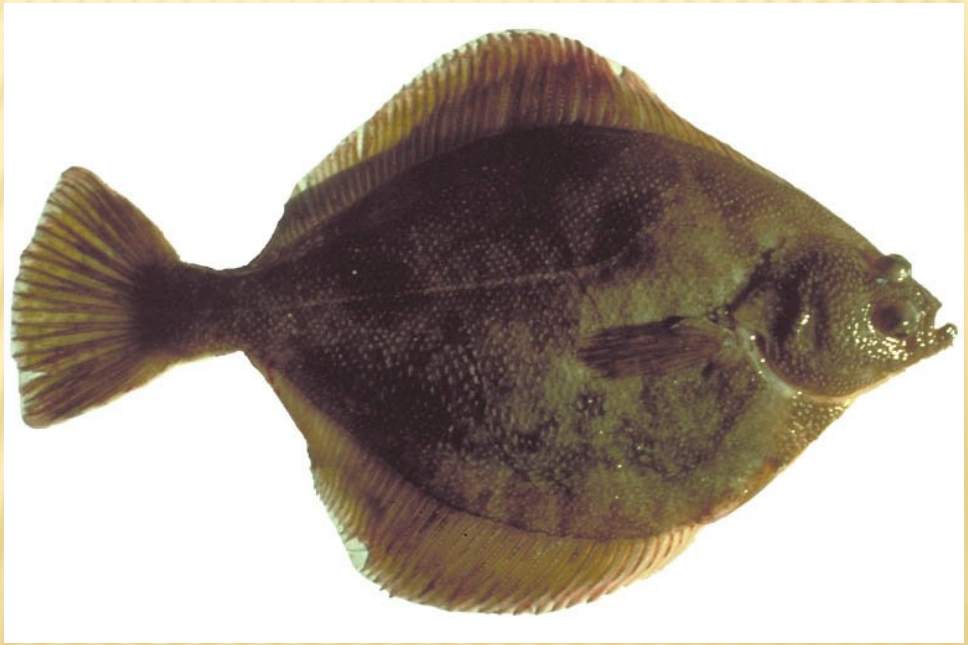
YELLOWFIN SOLE

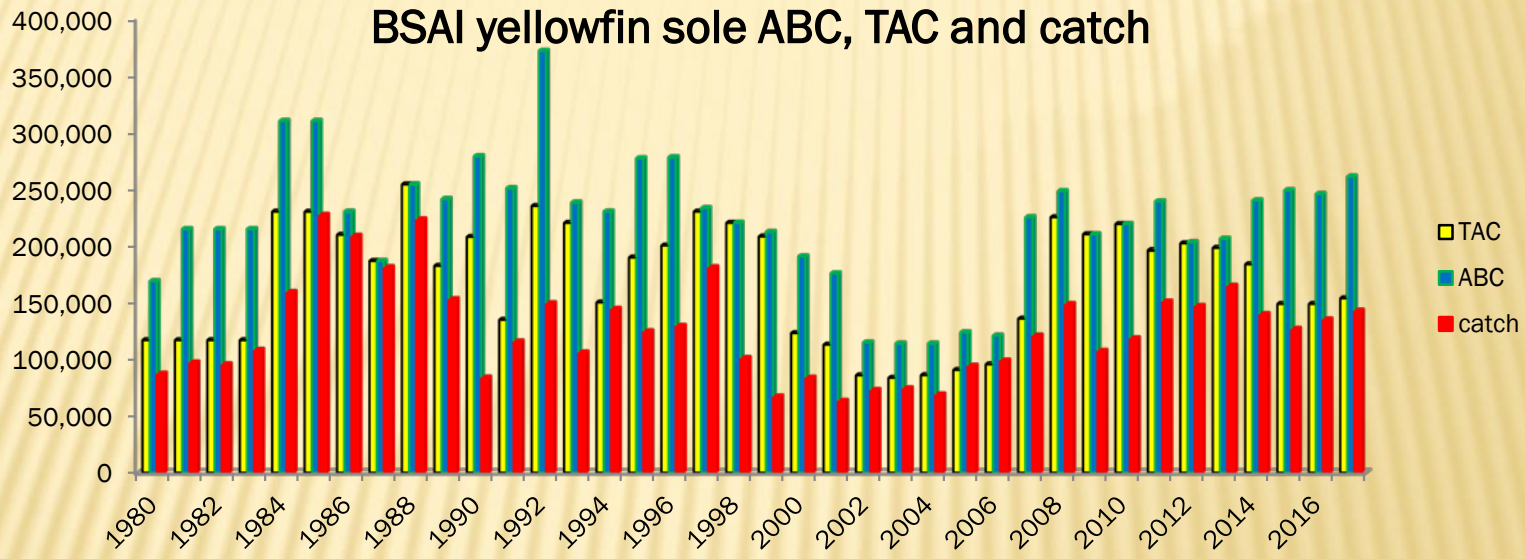
BY

WILDERBUER, NICHOL AND IANELLI



CHANGES TO THE INPUT DATA

- 2016 fishery age composition.
- 2016 survey age composition.
- 2017 trawl survey biomass point estimate and standard error.
- Estimate of catch (t) made through the end of 2017.
- Estimate of retained and discarded portions of the 2016 catch.
- Updated weight at age for survey and fishery


BSAI yellowfin sole ABC, TAC and catch
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
TAC
ABC
catch

BSAI YELLOWFIN SOLE

Survey ⇩ 3%

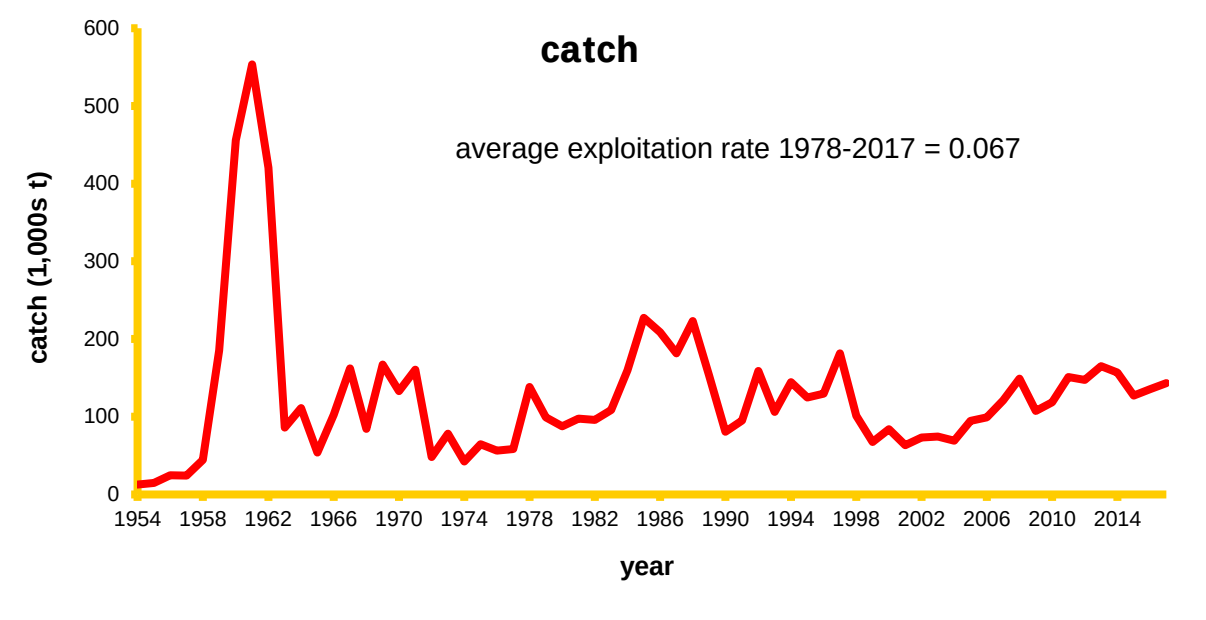
ABC ⇧ 6%

FSB ⇧ 11%

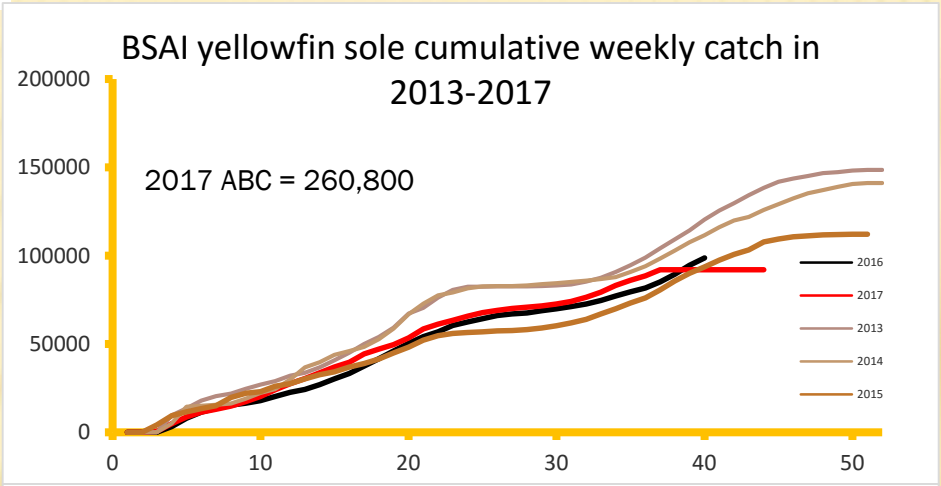
Fabc ⇩ a little

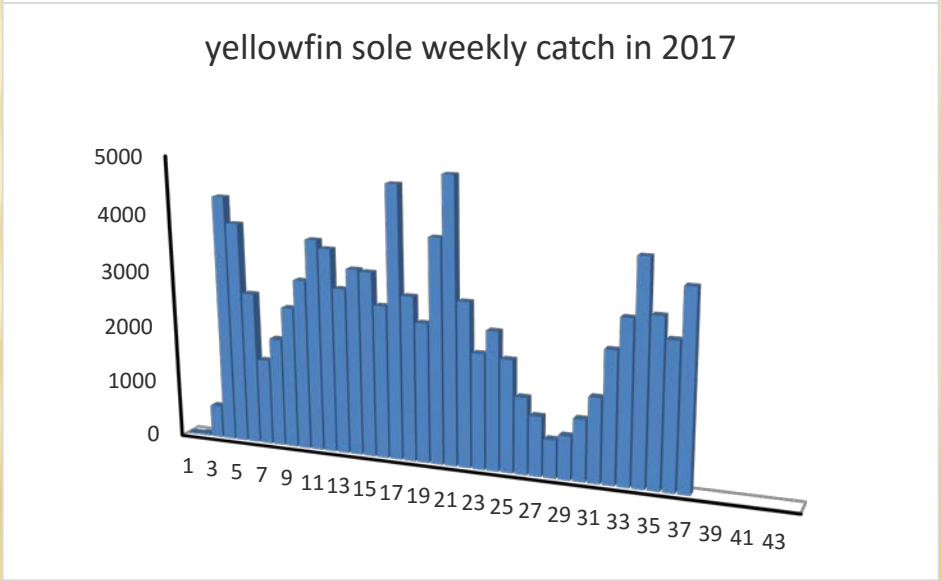
Quantity	As estimated or specified last year for:		As estimated or recommended this year for:	
	2017	2018	2018	2019
M (natural mortality rate)	0.12	0.12	0.12	0.12
Tier	1a	1a	1a	1a
Projected total (age 6+) biomass (t)	2,290,000	2,202,300	2,553,100	2,460,700
Female spawning biomass (t)	587,300			
Projected	778,600	770,900	895,000	890,000
B_0	1,202,700		1,204,000	
B_{MSY}	424,000		456,000	
F_{OFL}	0.125	0.125	0.12	0.12
maxF_{ABC}	0.114	0.114	0.109	0.109
F_{ABC}	0.114	0.114	0.109	0.109
OFL (t)	287,000	276,000	306,700	295,600
maxABC (t)	260,800	250,800	277,500	267,500
ABC (t)	260,800	250,800	277,500	267,500
Status	As determined last year for:		As determined this year for:	
	2015	2016	2016	2017
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

