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The Implications of Different Tunings of the CLA for Single Stock and NE Atlantic minke trials

ANDRÉ E. PUNT[1] AND JEFF M. BREIWICK[2]

Contact e-mail: aepunt@u.washington.edu

1 - School of Aquatic and Fishery Sciences, Box 355020, University of Washington, Seattle, WA 98195-5020, USA
2 – National Marine Mammal Laboratory, 7600 Sand Point Way NE, Bldg. 4, Seattle, WA 98115, USA

ABSTRACT
A semi-automatic approach for selecting the values for the tuning parameters of the Catch Limit Algorithm (CLA) is outlined. It appears that tuning the CLA re-seeding the random number seed after each simulation leads to more stable behaviour. The implications of applying alternative tunings of the CLA to the multi-stock scenarios represented by management of the minke whales in the North Atlantic (with particular focus on the North East Atlantic) are explored. As expected, the 0.66 tuning of the CLA leads to performance that is 'borderline' according to the criteria evaluated by Punt and Allison (2006), while the 0.72 tuning of the CLA satisfies the criteria for 'acceptable' performance and the 0.6 tuning of the CLA leads to performance that would be deemed to be 'unacceptable'.

KEYWORDS: WHALING – COMMERCIAL; MODELLING; RMP

INTRODUCTION

Aldin *et al.* (2006) explored the implications of several re-tuned versions of the Catch Limit Algorithm (CLA). These tunings were based on modifying the value of the control parameter PPROB to achieve selected values for the median final depletion for the D1 base-case trial (for different simulation lengths and values for MSYR). The value of the control parameter PSLOPE was modified if the value of PPROB for a particular value of the median final depletion was larger than 0.5 for the default value for PSLOPE of 3. The re-tuned versions of the CLA, along with the original versions, were then evaluated using the base-case single stock trials and many of the robustness tests developed by IWC (1993). These re-tuned variants of the CLA were not, however, examined using any of the multi-stock *Implementation Simulation Trials*.

This paper outlines a semi-automatic approach for selecting the values for the tuning parameters of the CLA, and then explores the implications of applying alternative tunings of the CLA to the multi-stock scenarios represented by management of the minke whales in the North Atlantic (with particular focus on the North East Atlantic).

RE-TUNING APPROACH

IWC (1999) specified a protocol for selecting the value for the control parameter PPROB. The aim of this protocol was to calculate the value of PPROB to within 0.0001 and so that the median final depletion for the D1 base-case trial equals the target median final depletion for this trial to within ±0.01 (IWC, 1999). This leads to needing to conduct 100,000 replicates for each set of trial values for the control parameters of the CLA.

Applying this algorithm can be extremely time-consuming, especially if conducted manually. An alternative (and faster) approach was therefore developed, based on the assumption that the order of median final depletions among simulations tends to be robust to the formulation of the CLA (i.e. the simulations that are “hard” [lead, for example, to low final depletions] always tend to “hard”; see, for example Figure 1). This alternative approach involves applying the following steps to find the value of the tuning parameters(s) so that the median final depletion for a specified trial equals a target value.

(1) Running 100,000 replicates based on the D1 base-case trial for the 0.72 tuning of the CLA and recording the seed for each trial as well as the final depletion.
(2) Identifying the 400 replicates (and hence random number seeds) that most closely bracket the median final depletion for this trial.
(3) Selecting the value of the tuning parameter(s) so that the median final depletion for the specified trial for these 400 replicates differs from the target value by less than 0.00001 [an R routine has been developed for this purpose].
(4) Refining the value for the tuning parameter(s) based on all 100,000 replicates so that median final depletion satisfies the requirements of IWC (1999).

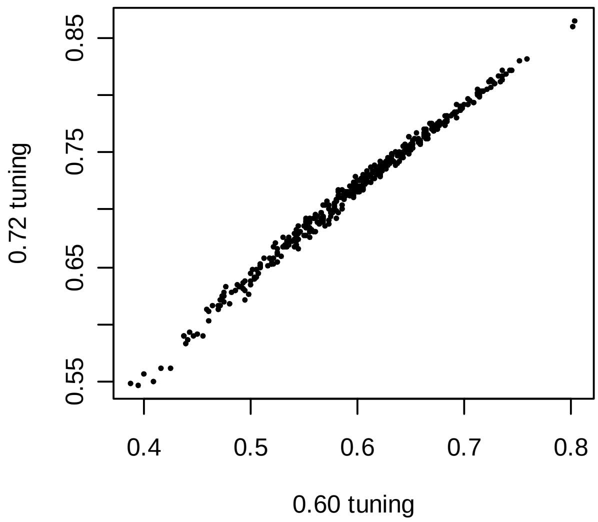

Figure 1
Final depletions for the 0.6 and 0.72 tunings of the CLA for trial T1-D1.

