KIRTLAND'S WARBLER AND ITS BAHAMA WINTERING GROUNDS

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The Kirtland's Warbler (*Dendroica kirtlandii*) has an extremely limited range, breeding solely in central Michigan and wintering only in the Bahama Islands. In addition, this warbler is a genuinely endangered species, with a total population that has declined from perhaps 1,000 individuals in 1951 and 1961 (Mayfield 1953, 1962) to about 400 in 1971–1973 (Mayfield, 1972a, 1973a, 1973b). The decline in the species in the last 10 to 20 years is certainly real, and factors most likely involved in it are: 1, the probably adverse effect of brood parasitism by the Brown-headed Cowbird (*Molothrus ater*); 2, a possibly inadequate amount of suitable breeding habitat; 3, a possible worsening of conditions on the wintering grounds in the Bahama Islands.

The first two factors are receiving adequate attention, at least judging from my experiences since becoming involved with the species in 1961. Consequently, I have concentrated on the third factor, as I recently had the good fortune of spending some time in the Bahamas. The following is a report on that venture.

WINTER RECORDS OF THE KIRTLAND'S WARBLER

The first clue that the Bahama Islands constituted the winter range of the Kirtland's Warbler came when a female was collected on Andros Island in 1879 (Cory, 1879). All winter records since then have been restricted to the Bahamas, and Van Tyne (1951, including map p. 540—also in Mayfield, 1960:38) gave a total of 71 specimens having been collected there. Of these, 66 were taken in the 14 year period, 1884–1897. After 1897, collections (and reliable sight records) dropped almost to the vanishing point.

In 1902 a specimen was collected on New Providence and another on Little Abaco (Bonhote, 1903). Maynard collected one on New Providence in 1913 and (possibly) another on the same island in 1915 (Van Tyne, 1951). A final specimen was taken on San Salvador (Watlings) in 1965 by Paulson (Mayfield, 1972b).

Van Tyne (1951) reported a sighting of a Kirtland's Warbler on Great Inagua by James Bond sometime in the period 1935–1940. Hundley (1967) lists the sighting of three on New Providence by Street in 1941. Challinor (1962) saw one on Hog Island (since renamed Paradise Island) in 1957. Since 1959 there has been a steady trickling of sightings on Grand Bahama, by groups from the Florida Audubon Society. From 1959 through 1966 they

sighted 13 Kirtland's Warblers on Grand Bahama, as well as two on Eleuthera (Hundley, 1967). Andrew Paterson (pers. comm.) saw three on Andros during a 3½ year residence ending in May 1971. Dr. John T. Emlen, Jr. (pers. comm.) saw one on Andros in 1970. Dr. Paul Fluck has observed at least five on Grand Bahama since taking up residence there in 1969. Fluck caught two of these in mist nets and banded them. To my knowledge he is the only person to have banded this species on its wintering grounds.

It seems obvious that the species was considerably more numerous in the 1880's and 1890's—as inferred from the collections in the Bahamas. It is thought that the population rose in that period in response to an increase in habitat. This was brought about by the forest fires which followed the lumbering operations in Michigan, which were at their height in the period 1875–1900. Furthermore, perhaps this increase was relatively unhindered by cowbird parasitism, as possibly this species did not build up to peak numbers on the Kirtland's Warbler nesting range until about 1900 (Mayfield, 1960:35, 1961).

Then winter records dropped off in this century apparently because there were fewer birds to be seen. This reduction coincides with the reduction in habitat—concomitant with increasingly effective fire fighting techniques—and, probably more importantly, with the maximizing of cowbird numbers.

MATERIALS AND METHODS

In 1972 I was in the Bahamas from 8 February to 13 April, visiting: Grand Bahama, Abaco, Andros, Eleuthera, and New Providence. In 1973 I was there from 6 January to 3 April, visiting: Exuma, Long Island, San Salvador, Cat Island, Crooked Island, and Acklins Island. The purposes of my visits were much the same in both years: 1, to survey and assess recent habitat changes; 2, to find Kirtland's Warblers, if possible; 3, to try to determine what the warbler's requirements are in winter and correlate these with findings regarding observed habitat changes.

