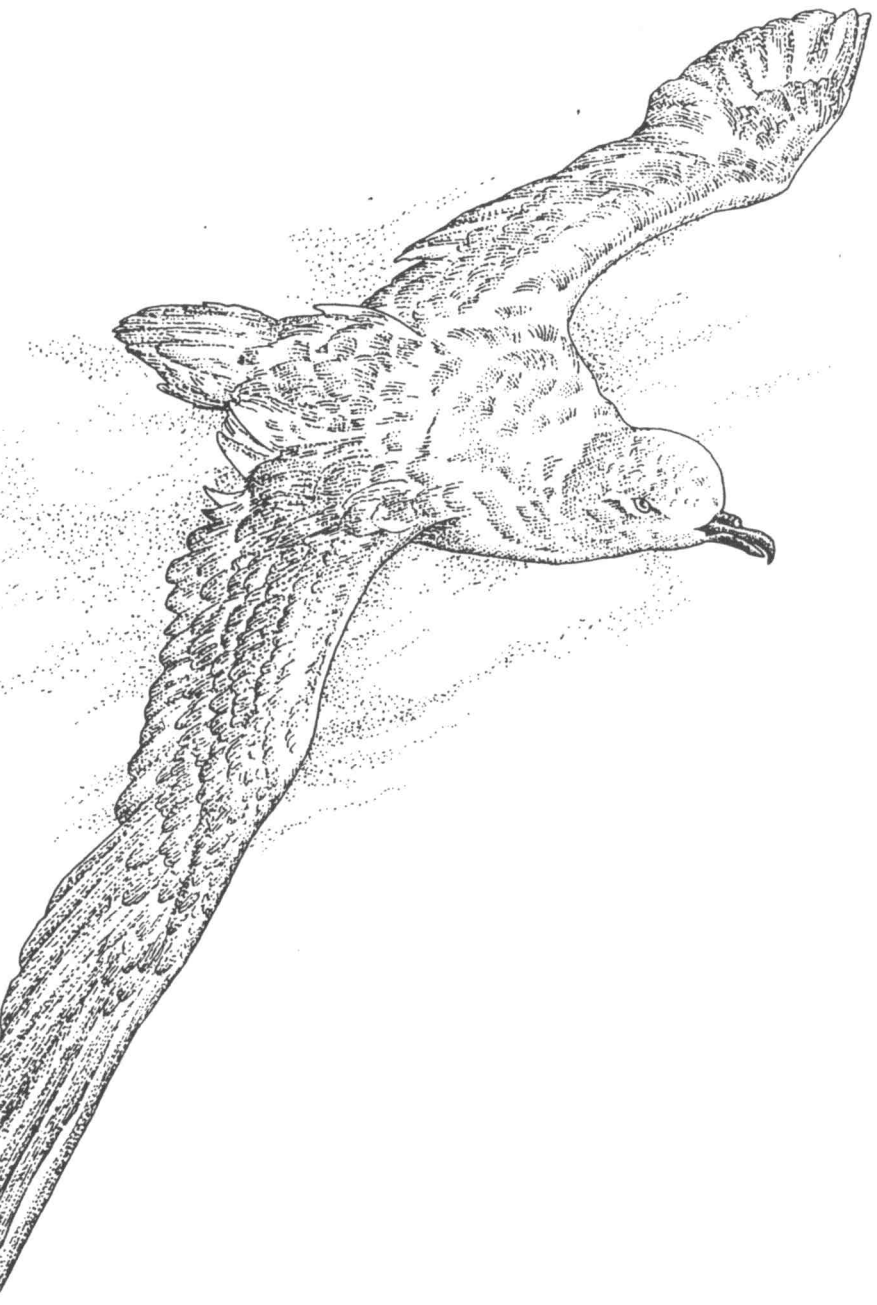


Illustrations and maps by Nancy Lou Gahan

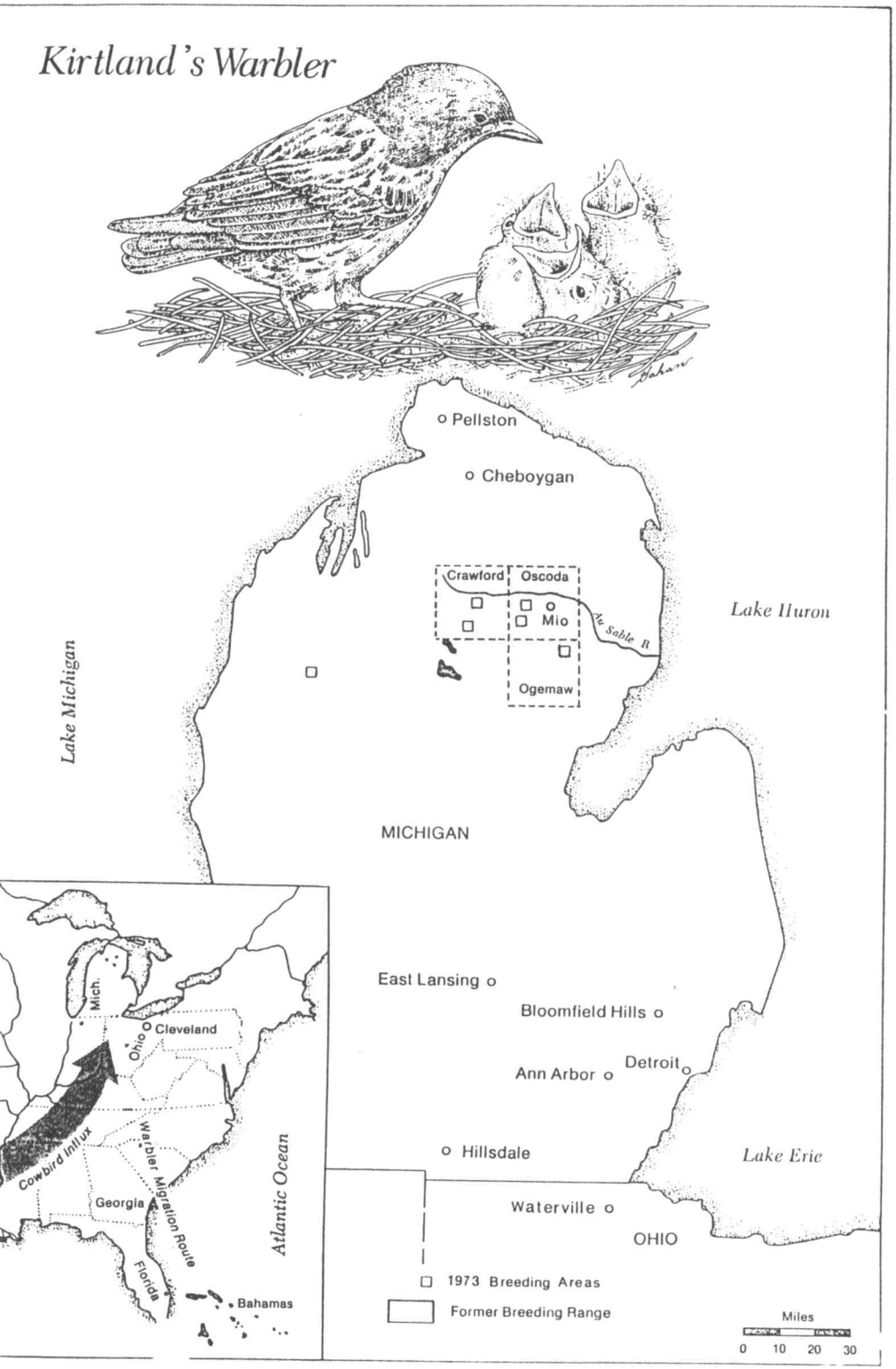
To Save a Bird in Peril

DAVID R. ZIMMERMAN

Foreword by S. Dillon Ripley

1970

Coward, McCann & Geoghegan, Inc.
New York



8

The Quest of the Warbler

SMALL land birds, delicate, shy, and hard to keep track of, are among the hardest to help. In North America one for which much has been done is a tiny, rare gem of a songster, Kirtland's warbler *(Dendroica kirtlandii)*. Bound, certainly, toward extinction, it has been the beneficiary of a long, costly, complex conservation effort, whose success—or failure—may soon be known.

