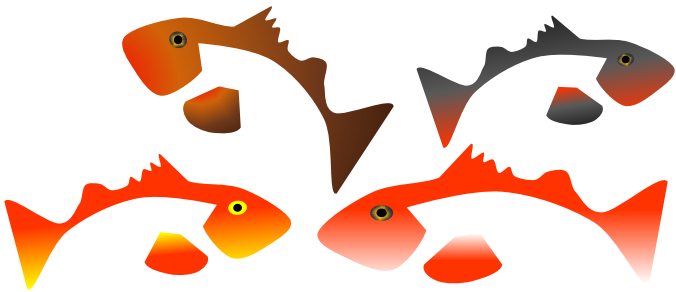
Evaluation and analysis of the Gulf of Alaska Pacific Ocean Perch stock assessment



Goal is to address some of the PT/SSC comments that have accumulated over the last several years, these include:

- *The Plan Team recommends evaluation of how the data weights given to the various fishery and survey age and length composition data affect the estimates of recruitment and age composition.* (Plan Team, September 2014)

- *Many assessments are currently exploring ways to improve model performance by re-weighting historic survey data. The SSC encourages the authors and PTs to refer to the forthcoming CAPAM data-weighting workshop report.* (SSC, December 2015)

- *The SSC recommends that the Gulf of Alaska Groundfish Plan Team (GOA GPT), BSAI GPT, and CPT encourage the continued use of multiple approaches to data weighting (not just the Francis (2011) method, but also including the harmonic mean and others).* (SSC, October 2016)

- *The Team recommends increasing the plus group for the length compositions to evaluate model performance.* (Plan Team, November 2015)

- *In September (2014), the PT and SSC recommended evaluating data weighting for fishery and survey age and length compositions with respect to estimates of recruitment and age compositions. The authors note that this issue pertains to all GOA rockfish assessments and plan to do a more thorough evaluation of this issue for future assessments. The SSC agrees and would recommend a broader look at the issue across all GOA rockfish species, and to consider relevant recommendations from the 2015 CAPAM workshop on data weighting. Further, the SSC concurs with the PT recommendations for the next full POP assessment to investigate 1) increasing the plus group for length compositions to evaluate model performance, 2) using an alternate trawl survey index, 3) using alternative length bins, 4) including sample sizes for composition data, and 5) relating fishery selectivity to average depth fished.* (SSC, December 2015)

4 categories of analysis to begin to address these comments:

1. Length bin/plus group analysis
2. Input sample size analysis
3. Fishery selectivity
4. VAST/GLMM alternative trawl survey index

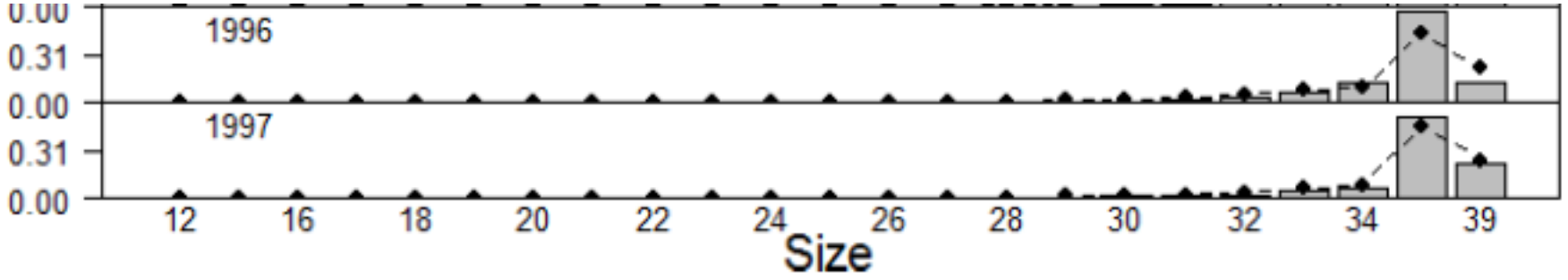
Statistics of model performance:

- RMSE of model fit to data
- Estimates of spawning biomass (and CV), estimates of recruitment from 1961-2015
- % difference compared to the 2015 assessment model for key parameter estimates ($F_{40\%}$, q, M, σ_r, and ln$R$).

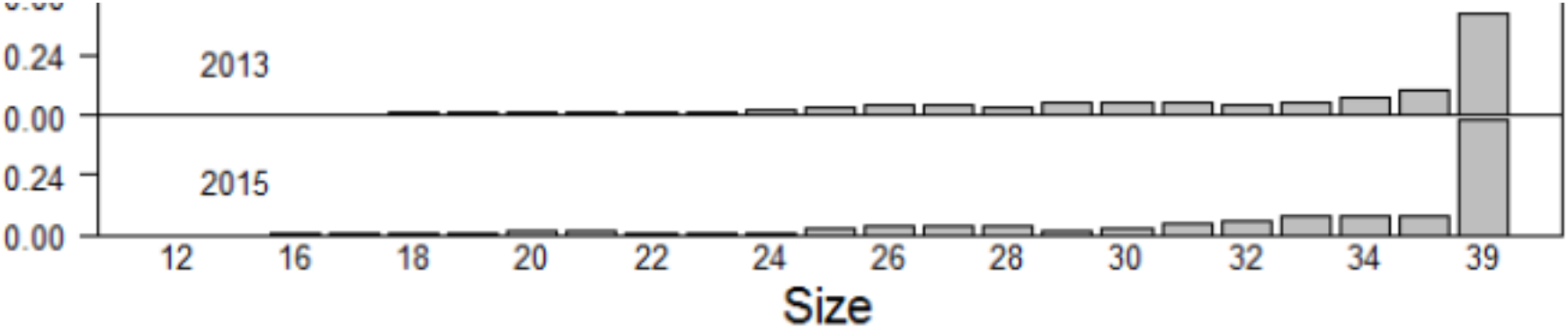
1. Length bin/plus group analysis

- Current bins: ≤12 cm, 13-15 cm, 16-34 cm in 1 cm increments, 35-38 cm, and ≥39 cm (have been used since inception of model)

