Red Snapper Catch Limits Derived Using Estimates of Absolute Abundance Obtained from a Re-analysis of the Great Red Snapper Count

Sustainable Fisheries Division, SEFSC

March, 2022

Purpose and Need

- The Great Red Snapper Count (GRSC) estimate of absolute abundance has been updated since the last time catch advice was considered (March 2021).

- Council requested that catch advice be produced and considered in light of the updated estimates of absolute abundance.

- GRSC catch advice was previously used to set the OFL but not adopted for setting the ABC which remains based on projections derived during SEDAR 52.

GRSC catch advice

- General approach
  - Turn GRSC estimate of age 2+ into numbers-at-age by region (east/west).
  - Update fishing mortality rate estimates through projections to account for unique GRSC recruitment and biomass distribution properties.
  - Use numbers-at-age, F-at-age, and mean landed weight-at-age to estimate catch

GRSC catch advice

- Two approaches used to quantify uncertainty.
  - Deterministic projections at 75%FSPR26%
  - Monte Carlo simulation incorporating uncertainty for
    - Number of 2+
    - Recruitment
    - Fishing mortality rates
    - Initial depletion

Methods (age 2+ estimate)

- Two candidate estimates of absolute abundance were considered for this analysis
  - Re-analysis of the GRSC estimate with the random forest sampling design in Florida accounted for in the estimation procedure.
    - Results no longer presented; numbers shown for reference
  - Florida Post-stratification of the above data into shallow water (10-25 meter) and mid water (25-40 meter) depth strata. LGL Louisiana abundance estimate

Methods (age 2+ estimate)

State/Region	Habitat Type	Post-strat & LGL	CV(%)	GRSC	CV(%)
TX	Natural	7,037,443	36	7,037,443	36
	Artificial	417,761	21	417,761	21
	Uncharacterized Bottom	14,569,830	46	14,569,830	46
	Total	22,025,035	32	22,025,035	32
LA	Natural	118,647	30	3,852,652	43
	Platform	727,210	14	NA	NA
	Artificial	86,954	13	3,849,325	15
	Uncharacterized Bottom	7,444,780	16	9,729,387	59
	Total	8,377,591	14	17,431,364	34
AL/MS	Natural	3,751,988	20	3,751,988	20
	Artificial	1,509,625	11	1,509,625	11
	Uncharacterized Bottom	3,199,472	51	3,199,472	51
	Total	8,461,085	21	8,461,085	21
FL	Natural & Uncharacterized Bottom	46,838,220	22	48,124,414	22
	Artificial	127,560	17	127,560	17
	Total	46,965,780		48,251,974	22
ALL	Pipeline	507,661	43	507,661	43
Gulf of Mexico		**85,609,941**		**96,677,118**	**14**

Methods (age 2+ estimate)

- Florida natural and UCB split into components assuming 37.13% from natural reef and the rest from UCB.
  - Percentage derived from random forest model
- Pipeline abundance separated into ecoregions using proportions from original analysis
- 18% TX, 65% LA, 16% MS/AL, 1% FL

