

ASSESSMENT OF THE DEMERSAL SHELF ROCKFISH STOCK COMPLEX IN THE SOUTHEAST OUTSIDE SUBDISTRICT OF THE GULF OF ALASKA



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GOA Southeast Alaska Outside (SEO) Demersal Shelf Rockfish (DSR)

- I. History of SEO DSR assessment
- II. Summary of 2022 assessment efforts
- III. Status-quo methods
- IV. Random effects models
- V. Risk table
- VI. Recommendations



GOA Southeast Alaska Outside (SEO) Demersal Shelf Rockfish (DSR)

- DSR Complex: Yelloweye, quillback, copper, rosethorn, China, canary and tiger
 - Yelloweye: Tier 4 (move to Tier 5)
 - Other DSR: Tier 6
- Yelloweye > 95% DSR catch
- Managed by state of Alaska
- Management based on biomass estimates of yelloweye rockfish
- Directed commercial fishing closed since 2020
- Sport fishing restrictions since 2020





SEO DSR Assessment History

- Status-quo methods for over a decade
 - Yearly justification of using lower 90% CI to establish targets
- Age-structured assessment attempted in 2015
 - Issues with fit, stability and uncertainty
 - High sensitivity to M
 - Lack of recruitment signals
- Random effects model in 2013 and 2015
 - Still aimed to use lower 90% CI
 - Greater uncertainty and lower targets than status-quo
 - Models rejected

2022 Assessment

1. Standardize status-quo methods ✓
2. Random effect model updated ✓
 - Spatially stratified
 - IPHC CPUE index as secondary
3. Harvest reconstruction
 - Developing methods to estimate unobserved discards in the halibut fishery
4. State-space surplus production model
 - Development
 - Risk analysis

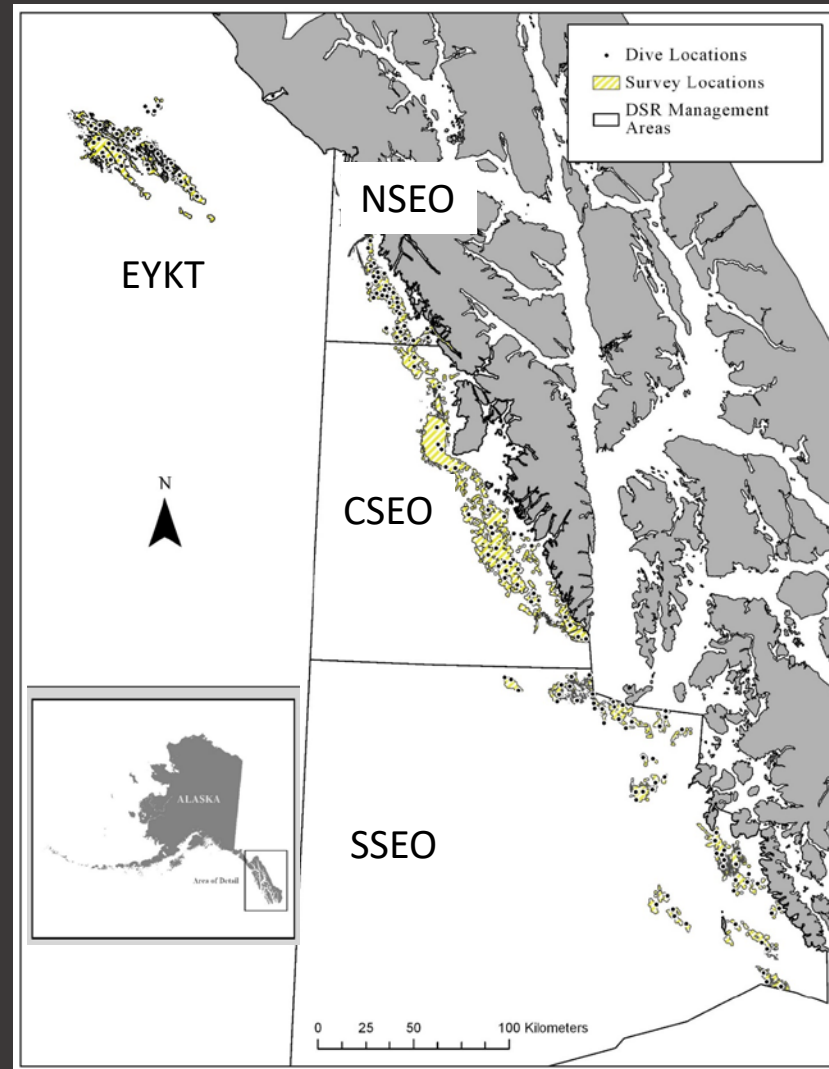
September Plan
Team
Recommendations:

OFL and ABC

Research Model
CIE review in 2023

Current Management

- 4 management areas
- Submersible/ROV surveys = Yelloweye **density** at management area level (1 area/ year)
- Biomass = Density*Weight*Habitat (km²)
- SEO Biomass = Σ (*most recent density estimates** updated weight data*Habitat)
- Assumed natural mortality M
- $F_{OFL} = M = 0.032$
- $\text{Max } F_{ABC} = M = 0.026$
- $\text{Rec } F_{ABC} = M = 0.02$

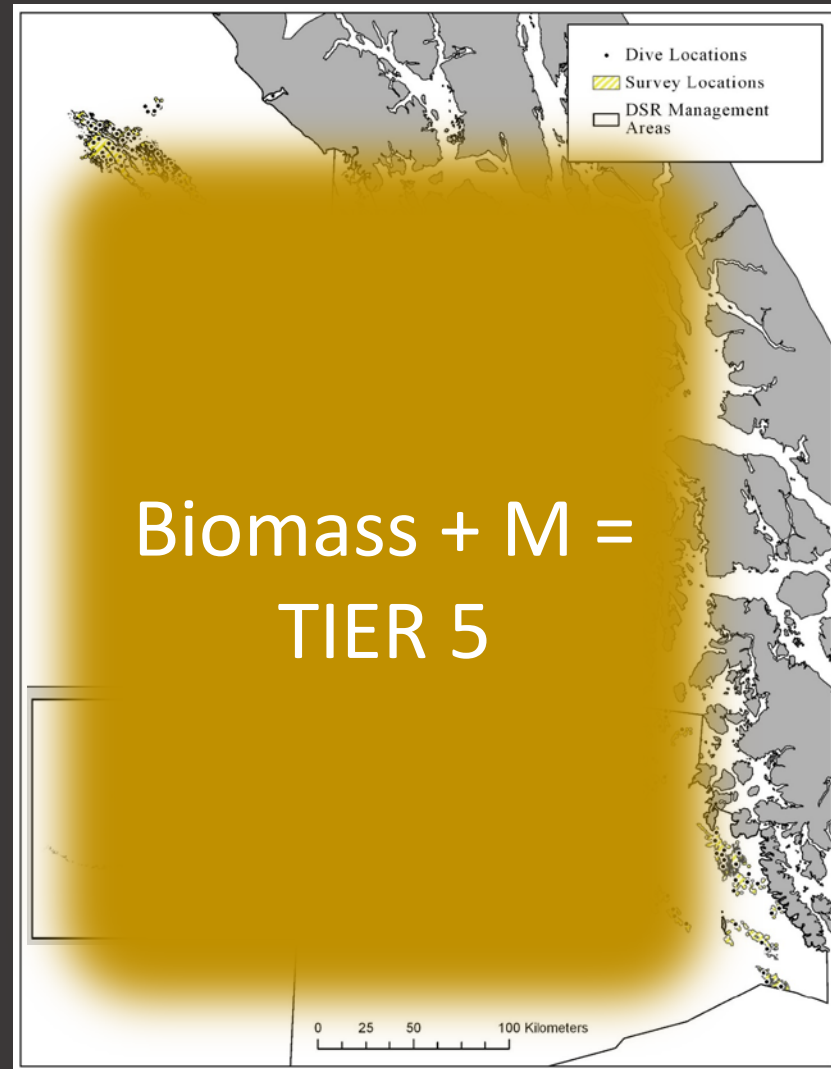


* Biomass lower 90% confidence interval

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? **Plan Team: Where'd these numbers come from?**
? * Lower 90% Confidence Interval
Green et al. 2015

