The Status of Chilipepper (*Sebastes goodei*) in U.S. Waters off California, Oregon and Washington in 2025



E.J. Dick*, John C. Field, Nicholas Grunloh and Tanya Rogers

* corresponding author; edward.dick@noaa.gov

Assessment Model and Current Status

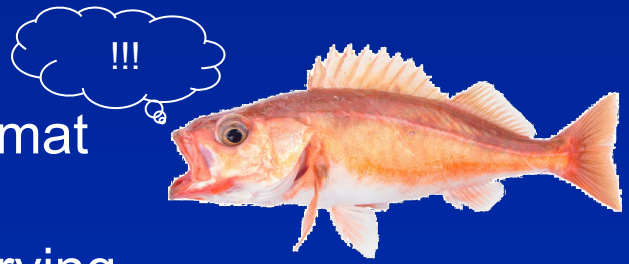
U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

NOAA FISHERIES

Outline

1. Transition from the last assessment
   a. Revisions to data sets and model structure
   b. Linking the pre-STAR base to 2017 catch-only update
2. Addition of triennial survey ages (revised base model)
3. Coastwide model for chilipepper rockfish
   a. Model structure, key assumptions
   b. Parameter estimates, evidence of convergence
   c. Fits to the data, residual analyses
   d. Evaluation of uncertainty
   e. Derived quantities
4. Reference Points
5. Risk Table Discussion Materials

Select revisions to data and model structure

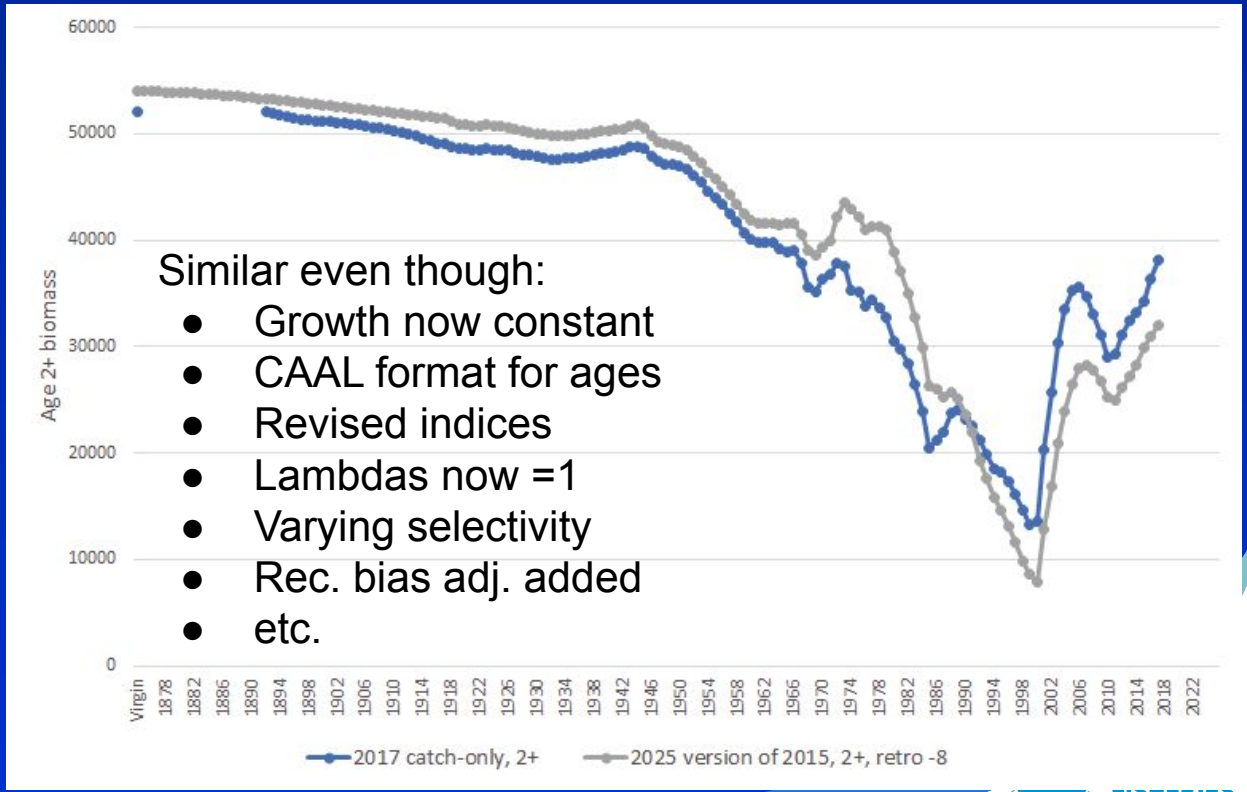


- All data sources re-analyzed
- Conversion of all age data to “CAAL” format
- Fleets-as-areas approach
- Growth is no-longer modeled as time-varying
- Updated priors for steepness and natural mortality
- Sex-specific natural mortality estimated in the model
- Data-weighting consistent with current recommendations
- Removal of fishery-dependent indices
- Addition of CalCOFI index of spawning output
- Addition of trawl discard fleet; at-sea hake bycatch
- Revised fecundity-length and weight-length relationships

Comparison of population scale (age 2+ biomass)

Pre-STAR base closely matches scale and trend of last update assessment when modified to match key parameters and data sets

- M (female & male)
- Bev.-Holt steepness
- Recruitment deviations
- Fecundity
- Weight-at-length
- Use fishery-dependent indices
- Exclude CalCOFI index

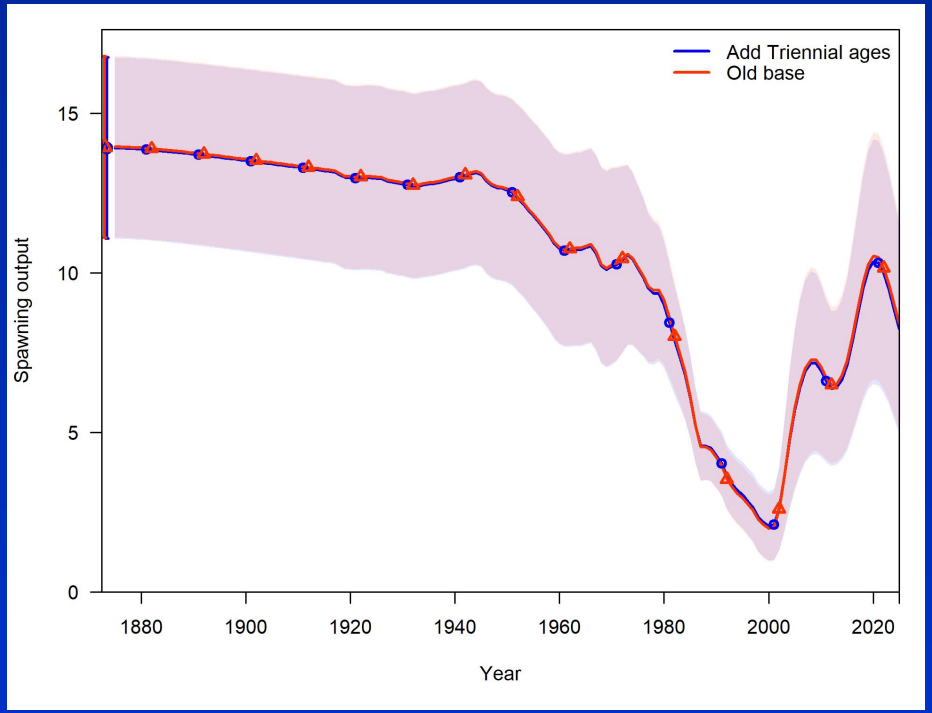


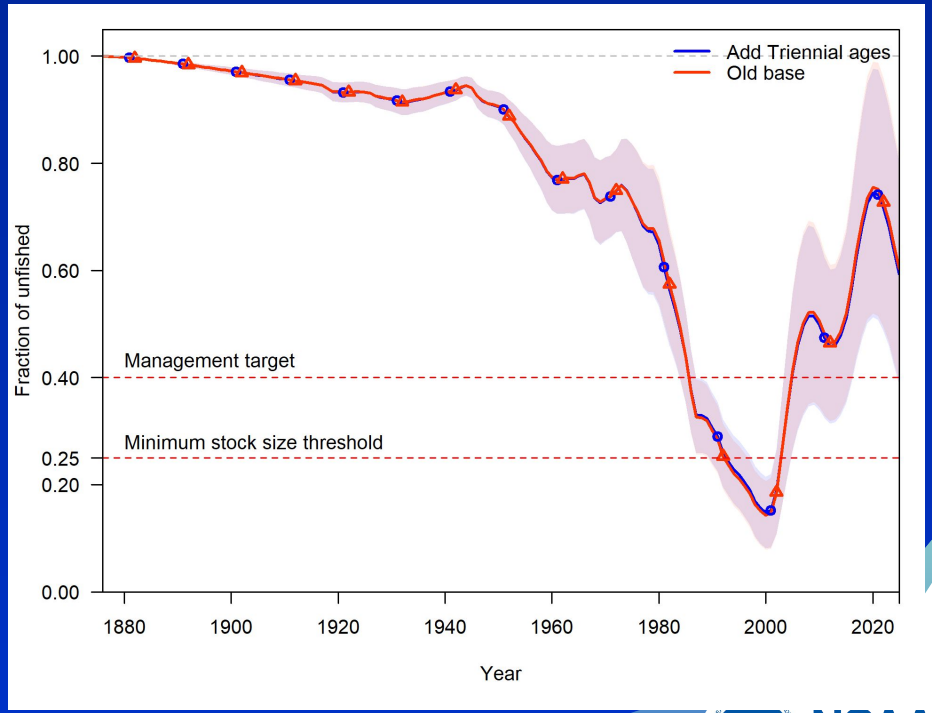
Similar even though:

- Growth now constant
- CAAL format for ages
- Revised indices
- Lambdas now =1
- Varying selectivity
- Rec. bias adj. added
- etc.

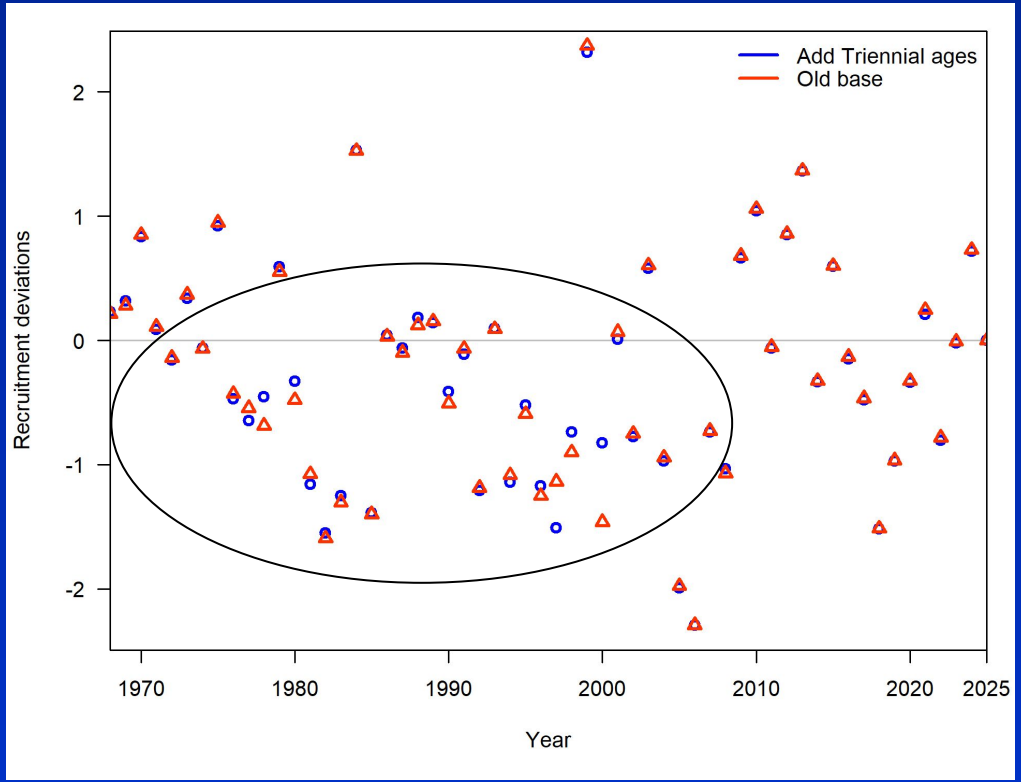
Revision to the pre-STAR base model

- Ages from triennial survey added for consistency with previous update





Revision to the pre-STAR base model



Parameter or Quantity	Add Triennial ages	Old base	% change
NatM_uniform_Fem_GP_1	0.171	0.171	-0.2%
L_at_Amax_Fem_GP_1	48.169	48.190	0.0%
VonBert_K_Fem_GP_1	0.194	0.194	0.2%
CV_young_Fem_GP_1	0.108	0.110	-1.7%
CV_old_Fem_GP_1	0.038	0.037	1.4%
NatM_uniform_Mal_GP_1	0.266	0.261	1.9%
L_at_Amax_Mal_GP_1	-0.333	-0.337	-1.3%
VonBert_K_Mal_GP_1	0.540	0.549	-1.7%
CV_young_Mal_GP_1	0.203	0.208	-2.5%
CV_old_Mal_GP_1	0.112	0.148	-24.8%
SR_LN(R0)	10.240	10.248	-0.1%
Bratio_2025	0.593	0.603	-1.6%
SSB_unfished	13904	13945	-0.3%
Totbio_unfished	60831	61069	-0.4%
Recr_unfished	27998	28215	-0.8%
Dead_Catch_SPR	2494	2509	-0.6%
OFLCatch_2025	2834	2894	-2.1%

Outline

1. Transition from the last assessment
   a. Revisions to data sets and model structure
   b. Linking the pre-STAR base to 2017 catch-only update
2. Addition of triennial survey ages (revised base model)
3. Coastwide model for chilipepper rockfish
   a. Model structure, key assumptions
   b. Parameter estimates, evidence of convergence
   c. Fits to the data, residual analyses
   d. Evaluation of uncertainty
   e. Derived quantities
4. Reference Points
5. Unresolved problems and major uncertainties

NOAA FISHERIES

Model Structure & Key Assumptions

- Single, sex-disaggregated population in U.S. waters from Mexico to Canada
- Annual time step from 1875-2024, tracking ages 0-35; assumed unfished in 1875
- 1-cm population length bins from 7-60+ cm; 2-cm data bins from 8-60+ cm
- Catch fleets
  - 6 commercial (defined by gear group and area; includes discard “fleet” for trawl)
  - 2 recreational (modes combined, by area; catch+discard)
- Fishery-independent “survey” fleets
  - West Coast Groundfish Bottom Trawl Survey
  - AFSC / NWFSC “Triennial” Trawl Survey
  - CalCOFI Ichthyoplankton survey
  - Rockfish Recruitment and Ecosystem Assessment Survey (RREAS)
- Length composition data (all catch fleets, plus bottom trawl surveys)
- Conditional age-at-length (CAAL) data
  - Commercial and recreational fleets; bottom trawl surveys

NOAA FISHERIES

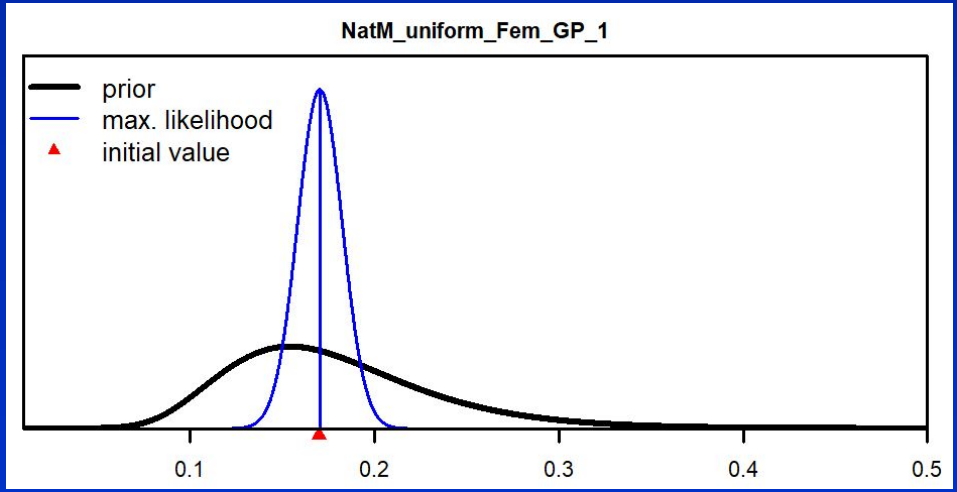
Model Structure & Key Assumptions

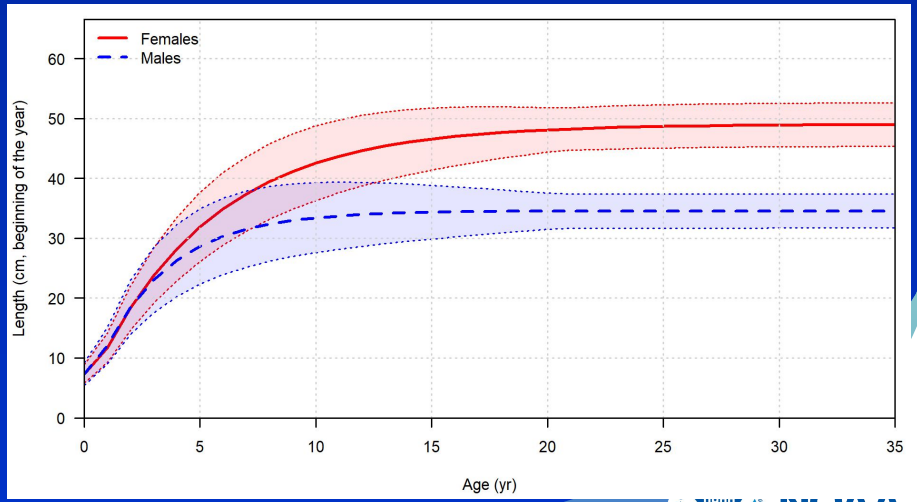
- 114 estimated parameters (including 57 rec. deviations and 12 forecast dev's)
- Natural mortality estimated for females (with prior) and males (offset, flat prior)
- Eight estimated parameters of von Bertalanffy growth function
  - Schnute parameterization (A_1 = 0.5 years, A_2 = 20.5 years)
  - $L(A_1)$ fixed at 7.3 cm for both sexes based on observations of settled YOY
  - $L(A_2)$, k, $CV(L(A_1))$ and $CV(L(A_2))$ estimated separately for both sexes
- Beverton-Holt stock-recruitment relationship; steepness fixed at prior mean (0.72)
- Estimated equilibrium unfished recruitment (R_0)
- Recruitment deviations estimated (1968-2024) with σ_R = 1.0
- All indices assumed proportional to vulnerable biomass (except RREAS)
- Added variance parameters for CalCOFI and RREAS indices
- Length-based selectivity: double-normal (some parameters fixed)
- Time-blocked selectivity for CA hook-and-line, trawl, and So. CA recreational fleets
- "Francis" weights applied to all length and age composition data

NOAA FISHERIES

Estimates of natural mortality and growth

- From revised base with additional triennial ages
- Female M ~ 0.17, Male M ~ 0.22
- Female L(age 20) ~ 48 cm, Male L(age 20) ~ 35
- Female k ~ 0.19, Male k ~ 0.33

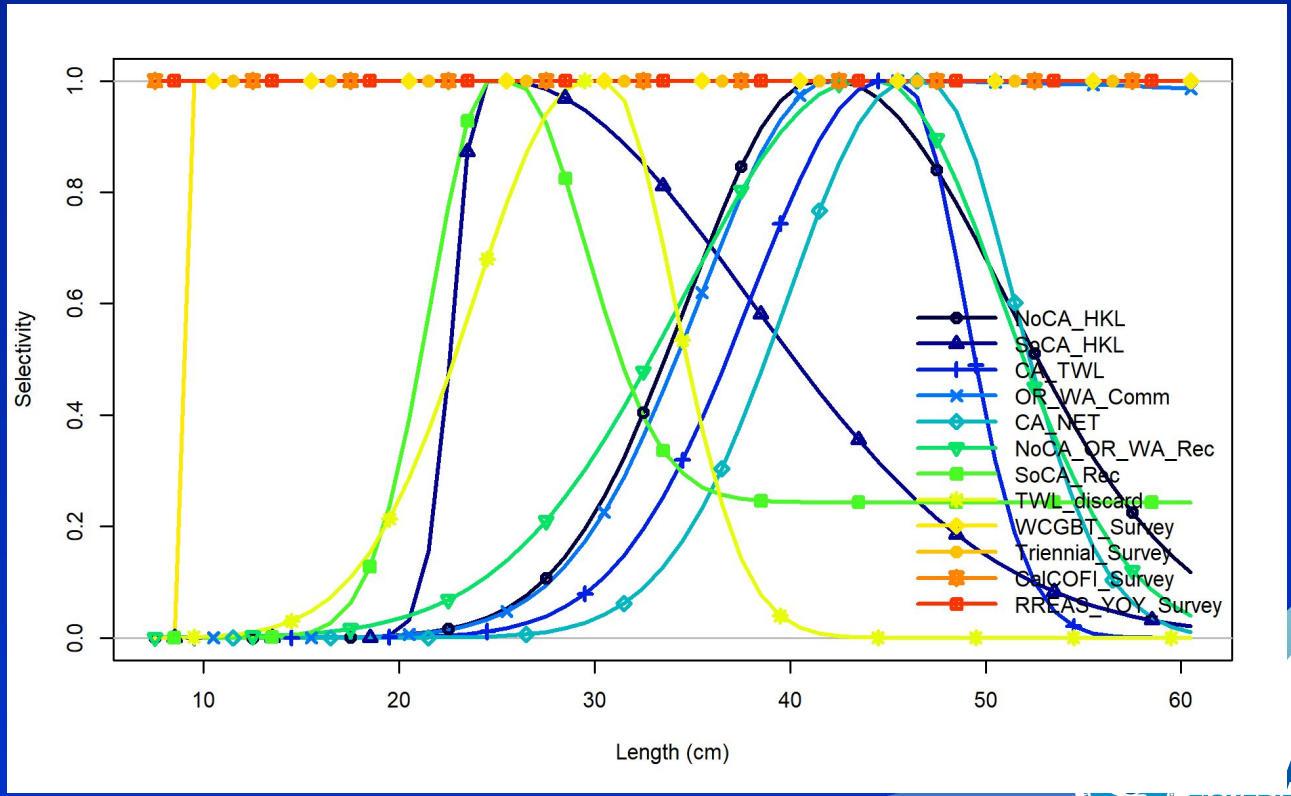




Estimated Selectivity Curves (revised base)

- Figure below shows selectivity in the model end year (2024)

- WCGBTS selectivity initially domed, but unstable; fixed at sel=1 for lengths >= 9.5 cm
- Triennial selectivity estimation produced asymptotic curves with steep slope and small inflection point; fixed at sel=1 for ages 1+



Estimated Selectivity Curves (revised base)

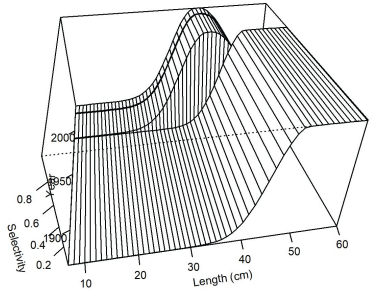
- Illustrations of time-varying selectivity; asymptotic → domed

- Time blocks:
  1875-1990
  (1991 sort requirement for bocaccio)

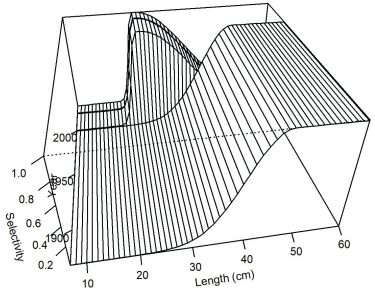
  1875-2000
  (2001 CCAs)

  1875-1999
  (bocaccio overfishing declaration)

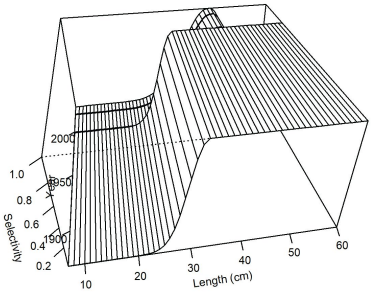
No. CA hook-and-line



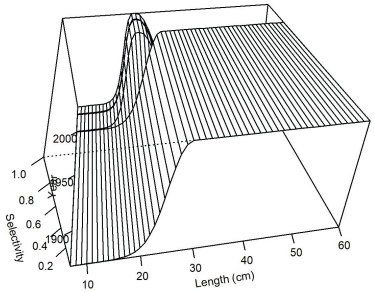
So. CA hook-and-line



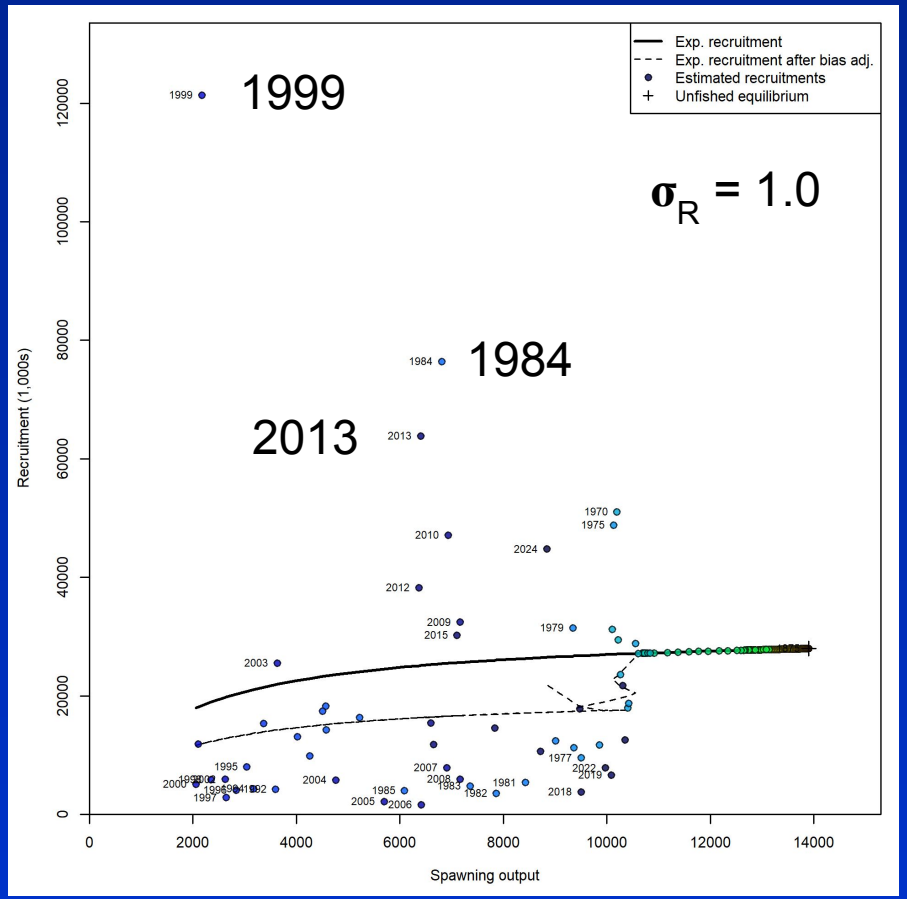
CA trawl

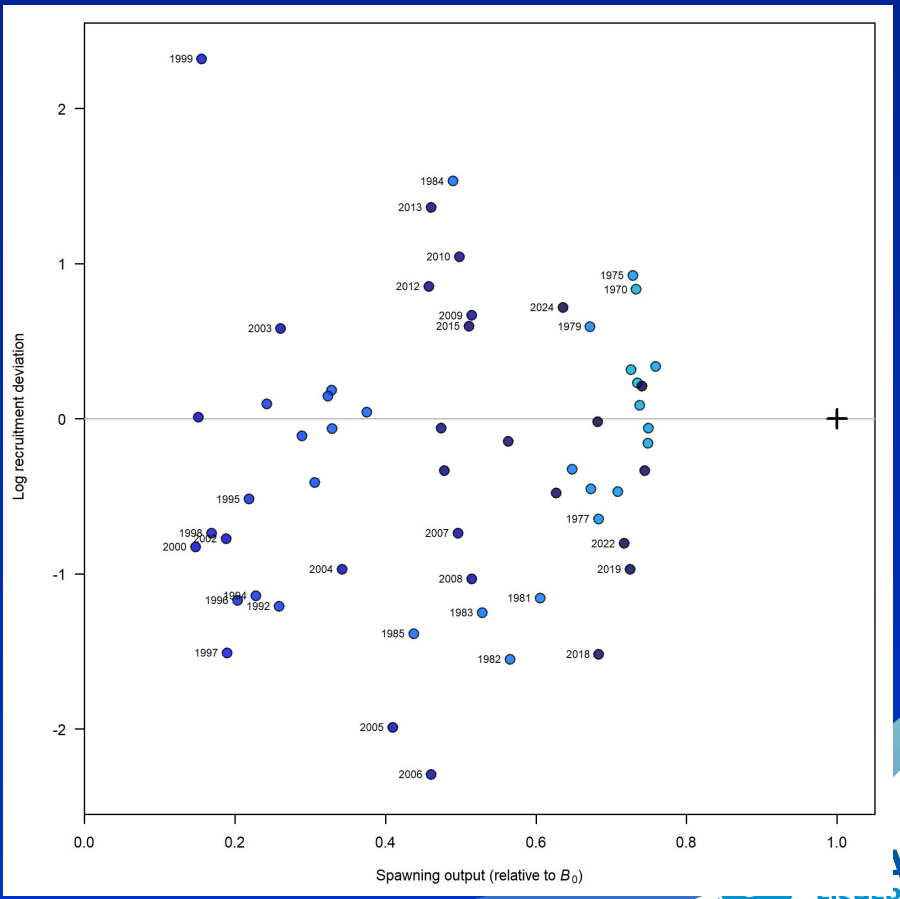


So. CA recreational



Estimated Recruitment Deviations (revised base)





Estimated Recruitment Deviations (revised base)

Tuning the input value of “sigma-R”: console output from the “r4ss” package (revised base)

```
$sigma_R_in
[1] 1

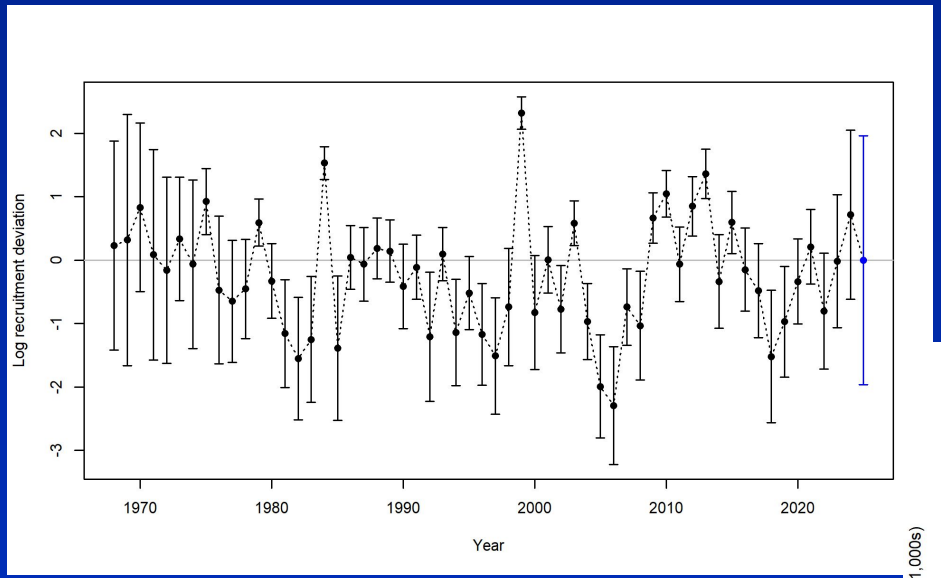
$sigma_R_info
           period N_devs SD_of_devs Var_of_devs   mean_SE mean_SEsquared sqrt_sum_of_components SD_of_devs_over_sigma_R sqrt_sum_over_sigma_R alternative_sigma_R
1            Main     57  0.8959091    0.8026531 0.4075883      0.2005549                1.001603                0.8959091                1.001603    1.00160273555619
2      Early+Main     57  0.8959091    0.8026531 0.4075883      0.2005549                1.001603                0.8959091                1.001603    1.00160273555619
3 Early+Main+Late     57  0.8959091    0.8026531 0.4075883      0.2005549                1.001603                0.8959091                1.001603    1.00160273555619

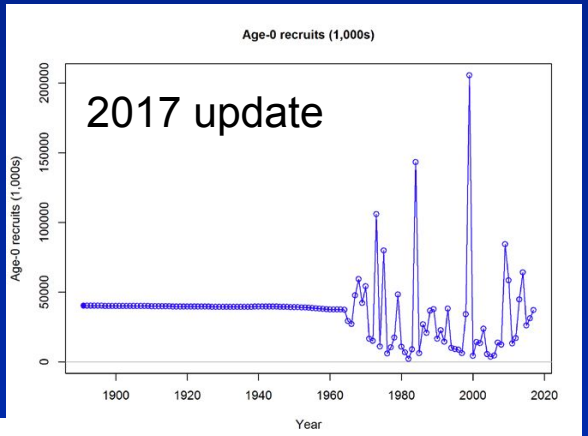
$rmse_table
    ERA  N     RMSE RMSE_over_sigmaR mean_BiasAdj
1  main 57 0.921187         0.848585     0.791273
2 early  0 0.000000         0.000000     0.000000
```

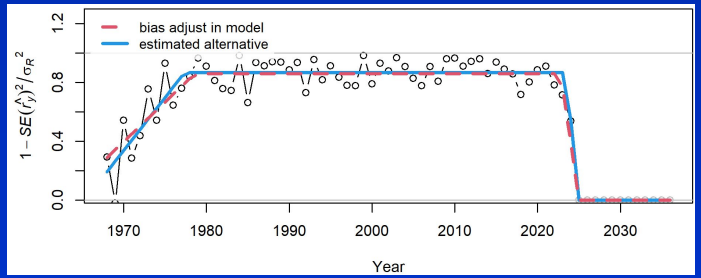
Recruitment deviations not constrained to sum to zero (option 2 in Stock Synthesis); recommended if using MCMC (see convergence diagnostics, below)

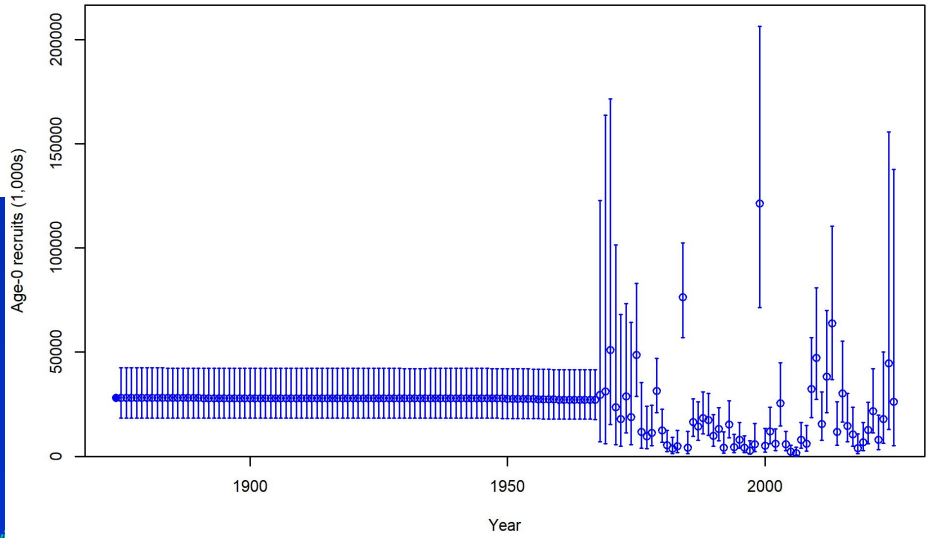
NOAA FISHERIES

Estimated Recruitment Deviations (revised base)









Evidence of Convergence (revised base)

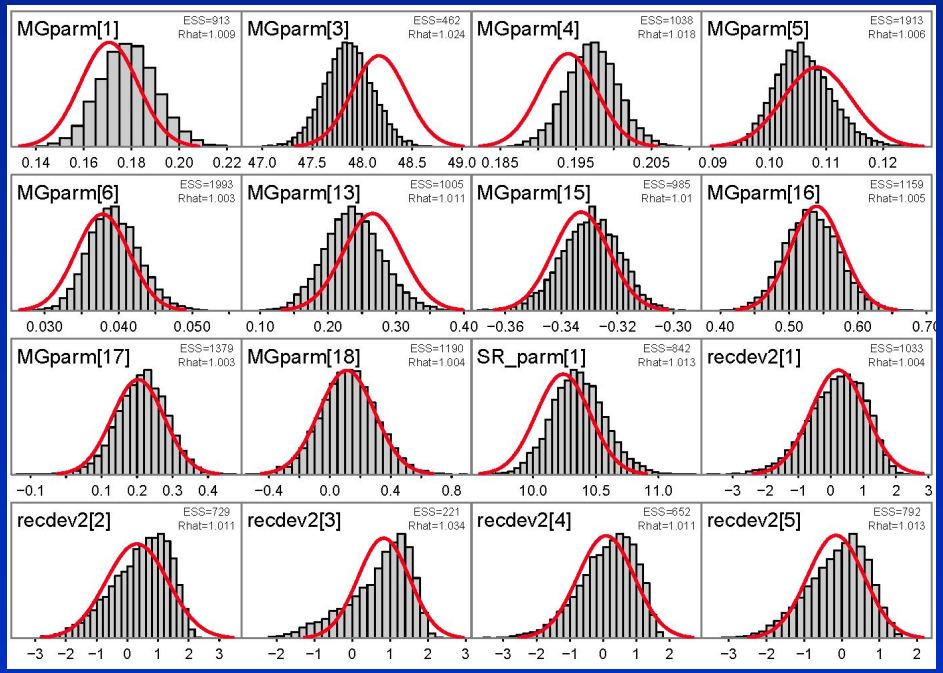
- Gradients generally around 10^{-3} or 10^{-4}
- Jitter analysis of revised base ("jitter fraction" = 0.2) did not find solution with a lower negative log likelihood (NLL)
- `-hess_step -binp ss3.bar` result: "2 Hessian steps reduced maxgrad from 0.0025274 to 0 and NLL by 3.28009e-09."

