Alaska Sablefish September Updates

(post-prioritization version)

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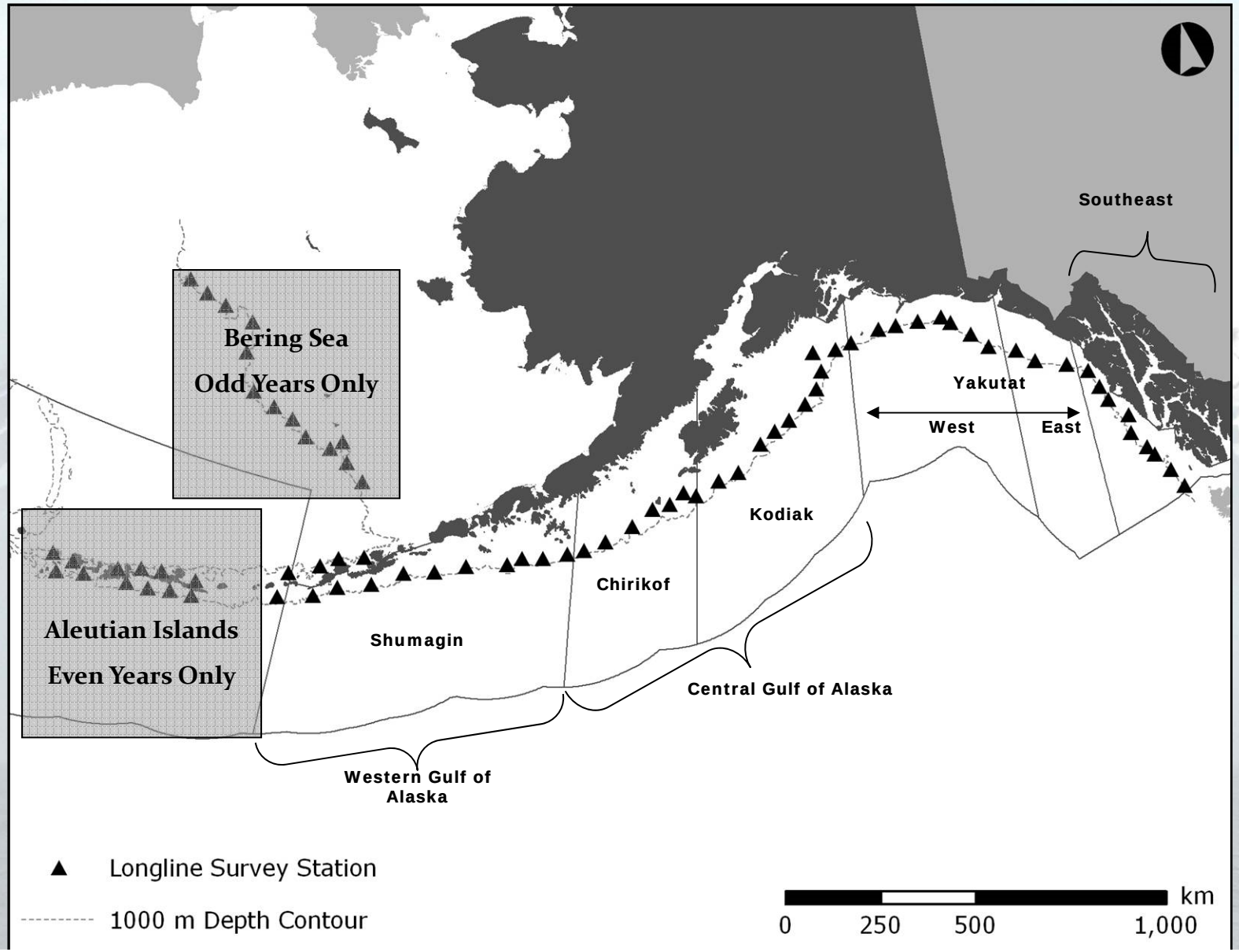
Outline

- Longline survey preliminary results
- Juvenile tagging
- CIE review
  - Summary and responses
- Preliminary model responses
  - Gaining imprecision
  - Whale depredation
  - Sensitivity runs
- Future prospects