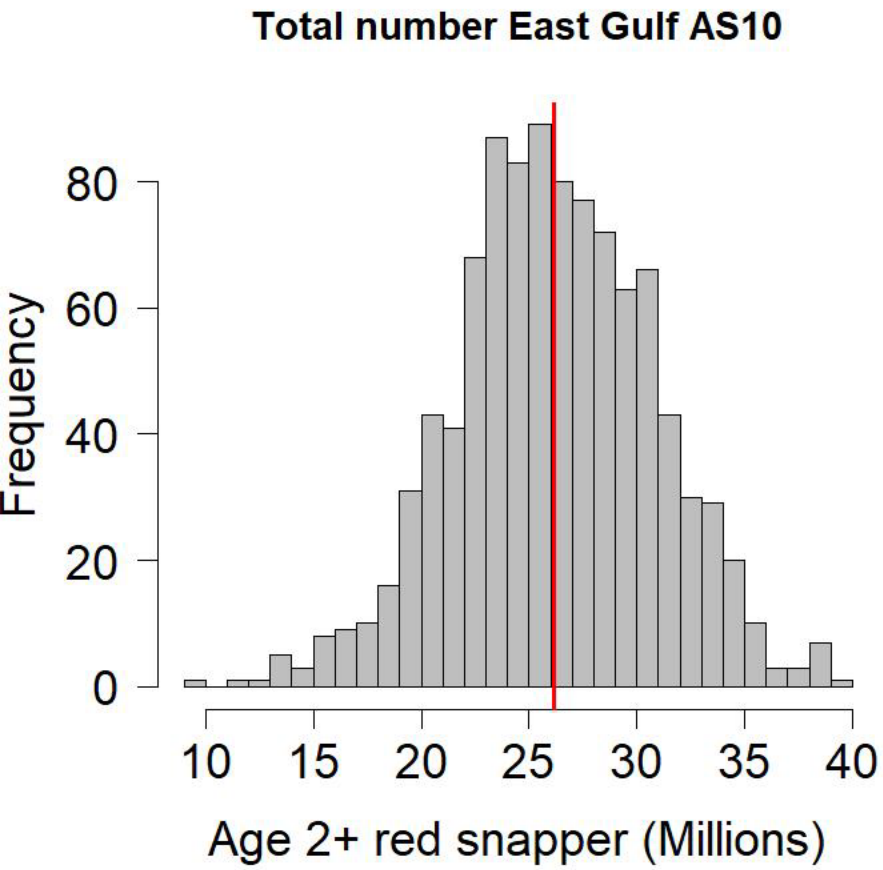
Methods (age 2+ estimate)

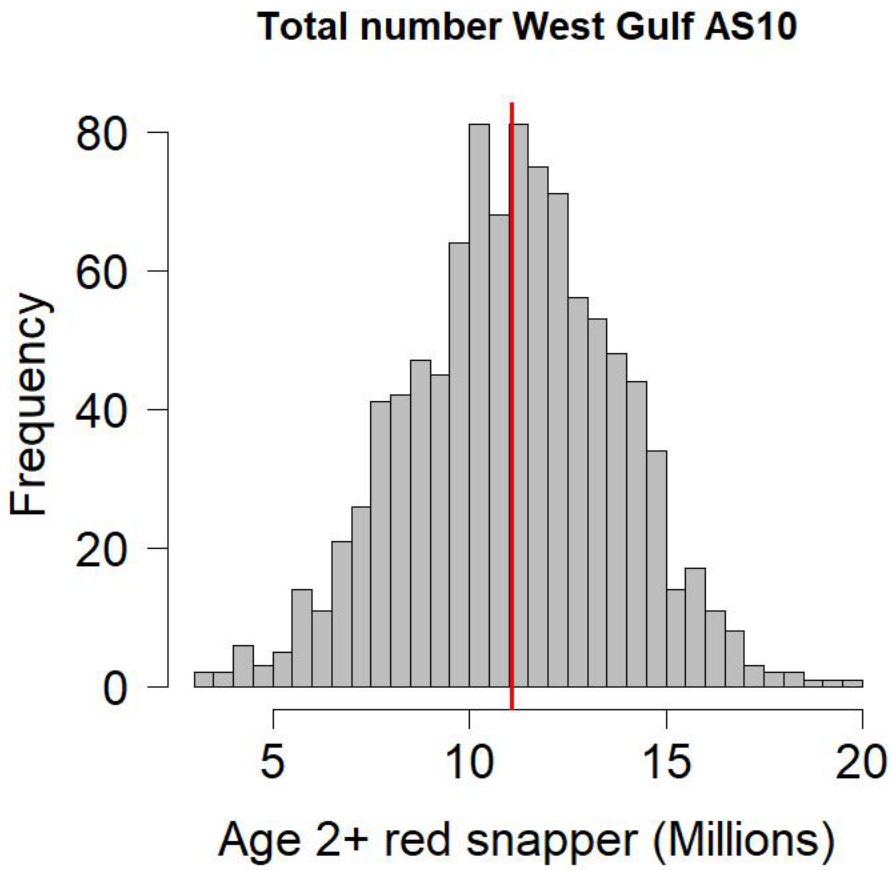
- 3 scenarios projected

		All Structure	All Structure + 10%	All Structure + 15%
GRSC estimate	East	23,344,070	26,689,599	28,362,364
	West	15,578,540	18,008,461	19,223,422
	Total	38,922,610	44,698,061	47,585,786
FL Post-strat. & LGL	East	22,866,506	26,131,172	27,763,505
	West	8,809,374	11,010,835	12,111,565
	Total	31,675,880	37,142,007	39,875,070

