Catch Advice for the Gulf of Mexico Red Snapper Stock Derived from Estimates of Absolute Abundance Produced as Part of the Great Red Snapper Count

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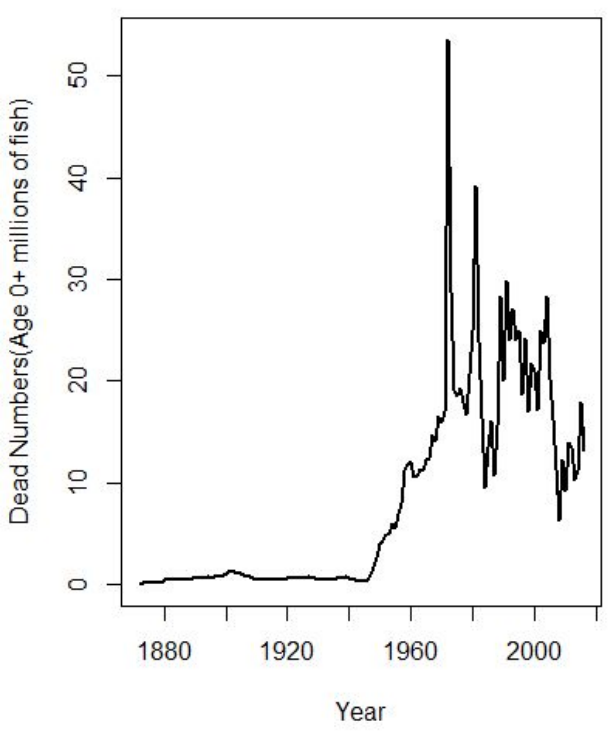
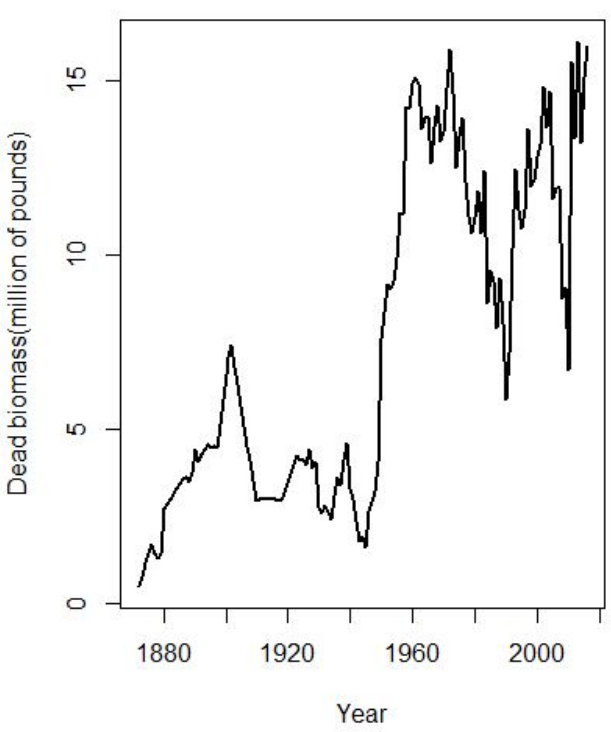
Purpose and Need

