Investigating the Impact of Carrying Over or Paying Back Multiple Theoretical Landings Underages/Overages on Population Status Metrics.

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Executive summary

- A series of 12 overage and underage scenarios were simulated for three example species to investigate the impact of carryover and payback provisions.
- Stock status and rebuilding time are not expected to be negatively impacted by carryovers or paybacks when implemented annually at 1:1 ratios.
- Current buffers between ABC and OFL catches are extremely small leaving little buffer for carryovers to not exceed the annual OFL.
- Carryovers and paybacks examined were implemented on a fleet specific basis; different carryover scenarios could yield different results due to different fleet selectivities and discard patterns

1. INTRODUCTION

At its April 2019 meeting the Gulf of Mexico Fisheries Management Council ("Council") requested that the National Marine Fisheries Service conduct additional analyses to investigate the impact of carrying over unrealized catch and paying back overharvest at a 1:1 ratio. These simulation analyses were requested for red snapper, greater amberjack, and gulf king mackerel. Previous analysis into the topic investigated the effect of single and repeated carryover events for red snapper and gulf king mackerel. They observed that even large carry over events had minimal impacts on spawning biomass in subsequent years and would therefore not impact chances of overfishing or time to rebuild. The Council requested that these simulations be extended to investigate the impact of paybacks at a 1:1 ratio and include greater amberjack as a third example species.

Using the 2018 SEDAR 52 red snapper, 2014 SEDAR 38 king mackerel, and 2016 SEDAR 33 Update greater amberjack assessments, several fixed catch projections were performed to investigate the impact of a series of theoretical underages and overages occurring between 2019 and 2030.

2. METHODS

For analysis of the overage/underage request 12 deterministic projections were produced for each of the three assessed species using Stock Synthesis (SS3, V3.24U; Methot and Wetzel, 2013):

1) A base projection where the stock is harvested from 2019-2030 at the OFL levels projected from the relevant SEDAR stock assessments.

2) A base projection where the stock is harvested from 2019-2030 at the ABC levels projected from the relevant SEDAR stock assessments.

3-5) Three single underage event projections where an underage of 10%, 25%, or 50% occurs in 2019 relative to the projected ABC for all fleets and is carried over 1:1 in 2020. All fleets are then projected to harvest at ABC levels from 2021-2030.

6-8) Three single overage event projections where an overage of 10%, 25%, or 50% occurs in 2019 relative to the projected ABC for all fleets and is paid back 1:1 in 2020. All fleets are then projected to harvest at ABC levels from 2021-2030.

9-10) Two multiple overage/underage projections where an underage of 50% occurs in 2019 and then a random underage/overage occurs in every year from 2020-2028. Every year the overage/underage from the previous year is paid back or carried over 1:1. All fleets are then projected to harvest at ABC levels in 2029 and 2030.

11-12) Two multiple overage/underage projections where an overage of 50% occurs in 2019 and then a random underage/overage occurs in every year from 2020-2028. Every year the overage/underage from the previous year is paid back or carried over 1:1. All fleets are then projected to harvest at ABC levels in 2029 and 2030.

Underages/overages were implemented as a percent reduction/increase in annual landings for each fleet in the stock assessment. An underage/overage and subsequent carryover/payback was calculated and prepared for input into SS using the following approach:

1. The annual ABC was taken from the relevant SEDAR projections.
2. The underage/overage for each fleet was calculated by multiplying the fleet-specific ABC by the annual percent underage/overage for the corresponding fleet.
3. The carryover/payback was applied equally 1:1 to all fleets in their native units of weight or numbers in the year immediately following the overage/underage.
4. In the four random overage/underage series the overage/underage was first calculated for every year and then the carryover/payback from the previous year was added. This represents a cumulative carryover/payback scenario which maintains the total 10 year catch sum equal to the original projected ABC total.

Note that in the overage/underage scenarios the base catches remain fixed at projected ABC in weight or numbers and are not updated to reflect the reduced or increased catch history. This approach was considered precautionary as it represents a simple management implementation without the need for annual assessment updates.

