Decision Tree for Making Informed Decisions about configurations for Yield Projections

GMFMC SSC Meeting
9/27/2021

Outline

- Make the decisions about projection settings more explicit
- Show the implications of the decisions in example projection runs using a case study
- Explain and demonstrate new code to supplement SS forecasting capabilities when considering allocations
- Add MSY

What decisions need to be made?

- Years over which to average fishing mortality
- Years over which to average the selectivity and retention parameters
- How to set recruitment
- Interim landings
- Allocation ratio, if any

Parameter	Value	Comment
Relative F	Average from 2016 – 2018	Average relative fishing mortality over terminal three years (2016-2018) of model
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Recruitment	Average from 2009 – 2018	Average recruitment over last 10 years
2019 and 2020 Landings	158.11 mt (Commercial Vertical Line), 12.4635 mt (Commercial Longline), 44.9437 thousands of fish (Charter/Private), 1.3209 thousands of fish (Headboat)	Average 2017-2019 landings
Allocation Ratio	27:73	commercial:recreational

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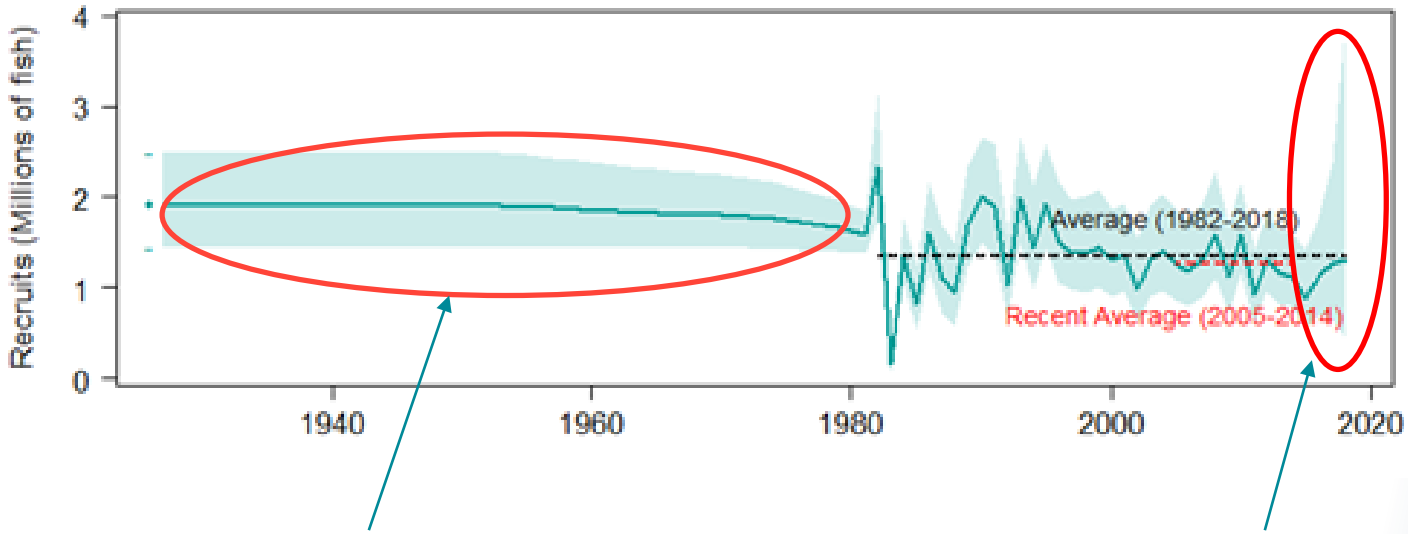
Impacts of management and changes in fishing

- We regularly use the last 3 years of the model to inform selectivity and retention patterns into the future.
- That decision should be made by considering whether recent management may have changed the retention pattern.
  - Has there been a more recent size limit change?
  - Has fishing changed recently that would affect fishing behavior?

What do we think about future recruitment?

- If we have a well-estimated or informed steepness value, we can consider using recruits from the stock-recruit curve.
- If steepness is not well-estimated, or we have no basis to inform steepness, we have to rely on model-estimated recruits
  - What model time period should be used to pull the estimated recruits?
    - The whole model time line
    - The data-rich period
    - The more recent period (be cautious of implying a regime shift)
  - The recruits should be plotted to show what each assumption provides

Consider uncertainties and whether using a subsample of the recruits is implying a change in future productivity



Should we use historic recruits or recent recruits with high uncertainty?

