Declining Scaup Populations: Reassessment of the Issues, Hypotheses, and Research Directions

Consensus Report from the Second Scaup Workshop
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The combined breeding-season population of greater (*Aythya marila*) and lesser scaup (*A. affinis*) (hereafter, scaup) appears to be in peril, declining from population estimates of 5 to >7 million birds in the 1970s to a record low of 3.39 million birds in 2005 (Figure 1). The 2005 estimate is 46% below the goal of 6.3 million scaup set in the North American Waterfowl Management Plan (NAWMP). This downward population trend concerns biologists, managers, and hunters alike. These concerns are exacerbated because factors limiting the population are unknown; therefore, appropriate management actions are unclear. Scaup have the most widespread distribution of all North American diving ducks, extending from the northern tundra in summer to southern Mexico in winter. This continental scope further challenges attempts to understand both the nature of constraints to the population and where they might be encountered. Evaluation of scaup breeding distribution and patterns of population change has helped focus concerns to the western boreal forest, where 70% of breeding-season scaup counted in traditional survey areas occur. Scaup in this region have experienced the fastest rates of decline, about 94,000 birds per year between 1978 and 2005. Factors outside the breeding grounds, however, probably are also involved in limiting population recovery. The desire to recover scaup populations led to two scientific workshops that addressed issues of concern, hypotheses about factors constraining the population, and research and management needs. The objective of this report is to summarize activities and conclusions of the most recent meeting.

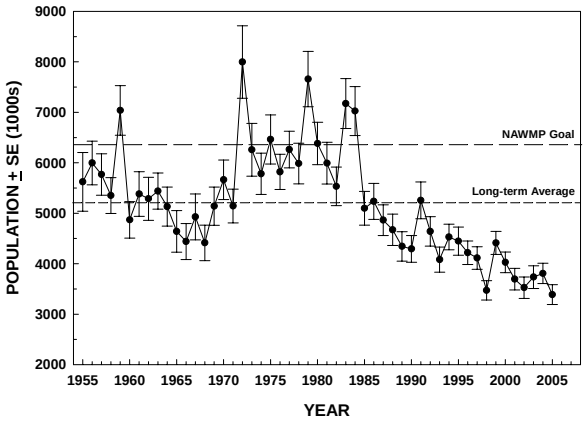

Figure 1. Trends in the combined breeding population estimates (mean ± SE) of greater and lesser scaup, 1955–2005. Data from the U.S. Fish and Wildlife Service annual waterfowl and habitat surveys.

The first workshop was held in 1998 and included 45 biologists representing state, federal, academic, and non-governmental organizations from the United States and Canada. Workshop participants reviewed current knowledge about greater and lesser scaup, examined potential problems facing the species, considered hypotheses for factors contributing to the population decline, identified information and research needs, and formulated strategies for addressing some of those needs. Participants concluded that contaminants, lower female survival, and changes in food resources on winter, migration, or breeding habitats were likely factors contributing to the decline. Participants believed that those factors are not mutually exclusive but likely interacted across seasons. Lack of information in the western

boreal forest, where much of the population decline was focused, was of particular concern. Ultimately, seven action items were identified: 1) further delineate where declines in the breeding populations have occurred, with a primary focus in the western Canadian boreal forest; 2) assess productivity in various areas throughout the breeding range through retrospective analyses and field studies at broad and local scales; 3) determine annual and seasonal survival rates in order to assess the roles of harvest or natural mortality; 4) investigate the effects of contaminants on reproduction, female body condition, and behavior; 5) examine use, distribution, and role of food resources relative to body condition and reproductive success; 6) assess affiliations among breeding, migration, and wintering areas; and 7) gather and improve information needed to manage greater and lesser scaup separately.

The 1998 workshop led to a number of studies that sought to address the hypotheses and action items summarized by workshop participants. This new information and continued low populations of scaup underscored the need to re-visit potential causes of the population decline and factors limiting recovery. Therefore, the second Scaup Workshop was held on 17–19 January 2006 in Bismarck, North Dakota. More than 60 biologists and managers participated, representing 18 state, federal, academic, or non-governmental organizations from the United States and Canada. The objectives of this workshop were to 1) synthesize information obtained since 1998; 2) re-evaluate and propose new hypotheses about factors limiting the population; and 3) recommend directions for research and management, including prioritizing research and information needs, promoting future coordination among programs, and scoping new approaches to secure funding and support.