- (All Structure) - numbers from reefs (natural and artificial) and pipelines
- (All Structure +) - All Structure plus 10% or 15% of uncharacterized bottom

Methods (age 2+ estimate; Monte Carlo)

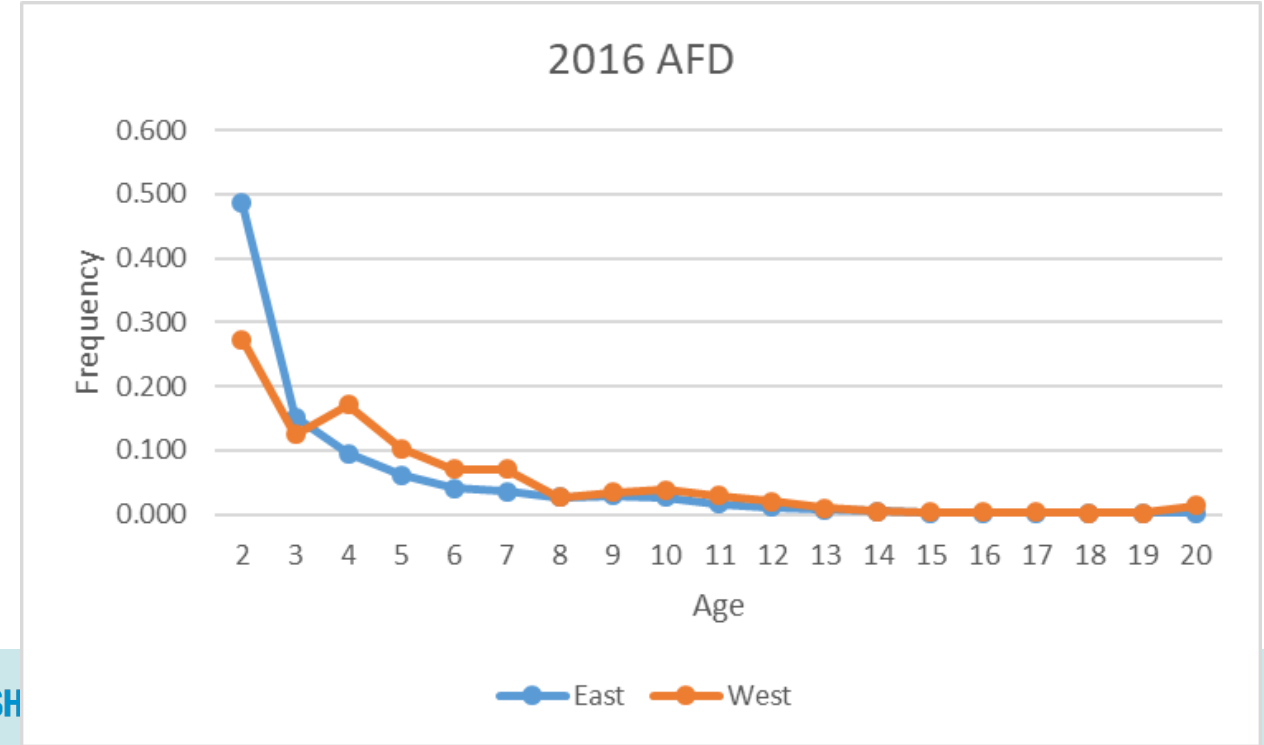




Example depicted from projection using all structure plus 10% UCB

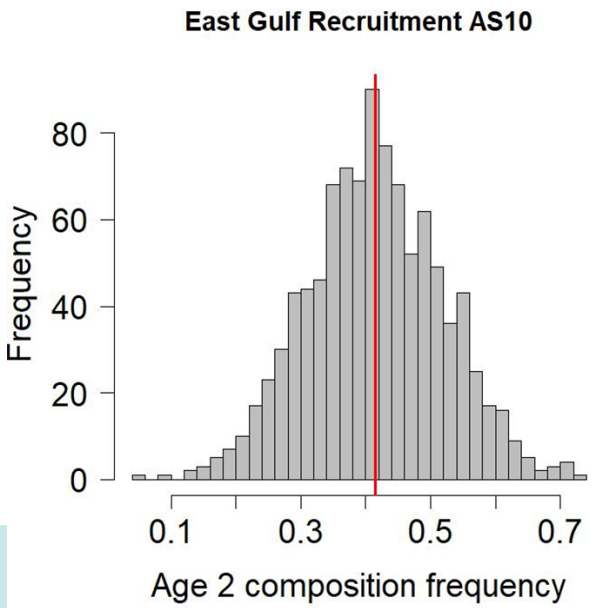
Methods (Numbers-at-Age)

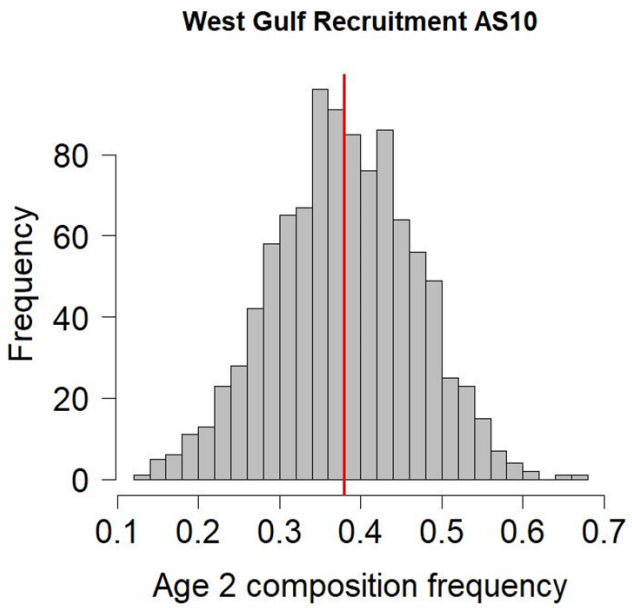
- GRSC subsets of 2+ fish needed to be separated by age.
- 2016 composition data from SEDAR 52 used to construct age 2+ age frequency distributions (AFDs) by area.
- 2016 last year fully informed by data



Methods (Numbers-at-Age; Monte Carlo)

- Frequency of age 2 fish randomly selected assuming normal distribution with mean and SD determined by last 10 years of available data (2007-2016)
- Age 3 and older fish follow the distribution from 2016 rescaled to sum to one





