An independent peer review of the

Status Review and Extinction Assessment of Cook Inlet Belugas

Prepared for:

Center for Independent Experts

Prepared by:

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I. Executive Summary

This report represents an independent peer review of Hobbs *et al.* (2006) *Status Review and Extinction Assessment of Cook Inlet Belugas*, the revised tables and figures (Hobbs and Sheldon 2007), an alternative population viability model by Wade (2007), as well as background reports, presentations, and supplemental analyses provided at the CIE panel meeting in Seattle, 13-16 November, 2007. The review focuses on the population viability analyses (PVA), which represents a synthesis of information on the population biology and risk factors for Cook Inlet beluga. The model adjusts the age-structure to account for selective harvests of white (adult) whales, is fitted to the time-series of abundance estimates from NMFS surveys, and used to project the likelihood of the population becoming extinct. The PVA approach is considered to be the most appropriate technique for assessing the risk of extinction, and the data, analysis and model used in the Status Review are generally considered to represent the best science available. However, the Status Review would benefit from a more detailed analysis of recent population trends and, insofar as possible, concurrent changes in the color/size/age-composition of the Cook Inlet beluga population. Recent survey data indicate the population has not recovered since large harvests were terminated in 1999, and may in fact be continuing to slowly decline. It is unclear whether this is merely a transitory effect due to the selective harvesting of adult (white) whales in the mid-late 1990s, or if it is indicative of a chronically unproductive or stressed population, which could have implications in assessing the future risk of extinction. A closer examination of how well the PVA projections track the post-harvest abundance surveys would also be beneficial, as it is these more recent trends, not the sharp declines caused by the large kills in the mid-late 1990s, are most pertinent in projecting the future prospects of this population. Currently, there exist insufficient empirical data on compensatory effects at high densities, depensatory (Allee) effects at low densities, impacts of constant removals (by predators or other sources) and catastrophic mortality events to reliably quantify the risk of extinction. However the PVA simulations presented in the Status Review allow for various scenarios and parameter estimates that likely span the plausible range of such effects. Collectively, the projections indicate that the population is at significant risk of extinction over a wide variety of conditions and assumptions, and the robustness of this conclusion is corroborated by the PVA simulations presented by Wade (2007). While some suggestions are provided on how the analyses and Status Review could be refined, none would change the basic conclusion that the Cook Inlet beluga population is genetically distinct, small and depleted, isolated within a contracted range, has exhibited no sign of recovery since the large harvests were terminated, and is thus at risk of becoming extinct.

II. Terms of Reference

1. Evaluate whether the adequacy, appropriateness, and application of data used in the assessment represents the best available science.

   The Status Review provides a comprehensive overview of the general biology, distribution and movements, potential risk factors, recent harvest data, and recent time-series of abundance estimates for Cook Inlet beluga, as well as a summary of life history attributes for other beluga populations. Combined, this information constitutes the best available scientific data for assessing the risk of extinction of Cook Inlet beluga.

2. Evaluate whether the adequacy, appropriateness, and application of analytical methods and modeling represents the best available science.

   The Status Review uses population viability analysis (PVA) that allows for a wide range of scenarios and stochastic variability within a Bayesian framework, which is considered to be the most appropriate approach for assessing risk of extinction. However, the Status Review would benefit from a more detailed analysis of population trends since the large harvests were terminated in 1999, and how well the PVA fits this most recent time-series of abundance estimates, as it is these recent trends, not the sharp declines precipitated by the large kills in the mid-late 1990s, that are most relevant in determining the future prospects of this population.

3. Do the biological data, population data, model structure and assumptions, and the analysis methods applied to the extinction risk assessment represent the best available data and methodology for sound science?

   The PVA allows for alteration of the age-structure of the population in the mid-late 1990s resulting from the selective removal of white (adult) whales, and the model is fitted to the recent time-series of abundance estimates, which are deemed to be the key biological and population data in determining risk of extinction. While empirical data and specific information are lacking on the nature of compensatory effects at high densities, depensatory (Allee) effects at low densities, impacts of constant removals (by predators or other sources) and catastrophic mortality events, the PVA simulations presented in the Status Review and Wade (2007) span the plausible range of such effects.

4. Does the status review provide an adequate assessment of the current knowledge regarding the biology of belugas in general and the Cook Inlet beluga population

in particular? Comment on the strengths and weakness of the status review in regard to this question.

The Status Review and citations within the review represent an impressive synthesis of information on the biology of Cook Inlet beluga. This is a small population inhabiting a challenging environment in a remote area, and an enormous amount has been learned about these animals since focused studies were initiated in the early 1990s. Some additional information, particularly maps showing the contraction over the past few decades, could be included, but I'm not aware of any significant information that has been overlooked that would be pertinent to the Status Review.

5. Do the population models adequately represent the processes within the population? Comment on the strengths and weakness of the models in regard to this question.