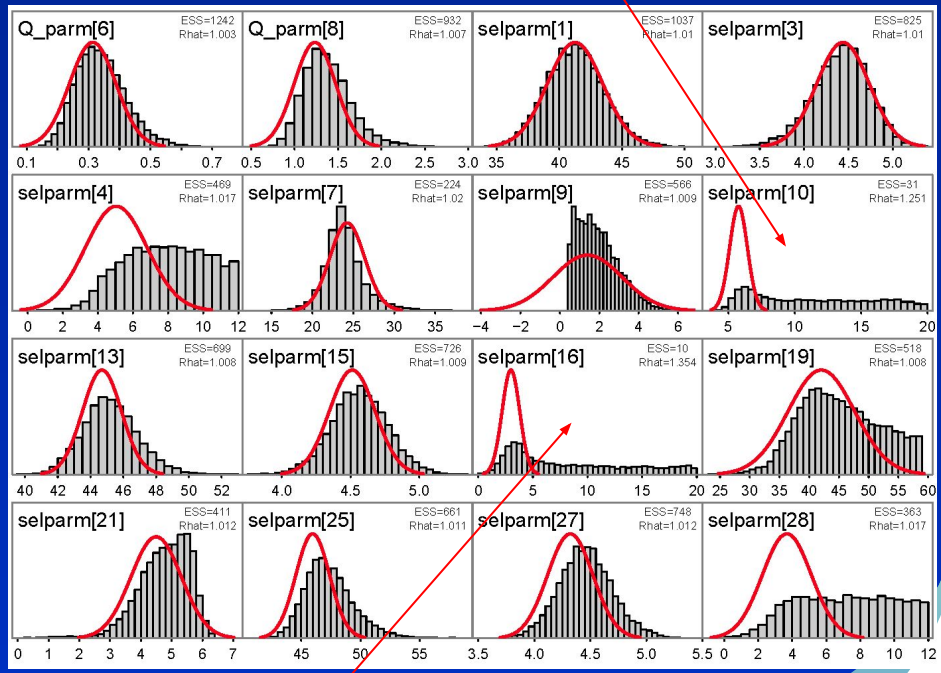
NLL	Frequency
2620.26	88
2625.96	4
2869.3	1
2988.76	1
4036.28	1
4335.66	1
4518.86	1
4911.35	1
5308.38	1
5835.44	1
Grand Total	100

NOAA FISHERIES

MCMC diagnostics (revised base)

descending scale for the SoCA HKL fleet



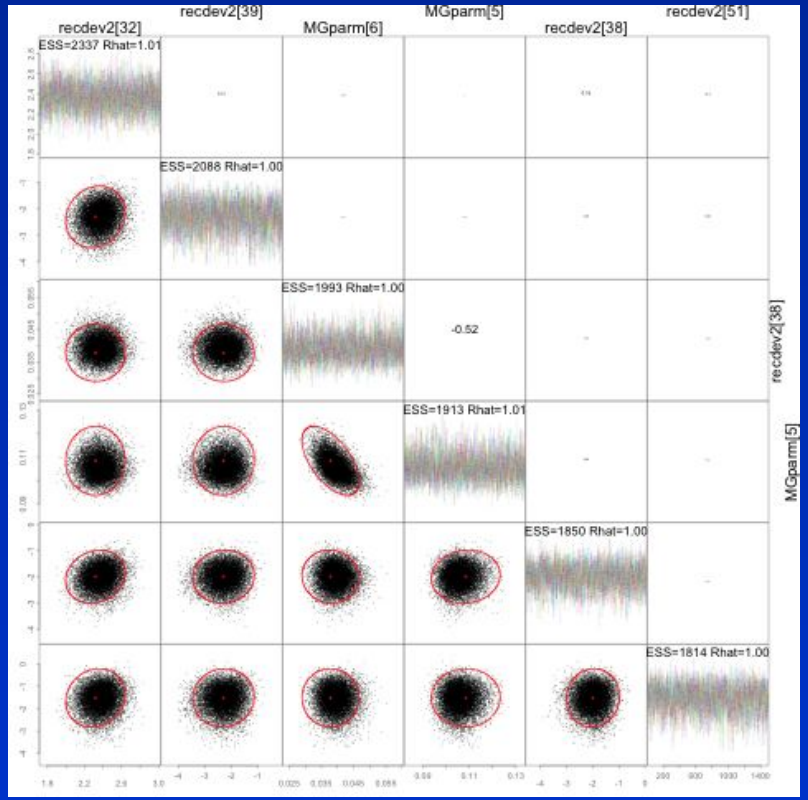


descending scale for the CA trawl fleet

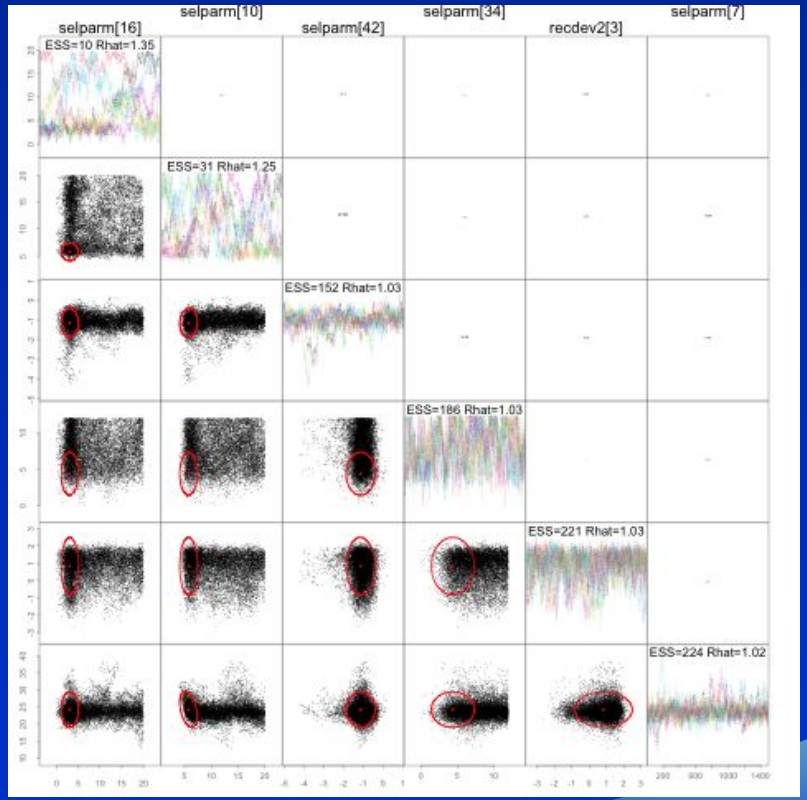
NOAA FISHERIES

MCMC diagnostics (revised base)

“Fast” mixing



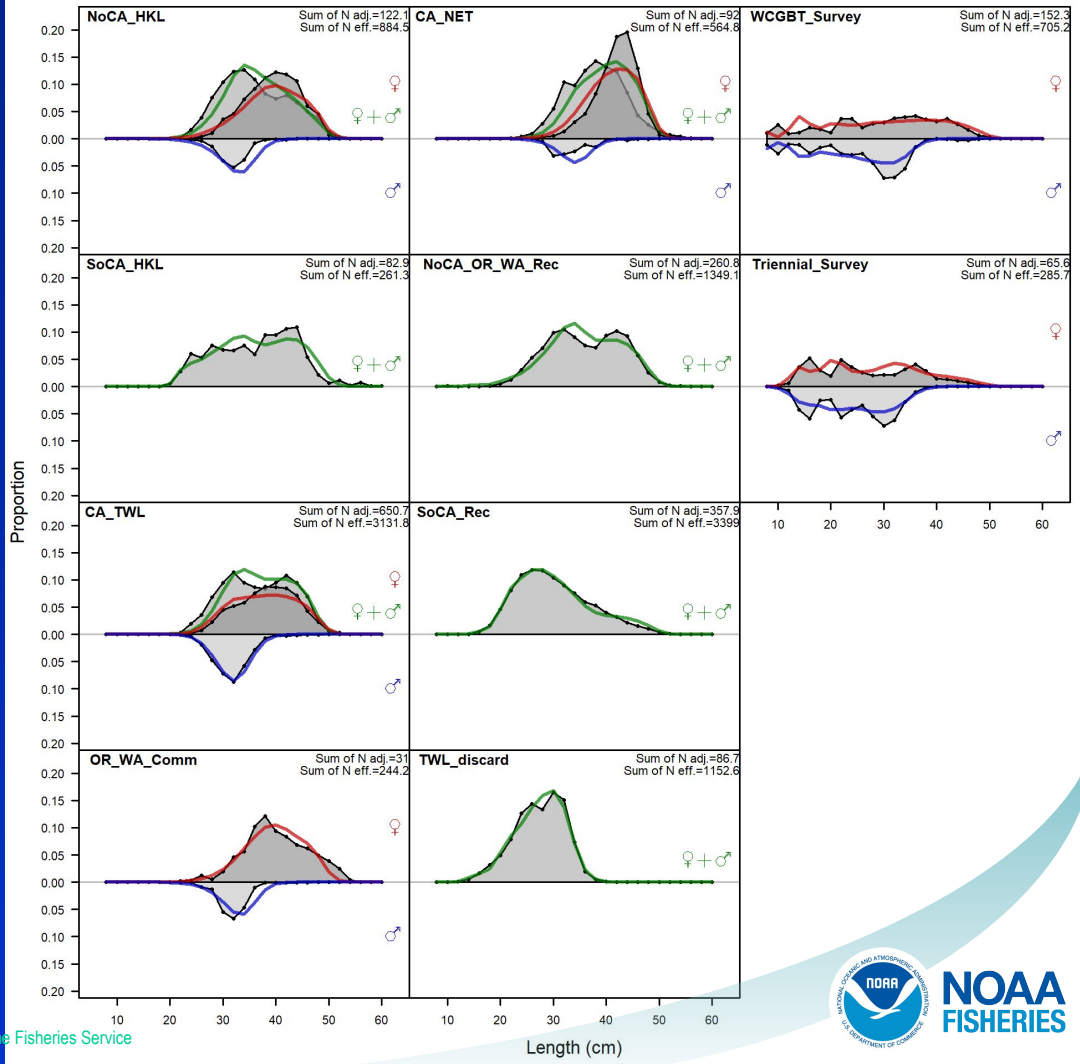
“Slow” mixing



NOAA FISHERIES

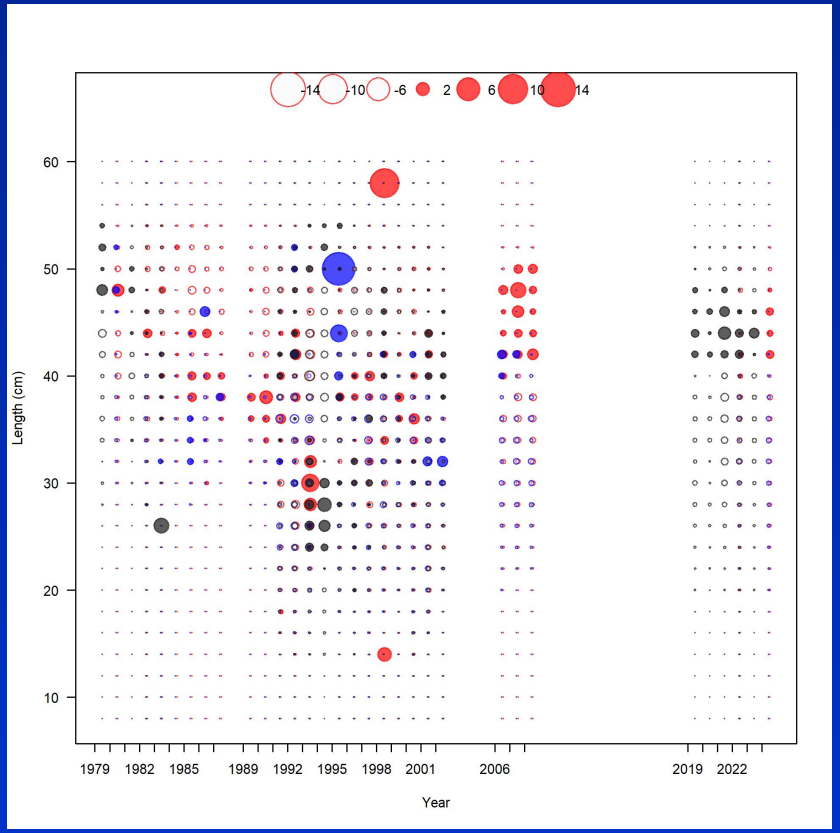
Fits to Composition Data: Aggregated Lengths

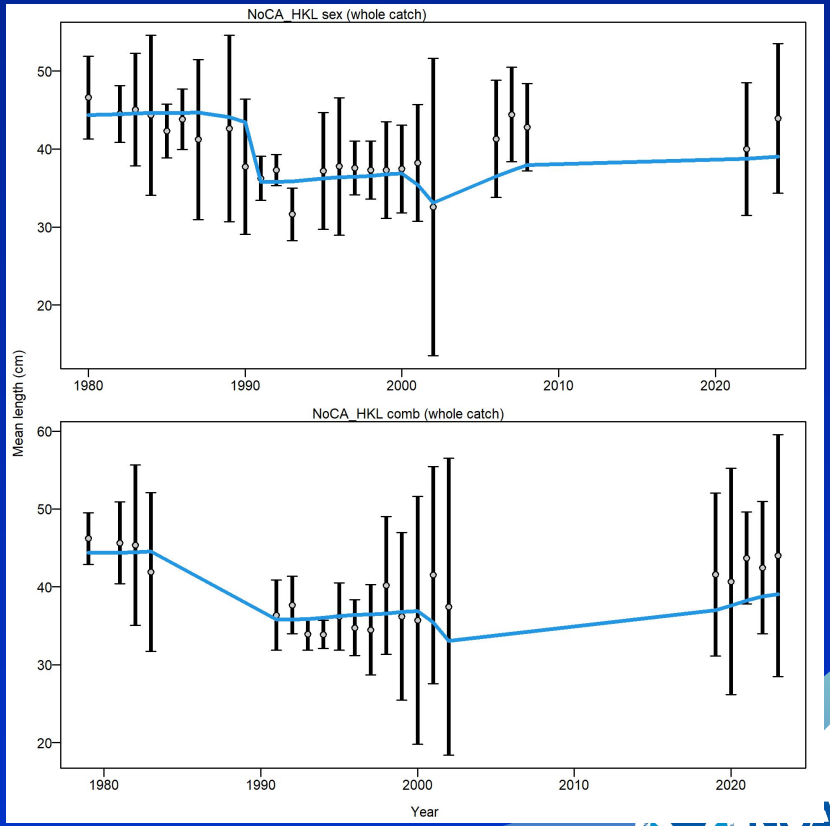
- As suggested in 2015 assessment, base model accounts for spatial differences in selectivity for hook-and-line and rec fleets
- Commercial trawl fleets reasonably well fit
- Discards from IFQ trawl fleet mostly < 35 cm
- Trawl surveys capture small sizes not seen in fisheries



