Northwest Atlantic  Fisheries Organization

NAFO SC Working Paper 18/007

SCIENTIFIC COUNCIL MEETING – JUNE 2018

Projections under the selected Management Procedure for Greenland Halibut

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Figures 1 to 5 plot the projected 95, 90 and 80% probability envelopes as well as the projected medians under the revised Management Procedure adopted in 2017 for Greenland Halibut for a series of quantities (annual catch, recruitment, and the five survey indices of abundance together with the composite index which combines the five) for the following SCAA-based Operating Models:

- OM1 (the Baseline, using data including 2016 and the O3 set of surveys),
- OM2 (larger recruitment variability with σ_R=0.6),
- OM4 (loRec – the recruitment of the first 8 years of the projections are at 50% of the level predicted by the stock-recruit function),
- OM7 (110TAC – future catches are taken as 110% of the TAC) and
- OM8 (noplus – zero selectivity for the plus group).

The probability envelopes have been computed from a 9-point averaging approach (see Appendix below) from 500 replicates. The 9-point approach was selected as it offered a reasonable trade-off between preserving trend and eliminating "jaggedness" from Monte Carlo variation.

An EXCEL file providing values for all the plots shown in this document has been provided to the Secretariat.

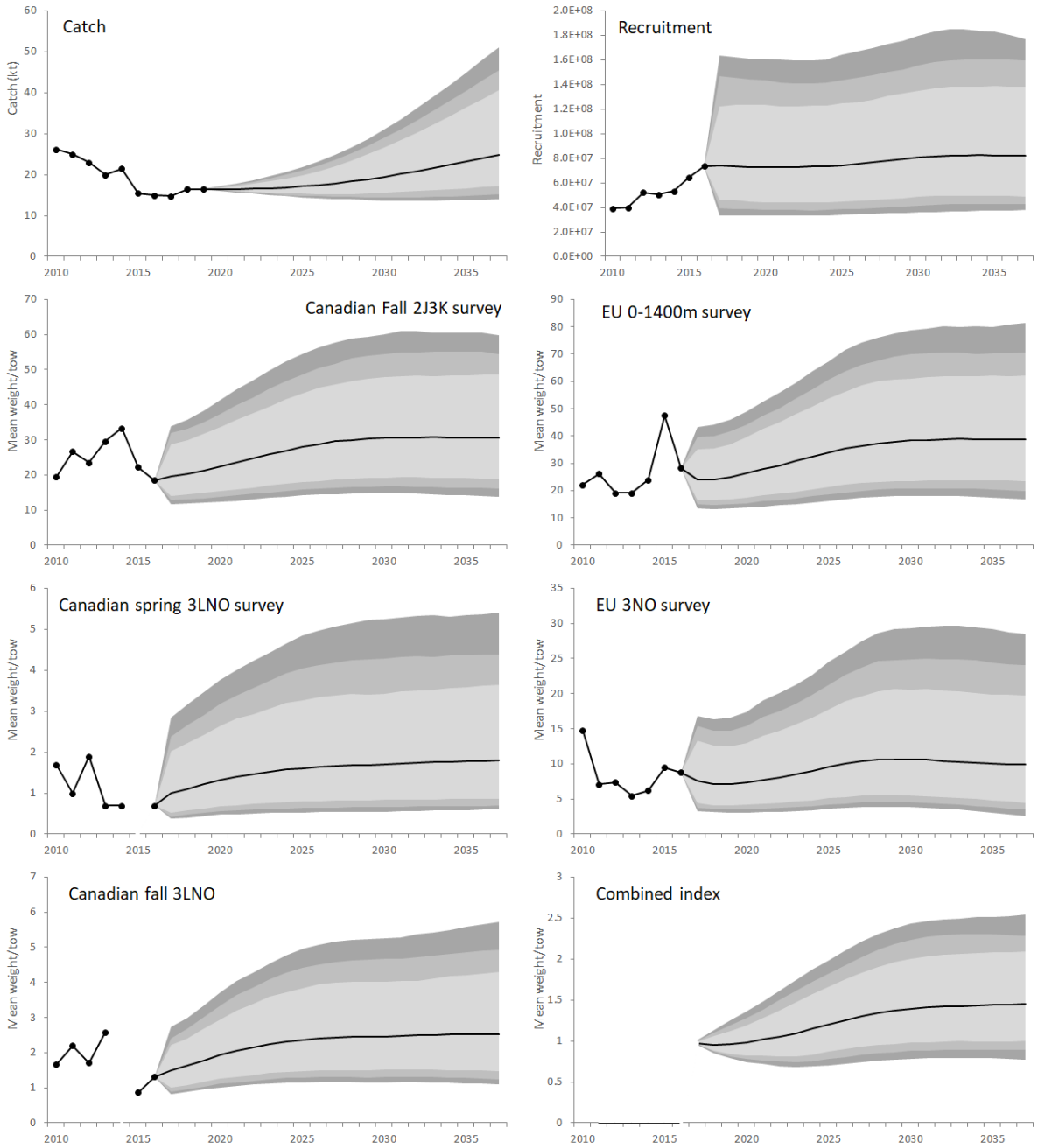

Figure 1: 95, 90 and 80% PI envelopes and medians for projected catch, recruitment, the five survey indices and the combined survey index under the MP adopted for OM1. Note that past values are not shown for the combined index because of missing values for some of the indices, together with the index involving averaging over three years.