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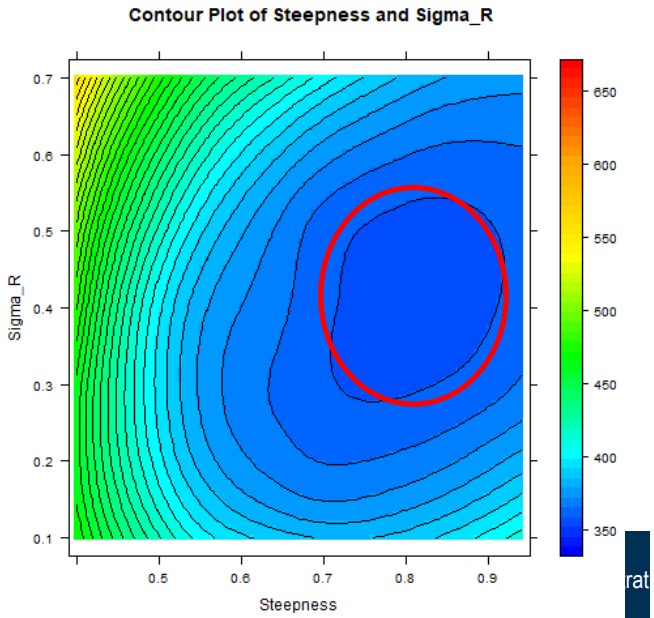
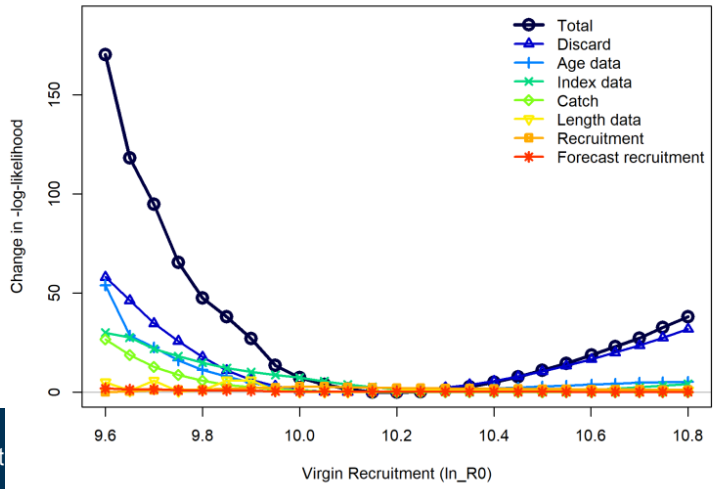
Should we use MSY or a proxy?

- If we have a well-estimated or informed steepness value, we can consider using MSY.
  - The benchmark 'in the books' matters.
    - If an SPR proxy is specified and a new assessment can estimate steepness, the SSC has to decide whether to make a new recommendation about the use of a proxy.
- How do we decide whether steepness is well-estimated ?
  - Diagnostics such a likelihood profiles or contour plots (2 dimensional likelihood profiles)

Consider the 3 stock recruit parameters:

- Steepness (h), virgin recruits (R0) and the uncertainty of the estimates of recruits (sigma_R)
- Across the likelihood surface, we are looking for the minimum of the total likelihood. If there is a minimum that agrees with the model estimate, that's evidence that the parameter is well-estimated. Is there one value or a range of values for each parameter and what is the correlation between them?





What's our target?

- In past projections and presentations to the SSC, we have used the SSB ratio (SSB/SSB_0) or the SPR ratio ($SSB/SSB_{SPR30\%}$)
- There's been very little discussion of the differences or merits of each approach
- When projected recruitment is close to R0 these two targets yield similar results

Implications of assumptions

- We will demonstrate the effects of the assumptions using the Greater Amberjack projections as a case study:
  - Benchmarks and expected stock size
  - Expected short term and long term yield
  - Rebuilding target
- The final piece of the puzzle is how the allocations change benchmarks and the resulting yield.

Greater Amberjack Case Study

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January 2021 SSC meeting projections configurations:

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Time varying retention blocks in SEDAR 70:

- COM_VL: 1950-1989, 1990-2007, 2008-2010, and 2011-2018
- COM_LL: 1950-1989 and 1990-2018.
- Charter+Private and HB: 1950-1989, 1990-1997, 1998-2007, 2008-2015, and 2016-2018.
- None indicate an argument against the current years used for selectivity and retention in the projections