Fishery length comps



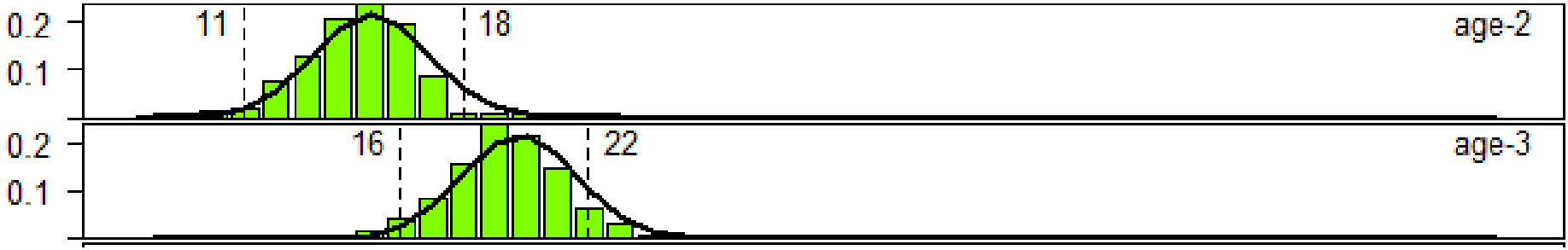
Survey length comps



1. Length bin/plus group analysis

- PT/SSC request was to evaluate bin structure and plus length group

Step 1: Figure out starting bin

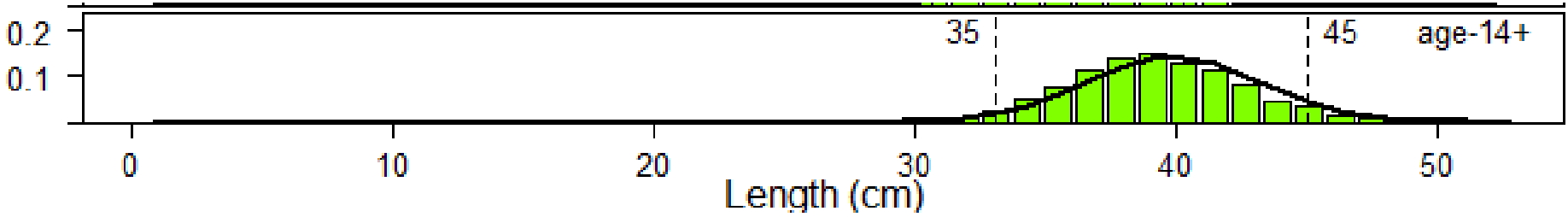


- Current starting bin ≤12 cm, recruitment age for model age-2
  - Virtually no age 2 observed less than 11 cm, majority of age-2 ≤12 cm
  - BSAI POP starting bin ≤15 cm, recommend GOA POP starting bin ≤16 cm (cutoff ≥10 cm)

1. Length bin/plus group analysis

- Request was to evaluate bin structure and plus length group

Step 2: Figure out alternative plus length group



- Current plus group ≥39 cm (same for BSAI POP)
  - 45 cm upper 95% length for pooled ages ≥14
  - Recommend ≥45 cm for alternative plus length group

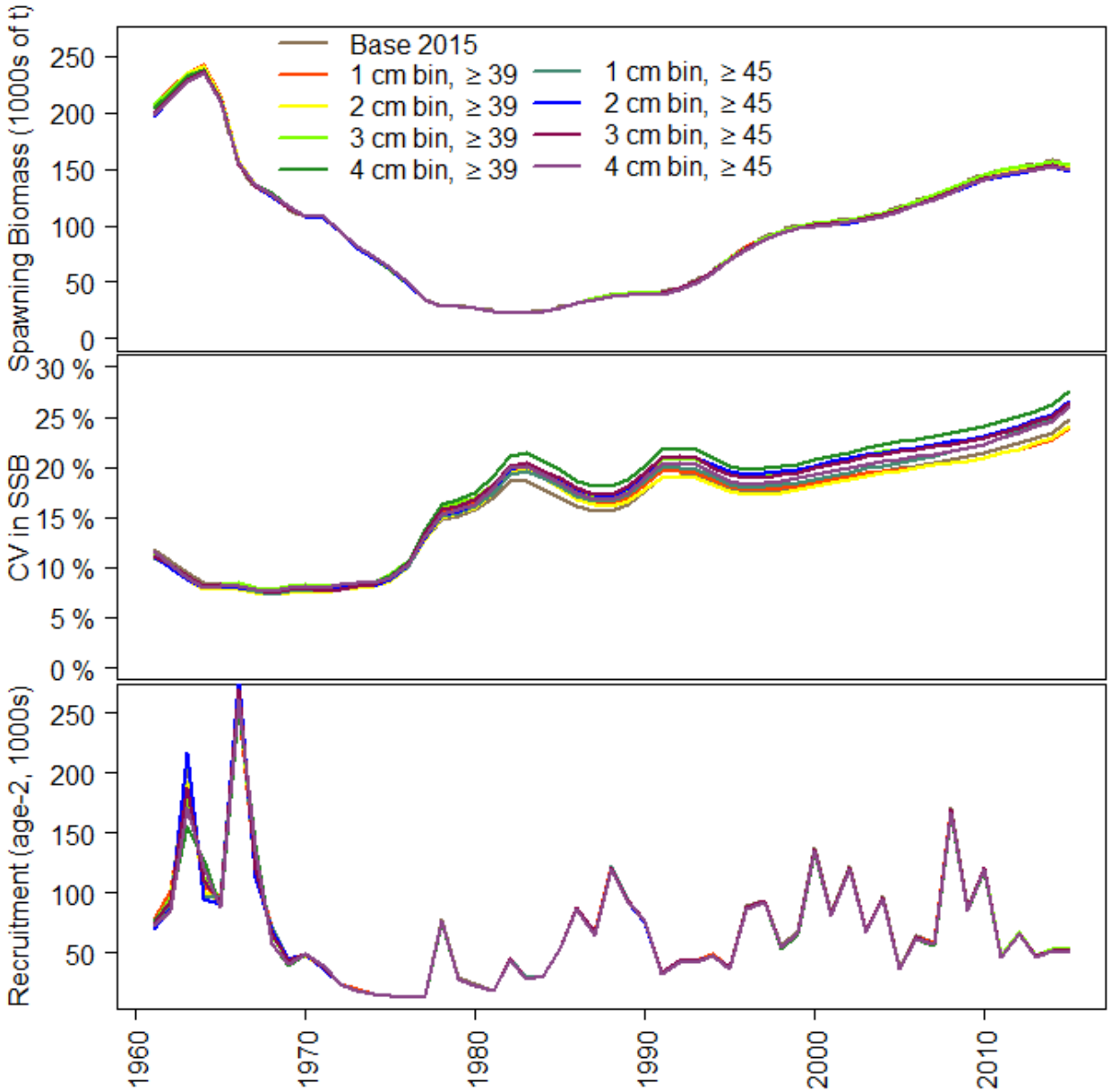
Step 3: Figure out alternative bin structure

