Mortality in Tundra Swans
Cygnus columbianus

JAMES C. BARTONEK, JEROME R. SERIE
and KATHRYN A. CONVERSE

Our paper identifies and examines the significance of hunting and non-hunting mortality affecting the Eastern Population (EP) and Western Population (WP) (see Serie & Bartonek 1991a) of Tundra Swans. Sport hunting (Serie & Bartonek 1991b), native subsistence hunting (Copp 1989, Stewart & Bernier 1989), malicious shooting (McKelvey & MacNeill 1981), avian cholera (Friend et al. 1981, Schroeder 1983), ecto- and endoparasites (Trauger & Bartonek 1977, Woebeser 1981), lead poisoning (Sherwood 1960, Friend et al. 1981), collision (Willard 1978), and drowning (Miller et al. 1986) have been documented as being direct or indirect causes of mortality in fledged Tundra Swans; but their relative importance remains unknown.

Hunting Mortality

Hunting is a well documented cause of death in swans because there are obligatory harvest surveys for the special Tundra Swan *Cygnus columbianus* hunting seasons. The average estimate of swans killed (retrieved and unretrieved, combined) is 2,919 EP (1986-88) and 1,290 WP swans (1979-88), approximately 3% and 2%, respectively, of the average 1987-89 preseason wintering populations (Serie & Bartonek 1991a, 1991b). Hunt plans for EP and WP swans consider hunting as an additive form of mortality; however, to date, this mortality is not limiting the overall status of either population (Serie & Bartonek 1991a).

Hunter preference, juvenile vulnerability, or both factors, result in the kill of a disproportionately greater number of young swans than observed in the population (Serie & Bartonek 1991b). During 1979-88, hunters killed an average of 26% (EP) and 38% (WP) grey-plumaged swans compared to fall population estimates of 16% (EP) and 31% (WP) juveniles. This harvest selectivity for juveniles in the population directs hunting pressure away from the adults and subadults creating higher survival rates in these age classes with greater potential for recruiting birds to the population.

Swans are killed illegally outside the special hunting seasons by incidental shooting during other waterfowl seasons, subsistence hunting and vandalised shooting. Collectively, we estimate this unregulated harvest to be between 6,000 to 10,000 swans, annually. EP Swans are killed on Canadian breeding grounds by subsistence hunters (Stewart & Bernier 1989). The size of that kill is not well measured but is believed to be proportionally much less than WP swans killed in western Alaska. There have been several attempts to measure subsistence harvests of waterfowl. Perhaps the best perspective on native subsistence harvests of waterfowl comes from Copp's (1989) survey of over 600 households from 18 communities on the Yukon-Kuskokwin Delta in Alaska during 1986-87 to determine the role of subsistence hunting in the declines in certain populations of Alaska-nesting geese. Using subsistence waterfowl harvests, Copp estimated 5,363 (1986) and 6,721 (1987) WP Tundra Swans were taken spring through early fall; approximately two-thirds of the swans were killed prior to mid-summer. In addition, 505 (1986) and 266 (1987) swan eggs were estimated to have been collected. More WP swans are taken in subsistence harvests during spring and summer on the Yukon-Kuskokwim Delta, where densities of both swans and humans are relatively high, than in any other area of Alaska or Canada where subsistence hunting occurs. Cooch (1986) believes that subsistence hunting does not unduly stress widely dispersed colonies of geese nesting in Arctic Canada. Hunting pressure there appears reduced from that which might be expected in western Alaska because the human populations are generally smaller or farther away. We believe the conditions present during subsistence harvest of EP swans to be similar to that for geese.