On each island I used a car for convenience in traveling the main roads. I surveyed, on foot, all trails, secondary vehicular roads, and many areas with no trails, for as long as my schedule permitted on each island. Combining the two years, I spent 800 hours in the field.

This routine provided good opportunity for a fairly extensive observation of habitats and habitat changes. The chances of seeing a Kirtland's Warbler this way are extremely small. To help increase the odds somewhat, I used a tape recorder (a Uher 4000L) for play-back of species song. The feasibility of this method was presented by Gorski (1969, 1972) for another species.

A SIGHTING ON CROOKED ISLAND

During my 800 hours of field work, I sighted only one Kirtland's Warbler: a male seen toward the east end of Crooked Island, southern Bahamas. I observed what I believe to be the same male (see reasons below) during three different days, spanning a period of 12 days: 11, 12, and 22 March. I saw

him from as close as two meters (and with binoculars), with actual observations totaling just under two hours during the three days. He appeared to be in complete breeding plumage except for a slight molting on the chin. The central part of his breast was immaculate, and I assumed from this that he was a fully adult male. He had an asymmetrical black blotch on the left side of his upper breast—this being the basis for my assumption that the same male was involved in all observations. This brings to 16 the number of islands and cays in the Bahamas on which Kirtland's Warblers have been collected (11) or reliably sighted.

I initially located this male Kirtland's Warbler through his responses to my playing recorded songs of the species. Essentially, these responses consisted of rather loud and persistent chipping and an approach towards the recorder. After the male was in sight, I did not play the recorder further. Rather, I turned it off and tried to follow him for as long as possible while his excitement subsided and he resumed his routine. After he was lost to view for some minutes, I played two or three songs only, to reestablish contact.

His reaction to recorded song on 12 March was similar to, but weaker than, his reaction on the previous day. He was not sighted on 13 or 14 March, although I walked about the area playing groups of five or six songs intermittently. On 15 March I proceeded to Acklins Island, as previously planned. I went back to Crooked Island on 21 March and returned to the warbler area on 22 March. On that day the male responded to play-back of song, although at the weakest level yet.

The territory or "foraging area" (term suggested by Harold Mayfield, pers. comm.) occupied by this male may well have been larger than I allowed for, although I played well outside the relatively small area wherein he was actually observed. This observation area measured just under 0.5 hectare. Considering the length of time it sometimes took him to respond, the direction from which he came, and the approximate distance the recorded song penetrated the scrub (about 200 m), a *guess* would be that he utilized at least seven ha (about 17 acres). The lack of responses on 13 and 14 March suggests the possibility of an even larger area. Alternatively, the lack of response may represent habituation to the recorded song as suggested, for somewhat different circumstances, by Emlen (1969).

After 22 March I could not find the male warbler again, although I tried on four other days through 31 March. I suspect that was *about* the time for him to begin northward migration. There are only four records from the southern Bahamas, two from the Caicos in January or February 1891, Bond's sighting on Inagua on 8 March, and the Crooked Island male as late as 22 March. All April Bahamian records are from farther north.

Behavior.—Some of the records submitted by Hundley (1967) on Grand Bahama involved observations of Kirtland's Warblers moving up the trunks of mature Caribbean pines (*Pinus caribaea*), in the manner of the Brown Creeper (*Certhia familiaris*). As Hundley points out, this behavior has not been observed on the breeding grounds, not did I see it in the male on Crooked Island. However, the trees on the Crooked Island foraging area were much smaller—up to only about 10 cm dbh—than those on Grand Bahama.