   The PVA population model is fit to the time-series of surveys initiated in 1994. The model tracks the steep decline that occurred in the mid-late 1990s when large numbers of whales were being harvested. However, it is less clear how well the model tracks what appears to be a continued slow decline after the large harvests were terminated. Also, it would be useful to compare any available information on changes in the color/size/age-composition observed in the population following the large harvests with the changes in age-structure predicted by the projection model.

6. Are the analysis methods valid and sufficient to estimate the extinction risk? Comment on the strengths and weakness of the analysis methods in regard to this question.

   Currently, there exist insufficient empirical data on compensatory effects at high densities, depensatory (Allee) effects at low densities, magnitude of constant removals (by predators or other sources) and catastrophic mortality events to reliably quantify the risk of extinction. However the PVA simulations presented in the Status Review allow for a wide range of scenarios and parameter values that likely span the plausible range of such effects. Collectively, the models indicate that the population faces a significant risk of extinction over a wide range of conditions and assumptions, and the robustness of this conclusion is corroborated by the PVA simulations presented by Wade (2007).

7. Are the conclusions of the status review supported by the scientific information presented?

   While some suggestions are provided on how the analyses and Status Review could be refined, none would change the basic conclusion that the Cook Inlet beluga population is genetically distinct, small and depleted, isolated within a contracted range, has exhibited no signs of recovery since harvests were terminated, and is thus at risk of becoming extinct.

III. Peer Review Findings

1. Evaluate whether the adequacy, appropriateness, and application of data used in the assessment represents the best available science.

   The Status Review and citations within the review provide a comprehensive summary of the general biology and ecology of Cook Inlet belugas. The list of potential risk factors appears to be complete. However, with respect to fishery interactions, the reported bycatch of beluga in salmon net fisheries during the late 1970s and early 1980s seems surprisingly high – the 3-6 whales caught per year is toward the upper end of the constant removals in the PVA that would dramatically increase the equilibrium threshold at which population tend to decline. In contrast, based on observers aboard "some" vessels in this fishery between 1999 and 2000, no interactions were recorded. Perhaps a brief description of the changes in fishing effort or gear, or on the extent and adequacy of observer coverage in the Cook Inlet salmon net fisheries in recent years, would be in order to explain the apparent change in this risk factor.

   The restricted range and especially the recent contraction in distribution of Cook Inlet beluga are important considerations in assessing the status of this population. While the temporal changes in distribution are described on pp.16-17, I found the maps in Rugh's PowerPoint presentation showing the changes in distribution by decade to be far more striking, and it might be useful to include them in the Status Review.

   The three key data inputs for the Population Viability Analysis (PVA) are: 1) the harvest records, particularly for the large kills in the mid-late 1990s, which reduced the size of the population and presumably skewed its age-structure toward juveniles; 2) the time-series of annual abundance estimates based on the NMFS aerial surveys conducted since 1994, which provide information on trends

in abundance and the absolute size of the population; and 3) the life-history parameters, which are used to project the population through time.

With respect to harvest records, the large takes in the mid-late 1990s are fairly well documented, and it is clear they were sufficient to have reduced the size of the population. It has been assumed only white (adult) animals were taken, in which case the harvest must have had a profound effect on the age-structure of the population. Overall abundance declined by about 50% during 1994-1998 (from 653 in 1994 to 347 in 1998), which was similar in magnitude to the 234-475 white (adult) whales estimated to have been taken during 1994-1998 (assuming 0.33 to 0.67 were landed). As a result, the Cook Inlet population must have been almost devoid of adults by 1999, which would be an important factor in accounting for the lack of recovery in recent years.

Coloration of beluga changes from gray in juveniles to white in adults, and color and size has been used as an index of age-composition in other studies. The Status Review does not include any information on the color/size/age-composition of Cook Inlet beluga, or how the composition might have changed over time. However, the panel was provided with a poster by Sim et al (2007) showing detailed color-composition data for the last few years [which does not seem to indicate a shortage of white (adult) whales]. While I have not seen the reference, Litzky (2001) has apparently undertaken analysis of changes in color composition following the harvest, although her work would probably have to be updated to account for one instead of two GLC's being deposited per year. Such information (along with the PVA model predictions regarding changes in the ratios of juveniles to adults) would be very useful for assessing the impacts of the large harvests in the mid-late 1990s, corroborating the PVA model predictions, and might assist in understanding the reasons for the lack of recent recovery.

The second key data input for the PVA are the abundance estimates from aerial surveys. The annual surveys initiated by NMFS in 1994 provide a fairly uniform time-series for assessing recent trends, and the ADF&G survey in 1979 appears to provide the best indication of known peak population levels.