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Interim landings

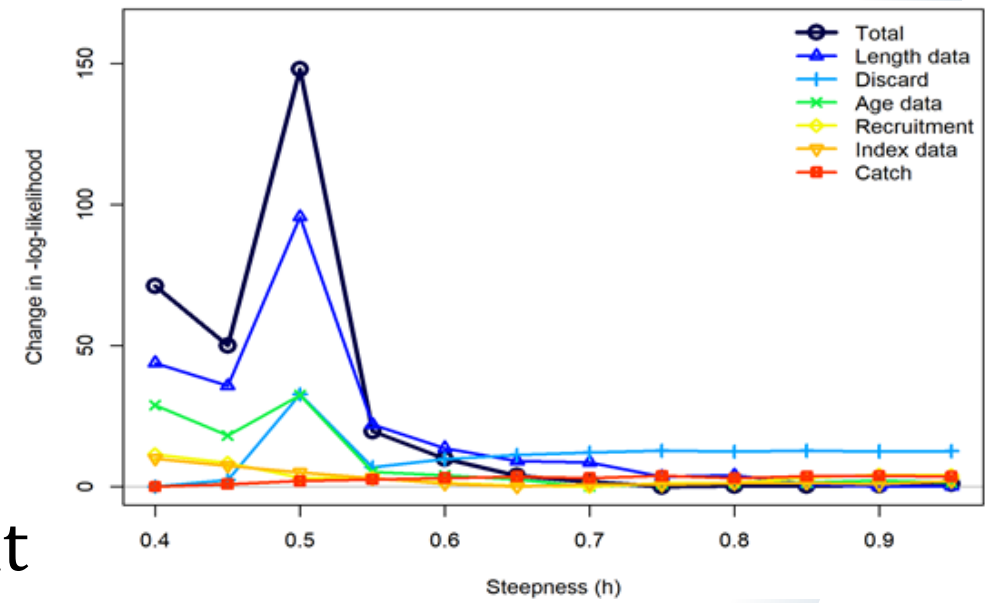
- SAR: 2019 and 2020 Landings — 284.01 mt (Commercial Vertical Line), 11.90 mt (Commercial Longline), 65.43 thousands of fish (Charter/Private), 1.38 thousands of fish (Headboat)
- 1/21 SSC meeting: 2019 and 2020 Landings — 158.11 mt (Commercial Vertical Line), 12.4635 mt (Commercial Longline), 44.9437 thousands of fish (Charter/Private), 1.3209 thousands of fish (Headboat)
- The updated landings reduced the take assumed in 2019 and 2020.

Is steepness estimated?

- Steepness initially estimated in base model, along with R0 and sigmaR.
- Profile on steepness and sigmaR was generally flat in the area of the MLE estimate, though there was a contour in the surface.
  - No prior was used, and yet the model still found the minimum in the likelihood surface

Profiling over steepness

- The steepness profiles indicated that the model favored values above 0.7, and values between 0.7 and 0.8 were more or less equally likely (Figure 62 of the SAR). The lowest likelihood was at steepness = 0.777.



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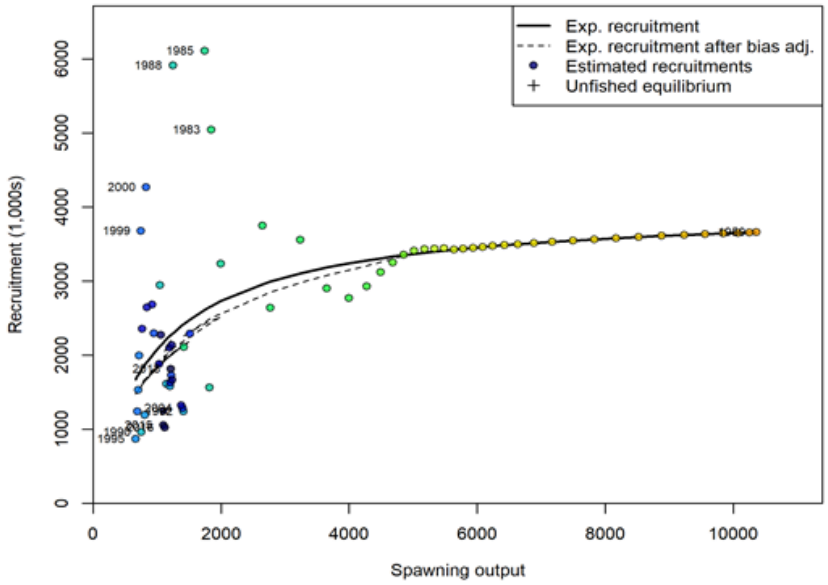
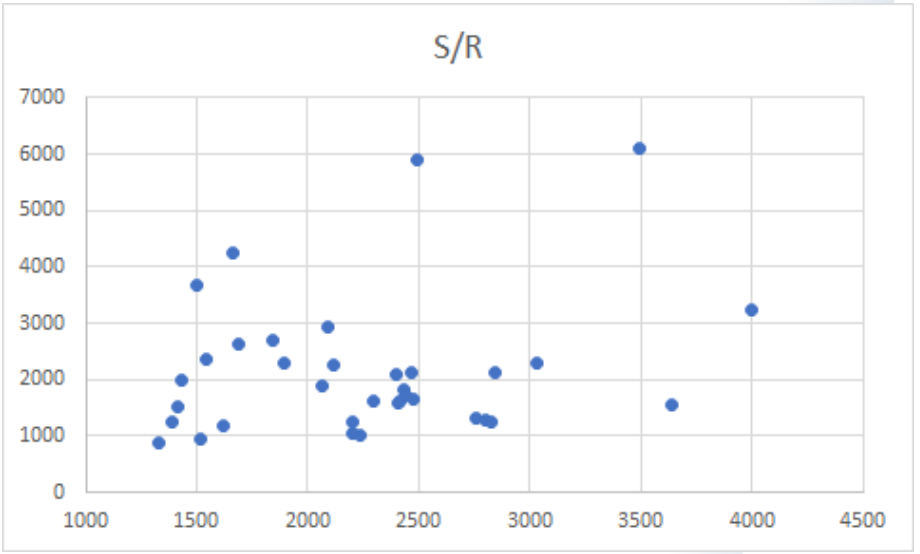
Do we see a relationship between stock size and number of recruits?