- Investigate 1, 2, 3, and 4 cm bins

1. Length bin/plus group analysis

RMSE		Trawl survey biomass	Fishery age composition	Survey age composition
Base 2015		0.31781	0.01618	0.02004
≥39	1 cm bin	0.31737	0.01621	0.01998
	2 cm bin	0.31735	0.01619	0.01997
	3 cm bin	0.31751	0.01617	0.02000
	4 cm bin	0.31693	0.01617	0.01994
≥45	1 cm bin	0.31684	0.01617	0.01995
	2 cm bin	0.31688	0.01616	0.01995
	3 cm bin	0.31698	0.01615	0.01995
	4 cm bin	0.31709	0.01615	0.01993

1. Length bin/plus group analysis



1. Length bin/plus group analysis

% difference		$F_{40\%}$	q	M	σ_r	lnR
Base 2015		0.102	1.95	0.061	0.877	3.97
≥39	1 cm	-0.3%	1.0%	-0.2%	0.1%	-0.1%
	2 cm	-0.5%	1.5%	-0.5%	0.2%	-0.3%
	3 cm	-0.7%	0.9%	-0.6%	0.0%	-0.2%
	4 cm	-1.1%	3.2%	-1.0%	0.7%	-0.8%
≥45	1 cm	0.6%	3.4%	1.7%	1.4%	-0.7%
	2 cm	0.3%	3.7%	1.4%	1.4%	-0.8%
	3 cm	0.0%	2.7%	1.0%	1.0%	-0.6%
	4 cm	-0.7%	3.5%	0.3%	1.2%	-1.0%

1. Length bin/plus group analysis

- Overall, no smoking gun pointing to ‘best’ bin or plus group
- In terms of code, any one of these alternatives is easier than current
- Recommendations for November?

2. Input sample size analysis

- Current input sample sizes:
  - square root of sample size for age comps
  - number of hauls scaled to a maximum of 100 for fishery length comps

- PT/SSC request was to evaluate alternatives to current input sample sizes

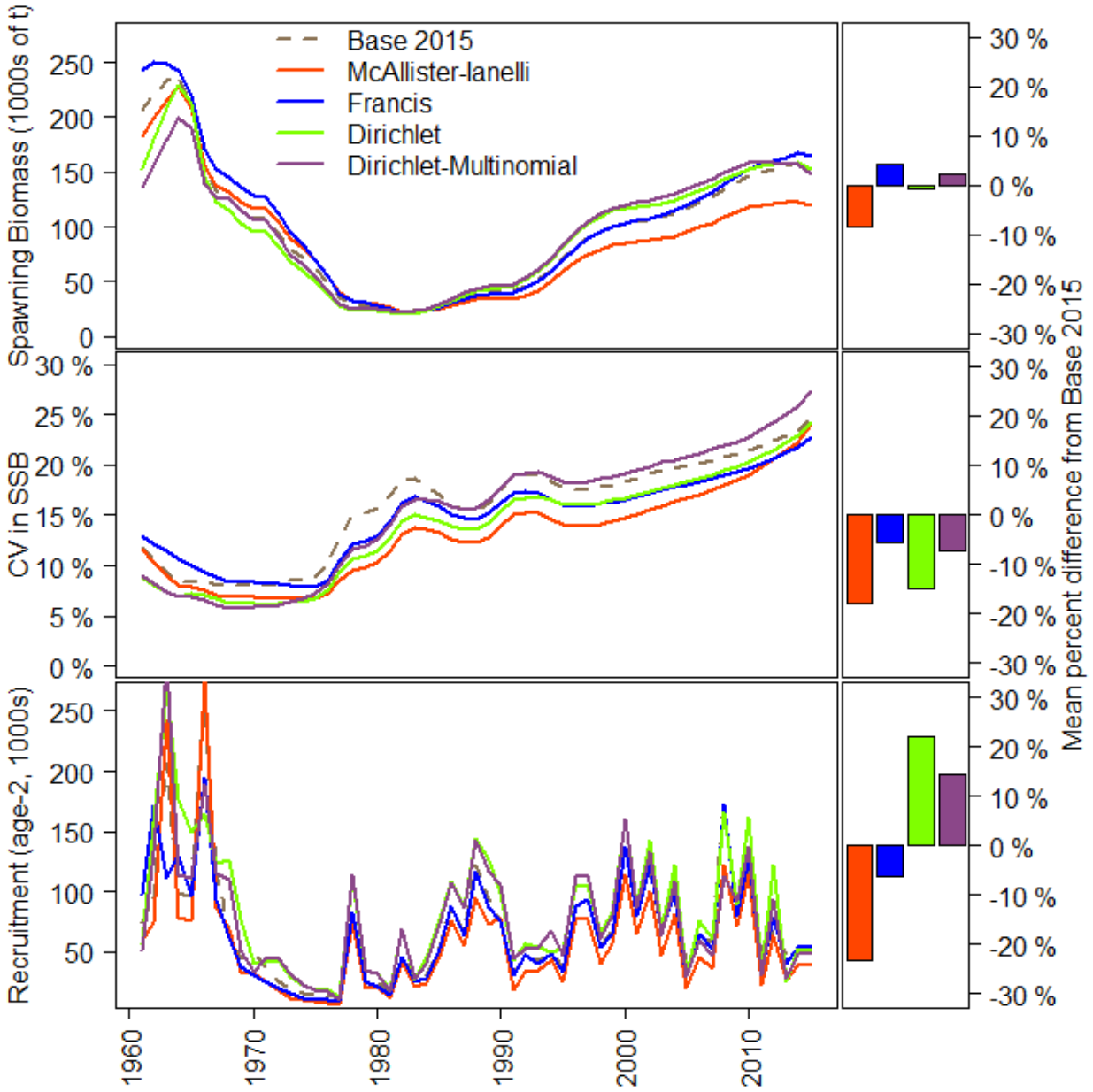
- 2 methods for estimating input sample size investigated:
  - Iterative estimation:
    - McAllister-Ianelli
    - Francis (TA1.8)
  - Parameter estimation
    - Dirichlet
    - Dirichlet-Multinomial

2. Input sample size analysis

Ratio of mean input ss	Base 2015	McAllister-Ianelli	Francis	Dirichlet	Dirichlet-Multinomial
Fishery age	1.00	7.13	1.75	4.70	6.60
Survey age	1.00	3.45	2.57	4.06	4.08
Fishery length	1.00	1.25	0.49	2.85	4.73