Finally, with respect to life history parameters, the upper limit for annual survival was estimated based on the number of dead beluga recovered in Cook Inlet per year (12 carcasses from a population of 350, representing maximum survival of 0.97). Killer whale predation was factored separately from other sources of natural mortality, and a lower limit established from the number of killer whale kills observed in recent years (21 beluga killed during 1985-2002, representing

about 1 per year; Sheldon *et al.* 2003). However, some of the recovered carcasses represented the remains from killer whale kills (6 of 47 according to Moore *et al.* 2001), and these should be removed in estimating non-predation natural mortality. This would not have any meaningful effect on the parameter estimates, but would dispel any concerns about double-counting of mortalities. The remaining life history parameters were obtained from the literature, and the summary provided in Table 2 seems complete and spans the entire range reported for this species.

2. Evaluate whether the adequacy, appropriateness, and application of analytical methods and modeling represents the best available science.

   Given the tendency of beluga whales to congregate in core areas, conventional line transect surveys along randomly or uniformly spaced transects are not efficient or appropriate for this species. Shoreline surveys are the only practical way of surveying beluga concentrations in core areas, and this appears to be particularly true for the Cook Inlet beluga. However, this approach is fraught with statistical limitations. Adjustments can be applied to account for animals available for sighting but missed because they were too small or distant or were submerged, but otherwise the census is assumed to represent an entire enumeration of the population (i.e. all groups were available for counting).

   Without first hand experience, I find it somewhat surprising that image size rather than coloration was the main determinant in the relative visibility of animals. I would have thought darker animals would be less obvious than white animals, especially in the murky waters of Cook Inlet. I also suspect that the criteria affecting visibility might change over time with the switch to higher-resolution video offering more pixels, such that white whales appear whiter whereas gray whales remain gray. However, the adjustment for image size appears to be a minor component of the correction factor and is unlikely to affect overall abundance or trend estimates.

   The main component of the survey correction is for animals within the group that were submerged and thus not available for counting during the counting window. The correction was based on an early formulation by McLaren (1961), which has not been used in recent beluga assessments, and may not be appropriate if dives are not synchronized or diving patterns vary with time or location.

   In some cases census coverage was incomplete due to logistical or weather constraints, but it was somewhat unclear as to what criteria were used to

determine whether incomplete counts were retained or discarded in estimating abundance. Apparently the decision was to some extent influenced by whether the "expected" number of animals had been seen (presumably based on the number and size of groups seen during other survey flights or in other areas). This could affect the independence of surveys required for statistical analysis, and influence the variability of replicate counts. Instead, it would be preferable to make decisions based on spatial coverage without any consideration as to the number of whales sighted, and to apply the average counts from other censuses for subareas that may have been missed. Since the adjustments for missed areas were presumably minimal, this is unlikely to affect abundance estimates, but could provide more defensible estimates of their precision.

In addition to the shoreline survey of core areas, some transects were flown over open areas. Although no or few whales have been seen in these offshore areas in recent years, its very important that sufficient numbers of these transects be retained as part of the survey design to ensure that significant densities of whales are not missed as this population recovers or re-colonizes its historic range.

In my mind, a significant shortcoming of the Status Review was the lack of detailed analysis of recent population trends following the intense harvests in the mid-late 1990s. I would have thought that the lack of recovery of the population after large-scale hunting was discontinued would be a primary determinant in listing this population (and a major influence in driving the PVA projections). The last paragraph on p.21 seems somewhat ambiguous, and needs to be updated to include the most recent survey data. Rates of population change should also be included, and the analyses would preferably be cast in a Bayesian framework similar to what was done with the PVA. On p.63 it was noted that "a Bayesian analysis including the 2005 estimate of abundance indicates there is a likelihood of less than 8% that the annual increases of 2% or greater will occur and a likelihood of 65% or more that the population will decline further". However, those figures were based on the PVA projections which, I suspect, were influenced by the sharp declines that occurred during the mid-late 1990s (or perhaps by the age-structure initialization process), and I am not fully convinced they accurately reflect the more recent trends since hunting was terminated.

With respect to the PVA analysis, I would prefer to see more information on the goodness of fit of the trajectories to the post-1998 time-series of abundance estimates. In projecting the risk of extinction, I would think it is less important how well the model fits the sharp declines during the period of intense harvests, but more important as to how the population has responded since harvesting was

terminated. On p.53 it indicates that the model "projections match the abundance time series closely during the period from 1994 and 2005", and later on p.58 it indicates that "As suggested by Figure 5, there was little variation in the fit of the different models to the time series data". In reality, Figure 5 is not at an appropriate scale to assess the fit to the post-hunting time series, and nowhere in the Status Review are the abundance estimates overlaid on the PVA trajectories to evaluate goodness of fit.

