	1342	1125	898	733	654	569
1992	4461	4209	3541	3382	3238	3032	2776	2187	2110	1879	1648	1580	1368	1199	1048	1008	867	662	507	519
1993	1726	1553	1460	1234	1155	1023	1019	762	764	677	564	530	448	357	393	322	236	201	184	151
1994	2003	1930	1707	1517	1365	1266	1379	916	904	770	715	644	550	498	429	342	369	254	237	182
1995	1980	1795	1508	1353	1221	1159	1114	718	757	736	623	538	495	375	358	302	293	231	201	143
1996	4032	3498	3097	2746	2442	2233	2139	1587	1545	1347	1216	1109	954	783	621	601	588	428	354	326
1997	3675	3383	3073	2756	2539	2352	2055	1672	1477	1271	1073	1067	889	695	610	495	447	335	290	248
1998	3541	3034	2591	2199	2011	1669	1760	1315	1166	1101	956	900	741	678	590	507	435	297	267	210
1999	1413	1277	1047	854	765	673	640	533	429	379	301	239	234	180	152	161	170	101	95	68
2000	1287	1195	1052	971	829	726	696	537	491	410	367	314	295	232	209	156	147	111	103	73
2001	913	774	703	556	501	436	453	353	335	271	252	225	210	185	147	105	110	93	67	65
2002	950	779	673	591	466	420	398	289	270	234	235	216	146	159	113	95	74	67	57	38
2003	1428	1290	985	879	756	592	518	418	334	297	241	206	166	156	117	96	83	75	63	43
2004	1375	1176	1067	862	792	681	579	502	394	346	272	261	213	154	124	107	104	81	60	53
2005	2188	1879	1560	1452	1331	1137	1151	838	756	630	553	463	383	290	263	179	154	99	106	64
2006	2391	2012	1891	1733	1504	1443	1375	1045	957	852	768	655	508	481	439	367	308	228	186	140
2007	1750	1625	1474	1466	1396	1286	1232	1049	880	871	753	690	592	473	428	366	333	257	185	152
2008	1222	1132	1051	952	1023	851	910	795	765	646	592	568	478	441	374	293	297	190	175	138
2009	678	529	493	454	389	370	353	283	266	219	214	194	177	165	137	113	109	83	68	62
2010	514	448	378	299	268	189	207	128	123	101	101	63	48	56	45	35	46	38	25	21
2011	590	486	382	371	308	241	230	174	142	111	99	93	63	76	59	44	49	30	28	24
2012	508	383	349	236	213	223	175	130	111	81	93	59	43	70	36	32	32	23	20	15
2013	558	502	376	323	248	218	192	129	111	103	113	70	51	37	38	28	39	19	20	12
2014	843	683	535	457	374	292	277	207	162	147	108	100	74	62	57	50	20	27	19	16
2015	979	836	708	593	467	416	343	232	178	168	142	105	69	69	52	42	45	21	20	16
2016	867	703	637	471	436	347	309	221	203	154	138	120	85	79	39	41	39	24	20	9
2017	959	772	629	517	434	363	308	240	173	167	116	102	94	70	48	45	20	24	32	23
2018	883	691	609	503	412	361	301	254	175	141	142	121	92	60	62	41	39	29	17	25
2019	416	379	294	263	207	194	138	112	105	87	61	54	44	37	27	22	26	19	12	6

Table 2.6a (page 6 of 6)—Fishery size composition data (Model 16.6i weighting, units = measured fish).

Year	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120+
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	3	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	1	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1983	6	7	4	0	6	0	4	0	0	2	0	0	0	0	0	0	0
1984	10	10	6	3	1	3	2	0	3	1	0	1	0	0	0	0	0
1985	27	33	23	9	8	5	5	3	2	4	4	4	0	0	2	0	0
1986	39	44	25	17	7	9	11	2	1	0	2	1	1	0	2	2	5
1987	134	132	64	42	25	23	26	14	9	5	7	6	1	3	3	0	0
1988	40	28	23	18	8	8	7	3	5	0	0	1	0	0	0	0	0
1989	61	49	35	23	12	21	12	7	7	5	1	1	0	3	0	2	19
1990	313	233	166	139	114	71	68	39	17	23	18	12	8	5	0	2	0
1991	436	371	252	183	149	74	64	40	39	17	17	8	2	0	4	1	4
1992	386	318	189	169	98	88	76	55	26	21	15	14	3	3	0	1	2
1993	117	90	59	41	36	42	28	5	10	3	5	5	6	7	2	0	4
1994	168	136	110	70	53	42	62	27	21	15	12	15	8	0	7	1	11
1995	128	103	76	47	35	24	44	11	16	8	7	10	7	0	2	1	12
1996	241	209	157	142	90	66	75	54	46	23	22	15	10	3	6	7	27
1997	219	175	116	112	79	66	62	19	25	12	6	9	5	8	2	1	13
1998	222	150	109	95	71	59	57	22	21	28	18	3	6	9	6	2	10
1999	52	61	45	32	28	20	27	12	10	4	1	3	4	2	1	2	16
2000	60	53	31	17	29	16	26	10	8	6	13	4	1	2	0	2	12
2001	40	39	32	22	19	14	11	4	5	7	5	3	1	0	0	1	0
2002	35	36	33	13	10	4	14	3	2	6	0	4	0	1	0	0	0
2003	31	26	18	15	14	4	9	4	4	0	1	2	1	0	0	1	1
2004	31	28	16	16	11	9	13	4	4	1	0	1	0	0	1	0	3
2005	74	36	30	13	10	12	6	4	4	4	0	2	0	0	2	0	0
2006	123	88	79	67	33	26	26	16	12	11	3	7	3	5	3	0	1
2007	135	92	60	54	33	25	22	8	10	7	7	5	2	2	0	0	4
2008	110	84	36	37	30	15	12	9	7	1	0	0	0	0	1	0	4
2009	47	39	28	20	12	13	10	9	8	0	4	0	0	1	0	0	0
2010	26	15	11	8	3	9	8	2	0	1	1	1	0	0	0	1	2
2011	10	19	13	8	6	2	1	2	3	2	0	0	0	0	0	0	3
2012	10	14	6	5	4	2	2	1	1	2	0	0	0	0	0	0	0
2013	9	11	7	4	8	3	0	0	1	0	1	1	0	1	0	0	0
2014	15	5	5	3	1	5	1	0	0	0	0	2	0	0	0	0	1
2015	9	2	3	6	4	0	0	0	0	0	0	0	0	0	0	0	1
2016	14	7	4	3	6	4	2	0	0	0	0	0	1	0	0	0	0
2017	9	9	5	10	5	0	0	0	4	0	0	0	0	0	0	0	0
2018	12	6	7	1	2	0	1	1	0	0	0	1	0	0	0	0	0
2019	6	3	2	3	2	0	1	0	0	0	1	0	0	0	0	0	0

Table 2.6b (page 1 of 6)—Fishery size composition data (Model 19.x weighting, units = proportions).

Year	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1977	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1978	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1979	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1980	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1981	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0002	0.0002
1982	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1983	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1984	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0003	0.0006	0.0006	0.0007
1985	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1986	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0002
1987	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0001	0.0000
1988	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1989	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000
1990	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
1991	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
1992	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
1993	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0006	0.0000	0.0000
1994	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
1996	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001
1998	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
2002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0001
2003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0002
2006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001
2008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000
2009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
2016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002

Table 2.6b (page 2 of 6)—Fishery size composition data (Model 19.x weighting, units = proportions).

Year	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1977	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0010	0.0023	0.0043	0.0067	0.0043	0.0113	0.0120	0.0133	0.0097	0.0073	0.0130	0.0097
1978	0.0002	0.0005	0.0002	0.0005	0.0008	0.0034	0.0040	0.0034	0.0034	0.0022	0.0016	0.0014	0.0005	0.0006	0.0019	0.0016	0.0013	0.0008	0.0011	0.0018
1979	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0005	0.0014	0.0026	0.0019	0.0042	0.0062	0.0087	0.0104	0.0165	0.0227	0.0223	0.0290	0.0331	0.0328
1980	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0010	0.0009	0.0021	0.0024	0.0022	0.0036	0.0058	0.0074	0.0122	0.0143	0.0250	0.0301	0.0351	0.0389
1981	0.0002	0.0002	0.0003	0.0002	0.0008	0.0007	0.0020	0.0043	0.0052	0.0116	0.0214	0.0298	0.0332	0.0391	0.0339	0.0258	0.0248	0.0165	0.0155	0.0197
1982	0.0001	0.0001	0.0000	0.0000	0.0002	0.0001	0.0002	0.0002	0.0003	0.0007	0.0021	0.0042	0.0049	0.0042	0.0055	0.0049	0.0032	0.0022	0.0032	0.0060
1983	0.0001	0.0002	0.0002	0.0001	0.0003	0.0005	0.0004	0.0008	0.0015	0.0021	0.0023	0.0020	0.0015	0.0015	0.0013	0.0018	0.0018	0.0028	0.0044	0.0056
1984	0.0008	0.0006	0.0008	0.0013	0.0018	0.0027	0.0034	0.0037	0.0036	0.0036	0.0035	0.0036	0.0037	0.0038	0.0044	0.0040	0.0037	0.0037	0.0038	0.0046
1985	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0002	0.0004	0.0007	0.0008	0.0008	0.0015	0.0017	0.0027	0.0040	0.0056	0.0076
1986	0.0003	0.0003	0.0003	0.0005	0.0007	0.0008	0.0010	0.0017	0.0024	0.0034	0.0040	0.0043	0.0048	0.0046	0.0043	0.0041	0.0046	0.0040	0.0043	0.0051
1987	0.0001	0.0001	0.0002	0.0002	0.0004	0.0007	0.0009	0.0011	0.0011	0.0013	0.0015	0.0015	0.0015	0.0016	0.0017	0.0021	0.0028	0.0037	0.0045	0.0058
1988	0.0001	0.0001	0.0001	0.0001	0.0003	0.0006	0.0011	0.0021	0.0029	0.0041	0.0050	0.0061	0.0069	0.0064	0.0071	0.0063	0.0076	0.0085	0.0111	0.0142
1989	0.0000	0.0000	0.0000	0.0000	0.0001	0.0003	0.0008	0.0016	0.0014	0.0027	0.0029	0.0038	0.0048	0.0046	0.0059	0.0054	0.0044	0.0049	0.0049	0.0055
1990	0.0002	0.0001	0.0003	0.0005	0.0006	0.0013	0.0014	0.0023	0.0019	0.0022	0.0021	0.0021	0.0021	0.0020	0.0016	0.0018	0.0017	0.0015	0.0014	0.0015
1991	0.0000	0.0001	0.0001	0.0002	0.0004	0.0007	0.0008	0.0011	0.0014	0.0015	0.0016	0.0016	0.0018	0.0015	0.0018	0.0020	0.0024	0.0024	0.0035	0.0038
1992	0.0001	0.0001	0.0002	0.0002	0.0003	0.0004	0.0009	0.0008	0.0010	0.0017	0.0018	0.0022	0.0022	0.0024	0.0032	0.0037	0.0051	0.0067	0.0086	0.0107
1993	0.0006	0.0001	0.0003	0.0008	0.0009	0.0030	0.0033	0.0033	0.0041	0.0039	0.0033	0.0036	0.0035	0.0050	0.0048	0.0115	0.0136	0.0160	0.0188	0.0192
1994	0.0000	0.0001	0.0002	0.0004	0.0005	0.0011	0.0016	0.0023	0.0029	0.0036	0.0037	0.0037	0.0040	0.0031	0.0031	0.0026	0.0031	0.0038	0.0054	0.0075
1995	0.0001	0.0001	0.0002	0.0003	0.0004	0.0009	0.0006	0.0008	0.0010	0.0011	0.0013	0.0014	0.0016	0.0021	0.0034	0.0058	0.0092	0.0122	0.0153	0.0186
1996	0.0000	0.0000	0.0001	0.0001	0.0004	0.0004	0.0007	0.0009	0.0013	0.0012	0.0013	0.0014	0.0013	0.0015	0.0013	0.0014	0.0016	0.0024	0.0031	0.0041
1997	0.0000	0.0001	0.0001	0.0003	0.0004	0.0006	0.0009	0.0015	0.0018	0.0024	0.0027	0.0033	0.0028	0.0030	0.0029	0.0029	0.0031	0.0036	0.0038	0.0050
1998	0.0000	0.0001	0.0002	0.0003	0.0005	0.0008	0.0010	0.0011	0.0012	0.0013	0.0013	0.0015	0.0015	0.0017	0.0017	0.0020	0.0026	0.0034	0.0044	0.0053
1999	0.0001	0.0000	0.0000	0.0001	0.0003	0.0006	0.0007	0.0013	0.0011	0.0011	0.0011	0.0013	0.0010	0.0015	0.0020	0.0032	0.0054	0.0080	0.0118	0.0148
2000	0.0000	0.0001	0.0001	0.0001	0.0003	0.0004	0.0006	0.0006	0.0009	0.0007	0.0005	0.0007	0.0009	0.0012	0.0015	0.0025	0.0036	0.0047	0.0060	0.0075
2001	0.0000	0.0003	0.0001	0.0004	0.0003	0.0001	0.0002	0.0003	0.0003	0.0004	0.0010	0.0029	0.0033	0.0015	0.0025	0.0025	0.0034	0.0042	0.0060	0.0064
2002	0.0001	0.0001	0.0002	0.0002	0.0004	0.0008	0.0011	0.0017	0.0024	0.0023	0.0030	0.0027	0.0034	0.0034	0.0035	0.0046	0.0047	0.0069	0.0081	0.0102
2003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0003	0.0007	0.0008	0.0010	0.0023	0.0019	0.0025	0.0029	0.0031	0.0036	0.0057	0.0063	0.0082
2004	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0003	0.0004	0.0005	0.0012	0.0015	0.0015	0.0024	0.0020	0.0023	0.0025	0.0028	0.0031	0.0038	0.0039
2005	0.0001	0.0000	0.0002	0.0002	0.0003	0.0003	0.0005	0.0009	0.0007	0.0009	0.0017	0.0020	0.0019	0.0020	0.0020	0.0021	0.0031	0.0039	0.0039	0.0052
2006	0.0000	0.0001	0.0002	0.0001	0.0002	0.0001	0.0001	0.0002	0.0006	0.0007	0.0011	0.0012	0.0014	0.0019	0.0018	0.0023	0.0022	0.0027	0.0037	0.0038
2007	0.0001	0.0001	0.0009	0.0001	0.0003	0.0003	0.0012	0.0008	0.0007	0.0016	0.0013	0.0015	0.0017	0.0017	0.0021	0.0027	0.0025	0.0025	0.0037	0.0058
2008	0.0002	0.0004	0.0008	0.0010	0.0012	0.0011	0.0013	0.0013	0.0012	0.0012	0.0018	0.0020	0.0026	0.0030	0.0035	0.0043	0.0055	0.0050	0.0056	0.0064
2009	0.0002	0.0000	0.0001	0.0001	0.0003	0.0002	0.0005	0.0005	0.0008	0.0007	0.0009	0.0010	0.0016	0.0012	0.0025	0.0034	0.0050	0.0063	0.0091	0.0100
2010	0.0000	0.0004	0.0012	0.0017	0.0015	0.0008	0.0015	0.0006	0.0004	0.0012	0.0015	0.0015	0.0026	0.0034	0.0036	0.0055	0.0064	0.0059	0.0066	0.0073
2011	0.0000	0.0000	0.0001	0.0001	0.0000	0.0002	0.0003	0.0002	0.0007	0.0004	0.0007	0.0005	0.0007	0.0011	0.0017	0.0031	0.0044	0.0065	0.0084	0.0102
2012	0.0001	0.0000	0.0005	0.0006	0.0006	0.0007	0.0005	0.0009	0.0009	0.0009	0.0012	0.0011	0.0010	0.0022	0.0019	0.0023	0.0022	0.0029	0.0036	0.0045
2013	0.0002	0.0001	0.0001	0.0004	0.0006	0.0008	0.0011	0.0009	0.0015	0.0015	0.0015	0.0020	0.0020	0.0026	0.0027	0.0035	0.0037	0.0051	0.0064	0.0076
2014	0.0000	0.0001	0.0000	0.0001	0.0001	0.0004	0.0004	0.0004	0.0007	0.0009	0.0009	0.0010	0.0007	0.0010	0.0016	0.0022	0.0037	0.0053	0.0081	0.0095
2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002	0.0008	0.0011	0.0012	0.0012	0.0015	0.0012	0.0016	0.0015	0.0019	0.0022	0.0019	0.0025	0.0044
2016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0004	0.0004	0.0006	0.0004	0.0013	0.0009	0.0013	0.0021	0.0024	0.0039	0.0057
2017	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0004	0.0001	0.0024	0.0005	0.0005	0.0007	0.0009	0.0012	0.0015
2018	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0001	0.0002	0.0002	0.0005	0.0010	0.0005	0.0038	0.0016	0.0022	0.0023
2019	0.0002	0.0000	0.0000	0.0002	0.0000	0.0000	0.0004	0.0001	0.0000	0.0004	0.0006	0.0006	0.0002	0.0007	0.0006	0.0014	0.0012	0.0023	0.0014	0.0036

Table 2.6b (page 3 of 6)—Fishery size composition data (Model 19.x weighting, units = proportions).

Year	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
1977	0.0047	0.0067	0.0047	0.0030	0.0067	0.0100	0.0167	0.0260	0.0450	0.0384	0.0454	0.0437	0.0370	0.0350	0.0330	0.0297	0.0344	0.0354	0.0377	0.0377
1978	0.0026	0.0040	0.0059	0.0076	0.0108	0.0134	0.0171	0.0237	0.0278	0.0338	0.0437	0.0508	0.0579	0.0657	0.0613	0.0638	0.0626	0.0567	0.0523	0.0438
1979	0.0290	0.0287	0.0277	0.0240	0.0224	0.0166	0.0155	0.0151	0.0180	0.0189	0.0206	0.0218	0.0230	0.0253	0.0282	0.0283	0.0298	0.0316	0.0339	0.0333
1980	0.0364	0.0384	0.0351	0.0375	0.0314	0.0312	0.0257	0.0284	0.0268	0.0250	0.0252	0.0272	0.0270	0.0249	0.0238	0.0263	0.0237	0.0243	0.0192	0.0170
1981	0.0239	0.0284	0.0339	0.0425	0.0393	0.0382	0.0378	0.0366	0.0373	0.0369	0.0334	0.0278	0.0285	0.0245	0.0231	0.0224	0.0209	0.0197	0.0164	0.0166
1982	0.0078	0.0114	0.0091	0.0130	0.0116	0.0116	0.0148	0.0116	0.0191	0.0174	0.0255	0.0256	0.0245	0.0229	0.0252	0.0279	0.0261	0.0291	0.0328	0.0330
1983	0.0067	0.0068	0.0079	0.0077	0.0083	0.0081	0.0073	0.0090	0.0102	0.0119	0.0153	0.0207	0.0221	0.0259	0.0266	0.0310	0.0321	0.0357	0.0380	0.0341
1984	0.0053	0.0063	0.0062	0.0058	0.0061	0.0063	0.0067	0.0069	0.0075	0.0074	0.0097	0.0113	0.0134	0.0169	0.0177	0.0200	0.0228	0.0255	0.0282	0.0299
1985	0.0087	0.0089	0.0097	0.0110	0.0116	0.0138	0.0154	0.0167	0.0186	0.0195	0.0201	0.0192	0.0177	0.0170	0.0157	0.0146	0.0148	0.0145	0.0152	0.0177
1986	0.0061	0.0077	0.0077	0.0092	0.0104	0.0117	0.0131	0.0153	0.0169	0.0175	0.0214	0.0224	0.0242	0.0264	0.0276	0.0282	0.0296	0.0301	0.0318	0.0316
1987	0.0065	0.0072	0.0089	0.0096	0.0101	0.0113	0.0132	0.0143	0.0169	0.0191	0.0216	0.0238	0.0246	0.0258	0.0266	0.0267	0.0276	0.0263	0.0266	0.0274
1988	0.0187	0.0210	0.0230	0.0245	0.0240	0.0225	0.0227	0.0205	0.0221	0.0227	0.0231	0.0221	0.0222	0.0217	0.0215	0.0199	0.0207	0.0202	0.0183	0.0180
1989	0.0071	0.0078	0.0097	0.0111	0.0112	0.0135	0.0147	0.0139	0.0156	0.0161	0.0166	0.0166	0.0166	0.0169	0.0172	0.0175	0.0183	0.0198	0.0194	0.0214
1990	0.0015	0.0015	0.0019	0.0024	0.0025	0.0036	0.0042	0.0064	0.0068	0.0080	0.0088	0.0103	0.0120	0.0136	0.0154	0.0176	0.0194	0.0215	0.0254	0.0264
1991	0.0059	0.0067	0.0086	0.0100	0.0107	0.0119	0.0118	0.0119	0.0114	0.0117	0.0120	0.0114	0.0130	0.0132	0.0139	0.0149	0.0172	0.0176	0.0207	0.0232
1992	0.0199	0.0162	0.0166	0.0159	0.0169	0.0193	0.0193	0.0189	0.0198	0.0195	0.0194	0.0194	0.0184	0.0194	0.0177	0.0191	0.0210	0.0197	0.0224	0.0217
1993	0.0197	0.0192	0.0207	0.0206	0.0200	0.0220	0.0256	0.0252	0.0278	0.0295	0.0325	0.0330	0.0324	0.0319	0.0317	0.0304	0.0294	0.0268	0.0273	0.0257
1994	0.0109	0.0148	0.0161	0.0188	0.0193	0.0191	0.0206	0.0193	0.0222	0.0236	0.0255	0.0278	0.0287	0.0311	0.0311	0.0318	0.0361	0.0340	0.0342	0.0348
1995	0.0209	0.0205	0.0203	0.0191	0.0172	0.0165	0.0173	0.0173	0.0184	0.0199	0.0214	0.0234	0.0246	0.0262	0.0275	0.0296	0.0310	0.0316	0.0324	0.0337
1996	0.0062	0.0079	0.0096	0.0113	0.0140	0.0173	0.0200	0.0225	0.0261	0.0276	0.0290	0.0303	0.0307	0.0309	0.0311	0.0310	0.0312	0.0307	0.0305	0.0308
1997	0.0069	0.0093	0.0107	0.0128	0.0131	0.0151	0.0150	0.0161	0.0167	0.0183	0.0199	0.0234	0.0244	0.0276	0.0285	0.0320	0.0343	0.0354	0.0371	0.0374
1998	0.0066	0.0081	0.0105	0.0105	0.0121	0.0134	0.0134	0.0150	0.0157	0.0176	0.0197	0.0199	0.0199	0.0235	0.0239	0.0243	0.0284	0.0284	0.0317	0.0328
1999	0.0163	0.0188	0.0198	0.0200	0.0205	0.0207	0.0207	0.0205	0.0209	0.0217	0.0207	0.0232	0.0228	0.0223	0.0227	0.0231	0.0252	0.0247	0.0267	0.0286
2000	0.0084	0.0112	0.0132	0.0153	0.0181	0.0199	0.0233	0.0259	0.0282	0.0292	0.0308	0.0321	0.0331	0.0331	0.0326	0.0341	0.0338	0.0334	0.0335	0.0328
2001	0.0077	0.0083	0.0109	0.0125	0.0130	0.0154	0.0175	0.0183	0.0228	0.0251	0.0259	0.0284	0.0317	0.0330	0.0337	0.0356	0.0379	0.0397	0.0395	0.0410
2002	0.0130	0.0125	0.0138	0.0157	0.0172	0.0183	0.0194	0.0206	0.0226	0.0231	0.0244	0.0254	0.0271	0.0282	0.0300	0.0317	0.0339	0.0356	0.0370	0.0377
2003	0.0105	0.0122	0.0139	0.0164	0.0180	0.0201	0.0210	0.0234	0.0266	0.0268	0.0285	0.0294	0.0306	0.0306	0.0301	0.0302	0.0311	0.0306	0.0310	0.0322
2004	0.0049	0.0067	0.0084	0.0110	0.0123	0.0144	0.0175	0.0195	0.0218	0.0244	0.0262	0.0297	0.0312	0.0329	0.0337	0.0360	0.0389	0.0389	0.0389	0.0402
2005	0.0063	0.0077	0.0090	0.0105	0.0121	0.0135	0.0142	0.0150	0.0175	0.0182	0.0204	0.0220	0.0234	0.0256	0.0263	0.0274	0.0309	0.0310	0.0324	0.0341
2006	0.0040	0.0057	0.0088	0.0102	0.0121	0.0132	0.0155	0.0167	0.0189	0.0207	0.0235	0.0242	0.0256	0.0263	0.0268	0.0271	0.0287	0.0280	0.0294	0.0295
2007	0.0044	0.0089	0.0076	0.0095	0.0105	0.0120	0.0138	0.0145	0.0173	0.0194	0.0198	0.0227	0.0237	0.0258	0.0288	0.0290	0.0339	0.0334	0.0341	0.0338
2008	0.0059	0.0080	0.0090	0.0100	0.0103	0.0118	0.0143	0.0140	0.0180	0.0199	0.0213	0.0243	0.0252	0.0275	0.0286	0.0307	0.0336	0.0341	0.0338	0.0356
2009	0.0113	0.0139	0.0166	0.0177	0.0214	0.0231	0.0268	0.0281	0.0283	0.0310	0.0274	0.0266	0.0256	0.0244	0.0251	0.0237	0.0260	0.0275	0.0295	0.0306
2010	0.0078	0.0078	0.0095	0.0108	0.0136	0.0159	0.0197	0.0232	0.0263	0.0306	0.0315	0.0366	0.0355	0.0381	0.0399	0.0392	0.0401	0.0404	0.0399	0.0407
2011	0.0114	0.0144	0.0165	0.0189	0.0219	0.0237	0.0246	0.0249	0.0238	0.0248	0.0247	0.0253	0.0264	0.0274	0.0296	0.0328	0.0354	0.0382	0.0406	0.0446
2012	0.0050	0.0066	0.0081	0.0093	0.0119	0.0162	0.0214	0.0266	0.0312	0.0353	0.0371	0.0396	0.0402	0.0401	0.0390	0.0396	0.0412	0.0398	0.0384	0.0391
2013	0.0080	0.0097	0.0107	0.0117	0.0139	0.0133	0.0165	0.0182	0.0216	0.0225	0.0252	0.0277	0.0291	0.0324	0.0327	0.0358	0.0418	0.0416	0.0427	0.0438
2014	0.0111	0.0120	0.0128	0.0143	0.0138	0.0151	0.0191	0.0193	0.0199	0.0213	0.0235	0.0255	0.0266	0.0286	0.0313	0.0306	0.0344	0.0328	0.0334	0.0377
2015	0.0052	0.0066	0.0082	0.0111	0.0126	0.0131	0.0154	0.0194	0.0223	0.0263	0.0305	0.0333	0.0364	0.0378	0.0380	0.0377	0.0393	0.0371	0.0381	0.0380
2016	0.0082	0.0105	0.0138	0.0154	0.0166	0.0165	0.0178	0.0201	0.0197	0.0210	0.0222	0.0234	0.0257	0.0289	0.0293	0.0315	0.0347	0.0371	0.0387	0.0427
2017	0.0016	0.0026	0.0035	0.0040	0.0055	0.0087	0.0113	0.0151	0.0181	0.0222	0.0278	0.0317	0.0332	0.0351	0.0388	0.0375	0.0395	0.0400	0.0404	0.0399
2018	0.0034	0.0028	0.0043	0.0043	0.0055	0.0061	0.0078	0.0089	0.0111	0.0139	0.0157	0.0170	0.0206	0.0237	0.0264	0.0299	0.0350	0.0396	0.0422	0.0466
2019	0.0019	0.0052	0.0040	0.0075	0.0088	0.0092	0.0127	0.0112	0.0127	0.0196	0.0163	0.0186	0.0187	0.0197	0.0196	0.0223	0.0228	0.0259	0.0290	0.0359

Table 2.6b (page 4 of 6)—Fishery size composition data (Model 19.x weighting, units = proportions).

Year	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
1977	0.0417	0.0410	0.0474	0.0344	0.0284	0.0264	0.0230	0.0220	0.0167	0.0120	0.0087	0.0133	0.0100	0.0097	0.0097	0.0053	0.0057	0.0037	0.0033	0.0010
1978	0.0391	0.0315	0.0230	0.0182	0.0183	0.0167	0.0155	0.0126	0.0103	0.0117	0.0106	0.0079	0.0079	0.0065	0.0060	0.0041	0.0034	0.0022	0.0040	0.0031
1979	0.0352	0.0347	0.0339	0.0303	0.0289	0.0218	0.0218	0.0203	0.0149	0.0135	0.0122	0.0090	0.0068	0.0071	0.0049	0.0033	0.0026	0.0028	0.0024	0.0013
1980	0.0163	0.0152	0.0119	0.0128	0.0144	0.0137	0.0168	0.0158	0.0150	0.0161	0.0144	0.0140	0.0131	0.0128	0.0101	0.0087	0.0072	0.0060	0.0050	0.0036
1981	0.0124	0.0133	0.0127	0.0100	0.0098	0.0086	0.0086	0.0071	0.0067	0.0059	0.0052	0.0046	0.0047	0.0032	0.0023	0.0022	0.0013	0.0016	0.0005	0.0011
1982	0.0347	0.0385	0.0375	0.0360	0.0375	0.0355	0.0387	0.0359	0.0381	0.0301	0.0279	0.0252	0.0212	0.0216	0.0148	0.0148	0.0112	0.0126	0.0065	0.0064
1983	0.0364	0.0379	0.0393	0.0357	0.0354	0.0363	0.0345	0.0316	0.0304	0.0282	0.0273	0.0254	0.0229	0.0228	0.0218	0.0204	0.0187	0.0161	0.0126	0.0111
1984	0.0337	0.0342	0.0345	0.0363	0.0379	0.0372	0.0369	0.0361	0.0355	0.0347	0.0326	0.0304	0.0296	0.0272	0.0250	0.0234	0.0207	0.0187	0.0171	0.0159
1985	0.0202	0.0238	0.0262	0.0301	0.0327	0.0355	0.0387	0.0379	0.0392	0.0380	0.0365	0.0347	0.0324	0.0303	0.0271	0.0240	0.0228	0.0191	0.0178	0.0154
1986	0.0327	0.0318	0.0301	0.0311	0.0279	0.0250	0.0230	0.0223	0.0220	0.0218	0.0225	0.0228	0.0211	0.0216	0.0210	0.0206	0.0197	0.0181	0.0162	0.0158
1987	0.0286	0.0283	0.0296	0.0301	0.0303	0.0292	0.0302	0.0291	0.0284	0.0285	0.0270	0.0265	0.0237	0.0231	0.0213	0.0186	0.0181	0.0153	0.0141	0.0137
1988	0.0191	0.0202	0.0201	0.0203	0.0232	0.0223	0.0249	0.0249	0.0251	0.0255	0.0245	0.0261	0.0220	0.0217	0.0198	0.0178	0.0164	0.0142	0.0113	0.0100
1989	0.0224	0.0232	0.0234	0.0235	0.0253	0.0267	0.0287	0.0280	0.0276	0.0295	0.0290	0.0308	0.0266	0.0272	0.0259	0.0249	0.0238	0.0220	0.0208	0.0184
1990	0.0281	0.0307	0.0322	0.0326	0.0329	0.0349	0.0342	0.0339	0.0349	0.0332	0.0336	0.0328	0.0316	0.0299	0.0280	0.0268	0.0241	0.0230	0.0209	0.0193
1991	0.0246	0.0265	0.0283	0.0301	0.0308	0.0328	0.0328	0.0314	0.0329	0.0322	0.0321	0.0318	0.0297	0.0278	0.0266	0.0251	0.0235	0.0212	0.0202	0.0188
1992	0.0257	0.0247	0.0245	0.0262	0.0274	0.0267	0.0271	0.0228	0.0238	0.0222	0.0227	0.0221	0.0206	0.0199	0.0196	0.0188	0.0182	0.0145	0.0145	0.0156
1993	0.0220	0.0219	0.0192	0.0192	0.0172	0.0167	0.0163	0.0144	0.0152	0.0137	0.0143	0.0140	0.0126	0.0114	0.0114	0.0106	0.0110	0.0091	0.0081	0.0079
1994	0.0360	0.0349	0.0328	0.0336	0.0325	0.0287	0.0288	0.0227	0.0206	0.0187	0.0166	0.0156	0.0126	0.0118	0.0105	0.0088	0.0092	0.0074	0.0067	0.0059
1995	0.0329	0.0345	0.0329	0.0336	0.0316	0.0299	0.0292	0.0248	0.0234	0.0208	0.0188	0.0171	0.0144	0.0127	0.0113	0.0102	0.0090	0.0073	0.0071	0.0062
1996	0.0308	0.0317	0.0305	0.0296	0.0285	0.0285	0.0286	0.0251	0.0244	0.0227	0.0218	0.0206	0.0183	0.0167	0.0155	0.0139	0.0133	0.0116	0.0105	0.0094
1997	0.0387	0.0391	0.0376	0.0366	0.0350	0.0340	0.0331	0.0279	0.0261	0.0233	0.0213	0.0199	0.0171	0.0152	0.0135	0.0121	0.0110	0.0087	0.0083	0.0078
1998	0.0345	0.0366	0.0362	0.0382	0.0386	0.0363	0.0369	0.0357	0.0315	0.0317	0.0289	0.0265	0.0248	0.0202	0.0201	0.0147	0.0131	0.0106	0.0102	0.0087
1999	0.0277	0.0289	0.0290	0.0300	0.0298	0.0288	0.0306	0.0277	0.0284	0.0246	0.0240	0.0214	0.0207	0.0170	0.0163	0.0146	0.0144	0.0119	0.0108	0.0094
2000	0.0324	0.0296	0.0295	0.0290	0.0278	0.0256	0.0252	0.0212	0.0217	0.0197	0.0183	0.0171	0.0153	0.0140	0.0129	0.0116	0.0110	0.0096	0.0086	0.0077
2001	0.0395	0.0401	0.0380	0.0373	0.0345	0.0324	0.0322	0.0263	0.0234	0.0206	0.0178	0.0158	0.0130	0.0109	0.0097	0.0092	0.0081	0.0073	0.0059	0.0051
2002	0.0372	0.0372	0.0361	0.0351	0.0346	0.0317	0.0309	0.0275	0.0254	0.0212	0.0198	0.0162	0.0140	0.0121	0.0108	0.0091	0.0078	0.0067	0.0058	0.0046
2003	0.0319	0.0320	0.0313	0.0311	0.0308	0.0290	0.0308	0.0269	0.0244	0.0220	0.0216	0.0187	0.0178	0.0155	0.0134	0.0123	0.0119	0.0094	0.0084	0.0076
2004	0.0387	0.0367	0.0354	0.0331	0.0328	0.0299	0.0295	0.0249	0.0221	0.0203	0.0178	0.0165	0.0152	0.0136	0.0126	0.0111	0.0110	0.0095	0.0088	0.0074
2005	0.0350	0.0358	0.0360	0.0363	0.0362	0.0341	0.0375	0.0389	0.0293	0.0266	0.0247	0.0222	0.0199	0.0173	0.0168	0.0137	0.0141	0.0121	0.0106	0.0092
2006	0.0301	0.0297	0.0298	0.0298	0.0305	0.0285	0.0313	0.0264	0.0267	0.0254	0.0252	0.0237	0.0219	0.0201	0.0193	0.0174	0.0177	0.0154	0.0146	0.0137
2007	0.0341	0.0337	0.0314	0.0311	0.0304	0.0277	0.0312	0.0248	0.0239	0.0227	0.0207	0.0203	0.0181	0.0173	0.0166	0.0142	0.0154	0.0135	0.0128	0.0127
2008	0.0360	0.0360	0.0371	0.0358	0.0352	0.0328	0.0330	0.0287	0.0253	0.0237	0.0213	0.0185	0.0156	0.0145	0.0129	0.0113	0.0108	0.0091	0.0089	0.0084
2009	0.0318	0.0322	0.0308	0.0332	0.0321	0.0301	0.0324	0.0279	0.0261	0.0238	0.0214	0.0187	0.0167	0.0134	0.0140	0.0109	0.0092	0.0086	0.0078	0.0058
2010	0.0392	0.0364	0.0339	0.0326	0.0291	0.0260	0.0261	0.0219	0.0197	0.0179	0.0161	0.0147	0.0127	0.0100	0.0092	0.0078	0.0077	0.0062	0.0048	0.0043
2011	0.0439	0.0444	0.0402	0.0389	0.0362	0.0321	0.0308	0.0239	0.0204	0.0171	0.0157	0.0129	0.0107	0.0087	0.0079	0.0067	0.0065	0.0052	0.0042	0.0035
2012	0.0365	0.0371	0.0342	0.0339	0.0328	0.0315	0.0322	0.0249	0.0222	0.0190	0.0179	0.0146	0.0122	0.0099	0.0079	0.0069	0.0059	0.0044	0.0037	0.0029
2013	0.0452	0.0447	0.0431	0.0397	0.0370	0.0342	0.0333	0.0274	0.0255	0.0208	0.0182	0.0164	0.0131	0.0103	0.0090	0.0073	0.0059	0.0047	0.0041	0.0029
2014	0.0367	0.0373	0.0345	0.0371	0.0362	0.0376	0.0366	0.0325	0.0303	0.0282	0.0250	0.0233	0.0185	0.0140	0.0127	0.0107	0.0094	0.0074	0.0061	0.0053
2015	0.0378	0.0379	0.0366	0.0368	0.0355	0.0321	0.0334	0.0266	0.0251	0.0231	0.0201	0.0177	0.0155	0.0131	0.0117	0.0104	0.0093	0.0074	0.0069	0.0058
2016	0.0436	0.0433	0.0415	0.0416	0.0394	0.0357	0.0353	0.0287	0.0265	0.0239	0.0228	0.0184	0.0160	0.0136	0.0120	0.0106	0.0091	0.0077	0.0059	0.0048
2017	0.0386	0.0391	0.0395	0.0370	0.0368	0.0360	0.0374	0.0314	0.0279	0.0282	0.0261	0.0236	0.0212	0.0181	0.0161	0.0122	0.0118	0.0085	0.0080	0.0064
2018	0.0483	0.0515	0.0469	0.0487	0.0455	0.0421	0.0403	0.0342	0.0320	0.0306	0.0268	0.0248	0.0213	0.0184	0.0161	0.0146	0.0139	0.0113	0.0091	0.0078
2019	0.0353	0.0341	0.0412	0.0416	0.0423	0.0470	0.0452	0.0414	0.0425	0.0408	0.0378	0.0347	0.0272	0.0240	0.0207	0.0165	0.0146	0.0136	0.0109	0.0081

Table 2.6b (page 5 of 6)—Fishery size composition data (Model 19.x weighting, units = proportions).

Year	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
1977	0.0033	0.0003	0.0023	0.0010	0.0000	0.0000	0.0003	0.0000	0.0013	0.0000	0.0000	0.0010	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1978	0.0023	0.0022	0.0014	0.0013	0.0012	0.0008	0.0004	0.0002	0.0004	0.0003	0.0004	0.0004	0.0001	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000
1979	0.0013	0.0014	0.0006	0.0008	0.0005	0.0005	0.0003	0.0005	0.0005	0.0003	0.0005	0.0001	0.0001	0.0001	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000
1980	0.0026	0.0024	0.0025	0.0022	0.0023	0.0009	0.0019	0.0012	0.0012	0.0010	0.0003	0.0007	0.0005	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0001
1981	0.0005	0.0007	0.0007	0.0005	0.0004	0.0002	0.0005	0.0002	0.0002	0.0000	0.0003	0.0000	0.0000	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000
1982	0.0056	0.0032	0.0023	0.0032	0.0022	0.0023	0.0028	0.0013	0.0019	0.0009	0.0015	0.0019	0.0009	0.0009	0.0005	0.0007	0.0001	0.0004	0.0000	0.0004
1983	0.0097	0.0086	0.0077	0.0062	0.0052	0.0037	0.0036	0.0028	0.0024	0.0020	0.0011	0.0009	0.0008	0.0007	0.0006	0.0004	0.0004	0.0003	0.0003	0.0001
1984	0.0137	0.0120	0.0094	0.0089	0.0076	0.0057	0.0050	0.0036	0.0032	0.0023	0.0019	0.0014	0.0009	0.0009	0.0005	0.0004	0.0003	0.0003	0.0002	0.0002
1985	0.0137	0.0127	0.0106	0.0087	0.0079	0.0069	0.0060	0.0045	0.0039	0.0034	0.0029	0.0023	0.0016	0.0013	0.0010	0.0010	0.0006	0.0005	0.0003	0.0003
1986	0.0135	0.0123	0.0106	0.0088	0.0075	0.0061	0.0054	0.0042	0.0034	0.0031	0.0025	0.0022	0.0016	0.0013	0.0010	0.0008	0.0008	0.0006	0.0004	0.0003
1987	0.0118	0.0111	0.0100	0.0092	0.0081	0.0073	0.0069	0.0058	0.0050	0.0046	0.0035	0.0033	0.0022	0.0021	0.0016	0.0014	0.0012	0.0008	0.0008	0.0006
1988	0.0087	0.0084	0.0074	0.0059	0.0053	0.0045	0.0051	0.0038	0.0030	0.0031	0.0023	0.0029	0.0018	0.0013	0.0012	0.0011	0.0010	0.0009	0.0007	0.0005
1989	0.0175	0.0156	0.0135	0.0129	0.0115	0.0096	0.0085	0.0069	0.0054	0.0059	0.0046	0.0044	0.0028	0.0030	0.0027	0.0025	0.0019	0.0019	0.0010	0.0010
1990	0.0176	0.0166	0.0150	0.0132	0.0121	0.0119	0.0093	0.0090	0.0085	0.0080	0.0065	0.0064	0.0052	0.0047	0.0041	0.0034	0.0023	0.0021	0.0018	0.0018
1991	0.0184	0.0162	0.0144	0.0130	0.0119	0.0114	0.0096	0.0083	0.0075	0.0064	0.0057	0.0051	0.0045	0.0045	0.0035	0.0030	0.0022	0.0019	0.0017	0.0014
1992	0.0133	0.0122	0.0111	0.0105	0.0094	0.0086	0.0089	0.0065	0.0065	0.0053	0.0056	0.0052	0.0046	0.0036	0.0028	0.0030	0.0025	0.0021	0.0018	0.0014
1993	0.0072	0.0065	0.0062	0.0056	0.0044	0.0040	0.0039	0.0031	0.0028	0.0025	0.0023	0.0027	0.0021	0.0013	0.0013	0.0011	0.0009	0.0007	0.0009	0.0007
1994	0.0059	0.0053	0.0045	0.0041	0.0039	0.0036	0.0038	0.0026	0.0027	0.0022	0.0021	0.0018	0.0015	0.0015	0.0013	0.0009	0.0012	0.0007	0.0006	0.0005
1995	0.0055	0.0052	0.0043	0.0038	0.0034	0.0033	0.0034	0.0021	0.0022	0.0021	0.0017	0.0015	0.0014	0.0011	0.0011	0.0009	0.0009	0.0007	0.0006	0.0004
1996	0.0087	0.0078	0.0069	0.0063	0.0057	0.0051	0.0049	0.0037	0.0035	0.0031	0.0028	0.0025	0.0022	0.0018	0.0015	0.0014	0.0014	0.0009	0.0008	0.0007
1997	0.0069	0.0062	0.0056	0.0051	0.0046	0.0043	0.0038	0.0032	0.0028	0.0023	0.0020	0.0019	0.0016	0.0014	0.0011	0.0010	0.0009	0.0006	0.0006	0.0005
1998	0.0074	0.0063	0.0054	0.0046	0.0041	0.0043	0.0037	0.0029	0.0026	0.0023	0.0020	0.0020	0.0015	0.0021	0.0013	0.0012	0.0010	0.0007	0.0006	0.0005
1999	0.0080	0.0074	0.0059	0.0051	0.0044	0.0039	0.0039	0.0029	0.0026	0.0023	0.0018	0.0015	0.0014	0.0010	0.0009	0.0009	0.0009	0.0006	0.0006	0.0004
2000	0.0070	0.0063	0.0053	0.0050	0.0044	0.0039	0.0037	0.0028	0.0026	0.0025	0.0020	0.0017	0.0014	0.0012	0.0011	0.0010	0.0010	0.0006	0.0006	0.0004
2001	0.0051	0.0042	0.0038	0.0036	0.0026	0.0025	0.0026	0.0019	0.0016	0.0016	0.0014	0.0013	0.0011	0.0009	0.0007	0.0005	0.0006	0.0006	0.0004	0.0005
2002	0.0039	0.0032	0.0030	0.0026	0.0022	0.0017	0.0019	0.0014	0.0012	0.0010	0.0010	0.0010	0.0007	0.0007	0.0006	0.0004	0.0003	0.0003	0.0003	0.0002
2003	0.0063	0.0055	0.0045	0.0038	0.0035	0.0026	0.0025	0.0021	0.0018	0.0013	0.0010	0.0012	0.0008	0.0007	0.0005	0.0004	0.0004	0.0004	0.0003	0.0002
2004	0.0073	0.0060	0.0059	0.0049	0.0042	0.0040	0.0037	0.0030	0.0025	0.0024	0.0020	0.0019	0.0015	0.0014	0.0011	0.0009	0.0008	0.0008	0.0005	0.0005
2005	0.0085	0.0074	0.0064	0.0058	0.0054	0.0045	0.0045	0.0033	0.0031	0.0025	0.0022	0.0021	0.0017	0.0012	0.0012	0.0008	0.0008	0.0006	0.0005	0.0004
2006	0.0128	0.0104	0.0102	0.0095	0.0080	0.0074	0.0070	0.0053	0.0050	0.0045	0.0039	0.0031	0.0028	0.0023	0.0024	0.0018	0.0016	0.0010	0.0009	0.0007
2007	0.0116	0.0108	0.0094	0.0096	0.0095	0.0079	0.0077	0.0065	0.0055	0.0053	0.0045	0.0046	0.0036	0.0029	0.0026	0.0022	0.0019	0.0016	0.0010	0.0010
2008	0.0075	0.0067	0.0063	0.0060	0.0058	0.0050	0.0059	0.0049	0.0045	0.0037	0.0036	0.0031	0.0025	0.0026	0.0021	0.0018	0.0018	0.0011	0.0011	0.0009
2009	0.0059	0.0040	0.0039	0.0037	0.0035	0.0027	0.0026	0.0023	0.0021	0.0016	0.0018	0.0014	0.0014	0.0012	0.0010	0.0009	0.0008	0.0007	0.0005	0.0004
2010	0.0040	0.0032	0.0028	0.0020	0.0018	0.0014	0.0016	0.0009	0.0009	0.0007	0.0007	0.0005	0.0005	0.0004	0.0003	0.0003	0.0002	0.0003	0.0002	0.0001
2011	0.0033	0.0027	0.0020	0.0022	0.0016	0.0013	0.0013	0.0009	0.0009	0.0006	0.0006	0.0005	0.0004	0.0004	0.0004	0.0003	0.0003	0.0002	0.0002	0.0001
2012	0.0027	0.0019	0.0017	0.0011	0.0011	0.0018	0.0011	0.0006	0.0005	0.0004	0.0005	0.0003	0.0002	0.0004	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
2013	0.0025	0.0021	0.0015	0.0014	0.0010	0.0008	0.0007	0.0007	0.0005	0.0004	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0000
2014	0.0038	0.0032	0.0022	0.0021	0.0018	0.0012	0.0012	0.0008	0.0007	0.0006	0.0005	0.0004	0.0003	0.0002	0.0002	0.0003	0.0001	0.0001	0.0001	0.0001
2015	0.0050	0.0040	0.0034	0.0030	0.0023	0.0021	0.0017	0.0011	0.0008	0.0007	0.0007	0.0005	0.0003	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001
2016	0.0045	0.0035	0.0034	0.0023	0.0022	0.0016	0.0016	0.0012	0.0010	0.0008	0.0007	0.0006	0.0004	0.0004	0.0006	0.0002	0.0002	0.0004	0.0001	0.0001
2017	0.0059	0.0050	0.0036	0.0027	0.0024	0.0026	0.0018	0.0015	0.0009	0.0009	0.0007	0.0006	0.0005	0.0004	0.0003	0.0003	0.0001	0.0001	0.0002	0.0001
2018	0.0067	0.0051	0.0051	0.0040	0.0029	0.0026	0.0023	0.0017	0.0011	0.0011	0.0012	0.0008	0.0010	0.0006	0.0004	0.0003	0.0002	0.0002	0.0001	0.0002
2019	0.0071	0.0053	0.0064	0.0042	0.0032	0.0032	0.0036	0.0023	0.0019	0.0015	0.0012	0.0008	0.0010	0.0008	0.0006	0.0004	0.0005	0.0004	0.0001	0.0001

Table 2.6b (page 6 of 6)—Fishery size composition data (Model 19.x weighting, units = proportions).

Year	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120+
1977	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1978	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1979	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1980	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1981	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1982	0.0000	0.0001	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1983	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1984	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1986	0.0002	0.0002	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	0.0004	0.0004	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1988	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1989	0.0009	0.0007	0.0005	0.0003	0.0002	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
1990	0.0012	0.0009	0.0006	0.0005	0.0004	0.0003	0.0003	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0010	0.0009	0.0006	0.0005	0.0004	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0011	0.0010	0.0007	0.0006	0.0003	0.0003	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1993	0.0005	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0005	0.0004	0.0003	0.0002	0.0001	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0004	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	0.0005	0.0004	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0004	0.0004	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0005	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0003	0.0004	0.0003	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2000	0.0004	0.0003	0.0002	0.0001	0.0001	0.0002	0.0004	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
2001	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0002	0.0003	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	0.0006	0.0005	0.0004	0.0003	0.0002	0.0001	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	0.0008	0.0006	0.0003	0.0003	0.0003	0.0002	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0007	0.0006	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
2009	0.0005	0.0002	0.0003	0.0001	0.0002	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2016	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2019	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 2.7—Size composition nominal sample sizes (fishery).

Year	Lengths	Hauls
1977	2090	30
1978	11558	160
1979	17072	235
1980	14963	208
1981	10729	148
1982	13423	187
1983	56692	782
1984	138445	1913
1985	204686	2825
1986	178623	2496
1987	340561	4726
1988	105626	1458
1989	70009	966
1990	260939	3601
1991	409581	5188
1992	372300	5322
1993	243488	2993
1994	378950	4687
1995	373284	5215
1996	468271	6618
1997	507042	7278
1998	449236	6838
1999	191354	9231
2000	202003	9731
2001	213017	10364
2002	233697	11472
2003	291291	14341
2004	243998	12242
2005	231473	11568
2006	182691	8849
2007	142215	6901
2008	168938	8320
2009	149247	7482
2010	131970	6514
2011	172023	8804
2012	189648	9287
2013	212579	11126
2014	235021	12165
2015	215955	11309
2016	187899	9772
2017	160850	8486
2018	125314	6462
2019	55005	2959

Table 2.8—Trawl survey abundance (design-based).

	EBS		NBS		EBS + NBS	
Year	Estimate	Sigma	Estimate	Sigma	Estimate	Sigma
1982	583,781	0.065			583,781	0.065
1983	752,456	0.107			752,456	0.107
1984	651,058	0.072			651,058	0.072
1985	841,108	0.134			841,108	0.134
1986	838,217	0.100			838,217	0.100
1987	697,075	0.064			697,075	0.064
1988	512,095	0.069			512,095	0.069
1989	301,748	0.066			301,748	0.066
1990	438,107	0.084			438,107	0.084
1991	496,765	0.103			496,765	0.103
1992	585,436	0.117			585,436	0.117
1993	814,187	0.121			814,187	0.121
1994	1,255,544	0.121			1,255,544	0.121
1995	761,681	0.099			761,681	0.099
1996	614,493	0.143			614,493	0.143
1997	493,660	0.143			493,660	0.143
1998	522,586	0.090			522,586	0.090
1999	542,229	0.100			542,229	0.100
2000	488,605	0.090			488,605	0.090
2001	974,016	0.094			974,016	0.094
2002	544,602	0.099			544,602	0.099
2003	516,468	0.120			516,468	0.120
2004	404,687	0.085			404,687	0.085
2005	464,647	0.136			464,647	0.136
2006	407,584	0.059			407,584	0.059
2007	753,821	0.256			753,821	0.256
2008	492,643	0.101			492,643	0.101
2009	721,812	0.087			721,812	0.087
2010	896,301	0.130	6,671	0.184	902,972	0.129
2011	844,482	0.094			844,482	0.094
2012	991,342	0.092			991,342	0.092
2013	760,225	0.163			760,225	0.163
2014	1,129,255	0.127			1,129,255	0.127
2015	985,698	0.115			985,698	0.115
2016	660,996	0.093			660,996	0.093
2017	364,129	0.088	137,182	0.123	501,311	0.073
2018	248,542	0.071			492,180	0.097
2019	525,688	0.120	202,148	0.113	727,836	0.092

Table 2.9a—VAST index alternatives (covariate = cold pool, bias correction = true).

	EBS				NBS				EBS+NBS			
Year	Est.	σ	L95%	U95%	Est.	σ	L95%	U95%	Est.	σ	L95%	U95%
1982	629277	0.055	565057	700796	20920	0.336	10824	40431	650197	0.055	583526	724485
1983	768218	0.059	684673	861958	44320	0.370	21475	91469	812539	0.060	722231	914139
1984	689763	0.054	620630	766598	17838	0.490	6825	46623	707602	0.055	635712	787621
1985	885941	0.052	800694	980265	23649	0.494	8972	62335	909591	0.052	820799	1007988
1986	852873	0.053	768456	946564	13787	0.494	5238	36292	866661	0.053	780744	962031
1987	718654	0.052	649131	795624	32866	0.518	11915	90661	751521	0.054	675438	836174
1988	520983	0.052	470083	577395	5886	0.492	2244	15442	526869	0.052	475422	583884
1989	315396	0.053	284319	349869	9715	0.529	3448	27372	325110	0.054	292502	361353
1990	454178	0.055	408127	505426	14554	0.511	5349	39603	468733	0.056	420388	522637
1991	507255	0.061	449842	571994	23851	0.464	9600	59256	531106	0.062	469975	600188
1992	573945	0.067	503759	653909	12968	0.515	4723	35608	586913	0.067	514928	668961
1993	796600	0.064	702602	903173	47914	0.455	19644	116871	844514	0.065	743015	959878
1994	1213283	0.057	1085907	1355600	23881	0.534	8379	68065	1237164	0.057	1107091	1382519
1995	760347	0.056	681955	847749	13743	0.553	4649	40625	774090	0.056	694118	863276
1996	630970	0.060	561168	709455	57785	0.549	19688	169601	688756	0.068	602894	786846
1997	494958	0.055	444745	550841	34300	0.480	13385	87893	529258	0.059	471576	593995
1998	538333	0.062	476886	607697	58687	0.489	22509	153016	597020	0.071	519918	685556
1999	539870	0.063	476940	611104	6563	0.566	2165	19895	546433	0.063	482876	618355
2000	483267	0.053	435531	536235	19424	0.471	7723	48854	502691	0.054	451826	559282
2001	983394	0.056	880600	1098187	30513	0.492	11625	80090	1013907	0.057	907324	1133010
2002	573232	0.061	508476	646234	39060	0.459	15874	96113	612292	0.064	540404	693743
2003	537707	0.066	472429	612005	56580	0.495	21457	149198	594287	0.073	514749	686115
2004	410458	0.056	367746	458132	26038	0.449	10791	62830	436497	0.059	389046	489735
2005	449774	0.055	404067	500651	33326	0.357	16561	67065	483100	0.056	432483	539641
2006	420395	0.054	378385	467069	7224	0.426	3132	16666	427619	0.054	384930	475042
2007	657651	0.066	578233	747977	14582	0.421	6384	33308	672233	0.065	591479	764012
2008	492652	0.060	438059	554049	7249	0.431	3116	16862	499900	0.060	444612	562064
2009	733335	0.053	660606	814072	13448	0.384	6337	28539	746783	0.053	672895	828785
2010	825808	0.058	736508	925935	4895	0.295	2746	8726	830703	0.058	741201	931011
2011	856192	0.057	765925	957098	24642	0.412	10982	55293	880834	0.057	787907	984722
2012	1039589	0.069	908979	1188966	9512	0.454	3911	23138	1049101	0.068	917811	1199172
2013	707204	0.061	627232	797372	22110	0.425	9613	50853	729314	0.061	646749	822420
2014	1134920	0.068	994039	1295767	103002	0.422	45070	235400	1237922	0.071	1077582	1422120
2015	973341	0.062	861814	1099300	98981	0.439	41849	234114	1072322	0.068	938049	1225816
2016	688581	0.058	614524	771562	204914	0.424	89292	470251	893494	0.098	737908	1081886
2017	379541	0.055	340797	422691	139791	0.098	115456	169255	519332	0.048	472454	570861
2018	284098	0.064	250779	321844	254397	0.139	193830	333890	538496	0.073	466983	620960
2019	553266	0.076	477004	641721	220212	0.096	182317	265983	773478	0.061	686109	871973

Table 2.9b—VAST index alternatives (covariate = cold pool, bias correction = false).

	EBS				NBS				EBS+NBS			
Year	Est.	σ	L95%	U95%	Est.	σ	L95%	U95%	Est.	σ	L95%	U95%
1982	575607	0.055	516864	641026	16658	0.336	8619	32195	592265	0.055	531534	659934
1983	700520	0.059	624337	785999	34475	0.370	16704	71150	734995	0.060	653305	826899
1984	631705	0.054	568390	702072	13124	0.490	5021	34301	644829	0.055	579316	717750
1985	813556	0.052	735273	900172	17197	0.494	6524	45327	830752	0.052	749656	920621
1986	783943	0.053	706348	870061	9972	0.494	3788	26249	793914	0.053	715210	881280
1987	658405	0.052	594711	728922	23715	0.518	8597	65417	682121	0.054	613064	758956
1988	480542	0.052	433593	532575	4332	0.492	1651	11366	484874	0.052	437527	537345
1989	290470	0.053	261850	322219	7005	0.529	2486	19737	297475	0.054	267639	330637
1990	418959	0.055	376479	466232	10559	0.511	3880	28731	429518	0.056	385217	478912
1991	467199	0.061	414320	526827	17645	0.464	7102	43836	484843	0.062	429037	547908
1992	525079	0.067	460868	598235	9195	0.515	3349	25246	534273	0.067	468745	608963
1993	733865	0.064	647270	832045	35354	0.455	14494	86235	769219	0.065	676770	874297
1994	1120257	0.057	1002647	1251661	16736	0.534	5872	47702	1136993	0.057	1017452	1270579
1995	699202	0.056	627114	779576	9526	0.553	3223	28159	708728	0.056	635509	790383
1996	581428	0.060	517107	653751	40515	0.549	13804	118911	621943	0.068	544410	710518
1997	454588	0.055	408470	505913	24777	0.480	9669	63490	479365	0.059	427121	538000
1998	494383	0.062	437952	558085	42341	0.489	16239	110396	536724	0.071	467409	616318
1999	496965	0.063	439036	562538	4386	0.566	1447	13296	501351	0.063	443038	567340
2000	447034	0.053	402877	496031	14129	0.471	5618	35536	461163	0.054	414500	513079
2001	909224	0.056	814183	1015359	22061	0.492	8405	57907	931286	0.057	833388	1040683
2002	528648	0.061	468928	595972	28468	0.459	11569	70051	557116	0.064	491706	631227
2003	492657	0.066	432848	560731	40213	0.495	15250	106038	532870	0.073	461552	615208
2004	378975	0.056	339539	422992	19074	0.449	7905	46026	398050	0.059	354778	446598
2005	415151	0.055	372962	462112	25602	0.357	12722	51520	440753	0.056	394573	492337
2006	390057	0.054	351079	433362	5340	0.426	2315	12318	395396	0.054	355924	439246
2007	606524	0.066	533279	689828	10795	0.421	4726	24659	617319	0.065	543162	701600
2008	456288	0.060	405725	513153	5310	0.431	2282	12352	461598	0.060	410545	518998
2009	676493	0.053	609401	750971	10197	0.384	4805	21640	686690	0.053	618748	762093
2010	767365	0.058	684385	860406	3944	0.295	2213	7031	771309	0.058	688207	864446
2011	791045	0.057	707646	884272	18847	0.412	8399	42291	809892	0.057	724449	905413
2012	948000	0.069	828897	1084217	6741	0.454	2771	16397	954741	0.068	835260	1091313
2013	648512	0.061	575178	731198	16306	0.425	7090	37504	664818	0.061	589555	749690
2014	1036673	0.068	907988	1183596	75720	0.422	33132	173049	1112393	0.071	968312	1277913
2015	895876	0.062	793226	1011811	72397	0.439	30609	171235	968273	0.068	847029	1106873
2016	631351	0.058	563449	707435	151365	0.424	65958	347363	782716	0.098	646419	947750
2017	347494	0.055	312021	386999	125515	0.098	103666	151970	473009	0.048	430312	519941
2018	258827	0.064	228472	293215	214565	0.139	163481	281612	473392	0.073	410526	545887
2019	501794	0.076	432626	582019	197095	0.096	163178	238061	698889	0.061	619945	787885

Table 2.9c—VAST index alternatives (covariate = none, bias correction = true).

	EBS				NBS				EBS+NBS			
Year	Est.	σ	L95%	U95%	Est.	σ	L95%	U95%	Est.	σ	L95%	U95%
1982	634948	0.056	569443	707989	23304	0.357	11567	46952	658253	0.056	589801	734649
1983	777887	0.060	691494	875074	41619	0.393	19276	89857	819506	0.061	726963	923830
1984	694380	0.054	624181	772474	19883	0.543	6861	57619	714263	0.056	640618	796375
1985	887202	0.052	801439	982142	28124	0.552	9541	82900	915326	0.053	824612	1016020
1986	851553	0.053	766896	945555	20966	0.554	7076	62120	872519	0.054	784857	969972
1987	717952	0.052	648728	794563	20482	0.510	7540	55644	738434	0.053	666162	818547
1988	522399	0.053	471052	579342	6526	0.527	2321	18348	528925	0.053	476939	586577
1989	318264	0.053	286651	353362	6030	0.532	2127	17099	324294	0.054	291944	360229
1990	456772	0.055	410065	508799	14826	0.552	5026	43738	471599	0.056	422442	526476
1991	511935	0.062	453481	577922	25302	0.500	9502	67374	537236	0.063	474498	608270
1992	585609	0.070	510729	671468	20057	0.566	6616	60802	605666	0.071	527325	695645
1993	800098	0.065	704869	908193	42765	0.477	16792	108911	842864	0.066	741197	958476
1994	1214787	0.057	1086135	1358677	40180	0.597	12476	129398	1254966	0.058	1119831	1406409
1995	759884	0.056	681399	847409	26359	0.608	8002	86823	786243	0.057	703140	879167
1996	627231	0.059	558810	704030	40238	0.557	13500	119934	667470	0.063	590011	755098
1997	497269	0.055	446272	554093	38822	0.525	13883	108560	536091	0.061	475318	604634
1998	529489	0.059	471881	594129	43264	0.502	16172	115744	572753	0.064	504981	649620
1999	521616	0.061	462906	587773	20455	0.599	6319	66218	542072	0.062	479648	612619
2000	485494	0.053	437206	539116	23670	0.532	8340	67178	509164	0.056	456179	568304
2001	992387	0.057	887239	1109997	32604	0.543	11252	94477	1024991	0.058	915336	1147783
2002	573851	0.061	509475	646360	31259	0.459	12706	76901	605109	0.062	535799	683385
2003	529994	0.063	468573	599466	35462	0.459	14426	87175	565457	0.065	497619	642542
2004	410878	0.056	368208	458493	20715	0.446	8637	49686	431593	0.057	385709	482935
2005	449349	0.054	404102	499663	27078	0.342	13862	52891	476427	0.055	427818	530558
2006	420263	0.054	378099	467129	8700	0.472	3450	21934	428963	0.054	385881	476854
2007	662775	0.067	581008	756049	22651	0.475	8936	57413	685425	0.067	600979	781738
2008	493190	0.061	437669	555754	12517	0.476	4923	31825	505707	0.061	448644	570028
2009	727717	0.053	655702	807642	20652	0.410	9247	46123	748369	0.053	674033	830902
2010	832482	0.059	741881	934149	5012	0.301	2779	9042	837495	0.059	746696	939335
2011	865608	0.058	772241	970262	17908	0.439	7569	42367	883515	0.058	788428	990071
2012	1028498	0.069	898513	1177287	19718	0.486	7613	51067	1048215	0.069	916385	1199011
2013	708041	0.062	626986	799574	29536	0.473	11695	74593	737577	0.063	652221	834104
2014	1147562	0.069	1002576	1313515	82113	0.444	34424	195867	1229676	0.070	1071044	1411802
2015	983422	0.063	869474	1112303	79148	0.465	31804	196969	1062570	0.067	932024	1211401
2016	683877	0.057	611633	764655	143736	0.446	59925	344766	827613	0.083	703106	974167
2017	379303	0.056	340156	422954	144023	0.099	118668	174796	523326	0.049	475513	575946
2018	278400	0.059	247861	312702	240266	0.136	183944	313834	518667	0.070	452331	594731
2019	556261	0.077	478703	646385	217015	0.096	179889	261804	773277	0.062	685195	872682

Table 2.9d—VAST index alternatives (covariate = none, bias correction = false).

	EBS				NBS				EBS+NBS			
Year	Est.	σ	L95%	U95%	Est.	σ	L95%	U95%	Est.	σ	L95%	U95%
1982	578694	0.056	518993	645263	18366	0.357	9116	37002	597060	0.056	534972	666354
1983	706822	0.060	628322	795130	31836	0.393	14746	68736	738659	0.061	655246	832691
1984	633828	0.054	569750	705112	14171	0.543	4890	41065	647999	0.056	581185	722493
1985	812602	0.052	734051	899559	19763	0.552	6705	58252	832365	0.053	749873	923932
1986	781366	0.053	703687	867620	14756	0.554	4980	43720	796122	0.054	716136	885042
1987	657122	0.052	593763	727242	14685	0.510	5406	39894	671807	0.053	606056	744692
1988	480749	0.053	433496	533153	4688	0.527	1667	13180	485437	0.053	437726	538349
1989	292625	0.053	263559	324896	4290	0.532	1513	12165	296915	0.054	267296	329816
1990	420250	0.055	377278	468117	10405	0.552	3527	30696	430655	0.056	385766	480768
1991	470180	0.062	416494	530786	18206	0.500	6837	48480	488386	0.063	431353	552961
1992	533858	0.070	465595	612129	13847	0.566	4568	41977	547705	0.071	476861	629074
1993	735788	0.065	648213	835195	30981	0.477	12165	78899	766769	0.066	674280	871944
1994	1120402	0.057	1001746	1253113	27457	0.597	8526	88424	1147859	0.058	1024258	1286377
1995	698068	0.056	625968	778473	17904	0.608	5436	58974	715973	0.057	640297	800592
1996	577621	0.059	514612	648345	27842	0.557	9341	82987	605463	0.063	535200	684951
1997	455510	0.055	408796	507562	27025	0.525	9665	75573	482535	0.061	427834	544231
1998	486402	0.059	433482	545782	30756	0.502	11496	82280	517158	0.064	455964	586563
1999	482265	0.061	427984	543430	14135	0.599	4366	45758	496400	0.062	439236	561004
2000	448235	0.053	403653	497741	16559	0.532	5835	46996	464794	0.056	416426	518780
2001	915390	0.057	818400	1023875	22703	0.543	7835	65787	938093	0.058	837735	1050475
2002	528427	0.061	469148	595197	22550	0.459	9166	55476	550977	0.062	487867	622250
2003	485686	0.063	429400	549350	25642	0.459	10431	63035	511329	0.065	449985	581035
2004	378814	0.056	339474	422714	15052	0.446	6276	36103	393867	0.057	351994	440721
2005	414298	0.054	372580	460687	20911	0.342	10705	40846	435209	0.055	390806	484657
2006	389356	0.054	350293	432775	6272	0.472	2488	15815	395629	0.054	355895	439798
2007	610130	0.067	534858	695995	16537	0.475	6524	41917	626667	0.067	549460	714724
2008	456558	0.061	405161	514474	9200	0.476	3619	23392	465758	0.061	413202	524998
2009	671113	0.053	604700	744821	15746	0.410	7050	35166	686859	0.053	618633	762609
2010	772285	0.059	688234	866599	4086	0.301	2265	7372	776371	0.059	692199	870778
2011	798511	0.058	712382	895054	13470	0.439	5693	31868	811981	0.058	724592	909909
2012	939610	0.069	820859	1075540	14276	0.486	5512	36974	953886	0.069	833919	1091111
2013	648148	0.062	573950	731938	21226	0.473	8405	53606	669374	0.063	591911	756975
2014	1045784	0.069	913657	1197018	59069	0.444	24763	140898	1104852	0.070	962323	1268491
2015	902975	0.063	798349	1021314	56501	0.465	22704	140608	959476	0.067	841596	1093868
2016	626277	0.057	560117	700251	104771	0.446	43680	251304	731048	0.083	621068	860502
2017	346504	0.056	310743	386381	129047	0.099	106328	156620	475551	0.049	432103	523368
2018	254255	0.059	226364	285582	204927	0.136	156889	267674	459182	0.070	400454	526522
2019	504445	0.077	434111	586173	194839	0.096	161507	235051	699284	0.062	619630	789177

Table 2.10 (page 1 of 6)—Size composition data (survey, units = proportions).

Year	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1982	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0007	0.0009	0.0018	0.0025	0.0049	0.0056	0.0103	0.0063	0.0048	0.0049	0.0044	0.0018	0.0008	0.0008
1983	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0073	0.0221	0.0346	0.0348	0.0368	0.0351	0.0330	0.0300	0.0192	0.0190	0.0091	0.0056	0.0034	0.0022
1984	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0020	0.0030	0.0045	0.0036	0.0022	0.0021	0.0021	0.0025	0.0038	0.0026	0.0053	0.0059	0.0074	0.0103
1985	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0033	0.0060	0.0106	0.0086	0.0128	0.0170	0.0180	0.0220	0.0298	0.0300	0.0312	0.0383	0.0331	0.0329
1986	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0025	0.0061	0.0087	0.0085	0.0131	0.0114	0.0115	0.0097	0.0060	0.0022	0.0017	0.0013	0.0014	0.0047
1987	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0003	0.0007	0.0022	0.0035	0.0056	0.0074	0.0099	0.0111	0.0110	0.0141	0.0113	0.0074	0.0056
1988	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0008	0.0007	0.0028	0.0013	0.0029	0.0026	0.0023	0.0042	0.0028	0.0019	0.0027	0.0034	0.0047
1989	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0003	0.0018	0.0046	0.0036	0.0067	0.0083	0.0105	0.0102	0.0098	0.0064	0.0038	0.0019	0.0021	0.0029
1990	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044	0.0123	0.0179	0.0264	0.0258	0.0318	0.0405	0.0446	0.0355	0.0258	0.0203	0.0155	0.0098	0.0061	0.0072
1991	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0042	0.0128	0.0153	0.0191	0.0186	0.0223	0.0181	0.0186	0.0176	0.0147	0.0184	0.0118	0.0099	0.0099
1992	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0017	0.0083	0.0189	0.0196	0.0180	0.0155	0.0204	0.0229	0.0242	0.0256	0.0222	0.0234	0.0117
1993	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0028	0.0077	0.0182	0.0406	0.0281	0.0386	0.0339	0.0307	0.0305	0.0331	0.0298	0.0307	0.0206	0.0129
1994	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0007	0.0004	0.0019	0.0029	0.0054	0.0064	0.0070	0.0071	0.0083	0.0097	0.0079	0.0074	0.0068	0.0100
1995	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0013	0.0016	0.0014	0.0021	0.0045	0.0040	0.0045	0.0060	0.0064	0.0087	0.0074	0.0037	0.0026	0.0020
1996	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0012	0.0010	0.0024	0.0035	0.0051	0.0068	0.0057	0.0071	0.0073	0.0068	0.0057	0.0038	0.0022
1997	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0019	0.0070	0.0123	0.0179	0.0207	0.0206	0.0213	0.0228	0.0307	0.0243	0.0234	0.0242	0.0191	0.0113
1998	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0004	0.0024	0.0055	0.0086	0.0120	0.0107	0.0140	0.0094	0.0047	0.0023	0.0007	0.0004	0.0020	0.0025
1999	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0012	0.0041	0.0077	0.0084	0.0094	0.0072	0.0087	0.0060	0.0032	0.0023	0.0034	0.0040	0.0034	0.0050
2000	0.0000	0.0000	0.0000	0.0003	0.0008	0.0018	0.0040	0.0078	0.0108	0.0235	0.0378	0.0459	0.0349	0.0219	0.0216	0.0113	0.0069	0.0026	0.0007	0.0010
2001	0.0000	0.0000	0.0000	0.0000	0.0002	0.0003	0.0013	0.0031	0.0064	0.0102	0.0156	0.0225	0.0330	0.0355	0.0383	0.0340	0.0332	0.0221	0.0177	0.0111
2002	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0005	0.0018	0.0035	0.0051	0.0064	0.0084	0.0128	0.0090	0.0133	0.0089	0.0057	0.0041	0.0028	0.0014
2003	0.0000	0.0000	0.0001	0.0000	0.0001	0.0002	0.0004	0.0009	0.0044	0.0073	0.0108	0.0160	0.0182	0.0162	0.0196	0.0199	0.0222	0.0198	0.0188	0.0156
2004	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0003	0.0018	0.0042	0.0078	0.0139	0.0097	0.0178	0.0172	0.0196	0.0192	0.0123	0.0131	0.0101	0.0061
2005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0003	0.0019	0.0038	0.0075	0.0119	0.0173	0.0213	0.0261	0.0245	0.0260	0.0249	0.0313	0.0312
2006	0.0000	0.0001	0.0000	0.0003	0.0006	0.0032	0.0080	0.0268	0.0323	0.0341	0.0363	0.0321	0.0275	0.0263	0.0287	0.0225	0.0195	0.0117	0.0085	0.0052
2007	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006	0.0098	0.0365	0.0883	0.1086	0.1067	0.0872	0.0562	0.0551	0.0406	0.0265	0.0318	0.0182	0.0095	0.0095
2008	0.0000	0.0000	0.0001	0.0000	0.0000	0.0004	0.0040	0.0126	0.0261	0.0283	0.0291	0.0262	0.0232	0.0169	0.0112	0.0056	0.0030	0.0016	0.0030	0.0056
2009	0.0000	0.0000	0.0000	0.0004	0.0021	0.0063	0.0239	0.0578	0.0630	0.0648	0.0523	0.0444	0.0388	0.0290	0.0277	0.0193	0.0132	0.0069	0.0021	0.0017
2010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0006	0.0023	0.0031	0.0038	0.0066	0.0065	0.0074	0.0061	0.0040	0.0020	0.0022	0.0012	0.0018	0.0041
2011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0009	0.0036	0.0068	0.0123	0.0147	0.0185	0.0198	0.0285	0.0301	0.0434	0.0425	0.0410	0.0257	0.0138
2012	0.0000	0.0000	0.0004	0.0000	0.0000	0.0056	0.0289	0.0523	0.0558	0.0429	0.0323	0.0318	0.0237	0.0312	0.0302	0.0159	0.0098	0.0036	0.0024	0.0008
2013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0026	0.0061	0.0077	0.0109	0.0117	0.0150	0.0129	0.0095	0.0067	0.0019	0.0011	0.0034	0.0045	0.0141
2014	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0005	0.0050	0.0065	0.0132	0.0189	0.0258	0.0288	0.0364	0.0276	0.0337	0.0272	0.0289	0.0171	0.0121
2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0022	0.0022	0.0044	0.0040	0.0027	0.0024	0.0029	0.0030	0.0031	0.0038	0.0044	0.0036	0.0040
2016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0009	0.0015	0.0031	0.0034	0.0023	0.0013	0.0029	0.0037	0.0056	0.0086	0.0129	0.0156	0.0147
2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002	0.0011	0.0030	0.0039	0.0039	0.0052	0.0048	0.0059	0.0072	0.0082	0.0106	0.0113	0.0133
2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0005	0.0006	0.0021	0.0022	0.0042	0.0038	0.0060	0.0051	0.0062	0.0107	0.0115
2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0026	0.0056	0.0100	0.0245	0.0337	0.0490	0.0408	0.0466	0.0546	0.0627	0.0624	0.0595

Table 2.10 (page 2 of 6)—Size composition data (survey, units = proportions).

Year	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1982	0.0002	0.0008	0.0017	0.0024	0.0038	0.0064	0.0082	0.0117	0.0183	0.0209	0.0227	0.0289	0.0300	0.0225	0.0186	0.0137	0.0138	0.0119	0.0130	0.0171
1983	0.0007	0.0004	0.0014	0.0026	0.0035	0.0042	0.0076	0.0095	0.0111	0.0132	0.0126	0.0162	0.0111	0.0097	0.0082	0.0046	0.0047	0.0066	0.0072	0.0108
1984	0.0190	0.0257	0.0312	0.0379	0.0473	0.0494	0.0533	0.0469	0.0393	0.0324	0.0284	0.0243	0.0181	0.0127	0.0088	0.0084	0.0072	0.0048	0.0077	0.0062
1985	0.0190	0.0126	0.0077	0.0054	0.0059	0.0063	0.0094	0.0130	0.0128	0.0161	0.0178	0.0183	0.0185	0.0170	0.0203	0.0208	0.0230	0.0245	0.0305	0.0296
1986	0.0074	0.0142	0.0234	0.0292	0.0453	0.0409	0.0401	0.0415	0.0425	0.0377	0.0362	0.0291	0.0261	0.0227	0.0216	0.0143	0.0126	0.0090	0.0082	0.0089
1987	0.0043	0.0059	0.0071	0.0111	0.0114	0.0184	0.0254	0.0280	0.0301	0.0270	0.0263	0.0193	0.0217	0.0187	0.0164	0.0183	0.0217	0.0209	0.0279	0.0316
1988	0.0070	0.0078	0.0088	0.0086	0.0110	0.0083	0.0126	0.0121	0.0136	0.0178	0.0189	0.0267	0.0214	0.0194	0.0209	0.0140	0.0182	0.0166	0.0240	0.0222
1989	0.0003	0.0015	0.0015	0.0034	0.0013	0.0033	0.0029	0.0027	0.0032	0.0036	0.0070	0.0032	0.0105	0.0110	0.0145	0.0114	0.0125	0.0098	0.0115	0.0113
1990	0.0076	0.0060	0.0086	0.0135	0.0136	0.0171	0.0182	0.0172	0.0161	0.0205	0.0214	0.0138	0.0197	0.0165	0.0116	0.0099	0.0116	0.0089	0.0080	0.0070
1991	0.0110	0.0138	0.0140	0.0236	0.0270	0.0374	0.0399	0.0446	0.0397	0.0510	0.0422	0.0343	0.0357	0.0268	0.0237	0.0195	0.0163	0.0117	0.0095	0.0087
1992	0.0123	0.0140	0.0192	0.0277	0.0299	0.0315	0.0364	0.0385	0.0363	0.0323	0.0314	0.0254	0.0230	0.0187	0.0157	0.0132	0.0192	0.0151	0.0223	0.0195
1993	0.0094	0.0059	0.0054	0.0064	0.0084	0.0090	0.0166	0.0198	0.0225	0.0278	0.0303	0.0230	0.0235	0.0217	0.0188	0.0146	0.0154	0.0178	0.0176	0.0212
1994	0.0092	0.0136	0.0122	0.0160	0.0237	0.0315	0.0403	0.0462	0.0523	0.0545	0.0479	0.0455	0.0334	0.0257	0.0206	0.0140	0.0084	0.0094	0.0083	0.0157
1995	0.0040	0.0051	0.0096	0.0118	0.0171	0.0211	0.0248	0.0236	0.0266	0.0245	0.0216	0.0169	0.0235	0.0269	0.0260	0.0345	0.0409	0.0405	0.0451	0.0457
1996	0.0024	0.0025	0.0062	0.0068	0.0138	0.0173	0.0206	0.0243	0.0291	0.0251	0.0265	0.0203	0.0212	0.0178	0.0167	0.0177	0.0164	0.0188	0.0227	0.0253
1997	0.0062	0.0044	0.0044	0.0038	0.0076	0.0118	0.0111	0.0165	0.0241	0.0248	0.0238	0.0189	0.0170	0.0167	0.0148	0.0157	0.0147	0.0137	0.0137	0.0149
1998	0.0061	0.0075	0.0193	0.0288	0.0398	0.0511	0.0622	0.0647	0.0635	0.0529	0.0554	0.0358	0.0269	0.0235	0.0171	0.0151	0.0139	0.0105	0.0131	0.0123
1999	0.0092	0.0096	0.0165	0.0181	0.0177	0.0246	0.0217	0.0231	0.0242	0.0191	0.0185	0.0178	0.0187	0.0242	0.0315	0.0292	0.0373	0.0422	0.0474	0.0513
2000	0.0019	0.0031	0.0062	0.0094	0.0135	0.0156	0.0176	0.0206	0.0242	0.0178	0.0157	0.0148	0.0152	0.0139	0.0159	0.0178	0.0204	0.0211	0.0241	0.0246
2001	0.0071	0.0059	0.0083	0.0116	0.0161	0.0188	0.0258	0.0331	0.0419	0.0416	0.0462	0.0405	0.0351	0.0258	0.0209	0.0152	0.0111	0.0096	0.0089	0.0077
2002	0.0035	0.0053	0.0087	0.0131	0.0197	0.0219	0.0351	0.0384	0.0448	0.0446	0.0421	0.0309	0.0322	0.0252	0.0238	0.0202	0.0236	0.0211	0.0335	0.0294
2003	0.0171	0.0121	0.0094	0.0054	0.0046	0.0047	0.0063	0.0046	0.0093	0.0113	0.0247	0.0169	0.0251	0.0191	0.0216	0.0231	0.0254	0.0287	0.0278	0.0312
2004	0.0052	0.0068	0.0085	0.0099	0.0172	0.0182	0.0202	0.0219	0.0253	0.0275	0.0290	0.0283	0.0308	0.0286	0.0298	0.0232	0.0225	0.0195	0.0191	0.0172
2005	0.0336	0.0325	0.0249	0.0181	0.0121	0.0121	0.0126	0.0102	0.0139	0.0156	0.0173	0.0170	0.0180	0.0200	0.0250	0.0220	0.0183	0.0177	0.0184	0.0185
2006	0.0044	0.0048	0.0045	0.0051	0.0072	0.0094	0.0138	0.0156	0.0199	0.0202	0.0214	0.0207	0.0252	0.0217	0.0244	0.0214	0.0200	0.0175	0.0165	0.0136
2007	0.0033	0.0037	0.0053	0.0071	0.0097	0.0094	0.0121	0.0095	0.0107	0.0113	0.0095	0.0088	0.0072	0.0072	0.0058	0.0048	0.0058	0.0061	0.0063	0.0053
2008	0.0125	0.0233	0.0363	0.0416	0.0539	0.0570	0.0555	0.0522	0.0429	0.0360	0.0263	0.0218	0.0151	0.0129	0.0118	0.0106	0.0101	0.0092	0.0112	0.0101
2009	0.0021	0.0049	0.0056	0.0104	0.0152	0.0202	0.0237	0.0280	0.0261	0.0203	0.0183	0.0132	0.0128	0.0128	0.0135	0.0180	0.0183	0.0217	0.0227	0.0227
2010	0.0079	0.0166	0.0255	0.0317	0.0467	0.0565	0.0554	0.0518	0.0520	0.0427	0.0358	0.0245	0.0222	0.0142	0.0127	0.0088	0.0099	0.0103	0.0163	0.0174
2011	0.0053	0.0019	0.0018	0.0027	0.0023	0.0028	0.0036	0.0058	0.0066	0.0091	0.0079	0.0112	0.0109	0.0131	0.0138	0.0194	0.0219	0.0324	0.0383	0.0413
2012	0.0022	0.0029	0.0045	0.0065	0.0136	0.0197	0.0205	0.0273	0.0270	0.0297	0.0216	0.0236	0.0145	0.0120	0.0076	0.0062	0.0048	0.0035	0.0049	0.0045
2013	0.0211	0.0345	0.0415	0.0519	0.0569	0.0444	0.0481	0.0344	0.0348	0.0220	0.0164	0.0127	0.0095	0.0092	0.0077	0.0066	0.0098	0.0081	0.0124	0.0158
2014	0.0062	0.0057	0.0051	0.0040	0.0053	0.0123	0.0137	0.0233	0.0184	0.0268	0.0256	0.0277	0.0194	0.0173	0.0102	0.0106	0.0081	0.0113	0.0158	0.0247
2015	0.0039	0.0040	0.0042	0.0063	0.0093	0.0145	0.0199	0.0271	0.0373	0.0468	0.0545	0.0575	0.0509	0.0485	0.0395	0.0298	0.0257	0.0148	0.0138	0.0104
2016	0.0129	0.0087	0.0062	0.0033	0.0021	0.0023	0.0039	0.0050	0.0060	0.0076	0.0103	0.0094	0.0131	0.0143	0.0170	0.0164	0.0191	0.0223	0.0268	0.0339
2017	0.0149	0.0153	0.0140	0.0115	0.0082	0.0083	0.0077	0.0101	0.0077	0.0095	0.0097	0.0106	0.0109	0.0134	0.0124	0.0131	0.0141	0.0156	0.0139	0.0163
2018	0.0146	0.0114	0.0093	0.0047	0.0047	0.0050	0.0046	0.0050	0.0086	0.0103	0.0123	0.0168	0.0188	0.0209	0.0202	0.0259	0.0245	0.0246	0.0253	0.0263
2019	0.0630	0.0578	0.0470	0.0375	0.0239	0.0073	0.0039	0.0015	0.0010	0.0010	0.0010	0.0010	0.0018	0.0020	0.0031	0.0036	0.0051	0.0055	0.0057	0.0081

Table 2.10 (page 3 of 6)—Size composition data (survey, units = proportions).

Year	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
1982	0.0192	0.0267	0.0287	0.0258	0.0311	0.0311	0.0266	0.0270	0.0256	0.0241	0.0226	0.0264	0.0245	0.0253	0.0213	0.0247	0.0250	0.0248	0.0213	0.0215
1983	0.0119	0.0161	0.0205	0.0229	0.0219	0.0227	0.0240	0.0193	0.0189	0.0187	0.0171	0.0227	0.0210	0.0196	0.0199	0.0187	0.0199	0.0187	0.0153	0.0170
1984	0.0075	0.0077	0.0079	0.0089	0.0110	0.0087	0.0090	0.0078	0.0090	0.0117	0.0106	0.0129	0.0137	0.0162	0.0163	0.0127	0.0177	0.0139	0.0164	0.0167
1985	0.0304	0.0286	0.0278	0.0213	0.0191	0.0144	0.0114	0.0099	0.0076	0.0057	0.0055	0.0061	0.0060	0.0062	0.0050	0.0051	0.0054	0.0050	0.0088	0.0065
1986	0.0106	0.0120	0.0140	0.0133	0.0160	0.0141	0.0161	0.0175	0.0168	0.0179	0.0187	0.0195	0.0147	0.0164	0.0163	0.0114	0.0111	0.0078	0.0095	0.0072
1987	0.0316	0.0314	0.0308	0.0302	0.0246	0.0247	0.0250	0.0149	0.0152	0.0126	0.0111	0.0140	0.0130	0.0091	0.0119	0.0085	0.0131	0.0127	0.0117	0.0120
1988	0.0196	0.0317	0.0275	0.0294	0.0275	0.0245	0.0307	0.0265	0.0228	0.0252	0.0253	0.0258	0.0223	0.0213	0.0228	0.0192	0.0198	0.0167	0.0206	0.0165
1989	0.0135	0.0179	0.0163	0.0174	0.0186	0.0170	0.0199	0.0251	0.0228	0.0256	0.0243	0.0232	0.0329	0.0290	0.0215	0.0234	0.0211	0.0292	0.0187	0.0221
1990	0.0066	0.0058	0.0064	0.0090	0.0069	0.0072	0.0053	0.0092	0.0060	0.0110	0.0100	0.0126	0.0107	0.0129	0.0130	0.0139	0.0149	0.0157	0.0160	0.0144
1991	0.0083	0.0071	0.0085	0.0072	0.0086	0.0103	0.0067	0.0084	0.0058	0.0101	0.0122	0.0080	0.0104	0.0057	0.0050	0.0058	0.0058	0.0048	0.0071	0.0067
1992	0.0228	0.0253	0.0193	0.0191	0.0167	0.0147	0.0158	0.0123	0.0110	0.0091	0.0081	0.0059	0.0065	0.0032	0.0044	0.0052	0.0053	0.0069	0.0046	0.0036
1993	0.0213	0.0224	0.0260	0.0198	0.0178	0.0185	0.0152	0.0145	0.0124	0.0110	0.0114	0.0104	0.0084	0.0061	0.0064	0.0076	0.0063	0.0054	0.0056	0.0051
1994	0.0134	0.0118	0.0165	0.0181	0.0188	0.0213	0.0123	0.0134	0.0163	0.0135	0.0128	0.0125	0.0155	0.0179	0.0178	0.0116	0.0155	0.0110	0.0144	0.0116
1995	0.0427	0.0370	0.0363	0.0319	0.0215	0.0205	0.0166	0.0154	0.0125	0.0107	0.0118	0.0103	0.0095	0.0100	0.0093	0.0079	0.0101	0.0107	0.0114	0.0109
1996	0.0306	0.0276	0.0311	0.0342	0.0321	0.0316	0.0345	0.0289	0.0301	0.0301	0.0263	0.0274	0.0220	0.0180	0.0166	0.0144	0.0153	0.0109	0.0101	0.0093
1997	0.0147	0.0183	0.0211	0.0249	0.0163	0.0185	0.0146	0.0165	0.0195	0.0202	0.0178	0.0183	0.0134	0.0232	0.0185	0.0189	0.0143	0.0142	0.0116	0.0122
1998	0.0142	0.0134	0.0184	0.0124	0.0120	0.0143	0.0118	0.0097	0.0094	0.0088	0.0086	0.0077	0.0067	0.0083	0.0096	0.0079	0.0070	0.0081	0.0092	0.0090
1999	0.0511	0.0429	0.0327	0.0335	0.0256	0.0191	0.0164	0.0144	0.0129	0.0115	0.0097	0.0101	0.0078	0.0083	0.0080	0.0074	0.0057	0.0095	0.0071	0.0081
2000	0.0277	0.0245	0.0290	0.0260	0.0315	0.0275	0.0282	0.0209	0.0251	0.0191	0.0205	0.0155	0.0161	0.0145	0.0129	0.0126	0.0117	0.0088	0.0080	0.0072
2001	0.0081	0.0095	0.0117	0.0143	0.0116	0.0135	0.0130	0.0119	0.0135	0.0139	0.0133	0.0120	0.0113	0.0118	0.0097	0.0108	0.0095	0.0077	0.0101	0.0067
2002	0.0369	0.0323	0.0321	0.0226	0.0269	0.0155	0.0189	0.0151	0.0137	0.0112	0.0134	0.0105	0.0130	0.0074	0.0095	0.0098	0.0105	0.0087	0.0094	0.0088
2003	0.0371	0.0346	0.0372	0.0342	0.0317	0.0233	0.0232	0.0195	0.0208	0.0219	0.0170	0.0157	0.0145	0.0123	0.0106	0.0120	0.0115	0.0094	0.0081	0.0060
2004	0.0167	0.0144	0.0139	0.0139	0.0161	0.0157	0.0189	0.0184	0.0148	0.0168	0.0161	0.0174	0.0157	0.0178	0.0135	0.0145	0.0158	0.0139	0.0132	0.0127
2005	0.0193	0.0150	0.0191	0.0154	0.0173	0.0119	0.0152	0.0112	0.0131	0.0117	0.0122	0.0101	0.0098	0.0090	0.0090	0.0090	0.0105	0.0076	0.0108	0.0077
2006	0.0141	0.0122	0.0126	0.0114	0.0137	0.0128	0.0167	0.0145	0.0148	0.0133	0.0153	0.0114	0.0149	0.0089	0.0105	0.0075	0.0082	0.0085	0.0080	0.0089
2007	0.0068	0.0063	0.0068	0.0066	0.0064	0.0048	0.0062	0.0058	0.0070	0.0055	0.0056	0.0048	0.0049	0.0043	0.0044	0.0043	0.0052	0.0043	0.0050	0.0041
2008	0.0110	0.0105	0.0106	0.0088	0.0104	0.0095	0.0096	0.0098	0.0112	0.0089	0.0085	0.0077	0.0088	0.0067	0.0092	0.0078	0.0090	0.0069	0.0066	0.0062
2009	0.0208	0.0201	0.0167	0.0174	0.0148	0.0108	0.0088	0.0088	0.0070	0.0062	0.0056	0.0051	0.0045	0.0047	0.0052	0.0054	0.0043	0.0051	0.0047	0.0032
2010	0.0305	0.0202	0.0220	0.0209	0.0208	0.0162	0.0179	0.0140	0.0195	0.0150	0.0204	0.0199	0.0184	0.0125	0.0185	0.0148	0.0133	0.0097	0.0119	0.0077
2011	0.0443	0.0420	0.0379	0.0305	0.0246	0.0169	0.0170	0.0135	0.0127	0.0091	0.0112	0.0108	0.0128	0.0089	0.0134	0.0116	0.0145	0.0111	0.0142	0.0091
2012	0.0065	0.0062	0.0101	0.0085	0.0150	0.0143	0.0183	0.0218	0.0290	0.0246	0.0312	0.0236	0.0242	0.0168	0.0152	0.0128	0.0126	0.0074	0.0093	0.0066
2013	0.0194	0.0232	0.0281	0.0219	0.0208	0.0195	0.0176	0.0143	0.0139	0.0107	0.0112	0.0074	0.0103	0.0078	0.0117	0.0105	0.0128	0.0106	0.0115	0.0114
2014	0.0255	0.0365	0.0376	0.0339	0.0311	0.0274	0.0236	0.0159	0.0121	0.0113	0.0116	0.0104	0.0093	0.0110	0.0140	0.0140	0.0112	0.0108	0.0114	0.0076
2015	0.0195	0.0193	0.0258	0.0245	0.0243	0.0221	0.0235	0.0166	0.0182	0.0180	0.0165	0.0175	0.0201	0.0175	0.0225	0.0172	0.0157	0.0114	0.0127	0.0082
2016	0.0354	0.0472	0.0517	0.0502	0.0511	0.0444	0.0400	0.0313	0.0242	0.0244	0.0173	0.0172	0.0166	0.0162	0.0148	0.0157	0.0151	0.0133	0.0138	0.0140
2017	0.0202	0.0166	0.0213	0.0198	0.0206	0.0239	0.0281	0.0256	0.0301	0.0304	0.0351	0.0375	0.0345	0.0336	0.0294	0.0231	0.0218	0.0208	0.0168	0.0197
2018	0.0220	0.0185	0.0168	0.0181	0.0166	0.0202	0.0180	0.0186	0.0212	0.0197	0.0216	0.0198	0.0199	0.0181	0.0200	0.0231	0.0209	0.0227	0.0207	0.0252
2019	0.0069	0.0067	0.0076	0.0081	0.0073	0.0058	0.0078	0.0064	0.0066	0.0061	0.0078	0.0073	0.0082	0.0075	0.0078	0.0061	0.0067	0.0070	0.0067	0.0078

Table 2.10 (page 4 of 6)—Size composition data (survey, units = proportions).

Year	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
1982	0.0192	0.0183	0.0180	0.0188	0.0116	0.0163	0.0118	0.0125	0.0069	0.0069	0.0068	0.0061	0.0042	0.0032	0.0035	0.0028	0.0019	0.0025	0.0023	0.0012
1983	0.0149	0.0152	0.0145	0.0126	0.0143	0.0134	0.0110	0.0137	0.0096	0.0093	0.0059	0.0061	0.0060	0.0051	0.0045	0.0030	0.0037	0.0025	0.0022	0.0018
1984	0.0155	0.0133	0.0162	0.0150	0.0149	0.0141	0.0126	0.0119	0.0068	0.0098	0.0080	0.0086	0.0062	0.0068	0.0046	0.0056	0.0038	0.0033	0.0026	0.0027
1985	0.0065	0.0067	0.0101	0.0073	0.0080	0.0087	0.0087	0.0080	0.0080	0.0071	0.0082	0.0063	0.0080	0.0059	0.0056	0.0035	0.0045	0.0035	0.0030	0.0029
1986	0.0052	0.0064	0.0049	0.0055	0.0046	0.0057	0.0068	0.0064	0.0058	0.0046	0.0059	0.0056	0.0045	0.0053	0.0046	0.0040	0.0054	0.0036	0.0035	0.0028
1987	0.0117	0.0124	0.0116	0.0122	0.0124	0.0103	0.0109	0.0086	0.0056	0.0084	0.0048	0.0053	0.0051	0.0022	0.0042	0.0033	0.0035	0.0040	0.0026	0.0027
1988	0.0115	0.0124	0.0099	0.0138	0.0105	0.0107	0.0081	0.0117	0.0084	0.0084	0.0057	0.0080	0.0072	0.0048	0.0043	0.0055	0.0072	0.0065	0.0053	0.0030
1989	0.0242	0.0180	0.0169	0.0248	0.0216	0.0136	0.0200	0.0106	0.0186	0.0204	0.0164	0.0161	0.0147	0.0116	0.0149	0.0109	0.0064	0.0054	0.0084	0.0062
1990	0.0143	0.0100	0.0147	0.0101	0.0114	0.0069	0.0118	0.0083	0.0100	0.0100	0.0096	0.0084	0.0059	0.0070	0.0071	0.0047	0.0067	0.0067	0.0021	0.0044
1991	0.0058	0.0036	0.0062	0.0057	0.0068	0.0064	0.0066	0.0047	0.0044	0.0035	0.0059	0.0045	0.0039	0.0019	0.0023	0.0027	0.0030	0.0046	0.0033	0.0032
1992	0.0027	0.0032	0.0032	0.0050	0.0038	0.0034	0.0026	0.0016	0.0023	0.0025	0.0022	0.0018	0.0026	0.0016	0.0018	0.0026	0.0030	0.0015	0.0018	0.0015
1993	0.0035	0.0063	0.0035	0.0035	0.0059	0.0027	0.0027	0.0014	0.0014	0.0015	0.0014	0.0016	0.0012	0.0011	0.0010	0.0012	0.0012	0.0011	0.0009	0.0005
1994	0.0128	0.0113	0.0091	0.0059	0.0094	0.0044	0.0073	0.0035	0.0047	0.0021	0.0029	0.0014	0.0021	0.0009	0.0015	0.0007	0.0006	0.0007	0.0009	0.0004
1995	0.0095	0.0077	0.0058	0.0066	0.0077	0.0076	0.0075	0.0055	0.0059	0.0048	0.0039	0.0031	0.0024	0.0040	0.0022	0.0026	0.0023	0.0021	0.0019	0.0013
1996	0.0086	0.0063	0.0066	0.0066	0.0062	0.0061	0.0051	0.0061	0.0068	0.0037	0.0050	0.0039	0.0029	0.0031	0.0037	0.0024	0.0023	0.0026	0.0027	0.0016
1997	0.0133	0.0112	0.0111	0.0102	0.0094	0.0076	0.0064	0.0067	0.0060	0.0033	0.0024	0.0033	0.0025	0.0031	0.0020	0.0013	0.0011	0.0010	0.0013	0.0020
1998	0.0077	0.0069	0.0102	0.0060	0.0067	0.0053	0.0049	0.0059	0.0059	0.0042	0.0055	0.0030	0.0038	0.0022	0.0022	0.0025	0.0013	0.0018	0.0010	0.0016
1999	0.0067	0.0078	0.0050	0.0055	0.0041	0.0049	0.0054	0.0039	0.0040	0.0040	0.0030	0.0023	0.0022	0.0019	0.0020	0.0021	0.0019	0.0015	0.0011	0.0014
2000	0.0067	0.0044	0.0051	0.0047	0.0041	0.0028	0.0040	0.0026	0.0031	0.0025	0.0027	0.0023	0.0018	0.0010	0.0011	0.0017	0.0018	0.0010	0.0014	0.0015
2001	0.0079	0.0076	0.0054	0.0041	0.0053	0.0034	0.0039	0.0029	0.0026	0.0017	0.0019	0.0013	0.0010	0.0013	0.0010	0.0016	0.0009	0.0009	0.0006	0.0006
2002	0.0083	0.0048	0.0088	0.0059	0.0054	0.0055	0.0048	0.0038	0.0030	0.0030	0.0027	0.0020	0.0025	0.0019	0.0011	0.0008	0.0016	0.0011	0.0005	0.0005
2003	0.0079	0.0057	0.0058	0.0058	0.0055	0.0056	0.0061	0.0040	0.0045	0.0034	0.0035	0.0030	0.0028	0.0022	0.0022	0.0014	0.0015	0.0017	0.0017	0.0009
2004	0.0113	0.0097	0.0092	0.0083	0.0101	0.0079	0.0060	0.0068	0.0057	0.0059	0.0032	0.0047	0.0043	0.0039	0.0042	0.0029	0.0025	0.0022	0.0021	0.0014
2005	0.0114	0.0097	0.0099	0.0095	0.0095	0.0074	0.0079	0.0068	0.0065	0.0053	0.0074	0.0046	0.0066	0.0050	0.0057	0.0044	0.0041	0.0038	0.0035	0.0028
2006	0.0076	0.0072	0.0083	0.0051	0.0081	0.0041	0.0057	0.0051	0.0049	0.0055	0.0057	0.0046	0.0050	0.0037	0.0047	0.0037	0.0047	0.0042	0.0042	0.0030
2007	0.0041	0.0037	0.0038	0.0025	0.0034	0.0033	0.0025	0.0018	0.0026	0.0018	0.0029	0.0017	0.0015	0.0011	0.0010	0.0014	0.0013	0.0015	0.0008	0.0009
2008	0.0079	0.0048	0.0060	0.0050	0.0064	0.0036	0.0044	0.0026	0.0036	0.0019	0.0034	0.0014	0.0021	0.0018	0.0019	0.0009	0.0012	0.0009	0.0014	0.0011
2009	0.0039	0.0043	0.0032	0.0024	0.0030	0.0019	0.0024	0.0019	0.0012	0.0015	0.0008	0.0011	0.0010	0.0010	0.0009	0.0003	0.0008	0.0004	0.0005	0.0003
2010	0.0088	0.0054	0.0056	0.0039	0.0029	0.0022	0.0026	0.0023	0.0012	0.0009	0.0009	0.0011	0.0013	0.0003	0.0010	0.0003	0.0002	0.0006	0.0003	0.0003
2011	0.0121	0.0083	0.0099	0.0073	0.0078	0.0056	0.0062	0.0030	0.0038	0.0025	0.0024	0.0014	0.0013	0.0012	0.0008	0.0007	0.0009	0.0003	0.0008	0.0005
2012	0.0079	0.0059	0.0061	0.0048	0.0051	0.0035	0.0056	0.0029	0.0037	0.0018	0.0022	0.0016	0.0015	0.0015	0.0013	0.0005	0.0008	0.0003	0.0005	0.0005
2013	0.0125	0.0116	0.0104	0.0088	0.0078	0.0073	0.0058	0.0058	0.0050	0.0027	0.0034	0.0024	0.0017	0.0023	0.0016	0.0017	0.0005	0.0016	0.0007	0.0013
2014	0.0079	0.0061	0.0060	0.0035	0.0035	0.0030	0.0038	0.0032	0.0030	0.0037	0.0028	0.0024	0.0023	0.0017	0.0016	0.0011	0.0009	0.0009	0.0005	0.0005
2015	0.0086	0.0059	0.0056	0.0059	0.0051	0.0042	0.0034	0.0032	0.0032	0.0030	0.0024	0.0028	0.0023	0.0019	0.0013	0.0013	0.0010	0.0013	0.0008	0.0004
2016	0.0125	0.0132	0.0146	0.0114	0.0105	0.0096	0.0100	0.0084	0.0055	0.0051	0.0040	0.0029	0.0027	0.0028	0.0021	0.0015	0.0014	0.0021	0.0010	0.0011
2017	0.0154	0.0137	0.0120	0.0120	0.0110	0.0129	0.0114	0.0083	0.0071	0.0096	0.0067	0.0076	0.0071	0.0064	0.0053	0.0055	0.0054	0.0016	0.0032	0.0027
2018	0.0243	0.0219	0.0193	0.0221	0.0169	0.0176	0.0164	0.0118	0.0118	0.0111	0.0081	0.0069	0.0066	0.0080	0.0053	0.0061	0.0065	0.0045	0.0040	0.0040
2019	0.0078	0.0067	0.0080	0.0064	0.0072	0.0062	0.0064	0.0065	0.0060	0.0072	0.0066	0.0049	0.0054	0.0048	0.0056	0.0033	0.0038	0.0031	0.0021	0.0018

Table 2.10 (page 5 of 6)—Size composition data (survey, units = proportions).

Year	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
1982	0.0007	0.0006	0.0009	0.0003	0.0006	0.0004	0.0001	0.0002	0.0003	0.0000	0.0002	0.0000	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1983	0.0013	0.0009	0.0001	0.0005	0.0006	0.0002	0.0009	0.0000	0.0000	0.0002	0.0003	0.0000	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1984	0.0022	0.0018	0.0023	0.0010	0.0013	0.0015	0.0010	0.0008	0.0003	0.0006	0.0005	0.0000	0.0003	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.0013	0.0022	0.0013	0.0013	0.0010	0.0008	0.0006	0.0005	0.0004	0.0005	0.0003	0.0001	0.0002	0.0004	0.0001	0.0002	0.0001	0.0000	0.0002	0.0000
1986	0.0019	0.0017	0.0023	0.0012	0.0014	0.0012	0.0020	0.0006	0.0011	0.0009	0.0003	0.0003	0.0004	0.0002	0.0005	0.0001	0.0003	0.0002	0.0000	0.0003
1987	0.0029	0.0031	0.0008	0.0008	0.0014	0.0009	0.0009	0.0012	0.0005	0.0011	0.0009	0.0001	0.0005	0.0006	0.0003	0.0001	0.0001	0.0002	0.0003	0.0000
1988	0.0033	0.0014	0.0028	0.0015	0.0008	0.0015	0.0003	0.0018	0.0003	0.0006	0.0006	0.0006	0.0005	0.0001	0.0004	0.0008	0.0003	0.0001	0.0003	0.0000
1989	0.0078	0.0085	0.0041	0.0063	0.0043	0.0014	0.0041	0.0029	0.0018	0.0023	0.0028	0.0031	0.0019	0.0010	0.0020	0.0011	0.0010	0.0021	0.0001	0.0022
1990	0.0037	0.0040	0.0033	0.0024	0.0021	0.0032	0.0022	0.0009	0.0008	0.0008	0.0011	0.0021	0.0017	0.0004	0.0003	0.0002	0.0008	0.0000	0.0010	0.0001
1991	0.0019	0.0018	0.0012	0.0020	0.0010	0.0011	0.0008	0.0007	0.0008	0.0005	0.0002	0.0009	0.0010	0.0004	0.0003	0.0004	0.0000	0.0001	0.0000	0.0008
1992	0.0012	0.0013	0.0014	0.0007	0.0010	0.0008	0.0013	0.0006	0.0007	0.0007	0.0004	0.0007	0.0008	0.0003	0.0009	0.0002	0.0004	0.0003	0.0003	0.0003
1993	0.0012	0.0010	0.0004	0.0007	0.0008	0.0007	0.0004	0.0003	0.0004	0.0007	0.0002	0.0007	0.0005	0.0004	0.0003	0.0003	0.0001	0.0002	0.0002	0.0001
1994	0.0006	0.0006	0.0006	0.0005	0.0003	0.0004	0.0024	0.0009	0.0007	0.0002	0.0001	0.0003	0.0004	0.0003	0.0001	0.0001	0.0002	0.0007	0.0004	0.0002
1995	0.0014	0.0011	0.0008	0.0008	0.0008	0.0008	0.0005	0.0012	0.0004	0.0005	0.0004	0.0011	0.0001	0.0003	0.0002	0.0003	0.0005	0.0001	0.0003	0.0001
1996	0.0028	0.0010	0.0015	0.0023	0.0019	0.0010	0.0004	0.0003	0.0007	0.0010	0.0003	0.0005	0.0005	0.0003	0.0003	0.0002	0.0004	0.0001	0.0002	0.0000
1997	0.0013	0.0011	0.0009	0.0010	0.0010	0.0005	0.0003	0.0009	0.0008	0.0002	0.0006	0.0004	0.0003	0.0004	0.0000	0.0001	0.0002	0.0000	0.0000	0.0001
1998	0.0011	0.0009	0.0010	0.0008	0.0004	0.0004	0.0006	0.0005	0.0010	0.0004	0.0006	0.0003	0.0001	0.0002	0.0002	0.0001	0.0001	0.0001	0.0009	0.0000
1999	0.0011	0.0009	0.0009	0.0014	0.0012	0.0005	0.0012	0.0005	0.0004	0.0004	0.0004	0.0002	0.0004	0.0005	0.0005	0.0003	0.0002	0.0001	0.0000	0.0002
2000	0.0007	0.0007	0.0004	0.0007	0.0021	0.0005	0.0006	0.0006	0.0003	0.0003	0.0008	0.0002	0.0006	0.0004	0.0003	0.0001	0.0000	0.0002	0.0000	0.0000
2001	0.0007	0.0003	0.0005	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002	0.0001	0.0002	0.0003	0.0000	0.0001	0.0000	0.0002	0.0000	0.0001	0.0000	0.0001
2002	0.0002	0.0006	0.0001	0.0003	0.0004	0.0001	0.0002	0.0003	0.0004	0.0004	0.0001	0.0003	0.0001	0.0003	0.0005	0.0001	0.0001	0.0000	0.0000	0.0001
2003	0.0011	0.0006	0.0008	0.0004	0.0005	0.0004	0.0003	0.0003	0.0002	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
2004	0.0021	0.0010	0.0024	0.0011	0.0018	0.0014	0.0012	0.0005	0.0004	0.0007	0.0004	0.0004	0.0004	0.0004	0.0003	0.0002	0.0000	0.0001	0.0000	0.0005
2005	0.0022	0.0015	0.0024	0.0018	0.0021	0.0012	0.0009	0.0013	0.0009	0.0007	0.0004	0.0008	0.0004	0.0002	0.0003	0.0000	0.0003	0.0002	0.0000	0.0001
2006	0.0036	0.0031	0.0028	0.0016	0.0028	0.0012	0.0019	0.0013	0.0014	0.0008	0.0008	0.0005	0.0010	0.0007	0.0001	0.0006	0.0004	0.0002	0.0002	0.0002
2007	0.0007	0.0021	0.0009	0.0007	0.0007	0.0011	0.0008	0.0010	0.0007	0.0003	0.0006	0.0003	0.0004	0.0002	0.0002	0.0002	0.0002	0.0001	0.0006	0.0001
2008	0.0010	0.0007	0.0015	0.0008	0.0008	0.0006	0.0012	0.0004	0.0007	0.0008	0.0007	0.0007	0.0002	0.0006	0.0006	0.0002	0.0003	0.0002	0.0005	0.0001
2009	0.0002	0.0004	0.0003	0.0003	0.0002	0.0002	0.0003	0.0000	0.0001	0.0001	0.0001	0.0002	0.0003	0.0001	0.0002	0.0000	0.0001	0.0001	0.0001	0.0000
2010	0.0001	0.0004	0.0006	0.0000	0.0003	0.0001	0.0003	0.0001	0.0001	0.0003	0.0001	0.0000	0.0002	0.0001	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000
2011	0.0003	0.0001	0.0002	0.0002	0.0002	0.0002	0.0001	0.0003	0.0002	0.0002	0.0004	0.0001	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001	0.0000
2012	0.0005	0.0003	0.0003	0.0003	0.0001	0.0001	0.0002	0.0002	0.0001	0.0002	0.0002	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
2013	0.0006	0.0006	0.0004	0.0004	0.0003	0.0002	0.0003	0.0002	0.0002	0.0003	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
2014	0.0005	0.0002	0.0003	0.0003	0.0002	0.0001	0.0004	0.0001	0.0002	0.0001	0.0000	0.0000	0.0002	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0001
2015	0.0006	0.0004	0.0009	0.0005	0.0003	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
2016	0.0013	0.0010	0.0006	0.0005	0.0004	0.0005	0.0003	0.0003	0.0003	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0000	0.0001	0.0002	0.0001	0.0001
2017	0.0018	0.0010	0.0009	0.0012	0.0009	0.0013	0.0003	0.0006	0.0007	0.0003	0.0005	0.0004	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0033	0.0015	0.0021	0.0024	0.0016	0.0013	0.0012	0.0007	0.0005	0.0005	0.0005	0.0004	0.0003	0.0004	0.0006	0.0004	0.0001	0.0000	0.0003	0.0000
2019	0.0023	0.0017	0.0011	0.0016	0.0012	0.0012	0.0013	0.0006	0.0006	0.0005	0.0006	0.0004	0.0002	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	0.0000

Table 2.10 (page 6 of 6)—Size composition data (survey, units = proportions).

Year	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
1982	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1983	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1984	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1986	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1988	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1989	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1990	0.0000	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0001	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0003	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
1993	0.0008	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0001	0.0005	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0002	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0000	0.0001	0.0000	0.0000	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	0.0001	0.0000	0.0001	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2016	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2019	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 2.11—Size composition nominal sample sizes (survey).