Of the time the Crooked Island male was observed in ordinary activities (i.e., not interfered with by the recorded song), about 70 percent was spent on the ground, actively hunting for food. While trade winds were not unusually strong during these observations, perhaps 8–16 knots, the bulk of the small insects may still have been near the ground. No food items were identified, but judging from the maneuverings of the male, the food items were not stationary. All items taken were small (presumably insects and spiders). Cory (1879) reported the stomach contents of the Andros female as "insects."

Avian associates.—The foraging area was not rich in bird life. Only 16 other species were noted during nine days (11 to 14, 22, 26, 28, and 30 to 31 March): Osprey (*Pandion haliaetus*), Peregrine Falcon (*Falco peregrinus*), Zenaida Dove (*Zenaida aurita*), Common Ground Dove (*Columbina passerina*), Bahama Woodstar (*Calliphlox evelynae*), Gray Kingbird (*Tyrannus dominicensis*), Bahama Mockingbird (*Mimus gundlachii*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Thick-billed Vireo (*Vireo crassirostris*), Black and White Warbler (*Mniotilta varia*), Yellow Warbler (*Dendroica petechia*), Prairie Warbler (*D. discolor*), Palm Warbler (*D. palmarum*), Bananaquit (*Coereba flaveola*), Stripe-headed Tanager (*Spindalis zena*), and Black-faced Grassquit (*Tiaris bicolor*).

The Osprey(s) and falcon(s) were passing overhead. The other species, each observed on almost every visit to the area, had a greater potential of being in close association with the Kirtland's Warbler. No conflicts—or even close approaches—were observed between the male Kirtland's Warbler and any other bird.

Habitat.—The dominant plant (vernacular names supplied by Mr. and Mrs. G. Ferguson—see Acknowledgments—and scientific names from Britton and Millspaugh, 1920) on the foraging area was "buttonwood." Both "black buttonwood" (probably black mangrove, *Avicennia nitida*) and "white buttonwood" (*Conocarpus erectus*) were present, with the former in greater abundance. Some of the other plants on the area were: "brasiletto" (*Caesalpinia* sp.), "cat's-paw" (*Solanum didymacanthum*), "madeira" (*Swietenia mahagoni*), "poisonwood" (*Metopium toxiferum*), "Lucy bush," "cherry,"

"marginelee," "wild plum," "rock bush," "darlin plant," "serfean," and "spoon bush." There were also two species of cactus: "dildo" (*Cephalocereus* sp.), and *Opuntia* sp. No plant, such as century-plant (*Agave* spp.), with a profusion of blossoms serving as a "food center" for both nectar- and insect-feeding birds, was present.

The dominant ground cover, of interest because the male Kirtland's Warbler spent so much time on or near the ground, was Bermuda grass (*Capriola dactylon*). There were lesser amounts of "parsley" and "broom." There was also much exposed limestone rock.

The habitat had somewhat the same configuration as do the jack pine (*P. banksiana*) areas on a typical, optimal breeding territory, i.e., there were thickets and openings. By "squinting," one could visualize the "habitat gestalt" much as it appears in Michigan (the shrubbery on Crooked Island is, of course, broad-leaved). The general height of the shrubbery was 1 to 1½ m, with a scattering of taller plants to a height of about 6 m.

On the larger Bahamian islands, the land often rises away from the sea to form a coastal ridge. Immediately inland from this ridge there is often a lower area or trough. Still farther inland from the trough the land more or less gradually rises to form the main part of the island. Depending on the depth of the trough, as well as on other factors, the habitat in this low area is variously marsh, mangrove swamp, pond, or a rather dry area—often dominated by coconut palm (*Cocos nucifera*) or thatch palm (*Thrinax* sp.). Existing water in the trough is brackish and the levels often rise and fall with the tides.

The area on which I found the male warbler was about 900 m north of the sea. The trough behind the coastal ridge (a very low, broken ridge in this instance) was occupied by a mangrove (*Rhizophora mangle*) swamp. The elevation inland from the mangrove increased only gradually. Thus as one proceeded inland from the mangrove one found, successively: a zone of stunted and very sparsely scattered mangrove; a zone consisting almost entirely of bare rock and Bermuda grass; a zone of stunted shrubland in which the Kirtland's Warbler was located; and, finally, the taller scrub typical of many of the southern Bahama islands.