With fixed R



Estimated in data-rich period



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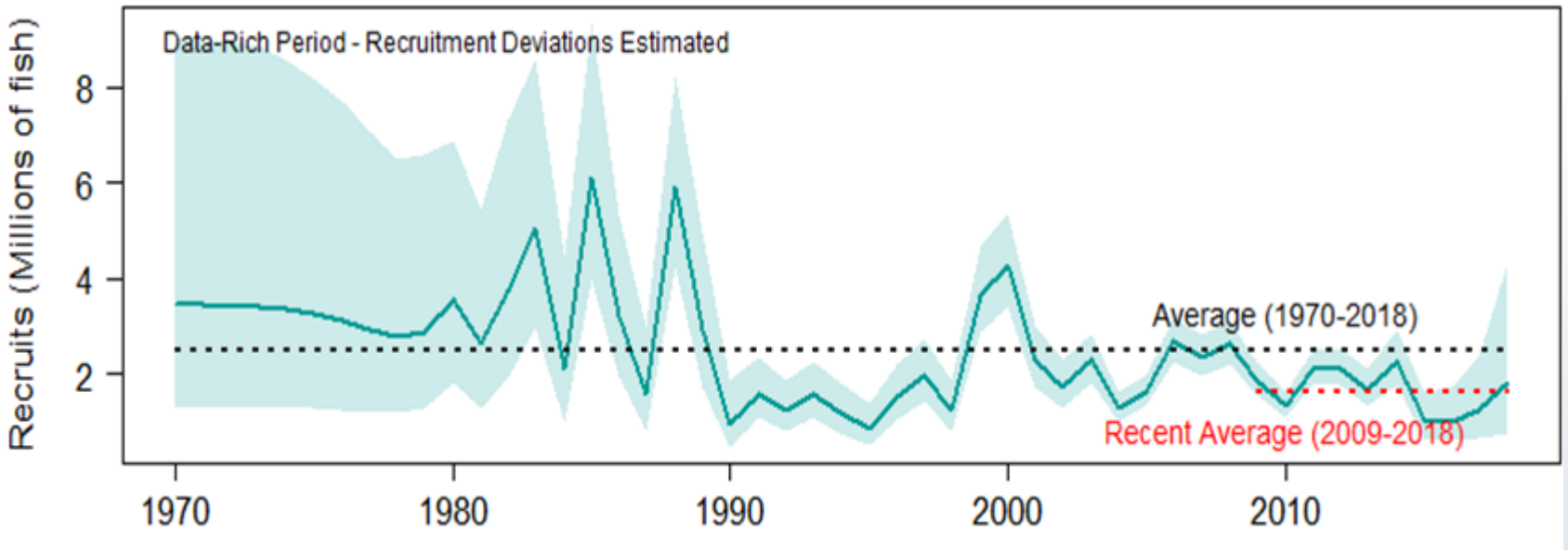
Recruitment



Recent average: 1650.66
Long term average: 2805.57
Data rich average (1984-2018): 2156.04
There is high uncertainty in the historic and terminal recruitment estimates.

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Inferring a regime shift?

- By using the recent years of recruitment for GAJ, we are inferring a regime shift.
- We are telling the projections that the recruitment, and therefore the productivity of the stock, is lower.
- The expected recruits and stock size, and thus yield, in the projections will be reduced
  - A lower expected stock size will be easier to achieve (i.e. rebuilding will be faster at the same F because the stock doesn't have to reach the higher threshold).