2017 CATCH = 143,100 T
AVERAGE 1978-2017 EXPLOITATION RATE = 0.067



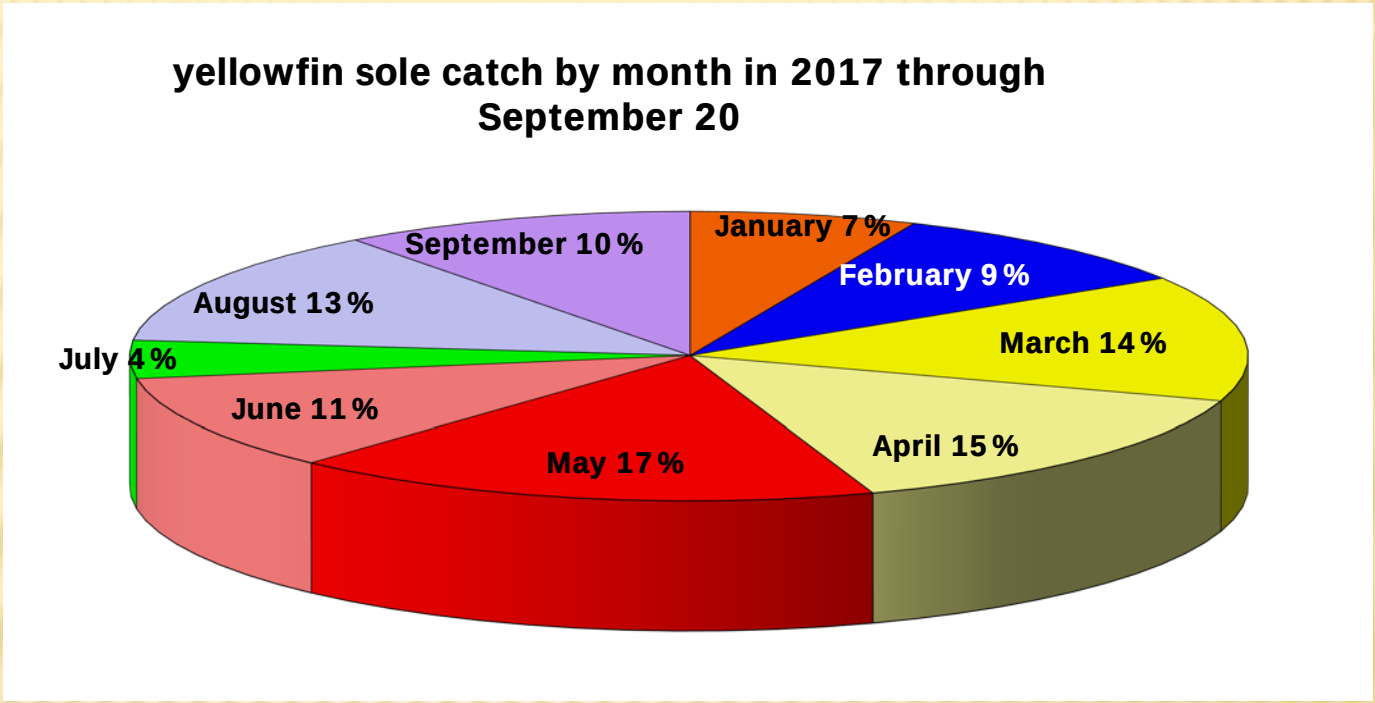
Cumulative and weekly catch



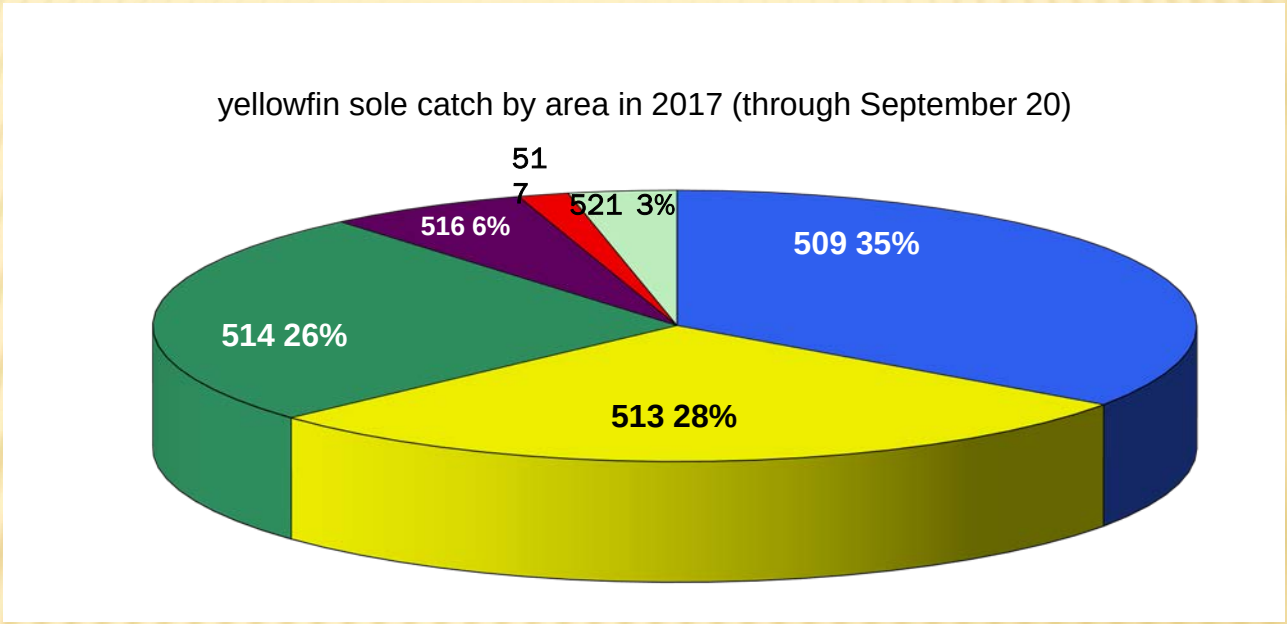


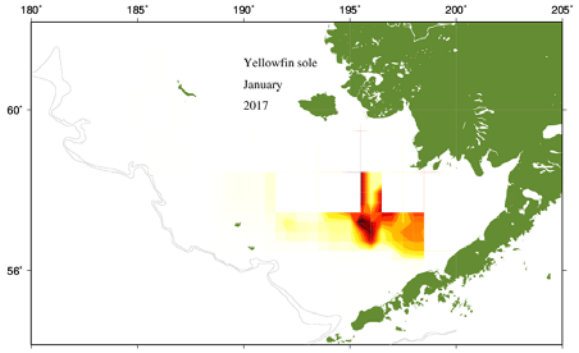
- Catch

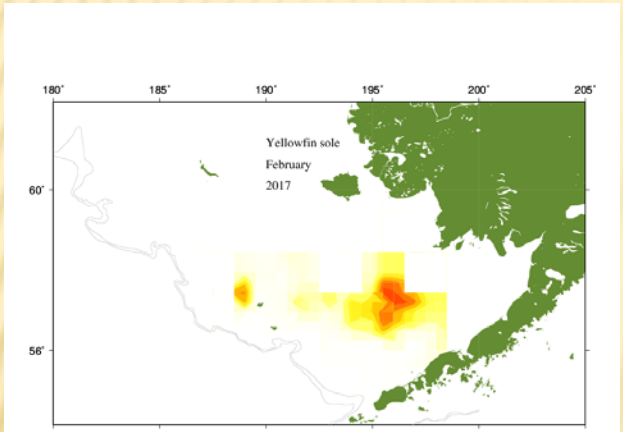
CATCH BY MONTH

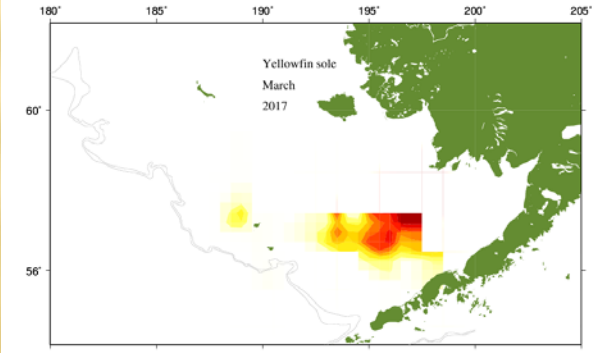


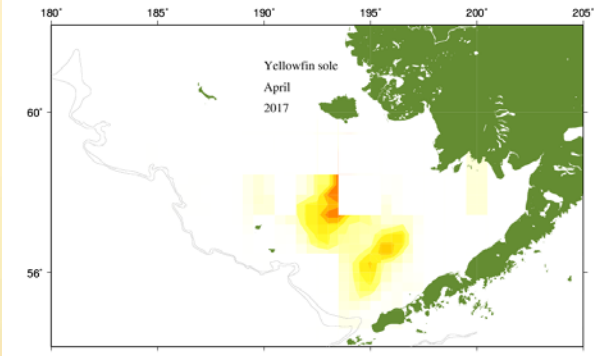
CATCH BY AREA

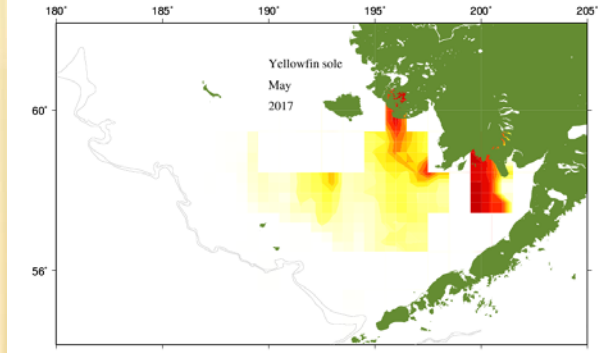


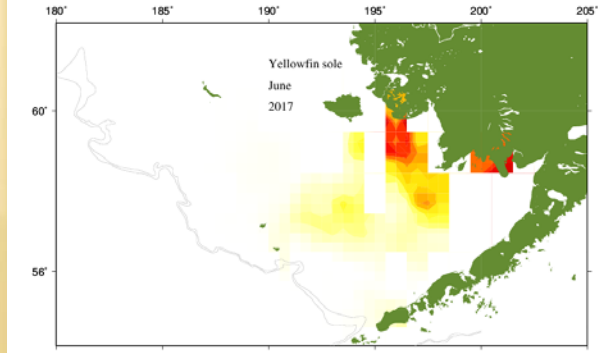

180°
185°
190°
195°
200°
205°
60°
56°
Yellowfin sole
January
2017

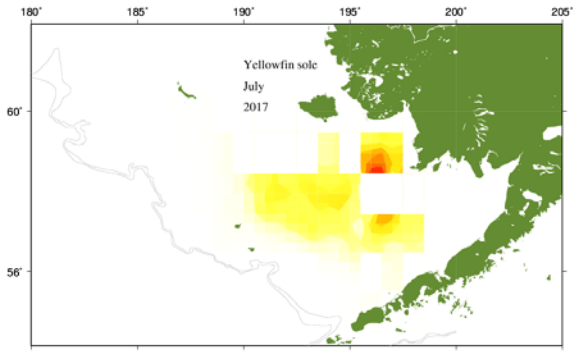

180°
185°
190°
195°
200°
205°
60°
56°
Yellowfin sole
February
2017

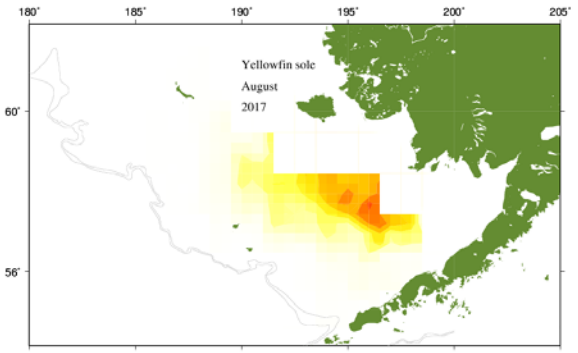

180°
185°
190°
195°
200°
205°
60°
56°
Yellowfin sole
March
2017

