Lobster Pre-Recruit Trigger Index Calculations

Calculation Methods

Three trigger index calculation methods were considered, the annual index and two smoothing methods including the three-year running average and three-year running median. For each method, all three survey-specific indices (Ventless Trap Survey, Spring ME/NH & MA Trawl Survey, and Fall ME/NH & MA Trawl Survey) were scaled to a 2017 reference point calculated with the same method used to calculate the index. That is, the 2017 reference point was the 2017 point value for the annual index method, the 2015-2017 average for the three-year running average method, and the 2015-2017 running median for the three-year running median method. These indices are of pre-recruit sizes expected to recruit to the stock assessment-modeled reference abundance the following year, so the indices were lagged by one year to map to the reference abundance years used in the stock assessment status determination (2016-2018). Scaled indices were then averaged across surveys to generate a single trigger index. The final trigger index value represents proportional change from the 2017 reference point. A value of one indicates no change, a value greater than one indicates an increase in abundance (e.g., 1.2 indicates a 20% increase from the reference point), and a value less than one indicates a decrease in abundance (e.g., 0.8 indicates a 20% decrease from the reference point). The scaled survey-specific and combined indices are compared to the various trigger points that have been discussed in Figure 1.

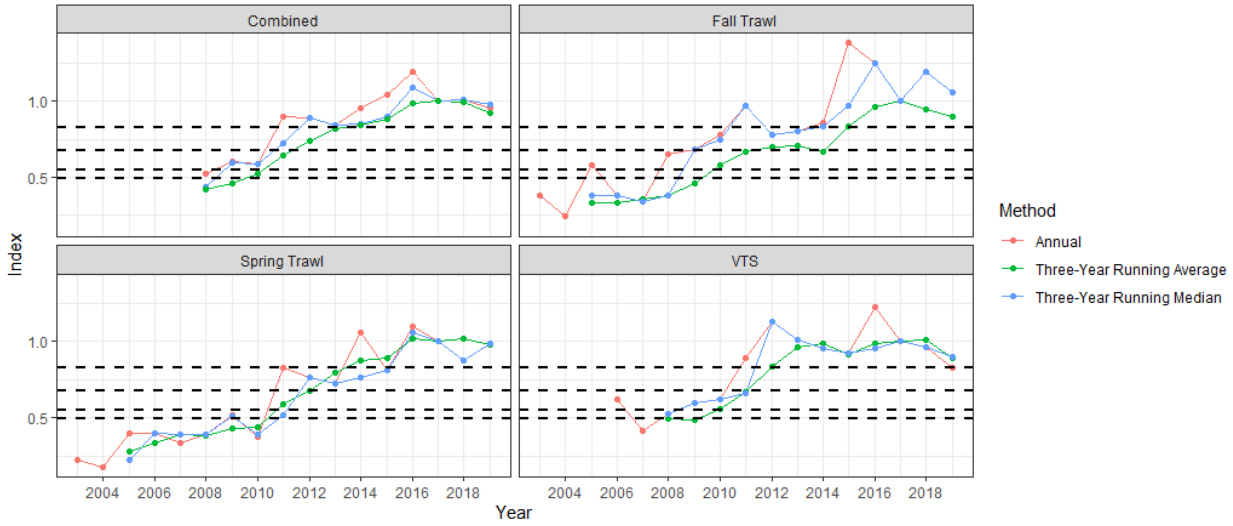

Figure 1. Scaled survey-specific and combined indices using three calculation methods compared to four trigger levels (0.83, 0.68, 0.55, 0.49) identified from potential stock assessment-modeled reference abundance declines (dashed lines).

Performance Evaluation

Performance of each calculation method considered was evaluated with simulation analysis. “True” indices for each survey were projected from 2018 to 2025 following a steady decline that reflected a 32% decline from the observed 2017 index value in 2021 and a 54% decline in the final year of 2025. It was unclear what impacts the method used to calculate the 2017 index value would have on performance of each method, so declines from the 2017 value using each method used to calculate trigger indices were evaluated in separate simulations. The 32% decline projected in 2021 is the trigger

point where the assessment reference abundance shifts between the high and moderate abundance regime and was treated as the trigger for action in these simulations. Indices were then sampled from these true trends with CVs equal to the average CV over the respective index's time series, assuming a lognormal error structure. These simulations only consider observation error and do not account for process error. If one or more of the indices does not accurately reflect stockwide abundance changes (e.g., hyperdepletion, hyperstability), performance may be overestimated. Indices were scaled to their reference point as described above, averaged across surveys, and the combined trigger index was evaluated for whether or not it would trigger action ($\leq$0.68) in each year of the projection period. This was repeated 1,000 times for each simulation and action determinations were tallied by year for each of the considered trigger index calculation methods.

