

Population limitation in migratory birds

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Many migratory bird populations are declining, but before conservation action is taken, it is important to know where the main limitation on numbers is occurring. Changes in the numbers of migratory birds, either long-term or year-to-year, may be caused by conditions in the breeding or non-breeding areas. The strongest driver of numerical change is provided in whichever area the effects of adverse factors on *per capita* fecundity or survival are greatest. Examples are given of some bird species whose numbers have changed in association with conditions in breeding areas, and of others whose numbers have changed in association with conditions in wintering areas, either year-to-year or long-term. In some species, the habitats occupied in breeding or wintering areas, and their associated food supplies, can influence the body condition, migration dates and subsequent breeding success of individual migrants. Similarly, poor weather and stress during breeding can lower the body condition of breeders, and reduce their subsequent survival, as 'carry-over' effects. Evidence is also reviewed on the effects of conditions at stopover sites on migratory bird populations. Competition for restricted food supplies at such sites can reduce fuelling rates, migration speed, and subsequent breeding and survival of migrants, sometimes affecting their subsequent breeding numbers. In addition, disturbance caused by natural predators or people at stopover sites can sometimes lower the food intake of birds, and in some populations of geese has proved sufficient to reduce subsequent breeding rates. Mass mortality events among migrants, attributed to adverse weather, have included: (1) in-flight losses, caused by storms and other adverse weather en route, (b) unseasonable cold weather soon after arrival in breeding areas, and (3) unseasonable cold weather just before departure from breeding areas. Records of in-flight weather-induced mortality, involving up to hundreds or thousands of birds at a time, have affected mainly small passerines, but also larger birds, including eagles and swans.