Additional *SLA* variants to further evaluate the proposed Makah hunt

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ABSTRACT

At the 2012 Annual Scientific Committee meeting, the Implementation Review for eastern North Pacific gray whales with a focus on the proposed Makah hunt and the Pacific Coast Feeding Group (PCFG) was completed. Two variants of the proposed hunt (one with research provisions) were agreed by the Committee to meet the conservation objectives of the Commission. However, the Committee also noted that neither of these variants exactly mimicked the proposed hunt and expressed concern that the actual conservation outcome of the proposed hunt had not been tested. The reason that an exact variant was not tested was because there is a temporal rule in the proposed hunt, such that all struck and lost whales from December through April are not counted against the Allowable PCFG Limit (APL), whereas any struck and lost whales in May are counted against the APL. There are insufficient data however, to determine the proportion of strikes that would occur in May or prior to May, and hence the two variants of the hunt were developed to bracket the range of possible strikes by month. Following the Committee's request for an exact evaluation of the proposed hunt management plan, six additional variants were identified intersessionally. In combination, these eight variants span the full range of possible strikes that could occur in May or prior to May, and hence provide a means of more precise evaluation. A broad comparison is provided here of this set of variants across all evaluation and robustness trials, and more detailed results are presented for trials identified as of interest during the Implementation Review. Perhaps not surprisingly, the conservation performance of the six additional variants is found to be in-between the two previously evaluated variants. The central questions remaining for management advice would then seem to pertain to whether the photo-ID research provision might be required for any (or all) of the additional variants presented here, and moreover, whether the research provision should apply to the proposed hunt management plan as a whole.

KEYWORDS: ABORIGINAL WHALING; MANAGEMENT PROCEDURE; NORTH PACIFIC; GRAY WHALES

INTRODUCTION

During the 2012 Scientific Committee meeting, the Implementation Review for eastern North Pacific gray whales was completed (IWC/64/Rep1 Annex E). The focus of that Implementation Review was on the proposed Makah hunt and the Pacific Coast Feeding Group (PCFG) of gray whales. Several variants of the proposed Makah hunt were examined (see SC/64/Rep3 Annex D), and the Scientific Committee agreed that two of these variants (one with research provisions – see below) performed acceptably in terms of meeting the aboriginal subsistence and conservation objectives of the Commission.

However, the Scientific Committee also noted that these two variants did not exactly mimic the proposed Makah hunt, and agreed that the Standing Working Group of the AWMP should develop and test an exact variant intersessionally, in order for the Scientific Committee to evaluate the results at this year's meeting.

During the AWMP intersessional meeting, the Standing Working Group reviewed a set of six

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additional variants suggested by Brandon and Scordino (2012), and agreed these were appropriate and sufficient to achieve the Scientific Committee's goal (SC/65a/Rep02).

Background and rationale for why a set of variants (rather than a single management variant) has been suggested in order to satisfy the Scientific Committee's request is outlined below. As described in the Scientific Committee's report (IWC/64/Rep1):

> *"In order to minimise the risk of taking PCFG whales, the management plan developed by the Makah Tribe restricts the hunt both temporally (to the migratory season for gray whales i.e. 1 December – 31 May) and geographically (to the Pacific Ocean region i.e. the Makah U&A[1] except the Strait of Juan de Fuca). Some PCFG whales are present during the migratory season and thus the plan proposes an allowable PCFG limit (APL) during hunts that are targeting eastern North Pacific migrating whales with the aim of ensuring that accidental takes of PCFG whales do not deplete the PCFG. Whales struck in May might have a higher probability of being PCFG whales since they feed in this area in June. The management plan thus proposes an additional requirement that all animals struck-and lost in May are assumed to be PCFG whales (i.e. count against the APL), whereas whales struck between December and April are not.*
>
> *Weather conditions and availability of whales makes it likely that most hunting will occur in May. However, there are insufficient data to assess the number of strikes by month. Thus, it is not possible to reliably estimate the proportion of struck-and-lost whales that would count towards the APL. Given this uncertainty about how the plan would respond to failing to take into account struck-and-lost PCFG whales, the Tribe had proposed two SLA variants (1 and 2) spanning the options as to when the hunt might occur.*
>
> *SLA variant 1 proposes that struck-and-lost whales do not count towards the APL i.e., there is no management response to PCFG whales struck but not landed. SLA variant 2 proposes that all struck-and-lost whales count to the APL irrespective of hunting month. i.e., the number of whales counted towards the APL may exceed the actual number of PCFG whales struck."*

Hence, the two agreed acceptable *SLA* variants (1 and 2) differ in their categorical assignment of struck and lost whales to the APL, and therefore each variant corresponds to the hunt taking place during two different time periods.

