

Guest Editorial, part of a Special Feature on [Quantifying Human-related Mortality of Birds in Canada](#)

On Avian Mortality Associated with Human Activities

Mortalité aviaire liée aux activités humaines

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INTRODUCTION

This special feature of *Avian Conservation and Ecology* contains a Special Issue of ten articles describing extent and character of avian mortality in Canada associated with human activities. These include estimates of mortality resulting from mowing and other mechanical operations, industrial forestry, domestic cats, collisions with windows, wind turbines, power lines and vehicles, bycatch in commercial fisheries, and both offshore and terrestrial oil and gas exploration and production. These articles contain sector-based assessments of the annual magnitude of the number of eggs or active nests destroyed and number of birds killed as a consequence of a wide range of human activities, excluding habitat development and hunting. This Special Issue represents an unprecedented snapshot of the state of knowledge for such sources of mortality for an entire country at a specific time. Needless to say, numbers of such avian mortalities that can be attributed to humans are large and unevenly distributed among species and different activities.

Researchers and managers often consider human-related mortality of birds to be important only when bird deaths result in a decline of the population of a species (Mayfield 1967), or when a species is killed that is listed as endangered or otherwise protected by law. These standards are, however, inadequate to guide conservation. First, for many species, even large declines are challenging to detect with existing monitoring schemes. Second, the effects of a single stressor are almost impossible to parse unless the focus population is spatially restricted or extraordinarily well monitored. Third, the effects of human-related mortality on other species or on ecosystem processes (Wenny et al. 2011) are not even considered when the standard for action is a documented population decline.

The effects of human-related mortality on bird populations will differ depending on whether mortality is additive to natural mortality or compensatory (Anderson and Burnham

1976, Burnham and Anderson 1984). In the absence of density-dependent processes to stabilize a population, any additional source of mortality would result in decline to extinction. In many instances, however, density-dependent changes in survival, age at maturity, or fecundity compensate for additional mortality. In practice, the response of a population to an additional source of mortality can occur anywhere along a spectrum from an effect greater than additive (depensatory mortality; Liermann and Hilborn 2001) to overcompensation, where survival increases in response to a new cause of mortality, for example because of reduced effects of competition (Boyce et al. 1999, Zipkin et al. 2008).

Discriminating between additive and compensatory mortality is difficult even when monitoring data are extensive and the magnitude of additional mortality is well known (e.g., Schaub and Lebreton 2004, Sandercock et al. 2011). In the papers that follow, authors expended considerable effort to refine estimates of the magnitude of mortality to the extent possible based on the quality of the available data. Yet, in many instances, estimates of human-related mortality are still uncertain and are assessed at the level of taxonomic groups. The actual extent of mortality endured by individual species and, indeed, even the population size of these species, is rarely known with high certainty.

Despite this uncertainty, we can generalize about the likelihood of additional mortality being additive or compensatory. Complete compensation is possible only when additional human-related mortality is lower than natural mortality in its absence (Anderson and Burnham 1976). For example, Ellis et al. 2013 and Calvert et al. 2013 (this Special Feature) report 4% human-related mortality for the Canadian population of Black-footed Albatross. Current adult survival for this species is 92%, and the natural rate of mortality may be less than 5% per year (Véran et al. 2007), leaving little room to compensate for human-related mortality of 4%. In contrast, demographic parameters for many bird species suggest ample

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room for compensatory mortality: for example, predators destroy 50% or more of nests of many open-nesting species (Ricklefs 1969) and small passerines have life histories that accommodate high adult mortality (Wasser and Sherman 2010). The reduced capacity of long-lived, low fecundity species to withstand additional mortality is a pattern documented across a variety of taxa (reviewed in Sandercock et al. 2011), as compared to species with lower survival and higher fecundity.

Population size and status, timing of mortality, and temporal or intersexual variation in mortality can all affect the ability of populations to withstand additional mortality. Density-dependent natural survival is the putative mechanism driving the compensation, so populations at habitat carrying capacity should be more resilient to additional mortality than low density or declining populations (Nichols et al. 1984, Bartmann et al. 1992). Timing of the mortality event also may play a role; mortality is more likely to be additive when it occurs during or after periods of high natural mortality, and more likely to be compensatory when it precedes such periods (Kokko 2001). These generalizations suggest situations where mortality might be more or less likely to have significant effects on population status. Determining the actual demographic effects of such mortality, however, would require spatially explicit study of individual species. For most species, it is not possible to account for heterogeneity in survival between sexes and age classes, for dispersal, and for spatial structure in populations and mortality given the paucity of reliable data.

