Kirtland's Warbler
(*Dendroica kirtlandii*)

5-Year Review:
Summary and Evaluation

Kirtland's warbler male in breeding plumage, Adams County, Wisconsin, 2008. Photo credit: Joel Trick, USFWS

U.S. Fish and Wildlife Service
East Lansing Field Office
East Lansing, Michigan

5-YEAR REVIEW

Species reviewed: Kirtland's warbler

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5-YEAR REVIEW
Kirtland's warbler (*Dendroica kirtlandii*)

1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2 Methodology used to complete the review

The United States Department of Interior Fish and Wildlife Service (Service) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12) as required by section 4(c)(2) of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), as amended Public Law 93-205 (Act). The Service announced this status review via the *Federal Register* notice (72 FR 41348-41350) and requested new scientific or commercial data and information that may have a bearing on the classification of the Kirtland's warbler (*Dendroica kirtlandii*) as an endangered species.

Biologists from the Service's East Lansing Field Office (ELFO) conducted this review in coordination with the cooperating field office and the Midwest Regional Office. On January 9, 2008, the Service held a workshop with members of the Kirtland's Warbler Recovery Team and other invited participants to develop an outline for the threats analysis section of this review. The Service also incorporated input from the Kirtland's Warbler Recovery Team and other experts into this review. According to the requirements described in the Service's 2006 Interim 5-Year Review Guidance, peer review is not necessary if the 5-year review results in a recommendation to change the status of the species because peer review will be conducted when the proposed rule to change the species' status is issued. Due to the recommendation to change the Kirtland's warbler status contained herein, we have not conducted a peer review at this time.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review:

72 FR 41348-41350 (July 27, 2007) Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Reviews of Three Wildlife Species and Two Plant Species in the Midwest Region.

1.3.2 Listing history

FR notice: 32 FR 4001
Date listed: March 11, 1967
Entity listed: Species
Classification: Endangered

1.3.3 Associated rulemakings

None

1.3.4 Review History

Kirtland's warbler was included in the following cursory 5-year reviews: May 21, 1979, for species listed prior to 1975 (44 FR 29566); July 22, 1985, for species listed before 1976, and in 1979 and 1980 (50 FR 29901); and November 6, 1991, of all species listed before January 1, 1991 (56 FR 56882). These 5-year reviews resulted in no change to the Kirtland's warbler listing classification of endangered.

1.3.5 Species' Recovery Priority Number at start of 5-year review

2C, indicating a species with a high degree of threat, a high potential for recovery, and conflict with the management and use of essential habitat located on military lands actively used for training, in northern Michigan.

1.3.6 Recovery Plan or Outline

Name of plan: Kirtland's Warbler Recovery Plan: 1985 Update
Date issued: September 30, 1985
Date of previous revisions: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

Yes

2.1.2 Is the species under review listed as a DPS?

No

2.1.3 Was the DPS listed prior to 1996?

Not Applicable

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

No. New information, which has become available since the issuance of the 1985 recovery plan, is not reflected in the current recovery criteria. The recovery criteria (objectives) in the 1985 revised recovery plan are generally appropriate measures of recovery, although some of the recovery objectives have since been clarified and amended (Ennis 2002; Thorson 2005).

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

No. The objectives in the 1985 revised plan address some, but not all five of the listing factors for the species.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The primary objective of the plan is to reestablish a self-sustaining Kirtland's warbler population throughout its known range at a minimum level of 1,000 pairs. Attainment of this objective will allow the species to be removed from the endangered species list.

The numeric goal of 1,000 pairs was reached and surpassed in 2001, and the population has remained above that level every year since then. The Kirtland's warbler population, however, is not a true self-sustaining population (Ennis 2002). The Kirtland's warbler population persists only through intensive management focused on development of appropriately aged stands of jack pine (*Pinus banksiana*) and removal of brown-headed cowbirds (*Molothrus ater).* A true self-sustaining population (i.e., one that is free from intensive management) is currently not possible (Ennis 2002). Modification of the primary objective due to updated information is discussed in section 2.3.

Secondary objectives, designed to accomplish the primary objective, are as follows:

1. Manage 127,600 acres for the Kirtland's warbler. Encourage management on private lands.

> This secondary objective has been met, but new information indicates that this acreage is not adequate to maintain a Kirtland's warbler population of 1,000 pairs (See section 2.3).
>
> Informational and educational programs, including guided tours, are conducted on the breeding grounds on an annual basis. In addition, numerous presentations are also given throughout the year to various groups on the wintering grounds. These forums allow public review and input to the habitat management program.

2. Protect the Kirtland's warbler on its wintering grounds and along the migration route.

> This secondary objective has not been fully met. The Commonwealth of The Bahamas has established regulations that protect the Kirtland's warbler from direct impacts and enable the protection of wintering habitat (See section 2.3.2.4). The Commonwealth of The Bahamas has also endorsed biodiversity conservation (National Biodiversity Strategy and Action Plan 1999). A comprehensive national system of parks, protected areas, and reserves are being developed for the conservation of biodiversity. The existing system of 26 national parks encompasses over 700,000 acres, some of which may provide wintering habitat for Kirtland's warbler (Bahamas National Trust 2009). In addition, the Kirtland's Warbler Research and Training Program (a cooperative effort involving several government and non-government organizations in the U.S. and Bahamas) has enhanced our understanding of wintering Kirtland's warblers and their habitats, and has also supported the development of expertise within the Bahamian conservation community (Ewert et al. 2009). Our understanding of migration patterns or threats along the migration route remains poor, in comparison.

3. Reduce key factors adversely affecting reproduction and survival of Kirtland's warbler.

> This secondary objective has been met. Human activities which may be detrimental to the Kirtland's warbler population have been controlled. Kirtland's warbler habitat is protected during the breeding season by

closure of the habitat to unauthorized use. Access is granted through Federal and State permits only. In addition, informational and educational programs advocate for protection on the breeding and winter range and during migration. Take and harassment of Kirtland's warblers as defined in the Act has also been prevented in compliance with federal and state regulations (See section 2.3.2.4).

Other factors that adversely affect the Kirtland's warbler, such as nest parasitism by brown-headed cowbirds, have been controlled. Brown-headed cowbird control has been conducted on an annual basis since 1972 (Elbert and Mensing 2010). Cowbird control has been strongly linked to increased reproduction of Kirtland's warblers (Cuthbert 1966; Kelly and DeCapita 1982). However, the effectiveness of cowbird control has not been monitored since the early 1980s.

4. Monitor breeding populations of the Kirtland's warbler to evaluate responses to management practices and environmental changes.

This secondary objective has been met. A census of singing males is conducted annually throughout all known and potential nesting habitat in Michigan. More recently, annual surveys have been initiated in both Wisconsin and Ontario, Canada. The census results are used to determine overall population trends.

5. Develop and implement emergency measures to prevent extinction.

This secondary objective has been met. Bocetti (1991) developed techniques to bring warblers into captivity for long periods of time and reintroduce them into new areas with suitable habitat, if the total population were to drop below 100 pairs. However, the Kirtland's warbler population has never dropped below 100 pairs, and the implementation of emergency measures has not been necessary. The future need for emergency measures is also unlikely given the population increase of Kirtland's warblers to record high levels.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Physical Appearance and Molts

The Kirtland's warbler is a relatively large, long-tailed and heavy-billed wood warbler, measuring approximately 14 cm in length and 12-15 g in weight (Mayfield 1960; Walkinshaw 1983; Dunn and Garrett 1997). Compared to other wood warblers, the Kirtland's warbler has a noticeably longer tarsus (Walkinshaw 1983). The plumage is generally bluish-gray on the upperparts and heavily streaked with black on the back. The throat, breast and belly are lemon-yellow in color and streaked in black on the sides and flanks, becoming white on the undertail coverts. The species is further distinguished by a broken white eye-ring split in front of and behind the eye. Kirtland's warblers are also identified by their habit of tail-pumping, similar in behavior to palm warblers (*Setophaga palmarum*) and prairie warblers (*Setophaga discolor*).

Males are brighter in color than females and have black lores during the breeding season. Juvenile birds are predominately grayish-brown, with heavily splotched, lighter colored feathers on the breast and belly. Plumage variation in males is fairly continuous from second-year to third-year to after-third-year, where overall plumage becomes more distinctive and brighter with age (Probst et al. 2007). Most males attain definitive alternate plumage by their second breeding season, and Probst et al. (2007) were able to distinguish after-second-year males from second-year males with 78.3% accuracy.

In autumn, the male warbler's bluish-gray plumage becomes mixed with brown, which makes it difficult to distinguish males from females and adults from hatch-year birds (Sykes et al. 1989). Post-breeding molt begins at about the time males stop singing (July 4^{th} – August 15^{th}) and lasts approximately 40 days (Sykes et al. 1989). Adult birds also undergo one partial, pre-breeding molt (body feathers only) on their wintering grounds between February and April (Mayfield 1992). At about 26 days of age, hatch-year birds undergo a post-juvenal molt, which lasts until the approximate age of 43 days (Mayfield 1992).

Diet and Foraging Behavior

Kirtland's warblers are primarily insectivorous and forage by gleaning pine needles, leaves, and ground cover, occasionally making short sallies, hover-gleaning at terminal needle clusters, and gathering flying insects on the wing. Kirtland's warblers have been observed foraging on a wide variety of prey items, including various types of larvae, moths, flies, beetles, grasshoppers, ants, aphids, spittlebugs, blueberries, pine needles, and pitch from twigs and jack pine (Mayfield 1960; Walkinshaw 1983; Fussman 1997). DeLoria et al. (2001) identified similar taxa from fecal samples collected from Kirtland's warblers but also observed that from July to September, homopterans (primarily spittlebugs), hymenopterans (primarily ants) and blueberries were proportionally greater in number than other taxa among samples. DeLoria (2001) suggested that differences in the relative importance of food items between spring foraging observations and late summer fecal samples were temporal and reflected a varied diet that shifts as food items become more or less available during the breeding season. Within nesting areas, arthropod numbers peak at the same time that most first broods reach the fledging stage (Fussman 1997). Planted and wildfire regenerated habitat were extremely similar in terms of arthropod diversity, abundance, and distribution, suggesting that current habitat management techniques are effective in simulating the effects that wildfire has on food resources for Kirtland's warblers (Fussman 1997).

Fussman (1997) observed that Kirtland's warblers foraged predominately from jack pines, and to a lesser degree from oak and ground vegetation. However, if oak trees were available, Kirtland's warblers used them for foraging, indicating that oak may be beneficial to the species. In jack pines, most foraging activities were observed in the middle half of trees, especially within wildfire regenerated habitat, though females tended to forage lower in height than males. Overall, Fussman (1997) found that the amount of food was similar among differently aged jack pine stands, but tended to shift vertically in abundance within trees as stand age increased. There was some evidence that the vertical distribution of prey abundance within jack pine trees, especially of larvae, may be related to the warbler's selection of younger stands and rejection of stands older than 20 years.

Wunderle et al. (2010) observed a direct correlation between fruit availability and Kirtland's warbler density on the wintering grounds. Seventy percent of Kirtland's warblers consumed fruits, such as snowberry (*Chiococca alba*), wild sage (*Lantana involucrate*), and black torch (*Erithalis fruticosa*), with wild sage being the overwhelmingly predominant food choice (Wunderle et al. 2010). Goat farming may be especially favorable for Kirtland's Warblers as goats appear to consume many shrub species that compete with wild sage and black torch, resulting in habitat patches with high concentrations of these fruiting species (Ewert et al. 2009).

By using isotope signatures found in the blood, feathers, and nails of Kirtland's warbler, Dr. Peter Marra (Smithsonian Environmental Research Center) and Ph.D. student Sarah Rockwell are currently testing the hypothesis that winter habitat and diet can influence arrival times and reproductive success (Marra 2009). The carbon, nitrogen, and hydrogen isotopes identified can subsequently help determine the habitat type, diet, and latitude, respectively, which the Kirtland's warblers are using on their wintering grounds and migration.

