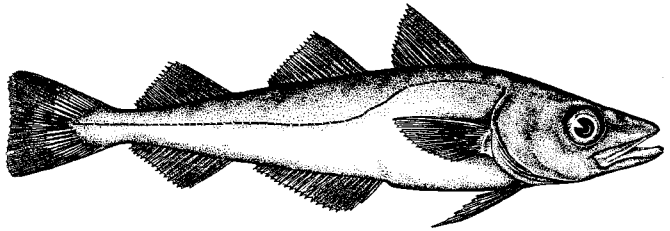
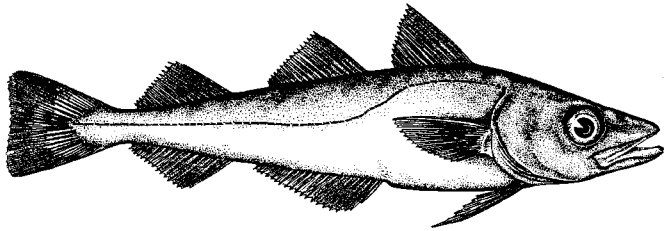


# Gulf of Alaska pollock
# **Overview: Surveys**

- 2016 is an “off” year for surveys in the GOA. No NMFS bottom trawl survey, no summer acoustic survey, no recruitment alliance work.

- 2016 Shelikof Strait acoustic survey biomass is 665,059 t, down 21% from 2015, but in line with model projections.

- The 2016 biomass estimate for pollock for the ADFG crab/groundfish survey was 18,470 t, down by 56% from 2015, already a large decline from the previous year. This is the lowest biomass estimate for the ADFG crab/groundfish time series.



# Gulf of Alaska pollock
# **Overview: Assessment**

- Minor changes to the assessment model.
  - Used RE model for fishery weight at age projection.
  - Used delta-GLM indices for the ADFG survey.

- GOA pollock is in Tier 3a.

- The authors' 2017 ABC recommendation is 203,769 t, which is a decrease of 20% from the 2016 ABC. The 2018 ABC should be about 50,000 t lower.

- Potential effects of recent temperature anomalies: strong decline in pollock weight at age, a lack of recruitment to the stock for three years, "wonky" surveys.

- Declines in ABC over the next few years should be expected, particularly if low recruitment continues.


# Plan Team and SSC comments

- *The SSC in its December 2015 minutes continued to recommend that a standard naming convention be used for different models presented in assessments.*

  In this assessment, we used the naming convention recommended by the SSC, and used option C in the SAFE guidelines for naming model runs.

- *The GOA plan team recommended in its November 2015 minutes further exploration, documentation and vetting of the net selectivity corrections for the Shelikof Strait acoustic survey.*

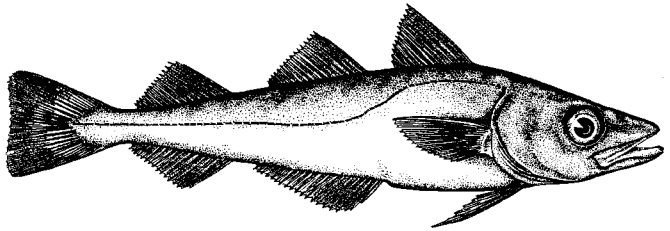
  In this assessment, we brought forward a model run with the net-selectivity correction applied retrospectively.

- *The GOA plan team recommended in its November 2015 minutes further exploration of hypotheses regarding temperature and fish distribution that may relate to the low abundance index in the ADFG trawl survey*

  We developed a delta-GLM model for the ADFG survey, and included it in the base model. The abundance of pollock in the ADFG survey showed a further substantial decline in 2016.

- *The GOA plan team recommended in its November 2015 minutes a re-evaluation of the form of the selectivity curve used for the summer acoustic trawl survey in the next assessment.*

  We explored dome-shaped double logistic models for selectivity for the summer acoustic survey using the two years of age composition data available for this survey. We concluded that additional data were needed to reliably estimate selectivity for this survey.

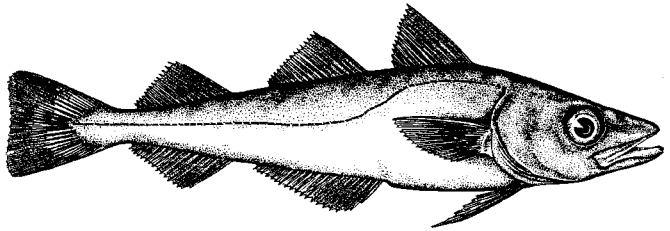


# Gulf of Alaska pollock
# **Economic Performance**

Table 1. Pollock in the Gulf of Alaska first-wholesale market data. Total catch and federal fisheries catch and retained catch (thousand metric tons), ex-vessel value (million US$), price (US$ per pound), and number of trawl vessels; 2005-2007 average, 2008-2010 average and 2011-2015.

| | Avg 05-07 | Avg 08-10 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| Total Catch K mt | 68.6 | 57.8 | 81.4 | 104 | 96.4 | 142.6 | 167.6 |
| Federal Catch K mt | 67.0 | 56.7 | 80 | 101 | 93 | 140 | 163 |
| Retained Catch K mt | 65.47 | 54.20 | 78 | 99 | 90.6 | 138.5 | 161.7 |
| Ex-vessel Value M $ | $ 19.7 | $ 21.4 | $ 28.1 | $ 38.5 | $ 36.4 | $ 38.2 | $ 43.8 |
| Ex-vessel Price/lb $ | $ 0.136 | $ 0.179 | $ 0.161 | $ 0.171 | $ 0.176 | $ 0.123 | $ 0.120 |
| Trawl Vessels # | 65.3 | 62.3 | 65 | 68 | 67 | 70 | 63 |

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



# Gulf of Alaska pollock
# **Economic Performance**

Table 2. Pollock in the Gulf of Alaska first-wholesale market data. First-wholesale production (thousand metric tons), value (million US$), price (US$ per pound), and head and gut, fillet, surimi, and roe production volume (thousand metric tons) value share and price (US$ per pound); 2005-2007 average, 2008-2010 average, and 2011-2015.

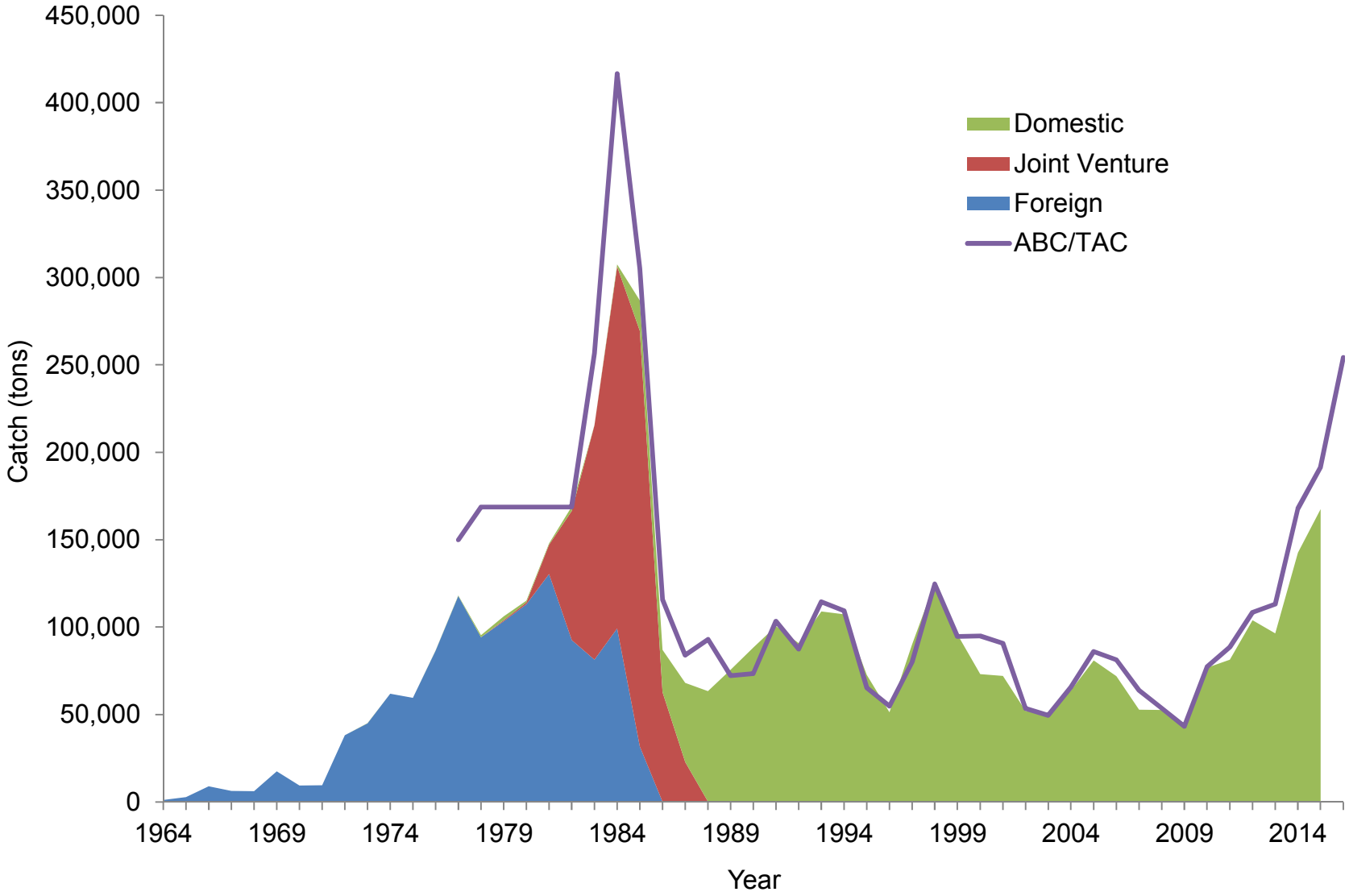
| | | Avg 05-07 | Avg 08-10 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|
| All Products | Volume K mt | 23.7 | 18.0 | 30.7 | 38.5 | 40.1 | 55.0 | 60.3 |
| All Products | Value M $ | $ 53.7 | $ 49.7 | $ 73.0 | $ 88.0 | $ 94.2 | $ 106.4 | $ 98.6 |
| All Products | Price lb $ | $ 1.03 | $ 1.25 | $ 1.08 | $ 1.04 | $ 1.07 | $ 0.88 | $ 0.74 |
| Head & Gut | Volume K mt | 6.9 | 7.7 | 14.8 | 19.0 | 21.3 | 29.7 | 30.3 |
| Head & Gut | Price lb $ | $ 0.63 | $ 0.75 | $ 0.66 | $ 0.60 | $ 0.78 | $ 0.62 | $ 0.49 |
| Head & Gut | Value share | 18.02% | 25.77% | 29.55% | 28.40% | 38.73% | 38.24% | 33.56% |
| Fillets | Volume K mt | 4.6 | 3.2 | 5.7 | 6.0 | 5.8 | 8.2 | 9.1 |
| Fillets | Price lb $ | $ 1.30 | $ 1.82 | $ 1.62 | $ 1.56 | $ 1.61 | $ 1.35 | $ 1.28 |
| Fillets | Value share | 24.69% | 26.21% | 27.96% | 23.43% | 21.98% | 22.95% | 26.02% |
| Surimi | Volume K mt | 7.1 | 4.5 | 7.1 | 9.9 | 8.6 | 12.3 | 14.6 |
| Surimi | Price lb $ | $ 0.91 | $ 1.62 | $ 1.25 | $ 1.26 | $ 1.07 | $ 0.89 | $ 0.87 |
| Surimi | Value share | 26.63% | 32.13% | 26.81% | 31.12% | 21.55% | 22.61% | 28.47% |
| Roe | Volume K mt | 1.8 | 0.9 | 1.3 | 1.7 | 2.2 | 3.5 | 3.1 |
| Roe | Price lb $ | $ 3.37 | $ 2.91 | $ 3.12 | $ 3.31 | $ 2.80 | $ 2.03 | $ 1.24 |
| Roe | Value share | 25.24% | 12.20% | 11.91% | 13.91% | 14.48% | 14.81% | 8.65% |

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).

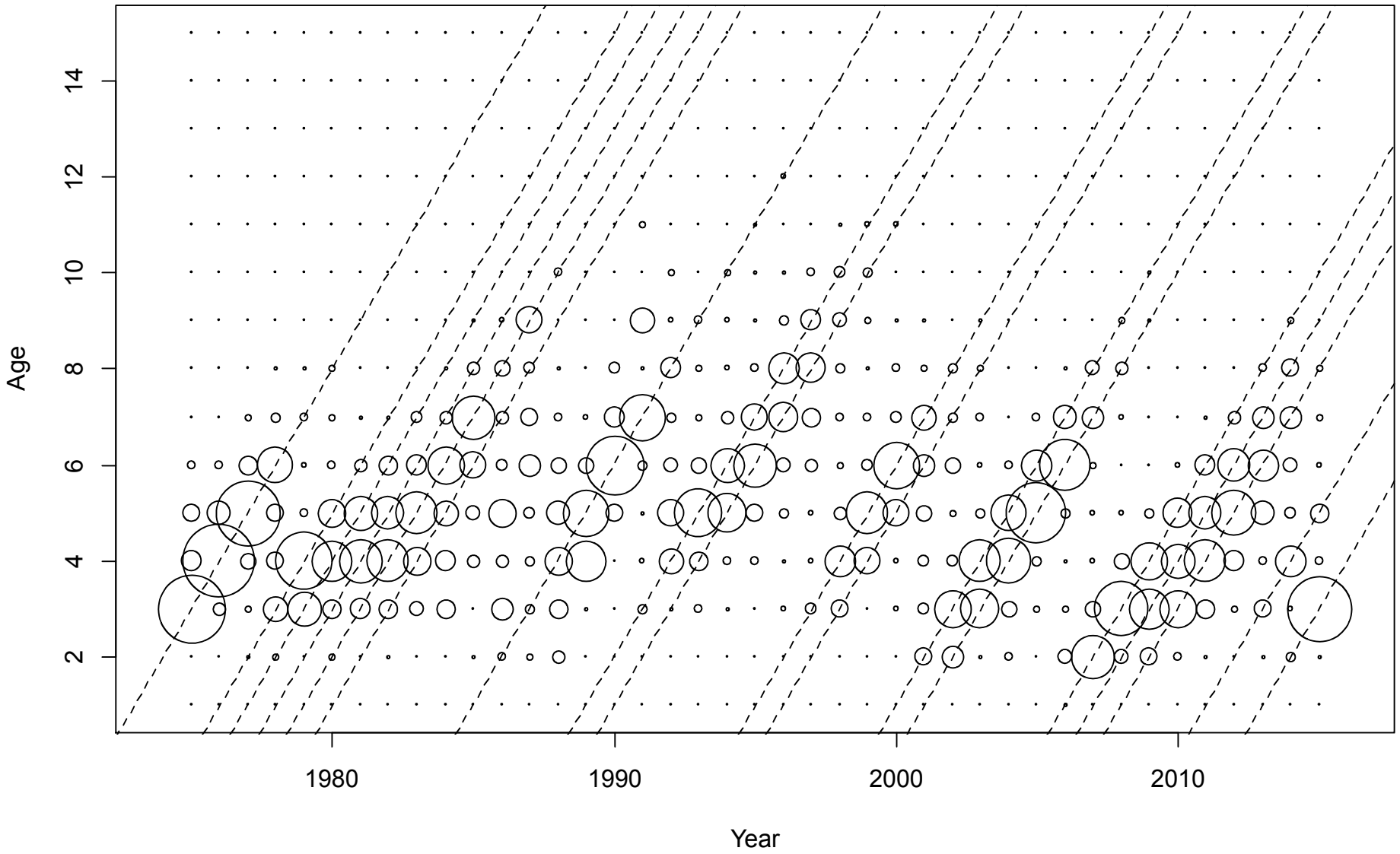
# Data used in the assessment

| Source | Data | Years |
|---|---|---|
| Fishery | Total catch | 1970-2015 |
| Fishery | Age composition | 1975-2015 |
| Shelikof Strait acoustic survey | Biomass | 1992-2016 |
| Shelikof Strait acoustic survey | Age composition | 1992-2016 |
| Summer acoustic survey | Biomass | 2013-2015 |
| Summer acoustic survey | Age composition | 2013,2015 |
| NMFS bottom trawl survey | Area-swept biomass | 1990-2015 |
| NMFS bottom trawl survey | Age composition | 1990-2015 |
| ADFG trawl survey | Area-swept biomass | 1989-2016 |
| ADFG survey | Age composition | 2000-2014 |

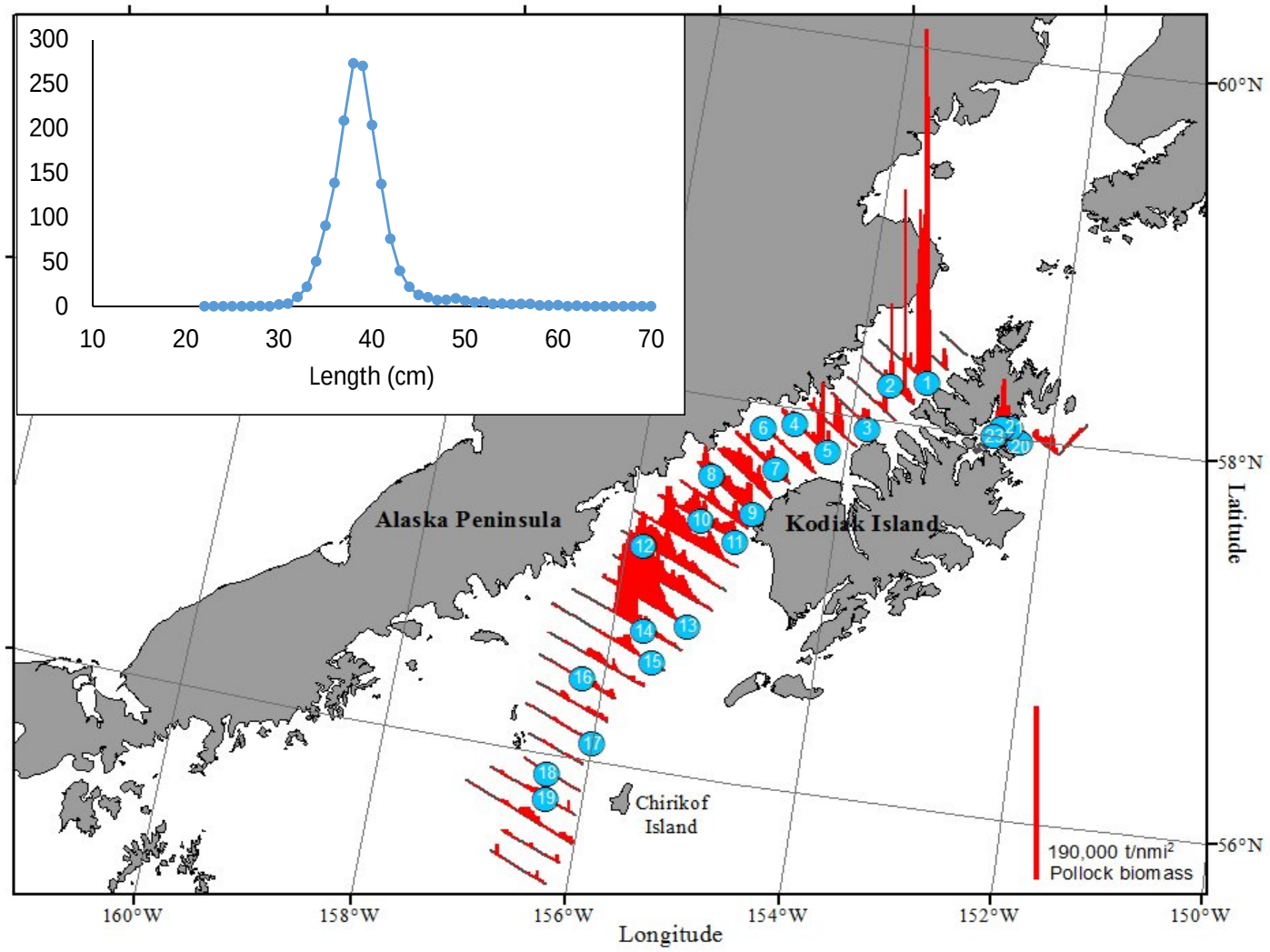
# Total catch 1964-2015



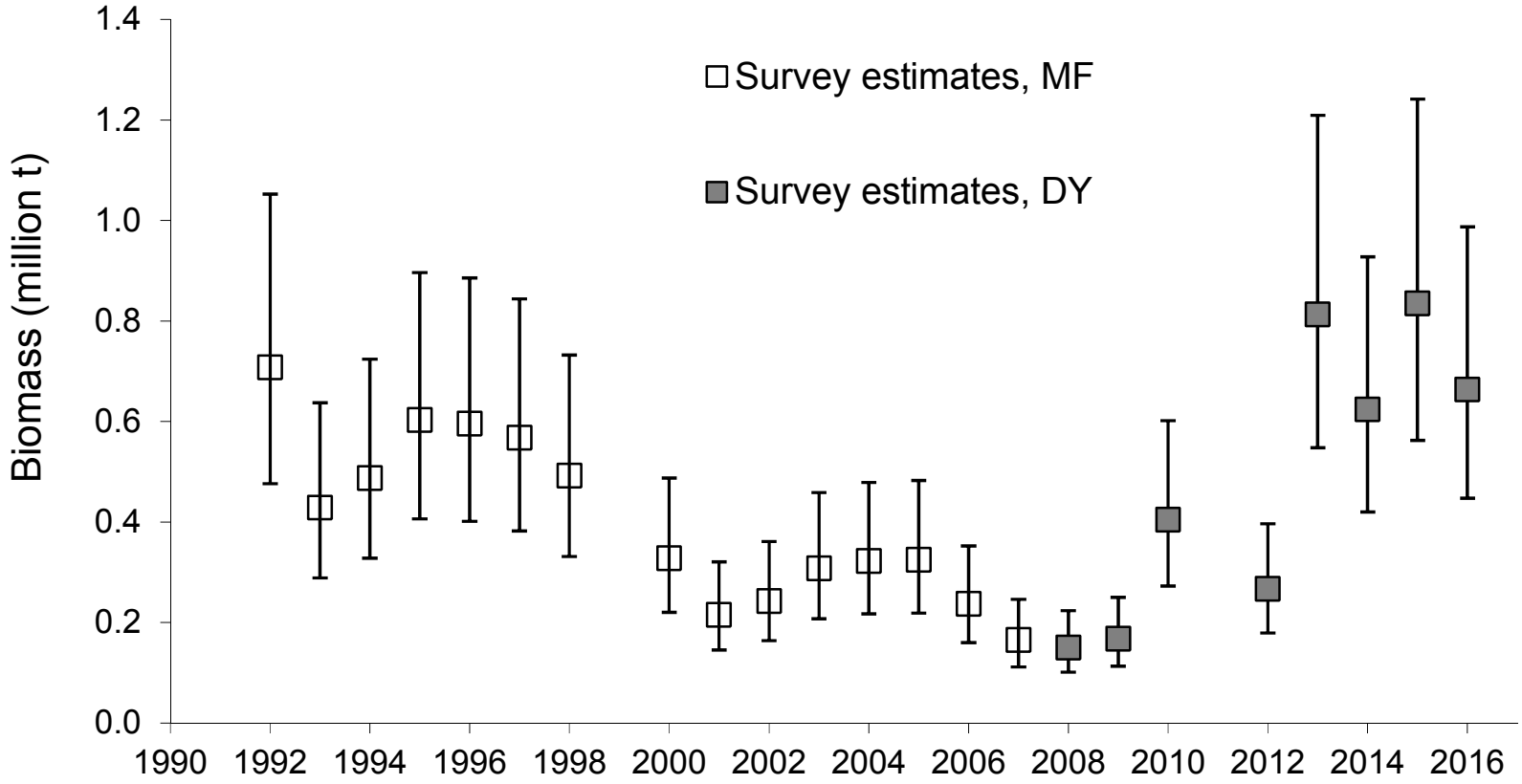
# Catch at age, 1975-2015



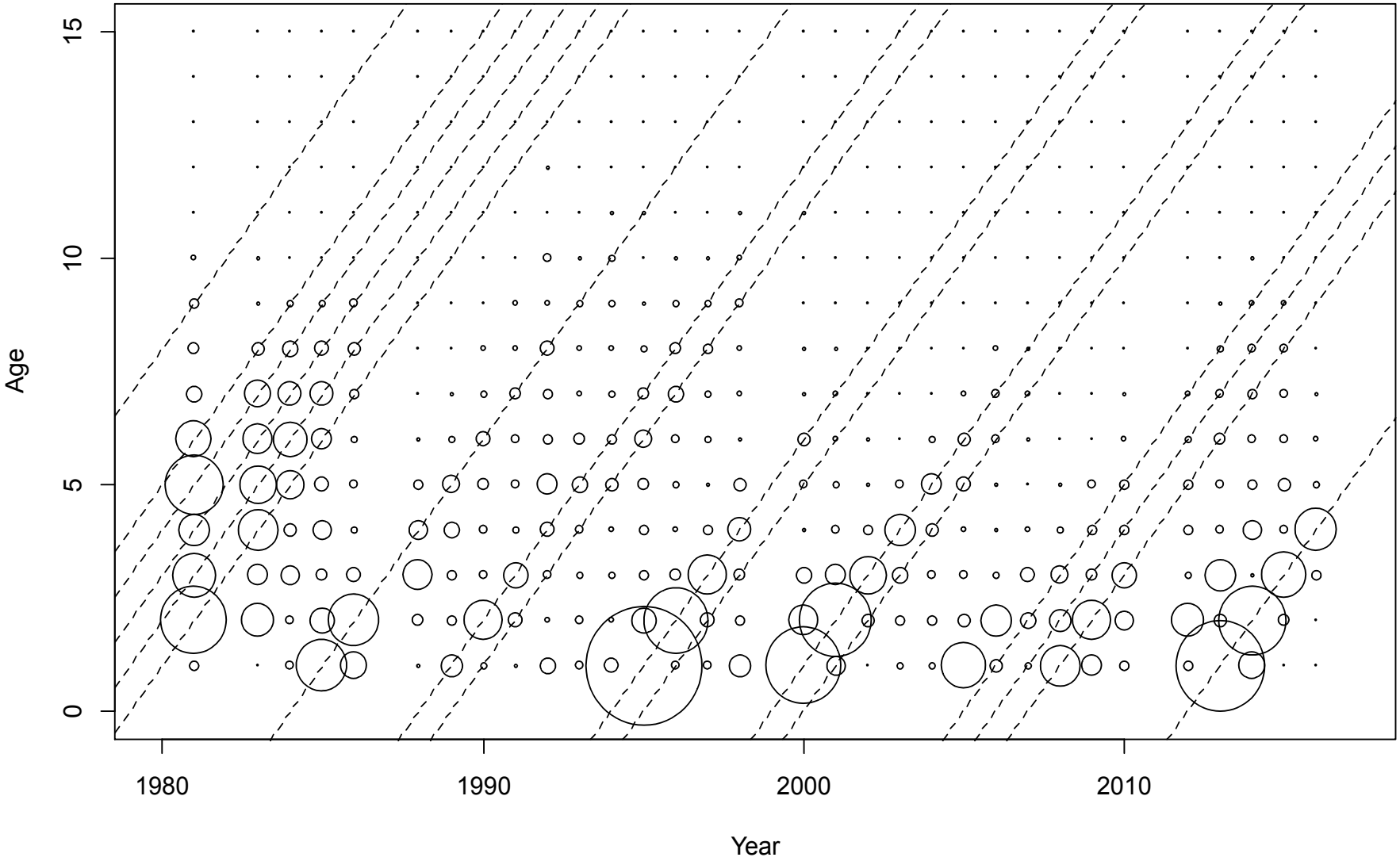
# 2016 Shelikof Strait (665,059 t)
# 89% Age 4 (2012 year class)



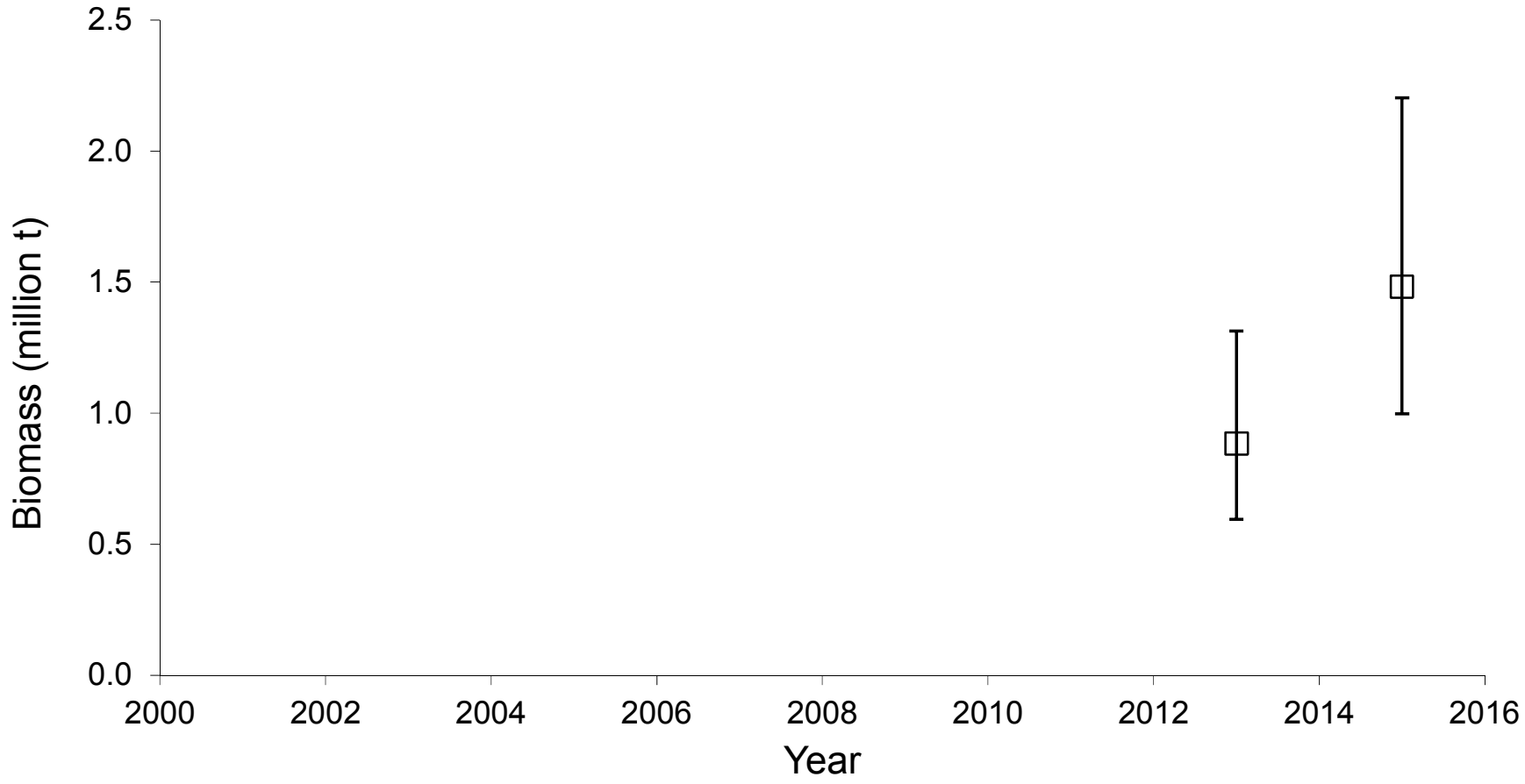
# Shelikof Strait acoustic survey, 1992-2016