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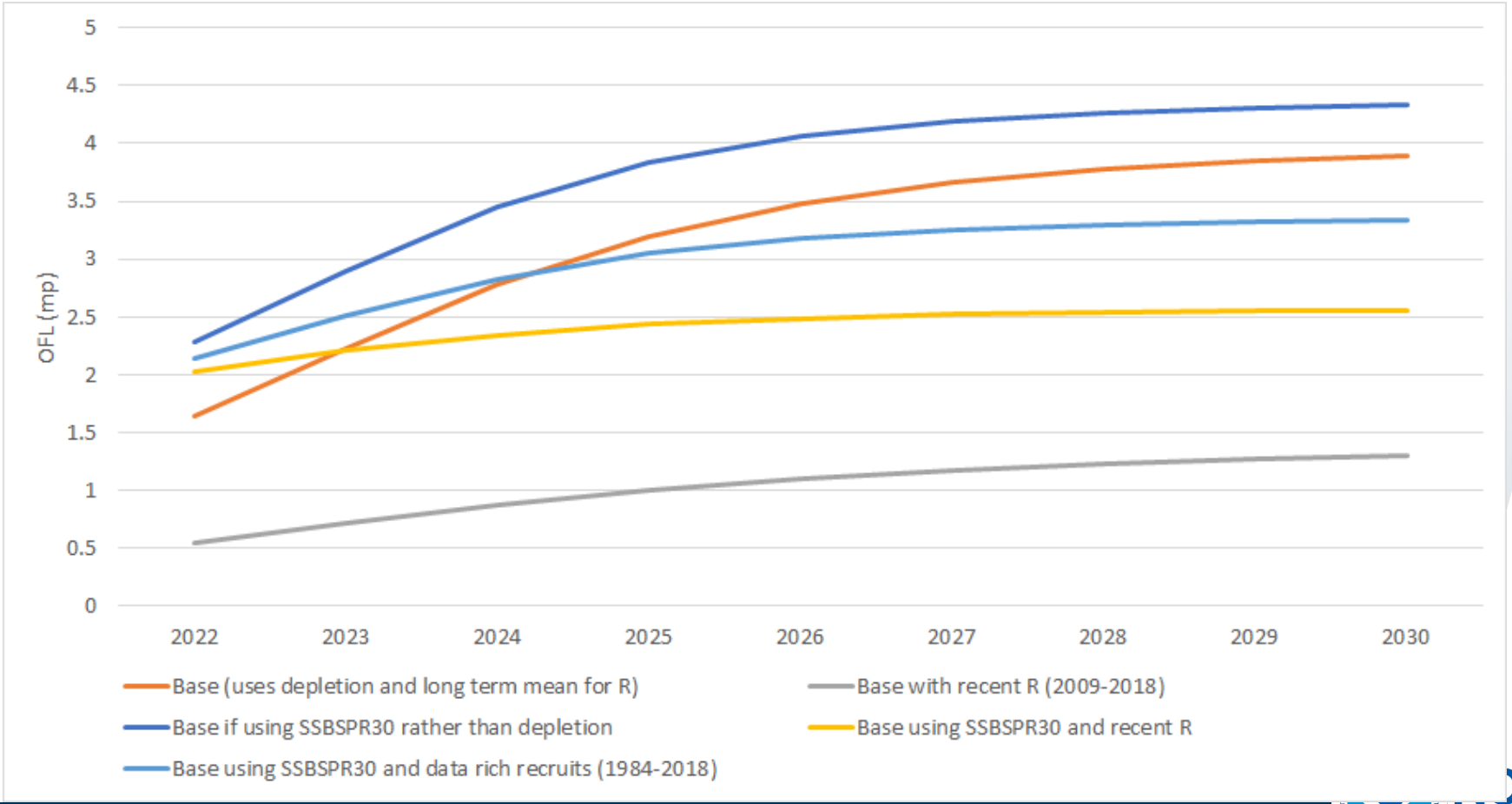
These are dependent on projections:

- These key quantities and SDCs will change based on our assumptions in the projections

Variable	Definition
Base M	Fully selected ages of Lorenzen Natural Mortality (M)
Steepness	Fixed Stock-Recruit (SR) parameter (not used in projections)
Virgin Recruitment	Estimated SR parameter (not used in projections)
Generation Time	Fecundity-weighted mean age
SSB Unfished	Estimated virgin spawning stock biomass
	Mortality Rate Criteria
$F_{MSYproxy}$	Equilibrium F that achieves SPR30%
MFMT	Equilibrium F that achieves SPR30%
$F_{Rebuild}$	F that rebuilds the stock to $SSB_{SPR30\%}$ by 2027
F_{OY}	0.75 * Directed F at $F_{SPR30\%}$
$F_{current}$	Geometric mean (F2016-2018)=$F_{Current}$
$F_{Current}/F_{MSYproxy}$	Current stock status based on $F_{MSYproxy}$
$F_{Current}/MFMT$	Current stock status based on MFMT
	Biomass Criteria
$SSB_{MSYproxy}$	Equilibrium SSB at $F_{SPR30\%}$
MSST	$0.5*SSB_{SPR30\%}$
SSB at Optimum Yield	Equilibrium SSB when Directed F = 0.75 * Directed F at $F_{SPR30\%}$
SSB_{2018}	SSB_{2018}
$SSB_{2018}/SSB_{FMSYproxy}$	Current stock status based on $SSB_{SPR30\%}$ (Equilibrium)
$SSB_{2018}/MSST$	Current stock status based on $MSST_{SPR30\%}$
$SSB_{2018}/SSB_{unfished}$	2018 SPR