Example depicted from projection using All structure plus 10% UCB

East – mean = 0.41, SD = 0.10

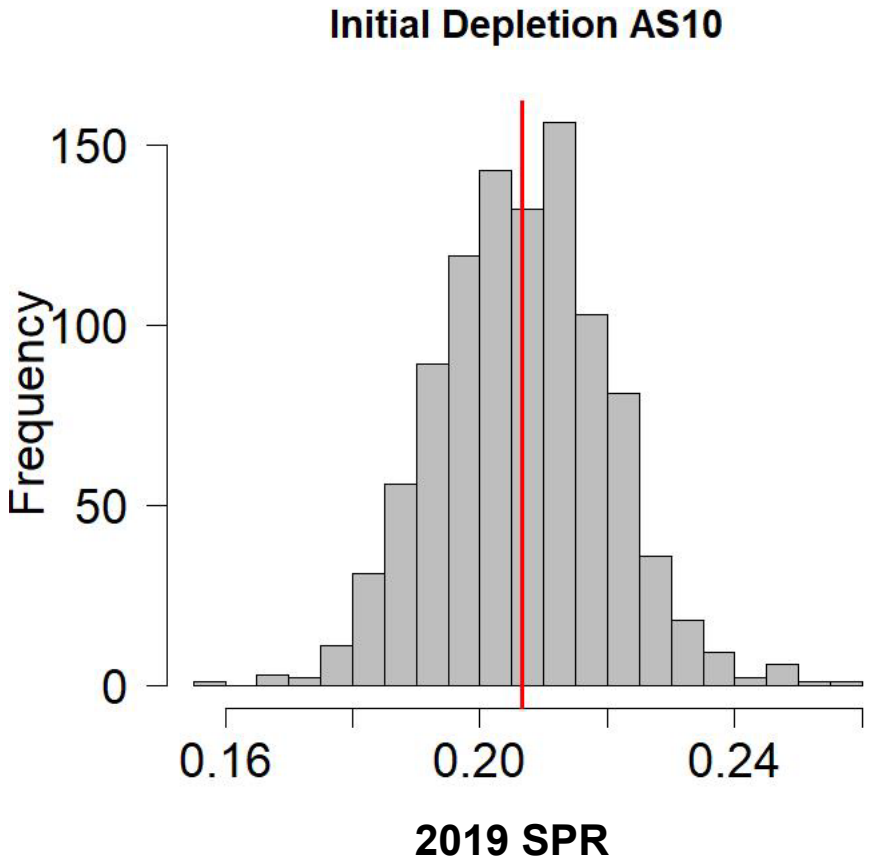
West – mean = 0.38, SD = 0.09

Methods (Initial depletion and SSB0)

- Needed a GRSC adjusted value of virgin biomass to carryout SPR based projections to re-estimate fishing mortality rates.
- $SSB0 = SSB2019/SPR2019$
- SPR 2019 taken from SEDAR 52 (0.207, sd = 0.013)

- $SSB2019 = \sum_a fec_a mat_a N_a$; for ages 0-20+
- *fec* = fecundity, *mat* = maturity, *N* = GRSC numbers

Methods (Initial depletion and SSB0)



Example depicted from projection using All structure plus 10% UCB

Methods (Fishing Mortality)

- 3 year average (2014 – 2016) fleet-specific F's used to set relative relationship among the fleet F's.
  - In Monte Carlo simulation fleet-specific F's were randomly generated assuming a mean equal to the three year average and CV=0.1
- Projections were used to adjust the magnitude of the directed fleet F's to achieve SPR target in equilibrium.
- Catch was calculated using Baranov's catch equation with the estimates of F-at-age, M-at-age, GRSC numbers-at-age, and mean landed weight-at-age

Results (Catch Advice)

- Catch produced by deterministic projections of $F_{SPR26\%}$ and:
  - Projections of $75\%F_{SPR26\%}$ for the directed fleets.
  - Incorporate uncertainty into the projections through Monte Carlo simulation and apply P* approach to landings distribution.

Results (Catch, deterministic projections)