Fitting a simple log-linear regression to the annual means of the survey counts since 1999 indicate a significant decreasing trend of just over 4% per annum, and the significant trend persists even when the anomalously high count in 2000 is eliminated. In contrast, in posterior estimates for Φ from the PVA indicate that annual growth multipliers of that order of magnitude are highly improbable. For reasons I do not understand, the realized priors tend to be trimmed on the high and low end of the initial range used for the uniform prior. One possibility is that a simple log-linear regression without proper weighting for the precision of the estimates does not accurately capture the rate of population change – a more detailed assessment of population trends would indicate whether this is the case. Another possibility is that the sharp declines that occurred during the large harvests in 1994-98 are influencing the range of Φ that are plausible – given the uncertainty in the harvest data and especially the struck-and-loss rates, I'd be somewhat concerned if this were the case. Or perhaps the high and low ends of the prior for Φ are being truncated by the age-structure initialization process. Starting the projection in 1979 with high Φ values may result in starting populations that are too large, whereas starting the projections with low Φ values may result in populations that are too small. If this were the case, I'd be very concerned, as I do not agree that the initialization process based on such scanty harvest data should have much if any influence on the potential range of Φ, which is a key parameter in projecting the rate of extinction. Instead, perhaps some scheme could be devised whereby the age-structure (but not the size) of the initial population is adjusted according to harvesting that occurred prior to 1994, and the initial size of the population in 1994 could be drawn based on the mean and CV of the 1994 abundance estimate. Or perhaps the very large harvests in 1994-98 had such a profound impact that adjusting for prior harvests is not all that important.

3. Do the biological data, population data, model structure and assumptions, and the analysis methods applied to the extinction risk assessment represent the best available data and methodology for sound science?

   The study period and time-series available for Cook Inlet beluga whales are too short (less than one generation) to document the frequency and magnitude of unusual mortality events, such as mass strandings. Moreover, population size has varied over too narrow of a range to observe the compensatory effects that would be expected at high densities or the depensatory effects that would be expected at lower densities. Given the lack of specific information on these processes in Cook Inlet beluga, the authors have incorporated a wide range of possible scenarios based on observations in other populations or ecological theory into the PVA models. While it would be difficult to justify any single set of parameters or any one scenario, the wide range of parameter values and scenarios utilized in the projections span the plausible range of these processes that have been observed in other population or employed in other PVA models, and thus represent the best science available.

   It was very useful to have the second PVA by Wade (2007). Although some of the population processes were parameterized quite differently, and the model structured somewhat differently, the basic results were comparable to the Hobbs *et al.* PVA. This suggests that the general conclusions provided by the PVA extrapolations are quite robust with respect to the biological data, model structure and assumptions used in the models. [Note: Wade's projections were based on the posterior distribution of Φ generated by the Hobbs *et al.* PVA, so the aforementioned concerns about how Φ were fitted to the recent survey data apply to both PVA models].

4. Does the status review provide an adequate assessment of the current knowledge regarding the biology of belugas in general and the Cook Inlet beluga population in particular? Comment on the strengths and weakness of the status review in regard to this question.

   Given my very limited prior knowledge of Cook Inlet beluga, as far as I can tell the researchers have done an impressive job of bringing together information for this population in the Status Review. It needs to be kept in mind that this is an inherently difficult species to study (full life tables still don't exist for beluga whales), and Cook Inlet is a challenging area in which to work. Except for a few

minor details (e.g. including maps showing recent contraction in distribution), the biological information in the Status Review appears to be thorough and complete.

5. Do the population models adequately represent the processes within the population? Comment on the strengths and weakness of the models in regard to this question.

   As are all models, the beluga PVA represents an oversimplification of the actual processes within the population. Given that the longevity of beluga whales exceeds 50 years, a complete sex- and age-structured model would have involved too many parameters for this type of analysis. On the other hand, some information on age-structure had to be included to account for the selective harvests that occurred in the late 1990s. The authors compromised between practicality and complexity by including separate age-classes for juveniles up to age 10 years, but also by pooling all adults into one age-category.

   Except for the elevated mortality of yearlings associated with the death of their mothers, survival rates were assumed to be equivalent across all ages and both sexes, and reproductive rates were assumed to be constant for all mature females. These assumptions are biologically unrealistic. Mammalian survivorship curves tend to be U-shaped, with young and old animals exhibiting the lowest survival and adolescent and young adults exhibiting the highest survival rates. Moreover, reproductive rates often decline with age in adults due to reproductive senescence.

   Although the vital rates are biologically unrealistic, I am not sure how important it is for the PVA. With respect to juvenile survival, what is most pertinent is how many survive to maturity, and not how mortality is distributed between age groups (which affects the proportion of juveniles in the population, but not the population multiplication rate). The increased mortality of older animals is probably of little consequence, since they typically constitute a small fraction of the total population. As noted during the panel discussions, the limitations associated with assuming equal juvenile and adult survival could be addressed by a single parameter that sets juvenile survival proportional to adult survival, as in the Wade (2007) model.