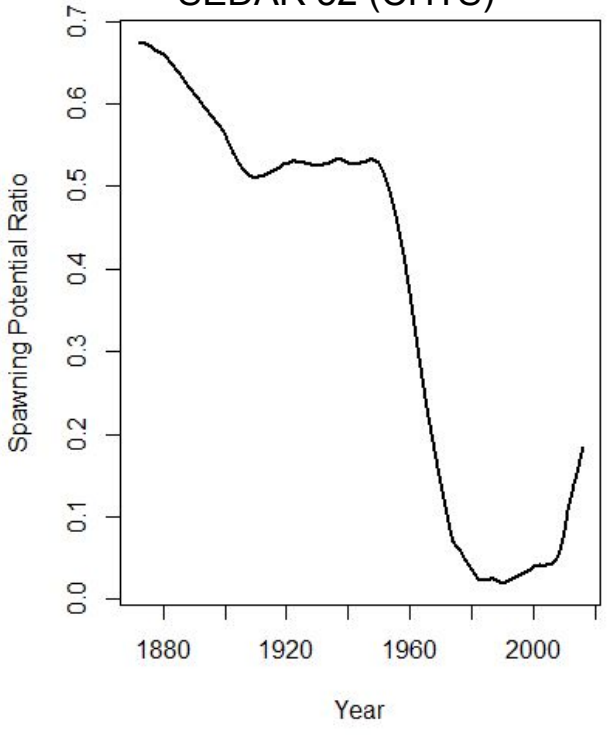
- The Great Red Snapper Count (GRSC) changed our understanding of Red Snapper abundance, distribution, and habitat utilization in the Gulf of Mexico.
- We need to determine whether the increase in abundance estimated by the GRSC supports additional removals.
- Catch advice would typically be determined through a full stock assessment (upcoming research track; 2023 season), but there isn't time to do that before 2021 advice is needed.
- The social and economic importance of Red Snapper to the Gulf region warranted an interim assessment to provide possible alternatives for the 2021 and 2022 fishing seasons.

Introduction

SEDAR 52 (CHTS)







- It's been 30-40 years since the lowest estimated biomass, but history tells us the stock, at least over the current fishing grounds, can be severely depleted.

Introduction

- The last accepted assessment was SEDAR 52:
  - Standard assessment with terminal data year 2016
  - Not overfished, not overfishing, rebuilding (0.18 SPR)
- Latest SEDAR 52 Projections started in 2019:
  - OFL – $F_{SPR26\%}$
  - ABC – $F_{REBUILD}$ and P* = 0.4
    - $F_{REBUILD}$ = F resulting in 26% SPR in 2032
- Model estimate of abundance in 2017 ~41 million age 2+ fish
- OFL and ABC based on 3 year avg. (2019 - 2021)
  - OFL = 15.5 mp WW and ABC = 15.1 mp WW

Introduction

- GRSC estimated a very different abundance and distribution of the Red Snapper stock than SEDAR 52
  - Abundance of age 2+ fish
    - GRSC ~ 110 million (2019) while SEDAR 52 ~ 41 million (2017)
  - Distribution of the stock of age 2+ fish
    - GRSC ~ 53:47 E/W while SEDAR 52 ~ 32:68 E/W
- SEDAR 52 results are based on data collected mainly from current fishing grounds
- Can the abundance over the uncharacterized/unconsolidated bottom estimated by the GRSC support more yield in the fishing grounds?

Introduction

- SEFSC asked to provide interim catch advice using the new abundance estimates from the GRSC (the traditional approach also available)
- General approach
  - Convert the GRSC estimate of age 2+ into numbers-at-age by region (east/west).
  - Re-estimate fishing mortality rates through spreadsheet projections to estimate F-at-age by region
  - Use numbers-at-age, F-at-age, and mean landed weight-at-age to estimate catch

Methods

- All the Red Snapper in the Gulf are not equally vulnerable to the fisheries.
- If only a subset are vulnerable to fishing, setting catch levels on total abundance would likely lead to localized depletion on the fishing grounds

State/Region	Habitat Type	Number	CV(%)
TX	Natural	6,119,180	38
	Artificial	1,058,051	40
	Uncharacterized Bottom	15,585,985	16
	Pipeline	115,314	10
	Total	22,878,530	15
LA	Natural	4,543,816	43
	Artificial	6,744,437	31
	Uncharacterized Bottom	17,055,231	27
	Pipeline	416,412	22
	Total	28,759,896	19
AL/MS	Natural	4,268,884	21
	Artificial	1,484,662	5
	Uncharacterized Bottom	4,102,745	32
	Pipeline	102,501	13
	Total	9,958,792	16
FL	Natural Bottom	17,007,020	32
	Artificial	123,377	16
	Uncharacterized Bottom	31,193,207	29
	Pipeline	6,407	5
	Total	48,330,011	22
Gulf of Mexico		**109,927,229**	**11**

