A Note Related to Determining "Abrupt Changes in Abundance" in Simulation Output

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ABSTRACT
Alternative definitions for "abrupt changes" in population size for use when evaluating simulation trials which explore the impact of environmental variation on the ability to estimate MSYR are outlined. These definitions are based on the frequency of years in which abundance drops by x% over y years. Example plots, based on the results presented by Cooke (2009), are provided.

KEYWORDS: MSYR; SIMULATION

INTRODUCTION

Cooke (2009) used Monte Carlo simulation to explore the ability to estimate MSYR in the face of environmental variation in productivity. IWC (2009) noted that there appears to be considerable inter-annual variation in the true time-trajectories of abundance in the simulations on which the analyses of Cooke (2009) were based, especially when deviations in productivity were temporally auto-correlated. Specifically, it was noted that there appeared to be "abrupt changes in abundance". IWC (2009) recommended that analyses be conducted to develop quantitative criteria for defining what is meant by "abrupt changes in abundance".

METHODS, RESULTS AND DISCUSSION

The proposed definition of "abrupt change" is based on the change in (true) abundance over a pre-specified period. For example, one could define the probability of abrupt change as the frequency of years in which abundance drops by x% over y years. There is no *a priori* basis to select x and y. Therefore, results are shown in Figs 1-5 for various choices for x and y.

Figures 1-4 plot the probability of abrupt changes in abundance for runs B1, C1, D1 and K1 of Cooke (2009) (see Table 1 for the specifications for these runs). Results are shown for four cases:

- Probability that the true population size drops by at least x% over y years starting each year.
- Probability that the true population size drops by at least x% over y years at least once during a simulation.
- Probability that the (linear) trend through the simulated abundance data drops by at least x% over y years starting each year.
- Probability that the (linear) trend through the simulated abundance data drops by at least x% over y years at least once during a simulation.

Results are shown for both the simulated abundance data and the true population size to allow comparisons to be made with data for monitored whale species. As expected, the probability of a true decline and observing a decline tends to increase with lower values for x and higher values for y. The probabilities are higher for scenarios D1 and K1, as expected, because these scenarios include higher levels of inter-annual correlation in productivity deviations (Table 1).

Figure 5 contrasts the probability that the true population drops by x% over y years at least once during a simulation for three variants of scenario K (high levels of process error and inter-annual correlation in process error) which vary the true value for MSYR. As expected, the probability of "abrupt changes" is greatest for low values for MSYR.

ACKNOWLEDGEMENTS
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REFERENCES

Cooke, J.C. 2009. The influence of environmental variability on baleen whale sustainable yield curves. Paper SC/N07/MSYR1 (revised) presented to the Intersessional Meeting on MSYR for baleen whales, February 2009 (unpublished) 19 pp.
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Table 1
Specifications of scenarios (from Cooke (2009))

Scenario	Habitat Quality	Variance	Correlation	Years of data	CV	True MSYR	True MSYL
B1	Low	0.5	0.5	25	0.2	0.010	0.514
B2	Medium	0.5	0.5	25	0.2	0.036	0.557
B3	High	0.5	0.5	25	0.2	0.059	0.616
C1	Low	0		25	0.2	0.010	0.514
C2	Medium	0		25	0.2	0.036	0.557
C3	High	0		25	0.2	0.059	0.616
D1	Low	0.5	0.9	25	0.2	0.010	0.514
D2	Medium	0.5	0.9	25	0.2	0.036	0.557
D3	High	0.5	0.9	25	0.2	0.059	0.616
K1	Low	1	0.9	25	0.2	0.010	0.514
K2	Medium	1	0.9	25	0.2	0.036	0.557
K3	High	1	0.9	25	0.2	0.059	0.616