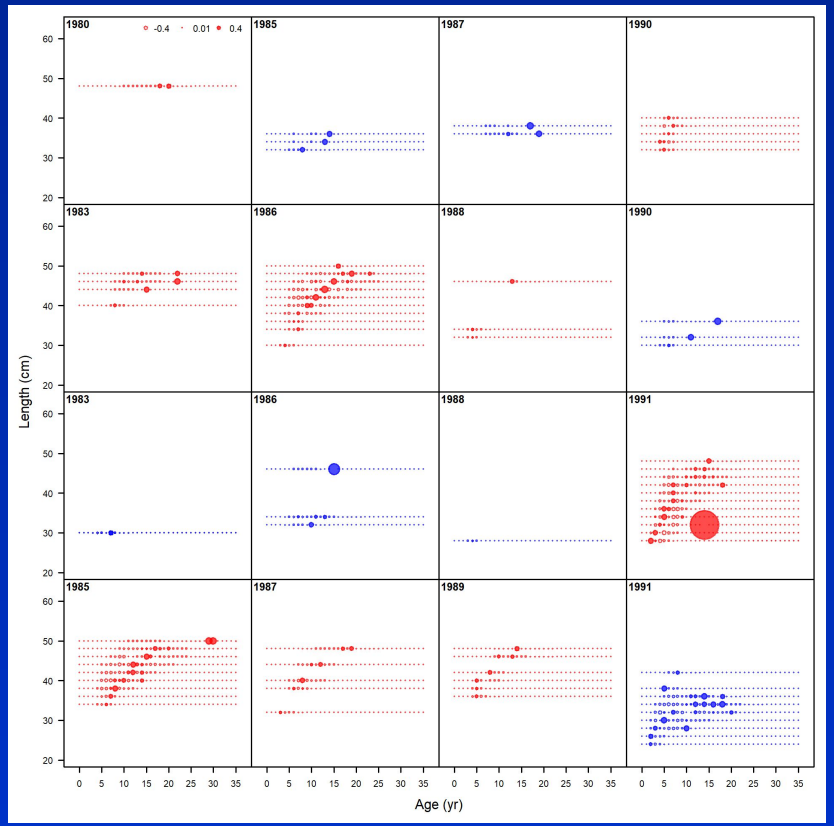
NOAA FISHERIES

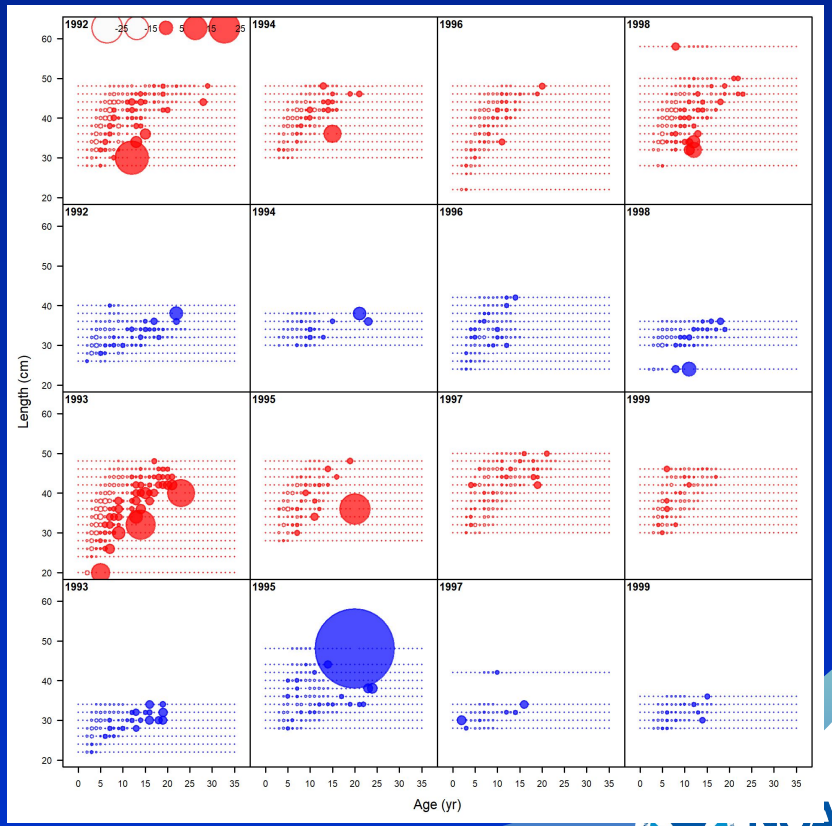
Northern CA Hook-and-Line Length Fits



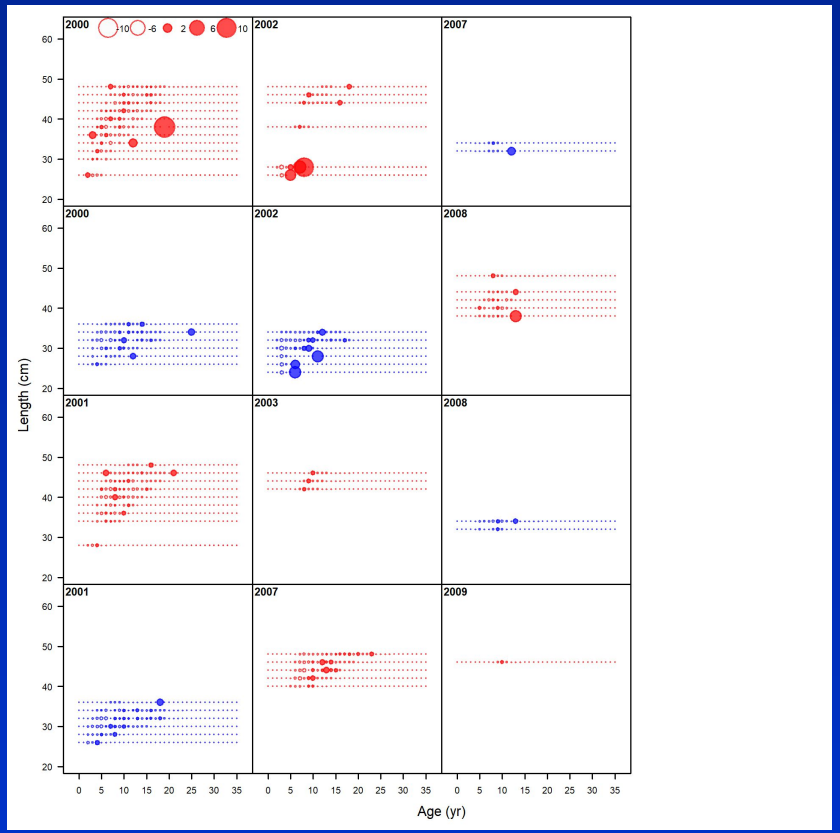


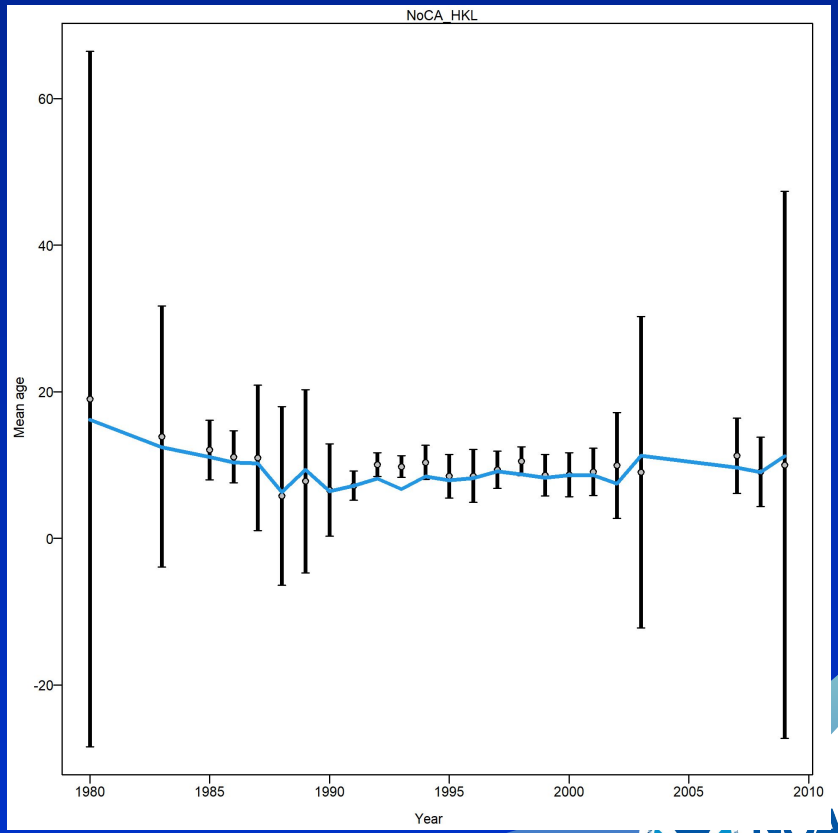
Northern CA Hook-and-Line Age Fits



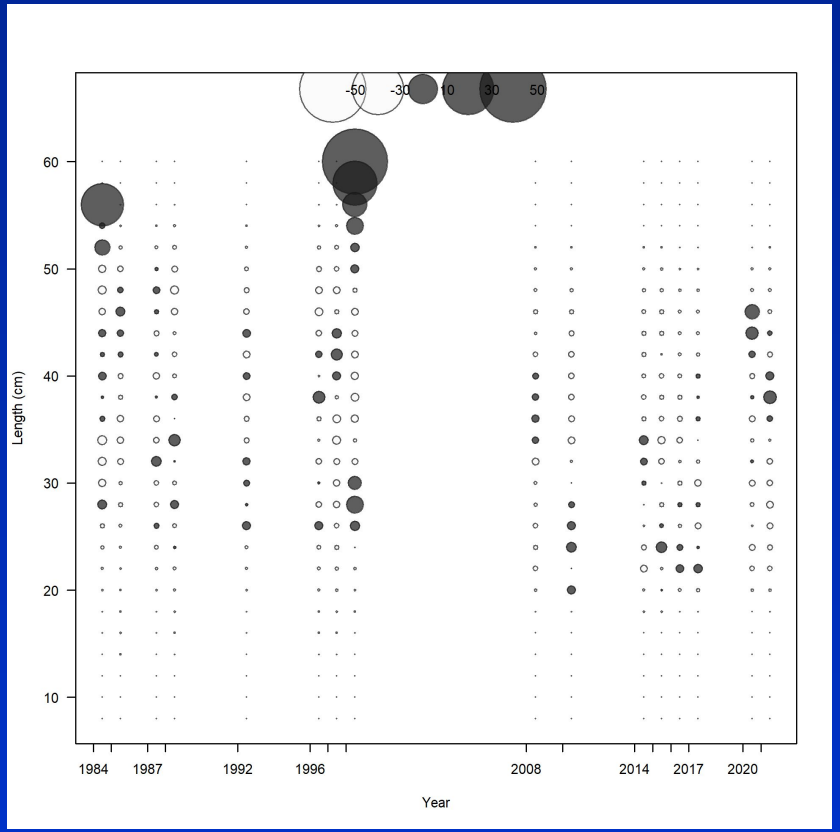


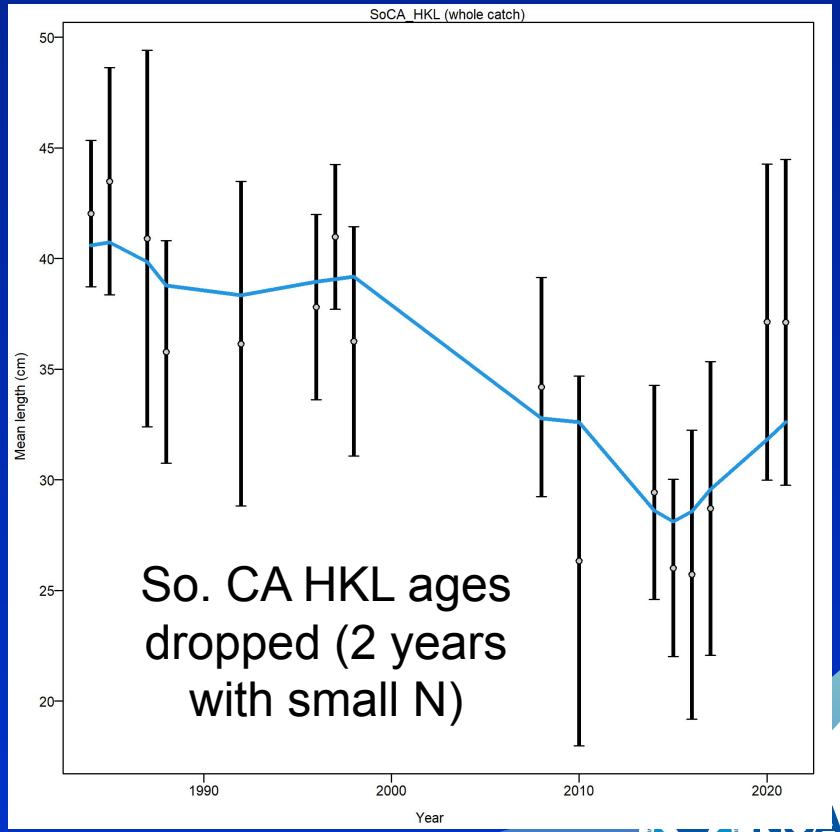
Northern CA Hook-and-Line Age Fits



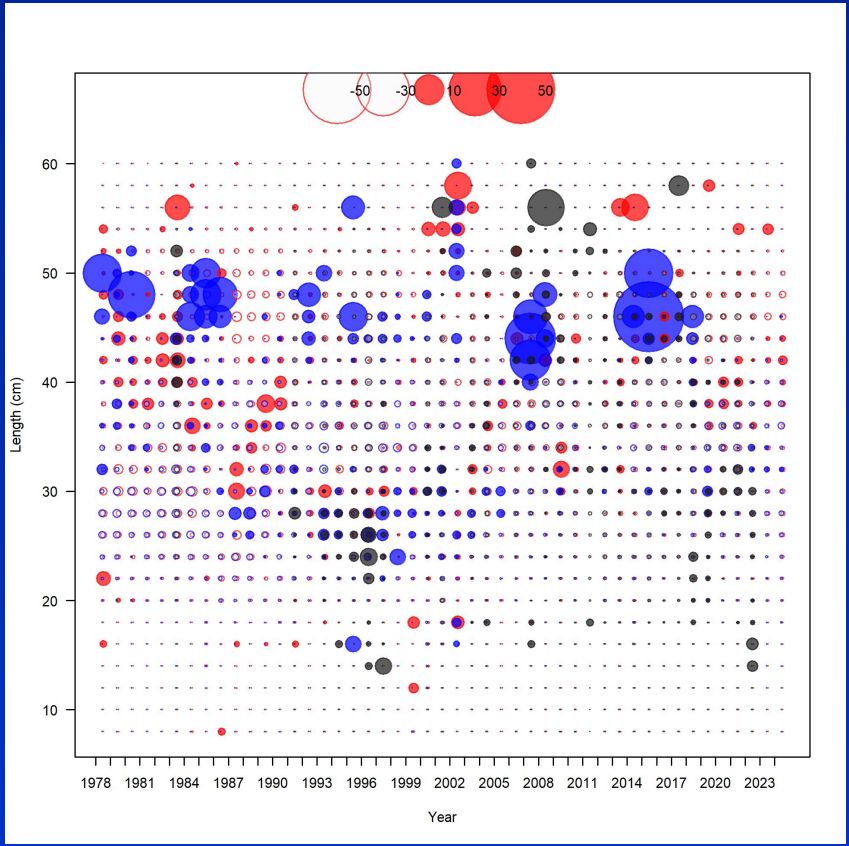


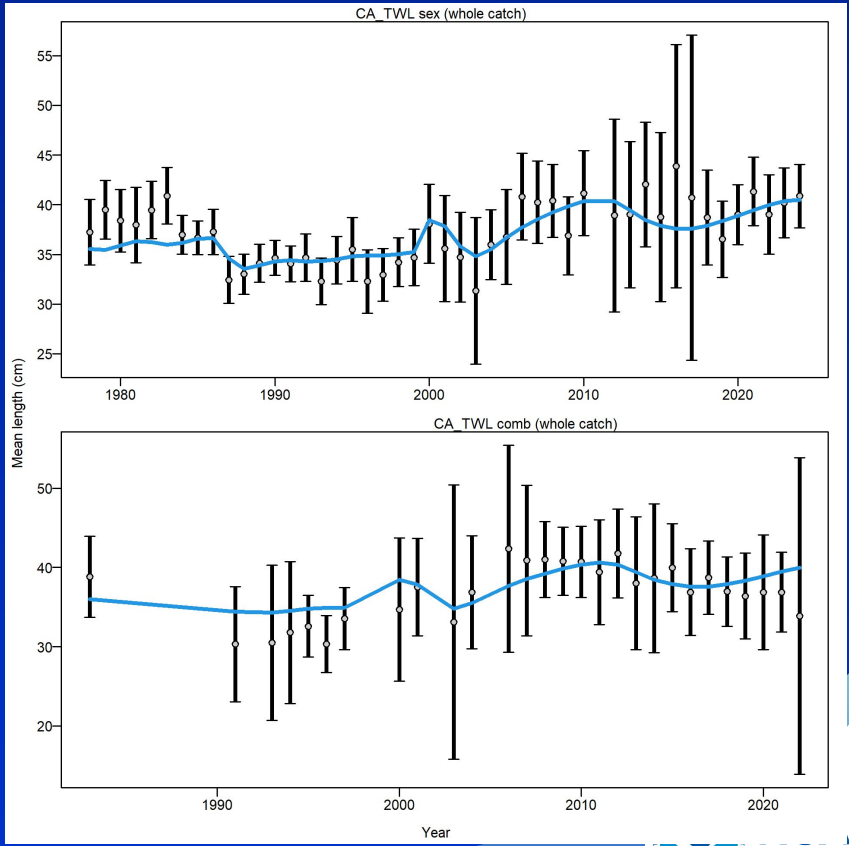
Southern CA Hook-and-Line Length Fits



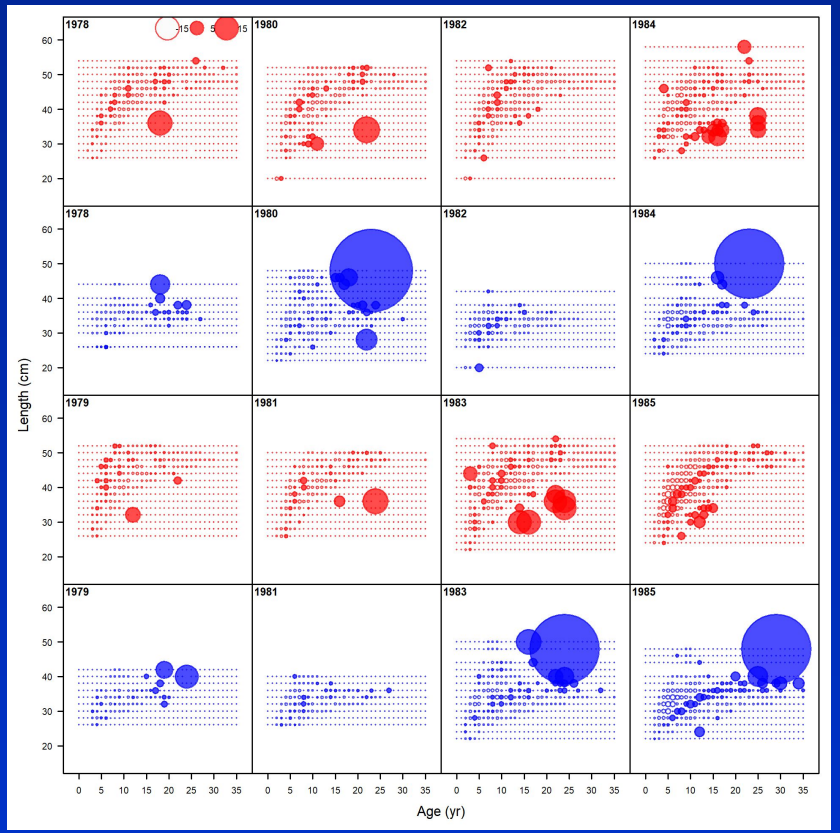


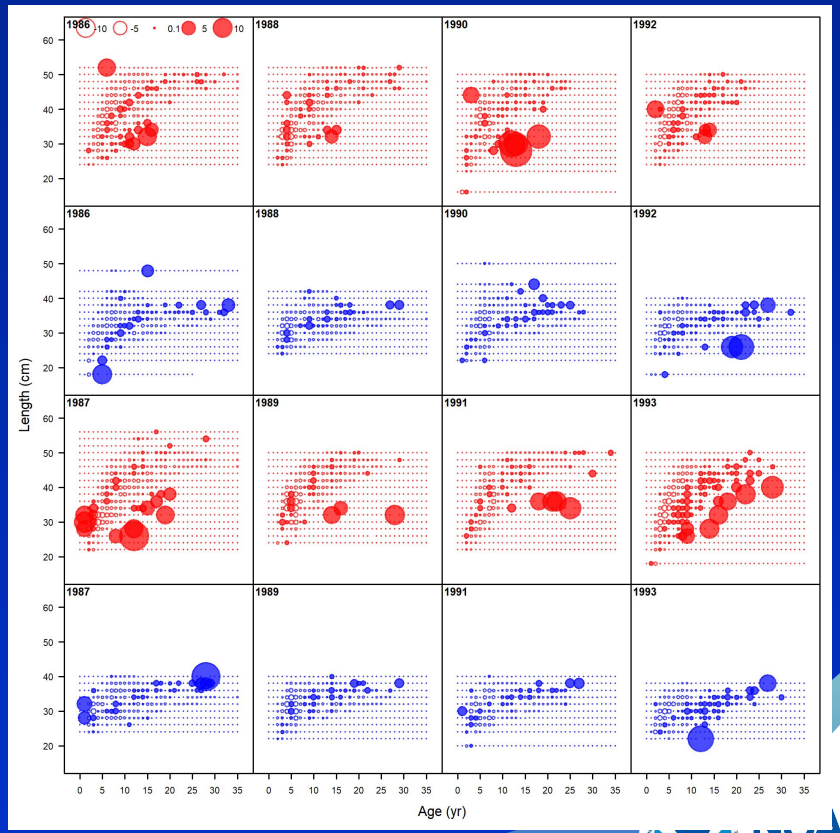
CA Trawl Length Fits



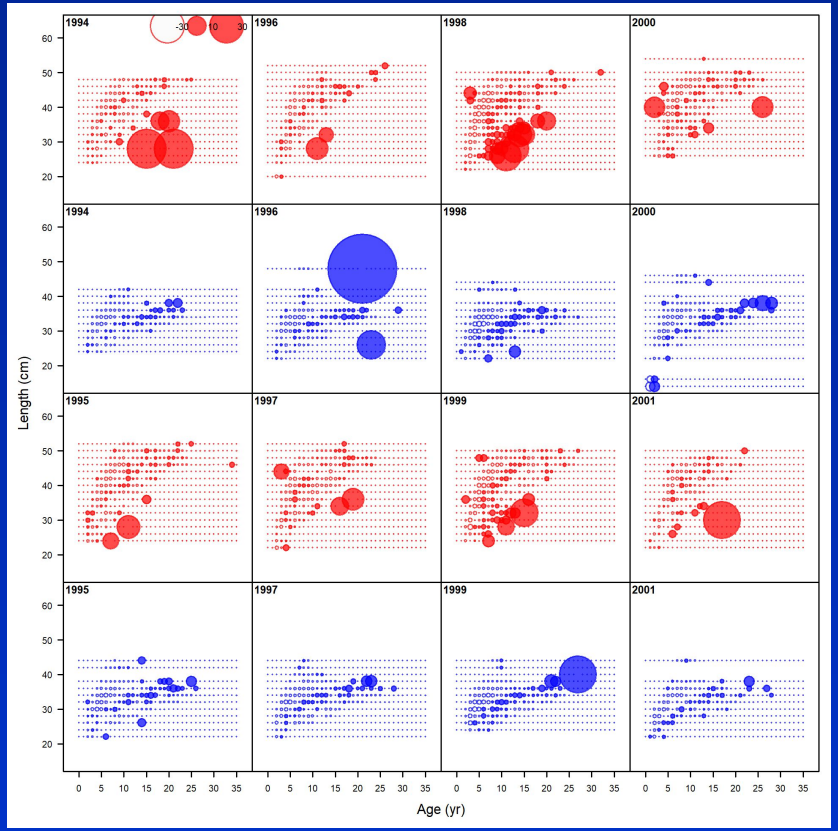


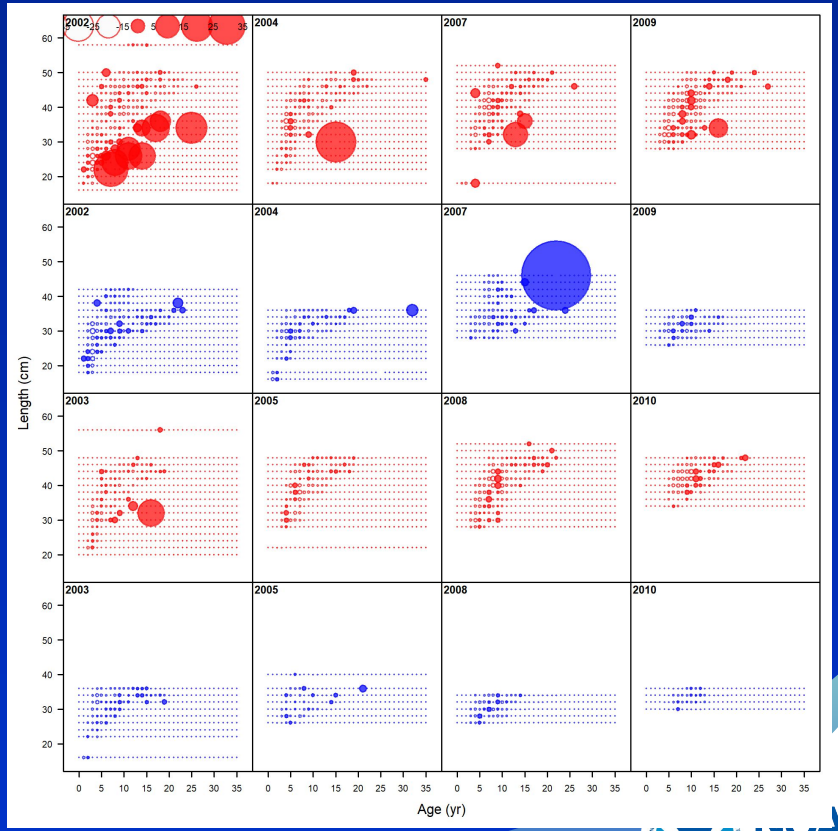
CA Trawl Age Fits



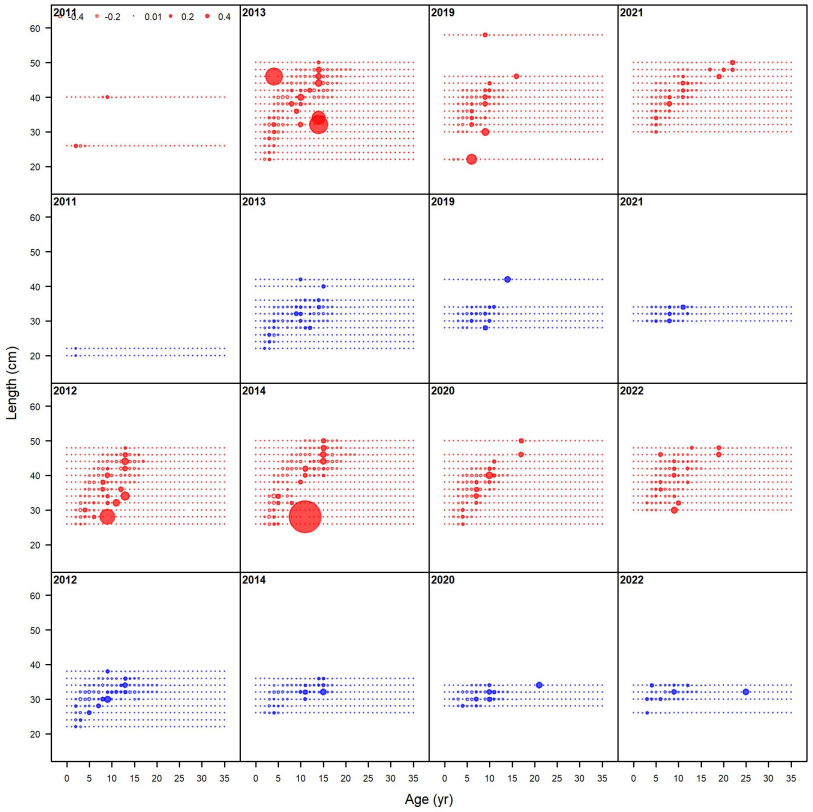


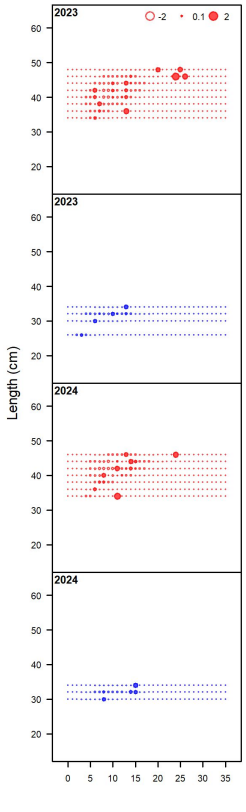
CA Trawl Age Fits

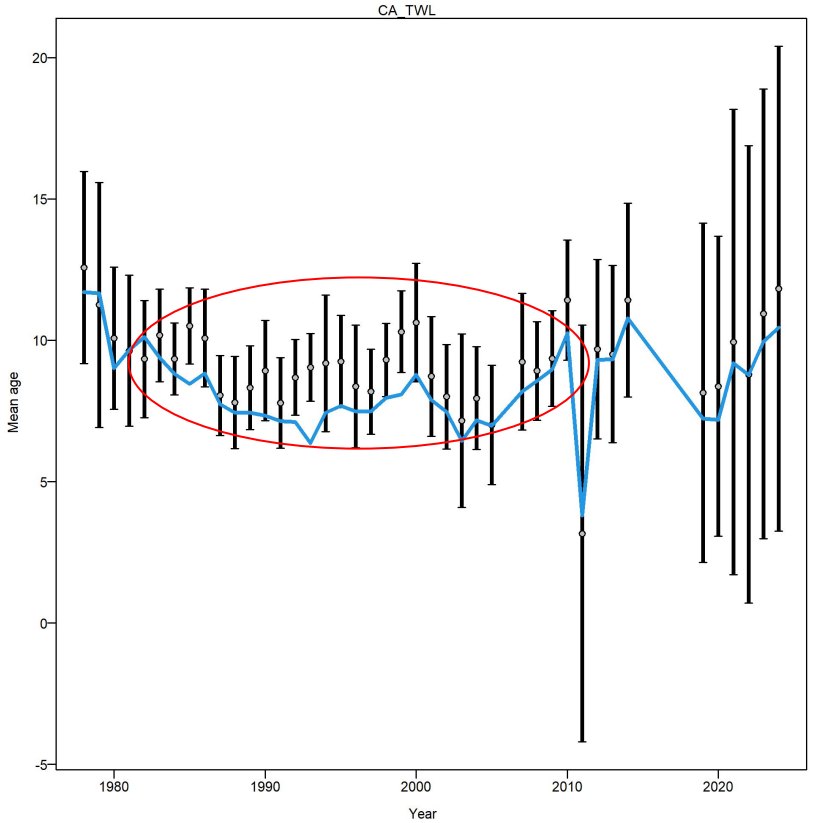




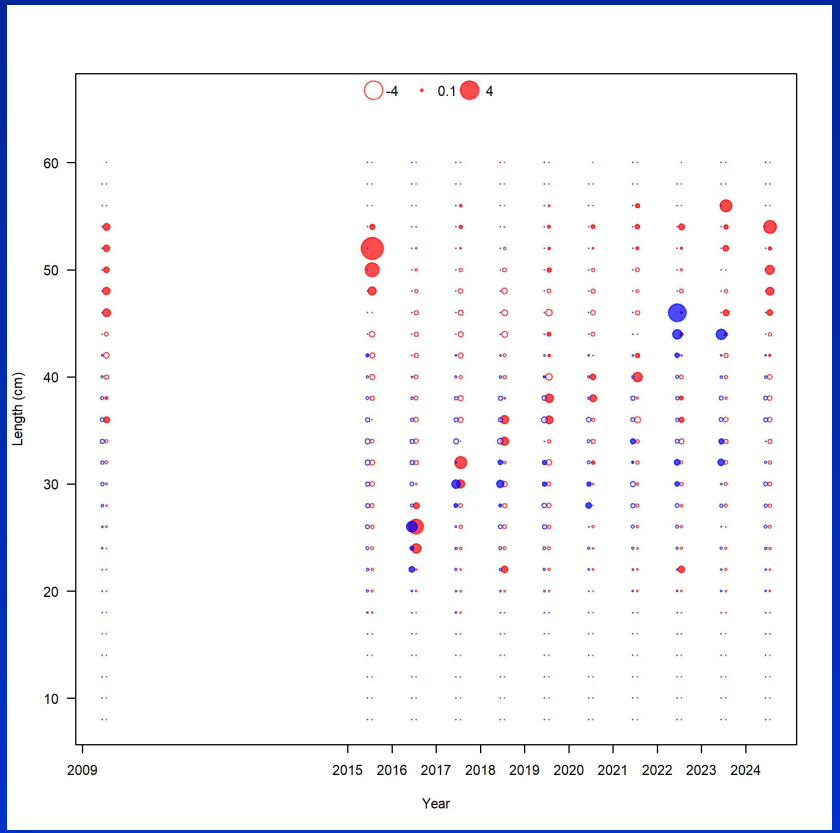
CA Trawl Age Fits

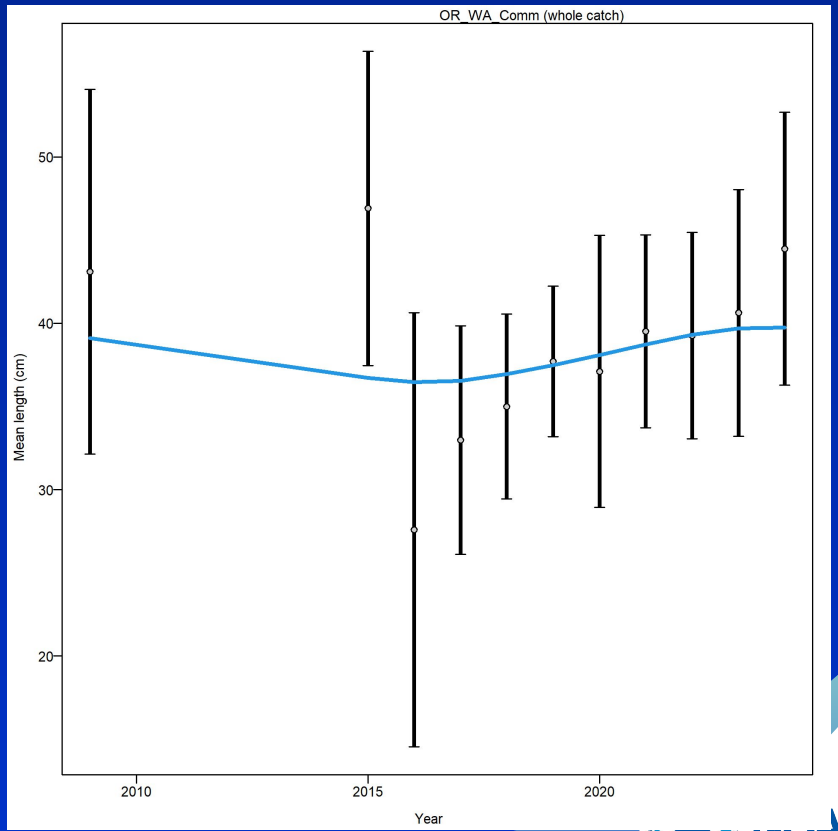




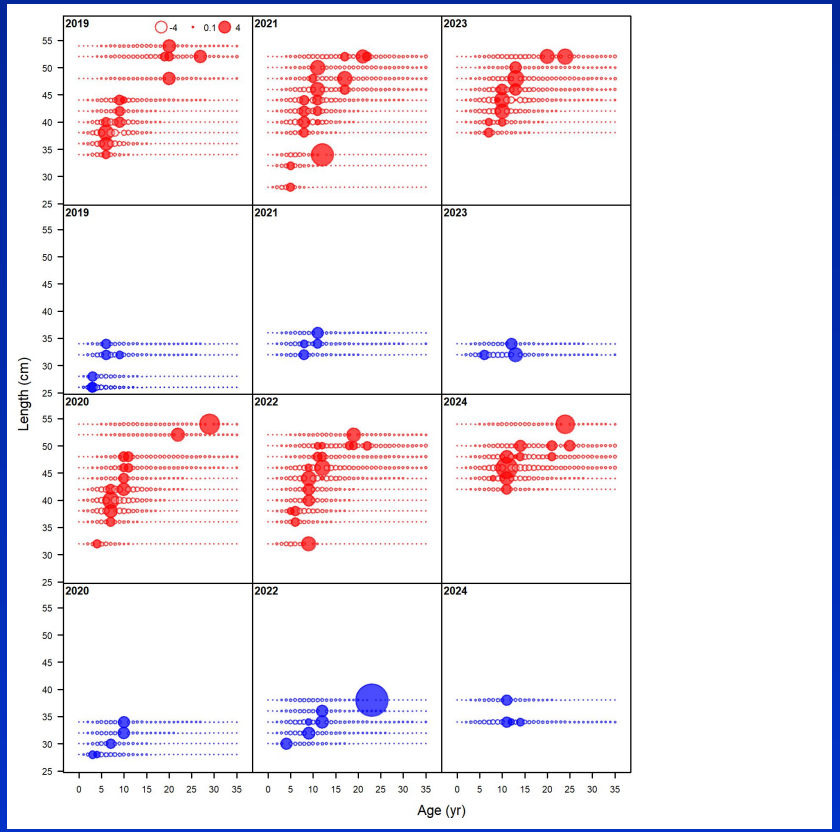


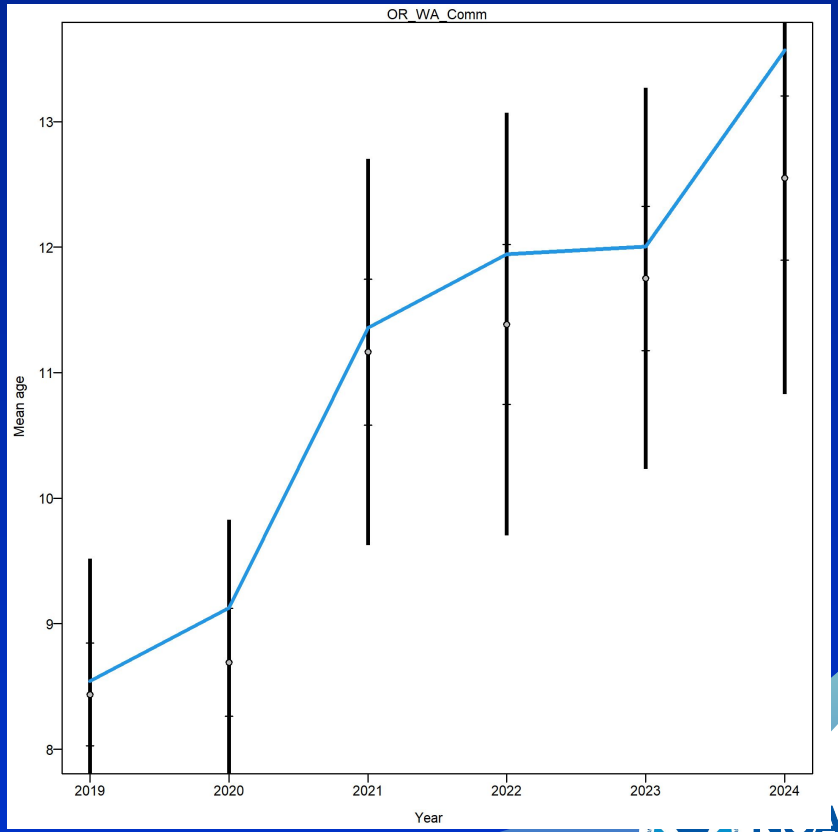
OR-WA Commercial Length Fits



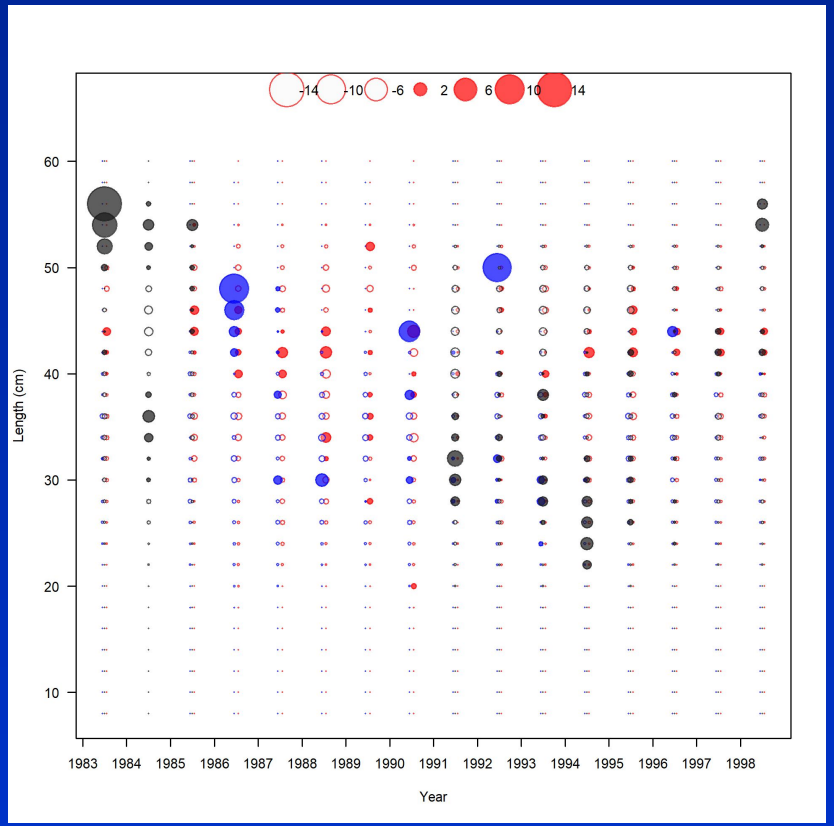


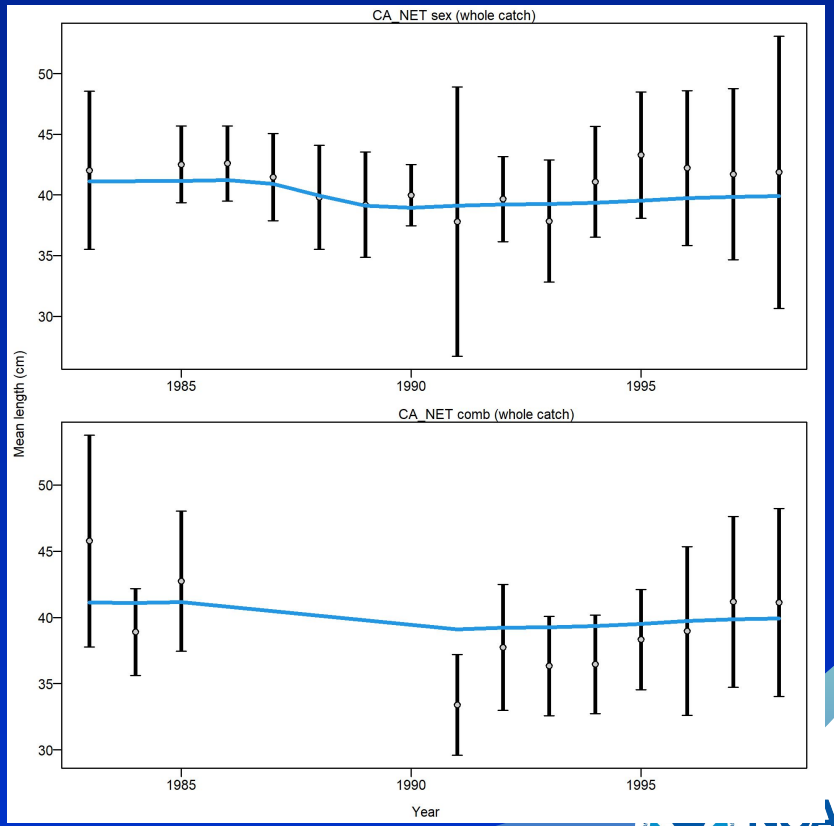
OR-WA Commercial Age Fits



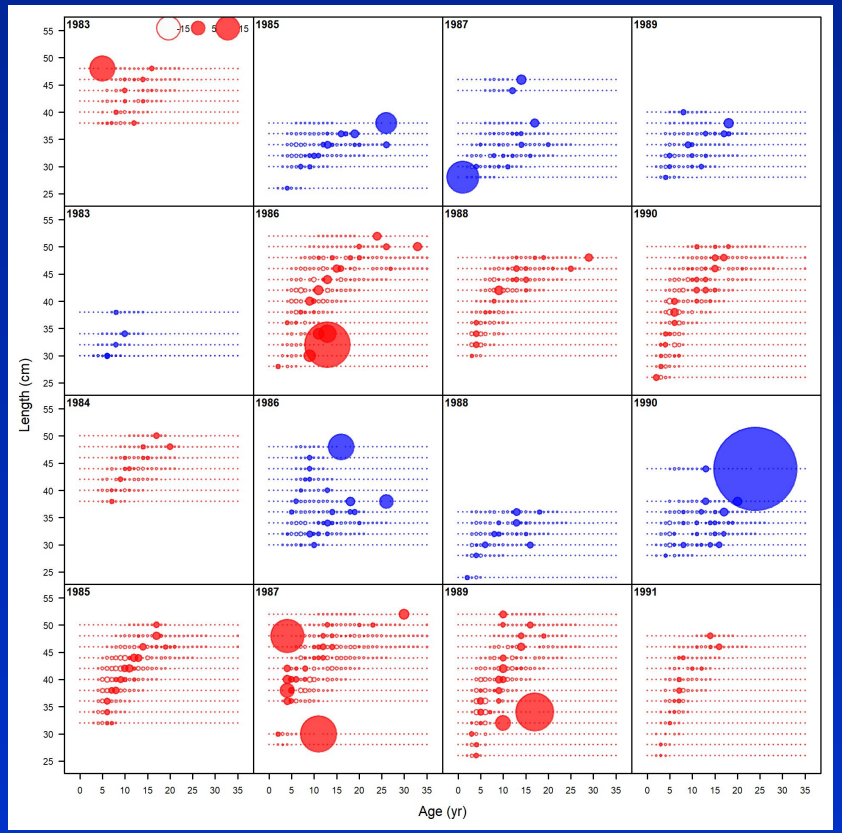


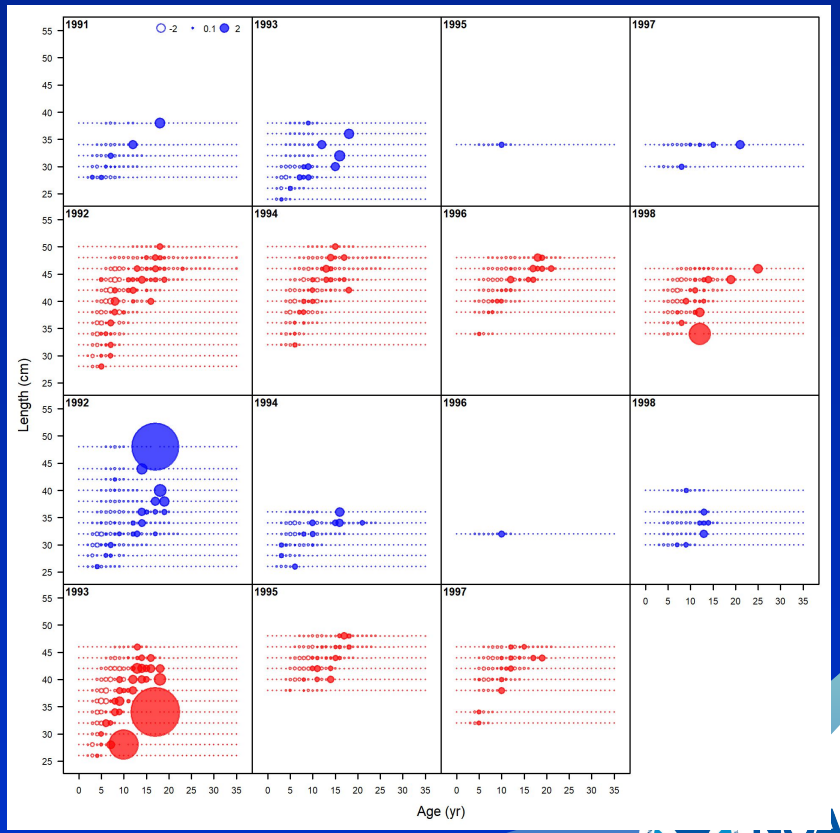
CA Net Gear Length Fits



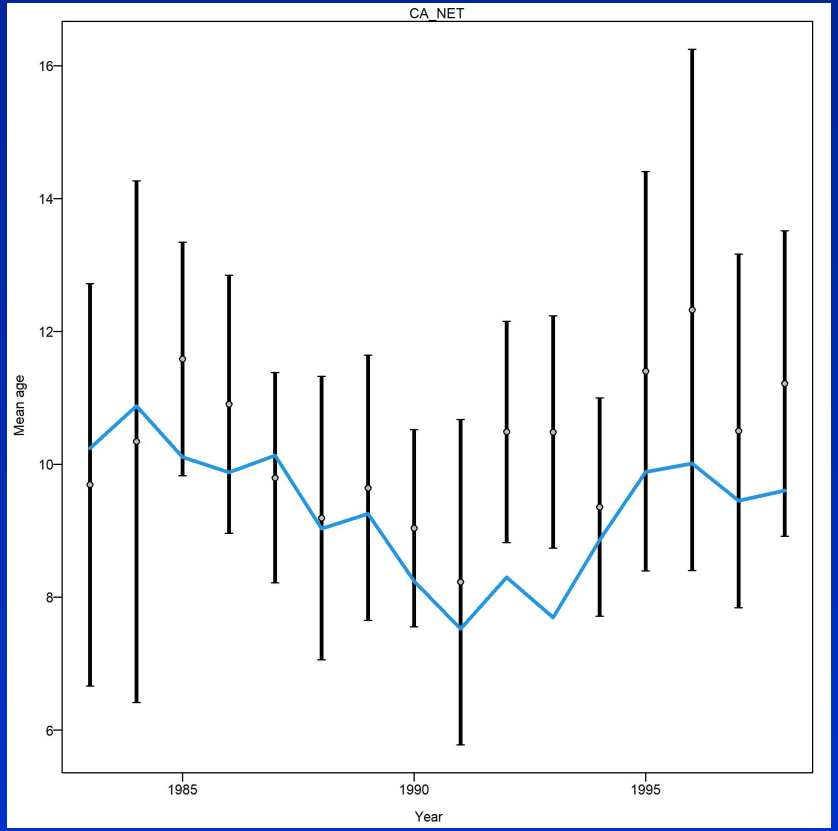


CA Net Gear Age Fits



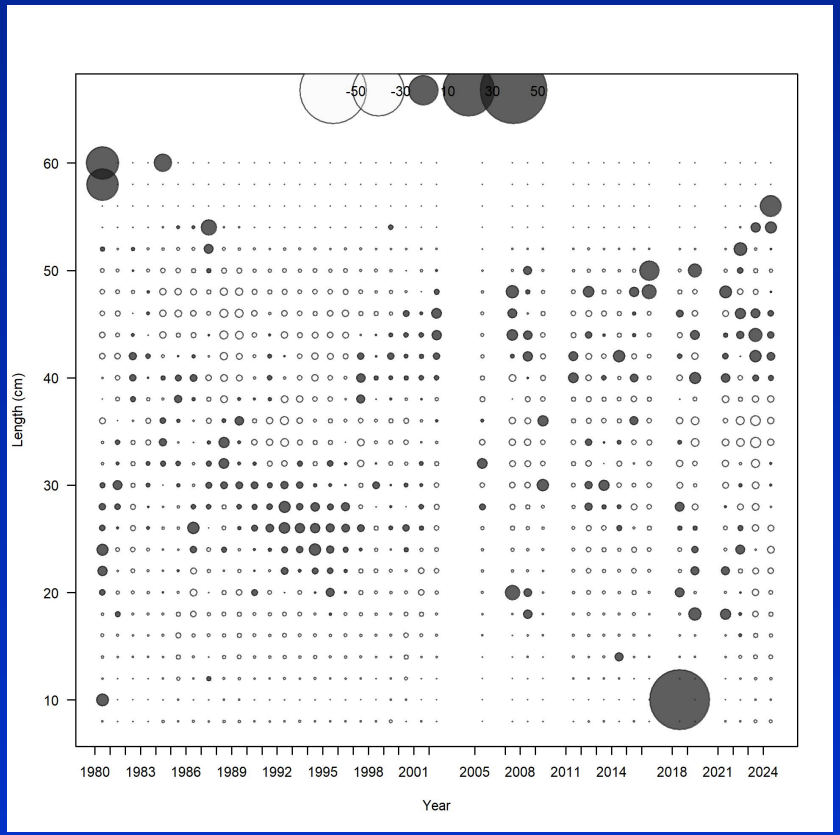


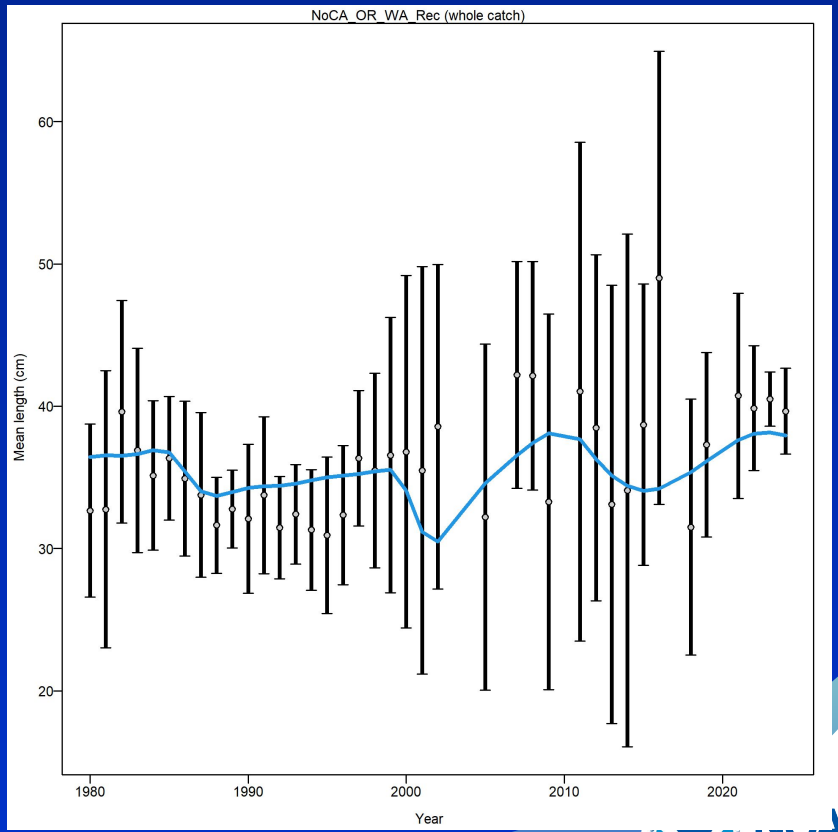
CA Net Gear Age Fits



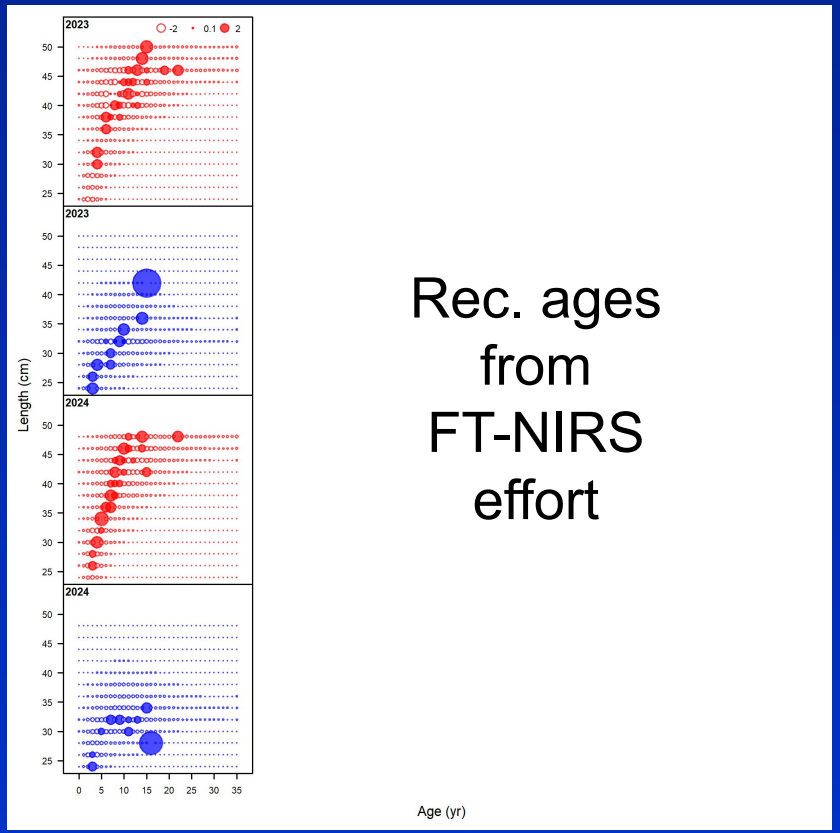
NOAA FISHERIES

Recreational Length Fits, North of Pt. Conception

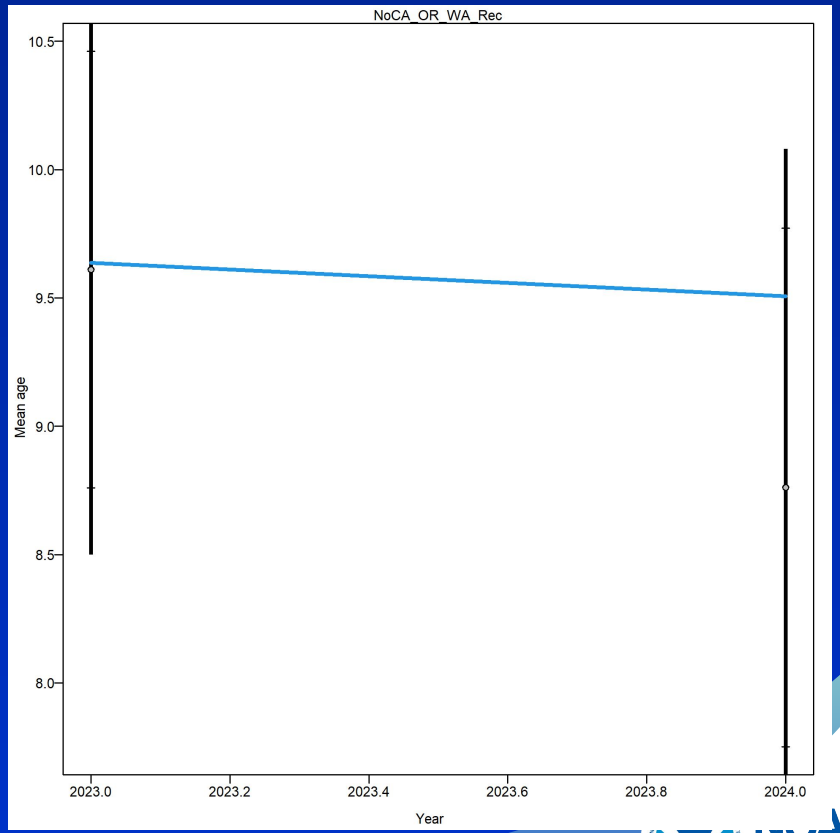




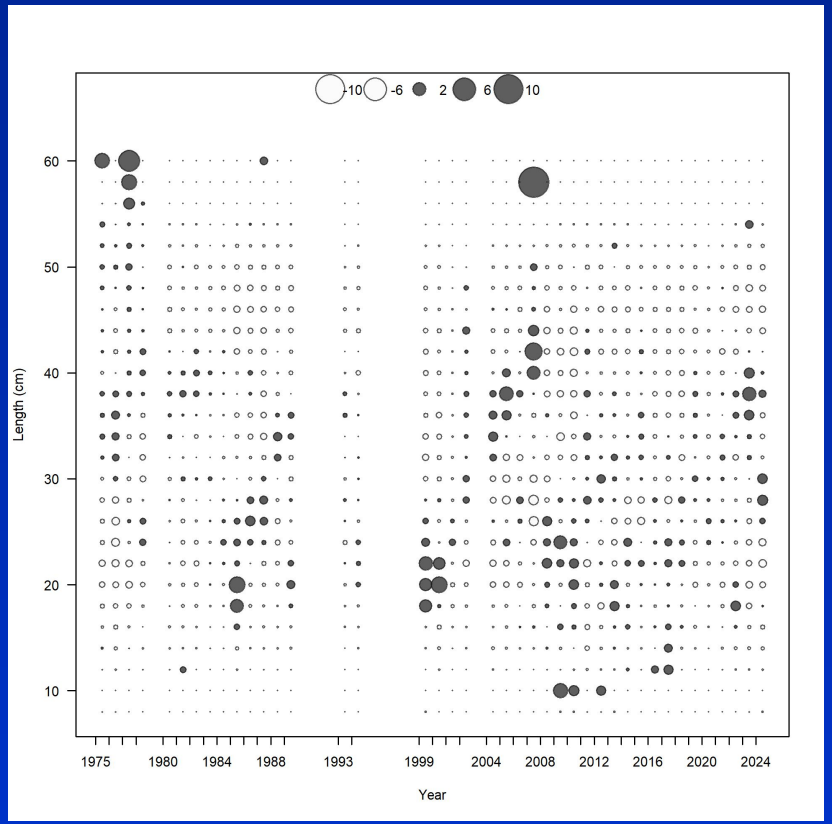
Recreational Age Fits, North of Pt. Conception

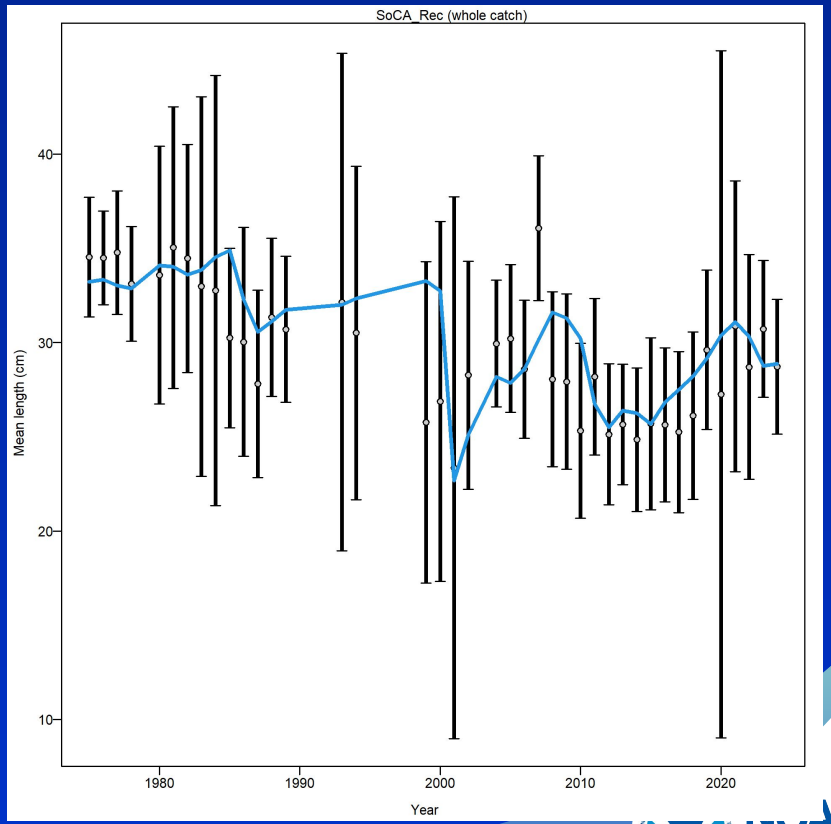


Rec. ages from FT-NIRS effort

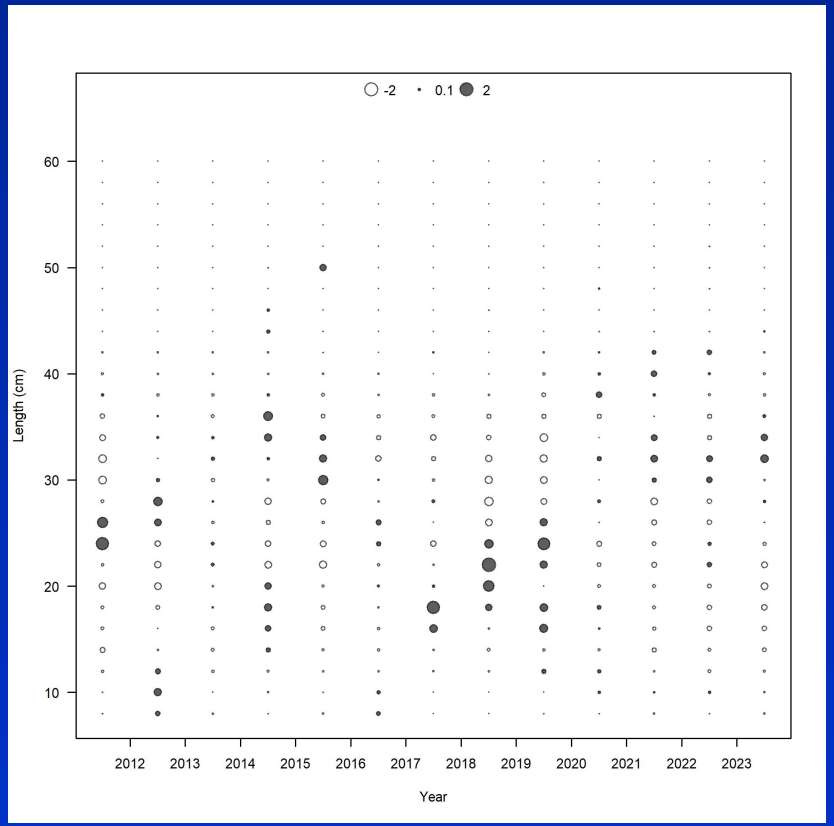


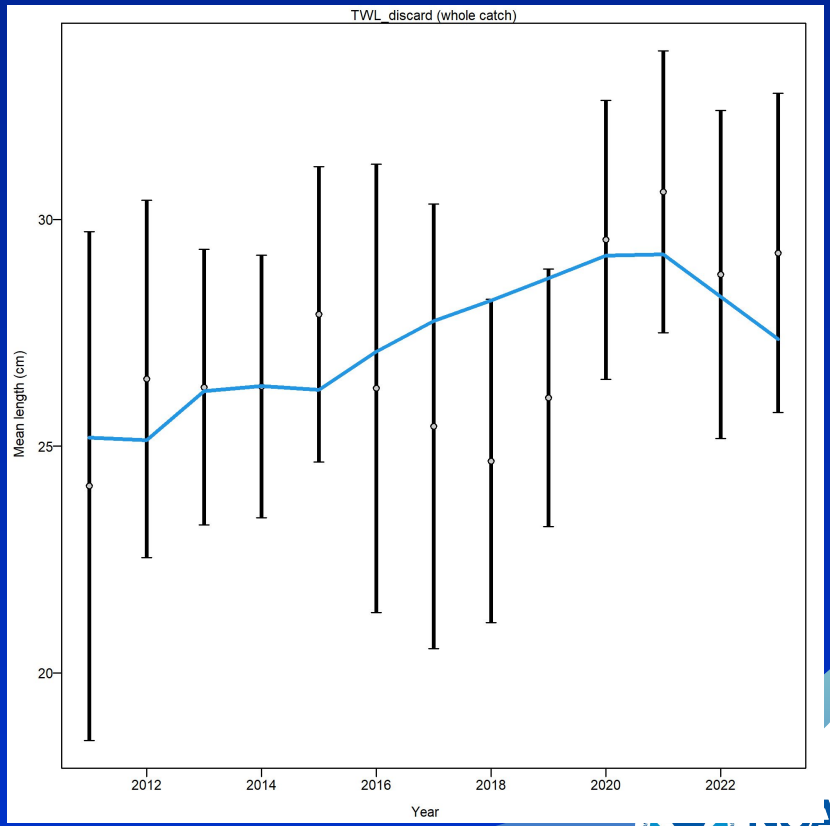
Recreational Length Fits, South of Pt. Conception



