U.S. Fish and Wildlife Service
Patuxent Wildlife Research Center
Endangered Species Research Branch
Ecology Section I

HABITAT USE, MOVEMENTS, AND REPRODUCTIVE SUCCESS OF KIRTLAND'S WARBLER AT THE MACK LAKE BURN AREA, OSCODA COUNTY, MICHIGAN

Justification

The population of Kirtland's Warbler (Dendroica kirtlandii) is limited to about 430 individuals (USFWS unpubl. data). Presumably the bird has always nested in the conifer zone on the sandy outwash plain of the Wisconsin Ice Sheet. The narrow habitat requirements of the warbler have greatly limited its range; the amount of habitat suitable to the warbler at any one time has always been small (USFWS 1976).

Kirtland's warbler currently is found during the breeding season in a six-county region of Michigan (Walkinshaw 1983) where its breeding habitat is distinctive. Most nests have been found in 8-21 year-old jack pine (Pinus banksiana) stands growing on the Grayling sand soil type. Most suitable stands have resulted from forest fires (USFWS 1976). Fire contributes to maintenance of the low ground cover necessary to conceal the warbler's nest, although site quality and shade history are the principal influences (J. Probst, U. S. Forest Service, pers. comm.). Most of the pines in the stand must be 2-5 m in height, and the occurrence of deciduous trees must be limited. To attract and maintain the warblers, a tract must be at least 33 ha in size and

consist of homogeneous thickets of small jack pine interspersed with many small openings. Micro-habitat characteristics important in supporting nesting warblers are poorly understood. Specific information on habitat use and occupancy by nesting Kirtland's warblers is needed by management to create optimum nesting habitat in the future.

Two problems identified early as factors limiting expansion of the Kirtland's warbler population on the breeding grounds were a shortage of nesting habitat (Mayfield 1960) and nest parasitism by brown-headed cowbirds (Molothrus ater) (Walkinshaw 1972). Subsequent habitat management by the U.S. Forest Service (USFS) and Michigan Department of Natural Resources (MDNR) has not yet resulted in a net increase in available habitat. The question of habitat availability is discussed by Ryel (1981) In 1976, about 2000 ha were presumed suitable for use by nesting warblers (USFWS 1976). Prior to initiation of brown-headed cowbird control in 1971, hatching success of Kirtland's warbler averaged about 0.8 young hatched per pair (Walkinshaw 1983). Cowbird control began in 1972, and the reproductive response was immediate. Beginning that year, hatching success increased to 4.0 young hatched per pair. The hatching rate has since varied from 2.0-4.0 young per pair with a mean per nest attempt of 2.74 (Walkinshaw 1983).

The number of adult Kirtland's warblers has remained essentially constant since 1971. The recovery plan called for establishment of 1000 breeding pairs as a recovery goal, although no target date was established for accomplishing the task (USFWS 1976). At the same time, the year 1990 was specified for reaching and maintaining an annual nesting habitat level of 14,600-16,200 ha. This amount of habitat was believed to be enough to support 1000 breeding pairs (USFWS 1976).

Management agencies have not met annual habitat goals of about 1000 ha since initiation of the Recovery Plan. Plantations of jack pines have been established to provide nesting habitat. From the standpoint of the public, plantations are more palatable than wildfire-created stands. However, artifically created and managed habitat is not as attractive to Kirtland's warbler as is wildfire habitat; the birds exhibit a greater use of wildfire habitat than plantations (J. Weinrich, MDNR, pers comm.). Evidence suggests that about 70% of the breeding Kirtland's warblers occupy only 40% of available habitat (MDNR, unpubl. data). The vast majority of the occupied habitat is wildfire-created.

In April 1980, a planned burn of several ha. near Mack Lake, Oscoda County, Michigan, escaped the fire line and ultimately burned over 10,800 ha of land. About 3575 ha of this area now support regenerating jack pine trees and are expected to provide suitable warbler breeding habitat beginning about 1986. The presence of a large, contiguous block of habitat that nearly equals all currently available nesting habitat provides the opportunity to answer a number of questions vital to successful future management of Kirtland's warbler. Because of the extent and age of regenerating jack pine in the Mack Lake Burn Area (MLBA), many biologists believe that a high percentage of the existing breeding Kirtland's warbler population may soon be concentrated there.