RMSE		Trawl survey biomass	Fishery age composition	Survey age composition	Fishery size composition
Base 2015		**0.3178**	0.0162	0.0200	0.0254
Iterated	McAllister-Ianelli	0.3224	**0.0150**	0.0190	0.0265
Iterated	Francis	0.3213	0.0162	**0.0184**	0.0297
Estimated	Dirichlet	0.3248	0.0176	0.0198	**0.0250**
Estimated	Dirichlet-Multinomial	0.3415	0.0172	0.0199	0.0260

2. Input sample size analysis



2. Input sample size analysis

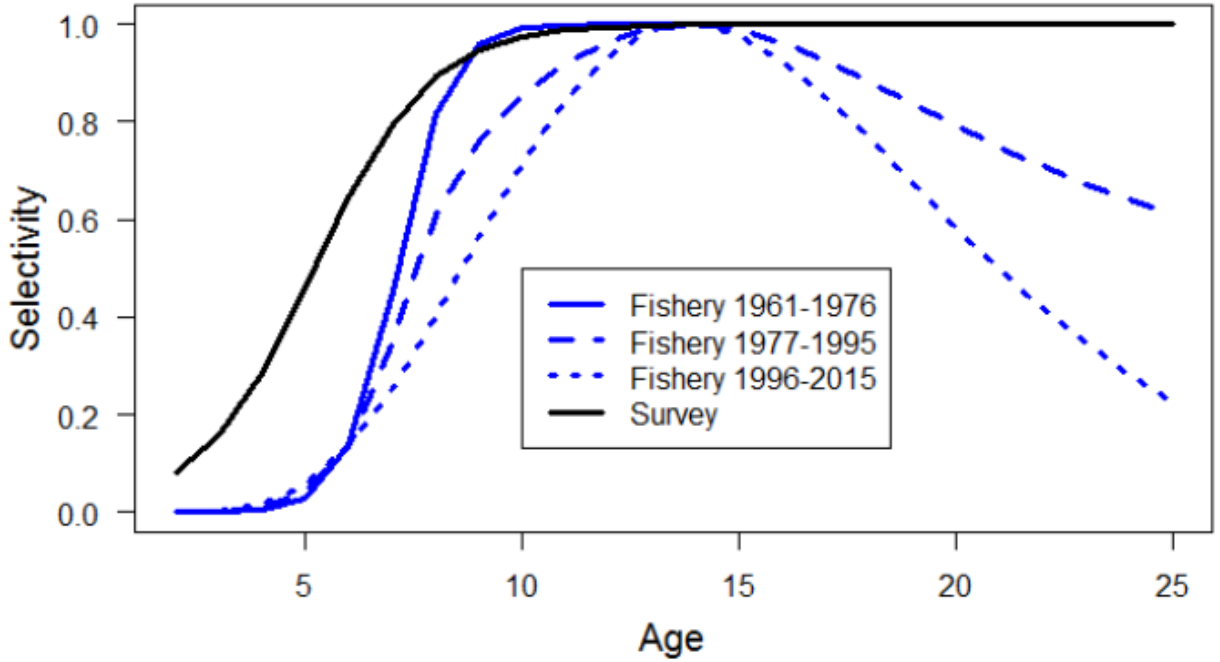
% difference		$F_{40\%}$	q	M	σ_r	lnR
Base 2015		0.102	1.954	0.061	0.877	3.965
Iterated	McAllister-Ianelli	-4.4%	21.3%	-9.1%	12.9%	-7.7%
Iterated	Francis	-2.7%	-1.5%	-7.3%	3.9%	0.2%
Estimated	Dirichlet	0.6%	-7.5%	18.5%	11.7%	-0.6%
Estimated	Dirichlet-Multinomial	-2.3%	-11.3%	15.1%	11.9%	-2.5%

2. Input sample size analysis

- Largest change in spawning biomass: Francis method
- Most interesting change (at least to me): estimating as parameter and subsequent adjustment to q
- Seems to be something going on (don't necessarily want to call it a conflict) between age/length comps and index
- 2 alternatives potentially for November: Francis and Dirichlet-Multinomial
  - PT recommendation?

3. Fishery selectivity

- Current convention: 3 time blocks
  1. 1961-1976 foreign fleets (logistic/asymptotic fishery selectivity)
  2. 1977-1995 transition from foreign to domestic fishery (average of logistic and gamma fishery selectivity)
  3. 1996-present domestic fishery (gamma/dome-shaped fishery selectivity).



3. Fishery selectivity

- 3 alternatives to fishery selectivity investigated compared to 2015 assessment

    1. Catch weighted average depth fished related as covariate to gamma parameter for slope

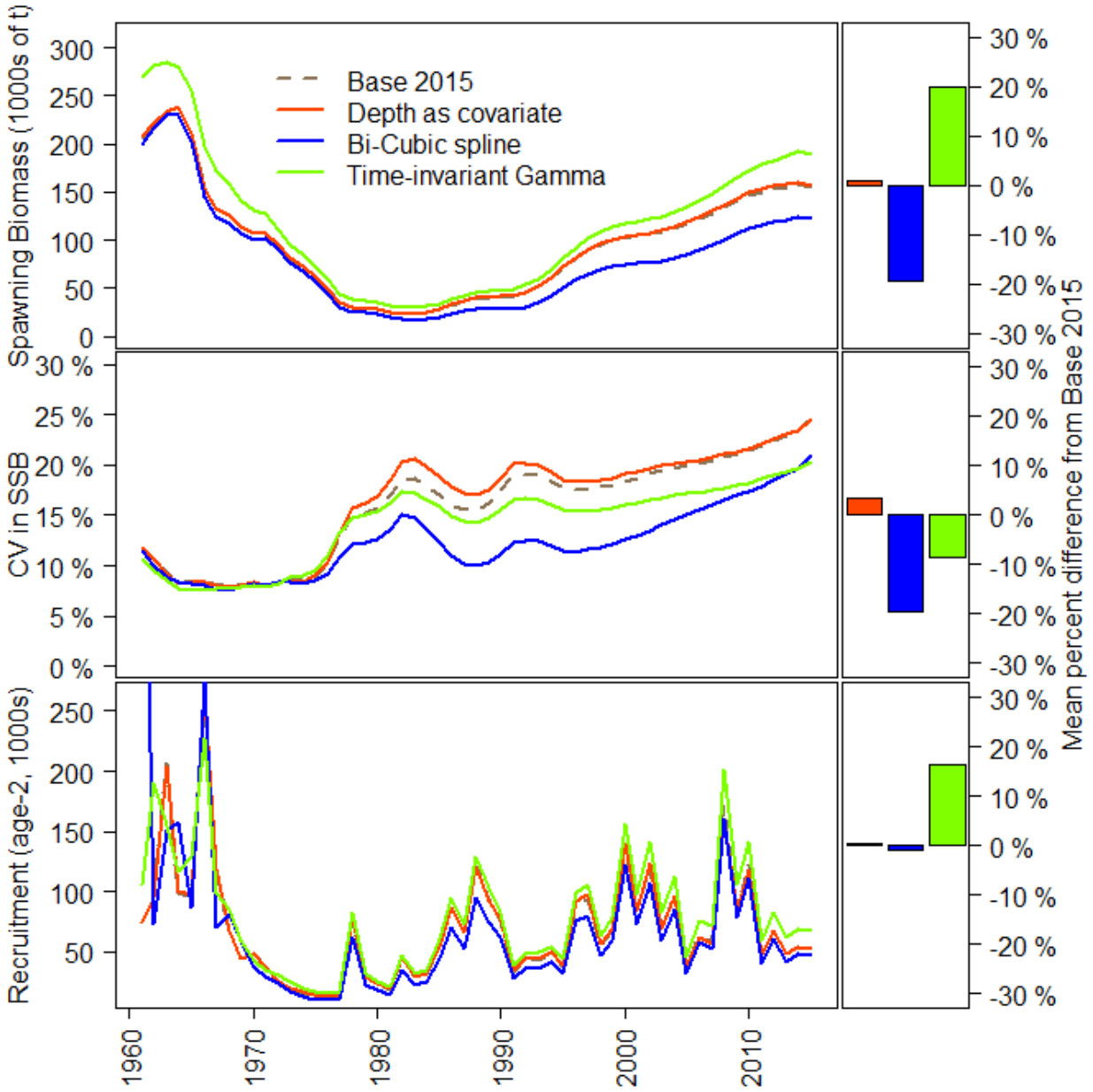
    2. Bi-Cubic spline as adopted in the 2016 BSAI POP assessment