Mating and Reproduction

Pair formation normally begins within one week after arrival on the breeding grounds (Mayfield 1992). During the breeding season, Kirtland's warblers may be monogamous or polygynous. Both monogamous and polygynous males establish and maintain multiple territories, and males may opportunistically change mating status from year to year (Bocetti 1994). Polygyny is spatially and temporally widespread across the Kirtland's warbler breeding range, occurring in stands of all ages, isolated stands, as well as stands that are part of a complex (Bocetti 1994). Bocetti (1994) found that males in wildfire stands had more mates than those in plantations. In wildfire stands, 8% of males were unmated and 22% had 2 females (Bocetti 1994). In plantations, 28% of males were unmated and only 6% had 2 females (Bocetti 1994). Data collected in 2007, 2008, and 2009, shows fewer than 10% of males were unmated in plantations (Sarah Rockwell, Ph.D. candidate University of Maryland, unpubl. data), which likely reflects improvements to management techniques.

Bocetti (1994) found that nests are preferentially placed towards the center of territories and hypothesized that females avoid placing nests near the edge of territory boundaries. Nests, which are composed of 50% coarse sedge (*Carex pennsylvanica*), up to 30% red pine needles (*Pinus resinosa*), and twigs of blueberry (*Vaccinium augustifolium*) and other woody plants, are embedded in the ground and concealed by grasses and other low lying vegetation (Southern 1961; Mayfield 1992). Surrounding vegetation is generally 10-30 cm in height and may include bluestem grasses (*Andropogon* spp.), sedges (*Carex* spp.), blueberry, northern dwarf cherry (*Prunus pumila*), bearberry, (*Arctostaphylos uva-ursi*), and sweet fern (*Comptonia peregrina*) (Smith 1979, Buech 1980). Pine needles and oak leaves also litter the ground adjacent to nests.

The first egg is laid on the day following completion of the nest, with the rest laid on successive days (Mayfield 1992). Eggs are ovoid, pale buff, whitish, or faintly pinkish with varying amounts of fine brown spots gathered in a cap or wreath pattern at the larger end of the egg (Mayfield 1992). Egg-laying takes five to six days during the first nesting attempt, and four days for subsequent nests, such that five eggs are usually laid in the first clutch and four eggs in replacement clutches (Mayfield 1960). The earliest first-egg date on record is May 17th (Rockwell, unpubl. data), which is close to Mayfield's (1960) estimate of May 16th as the first date that nests could be initiated. Mayfield (1960) found that 80% of nests were completed before June 15th, which is concurrent with more recently gathered data that shows June 1st as the average date of the first egg laid (Rockwell, unpubl. data). The latest first-egg date on record is June 30th (Rockwell, unpubl. data), which is consistent with earlier records of late season nesting attempts (June 28 see Berger and Radabaugh 1968, and July 2 recorded in 1990 at Ogemaw Plantation by Carol Bocetti, University of California at Pennsylvania, pers. communication, 2011). A total of 39 double broods have been recorded since 1954 (Mayfield 1960; Radabaugh 1972; Orr 1975; Rockwell, unpubl. data), with the majority of these occurrences observed since 2007. Approximately 10-12% of pairs will attempt a second nest after successfully fledging young (Rockwell, unpubl. data). Overall, clutches averaged 4.59 eggs per nest attempt and did not differ significantly between planted and wildfire-regenerated habitat (Bocetti 1994). The largest clutch of eggs found in a non-parasitized Kirtland's warbler nest is seven (Rockwell, unpubl. data). Incubation is done by the female, beginning on the day before the laying of the last egg, and continues for 13 to 15 days (mean = 14.2 days) (Walkinshaw 1983). Young fledge the nest at a mean of 9.4 days after hatching (Mayfield 1992).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Abundance and Population Trends
The Kirtland's warbler may have the most geographically restricted distribution of any mainland bird in the continental U.S. Nesting habitat within the jack pine forest is both highly specific and disturbance-dependent and has probably always been limited in the extent to which it naturally occurs (Mayfield 1960, 1975). Similarly, the known wintering range is restricted to the Bahamas archipelago. The size of the Kirtland's warbler population has likely fluctuated with gross trends in the extent of suitable habitat within these narrow confines, and it is improbable that the species has ever been particularly abundant during the past 10,000 years (Mayfield 1975).

Extrapolated population trends prior to 1951
Prior to 1951, the size of the Kirtland's warbler population has been extrapolated from anecdotal observations and knowledge about habitat conditions. The Kirtland's warbler population presumably peaked in the late 1800s, a time when conditions across the species distribution were universally beneficial (Mayfield 1960). Wildfires associated with intensive logging and agricultural burning in the Great Lakes region created an estimated 200,000 acres of early-successional jack pine forest annually, with most of it in large tracts (Zimmerman 1956; Pyne 1982). Widespread agriculture, associated with a period of intense commercialization in The Bahamas, was also decreasing, and suitable winter habitat consisting of low coppice (early-successional and dense, broadleaf vegetation) was becoming more abundant (Sykes and Clench 1998). Furthermore, brown-headed cowbirds had not yet become established within the Kirtland's warbler breeding range. During this time, Kirtland's warblers were found on nearly all of the islands in The Bahamas, and reports of migratory strays originated far west of the known breeding range (Mayfield 1993).

Between the early 1900s and the 1920s, agriculture in the north woods was being discouraged in favor of industrial tree farming and systematic fire suppression (Brown 1999). Mayfield (1960) estimated the amount of jack pine on the landscape suitably aged for Kirtland's warblers had decreased to approximately 100,000 acres annually. This reduction in habitat amount presumably resulted in fewer Kirtland's warblers from the preceding time period. Serious efforts to control forest fires in Michigan began in 1927, and resulted in a further reduction of total acres burned, as the number of wildfires decreased and the size of forest tracts that burned decreased (Mayfield 1960; Radtke and Byelich 1963). Brown-headed cowbirds had also become common within the Kirtland's warbler nesting range by this time (Wood and Frothingham 1905), and Kirtland's warblers had declined to the point where they occupied only a fraction of the available breeding habitat (Mayfield 1960).

Measured population trends, 1951 to 2011

Comprehensive surveys of the entire Kirtland's warbler population began in 1951. Because of the warbler's specific habitat requirements and the frequent, loud and persistent singing of males during the breeding season, a singing male census was established (Ryel 1976), and continues to provide a robust, relative index of Kirtland's warbler population change (Probst et al. 2005). The census was first conducted in 1951, again in 1961, and has been conducted every year since 1971 (Huber et al. 2011). The 1951 census documented a population of 432 singing males, confined to 28 townships in eight counties in northern Lower Michigan (Mayfield 1953). By 1971, there were about 10,130 acres of suitable nesting habitat available, the Kirtland's warbler population crashed to approximately 201 singing males, and was restricted to just 16 townships in six counties in northern Lower Michigan (Probst 1986). Following listing under the Endangered Species Preservation Act, the Kirtland's warbler population level remained relatively stable at approximately 200 singing males but experienced record lows of only 167 singing males in 1974 and again in 1987. Shortly after 1987, the population began a dramatic increase, reaching a record high of 1,828 singing males in 2011 (MDNR, unpubl. data; Figure 1).

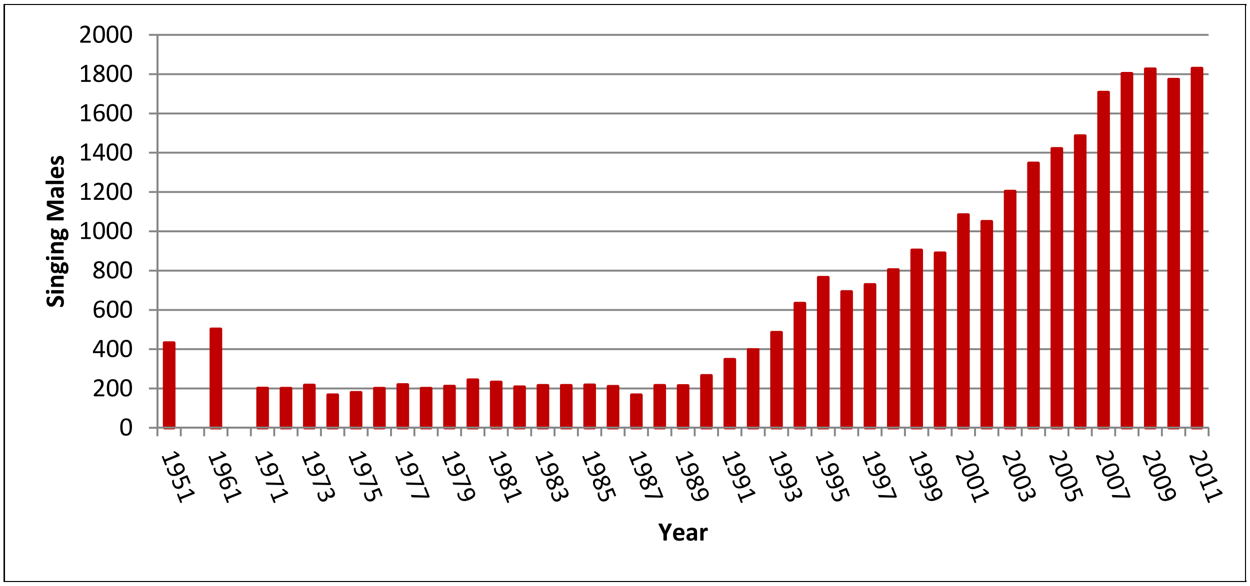

Figure 1. Kirtland's warbler singing male census results, 1951, 1961, 1971-2011 (MDNR data).

Influence of habitat amount on population trends
Since the implementation of the brown-headed cowbird control program, the Kirtland's warbler population size has closely tracked the amount of suitable habitat on the landscape in northern Lower Michigan (Donner et al. 2008). Overall, the amount of suitable habitat increased by nearly 150% from 1979 to 2004, primarily due to forest management that produced a four-fold increase in planted habitat as well as an increase in the mean size of planted stands. From 1979 to 1987, the amount of suitable habitat on the landscape was below 30% of the total landscape and declining, and the male warbler population returned to a record low in 1987. Between 1988 and 1994, the amount of suitable habitat on the landscape increased from 30 to 40% of the total landscape due to the Mack Lake Burn and new silvicultural techniques, and the population tripled in male warbler numbers. From 1994 to 2004, the amount of habitat on the landscape remained near 40% of the landscape, and the population continued to increase. Artificial regeneration of suitable habitat has been critical to Kirtland's warbler dramatic rebound in population size.

Demographic features and trends
Since the issuance of the updated recovery plan in 1985, Bocetti (1994) and Rockwell (unpubl. data) have collected new demographic information on reproductive success. Bocetti (1994) conducted nest searches in wildfire-regenerated and planted habitat in 1990, 1991, and 1992, and found a total of 73 nests (41 in wildfire regenerated sites and 32 in plantation sites). Forty-eight of those nests successfully fledged chicks, 14 were depredated, 1 was parasitized (but successfully fledged young), and 10 were of undetermined fate. Bocetti observed 158 males during the study, of which 29 males were polyterritorial, though only 20 males had

females on both territories. Annual production of young was 3.59 young fledged per nest attempt overall, and did not significantly vary between planted or wildfire-regenerated habitat. Rockwell (unpubl. data) conducted nest searches in 2007, 2008, and 2009 and found a total of 279 nests, primarily in planted habitat. Of the 279 nests found, 190 successfully fledged chicks, 72 were depredated, 3 were abandoned during building, 7 failed (never hatched), 3 were parasitized, and 4 were of undetermined fate. All 3 parasitized nests were found during the nestling stage, but despite removal of cowbird chicks, none fledged any warblers. The majority of these nests (213) were first attempts, but Rockwell also observed 35 renests following the depredation of a first attempt and 25 second nests after the successful fledging of a first nest. Only 6 of the 279 nests resulted from polyterritoriality with second females. Annual production of mated males averaged 3.52 offspring per nest attempt.

The average life expectancy of adults is approximately two and a half years (Walkinshaw 1983). The oldest Kirtland's warbler on record was an eleven-year old male, which, when recaptured in the Damon Kirtland's Warbler Management Area (KWMA) in 2005, appeared to be in good health and paired with a female (United States Department of Agriculture Forest Service [USFS], unpubl. data). Walkinshaw (1983) suggested that mortality is greatest for adult and juvenile Kirtland's warblers during migration or on their wintering grounds, where many factors are likely to affect survival. Rockwell (unpubl. data) found that monthly survival rates during summer were higher than monthly survival rates pooled from winter and migratory periods.

