High selenium burdens found in adult female Lesser and Greater Scaup collected on the lower Great Lakes.

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Since the mid-1980s the combined continental population of Lesser (*Aythya affinis*) and Greater Scaup (*Aythya marila*)(hereafter scaup) has declined substantially. Several hypotheses for this decline have been tabled, and a number of these are presently being tested. One cause for concern has been the substantial increase in the number of scaup staging on portions of the lower Great Lakes and the fact that these birds have switched to a diet dominated by zebra mussels (*Dreissena polymorpha*)(Hamilton and Ankney 1994, Petrie and Knapton 1999). Zebra mussels are filter feeders and they incorporate and accumulate sediment and water-associated contaminants into their tissue more readily than do native Great Lakes bivalves (de Kock and Bowmer 1993, Fisher et al. 1993, Swackhamer and Skoglund 1993, Brieger and Hunter 1993). Contaminants can subsequently be passed up the food chain to waterfowl that consume these mussels. For instance, the results of feeding captive Tufted Ducks (*A. Fuligula*) contaminated zebra mussels included: high contaminant levels in liver tissue; reduced kidney weights; disturbed vitamin A production; behavioural deviations; fewer and smaller eggs per nest; accumulation of organochlorines in eggs; reduced hatchability; lower chick weights and female mortality at the start of the breeding season (de Kock and Bowmer 1993). Therefore, consumption of large quantities of zebra mussels on the lower Great Lakes may be contributing to the continental scaup decline.

In response to this concern, the Long Point Waterfowl and Wetlands Research Fund (LPWWRF) embarked on a study of Lesser and Greater Scaup contaminant burdens, nutrient reserve dynamics and dietary intake on the lower Great Lakes in 1999. LPWWRF collected scaup on lakes Ontario, Erie and St. Clair during the fall of 1999 and spring of 2000 (n = 800 birds). All birds have been dissected and are presently being analyzed for 1) types and levels of contaminants and metals within liver tissue, 2) body condition (levels of fat, protein and ash), and 3) dietary intake.

Selenium was identified by Custer and Custer (2000) as being in an elevated to potentially harmful range in Lesser Scaup collected in western Lake Erie and Lake St. Clair in 1991 and 1993. Because they did not study Greater Scaup, and their Lesser Scaup sample included only three adult females, we decided that selenium burdens in scaup staging on the lower Great Lakes warranted more attention.

Our initial analysis involved spring collected (early March through early May) adult female Lesser and Greater Scaup. All birds analyzed were collected from pairs and flocks. Female Lesser Scaup had selenium levels ranging from 1.8-56.4 μg/g dry weight. Birds from

Lake Ontario had the highest selenium burdens (= 22.0 µg/g, range = 19.9-56.4, n = 10), those from Lake Erie the lowest burdens (= 12.7 µg/g, range = 9.2-25.0, n = 10) and Lake St. Clair birds had intermediate burdens (= 16.7 µg/g, range = 1.8-32.9, n = 10), although between-lake differences were insignificant (P = 0.160). Greater Scaup had selenium burdens ranging from 19.0-59.7 µg/g (= 28.4 µg/g, n = 13, samples from all three lakes combined) and these were significantly higher than found in Lesser Scaup (P = 0.005). Levels in both Lesser and Greater Scaup are cause for concern, because concentrations in livers above 10 µg/g (dry weight) in ovulating Mallards is associated with reproductive impairment, and because concentrations above 33 µg/g (dry weight) can be considered harmful to the health of a bird (Heinz 1996). One hundred percent of adult female Greater Scaup and 77% of adult female Lesser Scaup that we have analyzed had selenium levels above the level at which reproductive impairment could be expected. Preliminary results indicate that there are positive correlations between body fat and collection date (r= 0.614, P = 0.001), body fat and selenium burdens (r= 0.499, P = 0.002), and selenium burdens and collection date (r= 0.294, P = 0.128) in spring collected Lesser Scaup. This suggests that scaup are acquiring selenium and body fat while staging on the lower Great Lakes in spring. In contrast, PCB and p,p - DDE levels were found to be generally below Lowest Observed Effect Levels (LOEL) established for other bird species.

What is selenium and why is considered to be a problem?

Selenium is a semi-metallic trace element occurring naturally in some soils; its also a byproduct of smelting operations, and other industrial activities. Although selenium is nutritionally required by birds in small amounts, it is highly toxic in slightly greater amounts. Selenium concentrations build quickly in tissues when birds are introduced to a selenium-contaminated diet (Heinz et al 1989). Selenium is also quickly excreted from the body when removed from a selenium-contaminated diet; females use the egg as a route of selenium excretion (Heinz et al 1989). Heinz et al. (1989) fed female mallards 10 µg/g of selenium. After six weeks, selenium in the liver averaged 7.4 µg/g wet weight (approximately 28 µg/g dry weight). However, selenium in the liver had nearly peaked after about one week.

Selenium can also increase rapidly in aquatic organisms, particularly in filter feeders such as zebra mussels. Field studies show that benthic invertebrates can accumulate 20 to 370 µg/g of selenium and still maintain stable, reproducing populations (Lemly 1996). These levels are somewhat alarming as Heinz et al. (1989) showed that reproduction in Mallards was impaired at a dietary concentration of 9 ug/g, with the effects threshold falling between 4 and 9 ug/g. Lemly (1996) recommended 3 µg/g as the toxic threshold for selenium in aquatic food-chain organisms consumed by fish and wildlife.

During 2002-03, LPWWRF will be analyzing additional Lesser and Greater Scaup samples, including birds collected during fall. We will also be analyzing tissues that were collected from scaup on Lake Ontario (Canadian Wildlife Service) prior to zebra mussel introduction, as well as zebra mussels themselves. This should enable us to determine if there is in fact a link between selenium burdens in scaup on the lower Great Lakes and zebra mussel consumption. We hypothesize that while selenium inputs to the lower Great Lakes may not have increased substantially over the past 15 years, zebra mussels, through filter feeding and bioaccumulation, have concentrated selenium in their tissues, thereby increasing the availability of this semi-metallic trace element to certain species of waterfowl. Due to the large numbers of Lesser and Greater Scaup staging on the lower Great Lakes, where zebra mussels are readily available, this may be contributing to the continental decline of the combined populations of scaup.

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