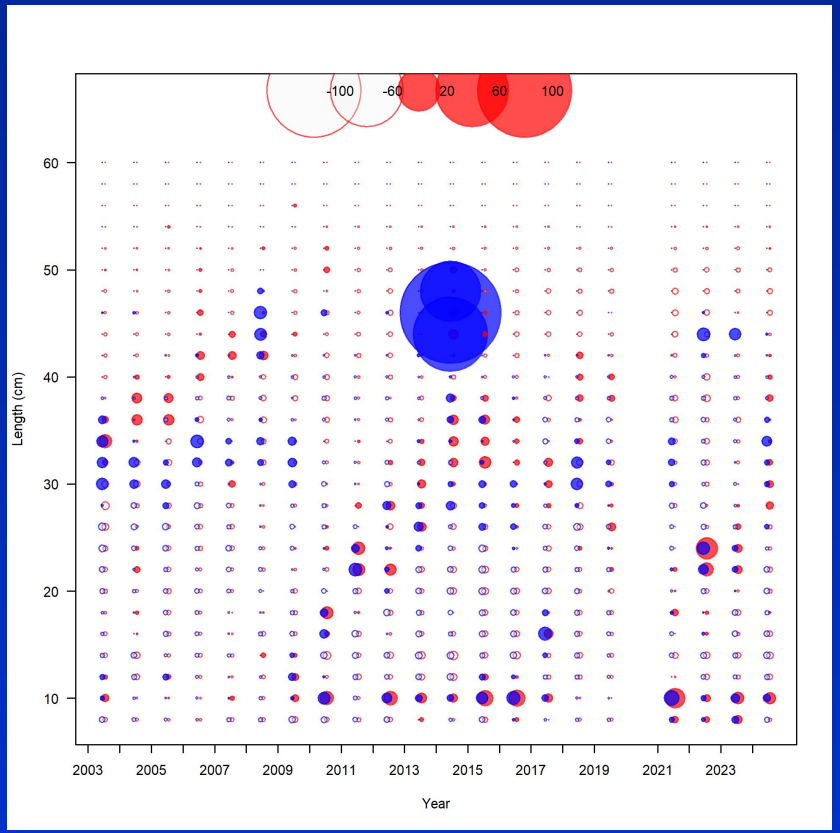


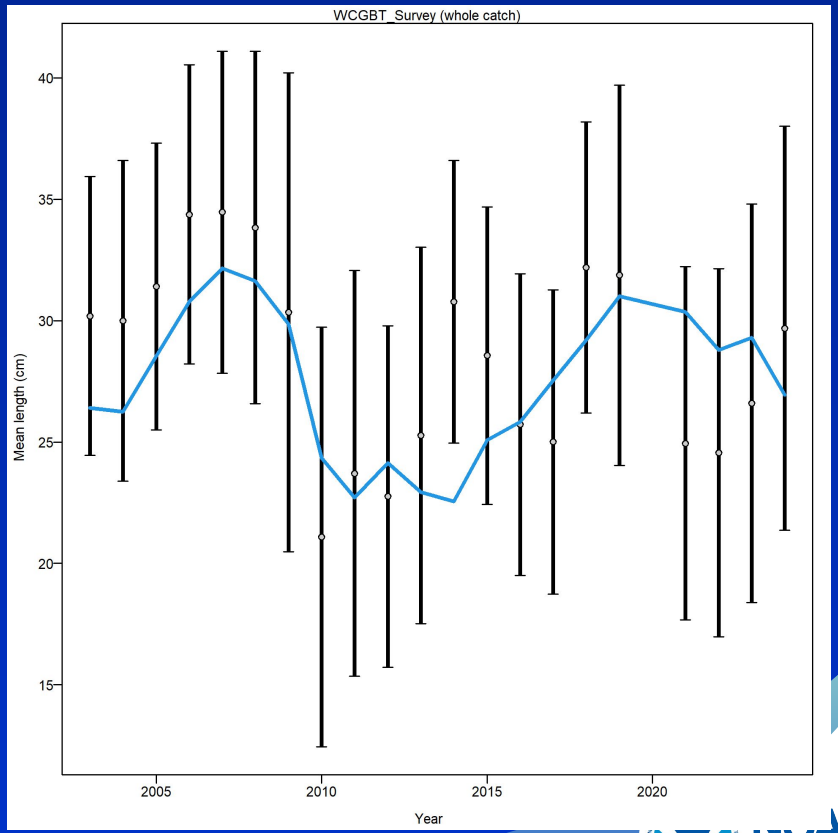
Trawl IFQ Discard Length Fits



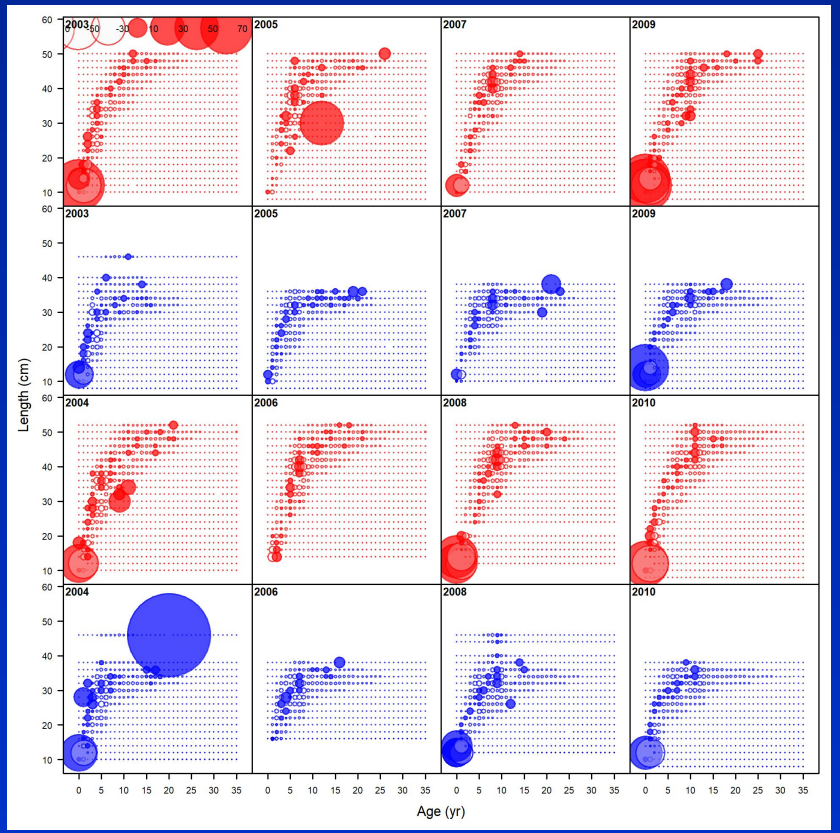


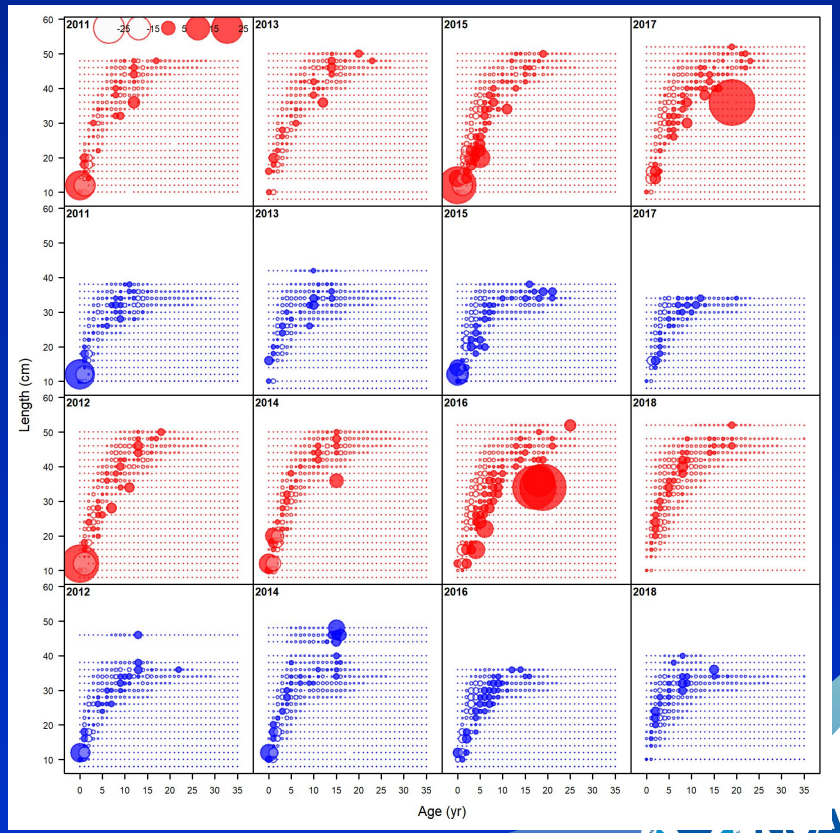
WCGBTS Length Fits



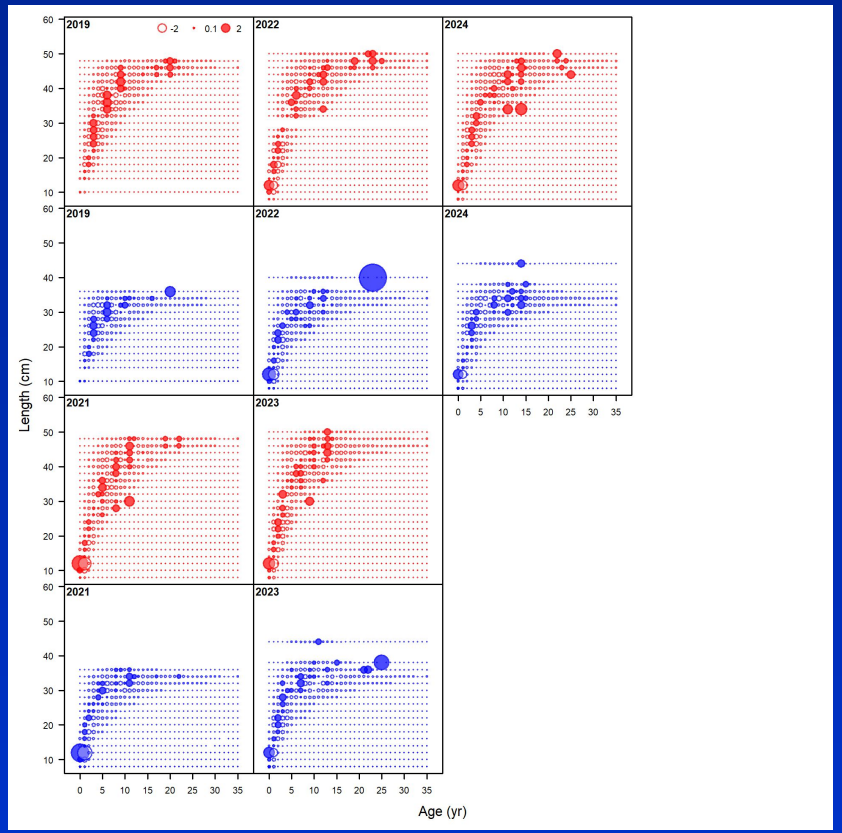


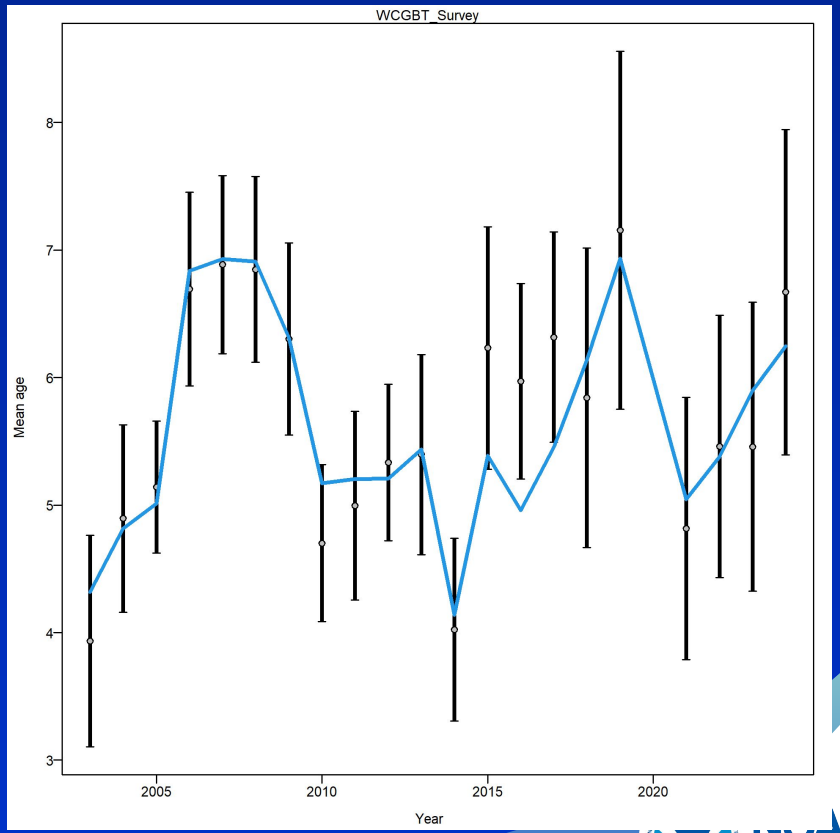
WCGBTS Age Fits





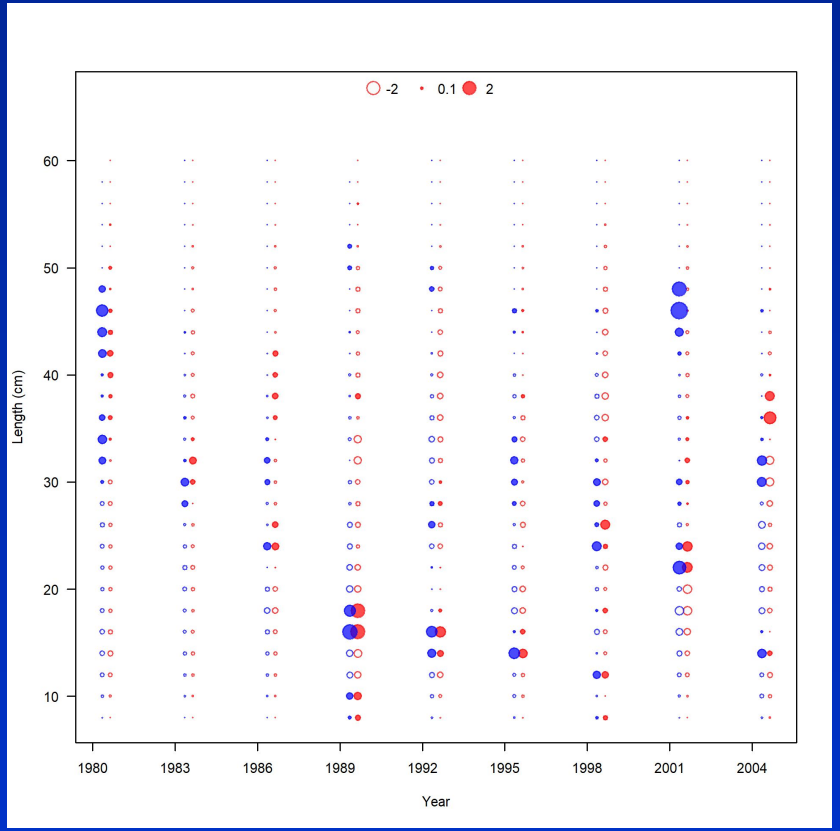
WCGBTS Age Fits

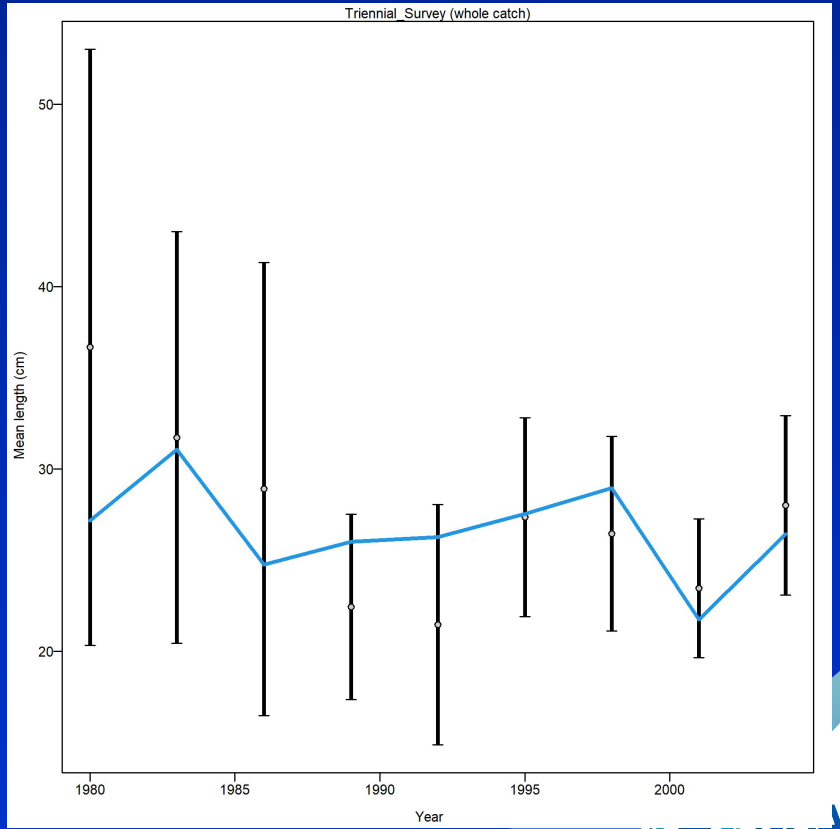




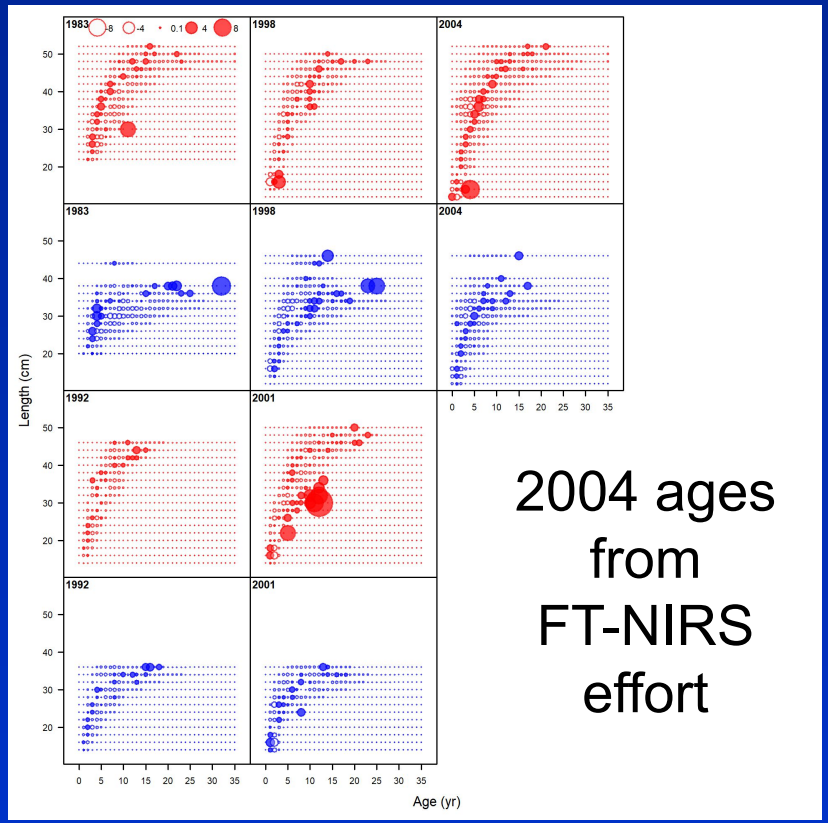
NOAA FISHERIES

Triennial Trawl Survey Length Fits

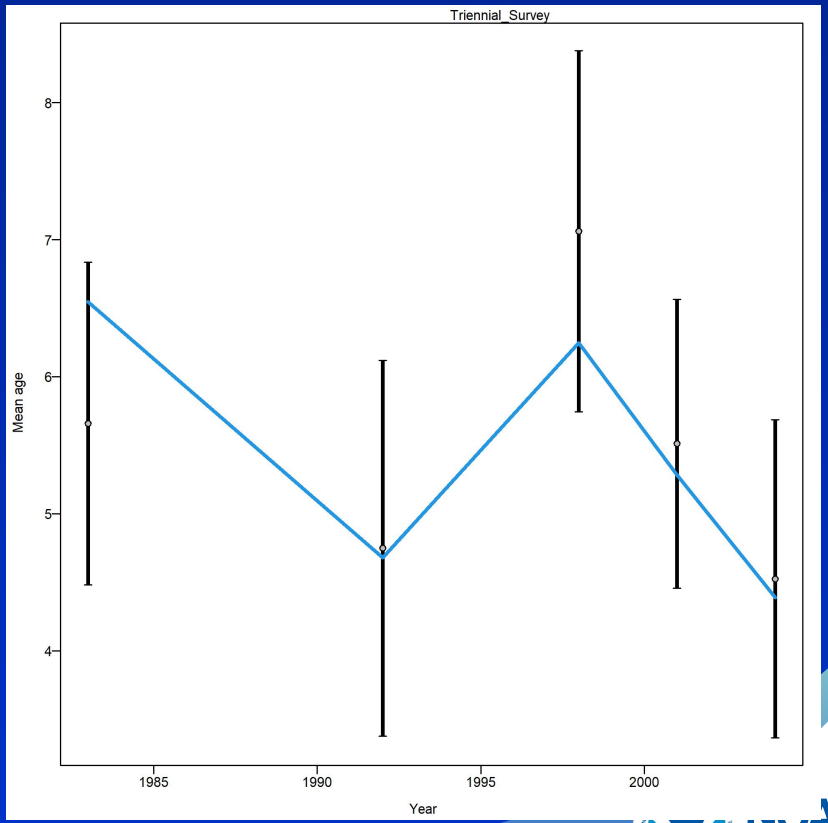




Triennial Trawl Survey Age Fits



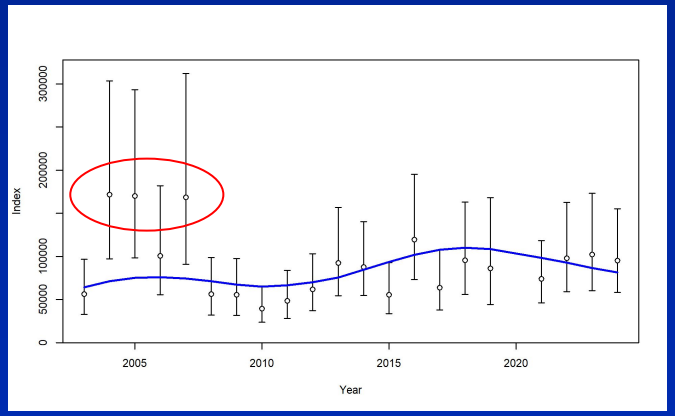
2004 ages from FT-NIRS effort

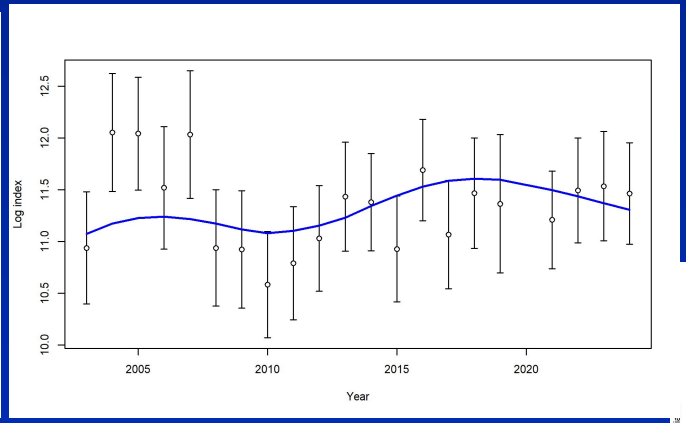


NOAA FISHERIES

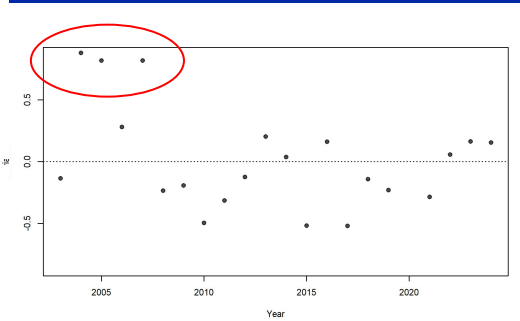
Fit to WCGBTS Index

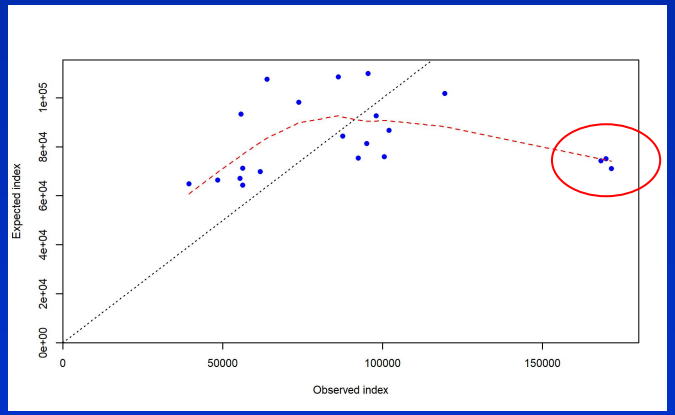
Calculated $\log_e$ catchability = 0.83; q = 2.29 (!)
No 'extra' variance estimated

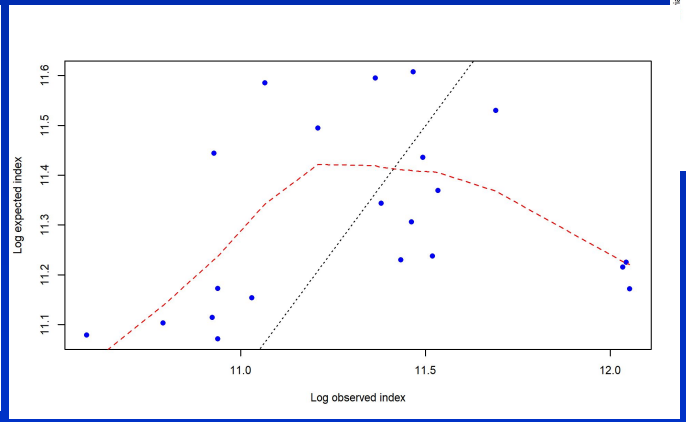




Survey q's were >1 in previous assessments, also

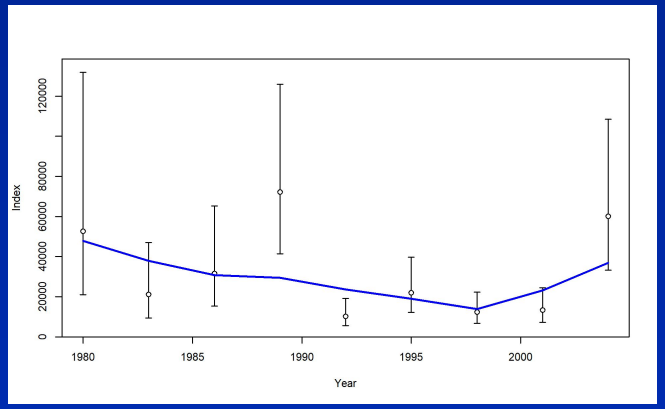


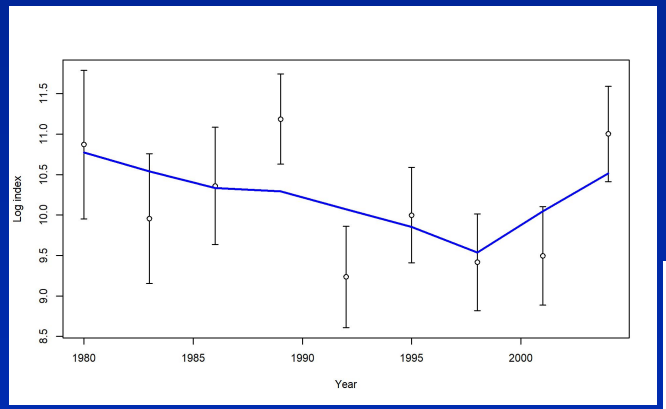


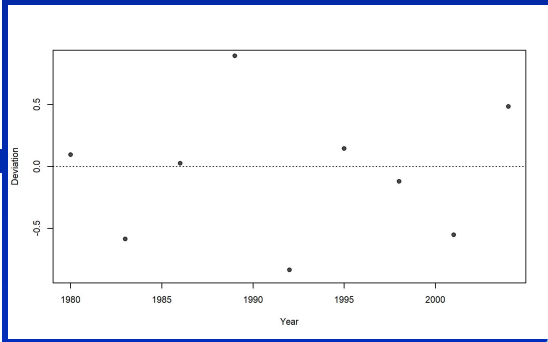


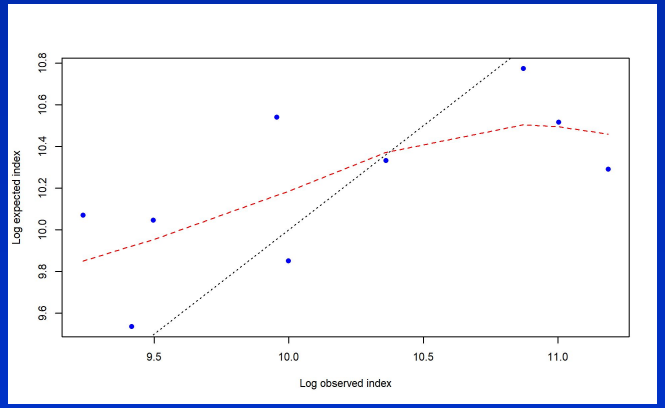
Fit to Triennial Index

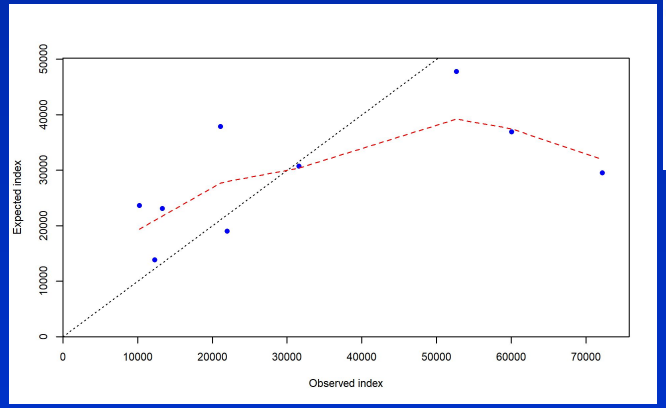
Calculated $\log_e$ catchability = 0.17; q = 1.19 (!)
No 'extra' variance estimated







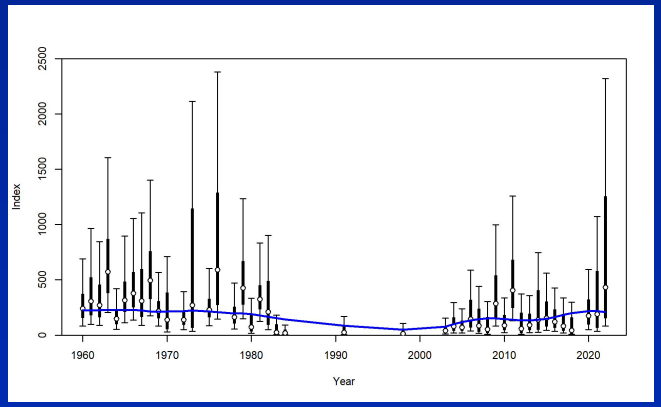


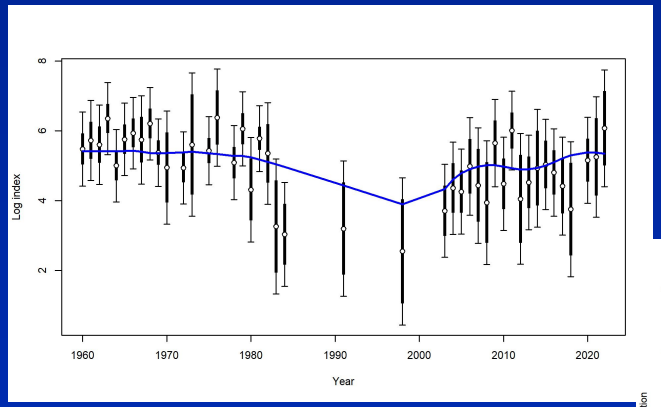


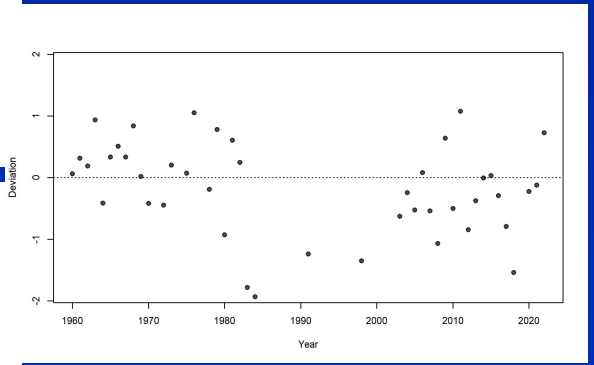
Fit to CalCOFI Index

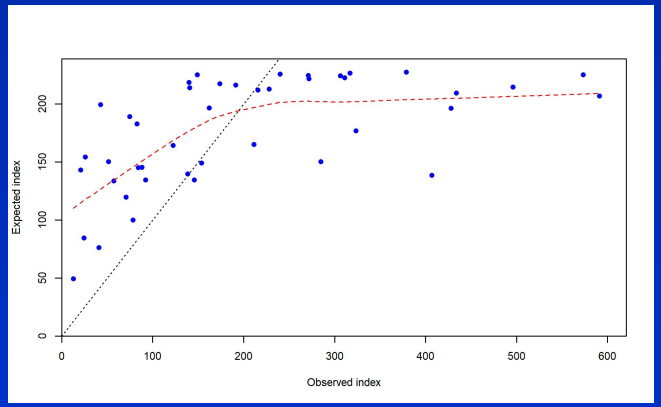
Calculated $\log_e$ catchability = -3.9

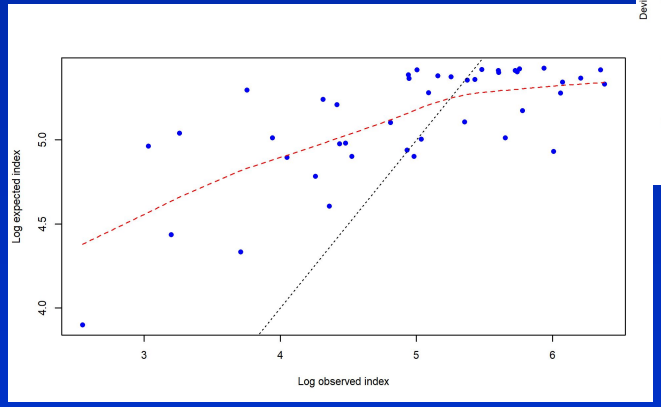
Estimated 'extra' variance = 0.31









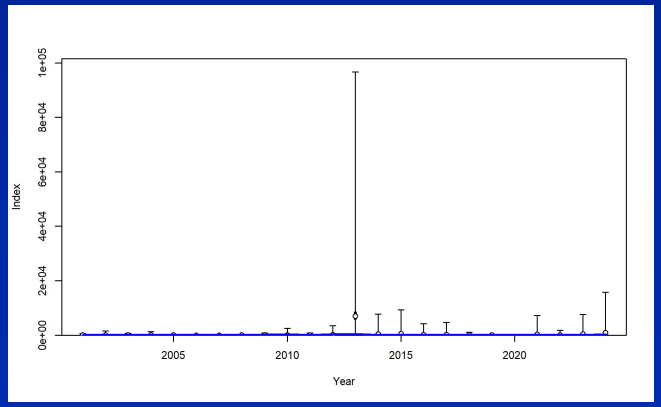


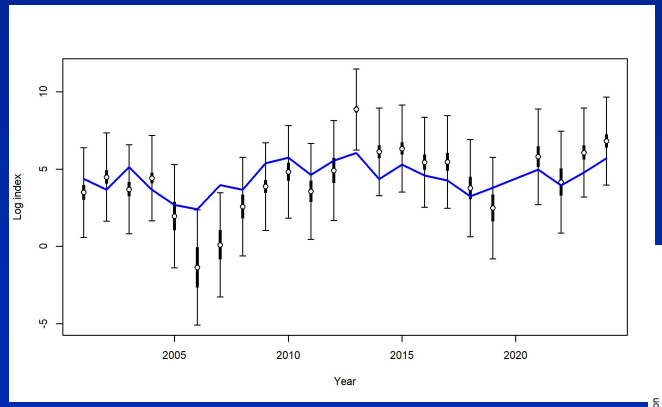
NOAA FISHERIES

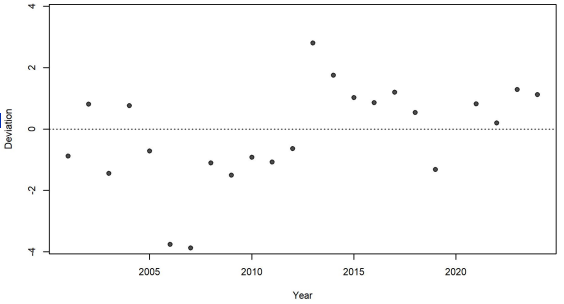
Fit to RREAS Index

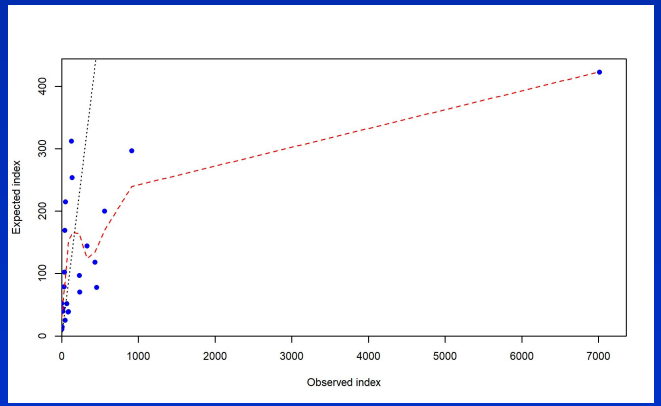
Calculated $\log_e$ catchability = -5.0

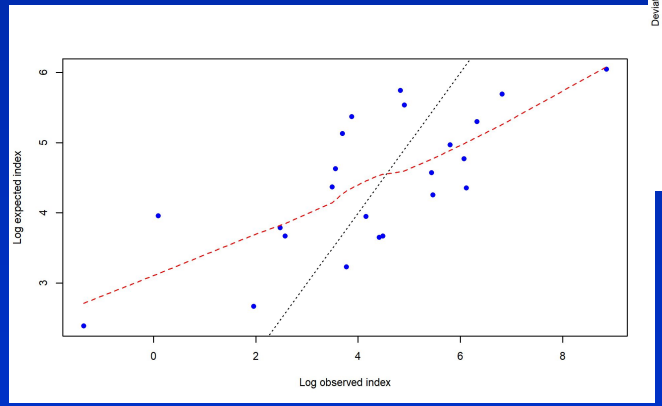
Estimated 'extra' variance = 1.23





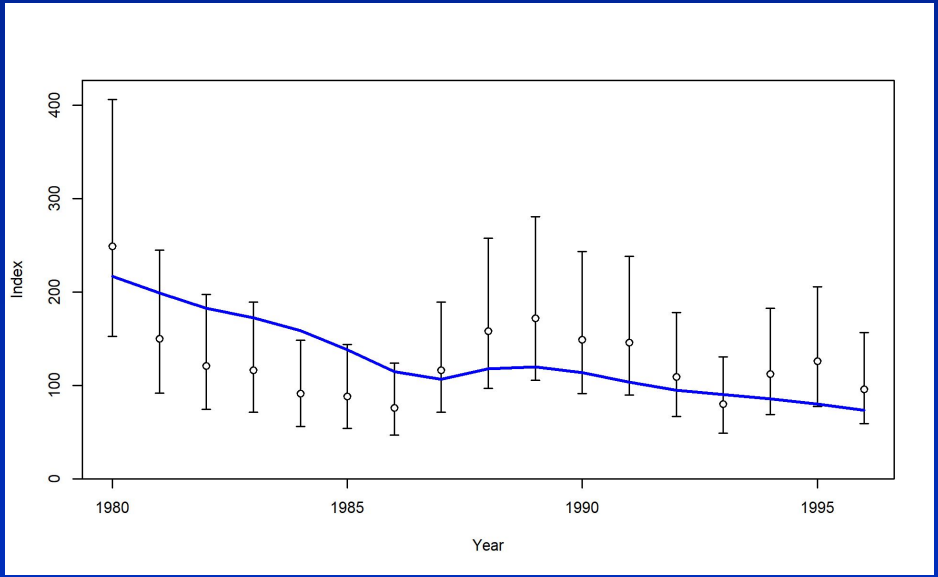


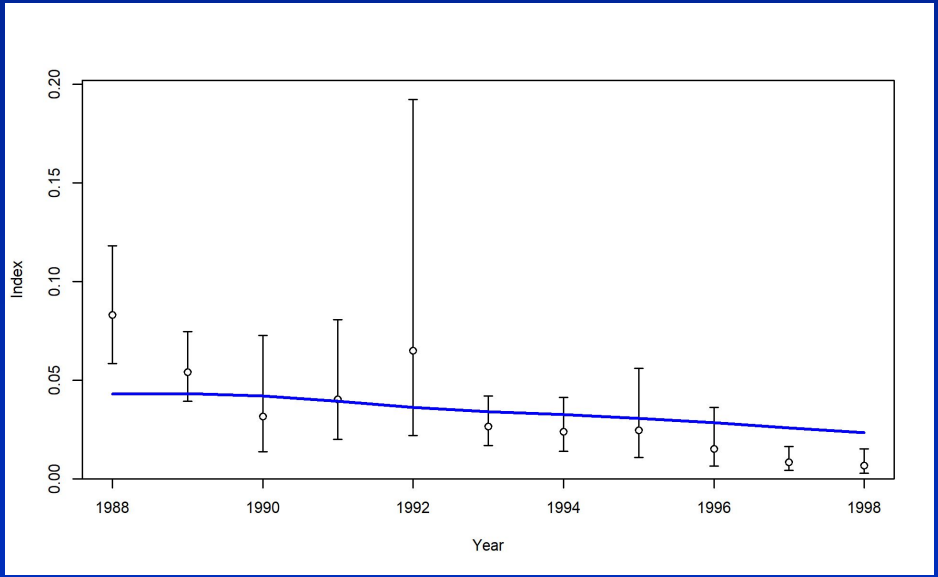




NOAA FISHERIES

Implied Fits to Fishery-Dependent Indices

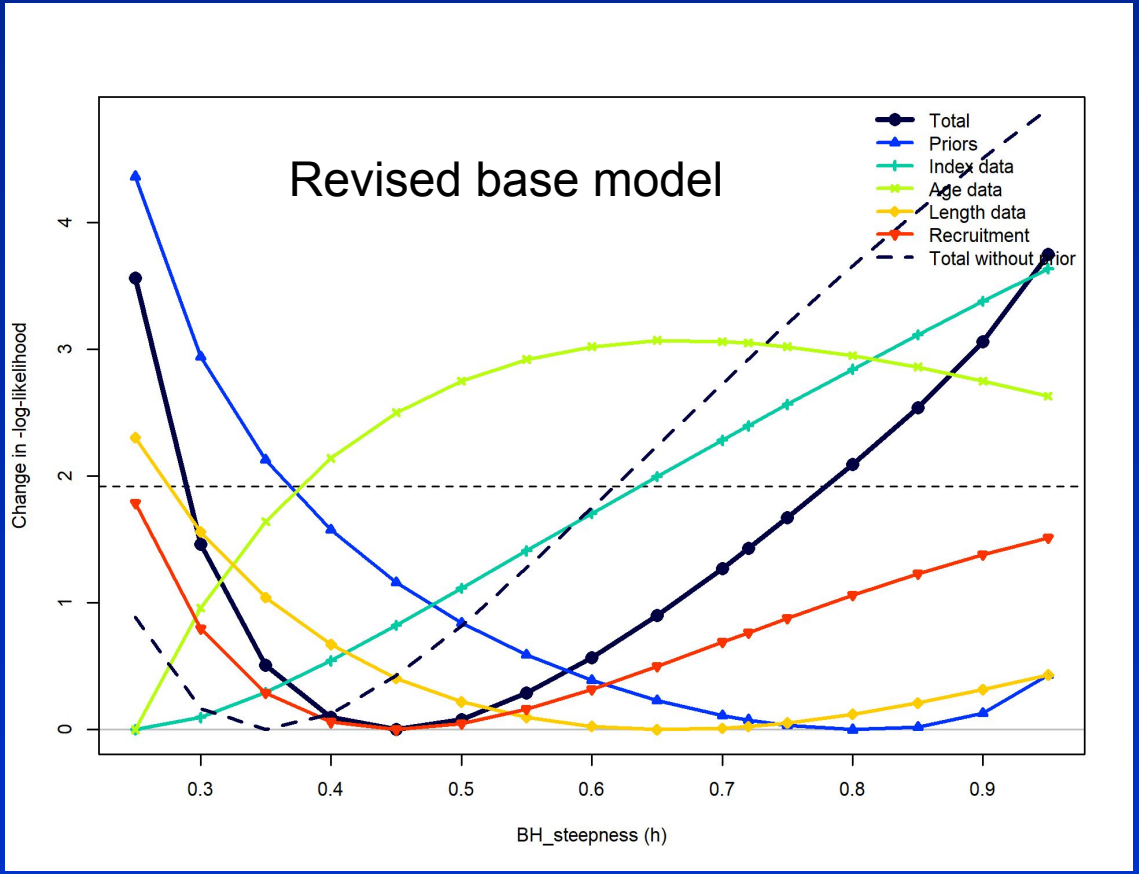


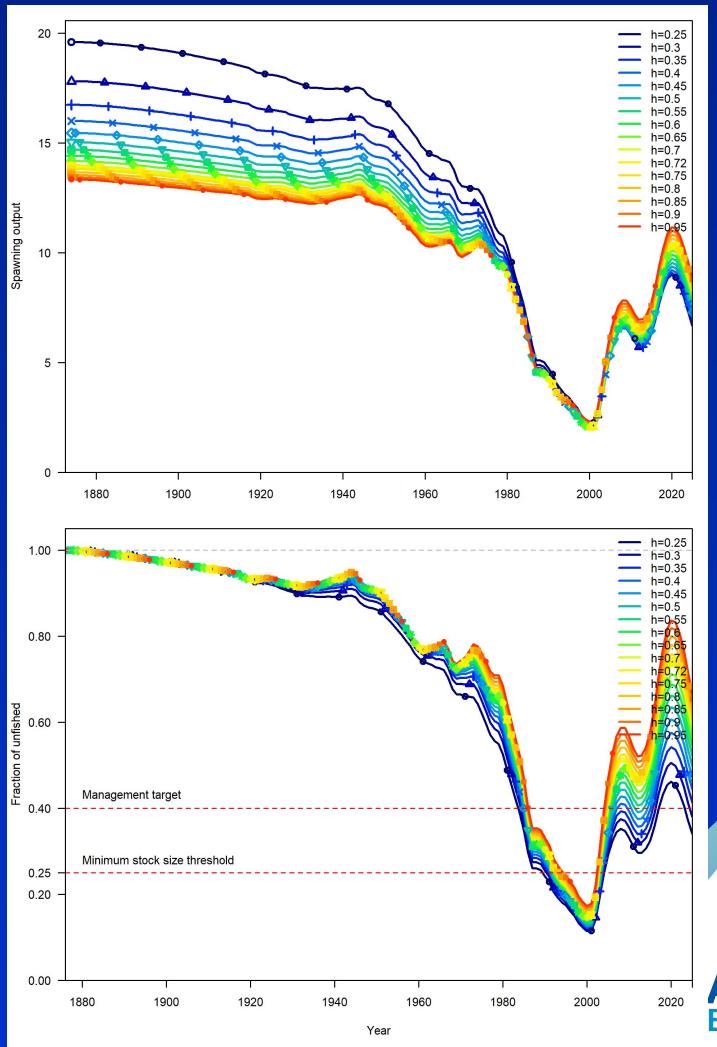


Model is not fit to either index

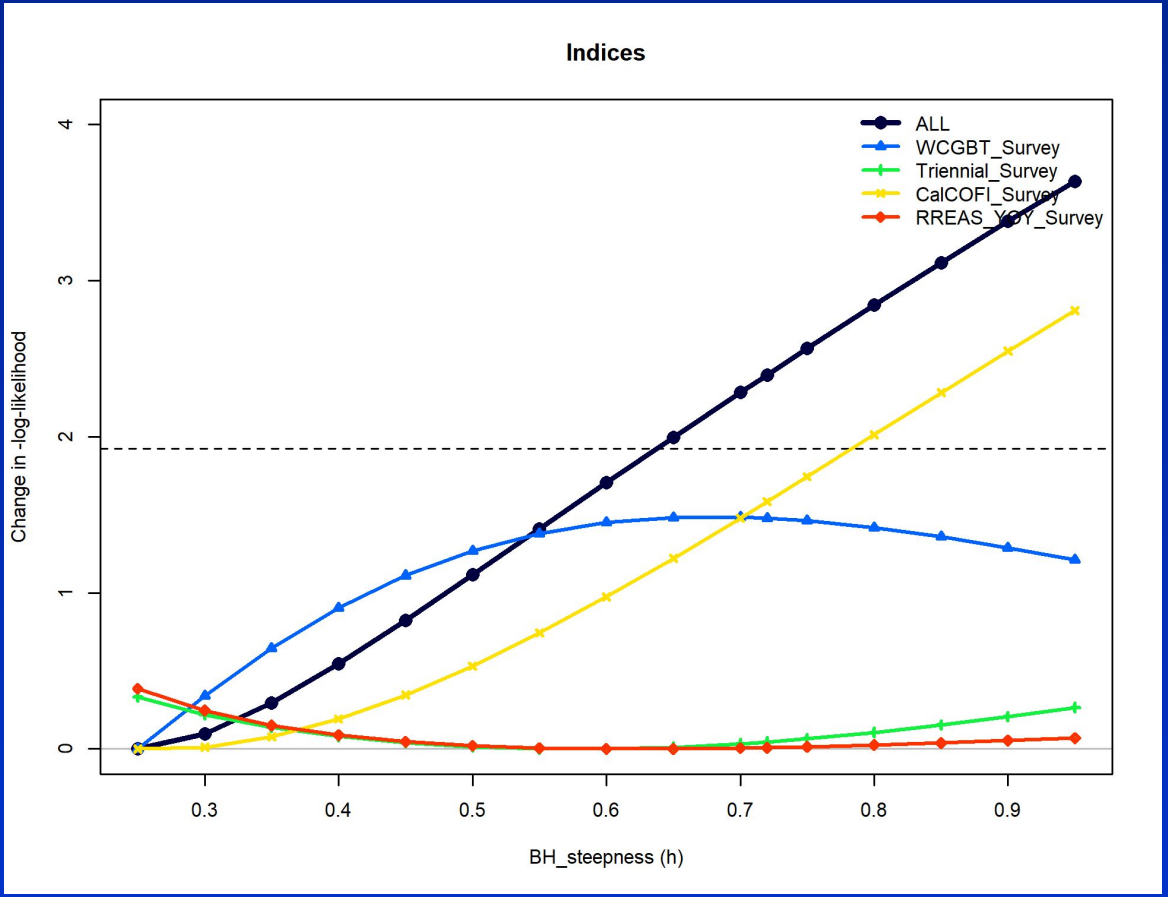
NOAA FISHERIES

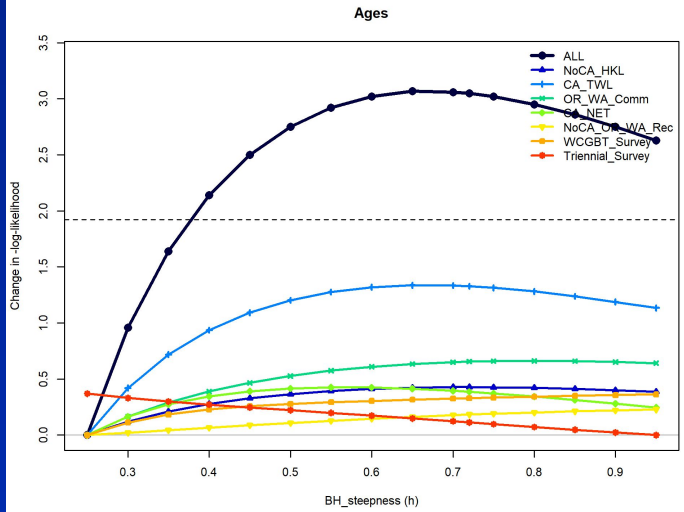
Likelihood Profile, Beverton-Holt Steepness