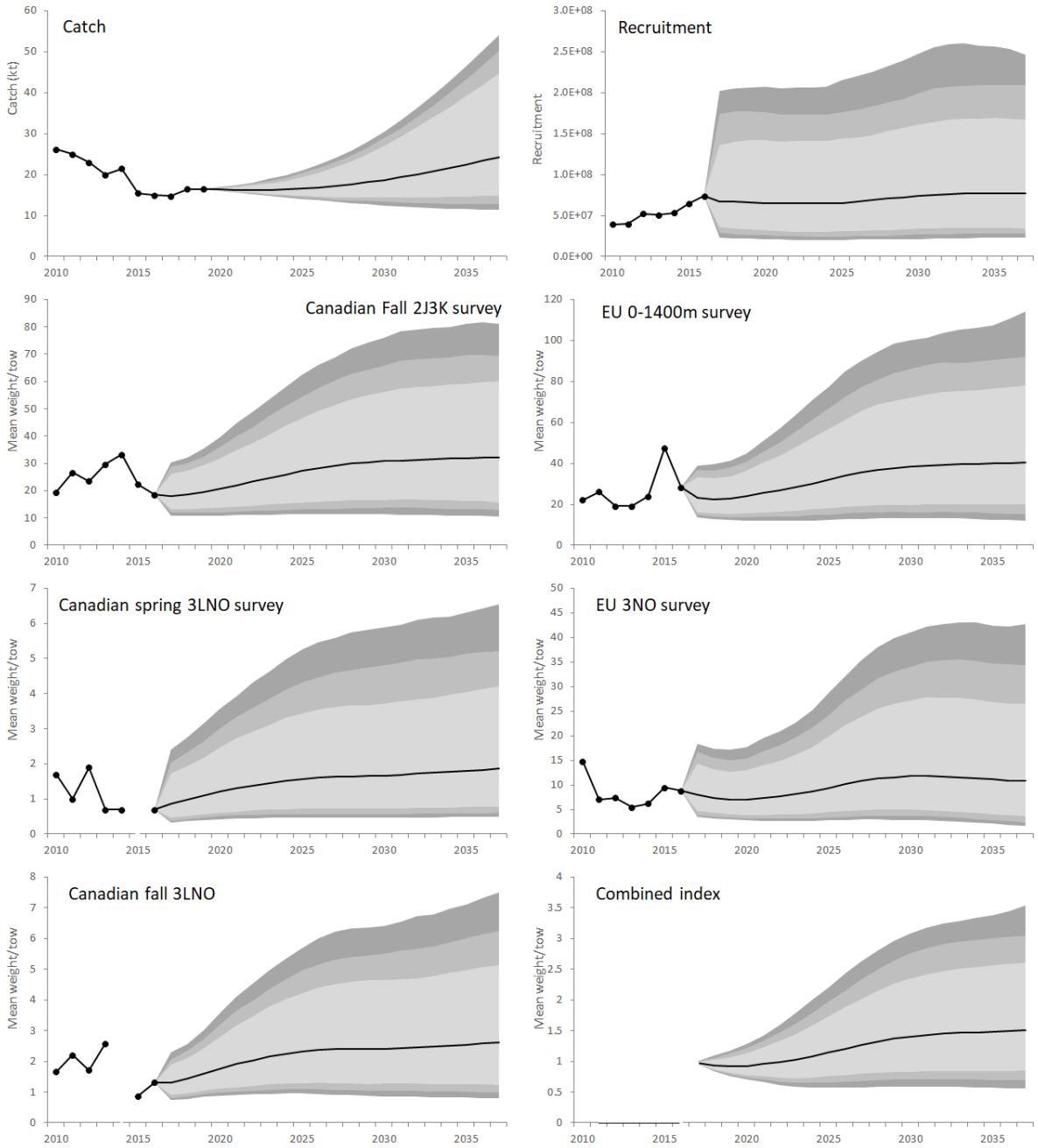

Figure 2: 95, 90 and 80% PI envelopes and medians for projected catch, recruitment, the five survey indices and the combined survey index under the MP adopted for OM2.