Projections with the key decisions for SEDAR 70 prior to the new code



New code for modeling allocations in SS

Dr. Nathan Vaughan's presentation

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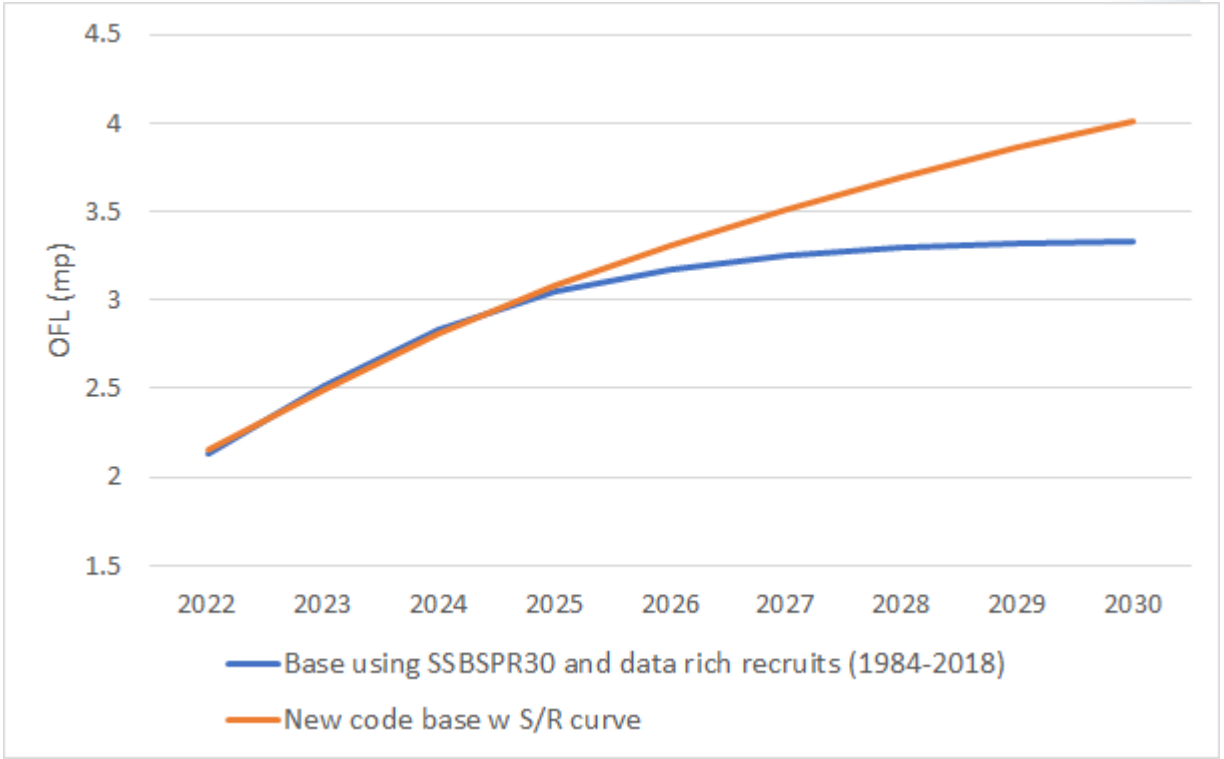
Comparing equal runs w and w/o new code

Base with SPR30% and recent recruitment	Yr	R	F	_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	OFL_mp
	2022	1650.6(	0.233	0.966	2471	0.777	1.555	0.104	0.3	2.031
	2023	1650.6(	0.237	0.983	2677	0.842	1.684	0.113	0.3	2.215
	2024	1650.6(	0.24	0.992	2847	0.896	1.791	0.12	0.3	2.347
	2025	1650.6(	0.241	0.998	2964	0.932	1.865	0.125	0.3	2.435
	2026	1650.6(	0.242	1	3045	0.958	1.916	0.128	0.3	2.489
	2027	1650.66	0.242	1.001	3098	0.975	1.949	0.131	0.3	2.521
	2028	1650.66	0.242	1.001	3133	0.986	1.971	0.132	0.3	2.539
	2029	1650.66	0.242	1	3152	0.992	1.983	0.133	0.3	2.549
	2030	1650.66	0.242	1	3164	0.995	1.991	0.133	0.3	2.555
Base with new code	Yr	R	F	F_FSPR30	SSB	SSB_SSBSPR30	SSB_MSSTSPR30	SSB_SSB0	SPR	OFL_mp
	2022	1650.66	0.242	1	2471	0.777	1.555	0.104	0.291	2.102
	2023	1650.66	0.242	1	2652	0.834	1.669	0.112	0.295	2.235
	2024	1650.66	0.242	1	2813	0.885	1.77	0.119	0.297	2.342
	2025	1650.66	0.242	1	2931	0.922	1.844	0.123	0.299	2.418
	2026	1650.66	0.242	1	3017	0.949	1.898	0.127	0.3	2.471
	2027	1650.66	0.242	1	3079	0.969	1.937	0.13	0.3	2.507
	2028	1650.66	0.242	1	3121	0.982	1.964	0.132	0.3	2.531
	2029	1650.66	0.242	1	3146	0.99	1.979	0.133	0.3	2.544
	2030	1650.66	0.242	1	3160	0.994	1.988	0.133	0.3	2.552

The new code accomplishes two straightforward

If MSY were used:

- The trajectories deviate after 2025.