Methods

- 3 scenarios projected (Total and 2 subsets)

	All Structure	All Structure +	Grand Total	SEDAR 52
East	22,992,851	28,287,244	58,288,803	12,941,804
West	18,997,210	23,893,392	51,638,426	28,084,409
Total	41,990,061	52,180,636	109,927,229	41,026,213
% East	0.55	0.54	0.53	0.32
% West	0.45	0.46	0.47	0.68
% Change	2.3	27.2	167.9	–

- (All Structure) - numbers from reefs (natural and artificial) and pipelines
- (All Structure +) - All Structure plus 15% of uncharacterized bottom
  - 15% is a rough estimate of vulnerable biomass that can be adjusted based on further evaluation of the current fleet distributions

Methods

	All Structure	All Structure +	Grand Total	SEDAR 52
East	22,992,851	28,287,244	58,288,803	12,941,804
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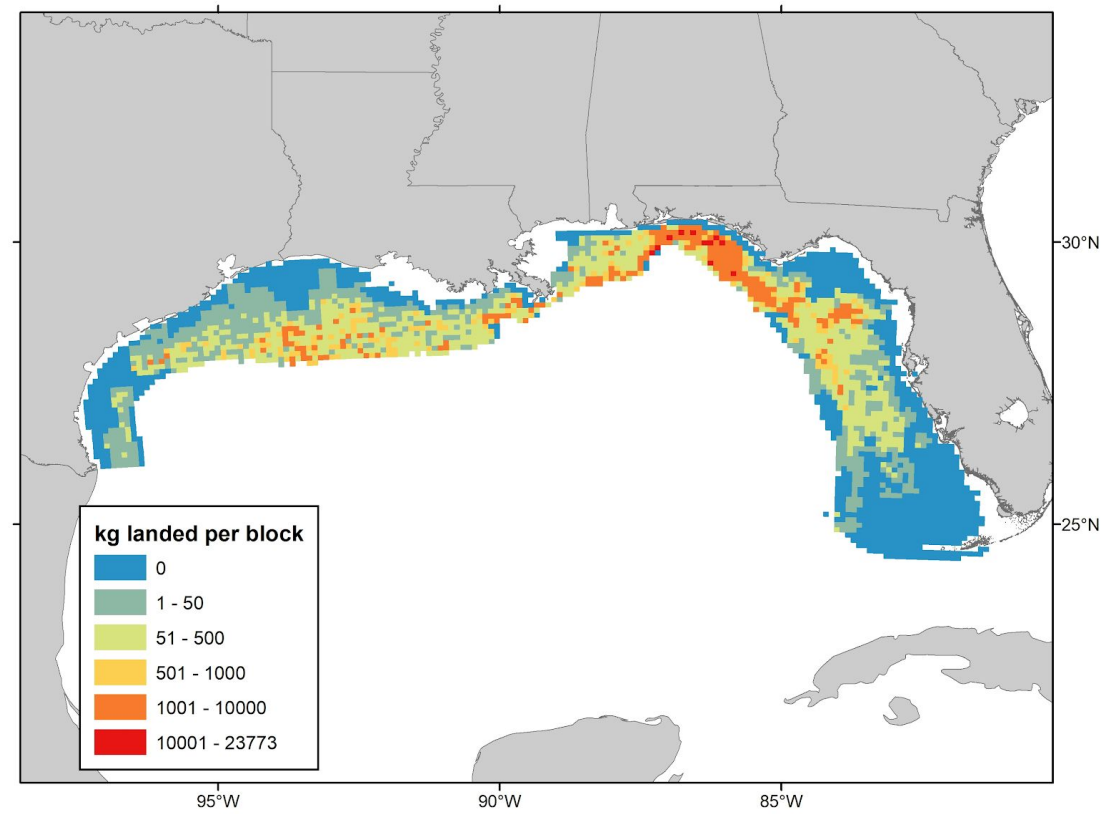
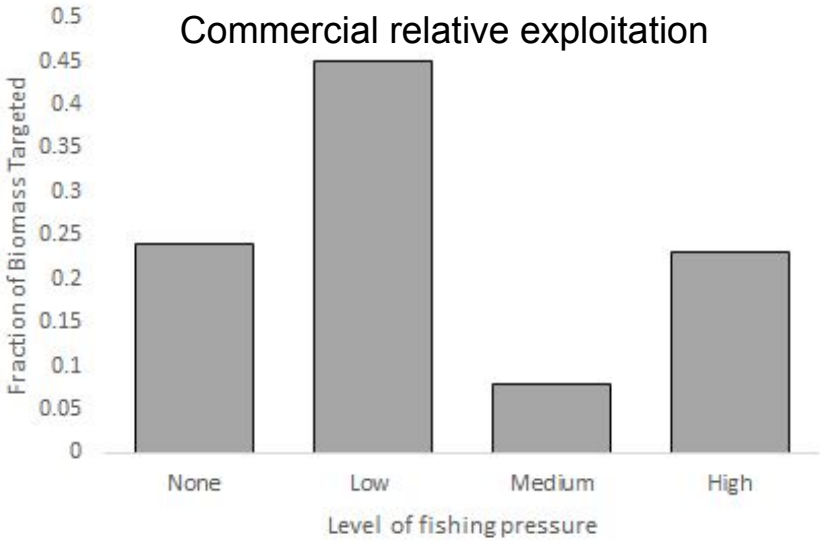
- (All Structure) = 38%; (All Structure +) = 47%
- Do these subsets represent plausible proportions for vulnerable biomass?