	EBS		NBS		EBS+NBS	
Year	Lengths	Hauls	Lengths	Hauls	Lengths	Hauls
1982	10863	313			10863	313
1983	13143	255			13143	255
1984	12133	264			12133	264
1985	16921	345			16921	345
1986	15872	349			15872	349
1987	9483	339			9483	339
1988	6765	339			6765	339
1989	4246	293			4246	293
1990	5428	329			5428	329
1991	7001	313			7001	313
1992	10129	332			10129	332
1993	10500	363			10500	363
1994	12931	364			12931	364
1995	9820	347			9820	347
1996	9348	359			9348	359
1997	9591	369			9591	369
1998	9574	362			9574	362
1999	11183	336			11183	336
2000	12170	355			12170	355
2001	19078	366			19078	366
2002	11897	364			11897	364
2003	11835	363			11835	363
2004	10437	361			10437	361
2005	11753	360			11753	360
2006	12530	354			12530	354
2007	13441	368			13441	368
2008	13430	338			13430	338
2009	16866	360			16866	360
2010	14009	342	255	63	14264	405
2011	19283	368			19283	368
2012	13215	356			13215	356
2013	18128	354			18128	354
2014	15830	373			15830	373
2015	19148	354			19148	354
2016	17173	376			17173	376
2017	11004	369	3871	112	14875	481
2018	8806	364	2511	49	11317	413
2019	9109	365	5255	114	14364	479

Table 2.12a—Age composition data (design-based).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12+
1994	0.00000	0.08923	0.38221	0.17151	0.12389	0.11889	0.07942	0.02029	0.00686	0.00459	0.00134	0.00097	0.00080
1995	0.00001	0.05525	0.26318	0.41972	0.09973	0.07967	0.04915	0.01568	0.00836	0.00573	0.00151	0.00083	0.00116
1996	0.00001	0.05722	0.20726	0.20254	0.29303	0.13617	0.05801	0.02848	0.00961	0.00412	0.00168	0.00102	0.00086
1997	0.00000	0.25721	0.16889	0.18421	0.15688	0.12022	0.07632	0.02138	0.00965	0.00289	0.00121	0.00079	0.00034
1998	0.00000	0.07711	0.44065	0.20411	0.11219	0.05658	0.05984	0.02837	0.01574	0.00389	0.00074	0.00058	0.00020
1999	0.00000	0.07951	0.19946	0.30280	0.23192	0.08067	0.05824	0.02720	0.01181	0.00514	0.00122	0.00145	0.00056
2000	0.00002	0.23442	0.12700	0.14998	0.24188	0.14762	0.06202	0.01399	0.01343	0.00525	0.00277	0.00122	0.00042
2001	0.00001	0.28965	0.23541	0.19359	0.09077	0.08370	0.06850	0.02622	0.00755	0.00210	0.00145	0.00079	0.00027
2002	0.00006	0.08017	0.18789	0.31773	0.23342	0.07222	0.05909	0.03367	0.01005	0.00370	0.00104	0.00051	0.00045
2003	0.00001	0.17536	0.15619	0.25046	0.20932	0.11884	0.04109	0.03015	0.01352	0.00358	0.00050	0.00051	0.00045
2004	0.00002	0.14401	0.16555	0.27094	0.12811	0.12794	0.09090	0.04006	0.01872	0.00849	0.00212	0.00252	0.00062
2005	0.00000	0.18334	0.24441	0.20925	0.12112	0.06527	0.07947	0.05507	0.02378	0.01041	0.00361	0.00364	0.00063
2006	0.00000	0.32441	0.14277	0.16496	0.12141	0.09301	0.06343	0.04642	0.02845	0.00985	0.00301	0.00141	0.00085
2007	0.00000	0.70068	0.09548	0.06707	0.04134	0.04593	0.01758	0.01428	0.00838	0.00504	0.00174	0.00150	0.00097
2008	0.00014	0.21331	0.44525	0.14489	0.08267	0.04862	0.03300	0.01036	0.01021	0.00570	0.00271	0.00138	0.00174
2009	0.00068	0.45428	0.18941	0.23091	0.06415	0.02879	0.01468	0.00945	0.00392	0.00202	0.00082	0.00057	0.00033
2010	0.00000	0.04654	0.47937	0.17931	0.20324	0.06443	0.01460	0.00772	0.00254	0.00123	0.00037	0.00052	0.00012
2011	0.00003	0.29079	0.07294	0.38794	0.11107	0.09553	0.02788	0.00692	0.00333	0.00160	0.00096	0.00055	0.00044
2012	0.00005	0.36624	0.23416	0.05827	0.23714	0.06170	0.03065	0.00743	0.00205	0.00154	0.00046	0.00016	0.00016
2013	0.00000	0.10724	0.42698	0.17804	0.10837	0.11292	0.05042	0.01095	0.00359	0.00081	0.00019	0.00029	0.00022
2014	0.00005	0.27949	0.18757	0.23783	0.19702	0.04776	0.03583	0.01022	0.00224	0.00087	0.00071	0.00013	0.00028
2015	0.00000	0.06386	0.42549	0.20207	0.19335	0.08191	0.01861	0.01123	0.00241	0.00054	0.00025	0.00015	0.00014
2016	0.00000	0.11204	0.09416	0.36104	0.22136	0.14505	0.04879	0.01147	0.00401	0.00126	0.00042	0.00029	0.00012
2017	0.00000	0.13108	0.15980	0.18671	0.28786	0.13280	0.07306	0.02000	0.00448	0.00285	0.00049	0.00047	0.00040
2018	0.00000	0.09350	0.11912	0.28383	0.15805	0.22759	0.07772	0.03161	0.00409	0.00281	0.00087	0.00045	0.00035

Table 2.12b—Age composition data (VAST).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12+
1994	0.00025	0.10417	0.40267	0.16742	0.10847	0.10804	0.07454	0.01909	0.00749	0.00421	0.00132	0.00113	0.00119
1995	0.00017	0.06416	0.25878	0.41689	0.10211	0.07539	0.05252	0.01320	0.00690	0.00531	0.00147	0.00164	0.00146
1996	0.00004	0.07234	0.19651	0.17980	0.28340	0.14625	0.07125	0.03270	0.00890	0.00359	0.00188	0.00165	0.00167
1997	0.00033	0.28754	0.16379	0.14897	0.14171	0.12011	0.09619	0.02484	0.01068	0.00236	0.00181	0.00101	0.00067
1998	0.00008	0.08439	0.43802	0.19571	0.10931	0.05791	0.06154	0.03104	0.01664	0.00341	0.00072	0.00080	0.00042
1999	0.00009	0.09356	0.21514	0.30887	0.20935	0.07175	0.05427	0.02677	0.01200	0.00512	0.00105	0.00139	0.00063
2000	0.00000	0.22119	0.11769	0.16382	0.23666	0.15666	0.06299	0.01441	0.01562	0.00499	0.00370	0.00155	0.00072
2001	0.00004	0.29752	0.23663	0.18181	0.08478	0.08844	0.07190	0.02654	0.00750	0.00182	0.00149	0.00109	0.00044
2002	0.00052	0.08285	0.19519	0.29793	0.23773	0.07196	0.06128	0.03783	0.00979	0.00285	0.00095	0.00050	0.00064
2003	0.00001	0.17276	0.15711	0.23258	0.20915	0.12810	0.04640	0.03255	0.01603	0.00353	0.00047	0.00057	0.00073
2004	0.00004	0.14485	0.15344	0.26666	0.13020	0.13418	0.09870	0.03892	0.02041	0.00769	0.00213	0.00197	0.00079
2005	0.00001	0.15946	0.23861	0.20251	0.12720	0.07025	0.09335	0.06354	0.02583	0.01063	0.00380	0.00427	0.00054
2006	0.00000	0.34492	0.14260	0.16558	0.11171	0.08701	0.06091	0.04593	0.02675	0.00944	0.00310	0.00128	0.00076
2007	0.00000	0.67412	0.10547	0.07236	0.04646	0.04857	0.01958	0.01611	0.00829	0.00535	0.00173	0.00102	0.00093
2008	0.00000	0.20250	0.43527	0.15142	0.09114	0.05277	0.03192	0.01133	0.01079	0.00650	0.00278	0.00217	0.00141
2009	0.00000	0.48368	0.17729	0.21682	0.06206	0.02718	0.01462	0.00944	0.00490	0.00187	0.00099	0.00072	0.00043
2010	0.00000	0.04760	0.48066	0.18246	0.19785	0.06240	0.01518	0.00823	0.00273	0.00149	0.00056	0.00065	0.00019
2011	0.00009	0.34228	0.07222	0.34955	0.10412	0.08923	0.02811	0.00738	0.00309	0.00163	0.00115	0.00068	0.00047
2012	0.00000	0.34326	0.25579	0.06175	0.22980	0.06408	0.03167	0.00837	0.00253	0.00180	0.00058	0.00015	0.00021
2013	0.00000	0.10223	0.38631	0.19775	0.11686	0.12433	0.05426	0.01282	0.00363	0.00098	0.00022	0.00032	0.00027
2014	0.00003	0.26564	0.16477	0.23986	0.21316	0.05745	0.04313	0.01138	0.00222	0.00090	0.00083	0.00009	0.00054
2015	0.00002	0.05968	0.43061	0.20113	0.19359	0.08228	0.01826	0.01116	0.00228	0.00046	0.00023	0.00010	0.00019
2016	0.00000	0.08118	0.09013	0.34852	0.23861	0.16834	0.05580	0.01186	0.00343	0.00128	0.00045	0.00026	0.00013
2017	0.00007	0.10704	0.16835	0.15421	0.30503	0.15241	0.08390	0.02104	0.00313	0.00297	0.00059	0.00056	0.00070
2018	0.00004	0.07381	0.09774	0.24525	0.16547	0.29537	0.08799	0.02891	0.00255	0.00177	0.00049	0.00022	0.00038

Table 2.13—Age composition nominal sample sizes (survey, units = otoliths read).

Year	Ages
1994	715
1995	1426
1996	711
1997	718
1998	635
1999	860
2000	864
2001	480
2002	947
2003	2711
2004	1044
2005	1280
2006	1299
2007	1440
2008	1213
2009	1412
2010	1469
2011	1253
2012	1301
2013	1385
2014	1420
2015	1819
2016	1624
2017	1382
2018	1532

Table 2.14—Trawl survey biomass time series (design-based).

	EBS		NBS		EBS+NBS	
Year	Biomass	Sigma	Biomass	Sigma	Biomass	Sigma
1987	1,064,600	0.060			1,064,600	0.060
1988	976,152	0.079			976,152	0.079
1989	868,804	0.072			868,804	0.072
1990	728,996	0.072			728,996	0.072
1991	530,488	0.072			530,488	0.072
1992	538,862	0.083			538,862	0.083
1993	669,305	0.079			669,305	0.079
1994	1,377,095	0.178			1,377,095	0.178
1995	1,008,293	0.091			1,008,293	0.091
1996	909,133	0.096			909,133	0.096
1997	627,151	0.109			627,151	0.109
1998	550,504	0.078			550,504	0.078
1999	618,679	0.091			618,679	0.091
2000	537,563	0.080			537,563	0.080
2001	827,176	0.088			827,176	0.088
2002	597,943	0.106			597,943	0.106
2003	625,659	0.099			625,659	0.099
2004	578,064	0.058			578,064	0.058
2005	638,764	0.068			638,764	0.068
2006	544,035	0.053			544,035	0.053
2007	450,337	0.078			450,337	0.078
2008	427,503	0.065			427,503	0.065
2009	430,084	0.081			430,084	0.081
2010	870,639	0.117	29,124	0.223	899,763	0.114
2011	911,082	0.073			911,082	0.073
2012	896,401	0.112			896,401	0.112
2013	811,667	0.091			811,667	0.091
2014	1,095,270	0.139			1,095,270	0.139
2015	1,109,115	0.136			1,109,115	0.136
2016	986,013	0.078			986,013	0.078
2017	643,953	0.077	283,615	0.126	927,568	0.066
2018	506,943	0.058			506,943	0.058
2019	516,910	0.044	364,982	0.146	881,892	0.066

Table 2.15—Annual weight length parameter offsets.

Year:	1978	1979	1980	1981	1982	1983	1984	1985	1986
α offset:	-2.33E-06	1.52E-06	-1.05E-07	8.53E-07	2.87E-06	4.90E-07	1.17E-05	-8.74E-07	-2.11E-06
β offset:	1.34E-01	-5.46E-02	8.48E-04	-3.92E-02	-9.22E-02	-1.04E-02	-2.84E-01	5.10E-02	1.24E-01

Year:	1987	1988	1989	1990	1991	1992	1993	1994	1995
α offset:	-6.01E-08	-2.04E-06	-1.12E-06	1.35E-06	1.83E-06	3.79E-07	2.82E-06	6.40E-07	-8.26E-07
β offset:	9.54E-03	1.26E-01	7.43E-02	-3.69E-02	-6.85E-02	-2.45E-02	-7.98E-02	-2.43E-02	4.17E-02

Year:	1996	1997	1998	1999	2000	2001	2002	2003	2004
α offset:	7.77E-06	1.34E-06	1.93E-06	2.02E-06	2.26E-06	4.15E-06	1.54E-06	-1.82E-07	2.22E-06
β offset:	-2.07E-01	-6.19E-02	-8.35E-02	-7.59E-02	-7.12E-02	-1.29E-01	-5.59E-02	8.52E-03	-7.93E-02

Year:	2005	2006	2007	2008	2009	2010	2011	2012	2013
α offset:	1.53E-07	1.10E-06	5.71E-07	1.27E-06	-5.65E-07	-1.67E-07	-3.04E-07	3.14E-06	-4.93E-07
β offset:	-2.47E-03	-4.05E-02	-1.71E-02	-4.80E-02	3.05E-02	7.03E-03	8.86E-03	-1.16E-01	1.79E-02

Year:	2014	2015	2016	2017	2018
α offset:	-1.79E-06	-2.02E-06	-1.76E-06	-2.07E-06	-6.90E-07
β offset:	8.48E-02	9.47E-02	8.23E-02	1.06E-01	2.87E-02

Table 2.16—Input size composition sample sizes (fishery).

	Survey		Fishery							H2	Hypothesis 1			Hypothesis 2			Hypothesis 3		
	Hauls		Lengths			Hauls				Basic	Basic	Smpl	Cplex	Basic	Smpl	Cplex	Basic	Smpl	Cplex
Year	EBS	E+N	N	Nadj	300	N	300	EBS	E+N	16.6i	19.7	19.8	19.9	19.1	19.11	19.12	19.13	19.14	19.15
1977			2090	334	2	30	1	2	2	2	2	1	2	2	1	2	2	1	2
1978			11558	1849	12	160	8	9	9	12	12	8	9	12	8	9	12	8	9
1979			17072	2732	17	235	12	13	14	17	17	12	13	17	12	14	17	12	14
1980			14963	2394	15	208	10	12	12	15	15	10	12	15	10	12	15	10	12
1981			10729	1717	11	148	7	8	9	11	11	7	8	11	7	9	11	7	9
1982	313	313	13423	2148	13	187	9	11	11	13	13	9	11	13	9	11	13	9	11
1983	255	255	56692	9071	57	782	39	45	46	57	57	39	45	57	39	46	57	39	46
1984	264	264	138445	22151	138	1913	94	109	112	138	138	94	109	138	94	112	138	94	112
1985	345	345	204686	32750	204	2825	139	161	165	204	204	139	161	204	139	165	204	139	165
1986	349	349	178623	28580	178	2496	123	142	146	178	178	123	142	178	123	146	178	123	146
1987	339	339	340561	54490	340	4726	233	270	277	340	340	233	270	340	233	277	340	233	277
1988	339	339	105626	16900	105	1458	72	83	85	105	105	72	83	105	72	85	105	72	85
1989	293	293	70009	11201	70	966	48	55	57	70	70	48	55	70	48	57	70	48	57
1990	329	329	260939	41750	261	3601	178	206	211	261	261	178	206	261	178	211	261	178	211
1991	313	313	409581	65533	358	5188	256	296	304	358	358	256	296	358	256	304	358	256	304
1992	332	332	372300	59568	371	5322	263	304	312	371	371	263	304	371	263	312	371	263	312
1993	363	363	243488	38958	233	2993	148	171	175	233	233	148	171	233	148	175	233	148	175
1994	364	364	378950	60632	373	4687	231	268	274	373	373	231	268	373	231	274	373	231	274
1995	347	347	373284	59725	370	5215	257	298	305	370	370	257	298	370	257	305	370	257	305
1996	359	359	468271	74923	465	6618	327	378	388	465	465	327	378	465	327	388	465	327	388
1997	369	369	507042	81127	504	7278	359	416	426	504	504	359	416	504	359	426	504	359	426
1998	362	362	449236	71878	448	6838	338	390	400	448	448	338	390	448	338	400	448	338	400
1999	336	336	191354	65060	405	9231	456	527	541	405	405	456	527	405	456	541	405	456	541
2000	355	355	202003	68681	426	9731	480	556	570	426	426	480	556	426	480	570	426	480	570
2001	366	366	213017	72426	450	10364	512	592	607	450	450	512	592	450	512	607	450	512	607
2002	364	364	233697	79457	493	11472	566	655	672	493	493	566	655	493	566	672	493	566	672
2003	363	363	291291	99039	614	14341	708	819	840	614	614	708	819	614	708	840	614	708	840
2004	361	361	243998	82959	499	12242	604	699	717	499	499	604	699	499	604	717	499	604	717
2005	360	360	231473	78701	488	11568	571	660	677	488	488	571	660	488	571	677	488	571	677
2006	354	354	182691	62115	386	8849	437	505	518	386	386	437	505	386	437	518	386	437	518
2007	368	368	142215	48353	300	6901	341	394	404	300	300	341	394	300	341	404	300	341	404
2008	338	338	168938	57439	356	8320	411	475	487	356	356	411	475	356	411	487	356	411	487
2009	360	360	149247	50744	316	7482	369	427	438	316	316	369	427	316	369	438	316	369	438
2010	342	405	131970	44870	278	6514	322	372	381	278	278	322	372	278	322	381	278	322	381
2011	368	368	172023	58488	364	8804	435	503	516	364	364	435	503	364	435	516	364	435	516
2012	356	356	189648	64480	401	9287	459	530	544	401	401	459	530	401	459	544	401	459	544
2013	354	354	212579	72277	505	11126	549	635	651	505	505	549	635	505	549	651	505	549	651
2014	373	373	235021	79907	498	12165	601	695	712	498	498	601	695	498	601	712	498	601	712
2015	354	354	215955	73425	458	11309	558	646	662	458	458	558	646	458	558	662	458	558	662
2016	376	376	187899	63886	398	9772	483	558	572	398	398	483	558	398	483	572	398	483	572
2017	369	481	160850	54689	340	8486	419	484	497	340	340	419	484	340	419	497	340	419	497
2018	364	413	125314	42607	265	6462	319	369	378	265	265	319	369	265	319	378	265	319	378
2019	365	479	55005	18702	116	2959	146	169	173	116	116	146	169	116	146	173	116	146	173
Mean:	347	356	199157	48342	300	6076	300	347	356	300	300	300	347	300	300	356	300	300	356

Table 2.17—Input size composition sample sizes (survey).

	EBS only				NBS only				EBS+NBS				H2	Hypothesis 1			Hypothesis 2			Hypothesis 3		
	Lengths		Hauls		Lengths		Hauls		Lengths		Hauls		Basic	Basic	Smpl	Cplex	Basic	Smpl	Cplex	Basic	Smpl	Cplex
Year	N	300	N	300	N	300	N	300	N	300	N	300	16.6i	19.7	19.8	19.9	19.10	19.11	19.12	19.13	19.14	19.15
1982	10863	267	313	271					10863	260	313	264	267	267	271	313	260	264	313	267	271	313
1983	13143	323	255	221					13143	315	255	215	323	323	221	255	315	215	255	323	221	255
1984	12133	298	264	228					12133	291	264	223	298	298	228	264	291	223	264	298	228	264
1985	16921	416	345	298					16921	405	345	291	416	416	298	345	405	291	345	416	298	345
1986	15872	390	349	302					15872	380	349	294	390	390	302	349	380	294	349	390	302	349
1987	9483	233	339	293					9483	227	339	286	233	233	293	339	227	286	339	233	293	339
1988	6765	166	339	293					6765	162	339	286	166	166	293	339	162	286	339	166	293	339
1989	4246	104	293	253					4246	102	293	247	104	104	253	293	102	247	293	104	253	293
1990	5428	133	329	285					5428	130	329	277	133	133	285	329	130	277	329	133	285	329
1991	7001	172	313	271					7001	168	313	264	172	172	271	313	168	264	313	172	271	313
1992	10129	249	332	287					10129	243	332	280	249	249	287	332	243	280	332	249	287	332
1993	10500	258	363	314					10500	251	363	306	258	258	314	363	251	306	363	258	314	363
1994	12931	318	364	315					12931	310	364	307	318	318	315	364	310	307	364	318	315	364
1995	9820	241	347	300					9820	235	347	293	241	241	300	347	235	293	347	241	300	347
1996	9348	230	359	310					9348	224	359	303	230	230	310	359	224	303	359	230	310	359
1997	9591	236	369	319					9591	230	369	311	236	236	319	369	230	311	369	236	319	369
1998	9574	235	362	313					9574	229	362	305	235	235	313	362	229	305	362	235	313	362
1999	11183	275	336	291					11183	268	336	283	275	275	291	336	268	283	336	275	291	336
2000	12170	299	355	307					12170	291	355	299	299	299	307	355	291	299	355	299	307	355
2001	19078	469	366	317					19078	457	366	309	469	469	317	366	457	309	366	469	317	366
2002	11897	292	364	315					11897	285	364	307	292	292	315	364	285	307	364	292	315	364
2003	11835	291	363	314					11835	283	363	306	291	291	314	363	283	306	363	291	314	363
2004	10437	256	361	312					10437	250	361	304	256	256	312	361	250	304	361	256	312	361
2005	11753	289	360	311					11753	282	360	304	289	289	311	360	282	304	360	289	311	360
2006	12530	308	354	306					12530	300	354	299	308	308	306	354	300	299	354	308	306	354
2007	13441	330	368	318					13441	322	368	310	330	330	318	368	322	310	368	330	318	368
2008	13430	330	338	292					13430	322	338	285	330	330	292	338	322	285	338	330	292	338
2009	16866	414	360	311					16866	404	360	304	414	414	311	360	404	304	360	414	311	360
2010	14009	344	342	296					14264	342	405	342	344	344	296	342	342	342	405	344	296	342
2011	19283	474	368	318					19283	462	368	310	474	474	318	368	462	310	368	474	318	368
2012	13215	325	356	308					13215	317	356	300	325	325	308	356	317	300	356	325	308	356
2013	18128	445	354	306					18128	434	354	299	445	445	306	354	434	299	354	445	306	354
2014	15830	389	373	323					15830	379	373	315	389	389	323	373	379	315	373	389	323	373
2015	19148	470	354	306					19148	459	354	299	470	470	306	354	459	299	354	470	306	354
2016	17173	422	376	325					17173	411	376	317	422	422	325	376	411	317	376	422	325	376
2017	11004	270	369	319					14875	356	481	406	270	270	319	369	356	406	481	270	319	369
2018	8806	216	364	315					11317	271	413	348	216	216	315	364	271	348	413	216	315	364
2019	9109	224	365	316					14364	344	479	404	224	224	316	365	344	404	479	224	316	365
Mean:	12212	300	347	300					12525	300	356	300	300	300	300	347	300	300	356	300	300	347
2010					255	26	63	224												26	224	63
2017					3871	391	112	398												391	398	112
2018					2511	253	49	174												253	174	49
2019					5255	530	114	405												530	405	114
Mean:					2973	300	85	300												300	300	85

Table 2.18—Input age composition sample sizes.

	EBS only				NBS only				EBS+NBS				H2	Hypothesis 1			Hypothesis 2			Hypothesis 3		
	Lengths		Hauls		Lengths		Hauls		Lengths		Hauls		Basic	Basic	Smpl	Cplex	Basic	Smpl	Cplex	Basic	Smpl	Cplex
Year	N	300	N	300	N	300	N	300	N	300	N	300	16.6i	19.7	19.8	19.9	19.10	19.11	19.12	19.13	19.14	19.15
1994	12931	292	364	304					12931	286	364	297	292	292	304	364	286	297	364	292	304	364
1995	9820	222	347	290					9820	217	347	283	222	222	290	347	217	283	347	222	290	347
1996	9348	211	359	300					9348	207	359	292	211	211	300	359	207	292	359	211	300	359
1997	9591	216	369	308					9591	212	369	301	216	216	308	369	212	301	369	216	308	369
1998	9574	216	362	302					9574	212	362	295	216	216	302	362	212	295	362	216	302	362
1999	11183	252	336	281					11183	247	336	274	252	252	281	336	247	274	336	252	281	336
2000	12170	275	355	296					12170	269	355	289	275	275	296	355	269	289	355	275	296	355
2001	19078	430	366	306					19078	422	366	298	430	430	306	366	422	298	366	430	306	366
2002	11897	268	364	304					11897	263	364	297	268	268	304	364	263	297	364	268	304	364
2003	11835	267	363	303					11835	262	363	296	267	267	303	363	262	296	363	267	303	363
2004	10437	235	361	301					10437	231	361	294	235	235	301	361	231	294	361	235	301	361
2005	11753	265	360	301					11753	260	360	293	265	265	301	360	260	293	360	265	301	360
2006	12530	283	354	296					12530	277	354	288	283	283	296	354	277	288	354	283	296	354
2007	13441	303	368	307					13441	297	368	300	303	303	307	368	297	300	368	303	307	368
2008	13430	303	338	282					13430	297	338	275	303	303	282	338	297	275	338	303	282	338
2009	16866	380	360	301					16866	373	360	293	380	380	301	360	373	293	360	380	301	360
2010	14009	316	342	286					14264	315	405	330	316	316	286	342	315	330	405	316	286	342
2011	19283	435	368	307					19283	426	368	300	435	435	307	368	426	300	368	435	307	368
2012	13215	298	356	297					13215	292	356	290	298	298	297	356	292	290	356	298	297	356
2013	18128	409	354	296					18128	401	354	288	409	409	296	354	401	288	354	409	296	354
2014	15830	357	373	311					15830	350	373	304	357	357	311	373	350	304	373	357	311	373
2015	19148	432	354	296					19148	423	354	288	432	432	296	354	423	288	354	432	296	354
2016	17173	387	376	314					17173	380	376	306	387	387	314	376	380	306	376	387	314	376
2017	11004	248	369	308					14875	329	481	392	248	248	308	369	329	392	481	248	308	369
2018	8806	199	364	304					11317	250	413	336	199	199	304	364	250	336	413	199	304	364
Mean:	13299	300	359	300					13565	300	368	300	300	300	300	359	300	300	368	300	300	359
2010					255	26	63	224												26	224	63
2017					3871	391	112	398												391	398	112
2018					2511	253	49	174												253	174	49
2019					5255	530	114	405												530	405	114
Mean:					2973	300	85	300												300	300	85

Table 2.19—Objective function values (negative log likelihood) and parameter counts.

Objective function values

Component	M16.6i	M19.7	M19.8	M19.9	M19.10	M19.11	M19.12	M19.13	M19.14	M19.15
Equil. catch	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Survey indices	-26.44	43.84	39.26	-88.78	43.14	34.73	-87.65	237.94	201.86	-95.89
Sizecomps	1573.25	1570.48	1451.03	794.33	1582.04	1444.40	814.26	1825.66	1968.74	938.24
Agecomps	278.62	255.80	262.76	227.09	267.66	269.91	251.33	330.75	388.35	268.15
Recruitment	-4.02	-2.11	-1.10	1.52	-2.62	-2.35	-0.41	-2.24	-7.22	-1.87
Initial recruitment	10.40	8.68	3.57	4.76	10.03	4.15	5.36	11.60	5.10	4.91
"Softbounds"	0.01	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.02
Parameter devs	n/a	n/a	n/a	99.27	n/a	n/a	97.79	n/a	n/a	121.51
Total	1831.81	1876.70	1755.52	1038.20	1900.26	1750.84	1080.68	2403.73	2556.83	1235.08

Parameter counts

Parameter type	M16.6i	M19.7	M19.8	M19.9	M19.10	M19.11	M19.12	M19.13	M19.14	M19.15
True parameters	18	18	20	24	18	20	24	21	23	29
Parameter devs	62	62	62	305	62	62	305	62	62	343
Total	80	80	82	329	80	82	329	83	85	372

Table 2.20—Fit to survey indices.

EBS+NBS (design-based)

Hypothesis:	2
Model:	M16.6i
RMSSR:	1.789

EBS only (VAST)

Hypothesis:	Hypothesis 1			Hypothesis 3		
Model:	M19.7	M19.8	M19.9	M19.13	M19.14	M19.15
RMSSR:	2.825	2.782	1.000	2.880	2.833	1.001

EBS+NBS (VAST)

Hypothesis:	Hypothesis 2		
Model:	M19.10	M19.11	M19.12
RMSSR:	2.808	2.728	1.000

NBS only (VAST)

Hypothesis:	Hypothesis 3		
Model:	M19.13	M19.14	M19.15
RMSSR:	7.059	6.485	1.000

Table 2.21—Fit to size composition and age composition data.

		Size composition data					Age composition data				
			McAllister-Ianelli		Thorson et al.			McAllister-Ianelli		Thorson et al.	
Model	Fleet	Nave	Neff	Ratio	Theta	Neff	Nave	Neff	Ratio	Theta	Neff
M16.6i	Fishery	300	581	1.937							
	EBS survey						300	60	0.199		
	EBS+NBS survey	300	282	0.940							
M19.7	Fishery	300	598	1.993							
	EBS survey	300	273	0.908			300	67	0.223		
M19.8	Fishery	300	626	2.086							
	EBS survey	300	278	0.927			300	71	0.236		
M19.9	Fishery	347	812	2.340	9.990	347					
	EBS survey	347	624	1.798	9.984	347	359	130	0.362	0.637	235
M19.10	Fishery	300	585	1.951							
	EBS+NBS survey	300	280	0.933			300	65	0.216		
M19.11	Fishery	300	610	2.035							
	EBS+NBS survey	300	285	0.949			300	68	0.226		
M19.12	Fishery	356	819	2.301	9.990	356					
	EBS+NBS survey	356	623	1.752	9.984	356	368	111	0.302	0.099	194
M19.13	Fishery	300	591	1.970							
	EBS survey	300	271	0.904			300	66	0.220		
	NBS survey	300	82	0.275			300	40	0.133		
M19.14	Fishery	300	610	2.034							
	EBS survey	300	270	0.901			300	63	0.210		
	NBS survey	300	99	0.331			300	47	0.157		
M19.15	Fishery	356	812	2.282	9.989	356					
	EBS survey	347	608	1.753	9.984	347	359	124	0.344	0.453	220
	NBS survey	85	110	1.297	9.696	84	85	35	0.417	0.073	44

Table 2.22—Computation of model weights.

		Hypothesis 1			Hypothesis 2			Hypothesis 3			
		Basic	Simple	Complex	Basic	Simple	Complex	Basic	Simple	Complex	
Criterion	Emphasis	M19.7	M19.8	M19.9	M19.10	M19.11	M19.12	M19.13	M19.14	M19.15	M16.6i
Plausible hypothesis	3	0	0	0	1	1	1	1	1	1	1
Plausible catchability	3	1	1	1	1	1	1	0	0	0	1
Acceptable retrospective bias	3	1	1	1	1	1	1	1	0	1	1
Comparable complexity	2	1	1	0	1	1	0	1	1	0	1
Dev sigmas estimated appropriately	2	0	1	1	0	1	1	0	1	1	0
Fits consistent with variances	2	0	0	1	0	0	1	0	0	1	0
Incremental changes	1	1	0	0	1	0	0	1	0	0	1
Objective criterion for sample sizes	1	0	0	1	0	0	1	0	0	1	0
Change in ageing criteria addressed	1	0	0	1	0	0	1	0	0	1	0
Exponential average emphasis:		0.0001	0.0003	0.0025	0.0025	0.0067	0.0498	0.0001	0.0000	0.0025	0.0025
Model weight:		0.0019	0.0052	0.0384	0.0384	0.1044	0.7712	0.0019	0.0003	0.0384	

Table 2.23a—Retrospective analysis of parameter values (correlations with "peels").

	H2	Hypothesis 1			Hypothesis 2			Hypothesis 3		
	Basic	Basic	Smpl	Cplx	Basic	Smpl	Cplx	Basic	Smpl	Cplx
Parameter	16.6i	19.7	19.8	19.9	19.10	19.11	19.12	19.13	19.14	19.15
Mean ageing bias at age 1[a]	0.365	0.773	0.686	0.168	0.595	0.789	0.077	0.874	0.636	0.420
Mean ageing bias at age 20[a]	0.916	0.915	0.977	0.810	0.682	0.986	0.878	0.965	0.973	0.830
Mean bias at age 1 (2008+)				0.499			0.356			0.960
Mean bias at age 20 (2008+)				0.624			0.612			0.776
Pre-1977 fishing mortality rate	0.529	0.562	0.740	0.464	0.056	0.680	0.050	0.491	0.671	0.428
Asymptotic length	0.871	0.875	0.942	0.052	0.326	0.902	0.351	0.703	0.701	0.043
Mean length at age 1.5	0.777	0.798	0.728	0.903	0.277	0.706	0.898	0.739	0.666	0.900
ln(EBS survey catchability)[b]	0.968	0.964	0.953	0.863	0.235	0.943	0.864	0.677	0.695	0.742
ln(NBS survey catchability)								0.117	0.670	0.792
Natural mortality rate	0.920	0.861	0.876	0.958	0.489	0.909	0.933	0.840	0.686	0.914
Richards growth coefficient	0.669	0.719	0.646	0.772	0.577	0.494	0.802	0.257	0.338	0.818
SD(length at age 20)	0.890	0.890	0.933	0.908	0.492	0.936	0.955	0.879	0.933	0.892
SD(length at age 1)	0.839	0.864	0.830	0.898	0.327	0.808	0.896	0.804	0.783	0.862
ln(mean post-1976 recruitment)	0.938	0.930	0.932	0.886	0.253	0.917	0.833	0.682	0.684	0.756
ln(pre-1977 recruitment offset)	0.606	0.755	0.851	0.663	0.435	0.466	0.735	0.698	0.570	0.669
SD(log-scale recruitment)	0.890	0.933			0.634			0.826		
Brody growth coefficient	0.849	0.871	0.881	0.292	0.560	0.790	0.497	0.647	0.548	0.261
Age_95%width_Fishery	0.947	0.949			0.533			0.871		
Age_inflection_Fishery	0.870	0.883			0.639			0.831		
Age_95%width_EBS_survey	0.924	0.851			0.572			0.842		
Age_inflection_EBS_survey	0.850	0.825			0.517			0.906		
Age_95%width_NBS_survey								0.683		
Age_inflection_NBS_survey								0.793		
Age_ascend_se_Fishery			0.915			0.909			0.739	
Age_descend_se_Fishery			0.786			0.828			0.850	
Age_end_logit_Fishery			0.819			0.898			0.931	
Age_peak_Fishery			0.878			0.868			0.698	
Age_top_logit_Fishery			0.887			0.410			0.424	
Age_ascend_se_EBS_survey			0.699			0.753			0.795	
Age_peak_EBS_survey			0.042			0.895			0.358	
Age_ascend_se_NBS_survey									0.608	
Age_peak_NBS_survey									0.160	
Size_ascend_se_Fishery				0.865			0.899			0.624
Size_descend_se_Fishery				0.005			0.392			0.131
Size_end_logit_Fishery				0.239			0.068			0.780
Size_peak_Fishery				0.027			0.448			0.039
Size_ascend_se_EBS_survey				0.333			0.448			0.235
Size_peak_EBS_survey				0.340			0.318			0.099
Size_ascend_se_NBS_survey										0.779
Size_peak_NBS_survey										0.500
Dirichlet (fishery sizecomps)				0.759			0.824			0.946
Dirichlet (EBS survey sizecomps)[c]				0.937			0.379			0.913
Dirichlet (NBS survey sizecomps)										0.774
Dirichlet (EBS survey agecomps)[c]				0.507			0.267			0.473
Dirichlet (NBS survey agecomps)										0.052

Table 2.23b—Retrospective analysis of parameter values (top four, by model and "peel").

		0	1	2	3	4	5	6	7	8	9	10		
Parameter	Model	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	Corr.	Slope
Mean ageing bias at age 20[a]	M16.6i	0.032	0.052	0.138	0.223	0.231	0.297	0.341	0.380	0.573	0.988	1.104	0.916	0.098
Mean ageing bias at age 20[a]	M19.7	0.174	0.187	0.246	0.320	0.324	0.397	0.464	0.500	0.691	1.076	1.201	0.915	0.096
Mean ageing bias at age 20[a]	M19.8	0.211	0.235	0.334	0.434	0.438	0.504	0.605	0.636	0.811	1.001	1.047	0.977	0.084
Mean ageing bias at age 20[a]	M19.9	0.827	0.819	0.840	0.815	0.815	0.814	0.854	0.889	1.006	1.002	0.950	0.810	0.018
Mean ageing bias at age 20[a]	M19.10	0.180	0.200	0.339	0.449	0.454	0.536	0.599	0.648	0.842	0.180	1.375	0.682	0.072
Mean ageing bias at age 20[a]	M19.11	0.226	0.257	0.442	0.579	0.578	0.651	0.744	0.790	0.967	1.142	1.219	0.986	0.097
Mean ageing bias at age 20[a]	M19.12	0.895	0.920	0.944	0.927	0.907	0.930	0.974	1.016	1.131	1.126	1.086	0.878	0.024
Mean ageing bias at age 20[a]	M19.13	-0.164	-0.075	0.210	0.230	0.327	0.400	0.464	0.504	0.691	1.060	1.218	0.965	0.123
Mean ageing bias at age 20[a]	M19.14	-0.134	-0.093	0.254	0.382	0.575	0.645	0.702	0.746	0.868	1.046	1.050	0.973	0.120
Mean ageing bias at age 20[a]	M19.15	0.821	0.836	0.839	0.839	0.815	0.833	0.864	0.897	1.018	1.010	0.961	0.830	0.019
SD(length at age 20)	M16.6i	9.069	9.473	9.579	9.674	9.784	9.809	9.861	9.605	9.905	10.296	10.412	0.890	0.099
SD(length at age 20)	M19.7	9.203	9.560	9.608	9.666	9.773	9.797	9.825	9.642	9.926	10.308	10.445	0.890	0.092
SD(length at age 20)	M19.8	9.121	9.652	9.700	9.801	9.897	10.008	10.011	9.911	10.239	10.604	10.758	0.933	0.127
SD(length at age 20)	M19.9	10.309	10.429	10.430	10.228	10.228	10.602	10.712	10.950	11.102	11.316	11.452	0.908	0.120
SD(length at age 20)	M19.10	9.110	9.531	9.616	9.706	9.791	9.812	9.830	9.646	9.934	9.110	10.578	0.492	0.059
SD(length at age 20)	M19.11	9.009	9.555	9.673	9.821	9.901	10.011	10.001	9.915	10.227	10.587	10.773	0.936	0.135
SD(length at age 20)	M19.12	9.687	10.015	10.117	10.158	10.402	10.535	10.624	11.297	10.772	11.196	11.462	0.955	0.164
SD(length at age 20)	M19.13	8.926	9.409	9.454	9.759	9.693	9.719	9.750	9.584	9.865	10.242	10.574	0.879	0.114
SD(length at age 20)	M19.14	8.326	9.212	9.204	9.329	9.426	9.537	9.629	9.641	9.918	10.255	10.727	0.933	0.174
SD(length at age 20)	M19.15	9.939	10.043	10.047	10.022	10.086	10.291	10.267	10.622	10.564	11.109	11.591	0.892	0.141
Natural mortality rate	M16.6i	0.333	0.334	0.345	0.346	0.350	0.346	0.343	0.356	0.362	0.368	0.379	0.920	0.004
Natural mortality rate	M19.7	0.353	0.352	0.358	0.354	0.358	0.354	0.354	0.366	0.374	0.381	0.387	0.861	0.003
Natural mortality rate	M19.8	0.419	0.421	0.423	0.421	0.425	0.422	0.431	0.449	0.455	0.455	0.445	0.876	0.004
Natural mortality rate	M19.9	0.360	0.358	0.362	0.364	0.364	0.373	0.379	0.379	0.385	0.386	0.402	0.958	0.004
Natural mortality rate	M19.10	0.334	0.335	0.348	0.348	0.353	0.350	0.350	0.362	0.370	0.334	0.354	0.489	0.002
Natural mortality rate	M19.11	0.402	0.407	0.415	0.415	0.418	0.415	0.421	0.439	0.446	0.445	0.434	0.909	0.004
Natural mortality rate	M19.12	0.349	0.346	0.356	0.357	0.360	0.368	0.374	0.361	0.387	0.393	0.397	0.933	0.005
Natural mortality rate	M19.13	0.318	0.328	0.347	0.335	0.362	0.358	0.358	0.370	0.378	0.387	0.356	0.840	0.005
Natural mortality rate	M19.14	0.396	0.393	0.443	0.475	0.534	0.540	0.566	0.600	0.602	0.597	0.448	0.686	0.017
Natural mortality rate	M19.15	0.358	0.359	0.367	0.371	0.380	0.384	0.392	0.392	0.404	0.415	0.390	0.914	0.005
ln(EBS survey catchability)[b]	M16.6i	0.065	0.065	0.012	-0.002	-0.052	-0.052	-0.040	-0.078	-0.096	-0.097	-0.138	-0.968	-0.019
ln(EBS survey catchability)[b]	M19.7	0.050	0.056	0.013	0.018	-0.022	-0.021	-0.007	-0.040	-0.060	-0.064	-0.078	-0.964	-0.013
ln(EBS survey catchability)[b]	M19.8	-0.127	-0.132	-0.178	-0.186	-0.224	-0.223	-0.221	-0.287	-0.305	-0.302	-0.282	-0.953	-0.018
ln(EBS survey catchability)[b]	M19.9	-0.021	-0.011	-0.028	-0.054	-0.054	-0.101	-0.119	-0.106	-0.084	-0.085	-0.181	-0.863	-0.013
ln(EBS survey catchability)[b]	M19.10	0.132	0.132	0.078	0.069	0.024	0.024	0.037	0.004	-0.013	0.132	0.123	-0.235	-0.004
ln(EBS survey catchability)[b]	M19.11	-0.053	-0.061	-0.113	-0.130	-0.166	-0.164	-0.156	-0.219	-0.239	-0.235	-0.212	-0.943	-0.019
ln(EBS survey catchability)[b]	M19.12	0.014	0.045	0.006	-0.003	-0.020	-0.052	-0.065	0.008	-0.069	-0.096	-0.128	-0.864	-0.014
ln(EBS survey catchability)[b]	M19.13	0.164	0.158	0.064	0.115	-0.041	-0.040	-0.028	-0.062	-0.080	-0.094	0.085	-0.677	-0.020
ln(EBS survey catchability)[b]	M19.14	-0.025	0.000	-0.225	-0.389	-0.759	-0.804	-0.932	-1.212	-1.266	-1.176	-0.295	-0.695	-0.100
ln(EBS survey catchability)[b]	M19.15	-0.032	-0.025	-0.076	-0.092	-0.161	-0.172	-0.211	-0.195	-0.206	-0.279	-0.100	-0.742	-0.018

Table 2.24a—Time-invariant parameters other than selectivity parameters.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated						Ensemble (19.x series)			
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex					
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
Natural mortality rate	0.33	0.01	0.35	0.01	0.42	0.02	0.36	0.01	0.33	0.01	0.40	0.02	0.35	0.01	0.32	0.01	0.40	0.02	0.36	0.01	0.35	0.01	0.37	0.02
Mean length at age 1.5	16.83	0.10	16.75	0.09	16.91	0.10	15.41	0.54	16.85	0.09	16.95	0.10	14.90	0.41	17.01	0.10	17.15	0.10	14.87	0.41	15.23	0.50	16.31	0.41
Asymptotic length	101.3	1.94	100.9	1.88	103.9	2.16	117.9	3.92	100.4	1.85	103.1	2.05	117.3	3.65	99.9	1.78	102.5	1.87	116.3	3.54	115.0	4.11	106.9	3.62
Brody growth coefficient	0.20	0.01	0.20	0.01	0.19	0.01	0.11	0.01	0.20	0.01	0.19	0.01	0.11	0.01	0.21	0.01	0.21	0.01	0.11	0.01	0.12	0.02	0.17	0.02
Richards growth coefficient	1.00	0.05	0.99	0.05	1.01	0.05	1.46	0.04	0.99	0.05	1.01	0.05	1.47	0.04	0.92	0.05	0.91	0.05	1.44	0.04	1.39	0.08	1.13	0.09
SD(length at age 1)	3.66	0.06	3.63	0.06	3.69	0.06	3.43	0.07	3.67	0.06	3.70	0.06	3.51	0.07	3.74	0.06	3.84	0.07	3.48	0.07	3.53	0.07	3.63	0.08
SD(length at age 20)	9.07	0.27	9.20	0.27	9.13	0.28	10.31	0.45	9.11	0.27	9.01	0.28	9.86	0.41	8.93	0.26	8.33	0.28	9.94	0.41	9.76	0.41	9.31	0.38
Mean ageing bias at age 1[a]	0.33	0.01	0.34	0.01	0.32	0.02	0.35	0.01	0.33	0.01	0.32	0.02	0.34	0.02	0.35	0.01	0.33	0.02	0.35	0.01	0.33	0.02	0.34	0.01
Mean ageing bias at age 20[a]	0.03	0.14	0.17	0.14	0.21	0.15	0.83	0.20	0.18	0.14	0.23	0.15	0.91	0.22	-0.16	0.13	-0.13	0.15	0.82	0.20	0.79	0.24	0.34	0.21
Mean bias at age 1 (2008+)							0.01	0.02					0.02	0.02					0.00	0.02	0.02	0.02	0.01	0.02
Mean bias at age 20 (2008+)							-1.85	0.33					-1.72	0.32					-1.94	0.35	-1.73	0.34	-1.84	0.20
ln(mean post-1976 recruitment)	12.96	0.09	13.05	0.09	13.56	0.14	13.15	0.10	12.97	0.09	13.49	0.13	13.10	0.10	12.82	0.08	13.35	0.13	13.15	0.10	13.14	0.12	13.18	0.13
SD(log-scale recruitment)	0.65	0.07	0.66	0.06	0.69	_	0.72	_	0.66	0.07	0.67	_	0.69	_	0.68	0.07	0.62	_	0.68	_	0.69	_	0.67	_
ln(pre-1977 recruitment offset)	-1.19	0.20	-1.17	0.20	-0.98	0.24	-0.97	0.21	-1.19	0.20	-0.98	0.23	-0.95	0.19	-1.23	0.19	-0.99	0.21	-0.93	0.20	-0.96	0.20	-1.04	0.21
Pre-1977 fishing mortality rate	0.18	0.07	0.20	0.08	0.16	0.06	0.15	0.05	0.18	0.07	0.15	0.05	0.13	0.04	0.21	0.09	0.16	0.05	0.14	0.05	0.14	0.05	0.16	0.06
ln(EBS survey catchability)[b]	0.06	0.06	0.05	0.05	-0.13	0.07	-0.02	0.07	0.13	0.05	-0.05	0.07	0.03	0.07	0.16	0.04	-0.02	0.06	-0.03	0.07	0.02	0.07	0.01	0.07
ln(NBS survey catchability)															-0.88	0.08	-0.57	0.17	-1.53	0.27	-1.49	0.26	-0.99	0.30

a. For Models 19.9, 19.12, and 19.15, this parameter applies to 1977-2007 only.

b. For Models 16.6i, 19.10, 19.11, and 19.12, this parameter applies to the combined EBS and NBS surveys.

Table 2.24b—Age composition devs in the initial year (1977).

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated						Ensemble (19.x series)			
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex					
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
Initial age 20 ln(recruits) dev	-0.01	0.65	0.00	0.65	0.00	0.69	-0.01	0.72	-0.01	0.66	0.00	0.67	-0.02	0.69	-0.01	0.67	0.00	0.62	-0.01	0.67	0.00	0.67	-0.01	0.67
Initial age 19 ln(recruits) dev	0.00	0.65	0.00	0.65	0.00	0.69	-0.01	0.72	0.00	0.66	0.00	0.67	-0.01	0.69	0.00	0.67	0.00	0.62	-0.01	0.67	0.00	0.67	0.00	0.67
Initial age 18 ln(recruits) dev	-0.01	0.65	0.00	0.65	0.00	0.69	-0.01	0.72	-0.01	0.66	0.00	0.67	-0.01	0.69	-0.01	0.67	0.00	0.62	-0.01	0.67	0.00	0.67	-0.01	0.67
Initial age 17 ln(recruits) dev	-0.01	0.65	-0.01	0.65	0.00	0.69	-0.02	0.71	-0.01	0.66	-0.01	0.67	-0.02	0.68	-0.01	0.67	-0.01	0.62	-0.02	0.67	-0.01	0.67	-0.01	0.67
Initial age 16 ln(recruits) dev	-0.02	0.64	-0.01	0.65	-0.01	0.69	-0.02	0.71	-0.02	0.66	-0.01	0.67	-0.03	0.68	-0.02	0.67	-0.01	0.62	-0.03	0.67	-0.01	0.67	-0.02	0.67
Initial age 15 ln(recruits) dev	-0.03	0.64	-0.02	0.65	-0.01	0.68	-0.04	0.71	-0.03	0.65	-0.02	0.67	-0.05	0.67	-0.03	0.67	-0.02	0.62	-0.04	0.66	-0.02	0.67	-0.03	0.66
Initial age 14 ln(recruits) dev	-0.05	0.64	-0.03	0.65	-0.02	0.68	-0.06	0.70	-0.05	0.65	-0.03	0.66	-0.07	0.67	-0.05	0.66	-0.03	0.62	-0.06	0.66	-0.03	0.66	-0.04	0.66
Initial age 13 ln(recruits) dev	-0.08	0.63	-0.05	0.64	-0.04	0.68	-0.09	0.69	-0.08	0.64	-0.05	0.66	-0.11	0.66	-0.07	0.66	-0.04	0.61	-0.09	0.65	-0.05	0.66	-0.07	0.65
Initial age 12 ln(recruits) dev	-0.12	0.62	-0.09	0.63	-0.06	0.67	-0.13	0.68	-0.12	0.63	-0.08	0.65	-0.16	0.64	-0.12	0.65	-0.07	0.61	-0.13	0.64	-0.08	0.65	-0.10	0.64
Initial age 11 ln(recruits) dev	-0.18	0.61	-0.14	0.62	-0.10	0.66	-0.19	0.66	-0.18	0.62	-0.12	0.64	-0.22	0.63	-0.18	0.63	-0.10	0.60	-0.19	0.62	-0.13	0.64	-0.16	0.63
Initial age 10 ln(recruits) dev	-0.26	0.59	-0.21	0.61	-0.15	0.65	-0.27	0.65	-0.26	0.60	-0.18	0.63	-0.30	0.61	-0.26	0.62	-0.16	0.58	-0.27	0.61	-0.19	0.62	-0.23	0.62
Initial age 9 ln(recruits) dev	-0.37	0.57	-0.31	0.59	-0.23	0.63	-0.36	0.63	-0.37	0.58	-0.25	0.61	-0.40	0.59	-0.37	0.60	-0.23	0.57	-0.36	0.59	-0.27	0.61	-0.32	0.60
Initial age 8 ln(recruits) dev	-0.49	0.55	-0.42	0.57	-0.32	0.61	-0.46	0.60	-0.49	0.56	-0.35	0.59	-0.50	0.57	-0.49	0.58	-0.32	0.55	-0.46	0.57	-0.37	0.59	-0.43	0.58
Initial age 7 ln(recruits) dev	-0.61	0.53	-0.55	0.54	-0.43	0.58	-0.56	0.58	-0.61	0.54	-0.46	0.57	-0.59	0.55	-0.62	0.56	-0.43	0.53	-0.55	0.55	-0.48	0.57	-0.54	0.56
Initial age 6 ln(recruits) dev	-0.71	0.51	-0.65	0.52	-0.54	0.56	-0.62	0.57	-0.71	0.52	-0.57	0.54	-0.65	0.54	-0.72	0.53	-0.54	0.51	-0.61	0.54	-0.58	0.54	-0.63	0.54
Initial age 5 ln(recruits) dev	-0.68	0.50	-0.65	0.51	-0.56	0.55	-0.58	0.57	-0.69	0.50	-0.58	0.53	-0.59	0.54	-0.71	0.51	-0.58	0.49	-0.56	0.53	-0.59	0.53	-0.62	0.53
Initial age 4 ln(recruits) dev	-0.27	0.48	-0.26	0.49	-0.23	0.53	-0.29	0.59	-0.28	0.48	-0.25	0.52	-0.28	0.55	-0.29	0.49	-0.30	0.48	-0.26	0.55	-0.25	0.52	-0.27	0.51
Initial age 3 ln(recruits) dev	-0.07	0.45	-0.02	0.46	-0.03	0.51	0.27	0.51	-0.06	0.46	-0.08	0.50	0.21	0.49	-0.02	0.46	-0.08	0.46	0.21	0.49	-0.06	0.50	0.01	0.49
Initial age 2 ln(recruits) dev	-0.20	0.51	-0.17	0.52	-0.16	0.57	-0.04	0.60	-0.20	0.52	-0.18	0.56	-0.08	0.57	-0.21	0.52	-0.21	0.51	-0.08	0.57	-0.17	0.56	-0.16	0.55
Initial age 1 ln(recruits) dev	0.82	0.47	0.82	0.48	0.83	0.51	0.68	0.69	0.81	0.48	0.79	0.50	0.82	0.55	0.84	0.47	0.65	0.46	0.78	0.57	0.79	0.51	0.78	0.52

Table 2.24c—Age 0 recruitment devs.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated											
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)					
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted			
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD		
ln(recruits) dev 1977	0.75	0.21	0.86	0.20	0.97	0.22	1.01	0.23	0.77	0.21	0.88	0.22	0.92	0.23	0.72	0.20	0.75	0.21	0.98	0.22	0.92	0.23	0.87	0.24		
ln(recruits) dev 1978	0.41	0.22	0.51	0.22	0.66	0.22	0.71	0.23	0.43	0.22	0.58	0.22	0.57	0.23	0.42	0.21	0.57	0.19	0.63	0.23	0.57	0.23	0.56	0.24		
ln(recruits) dev 1979	0.41	0.13	0.52	0.13	0.50	0.14	0.68	0.13	0.44	0.13	0.42	0.14	0.59	0.13	0.44	0.13	0.43	0.13	0.64	0.13	0.57	0.15	0.52	0.16		
ln(recruits) dev 1980	-0.30	0.13	-0.22	0.13	-0.17	0.14	-0.87	0.26	-0.27	0.13	-0.22	0.14	-0.85	0.24	-0.27	0.13	-0.19	0.13	-0.85	0.25	-0.76	0.32	-0.43	0.35		
ln(recruits) dev 1981	-0.90	0.14	-0.83	0.14	-0.82	0.15	-0.60	0.17	-0.88	0.14	-0.86	0.15	-0.67	0.17	-0.85	0.14	-0.84	0.15	-0.64	0.17	-0.70	0.18	-0.78	0.18		
ln(recruits) dev 1982	0.74	0.05	0.81	0.05	0.87	0.05	0.96	0.06	0.76	0.05	0.82	0.05	0.89	0.06	0.78	0.05	0.81	0.05	0.93	0.06	0.88	0.07	0.85	0.08		
ln(recruits) dev 1983	-0.63	0.13	-0.53	0.12	-0.53	0.14	-0.45	0.16	-0.61	0.12	-0.59	0.14	-0.50	0.16	-0.59	0.12	-0.53	0.13	-0.46	0.16	-0.51	0.16	-0.53	0.15		
ln(recruits) dev 1984	0.75	0.05	0.83	0.05	0.86	0.05	0.84	0.06	0.77	0.05	0.80	0.05	0.78	0.06	0.80	0.05	0.80	0.05	0.81	0.06	0.78	0.06	0.81	0.06		
ln(recruits) dev 1985	-0.24	0.09	-0.20	0.09	-0.08	0.08	0.08	0.09	-0.27	0.09	-0.15	0.08	0.01	0.09	-0.24	0.09	-0.08	0.08	0.04	0.09	-0.02	0.12	-0.10	0.15		
ln(recruits) dev 1986	-0.64	0.12	-0.62	0.11	-0.53	0.09	-0.51	0.11	-0.68	0.11	-0.58	0.09	-0.55	0.11	-0.65	0.11	-0.54	0.09	-0.53	0.11	-0.56	0.11	-0.58	0.12		
ln(recruits) dev 1987	-1.19	0.17	-1.23	0.17	-1.47	0.17	-1.63	0.23	-1.27	0.18	-1.50	0.17	-1.64	0.23	-1.20	0.17	-1.41	0.15	-1.62	0.23	-1.60	0.24	-1.44	0.25		
ln(recruits) dev 1988	-0.38	0.10	-0.42	0.10	-0.52	0.09	-0.19	0.09	-0.45	0.10	-0.55	0.09	-0.23	0.09	-0.42	0.10	-0.55	0.09	-0.22	0.09	-0.27	0.14	-0.39	0.16		
ln(recruits) dev 1989	0.51	0.06	0.51	0.05	0.48	0.05	0.49	0.06	0.48	0.06	0.45	0.05	0.45	0.06	0.50	0.05	0.44	0.05	0.47	0.06	0.45	0.06	0.48	0.06		
ln(recruits) dev 1990	0.35	0.06	0.39	0.06	0.38	0.06	0.46	0.07	0.35	0.06	0.33	0.06	0.40	0.07	0.39	0.06	0.35	0.05	0.43	0.07	0.40	0.07	0.39	0.07		
ln(recruits) dev 1991	-0.07	0.07	0.01	0.07	0.01	0.07	-0.16	0.10	-0.04	0.07	-0.03	0.07	-0.18	0.10	0.00	0.07	0.00	0.07	-0.18	0.10	-0.16	0.11	-0.06	0.11		
ln(recruits) dev 1992	0.74	0.04	0.85	0.04	0.87	0.04	0.85	0.04	0.80	0.04	0.82	0.04	0.80	0.04	0.84	0.04	0.83	0.03	0.82	0.04	0.81	0.05	0.83	0.04		
ln(recruits) dev 1993	-0.16	0.06	-0.08	0.06	-0.04	0.06	-0.02	0.07	-0.13	0.06	-0.09	0.06	-0.10	0.08	-0.09	0.06	-0.05	0.05	-0.05	0.07	-0.10	0.08	-0.07	0.07		
ln(recruits) dev 1994	-0.33	0.07	-0.32	0.07	-0.31	0.06	-0.24	0.07	-0.37	0.07	-0.36	0.06	-0.29	0.07	-0.32	0.06	-0.32	0.06	-0.26	0.07	-0.30	0.08	-0.31	0.08		
ln(recruits) dev 1995	-0.39	0.07	-0.38	0.07	-0.44	0.07	-0.36	0.08	-0.41	0.07	-0.47	0.07	-0.40	0.08	-0.37	0.07	-0.45	0.06	-0.38	0.08	-0.41	0.08	-0.41	0.08		
ln(recruits) dev 1996	0.58	0.04	0.60	0.04	0.61	0.04	0.81	0.04	0.57	0.04	0.58	0.04	0.75	0.04	0.58	0.04	0.57	0.03	0.78	0.04	0.73	0.08	0.65	0.10		
ln(recruits) dev 1997	-0.19	0.06	-0.12	0.06	-0.14	0.06	-0.02	0.07	-0.16	0.06	-0.19	0.06	-0.06	0.07	-0.13	0.06	-0.15	0.05	-0.04	0.07	-0.08	0.08	-0.11	0.08		
ln(recruits) dev 1998	-0.19	0.06	-0.19	0.06	-0.21	0.06	-0.26	0.09	-0.22	0.06	-0.24	0.06	-0.30	0.09	-0.16	0.06	-0.19	0.06	-0.27	0.09	-0.29	0.09	-0.23	0.08		
ln(recruits) dev 1999	0.47	0.04	0.52	0.04	0.49	0.04	0.59	0.05	0.48	0.04	0.45	0.04	0.53	0.05	0.51	0.04	0.46	0.04	0.57	0.05	0.52	0.06	0.51	0.06		
ln(recruits) dev 2000	0.26	0.04	0.34	0.04	0.27	0.04	0.25	0.05	0.30	0.04	0.22	0.04	0.22	0.05	0.33	0.04	0.28	0.04	0.25	0.05	0.22	0.06	0.27	0.06		
ln(recruits) dev 2001	-0.59	0.07	-0.56	0.07	-0.53	0.06	-0.55	0.10	-0.60	0.07	-0.57	0.06	-0.66	0.10	-0.55	0.07	-0.49	0.06	-0.57	0.10	-0.64	0.10	-0.56	0.09		
ln(recruits) dev 2002	-0.26	0.05	-0.23	0.05	-0.25	0.05	-0.13	0.06	-0.26	0.05	-0.28	0.05	-0.16	0.06	-0.22	0.05	-0.20	0.05	-0.12	0.06	-0.17	0.07	-0.21	0.08		
ln(recruits) dev 2003	-0.45	0.06	-0.41	0.06	-0.42	0.05	-0.20	0.07	-0.43	0.06	-0.44	0.05	-0.23	0.07	-0.39	0.06	-0.35	0.05	-0.18	0.07	-0.26	0.10	-0.34	0.12		
ln(recruits) dev 2004	-0.59	0.06	-0.55	0.06	-0.59	0.06	-0.47	0.08	-0.59	0.06	-0.63	0.06	-0.51	0.08	-0.52	0.06	-0.50	0.06	-0.45	0.08	-0.52	0.09	-0.53	0.09		
ln(recruits) dev 2005	-0.33	0.05	-0.28	0.05	-0.32	0.05	-0.29	0.08	-0.30	0.05	-0.34	0.05	-0.32	0.07	-0.26	0.05	-0.32	0.05	-0.30	0.07	-0.32	0.07	-0.30	0.06		
ln(recruits) dev 2006	0.79	0.03	0.79	0.03	0.76	0.03	0.80	0.04	0.76	0.03	0.73	0.03	0.77	0.04	0.78	0.03	0.64	0.03	0.75	0.04	0.77	0.04	0.75	0.06		
ln(recruits) dev 2007	-0.03	0.05	-0.05	0.05	-0.10	0.06	-0.13	0.09	-0.09	0.06	-0.13	0.06	-0.18	0.09	-0.07	0.05	-0.25	0.06	-0.19	0.09	-0.17	0.09	-0.13	0.09		
ln(recruits) dev 2008	1.10	0.03	1.10	0.03	1.07	0.03	1.09	0.04	1.10	0.03	1.06	0.03	1.07	0.04	1.07	0.03	0.95	0.03	1.03	0.04	1.07	0.04	1.06	0.06		
ln(recruits) dev 2009	-0.90	0.10	-0.90	0.10	-0.88	0.11	-0.87	0.15	-0.91	0.11	-0.89	0.11	-0.89	0.16	-0.81	0.10	-0.43	0.07	-0.71	0.13	-0.88	0.16	-0.81	0.19		
ln(recruits) dev 2010	0.60	0.04	0.62	0.04	0.58	0.04	0.60	0.05	0.66	0.04	0.63	0.04	0.64	0.05	0.61	0.04	0.45	0.04	0.55	0.05	0.63	0.05	0.59	0.07		
ln(recruits) dev 2011	0.98	0.04	0.89	0.03	0.85	0.04	0.80	0.05	0.95	0.03	0.91	0.04	0.88	0.05	0.91	0.03	0.78	0.03	0.76	0.05	0.88	0.06	0.86	0.07		
ln(recruits) dev 2012	0.19	0.06	0.05	0.06	0.05	0.06	-0.05	0.09	0.17	0.06	0.18	0.06	0.07	0.09	0.14	0.05	0.09	0.06	-0.04	0.09	0.07	0.10	0.07	0.11		
ln(recruits) dev 2013	1.00	0.04	0.87	0.04	0.84	0.04	0.83	0.05	1.04	0.04	1.04	0.04	1.10	0.05	0.95	0.03	0.87	0.03	0.83	0.05	1.07	0.09	0.93	0.11		
ln(recruits) dev 2014	-0.73	0.09	-0.93	0.09	-0.87	0.09	-0.83	0.11	-0.73	0.09	-0.66	0.09	-0.63	0.12	-0.86	0.07	-0.74	0.07	-0.84	0.11	-0.66	0.13	-0.79	0.13		
ln(recruits) dev 2015	-0.29	0.07	-0.58	0.07	-0.51	0.06	-0.59	0.08	-0.33	0.06	-0.26	0.06	-0.33	0.08	-0.44	0.05	-0.32	0.05	-0.51	0.08	-0.34	0.10	-0.43	0.14		
ln(recruits) dev 2016	-0.98	0.10	-1.17	0.10	-1.16	0.09	-1.30	0.10	-1.03	0.10	-1.03	0.09	-0.94	0.12	-1.38	0.08	-1.14	0.08	-1.11	0.12	-0.98	0.14	-1.14	0.16		
ln(recruits) dev 2017	-0.85	0.13	-1.23	0.14	-1.24	0.13	-1.53	0.22	-0.88	0.13	-0.93	0.12	-1.34	0.28	-0.92	0.09	-0.96	0.10	-1.21	0.23	-1.28	0.30	-1.14	0.27		
ln(recruits) dev 2018	0.96	0.11	0.98	0.10	1.01	0.09	0.40	0.11	1.08	0.09	1.10	0.08	0.53	0.10	0.93	0.09	0.92	0.08	0.45	0.10	0.60	0.23	0.82	0.28		

Table 2.24d—Selectivity parameters.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
Age_inflection_Fishery	4.33	0.04	4.31	0.04					4.32	0.04					4.32	0.04					4.32	0.04	4.32	0.04
Age_95%width_Fishery	1.19	0.03	1.17	0.03					1.18	0.03					1.19	0.03					1.18	0.03	1.18	0.03
Age_inflection_Survey	1.00	0.01	1.00	0.01					1.00	0.01					0.99	0.01					1.00	0.01	1.00	0.01
Age_95%width_Survey	0.29	0.05	0.28	0.05					0.29	0.04					0.28	0.05					0.29	0.05	0.29	0.05
Age_inflection_NBS_survey															1.22	0.14					1.22	0.03	1.22	0.08
Age_95%width_NBS_survey															0.41	0.25					0.41	0.05	0.41	0.14
Age_peak_Fishery					5.93	0.09					5.93	0.09					5.80	0.09			5.93	0.01	5.88	0.06
Age_top_logit_Fishery					-7.41	32.07					-5.04	1.15					-5.11	44.80			-5.15	0.50	-5.85	1.10
Age_ascend_se_Fishery					0.96	0.05					0.97	0.05					0.93	0.05			0.97	0.00	0.96	0.02
Age_descend_se_Fishery					-7.03	28.63					-9.94	1.93					-4.63	69.25			-9.79	0.67	-7.20	2.17
Age_start_logit_Fishery					-10.0	_					-10.0	_					-10.0	_			-10.0	_	-10.0	_
Age_end_logit_Fishery					1.44	0.47					1.37	0.43					1.48	0.46			1.37	0.02	1.43	0.05
Age_peak_Survey					2.91	0.14					2.98	0.14					2.95	0.14			2.97	0.01	2.94	0.03
Age_top_logit_Survey					10.00	_					10.00	_					10.00	_			10.00	_	10.00	_
Age_ascend_se_Survey					1.72	0.18					1.89	0.19					1.92	0.20			1.88	0.03	1.84	0.08
Age_descend_se_Survey					10.00	_					10.00	_					10.00	_			10.00	_	10.00	_
Age_start_logit_Survey					-10.0	_					-10.0	_					-10.0	_			-10.0	_	-10.0	_
Age_end_logit_Survey					10.00	_					10.00	_					10.00	_			10.00	_	10.00	_
Age_peak_NBS_survey																	7.96	1.12			7.96	0.00	7.96	0.00
Age_top_logit_NBS_survey																	10.00	_			10.00	_	10.00	_
Age_ascend_se_NBS_survey																	3.68	0.40			3.68	0.00	3.68	0.00
Age_descend_se_NBS_survey																	10.00	_			10.00	_	10.00	_
Age_start_logit_NBS_survey																	-10.0	_			-10.0	_	-10.0	_
Age_end_logit_NBS_survey																	10.00	_			10.00	_	10.00	_
Size_peak_Fishery							75.92	0.15					76.01	0.01					75.92	0.16	76.00	0.03	75.95	0.04
Size_top_logit_Fishery							-10.0	_					-10.0	_					-10.0	_	-10.0	_	-10.0	_
Size_ascend_se_Fishery							5.96	0.03					5.98	0.03					5.96	0.03	5.97	0.00	5.97	0.01
Size_descend_se_Fishery							-7.26	19.17					-9.99	0.46					-6.98	24.68	-9.73	0.82	-8.07	1.36
Size_start_logit_Fishery							-10.0	_					-10.0	_					-10.0	_	-10.0	_	-10.0	_
Size_end_logit_Fishery							2.06	0.32					2.01	0.31					1.93	0.29	2.01	0.02	2.00	0.05
Size_peak_Survey							20.77	0.83					20.80	0.82					20.93	0.85	20.80	0.03	20.83	0.07
Size_top_logit_Survey							10.00	_					10.00	_					10.00	_	10.00	_	10.00	_
Size_ascend_se_Survey							3.46	0.17					3.50	0.16					3.51	0.16	3.50	0.01	3.49	0.02
Size_descend_se_Survey							10.00	_					10.00	_					10.00	_	10.00	_	10.00	_
Size_start_logit_Survey							-10.0	_					-10.0	_					-10.0	_	-10.0	_	-10.0	_
Size_end_logit_Survey							10.00	_					10.00	_					10.00	_	10.00	_	10.00	_
Size_peak_NBS_survey																			110.0	0.98	110.0	0.00	110.0	0.00
Size_top_logit_NBS_survey																			10.00	_	10.00	_	10.00	_
Size_ascend_se_NBS_survey																			8.48	0.15	8.48	0.00	8.48	0.00
Size_descend_se_NBS_survey																			10.00	_	10.00	_	10.00	_
Size_start_logit_NBS_survey																			-10.0	_	-10.0	_	-10.0	_
Size_end_logit_NBS_survey																			10.00	_	10.00	_	10.00	_

Table 2.24e—Input standard deviations for dev vectors; Dirichlet-multinomial parameters.

Hypothesis:	1: EBS only		2: EBS+NBS		3: EBS, NBS					
Structure:	Complex		Complex		Complex		Ensemble (19.x series)			
Model:	M19.9		M19.12		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
SD(L at age 1.5 deviations)	0.21	_	0.15	_	0.16	_	0.16	_	0.17	_
SD(EBS catchability deviations)[a]	0.08	_	0.08	_	0.08	_	0.08	_	0.08	_
SD(NBS catchability deviations)					0.60	_	0.60	_	0.60	_
SD(fishery ascending_se deviations)	0.14	_	0.15	_	0.14	_	0.15	_	0.14	_
SD(fishery end_logit deviations)	0.81	_	0.77	_	0.82	_	0.77	_	0.80	_
SD(survey peak deviations)	0.22	_	0.22	_	0.23	_	0.22	_	0.22	_
SD(survey ascending_se deviations)	0.86	_	0.83	_	0.84	_	0.83	_	0.84	_
Dirichlet coef. (fishery sizecomps)	9.99	0.34	9.99	0.34	9.99	0.36	9.99	0.34	9.99	0.34
Dirichlet coef. (EBS survey sizecomps)[a]	9.98	0.48	9.98	0.52	9.98	0.50	9.98	0.51	9.98	0.50
Dirichlet coef. (NBS survey sizecomps)					9.70	8.61	9.70	8.61	9.70	8.61
Dirichlet coef. (EBS survey agecomps)[a]	0.64	0.32	0.10	0.23	0.45	0.28	0.14	0.27	0.40	0.36
Dirichlet coef. (NBS survey agecomps)					0.07	0.48	0.07	0.48	0.07	0.48

a. For Model 19.12, this parameter applies to the combined EBS and NBS surveys.

Table 2.24f—Length at age 1.5 devs.

Hypothesis:	1: EBS only		2: EBS+NBS		3: EBS, NBS					
Structure:	Complex		Complex		Complex		Ensemble (19.x series)			
Model:	M19.9		M19.12		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
L_at_Amin_Fem_GP_1_DEVmult_1977	0.47	0.91	0.40	0.96	0.29	0.95	0.39	0.95	0.38	0.94
L_at_Amin_Fem_GP_1_DEVmult_1978	-0.09	0.91	-0.11	0.94	-0.11	0.94	-0.11	0.94	-0.10	0.93
L_at_Amin_Fem_GP_1_DEVmult_1979	0.67	0.96	0.49	1.02	0.51	1.01	0.50	1.01	0.56	1.00
L_at_Amin_Fem_GP_1_DEVmult_1980	-0.05	0.86	-0.07	0.92	-0.06	0.91	-0.07	0.92	-0.06	0.90
L_at_Amin_Fem_GP_1_DEVmult_1981	-1.05	0.37	-1.12	0.47	-1.10	0.46	-1.12	0.46	-1.09	0.44
L_at_Amin_Fem_GP_1_DEVmult_1982	-0.88	0.25	-0.96	0.31	-0.93	0.30	-0.95	0.31	-0.92	0.29
L_at_Amin_Fem_GP_1_DEVmult_1983	0.88	0.67	1.09	0.79	1.07	0.72	1.08	0.79	1.01	0.74
L_at_Amin_Fem_GP_1_DEVmult_1984	0.13	0.20	0.37	0.23	0.35	0.23	0.36	0.24	0.28	0.25
L_at_Amin_Fem_GP_1_DEVmult_1985	-1.37	0.34	-1.57	0.43	-1.53	0.42	-1.55	0.43	-1.49	0.41
L_at_Amin_Fem_GP_1_DEVmult_1986	-0.07	0.22	0.09	0.27	0.12	0.26	0.09	0.27	0.05	0.26
L_at_Amin_Fem_GP_1_DEVmult_1987	-0.53	0.34	-0.52	0.43	-0.45	0.41	-0.52	0.43	-0.50	0.40
L_at_Amin_Fem_GP_1_DEVmult_1988	-0.82	0.34	-0.88	0.42	-0.80	0.41	-0.87	0.42	-0.83	0.39
L_at_Amin_Fem_GP_1_DEVmult_1989	-0.77	0.23	-0.82	0.28	-0.79	0.27	-0.82	0.28	-0.79	0.26
L_at_Amin_Fem_GP_1_DEVmult_1990	-0.20	0.25	-0.06	0.30	-0.03	0.29	-0.06	0.30	-0.10	0.29
L_at_Amin_Fem_GP_1_DEVmult_1991	0.22	0.21	0.50	0.25	0.50	0.25	0.49	0.26	0.41	0.27
L_at_Amin_Fem_GP_1_DEVmult_1992	-0.18	0.20	-0.04	0.23	-0.03	0.23	-0.04	0.23	-0.08	0.23
L_at_Amin_Fem_GP_1_DEVmult_1993	0.07	0.30	0.29	0.36	0.31	0.36	0.28	0.36	0.22	0.36
L_at_Amin_Fem_GP_1_DEVmult_1994	-0.25	0.23	-0.17	0.28	-0.11	0.27	-0.17	0.28	-0.18	0.27
L_at_Amin_Fem_GP_1_DEVmult_1995	-0.27	0.29	-0.23	0.35	-0.15	0.35	-0.22	0.35	-0.22	0.34
L_at_Amin_Fem_GP_1_DEVmult_1996	-0.21	0.22	-0.08	0.26	-0.07	0.25	-0.09	0.26	-0.12	0.25
L_at_Amin_Fem_GP_1_DEVmult_1997	-0.29	0.25	-0.18	0.31	-0.14	0.30	-0.18	0.31	-0.20	0.30
L_at_Amin_Fem_GP_1_DEVmult_1998	-0.76	0.25	-0.74	0.30	-0.73	0.29	-0.74	0.30	-0.74	0.28
L_at_Amin_Fem_GP_1_DEVmult_1999	-1.12	0.22	-1.26	0.26	-1.23	0.25	-1.26	0.26	-1.20	0.25
L_at_Amin_Fem_GP_1_DEVmult_2000	0.40	0.20	0.74	0.24	0.72	0.23	0.72	0.25	0.62	0.27
L_at_Amin_Fem_GP_1_DEVmult_2001	0.07	0.22	0.33	0.27	0.32	0.26	0.32	0.27	0.24	0.28
L_at_Amin_Fem_GP_1_DEVmult_2002	0.33	0.20	0.64	0.23	0.62	0.23	0.62	0.24	0.53	0.26
L_at_Amin_Fem_GP_1_DEVmult_2003	-0.03	0.24	0.15	0.29	0.15	0.28	0.15	0.29	0.09	0.28
L_at_Amin_Fem_GP_1_DEVmult_2004	0.78	0.20	1.30	0.24	1.22	0.23	1.27	0.26	1.10	0.32
L_at_Amin_Fem_GP_1_DEVmult_2005	-0.30	0.23	-0.18	0.28	-0.16	0.27	-0.19	0.28	-0.21	0.27
L_at_Amin_Fem_GP_1_DEVmult_2006	-0.37	0.19	-0.29	0.21	-0.23	0.21	-0.29	0.21	-0.29	0.21
L_at_Amin_Fem_GP_1_DEVmult_2007	-0.97	0.24	-1.03	0.30	-0.97	0.29	-1.03	0.30	-0.99	0.28
L_at_Amin_Fem_GP_1_DEVmult_2008	-1.11	0.20	-1.25	0.23	-1.19	0.23	-1.24	0.23	-1.18	0.23
L_at_Amin_Fem_GP_1_DEVmult_2009	-0.72	0.31	-0.78	0.37	-0.62	0.33	-0.77	0.37	-0.71	0.35
L_at_Amin_Fem_GP_1_DEVmult_2010	0.07	0.19	0.24	0.21	0.26	0.20	0.24	0.21	0.19	0.22
L_at_Amin_Fem_GP_1_DEVmult_2011	-0.98	0.23	-1.22	0.27	-1.05	0.27	-1.20	0.28	-1.08	0.28
L_at_Amin_Fem_GP_1_DEVmult_2012	-0.01	0.26	0.23	0.30	0.14	0.31	0.22	0.31	0.12	0.31
L_at_Amin_Fem_GP_1_DEVmult_2013	-0.32	0.19	-0.36	0.23	-0.23	0.22	-0.35	0.23	-0.30	0.22
L_at_Amin_Fem_GP_1_DEVmult_2014	-0.02	0.31	0.13	0.40	0.14	0.38	0.12	0.40	0.08	0.37
L_at_Amin_Fem_GP_1_DEVmult_2015	1.13	0.19	1.68	0.22	1.61	0.21	1.65	0.24	1.47	0.32
L_at_Amin_Fem_GP_1_DEVmult_2016	1.82	0.22	1.88	0.32	2.10	0.29	1.89	0.31	1.93	0.30
L_at_Amin_Fem_GP_1_DEVmult_2017	1.44	0.24	1.33	0.33	1.61	0.28	1.35	0.33	1.46	0.31
L_at_Amin_Fem_GP_1_DEVmult_2018	1.81	0.18	2.40	0.19	2.26	0.19	2.36	0.23	2.16	0.31
L_at_Amin_Fem_GP_1_DEVmult_2019	3.46	0.33	-0.37	1.34	-1.59	0.96	-0.26	1.55	0.50	2.36

Table 2.24g—Log catchability devs.

Hypothesis:	1: EBS only		2: EBS+NBS		3: EBS, NBS			
Structure:	Complex		Complex		Complex		Ensemble (19.x series)	
Model:	M19.9		M19.12		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
LnQ_base_EBS_survey(2)_DEVadd_1982	-0.04	0.72	0.10	0.70	0.00	0.71	0.09	0.71	0.02	0.71
LnQ_base_EBS_survey(2)_DEVadd_1983	0.60	0.75	0.81	0.74	0.64	0.74	0.79	0.74	0.68	0.75
LnQ_base_EBS_survey(2)_DEVadd_1984	-1.13	0.69	-0.91	0.67	-0.95	0.67	-0.93	0.68	-1.00	0.69
LnQ_base_EBS_survey(2)_DEVadd_1985	0.91	0.68	0.99	0.66	1.00	0.67	0.98	0.66	0.96	0.67
LnQ_base_EBS_survey(2)_DEVadd_1986	0.35	0.64	0.35	0.63	0.43	0.64	0.35	0.63	0.38	0.64
LnQ_base_EBS_survey(2)_DEVadd_1987	0.00	0.62	0.23	0.62	0.09	0.61	0.21	0.62	0.10	0.62
LnQ_base_EBS_survey(2)_DEVadd_1988	-0.26	0.61	-0.39	0.60	-0.19	0.61	-0.38	0.61	-0.28	0.61
LnQ_base_EBS_survey(2)_DEVadd_1989	-1.81	0.64	-1.85	0.63	-1.78	0.63	-1.85	0.63	-1.81	0.63
LnQ_base_EBS_survey(2)_DEVadd_1990	-0.93	0.70	-1.02	0.70	-0.91	0.70	-1.01	0.70	-0.95	0.70
LnQ_base_EBS_survey(2)_DEVadd_1991	-1.25	0.70	-1.16	0.70	-1.20	0.70	-1.16	0.70	-1.20	0.70
LnQ_base_EBS_survey(2)_DEVadd_1992	-1.28	0.71	-1.31	0.71	-1.21	0.71	-1.31	0.71	-1.27	0.71
LnQ_base_EBS_survey(2)_DEVadd_1993	0.54	0.72	0.67	0.71	0.58	0.71	0.66	0.71	0.60	0.72
LnQ_base_EBS_survey(2)_DEVadd_1994	4.15	0.64	4.02	0.63	4.21	0.64	4.03	0.64	4.12	0.64
LnQ_base_EBS_survey(2)_DEVadd_1995	1.90	0.63	1.80	0.62	1.96	0.63	1.81	0.62	1.89	0.63
LnQ_base_EBS_survey(2)_DEVadd_1996	1.84	0.65	2.07	0.68	1.88	0.65	2.05	0.68	1.93	0.67
LnQ_base_EBS_survey(2)_DEVadd_1997	-0.36	0.65	-0.14	0.67	-0.33	0.65	-0.16	0.67	-0.28	0.66
LnQ_base_EBS_survey(2)_DEVadd_1998	-0.55	0.69	-0.03	0.71	-0.51	0.69	-0.08	0.72	-0.36	0.73
LnQ_base_EBS_survey(2)_DEVadd_1999	-0.33	0.67	-0.46	0.66	-0.31	0.67	-0.45	0.67	-0.37	0.67
LnQ_base_EBS_survey(2)_DEVadd_2000	-1.59	0.64	-1.54	0.63	-1.61	0.63	-1.55	0.63	-1.58	0.63
LnQ_base_EBS_survey(2)_DEVadd_2001	1.80	0.64	1.87	0.64	1.80	0.64	1.86	0.64	1.82	0.64
LnQ_base_EBS_survey(2)_DEVadd_2002	-0.55	0.65	-0.29	0.66	-0.61	0.65	-0.31	0.67	-0.49	0.67
LnQ_base_EBS_survey(2)_DEVadd_2003	-0.01	0.69	0.49	0.71	-0.08	0.69	0.44	0.73	0.13	0.74
LnQ_base_EBS_survey(2)_DEVadd_2004	-1.18	0.64	-0.93	0.65	-1.34	0.64	-0.96	0.66	-1.15	0.66
LnQ_base_EBS_survey(2)_DEVadd_2005	-0.27	0.65	-0.04	0.65	-0.52	0.65	-0.07	0.66	-0.28	0.68
LnQ_base_EBS_survey(2)_DEVadd_2006	-0.81	0.65	-1.00	0.64	-1.08	0.64	-1.00	0.64	-0.96	0.66
LnQ_base_EBS_survey(2)_DEVadd_2007	-0.93	0.69	-1.00	0.68	-0.92	0.68	-1.00	0.68	-0.95	0.68
LnQ_base_EBS_survey(2)_DEVadd_2008	-2.27	0.66	-2.51	0.66	-2.23	0.66	-2.48	0.66	-2.33	0.67
LnQ_base_EBS_survey(2)_DEVadd_2009	-1.65	0.72	-2.05	0.69	-1.60	0.68	-2.02	0.70	-1.77	0.72
LnQ_base_EBS_survey(2)_DEVadd_2010	0.17	0.64	-0.17	0.63	0.42	0.63	-0.13	0.64	0.14	0.68
LnQ_base_EBS_survey(2)_DEVadd_2011	0.93	0.65	0.69	0.65	1.04	0.65	0.71	0.65	0.88	0.67
LnQ_base_EBS_survey(2)_DEVadd_2012	0.33	0.71	-0.18	0.72	0.44	0.70	-0.13	0.73	0.19	0.76
LnQ_base_EBS_survey(2)_DEVadd_2013	-0.93	0.66	-1.69	0.66	-0.80	0.65	-1.62	0.70	-1.14	0.77
LnQ_base_EBS_survey(2)_DEVadd_2014	2.51	0.71	1.94	0.72	2.54	0.70	2.00	0.74	2.33	0.76
LnQ_base_EBS_survey(2)_DEVadd_2015	2.00	0.67	0.67	0.70	1.94	0.67	0.79	0.79	1.54	0.92
LnQ_base_EBS_survey(2)_DEVadd_2016	1.60	0.67	0.82	0.80	1.50	0.66	0.88	0.82	1.31	0.79
LnQ_base_EBS_survey(2)_DEVadd_2017	-1.34	0.69	-1.31	0.66	-1.47	0.69	-1.32	0.66	-1.37	0.68
LnQ_base_EBS_survey(2)_DEVadd_2018	-0.10	0.75	1.59	0.76	-0.61	0.75	1.42	0.95	0.29	1.21
LnQ_base_EBS_survey(2)_DEVadd_2019	-0.07	0.87	0.92	0.81	-0.18	0.86	0.82	0.87	0.22	0.98
LnQ_base_NBS_survey(3)_DEVadd_1982					-1.33	0.58	-1.33	0.58	-1.33	0.58
LnQ_base_NBS_survey(3)_DEVadd_1985					-0.97	0.68	-0.97	0.68	-0.97	0.68
LnQ_base_NBS_survey(3)_DEVadd_1988					-2.19	0.68	-2.19	0.68	-2.19	0.68
LnQ_base_NBS_survey(3)_DEVadd_1991					-0.61	0.66	-0.61	0.66	-0.61	0.66
LnQ_base_NBS_survey(3)_DEVadd_2010					-3.20	0.55	-3.20	0.55	-3.20	0.55
LnQ_base_NBS_survey(3)_DEVadd_2017					1.96	0.42	1.96	0.42	1.96	0.42
LnQ_base_NBS_survey(3)_DEVadd_2018					3.19	0.44	3.19	0.44	3.19	0.44
LnQ_base_NBS_survey(3)_DEVadd_2019					3.16	0.43	3.16	0.43	3.16	0.43

Table 2.24h—Fishery selectivity "ascending standard error" devs.

Hypothesis:	1: EBS only		2: EBS+NBS		3: EBS, NBS					
Structure:	Complex		Complex		Complex		Ensemble (19.x series)			
Model:	M19.9		M19.12		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
DblN_ascend_se_Fishery_dev_1977	0.10	0.98	0.14	0.98	0.12	0.98	0.13	0.98	0.12	0.98
DblN_ascend_se_Fishery_dev_1978	0.07	0.92	0.08	0.91	0.08	0.92	0.08	0.91	0.08	0.92
DblN_ascend_se_Fishery_dev_1979	0.27	0.85	0.35	0.82	0.33	0.84	0.34	0.82	0.32	0.83
DblN_ascend_se_Fishery_dev_1980	0.24	0.88	0.29	0.86	0.27	0.88	0.29	0.86	0.27	0.87
DblN_ascend_se_Fishery_dev_1981	0.86	0.90	1.00	0.88	0.95	0.89	0.99	0.88	0.94	0.89
DblN_ascend_se_Fishery_dev_1982	-0.10	0.95	-0.10	0.94	-0.10	0.95	-0.10	0.94	-0.10	0.94
DblN_ascend_se_Fishery_dev_1983	0.10	0.86	0.09	0.83	0.09	0.85	0.09	0.83	0.09	0.85
DblN_ascend_se_Fishery_dev_1984	0.84	0.65	0.80	0.61	0.84	0.65	0.80	0.62	0.82	0.64
DblN_ascend_se_Fishery_dev_1985	-0.25	0.59	-0.24	0.55	-0.26	0.58	-0.24	0.55	-0.25	0.57
DblN_ascend_se_Fishery_dev_1986	0.59	0.60	0.56	0.57	0.57	0.60	0.56	0.57	0.57	0.59
DblN_ascend_se_Fishery_dev_1987	-0.18	0.51	-0.20	0.48	-0.22	0.51	-0.20	0.48	-0.20	0.50
DblN_ascend_se_Fishery_dev_1988	2.18	0.72	2.21	0.69	2.20	0.72	2.21	0.69	2.20	0.71
DblN_ascend_se_Fishery_dev_1989	0.92	0.82	0.97	0.80	0.93	0.82	0.97	0.80	0.94	0.81
DblN_ascend_se_Fishery_dev_1990	0.09	0.65	0.05	0.61	0.08	0.64	0.05	0.61	0.07	0.63
DblN_ascend_se_Fishery_dev_1991	-0.06	0.47	-0.10	0.43	-0.09	0.46	-0.10	0.44	-0.08	0.45
DblN_ascend_se_Fishery_dev_1992	-0.31	0.43	-0.28	0.40	-0.33	0.43	-0.28	0.41	-0.30	0.42
DblN_ascend_se_Fishery_dev_1993	1.70	0.54	1.63	0.51	1.69	0.54	1.63	0.51	1.67	0.53
DblN_ascend_se_Fishery_dev_1994	0.59	0.47	0.54	0.44	0.57	0.46	0.54	0.44	0.57	0.46
DblN_ascend_se_Fishery_dev_1995	0.82	0.46	0.79	0.43	0.81	0.46	0.79	0.43	0.81	0.45
DblN_ascend_se_Fishery_dev_1996	-0.39	0.46	-0.35	0.43	-0.39	0.46	-0.35	0.43	-0.38	0.45
DblN_ascend_se_Fishery_dev_1997	0.83	0.46	0.78	0.42	0.82	0.45	0.78	0.43	0.81	0.44
DblN_ascend_se_Fishery_dev_1998	-0.28	0.41	-0.29	0.38	-0.30	0.41	-0.29	0.39	-0.29	0.40
DblN_ascend_se_Fishery_dev_1999	-0.10	0.36	-0.11	0.34	-0.12	0.36	-0.11	0.34	-0.11	0.35
DblN_ascend_se_Fishery_dev_2000	-0.44	0.39	-0.43	0.37	-0.44	0.39	-0.43	0.37	-0.44	0.39
DblN_ascend_se_Fishery_dev_2001	-0.04	0.38	-0.07	0.35	-0.05	0.37	-0.07	0.35	-0.05	0.37
DblN_ascend_se_Fishery_dev_2002	0.68	0.36	0.65	0.33	0.67	0.36	0.65	0.34	0.67	0.35
DblN_ascend_se_Fishery_dev_2003	0.61	0.37	0.58	0.34	0.59	0.37	0.59	0.35	0.59	0.36
DblN_ascend_se_Fishery_dev_2004	0.78	0.39	0.72	0.37	0.75	0.39	0.72	0.37	0.75	0.38
DblN_ascend_se_Fishery_dev_2005	0.54	0.39	0.48	0.36	0.49	0.39	0.49	0.37	0.51	0.38
DblN_ascend_se_Fishery_dev_2006	0.03	0.42	0.00	0.39	-0.01	0.42	0.00	0.40	0.00	0.41
DblN_ascend_se_Fishery_dev_2007	-0.07	0.45	-0.11	0.42	-0.06	0.45	-0.10	0.42	-0.08	0.44
DblN_ascend_se_Fishery_dev_2008	-0.36	0.37	-0.38	0.35	-0.25	0.37	-0.37	0.35	-0.33	0.37
DblN_ascend_se_Fishery_dev_2009	-1.22	0.38	-1.13	0.35	-0.96	0.38	-1.13	0.35	-1.10	0.38
DblN_ascend_se_Fishery_dev_2010	-1.38	0.40	-1.28	0.37	-1.17	0.40	-1.28	0.37	-1.27	0.40
DblN_ascend_se_Fishery_dev_2011	-1.33	0.38	-1.24	0.35	-1.20	0.38	-1.24	0.35	-1.25	0.37
DblN_ascend_se_Fishery_dev_2012	-0.35	0.41	-0.43	0.38	-0.37	0.40	-0.42	0.38	-0.38	0.40
DblN_ascend_se_Fishery_dev_2013	-0.11	0.35	-0.26	0.32	-0.19	0.35	-0.25	0.33	-0.19	0.35
DblN_ascend_se_Fishery_dev_2014	-1.19	0.35	-1.24	0.32	-1.24	0.35	-1.24	0.33	-1.22	0.34
DblN_ascend_se_Fishery_dev_2015	-1.57	0.36	-1.69	0.32	-1.65	0.35	-1.68	0.33	-1.64	0.35
DblN_ascend_se_Fishery_dev_2016	-1.44	0.39	-1.64	0.35	-1.55	0.38	-1.62	0.36	-1.54	0.38
DblN_ascend_se_Fishery_dev_2017	-1.45	0.48	-1.54	0.44	-1.57	0.47	-1.53	0.44	-1.52	0.46
DblN_ascend_se_Fishery_dev_2018	-0.30	0.56	-0.24	0.52	-0.52	0.54	-0.25	0.52	-0.35	0.55
DblN_ascend_se_Fishery_dev_2019	0.05	0.66	0.63	0.62	0.22	0.65	0.58	0.64	0.30	0.69

Table 2.24i—Fishery selectivity "ending value" devs.

Hypothesis:	1: EBS only		2: EBS+NBS		3: EBS, NBS			
Structure:	Complex		Complex		Complex		Ensemble (19.x series)			
Model:	M19.9		M19.12		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
DblN_end_logit_Fishery_dev_1977	-0.07	1.02	-0.08	1.03	-0.09	1.03	-0.08	1.03	-0.08	1.03
DblN_end_logit_Fishery_dev_1978	-0.10	1.03	-0.11	1.03	-0.13	1.04	-0.11	1.03	-0.11	1.04
DblN_end_logit_Fishery_dev_1979	-0.10	1.03	-0.11	1.03	-0.13	1.04	-0.11	1.03	-0.11	1.04
DblN_end_logit_Fishery_dev_1980	0.01	0.99	0.00	1.00	0.00	0.99	0.00	1.00	0.01	1.00
DblN_end_logit_Fishery_dev_1981	-0.01	1.00	-0.01	1.00	-0.02	1.00	-0.01	1.00	-0.01	1.00
DblN_end_logit_Fishery_dev_1982	0.06	0.98	0.05	0.98	0.07	0.97	0.06	0.98	0.06	0.98
DblN_end_logit_Fishery_dev_1983	0.25	0.91	0.25	0.92	0.28	0.90	0.25	0.92	0.26	0.91
DblN_end_logit_Fishery_dev_1984	0.39	0.87	0.41	0.87	0.45	0.85	0.41	0.87	0.42	0.86
DblN_end_logit_Fishery_dev_1985	0.06	0.91	0.09	0.90	0.10	0.88	0.09	0.90	0.08	0.90
DblN_end_logit_Fishery_dev_1986	-0.08	0.94	-0.07	0.94	-0.07	0.91	-0.07	0.94	-0.07	0.93
DblN_end_logit_Fishery_dev_1987	0.10	0.88	0.03	0.88	0.13	0.85	0.04	0.88	0.09	0.87
DblN_end_logit_Fishery_dev_1988	0.08	0.94	0.06	0.95	0.09	0.93	0.06	0.95	0.08	0.94
DblN_end_logit_Fishery_dev_1989	0.32	0.89	0.31	0.89	0.36	0.87	0.31	0.89	0.33	0.89
DblN_end_logit_Fishery_dev_1990	0.82	0.78	0.83	0.79	0.89	0.76	0.83	0.79	0.85	0.78
DblN_end_logit_Fishery_dev_1991	0.44	0.82	0.49	0.82	0.51	0.79	0.49	0.81	0.48	0.81
DblN_end_logit_Fishery_dev_1992	-0.14	0.88	-0.10	0.87	-0.11	0.84	-0.11	0.87	-0.12	0.86
DblN_end_logit_Fishery_dev_1993	0.02	0.94	-0.01	0.94	0.02	0.92	-0.01	0.94	0.01	0.93
DblN_end_logit_Fishery_dev_1994	0.01	0.92	-0.08	0.94	0.00	0.90	-0.07	0.94	-0.02	0.92
DblN_end_logit_Fishery_dev_1995	-0.03	0.92	-0.06	0.93	-0.03	0.90	-0.06	0.93	-0.04	0.92
DblN_end_logit_Fishery_dev_1996	0.73	0.79	0.74	0.80	0.79	0.78	0.74	0.80	0.75	0.79
DblN_end_logit_Fishery_dev_1997	0.45	0.83	0.42	0.84	0.49	0.81	0.43	0.84	0.45	0.83
DblN_end_logit_Fishery_dev_1998	0.32	0.84	0.30	0.85	0.36	0.82	0.31	0.85	0.33	0.84
DblN_end_logit_Fishery_dev_1999	0.18	0.84	0.21	0.84	0.22	0.81	0.21	0.84	0.20	0.83
DblN_end_logit_Fishery_dev_2000	0.19	0.84	0.17	0.85	0.21	0.82	0.17	0.85	0.19	0.84
DblN_end_logit_Fishery_dev_2001	-0.25	0.88	-0.30	0.89	-0.27	0.84	-0.30	0.89	-0.27	0.87
DblN_end_logit_Fishery_dev_2002	-0.90	0.78	-0.85	0.82	-0.89	0.72	-0.86	0.81	-0.88	0.78
DblN_end_logit_Fishery_dev_2003	-0.12	0.81	-0.11	0.82	-0.11	0.77	-0.11	0.81	-0.11	0.80
DblN_end_logit_Fishery_dev_2004	0.04	0.82	0.00	0.83	0.05	0.79	0.01	0.83	0.03	0.81
DblN_end_logit_Fishery_dev_2005	0.16	0.81	0.15	0.82	0.20	0.78	0.15	0.82	0.17	0.81
DblN_end_logit_Fishery_dev_2006	0.75	0.78	0.78	0.78	0.83	0.76	0.78	0.78	0.79	0.77
DblN_end_logit_Fishery_dev_2007	0.60	0.80	0.63	0.80	0.67	0.78	0.63	0.80	0.64	0.79
DblN_end_logit_Fishery_dev_2008	-0.26	0.86	-0.24	0.86	-0.27	0.81	-0.25	0.86	-0.26	0.84
DblN_end_logit_Fishery_dev_2009	-0.76	0.88	-0.79	0.89	-0.96	0.76	-0.80	0.89	-0.84	0.85
DblN_end_logit_Fishery_dev_2010	-0.63	1.00	-0.73	1.00	-1.17	0.83	-0.74	1.00	-0.84	0.98
DblN_end_logit_Fishery_dev_2011	-0.05	0.93	-0.12	0.94	-0.29	0.92	-0.12	0.94	-0.15	0.94
DblN_end_logit_Fishery_dev_2012	-0.03	0.92	-0.07	0.93	-0.20	0.91	-0.07	0.93	-0.10	0.93
DblN_end_logit_Fishery_dev_2013	-0.83	0.90	-0.80	0.92	-0.96	0.79	-0.81	0.91	-0.86	0.87
DblN_end_logit_Fishery_dev_2014	-1.04	0.75	-0.87	0.81	-0.95	0.70	-0.88	0.81	-0.95	0.76
DblN_end_logit_Fishery_dev_2015	-0.51	0.86	-0.49	0.87	-0.46	0.81	-0.49	0.87	-0.49	0.85
DblN_end_logit_Fishery_dev_2016	-0.03	0.89	0.01	0.89	0.04	0.86	0.01	0.89	0.00	0.88
DblN_end_logit_Fishery_dev_2017	0.30	0.85	0.39	0.84	0.42	0.82	0.39	0.84	0.37	0.84
DblN_end_logit_Fishery_dev_2018	0.20	0.87	0.27	0.86	0.32	0.84	0.27	0.86	0.26	0.86
DblN_end_logit_Fishery_dev_2019	-0.52	1.01	-0.57	1.01	-0.44	0.96	-0.56	1.01	-0.51	0.99

Table 2.24j—Survey selectivity “peak” devs.

Hypothesis:	1: EBS only		2: EBS+NBS		3: EBS, NBS					
Structure:	Complex		Complex		Complex		Ensemble (19.x series)			
Model:	M19.9		M19.12		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
DblN_peak_EBS_survey_dev_1982	-0.22	0.43	-0.20	0.43	-0.22	0.42	-0.20	0.43	-0.21	0.43
DblN_peak_EBS_survey_dev_1983	-0.03	0.48	-0.14	0.49	-0.09	0.48	-0.13	0.49	-0.09	0.48
DblN_peak_EBS_survey_dev_1984	1.26	0.38	1.16	0.40	1.13	0.34	1.16	0.39	1.18	0.38
DblN_peak_EBS_survey_dev_1985	0.59	0.28	0.53	0.27	0.51	0.27	0.53	0.27	0.54	0.28
DblN_peak_EBS_survey_dev_1986	-0.40	0.50	-0.38	0.52	-0.38	0.50	-0.38	0.51	-0.39	0.50
DblN_peak_EBS_survey_dev_1987	0.12	0.35	0.09	0.34	0.09	0.34	0.09	0.34	0.10	0.34
DblN_peak_EBS_survey_dev_1988	0.14	0.53	0.15	0.53	0.16	0.52	0.15	0.53	0.15	0.53
DblN_peak_EBS_survey_dev_1989	0.56	0.51	0.58	0.51	0.58	0.50	0.58	0.51	0.57	0.51
DblN_peak_EBS_survey_dev_1990	-0.21	0.35	-0.27	0.35	-0.26	0.34	-0.27	0.35	-0.25	0.35
DblN_peak_EBS_survey_dev_1991	0.99	0.45	0.92	0.45	0.94	0.45	0.92	0.45	0.95	0.45
DblN_peak_EBS_survey_dev_1992	-0.43	0.45	-0.46	0.45	-0.46	0.44	-0.45	0.45	-0.45	0.45
DblN_peak_EBS_survey_dev_1993	0.23	0.33	0.13	0.33	0.16	0.32	0.14	0.33	0.17	0.33
DblN_peak_EBS_survey_dev_1994	0.71	0.47	0.61	0.44	0.67	0.46	0.62	0.44	0.67	0.46
DblN_peak_EBS_survey_dev_1995	0.81	0.42	0.73	0.43	0.78	0.42	0.74	0.43	0.77	0.43
DblN_peak_EBS_survey_dev_1996	0.53	0.42	0.44	0.38	0.49	0.42	0.44	0.38	0.49	0.41
DblN_peak_EBS_survey_dev_1997	0.84	0.36	0.76	0.34	0.78	0.34	0.76	0.34	0.79	0.35
DblN_peak_EBS_survey_dev_1998	2.09	0.32	1.99	0.32	2.01	0.31	1.99	0.32	2.03	0.32
DblN_peak_EBS_survey_dev_1999	0.36	0.49	0.41	0.49	0.41	0.47	0.41	0.49	0.39	0.48
DblN_peak_EBS_survey_dev_2000	-0.59	0.29	-0.64	0.29	-0.61	0.28	-0.64	0.29	-0.61	0.29
DblN_peak_EBS_survey_dev_2001	-0.65	0.33	-0.66	0.34	-0.64	0.32	-0.66	0.34	-0.65	0.33
DblN_peak_EBS_survey_dev_2002	0.32	0.46	0.14	0.44	0.28	0.46	0.16	0.45	0.25	0.46
DblN_peak_EBS_survey_dev_2003	0.32	0.31	0.28	0.30	0.28	0.30	0.28	0.30	0.29	0.30
DblN_peak_EBS_survey_dev_2004	0.31	0.34	0.25	0.35	0.27	0.34	0.26	0.35	0.28	0.34
DblN_peak_EBS_survey_dev_2005	0.13	0.39	-0.01	0.39	0.09	0.37	0.00	0.39	0.07	0.39
DblN_peak_EBS_survey_dev_2006	-1.46	0.32	-1.48	0.31	-1.47	0.29	-1.48	0.31	-1.47	0.31
DblN_peak_EBS_survey_dev_2007	-2.29	0.23	-2.29	0.24	-2.28	0.23	-2.29	0.24	-2.29	0.23
DblN_peak_EBS_survey_dev_2008	-1.45	0.29	-1.46	0.29	-1.46	0.28	-1.46	0.29	-1.46	0.29
DblN_peak_EBS_survey_dev_2009	-1.31	0.54	-1.59	0.41	-1.54	0.38	-1.58	0.42	-1.48	0.46
DblN_peak_EBS_survey_dev_2010	-0.47	0.39	-0.50	0.38	-0.18	0.47	-0.49	0.39	-0.38	0.44
DblN_peak_EBS_survey_dev_2011	-0.10	0.25	-0.10	0.25	-0.17	0.24	-0.11	0.25	-0.13	0.25
DblN_peak_EBS_survey_dev_2012	-2.12	0.33	-1.92	0.37	-2.11	0.29	-1.94	0.37	-2.05	0.34
DblN_peak_EBS_survey_dev_2013	0.75	0.40	0.85	0.33	0.71	0.39	0.84	0.34	0.77	0.38
DblN_peak_EBS_survey_dev_2014	-0.13	0.28	0.00	0.29	-0.16	0.27	-0.02	0.29	-0.10	0.29
DblN_peak_EBS_survey_dev_2015	0.36	0.44	0.43	0.45	0.32	0.43	0.42	0.45	0.37	0.44
DblN_peak_EBS_survey_dev_2016	1.08	0.31	1.18	0.33	1.06	0.31	1.17	0.33	1.11	0.32
DblN_peak_EBS_survey_dev_2017	-0.74	0.47	0.94	0.38	0.73	0.44	0.86	0.52	0.31	0.86
DblN_peak_EBS_survey_dev_2018	0.87	0.33	0.74	0.36	0.85	0.29	0.75	0.36	0.82	0.33
DblN_peak_EBS_survey_dev_2019	-0.78	0.25	-1.21	0.33	-1.26	0.33	-1.19	0.34	-1.08	0.37

Table 2.24k—Survey selectivity "peak" devs.

Hypothesis:	1: EBS only		2: EBS+NBS		3: EBS, NBS		Ensemble (19.x series)			
Structure:	Complex		Complex		Complex					
Model:	M19.9		M19.12		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
DblN_peak_EBS_survey_dev_1982	-0.22	0.43	-0.20	0.43	-0.22	0.42	-0.20	0.43	-0.21	0.43
DblN_peak_EBS_survey_dev_1983	-0.03	0.48	-0.14	0.49	-0.09	0.48	-0.13	0.49	-0.09	0.48
DblN_peak_EBS_survey_dev_1984	1.26	0.38	1.16	0.40	1.13	0.34	1.16	0.39	1.18	0.38
DblN_peak_EBS_survey_dev_1985	0.59	0.28	0.53	0.27	0.51	0.27	0.53	0.27	0.54	0.28
DblN_peak_EBS_survey_dev_1986	-0.40	0.50	-0.38	0.52	-0.38	0.50	-0.38	0.51	-0.39	0.50
DblN_peak_EBS_survey_dev_1987	0.12	0.35	0.09	0.34	0.09	0.34	0.09	0.34	0.10	0.34
DblN_peak_EBS_survey_dev_1988	0.14	0.53	0.15	0.53	0.16	0.52	0.15	0.53	0.15	0.53
DblN_peak_EBS_survey_dev_1989	0.56	0.51	0.58	0.51	0.58	0.50	0.58	0.51	0.57	0.51
DblN_peak_EBS_survey_dev_1990	-0.21	0.35	-0.27	0.35	-0.26	0.34	-0.27	0.35	-0.25	0.35
DblN_peak_EBS_survey_dev_1991	0.99	0.45	0.92	0.45	0.94	0.45	0.92	0.45	0.95	0.45
DblN_peak_EBS_survey_dev_1992	-0.43	0.45	-0.46	0.45	-0.46	0.44	-0.45	0.45	-0.45	0.45
DblN_peak_EBS_survey_dev_1993	0.23	0.33	0.13	0.33	0.16	0.32	0.14	0.33	0.17	0.33
DblN_peak_EBS_survey_dev_1994	0.71	0.47	0.61	0.44	0.67	0.46	0.62	0.44	0.67	0.46
DblN_peak_EBS_survey_dev_1995	0.81	0.42	0.73	0.43	0.78	0.42	0.74	0.43	0.77	0.43
DblN_peak_EBS_survey_dev_1996	0.53	0.42	0.44	0.38	0.49	0.42	0.44	0.38	0.49	0.41
DblN_peak_EBS_survey_dev_1997	0.84	0.36	0.76	0.34	0.78	0.34	0.76	0.34	0.79	0.35
DblN_peak_EBS_survey_dev_1998	2.09	0.32	1.99	0.32	2.01	0.31	1.99	0.32	2.03	0.32
DblN_peak_EBS_survey_dev_1999	0.36	0.49	0.41	0.49	0.41	0.47	0.41	0.49	0.39	0.48
DblN_peak_EBS_survey_dev_2000	-0.59	0.29	-0.64	0.29	-0.61	0.28	-0.64	0.29	-0.61	0.29
DblN_peak_EBS_survey_dev_2001	-0.65	0.33	-0.66	0.34	-0.64	0.32	-0.66	0.34	-0.65	0.33
DblN_peak_EBS_survey_dev_2002	0.32	0.46	0.14	0.44	0.28	0.46	0.16	0.45	0.25	0.46
DblN_peak_EBS_survey_dev_2003	0.32	0.31	0.28	0.30	0.28	0.30	0.28	0.30	0.29	0.30
DblN_peak_EBS_survey_dev_2004	0.31	0.34	0.25	0.35	0.27	0.34	0.26	0.35	0.28	0.34
DblN_peak_EBS_survey_dev_2005	0.13	0.39	-0.01	0.39	0.09	0.37	0.00	0.39	0.07	0.39
DblN_peak_EBS_survey_dev_2006	-1.46	0.32	-1.48	0.31	-1.47	0.29	-1.48	0.31	-1.47	0.31
DblN_peak_EBS_survey_dev_2007	-2.29	0.23	-2.29	0.24	-2.28	0.23	-2.29	0.24	-2.29	0.23
DblN_peak_EBS_survey_dev_2008	-1.45	0.29	-1.46	0.29	-1.46	0.28	-1.46	0.29	-1.46	0.29
DblN_peak_EBS_survey_dev_2009	-1.31	0.54	-1.59	0.41	-1.54	0.38	-1.58	0.42	-1.48	0.46
DblN_peak_EBS_survey_dev_2010	-0.47	0.39	-0.50	0.38	-0.18	0.47	-0.49	0.39	-0.38	0.44
DblN_peak_EBS_survey_dev_2011	-0.10	0.25	-0.10	0.25	-0.17	0.24	-0.11	0.25	-0.13	0.25
DblN_peak_EBS_survey_dev_2012	-2.12	0.33	-1.92	0.37	-2.11	0.29	-1.94	0.37	-2.05	0.34
DblN_peak_EBS_survey_dev_2013	0.75	0.40	0.85	0.33	0.71	0.39	0.84	0.34	0.77	0.38
DblN_peak_EBS_survey_dev_2014	-0.13	0.28	0.00	0.29	-0.16	0.27	-0.02	0.29	-0.10	0.29
DblN_peak_EBS_survey_dev_2015	0.36	0.44	0.43	0.45	0.32	0.43	0.42	0.45	0.37	0.44
DblN_peak_EBS_survey_dev_2016	1.08	0.31	1.18	0.33	1.06	0.31	1.17	0.33	1.11	0.32
DblN_peak_EBS_survey_dev_2017	-0.74	0.47	0.94	0.38	0.73	0.44	0.86	0.52	0.31	0.86
DblN_peak_EBS_survey_dev_2018	0.87	0.33	0.74	0.36	0.85	0.29	0.75	0.36	0.82	0.33
DblN_peak_EBS_survey_dev_2019	-0.78	0.25	-1.21	0.33	-1.26	0.33	-1.19	0.34	-1.08	0.37

Table 2.24k—Survey selectivity “ascending standard error” devs.

Hypothesis:	1: EBS only		2: EBS+NBS		3: EBS, NBS					
Structure:	Complex		Complex		Complex		Ensemble (19.x series)			
Model:	M19.9		M19.12		M19.15		Weighted		Unweighted	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
DblN_ascend_se_survey_dev_1982	-0.50	0.57	-0.51	0.59	-0.52	0.59	-0.51	0.59	-0.51	0.58
DblN_ascend_se_survey_dev_1983	0.52	0.58	0.44	0.61	0.47	0.60	0.44	0.61	0.48	0.60
DblN_ascend_se_survey_dev_1984	1.00	0.43	0.90	0.44	0.90	0.40	0.90	0.44	0.94	0.43
DblN_ascend_se_survey_dev_1985	0.72	0.35	0.68	0.36	0.66	0.35	0.68	0.36	0.69	0.36
DblN_ascend_se_survey_dev_1986	-0.07	0.62	-0.06	0.66	-0.07	0.65	-0.06	0.66	-0.07	0.64
DblN_ascend_se_survey_dev_1987	-0.01	0.52	-0.06	0.53	-0.05	0.53	-0.06	0.53	-0.04	0.53
DblN_ascend_se_survey_dev_1988	-0.03	0.65	-0.06	0.66	-0.03	0.65	-0.06	0.66	-0.04	0.65
DblN_ascend_se_survey_dev_1989	0.24	0.58	0.24	0.58	0.27	0.57	0.24	0.58	0.25	0.58
DblN_ascend_se_survey_dev_1990	0.22	0.42	0.15	0.43	0.15	0.43	0.15	0.43	0.17	0.43
DblN_ascend_se_survey_dev_1991	1.31	0.48	1.28	0.50	1.31	0.50	1.28	0.50	1.30	0.49
DblN_ascend_se_survey_dev_1992	-0.28	0.56	-0.35	0.58	-0.35	0.57	-0.35	0.58	-0.33	0.57
DblN_ascend_se_survey_dev_1993	0.73	0.41	0.65	0.42	0.66	0.42	0.66	0.42	0.68	0.42
DblN_ascend_se_survey_dev_1994	0.56	0.56	0.48	0.55	0.53	0.58	0.49	0.55	0.52	0.56
DblN_ascend_se_survey_dev_1995	0.55	0.50	0.49	0.53	0.54	0.52	0.49	0.53	0.53	0.52
DblN_ascend_se_survey_dev_1996	0.04	0.52	-0.08	0.49	0.00	0.53	-0.07	0.49	-0.01	0.51
DblN_ascend_se_survey_dev_1997	0.83	0.40	0.77	0.40	0.79	0.40	0.78	0.40	0.80	0.40
DblN_ascend_se_survey_dev_1998	2.00	0.33	1.96	0.34	1.98	0.33	1.96	0.33	1.98	0.33
DblN_ascend_se_survey_dev_1999	0.38	0.53	0.43	0.54	0.43	0.53	0.43	0.54	0.41	0.53
DblN_ascend_se_survey_dev_2000	-0.57	0.39	-0.66	0.40	-0.63	0.39	-0.66	0.40	-0.62	0.39
DblN_ascend_se_survey_dev_2001	-0.33	0.48	-0.37	0.50	-0.38	0.48	-0.37	0.50	-0.36	0.49
DblN_ascend_se_survey_dev_2002	0.30	0.55	0.11	0.56	0.25	0.57	0.12	0.56	0.22	0.57
DblN_ascend_se_survey_dev_2003	0.34	0.39	0.28	0.40	0.29	0.40	0.28	0.40	0.30	0.40
DblN_ascend_se_survey_dev_2004	0.22	0.44	0.14	0.46	0.16	0.45	0.15	0.46	0.17	0.45
DblN_ascend_se_survey_dev_2005	0.07	0.51	-0.10	0.53	0.01	0.51	-0.09	0.53	0.00	0.52
DblN_ascend_se_survey_dev_2006	-1.30	0.45	-1.37	0.45	-1.37	0.43	-1.36	0.45	-1.35	0.45
DblN_ascend_se_survey_dev_2007	-2.32	0.48	-2.39	0.49	-2.41	0.48	-2.39	0.49	-2.37	0.48
DblN_ascend_se_survey_dev_2008	-1.49	0.46	-1.56	0.47	-1.58	0.47	-1.56	0.47	-1.54	0.47
DblN_ascend_se_survey_dev_2009	-0.37	0.78	-0.78	0.64	-0.78	0.58	-0.76	0.65	-0.64	0.70
DblN_ascend_se_survey_dev_2010	-0.63	0.54	-0.70	0.53	-0.34	0.61	-0.68	0.54	-0.56	0.58
DblN_ascend_se_survey_dev_2011	-0.08	0.33	-0.15	0.33	-0.19	0.33	-0.15	0.33	-0.14	0.33
DblN_ascend_se_survey_dev_2012	-1.62	0.56	-1.38	0.61	-1.72	0.51	-1.41	0.61	-1.58	0.58
DblN_ascend_se_survey_dev_2013	0.88	0.41	0.93	0.35	0.85	0.42	0.92	0.36	0.89	0.40
DblN_ascend_se_survey_dev_2014	-0.05	0.39	-0.05	0.40	-0.12	0.39	-0.05	0.40	-0.07	0.39
DblN_ascend_se_survey_dev_2015	0.34	0.52	0.36	0.54	0.28	0.53	0.35	0.53	0.32	0.53
DblN_ascend_se_survey_dev_2016	0.77	0.42	0.82	0.44	0.73	0.42	0.82	0.44	0.77	0.43
DblN_ascend_se_survey_dev_2017	-0.82	0.71	0.89	0.48	0.72	0.51	0.81	0.61	0.26	0.96
DblN_ascend_se_survey_dev_2018	-0.06	0.41	0.11	0.42	-0.11	0.40	0.09	0.42	-0.02	0.42
DblN_ascend_se_survey_dev_2019	-1.49	0.42	-1.44	0.61	-1.32	0.60	-1.44	0.61	-1.42	0.56

Table 2.25—EBS (or EBS+NBS) catchability time series.