Figure 2 shows how the median final depletion changes with simulation number when the calculations are based on common control program (which does not re-seed the random number generators after each simulation; upper panels) and when the random number generators are re-seeded after each simulation (lower panels). Results are shown in Figure 2(a) for the 0.6 tuning of the CLA and in Figure 2(b) for 0.72 tuning of the CLA. The median final depletion seems to converge somewhat faster when the random number generators are re-seeded. The re-tuning results shown in the rest of this paper are therefore based on re-seeding the random number generators for each of the 100,000 replicates.

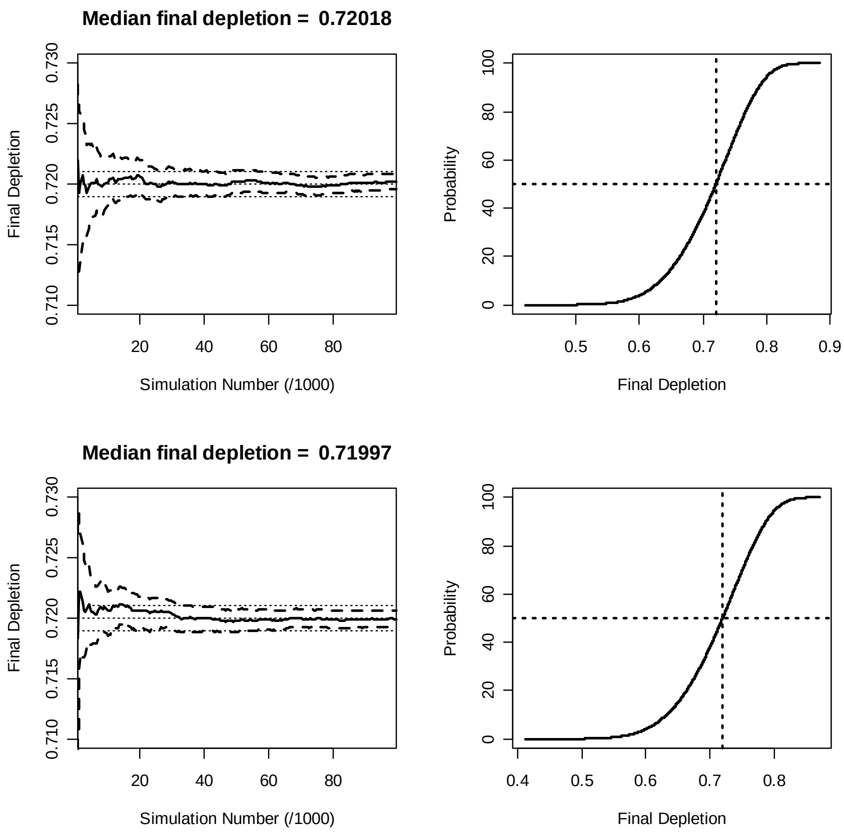

Figure 2(a)
Median final depletion versus number of trials (left panels) and the cumulative distribution for the median final depletion (right panels). The dashed lines in the left panels are 95% confidence intervals for the median final depletion. Results are shown in the upper panels for simulations based on the common control program and in the lower panels for simulations in which the random number generators are re-seeded after each simulation.