Participants reported new information in four general areas: population biology and harvest, spring migration ecology, contaminants, and habitat changes in migration and wintering areas and in the western boreal forest. Breeding population survey data were re-examined for accuracy and potential biases and for patterns over time and space, particularly within the western boreal forest. The harvest potential of continental scaup populations was assessed via a harvest model developed by the U.S. Fish and Wildlife Service, with discussion of implications for scaup recovery. New information on scaup demography in the western boreal forest and in other areas was synthesized. Demographic models, developed and refined since 1998, contributed to further discussions on vital rates and data gaps. Several studies examining spring migration ecology (body condition, feeding ecology, and contaminants) in the Mississippi Flyway, Great Lakes, and South Dakota provided new insights on the spring condition hypothesis and spring habitat conditions. The spring condition hypothesis also was evaluated from the perspective of data from the breeding grounds. Contaminant information on scaup during all seasons was synthesized and evaluated. Finally, habitat changes on wintering, staging areas, and boreal forest habitats were assessed relative to their probable impact to scaup distribution and vital rates. Throughout, participants identified many areas of information gaps or key limitations of existing data related to small sample size or insufficient spatial-temporal scope. Discussions highlighted many common issues of concern.

Identifying priority issues

Presentations, both oral and poster, and subsequent discussions served as a foundation for two rounds of breakout groups. The first round charged all groups with the same objective, to identify current factors thought to be limiting a scaup recovery. The resulting topics were discussed collectively and condensed into seven main research topics. Each research topic was then assigned to a breakout group in the second round. Each group explored the topic in greater detail and presented their conclusions for discussion with all participants. Finally, participants classified the seven research topics into two priority classes (highest priority and high priority), based on what could be addressed most immediately and would provide the greatest advance in knowledge. The voting resulted in the following array of priority topics:

Highest priority topics:

- Retrospective analyses to examine spatial and temporal patterns
- Breeding season demographic rates in the boreal forest
- Habitat changes in the western boreal forest habitat affecting vital rates
- Scaup harvest management

High priority topics:

- Obtain unbiased estimates of breeding propensity
- Factors influencing adult survival
- Changes in winter or spring migration habitat: implications for survival and cross-seasonal effects

This array reflected the relative importance of each of these topics within a larger list. Detailed discussion of these seven topics is presented below.

- **Retrospective analyses to examine spatial and temporal patterns.–**Analyses of existing data were considered the most immediate research need because results are critical to informing hypothesis generation, orienting collaborative research projects, and supporting funding proposals. A major step forward will be to examine spring breeding population data for spatial and temporal correlations in population trends between scaup and other waterfowl taxa at multiple scales. Patterns of covariation (or lack thereof) between populations should be interpreted relative to similarities and differences in life history traits and spatial distribution throughout the annual cycle. This may yield insight into the location and scale of factors limiting scaup. These analyses should be followed by analyses targeting underlying mechanisms. Specifically, climatic and remotely-sensed data on landscape characteristics are available with wide temporal and geographic scope and, when combined with results from breeding population data, may yield further insight into processes driving patterns observed in distribution and trends of waterfowl. Finally, we need to explore the extent to which harvest, midwinter inventory, and long-term local data sets can further inform our thinking about limiting factors.

- **Breeding season demographic rates in the boreal forest.–**Long-term declines in age ratios of scaup suggest that population declines reflect breeding season events, even if the reproductive failure has cross-seasonal components. While current estimates of breeding propensity for boreal scaup are practically non-existent, recent boreal studies suggest that nest success and brood survival are generally low but have much temporal variation. Retrospective analyses show substantial spatial variation in breeding population estimates of scaup across the boreal forest. Therefore, we recommend that research contrast breeding performance within differing geographic regions; this reiterates recommendations of the 1998 workshop. This approach would rely on retrospective analyses to find 2–3 replicate areas where boreal breeding populations have 1) changed from historic high densities to current low densities; 2) changed from historic low densities to current high densities (perhaps not an available change); and 3) are stable (historically and currently high densities). Long-term data from such sites are needed to understand inter-annual variability in vital rate estimates. We believe that such a geographic contrast of demographic rates would reveal the key vital rates influencing productivity and, with adequate ancillary studies, could help assess the relative contribution of bottom-up (e.g., changes in habitat availability, quality, and timing) and top-down (e.g., predator-prey interactions) regulation of scaup populations. Where possible, an experimental approach should be used to examine influences of bottom-up or top-down factors. Integration and coordination among studies will be essential to most effectively advance our knowledge

on the factors influencing demographic rates in the boreal forest.