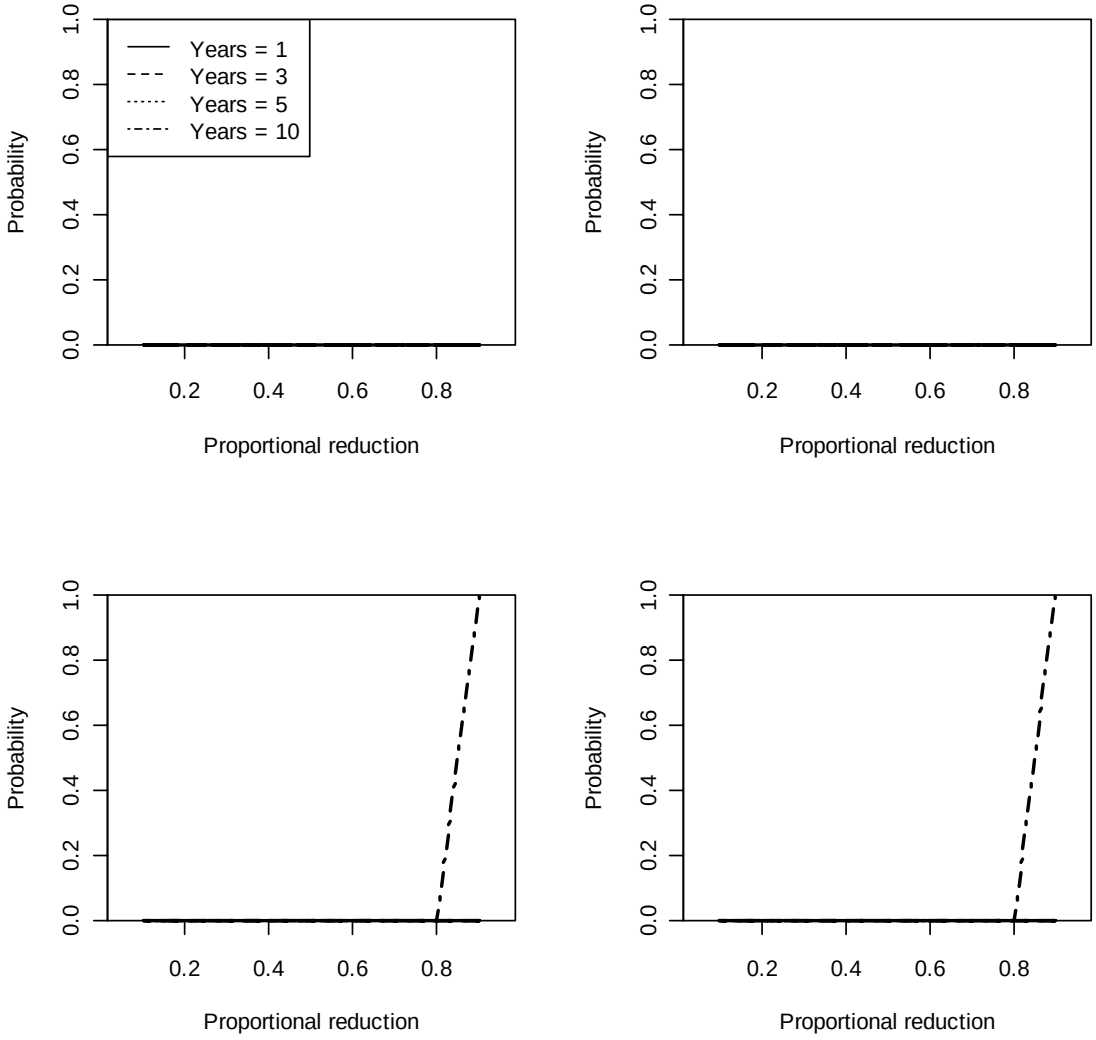

Figure 1. Probability of a reduction in abundance to a given amount (i.e. 0.2 implies a reduction of 80%) over a given period (1, 3, 5 and 10 years) each year (left panels) and at least once during a simulation (right panels). Results are shown for the true trajectories of population size in the upper panels and for the observations in the lower panels. The results in this plot are based on run C1 of Cooke (2009).

