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Characteristics for Recovery: Beluga Whale

Caractéristiques pour le rétablissement: Béluga

Jack Lawson[1], Mike Hammill[2], Garry Stenson[1]

[1] Department of Fisheries and Oceans
Marine Mammal Section
PO Box 5667, St. John's, NL A1C 5X1

[2] Department of Fisheries and Oceans
Maurice Lamontagne Institute
P.O. Box 1000, Mont-Joli, QC G5H 3Z4

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ABSTRACT

For listed species, the *Species at Risk Act* (SARA) requires that the responsible jurisdiction set explicit recovery goals for abundance and distribution. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) does not provide specific criteria that would lead to down- or de-listing although the listing criteria will likely be important in the decision process to down- or de-list the species. Here, we develop a framework that links recovery criteria to a more general management structure employing the Precautionary Approach. We consider the following characteristics when trying to identify criteria for "recovery" for a listed species:

1. Characteristics should be generic to enable application across a number of species.

2. Characteristics for recovery should be based on general life history parameters.

3. Because data are often limited, we need to base the recovery characteristics on one or only a few measures (preferably absolute abundance or some index of abundance) that can be obtained relatively easily.

4. The characteristics must be robust to uncertainty in our measurement parameters, where the effects of variation in these parameters can be examined using simulation models.

The recovery framework was applied to four beluga populations (Eastern Hudson Bay, Cumberland Sound, St. Lawrence Estuary, and Ungava Bay) that have been designated as endangered or threatened by COSEWIC. Given the imprecision of our knowledge of pristine population size, we need to establish a reference point for the population size at and above which we would consider that we have achieved population recovery. Historical population estimates based on reconstructions from catch data provide a metric of pristine population size. At an April 2005 beluga meeting scientists decided that if the listed population grew to a level above 70% of the estimated historical population size then the recovery objective would be deemed to be met. Scientists also examined other metrics and how they related to the following categories: ecological role, historical population, percent of historical population, percent of historic range, status consistent with traditional ecological knowledge, number of mature animals, production, growth rate, population composition, and sex ratio.

In addition to the issue of the population size necessary to be considered "recovered" – and eligible for down- or de-listing – additional important considerations include the length of time it would it take for the required level of population recovery to be achieved (increased risk with longer exposure to adverse factors when at lower abundance levels), and what resources Department of Fisheries and Oceans (DFO) would need to detect this level of population change.

RÉSUMÉ

Pour les espèces inscrites, la *Loi sur les espèces en péril* (LEP) requiert que les autorités compétentes établissent des objectifs précis afin d’en rétablir l’abondance et la distribution. D’autre part, Comité sur la situation des espèces en péril au Canada (COSEPAC) n’a pas déterminé de critères spécifiques qui permettraient de redéfinir à la baisse le statut d’une espèce, voire même de la retirer de la liste, mais les critères établis pour la désignation seront probablement important lors du processus de reclassification de ces espèces. Dans ce rapport, nous présentons un cadre qui repositionne les "critères de rétablissement" dans une structure plus générale de gestion, basée sur l'Approche de Précaution. Voici les caractéristiques sur lesquelles nous nous sommes basées dans notre tentative d’identifier les "critères de rétablissement" d’une espèce sur la liste:

1. Les caractéristiques devraient être génériques, afin de pouvoir s’appliquer à plusieurs espèces.

2. Les caractéristiques devraient être établies selon des paramètres du cycle biologique.

3. Parce que les données sont souvent limitées, les critères de rétablissement ne doivent se baser que sur une ou peu de mesures (de préférence une abondance absolue ou un indice quelconque d’abondance) qui peuvent être obtenues relativement facilement.

4. Les caractéristiques doivent être robustes à l'incertitude liée à nos paramètres de mesure, paramètres dont on pourrait examiner les effets des variations à partir de modèles de simulation.

Nous avons appliqué notre cadre de rétablissement à quatre populations de béluga (Est de la Baie d’Hudson, Détroit de Cumberland, Estuaire du St-Laurent et Baie d’Ungava) qui ont été désignées en voie de disparition ou menacée par le COSEPAC. Étant donné l’imprécision des connaissances concernant la taille de la population d’origine, nous devons établir un point de référence au-dessus duquel nous pourrions considérer avoir obtenu un rétablissement de la population. Des estimés historiques de population, calculés à partir des données de capture, donnent une taille de la population d’origine. En avril 2005, lors d’une réunion sur le béluga, des scientifiques se sont entendus pour dire que si la population d’une espèce identifiée dépassait le niveau de 70% du maximum de l'estimation historique de la taille de la population, alors l’objectif de recouvrement serait considéré comme atteint. Ces scientifiques ont également examiné d'autres indices et leur liens aux catégories suivantes: le rôle écologique, la taille de la population historique, le pourcentage de la population historique, le pourcentage de l’aire de distribution de la population historique, si la classification est compatible avec les connaissances écologiques traditionnelles, le nombre d’animaux matures, les taux de reproduction et de croissance, la structure de la population, et le sex-ratio.

En plus de la question de la taille de la population nécessaire pour que celle-ci soit considérée comme "étant rétablie" - et ainsi être éligible pour être reclassée à la baisse ou retirée de la liste, - il faut tenir compte de considérations importantes comme le temps nécessaire avant d’atteindre ce seuil de rétablissement (lors de faibles abondances, les risques augmentent en fonction de la durée d’exposition à des conditions hostiles), et déterminer les ressources nécessaires au ministère des Pêches et des Océans (MPO) afin de pouvoir détecter ce niveau de changement de la population.

BACKGROUND

In April, 2005 scientists and managers met to discuss the development of recovery criteria for four beluga stocks in Canada that are on the verge of being listed (DFO 2005a). Beluga were the first marine mammal species examined because of pressures concerning listing, and the imminent implementation of new management plans that raised concerns about possible conflicts with SARA. During the discussions it was recognized that in many cases it will be relatively easy to determine that a species should be listed, but once listed it would be difficult to identify when to de-list them. The beluga meeting was not concerned with discussing listing and delisting criteria, which are the mandate of COSEWIC. However, for any listed species SARA requires that the responsible jurisdiction set explicit recovery goals for abundance and distribution. Therefore, we examined some of the COSEWIC criteria for listing, with the view that they might assist us in developing metrics to evaluate recovery.