	H2	Hypothesis 1			Hypothesis 2			Hypothesis 3				
	Basic	Basic	Simple	Complex	Basic	Simple	Complex	Basic	Simple	Complex	Ensemble	
Year	M16.6i	M19.7	M19.8	M19.9	M19.10	M19.11	M19.12	M19.13	M19.14	M19.15	wtd	unw
1982	1.0669	1.0513	0.8788	0.9763	1.1416	0.9487	1.0424	1.1787	0.9758	0.9691	1.0305	1.0181
1983	1.0669	1.0513	0.8788	1.0274	1.1416	0.9487	1.1037	1.1787	0.9758	1.0195	1.0817	1.0362
1984	1.0669	1.0513	0.8788	0.8965	1.1416	0.9487	0.9611	1.1787	0.9758	0.8981	0.9620	0.9923
1985	1.0669	1.0513	0.8788	1.0522	1.1416	0.9487	1.1195	1.1787	0.9758	1.0492	1.0959	1.0440
1986	1.0669	1.0513	0.8788	1.0071	1.1416	0.9487	1.0639	1.1787	0.9758	1.0029	1.0495	1.0276
1987	1.0669	1.0513	0.8788	0.9795	1.1416	0.9487	1.0533	1.1787	0.9758	0.9755	1.0392	1.0204
1988	1.0669	1.0513	0.8788	0.9598	1.1416	0.9487	1.0020	1.1787	0.9758	0.9542	0.9981	1.0101
1989	1.0669	1.0513	0.8788	0.8495	1.1416	0.9487	0.8912	1.1787	0.9758	0.8410	0.9041	0.9730
1990	1.0669	1.0513	0.8788	0.9105	1.1416	0.9487	0.9533	1.1787	0.9758	0.9008	0.9567	0.9933
1991	1.0669	1.0513	0.8788	0.8880	1.1416	0.9487	0.9424	1.1787	0.9758	0.8808	0.9466	0.9874
1992	1.0669	1.0513	0.8788	0.8860	1.1416	0.9487	0.9308	1.1787	0.9758	0.8795	0.9375	0.9857
1993	1.0669	1.0513	0.8788	1.0222	1.1416	0.9487	1.0912	1.1787	0.9758	1.0147	1.0716	1.0337
1994	1.0669	1.0513	0.8788	1.3581	1.1416	0.9487	1.4279	1.1787	0.9758	1.3541	1.3572	1.1461
1995	1.0669	1.0513	0.8788	1.1374	1.1416	0.9487	1.1951	1.1787	0.9758	1.1324	1.1607	1.0711
1996	1.0669	1.0513	0.8788	1.1321	1.1416	0.9487	1.2216	1.1787	0.9758	1.1252	1.1806	1.0726
1997	1.0669	1.0513	0.8788	0.9524	1.1416	0.9487	1.0227	1.1787	0.9758	0.9438	1.0134	1.0104
1998	1.0669	1.0513	0.8788	0.9385	1.1416	0.9487	1.0317	1.1787	0.9758	0.9301	1.0193	1.0084
1999	1.0669	1.0513	0.8788	0.9547	1.1416	0.9487	0.9966	1.1787	0.9758	0.9449	0.9934	1.0079
2000	1.0669	1.0513	0.8788	0.8647	1.1416	0.9487	0.9137	1.1787	0.9758	0.8521	0.9225	0.9784
2001	1.0669	1.0513	0.8788	1.1288	1.1416	0.9487	1.2017	1.1787	0.9758	1.1182	1.1649	1.0693
2002	1.0669	1.0513	0.8788	0.9378	1.1416	0.9487	1.0107	1.1787	0.9758	0.9226	1.0028	1.0051
2003	1.0669	1.0513	0.8788	0.9788	1.1416	0.9487	1.0755	1.1787	0.9758	0.9625	1.0559	1.0213
2004	1.0669	1.0513	0.8788	0.8928	1.1416	0.9487	0.9596	1.1787	0.9758	0.8708	0.9597	0.9887
2005	1.0669	1.0513	0.8788	0.9590	1.1416	0.9487	1.0312	1.1787	0.9758	0.9298	1.0197	1.0106
2006	1.0669	1.0513	0.8788	0.9192	1.1416	0.9487	0.9543	1.1787	0.9758	0.8889	0.9573	0.9931
2007	1.0669	1.0513	0.8788	0.9107	1.1416	0.9487	0.9543	1.1787	0.9758	0.9005	0.9574	0.9934
2008	1.0669	1.0513	0.8788	0.8193	1.1416	0.9487	0.8458	1.1787	0.9758	0.8116	0.8668	0.9613
2009	1.0669	1.0513	0.8788	0.8602	1.1416	0.9487	0.8770	1.1787	0.9758	0.8530	0.8940	0.9739
2010	1.0669	1.0513	0.8788	0.9928	1.1416	0.9487	1.0203	1.1787	0.9758	1.0016	1.0153	1.0211
2011	1.0669	1.0513	0.8788	1.0539	1.1416	0.9487	1.0928	1.1787	0.9758	1.0524	1.0755	1.0416
2012	1.0669	1.0513	0.8788	1.0055	1.1416	0.9487	1.0191	1.1787	0.9758	1.0031	1.0150	1.0225
2013	1.0669	1.0513	0.8788	0.9109	1.1416	0.9487	0.9027	1.1787	0.9758	0.9091	0.9180	0.9886
2014	1.0669	1.0513	0.8788	1.1936	1.1416	0.9487	1.2089	1.1787	0.9758	1.1857	1.1755	1.0848
2015	1.0669	1.0513	0.8788	1.1471	1.1416	0.9487	1.0917	1.1787	0.9758	1.1305	1.0812	1.0605
2016	1.0669	1.0513	0.8788	1.1112	1.1416	0.9487	1.1045	1.1787	0.9758	1.0915	1.0883	1.0536
2017	1.0669	1.0513	0.8788	0.8815	1.1416	0.9487	0.9312	1.1787	0.9758	0.8618	0.9370	0.9833
2018	1.0669	1.0513	0.8788	0.9721	1.1416	0.9487	1.1755	1.1787	0.9758	0.9226	1.1312	1.0272
2019	1.0669	1.0513	0.8788	0.9743	1.1416	0.9487	1.1133	1.1787	0.9758	0.9547	1.0846	1.0242

Table 2.26—Female spawning biomass (millions of t).

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated						Ensemble (19.x series)			
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex					
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Year	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
1977	0.057	0.019	0.054	0.019	0.085	0.029	0.079	0.024	0.056	0.019	0.089	0.029	0.087	0.024	0.048	0.017	0.085	0.027	0.086	0.025	0.086	0.026	0.075	0.029
1978	0.055	0.019	0.053	0.019	0.085	0.029	0.082	0.024	0.055	0.019	0.090	0.029	0.089	0.024	0.046	0.016	0.085	0.026	0.089	0.025	0.088	0.026	0.075	0.029
1979	0.054	0.018	0.053	0.018	0.086	0.028	0.084	0.023	0.054	0.017	0.089	0.027	0.090	0.023	0.045	0.015	0.082	0.025	0.090	0.024	0.088	0.024	0.075	0.028
1980	0.071	0.018	0.071	0.018	0.110	0.028	0.105	0.024	0.071	0.017	0.111	0.027	0.111	0.024	0.059	0.014	0.100	0.024	0.111	0.024	0.109	0.025	0.094	0.030
1981	0.112	0.019	0.117	0.019	0.180	0.031	0.162	0.027	0.113	0.018	0.175	0.030	0.163	0.026	0.095	0.015	0.152	0.026	0.166	0.027	0.162	0.029	0.147	0.038
1982	0.191	0.023	0.205	0.023	0.303	0.039	0.259	0.033	0.194	0.021	0.290	0.036	0.254	0.032	0.168	0.017	0.253	0.031	0.262	0.033	0.256	0.037	0.243	0.052
1983	0.277	0.026	0.298	0.026	0.413	0.043	0.351	0.038	0.283	0.025	0.395	0.040	0.342	0.036	0.249	0.020	0.351	0.035	0.354	0.038	0.346	0.042	0.337	0.060
1984	0.299	0.024	0.321	0.024	0.413	0.036	0.358	0.034	0.306	0.022	0.397	0.034	0.349	0.033	0.273	0.019	0.359	0.030	0.360	0.034	0.353	0.037	0.349	0.051
1985	0.345	0.026	0.370	0.025	0.452	0.035	0.405	0.036	0.354	0.024	0.438	0.033	0.396	0.035	0.319	0.020	0.400	0.030	0.407	0.036	0.399	0.038	0.394	0.050
1986	0.339	0.024	0.362	0.023	0.434	0.031	0.399	0.034	0.349	0.022	0.423	0.029	0.391	0.033	0.317	0.019	0.389	0.027	0.401	0.034	0.394	0.035	0.385	0.045
1987	0.333	0.022	0.355	0.020	0.421	0.026	0.391	0.030	0.344	0.019	0.412	0.025	0.385	0.029	0.315	0.017	0.384	0.023	0.394	0.030	0.387	0.031	0.378	0.040
1988	0.358	0.021	0.380	0.019	0.449	0.025	0.417	0.029	0.369	0.018	0.439	0.024	0.411	0.029	0.343	0.016	0.414	0.023	0.420	0.029	0.413	0.031	0.405	0.040
1989	0.348	0.019	0.368	0.017	0.437	0.023	0.407	0.026	0.359	0.017	0.428	0.023	0.401	0.026	0.336	0.014	0.407	0.021	0.410	0.027	0.403	0.029	0.395	0.038
1990	0.319	0.016	0.335	0.014	0.390	0.019	0.366	0.022	0.328	0.014	0.383	0.019	0.363	0.022	0.310	0.012	0.367	0.018	0.369	0.023	0.364	0.024	0.357	0.031
1991	0.258	0.012	0.267	0.011	0.302	0.014	0.294	0.017	0.263	0.011	0.298	0.014	0.293	0.017	0.250	0.009	0.288	0.013	0.297	0.018	0.293	0.018	0.284	0.022
1992	0.184	0.010	0.187	0.009	0.209	0.011	0.214	0.014	0.185	0.009	0.208	0.011	0.216	0.014	0.175	0.008	0.199	0.010	0.217	0.015	0.213	0.015	0.201	0.019
1993	0.170	0.010	0.170	0.009	0.196	0.012	0.203	0.014	0.168	0.009	0.194	0.012	0.205	0.015	0.158	0.008	0.184	0.011	0.206	0.015	0.202	0.016	0.187	0.021
1994	0.179	0.010	0.178	0.009	0.208	0.012	0.205	0.013	0.175	0.008	0.205	0.012	0.207	0.013	0.164	0.007	0.196	0.011	0.209	0.013	0.206	0.014	0.194	0.020
1995	0.199	0.010	0.198	0.009	0.232	0.014	0.216	0.013	0.194	0.009	0.228	0.013	0.218	0.013	0.183	0.008	0.219	0.012	0.220	0.013	0.218	0.014	0.212	0.020
1996	0.197	0.010	0.200	0.010	0.243	0.016	0.210	0.013	0.195	0.009	0.236	0.015	0.211	0.013	0.183	0.008	0.226	0.014	0.213	0.013	0.213	0.016	0.213	0.022
1997	0.189	0.010	0.197	0.010	0.247	0.017	0.202	0.013	0.191	0.009	0.239	0.015	0.202	0.013	0.180	0.008	0.231	0.015	0.205	0.013	0.206	0.018	0.210	0.025
1998	0.164	0.009	0.175	0.010	0.221	0.016	0.177	0.012	0.169	0.009	0.214	0.015	0.177	0.012	0.158	0.008	0.206	0.014	0.180	0.013	0.181	0.017	0.186	0.024
1999	0.159	0.010	0.169	0.010	0.212	0.016	0.171	0.013	0.164	0.009	0.206	0.015	0.171	0.013	0.153	0.008	0.198	0.014	0.174	0.013	0.174	0.017	0.180	0.023
2000	0.165	0.010	0.174	0.010	0.222	0.017	0.181	0.014	0.169	0.010	0.216	0.016	0.181	0.014	0.157	0.008	0.207	0.015	0.185	0.014	0.184	0.018	0.188	0.025
2001	0.172	0.010	0.179	0.010	0.228	0.016	0.192	0.014	0.175	0.009	0.223	0.015	0.192	0.014	0.162	0.008	0.215	0.014	0.197	0.014	0.195	0.018	0.196	0.025
2002	0.186	0.010	0.191	0.010	0.236	0.015	0.209	0.014	0.188	0.009	0.232	0.015	0.209	0.014	0.175	0.008	0.224	0.014	0.214	0.015	0.211	0.016	0.209	0.023
2003	0.188	0.010	0.191	0.010	0.234	0.015	0.216	0.014	0.189	0.009	0.232	0.014	0.216	0.014	0.176	0.008	0.225	0.014	0.222	0.014	0.217	0.016	0.211	0.023
2004	0.191	0.009	0.196	0.009	0.239	0.014	0.221	0.013	0.193	0.009	0.236	0.014	0.221	0.013	0.181	0.007	0.232	0.013	0.228	0.014	0.222	0.015	0.216	0.023
2005	0.191	0.009	0.196	0.009	0.234	0.014	0.217	0.013	0.193	0.008	0.232	0.013	0.217	0.013	0.182	0.007	0.231	0.013	0.225	0.013	0.218	0.014	0.214	0.021
2006	0.169	0.008	0.173	0.008	0.203	0.012	0.192	0.011	0.172	0.008	0.203	0.012	0.192	0.011	0.163	0.006	0.204	0.011	0.201	0.012	0.193	0.013	0.189	0.018
2007	0.144	0.007	0.147	0.007	0.173	0.011	0.167	0.011	0.146	0.007	0.173	0.011	0.168	0.011	0.138	0.006	0.178	0.010	0.178	0.011	0.168	0.012	0.163	0.017
2008	0.123	0.006	0.125	0.006	0.147	0.009	0.143	0.009	0.125	0.006	0.148	0.009	0.146	0.010	0.118	0.005	0.156	0.009	0.155	0.010	0.145	0.011	0.140	0.016
2009	0.113	0.007	0.115	0.006	0.136	0.009	0.129	0.009	0.115	0.006	0.137	0.009	0.133	0.009	0.109	0.005	0.145	0.009	0.142	0.010	0.133	0.010	0.129	0.015
2010	0.119	0.007	0.121	0.007	0.150	0.011	0.128	0.009	0.121	0.007	0.150	0.010	0.132	0.010	0.112	0.005	0.151	0.009	0.139	0.010	0.133	0.012	0.134	0.016
2011	0.157	0.009	0.157	0.008	0.193	0.013	0.156	0.010	0.156	0.008	0.193	0.013	0.160	0.010	0.144	0.006	0.182	0.010	0.164	0.010	0.164	0.015	0.167	0.019
2012	0.185	0.010	0.181	0.009	0.225	0.015	0.183	0.011	0.180	0.009	0.225	0.015	0.187	0.012	0.164	0.007	0.199	0.012	0.186	0.011	0.190	0.017	0.192	0.023
2013	0.209	0.012	0.201	0.010	0.248	0.017	0.203	0.012	0.203	0.010	0.252	0.017	0.209	0.013	0.179	0.008	0.216	0.013	0.203	0.012	0.213	0.019	0.213	0.026
2014	0.215	0.014	0.203	0.011	0.248	0.018	0.200	0.013	0.210	0.012	0.257	0.019	0.212	0.014	0.180	0.008	0.213	0.014	0.200	0.013	0.216	0.021	0.214	0.027
2015	0.220	0.015	0.201	0.012	0.252	0.020	0.196	0.014	0.216	0.013	0.271	0.020	0.216	0.016	0.178	0.009	0.216	0.016	0.196	0.014	0.221	0.024	0.216	0.031
2016	0.253	0.018	0.222	0.013	0.277	0.022	0.212	0.016	0.249	0.015	0.311	0.023	0.248	0.019	0.201	0.010	0.238	0.018	0.212	0.016	0.252	0.030	0.241	0.037
2017	0.277	0.020	0.229	0.014	0.287	0.023	0.226	0.018	0.273	0.016	0.342	0.026	0.286	0.023	0.213	0.011	0.251	0.020	0.228	0.018	0.287	0.034	0.259	0.044
2018	0.288	0.022	0.222	0.015	0.277	0.023	0.226	0.020	0.285	0.018	0.355	0.027	0.311	0.026	0.215	0.012	0.252	0.021	0.230	0.020	0.308	0.038	0.264	0.049
2019	0.281	0.023	0.198	0.015	0.243	0.022	0.203	0.020	0.279	0.018	0.337	0.025	0.306	0.027	0.201	0.013	0.230	0.020	0.208	0.021	0.300	0.040	0.245	0.052
2020	0.245	0.022	0.153	0.014	0.188	0.019	0.160	0.020	0.243	0.017	0.287	0.022	0.267	0.026	0.163	0.012	0.186	0.018	0.165	0.020	0.260	0.039	0.201	0.052
2021	0.221	0.012	0.154	0.009	0.162	0.008	0.148	0.012	0.220	0.009	0.222	0.012	0.216	0.018	0.168	0.008	0.170	0.009	0.151	0.012	0.211	0.025	0.179	0.031

Table 2.27—Relative spawning biomass time series.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Year	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
1977	0.082	0.030	0.086	0.032	0.140	0.048	0.124	0.038	0.082	0.029	0.140	0.046	0.130	0.037	0.070	0.025	0.139	0.044	0.137	0.040	0.129	0.039	0.116	0.047
1978	0.080	0.029	0.084	0.031	0.141	0.048	0.128	0.038	0.079	0.029	0.141	0.046	0.133	0.037	0.066	0.025	0.139	0.044	0.141	0.040	0.132	0.040	0.117	0.048
1979	0.079	0.028	0.084	0.030	0.142	0.046	0.131	0.037	0.078	0.027	0.139	0.043	0.134	0.035	0.064	0.023	0.135	0.041	0.143	0.038	0.133	0.038	0.117	0.047
1980	0.102	0.028	0.113	0.030	0.183	0.047	0.164	0.039	0.102	0.028	0.175	0.044	0.165	0.037	0.084	0.023	0.163	0.041	0.176	0.040	0.164	0.040	0.147	0.051
1981	0.161	0.032	0.186	0.034	0.299	0.054	0.252	0.046	0.163	0.031	0.275	0.049	0.242	0.043	0.137	0.025	0.249	0.044	0.263	0.047	0.243	0.048	0.229	0.067
1982	0.276	0.042	0.324	0.044	0.502	0.068	0.405	0.061	0.282	0.040	0.454	0.060	0.378	0.055	0.241	0.033	0.413	0.056	0.416	0.060	0.385	0.065	0.379	0.095
1983	0.400	0.052	0.472	0.055	0.684	0.076	0.548	0.072	0.410	0.049	0.619	0.068	0.508	0.065	0.357	0.042	0.574	0.065	0.561	0.071	0.520	0.079	0.526	0.115
1984	0.432	0.051	0.509	0.052	0.685	0.065	0.559	0.067	0.444	0.047	0.622	0.058	0.519	0.060	0.392	0.042	0.588	0.057	0.571	0.065	0.531	0.072	0.543	0.102
1985	0.499	0.056	0.586	0.056	0.750	0.063	0.632	0.073	0.514	0.052	0.687	0.058	0.588	0.065	0.458	0.047	0.655	0.058	0.645	0.070	0.600	0.075	0.613	0.103
1986	0.489	0.052	0.574	0.052	0.720	0.055	0.623	0.069	0.506	0.048	0.663	0.051	0.582	0.062	0.454	0.044	0.637	0.051	0.636	0.066	0.591	0.069	0.599	0.095
1987	0.481	0.048	0.562	0.047	0.699	0.048	0.611	0.064	0.498	0.044	0.646	0.044	0.572	0.057	0.453	0.041	0.628	0.046	0.624	0.061	0.581	0.064	0.588	0.088
1988	0.517	0.049	0.602	0.048	0.744	0.047	0.651	0.064	0.535	0.045	0.689	0.043	0.611	0.057	0.492	0.042	0.676	0.045	0.666	0.061	0.620	0.065	0.630	0.090
1989	0.503	0.046	0.584	0.044	0.726	0.043	0.635	0.060	0.521	0.042	0.671	0.040	0.597	0.054	0.482	0.040	0.665	0.043	0.649	0.057	0.606	0.061	0.614	0.087
1990	0.461	0.040	0.530	0.038	0.647	0.036	0.572	0.052	0.475	0.036	0.600	0.033	0.540	0.046	0.444	0.035	0.600	0.036	0.586	0.048	0.547	0.052	0.555	0.073
1991	0.373	0.031	0.423	0.030	0.501	0.025	0.458	0.041	0.381	0.028	0.468	0.024	0.436	0.036	0.359	0.028	0.470	0.026	0.470	0.038	0.439	0.039	0.441	0.053
1992	0.265	0.023	0.296	0.022	0.347	0.019	0.334	0.031	0.268	0.021	0.326	0.018	0.321	0.028	0.251	0.020	0.326	0.019	0.344	0.030	0.320	0.030	0.313	0.040
1993	0.246	0.023	0.270	0.021	0.325	0.021	0.317	0.031	0.244	0.020	0.303	0.019	0.305	0.028	0.226	0.019	0.301	0.020	0.327	0.029	0.304	0.030	0.291	0.041
1994	0.259	0.023	0.281	0.022	0.346	0.022	0.321	0.030	0.253	0.020	0.321	0.020	0.308	0.026	0.235	0.019	0.321	0.021	0.331	0.028	0.309	0.029	0.302	0.042
1995	0.288	0.025	0.314	0.024	0.386	0.026	0.338	0.031	0.282	0.022	0.357	0.024	0.324	0.027	0.262	0.021	0.358	0.025	0.348	0.029	0.328	0.031	0.330	0.045
1996	0.284	0.025	0.317	0.025	0.402	0.030	0.328	0.031	0.283	0.023	0.370	0.027	0.314	0.027	0.262	0.022	0.370	0.028	0.338	0.029	0.320	0.034	0.332	0.050
1997	0.273	0.024	0.312	0.025	0.409	0.031	0.315	0.030	0.278	0.023	0.375	0.028	0.301	0.026	0.258	0.022	0.378	0.029	0.325	0.028	0.309	0.036	0.328	0.054
1998	0.237	0.022	0.277	0.023	0.367	0.030	0.276	0.028	0.245	0.021	0.336	0.027	0.263	0.025	0.227	0.020	0.337	0.028	0.285	0.026	0.272	0.035	0.290	0.051
1999	0.229	0.022	0.268	0.023	0.352	0.029	0.266	0.028	0.238	0.021	0.323	0.026	0.254	0.025	0.219	0.020	0.324	0.027	0.276	0.027	0.262	0.034	0.280	0.049
2000	0.238	0.023	0.275	0.024	0.368	0.030	0.282	0.030	0.245	0.022	0.339	0.027	0.268	0.027	0.225	0.020	0.339	0.029	0.293	0.029	0.277	0.036	0.293	0.052
2001	0.249	0.023	0.284	0.024	0.378	0.029	0.300	0.030	0.253	0.022	0.350	0.027	0.285	0.027	0.233	0.021	0.351	0.028	0.312	0.029	0.293	0.036	0.305	0.052
2002	0.269	0.024	0.303	0.024	0.391	0.028	0.326	0.032	0.272	0.023	0.364	0.026	0.311	0.028	0.251	0.021	0.367	0.028	0.340	0.030	0.317	0.035	0.325	0.051
2003	0.271	0.024	0.303	0.024	0.389	0.027	0.338	0.032	0.273	0.023	0.363	0.026	0.321	0.028	0.253	0.021	0.368	0.027	0.352	0.031	0.326	0.033	0.329	0.050
2004	0.277	0.024	0.310	0.024	0.397	0.027	0.346	0.032	0.279	0.023	0.370	0.025	0.329	0.028	0.259	0.021	0.380	0.027	0.362	0.030	0.333	0.033	0.337	0.051
2005	0.276	0.023	0.310	0.023	0.389	0.026	0.339	0.030	0.280	0.022	0.364	0.024	0.322	0.027	0.261	0.021	0.378	0.026	0.357	0.029	0.327	0.032	0.333	0.048
2006	0.245	0.021	0.275	0.021	0.338	0.022	0.299	0.027	0.250	0.020	0.318	0.021	0.286	0.024	0.233	0.019	0.334	0.023	0.319	0.026	0.289	0.028	0.294	0.041
2007	0.208	0.018	0.233	0.018	0.287	0.020	0.260	0.024	0.212	0.017	0.272	0.019	0.250	0.022	0.198	0.016	0.292	0.020	0.282	0.024	0.253	0.025	0.254	0.037
2008	0.177	0.015	0.198	0.016	0.244	0.017	0.224	0.021	0.182	0.015	0.232	0.016	0.217	0.019	0.170	0.014	0.255	0.017	0.246	0.021	0.218	0.022	0.219	0.033
2009	0.163	0.015	0.182	0.015	0.226	0.017	0.202	0.020	0.167	0.014	0.215	0.016	0.197	0.018	0.156	0.013	0.238	0.017	0.225	0.020	0.199	0.021	0.201	0.031
2010	0.172	0.016	0.192	0.016	0.249	0.019	0.200	0.020	0.175	0.015	0.235	0.018	0.196	0.018	0.161	0.014	0.248	0.018	0.221	0.020	0.200	0.023	0.208	0.034
2011	0.227	0.021	0.249	0.020	0.320	0.024	0.244	0.023	0.226	0.019	0.302	0.022	0.238	0.021	0.207	0.017	0.297	0.021	0.261	0.022	0.246	0.030	0.260	0.042
2012	0.267	0.025	0.286	0.023	0.373	0.028	0.285	0.026	0.262	0.022	0.353	0.027	0.278	0.024	0.235	0.019	0.326	0.024	0.295	0.024	0.286	0.034	0.299	0.048
2013	0.301	0.028	0.318	0.026	0.412	0.032	0.316	0.029	0.294	0.025	0.396	0.030	0.310	0.027	0.258	0.021	0.353	0.027	0.322	0.026	0.320	0.038	0.331	0.053
2014	0.311	0.030	0.321	0.027	0.411	0.033	0.312	0.029	0.304	0.027	0.404	0.032	0.314	0.028	0.258	0.022	0.349	0.028	0.317	0.027	0.324	0.040	0.332	0.054
2015	0.318	0.032	0.319	0.028	0.419	0.035	0.307	0.030	0.313	0.028	0.425	0.036	0.322	0.030	0.256	0.022	0.352	0.030	0.311	0.028	0.332	0.045	0.336	0.060
2016	0.365	0.037	0.352	0.031	0.460	0.039	0.331	0.033	0.361	0.033	0.487	0.041	0.368	0.036	0.288	0.025	0.389	0.034	0.337	0.031	0.378	0.053	0.375	0.068
2017	0.400	0.042	0.363	0.033	0.475	0.042	0.354	0.036	0.395	0.036	0.536	0.045	0.425	0.042	0.305	0.028	0.411	0.038	0.362	0.035	0.430	0.058	0.403	0.076
2018	0.416	0.044	0.351	0.033	0.459	0.041	0.353	0.038	0.414	0.038	0.557	0.046	0.462	0.046	0.308	0.028	0.412	0.039	0.364	0.037	0.462	0.063	0.409	0.081
2019	0.405	0.043	0.314	0.031	0.403	0.037	0.317	0.037	0.405	0.037	0.529	0.042	0.454	0.046	0.289	0.028	0.377	0.037	0.330	0.037	0.449	0.064	0.380	0.082
2020	0.354	0.040	0.242	0.027	0.311	0.032	0.250	0.034	0.353	0.033	0.450	0.036	0.397	0.043	0.234	0.024	0.304	0.032	0.261	0.034	0.389	0.061	0.311	0.078
2021	0.319	0.021	0.244	0.018	0.268	0.013	0.231	0.022	0.319	0.018	0.348	0.018	0.321	0.028	0.241	0.018	0.277	0.015	0.240	0.021	0.317	0.037	0.277	0.045

Table 2.28—Age 0 recruitment time series.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Year	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
1977	0.730	0.176	0.882	0.205	1.604	0.450	1.087	0.295	0.751	0.177	1.388	0.383	0.972	0.261	0.606	0.138	1.104	0.292	1.084	0.288	1.018	0.313	1.053	0.410
1978	0.520	0.129	0.623	0.152	1.179	0.322	0.812	0.218	0.532	0.131	1.025	0.275	0.683	0.182	0.447	0.104	0.914	0.225	0.762	0.202	0.723	0.228	0.775	0.307
1979	0.520	0.089	0.625	0.102	1.002	0.201	0.782	0.141	0.535	0.087	0.875	0.172	0.699	0.125	0.457	0.071	0.801	0.151	0.775	0.138	0.718	0.149	0.728	0.211
1980	0.256	0.042	0.300	0.047	0.513	0.103	0.167	0.049	0.264	0.041	0.462	0.090	0.165	0.046	0.225	0.034	0.429	0.081	0.174	0.049	0.203	0.108	0.300	0.143
1981	0.140	0.024	0.162	0.027	0.268	0.057	0.218	0.046	0.144	0.024	0.242	0.050	0.198	0.041	0.126	0.020	0.224	0.045	0.215	0.044	0.202	0.046	0.200	0.060
1982	0.722	0.081	0.842	0.085	1.457	0.223	1.041	0.134	0.742	0.074	1.303	0.188	0.942	0.121	0.645	0.061	1.164	0.170	1.029	0.133	0.981	0.181	1.018	0.285
1983	0.185	0.030	0.220	0.034	0.360	0.074	0.253	0.050	0.189	0.029	0.317	0.064	0.234	0.046	0.163	0.025	0.305	0.059	0.256	0.051	0.243	0.056	0.255	0.078
1984	0.735	0.079	0.854	0.085	1.440	0.218	0.923	0.115	0.749	0.073	1.276	0.182	0.841	0.104	0.656	0.061	1.151	0.166	0.913	0.113	0.892	0.182	0.978	0.277
1985	0.271	0.036	0.305	0.039	0.562	0.093	0.429	0.060	0.264	0.034	0.495	0.078	0.390	0.055	0.232	0.028	0.477	0.075	0.425	0.059	0.399	0.073	0.398	0.121
1986	0.183	0.027	0.201	0.028	0.360	0.059	0.239	0.037	0.176	0.025	0.320	0.050	0.223	0.034	0.154	0.021	0.302	0.047	0.240	0.037	0.233	0.049	0.246	0.076
1987	0.105	0.020	0.110	0.021	0.141	0.031	0.078	0.020	0.098	0.019	0.128	0.027	0.075	0.019	0.089	0.017	0.127	0.026	0.080	0.020	0.082	0.026	0.103	0.032
1988	0.236	0.032	0.245	0.032	0.364	0.058	0.328	0.045	0.221	0.028	0.332	0.050	0.308	0.042	0.193	0.024	0.299	0.045	0.327	0.045	0.309	0.047	0.291	0.069
1989	0.575	0.061	0.624	0.062	0.990	0.141	0.652	0.077	0.559	0.055	0.897	0.120	0.607	0.072	0.486	0.045	0.809	0.110	0.648	0.077	0.641	0.122	0.697	0.180
1990	0.489	0.052	0.554	0.055	0.888	0.130	0.630	0.075	0.490	0.048	0.796	0.110	0.580	0.069	0.434	0.041	0.734	0.102	0.627	0.074	0.604	0.104	0.637	0.161
1991	0.322	0.036	0.376	0.041	0.617	0.094	0.340	0.049	0.334	0.036	0.554	0.080	0.323	0.046	0.296	0.030	0.518	0.075	0.340	0.049	0.350	0.089	0.411	0.127
1992	0.726	0.068	0.871	0.078	1.453	0.203	0.934	0.098	0.773	0.067	1.300	0.170	0.864	0.091	0.682	0.056	1.190	0.157	0.928	0.098	0.914	0.174	0.999	0.272
1993	0.295	0.031	0.345	0.035	0.588	0.086	0.389	0.047	0.304	0.030	0.523	0.072	0.348	0.043	0.269	0.025	0.493	0.068	0.386	0.047	0.369	0.074	0.405	0.114
1994	0.248	0.027	0.272	0.029	0.448	0.066	0.314	0.038	0.240	0.025	0.400	0.056	0.289	0.036	0.214	0.021	0.376	0.052	0.314	0.039	0.301	0.054	0.319	0.084
1995	0.235	0.026	0.254	0.027	0.394	0.059	0.278	0.036	0.229	0.024	0.359	0.051	0.259	0.034	0.203	0.021	0.332	0.047	0.279	0.036	0.270	0.049	0.288	0.071
1996	0.617	0.061	0.677	0.062	1.121	0.156	0.889	0.101	0.611	0.054	1.023	0.133	0.819	0.092	0.529	0.044	0.918	0.121	0.889	0.101	0.838	0.127	0.831	0.209
1997	0.287	0.031	0.331	0.033	0.528	0.076	0.390	0.049	0.294	0.029	0.476	0.065	0.363	0.045	0.258	0.024	0.447	0.062	0.392	0.049	0.375	0.062	0.387	0.096
1998	0.287	0.029	0.310	0.030	0.496	0.072	0.306	0.040	0.277	0.027	0.450	0.062	0.286	0.037	0.251	0.023	0.430	0.059	0.310	0.040	0.305	0.066	0.346	0.095
1999	0.552	0.051	0.626	0.054	0.991	0.134	0.718	0.076	0.559	0.048	0.896	0.114	0.655	0.069	0.492	0.040	0.825	0.107	0.719	0.077	0.682	0.111	0.720	0.174
2000	0.450	0.042	0.523	0.046	0.796	0.108	0.511	0.056	0.466	0.040	0.716	0.091	0.480	0.052	0.412	0.034	0.687	0.089	0.522	0.057	0.509	0.095	0.568	0.141
2001	0.191	0.020	0.214	0.022	0.358	0.051	0.229	0.029	0.191	0.019	0.324	0.044	0.201	0.027	0.171	0.016	0.318	0.043	0.231	0.030	0.216	0.049	0.248	0.072
2002	0.267	0.026	0.296	0.028	0.474	0.064	0.348	0.040	0.266	0.025	0.431	0.056	0.330	0.037	0.238	0.021	0.423	0.055	0.361	0.042	0.340	0.054	0.352	0.086
2003	0.221	0.022	0.249	0.023	0.401	0.055	0.326	0.036	0.225	0.021	0.368	0.048	0.306	0.034	0.199	0.018	0.364	0.048	0.340	0.038	0.312	0.045	0.309	0.076
2004	0.192	0.020	0.216	0.021	0.339	0.047	0.248	0.032	0.193	0.019	0.306	0.041	0.232	0.030	0.176	0.016	0.316	0.042	0.258	0.033	0.240	0.040	0.254	0.063
2005	0.249	0.025	0.282	0.026	0.442	0.061	0.297	0.036	0.257	0.023	0.409	0.053	0.282	0.034	0.226	0.020	0.378	0.049	0.302	0.036	0.296	0.055	0.319	0.080
2006	0.764	0.071	0.821	0.069	1.299	0.171	0.881	0.088	0.741	0.061	1.189	0.147	0.838	0.085	0.646	0.049	0.981	0.122	0.859	0.086	0.875	0.148	0.917	0.223
2007	0.336	0.034	0.354	0.033	0.550	0.079	0.350	0.044	0.317	0.030	0.501	0.068	0.324	0.042	0.274	0.024	0.404	0.054	0.335	0.042	0.345	0.072	0.379	0.099
2008	1.041	0.097	1.124	0.094	1.777	0.236	1.187	0.122	1.037	0.086	1.659	0.208	1.125	0.116	0.863	0.065	1.338	0.164	1.140	0.114	1.184	0.214	1.250	0.313
2009	0.140	0.019	0.152	0.020	0.253	0.044	0.166	0.029	0.139	0.018	0.235	0.039	0.159	0.029	0.131	0.016	0.336	0.047	0.200	0.032	0.168	0.040	0.197	0.071
2010	0.633	0.062	0.692	0.061	1.092	0.152	0.724	0.079	0.668	0.059	1.073	0.142	0.734	0.083	0.543	0.043	0.817	0.106	0.704	0.077	0.767	0.141	0.783	0.198
2011	0.919	0.093	0.914	0.082	1.428	0.200	0.880	0.095	0.893	0.080	1.427	0.191	0.937	0.108	0.733	0.059	1.133	0.147	0.872	0.094	0.984	0.196	1.024	0.268
2012	0.419	0.046	0.394	0.039	0.642	0.097	0.377	0.049	0.409	0.041	0.686	0.100	0.414	0.057	0.339	0.031	0.568	0.079	0.389	0.051	0.441	0.106	0.469	0.137
2013	0.943	0.098	0.891	0.082	1.418	0.202	0.916	0.106	0.984	0.090	1.629	0.221	1.159	0.139	0.766	0.064	1.243	0.168	0.937	0.110	1.184	0.224	1.105	0.301
2014	0.166	0.021	0.147	0.018	0.255	0.042	0.173	0.026	0.167	0.020	0.297	0.046	0.205	0.032	0.125	0.013	0.249	0.037	0.176	0.026	0.211	0.046	0.199	0.062
2015	0.259	0.030	0.209	0.022	0.366	0.055	0.220	0.029	0.249	0.025	0.440	0.062	0.278	0.036	0.190	0.017	0.378	0.053	0.243	0.031	0.291	0.066	0.286	0.092
2016	0.130	0.018	0.116	0.015	0.191	0.031	0.108	0.015	0.123	0.016	0.204	0.032	0.151	0.025	0.074	0.008	0.167	0.025	0.134	0.022	0.153	0.032	0.141	0.045
2017	0.148	0.024	0.109	0.018	0.177	0.033	0.086	0.021	0.143	0.022	0.227	0.040	0.102	0.030	0.118	0.014	0.199	0.033	0.121	0.030	0.117	0.050	0.143	0.053
2018	0.903	0.127	0.994	0.130	1.674	0.277	0.592	0.082	1.023	0.122	1.723	0.262	0.655	0.085	0.744	0.088	1.304	0.200	0.640	0.089	0.784	0.357	1.039	0.445
2019	0.427	0.040	0.463	0.041	0.773	0.106	0.515	0.053	0.431	0.037	0.720	0.093	0.491	0.051	0.371	0.030	0.631	0.082	0.512	0.053	0.515	0.093	0.545	0.143
2020	0.427	0.040	0.463	0.041	0.773	0.106	0.515	0.053	0.431	0.037	0.720	0.093	0.491	0.051	0.371	0.030	0.631	0.082	0.512	0.053	0.515	0.093	0.545	0.143
2021	0.427	0.040	0.463	0.041	0.773	0.106	0.515	0.053	0.431	0.037	0.720	0.093	0.491	0.051	0.371	0.030	0.631	0.082	0.512	0.053	0.515	0.093	0.545	0.143

Table 2.29—Fishing mortality time series.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Year	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
1977	0.308	0.111	0.323	0.121	0.236	0.086	0.227	0.071	0.311	0.112	0.221	0.076	0.207	0.059	0.366	0.135	0.228	0.075	0.210	0.062	0.214	0.068	0.259	0.107
1978	0.402	0.152	0.418	0.162	0.297	0.109	0.276	0.083	0.406	0.153	0.279	0.097	0.253	0.070	0.489	0.188	0.290	0.096	0.256	0.074	0.264	0.086	0.329	0.146
1979	0.319	0.116	0.326	0.122	0.226	0.079	0.199	0.056	0.321	0.117	0.215	0.071	0.184	0.047	0.389	0.144	0.226	0.071	0.185	0.049	0.194	0.063	0.252	0.114
1980	0.353	0.106	0.353	0.107	0.249	0.072	0.199	0.046	0.354	0.105	0.241	0.067	0.189	0.041	0.426	0.127	0.259	0.069	0.190	0.042	0.203	0.061	0.273	0.114
1981	0.230	0.041	0.218	0.038	0.175	0.034	0.145	0.024	0.227	0.039	0.176	0.034	0.143	0.023	0.266	0.044	0.193	0.035	0.141	0.023	0.150	0.032	0.187	0.053
1982	0.125	0.014	0.115	0.012	0.097	0.013	0.106	0.014	0.122	0.013	0.100	0.013	0.108	0.014	0.140	0.014	0.111	0.014	0.105	0.014	0.107	0.015	0.111	0.018
1983	0.139	0.013	0.129	0.011	0.108	0.011	0.125	0.014	0.136	0.011	0.112	0.011	0.128	0.014	0.153	0.012	0.124	0.012	0.124	0.014	0.127	0.015	0.127	0.017
1984	0.187	0.015	0.173	0.012	0.157	0.015	0.171	0.016	0.182	0.013	0.159	0.014	0.174	0.017	0.202	0.013	0.174	0.016	0.170	0.016	0.173	0.017	0.173	0.019
1985	0.203	0.015	0.189	0.012	0.179	0.016	0.187	0.018	0.197	0.013	0.181	0.015	0.190	0.018	0.218	0.013	0.196	0.017	0.186	0.018	0.189	0.018	0.191	0.019
1986	0.202	0.014	0.188	0.011	0.189	0.016	0.176	0.017	0.195	0.012	0.191	0.015	0.179	0.017	0.214	0.012	0.203	0.017	0.176	0.017	0.181	0.017	0.190	0.019
1987	0.214	0.013	0.200	0.011	0.203	0.016	0.202	0.017	0.206	0.011	0.206	0.016	0.206	0.017	0.223	0.011	0.213	0.016	0.202	0.017	0.206	0.017	0.207	0.016
1988	0.281	0.017	0.264	0.013	0.258	0.017	0.239	0.019	0.271	0.014	0.262	0.017	0.240	0.019	0.291	0.014	0.272	0.017	0.238	0.019	0.244	0.020	0.259	0.024
1989	0.235	0.013	0.222	0.010	0.226	0.017	0.223	0.016	0.228	0.010	0.226	0.015	0.225	0.016	0.242	0.010	0.233	0.017	0.222	0.016	0.225	0.016	0.227	0.016
1990	0.262	0.013	0.250	0.010	0.242	0.015	0.250	0.016	0.256	0.011	0.246	0.014	0.252	0.016	0.269	0.010	0.253	0.014	0.248	0.016	0.251	0.016	0.252	0.016
1991	0.460	0.024	0.446	0.020	0.447	0.034	0.422	0.029	0.452	0.020	0.442	0.028	0.420	0.029	0.475	0.020	0.461	0.035	0.417	0.030	0.424	0.030	0.442	0.033
1992	0.547	0.035	0.542	0.031	0.559	0.046	0.466	0.041	0.547	0.031	0.556	0.045	0.458	0.039	0.576	0.031	0.571	0.045	0.460	0.041	0.473	0.053	0.526	0.061
1993	0.415	0.027	0.420	0.025	0.449	0.038	0.318	0.025	0.426	0.025	0.448	0.037	0.312	0.025	0.451	0.025	0.449	0.036	0.313	0.025	0.332	0.054	0.399	0.067
1994	0.451	0.025	0.457	0.024	0.477	0.037	0.425	0.030	0.466	0.024	0.480	0.036	0.421	0.029	0.495	0.024	0.480	0.035	0.419	0.030	0.429	0.036	0.458	0.041
1995	0.573	0.031	0.576	0.030	0.565	0.043	0.541	0.038	0.590	0.030	0.570	0.041	0.534	0.037	0.627	0.030	0.577	0.042	0.533	0.038	0.541	0.040	0.568	0.046
1996	0.536	0.031	0.519	0.029	0.505	0.042	0.529	0.038	0.536	0.029	0.509	0.040	0.524	0.037	0.570	0.028	0.514	0.041	0.519	0.037	0.523	0.037	0.525	0.040
1997	0.592	0.033	0.553	0.030	0.524	0.044	0.597	0.042	0.573	0.030	0.533	0.043	0.595	0.042	0.610	0.029	0.536	0.043	0.587	0.042	0.587	0.046	0.568	0.049
1998	0.479	0.029	0.443	0.026	0.388	0.031	0.483	0.037	0.458	0.026	0.395	0.031	0.482	0.037	0.490	0.026	0.406	0.032	0.474	0.037	0.471	0.045	0.447	0.050
1999	0.489	0.032	0.456	0.029	0.410	0.038	0.459	0.039	0.471	0.029	0.411	0.034	0.456	0.038	0.505	0.029	0.424	0.038	0.449	0.038	0.452	0.040	0.449	0.045
2000	0.467	0.031	0.444	0.028	0.416	0.037	0.441	0.037	0.457	0.029	0.419	0.036	0.441	0.037	0.490	0.028	0.422	0.036	0.431	0.037	0.439	0.038	0.440	0.040
2001	0.372	0.022	0.360	0.020	0.342	0.028	0.375	0.028	0.368	0.020	0.343	0.027	0.375	0.028	0.395	0.020	0.345	0.027	0.367	0.028	0.371	0.029	0.363	0.030
2002	0.443	0.025	0.433	0.023	0.395	0.029	0.406	0.030	0.439	0.023	0.394	0.028	0.402	0.029	0.471	0.023	0.402	0.028	0.397	0.029	0.403	0.030	0.415	0.037
2003	0.475	0.027	0.466	0.025	0.450	0.037	0.409	0.028	0.474	0.025	0.443	0.033	0.407	0.028	0.504	0.024	0.445	0.036	0.398	0.028	0.413	0.033	0.444	0.044
2004	0.453	0.023	0.440	0.021	0.438	0.033	0.420	0.027	0.448	0.022	0.437	0.032	0.420	0.026	0.475	0.021	0.429	0.031	0.407	0.027	0.423	0.028	0.435	0.033
2005	0.458	0.022	0.444	0.020	0.432	0.030	0.444	0.028	0.450	0.020	0.431	0.029	0.443	0.028	0.476	0.019	0.423	0.028	0.427	0.028	0.442	0.028	0.441	0.030
2006	0.525	0.026	0.510	0.025	0.497	0.038	0.482	0.032	0.513	0.025	0.488	0.034	0.479	0.031	0.543	0.023	0.476	0.034	0.456	0.031	0.481	0.033	0.494	0.039
2007	0.508	0.027	0.497	0.026	0.495	0.041	0.460	0.032	0.497	0.026	0.484	0.037	0.454	0.032	0.525	0.024	0.457	0.035	0.427	0.031	0.458	0.035	0.477	0.043
2008	0.627	0.037	0.614	0.035	0.595	0.049	0.566	0.044	0.610	0.035	0.582	0.046	0.553	0.042	0.644	0.033	0.530	0.038	0.516	0.040	0.558	0.045	0.579	0.056
2009	0.776	0.054	0.758	0.050	0.715	0.065	0.703	0.063	0.752	0.050	0.695	0.061	0.680	0.060	0.794	0.047	0.619	0.049	0.633	0.056	0.684	0.063	0.706	0.078
2010	0.610	0.041	0.597	0.038	0.587	0.054	0.637	0.054	0.600	0.038	0.575	0.051	0.617	0.052	0.638	0.036	0.538	0.043	0.591	0.051	0.612	0.053	0.598	0.055
2011	0.637	0.039	0.643	0.036	0.618	0.053	0.747	0.056	0.646	0.037	0.609	0.051	0.726	0.054	0.697	0.034	0.631	0.048	0.711	0.053	0.710	0.066	0.670	0.068
2012	0.616	0.040	0.633	0.037	0.602	0.051	0.656	0.046	0.634	0.037	0.589	0.049	0.643	0.046	0.705	0.036	0.663	0.052	0.652	0.046	0.638	0.049	0.642	0.055
2013	0.511	0.032	0.537	0.029	0.515	0.045	0.618	0.043	0.528	0.029	0.495	0.041	0.596	0.042	0.606	0.028	0.580	0.048	0.624	0.043	0.585	0.054	0.566	0.060
2014	0.590	0.042	0.636	0.040	0.569	0.049	0.701	0.057	0.606	0.038	0.533	0.045	0.651	0.054	0.724	0.039	0.645	0.053	0.704	0.057	0.640	0.067	0.641	0.077
2015	0.513	0.038	0.562	0.036	0.550	0.055	0.690	0.056	0.517	0.033	0.492	0.045	0.621	0.052	0.637	0.035	0.612	0.058	0.695	0.057	0.609	0.071	0.597	0.083
2016	0.449	0.033	0.523	0.033	0.493	0.045	0.657	0.055	0.458	0.029	0.427	0.037	0.555	0.048	0.578	0.031	0.559	0.050	0.659	0.056	0.546	0.071	0.545	0.087
2017	0.401	0.031	0.500	0.034	0.468	0.044	0.577	0.052	0.407	0.026	0.375	0.032	0.443	0.040	0.531	0.031	0.514	0.048	0.573	0.052	0.445	0.059	0.488	0.078
2018	0.304	0.024	0.406	0.029	0.390	0.038	0.468	0.045	0.304	0.019	0.288	0.024	0.323	0.029	0.409	0.024	0.406	0.039	0.460	0.045	0.330	0.051	0.384	0.070
2019	0.306	0.026	0.459	0.039	0.413	0.041	0.496	0.060	0.306	0.021	0.279	0.022	0.306	0.031	0.438	0.030	0.422	0.041	0.479	0.057	0.318	0.061	0.400	0.087
2020	0.259	0.040	0.185	0.029	0.353	0.060	0.223	0.040	0.260	0.035	0.432	0.029	0.339	0.019	0.157	0.023	0.304	0.053	0.229	0.040	0.337	0.053	0.276	0.092
2021	0.232	0.025	0.187	0.021	0.301	0.034	0.205	0.026	0.234	0.021	0.371	0.040	0.273	0.034	0.163	0.018	0.275	0.033	0.209	0.026	0.276	0.051	0.246	0.068

Table 2.30—Management reference points.

	Hypothesis:	2	1 (EBS only)			2 (EBS and NBS combined)			3 (EBS and NBS separated)			Ensemble (19.x)	
Year	Quantity	M16.6i	M19.7	M19.8	M19.9	M19.10	M19.11	M19.12	M19.13	M19.14	M19.15	Wtd	Unw
n/a	B100%	691,900	630,950	602,845	640,400	689,780	637,650	672,795	696,950	611,630	630,700	666,506	645,967
n/a	B40%	276,760	252,380	241,138	256,160	275,912	255,060	269,118	278,780	244,652	252,280	266,602	258,387
n/a	B35%	242,165	220,833	210,996	224,140	241,423	223,178	235,478	243,933	214,071	220,745	233,277	226,089
n/a	F40%	0.30	0.32	0.46	0.36	0.30	0.43	0.34	0.28	0.41	0.36	0.35	0.36
n/a	F35%	0.36	0.39	0.57	0.44	0.36	0.53	0.41	0.34	0.50	0.44	0.43	0.44
2020	Female spawning biomass	244,813	153,001	187,569	159,841	243,403	286,638	267,333	162,925	186,003	164,727	259,509	201,271
2020	Relative spawning biomass	0.35	0.24	0.31	0.25	0.35	0.45	0.40	0.23	0.30	0.26	0.39	0.31
2020	Pr(B/B100%<0.2)	0.00	0.06	0.00	0.07	0.00	0.00	0.00	0.08	0.00	0.04	0.00	0.03
2020	maxFABC	0.26	0.19	0.35	0.22	0.26	0.43	0.34	0.16	0.30	0.23	0.34	0.28
2020	maxABC	125,431	58,057	108,529	67,127	125,009	201,257	160,789	54,138	99,642	70,089	155,873	104,960
2020	Catch	125,431	58,057	108,529	67,127	125,009	199,691	160,789	54,138	99,642	70,089	155,873	104,960
2020	FOFL	0.32	0.23	0.44	0.27	0.32	0.53	0.41	0.19	0.37	0.28	0.41	0.34
2020	OFL	149,545	69,846	130,680	80,820	149,039	239,837	191,386	64,987	119,390	84,245	185,650	125,581
2020	Pr(maxABC>truOFL)	0.22	0.22	0.23	0.26	0.17	0.07	0.09	0.20	0.23	0.27	0.16	0.47
2021	Female spawning biomass	220,884	154,188	161,736	147,900	220,007	222,277	216,255	168,136	169,558	151,479	211,410	179,060
2021	Relative spawning biomass	0.32	0.24	0.27	0.23	0.32	0.35	0.32	0.24	0.28	0.24	0.32	0.28
2021	Pr(B/B100%<0.2)	0.00	0.01	0.00	0.08	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.01
2021	maxFABC	0.23	0.19	0.30	0.20	0.23	0.37	0.27	0.16	0.28	0.21	0.28	0.25
2021	maxABC	95,283	53,705	76,738	56,445	94,551	127,409	105,046	52,651	78,630	58,585	102,975	78,196
2021	Catch	95,283	53,705	76,738	56,445	94,551	127,409	105,046	52,651	78,630	58,585	102,975	78,196
2021	FOFL	0.28	0.23	0.37	0.25	0.29	0.46	0.33	0.20	0.34	0.26	0.34	0.30
2021	OFL	113,925	64,631	92,873	68,065	113,057	152,858	125,734	63,192	94,509	70,566	123,331	93,943
2021	Pr(maxABC>truOFL)	0.23	0.21	0.23	0.31	0.17	0.20	0.24	0.22	0.23	0.27	0.27	0.43

Legend:
B100% = equilibrium unfished female spawning biomass
B40% = 40% of B100% (the inflection point of the harvest control rules in Tier 3)
B35% = 35% of B100% (the BMSY proxy for Tier 3)
F40% = fishing mortality that reduces equilibrium spawning per recruit to 40% of unfished
F35% = fishing mortality that reduces equilibrium spawning per recruit to 35% of unfished
Relative spawning biomass = ratio of female spawning biomass to B100%
Pr(B/B100%<0.2) = probability that relative spawning biomass is less than 0.2
maxFABC = maximum permissible ABC fishing mortality rate under Tier 3
maxABC = maximum permissible ABC under Tier 3
Catch = estimated catch conditional on ABC=maxABC
FOFL = OFL fishing mortality rate under Tier 3
OFL = OFL under Tier 3
Pr(maxABC>truOFL) = probability that maxABC is greater than the "true" OFL

Table 2.31a—Length at age (ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	5.3	16.0	32.1	44.0	53.5	61.4	68.1	73.8	78.7	83.0	86.7	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	108.1
1978	5.0	16.0	31.5	44.0	53.5	61.4	68.1	73.8	78.7	83.0	86.7	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	108.1
1979	5.4	15.0	32.3	43.4	53.5	61.4	68.1	73.8	78.7	83.0	86.7	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.9
1980	5.0	16.3	31.5	44.1	53.1	61.4	68.1	73.8	78.7	83.0	86.7	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.7
1981	4.4	15.1	30.4	43.5	53.6	61.0	68.1	73.8	78.7	83.0	86.7	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.7
1982	4.5	13.2	30.5	42.6	53.1	61.5	67.8	73.8	78.7	83.0	86.7	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.6
1983	5.9	13.5	33.1	42.7	52.4	61.1	68.1	73.5	78.7	83.0	86.7	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.6
1984	5.3	17.6	32.1	44.7	52.5	60.5	67.8	73.9	78.5	83.0	86.7	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.6
1985	4.2	15.9	29.9	43.9	54.1	60.5	67.3	73.6	78.8	82.8	86.7	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.6
1986	5.1	12.5	31.7	42.3	53.4	61.9	67.4	73.1	78.5	83.0	86.5	89.9	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.7
1987	4.7	15.4	31.0	43.6	52.1	61.4	68.5	73.2	78.1	82.8	86.7	89.8	92.8	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.7
1988	4.5	14.2	30.6	43.1	53.2	60.2	68.1	74.2	78.2	82.5	86.5	90.0	92.6	95.3	97.5	99.4	101.1	102.6	104.0	105.2	107.7
1989	4.6	13.6	30.7	42.8	52.8	61.2	67.1	73.8	79.1	82.5	86.2	89.8	92.8	95.2	97.5	99.4	101.1	102.6	104.0	105.2	107.8
1990	5.0	13.7	31.5	42.8	52.5	60.8	67.9	72.9	78.7	83.3	86.3	89.5	92.7	95.3	97.4	99.4	101.1	102.6	104.0	105.2	107.8
1991	5.4	15.1	32.2	43.5	52.6	60.6	67.6	73.6	78.0	83.0	87.0	89.6	92.4	95.2	97.5	99.3	101.1	102.6	104.0	105.2	107.8
1992	5.0	16.2	31.5	44.0	53.1	60.6	67.4	73.4	78.6	82.3	86.7	90.2	92.5	95.0	97.4	99.4	101.0	102.6	104.0	105.2	107.7
1993	5.3	15.1	32.0	43.5	53.6	61.1	67.4	73.2	78.3	82.9	86.1	89.9	93.0	95.0	97.2	99.3	101.1	102.6	104.0	105.2	107.5
1994	5.0	15.8	31.4	43.8	53.1	61.5	67.8	73.2	78.2	82.6	86.6	89.4	92.8	95.5	97.2	99.2	101.0	102.7	103.9	105.2	107.2
1995	4.9	14.9	31.3	43.4	53.4	61.1	68.1	73.6	78.2	82.5	86.4	89.8	92.3	95.3	97.6	99.2	100.9	102.6	104.0	105.1	107.3
1996	5.0	14.8	31.5	43.3	53.0	61.3	67.8	73.8	78.5	82.6	86.3	89.7	92.7	94.9	97.5	99.6	100.9	102.4	103.9	105.2	106.9
1997	5.0	15.1	31.4	43.5	53.0	61.0	68.0	73.6	78.8	82.8	86.3	89.6	92.6	95.2	97.1	99.4	101.3	102.5	103.8	105.1	106.7
1998	4.6	14.9	30.7	43.4	53.1	61.0	67.7	73.7	78.5	83.0	86.5	89.6	92.5	95.1	97.4	99.1	101.1	102.8	103.8	105.0	106.9
1999	4.3	13.8	30.2	42.9	53.0	61.1	67.7	73.5	78.7	82.8	86.7	89.8	92.5	95.0	97.3	99.4	100.8	102.6	104.1	105.0	107.1
2000	5.6	13.0	32.6	42.5	52.6	61.0	67.8	73.5	78.5	82.9	86.5	90.0	92.7	95.0	97.2	99.3	101.1	102.4	104.0	105.3	107.6
2001	5.3	16.7	32.0	44.3	52.3	60.7	67.7	73.5	78.4	82.8	86.7	89.8	92.8	95.2	97.2	99.2	101.0	102.6	103.8	105.2	107.9
2002	5.5	15.9	32.4	43.9	53.8	60.4	67.5	73.5	78.5	82.7	86.5	89.9	92.7	95.3	97.4	99.2	100.9	102.5	103.9	105.0	107.2
2003	5.2	16.5	31.8	44.2	53.4	61.6	67.2	73.3	78.5	82.8	86.5	89.8	92.8	95.2	97.5	99.3	100.9	102.5	103.9	105.1	107.5
2004	6.0	15.5	33.4	43.7	53.7	61.3	68.3	73.1	78.3	82.8	86.5	89.8	92.6	95.3	97.4	99.4	101.0	102.5	103.8	105.1	107.1
2005	5.0	18.0	31.4	45.0	53.3	61.6	68.0	74.0	78.1	82.6	86.5	89.8	92.6	95.1	97.5	99.3	101.1	102.6	103.8	105.0	107.4
2006	4.9	14.9	31.2	43.4	54.3	61.2	68.2	73.8	78.9	82.4	86.3	89.8	92.7	95.1	97.4	99.4	101.1	102.7	103.9	105.0	107.6
2007	4.5	14.7	30.4	43.3	53.0	62.1	67.9	73.9	78.7	83.1	86.2	89.6	92.6	95.2	97.3	99.3	101.1	102.6	104.0	105.1	108.0
2008	4.3	13.4	30.2	42.7	52.9	61.0	68.7	73.7	78.8	83.0	86.8	89.5	92.5	95.1	97.4	99.3	101.0	102.6	103.9	105.2	107.4
2009	4.6	13.0	30.7	42.5	52.4	60.9	67.7	74.3	78.6	83.1	86.7	90.0	92.4	95.0	97.4	99.3	101.0	102.6	104.0	105.1	106.9
2010	5.2	13.8	31.9	42.9	52.3	60.5	67.7	73.5	79.2	82.9	86.8	89.9	92.9	94.9	97.3	99.3	101.0	102.5	103.9	105.2	106.9
2011	4.4	15.7	30.3	43.8	52.6	60.4	67.3	73.5	78.5	83.4	86.6	90.0	92.8	95.4	97.2	99.2	101.0	102.6	103.9	105.1	107.1
2012	5.2	13.1	31.9	42.5	53.3	60.6	67.2	73.1	78.4	82.8	87.0	89.9	92.8	95.3	97.6	99.1	100.9	102.6	103.9	105.1	106.7
2013	4.9	15.7	31.2	43.8	52.3	61.3	67.4	73.1	78.1	82.7	86.5	90.2	92.7	95.3	97.5	99.5	100.9	102.5	103.9	105.1	107.0
2014	5.2	14.6	31.7	43.2	53.3	60.4	68.0	73.2	78.1	82.5	86.5	89.8	93.1	95.2	97.5	99.4	101.2	102.4	103.8	105.1	107.2
2015	6.3	15.5	34.0	43.7	52.9	61.3	67.2	73.7	78.2	82.4	86.3	89.7	92.6	95.5	97.4	99.5	101.1	102.7	103.8	105.0	107.2
2016	6.5	18.9	34.5	45.5	53.2	60.9	68.0	73.1	78.6	82.6	86.2	89.6	92.6	95.1	97.7	99.4	101.2	102.6	104.0	105.0	106.6
2017	6.1	19.6	33.6	45.8	54.7	61.2	67.7	73.7	78.1	82.9	86.3	89.5	92.4	95.1	97.4	99.6	101.1	102.7	104.0	105.2	107.0
2018	7.0	18.2	35.4	45.1	55.0	62.4	67.9	73.4	78.6	82.4	86.6	89.6	92.4	95.0	97.3	99.3	101.3	102.6	104.0	105.2	107.2
2019	5.0	20.9	31.6	46.5	54.4	62.7	69.0	73.7	78.4	82.9	86.2	89.9	92.5	94.9	97.2	99.3	101.0	102.8	103.9	105.2	106.9

Table 2.31b—Length at age (ensemble unweighted average)

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	5.6	16.7	32.0	44.2	54.2	62.4	69.3	75.0	79.8	83.8	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.3
1978	5.4	16.7	31.7	44.2	54.2	62.4	69.3	75.0	79.8	83.8	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.3
1979	5.6	16.2	32.1	44.0	54.2	62.4	69.3	75.0	79.8	83.8	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.2
1980	5.4	16.8	31.8	44.3	54.0	62.4	69.3	75.0	79.8	83.8	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.1
1981	5.2	16.3	31.3	44.0	54.2	62.3	69.3	75.0	79.8	83.8	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.1
1982	5.2	15.5	31.3	43.6	54.0	62.5	69.1	75.0	79.8	83.8	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.1
1983	5.8	15.6	32.4	43.7	53.7	62.3	69.3	74.9	79.8	83.8	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.1
1984	5.5	17.3	31.9	44.5	53.7	62.0	69.1	75.0	79.7	83.8	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.1
1985	5.1	16.6	31.1	44.1	54.4	62.0	68.9	74.9	79.8	83.7	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.1
1986	5.4	15.2	31.8	43.5	54.1	62.6	69.0	74.7	79.7	83.8	87.1	90.0	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.1
1987	5.3	16.3	31.5	44.0	53.6	62.4	69.4	74.7	79.5	83.7	87.2	89.9	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.1
1988	5.2	15.9	31.4	43.8	54.0	61.9	69.2	75.1	79.5	83.5	87.1	90.0	92.3	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.1
1989	5.2	15.6	31.4	43.7	53.9	62.3	68.8	75.0	79.9	83.6	86.9	89.9	92.4	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.2
1990	5.4	15.7	31.7	43.7	53.8	62.2	69.2	74.6	79.7	83.9	87.0	89.8	92.3	94.5	96.1	97.6	98.9	99.9	100.9	101.6	103.2
1991	5.6	16.2	32.0	44.0	53.8	62.1	69.0	74.9	79.4	83.8	87.3	89.8	92.2	94.4	96.2	97.6	98.9	99.9	100.9	101.6	103.2
1992	5.4	16.7	31.7	44.2	54.0	62.1	69.0	74.8	79.7	83.5	87.1	90.1	92.3	94.3	96.1	97.6	98.8	99.9	100.9	101.6	103.1
1993	5.5	16.2	31.9	44.0	54.2	62.3	69.0	74.7	79.6	83.7	86.9	90.0	92.5	94.3	96.0	97.6	98.9	99.9	100.9	101.6	103.0
1994	5.4	16.5	31.7	44.1	54.0	62.4	69.1	74.7	79.5	83.6	87.1	89.8	92.4	94.5	96.0	97.5	98.8	100.0	100.8	101.6	102.9
1995	5.4	16.2	31.7	43.9	54.1	62.3	69.3	74.9	79.5	83.6	87.0	89.9	92.2	94.4	96.2	97.5	98.8	99.9	100.9	101.6	103.0
1996	5.4	16.1	31.7	43.9	54.0	62.4	69.1	75.0	79.7	83.6	87.0	89.9	92.4	94.3	96.1	97.7	98.8	99.9	100.8	101.7	102.8
1997	5.4	16.2	31.7	44.0	53.9	62.2	69.2	74.9	79.8	83.7	87.0	89.8	92.3	94.4	96.0	97.6	98.9	99.9	100.8	101.6	102.7
1998	5.2	16.1	31.4	43.9	54.0	62.2	69.1	74.9	79.7	83.8	87.1	89.8	92.3	94.3	96.1	97.5	98.9	100.0	100.8	101.6	102.8
1999	5.1	15.7	31.2	43.7	54.0	62.3	69.1	74.8	79.7	83.7	87.1	89.9	92.3	94.3	96.1	97.6	98.8	99.9	100.9	101.6	102.9
2000	5.6	15.4	32.1	43.6	53.8	62.2	69.1	74.8	79.6	83.7	87.1	90.0	92.3	94.3	96.1	97.6	98.8	99.8	100.9	101.7	103.1
2001	5.5	16.9	31.9	44.3	53.7	62.1	69.1	74.9	79.6	83.7	87.1	89.9	92.4	94.4	96.1	97.5	98.8	99.9	100.8	101.6	103.2
2002	5.6	16.5	32.1	44.1	54.3	62.0	69.0	74.8	79.7	83.7	87.1	90.0	92.3	94.4	96.1	97.5	98.8	99.9	100.8	101.6	102.9
2003	5.5	16.8	31.8	44.3	54.1	62.5	68.9	74.7	79.6	83.7	87.1	89.9	92.4	94.4	96.2	97.6	98.8	99.9	100.8	101.6	103.1
2004	5.8	16.4	32.5	44.1	54.2	62.4	69.3	74.7	79.6	83.7	87.1	89.9	92.3	94.4	96.1	97.6	98.8	99.9	100.8	101.6	102.9
2005	5.4	17.3	31.7	44.5	54.1	62.5	69.2	75.0	79.5	83.6	87.1	89.9	92.3	94.4	96.1	97.6	98.9	99.9	100.8	101.6	103.0
2006	5.4	16.1	31.6	43.9	54.5	62.3	69.3	74.9	79.8	83.5	87.0	89.9	92.3	94.4	96.1	97.6	98.8	99.9	100.8	101.6	103.1
2007	5.2	16.1	31.3	43.9	53.9	62.7	69.2	75.0	79.7	83.8	86.9	89.9	92.3	94.4	96.1	97.6	98.9	99.9	100.9	101.6	103.3
2008	5.1	15.5	31.2	43.6	53.9	62.2	69.5	74.9	79.8	83.7	87.2	89.8	92.3	94.4	96.1	97.6	98.8	99.9	100.8	101.6	103.0
2009	5.2	15.4	31.4	43.6	53.7	62.2	69.1	75.2	79.7	83.8	87.1	90.0	92.2	94.3	96.1	97.6	98.8	99.9	100.8	101.6	102.8
2010	5.5	15.7	31.9	43.7	53.7	62.0	69.1	74.8	79.9	83.7	87.2	90.0	92.4	94.3	96.1	97.6	98.8	99.9	100.8	101.6	102.8
2011	5.2	16.5	31.3	44.1	53.8	62.0	68.9	74.8	79.6	83.9	87.1	90.0	92.4	94.5	96.0	97.5	98.8	99.9	100.8	101.6	102.9
2012	5.5	15.5	31.8	43.6	54.1	62.1	68.9	74.7	79.6	83.7	87.3	89.9	92.4	94.4	96.2	97.5	98.8	99.9	100.8	101.6	102.7
2013	5.4	16.4	31.6	44.1	53.7	62.3	69.0	74.7	79.5	83.7	87.1	90.1	92.4	94.4	96.1	97.6	98.8	99.9	100.8	101.6	102.9
2014	5.5	16.1	31.8	43.9	54.1	62.0	69.2	74.7	79.5	83.6	87.0	89.9	92.5	94.4	96.2	97.6	98.9	99.9	100.8	101.6	102.9
2015	5.9	16.4	32.7	44.1	53.9	62.3	68.9	74.9	79.6	83.5	87.0	89.9	92.3	94.5	96.1	97.6	98.9	100.0	100.8	101.6	102.9
2016	6.1	17.7	33.1	44.8	54.1	62.2	69.2	74.7	79.7	83.6	86.9	89.8	92.3	94.4	96.2	97.6	98.9	99.9	100.9	101.6	102.7
2017	5.9	18.3	32.8	45.1	54.6	62.3	69.1	74.9	79.5	83.7	87.0	89.8	92.2	94.4	96.1	97.7	98.9	100.0	100.8	101.7	102.8
2018	6.2	17.8	33.3	44.8	54.9	62.8	69.2	74.8	79.7	83.5	87.1	89.9	92.2	94.3	96.1	97.6	98.9	99.9	100.9	101.6	103.0
2019	5.9	18.5	31.8	45.2	54.6	63.0	69.6	74.9	79.6	83.7	86.9	90.0	92.3	94.3	96.0	97.6	98.8	100.0	100.8	101.6	102.8

Table 2.32a—Weight at age (fishery, ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.00	0.07	0.52	1.27	2.21	3.22	4.26	5.31	6.41	7.55	8.67	9.75	10.77	11.72	12.60	13.41	14.14	14.80	15.40	15.92	17.17
1978	0.00	0.06	0.47	1.25	2.22	3.29	4.40	5.53	6.73	7.98	9.22	10.42	11.56	12.63	13.62	14.53	15.36	16.10	16.78	17.37	18.80
1979	0.01	0.06	0.55	1.26	2.24	3.26	4.28	5.32	6.41	7.53	8.63	9.69	10.68	11.61	12.47	13.25	13.96	14.60	15.18	15.69	16.81
1980	0.00	0.07	0.49	1.26	2.12	3.17	4.19	5.23	6.32	7.44	8.54	9.61	10.61	11.55	12.42	13.21	13.93	14.58	15.17	15.69	16.77
1981	0.00	0.06	0.44	1.20	2.14	3.08	4.13	5.15	6.22	7.31	8.38	9.41	10.39	11.29	12.13	12.89	13.59	14.22	14.78	15.28	16.30
1982	0.00	0.05	0.50	1.25	2.27	3.34	4.32	5.41	6.49	7.60	8.69	9.74	10.72	11.64	12.49	13.27	13.97	14.60	15.17	15.68	16.69
1983	0.01	0.04	0.59	1.24	2.18	3.32	4.45	5.48	6.68	7.85	9.01	10.13	11.18	12.16	13.07	13.90	14.66	15.34	15.96	16.50	17.59
1984	0.01	0.11	0.56	1.34	2.04	2.93	3.89	4.83	5.69	6.65	7.54	8.39	9.18	9.92	10.59	11.21	11.76	12.26	12.71	13.11	13.90
1985	0.00	0.07	0.45	1.32	2.38	3.26	4.35	5.55	6.79	7.94	9.20	10.37	11.47	12.49	13.45	14.32	15.12	15.83	16.48	17.05	18.21
1986	0.00	0.03	0.48	1.14	2.24	3.42	4.35	5.49	6.81	8.14	9.33	10.61	11.77	12.85	13.85	14.78	15.62	16.38	17.06	17.66	18.90
1987	0.00	0.06	0.49	1.29	2.14	3.33	4.47	5.36	6.48	7.74	8.97	10.02	11.13	12.12	13.03	13.86	14.62	15.31	15.92	16.47	17.60
1988	0.01	0.05	0.42	1.18	2.22	3.22	4.57	5.89	6.93	8.23	9.65	10.99	12.11	13.29	14.32	15.28	16.15	16.93	17.64	18.26	19.58
1989	0.00	0.05	0.47	1.23	2.26	3.45	4.48	5.85	7.21	8.26	9.52	10.86	12.10	13.12	14.19	15.12	15.96	16.73	17.41	18.02	19.32
1990	0.00	0.05	0.54	1.28	2.25	3.35	4.50	5.48	6.80	8.07	9.01	10.11	11.26	12.30	13.15	14.03	14.79	15.47	16.09	16.63	17.80
1991	0.01	0.06	0.55	1.27	2.13	3.12	4.16	5.24	6.17	7.41	8.57	9.39	10.35	11.34	12.22	12.94	13.67	14.30	14.86	15.35	16.42
1992	0.00	0.07	0.50	1.26	2.11	3.03	4.01	5.03	6.12	7.06	8.29	9.40	10.17	11.07	11.98	12.79	13.44	14.10	14.66	15.16	16.20
1993	0.01	0.07	0.55	1.32	2.35	3.37	4.41	5.51	6.69	7.92	8.93	10.22	11.35	12.12	13.01	13.91	14.70	15.33	15.96	16.50	17.50
1994	0.01	0.07	0.49	1.27	2.17	3.24	4.22	5.21	6.30	7.45	8.63	9.57	10.74	11.76	12.46	13.25	14.05	14.74	15.29	15.84	16.69
1995	0.00	0.06	0.47	1.21	2.19	3.20	4.32	5.36	6.43	7.61	8.81	10.00	10.93	12.09	13.08	13.75	14.52	15.28	15.94	16.46	17.44
1996	0.01	0.07	0.58	1.34	2.25	3.26	4.21	5.23	6.18	7.13	8.12	9.10	10.04	10.76	11.65	12.40	12.90	13.47	14.03	14.51	15.15
1997	0.01	0.06	0.48	1.18	2.05	3.02	4.03	5.00	6.08	7.08	8.05	9.04	10.00	10.92	11.63	12.49	13.21	13.69	14.23	14.76	15.38
1998	0.00	0.06	0.47	1.21	2.09	3.03	3.98	4.99	5.96	7.03	7.99	8.90	9.81	10.69	11.52	12.15	12.91	13.55	13.97	14.44	15.17
1999	0.00	0.05	0.47	1.22	2.17	3.17	4.15	5.17	6.26	7.30	8.42	9.38	10.29	11.18	12.04	12.84	13.44	14.16	14.76	15.15	15.97
2000	0.01	0.04	0.60	1.27	2.25	3.34	4.39	5.44	6.55	7.73	8.82	9.95	10.90	11.79	12.67	13.49	14.26	14.83	15.52	16.08	17.08
2001	0.01	0.09	0.57	1.37	2.16	3.19	4.23	5.23	6.26	7.33	8.43	9.42	10.42	11.25	12.02	12.76	13.46	14.11	14.58	15.15	16.24
2002	0.01	0.07	0.55	1.28	2.25	3.10	4.15	5.21	6.28	7.39	8.51	9.62	10.59	11.58	12.38	13.12	13.84	14.50	15.11	15.56	16.47
2003	0.01	0.08	0.50	1.27	2.18	3.25	4.12	5.22	6.37	7.52	8.65	9.74	10.82	11.75	12.69	13.46	14.15	14.82	15.45	16.01	17.07
2004	0.01	0.07	0.59	1.27	2.23	3.20	4.26	5.12	6.21	7.35	8.44	9.46	10.43	11.38	12.19	12.99	13.64	14.23	14.79	15.31	16.16
2005	0.00	0.10	0.49	1.36	2.21	3.29	4.31	5.44	6.37	7.56	8.76	9.86	10.89	11.86	12.79	13.59	14.37	15.01	15.57	16.11	17.14
2006	0.00	0.06	0.51	1.26	2.33	3.24	4.33	5.35	6.49	7.42	8.56	9.67	10.68	11.60	12.47	13.29	13.99	14.67	15.22	15.71	16.80
2007	0.00	0.06	0.48	1.27	2.23	3.41	4.36	5.49	6.58	7.78	8.72	9.85	10.94	11.91	12.79	13.61	14.39	15.04	15.68	16.18	17.46
2008	0.00	0.04	0.47	1.22	2.19	3.21	4.36	5.27	6.39	7.47	8.61	9.48	10.52	11.49	12.36	13.13	13.85	14.52	15.08	15.62	16.54
2009	0.00	0.03	0.49	1.23	2.19	3.28	4.33	5.53	6.52	7.75	8.89	10.08	10.96	12.01	12.98	13.83	14.60	15.30	15.95	16.48	17.29
2010	0.00	0.04	0.54	1.24	2.15	3.17	4.23	5.25	6.49	7.49	8.68	9.74	10.81	11.60	12.53	13.39	14.14	14.80	15.40	15.96	16.70
2011	0.00	0.06	0.47	1.29	2.13	3.10	4.11	5.18	6.26	7.54	8.51	9.62	10.60	11.58	12.29	13.13	13.89	14.56	15.14	15.66	16.52
2012	0.00	0.04	0.54	1.19	2.16	3.04	3.96	4.92	5.97	7.00	8.16	9.01	9.96	10.77	11.59	12.17	12.85	13.47	14.00	14.46	15.07
2013	0.00	0.06	0.48	1.24	2.06	3.17	4.09	5.06	6.14	7.33	8.47	9.72	10.62	11.62	12.46	13.31	13.91	14.60	15.23	15.76	16.58
2014	0.00	0.04	0.50	1.20	2.16	3.06	4.17	5.10	6.13	7.29	8.52	9.65	10.87	11.73	12.68	13.49	14.28	14.84	15.49	16.07	17.00
2015	0.00	0.04	0.59	1.23	2.09	3.12	4.00	5.11	6.09	7.17	8.32	9.48	10.52	11.64	12.42	13.28	14.01	14.71	15.21	15.78	16.73
2016	0.00	0.09	0.63	1.39	2.17	3.13	4.19	5.11	6.32	7.36	8.46	9.57	10.68	11.67	12.71	13.43	14.23	14.88	15.52	15.97	16.71
2017	0.00	0.11	0.58	1.42	2.34	3.20	4.20	5.32	6.32	7.61	8.67	9.76	10.85	11.92	12.86	13.85	14.52	15.26	15.87	16.45	17.25
2018	0.01	0.10	0.67	1.35	2.35	3.34	4.21	5.22	6.38	7.38	8.64	9.63	10.62	11.60	12.55	13.37	14.23	14.81	15.44	15.96	16.86
2019	0.01	0.14	0.50	1.46	2.29	3.38	4.38	5.25	6.30	7.49	8.49	9.72	10.66	11.58	12.49	13.35	14.10	14.87	15.38	15.94	16.68

Table 2.32b—Weight (kg) at age (fishery, ensemble unweighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1974	0.00	0.06	0.43	1.13	2.08	3.18	4.34	5.51	6.66	7.77	8.81	9.77	10.62	11.39	12.07	12.67	13.19	13.65	14.04	14.38	14.97
1977	0.00	0.06	0.43	1.14	2.09	3.20	4.36	5.53	6.69	7.80	8.84	9.79	10.64	11.41	12.08	12.68	13.20	13.65	14.05	14.39	15.09
1978	0.00	0.05	0.40	1.11	2.10	3.27	4.51	5.77	7.03	8.26	9.41	10.46	11.42	12.28	13.04	13.71	14.29	14.81	15.25	15.63	16.43
1979	0.00	0.06	0.46	1.15	2.13	3.24	4.39	5.54	6.68	7.77	8.79	9.72	10.56	11.30	11.96	12.54	13.05	13.49	13.87	14.20	14.84
1980	0.00	0.06	0.42	1.13	2.04	3.15	4.29	5.45	6.59	7.68	8.70	9.64	10.48	11.24	11.90	12.49	13.00	13.45	13.84	14.17	14.80
1981	0.00	0.06	0.40	1.10	2.06	3.10	4.24	5.37	6.48	7.55	8.54	9.45	10.26	10.99	11.64	12.20	12.70	13.13	13.50	13.82	14.42
1982	0.00	0.06	0.45	1.17	2.17	3.31	4.44	5.62	6.75	7.84	8.85	9.77	10.60	11.34	11.99	12.56	13.06	13.50	13.88	14.20	14.80
1983	0.00	0.05	0.47	1.15	2.13	3.31	4.55	5.73	6.95	8.10	9.18	10.16	11.04	11.83	12.53	13.15	13.69	14.16	14.56	14.91	15.55
1984	0.01	0.09	0.48	1.20	2.01	2.98	4.00	5.01	5.93	6.84	7.67	8.41	9.08	9.67	10.19	10.65	11.05	11.39	11.69	11.94	12.41
1985	0.00	0.06	0.40	1.17	2.21	3.29	4.52	5.81	7.08	8.23	9.38	10.40	11.33	12.15	12.88	13.53	14.09	14.59	15.01	15.38	16.06
1986	0.00	0.04	0.41	1.08	2.14	3.36	4.54	5.82	7.15	8.42	9.55	10.65	11.62	12.49	13.26	13.94	14.54	15.06	15.51	15.90	16.62
1987	0.00	0.06	0.43	1.16	2.10	3.29	4.53	5.65	6.84	8.03	9.14	10.09	11.00	11.79	12.49	13.11	13.65	14.12	14.52	14.88	15.53
1988	0.00	0.05	0.39	1.12	2.17	3.34	4.72	6.11	7.34	8.62	9.88	11.02	11.99	12.91	13.71	14.42	15.03	15.57	16.03	16.44	17.20
1989	0.00	0.05	0.42	1.16	2.21	3.46	4.71	6.10	7.46	8.62	9.80	10.93	11.94	12.79	13.59	14.28	14.88	15.40	15.85	16.24	16.99
1990	0.00	0.06	0.46	1.19	2.19	3.37	4.61	5.79	7.06	8.26	9.24	10.22	11.15	11.97	12.64	13.28	13.82	14.28	14.69	15.04	15.71
1991	0.00	0.06	0.45	1.15	2.07	3.15	4.29	5.45	6.51	7.64	8.67	9.49	10.30	11.06	11.73	12.27	12.78	13.21	13.58	13.90	14.51
1992	0.00	0.06	0.42	1.11	2.01	3.05	4.15	5.27	6.39	7.39	8.44	9.38	10.12	10.84	11.51	12.10	12.57	13.02	13.39	13.71	14.31
1993	0.01	0.07	0.47	1.22	2.26	3.40	4.60	5.82	7.03	8.20	9.21	10.26	11.17	11.87	12.55	13.19	13.75	14.18	14.60	14.94	15.55
1994	0.00	0.06	0.43	1.14	2.09	3.21	4.35	5.50	6.64	7.76	8.81	9.70	10.61	11.41	12.00	12.59	13.14	13.60	13.97	14.32	14.86
1995	0.00	0.05	0.41	1.11	2.09	3.21	4.43	5.62	6.79	7.94	9.04	10.05	10.89	11.76	12.50	13.05	13.59	14.10	14.53	14.87	15.47
1996	0.01	0.07	0.49	1.21	2.16	3.23	4.31	5.40	6.43	7.40	8.32	9.17	9.94	10.56	11.20	11.74	12.14	12.53	12.88	13.19	13.62
1997	0.00	0.06	0.41	1.09	1.99	3.03	4.14	5.22	6.32	7.32	8.25	9.13	9.93	10.65	11.22	11.82	12.32	12.68	13.04	13.37	13.81
1998	0.00	0.06	0.41	1.10	2.00	3.02	4.09	5.18	6.21	7.24	8.15	8.98	9.75	10.45	11.07	11.56	12.07	12.50	12.80	13.10	13.59
1999	0.00	0.05	0.42	1.13	2.08	3.16	4.27	5.40	6.52	7.56	8.56	9.44	10.22	10.94	11.59	12.17	12.62	13.09	13.47	13.75	14.27
2000	0.00	0.05	0.48	1.18	2.18	3.32	4.51	5.69	6.85	7.98	9.00	9.97	10.80	11.53	12.21	12.81	13.34	13.76	14.19	14.54	15.14
2001	0.01	0.07	0.47	1.21	2.11	3.21	4.35	5.47	6.56	7.61	8.60	9.47	10.29	10.98	11.59	12.14	12.63	13.06	13.40	13.74	14.36
2002	0.00	0.06	0.45	1.16	2.13	3.17	4.32	5.48	6.61	7.70	8.72	9.67	10.50	11.27	11.91	12.47	12.97	13.42	13.82	14.12	14.68
2003	0.00	0.06	0.42	1.14	2.08	3.21	4.31	5.50	6.68	7.81	8.85	9.81	10.69	11.45	12.16	12.74	13.25	13.71	14.11	14.47	15.10
2004	0.01	0.06	0.47	1.15	2.12	3.19	4.34	5.41	6.54	7.62	8.62	9.52	10.34	11.08	11.71	12.29	12.77	13.18	13.56	13.89	14.42
2005	0.00	0.07	0.42	1.18	2.11	3.25	4.42	5.63	6.73	7.88	8.95	9.92	10.79	11.57	12.27	12.86	13.41	13.86	14.24	14.59	15.21
2006	0.00	0.06	0.43	1.15	2.16	3.22	4.40	5.55	6.72	7.73	8.77	9.73	10.57	11.32	11.98	12.58	13.08	13.54	13.91	14.23	14.87
2007	0.00	0.06	0.42	1.15	2.13	3.32	4.46	5.68	6.84	7.99	8.96	9.94	10.83	11.61	12.29	12.90	13.44	13.89	14.30	14.64	15.35
2008	0.00	0.05	0.42	1.13	2.10	3.19	4.39	5.49	6.64	7.71	8.75	9.60	10.45	11.22	11.88	12.45	12.96	13.41	13.79	14.13	14.70
2009	0.00	0.04	0.42	1.12	2.10	3.26	4.45	5.70	6.84	8.01	9.08	10.10	10.92	11.74	12.47	13.10	13.64	14.12	14.54	14.89	15.43
2010	0.00	0.05	0.44	1.12	2.06	3.17	4.34	5.50	6.71	7.77	8.84	9.78	10.66	11.37	12.06	12.68	13.21	13.67	14.06	14.41	14.92
2011	0.00	0.05	0.40	1.13	2.04	3.11	4.25	5.41	6.55	7.71	8.68	9.64	10.47	11.24	11.85	12.45	12.98	13.44	13.82	14.16	14.71
2012	0.00	0.05	0.45	1.10	2.05	3.05	4.11	5.18	6.25	7.25	8.24	9.05	9.83	10.50	11.11	11.59	12.06	12.47	12.82	13.12	13.55
2013	0.00	0.06	0.41	1.11	2.01	3.14	4.25	5.38	6.51	7.64	8.69	9.70	10.51	11.29	11.95	12.56	13.03	13.49	13.90	14.24	14.78
2014	0.00	0.04	0.40	1.07	2.02	3.07	4.26	5.38	6.52	7.65	8.75	9.73	10.68	11.42	12.13	12.74	13.29	13.71	14.13	14.50	15.08
2015	0.00	0.04	0.43	1.06	1.97	3.05	4.14	5.32	6.43	7.52	8.57	9.56	10.43	11.26	11.91	12.53	13.05	13.52	13.88	14.24	14.83
2016	0.00	0.07	0.47	1.14	2.02	3.09	4.26	5.38	6.59	7.67	8.71	9.68	10.58	11.37	12.12	12.69	13.24	13.70	14.12	14.43	14.94
2017	0.00	0.08	0.45	1.17	2.10	3.15	4.31	5.52	6.66	7.86	8.90	9.88	10.78	11.62	12.34	13.02	13.53	14.02	14.43	14.80	15.35
2018	0.00	0.07	0.49	1.17	2.15	3.22	4.31	5.47	6.64	7.71	8.80	9.72	10.57	11.35	12.06	12.66	13.23	13.66	14.07	14.40	14.97
2019	0.01	0.09	0.48	1.22	2.14	3.28	4.41	5.50	6.64	7.77	8.76	9.77	10.59	11.35	12.04	12.66	13.18	13.68	14.04	14.39	14.90

Table 2.33a (page 1 of 2)—Weight (kg) at age (survey, Hypothesis 1 and 3 sub-ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.02	0.06	0.39	1.03	1.91	2.95	4.09	5.27	6.47	7.65	8.80	9.89	10.92	11.88	12.77	13.59	14.33	15.00	15.59	16.12	17.36
1978	0.01	0.06	0.34	1.01	1.91	3.00	4.21	5.50	6.80	8.10	9.36	10.58	11.73	12.81	13.81	14.73	15.57	16.32	17.00	17.60	19.01
1979	0.02	0.06	0.42	1.02	1.95	2.99	4.12	5.29	6.47	7.63	8.75	9.82	10.82	11.76	12.63	13.42	14.14	14.79	15.37	15.88	16.98
1980	0.02	0.07	0.36	1.04	1.82	2.90	4.02	5.19	6.37	7.54	8.66	9.74	10.75	11.70	12.58	13.38	14.12	14.77	15.36	15.88	16.95
1981	0.01	0.06	0.32	0.98	1.91	2.82	3.99	5.13	6.28	7.41	8.50	9.54	10.52	11.44	12.29	13.06	13.77	14.40	14.97	15.47	16.46
1982	0.02	0.05	0.35	0.98	1.94	3.08	4.11	5.36	6.54	7.69	8.81	9.87	10.86	11.79	12.65	13.43	14.15	14.79	15.36	15.87	16.85
1983	0.01	0.04	0.45	0.97	1.84	3.01	4.29	5.41	6.73	7.95	9.13	10.26	11.33	12.32	13.24	14.09	14.85	15.54	16.16	16.71	17.77
1984	0.02	0.11	0.44	1.14	1.77	2.67	3.74	4.81	5.71	6.72	7.63	8.49	9.29	10.03	10.72	11.34	11.90	12.41	12.86	13.26	14.03
1985	0.01	0.06	0.31	1.04	2.06	2.91	4.09	5.48	6.87	8.02	9.33	10.51	11.62	12.66	13.63	14.51	15.32	16.04	16.69	17.27	18.39
1986	0.01	0.03	0.35	0.89	1.93	3.16	4.12	5.40	6.86	8.29	9.46	10.77	11.94	13.03	14.05	14.98	15.83	16.60	17.28	17.89	19.10
1987	0.02	0.06	0.35	1.02	1.78	3.01	4.30	5.26	6.48	7.83	9.12	10.14	11.28	12.28	13.20	14.05	14.82	15.51	16.13	16.68	17.77
1988	0.01	0.05	0.32	0.98	1.97	2.94	4.41	5.90	6.97	8.32	9.78	11.17	12.26	13.47	14.52	15.49	16.37	17.16	17.87	18.50	19.78
1989	0.01	0.05	0.34	0.99	1.95	3.15	4.24	5.79	7.28	8.33	9.61	11.00	12.28	13.29	14.38	15.32	16.18	16.95	17.64	18.25	19.51
1990	0.01	0.05	0.39	1.01	1.91	3.02	4.28	5.35	6.80	8.16	9.08	10.20	11.39	12.47	13.31	14.21	14.98	15.67	16.29	16.84	17.97
1991	0.01	0.06	0.40	1.01	1.80	2.81	3.94	5.15	6.15	7.47	8.67	9.48	10.46	11.47	12.39	13.10	13.85	14.48	15.04	15.54	16.58
1992	0.02	0.06	0.35	1.00	1.79	2.71	3.78	4.95	6.15	7.12	8.39	9.53	10.29	11.19	12.13	12.97	13.61	14.29	14.85	15.35	16.36
1993	0.01	0.06	0.43	1.09	2.08	3.11	4.22	5.45	6.73	8.02	9.03	10.34	11.50	12.26	13.16	14.08	14.90	15.52	16.16	16.70	17.68
1994	0.01	0.07	0.36	1.03	1.87	2.96	4.03	5.14	6.32	7.54	8.74	9.67	10.87	11.92	12.60	13.40	14.22	14.94	15.48	16.04	16.86
1995	0.01	0.06	0.35	0.98	1.90	2.92	4.15	5.31	6.46	7.69	8.92	10.12	11.05	12.23	13.26	13.92	14.69	15.48	16.16	16.67	17.63
1996	0.03	0.08	0.42	1.06	1.93	2.96	3.99	5.15	6.18	7.17	8.19	9.19	10.14	10.87	11.78	12.56	13.05	13.62	14.19	14.69	15.31
1997	0.01	0.06	0.35	0.96	1.78	2.76	3.86	4.93	6.10	7.14	8.12	9.13	10.11	11.05	11.75	12.64	13.38	13.85	14.40	14.94	15.54
1998	0.01	0.05	0.35	0.96	1.78	2.73	3.78	4.91	5.96	7.09	8.07	8.99	9.91	10.81	11.65	12.28	13.07	13.72	14.13	14.60	15.33
1999	0.01	0.05	0.33	0.96	1.85	2.86	3.95	5.09	6.28	7.37	8.51	9.48	10.39	11.30	12.17	12.99	13.59	14.33	14.95	15.33	16.14
2000	0.02	0.05	0.43	0.98	1.89	3.00	4.16	5.36	6.57	7.80	8.91	10.06	11.02	11.92	12.81	13.65	14.43	15.00	15.70	16.28	17.27
2001	0.02	0.07	0.41	1.11	1.82	2.87	4.02	5.17	6.30	7.42	8.54	9.53	10.54	11.38	12.15	12.91	13.62	14.27	14.75	15.32	16.41
2002	0.02	0.07	0.41	1.04	1.96	2.81	3.96	5.19	6.38	7.53	8.65	9.76	10.73	11.72	12.54	13.28	14.00	14.68	15.29	15.74	16.64
2003	0.01	0.07	0.37	1.04	1.88	2.97	3.91	5.14	6.41	7.61	8.76	9.86	10.95	11.89	12.84	13.62	14.32	15.00	15.63	16.21	17.25
2004	0.02	0.07	0.45	1.03	1.95	2.93	4.09	5.04	6.23	7.43	8.53	9.57	10.55	11.51	12.33	13.14	13.81	14.40	14.97	15.49	16.32
2005	0.02	0.08	0.36	1.11	1.90	3.01	4.12	5.38	6.38	7.63	8.85	9.97	11.01	12.00	12.95	13.75	14.55	15.19	15.76	16.30	17.32
2006	0.02	0.05	0.36	1.00	2.02	2.93	4.12	5.26	6.50	7.45	8.63	9.77	10.79	11.73	12.61	13.45	14.16	14.85	15.40	15.89	16.98
2007	0.01	0.04	0.33	1.00	1.89	3.12	4.14	5.41	6.58	7.84	8.79	9.95	11.05	12.04	12.94	13.78	14.57	15.22	15.86	16.37	17.65
2008	0.02	0.04	0.32	0.94	1.85	2.88	4.18	5.21	6.44	7.55	8.72	9.59	10.64	11.63	12.50	13.29	14.02	14.70	15.26	15.80	16.72
2009	0.01	0.03	0.33	0.92	1.80	2.92	4.09	5.51	6.60	7.89	9.03	10.22	11.10	12.15	13.14	14.01	14.78	15.49	16.14	16.68	17.48
2010	0.02	0.05	0.37	0.94	1.75	2.79	3.99	5.18	6.57	7.61	8.81	9.87	10.95	11.74	12.68	13.55	14.31	14.98	15.59	16.15	16.88
2011	0.01	0.06	0.31	0.99	1.76	2.72	3.84	5.08	6.27	7.62	8.61	9.74	10.72	11.71	12.43	13.28	14.06	14.73	15.32	15.85	16.70
2012	0.01	0.04	0.38	0.93	1.85	2.73	3.73	4.83	5.99	7.07	8.26	9.11	10.07	10.90	11.72	12.31	13.00	13.63	14.16	14.63	15.22
2013	0.01	0.06	0.34	0.98	1.73	2.86	3.88	5.00	6.21	7.46	8.61	9.86	10.76	11.76	12.62	13.47	14.07	14.78	15.41	15.95	16.76
2014	0.01	0.04	0.34	0.91	1.79	2.69	3.95	5.04	6.20	7.42	8.66	9.79	11.02	11.88	12.85	13.66	14.46	15.03	15.68	16.27	17.18
2015	0.01	0.05	0.41	0.92	1.71	2.74	3.73	5.04	6.12	7.26	8.43	9.60	10.66	11.79	12.58	13.45	14.18	14.90	15.39	15.97	16.91
2016	0.02	0.09	0.49	1.07	1.78	2.76	3.93	4.99	6.34	7.42	8.54	9.68	10.81	11.81	12.87	13.60	14.40	15.07	15.71	16.16	16.89
2017	0.02	0.10	0.44	1.17	1.97	2.83	3.94	5.20	6.30	7.67	8.76	9.86	10.97	12.06	13.01	14.02	14.70	15.45	16.06	16.66	17.45
2018	0.03	0.11	0.52	1.14	2.12	3.06	4.00	5.14	6.38	7.44	8.73	9.73	10.74	11.73	12.70	13.54	14.41	14.99	15.63	16.15	17.05
2019	0.03	0.11	0.60	1.24	2.07	3.22	4.25	5.22	6.38	7.60	8.62	9.85	10.79	11.72	12.64	13.52	14.27	15.05	15.57	16.13	16.86

Table 2.33a (page 2 of 2)—Weight (kg) at age (survey, EBS, Hypothesis 1 and 3 sub-ensemble unweighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.01	0.06	0.38	1.04	1.98	3.09	4.30	5.53	6.72	7.85	8.89	9.84	10.70	11.46	12.13	12.73	13.24	13.69	14.08	14.42	15.10
1978	0.01	0.05	0.34	1.01	1.98	3.15	4.44	5.77	7.08	8.32	9.47	10.53	11.48	12.33	13.09	13.76	14.34	14.85	15.29	15.67	16.45
1979	0.01	0.06	0.40	1.06	2.02	3.13	4.33	5.54	6.72	7.83	8.85	9.78	10.61	11.35	12.01	12.59	13.09	13.52	13.90	14.23	14.85
1980	0.01	0.06	0.36	1.03	1.92	3.05	4.24	5.44	6.62	7.73	8.76	9.70	10.54	11.29	11.95	12.54	13.05	13.49	13.87	14.20	14.82
1981	0.01	0.06	0.35	1.02	1.95	3.00	4.19	5.37	6.52	7.60	8.59	9.50	10.31	11.04	11.68	12.24	12.74	13.16	13.53	13.85	14.43
1982	0.01	0.06	0.39	1.06	2.04	3.20	4.37	5.61	6.78	7.89	8.90	9.82	10.65	11.39	12.04	12.61	13.10	13.54	13.91	14.23	14.81
1983	0.01	0.05	0.41	1.05	2.00	3.20	4.49	5.72	6.98	8.15	9.23	10.21	11.10	11.89	12.58	13.20	13.73	14.19	14.60	14.94	15.57
1984	0.01	0.09	0.43	1.11	1.91	2.89	3.95	5.01	5.95	6.88	7.71	8.45	9.12	9.71	10.23	10.68	11.08	11.42	11.71	11.97	12.42
1985	0.01	0.06	0.35	1.06	2.08	3.17	4.44	5.79	7.11	8.28	9.44	10.46	11.38	12.21	12.94	13.58	14.14	14.63	15.05	15.41	16.08
1986	0.01	0.04	0.36	0.99	2.01	3.26	4.47	5.81	7.19	8.49	9.62	10.72	11.69	12.55	13.32	14.00	14.59	15.10	15.55	15.93	16.64
1987	0.01	0.06	0.37	1.05	1.96	3.17	4.47	5.63	6.86	8.08	9.20	10.14	11.05	11.84	12.54	13.15	13.69	14.16	14.56	14.91	15.55
1988	0.01	0.05	0.35	1.04	2.07	3.24	4.68	6.12	7.38	8.68	9.94	11.09	12.05	12.97	13.77	14.47	15.08	15.61	16.07	16.47	17.22
1989	0.01	0.05	0.37	1.07	2.09	3.35	4.63	6.09	7.50	8.67	9.85	10.99	12.01	12.84	13.64	14.33	14.92	15.44	15.89	16.28	17.01
1990	0.01	0.06	0.40	1.08	2.06	3.25	4.54	5.76	7.08	8.30	9.29	10.27	11.20	12.02	12.69	13.32	13.86	14.32	14.72	15.07	15.73
1991	0.01	0.06	0.39	1.04	1.95	3.04	4.22	5.43	6.52	7.67	8.71	9.53	10.34	11.11	11.78	12.31	12.82	13.24	13.61	13.93	14.53
1992	0.01	0.06	0.36	1.01	1.89	2.93	4.08	5.26	6.42	7.44	8.50	9.44	10.16	10.88	11.56	12.15	12.61	13.05	13.42	13.74	14.33
1993	0.01	0.06	0.42	1.13	2.15	3.31	4.54	5.82	7.07	8.25	9.27	10.31	11.22	11.92	12.60	13.24	13.79	14.22	14.63	14.97	15.56
1994	0.01	0.06	0.38	1.05	1.97	3.11	4.29	5.49	6.67	7.81	8.87	9.75	10.67	11.46	12.05	12.63	13.18	13.64	14.01	14.35	14.88
1995	0.01	0.05	0.36	1.02	1.98	3.11	4.38	5.62	6.82	7.99	9.09	10.11	10.95	11.81	12.55	13.09	13.64	14.14	14.57	14.90	15.49
1996	0.01	0.07	0.43	1.11	2.03	3.12	4.24	5.39	6.45	7.43	8.36	9.21	9.98	10.60	11.24	11.78	12.17	12.56	12.91	13.22	13.64
1997	0.01	0.06	0.37	1.00	1.88	2.94	4.08	5.21	6.34	7.36	8.30	9.17	9.97	10.69	11.27	11.86	12.36	12.72	13.07	13.40	13.83
1998	0.01	0.06	0.36	1.00	1.88	2.91	4.02	5.16	6.23	7.28	8.20	9.03	9.79	10.49	11.11	11.60	12.11	12.53	12.83	13.13	13.60
1999	0.01	0.06	0.37	1.02	1.96	3.04	4.21	5.38	6.54	7.60	8.61	9.48	10.27	10.99	11.63	12.21	12.66	13.12	13.51	13.77	14.29
2000	0.01	0.06	0.42	1.07	2.04	3.20	4.43	5.67	6.87	8.02	9.05	10.02	10.85	11.58	12.25	12.85	13.38	13.79	14.22	14.57	15.16
2001	0.01	0.07	0.41	1.11	1.99	3.09	4.28	5.46	6.59	7.66	8.65	9.53	10.34	11.03	11.63	12.18	12.67	13.10	13.43	13.77	14.38
2002	0.01	0.06	0.40	1.06	2.02	3.06	4.27	5.50	6.67	7.77	8.79	9.74	10.56	11.32	11.95	12.51	13.01	13.46	13.85	14.15	14.70
2003	0.01	0.06	0.37	1.04	1.97	3.11	4.24	5.49	6.72	7.86	8.91	9.87	10.75	11.50	12.20	12.78	13.29	13.74	14.15	14.50	15.12
2004	0.01	0.06	0.42	1.06	2.01	3.09	4.29	5.40	6.57	7.67	8.67	9.57	10.39	11.13	11.76	12.33	12.81	13.22	13.59	13.91	14.44
2005	0.01	0.06	0.37	1.08	1.99	3.15	4.36	5.63	6.76	7.92	9.00	9.97	10.84	11.62	12.32	12.91	13.45	13.89	14.27	14.62	15.23
2006	0.01	0.05	0.38	1.04	2.04	3.11	4.33	5.53	6.73	7.77	8.81	9.77	10.62	11.36	12.03	12.62	13.12	13.58	13.94	14.26	14.89
2007	0.01	0.05	0.37	1.05	2.01	3.21	4.39	5.66	6.86	8.03	9.01	9.99	10.88	11.66	12.34	12.94	13.48	13.93	14.34	14.66	15.37
2008	0.01	0.05	0.36	1.02	1.97	3.08	4.33	5.49	6.68	7.77	8.80	9.65	10.50	11.26	11.92	12.50	13.00	13.45	13.82	14.15	14.71
2009	0.01	0.05	0.36	1.01	1.96	3.12	4.37	5.71	6.89	8.09	9.16	10.16	10.98	11.79	12.52	13.14	13.68	14.15	14.57	14.92	15.45
2010	0.01	0.05	0.37	1.00	1.91	3.03	4.26	5.50	6.76	7.84	8.91	9.85	10.72	11.42	12.11	12.73	13.25	13.70	14.10	14.44	14.94
2011	0.01	0.05	0.34	1.01	1.89	2.97	4.16	5.40	6.58	7.76	8.73	9.69	10.52	11.29	11.89	12.49	13.02	13.47	13.86	14.19	14.73
2012	0.01	0.05	0.39	1.00	1.93	2.94	4.04	5.16	6.27	7.29	8.29	9.09	9.87	10.54	11.15	11.62	12.09	12.51	12.85	13.15	13.57
2013	0.01	0.05	0.35	1.00	1.88	3.03	4.18	5.38	6.57	7.72	8.76	9.76	10.57	11.34	12.00	12.61	13.07	13.53	13.93	14.27	14.80
2014	0.01	0.05	0.34	0.96	1.88	2.94	4.19	5.38	6.57	7.73	8.82	9.80	10.74	11.47	12.19	12.78	13.33	13.75	14.16	14.53	15.10
2015	0.01	0.05	0.36	0.94	1.82	2.91	4.05	5.31	6.46	7.57	8.63	9.61	10.48	11.31	11.95	12.57	13.09	13.56	13.91	14.27	14.85
2016	0.01	0.06	0.40	1.02	1.87	2.96	4.17	5.35	6.61	7.71	8.76	9.74	10.64	11.42	12.17	12.74	13.28	13.74	14.15	14.46	14.96
2017	0.01	0.07	0.38	1.05	1.95	3.01	4.22	5.49	6.67	7.90	8.95	9.93	10.84	11.67	12.38	13.06	13.57	14.06	14.47	14.83	15.37
2018	0.01	0.07	0.42	1.07	2.03	3.11	4.24	5.45	6.67	7.75	8.85	9.77	10.62	11.40	12.10	12.71	13.27	13.69	14.10	14.43	14.99
2019	0.01	0.07	0.46	1.12	2.04	3.20	4.36	5.51	6.69	7.83	8.83	9.83	10.65	11.40	12.08	12.70	13.22	13.71	14.07	14.42	14.92

Table 2.33b (page 1 of 2)—Weight (kg) at age (survey, EBS+NBS, Hypothesis 2 sub-ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.02	0.06	0.38	1.02	1.89	2.91	4.04	5.22	6.40	7.57	8.69	9.76	10.77	11.72	12.59	13.40	14.13	14.79	15.38	15.91	17.16
1978	0.01	0.05	0.33	0.99	1.88	2.96	4.17	5.43	6.72	8.00	9.25	10.44	11.57	12.62	13.61	14.51	15.34	16.09	16.76	17.35	18.78
1979	0.02	0.06	0.40	1.01	1.93	2.96	4.08	5.24	6.40	7.55	8.65	9.70	10.68	11.61	12.46	13.24	13.95	14.59	15.16	15.67	16.79
1980	0.01	0.06	0.35	1.01	1.81	2.87	3.98	5.14	6.30	7.45	8.56	9.62	10.61	11.54	12.41	13.20	13.92	14.57	15.15	15.67	16.76
1981	0.01	0.06	0.32	0.98	1.86	2.81	3.94	5.08	6.21	7.33	8.40	9.42	10.39	11.29	12.12	12.88	13.58	14.20	14.76	15.26	16.28
1982	0.02	0.06	0.36	0.99	1.93	3.02	4.09	5.30	6.47	7.61	8.70	9.75	10.72	11.64	12.48	13.25	13.96	14.59	15.15	15.66	16.68
1983	0.01	0.04	0.44	0.98	1.85	2.99	4.22	5.37	6.65	7.86	9.02	10.13	11.18	12.15	13.06	13.89	14.64	15.33	15.94	16.48	17.58
1984	0.02	0.11	0.44	1.12	1.78	2.67	3.71	4.75	5.66	6.65	7.55	8.39	9.18	9.91	10.58	11.20	11.75	12.25	12.70	13.09	13.89
1985	0.01	0.06	0.31	1.04	2.03	2.91	4.09	5.43	6.77	7.95	9.22	10.37	11.47	12.49	13.43	14.31	15.10	15.82	16.46	17.03	18.19
1986	0.01	0.03	0.35	0.90	1.92	3.11	4.11	5.38	6.80	8.17	9.36	10.63	11.77	12.85	13.84	14.76	15.60	16.36	17.04	17.64	18.89
1987	0.02	0.06	0.35	1.02	1.79	3.00	4.25	5.24	6.45	7.76	8.98	10.03	11.13	12.11	13.02	13.85	14.61	15.29	15.91	16.45	17.58
1988	0.01	0.05	0.33	0.98	1.96	2.95	4.39	5.83	6.93	8.26	9.68	10.99	12.11	13.28	14.31	15.26	16.13	16.91	17.62	18.24	19.56
1989	0.01	0.05	0.35	0.99	1.95	3.14	4.24	5.75	7.19	8.26	9.54	10.87	12.09	13.11	14.17	15.10	15.94	16.71	17.39	18.00	19.30
1990	0.01	0.05	0.39	1.01	1.91	3.01	4.25	5.33	6.75	8.06	9.00	10.11	11.25	12.29	13.14	14.02	14.77	15.46	16.07	16.61	17.78
1991	0.01	0.06	0.40	1.01	1.81	2.80	3.92	5.12	6.12	7.41	8.57	9.39	10.35	11.33	12.21	12.93	13.66	14.28	14.84	15.34	16.41
1992	0.02	0.06	0.35	1.00	1.79	2.71	3.77	4.92	6.11	7.07	8.31	9.41	10.18	11.07	11.98	12.78	13.43	14.09	14.65	15.15	16.19
1993	0.01	0.06	0.43	1.09	2.07	3.10	4.21	5.43	6.68	7.95	8.96	10.23	11.35	12.12	13.01	13.90	14.69	15.32	15.95	16.48	17.49
1994	0.01	0.07	0.36	1.02	1.87	2.95	4.02	5.11	6.29	7.47	8.65	9.58	10.75	11.75	12.45	13.24	14.03	14.73	15.27	15.82	16.67
1995	0.01	0.06	0.35	0.98	1.89	2.91	4.12	5.27	6.42	7.63	8.83	10.01	10.94	12.08	13.07	13.74	14.51	15.27	15.93	16.44	17.43
1996	0.03	0.08	0.42	1.06	1.92	2.95	3.98	5.12	6.14	7.12	8.12	9.10	10.04	10.76	11.64	12.39	12.89	13.46	14.02	14.49	15.13
1997	0.01	0.06	0.36	0.96	1.77	2.74	3.84	4.90	6.06	7.08	8.05	9.04	10.00	10.92	11.62	12.48	13.20	13.68	14.22	14.75	15.36
1998	0.01	0.05	0.35	0.96	1.78	2.72	3.76	4.88	5.92	7.03	7.99	8.90	9.81	10.68	11.51	12.14	12.90	13.53	13.95	14.42	15.16
1999	0.01	0.05	0.33	0.96	1.85	2.85	3.93	5.06	6.24	7.31	8.43	9.39	10.29	11.18	12.03	12.83	13.42	14.15	14.75	15.14	15.96
2000	0.02	0.05	0.43	0.98	1.90	2.99	4.15	5.32	6.52	7.74	8.83	9.95	10.91	11.79	12.66	13.48	14.25	14.82	15.50	16.07	17.07
2001	0.02	0.07	0.42	1.11	1.83	2.87	4.01	5.14	6.26	7.36	8.46	9.43	10.42	11.25	12.01	12.75	13.45	14.10	14.57	15.14	16.22
2002	0.02	0.07	0.41	1.04	1.95	2.81	3.96	5.16	6.34	7.46	8.57	9.66	10.61	11.58	12.38	13.12	13.83	14.49	15.10	15.54	16.45
2003	0.01	0.07	0.37	1.03	1.88	2.96	3.90	5.12	6.37	7.55	8.67	9.76	10.82	11.75	12.68	13.45	14.14	14.81	15.43	16.00	17.05
2004	0.02	0.07	0.45	1.03	1.94	2.92	4.07	5.02	6.20	7.37	8.46	9.47	10.44	11.37	12.18	12.98	13.63	14.22	14.78	15.29	16.14
2005	0.02	0.08	0.36	1.11	1.90	2.99	4.10	5.35	6.34	7.57	8.77	9.87	10.89	11.85	12.78	13.57	14.36	14.99	15.56	16.10	17.12
2006	0.02	0.05	0.36	1.00	2.01	2.92	4.10	5.23	6.45	7.40	8.56	9.67	10.67	11.59	12.46	13.28	13.98	14.66	15.20	15.69	16.78
2007	0.01	0.04	0.34	1.00	1.89	3.10	4.12	5.37	6.54	7.77	8.72	9.85	10.93	11.90	12.78	13.60	14.38	15.03	15.66	16.16	17.44
2008	0.02	0.04	0.33	0.95	1.85	2.88	4.16	5.17	6.39	7.49	8.64	9.50	10.53	11.49	12.35	13.12	13.84	14.51	15.06	15.60	16.53
2009	0.01	0.03	0.33	0.93	1.80	2.91	4.07	5.47	6.55	7.82	8.95	10.11	10.98	12.01	12.98	13.83	14.58	15.28	15.93	16.46	17.28
2010	0.02	0.05	0.37	0.94	1.76	2.79	3.97	5.16	6.52	7.54	8.73	9.77	10.83	11.61	12.53	13.38	14.13	14.78	15.38	15.94	16.69
2011	0.01	0.06	0.31	0.98	1.76	2.72	3.84	5.05	6.23	7.55	8.52	9.63	10.60	11.57	12.28	13.12	13.88	14.54	15.12	15.65	16.50
2012	0.01	0.04	0.39	0.93	1.84	2.72	3.72	4.81	5.95	7.01	8.18	9.02	9.96	10.77	11.58	12.16	12.84	13.46	13.98	14.44	15.05
2013	0.01	0.06	0.34	0.98	1.73	2.85	3.86	4.99	6.17	7.40	8.53	9.76	10.63	11.62	12.46	13.30	13.90	14.59	15.21	15.74	16.57
2014	0.01	0.05	0.34	0.91	1.79	2.68	3.93	5.00	6.16	7.36	8.58	9.69	10.89	11.73	12.68	13.48	14.27	14.83	15.48	16.05	16.98
2015	0.01	0.05	0.41	0.91	1.70	2.74	3.71	5.00	6.08	7.20	8.35	9.50	10.53	11.64	12.41	13.27	13.99	14.70	15.19	15.76	16.71
2016	0.02	0.09	0.44	1.06	1.78	2.74	3.91	4.95	6.28	7.36	8.47	9.58	10.68	11.66	12.70	13.42	14.21	14.87	15.50	15.95	16.69
2017	0.01	0.08	0.40	1.09	1.95	2.82	3.91	5.17	6.25	7.60	8.67	9.76	10.85	11.91	12.85	13.83	14.50	15.24	15.85	16.43	17.24
2018	0.02	0.09	0.50	1.07	2.02	3.03	3.97	5.10	6.35	7.38	8.65	9.63	10.62	11.60	12.54	13.36	14.22	14.80	15.42	15.94	16.84
2019	0.02	0.10	0.35	1.21	1.98	3.10	4.21	5.19	6.32	7.55	8.54	9.75	10.67	11.59	12.49	13.35	14.09	14.86	15.37	15.92	16.66