    3. Time-invariant gamma

3. Fishery selectivity

RMSE	Trawl survey biomass	Fishery age composition	Survey age composition	Fishery length composition
Base 2015	0.3178	0.0162	0.0200	0.0254
Depth as covariate	0.3221	0.0157	0.0200	0.0252
Bi-Cubic spline	0.3195	**0.0155**	0.0201	0.0244
Time-invariant gamma	**0.3174**	0.0170	**0.0198**	**0.0236**

3. Fishery selectivity



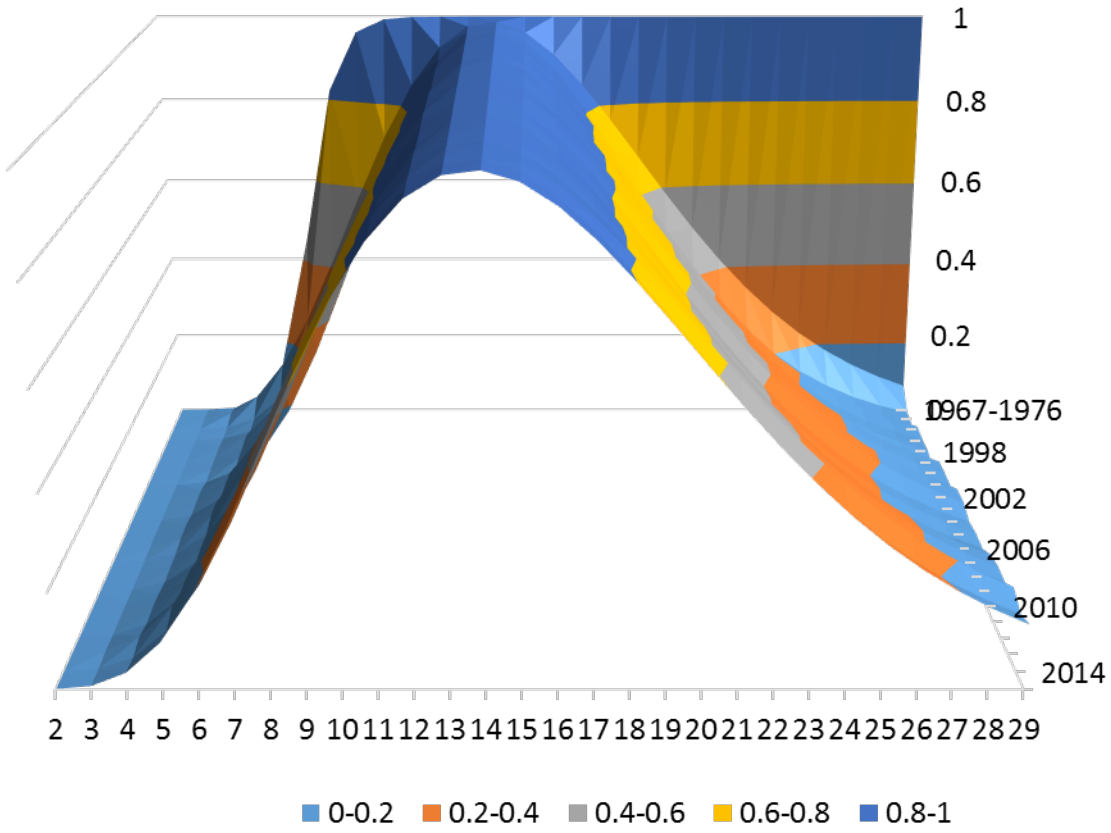
3. Fishery selectivity

% difference	$F_{40\%}$	q	M	σ_r	lnR
Base 2015	0.102	1.954	0.061	0.877	3.965
Depth as covariate	-8.9%	10.1%	-2.2%	0.8%	-1.4%
Bi-Cubic spline	-24.9%	34.1%	-2.1%	6.4%	-2.7%
Time-invariant gamma	4.3%	-14.3%	0.7%	-5.0%	6.3%

	Number of parameters	Data Likelihood	Total Likelihood
Base 2015	152	117.96	256.29
Depth as covariate	153	117.48	255.47
Bi-Cubic spline	168	119.64	274.71
Time-invariant gamma	150	110.17	247.11