Variant 1 was agreed to have performed acceptably for all trials deemed most plausible[2] during the Implementation Review, except that is, for two related trials where it was deemed to have marginal performance. Those two trials in question assume that the PCFG $MSYR_{1+}$ = 2% and further that the probability of striking a PCFG whale is double the observed proportion of PCFG whales in the available photo-identification studies during the proposed hunting season. Because the ratio of PCFG whales to migratory whales can be monitored through photo-identification studies during the proposed hunting season, variant 1 was agreed to meet the Commission's conservation objectives under the provision that annual photo-identification research be undertaken and results reported to the Scientific Committee for evaluation. Given the assumption that no struck and lost whales belong to the PCFG, variant 1 corresponds to the proposed hunt occurring entirely during Dec – Apr.

[1] Usual and accustomed fishing grounds

[2] Generally, the most challenging trials were agreed by the Committee to have low plausibility (*e.g.*, see the discussion regarding MSYR = 1% being at the lower bound of plausibility in IWC/64/Rep1 Annex E), and hence if a variant did not meet conservation criteria for those challenging lower plausibility trials, it was not judged that the variant performed unacceptably.

Variant 2, on the other hand, assumes all struck and lost whales belong to the PCFG, and as such counts all struck and lost whales against the APL. This variant performed acceptably for all trials deemed most plausible by the Scientific Committee (*i.e.*, it was agreed acceptable with no such research provision). Under the proposed hunting rules outlined above, variant 2 corresponds to hunting during May only.

Essentially then, the aspect of the proposed hunt that was not evaluated during the Implementation Review is the interaction between the actual number of strikes-per-month over the entire hunting season (Dec – May) and the time-varying assumption of whether a struck and lost whale belongs to the PCFG (*i.e.*, counts against the APL).

At present, there is no reliable way to predict the exact number (or model the probability) of strikes that may occur during a given month. However, one strategy to address this challenge is to evaluate a variant for each possible outcome of the number of strikes by month. To simplify this approach, months can be divided into two categories (May, or prior to May), given the assumption of whether or not struck and lost whales are counted against the APL during those time periods. This leads to the six additional variants suggested by Brandon and Scordino (2012). Variants 1 (all strikes prior to May) and 2 (all strikes in May) are logical bounds on the range of possible strikes by time period. Following the recommendation of the Scientific Committee, a comparison of the results of all eight variants (including *SLA* variants 1 and 2) is presented here to further evaluate the proposed Makah hunt management plan.

METHODS

The additional variants are labeled alphabetically (A-F) to avoid confusion with previously evaluated variants that were assigned numbers during the 2012 Implementation Review. The full range of variants considered in these analyses, including variants 1 and 2, is shown in Table 1. Note that the maximum strike limit per year in the proposed Makah hunt management plan is seven (SC/64/Rep3).

Table 1

Variant *SLA*s covering the range of possible strikes by time period (prior to May or during May), given the categorical assignment of struck and lost whales to the APL in the proposed Makah hunt management plan. Accordingly, the proposed management plan assumes that all whales struck and lost prior to May are migrants belonging to the greater northern feeding group, whereas it assumes that all whales struck and lost in May belong to the PCFG.

Variant	Description
1.	All strikes prior to May.
A.	Allow up to six strikes prior to May.
B.	“ ” five strikes prior to May.
C.	“ ” four strikes prior to May.
D.	“ ” three strikes prior to May.
E.	“ ” two strikes prior to May.
F.	“ ” one strike prior to May.
2.	All strikes in May.

Allocation of strikes by month

Variants D – F are outlined below as examples illustrating how the set of additional variants is modeled. Note that there are additional rules in the proposed management plan that could preclude hunting, even if the APL for a given year has not been reached (*i.e.*, the limit of 20 whales landed per five year quota, the maximum of five whales landed in any calendar year, and the maximum of three struck and lost whales in any calendar year; SC/64/Rep3). For the purposes of these illustrative examples, those additional rules are not included in the outline below but they are

nevertheless an active component of the simulated hunt (exactly as they were during the Implementation Review).