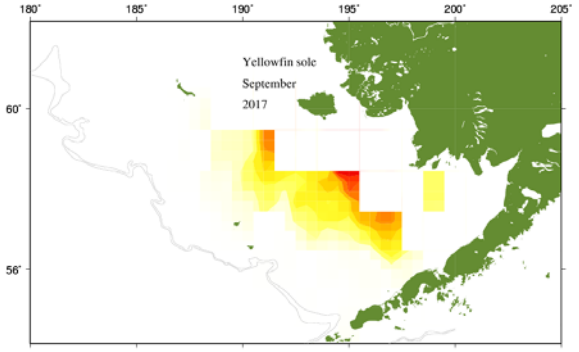

180°
185°
190°
195°
200°
205°
60°
56°
Yellowfin sole
April
2017


180°
185°
190°
195°
200°
205°
60°
56°
Yellowfin sole
May
2017

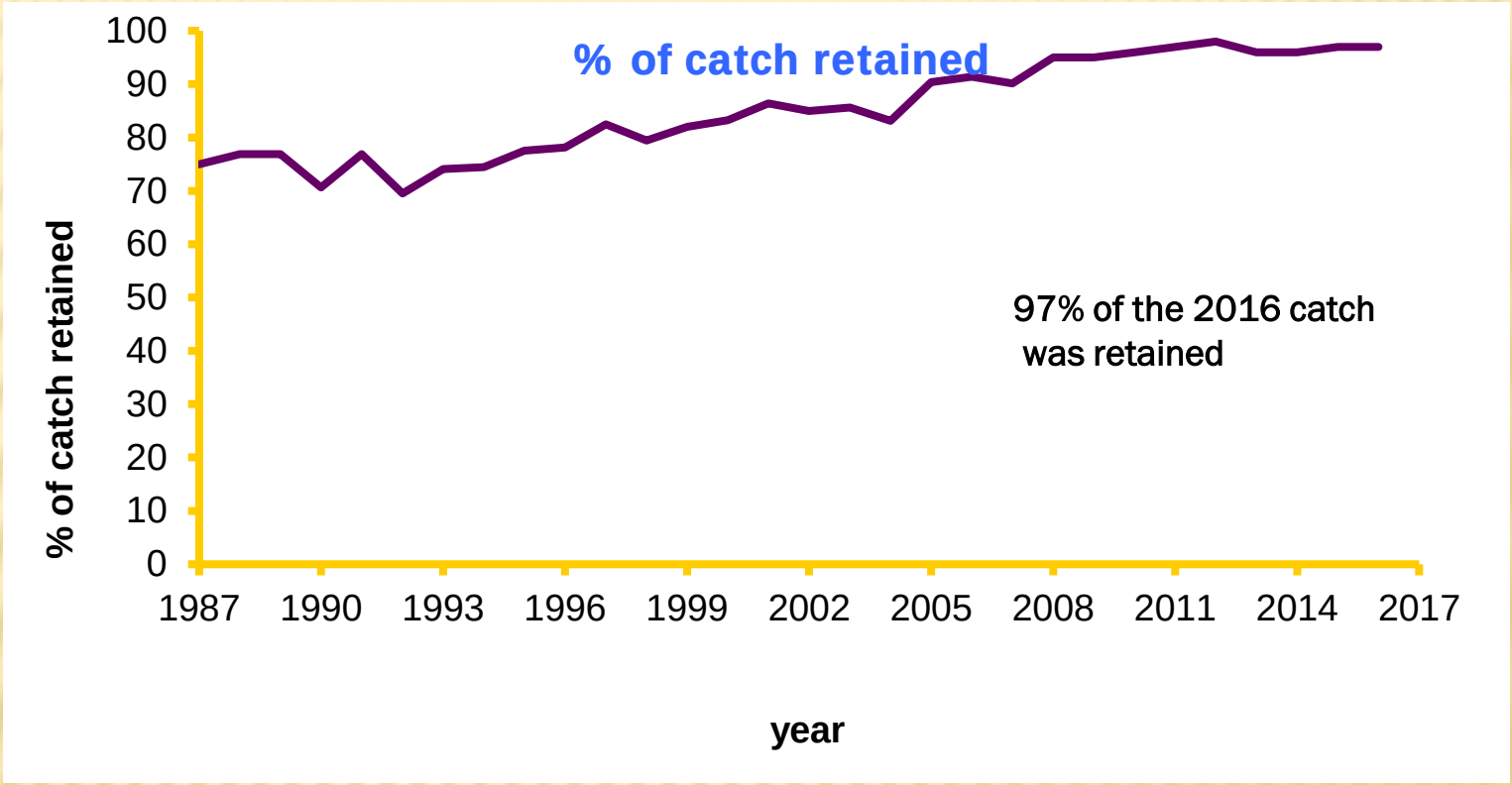

180°
185°
190°
195°
200°
205°
60°
56°
Yellowfin sole
June
2017


180°
185°
190°
195°
200°
205°
60°
56°
Yellowfin sole
July
2017


180°
185°
190°
195°
200°
205°
60°
56°
Yellowfin sole
August
2017

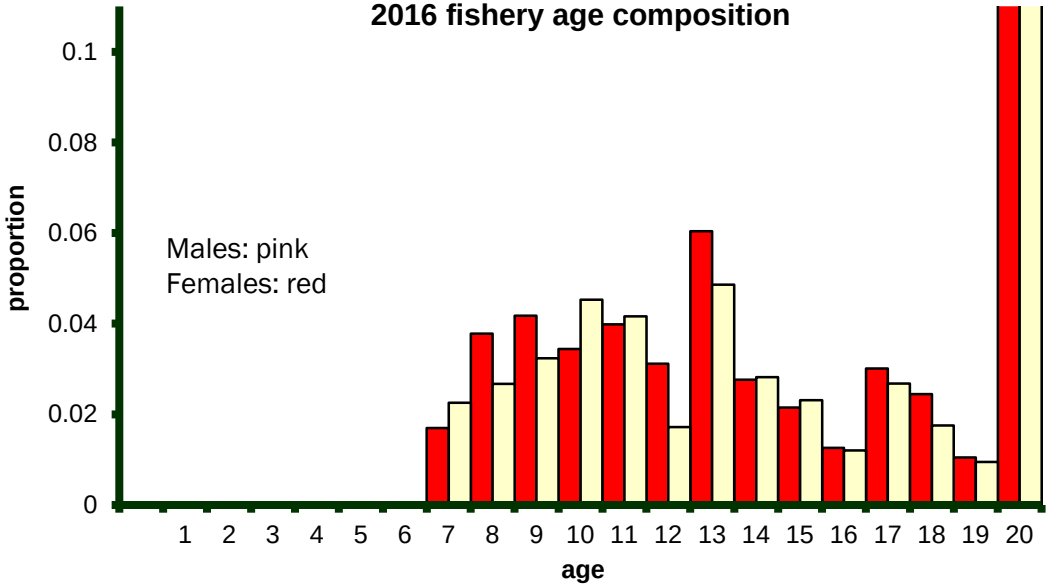

180°
185°
190°
195°
200°
205°
60°
56°
Yellowfin sole
September
2017

ANNUAL ESTIMATE OF RETAINED CATCH (%)

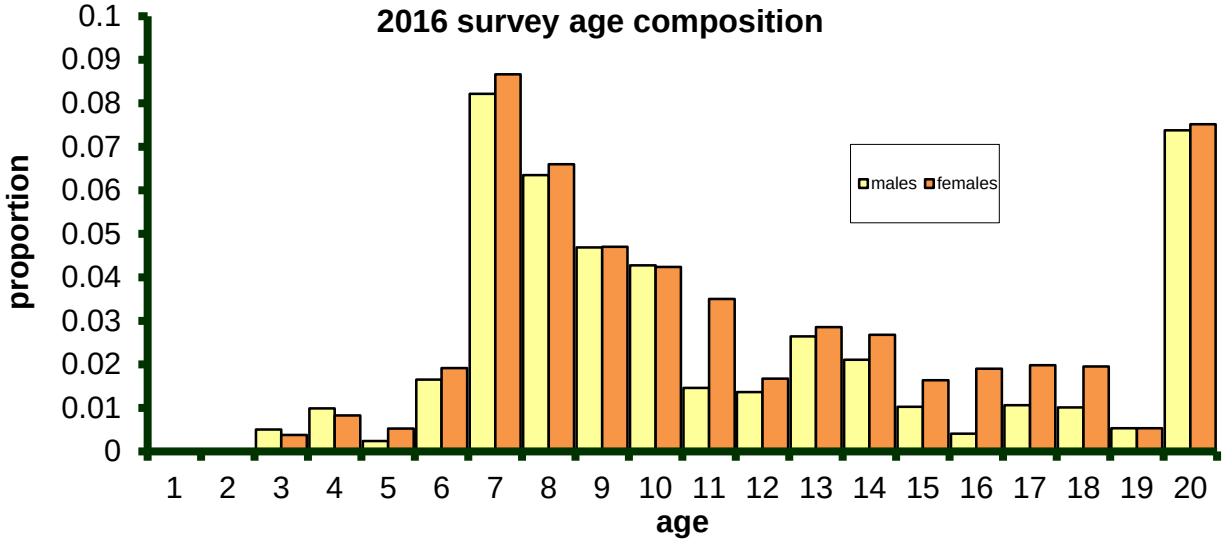


NEW DATA FOR 2017

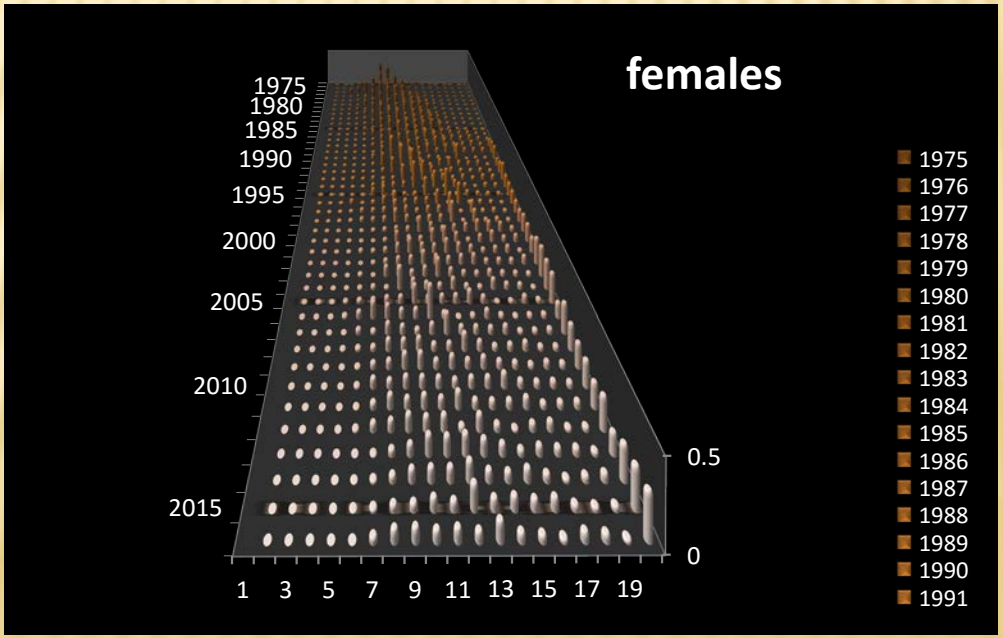
Avg. age = 12.6 years



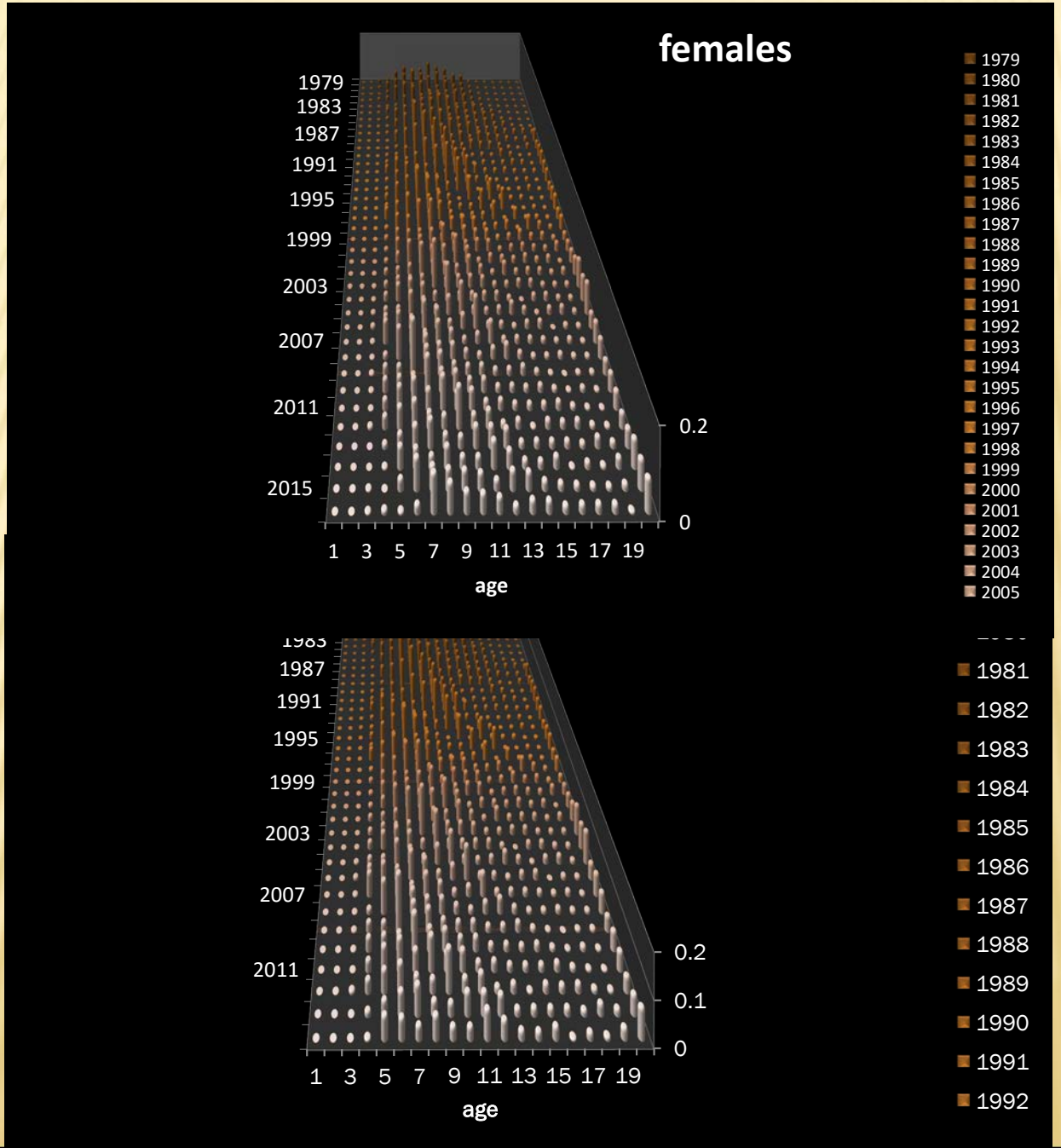
Model estimate of population Avg. age = 6.7 years