This project will address the following Kirtland's Warbler Recovery Plan Tasks:

Task #1--Maintain and develop suitable nesting habitat for Kirtland's warbler throughout its former range.

Task #4--Monitor populations of Kirtland's warbler to evaluate response to management practices and environmental changes.

Objectives

1. Determine the extent and nature of movement and dispersal of Kirtland's warblers from nearby areas to the MLBA; evaluate the rate and extent of colonization of available habitats in the MLBA from adjacent areas.
2. Determine site fidelity and reproductive success of nesting warblers in relation to changes in habitat characteristics and nesting densities.
3. Define characteristics of optimum nesting habitat at MLBA by relating parameters of warbler biology to edaphic, vegetative, and other site variables.
4. Develop a detailed quantitative and qualitative description of optimum nesting habitat to be used by land managers for development of productive habitat areas.

Procedures

Vegetation Sampling

Permanent vegetation sampling points will be established throughout the MLBA. The circular plot sampling technique (James and Shugart 1970), as modified by Noon (1981) will be used to describe habitat characteristics in a circle with a radius of 11.3 m. Vegetation in each circle will be measured once yearly through the duration of the study. Vegetation sampling will be initiated after July 20 when most nesting activities have ceased. Yearly mean habitat parameters will provide an indication of habitat change through time that can be compared to changes in Kirtland's warbler habitat occupancy and nesting success.

Habitat variables to be collected within each circle include the

following adapted from Noon (1981):

1. The diameter at breast height (dbh), 1.3 m above the ground of all live saplings and trees will be recorded by species in each of seven size classes ranging from 3-8 to 53-69 cm. Standing dead trees will be recorded seperately by size class.

2. Shrub density at breast height will be estimated along two transects running in the cardinal directions and centered within the 0.04 ha circle. The observer proceeds along the transect lines counting the number of woody stems 3 cm dbh intersected with his body and outstretched arms. The total number of contacts made in two transects (each 22.6 m long) multiplied by 125 will be used to give an estimate of the number of shrub stems per ha. The contribution of coniferous and deciduous shrubs will be recorded seperately.

3. Canopy cover and ground cover are estimated by sighting through an ocular tube made from a cardboard cylinder with crosshairs at one end. The observer walks along the transect lines used to estimate shrub density sighting up to the canopy and recording the total of 40 plus or minus readings (20 each transect) indicating the presence or absence of green vegetation at the intersection of the cross hairs. Percent canopy cover contributed by coniferous foliage is recorded in addition to total canopy cover. Green vegetation within one meter of the ground is recorded in an identical manner except that the observer sights downward through the tube held about 1 m above the ground. Canopy and ground cover are recorded as percentages (number of hits/40 x 100).

4. Canopy height is expressed as the mean height (in meters) of the canopy within the 0.04 ha circle determined from recording maximum and minimum estimates of 10 trees within the plot.

5. Maximum slope within the circular plot is determined with a clinometer.

6. Indices of tree and log dispersion are gathered from point-quarter techniques. The point is centered in the circle and the quarters are established by the transects used to estimate shrub density. Within each quarter, the distance to and dbh size class of the nearest tree are recorded. Also, the distance to, total length of, and dbh size class of the largest (by diameter) fallen log (1.5 m in length and 8 cm dbh) are recorded. The dbh size class of the log is determined by the maximum dbh attained throughout its length whether lying in the plot or not.

7. Understory foliage volume is estimated with a density board (Wight 1938, DeVos and Mosby 1969). The density board is divided into four height intervals: 0-0.3 m, 0.3-1 m, 1-2 m, and 2-3 m, corresponding to the low ground, high ground, and low and high shrub layers, respectively. The board is placed at each of the four points where the transect lines intersect the edge of the circle. Four readings are made from the center of the circle sighting along each of the transects. The observer counts the number of squares in each height interval at least 50% obscured by foliage and records this number.

8. Dominant shrub species and ground cover (to 1m tall) life forms are recorded in rank order with the most common species, or life form, listed first. The ranking is estimated only in the 0.04 ha circle.