Table 1. Annual survival estimates for different age and sex classes of the Kirtland's warbler.

Study	**Years**	**Age**	**Sex**	**Number**	**Survival Estimate**
Mayfield 1960*	1931-1957	AHY	Males	32	0.50
			Females	76	0.29
Berger and Radabaugh 1968*	1958-1966	AHY	Males	19	0.58
			Females	34	0.38
Walkinshaw 1983*	1972-1977	AHY	Males	63	0.62
			Females	62	0.41
		HY	Males	27	0.74
			Females	20	0.57
Bocetti et al. 2002 **	1986-1992	AHY	Males	259	0.65
			Females		0.62
		HY	Males	523	0.46
			Females		0.37
Rockwell unpubl. **	2006-2010	ASY	Males	217	0.59
		SY	Males	154	0.55
Trick unpubl.*	2008-2011	AHY	Males	35	0.89

*AHY, After-hatch-year birds; HY, hatch-year birds; ASY, after-second year birds; SY, second-year birds; M, males; F, females. * Any banded bird that escaped detection in years following banding was assumed to have perished. ** Detection probabilities were taken into account in calculation of survival estimate.*

Overall, Kirtland's warbler annual survival estimates (Table 1) are relatively high compared to those of non-endangered wood warblers, which ranged from 0.32 for the blackpoll warbler (*Setophaga striata*) to 0.66 for the golden-winged warbler (*Vermivora chrysoptera*), and averaged 0.47 across the wood warbler family (DeSante and Kaschube 2009). In order to maintain population numbers, Ryel (1981) estimated that 35% of young need to survive their first year of life in order to compensate for losses due to adult mortality. Studies indicate that survival rates are above the minimum needed to sustain the population (Table 1).

Within an individual nesting area, Kirtland's warblers generally grow in number for three to five years after colonization, level off for four to seven years, and then decline rapidly for three to five years (Probst 1986; Figure 2). Initial colonization of a jack pine stand may occur somewhat at random, with subsequent colony growth stemming from conspecific attraction and the recruitment of yearlings fledged primarily in other colonies (Ryel 1979). Most adults tend to return to the same nesting area year after year (Berger and Radabaugh 1968). Yearlings, however, are more likely to disperse to nesting areas other than the ones where they fledged (reviewed in Ryel 1979). For example, a female banded as a nestling in 1963 was not recaptured the following year, but was discovered 45 miles from the banding site in 1965 (Radabaugh et al. 1966). Failure to replace older birds with new recruits can cause a colony to decline rapidly in number (Ryel 1979). This pattern of individual colony growth and decline affects overall population levels, since population increases will occur only through the formation of new colonies. However, a habitat patch can support a colony for only a short period of time, and so the balance between the amounts of newly created habitat and aging habitat ultimately impacts overall population trends of the Kirtland's warbler.

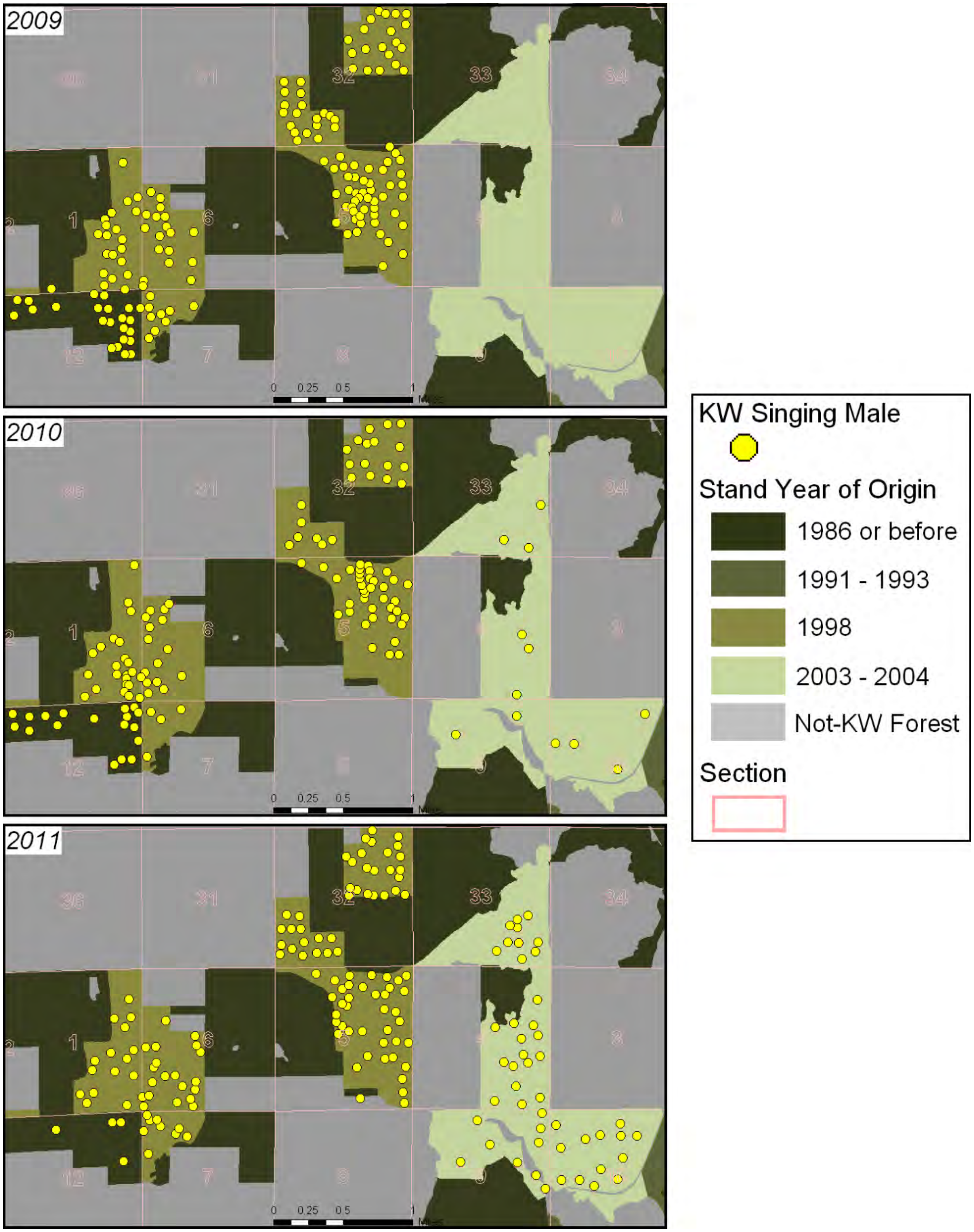

Figure 2. Location of male Kirtland's warblers and temporal buildup and decline of male numbers within individual jack pine stands of varying ages from 2009 to 2011 in the Pere Cheney Kirtland's Warbler Management Area, Crawford Co.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Kirtland's warblers display winter and breeding-ground panmixia. In 2007, eight birds examined from six different wintering sites on Eleuthera Island, The Bahamas were found on breeding territories in the Damon KWMA in Ogemaw County, Michigan (David Ewert, The Nature Conservancy, unpubl. data). Additionally, four other warblers banded from one wintering site on Eleuthera Island were found on breeding territories across four counties in northern Lower Michigan. Kirtland's warblers are also known to regularly move between geographic colonies on their breeding grounds (Probst et al. 2003). This suggests that the Kirtland's warbler's population exhibits panmictic rather than metapopulation demographic characteristics (Elser 2000). King et al. (2005) analyzed blood samples from 14 wintering Kirtland's warblers on Eleuthera Island and isolated 23 microsatellite DNA markers from these individuals. From this sample, King et al. (2005) concluded that the species does not display a geographically distinct genetic population structure and there is adequate gene flow among colonies.

2.3.1.4 Taxonomic classification or changes in nomenclature:

The Kirtland's warbler is classified in the Order Passeriformes, Family Parulidae. Spencer Baird originally described this species in 1852 and named it *Sylvicola kirtlandii* after Dr. Jared P. Kirtland of Cleveland, Ohio (Baird 1872). The American Ornithologists' Union Committee on Classification and Nomenclature-North and Middle America recently changed the classification of the Parulidae, which resulted in three genera (*Parula*, *Dendroica*, and *Wilsonia*,) being deleted and transferred to the genus *Setophaga* (Chesser et al. 2011). This decision was based on phylogenetic analyses of sequences of mitochondrial and nuclear DNA (Lovette et al. 2010), which indicated that all species formerly placed in *Dendroica*, as well as the hooded warbler, (*Wilsonia citrine*), the northern parula, (*Parula Americana*), and the tropical parula, (*Parula pitiayumi*), form a clade with the American redstart (*Setophaga ruticilla*). The generic name, *Setophaga*, had priority for this clade; so, the American Ornithologists' Union re-named the Kirtland's warbler as *Setophaga kirtlandii* and placed the species between the American redstart and the Cape May warbler (*Setophaga tigrina*) (Chesser et al. 2011).

Until *Setophaga kirtlandii* is formally accepted by the Service for the purposes of the ESA via Final Rule in the Federal Register, however, we continue to refer to the species as *Dendroica kirtlandii.*

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Breeding Grounds

Kirtland's warblers are not evenly distributed across their breeding range. More than 98% of all singing males have been counted in northern Lower Michigan since monitoring began in 1951 (MDNR, unpubl. data). The core of the Kirtland's warbler breeding range is concentrated in five counties in northern Lower Michigan (Ogemaw, Crawford, Oscoda, Alcona, and Iosco), where more than 86% of the singing males have been recorded since 2000, with nearly 33% counted in Ogemaw County alone and approximately 15% in just one township (MDNR, unpubl. data; Figure 3). The current distribution still reflects a collapse to the heart of the breeding range following the population crash in the 1960s.

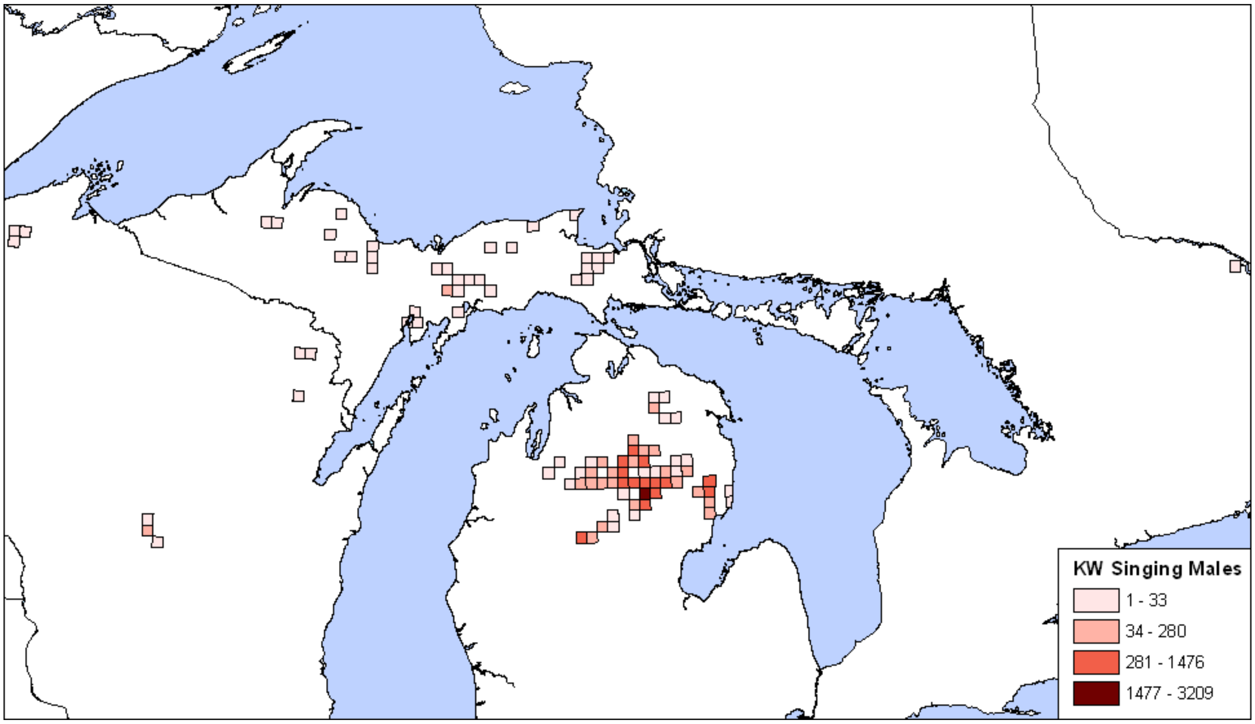

Figure 3. Frequency of Kirtland's warbler singing males counted per township from 2000-2011.