Table 2.33b (page 2 of 2)—Weight (kg) at age (survey, EBS+NBS, Hypothesis 2 sub-ensemble unweighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.02	0.06	0.38	1.02	1.89	2.91	4.04	5.22	6.40	7.57	8.69	9.76	10.77	11.72	12.59	13.40	14.13	14.79	15.38	15.91	17.16
1978	0.01	0.05	0.33	0.99	1.88	2.96	4.17	5.43	6.72	8.00	9.25	10.44	11.57	12.62	13.61	14.51	15.34	16.09	16.76	17.35	18.78
1979	0.02	0.06	0.40	1.01	1.93	2.96	4.08	5.24	6.40	7.55	8.65	9.70	10.68	11.61	12.46	13.24	13.95	14.59	15.16	15.67	16.79
1980	0.01	0.06	0.35	1.01	1.81	2.87	3.98	5.14	6.30	7.45	8.56	9.62	10.61	11.54	12.41	13.20	13.92	14.57	15.15	15.67	16.76
1981	0.01	0.06	0.32	0.98	1.86	2.81	3.94	5.08	6.21	7.33	8.40	9.42	10.39	11.29	12.12	12.88	13.58	14.20	14.76	15.26	16.28
1982	0.02	0.06	0.36	0.99	1.93	3.02	4.09	5.30	6.47	7.61	8.70	9.75	10.72	11.64	12.48	13.25	13.96	14.59	15.15	15.66	16.68
1983	0.01	0.04	0.44	0.98	1.85	2.99	4.22	5.37	6.65	7.86	9.02	10.13	11.18	12.15	13.06	13.89	14.64	15.33	15.94	16.48	17.58
1984	0.02	0.11	0.44	1.12	1.78	2.67	3.71	4.75	5.66	6.65	7.55	8.39	9.18	9.91	10.58	11.20	11.75	12.25	12.70	13.09	13.89
1985	0.01	0.06	0.31	1.04	2.03	2.91	4.09	5.43	6.77	7.95	9.22	10.37	11.47	12.49	13.43	14.31	15.10	15.82	16.46	17.03	18.19
1986	0.01	0.03	0.35	0.90	1.92	3.11	4.11	5.38	6.80	8.17	9.36	10.63	11.77	12.85	13.84	14.76	15.60	16.36	17.04	17.64	18.89
1987	0.02	0.06	0.35	1.02	1.79	3.00	4.25	5.24	6.45	7.76	8.98	10.03	11.13	12.11	13.02	13.85	14.61	15.29	15.91	16.45	17.58
1988	0.01	0.05	0.33	0.98	1.96	2.95	4.39	5.83	6.93	8.26	9.68	10.99	12.11	13.28	14.31	15.26	16.13	16.91	17.62	18.24	19.56
1989	0.01	0.05	0.35	0.99	1.95	3.14	4.24	5.75	7.19	8.26	9.54	10.87	12.09	13.11	14.17	15.10	15.94	16.71	17.39	18.00	19.30
1990	0.01	0.05	0.39	1.01	1.91	3.01	4.25	5.33	6.75	8.06	9.00	10.11	11.25	12.29	13.14	14.02	14.77	15.46	16.07	16.61	17.78
1991	0.01	0.06	0.40	1.01	1.81	2.80	3.92	5.12	6.12	7.41	8.57	9.39	10.35	11.33	12.21	12.93	13.66	14.28	14.84	15.34	16.41
1992	0.02	0.06	0.35	1.00	1.79	2.71	3.77	4.92	6.11	7.07	8.31	9.41	10.18	11.07	11.98	12.78	13.43	14.09	14.65	15.15	16.19
1993	0.01	0.06	0.43	1.09	2.07	3.10	4.21	5.43	6.68	7.95	8.96	10.23	11.35	12.12	13.01	13.90	14.69	15.32	15.95	16.48	17.49
1994	0.01	0.07	0.36	1.02	1.87	2.95	4.02	5.11	6.29	7.47	8.65	9.58	10.75	11.75	12.45	13.24	14.03	14.73	15.27	15.82	16.67
1995	0.01	0.06	0.35	0.98	1.89	2.91	4.12	5.27	6.42	7.63	8.83	10.01	10.94	12.08	13.07	13.74	14.51	15.27	15.93	16.44	17.43
1996	0.03	0.08	0.42	1.06	1.92	2.95	3.98	5.12	6.14	7.12	8.12	9.10	10.04	10.76	11.64	12.39	12.89	13.46	14.02	14.49	15.13
1997	0.01	0.06	0.36	0.96	1.77	2.74	3.84	4.90	6.06	7.08	8.05	9.04	10.00	10.92	11.62	12.48	13.20	13.68	14.22	14.75	15.36
1998	0.01	0.05	0.35	0.96	1.78	2.72	3.76	4.88	5.92	7.03	7.99	8.90	9.81	10.68	11.51	12.14	12.90	13.53	13.95	14.42	15.16
1999	0.01	0.05	0.33	0.96	1.85	2.85	3.93	5.06	6.24	7.31	8.43	9.39	10.29	11.18	12.03	12.83	13.42	14.15	14.75	15.14	15.96
2000	0.02	0.05	0.43	0.98	1.90	2.99	4.15	5.32	6.52	7.74	8.83	9.95	10.91	11.79	12.66	13.48	14.25	14.82	15.50	16.07	17.07
2001	0.02	0.07	0.42	1.11	1.83	2.87	4.01	5.14	6.26	7.36	8.46	9.43	10.42	11.25	12.01	12.75	13.45	14.10	14.57	15.14	16.22
2002	0.02	0.07	0.41	1.04	1.95	2.81	3.96	5.16	6.34	7.46	8.57	9.66	10.61	11.58	12.38	13.12	13.83	14.49	15.10	15.54	16.45
2003	0.01	0.07	0.37	1.03	1.88	2.96	3.90	5.12	6.37	7.55	8.67	9.76	10.82	11.75	12.68	13.45	14.14	14.81	15.43	16.00	17.05
2004	0.02	0.07	0.45	1.03	1.94	2.92	4.07	5.02	6.20	7.37	8.46	9.47	10.44	11.37	12.18	12.98	13.63	14.22	14.78	15.29	16.14
2005	0.02	0.08	0.36	1.11	1.90	2.99	4.10	5.35	6.34	7.57	8.77	9.87	10.89	11.85	12.78	13.57	14.36	14.99	15.56	16.10	17.12
2006	0.02	0.05	0.36	1.00	2.01	2.92	4.10	5.23	6.45	7.40	8.56	9.67	10.67	11.59	12.46	13.28	13.98	14.66	15.20	15.69	16.78
2007	0.01	0.04	0.34	1.00	1.89	3.10	4.12	5.37	6.54	7.77	8.72	9.85	10.93	11.90	12.78	13.60	14.38	15.03	15.66	16.16	17.44
2008	0.02	0.04	0.33	0.95	1.85	2.88	4.16	5.17	6.39	7.49	8.64	9.50	10.53	11.49	12.35	13.12	13.84	14.51	15.06	15.60	16.53
2009	0.01	0.03	0.33	0.93	1.80	2.91	4.07	5.47	6.55	7.82	8.95	10.11	10.98	12.01	12.98	13.83	14.58	15.28	15.93	16.46	17.28
2010	0.02	0.05	0.37	0.94	1.76	2.79	3.97	5.16	6.52	7.54	8.73	9.77	10.83	11.61	12.53	13.38	14.13	14.78	15.38	15.94	16.69
2011	0.01	0.06	0.31	0.98	1.76	2.72	3.84	5.05	6.23	7.55	8.52	9.63	10.60	11.57	12.28	13.12	13.88	14.54	15.12	15.65	16.50
2012	0.01	0.04	0.39	0.93	1.84	2.72	3.72	4.81	5.95	7.01	8.18	9.02	9.96	10.77	11.58	12.16	12.84	13.46	13.98	14.44	15.05
2013	0.01	0.06	0.34	0.98	1.73	2.85	3.86	4.99	6.17	7.40	8.53	9.76	10.63	11.62	12.46	13.30	13.90	14.59	15.21	15.74	16.57
2014	0.01	0.05	0.34	0.91	1.79	2.68	3.93	5.00	6.16	7.36	8.58	9.69	10.89	11.73	12.68	13.48	14.27	14.83	15.48	16.05	16.98
2015	0.01	0.05	0.41	0.91	1.70	2.74	3.71	5.00	6.08	7.20	8.35	9.50	10.53	11.64	12.41	13.27	13.99	14.70	15.19	15.76	16.71
2016	0.02	0.09	0.44	1.06	1.78	2.74	3.91	4.95	6.28	7.36	8.47	9.58	10.68	11.66	12.70	13.42	14.21	14.87	15.50	15.95	16.69
2017	0.01	0.08	0.40	1.09	1.95	2.82	3.91	5.17	6.25	7.60	8.67	9.76	10.85	11.91	12.85	13.83	14.50	15.24	15.85	16.43	17.24
2018	0.02	0.09	0.50	1.07	2.02	3.03	3.97	5.10	6.35	7.38	8.65	9.63	10.62	11.60	12.54	13.36	14.22	14.80	15.42	15.94	16.84
2019	0.02	0.10	0.35	1.21	1.98	3.10	4.21	5.19	6.32	7.55	8.54	9.75	10.67	11.59	12.49	13.35	14.09	14.86	15.37	15.92	16.66

Table 2.33c (page 1 of 2)—Weight (kg) at age (survey, NBS, Hypothesis 3 sub-ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.01	0.05	0.41	1.08	1.98	3.04	4.19	5.39	6.60	7.78	8.92	10.01	11.03	11.98	12.86	13.67	14.41	15.07	15.66	16.19	17.44
1978	0.01	0.04	0.36	1.05	1.98	3.09	4.33	5.63	6.94	8.24	9.50	10.71	11.85	12.92	13.91	14.82	15.65	16.40	17.08	17.68	19.10
1979	0.01	0.05	0.44	1.08	2.02	3.08	4.23	5.41	6.60	7.76	8.88	9.94	10.93	11.86	12.72	13.51	14.22	14.86	15.44	15.95	17.06
1980	0.01	0.06	0.38	1.08	1.91	2.99	4.13	5.31	6.50	7.67	8.79	9.86	10.87	11.80	12.67	13.47	14.19	14.85	15.43	15.95	17.03
1981	0.01	0.05	0.35	1.04	1.97	2.93	4.09	5.25	6.40	7.53	8.62	9.66	10.63	11.54	12.38	13.14	13.84	14.47	15.03	15.53	16.54
1982	0.01	0.04	0.38	1.04	2.03	3.16	4.24	5.48	6.66	7.82	8.93	9.98	10.97	11.89	12.74	13.52	14.22	14.86	15.43	15.93	16.94
1983	0.01	0.04	0.48	1.03	1.93	3.12	4.40	5.56	6.86	8.08	9.26	10.39	11.44	12.43	13.34	14.17	14.93	15.62	16.23	16.78	17.86
1984	0.01	0.09	0.47	1.19	1.85	2.77	3.85	4.91	5.83	6.82	7.73	8.58	9.38	10.11	10.79	11.41	11.96	12.47	12.91	13.31	14.09
1985	0.01	0.05	0.33	1.11	2.15	3.03	4.23	5.63	7.00	8.19	9.47	10.64	11.74	12.77	13.73	14.61	15.40	16.12	16.77	17.34	18.49
1986	0.01	0.02	0.38	0.95	2.03	3.27	4.27	5.57	7.03	8.43	9.63	10.91	12.06	13.15	14.15	15.08	15.92	16.68	17.36	17.97	19.20
1987	0.01	0.05	0.38	1.09	1.87	3.14	4.44	5.42	6.65	7.99	9.24	10.29	11.40	12.38	13.30	14.14	14.90	15.58	16.20	16.75	17.86
1988	0.01	0.04	0.35	1.05	2.07	3.07	4.57	6.06	7.15	8.50	9.95	11.30	12.42	13.59	14.63	15.59	16.46	17.25	17.95	18.58	19.89
1989	0.01	0.03	0.37	1.06	2.05	3.29	4.39	5.96	7.45	8.51	9.79	11.16	12.41	13.43	14.49	15.42	16.27	17.03	17.72	18.33	19.61
1990	0.01	0.04	0.43	1.07	2.01	3.15	4.43	5.50	6.97	8.31	9.24	10.36	11.53	12.58	13.43	14.30	15.06	15.75	16.36	16.90	18.06
1991	0.01	0.05	0.44	1.07	1.89	2.92	4.08	5.30	6.30	7.63	8.81	9.63	10.59	11.59	12.48	13.19	13.92	14.55	15.11	15.61	16.67
1992	0.01	0.06	0.38	1.06	1.88	2.82	3.92	5.09	6.31	7.27	8.54	9.66	10.42	11.32	12.24	13.05	13.70	14.36	14.92	15.41	16.45
1993	0.01	0.05	0.46	1.16	2.18	3.24	4.36	5.61	6.90	8.19	9.19	10.50	11.63	12.39	13.28	14.19	14.98	15.61	16.23	16.77	17.77
1994	0.01	0.05	0.40	1.09	1.96	3.09	4.17	5.29	6.48	7.70	8.90	9.82	11.01	12.03	12.72	13.51	14.32	15.01	15.56	16.10	16.95
1995	0.01	0.04	0.38	1.04	1.99	3.04	4.30	5.47	6.63	7.86	9.08	10.28	11.20	12.37	13.37	14.03	14.80	15.57	16.23	16.75	17.72
1996	0.01	0.06	0.45	1.13	2.02	3.08	4.13	5.29	6.32	7.31	8.33	9.32	10.27	10.98	11.88	12.64	13.13	13.70	14.26	14.74	15.38
1997	0.01	0.05	0.38	1.02	1.87	2.87	4.00	5.08	6.26	7.29	8.27	9.27	10.24	11.17	11.86	12.74	13.46	13.94	14.48	15.01	15.61
1998	0.01	0.05	0.36	1.02	1.87	2.84	3.91	5.05	6.11	7.24	8.21	9.12	10.04	10.93	11.76	12.38	13.16	13.79	14.21	14.67	15.41
1999	0.01	0.04	0.35	1.02	1.94	2.98	4.08	5.24	6.44	7.52	8.67	9.63	10.53	11.43	12.29	13.09	13.68	14.42	15.02	15.40	16.22
2000	0.01	0.04	0.47	1.04	1.99	3.12	4.31	5.51	6.73	7.97	9.07	10.21	11.17	12.05	12.93	13.76	14.53	15.09	15.79	16.35	17.36
2001	0.01	0.07	0.45	1.18	1.91	2.98	4.16	5.32	6.45	7.58	8.69	9.67	10.67	11.50	12.26	13.01	13.72	14.36	14.83	15.40	16.50
2002	0.01	0.06	0.45	1.11	2.06	2.92	4.10	5.35	6.54	7.69	8.81	9.91	10.87	11.85	12.65	13.38	14.10	14.77	15.38	15.82	16.73
2003	0.01	0.06	0.40	1.10	1.98	3.10	4.04	5.29	6.57	7.77	8.92	10.02	11.09	12.02	12.96	13.73	14.42	15.10	15.72	16.29	17.35
2004	0.01	0.05	0.49	1.10	2.04	3.05	4.24	5.18	6.39	7.59	8.69	9.71	10.69	11.64	12.44	13.25	13.90	14.48	15.05	15.57	16.41
2005	0.01	0.08	0.39	1.19	2.00	3.13	4.27	5.54	6.54	7.79	9.02	10.13	11.16	12.13	13.07	13.86	14.65	15.28	15.85	16.39	17.42
2006	0.01	0.05	0.40	1.06	2.12	3.05	4.27	5.42	6.66	7.61	8.79	9.92	10.93	11.86	12.73	13.56	14.25	14.94	15.49	15.97	17.07
2007	0.01	0.04	0.36	1.07	1.99	3.25	4.28	5.57	6.75	8.01	8.95	10.10	11.20	12.18	13.06	13.89	14.67	15.32	15.95	16.46	17.75
2008	0.01	0.04	0.35	1.00	1.95	3.00	4.33	5.36	6.60	7.72	8.88	9.73	10.78	11.76	12.62	13.40	14.12	14.79	15.34	15.88	16.81
2009	0.01	0.03	0.36	0.98	1.89	3.04	4.24	5.68	6.76	8.06	9.20	10.38	11.24	12.29	13.27	14.12	14.89	15.58	16.23	16.77	17.58
2010	0.01	0.04	0.40	1.00	1.84	2.90	4.13	5.34	6.74	7.77	8.98	10.03	11.10	11.87	12.80	13.67	14.41	15.07	15.68	16.23	16.97
2011	0.01	0.05	0.34	1.05	1.85	2.83	3.98	5.24	6.43	7.79	8.76	9.89	10.86	11.85	12.55	13.39	14.16	14.82	15.41	15.93	16.79
2012	0.01	0.04	0.41	0.98	1.94	2.84	3.85	4.97	6.14	7.21	8.40	9.24	10.20	11.01	11.83	12.41	13.09	13.71	14.24	14.70	15.30
2013	0.01	0.05	0.37	1.04	1.82	2.98	4.02	5.15	6.37	7.62	8.77	10.02	10.90	11.90	12.74	13.58	14.17	14.87	15.50	16.03	16.85
2014	0.01	0.04	0.37	0.97	1.88	2.80	4.09	5.19	6.35	7.58	8.82	9.95	11.17	12.01	12.97	13.77	14.57	15.12	15.77	16.35	17.28
2015	0.01	0.04	0.45	0.98	1.80	2.86	3.86	5.19	6.29	7.41	8.59	9.76	10.80	11.92	12.70	13.56	14.28	14.99	15.48	16.05	17.01
2016	0.01	0.08	0.50	1.14	1.87	2.88	4.06	5.13	6.50	7.59	8.70	9.83	10.95	11.94	12.99	13.71	14.51	15.16	15.80	16.24	16.98
2017	0.01	0.09	0.46	1.21	2.07	2.95	4.08	5.35	6.46	7.84	8.93	10.02	11.12	12.20	13.14	14.14	14.81	15.55	16.16	16.74	17.54
2018	0.01	0.08	0.55	1.19	2.19	3.19	4.14	5.29	6.54	7.60	8.89	9.89	10.88	11.87	12.82	13.65	14.51	15.09	15.72	16.23	17.14
2019	0.01	0.11	0.33	1.30	2.15	3.32	4.40	5.37	6.53	7.76	8.78	10.00	10.94	11.85	12.76	13.63	14.37	15.14	15.65	16.21	16.95

Table 2.33c (page 2 of 2)—Weight (kg) at age (survey, NBS, Hypothesis 3 sub-ensemble unweighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.01	0.05	0.38	1.06	2.01	3.14	4.37	5.61	6.81	7.93	8.97	9.90	10.74	11.48	12.13	12.70	13.19	13.62	13.99	14.30	14.95
1978	0.00	0.05	0.35	1.03	2.01	3.21	4.52	5.86	7.17	8.41	9.55	10.59	11.52	12.35	13.08	13.72	14.28	14.76	15.18	15.54	16.28
1979	0.01	0.06	0.41	1.08	2.05	3.18	4.40	5.62	6.80	7.91	8.92	9.83	10.65	11.37	12.00	12.56	13.04	13.45	13.81	14.12	14.71
1980	0.00	0.06	0.37	1.05	1.96	3.10	4.30	5.52	6.71	7.81	8.83	9.75	10.58	11.31	11.95	12.51	12.99	13.42	13.78	14.09	14.68
1981	0.00	0.05	0.36	1.04	1.98	3.06	4.26	5.45	6.60	7.68	8.67	9.56	10.35	11.06	11.68	12.22	12.69	13.09	13.44	13.74	14.30
1982	0.01	0.05	0.40	1.09	2.08	3.25	4.45	5.69	6.87	7.97	8.97	9.88	10.69	11.40	12.03	12.58	13.05	13.46	13.82	14.12	14.68
1983	0.01	0.05	0.42	1.07	2.05	3.26	4.56	5.81	7.07	8.24	9.31	10.28	11.14	11.90	12.58	13.16	13.68	14.12	14.50	14.83	15.42
1984	0.01	0.08	0.44	1.13	1.95	2.94	4.02	5.07	6.03	6.95	7.77	8.50	9.15	9.72	10.22	10.66	11.04	11.36	11.64	11.88	12.32
1985	0.00	0.05	0.36	1.08	2.11	3.23	4.53	5.89	7.20	8.38	9.51	10.52	11.42	12.22	12.93	13.55	14.08	14.55	14.95	15.29	15.92
1986	0.00	0.04	0.37	1.01	2.06	3.32	4.56	5.91	7.29	8.58	9.71	10.78	11.73	12.57	13.31	13.96	14.53	15.02	15.44	15.80	16.48
1987	0.00	0.05	0.38	1.08	2.01	3.24	4.54	5.73	6.97	8.17	9.27	10.21	11.09	11.86	12.53	13.12	13.63	14.08	14.46	14.79	15.40
1988	0.00	0.05	0.36	1.07	2.12	3.31	4.77	6.22	7.49	8.79	10.04	11.16	12.11	12.99	13.76	14.43	15.02	15.52	15.96	16.34	17.05
1989	0.00	0.05	0.38	1.09	2.14	3.42	4.72	6.20	7.60	8.78	9.95	11.07	12.05	12.87	13.64	14.29	14.86	15.35	15.78	16.15	16.84
1990	0.01	0.05	0.41	1.11	2.11	3.31	4.62	5.86	7.18	8.39	9.38	10.35	11.25	12.04	12.69	13.29	13.80	14.25	14.63	14.96	15.58
1991	0.01	0.06	0.41	1.07	1.99	3.10	4.30	5.52	6.62	7.77	8.79	9.60	10.40	11.13	11.77	12.29	12.77	13.17	13.52	13.82	14.39
1992	0.01	0.06	0.37	1.03	1.93	2.99	4.16	5.35	6.52	7.53	8.58	9.50	10.21	10.91	11.56	12.12	12.57	12.98	13.33	13.63	14.19
1993	0.01	0.06	0.44	1.16	2.20	3.38	4.63	5.92	7.17	8.35	9.36	10.38	11.27	11.95	12.61	13.22	13.73	14.15	14.54	14.86	15.42
1994	0.01	0.06	0.39	1.07	2.02	3.17	4.37	5.58	6.77	7.90	8.95	9.82	10.72	11.48	12.05	12.61	13.13	13.57	13.92	14.24	14.74
1995	0.00	0.05	0.37	1.04	2.02	3.17	4.46	5.71	6.93	8.10	9.19	10.18	11.00	11.84	12.54	13.07	13.59	14.06	14.47	14.78	15.35
1996	0.01	0.07	0.44	1.13	2.07	3.18	4.31	5.47	6.54	7.52	8.44	9.27	10.02	10.63	11.24	11.75	12.13	12.50	12.84	13.12	13.52
1997	0.01	0.05	0.38	1.02	1.92	3.00	4.16	5.30	6.43	7.45	8.38	9.24	10.02	10.72	11.27	11.84	12.31	12.66	12.99	13.30	13.70
1998	0.01	0.05	0.37	1.02	1.92	2.97	4.10	5.25	6.32	7.36	8.27	9.09	9.84	10.52	11.11	11.59	12.07	12.47	12.75	13.04	13.48
1999	0.01	0.05	0.38	1.05	2.00	3.11	4.28	5.47	6.64	7.69	8.69	9.55	10.32	11.01	11.64	12.19	12.62	13.06	13.42	13.68	14.16
2000	0.01	0.05	0.43	1.09	2.08	3.26	4.51	5.76	6.97	8.12	9.14	10.09	10.90	11.61	12.26	12.83	13.34	13.73	14.13	14.46	15.02
2001	0.01	0.07	0.43	1.13	2.03	3.16	4.36	5.55	6.69	7.75	8.73	9.59	10.39	11.06	11.64	12.16	12.63	13.04	13.35	13.67	14.25
2002	0.01	0.06	0.41	1.09	2.06	3.12	4.35	5.59	6.77	7.87	8.88	9.81	10.61	11.34	11.96	12.49	12.97	13.40	13.77	14.05	14.57
2003	0.01	0.06	0.38	1.07	2.01	3.17	4.32	5.59	6.82	7.96	9.00	9.94	10.80	11.53	12.21	12.76	13.24	13.68	14.06	14.39	14.98
2004	0.01	0.06	0.43	1.08	2.05	3.16	4.37	5.49	6.66	7.76	8.75	9.64	10.44	11.16	11.76	12.31	12.77	13.16	13.51	13.81	14.31
2005	0.01	0.06	0.38	1.11	2.04	3.21	4.44	5.72	6.86	8.02	9.09	10.05	10.89	11.64	12.32	12.89	13.40	13.82	14.19	14.51	15.09
2006	0.01	0.05	0.39	1.07	2.08	3.17	4.41	5.63	6.83	7.86	8.90	9.84	10.67	11.39	12.03	12.60	13.08	13.51	13.86	14.16	14.75
2007	0.01	0.05	0.38	1.07	2.05	3.27	4.47	5.75	6.96	8.12	9.10	10.06	10.93	11.69	12.34	12.92	13.44	13.86	14.25	14.56	15.22
2008	0.01	0.05	0.37	1.05	2.01	3.14	4.41	5.58	6.78	7.86	8.89	9.73	10.55	11.29	11.93	12.48	12.96	13.38	13.73	14.05	14.58
2009	0.00	0.05	0.37	1.03	2.00	3.19	4.45	5.81	6.99	8.19	9.25	10.24	11.04	11.82	12.52	13.12	13.64	14.08	14.48	14.81	15.31
2010	0.01	0.05	0.38	1.03	1.96	3.09	4.35	5.59	6.86	7.93	8.99	9.92	10.77	11.45	12.12	12.71	13.21	13.64	14.01	14.34	14.81
2011	0.00	0.05	0.35	1.03	1.94	3.03	4.24	5.49	6.67	7.85	8.82	9.76	10.57	11.32	11.90	12.48	12.98	13.41	13.77	14.08	14.59
2012	0.01	0.05	0.40	1.03	1.97	3.00	4.11	5.25	6.36	7.38	8.37	9.16	9.92	10.56	11.15	11.61	12.06	12.45	12.77	13.05	13.45
2013	0.00	0.05	0.36	1.03	1.92	3.09	4.26	5.47	6.67	7.81	8.84	9.83	10.62	11.37	12.00	12.58	13.03	13.47	13.85	14.17	14.66
2014	0.00	0.04	0.35	0.98	1.92	3.00	4.27	5.48	6.67	7.83	8.91	9.87	10.79	11.50	12.19	12.76	13.29	13.68	14.07	14.42	14.96
2015	0.00	0.04	0.37	0.97	1.86	2.97	4.13	5.41	6.56	7.67	8.72	9.69	10.53	11.34	11.96	12.55	13.04	13.49	13.82	14.16	14.71
2016	0.01	0.06	0.40	1.04	1.91	3.02	4.25	5.45	6.71	7.81	8.85	9.81	10.69	11.45	12.17	12.71	13.24	13.67	14.06	14.35	14.82
2017	0.00	0.06	0.38	1.07	1.99	3.07	4.30	5.58	6.78	8.00	9.04	10.00	10.89	11.70	12.39	13.04	13.52	13.99	14.37	14.72	15.22
2018	0.01	0.06	0.43	1.08	2.06	3.17	4.32	5.55	6.76	7.85	8.94	9.85	10.67	11.43	12.11	12.68	13.23	13.63	14.01	14.32	14.86
2019	0.00	0.08	0.36	1.14	2.07	3.24	4.44	5.60	6.78	7.93	8.92	9.90	10.70	11.43	12.09	12.68	13.18	13.64	13.98	14.31	14.78

Table 2.34a—Selectivity at age (fishery, ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.000	0.000	0.011	0.089	0.302	0.604	0.813	0.883	0.888	0.885	0.880	0.876	0.874	0.873	0.872	0.872	0.872	0.872	0.872	0.872	0.872
1978	0.000	0.000	0.009	0.088	0.300	0.602	0.812	0.882	0.886	0.883	0.878	0.874	0.872	0.871	0.870	0.870	0.870	0.869	0.869	0.869	0.869
1979	0.000	0.000	0.013	0.087	0.310	0.611	0.817	0.884	0.887	0.883	0.878	0.874	0.872	0.870	0.870	0.870	0.869	0.869	0.869	0.869	0.869
1980	0.000	0.000	0.010	0.095	0.296	0.609	0.817	0.886	0.892	0.890	0.885	0.882	0.880	0.879	0.878	0.878	0.878	0.878	0.878	0.878	0.877
1981	0.000	0.000	0.012	0.105	0.339	0.620	0.830	0.892	0.894	0.890	0.884	0.881	0.879	0.878	0.877	0.877	0.877	0.877	0.877	0.876	0.876
1982	0.000	0.000	0.007	0.067	0.282	0.599	0.802	0.884	0.892	0.892	0.888	0.885	0.883	0.882	0.882	0.881	0.881	0.881	0.881	0.881	0.881
1983	0.000	0.000	0.013	0.072	0.268	0.591	0.816	0.886	0.900	0.902	0.899	0.896	0.895	0.894	0.894	0.893	0.893	0.893	0.893	0.893	0.893
1984	0.000	0.001	0.016	0.119	0.299	0.594	0.822	0.899	0.907	0.909	0.907	0.905	0.904	0.903	0.903	0.902	0.902	0.902	0.902	0.902	0.902
1985	0.000	0.000	0.005	0.079	0.307	0.560	0.785	0.880	0.893	0.893	0.890	0.887	0.885	0.884	0.884	0.883	0.883	0.883	0.883	0.883	0.883
1986	0.000	0.000	0.013	0.078	0.318	0.636	0.804	0.880	0.890	0.886	0.881	0.877	0.874	0.873	0.873	0.873	0.872	0.872	0.872	0.872	0.872
1987	0.000	0.000	0.007	0.077	0.250	0.591	0.819	0.875	0.890	0.891	0.887	0.884	0.882	0.881	0.881	0.880	0.880	0.880	0.880	0.880	0.880
1988	0.000	0.001	0.024	0.136	0.378	0.635	0.851	0.906	0.900	0.896	0.890	0.886	0.884	0.883	0.882	0.882	0.882	0.882	0.882	0.882	0.881
1989	0.000	0.000	0.013	0.095	0.314	0.624	0.807	0.898	0.906	0.906	0.903	0.900	0.898	0.898	0.897	0.897	0.897	0.897	0.897	0.897	0.897
1990	0.000	0.000	0.009	0.073	0.271	0.580	0.811	0.886	0.917	0.924	0.924	0.923	0.923	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922
1991	0.000	0.000	0.010	0.078	0.267	0.567	0.798	0.890	0.904	0.911	0.910	0.909	0.908	0.907	0.907	0.906	0.906	0.906	0.906	0.906	0.906
1992	0.000	0.000	0.008	0.080	0.275	0.562	0.786	0.874	0.885	0.884	0.878	0.874	0.872	0.871	0.870	0.870	0.870	0.870	0.870	0.870	0.870
1993	0.000	0.001	0.023	0.125	0.365	0.642	0.827	0.892	0.896	0.891	0.886	0.881	0.879	0.878	0.878	0.877	0.877	0.877	0.877	0.877	0.877
1994	0.000	0.000	0.012	0.098	0.307	0.620	0.815	0.881	0.889	0.887	0.881	0.877	0.875	0.874	0.873	0.873	0.873	0.872	0.872	0.872	0.872
1995	0.000	0.000	0.013	0.098	0.325	0.615	0.828	0.887	0.891	0.888	0.882	0.878	0.876	0.874	0.874	0.873	0.873	0.873	0.873	0.873	0.873
1996	0.000	0.000	0.007	0.070	0.270	0.584	0.801	0.894	0.912	0.920	0.920	0.920	0.919	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.918
1997	0.000	0.000	0.013	0.099	0.313	0.612	0.827	0.896	0.908	0.910	0.908	0.906	0.905	0.904	0.904	0.903	0.903	0.903	0.903	0.903	0.903
1998	0.000	0.000	0.006	0.072	0.274	0.574	0.798	0.886	0.900	0.903	0.901	0.899	0.898	0.897	0.897	0.897	0.897	0.896	0.896	0.896	0.896
1999	0.000	0.000	0.006	0.070	0.279	0.584	0.801	0.883	0.898	0.899	0.896	0.894	0.893	0.892	0.891	0.891	0.891	0.891	0.891	0.891	0.891
2000	0.000	0.000	0.009	0.059	0.255	0.570	0.796	0.879	0.895	0.897	0.894	0.892	0.890	0.889	0.889	0.889	0.888	0.888	0.888	0.888	0.888
2001	0.000	0.000	0.010	0.089	0.260	0.571	0.799	0.874	0.878	0.872	0.865	0.860	0.858	0.857	0.856	0.856	0.855	0.855	0.855	0.855	0.855
2002	0.000	0.000	0.016	0.102	0.331	0.586	0.803	0.864	0.850	0.833	0.819	0.811	0.807	0.804	0.803	0.803	0.803	0.802	0.802	0.802	0.802
2003	0.000	0.000	0.013	0.105	0.318	0.627	0.801	0.881	0.888	0.884	0.878	0.874	0.871	0.870	0.870	0.869	0.869	0.869	0.869	0.869	0.869
2004	0.000	0.000	0.020	0.101	0.331	0.621	0.830	0.882	0.893	0.891	0.885	0.882	0.880	0.879	0.878	0.878	0.878	0.878	0.878	0.878	0.878
2005	0.000	0.001	0.011	0.114	0.309	0.621	0.820	0.893	0.897	0.898	0.894	0.891	0.889	0.888	0.888	0.888	0.887	0.887	0.887	0.887	0.887
2006	0.000	0.000	0.008	0.078	0.322	0.593	0.819	0.896	0.916	0.921	0.922	0.921	0.921	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920
2007	0.000	0.000	0.006	0.075	0.279	0.621	0.808	0.895	0.911	0.917	0.916	0.915	0.914	0.914	0.913	0.913	0.913	0.913	0.913	0.913	0.913
2008	0.000	0.000	0.005	0.062	0.266	0.572	0.817	0.873	0.879	0.875	0.868	0.864	0.862	0.860	0.860	0.859	0.859	0.859	0.859	0.859	0.859
2009	0.000	0.000	0.004	0.047	0.225	0.543	0.773	0.855	0.847	0.834	0.823	0.816	0.813	0.811	0.810	0.809	0.809	0.809	0.808	0.808	0.808
2010	0.000	0.000	0.004	0.048	0.217	0.521	0.768	0.848	0.848	0.838	0.827	0.821	0.817	0.816	0.815	0.814	0.814	0.814	0.814	0.814	0.814
2011	0.000	0.000	0.003	0.057	0.226	0.519	0.762	0.864	0.880	0.880	0.876	0.872	0.871	0.869	0.869	0.869	0.869	0.868	0.868	0.868	0.868
2012	0.000	0.000	0.007	0.060	0.277	0.557	0.779	0.870	0.885	0.885	0.879	0.876	0.874	0.873	0.873	0.872	0.872	0.872	0.872	0.872	0.872
2013	0.000	0.000	0.007	0.077	0.254	0.586	0.784	0.853	0.850	0.836	0.823	0.814	0.811	0.809	0.808	0.808	0.807	0.807	0.807	0.807	0.807
2014	0.000	0.000	0.004	0.052	0.246	0.520	0.776	0.842	0.842	0.829	0.815	0.808	0.803	0.801	0.800	0.800	0.800	0.799	0.799	0.799	0.799
2015	0.000	0.000	0.006	0.049	0.218	0.536	0.747	0.854	0.861	0.857	0.850	0.844	0.841	0.840	0.839	0.839	0.838	0.838	0.838	0.838	0.838
2016	0.000	0.000	0.007	0.069	0.230	0.524	0.774	0.857	0.884	0.887	0.884	0.881	0.880	0.879	0.878	0.878	0.878	0.878	0.878	0.878	0.878
2017	0.000	0.000	0.006	0.075	0.276	0.539	0.768	0.874	0.895	0.905	0.905	0.903	0.902	0.902	0.901	0.901	0.901	0.901	0.901	0.901	0.901
2018	0.000	0.000	0.018	0.095	0.335	0.628	0.803	0.882	0.899	0.902	0.899	0.897	0.896	0.895	0.895	0.894	0.894	0.894	0.894	0.894	0.894
2019	0.000	0.001	0.014	0.145	0.348	0.662	0.838	0.874	0.867	0.855	0.846	0.839	0.836	0.834	0.833	0.832	0.832	0.832	0.832	0.832	0.832

Table 2.34b—Selectivity at age (fishery, ensemble unweighted average).

Yr	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.000	0.000	0.006	0.059	0.293	0.722	0.923	0.916	0.899	0.898	0.896	0.895	0.894	0.894	0.894	0.894	0.894	0.894	0.894	0.894	0.894
1978	0.000	0.000	0.005	0.058	0.292	0.722	0.922	0.916	0.899	0.898	0.896	0.894	0.893	0.893	0.893	0.893	0.893	0.893	0.893	0.893	0.893
1979	0.000	0.000	0.007	0.057	0.296	0.725	0.924	0.917	0.899	0.898	0.896	0.894	0.893	0.893	0.893	0.893	0.893	0.893	0.893	0.892	0.892
1980	0.000	0.000	0.006	0.061	0.290	0.724	0.924	0.918	0.901	0.900	0.899	0.897	0.897	0.896	0.896	0.896	0.896	0.896	0.896	0.896	0.896
1981	0.000	0.000	0.006	0.064	0.307	0.727	0.928	0.919	0.902	0.900	0.898	0.897	0.896	0.896	0.896	0.896	0.896	0.895	0.895	0.895	0.895
1982	0.000	0.000	0.004	0.049	0.285	0.722	0.918	0.917	0.901	0.901	0.900	0.899	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.897	0.897
1983	0.000	0.000	0.007	0.051	0.278	0.717	0.924	0.918	0.905	0.905	0.905	0.904	0.903	0.903	0.903	0.903	0.903	0.903	0.903	0.903	0.903
1984	0.000	0.000	0.008	0.071	0.290	0.717	0.926	0.923	0.908	0.909	0.908	0.907	0.907	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906
1985	0.000	0.000	0.004	0.054	0.295	0.704	0.911	0.915	0.902	0.902	0.900	0.899	0.899	0.899	0.898	0.898	0.898	0.898	0.898	0.898	0.898
1986	0.000	0.000	0.007	0.053	0.298	0.735	0.918	0.915	0.900	0.899	0.897	0.895	0.895	0.894	0.894	0.894	0.894	0.894	0.894	0.894	0.894
1987	0.000	0.000	0.005	0.053	0.272	0.717	0.925	0.914	0.901	0.902	0.901	0.900	0.899	0.899	0.898	0.898	0.898	0.898	0.898	0.898	0.898
1988	0.000	0.000	0.011	0.075	0.320	0.732	0.936	0.925	0.904	0.903	0.901	0.899	0.899	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898
1989	0.000	0.000	0.007	0.059	0.296	0.729	0.919	0.922	0.907	0.907	0.906	0.905	0.905	0.904	0.904	0.904	0.904	0.904	0.904	0.904	0.904
1990	0.000	0.000	0.005	0.052	0.280	0.712	0.922	0.918	0.912	0.915	0.915	0.915	0.914	0.914	0.914	0.914	0.914	0.914	0.914	0.914	0.914
1991	0.000	0.000	0.006	0.054	0.278	0.707	0.916	0.919	0.906	0.909	0.909	0.908	0.908	0.908	0.908	0.908	0.908	0.907	0.907	0.907	0.907
1992	0.000	0.000	0.005	0.055	0.281	0.705	0.912	0.912	0.898	0.897	0.895	0.894	0.893	0.893	0.893	0.892	0.892	0.892	0.892	0.892	0.892
1993	0.000	0.000	0.011	0.071	0.316	0.736	0.927	0.920	0.903	0.901	0.899	0.898	0.897	0.897	0.896	0.896	0.896	0.896	0.896	0.896	0.896
1994	0.000	0.000	0.006	0.062	0.294	0.728	0.923	0.916	0.901	0.900	0.898	0.897	0.896	0.896	0.895	0.895	0.895	0.895	0.895	0.895	0.895
1995	0.000	0.000	0.007	0.062	0.301	0.725	0.927	0.918	0.901	0.900	0.898	0.896	0.896	0.895	0.895	0.895	0.895	0.895	0.895	0.895	0.895
1996	0.000	0.000	0.005	0.051	0.280	0.714	0.917	0.921	0.910	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913
1997	0.000	0.000	0.007	0.062	0.296	0.725	0.927	0.922	0.908	0.909	0.909	0.908	0.907	0.907	0.907	0.907	0.907	0.907	0.907	0.907	0.907
1998	0.000	0.000	0.004	0.051	0.281	0.710	0.917	0.918	0.905	0.906	0.906	0.905	0.905	0.904	0.904	0.904	0.904	0.904	0.904	0.904	0.904
1999	0.000	0.000	0.004	0.051	0.283	0.714	0.917	0.917	0.904	0.904	0.903	0.902	0.902	0.902	0.901	0.901	0.901	0.901	0.901	0.901	0.901
2000	0.000	0.000	0.005	0.046	0.274	0.709	0.915	0.915	0.903	0.904	0.903	0.902	0.902	0.901	0.901	0.901	0.901	0.901	0.901	0.901	0.901
2001	0.000	0.000	0.006	0.058	0.276	0.708	0.917	0.913	0.895	0.894	0.891	0.889	0.888	0.888	0.888	0.888	0.888	0.887	0.887	0.887	0.887
2002	0.000	0.000	0.008	0.063	0.303	0.714	0.917	0.907	0.883	0.876	0.870	0.867	0.866	0.865	0.864	0.864	0.864	0.864	0.864	0.864	0.864
2003	0.000	0.000	0.007	0.064	0.298	0.730	0.917	0.915	0.899	0.898	0.896	0.894	0.893	0.893	0.893	0.893	0.893	0.893	0.893	0.893	0.892
2004	0.000	0.000	0.009	0.063	0.303	0.728	0.929	0.916	0.902	0.901	0.899	0.898	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897
2005	0.000	0.000	0.006	0.068	0.295	0.728	0.925	0.920	0.903	0.904	0.903	0.902	0.901	0.901	0.901	0.900	0.900	0.900	0.900	0.900	0.900
2006	0.000	0.000	0.005	0.054	0.300	0.717	0.924	0.922	0.911	0.913	0.914	0.914	0.914	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913
2007	0.000	0.000	0.004	0.053	0.283	0.728	0.920	0.922	0.909	0.912	0.912	0.911	0.911	0.911	0.911	0.911	0.911	0.911	0.911	0.910	0.910
2008	0.000	0.000	0.004	0.048	0.279	0.710	0.924	0.912	0.895	0.894	0.891	0.890	0.889	0.888	0.888	0.888	0.888	0.888	0.888	0.888	0.888
2009	0.000	0.000	0.003	0.042	0.263	0.699	0.906	0.904	0.881	0.875	0.871	0.868	0.867	0.866	0.866	0.866	0.866	0.866	0.865	0.865	0.865
2010	0.000	0.000	0.004	0.043	0.259	0.690	0.904	0.901	0.880	0.875	0.870	0.868	0.866	0.865	0.865	0.865	0.865	0.865	0.865	0.865	0.865
2011	0.000	0.000	0.003	0.046	0.263	0.689	0.903	0.909	0.896	0.895	0.894	0.893	0.892	0.892	0.891	0.891	0.891	0.891	0.891	0.891	0.891
2012	0.000	0.000	0.005	0.047	0.283	0.704	0.909	0.911	0.898	0.898	0.895	0.894	0.894	0.893	0.893	0.893	0.893	0.893	0.893	0.893	0.893
2013	0.000	0.000	0.005	0.054	0.275	0.716	0.911	0.903	0.882	0.876	0.871	0.867	0.866	0.865	0.865	0.865	0.865	0.864	0.864	0.864	0.864
2014	0.000	0.000	0.004	0.044	0.271	0.690	0.908	0.899	0.878	0.872	0.867	0.864	0.862	0.861	0.861	0.861	0.861	0.860	0.860	0.860	0.860
2015	0.000	0.000	0.004	0.043	0.261	0.696	0.898	0.905	0.888	0.887	0.884	0.882	0.881	0.881	0.880	0.880	0.880	0.880	0.880	0.880	0.880
2016	0.000	0.000	0.005	0.052	0.266	0.693	0.908	0.907	0.898	0.899	0.898	0.897	0.897	0.896	0.896	0.896	0.896	0.896	0.896	0.896	0.896
2017	0.000	0.000	0.005	0.056	0.284	0.698	0.906	0.913	0.903	0.906	0.906	0.906	0.906	0.905	0.905	0.905	0.905	0.905	0.905	0.905	0.905
2018	0.000	0.000	0.009	0.063	0.309	0.730	0.918	0.916	0.904	0.905	0.904	0.904	0.903	0.903	0.903	0.903	0.903	0.903	0.903	0.903	0.903
2019	0.000	0.001	0.013	0.077	0.311	0.745	0.930	0.912	0.891	0.887	0.884	0.882	0.881	0.880	0.880	0.880	0.879	0.879	0.879	0.879	0.879

Table 2.35a (page 1 of 2)—Selectivity at age (survey, EBS, Hypothesis 1 and 3 sub-ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.010	0.524	0.988	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	1.000	1.000
1978	0.008	0.524	0.988	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	1.000	1.000
1979	0.011	0.411	0.989	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	1.000	1.000
1980	0.008	0.576	0.988	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	1.000	1.000
1981	0.005	0.420	0.987	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	1.000	1.000
1982	0.003	0.230	0.987	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	1.000	1.000
1983	0.039	0.371	0.989	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	1.000	1.000
1984	0.005	0.372	0.976	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	1.000	1.000
1985	0.006	0.408	0.980	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	1.000	1.000
1986	0.018	0.289	0.989	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	1.000	1.000
1987	0.004	0.390	0.987	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	1.000	1.000
1988	0.003	0.279	0.986	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	1.000	1.000
1989	0.002	0.170	0.981	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	1.000	1.000
1990	0.019	0.392	0.989	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	1.000	1.000
1991	0.021	0.337	0.984	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	1.000	1.000
1992	0.012	0.626	0.989	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	1.000	1.000
1993	0.024	0.466	0.988	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	1.000	1.000
1994	0.005	0.318	0.983	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	1.000	1.000
1995	0.004	0.230	0.981	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	1.000	1.000
1996	0.002	0.221	0.984	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	1.000	1.000
1997	0.007	0.279	0.982	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	1.000	1.000
1998	0.008	0.194	0.892	0.999	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	1.000
1999	0.005	0.245	0.983	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	1.000	1.000
2000	0.015	0.313	0.989	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	1.000	1.000
2001	0.020	0.727	0.989	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	1.000	1.000
2002	0.009	0.406	0.988	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	1.000	1.000
2003	0.008	0.477	0.987	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	1.000	1.000
2004	0.010	0.368	0.988	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	1.000	1.000
2005	0.006	0.634	0.987	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	1.000	1.000
2006	0.024	0.700	0.989	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	1.000	1.000
2007	0.034	0.801	0.989	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	1.000	1.000
2008	0.012	0.518	0.989	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	1.000	1.000
2009	0.044	0.585	0.989	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	1.000	1.000
2010	0.007	0.330	0.989	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	1.000	1.000
2011	0.005	0.496	0.987	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	1.000	1.000
2012	0.066	0.684	0.989	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	1.000	1.000
2013	0.010	0.348	0.983	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	1.000	1.000
2014	0.010	0.409	0.988	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	1.000	1.000
2015	0.015	0.373	0.989	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	1.000	1.000
2016	0.010	0.461	0.988	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	1.000	1.000
2017	0.022	0.804	0.988	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	1.000	1.000
2018	0.002	0.452	0.988	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	1.000	1.000
2019	0.058	0.925	0.989	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	1.000	1.000

Table 2.35a (page 2 of 2)—Selectivity at age (survey, EBS, Hypothesis 1 and 3 sub-ensemble unweighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.004	0.479	0.942	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	1.000	1.000
1978	0.003	0.479	0.942	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	1.000	1.000
1979	0.004	0.437	0.942	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	1.000	1.000
1980	0.003	0.498	0.942	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	1.000	1.000
1981	0.002	0.440	0.941	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	1.000	1.000
1982	0.001	0.369	0.941	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	1.000	1.000
1983	0.014	0.422	0.942	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	1.000	1.000
1984	0.002	0.422	0.937	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	1.000	1.000
1985	0.002	0.436	0.939	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	1.000	1.000
1986	0.007	0.391	0.942	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	1.000	1.000
1987	0.002	0.429	0.941	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	1.000	1.000
1988	0.001	0.387	0.941	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	1.000	1.000
1989	0.001	0.347	0.939	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	1.000	1.000
1990	0.007	0.430	0.942	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	1.000	1.000
1991	0.008	0.409	0.940	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	1.000	1.000
1992	0.005	0.517	0.942	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	1.000	1.000
1993	0.009	0.457	0.942	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	1.000	1.000
1994	0.002	0.402	0.940	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	1.000	1.000
1995	0.001	0.369	0.939	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	1.000	1.000
1996	0.001	0.366	0.940	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	1.000	1.000
1997	0.003	0.387	0.939	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	1.000	1.000
1998	0.003	0.356	0.906	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	1.000	1.000
1999	0.002	0.375	0.940	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	1.000	1.000
2000	0.006	0.400	0.942	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	1.000	1.000
2001	0.008	0.555	0.942	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	1.000	1.000
2002	0.003	0.435	0.942	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	1.000	1.000
2003	0.003	0.462	0.941	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	1.000	1.000
2004	0.004	0.421	0.942	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	1.000	1.000
2005	0.002	0.520	0.941	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	1.000	1.000
2006	0.009	0.545	0.942	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	1.000	1.000
2007	0.013	0.583	0.942	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	1.000	1.000
2008	0.005	0.477	0.942	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	1.000	1.000
2009	0.017	0.502	0.942	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	1.000	1.000
2010	0.003	0.406	0.942	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	1.000	1.000
2011	0.002	0.468	0.941	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	1.000	1.000
2012	0.025	0.539	0.942	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	1.000	1.000
2013	0.004	0.413	0.940	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	1.000	1.000
2014	0.004	0.436	0.942	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	1.000	1.000
2015	0.005	0.423	0.942	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	1.000	1.000
2016	0.004	0.455	0.942	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	1.000	1.000
2017	0.008	0.584	0.942	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	1.000	1.000
2018	0.001	0.452	0.942	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	1.000	1.000
2019	0.022	0.629	0.942	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	1.000	1.000

Table 2.35b (page 1 of 2)—Selectivity at age (survey, EBS+NBS, Hypothesis 2 sub-ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.010	0.490	0.979	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	1.000	1.000
1978	0.008	0.490	0.978	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	1.000	1.000
1979	0.010	0.401	0.979	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	1.000	1.000
1980	0.008	0.507	0.978	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	1.000	1.000
1981	0.005	0.408	0.977	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	1.000	1.000
1982	0.003	0.247	0.978	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	1.000	1.000
1983	0.038	0.392	0.979	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	1.000	1.000
1984	0.005	0.362	0.969	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	1.000	1.000
1985	0.006	0.417	0.972	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	1.000	1.000
1986	0.018	0.304	0.979	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	1.000	1.000
1987	0.005	0.395	0.978	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	1.000	1.000
1988	0.003	0.284	0.977	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	1.000	1.000
1989	0.002	0.185	0.972	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	1.000	1.000
1990	0.020	0.403	0.979	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	1.000	1.000
1991	0.021	0.353	0.976	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	1.000	1.000
1992	0.012	0.615	0.979	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	1.000	1.000
1993	0.025	0.479	0.979	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	1.000	1.000
1994	0.005	0.343	0.975	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	1.000	1.000
1995	0.004	0.250	0.973	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	1.000	1.000
1996	0.002	0.238	0.976	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	1.000	1.000
1997	0.008	0.302	0.974	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	1.000	1.000
1998	0.009	0.216	0.906	0.999	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	1.000
1999	0.005	0.263	0.974	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	1.000	1.000
2000	0.016	0.332	0.979	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	1.000	1.000
2001	0.021	0.712	0.979	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	1.000	1.000
2002	0.010	0.446	0.979	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	1.000	1.000
2003	0.008	0.483	0.978	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	1.000	1.000
2004	0.011	0.384	0.979	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	1.000	1.000
2005	0.006	0.654	0.978	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	1.000	1.000
2006	0.024	0.682	0.979	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	1.000	1.000
2007	0.034	0.772	0.979	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	1.000	1.000
2008	0.013	0.514	0.979	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	1.000	1.000
2009	0.044	0.595	0.979	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	1.000	1.000
2010	0.008	0.354	0.979	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	1.000	1.000
2011	0.005	0.475	0.977	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	1.000	1.000
2012	0.061	0.624	0.979	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	1.000	1.000
2013	0.009	0.342	0.972	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	1.000	1.000
2014	0.008	0.355	0.979	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	1.000	1.000
2015	0.014	0.357	0.979	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	1.000	1.000
2016	0.007	0.440	0.977	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	1.000	1.000
2017	0.012	0.582	0.977	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	1.000	1.000
2018	0.005	0.416	0.979	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	1.000	1.000
2019	0.012	0.899	0.979	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	1.000	1.000

Table 2.35b (page 2 of 2)—Selectivity at age (survey, EBS+NBS, Hypothesis 2 sub-ensemble unweighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.010	0.490	0.979	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	1.000	1.000
1978	0.008	0.490	0.978	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	1.000	1.000
1979	0.010	0.401	0.979	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	1.000	1.000
1980	0.008	0.507	0.978	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	1.000	1.000
1981	0.005	0.408	0.977	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	1.000	1.000
1982	0.003	0.247	0.978	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	1.000	1.000
1983	0.038	0.392	0.979	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	1.000	1.000
1984	0.005	0.362	0.969	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	1.000	1.000
1985	0.006	0.417	0.972	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	1.000	1.000
1986	0.018	0.304	0.979	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	1.000	1.000
1987	0.005	0.395	0.978	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	1.000	1.000
1988	0.003	0.284	0.977	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	1.000	1.000
1989	0.002	0.185	0.972	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	1.000	1.000
1990	0.020	0.403	0.979	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	1.000	1.000
1991	0.021	0.353	0.976	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	1.000	1.000
1992	0.012	0.615	0.979	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	1.000	1.000
1993	0.025	0.479	0.979	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	1.000	1.000
1994	0.005	0.343	0.975	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	1.000	1.000
1995	0.004	0.250	0.973	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	1.000	1.000
1996	0.002	0.238	0.976	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	1.000	1.000
1997	0.008	0.302	0.974	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	1.000	1.000
1998	0.009	0.216	0.906	0.999	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	1.000
1999	0.005	0.263	0.974	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	1.000	1.000
2000	0.016	0.332	0.979	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	1.000	1.000
2001	0.021	0.712	0.979	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	1.000	1.000
2002	0.010	0.446	0.979	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	1.000	1.000
2003	0.008	0.483	0.978	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	1.000	1.000
2004	0.011	0.384	0.979	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	1.000	1.000
2005	0.006	0.654	0.978	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	1.000	1.000
2006	0.024	0.682	0.979	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	1.000	1.000
2007	0.034	0.772	0.979	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	1.000	1.000
2008	0.013	0.514	0.979	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	1.000	1.000
2009	0.044	0.595	0.979	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	1.000	1.000
2010	0.008	0.354	0.979	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	1.000	1.000
2011	0.005	0.475	0.977	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	1.000	1.000
2012	0.061	0.624	0.979	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	1.000	1.000
2013	0.009	0.342	0.972	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	1.000	1.000
2014	0.008	0.355	0.979	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	1.000	1.000
2015	0.014	0.357	0.979	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	1.000	1.000
2016	0.007	0.440	0.977	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	1.000	1.000
2017	0.012	0.582	0.977	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	1.000	1.000
2018	0.005	0.416	0.979	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	1.000	1.000
2019	0.012	0.899	0.979	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	1.000	1.000

Table 2.35c (page 1 of 2)—Selectivity at age (survey, NBS, Hypothesis 3 sub-ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.010	0.073	0.245	0.373	0.489	0.590	0.675	0.745	0.801	0.845	0.880	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.988
1978	0.009	0.073	0.239	0.373	0.489	0.590	0.675	0.745	0.801	0.845	0.880	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.988
1979	0.011	0.067	0.249	0.367	0.489	0.590	0.675	0.745	0.801	0.845	0.880	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1980	0.009	0.077	0.240	0.376	0.484	0.590	0.675	0.745	0.801	0.845	0.880	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1981	0.007	0.068	0.227	0.368	0.492	0.586	0.675	0.745	0.801	0.845	0.880	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1982	0.007	0.054	0.229	0.355	0.485	0.593	0.672	0.745	0.801	0.845	0.880	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1983	0.012	0.056	0.258	0.357	0.474	0.586	0.677	0.742	0.801	0.845	0.880	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1984	0.010	0.087	0.246	0.385	0.475	0.577	0.672	0.747	0.799	0.845	0.880	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1985	0.006	0.074	0.222	0.374	0.500	0.578	0.664	0.743	0.802	0.843	0.880	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1986	0.010	0.049	0.243	0.351	0.490	0.599	0.666	0.736	0.799	0.846	0.878	0.906	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1987	0.008	0.070	0.235	0.370	0.470	0.591	0.683	0.737	0.794	0.843	0.880	0.905	0.927	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1988	0.008	0.062	0.230	0.363	0.487	0.574	0.676	0.751	0.795	0.839	0.878	0.907	0.926	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1989	0.008	0.058	0.230	0.359	0.480	0.588	0.662	0.746	0.806	0.840	0.875	0.905	0.927	0.942	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1990	0.009	0.058	0.240	0.359	0.477	0.583	0.674	0.734	0.801	0.849	0.876	0.903	0.926	0.943	0.954	0.963	0.970	0.976	0.980	0.983	0.987
1991	0.011	0.068	0.248	0.368	0.477	0.580	0.669	0.744	0.792	0.845	0.883	0.903	0.924	0.942	0.955	0.963	0.970	0.976	0.980	0.983	0.987
1992	0.009	0.077	0.240	0.376	0.485	0.580	0.666	0.740	0.800	0.838	0.880	0.909	0.924	0.940	0.954	0.964	0.970	0.976	0.980	0.983	0.987
1993	0.010	0.068	0.245	0.368	0.492	0.587	0.667	0.738	0.797	0.844	0.874	0.907	0.929	0.941	0.953	0.963	0.971	0.975	0.980	0.983	0.987
1994	0.009	0.073	0.239	0.373	0.485	0.592	0.672	0.738	0.795	0.842	0.879	0.902	0.927	0.944	0.953	0.962	0.970	0.976	0.980	0.983	0.986
1995	0.009	0.067	0.239	0.367	0.489	0.587	0.677	0.743	0.795	0.840	0.877	0.906	0.924	0.943	0.956	0.962	0.969	0.975	0.980	0.983	0.986
1996	0.009	0.066	0.240	0.367	0.484	0.590	0.673	0.747	0.799	0.841	0.876	0.904	0.926	0.940	0.955	0.964	0.970	0.975	0.980	0.983	0.985
1997	0.009	0.068	0.239	0.368	0.484	0.586	0.675	0.743	0.802	0.844	0.876	0.904	0.925	0.942	0.952	0.964	0.971	0.975	0.979	0.983	0.985
1998	0.008	0.067	0.231	0.367	0.484	0.586	0.672	0.745	0.799	0.846	0.878	0.904	0.925	0.941	0.954	0.962	0.970	0.976	0.979	0.982	0.986
1999	0.007	0.059	0.225	0.360	0.484	0.586	0.672	0.742	0.801	0.844	0.880	0.905	0.925	0.941	0.954	0.963	0.969	0.976	0.980	0.982	0.986
2000	0.011	0.053	0.252	0.354	0.477	0.586	0.672	0.742	0.799	0.845	0.878	0.907	0.926	0.941	0.953	0.963	0.970	0.975	0.980	0.983	0.987
2001	0.010	0.080	0.245	0.379	0.472	0.580	0.672	0.742	0.798	0.843	0.880	0.905	0.927	0.942	0.953	0.963	0.970	0.976	0.979	0.983	0.988
2002	0.011	0.074	0.250	0.373	0.495	0.576	0.667	0.742	0.799	0.843	0.878	0.906	0.926	0.943	0.954	0.963	0.970	0.975	0.980	0.982	0.986
2003	0.010	0.079	0.243	0.378	0.489	0.595	0.663	0.738	0.798	0.843	0.878	0.905	0.927	0.942	0.955	0.963	0.970	0.975	0.979	0.983	0.987
2004	0.013	0.071	0.261	0.371	0.493	0.590	0.679	0.735	0.795	0.843	0.878	0.905	0.926	0.943	0.954	0.964	0.970	0.975	0.979	0.983	0.986
2005	0.009	0.090	0.239	0.388	0.487	0.594	0.676	0.748	0.793	0.841	0.878	0.905	0.926	0.942	0.954	0.963	0.971	0.975	0.979	0.983	0.987
2006	0.009	0.066	0.238	0.367	0.502	0.589	0.678	0.745	0.804	0.839	0.876	0.905	0.926	0.942	0.954	0.964	0.970	0.976	0.980	0.983	0.987
2007	0.007	0.065	0.228	0.366	0.483	0.602	0.674	0.748	0.801	0.847	0.875	0.904	0.926	0.942	0.954	0.963	0.970	0.975	0.980	0.983	0.988
2008	0.007	0.056	0.226	0.357	0.483	0.585	0.685	0.744	0.803	0.845	0.881	0.903	0.925	0.942	0.954	0.963	0.970	0.976	0.980	0.983	0.987
2009	0.008	0.053	0.232	0.355	0.475	0.585	0.671	0.753	0.800	0.847	0.880	0.908	0.924	0.941	0.954	0.963	0.970	0.975	0.980	0.983	0.985
2010	0.010	0.060	0.245	0.361	0.473	0.578	0.671	0.742	0.807	0.844	0.881	0.906	0.928	0.940	0.953	0.963	0.970	0.975	0.980	0.983	0.985
2011	0.007	0.073	0.227	0.372	0.478	0.576	0.665	0.741	0.798	0.850	0.879	0.907	0.927	0.943	0.953	0.963	0.970	0.975	0.980	0.983	0.986
2012	0.010	0.055	0.243	0.356	0.488	0.581	0.664	0.737	0.798	0.843	0.883	0.906	0.928	0.943	0.955	0.962	0.970	0.975	0.980	0.983	0.985
2013	0.009	0.071	0.237	0.371	0.474	0.590	0.668	0.736	0.794	0.843	0.878	0.909	0.927	0.943	0.954	0.964	0.969	0.975	0.980	0.983	0.986
2014	0.010	0.065	0.243	0.366	0.487	0.577	0.675	0.739	0.793	0.840	0.878	0.905	0.929	0.942	0.955	0.964	0.971	0.975	0.979	0.983	0.986
2015	0.014	0.071	0.269	0.371	0.483	0.588	0.665	0.745	0.796	0.839	0.876	0.905	0.926	0.944	0.954	0.964	0.970	0.976	0.979	0.983	0.986
2016	0.016	0.098	0.280	0.395	0.487	0.585	0.674	0.736	0.801	0.841	0.875	0.903	0.926	0.942	0.956	0.963	0.971	0.976	0.980	0.982	0.985
2017	0.014	0.109	0.269	0.405	0.509	0.589	0.671	0.744	0.794	0.845	0.877	0.903	0.924	0.942	0.954	0.964	0.970	0.976	0.980	0.983	0.986
2018	0.017	0.098	0.284	0.395	0.517	0.607	0.674	0.741	0.800	0.840	0.879	0.904	0.924	0.941	0.954	0.963	0.971	0.976	0.980	0.983	0.986
2019	0.006	0.113	0.222	0.409	0.509	0.615	0.689	0.744	0.798	0.844	0.875	0.906	0.925	0.940	0.953	0.963	0.970	0.976	0.980	0.983	0.985

Table 2.35c (page 2 of 2)—Selectivity at age (survey, NBS, Hypothesis 3 sub-ensemble unweighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	0.004	0.118	0.487	0.587	0.684	0.773	0.847	0.901	0.930	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.996
1978	0.003	0.118	0.485	0.587	0.684	0.773	0.847	0.901	0.930	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.996
1979	0.004	0.116	0.488	0.585	0.684	0.773	0.847	0.901	0.930	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.996
1980	0.003	0.119	0.485	0.588	0.683	0.773	0.847	0.901	0.930	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
1981	0.003	0.116	0.481	0.585	0.685	0.772	0.847	0.901	0.930	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
1982	0.003	0.111	0.481	0.581	0.683	0.774	0.846	0.901	0.930	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
1983	0.004	0.112	0.492	0.582	0.679	0.772	0.848	0.900	0.930	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
1984	0.004	0.123	0.488	0.591	0.679	0.769	0.846	0.901	0.929	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
1985	0.002	0.118	0.479	0.587	0.688	0.769	0.843	0.900	0.930	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
1986	0.003	0.110	0.486	0.579	0.685	0.776	0.844	0.897	0.929	0.946	0.957	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
1987	0.003	0.117	0.484	0.586	0.677	0.773	0.850	0.898	0.927	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
1988	0.003	0.114	0.482	0.584	0.683	0.767	0.847	0.903	0.928	0.943	0.957	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
1989	0.003	0.113	0.482	0.582	0.681	0.773	0.842	0.901	0.932	0.944	0.956	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.996
1990	0.003	0.113	0.486	0.582	0.680	0.771	0.847	0.897	0.930	0.947	0.956	0.966	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.996
1991	0.004	0.116	0.488	0.585	0.680	0.769	0.845	0.900	0.927	0.946	0.959	0.966	0.973	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.996
1992	0.003	0.119	0.486	0.588	0.683	0.769	0.844	0.899	0.930	0.943	0.958	0.968	0.973	0.979	0.984	0.987	0.989	0.991	0.993	0.994	0.995
1993	0.004	0.116	0.487	0.585	0.685	0.772	0.844	0.898	0.928	0.945	0.956	0.967	0.975	0.979	0.983	0.987	0.990	0.991	0.993	0.994	0.995
1994	0.003	0.118	0.485	0.587	0.683	0.774	0.846	0.898	0.928	0.944	0.957	0.965	0.974	0.980	0.983	0.987	0.989	0.991	0.993	0.994	0.995
1995	0.003	0.116	0.485	0.585	0.684	0.772	0.848	0.900	0.928	0.944	0.957	0.967	0.973	0.980	0.984	0.987	0.989	0.991	0.993	0.994	0.995
1996	0.003	0.116	0.485	0.585	0.683	0.773	0.846	0.901	0.929	0.944	0.956	0.966	0.974	0.979	0.984	0.987	0.989	0.991	0.993	0.994	0.995
1997	0.003	0.116	0.485	0.585	0.682	0.772	0.847	0.900	0.930	0.945	0.956	0.966	0.974	0.980	0.983	0.987	0.990	0.991	0.993	0.994	0.995
1998	0.003	0.116	0.482	0.585	0.683	0.772	0.846	0.901	0.929	0.946	0.957	0.966	0.973	0.979	0.984	0.987	0.990	0.992	0.993	0.994	0.995
1999	0.003	0.113	0.480	0.582	0.682	0.772	0.846	0.900	0.930	0.945	0.958	0.967	0.973	0.979	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2000	0.004	0.111	0.490	0.580	0.680	0.772	0.846	0.900	0.929	0.945	0.957	0.967	0.974	0.979	0.984	0.987	0.990	0.991	0.993	0.994	0.995
2001	0.004	0.121	0.487	0.589	0.678	0.770	0.846	0.900	0.929	0.945	0.958	0.967	0.974	0.980	0.984	0.987	0.989	0.991	0.993	0.994	0.996
2002	0.004	0.118	0.489	0.587	0.686	0.768	0.844	0.900	0.929	0.945	0.957	0.967	0.974	0.980	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2003	0.004	0.120	0.486	0.589	0.684	0.775	0.843	0.898	0.929	0.945	0.957	0.967	0.974	0.980	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2004	0.005	0.117	0.493	0.586	0.686	0.773	0.849	0.897	0.928	0.945	0.957	0.967	0.974	0.980	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2005	0.003	0.124	0.485	0.592	0.684	0.775	0.847	0.902	0.927	0.944	0.957	0.967	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
2006	0.003	0.116	0.485	0.585	0.689	0.773	0.848	0.901	0.931	0.943	0.956	0.967	0.974	0.980	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2007	0.003	0.115	0.481	0.585	0.682	0.777	0.847	0.902	0.930	0.946	0.956	0.966	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.996
2008	0.003	0.112	0.480	0.581	0.682	0.772	0.851	0.900	0.931	0.945	0.958	0.966	0.974	0.980	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2009	0.003	0.111	0.483	0.581	0.679	0.771	0.846	0.903	0.930	0.946	0.958	0.967	0.973	0.979	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2010	0.004	0.113	0.487	0.583	0.679	0.769	0.846	0.900	0.932	0.945	0.958	0.967	0.975	0.979	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2011	0.003	0.118	0.481	0.587	0.681	0.768	0.844	0.899	0.929	0.947	0.957	0.967	0.974	0.980	0.983	0.987	0.989	0.991	0.993	0.994	0.995
2012	0.003	0.112	0.486	0.581	0.684	0.770	0.843	0.898	0.929	0.945	0.959	0.967	0.975	0.980	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2013	0.003	0.117	0.485	0.586	0.679	0.773	0.845	0.897	0.928	0.945	0.957	0.968	0.974	0.980	0.984	0.987	0.989	0.991	0.993	0.994	0.995
2014	0.003	0.115	0.486	0.585	0.684	0.769	0.847	0.898	0.927	0.944	0.957	0.967	0.975	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
2015	0.005	0.117	0.496	0.586	0.682	0.773	0.843	0.901	0.928	0.943	0.956	0.967	0.974	0.980	0.984	0.987	0.990	0.992	0.993	0.994	0.995
2016	0.006	0.127	0.499	0.595	0.684	0.771	0.847	0.898	0.930	0.944	0.956	0.966	0.974	0.980	0.984	0.987	0.990	0.991	0.993	0.994	0.995
2017	0.005	0.131	0.496	0.598	0.691	0.773	0.846	0.900	0.927	0.945	0.957	0.966	0.973	0.979	0.984	0.987	0.990	0.991	0.993	0.994	0.995
2018	0.006	0.127	0.501	0.595	0.694	0.779	0.847	0.899	0.930	0.943	0.958	0.966	0.973	0.979	0.984	0.987	0.990	0.991	0.993	0.994	0.995
2019	0.002	0.132	0.479	0.600	0.691	0.782	0.852	0.900	0.929	0.945	0.956	0.967	0.974	0.979	0.983	0.987	0.989	0.992	0.993	0.994	0.995

Table 2.36—Biomass time series comparison (last year's assessment and this year's assessment).

	Last year's assessment			Ensemble (wtd)			Ensemble (unw)		
Year	Age 0+	Spawn.	SB SD	Age 0+	Spawn.	SB SD	Age 0+	Spawn.	SB SD
1977	186,620	56,343	19,684	284,580	85,836	25,606	250,157	74,561	28,673
1978	202,963	54,375	19,392	314,555	87,622	25,631	276,211	74,821	29,303
1979	290,308	54,020	18,331	430,298	88,237	24,454	387,150	74,691	28,425
1980	451,229	71,221	18,399	615,400	108,942	25,256	571,677	94,357	30,308
1981	665,330	115,332	19,672	836,697	162,030	28,640	803,495	146,971	37,995
1982	906,021	200,351	24,308	1,079,735	256,201	36,672	1,056,481	243,054	52,065
1983	1,034,070	290,059	28,413	1,188,604	346,140	42,346	1,176,069	337,162	60,162
1984	1,010,460	312,996	26,220	1,152,284	353,297	37,325	1,137,852	348,564	50,683
1985	1,092,330	358,279	27,867	1,245,974	399,396	38,401	1,227,216	393,502	49,608
1986	1,095,860	349,352	25,477	1,246,509	393,602	35,042	1,228,940	384,977	44,788
1987	1,127,740	343,533	22,696	1,269,507	386,620	31,376	1,254,490	377,830	40,415
1988	1,160,170	366,902	21,984	1,301,150	413,054	30,881	1,285,533	404,603	40,310
1989	1,066,060	356,688	19,986	1,192,318	403,119	28,550	1,175,017	394,805	38,450
1990	913,659	326,482	16,708	1,017,617	364,109	23,702	996,998	356,696	31,233
1991	756,962	262,913	12,922	850,536	292,624	18,061	821,644	283,523	22,489
1992	649,704	186,394	10,541	733,792	213,470	15,408	703,174	201,081	18,546
1993	747,847	173,578	10,691	824,284	202,459	16,255	800,348	187,132	20,653
1994	777,724	182,470	9,931	832,853	205,785	14,412	827,649	194,133	19,765
1995	827,716	202,656	10,312	877,450	218,191	14,245	886,261	212,057	19,543
1996	827,777	201,202	10,593	872,267	213,305	15,819	893,785	213,042	22,233
1997	715,100	193,372	10,156	755,610	205,924	17,647	777,042	210,464	25,125
1998	618,216	169,279	9,933	661,853	180,738	17,371	679,825	186,357	24,077
1999	644,510	163,841	10,220	699,513	174,436	17,257	710,867	179,727	23,169
2000	699,653	169,954	10,756	766,390	184,198	18,165	770,820	187,783	24,914
2001	714,392	177,481	10,572	792,396	194,777	17,619	787,788	195,863	24,908
2002	747,995	191,153	10,617	831,592	210,873	16,490	822,396	208,751	23,392
2003	749,296	191,754	10,348	825,677	216,894	15,752	819,466	211,257	23,282
2004	730,652	195,989	9,876	800,363	221,829	15,349	796,062	216,374	23,460
2005	664,952	195,047	9,333	733,730	217,739	14,446	727,635	214,087	21,481
2006	575,974	172,594	8,363	643,765	192,737	12,691	635,402	189,228	18,223
2007	508,416	146,162	7,616	574,184	168,149	11,788	566,490	163,216	17,265
2008	499,841	124,906	6,862	548,609	145,346	10,606	550,043	140,427	15,624
2009	565,723	115,291	6,985	595,645	132,598	10,318	605,412	129,109	14,963
2010	678,212	122,822	7,690	693,832	133,423	11,520	705,427	133,793	16,310
2011	818,946	162,726	9,371	818,328	163,545	14,750	829,953	167,282	19,351
2012	885,599	192,460	11,449	873,696	190,467	17,145	883,439	192,147	22,754
2013	916,688	217,833	13,472	901,980	212,793	19,442	903,497	212,716	25,670
2014	954,799	225,546	15,110	924,413	215,518	20,975	919,622	213,613	26,859
2015	997,176	230,986	16,742	987,567	220,654	24,493	947,986	215,925	31,289
2016	1,071,670	265,757	19,667	1,084,972	251,685	29,579	1,003,829	241,100	37,404
2017	1,045,740	290,364	22,721	1,074,857	286,544	33,623	961,670	259,318	43,506
2018	965,220	303,676	25,143	995,712	307,608	37,784	855,700	263,562	49,371
2019	823,559	290,205	25,792	877,284	299,528	40,008	729,546	245,130	52,276
2020				751,708	259,509	39,282	636,942	201,271	51,605

Table 2.37—Recruitment time series comparison (last year's assessment and this year's assessment).

	Last year's values		Ensemble (wtd)		Ensemble (unw)	
Year	Recruits	Std. dev.	Recruits	Std. dev.	Recruits	Std. dev.
1977	825,468	203,175	1,018,077	313,203	1,053,068	410,050
1978	553,645	146,769	722,939	227,739	775,100	306,981
1979	559,855	99,066	718,495	148,717	728,043	210,824
1980	267,150	45,239	202,645	107,945	299,951	142,992
1981	148,585	26,326	202,041	46,128	199,634	60,398
1982	772,190	88,432	981,447	181,041	1,018,362	284,664
1983	201,748	32,837	242,814	56,464	255,092	78,022
1984	779,242	85,869	891,768	182,077	978,051	277,022
1985	286,881	38,806	399,324	72,740	397,653	121,267
1986	189,896	28,223	233,070	48,992	246,317	75,617
1987	106,532	21,604	82,405	26,272	102,853	32,235
1988	252,215	34,235	308,537	47,470	290,940	68,804
1989	608,156	65,443	640,547	121,915	697,001	180,287
1990	517,445	55,750	603,814	104,053	636,887	160,863
1991	332,437	38,600	350,357	88,905	410,829	126,582
1992	769,721	73,524	914,145	174,381	999,365	271,714
1993	317,834	33,722	368,989	74,178	404,982	114,433
1994	260,675	28,355	301,451	53,800	318,541	83,798
1995	240,271	26,926	270,425	48,681	287,563	70,566
1996	656,826	65,485	838,270	127,030	830,722	208,910
1997	299,540	32,544	374,838	62,184	386,606	96,291
1998	293,149	30,842	305,239	66,037	346,279	95,122
1999	600,535	56,944	682,380	111,000	719,930	173,784
2000	457,627	44,040	508,748	94,732	568,221	141,251
2001	206,697	21,754	216,146	49,076	248,367	71,584
2002	276,764	27,628	340,273	53,587	351,928	86,163
2003	234,954	23,554	311,571	45,278	308,800	75,846
2004	199,734	20,871	240,136	40,463	253,711	62,629
2005	264,694	26,978	296,383	54,615	319,378	79,613
2006	815,063	77,717	875,028	147,524	917,070	222,923
2007	357,509	37,854	344,809	72,219	378,768	98,760
2008	1,108,580	107,114	1,183,524	214,096	1,250,063	313,373
2009	146,002	20,834	168,179	39,699	196,641	71,088
2010	671,321	68,503	766,939	141,249	782,758	198,384
2011	995,183	104,072	983,536	196,490	1,024,034	268,054
2012	443,680	50,392	440,583	106,168	468,573	136,998
2013	982,145	105,381	1,183,565	223,545	1,104,817	300,536
2014	175,220	23,225	211,002	45,785	199,267	61,683
2015	244,408	29,663	290,786	65,909	286,075	91,609
2016	157,246	23,261	153,045	32,163	140,935	44,924
2017	76,186	22,424	116,880	49,576	142,621	53,366
2018			784,138	357,445	1,039,008	445,159
Average	430,561		501,650		532,495	

Table 2.38a—Numbers at age (ensemble weighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	1018077	246467	69518	63805	28392	13902	8587	5732	3930	2709	1853	1251	831	544	352	225	143	91	57	36	60
1978	722939	713766	172895	48690	44004	18695	8587	5074	3339	2288	1579	1082	731	486	319	206	132	84	53	34	56
1979	718495	506663	500599	121054	33424	28608	11207	4884	2835	1863	1278	884	606	410	273	179	116	74	47	30	51
1980	202645	504185	355228	350432	83605	22128	17922	6735	2904	1684	1108	761	527	362	245	163	107	69	44	28	48
1981	202041	141341	353914	248672	241497	55342	13760	10742	3972	1713	994	654	450	312	214	145	97	63	41	26	46
1982	981447	141797	98639	248101	171867	161270	35430	8557	6637	2450	1058	614	404	278	193	133	90	60	39	26	45
1983	242814	688269	99552	68838	173033	117055	106242	22863	5476	4246	1566	677	393	259	178	123	85	58	38	25	45
1984	891768	170307	482859	69800	47691	117527	76297	67358	14372	3436	2665	983	425	247	163	112	78	53	36	24	44
1985	399324	625018	119487	337983	48024	31702	74609	46525	40542	8638	2065	1603	591	256	149	98	67	47	32	22	41
1986	233070	280171	438238	83789	233761	31844	19868	45284	27690	24070	5130	1228	954	352	152	88	58	40	28	19	38
1987	82405	163404	196642	306727	58019	155044	19963	11965	27194	16580	14427	3080	738	575	212	92	53	35	24	17	34
1988	308537	57726	114606	137873	211897	38711	96487	11876	6994	15930	9705	8454	1807	433	338	124	54	31	21	14	30
1989	640547	216701	40448	79959	93692	135770	23304	55131	6705	3934	9014	5496	4794	1026	246	192	71	31	18	12	25
1990	603814	449044	152246	28283	54950	61332	82819	13676	31691	3847	2251	5176	3157	2755	590	142	111	41	18	10	21
1991	350357	423485	314921	106755	19489	36050	37308	47475	7705	17703	2145	1254	2887	1761	1537	329	79	62	23	10	18
1992	914145	245355	297114	220053	72608	12210	19915	18757	22893	3695	8463	1027	598	1383	843	737	158	38	30	11	13
1993	368989	640740	171891	207824	148827	44864	6527	9678	8774	10613	1717	3944	480	277	648	395	345	74	18	14	11
1994	301451	258625	449208	119645	140263	92774	25572	3479	5095	4618	5577	906	2083	254	145	343	209	183	39	9	13
1995	270425	211407	181329	313598	80567	86381	49880	12768	1679	2455	2229	2694	439	1010	123	70	167	101	89	19	11
1996	838270	189658	148297	126317	208894	47481	43523	22448	5590	730	1071	976	1182	193	444	54	31	73	45	39	13
1997	374838	588240	133062	103699	85479	127369	24488	20198	9904	2438	317	465	424	514	84	193	24	13	32	19	23
1998	305239	262965	412872	92668	68679	49968	62493	10588	8395	4076	1000	130	191	175	212	35	80	10	6	13	17
1999	682380	213890	184546	289088	62894	42396	26811	30215	4904	3852	1868	458	60	88	80	97	16	37	4	3	14
2000	508748	478597	149940	129210	196701	38946	22899	13131	14255	2297	1803	875	215	28	41	38	46	7	17	2	8
2001	216146	356641	335798	104765	88415	123577	21317	11369	6278	6767	1089	856	416	102	13	20	18	22	4	8	5
2002	340273	151425	250100	234877	71149	56407	70432	11158	5784	3186	3441	555	437	213	52	7	10	9	11	2	7
2003	311571	238721	106119	174405	158352	43737	31341	35949	5546	2889	1603	1741	282	223	108	27	3	5	5	6	4
2004	240136	218690	167518	74026	117356	97589	23645	15877	17626	2706	1413	785	854	138	110	53	13	2	3	2	5
2005	296383	168460	153534	116652	49812	71688	52735	11694	7710	8511	1307	684	381	415	67	53	26	6	1	1	4
2006	875028	207803	118199	107303	77909	30511	38238	25850	5544	3648	4025	619	325	181	197	32	25	12	3	0	2
2007	344809	613589	145750	82657	72605	46900	16077	18128	11833	2510	1648	1818	280	147	82	89	14	11	6	1	1
2008	1183524	241655	430419	101976	56107	44914	24796	7794	8464	5487	1160	763	842	130	68	38	41	7	5	3	1
2009	168179	829716	169427	301200	69169	33976	23021	11083	3372	3648	2373	503	332	367	57	30	17	18	3	2	2
2010	766939	117892	581904	118552	204772	41625	16525	9638	4363	1332	1454	954	203	135	149	23	12	7	7	1	2
2011	983536	537719	82674	407192	80802	125995	21320	7314	4050	1827	561	617	407	87	58	64	10	5	3	3	1
2012	440583	689407	377151	57878	274428	48351	61565	8780	2786	1517	685	211	233	154	33	22	24	4	2	1	2
2013	1183565	308645	483430	263403	39104	161589	23817	26472	3550	1112	606	275	85	94	62	13	9	10	2	1	1
2014	211002	830112	216302	337774	176729	23676	80762	10625	11315	1516	479	263	120	37	41	27	6	4	4	1	1
2015	290786	147952	582435	151245	229341	106076	11965	34662	4364	4636	627	200	110	51	16	17	11	2	2	2	1
2016	153045	203781	103782	407341	103025	141130	54005	5365	14517	1816	1932	262	84	46	21	7	7	5	1	1	1
2017	116880	107364	142865	72552	275474	63850	74825	25015	2366	6304	787	838	114	36	20	9	3	3	2	0	1
2018	784138	81706	75344	99952	49260	171282	35344	37531	11954	1118	2971	371	395	54	17	9	4	1	2	1	1
2019	515411	547297	57144	52580	67994	31006	98086	19108	19795	6266	585	1558	195	207	28	9	5	2	1	1	1

Table 2.38b—Numbers at age (ensemble unweighted average).

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
1977	1053068	234145	64242	53978	26741	12636	7697	5007	3334	2219	1458	942	598	375	232	143	88	53	33	20	31
1978	775100	725291	161336	44251	36772	17171	7303	4234	2762	1849	1232	810	524	334	209	130	80	49	30	18	28
1979	728043	533463	500024	111113	30014	23227	9449	3800	2210	1451	972	649	427	277	177	111	69	43	26	16	25
1980	299951	502283	367520	344581	75735	19332	13583	5253	2129	1244	817	548	366	242	157	100	63	39	24	15	24
1981	199634	205968	346861	253127	234576	48521	11093	7499	2892	1184	692	455	305	204	135	88	56	35	22	14	22
1982	1018362	137739	141593	239538	172883	153488	29380	6519	4444	1714	704	411	270	182	122	81	52	34	21	13	21
1983	255092	701895	95128	97415	164849	115805	98172	18403	4089	2796	1077	442	258	170	114	77	51	33	21	13	22
1984	978051	175848	484265	65703	66738	110257	73281	60607	11367	2531	1733	666	274	160	105	71	47	31	20	13	22
1985	397653	673902	121340	334010	44892	43821	67645	43295	35842	6740	1501	1030	396	163	95	62	42	28	19	12	21
1986	246317	273986	464814	83757	228517	29392	26291	39547	25220	20941	3939	879	604	232	95	56	37	25	17	11	19
1987	102853	169642	188963	320566	57338	149523	17752	15151	23125	14762	12269	2310	517	356	136	56	33	22	14	10	18
1988	290940	71021	116954	130333	219168	37537	89462	10198	8664	13341	8505	7075	1333	298	206	79	32	19	12	8	16
1989	697001	201081	49091	80508	88324	139775	21542	48768	5587	4735	7352	4685	3901	736	165	114	44	18	11	7	14
1990	636887	480609	139107	33929	54872	57146	82038	12147	27476	3160	2669	4160	2649	2207	417	94	65	25	10	6	12
1991	410829	439277	331738	96195	23219	35387	33200	45123	6700	15166	1743	1470	2296	1461	1218	230	52	36	14	6	10
1992	999365	282940	303275	228684	65076	14216	17974	15458	20882	3124	7062	812	681	1071	681	568	107	24	17	6	7
1993	404982	688692	195059	209115	153891	39019	6714	7779	6728	9089	1365	3092	357	293	471	300	250	47	11	8	6
1994	318541	279022	475050	134196	140988	94277	20381	3211	3800	3321	4452	673	1525	177	142	234	148	124	24	5	7
1995	287563	219630	192424	327178	90332	85440	46808	9427	1470	1764	1545	2064	313	710	82	65	109	69	58	11	6
1996	830722	198407	151573	132361	218688	52789	39335	19264	3936	613	743	653	869	132	300	35	27	46	29	25	7
1997	386606	573158	137028	104477	89089	130797	25059	16984	8267	1696	263	320	281	374	57	129	15	12	20	13	14
1998	346279	266704	395805	94366	69722	52161	60275	10272	6994	3420	699	109	132	116	155	24	54	6	5	8	11
1999	719930	238672	184168	273105	63810	42604	26428	27890	4736	3234	1581	322	50	61	54	72	11	25	3	2	9
2000	568221	496649	164671	127073	184660	38945	21502	12176	12851	2194	1498	733	149	23	28	25	33	5	12	1	5
2001	248367	391900	342954	113494	86146	113540	19810	10009	5660	6007	1025	701	343	70	11	13	12	16	2	5	3
2002	351928	171092	270564	236602	76872	54022	61236	9887	4995	2840	3017	515	353	173	35	5	7	6	8	1	4
2003	308800	242778	117975	186445	159561	46975	27952	29277	4723	2413	1377	1467	250	173	84	17	3	3	3	4	3
2004	253711	213109	167637	81218	125601	96949	23458	13011	13664	2212	1133	647	690	117	81	40	8	1	2	1	3
2005	319378	175029	147205	115421	54679	76329	49060	10863	6100	6445	1042	535	306	326	55	39	19	4	1	1	2
2006	917070	220278	120858	101506	77500	33253	38336	22733	5030	2849	3012	487	250	143	153	26	18	9	2	0	1
2007	378768	632653	152078	83345	68391	46336	16147	16853	10050	2231	1266	1339	216	111	64	68	12	8	4	1	1
2008	1250063	261237	436878	104901	56259	41446	22737	7226	7554	4541	1006	573	607	98	51	29	31	5	4	2	1
2009	196641	862189	180356	301360	70632	33192	19261	9319	2977	3138	1896	420	241	256	41	21	12	13	2	2	1
2010	782758	135385	595247	124374	202507	40654	14203	7239	3470	1126	1191	727	161	93	100	16	8	5	5	1	1
2011	1024034	539995	93300	410541	83913	120304	18814	5827	2968	1436	468	497	305	68	39	42	7	4	2	2	1
2012	468573	706278	372888	64236	275373	48819	53263	7224	2207	1128	547	179	190	117	26	15	16	3	1	1	1
2013	1104817	322965	487609	257013	43031	159213	21629	20886	2811	865	443	215	71	75	46	10	6	6	1	1	1
2014	199267	762267	222829	336147	172468	25478	74063	9038	8731	1187	367	189	92	30	32	20	4	3	3	0	1
2015	286075	137329	526443	153571	226146	100623	11412	29047	3552	3475	475	148	77	37	12	13	8	2	1	1	0
2016	140935	197091	94735	363044	103514	134355	46573	4664	11820	1457	1425	196	61	32	15	5	5	3	1	0	1
2017	142621	97106	135920	65229	244234	62157	64566	19969	1981	5059	623	609	84	26	13	7	2	2	1	0	0
2018	1039008	98305	66972	93635	43861	147772	30877	29166	8970	890	2283	281	275	38	12	6	3	1	1	1	0
2019	545039	714203	67831	46082	63208	27026	78106	15214	14403	4452	440	1135	140	137	19	6	3	1	0	1	0

Table 2.39—Some statistics of the ABC and OFL distributions for 2020 and 2021.

			Hypothesis 1			Hypothesis 2			Hypothesis 3			Ensemble	
Year	Quantity	Statistic	M19.7	M19.8	M19.9	M19.10	M19.11	M19.12	M19.13	M19.14	M19.15	Wtd	Unw
2020	ABC	mean	58057	108529	67127	125009	201257	160789	54138	99642	70089	155873	104960
2020	ABC	sdev	12707	24817	18197	21423	21727	19533	10567	22815	18896	36014	51287
2020	OFL	mean	69846	130680	80820	149039	239837	191386	64987	119390	84245	185650	125581
2020	OFL	sdev	15200	29683	21759	25272	26132	23263	12625	27153	22551	42739	60867
2021	ABC	mean	53705	76738	56445	94551	127409	105046	52651	78630	58585	102975	78196
2021	ABC	sdev	7462	9565	13527	9117	25205	18420	6863	10293	10665	24157	28240
2021	OFL	mean	64631	92873	68065	113057	152858	125734	63192	94509	70566	123331	93943
2021	OFL	sdev	13300	22093	22898	19642	30036	29939	11549	21822	19146	34349	36847
2019	Bratio	mean	0.3142	0.4030	0.3168	0.4050	0.5289	0.4543	0.2887	0.3765	0.3302	0.4493	0.3797
2019	Bratio	sdev	0.0310	0.0373	0.0371	0.0371	0.0422	0.0464	0.0276	0.0368	0.0366	0.0639	0.0820

			Ensemble	
Year	Quantity	Statistic	Wtd	Unw
2020	ABC	median	160089	92537
2020	OFL	median	190547	111117
2021	ABC	median	103721	72996
2021	OFL	median	124182	87024

Table 2.40a—Standard harvest scenario 1.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Quantity	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
B2020	244.8	22.4	153.0	14.2	187.6	18.7	159.8	19.6	243.4	17.1	286.6	21.8	267.3	26.0	162.9	12.4	186.0	18.2	164.7	20.1	259.5	39.3	201.3	51.6
B2021	220.9	12.5	154.2	8.8	161.7	8.1	147.9	12.3	220.0	9.3	221.7	12.2	216.3	17.6	168.1	8.5	169.6	8.6	151.5	12.5	211.3	24.9	179.0	31.4
B2022	227.6	11.3	179.0	8.2	191.1	9.1	149.8	9.6	231.0	8.8	233.1	9.8	198.6	11.9	191.1	8.0	195.6	8.2	156.4	9.8	199.8	21.3	191.7	28.4
B2023	264.6	14.3	229.5	11.5	252.2	13.1	174.3	9.6	274.3	12.1	286.3	12.7	213.0	11.0	238.6	10.8	250.1	10.9	184.4	9.9	220.7	29.5	233.6	37.4
B2024	290.9	15.5	263.4	12.6	270.6	12.2	207.3	9.2	301.0	13.9	301.8	12.5	237.4	10.2	277.4	13.0	268.0	10.6	217.0	9.2	244.9	26.5	260.4	33.8
B2025	296.9	16.0	270.6	12.9	261.5	8.9	232.1	7.9	305.6	14.8	287.8	9.6	254.7	8.9	290.2	14.5	262.9	8.7	238.3	7.7	258.8	17.7	267.1	25.3
B2026	293.8	15.8	267.7	12.7	253.8	6.8	244.6	7.3	299.7	14.9	274.8	7.8	262.8	8.1	291.2	15.3	256.9	7.3	247.6	6.9	264.2	12.6	266.6	20.6
B2027	288.6	15.6	262.7	12.6	248.4	5.9	249.1	7.4	292.1	14.9	266.7	6.9	265.5	8.0	288.4	15.7	252.2	6.7	250.2	6.8	265.4	10.8	263.9	18.6
B2028	284.2	15.4	258.6	12.6	244.9	5.4	250.0	7.5	286.0	14.9	261.4	6.3	265.9	8.1	285.3	15.9	248.8	6.4	250.4	6.9	264.9	10.3	261.3	17.6
B2029	281.1	15.3	255.9	12.6	242.9	5.2	249.8	7.5	281.8	14.8	258.3	5.9	265.7	8.1	282.8	15.9	246.8	6.1	250.0	6.9	264.2	10.2	259.3	17.0
B2030	279.1	15.2	254.2	12.6	241.8	5.0	249.5	7.5	279.2	14.7	256.5	5.6	265.4	8.1	281.1	15.9	245.6	5.9	249.6	6.9	263.7	10.1	258.1	16.7
B2031	277.9	15.2	253.2	12.5	241.3	4.8	249.2	7.5	277.6	14.7	255.6	5.4	265.2	8.1	280.0	15.9	244.9	5.8	249.4	6.9	263.3	10.1	257.4	16.4
F2020	0.259	0.040	0.185	0.029	0.353	0.060	0.223	0.040	0.260	0.035	0.432	0.029	0.339	0.019	0.157	0.023	0.304	0.053	0.229	0.040	0.337	0.053	0.276	0.092
F2021	0.232	0.025	0.187	0.021	0.301	0.034	0.205	0.026	0.234	0.021	0.371	0.040	0.273	0.034	0.163	0.018	0.275	0.033	0.209	0.026	0.276	0.051	0.246	0.068
F2022	0.240	0.021	0.219	0.020	0.360	0.039	0.208	0.020	0.246	0.019	0.391	0.036	0.249	0.022	0.187	0.017	0.321	0.034	0.216	0.021	0.261	0.052	0.266	0.074
F2023	0.281	0.024	0.286	0.025	0.462	0.036	0.245	0.020	0.295	0.023	0.432	0.029	0.268	0.020	0.237	0.020	0.408	0.031	0.258	0.022	0.286	0.057	0.321	0.086
F2024	0.296	0.015	0.317	0.014	0.462	0.036	0.295	0.021	0.298	0.013	0.432	0.029	0.301	0.020	0.278	0.020	0.408	0.031	0.307	0.023	0.315	0.047	0.344	0.070
F2025	0.296	0.015	0.317	0.014	0.462	0.036	0.332	0.020	0.298	0.013	0.432	0.029	0.324	0.020	0.280	0.012	0.408	0.031	0.339	0.021	0.336	0.040	0.355	0.064
F2026	0.296	0.015	0.317	0.014	0.462	0.036	0.351	0.019	0.298	0.013	0.432	0.029	0.335	0.019	0.280	0.012	0.408	0.031	0.353	0.020	0.346	0.038	0.360	0.063
F2027	0.296	0.015	0.317	0.014	0.462	0.036	0.358	0.018	0.298	0.013	0.432	0.029	0.339	0.018	0.280	0.012	0.408	0.031	0.357	0.019	0.349	0.037	0.361	0.062
F2028	0.296	0.015	0.317	0.014	0.462	0.036	0.359	0.018	0.298	0.013	0.432	0.029	0.339	0.018	0.280	0.012	0.408	0.031	0.357	0.019	0.349	0.037	0.361	0.062
F2029	0.296	0.015	0.317	0.014	0.462	0.036	0.359	0.018	0.298	0.013	0.432	0.029	0.339	0.018	0.280	0.012	0.408	0.031	0.357	0.018	0.349	0.037	0.361	0.062
F2030	0.296	0.015	0.317	0.014	0.462	0.035	0.359	0.018	0.298	0.013	0.432	0.029	0.339	0.018	0.280	0.012	0.408	0.031	0.356	0.019	0.349	0.037	0.361	0.062
F2031	0.296	0.015	0.317	0.014	0.461	0.036	0.358	0.018	0.298	0.013	0.431	0.028	0.338	0.018	0.280	0.012	0.407	0.030	0.356	0.019	0.348	0.037	0.361	0.062
C2020	125.4	26.5	58.1	12.7	108.5	24.8	67.1	18.2	125.0	21.4	201.3	21.7	160.8	19.5	54.1	10.6	99.6	22.8	70.1	18.9	155.9	36.0	105.0	51.3
C2021	95.3	11.8	53.7	7.5	76.7	9.6	56.4	13.5	94.6	9.1	126.7	16.0	105.0	18.4	52.7	6.9	78.6	10.3	58.6	10.7	102.9	23.3	78.1	27.4
C2022	106.5	10.6	78.0	8.7	107.6	13.1	60.3	11.3	111.3	8.9	143.1	14.8	92.5	12.5	72.3	7.4	107.2	12.1	65.7	10.3	96.3	22.2	93.1	27.6
C2023	168.2	18.7	153.7	17.9	212.9	19.4	86.1	12.7	185.9	17.4	228.9	18.2	112.3	12.1	132.4	13.6	198.2	15.6	96.2	12.4	126.3	41.2	156.3	52.1
C2024	186.3	10.1	182.7	9.7	231.4	16.7	123.3	13.4	195.3	9.2	244.9	15.6	141.7	11.9	170.5	12.7	210.6	13.3	133.8	13.0	154.1	35.8	181.6	42.8
C2025	182.7	8.6	179.0	8.2	209.6	11.4	152.3	11.6	189.2	8.1	221.0	10.5	161.8	9.7	171.9	7.2	195.5	9.5	158.5	10.5	168.8	21.4	182.1	24.3
C2026	178.4	7.8	174.5	7.5	201.4	9.6	166.7	10.0	183.0	7.5	206.7	8.7	170.5	7.9	169.7	7.1	188.9	7.9	168.6	8.3	174.7	14.0	181.1	16.4
C2027	175.1	7.5	171.1	7.3	197.6	9.0	171.3	9.1	178.2	7.4	201.5	8.2	172.9	7.2	167.5	7.1	185.8	7.3	170.9	7.3	176.1	11.6	179.6	14.1
C2028	172.7	7.4	168.8	7.2	195.4	8.8	171.5	8.8	175.0	7.4	198.4	8.0	173.0	6.9	165.7	7.1	183.8	7.1	170.6	7.0	175.7	10.7	178.0	13.5
C2029	171.2	7.4	167.3	7.3	194.2	8.8	171.2	8.7	173.0	7.4	196.7	8.1	172.6	6.9	164.5	7.2	182.7	7.0	170.0	7.0	175.0	10.4	176.9	13.4
C2030	170.2	7.4	166.5	7.3	193.4	8.7	170.9	8.7	171.7	7.5	195.7	8.1	172.2	6.9	163.7	7.2	182.1	7.0	169.5	7.0	174.6	10.3	176.2	13.3
C2031	169.7	7.4	165.9	7.3	192.8	8.9	170.6	8.8	171.0	7.5	195.0	8.0	172.0	6.9	163.2	7.2	181.4	6.9	169.2	7.1	174.3	10.2	175.7	13.2

Table 2.40b—Standard harvest scenario 2. Shaded cells are those that differ from scenario 1.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Quantity	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
B2020	244.8	22.4	153.0	14.2	187.6	18.7	159.8	19.6	243.4	17.1	286.6	21.8	267.3	26.0	162.9	12.4	186.0	18.2	164.7	20.1	259.5	39.3	201.3	51.6
B2021	220.9	12.5	154.2	8.8	161.7	8.1	147.9	12.3	220.0	9.3	222.3	19.3	216.3	17.6	168.1	8.5	169.6	8.6	151.5	12.5	211.4	25.4	179.1	31.9
B2022	227.6	11.3	179.0	8.2	191.1	9.1	149.8	9.6	231.0	8.8	233.4	11.8	198.6	11.9	191.1	8.0	195.6	8.2	156.4	9.8	199.9	21.5	191.8	28.5
B2023	264.6	14.3	229.5	11.5	252.2	13.1	174.3	9.6	274.3	12.1	286.3	13.1	213.0	11.0	238.6	10.8	250.1	10.9	184.4	9.9	220.7	29.5	233.6	37.5
B2024	290.9	15.5	263.4	12.6	270.6	12.2	207.3	9.2	301.0	13.9	301.9	12.5	237.4	10.2	277.4	13.0	268.0	10.6	217.0	9.2	244.9	26.6	260.4	33.8
B2025	296.9	16.0	270.6	12.9	261.5	8.9	232.1	7.9	305.6	14.8	287.8	9.6	254.7	8.9	290.2	14.5	262.9	8.7	238.3	7.7	258.8	17.7	267.1	25.3
B2026	293.8	15.8	267.7	12.7	253.8	6.8	244.6	7.3	299.7	14.9	274.8	7.8	262.8	8.1	291.2	15.3	256.9	7.3	247.6	6.9	264.2	12.6	266.6	20.6
B2027	288.6	15.6	262.7	12.6	248.4	5.9	249.1	7.4	292.1	14.9	266.7	6.9	265.5	8.0	288.4	15.7	252.2	6.7	250.2	6.8	265.4	10.8	263.9	18.6
B2028	284.2	15.4	258.6	12.6	244.9	5.4	250.0	7.5	286.0	14.9	261.4	6.2	265.9	8.1	285.3	15.9	248.8	6.4	250.4	6.9	264.9	10.3	261.3	17.6
B2029	281.1	15.3	255.9	12.6	242.9	5.2	249.8	7.5	281.8	14.8	258.3	5.8	265.7	8.1	282.8	15.9	246.8	6.1	250.0	6.9	264.2	10.2	259.3	17.0
B2030	279.1	15.2	254.2	12.6	241.8	5.0	249.5	7.5	279.2	14.7	256.5	5.6	265.4	8.1	281.1	15.9	245.6	5.9	249.6	6.9	263.7	10.1	258.1	16.7
B2031	277.9	15.2	253.2	12.5	241.3	4.8	249.2	7.5	277.6	14.7	255.6	5.4	265.2	8.1	280.0	15.9	244.9	5.8	249.4	6.9	263.3	10.1	257.4	16.4
F2020	0.259	0.040	0.185	0.029	0.353	0.060	0.223	0.040	0.260	0.035	0.428	0.039	0.339	0.019	0.157	0.023	0.304	0.053	0.229	0.040	0.336	0.053	0.275	0.092
F2021	0.232	0.025	0.187	0.021	0.301	0.034	0.205	0.026	0.234	0.021	0.372	0.054	0.273	0.034	0.163	0.018	0.275	0.033	0.209	0.026	0.276	0.052	0.246	0.069
F2022	0.240	0.021	0.219	0.020	0.360	0.039	0.208	0.020	0.246	0.019	0.391	0.042	0.249	0.022	0.187	0.017	0.321	0.034	0.216	0.021	0.261	0.053	0.266	0.074
F2023	0.281	0.024	0.286	0.025	0.462	0.036	0.245	0.020	0.295	0.023	0.432	0.029	0.268	0.020	0.237	0.020	0.408	0.031	0.258	0.022	0.286	0.057	0.321	0.086
F2024	0.296	0.015	0.317	0.014	0.462	0.036	0.295	0.021	0.298	0.013	0.432	0.029	0.301	0.020	0.278	0.020	0.408	0.031	0.307	0.023	0.315	0.047	0.344	0.070
F2025	0.296	0.015	0.317	0.014	0.462	0.036	0.332	0.020	0.298	0.013	0.432	0.029	0.324	0.020	0.280	0.012	0.408	0.031	0.339	0.021	0.336	0.040	0.355	0.064
F2026	0.296	0.015	0.317	0.014	0.462	0.036	0.351	0.019	0.298	0.013	0.432	0.029	0.335	0.019	0.280	0.012	0.408	0.031	0.353	0.020	0.346	0.038	0.360	0.063
F2027	0.296	0.015	0.317	0.014	0.462	0.036	0.358	0.018	0.298	0.013	0.432	0.029	0.339	0.018	0.280	0.012	0.408	0.031	0.357	0.019	0.349	0.037	0.361	0.062
F2028	0.296	0.015	0.317	0.014	0.462	0.036	0.359	0.018	0.298	0.013	0.432	0.029	0.339	0.018	0.280	0.012	0.408	0.031	0.357	0.019	0.349	0.037	0.361	0.062
F2029	0.296	0.015	0.317	0.014	0.462	0.036	0.359	0.018	0.298	0.013	0.432	0.029	0.339	0.018	0.280	0.012	0.408	0.031	0.357	0.018	0.349	0.037	0.361	0.062
F2030	0.296	0.015	0.317	0.014	0.462	0.035	0.359	0.018	0.298	0.013	0.432	0.029	0.339	0.018	0.280	0.012	0.408	0.031	0.356	0.019	0.349	0.037	0.361	0.062
F2031	0.296	0.015	0.317	0.014	0.461	0.036	0.358	0.018	0.298	0.013	0.431	0.028	0.338	0.018	0.280	0.012	0.407	0.030	0.356	0.019	0.348	0.037	0.361	0.062
C2020	125.4	26.5	58.1	12.7	108.5	24.8	67.1	18.2	125.0	21.4	199.7	0.0	160.8	19.5	54.1	10.6	99.6	22.8	70.1	18.9	155.7	35.1	104.8	50.4
C2021	95.3	11.8	53.7	7.5	76.7	9.6	56.4	13.5	94.6	9.1	127.4	25.2	105.0	18.4	52.7	6.9	78.6	10.3	58.6	10.7	103.0	24.2	78.2	28.2
C2022	106.5	10.6	78.0	8.7	107.6	13.1	60.3	11.3	111.3	8.9	143.4	18.2	92.5	12.5	72.3	7.4	107.2	12.1	65.7	10.3	96.3	22.5	93.2	27.9
C2023	168.2	18.7	153.7	17.9	212.9	19.4	86.1	12.7	185.9	17.4	229.0	18.5	112.3	12.1	132.4	13.6	198.2	15.6	96.2	12.4	126.3	41.3	156.3	52.1
C2024	186.3	10.1	182.7	9.7	231.4	16.7	123.3	13.4	195.3	9.2	244.9	15.7	141.7	11.9	170.5	12.7	210.6	13.3	133.8	13.0	154.1	35.8	181.6	42.8
C2025	182.7	8.6	179.0	8.2	209.6	11.4	152.3	11.6	189.2	8.1	221.0	10.5	161.8	9.7	171.9	7.2	195.5	9.5	158.5	10.5	168.8	21.4	182.1	24.3
C2026	178.4	7.8	174.5	7.5	201.4	9.6	166.7	10.0	183.0	7.5	206.7	8.8	170.5	7.9	169.7	7.1	188.9	7.9	168.6	8.3	174.7	14.0	181.1	16.4
C2027	175.1	7.5	171.1	7.3	197.6	9.0	171.3	9.1	178.2	7.4	201.5	8.2	172.9	7.2	167.5	7.1	185.8	7.3	170.9	7.3	176.1	11.6	179.6	14.1
C2028	172.7	7.4	168.8	7.2	195.4	8.8	171.5	8.8	175.0	7.4	198.4	8.0	173.0	6.9	165.7	7.1	183.8	7.1	170.6	7.0	175.7	10.7	178.0	13.5
C2029	171.2	7.4	167.3	7.3	194.2	8.8	171.2	8.7	173.0	7.4	196.7	8.1	172.6	6.9	164.5	7.2	182.7	7.0	170.0	7.0	175.0	10.4	176.9	13.4
C2030	170.2	7.4	166.5	7.3	193.4	8.7	170.9	8.7	171.7	7.5	195.7	8.1	172.2	6.9	163.7	7.2	182.1	7.0	169.5	7.0	174.6	10.3	176.2	13.3
C2031	169.7	7.4	165.9	7.3	192.8	8.9	170.6	8.8	171.0	7.5	195.0	8.0	172.0	6.9	163.2	7.2	181.4	6.9	169.2	7.1	174.3	10.2	175.7	13.2