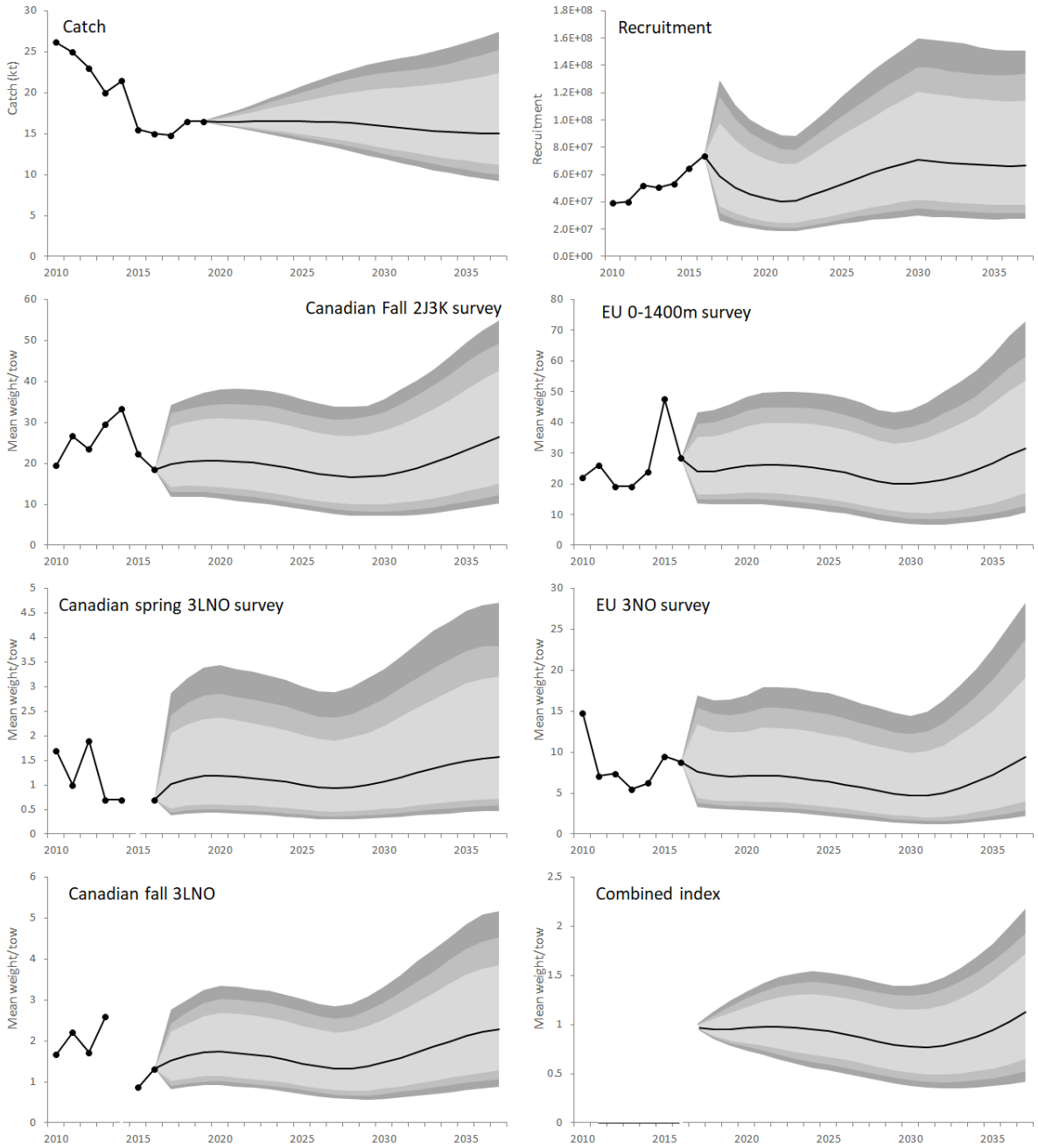

Figure 3: 95, 90 and 80% PI envelopes and medians for projected catch, recruitment, the five survey indices and the combined survey index under the MP adopted for OM4.