Longline survey 2016

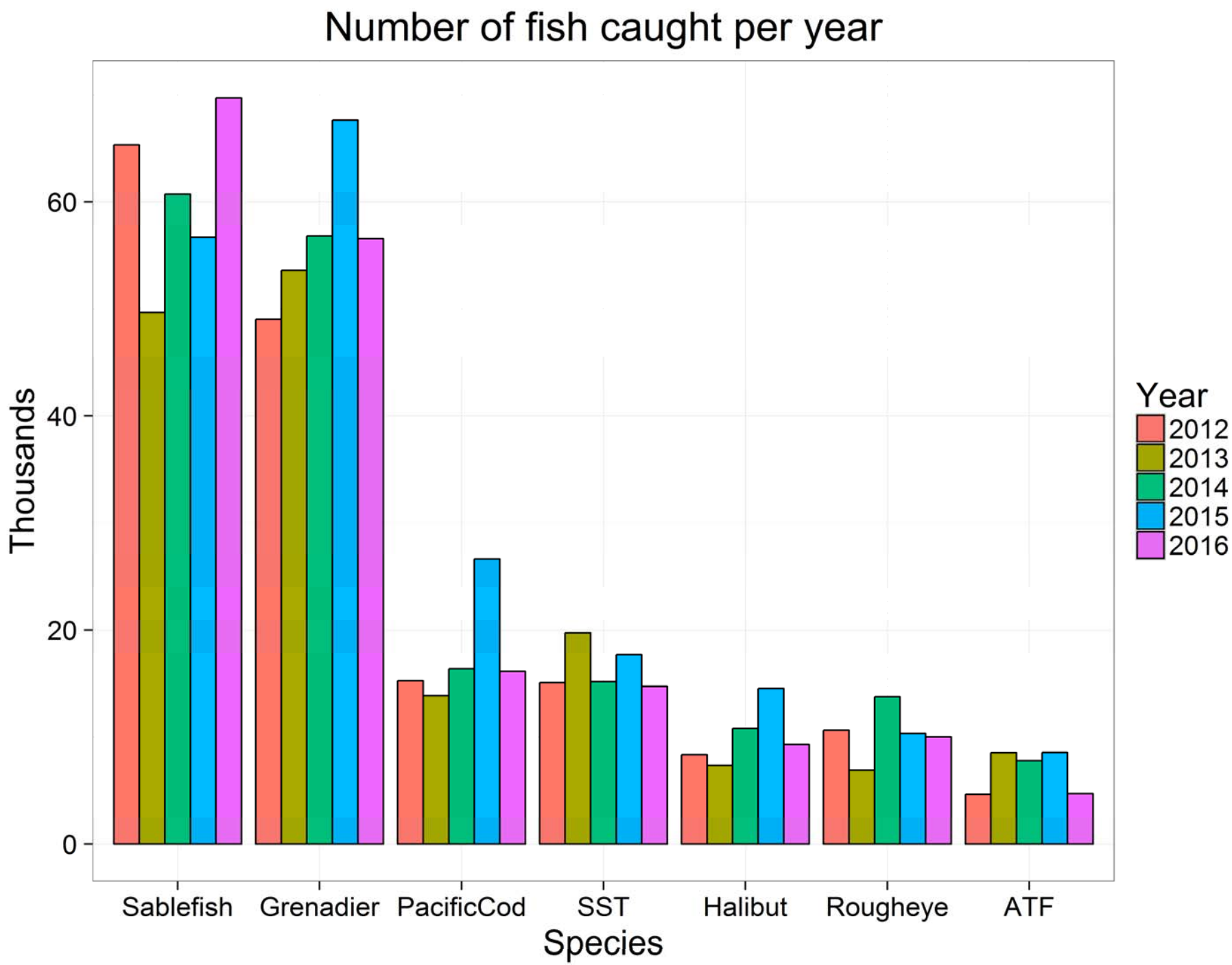
Aleutian year, *Preliminary results*

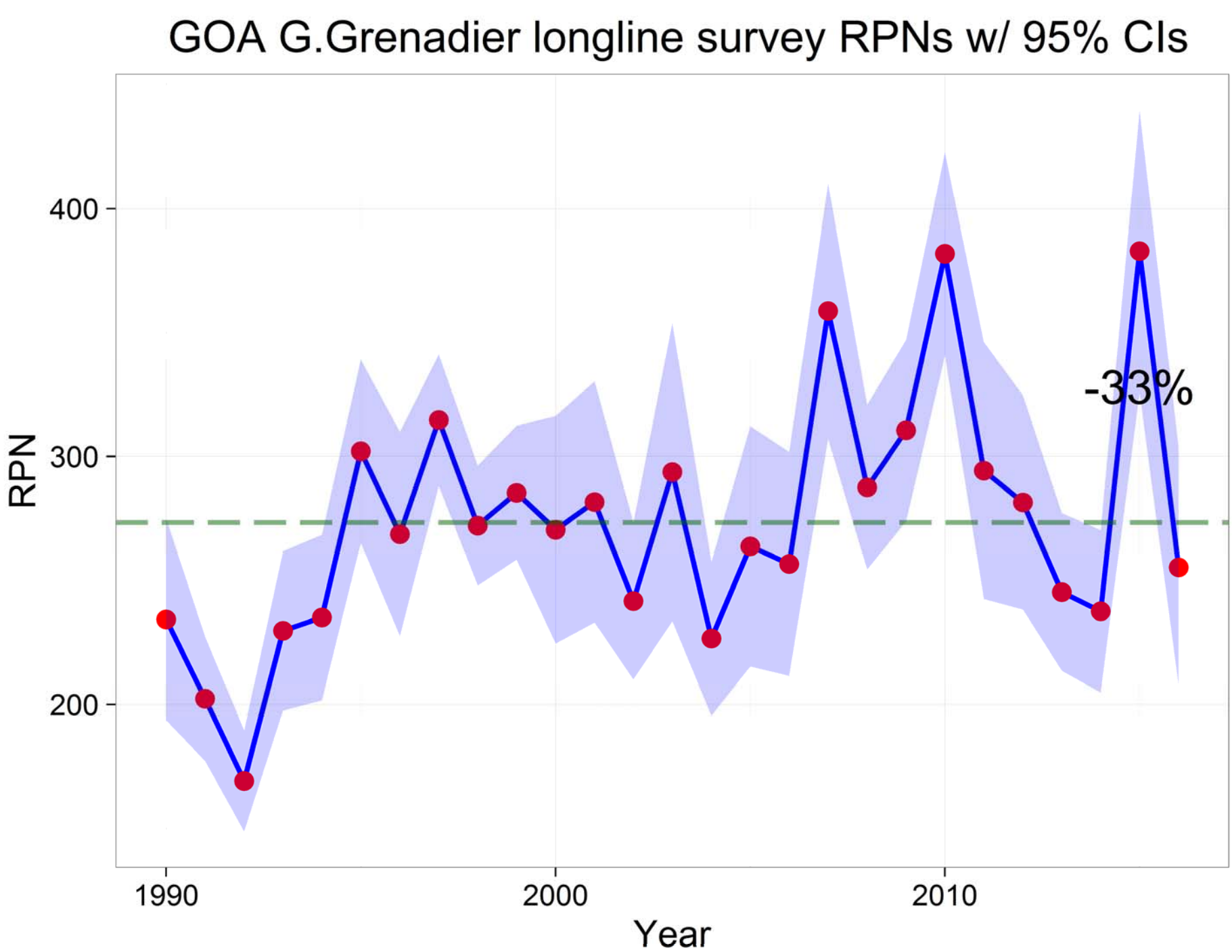
Survey Geographic Coverage

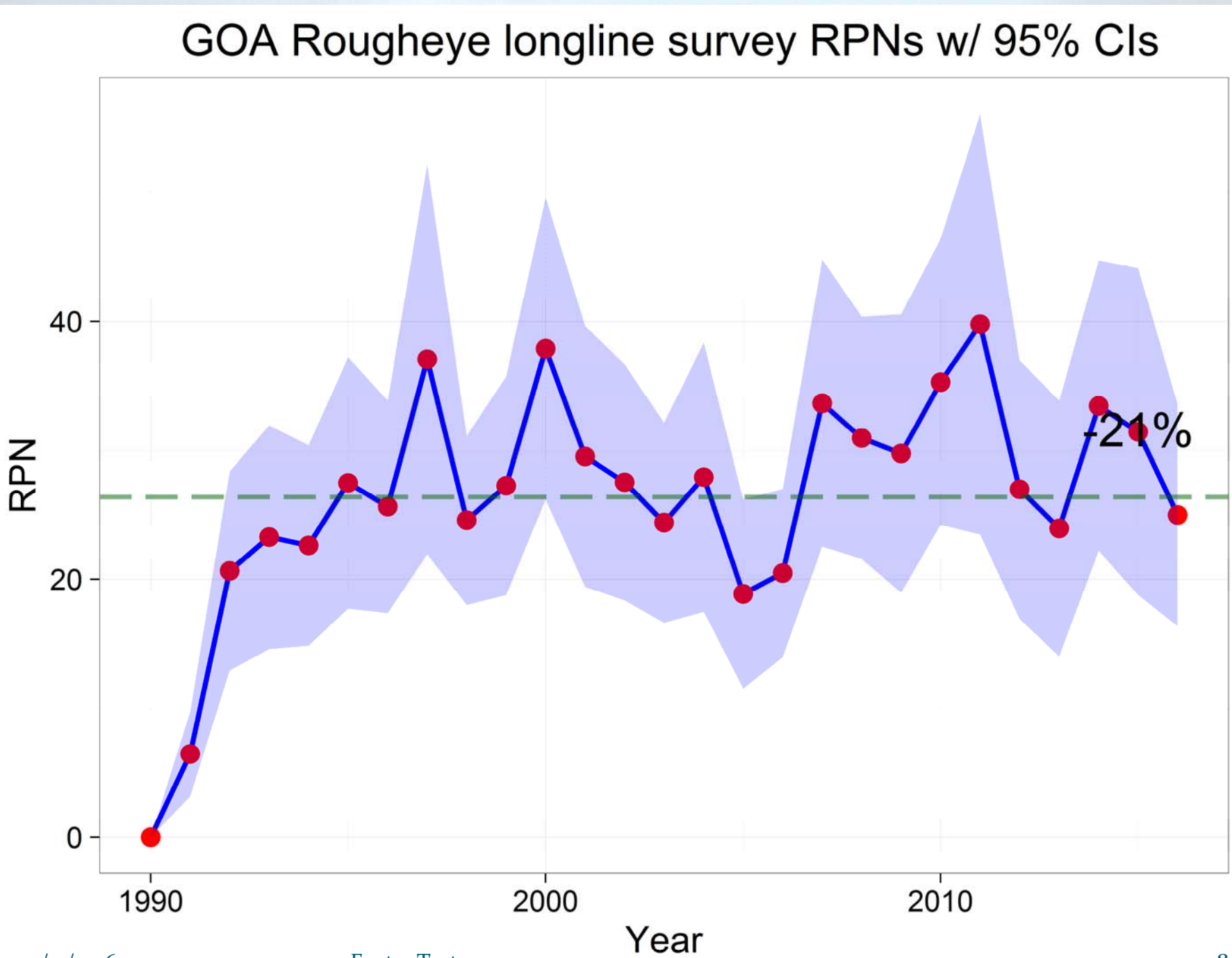


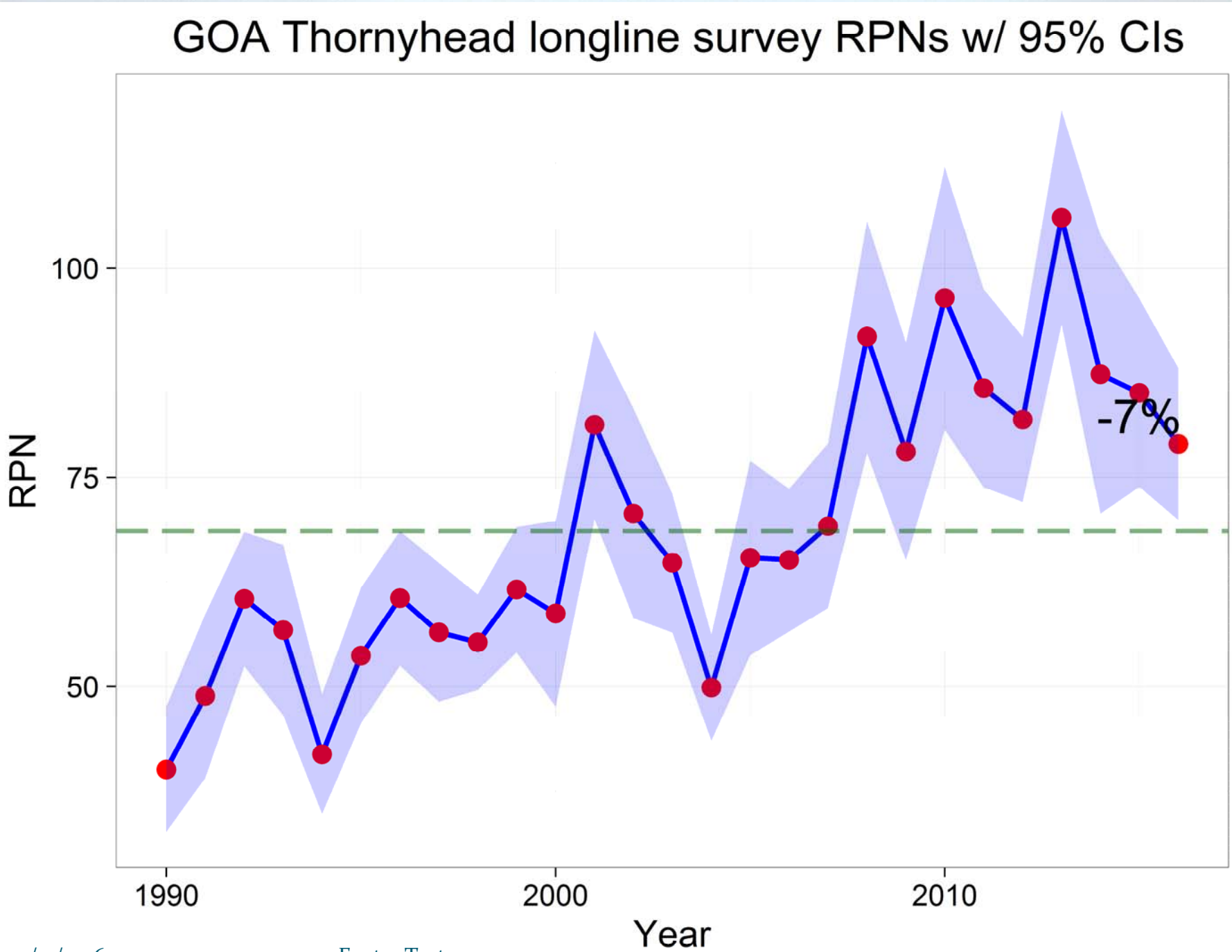
Preliminary results

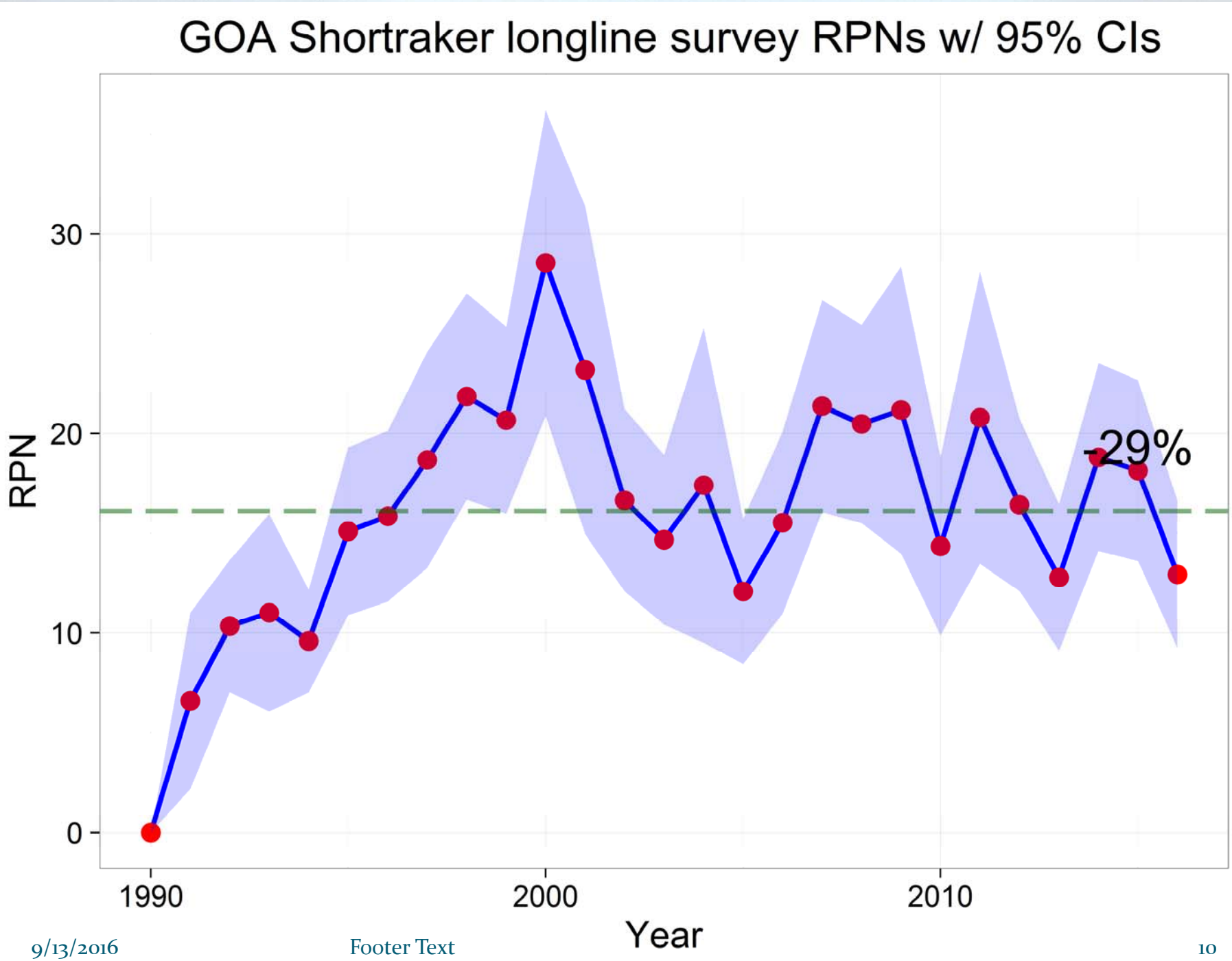
- Just compiled over the weekend so use caution
- These use the new area sizes calculated in Echave et al. (2013)
- These also use the 150-200 m depth strata allowed by using the new area sizes

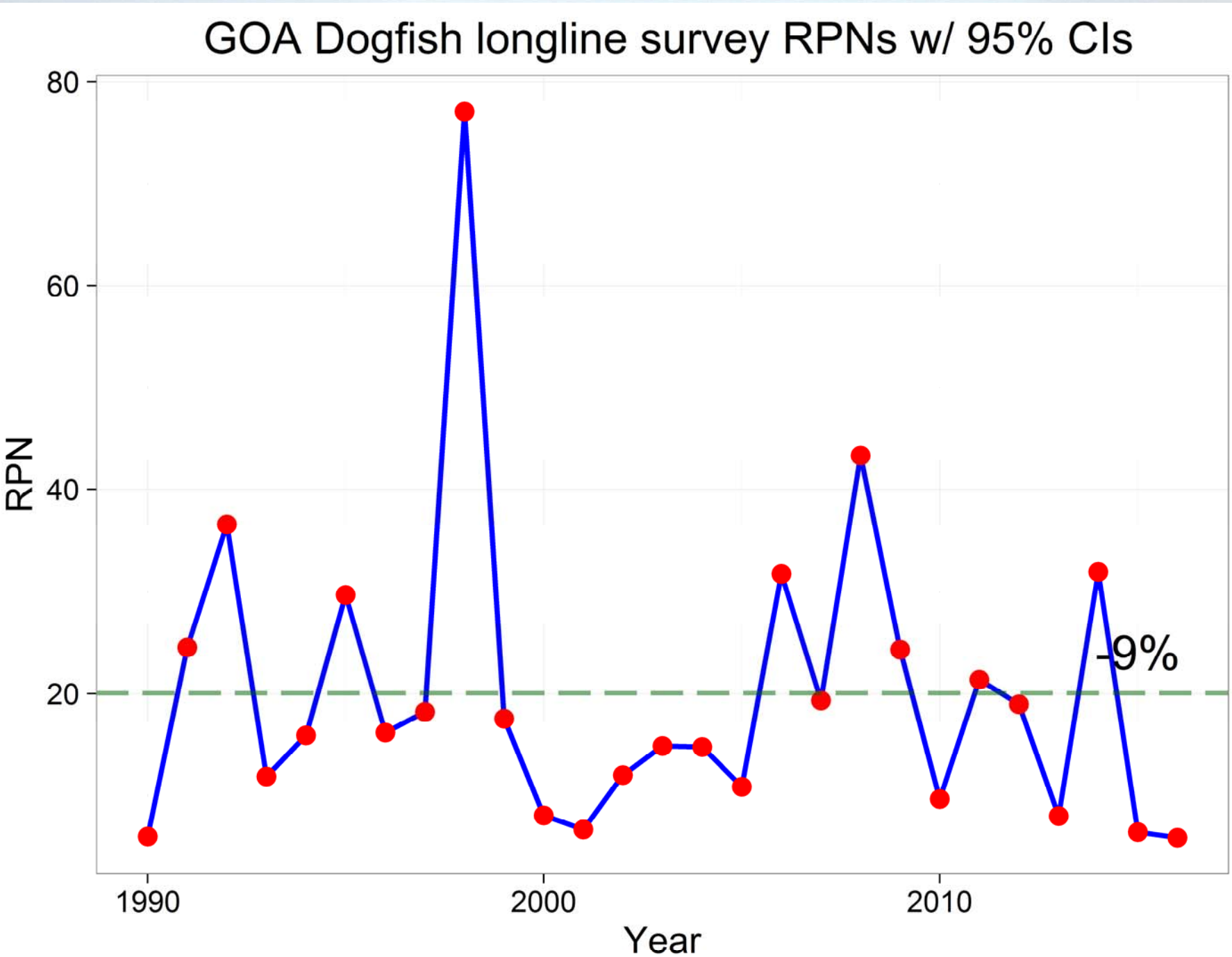

Number of fish caught per year
Thousands
60
40
20
0
Sablefish
Grenadier
PacificCod
SST
Halibut
Rougheye
ATF
Species
Year
2012
2013
2014
2015
2016

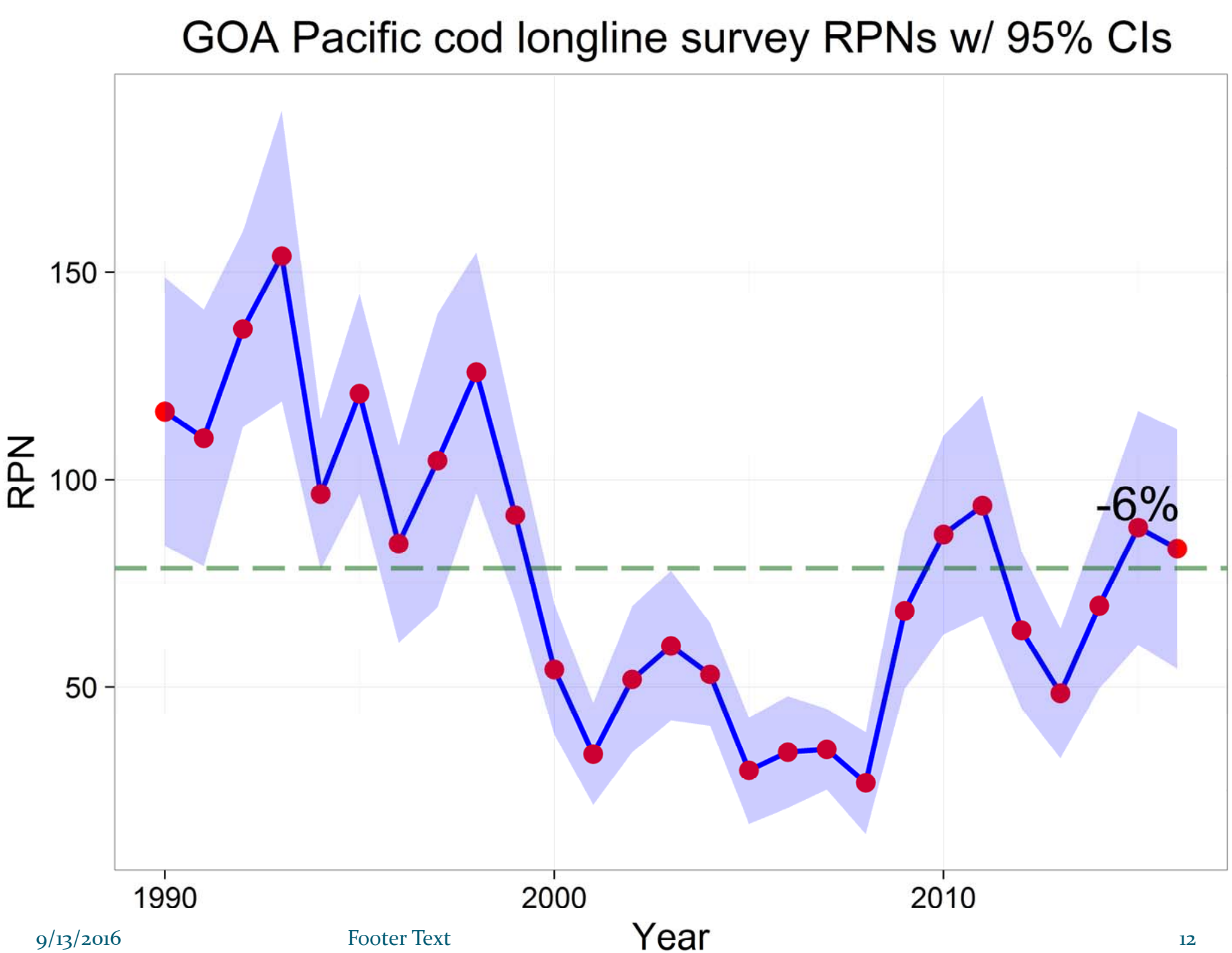

GOA G.Grenadier longline survey RPNs w/ 95% CIs
RPN
400
300
200
1990
2000
2010
Year
-33%

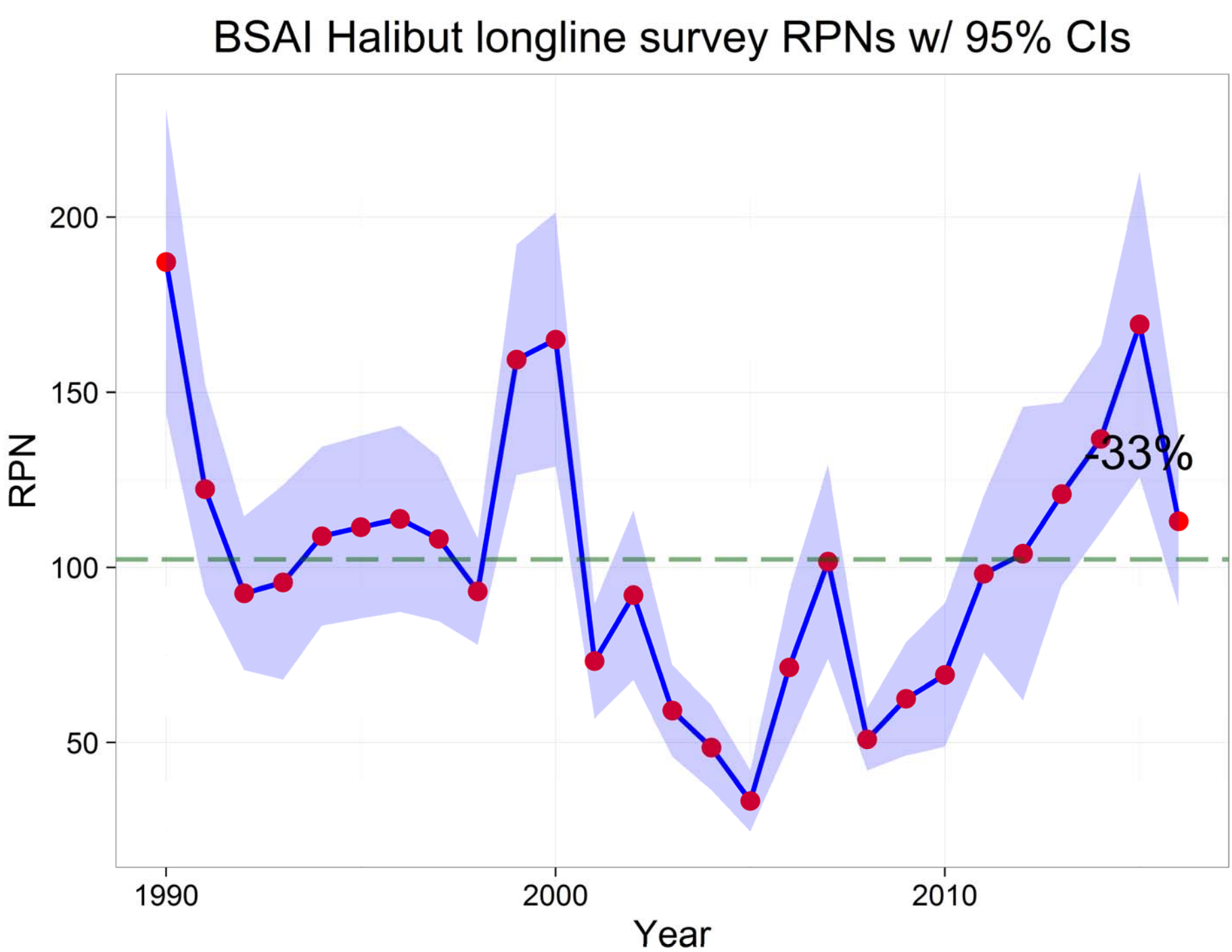

GOA Rougheye longline survey RPNs w/ 95% CIs
RPN
40
20
0
1990
2000
2010
Year
-21%

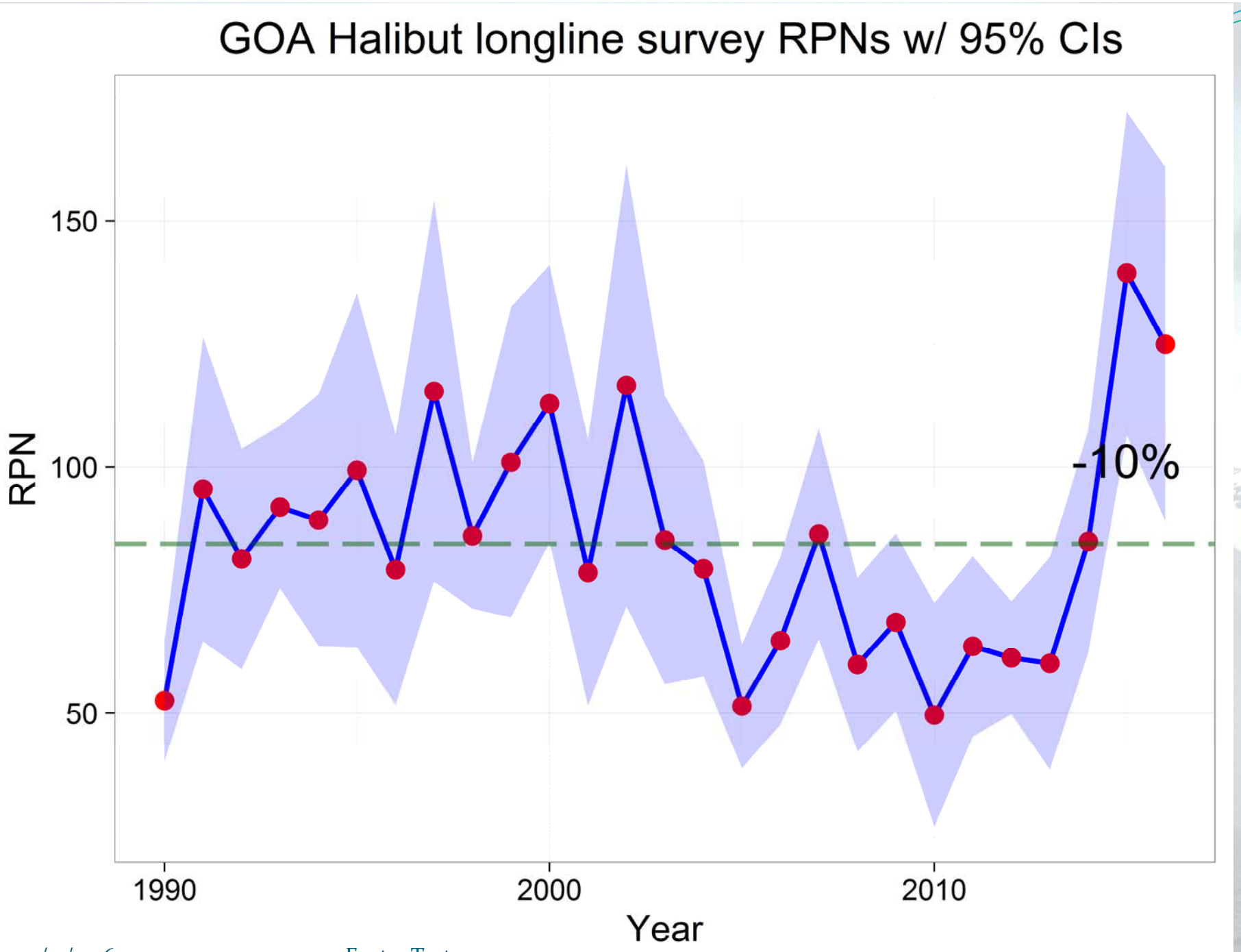

GOA Thornyhead longline survey RPNs w/ 95% CIs
RPN
100
75
50
1990
2000
2010
Year
-7%