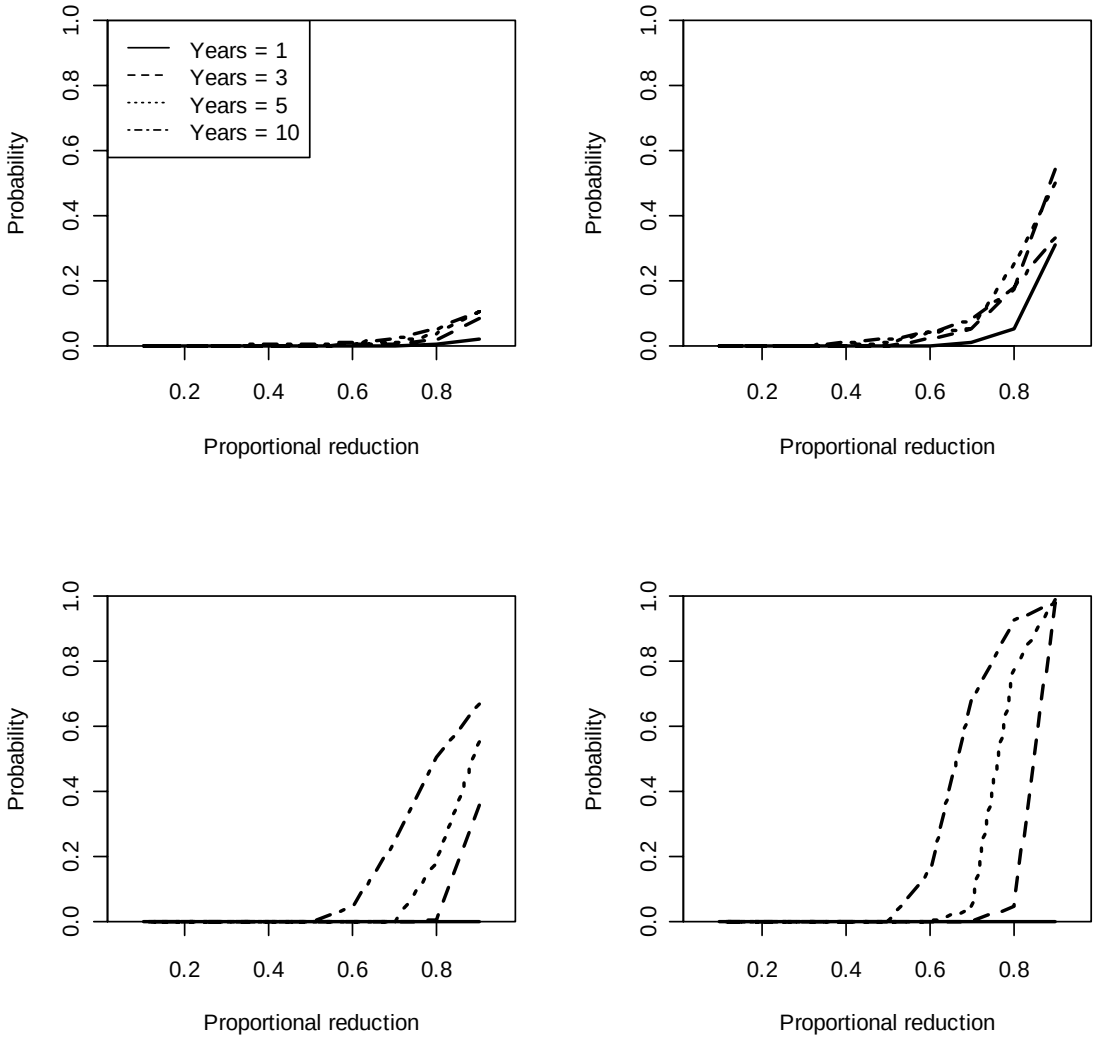

Figure 2. As for Figure 1, except that the results pertain to run B1 of Cooke (2009).