Kirtland's is a bird of entrancing beauty. Its colors—blue, flecked with black above, pale lemon-yellow below—are of breathtaking purity when it is seen close up on its breeding ground in the light of the summer sun. It is a perky, jaunty bird, a persistent tail jerker that in many ways is frustratingly elusive, yet is remarkably unconcerned by or unafraid of man.

Since its discovery in 1851, its numbers always have been incredibly few; its population has been counted in hundreds or low thousands rather than in the tens or hundreds of thousands in which some species of the wood warbler family *(Parulidae)* may be reckoned. While a Kirtland's is a large bird, as wood warblers go, it is still so tiny—the average breeding adult weighs less than half an ounce—and its numbers now are so low that its current chief

admirer and champion, Harold Mayfield of Waterville, Ohio, could remark that, as of May, 1974, "all Kirtland's in existence"—fewer than five hundred birds—"would fit into one large shopping bag."

Clearly, Mayfield said, Kirtland's is not of concern because of its biomass, which is inconsequential. Or its environmental impact, which is slight.

It is valued rather for other reasons. Its beauty. Its rarity. Its elusiveness. The frustrating challenges that it seems to impose on all who would know or assist it.

It has a romantic allure and kindles an intense, ascetic fervor in its admirers. Kirtland's champions approach it clothed in the religion of science. Their pursuit of its mysteries is reminiscent of the Arthurian knights' quest of the Holy Grail.

Whether they succeed or fail, Kirtland's has aroused—and sustains—in its admirers some of the most intense and ennobling feelings of the Western tradition.

The warbler is named for Dr. Jared Kirtland, a pioneer physician and naturalist in northern Ohio, on whose farm, near Cleveland, the type specimen was shot.[1] The date: May 13, 1851. Kirtland realized that it had not been previously described.

He gave the specimen to a friend, ornithologist Spencer Baird, who stopped at his farm to visit a day or so later. Baird, the assistant secretary of the Smithsonian Institution, wrote the official report of the bird's discovery. He named it for Kirtland in honor of "a gentleman to whom, more than any one living, we are indebted for a knowledge of the natural history of the Mississippi Valley."[2]

Kirtland had studied the birds of Ohio with great care. A century later, in a way that neither he nor Baird could have anticipated, his data were to contribute, importantly, to efforts to save his namesake bird.

The first reported specimen had been shot on northward migration. Thirty years passed before the wintering ground, whence it came, was discovered: the Bahama Islands. Only after fifty years, in June of 1903, was the breeding ground found whence it was bound.

An ornithologist from the University of Michigan Museum of

Zoology in Ann Arbor had gone to fish in the Au Sable River, in western Oscoda County, in the Lower Peninsula of Michigan; the area now is inside or just adjacent to the Huron National Forest. When he heard an unfamiliar bird, he shot it and fetched it back to Ann Arbor, where the museum's curator of birds, Norman Wood, identified it as a Kirtland's warbler. Wood, who was a taxidermist and a self-taught biologist, quickly retraced his colleague's steps to find a Kirtland's nest.

He reached a timber tract of several hundred acres that had been burned over by a forest fire several years before: New, young Christmas-treelike jack pines *(Pinus banksiana)* had sprung up in the ashes, between the charred, black snags. Here Wood's search ended. His excitement in his discovery is clearly revealed in jottings that he made in his pocket notebook. They have been transcribed and published by Mayfield in his authoritative—and excellent—life history, *The Kirtland's Warbler.* Wood wrote:

> Leaving the river bottom I climbed to the top of the first plain and walked slowly along. . . . Suddenly I heard a new song, so rich, loud, and clear, I knew it must be the one I was in search of. I followed it around and heard it sing many times. . . . After a long time I saw him alight in a low bush and sing. . . .
>
> I shall be disappointed if I do not find the nest low down (in a jack pine probably) or maybe on the ground. . . . I had hoped by watching the birds to find the nest, but found [it] hard even to see the bird after locating it by the song. . . .
>
> I have just found a pair of Kirtland's warblers and, as I write, the female is three feet away, fluttering her wings. . . . The male is on top of a dead stub 20 feet high. . . . I saw him go down and went over there. I saw him come to the stub, and he had a worm in his mouth. . . . Down into the jack pine he went. . . . No bird and no nest!
>
> I watched a few minutes longer and saw the female in the low jack pines. I watched her and she seemed very uneasy. I began looking carefully on the ground, as I had made up my mind it would be found there. Suddenly I saw the nest! . . . In [it] were two young birds a few days old, and, as luck would have it, one beautiful egg . . . pinkish

white, thinly sprinkled with chocolate brown spots gathered in a wreath at the larger end.[3]

In his discovery, Wood saw, heard, and noted much that later would be confirmed as species traits of the warbler in its breeding season. Foremost was the richness of the male's song, his territorial claim and threat, which a later keen-eared listener, poet Hazen Miller, has transcribed as: *"Please, let me be—let me be, will you, please?"*[4]

The song lasts one to one and a half seconds. It may be repeated ten times in a minute and more than two thousand times in a day, and it is rare that a breeding male will let even five minutes of a fine June morning pass without its utterance. This bent for frequent, loud singing, almost always from within the male's several-acre breeding territory, is of inestimable value to conservationists: It permits them to find, map, and count all breeding members of a species that at other times, when the males are not singing, are virtually never seen.°

Their nests are so well concealed that a searcher can have his nose within inches of one without seeing it. The nest is built on the ground, invisible from all sides, in a tiny hollowed-out opening in

°This is the only reliable way to find a Kirtland's. Many of the nests, however, though not all, now are in areas where walking is discouraged or forbidden during breeding season to protect the warbler.

Kirtland's is officially designated as endangered by the U.S. Department of the Interior and so is protected by the U.S. Endangered Species Act of 1973, which makes it a federal crime to harm or harass them in any way.

This has not wholly discouraged bird watchers. One group, who said they were en route to a meeting of the Wilson Ornithological Society, were caught on the breeding ground in 1974, attempting to call up male birds by playing tape-recorded Kirtland's songs toward them.

Federal and state wildlife workers would prefer that bird watchers not go looking for Kirtland's by themselves and may try to forbid it, according to wildlife biologist John Byelich of the Michigan Department of Natural Resources (DNR) in Lansing. To assist bird watchers and protect the birds, federal and state officials run roughly similar public briefings during the breeding season, from mid-May to early July, and may direct or guide bird watchers to a site in one of the Kirtland's warbler management areas where they can hear and/or see a singing male Kirtland's. The briefings have been held at the office of the Huron-Manistee National Forests in Mio, Michigan, and the Michigan DNR office in the fish hatchery in Grayling, Michigan.

the grass. Usually it is under or near the lower branches of a jack pine; because of the bird's association with the tree, it has been given the popular name "jack pine warbler."

For a warbler to use a particular tree or, rather, its sheltering shadow, the tree must be between about three and fifteen feet tall; it must be part of a stand of many acres of similar-size jack pines; and it probably will be near the edge of the stand rather than the middle.