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If MSY were used:

- Depletion is less and the SPR is greater than 30% in the long term

Yr	R	F	F_FSPR30	SSB	SSB_SSBmsy	SSB_MSST	SSB_SSB0	SPR	OFL_mp
2022	2345.03	0.221	1	2622	0.401	0.802	0.11	0.301	2.152
2023	2498.24	0.221	1	3082	0.472	0.943	0.13	0.311	2.493
2024	2631.2	0.221	1	3565	0.545	1.091	0.15	0.319	2.815
2025	2725.96	0.221	1	3972	0.608	1.215	0.167	0.321	3.08
2026	2795.43	0.221	1	4311	0.66	1.319	0.182	0.322	3.305
2027	2851.37	0.221	1	4615	0.706	1.412	0.194	0.322	3.508
2028	2899.23	0.221	1	4899	0.75	1.499	0.206	0.323	3.697
2029	2939.64	0.221	1	5160	0.789	1.579	0.217	0.324	3.865
2030	2972.69	0.221	1	5389	0.825	1.649	0.227	0.325	4.011

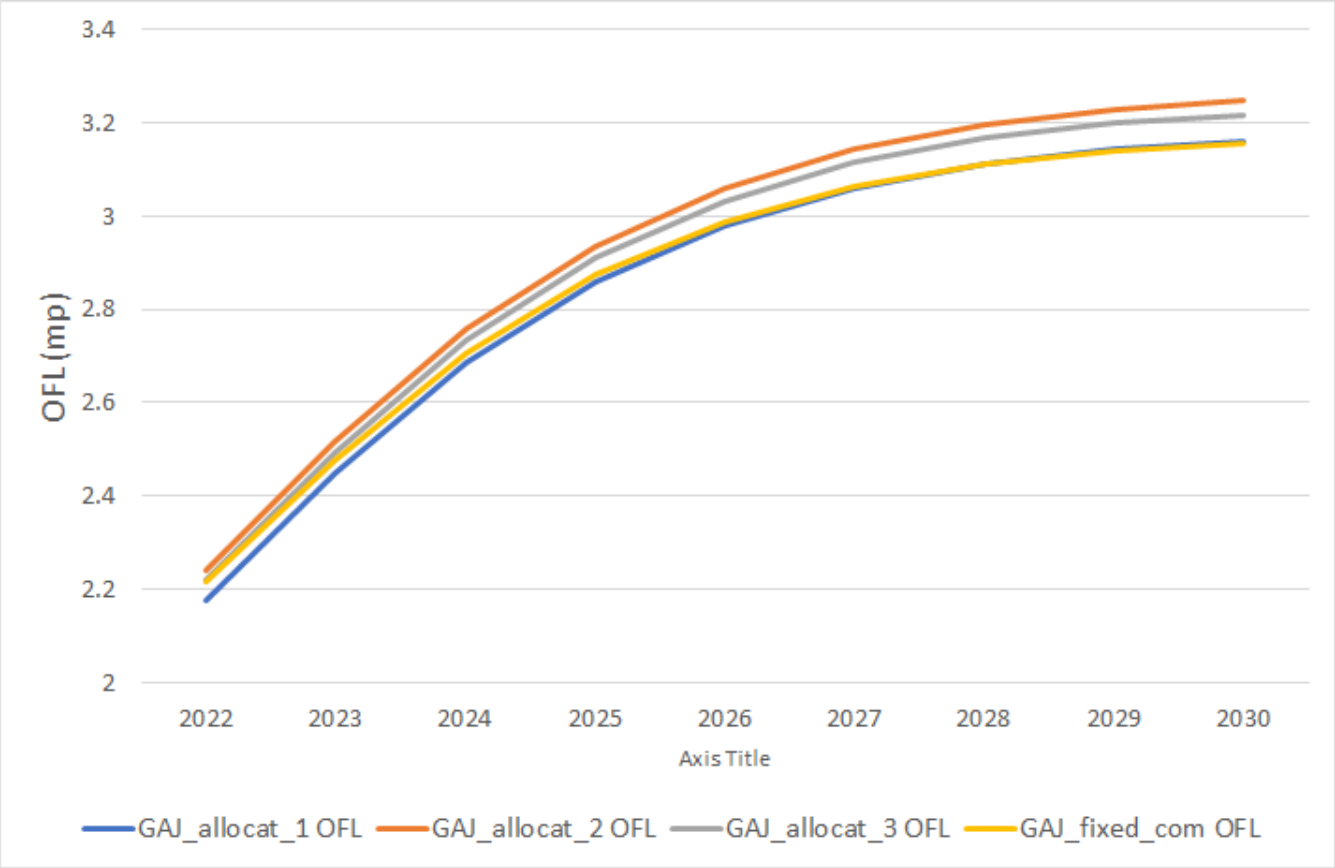
OFL projections under requested allocation scenarios