Results show similar patterns between scenarios with a true decline from the 2017 point value and the 2015-2017 average (Table 1, Figures 2-3). The 2015-2017 running median was equal to the 2017 point value for all indices, so the results with a true decline from this value were identical to the 2017 point value scenario (Table 1, Figure 4). Incorrect action is triggered very infrequently (<3% of the time) by the annual and running median methods in the first two years of the projection period and never by the running average method. On average, the annual and running median methods incorrectly triggered action about 9% of the time and about 15 times more frequently than the running average method the year before the true decline reached the threshold (2020), but also correctly triggered action ≈38% of the time and roughly twice as frequently as the running average method in the year when the threshold was met (2021). The running average method then tended to perform as well as or better than the other methods from 2022-2025, albeit generally at smaller margins of difference as all methods tended to perform relatively well in these later years when the decline is exacerbated.

Based on these results, the annual and running median methods may be considered more precautionary methods that perform better for an immediate trigger at the cost of some risk of premature triggering of action. The running average method may provide a less responsive method, less likely to incorrectly trigger premature action, that performs well after an initial risk of not triggering action when needed.

Table 1. Percentage of 1,000 simulations that triggered action for three true decline starting point specifications and averages across these simulations. The true indices were projected to trigger action in 2021.

True Decline Starting Point	Index Calculation Method	2018	2019	2020	2021	2022	2023	2024	2025
2017 Point Value	Annual	0%	2%	12%	50%	85%	97%	100%	100%
	Three-Year Running Average	0%	0%	1%	27%	86%	100%	100%	100%
	Three-Year Running Median	0%	2%	12%	44%	84%	98%	100%	100%
2015-2017 Average	Annual	0%	0%	3%	21%	59%	89%	99%	100%
	Three-Year Running Average	0%	0%	0%	3%	46%	95%	100%	100%
	Three-Year Running Median	0%	0%	3%	19%	60%	90%	99%	100%
2015-2017 Running Median	Annual	0%	2%	12%	50%	85%	97%	100%	100%
	Three-Year Running Average	0%	0%	1%	27%	86%	100%	100%	100%
	Three-Year Running Median	0%	2%	12%	44%	84%	98%	100%	100%
Average	**Annual**	**0%**	**2%**	**9%**	**40%**	**76%**	**94%**	**100%**	**100%**
	Three-Year Running Average	**0%**	**0%**	**1%**	**19%**	**73%**	**98%**	**100%**	**100%**
	Three-Year Running Median	**0%**	**1%**	**9%**	**36%**	**76%**	**95%**	**100%**	**100%**

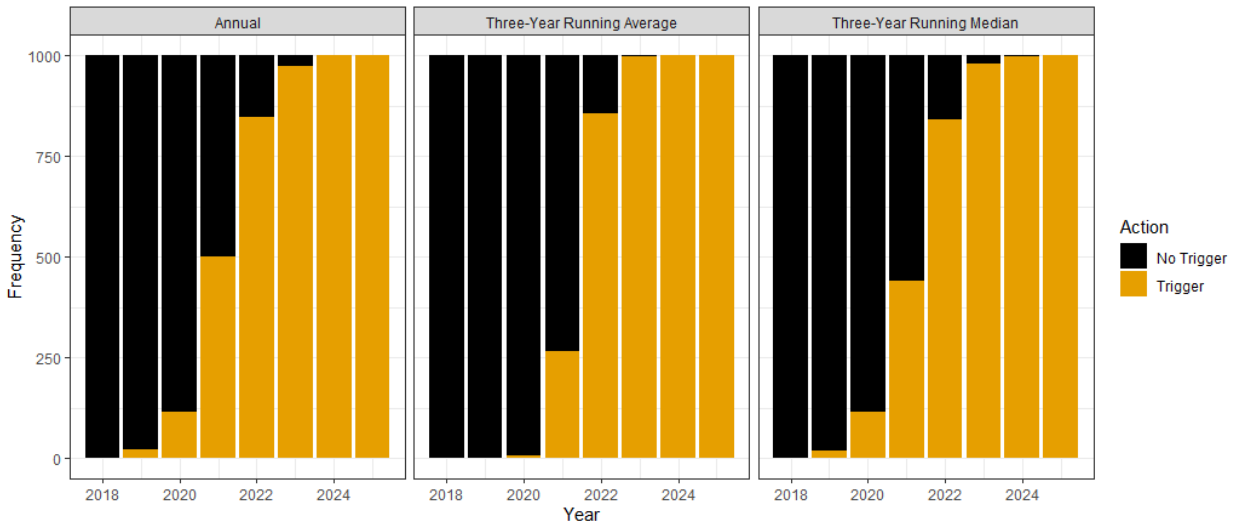

Figure 2. Annual action determinations by method from 1,000 simulations with the true index trends declining from their 2017 point values. The true indices were projected to trigger action in 2021.