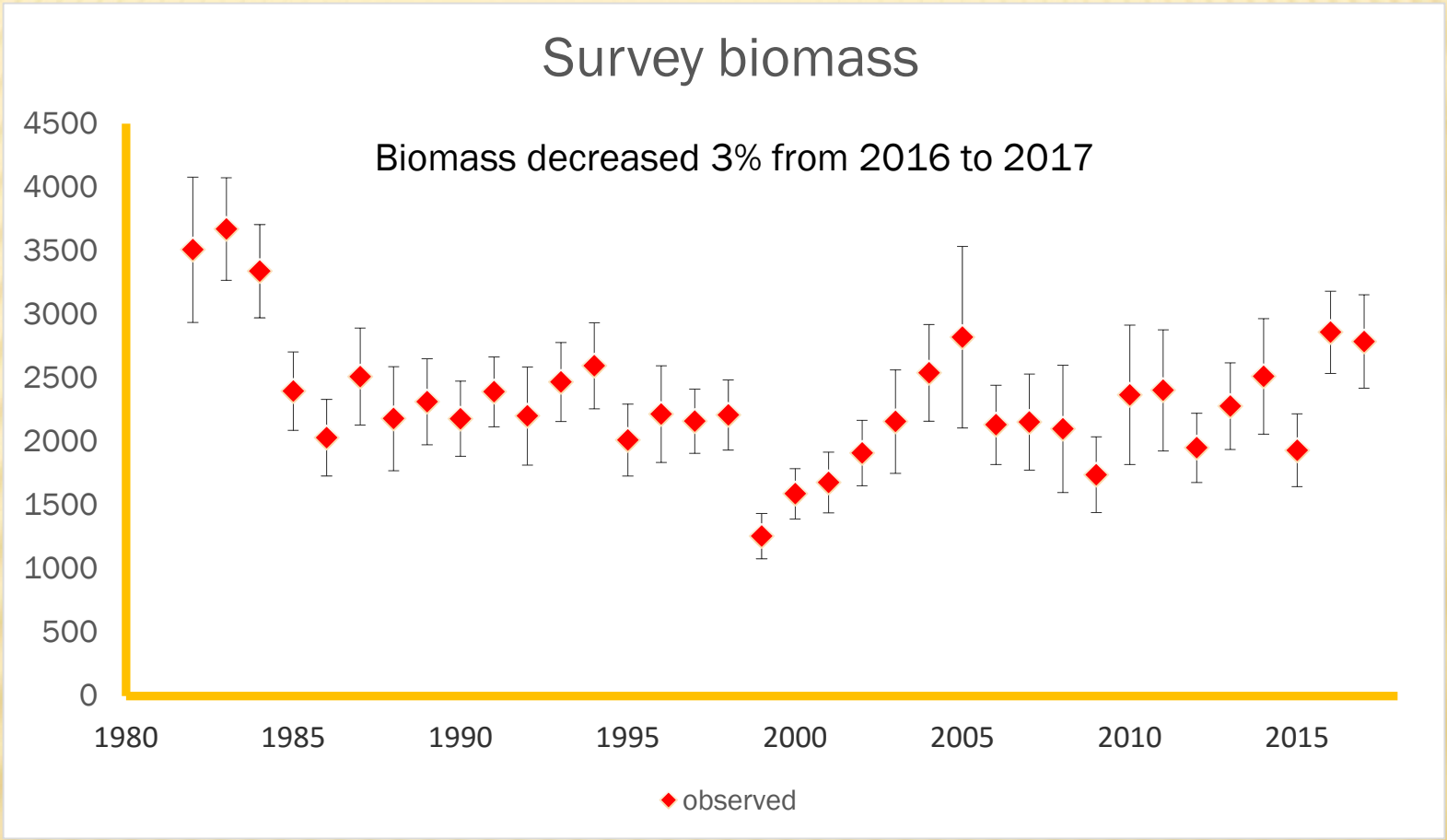
Fishery age composition



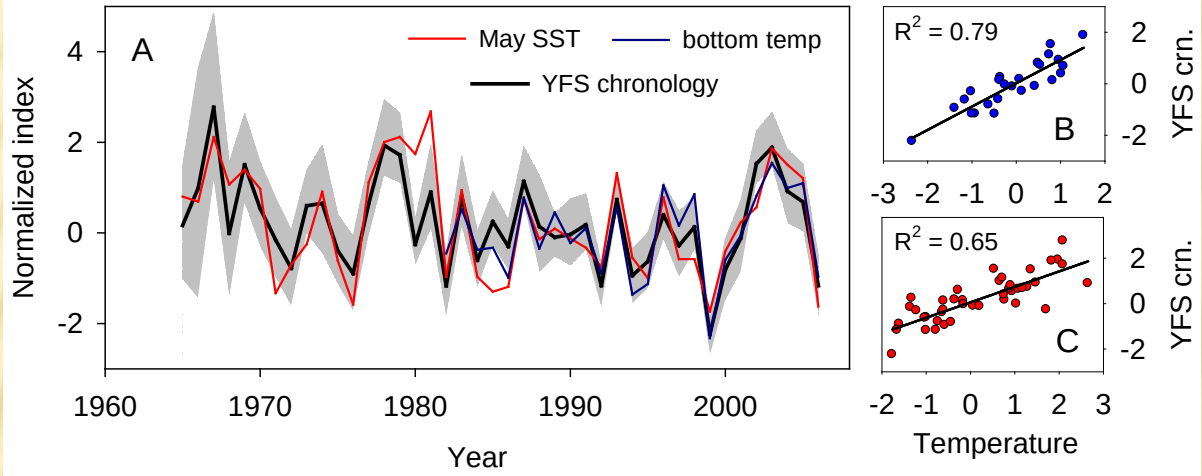
Survey age composition



2017 SHELF SURVEY BIOMASS ESTIMATE = 2,787,500 T

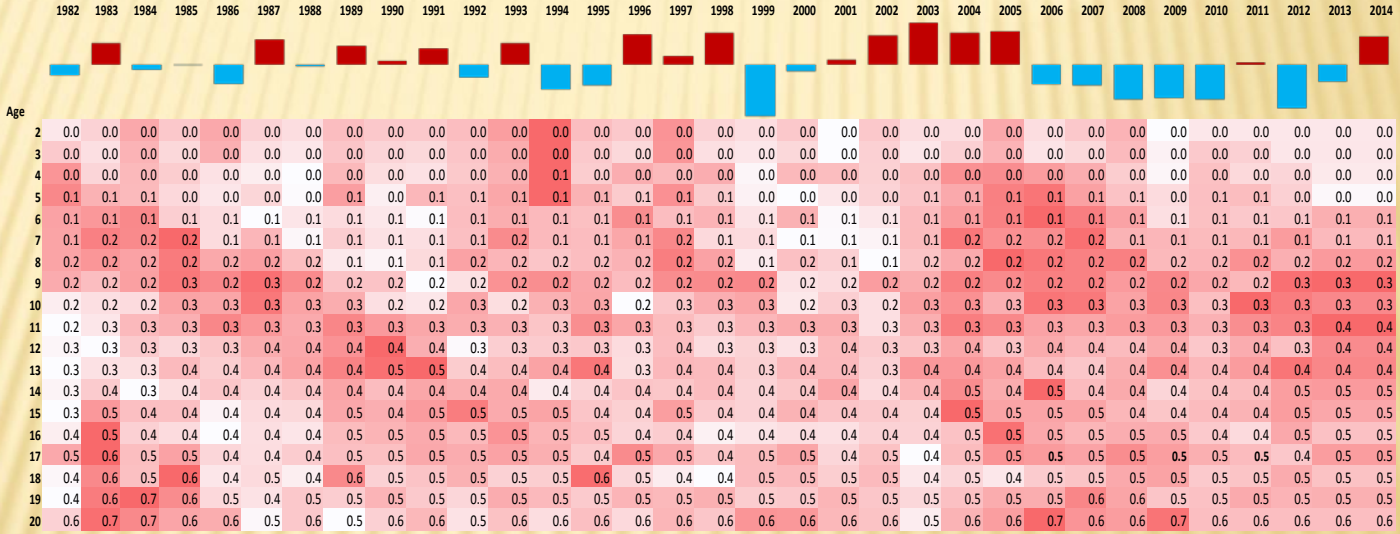


YEAR EFFECT ON GROWTH

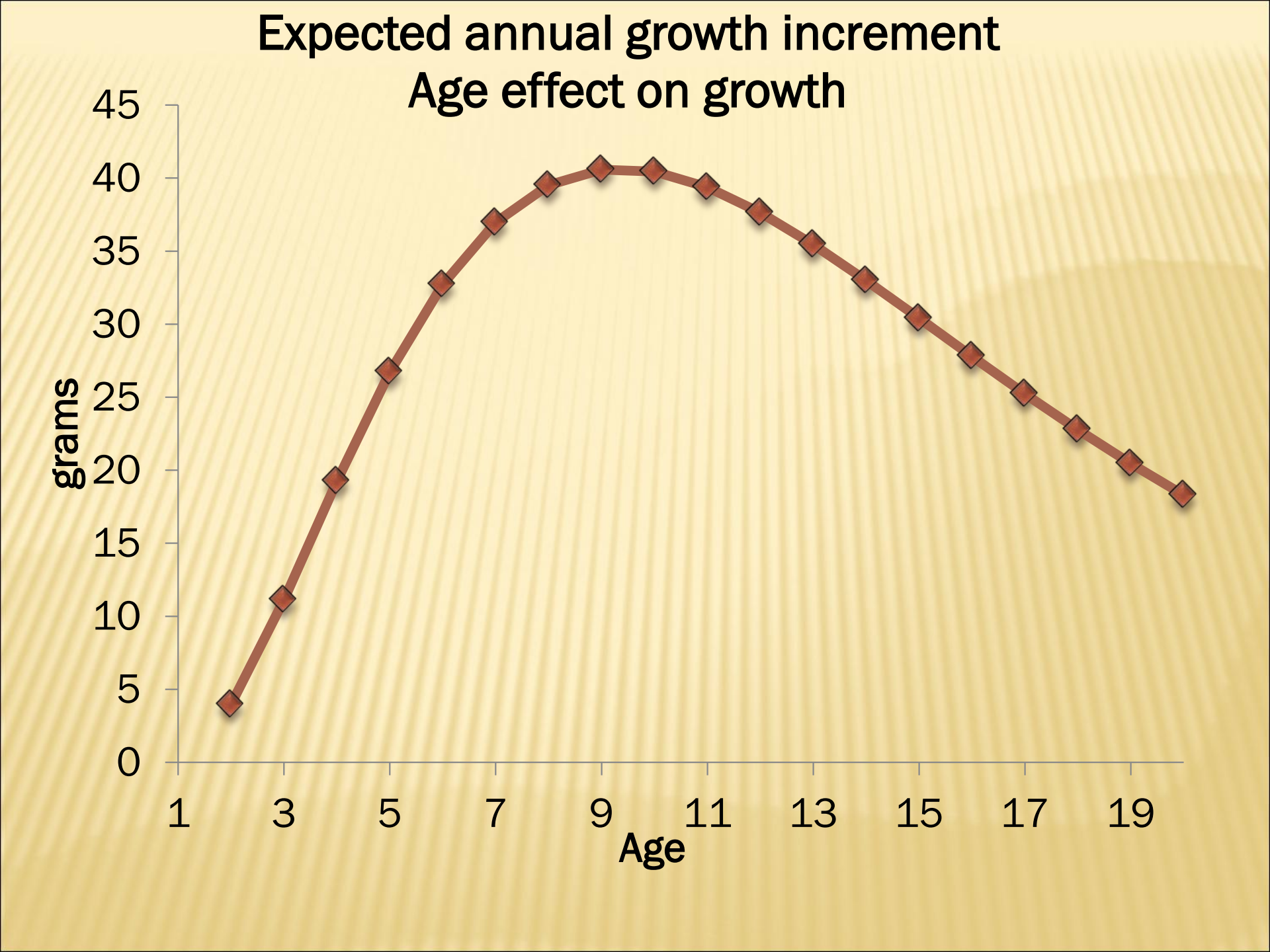


Annual growth corresponds to annual temperature

Assessment uses empirical data from annual survey length at age estimates



Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0
6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
7	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
10	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
11	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4
12	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.4	0.4
13	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
14	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5
15	0.3	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.5
16	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.5
17	0.5	0.6	0.5	0.5	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.4	0.5	0.5	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.5
18	0.4	0.6	0.5	0.6	0.4	0.5	0.4	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
19	0.4	0.6	0.7	0.6	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5
20	0.6	0.7	0.7	0.6	0.6	0.5	0.6	0.5	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6


Expected annual growth increment
Age effect on growth
grams
45
40
35
30
25
20
15
10
5
0
1
3
5
7
9
11
13
15
17
19
Age

FLATFISH SPLIT-SEX MODEL

Input:

sex-specific estimates of fishery and survey age composition and weight at age, survey biomass, maturity

Output:

Sex-specific estimates of population number, fishing mortality, selectivity, fishery and survey age composition.

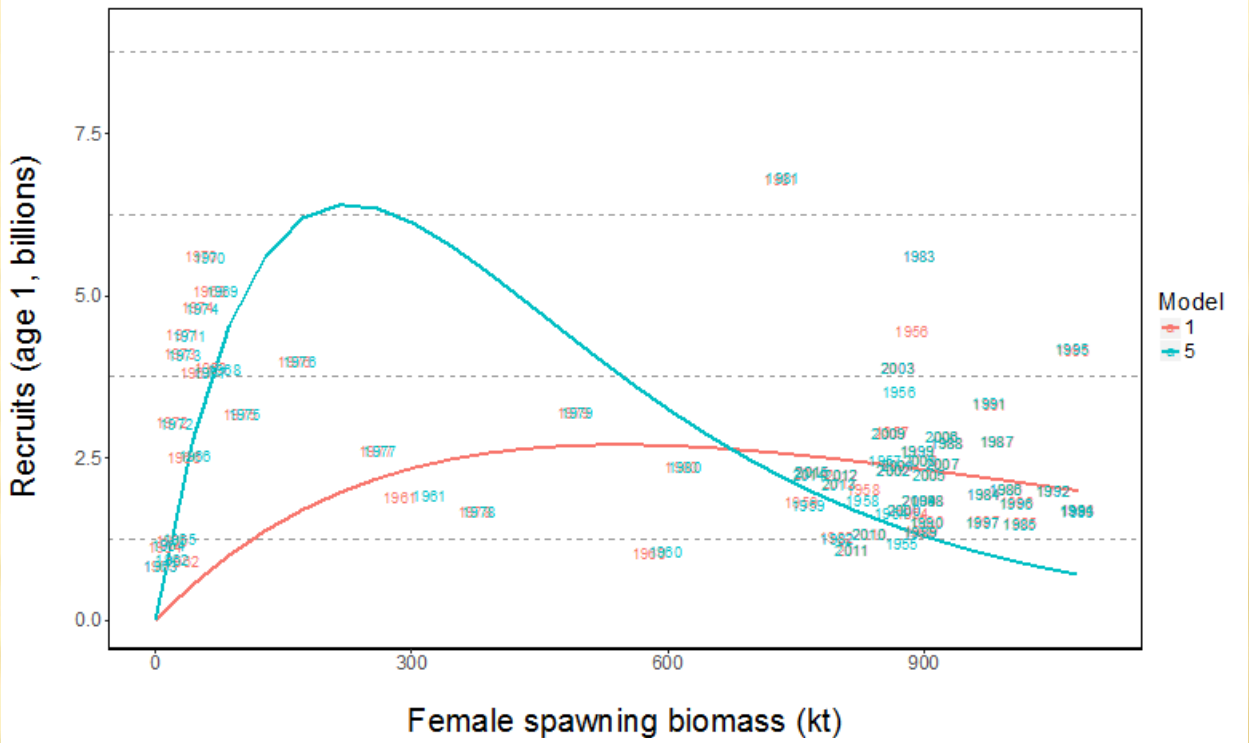
Allows for estimation of sex-specific natural mortality