#1 = 84:16

#2 = 78:22

#3 = 80:20

#4 = Comm fixed



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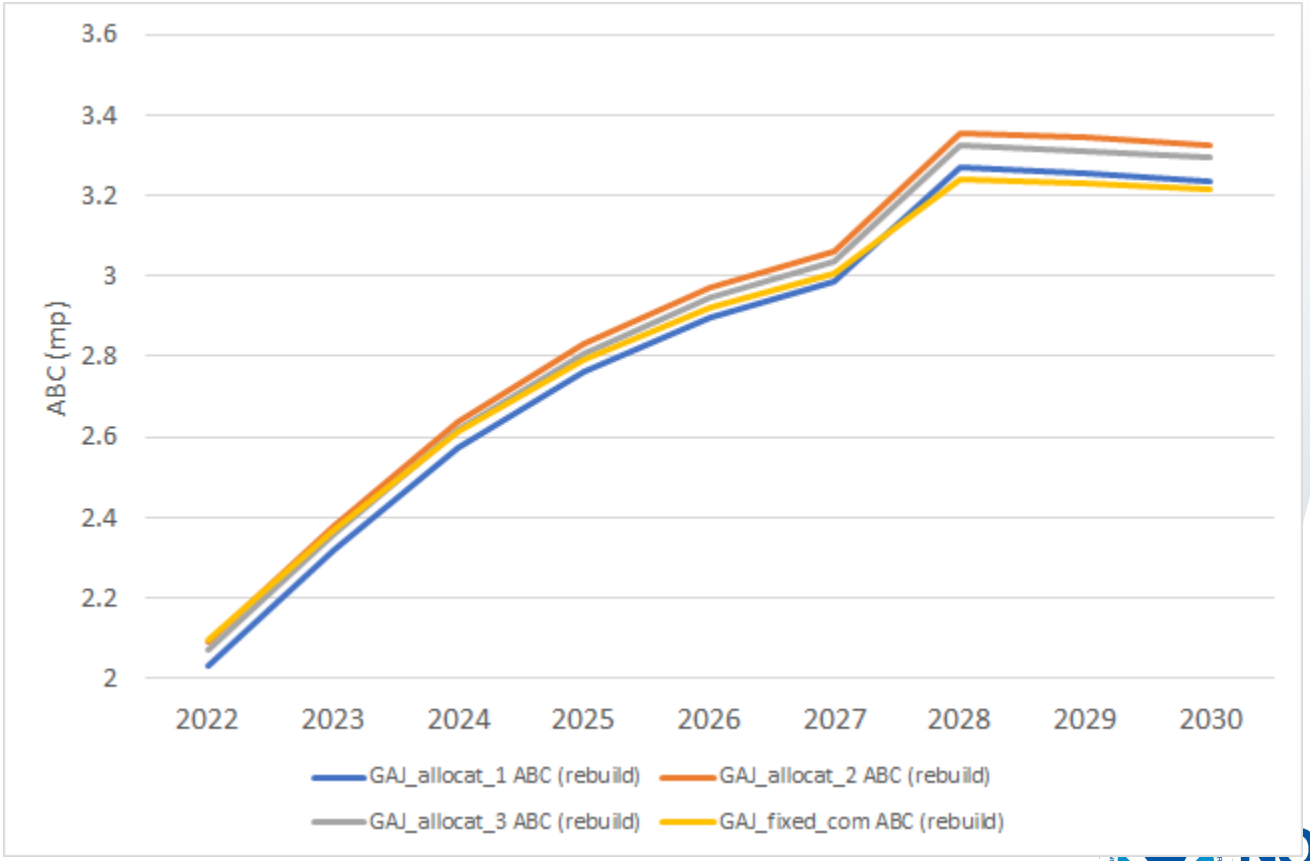
Rebuild projections under requested allocation scenarios

#1 = 84:16

#2 = 78:22

#3 = 80:20

#4 = Comm fixed at 484,380 lbs ww



New projections and document(s) following SSC discussion

- We would like to capture the discussion as well as what we've provided to document the full body of scientific input to date about projections in our region.
- We will provide updated projections based on decisions and discussions at the SSC meeting.

Feedback from the SSC

- List of decisions for the base GAJ projections.
  - Those decisions will be carried through the allocations requests.
- Discussion about the best practices for how to treat recruitment now and into the future.
- Discussion about SPR proxies as opposed to using a proxy level of depletion as a target.

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