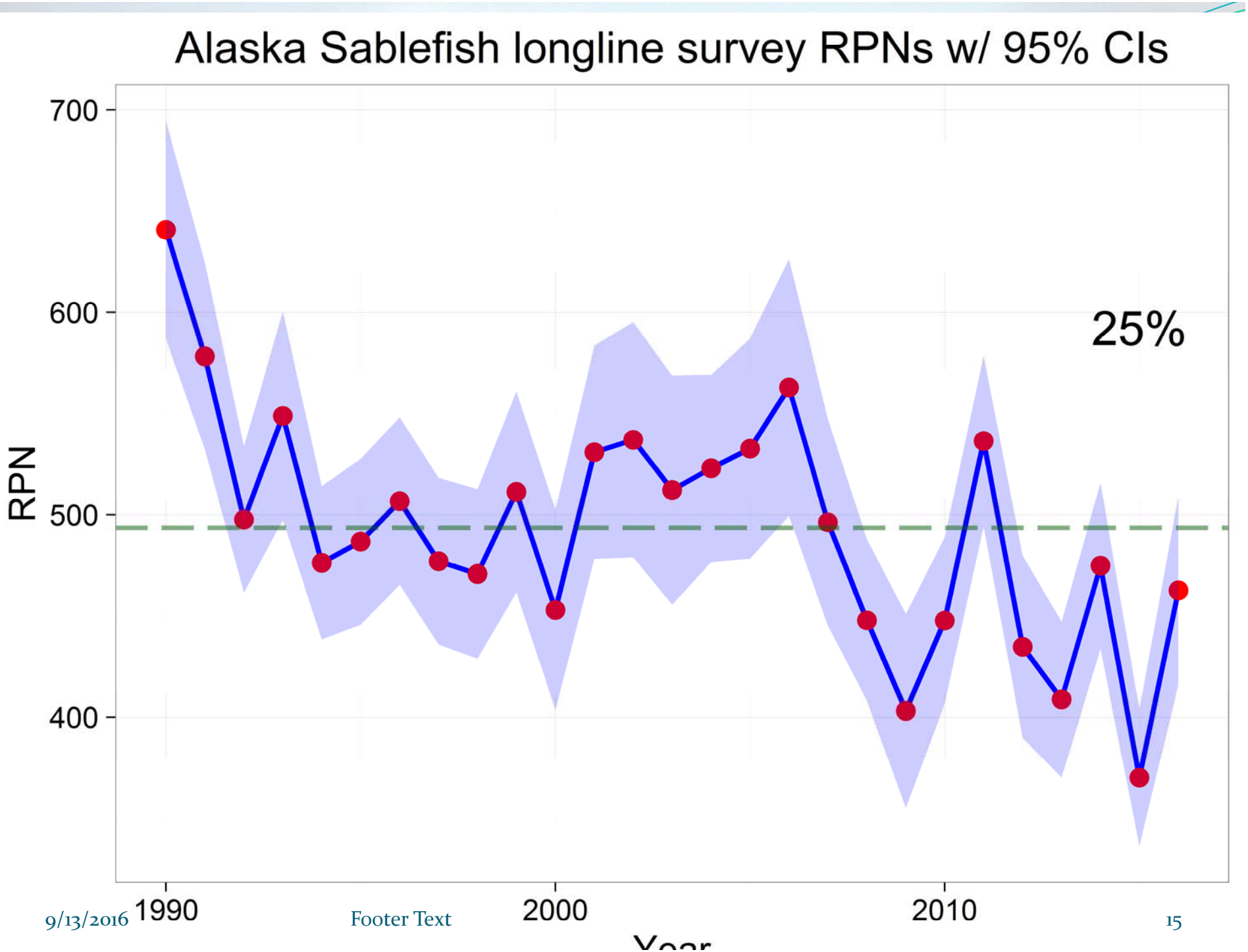

GOA Shortraker longline survey RPNs w/ 95% CIs
RPN
30
20
10
0
1990
2000
2010
Year
-29%

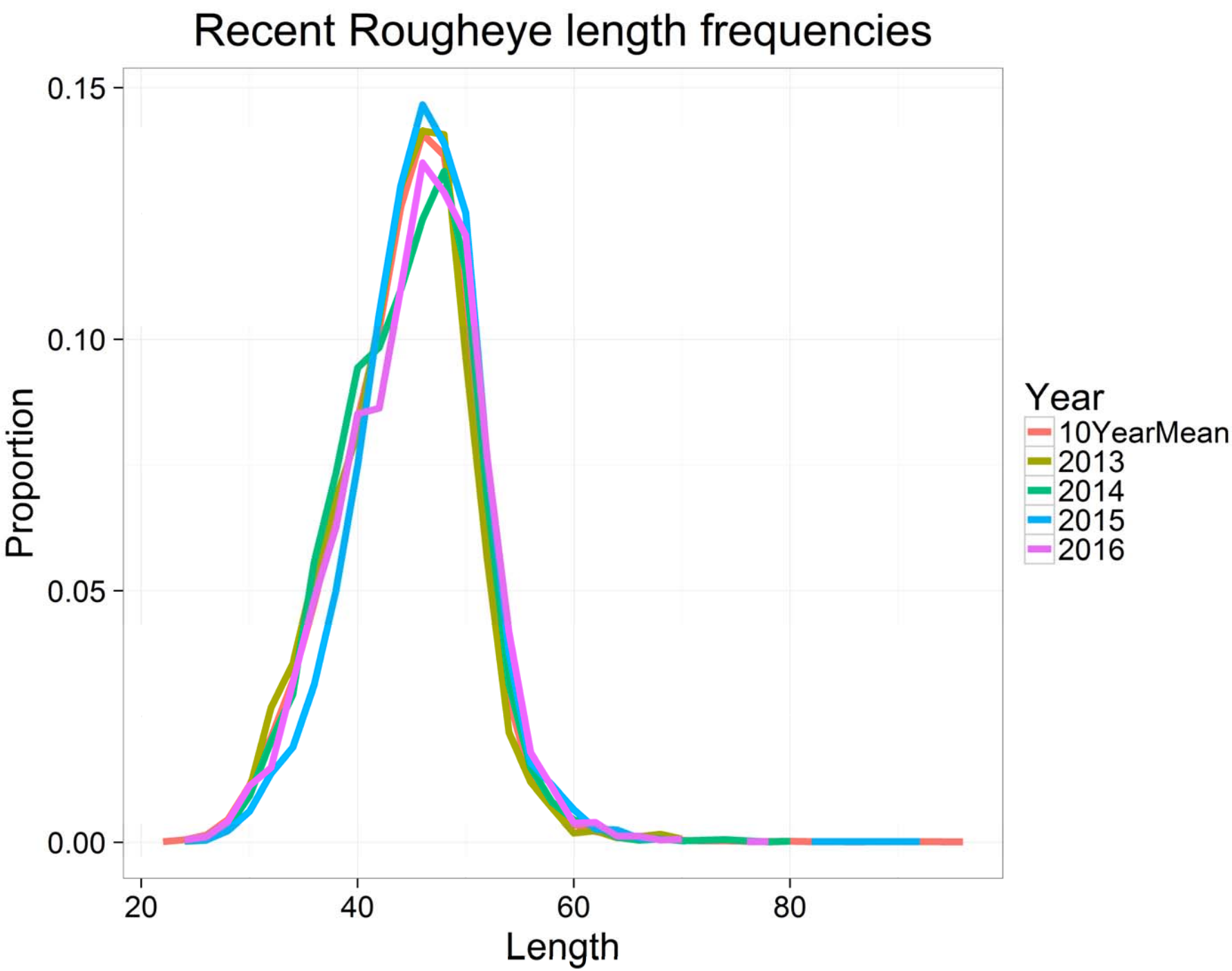

GOA Dogfish longline survey RPNs w/ 95% CIs
80
60
40
20
RPN
-9%
1990
2000
2010
Year

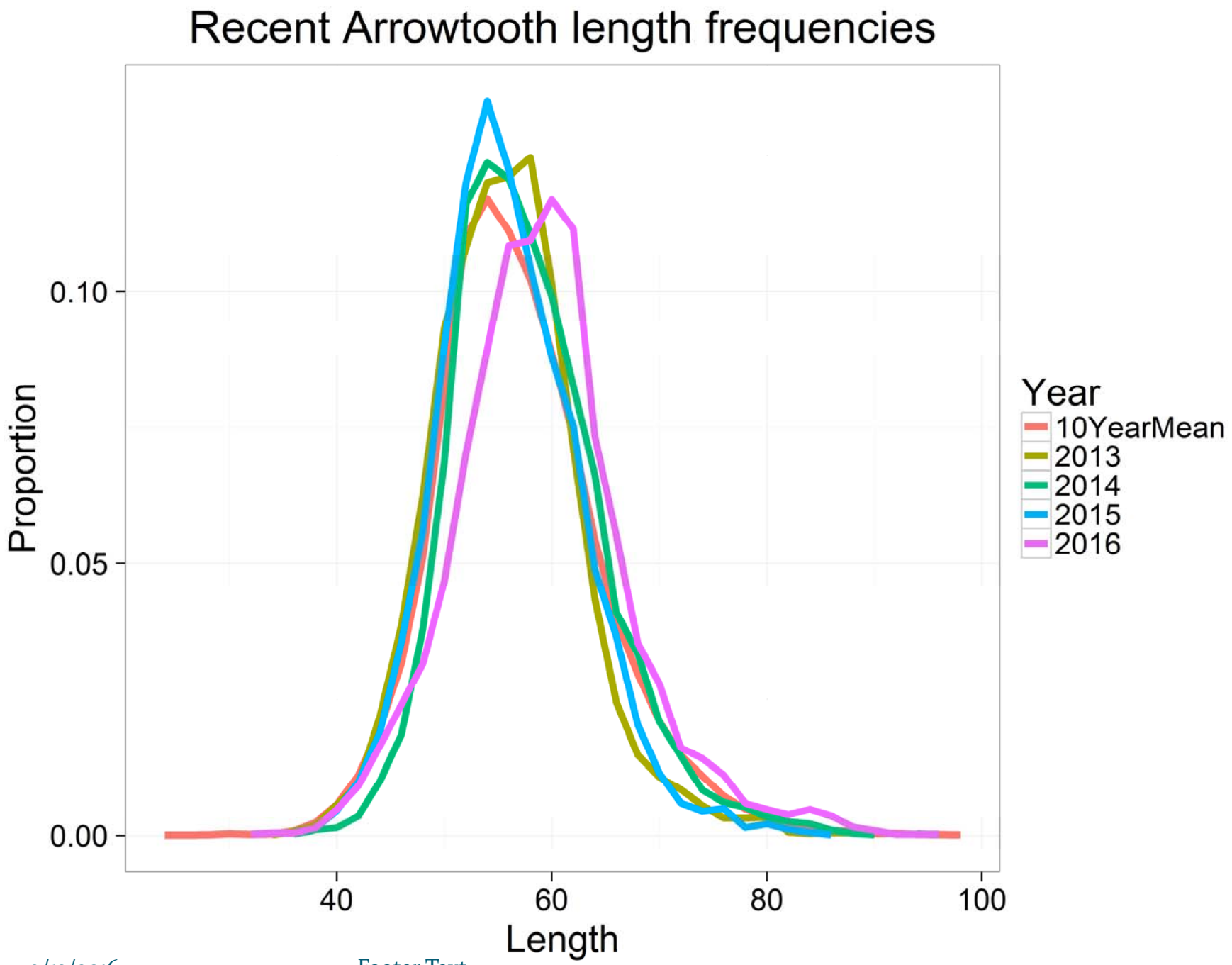

GOA Pacific cod longline survey RPNs w/ 95% CIs
RPN
150
100
50
-6%
1990
2000
2010
Year

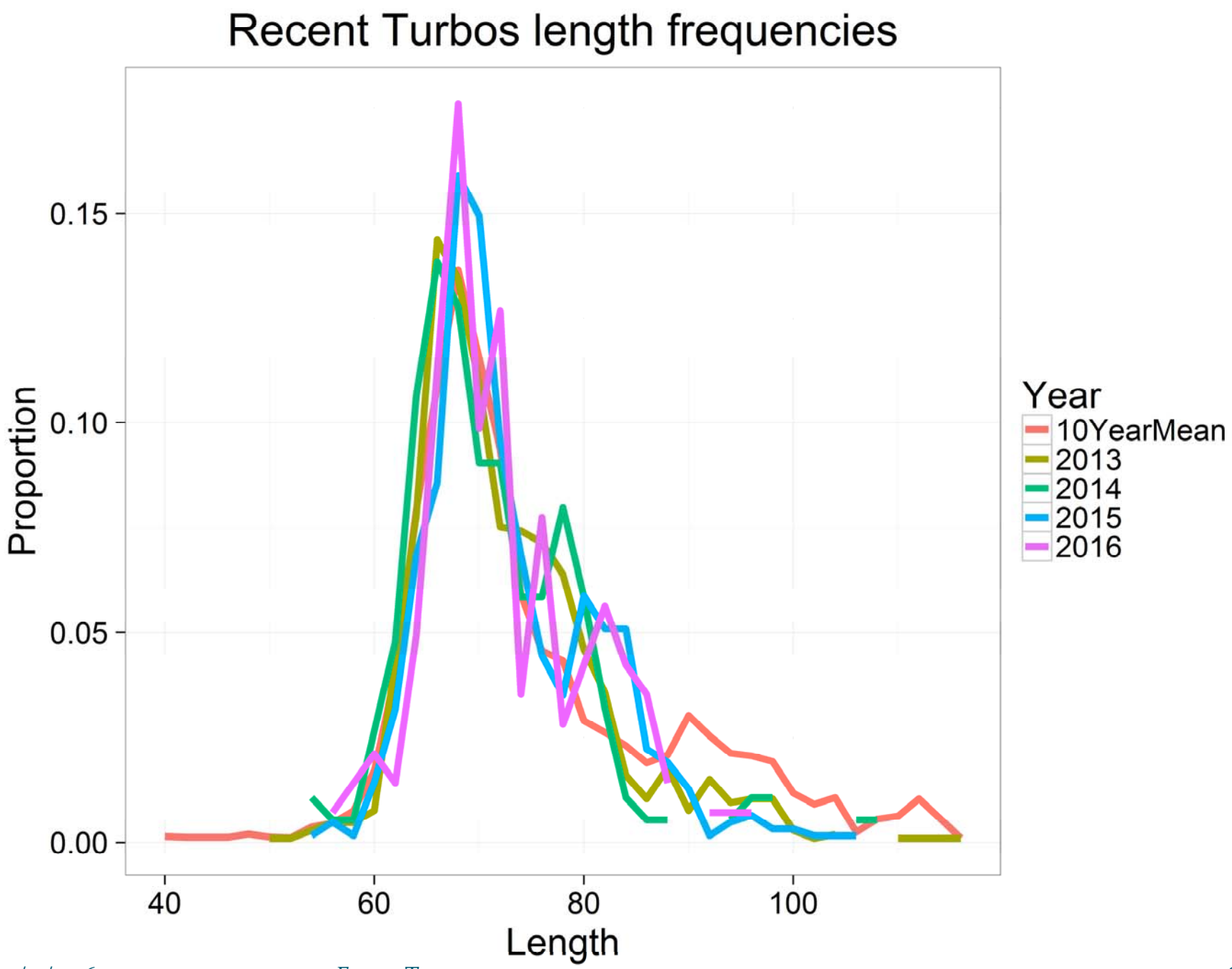

BSAI Halibut longline survey RPNs w/ 95% CIs
RPN
200
150
100
50
1990
2000
2010
Year
-33%

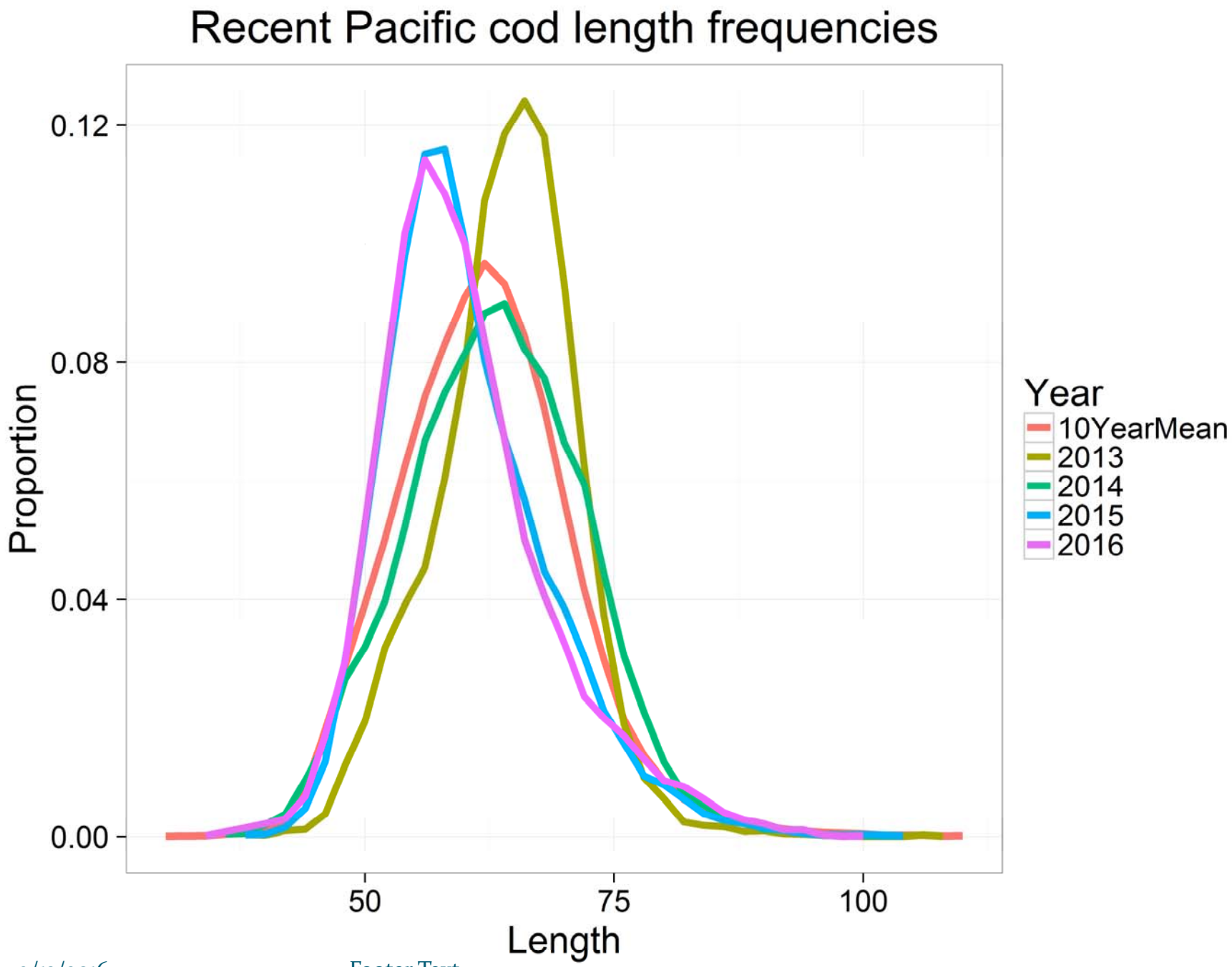

GOA Halibut longline survey RPNs w/ 95% CIs
150
100
50
RPN
-10%
1990
2000
2010
Year