The meeting was held to address the specific issue of beluga. However, the discussions held then are applicable to a discussion of recovery in all marine mammals, as well as other marine species.

CONSERVATION APPROACHES AND REGULATORY MECHANISMS

The Precautionary Approach (PA) enables scientists, resource managers, and stakeholders to identify clear management objectives, to establish specific benchmark or reference levels for populations, to enable the status of the resource to be evaluated, and to identify specific management actions that would be triggered when a population approaches or falls below the benchmark(s) (for a recent review see Hammill and Stenson 2003). Canada has subscribed to the Precautionary Principle as outlined in the Rio convention. Within this framework, Conservation, Precautionary, and Target reference points can be identified and linked to specific actions to aid in managing a natural resource. The PA also recognizes that the amount of information concerning the status of a resource may vary and that a lack of information is not sufficient to delay taking a management decision.

One means that Canada has to safeguard species is the protection afforded by the review and listing process of COSEWIC. COSEWIC is responsible for evaluating the status of plants and animals in Canada and making recommendations as to whether a taxon should be listed for protection, or not. For marine mammals some reviews are conducted on a species-wide basis, while in other cases, where there is sufficient evidence to warrant separation, reviews may be conducted at the population level. COSEWIC's criteria for evaluating the status of a species can be found at: www.cosewic.gc.ca/eng/sct0/assessment_process_e.cfm. These criteria include the rate of decline observed in the population, a reduction in the distribution or area of occupation, small absolute population size, or if through a quantitative analysis it is indicated that risk of extinction is high within a limited time frame. COSEWIC does not provide specific criteria that would lead to down- or de-listing. However, it is worth considering that criteria used to list a species will likely be important in the decision process to down- or de-list the species.

At one time, the proponents of the PA had identified a clear separation between the concepts of PA and the category of endangered species. However, over time these two aspects of conservation biology have become integrated. Within the American regulatory system there is a clear connection between species management and endangered species legislation. Within Canada there is already a seamless fit (although not consciously stated) between the PA and SARA as implemented by COSEWIC for the management of Atlantic seals (Anonymous 2003). This plan outlines an approach where lower-risk activities should be implemented as a seal population declines. At the same time, this scheme if used in the "reverse" might provide a framework that could be used to evaluate population recovery.

COSEWIC deals with four main criteria - abundance, rate of decline, number of "colonies", and area of extent. For marine species the last two criteria are not usually an issue (although number of breeding colonies could be a concern for marine mammals such as seals or sea otters). Given that the intention is for the rate of population decline to be less than zero, we can focus on the number of individuals – i.e. the number with respect to recovery.

What characteristics should we consider when trying to identify criteria for "recovery" for a listed species? Some of the characteristics feature the following:

1. Since we will be responsible for applying these across a number of species, they should be generic to, at least, species groups.

2. For many of these listed species we have limited biological information, so the characteristics for recovery must be based on general life history parameters.

3. The data we have or can collect are often limited therefore we need to base the recovery characteristics on one or at a most, a few measures (preferably absolute abundance or some index of abundance) that can be obtained relatively easily.

4. The characteristics must be robust to uncertainty in our measurement parameters, where the effects of variation in these parameters can be examined using simulation models.

CHARACTERISTICS OF RECOVERY FOR BELUGA

Beluga occur in the St. Lawrence river estuary and throughout the Canadian Arctic (DFO 2005b). They are a medium-sized toothed whale (3 m long) which reaches sexual maturity at approximately four to seven years of age. Thereafter females have a single calf every three years. Maximum longevity is not known, but appears to be at least 35 years. The maximum rate of increase is not known, but modelling suggests it is around 4% per year. Beluga are associated with ice-covered waters for all or part of the year. They move into estuaries in summer making them vulnerable to harvesting and disturbance by anthropogenic noise.

Canadian beluga populations are thought to be smaller than historic (pre-exploitation) levels, and based on current population size, population trends, and harvest levels, there is a risk that one or more populations might be reduced further. Once the population (or unit, or stock) of a species such as the beluga is listed, a general question then becomes "what would be needed to down- or de-list the species/unit?" Bearing in mind that it is only COSEWIC that will determine whether a species should be down-listed, nonetheless it was our objective to be able to set explicit (measurable and reportable) recovery goals for abundance and distribution for several beluga populations that would hopefully lead to subsequent down- or de-listing. To examine this issue one needs to consider the criteria used by COSEWIC to list species.

As mentioned previously, the predominant criteria for most marine mammals considered by COSEWIC appears to be abundance - either a rate of population reduction within a defined time, or a decline to a minimum population size. Thus, DFO should want to restore the listed species to a population size that was present before the concern of COSEWIC was triggered. In the case of marine mammals we usually have a catch history, but little historical abundance data. For many species even current abundance estimates are imprecise. This can necessitate the use of historical population estimates based on reconstructions from catch data. Admittedly this approach is weak because we know little about recruitment patterns in the past, and catch records tend to be incomplete. At the same time, it is likely that such historic population estimates are negatively biased.

Given the imprecision of our knowledge of historic population size, we need to establish a reference point for the population size at and above which we would consider that we have achieved population recovery. At the beluga meeting scientists decided that if the listed population grew to a level above 70% of the historical population estimate then the recovery objective would be deemed to be met. This was considered the primary metric. Scientists examined other metrics as well when they considered four beluga populations and how they fit into a biological template with the following subheadings: ecological role, historical population, percent of historical population, percent of historic range, status consistent with traditional ecological knowledge (TEK), number of mature animals, production, growth rate, population composition, and sex ratio.

During the meeting there was discussion of the utility of the biological properties for assessing the state or recovery of a beluga whale population. Considerations for each biological property included its biological relevance, conceptual strength, existence of methods to measure the property, existence of historic data, whether the property is monitored currently, and whether the recovery target is estimable. An example of this approach is presented in Table 1. Most (8 of 13) biological properties were deemed either unlikely to be informative, or unlikely to be possible to monitor in a cost-effective manner. The approach was applied to beluga in Canada (Table 2), and specifically to the four beluga populations under consideration (Appendix 1).