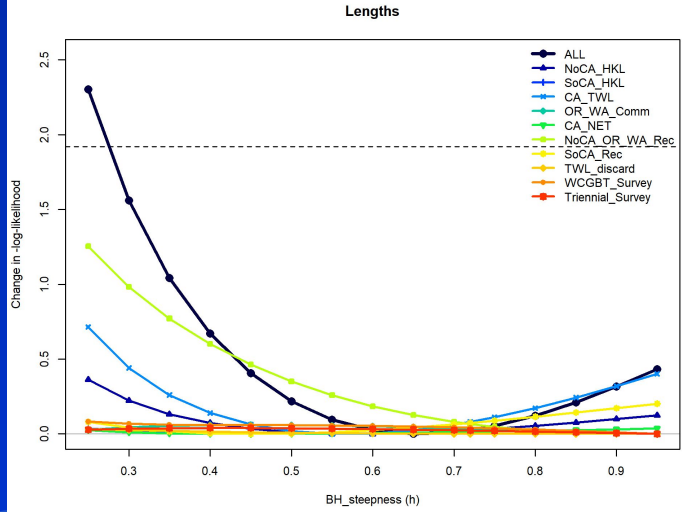




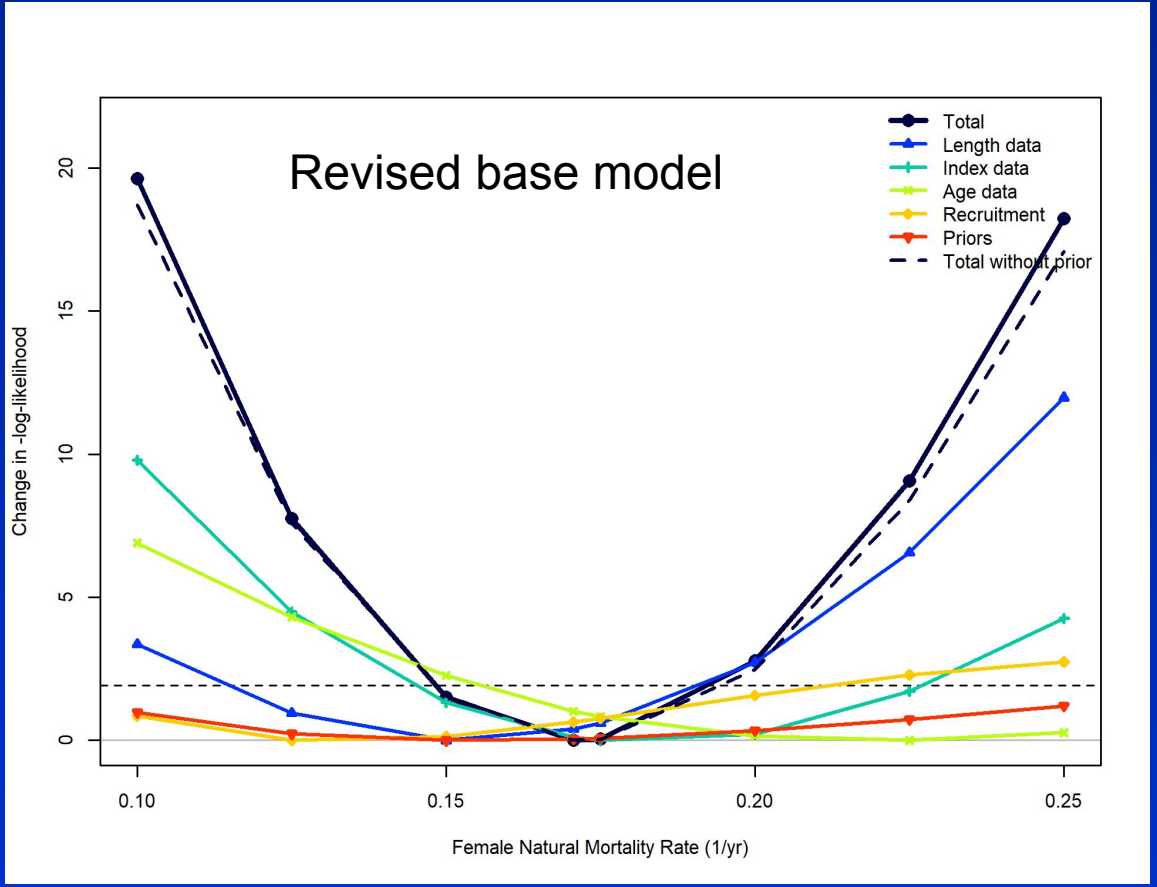
Likelihood Profile, Beverton-Holt Steepness

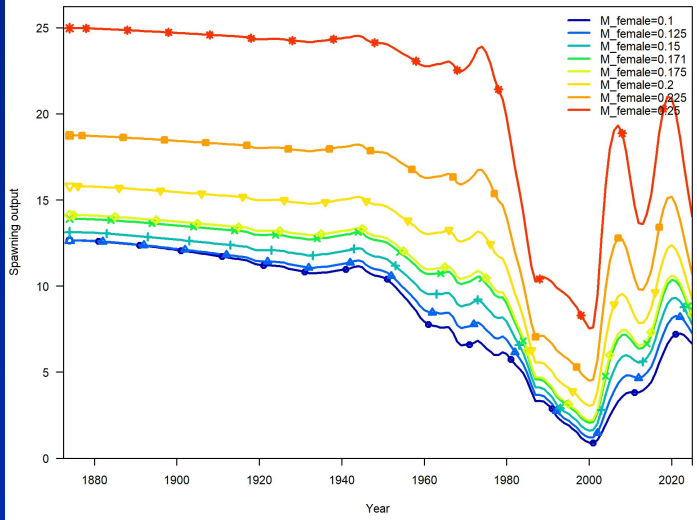


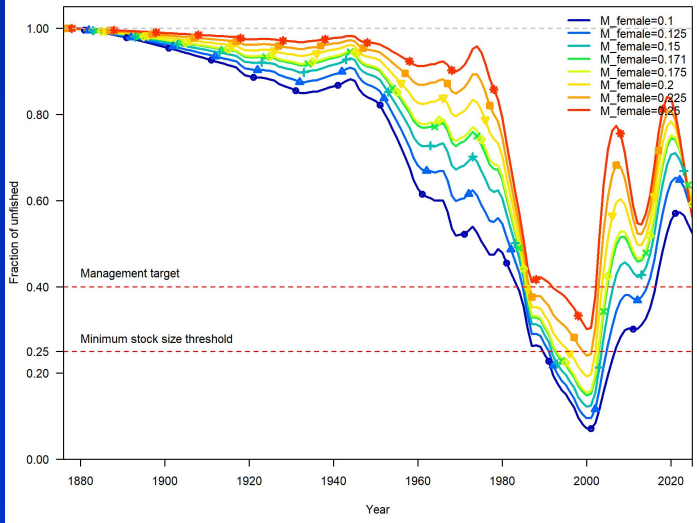




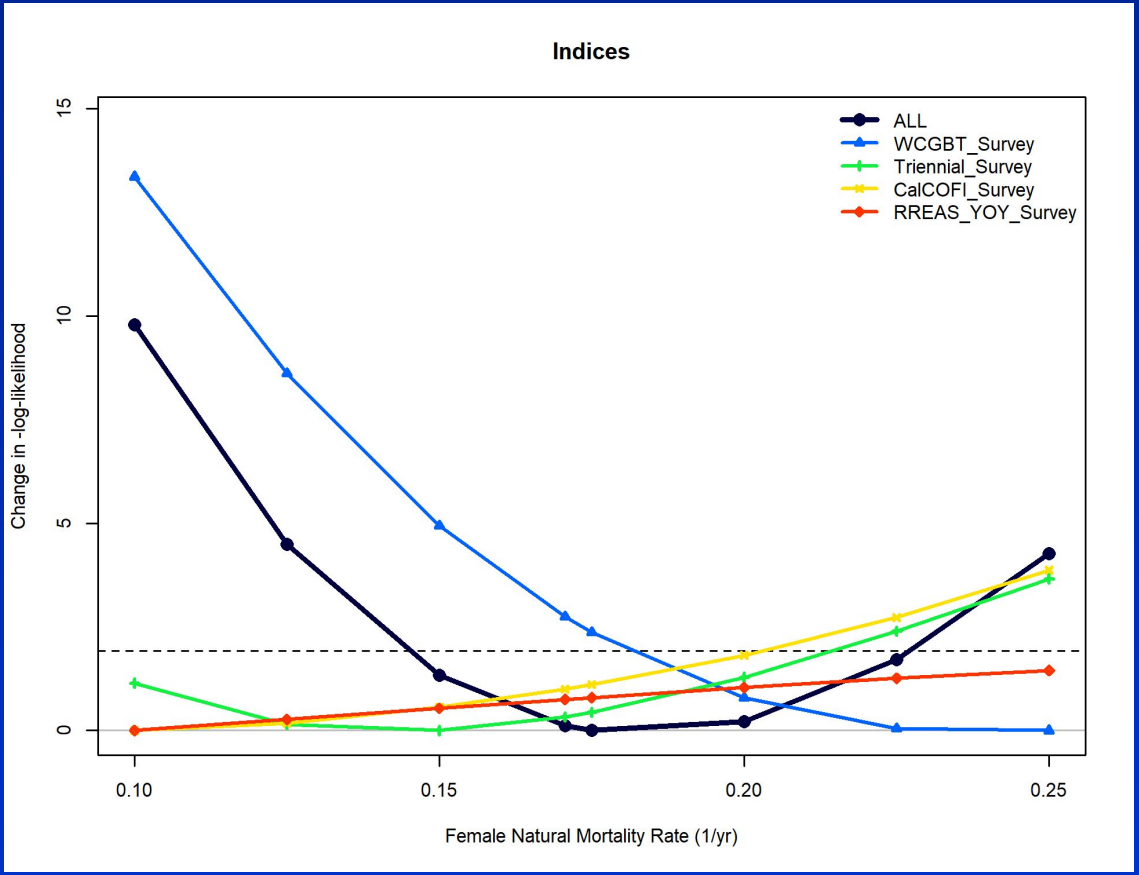
Likelihood Profile, Female Natural Mortality

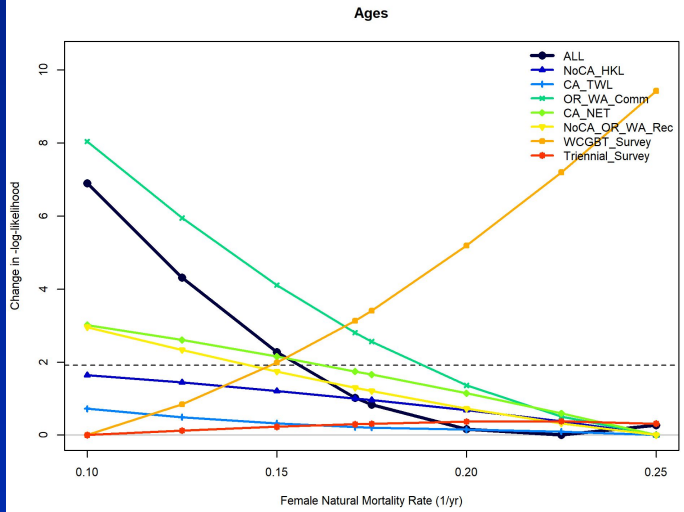


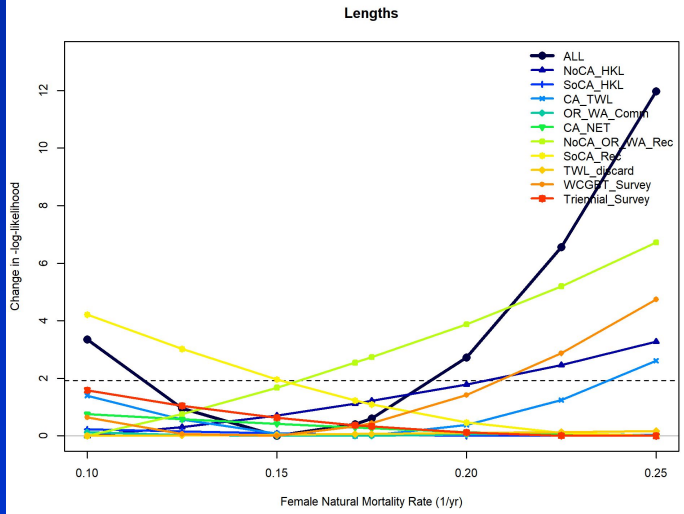




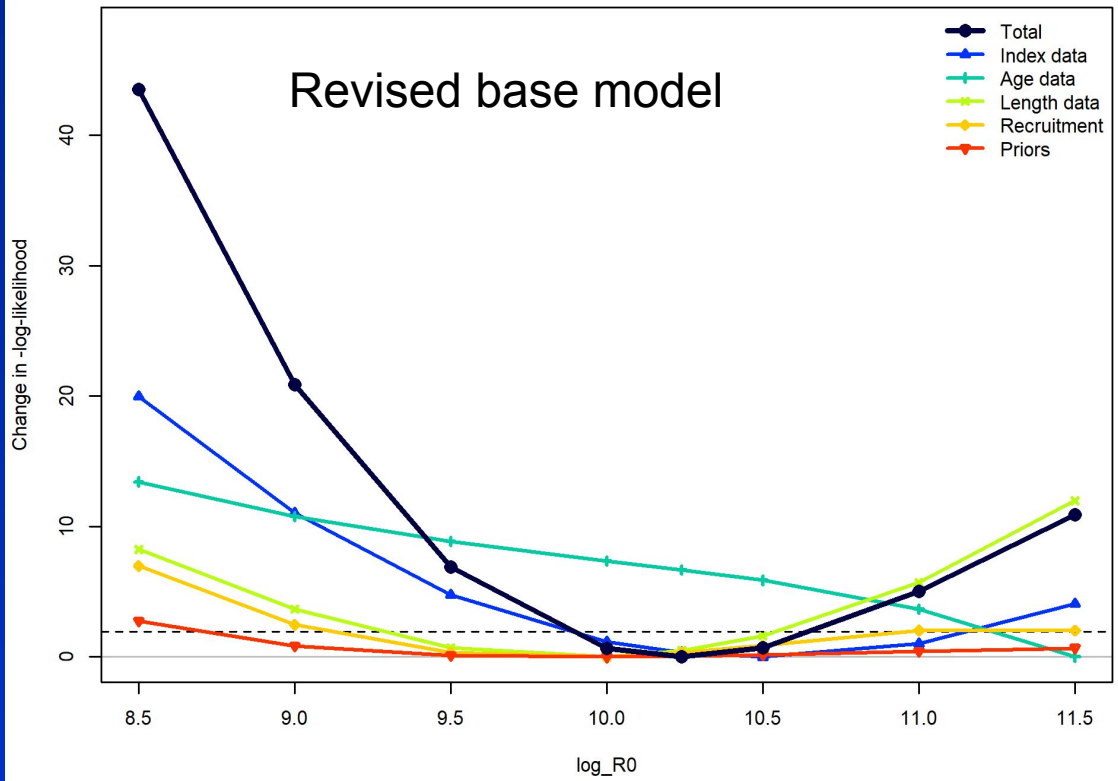
Likelihood Profile, Female Natural Mortality

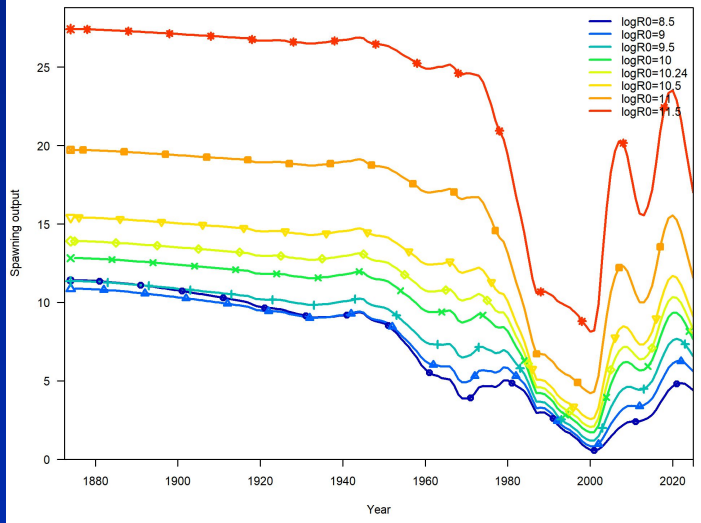


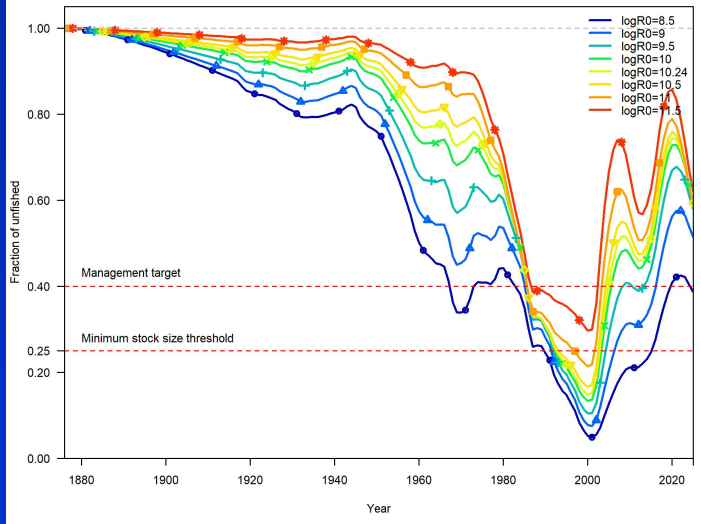




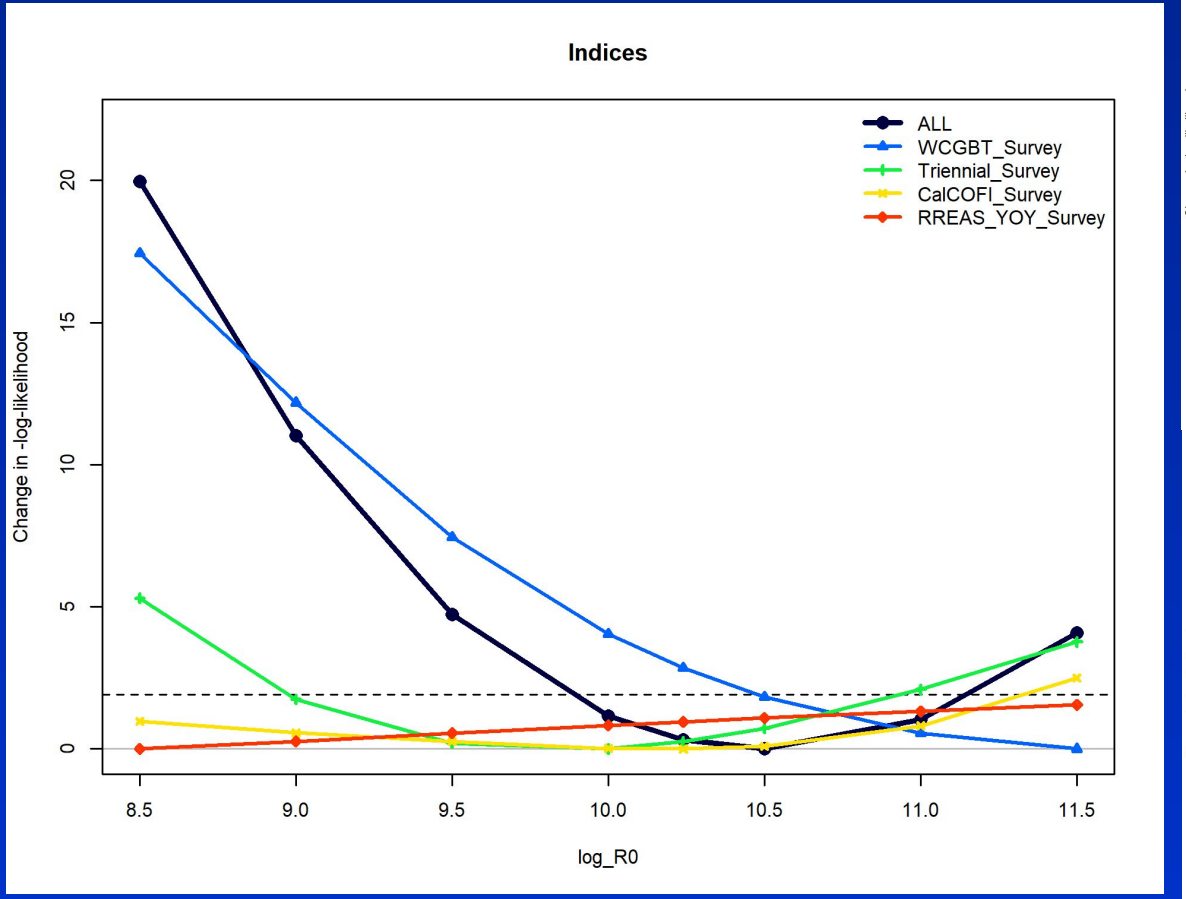
Likelihood Profile, log(R0)

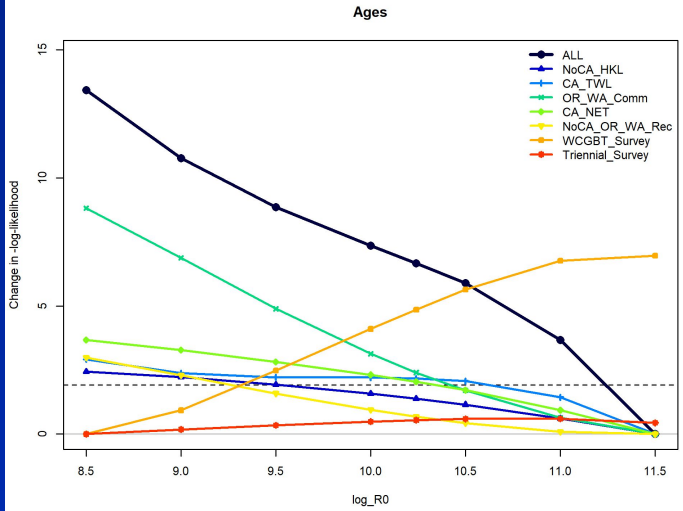


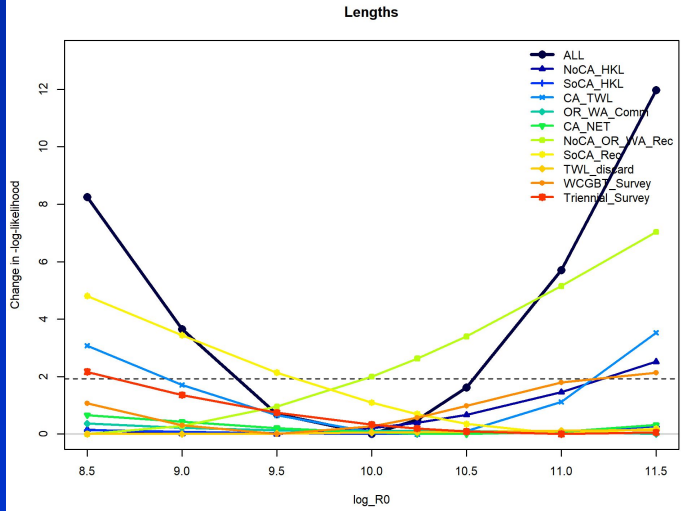




Likelihood Profile, log(R0)

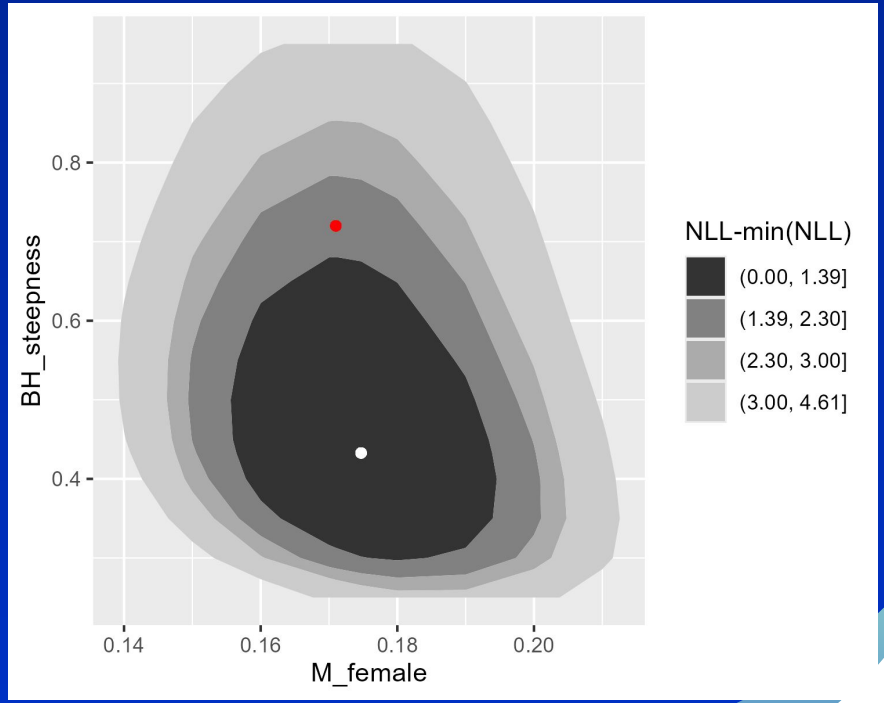




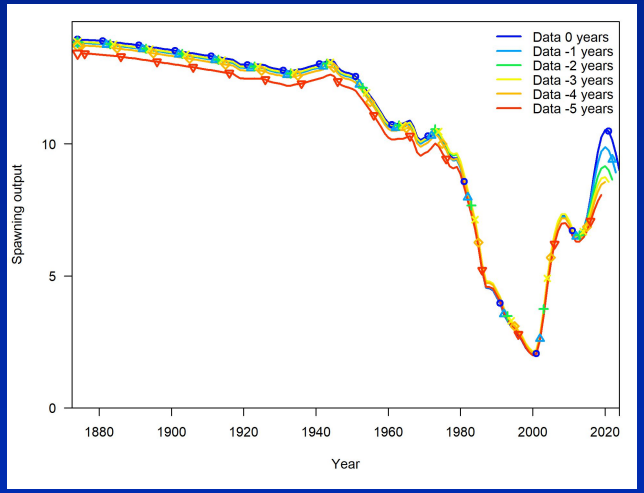


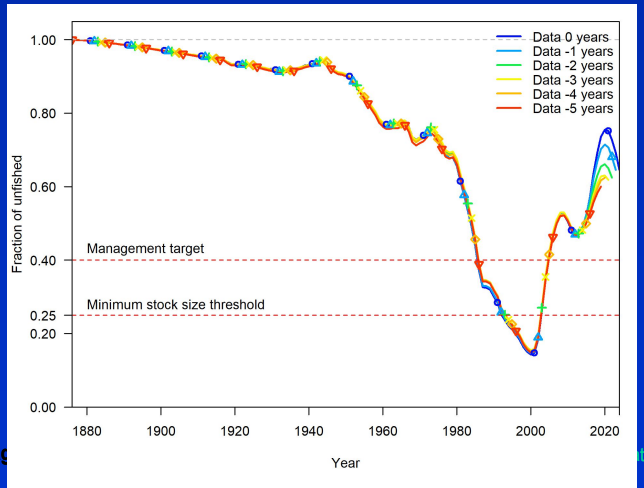
Bivariate Likelihood Profile over Steepness (h) and Female Natural Mortality (M)

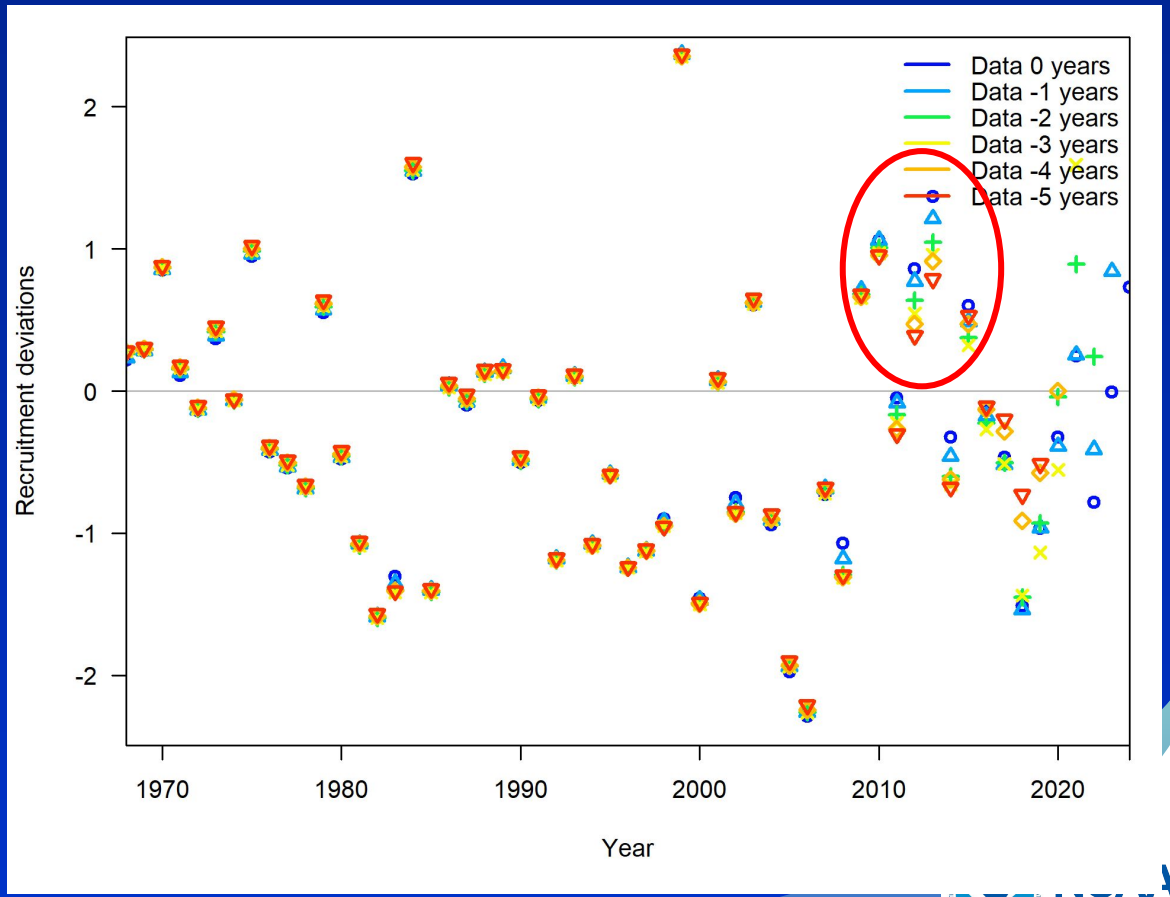
- NOT updated for revised base (but likely to be very similar)
- Contours represent bivariate C.I.'s at 75%, 90%, 95%, and 99%
- White point is minimum; red point is minimum given h=0.72
- Male M estimated as offset from female M in each iteration



Retrospective Analysis (not revised base)





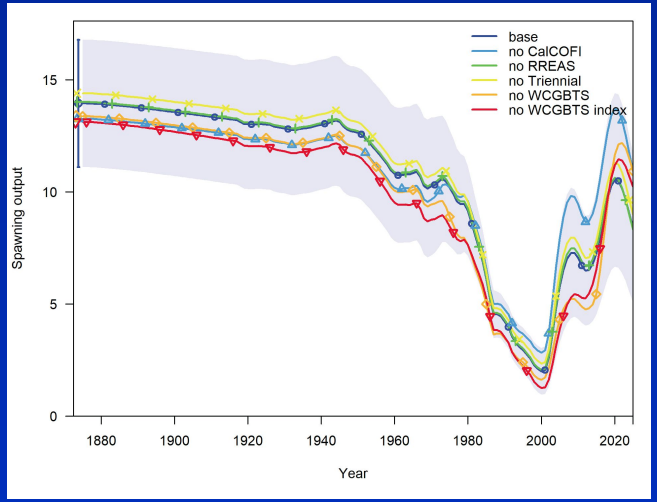


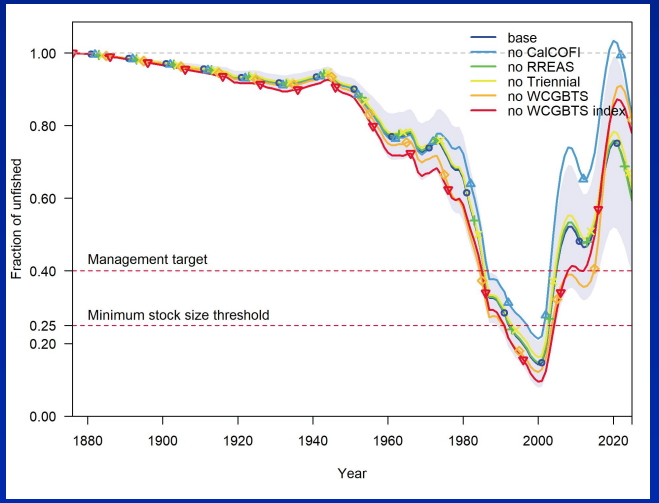
Sensitivity Analyses (not with revised base)

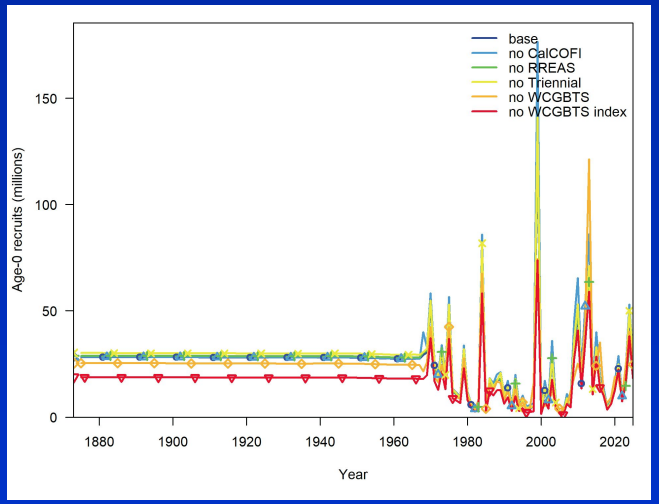
- ‘Drop-1’ analyses (removal of individual data sets)
- Comparison of ‘Francis’ and ‘McAllister-Ianelli’ weighting
- Inclusion of fishery-dependent data sources
- Time-varying vs. constant growth
- Time-varying vs. constant trawl selectivity
- Assume the same natural mortality rate for both sexes
- Estimation of steepness and natural mortality (both sexes)
- Turn off recruitment deviations
- Estimation of sex-specific selectivity for trawl fleet
- Alternative configurations of CalCOFI and RREAS indices

NOAA FISHERIES

“Drop-1” Sensitivity



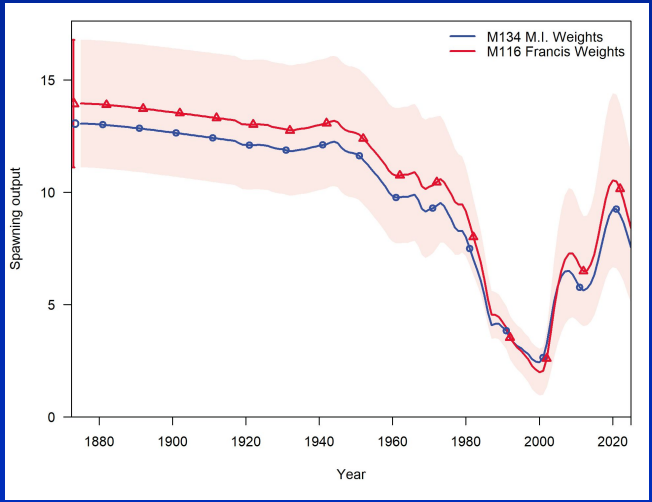


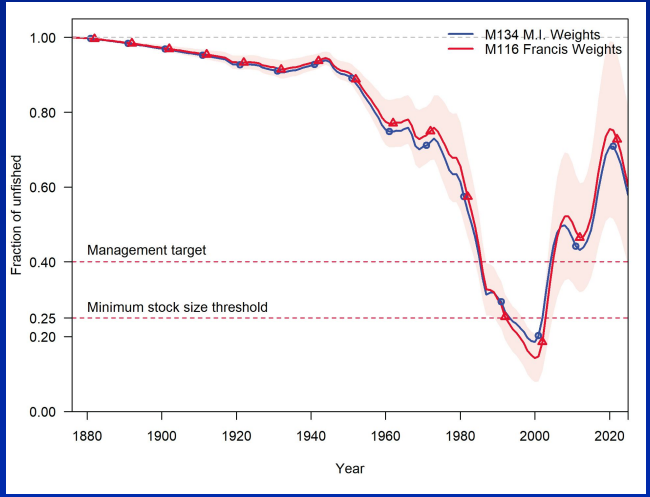


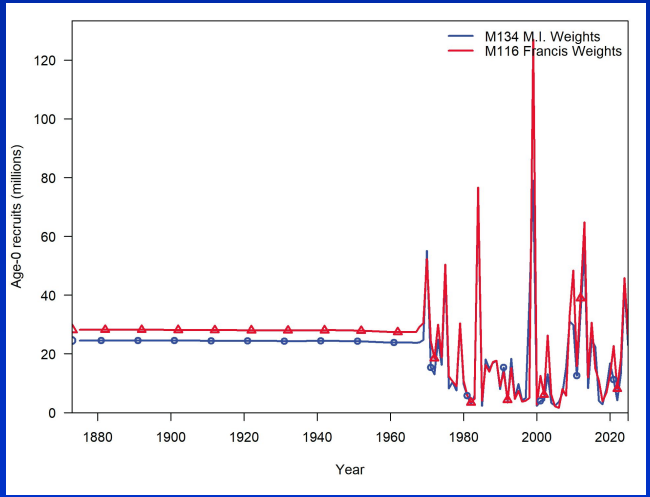
See draft assessment for likelihoods, parameters, and derived quantities, e.g., Table 18