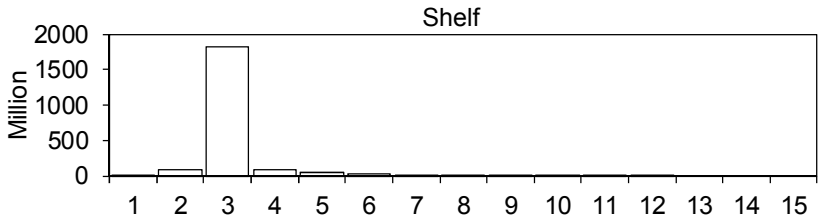
# Shelikof Strait survey age comp, 1992-2016

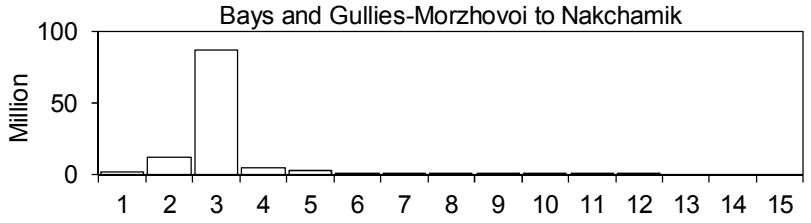


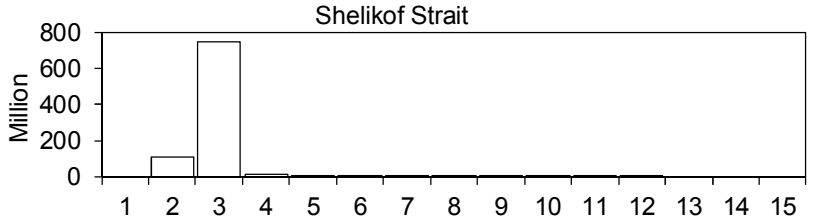
# Summer acoustic survey, 2013-2015

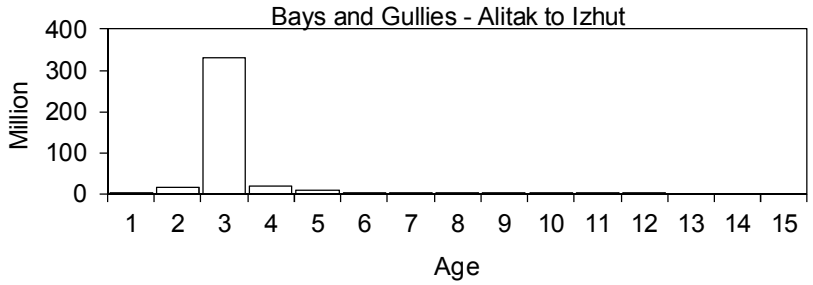


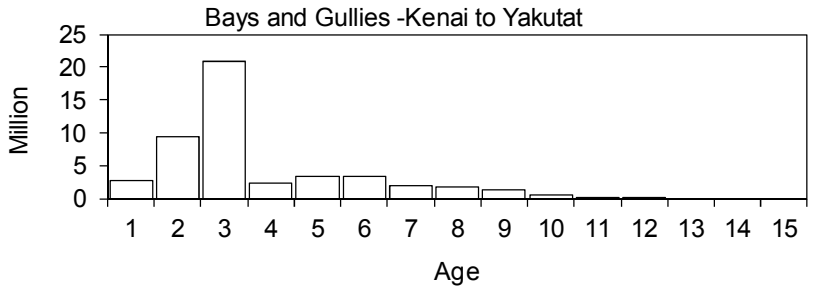
# 2015 Summer acoustic survey



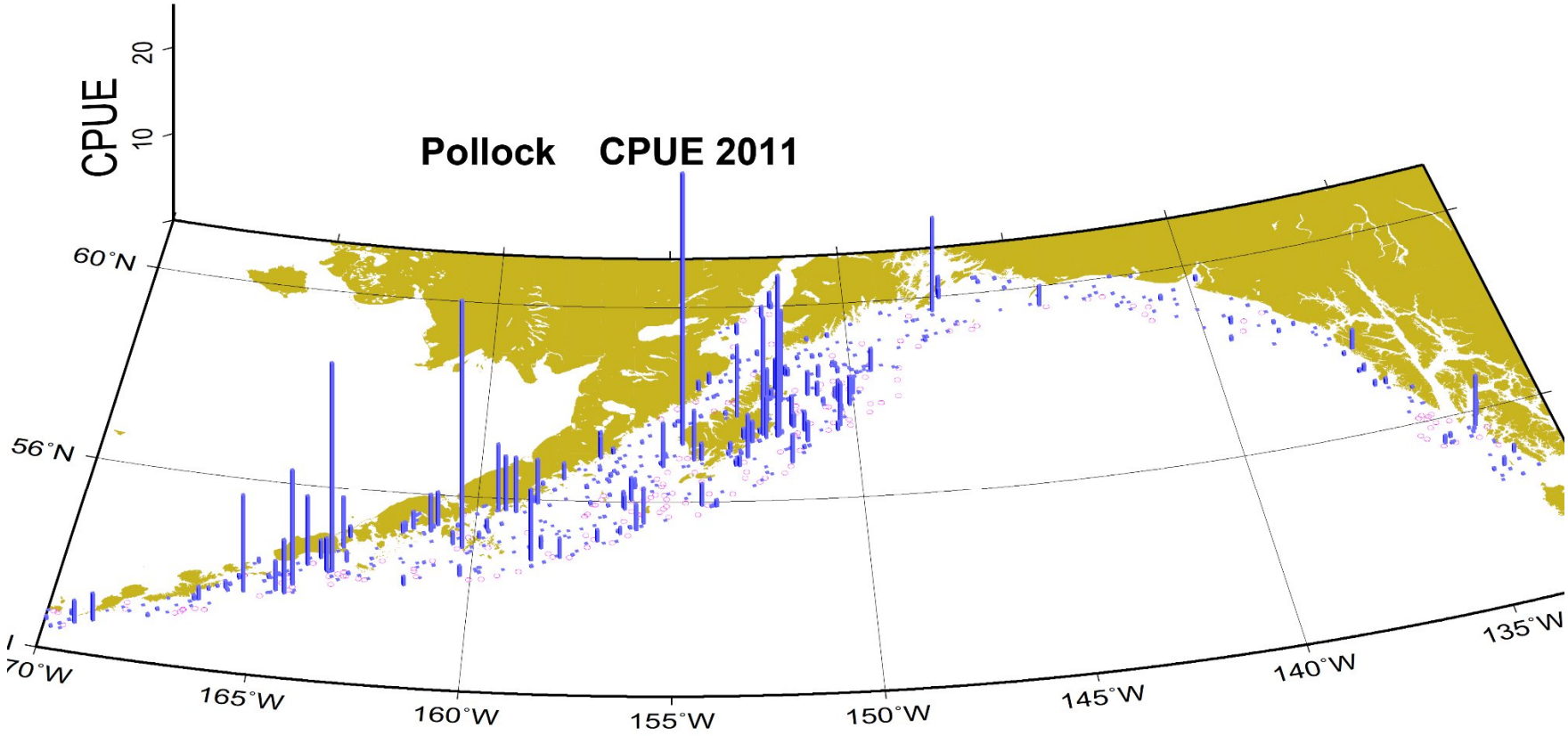



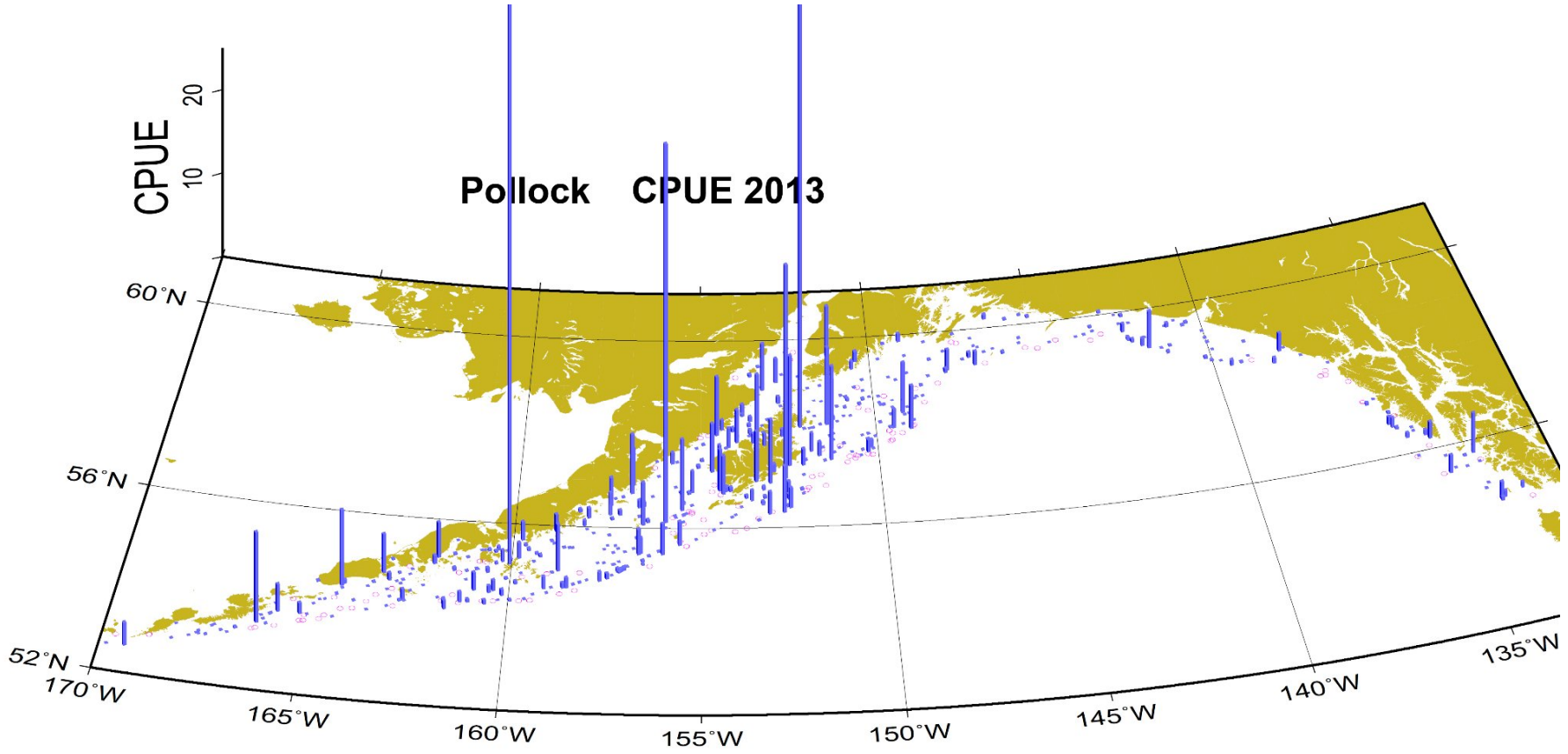



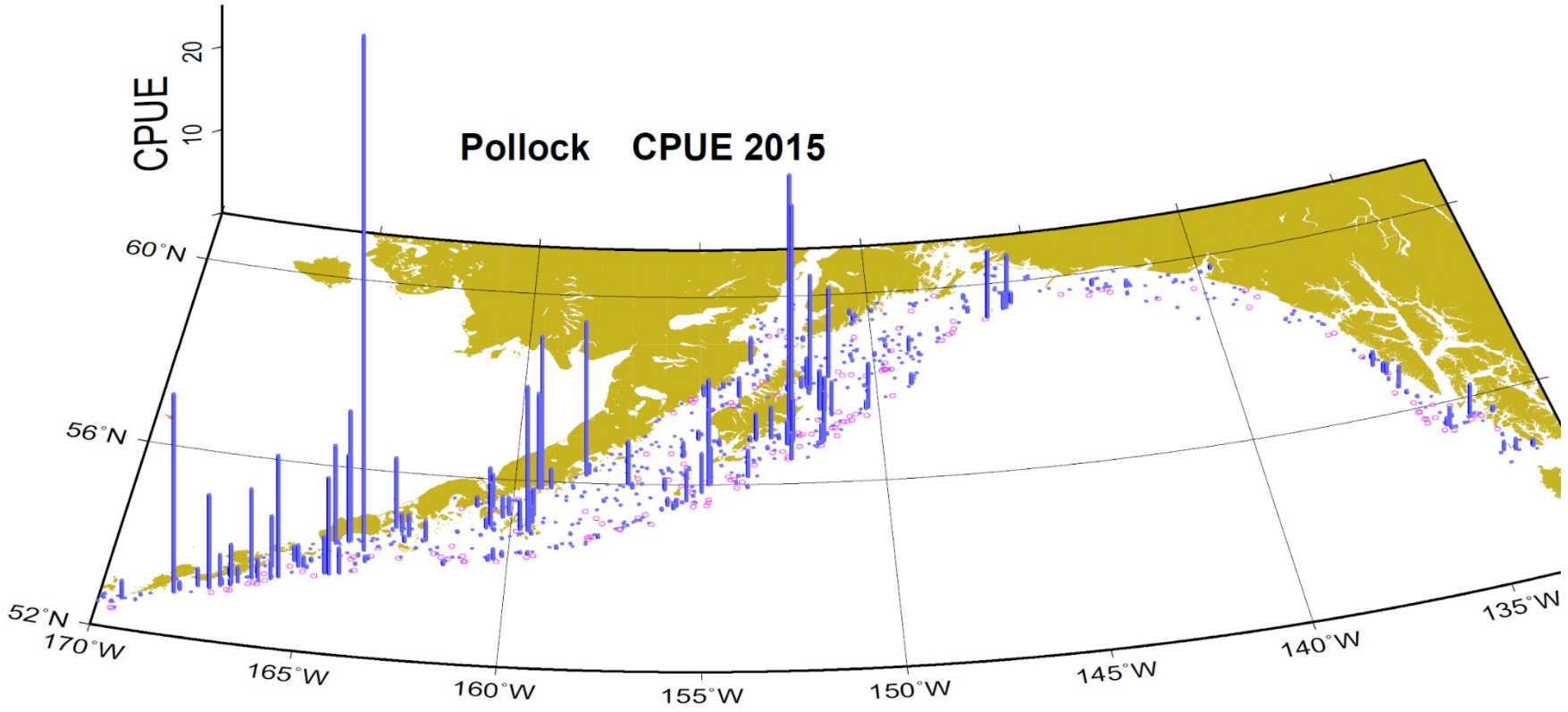
# 2011 NMFS bottom trawl survey



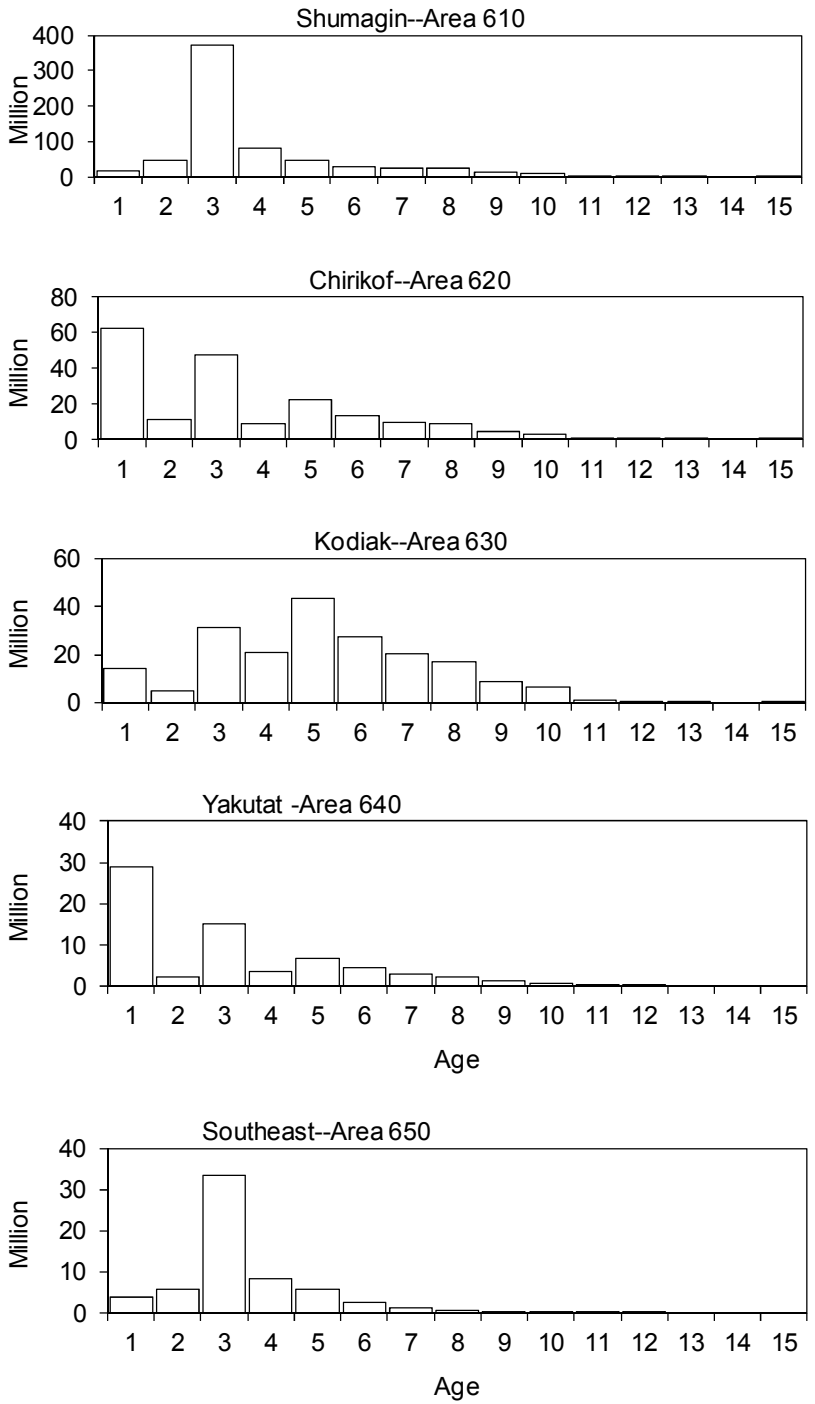
# 2013 NMFS bottom trawl survey



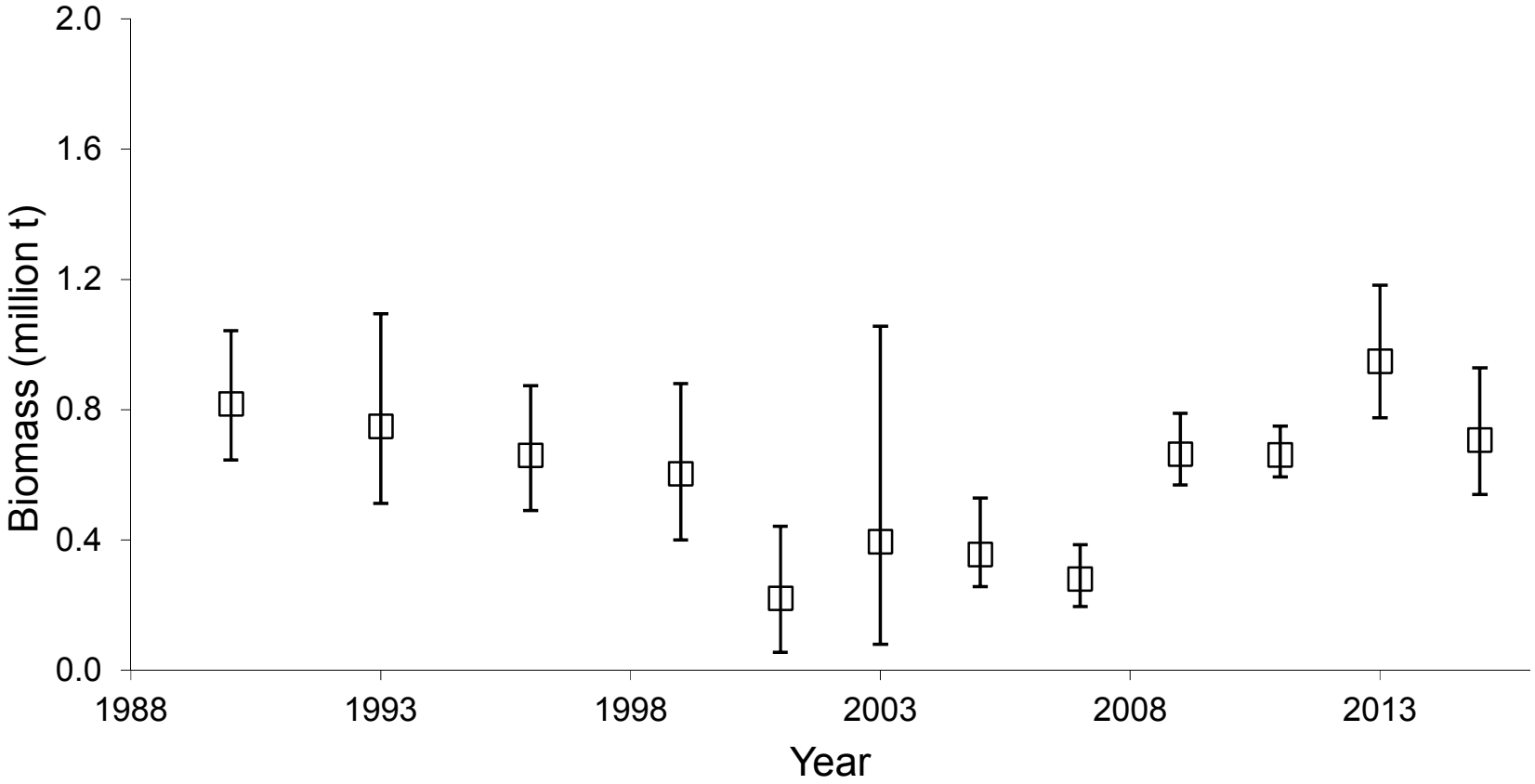
# 2015 NMFS bottom trawl survey



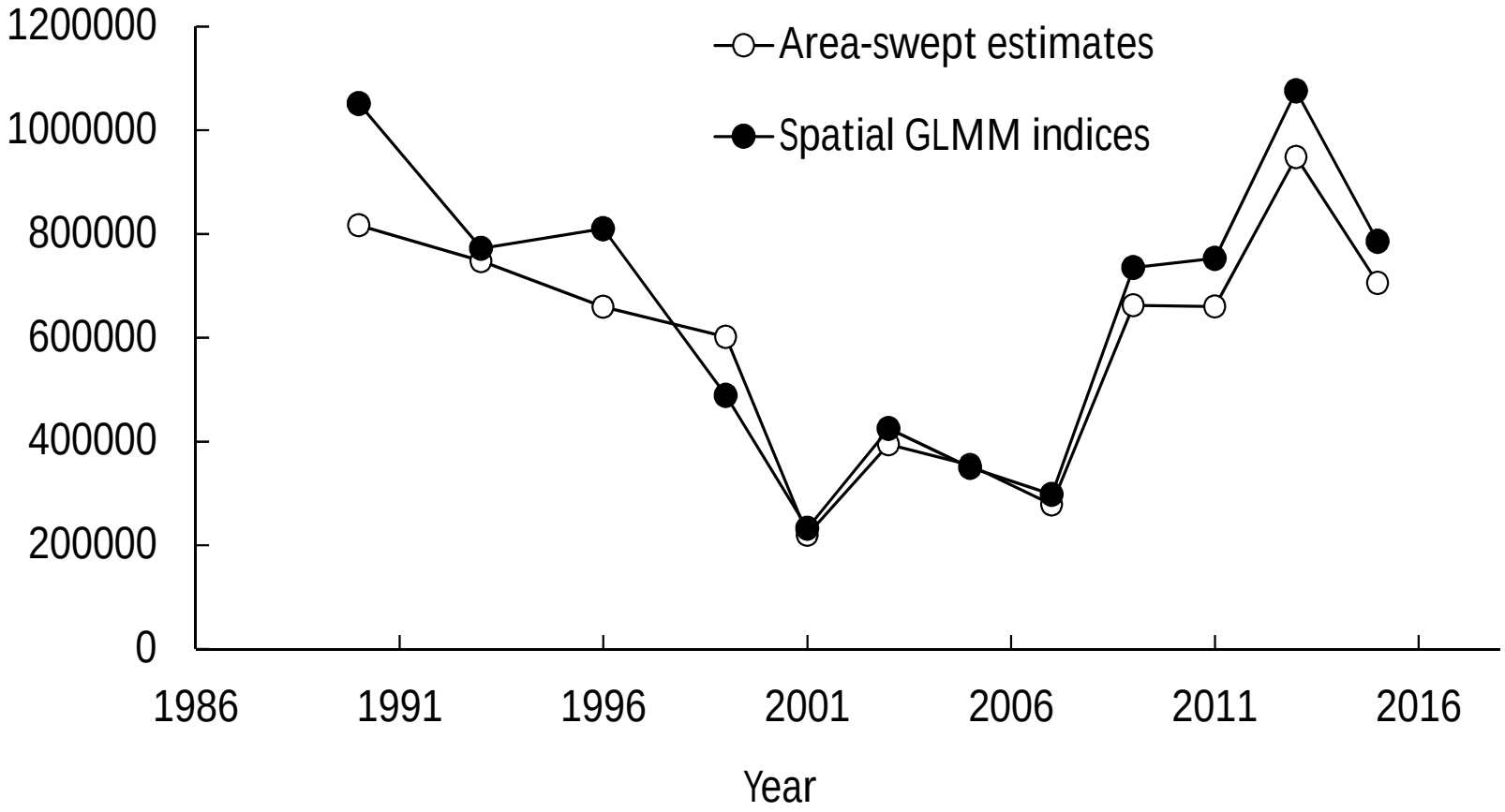
# 2015 NMFS bottom trawl survey



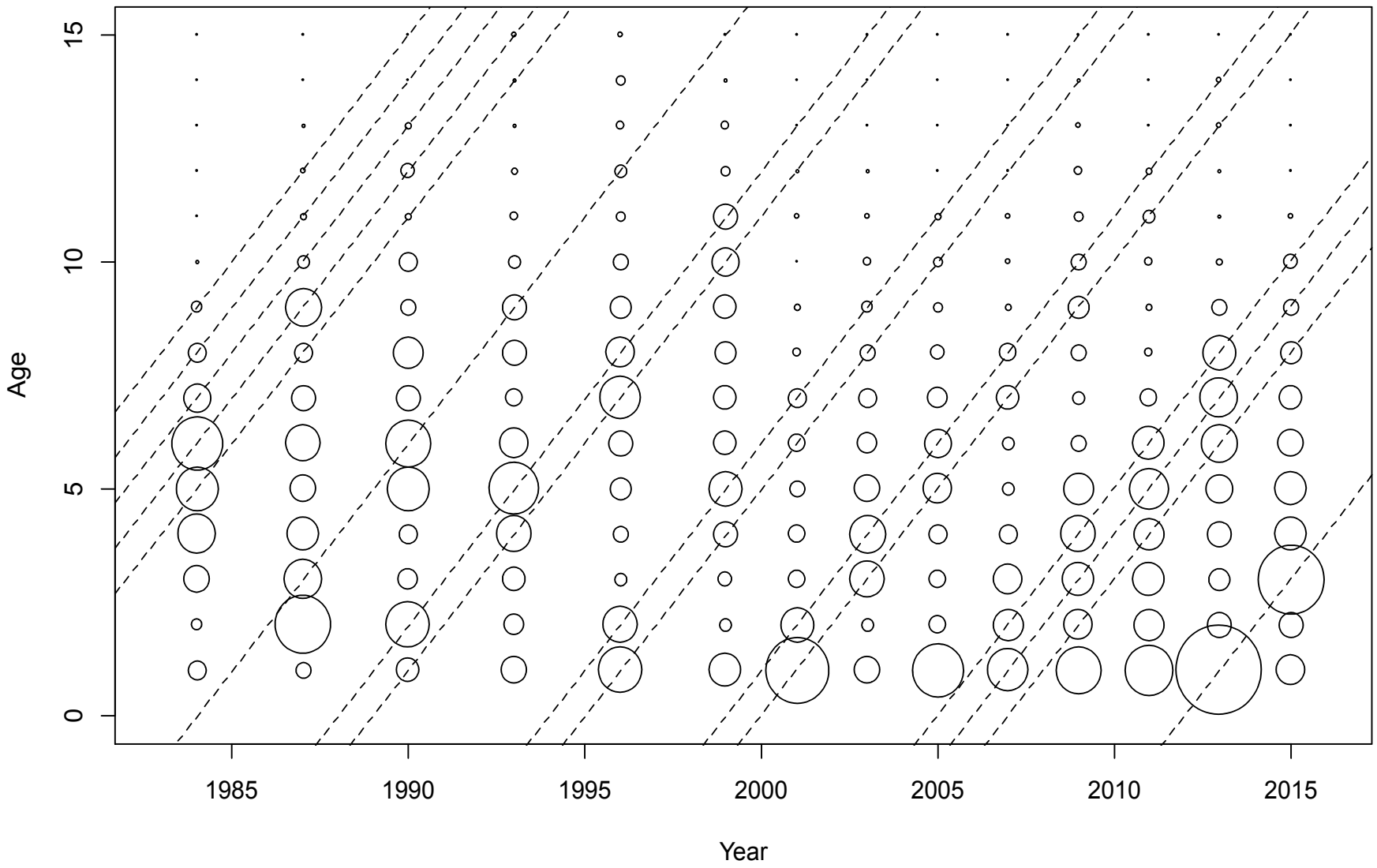
# NMFS bottom trawl survey (1990-2015)