This preference for edges is attributed by Mayfield to the furtiveness with which Kirtland's approaches its nest. It will not descend along bare branches, where it might be seen, but rather chooses to move along concealing needled limbs. Inside a stand of jack pines, the lower limbs, deprived of light, have died and lost their needles. Only on edge trees do needled branches provide a hidden pathway right down to the ground.

There are millions of acres of jack pines in Michigan and in contiguous areas of the United States and Canada. But for the warbler to use the trees they must grow on a particular kind of rather poor, porous soil called *grayling sand,* large patches of which are found on Michigan's Lower Peninsula around the town of Grayling. Only one Kirtland's nest has ever been found on another type of soil.

Grayling sand provides good drainage, so the nests are not flooded. It supports only a low ground cover, which Kirtland's seem to like. Because of its relative sterility, it attracts relatively few natural predators of warblers.

Why Kirtland's is so choosy, and why, moreover, it breeds on only a certain few of the sites that seem to have *all* of the special features that it requires, long has puzzled Kirtland's champions. Their failure to solve the puzzle has been a matter of much frustration to them. For its every bright, tiny feather's worth of enchantment, Kirtland's has been a mind-defying challenge.

Jack pines cover over half a million acres of Michigan's Lower Peninsula. But the warblers have never been found outside of a dozen counties in which these trees are very abundant. Norman Wood discovered the first nest near the center of this twelve-county breeding ground, and no nest ever has been found more than sixty miles from that spot. As Kirtland's numbers have dropped in recent de-

cades, its breeding area has shrunk in toward the center of its range. By 1973 all breeders, save one tiny, isolated group, were found in eight colonies in Crawford, Ogemaw, and Oscoda counties.

In the search for the warblers' limiting factors, attention has recently been focused on the breeding ground. A few of its champions, and particularly, at present, naturalist Bruce Radabaugh of Hillsdale, Michigan, have suggested that environmental injury to the Bahamian wintering ground, particularly timber operators' recent destruction of island pinelands, may be partly to blame.

Harold Hillsdale pooh-poohs these fears. "I find them hard to believe," he says. But if correction of the paramount problems on the breeding ground were to fail to halt the species' decline, then its wintering habitat would command enhanced attention.

Under natural circumstances the jack pine tracts the warbler favors—extensive growths of uniform size trees—occur only after a forest fire. When all vegetation in an area has burned, the jack pines regrow synchronously and so reach warbler height together. The first nest found by Norman Wood was in a burned area, as have been most nests found since then. Fire thus is an important, positive ecologic factor for Kirtland's.

In primeval times forest fires were lit by lightning and by Indians and might burn huge areas before being extinguished by rain. These conditions did not change much, Mayfield says, until about 1875, when railroads were pushed into central Michigan, opening it for logging.

Jack pine was not cut; it was considered worthless. Rather, loggers cut the more valuable red pine *(P. resinosa),* which grew well on grayling sand, on which it was the only commercially useful tree. Taking the trunks, the loggers left the slash, the boughs and needles, on the ground. It burned readily. There were many fires.

Then timbering practices were cleaned up; fires were controlled; and the Smokey the Bear philosophy—that fires are bad for forests—became Holy Writ, which only recently has been challenged.

With fewer fires there were fewer synchronous stands of young jack pine and so, fewer warblers. This may—or may not—have started the species on a decline toward extinction in the first half of this century. No one ever will know. What is certain is that much of the

conservation effort for Kirtland's was—and still is—directed toward the creation and protection of suitable breeding habitat. Areas now are burned for it. Areas that happen to burn are protected. Staged stands of jack pines are planted on other cleared places in the hope they will appeal to the warblers.

State and federal forestry officials take great pride in their work for the warbler, which undoubtedly improves its chances for survival. Despite this helpful activity, however, the total amount of jack pine on grayling sand has continued to diminish, and there have been only a few really large burns in the last several decades. So the part, if any, that land management contributes to their survival cannot be said with certainty. Meanwhile, a different threat—identified early, but long discounted—has emerged as a major force that appears to have pushed Kirtland's toward extinction.

For two decades after Wood found the first nest, there was little serious research on the warbler's breeding behavior. Then, in the spring of 1922, Wood had an undergraduate student who became greatly intrigued by his accounts of Kirtland's. The student was an extremely bright, academically precocious young man, who then was seventeen years old. He was the scion of a very wealthy Chicago family and was headed for a career in law. He was an avid bird watcher, bird collector—he reportedly had a special permit to shoot birds in the Chicago parks—and ornithologist. His name: Nathan F. Leopold, Jr.

Adventurously, Leopold decided to retrace Wood's steps of 1903 to find—and study—the Kirtland's. He and another young man spent five days in the breeding area in 1922, but, he reported, "we saw no sign of the bird."

When he returned to Ann Arbor, Wood appears to have provided him with a clue to his failure, for Leopold later wrote:

"The reason for this failure may be looked for chiefly in the change in the character of the country. . . . The very trees which 20 years before, at the time of Mr. Wood's expedition, had offered ideal nesting sites for the warbler, had by the time of our arrival attained a much greater height, and were no longer a likely home for the bird."[5]

The next year, in mid-June, Leopold returned, accompanied by

several companions. Near a different stretch of the Au Sable River an unfamiliar song was heard. All piled out of the car. Leopold recalls:

> We fought our way several hundred yards through extremely dense jack pine, when Mr. [J.] Watson and the writer simultaneously caught a view of the singer perched in a large pine tree . . . a fine adult male *D. kirtlandii* in full nuptial plumage. . . .
>
> The bird perches on a limb, every muscle in its body tense, points his head toward the sky and lets out a burst of clear, bubbling song. . . . So much effort and vigor are put forth that . . . it seems as though the singer's throat will burst from the sheer force of the song.[6]

Later, with much difficulty, they found nests. A state conservation official came with them to photograph one of them. The birds were quite tame, and as Leopold lay in the grass, attempting to feed a horsefly to one of the young, the adult male "approached . . . and scrutinized me carefully, apparently not alarmed. . . . I lay very still and extended a fly held between the fingers of my left hand. . . . To my great surprise . . . [he] perched on a twig within a few inches of my hand and snatched the fly, which he ate."[7]

When they looked into the nest, they found but one baby Kirtland's, not the four or five that might have been there. They also found a second, much larger hatchling, of a different species, and an egg of the same species, the brown-headed cowbird *(Molothrus ater)*.

As Leopold and his companions watched and photographed the birds, they could see that the young cowbird "was getting all of the food [and was] crowding [out] the young Kirtland's." The watchers switched roles, from observers to conservers, and committed a historic, precedent-setting act. Leopold recounts: "By one o'clock we decided to remove the young cowbird. . . . We did this and then returned to the hotel for lunch."[8]

Leopold spent only five days watching the warblers, but in that time he identified and graphically described the cowbird threat:

> It has long been a subject of speculation why the Kirtland's warbler,

> which raises as large a brood as most other warblers, and which apparently has no more natural enemies than the other warblers, should continue to be so extremely scarce. I suggest as a reason for this the fact that the bird is largely preyed upon by the cowbird. Whenever we saw a singing male Kirtland's there were a number of cowbirds perched about in the tall dead trees, apparently in quest of the same thing for which we were looking.
>
> I am afraid that our first [undisturbed] nest represented the exception, and the second where there was but one baby Kirtland, a baby cowbird and a cowbird's egg, the rule. It seems that the cowbird had disposed of three or four baby Kirtland's which must have been in the nest originally.
>
> This seems the most plausible explanation. . . . It is greatly to be feared that *D. kirtlandii* may soon be another of the American birds on the extinct list.[9]

Leopold submitted the report of his expedition to *Auk,* which is the official journal of the American Ornithologists' Union. The journal published it before he was twenty, in its issue of January, 1924, and included the photo of the male warbler taking a horsefly from his hand. The report is considered an important contribution to the Kirtland's literature; a later expert was to call it the "first important life history study."[10]

Regrettably, little heed was paid to Leopold's warning. Neither was his example of destroying the cowbirds followed. Leopold himself, though he was to sustain a lifelong passion for Kirtland's, was to have little subsequent influence on its fortunes. In fact, forty-one years were to pass before his next visit to the breeding ground.