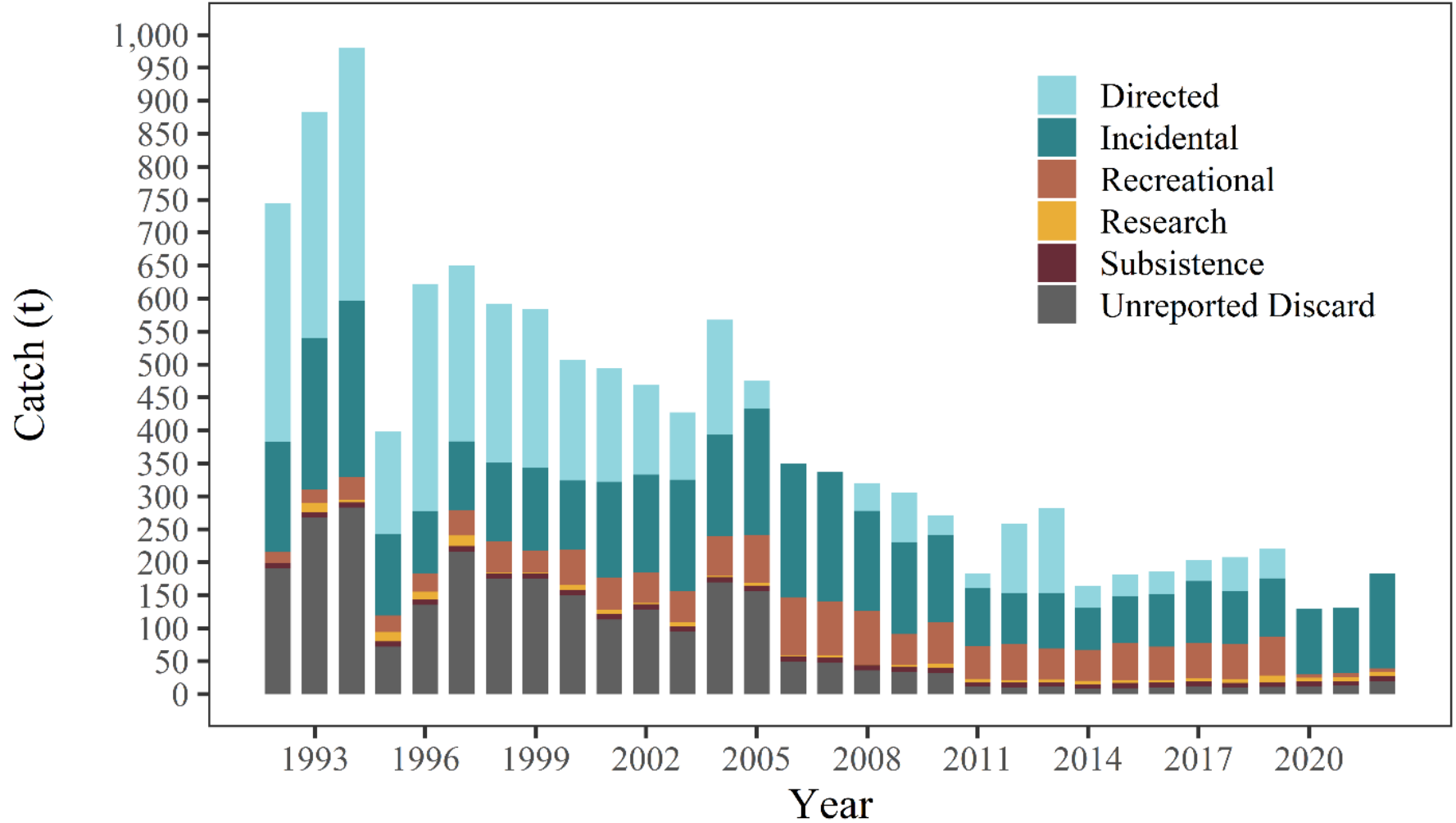


Density Estimation

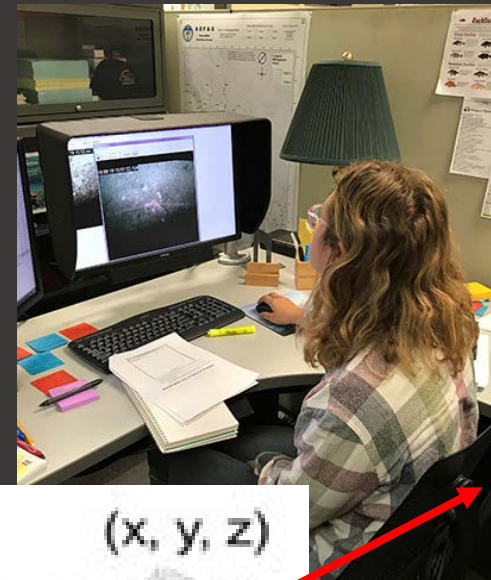
- Distance sampling methodology using ROV surveys
- Transect locations randomly selected
- Sample size based on encounter rate and desired precision ($< 15\%$)
 - At least 20 transects (each ~ 1 km)
 - At least 80 fish total
- Dives recorded on stereoscopic cameras