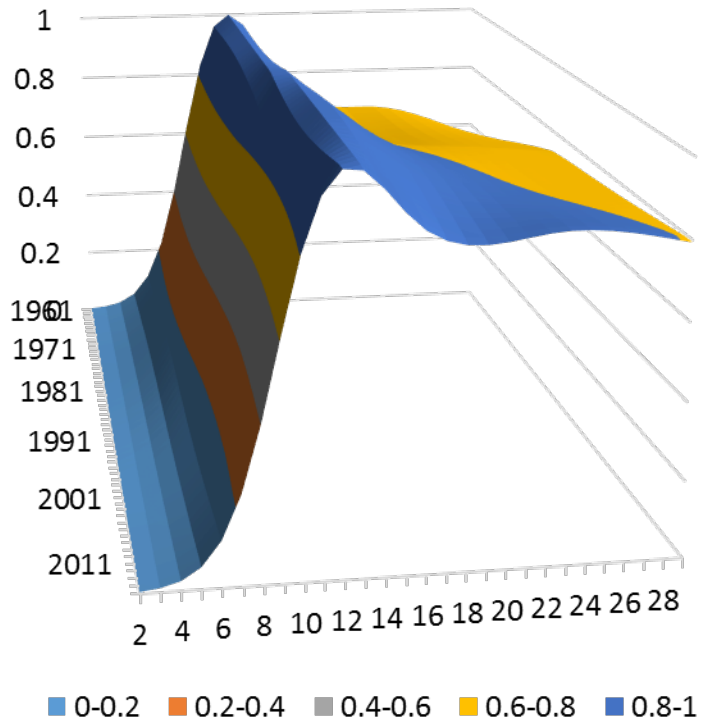
3. Fishery selectivity

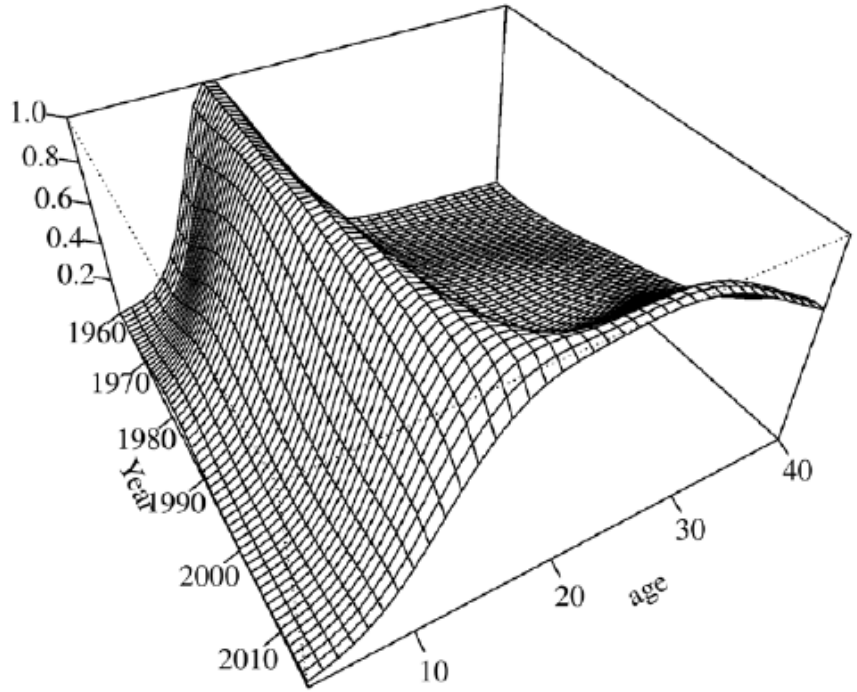
- Depth as covariate didn't do much
  - Perhaps not end of story, just not significant as applied to fishery selectivity



3. Fishery selectivity

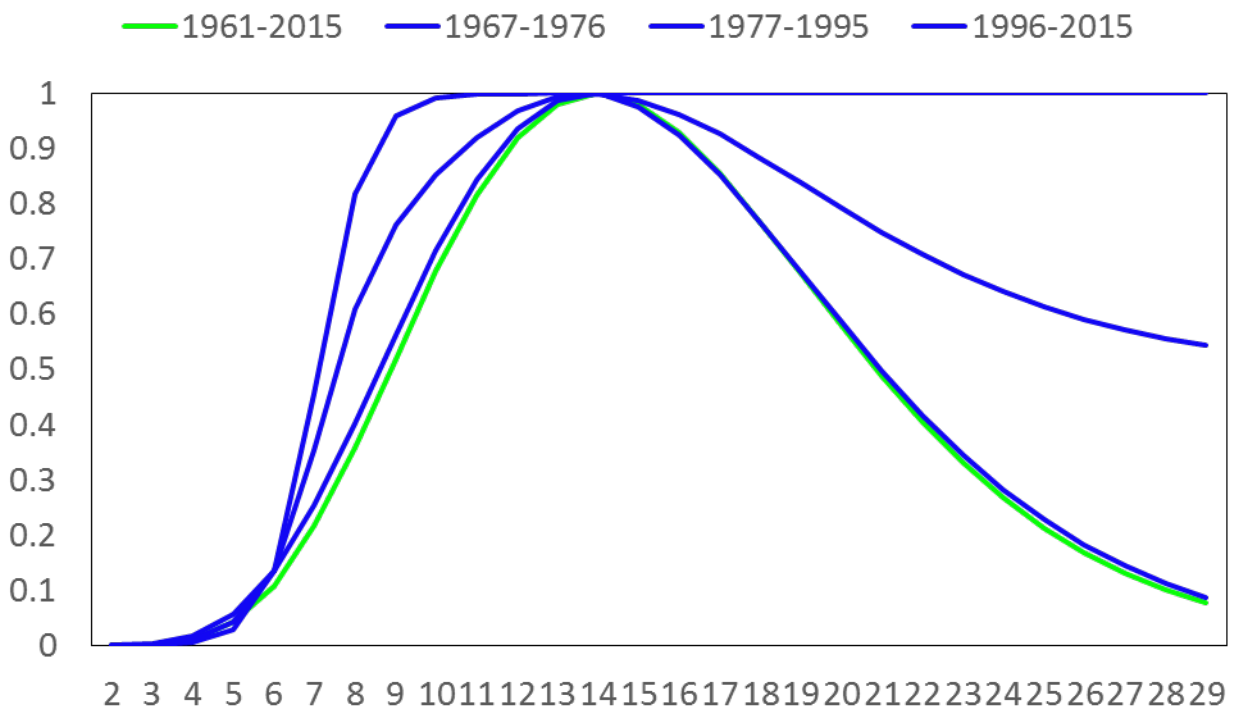
- Bi-Cubic spline didn't seem to improve model performance, in terms of fit to data balanced with additional parameters
  - Nodes/weightings same as BSAI POP, could perhaps investigate alternatives (when I did, basically just went to dome-shaped for all years)