Dismissing human-related mortality as compensatory, even when populations are well monitored, is a risky bet. Researchers without adequate data can get it wrong. For example, the argument that the high mortality of American Black Duck from hunters was totally compensatory was wrong (Grandy 1983), as documented by Francis et al. (1998) who analyzed 44 years of banding data over three periods of increasingly restrictive harvest regulations and determined that estimated mean survival rates increased from the first to the second period consistent with a model of additivity of hunting mortality. Effects of some sources of mortality may take time to recognize, such as the slow-motion catastrophe for birds caused by second generation anticoagulant rodenticides (Thomas et al. 2011). Many sources of mortality also may work together cumulatively to suppress populations, and at different places across their life cycles (Loss et al. 2012). Assumptions about population-level effects may be misleading if analyzed at the national scale, which may mask effects that are significant at local levels but not evident at coarser spatial scales.

Perhaps more importantly, anthropogenic avian mortality affects more than just the species being killed. When considering effects of human activities on wildlife and

ecosystems, the “legacy effects” of habitat loss and degradation are often the focus. Unnatural removal of birds from the environment, however, can still affect ecosystems even if habitat remains intact. If a cat kills a bird, the bird is lost as prey for a raptor (George 1974). If a bird dies from impact against a window and is swept away in the garbage, it cannot be food for its natural decomposers. When a bird is killed as a nestling by a mowing machine, it is not alive to eat insects for several months until it might have otherwise died of natural causes during migration (Whelan et al. 2008). Birds’ perception of hazards on the landscape can also have important effects on behavior, with indirect but significant adverse consequences (Bonnington et al. 2013). Disturbance and incidental mortality can alter timing of breeding, habitat use, and foraging behavior—all with the potential to influence ecosystems and ecosystem services. All of these nuances are lost when the focus is only on direct effects on single-species population dynamics.

The value of these ecosystem services is not small and should not be underestimated (Wenny et al. 2011). For example, the natural build-up of fertile soil for agriculture, an ecosystem service dependent on a complex web of organisms, including birds, is estimated to have aggregate value of over \$17 trillion per year, nearly equivalent to the global Gross National Product (Costanza et al. 1997). Insectivorous birds exert top-down control on populations of invertebrates in many ecosystems, and crop yields are known to be higher in areas where bird populations control populations of herbivorous insects (reviewed in Whelan et al. 2008). In one example, birds raised the income at coffee plantations in Jamaica by \$75–310 per ha per year by controlling populations of crop pests (Kellermann et al. 2008, Johnson et al. 2010). The economic value of birds as dispersers of tree seeds has been estimated at \$2,000–\$9,000 per ha in Sweden (Hougnier et al. 2006) and the United States (Tombback, *unpublished data*, in Wenny et al. 2011). Larger still, given the observed costs to human and livestock health following the collapse of vulture populations in South Asia, the value of vultures’ services as scavengers was estimated at \$34 billion for the years 1993–2006 (Markandya et al. 2008). Many of the ecosystem services provided by birds have yet to be translated into economic terms, and scaling up from local examples such as these remains a challenge. The economic contributions made by birds through pest control, pollination, seed dispersal, and scavenging, however, are undoubtedly significant (Whelan et al. 2008, Wenny et al. 2011). Some species of birds also cause economic damage in agriculture and aquaculture, but neither the effects of human-related avian mortality on ecosystem services nor on these disservices is accounted for by single-species assessments that focus only on whether population-level effects are occurring.

Therefore, in reading and incorporating the contents of the papers that follow, we encourage managers and decision

makers not to insist on documented species population decline resulting from a single mortality source as the standard of evidence required before action. The world is more complicated than this, and even compensatory mortality has adverse effects on community structure and function. Instead, a precautionary approach is warranted (Cooney 2004), where best management practices to minimize avian mortality are encouraged or required of industries and activities. Improved monitoring and reporting, as advocated in this issue and elsewhere (Loss et al. 2012), and with greater taxonomic specificity (Longcore et al. 2013), is similarly essential. None of these information needs, however, should paralyze decisions to take actions to reduce anthropogenic mortality of birds or to educate the public to advocate for and to implement corrective measures.

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