$F_{SPR26\%}$

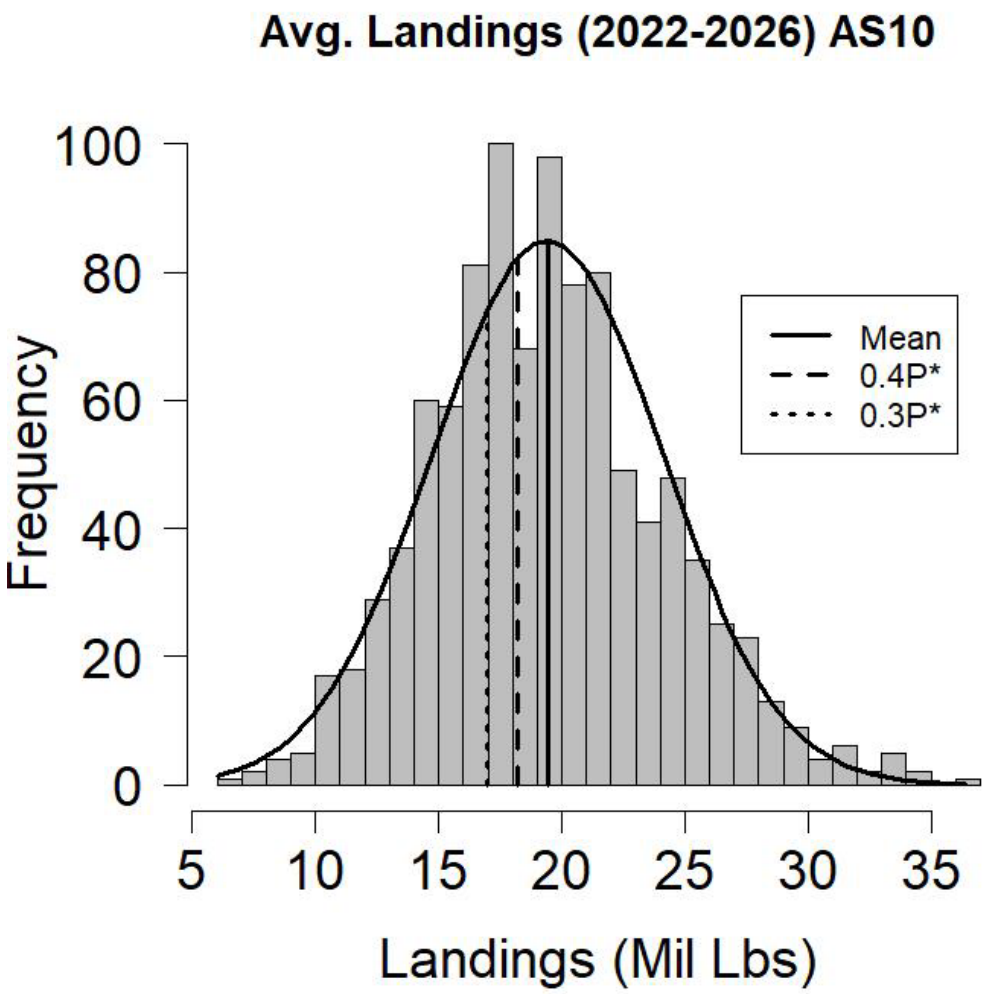
Year	All Structure	All Structure + 10%	All Structure + 15%
2022	16.61	19.33	20.69
2023	16.97	19.72	21.10
2024	17.31	20.09	21.49
2025	17.59	20.40	21.80
2026	17.77	20.60	22.02
3 yr. avg. ('22-'24)	16.97	19.72	21.09
5 yr. avg. ('22-'26)	17.25	20.03	21.42

75% $F_{SPR26\%}$

Year	All Structure	All Structure + 10%	All Structure + 15%
2022	14.58	16.98	18.18
2023	15.24	17.71	18.94
2024	15.79	18.33	19.60
2025	16.23	18.82	20.12
2026	16.52	19.15	20.47
3 yr. avg. ('22-'24)	15.67	18.20	19.46
5 yr. avg. ('22-'26)	15.67	18.20	19.46