In addition to the issue of the population size necessary to be considered "recovered" – and eligible for down- or de-listing - there were several additional important considerations:

1. How long would it take for the required level of population recovery to be achieved?

2. What resources would DFO need to detect this level of population change?

It was decided that both of these questions should be handled by the Minister, rather than Science, although Science can provide some guidance. Therefore, we indicated what rates of population recovery would likely be achieved under different harvest schemes. We also indicated how long it would take or what kind of population change would need to occur before we could detect this change (number of surveys and time between surveys). As well, the cost associated with this monitoring effort was estimated. We felt that this information would allow the Minister to make an informed decision.

POST-MEETING COMMENTS ON THE TEMPLATE

Following the current meeting the template developed for beluga was circulated and the following comments were received about the applicability of this template for use with other species. Examples of these comments and how the categories could be applied to marine mammals are given below.

Ecological role: Attendees all agreed that this was important to include, but it was difficult to determine what should be included. In general the term was rather nebulous and non-quantitative.

Historical population: A recovered population might return to levels observed under pristine conditions. However, most marine mammal populations were already reduced substantially at the start of the 20th century, so estimates of "pristine" or largest population size known are not available. Catch data are available for some marine mammal populations (e.g. beluga) that can be used to estimate a historical population size, which is often our best estimate of the largest population size. For some species, this level could also be considered as the population that we would like to move towards i.e. the "recovered" population. Recently, there are concerns that changing ecological regimes may make it difficult or impossible for species to recover to historic levels.

Percent of historical population: This puts into perspective the estimated current abundance compared to what we would expect of a recovered population.

Percent of historic range: What is the distribution of the species compared to what we know historically (often difficult to determine)?

Status consistent with TEK: COSEWIC is obliged to consider traditional knowledge in its assessments. For marine mammals this can be important. The difficulty is to find the documentation for TEK, and to account for the known sources of bias in human memory and recall processes. In some cases TEK is available, although for many it is not.

Number of mature animals: In many marine mammal populations we do not have an age structure. For this application we used the COSEWIC standard that 60% of the total mammal population is mature.

Production: For marine mammals this can often be estimated (although with difficulty in some cases).

Growth rate: For marine mammals there are actually very few populations where maximum growth rate has been measured. Often this estimate if based upon a model using simulated data.

Population composition: this overlaps with number of mature animals. We do not have age structures for many marine mammal populations (see above).

Sex ratio: These data are not always available. More data are available for seals than for whales.

Growth at next 10 year COSEWIC assessment (2015): COSEWIC must re-evaluate every listed population at least every 10 years, or more often if new information suggesting a change in status is brought forward. We felt that it was important to provide an assessment of where we expected the population to be at the time of the next assessment, with certain caveats.

Growth to 70% of historical population size: It was agreed that the recovery objective for marine mammals was achieved if the population of interest had recovered to at least 70% of the historical population estimate. There were several considerations here:

1. Given the 95% confidence interval around most population estimates, at a level of 70% of the maximum most confidence limits would overlap the mean. Although it was not applied to beluga, the Atlantic seal model requires an 80% probability that the population is above the given reference level.

2. In many models using Maximum Sustainable Yield (MSY) or Optimum Sustainable Yield (OSY), density dependent factors begin to operate to reduce population growth rates at about 70% of the pristine population size. With some populations this occurs at levels as low as 54%.

3. COSEWIC has already adopted a scale where a population that had declined by 30% within 10 years or three generations (whichever is longer) would automatically be singled out for concern. Keeping with this theme, the ability to return the population to 70% of “pristine” values should indicate a reduction in concern.

OTHER CONSIDERATIONS

Overall, a recovery target equal to 70% of the maximum or historical population size (termed N70) follows a framework currently in use to manage Atlantic seals (see below). This framework identifies a precautionary level at 70% of the maximum, a second precautionary level at 50% of the maximum (N50), and a reference limit point at 30% of the maximum (N30). The closer a population is to the limit reference point, the more conservative and risk-averse harvesting strategies must be. The current reference levels are compatible with COSEWIC criteria. For a recovering population it could be used in reverse to provide benchmarks to evaluate progress towards recovery (Figure 1), and support intermediate listings (threatened, special concern) prior to eventual de-listing.

Attendees did not pursue the idea of recovery time during the beluga meeting. In the case of endangered species, it is evident that recovery will occur more quickly if no anthropogenic harvesting occurs. At the same time, DFO may decide not to stop harvesting completely (e.g. for economic, cultural, or subsistence reasons). Achieving complete compliance with a no-harvest rule may require more resources than the Minister is willing to expend. At the same time, there is a legislative requirement for the Minister to favour recovery for listed species. Therefore, attendees decided that it was not the task of science to decide how soon recovery must occur. However, attendees did examine and present estimates of how long recovery would take under different harvest scenarios. They also examined the ability to detect population changes which would allow for allocation of survey effort as well. This is an approach that should be considered under most management scenarios for harvested species.

It was also recognized that recovery time “costs” should consider the increased risk to the species of concern with longer exposure to adverse factors when at lower abundance levels. For instance, if the “reduced” beluga populations are less able to withstand perturbations due to climate change or unusual mass mortality events, then the longer they are below the historic level (or perhaps N70) the greater the risk to the population of extirpation, etc. So, the costs related to recovery time are not just measured in dollars, but might also be in an increased risk of adverse population trends with exposure to factors which for a healthy population would be less consequential.

A REFERENCE POINT APPROACH TO RECOVERY CRITERIA: AN EXAMPLE FROM THE MANAGEMENT OF ATLANTIC SEAL POPULATIONS

The recently-developed management strategy for Atlantic seals provides a useful basis to develop recovery criteria for listed species as we have only to reverse the goals of this approach. The conceptual framework for applying the Precautionary Approach to managing seals in Atlantic Canada is outlined in Hammill and Stenson (2003). This scheme triggers different management responses if different population thresholds are surpassed. For a data-rich species, two precautionary and a conservation reference level are proposed.

In the harvest context of the current scheme or model, thresholds are established at 70%, 50%, and 30% of the pristine population size or proxy of the pristine population (e.g. maximum population size; Fig. 1). When populations fall below these thresholds, increasingly restrictive harvest limits are implemented (Fig. 1).