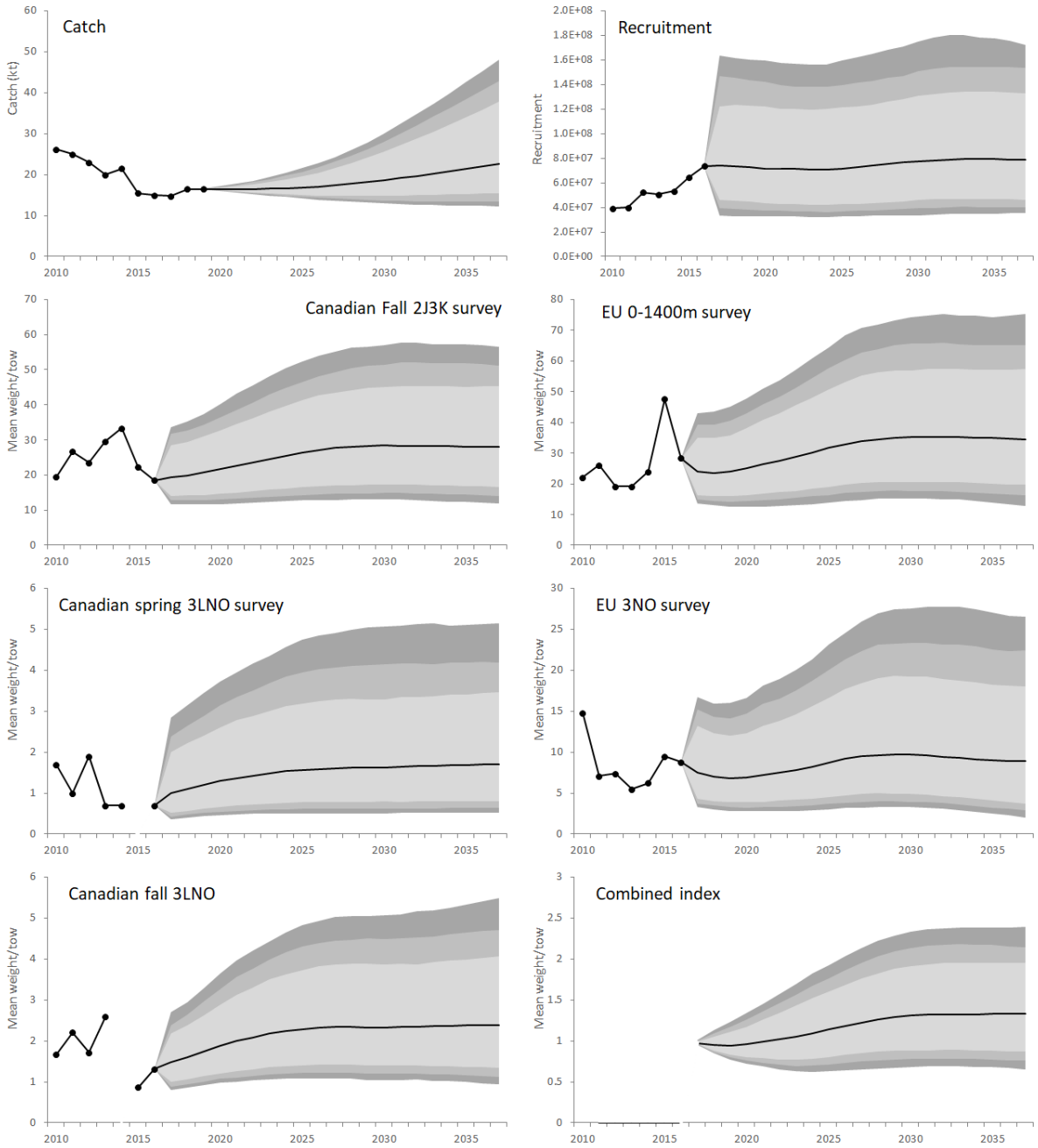

Figure 4: 95, 90 and 80% PI envelopes and medians for projected catch, recruitment, the five survey indices and the combined survey index under the MP adopted for OM7.