Variant D: Allow up to 3 strikes prior to May, remaining (max of 4) strikes in May
1. Compute the APL.
2. If hunting is allowed under the APL, the first strike of the season occurs prior to May.
3. If the first whale is struck and lost, it does not count against the APL.
4. If a second strike is allowed under the APL, the second strike occurs prior to May.
5. If the second whale is struck and lost, it does not count against the APL.
6. If a third strike is allowed under the APL, the third strike occurs prior to May.
7. If the third whale is struck and lost, it does not count against the APL.
8. If subsequent strikes are allowed under the APL, they occur in May. If any of these are struck and lost, they are assumed to be PCFG whales and those strikes apply to the APL.

Variant E: Allow up to 2 strikes prior to May, remaining (max of 5) strikes in May
1. Compute the APL.
2. If hunting is allowed under the APL, the first strike of the season occurs prior to May.
3. If the first whale is struck and lost, it does not count against the APL.
4. If a subsequent strike is allowed under the APL, the second strike occurs prior to May.
5. If the second whale is struck and lost, it does not count against the APL.
6. If subsequent strikes are allowed under the APL, they occur in May. If any of these are struck and lost, they are assumed to be PCFG whales and those strikes apply to the APL.

Variant F: Allow up to 1 strike prior to May, remaining (max of 6) strikes in May
1. Compute the APL.
2. If hunting is allowed under the APL, the first strike of the season occurs prior to May.
3. If the whale is struck and lost, it does not count against the APL.
4. If any subsequent strikes are allowed under the APL, they occur in May. If any of these are struck and lost, they are assumed to be PCFG whales and those strikes apply to the APL.

Variants A-C proceed accordingly, and all other parameters of the operating model and trials are identical to those used during the Implementation Review (SC/64/Rep3 Annex F).

Further, as recommended by the Standing Working Group (SC/65a/Rep02), all of the additional variants were run across all of the evaluation and robustness trials examined during the 2012 Implementation Review, and the results compared with *SLA* variants 1 and 2.

RESULTS

Figure 1 shows the lower 5th percentile (5%ile) of (a) final PCFG (age 1+) depletion, and; (b) rescaled (age 1+) PCFG depletion for all evaluation and robustness trials given the range of possible maximum strikes prior to May (including *SLAs* 1 and 2 for comparison).

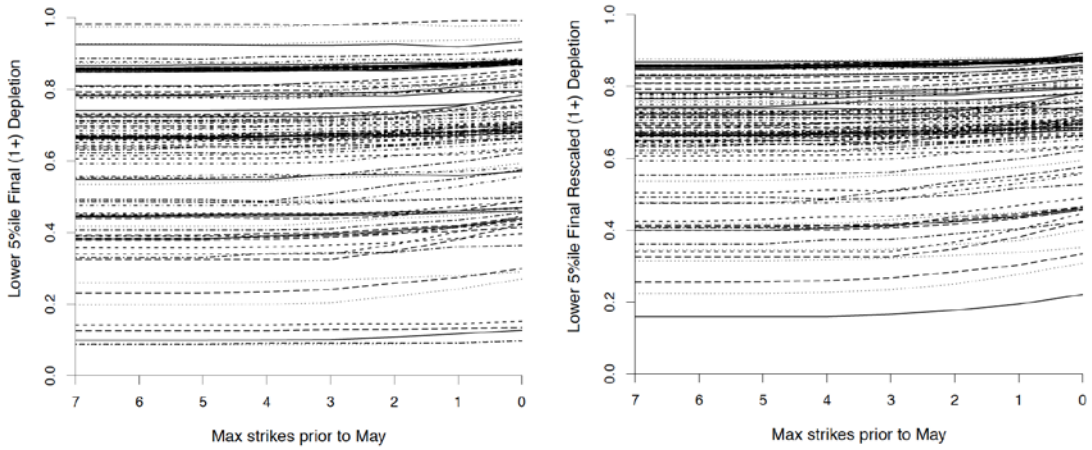

Fig. 1. The lower 5th percentile (5%ile) of PCFG final depletion (left panel) and rescaled (1+) depletion (right panel) are shown as a function of the maximum number of strikes prior to May for all evaluation and robustness trials. The lines connect the results for a single trial across variants. *SLA* variant 1 corresponds to all (maximum of seven) strikes prior May, *SLA* variant 2 corresponds to zero strikes prior to May (*i.e.*, all strikes occur in May), and variants A-F correspond with the intermediate number of (maximum) strikes prior to May (Table 1).