Table 2.40c—Standard harvest scenario 3.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Quantity	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
B2020	244.8	22.4	153.0	14.3	187.6	18.7	159.8	19.6	243.4	17.1	286.6	21.9	267.3	26.0	162.9	12.4	186.0	18.3	164.7	20.1	259.5	39.3	201.3	51.6
B2021	189.5	14.5	119.3	8.6	148.2	12.3	112.1	11.8	187.7	10.7	223.5	14.3	189.1	16.3	121.1	7.4	144.0	11.9	115.2	12.1	211.3	24.9	179.0	31.4
B2022	178.9	12.0	128.5	8.2	168.2	12.8	96.3	8.5	181.5	9.1	228.7	13.9	152.8	11.6	122.6	6.8	156.9	11.4	102.6	9.0	199.8	21.3	191.7	28.4
B2023	206.3	14.1	169.0	11.4	227.0	17.2	112.0	8.2	215.3	11.7	280.0	17.6	156.6	10.4	155.9	9.3	204.8	14.3	121.0	8.9	220.7	29.5	233.6	37.4
B2024	223.1	13.7	188.6	11.1	251.2	16.0	135.6	7.8	232.2	11.8	299.6	16.7	172.6	9.3	172.6	9.0	220.0	12.9	143.2	8.2	244.9	26.5	260.4	33.8
B2025	223.1	11.4	188.9	9.2	246.2	12.2	152.2	7.1	228.7	10.2	288.7	12.8	184.3	8.0	172.9	7.8	213.6	9.9	156.6	7.0	258.8	17.7	267.1	25.3
B2026	217.9	9.9	184.5	8.2	241.4	10.8	161.2	6.7	220.0	9.2	277.5	10.4	190.5	7.1	169.3	7.4	208.5	9.4	163.1	6.3	264.2	12.6	266.6	20.6
B2027	213.2	9.3	180.9	8.0	237.7	10.1	165.8	6.6	213.1	9.0	270.2	9.4	193.7	6.7	166.4	7.4	205.1	8.8	166.2	6.1	265.4	10.8	263.9	18.6
B2028	210.1	9.2	178.7	8.0	235.2	9.7	167.9	6.5	208.7	9.1	265.4	9.0	195.3	6.6	164.7	7.5	203.0	8.6	167.6	6.0	264.9	10.3	261.3	17.6
B2029	208.3	9.3	177.6	8.1	233.8	9.6	168.9	6.5	206.3	9.2	262.4	8.8	196.1	6.6	163.8	7.6	201.9	8.5	168.2	6.0	264.2	10.2	259.3	17.0
B2030	207.4	9.3	177.0	8.1	233.1	9.6	169.4	6.5	205.0	9.3	260.8	8.7	196.5	6.6	163.4	7.7	201.3	8.4	168.5	5.9	263.7	10.1	258.1	16.7
B2031	206.9	9.3	176.8	8.1	232.7	9.5	169.6	6.5	204.3	9.3	259.8	8.7	196.7	6.6	163.2	7.7	201.1	8.4	168.7	5.9	263.3	10.1	257.4	16.4
F2020	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.337	0.053	0.276	0.092
F2021	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.276	0.051	0.246	0.068
F2022	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.261	0.052	0.266	0.074
F2023	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.286	0.057	0.321	0.086
F2024	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.315	0.047	0.344	0.070
F2025	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.336	0.040	0.355	0.064
F2026	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.346	0.038	0.360	0.063
F2027	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.349	0.037	0.361	0.062
F2028	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.349	0.037	0.361	0.062
F2029	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.349	0.037	0.361	0.062
F2030	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.349	0.037	0.361	0.062
F2031	0.450	0.000	0.530	0.000	0.490	0.000	0.620	0.000	0.460	0.000	0.420	0.000	0.520	0.000	0.580	0.000	0.550	0.000	0.620	0.000	0.348	0.037	0.361	0.062
C2020	201.4	17.0	144.3	12.2	143.7	14.9	163.1	18.6	203.4	13.1	196.7	15.3	231.2	21.2	167.6	11.7	165.0	16.5	166.2	19.0	155.9	36.0	105.0	51.3
C2021	145.1	10.4	102.4	6.8	107.4	8.2	115.5	17.3	144.7	7.7	142.3	9.1	162.4	13.1	114.0	6.4	121.8	8.8	118.8	11.5	102.9	23.3	78.1	27.4
C2022	149.8	10.3	127.8	8.7	125.9	9.7	111.2	13.7	156.2	8.4	149.7	9.5	142.7	11.8	133.5	8.0	142.2	10.3	120.1	11.8	96.3	22.2	93.1	27.6
C2023	207.1	15.7	204.4	15.2	205.2	16.9	139.4	12.6	224.7	13.8	219.4	15.5	158.2	10.9	203.6	13.3	216.9	15.6	150.7	11.5	126.3	41.2	156.3	52.1
C2024	212.0	12.6	210.0	11.5	228.0	13.5	167.8	11.3	225.7	11.1	238.1	12.7	176.7	9.4	209.5	10.3	227.4	11.4	176.1	9.8	154.1	35.8	181.6	42.8
C2025	204.0	9.5	201.6	8.7	209.3	9.9	184.2	10.2	212.6	8.7	216.9	8.3	186.6	7.6	202.0	8.3	209.9	8.7	188.4	7.9	168.8	21.4	182.1	24.3
C2026	197.7	8.3	195.5	7.9	202.9	7.1	192.2	9.8	203.1	8.0	203.9	6.6	191.1	6.6	196.7	8.1	203.4	6.2	193.7	7.1	174.7	14.0	181.1	16.4
C2027	193.7	8.0	192.1	7.9	200.0	6.4	195.9	9.7	197.4	8.0	199.2	5.8	193.3	6.2	193.7	8.2	200.6	5.7	196.1	6.8	176.1	11.6	179.6	14.1
C2028	191.5	8.0	190.3	8.0	198.4	6.2	197.7	9.7	194.2	8.1	196.4	5.4	194.3	6.1	192.1	8.3	199.1	5.6	197.2	6.7	175.7	10.7	178.0	13.5
C2029	190.3	8.0	189.4	8.0	197.5	6.1	198.4	9.6	192.5	8.2	194.8	5.3	194.9	6.0	191.4	8.4	198.3	5.5	197.7	6.7	175.0	10.4	176.9	13.4
C2030	189.6	8.1	189.0	8.1	197.0	6.1	198.8	9.6	191.6	8.2	193.9	5.3	195.1	6.0	191.0	8.4	198.0	5.5	197.9	6.7	174.6	10.3	176.2	13.3
C2031	189.3	8.1	188.8	8.1	196.8	6.1	198.9	9.6	191.2	8.3	193.5	5.3	195.3	6.0	190.9	8.5	197.8	5.5	198.0	6.7	174.3	10.2	175.7	13.2

Table 2.40d—Standard harvest scenario 4.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated											
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Quantity	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
B2020	244.8	22.4	153.0	14.2	187.6	18.7	159.8	19.6	243.4	17.1	286.6	21.8	267.3	26.0	162.9	12.4	186.0	18.2	164.7	20.1	259.5	39.3	201.3	51.6
B2021	247.3	16.5	166.5	11.1	183.5	12.1	161.1	15.4	246.3	12.2	261.5	15.4	247.9	20.9	179.8	10.2	189.7	12.3	165.4	15.8	242.1	31.1	200.2	40.4
B2022	266.8	14.5	199.6	10.2	220.7	11.9	171.0	13.1	269.8	10.7	283.3	14.2	241.7	16.0	211.8	9.6	225.2	11.2	178.3	13.4	241.7	28.3	222.4	37.9
B2023	312.4	16.7	258.9	13.1	290.4	15.7	200.9	12.7	322.3	13.4	346.1	17.5	260.1	14.5	268.3	12.0	289.4	13.5	212.3	13.2	267.6	36.2	272.1	46.4
B2024	359.7	19.9	313.1	16.1	338.6	16.5	241.4	12.2	374.5	16.8	389.3	17.8	289.5	13.6	324.7	14.7	335.4	14.1	253.6	12.5	300.3	39.4	317.8	49.4
B2025	390.6	20.9	347.8	16.7	356.6	13.6	277.5	10.7	405.5	18.2	400.6	15.0	317.9	13.0	364.3	16.6	355.7	12.2	287.7	11.8	327.6	34.7	346.0	44.5
B2026	406.1	20.7	365.4	16.4	363.6	10.8	306.2	10.1	418.3	18.7	400.3	12.2	340.9	12.2	387.9	17.9	364.8	10.4	314.1	10.8	348.0	28.0	362.4	37.8
B2027	412.8	20.6	373.4	16.5	365.4	9.0	327.5	9.9	421.8	19.2	397.2	10.4	358.2	11.6	401.1	19.1	368.2	9.3	333.3	10.0	362.7	22.3	371.8	32.1
B2028	415.4	20.9	376.8	16.8	365.0	8.1	342.7	9.9	421.5	19.8	393.2	9.3	370.6	11.3	408.4	20.2	368.9	8.8	346.7	9.6	373.0	18.3	377.1	28.3
B2029	416.2	21.3	378.2	17.3	364.1	7.6	353.2	10.1	420.0	20.4	389.7	8.8	379.3	11.2	412.5	21.2	368.6	8.6	355.8	9.6	380.0	16.0	380.2	26.1
B2030	416.2	21.6	378.6	17.8	363.2	7.4	360.2	10.4	418.3	20.9	387.1	8.4	385.3	11.3	414.8	21.9	368.1	8.6	362.0	9.7	384.8	15.0	382.0	25.0
B2031	415.9	22.0	378.7	18.1	362.6	7.3	364.9	10.6	416.9	21.2	385.3	8.2	389.3	11.5	416.1	22.5	367.7	8.5	366.0	9.8	388.0	14.6	383.1	24.5
F2020	0.121	0.018	0.086	0.013	0.160	0.026	0.103	0.018	0.122	0.016	0.198	0.012	0.158	0.008	0.074	0.011	0.141	0.024	0.106	0.018	0.156	0.024	0.128	0.041
F2021	0.122	0.015	0.094	0.011	0.156	0.020	0.104	0.015	0.123	0.013	0.198	0.012	0.147	0.019	0.082	0.010	0.144	0.019	0.107	0.015	0.148	0.027	0.128	0.037
F2022	0.133	0.013	0.115	0.012	0.190	0.021	0.111	0.013	0.136	0.012	0.198	0.012	0.143	0.014	0.098	0.010	0.173	0.020	0.116	0.013	0.146	0.024	0.142	0.037
F2023	0.138	0.006	0.148	0.006	0.210	0.015	0.132	0.013	0.139	0.006	0.198	0.012	0.154	0.013	0.126	0.012	0.189	0.013	0.139	0.013	0.157	0.020	0.159	0.032
F2024	0.138	0.006	0.148	0.006	0.210	0.015	0.160	0.013	0.139	0.006	0.198	0.012	0.158	0.008	0.132	0.005	0.189	0.013	0.166	0.008	0.162	0.016	0.167	0.027
F2025	0.138	0.006	0.148	0.006	0.210	0.015	0.166	0.009	0.139	0.006	0.198	0.012	0.158	0.008	0.132	0.005	0.189	0.013	0.166	0.008	0.162	0.016	0.167	0.027
F2026	0.138	0.006	0.148	0.006	0.210	0.015	0.166	0.009	0.139	0.006	0.198	0.012	0.158	0.008	0.132	0.005	0.189	0.013	0.166	0.008	0.162	0.016	0.167	0.027
F2027	0.138	0.006	0.148	0.006	0.210	0.015	0.166	0.009	0.139	0.006	0.198	0.012	0.158	0.008	0.132	0.005	0.189	0.013	0.166	0.008	0.162	0.016	0.167	0.027
F2028	0.138	0.006	0.148	0.006	0.210	0.015	0.166	0.009	0.139	0.006	0.198	0.012	0.158	0.008	0.132	0.005	0.189	0.013	0.166	0.008	0.162	0.016	0.167	0.027
F2029	0.138	0.006	0.148	0.006	0.210	0.015	0.166	0.009	0.139	0.006	0.198	0.012	0.158	0.008	0.132	0.005	0.189	0.013	0.166	0.008	0.162	0.016	0.167	0.027
F2030	0.138	0.006	0.148	0.006	0.210	0.015	0.166	0.009	0.139	0.006	0.198	0.012	0.158	0.008	0.132	0.005	0.189	0.013	0.166	0.008	0.162	0.016	0.167	0.027
F2031	0.138	0.006	0.148	0.006	0.210	0.015	0.166	0.009	0.139	0.006	0.198	0.012	0.158	0.008	0.132	0.005	0.189	0.013	0.166	0.008	0.162	0.016	0.167	0.027
C2020	62.3	13.5	28.2	6.3	52.8	12.3	32.4	8.9	62.1	10.9	100.4	10.6	79.9	9.7	26.4	5.2	49.1	11.4	34.0	9.3	77.4	18.1	51.7	25.8
C2021	59.0	9.3	30.6	5.0	47.7	7.7	32.2	8.5	58.6	7.4	84.6	7.2	67.2	12.6	29.5	4.5	48.1	7.9	33.6	7.1	65.8	16.3	48.0	19.6
C2022	71.0	8.9	46.7	6.1	68.2	9.4	37.3	8.1	73.6	7.4	91.6	7.2	65.3	10.1	43.1	5.2	68.4	9.1	40.6	7.6	66.3	14.9	59.4	19.1
C2023	100.2	7.1	92.3	6.7	117.4	10.9	54.0	9.4	106.1	6.3	131.8	11.3	78.9	9.9	81.1	9.3	111.3	9.2	60.3	9.2	84.0	20.9	92.6	26.5
C2024	112.1	7.2	106.3	6.7	141.5	11.4	79.2	10.6	118.4	6.3	153.5	11.3	91.6	6.0	98.8	5.1	129.6	9.2	85.8	6.4	98.7	21.2	111.7	25.8
C2025	116.6	6.3	112.0	5.9	137.6	8.9	93.4	6.9	121.8	5.7	148.3	8.6	100.3	5.8	105.7	4.8	128.2	7.4	96.2	6.2	106.0	16.6	115.9	19.4
C2026	118.7	5.7	114.7	5.4	136.8	7.4	101.5	6.8	122.8	5.2	142.6	7.1	106.5	5.6	109.7	4.7	128.1	6.1	103.3	5.8	110.7	13.0	118.4	15.3
C2027	119.6	5.3	116.0	5.1	136.7	6.7	107.1	6.7	122.8	5.0	140.9	6.3	110.8	5.3	112.1	4.6	128.4	5.6	108.2	5.6	114.3	11.1	120.3	13.1
C2028	120.0	5.2	116.6	5.0	136.3	6.4	111.0	6.5	122.4	5.0	139.5	5.9	113.7	5.2	113.5	4.7	128.3	5.2	111.5	5.4	116.7	9.7	121.4	11.7
C2029	120.0	5.1	116.8	5.0	135.9	6.2	113.6	6.4	121.9	5.1	138.5	5.7	115.8	5.0	114.3	4.8	128.2	5.0	113.7	5.2	118.3	8.8	122.1	10.7
C2030	120.0	5.1	116.9	5.0	135.6	6.0	115.3	6.3	121.4	5.1	137.8	5.6	117.2	4.9	114.7	4.9	128.0	4.9	115.1	5.1	119.4	8.2	122.5	10.1
C2031	119.9	5.1	116.9	5.0	135.4	6.0	116.5	6.2	121.1	5.2	137.3	5.5	118.1	4.9	115.0	5.0	127.8	4.8	116.1	5.0	120.2	7.8	122.7	9.7

Table 2.40e—Standard harvest scenario 5.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Quantity	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
B2020	244.8	22.4	153.0	14.2	187.6	18.7	159.8	19.6	243.4	17.1	286.6	21.8	267.3	26.0	162.9	12.4	186.0	18.2	164.7	20.1	259.5	39.3	201.3	51.6
B2021	273.5	21.4	178.1	13.4	204.4	16.5	173.6	18.6	272.5	16.0	301.7	18.9	279.6	24.3	191.0	12.1	209.4	16.4	178.6	19.1	272.9	37.8	221.0	50.1
B2022	315.7	21.3	222.7	13.6	257.1	17.4	194.7	18.0	318.3	15.6	351.3	18.7	296.9	22.9	234.7	12.4	261.7	16.9	203.2	18.7	295.4	39.6	260.1	53.1
B2023	383.6	23.6	296.9	16.6	345.7	21.8	235.4	18.6	393.7	17.7	437.1	22.1	333.0	22.7	306.0	14.9	346.5	19.9	248.7	19.4	339.2	48.7	327.0	63.8
B2024	462.9	27.0	383.0	20.5	430.1	24.2	290.6	19.2	480.1	21.3	516.5	24.2	381.6	22.7	391.6	18.5	428.5	21.4	306.9	20.1	393.4	56.5	401.0	72.4
B2025	530.3	28.7	456.1	22.5	491.7	23.1	349.5	19.1	550.6	23.5	570.4	23.3	432.2	22.1	468.6	21.1	489.8	20.4	366.2	19.8	445.9	57.3	463.9	73.2
B2026	579.2	29.0	509.2	22.9	532.5	20.2	404.7	18.2	598.8	24.6	602.5	20.7	478.6	20.8	528.5	22.6	531.7	18.0	420.1	18.7	491.5	52.8	511.8	68.2
B2027	613.2	29.0	546.2	23.1	558.6	17.0	452.7	17.1	630.0	25.6	620.5	18.0	518.6	19.5	573.1	24.3	559.5	15.6	465.8	17.3	529.3	46.0	547.2	60.7
B2028	636.7	29.5	571.9	23.8	575.1	14.5	492.4	16.1	650.3	26.9	630.2	15.8	551.5	18.3	606.1	26.2	577.7	13.9	503.2	16.0	559.7	39.0	573.2	53.4
B2029	653.2	30.4	589.8	24.8	585.5	12.9	524.3	15.4	663.6	28.5	635.1	14.4	578.0	17.6	630.5	28.4	589.6	13.1	532.9	15.2	583.6	33.1	592.1	47.5
B2030	664.7	31.6	602.3	26.0	591.9	12.1	549.3	15.2	672.4	30.0	637.4	13.6	598.9	17.2	648.4	30.4	597.3	12.8	555.9	14.7	602.2	28.7	606.0	43.5
B2031	672.8	32.8	611.0	27.1	596.0	11.7	568.5	15.2	678.1	31.4	638.3	13.3	615.0	17.2	661.5	32.3	602.3	12.9	573.5	14.6	616.4	25.8	616.0	41.0
F2020	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2021	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2022	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2023	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2024	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2025	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2026	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2027	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2028	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2029	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2030	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2031	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C2020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2022	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2024	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2026	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2027	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2028	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2029	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2030	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2031	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2.40f—Standard harvest scenario 6.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Quantity	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
B2020	244.8	22.4	153.0	14.2	187.6	18.7	159.8	19.6	243.4	17.1	286.6	21.8	267.3	26.0	162.9	12.4	186.0	18.2	164.7	20.1	259.5	39.3	201.3	51.6
B2021	210.9	11.3	149.4	8.0	153.2	6.9	142.7	11.2	210.0	8.5	206.6	11.1	204.4	16.5	163.6	7.9	161.8	7.4	146.1	11.3	199.8	22.7	170.9	28.3
B2022	214.9	10.7	171.9	7.6	181.3	8.5	142.5	8.7	218.4	8.5	217.9	9.1	184.9	10.8	183.9	7.6	185.9	7.6	148.8	8.8	186.6	19.6	181.7	26.0
B2023	250.5	13.7	220.1	11.1	240.5	12.5	165.9	8.9	260.2	11.7	270.7	12.1	199.5	10.2	229.0	10.5	238.2	10.3	175.7	9.2	207.4	28.2	222.2	35.5
B2024	273.0	14.7	248.4	11.9	249.2	8.2	197.1	8.5	282.1	13.3	276.3	11.4	223.3	9.4	262.8	12.6	248.9	8.0	206.1	8.5	229.6	22.9	243.8	29.7
B2025	272.2	14.6	248.5	11.9	233.0	6.8	218.9	7.3	278.2	13.8	255.4	8.5	238.7	8.1	270.8	13.9	236.4	7.5	224.2	7.0	240.7	13.5	244.9	21.4
B2026	265.0	14.7	241.3	12.1	225.6	5.2	228.6	6.9	267.3	13.7	240.7	6.0	244.8	7.6	267.1	14.8	229.8	6.1	230.8	6.4	244.0	10.0	241.8	17.7
B2027	259.7	14.5	236.3	12.0	223.2	4.8	231.2	7.0	259.8	13.7	236.8	5.4	246.2	7.5	262.5	15.1	227.2	5.7	231.9	6.4	244.5	9.6	239.5	16.1
B2028	257.1	14.3	234.1	11.8	222.6	4.6	231.3	7.1	256.4	13.7	235.6	5.1	246.1	7.6	259.7	15.0	226.3	5.5	231.5	6.5	244.1	9.5	238.2	15.4
B2029	256.2	14.1	233.4	11.7	222.5	4.5	230.8	7.1	255.3	13.6	235.5	4.9	245.7	7.6	258.5	14.8	226.1	5.4	231.0	6.5	243.7	9.4	237.7	15.1
B2030	256.0	14.0	233.3	11.6	222.6	4.5	230.5	7.1	255.1	13.5	235.5	4.9	245.4	7.6	258.1	14.7	226.1	5.3	230.7	6.4	243.5	9.4	237.5	15.0
B2031	256.0	14.0	233.4	11.6	222.6	4.5	230.3	7.0	255.2	13.5	235.5	4.9	245.3	7.5	258.0	14.7	226.2	5.3	230.6	6.4	243.4	9.4	237.5	15.0
F2020	0.316	0.050	0.227	0.036	0.438	0.076	0.273	0.049	0.318	0.043	0.534	0.037	0.415	0.024	0.191	0.028	0.374	0.066	0.280	0.050	0.412	0.066	0.339	0.115
F2021	0.270	0.027	0.221	0.024	0.352	0.039	0.241	0.030	0.272	0.023	0.425	0.045	0.314	0.039	0.192	0.021	0.322	0.037	0.245	0.030	0.318	0.057	0.287	0.076
F2022	0.275	0.023	0.257	0.023	0.422	0.046	0.241	0.022	0.283	0.021	0.450	0.042	0.282	0.024	0.218	0.020	0.374	0.039	0.251	0.023	0.297	0.060	0.309	0.085
F2023	0.324	0.028	0.335	0.029	0.570	0.064	0.284	0.023	0.341	0.026	0.534	0.037	0.306	0.023	0.276	0.023	0.486	0.051	0.300	0.025	0.331	0.076	0.381	0.115
F2024	0.355	0.026	0.381	0.026	0.573	0.046	0.342	0.024	0.364	0.017	0.534	0.037	0.345	0.023	0.320	0.022	0.502	0.039	0.356	0.026	0.367	0.065	0.413	0.095
F2025	0.354	0.020	0.381	0.019	0.551	0.041	0.383	0.023	0.364	0.017	0.532	0.038	0.370	0.022	0.330	0.018	0.482	0.035	0.389	0.024	0.389	0.056	0.420	0.080
F2026	0.344	0.017	0.369	0.016	0.532	0.042	0.401	0.021	0.351	0.017	0.500	0.033	0.380	0.022	0.325	0.015	0.468	0.036	0.401	0.022	0.394	0.045	0.414	0.071
F2027	0.336	0.016	0.361	0.016	0.527	0.042	0.406	0.021	0.340	0.015	0.491	0.033	0.382	0.021	0.319	0.014	0.463	0.035	0.403	0.022	0.395	0.043	0.410	0.071
F2028	0.333	0.017	0.357	0.016	0.525	0.042	0.406	0.020	0.336	0.015	0.489	0.034	0.382	0.021	0.316	0.014	0.461	0.035	0.403	0.021	0.394	0.042	0.408	0.072
F2029	0.332	0.017	0.356	0.017	0.525	0.042	0.405	0.020	0.334	0.015	0.488	0.034	0.382	0.021	0.314	0.014	0.460	0.036	0.402	0.021	0.393	0.042	0.407	0.072
F2030	0.331	0.017	0.356	0.017	0.525	0.042	0.404	0.020	0.334	0.015	0.489	0.034	0.381	0.021	0.314	0.014	0.460	0.036	0.401	0.021	0.393	0.043	0.407	0.072
F2031	0.331	0.017	0.356	0.017	0.525	0.042	0.404	0.020	0.334	0.015	0.489	0.034	0.381	0.021	0.314	0.014	0.460	0.036	0.401	0.021	0.393	0.043	0.407	0.072
C2020	149.5	31.3	69.8	15.2	130.7	29.7	80.8	21.8	149.0	25.3	239.8	26.1	191.4	23.3	65.0	12.6	119.4	27.2	84.2	22.6	185.7	42.7	125.6	60.9
C2021	104.1	11.5	60.6	7.8	83.5	9.1	63.5	14.6	103.2	8.8	133.1	16.0	113.1	19.3	59.8	7.3	86.3	10.1	65.8	11.2	110.7	23.8	85.4	27.6
C2022	114.6	10.8	87.0	9.3	118.3	14.1	66.3	11.8	120.2	9.1	152.5	15.7	97.5	12.7	80.7	7.8	117.5	12.7	72.4	10.7	102.0	23.3	101.4	28.8
C2023	182.7	20.1	171.0	19.6	244.5	32.4	95.1	13.4	202.4	18.8	262.3	21.0	120.1	12.6	147.1	14.8	221.2	25.4	106.2	13.2	137.4	48.9	174.4	61.3
C2024	206.5	16.1	203.0	15.3	255.7	14.2	135.4	14.0	219.6	10.2	269.3	16.5	152.4	12.3	184.0	13.0	234.3	11.6	146.4	13.4	167.0	40.4	200.0	47.9
C2025	197.6	9.8	194.1	9.0	218.4	10.8	164.5	11.9	207.0	8.7	236.2	13.2	172.5	9.8	186.6	8.6	204.8	9.6	170.1	10.5	180.4	23.0	194.9	24.9
C2026	185.9	7.9	181.7	7.6	204.5	8.8	176.7	10.2	190.7	8.3	208.4	7.9	179.6	8.1	179.3	7.5	192.8	7.1	177.8	8.3	183.0	12.3	187.9	13.9
C2027	179.0	7.7	174.8	7.6	201.2	9.0	179.5	9.5	181.0	7.5	203.2	8.1	180.7	7.5	173.2	7.5	189.3	7.1	178.6	7.5	183.0	10.4	184.6	13.0
C2028	176.0	7.7	172.1	7.6	200.5	9.3	179.1	9.2	177.1	7.7	202.1	8.5	180.2	7.3	169.9	7.6	188.3	7.3	177.6	7.4	182.3	10.3	183.0	13.6
C2029	175.1	7.8	171.4	7.7	200.5	9.4	178.3	9.2	176.0	7.9	202.1	8.7	179.6	7.3	168.6	7.6	188.2	7.5	176.8	7.4	181.7	10.5	182.4	13.9
C2030	174.9	7.8	171.4	7.7	200.6	9.5	177.8	9.3	175.9	7.9	202.3	8.8	179.2	7.3	168.3	7.5	188.3	7.5	176.4	7.5	181.4	10.6	182.2	14.1
C2031	175.0	7.8	171.5	7.7	200.7	9.5	177.5	9.4	176.1	7.9	202.4	8.8	179.0	7.4	168.2	7.5	188.3	7.5	176.2	7.5	181.3	10.7	182.2	14.1

Table 2.40g—Standard harvest scenario 7.

Hypothesis:	2:EBS+NBS		1: EBS only						2: EBS and NBS combined						3: EBS and NBS separated									
Structure:	Basic		Basic		Simple		Complex		Basic		Simple		Complex		Basic		Simple		Complex		Ensemble (19.x series)			
Model:	M16.6i		M19.7		M19.8		M19.9		M19.10		M19.11		M19.12		M19.13		M19.14		M19.15		Weighted		Unweighted	
Quantity	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
B2020	244.8	22.4	153.0	14.2	187.6	18.7	159.8	19.6	243.4	17.1	286.6	21.8	267.3	26.0	162.9	12.4	186.0	18.2	164.7	20.1	259.5	39.3	201.3	51.6
B2021	220.9	21.4	154.2	13.4	161.7	16.7	147.9	18.6	220.0	16.0	221.7	19.3	216.3	24.3	168.1	12.1	169.6	16.7	151.5	19.2	211.3	29.7	179.0	34.2
B2022	220.0	13.3	174.6	9.5	185.0	11.2	145.5	11.8	223.4	9.9	223.5	10.6	190.7	13.2	186.8	9.0	189.5	10.4	151.9	12.3	192.0	21.2	185.6	27.6
B2023	252.7	14.1	221.4	11.4	241.7	12.9	167.5	9.8	262.3	11.7	272.2	12.3	202.2	10.7	230.5	10.6	239.5	10.8	177.3	10.3	209.9	28.1	223.9	35.6
B2024	273.5	14.6	248.7	11.8	249.2	8.2	197.7	8.6	282.6	13.2	276.8	11.4	224.2	9.5	263.3	12.5	249.0	8.0	206.7	8.7	230.5	22.8	244.2	29.6
B2025	272.2	14.7	248.4	11.9	232.9	6.9	219.1	7.3	278.3	13.8	255.6	8.5	238.9	8.2	270.8	13.9	236.4	7.5	224.3	7.0	240.9	13.5	245.0	21.4
B2026	264.9	14.7	241.3	12.1	225.5	5.2	228.6	6.9	267.2	13.8	240.7	6.0	244.7	7.6	267.1	14.9	229.7	6.1	230.7	6.5	243.9	10.1	241.7	17.7
B2027	259.6	14.6	236.3	12.0	223.2	4.8	231.2	7.0	259.7	13.7	236.7	5.4	246.1	7.6	262.5	15.1	227.2	5.7	231.9	6.5	244.4	9.6	239.4	16.1
B2028	257.1	14.3	234.1	11.8	222.6	4.6	231.2	7.1	256.4	13.7	235.6	5.1	246.0	7.6	259.7	15.0	226.3	5.5	231.5	6.5	244.1	9.5	238.2	15.4
B2029	256.2	14.1	233.4	11.7	222.5	4.5	230.8	7.1	255.3	13.6	235.4	4.9	245.7	7.6	258.5	14.8	226.1	5.4	231.0	6.5	243.7	9.4	237.6	15.1
B2030	256.0	14.0	233.3	11.6	222.6	4.5	230.5	7.1	255.1	13.5	235.5	4.9	245.4	7.6	258.1	14.7	226.1	5.3	230.7	6.4	243.5	9.4	237.5	15.0
B2031	256.0	14.0	233.4	11.6	222.6	4.5	230.3	7.0	255.2	13.5	235.5	4.9	245.3	7.5	258.0	14.7	226.2	5.3	230.6	6.4	243.4	9.4	237.5	15.0
F2020	0.259	0.025	0.185	0.017	0.353	0.042	0.223	0.028	0.260	0.019	0.432	0.040	0.339	0.035	0.157	0.012	0.304	0.035	0.229	0.029	0.337	0.059	0.276	0.089
F2021	0.283	0.045	0.228	0.034	0.373	0.066	0.251	0.045	0.285	0.038	0.458	0.068	0.333	0.054	0.198	0.028	0.338	0.059	0.255	0.046	0.338	0.073	0.302	0.092
F2022	0.282	0.031	0.261	0.028	0.431	0.056	0.247	0.030	0.290	0.028	0.462	0.049	0.291	0.031	0.222	0.024	0.381	0.048	0.256	0.032	0.307	0.064	0.316	0.090
F2023	0.327	0.030	0.337	0.031	0.573	0.067	0.287	0.026	0.344	0.029	0.534	0.037	0.310	0.025	0.278	0.025	0.489	0.054	0.303	0.028	0.335	0.076	0.384	0.115
F2024	0.355	0.026	0.381	0.026	0.573	0.046	0.343	0.025	0.364	0.017	0.534	0.037	0.346	0.024	0.320	0.023	0.502	0.039	0.357	0.027	0.368	0.064	0.413	0.095
F2025	0.354	0.020	0.381	0.019	0.551	0.041	0.383	0.023	0.364	0.017	0.533	0.038	0.370	0.022	0.330	0.018	0.482	0.035	0.389	0.024	0.389	0.056	0.420	0.080
F2026	0.344	0.017	0.369	0.016	0.532	0.041	0.401	0.021	0.351	0.017	0.500	0.033	0.380	0.021	0.325	0.015	0.468	0.036	0.401	0.022	0.394	0.045	0.414	0.071
F2027	0.336	0.016	0.361	0.016	0.526	0.042	0.405	0.020	0.340	0.015	0.491	0.033	0.382	0.021	0.319	0.014	0.462	0.035	0.403	0.021	0.394	0.043	0.410	0.071
F2028	0.333	0.017	0.357	0.016	0.525	0.042	0.406	0.020	0.336	0.015	0.489	0.034	0.382	0.021	0.316	0.014	0.461	0.035	0.402	0.021	0.394	0.042	0.408	0.072
F2029	0.332	0.017	0.356	0.017	0.525	0.042	0.405	0.020	0.334	0.015	0.488	0.034	0.382	0.021	0.314	0.014	0.460	0.036	0.402	0.021	0.393	0.043	0.407	0.072
F2030	0.331	0.017	0.356	0.017	0.525	0.042	0.404	0.020	0.334	0.015	0.489	0.034	0.381	0.021	0.314	0.014	0.460	0.036	0.401	0.021	0.393	0.043	0.407	0.072
F2031	0.331	0.017	0.356	0.017	0.525	0.042	0.404	0.020	0.334	0.015	0.489	0.034	0.381	0.021	0.314	0.014	0.460	0.036	0.401	0.021	0.393	0.043	0.407	0.072
C2020	125.4	0.0	58.1	0.0	108.5	0.0	67.1	0.0	125.0	0.0	201.3	0.0	160.8	0.0	54.1	0.0	99.6	0.0	70.1	0.0	155.9	30.1	105.0	47.4
C2021	113.9	24.9	64.6	13.3	92.9	22.1	68.1	22.9	113.1	19.6	152.1	30.0	125.7	29.9	63.2	11.5	94.5	21.8	70.6	19.1	123.2	34.3	93.9	36.7
C2022	119.6	16.1	89.6	12.0	122.7	18.7	68.9	16.0	125.3	13.3	159.4	19.1	103.2	16.5	83.0	10.2	121.6	17.5	75.1	14.9	107.5	26.2	105.4	31.8
C2023	185.2	21.8	172.5	20.6	246.1	33.4	96.6	15.3	205.0	20.0	262.9	21.0	122.9	14.0	148.6	15.8	222.9	26.7	107.8	15.1	139.9	48.7	176.1	61.5
C2024	207.0	16.2	203.2	15.3	255.4	13.9	136.1	14.3	219.6	10.2	269.3	16.4	153.4	12.6	184.5	13.1	234.1	11.4	147.0	14.0	167.8	40.1	200.3	47.6
C2025	197.5	9.7	193.9	8.9	218.2	10.6	164.6	11.6	207.0	8.7	236.3	13.1	172.5	9.7	186.6	8.5	204.7	9.4	170.2	10.4	180.4	22.9	194.9	24.8
C2026	185.7	7.9	181.6	7.6	204.4	8.7	176.6	9.9	190.5	8.2	208.4	7.9	179.4	7.9	179.2	7.5	192.7	7.0	177.7	8.1	182.8	12.2	187.8	13.9
C2027	178.9	7.7	174.7	7.6	201.1	9.0	179.4	9.3	180.9	7.5	203.2	8.1	180.6	7.4	173.1	7.6	189.3	7.0	178.5	7.4	182.9	10.4	184.5	13.0
C2028	176.0	7.7	172.1	7.6	200.5	9.3	179.0	9.2	177.1	7.7	202.1	8.5	180.1	7.2	169.9	7.6	188.3	7.3	177.6	7.3	182.2	10.3	183.0	13.6
C2029	175.0	7.8	171.4	7.7	200.5	9.4	178.3	9.2	176.0	7.9	202.1	8.7	179.5	7.3	168.6	7.6	188.2	7.5	176.8	7.4	181.7	10.5	182.4	13.9
C2030	174.9	7.8	171.4	7.7	200.6	9.5	177.8	9.3	175.9	7.9	202.3	8.8	179.2	7.3	168.3	7.5	188.3	7.5	176.4	7.5	181.4	10.6	182.2	14.1
C2031	175.0	7.8	171.5	7.7	200.7	9.5	177.5	9.4	176.1	7.9	202.4	8.8	179.0	7.4	168.2	7.5	188.3	7.5	176.2	7.5	181.3	10.7	182.2	14.1

Table 2.41a (page 1 of 2)—Incidental catch of FMP species in the Pacific cod target fishery (trawl gear).

Species/group	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Alaska Plaice												0.03	0.03	0.05	0.04
Arrowtooth Flounder	0.06	0.24	0.21	0.16	0.20	0.26	0.24	0.11	0.12	0.11	0.19	0.38	0.43	0.52	0.41
Atka Mackerel	0.12	0.20	0.01	0.02	0.01	0.11	0.22	0.82	0.11	0.19	0.27	0.35	0.75	0.76	0.36
Flathead Sole					0.32	0.30	0.29	0.16	0.21	0.19	0.11	0.22	0.23	0.33	0.23
Flounder	0.02	0.07	0.13	0.14											
Greenland Turbot	0.02	0.03	0.04	0.02	0.06	0.06	0.02	0.09	0.01	0.05	0.03	0.04	0.11	0.17	0.05
Kamchatka Flounder															
Northern Rockfish												0.40	0.24	0.59	0.31
Octopus															
Other Flatfish					0.06	0.07	0.06	0.04	0.03	0.05	0.05	0.14	0.33	0.49	0.35
Other Rockfish	0.04	0.28	0.23	0.05	0.14	0.11	0.07	0.35	0.14	0.19	0.02	0.11	0.28	0.33	0.32
Other Species													0.12	0.12	0.07
Pacific Cod	0.08	0.14	0.17	0.16	0.20	0.12	0.17	0.03	0.12	0.06	0.06	0.16	0.09	0.07	0.03
Pacific Ocean Perch	0.21	0.24	0.27	0.23	0.29	0.19	0.39	0.27	0.14	0.53	0.04	0.02	0.04	0.26	0.22
Pollock	0.05	0.12	0.24	0.20	0.21	0.25	0.30	0.23	0.45	0.30	0.18	0.27	0.38	0.39	0.36
Rock Sole	0.04	0.08	0.12	0.18	0.34	0.31	0.30	0.22	0.31	0.19	0.27	0.22	0.27	0.30	0.37
Rougheye Rockfish														0.12	0.05
Sablefish	0.01	0.01	conf	0.01	0.00	0.04	0.00	0.03	0.06	0.08	0.04	0.10	0.19	0.32	0.09
Sculpin															
Shark															
Sharpchin/Northern Rockfish		0.29	0.30								0.12				
Shortraker Rockfish														conf	
Shortraker/Rougheye Rockfish		0.02	conf								conf	0.05	0.05		
Short/Rough/Sharp/North Rockfish	0.26	0.58	0.18	0.12	0.17	0.13	0.45	0.27	0.16	0.28	0.46				
Skate															
Squid	0.01	0.03	0.00	0.28	0.00	conf	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.01	0.00
Yellowfin Sole	0.00	0.01	0.03	0.04	0.01	0.05	0.02	0.02	0.03	0.07	0.05	0.09	0.06	0.11	0.11

Table 2.41a (page 2 of 2)—Incidental catch of FMP species in the Pacific cod target fishery (trawl gear).

Species/group	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alaska Plaice	0.02	0.03	0.00	0.01	0.00	0.01	0.01	0.05	0.02	0.00	0.00	0.00	0.00	0.01
Arrowtooth Flounder	0.45	0.23	0.08	0.08	0.07	0.06	0.07	0.07	0.08	0.08	0.08	0.07	0.08	0.06
Atka Mackerel	0.24	0.17	0.10	0.40	0.39	0.34	0.28	0.11	0.09	0.03	0.84	0.00	0.03	0.00
Flathead Sole	0.41	0.39	0.11	0.07	0.06	0.08	0.08	0.07	0.08	0.07	0.07	0.08	0.06	0.05
Flounder														
Greenland Turbot	0.11	0.21	0.01	0.00	0.03	0.00	0.02	0.01	0.01	0.02	0.00	conf	0.06	conf
Kamchatka Flounder						0.01	0.01	0.02	0.04	0.02	0.02	0.01	0.03	0.03
Northern Rockfish	0.28	0.08	0.05	0.03	0.20	0.12	0.11	0.01	0.01	0.00	conf	0.21	0.00	0.06
Octopus						0.03	0.01	0.02	0.02	0.01	0.00	0.06	0.16	0.00
Other Flatfish	0.20	0.07	0.03	0.03	0.04	0.03	0.03	0.03	0.01	0.07	0.11	0.04	0.04	0.06
Other Rockfish	0.24	0.06	0.06	0.02	0.03	0.03	0.35	0.03	0.03	0.07	0.04	0.00	0.01	0.00
Other Species	0.11	0.17	0.04	0.03	0.03									
Pacific Cod	0.08	0.12	0.01	0.06	0.05	0.04	0.04	0.02	0.04	0.04	0.03	0.02	0.06	0.09
Pacific Ocean Perch	0.08	0.04	0.01	0.01	0.00	0.01	0.07	0.00	conf	0.00	0.00	0.00	0.00	0.00
Pollock	0.53	0.75	0.43	0.37	0.31	0.41	0.30	0.22	0.17	0.05	0.10	0.04	0.07	0.05
Rock Sole	0.35	0.27	0.14	0.07	0.12	0.18	0.16	0.07	0.21	0.29	0.25	0.14	0.30	0.10
Rougheye Rockfish			conf		conf						conf	conf		conf
Sablefish	0.00	0.00	0.00	conf	conf	conf	conf	0.02		0.01	0.00	0.01	conf	0.02
Sculpin						0.07	0.07	0.07	0.07	0.07	0.12	0.05	0.09	0.04
Shark								0.00	0.00	0.01	conf	0.01	conf	0.00
Sharpchin/Northern Rockfish														
Shortraker Rockfish	conf	conf		conf				conf			conf	conf		
Shortraker/Rougheye Rockfish														
Short/Rough/Sharp/North Rockfish														
Skate						0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03
Squid	conf	0.00	conf		0.00	0.00	0.00	0.00	0.00	0.00	conf	0.00	conf	
Yellowfin Sole	0.08	0.03	0.01	0.00	0.01	0.01	0.01	0.06	0.02	0.00	0.00	0.00	0.01	0.01

Table 2.41b (page 1 of 2)—Incidental catch of FMP species in the Pacific cod target fishery (longline gear).

Species/group	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Alaska Plaice												0.00	0.00	0.00	0.00
Arrowtooth Flounder	0.11	0.15	0.08	0.10	0.20	0.15	0.23	0.11	0.08	0.14	0.14	0.11	0.11	0.09	0.14
Atka Mackerel	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00
Flathead Sole		conf			0.03	0.03	0.03	0.05	0.06	0.06	0.08	0.09	0.09	0.11	0.14
Flounder	0.01	0.01	0.01	0.01											
Greenland Turbot	0.10	0.20	0.05	0.09	0.14	0.19	0.19	0.07	0.04	0.12	0.05	0.08	0.17	0.11	0.12
Kamchatka Flounder															
Northern Rockfish												0.08	0.09	0.05	0.08
Octopus															
Other Flatfish					0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.06	0.04	0.06	0.09
Other Rockfish	0.03	0.12	0.14	0.08	0.06	0.20	0.11	0.08	0.20	0.12	0.35	0.25	0.11	0.23	0.26
Other Species													0.56	0.65	0.68
Pacific Cod	0.09	0.08	0.07	0.10	0.09	0.11	0.16	0.70	0.42	0.69	0.62	0.58	0.65	0.75	0.82
Pacific Ocean Perch	0.00	0.01	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Pollock	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.02	0.05	0.06	0.04	0.05	0.03	0.03
Rock Sole	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rougheye Rockfish														0.14	0.33
Sablefish	0.05	0.73	0.07	0.08	0.12	0.13	0.12	0.08	0.08	0.39	0.32	0.20	0.30	0.16	0.22
Sculpin															
Shark															
Sharpchin/Northern Rockfish		0.01	0.01								0.05				
Shortraker Rockfish														0.12	0.31
Shortraker/Rougheye Rockfish		0.10	0.19								0.74	0.19	0.20		
Short/Rough/Sharp/North Rockfish	0.03	0.05	0.04	0.11	0.18	0.18	0.05	0.14	0.03	0.19	0.05				
Skate															
Squid										0.00		conf	conf	conf	conf
Yellowfin Sole	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.07	0.05	0.05	0.04	0.07

Table 2.41b (page 2 of 2)—Incidental catch of FMP species in the Pacific cod target fishery (longline gear).

Species/group	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alaska Plaice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arrowtooth Flounder	0.12	0.16	0.18	0.20	0.16	0.22	0.28	0.14	0.21	0.33	0.26	0.38	0.21	0.13
Atka Mackerel	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.26	0.17	0.02	0.05	0.11	0.01	0.01
Flathead Sole	0.11	0.06	0.14	0.12	0.14	0.18	0.17	0.24	0.39	0.39	0.36	0.53	0.45	0.51
Flounder														
Greenland Turbot	0.13	0.15	0.11	0.15	0.14	0.14	0.11	0.01	0.02	0.13	0.43	0.46	0.26	0.28
Kamchatka Flounder						0.13	0.11	0.07	0.09	0.13	0.19	0.14	0.18	0.05
Northern Rockfish	0.04	0.11	0.30	0.56	0.68	0.37	0.16	0.46	0.51	0.48	0.35	0.53	0.12	0.12
Octopus						0.05	0.12	0.11	0.06	0.08	0.08	0.12	0.11	0.15
Other Flatfish	0.07	0.01	0.01	0.06	0.07	0.02	0.03	0.01	0.01	0.04	0.02	0.02	0.01	0.01
Other Rockfish	0.24	0.24	0.19	0.16	0.58	0.39	0.22	0.39	0.54	0.54	0.23	0.36	0.27	0.05
Other Species	0.56	0.44	0.51	0.51	0.53									
Pacific Cod	0.63	0.68	0.63	0.73	0.52	0.80	0.68	0.65	0.79	0.81	0.83	0.70	0.76	0.57
Pacific Ocean Perch	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Pollock	0.03	0.03	0.11	0.10	0.23	0.18	0.10	0.12	0.04	0.06	0.08	0.09	0.05	0.05
Rock Sole	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.03	0.05	0.02	0.03	0.02	0.01
Rougheye Rockfish	0.68	0.48	0.39	0.31	0.18	0.27	0.19	0.18	0.26	0.45	0.41	0.09	0.24	0.02
Sablefish	0.21	0.16	0.03	0.04	0.04	0.16	0.02	0.10	0.07	0.26	0.72	0.21	0.12	0.02
Sculpin						0.25	0.25	0.17	0.31	0.38	0.35	0.38	0.34	0.30
Shark						0.33	0.37	0.41	0.43	0.45	0.39	0.29	0.30	0.19
Sharpchin/Northern Rockfish														
Shortraker Rockfish	0.20	0.63	0.12	0.64	0.31	0.29	0.23	0.09	0.09	0.23	0.12	0.13	0.09	0.02
Shortraker/Rougheye Rockfish														
Short/Rough/Sharp/North Rockfish														
Skate						0.77	0.77	0.78	0.82	0.89	0.91	0.89	0.85	0.65
Squid			conf	conf	conf	0.00		0.00	0.00	0.00	conf	0.00	conf	
Yellowfin Sole	0.05	0.02	0.06	0.09	0.03	0.14	0.20	0.23	0.39	0.47	0.36	0.37	0.43	0.21

Table 2.41c (page 1 of 2)—Incidental catch of FMP species in the Pacific cod target fishery (pot gear).

Species/group	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Alaska Plaice												conf	conf	conf	conf
Arrowtooth Flounder	0.00	0.00	conf	conf	0.00	0.00	0.00	0.00	conf	conf	conf	0.02	0.00	0.00	0.00
Atka Mackerel	0.00	0.03	conf	0.05	0.23	0.11	0.29	0.03	conf	conf	conf	conf	0.06	0.03	0.17
Flathead Sole					conf	0.00	conf	conf	0.00	conf	conf	conf	0.00	0.00	0.00
Flounder	conf	0.00	conf	conf											
Greenland Turbot	conf	conf		conf	0.00	0.00	conf	conf	conf		conf	conf	0.00		conf
Kamchatka Flounder															
Northern Rockfish												conf	0.02	0.01	0.02
Octopus															
Other Flatfish					conf	0.00	0.00	conf	conf	conf	conf	conf	0.00	0.00	0.00
Other Rockfish	0.00	0.00	conf	0.01	0.02	0.04	0.06	0.03	conf	conf	conf	conf	0.07	0.04	0.10
Other Species													0.02	0.01	0.01
Pacific Cod	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.03	0.06	0.02	0.02
Pacific Ocean Perch	conf	conf	conf	conf	0.00	0.00	conf	conf	conf	conf	conf	conf	0.00	0.00	0.00
Pollock	0.00	0.00	conf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	conf	0.00	0.00	0.00	0.00
Rock Sole	0.00	0.00	conf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	conf	conf	0.00	0.00	0.00
Rougheye Rockfish														0.00	0.01
Sablefish	conf	conf		conf	conf	conf	conf	conf	conf		conf	conf	0.00	0.01	0.00
Sculpin															
Shark															
Sharpchin/Northern Rockfish		conf	conf								conf				
Shortraker Rockfish															
Shortraker/Rougheye Rockfish		conf	conf								conf	conf	0.00		
Short/Rough/Sharp/North Rockfish	0.00			conf	0.01	0.00	0.00	conf	conf	conf	conf				
Skate															
Squid					conf	conf			conf		conf	conf			conf
Yellowfin Sole	0.00	0.00	conf	conf	0.00	0.01	0.00	0.00	0.00	0.00	conf	0.00	0.01	0.01	0.01

Table 2.41c (page 2 of 2)—Incidental catch of FMP species in the Pacific cod target fishery (pot gear).

Species/group	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alaska Plaice	conf	conf					0.00	conf	conf	conf	conf	conf	conf	
Arrowtooth Flounder	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atka Mackerel	0.29	0.11	0.68	0.03	0.56	0.11	0.05	0.38	0.36	0.07	0.08	0.08	0.10	0.54
Flathead Sole	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flounder														
Greenland Turbot	0.00	conf	conf	conf		0.00			conf	conf	conf	conf	conf	
Kamchatka Flounder						0.00	0.00	0.00	conf	0.00	0.00	0.00	0.00	0.00
Northern Rockfish	0.01	0.02	0.11	0.06	0.02	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	conf
Octopus						0.89	0.81	0.85	0.90	0.86	0.87	0.77	0.56	0.65
Other Flatfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Other Rockfish	0.12	0.01	0.02	0.00	0.02	0.04	0.02	0.12	0.03	0.03	0.03	0.04	0.02	0.00
Other Species	0.02	0.01	0.02	0.01	0.01									
Pacific Cod	0.03	0.02	0.08	0.01	0.00	0.00	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.02
Pacific Ocean Perch	0.00	conf	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rock Sole	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rougheye Rockfish														
Sablefish	0.08					conf		0.00			0.01	0.01	0.03	0.01
Sculpin						0.03	0.02	0.06	0.07	0.06	0.07	0.04	0.04	0.04
Shark						conf	0.00							
Sharpchin/Northern Rockfish														
Shortraker Rockfish					0.00				conf					
Shortraker/Rougheye Rockfish														
Short/Rough/Sharp/North Rockfish														
Skate						0.00	conf		0.00	conf	conf	conf	0.00	
Squid		conf			conf				conf		0.00			
Yellowfin Sole	0.01	0.02	0.02	0.01	0.00	0.01	0.01	0.05	0.08	0.08	0.03	0.04	0.08	0.21

Table 2.42—Incidental catch of members of the former "Other Species" complex.

Species Common Name	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
octopus, North Pacific									conf	conf	conf	0.73	0.81	0.82	0.88
Pacific sleeper shark									conf	conf	0.05	0.09	0.50	0.56	0.60
shark, other												conf	0.66	0.35	0.52
shark, salmon									conf				conf	conf	0.07
shark, spiny dogfish										0.91	0.42	0.92	0.99	0.97	0.98
skate, Alaskan															
skate, big														0.84	0.72
skate, longnose												conf	0.71	0.55	0.97
skate, other									0.16	0.04	conf	0.43	0.81	0.85	0.85
squid, majestic	0.01	0.03	0.00	0.28	0.00	conf	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.01	0.00

Species Common Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
octopus, North Pacific	0.94	0.89	0.90	0.66	0.86	0.97	0.95	0.98	0.97	0.95	0.95	0.95	0.83	0.79
Pacific sleeper shark	0.41	0.20	0.17	0.30	0.60	0.54	0.26	0.42	0.65	0.64	0.56	0.59	0.56	0.54
shark, other	0.01	0.16	0.42	0.72	0.92	1.00	0.61	1.00	1.00	0.76	1.00	0.96	conf	conf
shark, salmon	0.02							conf		conf	0.05		conf	0.01
shark, spiny dogfish	0.97	0.83	0.63	0.95	0.93	0.94	0.98	0.80	0.88	0.89	0.88	0.92	0.90	0.94
skate, Alaskan					0.26									
skate, big	0.92	0.73	0.71	0.51	0.73									
skate, longnose	0.67	0.37	1.00	0.67	0.49									
skate, other	0.78	0.75	0.70	0.67	0.94	0.78	0.78	0.80	0.83	0.90	0.92	0.90	0.86	0.68
squid, majestic	conf	0.00	conf	conf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table 2.43—Incidental catch of prohibited species. Bycatch units are tons for halibut and herring; numbers of individuals for crab and salmon.

Species Group Name	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Bairdi Tanner Crab	0.20	0.10	0.07	0.13	0.14	0.22	0.15	0.10	0.17	0.16	0.14	0.29	0.24	0.31	0.19
Blue King Crab													0.91	0.94	0.95
Chinook Salmon	0.09	0.12	0.13	0.18	0.34	0.09	0.09	0.04	0.14	0.20	0.08	0.04	0.04	0.09	0.04
Golden (Brown) King Crab													0.01	0.00	0.21
Halibut	0.52	0.64	0.49	0.67	0.71	0.74	0.71	0.68	0.66	0.69	0.63	0.67	0.67	0.71	0.64
Herring	conf	0.01	0.03	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.01	0.03
Non-Chinook Salmon	0.00	0.00	0.00	0.01	0.04	0.00	0.01	0.01	0.00	0.00	0.03	0.01	0.01	0.01	0.00
Opilio Tanner (Snow) Crab	0.02	0.02	0.02	0.04	0.05	0.10	0.17	0.17	0.33	0.12	0.12	0.34	0.27	0.14	0.08
Other King Crab	0.02	0.12	0.01	0.08	0.16	0.66	0.54	0.73	0.35	0.33	0.58	0.69			
Red King Crab	0.31	0.07	0.01	0.01	0.17	0.78	0.36	0.23	0.18	0.38	0.26	0.32	0.14	0.14	0.16
Species Group Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Bairdi Tanner Crab	0.41	0.60	0.67	0.54	0.40	0.21	0.22	0.26	0.50	0.61	0.61	0.51	0.58	0.35	
Blue King Crab	0.70	1.00	0.87	0.89	1.00	0.60	0.80	0.37	0.74	0.84	0.83	0.99	0.93	0.80	
Chinook Salmon	0.03	0.04	0.03	0.02	0.04	0.00	0.05	0.04	0.05	0.05	0.08	0.05	0.08	0.05	
Golden (Brown) King Crab	0.01	0.00	0.00	0.01	0.02	0.00	0.02	0.03	0.03	0.02	0.02	0.71	0.09	0.10	
Halibut	0.67	0.62	0.55	0.60	0.65	0.68	0.69	0.67	0.64	0.67	0.62	0.73	0.68	0.60	
Herring	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	
Non-Chinook Salmon	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Opilio Tanner (Snow) Crab	0.34	0.54	0.47	0.54	0.24	0.16	0.08	0.06	0.20	0.23	0.21	0.49	0.04	0.17	
Other King Crab															
Red King Crab	0.15	0.33	0.29	0.10	0.06	0.35	0.26	0.76	0.82	0.90	0.40	0.37	0.91	0.52	

Species Group Name	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Halibut				0.46	0.50	0.53	0.47	0.44	0.46	0.42	0.34	0.43	0.47	0.55	0.49
Species Group Name	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Halibut	0.48	0.39	0.26	0.23	0.25	0.27	0.31	0.26	0.23	0.27	0.25	0.24	0.20	0.22	

Table 2.44 (page 1 of 2)—Incidental catch of nontarget species in the Pacific cod fisheries.

Species Group Name	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Benthic urochordata	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.04	0.20	0.28	0.21	0.30	0.27	0.05	0.07	0.51	0.03
Bivalves	0.42	0.85	0.74	0.77	0.62	0.85	0.85	0.47	0.82	0.92	0.89	0.80	0.81	0.77	0.86	0.80	0.54
Bristlemouths																	
Brittle star Unid.	0.02	0.02	0.01	0.02	0.04	0.01	0.05	0.01	0.07	0.06	0.09	0.04	0.08	0.05	0.40	0.12	0.02
Capelin		0.02			0.00	0.00		0.00	0.00	0.00	0.11	0.02	0.00		0.00		
Corals Bryozoans - Corals Bryozoans Unid.	0.51	0.48	0.40	0.10	0.88	0.15	0.85	0.24	0.50	0.92	0.25	0.48	0.60	0.37	0.81	0.32	0.21
Corals Bryozoans - Red Tree Coral	0.90	0.66	0.46	0.01	0.99	conf	0.09								1.00		
Dark Rockfish						0.98	0.96										
Deep sea smelts (bathylagidae)																	
Eelpouts	0.23	0.37	0.47	0.30	0.11	0.09	0.04	0.05	0.05	0.14	0.16	0.28	0.58	0.50	0.62	0.49	0.14
Eulachon		0.00	0.00	conf	0.00	0.00		0.00	conf	0.00			0.00		0.00		
Giant Grenadier	0.03	0.08	0.12	0.06	0.07	0.08	0.07	0.14	0.29	0.21	0.11	0.20	0.04	0.16	0.11	0.19	0.14
Greenlings	0.75	0.66	0.58	0.65	0.20	0.73	0.74	0.78	0.64	0.77	1.00	0.84	0.69	0.62	0.53	0.37	0.30
Grenadier - Pacific Grenadier		0.70	0.00					0.05									
Grenadier - Ratail Grenadier Unid.	0.09	0.11	0.14	0.10	0.23	0.40	0.08										
Grenadier - Rattail Grenadier Unid.								0.15	0.04	0.04	0.76	0.07	0.62	0.11	0.01		0.06
Gunnels		1.00	1.00		0.03									0.01			
Hermit crab Unid.	0.05	0.05	0.02	0.04	0.03	0.03	0.06	0.02	0.03	0.06	0.08	0.07	0.15	0.17	0.37	0.32	0.41
Invertebrate Unid.	0.03	0.01	0.01	0.08	0.22	0.02	0.24	0.41	0.38	0.21	0.25	0.31	0.28	0.51	0.47	0.51	0.09
Lanternfishes (myctophidae)		0.06														0.05	
Large Sculpins	0.62	0.60	0.50	0.45	0.37												
Large Sculpins - Bigmouth Sculpin						0.35	0.46										
Large Sculpins - Brown Irish Lord						1.00	1.00										
Large Sculpins - Great Sculpin						0.19	0.16										
Large Sculpins - Hemilepidotus Unid.						0.90	0.99										
Large Sculpins - Myoxocephalus Unid.						0.24	0.62										
Large Sculpins - Plain Sculpin						0.01	0.01										
Large Sculpins - Red Irish Lord						0.11	0.64										
Large Sculpins - Warty Sculpin						0.22	0.15										
Large Sculpins - Yellow Irish Lord						0.52	0.33										
Misc crabs	0.15	0.12	0.16	0.46	0.38	0.18	0.12	0.19	0.11	0.15	0.20	0.22	0.20	0.16	0.42	0.45	0.20
Misc crustaceans	0.26	0.21	0.51	0.17	0.21	0.03	0.02	0.05	0.04	0.03	0.11	0.09	0.06	0.15	0.02	0.02	0.10
Misc deep fish																	
Misc fish	0.48	0.43	0.40	0.28	0.19	0.15	0.19	0.20	0.24	0.36	0.24	0.62	0.45	0.52	0.27	0.33	0.24
Misc inverts (worms etc)	0.07	0.02	0.01	0.06	0.33	0.01	conf	0.00	0.01	0.00	conf	0.02	0.03		0.00		0.00
Other Sculpins	0.49	0.65	0.56	0.57	0.41	0.70	0.59										
Other osmerids	0.01	0.06	0.00	conf	0.00		0.00	0.00	0.00	0.00	conf		0.00		0.00		

Table 2.44 (page 2 of 2)—Incidental catch of nontarget species in the Pacific cod fisheries.

Species Group Name	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Pacific Hake																	
Pacific Sand lance	0.45	0.34	0.60	0.04	0.12	conf		conf	0.01	0.00		0.01	0.02	0.03	0.13	0.02	0.00
Pacific Sandfish								conf				0.07	0.19	0.31	0.95	0.14	
Pandalid shrimp	0.09	0.17	0.01	0.02	0.09	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Polychaete Unid.	0.13	0.02	0.73	0.00	0.01	0.00	0.10	0.04	0.08	0.37	0.04	0.29	0.42	0.48	0.03	0.00	0.00
Scypho jellies	0.10	0.09	0.07	0.02	0.04	0.01	0.01	0.01	0.02	0.02	0.05	0.01	0.02	0.01	0.01	0.02	0.01
Sea anemone Unid.	0.68	0.62	0.86	0.79	0.35	0.51	0.74	0.62	0.76	0.86	0.76	0.81	0.86	0.88	0.80	0.71	0.46
Sea pens whips	0.87	0.90	0.93	0.87	0.63	0.86	0.92	0.87	0.90	0.91	0.96	0.96	0.96	0.96	0.95	0.91	0.93
Sea star	0.11	0.14	0.16	0.12	0.09	0.07	0.15	0.11	0.09	0.20	0.16	0.23	0.21	0.19	0.26	0.14	0.15
Snails	0.13	0.07	0.10	0.08	0.10	0.09	0.25	0.17	0.17	0.25	0.31	0.43	0.46	0.69	0.66	0.70	0.63
Sponge Unid.	0.03	0.10	0.07	0.15	0.08	0.08	0.07	0.03	0.06	0.15	0.09	0.09	0.17	0.15	0.18	0.27	0.19
Squid																	0.00
State-managed Rockfish								0.96	0.98	0.79	0.98	0.28	0.77	0.23	0.67	0.27	0.02
Stichaeidae	0.17	0.06	0.14	conf	0.01	0.04	0.00	0.00					0.03			0.86	
Surf smelt																	
urchins dollars cucumbers	0.37	0.49	0.50	0.43	0.26	0.17	0.08	0.15	0.35	0.41	0.26	0.38	0.48	0.59	0.24	0.34	0.06

FIGURES

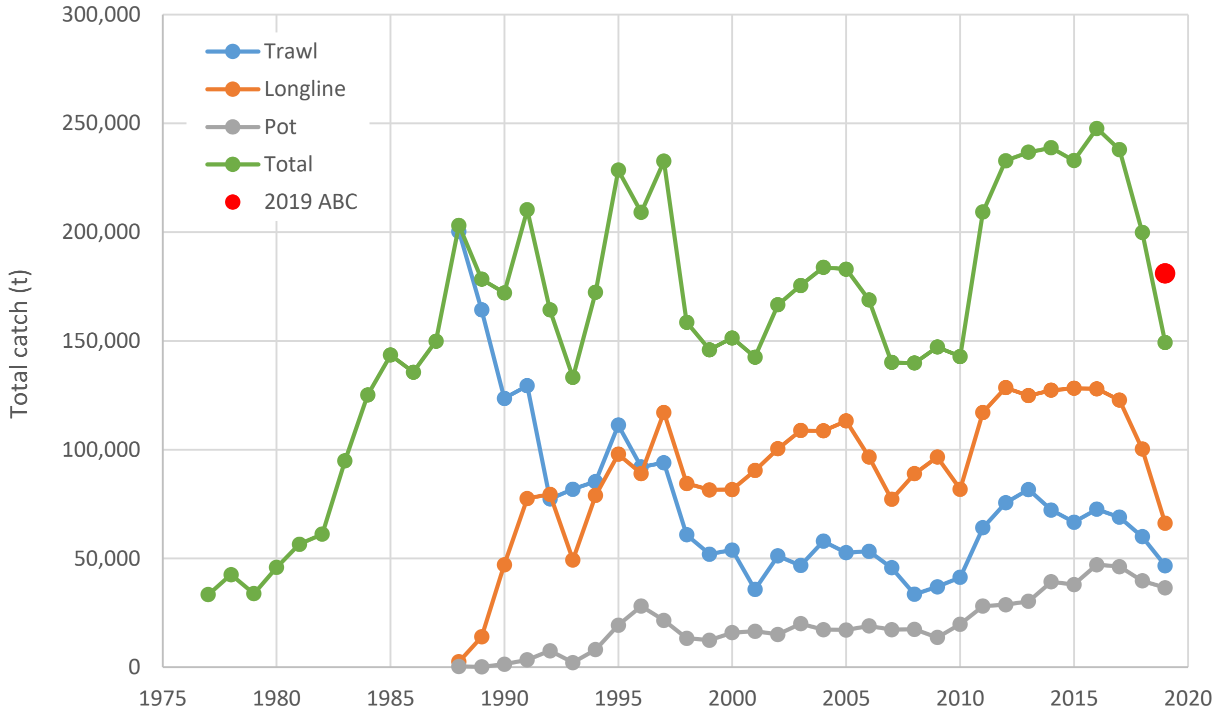


Figure 2.1. Total catch and catch by gear type.

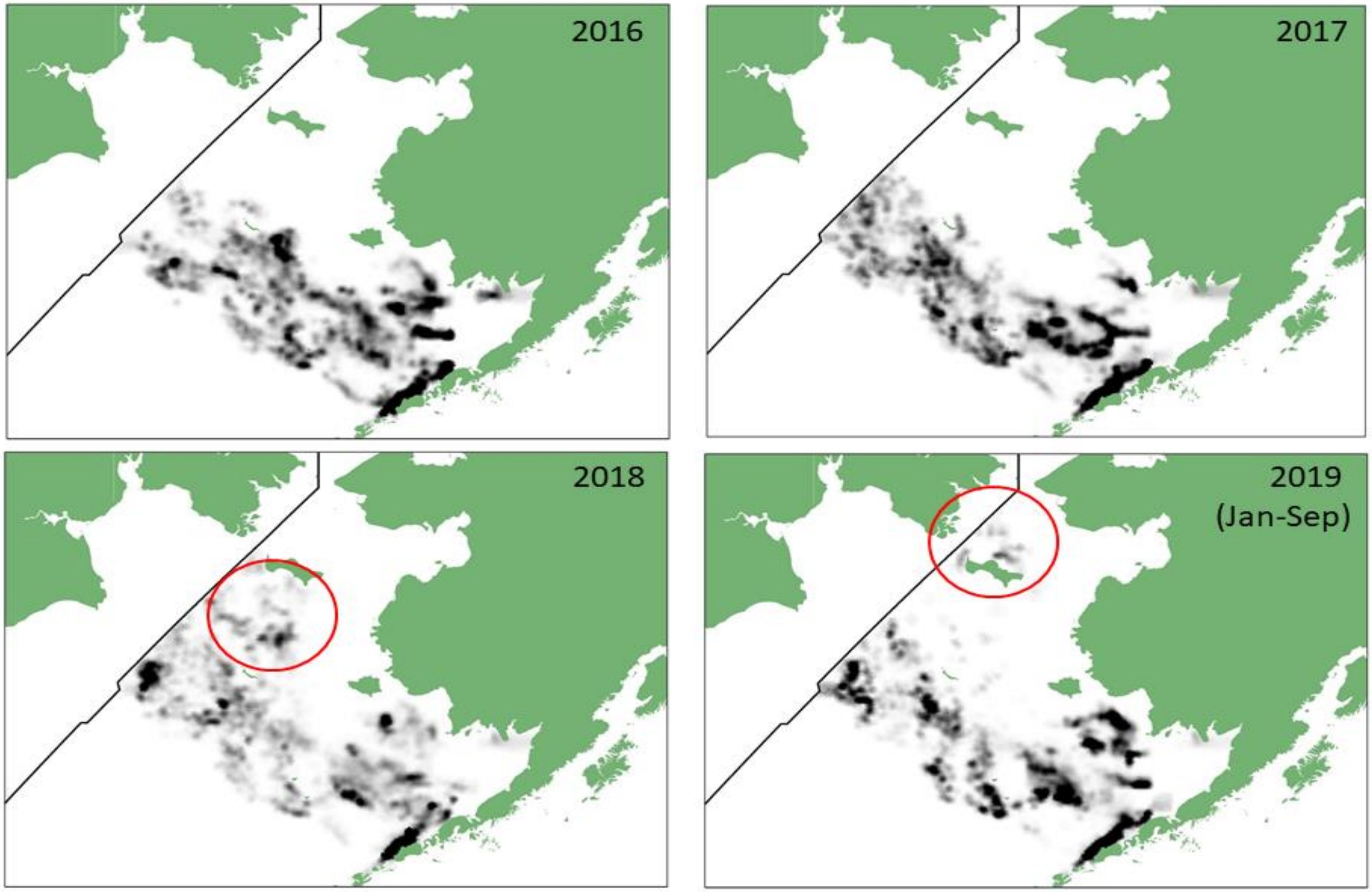


Figure 2.2. Geographic distribution of observed catch, 2016-2019.

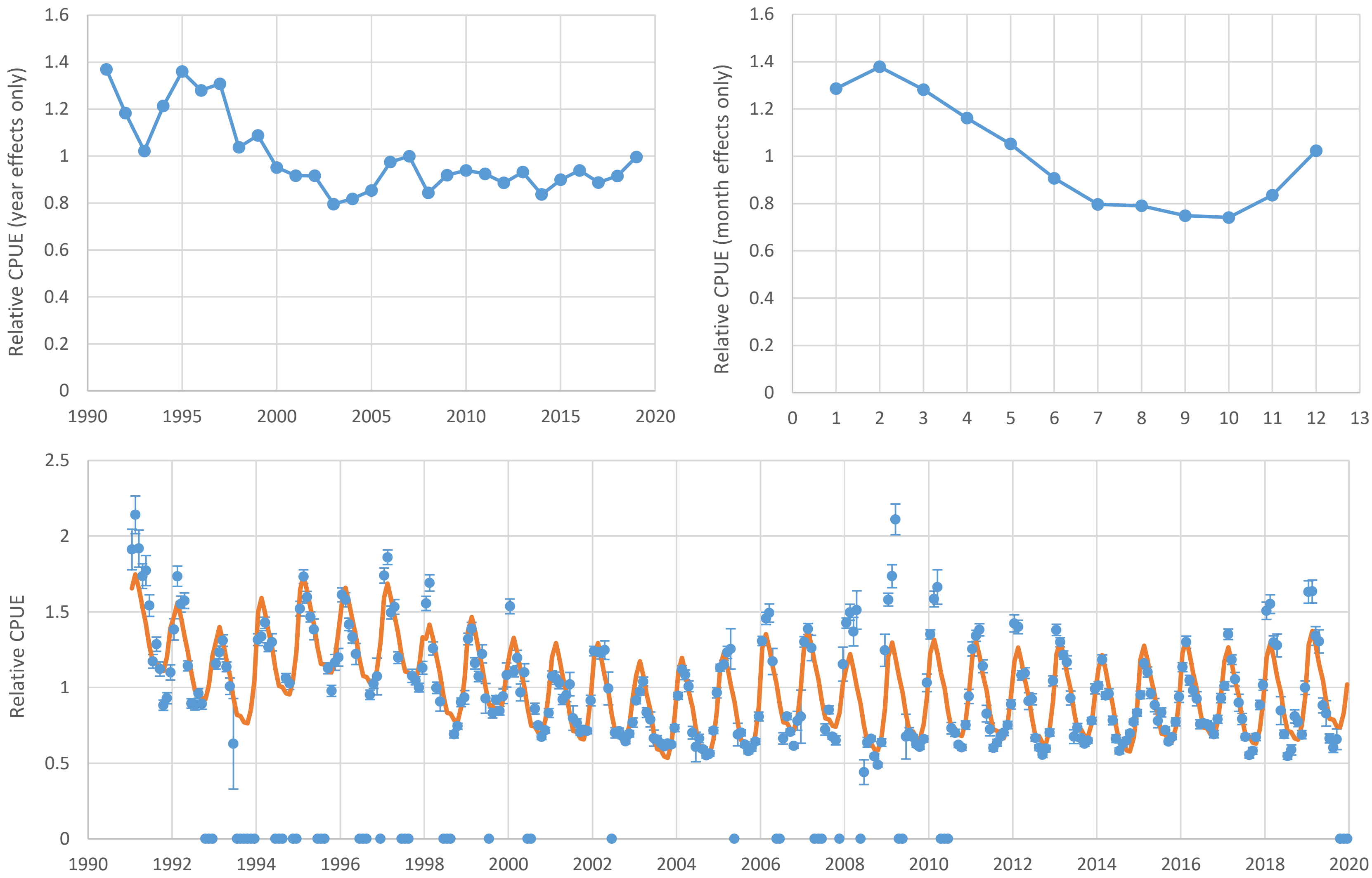


Figure 2.3. Longline fishery CPUE. Upper left panel: year effects, upper right panel: month effects, lower panel: monthly data and model fit.

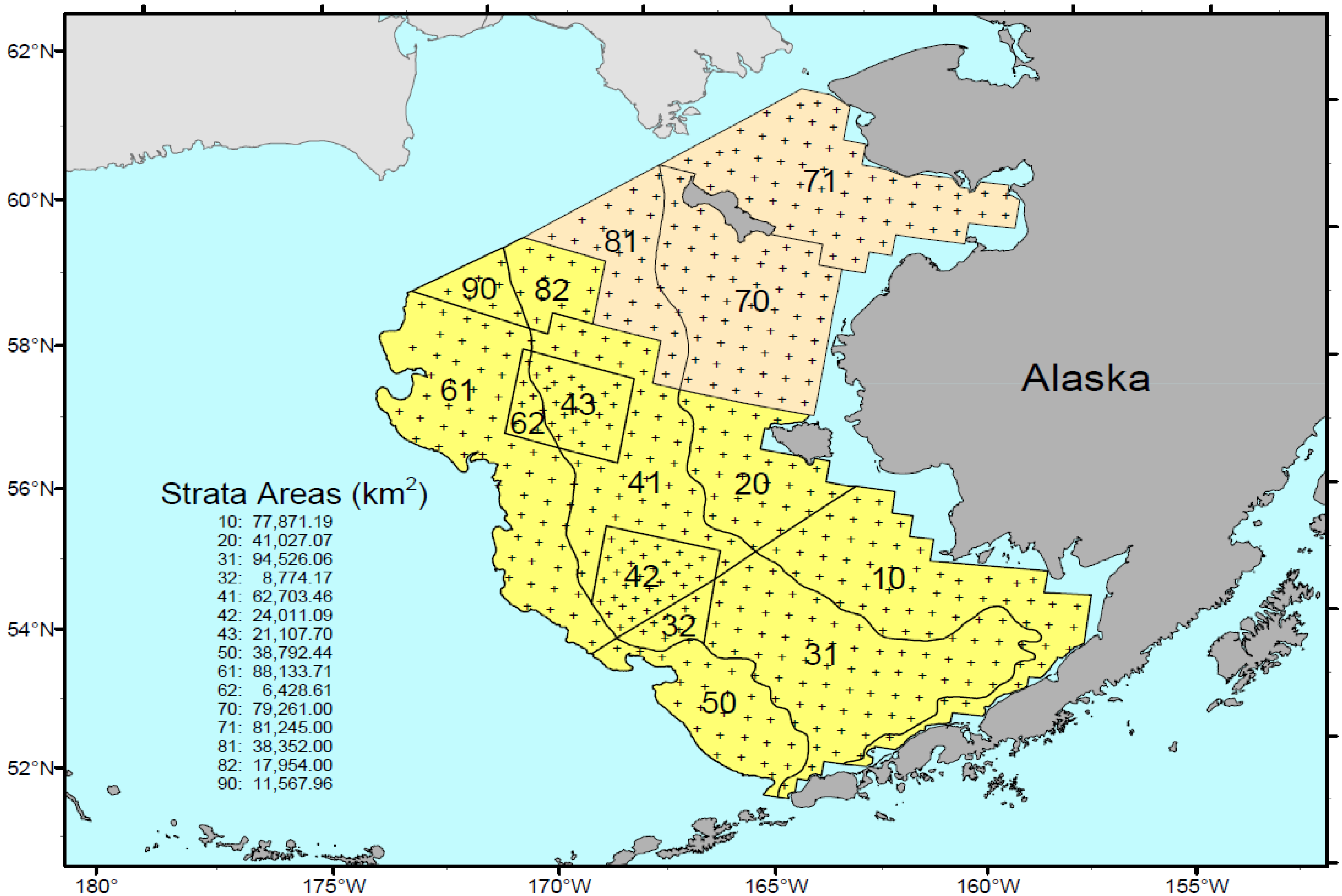


Figure 2.4. Map of EBS shelf (yellow) and NBS (tan) bottom trawl survey strata.

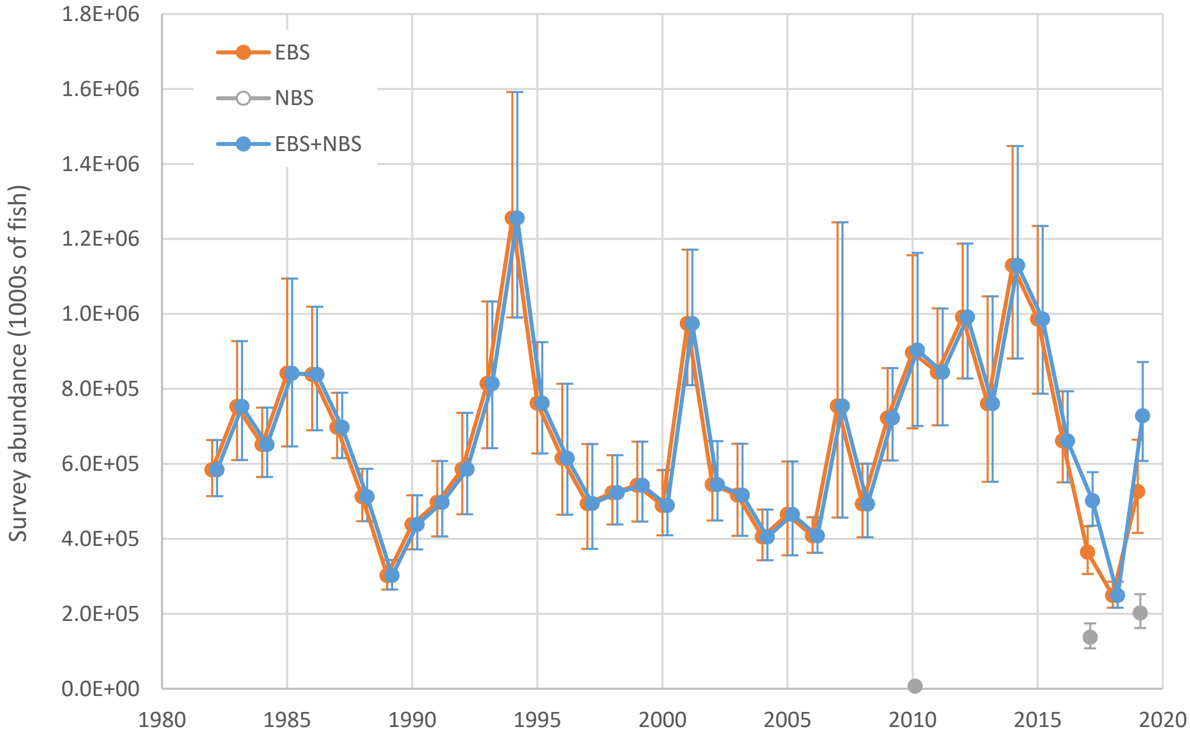


Figure 2.5. Trawl survey abundance time series (design-based).

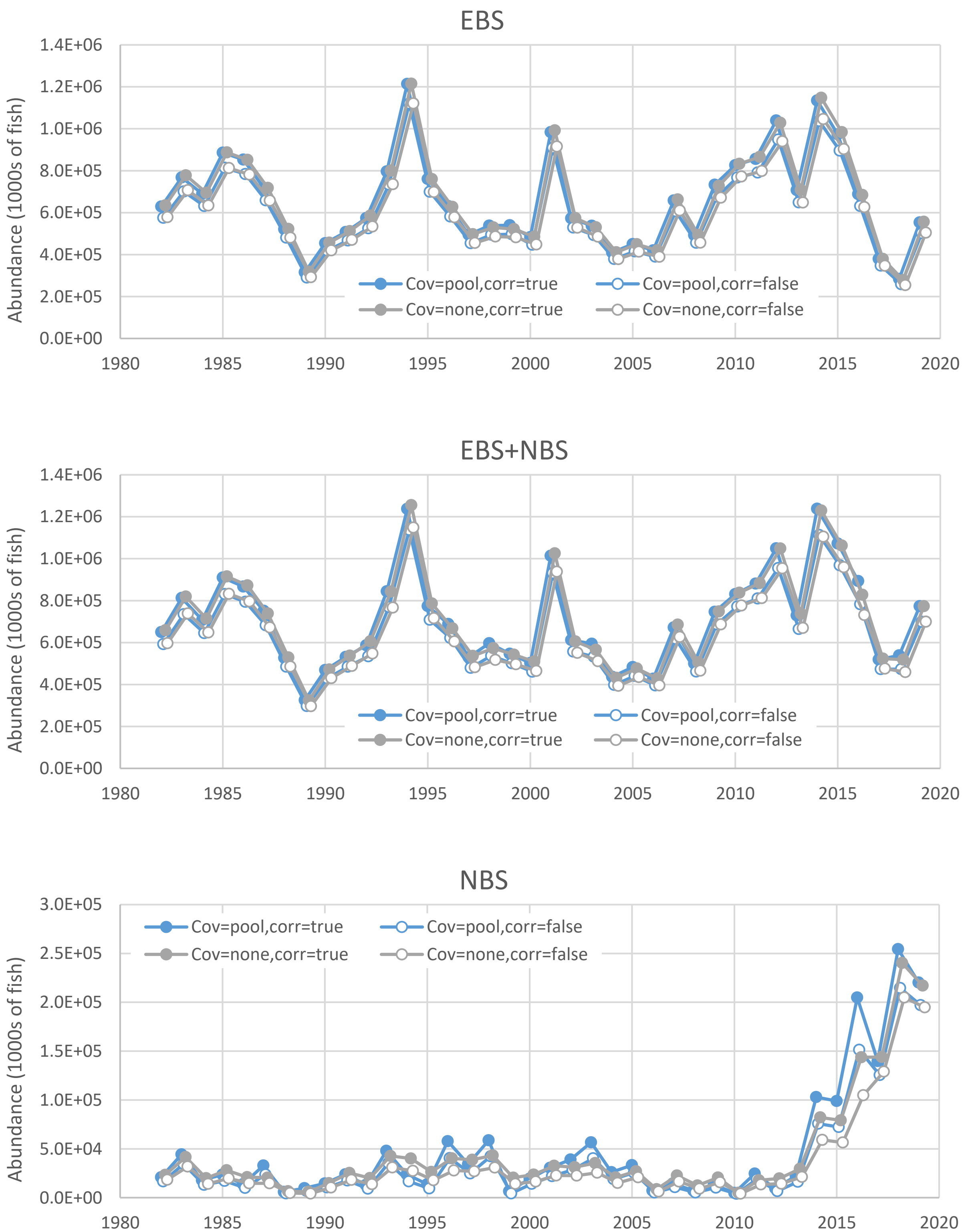


Figure 2.6. Trawl survey abundance alternatives (VAST).

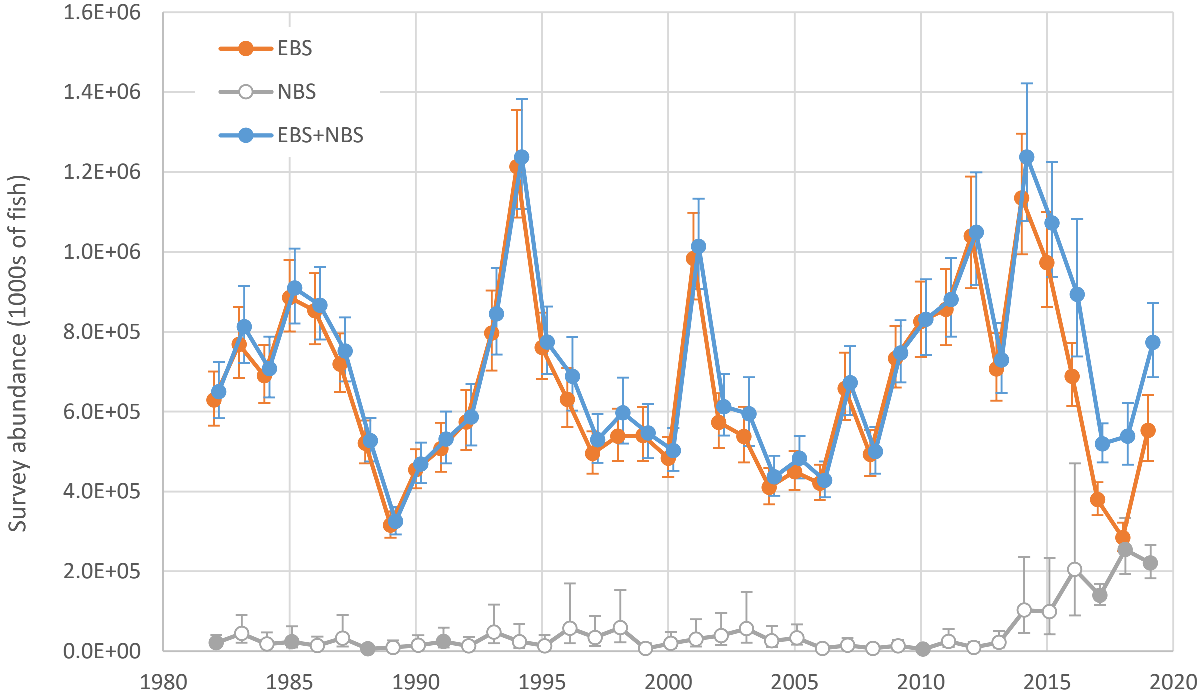


Figure 2.7. VAST survey indices (covariate = cold pool, bias correction = true).

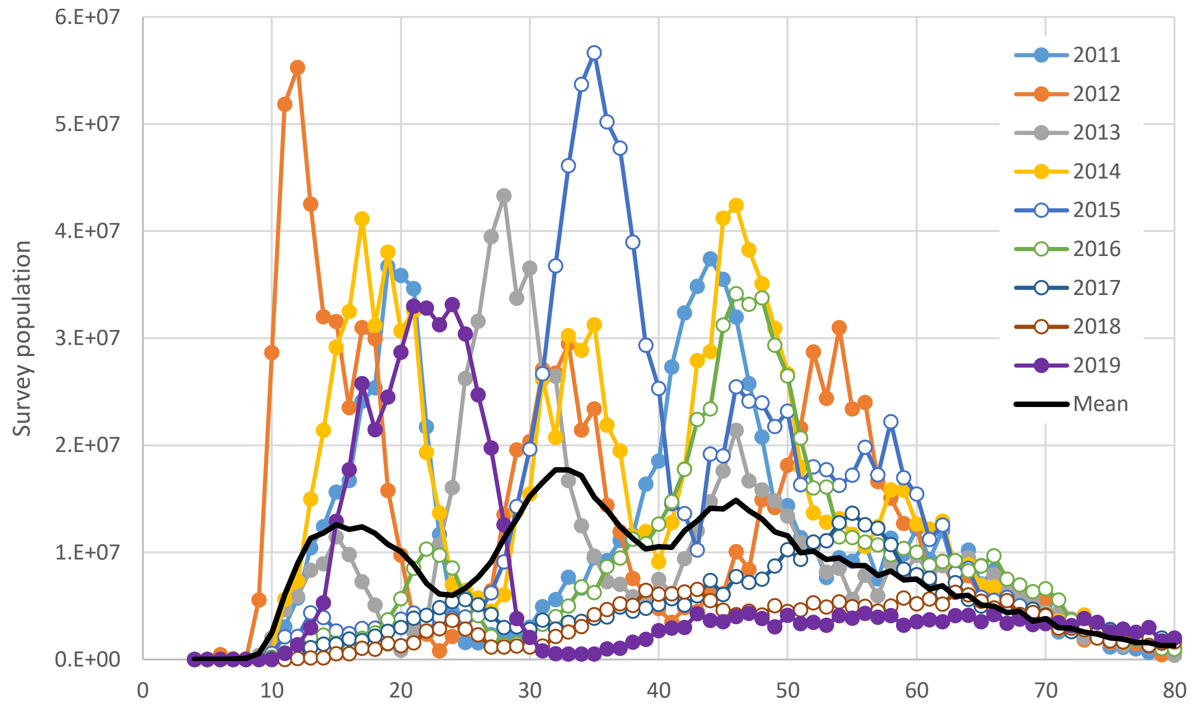


Figure 2.8a. Recent survey size compositions (EBS).

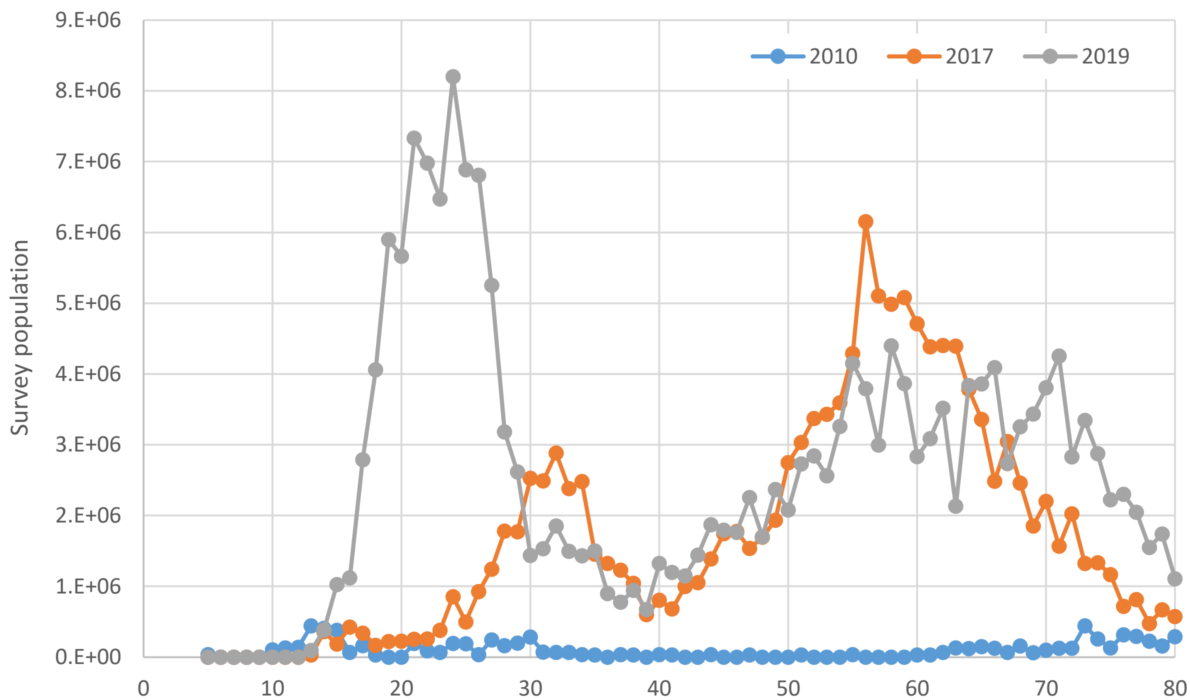


Figure 2.8b. Recent survey size compositions (NBS).

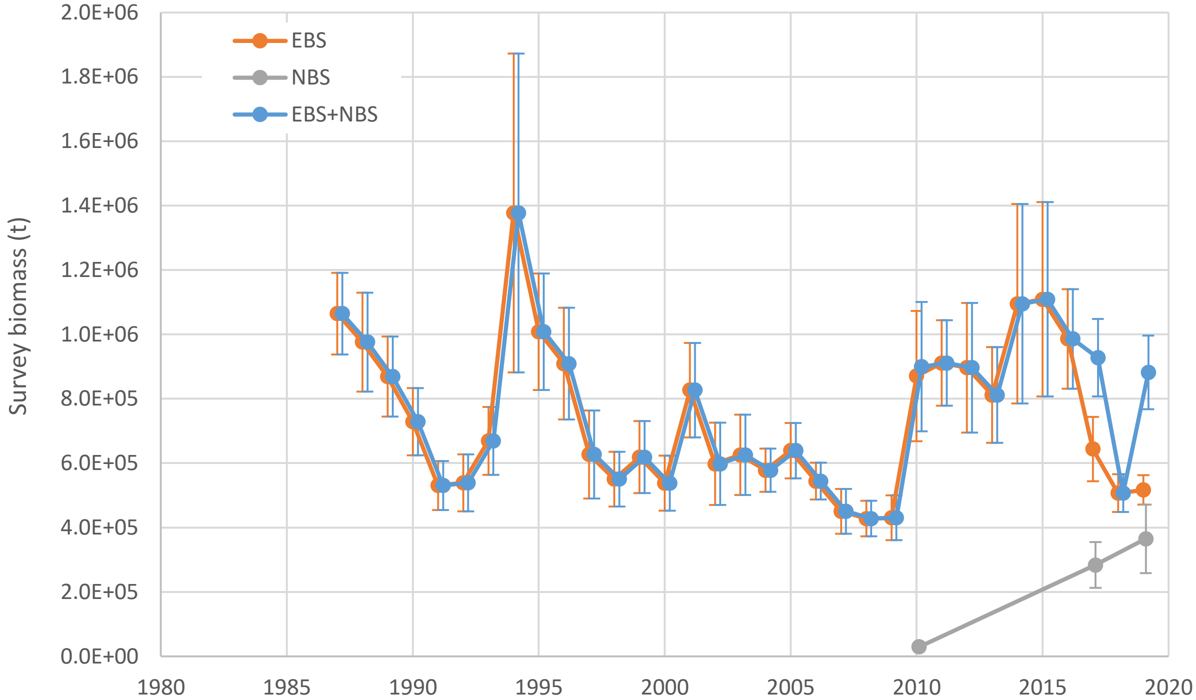


Figure 2.9. Survey biomass (design-based).

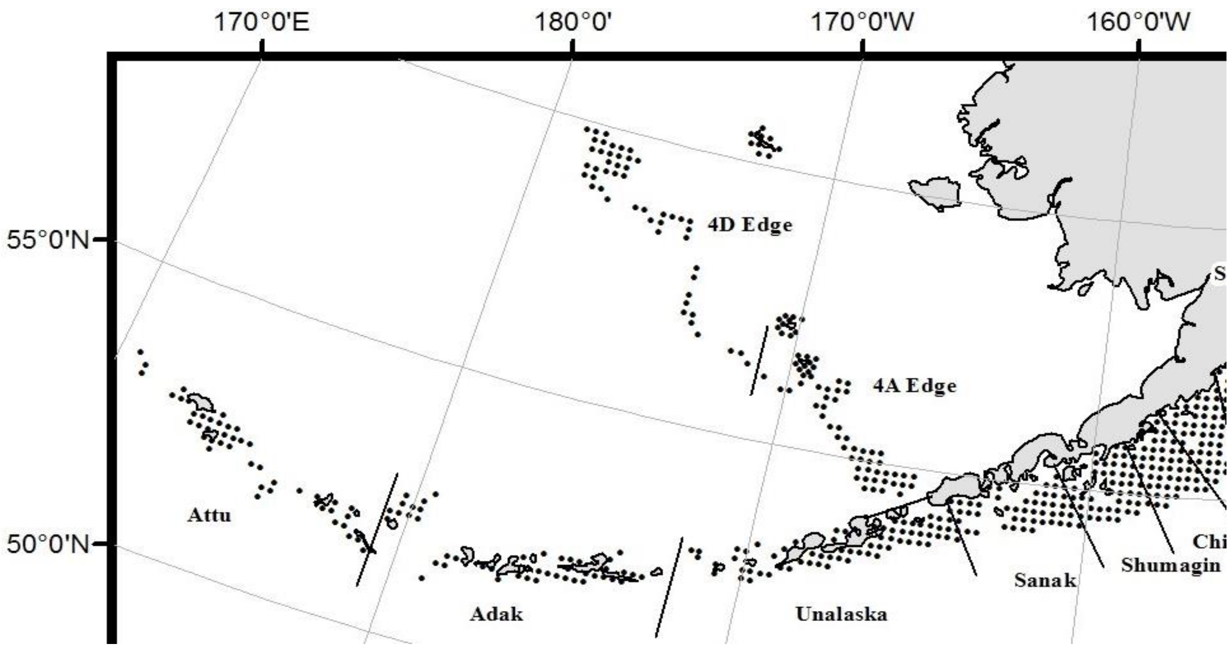


Figure 2.10a. Locations of IPHC survey stations in the BSAI region.

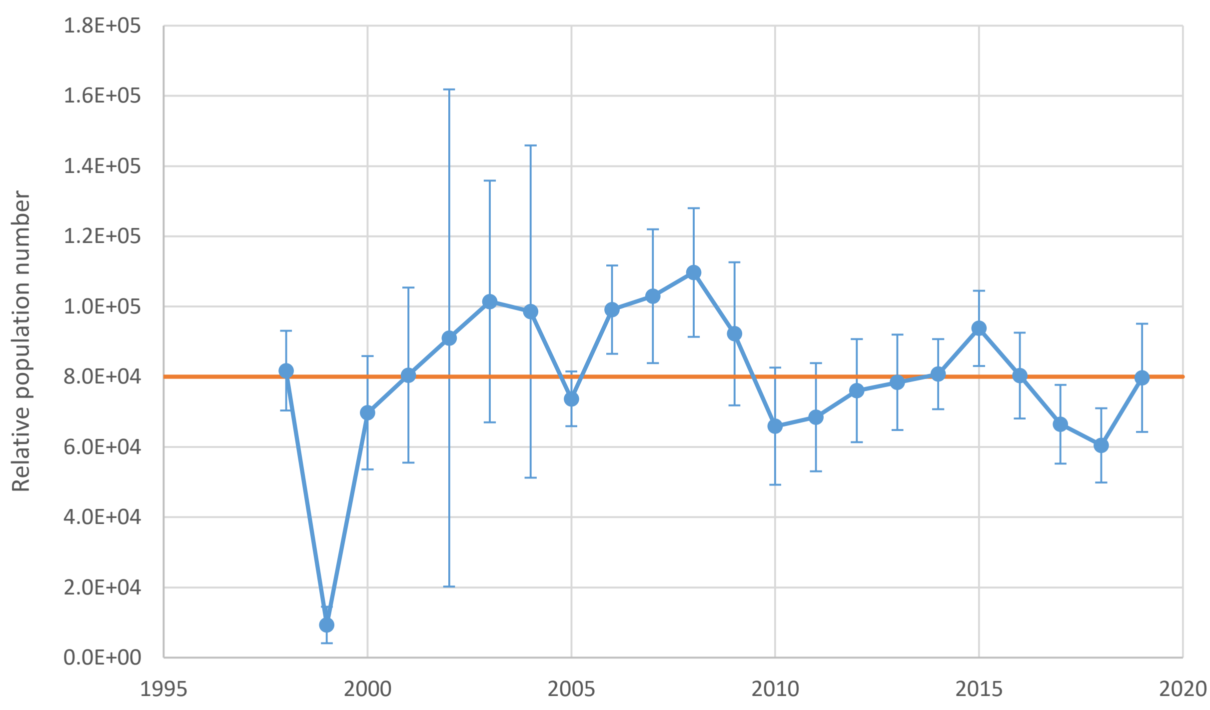


Figure 2.10b. IPHC survey relative population number.

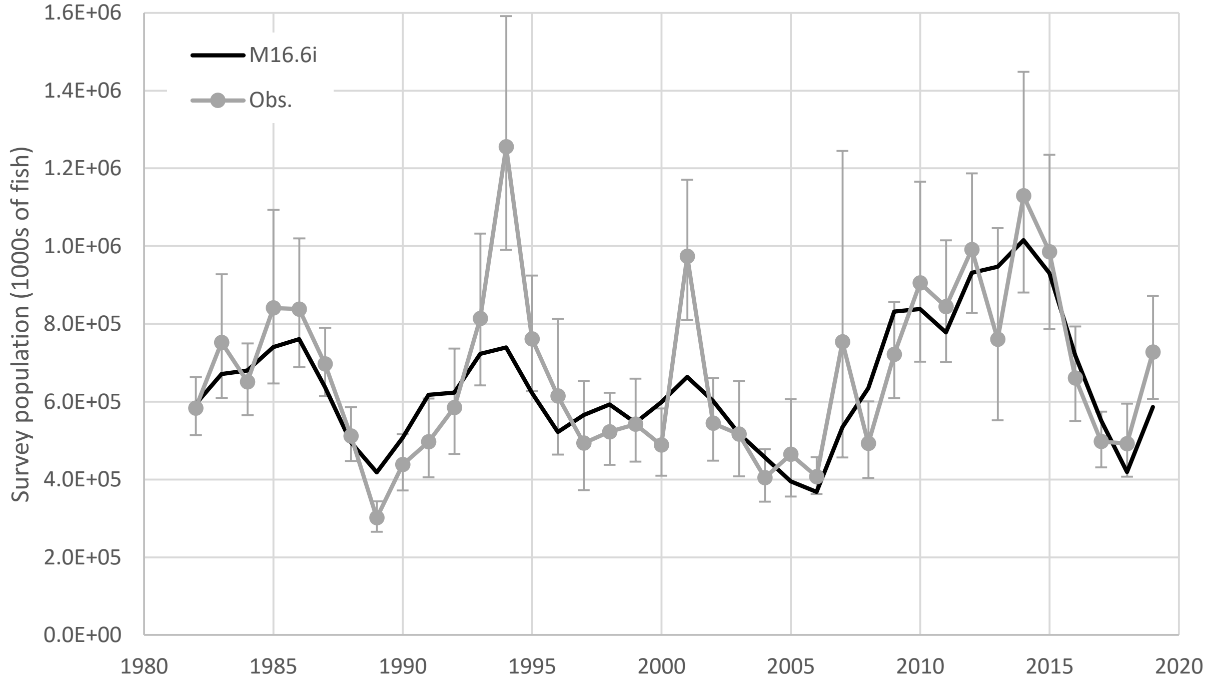


Figure 2.11a. Fit of the base model to the design-based EBS survey index.

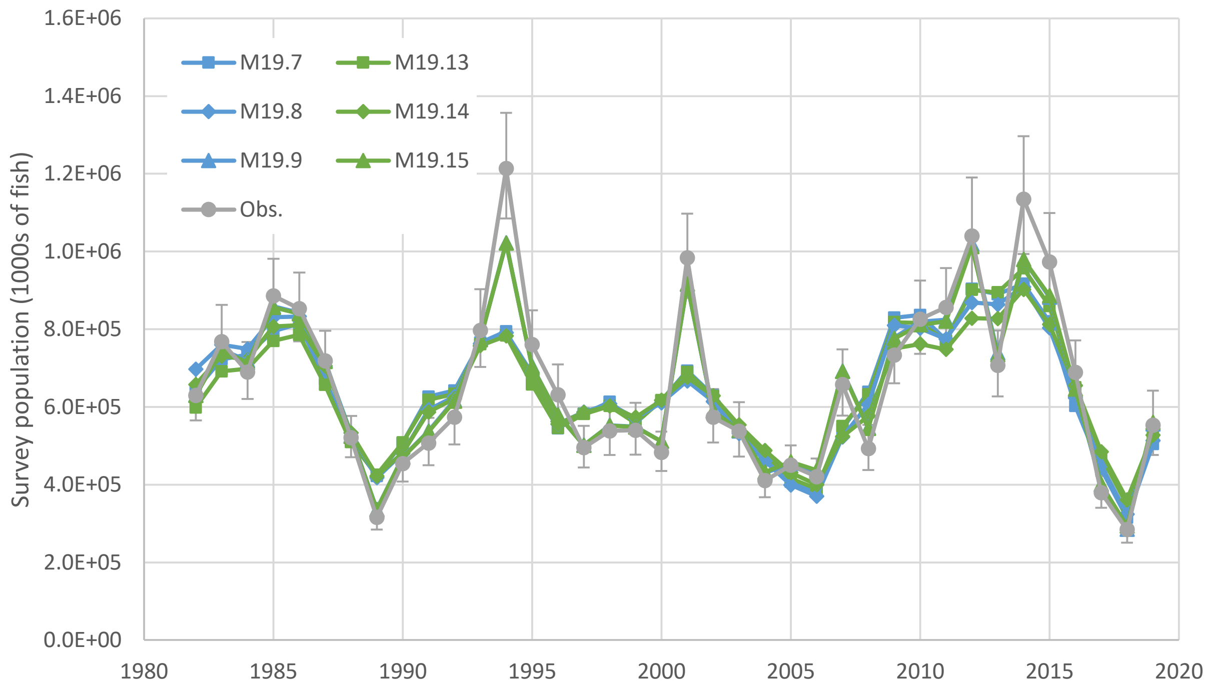


Figure 2.11b. Fits of the Hypothesis 1 and 3 models to the VAST EBS survey index.

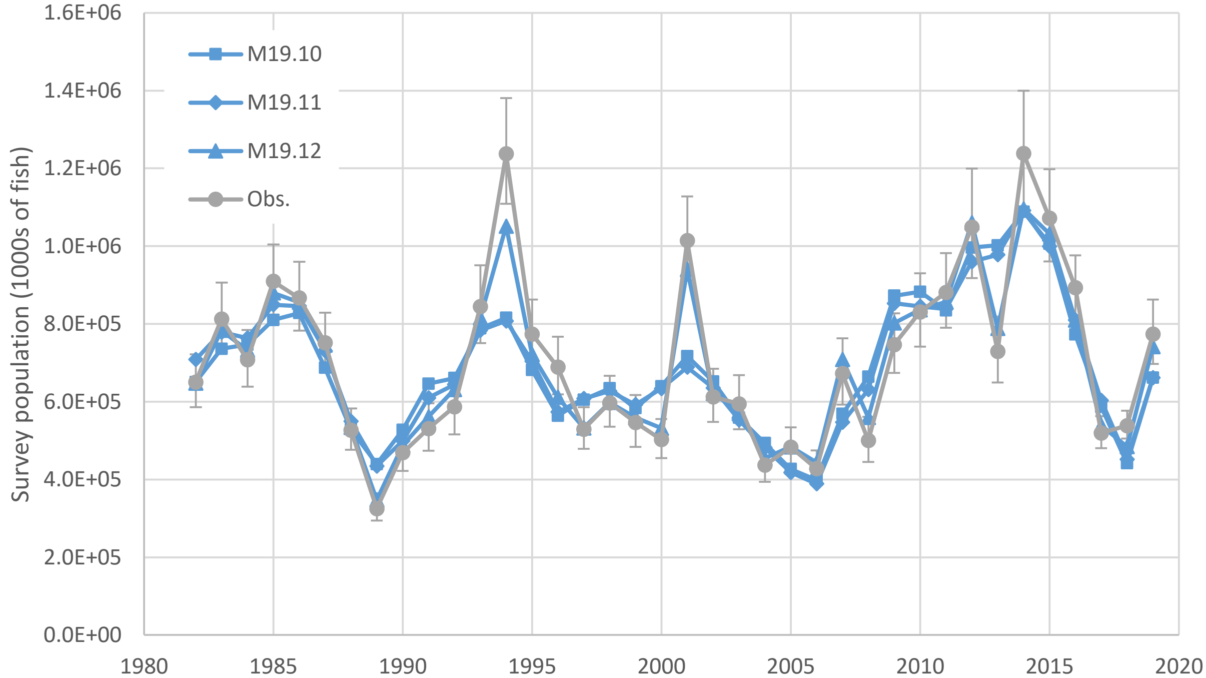


Figure 2.11c. Fits of the Hypothesis 2 models to the VAST combined EBS+NBS survey index.

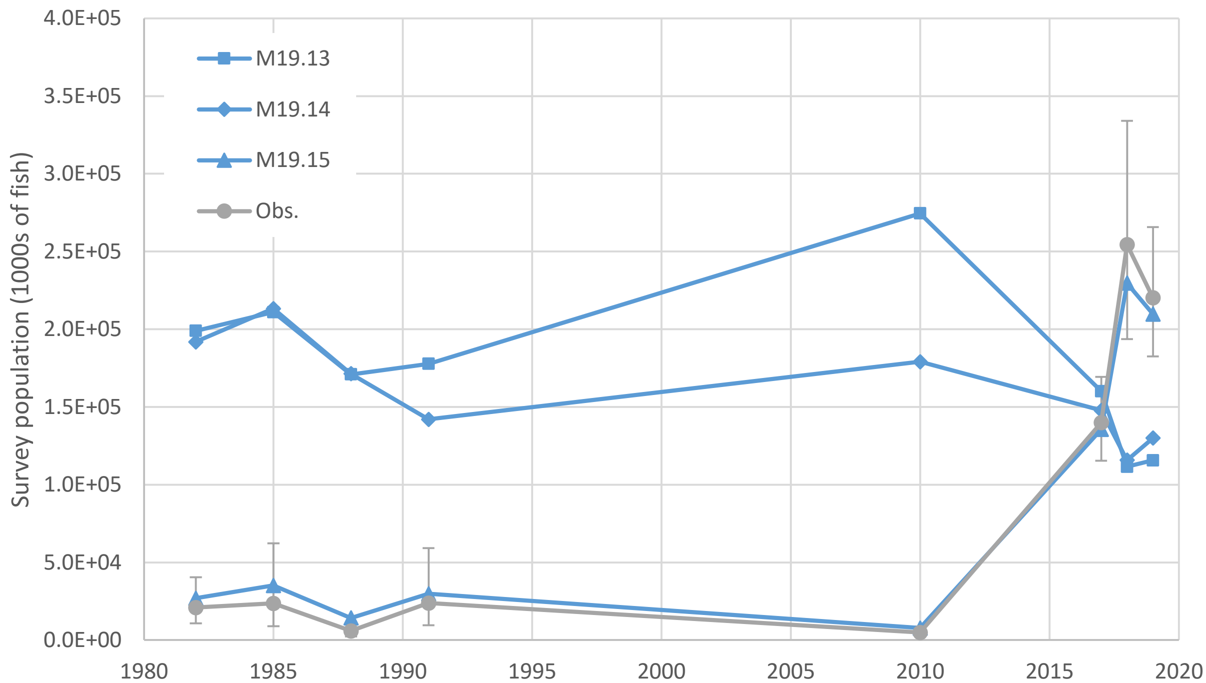


Figure 2.11d. Fits of the Hypothesis 3 models to the VAST NBS survey index.

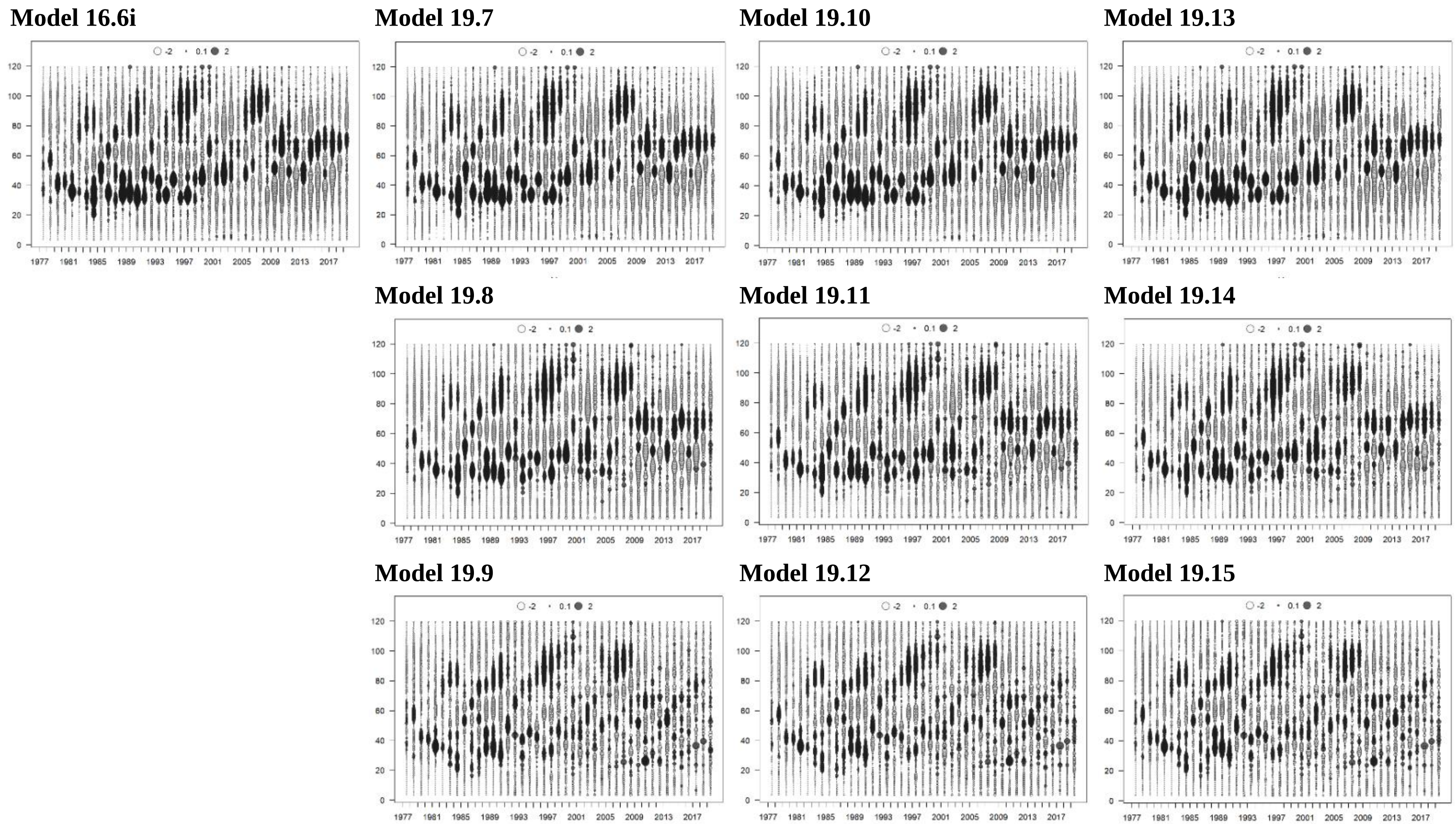


Figure 2.12a. Residual plots of model fits to the fishery size composition data.