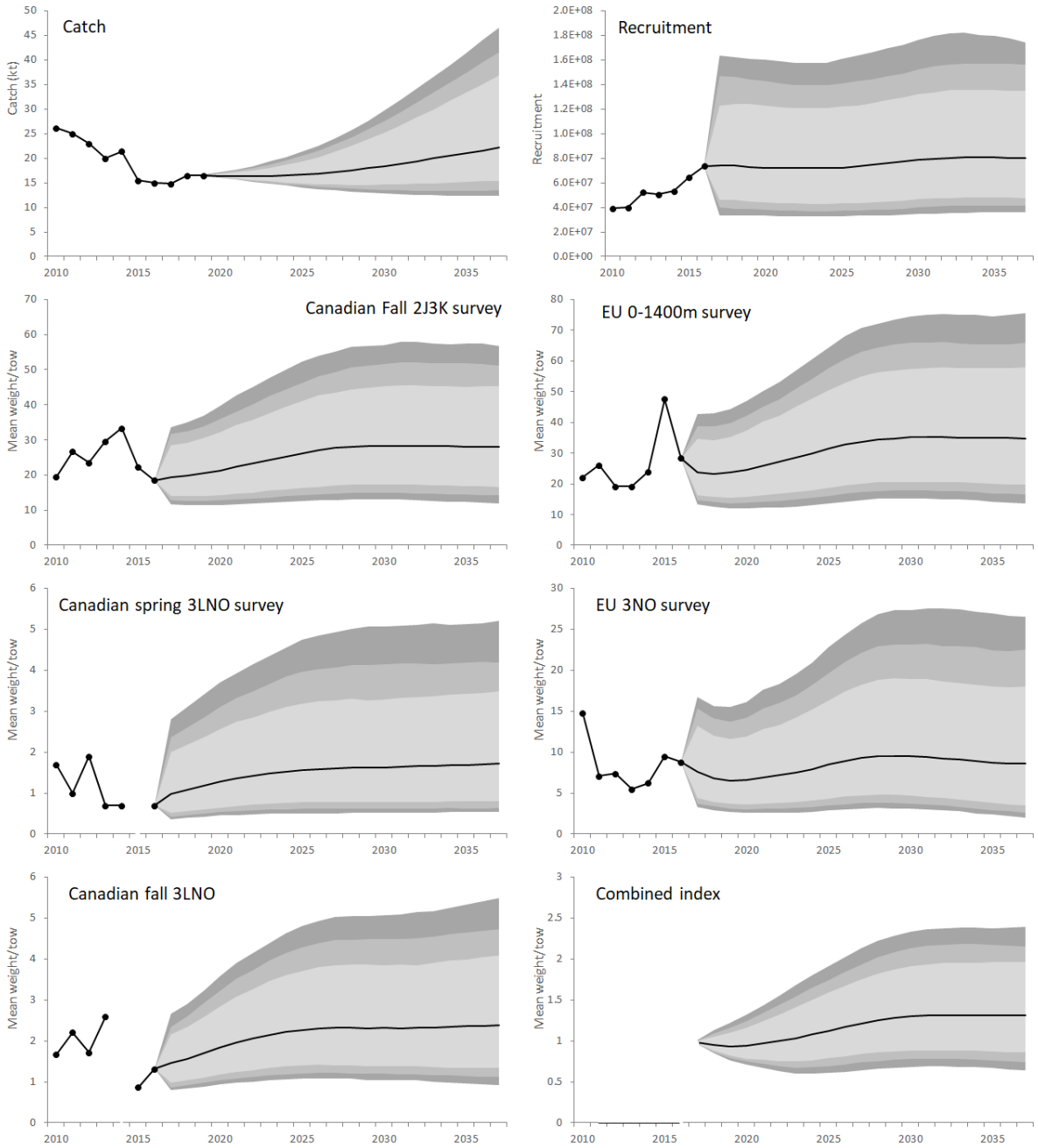

Figure 5: 95, 90 and 80% PI envelopes and medians for projected catch, recruitment, the five survey indices and the combined survey index under the MP adopted for OM8.

Appendix

Smoothing methodology

For the higher probability interval envelopes in particular, the curves can become quite jagged even for 500 replicates. This is a consequence of Monte Carlo error. Increasing the number of replicates to reduce this jaggedness would be prohibitive in terms of computation time, so it becomes more computationally efficient to use a different approach to obtain curves that are smoother over time as would be needed to serve as a basis for management decisions. The fact that the exact results (as the number of replicates is increased indefinitely) would be smooth over time, because the population trajectories are themselves fairly smooth, assists this process, and allows an ***n*-point averaging** approach to be applied, with details as set out below.

Each value I_y is replaced by $\bar{I}_y$ where:
For year $y_{start} + \frac{n-1}{2} + 1$ to year $y_{final} - \frac{n-1}{2}$:

$$\bar{I}_y = \frac{\sum_{y-\frac{n-1}{2}}^{y+\frac{n-1}{2}} I_y}{n} \qquad (1)$$

For the years for which all the *n* points are not available, i.e. from the years y_{start} to $y_{start} + \frac{n-1}{2}$, and from $y_{final} - \frac{n-1}{2} + 1$ to y_{final}, a linear regression to the values available against year is calculated and then used to replace the original value by the estimate from the regression line.

Figure A.1 compares the original values for the 95% PIs with those from 7- and 9-point averaging.