STOCK ASSESSMENT MODEL

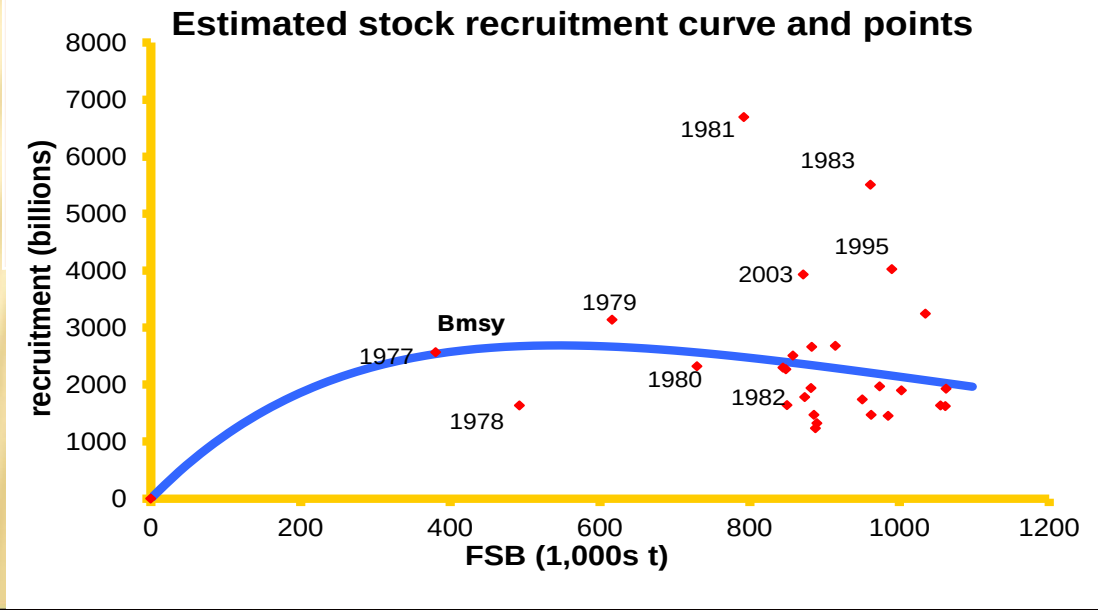
- Data components include fishery and trawl survey age compositions and survey biomass and standard error
- Selectivity is fixed asymptotic for older fish
- Runs made with natural mortality fixed at 0.12 and estimated
- Ricker spawner-recruit curve estimated inside the model
- Fishery selectivity is estimated for each year and gender
- Catchability (q) is estimated for each year in the model by considering the relationship to annual bottom water temperature

$$q = e^{\alpha + \beta T}$$

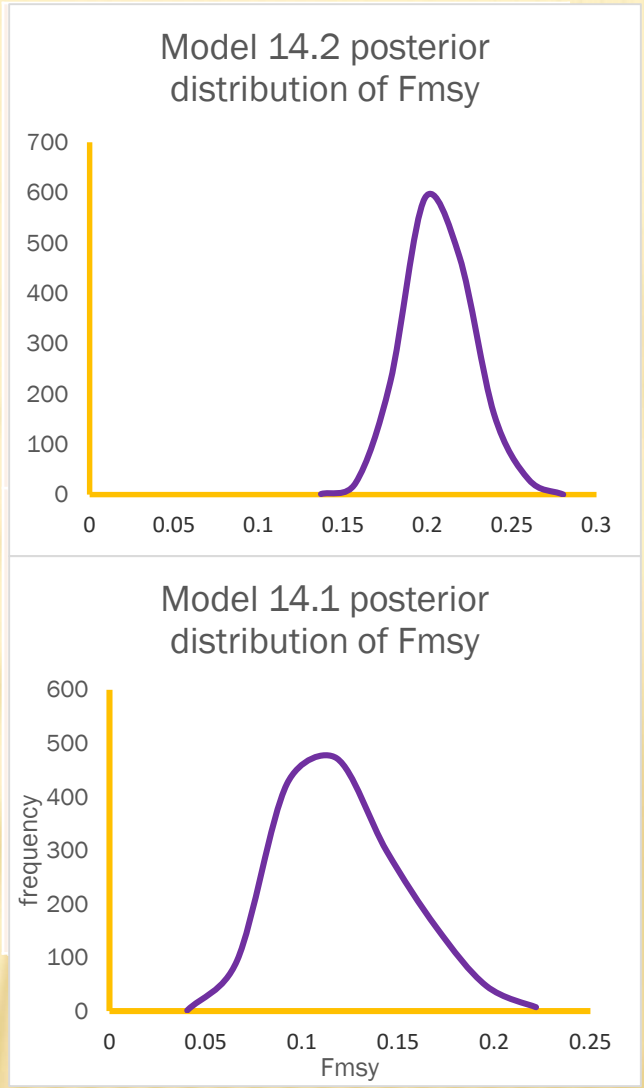
B_{msy} = 333,700 t



B_{msy} = 454,000 t



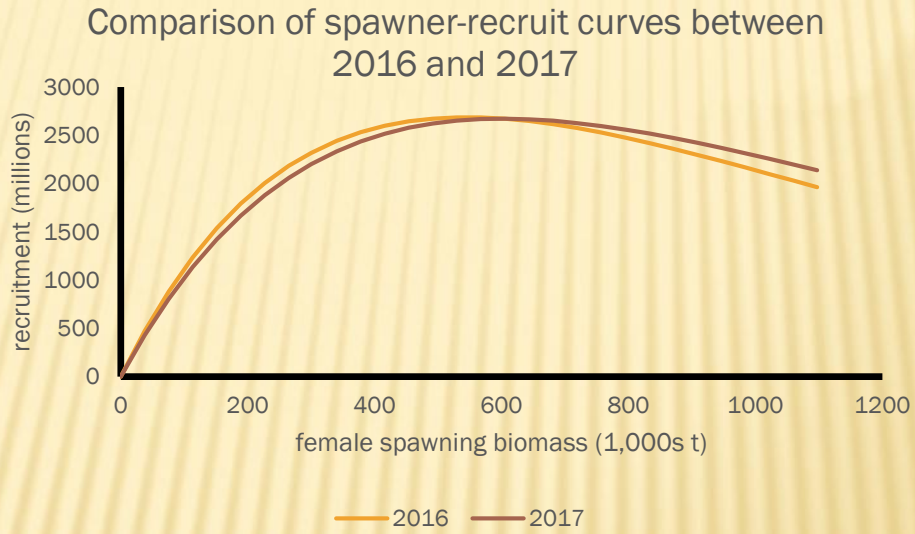
Distribution of pdf F_{msy} from mcmc runs



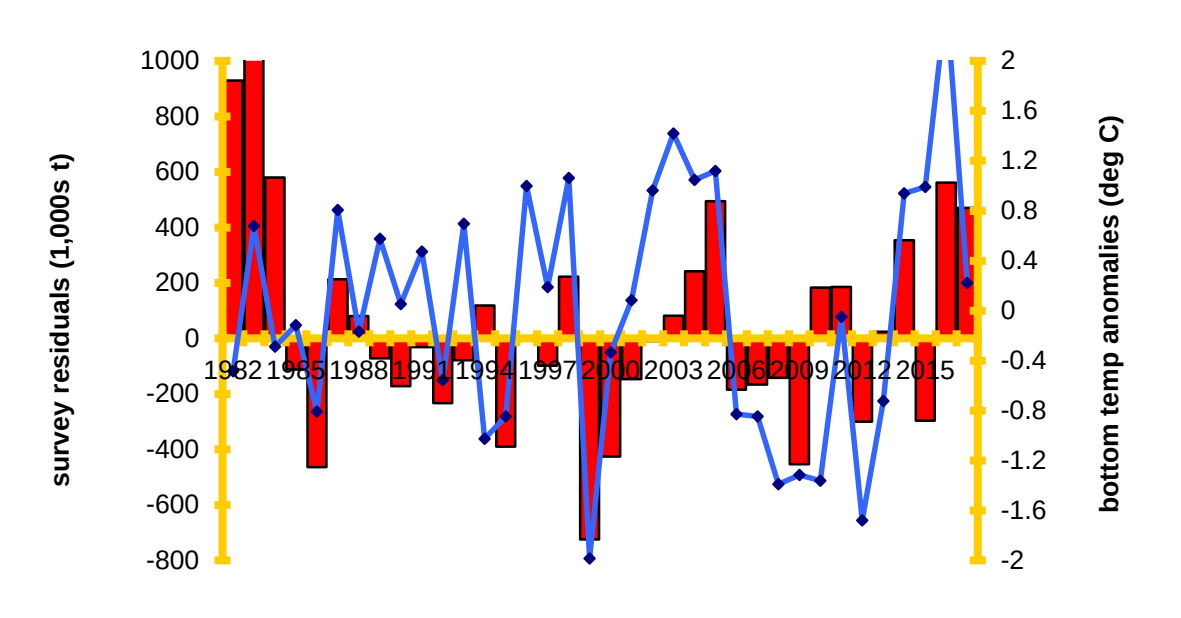
1955-2010

1978-2010

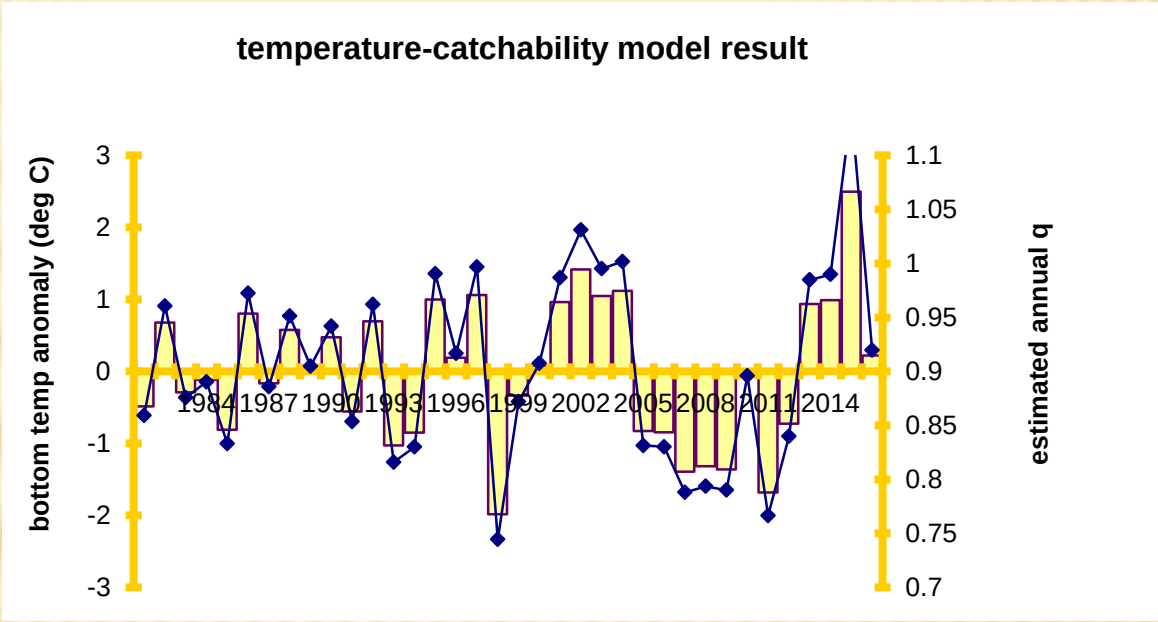
EFFECT OF NEW WEIGHT-AT-AGE INFORMATION AND INCLUDING TWO MORE YEARS TO THE SPAWNER-RECRUIT TIME-SERIES



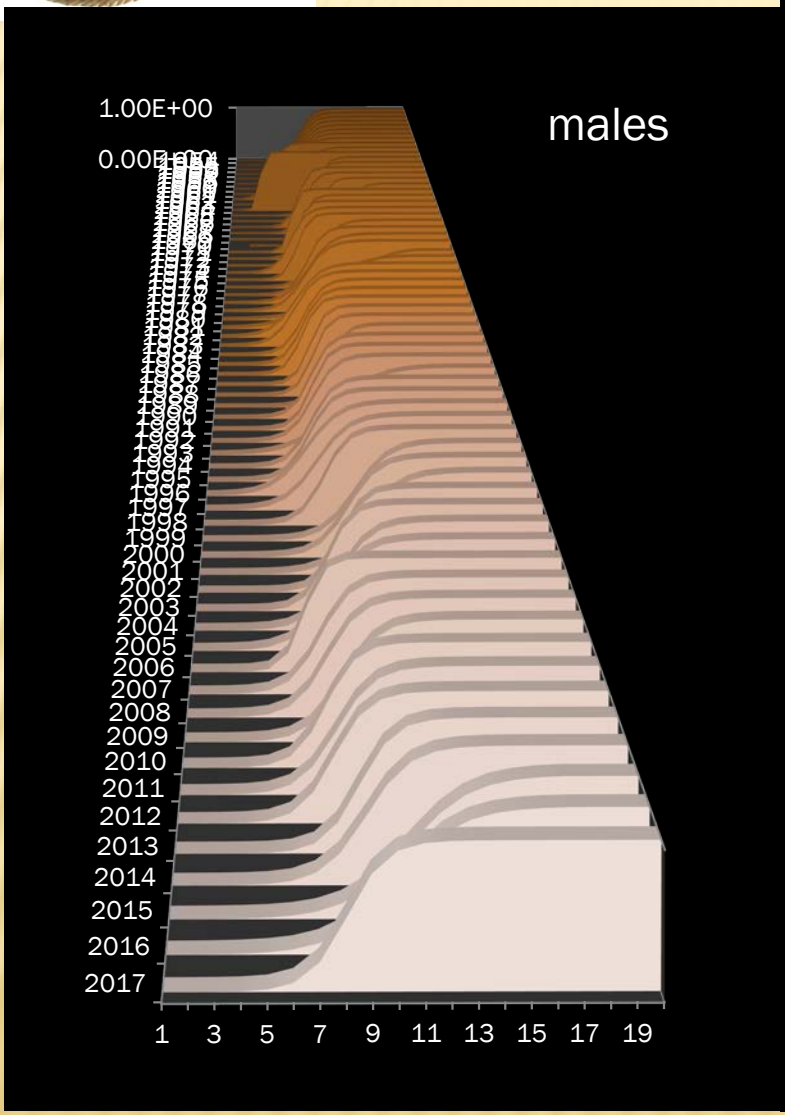
TRAWL SURVEY RESIDUALS (RED BARS) AND BOTTOM TEMPERATURE ANOMALIES (BLUE LINE)