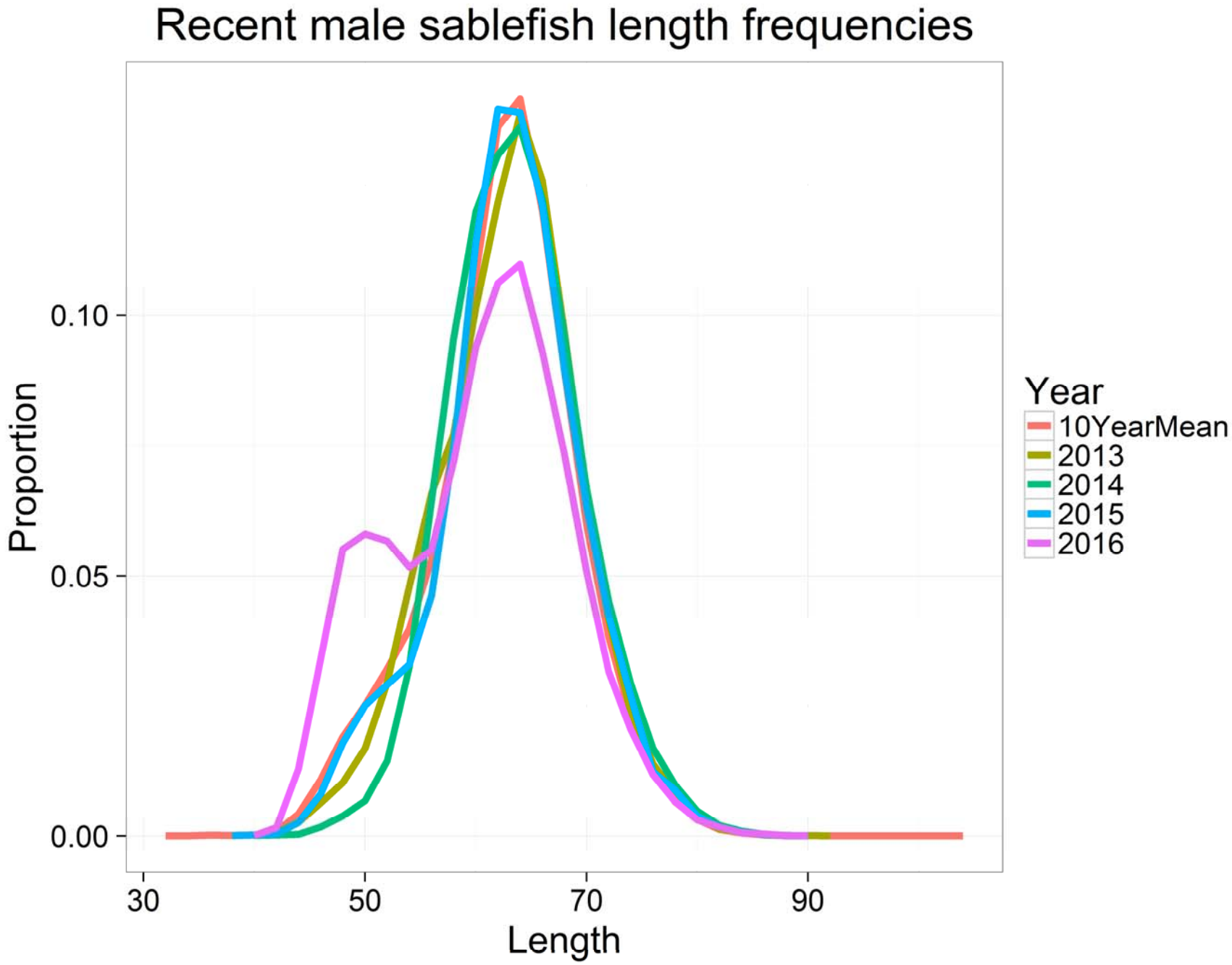

Alaska Sablefish longline survey RPNs w/ 95% CIs
700
600
500
400
RPN
25%
1990
2000
2010


Recent Rougheye length frequencies
0.15
0.10
0.05
0.00
Proportion
20
40
60
80
Length
Year
10YearMean
2013
2014
2015
2016

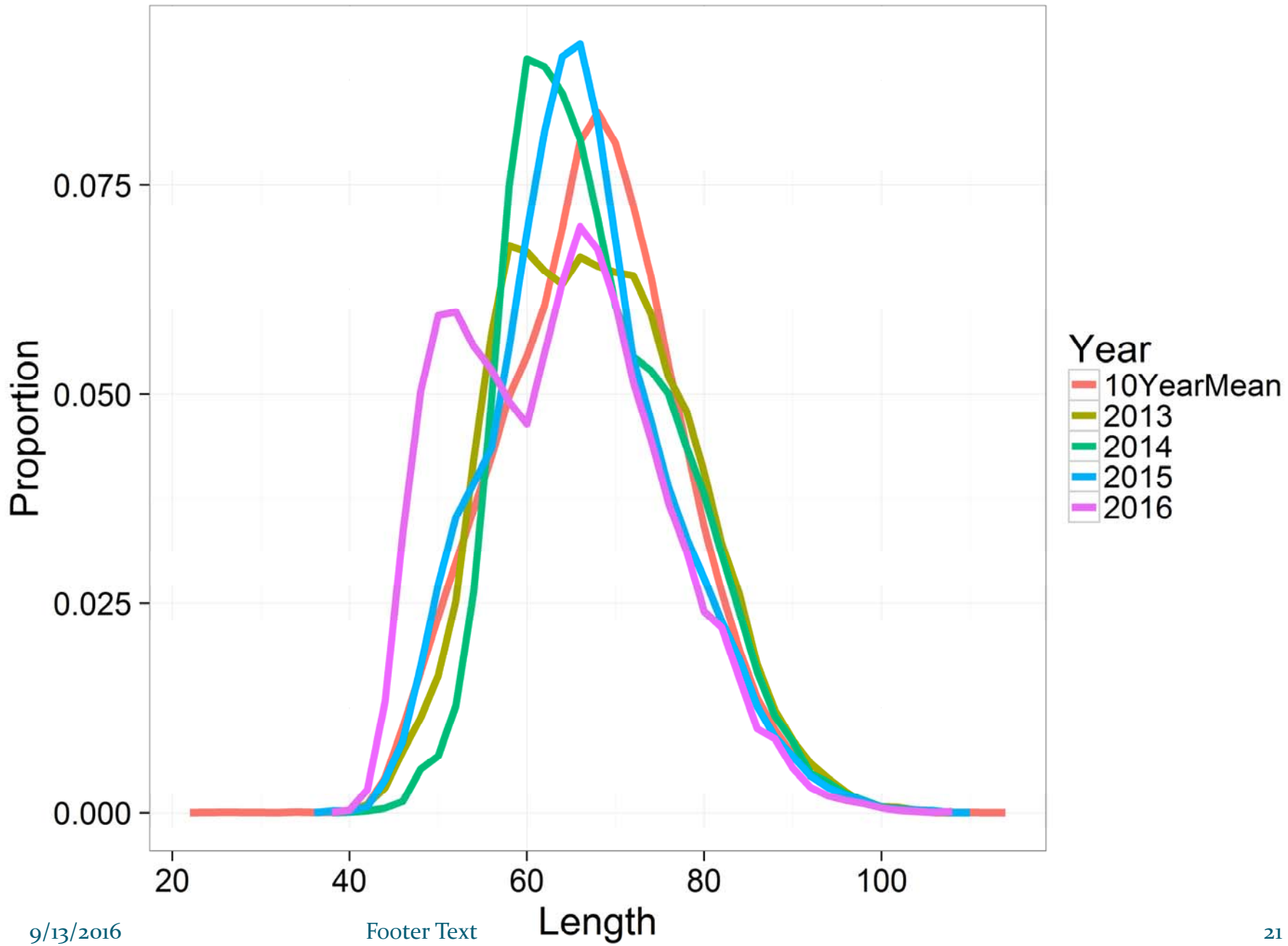

Recent Arrowtooth length frequencies
Proportion
0.10
0.05
0.00
40
60
80
100
Length
Year
10YearMean
2013
2014
2015
2016


Recent Turbos length frequencies
Proportion
0.15
0.10
0.05
0.00
40
60
80
100
Length
Year
10YearMean
2013
2014
2015
2016


Recent Pacific cod length frequencies
0.12
0.08
0.04
0.00
Proportion
50
75
100
Length
Year
10YearMean
2013
2014
2015
2016


Recent male sablefish length frequencies
Proportion
0.10
0.05
0.00
30
50
70
90
Length
Year
10YearMean
2013
2014
2015
2016

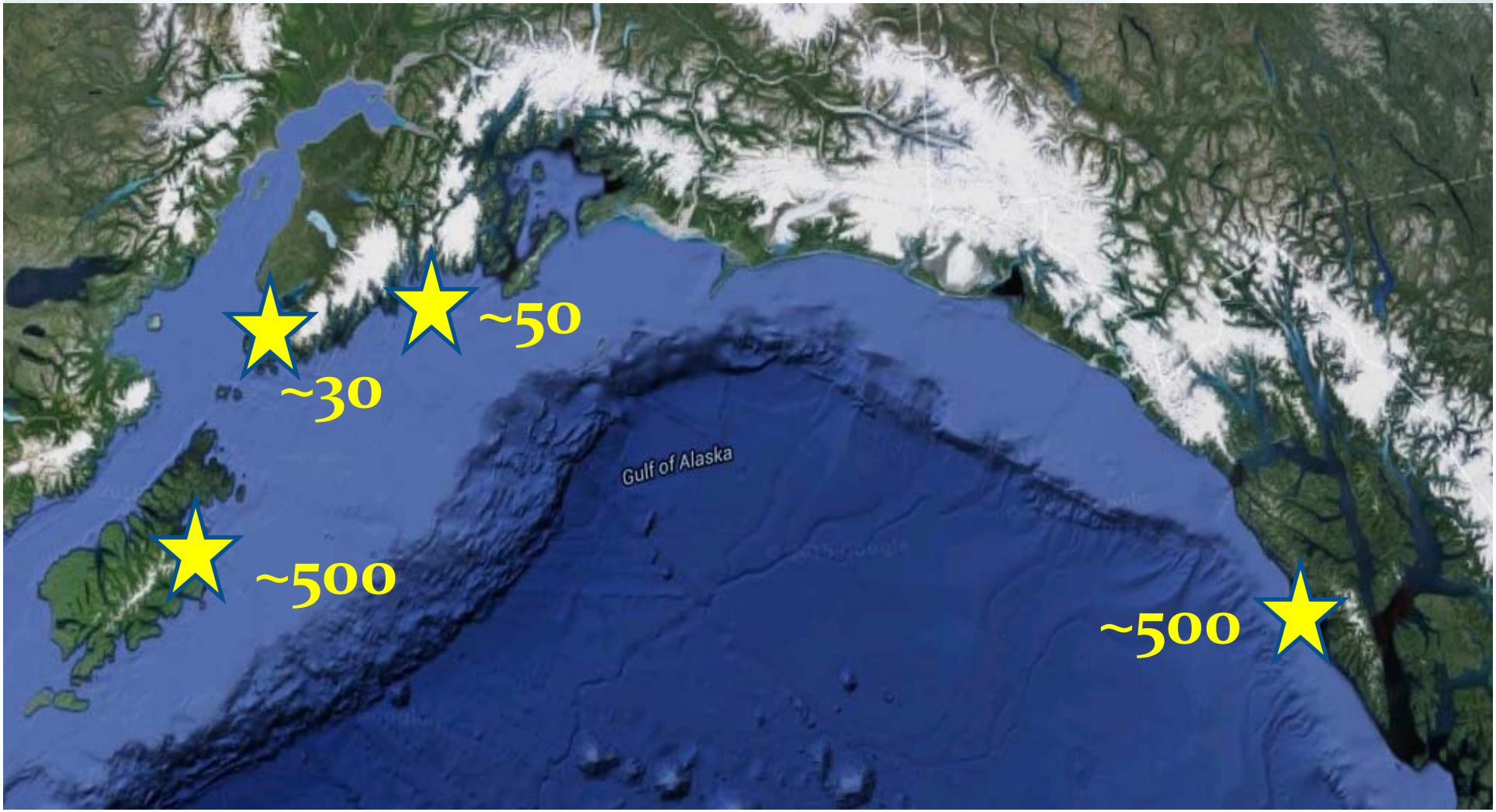
Recent female sablefish length frequencies



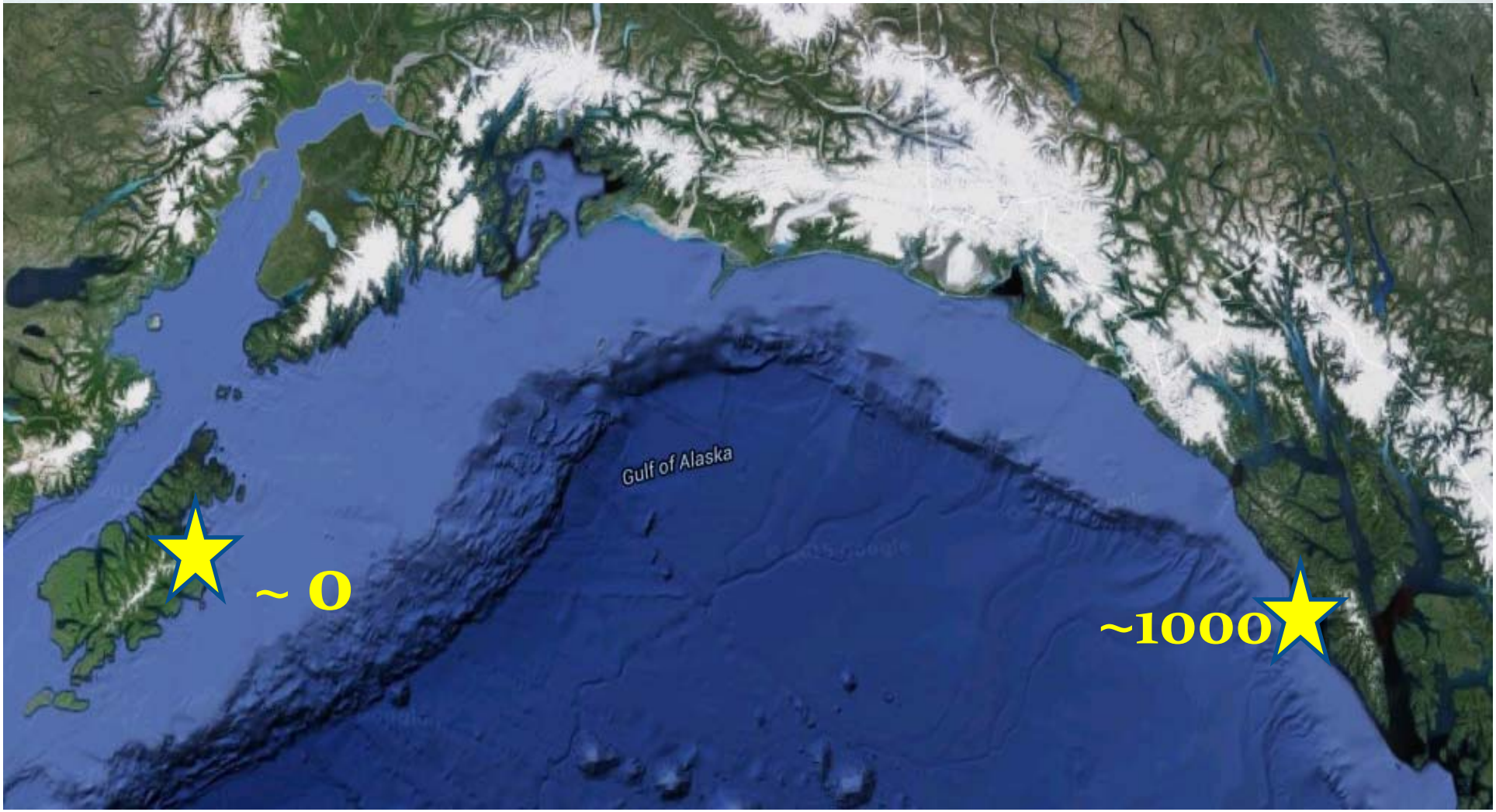
Bring on the blob?

- 2014:
  - Lots of YOYs caught in surface trawl surveys
  - Lots of fishermen reports of YOY in coho bellies
- 2015:
  - One year olds reported all over by sport fishermen
  - YOYs found in coho and pomfret stomachs on GOA project survey
  - More fisherman reporting YOY in coho stomachs
- 2016:
  - Many YOY caught in new surface trawl experiment EGOA
  - More fisherman reporting YOY in coho stomachs

Juvenile sablefish tagging 2015



Juvenile sablefish tagging 2016



Sablefish CIE 2016

- May 10 – 12, Auke Bay Labs, Juneau
  - Noel Cadigan, Memorial University, Newfoundland
  - Neil Klaer, CSIRO (retired), Australia
  - Tom Carruthers, University of British Columbia
- May 27: Consensus recommendations
- July 27: Individual CIE reports
- September 13: Responses to consensus recommendations, some preliminary model responses

Terms of Reference A.

- Evaluation, findings, and recommendations on quality of input data and methods used to process them for inclusion in the assessment
  - *"Assessment authors have generally carefully considered the data inputs regarding error and bias and have appropriately processed them for inclusion in the assessment."* -- **Klaer**
  - *"…further improvements may be possible, particularly concerning the development of a recruitment index from the trawl survey, calculation of fishery CPUE, and the calculation of age-length keys with consideration of measurement error in length and age"* -- **Cadigan**

Terms of Reference B.

- Evaluation, findings, and recommendations of the analytical approach used to assess stock condition and stock status

- *"The outstanding negative feature of the model is that it provides unrealistically precise estimates of stock biomass (CV~ 5%). Simulation studies have consistently found stock assessments of similar structure to provide unreliable estimates of absolute current biomass (Deroba et al. 2015). This may suggest the model is on a particular end of the bias-variance trade-off."* -- **Carruthers**

- *"Of the many stock assessments that I have reviewed this was arguably the most comprehensive, supported by excellent data and subject to careful consideration of alternative modelling assumptions. The fits to the various data were very good to excellent and there was little evidence of model misspecification or pathological model behavior such as strong patterns in residual errors or consistent retrospective patterns in model predictions."* -- **Carruthers**

Terms of Reference C.

- Evaluation, findings, recommendations on estimation and strategies for accounting for whale depredation
- *"I found the text on this model to be confusing. The Binomial and Poisson model structure should be clearly defined. I struggled with Equation (7) in Peterson and Hanselman. This should be more clearly defined and explained …The above models used to estimate depredation effects are fairly complicated because the data are fairly complicated…"* -- **Cadigan**
- *"Although I am not experienced in estimation of- and accounting for- depredation by mammals, the general framework for estimating depredation (presented by Petersen and Hanselman) appears to be defensible"* -- **Carruthers**

Terms of Reference D.

- Evaluation, findings, recommendations of areal harvest apportionment strategy as related to movement and optimizing spawning stock biomass
- *"Tagging and other research indicate high sablefish movement rates throughout their lives which indicate a well-mixed stock. My reservation and uncertainty here is that little is known (or presented to RP) about the spatial spawning dynamics of this stock."* -- **Cadigan**
- *"Available evidence mainly from tagging shows that the stock is highly mixed across all areas and that spawning on the slope is also widely distributed across areas. Compared with many other stocks that are likely to be sub-structured but generally treated as one for management purposes, this is favorable for the Alaska sablefish assessment"* -- **Klaer**

Terms of Reference E.