On May 20, 1924, a few months after his *Auk* report was published, while the Kirtland's were building their nests of the year, Leopold, then nineteen years old, and a friend, Richard Loeb, lured a neighbor boy in Chicago into a car, killed him, and left his body in a culvert near a swamp that Leopold frequented to watch birds.

They were quickly arrested and charged with the murder, which came to be called "the crime of our century."[11] They pleaded guilty and were convicted. Only masterful pleading for mercy by their lawyer, Clarence Darrow, spared them the gallows, and they were

sent to the Illinois State Penitentiary in Joliet with life sentences.*

For all of the thirty-three years that Leopold remained in prison, the relationship of the warbler and the cowbird was much studied. But little was done about it. In large part this was because Kirtland's next champion, intensely devoted to it as he was, did not agree that the cowbird was a mortal peril, and if he had thought that it was, it is

*Unreported by Leopold in his *Auk* account is the fact that he shot two adult Kirtland's at one nest and also collected their three nestlings, a baby cowbird that was with them, the nest itself, and a three-foot-square chunk of the surrounding habitat, including a jack pine. This remained unmentioned because Leopold lacked a license to collect a Kirtland's, which even then was highly protected.

The birds were shipped quickly by train to Chicago where a taxidermist at the Field Museum of Natural History skillfully prepared them and the habitat for a life-like group display. By the time he finished, Leopold already was in prison.

"I wanted to give the group to the Field Museum," Leopold said later, "but I wanted awfully to see it first. Warden [John] Whitman was most gracious about granting permission, and one day Sven, the chauffeur who had been with our family since I was six months old, brought the large case down to the prison.

"I was called to the warden's office and permitted to admire it for half an hour."[12]

The exhibit went back to the museum, but was never displayed, contrary to Leopold's belief at the time. It remained in storage thirty-years, still in its original wrappings.[13]

Just before Leopold was paroled in 1958, a warbler worker, Douglas Middleton of Detroit, Michigan, wrote to ask for a reprint of his *Auk* report.[14] A correspondence grew up between Leopold and Middleton and then an acquaintanceship, for Leopold, who had moved to Puerto Rico, was anxious to revisit Kirtland's country. In 1964 Middleton took him to it.

"[I] can't tell you, Doug, how often during the past week I've thought of our glorious two days together," Leopold wrote in a thank-you letter. "That trip, getting to know you, meeting the other K.W. enthusiasts, and, of course, renewing acquaintance with The Bird, constituted a glorious experience."[15]

Middleton had won Leopold's trust and affection, and Leopold told him about the habitat group, still stored at the Field Museum. He said he still owned the display and wished now to give it to a museum in Michigan. He had ruled out the University of Michigan Museum, he said, because it had the one other habitat group for the species, collected by Norman Wood in 1903. Asked Leopold of Middleton: "Perhaps you can suggest the proper repository for the group."[16]

Middleton recommmended the Cranbrook Institute of Science in Bloomfield Hills, Michigan, a suburb of Detroit, because it had published Mayfield's book. Leopold agreed. The exhibit arrived there in 1965. After the flora was refurbished, it was placed on public display in 1966. It currently (1974) is part of a larger exhibit, "One Does Not Live Alone," in the Ecology Hall; the label does not indicate that Leopold was the donor.

Leopold made two further visits to the breeding ground before his death in 1971, each time with Middleton, to whom he wrote, after his last visit, in 1970: "Seeing and hearing the Kirtland's was wonderful. They're great birds. . . ."[17]

not clear, for reasons of temperament, that he could have or would have done anything about it.

He began his doctoral work in zoology at the University of Michigan in 1925. Like Leopold, his schoolmate, he became an associate of Norman Wood, whom he later was to succeed as the university museum's curator of birds.

His name: Josselyn Van Tyne.

He was one of the pillars of American ornithology in this century. He labored as a museum curator, scientist, and, starting in 1939, as editor of the ornithologic journal *The Wilson Bulletin*. His field companion, friend, and disciple, Harold Mayfield, says:

> For this anonymous and, at times, thankless contribution to ornithology, he paid a high price. His expenditure of energy was tremendous. He consulted with others, but he did not find it easy to delegate responsibility; therefore, the major part of each editorial burden fell on his own shoulders.
>
> His answer to this problem was unrelenting work. Seven o'clock in the morning found him at his desk. Unless he had a meeting or a guest, the evening found him steadily at work. This was the pattern nearly every day, with no exception for Saturdays, Sundays, or holidays. His idea of a vacation was a field trip, with correspondence still coming from his pen each evening.[18]

In Van Tyne's severe self-regimen, Kirtland's, whose breeding ground he first visited in 1930, seems to have been the moment of light, joy, and inspiration. Mayfield says the annual few spring weeks spent in warbler land were "half work and half recreation" for Van Tyne, "the one time of the year just to get away and have some fun."

Van Tyne visited the warbler colonies—which are more than 150 miles from Ann Arbor—in most years until his tragically early death of cancer in 1957 at the age of fifty-four. For years he had said, and perhaps had believed, that his Life History of the Kirtland's Warbler would be his magnum opus. Yet, as may happen to a demanding editor—one who has meticulously raked and tended the words of others—the editorial bent or its animating emotions seem to have stifled the literary impulse. When Van Tyne died, no manuscript could be

found, not even a draft. He left only a stack of 3 x 5 note cards and a few scattered notes, cryptically written and difficult to decipher.*

Mayfield suddenly found himself the literary heir to Van Tyne's barely started Life History.

In accepting this task, Mayfield became Kirtland's new champion, its reigning knight. Even today it is he who leads, shapes, and coordinates the efforts of the several government agencies and private groups that protect the warbler, and it is his diplomacy, perhaps more than any other single factor, that has sustained their unity of purpose. The bitter rifts and conflicts that have hindered the whooping crane conservation effort, among others, seem not to have paralyzed the Kirtland's effort, and the reason seems to be that Mayfield has skillfully suppressed them.

Now in his mid-sixties—he was born March 25, 1911—Mayfield is a tall, gnarled, courtly man, a gracious leader, but one who brooks no challenge to his personal authority. He is a man who knows his mind, knows what he wants, and also knows how to work effectively with others to get it. In short, Mayfield is a consummate politician.

His achievements in the bird world reflect these abilities. Like Van Tyne, he had been president of two of the principal North American ornithologic organizations, the American Ornithologists' Union (AOU) and Wilson Ornithological Society, and in 1974 he added the third, becoming president of the Cooper Ornithological Society. That he is the first person ever to achieve this is all the more remarkable in light of the fact that he is not, by training or by profession, an ornithologist or even a biologist; he took his MA in mathematics. Through much of his working life, he served Owens-Illinois, Inc., the world's largest packaging company, where he became personnel director at the headquarters in Toledo, Ohio.

Mayfield says he has always enjoyed the out-of-doors and identified his first bird from a guide book when he was six. He was an accomplished athlete; played tennis and semiprofessional basketball; and then, in his late twenties, asked himself which of his hobbies would provide the most fun in the years ahead. He put down his tennis racket and returned to bird watching and study.