3. RESULTS

Impact on forecasted yields

The carryover/payback adjusted yields relative to base ABC varied across years and forecasting scenarios (Table 1 A-C). In years with no overage/underage or carryover/payback the yields were always within ±1% of ABC.

Impact on rebuilding/biomass status

In single overage/underage scenarios the spawning stock biomass was only significantly impacted in the year immediately following the overage and returned to within 1% of ABC expected levels within 2 years following the carryover/payback (Table 2 A-C). The spawning stock biomass oscillated around ABC expected levels throughout the repeated overage/underage simulations though quickly returned to within 1% of expected levels within two years of returning to ABC catches. For all the projections the spawning biomass ratios were imperceptibly different from the base ABC case by the year 2030 (<1%). These simulations show that when payback and carryover is implemented at 1:1 levels, rebuilding time can be expected to be equal to the projected time under constant ABC catches.

DISCUSSION

- Given that spawning biomass was imperceptibly different than expected ABC levels following the repayment of carryover/paybacks it is expected that rebuilding timelines will not be impacted by either of these procedures.
- The small deviations in yields, spawning biomass, and F in years without overages/underages or carryover/payback can be attributed to the effect of applying ABC in numbers for recreational fleets resulting in slight deviations in the weight of catch.
- The simulations presented were designed to identify the potential impacts of implementing 1:1 carryovers and paybacks. Due to the small buffers between ABC and OFL carry overs of underages often exceeded OFL in the following year, under a 1:1 carryover scenario.
- Applying a 50% buffer between ABC and OFL as a carryover limit would prevent carryovers larger than 1-8%, depending upon the original buffer.
- The simulations presented did not recalculate annual ABCs in the projection of overage/underage impacts. However, the small (<5%) impact of one year's catch deviation on stock abundance and moderate exploitation rates (5-20%) mean that this impact is expected to be small (<1%).
- These results support previous carryover results for red snapper and king mackerel. They further extend their findings of no negative impacts on stock status and rebuilding in cases of 1:1 paybacks following a quota overage.
- It is therefore expected that implementation of 1:1 carryover and payback procedures will not negatively impact stock status or rebuilding time in the years between formal stock assessment updates. In the cases that carryover is applied at less than 1:1 due to OFL caps the stock would be predicted to build at a faster rate than the original projections.
- In cases that carryover is capped, these results also suggest that unutilized carryover could be considered an underage in that year and rolled over to subsequent years to stay within the OFL buffer.
- These results suggest that implementing combined multi-year accounting of OFL and ABC could allow more flexible carryover following large underages while maintaining sustainability. However, this is currently forbidden under NS1 guidelines.

CAVEATS

- Differences in selectivity and discarding patterns between fleets mean that reassigning carryovers or paybacks to fleets other than the ones that originally observed the overage or underage may lead to differential impacts on stock status and rebuilding.
- Due to the hypothetical nature of these simulations the results are not meant to be used as the basis for setting future catches for the example stock assessments presented.

4. ACKNOWLEDGEMENTS

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Matthew Campbell (Discard mortality) Beverly Sauls and Alisha Gray (Headboat Discard Age Comp), and Elizabeth Scott-Denton (Shrimp Bycatch Age Composition).

6. LITERATURE CITED

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TABLES

Table 1 A. Red snapper forecasted annual yield streams relative to base ABC for all projected scenarios from 2017-2030. The values are obtained by dividing the predicted yields by the ABC. For example, in the case of a 10% overage, the yield would be approximately 1.1 times the ABC and similarly, 0.9 for a 10% underage. In the following year the payback or carryover would then require approximately a 10% reduction or 10% increase. For reference the ratio of the OFL/ABC for each year is shown on the far left column which indicates the buffer between the OFL and the ABC. Yield ratios greater than the OFL ratio would imply a yield higher than the OFL.