Quantity Description	base	no CalCOFI	no RREAS	no Triennial	no WCGBTS	no WCGBTS index
N_Parms	114	114	114	114	114	114
TOTAL	2597.98	2590.69	2575.76	2524.52	1656.39	2600.01
Survey	24.51	19.37	3.02	21.99	29.22	28.55
Length_comp	572.24	573.73	571.41	545.92	464.54	571.21
Age_comp	1976.25	1973.68	1976.89	1931.66	1144.73	1975.63
Recruitment	24.92	23.83	24.38	24.86	17.88	24.58
Parm_priors	0.06	0.09	0.06	0.07	0.02	0.02
NatM_uniform_Fem_GP_1	0.171	0.176	0.173	0.174	0.164	0.144
L_at_Amax_Fem_GP_1	48.190	48.245	48.197	48.272	47.922	48.116
VonBert_K_Fem_GP_1	0.194	0.193	0.193	0.192	0.194	0.194
CV_young_Fem_GP_1	0.110	0.112	0.111	0.112	0.092	0.109
CV_old_Fem_GP_1	0.037	0.037	0.037	0.037	0.046	0.038
NatM_uniform_Mal_GP_1	0.261	0.250	0.258	0.261	0.185	0.323
L_at_Amax_Mal_GP_1	-0.337	-0.338	-0.338	-0.336	-0.393	-0.336
VonBert_K_Mal_GP_1	0.549	0.551	0.552	0.538	0.746	0.545
CV_young_Mal_GP_1	0.208	0.196	0.203	0.224	-0.488	0.223
CV_old_Mal_GP_1	0.148	0.157	0.155	0.119	1.089	0.132
SR_LN(R0)	10.248	10.251	10.270	10.313	10.142	9.838
Q_extraSD_CalCOFI_Survey(11)	0.313	0.314	0.316	0.321	0.308	0.310
Q_extraSD_RREAS_YOY_Survey(12)	1.233	1.251	1.233	1.235	1.156	1.185
Size_DblN_peak_NoCA_HKL(1)	41.247	40.988	41.232	40.984	42.149	41.382
Size_DblN_ascend_se_NoCA_HKL(1)	4.428	4.398	4.425	4.405	4.389	4.463
Size_DblN_descend_se_NoCA_HKL(1)	5.024	4.932	4.997	4.979	9.159	5.164
Size_DblN_peak_SoCA_HKL(2)	24.245	24.234	24.211	24.270	24.810	24.249
Size_DblN_ascend_se_SoCA_HKL(2)	1.410	1.407	1.396	1.422	1.481	1.410
Size_DblN_descend_se_SoCA_HKL(2)	5.781	5.772	5.783	5.774	6.407	5.794
Size_DblN_peak_CA_TWL(3)	44.673	44.535	44.644	44.602	45.224	44.794
Size_DblN_ascend_se_CA_TWL(3)	4.502	4.491	4.500	4.502	4.475	4.518
Size_DblN_descend_se_CA_TWL(3)	2.985	2.972	2.989	2.958	3.131	3.014
Size_DblN_peak_OR_WA_Comm(4)	41.925	41.762	41.754	41.848	44.426	41.936
Size_DblN_ascend_se_OR_WA_Comm(4)	4.476	4.461	4.463	4.469	4.554	4.492
Size_DblN_peak_CA_NET(5)	45.868	45.687	45.836	45.707	47.115	46.111
Size_DblN_ascend_se_CA_NET(5)	4.307	4.293	4.304	4.296	4.351	4.339
Size_DblN_descend_se_CA_NET(5)	3.632	3.557	3.617	3.517	5.330	3.775
Size_DblN_peak_NoCA_OR_WA_Rec(6)	43.491	43.303	43.454	43.325	45.947	43.460
Size_DblN_ascend_se_NoCA_OR_WA_Rec(6)	5.090	5.074	5.087	5.077	5.180	5.118
Size_DblN_descend_se_NoCA_OR_WA_Rec(6)	4.321	4.279	4.290	4.273	7.284	4.451
Size_DblN_peak_SoCA_Rec(7)	24.645	24.627	24.631	24.670	23.993	24.630
Size_DblN_ascend_se_SoCA_Rec(7)	2.913	2.907	2.916	2.914	2.796	2.910
Size_DblN_descend_se_SoCA_Rec(7)	3.365	3.378	3.366	3.404	3.211	3.396
Size_DblN_end_logit_SoCA_Rec(7)	-1.108	-1.130	-1.098	-1.119	-0.542	-1.121
Size_DblN_peak_TWL_discard(8)	29.547	29.511	29.523	29.598	30.992	29.528
Size_DblN_ascend_se_TWL_discard(8)	4.182	4.177	4.189	4.178	4.403	4.186
Size_DblN_descend_se_TWL_discard(8)	3.200	3.209	3.206	3.178	2.930	3.193
Size_DblN_peak_NoCA_HKL(1)_BLK1repl_1875	50.237	50.272	50.221	50.016	51.419	50.306
Size_DblN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.050	4.050	4.049	4.032	4.138	4.059
Size_DblN_peak_SoCA_HKL(2)_BLK2repl_1875	47.410	47.191	47.373	47.187	48.939	47.705
Size_DblN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.717	4.705	4.714	4.709	4.725	4.749
Size_DblN_peak_CA_TWL(3)_BLK3repl_1875	33.585	33.529	33.609	33.401	36.561	33.451
Size_DblN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.234	3.215	3.239	3.186	3.732	3.220
Size_DblN_peak_SoCA_Rec(7)_BLK2repl_1875	30.581	30.753	30.598	30.563	35.165	30.363
Size_DblN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.732	3.754	3.734	3.723	4.458	3.712
Bratio_2025	0.603	0.825	0.594	0.625	0.817	0.780
SSB_unfished	13945	13260	14010	14396	13371	13115
Totbio_unfished	61069	58718	61564	63220	59406	53619
Recr_unfished	28215	28320	28853	30132	25380	18727
Dead_Catch_SPR	2509	2457	2543	2627	2313	1934
OFLCatch_2025	2894	3791	2867	3107	3975	3006

Sensitivity to Data-Weighting Methods



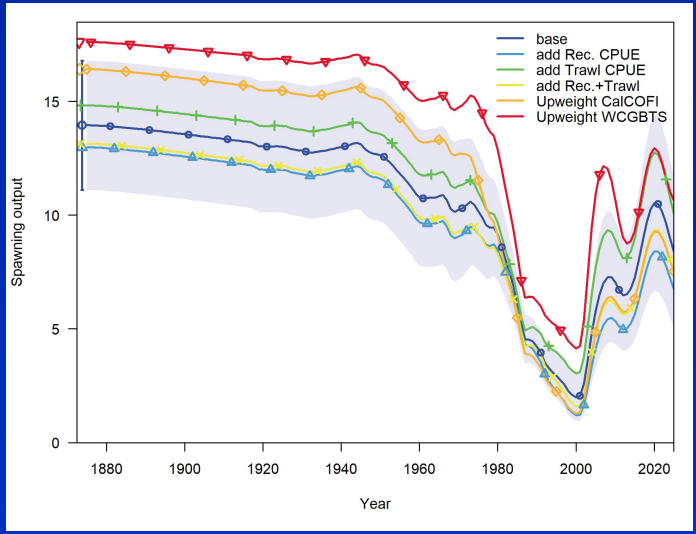


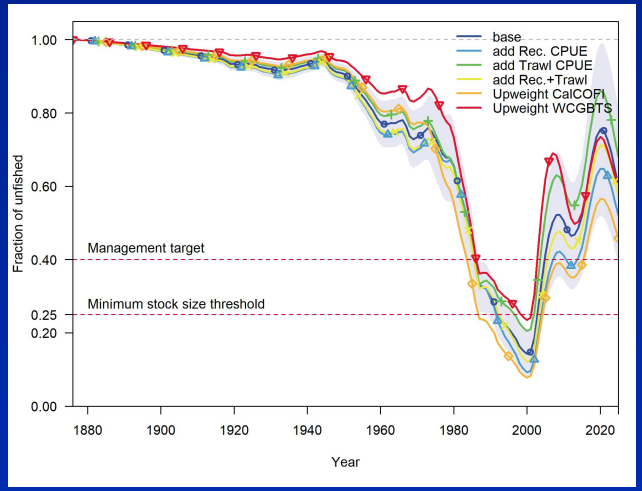


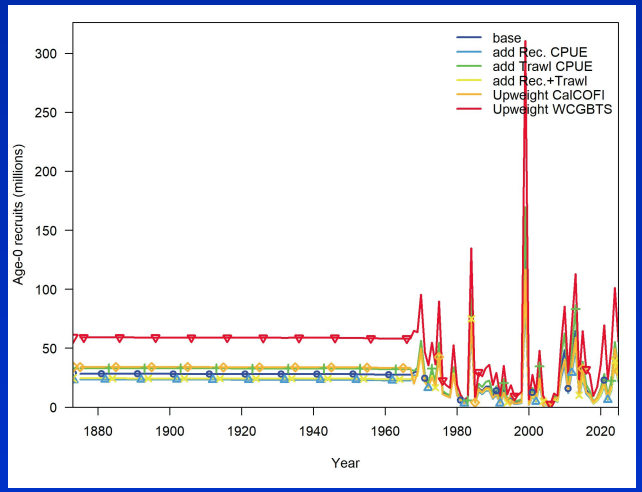
See Tables 19 & 20
in the draft assessment

NOAA FISHERIES

Sensitivity to inclusion of fishery-dependent indices, or increasing the influence of other indices

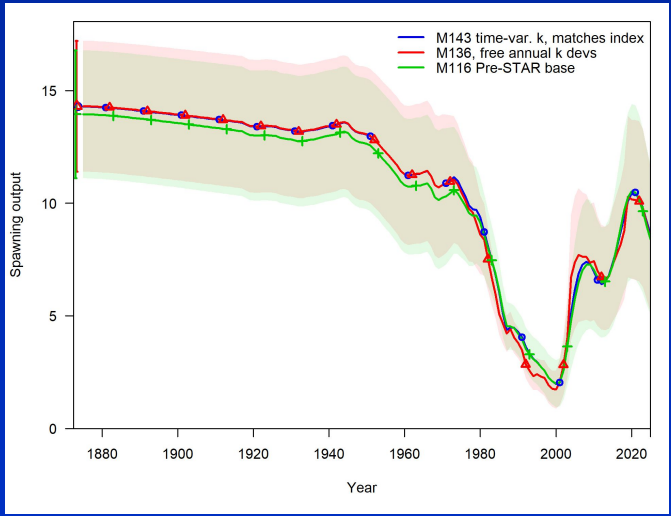


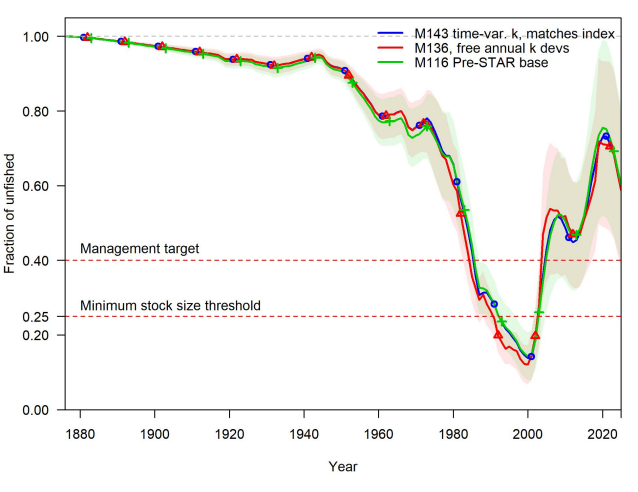


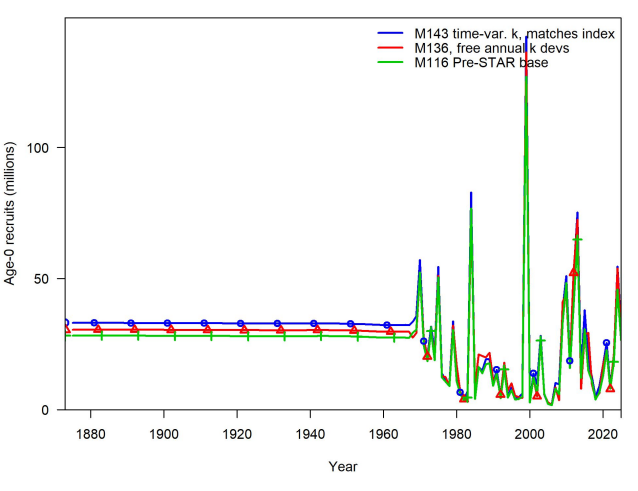


See Table 21
in the draft assessment

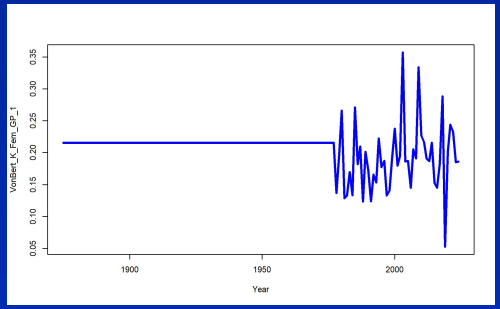
Sensitivity to variation in growth (‘k’ parameter of the von Bertalanffy model) over time

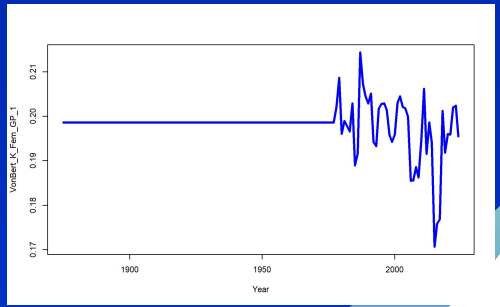






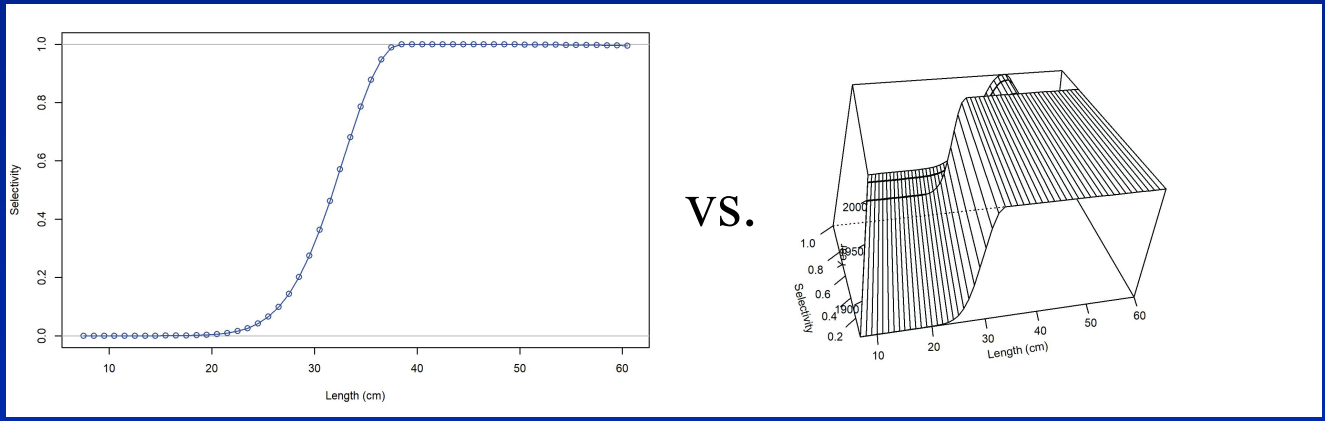
This analysis now includes a run with time-varying k linked to an index of annual variability (**see Appendix A** in the draft assessment)



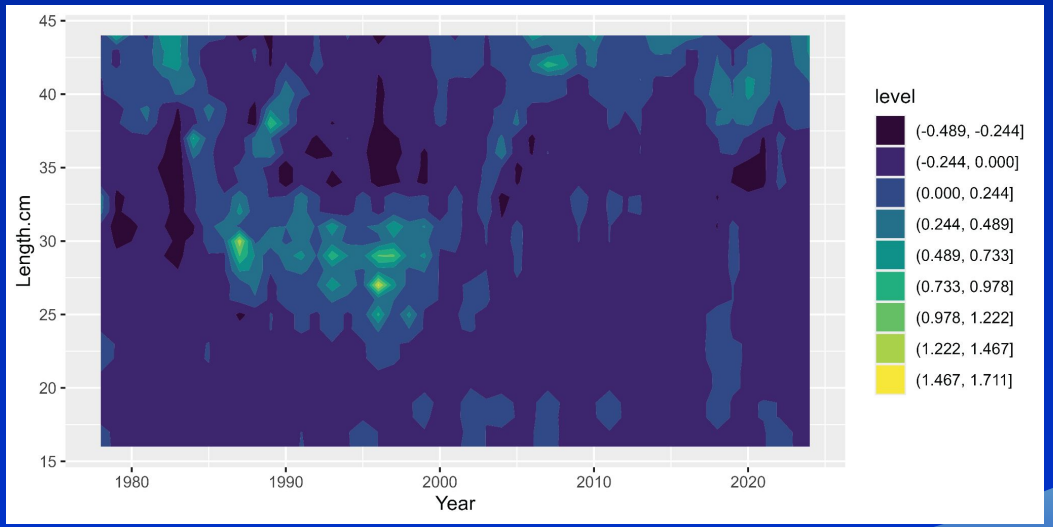


NOAA FISHERIES

Sensitivity to variation in trawl selectivity over time

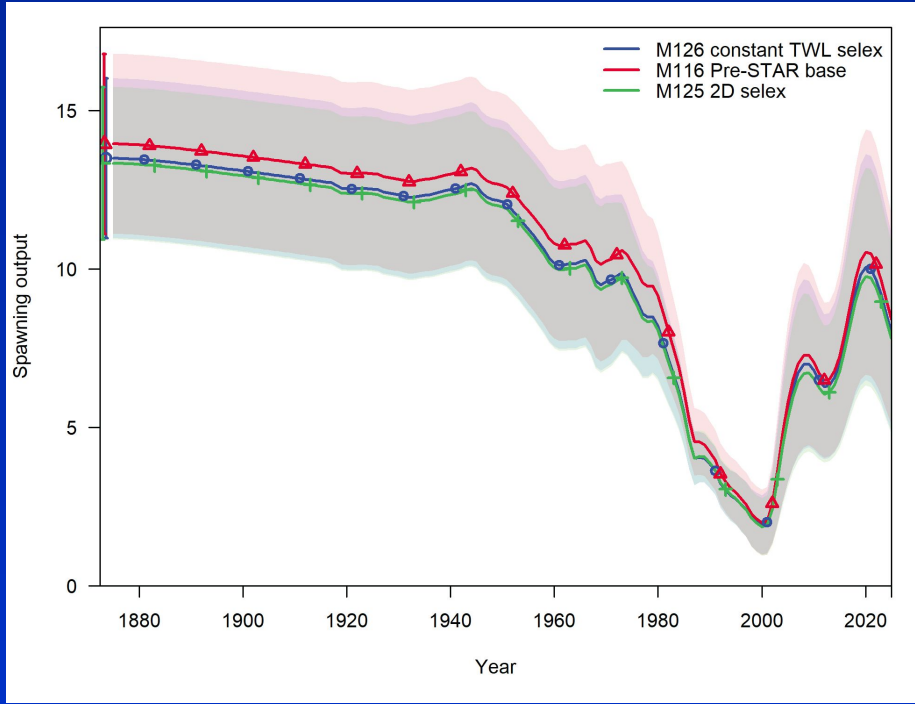


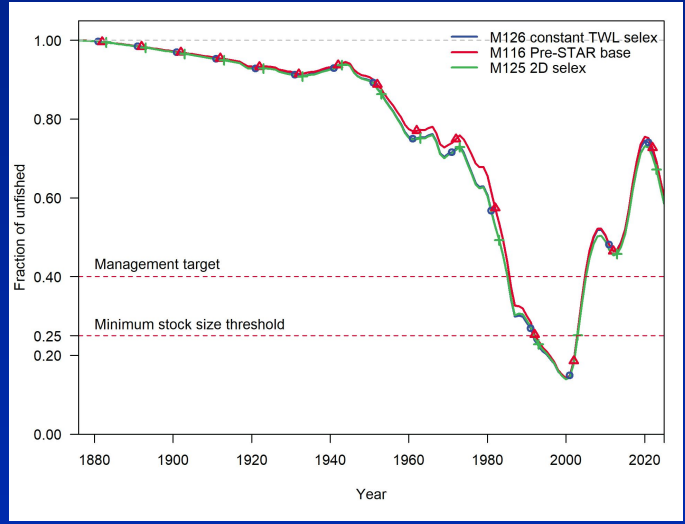
vs.

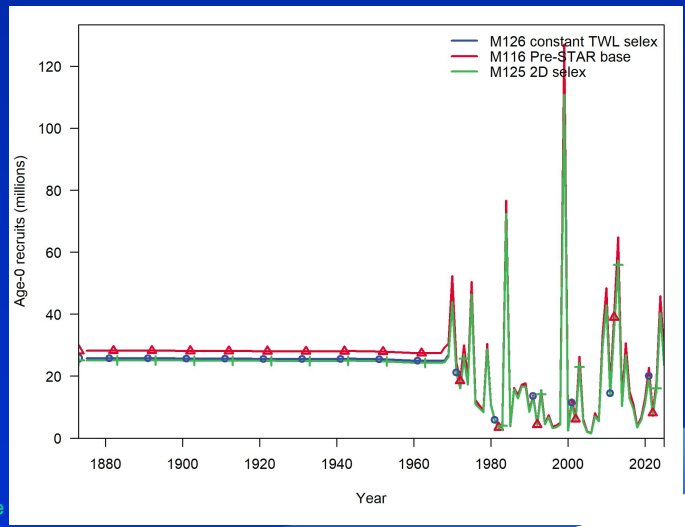


NOAA FISHERIES

Sensitivity to variation in trawl selectivity over time



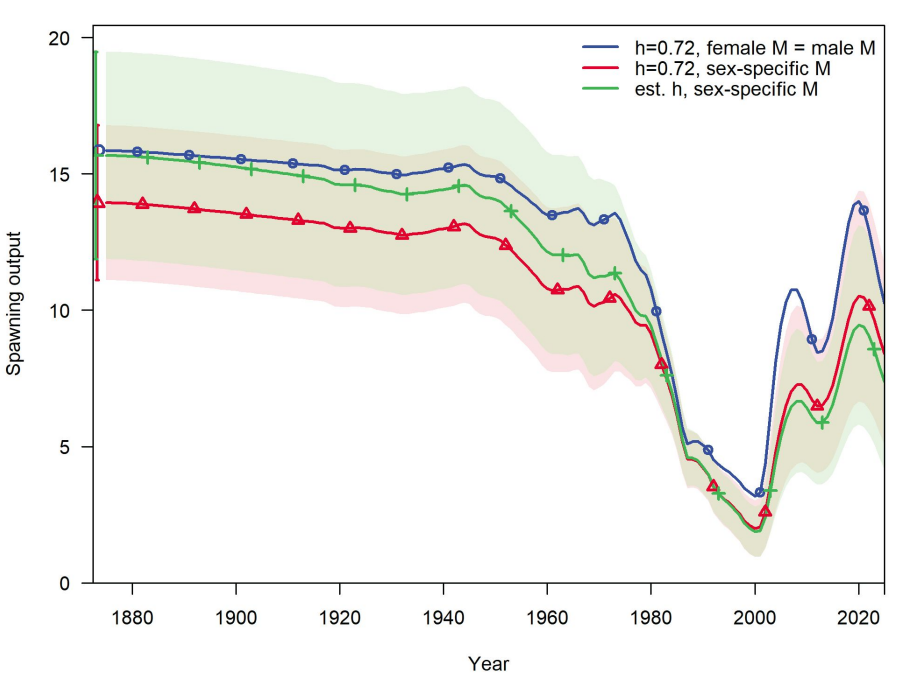


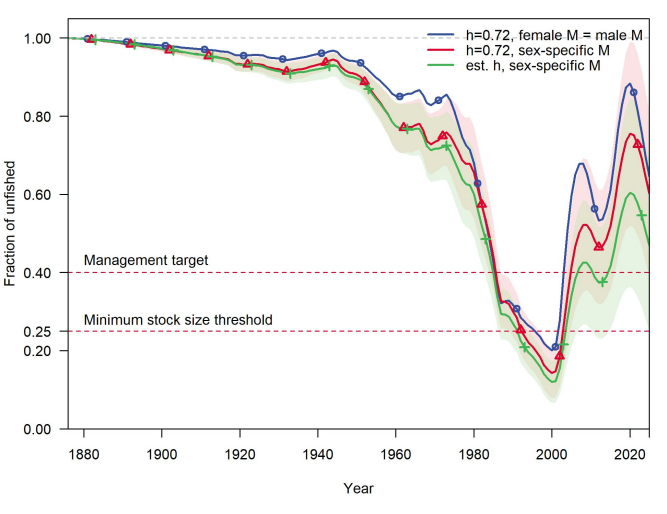


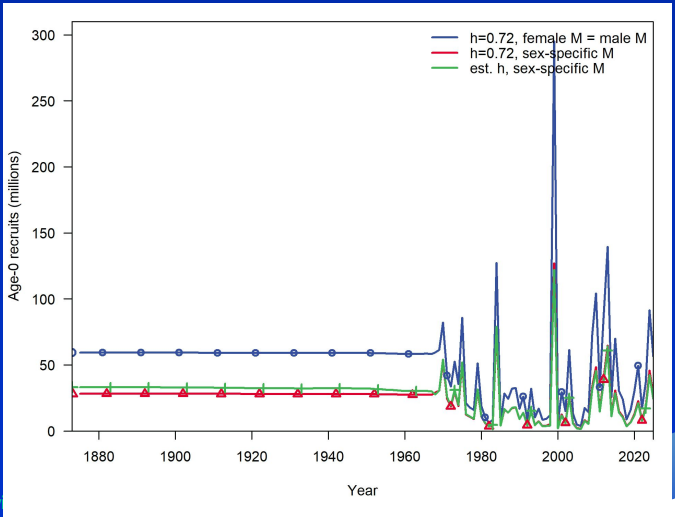
See Table 23 in the draft assessment

NOAA FISHERIES

Sensitivity to sex-independent natural mortality rate (M = 0.224) and estimation of steepness

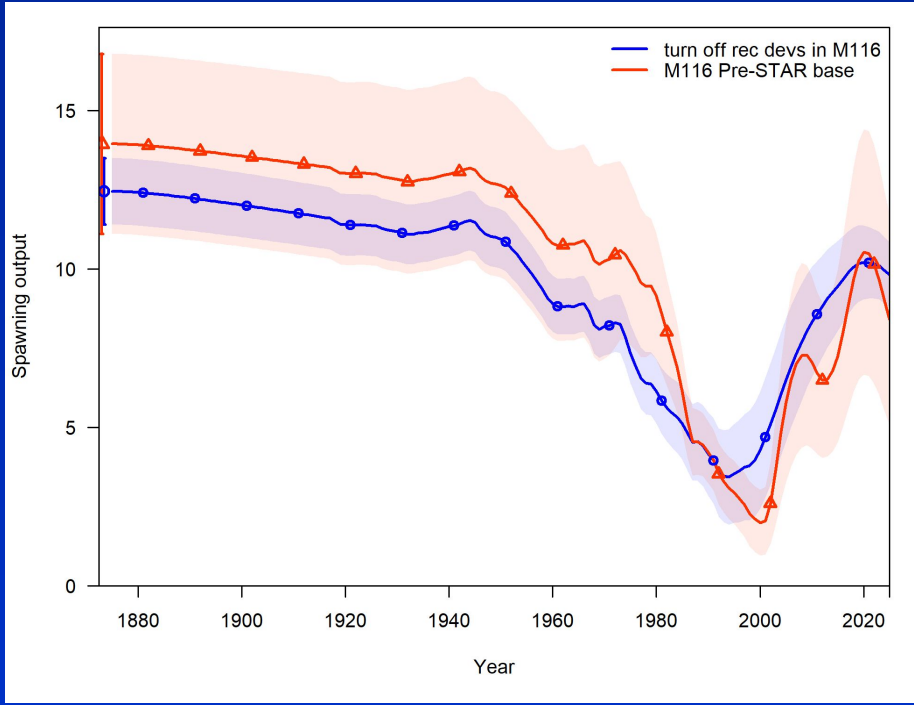


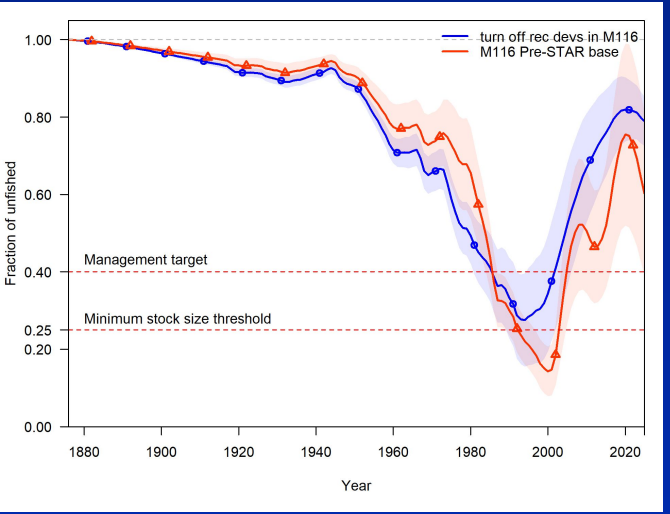


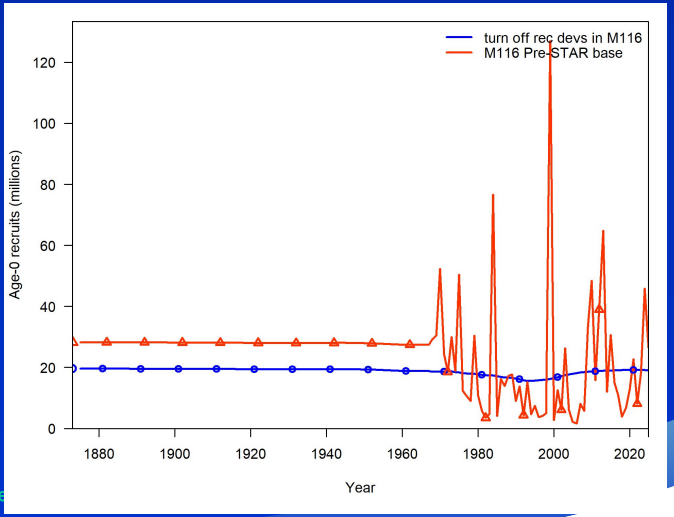


See Table 24 in the draft assessment (note: caption is incorrect)

Sensitivity to assumption of deterministic recruitment (age-structured production model)

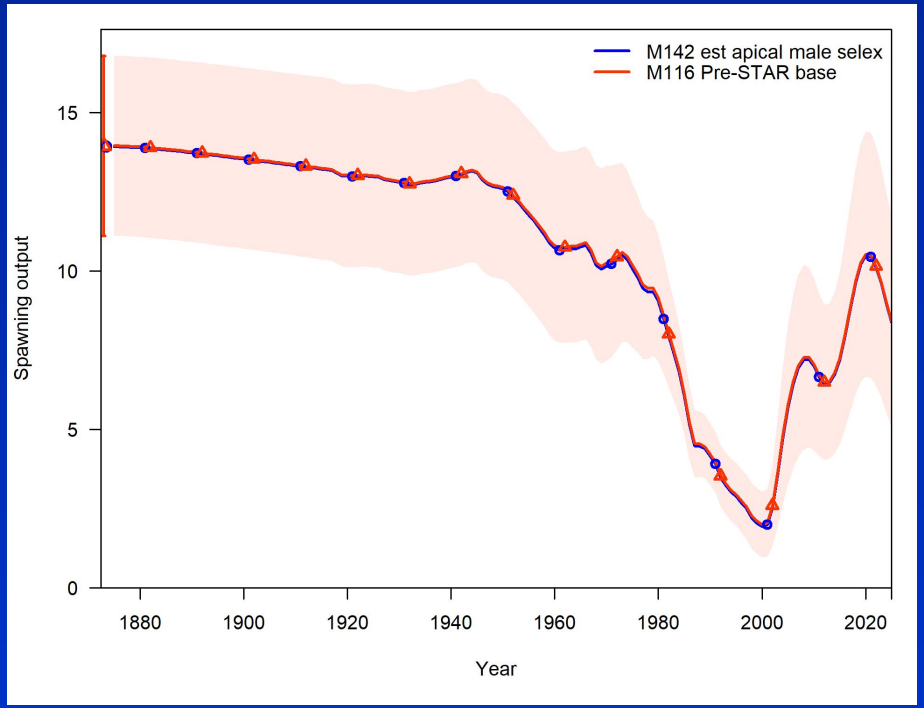


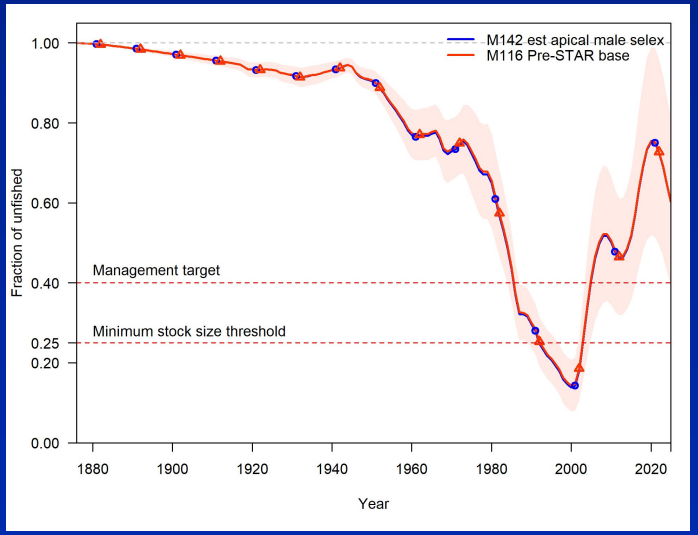


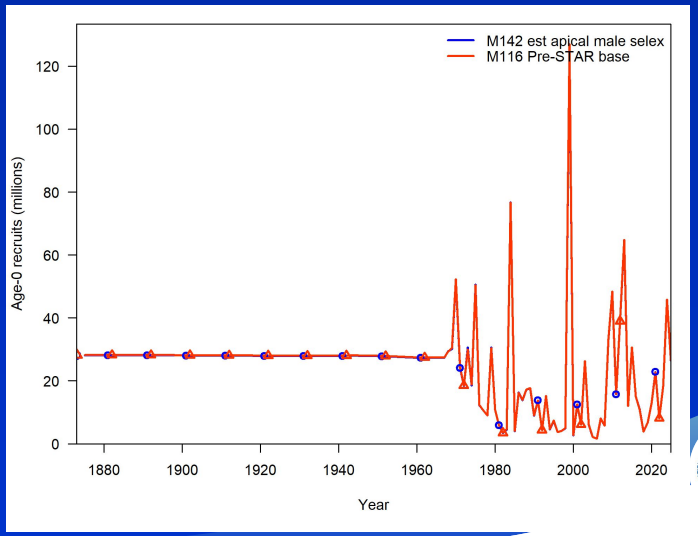


NOAA FISHERIES

Sensitivity to sex-specific selectivity in the trawl fishery







NOAA FISHERIES

Sensitivity to sex-specific selectivity in the trawl fishery

Label	M142 est apical male selex	M116 Pre-STAR base
N.Parms	115	114
TOTAL	2629.780	2597.980
Survey	24.472	24.512
Length_comp	578.810	572.241
Age_comp	2001.350	1976.250
Recruitment	25.084	24.915
Parm_priors	0.054	0.055
NatM_uniform_Fem_GP_1	0.171	0.171
L_at_Amax_Fem_GP_1	48.177	48.190
VonBert_K_Fem_GP_1	0.193	0.194
CV_young_Fem_GP_1	0.110	0.110
CV_old_Fem_GP_1	0.037	0.037
NatM_uniform_Mal_GP_1	0.246	0.261
L_at_Amax_Mal_GP_1	-0.335	-0.337
VonBert_K_Mal_GP_1	0.548	0.549
CV_young_Mal_GP_1	0.208	0.208
CV_old_Mal_GP_1	0.127	0.148
SR_LN(R0)	10.244	10.248
Q_extraSD_CalCOFI_Survey(11)	0.312	0.313
Q_extraSD_RREAS_YOY_Survey(12)	1.232	1.233
Size_DblN_peak_NoCA_HKL(1)	41.866	41.247
Size_DblN_ascend_se_NoCA_HKL(1)	4.501	4.428
Size_DblN_descend_se_NoCA_HKL(1)	4.838	5.024
Size_DblN_peak_SoCA_HKL(2)	24.214	24.245
Size_DblN_ascend_se_SoCA_HKL(2)	1.394	1.410
Size_DblN_descend_se_SoCA_HKL(2)	5.793	5.781
Size_DblN_peak_CA_TWL(3)	44.614	44.673
Size_DblN_ascend_se_CA_TWL(3)	4.518	4.502
Size_DblN_descend_se_CA_TWL(3)	3.028	2.985
SzSel_Male_Peak_CA_TWL(3)	0	NA
SzSel_Male_Ascend_CA_TWL(3)	0	NA
SzSel_Male_Descend_CA_TWL(3)	0	NA
SzSel_Male_Final_CA_TWL(3)	0	NA
SzSel_Male_Scale_CA_TWL(3)	0.860296	NA

Label	M142 est apical male selex	M116 Pre-STAR base
Size_DblN_peak_OR_WA_Comm(4)	42.269	41.925
Size_DblN_ascend_se_OR_WA_Comm(4)	4.516	4.476
Size_DblN_peak_CA_NET(5)	46.059	45.868
Size_DblN_ascend_se_CA_NET(5)	4.315	4.307
Size_DblN_descend_se_CA_NET(5)	3.686	3.632
Size_DblN_peak_NoCA_OR_WA_Rec(6)	43.839	43.491
Size_DblN_ascend_se_NoCA_OR_WA_Rec(6)	5.120	5.090
Size_DblN_descend_se_NoCA_OR_WA_Rec(6)	4.286	4.321
Size_DblN_peak_SoCA_Rec(7)	24.678	24.645
Size_DblN_ascend_se_SoCA_Rec(7)	2.923	2.913
Size_DblN_descend_se_SoCA_Rec(7)	3.308	3.365
Size_DblN_end_logit_SoCA_Rec(7)	-1.107	-1.108
Size_DblN_peak_TWL_discard(8)	29.471	29.547
Size_DblN_ascend_se_TWL_discard(8)	4.172	4.182
Size_DblN_descend_se_TWL_discard(8)	3.217	3.200
Size_DblN_peak_NoCA_HKL(1)_BLK1repl_1875	50.294	50.237
Size_DblN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.043	4.050
Size_DblN_peak_SoCA_HKL(2)_BLK2repl_1875	47.777	47.410
Size_DblN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.735	4.717
Size_DblN_peak_CA_TWL(3)_BLK3repl_1875	33.207	33.585
Size_DblN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.153	3.234
Size_DblN_peak_SoCA_Rec(7)_BLK2repl_1875	30.552	30.581
Size_DblN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.730	3.732
Bratio_2025	0.602	0.603
SSB_unfished	13914	13945
Totbio_unfished	61439	61069
Recr_unfished	28113	28215
Dead_Catch_SPR	2490	2509
OFLCatch_2025	2875	2894

Male M changes from 0.218 to 0.222

NOAA FISHERIES

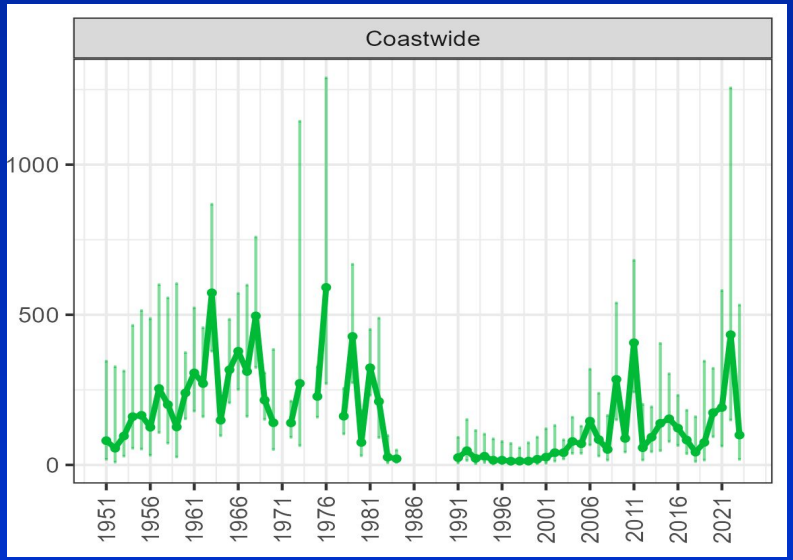
Sensitivity Analyses

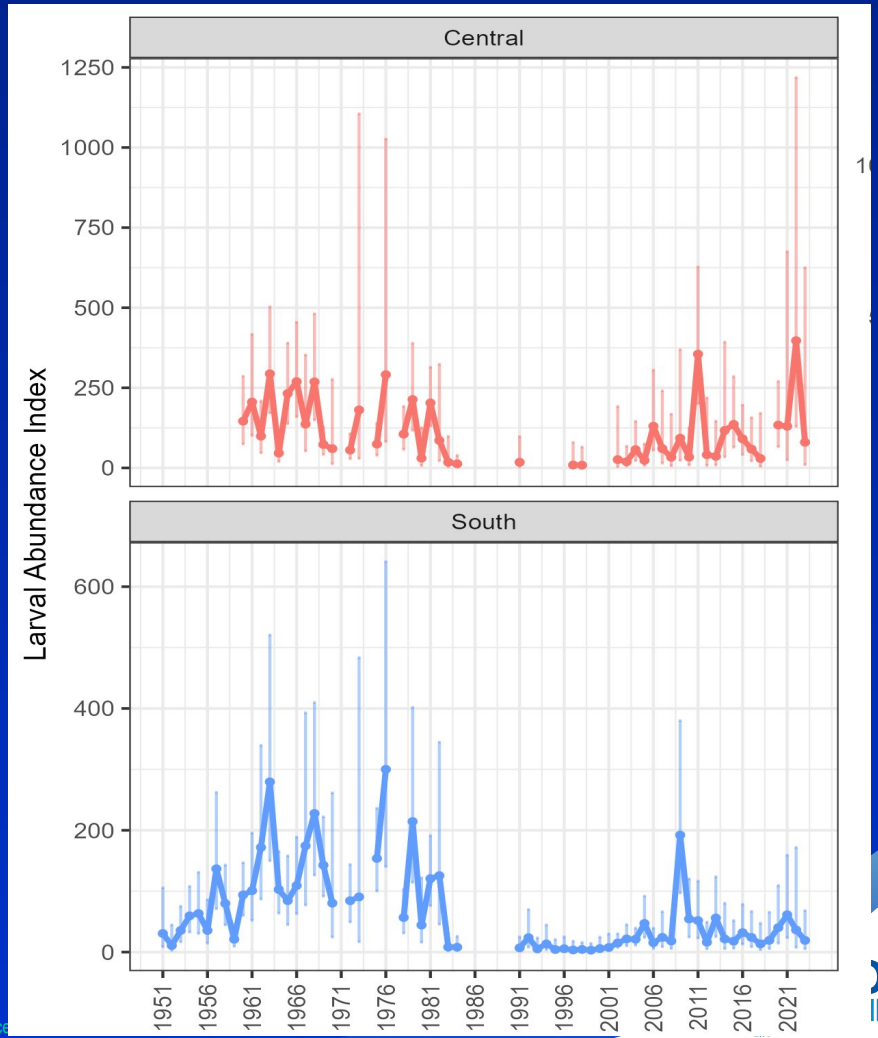
CalCOFI and
RREAS surveys

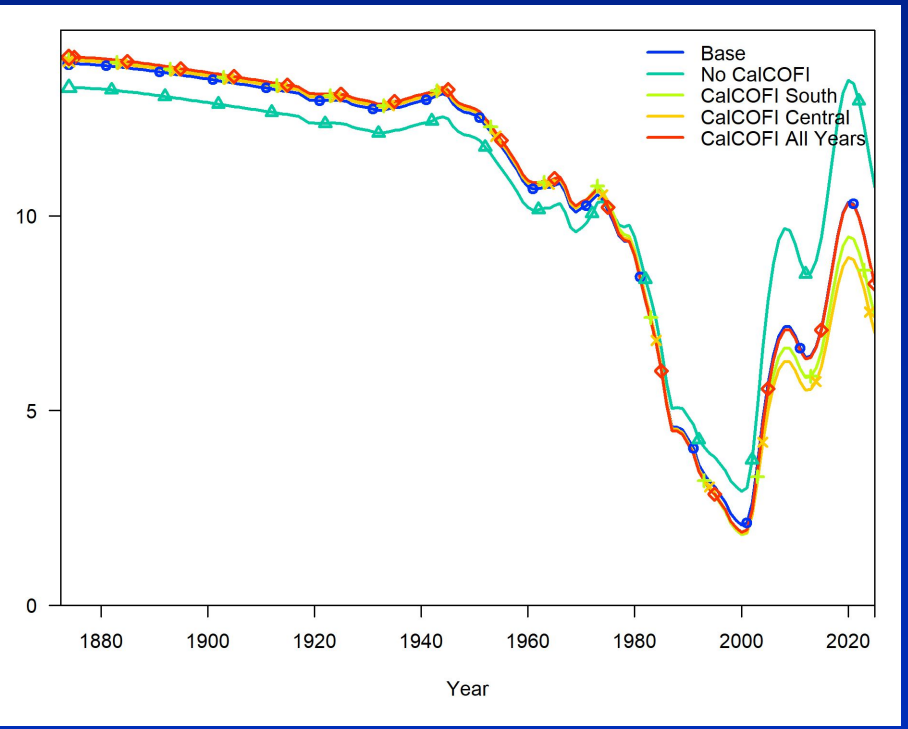


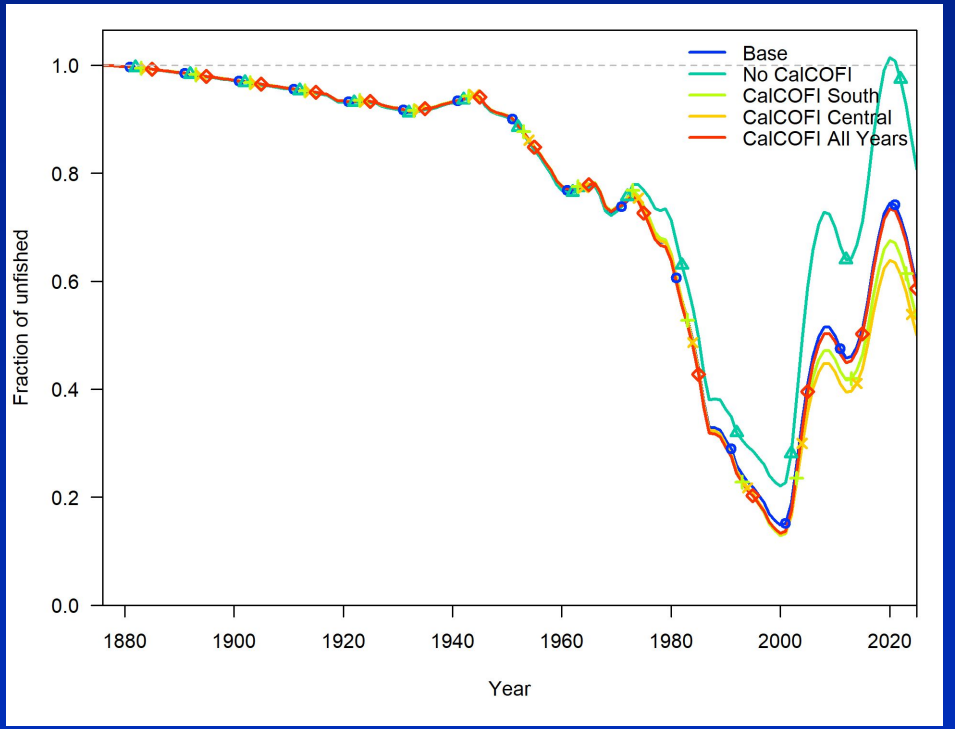
NOAA FISHERIES

The CalCOFI regional models suggest that larval output may have been lower in southern area in the 1950s relative to the 1960s, and that southern area may also be relatively more depleted currently. For the base model, we used only years in which both southern and central data were available (exclude 50s).