- Catches are in millions of pounds ww and are landings and dead discards (i.e., no dead B2's)

Results (Monte Carlo simulation)



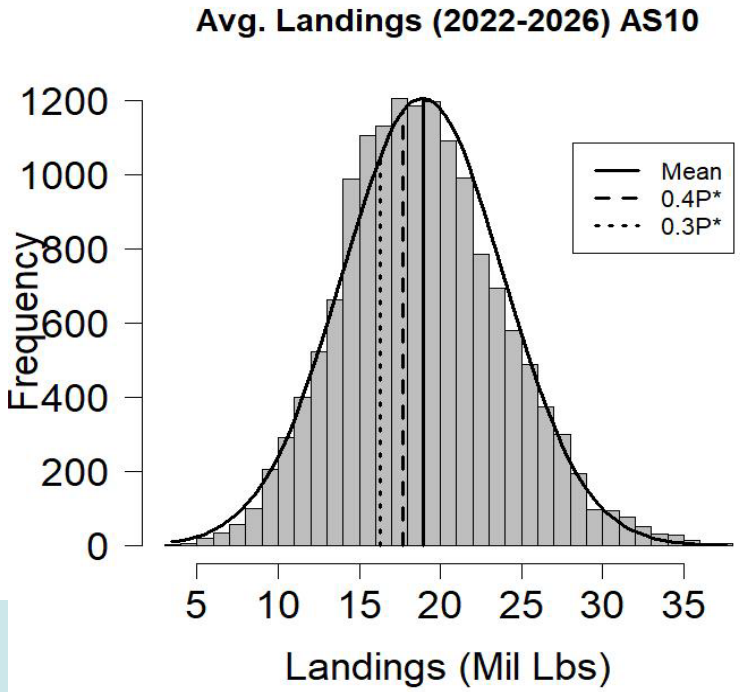
	All Structure				All Structure + 10%			
Year	Mean	SD	P*0.4	P*0.3	Mean	SD	P*0.4	P*0.3
2022	16.64	3.67	15.71	14.71	19.40	4.04	18.37	17.28
2023	16.63	4.05	15.61	14.51	19.33	4.48	18.20	16.99
2024	16.71	4.34	15.61	14.43	19.39	4.82	18.17	16.86
2025	16.78	4.55	15.63	14.40	19.46	5.06	18.18	16.81
2026	16.83	4.68	15.64	14.37	19.50	5.20	18.19	16.78
3 yr. avg. ('22-'24)	16.66	4.01	15.64	14.56	19.37	4.43	18.25	17.05
5 yr. avg. ('22-'26)	16.72	4.24	15.64	14.49	19.42	4.70	18.23	16.95