Catch History

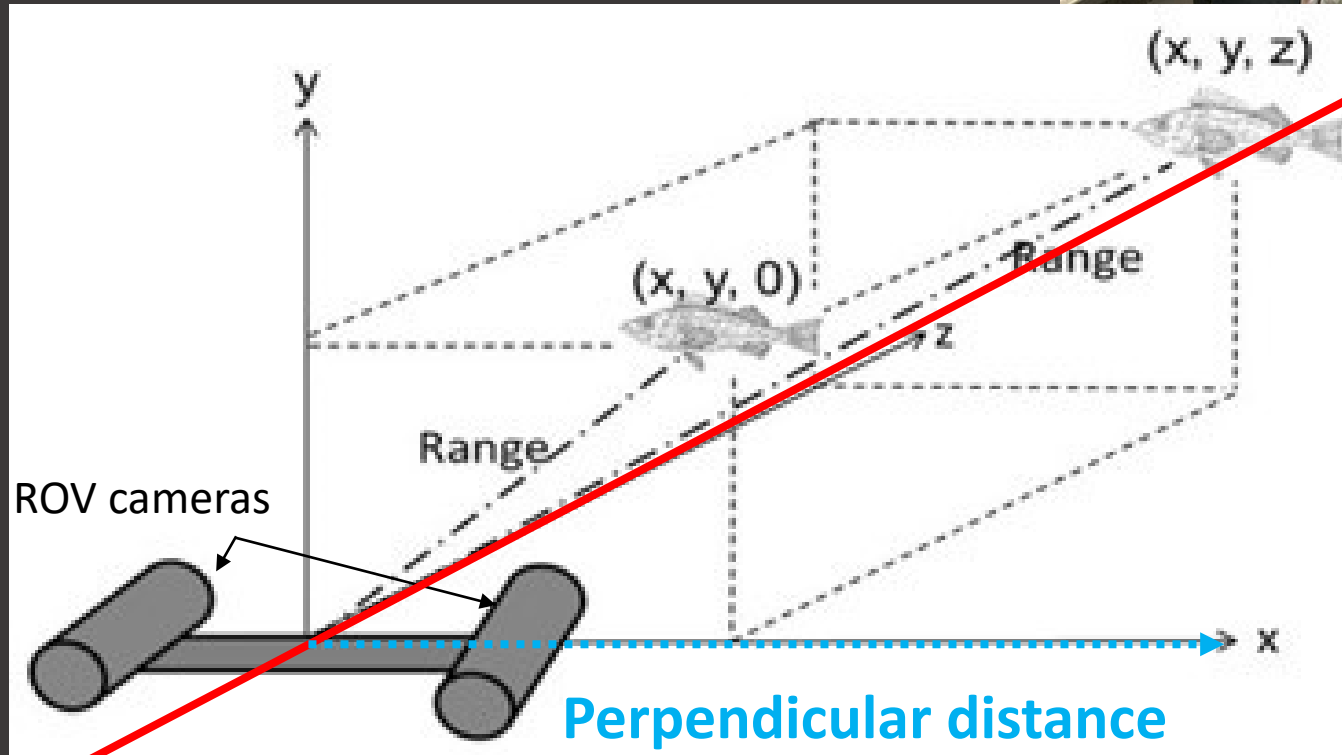


Density Estimation



Video review:

- Numbers of yelloweyes and their distance from transect line

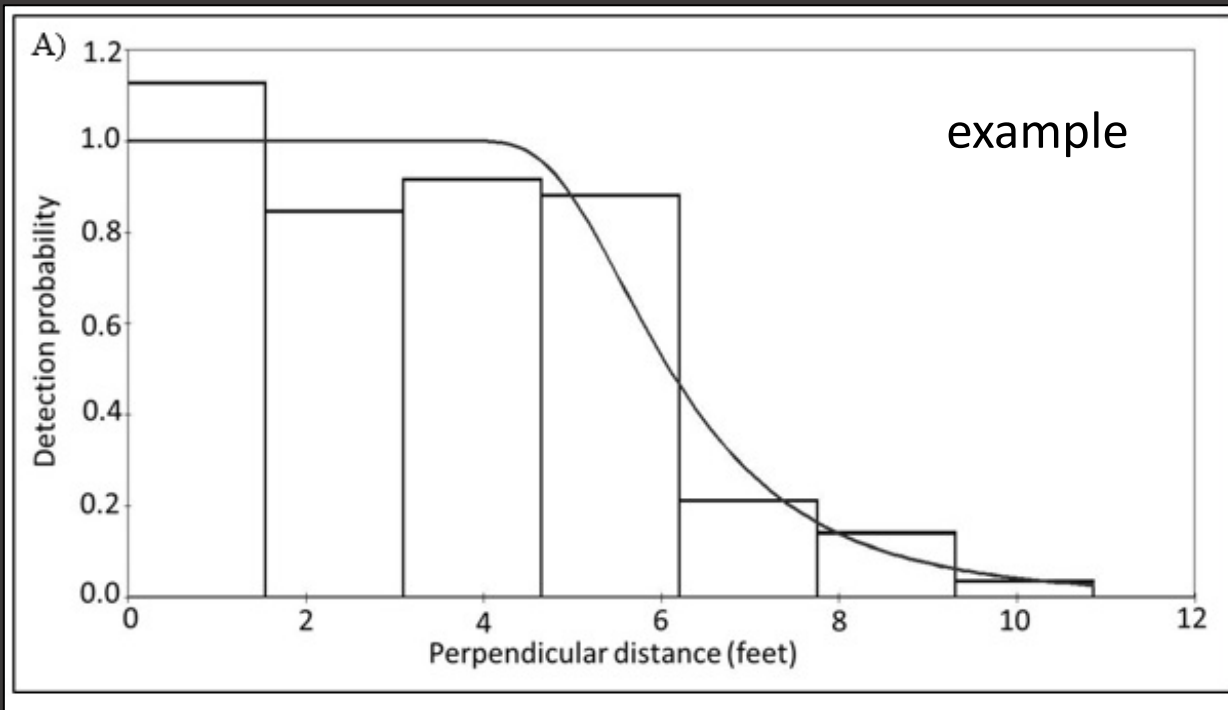


Transect

**Perpendicular distance
from transect line**

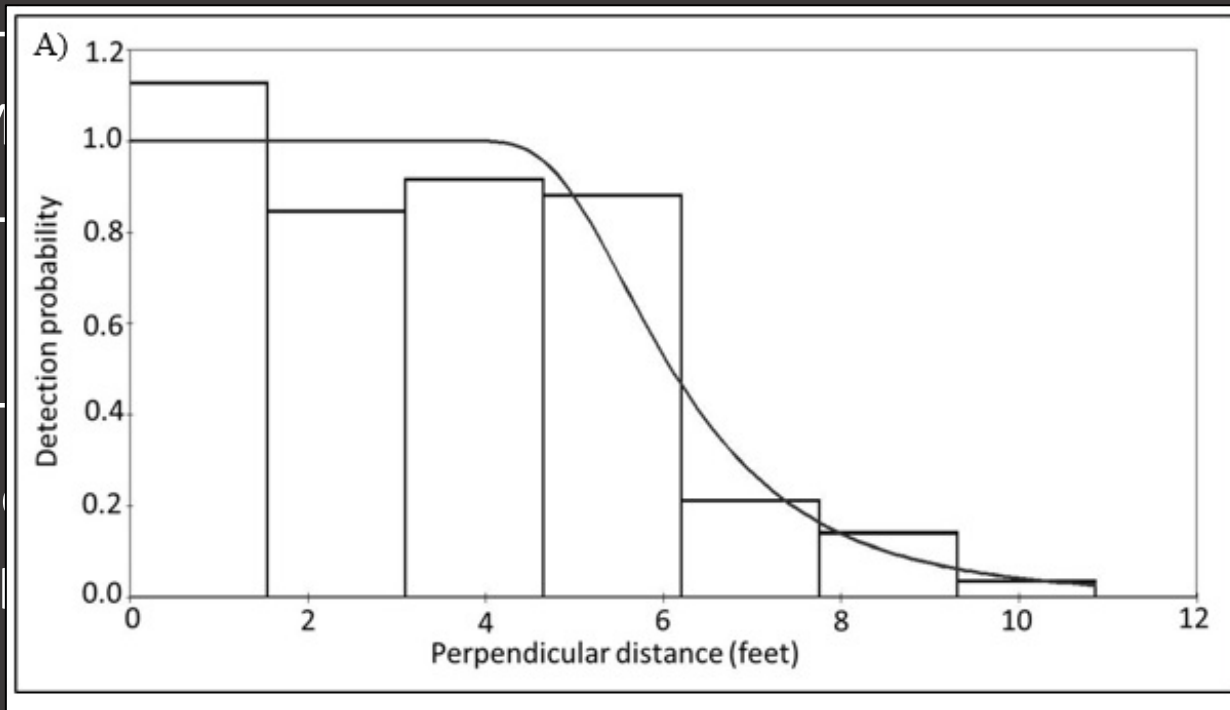
Density Estimation

- Distance sampling methods applied using *Distance* package in R:
- Data fit to detection function describing probability that a fish is observed given it's distance from transect line