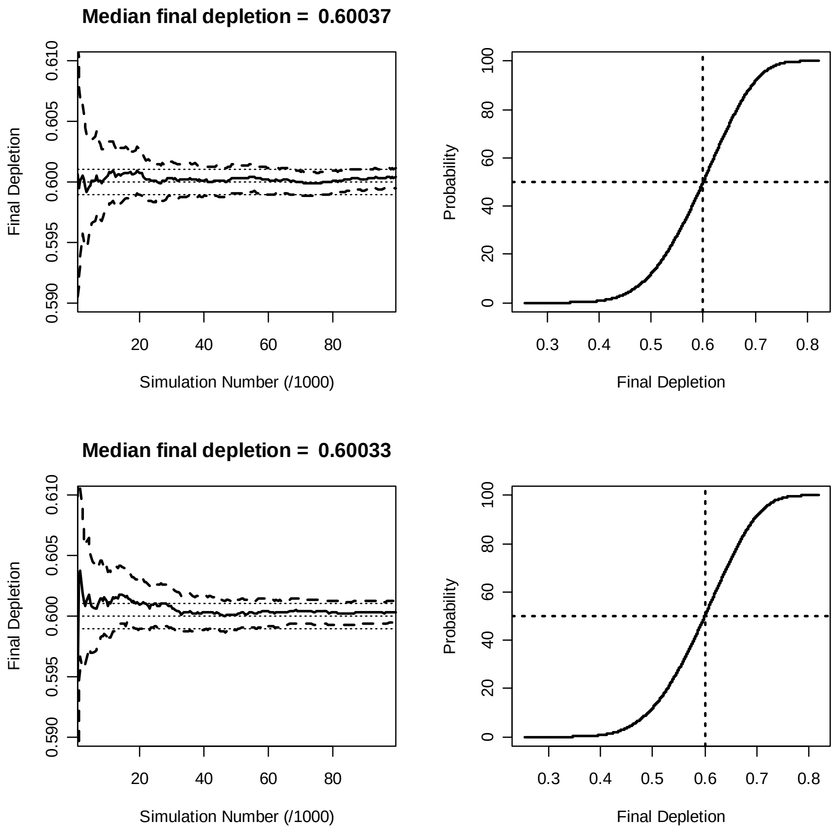

Figure 2(b)
Median final depletion versus number of trials (left panels) and the cumulative distribution for the median final depletion (right panels). The dashed lines in the left panels are 95% confidence intervals for the median final depletion. Results are shown in the upper panels for simulations based on the common control program and in the lower panels for simulations in which the random number generators are re-seeded after each simulation.

Figure 3 shows the application of the above algorithm to select the value of PPROB so that the specification "final depletion = 0.72" is satisfied when the specification "MSYR=1%" pertains to the total (1+) rather than the mature female component of the population. The value of PPROB converges after about five steps in this case.

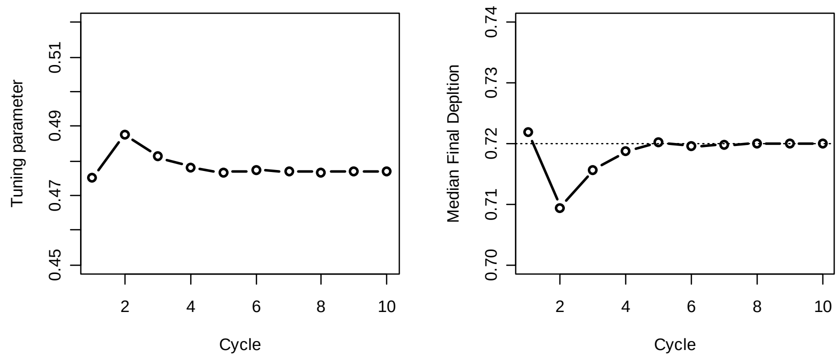

Figure 3
Application of the tuning algorithm to calculate the value for the tuning parameter PPROB so that the median final depletion for a variant of the D1 trial in which the specification “MSYR=1%” pertains to the 1+ component of the population, equals 0.72.

PERFORMANCE FOR THE NORTH EAST ATLANTIC MINKE WHALES

Sixteen *Implementation Simulation Trials* were developed for the North East Atlantic minke whales (IWC, 1993). Table 1 lists the values for two performance statistics (the lower 5%ile of the final depletion distribution and the lower 5%ile of the distribution for the depletion ratio (the minimum over each of the 100 years of the ratio of the population size to that when there are only aboriginal subsistence catches off West Greenland) for six of these trials (Table 2). These six trials formed the basis for the most recent *Implementation Review* for the NE Atlantic minke whales. Results are shown in Table 1 when the 0.72, 0.66 and 0.6 tunings of the CLA are used as the basis for determining catch limits, along with those for the variant of the CLA which is tuned to a variant of the D1 base-case trial in which the specification “MSYR=1%” pertains to the total (1+) rather than the mature female component of the population (Figure 3).

The values for the two performance statistics are compared to the threshold values based on the approach evaluated by Punt and Allison (2006). As expected from the results reported by Punt and Allison (2006), the 0.72 tuning of CLA achieves values for the performance statistics that exceed the thresholds for ‘acceptable’ performance, except in one case (the CM stock for trial NO-6), when performance is ‘borderline’. In contrast, the performance of the 0.6 tuning of CLA leads to values for the two performance statistics that are below the ‘unacceptable’ thresholds in most cases. The performance of the 0.66 tuning of the CLA and the tuning of the CLA in which the specification “median final depletion = 0.72” pertains to a MSYR that is 1% of the total (1+) population size are generally ‘borderline’, as might be expected given that the 0.72 tuning of the CLA defines the threshold for ‘acceptable’ performance while the 0.60 tuning of the CLA defines the threshold for ‘unacceptable’ performance (IWC, 2007).

The poor performance of the 0.6 tuning of the CLA in this case is perhaps somewhat unexpected because the thresholds for ‘unacceptable’ performance are based on application of the 0.6 tuning of the CLA to (single stock) trials in which the initial depletion is set to that for each stock in the multi-stock trials separately.

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Table 1
Summary of the application of the performance criteria for the North Atlantic minke trials. The four numbers for each performance statistic are respectively those based on the conventional 0.72, 0.66 and 0.6 tunings of the *CLA* and a variant of the CLA that is tuned to a median final depletion of 0.72 for the D1 trial when MSYR is defined in terms of the 1+ component of the population. Values that fall below the 'unacceptable' thresholds are indicated in underline while values that fall above the 'acceptable' thresholds are bolded. Results are only shown in this table for stocks for which MSYR(mat)=1%.

