IMPACTS OF ACID RAIN ON AQUATIC BIRDS*

A. W. DIAMOND**

National Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario K1A OH3

(Received March 1989)

Abstract. Studies of toxicological and ecological effects of acidification on aquatic birds in Europe and North America are reviewed. Heavy metals are deposited by acid emissions, which also increase solubility and mobility of heavy metals in soil and water. Aluminium is leached from soil and mobilized from lake sediments under acid conditions; it removes susceptible fish and invertebrate species and contaminates remaining invertebrates. It is not highly toxic to birds, but may interfere with their regulation of calcium and phosphorus. Mercury is concentrated as methylmercury in fish tissues, and tends to be biomagnified in aquatic food chains. Experimental studies have demonstrated negative effects on reproduction of birds, and wild Common Loons Gavia immer breed less successfully in territories contaminated by mercury.

The clearest demonstrable effect of acidification on aquatic birds is the disruption of their food chains. The loss of invertebrates and fish affects both the food-webs and the predators and competitors of aquatic birds. Cyprinid fish are important food resources for fish-eating birds, in Europe as well as North America, and are particularly sensitive to acidification. Fish-eating waterfowl in Ontario are scarcer, and breed less successfully, in areas of high acidic deposition. Experimental studies of imprinted young Black Duck Anas rubripes showed that they grew more slowly on acidic lakes, apparently due to competition from acid-tolerant fish for a reduced invertebrate resource. Negative effects of acidified habitats on growth and reproduction, again through depletion of the food-web, have also been demonstrated in field studies of Tree Swallows Tachycineta bicolor and European Dippers Cinclus cinclus.

Introduction

Although birds may not be affected directly by acid deposition, the fish and aquatic invertebrates on which they feed do suffer direct effects, so the birds are vulnerable through changes to their food supply. Birds are likely to be affected through their food-webs in two ways (Figure 1): toxicologically, as prey species absorb toxic metals released by acidity and pass them on up the food-chain to the birds; and ecologically, by changes in the species composition of the prey communities of the food-web, as prey species which are sensitive to acidification are replaced by those which tolerate it.

Toxicological Effects

Acid deposition increases the exposure of wildlife to toxic metals in two ways. The acidic emissions themselves contain metals, which are deposited along with the acids; and acidification increases the solubility and mobility in soil and water of metals, including those which are potentially highly toxic to wildlife such as cadmium and

** Present address: Prairie and Northern Wildlife Centre, Canadian Wildlife Service, Saskatoon, Saskatchewan S7N OX4, Canada.

lead (Schindler et al., 1980). Acidification also increases the biological availability of methylmercury, the organic form of mercury which is most readily absorbed and is also highly toxic (Wood 1985). The levels of methylmercury which are normally found in prey from acidified environments are rarely high enough to be acutely toxic to birds; they pose a threat instead through their long-term low-level (i.e. chronic) effects (Scheuhammer, pers. com.; see also Scheuhammer, 1987a,b; Wiener, 1987). The metals generally considered to be the most significant in terms of their toxicology and their association with acidification are mercury, cadmium, lead and aluminum (Scheuhammer, 1987a,b). The chronic toxicity of these metals is reviewed in detail by Scheuhammer (1987a). In this review I will concentrate on aluminum and mercury because more is known about the effects of these metals on birds in acidified environments.

In practice we can rarely distinguish losses of prey species due to elevated metal concentrations from losses due to other changes associated with increased acidity, or to the increased acidity itself, so further discussion of ecological changes in