- Recommendations for further improvements
- *"Continue to conduct ecosystem research that may be used to provide improved tactical fisheries management advice (e.g. definition of regimes, improved precision of short term recruitment forecasts, incorporation of environmental variables in long term recruitment forecasts, essential fish habitat). "* -- **Cadigan**
- *"A spatial operating model can also be used to prioritize regional fishery data collection protocols, establish suitable design of tagging studies and investigate assessment biases due to phenomena such as variable regional recruitment trends."* -- **Carruthers**

CIE Responses (Appendix)

- Short-term
  - Gaining imprecision
  - Incorporate whale depredation
  - Show structural uncertainty
- Long-term
  - Tag-integrated model
  - Growth inside model
  - Consider Canadian catches
  - Fishery CPUE

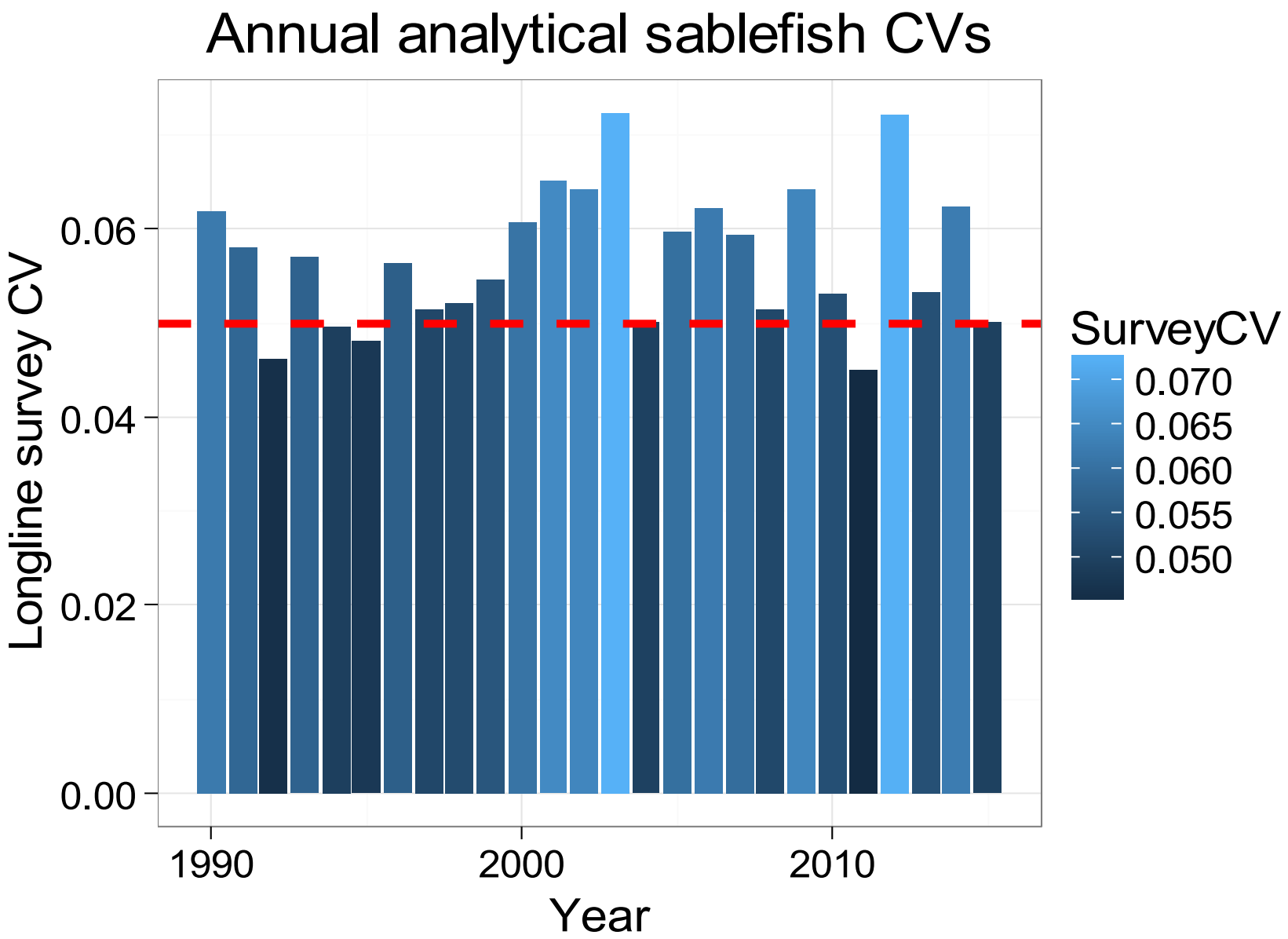
Models (with poor numbering)

- Maintenance updates (B1)
  - Variance estimates on the longline survey
  - New area sizes for the longline survey
- Addressing imprecision
  - Tuning SDNR of LL survey to 1 (B2)
  - Estimating M (B3 & B4)
  - Estimating maturity inside model (B5)

- Including whale depredation (W2 & W3)

LL Survey variance estimates

- Currently use a CV of 5% on the longline survey
  - Based on bootstrapping the data
  - Doesn't account for annual variability
- Now have analytical estimates that assume:
  - Station-stratum combinations are a representative sample
  - There is significant sample covariance between station stratum means:


Annual analytical sablefish CVs
Longline survey CV
0.06
0.04
0.02
0.00
1990
2000
2010
Year
SurveyCV
0.070
0.065
0.060
0.055
0.050

Variance estimates

- Other species have higher CVs:
  - Pacific cod in the GOA: 15%
  - Rougheye in the GOA: 18%

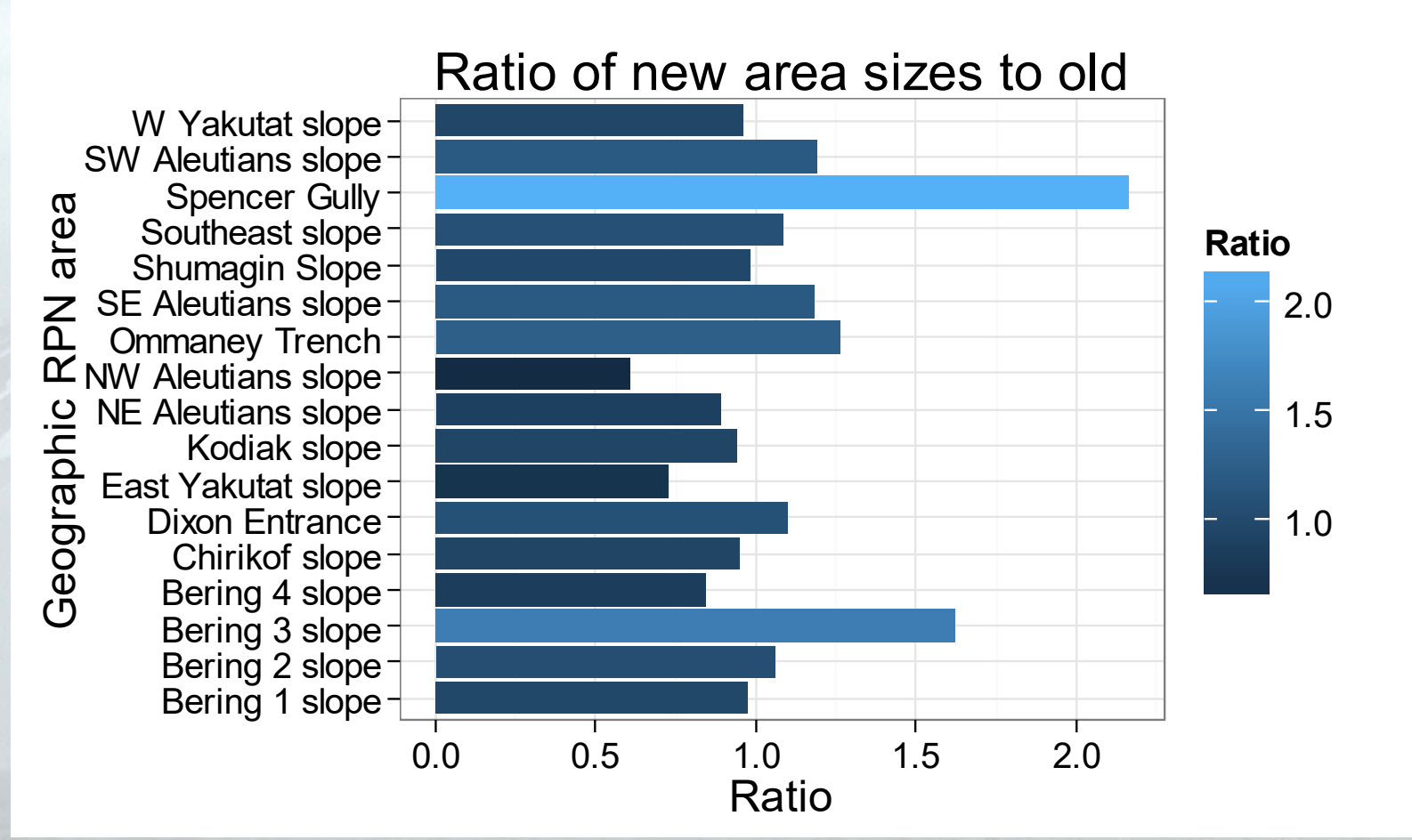
- And when estimated for smaller areas are larger
- E.g., sablefish in the WGOA: CV = 16%
- Will be useful for fitting spatial models and exploring apportionment scenarios

New area sizes

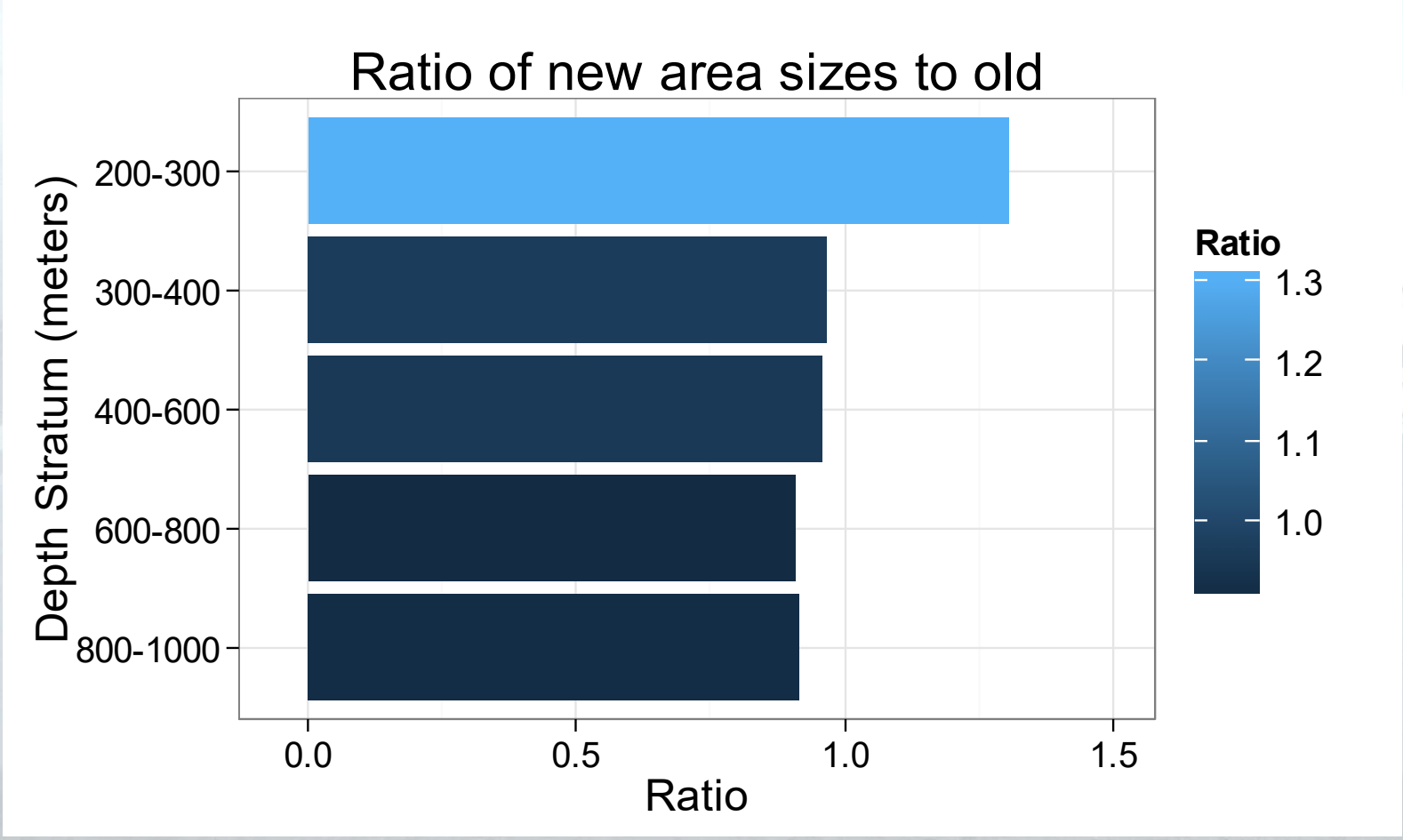
- Echave, K. B., C. J. Rodgveller, and S. K. Shotwell. 2013. Calculation of the Geographic Area Sizes Used to Create Population Indices for the AFSC Longline Survey. NOAA technical memorandum NMFS-AFSC no. 253

- Estimated area sizes using GIS instead of a plenometer
- Updated bathymetry
- Calculated area sizes for 150-200 m depths

