A Review of Climate Change Impacts on Birds[1]

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Abstract

Regions of the world with high coastal zone biological productivity often support large numbers of birds. Important sources of this productivity are oceanographic upwelling created by winds and ocean currents, and runoff from the land. It is suggested that climate change effects on winds and ocean currents will potentially affect the timing and magnitude of coastal biological productivity, and that bird populations will seek new levels and distributions in response to these changes. We are at an early stage in projecting trends. However, ecological responses to climate change are clearly visible which underscores the importance of basic research into ecological processes that support birds in coastal environments, and to provide advice on how to mitigate against the impact of climate change.

Key words: climate change, climate variability, ENSO, global warming, PDO, waterbirds.

There is ample evidence that global climate change has already had a detectable effect on terrestrial and marine environments (reviewed by Walther et al. 2002). Two issues for us to consider are which species will be most sensitive to climate change and what actions should we take? In this paper, we examine how birds have adapted to natural fluctuations in climate to understand which bird groups might be most at risk to climate change, and propose some actions we might take to ameliorate the future impact of climate change on birds.

Many birds have evolved adaptations in response to climate fluctuations. One of the most studied systems is the north Pacific Ocean where climate variability over the past 400 years has been characterized by a 2-8 year El Niño-Southern Oscillation (ENSO) cycle, a 20-40 year interdecadal oscillation, and 60-80 year multi-year oscillation (reviewed by Ware and Thomson 2000). Emerging from these studies is evidence suggesting that the ENSO intensified in the late 20th century, and North American droughts were far more severe in the 16th century than in the 'Dirty Thirties' (Woodhouse and Overpeck 1998). Biological studies in North America and Australia indicate that waterfowl either postpone breeding or move to other regions in drought years (Batt et al. 1989, Norman and Nicholls 1991, Bethke and Nudds 1995).

Climate variability also affects bird distribution and abundance indirectly through trophic level impacts on food availability. Some of the best examples are the population changes in seabirds in relation to ocean productivity (e.g., Briggs et al. 1984, Ainley et al. 1988, Ainley and Boekelheide 1990, Duffy 1993, Springer et al. 1999, Kitaysky and Golubova 2000, Bertram et al. 2001, Hedd et al. 2002). Ocean productivity has naturally occurring seasonal, decadal and multi-decadal oscillations (Ware and Thomson 2000). During ENSO years, some seabirds postpone reproduction and incur higher mortality than in non-ENSO years (Duffy 1993).

The link between ocean processes and seabird nesting success and survival is now being extended to other species of birds. For example, the world-wide distribution and abundance of shorebirds has been shown to be positively related to the strength of coastal zone productivity in waters adjacent to the coastal habitats where they spend the winter (Butler et al. 2001). These authors suggested that shorebird behavior, physiology, and the choice of migration pathways evolved in response to the spacing of rich foraging habitats created in part by coastal zone productivity. Taken together, these diverse studies of bird groups with very different life histories and from disparate parts of the world, suggest that the climate has always played a large role in the distribution, abundance and ultimately the evolution of many waterbirds.

The mechanism that links waterbird abundance to climate processes is likely associated with nutrient availability in the food chain. At-sea studies suggests that the availability of nitrates carried by ocean currents and up welling is a key feature of plankton growth and the prey species eaten by seabirds (Springer et al. 1999). In the tropics, the presence of small fish and invertebrates on beaches in Panama coincide with the time of year of ocean upwelling of phosphates in local waters (Kwiecinski and Chial 1983, Delgado 1998). These

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studies suggest that ocean processes are an important component in the temporal and spatial distribution and abundance of many marine birds. Timescale climate variations in the North Pacific Ocean have been recognized as having world-wide effects (Ware and Thomson 2000). This suggests that fluctuations in climate might alter the spatial and temporal distribution of many birds (Walther et al. 2002).

Conservation response to climate change should address means to ensure adequate habitats are available and mitigating against climate change impact on ecological processes that support birds. Species groups that are likely most at risk from habitat loss are species that are restricted to island, alpine and coastal beaches backed by dikes. Similarly, tundra-nesting species are vulnerable to encroachment of southern, incompatible habitats and species. Coastal-dwelling species that depend on beaches backed by impregnable dikes will lose habitat as sea level rises. For other species with room to move, it is also imperative that suitable habitat is made available for populations to recover in good years, and that refugia be identified for the survivors in poor years. Specifically, ensuring that breeding colonies remain for seabirds is an important policy and we need to discover where non-breeding populations go during ENSO events.

Waterfowl populations appear to closely track periods of precipitation. The conservation policy of the North American Waterfowl Plan correctly aims at providing sufficient habitat for populations to recover when wet years fill dried ponds. Ponds that are present during dry years might become refuges during droughts. Most of the world's shorebirds spend the winter in tropical or sub-tropical environments (Hayman et al. 1986). We need to know how ENSO events affect those populations and if there are refugia during ENSO events. For example, estuaries and bays might be less affected by ENSO events and hence provide refuge to shorebirds from other coastal habitats.

Our review indicates that climate change will likely result in increased fluctuations in biological productivity, which will be reflected in the numbers of seabirds, shorebirds and waterfowl. In the case of waterfowl and shorebirds residing in freshwater habitats, it is important to ensure that adequate dried out ponds during dry years remain in place for the recovery of breeding populations in wet years. In addition, it is important to secure areas used as refugia during periods of climatic uncertainty.

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