	All Structure + 15%			
Year	Mean	SD	P*0.4	P*0.3
2022	20.60	4.32	19.51	18.34
2023	20.52	4.76	19.31	18.02
2024	20.56	5.11	19.27	17.88
2025	20.62	5.36	19.27	17.81
2026	20.66	5.52	19.27	17.77
3 yr. avg. ('22-'24)	20.56	4.72	19.37	18.09
5 yr. avg. ('22-'26)	20.59	4.99	19.33	17.97

- Catches are in millions of pounds ww and are landings and dead discards (i.e., no dead B2's)

Ensemble advice across UCB levels

- Estimate a grand mean and variance for the catch advice from three levels of UCB (0%, 10%, & 15%)
- Provides a broader uncertainty in the catch advice by incorporating the uncertainty in %UCB.



Ensemble advice across UCB levels

Year	Ensemble UCB			
	Mean	SD	P*0.4	P*0.3
2022	18.88	4.35	17.78	16.60
2023	18.83	4.73	17.63	16.35
2024	18.89	5.03	17.61	16.25
2025	18.96	5.25	17.62	16.20
2026	19.00	5.39	17.63	16.17
3 yr. avg. ('22-'24)	18.87	4.71	17.67	16.40
5 yr. avg. ('22-'26)	18.91	4.96	17.65	16.31

Final Thoughts

- Projections capable of running additional scenarios on request
  - % F
  - P*
  - Alternate 2+ scenarios (e.g., 20%UCB etc.)
- While we attempted to incorporate uncertainty into the catch advice the full scientific uncertainty was not captured in this analysis.

Thank You

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Results (Catch, deterministic projections)

$F_{SPR26\%}$

Year	All Structure	All Structure + 10%	All Structure + 15%
2022	16.61	19.33	20.69
2023	16.97	19.72	21.10
2024	17.31	20.09	21.49
2025	17.59	20.40	21.80
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3 yr. avg. ('22-'24)	16.97	19.72	21.09
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75% $F_{SPR26\%}$

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2022	14.58	16.98	18.18
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Year	All Structure + 15%				Ensemble UCB			
	Mean	SD	P*0.4	P*0.3	Mean	SD	P*0.4	P*0.3
2022	20.60	4.32	19.51	18.34	18.88	4.35	17.78	16.60
2023	20.52	4.76	19.31	18.02	18.83	4.73	17.63	16.35
2024	20.56	5.11	19.27	17.88	18.89	5.03	17.61	16.25
2025	20.62	5.36	19.27	17.81	18.96	5.25	17.62	16.20
2026	20.66	5.52	19.27	17.77	19.00	5.39	17.63	16.17
3 yr. avg. ('22-'24)	20.56	4.72	19.37	18.09	18.87	4.71	17.67	16.40
5 yr. avg. ('22-'26)	20.59	4.99	19.33	17.97	18.91	4.96	17.65	16.31