This approach can be used in a recovery context (the reverse sense of a harvest-induced decline model) so that as the population of a listed species grows from 30 to 50 or 70% we can evaluate its status with respect to recovery. Such science-based, risk-averse, and pre-determined “reference points” (thresholds) provide a solid benchmark for all stakeholders to be able to consider any potential change in status.

In Figure 1 we have indicated a “recovery” trend in the population. Using this threshold approach with the beluga example, DFO would consider the population to be “recovered” (and a candidate for down- or de-listing under SARA) when it reaches a population level of N70 (70% of the estimated historic maximum population).

An important point to consider is that as beluga reach intermediate levels (e.g. N30 and N50) it could be considered for down-listing (from, for example, endangered to threatened to special concern), with complete de-listing occurring at the N70 level. Stakeholders participating in the recovery strategy could then have evidence that the recovery process is working without waiting for the eventual de-listing stage (potentially much) later in time.

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Table 1. Utility of biological properties for determining recovery as applied to the Eastern Hudson Bay (EHB) beluga whale in Canada.

Biological Property	Ecological Function	Abundance/Biomass	Range/Area	TEK	Minimum Number	Productivity-Recruitment	Productivity-Growth	Sex Composition	Age Comp	Condition/Size	Pathogens/Contaminant	Subpopulation	Population Growth Rate
Utility[a]	U	Y	Y	Y	Y	P	U	U	U	U	U	U	P

[a]Utility of the biological property in assessing the state of the population. Y = yes it can be used; P = it would be possible to use, but only with some additional research and/or new monitoring; or U = it would be unlikely to be informative, or else unlikely to be possible to monitor in a cost-effective manner.

Table 2. Hypothetical and generic population characteristics for the beluga whale in Canada.

Population Characteristic	**Life History**	**Distribution**	**Abundance**
Life span	Possibly 35 yrs		
Age at first reproduction	4-7 yrs		
Reproductive potential	Low		
Sex ratio	Insufficient data		
Morphometric plasticity	Low		
Other species as habitat?			
Status of habitat species?		Threatened	
Migratory?		Yes	
Diadromous, marine or freshwater		Diadromous	
Sensitivity to contaminants	High		Perhaps
Historic range		Ice-free pan-Arctic	
Current range		Migratory, 500 km^2	
Edge of range?		No	
Historic abundance			Estimable
Current abundance			Estimable
Main reason for listing		Habitat loss (anthropogenic)	Hunting removals
Possibility of rescue effect			High
Competition from other species? (e.g. niche loss)	Low		

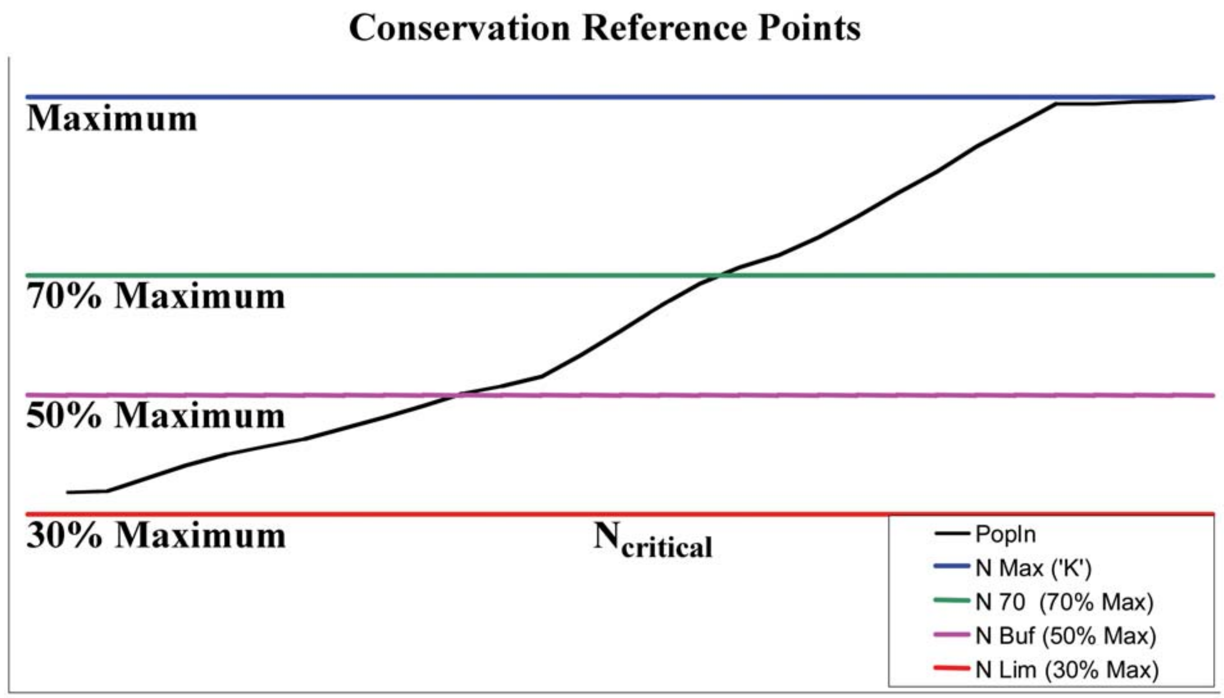

Figure 1. A conservation approach such as is currently used in the management of Atlantic seal populations. Reference points at pre-determined population levels trigger different management strategies (or listing recommendations).

APPENDIX 1: RECOVERY CONSIDERATIONS FOR CANADIAN BELUGA POPULATIONS

1. SUMMARY OF EASTERN HUDSON BAY BELUGA RECOVERY CONSIDERATIONS

- Ecological role: The EHB beluga population serves as an upper level predator in the Hudson Bay/Hudson Strait and NW Atlantic ecosystem. It is also an important food resource for Inuit living in northern Quebec and also to Inuit living in the Belcher Islands. Recovery to a large and productive population size would allow the population to fulfil its ecological role.

- Historical population: The historical pre-commercial whaling population size is estimated at 12,500.

- Percent of historical population: The population is estimated to have been 3,100 (S.E. = 800) in 2004, or 25% of its historical size pre-commercial whaling.