Kirtland's warblers have also been observed in Ontario since 1900 (Samuel 1900) and in Wisconsin since the 1840s (Hoffman 1989). Systematic searches for the presence of Kirtland's warblers in states and provinces adjacent to Michigan, however, did not begin until 1977 (Aird 1989; Hoffman 1989). Shortly after these searches began, male Kirtland's warblers were found on territory in Ontario (in 1977), Quebec (in 1978), Wisconsin (in 1978), and the Upper Peninsula of Michigan (in 1982) (reviewed in Aird 1989). Nesting was confirmed in the Upper Peninsula in 1996 (Weinrich 1996; Weise and Weinrich 1997) and in Wisconsin and Ontario in 2007 (Richard 2008; Trick et al. 2008). In Wisconsin, nesting pairs have been recorded at three locations in Adams County every year since 2007 and once in Marinette County in 2009. Scattered observations of mostly solitary birds have also occurred in recent years at several other sites in Marinette, Bayfield, Douglas, Vilas, Washburn, and Jackson counties in Wisconsin (Joel Trick, U.S. Fish and Wildlife Service, pers. comm. 2011). Similarly in Ontario, nesting pairs have been recorded at Canadian Forces Base Petawawa in Renfrew County every year since 2007 (Paul Aird, University of Toronto, pers. comm. 2007, 2011).

In 2011, the number of singing males in Wisconsin (21), Ontario (2), and the Upper Peninsula (34) represented 3% of the total male population (MDNR, unpubl. data). This recent increase may be related to local recruitment or dispersion from the primary breeding grounds in northern Lower Michigan. For example, 23 males have been banded in Adams County, Wisconsin since 2008. However, none of these birds were banded as hatch-year birds (Trick, pers. comm. 2011), making conclusions regarding their origin tenuous.

Wintering Grounds

A long-standing body of evidence dating to 1841 when the very first specimen was collected off the coast of Abaco Island (Baird 1872; Figure 4) indicates that Kirtland's warblers winter almost exclusively within the Bahamas archipelago. Haney et al. (1998) found that only three of 107 reports originated from outside of The Bahamas- two sightings from northern Dominican Republic and one sighting from coastal Mexico (Figure 5). In addition, two recent winter reports of solitary individuals have originated from Bermuda (Amos 2005) and Cuba (Isada 2006). Eleuthera Island supports the largest known population of wintering Kirtland's warblers (Ewert et al. 2009); though other islands have not been studied as intensively and potentially support numbers comparable to those on Eleuthera Island.

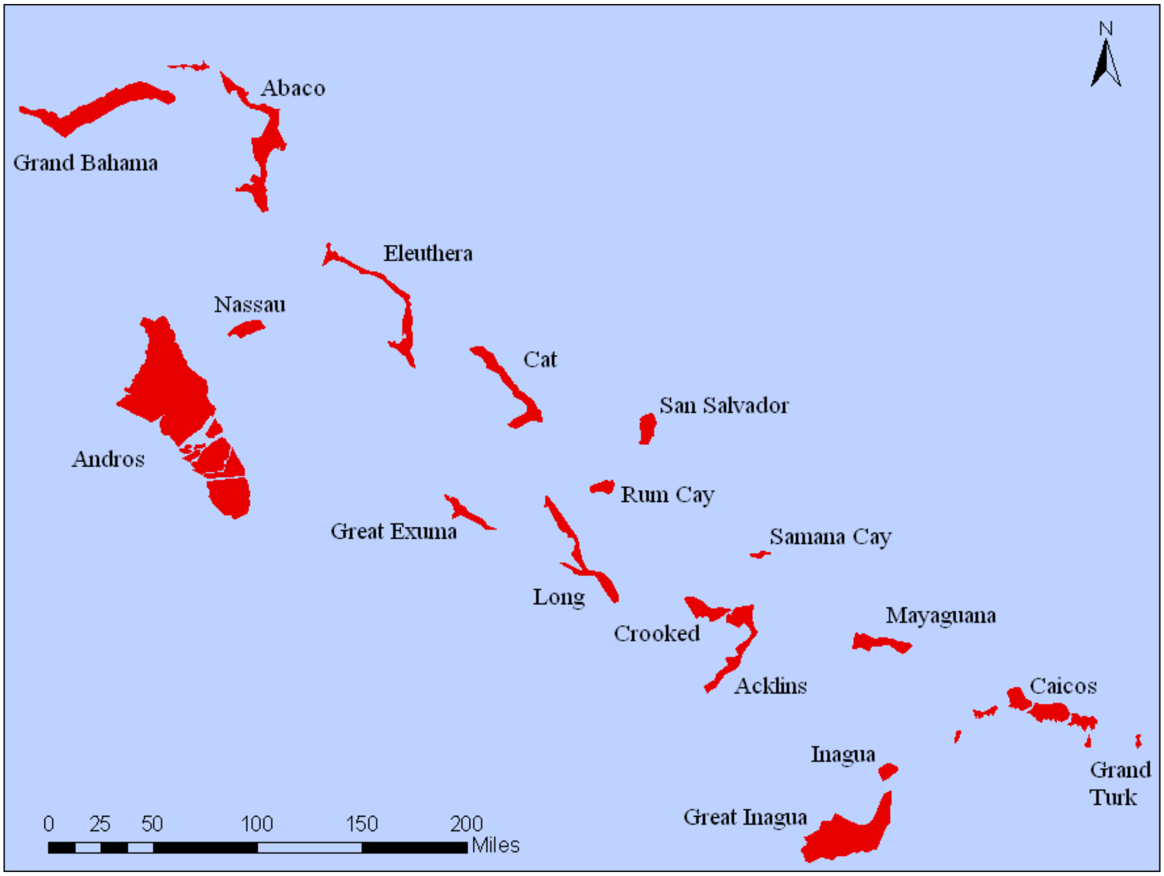

Figure 4. The Bahamas archipelago.

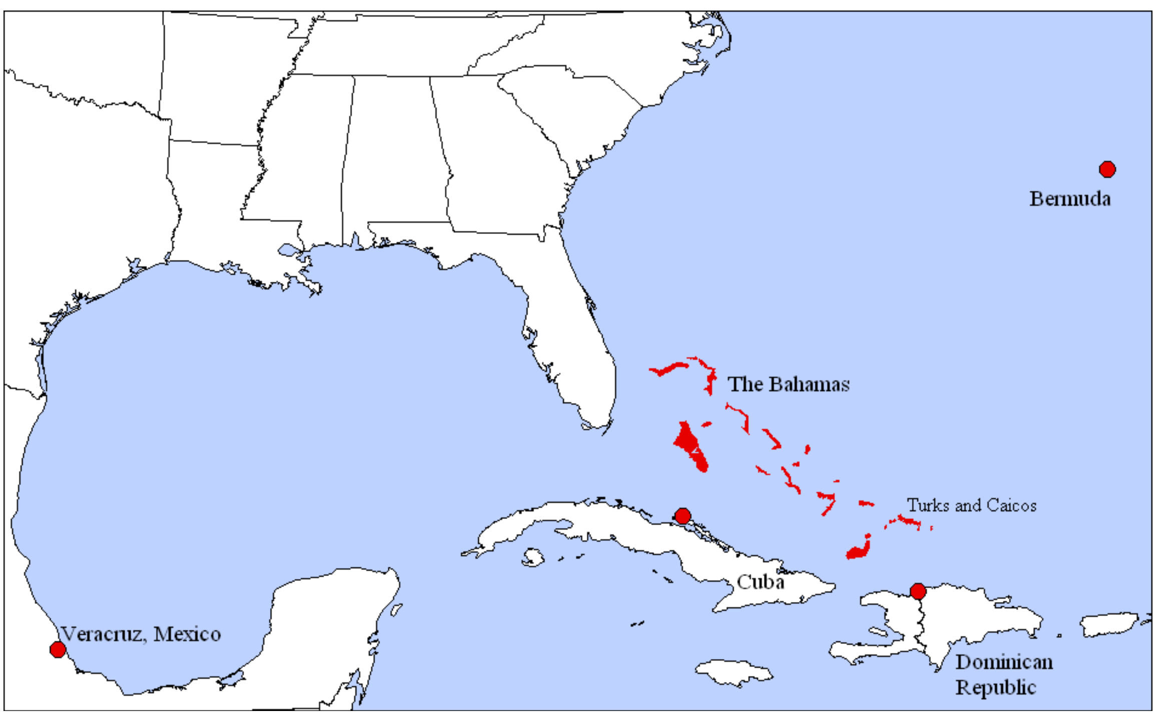

Figure 5. Winter range of the Kirtland's warbler in The Bahamas, Turks and Caicos (red), with reports of solitary individuals observed during winter in Mexico, Dominican Republic, Cuba, and Bermuda (red dots).

Kirtland's warblers are difficult to detect during the winter and are infrequently observed on their wintering grounds. Males do not generally sing during the winter, the warblers tend to skulk in low-lying, dense vegetation, and they are unevenly distributed across the landscape (Currie et al. 2003, 2005a). Extensive searches in the past have produced few sightings (Mayfield 1996; Lee et al. 1997). Prior to 2002, approximately 200 individuals had been recorded in The Bahamas since 1841 (Currie et al. 2003). Of those 200 records, 63 were specimens taken between 1879 and 1897, and the remaining records have usually been of solitary birds seen briefly (Mayfield 1993). Consequently, conclusions regarding the winter distribution and preferred habitats of the Kirtland's warbler have been based on limited observational data and have not generated consensus. For example, Sykes and Clench (1998) concluded that Kirtland's warblers used nearly all upland habitat types except high coppice within The Bahamas and proposed that the species is widely dispersed across the archipelago. Alternatively, Haney et al. (1998) contended that Kirtland's warblers primarily utilize the northern, pine-dominated islands of The Bahamas.

Recently, the Kirtland's Warbler Research and Training Project has been focused on locating, banding, and observing Kirtland's warblers on their wintering grounds in The Bahamas (Ewert et al. 2009). This effort has been concentrated on Eleuthera Island, exclusively within low coppice habitats. Between 2002 and 2010, 232 Kirtland's warblers were captured and color-banded on Eleuthera Island. In addition, 10 Kirtland's warblers were observed on Long Island, 1 bird was found on Grand Bahama Island, at least 4 birds were seen on the Exuma islands and others on New Providence Island and Abaco Island (Eric Carey, Bahamas National Trust; Leno Davis, The Nature Conservancy; David Ewert, The Nature Conservancy; Anthony White, citizen scientist; Joseph Wunderle, International Institute of Tropical Forestry; unpubl. data).

Migration

Spring departure from The Bahamas is estimated to occur from mid-April to early May, based on spring landfall records in the southeastern U.S. (Mayfield 1992; Mike Petrucha, MDNR, unpubl. data), and late departure dates on Eleuthera (J. Wunderle; Dave Currie, Puerto Rico Conservation Foundation c/o International Institute of Tropical Forestry; Jennifer White, Puerto Rico Conservation Foundation; unpubl data). Recent evidence suggests that spring departure in Kirtland's warblers may be related to variation of March rainfall and food abundance in The Bahamas (Rockwell 2010; Studds and Marra 2011). The earliest records of Kirtland's warblers arriving on the mainland (Florida and Georgia) occurred on April 12th in 1897, 1902, and 1970 (Petrucha, unpubl. data). The shortest recorded duration of spring migration is 13 days (Ewert et al., in prep.), and most male Kirtland's warblers arrive on the breeding grounds between May 1st and May 18th (mean range between May 12th and May 15th), with the first females arriving a week or so after the first males (Mayfield 1960; Rockwell, unpubl. data). The earliest record of a Kirtland's warbler on the breeding grounds is May 1st (Petrucha and Carlson 2011). Hatch-year birds are thought to leave the breeding grounds between mid-August and early September (Sykes et al. 1989). Sykes et al. (1989) found that a substantial number of adult breeding birds remain on the breeding grounds through September and suggested that a few individuals likely remain into early October. The latest record of a Kirtland's warbler on the breeding grounds is October 1st (Sykes and Munson 1989). The latest mainland records occurred on October 29th in 1903 in South Carolina and again on October 29th in 2006 in Florida (Petrucha, unpubl. data). The earliest recorded sighting in The Bahamas was August 20th (Robertson 1971).