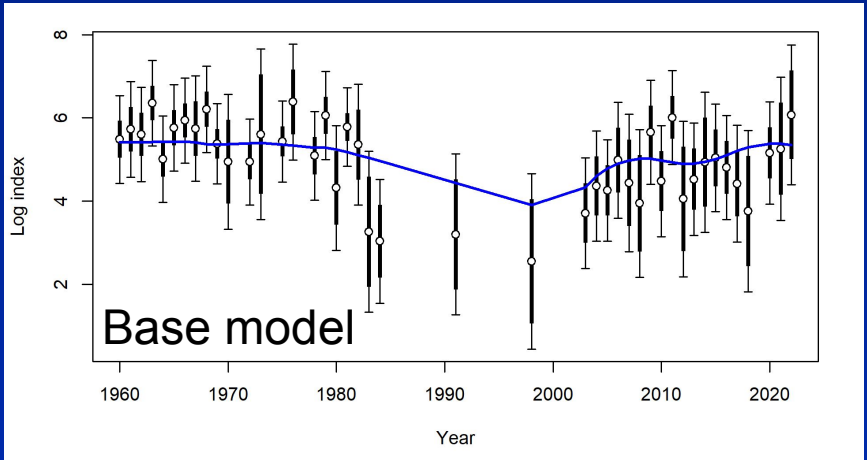


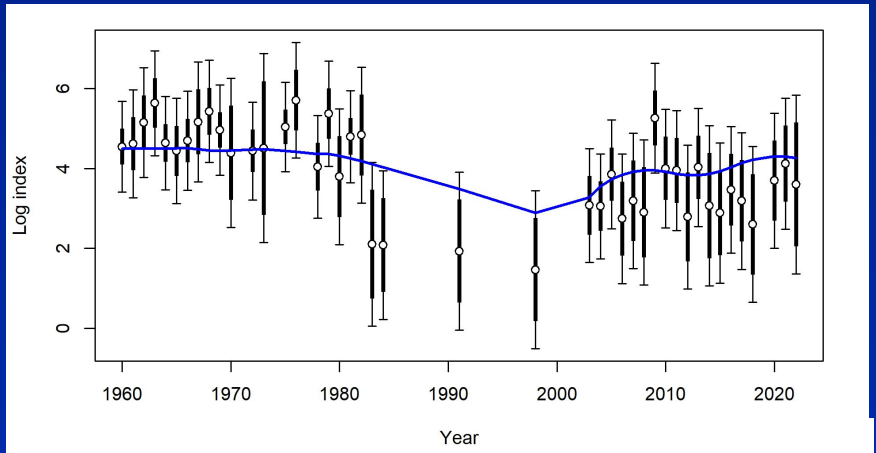


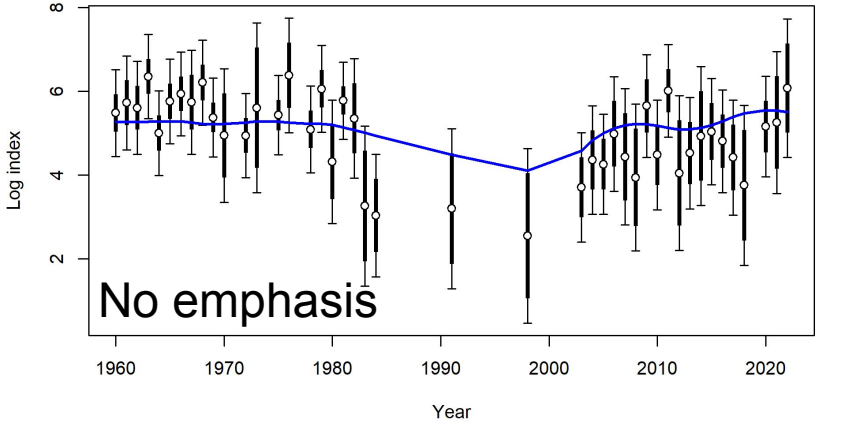


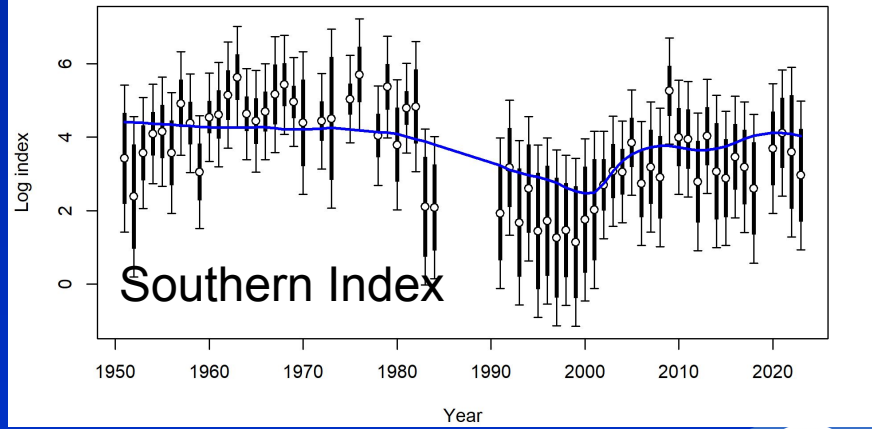


CalCOFI survey: We compared the base model to regional indices (south and central) as well as with index removed (previously shown) and with the extended time series (adding back the years that only had southern data in the coastwide index, such as the 1950s and 1990s). Most changes modest, interesting that the regional indices were both more pessimistic than the bas

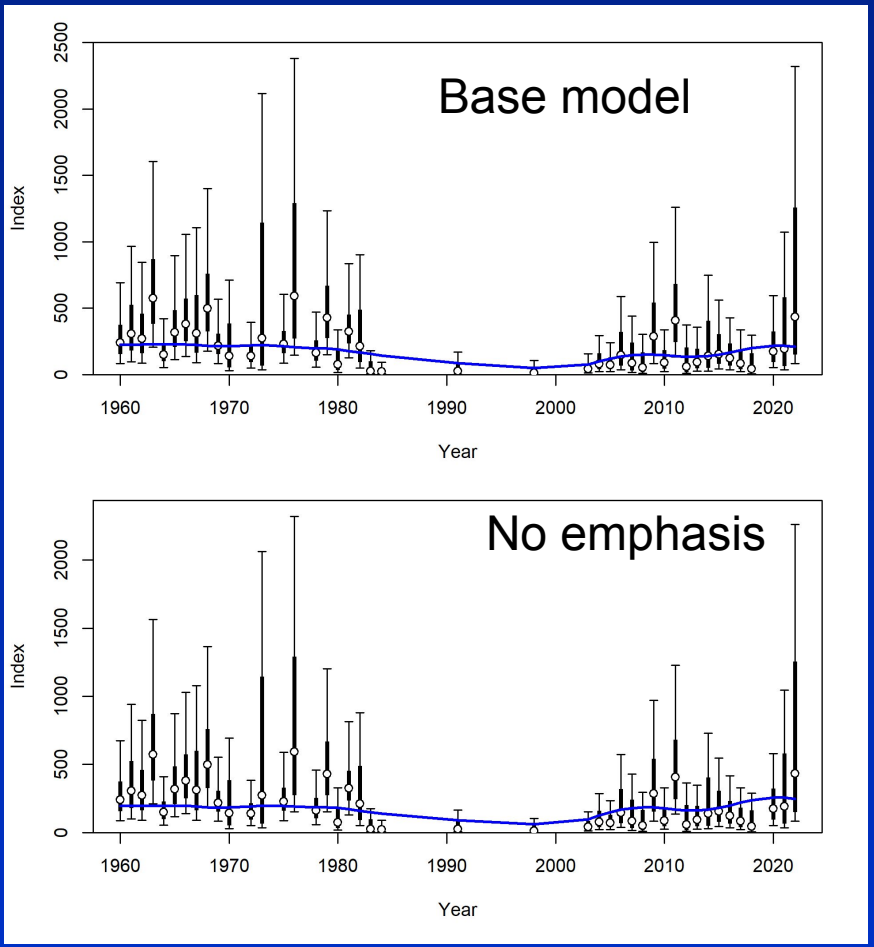


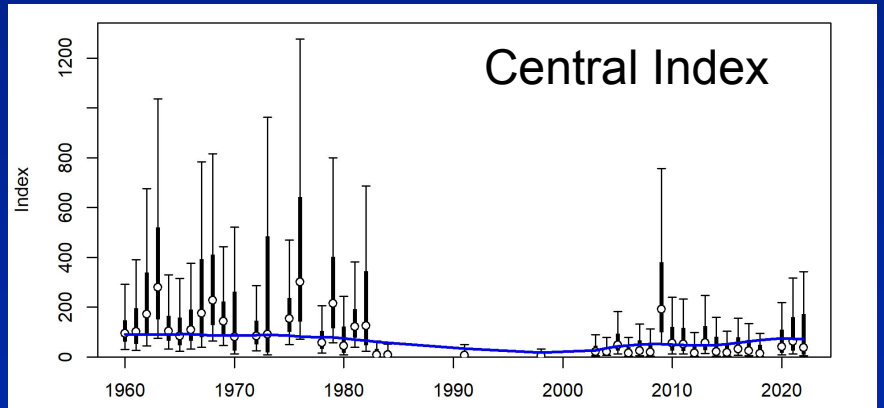


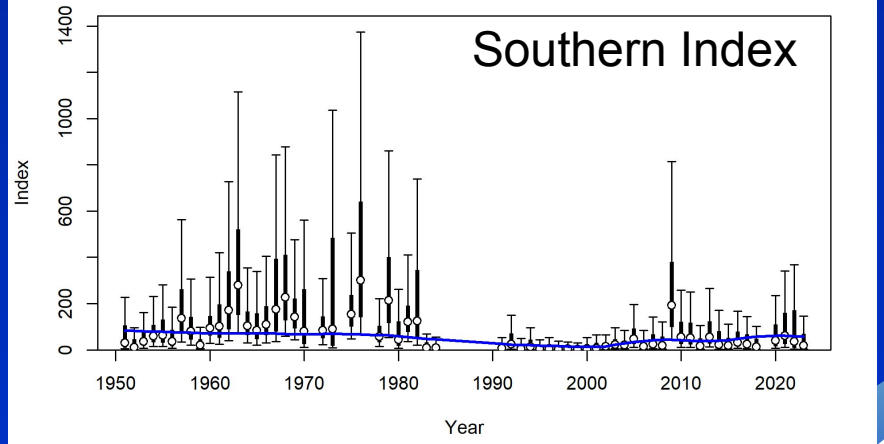




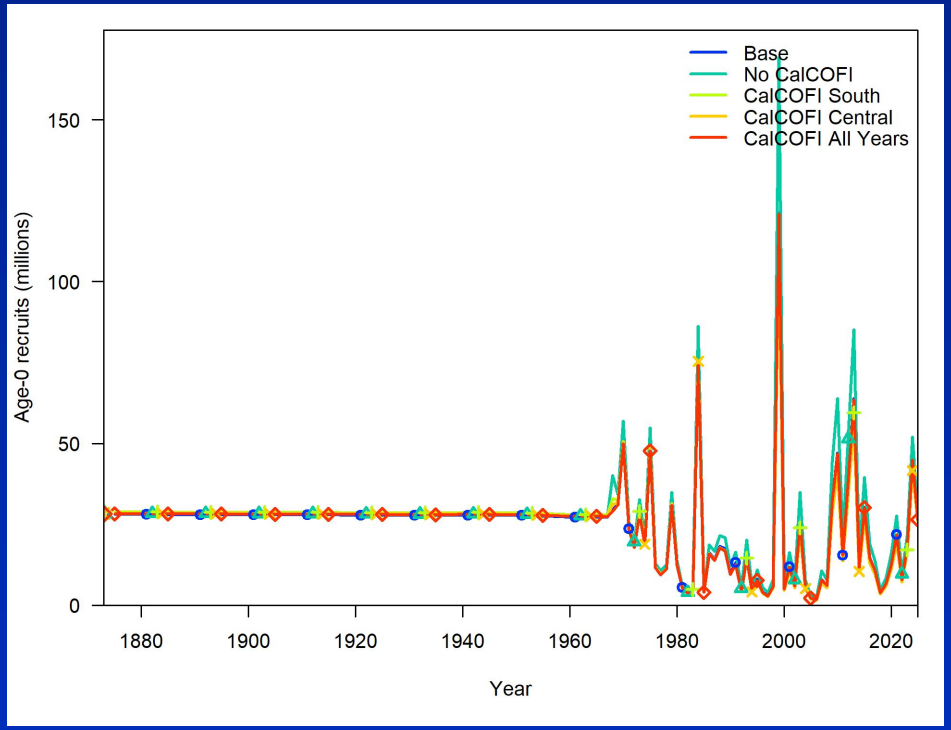
Survey fit comparisons (can't use plotcompare as index changes)

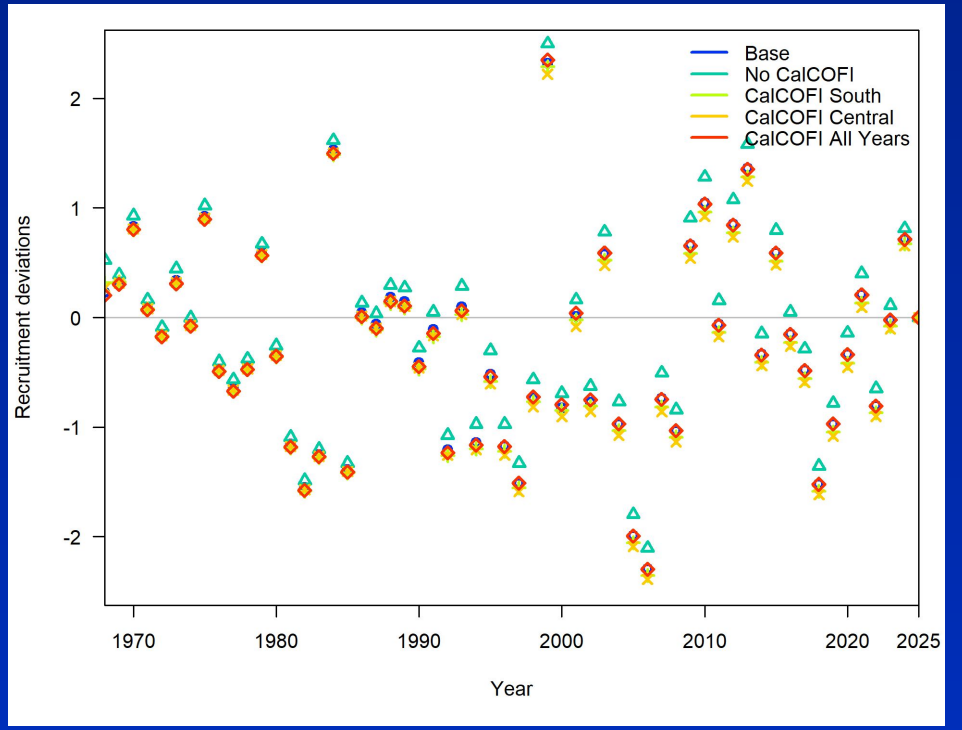




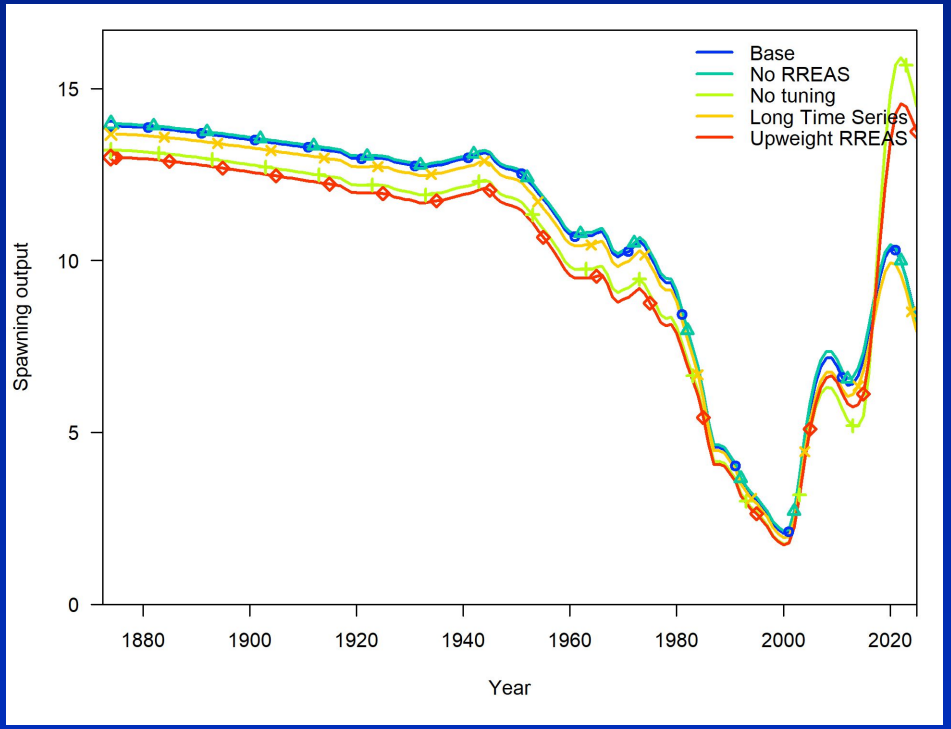


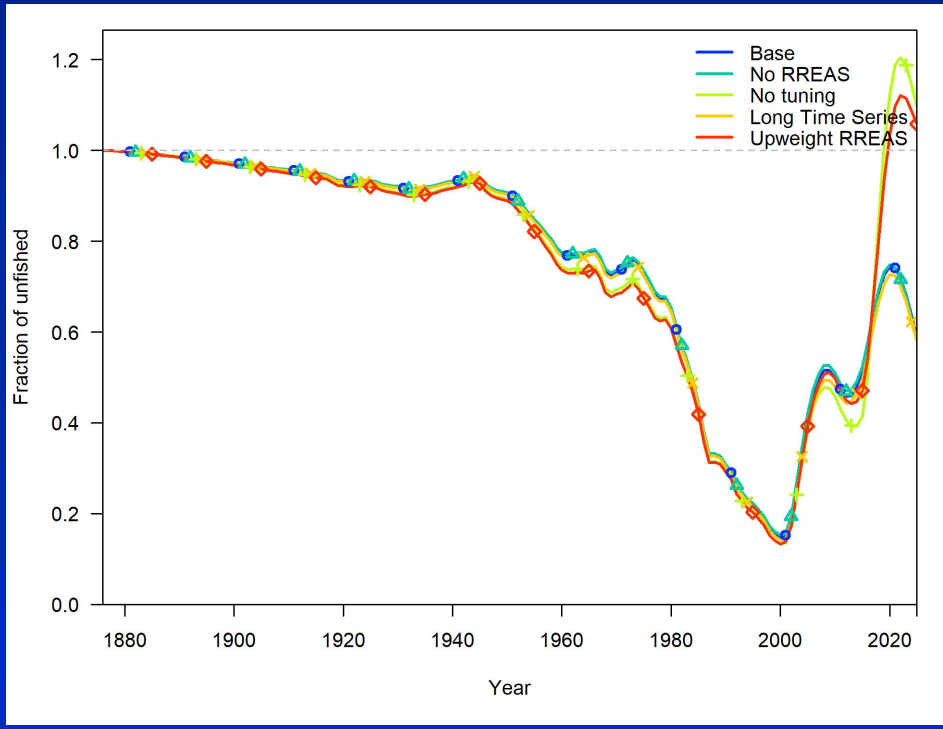
Survey fit comparisons (arithmetic)





So model without CalCOFI data wants to scale up all recruitments, not entirely clear why…

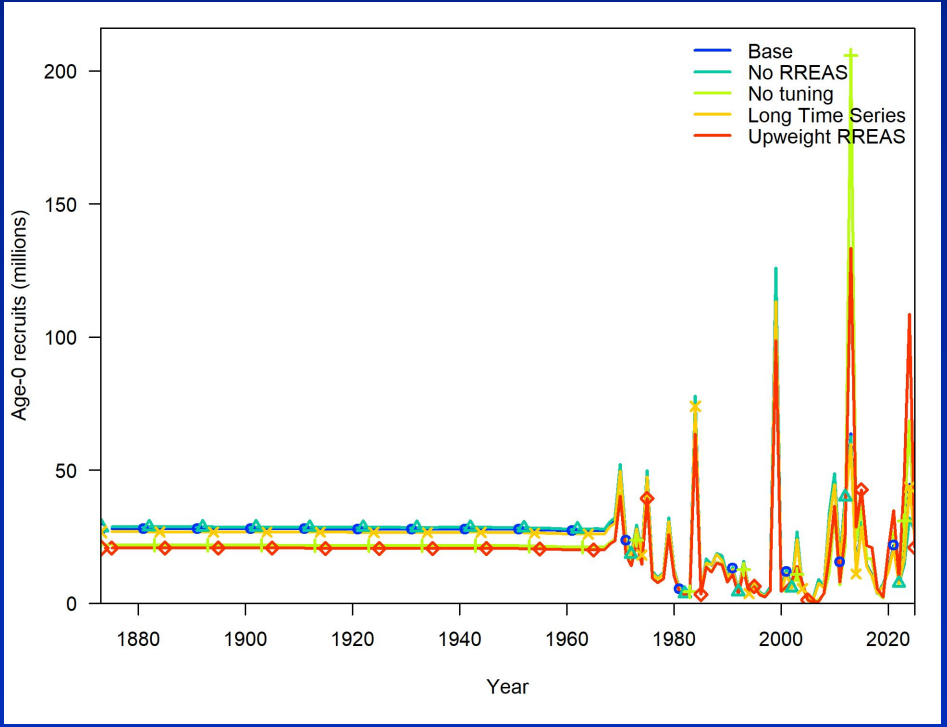


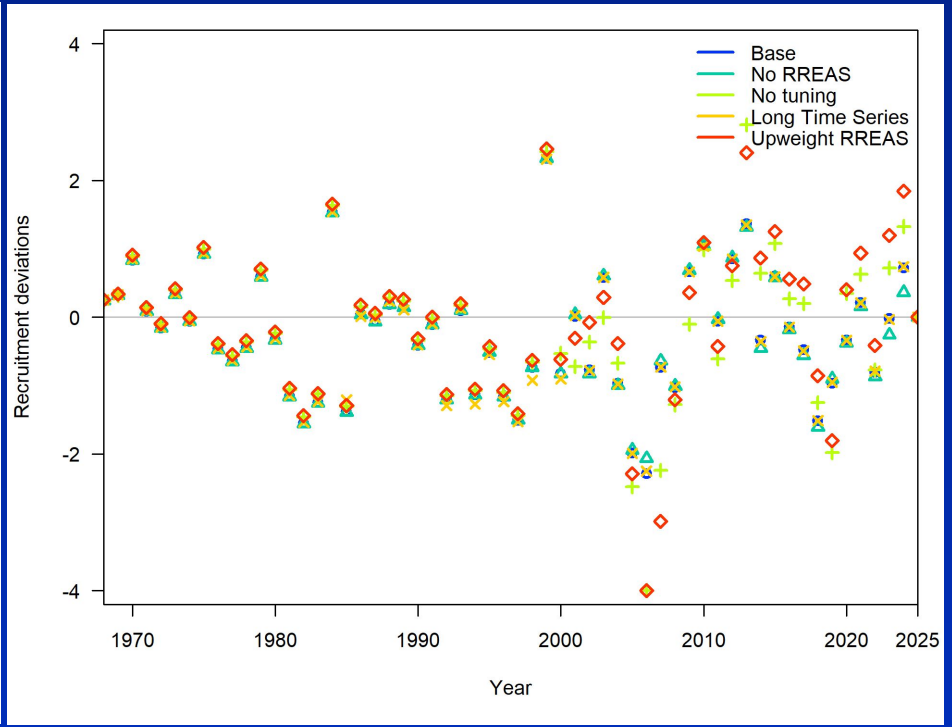


Compared the base model to models in which index was removed, in which index included but tuning was removed (so no added variance), tuning unaltered but index upweighted (lambda=10), the long time series was used (1984-2024).

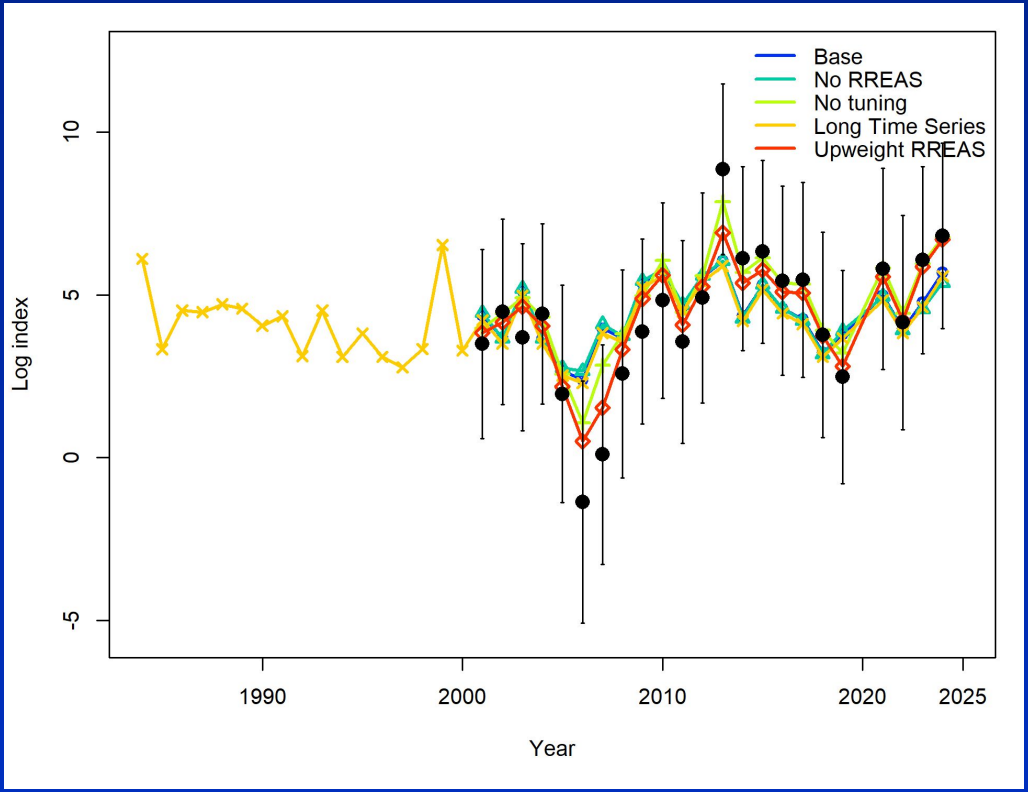
Models that upweight the survey are considerably more optimistic re: stock status!

NOAA FISHERIES



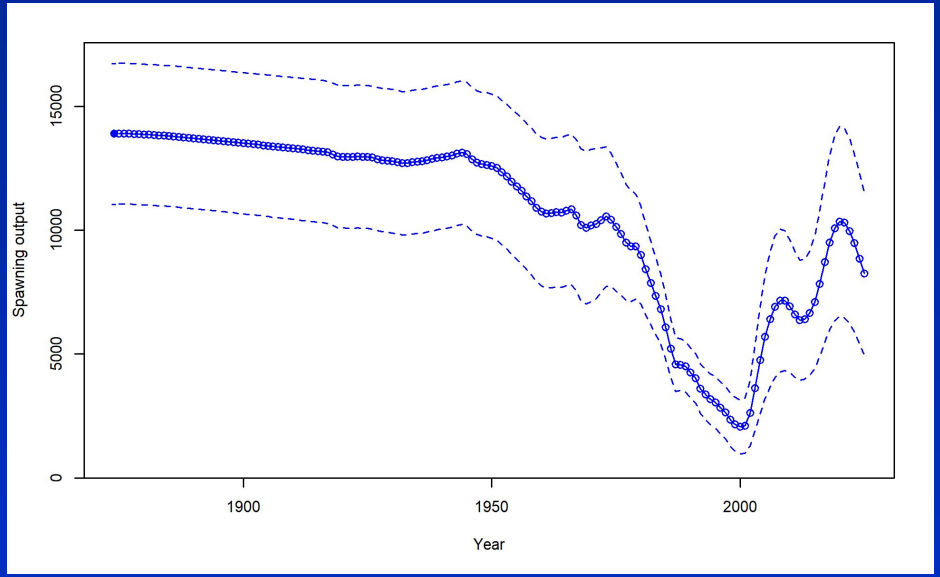


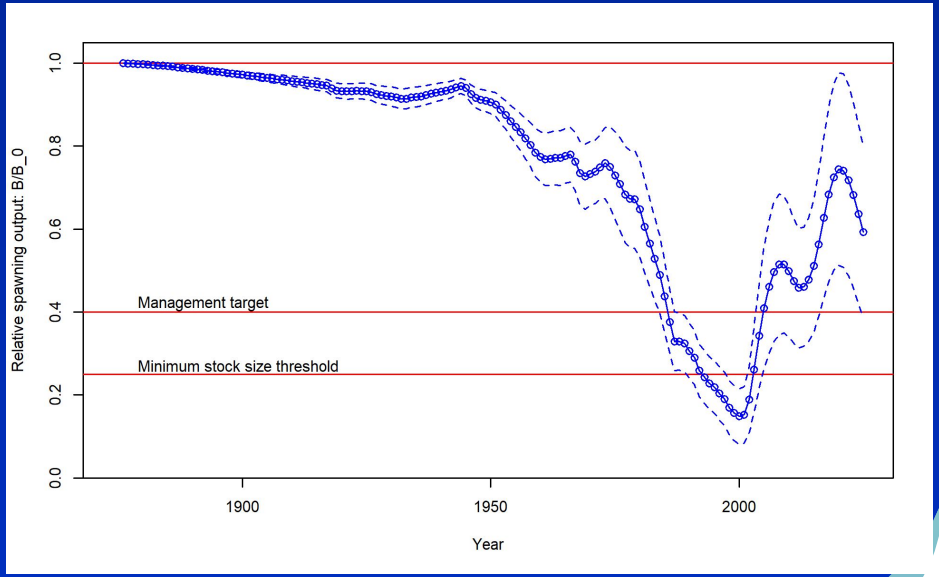
Not tuning or upweighting leads to higher recent recruitments, a number of lower mid 2000s recruitments.



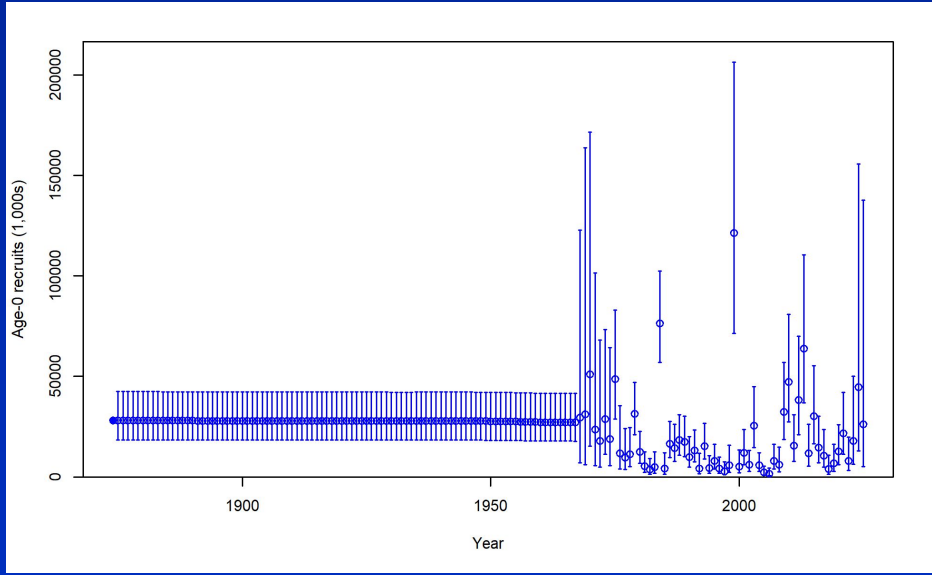
Fits understandably better when upweighted (or not tuned out). Seems that there may be some information in WCGBTS to support above average recruitment as well (given dev above 0 w/out RREAS).

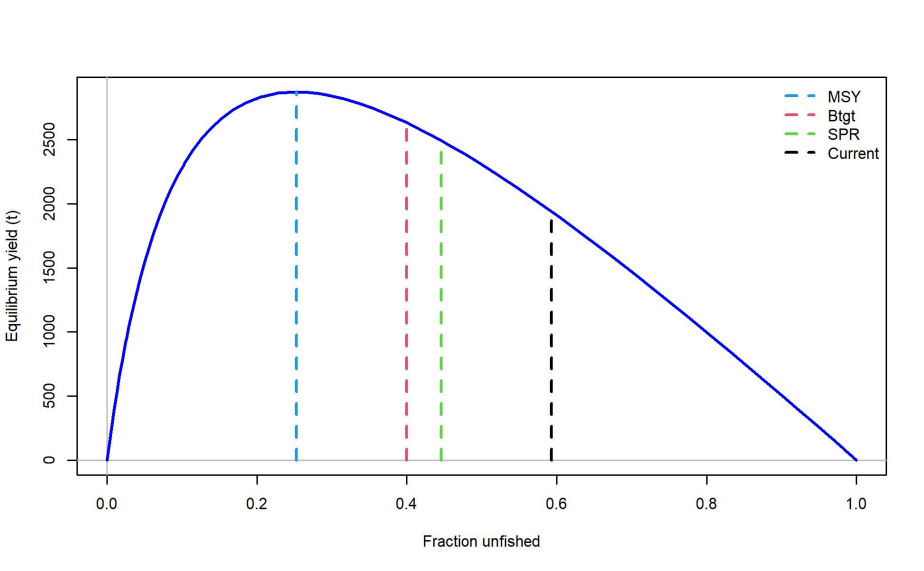
Revised Chilipepper Base Model





Revised Chilipepper Base Model





Shape of yield curve is based on assumption that h = 0.72

Reference Points (revised base model)

Reference Point	Estimate	Lower Interval	Upper Interval
Unfished Spawning Output (billions of eggs)	13,904	11,069	16,738
Unfished Age 3+ Biomass (mt)	58,489	44,932	72,045
Unfished Recruitment (R0, 1000s)	27,998	16,228	39,769
Spawning Output (2025, billions of eggs)	8,246	4,946	11,545
Fraction Unfished (2025)	0.593	0.385	0.801
Reference Points Based SB40%			
Proxy Spawning Output SB40%	5,561	4,428	6,695
SPR Resulting in SB40%	0.458	0.458	0.458
Exploitation Rate Resulting in SB40%	0.090	0.081	0.099
Yield with SPR Based On SB40% (mt)	2,634	1,800	3,468
Reference Points Based on SPR Proxy for MSY			
Proxy Spawning Output (SPR50)	6,203	4,939	7,468
SPR50	0.5	--	--
Exploitation Rate Corresponding to SPR50	0.078	0.070	0.086
Yield with SPR50 at SB SPR (mt)	2,494	1,706	3,281
Reference Points Based on Estimated MSY Values			
Spawning Output at MSY (SB MSY)	3,514	2,807	4,221
SPR MSY	0.325	0.320	0.331
Exploitation Rate Corresponding to SPR MSY	0.140	0.124	0.155
MSY (mt)	2,873	1,953	3,792

2017 Ref. Points

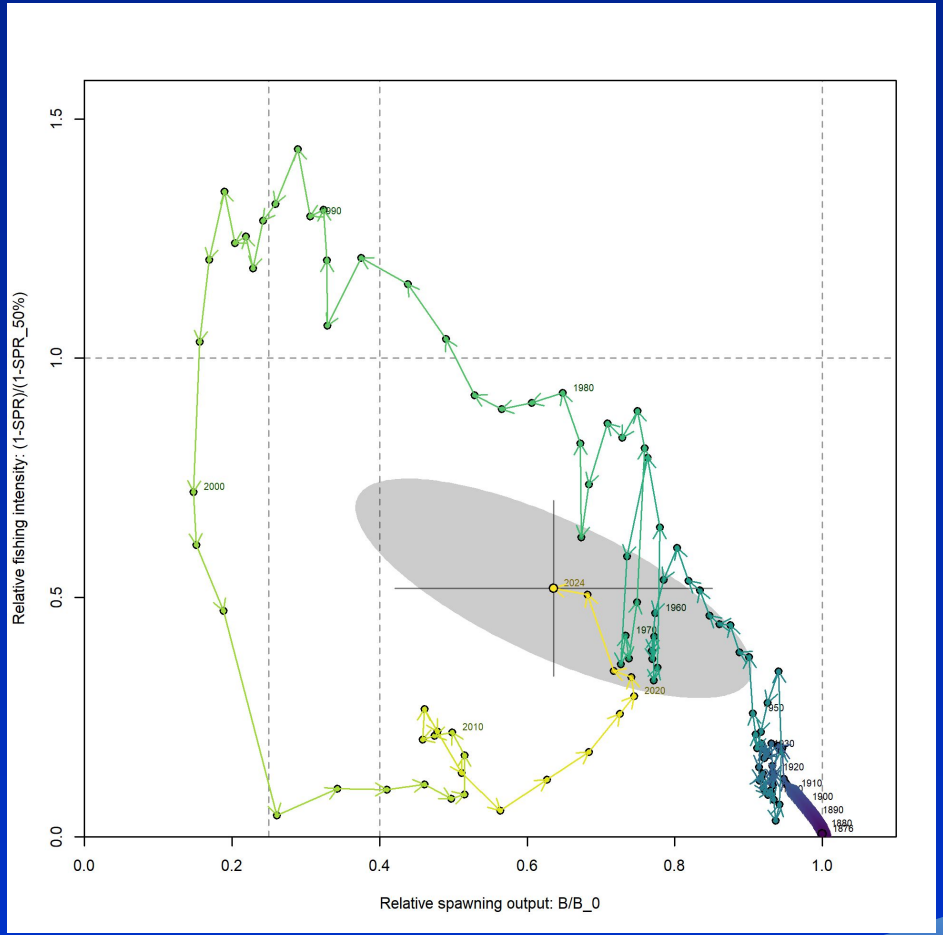
- SSB=billions of larvae
- Resolved W-L issue in current model
- 2017 summary bio = age 1+

	Estimate
SSB_Unfished (millions larvae)	6803
SmryBio_Unfished	51079
Recr_Unfished	40333

	Yield
Btarget	2064
SPR target	2042
MSY	2091

NOAA FISHERIES

Revised base model suggests the stock is above target and not experiencing overfishing

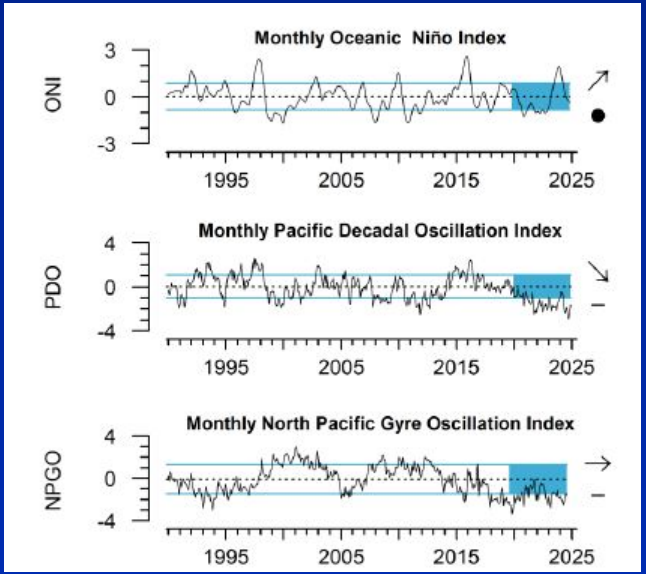


Risk table discussion

(left is description of levels 1, 2, 3; below is draft sablefish table from CCIEA Team Report; Agenda Item H.1.a from Sept. 2024 PFMC Briefing Book)

	Ecosystem and environmental conditions	Assessment data inputs	Assessment model fits and structural uncertainty
Level 1: favorable	Indicators not used in the stock assessment show medium to high level of agreement and moderate to strong evidence supporting high species productivity	Reliable catch reconstruction, informative fishery-independent survey, age and length composition data for landed fish and bycatch for key fleets across a range	Most productivity parameters across multiple processes (recruitment, natural mortality, growth) are estimated internally, minimal evidence for temporally and/or spatially varying
Level 2: neutral	Majority of indicators show no notable trends and/or no apparent environmental and ecosystem concerns	Historical catches with moderate uncertainty, but reliable catches over the last 4+ decades; age and length composition data covering landed catch for fleets that account for the	Moderate fits to data, multiple productivity parameters (recruitment, natural mortality, growth) are estimated internally, possible weak-moderate evidence for temporally and/or
Level 3: unfavorable	Majority of indicators show medium to high level of agreement and moderate to strong evidence supporting low species productivity	Uncertain catch reconstructions both historically and more recently; limited age composition data; maturity and fecundity based on other species and/or regions	Some problematic fits to data, most productivity parameters (recruitment, natural mortality, growth) are fixed or estimated externally, although recruitment deviations are

Ecosystem and environmental conditions	Assessment data inputs	Assessment model fits and structural uncertainty
• Recruitment: 2020-2021 recruitment indicators were positive (environmental conditions, abundance of age-0 sablefish), but have returned to neutral and forecast of El Niño suggests potential downturn • Prey: increasing (krill, juvenile hake) • Predators: no trend • CVA rank: moderate	• Most important: no fishery-dependent ages in final two years of model. These greatly increase the uncertainty in the unprecedented recruitment event. • Informative fishery-independent survey index • Reliable catch reconstruction • Includes sea-level height index of recruitment • Generally well-sampled fishery-dependent age compositions	• Potential for density-dependent decreases in growth from large recruitment event • Evidence of changing length-at-age not captured by model. • Transboundary MSE indicates southern portion of stock may be at risk of overexploitation • Age compositions of older fish not captured well. • Many biological parameters estimated internally
Level 2 (medium agreement, robust evidence)	Level 3	Level 3



- The Oceanic Niño Index (ONI) describes the equatorial El Niño Southern Oscillation (ENSO). An ONI above 0.5°C indicates El Niño conditions, which often lead to lower primary production, weaker upwelling, poleward transport of equatorial waters and species, and more southerly storm tracks in the CCE. An ONI below -0.5°C means La Niña conditions, which influence atmospheric pressure conditions that lead to upwelling-favorable winds that drive productivity in the CCE.