Density Estimation

- Distance Sampling Methods (Distance package in R):
- Data fit to detection function describing probability that a fish is observed given it's distance from transect line



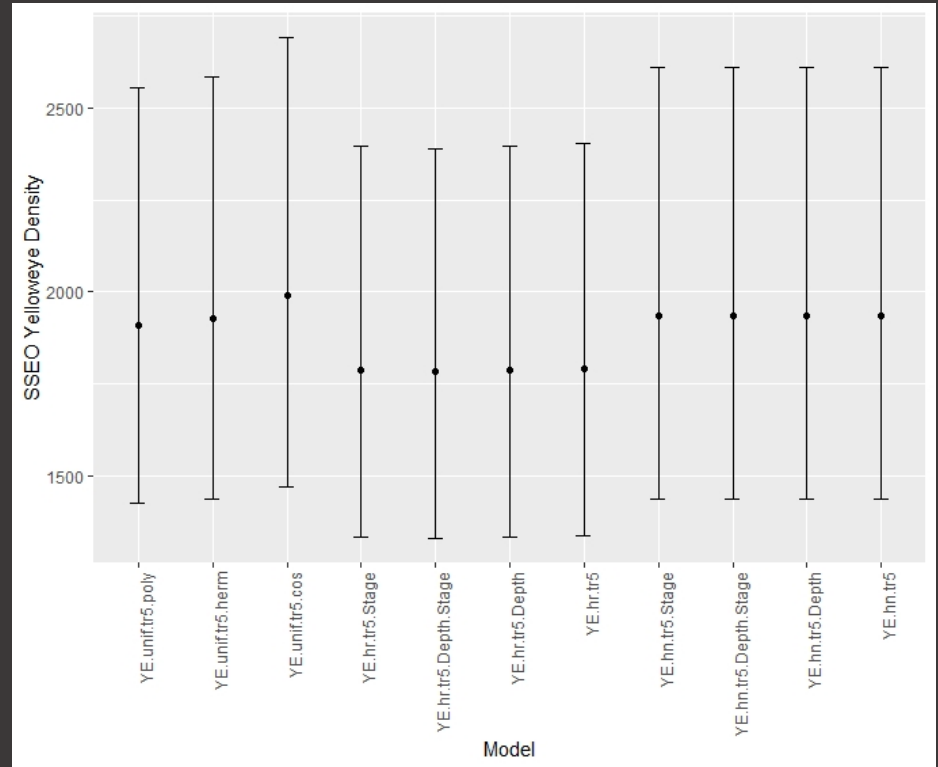
sub-adult)

al

functions

Density Estimation

- Final density estimate from model averaging (Thomas et al. 2010)
- Multiple models with similar AICc (delta AICc < 6) = uncertainty in true shape of detection function
- Bootstrap procedure
 1. Resample transects with replacement
 2. Fit candidate models to bootstrap sample
 3. Pick “best” model based on AICc
 4. Save density
 5. Model averaged density = average of bootstrap densities and CV from sd of bootstrap estimates

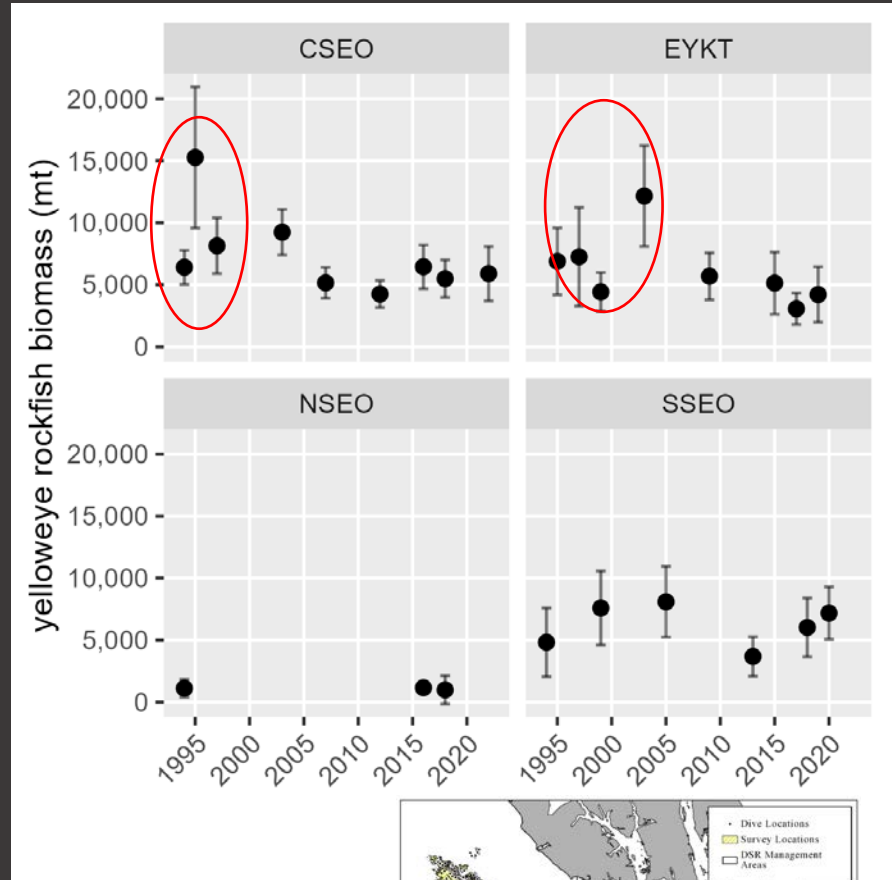


Biomass estimate

- Density (+ variance)
- * Avg. weight of yelloweye from portside sampling (+ variance)
- * Estimate of yelloweye habitat (**no variance**)