Determining Vulnerable Biomass - Commercial

Estimated commercial landings.10x10 km grid

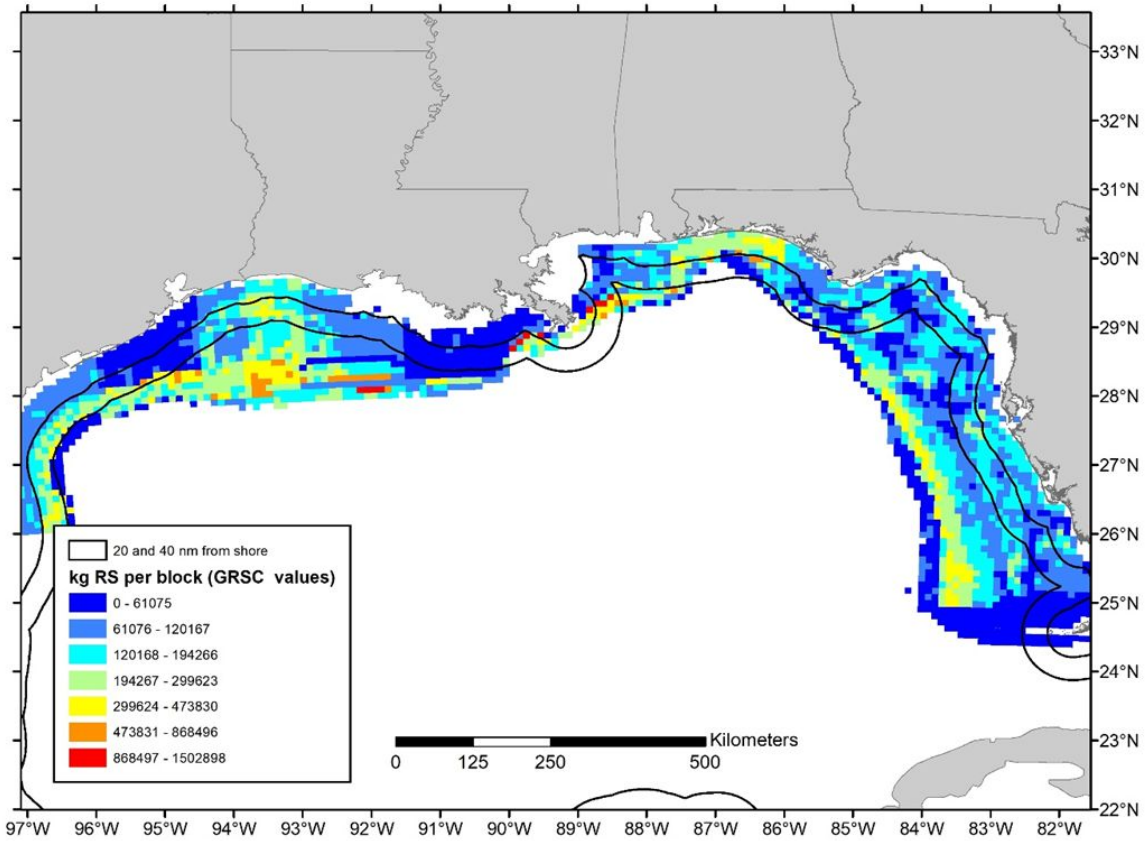




- Used VMS and TIP to map landings to grid.
- Harvest rate calculated by dividing landings per grid by biomass per grid (Karnauskas et al. 2017)

Determining Vulnerable Biomass - Recreational