- Percent of historic range: Based on local knowledge (TEK), the population does not appear to have changed in its historical range, but it is no longer seen at some estuaries within that range or is seen in fewer numbers at certain estuaries. Nevertheless, the TEK study is based on respondents that were born in the middle of the last century and may reflect a range at the final stage of commercial whaling. It is therefore possible that the historical range was larger than present.

- Status consistent with TEK: Local respondents have conflicting views. Hunters living in the Hudson Bay area say that there are fewer beluga than in the past. Residents of Hudson Strait, an area where two or more stocks of beluga, the large western Hudson Bay beluga population and the small EHB beluga population both migrate through this area, during spring or fall, believe that beluga are still abundant.

- Number of mature animals: The current population estimate is 3,100. Using COSEWIC's default proportion of 60% mature to total population, the mature individuals would then number 1,860.

- Production: The gross production is not considered to be a problem. Although there is no formal estimate of gross production because of the difficulty in spotting calves during visual aerial surveys.

- Growth rate: Maximum growth rate for this population is not known, but beluga are thought to have a maximum rate of increase of approximately 4%. At current reported harvest levels the population is thought to be stable.

- Population composition: There is no data on this characteristic.
- Sex ratio: There is no data on this characteristic.

- Growth at next 10 year COSEWIC assessment in 2015: Based on population model fitted to aerial survey data, stock composition of the harvest and reported harvest levels, the population is expected to increase if reported harvests stay below 60 animals. Scenarios below are for reported harvests. Actual harvest levels appear to be higher and can be calculated by multiplying reported harvests by 1.67.

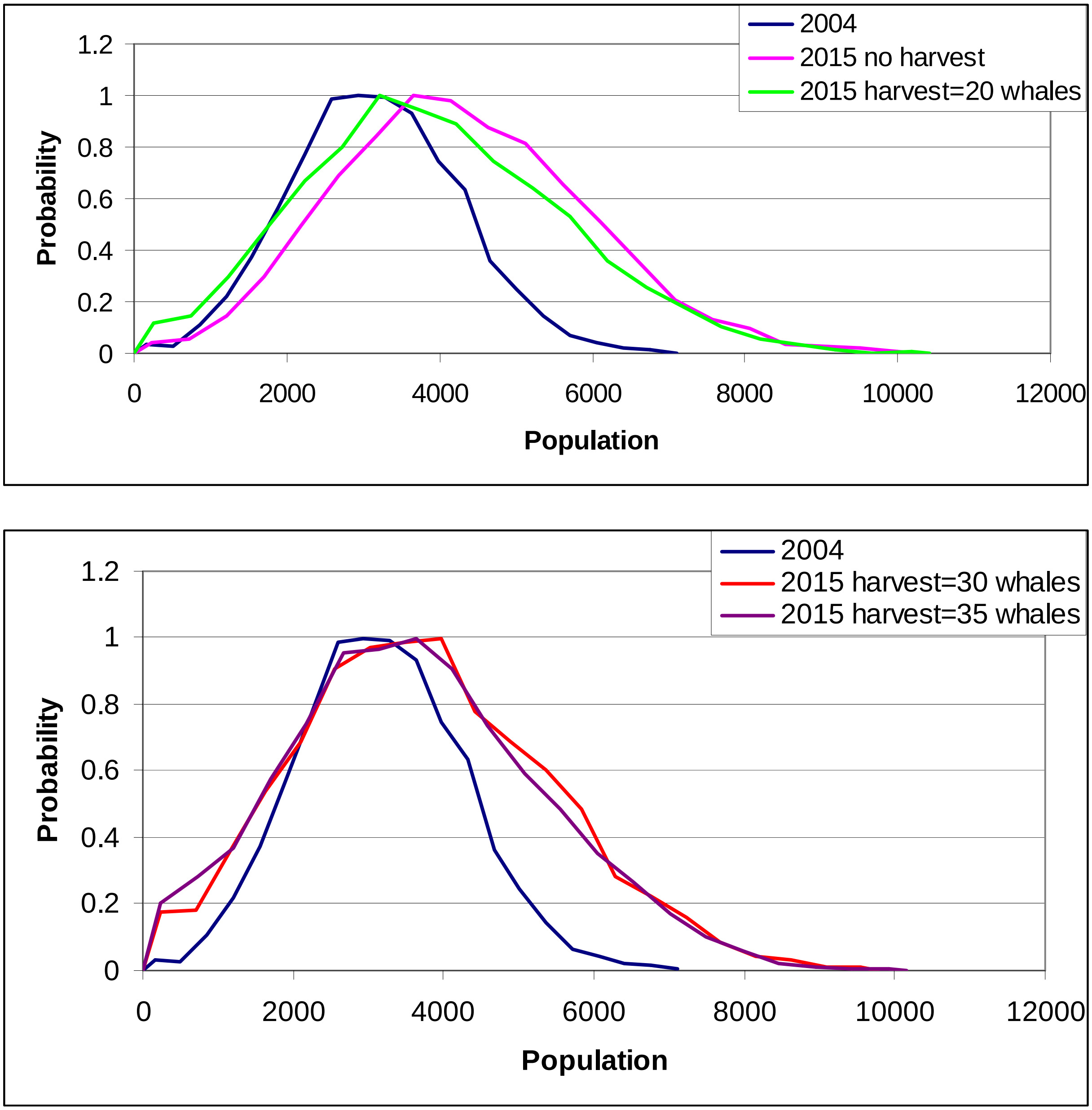

Figure 2: Probability density distributions for the Eastern Hudson Bay beluga population in 2004 and 2015 under various scenarios of reported harvests.

- Growth to 70% of historical population size (0.7 x 12,500 = 8,750): Based on different levels of reported harvest. Current reported harvests number around 60 animals which will result in little change in population size. Harvest levels below this will allow population recovery, but the rate will depend on overall levels.