The plants on the area occupied by the Kirtland's Warbler occur on, as it were, an intermediate zone—in both elevation and salinity of ground water. The stunted habit is perhaps due to the ground water being brackish. One dominant plant on the area (the probable black mangrove) evidenced these conditions (and its adaptation to them) by its large size and relative abundance (and by its ability to exude salt through its leaves). Most of the other plants on the area are also found farther inland, and existence in this inter-

mediate zone appears to be marginal for them. They were not only stunted but less densely distributed than is the case only slightly farther inland.

Such an intermediate zone can be found along many stretches of coast and around the perimeters of many inland low areas. These zones are narrow—as narrow as 200 m—and would constitute a rather severe restriction of distribution and habitat choice for any organism limited to them. We have no evidence that the Kirtland's Warbler is so restricted. Also we have no way of knowing yet how typical this male might be relative to others of the species utilizing non-pine areas and islands in winter.

Such areas as the above appear in no imminent danger as they are not in demand by man. Island farming would be impossible in such areas. Any coastal area is in *potential* danger of alteration through highway construction and coastal development in general.

ENVIRONMENTAL CONDITIONS IN THE BAHAMAS

Lumbering of Caribbean pine forest.—The most significant environmental alteration I observed—and probably the most significant single change ever to occur in the Bahamas—was the lumbering of the Caribbean pines. To my knowledge, only four islands support pines: Grand Bahama, Abaco, New Providence, and Andros. Britton and Millspaugh (1920) state that this pine species is also found in the Caicos, but I have not visited these islands nor found evidence to verify this. There are no pines on the western end of Grand Bahama. They begin about five or six km west of Freeport and cover much of the remainder of the island eastward.

The Abaco Lumber Company carried on a pulpwood operation on Grand Bahama from about 1948 to 1955. From 1956 to 1959, Owens-Illinois also engaged in a pulpwood operation on Grand Bahama. They lumbered off some 53,000 ha (130,000 acres). (The total area of Grand Bahama is about 111,000 ha or 275,000 acres.) They then moved to Abaco, lumbering there until 1970, and in 1968, they began on Andros. They were cutting on Andros when I was there in March 1972, and my impression is that they were to be done there by the end of 1973.

In this 18 year period, from 1956 to 1973, Owens-Illinois has used a 10 cm (4 inch) dbh criterion—i.e., all trees 10 cm dbh and over were cut. Five "seed trees" per acre were left standing for regeneration. Regeneration on Grand Bahama has been good. On Abaco, recurrent forest fires have stalled regeneration on a large area in the south, where an approximate 20,000 ha (55,000 acre) area is now virtually treeless. Most of the rest of Abaco has also been lumbered, and regeneration northward seems good. The total area of Abaco is about 168,000 ha (415,000 acres). It is still too early to judge the quality of pine regeneration on Andros. Caribbean pines are slow-

growing, and the establishment of young pines is constantly threatened by forest fires (particularly in the drier, winter months). I observed unattended (and unfought) forest fires burning for days on both Grand Bahama and Andros.

The pulpwood operations at least temporarily remove, and sometimes completely destroy, the Caribbean pine association or ecosystem over vast areas on the islands involved. The recent Kirtland's Warbler sightings on Grand Bahama (Hundley, 1967) among Caribbean pines suggest that some portion of the population utilizes this habitat in winter. Warblers have, in fact, been observed on both the pines proper and on the broad-leaved plants of the understory. It makes little difference what kind of plant they use at any given moment in these areas, as the entire association to which they are attracted, and upon which they depend, is being severely affected by the pulpwood operation. To the extent that the Kirtland's Warbler, as a species, relies on pinelands in winter, lumbering could well have been detrimental to the point of having contributed to the recent decline in their numbers.