   With respect to reproductive rates, the pregnancy rates given in Table 2 indicate that reproductive performance of females declines with age. This might not be too important for the long-term projections in which age-structures converge toward stability, and the uniform reproductive rate applied could be thought of as

an overall average for adult females. However, age-specific differences in reproductive rates could be more important in short-term projections when the age-structure of the population has been altered. As noted above, by 1999 the population had presumably been depleted of adults by the selective harvests. In subsequent years, few new calves would be been born due to the lack of adult females, but juveniles would begin maturing, so one would anticipate a pulse of young, fecund females being recruited in the years following the large harvest. I do not believe that the existing model is adequate for discerning these short-term transitory effects. One possible solution would be to group females into 10-year age-categories and apply the age-specific reproductive rates to each age-group in a stage-structured model.

6. Are the analysis methods valid and sufficient to estimate the extinction risk? Comment on the strengths and weakness of the analysis methods in regard to this question.

   As previously noted, there is too little empirical information or specific knowledge of population processes and high and particularly low densities to precisely quantify the risk of extinction of Cook Inlet beluga. However, the VPA projections in the Status Review encompass a wide range of scenarios and parameter values, and these collectively indicate that there is a relatively high probability the population will become extinct.

   A fundamental issue that remains unresolved in my mind is whether the lack of recovery (and apparent continued decline) of the population since the large kills were terminated is attributable to the distortion of age-structure as a result of the selective removal of adult (white) whales during the mid-late 1990s, or whether it is indicative of low productivity (poor survival and/or low reproductive rates) of the animals that survived the large kills. In the former case, the lack of recovery would be expected to be a transitory phenomenon. As whales mature and the population retains a normal age-structure, one would expect reproductive rates to increase and the population to exhibit delayed recovery. This being the case, the risk of extinction may have been overestimated. On the other hand, if the lack of recovery is due to chronic low productivity of animals, it would imply that there are some unrecognized stresses that are currently impeding recovery. As previously noted, I am also concerned that the low end of the prior for Φ may have been artificially trimmed, and that the population could actually be declining more rapidly than allowed for in the PVA. This being the case, the risk of extinction may have been underestimated.

The PVA model and initialization process are tailored to account for perturbations in the age-structure of the population due to selective harvesting. However, as far as I can see, the predicted impact of these perturbations or their potential role in impeding recovery of the population is never mentioned in the Status Review. It is thus impossible to discern between the above two possibilities.

7. Are the conclusions of the status review supported by the scientific information presented?

My comments are offered in the hope they may lead to some refinements of the Status Review or considered as food-for-thought in future analyses. However, none of the comments are serious enough to alter the basic conclusion that the Cook Inlet beluga population is genetically distinct, small and depleted, isolated within a contracted range, has exhibited no signs of recovery since harvests were terminated, and is thus at risk of becoming extinct.

IV. Further Analyses and Evaluations

No further analyses or evaluations are recommended beyond those already outlined in previous sections.

VI. Additional Comments

We briefly discussed various activities in Cook Inlet such as oil and gas exploration and extraction, bridge construction, fishing, illegal killing, etc., that may be important in determining the future status of Cook Inlet beluga, but these were considered to fall outside the scope of this scientific review.

Also, I did not consider the issue as to whether the Cook Inlet belugas constitute a Distinct Population Segment, although the background information provided in the Status Review seems adequate and accurate in this regard.

The Status Review also provided an overview of the history of status assessment, court challenges, and regulations, but I did not consider that information to be relevant to this scientific review.

V. Recommendations

1. Evaluate whether the adequacy, appropriateness, and application of data used in the assessment represents the best available science.

   The data on the general biology, distribution and movements, potential risk factors, recent harvest data, and recent time-series of abundance estimates used for Cook Inlet beluga represents the best science available, but I think the Status Review might be improved by including whatever information exists on temporal changes in the color/size/age-composition of the population during and following the large selective harvests in the mid-late 1990s.

2. Evaluate whether the adequacy, appropriateness, and application of analytical methods and modeling represents the best available science.

   The Status Review uses population viability analysis (PVA) that allow for a wide range of scenarios and stochastic variability within a Bayesian framework, which is considered to be the most appropriate approach for assessing risk of extinction. However, the Status Review would benefit from a more detailed analysis of recent population trends since the large harvests were terminated in 1999, and an assessment of how well the PVA fits the recent time-series of abundance estimates, as its these most recent trends, and not the sharp declines precipitated by the large kills in the mid-late 1990s, that are most relevant in determining the future prospects of this population.

3. Do the biological data, population data, model structure and assumptions, and the analysis methods applied to the extinction risk assessment represent the best available data and methodology for sound science?