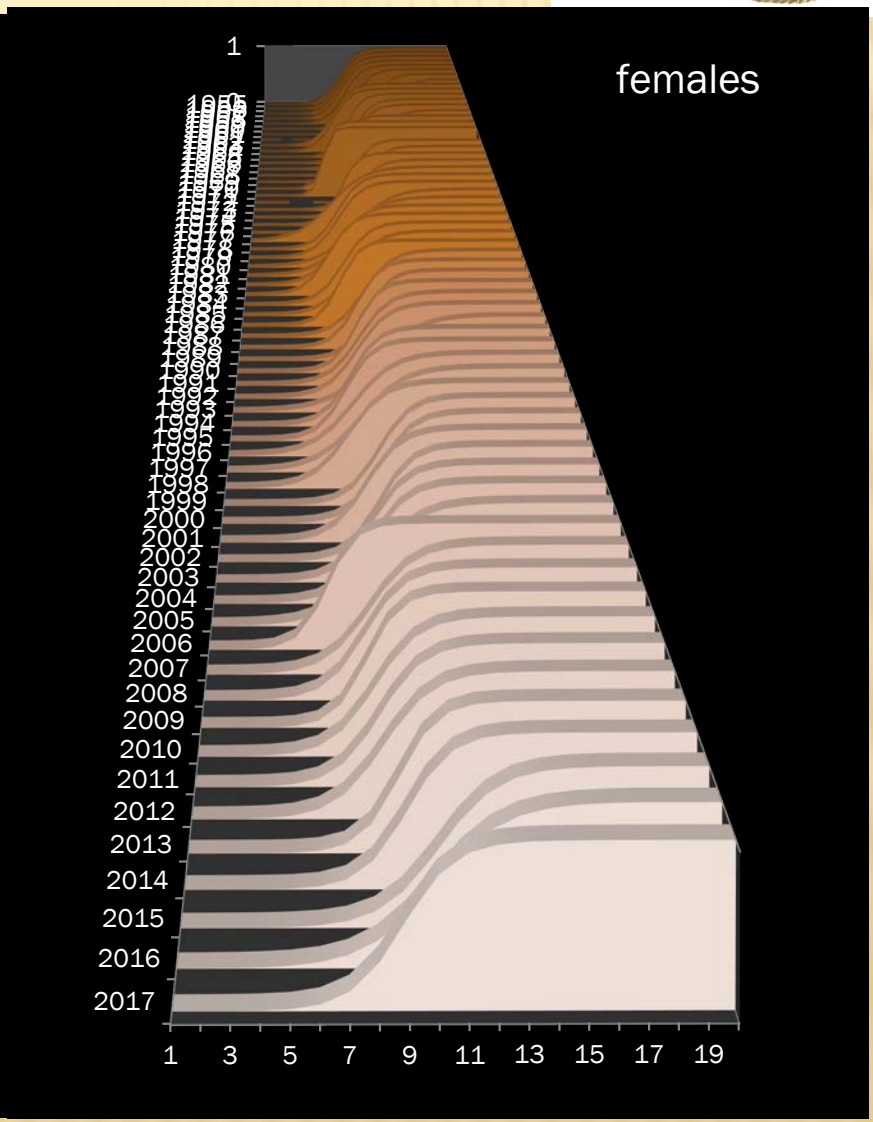


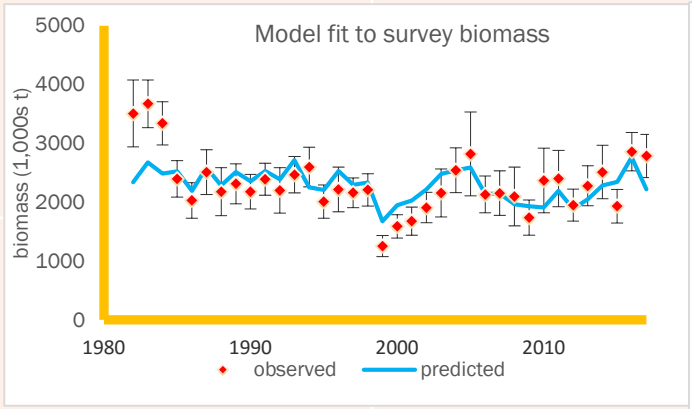
TIME-VARYING SURVEY CATCHABILITY

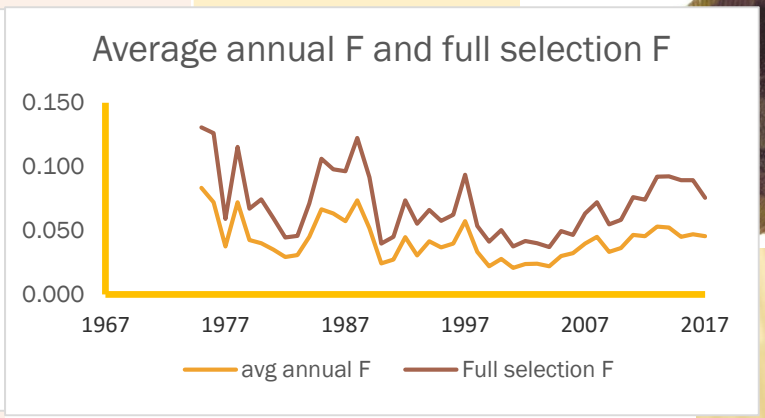


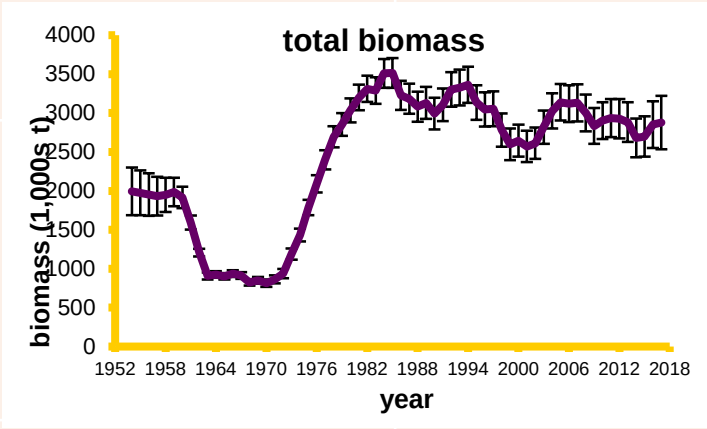
TIME-VARYING FISHERY SELECTIVITY

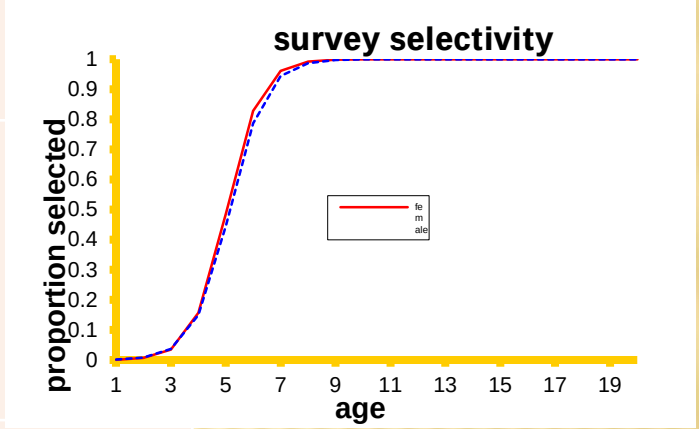


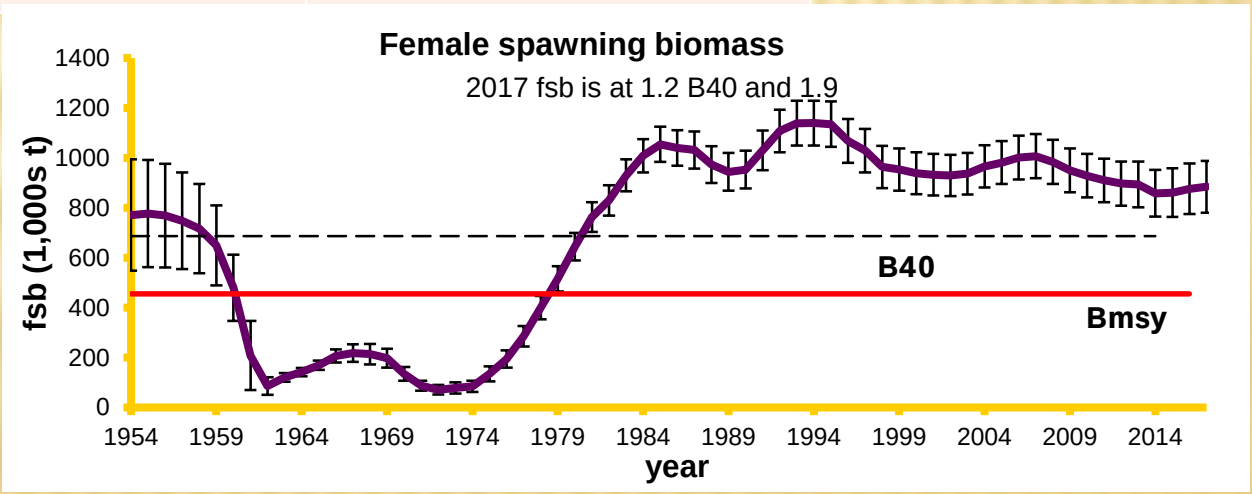



Model fit to survey biomass
biomass (1,000s t)
5000
4000
3000
2000
1000
0
1980
1990
2000
2010
observed
predicted

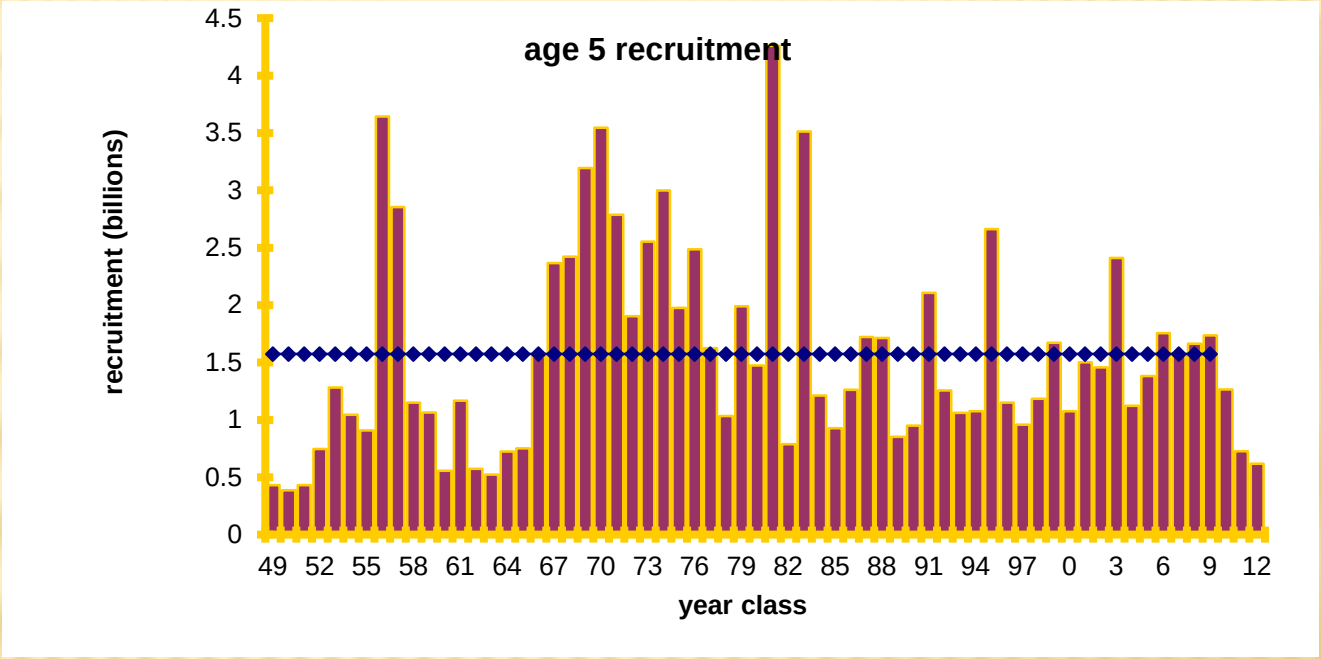

Average annual F and full selection F
0.150
0.100
0.050
0.000
1967
1977
1987
1997
2007
2017
avg annual F
Full selection F


total biomass
biomass (1,000s t)
4000
3500
3000
2500
2000
1500
1000
500
0
1952
1958
1964
1970
1976
1982
1988
1994
2000
2006
2012
2018
year

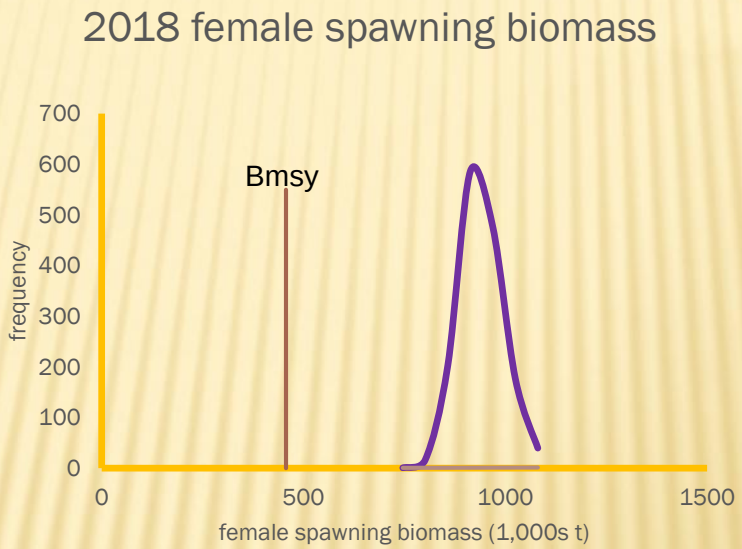

survey selectivity
proportion selected
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
3
5
7
9
11
13
15
17
19
age