GRSC adjusted biomass map based on distribution patterns from Karnauskas et al. 2017



Gardner et al. *in prep*

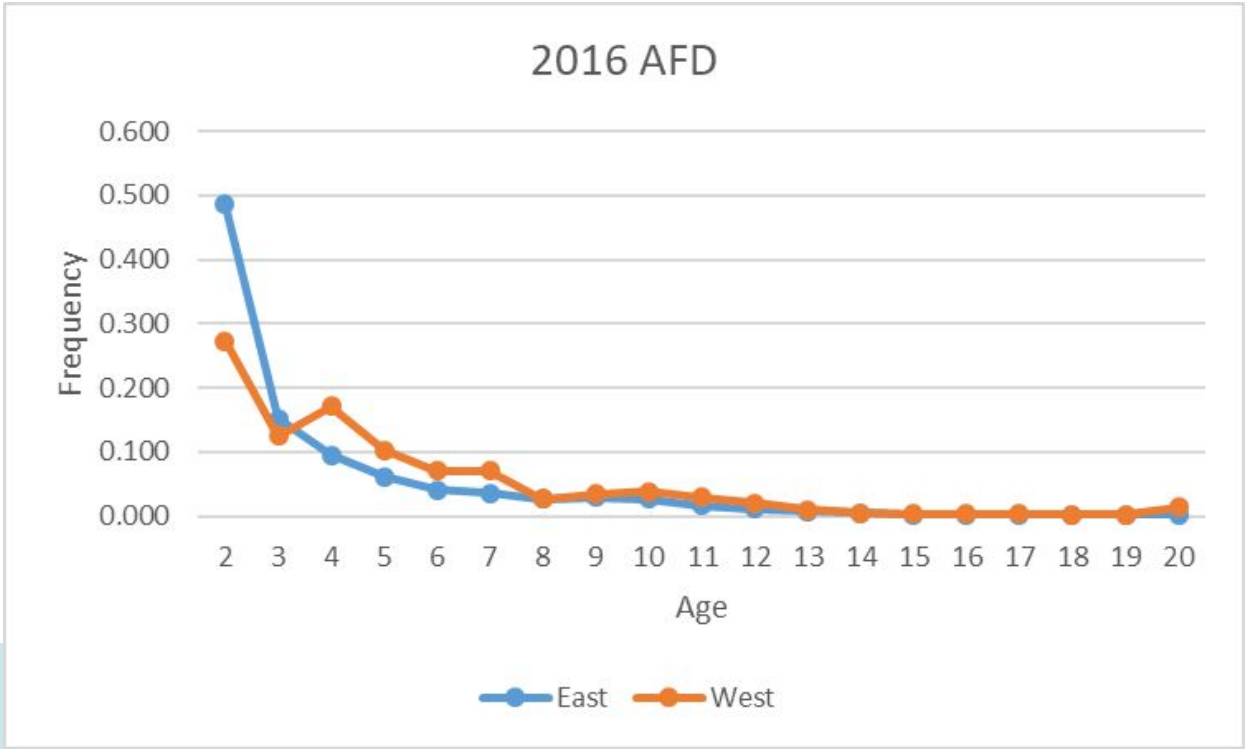
- No VMS equivalent for recreational
- Significant amount of biomass estimated to be >40 nm offshore from TX, LA and FL
- Assuming proportion vulnerable to rec fleet ≤ comm. fleet, between 40-70% of stock experiences little to no fishing per year