   The PVA compensates for changes in the age-structure of the population up to the mid-late 1990s resulting from the selective removal of white (adult) whales, and the model is fitted to the recent time-series of abundance estimates, which are deemed to be the key biological and population data for determining risk of extinction. While empirical data are lacking on the nature of compensatory population effects at high densities, depensatory (Allee) effects at low densities, impacts of constant removals (by predators or other sources) and catastrophic mortality events, the PVA simulations presented in the Status Review and Wade (2007) probably span the plausible range of such population processes. The PVA model could potentially be refined, especially for short-term projections following

perturbations (such as the large harvest in the mid-late 1990s), by grouping females into age-categories and allowing for age-specific changes in reproductive rates, and introducing a parameter that allows for different survival rates for juveniles and adults.

4. Does the status review provide an adequate assessment of the current knowledge regarding the biology of belugas in general and the Cook Inlet beluga population in particular? Comment on the strengths and weakness of the status review in regard to this question.

   The Status Review and citations within the review represent an impressive synthesis of information on the biology of Cook Inlet beluga. This is a small population that inhabits a challenging environment in a remote area, and an enormous amount has been learned about these animals since focused studies were initiated in the early 1990s. Some additional information, particularly maps showing the contraction over the past few decades, could be included, but Iam not aware of any significant information that has been overlooked that would be pertinent to the Status Review.

5. Do the population models adequately represent the processes within the population? Comment on the strengths and weakness of the models in regard to this question.

   The population models are fit to the time-series of surveys initiated in 1994. The model tracks the steep decline that occurred in the mid-late 1990s when the large harvests were taken. However, it is less clear how well the model tracks what appears to be a continued slow decline after the large harvests were terminated. Also, it would be useful to present any information available on changes in color/size/age-composition of the population during and following the large harvests in the mid-late 1990s, and compare it with the model projections over the same period. As noted above, these recent trends are important as they drive the extrapolations that determine the risk extinction.

6. Are the analysis methods valid and sufficient to estimate the extinction risk? Comment on the strengths and weakness of the analysis methods in regard to this question.

   Currently, there is insufficient empirical data on the compensatory effects expected at high densities, depensatory (Allee) effects expected at low densities, impacts of constant removals (by predators or other sources) and catastrophic mortality events to be able to reliably quantify the risk of extinction. However the PVA simulations presented in the Status Review allow for a wide range of scenarios that likely span the plausible range of such effects. Collectively, the models indicate that the population faces a significant risk of extinction over a wide range of scenarios and assumptions, and the robustness of this conclusion is corroborated by the PVA simulations presented by Wade (2007). Thus, while I do not believe it is possible to precisely quantify the risk of extinction, I do believe the models demonstrate that the risk is relatively high.

7. Are the conclusions of the status review supported by the scientific information presented?

   While some suggestions are provided on how the analyses and Status Review could be refined, none would change the basic conclusion that the Cook Inlet beluga population is genetically distinct, small and depleted, isolated within a contracted range, has exhibited no signs of recovery since harvests were terminated, and is thus at risk of becoming extinct.

VI. Reviewer Statements

This review represents an accurate and complete independent summary of my views on the Status Review of Cook Inlet beluga. My review benefited from and was influenced by discussions with NMFS researchers and my CIE panel colleagues during our deliberations in Seattle, but the conclusions and recommendations presented in this report represent my own interpretations and views, and I assume full responsibility for all misconceptions and misinterpretations. I am very grateful to our gracious hosts at NMML including Rod Hobbs, Kim Shelden, and Paul Wade, who went well beyond the call of duty in patiently explaining things and providing all the reports, presentations, and follow-up analysis we requested.

Appendix I: Background documents

1. Status Review and Extinction Assessment of Cook Inlet Belugas, November 2006.
2. Revised and updated model result tables of the existing model in the status review by Dr. Rod Hobbs including the abundance estimate for 2006
3. Report on an alternative model by Dr. Paul Wade

Appendix II: Statement of Work

Consulting Agreement between NTVI and Peter Olesiuk

October 17, 2007

Statement of Work

Overview

The National Marine Mammal Laboratory (NMML) of the Alaska Fisheries Science Center (AFSC) requires an independent review of scientific documents, analysis, and the resulting conclusions which support the proposed listing of the Cook Inlet beluga (CIB) as endangered under the Endangered Species Act. Specifically, a review of the background biological data, population data, model structure and assumptions and the analysis methods applied to the extinction risk assessment and the conclusions resulting from that assessment. A revised and updated status review will be published in February 2008 as an AFSC processed report. This revised status review will address scientific issues raised during the public comment period (that closed on August 3, 2007) and update the November 2006 report, Status Review and Extinction Assessment of Cook Inlet Belugas, to account for scientific data and other information that has become available in the interim including abundance estimates from 2006 and 2007. The recommendations from the peer review, including updated and auxiliary analysis, will be addressed in the final revisions prior to publication of the status review in February 2008.