Usage of scrub habitats.—Most of the winter records of Kirtland's Warbler are from the northern Bahamas. It seems inescapable that this is true simply because there are more visitors to these islands. For example, 45 of the 72 specimens have been collected from New Providence, where ships have been putting in for decades. The four "pine islands" are also in the north. However, even there many of the Kirtland's collected or seen have been in broad-leaved scrub. More telling, it would seem, is the fact that 24 specimens have been taken on islands and cays which lack pines.

Unfortunately, collectors reported very little regarding the habitats in which the warblers were taken. Thus, while one might wish the literature contained much more information on this aspect, one is forced to the same conclusion Mayfield (1972b) drew from the available data: "The Kirtland's Warbler usually inhabits low, broad-leaved scrub in the Bahamas. Areas that have been cleared and then allowed to grow back but have not yet reached their maximum height and density . . . it is significant that no one has reported them in the high scrub or coppice, trees 15 feet or more in height, that abound in these islands."

I agree especially with the possible significance to the warbler of the small scrub size; however, such areas do not have to begin with cleared land. New Providence, and particularly Nassau, have been fairly heavily populated for a long time. Much of the land there must have been cleared for agriculture and then variously abandoned. Such a circumstance might have attracted a greater number of Kirtland's to these areas. It is even possible that the greater number of Kirtland's Warblers collected on New Providence is not entirely an artifact of the presence of a greater number of collectors; this

may, in part, result from ideal habitat conditions and a concomitant higher local warbler population.

Such clearing of the land has not been nearly so extensive on the Out Islands, with the possible exception of Eleuthera. Certainly it was not true in the past when the Kirtland's Warblers were wintering in the Bahamas, long before the Arawak Indians settled there. Rather, a supply of this low scrub habitat could result from the stunted growth described earlier. It is likely that such areas have always existed in the Bahamas. In fact, judging from the extensive shallow offshore areas of today, such stunted areas were probably greater in extent during glacial maxima when sea levels dropped, exposing more land of very low altitude.

While an unknown proportion of the total Kirtland's Warbler population utilized the Caribbean pine ecosystem in winter (this proportion likely varied from year to year), from at least spatial considerations, it appears that the bulk of the population is to be found in low, broad-leaf scrub growth—either young or stunted. If so, this would narrow down the search area for them somewhat. Hopefully enough careful records can be obtained in the next few years to permit a fairly definitive statement on the winter requirements of this species.

Other possibilities.—Another possibility exists as a contributing factor to the recent Kirtland's Warbler decline and should be stated here. Both Paul Fluck, in the Freeport, Grand Bahama, area, and Alexander Sprunt, in Tavernier, Florida, report heavy losses among various species of warblers during spring migration of 1971. Both believe that the drought conditions that prevailed during much of the winter of 1970–1971 in the Bahamas and southern Florida were responsible. Presumably the drought reduced the insect populations, and many warblers may have starved in a time of high energy needs. It is impossible to put these losses in numerical terms. However, Fluck described the warbler losses on Grand Bahama as very heavy, with "bushel baskets" of dead birds along the Queen's Highway every morning. We know nothing about the distribution in time of the 60 percent decline of the Kirtland's Warbler between 1961 and 1971; however, a catastrophic type loss cannot be ruled out as a partial cause.

SUMMARY

The population of Kirtland's Warbler declined from an estimated 1,000 in 1961 to about 400 in 1971. Principle causes appear to be parasitism by the Brown-headed Cowbird and a possibly inadequate amount of breeding habitat. The species requirements on its wintering grounds in the Bahama Islands are virtually unknown. Necessary conditions there may be worsening.

Most of the winter records of Kirtland's Warbler are reviewed. I spent 800 hours in the field on 11 of the larger islands during the winters of 1971–1972 and 1972–1973,

trying to find Kirtland's Warblers by means of recorded song, and surveying habitats and recent habitat changes. One male Kirtland's was seen on Crooked Island. The bird was under observation for just under two hours during three days—11, 12, and 22 March 1973. It occupied an area perhaps twice the size of an average breeding territory. This area consisted of low, broad-leaved scrub with a stunted habit, possibly due to the brackish ground water. The plants on this foraging area are described in some detail.