A circular plot technique was selected over line transects because fine-scale habitat characteristics are more readily defined from plots. Transects will only characterize coarse-scale habitat heterogeneity (H.H.Shugart, pers. comm). Several simulation models are available to project the succession of habitat variables in jack pine stands (Shugart

1984). These models are based on 0.04 ha circular plots.

In the first year of the study, 200 vegetation sampling plots will be permanently established in the MLBA. Two hundred sampling plots were selected as the minimum sample size necessary to adequately examine habitat variability in a statistically rigorous manner (B.K. Williams, PWRC Biometrics Section, pers comm). Sample plots will be established randomly within strata based on stand-site characteristics including topography, drainage, soils, orientation, etc. Initial-year data will be used to determine the amount of variability. The exact number of vegetation sampling points to be used for the duration of the study will then be determined.

Movements

Immigration of Kirtland's warblers from surrounding habitat areas to the MLBA is expected. Walkinshaw and Faust (1974) described the rapid build-up in singing males on a 934 ha burn in Crawford County, Michigan. In 1961, there were four males present; by 1966 nearly 100 males occupied the site. Rates of colonization of developing habitats and the degree of site fidelity once an area has been occupied will be determined through color-banding and subsequent observation of warblers. All occupied habitat existing within concentric bands 0-15 km, 15-30 km, and greater than 30 km from the MLBA will be identified on scale maps and aerial photographs. Within each band and inside the MLBA, a minimum of 30 immature and 10 adult Kirtland's warblers will be banded and color-marked annually. Each bird will be marked with one size 1 U. S. Fish and Wildlife Service aluminum leg band and three colored

plastic leg bands in a unique combination to allow individual recognition.

During the first year of field work, banding and handling techniques will be perfected to insure safety of Kirtland's warblers. A maximum sample of 60 birds (20 from each of three concentric bands surrounding the MLBA) will be marked. This effort, although at a minimum level, will serve to perfect capture and handling techniques and will provide additional experience for personnel banding the birds. A yearly color-marking sample of at least 160 birds during the remainder of the study was selected as the minimum sample size necessary to adequately examine emigration and immigration rates, site fidelity, turnover, adult and immature survival, age at first breeding, and other age-related phenomena in a statistically rigorous manner (B. K. Williams, PWRC Biometrics Section, pers. comm).

A gradual shift in banding emphasis away from adjacent natal areas along with an associated increased banding emphasis on the MLBA will be accomplished through the life of the study. One criterion for the cessation of banding and color-marking will be the rate of decrease in breeding population of a particular natal area. For example, if 40 pairs are present in an area during the study's first year, banding will continue until the area supports 10 or fewer pairs in any subsequent year. This population level will be assumed to be related to reduced suitability of the nesting habitat. An increase in banding and color-marking at MLBA will be necessary to determine long-term site fidelity in addition to natal area philopatry.

The entire MLBA will be randomly searched each year for marked birds. Search crews may include well-trained and qualifed volunteers in

addition to U.S. Forest Service, U.S. Fish and Wildlife Service, and Michigan Department of Natural Resources personnel. Subsequent observations of marked warblers will provide data on the distance and direction moved when colonizing new habitats and the extent that marked birds return annually to their established territories. The stage of succession that is most important for colonization will be inferred based on immigration rates and the relationship of reproductive output (discussed below) to successional stage. These data will provide land managers with information useful in determining specific vegetative characteristics that are optimal for attracting and supporting maximum numbers of breeding Kirtland's warblers and for maximizing reproduction.

Reproductive Success

Walkinshaw and Faust (1974) made weekly visits to nesting areas but reported no human-related mortality. Walkinshaw (1983) reported on observations of reproductive success at 339 nests; no mention was made of mortality attributable to his presence at or near the nest. Territory establishment among Kirtland's warblers begins with the arrival of the first males in mid-May and activity is heightened when the females arrive in late May. Walkinshaw (1983) reported that the mean date of first egg laying was May 31 (range May 21-June 12). Dates of maximum egg laying range from June 6-13, while dates of maximum numbers of nestlings present are from June 18-27 (Walkinshaw 1983). The mean date for the last nestling leaving the nest is July 29.

The above information points to the need for field workers to be

present in the nesting territories from about May 20-July 31 each year. At least 15 Kirtland's warbler nests will be examined twice-weekly in the MLBA each year to determine clutch size, hatching success, fledging success, and causes of nest loss. A yearly sample size of at least 15 nests was selected as the minimum necessary to adequately examine nest-related data in a statistically rigorous manner (B.K. Williams, PWRC Biometrics Section, pers comm).