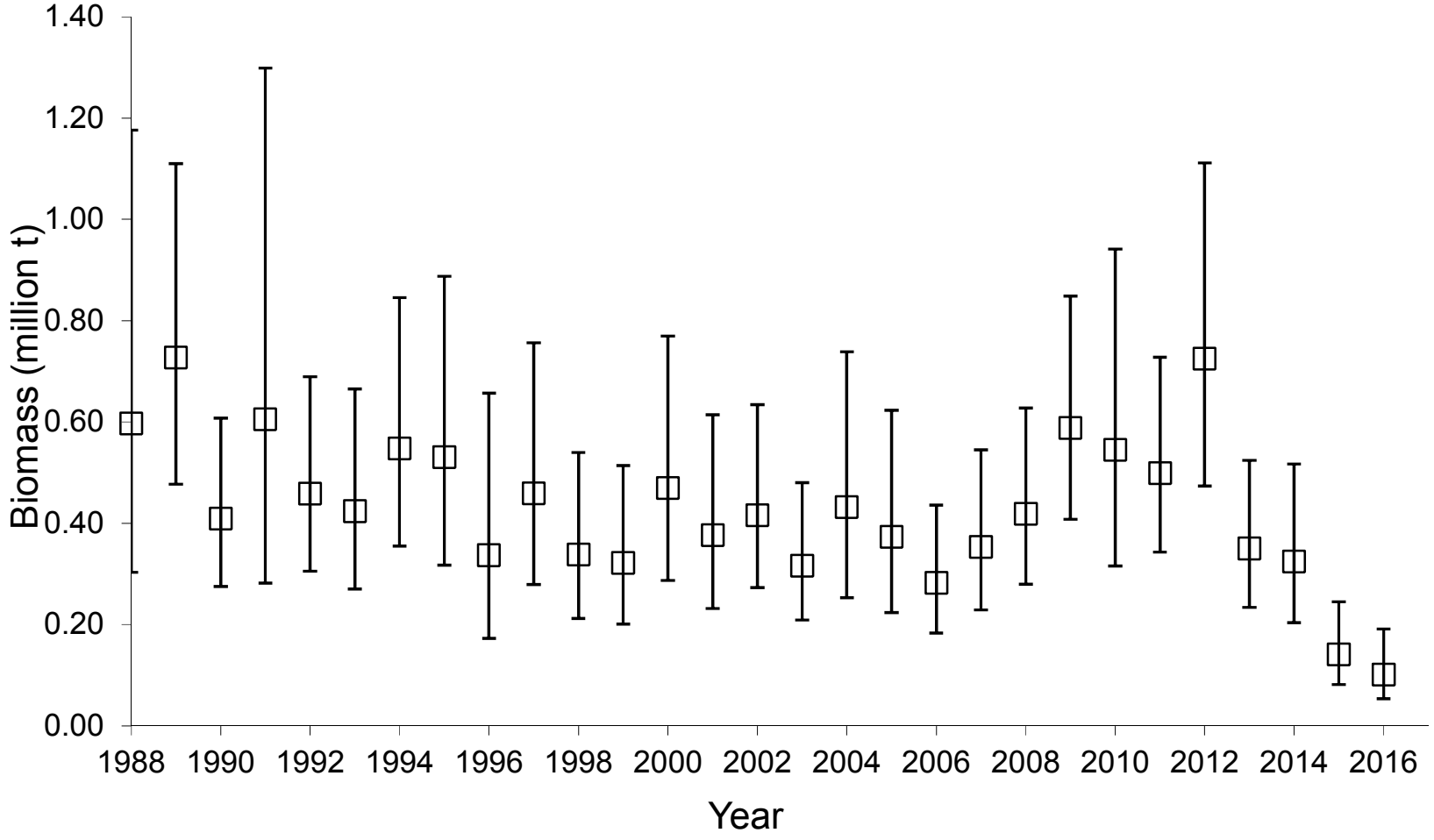
# NMFS bottom trawl survey area-swept vs spatial GLMM (Thorson)



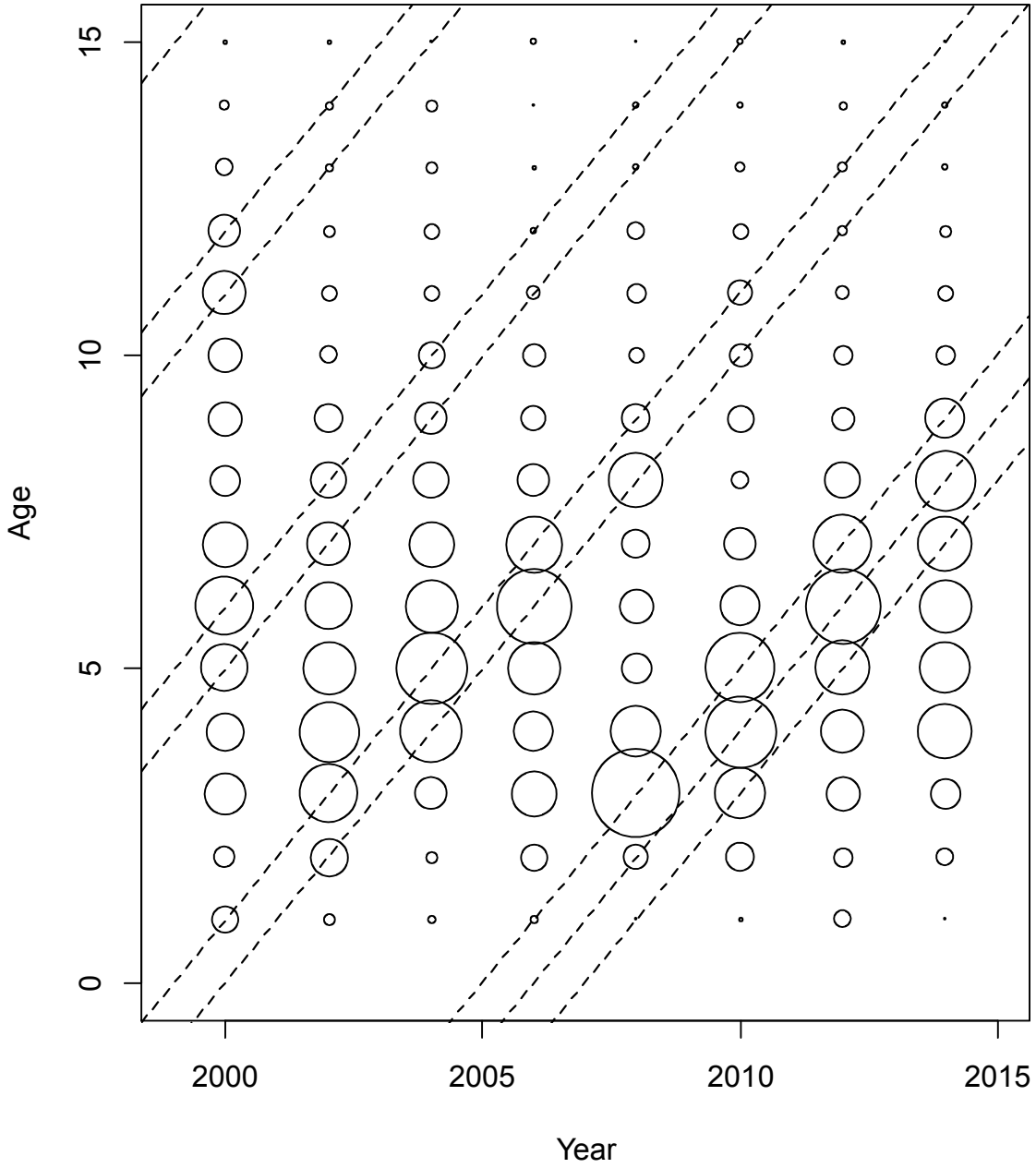
# NMFS Bottom trawl survey age comp (1990-2015)



# ADFG crab/groundfish trawl survey (1989-2016)



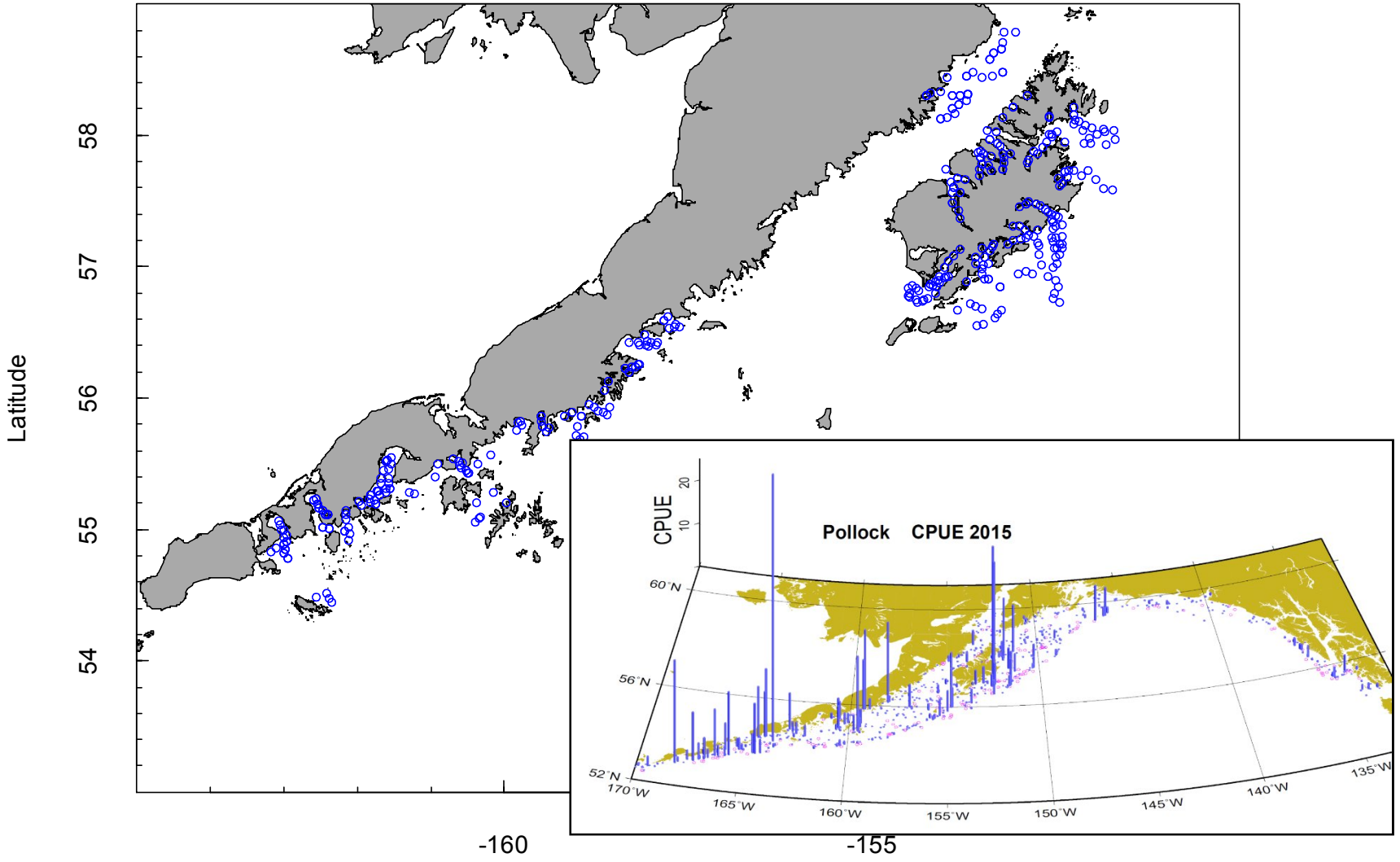
# ADFG crab/groundfish trawl survey age comp (2000-2014)



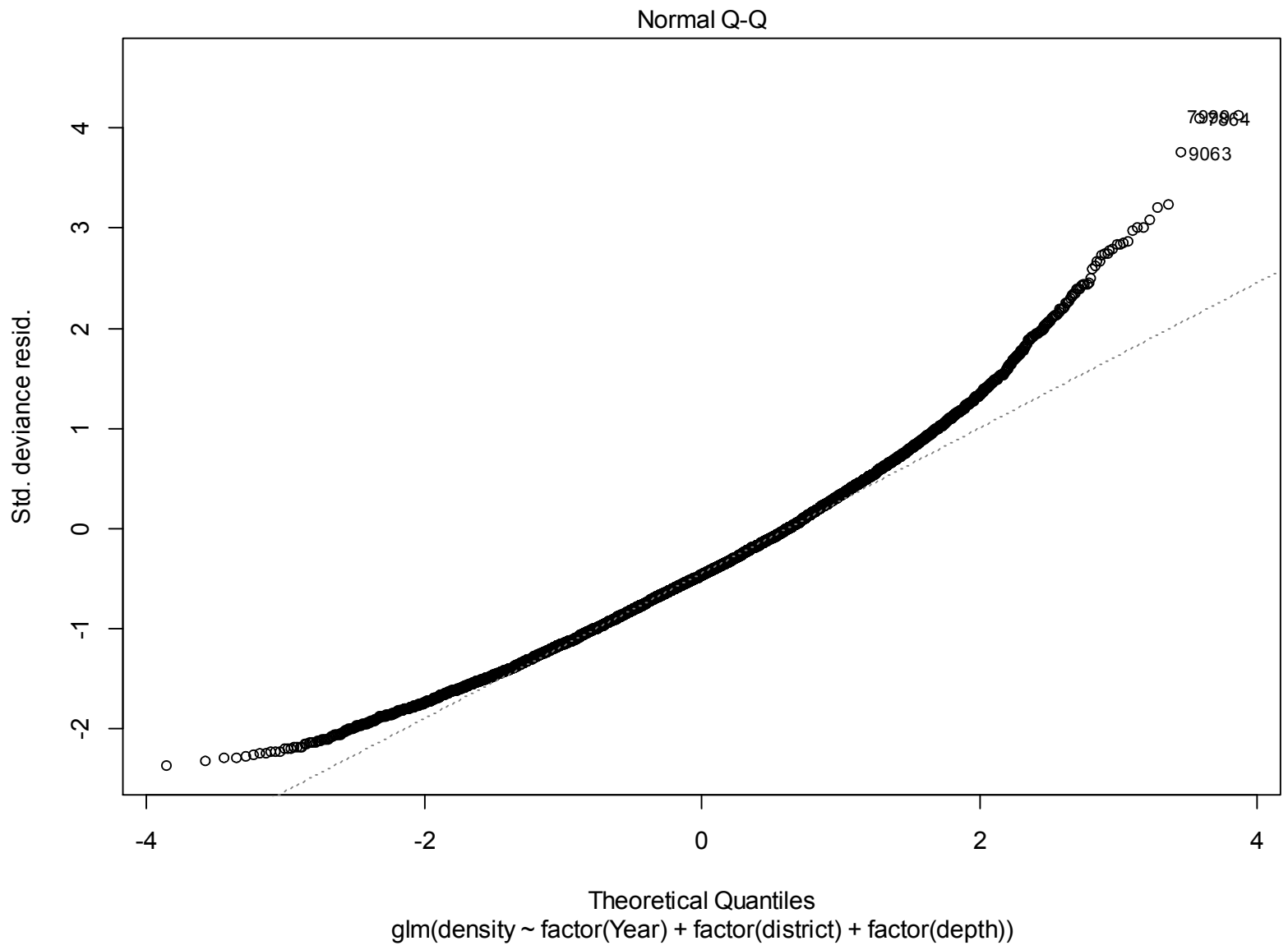
# Delta-GLM for ADFG survey

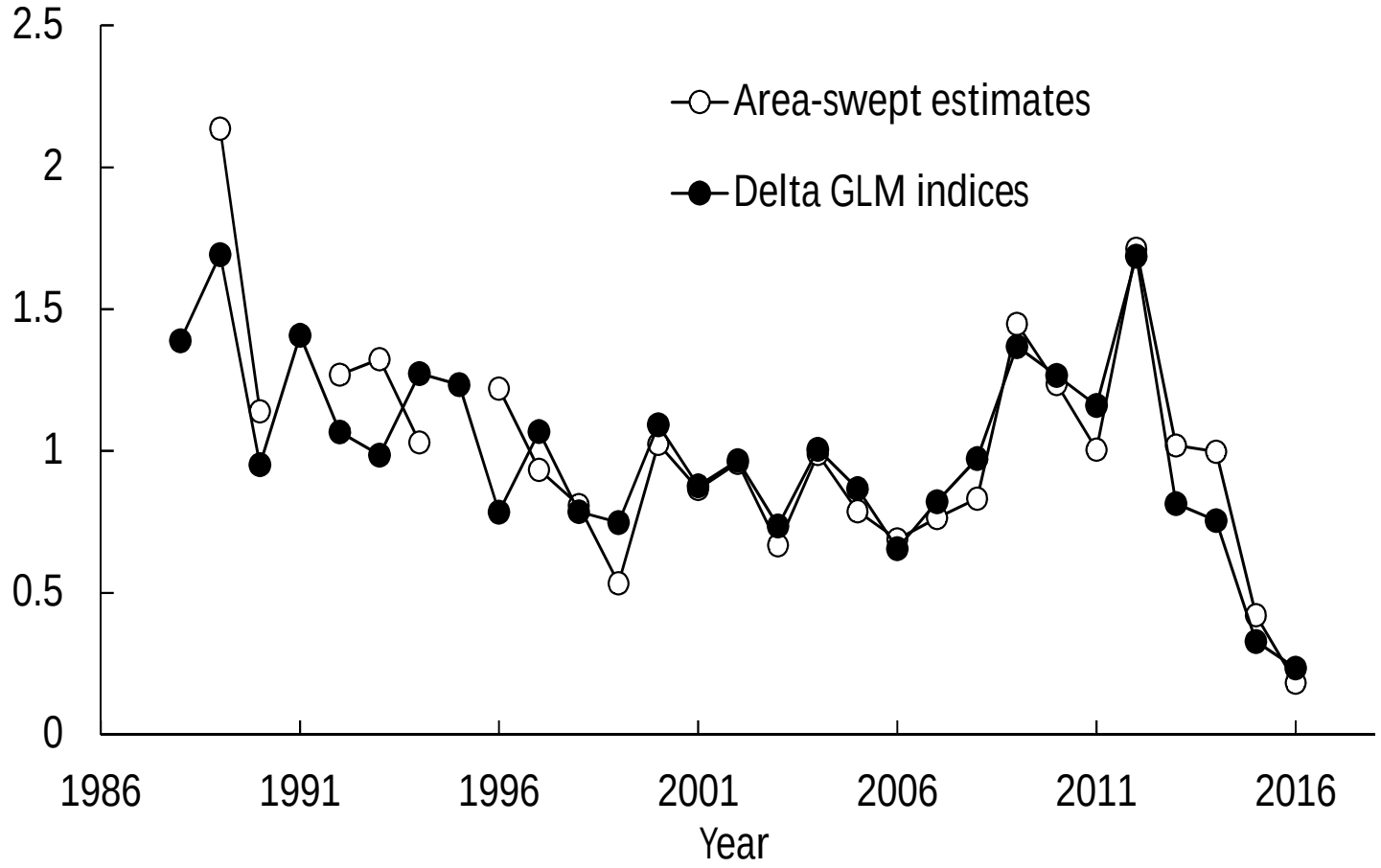
- Excluded data: no location (1 tow), no depth (14 tows), lower Shelikof Strait stations (157).
- Fixed effects model with area (ADFG districts Kodiak, Chignik, and South Peninsula) and depth (<30 fm, 30-100 fm, > 100 fm)
- Evaluated log normal, gamma, and inverse Gaussian error assumptions.
- AIC strongly preferred gamma error assumption ($\Delta AIC = 602.7$).
- CVs ranged from 0.09 to 0.20. Multiplied by 2X to make them comparable to previous weights

# 2016 ADFG survey stations

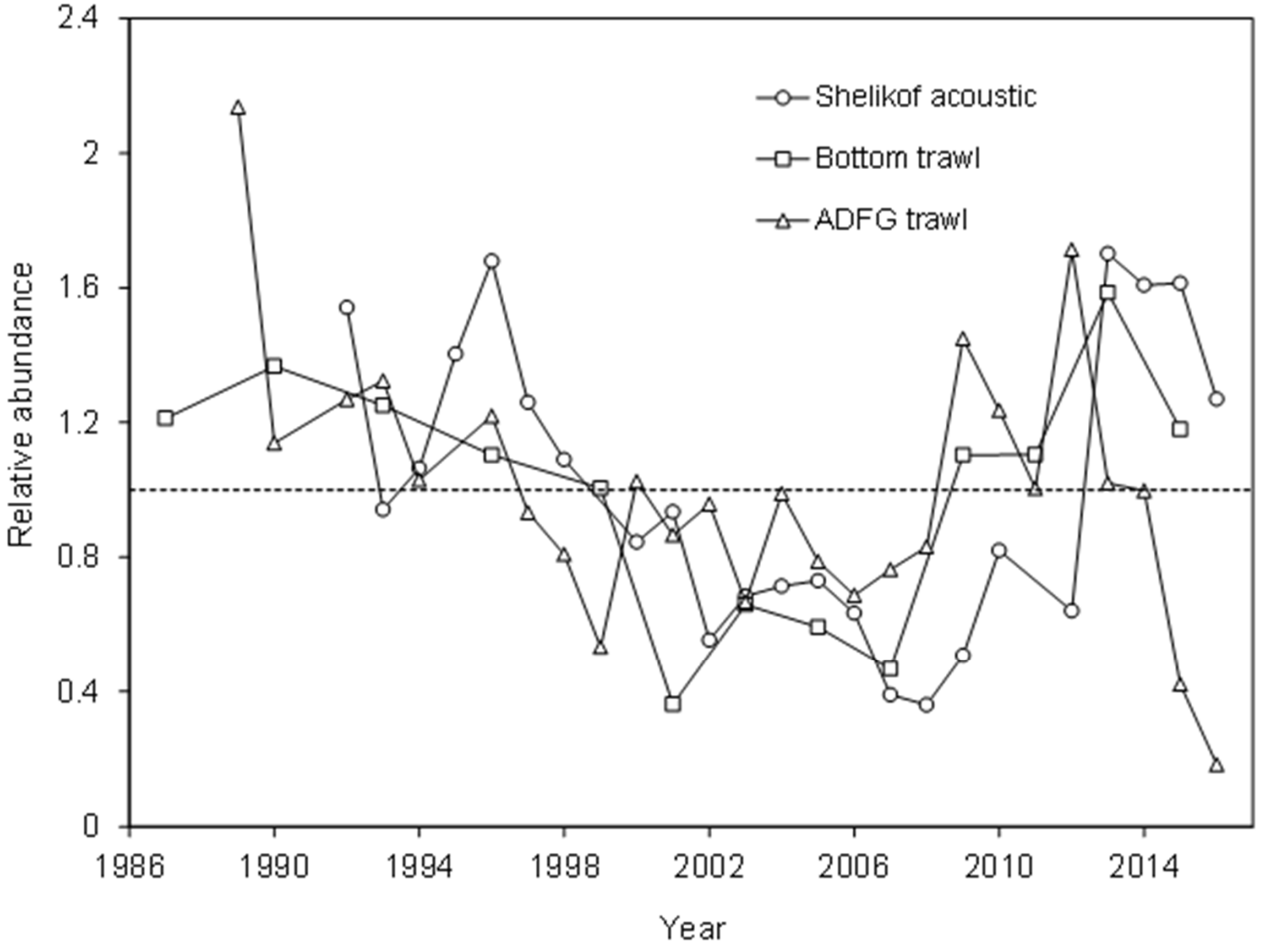


# QQ plot for gamma error assumption




2.5
2
1.5
1
0.5
0
1986
1991
1996
2001
2006
2011
2016
Year
Area-swept estimates
Delta GLM indices

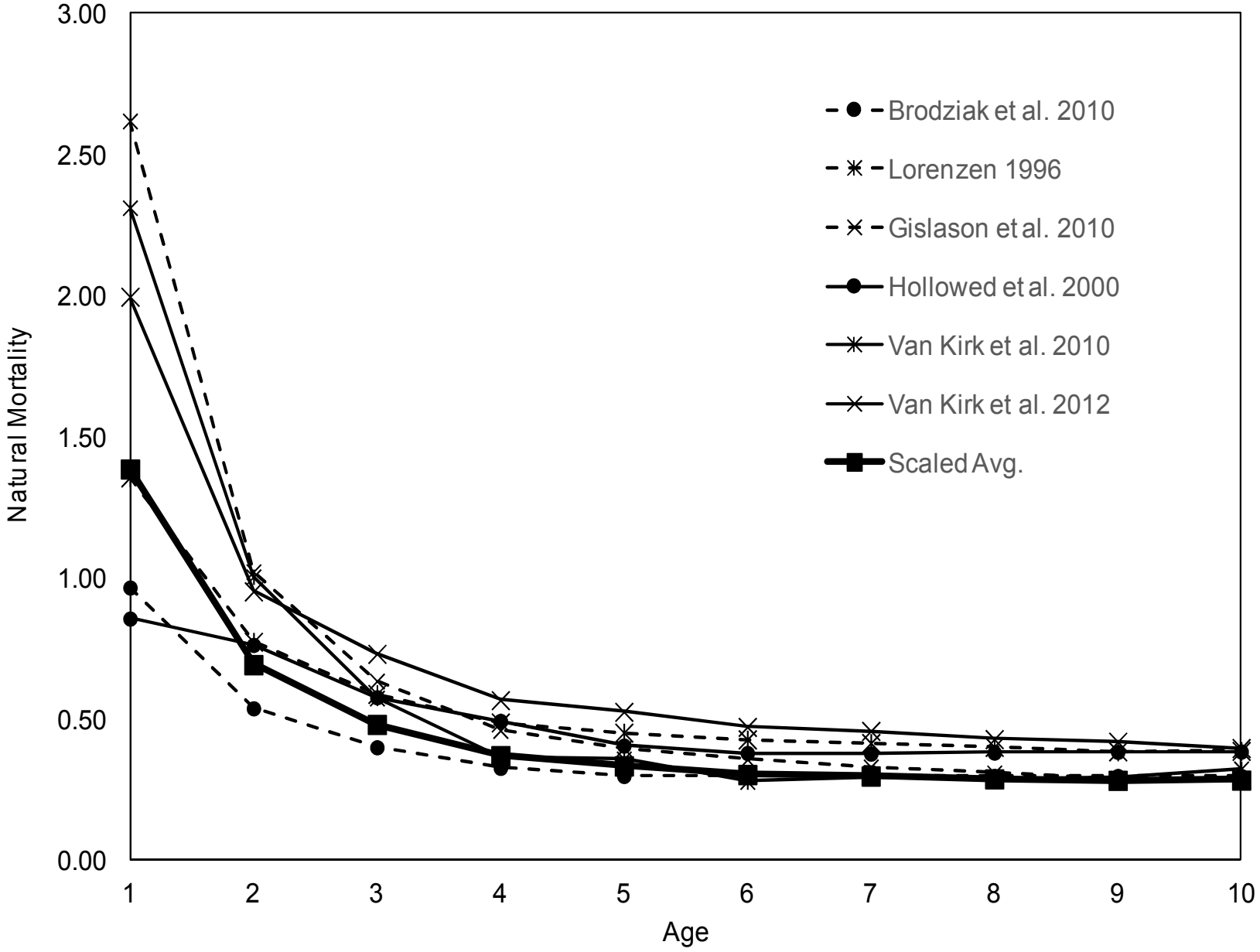
# Relative trends in abundance indices (1987-2016)