- **Habitat changes in the western boreal forest affecting vital rates.–**The western boreal forest (WBF) provides both staging and breeding habitat for scaup. Retrospective analyses suggest that some major limiting factors may be acting there, particularly in the Northwest Territories. While southern portions of the WBF are undergoing rapid industrialization, oil and gas interests in the northern WBF are poised for or are undergoing considerable expansion. Overlaid on these sources of direct anthropogenic change is dramatic warming in northern regions. This temperature rise is associated with both climate change and the North Pacific Decadal Oscillation, has been implicated in wetland ecosystem change and habitat loss in boreal Alaska, and also may influence boreal wetlands in western Canada. Therefore, we must answer the following questions: 1) what is the spatial extent of wetland ecosystem change and loss across the boreal forest, 2) how does prey abundance and community structure vary across wetland types and influence both site selection and productivity of scaup, and 3) how do different wetland prey communities and wetland types vary in their susceptibility to effects of climate warming and changes in surrounding land use?

- **Scaup Harvest Management.–**We focused our discussion on the need to identify and reduce the key sources of uncertainty relative to the development of an informed decision-making framework for scaup harvest management. We evaluated the strengths and weaknesses of the available monitoring information describing population and harvest dynamics of scaup and the gaps in our current knowledge of scaup harvest potential. In addition, we discussed several assumptions of the current assessment framework, focusing on issues involving breeding population and harvest scaling and model uncertainty. These discussions highlighted the need to explore the following: 1) evaluate sources of uncertainty in scaup harvest potential; 2) assess the value of using harvest age ratios to support harvest management decisions; 3) assess the precision and bias in scaup harvest data; and 4) assess the potential value of preseason banding, versus its cost, for harvest management.

- **Obtain unbiased estimates of breeding propensity.–**Breeding propensity (the likelihood that a female will lay at least one egg in a given year) is the demographic rate that we know least about yet may be most likely to be influenced by cross-seasonal effects (*see* Changes in winter or spring migration habitat, below). Most population models assume a high and constant breeding propensity. However, we have reason to be concerned about scaup breeding propensity. If breeding propensity is low or varies appreciably, it could be an important factor regulating population growth rates. Before mechanisms contributing to variation in this parameter can be understood, several questions about how to attain unbiased estimates of breeding propensity need to be addressed: 1) is a bird's decision to breed made in multiple stages and, if so, when and where are birds at each critical stage and what are the thresholds required to pass to the next stage? 2) do all non-breeding females reach breeding areas, and if not where do they go? 3) how long after mean nest initiation can examination of post-ovulatory follicles (POF) accurately identify females that laid at least one egg? 4) when and where can an unbiased sample of females be secured to examine POF? and 5) how useful are other potential methods for assessing breeding propensity (e.g., blood chemistry, radio marking, and mark-resighting)? Once unbiased measures of breeding propensity are developed, studies are needed to investigate what factors affect age-specific breeding propensity, including: 1) local breeding habitat conditions, 2) winter and spring migration habitat, 3) body condition (upon arrival or during migration), 4) disease (pathogens, contaminants and parasites), 5) weather, 6) breeding

population density, 7) migration distance, 8) population sex ratio, 9) date of hatch, and 10) duckling growth rate.

- **Factors influencing adult survival.–** Current estimates of annual adult survival are lacking for the continental and regional level, although some estimates are available for some local breeding areas and one wintering area. The quality and quantity of data supporting local survival estimates for breeding females are mixed and spatially limited. Overall, however, existing data suggest that breeding season survival of adult females is low and variable. Survival data from banding and marking studies, including satellite telemetry, are critically needed to estimate contemporary annual and seasonal survival. Data need to be collected concurrently across multiple areas that are representative of differing habitats or rates of population change. A geographic contrast approach, similar to that suggested above for productivity, would help address spatial and temporal patterns in adult survival. Intensive field studies are needed to address specific factors influencing seasonal survival rates.