The most profound habitat change observed has been the lumbering off of the Caribbean pines by the Owens-Illinois Company on the "pine islands" of Grand Bahama, Abaco, and Andros between 1956 and 1973. This destruction of the pine ecosystem may well have contributed to the recent decline in the Kirtland's Warbler population. It may be, however, that most of the population utilizes young or stunted broad-leaved scrub areas in winter. The proportions are unknown. A drought in the Bahamas and southern Florida in the winter of 1970–1971 may have led to the observed heavy loss of birds in the spring migration of 1971. This, too, may have contributed to the Kirtland's Warbler decline.

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LITERATURE CITED

Bond, J. 1971. Birds of the West Indies. Collins, London.

Bonhote, J. L. 1903. On a collection of birds from the northern islands of the Bahama groups. Ibis, 3 (8th Series) :273–315.

Britton, N. L., and C. F. Millspaugh. 1920. The Bahama flora. Published by the authors.

Challinor, D., Jr. 1962. Recent sight record of Kirtland's Warbler in the Bahamas. Wilson Bulletin, 74:290.

Cory, C. B. 1879. Capture of Kirtland's Warbler (*Dendroeca kirtlandi*) in the Bahama Islands. Bull. Nutt. Ornith. Club, 4:118.

Emlen, J. T., Jr. 1969. The 'squeak lure' and predator mobbing in wild birds. Anim. Behav., 17:515–516.

Gorski, L. J. 1969. Traill's Flycatchers of the "fitz-bew" songform wintering in Panama. Auk, 86:745–747.

Gorski, L. J. 1971. Traill's Flycatchers of the "fee-bee-o" songform in Peru. Auk, 88:429–431.

HUNDLEY, M. 1967. Recent wintering records of the Kirtland's Warbler. Auk, 84:425–426.

MAYFIELD, H. F. 1953. A census of the Kirtland's Warbler. Auk, 70:17–20.

MAYFIELD, H. F. 1960. The Kirtland's Warbler. Cranbrook Instit. of Sci., Bull. No. 40.

MAYFIELD, H. F. 1961. Cowbird parasitism and the population of the Kirtland's Warbler. Evolution, 15:174–179.

MAYFIELD, H. F. 1962. 1961 decennial census of the Kirtland's Warbler. Auk, 79: 173–182.

MAYFIELD, H. F. 1972a. Third decennial census of Kirtland's Warbler. Auk, 89:263–268.

MAYFIELD, H. F. 1972b. Winter habitat of Kirtland's Warbler. Wilson Bulletin. 84: 347–349.

MAYFIELD, H. F. 1973a. Census of Kirtland's Warbler in 1972. Auk, 90:684–685.

MAYFIELD, H. F. 1973b. Kirtland Warbler census, 1973. American Birds, 27:950–952.

PATERSON, A. 1972. Birds of the Bahamas. Durrell Publications. Brattleboro, Vt.

VAN TYNE, J. 1951. The Distribution of the Kirtland Warbler (*Dendroica kirtlandii*). Proc. Xth Internatl. Ornith. Cong., Proc. 537–544.

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THIRD NATIONAL WILD TURKEY SYMPOSIUM

This symposium will be held at San Antonio, Texas, on 11–13 February 1975, under the sponsorship of the Texas Chapter of the Wildlife Society. The theme is "The Wild Turkey: Its restoration, preservation, and management." Formal papers are slated for the first two days, and a full roster of speakers has been recruited from universities, conservation agencies, and elsewhere. The symposium will be at the Sheraton San Antonio Motor Inn, and information can be obtained on the event from Mr. Charles W. Ramsey, Wildlife Extension Specialist, Wildlife and Fisheries Dept., Texas A & M University, College Station, Texas 77843.