3. Fishery selectivity

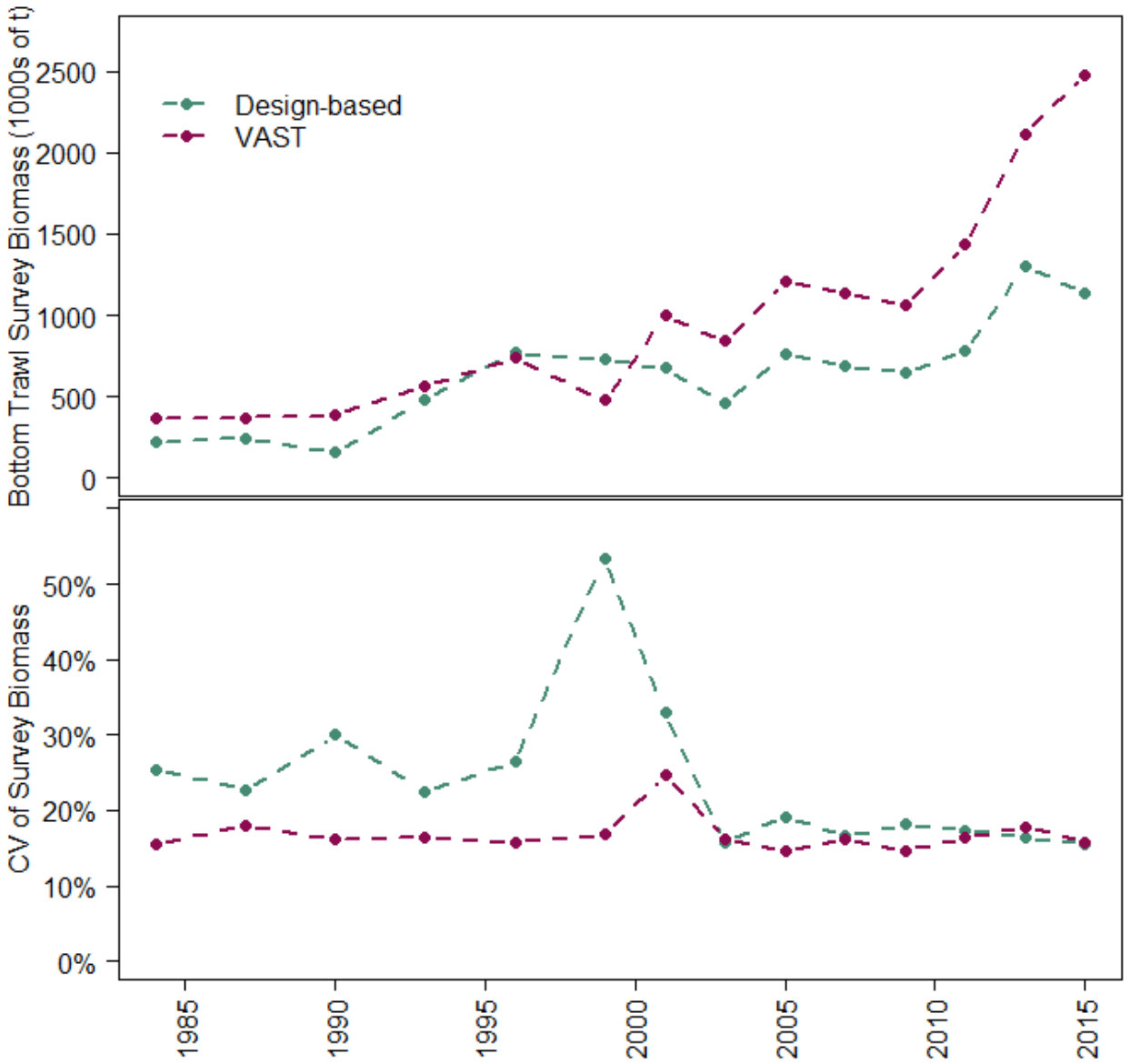
- Gamma for all years had best data fit, smallest RMSE for all years (except for fishery age)
  - Further pursue for November?
  - PT recommendations?



4. VAST/GLMM alternative trawl survey index

- Alternative trawl survey biomass adopted for GOA dusky rockfish in last full assessment
- PT/SSC recommendation was to investigate this further
- Here investigate VAST trawl survey index as put together by Curry Cunningham
- Additionally investigate removing 1980s trawl survey data