= Management Area Biomass

*High interannual variability;
unlikely for long lived species*

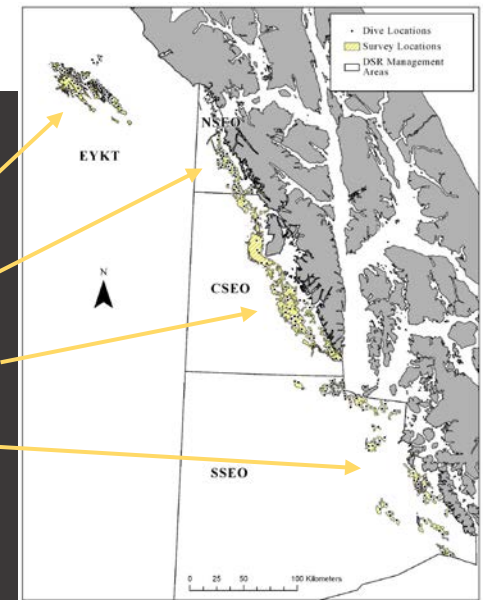


EYKT: 739 km²

NSEO: 442 km²

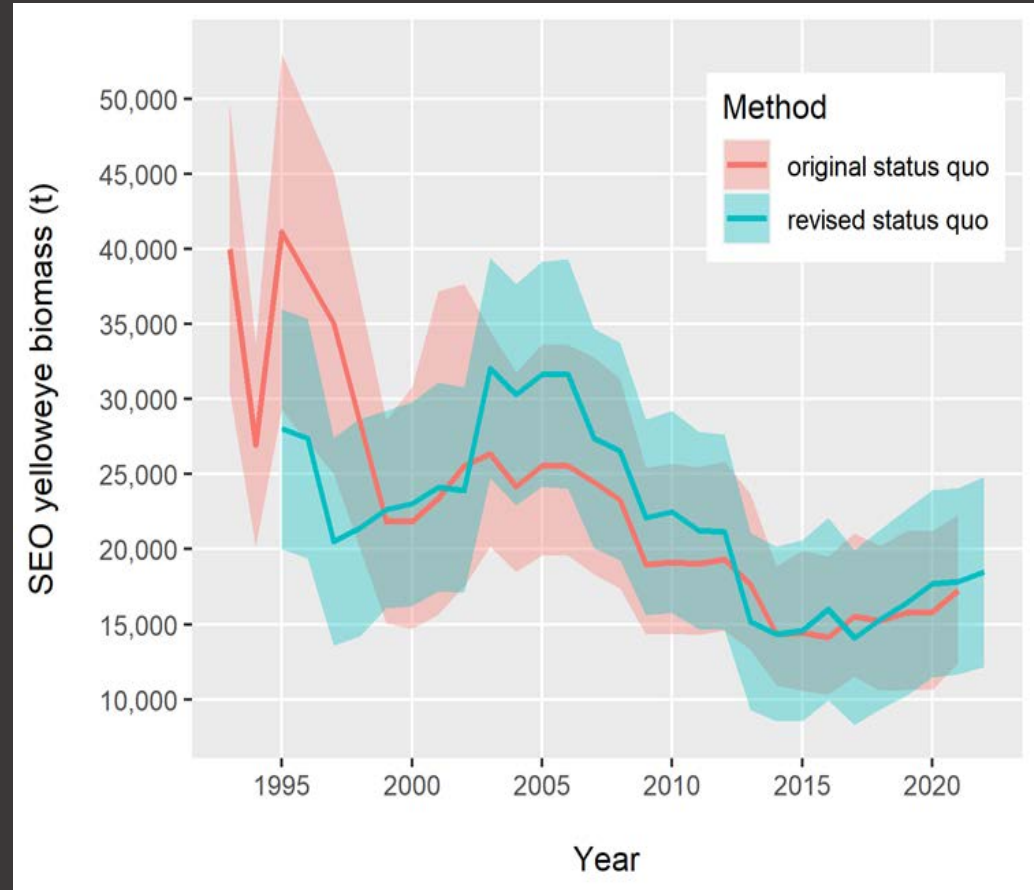
CSEO: 1,661 km²

SSEO: 1,056 km²



Biomass est.

- SEO Biomass = Σ (*most recent density estimates** updated weight data* Total Habitat)

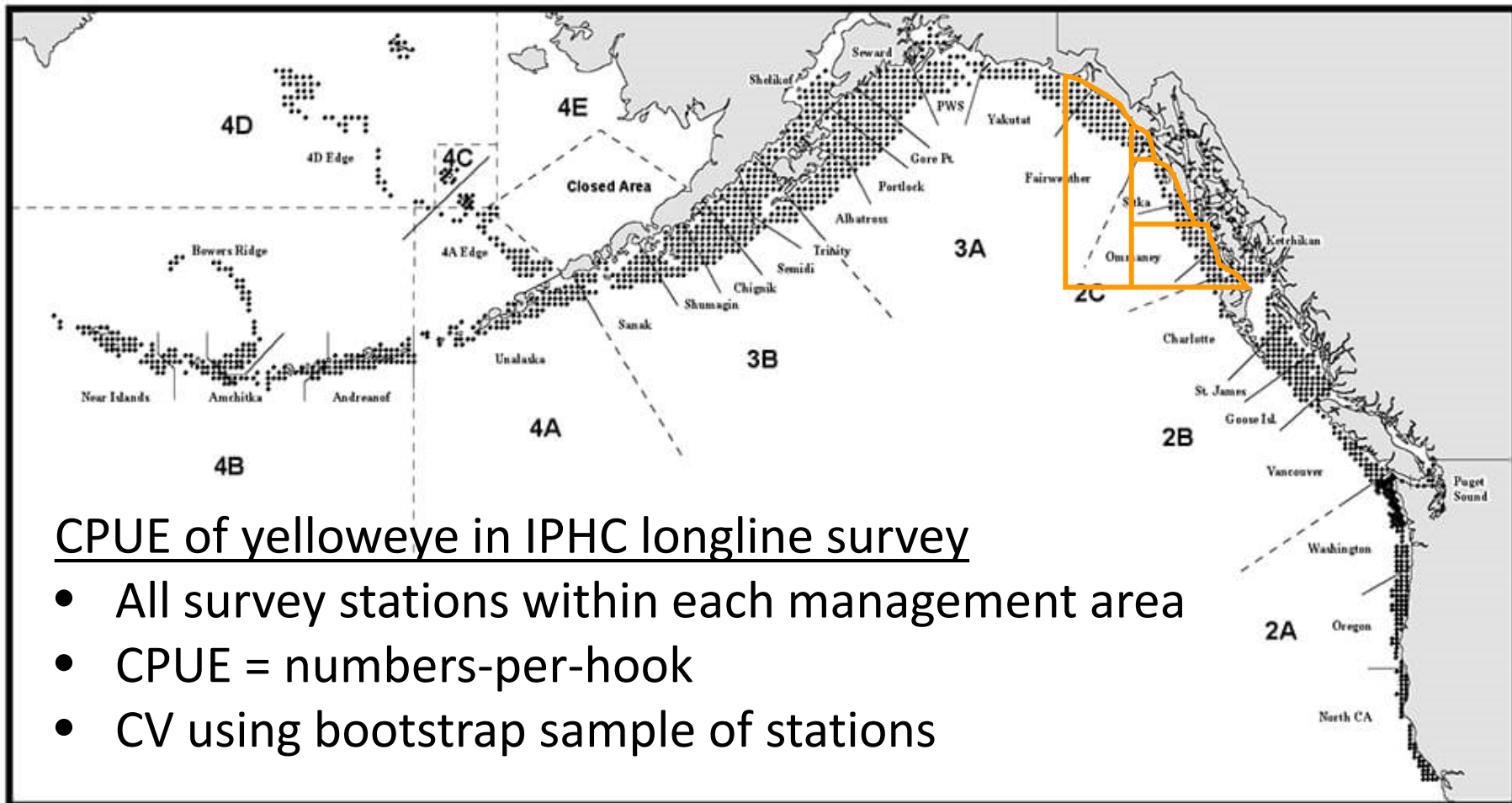


- Uncertainty in calculations?
- Amount of habitat
- Application of density to areas