New area sizes

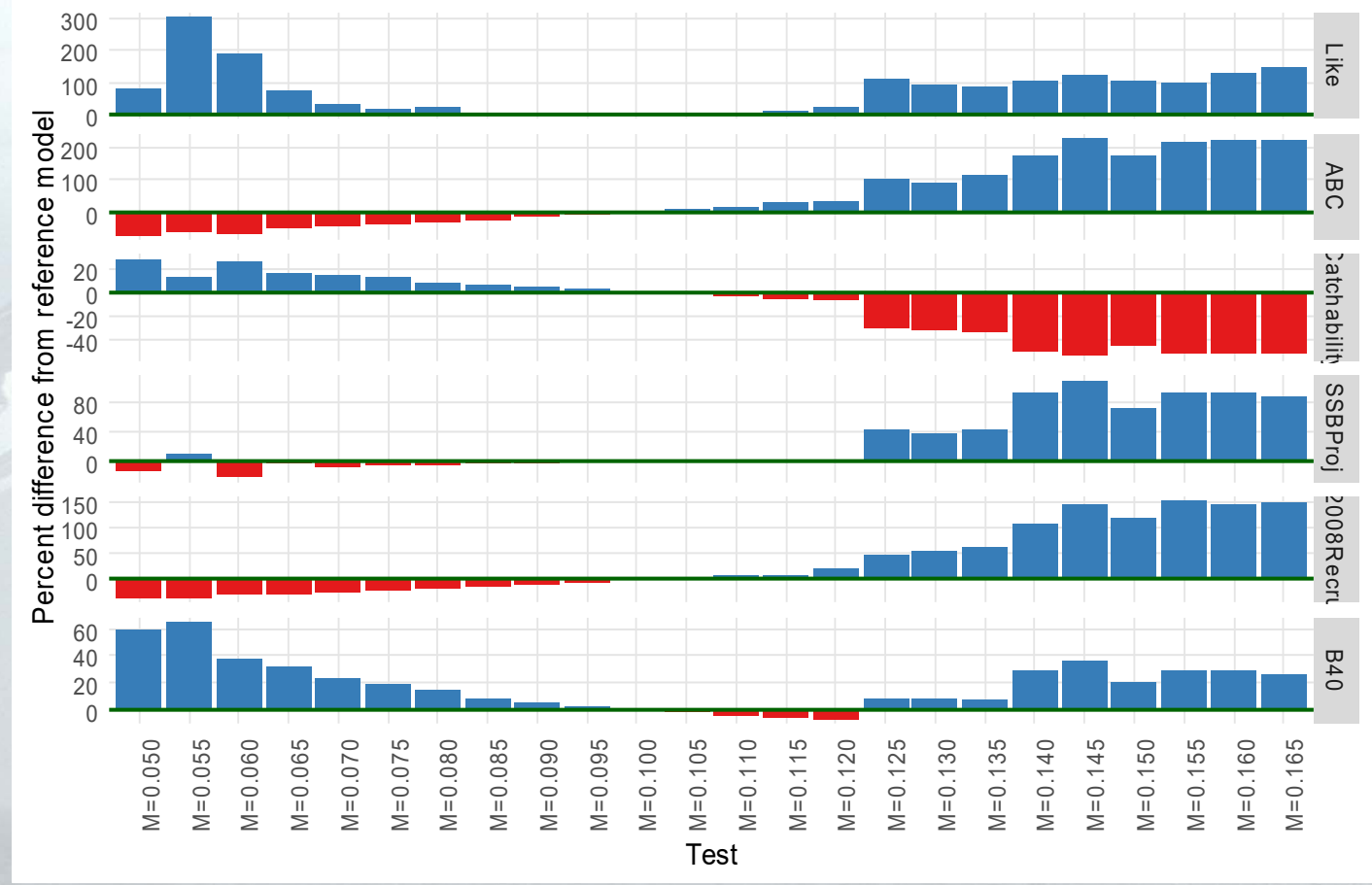


New area sizes

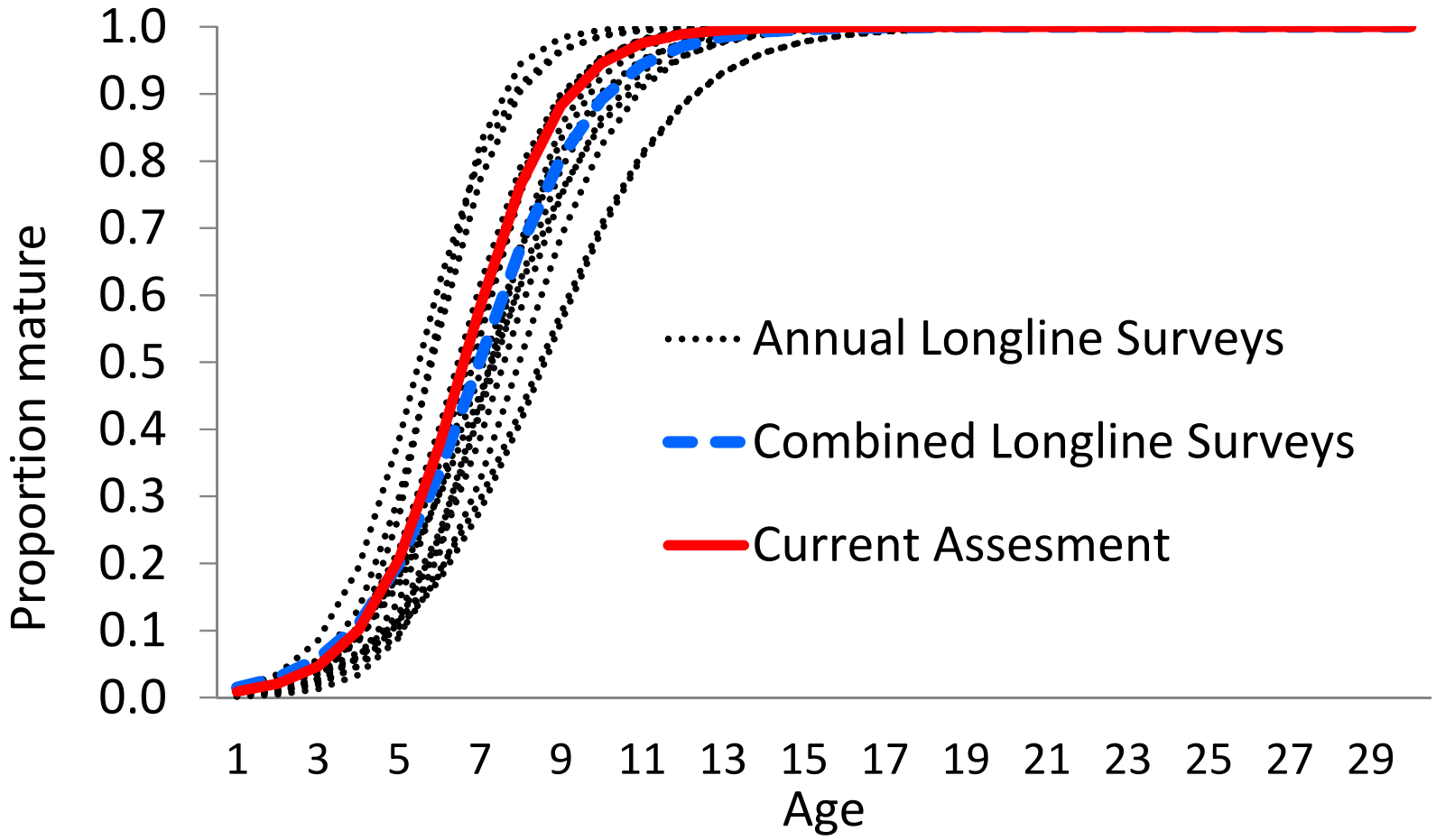


Gaining imprecision

Profiling over natural mortality



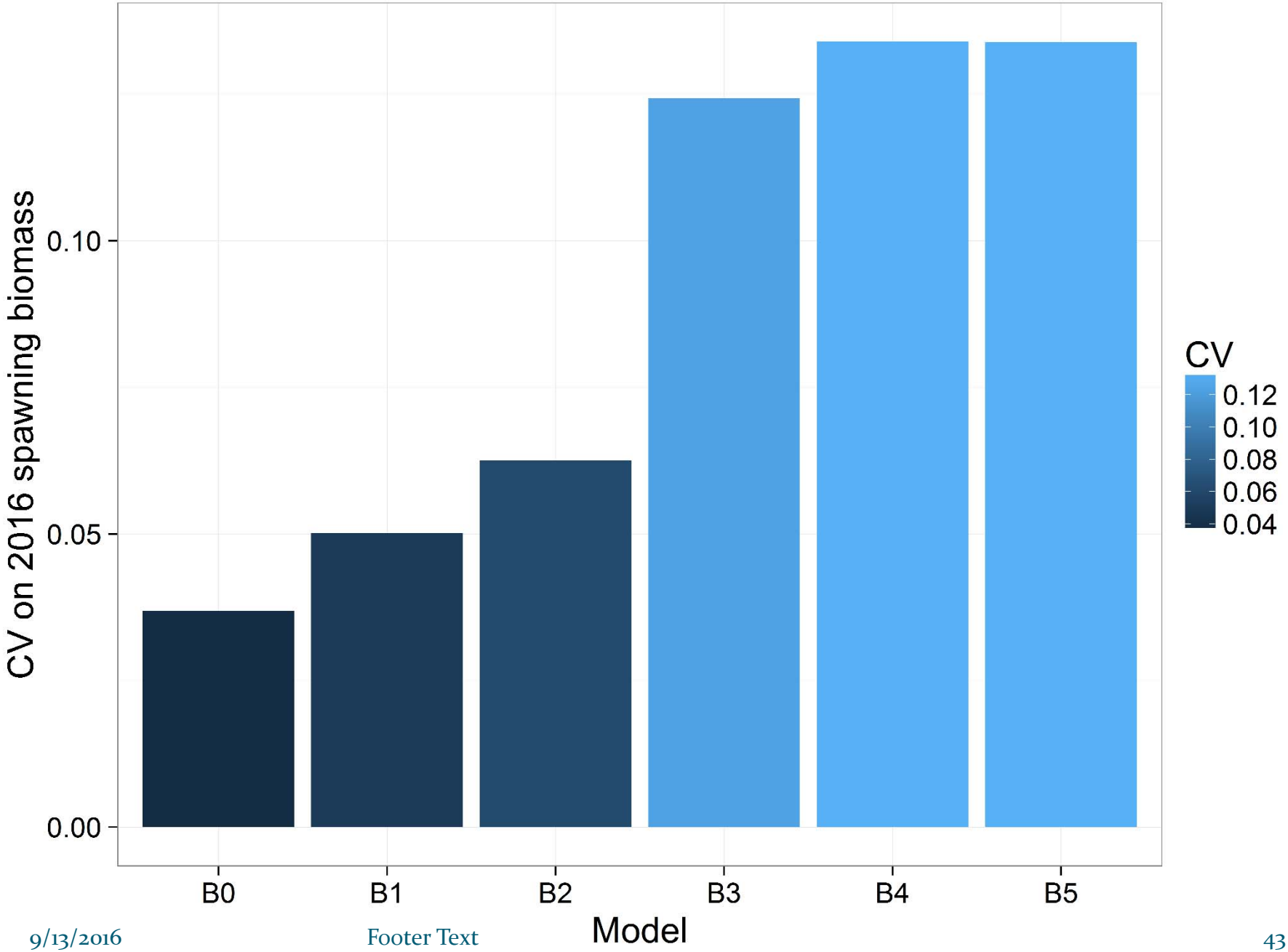
Maturity Data



Gaining imprecision

	B0	B1	B2	B3	B4	B5
Description	2015 model	Variance estimates New area sizes	Tune LL survey to SDNR = 1	Estimate M with 20% CV prior	Estimate M with 500% CV prior	Estimate maturity inside model
SDNR						
Domestic LL survey	**1.92**	**1.83**	**1.00**	**1.00**	**1.00**	**1.00**
Cooperative LL survey	1.50	1.51	0.83	0.83	0.83	0.83
Domestic Fishery CPUE	0.87	0.84	0.45	0.45	0.45	0.45
Japanese Fishery CPUE	1.29	1.42	0.87	0.75	0.75	0.75
GOA Trawl survey	1.82	1.81	0.95	0.95	0.95	0.95
Fishery ages	**1.14**	**1.14**	**1.01**	**1.01**	**1.01**	**1.01**
Fixed fishery lengths	0.89	0.89	0.37	0.37	0.37	0.37
Trawl fishery lengths	**0.84**	**0.81**	**0.99**	**0.99**	**0.99**	**0.99**
Survey ages	**1.02**	**1.01**	**1.01**	**1.01**	**1.01**	**1.01**
Domestic LL survey lengths	0.30	0.29	0.30	0.30	0.30	0.30
Coop. LL survey lengths	0.32	0.32	0.33	0.33	0.33	0.33
GOA trawl survey lengths	**0.97**	**0.97**	**0.98**	**0.98**	**0.98**	**0.98**
Precision/parameters						
2015 SSB	86.6	83.3	85.5	88.6	88.6	83.9
2015 SSB CV	**4%**	**5%**	**6%**	**12%**	**13%**	**13%**
ABC CV	**7%**	**10%**	**12%**	**25%**	**27%**	**27%**
M	0.1	0.1	0.1	0.102	0.103	0.103
Domestic q	7.63	7.56	7.39	7.17	7.12	7.12
-lnL	1558.7	1532.3	1363.9	1361.1	1361.1	1361.1

Gaining Imprecision



Whale depredation and the sablefish stock assessment

Sperm whale and killer whale depredation

Visser 2000

SEASWAP

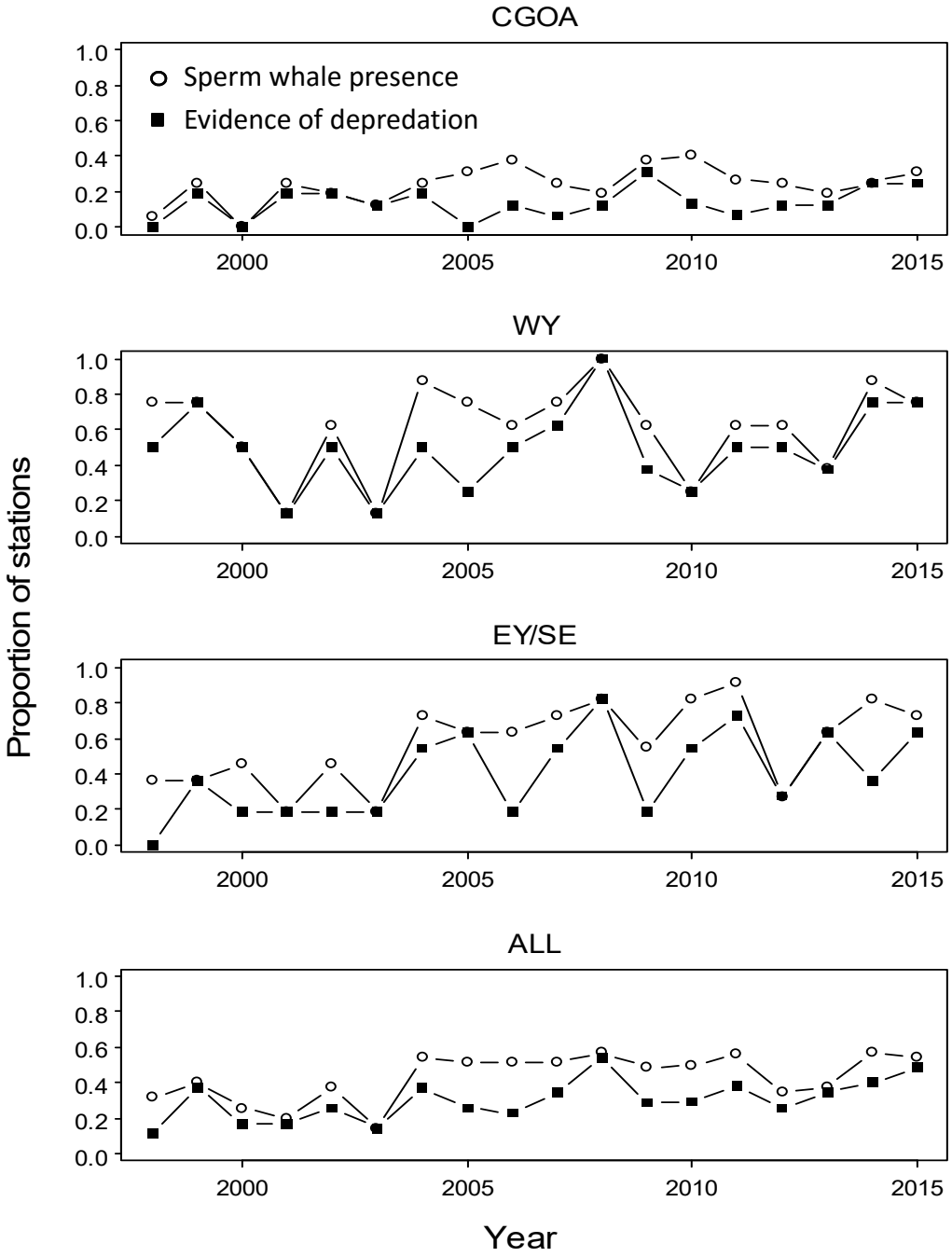
Outline

PART 1: Longline survey abundance index

PART 2: Commercial fishery abundance index

PART 3: Stock assessment application

PART 1: Longline survey abundance index



Increasing trend presence

Increasing trend presence & evidence

Increasing trend presence & evidence

4 across-area models

All across-area models treat area (A_i), depth stratum (D_j), and their interaction $(AD)_{ij}$ as fixed-effects and all remaining terms as random effects, Poisson distribution

$$\log(C_{tjk[i]}) = \log(H_{tjk[i]}) + Y_t + A_i + D_j + (YA)_{ti} + (YD)_{tj} + (AD)_{ij} + (YAD)_{tij} + S_{k[i]} + (YS)_{tk[i]} + (DS)_{jk[i]} + (YDS)_{tjk[i]},$$

Results

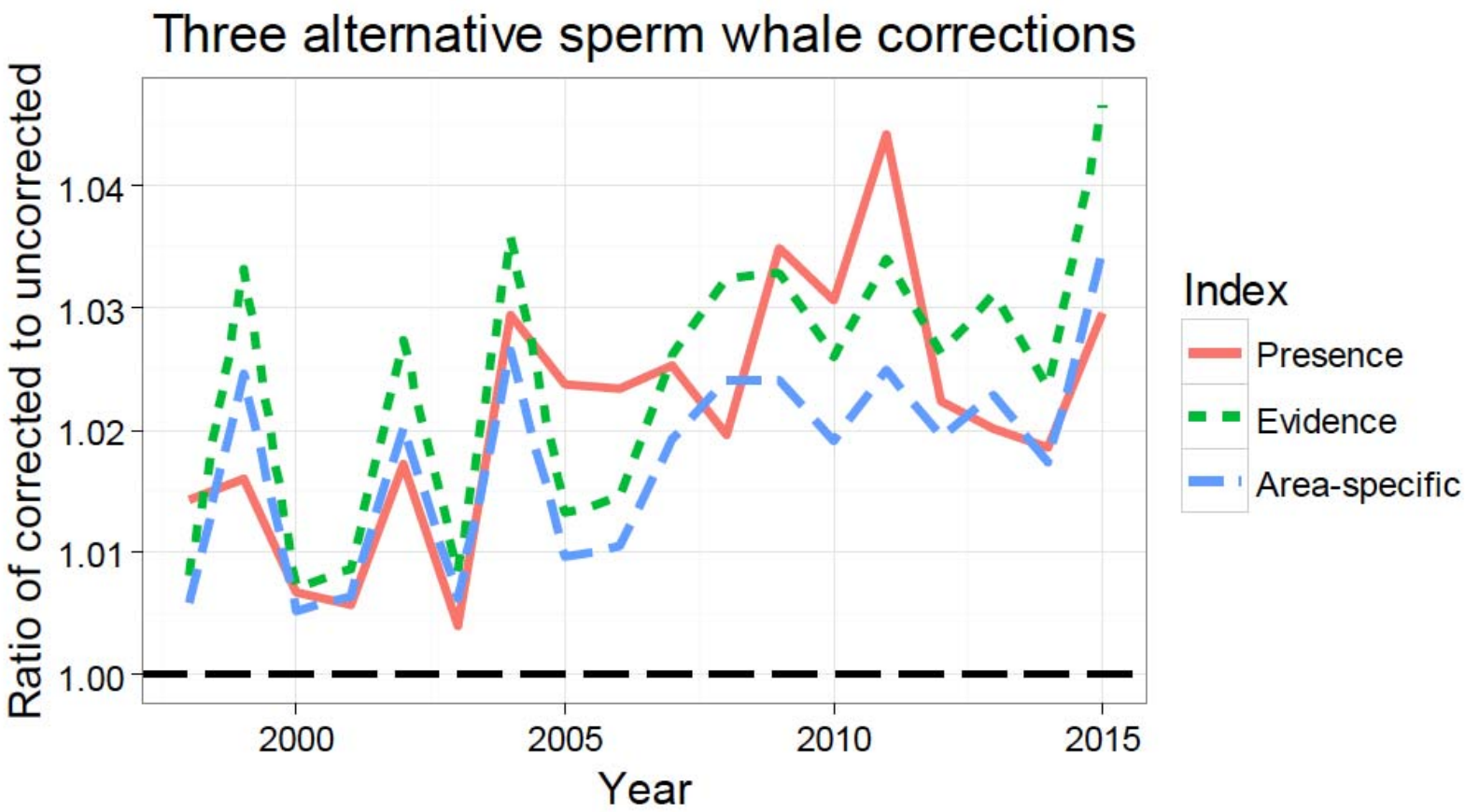
						Proportional change			Delta
Model	Flag	Area	Estimate (λ)	SE	P value	e^{λ}	LCI	UCI	AIC
1	**Evidence**	**All**	**-0.133**	**0.03**	**<0.001**	**0.88**	**0.82**	**0.94**	**0**
2	Evidence	CGOA	-0.117	0.06	0.07	0.89	0.78	1.01	3.9
		WY	-0.13	0.06	<0.001	0.88	0.78	0.99	
		EY/SE	-0.148	0.05	<0.001	0.86	0.77	0.96	

Results con't….

- 12% CPUE reduction across areas (95% CI: 6% - 18%) based on evidence alone

- 9% CPUE reduction across areas (95% CI: 3% - 15%) based on presence

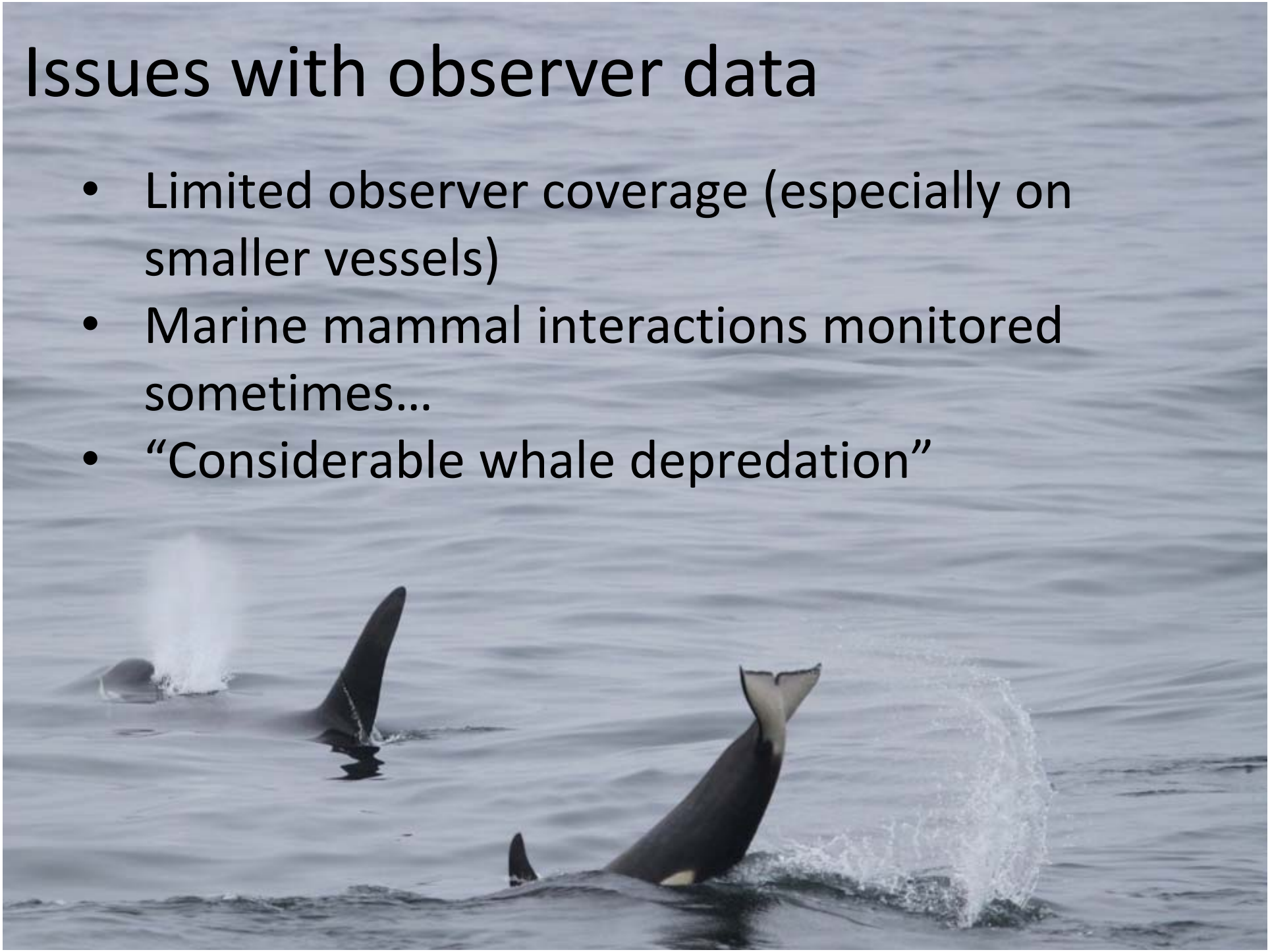
*Evidence flag desirable but presence still a useful/practical proxy for depredation


Three alternative sperm whale corrections
Ratio of corrected to uncorrected
1.04
1.03
1.02
1.01
1.00
2000
2005
2010
2015
Year
Index
Presence
Evidence
Area-specific