Based on the absence of conspecifics mentioned in published accounts of migrating individuals, Sykes et al. (1989) suggest that Kirtland's warblers tend to migrate alone in the fall rather than in groups. Both spring and fall migrations are generally thought to follow a narrow band, traversing South and North Carolina, western Virginia, West Virginia, Ohio and southern Michigan (Mayfield 1992). Since 1851, 495 observations of Kirtland's warblers in migration have been recorded (Petrucha, unpubl. data; Figure 6). Most of these records have originated from Ohio and Ontario, particularly near the shoreline of western Lake Erie (Petrucha, unpubl. data; Figure 6). Other areas with relatively numerous records of migrants include the eastern shoreline of Florida and the Lake Michigan shoreline (Petrucha, unpubl. data; Figure 6). However, these records represent a somewhat limited data set and could be biased, based on the level of effort in highly-trafficked versus seldom-visited birding areas.

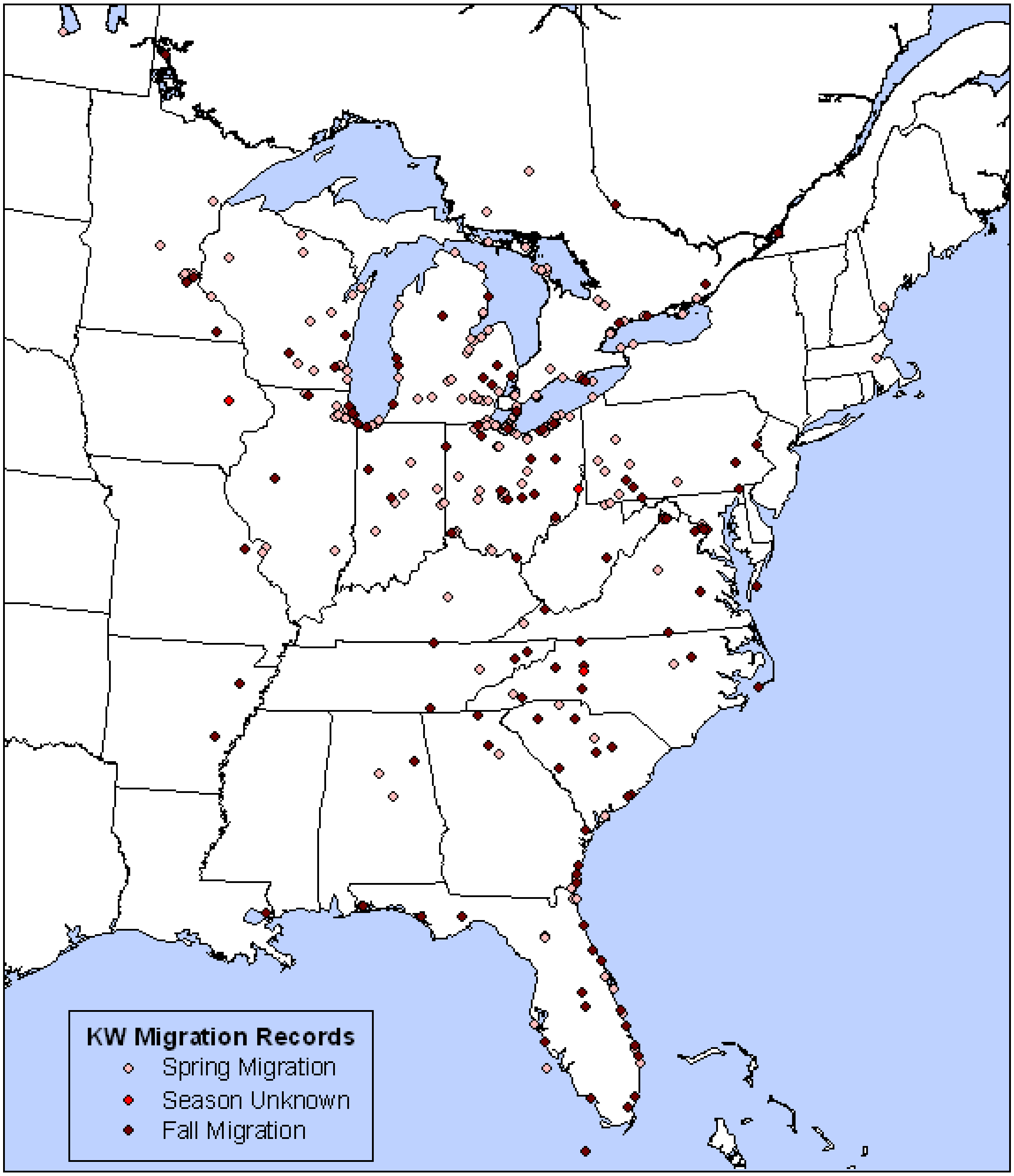

Figure 6. Fall and spring Kirtland's warbler migration records (includes song, sight, photographic, and specimen records) from 1851-2011, n = 495 (Petrucha, unpubl. data).

It remains unclear how Kirtland's warbler migrate; whether the majority of birds make a non-stop flight between breeding and wintering grounds, with a only a few birds pausing at stopover sites enroute, or that most make a number of shorter flights with repeated stops to refuel (Mayfield 1983, 1988). Migration patterns in Kirtland's warblers may vary by season, reflecting differences between breeding and non-breeding strategies that have been observed in other closely related wood warblers (Morris et al. 1994, Otahal 1995, Morris and Glasgow 2001). Sykes et al.

(1989) found that a large proportion of birds sampled on the breeding grounds during the post-breeding period from mid-July through early October had no or only low levels of subcutaneous fat deposition, indicating that most Kirtland's warblers do not accumulate large energy reserves prior to initiating fall migration. Further research could help clarify how Kirtland's warblers offset the energetic costs of migration, as well as identify important stopover sites and associated habitat characteristics, and increase our understanding of migration patterns.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Breeding Habitat

Habitat Amount and Distribution

Extensive tracts of suitable breeding habitat are found on glacial outwash plains, most commonly in northern Lower Michigan, with scattered locations in the Upper Peninsula of Michigan, Wisconsin, and Ontario. Jack pine forests are disturbance-dependent ecosystems that were historically maintained by naturally recurring wildfire. Jack pine dominated forests of the historic northern Great Lakes Region experienced large, frequent, and catastrophic stand-replacing fires (Cleland et al. 2004). These fires occurred approximately every 60 years, burned approximately 211,077 acres per year, and resulted in jack pine comprising 53.4% of the total land cover (Cleland et al. 2004). Modern wildfire suppression has since increased the average fire return interval within this same landscape to approximately 775 years, decreased the amount of area burned to approximately 15,558 acres per year, and reduced the contribution of jack pine to 36.8% of the current land cover (Cleland et al. 2004). The overall effect has been a reduction in the extent of dense jack pine forest, and in turn, Kirtland's warbler breeding habitat.

Habitat management to benefit Kirtland's warblers began as early as 1957 on state forest land and 1962 on federal forest land (Mayfield 1963; Radtke and Byelich 1963). Efforts increased in 1981 with the establishment of an expanded habitat management program to supplement wildfire-regenerated habitat and ensure relatively large patches of early successional jack pine forest would be continuously available for nesting (Kepler et al. 1996). At the time the updated recovery plan was issued, 127,600 acres of public forest lands were designated for Kirtland's warbler habitat management in order to meet the recovery objective of 1,000 pairs. Approximately 74,100 acres were on state forest lands in 16 management areas in nine counties and about 53,500 acres were on federal forest lands in 7 management areas in four counties (USFS and MDNR 1981). These acreages were determined by factoring an average population density of one breeding pair per 30 acres into a 45- to 50-year commercial harvest rotation, which would produce suitable habitat as well as marketable timber (Byelich et al. 1985). Data collected from the annual singing male census from 1980 to 1995 indicated that a breeding pairs used closer to 38 acres within suitably aged habitat (Bocetti et al. 2001). Based on these data, the Kirtland's Warbler Recovery Team recommended increasing the total amount of managed habitat to 190,000 acres (Ennis 2002). Under this prescription, 38,000 acres of nesting habitat would be maintained on an annual basis (Ennis 2002). The primary method used to regenerate jack pine stands involves harvesting 4,070 acres of mature jack pine annually (1,800 acres on MDNR land and 2,270 acres on USFS land) and replanting these areas with two year old jack pine saplings. Stands are planted at a stocking density of 1,600 to 2,000 stems/acre in an opposable weave pattern that builds regularly spaced openings (1/4 acre for every acre planted) and thickets into the plantation. Currently, the MDNR, USFS, and Service manage more than 219,000 acres of jack pine forest in this way (Figure 7).

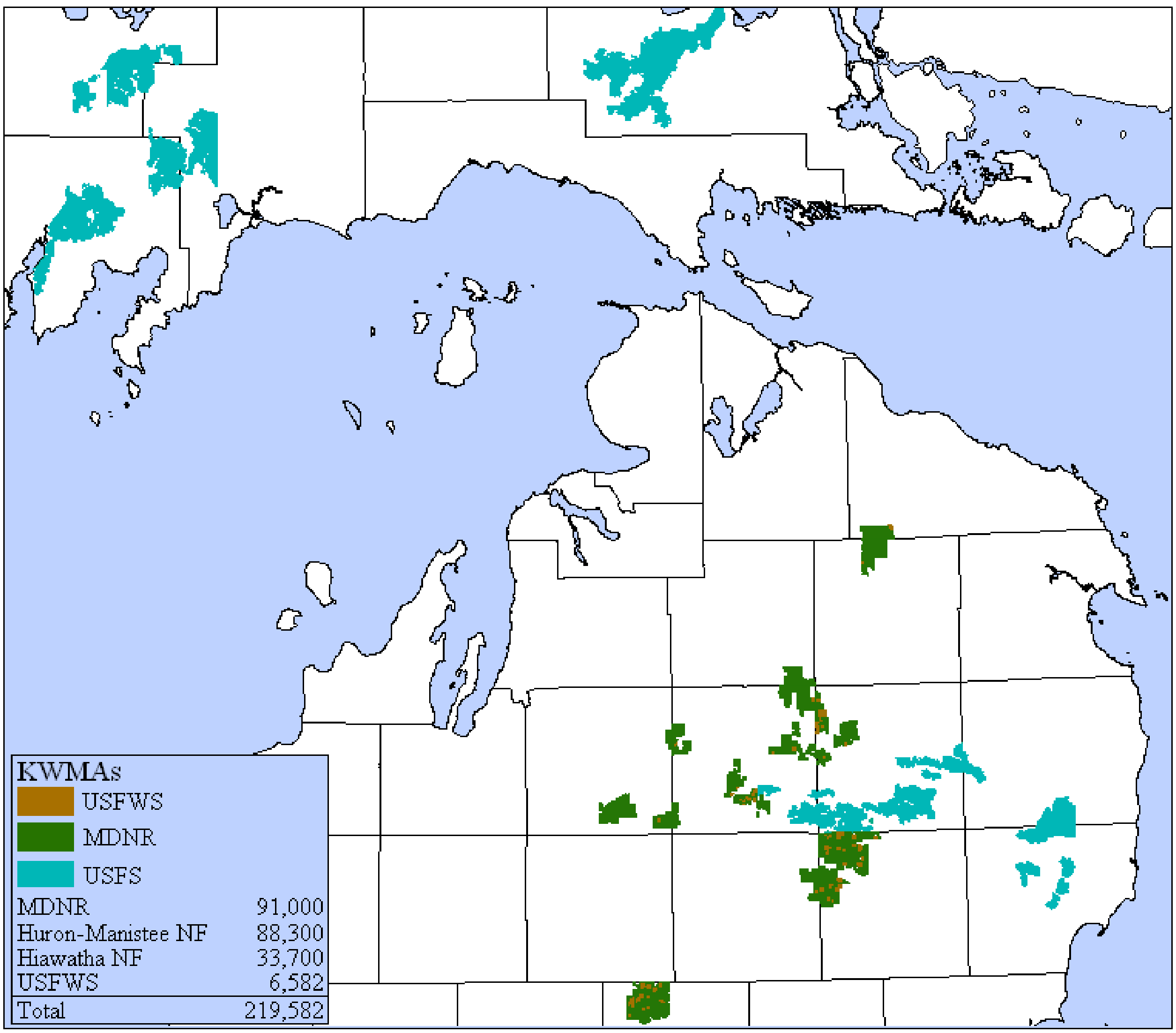

Figure 7. Kirtland's Warbler Management Areas, Upper and Lower Peninsula, MI.