*In his lifetime Van Tyne published only two dozen pages on Kirtland's. His most popular contribution certainly is his shortest: his signed three-hundred-word entry for the warbler that has appeared in most of the 1.4 million copies thus far printed of Roger Peterson's *A Field Guide to the Birds: Eastern Land and Water Birds*, rev. ed. (Boston: Houghton Mifflin, 1947).

He submitted several Notes to Van Tyne as editor of the *Wilson Bulletin*. When Mayfield wanted to do library research, he would drive the fifty miles north to the University of Michigan Museum in Ann Arbor, where he met Van Tyne; their friendship soon grew.

Mayfield genuinely liked "Van," and Van Tyne allowed himself to reciprocate, not only because he liked "Harold" but also because Mayfield was not an ornithologist.

"Van was such an intolerant man in some ways," Mayfield says. "His standards were so high that he didn't find many ornithologists who had his full respect. . . . He thought a lot [of them] were scoundrels. . . .

"But I wasn't a professional. He didn't judge me in that context. There was no professional jealousy on either side. I used to do a lot of kidding, and Van appreciated that for he had a dry sense of humor. That made it very feasible for me to be a non-ornithologist whom he could be close to. . . . He and I got along just great!"

Van Tyne invited Mayfield to share in his Kirtland's research, and for many springs the two of them visited the breeding ground together. Their studies on the warbler and on the cowbird's role in its breeding are carefully reported in the Life History, *The Kirtland's Warbler*, which Mayfield published in 1960, three years after Van Tyne's death. For the reluctant author that he says he was, Mayfield has more than done justice to his friend, to himself, and to his subject; the book surely is a model of its genre.*

Cowbirds intrude on the warblers in various ways, Mayfield points out in the book. But few such incursions actually had been witnessed by humans, for one needed to arise early and exercise great patience and skill to see them. Describing one case, Mayfield

*It won the AOU's coveted William Brewster Award for research, an honor that pleases and also amuses Mayfield. "Although most of my professional colleagues in ornithology—indeed nearly all—are more than cordial to me," he says, "I think a few find it a little galling that an amateur should win the highest award for a scientific work in American ornithology."

Van Tyne might gleefully have agreed!

says that "on June 17, 1947, I watched a female warbler putting the finishing touches on her nest. In the afternoon, Van Tyne and I placed a blind nearby."[19]

The next, cold morning no cowbirds came.

> On June 19, it was a frosty morning again . . . and Van Tyne was in the blind as before. At 6:45 . . . six or seven cowbirds lighted on the ground about 25 feet away. There was some gurgling and posturing in the group, and a female detached herself and moved toward the nest. She did not come to it directly, but made several short flights to the side. . . . Then she lighted [about a yard] from the nest and walked toward it in a zigzag course as though unsure of its exact location.
>
> She appeared nervous. After looking first at the wrong side of the clump of grass under which the nest was placed, she turned toward the nest and thrust her head through the grass overarching it, not using the proper entrance. She peered in an instant, and then withdrew and flew hastily [away].[20]

Cowbirds may hesitate, to be sure their hosts actually are using a nest. The next morning, Van Tyne put a warbler egg from a deserted nest into the nest that he was watching to serve as a decoy.

> At 4.23 he heard the cluck of a cowbird and a rustle of wings nearby, but the bird flew away. At 4:33 a female cowbird . . . walked up [to the nest] without the hesitation of the previous day.
>
> She climbed awkwardly over the edge, peered in twice, and entered. She seemed to rotate her body until only her bill could be seen in the faint predawn light. She remained 20 seconds, then emerged and flew away quickly.

In that brief moment she had laid an egg.

Van Tyne now removed his decoy warbler egg. A half hour after the cowbird's visit the female Kirtland's entered her nest.

Thirty-three minutes after entering, she left the nest and moved in a leisurely way up into the trees, feeding as she went. A warbler egg was in the nest.

"Van Tyne left at 5:45 Returning at 9:25, he discovered that the warbler egg laid at 5:30 was gone."

This, beyond doubt, was the work of the female cowbird, for it is

in her nature not only to lay one or more of her eggs in another bird's nest but also to carry out of it and destroy one or more of her hostess' eggs.

Van Tyne returned again early the next day. Mayfield reports:

"At 4:32 a female cowbird came to the nest . . . looked in, hesitated, then entered. . . . In 25 seconds . . . another cowbird egg had been added. . . . At 5:17 the female warbler . . . entered. . . . At 5:33 . . . [she] departed, leaving an egg. As she sat on the nest, the male warbler sang nearby."

A few minutes later a female cowbird appeared, perhaps to throw out the warbler's egg. But she became frightened, perhaps by Van Tyne's presence, and fled.

Two mornings later the cowbird and the warbler each laid a final egg in the nest. In this case a human visitor—it was not Van Tyne or Mayfield, for, Mayfield says, they were studying the situation and would not have disturbed it—removed two of the cowbird eggs.* So the final count as the warbler began brooding was three of her own eggs to one cowbird's. Without human interference the count might have been two warbler eggs and three cowbird eggs—a lethal combination for warbler young, as will be seen.

Unlike some hosts, which throw them out, the warblers incubate the cowbird eggs as their own. The added eggs are larger, and in brooding them the female warbler tends to leave her own eggs out to the side, uncovered. They get less warmth, and so the hatch rate is lower than in unparasitized nests.

Greater damage is done after hatching. The cowbirds usually hatch first, about two days before the warblers. They are heavier and grow much more rapidly than warbler hatchlings, which they step on and kill. Mayfield says:

"The life of a newly hatched warbler, when unfed and trampled beneath one or more cowbirds, may be only a few hours. . . . [It] is feeble and weighs only about 1.3 grams, while the two-day-old cowbird in the same nest is vigorous and weighs about 10 grams."

*One who was less scientifically fastidious was conservation officer Verne Dockham, who lived in the area and who prowled the breeding ground destroying cowbird eggs when he could find them. One field worker who knew Van Tyne, Mayfield, and Dockham says: "Dockham used to puncture the cowbird eggs, and that used to get Van Tyne very up tight."

The two-day-old cowbird thus weighs eight times as much as a hatchling warbler. By its third day its weight is equal to that of an adult Kirtland's!

Mayfield says he has no record of a warbler ever having survived in a nest with two older cowbirds. Concerning nests with only one older cowbird he knows of none that has fledged more than two warblers, albeit in unparasitized warbler nests four or even five young warblers may fledge.

What did their extensive field observations and data mean? Here Van Tyne and Mayfield part company. For Van Tyne did not believe that the cowbird was driving the warbler to extinction—and he scoffed at those who said that it was. In what is perhaps his most definitive and authoritative comment on the warbler-cowbird nexus, Van Tyne wrote:

> Leopold was probably correct in considering the cowbird the most important enemy of Kirtland's warbler. . . . A very large number of nests are parasitized . . . [and] frequently the competition is too great, and the warbler young do not survive. *However, there seems to be no reason to share Leopold's fear that the cowbird "may soon" exterminate this warbler.* It is probable that the major changes that have been observed in the number of Kirtland's are the result of changes in the amount of suitable habitat in Michigan or in the Bahamas.[21] [Emphasis added.]

Mayfield himself changed only slowly from observer to conserver, willing to act for the warbler against the cowbird. Van Tyne, he says, never calculated any survival data. Mayfield did, and as he brought his mathematical expertise to bear on their field data, the threat became strikingly clear.

Of every 100 warbler eggs in parasitized nests, for example, 41 are removed by cowbirds, and an additional 6 fail to hatch because cowbird eggs hinder their incubation. Of the 53 warblers that hatch, 31 will die from competition with the cowbird chicks, leaving only 22 warblers to fledge.

