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OVERVIEW

DISEASE EMERGENCE IN BIRDS: CHALLENGES FOR THE TWENTY-FIRST CENTURY

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THE PAPER BY Hartup et al. (2001) on House Finch (*Carpodacus mexicanus*) conjunctivitis is an example of the rapid geographic spread that can result from disease emergence in naïve populations. That event was neither novel nor transient relative to its occurrence or effects. Disease emergence and reemergence are hallmarks of the latter part of the twentieth century (Center for Disease Control 1994, Levins et al. 1994, DaSilva and Laccarino 1999, Gratz 1999). Current examples involving domestic animals include the problems in Europe with bovine spongiform encephalopathy (BSE, or "mad cow disease") (Brown 2001) and foot-and-mouth disease (FMD) (Kitching 1999). Human health has been affected by diseases caused by an array of viruses (Morse 1993, Nichol et al. 1993, Murphy and Nathanson 1994), bacteria (Dennis 1998, DaSilva and Laccarino 1999), rickettsia (Walker and Dumier 1996, Azad et al. 1997), protozoans (Tuerrant 1997, Saini et al. 2000), and metazoan parasites (Hildreth et al. 1991, Gubler 1998), as well as other causes. Acquired immune deficiency syndrome (AIDS) has received the most notoriety of those diseases (Hahn et al. 2000, Schwartlander et al. 2000). A similar pattern exists on a global scale for free-ranging wildlife populations (Table 1) (Friend 1994, 1995; Epstein et al. 1998, Daszak et al. 2000). However, in comparison to disease emergence affecting humans and domestic animals, response to emerging diseases of wildlife is generally superficial. We present concepts and data to support our contention that failure to adequately address disease emergence in free-ranging wildlife is resulting in a diminished capability to achieve and sustain desired geographic distributions and population abundance for species of wild birds, including some threatened and endangered avifauna.

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For clarity, we define *disease* and *disease emergence* in the context of our use of those terms because they are the focus of our comments. *Disease* is any departure from health (Guralnik 1982); that is, dysfunction contributing to physiological, physical, reproductive, behavioral, or other impairment that reduces the probability of survival of individuals. If enough individuals are affected, the collective effects can reduce the sustainability of the population. Although disease can result from exposure to a wide variety of physical, chemical, and biological agents and other conditions, we focus this paper on microbes and parasites and to overt mortality caused by them. Thus, disease effects presented only represent the proverbial "tip of the iceberg" relative to the challenges wild avifauna face from disease. Our perspective of *disease emergence* expands the earlier definitions of emerging diseases by others (Centers for Disease Control and Prevention 1994, Morse 1995) to include all species. Our comments are defined by the context of disease occurrences that have increased within the past three decades, or threaten to increase in the near future relative to populations affected, geographic distribution, or magnitude of effects.

DISEASE EFFECTS

Haldane (1949) cited by May (1988) stated ". . . infectious diseases have undoubtedly been the main agents of morbidity and mortality (and thus the dominant selective factors) in human populations at least for the past 10,000 years." Support for the continued dominance of microbes and protozoan and metazoan parasites over humankind can be found in the writings of such notable scholars as McNeill (1976) and Lederberg (1988, 1993, 1997).

It is folly to think that wild birds and other wildlife are less susceptible to the influences of disease than humans and domestic animals. Nevertheless, ". . . ecologists and evolutionary

TABLE 4. Examples of single event losses of wild birds due to avian botulism (*Clostridium botulinum* type C) and avian cholera (*Pasteurella multocida*).

Year	Geographic location	Primary taxa affected[a]	Losses[b]
Avian botulism			
1980	Utah, USA (Bear River Marshes, Box Elder Co.)	Anatidae	105,000[c]
1982	Caspian Sea, Russia (Guryev Region, Kazachstan)	Anatidae	1,000,000[d]
1995	Alberta, Canada (Pakowki Lake)	Anatidae	(>100,000)[e]
1996	Saskatchewan, Canada (Old Wives Lake)	Anatidae	134,000[e]
1997	Saskatechwan, Canada (Old Wives Lake)	Anatidae	1,000,000[e]
1997	Utah, USA (Bear River Marshes, Box Elder Co.)	Anatidae	500,000[e]
Avian cholera			
1970	Maryland, USA (Chesapeake Bay)	Anatidae	88,000[f,g]
1978	Maryland, USA (Chesapeake Bay)	Anatidae	(31,295)[h]
1980	Nebraska, USA (Rainwater Basins)	Anatidae	80,000[c,i]
1982	Nebraska, USA (Rainwater Basins)	Anatidae	32,800–36,300[i]
1995	Northwest Territories, Canada (Egg River Colony, Banks Island)	Anatidae	30,000[k]
1998	Utah, USA (Great Salt Lake, Salt Lake Co.)	Podicipedidae, Anatidae	50,000[e]

[a] Although Anatidae is the primary taxa affected by avian botulism, large numbers of shorebirds (*Scolopacidae*), American Coot (*Rallidae*) and Recorvirostridae (American Avocets, *Recurvirostra americana*, and Black-Necked Stilts, *Himantopus mexicanus*) also commonly die during avian botulism epizootics.

[b] Estimated losses and (carcasses retrieved = minimum losses).

[c] Data from U.S. Geological Survey, National Wildlife Health Center Epizootiology Database.

[d] Kuznetsov 1992.

[e] Ball et al. 1998.

[f] National Wildlife Federation 1970.

[g] Locke et al. 1970.

[h] Montgomery et al. 1980.

[i] Brand 1984.

[j] Hurt et al. 1963.

[k] Samuel et al. 1999.

cations, and reports and other actions focused on combating that problem on behalf of human health. The economic effects of emerging diseases such as BSE and FMD are enormous and demand aggressive efforts to combat the emergence of not only those diseases, but also other emerging diseases that threaten the products of agriculture needed to provide food and fiber for a continually expanding human population and global economy.

We have provided testimony of the biological effects for avifauna of emerging disease, a situation that also extends to other species and groups of free-ranging wildlife. Our testimony deals only with the tip of the iceberg rather than the full effect of disease emergence. The true cost from disease is associated with the chronic attrition that occurs from the broad spectrum of diseases present, rather than from the high-visibility events that generate media attention and transient crisis responses from the conservation community. In addition, the magnitude of losses from some disease events can be of sufficient severity to challenge the ability of already diminished avian populations to overcome those single-event losses.

If disease emergence is not aggressively addressed on behalf of avifauna, the resulting effects will extend beyond the biological to social and economic losses as well. Consider for example the potential effects of significant reductions of scavenger species such as vultures in India and crows in the United States on the removal of carcasses; revenue lost from ecotour-