The habitat management program has been extremely important in supplementing the amount of wildfire-regenerated habitat needed to sustain population numbers. The amount of wildfire-regenerated habitat decreased from approximately 33% of the total extent of suitable habitat in the 1980s and mid-1990s to only 18.2% by 2004 (Donner et al. 2008). During this same period of time, the total amount of suitable habitat increased by nearly 150%, 75% of which was planted habitat (Donner et al. 2008). Prior to 1963, the Kirtland's warbler had never been found in an area which had been kept free of fire following timber cutting (Radtke and Byelich 1963). By 2004, 85% of the singing males censused were located in planted habitat (Donner et al. 2008).

Habitat Occupancy

Kirtland's warblers generally occupy jack pine stands that are 5-23 years old and at least 30 acres in size (Donner et al. 2008). The most obvious difference between occupied and unoccupied stands is the percent canopy cover (Probst 1988). Stands with less than 20% canopy cover are rarely used for nesting (Probst 1988). Tree canopy cover reflects overall stand structure, combining individual structural components such as tree stocking, spacing, and height factors (Probst 1988). Tree canopy cover may, therefore, be an important environmental cue for Kirtland's warblers when selecting nesting areas.

Occupied stands usually occur on dry, excessively drained and nutrient poor glacial outwash sands. They are structurally homogenous with trees ranging 1.7-5.0 m in height, and are generally of three types: wildfire-regenerated, planted, and unburned-unplanted (Probst and Weinrich 1993). Wildfire-regenerated stands occur naturally from serotinous seeding following stand-replacing fire. Planted stands are stocked with jack pine saplings after a clearcut, according to a prescription described below (see Habitat Management). Unburned-unplanted stands originate from clearcuts that regenerate from non-serotinous, natural seeding.

Kirtland's warblers will also use stands with significant components of red pine (*Pinus resinosa*) and pin oak (*Quercus palustris*) (Mayfield 1953; Orr 1975; Byelich et al. 1985, Fussman 1997; Anich et al. 2011). Use of these areas in Michigan is rare and occurs for only short durations (Huber et al. 2001). In Wisconsin, however, breeding has occurred primarily in red pine plantations that have experienced extensive red pine mortality and substantial natural jack pine regeneration (Anich et al. 2011). Anich et al. (2011) suggest that in this case, a matrix of openings and thickets has produced conditions suitable for Kirtland's warblers, and that the red pine component may actually prolong the use of these sites due to a longer persistence of low live branches on red pines.

Stand and landscape structure also influence Kirtland's warbler occupancy. Timing of colonization and extinction events among nesting areas were related to stand size, distance to an occupied stand, habitat regeneration-type, the number of occupied stands in the landscape, and the rate of habitat influx (Probst and Weinrich 1993; Donner et al. 2010). Large stands and stands that were near other occupied sites were colonized at younger ages, used for longer periods of time, and abandoned at older ages. As the number of occupied stands in the landscape increased, stands were also colonized and abandoned at earlier ages. Donner et al. (2010) reported mean patch age for wildfire-regenerated habitat at colonization was 8.5 years, compared to 9.0 years for planted habitat, and 11.6 years for unburned-unplanted habitat. Similarly, wildfire-regenerated habitat was used for an average duration of 8.2 years, compared to 4.9 years in plantation habitat and 2.6 years in unburned-unplanted habitat (Donner et al. 2010).

Habitat Quality

Avian density can be a good indicator of avian habitat quality, particularly in relatively natural areas (Bock and Jones 2004). Studies found that stand age, overall, is the primary predictor of male Kirtland's warbler density, reflecting the transient nature of the nesting habitat (Probst and Weinrich 1993; Bocetti 1994; Donner et al. 2009). These studies have found that male Kirtland's warbler density is also related to different stand- and landscape-scale attributes and that the relationship can change over time depending on the amount of nesting habitat and the species' population level. For example, when habitat amounts and population levels were low, stand regeneration type helped predict male Kirtland's warbler density. At that time, wildfire-regenerated and planted habitat had significantly greater densities of males than unburned-unplanted habitat. As habitat amounts and population levels increased, however, stand regeneration type became less reliable as a predictor of male density while stand size and distance from an occupied stand increased in importance (Donner et al. 2009). Greater male densities have been observed in large patches (Probst and Weinrich 1993), and decreased densities have been associated with increased distances to other occupied stands (Bocetti 1994; Donner et al. 2009).

The response of male Kirtland's warblers to spatiotemporal changes in habitat amount and configuration demonstrates a density-dependent relationship with habitat quality. Individuals should, theoretically, select the habitat of highest suitability (Fretwell and Lucas 1969). However, if breeding sites are limiting, surplus individuals should emigrate to other sites because they can achieve a higher fitness than by settling in an over-saturated site (Pulliam 1988). Consistent with these theories, wildfire-regenerated habitat had more females, higher pairing success and more mates per male than other habitat types (Probst and Hayes 1987; Bocetti 1994). In addition, Probst and Weinrich (1993) determined that the occurrence of males in unburned-unplanted habitat was a consequence of severe habitat limitation and saturation of wildfire-regenerated and planted habitat stands. Increased population levels at the core of the nesting range have also facilitated dispersion into peripheral Kirtland's Warbler Management Areas (KWMAs) (Donner et al. 2008), and continued expansion of breeding range and habitat should be expected with continued population growth.

Optimal habitat can been characterized as large stands (> 80 acres) composed of 8 to 15-year old jack pines that regenerated after wildfires, with 35 to 65% canopy cover, and more than 7,500 stems/ha (Probst 1988; Probst and Weinrich 1993). These attributes may be important to the Kirtland's warbler as they relate to the nesting biology and foraging ecology of this ground-nesting species (Probst 1986; Byelich et al. 1985; Probst and Donnerwright 2003). The poor quality and well-drained soils reduce the risk of nest flooding and maintain low shrubs that provide important cover for nesting and brood-rearing. Yet as jack pine saplings grow in height, percent canopy cover increases, causing self-pruning of the lower branches and changes in light regime, which diminishes cover of small herbaceous understory plants (Probst 1988; Probst and Weinrich 1993; Probst and Donnerwright 2003). Bocetti (1994) found that nest sites were selected based on higher jack pine densities, higher percent cover of blueberry, and lower percent cover of woody debris than would be expected if nests were placed at random. Predation rates may be higher for Kirtland's warblers nesting in small patches bordered by mature trees than in large patches, due to edge effects associated with low area-to-perimeter ratios (Probst 1988; Robinson et al. 1995; Helzer and Jelinski 1999). Foraging requirements may also be negatively influenced as jack pines mature (Fussman 1997).

Conversely, marginal habitat has been characterized as jack pine stands with at least 20-25% tree canopy cover and a minimum density of 2,000 stems/ha (Byelich et al. 1985; Walkinshaw 1983; Probst and Weinrich 1993; Nelson and Buech 1996), and is often associated with unburned-unplanted areas (Donner et al. 2010). Probst and Hayes (1987) indicate that the main disadvantage of marginal habitat is reduced pairing success. Fewer warblers within marginal habitat, however, may lessen competition for resources among individual birds and promote near-equal nesting success rates compared to more densely populated sites of higher quality (Pimm and Pimm 1982).

Wintering Habitat

Research indicates that wintering Kirtland's warblers occur in early successional scrublands, characterized by dense low broadleaf shrubs of varied foliage layers with small openings, resulting from natural or anthropogenic disturbances (locally known as low coppice) (Maynard

1896; Challinor 1962; Mayfield 1972, 1992, 1996; Radabaugh 1974; Lee et al. 1997; Haney et al. 1998; Sykes and Clench 1998; Wunderle et al. 2007, 2010). However, studies examining habitat occupancy of wintering Kirtland's warblers have been limited in scope. Only a small proportion of the population has been examined within its wintering range, and the majority of this effort has been restricted to Eleuthera Island.

The clearing of vegetation by bulldozers, wildfires, hurricanes, and local agricultural practices, such as "slash and burn," can create suitable habitat on Eleuthera Island (Wunderle et al. 2007), and the warbler has likely benefited from recent declines in agriculture as fallow lands have reverted to early successional scrublands (Sykes and Clench 1998). These sites tend to be small and dominated by dense, fruit-bearing shrubs, 0.5 to 1.0 m in height, including snowberry, wild sage, and black torch (Wunderle et al. 2010). Kirtland's warblers typically occupy sites 3 to 28 years (mean = 14.6 years) after human disturbance (Wunderle et al. 2010). As local food resources diminish in abundance, these sites may not be sufficient to sustain an individual for an entire winter; therefore, individuals must move widely from patch to patch, tracking changes in fruit abundance (Wunderle et al. 2007, 2010). Fifty-nine Kirtland's warblers were fixed with radio transmitters between 2004 and 2009 and were observed for approximately three weeks each (Wunderle, pers. comm. 2011). Results from these studies found an average winter home range to be 40 acres during the three-week period. However, winter home ranges for the seven months Kirtland's warblers spend in The Bahamas might be as large as 50 acres, depending on food availability (Wunderle, pers. comm. 2011).

Migratory Stopover Habitat

Specific habitat used by Kirtland's warblers during migration is poorly understood. While specific locations of importance remain uncertain, two areas of potential importance include coastal areas along the Atlantic Ocean and the Great Lakes (Figure 6). These coastlines are also highly developed. Much of central and northern Ohio, southern Michigan and southwestern Ontario have little natural habitat remaining due to conversion to agricultural and urban areas (Ewert et al. 2006). Atlantic coastal areas have experienced similar development (Crossett et al. 2004).

Migrating Kirtland's warblers have been observed in a variety of habitats, including residential, woodland, scrub, park, and orchard (Petrucha, pers. comm. 2011). There is some evidence that dense vegetation less than 1.5 m in height may be important to migrating Kirtland's warblers (Stevenson and Anderson 1994). A migrating juvenile Kirtland's warbler was banded and recaptured twice in an 11-day period during fall migration in 1971 in a dense hawthorn (*Crataegus* spp.) and crabapple (*Pyrus coronaria*) thicket (Clench 1973).

2.3.1.7 Other: N/A

2.3.2 Five-Factor Analysis

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range

Threats to Natural Breeding Habitat
The recovery plan states, "The ultimate limiting factor on the nesting population is the special habitat required." Historically, wildfires were the most important factor in the establishment of natural jack pine forests and Kirtland's warbler nesting habitat. However, modern wildfire suppression has greatly altered the natural disturbance regime that generated Kirtland's warbler breeding habitat for thousands of years (Byelich et al. 1985; Cleland et al. 2004). Prior to the 20th century, the fire recurrence in jack pine forests averaged 60 years, though it is now estimated to recur in cycles as long as 775 years (Cleland et al. 2004).