PART 2: Commercial fishery depredation

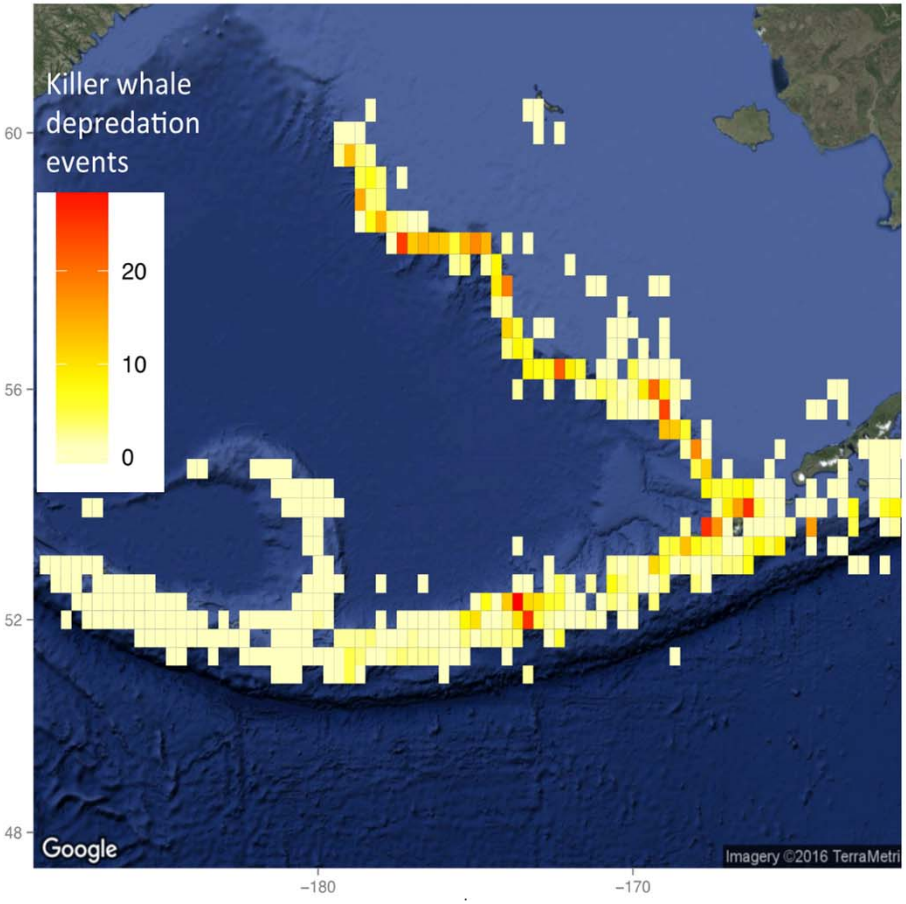
Issues with observer data

- Limited observer coverage (especially on smaller vessels)
- Marine mammal interactions monitored sometimes…
- “Considerable whale depredation”

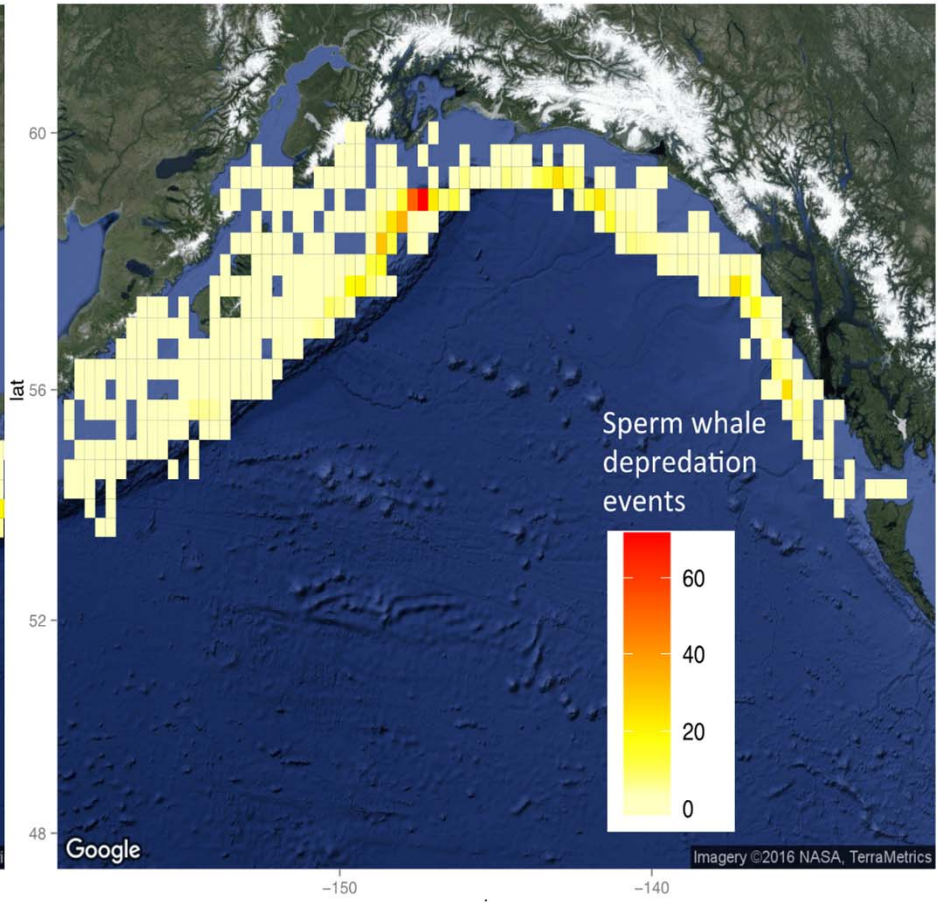


Commercial sablefish fishery observed sets 1995-2014

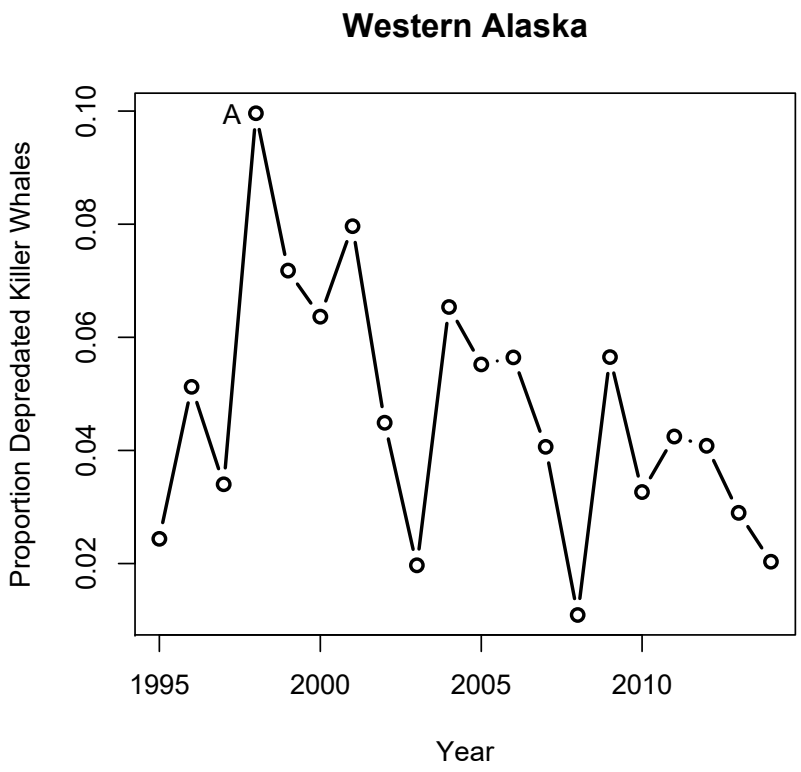
Western Alaska (n=19,921 sets)

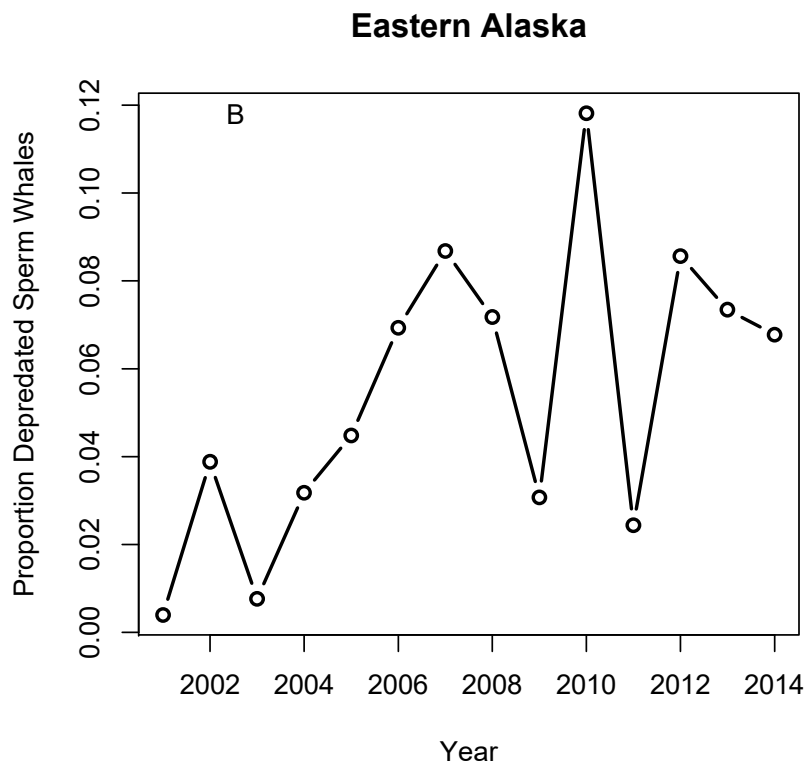


Gulf of Alaska (n=16,443 sets)



Proportion of sets impacted by whales





Compared a number of model formats using area-specific models

- GLMs
- GLMMs
- GAMs
- GAMMs

Point estimates, standard errors, bootstrap/simulations

→ selected GAM model with random effects included

$$Log(sable\_CPUE) = \beta_0 + \boxed{whale\_dep} + depth + jul\_day + (lat,long) + gren\_CPUE + hal\_CPUE + year + vessel + \varepsilon$$

$$Log(sable\_CPUE) = \beta_0 + \boxed{whale\_dep} + depth + year + jul\_day + (lat,long) + vessel + gren\_CPUE + hal\_CPUE + \varepsilon$$

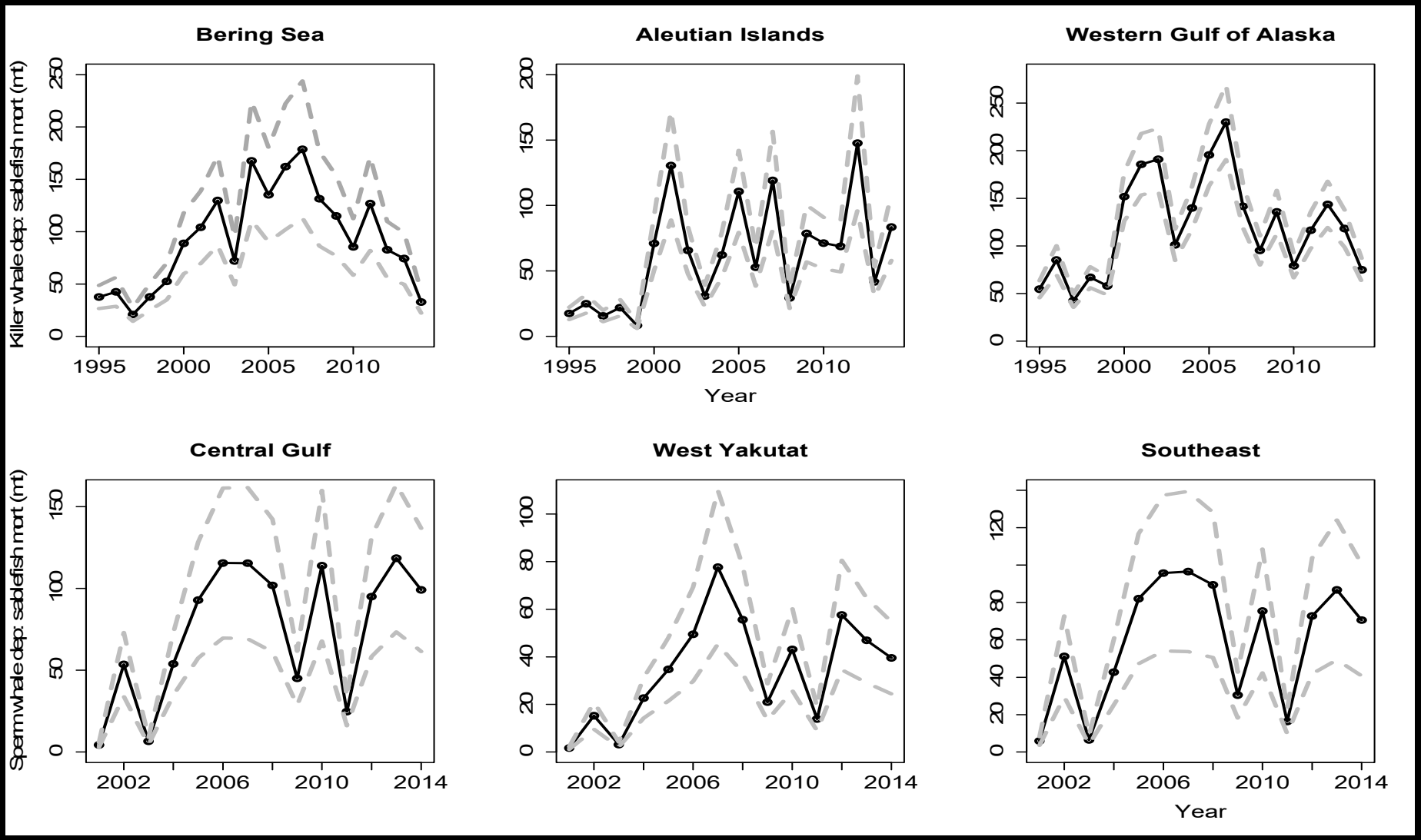
Area	Depredation coefficient (% CPUE red)	2 * SE	n	%dev
Bering Sea	45.7%	40.2% - 51.2%	4339	49.7%
Aleutians	57.7%	50.1% - 65.2%	6744	37.2%
Western Gulf of Alaska	69.4%	63.0% - 75.9%	5950	31.0%
Central Gulf of Alaska	23.8%	19.4% - 28.1%	8218	46.4%
West Yakutat	26.3%	21.5% - 31.1%	3919	52.7%
Southeast	29.4%	22.6% - 36.2%	2865	43.5%

Estimating sablefish removals due to whales

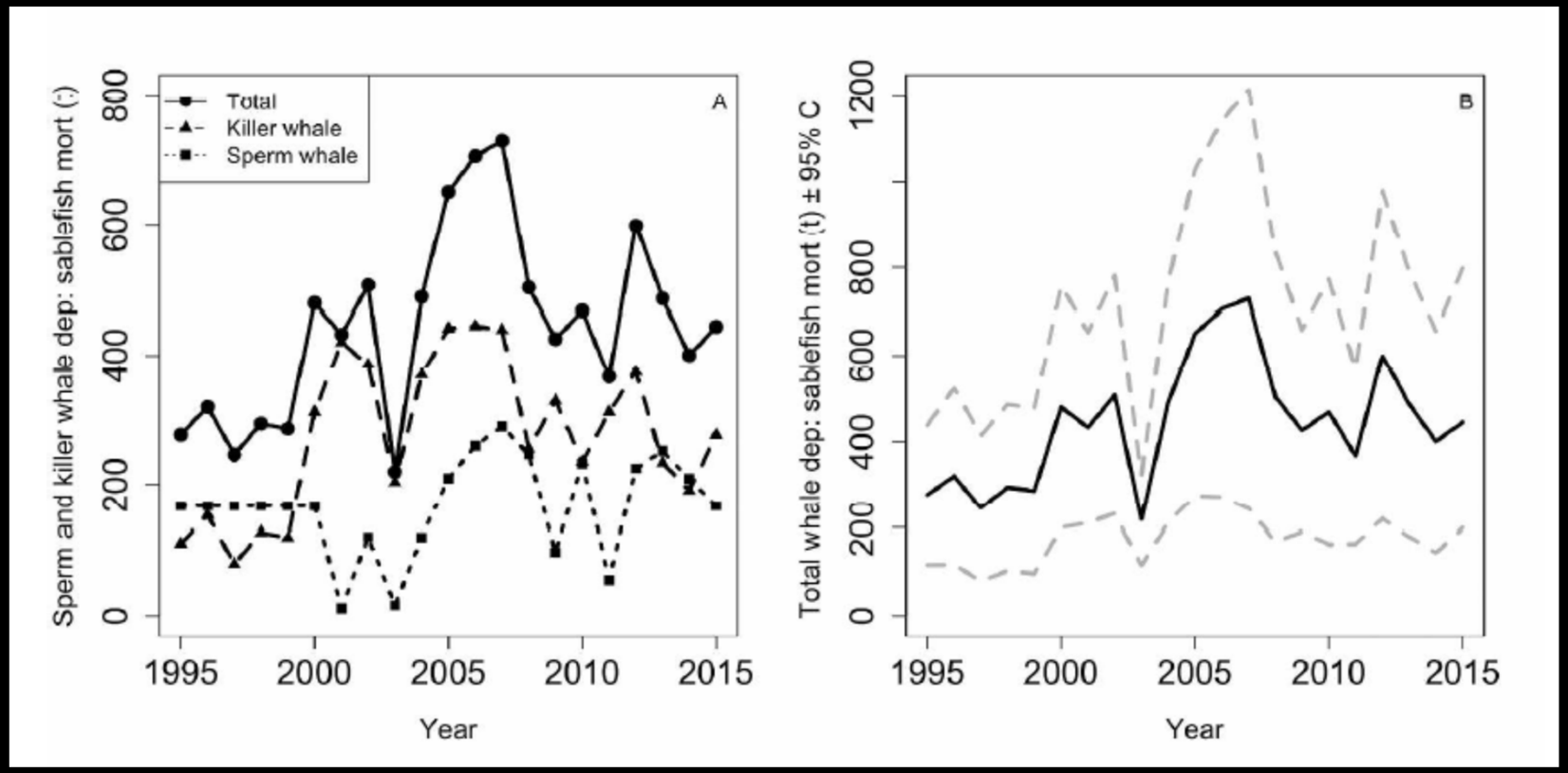
- Data gridded into 1/3° by 1/3° (approx 36 km by 25 km)
- Fishery characteristics averaged or summed per grid
- Zero Inflated Poisson (ziP) distribution GAM to model # sets depredated per grid

$$sable\ mort = \widehat{prop\_dep}\ per\ grid * landings\ per\ grid * \left(\frac{1}{(1 - \widehat{prop\_reduct})} - 1\right)$$

- Landings per grid from Catch-in-Areas database based on Catch Accounting and VMS data (pers.comm. Steve Lewis – AKRO)


Bering Sea
Aleutian Islands
Western Gulf of Alaska
Central Gulf
West Yakutat
Southeast
Killer whale dep: sablefish mort (mt)
Sperm whale dep: sablefish mort (mt)
Year
Year