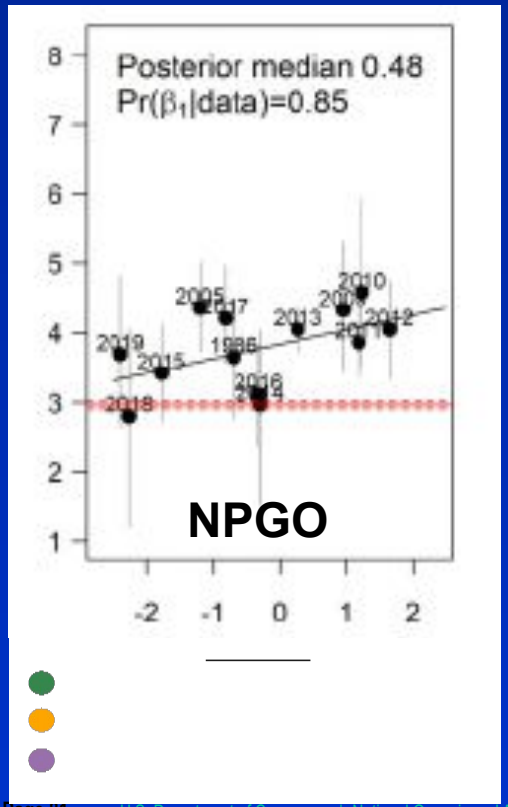
- The Pacific Decadal Oscillation (PDO) describes North Pacific sea surface temperature (SST) anomalies that may persist for many years. Positive PDOs are associated with warmer SST and lower productivity in the CCE, while negative PDOs indicate cooler SST and are associated with higher productivity.

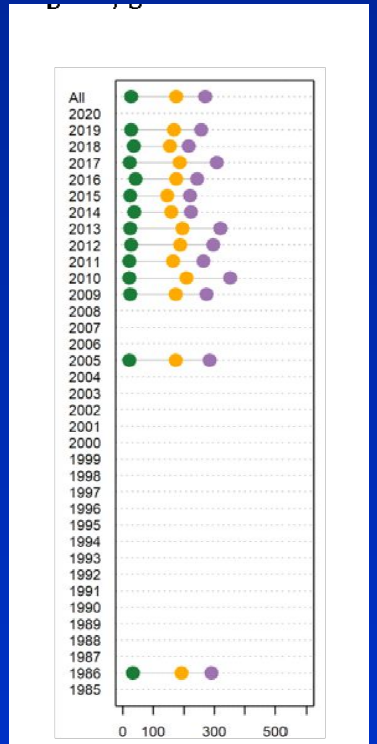
- The North Pacific Gyre Oscillation (NPGO), an index of sea surface height, indicates changes in circulation that affect source waters for the CCE. Positive NPGOs are associated with strong equatorward flow and higher salinity, nutrients, and chlorophyll-a. Negative NPGOs are associated with decreased subarctic source water and lower CCE productivity.

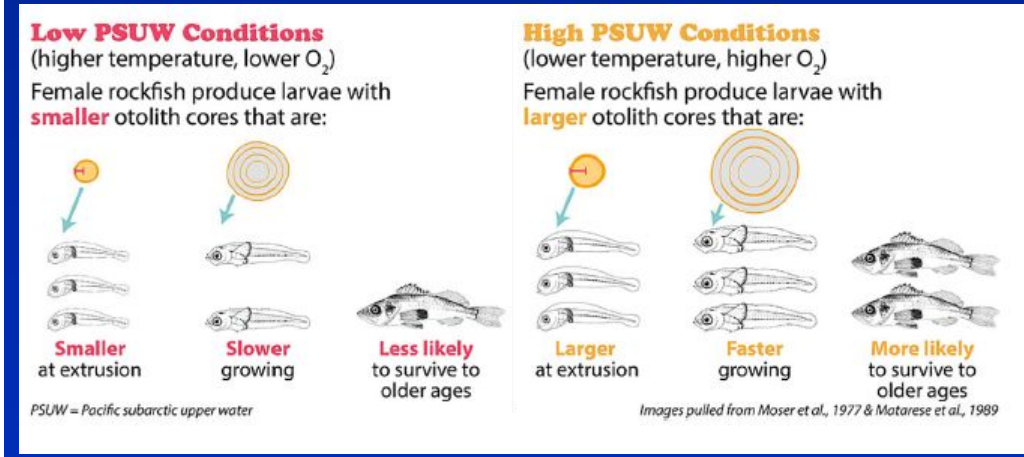
The ONI was positive during the beginning of the year and indicative of El Niño conditions, with a shift towards negative at the end of the year, whereas the PDO and NPGO were negative during the entire year (Fig. 2.1). Although the PDO remained negative for a 5th consecutive year (Fig. 2.1 top), it shifted towards more positive values during the early part of the year, in concert with the El Niño. After reaching relatively neutral values during parts of 2021 and 2022, the NPGO has remained negative since then (Fig. 2.1, bottom), indicating weaker than average general circulation (from 2025 CCIEA Ecosystem Status Report)

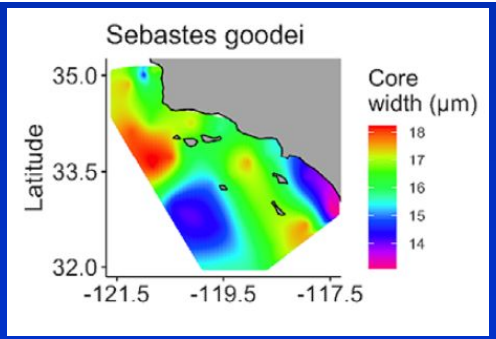
NOAA FISHERIES

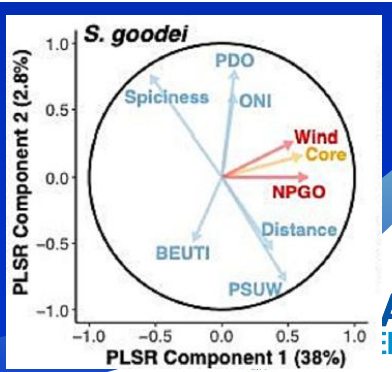
Fecundity and larval condition: Less favorable with negative NPGO (throughout 2024 summer and fall NPGO values negative)

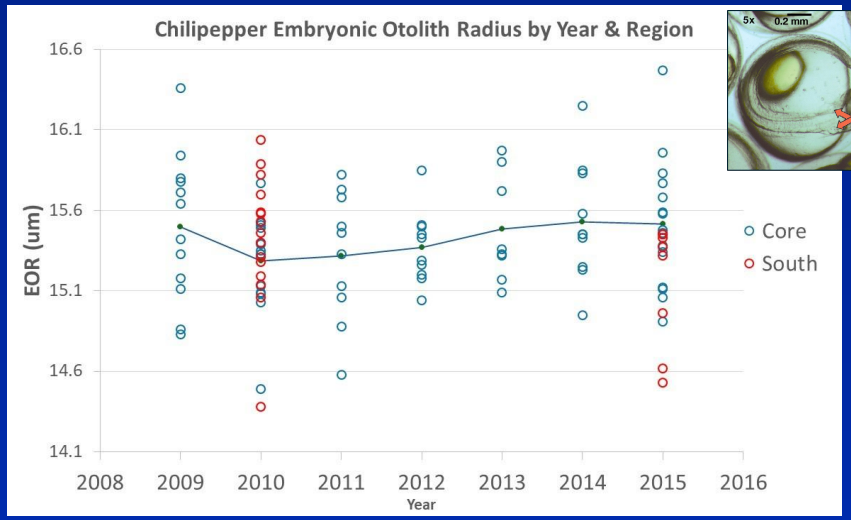


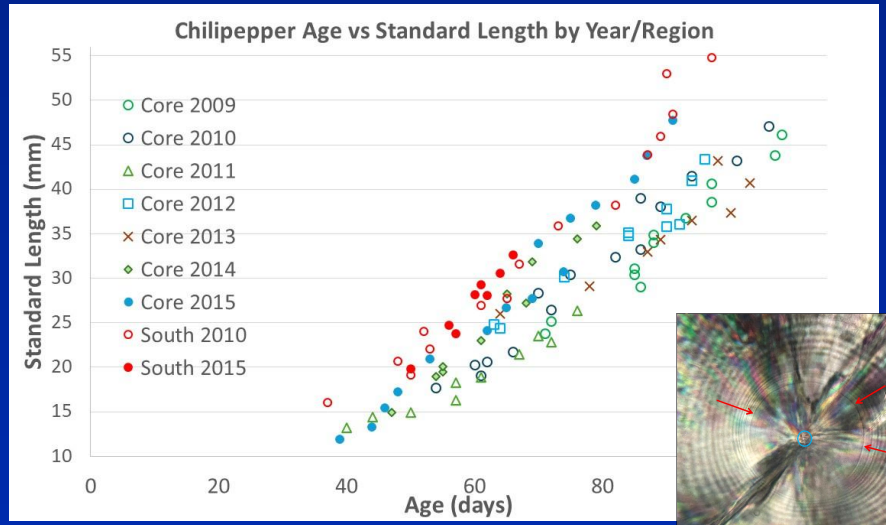


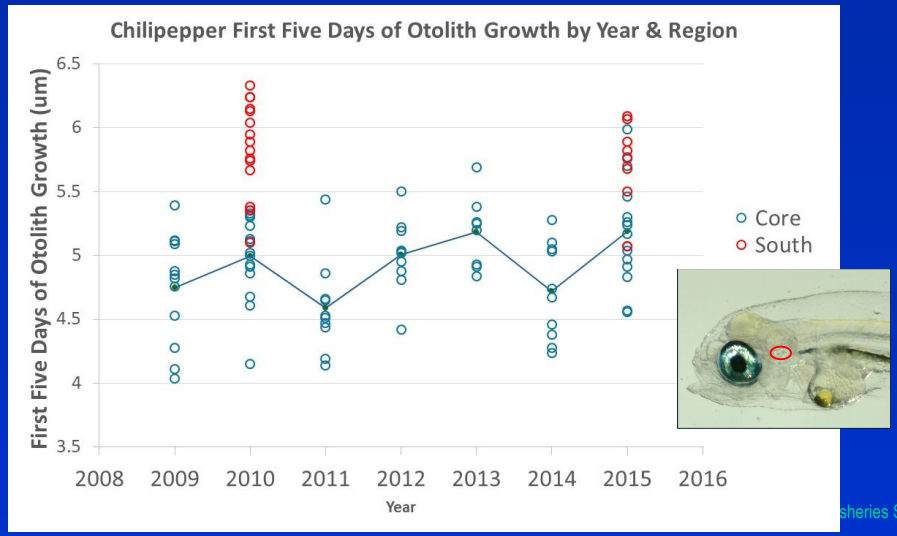








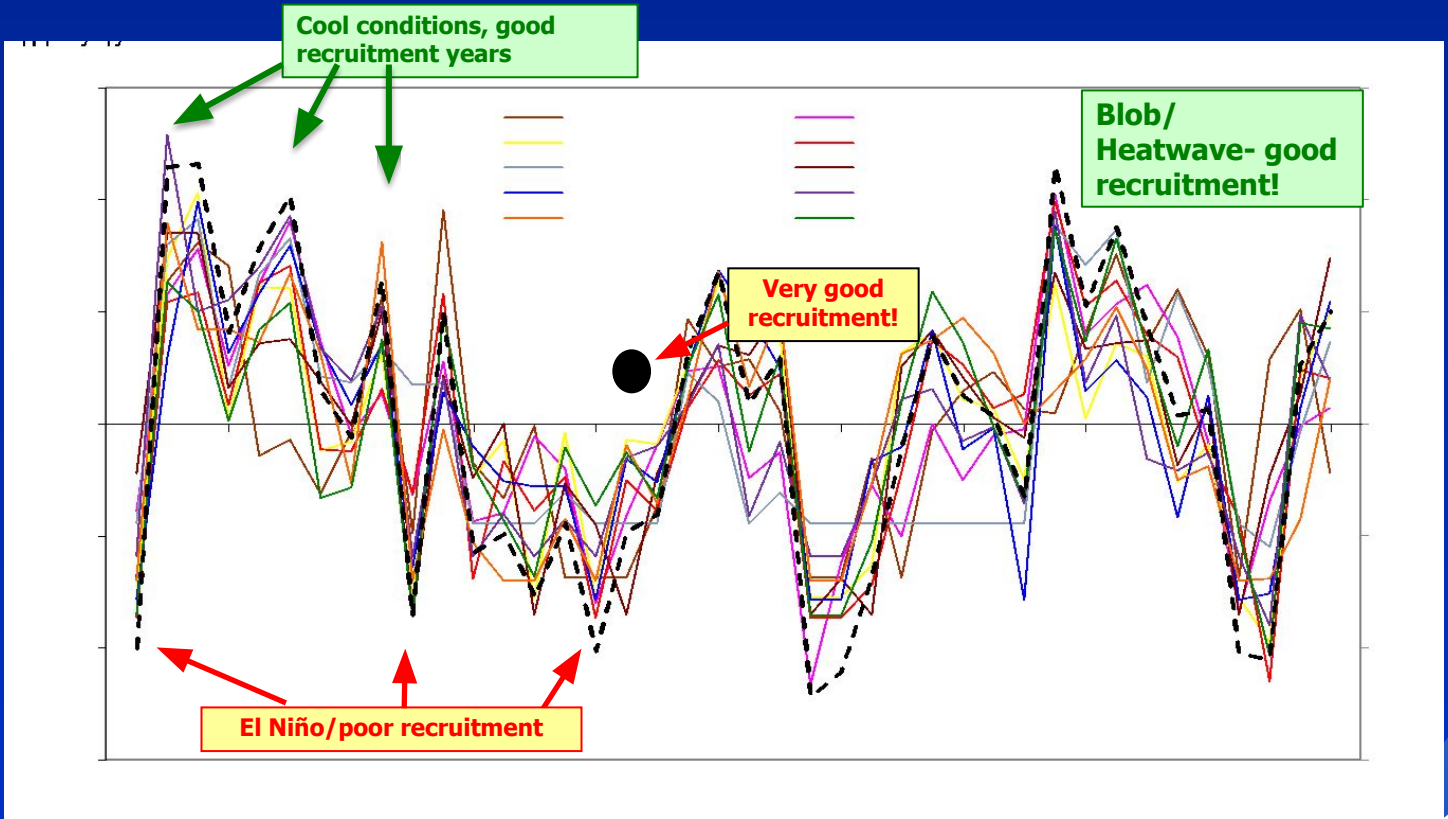




We are early into an effort to compare surviving pelagic YOY rockfish embryonic otolith width, larval growth rates, and juvenile growth rates to both larval characteristics (from Fennie et al. 2024) and ocean conditions. Low variability of larval EOR with no clear relationship to growth, but stronger signals in early larval [illegible] juvenile growth

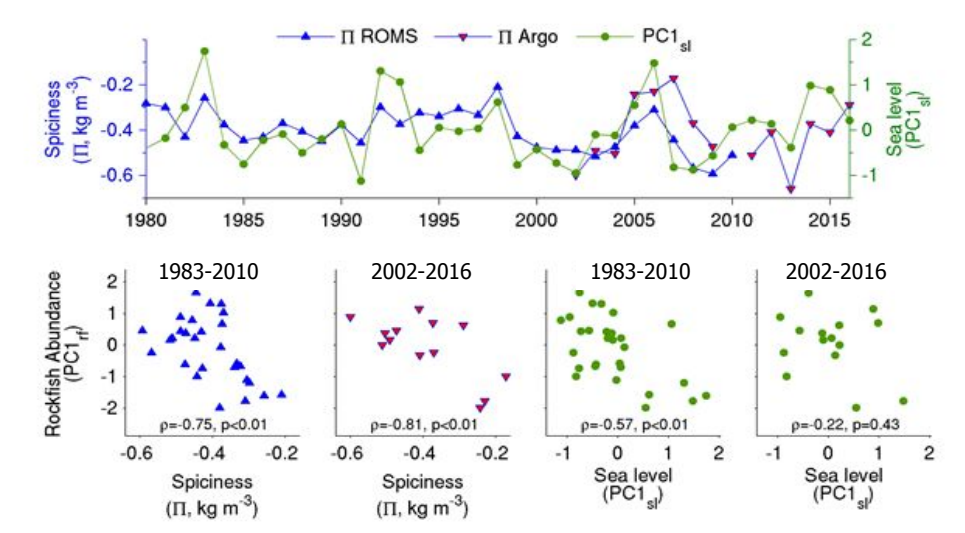
NOAA FISHERIES

Pelagic juvenile abundance has been shown to be strongly related to ocean conditions (Updated from Ralston et al. 2013 and Schroeder et al. 2019)

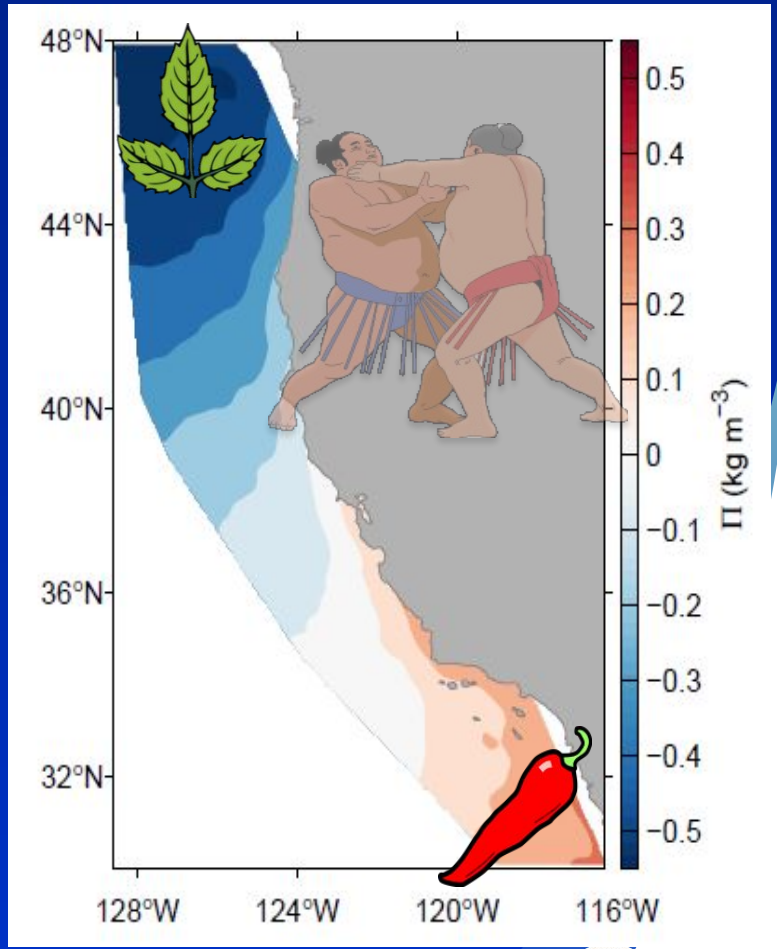


NOAA FISHERIES

Source waters affect recruitment



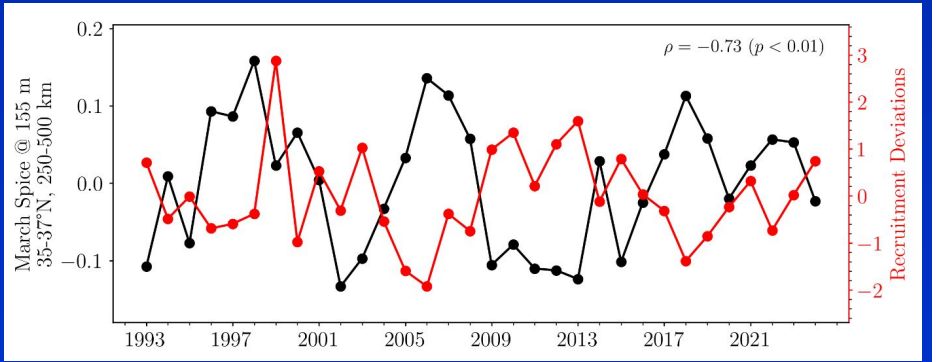
Early results showed strong relationship between YOY rockfish abundance and sea level, where latter has frequently been an indicator of transport and productivity in the California Current (as in sablefish). However, Schroeder et al. (2019) provided the basis for linking recruitment to "spiciness," essentially the mix of "subarctic" versus "equatorial" source waters in the CCS.

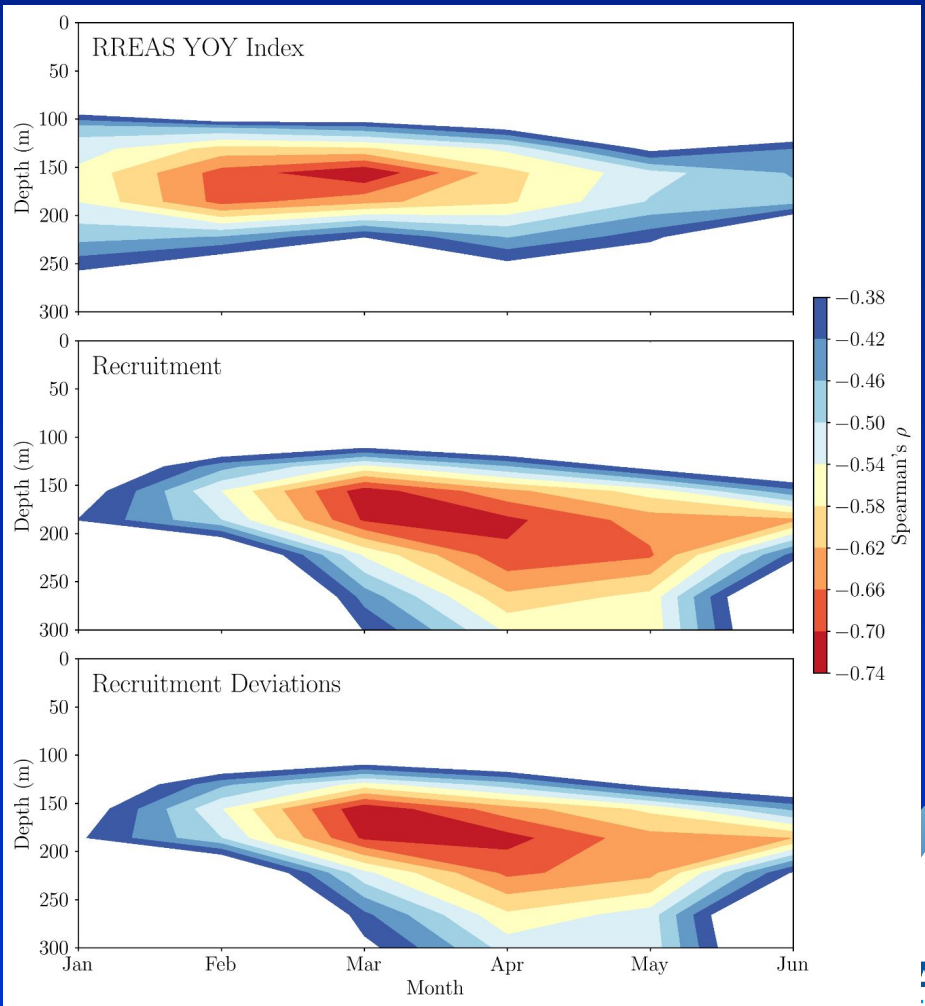


NOAA FISHERIES

RREAS data suggest strong recruitment in 2024, despite mixed indices. For winter and spring of 2025, PDO values have been negative, and subsurface (roughly 150-250 meters depth) waters offshore of central California (35-37° N) have been among “mintiest” (most subarctic) since 2015 (GLORYS12V1 product).

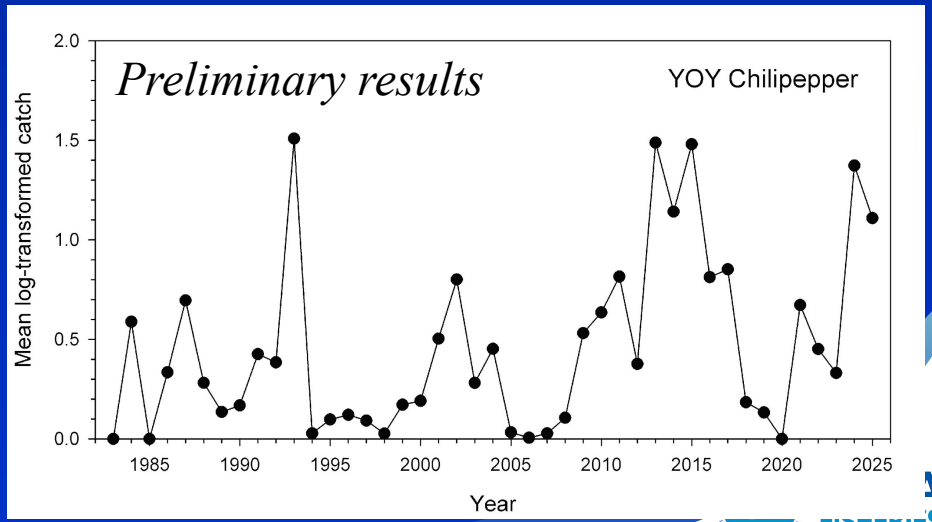
We have found a strong correlation between this index of spiciness with both the recruitment estimates and recruitment deviations estimated in this assessment for the 1993-2024 time period. This would suggest that the 2025 year class should be well above average

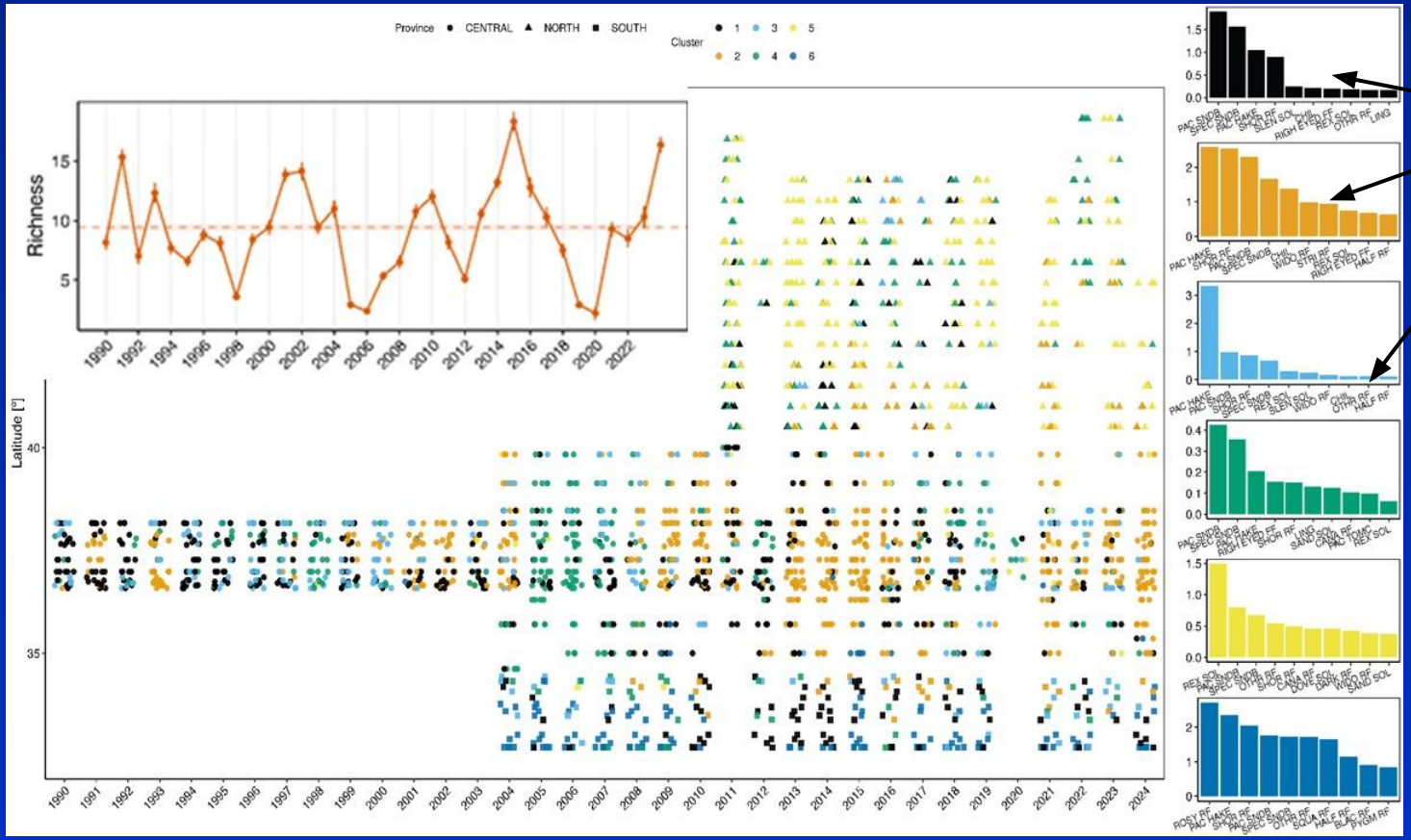




PRELIMINARY data (from the RREAS survey that ended last Saturday) – of raw (not modeled) catch rates (log transformed) would suggest that 2025 pelagic young-of-the-year abundance of chilipepper is comparable to 2024 levels, which are well above average. Fish were larger in 2024 as well.

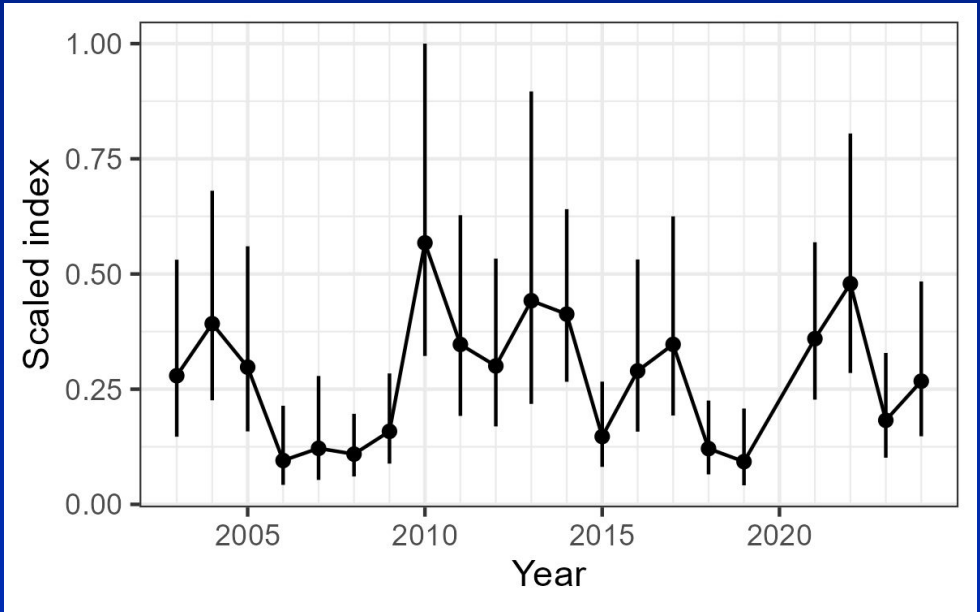


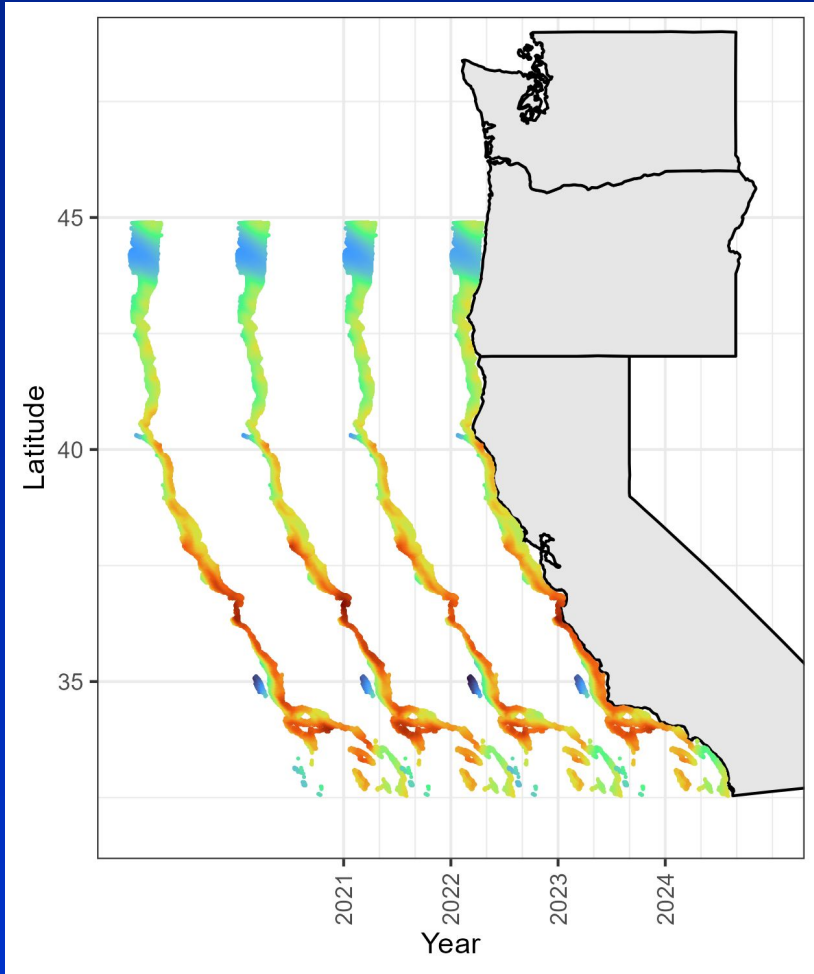




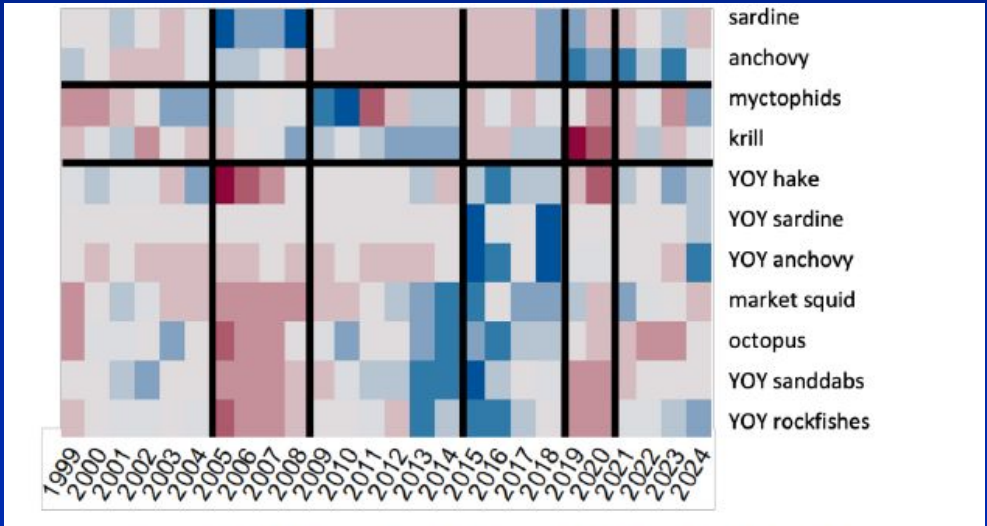


Gasbarro et al. (2024) found that years of high productivity were associated with both high estimates of diversity. Updating the model through 2024 indicated that the abundance and diversity of groundfish was higher than it had been since the peak abundance levels of 2015, and that this high abundance was associated with greater species richness and diversity. 2025 qualitatively diverse…





Settled age 0-1 chilipepper from WCGBTS (N. Tolimieri), catch rates for fish 16 cm and smaller, which should be all age 0, most age 1 fish (N. Tolimieri, NWFSC), recent years on the right. Not clear signs of strong incoming recruitment, but certainly no signs of low..









(Lingcod w/ yelloweye, inaturalist:https://www.inaturalist.org/posts/12101-observation-of-the-week-10-13-17)

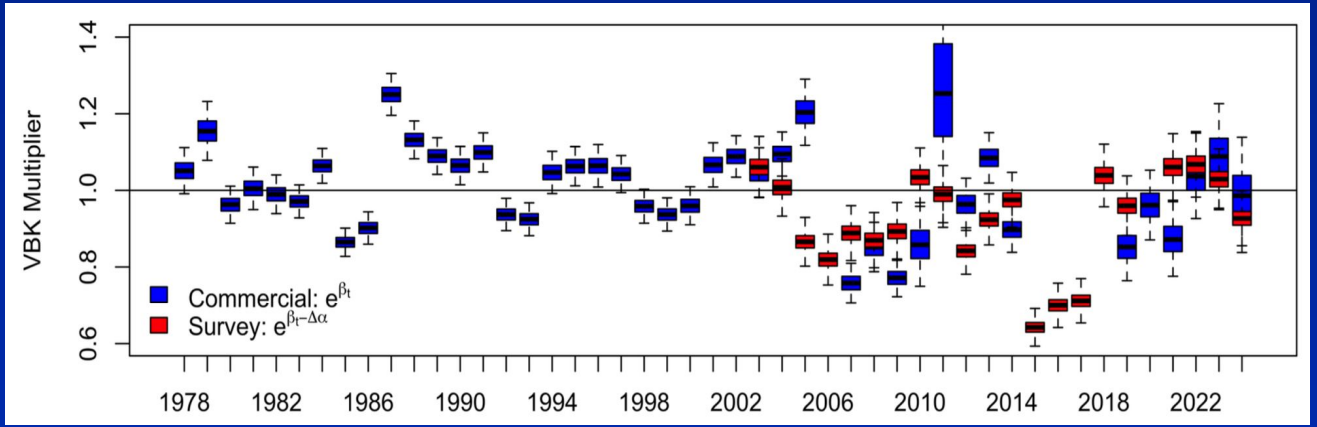
Forage conditions in 2024 and presently should be good for a mid-shelf omnivore; krill above mean levels (likely well above for 2025), most forage fishes above mean levels (YOY hake and rockfish, anchovy, myctophids). Forage conditions should be favorable.

Predators: many piscivorous fishes increasing (e.g., bocaccio, lingcod), CA sea lions, other marine mammals increasing or stable, few changing at rapid rates. Neutral overall? Had Humboldt squid been around still, could have been a basis for unfavorable conditions as a result of predation…!

NOAA FISHERIES

Time-varying growth rigorously evaluated. Indicates that periods of above and below average growth varied throughout the 1980s and 1990s, and growth conditions were poor between approximately 2005 and 2009, and again between 2015 and 2017 (latter period of the large marine heatwave).

Recent years close to average, but autocorrelation could suggest that a period of low growth may be observed in the relatively near future.



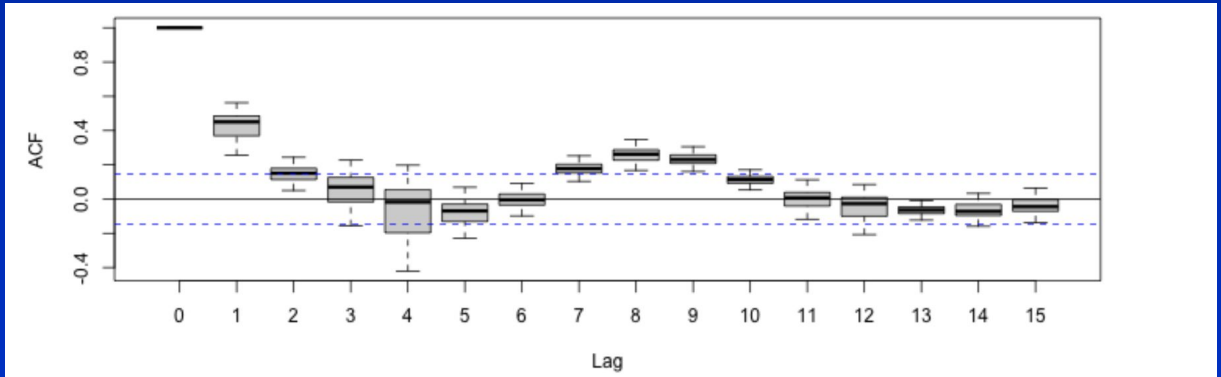


Figure 5: The grey boxplots represent the autocorrelation function as applied to the posterior draws of the combined index (whiskers represent an approximate 2σ interval). The blue dashed lines represent the asymptotic 2σ interval around the classical null hypothesis of 0 autocorrelation.

NOAA FISHERIES

Draft Risk Table for chilipepper

Ecosystem and environmental conditions	Assessment data inputs	Assessment model fits and structural uncertainty
Larval production and condition: Based on 2024- 2025 NPGO, neutral to unfavorable. Recruitment: 2024 pelagic YOY abundance high (index in model), diverse pelagic YOY groundfish community (not in model). 2025 environmental conditions are favorable (minty/subarctic), as are preliminary RREAS catches (not in model). Overall, favorable indicators for recruitment. Prey: Most evidence suggests abundant forage, favorable conditions, positive. Predators: Ongoing long-term increases in abundance, but no evidence of recent sharp increases, neutral. Growth: Neutral (recent years) to potentially unfavorable in near term (based on autocorrelation in growth variability).	Historically and currently among most important commercial species in California, catch reconstruction and recent catch data are reliable Robust age data to inform assessment, good fits to age and length composition data. Modest aging error concerns need resolution Robust information on reproductive ecology, but some uncertainty in role of multiple brooding Long term time series (CalCOFI) is noisy but provides a "low frequency" signal, WCGBTS index is reasonably well fit in most years Index of pelagic juvenile abundance provides information on incoming recruitment	TO BE COMPLETED FOLLOWING THE STAR PANEL
Level 1	Level 1	