In the absence of wildfire, land managers must take an active role in recreating natural processes that regularly occur within the jack pine ecosystem, namely stand-replacing disturbance events. This is done through large-scale timber harvesting and artificial reforestation. Although planted stands tend to be more structurally simplified than wildfire-regenerated stands (Spaulding and Rothstein 2009), land managers have succeeded in selecting Kirtland's Warbler Management Areas that have landscape features of the natural breeding habitat, and have developed silvicultural techniques that produce conditions within planted stands suitable for Kirtland's warbler nesting. Over 75% of the suitable habitat on the landscape has been artificially created, of which 85% of the Kirtland's warbler population uses during the breeding season (Donner et al. 2008). The effectiveness of these strategies is also evident by the reproductive output observed in planted stands, which function as population sources (Bocetti 1994). Threats to natural breeding habitat have successfully been mitigated, and continued survival of Kirtland's warblers depends largely on the production of managed breeding habitat.

Threats to Managed Breeding Habitat
The rebound of Kirtland's warblers reflects successful interagency cooperation in managing large acreages of jack pine to create suitable breeding habitat. To maintain 1,000 pairs of Kirtland's warblers, 38,000 acres of suitable habitat must be available at all times (Ennis 2002), requiring land management agencies to jointly manage 4,070 acres of habitat annually (USFS 2006a, 2006b; Keith Fisher, MDNR, pers. comm. 2011). Since this strategy was put into effect in 2006, the average amount of newly established habitat on various public lands in Michigan has surpassed management targets (Figure 8). In some years, however,

management targets were achieved only because of the addition of habitat created by wildfire, which is not relied upon as a consistent source of habitat generation. Threats to the successful and continued implementation of this strategy include; fluctuating timber markets, declining budgets for land management agencies, public pressure to limit the use of current management techniques, management restrictions imposed in areas where unexploded ordnance endangers human safety, and natural events that include drought, fire, and disease and insect outbreak that have the potential to damage suitable habitat.

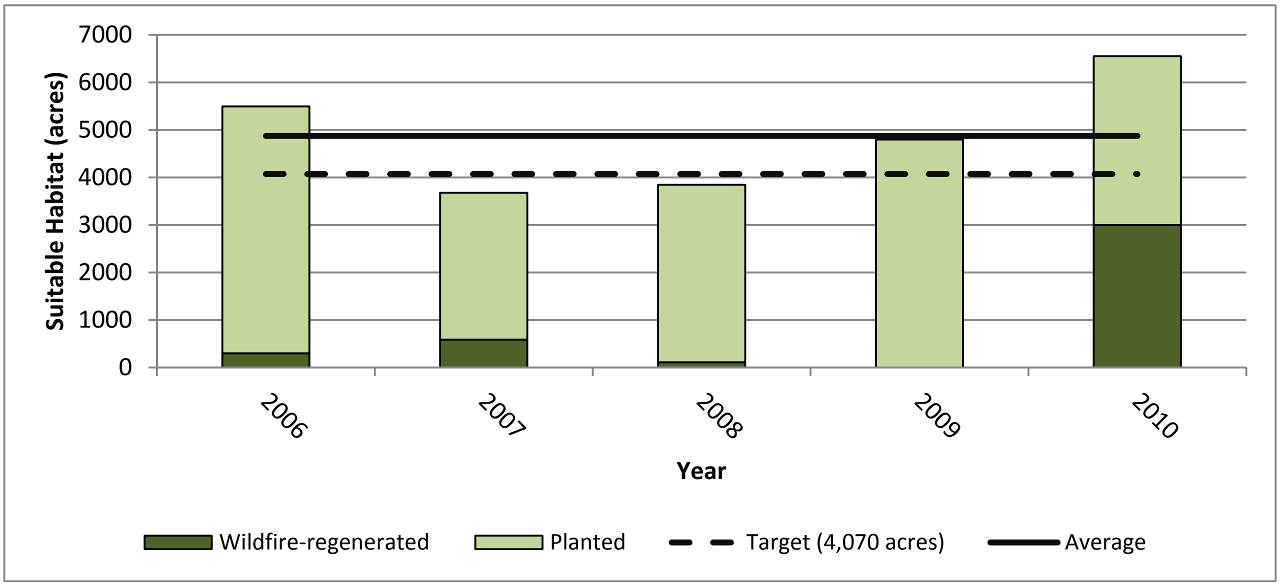

Figure 8. Amount of new Kirtland's warbler habitat established on public lands in Michigan, 2006-2010.

Nearly all managed breeding habitat is created through clearcuts and planting of jack pine trees. The sale of mature jack pine timber on sites where reforestation will occur is critical to this process. Jack pine managed for breeding habitat, however, is not optimal for timber production due to its spacing and pattern. U.S. softwood timber markets have generally declined since 1965 (Yin and Baek 2004), and demand for jack pine products has fluctuated in recent years (Tim Greco, MDNR, pers. comm. 2011; Phil Huber, USFS, pers. comm. 2011). The USFS receives considerably fewer bids and lower prices for timber sales compared to the MDNR, primarily due to the average sale size, which has been three times larger for USFS sales than MDNR sales (Leefers et al. 2006). The USFS is therefore more likely to be affected by periods of fluctuating timber markets, because some of the money generated through their jack pine timber sales is used to offset reforestation costs associated with creating Kirtland's warbler habitat (Huber, pers. comm., 2011).

The majority of funds for reforestation for all agencies come from state wildlife grants, endangered species funds, and the Arbor Day Foundation (Fisher, pers. comm. 2011). Budgets are generally remaining flat or declining, while all costs related to reforestation continue to increase. Shifting agency priorities and competition for limited resources also constrain the ability of land managers to fund reforestation of areas suitable for Kirtland's warblers. Deer Range Improvement Program funds, for example, have been used for jack pine work on state forest lands since the inception of the program in 1971 as well as to maximize the amount of federally apportioned State Wildlife Grant money received by the State of Michigan (Michigan Natural Resources Commission 2010). In 2010, however, use of this fund for jack pine work was banned in favor of other deer range needs (Michigan Natural Resources Commission 2010). Low timber sale revenues in conjunction with reduced budgets, increased reforestation costs, and competition with other programs, threaten the agencies' ability to meet annual habitat development objectives.

It is worth noting, however, that shifting timber markets such as the biofuels market could improve demand for jack pine (Becker et al. 2009). Low biomass retention is considered appropriate for management of jack pine stands in Michigan (MDNRE 2010), and whole tree harvesting silviculture has been observed to have similar impacts on soil biogeochemistry processes as wildfire (Rothstein and Spaulding 2010). Although developing biofuel markets have been focused primarily on biomass derived from hardwood species, as markets expand, opportunities may allow managers to sell mature jack pine at higher prices, or sell previously unmarketable immature jack pine (Greco, pers. comm. 2011; Huber, pers. comm. 2011).

Management restrictions have also been enacted in specific situations on public land designated for Kirtland's warbler management. In 2007, unexploded ordnance was discovered on an abandoned U.S. Air Force bombing and gunnery range located within the Kokosing Block of the Pine River KWMA. Safety issues surrounding unexploded ordnance and the ground-disturbance techniques used to reforest Kirtland's warbler habitat (i.e., trenching) may affect the USFS's ability to manage the Kokosing Block in the future. At this time, reforestation of this site is uncertain, pending unexploded ordinance surveys by the Department of Defense (Huber 2008). The Kokosing Block covers 201 acres and makes up approximately 1% of the of the Pine River KWMA, or 0.24% of the total acreage currently set aside for Kirtland's warbler management on the Huron-Manistee National Forest.

The relative importance of the Kokosing Block is also small when considered in terms of the current assembly of KWMAs bearing suitable habitat, representing only 0.53% of the 38,000 acres necessary to maintain population recovery objectives. If the USFS loses the ability to artificially reforest the Kokosing Block, the amount of newly created nesting habitat near currently occupied stands will be less than planned, likely resulting in lower than expected levels of recruitment to this portion of the Pine River KWMA and a potential reduction in the numbers of Kirtland's warblers produced over the near future (Paul Thompson, USFS, pers. comm. 2011). Some amount of suitable habitat has naturally regenerated within the Kokosing Block, however, and was occupied by Kirtland's warblers for the first time in 2011 (Thompson, pers. comm. 2011). Therefore, loss of the Kokosing Block from the current management rotation is not considered an immediate or significant threat to the Kirtland's warbler population.

Another on-going threat to managed habitat is public opposition to clearcutting stands of mature jack pines. Examination of historical biogeography suggests that Kirtland's warblers prefer to use very large forest stands in the thousands of acres (Mayfield 1993). This evidence has led the management agencies to harvest and reforest larger stands (Jerry Weinrich, MDNR retired, pers. comm. 2011). Residents and visitors to northern Michigan, however, periodically express disapproval of the size of the clearcuts, citing aesthetic reasons (Borak 2011). To help visually break up large clearcuts and reduce aesthetic concerns, land managers have modified clearcut designs for aesthetics and strategically left strips of live trees (Keith Kintigh, MDNR, pers. comm. 2011; Huber pers. comm. 2011). While public concern has not prevented any specific blocks of habitat from being harvested and reforested, political intervention could potentially force agencies to limit the size of clearcuts, thereby reducing the quality of breeding habitat. Survey data (Solomon 1998), however, suggests that the residents in northeastern Lower Michigan are generally knowledgeable of Kirtland's warblers and why it is endangered, and support the program to protect and recover the Kirtland's warbler. Solomon (1998) suggested that improvements in government outreach programs could be made by focusing efforts more on informing local women of the plight of the Kirtland's warbler, and older residents on the value of endangered species protection.

Once planted for Kirtland's warbler habitat, jack pine trees need to survive to provide useable habitat. Multiple natural events, such as fire, drought, disease and insect outbreaks, affect survival of jack pine trees and longevity of suitable habitat. Wildfire can be harmful when it destroys occupied habitat. For example, on June 6, 2011, lightning ignited a wildfire that destroyed approximately 150 acres of 11 year old habitat in the Manistee River KWMA where seven males were counted during the 2011 census (MDNR, unpubl. data). Drought can cause mortality of jack pine seedlings (Rajasekaran and Blake 1999) and reduce the density of jack pine trees required by Kirtland's warblers for nesting (Kintigh, pers. comm. 2011). Drought can also stress older jack pines and make them more susceptible to insects and diseases (Kintigh, pers. comm. 2011).

Two fungal pests, *Gremmeniella abietina* var. *abientina* and *Diplodia pinea*, are known to cause mortality in jack pine trees (USFS and MDNR 1981). Jack pine budworm (*Choristoneura pinus pinus*) and mountain pine beetle (*Dedroctonus ponderosae*) can also cause topkill and mortality in jack pine trees (McCullough 2000; Colgan and Erbilgin 2011; Cullingham et al. 2011). In general, these threats pose little immediate danger to managed habitat, but under the right circumstances, could harm potentially significant amounts of managed habitat and therefore warrant continued monitoring.

Despite issues with timber markets, funding, management restrictions, public opposition, and natural events that threaten managed habitat, land management agencies have been successful in maintaining sufficient amounts of suitable habitat to support historically high numbers of Kirtland's warblers. Management efforts have been adaptive in terms of the acreage, spatial and temporal configuration of habitat needed to mitigate the effects associated with natural breeding habitat loss and fragmentation. The agencies have further shown a commitment to Kirtland's warbler habitat management by signing a Memorandum of Understanding that provides assurances that Kirtland's warbler habitat management will continue. Additionally, the National Fish and Wildlife Foundation has been working to develop a Kirtland's warbler friends group and endowment, which are intended to facilitate management for the species. Together, these strategies promise long-term protection of the Kirtland's warbler through local and government-supported conservation.

Threats to Migratory Habitat

Areas that appear geographically important to migrating Kirtland's warblers are also areas that have been highly developed and fragmented. Within this context, competition for food sources between long-distance passerine migrants is expected to be high, especially in fall-out areas (Moore and Yong 1991; Kelly et al. 2002; Németh and Moore 2007; Ktitorov et al. 2008). This is significant for Kirtland's warblers given that the majority of adults may not accumulate large energy reserves prior to initiating fall migration (Sykes et al. 1989), and that fuel storage levels determine stopover duration (Schaub et al. 2008; Goymann et al. 2010). Low level of subcutaneous fat, for example, was related to longer stopover duration and more stopovers than was expected in other warbler species (Goymann et al. 2010).