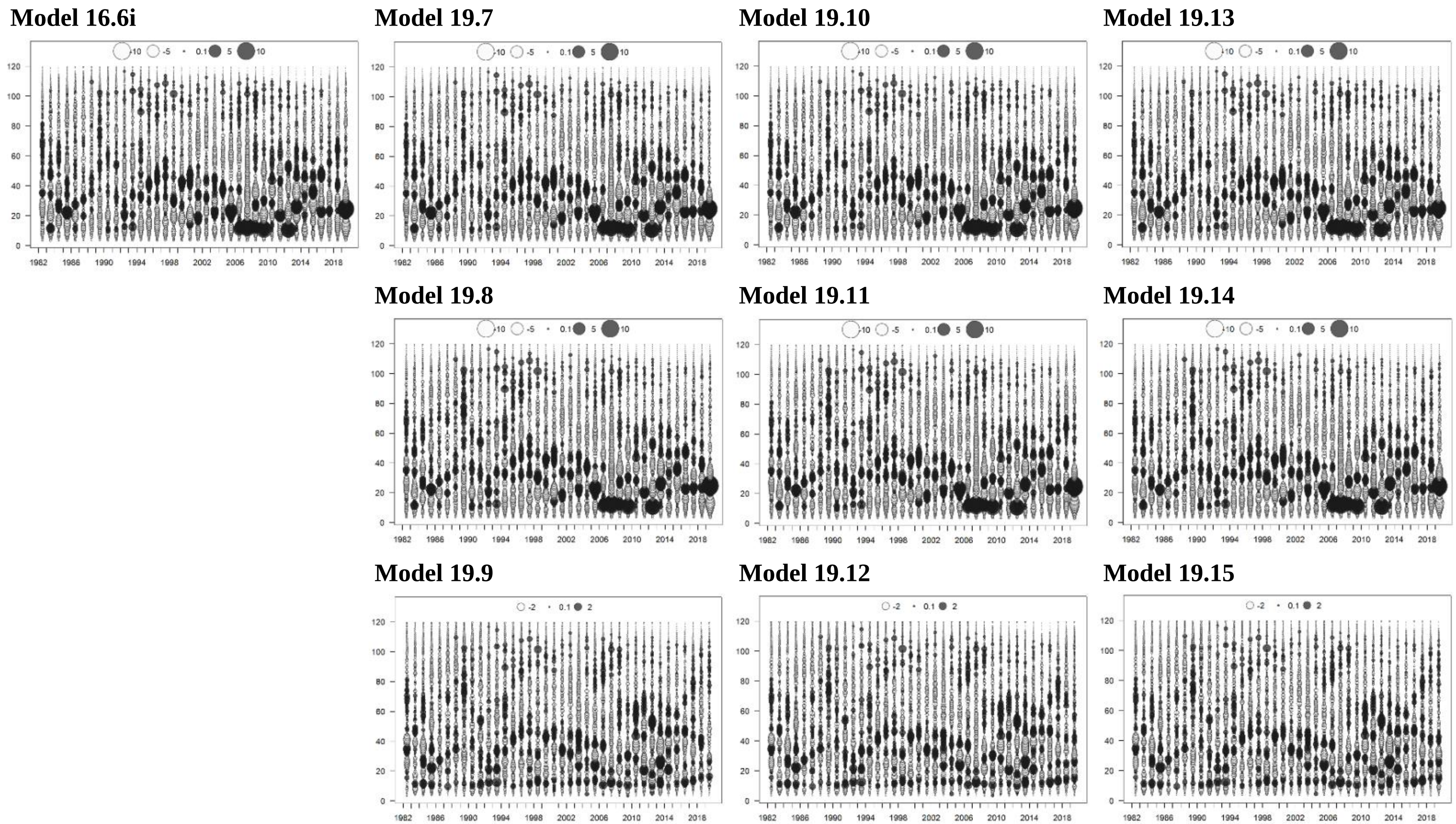


Figure 2.12b. Residual plots of model fits to the EBS (or combined EBS and NBS) survey size composition data.

Model 19.13 **Model 19.14** **Model 19.15**

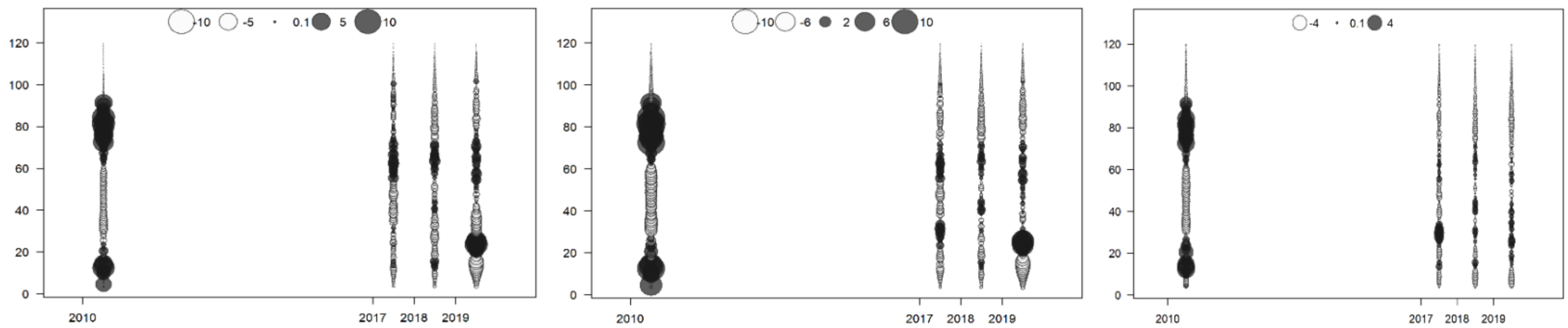


Figure 2.12c. Residual plots of model fits to the NBS survey size composition data.

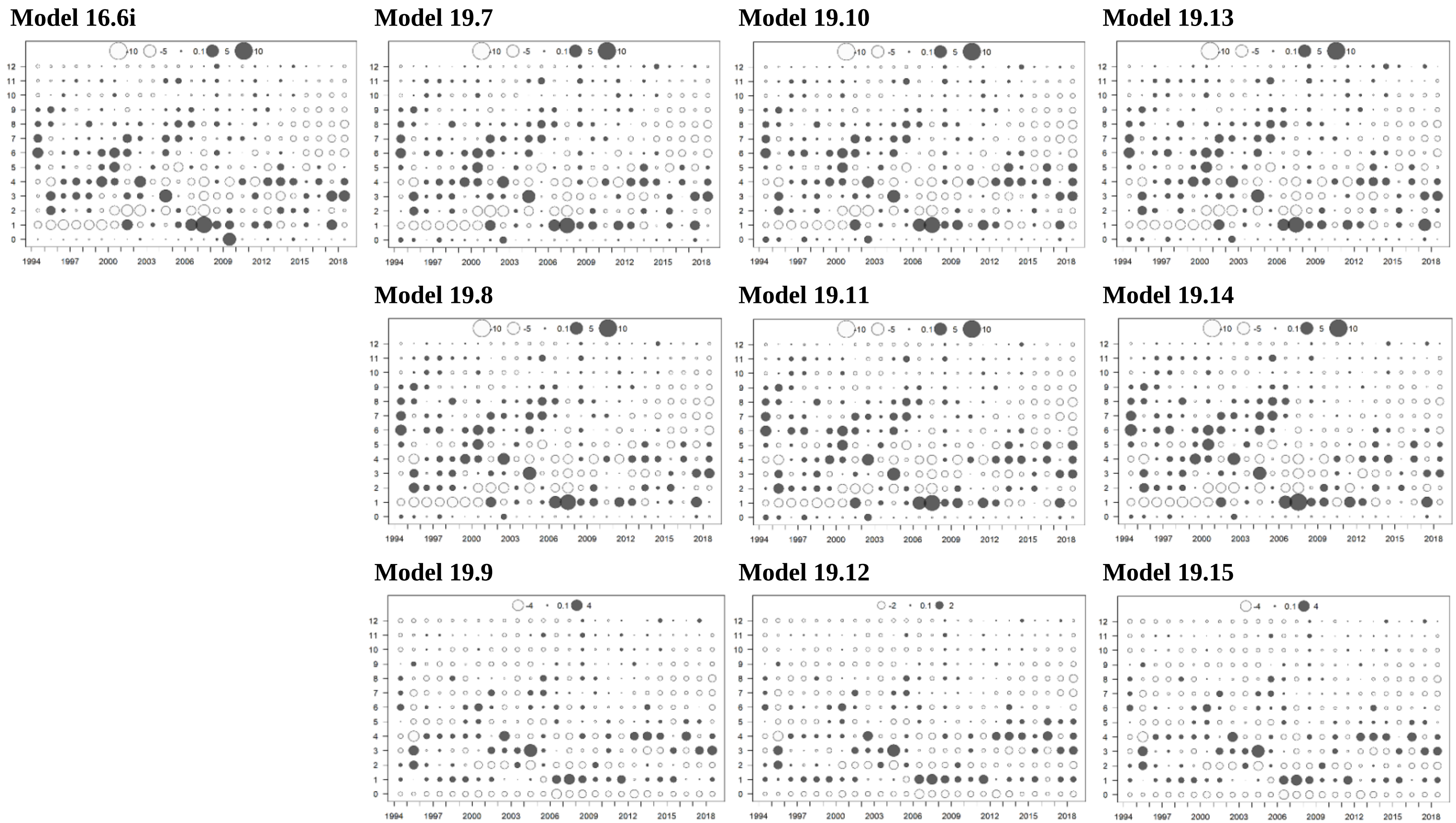


Figure 2.13a. Residual plots of model fits to the EBS (or combined EBS and NBS) survey age composition data.

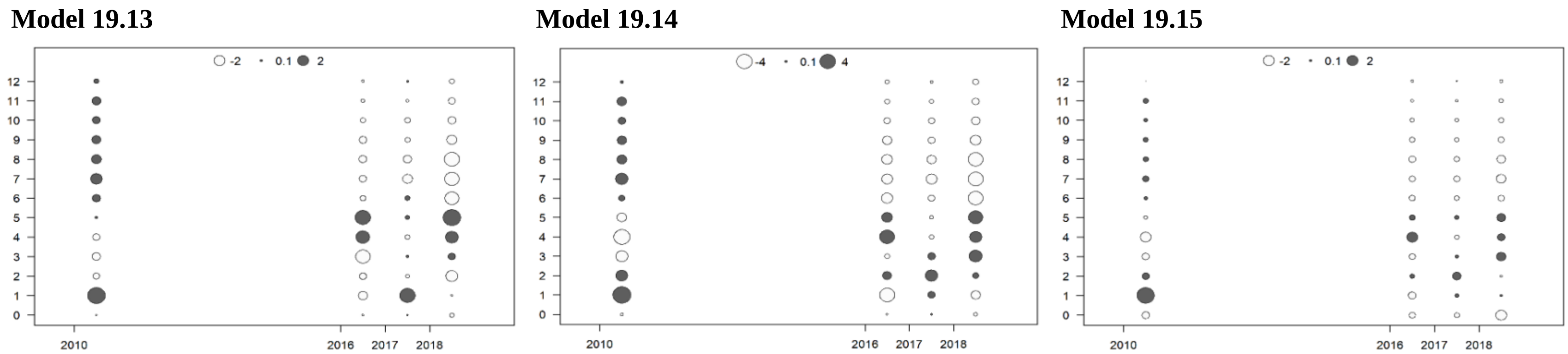


Figure 2.13b. Residual plots of model fits to the NBS survey age composition data.

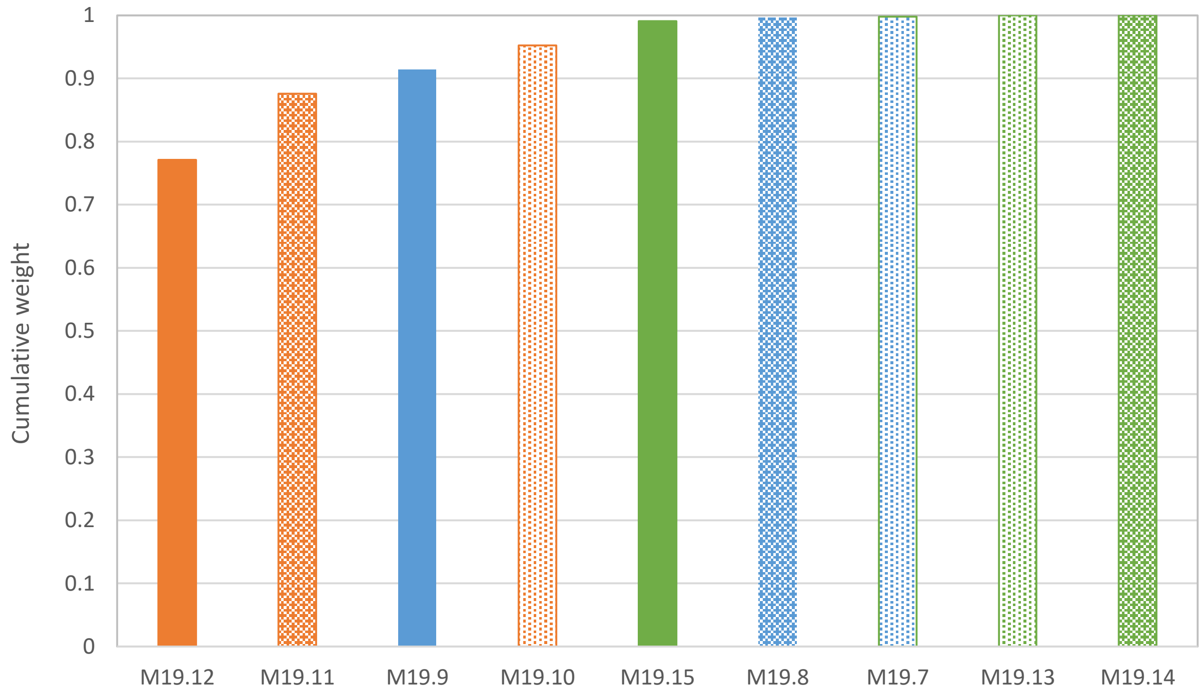
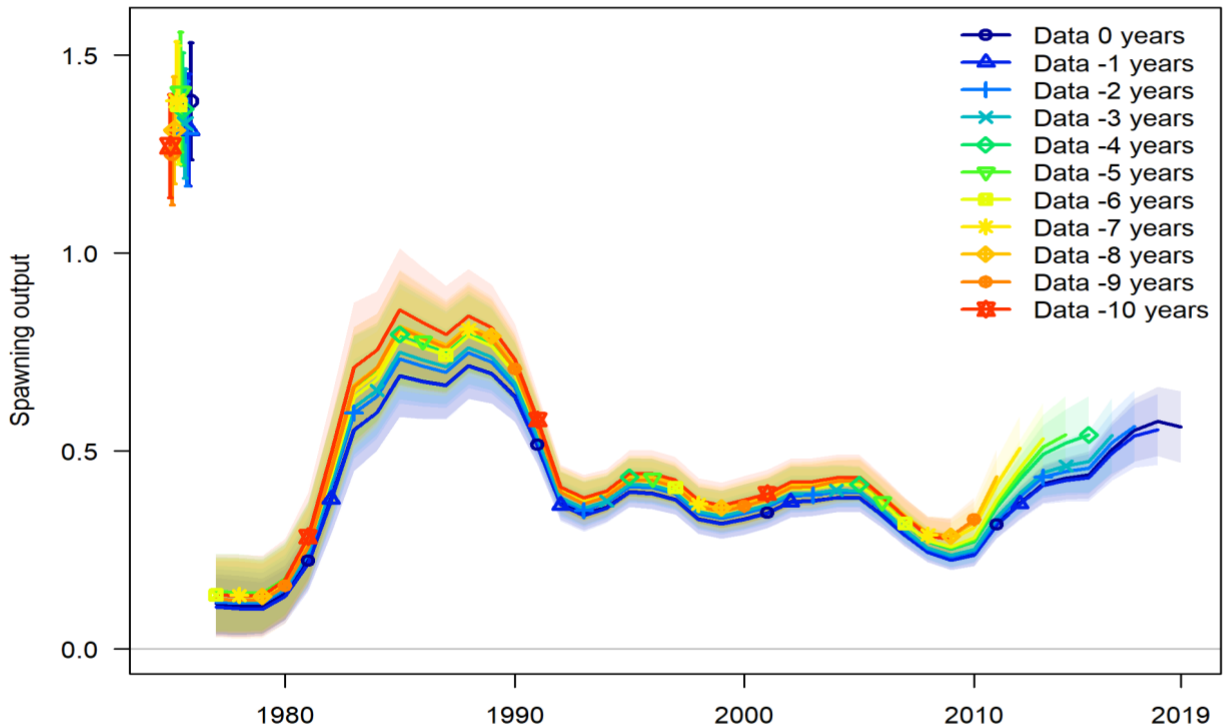


Figure 2.14. Cumulative model weights. Legend: blue = Hypothesis 1, orange = Hypothesis 2, green = Hypothesis 3; lightly stippled = "basic," heavily stippled = "simple," sold = "complex."



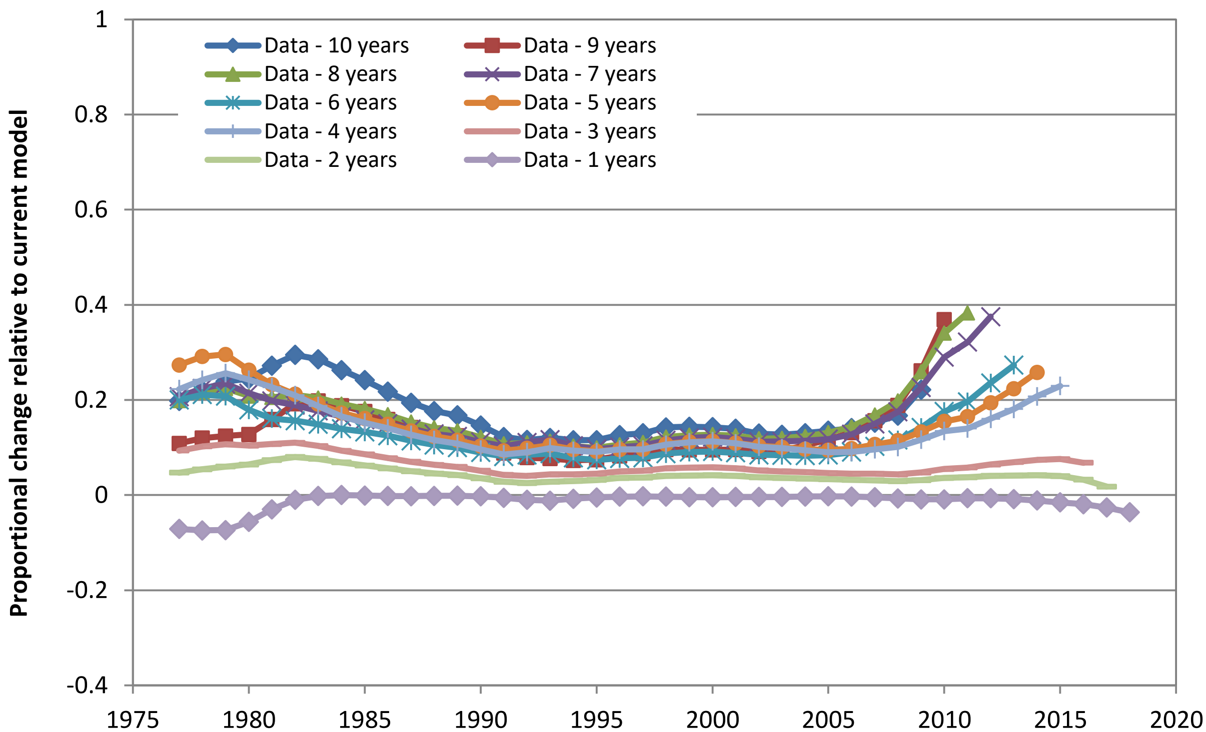


Figure 2.15a. Retrospective analysis of Model 16.6i.

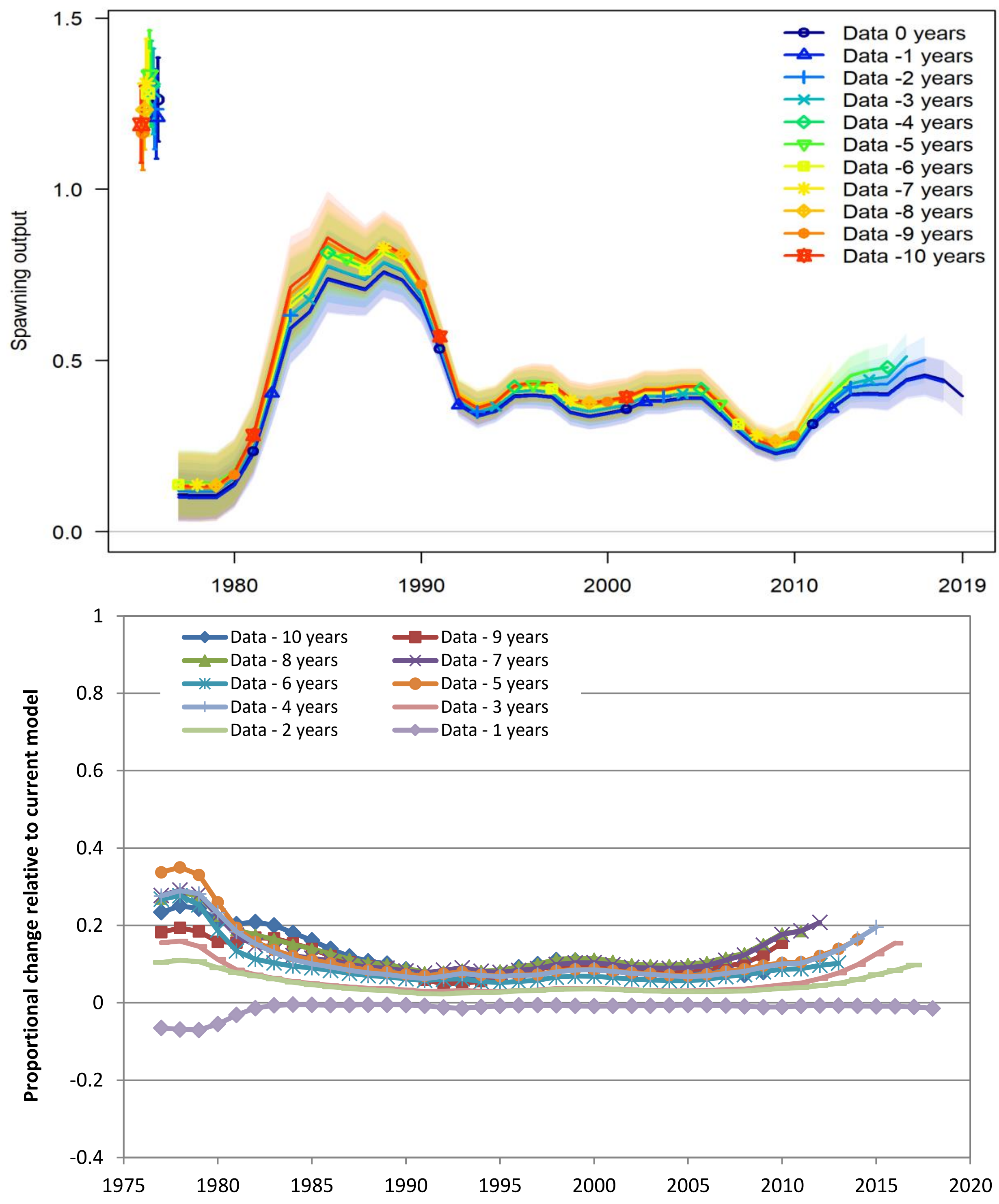


Figure 2.15b. Retrospective analysis of Model 19.7.

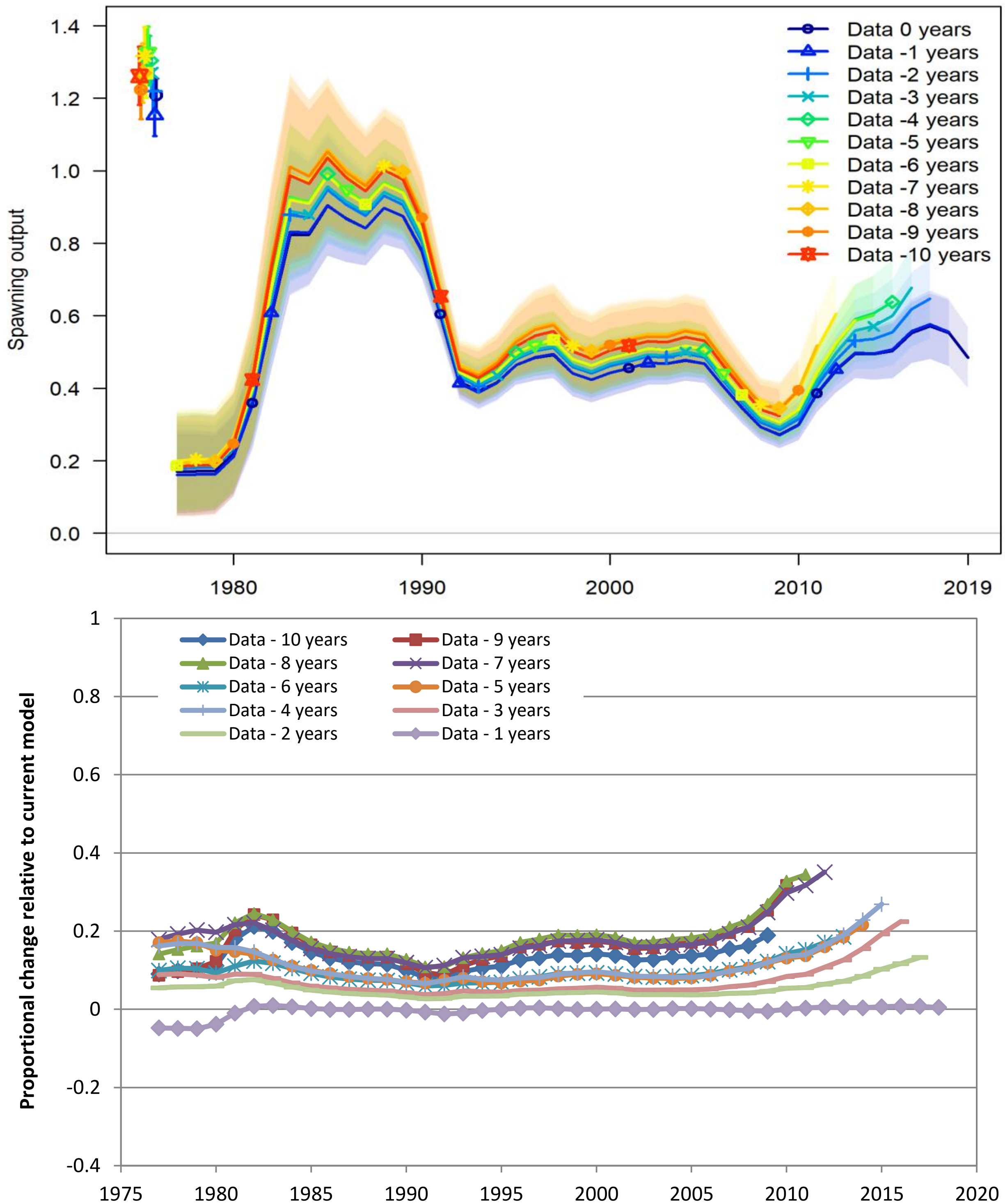


Figure 2.15c. Retrospective analysis of Model 19.8.

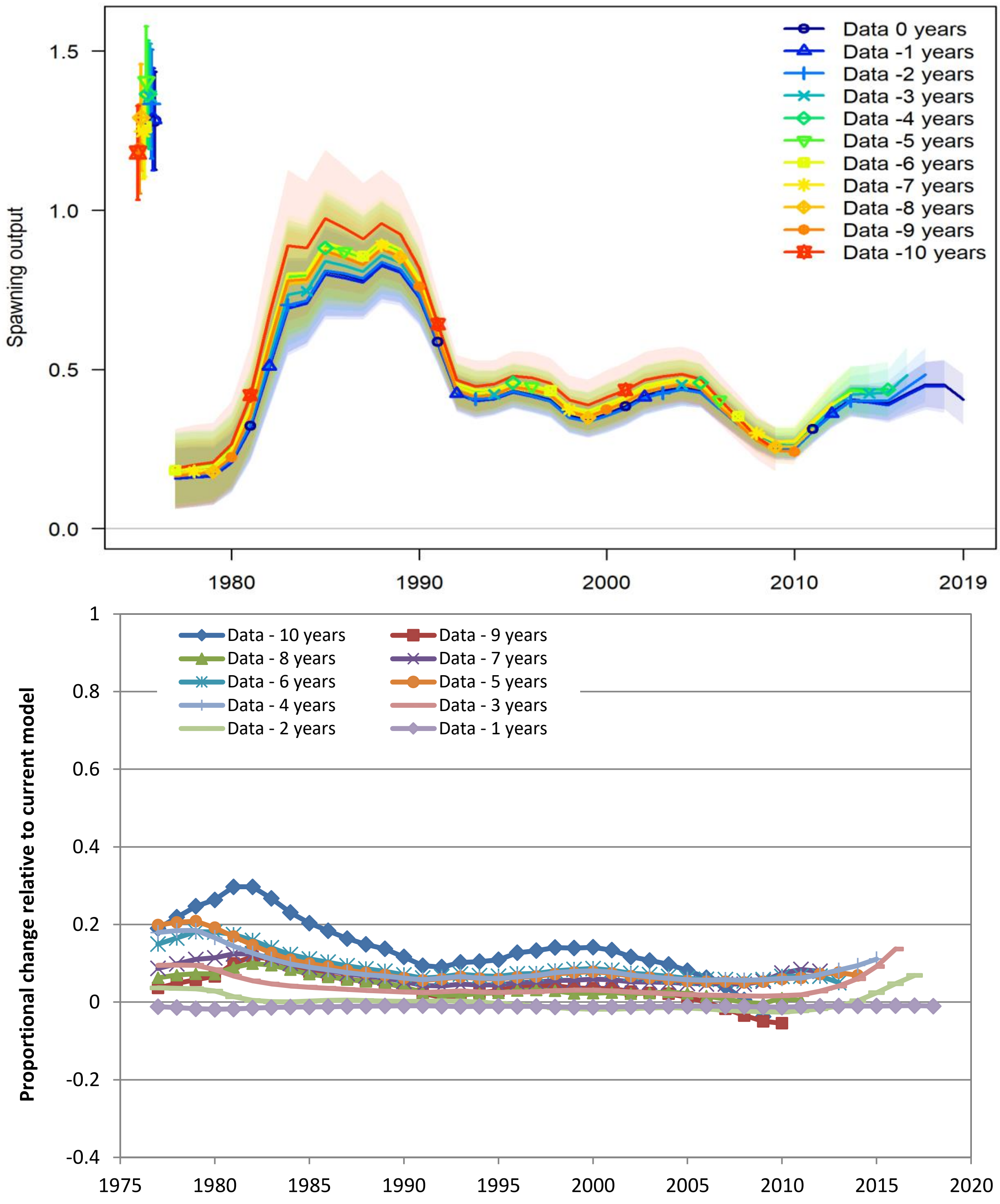
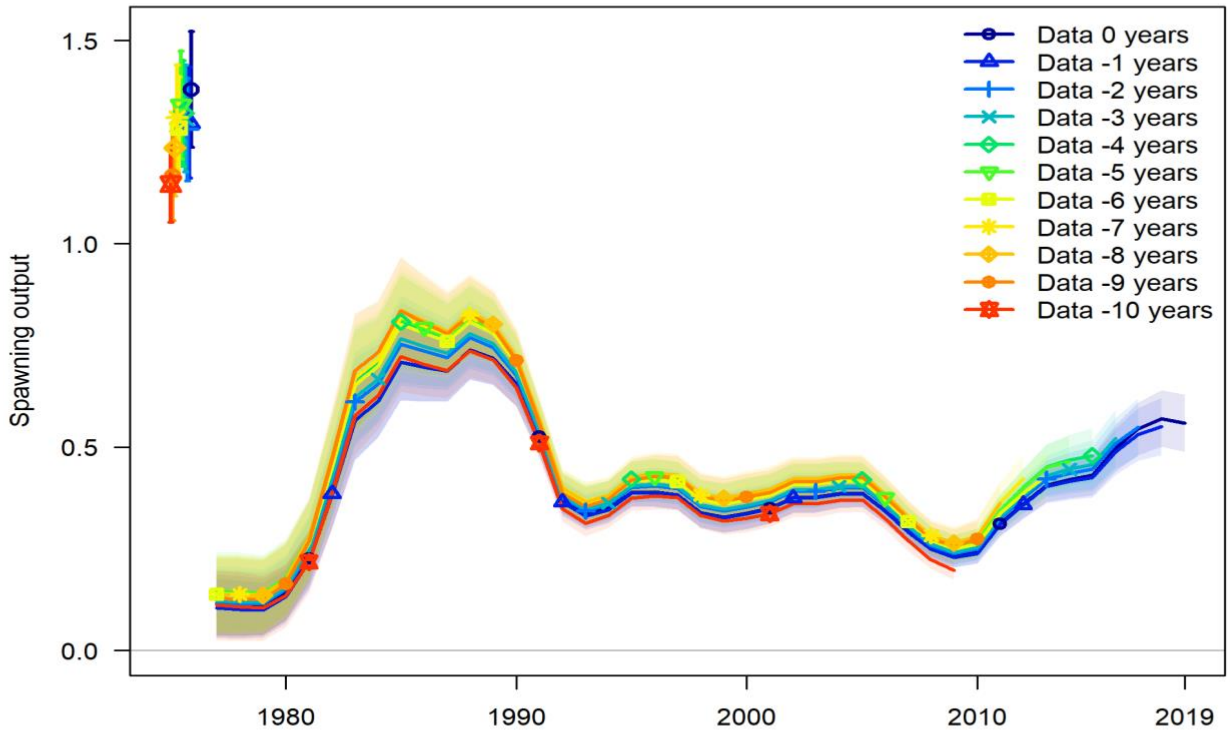


Figure 2.15d. Retrospective analysis of Model 19.9.



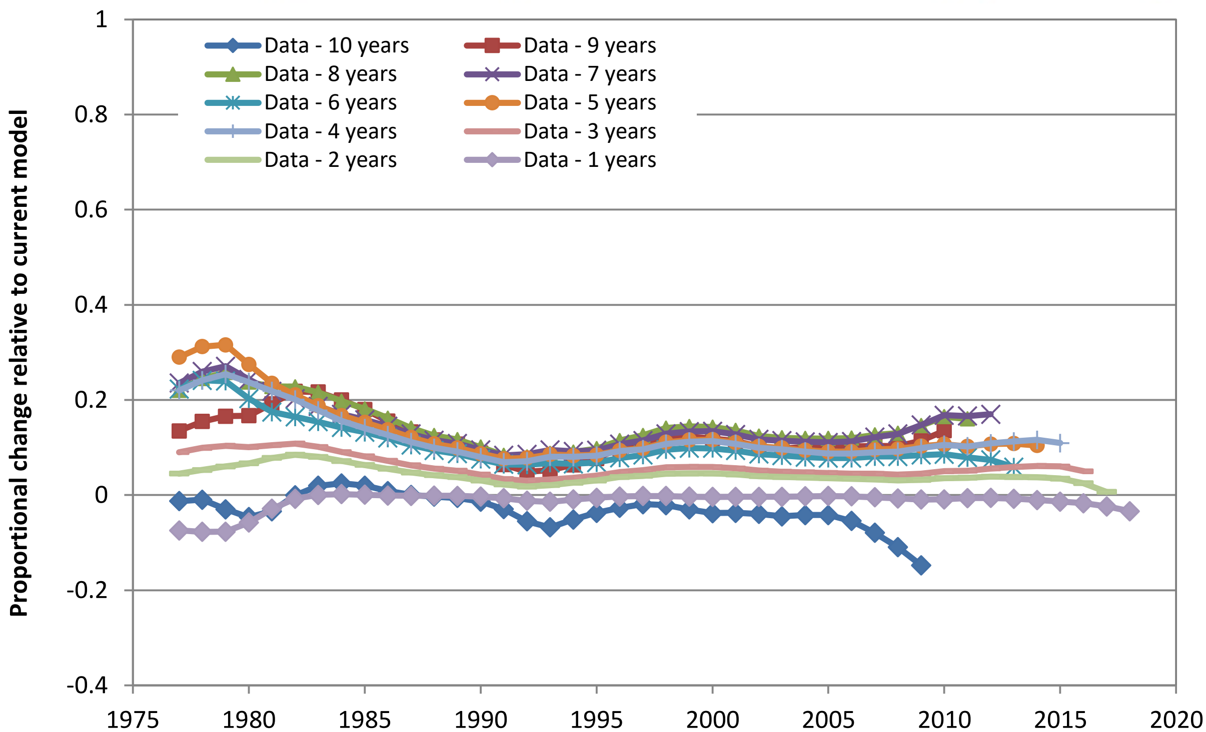


Figure 2.15e. Retrospective analysis of Model 19.10.

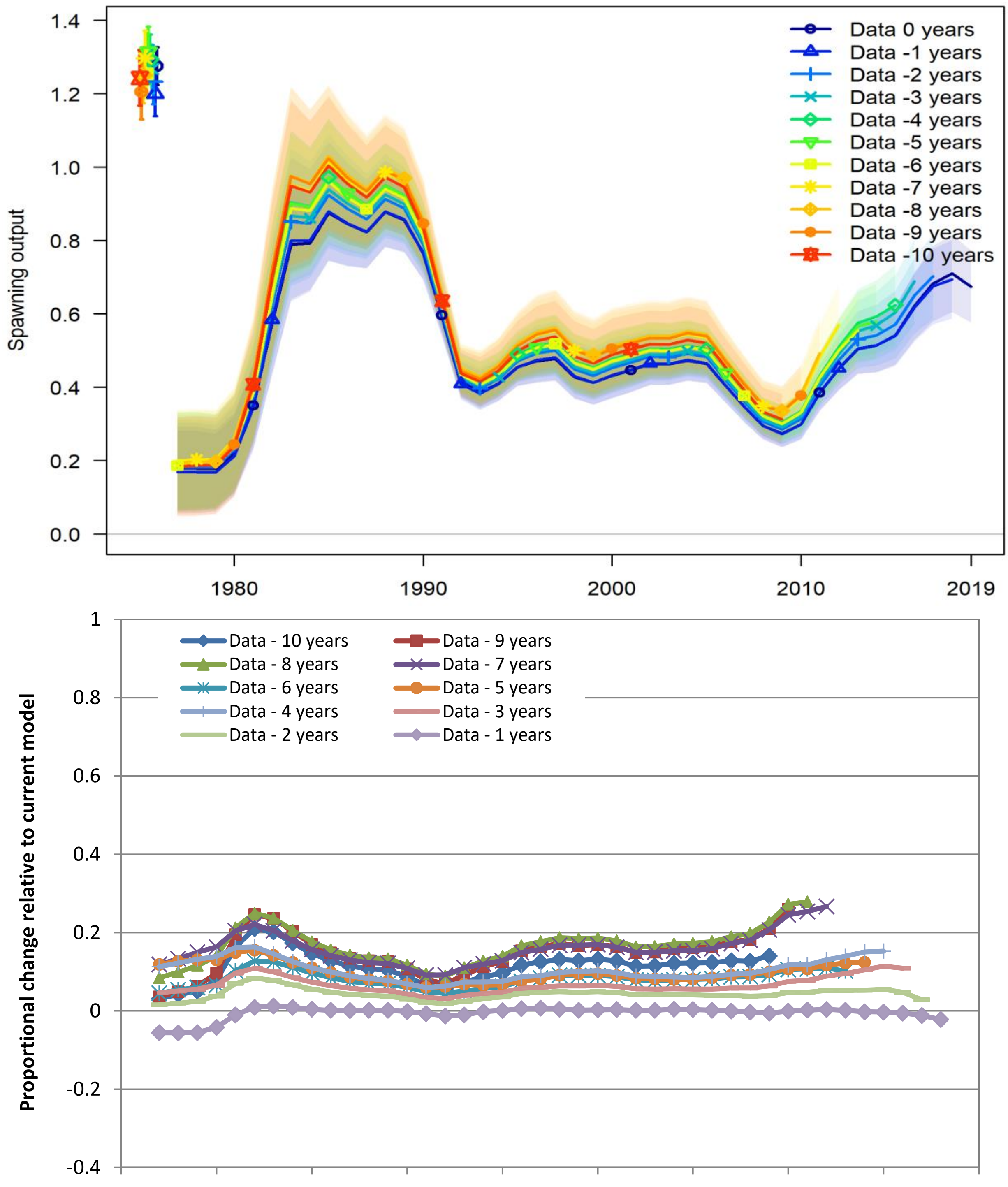


Figure 2.15f. Retrospective analysis of Model 19.11.

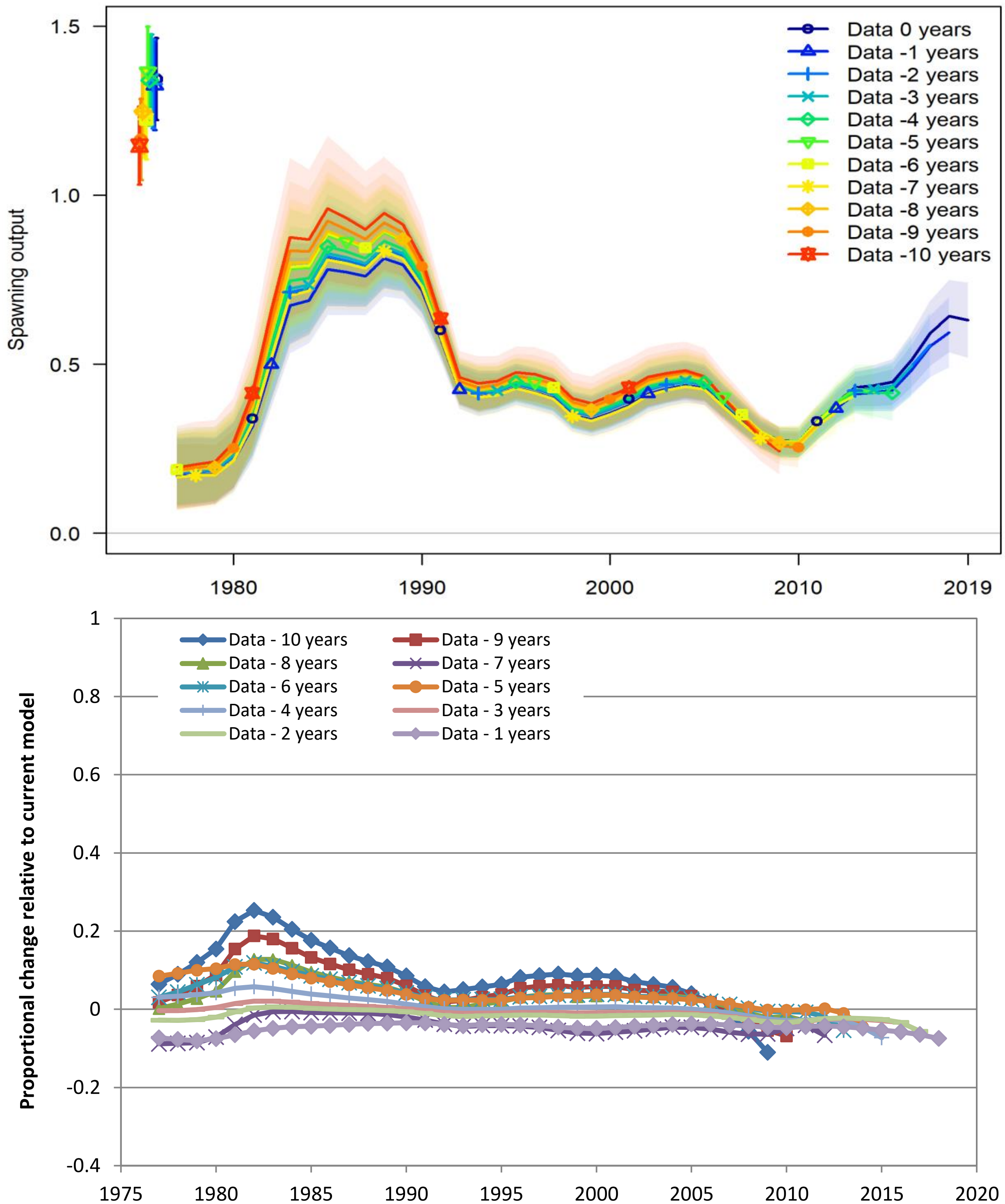


Figure 2.15g. Retrospective analysis of Model 19.12.

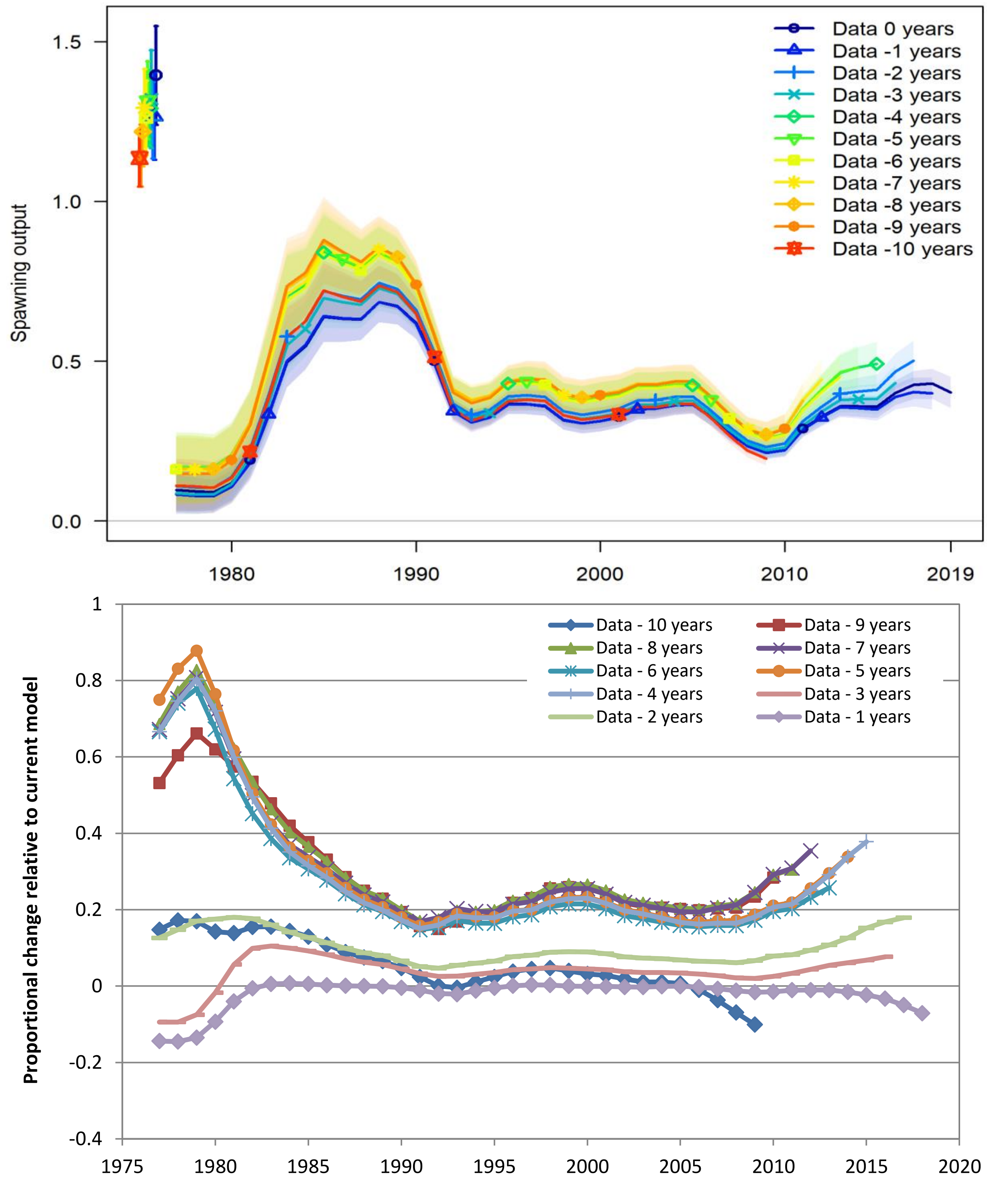


Figure 2.15h. Retrospective analysis of Model 19.13.

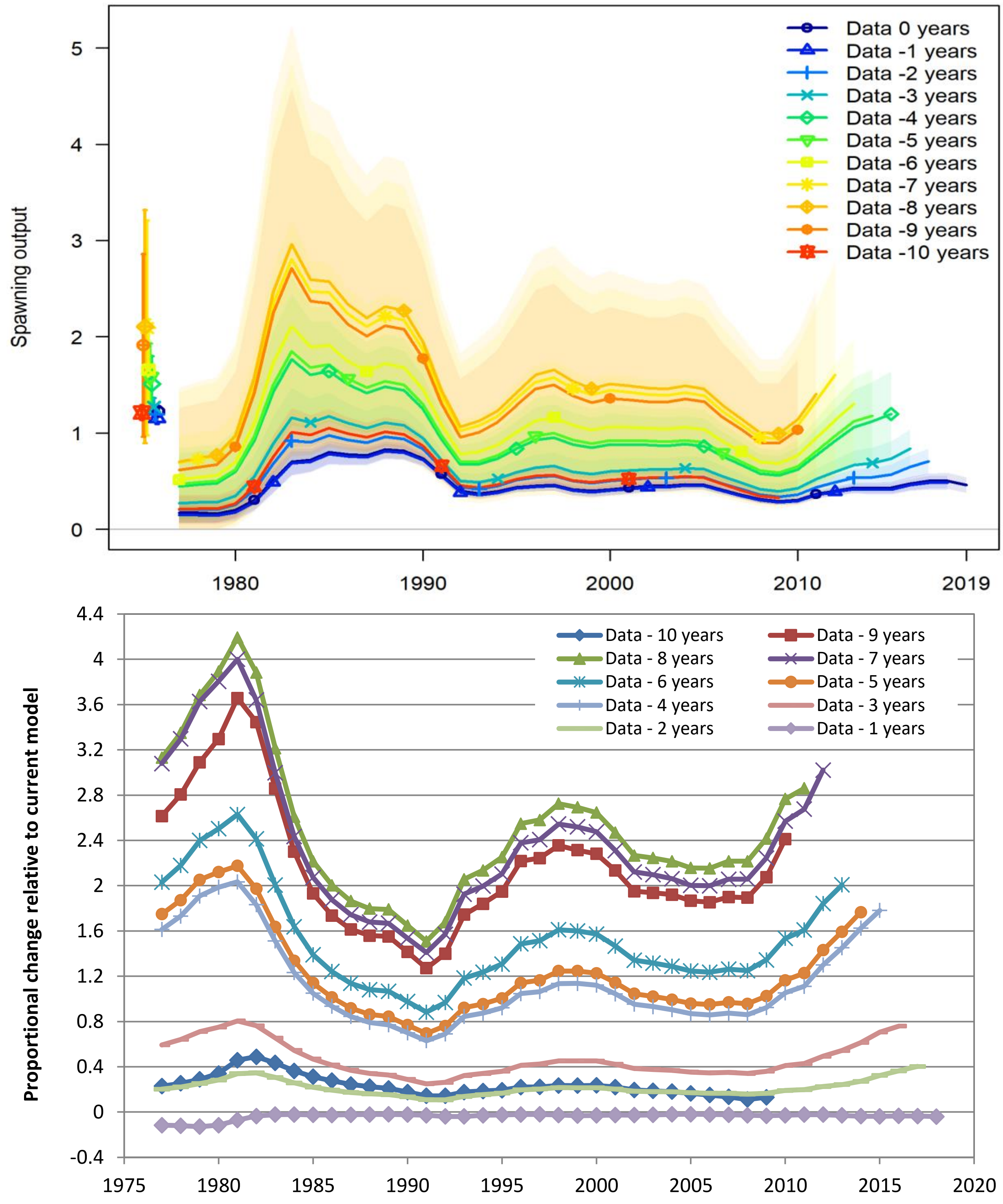


Figure 2.15i. Retrospective analysis of Model 19.14.

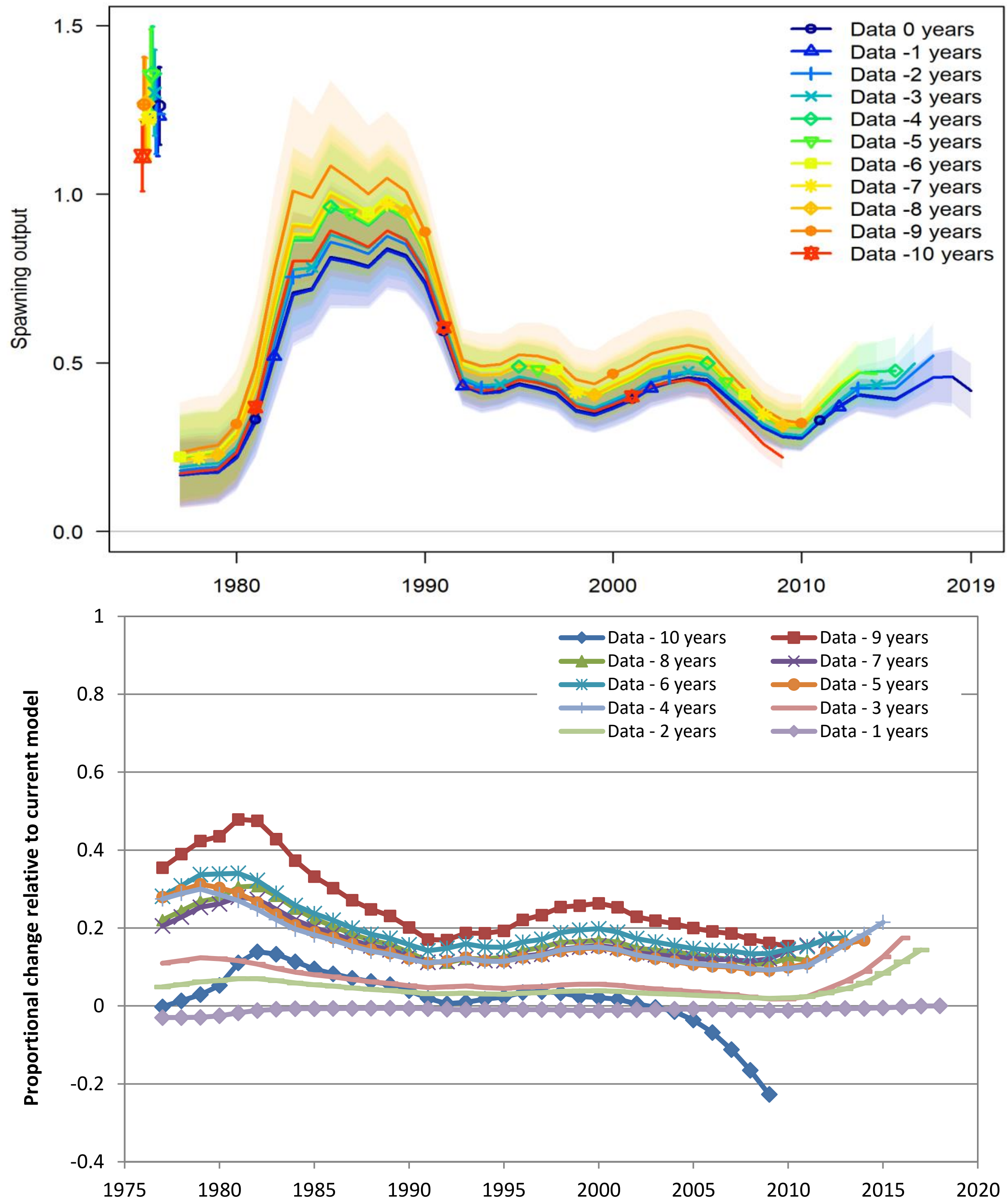


Figure 2.15j. Retrospective analysis of Model 19.15.

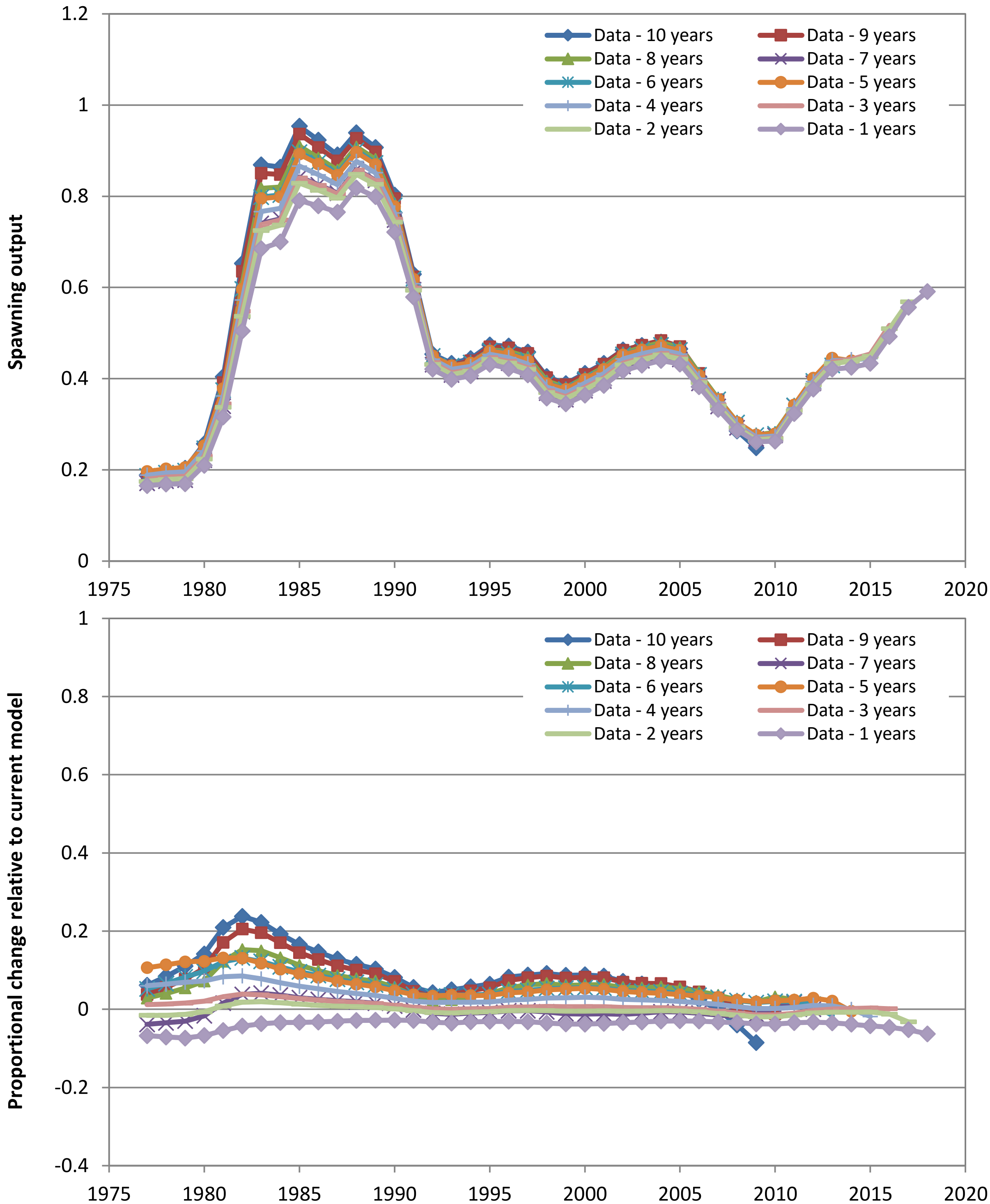


Figure 2.15k. Retrospective analysis of the ensemble weighted average.

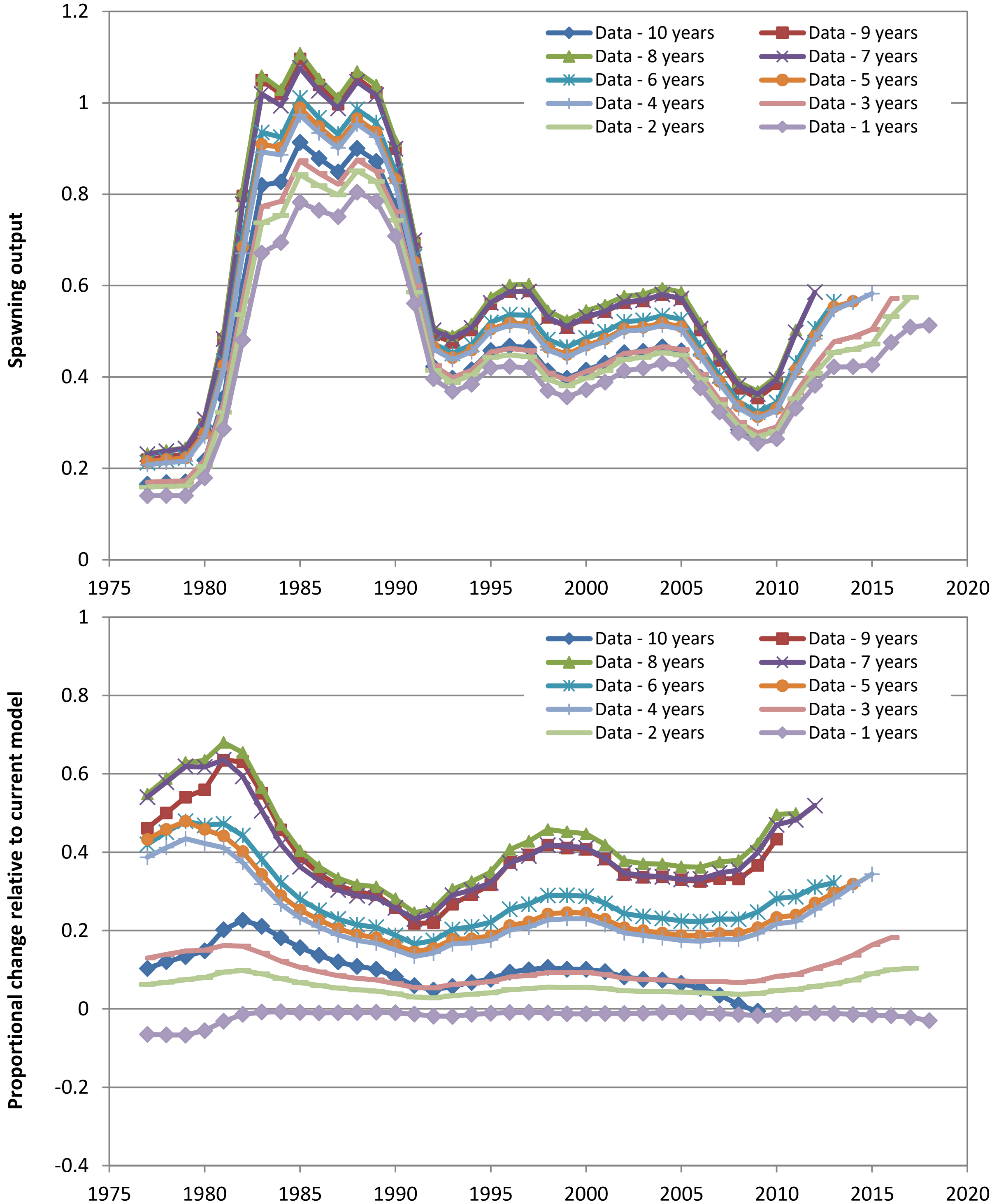


Figure 2.15l. Retrospective analysis of the ensemble unweighted average.

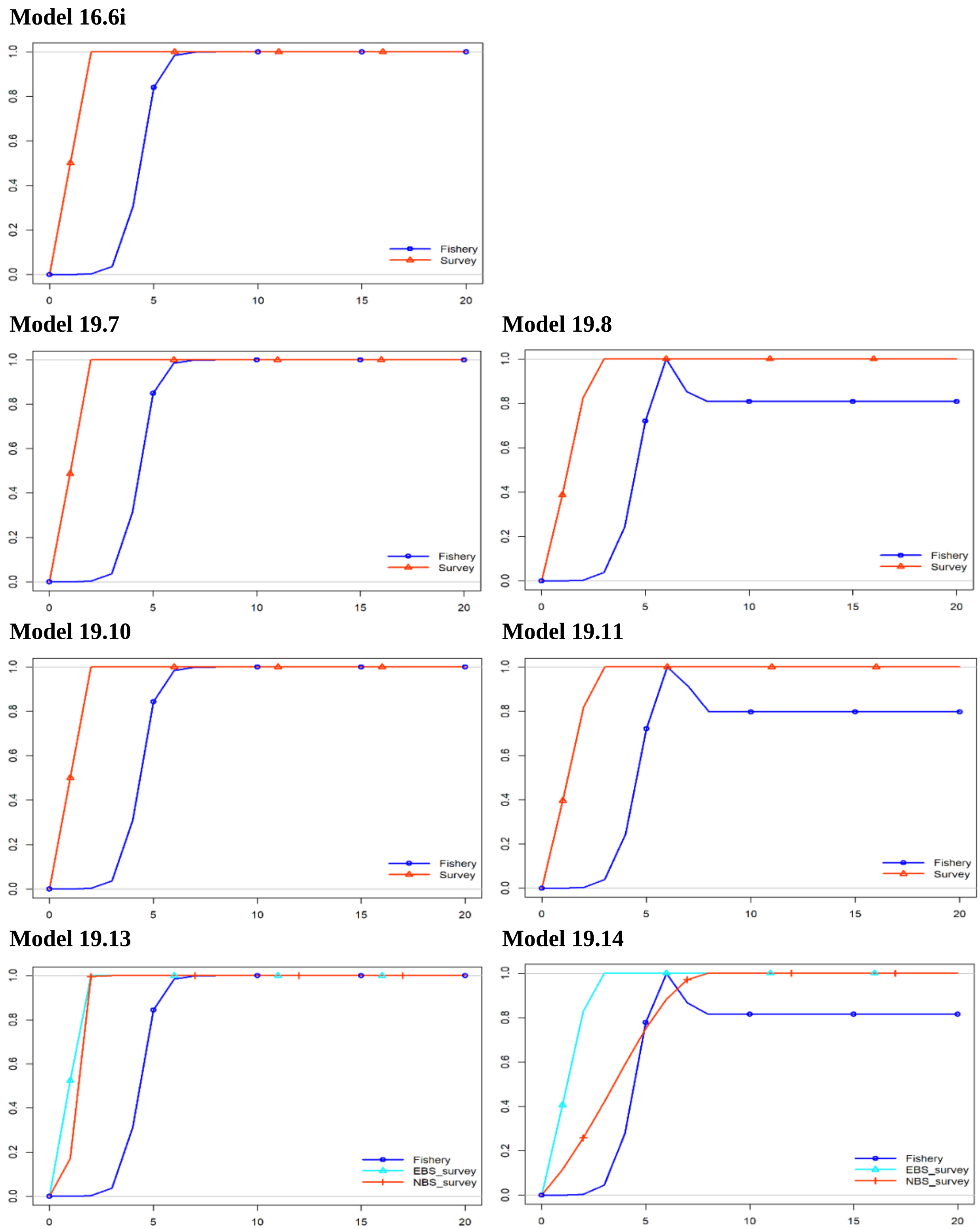


Figure 2.16a. Selectivity (fishery and survey, "basic" and "simple" models).

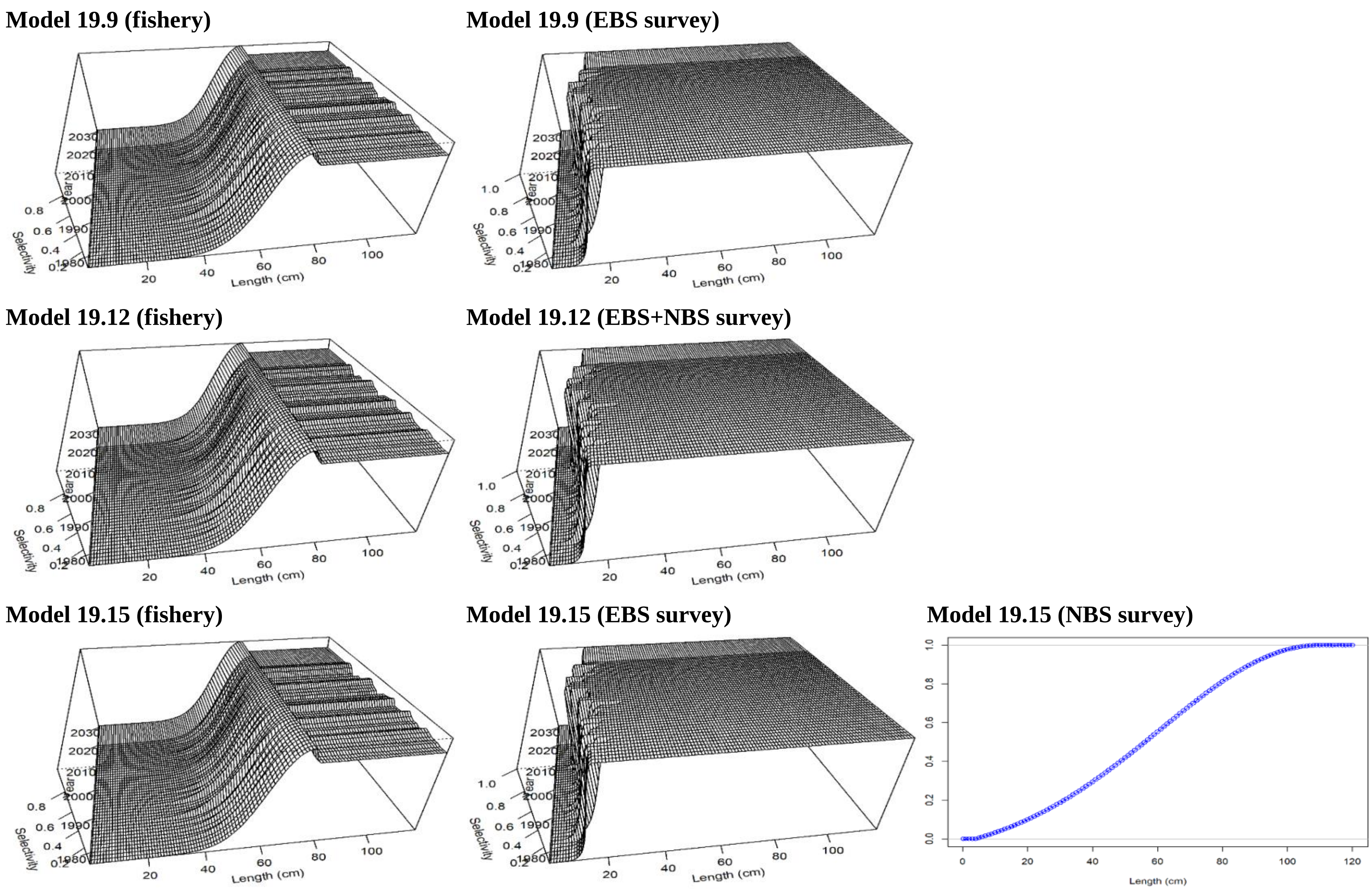


Figure 2.16b. Selectivity (fishery and survey, “complex” models).

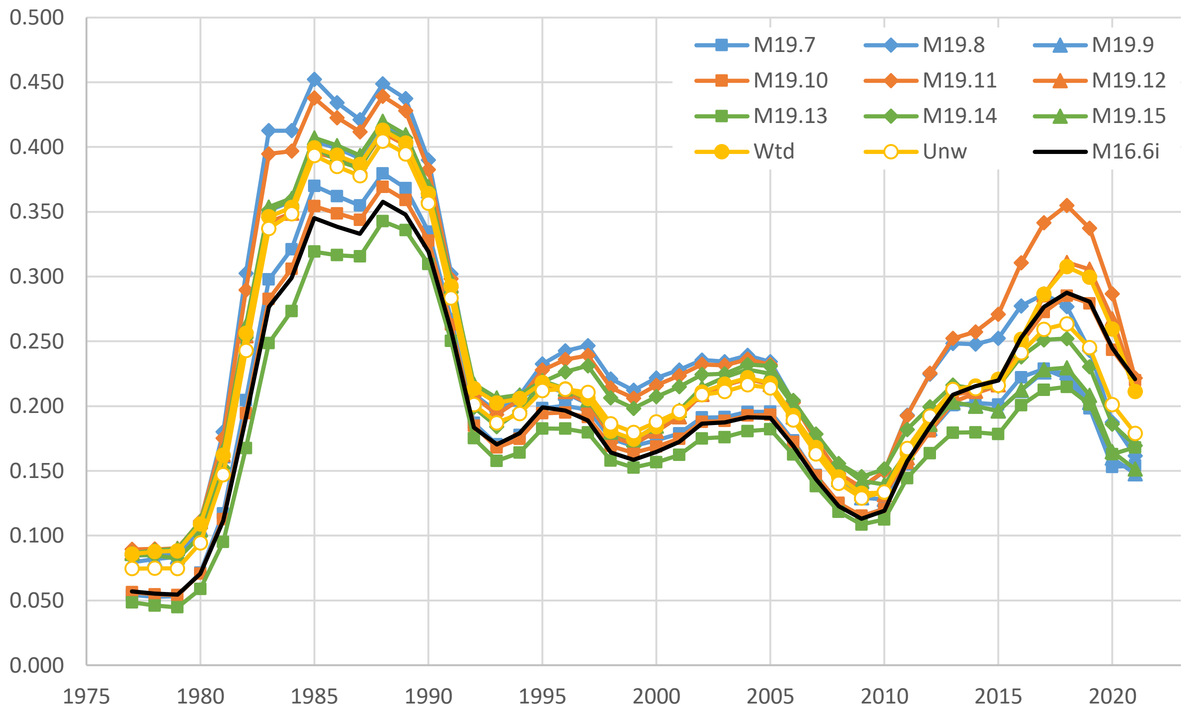


Figure 2.17. Female spawning biomass (millions of t) time series.

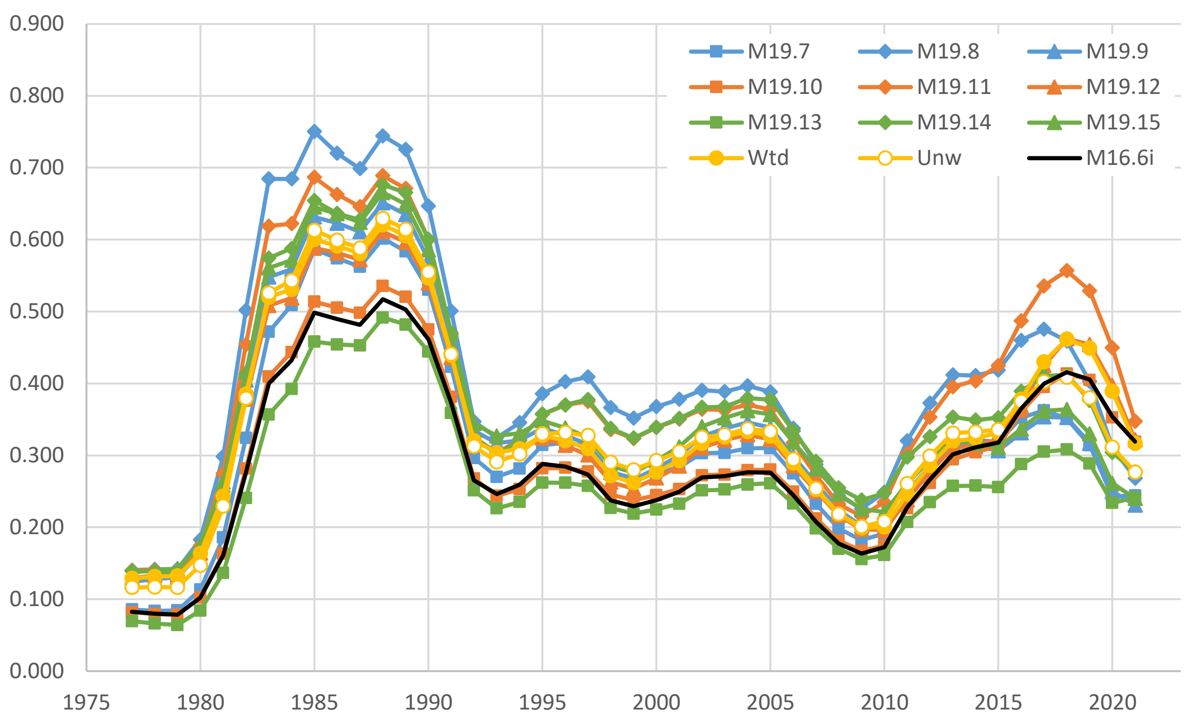


Figure 2.18. Relative spawning biomass time series.

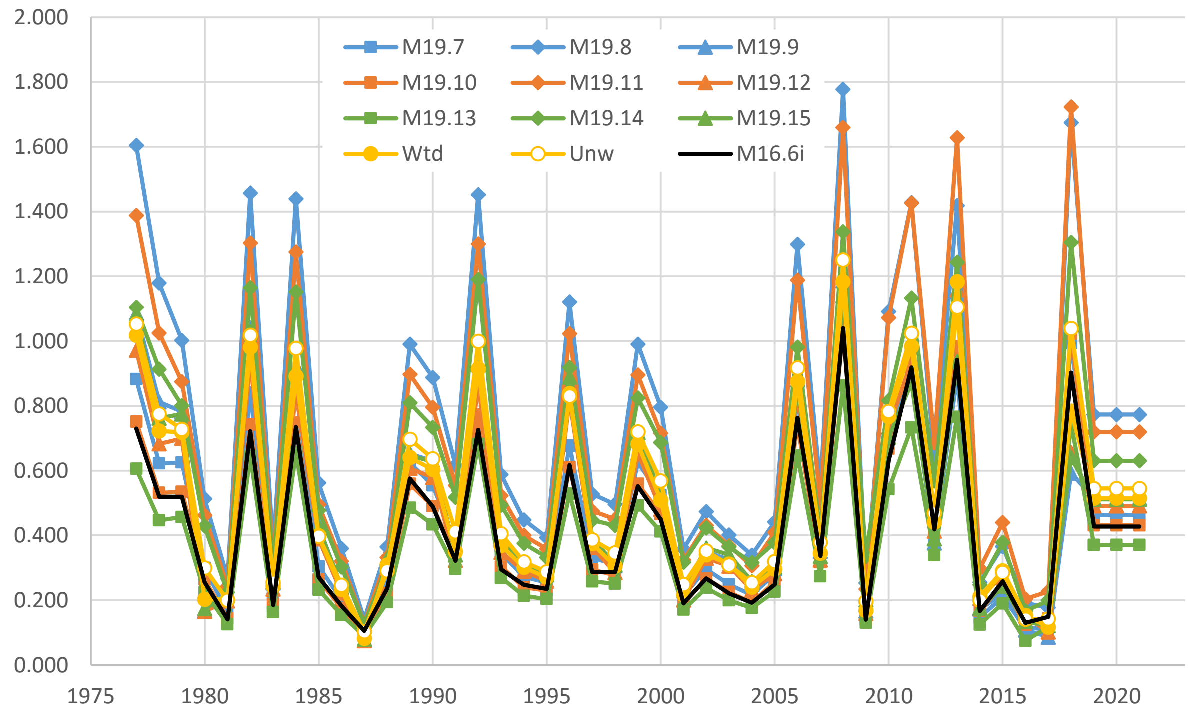


Figure 2.19. Recruitment (billions of fish) time series.

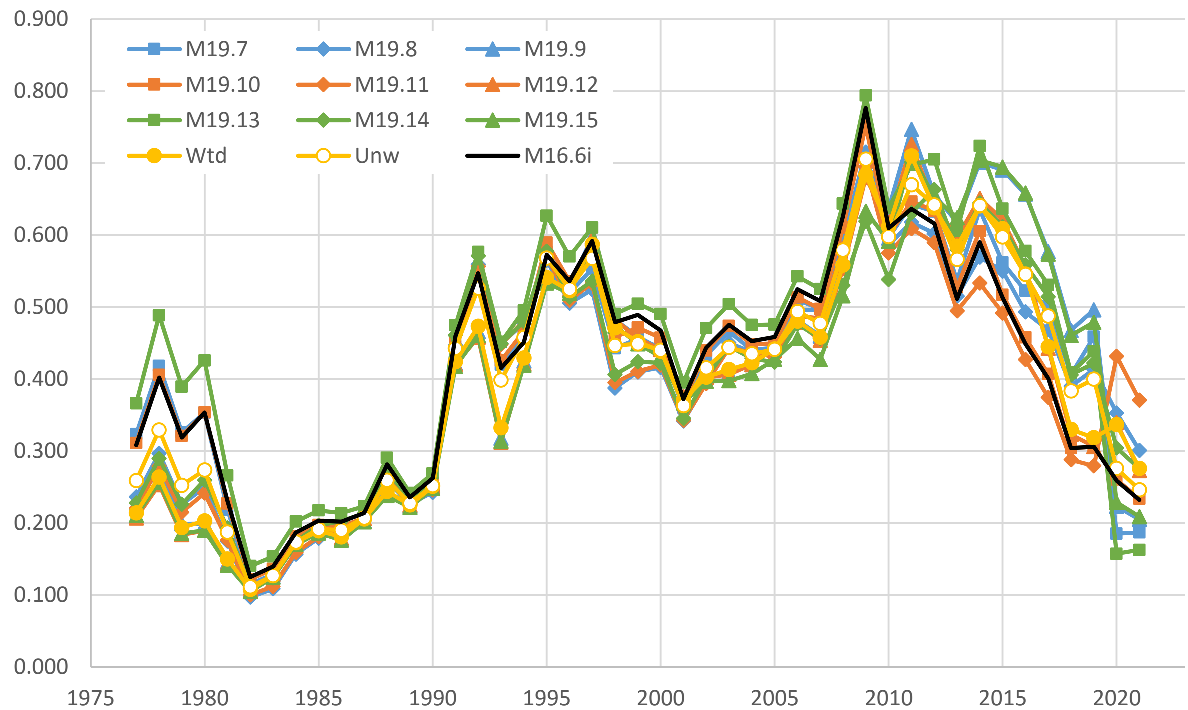


Figure 2.20. Full selection fishing mortality time series.

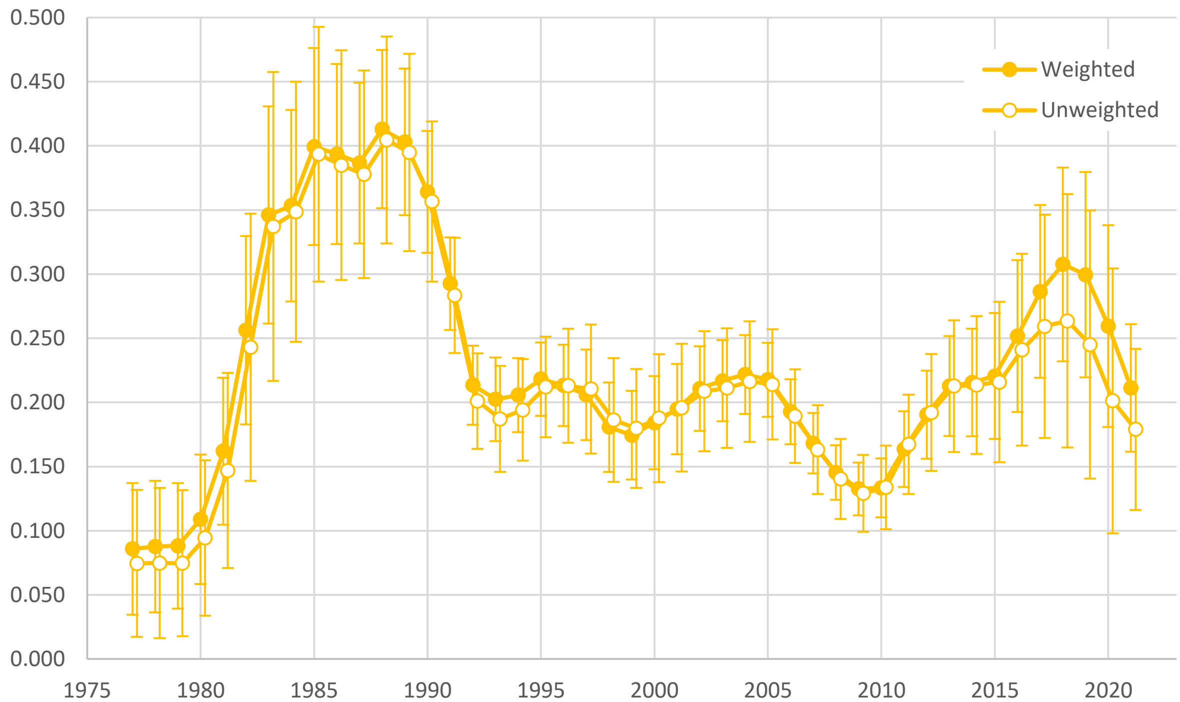


Figure 2.21. Ensemble estimates of female spawning biomass (millions of t), +/– 2 standard deviations.

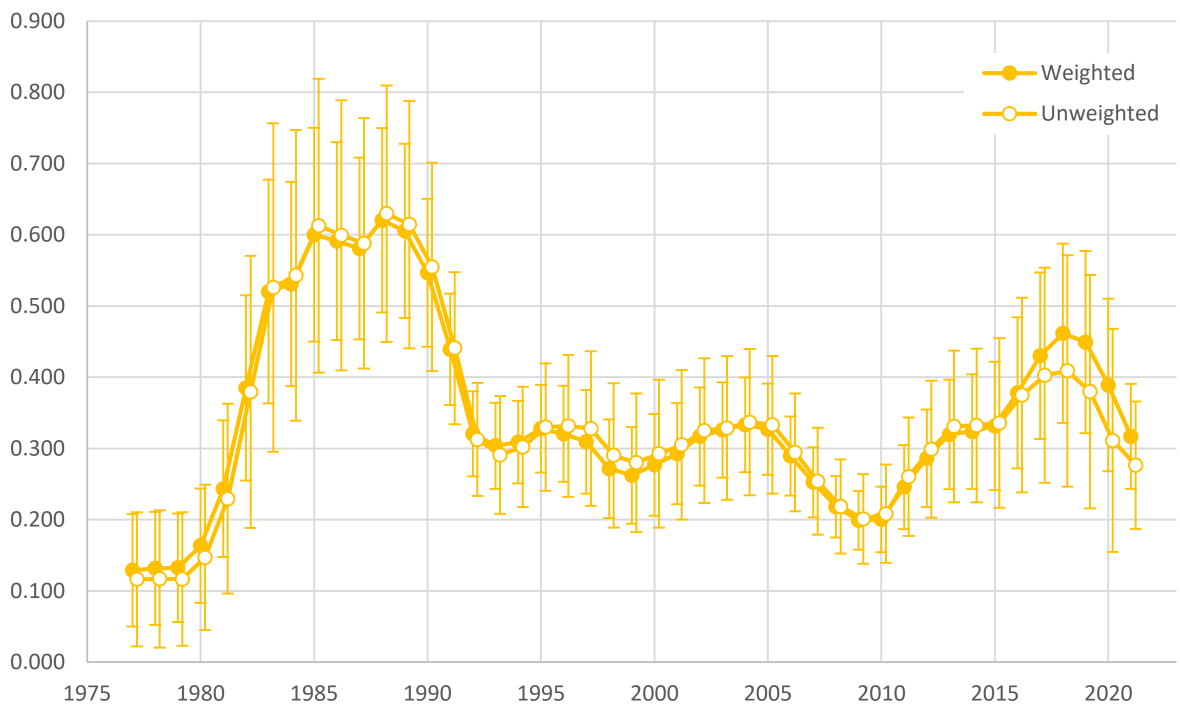


Figure 2.22. Ensemble estimates of relative spawning biomass, +/– 2 standard deviations.

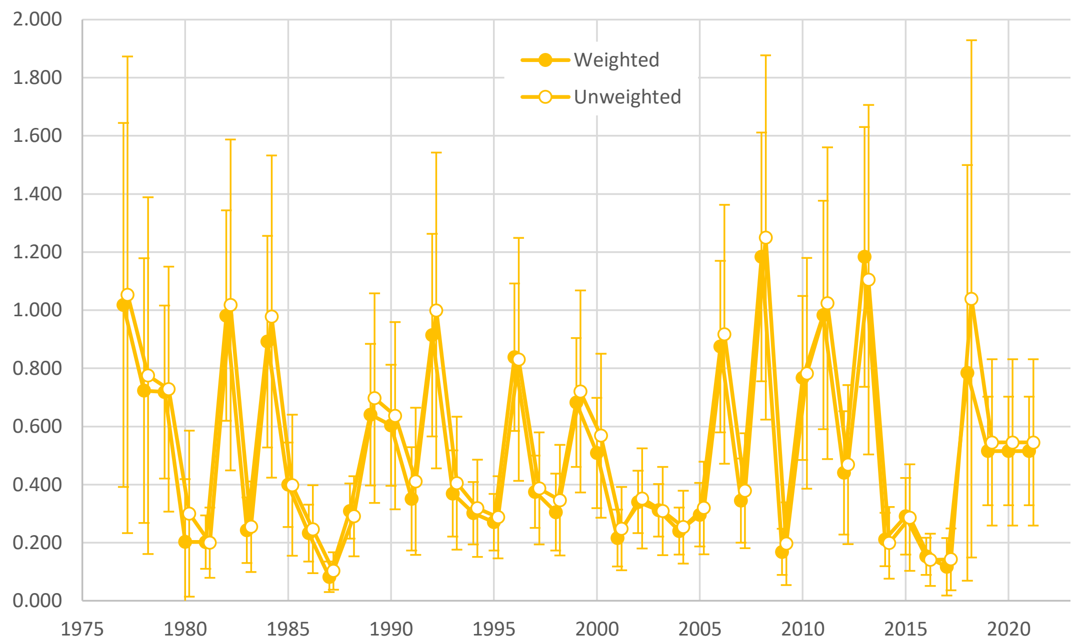


Figure 2.23. Ensemble estimates of recruitment (billions of fish), +/– 2 standard deviations.

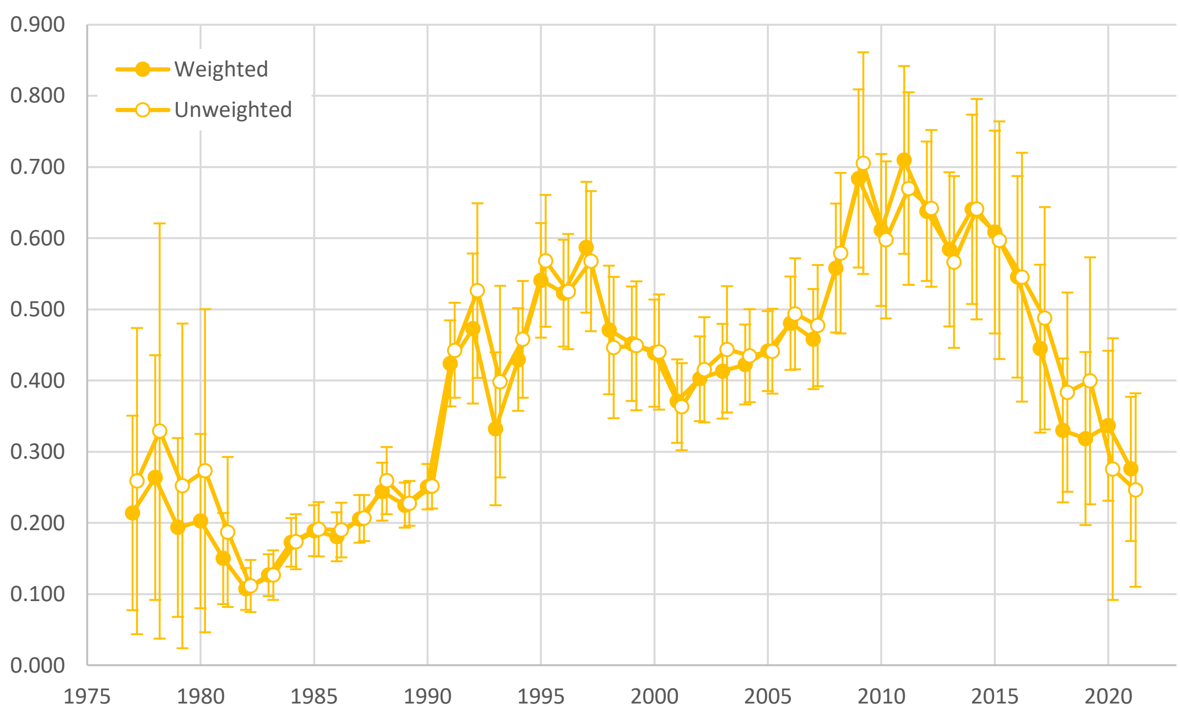


Figure 2.24. Ensemble estimates of full selection fishing mortality, +/– 2 standard deviations.

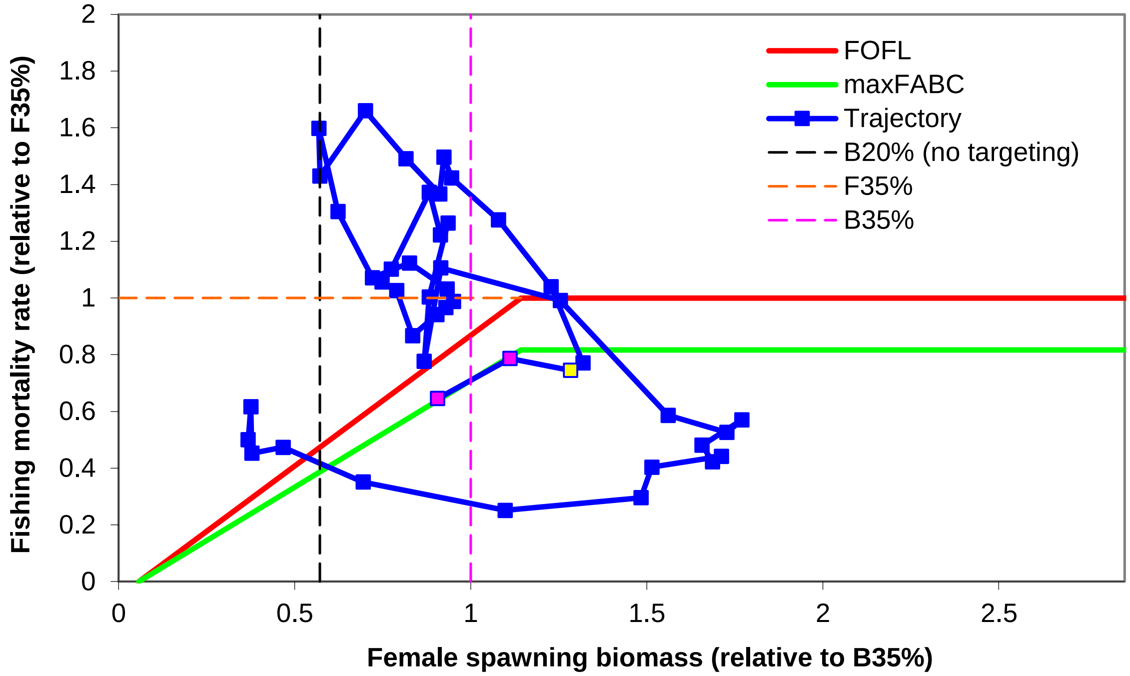


Figure 2.25a. Phase plane for the weighted average ensemble.

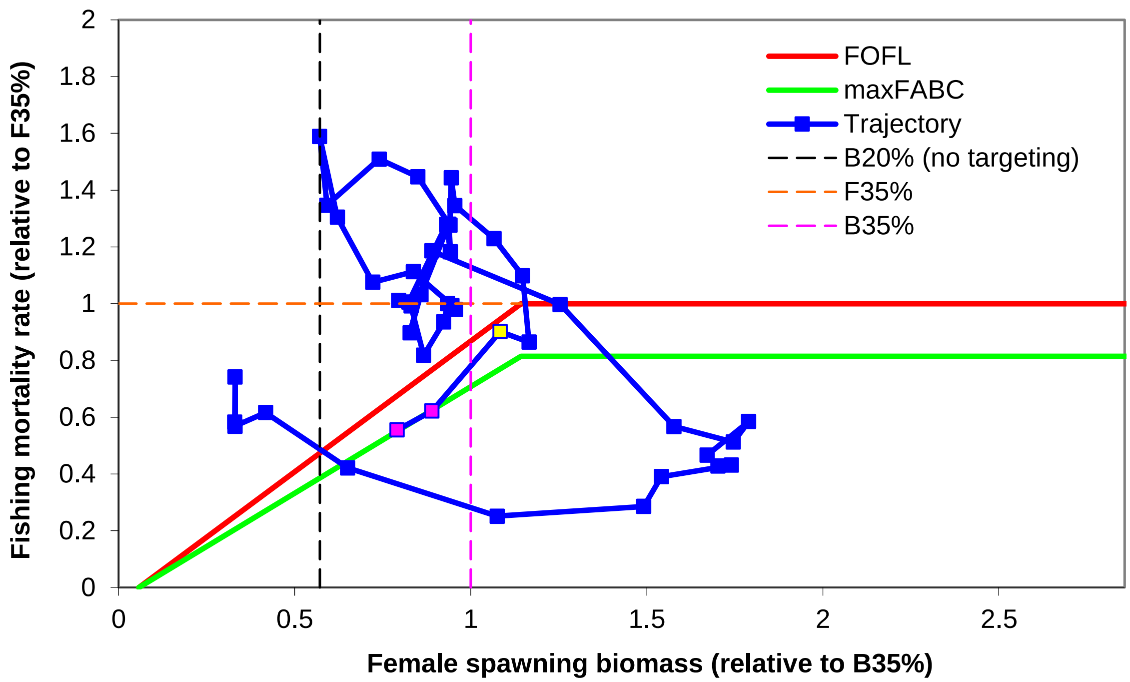


Figure 2.25b. Phase plane for the unweighted average ensemble.

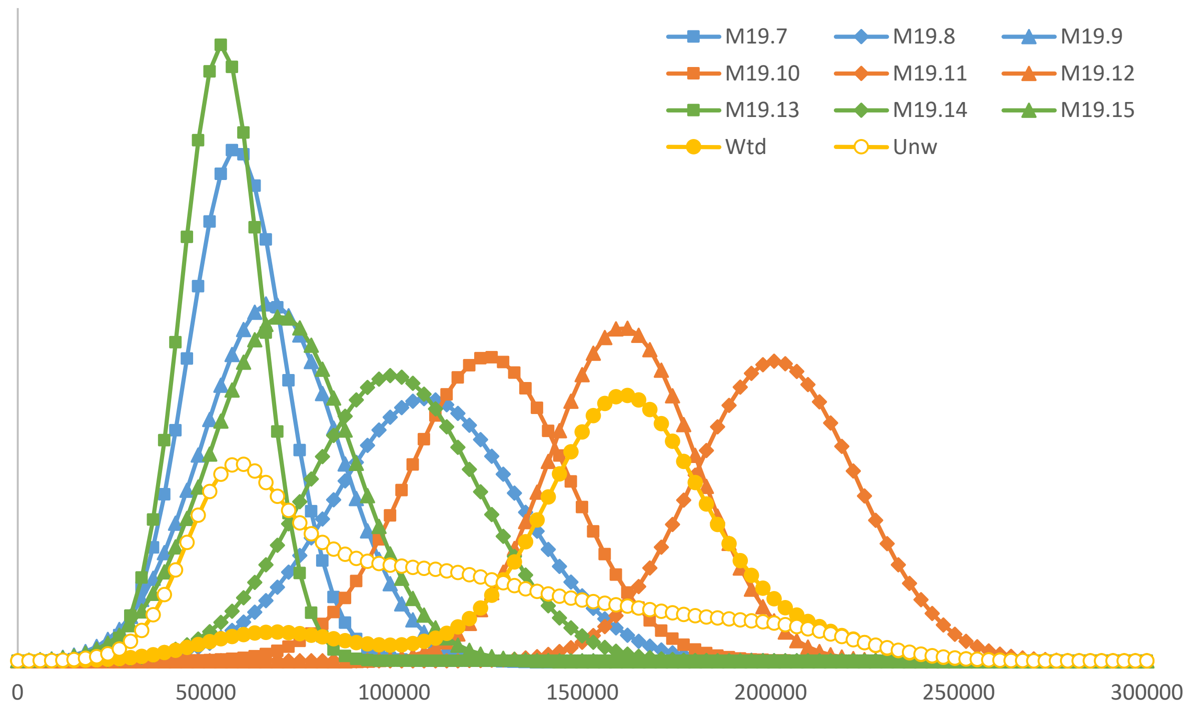


Figure 2.26a. Individual model and ensemble distributions of 2020 ABC.

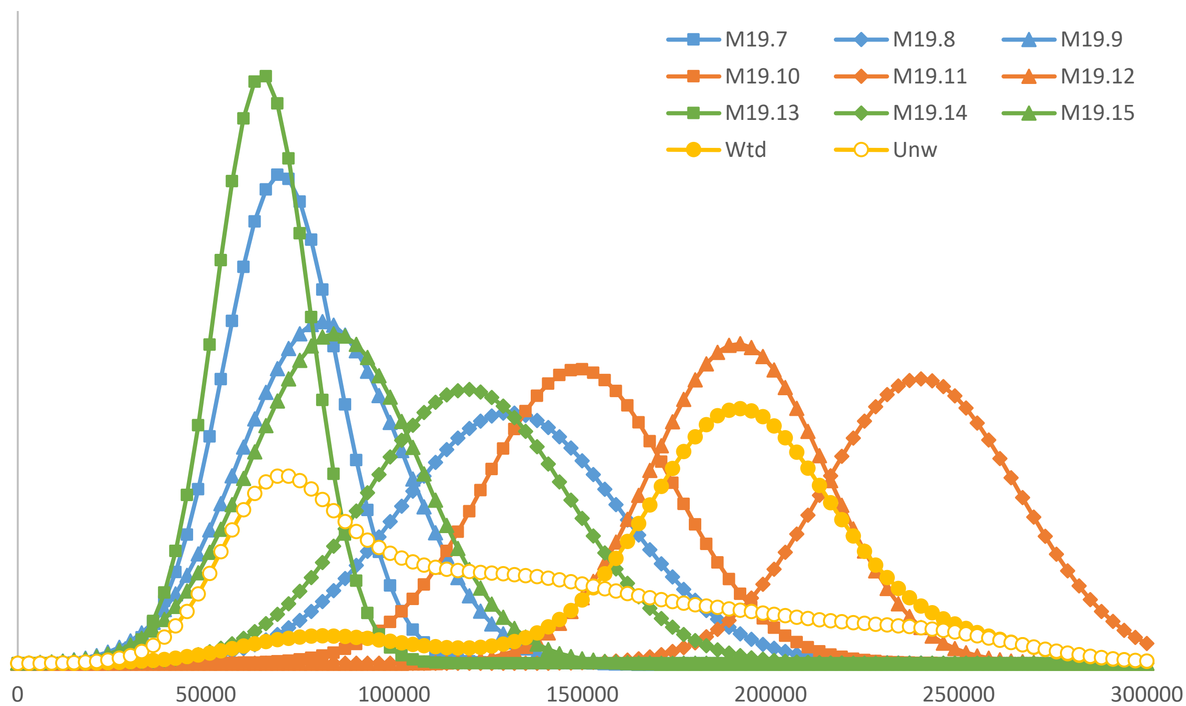


Figure 2.26b. Individual model and ensemble distributions of 2020 OFL.

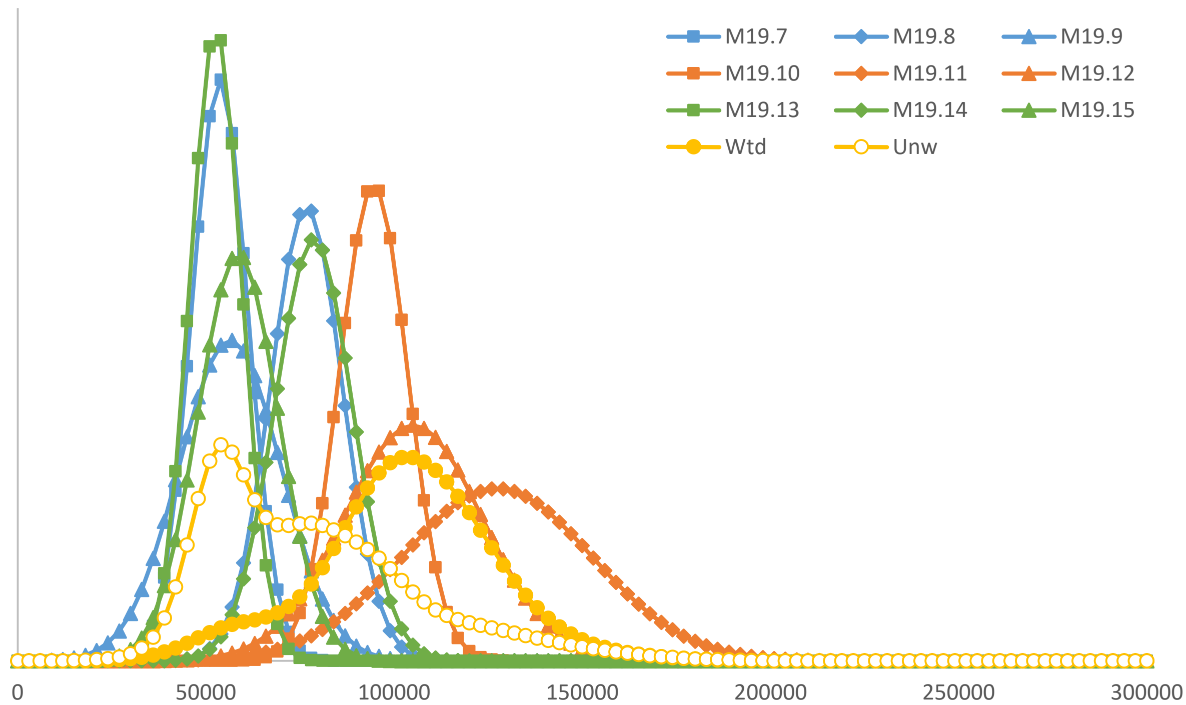


Figure 2.26c. Individual model and ensemble distributions of 2021 ABC.

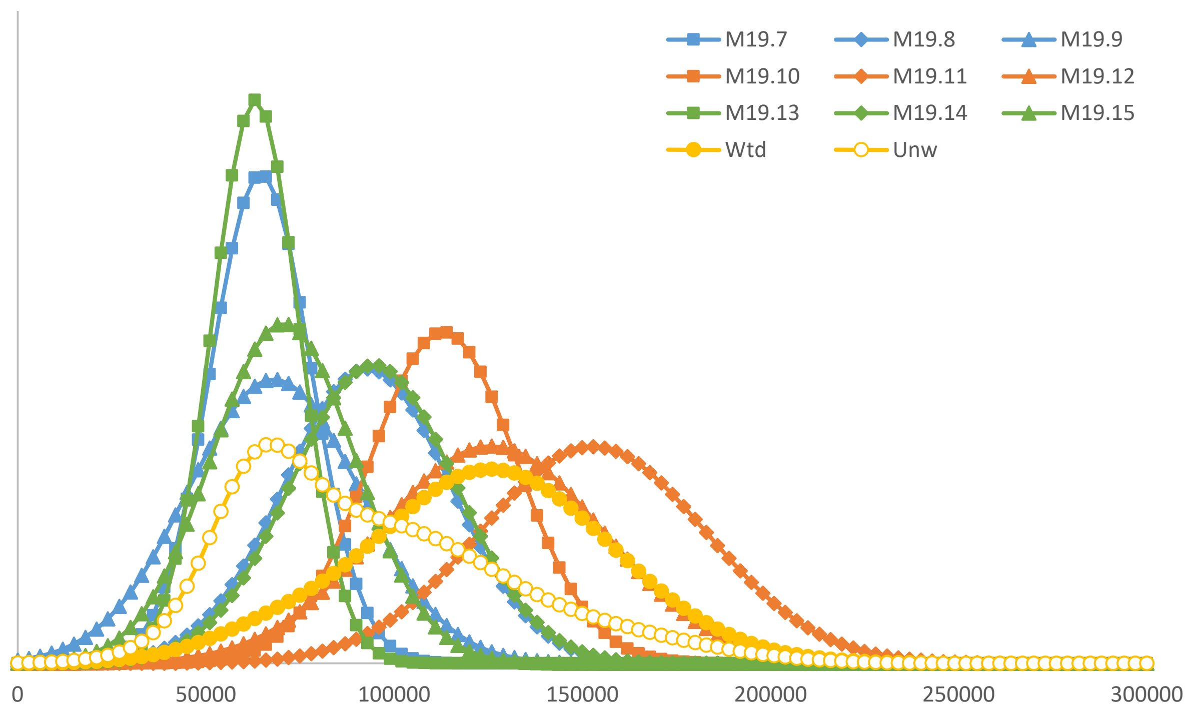


Figure 2.26d. Individual model and ensemble distributions of 2021 OFL.

APPENDIX 2.1: PRELIMINARY ASSESSMENT OF THE PACIFIC COD STOCK IN THE EASTERN BERING SEA

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Introduction

This document represents an effort to respond to comments made by the BSAI Plan Team ("Team") and the Scientific and Statistical Committee ("SSC") on last year's assessment of the Pacific cod stock in the eastern Bering Sea ("EBS," Thompson 2018).

Responses to Team and SSC comments on assessments in general

Comments from the December 2018 SSC meeting
SSC1: "The SSC requests that all authors fill out the risk table in 2019, and that the PTs provide comment on the author's results in any cases where a reduction to the ABC may be warranted (concern levels 2-4)."
Response: This request will be addressed in the final assessment.

SSC2: "In response to the PT's request for guidance on model averaging and the development of ensembles, the SSC offers the following general recommendations:

- "Progress on this effort will require an example to work through both expected and unanticipated details of how this process may work. The SSC requests again for 2019 that one or more assessments bring forward an ensemble of models.
- "The combining of model output should occur on the basic estimates from the assessment (biomass, F, etc.) and not the reference points themselves.
- "Where variance estimates among models differ appreciably, it may be more appropriate to combine the posterior distribution functions from each model than to average the expectations.
- "It will be difficult for the PTs to combine model results without the author's assistance. Such an approach should only be attempted in unique cases, and it is preferable for the author to identify the intention to bring forward an ensemble in September and perform the analysis before the November PT meetings."

Response: A document describing a new method for model weighting that may be useful in developing an example will be discussed at the September Team meeting. Although it does not satisfy the recommendation to operate on the "basic estimates from the assessment (biomass, F, etc.)," it does satisfy the recommendation to average posterior distribution functions.

Responses to Team and SSC comments specific to this assessment

Comments from the November 2018 Team meeting
"For next year's assessment, the Team recommended that...

BPT1: "...the EBS Pacific cod ages be examined for potential biases and reader effects as seen with GOA Pacific cod (i.e., Barbeaux et al 2018/GOA cod assessment and Kastelle et al., 2017/Age validation of Pacific cod (*Gadus macrocephalus*) using high-resolution stable oxygen isotope (δ18O) chronologies in otoliths)." *Response*: All assessments of the EBS Pacific cod stock since 2009 have included estimates of ageing bias, and this practice is continued in all models presented here. In response to a recent concern that ageing criteria may have shifted after 2007, three of the models presented here include separate estimates of ageing bias for the pre-2008 and post-2007 portions of the time series.

BPT2: "...fisheries data be examined to determine if there are within-year patterns that may indicate seasonal movement, and if the survey timing may intersect with that seasonal migration." *Response*: The requested analysis is presented in the Discussion section.

BPT3: "...a model-based survey time-series be developed that can predict combined abundance of the expanded EBS survey area and the Northern Bering Sea survey area for all years. Length and age compositions should also be created that account for and are appropriately weighted by these model-based estimates. Validate the predictions using various methods as well as consistency with observations from other external surveys (e.g., BASIS)." *Response*: A model-based survey time series for the combined EBS and Northern Bering Sea (NBS) areas, based on the vector autoregressive spatio-temporal (VAST) method developed by Thorson (2019), has been developed and is used in two of the models presented here, as are corresponding VAST estimates of survey age composition. However, when attempts were made to estimate corresponding VAST estimates of survey size composition, the 1-cm bin size currently used in the models caused computational problems that have not yet been resolved. Validation of the estimates using various methods and comparison for consistency with other surveys has not yet been attempted.

BPT4: "...the NBS survey be conducted again in 2019 to provide data for the Pacific cod assessment." *Reponse*: The NBS survey was conducted again in 2019 and will provide data for the Pacific cod assessment.

BPT5: "...Pacific cod fishery catches and Pacific cod survey data in Russia be researched and summarized." *Response*: A small amount of data on Russian catches of Pacific cod has been obtained and efforts to obtain further estimates, perhaps using Automatic Identification System data, are being discussed. The available data will be reported in the final assessment.

BPT6: "...the significance of retrospective patterns when using a time-series with data mainly in recent years (for example, removing 2017 and 2018 leaves only one observation for the Northern Bering Sea survey time-series) be investigated and explained. For example, are the Mohn's ρ estimates useful to compare across models?" *Response*: Some results pertaining to this issue are presented in the Discussion section.

BPT7: "...the author considers an ensemble of models using the three hypotheses discussed above to address the structural uncertainty resulting from these hypotheses, as well as additional uncertainties captured by various models. The three hypotheses are 1) P. cod in the NBS are insignificant to the managed stock, 2) P. cod in the NBS are simply the same stock as in the EBS and should be managed as one stock, and 3) P. cod in the NBS and EBS are from the same stock and should be managed as one stock, but P. cod in the NBS should be modeled separately within one model with separate catchability and selectivity to capture differences observed in the fish in that area. *Response*: In addition to the base model, six new models are presented here, spread across the Team's three hypotheses (specifically, two new models per hypothesis).

BPT8: "...the author considers bringing forward an ensemble of models to capture structural uncertainty with a justifiable weighting as well as a "null" approach with equal weights. The Plan Team may also consider an ensemble even if not recommended by the author. If an ensemble is used, all model outputs in the ensemble that are management related should be averaged, and the ABC should be determined from those averaged outputs (i.e., the application of the control rule to averaged biological reference values).

The Team would appreciate feedback from the SSC on appropriate methods to average model outputs to determine an ABC." *Response*: See Comment SSC2. The document describing a new model averaging approach includes a focus on justifiable model weights.

BPT9: "...the authors coordinate with Council staff to augment the fishery information section of the assessment for next year. Council staff will be providing a cod allocation review in 2019 and will work with the author to provide pertinent summary sections over the summer." *Response*: The requested augmentation will occur in the final assessment.

BPT10: "...the authors coordinate with Alaska Department of Fish and Game on assessment data needs from the state managed Area O Pacific cod fishery as the fishery GHL is expanded under new allocation rules from 6.4% to a maximum 15% of the Bering Sea Pacific cod ABC." *Response*: Representatives from the Alaska Department of Fish and Game have been contacted regarding the need for data from the State-managed Pacific cod fishery in the EBS. They indicate a willingness to begin collecting these data. Specifics of the collection process will be developed soon.

Comments from the December 2018 SSC meeting

SSC3: "The SSC recommends that future efforts focus on treatment of the Northern Bering Sea data prior to adding to the assessment – via summation of the components (as in model 16.6i) or through model-based approaches that can estimate contributions of unsampled areas (such as developed for EBS walleye pollock). However, the SSC noted that many requested changes made in development of the 17.x and 18.x series of models represent improvements over the 16.x models. These improvements include inclusion of fishery age composition data, the prior on natural mortality, composition data weighted by the number of hauls, and harmonic mean composition weights. Other changes continue to be worthy of evaluation, but may not be clear improvements, such as time-varying selectivity and catchability. The SSC recommends bringing these branched model series back together either in the form of one model, or an ensemble of models for 2019." *Response*: Results from Model 16.6i, which uses simple summation of the design-based survey estimates, are again reported here, along with results from six new models, two of which use VAST estimates of survey abundance and age composition (see Comment BPT3). All of the new models include fishery age composition data and initial weighting of compositional data by the number of hauls (in either absolute or relative terms), and three of the new models include reweighting of compositional data and time-varying selectivity and catchability.

SSC4: "The greatest concern identified by the SSC was the future survival and contribution to the greater cod stock of the fish observed in the Northern Bering Sea (over half of the total biomass) in 2018. The SSC reiterated its recommendation from October that in-season reporting of fishery performance be used to track the presence and/or success of these fish into next spring." *Response*: This request could not be accommodated due to lack of the necessary data.