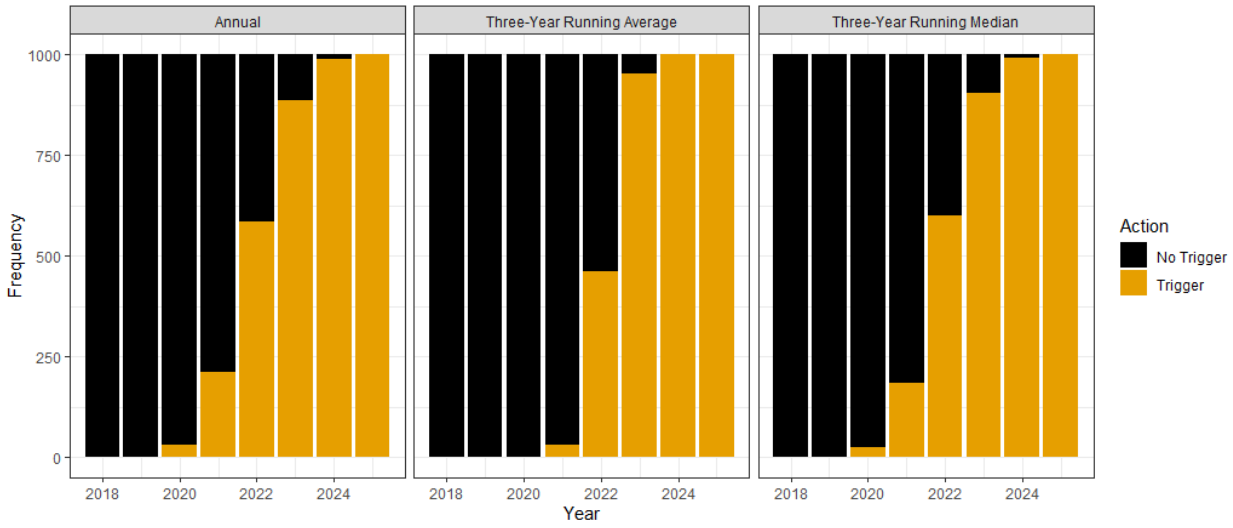

Figure 3. Annual action determinations by method from 1,000 simulations with the true index trends declining from their 2015-2017 average. The true indices were projected to trigger action in 2021.

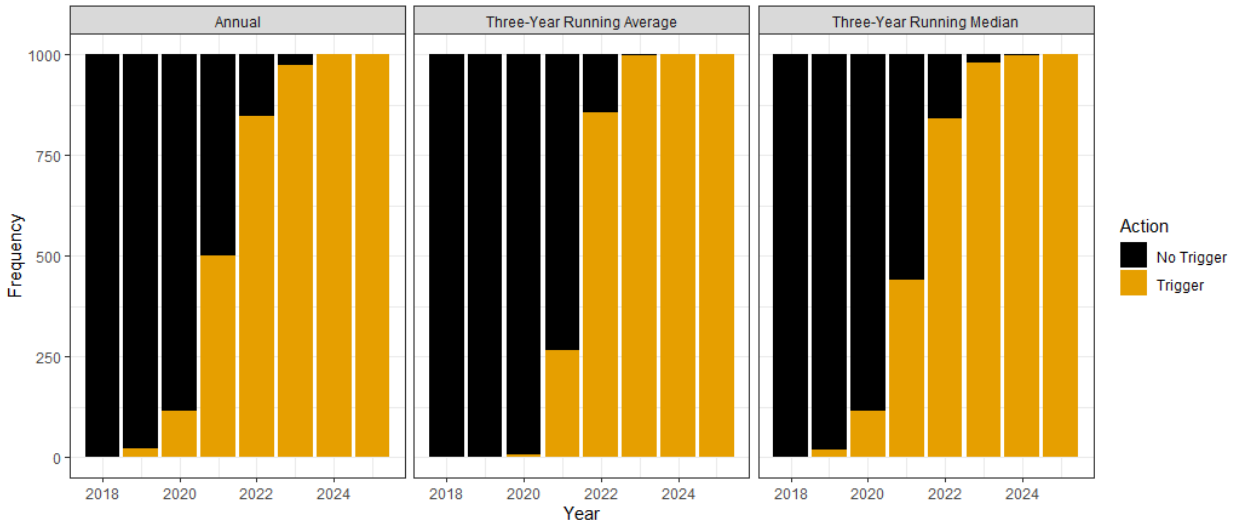

Figure 4. Annual action determinations by method from 1,000 simulations with the true index trends declining from their 2015-2017 running median. The true indices were projected to trigger action in 2021.