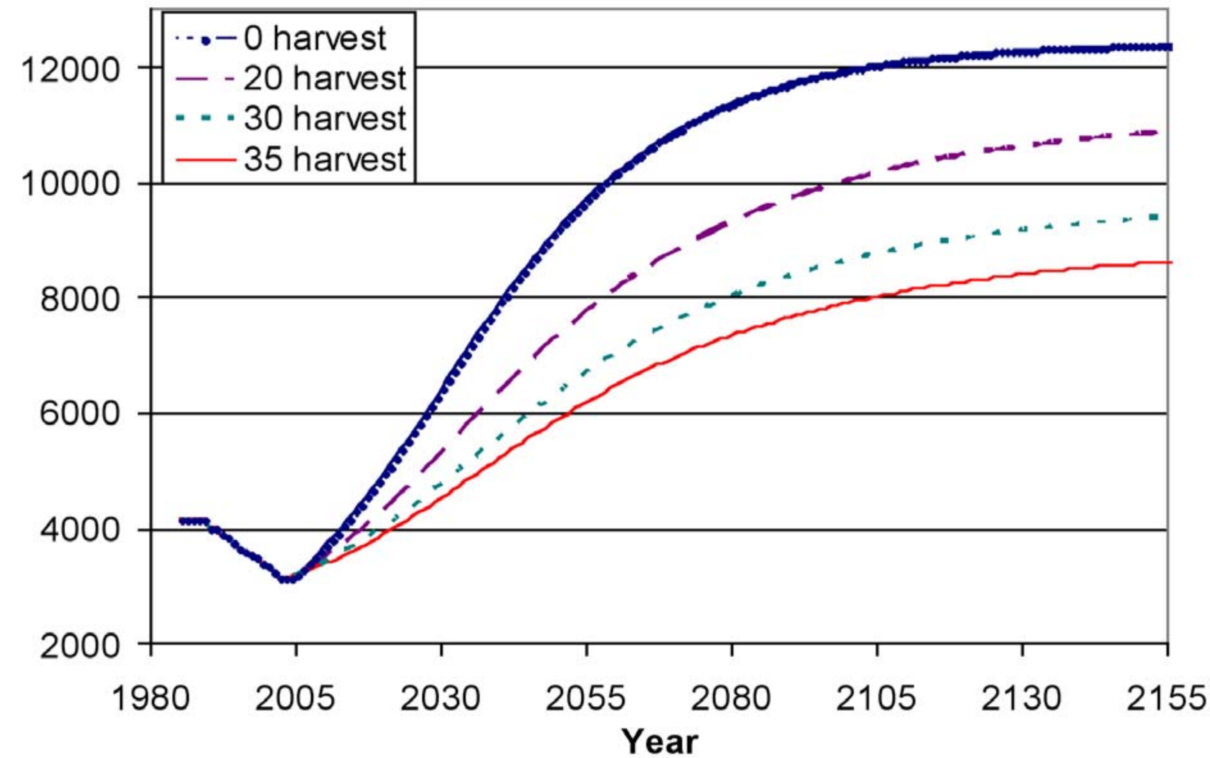

Figure 3: Projected population growth under four catch scenarios.

2. SUMMARY OF CUMBERLAND SOUND BELUGA RECOVERY CONSIDERATIONS

- Ecological role: The Cumberland Sound beluga population's ecological role has been for centuries to act as prey for its main predator, the Inuit and to a lesser extent for other marine mammal predators, such as killer whales and sharks. Recovery to a large and productive population size would allow the population to fulfil its ecological role.

- Historical population: The historical pre-commercial whaling population size is estimated at 8,465 (S.E. = 426).

- Percent of historical population: The population is estimated to have been 2,018 (S.E. = 271) in 2002, or 24% of its historical size pre-commercial whaling.

- Percent of historic range: Based on local knowledge (TEK), the population does not appear to have changed in its historical range. Nevertheless, the TEK study is based on respondents that were born in the middle of the last century and may reflect a range at the final stage of commercial whaling. It is therefore possible that the historical range was larger than present.

- Status consistent with TEK: Local respondents and co-management and recovery team participants state that the population is smaller than in the middle of the 20^{th} century but the range has not changed.

- Number of mature animals: Despite the assessment of COSEWIC which was based on a preliminary estimate of the population size, a recent Bayesian model estimate puts the population at 2,018 (S.E. = 271) in 2002. Using COSEWIC's default proportion of 60% mature to total population, the mature individuals would then number 1,211, which is above the criteria which triggered their proposed *Threatened* listing.

- Production: The gross production is not considered to be a problem. Although there is no formal estimate of gross production because of the difficulty in seeing the dark coloured neonates in the silted waters of the Ranger River of Clearwater Fiord (where the whales aggregate), many neonates are observed during aerial surveys and by the Pangnirtung residents. Bayesian modelling suggests a high probability of positive growth (net production) despite the annual catch quota of 41 per year and hunting losses.

- Growth rate: Maximum growth rate for this population is estimated at 3.01% (SE = 0.3%) but this result is strongly influenced by the priors used in the Bayesian model. It is expected that more surveys will be allow a relaxation of the strong priors and a better estimate of the maximum growth rate and of the net growth rate. The present net growth is estimated to be positive despite the annual catch by Pangnirtung residents.

- Population composition: There is no data on this characteristic.

- Sex ratio: There is no data on this characteristic.

- Growth at next 10 year COSEWIC assessment in 2015: Based on Bayesian parameter estimates and of loss rates with parameters with a triangular distribution (min bound = 0%, most likely = 8.3%, max bound = 32%), the population will grow from now until 2015 for scenarios of landed catch between 0 and 41 (i.e. present quota) but a catch of 60 would result in a declining population.