Methods

- If 40-70% of the stock is assumed to experience little to no fishing then conversely, 30 – 60% of the stock is actively exploited by the fishery in any given year.
- The All Structure subset (38% of total) represents are reasonable proxy for the lower end of vulnerable biomass
- All Structure + (47% of total) represents a reasonable proxy for the average vulnerable biomass
- Runs utilizing different proportions of the uncharacterized fish can be completed upon request

Methods (Numbers-at-Age)

- The GRSC provided abundance of age 2+ fish, which needed to be separated by age.
- 2016 composition data from SEDAR 52 were used to construct age 2+ age frequency distributions (AFDs) by area.
- 2016 is the last year in the assessment fully informed by data.



Methods (Numbers-at-Age)

- AFDs multiplied by subsets of GRSC estimate to create vectors of GRSC numbers-at-age

GRSC Subset	Area	2	3	4	5	6	7	…	20
All Structure	East	11,171,774	3,483,078	2,179,733	1,399,531	941,584	824,966	…	36,068
All Structure	West	5,176,209	2,372,249	3,243,826	1,957,019	1,350,291	1,332,646	…	273,539
All Structure +	East	13,744,215	4,285,101	2,681,644	1,721,791	1,158,395	1,014,925	…	44,373
All Structure +	West	6,510,282	2,983,653	4,079,862	2,461,405	1,698,304	1,676,111	…	344,039
Grand Total	East	28,321,383	8,829,895	5,525,806	3,547,929	2,386,993	2,091,358	…	91,435
Grand Total	West	14,070,029	6,448,275	8,817,403	5,319,590	3,670,376	3,622,414	…	743,537

- AFDs also informed recruitment (estimate of area-specific age 2 fish) in projections

Methods (Recruitment)

	All Structure	All Structure +	Grand Total	SEDAR 52
East	11,172	13,744	28,321	5,534
West	5,176	6,510	14,070	10,653
Total	16,348	20,254	42,391	16,187
% East	0.68	0.68	0.67	0.34
% West	0.32	0.32	0.33	0.66
% Change	1	25	162	–

- Recruitment is fixed in the projections and set equal to the number of age 2 fish by area for each subset.
- SEDAR 52 estimated recruitment distribution skews west (likely due to shrimp bycatch).
- GRSC-informed recruitment is determined by composition data used to create AFDs.

Methods (Fishing Mortality)

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

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

Methods (Fishing Mortality)

- F's would normally be derived from an updated assessment model.
- We could not update SEDAR 52 (CHTS to FES, Hoenig to Then (M), discard mortality, etc.) and incorporate GRSC within the time constraints.
  - Results would have been incomplete and produced without transparency or complete review.
- Differences between SEDAR 52 and GRSC necessitated some form of projection be done to estimate fishing mortality rates that reflected the changed stock dynamics.