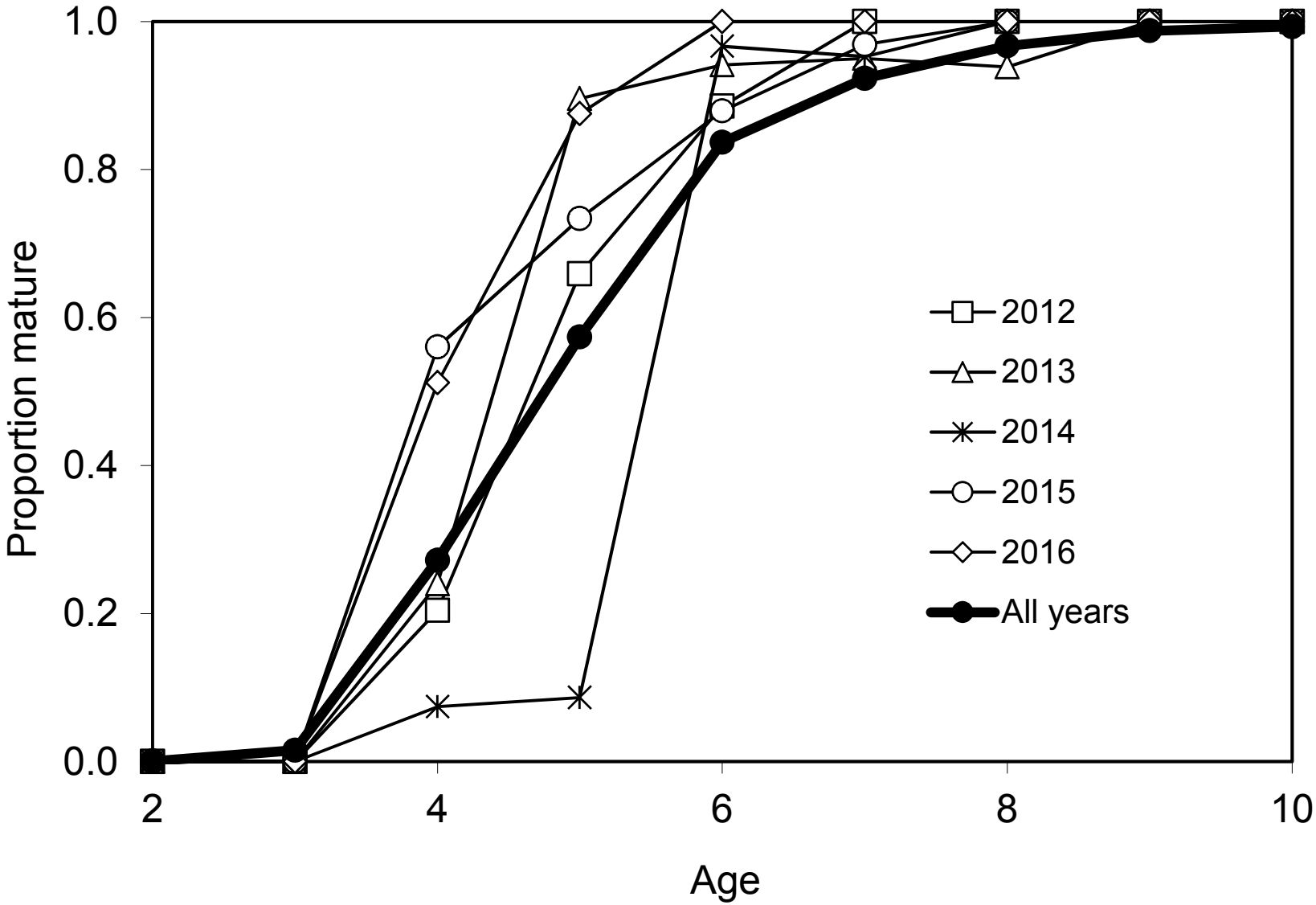
Parameters estimated independently

- Natural mortality: new age-specific pattern from the 2014 assessment
- Weight at age by fishery and survey
- New RE model fishery weights at age in 2016 and 2017.
- Proportion mature at age

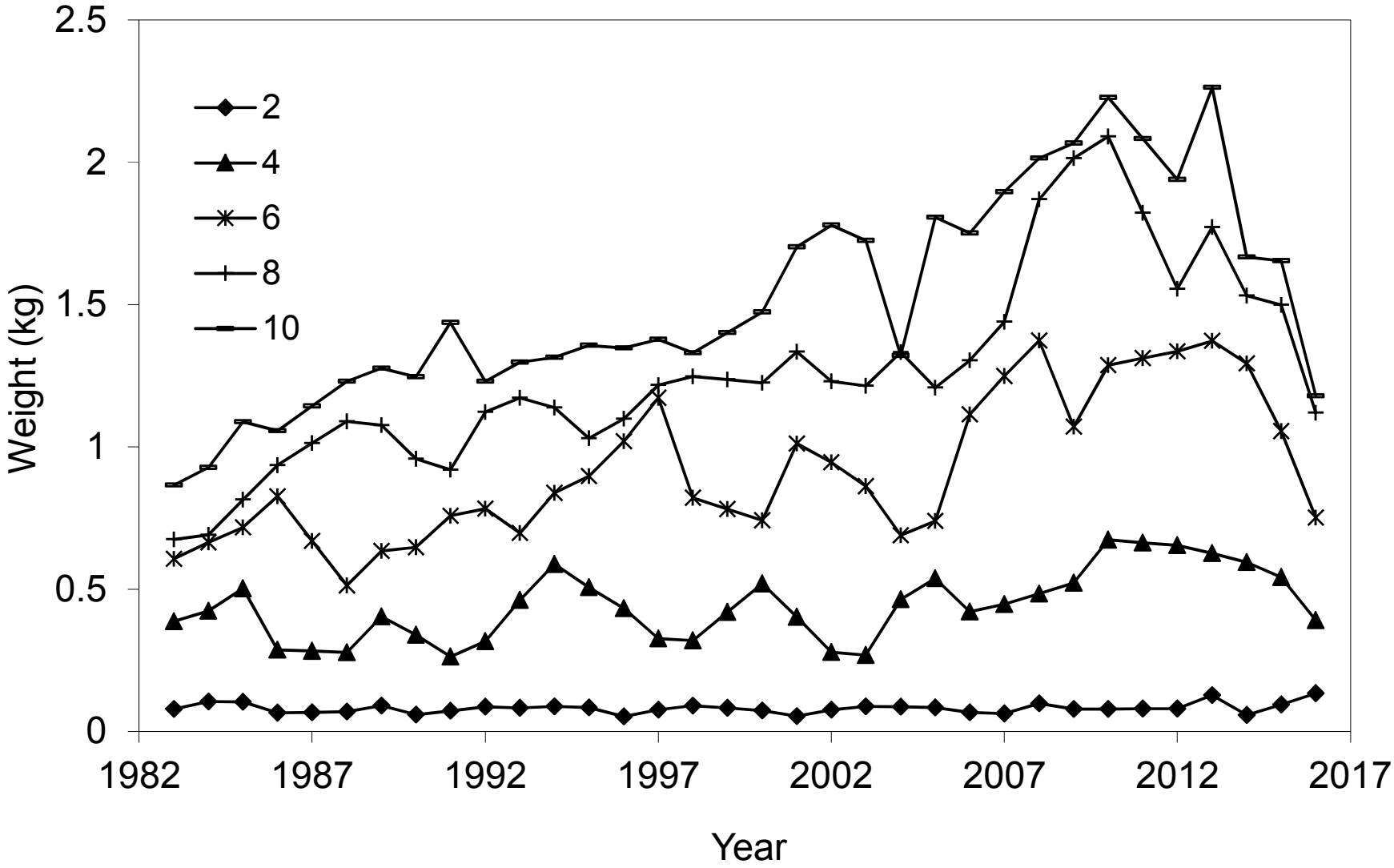
# Natural mortality estimates



# Recent maturity curves



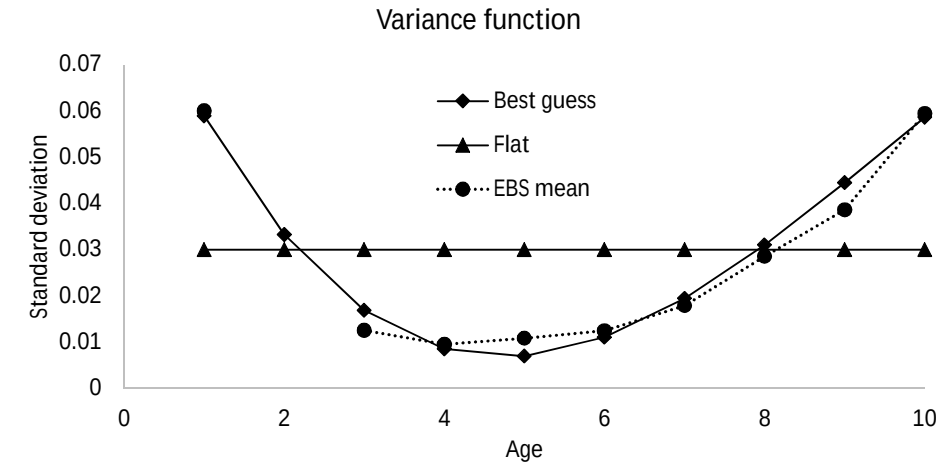
# Shelikof survey changes in weight at age

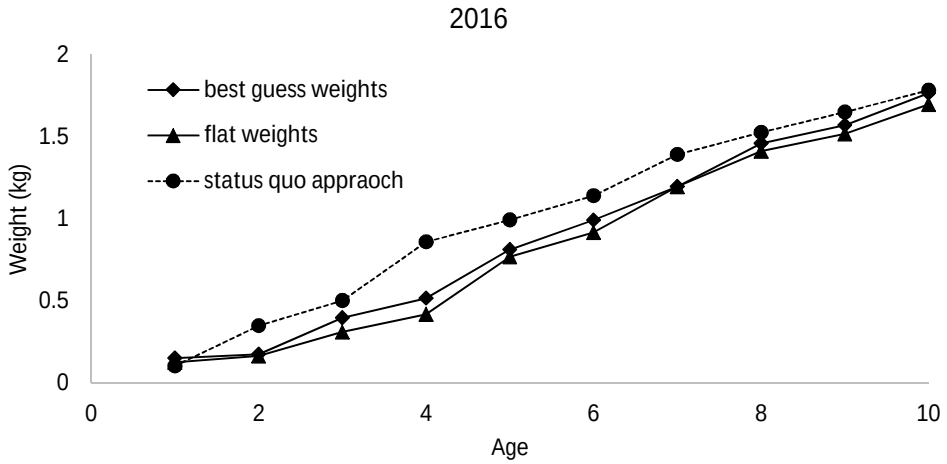


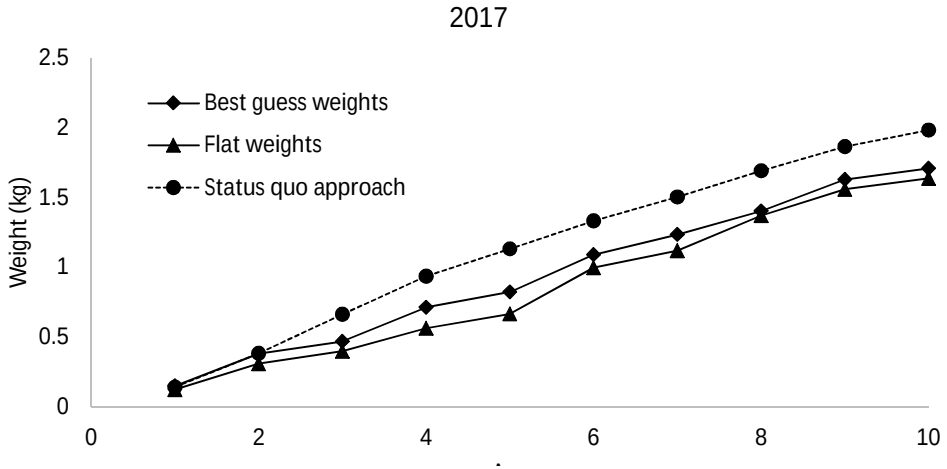
Random effects model for weight at age

- Developed in the EBS pollock stock assessesment (see Appendix 1.A in Ianelli et al. 2016)
- Underlying LVB growth curve
- Cohort and year RE effects on growth increments.
- Survey data incorporated with an offset (used both NMFS bottom trawl and Shelikof Strait acoustic survey weight-at-age estimates.
- Used to predict fishery WAA in 2016 (Shelikof Strait survey ageing data available but not fishery) and in 2017 (including $F_{SPR}$ calcs).

# RE model for fishery weight at age



# Likelihood components

| Likelihood component | Statistical model for error | Variance assumption |
|---|---|---|
| Fishery total catch (1970-2016) | Log-normal | CV = 0.05 |
| Fishery age comp. (1975-2015) | Multinomial | Initial sample size: 200 or the number of tows/deliveries if less than 200 |
| Shelikof acoustic survey biomass (1992-2016) | Log-normal | CV = 0.20 |
| Shelikof acoustic survey age comp. (1992-2016) | Multinomial | Initial sample size = 60 |
| Winter acoustic survey age-1 and age-2 indices (1994-2016) | Log-normal | Tuned CVs = 1.20 and 0.89 |
| Summer acoustic survey biomass (2013-2015) | Log-normal | CV = 0.25 |
| Summer acoustic survey age comp. (2013, 2015) | Multinomial | Initial sample size = 10 |
| NMFS bottom trawl survey biom. (1990-2015) | Log-normal | Survey-specific CV from random-stratified design = 0.12-0.38 |
| NMFS bottom trawl survey age comp. (1990-2015) | Multinomial | Initial sample size = 60 |
| ADFG trawl survey biomass (1989-2016) | Log-normal | CV = 0.25 |
| ADFG survey age comp. (2000-2014) | Multinomial | Initial sample size = 30 |
| Recruit process error (1970-1977, 2015, 2016) | Log-normal | $\sigma_R$ =1.0 |

# Model parameters

| Population process modeled | Number of parameters | Estimation details |
|---|---|---|
| Recruitment | Years 1970-2016 = 47 | Estimated as log deviances from the log mean; recruitment in 1970-77, and 2015 and 2016 constrained by random deviation process error. |
| Natural mortality | Age-specific= 10 | Not estimated in the model |
| Fishing mortality | Years 1970-2016 = 47 | Estimated as log deviances from the log mean |
| Mean fishery selectivity | 4 | Slope parameters estimated on a log scale, intercept parameters on an arithmetic scale |
| Annual changes in fishery selectivity | 2 * (No. years-1) = 92 | Estimated as deviations from mean selectivity and constrained by random walk process error |
| Survey catchability | No. of surveys + 1 = 7 | Catchabilities estimated on a log scale. Two catchability periods were estimated for the Shelikof Strait acoustic survey. Separate catchabilities were also estimated for age-1 and age-2 winter acoustic indices. |
| Survey selectivity | 6 (Shelikof acoustic survey: 2, BT survey: 2, ADFG survey: 2) | Slope parameters estimated on a log scale. |
| Total | 111 estimated parameters + 92 process error parameters + 10 fixed parameters = 213 | |

# Model input changes

- Fishery:  2015 total catch and catch at age.
- Shelikof Strait acoustic survey: 2016 biomass and age composition.
- NMFS bottom trawl survey:  2015 age composition.
- ADFG crab/groundfish trawl survey:  2016 biomass.

# Alternative Models

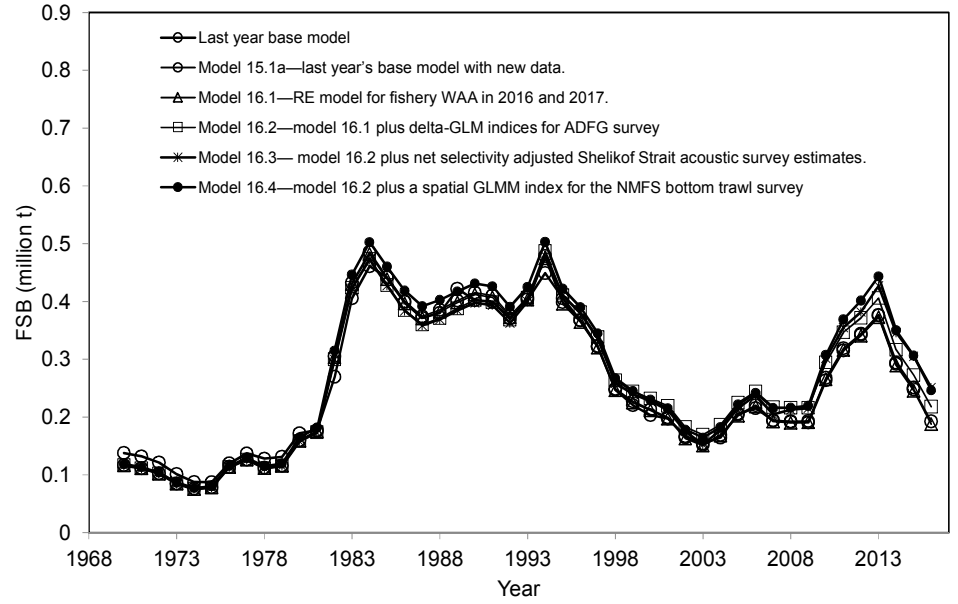
Model 15.1a—last year's base model with new data.

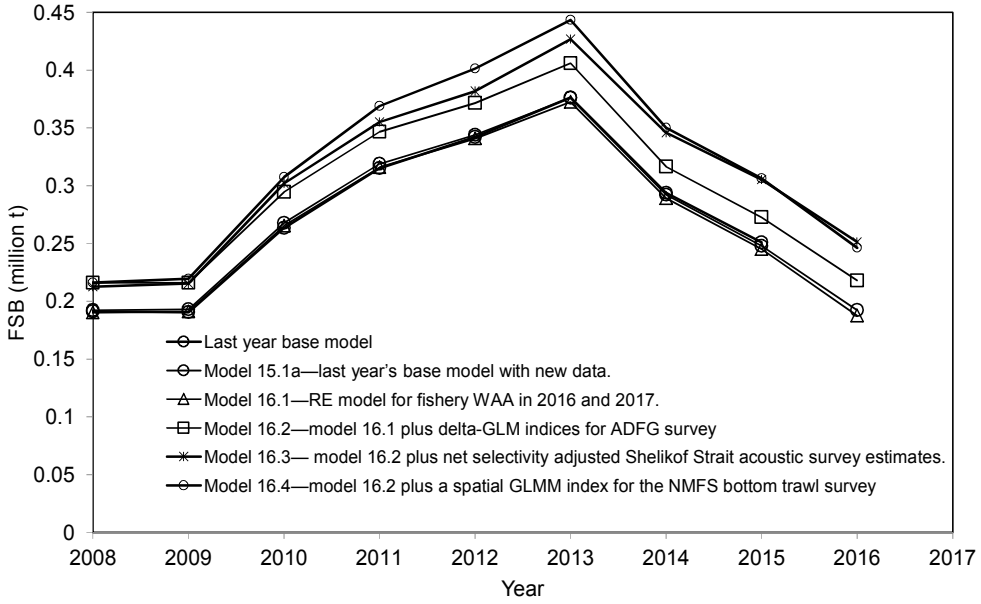
Model 16.1—use random effects model for fishery weight at age in 2016 and 2017.

Model 16.2—model 16.1 plus new indices for the ADFG survey from a delta-GLM model instead of area-swept estimates.

Model 16.3— model 16.2 plus revised Shelikof Strait acoustic survey estimates for net selectivity.

Model 16.4—model 16.2 plus a spatial GLMM index for the NMFS bottom trawl survey instead of area-swept estimates.



Model 15.1a—last year's base model with new data.

Model 16.1—use random effects model for fishery weight at age in 2016 and 2017.

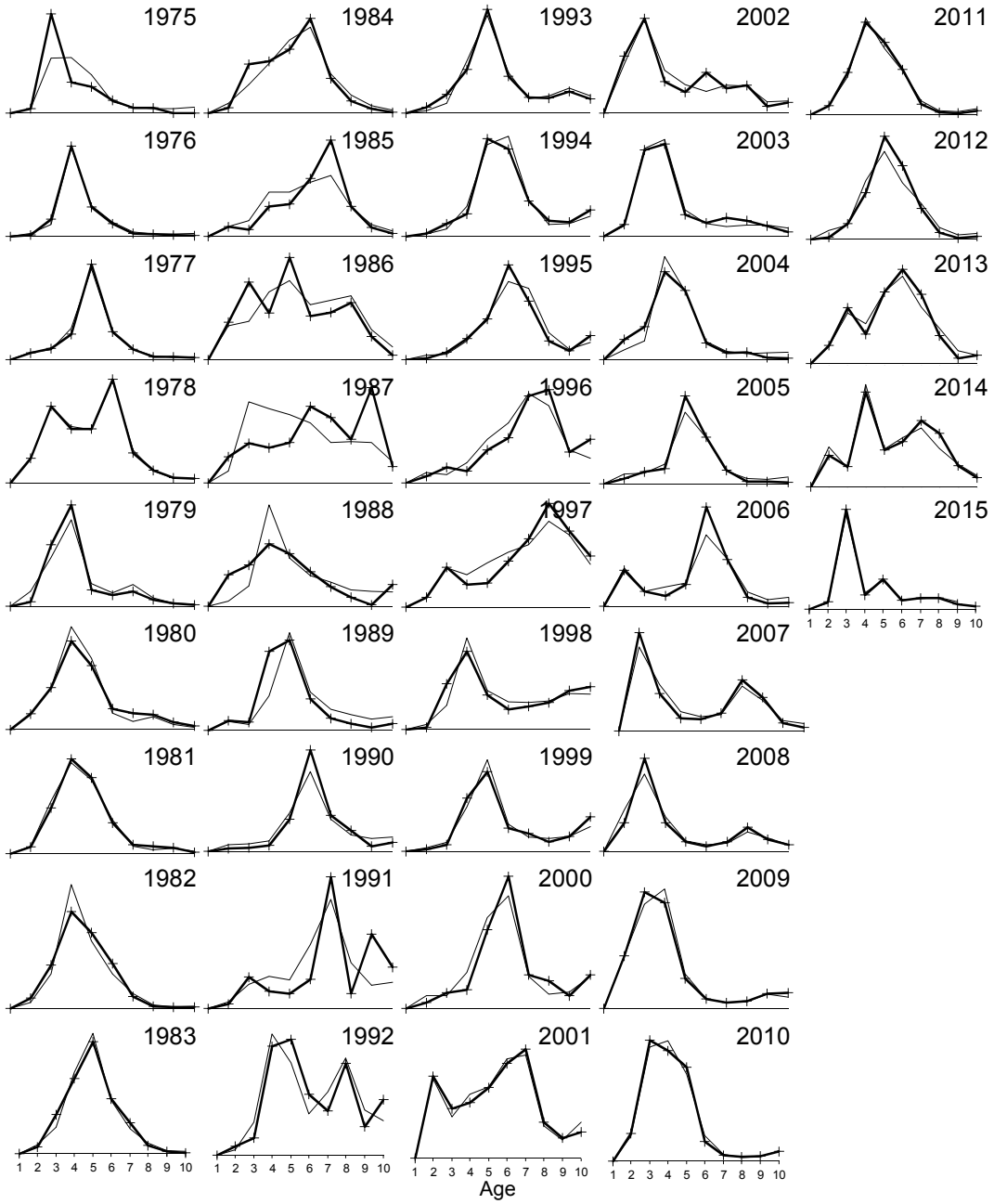
Model 16.2—model 16.1 plus new indices for the ADFG survey from a delta-GLM model instead of area-swept estimates.

Model 16.3— model 16.2 plus revised Shelikof Strait acoustic survey estimates for net selectivity.

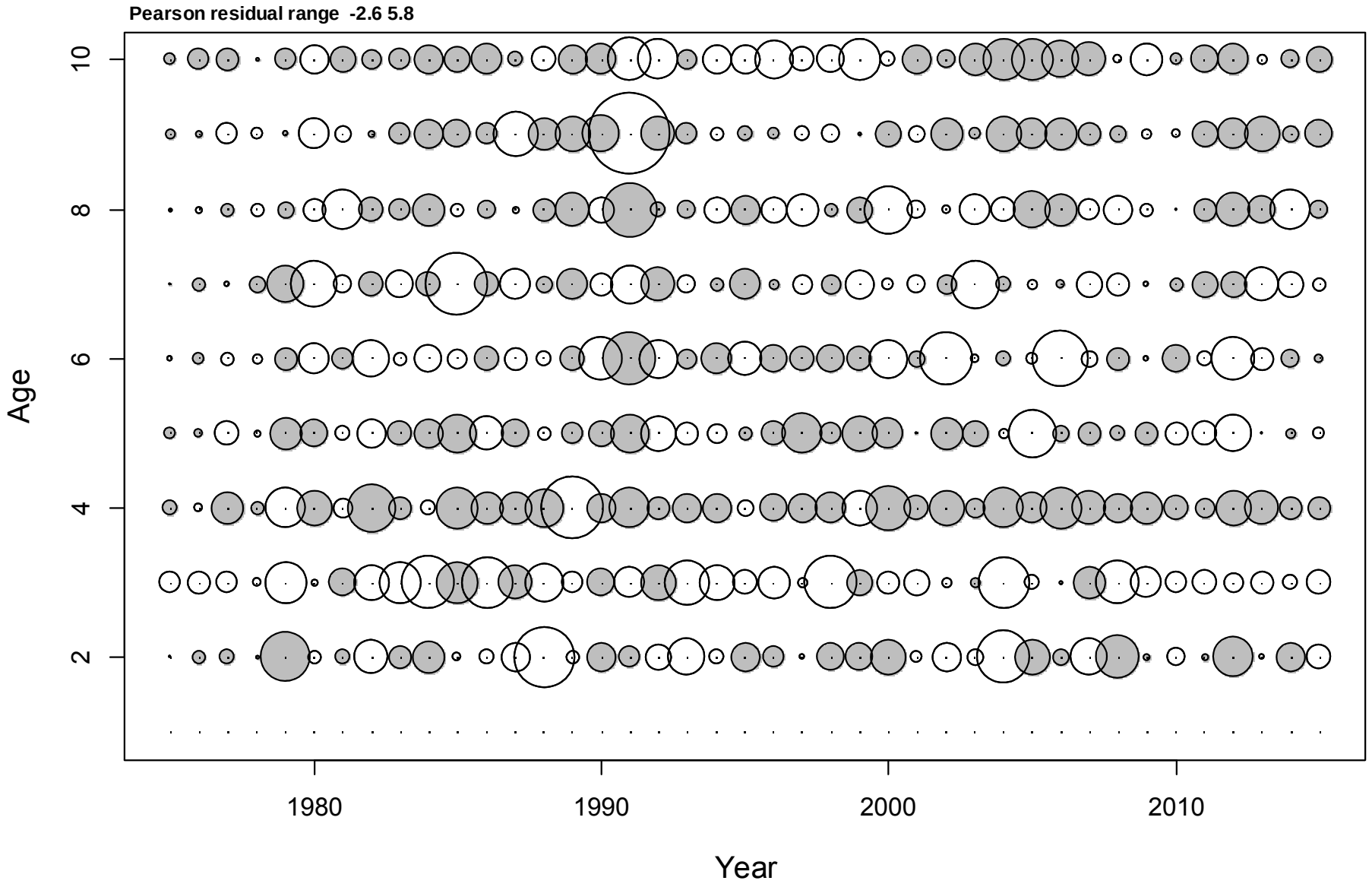
Model 16.4—model 16.2 plus a spatial GLMM index for the NMFS bottom trawl survey instead of area-swept estimates.

| | *Model 15.1a* | *Model 16.1* | *Model 16.2* | *Model 16.3* | *Model 16.4* |
|---|---|---|---|---|---|
| **Model fits** | | | | | |
| Total log(Likelihood) | -390.84 | -389.95 | -390.53 | -400.09 | -405.75 |
| Catch | -0.10 | -0.10 | -0.09 | -0.09 | -0.09 |
| Fishery age | -137.69 | -137.72 | -138.69 | -138.38 | -137.49 |
| Acoustic survey biomass | -44.61 | -44.68 | -44.26 | -52.49 | -45.03 |
| Age-1 and age-2 indices | -25.34 | -25.34 | -25.18 | -25.11 | -25.22 |
| Acoustic survey age | -38.05 | -38.03 | -38.68 | -38.43 | -38.50 |
| Bottom trawl survey biomass | -9.37 | -9.38 | -8.44 | -6.38 | -19.67 |
| Bottom trawl survey age and length comp | -36.95 | -36.97 | -37.67 | -37.57 | -37.31 |
| ADFG trawl survey biomass | -40.09 | -39.06 | -39.19 | -44.34 | -44.83 |
| ADFG trawl survey age | -25.99 | -25.98 | -25.89 | -25.84 | -25.50 |
| Summer acoustic biomass | -1.29 | -1.29 | -1.08 | -0.92 | -1.05 |
| Summer acoustic age and length comp. | -2.28 | -2.27 | -2.06 | -1.87 | -2.04 |
| Priors/Penalties | -29.09 | -29.13 | -29.30 | -28.67 | -29.01 |
| Composition data | | | | | |
| Fishery age comp. effective N | 118 | 118 | 119 | 119 | 119 |
| Shelikof Strait acoustic age comp. effective N | 10 | 10 | 10 | 10 | 10 |
| NMFS bottom trawl age comp. effective N | 29 | 29 | 28 | 28 | 28 |
| ADF&G trawl age comp. effective N | 33 | 33 | 32 | 32 | 33 |
| Survey abundance | | | | | |
| Shelikof Strait Acoustic RMSE | | | | | |
| EK500 | 0.26 | 0.26 | 0.27 | 0.38 | 0.28 |
| Dyson | 0.56 | 0.56 | 0.55 | 0.52 | 0.55 |
| Age-1 index | 1.31 | 1.31 | 1.30 | 1.30 | 1.30 |
| Age-2 index | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 |
| NMFS bottom trawl RMSE | 0.27 | 0.27 | 0.26 | 0.25 | 0.23 |
| ADFG trawl RMSE | 0.44 | 0.43 | 0.43 | 0.46 | 0.46 |
| Summer acoustic RMSE | 0.28 | 0.28 | 0.26 | 0.24 | 0.26 |
| **Catchability estimates** | | | | | |
| NMFS trawl | 0.89 | 0.89 | 0.86 | 0.86 | 0.88 |
| Shelikof Strait acoustic | | | | | |
| Miller Freeman | 0.56 | 0.56 | 0.52 | 0.39 | 0.50 |
| Dyson | 0.62 | 0.62 | 0.58 | 0.44 | 0.55 |
| Age-1 index linear term | 0.09 | 0.09 | 0.08 | 0.07 | 0.07 |
| Age-1 index power term | 1.20 | 1.20 | 1.19 | 1.16 | 1.17 |
| Age-2 index | 0.63 | 0.64 | 0.59 | 0.56 | 0.56 |
| Summer acoustic | 0.98 | 0.98 | 0.87 | 0.77 | 0.79 |
| ADFG trawl | 0.16 | 0.17 | 0.63 | 0.64 | 0.62 |
| **Stock status (t)** | | | | | |
| 2017 Spawning biomass | 315,340 | 292,682 | 352,850 | 419,258 | 400,216 |
| Depletion (B2017/B0) | 49% | 46% | 53% | 62% | 58% |
| $B_{40\%}$ | 257,075 | 255,713 | 265,457 | 271,403 | 275,740 |
| **2016 yield (1000 t)** | | | | | |
| Author's recommended ABC | 231,263 | 156,859 | 197,906 | 235,919 | 221,539 |