4. VAST/GLMM alternative trawl survey index

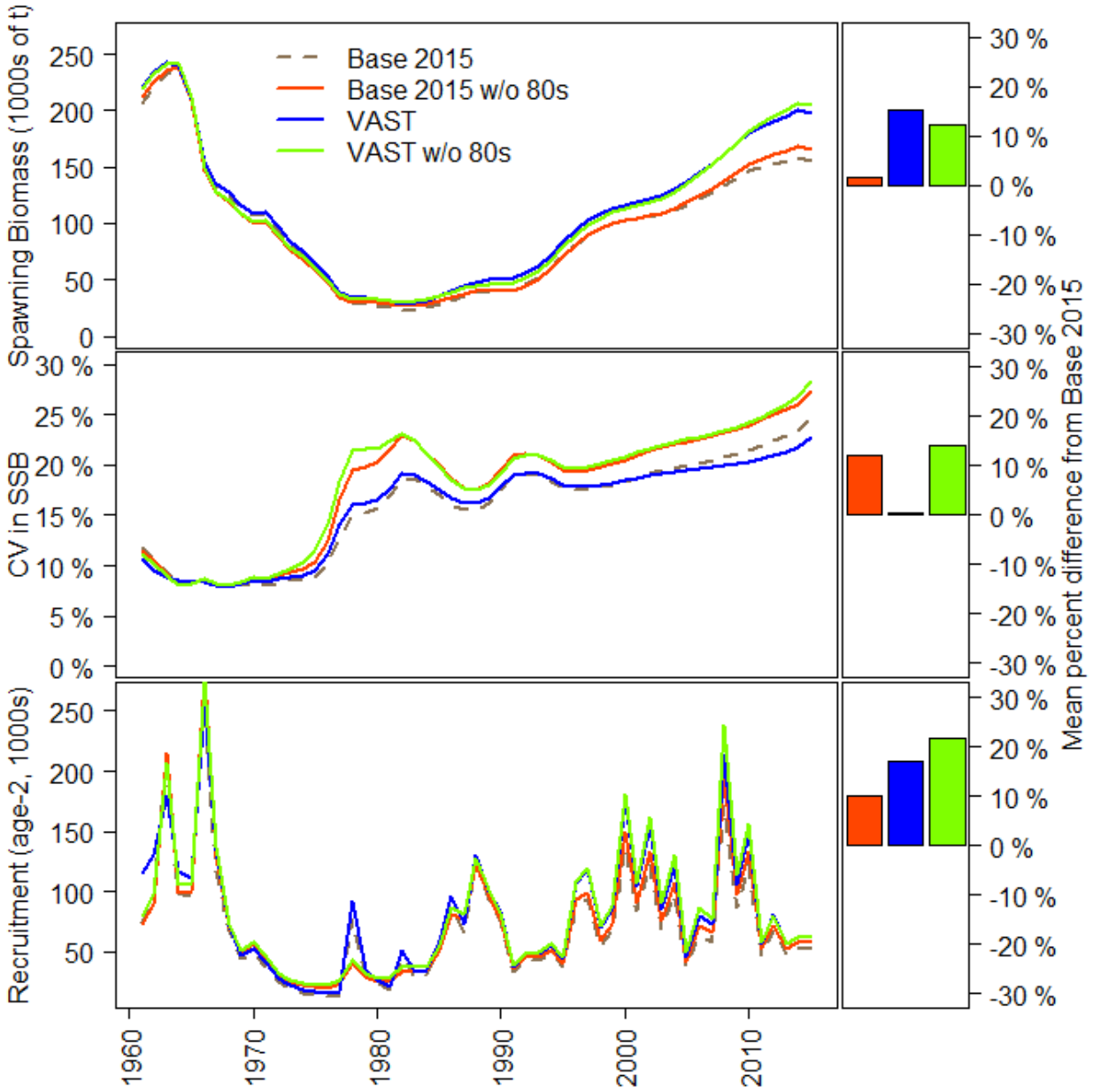


4. VAST/GLMM alternative trawl survey index

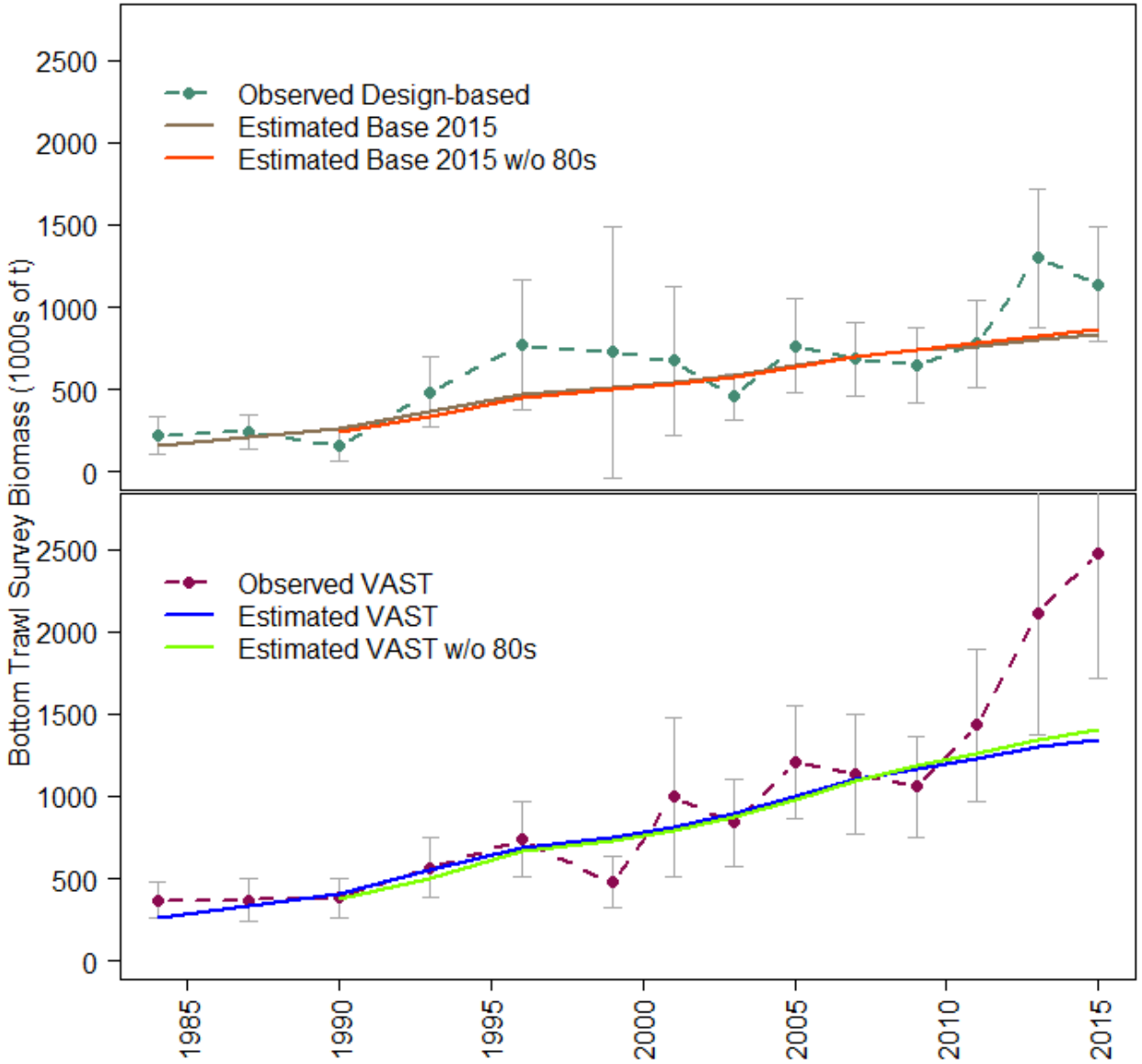
RMSE	Fishery age composition	Survey age composition	Fishery length composition
Base 2015	0.0162	0.0200	0.0254
Base 2015 w/o 80s	0.0165	0.0150	0.0252
VAST	0.0160	0.0205	0.0261
VAST w/o 80s	0.0164	0.0153	0.0256

% difference	$F_{40\%}$	q	M	σ_r	lnR
Base 2015	0.102	1.954	0.061	0.877	3.965
Base 2015 w/o 80s	0.86%	0.02%	3.35%	-5.08%	2.26%
VAST	1.95%	27.46%	3.98%	0.65%	4.00%
VAST w/o 80s	1.54%	31.89%	4.39%	-5.02%	4.14%

4. VAST/GLMM alternative trawl survey index



4. VAST/GLMM alternative trawl survey index



4. VAST/GLMM alternative trawl survey index

- Decrease in trawl survey biomass uncertainty desirable, but increase above 2.5 for catchability warrants further investigation
- Not large difference when removing 80s trawl survey data
- PT recommendations for November?

Conclusion/Bridging analysis

- Plan to do a bridging analysis in November with a subset of the alternatives investigated for each of the four categories

- Author recommendations for each category, with requests from PT:
  1. No recommendation, could use PT input
  2. Francis and Dirichlet-Multinomial, more/less?
  3. Time-invariant gamma fishery selectivity?
  4. Remove 80s? VAST index for comparison?