"As a direct result of the cowbird," Mayfield says, "seventy-eight percent of warbler eggs in parasitized nests fail to produce fledglings."

In the period that Mayfield and Van Tyne worked together in the

field, 55 percent of warbler nests were parasitized, resulting in a loss of 43 percent of all warbler eggs between hatching and fledgling.

These figures changed somewhat in the next fifteen years. Parasitism continued to rise until 70 percent of nests were disturbed in some colonies.

These losses are far, far greater—by an order of magnitude or more—than the cowbird inflicts on any other host species. Few other hosts have more than one or two percent of their nests used. Many parasitized species, moreover, have ways to protect themselves. They throw out the cowbird eggs, cover them with a new nest floor, or abandon the nest and start over. Others regularly produce second and/or third clutches when the cowbirds are out of season. Kirtland's practices none of these defenses.

"The cowbird finds the Kirtland's warbler the perfect host," Mayfield says, using it "astonishingly" more often than it does the nests of other hosts. "For the Kirtland's warbler, the cowbird is the man who came to dinner!"

The elaboration of a hypothesis to explain the magnitude of the cowbird's depredations against the warbler has been wholly Mayfield's contribution. His explanation: The cowbird came only recently to Kirtland's country.

The cowbird is believed to be native to the short-grass plains west of the Mississippi River, where it foraged behind the bison. It moved eastward, experts reason, when the forests were felled, creating open farm country that was to its liking. Farmers brought in grazing animals, which the cowbirds followed as if they were bison.

This hypothesis was difficult to prove, since the cowbirds arrived in most settled areas ahead of the ornithologists. Nevertheless, Mayfield did find some compelling evidence that cowbird and Kirtland's were recently met.

The best, ironically, came from none other than Dr. Jared Kirtland. He had prepared the first checklist of Ohio's birds in 1838. The state already was heavily farmed, but the cowbird seemed hardly to have arrived. It "is admitted into our catalogue on rather doubtful authority," Mayfield quotes Kirtland as saying. To the north a similar checklist for Michigan listed the cowbird as present. But a field birder working in southern Ontario, to the northeast, failed to record the species at any time before 1840. "It would appear,"

Mayfield says, "that the cowbird began to move into the settled lands of Ohio and Michigan from the southwest just prior to 1840."[22]

Only in the last century could the cowbird have become a mortal threat to Kirtland's. But because the warbler already was a marginal species and was unprepared, it soon was devastated by it.

How devastated, however, no one knew. No one had counted them. No one had ever attempted to count the population of *any* small songbird.

Mayfield proposed to try.

Van Tyne, the solo scientist, who could not delegate authority, said that such a count could not be done, Mayfield later would recall. Mayfield, the businessman, at home with delegated responsibility and teamwork, believed that a census was feasible and set about to do it.

In 1951 he and thirty-two other census takers went afield. They exploited the fact that singing males sing often each day, but rarely leave their breeding territories. They counted singing males, found 432, and doubled this number to reach a total of 864 breeding adults.

The second census was conducted ten years later, in 1961. Mayfield was sure it would show a marked decline, for cowbird parasitism clearly was getting worse. But, much to his surprise, the forty-nine census takers found 502 singing males, suggesting that the warbler was holding its own—and might even be increasing in numbers. Mayfield says these statistics did not seem wholly believable—but they were, after all, the best data available. He lived, uneasily, with them for a decade.

In 1971 forty-eight census takers went afield. Their findings, Mayfield says, "confirmed my worst predictions." Only 201 singing males were found—a decrease of 60 percent in ten years.

Mayfield and the warbler's other friends panicked. Clearly, extinction threatened.*

*Why no downward trend was discerned in 1961 is unknown. Conceivably, many warblers had been missed in 1951. Or, as one census taker suspects, there was an overcount in 1961. Or perhaps a real but temporary upsurge in numbers. Or perhaps the effects of cowbird parasitism became dramatically manifest only after 1961.

Something had to be done.

The initiative came from biologist G. William Irvine of the U.S. Forest Service and biologist John Byelich of the Michigan DNR. A strategy meeting was convened at the University of Michigan Museum on October 30, 1971. The focus of the meeting was the cowbird menace.

The minutes say:

"[Mayfield] did not have confidence in the hypothesis that the trouble is in the Bahamas. The warblers are not limited to pine habitat on their wintering grounds, and are found in both deciduous and pine habitats.

"Development of the Islands has occurred on the shores, while the interiors have gone back to scrub. [Mayfield] would not recommend spending research funds there until someone learns how to find the birds."[23]

Despite his doubts, there was a recommendation that a new effort be made to find and study the warblers in the Bahamas. Naturalist Bruce Radabaugh of Hillsdale, Michigan, agreed to go.

The principal, urgent recommendation of the day was that cowbirds be killed at all warbler colonies.

The idea was not new. Mayfield had broached it in his monograph a decade before, but had not pursued it.

In their first attempt to control cowbirds, in 1965, biologist Nicholas Cuthbert of Central Michigan University in Mt. Pleasant and naturalist Rudabaugh hid in a Kirtland's colony at various times of the day. They used a portable tape recorder to play cowbird calls. When cowbirds flew near to investigate, they shot them.

This yielded some dead cowbirds and some sore shoulders, and they decided a better method was needed. The obvious solution was a trap, and Mayfield says he found the design for a suitable one in an agricultural journal. It was a trap used on grain farms to control blackbirds.

As used for cowbirds, which are closely related, the trap is made almost wholly of chicken wire. It is square, 16 feet on a side and 6 feet high. In the center of the top panel, like an inverted smokestack, is a 4 x 4 x 4-foot recess, the bottom of which is made of a slightly wider mesh than the rest of the structure. Cowbirds land on it and

then, wings tucked, easily drop through the wider mesh. Usually they later try to escape by flying at the sides of the cage, where the smaller mesh defeats them. Even if they do fly upward toward the larger openings through which they entered, their flapping wings make them too wide to pass, and they are retained. The traps are baited with sunflower seeds, and several cowbirds are kept inside to decoy others in.

At the 1971 strategy meeting Cuthbert and Radabaugh reported promising experimental successes. In one warbler area in 1966, when there had been no cowbird control, 25 out of 29 warbler nests had been parasitized, or 86 percent. The following year, with control, parasitism fell to 9 nests out of 19, or 47 percent.

From 1965 to 1971, Radabaugh added, 21 percent of nests in control areas were parasitized, less than one-third the rate in uncontrolled areas. Cuthbert said that in one of his traps he had caught 800 cowbirds in a single season—clearly there were a lot around.

What is more, each of the females laid a dozen or more eggs each year, according to ornithologist Robert Payne, a curator of birds at the university museum. As few as 20 female cowbirds thus could put one egg in each and every one of the 200 or so remaining Kirtland's nests each year. Because each cowbird could do so much harm, he and others suggested that all be killed.

A remarkable unanimity of purpose and a high degree of cooperation resulted from the meeting. An advisory committee was established, with Mayfield as chief. The Department of Interior's Fish and Wildlife Service provided funds to pay cowbird trappers. The U.S. Forest Service assisted. The Michigan DNR arranged for convicts to make the traps, using materials provided by the Michigan Audubon Society—whose participation was a tactical advantage: It tended to damp protectionist feelings, common among Audubonists, that could have jeopardized the control effort.

While traps were being built, biologist Radabaugh spent a frustrating—and disturbing—winter in the Bahamas, looking for Kirtland's. He investigated five of the larger islands on which most had been seen or collected. He found none himself.

