

Response to: Review of the Boomer & Johnson Scaup Population Model [21 February 2008]  
Division of Migratory Bird Management  
U. S. Fish and Wildlife Service

We would like to acknowledge the time and effort of the Review Panel and thank Delta Waterfowl for sponsoring a review of the scaup assessment framework. Moreover, we appreciate the endorsement of the initial modeling work and the overall approach to developing a structured decision making framework to inform scaup harvest management. We believe the review committee highlighted some legitimate concerns and provided some constructive suggestions for future work. However, we also believe it is important to note that we have attempted to address or are currently investigating many of the issues raised in the Review. In addition, many of the Review Panel's suggestions may not be directly applicable given the current management scale and the limited monitoring information available for scaup.

We believe that it is important to recognize and qualify that the primary goal of the Division's assessment is to support the development of a decision-making framework to inform scaup harvest management. We have chosen to adopt a structured decision-making framework to approach this difficult task. We acknowledge that the modeling framework we have adopted is only one component of the decision making framework that is dependent on significant guidance from the management community in the form of clearly articulated management objectives and agreed-upon regulatory alternatives. While the Review focuses on the technical aspects of our modeling framework and the description of alternative models, we contend that many of the key sources of uncertainty regarding harvest management decisions involve policy-related decisions which are often more complex and harder to resolve. We agree with the Review Panel's assertion that we need strong collaborative interactions to develop the consensus necessary to implement an informed decision-making framework for scaup harvest management.

### **Objective Function**

- The Panel recommended consideration of alternative forms of an objective function, and specifically consideration of one that maximizes harvest opportunity while minimizing the risk of the population becoming too small.

We agree that the successful implementation of an informed decision-making framework is dependent upon clearly articulated and agreed-upon objectives. One of the challenges in the development of a decision-making protocol for scaup harvest management has been eliciting communication and the necessary feedback to clearly articulate the objective of scaup harvest management. We agree that the specification of an objective function is one of the most critical components in the development of a decision framework.

We have not considered the specification of a utility function to represent the dual objective of maximizing harvest opportunity while minimizing the risk of continued population decline. We believe this merits further consideration as we continue to work with the waterfowl management community to determine appropriate objectives for scaup harvest management. We have considered the inclusion of a closed season constraint in the optimization to reflect the beliefs that there may be population sizes for which season closure may not be acceptable. However,

we acknowledge that the resulting policy behavior from this type of constraint may be very different than a policy resulting from the use of an explicit utility function that attempts to maximize harvest while minimizing the likelihood that population abundance will fall below a critical threshold. We will continue to solicit feedback from the management community regarding appropriate harvest management objectives.

### Data Considerations

- The Review Panel expressed concern that a truncated time series of population estimates had been used to model scaup population dynamics.

In 2005, the Division conducted an intensive review of scaup breeding population estimates to examine potential biases in these data that might invalidate their use as a basis for the current assessment or otherwise call into question inferences derived through that assessment. At the 2006 Scaup Workshop, the Division presented the results of the evaluation of potential biases in population estimates along with a description of the scaup assessment and decision-making framework. A key finding of our review was that population estimates prior to approximately 1974 were likely biased low because of the inconsistent treatment of grouped scaup observations by survey crews. During the early years of the Waterfowl Breeding Population and Habitat Survey some survey crews were not recording observations of scaup in groups. By 1974 it appears this inconsistency in operating procedures had been resolved and all scaup groups were recorded by all crews. Moreover, an evaluation of these early population estimates suggests that scaup populations were not increasing markedly from the 1960s to 1970s but that this increase was likely the spurious result of changes in operating procedures. This is supported by an examination of scaup pair observations (which have been consistently recorded over time) which indicate relatively stable populations prior to the late 1970s. The Review Panel raised concerns about not including data prior to 1974 in the assessment since this removes the period of population increase from the 1960s to 1970s and could cause  $r_{max}$  to be underestimated. We suggest that a greater concern would be reliance on population estimates known to be biased (prior to the early 1970s). When comparing estimates of  $r$  based on the earlier assessment (Boomer et al. 2004) with the current assessment (Boomer and Johnson 2007), it is important to also recognize that the original assessment did not explicitly control for scaling issues in the harvest and population abundance data. Changes in the estimation framework may also explain some of the differences in the estimates of  $r$ .

However, we are sensitive to the Panel's concerns regarding data selection and the possible influence on assessment results. One idea that was discussed at the Review was to perform the scaup assessment with different consecutive years of data (e.g., 1974:2005, 1975: 2005, etc.). The results from such an analysis could possibly yield insight into the sensitivity of the model results to any potential retrospective patterns in the data that may be related to a changing system. These results may also provide some evidence to determine if there are patterns in  $r$  or  $K$ , which may prove useful as we begin to consider possible models to represent a declining carrying capacity.

- The Review Panel suggested that we consider a female-only population model, or that it might be important to include sex-specific components in the model(s) of scaup population dynamics.

Because available monitoring programs do not support the collection of sex-specific population abundance data or the estimation of sex-specific demographic parameters at the current management scale, we believe it is not possible to develop a female-only population model. The suggestion to treat sex-specific abundance as a latent variable is intriguing and could be evaluated in the future; however, we do not believe that data presently exist to estimate or predict state transitions.

### **Statistical Analysis**

- The Review Panel recommended more justification be provided for Bayesian priors and that we explore the sensitivity of model output to priors.

We chose to use vague priors for the model parameters that admitted a wide range of variation within biological bounds. For example,  $r$  was allowed to vary from 0.00001 to 2, while the 90% quantiles for the prior distribution for  $K$  ranged from approximately 3 to 25. While we have not performed a formal sensitivity analysis, we have explored model output using different distributional forms (e.g., uniform or lognormal) and did not find any major differences.