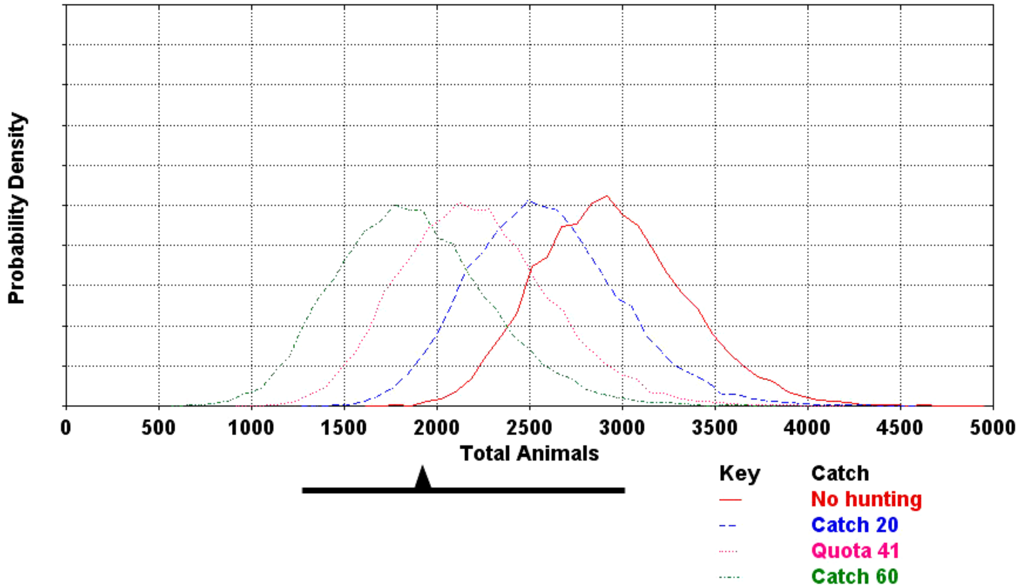

Figure 4: Probability density distributions of the Cumberland Sound beluga population in 2015 under various scenarios of landed catch, assuming an uncertainty distribution of hunting losses defined by TRIANG (0% , 8.5%, 32%). The black bar under the graph indicates the starting population's estimated probability density distribution in 2002. The triangle indicates the mode of that distribution.

- <u>Growth to 70% of historical population size (0.7 x 8,465 = 5,926)</u>: Based on Bayesian parameter estimates and of loss rates with parameters with a triangular distribution (min bound = 0%, most likely = 8.3%, max bound = 32%), the population size could reach the target of 5,926 in 40 to 90 years depending on catch scenarios of 0-41 (quota) but might otherwise show a declining trend for the landed catch scenario of 60.

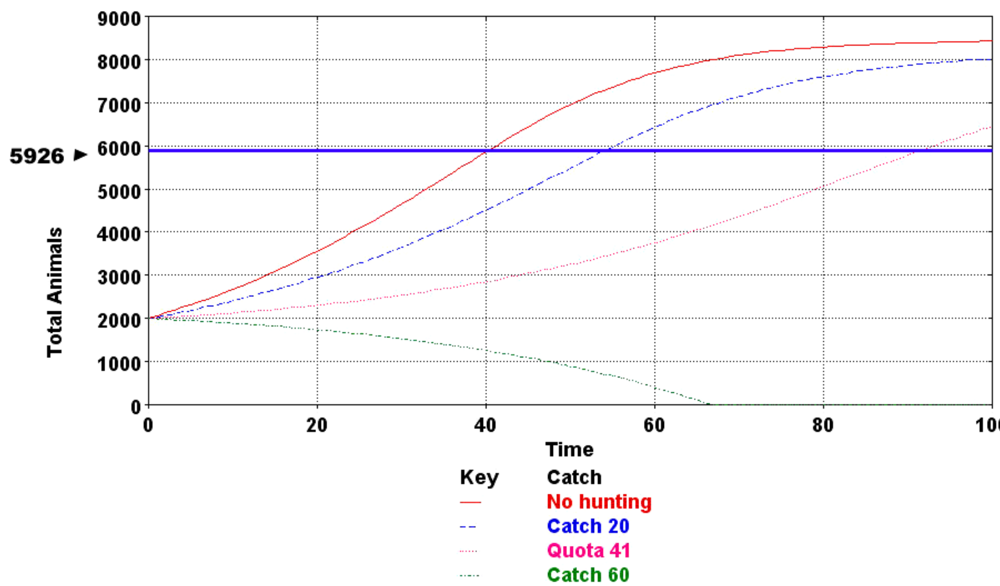

Figure 5: Projected population growth for the Cumberland Sound population under four catch scenarios, assuming an uncertainty distribution of hunting losses defined by TRIANG (0%, 8.5%, 32%).

3. SUMMARY OF ST. LAWRENCE ESTUARY BELUGA RECOVERY CONSIDERATIONS

- Ecological role: The St. Lawrence Estuary beluga population was a much more important upper trophic level predator in the St. Lawrence Estuary ecosystem. It was also preyed upon by sharks and killer whales. Recovery to a large and productive population size would allow the population to fulfil its ecological role.

- Historical population: The historical pre-commercial whaling population size is estimated at 10,100.

- Percent of historical population: The population is estimated to have been 1,100 (S.E. = 200) in 2003, or 11% of its historical size pre-commercial whaling.

- Percent of historic range: Based on available information, the population was seen as far west as Quebec City on occasion and as far east as Sept-Iles and Baie de Chaleurs. The normal summer distribution was from Ile au Coudres to the Manicougan Banks off Baie Comeau. Currently, the population summer distribution is concentrated between Bic-Forestville in the east and Ile au Coudres St. Jean de Port-Joli in the west.

- Status consistent with TEK: NA.

- Number of mature animals: The current population estimate is 1,100. Using COSEWIC's default proportion of 60% mature to total population, the mature individuals would then number 660.

- Production: Information on production is not available.

- Growth rate: Maximum growth rate of healthy beluga populations is thought to be around 4%. In spite of protection from hunting since 1979, recovery of this population has been very slow. It is uncertain if this results from a decline in production, increases in mortality or a combination of the two. A stranding programme recovers on average 15 animals per year. A large proportion of these are old animals. Causes of mortality vary between age classes, with cancer, parasitic, bacterial and viral infections identified as the most serious causes of death.

- Population composition: There is no data on this characteristic.

- Sex ratio: There is no data on this characteristic.

- Growth at next 10 year COSEWIC assessment in 2015: The population is expected to increase slightly under current conditions and would likely number around 1,200 animals.