Methods (Fishing Mortality)

- Spreadsheet projections were completed using
  - GRSC numbers-at-age
  - SEDAR 52 life history, selectivity, and retention relationships
  - SEDAR 52 Relative F's for directed fleets
  - SEDAR 52 Absolute F's for discard and bycatch fleets
- $F_{SPR26\%}$ and $F_{SPR40\%}$ were estimated through the spreadsheet projections for each of the three GRSC abundance subsets
  - $F_{SPR26\%}$ is the current F_{MSY} proxy.
  - $F_{SPR40\%}$ is informed by the Harford et al. (2019) study.

Methods (Fishing Mortality)

- Used SEDAR 52 fleet-specific relative F's as starting point for directed fleets

Directed fleets

	HL_E	HL_W	LL_E	LL_W	MRIP_E	MRIP_W	HBT_E	HBT_W
Apical F	0.1559	0.1144	0.0146	0.0014	0.3864	0.0480	0.0306	0.0209
Relative F	0.2019	0.1481	0.0189	0.0018	0.5003	0.0621	0.0396	0.0271
Initial Projection F	0.2019	0.1481	0.0189	0.0018	0.5003	0.0621	0.0396	0.0271

Discard and Bycatch fleets

	C_Clsd_E	C_Clsd_W	R_Clsd_E	R_Clsd_W	Shr_E	Shr_W
Apical F	0.0029	0.0008	0.4277	0.0322	0.0069	0.1537
Relative F	N/A	N/A	N/A	N/A	N/A	N/A
Initial Projection F	0.0029	0.0008	0.4277	0.0322	0.0069	0.1537

- Fixed discard and bycatch fleets at Apical F from S52

Methods (Fishing Mortality)

- With the relative relationship between the directed fleet F's fixed, projections were used to adjust the magnitude of the F's to achieve SPR targets in equilibrium.
- From the projections we obtained estimates of F-at-age by fleet.
- 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)

Year	All Structure		All Structure +		Grand Total	
	$F_{SPR26\%}$	$F_{SPR40\%}$	$F_{SPR26\%}$	$F_{SPR40\%}$	$F_{SPR26\%}$	$F_{SPR40\%}$
2021	21.40	16.24	26.11	20.81	54.79	43.60
2022	21.05	16.79	26.05	21.51	54.58	45.01
2023	21.01	17.37	26.14	22.14	54.72	46.29
2024	21.09	17.88	26.27	22.66	54.97	47.33
2025	21.21	18.30	26.37	23.01	55.17	48.06
3 yr. avg. ('21-'23)	21.15	16.80	26.10	21.49	54.69	44.96
5 yr. avg. ('21-'25)	21.15	17.32	26.19	22.03	54.85	46.06
Current ABC	15.1	15.1	15.1	15.1	15.1	15.1
% increase of 5 yr. avg.	40	15	73	46	263	205

- All scenarios tested produced increased catch advice relative to current management.
- % change in catch advice varies depending on reference point and GRSC subset selection.
- Catches are landings and dead discards (i.e., no dead B2's)

Key Assumptions

- Rates assumed in SEDAR 52 (M, fecundity and maturity, selectivity, retention, weight-at-age) are appropriate irrespective of total abundance.
- Using relative allocation of F across fleets rather than apical F's estimated in SEDAR 52 is appropriate.
- Estimated depletion level in 2019 is appropriate.
- SEDAR 52 estimate of age composition by region represents true age composition.
- Recruitment and SSB0 estimates derived solely from the abundance subsets (i.e., little to no connectivity to cryptic biomass)

Discussion points

- These results are contingent upon acceptance of the GRSC as is.
- Process used to create catch advice is flexible:
  - % exploitable population can be changed
  - Other reference points can be used
- OFL – based on $F_{SPR26\%}$
- ABC – could be calculated using:
  - Different reference point
  - Different subset of GRSC
  - P* approach; would need to specify P* and σ_{min}

Thank You

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