Year	OFL	Overage Random 1	Overage Random 2	50% Overage	25% Overage	10% Overage	ABC	10% Underage	25% Underage	50% Underage	Underage Random 1	Underage Random 2
2017	1.10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2018	1.07	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2019	1.05	1.50	1.50	1.50	1.25	1.10	1.00	0.90	0.75	0.50	0.50	0.50
2020	1.04	0.62	0.70	0.45	0.72	0.89	1.00	1.11	1.28	1.56	1.74	1.82
2021	1.03	0.46	0.48	0.99	1.00	1.00	1.00	1.00	1.00	1.01	0.46	0.48
2022	1.02	1.54	0.82	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.55	0.82
2023	1.02	1.31	1.84	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.31	1.84
2024	1.02	0.12	0.22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.12	0.22
2025	1.03	1.35	1.87	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.34	1.86
2026	1.03	1.23	0.64	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.23	0.64
2027	1.03	0.37	0.74	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.37	0.74
2028	1.02	1.32	0.78	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.31	0.78
2029	1.02	1.14	1.37	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.14	1.37
2030	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 1 B. Greater Amberjack forecasted annual yield streams relative to base ABC for all projected scenarios from 2017-2030. The values are obtained by dividing the predicted yields by the ABC. For example, in the case of a 10% overage, the yield would be approximately 1.1 times the ABC and similarly, 0.9 for a 10% underage. In the following year the payback or carryover would then require approximately a 10% reduction or 10% increase. For reference the ratio of the OFL/ABC for each year is shown on the far left column which indicates the buffer between the OFL and the ABC. Yield ratios greater than the OFL ratio would imply a yield higher than the OFL.

Year	OFL	Overage Random 1	Overage Random 2	50% Overage	25% Overage	10% Overage	ABC	10% Underage	25% Underage	50% Underage	Underage Random 1	Underage Random 2
2017	1.30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2018	1.28	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2019	1.25	1.49	1.49	1.49	1.24	1.09	1.00	0.89	0.75	0.50	0.50	0.50
2020	1.21	0.75	0.83	0.57	0.78	0.91	1.00	1.08	1.21	1.42	1.60	1.68
2021	1.18	0.49	0.53	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.49	0.53
2022	1.15	1.51	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.51	0.80
2023	1.13	1.33	1.81	1.01	1.01	1.01	1.00	1.01	1.01	1.01	1.33	1.81
2024	1.12	0.15	0.25	1.01	1.01	1.01	1.00	1.01	1.01	1.01	0.15	0.25
2025	1.11	1.34	1.86	1.01	1.01	1.01	1.00	1.01	1.01	1.01	1.34	1.86
2026	1.10	1.23	0.66	1.01	1.01	1.01	1.00	1.01	1.01	1.01	1.23	0.66
2027	1.10	0.38	0.75	1.00	1.01	1.01	1.00	1.01	1.01	1.01	0.38	0.75
2028	1.09	1.31	0.79	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.31	0.79
2029	1.09	1.14	1.37	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.14	1.37
2030	1.09	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01

Table 1 C. Gulf king mackerel forecasted annual yield streams relative to base ABC for all projected scenarios from 2017-2030. The values are obtained by dividing the predicted yields by the ABC. For example, in the case of a 10% overage, the yield would be approximately 1.1 times the ABC and similarly, 0.9 for a 10% underage. In the following year the payback or carryover would then require approximately a 10% reduction or 10% increase. For reference the ratio of the OFL/ABC for each year is shown on the far left column which indicates the buffer between the OFL and the ABC. Yield ratios greater than the OFL ratio would imply a yield higher than the OFL.

Year	OFL	Overage Random 1	Overage Random 2	50% Overage	25% Overage	10% Overage	ABC	10% Underage	25% Underage	50% Underage	Underage Random 1	Underage Random 2
2017	1.04	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2018	1.04	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2019	1.04	1.50	1.50	1.50	1.25	1.10	1.00	0.90	0.75	0.50	0.50	0.50
2020	1.04	0.67	0.75	0.49	0.75	0.90	1.00	1.10	1.25	1.51	1.69	1.77
2021	1.04	0.47	0.49	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.47	0.50
2022	1.04	1.54	0.81	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.54	0.82
2023	1.04	1.31	1.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.31	1.83
2024	1.04	0.12	0.22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.12	0.22
2025	1.04	1.35	1.87	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.35	1.86
2026	1.04	1.23	0.64	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.23	0.64
2027	1.04	0.37	0.74	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.37	0.74
2028	1.04	1.31	0.79	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.31	0.78
2029	1.04	1.14	1.37	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.14	1.37
2030	1.04	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2 A. Red snapper forecasted spawning biomass relative to biomass projected under constant catches at the ABC, for all projected scenarios from 2017-2030.