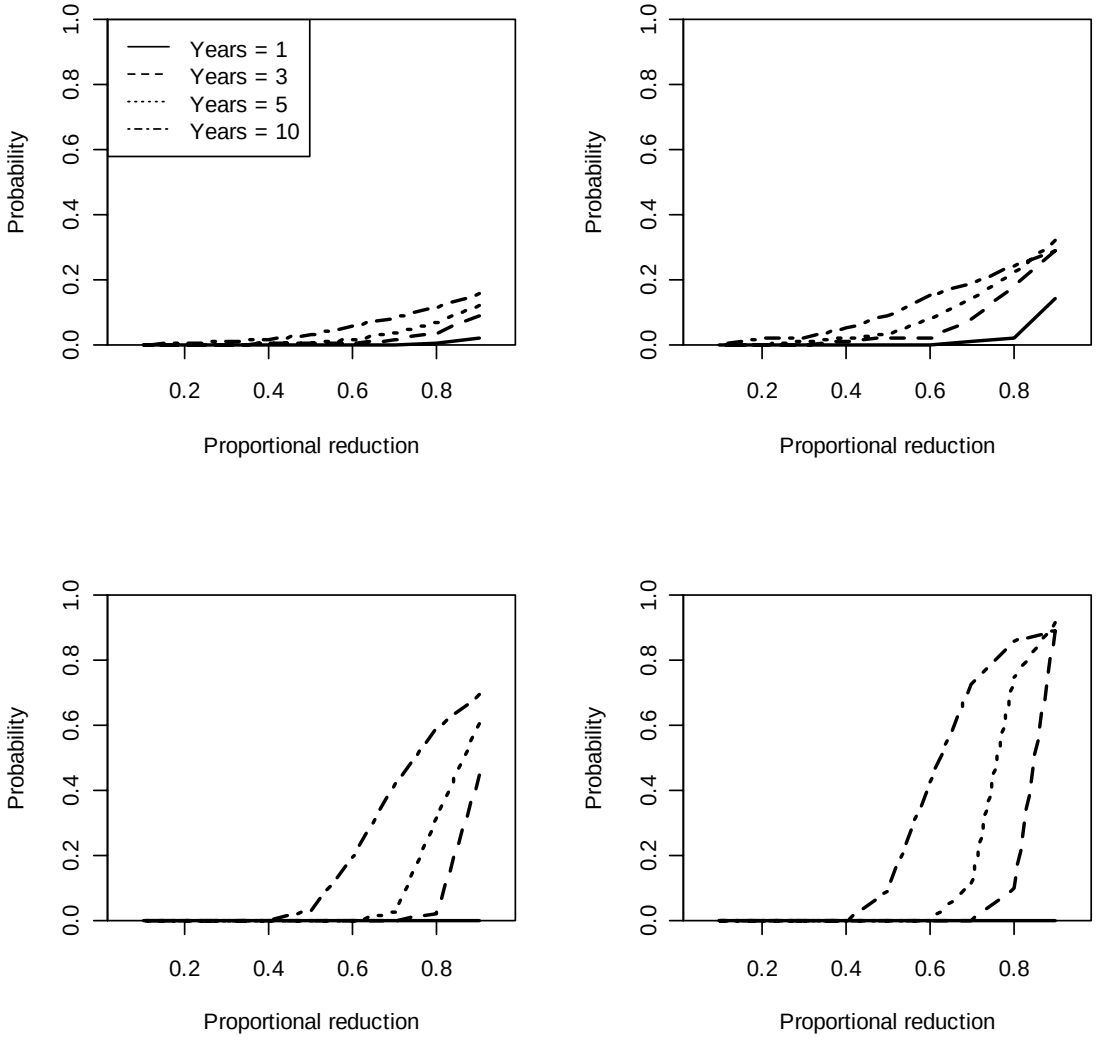

Figure 3. As for Figure 1, except that the results pertain to run D1 of Cooke (2009).