Trials / Stock	Initial depletion	Final depletion		Depletion ratio	
		Thresholds	Lower 5^{th}%ile	Thresholds	Lower 5^{th}%ile
Trial NO-1					
CIC	0.7628	0.396/ 0.562	**0.642** / 0.569 / <u>0.319</u> / 0.549	0.418/ 0.593	**0.685** / **0.606** / <u>0.314</u> / 0.586
CM	0.8195	0.403/ 0.560	**0.622** / 0.549 / <u>0.316</u> / 0.531	0.417/ 0.582	**0.663** / **0.583** / <u>0.303</u> / 0.566
EN	0.5269	0.383/ 0.543	**0.574** / 0.495 / <u>0.335</u> / 0.477	0.459/ 0.653	**0.740** / 0.639 / <u>0.382</u> / 0.615
EC	0.5009	0.385/ 0.541	**0.542** / 0.456 / <u>0.320</u> / 0.435	0.469/ 0.665	**0.665** / 0.540 / <u>0.138</u> / 0.512
ES	0.4690	0.383/ 0.536	**0.584** / 0.507 / <u>0.336</u> / 0.488	0.483/ 0.679	**0.753** / 0.654 / <u>0.414</u> / 0.630
EB	0.4759	0.385/ 0.536	**0.582** / 0.505 / <u>0.336</u> / 0.486	0.480/ 0.676	**0.750** / 0.652 / <u>0.412</u> / 0.627
Trial NO-3					
EN	0.4442	0.385/ 0.530	**0.542** / 0.477 / <u>0.330</u> / 0.462	0.500/ 0.691	**0.793** / **0.695** / <u>0.455</u> / 0.674
EC	0.4168	0.386/ 0.523	**0.523** / 0.452 / <u>0.328</u> / 0.436	0.510/ 0.704	**0.737** / 0.603 / <u>0.240</u> / 0.574
ES	0.3809	0.380/ 0.515	**0.546** / 0.480 / <u>0.328</u> / 0.466	0.534/ 0.727	**0.799** / 0.702 / <u>0.474</u> / 0.681
EB	0.3877	0.383/ 0.512	**0.545** / 0.480 / <u>0.333</u> / 0.466	0.529/ 0.721	**0.797** / 0.703 / <u>0.472</u> / 0.682
Trial NO-4					
CIC	0.7858	0.400/ 0.564	**0.626** / 0.541 / <u>0.291</u> / 0.524	0.419/ 0.591	**0.671** / 0.580 / <u>0.296</u> / 0.562
CM	0.8084	0.403/ 0.564	**0.616** / 0.529 / <u>0.284</u> / 0.508	0.417/ 0.586	**0.658** / 0.567 / <u>0.275</u> / 0.543
Trial NO-5					
EN	0.6102	0.384/ 0.550	**0.595** / 0.506 / <u>0.321</u> / 0.486	0.434/ 0.623	**0.703** / 0.598 / <u>0.339</u> / 0.574
EC	0.5865	0.381/ 0.549	**0.549** / 0.446 / <u>0.301</u> / 0.425	0.437/ 0.631	0.601 / 0.460 / <u>0.093</u> / <u>0.428</u>
ES	0.5595	0.383/ 0.545	**0.609** / 0.521 / <u>0.320</u> / 0.499	0.448/ 0.638	**0.719** / 0.615 / <u>0.369</u> / 0.590
EB	0.5659	0.383/ 0.546	**0.606** / 0.518 / <u>0.323</u> / 0.497	0.446/ 0.636	**0.716** / 0.612 / <u>0.366</u> / 0.587
Trial NO-6					
CIC	0.7271	0.393/ 0.561	**0.611** / 0.522 / <u>0.242</u> / 0.503	0.420/ 0.600	**0.654** / 0.557 / <u>0.254</u> / 0.538
CM	0.8090	0.404/ 0.564	0.560 / 0.452 / <u>0.136</u> / 0.428	0.417/ 0.587	**0.590** / 0.482 / <u>0.095</u> / 0.456

Table 2

Six of the sixteen *Implementation Simulation Trials* for the North Atlantic minke whales. All of these trials are based on 3 stocks and 10 sub-stocks, all ignore leakage, and all are based on the standard catch mixing matrix. Catch limits are not set for the *Small Areas* WC, CG and CIP for these trials. See IWC (1993) for additional details.

Trial No	Stock abundance	MSYR (W C E)
1	N3	4 1 1
2	N3	4 4 4
3	N1	4 4 1
4	N1	4 1 4
5	N2	4 4 1
6	N2	4 1 4