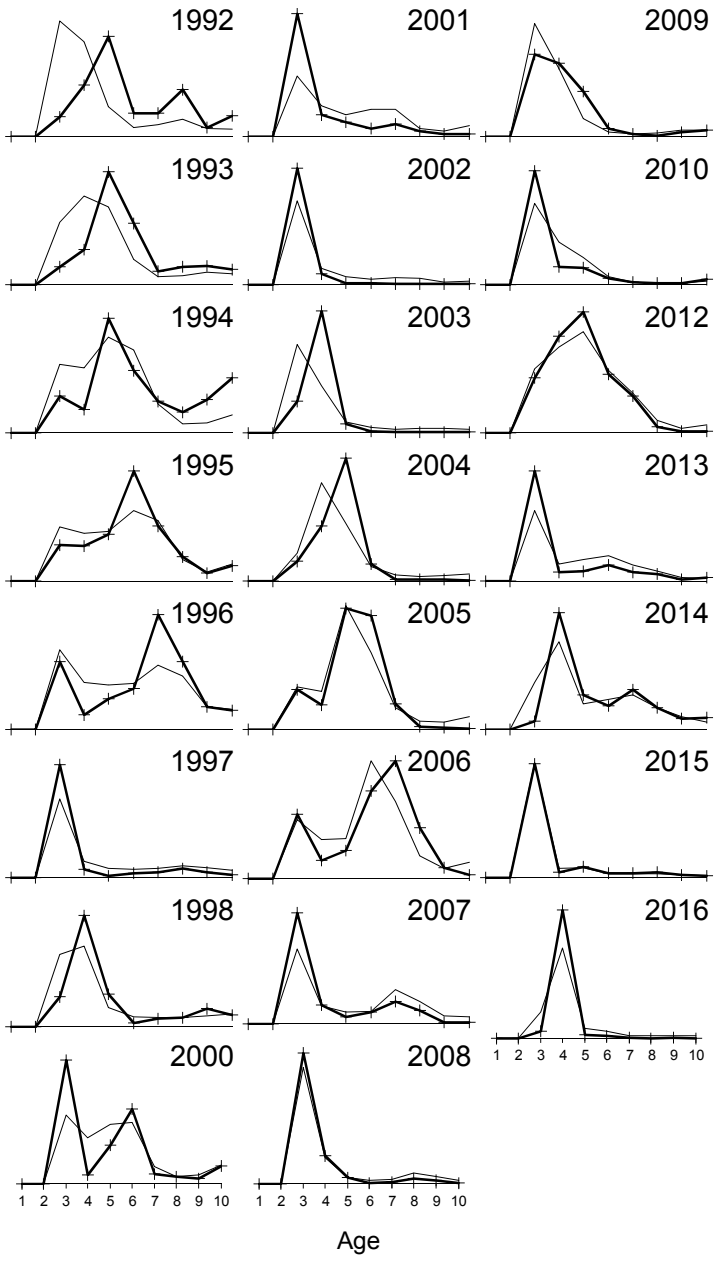
# Fishery age composition (predicted vs observed)



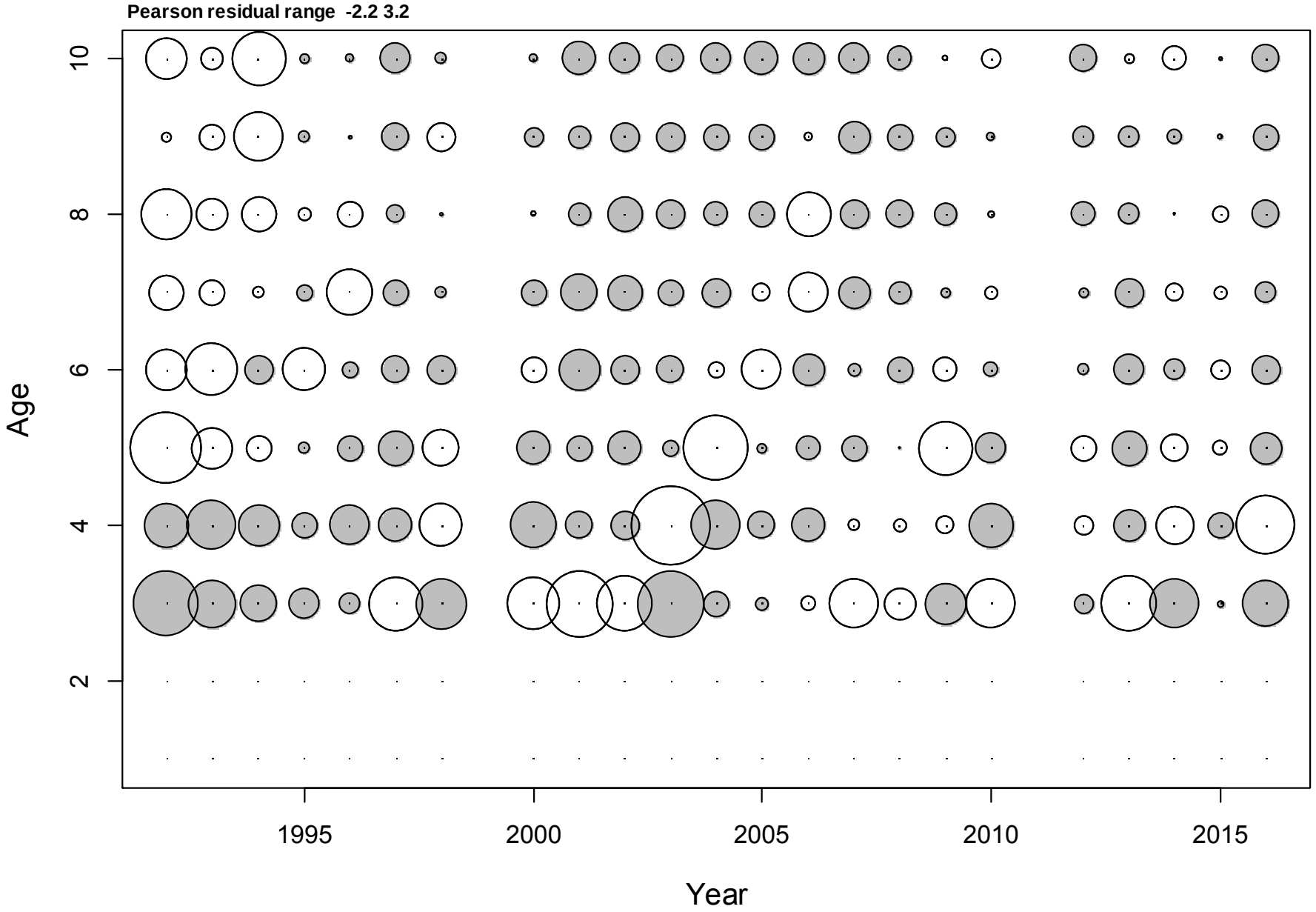
# Fishery age composition (residuals)



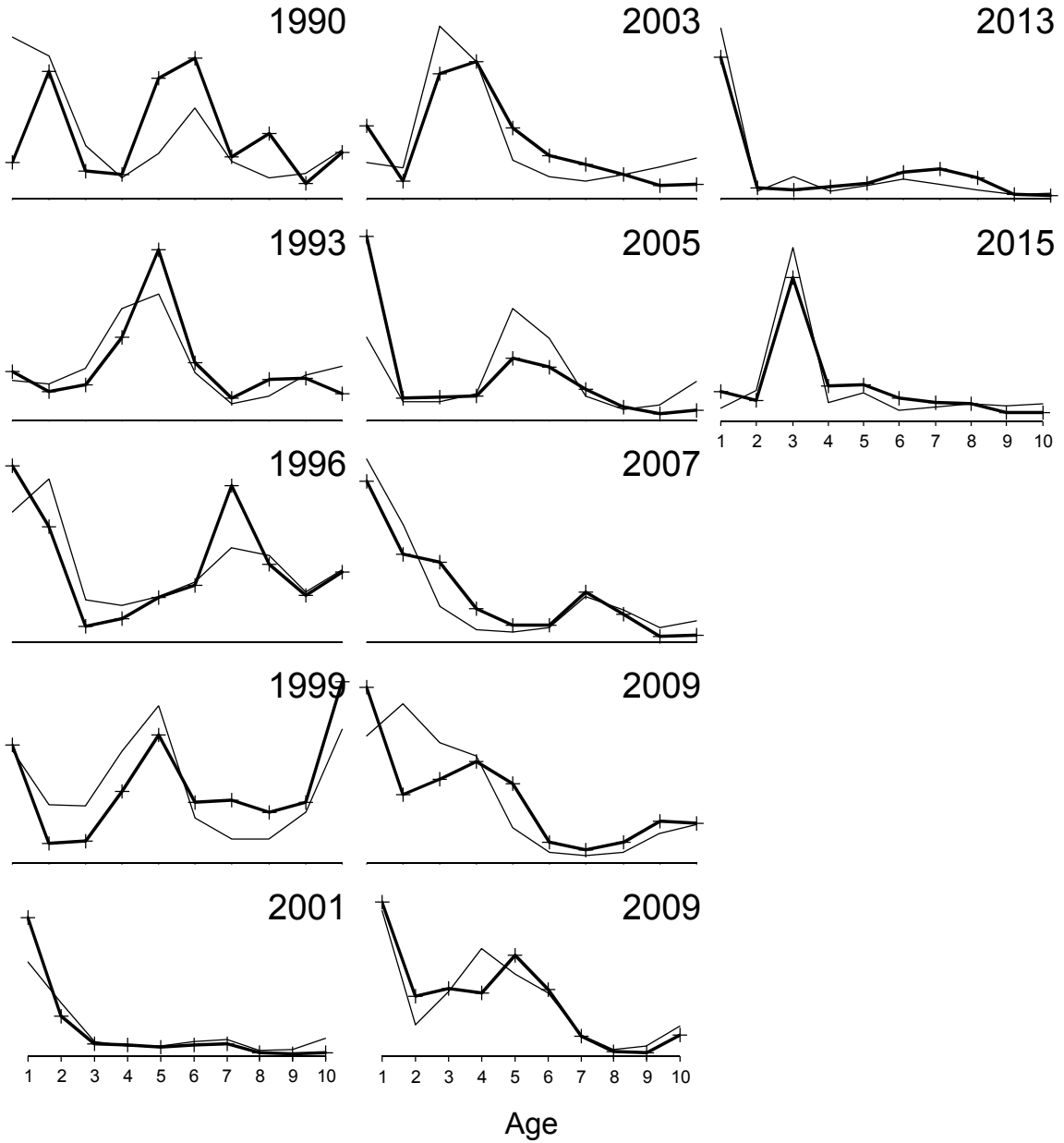
# Shelikof Strait EIT age composition (predicted vs observed)



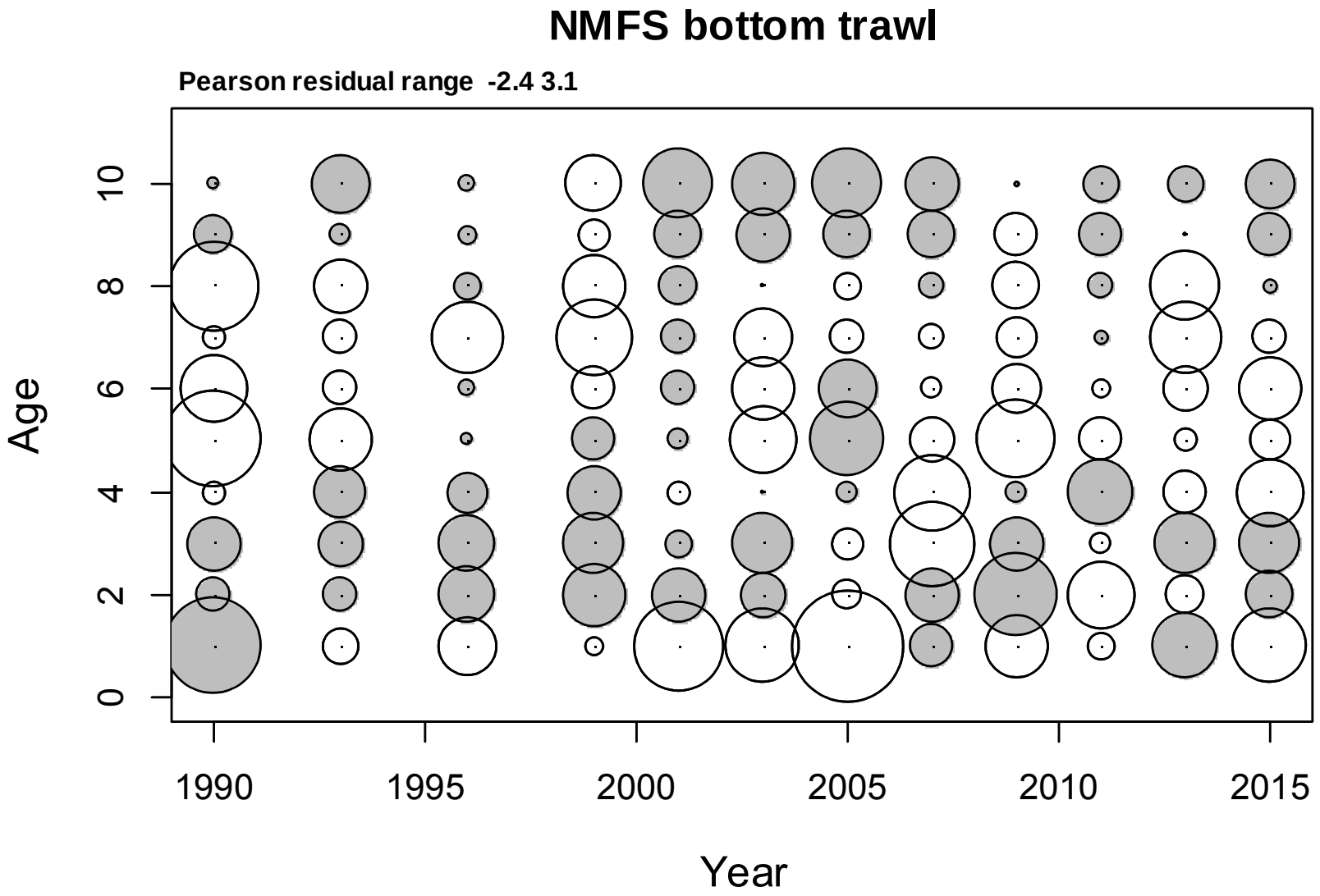
# Shelikof Strait EIT age composition (residuals)



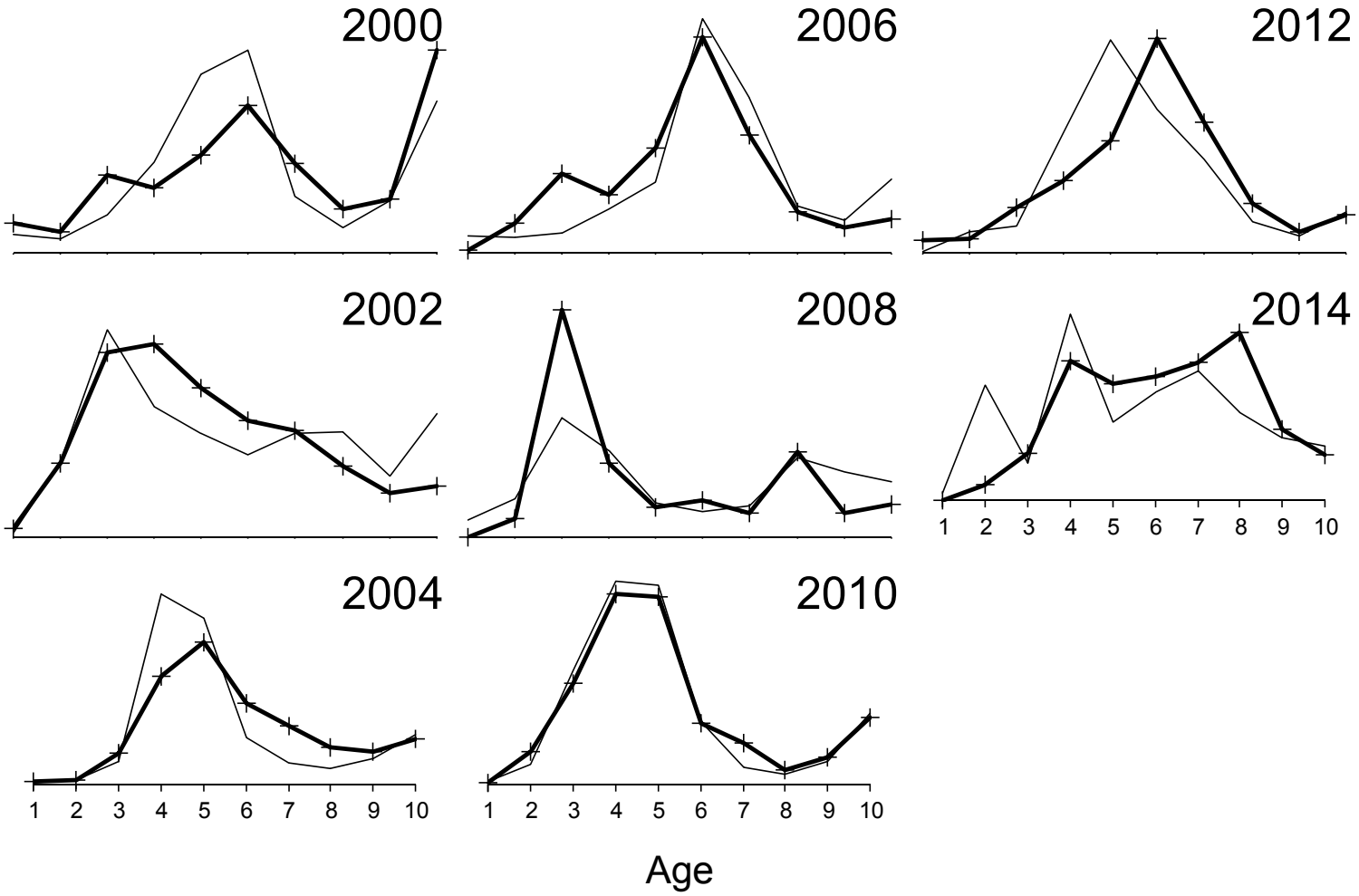
# NMFS bottom trawl age composition (predicted vs observed)



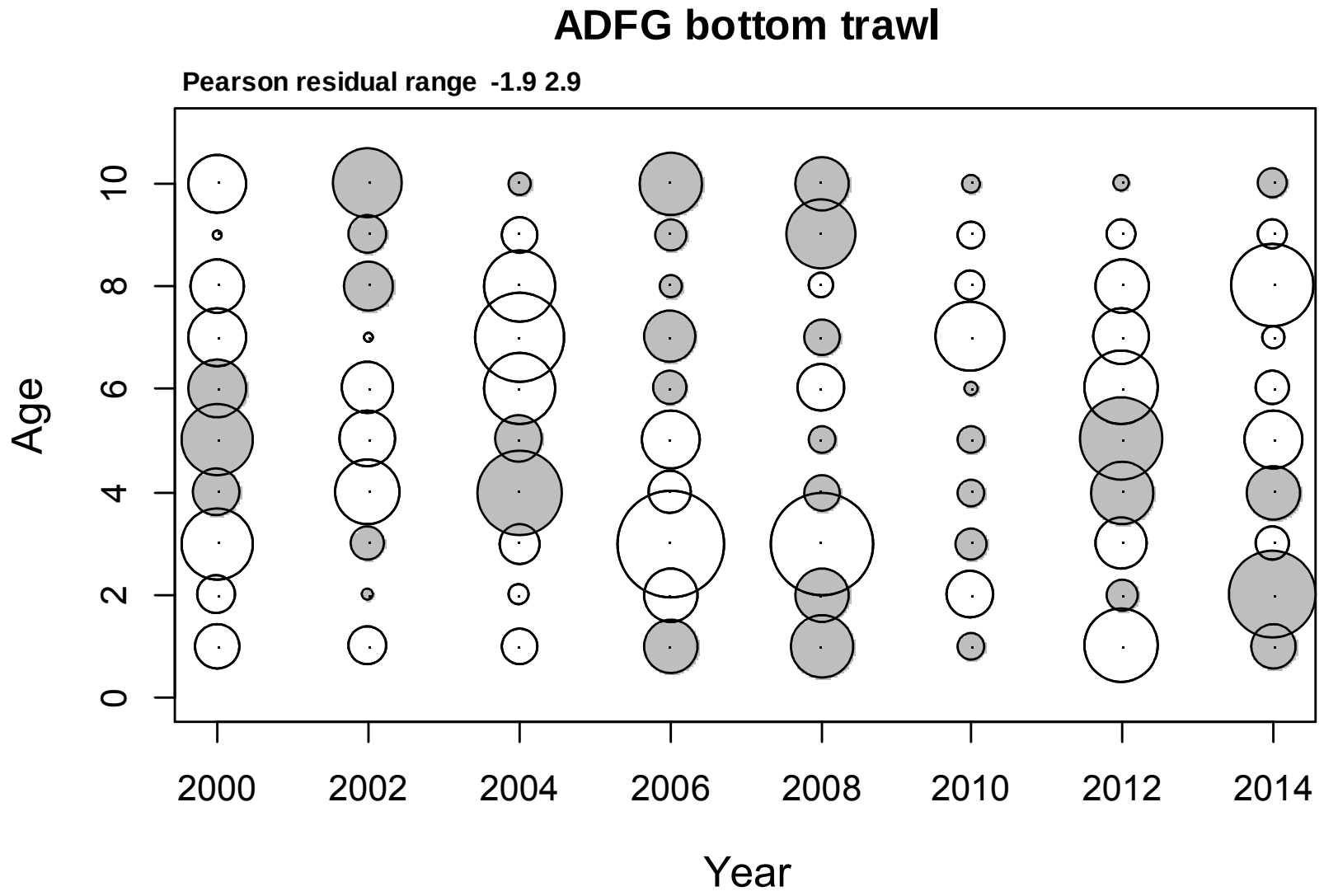
# NMFS bottom trawl age composition (residuals)



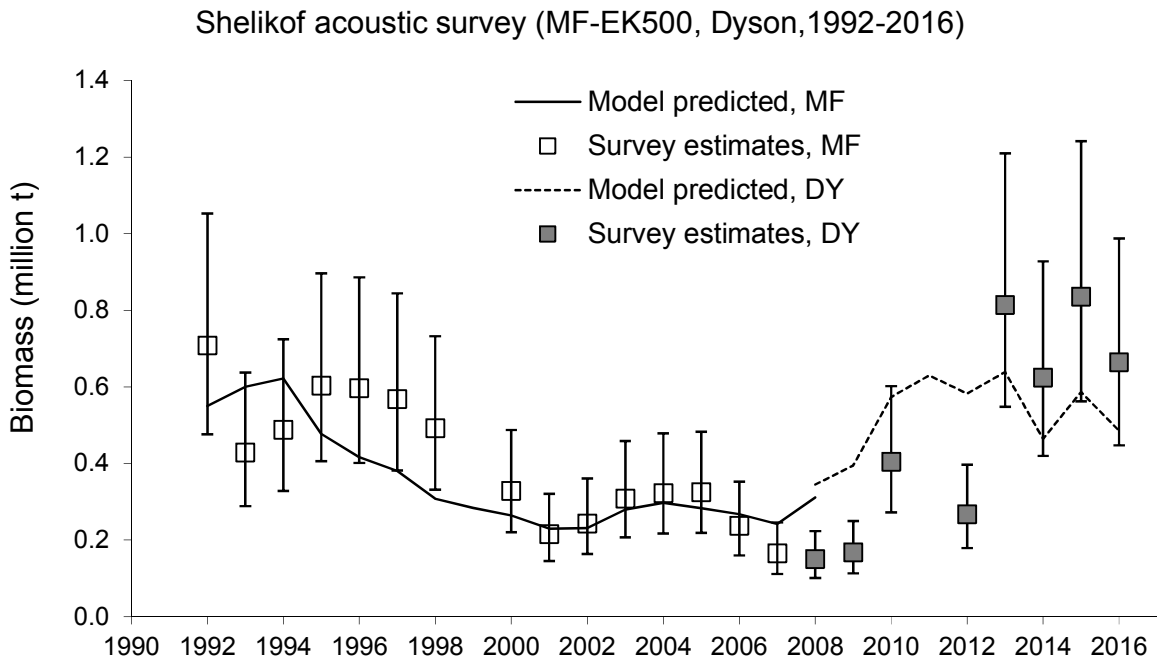
# ADFG bottom trawl age composition (predicted vs observed)



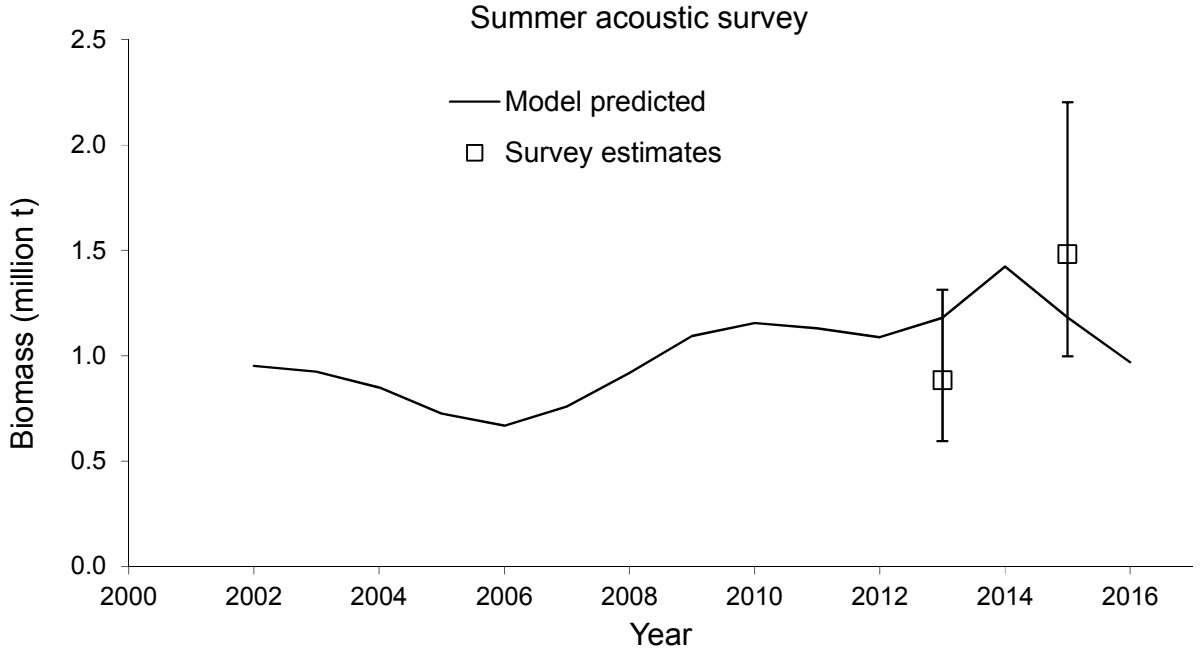
# ADFG bottom trawl age composition (residuals)



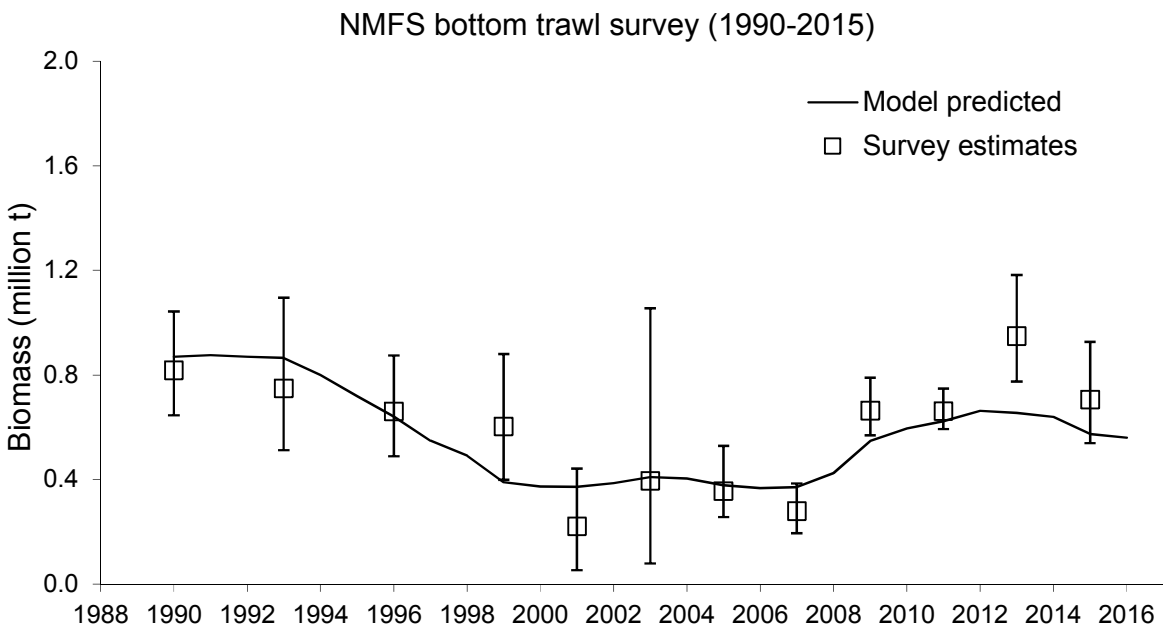
# Fit to Shelikof Strait acoustic survey



