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Kirtland's Warblers benefit from large forest tracts.—There is growing recognition that some songbirds prosper only on tracts of suitable habitat larger than logic would suggest—that is, larger than the total of their defended territories. Recent declines in some American songbirds have focused attention on the role of forest fragmentation, especially among Neotropical migrants (Askins et al. 1990). The Kirtland's Warbler (*Dendroica kirtlandii*) provides a prime example. Present evidence suggests that major increases in the population of this species have resulted from the sudden availability of very large tracts of suitable habitat on the nesting grounds. Very large forest fires that have produced vast areas of young jack pine (*Pinus banksiana*) repeatedly have resulted in increases in the bird's population over more than a century.

This history began in 1871. In that year, "an empire burned" in the pinelands of the Great Lakes states (Pyne 1982). In the heart of the Kirtland's Warbler nesting range in Michigan more than 500,000 ha burned. This unprecedented fire provided an enormous increase in nesting habitat for the warbler. Indeed, this fire, and the lumbering before and after it, largely transformed the original white pine (*P. strobus*) forests into jack pine on the sandy uplands of northern Michigan (Zimmerman 1956). In a little more than ten years after the 1871 fire, Kirtland's Warbler became more numerous in winter and in migration than ever before or since.

The best evidence for the warbler population in that period was in the Bahama Islands, where the bird winters. Here Henry Bryant collected assiduously in winter and spring of 1859 and 1866 without finding any Kirtland's Warblers. All of this changed in the 1880s and 1890s, however, when visitors found the warblers on virtually all the islands. They brought back 63 specimens between 1879 and 1897. Charles Maynard took 24 specimens from one area of New Providence Island in 1884 (Mayfield 1960). In contrast, many more searchers with better binoculars have had difficulty finding the species in winter in recent decades. The few sight records usually have been of single birds seen briefly.

Also in the 1880s and 1890s, although bird watchers were few, they found several spring migrants, verified by specimens, as far west as Missouri and Minnesota, where they have not been seen since. A larger population should produce more migratory strays. The few records over the last century in the southeastern states give some insight into the route traveled but not the size of the population (Mayfield 1960).

No precise measurement of the population existed until 1951, when a count on the nesting ground showed 432 singing males (about 25% greater than recently). One half of these came from the sites of two fires, one of 12,500 ha in 1933 and one of 11,300 ha in 1939 (Mitchell and Robson 1950).

Ten years later, in 1961, the census was repeated, and the population had increased 16% to 502 singing males. At this time the burned areas of 1933 and 1939 were still occupied by warblers, and a fire of 7500 ha in 1946 was now accounting for nearly a quarter of the population. Since that time the contribution from separate fires is hard to measure because extensive plantings of pines, sometimes overlapping burned tracts, are often used by nesting warblers. Between 1946 and 1980 there were no fires larger than 4000 ha within the nesting range.

The third decennial census, in 1971, revealed an alarming decrease of 60% from the 1961 count, to 201 singing males. Steps to help the bird were instituted. These included annual counts and removal of Brown-headed Cowbirds (*Molothrus ater*) from nesting sites. This brood parasite arrived in the region about 1880 and steadily became more numerous and damaging during the present century. Calculations predicted the extinction of the Kirtland's Warbler by 1980 if cowbirds were not restrained (Mayfield 1975). Beginning in 1972 effective cowbird control began, but the warbler population did not rebound as hoped. The numbers of warblers remained nearly flat over the next 20 years, varying between 167 and 242 males. In 1991 the first significant increase in decades raised the count to 347, with more than half the total from the new 11,300 ha Mack Lake burn of 1980, the largest fire in more than 50 years. This total increased to 397 in 1992. Please note, however, that only a fraction of a burned tract ordinarily produces habitat suited to Kirtland's Warblers (Mayfield 1992).

This is not to imply that major fires produce all the habitat used by the warbler. In most years, there are dozens of fires and clear-cuttings of various extent. These events affect nearly 200,000 ha of forest on which jack pine is the dominant tree. However, only a small fraction is suitable for the warbler at any one time, less than 10,000 ha at present. It would be useful to refine our estimate of available habitat, but this is difficult. Some tracts of marginal size that look acceptable to us are not occupied, and some that appear unsuitable attract nesting

warblers. Every student of the warbler since the discovery of the first nest in 1903 has remarked on areas that appeared similar to occupied tracts but had no warblers. For example, the warbler seldom nests on tracts less than 30 ha, but sometimes it does so. Also it seems not to use all the space available to it. It now nests on 21 sites in seven counties.

While it is clear that changes in the population of Kirtland's Warbler are affected by availability of large tracts of nesting habitat, we cannot ignore the problems of survival on the wintering grounds, where the bird spends more than half of each year. We know little of the bird's life in the Bahama Islands, but since the warbler population has been remarkably stable over the last 20 years, and the climate and vegetation there have changed little in centuries, we see no cause for alarm there at present. Attempts to clear the scrub forests and farm the thin soil reached their peak in the 1800s, and there is little evidence of deforestation on most of these islands at present (Mayfield 1992). The Bahamas are stable geologically and climatically, except for occasional hurricanes which may be devastating at the point of impact but hit only a few islands at one time. We have found no correlation between population size and the occurrence of hurricanes. Like many other warblers nesting in North America and wintering in the Neotropics, Kirtland's Warbler seems solitary in winter and may be affected by variations in food supply. Eyewitnesses reported heavy mortality among songbirds in the Bahamas during a drought in the winter of 1971-1972, with "bushels of dead birds" along the roadsides (Radabaugh 1974). During the 1980s, Lawrence Ryel and Duncan Evered (unpubl. data) separately found positive correlations between annual counts in Michigan and rainfall at Nassau in the Bahamas. The fluctuations have been modest, but we cannot discount possible serious effects from a series of dry winters.

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