Random Effects Model

- Assess biomass across management areas
- Biomass estimated as a series of random effects
 - Process error parameters constrained using random walk model
 - Accommodates data gaps (missing years)
- Management area ROV biomass estimates
- IPHC survey CPUE as secondary abundance index (management area scale)
- Extra variance (observation error) on ROV biomass
- AIC and visual examination to assess fit and compare models
- *rema* package in R





Random Effect Models

Model	IPHC CPUE	Extra variance in biomass	Δ AIC
22.1	YES	No	9
22.2		Yes	0
22.4	NO	No	1.6
22.5		Yes	0

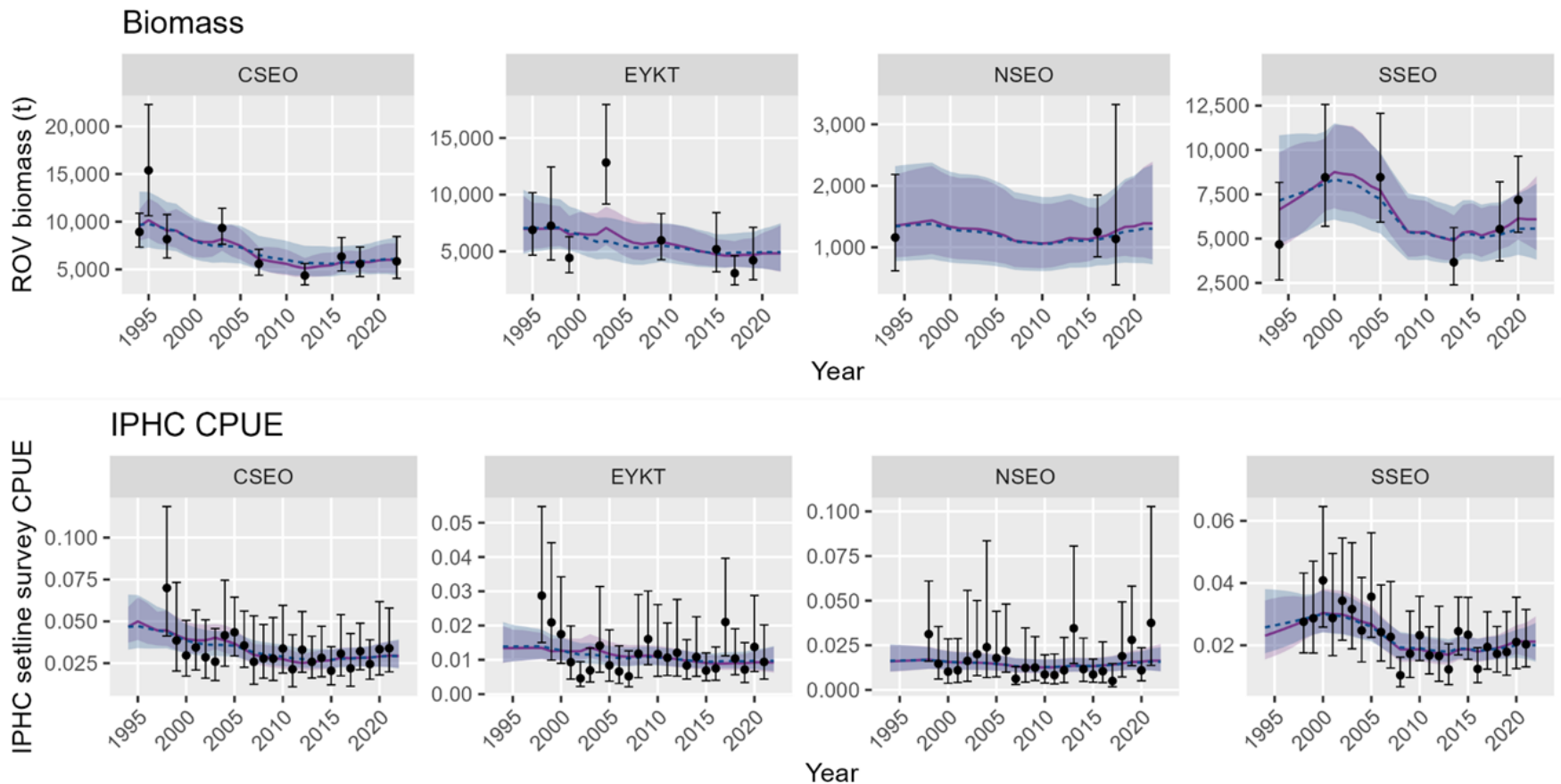
- Single process error for all 4 management areas
No convergence with area specific process error
- Area specific scaling parameters for IPHC CPUE for all 4 management areas
- AIC support for extra variance
(can't compare IPHC CPUE using AIC)
- All models gave similar biomass estimates...

- More **process error** without the extra observation error
- More **process error** without the IPHC CPUE data when no extra observation error
- But, **slightly less process error** without the IPHC CPUE data when there is extra observation error

Model	Parameter	Estimate	SE	LCI	UCI	2022 Biomass (mt)
Model 22.1	Process error	0.104	0.031	0.064	0.190	18,104
	CSEO scaling parameter (q)	0.00000505	0.00000040	0.00000432	0.00000590	
	EYKT q	0.00000197	0.00000022	0.00000158	0.00000245	
	NSEO q	0.00001257	0.00000268	0.00000828	0.00001909	
	SSEO q	0.00000351	0.00000036	0.00000288	0.00000429	
Model 22.2	Process error	0.085	0.025	0.048	0.152	17,511
	CSEO q	0.00000500	0.00000060	0.00000396	0.00000631	
	EYKT q	0.00000200	0.00000029	0.00000151	0.00000265	
	NSEO q	0.00001302	0.00000341	0.00000779	0.00002175	
	SSEO q	0.00000364	0.00000053	0.00000274	0.00000484	
	Extra biomass observation error	0.257	0.063	0.155	0.404	
Model 22.4	Process error	0.179	0.0489	0.105	0.306	17,765
Model 22.5	Process error	0.065	0.0418	0.0187	0.229	17,986
	Extra biomass observation error	0.277	0.0773	0.156	0.461	

- Similar trends in ROV Biomass and IPHC CPUE...
 - Downward trend with plateauing in recent years
- ... with lots of uncertainty