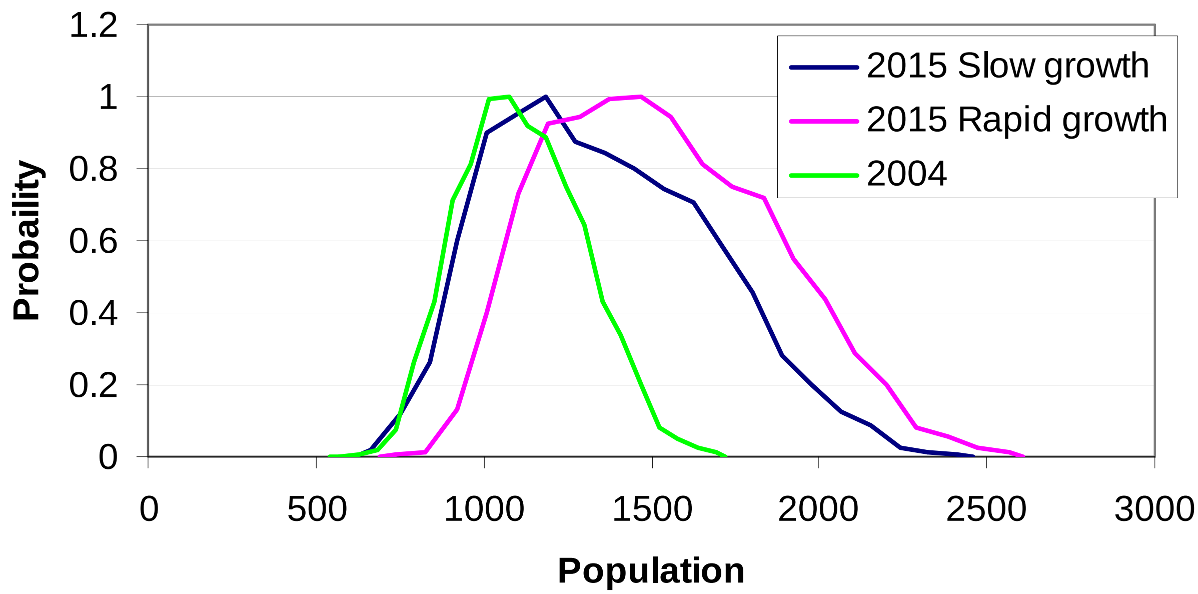

Figure 6: Probability density distributions of the St. Lawrence beluga population in 2015 under a scenario of rapid growth (factors limiting recovery eliminated), and slow growth, assuming current conditions continue.

- Growth to 70% of historical population size (0.7 x 10,100 = 7,070):

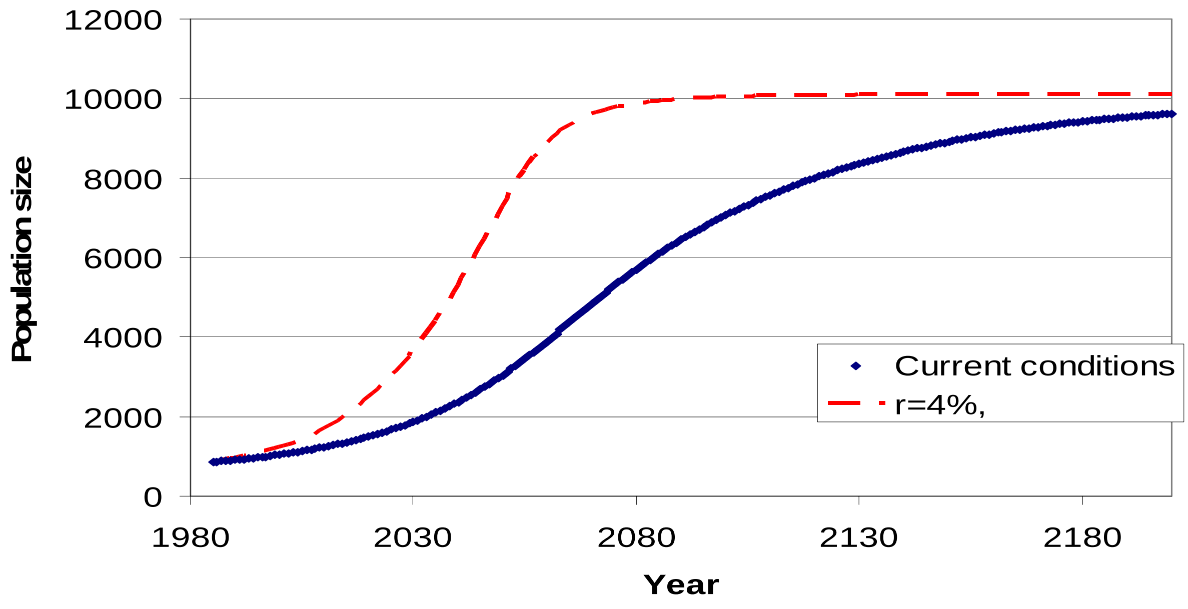

Figure 7: Projected population growth for the St. Lawrence population under current conditions and growth if factors limiting recovery can be determined and rectified.

4. SUMMARY OF UNGAVA BAY BELUGA RECOVERY CONSIDERATIONS

- Ecological role: The Ungava Bay beluga population role has been for centuries to act as an important food resource for Inuit living in the Ungava Bay region of northern Quebec. Recovery to a large and productive population size would allow the population to fulfil its ecological role.

- Historical population: The historical pre-commercial whaling population size is estimated at 1,900.

- Percent of historical population: There is currently no reliable estimate of population size. It is thought to number less than 200 animals, which would place it at less than 10% of its historical size pre-commercial whaling.

- Percent of historic range: Based on local knowledge, animals do not appear to have altered their historical range, but much fewer numbers and there is less frequentation of the Leaf, Payne, Koksoak and Mucalic rivers in summer. Small numbers of beluga continue to be seen in the Mucalic River, in southern Ungava Bay during the summer. A recovered population of 70% of the historical estimate, would number 1,300 animals. Any harvesting on this population poses a threat to recovery.

- Status consistent with TEK: Local respondents observe few beluga in Ungava Bay during summer.

- Number of mature animals: The current population estimate is <200. Using COSEWIC's default proportion of 60% mature to total population, the mature individuals would then number <140 animals.

- Production: Little is known of this population. Continued low level harvesting at the Mucalic River during the summer pose serious threats to this population.

- Growth rate: Maximum growth rate for this population is not known, but beluga are thought to have a maximum rate of increase of approximately 4%.

- Population composition: There is no data on this characteristic.

- Sex ratio: There is no data on this characteristic.

- Growth at next 10 year COSEWIC assessment in 2015: Harvesting remains the most serious threat to this population. Abundance is so low that estimates of population size cannot be determined using the current aerial survey design.