There are several note-worthy patterns that emerge from these results across all trials: (1) the additional variants (A-F) have intermediate conservation performance between *SLAs* 1 and 2; (2) any trend that exists in conservation performance between variants for a given trial is best described as a monotonically increasing function of the number of strikes that occur during May (*i.e.*, there is no pattern of convexity or concavity in conservation performance across variants), and; (3) there appears to be a saturation point (dependent on the trial), after which the number of allowable strikes prior to May does not lead to a decrease in conservation performance.

We did also investigate the output for the other conservation statistics of interest for all trials (e.g. minimum number of mature females) and found the same patterns hold true as shown in Fig. 1. Due to considerations of space, we have not presented results for every performance statistic for each trial across all variants, but these have been provided to the Secretariat and are on file for reference.

Given the fundamental result that variants A-F are intermediate in conservation performance across all evaluation and robustness trials, only the subset of trials identified as having questionable conservation performance during the 2012 Implementation Review is considered further here. The lower 5th percentile and median of the final and rescaled final depletion statistics are shown in Table 2 for those trials.

In the more detailed presentation of results across variants provided in Table 2, variants A through F can again be seen to result in conservation performance that is in-between variants 1 and 2 (excepting the rare cases of apparent monte-carlo sampling error in the third decimal). Likewise, as the number of strikes prior to May decreases, conservation performance can also be seen to increase.

Of the set of trials in Table 2, GB10B and GP10B are of particular interest because the conservation performance of *SLA* 1 was found to have been marginal for these two trials during the Implementation Review. The Zeh plots for these two trials are provided in Fig. 2 across all eight variants. These plots display the trade-off between conservation performance and need satisfaction across the range of possible strikes by month.

Table 2

Final and rescaled final depletion statistics for the eight *SLA* variants for the trials with $MSYR_{1+}$=1% and the trials with $MSYR_{1+}$=2% for which conservation performance might be considered to be questionable given the results of the 2012 Implementation Review.