The requested peer review will be conducted by four appointed reviewers from the Center for Independent Experts (CIE), one of which will be selected as the CIE chair for the panel review meeting. The panel will convene at the NMML in Seattle, Washington during November 13-16, 2007 to review the extinction risk assessment for CIB according to the Terms of Reference specified herein. Each reviewer will be provided with the report on Status Review and Extinction Assessment of Cook Inlet Belugas and other documents for review prior to the panel review meeting scheduled in Seattle during November 13-16, 2007. The three independent CIE reviewers and CIE chair will participate during the panel review meeting and provide their peer review reports as stated in the Terms of Reference and Schedule specified herein. The CIE reviewer's primary responsibility is to determine whether the best available science has been utilized, and to provide recommendations for improving the science for the Status Review and Extinction Assessment of Cook Inlet Belugas.

CIE Reviewer Responsibilities

The CIE's deliverables shall be provided according to the schedule of milestones listed below in this statement of work. Three CIE reviewers shall review and provide an

independent peer review each, and the CIE chairperson will provide a summary report. CIE reviewers will review material provided before the panel review meeting, attend the panel review meeting, and prepare final reports according to the scheduled outlined below. The three independent CIE peer review reports and the CIE chair's summary report shall be an accurate representation of the discussions, conclusions and recommendations from the review process.

The three independent CIE reviewers' duties shall occupy a maximum of 14 days per person (i.e., several days prior to the meeting for document review; travel and participation at the panel review meeting in Seattle; and preparation of their review reports after the meeting according to the schedule specified below in this statement of work). The CIE chair's duties shall occupy a maximum of 16 days (i.e., the same schedule as above with the addition of two days to finalize the summary report).

Pre-meeting Documents for CIE Peer Review

The CIE review panel, consisting of three independent CIE reviewers and one CIE chair, shall conduct a peer-review of the following three manuscripts:

4. Status Review and Extinction Assessment of Cook Inlet Belugas, November 2006.
5. Revised and updated model result tables of the existing model in the status review by Dr. Rod Hobbs including the abundance estimate for 2006, available by October 30, 2007.
6. Report on an alternative model by Dr. Paul Wade, available October 30, 2007.

The CIE reviewers are not responsible for any of the above mentioned reports that are distributed to them later than November 2, 2007.

NMML Contact person for pre-meeting review material:
Dr. Roderick Hobbs, email: Rod.Hobbs@noaa.gov, telephone: (206) 526-6278

Terms of Reference for CIE Peer Review

The CIE reviewers shall conduct a peer review of the pre-meeting documents specified above, participate during the panel review meeting, and complete their CIE reports according to the Terms of Reference as stated below:

1. Evaluate whether the adequacy, appropriateness, and application of data used in the assessment represents the best available science.
2. Evaluate whether the adequacy, appropriateness, and application of analytical methods and modeling represents the best available science.

3. Do the biological data, population data, model structure and assumptions, and the analysis methods applied to the extinction risk assessment represent the best available data and methodology for sound science?
4. Does the status review provide an adequate assessment of the current knowledge regarding the biology of belugas in general and the Cook Inlet beluga population in particular? Comment on the strengths and weakness of the status review in regard to this question.
5. Do the population models adequately represent the processes within the population? Comment on the strengths and weakness of the models in regard to this question.
6. Are the analysis methods valid and sufficient to estimate the extinction risk? Comment on the strengths and weakness of the analysis methods in regard to this question.
7. Are the conclusions of the status review supported by the scientific information presented?

The CIE panel should evaluate and indicate as to whether the presented models, analysis, and conclusions are the best available science at this time. The CIE reviewers shall not provide specific management advice. If the panel rejects the models or any components, analysis, results or conclusions, the panel should explain the rejection and provide recommendations for suitable alternatives. According to the schedule outlined below, three CIE reviewers shall submit independent peer review reports and the fourth CIE reviewer acting as Chair during the panel review meeting shall submit a peer review summary report.

Review Panel Meeting Supplementary Instructions for CIE Reviewers

(1) Prior to the meeting

CIE reviewers shall review the three documents (specified above) and any other supporting documents, background documents or reference documents provided before November 2, 2007. It is permissible to request additional information if it is needed to clarify or provide further background.

(2) During the panel meeting

The CIE reviewers shall participate during the panel review meeting and conduct their peer review according to the above Terms of Reference. Three of the CIE reviewers shall provide independent peer reviews, while the fourth CIE reviewer appointed as Chair for the panel review meeting shall provide a peer review summary report. The CIE Chair's duties shall include guidance of the meeting, coordination of presentations and discussion, and facilitation of discussions making sure each Term of Reference is addressed. It is permissible to request

additional materials from the authors, if it is deemed necessary to accomplish the goals of the peer review.

The CIE panel, lead by the CIE chair, will then work through the documents provided and discuss the comments of each reviewer and the points in the documents to complete the review. It is anticipated that the peer review can be completed during the three day panel review meeting, providing the fourth day to complete the draft reports.