- The Review Panel recommended that the criterion to be used for model selection or model weighting be agreed-upon prior to model development.

We agree that methods for model selection and weighting in an adaptive management framework should be carefully considered. We are currently exploring these issues and will continue to engage the waterfowl management community to determine the appropriate methods for weighting models in an adaptive management framework.

### **Alternative Models**

- The Review Panel recommended that an expanded model set should be considered to: i) allow for decline in the carrying capacity of the scaup population; ii) explicitly model additive and compensatory processes, and, iii) incorporate different functional forms of density dependence.

In November 2007 at the recommendation of the AHM Working Group, the Division agreed to consider an alternative model for inclusion in the scaup decision-making framework. This model would encapsulate the alternative belief that the scaup population will continue to decline to some lower equilibrium level due to declining carrying capacity, and that harvest at current levels is completely compensatory in the decline. The Division has committed to the development of an alternative model to be evaluated for use in an adaptive framework to derive a scaup harvest policy.

### *Declining carrying capacity*

One of the outstanding technical challenges in the development of an alternative model will be the specification of a functional form to represent a continued scaup decline. With the absence of a direct relationship between scaup population change and an environmental driver, the relationship may have to be specified by policy decision and parameterized with agreed-upon constants. We agree with the Review Panel that the identification of environmental drivers that may help explain the scaup population decline would be highly useful and improve our ability to predict scaup population dynamics. Unfortunately, our efforts to locate data sets describing patterns in scaup habitats or environmental conditions at sufficient temporal and spatial scales have been unsuccessful to date.

Early in our work to develop models for scaup population dynamics, we included parameterizations that allow  $r$  or  $K$  to vary according to a simple random walk (Boomer et al. 2004). Subsequently, we also attempted to fit alternative functional forms of declining  $K$  (e.g., declining logistic function). These models were developed to capture the idea that scaup demographic parameters may not be fixed especially in relation to the evidence of a long term decline from the breeding population estimates time series. We quickly found that the breeding population estimates and harvest data were not sufficient to support the additional complexity of incorporating a dynamic model for changes in  $r$  or  $K$ . The process variation from the resulting models was being absorbed by the variation in the associated parameters describing changes in  $r$  or  $K$  in the estimation. In addition, the interpretation of the derived estimates for  $r$  and  $K$  were not biologically realistic. However, we do agree that hierarchical models that allowed for changing  $r$  or  $K$  as a function of auxiliary information would be worth considering if the additional data were available. We believe the successful development of such a model would provide the necessary linkage between some aspect of the changing system and the scaup population decline. We are very interested in the Review Panel's suggestion to try and develop a submodel to predict changes in  $r$  as a function of scaup age ratios. It would be very useful to determine if the additional information in the age ratio data may be sufficient to support the further development of dynamic models that represent changes in  $r$  or  $K$ .

### *Additive/compensatory mortality*

The Panel recognized in the review that the present model form admits the possibility of compensatory harvest mortality but that the effect of harvest mortality is confounded with the effects of scaling issues associated with monitoring data used to develop the model. We agree that the existing modeling framework does not allow us to explicitly consider scaup harvest mortality to be strictly compensatory (or additive) because of the difficulty in interpreting the role of the scaling parameter  $q$ . However, the density dependent relationship inherent in the discrete logistic model does provide for a compensatory response of the population to losses from harvest, albeit, this feedback has to be interpreted as a subsequent pulse of production the following spring.

The Panel believed that alternative models that decouple these influences are important in order to learn about the effects of harvest on overall scaup mortality and population dynamics. We agree that it would be useful to decouple these influences and believe that the lack of available information required to support the required analyses does not preclude the development of an explicit model to represent compensatory mortality. Unfortunately, the

functional form of this model and resulting parameter estimates may have to be specified by policy decision in the absence of relevant data. Under this scenario, we would also have to specify by policy decision the threshold or population size at which compensatory harvest mortality becomes additive. We also point out that it is unlikely that modeling efforts alone will resolve uncertainties surrounding the relationship between harvest and annual survival (as it remains equivocal even for mallards), but that large scale experimentation with hunting regulations would be required to fully investigate this relationship.

### *Different functional forms of density (in)dependence*

The Panel recommended that the Division consider models that capture alternative forms of density dependent regulation. We have investigated fitting theta-logistic models to the scaup monitoring information and found this parameter to be very difficult to estimate. This result is not surprising given the uncertainty within the scaup monitoring information and the inherent difficulty of fitting this model to population and harvest data (Quinn and Deriso 1999).

The Division remains open to consideration of models that describe alternative forms of density dependence and will continue to evaluate this possibility. However, it is important to note that while we acknowledge that we consider only 1 functional form (i.e., the discrete logistic) to describe scaup population dynamics, the model is sufficiently general to account for a broad range of dynamics and responses to harvest. In addition, we explicitly account for circumstances where the discrete, logistic model may not perfectly represent scaup change by representing this process error in the estimation framework and during the derivation of the optimal policy. More importantly, the entire range of population behaviors that are supported by available data are considered in the derivation of an optimal harvest strategy through the use of 27 different combinations of population parameters ( $r$ ,  $K$ ,  $q$ ). Collectively, these combinations result in a wide range of possible maximum harvestable surpluses (~150 to 800 thousand birds) that we believe covers a wide range of possible responses to exploitation.

### **Literature Cited**

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### Contact:

Mark Koneff, Chief, Population and Habitat Assessment Branch  
 USFWS- Division of Migratory Bird Management  
 11510 American Holly Drive  
 Laurel, Maryland 20708-4017  
 TEL: 301-497-5648