	Final Dep (1+)		Rescaled Final Dep		Final Dep (1+)		Rescaled Final Dep	
SLA Variant	**Low 5%**	**Median**	**Low 5%**	**Median**	**Low 5%**	**Median**	**Low 5%**	**Median**
	Trial GB01C				**Trial GB08B**			
SLA 1 (7 strikes before May)	0.259	0.343	0.314	0.383	0.357	0.458	0.505	0.594
6 strikes before May	0.259	0.343	0.314	0.383	0.357	0.458	0.505	0.594
5 strikes before May	0.259	0.342	0.314	0.383	0.357	0.460	0.505	0.596
4 strikes before May	0.262	0.344	0.317	0.383	0.359	0.462	0.512	0.598
3 strikes before May	0.267	0.346	0.323	0.386	0.365	0.463	0.509	0.601
2 strikes before May	0.273	0.349	0.330	0.394	0.371	0.468	0.525	0.611
1 strikes before May	0.280	0.356	0.338	0.403	0.384	0.484	0.542	0.628
SLA 2 (7 strikes in May)	0.290	0.365	0.352	0.414	0.396	0.504	0.560	0.656
	Trial GP01C				**Trial GB10B**			
SLA 1 (7 strikes before May)	0.382	0.461	0.400	0.472	0.492	0.556	0.492	0.557
6 strikes before May	0.382	0.461	0.400	0.472	0.492	0.556	0.492	0.557
5 strikes before May	0.382	0.460	0.400	0.472	0.492	0.556	0.492	0.557
4 strikes before May	0.390	0.464	0.406	0.476	0.487	0.560	0.487	0.562
3 strikes before May	0.396	0.468	0.414	0.479	0.508	0.566	0.510	0.567
2 strikes before May	0.405	0.476	0.424	0.488	0.533	0.584	0.535	0.584
1 strikes before May	0.417	0.494	0.439	0.509	0.550	0.604	0.552	0.606
SLA 2 (7 strikes in May)	0.438	0.515	0.460	0.528	0.575	0.633	0.576	0.635
	Trial GP02C				**Trial GP08B**			
SLA 1 (7 strikes before May)	0.231	0.272	0.255	0.295	0.330	0.442	0.475	0.578
6 strikes before May	0.231	0.272	0.255	0.295	0.330	0.442	0.475	0.578
5 strikes before May	0.231	0.272	0.256	0.295	0.330	0.442	0.475	0.582
4 strikes before May	0.234	0.276	0.260	0.299	0.341	0.441	0.486	0.579
3 strikes before May	0.241	0.281	0.267	0.304	0.343	0.443	0.489	0.582
2 strikes before May	0.258	0.297	0.284	0.319	0.345	0.451	0.497	0.595
1 strikes before May	0.274	0.320	0.303	0.345	0.360	0.466	0.517	0.610
SLA 2 (7 strikes in May)	0.299	0.347	0.334	0.372	0.364	0.482	0.528	0.635
	Trial GI01C				**Trial GP10B**			
SLA 1 (7 strikes before May)	0.378	0.446	0.399	0.459	0.475	0.536	0.476	0.538
6 strikes before May	0.378	0.446	0.399	0.459	0.475	0.536	0.476	0.538
5 strikes before May	0.378	0.449	0.399	0.460	0.475	0.537	0.476	0.538
4 strikes before May	0.381	0.451	0.401	0.465	0.475	0.542	0.476	0.543
3 strikes before May	0.387	0.455	0.407	0.469	0.482	0.549	0.483	0.549
2 strikes before May	0.395	0.465	0.416	0.478	0.508	0.566	0.510	0.567
1 strikes before May	0.414	0.477	0.433	0.491	0.528	0.587	0.530	0.588
SLA 2 (7 strikes in May)	0.434	0.497	0.457	0.513	0.556	0.619	0.557	0.621