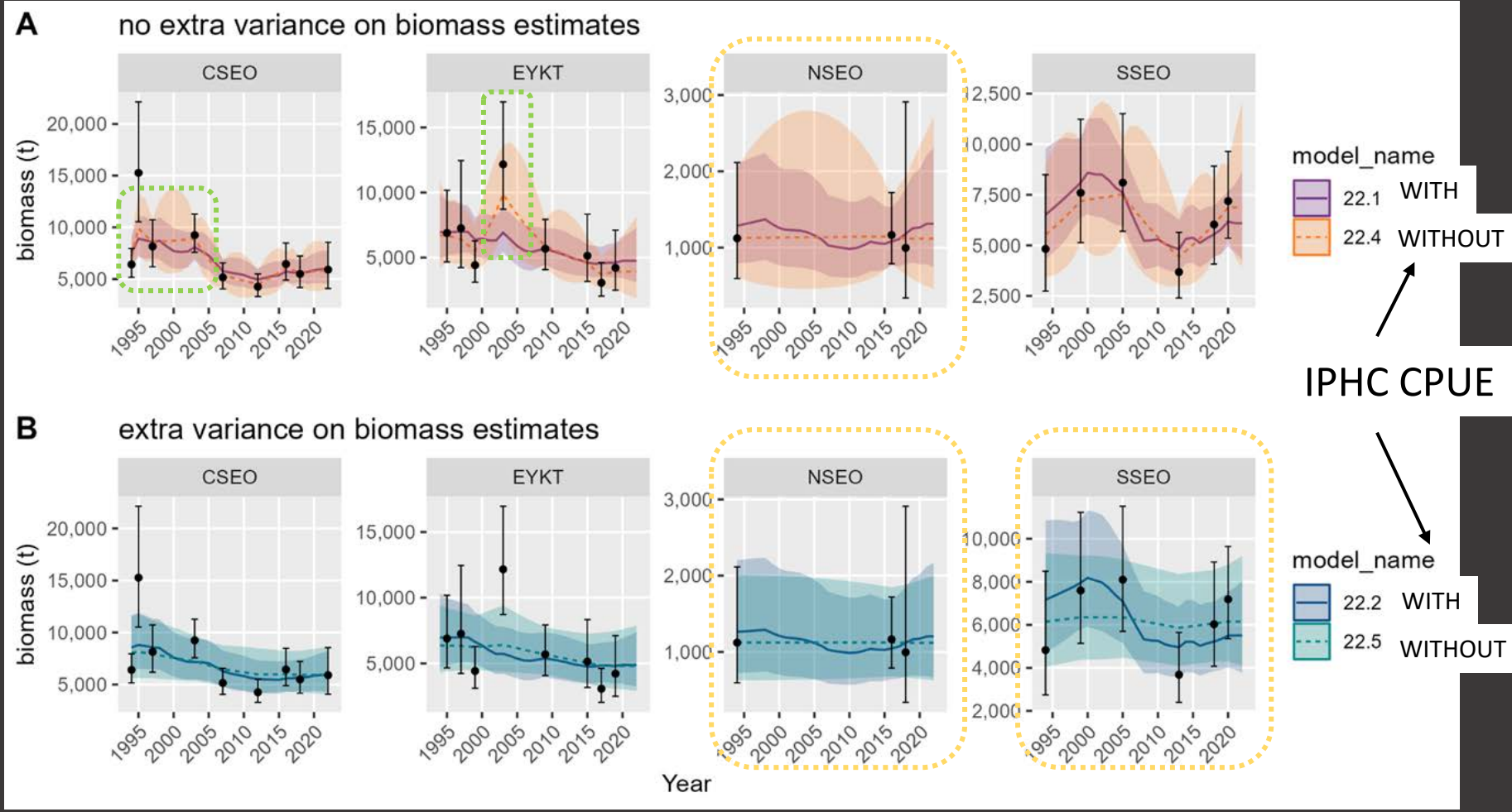
model_name 22.1 22.2



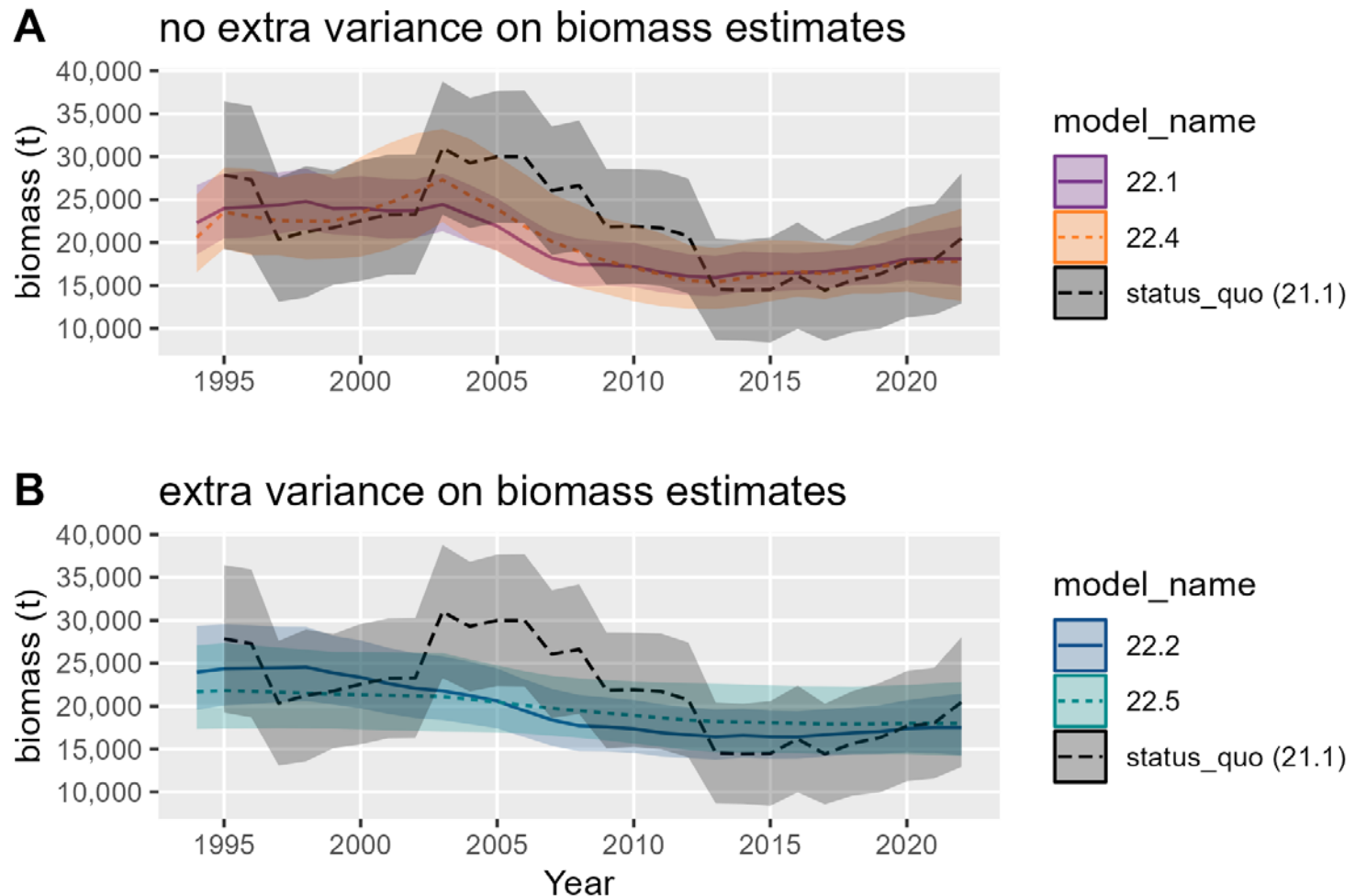
→ IPHC CPUE seems informative

→ Smooths unlikely volatility in biomass estimates in some instances

→ Adds contrast that REMA model otherwise smooths in other instances



Entire SEO: Random Effect Models vs. Status-quo



Yelloweye OFL and max ABC

Preferred Model 22.2: Extra observation error & IPHC CPUE index

YELLOW

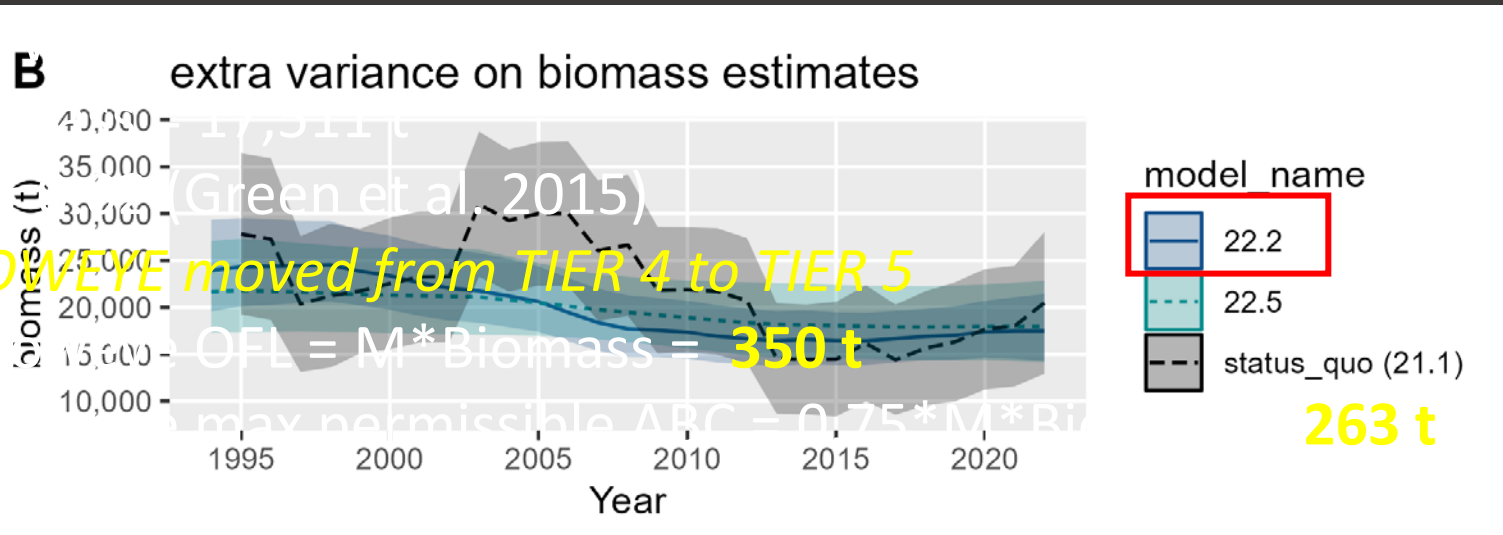
• Bio

• M

• Yel

• Yel

• Yel



Total DSR OFL and max ABC

* only years with
commercial, subsistence
and recreational
estimates

TIER 6

Species	Scientific Name	Max catch (t) 2010–2014*	OFL (t)	ABC (t)
Canary rockfish	<i>S. pinniger</i>	5.6	5.6	4.2
China rockfish	<i>S. nebulosus</i>	1.4	1.4	1.1
Copper rockfish	<i>S. caurinus</i>	4.4	4.4	3.3
Quillback rockfish	<i>S. maliger</i>	13.9	13.9	10.4
Rosethorn rockfish	<i>S. helvomaculatus</i>	0.0	0.0	0.0
Tiger rockfish	<i>S. nigrocinctus</i>	0.8	0.8	0.6
Sum Tier 6 (t)			26.1	19.6

OTHER, NON-YELLOWEYE DSR

- Non-yelloweye DSR OFL (Tier 6) = **26 t**
- Non-yelloweye DSR ABC (Tier 6) = **20 t**

TOTAL GOA DSR:

- Total DSR OFL = yelloweye OFL + other DSR OFL = **376 t**
- Total DSR max ABC = yelloweye ABC + other DSR ABC = **283 t**

Risk Table

<i>Assessment-related considerations</i>	<i>Population dynamics considerations</i>	<i>Environmental/ecosystem considerations</i>	<i>Fishery Performance considerations</i>
Level 2: Substantially increased concerns	Level 2: Substantially increased concerns	Level 1: Normal	Level 2: Substantially increased concern

- Assessment: uncertainty in biomass estimates, no age-structured model

-

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Recommend a 15% reduction in yelloweye ABC

recreational fisheries, bulk of current catch is bycatch in other fisheries

Risk Table