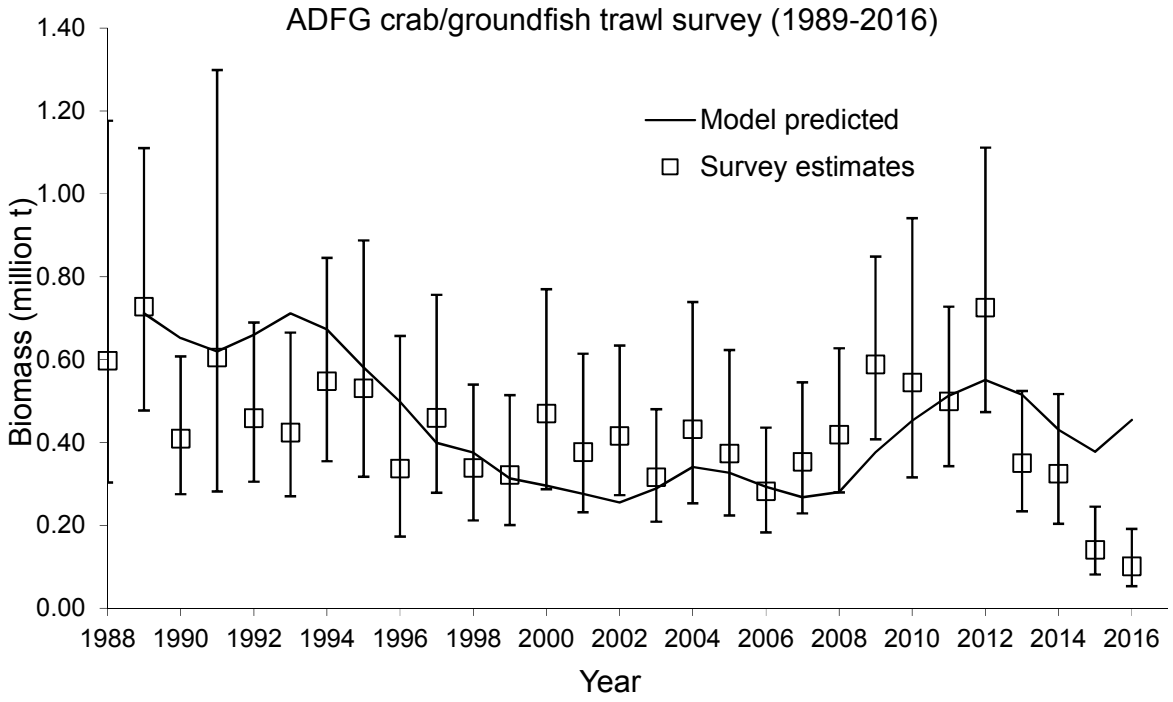

# Fit to summer Acoustic survey



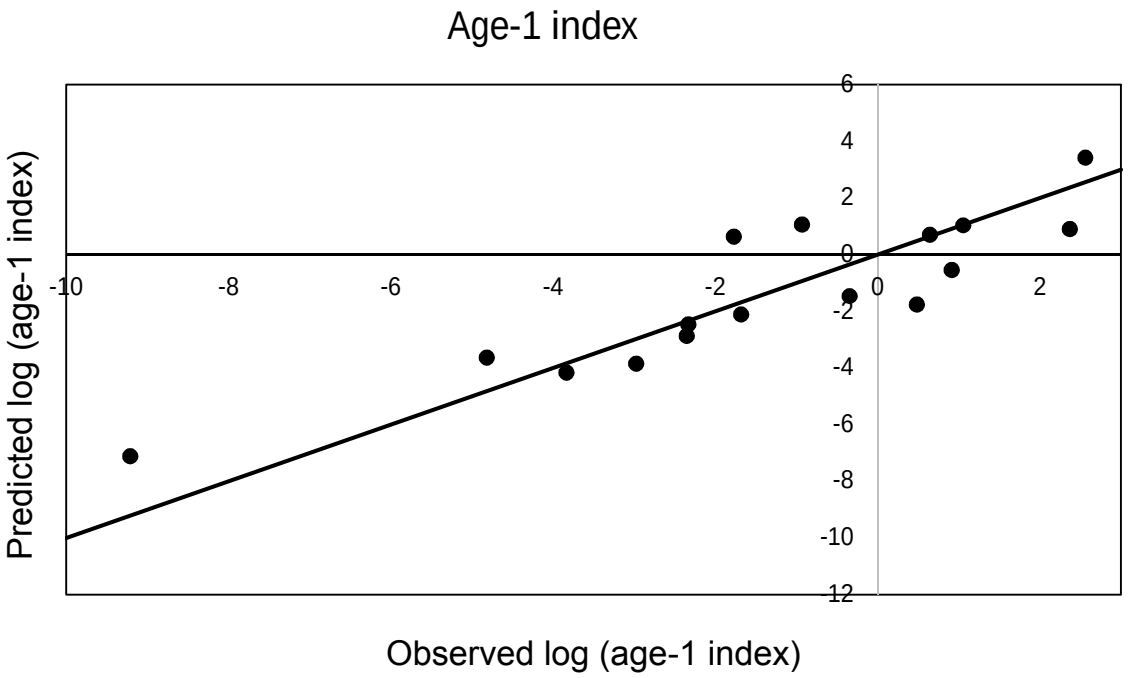
# Fit to NMFS bottom trawl survey



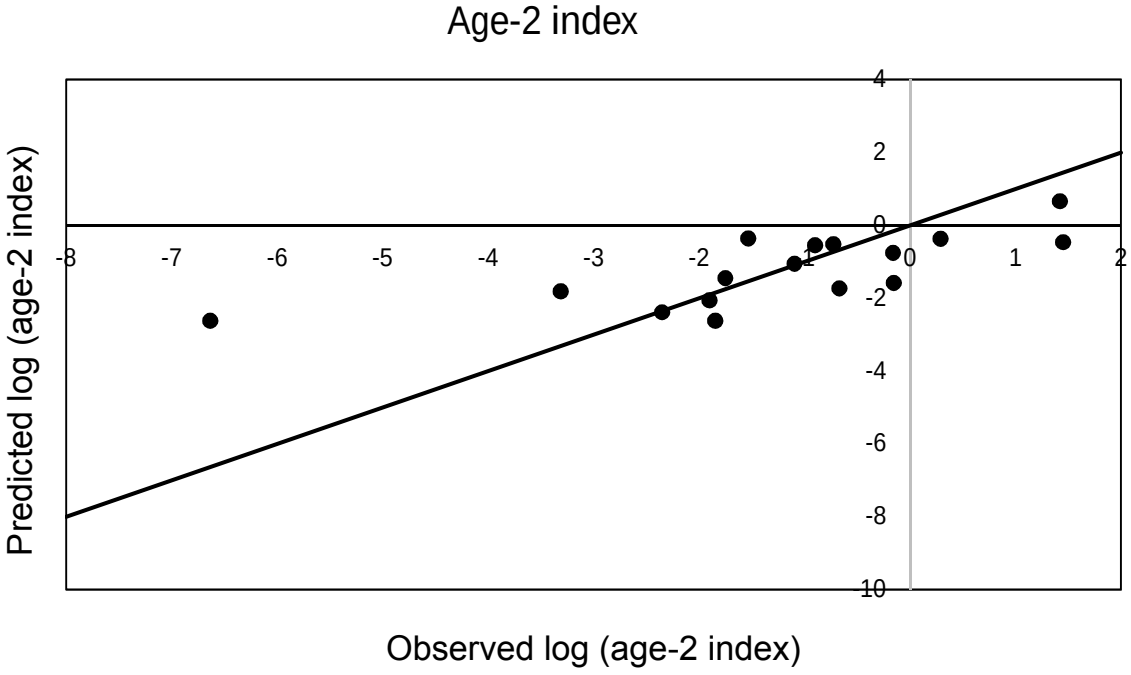

# Fit to ADFG survey



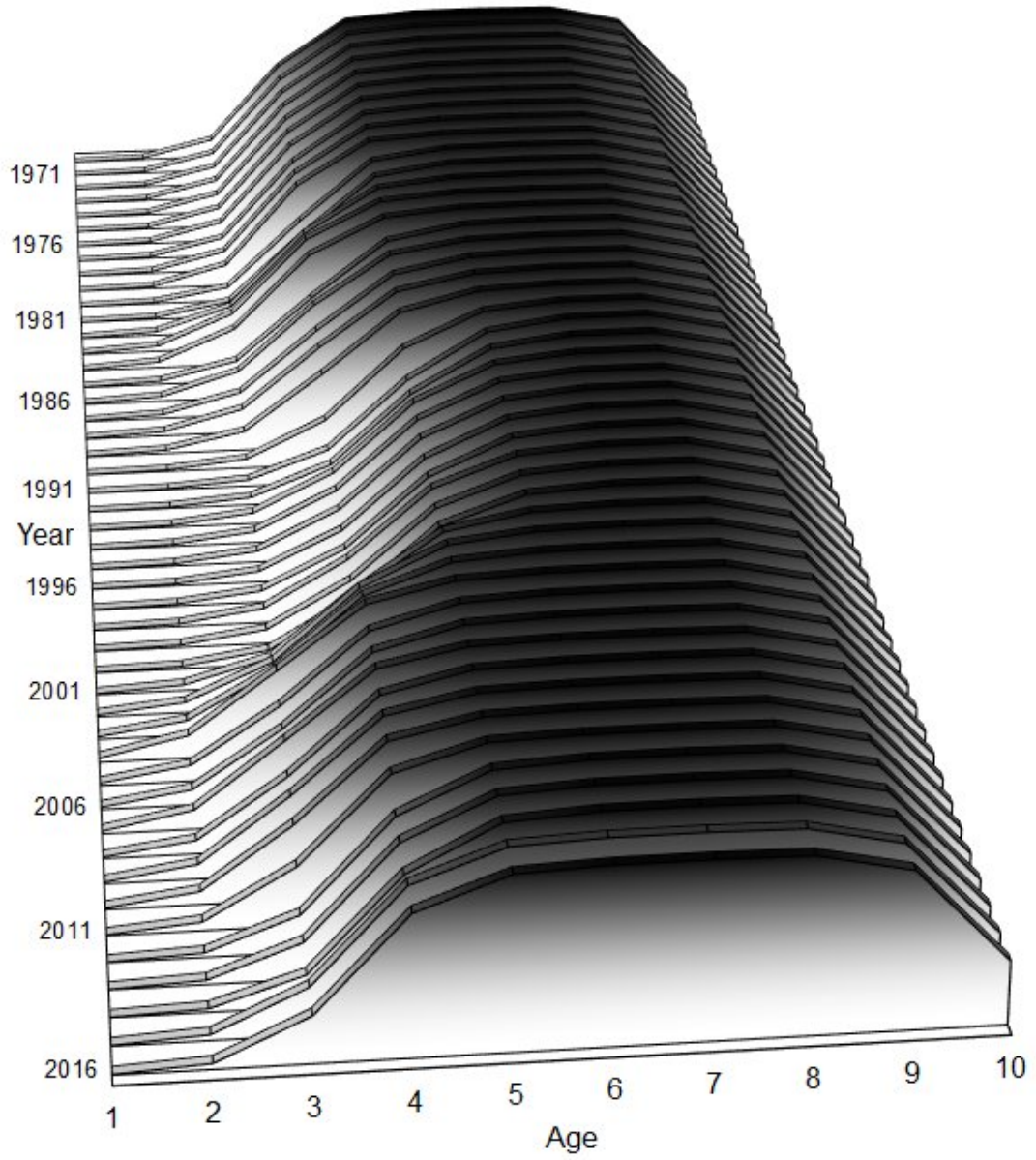
# Fit to Age-1 index



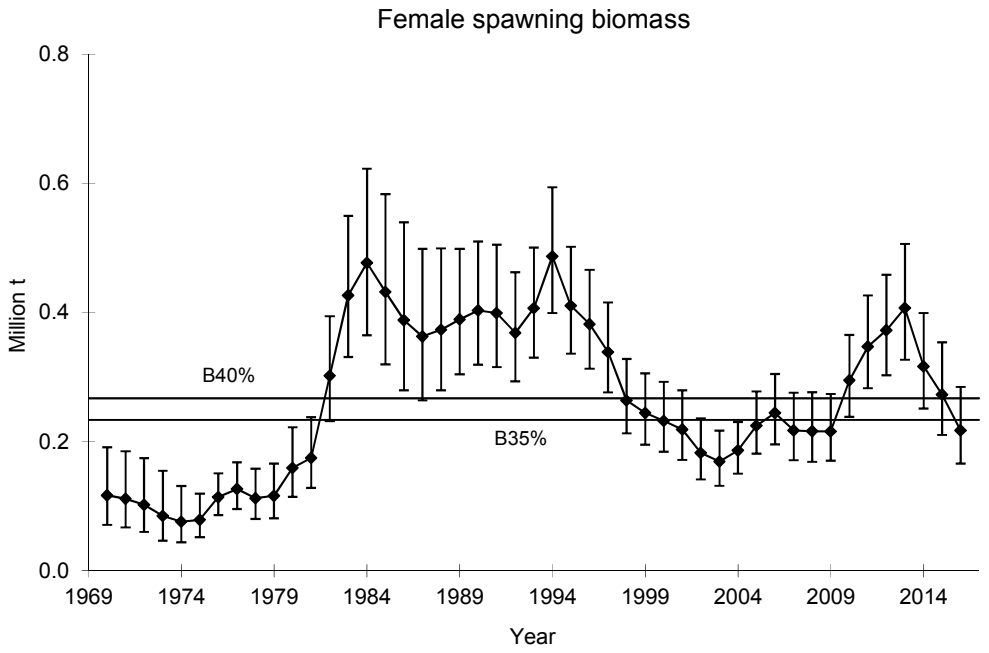

# Fit to Age-2 index



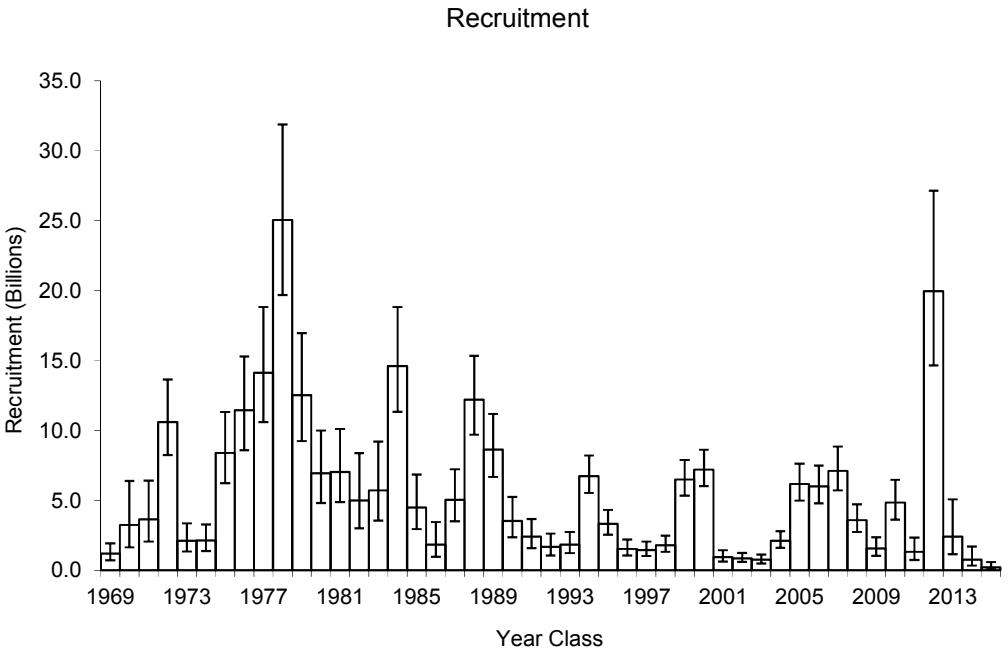
# Fishery selectivity



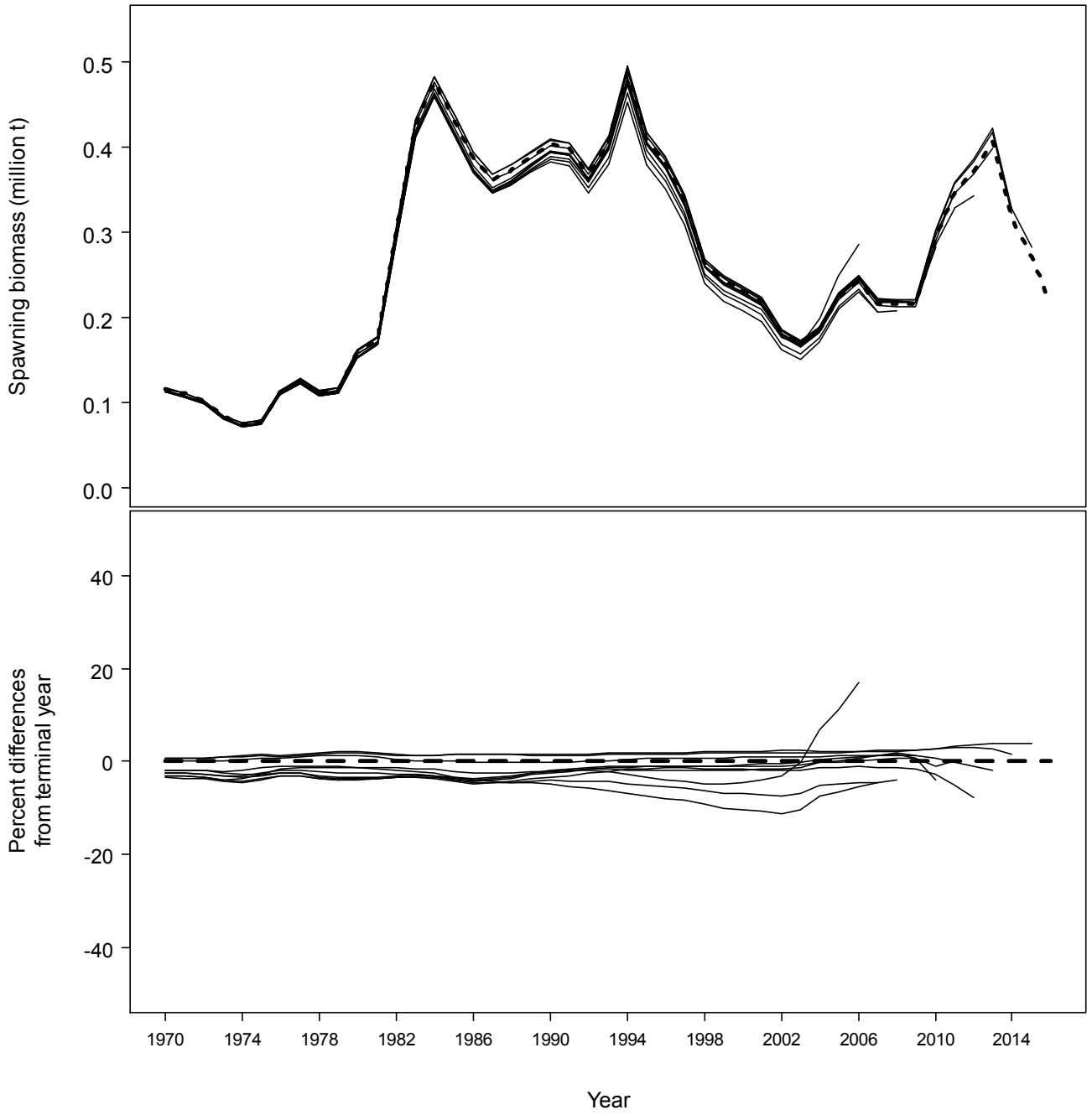
# Spawning biomass



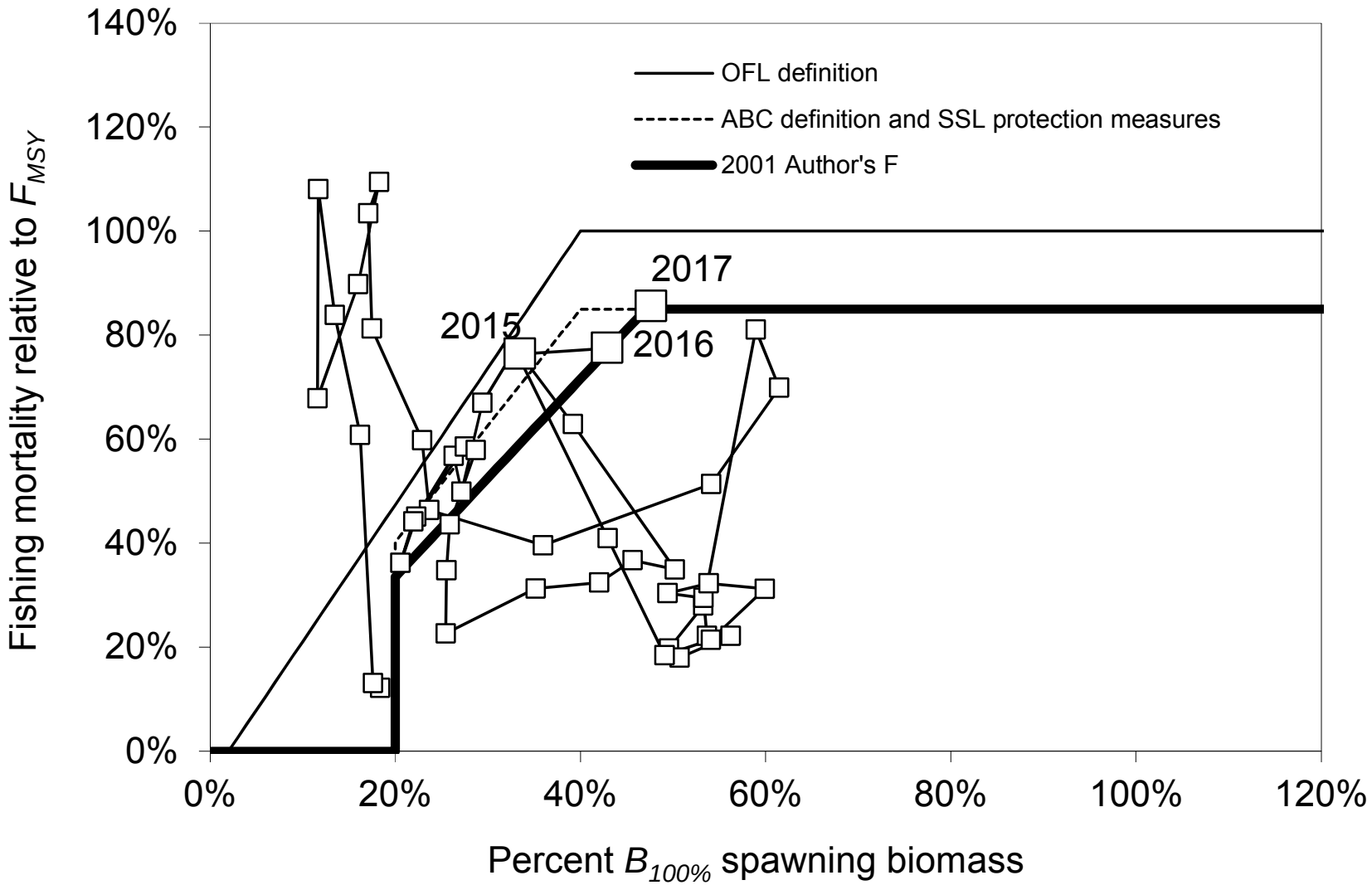

# Recruitment



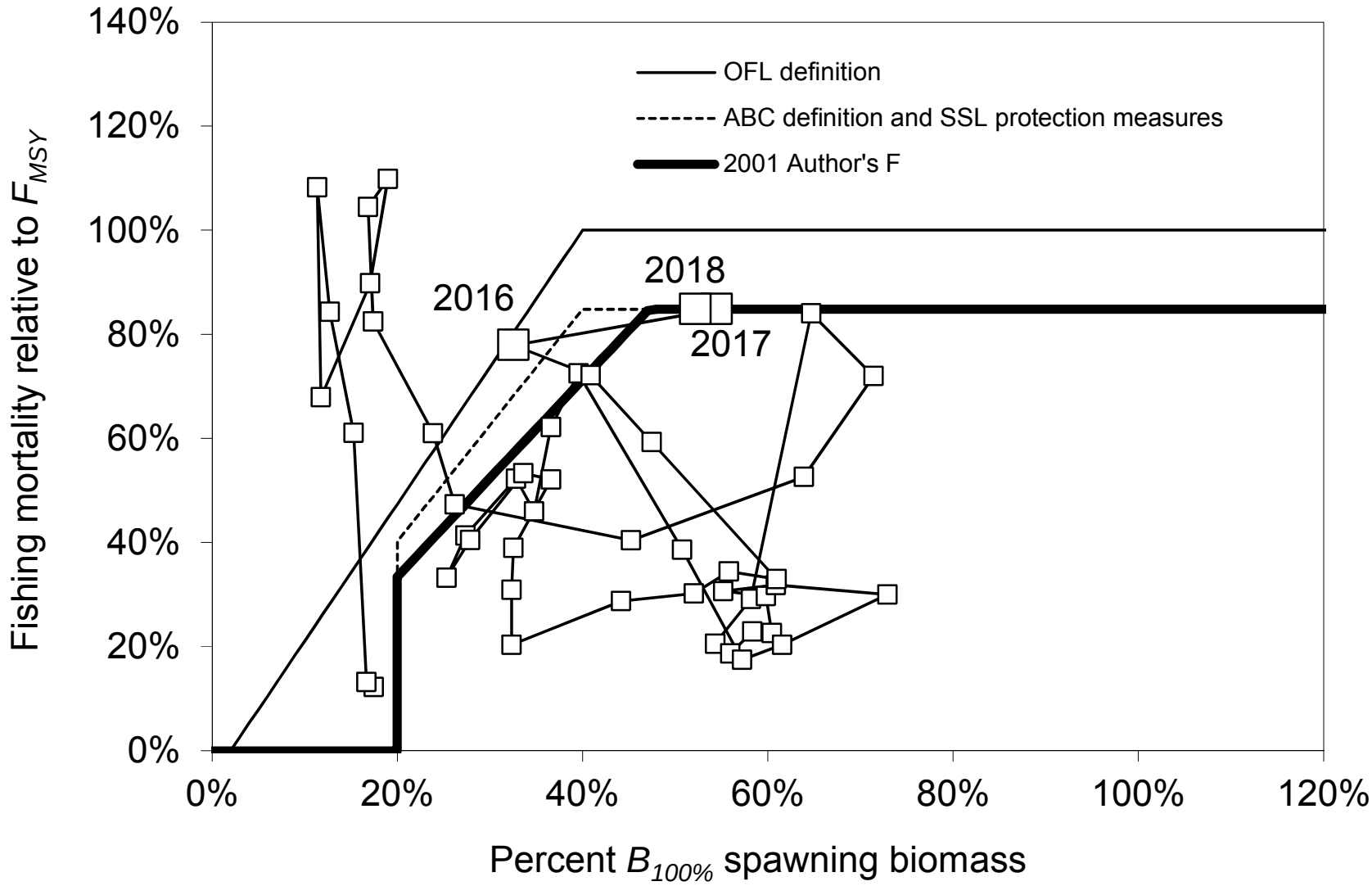
# Retrospective plot



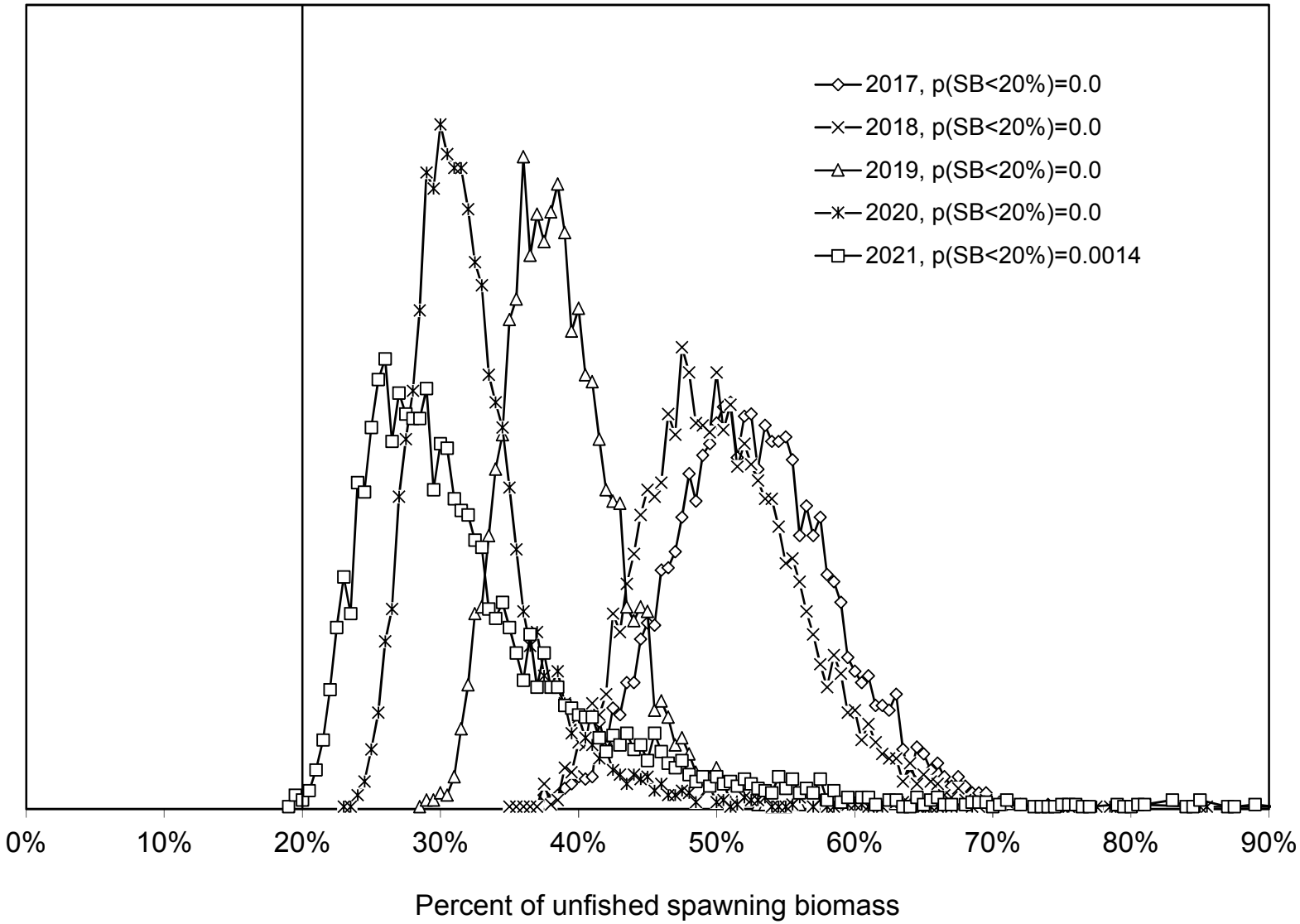
# Spawning biomass vs fishing mortality (last year)