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Non-Hunting Mortality

The US Fish and Wildlife Service's National Wildlife Health Research Center (NWHR), in Madison, Wisconsin, receives wildlife found dead, sick, or injured from throughout North America. Carcasses or samples from dead and live animals are sent to NWHR for diagnostic examination. NWHR also maintains databases on diagnostic submissions and epizootic events in wildlife and all diagnostic specimens. Migratory birds, particularly waterfowl, constitute a majority of these diagnostic specimens and information in these epizootic records. Between December 1981 and December 1988, NWHR received reports of 53 mortality events involving swans and examined 171 carcasses and 221 tissues from 392 dead Tundra Swans. The major causes of death in 171 Tundra Swans submitted to the NWHR were: lead poisoning (29%), avian cholera (15%), trauma (8%), emaciation (8%), kidney dysfunctions (7%), aspergillosis (5%), necrotic enteritis (4%), parasites (2%), drowning and suffocation (2%), botulism (2%), and other (2%). The diagnosis remained undetermined in 12% of the swans. This mortality data on swans should be interpreted with caution, recognising three potential biases: (1) a particular specimen may represent an event involving just one bird or it may represent a sample of many birds involved in a major die-off; (2) mortalities in and around wildlife management areas and densely populated areas tend to be detected at a higher rate; and (3) for similar reasons, most swan specimens are collected during winter or in migration but not in summer on remote nesting grounds.

Lead poisoning, from ingesting spent lead shot or lead fishing sinkers, has long been known to be a cause of non-hunting mortality in both EP and WP swans during migration and on wintering areas (Wetmore 1919, Friend *et al.* 1981, Blus *et al.* 1989). Lead poisoning was the cause or suspected cause of death of 663 swans collected during lead poisoning die-offs. NWHR confirmed lead poisoning in 50 swans that represented 18 separate events and involved four EP states and five WP states.

Avian cholera caused by the bacterium *Pasteurella multocida* is an important disease among wintering WP swans; 2,640 swans were picked up during 17 avian cholera die-offs. NWHR confirmed or suspected avian cholera in 26 swans submitted from nine events in five states. During January and February 1975, 1,004 Tundra Swans died from cholera in California; between November 1987 and March 1988 another 1,100 swans died from avian cholera in California. There are no reports of avian cholera in EP swans; however, because outbreaks of this disease in other waterfowl species has occurred in EP states, swans remain at risk.

Separate traumatic events caused death to 14 swans from four EP States and five WP States; gunshot wounds were identified as the cause of trauma in at least nine swans. Some gunshot mortality occurred outside the hunting season for swans or in areas having no swan hunting seasons. Swans are reported to die after collision with transmission lines (Willard 1978); however, collision was not reported by NWHRC as a cause of trauma.

Drowning, while uncommon, can significantly impact local flocks. Miller *et al.* (1986) reported finding 135 Tundra Swan carcasses in sand at the mouth of the Eel River on the northern coast of California on 7 January 1985. The swans were presumed to have died from drowning or trauma from a strong surf. NWHR confirmed drowning in the two swans examined. This mortality represented about a fifth of the swans wintering in that locality.

We are unaware of any records of non-hunting mortality of fledged Tundra Swans during summer on the nesting grounds. However, Barry's (1967) observations of several avian predators and both small and large mammalian predators on the AndersonRiver Delta in Arctic Canada in relation to nesting geese, suggests that predation on Tundra Swans would likely be directed at eggs in unoccupied nests or at cygnets that have strayed. Cygnet mortality from exhaustion or starvation during sustained migration (Bartonek pers. obs.) is likely to be more important in years that cygnets develop late in the season or when available water freezes early than in years when conditions are more favourable for physical development and a later migration departure.

Summary

Causes of mortality are reported during winter and migration but not during the nesting season and summer; therefore, their relative importance cannot be quantified. Shooting is probably the most significant cause of mortality; over 4,000 swans are killed annually during regulated special hunting seasons and an estimated 6,000-10,000 during unregulated hunting. The leading causes of non-hunting mortality are lead poisoning, affecting swans nationwide, and

avian cholera, an important disease restricted to the WP. To better understand the population dynamics of this species, more information is needed on adult and cygnet mortality during the nesting season and annual productivity or breeding success must be better measured.

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James C. Bartonek, Pacific Flyway Representative, US Fish and Wildlife Service, Portland, Oregon, USA.
Jerome R. Serie, Atlantic Flyway Representative, US Fish and Wildlife Service, Laurel, Maryland, USA.
Kathryn A. Converse, Wildlife Disease Specialist, US Fish and Wildlife Service, Madison, Wisconsin, USA.