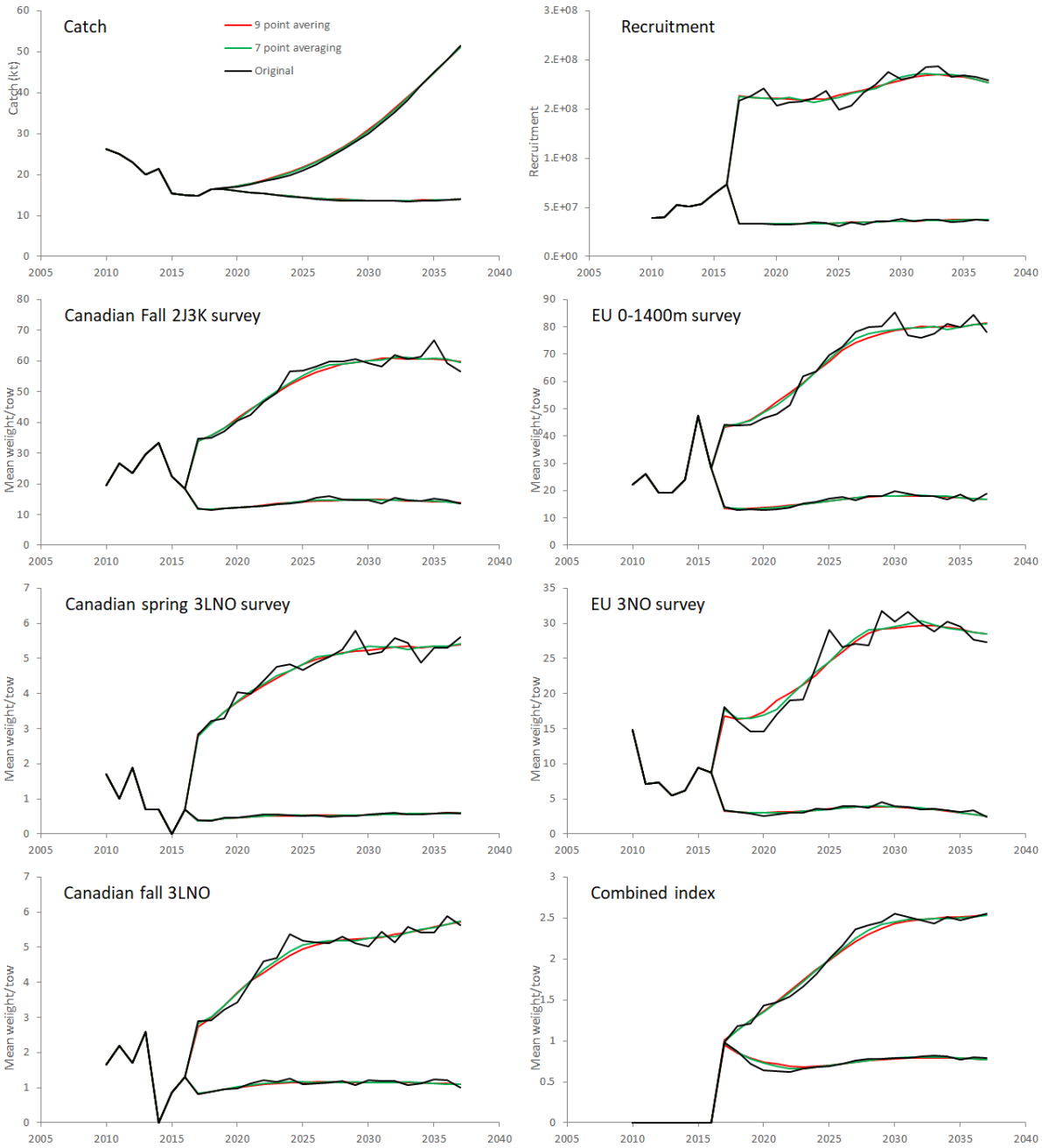

Figure A.1: A comparison of the original estimates of 95% probability interval envelopes for projections for the base case OM under the adopted MP from 500 replicates with those that result from 7- and 9-point averaging, as detailed in the text.