What he did find was that four of these islands—Grand Bahama, New Providence, Great Abaco, and Andros—have supported extensive stands of the Caribbean pine *(P. caribaea)*, on which a pineland breeder like Kirtland's might feel particularly at home in winter. Starting in 1956, Radabaugh learned, intensive timbering, using modern methods, had been introduced to all of these islands except New Providence.

A motorized tree-cutting machine called the Sicard, after its original manufacturer, is used. One man can cut, haul, and stack by the road 3,000 trees each day.

While earlier timber operators had left trees under eight inches in diameter, the new ones harvested every tree down to four inches in diameter, essentially clearing the land. In many areas forest fires finished the job. Whole islands, Radabaugh said, were denuded of pine.

The major and most destructive timber operator on these islands, Radabaugh said in a report on his expedition, was Owens-Illinois, Inc., which operates there under the name BAIL, Ltd.

Owens-Illinois is the company for which Harold Mayfield worked during much of his business career.

More than one Kirtland's worker has noted this fact and has remarked that it may have made it difficult for Mayfield to evaluate objectively the harm that may have been done to Kirtland's by Owens-Illinois.

Radabaugh concluded:

"By far the greatest alteration I observed was to pinelands. The two dominant agents . . . were Owens-Illinois . . . and forest fires. . . . Mature pine habitat, with its characteristic understory . . . has been *drastically changed.*"[24] (Emphasis in the original.)

Radabaugh noted that the timbering coincided closely with the 60 percent decline in Kirtland's and could explain it.

"Such a hypothesis," he said, "rests on the point of whether the species relies on pinelands in winter or not. It is Mayfield's contention that they [rather] rely on scrub."

Mayfield, who concedes that he may be biased, nevertheless stands by his belief that timbering is not the problem. He notes that pines covered 18 percent of the Bahamian land surface, but says that no more than one-third of the total was cut in any seven-year period. The 16 square miles of pines on New Providence were not cut.

On Grand Bahama 225 square miles of pineland were cut, and 30 were left. On Great Abaco 200 were cut and 25 left. On Andros 220 were cut, and 50 square miles were left.

In all, by Mayfield's own analysis, 645 square miles of Bahamian pinelands were cut over in the last two decades. Only 121 square miles, much of it in small stands, remained uncut.

Destruction of wintering habitat is only one hypothesis, and perhaps not the strongest one, to explain Kirtland's decline, Radabaugh conceded in 1972. But, he insisted:

"If the population continues to decline in the face of new breeding habitat now coming in, and a successful and expanded cowbird control program, *then* we might return to the Bahama pine land hypothesis. By then," he added with bitter anger, "it would only be to seek an explanation for the warbler's passing, however, because the damage has been done already."*[25]

Trapping of cowbirds began at all warbler breeding colonies in the spring of 1972. By 1974 it was in its third year.

In June of that year Mayfield and several other Kirtland's workers, not including Radabaugh, presented a symposium on its survival before a couple of hundred bird watchers and ornithologists at the Wilson Ornithological Society's 1974 annual meeting, held not far from the warbler breeding area at the University of Michigan's Biological Station near Pellston, Michigan.

Encyclopedic data were presented—more than a hundred slides flashed on and off the screen—and the warbler workers managed to tell their audience virtually everything they ever might want to know about Kirtland's and the cowbird threat *except* the key fact: that at that very hour, nearby on the breeding ground, the success of cowbird control and thus perhaps the warbler's fate were being critically tested. Such are the weaknesses of formal scientific communication that seven experts could talk on a subject for several hours—and never really come to the point!

One speaker was the chief cowbird trapper, wildlife biologist William Shake of the U.S. Fish and Wildlife Service; he is a specialist in the control of nuisance animals in agriculture and is stationed in Lansing, Michigan. Born in 1942, he is a husky, casual, youngish-looking man. The trapping program, he reported, had been enormously successful.

*In 1973 Radabaugh found one male Kirtland's, on Crooked Island, a nonpine island. This led him to back off from, but not wholly abandon, his view that pine timbering may be the limiting factor.[26]

In the first year, 1972, Shake said he had operated fifteen traps from roughly mid-May to mid-July. Including a few hundred that had been shot, the staggering sum of 2,200 cowbirds had been removed and killed.

An attempt had been made to move some cowbirds away rather than kill them, Shake said. These birds first had been banded. Released as far as fifty miles away, they soon returned and naïvely reentered the traps. So, he said, most now are killed. They first are shooed into a smaller cage, then into a plastic bag, the mouth of which is attached to the exhaust pipe of a car. When the motor is started, carbon monoxide gas kills them.

"Death occurs almost instantly," Shake said.

In 1972, Shake said, cowbird parasitism occurred in only 2 out of 31 warbler nests in one closely watched study area.

In 1973 he operated 18 traps. He removed 3,305 cowbirds. There were 33 warbler nests in that area, and in 1973 not one of them was parasitized by cowbirds. Each nest, on the average, yielded 2.79 fledglings—two to three times the yield of years before cowbird-control measures.

While the warblers were breeding and the cowbirds were being killed, Mayfield organized new annual censuses; there would be no ten-year waits. Some Kirtland's breed at one year of age, so increased fledgling production might have been manifest as a rise in the number of singing adult males as early as 1973.

The 1973 count was not too discouraging. But it was not too encouraging either: in twenty-five mile-square sections of four counties the enumerators found 216 singing males, up 15 from the two previous years.

The "gloomiest view," Mayfield remarked that summer, was that this rise was no rise at all and might only represent a fault in the census method. The "most optimistic view," he added, was that "a good many warblers may not breed the first year, and so wouldn't be reflected in our count.

"Our only hope," he added none too cheerily, "is that many warblers don't achieve full breeding condition until age two."

And so the stage was set for 1974.

The warbler workers presented their Wilson Society symposium just before they conducted their 1974 census. So the most important question remained unanswered. The indirect indices, however, looked better than ever. Cowbird kills remained high. Bill Shake said he had increased his traps to twenty-two. By June 3 he had caught more than 3,000 cowbirds and so was running ahead of previous years. One gratifying surprise, he and others agreed, was how extraordinarily effective the traps were proving to be.

A mile-square jack pine stand is a surprisingly large area when one beats one's way through it looking for birdlife. Mayfield remarked that it had seemed simplistic to him to believe that two traps, at each end of a warbler colony, could make great inroads against the cowbirds. Yet they seemed to do just that.

"It's just like a vacuum cleaner!" Mayfield exclaimed. "It sucks the cowbirds out of a whole [mile-square] area."

Freed of their yoke, the warblers undoubtedly were producing more young. One of the oldest and most respected warbler field workers, Dr. Lawrence Walkinshaw, who is a retired dentist in Muskegon, Michigan, said that parasitism in his study area had fallen from 75 percent of nests to *zero*. Most warblers, he said, now were incubating full, five-egg clutches. Including several study areas, he added, the number of young had risen from 1.31 per nest in 1966–1971 to 3.38 per nest in 1972–1973.*

In other words, each active nest now was producing two more warbler young per year than it had just three or four years before! Said Walkinshaw: "There is no reason why Kirtland's shouldn't increase if we continue this program!"

Three months later, when the census was complete and the results tallied, there was only dismay.

Only 167 singing males, representing 334 breeding adult birds,

*A few Kirtland's pairs renest and produce a second brood late in July, after the cowbird threat has abated. Adding in these young, Walkinshaw estimated that each active pair of adults now produced four young each summer.

had been found. This was a 23 percent decrease from the 216 singing males counted in 1973.

The counts thus had been:

1951—432 singing males, or 864 breeding adults
1961—502 singing males, or 1,004 breeding adults
1971—201 singing males, or 402 breeding adults
1972—200 singing males, or 400 breeding adults
1973—216 singing males, or 432 breeding adults
1974—167 singing males, or 334 breeding adults.