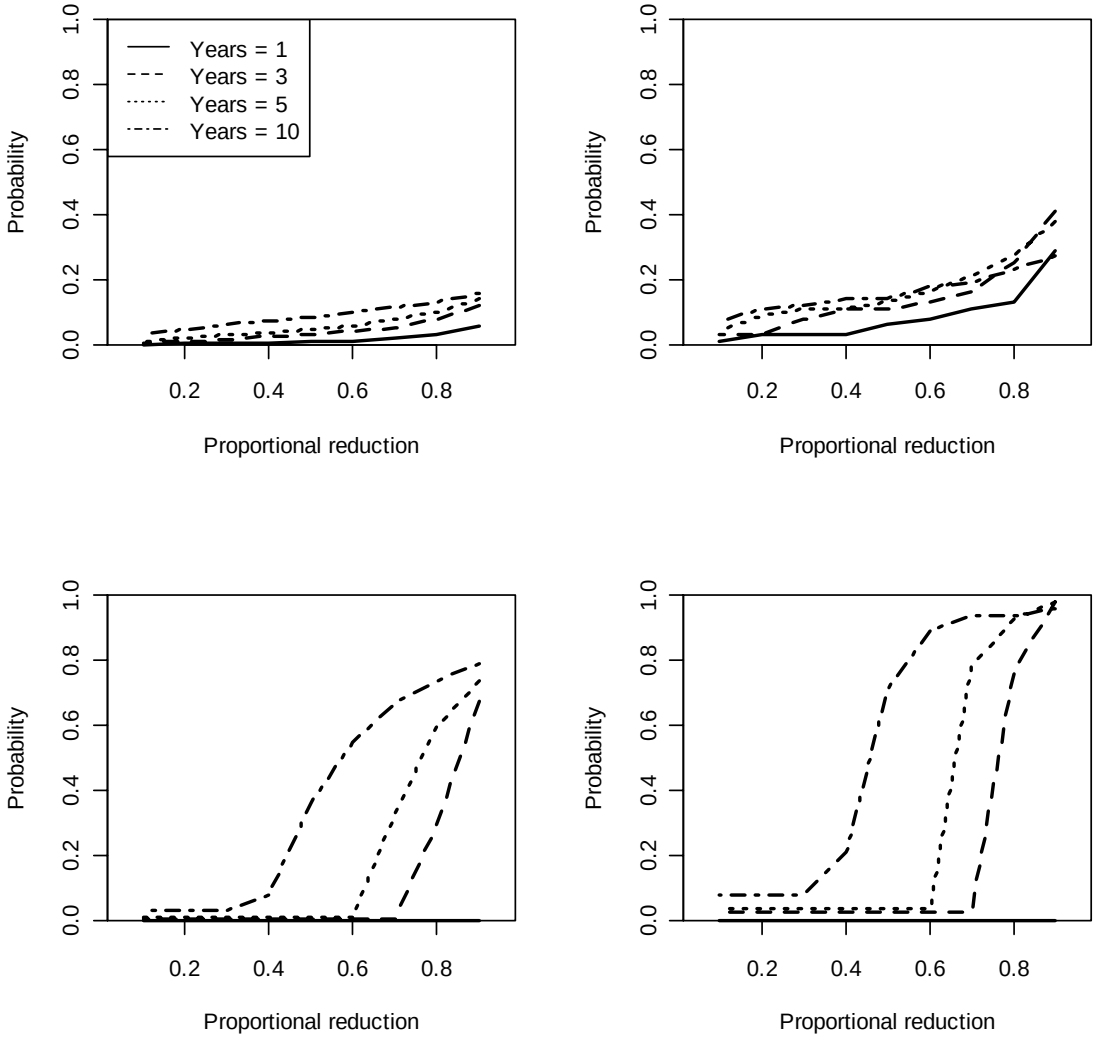

Figure 4. As for Figure 1, except that the results pertain to run K1 of Cooke (2009).