- **Changes in winter or spring migration habitat: Implications for survival and cross-seasonal effects.–**Eighty-six percent of the continental scaup winters in the Mississippi, Central, and Atlantic Flyways, often in urbanized or industrialized areas. Large portions of these wintering populations likely migrate through areas common to these flyways, particularly through the Great Lakes, upper Midwestern United States (Iowa, Minnesota, and South and North Dakota), and prairie and boreal Canada. Reduced habitat availability and quality along the Atlantic Coast, upper Midwestern United States, and Great Lakes have occurred concurrent with an apparent decline in body condition of female lesser scaup migrating through the upper Midwest. Major wintering and early spring stopover areas (e.g., Pool 19 of the Mississippi River and Great Lakes) may be increasingly important for accumulation of nutrient reserves because of deteriorating habitat conditions elsewhere in the upper Midwestern United States. Thus, current information is required to better protect the availability and quality of these habitats. There are no data on migration ecology of scaup through prairie and boreal Canada. We need to evaluate spatial variation in food and habitat quality continentally to better understand how cumulative habitat changes (positive or negative) affect scaup energetic or migration strategies. Furthermore, we need to improve our understanding of how nutrient-reserve levels influence female survival during migration, breeding propensity, timing of breeding, and ultimately reproductive success. Reduced body condition during migration or upon arrival at breeding areas, changes in breeding habitat, and health issues (pathogens, contaminants, and parasites) may have additive or interactive effects on reproductive success and need to be considered when evaluating the role of habitat change on population dynamics. Current information also is required on scaup winter and spring ecology in both freshwater and marine coastal areas to better protect these habitats.

Limitations and Opportunities

We have made advances in our understanding of factors limiting recovery of scaup populations and much of this progress has occurred through productive collaboration among researchers. Nevertheless, participants recognized that we must do better. A first step would be to agree upon a common set of research objectives and field techniques for similar projects. Another step would be to seek novel partnerships outside the waterfowl world, such as with climatologists, hydrologists and landscape ecologists. Such affiliations will help ensure a broad-minded, strategic approach to scaup research permitting landscape-level inference. Such collaborations also will encourage development of multi-partner and multi-disciplinary project proposals that may be more successful in surmounting a key limitation to scaup research – securing adequate funding.

Workshop participants outlined eleven directions for marketing scaup research and generally agreed that declining scaup populations alone will not motivate people outside the waterfowl community. The general public, hence many funding agencies, may be more responsive to umbrella issues like declining water quality that have direct implications for their lives. Scaup research proposals should be linked with these big issues. For example, promoting scaup as potential indicators of ecosystem health may be attractive to diverse organizations interested in environmental health and sustainable land-use practices. However, this view must be marketed on a project – specific basis, meaning that an expectation for non-earmarked money for "scaup research" in general is unrealistic.

Maximizing Momentum

Workshop participants concluded that synthesizing recent findings in a group setting was critical for advancing our understanding of constraints on scaup, but gathering once every seven years was inadequate for maintaining momentum. Clearly, scaup issues need a forum to foster communication and coordination among researchers and managers, integrate new results, discuss emerging issues, and keep scaup at the forefront of management concerns. Although these activities have occurred collectively, participants agreed that this need would best be served by an official Scaup Action Group under the North American Waterfowl Management Plan, modeled in part after the Pintail Action Group formed in 2003. Such a group could help ensure that scaup issues are integrated with Joint Venture and Flyway objectives and may, via endorsement, lend additional weight to scaup funding proposals. A scoping committee was formed to further explore this idea and develop a draft prospectus for review in August 2006 at the Fourth Duck Symposium.

Closing Remarks

The 1998 Scaup Workshop left us with a list of hypotheses about their decline and undoubtedly spurred scaup research, which we have conducted somewhat independently and by cobbling together small amounts of new funds. The synthesis of these findings at the 2006 Bismarck meeting has allowed us to re-evaluate competing hypotheses and set renewed direction for research and management, including ways to promote future coordination among programs. This coordination is critical to the challenge ahead: rapidly identifying management actions that allow us to slow, halt, or, most hopefully, reverse the scaup decline.

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This consensus report reflects the professional wisdom of the scientists and managers at the Scaup Workshop and not necessarily the institutions or agencies in which they are employed, nor does it represent official policies of the U.S. Geological Survey.

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