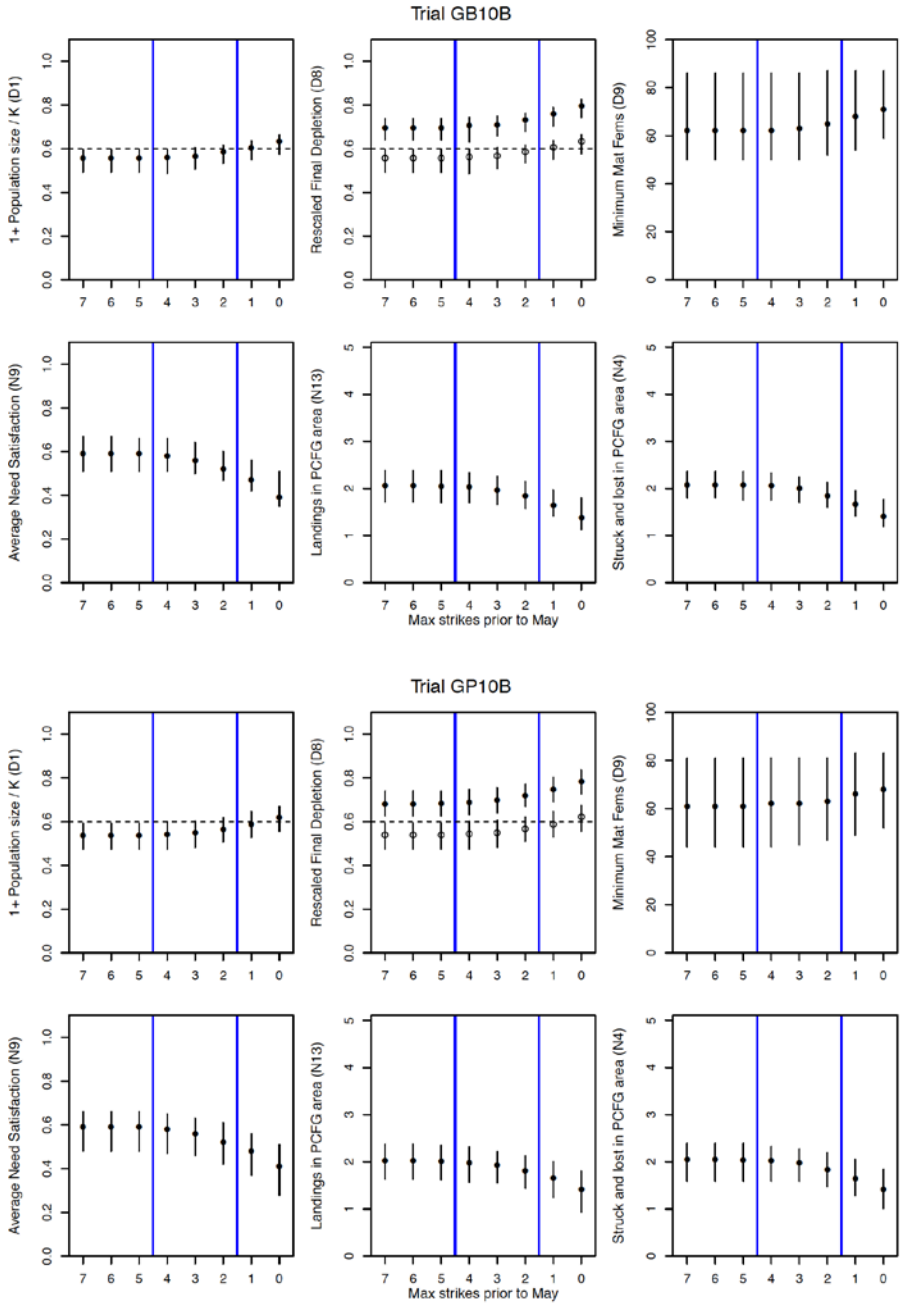

Fig. 2. Zeh plots for the two trials (GB10B upper panel, and GP10B lower panel) that assume that PCFG $MSYR_{1+}$ = 2% and that the probability of striking a PCFG whale is double the proportion of PCFG whales observed in the photo-ID data during the proposed hunting season. The conservation performance for variant 1 (all strikes prior to May) was found to be marginal for these trials during the Implementation Review. The maximum number of strikes that could occur prior to May for each variant is indicated along the x-axis, and the depletion plots (upper left two panels for each trial) are shown with a dashed horizontal line at 0.60 for reference.

DISCUSSION

The result that variants A - F achieve conservation performance that is intermediate between variants 1 and 2 is perhaps not surprising, given the original design that variants 1 and 2 should bracket the expected performance of the proposed Makah whaling management plan.

Variant 1 is less conservative with respect to the resource than variant 2 because it does not make the assumption that struck and lost whales belong to the PCFG. In other words, if a struck and lost whale is indeed a PCFG whale, variant 1 does not count this strike against the APL, and it

is therefore possible under variant 1 to strike more PCFG whales before the hunt would be stopped (*e.g.*, because the APL was reached) than it is under variant 2.

Mechanically, variants A-F are bounded by variants 1 and 2 in terms of conservation performance because the percentage of strikes assumed to be PCFG can not be less than none (variant 1) or greater than all (variant 2). This logically leads to a transitive relationship of inequality with respect to conservation performance under the APL. In other words, variants A-F can only perform equal to or greater than variant 1 (and no better than variant 2). This relationship is evident in Figs. 1 and 2, and Table 2.

Given the relationship across these variants (*i.e.*, the number of strikes allotted by monthly time period), if variant 1 performed acceptably for a certain trial during the Implementation Review, then variants A-F (and variant 2) would be expected to perform acceptably for that trial as well. Hence, we propose that it is redundant to re-visit in detail the results of variants A-F for any trials except those for which variant 1 was deemed to have performed unacceptably.

The trials in Table 2 were identified during the Implementation Review as those for which either variants 1 or 2 had questionable performance. However, of those trials, only the results from GB10B and GP10B were considered further. The associated marginal conservation performance of variant 1 for GB10B and GP10B lead to the recommended research provision to hedge against the risk identified in those two trials. The other trials in Table 2 were deemed to have low plausibility.

Given the recommendations from the 2012 Implementation Review with respect to the two extremes of when strikes might occur (variants 1 and 2) -- and the results of the additional variants presented here which provide a finer resolution on this issue -- it seems that the central questions remaining for management advice pertain to whether the photo-ID research provision might be required for any (or all) of the additional variants (A-F), and moreover whether the research provision should apply for the proposed hunt management plan as a whole.

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