A pilot study will be conducted in habitat areas adjacent to the MLBA to examine the relationship of nest visitation to nesting success. In this study, a sample of 15 randomly selected nests (controls) of Kirtland's warbler will be examined only at the onset of incubation and then at the approximate date of fledging. The only data collected will be clutch and brood size. At the approximate time of fledging, the number of young in the nest will be recorded. A second set of 15 randomly selected nests (experimental) will be visited during the onset of egg-laying and incubation and then twice weekly until fledging. Relative success of the control and experimental nests will be examined to determine if frequent nest visitation contributes significantly to failure of the nesting effort.

Seperate data will be collected on the degree of matedness of color-marked male Kirtland's warblers. Preliminary information from other areas in the species' nesting range suggests that only about 60% of the adult males are actually mated (J.Probst, USFS, pers comm.). If this is the case, then previous estimates of reproductive output and the number of young fledged are grossly overestimated. Field evidence suggests that observation of a male for up to 90 min will confirm its mated status (J. Probst, unpubl. data). The data obtained from this

investigation will provide a yearly index that can be used with other nesting data to refine estimates of reproductive output.

Hatching and fledging success will be calculated using the Mayfield method (Mayfield 1961, 1975). This technique, which is based on nest exposure days, provides an accurate estimate of reproductive success. Numbers of eggs lost per egg-day will also provide an indication of the rate of predation on Kirtland's warbler nests.

Habitat characteristics at each nest site will be quantified using the circular plot technique described by Noon (1981). These data will be gathered after the young leave the nest and in the same manner as the study area-wide vegetation analysis. Habitat data will be examined to relate reproductive success to any micro-habitat differences that may exist between the large-scale characteristics of the habitat versus that used for nest site selection, and for temporal changes in nest site selection related to size, composition, and physiognomy of the vegetation.

Review

Yearly research findings will be reviewed by the Chief, Endangered Species Research Branch, Patuxent Wildlife Research Center, and by the U.S. Fish and Wildlife Service Endangered Species program. The purpose of the reviews, especially during the initial pilot studies, will be to provide an assessment of the degree of risk being placed on the birds studied. If evidence suggests a high degree of risk, then appropriate steps will be taken to alter study procedures to reduce the risk to an acceptable level.

Location

Field work will be conducted in the MLBA, Oscoda County, Michigan. The work will be conducted through the Southeast Field Station, Patuxent Wildlife Research Center, Athens, Georgia.

Completion Report Due

Research findings will be summarized in annual reports submitted to the Patuxent Wildlife Research Center. Interim manuscripts that report significant findings will be produced in FY 92; final manuscripts and reports will be completed during FY 98 and FY 99.

Work Schedule

Field work will extend from May 15 to September 15 each year from 1988 through 1999 (tentatively). The research will continue to the point where MLBA no longer attracts new Kirtland's warblers, or preferably until the warblers cease nesting attempts there. This may or may not correspond with the stated 12-year duration of the study. If indicated, plans will be made by FY 95 to extend or abbreviate the project.

First Year: Establish 200 permanent vegetation sampling points; measure vegetation and analyze initial year's data; survey and identify on maps and aerial photographs habitat occupied by Kirtland's warbler adjacent to MLBA; mist net, band and color mark at least 60 Kirtland's

warblers. Survey MLBA for presence of Kirtland's warblers and quantify habitat use by marked birds. Determine reproductive success from a pilot study of nesting warblers on the MLBA, and assess the degree of risk to nesting birds from nest examination. Measure specific vegetation characteristics at nest sites after birds have fledged.

Second through final year: Establish permanent vegetation sampling points based on initial year's data. Continue to conduct field work outlined under first year. Complete statistical analyses of data and formulate research recommendations and future management strategies.

Investigators

To be assigned

Budget and FTE Requirements

	Costs (x $1000)		
	FY 88	FY 89-98	FY 99
Salary	75	129	135
Equipment	6	3	
Support Services and Overhead	69	103	98
Travel	15	15	7
Total	165	250	242
FTE	2.0	2.0	2.0

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