Year	OFL	Overage Random 1	Overage Random 2	50% Overage	25% Overage	10% Overage	ABC	10% Underage	25% Underage	50% Underage	Underage Random 1	Underage Random 2
2017	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2018	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2019	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2020	0.97	0.95	0.95	0.95	0.98	0.99	1.00	1.01	1.02	1.05	1.05	1.05
2021	0.97	0.98	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.01	0.99	0.98
2022	0.96	1.02	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.03	1.02
2023	0.96	0.99	1.03	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.04
2024	0.96	0.96	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.98
2025	0.96	1.02	1.03	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.02	1.03
2026	0.95	1.00	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97
2027	0.95	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
2028	0.95	1.03	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.03	1.00
2029	0.95	1.02	1.03	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.02
2030	0.95	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2 B. Greater amberjack forecasted spawning biomass relative to biomass projected under constant catches at the ABC, for all projected scenarios from 2017-2030.

Year	OFL	Overage Random 1	Overage Random 2	50% Overage	25% Overage	10% Overage	ABC	10% Underage	25% Underage	50% Underage	Underage Random 1	Underage Random 2
2017	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2018	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2019	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2020	0.95	0.90	0.90	0.90	0.95	0.98	1.00	1.02	1.05	1.10	1.10	1.10
2021	0.94	0.96	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.01	0.97	0.95
2022	0.93	1.08	1.05	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.08	1.05
2023	0.91	0.97	1.10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	1.10
2024	0.90	0.89	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.89	0.92
2025	0.88	1.07	1.07	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.08	1.08
2026	0.86	1.01	0.89	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.01	0.90
2027	0.85	0.96	0.96	0.99	0.99	1.00	1.00	1.00	1.00	1.00	0.96	0.97
2028	0.84	1.09	1.02	0.99	0.99	0.99	1.00	0.99	1.00	1.00	1.09	1.03
2029	0.83	1.02	1.07	0.99	0.99	0.99	1.00	0.99	0.99	0.99	1.03	1.08
2030	0.82	0.99	1.00	0.99	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00

Table 2 C. Gulf king mackerel forecasted spawning biomass relative to biomass projected under constant catches at the ABC, for all projected scenarios from 2017-2030.

Year	OFL	Overage Random 1	Overage Random 2	50% Overage	25% Overage	10% Overage	ABC	10% Underage	25% Underage	50% Underage	Underage Random 1	Underage Random 2
2017	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2018	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2019	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2020	0.97	0.92	0.92	0.92	0.96	0.98	1.00	1.02	1.04	1.08	1.08	1.08
2021	0.96	0.97	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.96
2022	0.96	1.06	1.04	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.05	1.03
2023	0.95	0.98	1.08	1.01	1.00	1.00	1.00	1.00	1.00	0.99	0.97	1.07
2024	0.95	0.93	0.95	1.01	1.00	1.00	1.00	1.00	1.00	0.99	0.91	0.93
2025	0.94	1.07	1.07	1.01	1.00	1.00	1.00	1.00	1.00	0.99	1.05	1.05
2026	0.94	1.02	0.93	1.01	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.92
2027	0.94	0.98	0.98	1.01	1.00	1.00	1.00	1.00	1.00	0.99	0.97	0.97
2028	0.94	1.08	1.03	1.01	1.00	1.00	1.00	1.00	1.00	0.99	1.07	1.02
2029	0.93	1.03	1.06	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.02	1.05
2030	0.93	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00