"The SSC agreed with PT recommendations for additional work on...

SSC5: "...resolving issues with ageing methods and historical age data, following the issues raised in the GOA Pacific cod assessment which may be applicable in the Bering Sea." Response: See Comment BPT1.

SSC6: "...use of a model-based method for developing a survey abundance estimate for the entire Bering Sea." See Comment BPT3.

SSC7: "...the critical importance of a Northern Bering Sea survey in 2019." See Comment BPT4.

SSC8: "The SSC strongly supported the PT approach of organizing alternative models around explicit hypotheses regarding the assessment structure or population dynamics. This approach was very helpful to make clear where the need for additional research was most important, and also provided a logical framework for developing an ensemble of models corresponding to each hypothesis. Moving forward, weighting of models for an ensemble may be developed based on the relative plausibility of each model hypothesis. The SSC recommends further efforts in developing this approach." *Response*: See Comment BPT7 regarding the Team's three hypotheses. See Comments SSC2 and BPT8 regarding model averaging. In addition to including a focus on justifiable model weights, the document describing a new model averaging approach also provides an explicit role for the relative plausibility of each model in the ensemble.

SSC9: "The SSC supports tagging, which may be helpful for understanding connectivity among areas of the greater Bering Sea." *Response*: This year's NBS survey included plans to fit 32 fish with satellite archival tags. Genetic samples were to be taken prior to release, to determine spawning site fidelity.

SSC10: "The SSC supported the use of projections integrated with the assessment analysis and the use of fixed catches (rather than fishing mortality rates) in these projections. This approach provided for more realistic projections that included uncertainty in the fishing mortality rate, parameter uncertainty, and allowed for the explicit calculation of the probability of exceeding the overfishing limit. The SSC suggest that this method be explored in other assessments and considered for routine use." *Response*: Projections are again integrated with the assessment analysis here.

SSC11: "The SSC also encouraged additional work to investigate recent and historical fishery catch in the Northern Bering Sea as there were a number questions regarding reports of fishery activity, but only a small amount of fishing identified by the author." *Response*: Additional investigation revealed that the absence of fishery data from the NBS survey area last year was due to the timing of last year's analysis. Last year's data query was run in July, and resulted in very few records. However, when the same query was run *this* July, 620 records (hauls) were retrieved for 2018, all but 12 of which were for the months August-December. No records were retrieved for 2019 as a result of this year's query, however.

Models

Software
As with all assessments of the EBS Pacific cod stock since 1992, the Stock Synthesis (SS) software package (Methot and Wetzel 2013) was used to develop and run the models. Since 2005, new versions of SS have been programmed in ADMB (Fournier et al. 2012). SS V3.30.14.00 was used to run all of the models in this preliminary assessment. For the current base model, this version of SS gave the same value for the objective function as the version used in last year's assessment (Thompson 2018).

Base model
Model 16.6i was adopted by the SSC last year as the new base model. Like its predecessor (Model 16.6, adopted in 2016), Model 16.6i 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.

The only difference between Model 16.6i and Model 16.6 is the inclusion in Model 16.6i of data from the NBS survey, which were incorporated by simple summation with the EBS survey data.

Alternative models

A total of six alternative models are presented here in addition to the base model. These constitute a factorial design involving the Team's three hypotheses regarding treatment of the NBS (Comments BPT7 and SSC8) and the SSC's desire to explore multiple ranges of possible enhancements to the structure of the base model (Comment SSC3).

The Team's three hypotheses are:

4. Pacific cod in the NBS are insignificant to the managed stock, so the assessment should include data from the EBS only.
5. Pacific cod in the EBS and NBS comprise a single stock, and the EBS and NBS surveys can be modeled in combination.
6. Pacific cod in the EBS and NBS comprise a single stock, but the EBS and NBS surveys should be modeled separately.

Relative to the base model, two ranges of structural modifications are featured among the alternative models. More specifically, two models are presented for each hypothesis, one of which contains a certain set of structural modifications, and the other of which contains a second, larger, set of structural modifications. The two sets of structural modifications are the same across hypotheses, except that an additional set of survey parameters is required for Hypothesis 3. In addition to structural differences, the models for the various hypotheses also involve different data.

The first (smaller) set of structural modifications is as follows:

- Set input sample size for compositional data equal to the number of hauls, rescaled to an average of 300 for each component (Model 16.6i sets input sample size equal to the number of *observations*, rescaled to an average of 300 for each component).
- Include the available fishery age composition data (Model 16.6i ignores those data).
- Use age-based, double-normal selectivity, potentially dome-shaped for the fishery but forced asymptotic for the survey (Model 16.6i uses age-based, logistic survey for both fleets).
- Tune the input standard deviation of log-scale recruitment deviations (σ_R) to match the square root of the variance of the estimates plus the sum of the estimates' variances (Methot and Taylor 2011; Model 16.6i estimates σ_R internally).
- Use size-based maturity (Model 16.6i uses age-based maturity).

The second (larger) set of structural modifications is as follows:

- Set input sample size for compositional data equal to raw number of hauls rather (than rescaled to an average of 300 for each component).
- Reweight compositional data internally using the Dirichlet-multinomial distribution (Thorson et al. 2017; see also Discussion section here).
- Use size-based double-normal selectivity rather than age-based (but keeping the assumption of asymptotic survey selectivity).
- Allow mean ageing bias at ages 1 and 20 to differ between the pre-2008 and post-2007 periods in order to compensate for an apparent change in ageing criteria (Beth Matta, AFSC Age and Growth Program, pers. commun., 6/27/2019) .
- Allow yearly random variation in survey selectivity (two parameters), with the input standard deviation of the deviations tuned to set the variance of the estimates plus the sum of the estimates' variances equal to unity.

- Allow yearly random variation in survey catchability, with the input standard deviation of the deviations tuned to set the variance of the estimates plus the sum of the estimates' variances equal to unity.
- Allow yearly random variation in mean length at age 1.5, with the input standard deviation of the deviations tuned to set the variance of the estimates plus the sum of the estimates' variances equal to unity, in order to address the significant amount of time-variability in growth documented by Puerta et al. (2019).
- Allow yearly random variation in fishery selectivity (three parameters), with the input standard deviation of the deviations tuned to set the variance of the estimates plus the sum of the estimates' variances equal to unity.

(Note that the method for tuning the input standard deviations of log-scale recruitment deviations is slightly different than the method for tuning the input standard deviations of all other deviation vectors. This is because SS treats log-scale recruitment deviations differently from all other deviation vectors.)

Referring to models conforming to the first set of structural modifications as "simple" and models conforming to the second (larger) set of structural modifications as "complex," the set of alternative models can be summarized as follows:

Hypothesis:	1: EBS only		2: Combine EBS and NBS		3: Separate EBS and NBS	
Structure:	Simple	Complex	Simple	Complex	Simple	Complex
Name:	M19.1	M19.2	M19.3	M19.4	M19.5	M19.6

Features explored but not included in the models presented here

A total of 256 one-at-a-time model runs (plus 862 "jitter" runs—see "Convergence behavior" below—and over 60 retrospective runs) were made in developing the models presented here. Many of these explored various features, sometimes in multiple combinations, that ultimately were not included in the models presented here. Among those features were the following:

- Use of VAST estimates of survey abundance without the cold pool as a covariate
- Use of VAST estimates of survey abundance without bias correction
- Internal estimation of a time-invariant increment to the log-scale survey index standard error
- Allowing yearly random variation in the Brody growth coefficient (K)
- Internal estimation of a parameter expressing cohort-specific growth
- External re-weighting of compositional data components
- Survey catchability fixed (not estimated statistically) at 1.0
- Exponential-logistic fishery selectivity
- Exponential-logistic survey selectivity
- Different combinations of selectivity parameters that are subject to yearly random variation
- Allowing survey selectivity to be dome-shaped

Data

The data used in the base model were described in last year's assessment (Thompson 2018). Various modifications were used in the alternative models.

The data files for all of the alternative models involve changes to the input sample size for compositional data, substituting either rescaled number of hauls (Models 19.1, 19.3, 19.5) or raw number of hauls (Models 19.2, 19.4, 19.6) for the rescaled number of observations used in Model 16.6i. The time series of raw and rescaled numbers of hauls for the fishery, EBS survey, NBS survey, and combined EBS and NBS surveys are shown in Table 2.1.1.

In addition, the design-based EBS+NBS survey estimates used in Model 16.6i were replaced by design-based EBS-only survey estimates in Models 19.1 and 19.2 (Hypothesis 1), VAST estimates for the combined surveys in Models 19.3 and 19.4 (Hypothesis 2), and area-specific design-based estimates for the EBS and NBS surveys in Models 19.5 and 19.6 (Hypothesis 3). The various time series of survey index estimates are shown in Table 2.1.2, and the time series for the design-based estimates and VAST estimates of the combined EBS and NBS surveys are also shown in Figure 2.1.1. This figure suggests that few Pacific cod were present in the NBS during years when that region was not surveyed. The VAST estimates incorporated a cold pool effect and were bias corrected. In addition, all settings used to generate the VAST estimates followed the recommendations given by Thorson (2019).

Finally, the VAST estimates of age composition were substituted for their design-based counterparts in all models. The differences between the two sets of estimates (VAST minus design-based) are shown in Table 2.1.3, where the color scale extends from red=low to green=high. In general the differences between the two sets of estimates are small, with 84% of the cells in Table 2.1.3 falling within the range (-0.01,0.01), 95% falling within the range (-0.02,0.02), and 99% falling within the range (-0.04,0.04). Age 1 had the largest positive changes (4% increases in 1997 and 2009, 5% increase in 2011) and ages 2 and 3 had the largest negative changes (4% decreases at age 2 in 2013 and age 3 in 1997).

Convergence behavior

As in previous assessments, development of the final versions of all models included calculation of the Hessian matrix and a requirement that all models pass a "jitter" test of 50 runs. Following the procedure used in every EBS Pacific cod assessment since 2016, when running a jitter test, the bounds for each parameter in the model were adjusted to match the 99.9% confidence interval (based on the normal approximation obtained by inverting the Hessian matrix). A jitter rate (equal to half the standard deviation of the logit-scale distribution from which "jittered" parameter values are drawn) was set at 1.0 for all models. Standardizing the jittering process in this manner will not explore parameter space as thoroughly as possible; however, it makes the jitter rate more interpretable, and shows the extent to which the identified minimum (local or otherwise) is well behaved.

In the event that a jitter run produced a better value for the objective function than the base run, then:

- The model was re-run starting from the final parameter file from the best jitter run.
- The resulting new control file, with the parameter estimates from the best jitter run incorporated as starting values, became the new base run.
- The entire process (starting with a new set of jitter runs) was repeated until no jitter run produced a better value for the objective function than the most recent base run.

Results

Note: In all tables with color scales, red and green correspond to the minimum and maximum values within the given row or column (whether the scale varies horizontally or vertically varies by table).

Bridging analysis, part 1: Model 16.6i to Model 19.3

The differences between Model 16.6i and Model 19.3 serve as a convenient bridge from the current base model to the set of alternative models, as both have a relatively simple structure and both use data from the combined EBS and NBS surveys (design-based estimates in the former case, VAST estimates in the latter). The steps can be outlined as shown in the following table, where Steps 1-4 all involve changes in data and Steps 5-8 all involve changes in model structure:

Step	Description
0	Model 16.6i (base model)
1	Same as Step 0, but using VAST survey index
2	Same as Step 1, but using VAST agecomps
3	Same as Step 2, but with sizecomp N = rescaled number of hauls
4	Same as Step 3, but with fishery agecomp data included (N = rescaled no. hauls)
5	Same as Step 4, but with asymptotic double-normal selectivity (fishery and survey)
6	Same as Step 5, but with potentially domed fishery selectivity
7	Same as Step 6, but with SD(ln(recruits)) tuned iteratively
8	Same as Step 7, but with size-based maturity

The results of the above are shown in Table 2.1.4.

The first 8 rows show management-related quantities for 2019 and 2020: female spawning biomass (B), maximum permissible acceptable biological catch (maxABC), the ratio of B to equilibrium unexploited female spawning biomass (B100%), and fishing mortality at maxABC (maxFABC). Most of these quantities reach a minimum in Step 4 and a maximum somewhere between Steps 5 and 8.

The value of the overall objective function is shown in row 9, and the next 8 rows show the individual components of that overall value. These rows are not color shaded, as they are not truly comparable, given differences in data and number of parameters across steps.

The next 16 rows show the values of some key parameters. Estimates of the natural mortality rate ranged between 0.31 and 0.37 and estimates of log catchability ranged between 0.03 (catchability=1.03) to 0.22 (catchability=1.24).

The next row shows the root-mean-squared-error (RMSE) of the survey index, which shows very little difference across steps.

The final four rows show effective sample size, as calculated by the method of McAllister and Ianelli (1997). Again, there is very little difference in any of these measures of goodness of fit across steps.

Bridging analysis, part 2: Model 19.3 to Model 19.4
Having created a bridge from the current base model to the closest analogue within the set of alternative models, it may be helpful to create a bridge from the "simple" Model 19.3 to its "complex" counterpart, Model 19.4. The steps can be outlined as shown in the following table, where Steps 1 involves a change in data and Steps 2-9 all involve changes in model structure:

Step	Description
0	Model 19.3
1	Same as Step 0, but with composition input N = number of hauls (no rescaling)
2	Same as Step 1, but with Dirichlet composition data weights
3	Same as Step 2, but with size-based selectivity
4	Same as Step 3, but with block-specific ageing bias (pre-2008, post-2007)
5	Same as Step 4, but with yearly random variation in survey selectivity (2 parameters)
6	Same as Step 5, but with re-tuned SD(ln(recruits))
7	Same as Step 6, but with yearly random variation in survey catchability
8	Same as Step 7, but with yearly random variation in mean length at age 1.5
9	Same as Step 8, but with yearly random variation in fishery selectivity (3 parameters)

The results of the above are shown in Table 2.1.5, which has the same structure as Table 2.1.4. In general, differences across steps in Table 2.1.5 are greater than those in Table 2.1.4. For the management-related quantities in the first 8 rows, Step 1 consistently resulted in the lowest values and Step 8 the highest, with the ratio between the two (high to low) ranging between 1.8 and 4.7. Natural mortality ranged between 0.28 to 0.37, and log catchability ranged between 0.01 (catchability=1.01) and 0.40 (catchability=1.49). Survey RMSE ranged between 0.06 and 0.20, and effective sample sizes all showed fairly wide ranges as well.

One thing to keep in mind when examining the results of a bridging analysis such as this is that the results can be highly dependent on the order in which the steps are taken. That is, a step that shows a big increase (or decrease) in some quantity might show a smaller (or even opposite) change if the steps were rearranged.

Main results

Table 2.1.6 presents the main results for the base model and the six alternative models, and contains most of the same rows as Tables 2.1.4 and 2.1.5 (parameter estimates are not shown, as they appear in a separate table), plus two new rows near the top of the table. The first of the new rows shows the "average difference in spawning biomass" (ADSB) that is used to distinguish models that are "minor" changes relative to the original form of the base model (ADSB<0.1) from those that are "major" (ADSB>0.1). All of the alternative models qualify as major changes, although two of them (Models 19.3 and 19.5) do so just barely. The second of the new rows shows Mohn's ρ, a measure of retrospective bias. All models except Models 16.6i and 19.1 show large positive retrospective biases.

Many of the rows in Table 2.1.6 show wide ranges of values. For the 8 management-related quantities, Model 19.1 is a clear outlier, with values far below those of any other model. Although Model 19.1 passed the standard convergence test, it should be remembered that this is a test of local stability only, and it is possible that Model 19.1 converged at a local minimum other than the global minimum. Model 19.4 has the highest values for all of the management-related quantities. The "complex" models tend to have lower survey RMSEs and higher effective sample sizes than the "simple" models, as would be expected.

The models' fits to the survey index data are shown in Figure 2.1.2.

Parameter estimates and derived time series

Table 2.1.7 lists the estimates and standard deviations of all parameters except fishing mortality (constants estimated outside the model are not shown, and have the same values reported in last year's assessment).

Table 2.1.7a shows the values of the main parameters. A blank cell indicates that the respective parameter (row) is not used in the respective model (column), and a parameter with an estimate (Est.) but no standard deviation (SD) means that the respective parameter was estimated iteratively rather than internally. Natural mortality ranges between 0.265 and 0.380. The Brody growth coefficient ranges between 0.083 and 0.197. When ageing bias is permitted to vary between the pre-2008 and post-2007 eras, the sign of the bias flips from mostly positive (pre-2008) to mostly negative (post-2007). Initial fishing mortality ranges between 0.142 and 1.827. Log catchability for the EBS survey (or the combined EBS and NBS surveys in the case of Models 16.6i, 19.3, or 19.4) ranges from -0.058 (catchability=0.943) to 0.356 (catchability=1.428).

Table 2.1.7b shows log recruitment deviations for the initial numbers-at-age vector, and Table 2.1.7c shows log recruitment deviations for the time series. Table 2.1.7d shows selectivity parameters (not counting deviations).

Tables 2.1.7e-l apply to the "complex" models only (Models 19.2, 19.4, and 19.6).

Table 2.1.7e shows input standard deviations for deviation vectors other than log recruitment (all estimated iteratively) and the coefficients governing compositional data weighting in the Dirichlet-multinomial approach (Thorson et al. 2017). The Dirichlet coefficients for the fishery size composition data and the EBS survey size composition data (EBS+NBS in the case of Model 19.4) were all bound high (upper bound = 10.0), and so estimation of those parameters was disabled. The input sample sizes and the effective sample sizes using the definitions of both Thorson et al. 2017 and McAllister and Ianelli (1997, harmonic mean) are as follow:

	Average no. hauls			Thorson N			McAllister-Ianelli N		
Component	M19.2	M19.4	M19.6	M19.2	M19.4	M19.6	M19.2	M19.4	M19.6
Fishery sizecomps	5225	5225	5225	5225	5225	5225	2012	2013	2007
EBS survey sizecomps	346	352	346	346	352	346	578	561	576
NBS survey sizecomps	n/a	n/a	68	n/a	n/a	68	n/a	n/a	81
Fishery agecomps	9517	9517	9517	173	155	172	215	212	218
EBS survey agecomps	359	359	359	184	167	182	107	100	106
NBS survey agecomps	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 2.1.7f shows deviations for mean length at age 1.5, The corresponding time series of mean length at age 1.5 is shown in Figure 2.1.3, and the time series of the full length-at-age relationship is shown in Figure 2.1.4.

Table 2.1.7g shows deviations for log catchability. The catchability time series is shown in Figure 2.1.5.

Tables 2.1.7h-l show deviations for the time-varying selectivity parameters. The selectivity schedules corresponding to the parameters listed in Tables 2.1.7d and 2.1.7h-l are displayed in Figure 2.1.6, with fishery selectivity shown in Figure 2.1.6a, EBS survey selectivity (EBS+NBS in the case of Model 19.3 or Model 19.4) shown in Figure 2.1.6b, and NBS survey selectivity shown in Figure 2.1.6c.

The time series of full-selection fishing mortality rates are shown in Table 2.1.8.

The time series of age 0 recruitment, total (age 0+) biomass, and relative spawning biomass are shown in Figures 2.1.7, 2.1.8, and 2.1.9, respectively.

Discussion

Spatio-temporal trends in fishery CPUE during summer

Comment BPT2 raises the question of whether fishery CPUE data might suggest that Pacific cod are migrating in space and time in a manner similar to the survey vessels, which could support estimates of catchability greater than unity. This might be especially important for 2017 and 2018, when the NBS survey found unprecedented biomasses of Pacific cod.

The observer database was queried for CPUE data (longline vessels only, measured in kg per 1000 hooks), binned into half-by-one latitude-longitude blocks for the months of June, July, and August. When the data are screened for confidentiality, the patterns shown in Figure 2.1.10 result (the polygon at the top of each panel is a rough approximation of the standard NBS survey area). Figures 2.1.10a-c show June-August CPUE for all years combined, Figures 2.1.10d-f show June-August CPUE for 2017, and Figures 2.1.10g-i show June-August CPUE for 2018. These results do not suggest a strong pattern of movement along the same spatio-temporal lines as the survey vessels.

To see if the confidentiality screening might be obscuring such a pattern, a set of linear regressions using all data was conducted: one for 2017 only, one for 2018 only, and one for 2017 and 2018 combined. Fishery CPUE was the dependent variable, and the independent variables were:

- Day of year
- Latitude
- Longitude
- Day × latitude
- Day × longitude
- Latitude × longitude
- Day × latitude × longitude

The resulting parameter estimates, and the ratios of the estimates to their respective standard deviations, were as follow:

	2017 model		2018 model		2017-2018 model	
Parameter	Est.	Est./SD	Est.	Est./SD	Est.	Est./SD
Intercept	-4.85E+05	8.03E+00	-4.34E+04	6.88E-01	-3.53E+05	8.74E+00
Day	2.39E+03	8.45E+00	3.01E+02	9.81E-01	1.75E+03	9.00E+00
Latitude	8.32E+03	7.98E+00	6.63E+02	6.17E-01	6.08E+03	8.83E+00
Longitude	-2.81E+03	7.94E+00	-2.46E+02	6.68E-01	-2.05E+03	8.65E+00
Day x latitude	-4.10E+01	8.38E+00	-4.71E+00	9.01E-01	-3.00E+01	9.05E+00
Day x longitude	1.39E+01	8.38E+00	1.74E+00	9.69E-01	1.02E+01	8.93E+00
Latitude x longitude	4.81E+01	7.90E+00	3.71E+00	5.91E-01	3.52E+01	8.73E+00
Day x latitude x longitude	-2.38E-01	8.32E+00	-2.72E-02	8.89E-01	-1.74E-01	8.98E+00

None of the models fit the data very well (the coefficients of determination for the 2017, 2018, and 2017-2018 models were 0.20, 0.05, and 0.10, respectively), and the coefficients of the 2018 model were estimated very imprecisely (see Est./SD column), although the coefficients of the other two models were fairly well estimated. Regardless, the estimated coefficient for Day × latitude was negative in all three models, suggesting that Pacific cod overall are not migrating northward during the summer months.

Calculating retrospective bias with short time series

Comment BPT6 raises the question of whether estimates of retrospective bias are meaningful when one or more parameters are associated with a data set that does not span the full number of "peels" in the retrospective analysis. For example, the catchability and selectivity parameters for the NBS survey have no meaning apart from the NBS survey, but after the first two peels (stripping away the 2018 and 2017 data), the only remaining year in the NBS survey time series is 2010, and even that disappears after the eighth peel.

Retrospective analysis of Models 19.5 and 19.6 provides an opportunity to address this issue, as these models treat the NBS survey separately from the EBS survey. The table below shows the models estimates of log catchability for the NBS survey for each peel of the analysis, along with the standard deviations of those estimates and the retrospective bias associated with each peel (these are the quantities that are averaged to compute Mohn's ρ). Rows shaded gray correspond to years with NBS surveys. The last two rows correspond to peels for which no NBS survey data remain in the data file.

		Model 19.5			Model 19.6		
Peel	Last_yr	Est.	SD	Bias	Est.	SD	Bias
0	2018	-1.686	1.17E-01	n/a	-1.564	3.52E-01	n/a
1	2017	-2.184	1.63E-01	0.146	-2.359	4.46E-01	0.083
2	2016	-4.527	3.92E-01	0.206	-2.258	9.47E-01	0.236
3	2015	-4.604	3.83E-01	0.428	-2.359	9.41E-01	0.345
4	2014	-4.661	3.82E-01	0.537	-2.448	9.43E-01	0.448
5	2013	-4.793	4.54E-01	0.695	-2.547	9.48E-01	0.553
6	2012	-4.948	5.79E-01	0.875	-2.777	9.45E-01	0.775
7	2011	-5.028	5.70E-01	0.823	-2.937	9.25E-01	0.961
8	2010	-5.143	5.58E-01	0.833	-3.089	9.40E-01	1.231
9	2009	-1.684	1.25E+04	0.596	-1.478	1.21E+04	1.811
10	2008	-1.684	1.25E+04	0.436	-1.484	1.21E+04	0.916

Note that the standard deviations of the estimates become immense once the NBS survey data have been peeled away. Other than that, it is not obvious that the removal of the entire NBS survey time series has a particular effect on the retrospective bias. For example, in Model 19.5, the retrospective bias is lower in peels 9 and 10 (where no NBS survey data exist) than in peels 4 through 8, and in Model 19.6, the retrospective bias in peel 10 is lower than in peels 8 and 9.

Internal estimation of compositional sample size

Comment SSC3 lists "harmonic mean composition weights" as a possible candidate for further investigation. While harmonic mean weighting has advantages over simply assuming a sample size a priori, a different approach was taken in the present investigation, viz., the Dirichlet-multinomial approach of Thorson et al. (2017). The authors list the following as reasons to prefer their approach:

- The approach is faster than alternatives based on iteration, as the weighting is done internally by estimation of a single additional parameter.
- Because the single additional parameter is estimated, uncertainty in that estimate is propagated appropriately, unlike iterative approaches that result in a fixed constant.
- The same standard for convergence that is used for all other parameters applies to the weighting, unlike iterative approaches.
- The resulting estimates of effective sample size can never exceed the input sample size, which is a desirable property so long as the input sample size is appropriate.

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Tables

Table 2.1.1. Compositional sample sizes.

	Fishery		EBS only		NBS only		EBS and NBS	
Year	Raw	Rescaled	Raw	Rescaled	Raw	Rescaled	Raw	Rescaled
1977	30	1						
1978	160	8						
1979	235	12						
1980	208	10						
1981	148	7						
1982	187	9	308	267			308	263
1983	782	39	255	221			255	218
1984	1913	95	264	229			264	225
1985	2825	140	342	296			342	292
1986	2496	124	349	302			349	298
1987	4726	235	339	294			339	289
1988	1458	72	339	294			339	289
1989	966	48	293	254			293	250
1990	3601	179	329	285			329	281
1991	5188	258	313	271			313	267
1992	5322	264	332	288			332	283
1993	2993	149	363	315			363	310
1994	4687	233	364	315			364	311
1995	5215	259	347	301			347	296
1996	6618	329	359	311			359	306
1997	7278	361	369	320			369	315
1998	6838	340	362	314			362	309
1999	9231	458	336	291			336	287
2000	9731	483	355	308			355	303
2001	10364	515	366	317			366	312
2002	11472	570	364	315			364	311
2003	14341	712	363	315			363	310
2004	12242	608	361	313			361	308
2005	11568	574	360	312			360	307
2006	8849	439	354	307			354	302
2007	6901	343	368	319			368	314
2008	8320	413	338	293			338	288
2009	7482	371	360	312			360	307
2010	6514	323	342	296	6	26	348	297
2011	8804	437	368	319			368	314
2012	9287	461	356	309			356	304
2013	11126	552	354	307			354	302
2014	12165	604	373	323			373	318
2015	11309	561	354	307			354	302
2016	9773	485	376	326			376	321
2017	7154	355	369	320	119	525	488	416
2018	3267	162	364	315	79	349	443	378

Table 2.1.2. Comparison of design-based and VAST survey indices.

	Design-based EBS		Design-based NBS		Design-based E+N		VAST E+N	
Year	Est.	Sigma	Est.	Sigma	Est.	Sigma	Est.	Sigma
1982	583781	0.065			583781	0.065	649671	0.055
1983	752456	0.107			752456	0.107	814129	0.060
1984	651058	0.072			651058	0.072	708088	0.055
1985	841108	0.134			841108	0.134	909961	0.053
1986	838217	0.1			838217	0.100	867470	0.054
1987	697075	0.064			697075	0.064	752342	0.055
1988	512095	0.069			512095	0.069	526940	0.053
1989	301748	0.066			301748	0.066	325492	0.054
1990	438107	0.084			438107	0.084	468569	0.056
1991	496765	0.103			496765	0.103	532064	0.063
1992	585436	0.117			585436	0.117	587264	0.067
1993	814187	0.121			814187	0.121	847643	0.066
1994	1255544	0.121			1255544	0.121	1236873	0.057
1995	761681	0.099			761681	0.099	773905	0.056
1996	614493	0.143			614493	0.143	694181	0.069
1997	493660	0.143			493660	0.143	530345	0.059
1998	522586	0.09			522586	0.090	602707	0.072
1999	542229	0.1			542229	0.100	547447	0.063
2000	488605	0.09			488605	0.090	503574	0.055
2001	974016	0.094			974016	0.094	1016424	0.057
2002	544602	0.099			544602	0.099	617107	0.065
2003	516468	0.12			516468	0.120	601214	0.075
2004	404687	0.085			404687	0.085	438444	0.059
2005	464647	0.136			464647	0.136	485142	0.057
2006	407584	0.059			407584	0.059	427740	0.054
2007	753821	0.256			753821	0.256	673575	0.066
2008	492643	0.101			492643	0.101	500108	0.060
2009	721812	0.087			721812	0.087	747307	0.053
2010	896301	0.13	6671	0.184	902971	0.129	832106	0.059
2011	844482	0.094			844482	0.094	880293	0.057
2012	991342	0.092			991342	0.092	1050007	0.069
2013	760225	0.163			760225	0.163	727888	0.061
2014	1129255	0.127			1129255	0.127	1235189	0.071
2015	985698	0.115			985698	0.115	1069240	0.068
2016	660996	0.093			660996	0.093	890248	0.097
2017	364129	0.088	137182	0.123	501310	0.073	519020	0.049
2018	248542	0.071	243638	0.18	492180	0.097	552584	0.077

Table 2.1.3. Comparison of design-based and VAST survey age compositions.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12
1994	0.00024	0.01528	0.01794	-0.00408	-0.01527	-0.00916	-0.00426	-0.00120	0.00045	-0.00043	-0.00002	0.00014	0.00038
1995	0.00016	0.00959	-0.00607	-0.00518	0.00325	-0.00250	0.00420	-0.00239	-0.00163	-0.00045	-0.00005	0.00079	0.00029
1996	0.00003	0.01601	-0.01188	-0.02337	-0.00894	0.01058	0.01321	0.00430	-0.00090	-0.00063	0.00014	0.00062	0.00081
1997	0.00032	0.04365	-0.00851	-0.03707	-0.01698	-0.00266	0.01743	0.00273	0.00071	-0.00069	0.00054	0.00020	0.00032
1998	0.00008	0.01032	-0.00432	-0.00957	-0.00389	0.00147	0.00212	0.00294	0.00103	-0.00052	-0.00005	0.00022	0.00021
1999	0.00009	0.01432	0.01333	0.00788	-0.02138	-0.00920	-0.00411	-0.00056	-0.00005	-0.00011	-0.00020	-0.00007	0.00006
2000	-0.00002	-0.01059	-0.01025	0.01305	-0.00573	0.00897	0.00098	0.00053	0.00206	-0.00046	0.00086	0.00029	0.00029
2001	0.00003	0.00701	0.00095	-0.00892	-0.00634	0.00413	0.00295	0.00018	-0.00014	-0.00033	0.00001	0.00029	0.00016
2002	0.00045	0.00381	0.00500	-0.02090	0.00564	0.00039	0.00253	0.00425	-0.00032	-0.00091	-0.00010	-0.00002	0.00017
2003	0.00000	-0.00014	0.00095	-0.01812	-0.00179	0.00882	0.00526	0.00241	0.00242	-0.00009	-0.00003	0.00006	0.00026
2004	0.00002	0.00338	-0.01270	-0.00666	0.00151	0.00660	0.00849	-0.00091	0.00157	-0.00089	-0.00003	-0.00057	0.00016
2005	0.00001	-0.02183	-0.00631	-0.00766	0.00557	0.00493	0.01396	0.00847	0.00203	0.00014	0.00017	0.00061	-0.00009
2006	0.00000	0.02470	-0.00110	-0.00096	-0.01076	-0.00640	-0.00249	-0.00076	-0.00167	-0.00045	0.00011	-0.00012	-0.00008
2007	0.00000	-0.02258	0.00829	0.00461	0.00453	0.00218	0.00195	0.00155	-0.00019	0.00023	-0.00003	-0.00049	-0.00006
2008	-0.00014	-0.00843	-0.01302	0.00676	0.00860	0.00442	-0.00089	0.00095	0.00052	0.00075	0.00006	0.00077	-0.00033
2009	-0.00068	0.04061	-0.01629	-0.01866	-0.00354	-0.00213	-0.00026	-0.00014	0.00089	-0.00020	0.00014	0.00014	0.00010
2010	0.00000	0.00171	0.00217	0.00201	-0.00589	-0.00194	0.00061	0.00053	0.00019	0.00025	0.00019	0.00012	0.00005
2011	0.00006	0.04794	-0.00215	-0.03108	-0.00716	-0.00764	-0.00025	0.00029	-0.00028	-0.00001	0.00017	0.00011	0.00002
2012	-0.00005	-0.01793	0.01913	0.00251	-0.00917	0.00241	0.00116	0.00096	0.00050	0.00027	0.00013	-0.00001	0.00006
2013	0.00000	-0.00272	-0.04109	0.01808	0.00820	0.01153	0.00387	0.00182	0.00003	0.00017	0.00003	0.00002	0.00005
2014	-0.00002	-0.00291	-0.02199	-0.00204	0.01135	0.00830	0.00619	0.00091	-0.00008	0.00000	0.00009	-0.00004	0.00025
2015	0.00002	-0.00202	0.00452	-0.00249	-0.00004	0.00058	-0.00029	-0.00007	-0.00011	-0.00009	-0.00002	-0.00005	0.00005
2016	0.00000	-0.02911	-0.00511	-0.01275	0.01747	0.02287	0.00684	0.00037	-0.00061	0.00001	0.00004	-0.00003	0.00001
2017	0.00007	-0.02334	0.00862	-0.03243	0.01693	0.01940	0.01070	0.00096	-0.00148	0.00010	0.00008	0.00008	0.00032
Ave:	0.00003	0.00403	-0.00333	-0.00779	-0.00141	0.00316	0.00375	0.00117	0.00021	-0.00018	0.00009	0.00013	0.00014

Table 2.1.4. Results of bridging analysis, part 1 (Model 16.6i to Model 19.3).

Step	0	1	2	3	4	5	6	7	8
B(2019)	290205	276542	281489	296803	260110	296340	299878	297312	303532
B(2020)	246467	235633	237954	252229	241528	243672	246114	245173	244208
maxABC(2019)	181431	176213	178281	184627	135539	196561	199539	196689	200978
maxABC(2020)	137364	130401	131135	140557	108726	148361	149111	141119	142515
B(2019)/B100%	0.44	0.43	0.44	0.45	0.37	0.48	0.48	0.46	0.47
B(2020)/B100%	0.38	0.37	0.37	0.38	0.34	0.40	0.40	0.38	0.38
maxFABC(2019)	0.31	0.31	0.31	0.30	0.24	0.32	0.33	0.33	0.34
maxFABC(2020)	0.29	0.28	0.28	0.29	0.22	0.32	0.33	0.31	0.31
Objective function	1679.54	1762.47	1737.49	1659.54	1773.34	1744.61	1743.21	1743.68	1743.68
Equilibrium catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Survey index	-26.54	45.77	45.63	37.54	41.20	37.95	37.69	37.78	37.78
Size compostion	1427.42	1437.81	1434.17	1349.17	1367.17	1357.60	1355.58	1354.36	1354.36
Age composition	271.94	272.60	250.74	266.17	357.12	346.41	347.52	347.41	347.41
Recruitment	-2.57	-2.84	-2.04	-0.22	-0.67	-3.11	-3.18	-1.18	-1.18
Initial regime	9.27	9.13	8.98	6.87	8.51	5.77	5.59	5.31	5.31
"Softbounds"	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Deviations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural mortality	0.34	0.34	0.34	0.34	0.31	0.37	0.37	0.36	0.36
Length at age 1.5	16.38	16.38	16.38	16.38	16.42	16.42	16.43	16.42	16.42
Asymptotic length	100.62	99.57	99.56	100.53	101.39	102.26	102.39	102.43	102.43
Brody growth (K)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Richards growth	1.04	1.01	1.02	1.02	1.02	0.99	0.99	0.99	0.99
SD(length at *a* =1)	3.46	3.45	3.45	3.44	3.48	3.48	3.48	3.48	3.48
SD(length at *a* =20)	9.53	9.54	9.57	9.19	8.60	8.48	8.48	8.50	8.50
Ageing bias (*a* =1)	0.33	0.33	0.33	0.33	0.34	0.32	0.33	0.33	0.33
Ageing bias (*a* =20)	0.16	0.22	0.41	0.38	-0.30	-0.25	-0.27	-0.27	-0.27
Bias (*a* =1, 2008+)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bias (*a* =20, 2008+)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ln(mean recruits)	12.98	12.99	12.99	12.96	12.76	13.12	13.12	13.14	13.14
SD(ln(recruits))	0.66	0.65	0.66	0.66	0.67	0.62	0.62	0.69	0.69
ln(regime offset)	-1.16	-1.15	-1.15	-0.99	-1.01	-0.95	-0.93	-0.99	-0.99
Initial fishing mort.	0.19	0.19	0.19	0.14	0.13	0.13	0.14	0.14	0.14
ln(catchability)	0.03	0.11	0.10	0.10	0.22	0.10	0.09	0.10	0.10
Survey RMSE	0.18	0.17	0.17	0.17	0.17	0.17	0.16	0.17	0.17
Neff(fishery,size)	583	585	586	495	495	519	520	533	533
Neff(survey,size)	321	321	320	311	308	310	310	310	310
Neff(fishery,age)	n/a	n/a	n/a	n/a	116	133	134	134	134
Neff(survey,age)	61	60	66	63	60	61	61	61	61

For all runs in this table, "survey" means the combined EBS and NBS surveys
Step 0 uses design-based survey estimates; all other steps used VAST survey estimates

Table 2.1.5. Results of bridging analysis, part 2 (Model 19.3 to Model 19.4).

Step	0	1	2	3	4	5	6	7	8	9
B(2019)	303532	173690	230190	201686	205506	261955	262341	229335	248724	322998
B(2020)	244208	191242	225249	210212	211002	223558	223457	199915	211349	266750
maxABC(2019)	200978	46439	100880	72697	77731	176911	177884	149193	167945	218243
maxABC(2020)	142515	52740	89744	73762	76683	124003	134001	108160	120215	169733
B(2019)/B100%	0.47	0.20	0.30	0.27	0.28	0.40	0.44	0.39	0.42	0.50
B(2020)/B100%	0.38	0.23	0.29	0.28	0.29	0.34	0.37	0.34	0.36	0.42
maxFABC(2019)	0.34	0.12	0.20	0.16	0.17	0.34	0.34	0.33	0.34	0.37
maxFABC(2020)	0.31	0.13	0.20	0.17	0.18	0.29	0.32	0.28	0.30	0.37
Objective function	1743.68	7027.31	5571.25	5328.35	5315.12	4725.28	4726.94	4609.49	4376.22	2094.11
Equilibrium catch	0.00	0.06	0.04	0.06	0.06	0.02	0.04	0.04	0.04	0.01
Survey index	37.78	105.08	77.41	82.96	82.77	32.32	32.42	-84.15	-84.73	-85.07
Size compostion	1354.36	5149.60	4950.84	4660.78	4662.90	4133.31	4134.33	4083.91	3861.44	1602.93
Age composition	347.41	1756.49	530.01	563.74	549.22	509.09	509.01	512.15	499.47	436.92
Recruitment	-1.18	-5.25	-5.84	-1.63	-1.58	-4.46	-8.87	-8.80	-11.33	-10.05
Initial regime	5.31	21.32	18.76	22.44	21.75	14.57	19.62	19.69	19.32	9.67
"Softbounds"	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deviations	0.00	0.00	0.00	0.00	0.00	40.43	40.38	86.65	92.01	139.70
Natural mortality	0.36	0.28	0.31	0.28	0.29	0.36	0.36	0.36	0.36	0.37
Length at age 1.5	16.42	16.61	16.58	13.84	13.83	14.72	14.71	14.71	15.56	15.13
Asymptotic length	102.43	116.52	107.72	105.56	106.05	104.85	104.99	104.98	104.57	104.07
Brody growth (K)	0.20	0.13	0.17	0.16	0.16	0.17	0.17	0.18	0.17	0.18
Richards growth	0.99	1.29	1.13	1.23	1.23	1.12	1.12	1.11	1.15	1.12
SD(length at *a* =1)	3.48	3.45	3.51	3.58	3.57	3.46	3.46	3.46	3.36	3.46
SD(length at *a* =20)	8.50	9.23	8.65	10.05	10.10	9.83	9.81	9.78	9.94	9.09
Ageing bias (*a* =1)	0.33	0.25	0.33	0.33	0.31	0.31	0.31	0.30	0.31	0.33
Ageing bias (*a* =20)	-0.27	-0.70	0.28	0.48	1.62	1.55	1.57	1.66	1.50	0.89
Bias (*a* =1, 2008+)	n/a	n/a	n/a	n/a	0.03	0.03	0.03	0.04	0.04	0.02
Bias (*a* =20, 2008+)	n/a	n/a	n/a	n/a	-1.73	-1.53	-1.54	-1.84	-1.60	-2.22
ln(mean recruits)	13.14	12.59	12.76	12.54	12.57	13.15	13.08	13.05	13.04	13.22
SD(ln(recruits))	0.69	0.69	0.69	0.69	0.69	0.69	0.56	0.56	0.56	0.56
ln(regime offset)	-0.99	-1.48	-1.55	-1.50	-1.51	-1.63	-1.56	-1.55	-1.53	-1.13
Initial fishing mort.	0.14	1.37	1.07	1.13	1.10	0.69	0.70	0.74	0.70	0.23
ln(catchability)	0.10	0.39	0.30	0.40	0.38	0.16	0.15	0.19	0.16	0.01
Survey RMSE	0.17	0.20	0.19	0.19	0.19	0.16	0.16	0.07	0.06	0.06
Neff(fishery,size)	533	750	762	727	726	723	726	728	739	2013
Neff(survey,size)	310	258	255	261	262	396	396	412	502	561
Neff(fishery,age)	134	259	75	51	47	40	40	38	30	212
Neff(survey,age)	61	45	42	38	38	64	64	63	71	100

For all runs in this table, "survey" means the combined EBS and NBS surveys, using VAST estimates.
For Steps 4-9, the two rows labeled "Ageing bias..." apply to 1977-2007 only.

Table 2.1.6. Main results.

EBS/NBS hypothesis:	Combine	EBS only		Combine		Separate	
Model structure:	Base	Simple	Complex	Simple	Complex	Simple	Complex
Model	M16.6i	M19.1	M19.2	M19.3	M19.4	M19.5	M19.6
ADSB	0.090	0.323	0.255	0.106	0.573	0.100	0.351
Mohn's ρ	0.207	0.093	0.679	0.337	0.741	0.558	0.736
B(2019)	290205	96355	190394	303532	322998	221920	201524
B(2020)	246467	118012	169236	244208	266750	194879	176107
maxABC(2019)	181431	12191	108116	200978	218243	135217	120504
maxABC(2020)	137364	17707	81106	142515	169733	98986	87074
B(2019)/B100%	0.44	0.11	0.32	0.47	0.50	0.35	0.34
B(2020)/B100%	0.38	0.13	0.28	0.38	0.42	0.31	0.29
maxFABC(2019)	0.31	0.05	0.30	0.34	0.37	0.30	0.32
maxFABC(2020)	0.29	0.07	0.27	0.31	0.37	0.26	0.28
Objective function	1679.54	6582.42	2046.81	1743.68	2094.11	1796.06	2091.54
Equilibrium catch	0.00	0.11	0.01	0.00	0.01	0.00	0.01
Survey index	-26.54	4.63	-66.47	37.78	-85.07	140.42	-70.16
Size compostion	1427.42	4938.20	1566.20	1354.36	1602.93	1327.04	1599.77
Age composition	271.94	1619.83	426.08	347.41	436.92	324.75	427.56
Recruitment	-2.57	-5.32	-7.25	-1.18	-10.05	-1.29	-7.32
Initial regime	9.27	24.97	9.02	5.31	9.67	5.13	9.15
"Softbounds"	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Deviations	0.00	0.00	119.22	0.00	139.70	0.00	132.53
Main survey RMSE	0.18	0.21	0.11	0.17	0.06	0.20	0.11
NBS survey RMSE	n/a	n/a	n/a	n/a	n/a	1.85	0.18
Neff(fishery,size)	583	748	2012	533	2013	533	2007
Neff(main survey,size)	321	248	578	310	561	319	576
Neff(NBS survey, size)	n/a	n/a	n/a	n/a	n/a	667	81
Neff(fishery,age)	n/a	278	215	134	212	125	218
Neff(main survey,age)	61	43	107	61	100	65	106

For Models 16.6i, 19.3, and 19.4, "Main survey" means the combined EBS and NBS surveys.
For all other models, "Main survey" means the EBS survey only.
Models 19.3 and 19.4 use VAST survey index and agecomp estimates.
All other models use design-based survey index and agecomp estimates.

Table 2.1.7a. Main parameters.

Treatment of EBS and NBS surveys:[a]	Combined		EBS only				Combined				Separated			
Model:	Model 16.6i		Model 19.1		Model 19.2		Model 19.3		Model 19.4		Model 19.5		Model 19.6	
Reweighted, size select., time-varying:	No		No		Yes		No		Yes		No		Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
Natural mortality rate	0.340	0.012	0.265	0.013	0.382	0.012	0.363	0.017	0.372	0.013	0.366	0.017	0.380	0.012
Length at age 1.5	16.377	0.088	16.673	0.090	15.205	0.406	16.425	0.091	15.128	0.408	16.530	0.093	15.177	0.395
Asymptotic length	100.619	1.955	139.565	5.677	104.772	1.203	102.426	1.898	104.071	1.138	104.061	2.149	104.797	1.194
Brody growth coefficient (K)	0.195	0.012	0.083	0.008	0.178	0.007	0.197	0.011	0.180	0.007	0.185	0.011	0.178	0.007
Richards growth coefficient	1.039	0.047	1.449	0.033	1.118	0.034	0.992	0.045	1.120	0.034	1.019	0.046	1.121	0.034
SD(length at age 1)	3.456	0.058	3.501	0.053	3.430	0.061	3.478	0.060	3.456	0.061	3.529	0.061	3.447	0.061
SD(length at age 20)	9.532	0.272	9.877	0.250	9.150	0.205	8.497	0.271	9.087	0.203	8.907	0.282	9.119	0.205
Mean ageing bias at age 1[b]	0.335	0.012	0.188	0.024	0.343	0.016	0.325	0.014	0.332	0.017	0.320	0.015	0.343	0.016
Mean ageing bias at age 20[b]	0.157	0.145	-0.520	0.095	0.754	0.221	-0.267	0.130	0.888	0.233	-0.256	0.132	0.743	0.222
Mean ageing bias at age 1 (post-2007)					0.011	0.026			0.024	0.026			0.012	0.026
Mean ageing bias at age 20 (post-2007)					-2.163	0.341			-2.223	0.362			-2.149	0.342
ln(mean post-1976 recruitment)	12.984	0.097	12.377	0.089	13.233	0.104	13.142	0.124	13.218	0.110	13.161	0.125	13.219	0.102
SD(log-scale recruitment)	0.656	0.067	0.618	_	0.592	_	0.687	_	0.563	_	0.685	_	0.586	_
ln(pre-1977 mean recruitment offset)	-1.158	0.201	-1.336	0.050	-1.187	0.190	-0.993	0.204	-1.130	0.182	-0.985	0.205	-1.179	0.188
Pre-1977 mean fishing mortality rate	0.190	0.075	1.827	0.657	0.261	0.094	0.142	0.047	0.226	0.076	0.147	0.050	0.259	0.092
ln(catchability) for EBS survey[c]	0.030	0.059	0.356	0.041	-0.054	0.069	0.101	0.059	0.007	0.072	-0.016	0.061	-0.058	0.068
ln(catchability) for NBS survey											-1.686	0.117	-1.564	0.352

a. Survey abundance data are design-based estimates in all cases except for Models 19.3 and 19.4, which use VAST estimates.

b. For Models 19.2, 19.4, and 19.6, this parameter applies to 1977-2007 only.

c. For Models 16.6i, 19.3, and 19.4, this parameter applies to the combined EBS and NBS surveys.

d. For Model 19.4, this parameter applies to the combined EBS and NBS surveys.

Table 2.1.7b. Log recruitment deviations for the initial (1977) numbers-at-age vector.

Treatment of EBS and NBS surveys:	Combined		EBS only				Combined				Separated			
Model:	Model 16.6i		Model 19.1		Model 19.2		Model 19.3		Model 19.4		Model 19.5		Model 19.6	
Reweighted, size select., time-varying:	No		No		Yes		No		Yes		No		Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
Initial age 20 ln(recruits) dev	-0.005	0.655	0.000	0.618	-0.009	0.589	-0.007	0.685	-0.018	0.558	-0.006	0.683	-0.011	0.583
Initial age 19 ln(recruits) dev	-0.003	0.655	0.000	0.618	-0.009	0.590	-0.004	0.686	-0.010	0.560	-0.004	0.684	-0.006	0.585
Initial age 18 ln(recruits) dev	-0.005	0.654	0.000	0.618	-0.009	0.589	-0.007	0.685	-0.015	0.558	-0.006	0.683	-0.010	0.583
Initial age 17 ln(recruits) dev	-0.009	0.653	0.000	0.618	-0.014	0.587	-0.011	0.684	-0.023	0.556	-0.010	0.682	-0.017	0.582
Initial age 16 ln(recruits) dev	-0.015	0.651	0.000	0.618	-0.026	0.585	-0.017	0.682	-0.035	0.553	-0.016	0.680	-0.026	0.579
Initial age 15 ln(recruits) dev	-0.025	0.649	0.000	0.618	-0.039	0.581	-0.027	0.679	-0.051	0.549	-0.026	0.677	-0.040	0.576
Initial age 14 ln(recruits) dev	-0.041	0.644	0.000	0.618	-0.057	0.576	-0.042	0.674	-0.076	0.544	-0.041	0.672	-0.059	0.571
Initial age 13 ln(recruits) dev	-0.066	0.638	0.000	0.618	-0.089	0.569	-0.066	0.667	-0.109	0.536	-0.063	0.666	-0.089	0.564
Initial age 12 ln(recruits) dev	-0.105	0.628	0.000	0.618	-0.131	0.560	-0.100	0.658	-0.153	0.527	-0.097	0.656	-0.132	0.555
Initial age 11 ln(recruits) dev	-0.161	0.616	0.000	0.618	-0.182	0.549	-0.148	0.645	-0.208	0.517	-0.145	0.644	-0.184	0.545
Initial age 10 ln(recruits) dev	-0.238	0.601	0.001	0.618	-0.253	0.538	-0.213	0.630	-0.272	0.506	-0.210	0.629	-0.253	0.533
Initial age 9 ln(recruits) dev	-0.338	0.583	0.005	0.620	-0.327	0.526	-0.297	0.612	-0.342	0.496	-0.294	0.611	-0.327	0.521
Initial age 8 ln(recruits) dev	-0.457	0.562	0.027	0.625	-0.399	0.514	-0.400	0.591	-0.407	0.486	-0.401	0.589	-0.398	0.510
Initial age 7 ln(recruits) dev	-0.580	0.540	0.118	0.647	-0.452	0.501	-0.520	0.568	-0.455	0.475	-0.524	0.565	-0.451	0.497
Initial age 6 ln(recruits) dev	-0.674	0.519	0.570	0.690	-0.444	0.485	-0.628	0.545	-0.458	0.460	-0.625	0.544	-0.445	0.481
Initial age 5 ln(recruits) dev	-0.656	0.505	-0.054	0.467	-0.343	0.455	-0.637	0.532	-0.393	0.437	-0.616	0.533	-0.345	0.452
Initial age 4 ln(recruits) dev	-0.273	0.486	0.261	0.186	-0.075	0.444	-0.306	0.518	-0.131	0.430	-0.256	0.517	-0.077	0.441
Initial age 3 ln(recruits) dev	-0.083	0.467	0.502	0.123	0.843	0.267	-0.057	0.481	0.706	0.263	-0.069	0.495	0.837	0.265
Initial age 2 ln(recruits) dev	-0.170	0.522	-0.966	0.343	-0.742	0.396	-0.249	0.543	-0.788	0.375	-0.204	0.555	-0.741	0.392
Initial age 1 ln(recruits) dev	0.803	0.494	1.292	0.102	1.355	0.235	0.746	0.461	1.247	0.231	0.819	0.474	1.341	0.234

Table 2.1.7c. Log recruitment deviations for the time series.

Treatment of EBS and NBS surveys:	Combined		EBS only				Combined				Separated			
Model:	Model 16.6i		Model 19.1		Model 19.2		Model 19.3		Model 19.4		Model 19.5		Model 19.6	
Reweighted, size select., time-varying:	No		No		Yes		No		Yes		No		Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
ln(recruits) dev 1977	0.855	0.209	0.293	0.084	0.752	0.154	0.762	0.211	0.686	0.152	0.842	0.217	0.748	0.152
ln(recruits) dev 1978	0.456	0.238	0.284	0.079	0.397	0.195	0.560	0.197	0.331	0.195	0.575	0.210	0.403	0.193
ln(recruits) dev 1979	0.467	0.138	0.253	0.063	0.739	0.105	0.456	0.128	0.672	0.104	0.476	0.135	0.741	0.103
ln(recruits) dev 1980	-0.273	0.134	-0.581	0.095	-0.353	0.153	-0.173	0.126	-0.425	0.150	-0.189	0.136	-0.357	0.153
ln(recruits) dev 1981	-0.860	0.141	0.149	0.047	-0.304	0.108	-0.797	0.145	-0.366	0.106	-0.795	0.151	-0.300	0.108
ln(recruits) dev 1982	0.788	0.051	0.453	0.039	0.811	0.053	0.823	0.052	0.747	0.050	0.863	0.055	0.811	0.052
ln(recruits) dev 1983	-0.554	0.125	-0.096	0.060	0.037	0.084	-0.482	0.129	-0.032	0.083	-0.510	0.139	0.036	0.083
ln(recruits) dev 1984	0.797	0.051	0.593	0.035	0.524	0.058	0.802	0.050	0.463	0.056	0.847	0.052	0.526	0.057
ln(recruits) dev 1985	-0.202	0.095	-0.030	0.047	0.316	0.057	-0.055	0.079	0.250	0.056	-0.024	0.083	0.316	0.056
ln(recruits) dev 1986	-0.614	0.118	-0.475	0.054	-0.354	0.079	-0.497	0.090	-0.436	0.079	-0.446	0.093	-0.355	0.078
ln(recruits) dev 1987	-1.193	0.181	-0.562	0.051	-0.814	0.109	-1.355	0.153	-0.902	0.109	-1.303	0.159	-0.813	0.108
ln(recruits) dev 1988	-0.331	0.100	-0.123	0.038	-0.274	0.058	-0.473	0.084	-0.341	0.057	-0.382	0.085	-0.271	0.057
ln(recruits) dev 1989	0.549	0.058	0.496	0.027	0.365	0.044	0.494	0.050	0.304	0.043	0.557	0.051	0.366	0.042
ln(recruits) dev 1990	0.388	0.062	0.439	0.028	0.394	0.047	0.384	0.055	0.341	0.046	0.391	0.057	0.395	0.045
ln(recruits) dev 1991	-0.055	0.076	0.019	0.037	-0.343	0.064	0.019	0.067	-0.367	0.063	0.012	0.069	-0.342	0.063
ln(recruits) dev 1992	0.785	0.038	0.753	0.021	0.767	0.040	0.871	0.035	0.746	0.036	0.858	0.036	0.770	0.037
ln(recruits) dev 1993	-0.099	0.059	-0.184	0.034	-0.257	0.060	-0.029	0.054	-0.330	0.058	-0.055	0.055	-0.258	0.058
ln(recruits) dev 1994	-0.298	0.062	-0.293	0.029	-0.367	0.058	-0.310	0.057	-0.439	0.052	-0.291	0.058	-0.364	0.055
ln(recruits) dev 1995	-0.379	0.070	-0.161	0.027	-0.328	0.053	-0.380	0.062	-0.379	0.051	-0.344	0.063	-0.323	0.051
ln(recruits) dev 1996	0.626	0.038	0.469	0.020	0.738	0.042	0.630	0.035	0.685	0.039	0.679	0.035	0.741	0.040
ln(recruits) dev 1997	-0.159	0.061	0.055	0.025	0.363	0.049	-0.116	0.054	0.300	0.048	-0.110	0.056	0.364	0.048
ln(recruits) dev 1998	-0.180	0.064	0.180	0.023	0.023	0.053	-0.114	0.057	-0.048	0.053	-0.078	0.058	0.025	0.052
ln(recruits) dev 1999	0.537	0.040	0.661	0.018	0.501	0.042	0.547	0.038	0.451	0.041	0.556	0.038	0.502	0.040
ln(recruits) dev 2000	0.265	0.044	0.199	0.025	0.233	0.046	0.297	0.041	0.188	0.044	0.256	0.043	0.233	0.044
ln(recruits) dev 2001	-0.530	0.067	-0.384	0.033	-0.655	0.064	-0.466	0.060	-0.697	0.063	-0.480	0.062	-0.654	0.063
ln(recruits) dev 2002	-0.238	0.053	0.013	0.024	-0.151	0.049	-0.173	0.049	-0.180	0.047	-0.210	0.050	-0.146	0.048
ln(recruits) dev 2003	-0.402	0.057	-0.142	0.026	-0.231	0.053	-0.314	0.052	-0.246	0.051	-0.367	0.053	-0.226	0.052
ln(recruits) dev 2004	-0.564	0.062	-0.405	0.030	-0.688	0.060	-0.558	0.059	-0.702	0.060	-0.643	0.061	-0.683	0.059
ln(recruits) dev 2005	-0.282	0.055	-0.439	0.030	-0.544	0.061	-0.398	0.054	-0.553	0.060	-0.439	0.056	-0.539	0.060
ln(recruits) dev 2006	0.842	0.034	0.634	0.018	0.705	0.046	0.692	0.034	0.638	0.044	0.705	0.036	0.705	0.044
ln(recruits) dev 2007	0.018	0.056	0.222	0.022	-0.134	0.076	-0.106	0.055	-0.199	0.078	-0.056	0.056	-0.140	0.075
ln(recruits) dev 2008	1.150	0.031	1.059	0.017	0.843	0.044	1.050	0.031	0.820	0.043	1.051	0.033	0.845	0.042
ln(recruits) dev 2009	-0.877	0.111	-0.659	0.037	-1.217	0.159	-0.850	0.096	-1.155	0.159	-0.936	0.100	-1.208	0.159
ln(recruits) dev 2010	0.648	0.043	0.728	0.018	0.416	0.055	0.648	0.040	0.494	0.056	0.631	0.041	0.426	0.053
ln(recruits) dev 2011	1.042	0.039	0.778	0.018	0.627	0.054	1.001	0.036	0.743	0.057	0.952	0.036	0.642	0.052
ln(recruits) dev 2012	0.234	0.063	0.257	0.024	-0.081	0.082	0.358	0.056	0.106	0.082	0.239	0.057	-0.059	0.081
ln(recruits) dev 2013	1.029	0.045	0.696	0.028	0.663	0.065	1.127	0.039	0.935	0.060	0.937	0.043	0.702	0.063
ln(recruits) dev 2014	-0.695	0.094	-0.937	0.070	-0.838	0.118	-0.710	0.092	-0.626	0.119	-0.719	0.085	-0.785	0.114
ln(recruits) dev 2015	-0.362	0.079	-1.016	0.075	-0.990	0.109	-0.363	0.071	-0.647	0.101	-0.394	0.068	-0.848	0.104
ln(recruits) dev 2016	-0.803	0.113	-1.233	0.104	-0.920	0.149	-1.286	0.123	-0.526	0.138	-0.891	0.095	-0.912	0.147
ln(recruits) dev 2017	-1.528	0.269	-1.962	0.227	-0.368	0.597	-1.516	0.218	-0.304	0.457	-1.767	0.205	-0.713	0.381

Table 2.1.7d. Selectivity parameters (other than parameter deviations).

Treatment of EBS and NBS surveys:	Combined		EBS only				Combined				Separated			
Model:	Model 16.6i		Model 19.1		Model 19.2		Model 19.3		Model 19.4		Model 19.5		Model 19.6	
Reweighted, size select., time-varying:	No		No		Yes		No		Yes		No		Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
Age_inflection_Fishery(1)	4.346	0.044												
Age_95%width_Fishery(1)	1.180	0.031												
Age_inflection_Survey(2)	1.006	0.006												
Age_95%width_Survey(2)	0.285	0.055												
Age_DblN_peak_Fishery(4)	5.780	0.073	6.044	0.023			5.651	0.075			5.771	0.073		
Age_DblN_top_logit_Fishery(4)	-1.927	3.415	-1.895	0.263			-2.476	4.460			-1.937	3.326		
Age_DblN_ascend_se_Fishery(4)	0.929	0.047	1.134	0.013			0.886	0.050			0.930	0.047		
Age_DblN_descend_se_Fishery(4)	-3.464	35.553	2.364	0.215			-1.705	25.353			-3.417	34.680		
Age_DblN_start_logit_Fishery(4)	-10.000	_	-10.000	_			-10.000	_			-10.000	_		
Age_DblN_end_logit_Fishery(4)	2.169	1.118	-9.410	14.197			1.700	0.782			1.869	0.873		
Age_DblN_peak_EBS_survey(5)	2.896	0.170	2.233	0.217			2.889	0.157			2.912	0.166		
Age_DblN_top_logit_EBS_survey(5)	10.000	_	10.000	_			10.000	_			10.000	_		
Age_DblN_ascend_se_EBS_survey(5)	2.043	0.257	1.420	0.516			2.014	0.238			2.055	0.252		
Age_DblN_descend_se_EBS_survey(5)	10.000	_	10.000	_			10.000	_			10.000	_		
Age_DblN_start_logit_EBS_survey(5)	-10.000	_	-10.000	_			-10.000	_			-10.000	_		
Age_DblN_end_logit_EBS_survey(5)	10.000	_	10.000	_			10.000	_			10.000	_		
Age_DblN_peak_NBS_survey(6)	5.534	1.177									3.728	0.439		
Age_DblN_top_logit_NBS_survey(6)	10.000	_									10.000	_		
Age_DblN_ascend_se_NBS_survey(6)	-3.833	30.059									2.013	0.574		
Age_DblN_descend_se_NBS_survey(6)	10.000	_									10.000	_		
Age_DblN_start_logit_NBS_survey(6)	-10.000	_									-10.000	_		
Age_DblN_end_logit_NBS_survey(6)	10.000	_									10.000	_		
Size_DblN_peak_Fishery(1)					74.220	1.108			73.868	1.098			74.198	1.104
Size_DblN_top_logit_Fishery(1)					-10.000	_			-10.000	_			-10.000	_
Size_DblN_ascend_se_Fishery(1)					5.843	0.074			5.835	0.076			5.843	0.075
Size_DblN_descend_se_Fishery(1)					4.381	0.118			4.419	0.114			4.385	0.117
Size_DblN_start_logit_Fishery(1)					-10.000	_			-10.000	_			-10.000	_
Size_DblN_end_logit_Fishery(1)					0.699	0.298			0.556	0.294			0.695	0.297
Size_DblN_peak_EBS_survey(2)					23.636	1.467			23.500	1.405			23.518	1.429
Size_DblN_top_logit_EBS_survey(2)					10.000	_			10.000	_			10.000	_
Size_DblN_ascend_se_EBS_survey(2)					3.899	0.223			3.901	0.216			3.884	0.220
Size_DblN_descend_se_EBS_survey(2)					10.000	_			10.000	_			10.000	_
Size_DblN_start_logit_EBS_survey(2)					-10.000	_			-10.000	_			-10.000	_
Size_DblN_end_logit_EBS_survey(2)					10.000	_			10.000	_			10.000	_
Size_DblN_peak_NBS_survey(3)													66.701	8.978
Size_DblN_top_logit_NBS_survey(3)													10.000	_
Size_DblN_ascend_se_NBS_survey(3)													6.999	0.445
Size_DblN_descend_se_NBS_survey(3)													10.000	_
Size_DblN_start_logit_NBS_survey(3)													-10.000	_
Size_DblN_end_logit_NBS_survey(3)													10.000	_

Table 2.1.7e. Input standard deviations for deviation vectors (except recruitment); Dirichlet coefficients.

Treatment of EBS and NBS surveys:	EBS only		Combined		Separated	
Model:	Model 19.2		Model 19.4		Model 19.6	
Reweighted, size select., time-varying:	Yes		Yes		Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD
SD(L at age 1.5 deviations)	0.155	_	0.156	_	0.150	_
SD(EBS catchability deviations)[a]	0.110	_	0.090	_	0.108	_
SD(NBS catchability deviations)					0.531	_
SD(fishery peak deviations)	0.089	_	0.088	_	0.088	_
SD(fishery ascending_se deviations)	0.455	_	0.461	_	0.457	_
SD(fishery end_logit deviations)	1.446	_	1.457	_	1.439	_
SD(survey peak deviations)	0.360	_	0.348	_	0.353	_
SD(survey ascending_se deviations)	1.257	_	1.218	_	1.244	_
Dirichlet coef. (fishery sizecomps)	9.990	_	10.000	_	9.967	_
Dirichlet coef. (EBS survey sizecomps)[a]	9.983	_	10.000	_	9.978	_
Dirichlet coef. (NBS survey sizecomps)					9.976	_
Dirichlet coef. (fishery agecomps)	-3.998	0.197	-4.109	0.206	-4.002	0.197
Dirichlet coef. (EBS survey agecomps)[a]	0.049	0.201	-0.144	0.183	0.022	0.198
Dirichlet coef. (NBS survey agecomps)					0.000	_

Table 2.1.7f. Deviations in mean length at age 1.5.

Treatment of EBS and NBS surveys:	EBS only		Combined		Separated	
Model:	Model 19.2		Model 19.4		Model 19.6	
Reweighted, size select., time-varying:	Yes		Yes		Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD
L at age 1.5 dev 1977	-0.065	0.826	-0.035	0.845	-0.045	0.836
L at age 1.5 dev 1978	-1.883	0.622	-1.881	0.624	-1.875	0.633
L at age 1.5 dev 1979	-0.975	0.749	-0.954	0.751	-0.936	0.760
L at age 1.5 dev 1980	-0.317	1.057	-0.313	1.061	-0.289	1.059
L at age 1.5 dev 1981	0.345	0.374	0.356	0.372	0.358	0.384
L at age 1.5 dev 1982	-0.709	0.342	-0.703	0.338	-0.738	0.355
L at age 1.5 dev 1983	0.179	0.452	0.187	0.450	0.200	0.464
L at age 1.5 dev 1984	0.273	0.225	0.294	0.224	0.295	0.229
L at age 1.5 dev 1985	-1.267	0.446	-1.277	0.452	-1.293	0.458
L at age 1.5 dev 1986	0.094	0.237	0.100	0.237	0.105	0.242
L at age 1.5 dev 1987	-0.195	0.277	-0.203	0.278	-0.198	0.284
L at age 1.5 dev 1988	0.190	0.282	0.191	0.283	0.201	0.289
L at age 1.5 dev 1989	-0.695	0.266	-0.685	0.265	-0.711	0.272
L at age 1.5 dev 1990	0.162	0.236	0.181	0.236	0.177	0.241
L at age 1.5 dev 1991	0.001	0.213	0.009	0.213	0.012	0.217
L at age 1.5 dev 1992	-0.361	0.214	-0.320	0.214	-0.368	0.218
L at age 1.5 dev 1993	0.699	0.256	0.743	0.258	0.731	0.263
L at age 1.5 dev 1994	-0.535	0.217	-0.557	0.215	-0.547	0.220
L at age 1.5 dev 1995	-0.063	0.384	-0.306	0.326	-0.077	0.364
L at age 1.5 dev 1996	-0.078	0.231	-0.063	0.223	-0.078	0.235
L at age 1.5 dev 1997	0.053	0.224	0.111	0.221	0.064	0.227
L at age 1.5 dev 1998	-0.897	0.213	-0.854	0.213	-0.914	0.216
L at age 1.5 dev 1999	-1.245	0.226	-1.251	0.228	-1.279	0.230
L at age 1.5 dev 2000	0.431	0.216	0.472	0.216	0.457	0.220
L at age 1.5 dev 2001	0.323	0.212	0.353	0.212	0.342	0.215
L at age 1.5 dev 2002	0.587	0.204	0.593	0.204	0.610	0.207
L at age 1.5 dev 2003	0.517	0.269	0.500	0.271	0.535	0.275
L at age 1.5 dev 2004	0.833	0.215	0.841	0.215	0.872	0.218
L at age 1.5 dev 2005	0.409	0.239	0.439	0.238	0.436	0.244
L at age 1.5 dev 2006	-0.364	0.206	-0.333	0.206	-0.362	0.209
L at age 1.5 dev 2007	-1.217	0.260	-1.200	0.261	-1.236	0.266
L at age 1.5 dev 2008	-0.993	0.212	-0.944	0.212	-1.014	0.216
L at age 1.5 dev 2009	-0.401	0.328	-0.407	0.335	-0.420	0.338
L at age 1.5 dev 2010	0.108	0.202	0.081	0.203	0.104	0.205
L at age 1.5 dev 2011	-1.230	0.281	-1.363	0.277	-1.273	0.288
L at age 1.5 dev 2012	0.079	0.268	0.058	0.274	0.091	0.274
L at age 1.5 dev 2013	-0.371	0.217	-0.401	0.220	-0.390	0.221
L at age 1.5 dev 2014	0.278	0.370	0.353	0.371	0.292	0.383
L at age 1.5 dev 2015	1.503	0.206	1.488	0.207	1.546	0.209
L at age 1.5 dev 2016	1.985	0.265	1.935	0.285	2.081	0.283
L at age 1.5 dev 2017	1.844	0.311	1.755	0.299	1.598	0.320
L at age 1.5 dev 2018	2.966	0.292	3.009	0.270	2.930	0.294

Table 2.1.7g. Deviations in log catchability.

Treatment of EBS and NBS surveys:	EBS only		Combined		Separated	
Model:	Model 19.2		Model 19.4		Model 19.6	
Reweighted, size select., time-varying:	Yes		Yes		Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD
ln(EBS Q) dev 1982	-0.283	0.624	0.164	0.653	-0.238	0.629
ln(EBS Q) dev 1983	-0.078	0.754	0.098	0.703	-0.055	0.759
ln(EBS Q) dev 1984	-1.036	0.617	-0.945	0.611	-0.994	0.622
ln(EBS Q) dev 1985	-0.024	0.792	0.263	0.609	0.001	0.796
ln(EBS Q) dev 1986	0.435	0.703	0.653	0.588	0.468	0.707
ln(EBS Q) dev 1987	-0.460	0.565	-0.254	0.585	-0.413	0.570
ln(EBS Q) dev 1988	-0.683	0.577	-0.964	0.561	-0.642	0.582
ln(EBS Q) dev 1989	-1.240	0.673	-1.383	0.693	-1.235	0.677
ln(EBS Q) dev 1990	-1.443	0.670	-1.732	0.637	-1.417	0.675
ln(EBS Q) dev 1991	-0.884	0.721	-1.105	0.656	-0.855	0.725
ln(EBS Q) dev 1992	-0.535	0.749	-1.136	0.651	-0.504	0.753
ln(EBS Q) dev 1993	0.658	0.764	1.002	0.666	0.680	0.769
ln(EBS Q) dev 1994	2.805	0.763	4.485	0.622	2.820	0.767
ln(EBS Q) dev 1995	1.587	0.691	2.138	0.578	1.621	0.696
ln(EBS Q) dev 1996	1.067	0.805	2.504	0.646	1.081	0.808
ln(EBS Q) dev 1997	0.026	0.806	0.015	0.629	0.041	0.810
ln(EBS Q) dev 1998	0.001	0.692	0.485	0.700	0.018	0.697
ln(EBS Q) dev 1999	0.315	0.724	-0.005	0.680	0.327	0.728
ln(EBS Q) dev 2000	-2.054	0.667	-3.058	0.587	-2.024	0.672
ln(EBS Q) dev 2001	0.703	0.681	1.020	0.599	0.739	0.686
ln(EBS Q) dev 2002	-0.983	0.693	-0.914	0.628	-0.956	0.698
ln(EBS Q) dev 2003	-0.370	0.755	0.029	0.681	-0.344	0.760
ln(EBS Q) dev 2004	-1.142	0.654	-1.434	0.618	-1.120	0.659
ln(EBS Q) dev 2005	-0.033	0.791	-0.271	0.602	-0.018	0.795
ln(EBS Q) dev 2006	-0.950	0.552	-1.371	0.590	-0.926	0.557
ln(EBS Q) dev 2007	0.040	0.921	-0.879	0.644	0.059	0.923
ln(EBS Q) dev 2008	-1.271	0.709	-2.177	0.627	-1.232	0.714
ln(EBS Q) dev 2009	-1.393	0.665	-2.194	0.599	-1.342	0.670
ln(EBS Q) dev 2010	0.832	0.776	0.643	0.600	0.862	0.780
ln(EBS Q) dev 2011	1.435	0.687	1.707	0.620	1.480	0.692
ln(EBS Q) dev 2012	0.598	0.687	0.396	0.703	0.616	0.692
ln(EBS Q) dev 2013	0.245	0.837	-0.993	0.637	0.240	0.841
ln(EBS Q) dev 2014	1.771	0.778	2.130	0.692	1.740	0.783
ln(EBS Q) dev 2015	1.640	0.754	1.036	0.682	1.555	0.758
ln(EBS Q) dev 2016	1.376	0.709	1.110	0.777	1.224	0.714
ln(EBS Q) dev 2017	-0.139	0.726	-0.506	0.677	-0.431	0.729
ln(EBS Q) dev 2018	-0.520	0.773	1.443	0.789	-0.823	0.764
ln(NBS Q) dev 2010					-4.134	0.639
ln(NBS Q) dev 2017					1.421	0.618
ln(NBS Q) dev 2018					2.715	0.634

Table 2.1.7h. Deviations in the size at peak fishery selectivity.

Treatment of EBS and NBS surveys:	EBS only		Combined		Separated	
Model:	Model 19.2		Model 19.4		Model 19.6	
Reweighted, size select., time-varying:	Yes		Yes		Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD
DblN_peak_Fishery_dev_1977	-0.467	0.572	-0.558	0.556	-0.473	0.571
DblN_peak_Fishery_dev_1978	-1.130	0.502	-1.213	0.471	-1.137	0.499
DblN_peak_Fishery_dev_1979	-1.361	0.421	-1.314	0.394	-1.357	0.421
DblN_peak_Fishery_dev_1980	0.000	0.534	-0.008	0.509	-0.006	0.536
DblN_peak_Fishery_dev_1981	-2.118	0.995	-2.137	1.013	-2.126	0.997
DblN_peak_Fishery_dev_1982	1.240	0.502	1.223	0.490	1.237	0.501
DblN_peak_Fishery_dev_1983	1.722	0.386	1.727	0.376	1.726	0.386
DblN_peak_Fishery_dev_1984	1.606	0.302	1.654	0.297	1.619	0.302
DblN_peak_Fishery_dev_1985	0.128	0.227	0.167	0.229	0.132	0.228
DblN_peak_Fishery_dev_1986	0.494	0.225	0.504	0.227	0.491	0.226
DblN_peak_Fishery_dev_1987	0.485	0.211	0.485	0.211	0.482	0.211
DblN_peak_Fishery_dev_1988	0.838	0.286	0.838	0.286	0.835	0.286
DblN_peak_Fishery_dev_1989	2.144	0.332	2.152	0.331	2.143	0.332
DblN_peak_Fishery_dev_1990	1.721	0.253	1.720	0.251	1.723	0.253
DblN_peak_Fishery_dev_1991	-0.075	0.266	-0.112	0.264	-0.076	0.266
DblN_peak_Fishery_dev_1992	-0.400	0.202	-0.405	0.201	-0.403	0.202
DblN_peak_Fishery_dev_1993	-0.187	0.255	-0.174	0.248	-0.191	0.254
DblN_peak_Fishery_dev_1994	-0.093	0.209	-0.041	0.206	-0.092	0.208
DblN_peak_Fishery_dev_1995	-0.048	0.229	0.068	0.231	-0.039	0.229
DblN_peak_Fishery_dev_1996	1.249	0.237	1.351	0.243	1.253	0.237
DblN_peak_Fishery_dev_1997	0.411	0.218	0.403	0.219	0.415	0.218
DblN_peak_Fishery_dev_1998	-0.124	0.197	-0.138	0.197	-0.119	0.197
DblN_peak_Fishery_dev_1999	-0.123	0.192	-0.141	0.191	-0.119	0.192
DblN_peak_Fishery_dev_2000	0.055	0.192	0.027	0.192	0.055	0.193
DblN_peak_Fishery_dev_2001	-0.355	0.191	-0.353	0.189	-0.355	0.191
DblN_peak_Fishery_dev_2002	-0.581	0.192	-0.559	0.190	-0.583	0.192
DblN_peak_Fishery_dev_2003	-0.761	0.195	-0.723	0.195	-0.768	0.195
DblN_peak_Fishery_dev_2004	-1.436	0.180	-1.398	0.180	-1.438	0.180
DblN_peak_Fishery_dev_2005	-0.893	0.181	-0.853	0.182	-0.891	0.181
DblN_peak_Fishery_dev_2006	-0.925	0.202	-0.893	0.203	-0.921	0.203
DblN_peak_Fishery_dev_2007	-0.436	0.218	-0.400	0.218	-0.432	0.218
DblN_peak_Fishery_dev_2008	-1.122	0.186	-1.094	0.185	-1.122	0.186
DblN_peak_Fishery_dev_2009	-0.572	0.179	-0.562	0.179	-0.575	0.179
DblN_peak_Fishery_dev_2010	0.370	0.522	0.131	0.551	0.336	0.527
DblN_peak_Fishery_dev_2011	0.232	0.585	0.240	0.581	0.230	0.585
DblN_peak_Fishery_dev_2012	0.785	0.416	0.745	0.407	0.780	0.416
DblN_peak_Fishery_dev_2013	-0.080	0.453	-0.074	0.448	-0.079	0.453
DblN_peak_Fishery_dev_2014	0.428	0.430	0.414	0.426	0.427	0.430
DblN_peak_Fishery_dev_2015	0.570	0.458	0.546	0.461	0.567	0.457
DblN_peak_Fishery_dev_2016	0.292	0.427	0.243	0.427	0.292	0.426
DblN_peak_Fishery_dev_2017	-0.121	0.418	-0.083	0.428	-0.079	0.422
DblN_peak_Fishery_dev_2018	-1.362	0.210	-1.398	0.207	-1.368	0.210

Table 2.1.7i. Deviations in fishery selectivity log-scale ascending width.

Treatment of EBS and NBS surveys: Model: Reweighted, size select., time-varying:	EBS only Model 19.2 Yes		Combined Model 19.4 Yes		Separated Model 19.6 Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD
DblN_ascend_se_Fishery_dev_1977	-0.212	0.638	-0.187	0.638	-0.209	0.636
DblN_ascend_se_Fishery_dev_1978	-0.723	0.453	-0.776	0.438	-0.725	0.450
DblN_ascend_se_Fishery_dev_1979	-0.631	0.380	-0.585	0.362	-0.619	0.378
DblN_ascend_se_Fishery_dev_1980	0.539	0.396	0.548	0.381	0.538	0.394
DblN_ascend_se_Fishery_dev_1981	0.525	0.780	0.522	0.789	0.523	0.778
DblN_ascend_se_Fishery_dev_1982	0.729	0.396	0.717	0.389	0.725	0.394
DblN_ascend_se_Fishery_dev_1983	1.415	0.285	1.406	0.279	1.408	0.284
DblN_ascend_se_Fishery_dev_1984	1.570	0.223	1.581	0.220	1.568	0.222
DblN_ascend_se_Fishery_dev_1985	0.069	0.218	0.100	0.218	0.074	0.218
DblN_ascend_se_Fishery_dev_1986	0.800	0.204	0.803	0.204	0.796	0.203
DblN_ascend_se_Fishery_dev_1987	0.515	0.196	0.509	0.196	0.511	0.196
DblN_ascend_se_Fishery_dev_1988	2.005	0.242	2.007	0.241	1.998	0.241
DblN_ascend_se_Fishery_dev_1989	2.222	0.259	2.223	0.258	2.212	0.258
DblN_ascend_se_Fishery_dev_1990	1.401	0.211	1.395	0.210	1.394	0.211
DblN_ascend_se_Fishery_dev_1991	0.125	0.224	0.098	0.223	0.125	0.224
DblN_ascend_se_Fishery_dev_1992	-0.269	0.196	-0.282	0.194	-0.267	0.195
DblN_ascend_se_Fishery_dev_1993	0.632	0.215	0.611	0.211	0.628	0.214
DblN_ascend_se_Fishery_dev_1994	0.551	0.187	0.556	0.185	0.549	0.186
DblN_ascend_se_Fishery_dev_1995	0.301	0.204	0.371	0.204	0.307	0.204
DblN_ascend_se_Fishery_dev_1996	1.202	0.199	1.263	0.200	1.199	0.198
DblN_ascend_se_Fishery_dev_1997	0.738	0.188	0.742	0.188	0.736	0.188
DblN_ascend_se_Fishery_dev_1998	-0.051	0.182	-0.051	0.182	-0.048	0.181
DblN_ascend_se_Fishery_dev_1999	-0.149	0.182	-0.148	0.181	-0.143	0.182
DblN_ascend_se_Fishery_dev_2000	-0.338	0.183	-0.346	0.182	-0.334	0.183
DblN_ascend_se_Fishery_dev_2001	-0.563	0.183	-0.558	0.182	-0.558	0.183
DblN_ascend_se_Fishery_dev_2002	-0.234	0.183	-0.223	0.182	-0.231	0.183
DblN_ascend_se_Fishery_dev_2003	-0.331	0.190	-0.308	0.189	-0.333	0.190
DblN_ascend_se_Fishery_dev_2004	-1.197	0.183	-1.167	0.183	-1.193	0.183
DblN_ascend_se_Fishery_dev_2005	-0.771	0.183	-0.747	0.182	-0.766	0.182
DblN_ascend_se_Fishery_dev_2006	-0.915	0.205	-0.897	0.205	-0.906	0.205
DblN_ascend_se_Fishery_dev_2007	-0.396	0.207	-0.371	0.206	-0.390	0.207
DblN_ascend_se_Fishery_dev_2008	-1.276	0.183	-1.230	0.183	-1.266	0.183
DblN_ascend_se_Fishery_dev_2009	-1.404	0.180	-1.338	0.180	-1.392	0.180
DblN_ascend_se_Fishery_dev_2010	-0.027	0.452	-0.100	0.471	-0.034	0.453
DblN_ascend_se_Fishery_dev_2011	-0.161	0.554	-0.160	0.554	-0.159	0.551
DblN_ascend_se_Fishery_dev_2012	-0.220	0.539	-0.254	0.537	-0.225	0.536
DblN_ascend_se_Fishery_dev_2013	-0.210	0.425	-0.273	0.428	-0.215	0.423
DblN_ascend_se_Fishery_dev_2014	-0.263	0.454	-0.345	0.454	-0.270	0.452
DblN_ascend_se_Fishery_dev_2015	-0.520	0.456	-0.587	0.458	-0.530	0.453
DblN_ascend_se_Fishery_dev_2016	-1.070	0.510	-1.152	0.522	-1.085	0.506
DblN_ascend_se_Fishery_dev_2017	-1.592	0.680	-1.508	0.690	-1.575	0.683
DblN_ascend_se_Fishery_dev_2018	-1.828	0.249	-1.857	0.245	-1.823	0.247

Table 2.1.7j. Deviations in fishery logit-scale selectivity at maximum length.

Treatment of EBS and NBS surveys: Model: Reweighted, size select., time-varying:	EBS only Model 19.2 Yes		Combined Model 19.4 Yes		Separated Model 19.6 Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD
DblN_end_logit_Fishery_dev_1977	-0.878	0.867	-0.990	0.789	-0.886	0.864
DblN_end_logit_Fishery_dev_1978	-0.934	0.652	-1.068	0.575	-0.948	0.649
DblN_end_logit_Fishery_dev_1979	-0.970	0.619	-1.122	0.559	-0.984	0.618
DblN_end_logit_Fishery_dev_1980	-0.058	0.873	-0.208	0.824	-0.062	0.874
DblN_end_logit_Fishery_dev_1981	0.308	0.840	0.303	0.831	0.300	0.841
DblN_end_logit_Fishery_dev_1982	0.030	0.902	-0.019	0.883	0.025	0.902
DblN_end_logit_Fishery_dev_1983	-0.094	0.870	-0.177	0.831	-0.102	0.870
DblN_end_logit_Fishery_dev_1984	-0.344	0.687	-0.397	0.657	-0.357	0.688
DblN_end_logit_Fishery_dev_1985	0.382	0.380	0.453	0.372	0.396	0.384
DblN_end_logit_Fishery_dev_1986	-0.334	0.307	-0.221	0.304	-0.324	0.308
DblN_end_logit_Fishery_dev_1987	-0.105	0.272	-0.001	0.267	-0.099	0.273
DblN_end_logit_Fishery_dev_1988	-0.276	0.389	-0.196	0.377	-0.275	0.389
DblN_end_logit_Fishery_dev_1989	-0.153	0.636	-0.065	0.616	-0.145	0.636
DblN_end_logit_Fishery_dev_1990	0.735	0.587	0.852	0.566	0.739	0.585
DblN_end_logit_Fishery_dev_1991	1.874	0.524	1.907	0.516	1.878	0.525
DblN_end_logit_Fishery_dev_1992	0.370	0.293	0.391	0.274	0.370	0.293
DblN_end_logit_Fishery_dev_1993	0.044	0.343	0.066	0.318	0.040	0.342
DblN_end_logit_Fishery_dev_1994	-0.258	0.262	-0.233	0.253	-0.268	0.262
DblN_end_logit_Fishery_dev_1995	0.462	0.374	0.417	0.349	0.443	0.371
DblN_end_logit_Fishery_dev_1996	1.116	0.603	1.062	0.597	1.099	0.604
DblN_end_logit_Fishery_dev_1997	1.233	0.521	1.316	0.510	1.225	0.519
DblN_end_logit_Fishery_dev_1998	0.663	0.365	0.676	0.340	0.670	0.366
DblN_end_logit_Fishery_dev_1999	0.319	0.288	0.333	0.273	0.329	0.290
DblN_end_logit_Fishery_dev_2000	0.525	0.333	0.468	0.297	0.535	0.335
DblN_end_logit_Fishery_dev_2001	0.007	0.266	-0.044	0.249	0.003	0.266
DblN_end_logit_Fishery_dev_2002	0.060	0.266	0.023	0.253	0.059	0.267
DblN_end_logit_Fishery_dev_2003	-0.180	0.240	-0.160	0.233	-0.179	0.240
DblN_end_logit_Fishery_dev_2004	-0.400	0.218	-0.339	0.213	-0.407	0.218
DblN_end_logit_Fishery_dev_2005	-0.176	0.220	-0.105	0.215	-0.181	0.221
DblN_end_logit_Fishery_dev_2006	1.856	0.500	1.906	0.491	1.855	0.500
DblN_end_logit_Fishery_dev_2007	2.137	0.506	2.196	0.498	2.146	0.506
DblN_end_logit_Fishery_dev_2008	-0.128	0.238	-0.047	0.232	-0.125	0.239
DblN_end_logit_Fishery_dev_2009	-1.214	0.220	-1.113	0.214	-1.216	0.220
DblN_end_logit_Fishery_dev_2010	-0.412	0.903	-0.292	0.856	-0.396	0.902
DblN_end_logit_Fishery_dev_2011	-0.143	0.865	-0.194	0.845	-0.141	0.866
DblN_end_logit_Fishery_dev_2012	-1.290	0.738	-1.305	0.716	-1.298	0.737
DblN_end_logit_Fishery_dev_2013	-0.918	0.732	-0.975	0.701	-0.927	0.731
DblN_end_logit_Fishery_dev_2014	-0.842	0.785	-0.893	0.753	-0.849	0.784
DblN_end_logit_Fishery_dev_2015	-0.030	0.914	-0.084	0.904	-0.032	0.915
DblN_end_logit_Fishery_dev_2016	-1.023	0.796	-1.074	0.764	-1.023	0.798
DblN_end_logit_Fishery_dev_2017	-1.085	0.778	-1.059	0.774	-1.065	0.788
DblN_end_logit_Fishery_dev_2018	0.118	0.324	0.011	0.276	0.175	0.330

Table 2.1.7k. Deviations in the size at peak survey selectivity.

Treatment of EBS and NBS surveys:	EBS only		Combined		Separated	
Model:	Model 19.2		Model 19.4		Model 19.6	
Reweighted, size select., time-varying:	Yes		Yes		Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD
DblN_peak_EBS_survey_dev_1982	1.321	0.252	1.351	0.254	1.352	0.255
DblN_peak_EBS_survey_dev_1983	-0.085	0.523	-0.187	0.529	-0.110	0.540
DblN_peak_EBS_survey_dev_1984	0.425	0.237	0.446	0.240	0.446	0.238
DblN_peak_EBS_survey_dev_1985	-0.097	0.228	-0.108	0.228	-0.089	0.228
DblN_peak_EBS_survey_dev_1986	0.246	0.478	0.203	0.493	0.266	0.486
DblN_peak_EBS_survey_dev_1987	-0.093	0.283	-0.118	0.286	-0.087	0.286
DblN_peak_EBS_survey_dev_1988	0.305	0.305	0.305	0.309	0.321	0.308
DblN_peak_EBS_survey_dev_1989	2.523	0.339	2.563	0.337	2.564	0.348
DblN_peak_EBS_survey_dev_1990	-0.487	0.270	-0.499	0.273	-0.492	0.272
DblN_peak_EBS_survey_dev_1991	0.772	0.304	0.811	0.308	0.792	0.304
DblN_peak_EBS_survey_dev_1992	-0.766	0.294	-0.727	0.289	-0.774	0.299
DblN_peak_EBS_survey_dev_1993	-0.222	0.239	-0.224	0.242	-0.219	0.240
DblN_peak_EBS_survey_dev_1994	1.119	0.233	1.034	0.257	1.147	0.234
DblN_peak_EBS_survey_dev_1995	0.111	0.297	0.034	0.303	0.125	0.301
DblN_peak_EBS_survey_dev_1996	0.571	0.562	0.124	0.333	0.576	0.485
DblN_peak_EBS_survey_dev_1997	0.332	0.277	0.255	0.256	0.345	0.280
DblN_peak_EBS_survey_dev_1998	1.159	0.207	1.178	0.208	1.190	0.207
DblN_peak_EBS_survey_dev_1999	1.774	0.232	1.782	0.243	1.811	0.234
DblN_peak_EBS_survey_dev_2000	-0.850	0.220	-0.837	0.223	-0.856	0.221
DblN_peak_EBS_survey_dev_2001	-0.700	0.238	-0.734	0.240	-0.706	0.239
DblN_peak_EBS_survey_dev_2002	-0.099	0.315	-0.114	0.334	-0.097	0.323
DblN_peak_EBS_survey_dev_2003	-0.083	0.235	-0.090	0.237	-0.077	0.237
DblN_peak_EBS_survey_dev_2004	0.263	0.333	0.258	0.342	0.268	0.336
DblN_peak_EBS_survey_dev_2005	-0.542	0.249	-0.495	0.251	-0.544	0.252
DblN_peak_EBS_survey_dev_2006	-1.470	0.217	-1.525	0.221	-1.480	0.218
DblN_peak_EBS_survey_dev_2007	-1.819	0.191	-1.861	0.193	-1.839	0.192
DblN_peak_EBS_survey_dev_2008	-1.240	0.239	-1.246	0.239	-1.253	0.241
DblN_peak_EBS_survey_dev_2009	-1.676	0.240	-1.720	0.241	-1.696	0.242
DblN_peak_EBS_survey_dev_2010	-0.599	0.368	-0.371	0.387	-0.595	0.373
DblN_peak_EBS_survey_dev_2011	-0.328	0.201	-0.349	0.209	-0.324	0.206
DblN_peak_EBS_survey_dev_2012	-1.717	0.230	-1.568	0.287	-1.728	0.231
DblN_peak_EBS_survey_dev_2013	0.294	0.234	0.387	0.248	0.318	0.236
DblN_peak_EBS_survey_dev_2014	-0.384	0.223	-0.330	0.230	-0.371	0.224
DblN_peak_EBS_survey_dev_2015	0.295	0.423	0.372	0.453	0.324	0.431
DblN_peak_EBS_survey_dev_2016	0.166	0.235	0.299	0.242	0.250	0.242
DblN_peak_EBS_survey_dev_2017	0.527	0.264	0.780	0.280	0.582	0.294
DblN_peak_EBS_survey_dev_2018	1.045	0.483	0.918	0.357	0.651	0.288

Table 2.1.7l. Deviations in survey selectivity log-scale ascending width.

Treatment of EBS and NBS surveys: Model: Reweighted, size select., time-varying:	EBS only Model 19.2 Yes		Combined Model 19.4 Yes		Separated Model 19.6 Yes	
Parameter	Est.	SD	Est.	SD	Est.	SD
DblN_ascend_se_survey_dev_1982	1.146	0.264	1.167	0.268	1.164	0.266
DblN_ascend_se_survey_dev_1983	0.427	0.652	0.322	0.676	0.402	0.672
DblN_ascend_se_survey_dev_1984	0.241	0.283	0.245	0.288	0.256	0.285
DblN_ascend_se_survey_dev_1985	0.128	0.290	0.119	0.293	0.138	0.291
DblN_ascend_se_survey_dev_1986	0.472	0.523	0.432	0.544	0.493	0.528
DblN_ascend_se_survey_dev_1987	-0.176	0.412	-0.216	0.423	-0.172	0.416
DblN_ascend_se_survey_dev_1988	0.092	0.385	0.075	0.392	0.102	0.387
DblN_ascend_se_survey_dev_1989	2.203	0.318	2.230	0.319	2.222	0.323
DblN_ascend_se_survey_dev_1990	-0.145	0.339	-0.169	0.344	-0.146	0.341
DblN_ascend_se_survey_dev_1991	1.173	0.344	1.198	0.350	1.191	0.343
DblN_ascend_se_survey_dev_1992	-0.762	0.426	-0.729	0.412	-0.769	0.434
DblN_ascend_se_survey_dev_1993	0.090	0.299	0.094	0.306	0.095	0.300
DblN_ascend_se_survey_dev_1994	1.187	0.265	1.183	0.296	1.208	0.265
DblN_ascend_se_survey_dev_1995	-0.010	0.381	-0.072	0.397	0.002	0.385
DblN_ascend_se_survey_dev_1996	0.341	0.619	-0.174	0.422	0.336	0.533
DblN_ascend_se_survey_dev_1997	0.365	0.319	0.291	0.298	0.375	0.321
DblN_ascend_se_survey_dev_1998	1.002	0.222	1.030	0.226	1.023	0.223
DblN_ascend_se_survey_dev_1999	1.723	0.241	1.755	0.253	1.746	0.242
DblN_ascend_se_survey_dev_2000	-0.862	0.305	-0.863	0.310	-0.863	0.307
DblN_ascend_se_survey_dev_2001	-0.537	0.350	-0.575	0.358	-0.540	0.352
DblN_ascend_se_survey_dev_2002	-0.038	0.401	-0.055	0.427	-0.038	0.410
DblN_ascend_se_survey_dev_2003	-0.024	0.301	-0.045	0.306	-0.020	0.303
DblN_ascend_se_survey_dev_2004	0.402	0.411	0.376	0.425	0.403	0.413
DblN_ascend_se_survey_dev_2005	-0.678	0.383	-0.635	0.383	-0.683	0.387
DblN_ascend_se_survey_dev_2006	-1.583	0.328	-1.645	0.341	-1.580	0.331
DblN_ascend_se_survey_dev_2007	-2.139	0.348	-2.185	0.359	-2.146	0.351
DblN_ascend_se_survey_dev_2008	-1.365	0.380	-1.376	0.376	-1.373	0.384
DblN_ascend_se_survey_dev_2009	-1.345	0.407	-1.399	0.411	-1.351	0.409
DblN_ascend_se_survey_dev_2010	-0.697	0.520	-0.323	0.470	-0.693	0.523
DblN_ascend_se_survey_dev_2011	-0.338	0.251	-0.385	0.266	-0.338	0.260
DblN_ascend_se_survey_dev_2012	-1.626	0.390	-1.352	0.467	-1.621	0.388
DblN_ascend_se_survey_dev_2013	0.438	0.260	0.465	0.272	0.453	0.261
DblN_ascend_se_survey_dev_2014	-0.348	0.301	-0.335	0.309	-0.341	0.302
DblN_ascend_se_survey_dev_2015	0.365	0.500	0.419	0.525	0.371	0.503
DblN_ascend_se_survey_dev_2016	0.065	0.308	0.131	0.316	0.128	0.318
DblN_ascend_se_survey_dev_2017	0.359	0.334	0.571	0.339	0.495	0.356
DblN_ascend_se_survey_dev_2018	0.483	0.485	0.431	0.372	0.067	0.348

Table 2.1.8. Full-selection fishing mortality.

	Model 16.6i		Model 19.1		Model 19.2		Model 19.3		Model 19.4		Model 19.5		Model 19.6	
Year	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
1977	0.312	0.117	1.226	0.131	0.306	0.097	0.226	0.071	0.271	0.082	0.231	0.075	0.304	0.096
1978	0.411	0.162	1.208	0.100	0.290	0.068	0.290	0.092	0.277	0.063	0.297	0.097	0.288	0.068
1979	0.325	0.125	0.762	0.066	0.194	0.039	0.226	0.068	0.192	0.039	0.231	0.072	0.193	0.039
1980	0.359	0.114	0.730	0.060	0.184	0.041	0.254	0.064	0.178	0.039	0.260	0.067	0.183	0.041
1981	0.227	0.042	0.444	0.032	0.086	0.014	0.185	0.031	0.086	0.014	0.188	0.033	0.086	0.014
1982	0.119	0.014	0.244	0.015	0.136	0.027	0.109	0.013	0.132	0.025	0.109	0.013	0.136	0.026
1983	0.134	0.012	0.254	0.014	0.155	0.023	0.124	0.012	0.152	0.022	0.123	0.012	0.155	0.023
1984	0.179	0.014	0.323	0.017	0.190	0.022	0.169	0.013	0.189	0.022	0.167	0.014	0.191	0.022
1985	0.196	0.015	0.327	0.017	0.172	0.016	0.187	0.014	0.171	0.016	0.183	0.014	0.172	0.016
1986	0.197	0.014	0.297	0.014	0.168	0.015	0.190	0.013	0.166	0.015	0.189	0.014	0.167	0.015
1987	0.208	0.013	0.306	0.014	0.190	0.015	0.202	0.013	0.187	0.015	0.202	0.014	0.190	0.015
1988	0.276	0.017	0.387	0.016	0.218	0.017	0.264	0.016	0.216	0.017	0.264	0.017	0.218	0.017
1989	0.231	0.013	0.334	0.012	0.235	0.020	0.221	0.012	0.230	0.020	0.222	0.014	0.235	0.020
1990	0.257	0.013	0.346	0.011	0.256	0.021	0.244	0.013	0.250	0.020	0.238	0.013	0.256	0.020
1991	0.453	0.024	0.573	0.017	0.330	0.022	0.428	0.023	0.325	0.022	0.414	0.024	0.330	0.022
1992	0.543	0.036	0.634	0.021	0.357	0.024	0.514	0.035	0.356	0.025	0.484	0.032	0.356	0.024
1993	0.412	0.028	0.485	0.016	0.253	0.019	0.403	0.027	0.254	0.020	0.387	0.027	0.253	0.019
1994	0.446	0.026	0.565	0.016	0.344	0.020	0.445	0.028	0.345	0.021	0.434	0.027	0.344	0.020
1995	0.566	0.032	0.711	0.019	0.453	0.027	0.551	0.034	0.453	0.029	0.542	0.033	0.453	0.027
1996	0.530	0.031	0.691	0.018	0.513	0.036	0.487	0.032	0.503	0.039	0.494	0.031	0.513	0.036
1997	0.580	0.034	0.833	0.023	0.543	0.038	0.517	0.035	0.520	0.040	0.536	0.035	0.543	0.038
1998	0.464	0.029	0.683	0.019	0.427	0.031	0.403	0.028	0.409	0.034	0.415	0.028	0.426	0.031
1999	0.475	0.032	0.720	0.022	0.427	0.037	0.408	0.029	0.408	0.039	0.423	0.030	0.425	0.037
2000	0.458	0.031	0.716	0.024	0.411	0.040	0.399	0.030	0.393	0.041	0.412	0.029	0.410	0.040
2001	0.364	0.022	0.588	0.020	0.300	0.025	0.328	0.022	0.294	0.026	0.336	0.022	0.299	0.025
2002	0.435	0.025	0.625	0.020	0.279	0.020	0.386	0.024	0.277	0.021	0.390	0.024	0.278	0.020
2003	0.470	0.027	0.610	0.020	0.278	0.018	0.410	0.025	0.277	0.019	0.419	0.025	0.278	0.018
2004	0.444	0.023	0.561	0.017	0.307	0.018	0.395	0.024	0.305	0.019	0.408	0.023	0.308	0.018
2005	0.452	0.022	0.550	0.016	0.343	0.021	0.401	0.022	0.336	0.022	0.420	0.022	0.343	0.021
2006	0.517	0.027	0.595	0.017	0.327	0.022	0.446	0.025	0.316	0.023	0.474	0.025	0.326	0.022
2007	0.502	0.028	0.537	0.015	0.318	0.024	0.423	0.025	0.302	0.024	0.461	0.025	0.317	0.024
2008	0.619	0.038	0.594	0.015	0.443	0.030	0.506	0.031	0.415	0.030	0.572	0.032	0.440	0.030
2009	0.768	0.056	0.718	0.018	0.736	0.060	0.617	0.041	0.669	0.056	0.737	0.047	0.730	0.059
2010	0.600	0.043	0.729	0.018	0.578	0.102	0.543	0.038	0.499	0.087	0.654	0.043	0.569	0.100
2011	0.618	0.040	0.918	0.022	0.660	0.103	0.631	0.044	0.630	0.097	0.733	0.047	0.660	0.102
2012	0.595	0.041	0.930	0.022	0.846	0.116	0.637	0.046	0.798	0.111	0.731	0.047	0.849	0.116
2013	0.490	0.033	0.841	0.019	0.621	0.058	0.556	0.041	0.595	0.059	0.635	0.042	0.624	0.058
2014	0.566	0.043	0.969	0.023	0.823	0.088	0.636	0.052	0.745	0.087	0.742	0.054	0.824	0.088
2015	0.492	0.039	0.946	0.026	0.901	0.138	0.535	0.046	0.741	0.121	0.646	0.052	0.897	0.136
2016	0.427	0.034	0.924	0.029	0.881	0.123	0.454	0.038	0.660	0.094	0.557	0.046	0.871	0.121
2017	0.384	0.032	0.941	0.042	0.694	0.102	0.384	0.032	0.473	0.068	0.501	0.044	0.683	0.100
2018	0.292	0.025	0.869	0.059	0.441	0.048	0.283	0.023	0.285	0.028	0.388	0.037	0.418	0.045

Figures

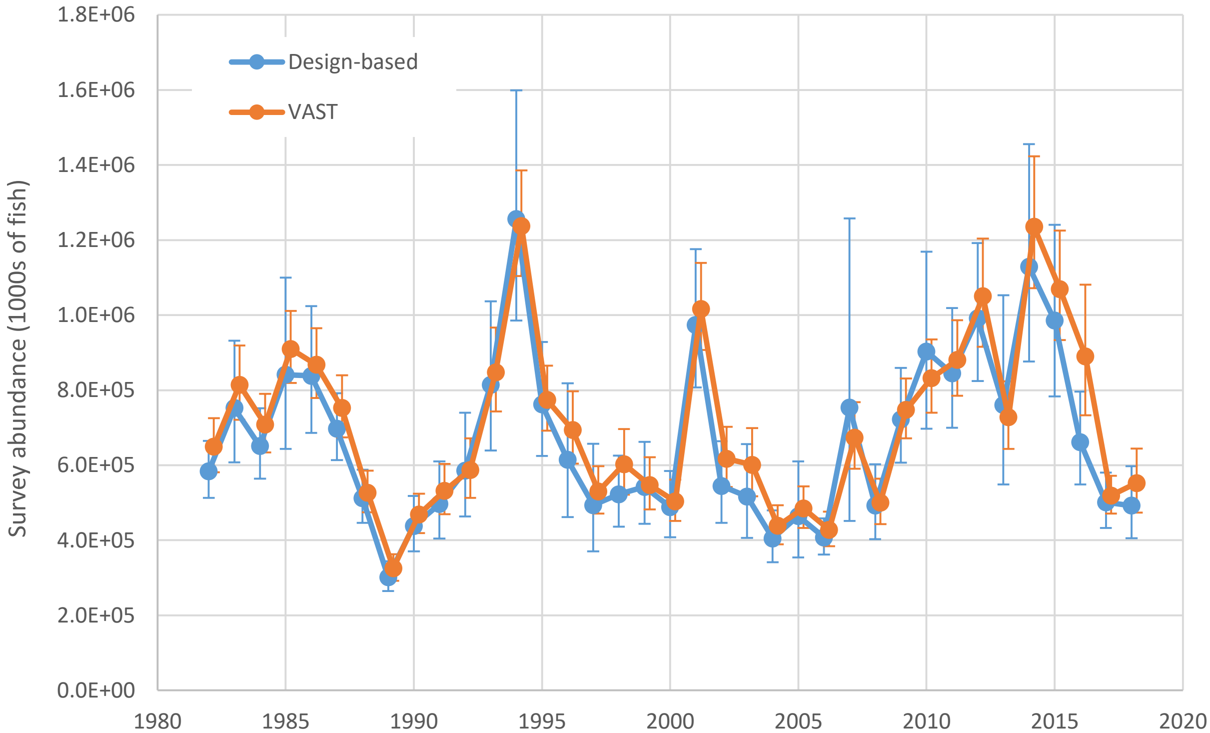


Figure 2.1.1. Comparison of design-based and VAST survey indices (EBS and NBS combined).

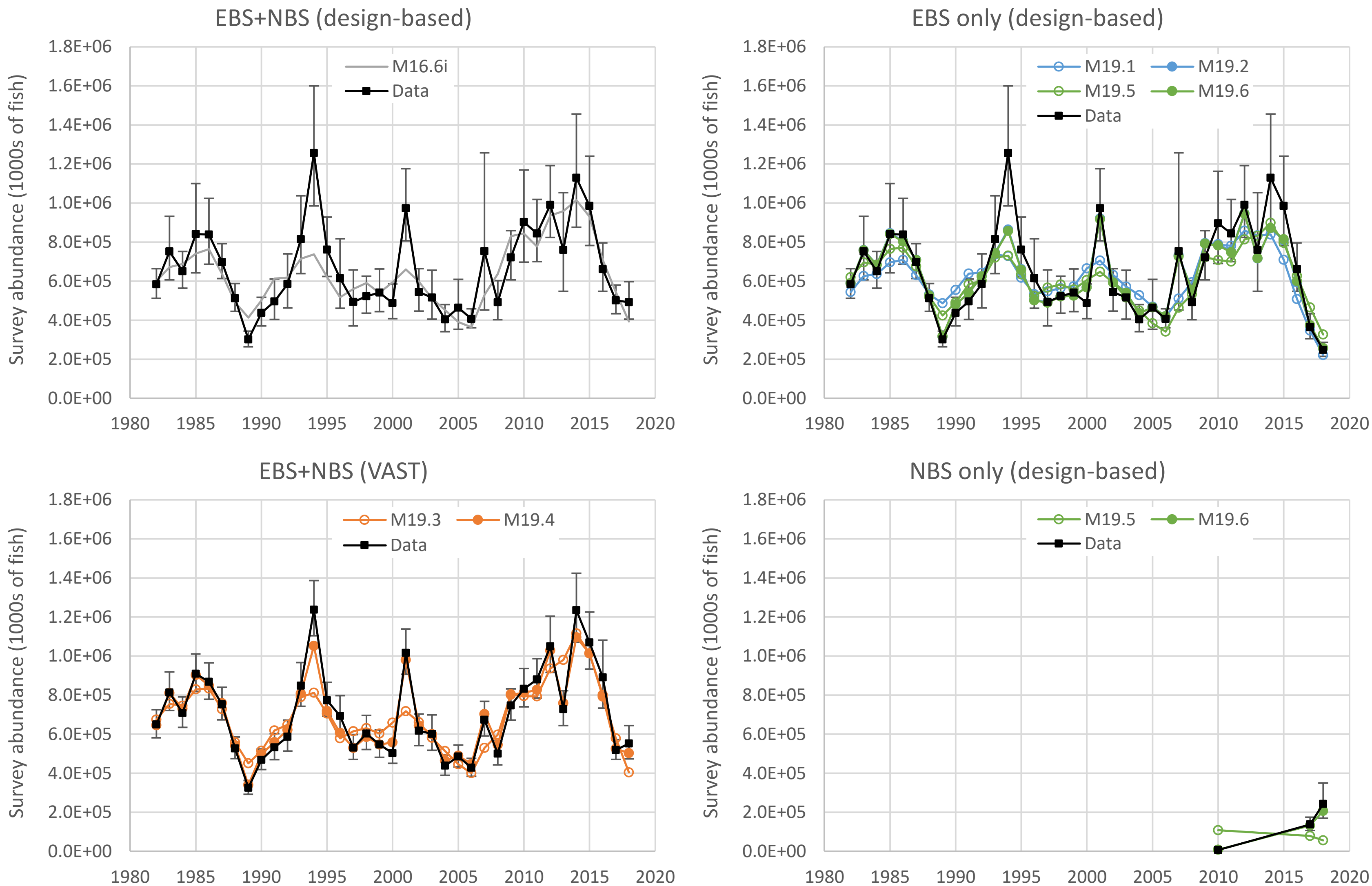


Figure 2.1.2. Fits to survey indices.

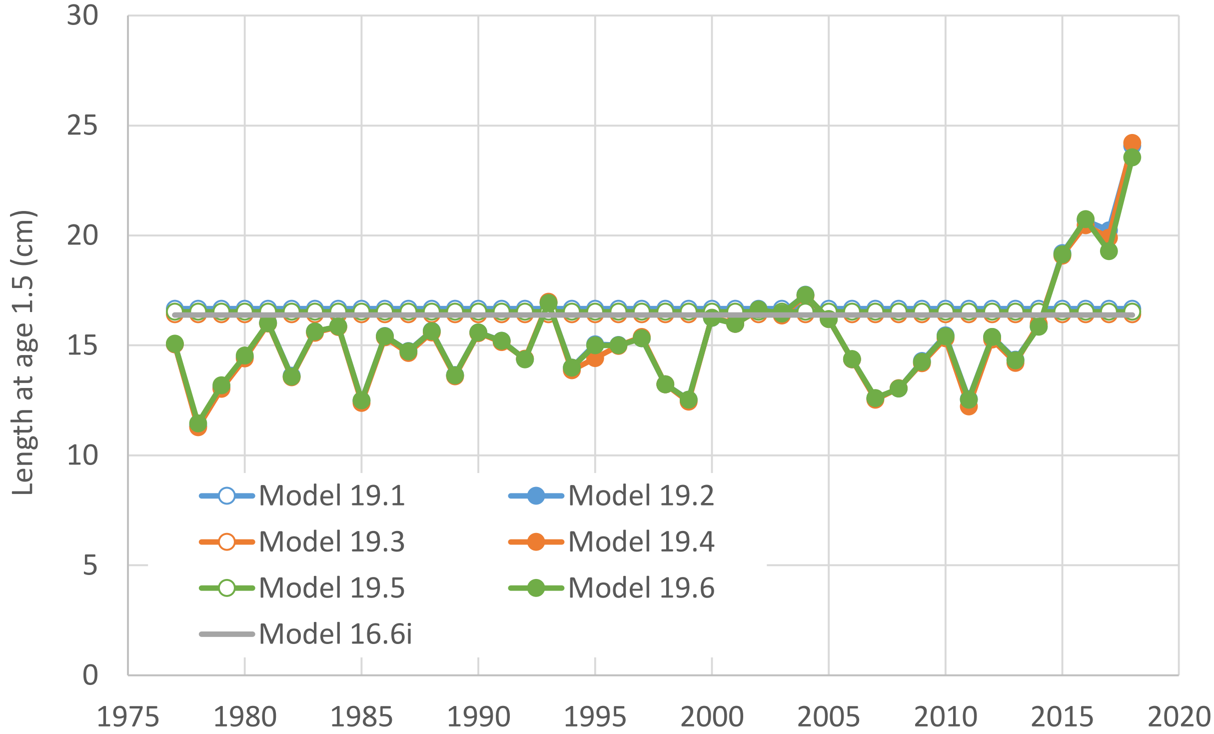
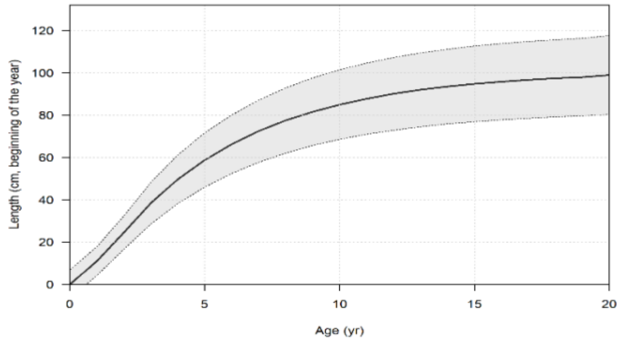
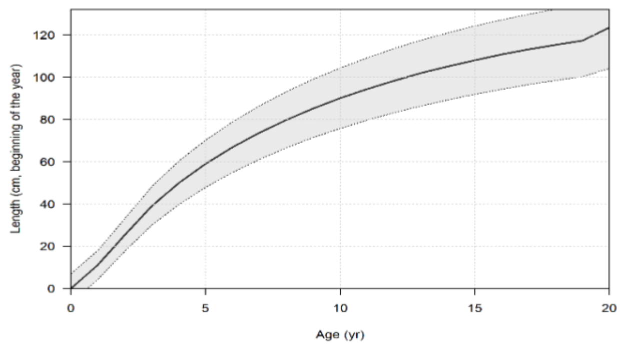


Figure 2.1.3. Mean length at age 1.5.