More certainly now than ever before, Kirtland's stood at the brink of extinction. More frustratingly than heretofore, its many dedicated knights had virtually run out of moves. There was no one additional new gambit that anyone could think to make that promised to stem the fatal decline. They were back to square one, after years of work, with half a dozen unmeat possibilities to study and/or attempt to act on—and perhaps no time left to do it.

When Mayfield analyzed the available data, some striking facts emerged:

In June, 1972, the first year of widespread cowbird control, 400 adult Kirtland's were on the breeding ground. They produced about 4 young per pair, so that the population at the end of July, just before southward migration, must have been 1,200.

The following spring, 1973, only 216 males, or 432 adults, were counted, suggesting a survival rate for the eleven-month period of only 36 percent.

If these 432 adults produced 864 fledglings, then there were 1,296 Kirtland's at the end of July, 1973. In June, 1974, there were only 167 singing males, or 334 breeding adults, suggesting an incredibly low over-winter survival rate of only 26 percent.

If these figures are accurate, then there had been enormous —inexplicable—over-winter loss in at least these two years. What confound these apparently reasonable estimates are banding data by field biologist Lawrence Walkinshaw.

He banded fledglings in 1972 and trapped 13 of them in 1973. The following summer, 1974, he trapped 11 of the 13 again, indicating a remarkably high 84 percent over-winter survival for this small sample. This is quite at variance with the 26 percent over-winter surviv-

al for the population as a whole calculated by Mayfield from the census data.

This conflict has not been resolved.

One thing that seemed certain was that cowbird control had helped warbler reproduction enormously.

Using the one fledgling per pair productivity reckoned from the immediate precontrol period, and the over-winter survival rates of 36 percent and 26 percent for the winters of 1972–1973 and 1973–1974, Mayfield calculated that the population would have dropped to but 42 pairs, or 84 adult birds, by June, 1974, if the cowbirds had not been removed. This is exactly half the number that actually were counted in June, 1974.

Clearly, cowbird control was of value. Clearly, too, it, and everything else, now was no longer enough.

There is only speculation, and quite speculative speculation at that, as to what is pulling the count down. Suggestions include:

- Some warblers were missed in the census.
- Cool, rainy weather in June, 1974, depressed breeding and/or discouraged singing males.
- The present breeding habitat is qualitatively or quantitatively inadequate.
- Something is killing warblers on migration, storms perhaps.
- A new factor is taking a toll, pesticides perhaps.
- Something is wrong on the wintering ground, lumbering, or competition with other species, or perhaps deaths owing to abnormally dry winters that have been recorded recently in the Bahamas.

None of these hypotheses offered the warbler workers much to grab onto. The knights of the warbler were left in a position comparable to the knights of the Grail after a severe setback in their quest. They could cherish hope, deep in their hearts, that something good would happen, that somehow next year they would do better. And they could pray that it be so.

5. N. Leopold, *Auk*, Vol. 41 (January, 1924), pp. 44–58.
6. *Ibid.*
7. *Ibid.*
8. *Ibid.*
9. *Ibid.*
10. Andrew Berger, *Living Bird*, Vol. 7 (1968), pp. 103–16.
11. Meyer Levin, *Compulsion* (New York: Pocket Books, 1973), p. 1.
12. N. Leopold, *Life Plus 99 Years* (Garden City, N.Y.: Doubleday, 1958), p. 171.
13. N. Leopold to Douglas Middleton, February 11, 1964.
14. D. Middleton to N. Leopold, February 25, 1958, cited in N. Leopold to D. Middleton, February 26, 1958.
15. N. Leopold to D. Middleton, June 13, 1964.
16. N. Leopold to D. Middleton, February 11, 1964.
17. N. Leopold to D. Middleton, June 20, 1970.
18. H. Mayfield, *Auk*, Vol. 74 (1957), pp. 322–32.
19. H. Mayfield, *op. cit.* (1960), p. 167.
20. *Ibid.*, pp. 167–68. The quotes that follow in this episode are from this source.
21. J. Van Tyne, "Kirtland's Warbler," in Arthur C. Bent, *Life Histories of North American Wood Warblers,* United States National Museum Bulletin 203 (Washington, D.C.: Smithsonian Institution, 1953), pp. 417–28.
22. H. Mayfield, *op. cit.* (1960), p. 145.
23. Minutes of an ad hoc meeting to review the status of the Kirtland's warbler, Ann Arbor, University of Michigan Natural Science Museum, October 30, 1971 (unpublished).
24. B. Radabaugh, untitled report on trip to Bahamas to study wintering ground of Kirtland's warbler (1972), pp. 12–13.
25. *Ibid.*, p. 16.
26. B. Radabaugh, "Report of a Trip to Some Central and Southern Islands of the Commonwealth of the Bahamas in Search of Kirtland's Warblers from January 5 to April 3, 1973" (unpublished), pp. 3–9. More accessible is a combined, shortened report of his two trips: B. Radabaugh, *Wilson Bulletin,* Vol. 86 (1974), pp. 374–83. In this later version he has backed down almost entirely from his earlier thesis that lumbering in the Bahamas was responsible for Kirtland's decline.

Chapter 9. Exorcising Eagles' Curse of Cain

1. B.-U. Meyburg, *"Zur Biologie des Schreiadlers (Aquila pomarina),"* in *Deutscher Falkenorden 1969* (1970), pp. 32–66. The paper

4. *Ibid.*, p. 114.
5. J. Iribarren, *"Los Comederos de Buitres"* (unpublished).
6. Jean-François Terrasse to author, April 11, 1973.
7. Alden Miller, Preface, in Carl Koford, *The California Condor* New York: Dover, 1966), p. vii.
8. S. Wilbur, "California Condor Supplemental Feeding Program (unpublished, November 11, 1973).
9. S. Wilbur, "Food Resources of the California Condor" (unpublished administrative report, Portland, Oregon: U.S. Department of the Interior, 1972). This is the most detailed current assessment of condor food needs, past and present.
10. S. Wilbur, W. Dean Carrier, and John Borneman, *Journal of Wildlife Management*, Vol. 38 (April, 1974), pp. 343–46.
11. *Ibid.*
12. C. Koford, *op. cit.*, p. 135.
13. *Ibid.*, p. 138.
14. S. Wilbur, 1973, *op. cit.*
15. D. Mertz, *American Naturalist*, Vol. 105 (1971), pp. 437–53. The analysis in the following paragraphs is based on this source, save for the minimal allowable adult survival and maximal population growth and doubling time, given annual breeding, which Mertz has kindly provided at the author's request.
16. *Ibid.*
17. B. Helander, "The Sea Eagle in Sweden, 1973 Report" (unpublished, Stockholm; Swedish Society for the Conservation of Nature, January, 1974).
18. *Ibid.*
19. M. Bijleveld to author, October 30, 1973.

Chapter 8. The Quest of the Warbler

1. Harold Mayfield, *The Kirtland's Warbler* (Bloomfield Hills, Michigan: Cranbrook Institute of Science, 1960), p. 5. This detailed monograph is the major source for the historical account here. It covers developments through the 1950's. Subsequently, Mayfield has published periodic progress reports in *Auk* and the *Wilson Bulletin*. Unlike many of the species and conservation projects described here, the Kirtland's work has been well reported in ornithologic and natural-history publications.
2. S. Baird, *Annals of the Lyceum of Natural History of New York*, Vol. 5 (1852), pp. 217–18, cited in Mayfield, *loc. cit.*
3. *Ibid.*, p. 7.
4. H. Miller, *The Old Au Sable* (Grand Rapids, Michigan: Eerdmans, 1963), p. 162.