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Level 2: Substantially increased concerns	Level 2: Substantially increased concerns	Level 1: Normal	Level 2: Substantially increased concern

TOTAL GOA DSR:

- Yelloweye recommended ABC = $0.85 \times \text{yelloweye max ABC} = \mathbf{224 \text{ t}}$
- Total recommended DSR ABC = rec YE ABC + other DSR ABC = **244 t**

Species	Year	Biomass ¹	OFL	ABC	TAC ²	Commercial catch ³	Recreational mortality ⁴	Total catch ⁵
DSR	2019	10,592	411	261	254	145	59	221
	2020	10,620	375	238	231	111	5	129
	2021	10,648	405	257	250	112	6	131
	2022	12,388	422	268	261	164	6	183
	2023 ⁶	17,501 ⁶	376	244	236	-	-	-

- Rec. ABC 9% reduction from last year
- Still above recent harvests/removals

Future Work

- Revisit **natural mortality** estimates
- Refinement of the **IPHC CPUE index**
- Development of historical **discard estimation** methods for the halibut fishery
- Development and CIE review of the **state-space surplus production model**
- **Life history** data on yelloweye rockfish
 - Maturity
 - Fecundity





Quantity	As estimated or specified last year for:		As estimated or recommended this year for:		
	2022	2023	2023	2024	
<i>M</i> (natural mortality)	0.02	0.02	0.02	0.02	
Tier	4	4	5	5	
Yelloweye Biomass (t)	12,388 (17,273)		17,511		
$F_{OFL} = F_{35\%}$	0.032	0.032	$F_{OFL} (F=M)$	0.02	0.02
$maxF_{ABC}$	0.026	0.026	$maxF_{ABC}$	0.015	0.015
F_{ABC}	0.020	0.020	F_{ABC}	0.01275	0.01275
DSR OFL (t)	422	422	376	376	
DSR max ABC (t)	342	342	283	283	
Recommended ABC (t)	268	268	244	244	
Status	As determined last year for:		As determined this year for:		
	2020	2021	2021	2022	
Overfishing	No	n/a	No	n/a	

QUESTIONS AND DISCUSSION

ASSESSMENT OF THE DEMERSAL SHELF ROCKFISH STOCK COMPLEX IN THE SOUTHEAST OUTSIDE SUBDISTRICT OF THE GULF OF ALASKA:

A NEW STATE-SPACE SURPLUS PRODUCTION MODEL

September 2022

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