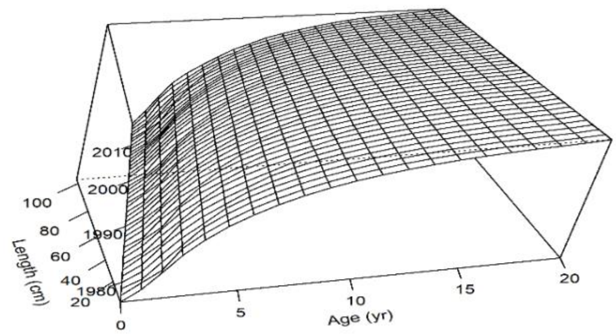
Model 16.6i



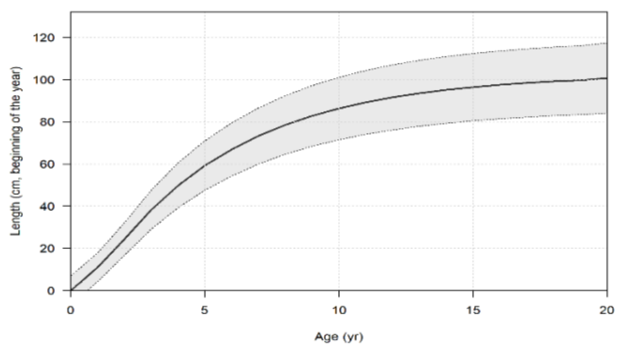
Model 19.1



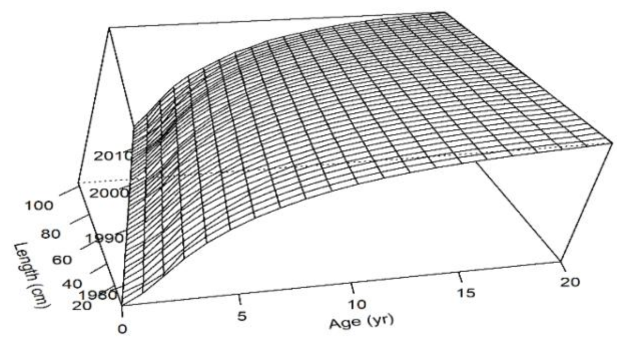
Model 19.2



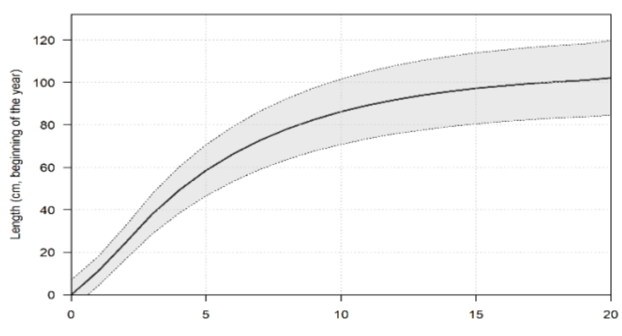
Model 19.3



Model 19.4



Model 19.5



Model 19.6

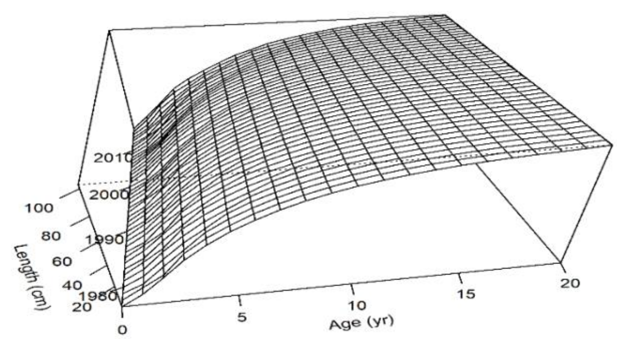


Figure 2.1.4. Length at age.

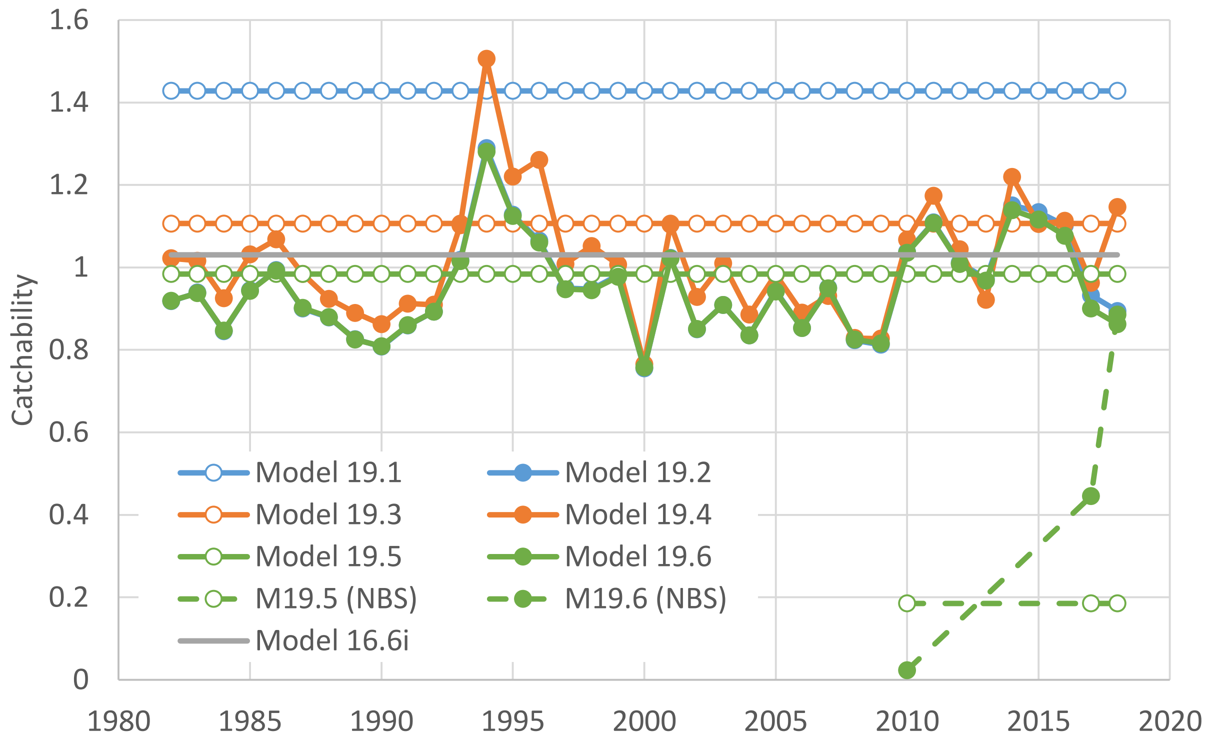


Figure 2.1.5. Survey catchability.

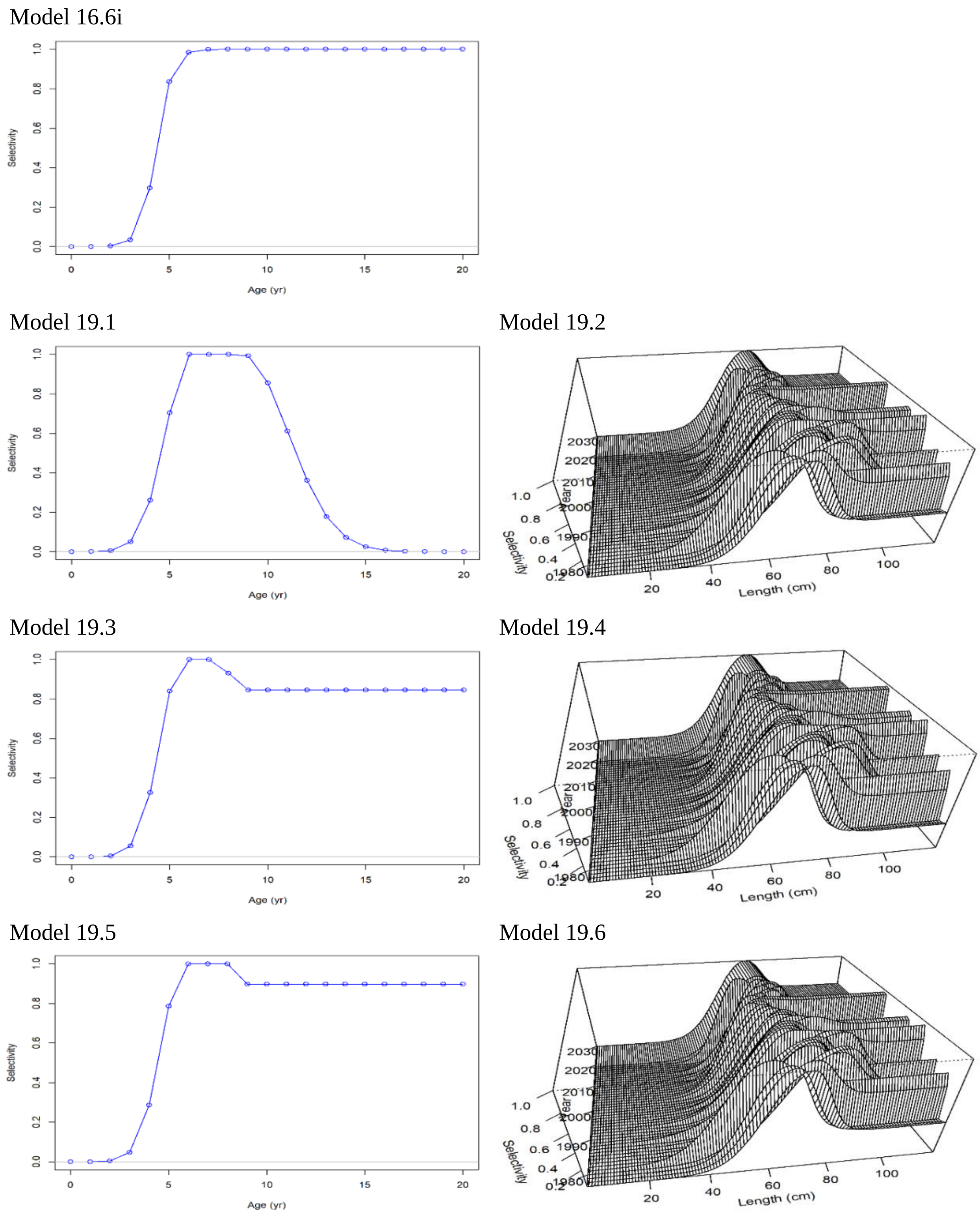
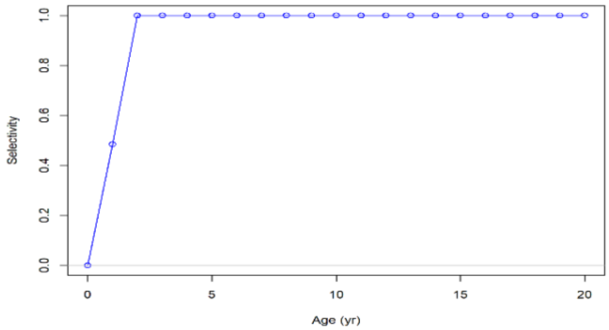
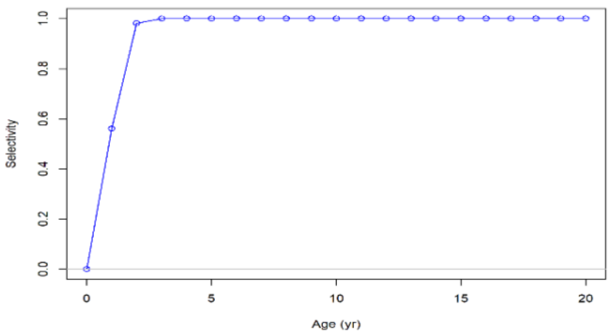


Figure 2.1.6a. Fishery selectivity.

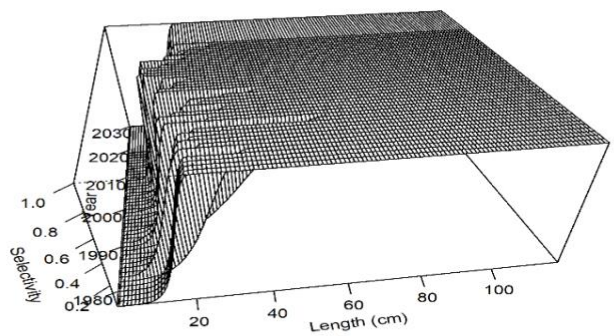
Model 16.6i



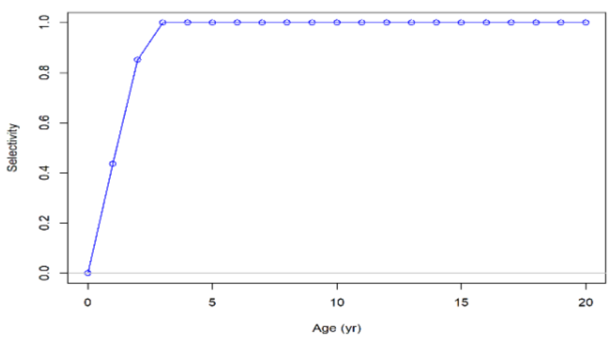
Model 19.1



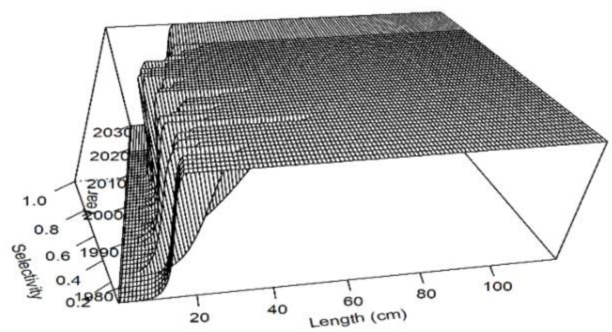
Model 19.2



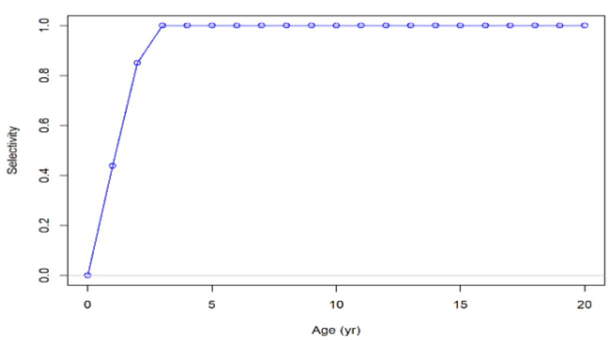
Model 19.3



Model 19.4



Model 19.5



Model 19.6

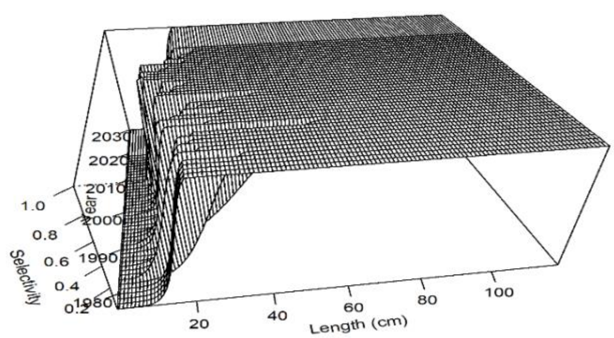


Figure 2.1.6b. EBS survey selectivity (EBS+NBS for Models 16.6i, 19.3, and 19.4).

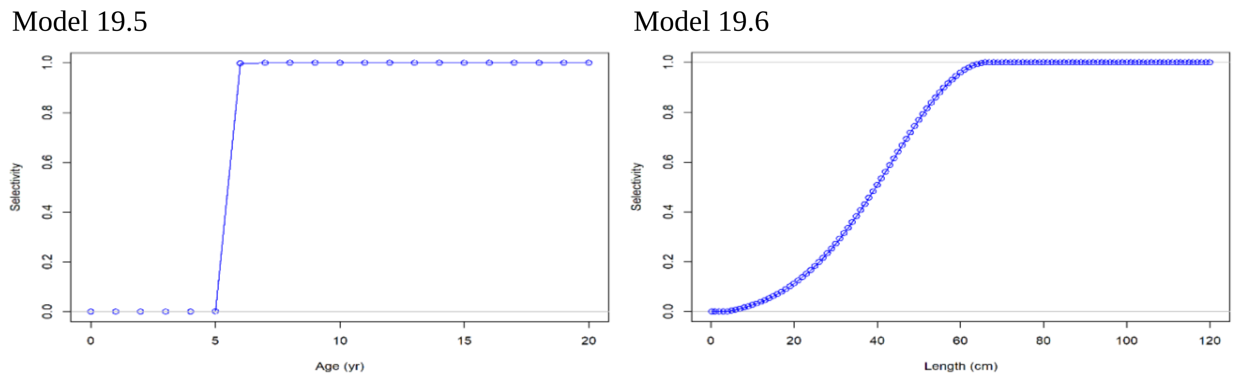


Figure 2.1.6c. NBS survey selectivity.

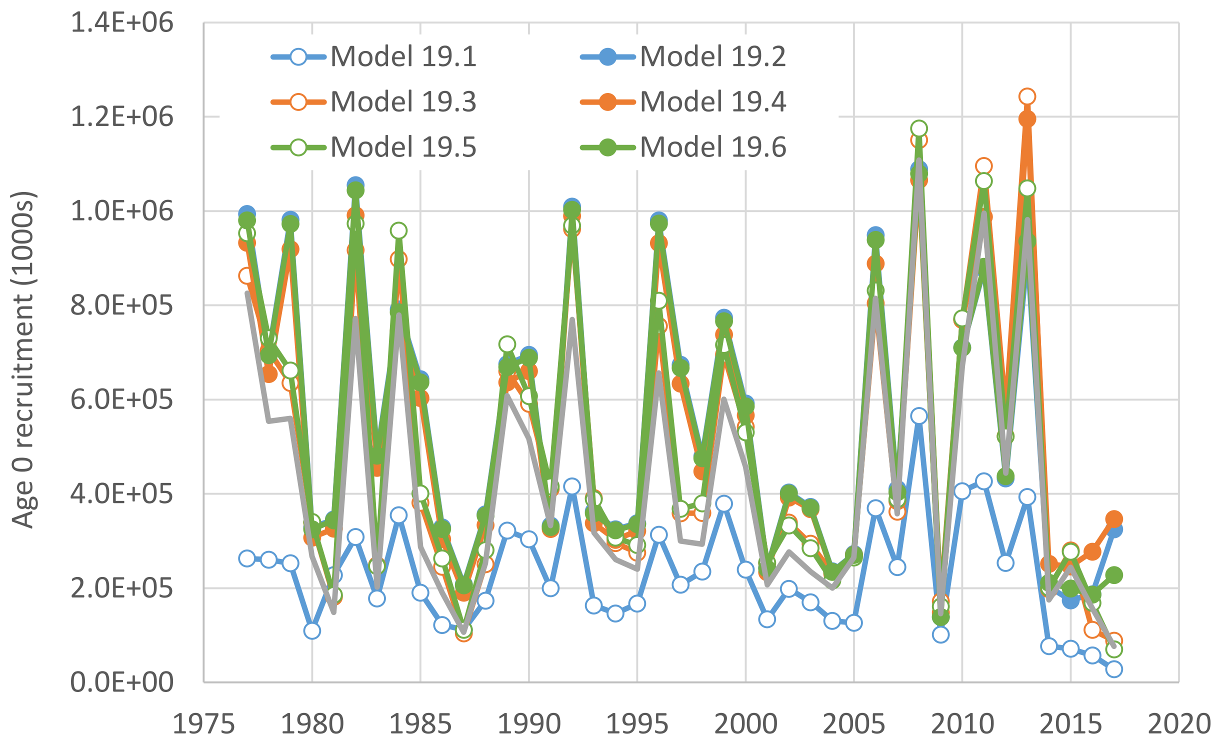


Figure 2.1.7. Age 0 recruitment.

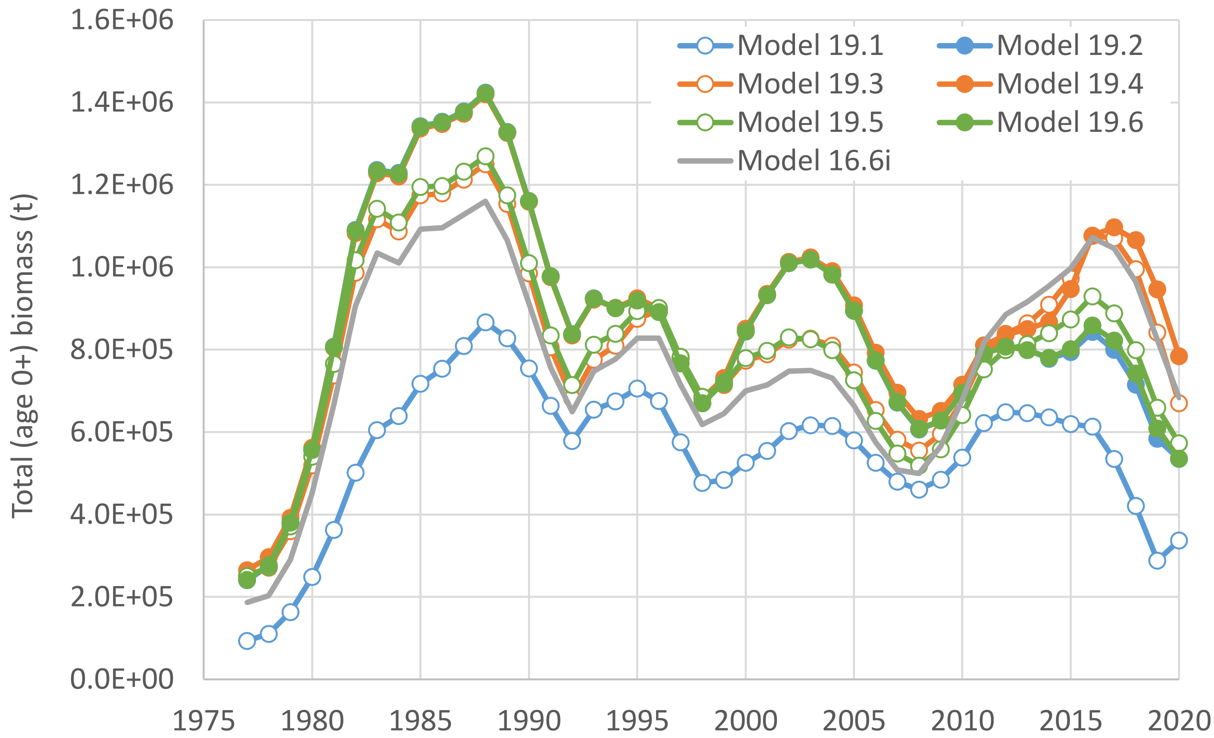


Figure 2.1.8. Total (age 0+) biomass.

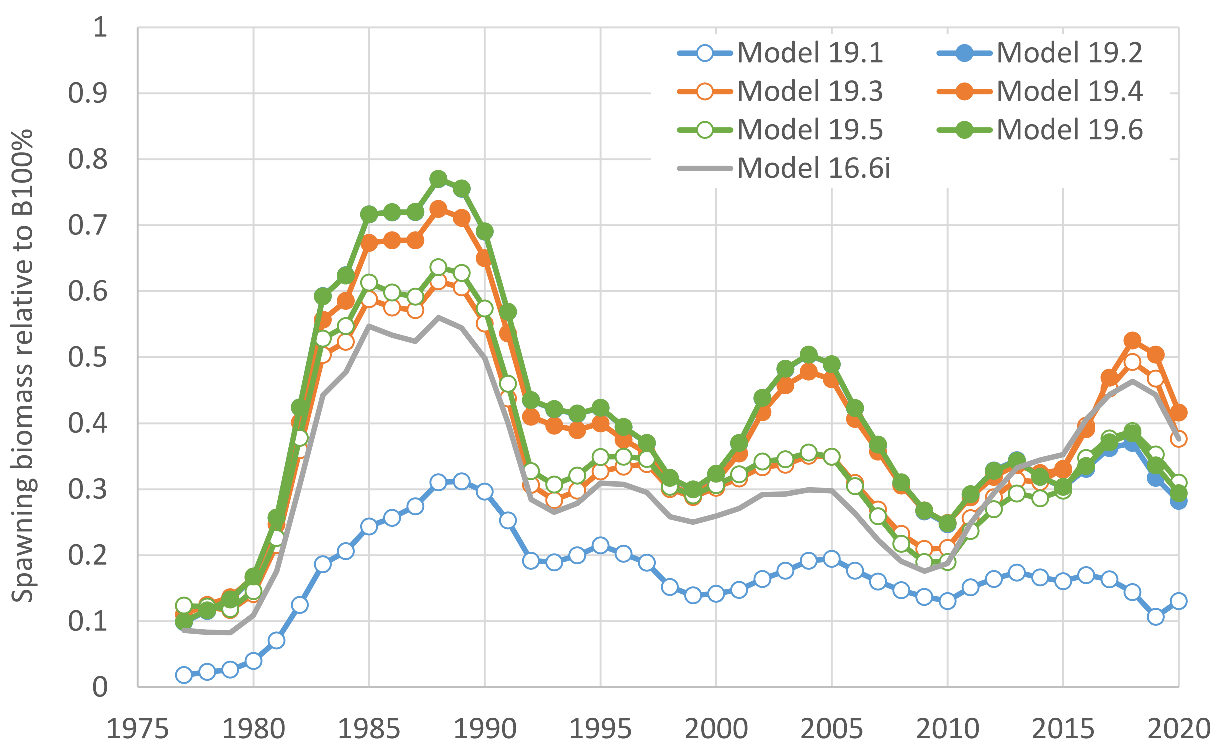


Figure 2.1.9. Relative spawning biomass.

	-178	-177	-176	-175	-174	-173	-172	-171	-170	-169	-168	-167	-166	-165	-164	-163	-162	-161	All
-62.5																			
-62																			
-61.5																			
-61			437	455															446
-60.5			377	405															391
-60	354			333															344
-59.5	579	490	546		572	412	250												481
-59	967	630	488	698	675	423	402	539	473										555
-58.5		775	643	727	663	486	430	437	446										570
-58				198	979	356	387	427	403										485
-57.5					754	538	173	310	396		450								437
-57						738	561	363	340	343	440								468
-56.5						767	646	471		405									624
-56								653	499	310								557	460
-55.5											533								533
-55															824				824
-54.5														655					655
-54													308						308
-53.5												610							610
-53																			
All	620	632	528	552	731	551	455	419	431	337	460	610	308	655	824			557	510

Figure 2.1.10a. Longline fishery CPUE, June, all years combined.

	-178	-177	-176	-175	-174	-173	-172	-171	-170	-169	-168	-167	-166	-165	-164	-163	-162	-161	All
-62.5																			
-62																			
-61.5																			
-61																			
-60.5			188	428															308
-60	949	331		270		426	357	488											537
-59.5	635	426	336	415	335	379	292	541	511										392
-59	700	704	501	519	380	338	322	484	345	669									475
-58.5		683	388	454	492	488	353	395	437	500	465								460
-58				1166	625	510	287	419	415	369	380		250						477
-57.5					408	407	416	357	396	258	250								386
-57						381	402	262	339		481	478							374
-56.5						318	236	376	252	359	384	334	223				310		328
-56								443	464	447	506	282	298	392		131	386	592	419
-55.5											444	255	330	356			309		378
-55												481	522	241	478				458
-54.5														329					329
-54													229	874					551
-53.5												415							415
-53																			
All	803	585	405	487	463	409	334	407	386	439	436	387	305	416	478	131	348	592	425

Figure 2.1.10b. Longline fishery CPUE, July, all years combined.

	-178	-177	-176	-175	-174	-173	-172	-171	-170	-169	-168	-167	-166	-165	-164	-163	-162	-161	All
-62.5								386											386
-62									326										326
-61.5																			
-61			356																356
-60.5	225	294	349	310		729													360
-60	372	329	312	388	262	428		736											372
-59.5	322	418	330	313	290	329	341	524	432										345
-59	459	410	393	359	324	268	329	331	322										357
-58.5		417	382	366	501	472	316	279	401			368							404
-58				544	544	386	240	234	385	431		393	354						408
-57.5					446	435	352	252	461	446	364	474	322	427					400
-57						335	395	326	411	393	336	328	312			276	223		358
-56.5						189	375	362	292	348	417	384	365		358	422			367
-56								348	429	368	482	394	392	370	323	388			398
-55.5											401	239		372	385	440			388
-55												364	351	378	355	252			353
-54.5													393	576					531
-54																			
-53.5												443							443
-53																			
All	346	392	361	367	422	387	352	344	389	369	434	371	369	407	357	402	223		380

Figure 2.1.10c. Longline fishery CPUE, August, all years combined.

	-178	-177	-176	-175	-174	-173	-172	-171	-170	-169	-168	-167	-166	-165	-164	-163	-162	-161	All
-62.5																			
-62																			
-61.5																			
-61																			
-60.5																			
-60																			
-59.5																			
-59							511	572	365										482
-58.5							608	453	544										535
-58								540	357										448
-57.5								275	305										290
-57									314	420	313								349
-56.5																			
-56																			
-55.5																			
-55																			
-54.5																			
-54																			
-53.5																			
-53																			
All							559	460	377	420	313								429

Figure 2.1.10d. Longline fishery CPUE, June, 2017.

	-178	-177	-176	-175	-174	-173	-172	-171	-170	-169	-168	-167	-166	-165	-164	-163	-162	-161	All
-62.5																			
-62																			
-61.5																			
-61																			
-60.5																			
-60																			
-59.5					312	417	380												370
-59				311	455	360	394												380
-58.5						335	411	393											379
-58						327	304	366											332
-57.5						294													294
-57									278										278
-56.5									251								310		280
-56										238							317		277
-55.5																			
-55																			
-54.5																			
-54																			
-53.5																			
-53																			
All				311	384	347	372	379	264	238							313		340

Figure 2.1.10e. Longline fishery CPUE, July, 2017.

	-178	-177	-176	-175	-174	-173	-172	-171	-170	-169	-168	-167	-166	-165	-164	-163	-162	-161	All
-62.5																			
-62																			
-61.5																			
-61																			
-60.5																			
-60	392																		392
-59.5	210																		210
-59		173	175		154		297												200
-58.5			220	267			246												244
-58						264	230												247
-57.5																			
-57						193					250								221
-56.5												307	253						280
-56													294	256	258				269
-55.5															262				262
-55												244			313				278
-54.5																			
-54																			
-53.5																			
-53																			
All	301	173	198	267	154	228	258				250	275	273	256	278				250

Figure 2.1.10f. Longline fishery CPUE, August, 2017.

	-178	-177	-176	-175	-174	-173	-172	-171	-170	-169	-168	-167	-166	-165	-164	-163	-162	-161	All
-62.5																			
-62																			
-61.5																			
-61			437	455															446
-60.5			377	405															391
-60	354			333															344
-59.5							250												250
-59							405												405
-58.5								422	322										372
-58								298											298
-57.5								233											233
-57																			
-56.5																			
-56																			
-55.5																			
-55																			
-54.5																			
-54																			
-53.5																			
-53																			
All	354		407	398			328	318	322										358

Figure 2.1.10g. Longline fishery CPUE, June, 2018.

	-178	-177	-176	-175	-174	-173	-172	-171	-170	-169	-168	-167	-166	-165	-164	-163	-162	-161	All
-62.5																			
-62																			
-61.5																			
-61																			
-60.5			188																188
-60				255															255
-59.5					247	284													265
-59						297	251												274
-58.5					450														450
-58																			
-57.5																			
-57								223	230										227
-56.5																			
-56																			
-55.5																			
-55																			
-54.5																			
-54																			
-53.5																			
-53																			
All			188	255	349	290	251	223	230										269

Figure 2.1.10h. Longline fishery CPUE, July, 2018.

	-178	-177	-176	-175	-174	-173	-172	-171	-170	-169	-168	-167	-166	-165	-164	-163	-162	-161	All
-62.5								386											386
-62									326										326
-61.5																			
-61																			
-60.5																			
-60																			
-59.5						229													229
-59					297														297
-58.5				242	212														227
-58																			
-57.5						228													228
-57																			
-56.5																			
-56																			
-55.5															283				283
-55																			
-54.5																			
-54																			
-53.5																			
-53																			
All				242	254	229		386	326						283				275

Figure 2.1.10i. Longline fishery CPUE, August, 2018.

APPENDIX 2.2: BSAI PACIFIC COD ECONOMIC PERFORMANCE REPORT FOR 2018

Ben Fissel

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Pacific cod is the second largest species in terms of catch in the Bering Sea & Aleutian Island (BSAI) region. Pacific cod accounted for 11% of the BSAI's FMP groundfish harvest and 94% of the total Pacific cod harvest in Alaska. Retained catch of Pacific cod decreased 13% to 218 thousand t in 2018 and was higher than the 2009-2013 average (Table 1). The products made from BSAI Pacific cod had a first-wholesale value of $461 million in 2018, which was up from $435 million in 2017 and above the 2009-2013 average of $303 million (Table 2). The higher revenue is the result of increased first-wholesale prices for fillet and headed-and-gutted (H&G) Pacific cod products.

Cod is an iconic fishery with a long history of production across much of the globe. Global catch was consistently over 2 million t through the 1980s, but began to taper off in the 1990s as cod stocks began to collapse in the northwest Atlantic Ocean. Over roughly the same period, the U.S. catch of Pacific cod (caught in Alaska) grew to approximately 250 thousand tons where it remained throughout the early to mid-2000s. European catch of Atlantic cod in the Barents Sea (conducted mostly by Russia, Norway, and Iceland) slowed and global catch hit a low in 2007 at 1.13 million t. U.S. Pacific cod's share of global catch was at a high at just over 20% in the early 2000s. Since 2007 global catch has grown to roughly 1.8 million t in recent years as catch in the Barents Sea has rebounded and U.S. catch has remained strong at over 300 thousand t since 2011 (Table 3). European Atlantic cod and U.S. Pacific cod remain the two major sources supplying the cod market over the past decade accounting for roughly 75% and 20%, respectively. Atlantic cod and Pacific cod are substitutes in the global market. Because of cod's long history global demand is present in a number of geographical regions, but Europe, China, Japan, and the U.S. are the primary markets for many Pacific cod products. The market for cod is also indirectly affected by activity in the pollock fisheries which experienced a similar period of decline in 2008-2010 before rebounding. Cod and pollock are commonly used to produce breaded fish portions. Alaska caught Pacific cod in the BSAI became certified by the Marine Stewardship Council (MSC) in 2010, a NGO based third-party sustainability certification, which some buyers seek.

The Pacific cod total allowable catch (TAC) is allocated to multiple sectors (fleets). CDQ entities receive 10% of the total BSAI quota. The largest sectoral allocation goes to the Freezer longline CPs which receive roughly 44% of the total BSAI cod quota (48.7% non-CDQ quota). While not an official catch share program, the Freezer longline CPs have formed a voluntary cooperative that allows them to form private contracts among members to distribute the sectoral allocation. The remaining large sectors are the trawl CPs, trawl CVs, the pot gear CVs and some smaller sideboard limits to cover the catch of Pacific cod while targeting other species. The CVs (collectively referred to as the inshore sector) make deliveries to shore-based processors, and catcher/processors process catch at-sea before going directly to the wholesale markets. Among the at-sea CPs, catch is distributed approximately three-quarters to the hook-and-line and one quarter to trawl. Prior to 2016 the inshore sector accounted for 25-30% of the total BSAI Pacific cod retained catch. Since 2016 this share has increased to 33-38%. Since 2016, approximately half of the retained catch is harvested by the trawl sector and half by the pot gear sector. The retained catch of the inshore sectors decreased 6% to 82.5 thousand t. The value of these deliveries (shoreside ex-vessel value) totaled $65.1 million in 2018, which was up 20% from 2017, as ex-vessel prices also increased 26% to $0.40 per pound. Changes in ex-vessel prices over time generally reflect changes in the corresponding wholesale prices. Catch from the fixed gear vessels (which includes hook-and-line and pot gear) typically receive a slightly higher price from processors because they incur less damage when caught. The fixed gear price premium has varied over time but recently has been about $0.03 per pound.

The first-wholesale value of Pacific cod products was up 6% to $461 million in 2018, and revenues in recent years have remained high as result of increased prices as catch and production saw marginal decreases in 2017 and 2018 (Table 2). The average price of Pacific cod products in 2018 increased 18% to $1.95. Head and gut (H&G) production is the focus of the BSAI processors but a significant amount of fillets are produced as well. H&G typically constitutes approximately 70%-80% of value and fillets approximately 10%-20% of value. Shoreside processors produce the majority of the fillets. Almost all of the at-sea sector's catch is processed into H&G. Other product types are not produced in significant quantities. At-sea head and gut prices tend to be about 20%-30% higher, in part because of the shorter period of time between catch and freezing, and in part because the at-sea sector is disproportionately caught by hook-and-line which yields a better price. Head & gut prices bottomed out at $1.05 per pound in 2013, a year in which Barents Sea cod catch increased roughly 240 thousand t (an increase that is approximately the size of Alaska's cod total catch) but rebounded to $1.37 in 2015. The H&G price was up 19% to $1.87 per pound in 2018. Fillet prices steady declined from over $3 in 2011 to $2.67 in 2015. Fillet prices have rebounded since then and increased 13% in 2018 to $4.19 from 2017. Changes in global catch and production account for much the trends in the cod markets. In particular, average first-wholesale prices peaked at over $1.80 per pound in 2007-2008 and subsequent declined precipitously in 2009 to $1.20 per pound as markets priced in consecutive years of approximately 100 thousand t increases in the Barents Sea cod catch in 2009-2011; coupled with reduced demand from the recession. Average first-wholesale prices since have fluctuated between approximately $1.20 and $1.55 per pound up to 2016. Since 2016 reductions in global supply have put upward pressure on prices resulting in significant year over year price increases in 2017 and 2018. Available information on 2019 prices indicate that prices may be leveling off as reflected in the highly exported H&G product type where the price through June of 2019 fell 2%.

U.S. exports of cod are roughly proportional to U.S. cod production. More than 90% of the exports are H&G, much of which goes to China for secondary processing and re-export (Table 3). China's rise as re-processor is fairly recent. Between 2001 and 2011 exports to China have increased nearly 10 fold and continued to increase up to 2016. Since 2017 China's share of exports has declined slightly going from 55% in 2016 to 47% in 2018. The cod industry has largely avoided U.S. tariffs that would have a significant negative impact on them in the U.S.-China trade war. However, Chinese tariffs on U.S. products could inhibit growth in that market. Japan and Europe (mostly Germany and the Netherlands) are also important export destinations. Japan and Europe accounted for 15% and 16% of the export volume respectively. Approximately 35% of Alaska's cod production is estimated to remain in the U.S.. Because U.S. cod production is approximately 20% of global production and the BSAI is approximately 90% of U.S. production, the BSAI Pacific cod is a significant component of the broader global cod market. Strong demand and tight supply in 2017-2018 from the U.S. and globally have contributed to increasing prices. The Barents Sea quota was reduced by 13% 2018 and the global cod supply will remain constrained. Groundfish forum estimates for 2019 indicate global catches of Atlantic and Pacific cod will be reduced by approximately 100 thousand t. Markets may have incorporated these supply adjustments as export prices in 2019 have leveled off, decreasing slightly by 2% (Table 3). A portion of the Russian catch of Pacific cod became MSC certified in Oct. 2019 which could put further downward pressure on prices going forward.

Table 2.2.1. Bering Sea & Aleutian Islands Pacific cod catch and ex-vessel data. Total and retained catch (thousand metric tons), number of vessel, catcher/processor (CP) hook-and-line (H&L) share of catch, CP trawl share of catch, Shoreside retained catch (thousand metric tons), shoreside number of vessel, shoreside pot gear share of catch, shoreside trawl share of catch, shoreside ex-vessel value and price (million US$), and fixed gear to trawl price premium (US$ per pound); 2009-2013 average and 2014-2018.

	Avg 09-13	2014	2015	2016	2017	2018
Total catch K mt	213.82	249.3	242.1	260.9	253.1	220.3
Retained catch K mt	209.8	244.5	239.0	257.7	250.1	218.0
Vessels #	171.2	156	149	162	170	190
CP H&L share of BSAI catch	53%	50%	54%	49%	50%	46%
CP trawl share of BSAI catch	16%	14%	15%	14%	13%	14%
Shoreside retained catch K mt	60.1	79.1	68.4	86.0	88.0	82.5
Shoreside catcher vessels #	117.2	109	100	110	125	141
CV pot gear share of BSAI catch	10%	14%	13%	15%	17%	19%
CV trawl share of BSAI catch	18%	17%	16%	18%	18%	18%
Shoreside ex-vessel value M $	$33.1	$44.8	$34.1	$44.6	$54.1	$65.1
Shoreside ex-vessel price lb $	$0.250	$0.274	$0.248	$0.264	$0.316	$0.399
Shoreside fixed gear ex-vessel price premium	$0.05	$0.03	$0.03	$0.03	$0.04	$0.03

Source: NMFS Alaska Region Blend and Catch-accounting System estimates; NMFS Alaska Region At-sea Production Reports; and ADF&G Commercial Operators Annual Reports (COAR). Data compiled and provided by the Alaska Fisheries Information Network (AKFIN).

Table 2.2.2. Bering Sea & Aleutian Islands Pacific cod first-wholesale market data. First-wholesale production (thousand metric tons), value (million US$), price (US$ per pound); fillet and head and gut volume (thousand metric tons), value share, and price (US$ per pound); At-sea share of value and at-sea shoreside price difference (US$ per pound); 2009-2013 average and 2014-2018.

		Avg 09-13	2014	2015	2016	2017	2018
All products	**volume K mt**	103.11	123.51	120.47	126.40	119.54	107.36
All products	**Value M $**	$ 302.5	$ 352.5	$ 365.0	$ 388.3	$ 434.7	$ 461.0
All products	**price lb $**	$ 1.33	$ 1.29	$ 1.37	$ 1.39	$ 1.65	$ 1.95
Fillets	**volume K mt**	6.49	8.42	6.28	10.03	10.01	10.36
Fillets	**value share**	14%	14%	10%	19%	19%	21%
Fillets	**price lb $**	$ 2.88	$ 2.68	$ 2.67	$ 3.37	$ 3.70	$ 4.19
Head & Gut	**volume K mt**	84.48	100.56	100.82	98.68	92.38	78.99
Head & Gut	**value share**	79%	79%	83%	72%	74%	70%
Head & Gut	**price lb $**	$ 1.29	$ 1.25	$ 1.36	$ 1.29	$ 1.57	$ 1.87
At-sea	**value share**	74%	69%	76%	69%	70%	63%
At-sea	**price premium ($/lb)**	-$0.08	-$0.02	$0.07	-$0.32	-$0.33	-$0.53

Source: NMFS Alaska Region Blend and Catch-accounting System estimates; NMFS Alaska Region At-sea Production Reports; and ADF&G Commercial Operators Annual Reports (COAR). Data compiled and provided by the Alaska Fisheries Information Network (AKFIN).

Table 2.2.3. Cod U.S. trade and global market data. Global production (thousand metric tons), U.S. share of global production, and Europe's share of global production; U.S. export volume (thousand metric tons), value (million US$), and price (US$ per pound); U.S. cod consumption (estimated), and share of domestic production remaining in the U.S. (estimated); and the share of U.S. export volume and value for head and gut (H&G), fillets, China, Japan, and Germany and Netherlands; 2009-2013 average and 2014-2019.

		Avg 09-13	2014	2015	2016	2017	2018	2019 (thru June)
Global cod catch K mt		1,506	1,852	1,762	1,792	1,759	-	-
U.S. P. cod share of global catch		18.6%	17.6%	18.0%	17.9%	17.0%	-	-
Europe share of global catch		74.2%	75.9%	74.8%	74.8%	75.7%	-	-
Pacific cod share of U.S. catch		97.8%	99.3%	99.5%	99.5%	99.7%	-	-
U.S. cod consumption K mt (est.)		88	115	108	114	119	113	-
Share of U.S. cod not exported		27%	31%	26%	29%	32%	35%	-
Export volume K mt		98.3	107.3	113.2	105.3	92.8	73.2	39.4
Export value M US$		$309.9	$314.2	$335.0	$312.0	$295.5	$253.6	$133.6
Export price lb US$		$1.429	$1.328	$1.342	$1.344	$1.445	$1.570	$1.539
Frozen (H&G)	volume Share	74%	92%	91%	94%	94%	91%	90%
	value share	74%	91%	90%	92%	92%	90%	89%
Fillets	volume Share	10%	2%	3%	3%	4%	5%	6%
	value share	12%	4%	4%	4%	5%	6%	6%
China	volume Share	39%	54%	53%	55%	52%	47%	47%
	value share	37%	51%	51%	52%	50%	46%	45%
Japan	volume Share	17%	16%	13%	14%	16%	15%	7%
	value share	18%	16%	14%	15%	18%	17%	8%
Europe*	volume Share	30%	20%	19%	17%	17%	16%	20%
	value share	32%	22%	19%	18%	18%	18%	21%

Notes: Pacific cod in this table is for all U.S. Unless noted, `cod' in this table refers to Atlantic and Pacific cod. Russia, Norway, and Iceland account for the majority of Europe's cod catch which is largely focused in the Barents Sea.

*Europe refers to: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom

Source: FAO Fisheries & Aquaculture Dept. Statistics http://www.fao.org/fishery/statistics/en. NOAA Fisheries, Fisheries Statistics Division, Foreign Trade Division of the U.S. Census Bureau, http://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/index. U.S. Department of Agriculture http://www.ers.usda.gov/data-products/agricultural-exchange-rate-data-set.aspx

APPENDIX 2.3: HISTORY OF PREVIOUS EBS PACIFIC COD MODEL STRUCTURES DEVELOPED UNDER STOCK SYNTHESIS

For 2005 and beyond, the SSC's accepted model from the final assessment is shown in **bold red**.

Pre-2005

Timeline

- Pre-1985: Simple projections of current survey numbers at age
- 1985: Projections based on 1979-1985 survey numbers at age
- 1986-1991: *ad hoc* separable age-structured FORTRAN model
- 1992: FORTRAN-based Stock Synthesis (SS), with age-based data
    - Strong 1989 cohort "disappears;" production ageing ceased
- 1993-2003: Models continued to be developed using SS, with length-based data only
- 2001: CIE review of code for proposed "ALASKA" (Age-, Length-, and Area-Structured Kalman Assessment) model and methodology for decision-theoretic estimation of OFL and ABC
    - Although review was favorable, use of ALASKA was postponed "temporarily"
- 2004: Models continued to be developed using SS, with length- *and* age-based data
    - New age data, based on revised ageing protocol
    - Agecomp data used in "marginal" form

Main features of the early Stock Synthesis EBS Pacific cod models

- Start year = 1977
- Three seasons (Jan-May, Jun-Aug, Sep-Dec)
- Four fisheries (Jan-May trawl, Jun-Dec trawl, longline, pot)
- M constant at 0.37
- Q constant at 1.00
- Efforts at internal estimation of M, Q unsuccessful
- Double-logistic selectivity for all fleets (fisheries and survey)
- No fleets constrained to exhibit asymptotic selectivity
- Sizecomp input sample size = square root of true sample size
- Survey index standard deviations set to values reported by RACE Division

2005

This assessment marked the first application of ADMB-based Stock Synthesis to EBS Pacific cod

Three models were included:

- Model 1 was identical to the 2004 final model (configured under FORTRAN-based SS), except for use of new maturity schedule developed by Stark
- **Model 2** was configured under ADMB-based SS, and was designed to be as close as possible to Model 1 given the limitations of the respective software packages, except:
    - Nonuniform priors used throughout
    - M fixed at 0.37, Q fixed at 1.00
- Model 3 was identical to Model 2 except that M and Q were estimated internally

Weight-length and length-age data examined for evidence of sexual dimorphism; none found.

2006

Nine models were included, consisting of 2005 final model and a 3-way factorial design of alternative models (the factorial models all differed from the 2005 final model in that they estimated trawl survey Q

internally—in the 2005 final model, it was fixed at 1.0; and they estimated all selectivity parameters except for selectivity at the minimum size bin internally—in the 2005 final model, a few selectivity parameters were fixed externally):

- Model 0 was identical to 2005 final model
- Model A1 was identical to Model 0 except as noted above, with:
  - NMFS longline survey data omitted
  - Double logistic selectivity
  - Prior emphasis = 1.0
- Model A2 was identical to Model 0 except as noted above, with:
  - NMFS longline survey data omitted
  - Double logistic selectivity
  - Prior emphasis = 0.5
- **Model B1** was identical to Model 0 except as noted above, with:
  - NMFS longline survey data omitted
  - Double normal (four parameter) selectivity
  - Prior emphasis = 1.0
- Model B2 was identical to Model 0 except as noted above, with:
  - NMFS longline survey data omitted
  - Double normal (four parameter) selectivity
  - Prior emphasis = 0.5
- Model C1 was identical to Model 0 except as noted above, with:
  - NMFS longline survey data included
  - Double logistic selectivity
  - Prior emphasis = 1.0
- Model C2 was identical to Model 0 except as noted above, with:
  - NMFS longline survey data included
  - Double logistic selectivity
  - Prior emphasis = 0.5
- Model D1 was identical to Model 0 except as noted above, with:
  - NMFS longline survey data included
  - Double normal (four parameter) selectivity
  - Prior emphasis = 1.0
- Model D2 was identical to Model 0 except as noted above, with:
  - NMFS longline survey data included
  - Double normal (four parameter) selectivity
  - Prior emphasis = 0.5

2007

Technical workshop
SS introduced a six-parameter form of the double normal selectivity curve (the previous version used only four parameters). This functional form is constructed from two underlying and linearly rescaled normal distributions, with a horizontal line segment joining the two peaks. As configured in SS, the equation uses the following six parameters:

1. *beginning_of_peak_region* (where the curve first reaches a value of 1.0)
2. *width_of_peak_region* (where the curve first departs from a value of 1.0)
3. *ascending_width* (equal to twice the variance of the underlying normal distribution)
4. *descending_width* (equal to twice the variance of the underlying normal distribution)
5. *initial_selectivity* (at minimum length/age)

6. *final_selectivity* (at maximum length/age)

All but *beginning_of_peak_region* are transformed: The *ascending_width* and *descending_width* are log-transformed and the other three parameters are logit-transformed.

Model 0 was prepared ahead of workshop:

- *M* estimated internally
- Length-at-age parameters estimated internally
- Disequilibrium initial age structure
- Regime shift recruitment offset estimated internally
- Start year changed from 1964 to 1976
- New six-parameter double normal selectivity function used
- Prior distributions reflect 50% CV for most parameters

Twenty-one other models were prepared ahead of workshop, each of which was based on Model 0:

- Two models to examine inside/outside growth estimation:
    - Model 1 was identical to Model 0 except length-at-age parameters estimated outside the model
    - Model 2 was identical to Model 0 except standard deviation of length at age 12 estimated internally
- Two models to examine *M* conditional on *Q*, vice-versa:
    - Model 3 was identical to Model 0 except *M* fixed at 0.37 and *Q* free
    - Model 4 was identical to Model 0 except *Q* fixed at 0.75 and *M* free
- Six models to examine effects of prior distributions:
    - Model 5 was identical to Model 0 except 30% CV instead of 50%
    - Model 6 was identical to Model 0 except 40% CV instead of 50%
    - Model 7 was identical to Model 0 except emphasis = 0.2 instead of 1.0
    - Model 8 was identical to Model 0 except emphasis = 0.4 instead of 1.0
    - Model 9 was identical to Model 0 except emphasis = 0.6 instead of 1.0
    - Model 10 was identical to Model 0 except emphasis = 0.8 instead of 1.0
- Four models to examine effects of asymptotic selectivity:
    - Model 11 was identical to Model 0 except Jan-May trawl fishery selectivity forced asymptotic
    - Model 12 was identical to Model 0 except longline fishery selectivity forced asymptotic
    - Model 13 was identical to Model 0 except pot fishery selectivity forced asymptotic
    - Model 14 was identical to Model 0 except shelf trawl survey selectivity forced asymptotic
- One model to examine estimation of stock-recruit relationship:
    - Model 15 was identical to Model 0 except parameters of a Ricker stock-recruitment relationship estimated internally
- Six models to address EBS-specific comments from the public:
    - Model 16 was identical to Model 0 except input *N* determined by iterative re-weighting
    - Model 17 was identical to Model 0 except input *N* for mean-size-at-age data decreased by an order of magnitude
    - Model 18 was identical to Model 0 except standard error from the shelf trawl survey doubled
    - Model 19 was identical to Model 0 except all age data removed
    - Model 20 was identical to Model 0 except slope survey data removed
    - Model 21 was identical to Model 0 except start year changed to 1982

An immense factorial grid of fixed $M \times Q$ models also prepared ahead of workshop, for which only partial results were presented

Eight models were developed during the workshop itself:

- Model 22 was identical to Model 0 except "old" (pre-Stark) maturity schedule used
- Model 23 was identical to Model 0 except priors turned off and separate *M* estimated for ages 1-2
- Model 24 was identical to Model 0 except priors turned off and longline fishery CPUE included as an index of abundance
- Model 25 was identical to Model 0 except priors turned off and Pcod bycatch from IPHC survey included as an index of abundance
- Model 26 was identical to Model 0 except priors turned off and either *Q* (=0.75) or *M* (=0.37) fixed
- Model 27 was identical to Model 0 except all priors turned off other than that for Jan-May trawl selectivity in largest size bin
- Model 28 was identical to Model 0 except survey selectivity forced asymptotic and *Q* fixed at 0.5
- Model 29 was identical to Model 0 except separate *M* estimated for ages 9+

Preliminary assessment
In general:

- Agecomp data presented as "age conditioned on length" (i.e., not marginals)
- Length-at-age SD a linear function of age
- Annual *dev*s for length at age 1, sigma=0.11
- Annual *dev*s for recruitment, sigma=0.6, 1973-2005
- Annual *dev*s for ascending selectivity, sigma=0.4
- All parameters estimated internally
- Except selectivity parameters pinned against bounds
- Uniform priors used exclusively
- Monotone selectivity for Jan-May trawl fishery
- All other selectivities new "double normal"

Four models were included, all of which were identical to the 2006 final model except as specified above and below:

- Model 1:
    - Estimated effect of 1976 regime shift on median recruitment
    - Added a large constant to fishery CPUE sigmas
- Model 2 was identical to Model 1 except age-dependent *M* estimated for ages 8+
- Model 3 was identical to Model 1 except that it did not add the large constant to longline CPUE sigmas
- Model 4 was identical to Model 1 except:
    - Effect of regime shift assumed to be zero
    - Did not add large constant to longline CPUE sigmas
    - Zero emphasis placed on initial catch and age composition
    - Iteratively re-weighted input sigmas and input *N*

Also attempted but not included:

- Simplified model with only a single fishery and no seasons

Final assessment
Four models were included:

- **Model 1** (comparisons to 2006 final model in parentheses):
    - *M* fixed at 0.34 (*M* fixed at 0.37 in 2006)
    - Length-at-age parameters estimated internally (fixed at point estimates from data in 2006)
    - Start year set at 1977 (start year set at 1964 in 2006)
    - Three age groups in initial state vector estimated (initial state vector assumed to be in equilibrium in 2006)
    - 6-parameter double normal selectivity (4-parameter version used in 2006)
    - Uniform priors used exclusively (informative normal priors used for many parameters in 2006)
    - Fishery selectivities constant across all years (approximately decadal "time blocks" used in 2006)
    - Ascending limb of survey selectivity varies annually with σ=0.2 (survey selectivity assumed to be constant in 2006)
    - Survey selectivity based on age (length-based selectivity used in 2006)
    - Some fishery selectivities forced asymptotic (all selectivities free in 2006)
    - Fishery CPUE data included for comparison (not included in 2006)
    - Age-based maturity schedule (length-based schedule used in 2006)
    - All fisheries seasonally structured (trawl partially seasonal, other gears non-seasonal in 2006)
    - Trawl survey abundance measured in numbers (abundance measured in biomass in 2006)
    - Multinomial *N* based on rescaled bootstrap (sample size set equal to square root of actual *N* in 2006)
- Model 2 was identical to Model 1 except *M* fixed at 0.37
- Model 3 was identical to Model 1 except *M* estimated internally
- Model 4 was identical to Model 1 except:
    - *M* estimated internally
    - Survey selectivities forced to be asymptotic
    - Age data ignored
    - Start year set at 1982; 1977 regime shift ignored
    - Length-based maturity used
    - Length-based survey selectivity used
    - Sigma=0.4 for annual deviations in selectivity parameters
    - Initial catch ignored in estimating initial fishing mortality

2008

Preliminary assessment
Five models were included:

- Model 1 was identical to the 2007 final model
- Model 2 was identical to Model 1 except growth parameter *L2* estimated externally
- Model 3 was identical to Model 1 except exponential-logistic selectivity used instead of double normal
- Model 4 was identical to 2007 Model 4
- Model 5 was identical to Model 1 except:
    - Fishery selectivity blocks (5 yr, 10 yr, 20 yr, or no blocks) chosen by AIC
    - Lower bound of descending "width" = 5.0
    - Regime-specific recruitment "dev" vectors
    - "SigmaR" set equal (iteratively) to stdev(dev) from current regime

- Seasonal weight-length, based on fishery data
- Number of free initial ages chosen by AIC
- Size-at-age data used if modes ambiguous

Final assessment
Eight models were included:

- Model A1 was identical to Model 5 from September except lower bound on selectivity descending "width" parameter relaxed so as not to be constraining
- Model A2 was identical to Model A1, except without age data
- **Model B1** was identical to Model A1, except:
    - "Asymptotic algorithm" used to determine which fisheries will be forced to exhibit asymptotic selectivity
    - "Constant-parameters-across-blocks algorithm" used to determine which selectivity parameters can be held constant across blocks
- Model B2 was identical to Model B1, except without age data
- Model C1 was identical to Model B1, except with M estimated internally
- Model D2 was identical to Model B1, except:
    - No age data
    - Maturity modeled as function of length rather than age
    - M estimated iteratively, based on mat. at len and len. at age
- Model E2 was identical to Model B1, except:
    - No age data
    - Post-1981 trawl survey selectivity forced to be asymptotic
    - *M* estimated internally
- Model F2 was identical to Model 4 from the final assessment for 2007, except start year = 1977

2009

Preliminary assessment
Eight models were included, based on factorial design of the following:

- Selectivity functional form: double normal or exponential-logistic?
- Catchability: free or fixed at 1.0?
- Survey selectivity estimation: free or forced asymptotic?

Partial results were presented for a model with a prior distribution for *Q* based on archival tags (the prior had virtually no impact, which was why only partial results were presented)

Other features explored but not included in the above models:

- Fixing trawl survey catchability at the mean of the above normal prior distribution
- Allowing trawl survey catchability to vary as a random walk
- Fixing trawl survey catchability at a value of 1.00 for the pre-1982 portion of the time series, but allowing it to be estimated freely for the post-1981 portion of the time series
- Reducing the number of survey selectivity parameters subject to annual deviations
- Use of additive, rather than multiplicative, deviations for certain survey selectivity parameters
- Decreasing the value of the σ parameter used to constrain annual survey selectivity deviations
- Turning off annual deviations in survey selectivity parameters for the three most recent years
- Turning off all annual deviations in survey selectivity parameters

- Forcing trawl survey selectivity to peak at age 6.5, the approximate mid-point of the size range of 60-81 cm spanned by the results of Nichol et al. (2007)
- Imposing a beta prior distribution on the shape parameter of the exponential-logistic selectivity function in the trawl survey.

Final assessment
Fourteen models were included (all new since the preliminary assessment except for Model A1):

- Models without mean-size-at-age data:
    - Model A1 was identical to the 2008 final model, with the addition of new data, including the first available fishery agecomp data (from the 2008 Jan-May longline fishery)
    - Model A2 was identical to Model A1, except all agecomp data omitted
    - Model A3 was identical to Model A1, except 2008 Jan-May longline fishery agecomp data omitted
    - Model F2 was identical to Model F2 from the final assessment for 2008
- Models with mean-size-at-age data and agecomp data:
    - **Model B1** was identical to Model A1 except:
        - Survey selectivity held constant for most recent two years
        - Cohort-specific growth included
        - Input standard deviations of all "dev" vectors were set iteratively by matching the standard deviations of the set of estimated *dev*s
        - Standard deviation of length at age was estimated outside the model as a linear function of mean length at age
        - Selectivity at maximum size or age was treated as a controllable parameter
        - *Q* for the post-1981 trawl survey was fixed at the value that sets the average (weighted by numbers at length) of the product of *Q* and selectivity for the 60-81 cm size range equal to the point estimate of 0.47 obtained by Nichol et al. (2007)
        - Potential ageing bias was accounted for in the ageing error matrix by examining alternative bias values in increments of 0.1 for ages 2 and above (age-specific bias values were also examined, but did not improve the fit significantly).
    - Model C1 was identical to Model B1 except:
        - Input standard deviations for all "dev" vectors and the amount of ageing bias fixed at the values obtained iteratively in Model B1
        - *Catchability itself* (rather than the average product of catchability and selectivity for the 60-81 cm size range) set equal to 0.47
    - Model D1 was identical to Model B1 except:
        - Input standard deviations for all "dev" vectors and the amount of ageing bias fixed at the values obtained iteratively in Model B1
        - Selectivity at maximum size or age was removed from the set of controllable parameters (instead, selectivity at maximum size or age becomes a function of other selectivity parameters)
    - Model E1 was identical to Model B1 except:
        - Input standard deviations for all "dev" vectors and the amount of ageing bias fixed at the values obtained iteratively in Model B1
        - Selectivity at maximum size or age for all non-asymptotic fleets was set equal to a single value that was constant across fleets
    - Model G1 was identical to Model B1 except:
        - Input standard deviations for all "dev" vectors and the amount of ageing bias fixed at the values obtained iteratively in Model B1
        - Survey selectivity was held constant across all years (i.e., no selectivity *dev*s are estimated for any years)

- Models with mean-size-at-age data and without agecomp data:
  - Models B2, C2, D2, E2, and G2 were identical to their B1, C1, D1, E1, and G1 counterparts except that agecomp data were ignored and the corresponding sizecomp data were active.

2010

Preliminary assessment
Six models were included:

- Model 1 was identical to the 2009 final model
- Model 2 was identical to Model 1 except:
  - Input standard deviations for all "dev" vectors fixed at the values obtained iteratively in Model 1
  - IPHC survey data omitted
  - Fishery age data omitted
  - Traditional 3-or-5 cm size bins replaced with 1 cm size bins
  - Traditional 3-season structure replaced with new, 5-season structure
  - Spawn time changed from beginning of season 1 to beginning of season 2
- Model 3 was identical to Model 2 except:
  - Non-uniform prior distributions used for selectivity parameters and *Q*
- Model 4 was identical to Model 2 except:
  - All age data omitted
  - Maturity schedule was length-based rather than age-based
- Model 5 was identical to Model 4 except:
  - Parameters governing spread of lengths at age around mean length at age estimated internally
- Model 6 was identical to Model 5 except:
  - Cohort-specific growth replaced by annual variability in each of the three von Bertalanffy parameters

Final assessment
Three models were included:

- Model A was identical to Model 1 from the preliminary assessment
- **Model B** was identical Model 2 from the preliminary assessment, except cohort-specific growth replaced by constant growth
- Model C: same as Model 4 from the preliminary assessment, except cohort-specific growth replaced by constant growth

2011

CIE review
Exploratory model developed prior to review, which was the same as the 2010 final model, except:

  - All sizecomp data turned on
  - Nine season × gear fisheries consolidated into five seasonal fisheries
  - Pre-1982 trawl survey data omitted
  - Mean-size-at-age data omitted
  - Fishery CPUE data omitted
  - Average input *N* set to 100 for all fisheries and the survey
  - First reference age for length-at-age relationship set at 0.833333
  - Richards growth implemented
  - Ageing bias estimated internally

- Selectivities modeled as random walks with age (constant for ages 8+)

Twelve new models were developed during the review itself:

- Model 1 was identical to the 2010 final model except:
  - Length at age 0 constrained to be positive
  - Richards growth implemented
- Model 2 was identical to the 2010 final model except length at age 0 constrained to be positive
- Model 3 was identical to the 2010 final model except:
  - All time blocks removed
  - All selectivity parameters freed except fishery selectivity at initial age
  - All selectivity parameters initialized at mid-point of bounds
- Model 4 was identical to the 2010 final model except:
  - All time blocks removed
  - Emphasis on fishery sizecomps set to 0.001
- Model 5 was identical to the 2010 final model except:
  - Richards growth implemented
  - Ageing bias estimated internally
- Model 6 was identical to Model 4 except time blocks included
- Model 7 was identical to the 2010 final model except *Q* estimated internally
- Model 8 was identical to the 2010 final model except *M* estimated internally with an informative prior
- Model 9 was identical to the 2010 final model except tail compression increased
- Model 10 was identical to the 2010 final model except mean-size-at-age data turned off
- Model 11 was the same the "exploratory" model except:
  - Pre-1982 trawl survey data included
  - All time blocks removed
  - Fishery CPUE data included (but not used for estimation)
  - Input *N* set as in the 2010 final model
  - First reference age for length-at-age relationship set at as in the 2010 final model
- Model 12 was identical to Model 11 except two iterations of survey variance and input *N* re-weighting added

Preliminary assessment
Seven models were included:

- Model 1 was identical to the 2010 final model
- Model 2a was identical to Model 1 except for use of spline-based selectivity
- Model 2b was identical to Model 1 except for omission of pre-1982 survey data
- Model 3 was identical to Model 2b except:
  - Ageing bias estimated internally rather than by trial and error
  - First reference age for length-at-age relationship (*amin*) set at 1.0
  - Standard deviation of length at age *amin* tuned iteratively to match the value predicted externally by regression
- Model 4 was identical to Model 2b except:
  - All agecomp data turned off
  - All sizecomp data turned on
  - First reference age for length-at-age relationship (*amin*) set at 1.0
  - Parameters governing standard deviation of length at age estimated internally
- Model A was identical to Model 2b except:

  - First reference age in the mean length-at-age relationship was set at 1.41667, to coincide with age 1 at the time of year when the survey takes place (in Models 1-2b, first reference age was set at 0; in Models 3-4, it was set at 1)
  - Richards growth equation was used (in Models 1-4, von Bertalanffy was used)
  - Ageing bias was estimated internally (as in Model 3; in Models 1-2 and 4, ageing bias was left at the values specified in the 2009 and 2010 assessments—although this was irrelevant for Model 4, which did not attempt to fit the age data)
  - σ_R was estimated internally (in Models 1-4, this parameter was left at the value used in the 2009 and 2010 assessments)
  - Fishery selectivity curves were defined for each of the five seasons, but were not stratified by gear type (in Models 1-4, seasons 1-2 and 4-5 were lumped into a pair of "super" seasons, and fisheries were also *gear*-specific)
  - Selectivity curve for the fishery that came closest to being asymptotic on its own (in this case, the season 4 fishery) was forced to be asymptotic by fixing both *width_of_peak_region* and *final_selectivity* at a value of 10.0 and *descending_width* at a value of 0.0 (in Models 1-4, the Jan-Apr trawl fishery was forced to exhibit asymptotic selectivity)
  - Survey selectivity was modeled as a function of length (in Models 1-4, survey selectivity was modeled as a function of age)
  - Number of estimated year class strengths in the initial numbers-at-age vector was set at 10 (in Models 1-4, only 3 elements were estimated)
  - The following parameters were tuned iteratively:
    - Standard deviation of length at the first reference age was tuned iteratively to match the value from the regression of standard deviation against length at age presented in the final assessment for 2010 (as in Model 3; in Models 1-2, this parameter was set at 0.01 because the first reference age was 0; in Model 4, it was estimated internally)
    - Base value for *Q* was tuned iteratively to set the average of the product of *Q* and survey selectivity across the 60-81 cm range equal to 0.47, corresponding to the Nichol et al. (2007) estimate (in Models 1-4, the base value was left at the value used in the 2009 and 2010 assessments)
    - *Q* was given annual (but not random walk) *dev*s, with σdev tuned iteratively to set the root-mean-squared-standardized-residual of the survey abundance estimates equal to 1.0 (in Models 1-4, *Q* was constant)
    - All estimated selectivity parameters were given annual random walk *dev*s with *σdev* tuned iteratively to match the standard deviation of the estimated *dev*s, except that the *dev*s for any selectivity parameter with a tuned σdev less than 0.005 were removed (in Models 1-4, certain fishery selectivity parameters were estimated independently in pre-specified blocks of years; the only time-varying selectivity parameter for the survey was *ascending_width*, which had annual—but not random walk—*dev*s with *σdev* set at the value used in the 2009 and 2010 assessments)
    - Age composition "variance adjustment" multiplier was tuned iteratively to set the mean effective sample size equal to the mean input sample size (in Models 1-4, this multiplier was fixed at 1.0)
- Model 5 was identical to Model A except that it used the time series of selectivity parameters estimated (using random walk *dev*s) in Model A to identify appropriate breakpoints for defining block-specific selectivity parameters

Other model features explored but not included in any of the above:

- Annually varying Brody growth parameter
- Annually varying length at the first reference age
- Internal estimation of standard deviation of length at age

- Ordinary (not random walk) *dev*s for annually varying selectivity parameters
- One selectivity parameter for each age (up to some age-plus group) and fleet, either with ordinary or random walk *dev*s or constant
- Not forcing any fleet to exhibit asymptotic selectivity
- Internal estimation of survey catchability
- Iterative re-weighting of size composition likelihood components
- Internal estimation of the natural mortality rate
- Changing the SS parameter *comp_tail_compression* (the tails of each age or size composition record are compressed until the specified amount was reached; sometimes referred to as "dynamic binning")
- Changing the SS parameter *add_to_comp* (this amount was added to each element of each age or size composition vector—both observed and expected, which avoids taking the logarithm of zero and may also have robustness-related attributes)
- Internal estimation of ageing error variances

Final assessment
Five models were included:

- Model 1 was identical to the 2010 final model (and Model 1 from the preliminary assessment)
- Model 2b was identical to Model 2b from the preliminary assessment
- Model 3 was identical to Model 3 from the preliminary assessment
- Model 4 was identical to Model 4 from the preliminary assessment
- **Model 3b** was identical to Model 3 from the preliminary assessment except:
  - Parameters governing variability in length at age estimated internally
  - All sizecomp data turned on
  - Mean-size-at-age data turned off

2012

Preliminary assessment
Five primary and nine secondary models were included (names of secondary models have decimal points; full results presented for primary models only):

- Model 1 was identical to the 2011 final model
  - Model 1.1: Same as Model 1, except survey catchability estimated internally
  - Model 1.2: Same as Model 1, except ageing bias parameters fixed at GOA values
  - Model 1.3 Same as Model 1, except with revised weight-length representation
- Model 2 was identical to Model 1, except survey catchability re-tuned to match archival tag data
- Model 3 was identical to Model 1, except new fishery selectivity period beginning in 2008
- Model 4 was identical to Model 4 from the final assessment for 2011
  - Model Pre5.1: Same as Model 1.3, except for three minor changes to the data file
  - Model Pre5.2: Same as Model Pre5.1, except ages 1-10 in the initial vector estimated individually
  - Model Pre5.3: Same as Model Pre5.2, except Richards growth curve used
  - Model Pre5.4: Same as Model Pre5.3, except σ for recruitment *dev*s estimated internally as a free parameter
  - Model Pre5.5: Same as Model Pre5.4, except survey selectivity modeled as a function of length
  - Model Pre5.6: Same as Model Pre5.5, except fisheries defined by season only (not season-and-gear)
- Model 5: Same as Model Pre5.6, except four quantities estimated iteratively:
  - Survey catchability tuned to match archival tag data

  - Agecomp *N* tuned to set the mean ratio of effective *N* to input *N* equal to 1
  - Selectivity *dev* sigmas tuned according to the new method described in Annex 2.1.1 of the SAFE chapter

Final assessment
Four models were included:

- **Model 1** was identical to the 2011 final model
- Model 2 was identical to Model 1 except *Q* was estimated freely
- Model 3 was identical to Model 1 except:
  - Ageing bias was not estimated
  - All agecomp data are ignored
- Model 4 was identical to Model 5 from the the preliminary assessment

2013

Preliminary assessment
Four models were included:

- Model 1 was identical to the 2012 final model
- Model 2 was identical to Model 4 from the final 2012 assessment except *Q* estimated internally using a non-constraining uniform prior distribution
- Model 3 was identical to Model 4 from the final 2012 assessment except:
  - *Q* estimated internally using a prior distribution based on archival tagging data
  - Survey selectivity forced asymptotic
- Model 4 was identical to Model 4 from the final 2012 assessment

Final assessment
Due to a protracted government shutdown during the peak of the final assessment season, only one model was presented:

- The **unnumbered model** was identical to the 2012 final model

2014

Preliminary assessment
Six models were included:

- Model 1 was identical to the 2011-2013 final models
- Model 2 was the identical to Model 5 from the 2012 preliminary assessment (also identical to Model 4 in the 2012 final assessment and the 2013 preliminary assessment)
- Model 3 was identical to Model 2, except that survey catchability *Q* was fixed at 1.0
- Model 4 was identical to Model 2, except that *Q* was estimated with a uniform prior and with an internally estimated constant added to each year's log-scale survey abundance standard deviation
- Model 5 was identical to Model 2, except that Q was fixed at 1.0, survey selectivity was forced to be asymptotic, and the natural mortality rate *M* was estimated freely
- Model 6 was a substantially new model, with the following differences from Model 1:
  - Each year consisted of a single season instead of five
  - A single fishery was defined instead of nine season-and-gear-specific fisheries
  - The survey was assumed to sample age 1 fish at true age 1.5 instead of 1.41667
  - Initial abundances were estimated for the first ten age groups instead of the first three
  - The natural mortality rate was estimated internally

- The base value of survey catchability was estimated internally
- Length at age 1.5 was allowed to vary annually
- Survey catchability was allowed to vary annually
- Selectivity for both the fishery and the survey were allowed to vary annually
- Selectivity for both the fishery and survey was modeled using a random walk with respect to age (SS selectivity-at-age pattern #17) instead of the usual double normal
- Several quantities were tuned iteratively: prior distributions for selectivity parameters, catchability, and time-varying parameters other than catchability

Final assessment
Two models were included:

- **Model 1** was identical to the 2011-2013 final models
- Model 2 was identical to Model 2 from the preliminary assessment, except that the *L1* growth parameter was not allowed to vary with time

2015

Preliminary assessment
Eight models were included.

Group A:

- Model 0 was the same as Model 1 from the 2014 final assessment.
- Model 7 was the same as Model 0, but with composition data weighted by Equation TA1.8 of Francis (2011).
- Model 8 was the same as Model 0, but with Richards growth (Model 0 used von Bertalanffy growth, which is a special case of Richards growth).

Subgroup B1:

- Model 2 was the same as Model 2 from the 2014 final assessment.
- Model 3 was the same as Model 2, but with composition data weighted by tuning the mean input sample size to the harmonic mean of the effective sample size, and with time-varying survey catchability (Q) turned off.
- Model 4 was the same as Model 2, but with 20 age groups estimated in the initial numbers-at-age vector (Model 2 estimated 10 age groups in the initial numbers-at-age vector).

For all models in Subgroup B1, selectivity prior distributions and the parameters governing time-variability in recruitment, selectivity, and survey catchability were *not* re-tuned. That is, they were left at the values estimated for Model 2 during the 2014 assessment, except that time variability in survey catchability was turned off in Model 3. Note that the tuning for Model 2 was performed during the 2014 *preliminary* assessment (where it was labeled Model 6), and was not updated during the final 2014 assessment.

Subgroup B2:

- Model 5 was based on Model 2, but had a number of differences (described below), one of which was that SS runs were accepted even if the gradient was large, so long as the estimated covariance matrix of the parameters appeared reasonable.

- Model 6 was the same as Model 5, except that SS runs were accepted only if the gradient was small. In the event that a large gradient was obtained, age-specific selectivity *dev* vectors were removed, one at a time, until the large gradient disappeared.

Except for some procedures related to iterative tuning (see next set paragraph), the differences between Model 5 and Model 2 were as follow:

- Composition data were given a weight of unity if the harmonic mean of the effective sample size was greater than the mean input sample size of 300; otherwise, composition data were weighted by tuning the mean input sample size to the harmonic mean of the effective sample size.
- 20 age groups were estimated in the initial numbers-at-age vector.
- Selectivity at ages 9+ was constrained to equal selectivity at age 8 for both the fishery and the survey.
- A superfluous selectivity parameter was fixed at the mean of the prior (in Model 2, the estimate of this parameter automatically went to the mean of the prior).
- The SS feature known as "Fballpark" was turned off (this feature, which functions something like a very weak prior distribution on the fishing mortality rate in some specified year, did not appear to be providing any benefit in terms of model performance, and what little impact it had on resulting estimates was not easily justified).
- SS runs were accepted even if the gradient was large, so long as the estimated covariance matrix of the parameters appeared reasonable (i.e., all values were numeric, no values were unbelievably large).

Iterative tuning of prior distributions for selectivity parameters and time-varying catchability in Model 5 proceeded as in Model 2, except that all iterative tuning procedures were undertaken simultaneously, rather than in the phased approach used for Model 2. For time-varying recruitment and selectivity, the approach used in Model 2, which was based on the method of Thompson and Lauth (2012), was not retained in Model 5. For a univariate model, *if* the method of Thompson and Lauth (2012) returns a non-zero estimate of σ, there is reason to believe that this estimate will be unbiased. However, the method carries a fairly high probability of returning a "false negative;" that is, returning a zero estimate for σ when the true value is non-zero (Thompson in prep.). To reduce this bias toward under-parameterization, the following algorithm was used in Model 5 (Thompson in prep.; note that this is a multivariate generalization of one of the methods mentioned by Methot and Taylor (2011, *viz*., the third method listed on p. 1749)):

1. Set initial guesses for the σs.
2. Run SS.
3. Compute the covariance matrix (**V1**) of the set of *dev* vectors (e.g., element {*i*,*j*} is equal to the covariance between the subsets of the *i*th *dev* vector and the *j*th *dev* vector consisting of years that those two vectors have in common).
4. Compute the covariance matrix of the parameters (the negative inverse of the Hessian matrix).
5. Extract the part of the covariance matrix of the parameters corresponding to the *dev* vectors, using only those years common to all *dev* vectors.
6. Average the values in the matrix obtained in step 5 across years to obtain an "average" covariance matrix (**V2**).
7. Compute the vector of σs corresponding to **V1**+**V2**.
8. Return to step 2 and repeat until the σs converge.

To speed the above algorithm, the σs obtained in step 7 were sometimes substituted with values obtained by extrapolation or interpolation based on previous runs.

As noted above, the procedure used in Model 5 for iterative tuning of time-varying *Q* was the same as that used in Model 2. However, unlike Model 2, this procedure resulted in time-varying *Q* being "tuned out" in Model 5. Model 6, which also used this procedure, ended up retaining time-varying *Q*.

Final assessment
The final assessment included the same two models that were featured in the 2014 final assessment:

- **Model 11.5** was identical to the 2011-2014 final models
- Model 14.2 was identical to Model 2 from the 2014 final assessment

2016

Preliminary assessment
Six models were presented in this preliminary assessment, including Model 11.5 and five variants of Model 15.6, which was introduced in the 2015 preliminary assessment (where it was labeled "Model 6"). As described by the Joint Team Subcommittee (with subsequent re-numbering to adhere to the established model numbering convention), the full set of models consisted of the following:

- Model 11.5: BS Model 11.5, the final model from 2015
- Model 16.1: Like BS Model 15.6, but simplified as follows:
  - Weight abundance indices more heavily than sizecomps.
  - Use the simplest selectivity form that gives a reasonable fit.
  - Do not allow survey selectivity to vary with time.
  - Do not allow survey catchability to vary with time.
  - Force trawl survey selectivity to be asymptotic.
  - Do not allow strange selectivity patterns.
  - Use empirical weight at age.
- Model 16.2: Like Model 15.6, but including the IPHC longline survey data and other features, specifically:
  - Do not allow strange selectivity patterns.
  - Estimate catchability of new surveys internally with non-restrictive priors.
  - Include additional data sets to increase confidence in model results.
  - Include IPHC longline survey, with 'extra SD.'
- Model 16.3: Like Model 16.2 above, but including the NMFS longline survey instead of the IPHC longline survey.
- Model 16.4: Like Models 16.2 and 16.3 above, but including both the IPHC and NMFS longline survey data and two features not included in either Model 16.2 or 16.3, specifically:
  - Start including fishery agecomp data.
  - Use empirical weight at age.
- Model 16.5: Like Model 16.4 above, but including two features not included in Model 16.4, specifically:
  - Use either Francis or harmonic mean weighting.
  - Explore age-specific M (e.g., using Lorenzen function)."

Note that some points in the above lists of features may be somewhat duplicative, but were included by the JTS in order to address specific comments made by CIE reviewers. For Model 6, harmonic mean weighting (Punt in press) and the age-specific natural mortality function proposed by Lorenzen (1996, 2011) were used.

In the minutes of its May 2016 meeting, the JTS recognized that some of the terms used in the descriptions of its requested models were somewhat subjective and that, in making those requests, the assessment author would need to determine:

1. How to measure the "weight" assigned to abundance indices and size composition data in the same units (Model 16.1).
2. What constitutes a "reasonable fit" to the size/age composition data (Model 16.1).
3. What constitutes a "strange" selectivity pattern (Models 16.1-16.5).

These issues were addressed as follows:

1. The relative "weight" assigned to abundance indices and size composition data was determined by comparing the average spawning biomasses from three models:
    A. a model with a specified set of likelihood "emphasis" (λ) values, with each $\lambda \geq 1.0$;
    B. a model in which λ for the abundance data was set equal to 0.01 while each λ for the size composition data (fishery and survey) was left at the value specified in model A; and
    C. a model in which each λ for the size composition data (fishery and survey) was set equal to 0.01 while each λ for the abundance data was left at the value specified in model B.

    Model B was taken to represent model A with the *abundance* data "turned off," while model C was taken to represent model A with the *size composition* data "turned off" (a λ value of 0.01 rather than 0 was used for to represent "turning off" a data component because some parameters might prove inestimable if that data component were removed entirely). The abundance data in model A were determined to receive greater weight than the size composition data in that model if the absolute value of the proportional change in spawning biomass between models B and A exceeded the analogous value between models C and A. The JTS requested that this criterion (giving greater weight to abundance data than size composition data) be included in Model 16.1 only. As it turned out, the default λ value of 1.0 for all data components was sufficient to satisfy this criterion, so no adjustments to any of the λ values were necessary.
2. To focus on the ability of a particular functional form to fit the data, independent of the absolute values of the sample sizes specified for the associated multinomial distribution or λ values, weighted coefficients of determination (R^2), computed on both the raw and logit scales, were used to measure goodness of fit (the equations below are written in terms of age composition; the equations for size compositions are analogous):

$$R^2 = \sum_{y=ymin}^{ymax} \left(w_y \cdot \left(1 - \frac{\sum_{a=0}^{amax} \left(Pobs_{a,y} - Pest_{a,y} \right)^2}{\sum_{a=0}^{amax} \left(Pobs_{a,y} - Pobs_{ave,y} \right)^2} \right) \right) \quad ,$$

and

$$R^2 = \sum_{y=ymin}^{ymax} \left(w_y \cdot \left(1 - \frac{\sum_{a=0}^{amax} \left(logit\left(Pobs_{a,y} \right) - logit\left(Pest_{a,y} \right) \right)^2}{\sum_{a=0}^{amax} \left(logit\left(Pobs_{a,y} \right) - logit\left(Pobs_{ave,y} \right) \right)^2} \right) \right) \quad ,$$

where

$$w_y = \frac{n_y}{\sum_{i=ymin}^{ymax} n_i} \quad ,$$

$Pobs_{a,y}$ represents the observed proportion at age a in year y, $Pobs_{ave,y}$ represents the average (across ages) observed proportion in year y, $Pest_{a,y}$ represents the estimated proportion at age a in year y, and n_y represents the specified multinomial sample size in year y. To guard against the possibility of achieving misleadingly high R^2 values by extending the size or age range beyond the sizes or ages actually observed, the data were filtered by removing all records with $Pobs_{a,y} < 0.001$ prior to computing the R^2 values. A fit was determined to be "reasonable" if it yielded *both* an R^2 value of at least 0.99 on the raw scale *and* an R^2 value of at least 0.70 on the logit scale. As with #1 above, the JTS requested that this criterion (simplest selectivity function that gives a reasonable fit) be included in Model 16.1 only. Because the "random walk with respect to age" selectivity function gave a reasonable fit, the function was simplified in successive steps first by removing all time-variability, then by switching to a double-normal function, and finally by switching to a logistic function. The logistic function (for both the fishery and the survey) gave a reasonable fit to the fishery size composition data, the survey size composition data, and the survey age composition data, so it was retained as the final functional form.

3. In general, a "strange" selectivity pattern was defined here as one which was non-monotonic (i.e., where the signs of adjacent first differences changed), particularly if the first differences associated with sign changes were large (in absolute value), and particularly if sign changes in first differences occurred at relatively early ages. Specifically, an index of "strangeness" was defined as follows:
   A. Age-specific weighting factors P_a were calculated as the equilibrium unfished numbers at age expressed as a proportion of equilibrium unfished numbers.
   B. For each year, age-specific first differences in selectivity $\Delta_{a,y}$ were calculated.
   C. "Strangeness" was then calculated as:

$$\left(\frac{1}{ymax - ymin + 1}\right) \cdot \sum_{y=ymin}^{ymax} \sqrt{\sum_{a=2}^{amax} \left(P_a \cdot \left(\left(sign(\Delta_{a,y}) \neq sign(\Delta_{a-1,y})\right) \cdot (\Delta_a)^2\right)\right)} \quad ,$$

   where the expression $sign(\Delta_{a,y}) \neq sign(\Delta_{a-1,y})$ returned a value of 1 if the sign of $\Delta_{a,y}$ differed from the sign of $\Delta_{a-1,y}$ and a value of 0 otherwise. This index attains a minimum of 0 when selectivity is constant across age (or varies monotonically) and a maximum of 1 if selectivity alternates between values of 0 and 1 at all pairs of adjacent ages.

A time series of selectivity at age (for a given fleet) was determined to be "strange" if the index described above exceeded a value of 0.05. If a model produced a "strange" selectivity pattern, the standard deviations of the prior distributions for the selectivity parameters and the standard deviations of any selectivity *dev* vectors were decreased proportionally relative to the values estimated for Model 15.6 in last year's assessment until the threshold value of 0.05 was satisfied.

Final assessment

The final assessment included Models 11.5 and Model 16.1 from the preliminary assessment, and four variants of Model 16.1:

- **Model 16.6**: Model 16.1 without empirical weight at age
- Model 16.7: Model 16.1 without empirical weight at age and including the NMFS LL survey
- Model 16.8: Model 16.1 with time-varying survey selectivity

- Model 16.9: Model 16.1 with time-varying fishery selectivity

Empirical weight at age was first explored for the EBS Pacific cod stock in this year's preliminary assessment. Some key similarities and differences between the models *without* empirical weight at age (Models 11.5, 16.6, and 16.7) and those *with* empirical weight at age (Models 16.1, 16.8, and 16.9) are as follow: All six models estimate (internally) a time-invariant relationship between mean length and age, which is used for fitting the size composition data, among other things. Models *without* empirical weight at age use externally estimated parameters describing a weight-at-length relationship (seasonally varying but constant across years in the case of Model 11.5, annually varying in the cases of Models 16.6 and 16.7) in combination with the internally estimated length-at-age relationship to compute weight at age. Models *with* empirical weight at age bypass the link between weight at age and length at age, and instead use externally estimated, time-varying schedules of weight at age directly.

In Model 16.7, logistic selectivity was assumed for the NMFS longline survey, just as for fishery and trawl survey selectivity.

Time-varying selectivity in Models 16.8 and 16.9 was implemented in the form of annual deviations from a base selectivity function. The "sigma" parameters governing the extent to which selectivity *dev*s can vary from zero (specified as inputs to the model, not estimated internally) in Models 16.8 and 16.9 were set at large values to maximize those models' ability to fit the data, essentially treating each *dev* as an unconstrained parameter. Values of the sigma parameters were increased across several trial runs of each model until the resulting estimate of 2016 spawning biomass did not change (to 3 significant digits) with further increases.

2017

Preliminary assessment
The Joint Team Subcommittee (with subsequent re-numbering to adhere to the established model numbering convention) requested the following six models, all of which were included:

- Model 16.6 (last year's final model), after translating from SS V3.24u to V3.30.
- Model 17.1: Same as Model 16.6, but with the following features added:
    1. Adjust timing of the fishery and survey in SS.
    2. Do not use currently available fishery agecomp data, but do add new fishery agecomps.
    3. Switch to haul-based input sample size and catch-weighted sizecomp data.
    4. Develop a prior distribution for natural mortality based on previous estimates.
    5. Switch to age-based, flat-topped, double normal selectivity.
    6. Allow random time variability in selectivity, with σs fixed at the restricted MLEs.
- Model 17.2: Same as Model 17.1, but with the following features added:
    1. Use harmonic mean weighting of composition data.
    2. Allow time-varying selectivity for the fishery but not the survey.
- Model 17.3: Same as Model 17.1, but with the following features added:
    1. Use harmonic mean weighting of composition data.
    2. Estimate survey index standard error internally ('extra SD' option in SS).
- Model 17.4: Same as Model 17.1, but with the following feature added:
    1. Use Francis weighting.
- Model 17.5: Same as Model 17.1, but with the following feature added:
    1. Give less weight to fishery comps than survey comps, less to sizecomps than agecomps."

In addition to the above six models, a seventh model, designated Model 17.6, was also included in the preliminary assessment. It was similar to Model 17.2, except that it includes annually time-varying length at age 1.5, trawl survey catchability, and survey selectivity.

Final assessment
The SSC requested the following six models, of which the first five were included in the preliminary assessment:

- **Model 16.6**
- Model 17.1
- Model 17.2
- Model 17.3
- Model 17.6
- Model 17.7, which was the same as Model 17.6, but with all sizecomp and agecomp multipliers capped at a value of 1.0.

2018

Preliminary assessment
A total of 15 alternative models were presented in addition to the base model. These differed either in terms of model structure, data used, or both. Two of the alternative models were presented in the 2016 assessment, and the other 13 were new (8 of which constituted minor changes from the base model and 5 of which constituted major changes). The list of alternative models was as follows (the distinction between "minor" and "major" changes, along with the model numbering convention, conform to Option A in the SAFE chapter guidelines; the symbols *Q*, *K*, *Lmin*, and *M* represent catchability, the Brody growth coefficient, length at age 1.5, and the instantaneous natural mortality rate, respectively).

Models constituting minor changes from the base model
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 EBS survey data for 1987-2017.
- Model 16.6b
  - Structure difference: Estimate a separate *Q* for the 1982-1986 EBS survey.
  - Data difference: Switch to expanded EBS survey data for 1987-2017.

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 (as z-scores).
- Model 16.6d
  - Structure difference: Estimate a parameter linking *Lmin* to bottom temperature.
  - Data difference: Include the bottom temperature time series (as z-scores).

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 (as z-scores).

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 (as z-scores).

<u>Models constituting major changes from the base model</u>
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 for the fishery and survey
    - Allow randomly time-varying fishery selectivity
    - Use harmonic mean weighting of composition data
  - Data differences:
    - Set multinomial input sample size equal to number of sampled hauls
    - Include fishery age composition data (data for 2011 and 2012 new this year)
- 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

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.
- 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 (as z-scores).
        - Include benthic forager biomass index (as z-scores).
        - Include seabird breeding success index (as z-scores).

Models incorporating an environmental covariate of the instantaneous natural mortality rate:

- Model 18.3
    - Structure difference: Estimate a parameter linking *M* to fish condition
    - Data difference: Include fish condition time series (as z-scores)
- 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 (as z-scores)

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.
    - Data differences:
        - Include NBS survey data.
        - Treat EBS and NBS as separate areas.
        - Include the North Pacific Index time series (as z-scores).
        - Include the nutrition deficit time series (as z-scores).

Models 17.2 and 17.6 were requested by the Team and SSC, Model 16.6a was requested by the Team, Model 16.6b was requested by the SSC, and several of the other models were requested by various AFSC scientists.

Final assessment
The following eight models were included in the final assessment (the first six were requested by the SSC, and the last two were added by the author in an attempt to address some behaviors of Models 16.6k and 18.6 that might not have been anticipated by the SSC):

- Model 16.6: The current base model, exhibiting the following features:
    - One fishery, one gear type, one season per year.
    - Input sample sizes average 300, with season×gear catch-weighted sizecomps.
    - 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.
- **Model 16.6i**: Same as Model 16.6, but with the following features added:
  - Include EBS survey strata 82 and 90 (i.e., use the 1987-2018 expanded EBS survey area).
  - Sum the EBS survey and NBS survey data sets into a single survey.
- Model 16.6j: Same as Model 16.6i, but with the following feature added:
  - Allow randomly time-varying catchability for the combined EBS+NBS survey.
- Model 16.6k: Same as Model 16.6, but with the following feature added:
  - Include EBS survey strata 82 and 90 (i.e., use the 1987-2018 expanded EBS survey area).
  - Include the NBS survey as a separate data set.
  - Allow randomly time-varying catchability for the EBS survey.
  - Estimate NBS survey catchability internally.
  - Allow randomly time-varying catchability for the NBS survey.
- Model 17.2: Same as Model 16.6, but with the following features added:
  - Include fishery agecomps.
  - Include a prior distribution for natural mortality based on previous estimates.
  - Switch to age-based, flat-topped, double normal selectivity.
  - Allow randomly time-varying fishery selectivity, with σs fixed at the restricted MLEs.
  - Switch to haul-based input sample size and week×gear×area catch-weighted sizecomps.
  - Use harmonic mean weighting of composition data.
- Model 18.6: Same as Model 17.2, but with the following features added:
  - Include EBS survey strata 82 and 90 (i.e., use the 1987-2018 expanded EBS survey area).
  - Include the NBS survey as a separate data set.
  - Allow randomly time-varying catchability for the EBS survey.
  - Estimate NBS survey catchability internally.
  - Allow randomly time-varying catchability for the NBS survey.
- Model 18.7: Same as Model 16.6k, but with the following changes:
  - Instead of estimating EBS survey catchability internally, set it equal to the average EBS proportion of combined EBS+NBS survey abundance.
  - Instead of estimating NBS survey catchability internally, set it equal to the average NBS proportion of combined EBS+NBS survey abundance.
- Model 18.8: Same as Model 18.6, but with the following changes:
  - Instead of estimating EBS survey catchability internally, set it equal to the average EBS proportion of combined EBS+NBS survey abundance.
  - Instead of estimating NBS survey catchability internally, set it equal to the average NBS proportion of combined EBS+NBS survey abundance.

APPENDIX 2.4: SUPPLEMENTAL CATCH DATA

NMFS Alaska Region has made substantial progress in developing a database documenting many of the removals of FMP species that have resulted from activities outside of fisheries prosecuted under the BSAI Groundfish FMP, including removals resulting from scientific research, subsistence fishing, personal use, recreational fishing, exempted fishing permit activities, and commercial fisheries other than those managed under the BSAI groundfish FMP. Estimates for EBS Pacific cod from this dataset are shown in Table 2.4.1.

Although many sources of removal are documented in Table 2.4.1, the time series is highly incomplete for many of these. Cells shaded gray represent data contained in the NMFS database. Other entries represent extrapolations for years in which the respective activity was known or presumed to have taken place, where each extrapolated value consists of the time series average of the official data for the corresponding activity. In the case of surveys, years with missing values were identified from the literature or by contacting individuals knowledgeable about the survey (the NMFS database contains names of contact persons for most activities); in the case of fisheries, it was assumed that the activity occurred every year.

In the 2012 analysis (Attachment 2.4 of Thompson and Lauth 2012), the supplemental catch data were used to provide estimates of potential impacts of these data in the event that they were included in the catch time series used in the assessment model. The results of that analysis indicated that $F_{40\%}$ increased by about 0.01 and that the one-year-ahead catch corresponding to harvesting at $F_{40\%}$ decreased by about 4,000 t. Note that this is a separate issue from the effects of taking other removals "off the top" when specifying an ABC for the groundfish fishery; the former accounts for the impact on reference points, while the latter accounts for the fact that "other" removals will continue to occur.

The average of the total removals in Table 2.4.1 for the last three complete years (2016-2018) is 6,486 t.

It should be emphasized that these calculations are provided purely for purposes of comparison and discussion, as NMFS and the Council continue to refine policy pertaining to treatment of removals from sources other than the directed groundfish fishery.

Reference

Thompson, G. G., and R. R. Lauth. 2012. Assessment of the Pacific cod stock in the Eastern Bering Sea and Aleutian Islands Area. *In* Plan Team for the Groundfish Fisheries of the Bering Sea/Aleutian Islands (compiler), Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions, p. 245-544. North Pacific Fishery Management Council, 605 W. 4th Avenue Suite 306, Anchorage, AK 99501

Table 2.4.1—Total removals of Pacific cod (t) from activities not related to directed fishing. Cells shaded gray represent data contained in the NMFS database. Other entries represent extrapolations for years in which the respective activity was known or presumed to have taken place.

Activity	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AFSC Annual Longline Survey			28	28	28	28	28	28	28	28	28	28	28	28
AI Bottom Trawl Survey				2			2			2				
Bait for Crab Fishery	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496
Bering Sea Slope Survey			1		1	1			1			1		
EBS Bottom Trawl Survey	36	36	36	36	36	36	36	36	36	36	36	36	36	36
EBS Acoustic Trawl Survey			0			0			0			0		
GOA Bottom Trawl Survey								0			0			0
IPHC Annual Longline Survey														
Large-Mesh Trawl Survey														1
NBS Bottom Trawl Survey			5		5	5			5			5		
Pollock EFP 11-01														
Pribilof Islands Crab Survey														
Sport fishery	2	2	2	2	2	2	2	2	2	2	2	2	2	2
St. Mathews Crab Survey														
Subsistence Fishery	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Summer EBS Survey w/ Russia														

Activity	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AFSC Annual Longline Survey	28	28	28	28			38		30		36		30	
AI Bottom Trawl Survey	2			2			2			2		2		2
Bait for Crab Fishery	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496	6496
Bering Sea Slope Survey	1									1		1		1
EBS Bottom Trawl Survey	36	36	36	36	36	36	36	36	36	36	36	36	36	36
EBS Acoustic Trawl Survey	0			0		0	0		0	0		0		0
GOA Bottom Trawl Survey			0			0			0		0		0	
IPHC Annual Longline Survey								36	36	36	36	36	36	36
Large-Mesh Trawl Survey	1			1	1				1	1			1	1
NBS Bottom Trawl Survey	5													
Pollock EFP 11-01														
Pribilof Islands Crab Survey													5	
Sport fishery	2	2	2	2	2	2	2	2	2	2	2	2	2	2
St. Mathews Crab Survey					6			6			6			6
Subsistence Fishery	2	0	2	5	2	2	2	1	0	2	2	2	2	2
Summer EBS Survey w/ Russia				0								0		0

Activity	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
AFSC Annual Longline Survey	23		25		20		24		27		32		25	
AI Bottom Trawl Survey		2				2		1		2		2		3
Bait for Crab Fishery	6496	6496	6496	6496	6496	1737	4544	6697	6618	9452	10233	8481	5406	5293
Bering Sea Slope Survey				1		2		1	1	1		1		
EBS Bottom Trawl Survey	36	36	36	36	36	38	42	52	33	39	39	36	24	19
EBS Acoustic Trawl Survey		0	0	0	0	0		0		0		0		0
GOA Bottom Trawl Survey	0		0		0		0		0		0		0	0
IPHC Annual Longline Survey	36	36	36	36	36	32	20	17	29	52	59	47	37	34
Large-Mesh Trawl Survey	1	1	1	1	1	1	1	2	1	1	1	1	1	0
NBS Bottom Trawl Survey						1							9	6
Pollock EFP 11-01							11	307						
Pribilof Islands Crab Survey	5			5			5					5		5
Sport fishery	2	2	2	2	2	2	2	2	2	2	2	2	2	4
St. Mathews Crab Survey			6			9			6		6	6	5	3
Subsistence Fishery	2	2	2	2	2	2	2	2	2	2	2		2	2
Summer EBS Survey w/ Russia			0	0	0	0		0						

APPENDIX 2.5: PARALLEL RESULTS FOR THE "HARVEST RECOMMENDATIONS" SECTION, BASED ON MODEL 16.6i

The results presented in the "Harvest Recommendations" section of the main text are based on a particular weighted average of the ensemble consisting of Models 19.7-19.15. Because the structure of this ensemble average differs substantively from Model 16.6i (the current base model), a set of parallel results for the items in that section, based on Model 16.6i, is provided here.

Amendment 56 Reference Points
Model 16.6i's estimates of $B_{100\%}$, $B_{40\%}$, and $B_{35\%}$ are 691,900 t, 276,760 t, and 242,165 t, respectively.

Specification of OFL and Maximum Permissible ABC
Given the assumptions of Scenario 1 (below), female spawning biomass for 2020 and 2021 is estimated by Model 16.6i to be below the $B_{40\%}$ value of 276,760 t, thereby placing Pacific cod in sub-tier "b" of Tier 3 for both 2020 and 2021. Given this, Model 16.6i estimates OFL, maximum permissible ABC, and the associated fishing mortality rates for 2020 and 2021 as follows:

Year	Overfishing Level	Maximum Permissible ABC
2020	OFL = 149,545 t	maxABC = 125,431 t
2021	OFL = 113,925 t	maxABC = 95,283 t
2020	*FOFL* = 0.32	*maxFABC* = 0.26
2021	*FOFL* = 0.28	*maxFABC* = 0.23

The age 0+ biomass projections for 2020 and 2021 from Model 16.6i are 734,205 t and 777,914 t. For comparison, the age 3+ biomass projections for 2020 and 2021 from Model 16.6i are 649,783 t and 735,153 t.

Standard Harvest Scenarios, Projection Methodology, and Projection Results
The standard harvest scenarios and projection methodology were the same as described in the main text. Projections corresponding to the standard harvest scenarios are shown for Model 16.6i in Table 2.5.1.

Status Determination
Methodology for status determination is as described in the main text. The status with respect to overfishing is independent of model choice for next year's specifications, as it depends entirely on the previous year's catch and OFL.

Based on the criteria described in the main text and the results shown in Table 2.5.1, the stock is not overfished and is not approaching an overfished condition.

Table 2.5.1. Results of the 7 standard harvest scenarios for Model 16.6i, the current base model.

	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5		Scenario 6		Scenario 7	
Quantity	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
B2020	244.8	22.4	244.8	22.4	244.8	22.4	244.8	22.4	244.8	22.4	244.8	22.4	244.8	22.4
B2021	220.9	12.5	220.9	12.5	189.5	14.5	247.3	16.5	273.5	21.4	210.9	11.3	220.9	21.4
B2022	227.6	11.3	227.6	11.3	178.9	12.0	266.8	14.5	315.7	21.3	214.9	10.7	220.0	13.3
B2023	264.6	14.3	264.6	14.3	206.3	14.1	312.4	16.7	383.6	23.6	250.5	13.7	252.7	14.1
B2024	290.9	15.5	290.9	15.5	223.1	13.7	359.7	19.9	462.9	27.0	273.0	14.7	273.5	14.6
B2025	296.9	16.0	296.9	16.0	223.1	11.4	390.6	20.9	530.3	28.7	272.2	14.6	272.2	14.7
B2026	293.8	15.8	293.8	15.8	217.9	9.9	406.1	20.7	579.2	29.0	265.0	14.7	264.9	14.7
B2027	288.6	15.6	288.6	15.6	213.2	9.3	412.8	20.6	613.2	29.0	259.7	14.5	259.6	14.6
B2028	284.2	15.4	284.2	15.4	210.1	9.2	415.4	20.9	636.7	29.5	257.1	14.3	257.1	14.3
B2029	281.1	15.3	281.1	15.3	208.3	9.3	416.2	21.3	653.2	30.4	256.2	14.1	256.2	14.1
B2030	279.1	15.2	279.1	15.2	207.4	9.3	416.2	21.6	664.7	31.6	256.0	14.0	256.0	14.0
B2031	277.9	15.2	277.9	15.2	206.9	9.3	415.9	22.0	672.8	32.8	256.0	14.0	256.0	14.0
F2020	0.259	0.040	0.259	0.040	0.450	0.000	0.121	0.018	0.000	0.000	0.316	0.050	0.259	0.025
F2021	0.232	0.025	0.232	0.025	0.450	0.000	0.122	0.015	0.000	0.000	0.270	0.027	0.283	0.045
F2022	0.240	0.021	0.240	0.021	0.450	0.000	0.133	0.013	0.000	0.000	0.275	0.023	0.282	0.031
F2023	0.281	0.024	0.281	0.024	0.450	0.000	0.138	0.006	0.000	0.000	0.324	0.028	0.327	0.030
F2024	0.296	0.015	0.296	0.015	0.450	0.000	0.138	0.006	0.000	0.000	0.355	0.026	0.355	0.026
F2025	0.296	0.015	0.296	0.015	0.450	0.000	0.138	0.006	0.000	0.000	0.354	0.020	0.354	0.020
F2026	0.296	0.015	0.296	0.015	0.450	0.000	0.138	0.006	0.000	0.000	0.344	0.017	0.344	0.017
F2027	0.296	0.015	0.296	0.015	0.450	0.000	0.138	0.006	0.000	0.000	0.336	0.016	0.336	0.016
F2028	0.296	0.015	0.296	0.015	0.450	0.000	0.138	0.006	0.000	0.000	0.333	0.017	0.333	0.017
F2029	0.296	0.015	0.296	0.015	0.450	0.000	0.138	0.006	0.000	0.000	0.332	0.017	0.332	0.017
F2030	0.296	0.015	0.296	0.015	0.450	0.000	0.138	0.006	0.000	0.000	0.331	0.017	0.331	0.017
F2031	0.296	0.015	0.296	0.015	0.450	0.000	0.138	0.006	0.000	0.000	0.331	0.017	0.331	0.017
C2020	125.4	26.5	125.4	26.5	201.4	17.0	62.3	13.5	0.0	0.0	149.5	31.3	125.4	0.0
C2021	95.3	11.8	95.3	11.8	145.1	10.4	59.0	9.3	0.0	0.0	104.1	11.5	113.9	24.9
C2022	106.5	10.6	106.5	10.6	149.8	10.3	71.0	8.9	0.0	0.0	114.6	10.8	119.6	16.1
C2023	168.2	18.7	168.2	18.7	207.1	15.7	100.2	7.1	0.0	0.0	182.7	20.1	185.2	21.8
C2024	186.3	10.1	186.3	10.1	212.0	12.6	112.1	7.2	0.0	0.0	206.5	16.1	207.0	16.2
C2025	182.7	8.6	182.7	8.6	204.0	9.5	116.6	6.3	0.0	0.0	197.6	9.8	197.5	9.7
C2026	178.4	7.8	178.4	7.8	197.7	8.3	118.7	5.7	0.0	0.0	185.9	7.9	185.7	7.9
C2027	175.1	7.5	175.1	7.5	193.7	8.0	119.6	5.3	0.0	0.0	179.0	7.7	178.9	7.7
C2028	172.7	7.4	172.7	7.4	191.5	8.0	120.0	5.2	0.0	0.0	176.0	7.7	176.0	7.7
C2029	171.2	7.4	171.2	7.4	190.3	8.0	120.0	5.1	0.0	0.0	175.1	7.8	175.0	7.8
C2030	170.2	7.4	170.2	7.4	189.6	8.1	120.0	5.1	0.0	0.0	174.9	7.8	174.9	7.8
C2031	169.7	7.4	169.7	7.4	189.3	8.1	119.9	5.1	0.0	0.0	175.0	7.8	175.0	7.8

APPENDIX 2.6: RISK TABLE INFORMATION FOR "ENVIRONMENTAL/ECOSYSTEM CONSIDERATIONS"

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The winter of 2018/2019 began with near-average accumulation of sea ice in the Bering Sea during December and January, but warm, moist winds from the southwest persisted throughout February and eroded sea ice to extremely low levels (only 2018 was lower). Trends in sea ice and resulting extent of the cold pool were similar between 2018 and 2019; ecosystem indicators from 2018 may provide insights into 2019 conditions for Pacific cod. In 2018, warm water temperatures and salinity north of St. Lawrence Island may have contributed to the northward movement of Pacific cod into the northern Bering Sea (see Eisner et al. EBS ESR). With warm conditions persisting through winter 2018/2019, it is possible that Pacific cod remained in the northern Bering Sea or were able to move northward early in the spring/summer of 2019, thereby continuing their expanded range and habitat use into the northern Bering Sea.

The 2018 year class was sampled using surface trawls in the SEBS and NBS as age-0 in late summer 2018. These fish represent pre-settlement fish and their correlation with year class strength is unknown. However, age-0 fish in the SEBS were large (based on length) (Siddon et al. EBS ESR) and age-0 fish in the NBS had higher total energy in 2018 compared to 2017 (Sewall et al. EBS ESR). In 2019, the condition of adult Pacific cod over the southeastern and northern Bering Sea shelves was above average (based on positive length-weight residuals) and continued an upward trend that began in 2017 for both SEBS and NBS (Laman et al. EBS ESR). These results suggest that both juvenile and adult Pacific cod were able to find sufficient prey resources.

Prey: Direct information available on prey dynamics for the 2018 and 2019 year classes indicates low abundances of euphausiids in both 2018 (see Ressler 2018 EBS ESR) and 2019 (see Kimmel et al 2019 EBS ESR). In 2019, euphausiid abundances were very low along the southern shelf in spring, but numbers increased during fall; abundances remained low (to zero) across the NBS region. Indirect information on prey resources for Pacific cod is discussed below under 'Competitors'.

Predators: Pacific cod are cannibalistic and rates of cannibalism might be expected to increase as the abundance of older, larger fish increases concurrent with increases in juvenile abundance. However, a spatial mismatch may mediate that stressor; based on bottom trawl survey results, large increases of small fish occurred over the SEBS while larger fish occurred over the NBS (confirm with Lyle). Other predators of Pacific cod include northern fur seals, Steller sea lions, various whale species, and tufted puffin. At this time there are no indicators that suggest these populations are increasing in the eastern Bering Sea (although note that the Bogoslof Island population of northern fur seals in increasing while the Pribilof Islands populations are decreasing; see C. Kuhn 'Noteworthy' in the 2019 EBS ESR).

Competitors for Pacific cod prey resources may include gray whales (e.g., benthic amphipods). Since January 2019, a total of 213 gray whale strandings have been reported, with 49 of those within Alaska. An Unusual Mortality Event was declared for gray whales in 2019 (see K. Savage 'Noteworthy' in the 2019 Eastern Bering Sea Ecosystem Status Report for more information). Gray whale life history includes annual migrations of up to 20,000 km from summer feeding grounds in the northern Bering and Chukchi seas to southern Baja California to mate and calve. Preliminary findings in several of the whales shows evidence of emaciation; benthic prey (primarily amphipods) in the Bering, Chukchi, and Beaufort seas are a main prey source. The 2019 strandings may reflect 2018 conditions (prior to their migration) of poor feeding or competition for limited prey resources and/or indicate thresholds in the carrying capacity of the northern Bering Sea ecosystem coincident with northward movement of Pacific cod into the region.

Similarly, a widespread die-off event of short-tailed shearwaters that began in the SEBS in June 2019 extended into the NBS and Chukchi Sea in August. These events may also reflect 2018 conditions as shearwaters feed in the Bering Sea in summer before migrating to the southern hemisphere for breeding during the winter. Most sampled birds showed signs of emaciation; shearwaters are planktivorous birds and feed on euphausiids.

While historical recruitment trends between Pacific cod and walleye pollock have mirrored each other, suggesting the species respond similarly to environmental conditions, the timeseries appear to decouple after approximately 2010 and may indicate broad-scale transitions in the southeastern Bering Sea ecosystem (e.g., from pelagic- to benthic-dominated production) (Figure 1). The mechanisms driving early life history survival versus recruitment success of Pacific cod and walleye pollock may differ based on pelagic versus benthic habitat associations (e.g., prey availability). The decoupling of abundance timeseries after 2010 suggests a shift (or greater disparity) between drivers of survival in these two populations.

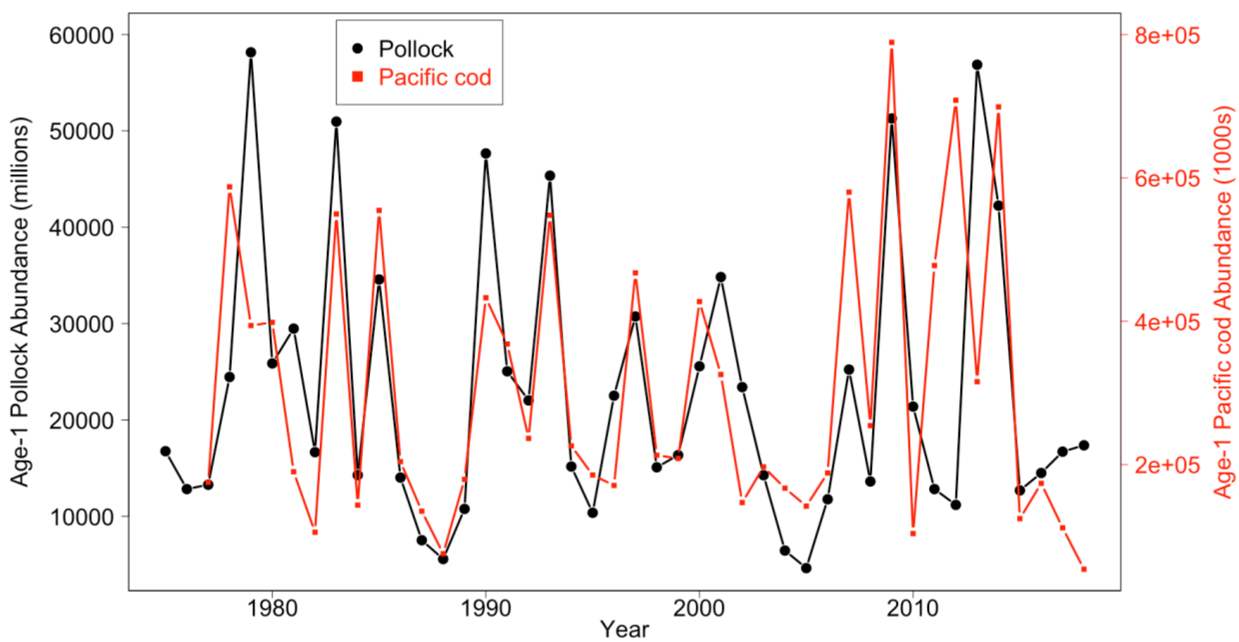

Figure 1. Plot of age-1 abundance for walleye pollock (black; in millions) and Pacific cod (red; in 1000s) as estimated in the 2018 stock assessments (Ianelli et al. 2018; Thompson 2018).