# Spawning biomass vs fishing mortality (this year)

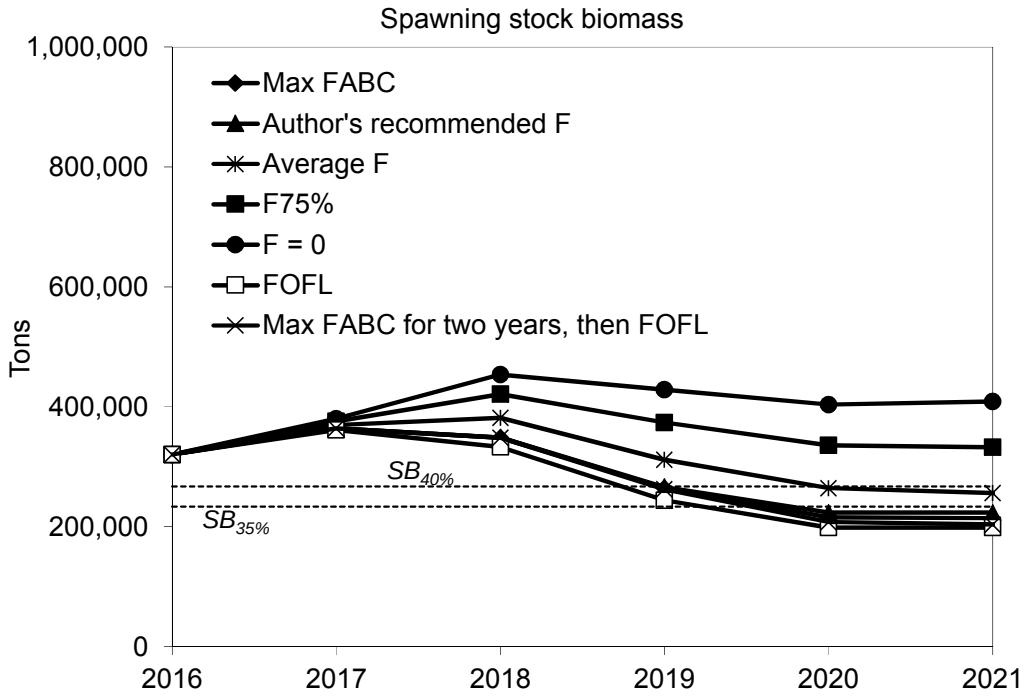


# 5-year pr(SB<B20%)

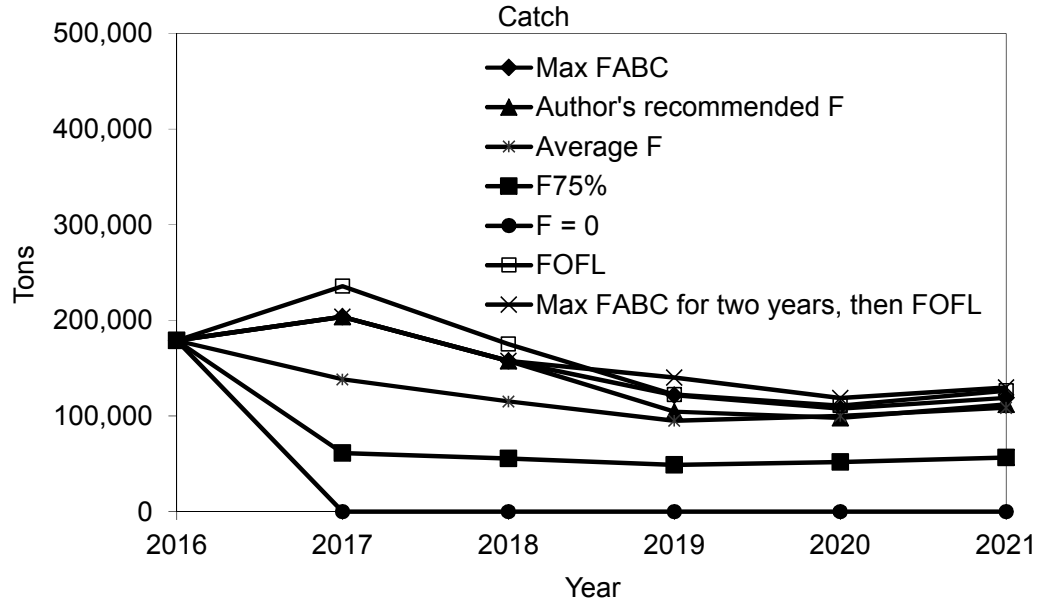


5-year projections

Mean spawning biomass

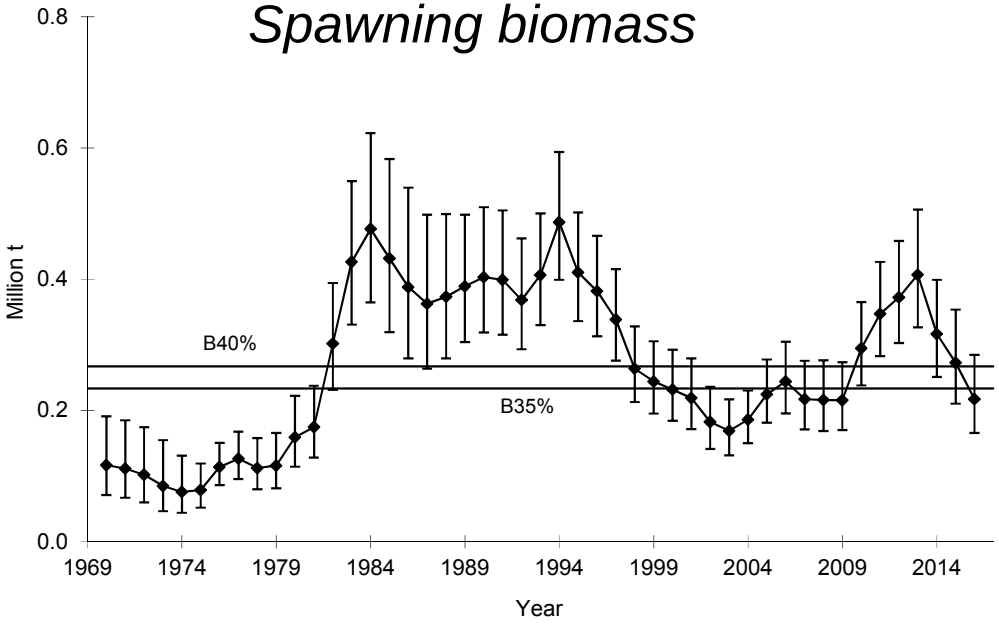



Mean yield

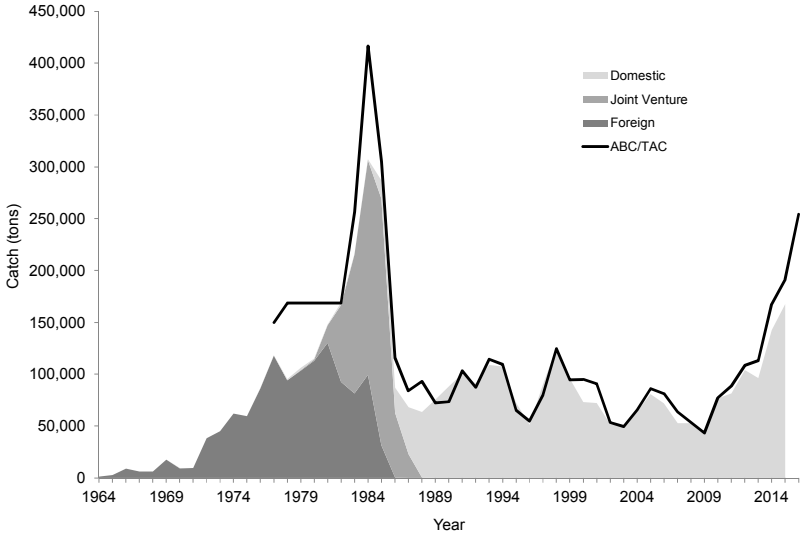


*Gulf of Alaska pollock*

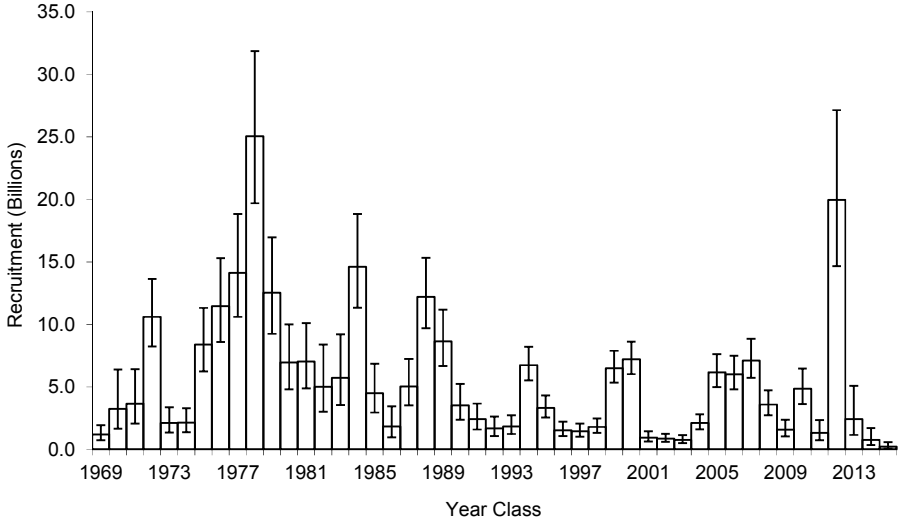
## *Spawning biomass*



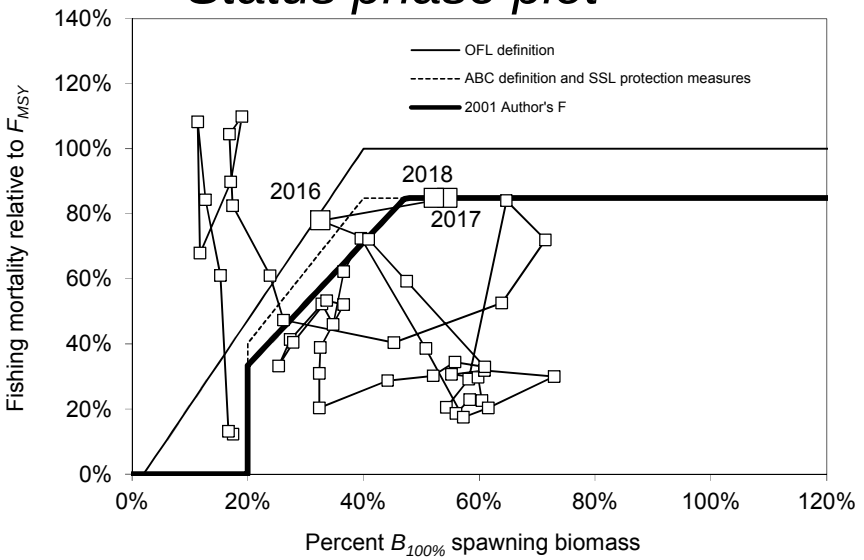

## *Catch*




## *Recruitment*




## *Status phase plot*

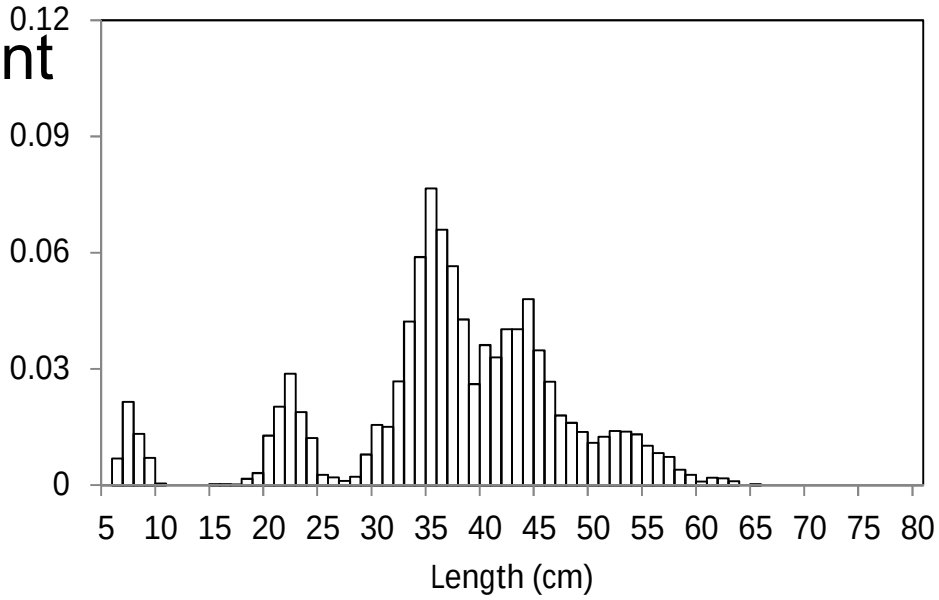


# Summary table

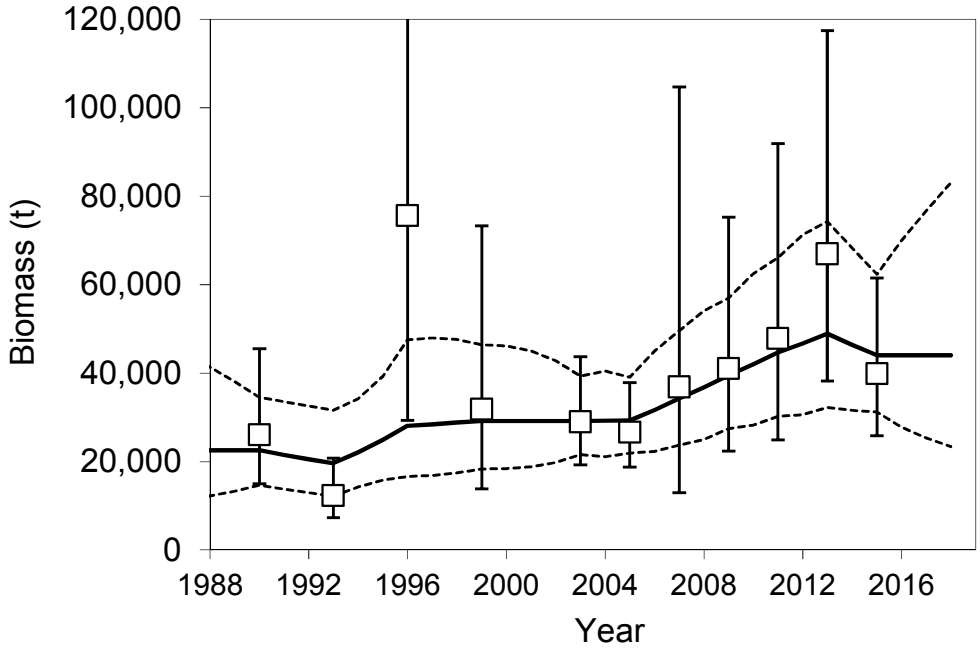
| **Quantity/Status** | As estimated or specified *last* year for 2016 | 2017 | As estimated or specified *this* year for 2017 | 2018 |
|---|---|---|---|---|
| *M* (natural mortality rate) | 0.3 | 0.3 | 0.3 | 0.3 |
| Tier | 3a | 3a | 3a | 3a |
| Projected total (age 3+) biomass (t) | 1,937,900 | 1,543,100 | 1,391,290 | 991,030 |
| Female spawning biomass (t) | 321,626 | 357,193 | 363,800 | 348,330 |
| $B_{100\%}$ | 750,000 | 750,000 | 667,000 | 667,000 |
| $B_{40\%}$ | 300,000 | 300,000 | 267,000 | 267,000 |
| $B_{35\%}$ | 262,000 | 262,000 | 234,000 | 234,000 |
| $F_{OFL}$ | 0.29 | 0.29 | 0.30 | 0.30 |
| $maxF_{ABC}$ | 0.25 | 0.25 | 0.25 | 0.25 |
| $F_{ABC}$ | 0.23 | 0.25 | 0.25 | 0.25 |
| OFL (t) | 322,858 | 289,937 | 235,807 | 182,204 |
| maxABC (t) | 278,385 | 250,544 | 203,769 | 157,496 |
| ABC (t) | 254,310 | 250,544 | 203,769 | 157,496 |
| **Status** | As determined *last* year for 2014 | 2015 | As determined *this* year for 2015 | 2016 |
| Overfishing | No | n/a | No | n/a |
| Overfished | n/a | No | n/a | No |
| Approaching overfished | n/a | No | n/a | No |

Southeast Alaska Assessment

2015 length composition




Biomass trend



# Winter apportionment table (example calculations for one area)

| *Survey* | *Year* | *Model estimates of total 2+ biomass at spawning* | *Survey biomass estimate* | *Multiplier from vessel comparison (OD/MF)* | *Percent* | *Percent by management area* | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | *Area 610* | *Area 620* | *Area 630* |
| Shelikof | 2013 | 1,227,590 | 831,486 | 1.00 | 67.7% | 0.0% | 95.0% | 5.0% |
| Shelikof | 2014 | 1,130,420 | 883,177 | 1.00 | 78.1% | 0.0% | 96.7% | 3.3% |
| Shelikof | 2015 | 1,160,190 | 845,210 | 1.00 | 72.9% | 0.0% | 91.9% | 8.1% |
| Shelikof | 2016 | 934,934 | 665,059 | 1.00 | 71.1% | 0.0% | 79.3% | 20.7% |
| Shelikof | Average | | | | 72.5% | 0.0% | 90.7% | 9.3% |
| | Percent of total 2+ biomass | | | | | 0.0% | 65.7% | 6.7% |

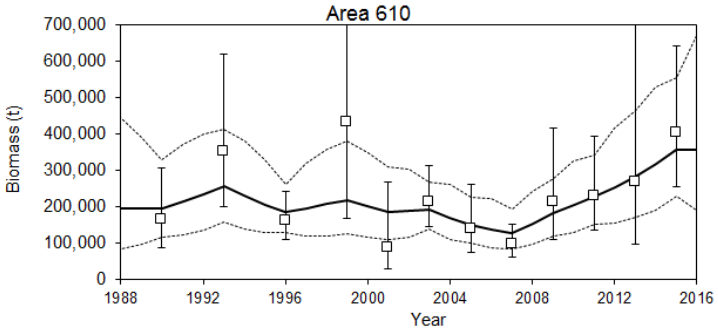
# Winter apportionment table

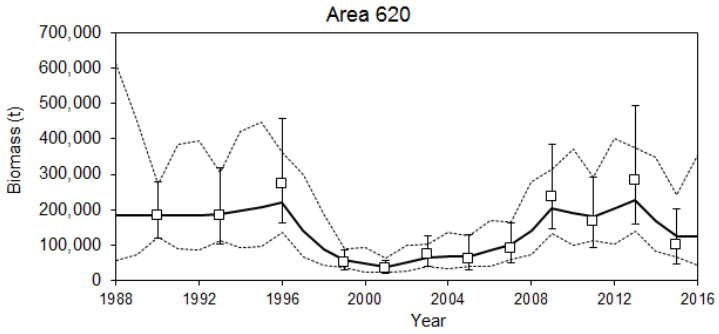
| *Survey* | *Year* | *Model estimates of total 2+ biomass at spawning* | *Survey biomass estimate* | *Multiplier from vessel comparison (OD/MF)* | *Percent* | *Percent by management area* | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | *Area 610* | *Area 620* | *Area 630* |
| Shelikof | Average | | | | 72.5% | 0.0% | 90.7% | 9.3% |
| | Percent of total 2+ biomass | | | | | 0.0% | 65.7% | 6.7% |
| Chirikof | Average | | | | 2.2% | 0.0% | 27.4% | 72.6% |
| | Percent of total 2+ biomass | | | | | 0.0% | 0.6% | 1.6% |
| Marmot | Average | | | | 2.2% | 0.0% | 0.0% | 100.0% |
| | Percent of total 2+ biomass | | | | | 0.0% | 0.0% | 2.2% |
| Shumagin | Average | | | | 3.6% | 66.4% | 33.6% | 0.0% |
| | Percent of total 2+ biomass | | | | | 2.4% | 1.2% | 0.0% |
| Sanak | Average | | | | 0.9% | 100.0% | 0.0% | 0.0% |
| | Percent of total 2+ biomass | | | | | 0.9% | 0.0% | 0.0% |
| Mozhovoi | Average | | | | 0.5% | 100.0% | 0.0% | 0.0% |
| | Percent of total 2+ biomass | | | | | 0.5% | 0.0% | 0.0% |
| Total | | | | | 81.92% | 3.83% | 67.57% | 10.53% |
| Rescaled total | | | | | 100.00% | 4.67% | 82.48% | 12.85% |

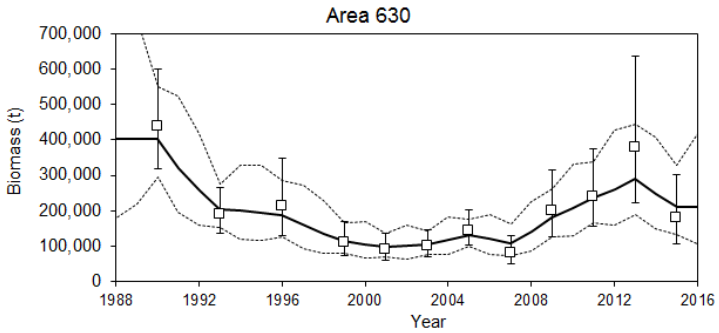
# Extras

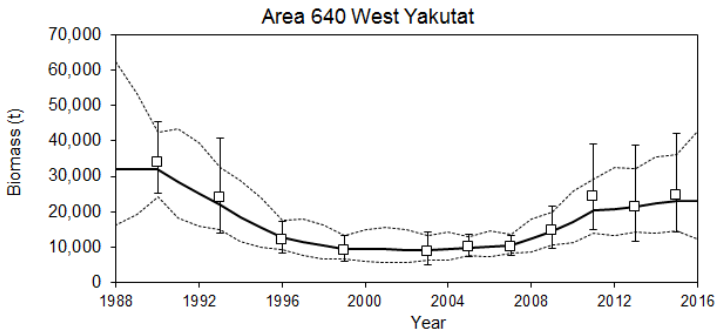
*Gulf of Alaska pollock*

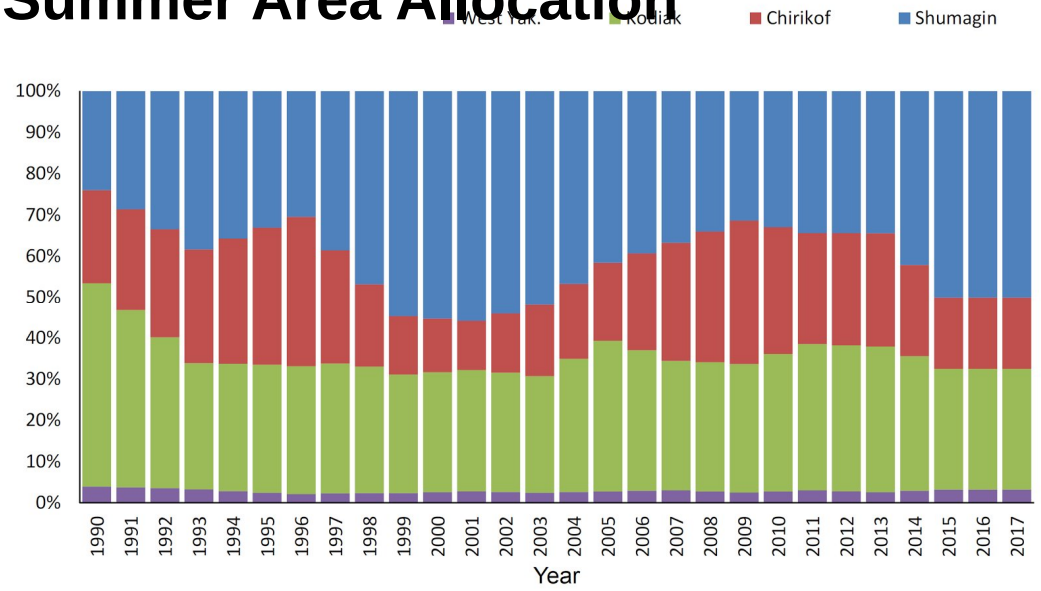
# Summer Area Allocation



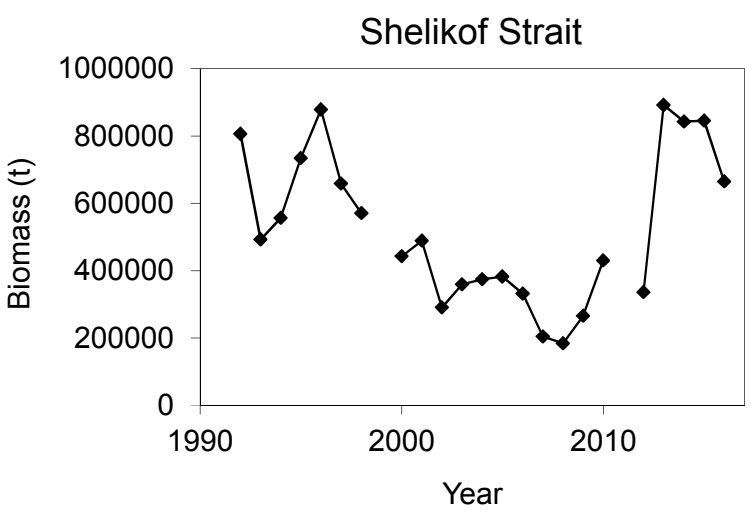

Percentages by area bottom trawl RE model--

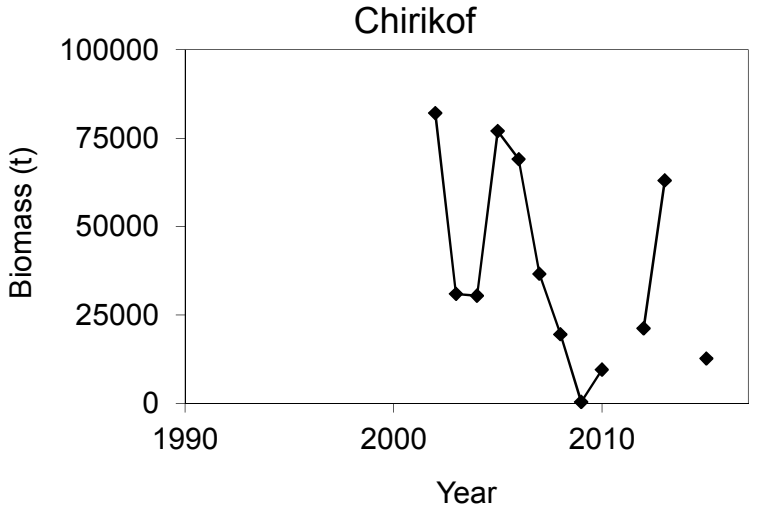
610: 50.00%
620: 17.52%
630 29.27%
640 3.22%

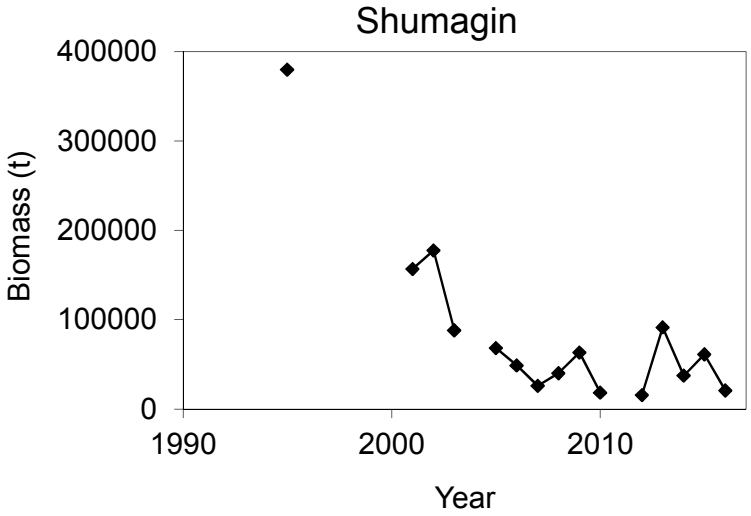
Percentages for summer acoustic survey-
610: 28.80%
620: 32.18%
630: 34.70%
640: 4.32%