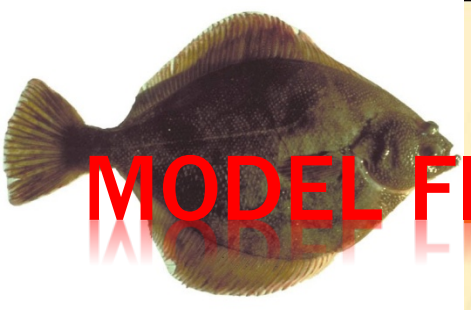

Female spawning biomass
2017 fsb is at 1.2 B40 and 1.9
fsb (1,000s t)
1400
1200
1000
800
600
400
200
0
1954
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
2009
2014
year
B40
Bmsy

MODEL RESULTS

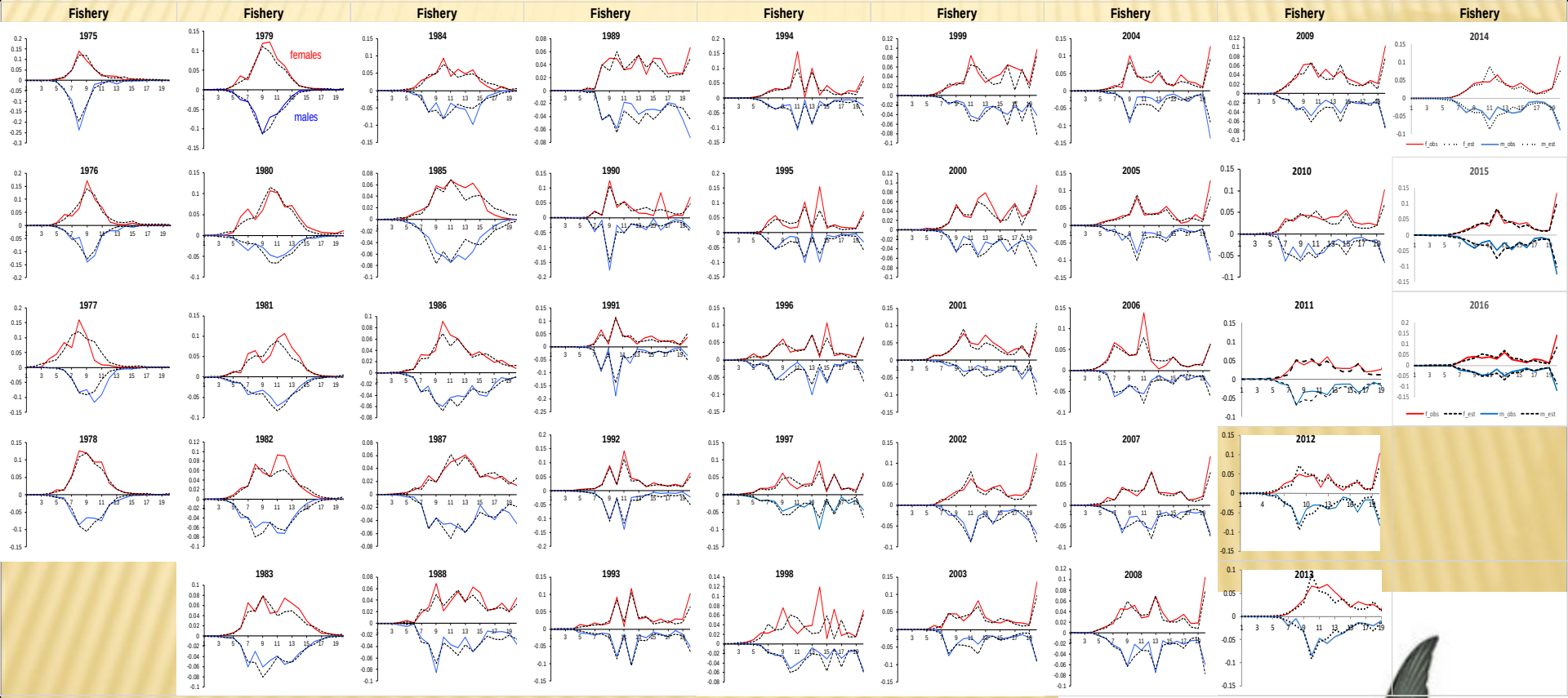


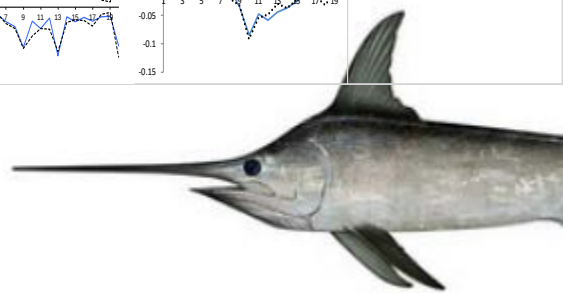
YELLOWFIN SOLE



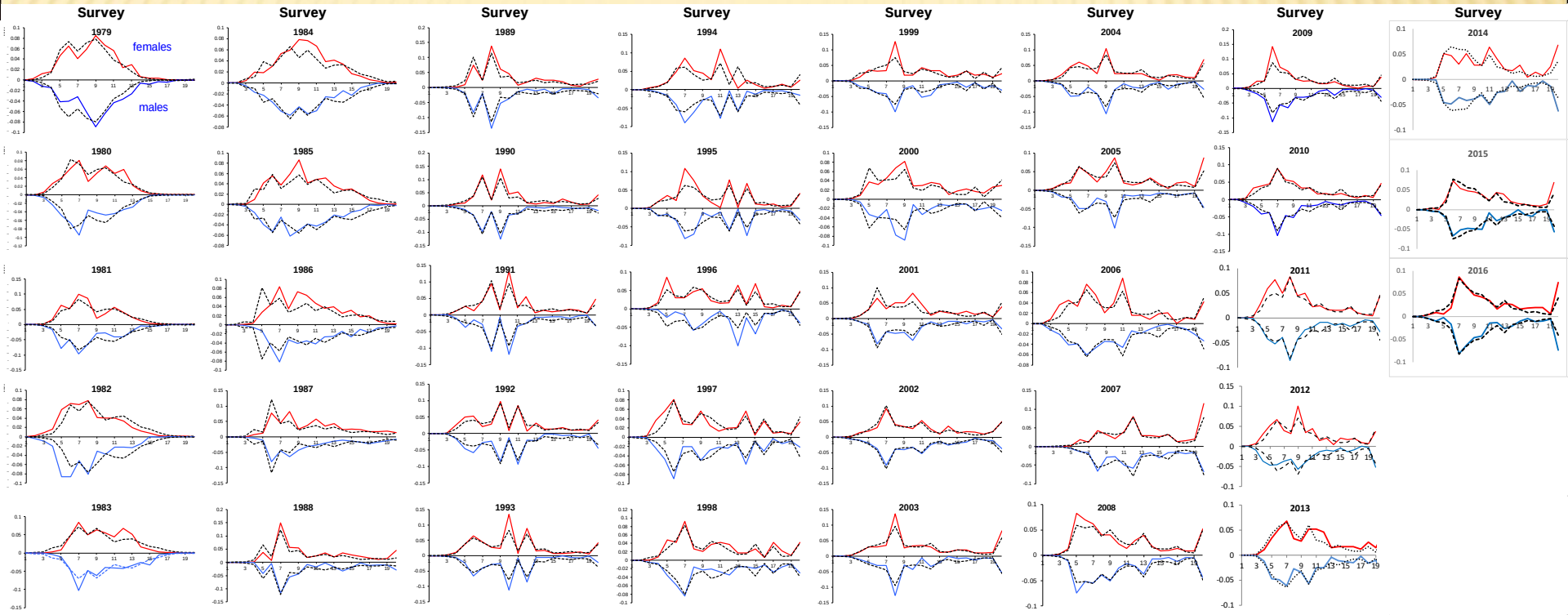


MODEL FIT TO FISHERY AGE COMPOSITION

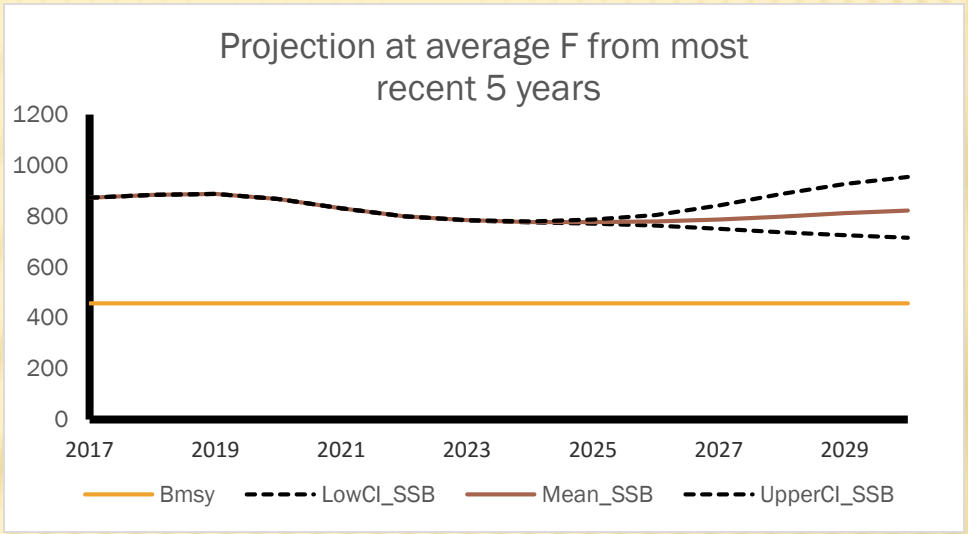




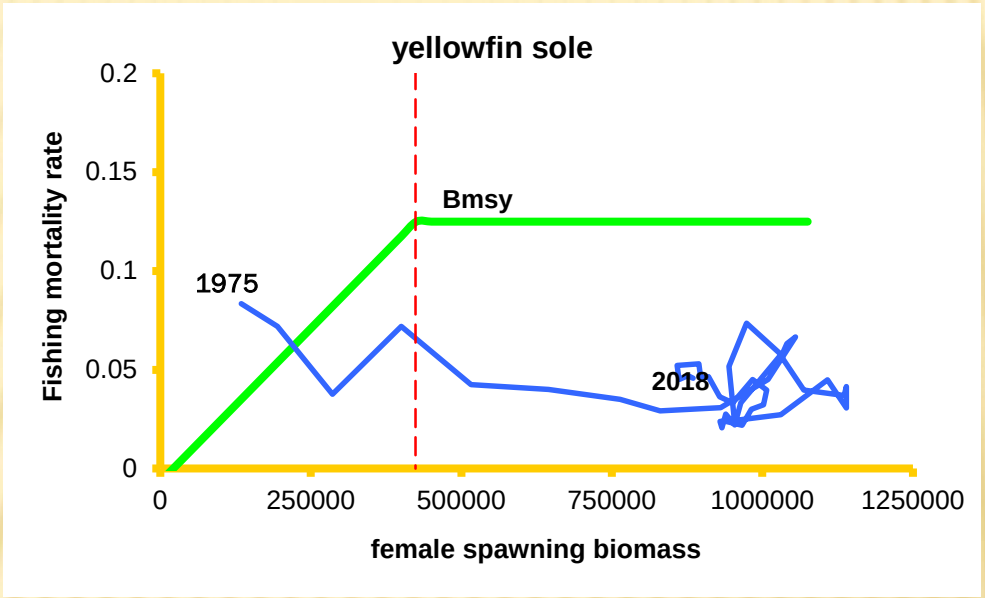
MODEL FIT TO SURVEY AGE COMPOSITION

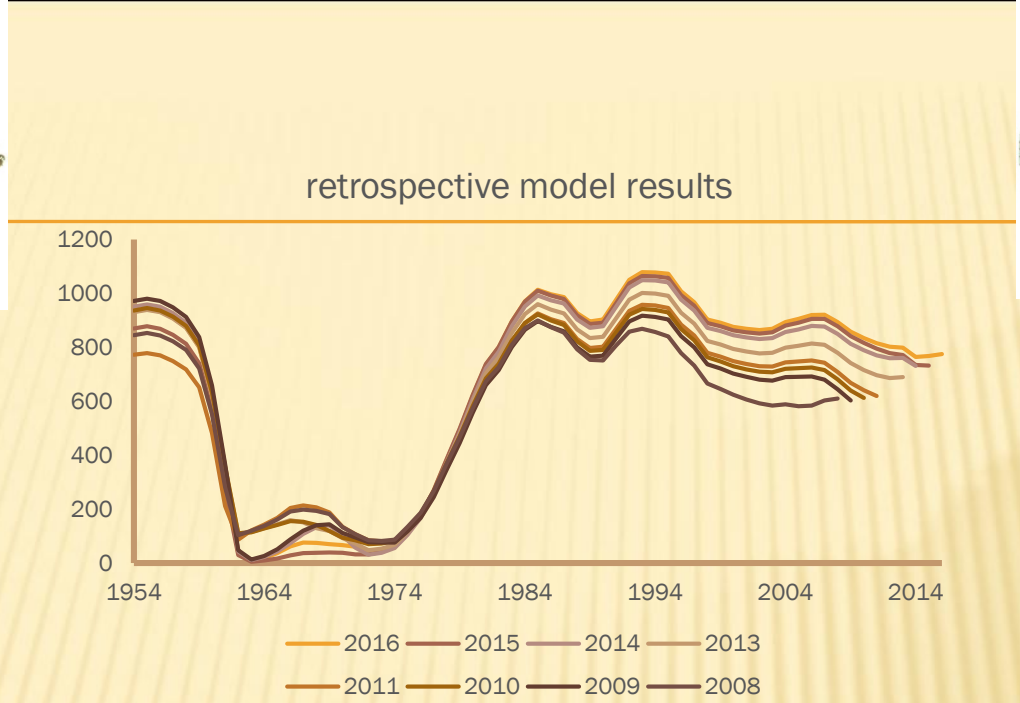


PROJECTED FEMALE SPAWNING BIOMASS



YELLOWFIN SOLE





Trials:

Increased survey standard error by 10%, 20% and 30% over the actual value.