(3) After the Panel Review meeting

After the panel meeting, the CIE independent reviewers are responsible for completing their independent peer-review reports with submission of the reports to the CIE program manager according to the schedule specified in the following table. The draft CIE reports will be sent to the CIE Chair who will compile a concise summary report for submission to CIE according the schedule specified below. The CIE reports shall be reviewed by the CIE Steering Committee and forwarded to the COTR at the NMFS Office of Science and Technology for approval according to the schedule specified below.

Schedule

The milestones and schedule are summarized in the table below.

Milestone	**Date**
Pre-meeting documents provided to CIE reviewers no later than	November 2, 2007
CIE reviewers participate during panel review meeting in Seattle WA	November 13-16
CIE independent peer review reports provided to CIE and Chair	November 30
CIE Chair's summary report provided to CIE	December 12
Final CIE reports provided to COTR	December 21
Final CIE reports approved and distributed by COTR to NMML	January 4, 2008

Upon approval of final CIE independent peer-review reports by the COTR, the reports will be distributed to the NMML. The NMML will utilize the reports for updating the revised status review as part of the document package presented for the evaluation of the proposed listing of the CIB as endangered under the ESA.

Submission and Acceptance of CIE Reports

According to the schedule and deadline outline above, the CIE shall provide via e-mail the final CIE independent peer review reports and the CIE chair's summary report to the COTR William Michaels (William.Michaels@noaa.gov) at NOAA Fisheries. The COTR and alternate COTR Dr. Stephen K. Brown (Stephen.K.Brown@noaa.gov) will review

the CIE reports to determine that the Terms of Reference are met, notify the CIE program manager via e-mail regarding acceptance of the reports, and then distribute the reports to the NMML contact person.

Review of Extinction Risk Assessment for Cook Inlet Beluga
Tentative Agenda (Seattle, WA, 13-16 November 2007):

Tuesday November 13

9:00 Introductions, Review Terms of Reference Coordinator, R. Hobbs

Break

10:30 -12:00 Closed session Panel discussions CIE Chair

12:00-13:30 Lunch

13:30-15:00 Hobbs presentation and Q&A session on PVA model CIE Chair.

Break

15:30-17:30 Further discussion on PVA model CIE Chair

Wednesday November 14

9:00-10:30 Wade presentation and Q&A session on Alternative model CIE Chair.

Break

11:00 -12:00 Further discussion on Alternative Model CIE Chair

12:00-13:30 Lunch

13:30-17:30 Other requested presentation and Q&A session CIE Chair

Break as needed

Thursday November 15

9:00-17:30 Summary discussions or Closed session at discretion of panel. CIE Chair
Report preparation. Break as needed

Friday November 16

9:00-17:30 Report preparation at discretion of panel. Break as needed CIE Chair

ANNEX 1:

Contents of CIE Independent Peer Review Reports

I. Executive Summary

An abstract of the independent peer review report.

II. Terms of Reference

List each Term of Reference, and include a clear statement indicating whether or not the criteria in each element of the Terms of Reference are satisfied.

III. Peer Review Findings

Independent peer review findings for each criteria of the Terms of Reference, including recommendations for improvement.

IV. Further Analyses and Evaluations

Analytical requests not previously addressed in TOR discussion above.

VI. Additional Comments

Provide a summary of any additional discussions not captured in the Terms of Reference statements.

V. Recommendations

Provide an independent statement as to whether the best available science was utilized in regard to each of the Term of Reference criteria, including suggestions to improve the Status Review and Extinction Assessment of Cook Inlet Belugas.

VI. Reviewer Statements

Each individual reviewer should provide a statement attesting whether or not the contents of the Independent Peer Review Report provide an accurate and complete independent summary of their views on the issues covered in the review. Reviewers may also make any additional individual comments or suggestions desired.

ANNEX 2:

Contents of CIE Chair's Summary Peer Review Report

I. Executive Summary

An abstract of the summary peer review report.

II. Terms of Reference

List each Term of Reference, and include a concise summary from the panel review discussions and independent CIE reports indicating whether or not the criteria in each element of the Term of Reference are satisfied.

III. Peer Review Findings

Concise summary of *peer review findings from the panel review discussions and independent CIE summary reports for each criteria of the Term of Reference, including recommendations for improvement.*

IV.. Further Analyses and Evaluations

Summary of a*nalytical requests not previously addressed in TOR discussion above.*

IV. Additional Comments

Provide a summary of any additional discussions not captured in the Terms of Reference statements.

V. Recommendations

Provide a summary statement as to whether the best available science was utilized in regard to each of the Term of Reference criteria, including suggestions to improve the Status Review and Extinction Assessment of Cook Inlet Belugas.

VI. Reviewer Statements

Provide *a statement attesting whether or not the contents of the Summary Peer Review Report provide an accurate and concise summary of the panel review discussions and independent reviewer's reviews on the issues covered in the review. Reviewer may also make any additional individual comments or suggestions desired.*