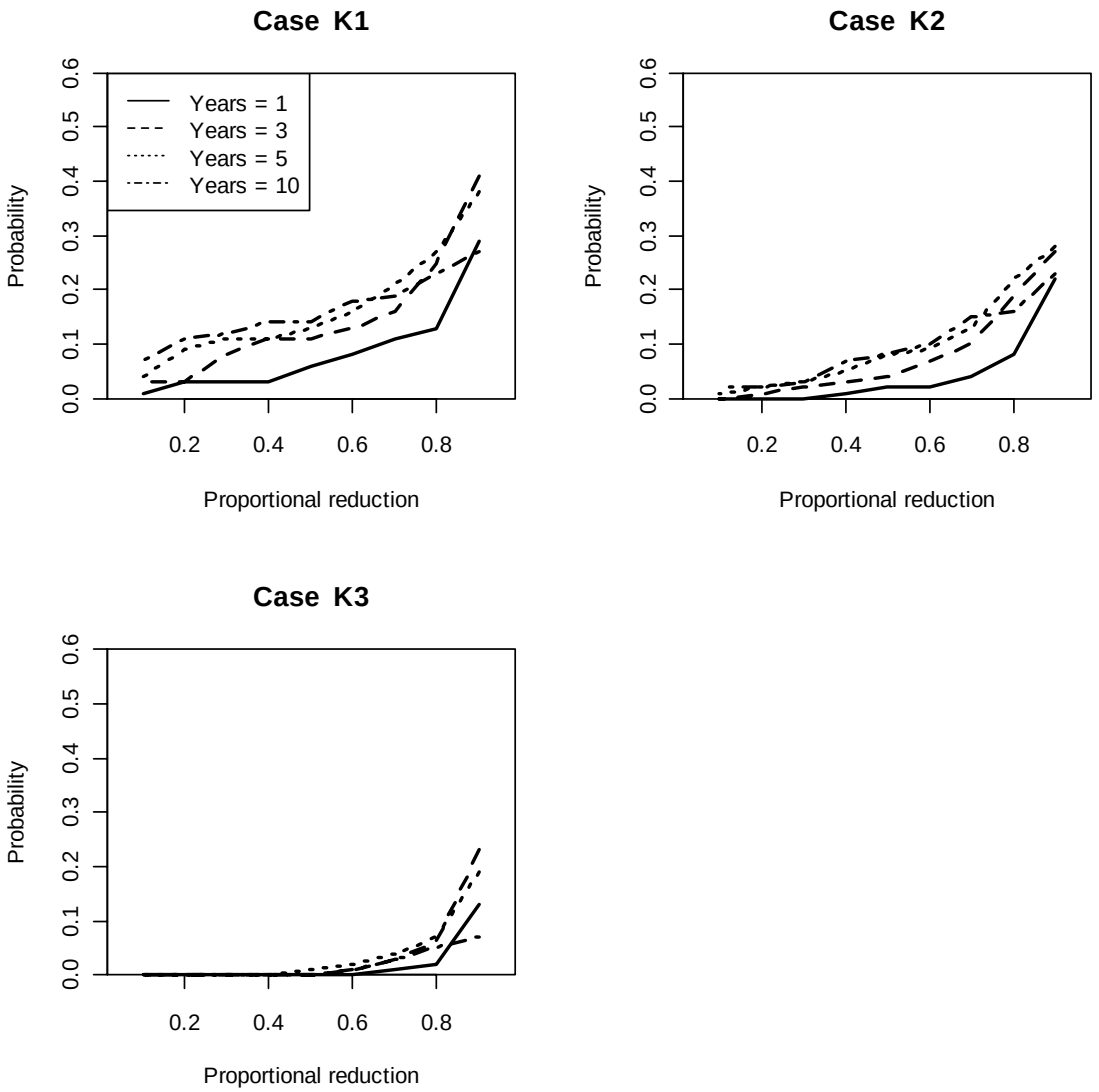

Figure 5. Probability of a reduction in "true" abundance to a given amount over a given period at least once during a simulation. The results in this plot are based on runs K1, K2, and K3 of Cooke (2009).