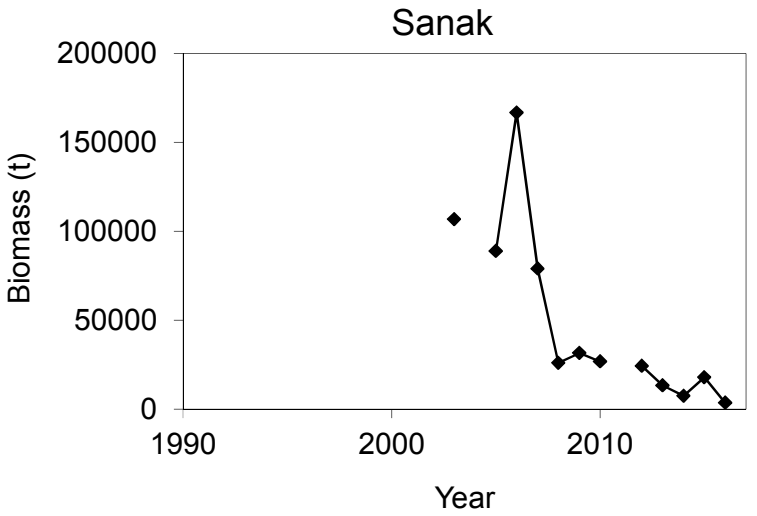
Averaging the results from the random effects model and the 2015 acoustic survey distribution gives a summer allocation-
610: 39.40%
620: 24.85%,
630: 31.98%
640: 3.77%

# Acoustic surveys outside Shelikof Strait



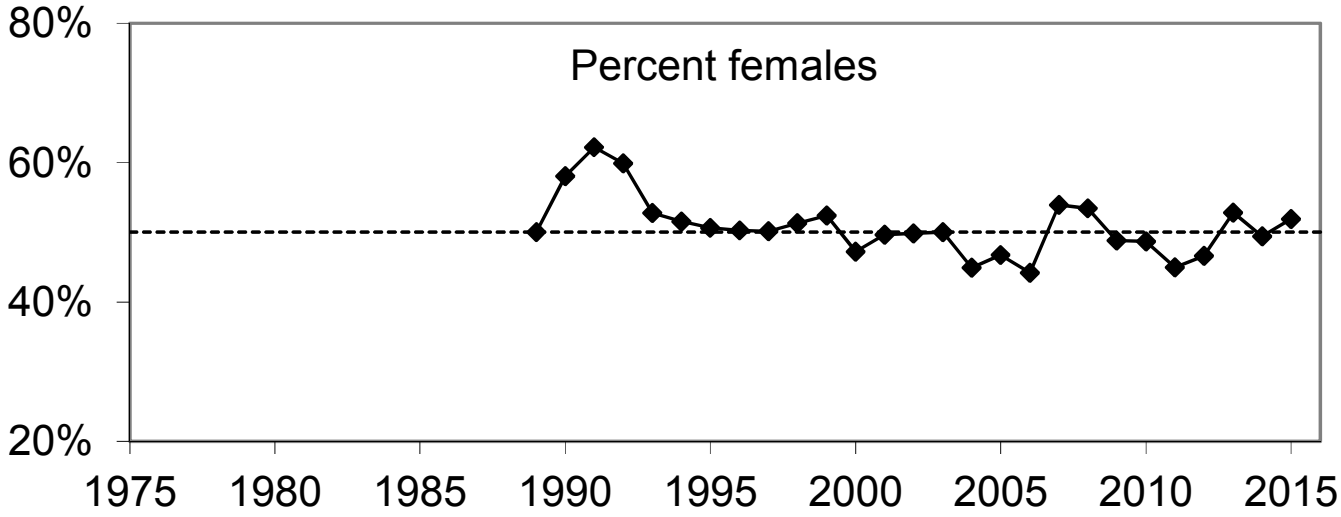



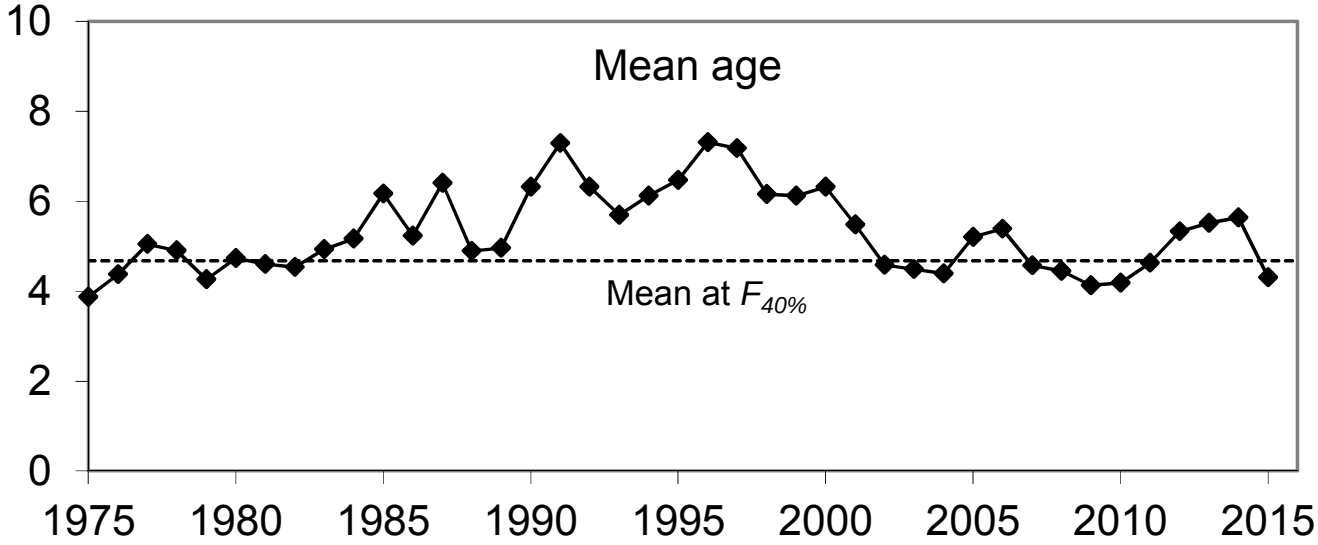



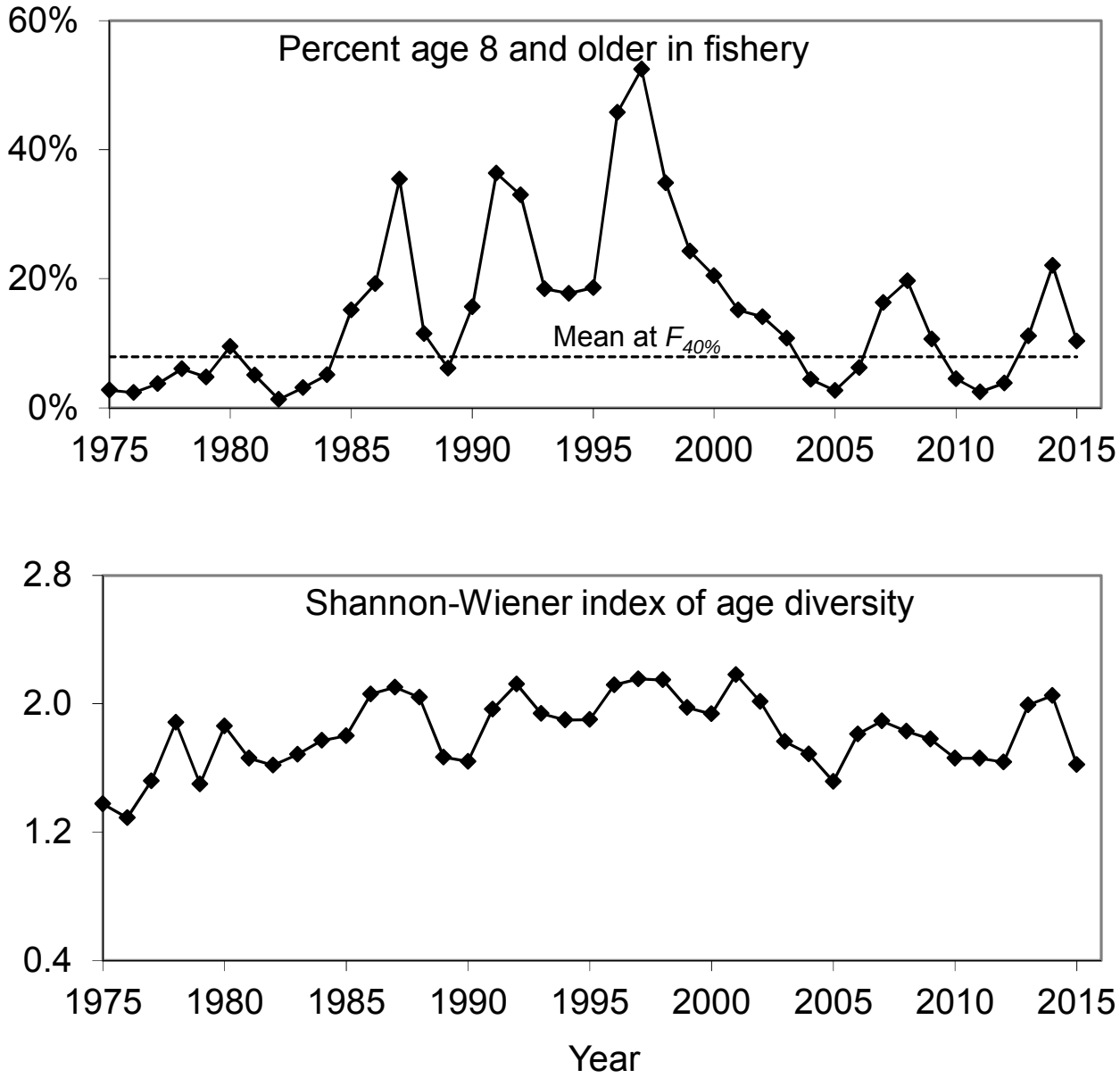

Total for all winter acoustic surveys = 740,794 t (90% in Shelikof Strait)

# Fishery catch characteristics



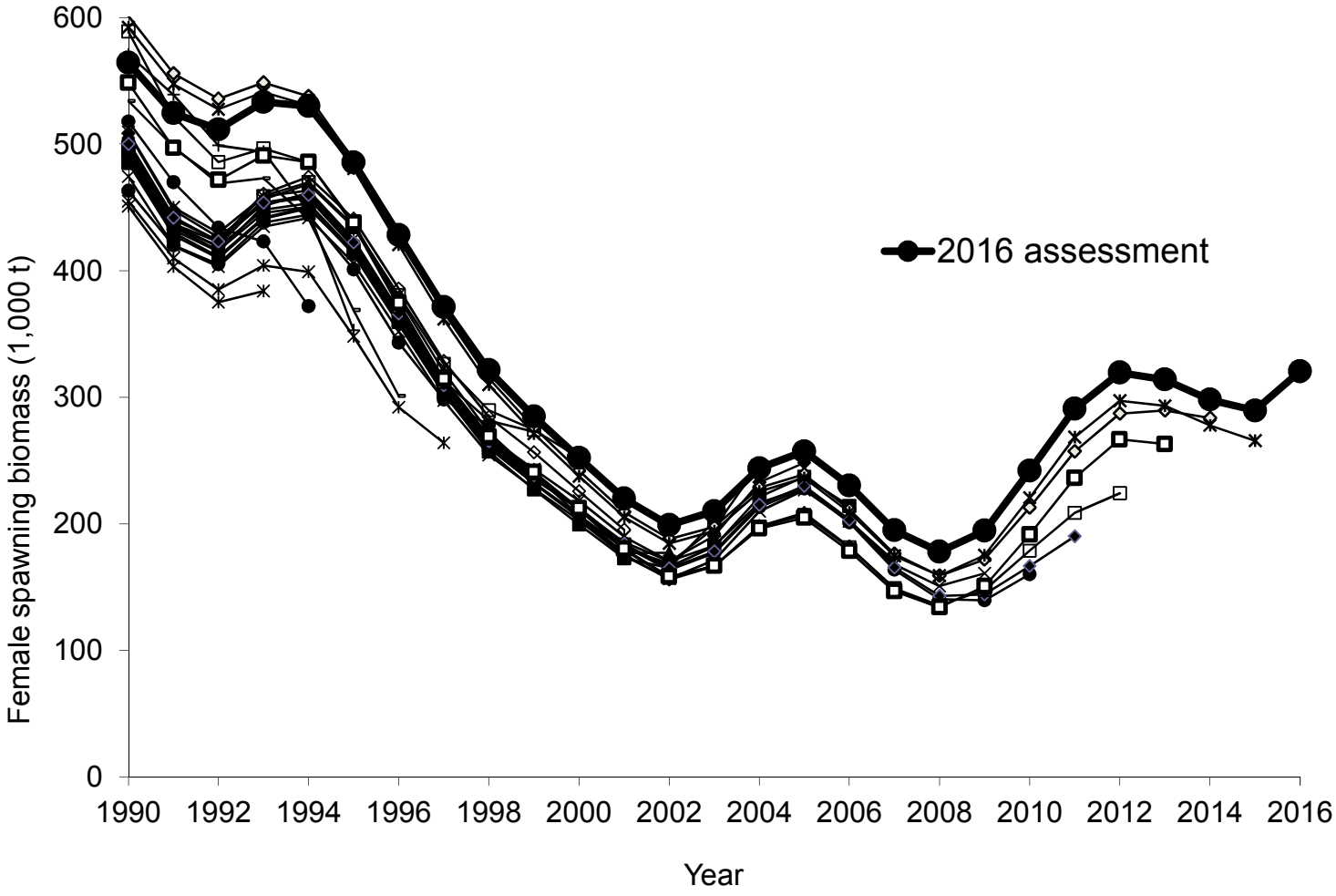
# Fishery catch characteristics



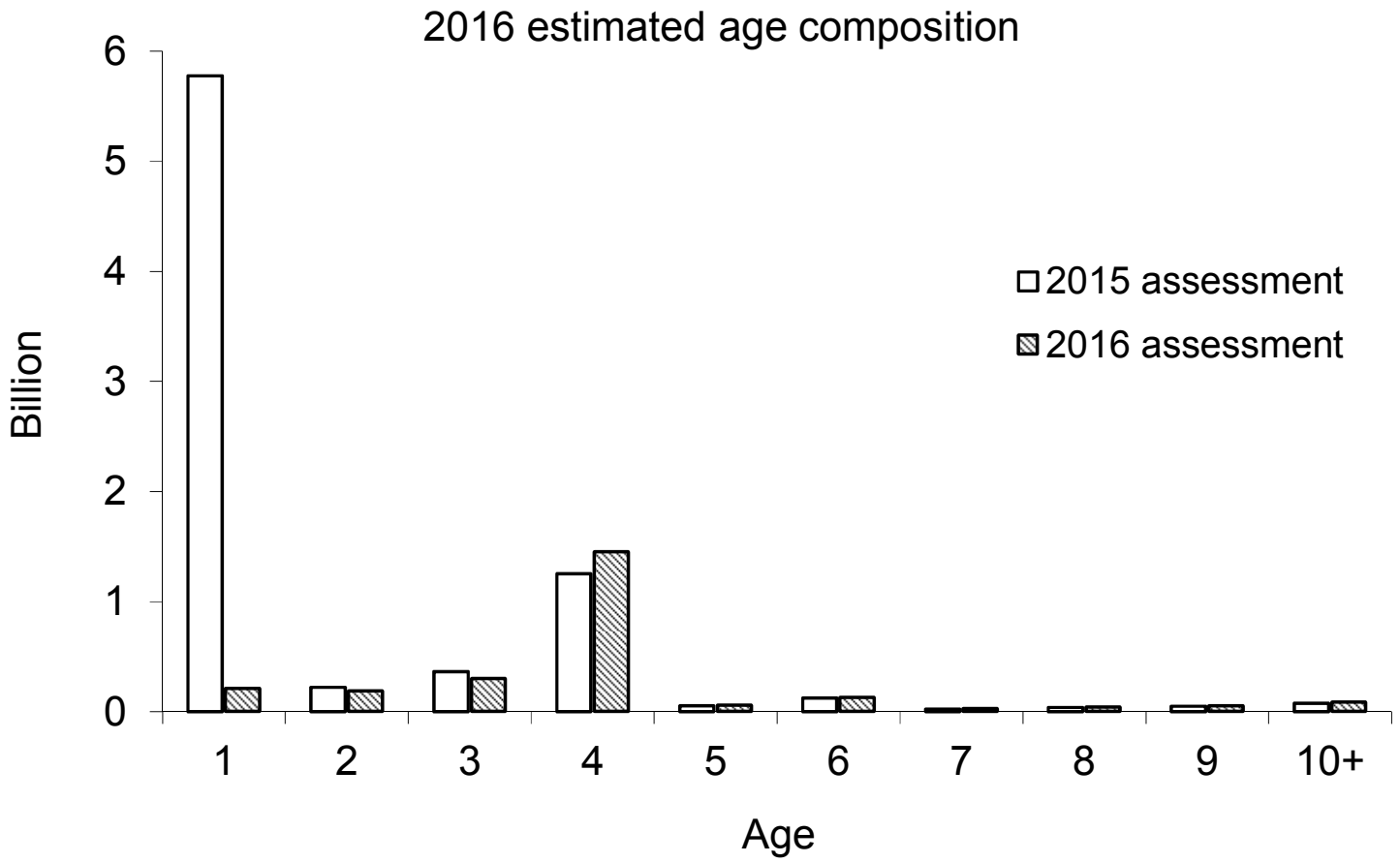
# Southeast Pollock Summary Table

| **Quantity** | As estimated or *specified last* year for: 2016 | 2017 | As estimated or *recommended this* year for: 2017 | 2018 |
|---|---|---|---|---|
| *M* (natural mortality rate) | 0.3 | 0.3 | 0.3 | 0.3 |
| Tier | 5 | 5 | 5 | 5 |
| Biomass (t) | | | | |
| Upper 95% confidence interval | 70,015 | 76,781 | 76,781 | 83,089 |
| Point estimate | 44,087 | 44,087 | 44,087 | 44,087 |
| Lower 95% confidence interval | 27,761 | 25,315 | 25,315 | 23,393 |
| $F_{OFL}$ | 0.30 | 0.30 | 0.30 | 0.30 |
| $maxF_{ABC}$ | 0.23 | 0.23 | 0.23 | 0.23 |
| $F_{ABC}$ | 0.23 | 0.23 | 0.23 | 0.23 |
| OFL (t) | 13,226 | 13,226 | 13,226 | 13,226 |
| maxABC (t) | 9,920 | 9,920 | 9,920 | 9,920 |
| ABC (t) | 9,920 | 9,920 | 9,920 | 9,920 |
| **Status** | As determined *last* year for: 2014 | 2015 | As determined *this* year for: 2015 | 2016 |
| Overfishing | No | n/a | No | n/a |

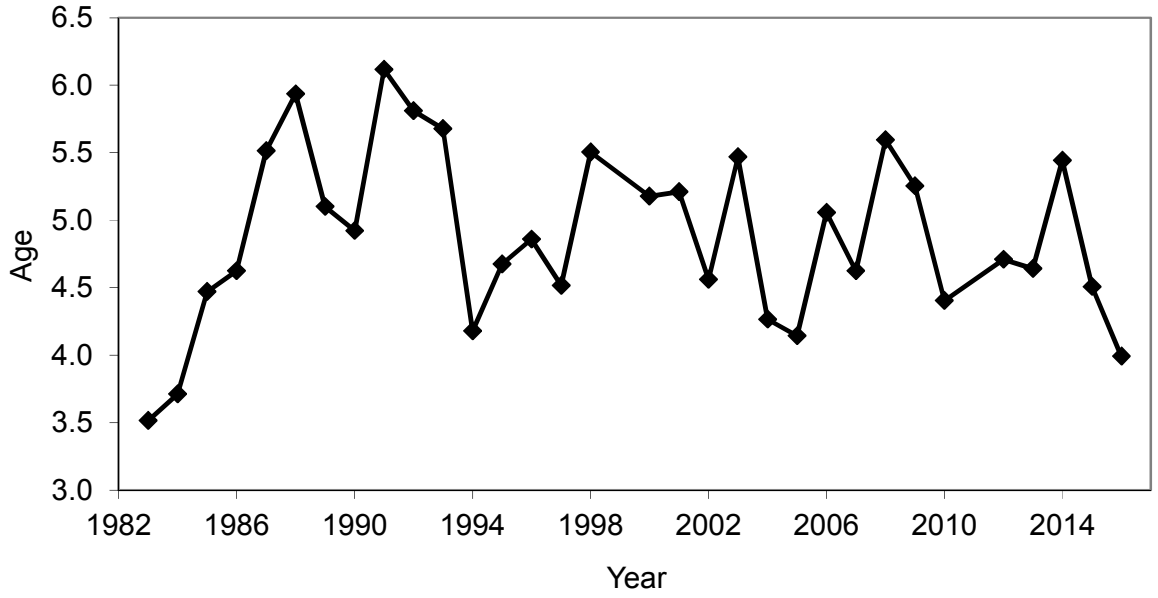
# Retrospective patterns



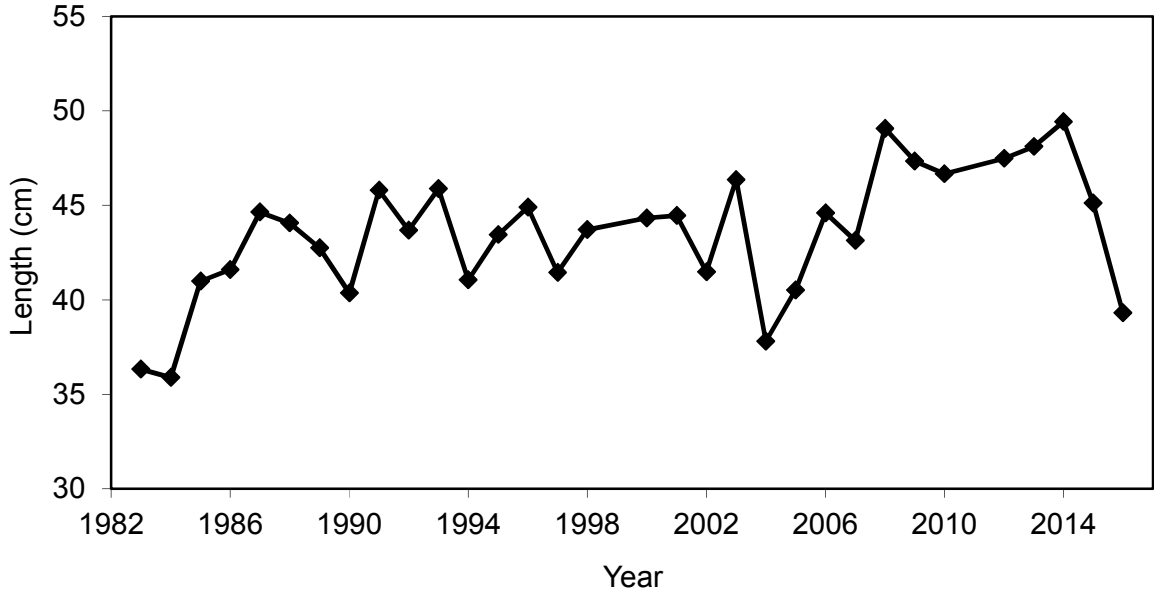
# Changes in estimated age composition



Age at 50% mature




Length at 50% mature



# Natural mortality estimates

| *Age* | *Length (cm)* | *Weight (g)* | *Brodziak et al. 2010* | *Lorenzen 1996* | *Gislason et al. 2010* | *Hollowed et al. 2000* | *Van Kirk et al. 2010* | *Van Kirk et al. 2012* | *Average* | *Rescaled Avg.* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15.3 | 26.5 | 0.97 | 1.36 | 2.62 | 0.86 | 2.31 | 2.00 | 1.69 | 1.39 |
| 2 | 27.4 | 166.7 | 0.54 | 0.78 | 1.02 | 0.76 | 1.01 | 0.95 | 0.84 | 0.69 |
| 3 | 36.8 | 406.4 | 0.40 | 0.59 | 0.64 | 0.58 | 0.58 | 0.73 | 0.59 | 0.48 |
| 4 | 44.9 | 752.4 | 0.33 | 0.49 | 0.46 | 0.49 | 0.37 | 0.57 | 0.45 | 0.37 |
| 5 | 49.2 | 966.0 | 0.30 | 0.45 | 0.40 | 0.41 | 0.36 | 0.53 | 0.41 | 0.34 |
| 6 | 52.5 | 1154.2 | 0.30 | 0.43 | 0.36 | 0.38 | 0.28 | 0.47 | 0.37 | 0.30 |
| 7 | 55.1 | 1273.5 | 0.30 | 0.42 | 0.33 | 0.38 | 0.30 | 0.46 | 0.36 | 0.30 |
| 8 | 57.4 | 1421.7 | 0.30 | 0.40 | 0.31 | 0.38 | 0.29 | 0.43 | 0.35 | 0.29 |
| 9 | 60.3 | 1624.8 | 0.30 | 0.39 | 0.29 | 0.39 | 0.29 | 0.42 | 0.35 | 0.28 |
| 10 | 61.1 | 1599.6 | 0.30 | 0.39 | 0.28 | 0.39 | 0.33 | 0.40 | 0.35 | 0.29 |

Clay Porch's nifty rescaling equation: $$M(t) = M_{target} \frac{nL(t)}{\sum_{t_?}^{t_? \; ??} L(t)}$$

# Tuning details—Initial and ending input N

Fishery age composition:

Initial N: Use the number of tows/deliveries for the age composition sample if number of tows < 200, otherwise use 200

Ending N: 120.3

Bottom trawl survey

Initial N = 60

Ending N = 28.1

Acoustic survey

Initial N = 60

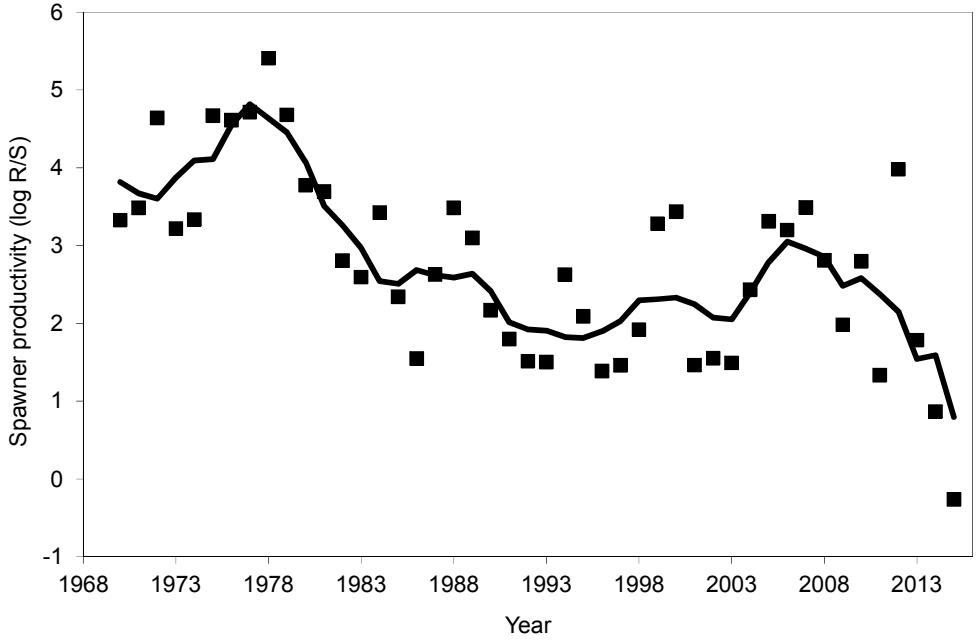
Ending N = 9.7

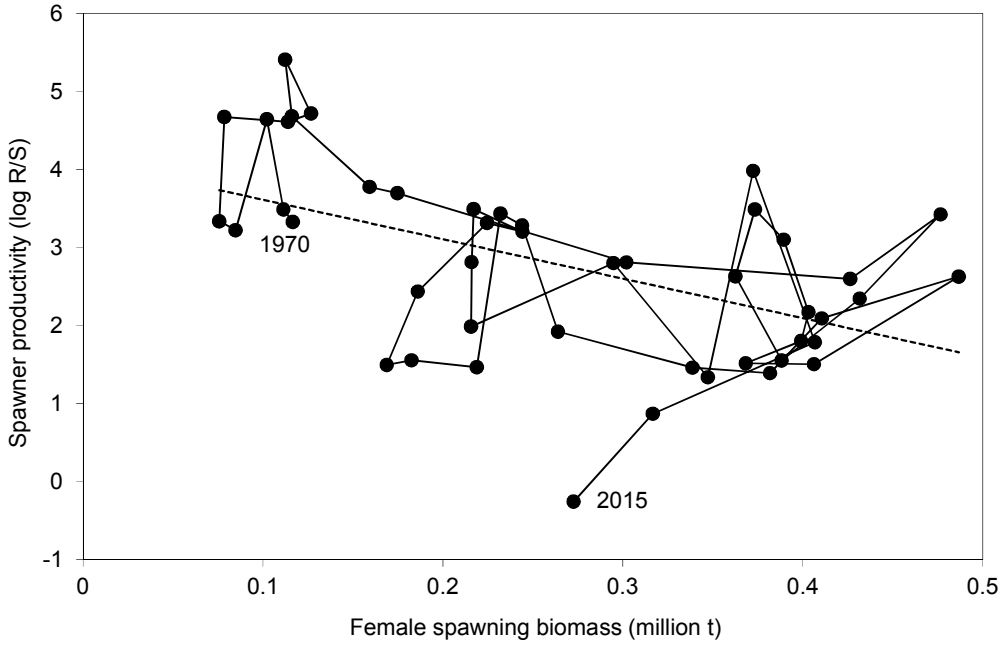
ADFG survey

Initial N = 30

Ending N = 32.2

# Spawner productivity



# Annual SPR rate