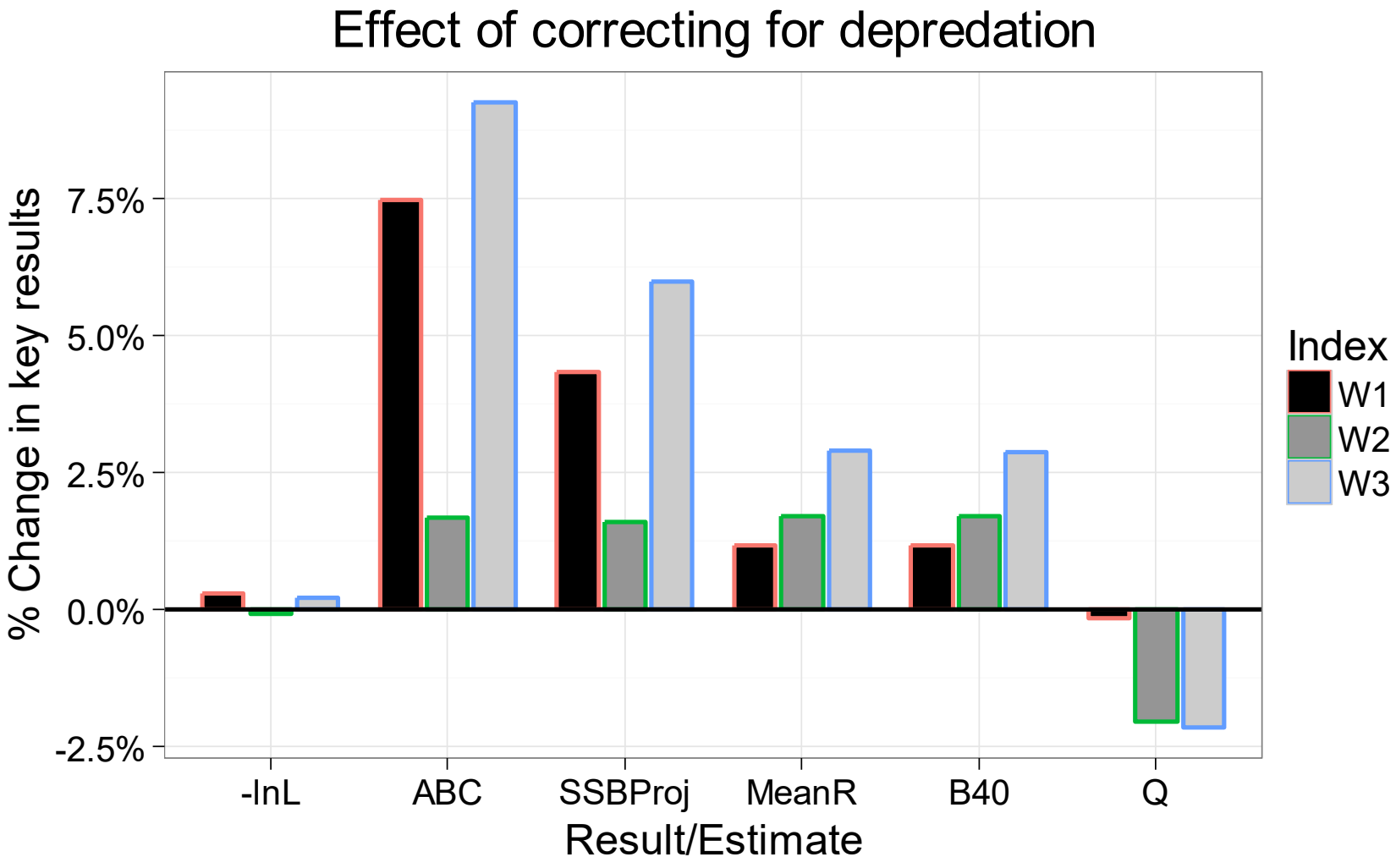
Whale depredation in fishery

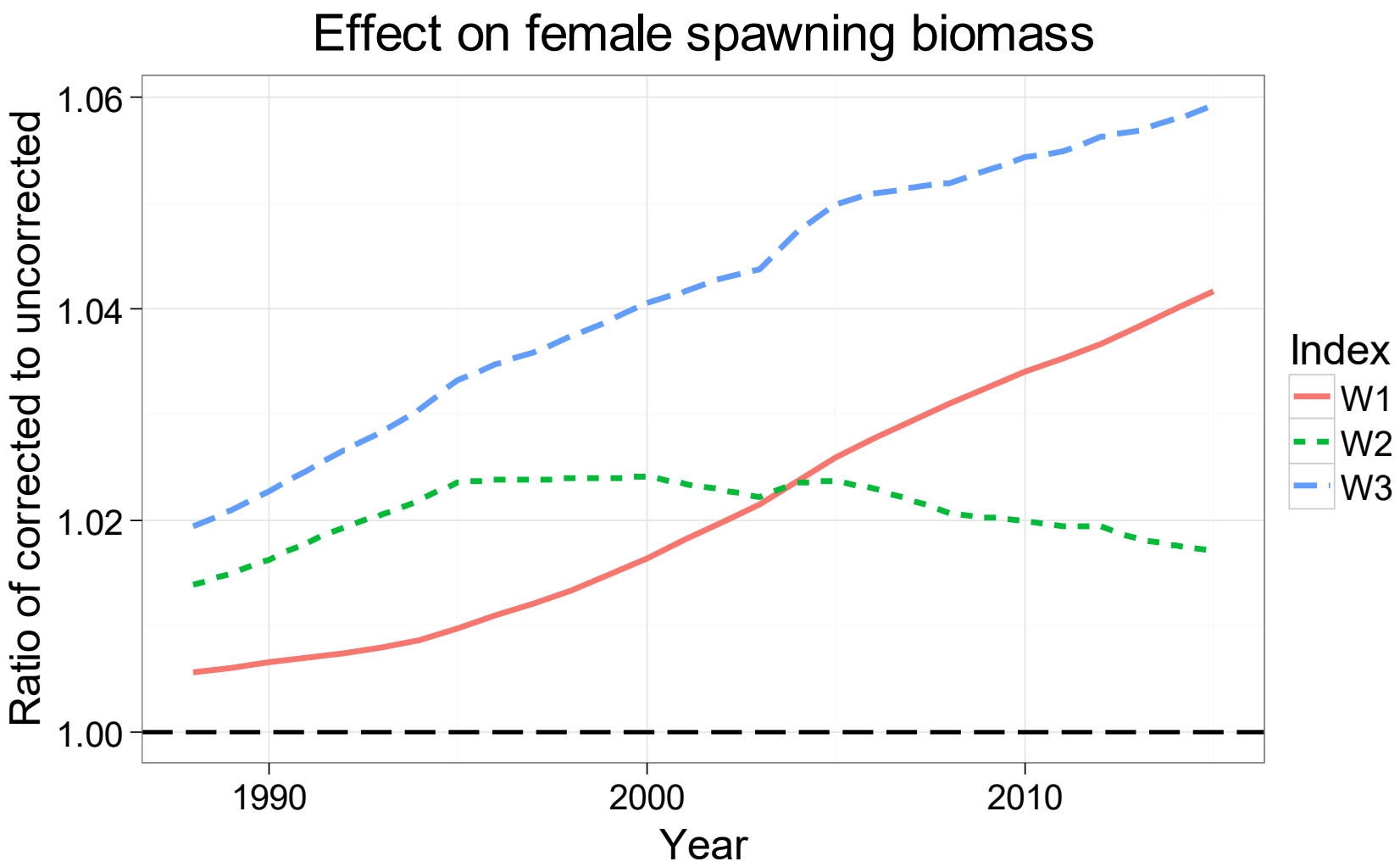


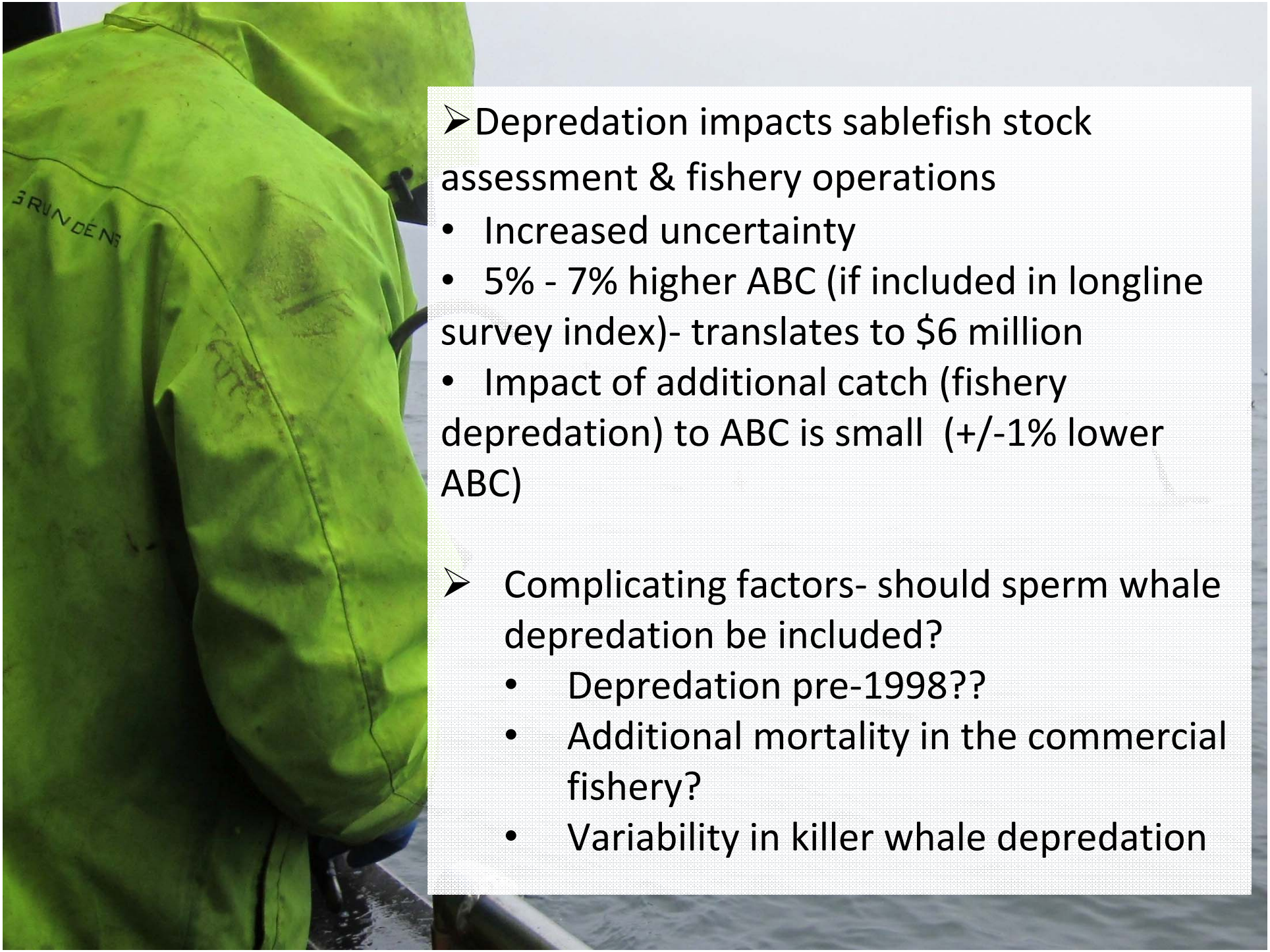
PART 3: Stock assessment application

Incorporating Depredation

- Comparing to Model B1 presented earlier that uses new area sizes and variance estimates
- W1 – correct for sperm whales in survey
- W2 – add additional catch in the fishery
- W3 – do both


Effect of correcting for depredation
% Change in key results
7.5%
5.0%
2.5%
0.0%
-2.5%
-lnL
ABC
SSBProj
MeanR
B40
Q
Result/Estimate
Index
W1
W2
W3


Effect on female spawning biomass
Ratio of corrected to uncorrected
1.06
1.04
1.02
1.00
1990
2000
2010
Year
Index
W1
W2
W3



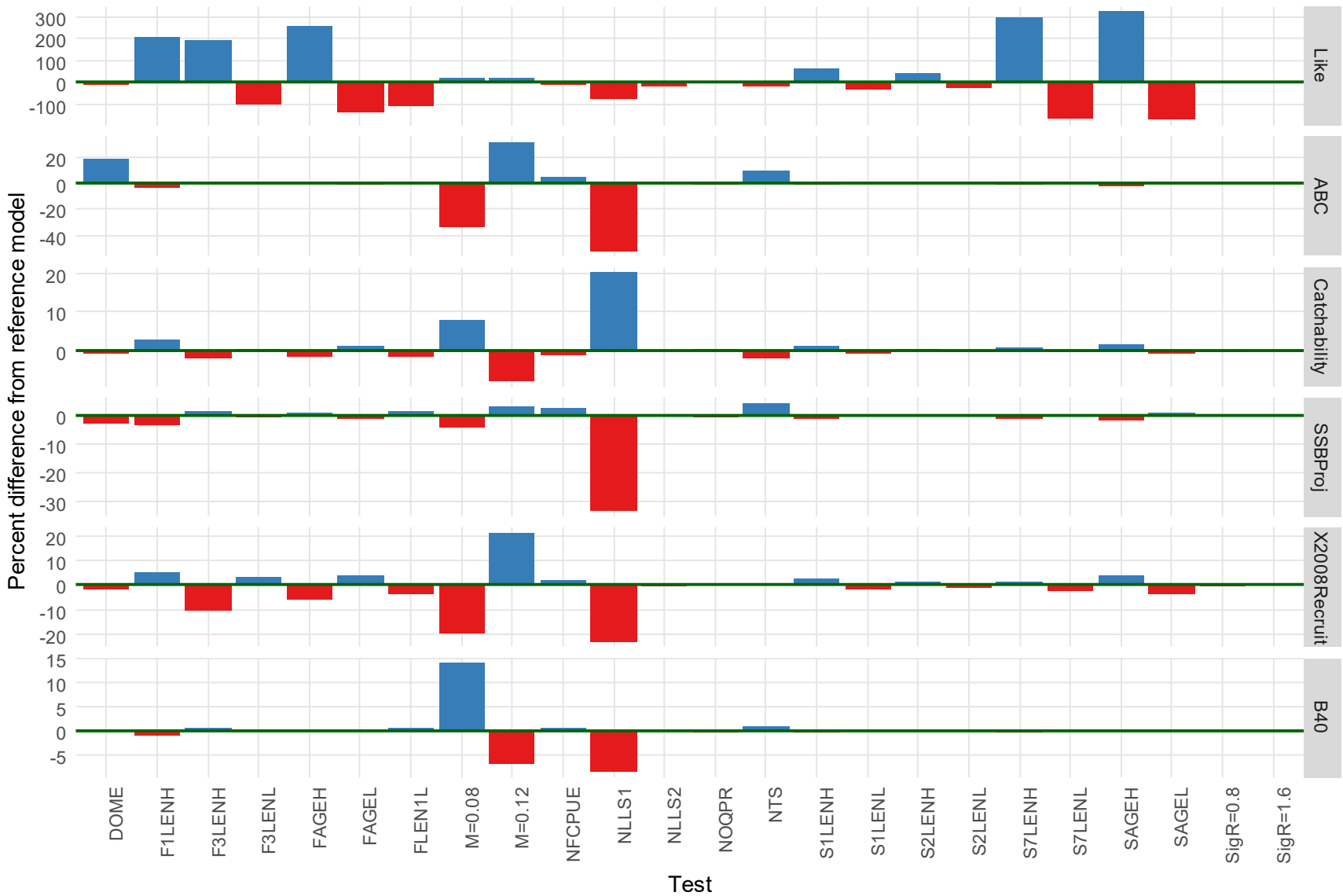
- Depredation impacts sablefish stock assessment & fishery operations
  - Increased uncertainty
  - 5% - 7% higher ABC (if included in longline survey index)- translates to $6 million
  - Impact of additional catch (fishery depredation) to ABC is small (+/-1% lower ABC)

- Complicating factors- should sperm whale depredation be included?
  - Depredation pre-1998??
  - Additional mortality in the commercial fishery?
  - Variability in killer whale depredation

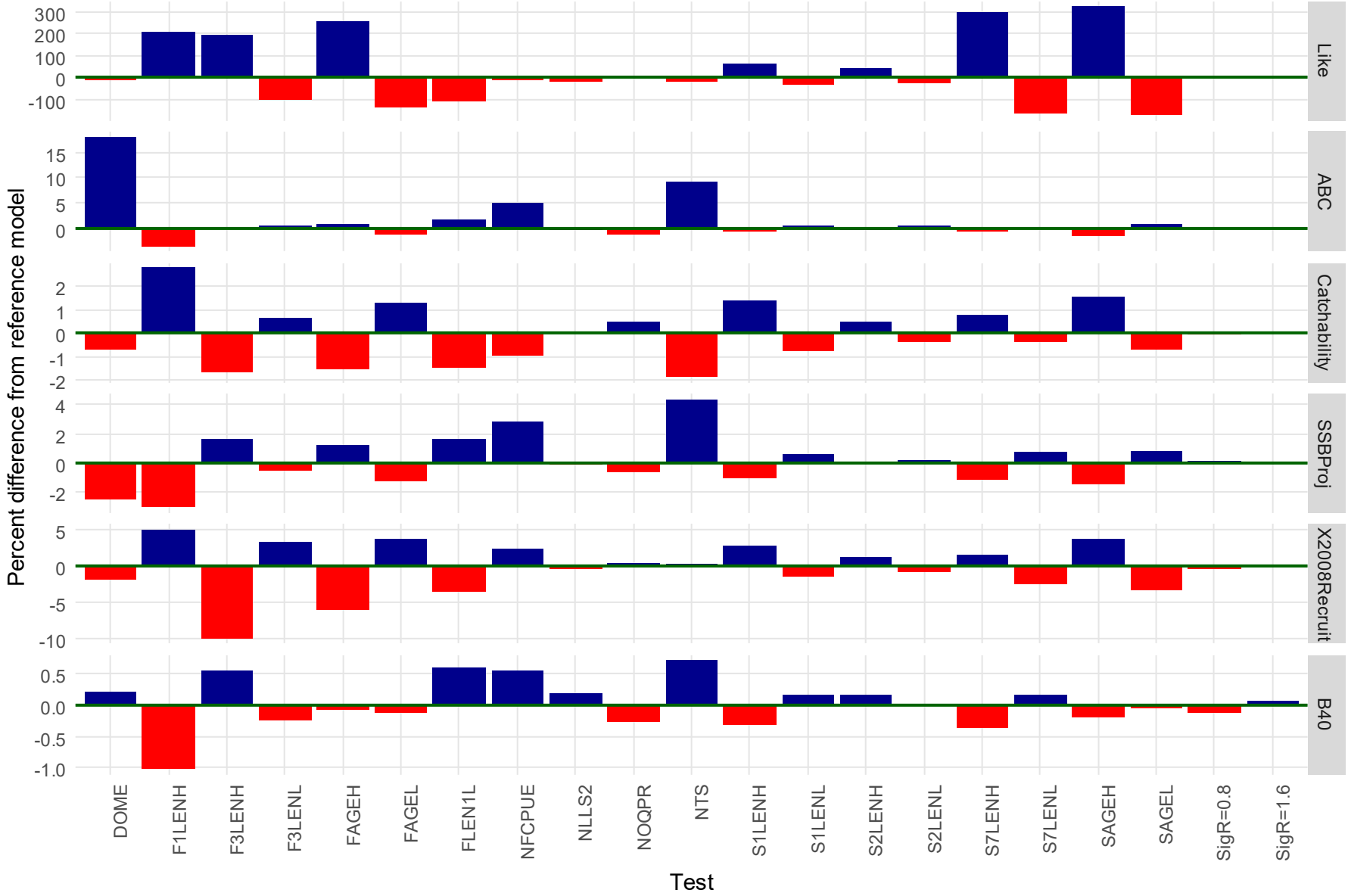
2015 Example

	EY	WY	CG	WG	AI	BS
2015 ABC	2,823	1,567	4,658	1,473	1,802	1,333
Apportionment	11%	34%	11%	13%	10%	11%
2016 ABC	2,438	1,353	4,023	1,272	1,556	1,151
Run with whale corrections for survey and fishery						
Inflated ABC	2,585	1,435	4,265	1,349	1,650	1,220
3 year average depredation	77	48	104	112	91	63
Ratio of 2016 ABC/2015 ABC = 0.86						
Deduct 3 year average * 0.86						
2016 ABC_{WC}	2,518	1,393	4,175	1,252	1,571	1,166
Change	3.3%	2.9%	3.8%	-1.6%	1.0%	1.3%

Sensitivity



Sensitivities (-3)



For November

- Model with ‘maintenance updates’
- Model with SDNRs tuned
- Model with M estimates
- Model with whale depredation
- Maybe all of it (BW.3)

Apportionment

- CIE recommends seeking further input on objectives
- CIE not concerned with static apportionment
- We believe it is best to stay put (and we have no new alternatives prepared)
- MSEs and spatial work continue (and we have a new hire)

Future

- Consider estimating growth within model
- Spatial modeling
- Continue work on recruitment/environmental relationships to improve projections
- Consider alternative recruitment regimes
- Continue maturity work

Questions