Up-weighted survey age comps (200 to 500) and down-weighted survey SE (increased 30%)

Down-weighted survey age comps, base st. dev values

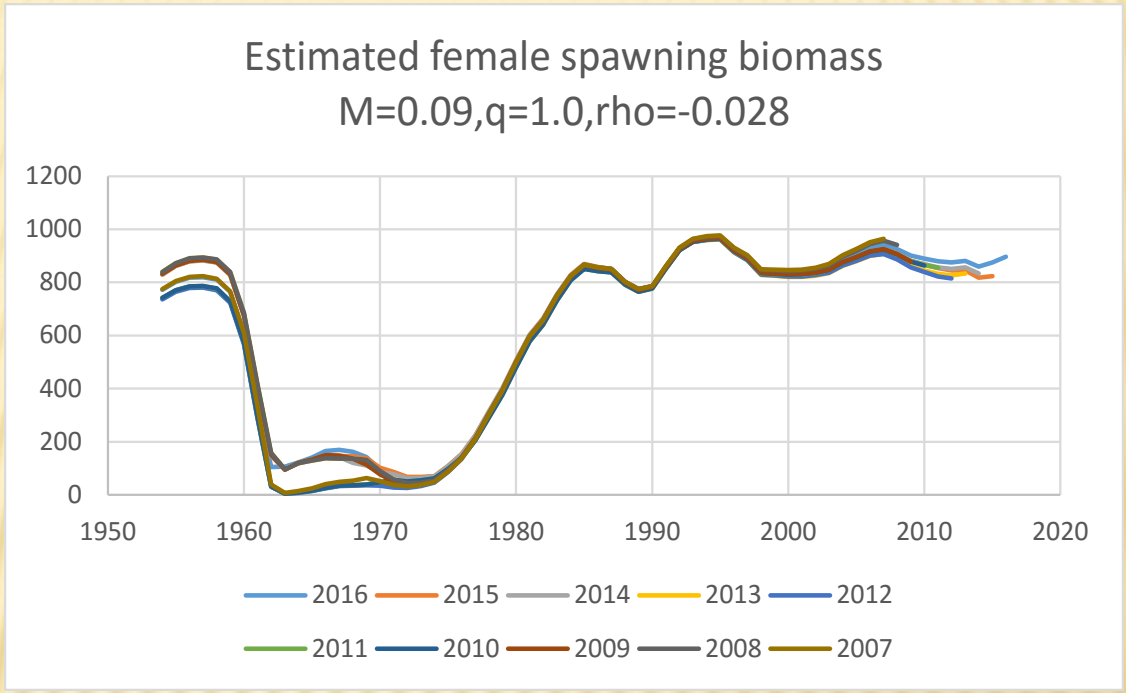
Varied M and q as per plan team request

RETROSPECTIVE ANALYSIS

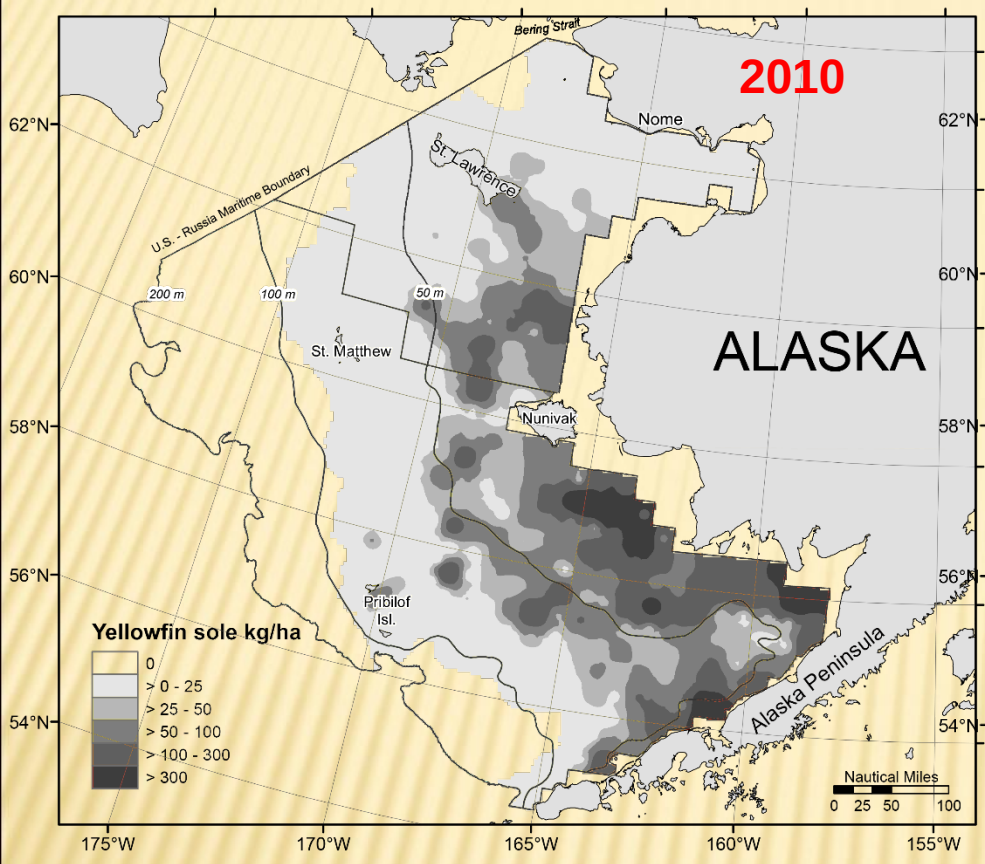
Plan Team request to vary M and Q

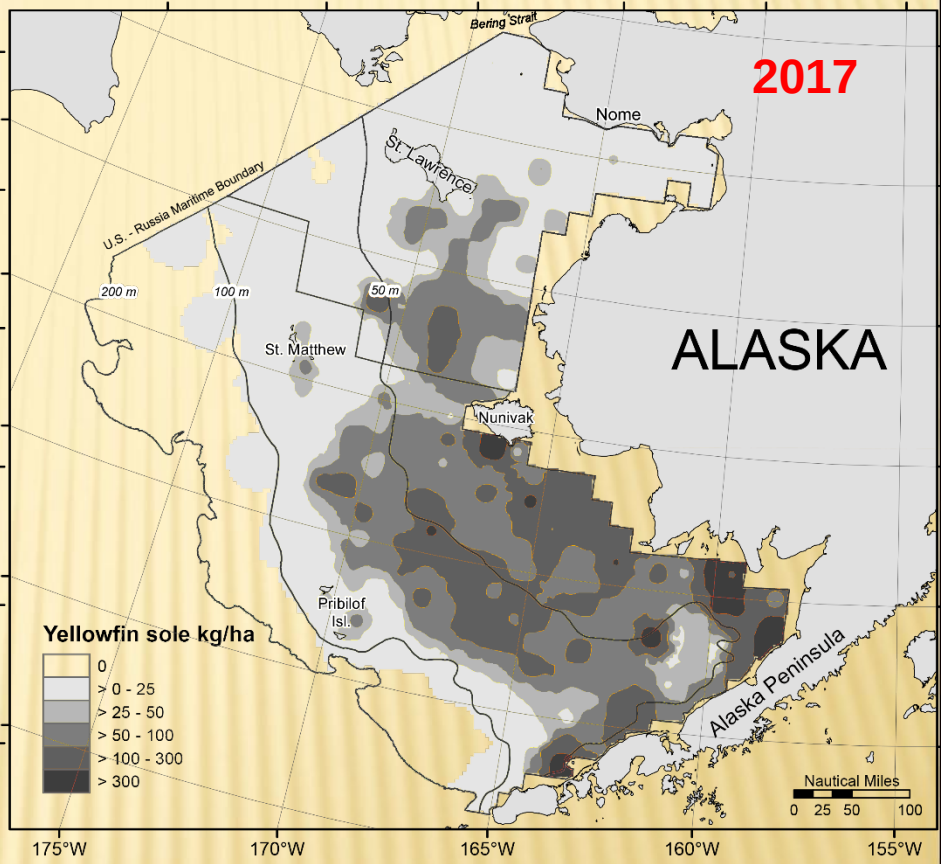
		absolute values				
				Catchability		
		0.8	0.9	1	1.1	1.2
	0.09	0.019	0.003	0.028	0.0511	0.076
	0.1	0.013	0.036	0.059	0.084	0.107
Natural mortality	0.11	0.043	0.066	0.087	0.11	0.131
	0.12	0.07	0.105	0.113	0.135	0.155
	0.13	0.051	0.114	0.135	0.156	0.177
	0.14	0.114	0.135	0.153	0.177	0.2

BSAI YELLOWFIN SOLE



Northern Bering Sea





15.6% of EBS biomass in northern Bering Sea

13.6% of EBS biomass in northern Bering Sea

BSAI YELLOWFIN SOLE

Quantity	As estimated or specified last year for:		As estimated or recommended this year for:	
	2017	2018	2018	2019
M (natural mortality rate)	0.12	0.12	0.12	0.12
Tier	1a	1a	1a	1a
Projected total (age 6+) biomass (t)	2,290,000	2,202,300	2,553,100	2,460,700
Female spawning biomass (t)	587,300			
Projected	778,600	770,900	895,000	890,000
B_0	1,202,700		1,204,000	
B_{MSY}	424,000		456,000	
F_{OFL}	0.125	0.125	0.12	0.12
maxF_{ABC}	0.114	0.114	0.109	0.109
F_{ABC}	0.114	0.114	0.109	0.109
OFL (t)	287,000	276,000	306,700	295,600
maxABC (t)	260,800	250,800	277,500	267,500
ABC (t)	260,800	250,800	277,500	267,500
Status	As determined last year for:		As determined this year for:	
	2015	2016	2016	2017
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

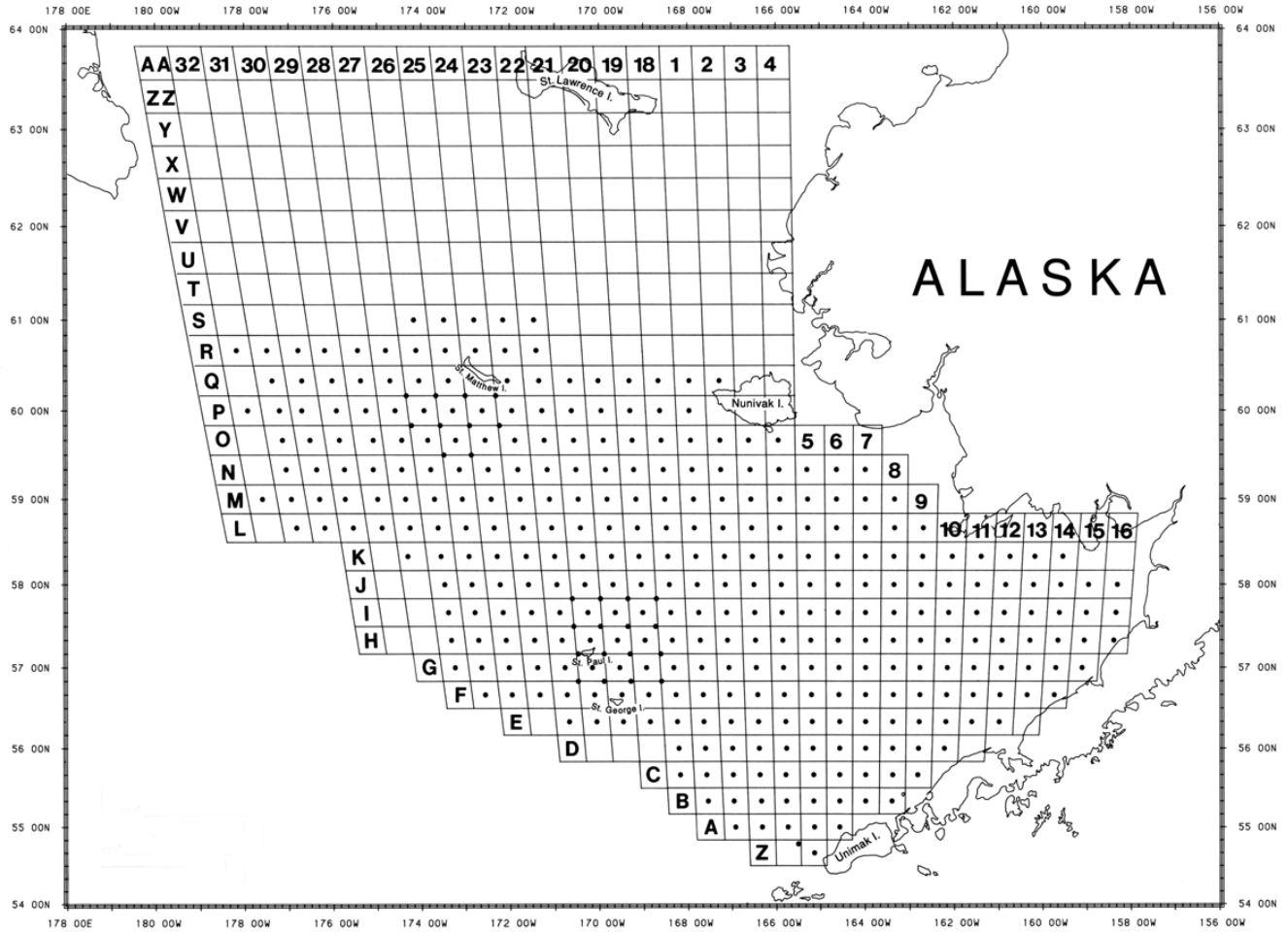


Figure 1. -- Eastern Bering Sea survey grid map of sampled stations.