Small, isolated woodlots within highly developed and fragmented landscapes may support high abundances of fruit and insects important for migrating birds (Mehlman et al. 2005, Packett and Dunning 2009). Although there is some evidence that survival is lower during migration than during the breeding season (Rockwell, unpubl. data), as a whole, survivorship levels are above the minimum needed to sustain the population (Table 1. Annual survival estimates for different age and sex classes of the Kirtland's warbler.). This suggests that mortality associated with migration is not greatly impacting population numbers (Mayfield 1983). Small habitat patches situated within generally inhospitable landscape matrices may present important conservation targets (Mehlman et al. 2005, Packett and Dunning 2009).

Threats to Winter Habitat

Relatively little is known about the wintering grounds in the Bahamas archipelago compared to the breeding grounds. Threats on the wintering grounds, as well as the magnitude of those threats, remain somewhat uncertain. Potential threats include the lack of protected lands or reserves, habitat loss caused by human development, altered fire regime, changes in agricultural practices, rising sea levels due to climate change, drought, cats, and invasive plant species.

Few of the known Kirtland's warbler wintering sites occur on protected land. The Bahamas National Trust administers 26 national parks that cover over 700,000 acres (Bahamas National Trust 2009), but a large percentage of this area does not provide suitable habitat for Kirtland's warblers. There are also considerable amounts of government-owned land (crown land), but these provide limited suitable habitat, as they occur primarily on fire-prone, pine-dominated islands. Furthermore, neither national parks nor crown lands are fully protected, and none of the protected areas are dedicated to Kirtland's warblers. For example, there are no national parks on Cat Island or Long Island, which support favorable winter habitat conditions such as low coppice, and low intensity agriculture that includes goat farming (Haney et al. 1998, Wunderle, unpubl. data). Alternatively, the Leon Levy Native Plant Preserve, a new national park established on Eleuthera Island in 2011, provides some habitat for wintering Kirtland's warblers. Additionally, a small number of Kirtland's warblers have recently been observed in the Harrold and Wilson Ponds National Park on New Providence Island as well as in the Exuma Cays Land and Sea Park on Hawksbill Cay (The Nature Conservancy 2011).

Simply protecting parcels of land, however, will be insufficient to sustain adequate amounts of habitat for the warbler because of the species' dependence on early successional habitat (Mayfield 1972; Sykes and Clench 1998; Haney et al. 1998; Wunderle et al. 2010), which changes in distribution over time. In addition, food availability at any one site varies seasonally, as well as between years, and is not synchronous across all sites (Wunderle et al. 2010). Habitat management in the Bahamas archipelago will likely require a landscape scale approach in order to provide enough suitable habitat for Kirtland's warbler (Wunderle et al. 2010).

In The Bahamas, residential and commercial development could result in direct loss of Kirtland's warbler habitat, especially on New Providence and Grand Bahama, which together support 85% of the Bahamian population (Moore and Gape 2009, Wunderle et al. 2010; Ewert pers. comm. 2011). This loss could occur on both private and commonage lands (land held communally by rural settlements), as well as generational lands (lands held jointly by various family members). Local depletion and degradation of the water table from wells and other water extraction and introduction of salt water through man-made channels or other disturbances to natural hydrologies may also threaten Kirtland's warblers by affecting fruit and arthropod availability (Ewert pers. comm. 2011).

Fire may be a threat or a benefit to winter habitat, depending on numerous interactions that affect the frequency and intensity of fires. Fires are relatively common and widespread on the pine islands in the northern part of the archipelago, but have increased since settlement, especially during the dry winter season when Kirtland's warblers are present (The Nature Conservancy 2003). Man-made fires may negatively impact wintering Kirtland's warblers if they result in reduced density and fruit production of understory shrubs in Caribbean pine (*Pinus caribaea*) stands (Lee et. al. 1997; Currie et al. 2005b). On non-pine islands, fire may benefit Kirtland's warblers when succession of low coppice to tall coppice is set back (Currie et al. 2005b).

Invasive plants are another potential factor that could significantly limit the extent of winter habitat in The Bahamas. Brazilian pepper (*Schinus terebinthifolius)*, jumbie bean (*Leucanea leucocephala)*, and Guinea grass (*Panicum maximum)* may be the most important invasive species of immediate concern (Ewert et al., pers. obs. 2011). These aggressive plants colonize patches early after disturbances and may form monocultures, which preclude the establishment of species heavily used by Kirtland's warblers. Some invasive species, such as jumbie bean, are good forage for goats. By browsing on these invasive plants, goats create conditions that favor native shrubs and may increase the density of native shrubs used by Kirtland's warblers (Ewert, pers. comm. 2011). Goat farming could play a role in controlling the spread of some invasive species at a local scale, while aiding in the restoration of native vegetation patches. Still, many plants such as Royal Poinciana (*Delonix regia*), Tropical Almond (*Terminalia catappa*) and Morning Glory (*Ipomoea indica*) are commonly imported for landscaping and have the potential to escape into the wild, and become invasive (Smith 2010; Ewert, pers. comm. 2011).

There is relatively little protected land in The Bahamas, increasing the overall vulnerability of suitable winter habitat to several potential sources of habitat loss. Negative impacts caused by residential, commercial and hydrological development, in particular, as well as the spread of invasive species will have to be monitored closely to better determine the magnitude of these threats in the future. Managing winter habitat will likely require a coordinated effort at a landscape scale in order to provide conditions suitable for wintering Kirtland's warblers.

Development on Adjacent Lands

Expanded development adjacent to occupied habitats in both breeding and wintering grounds provides the potential for additional threats to Kirtland's warblers. More than 25% of private land adjacent to the Huron-Manistee National Forest is projected to experience housing growth by the year 2030 (Stein et al. 2007). Conflicting land uses adjacent to occupied habitat on the breeding grounds include the development of residential communities, golf courses, ORV trails, highway improvements (widened roads and right-of-ways), fuel break creation, and oil and gas production. The increased number of people and increased development pressure may disturb or directly take Kirtland's warblers or threaten Kirtland's warbler habitat by reducing the amount of nesting habitat available. Mortality due to vehicle collision has been documented (Jim Enger, Kirtland Community College, pers. comm. 2007), but the threat has not been fully quantified. On the wintering grounds, development of lands adjacent to occupied stands poses similar threats. Tourism is the primary economic activity in The Bahamas, accounting for 65% if the gross domestic product and the Family Islands Development Encouragement Act of 2008 supports the development of resorts on each of the major Family Islands (Moore and Gape 2009). Mortality due to vehicle strikes has also been documented on Eleuthera (Dave Currie, Puerto Rico Conservation Foundation c/o International Institute of Tropical Forestry, pers. comm., 2007).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

There is no threat of overutilization in the form of harvest on Kirtland's warbler breeding and wintering grounds. The Kirtland's warbler is a non-game species and there is no known or potential commercial harvest in either location. Overutilization in the form of disturbance for recreational, scientific or educational purposes is a minimal threat on the breeding grounds. Recreational uses include blueberry picking, firewood collection, mushroom hunting, off-road vehicles, and bird watching. Recreational use is controlled through habitat closure, access permits, and guided Kirtland's warbler tours. Not all Kirtland's warbler habitat is closed during the breeding season (e.g., habitat in Wisconsin and the Upper Peninsula of Michigan) and some habitat on State land in Michigan's northern Lower Peninsula. Limited access permits restrict scientific and educational uses, including filming and photography for brochures and tours. On the wintering grounds, the threat of overutilization in the form of disturbance is also minimal. There is very little recreational usage of suitable winter habitat, and The Commonwealth of The Bahamas regulates scientific utilization of Kirtland's warbler, based on recommendations provided by the Kirtland's Warbler Recovery Team (Bocetti, pers. comm. 2011).

2.3.2.3 Disease or predation

The Kirtland's warbler does not appear to be affected by disease. On both breeding and wintering grounds, no evidence of disease threats has emerged since listing.

The recovery plan lists the identification and control of other predators and parasites as a medium-level research priority. For most passerines, nest predation has the greatest negative impact on reproductive success and can affect entire populations (Ricklefs 1969; Martin 1992). Nest predation may be particularly detrimental for ground-nesting species in shrublands (Martin 1993). Predation of Kirtland's warbler nests have ranged from 3 to 67% of nests examined (Mayfield 1960; Cuthbert 1982; Walkinshaw 1983; Bocetti 1994) and is considered the single major remaining cause of nest failure, within the context of cowbird control (Walkinshaw 1983).

In addition to the brown-headed cowbird, blue jay (*Cyanocitta cristata*), American crow (*Corvus brachyrhynchos*), thirteen-lined ground squirrel, (*Spermophilus tridecemlineatus*), red squirrel (*Tamiasciurus hudsonicus*), house cat (*Felis catus*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), weasels (*Mustela* spp.), red fox (*Vulpes fulva*), smooth green snake (*Opheodrys vernalis*), garter snakes (*Thamnophis* spp.), and Eastern hognose snake (*Heterodon platyrhinos*) have been identified as potential predators of Kirtland's warbler nests (Mayfield 1960; Walkinshaw 1972, 1983; Orr 1975; Anderson and Storer 1976). Of these potential predators, blue jay, American crow, thirteen-lined ground squirrel, and red squirrel are all common species within Kirtland's warbler breeding habitat and are believed to be the primary nest predators (Mayfield 1960; Walkinshaw 1983). Mayfield (1960) also identified potential predators of adult Kirtland's warblers, including Northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), and great-horned owl (*Bubo virginianus)*. However, few predation events have been directly observed, and in general, evidence regarding the importance of certain nest or adult predators lack quantitative support (Mayfield 1960; Walkinshaw 1972, 1983).

Overall, nest predation rates for Kirtland's Warblers are similar to non-endangered passerines (Bocetti 1994; Rockwell, unpubl. data) and are below levels that would compromise population replacement. The specter of increasing numbers of house cats in the breeding and wintering habitats is recognized (Lepczyk et al. 2003; Horn et al. 2011), but is currently not considered a threat to the species.

2.3.2.4 Inadequacy of existing regulatory mechanisms

Federal Protections

The Act is the primary Federal law providing protection for the Kirtland's warbler and the ecosystems upon which it depends. Section 7 of the Act requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species or their habitats. Federal agencies in Michigan and Wisconsin are generally aware of this obligation and the Service has analyzed the potential effects of many projects in relation to Kirtland's warblers and essential nesting habitat. Compliance in Michigan and Wisconsin is considered good. In comparison, far fewer projects that could potentially impact Kirtland's warblers have been evaluated in states lying within the migratory pathway. This apparent lack of consultation reflects a paucity of information relating to Kirtland's warbler migratory ecology and threats to the species rather than unawareness or avoidance of Federal agency obligations required under Section 7. Section 9 of the Act prohibits the unlawful take of federally listed species. Lethal take is considered to be very rare, but other forms of take such as harassment of nesting adults are considered more likely to occur. Take permits, pursuant to Section 10 of the Act, may be issued for scientific research or educational purposes. Numerous take permits have been issued for scientific research on the Kirtland's warbler, which have greatly informed management targeting this species. Section 10 also provides protection for the warbler through issuance of incidental take permits that detail measures to avoid and minimize the potential impacts of a project to the species.

The Kirtland's warbler is also protected by the Migratory Bird Treaty Act of 1918 (MBTA). The MBTA prohibits take, capture, killing, trade or possession of Kirtland's warblers and their parts, as well as their nests and eggs. In general, the MBTA provides less protection than the Endangered Species Act, as it does not extend protection to the warbler's habitat. Executive Order 13186, "Responsibilities of Federal Agencies To Protect Migratory Birds" (66 FR 3853), however, directs Federal agencies to develop a Memorandum of Understanding (MOU) with the Service to promote the conservation of migratory bird populations. The USFS and the Service have signed a MOU (FS Agreement # 08-MU-1113-2400-264) pursuant to E.O. 13186.

In addition, National Forest Land and Resource Management Plans have been developed in compliance with the provisions of Section 7 of the Act as well as the Healthy Forest Restoration Act of 2003. These plans give emphasis to management that maintains and develops essential nesting habitat for the Kirtland's warbler (USFS 2006a, 2006b). The Service, USFS and MDNR have also signed a MOU (FS Agreement # 11-MU-1109100-008), which details these agencies' commitment to continue collaborative habitat management, brown-headed cowbird control, monitoring, research, and education in order to maintain a Kirtland's warbler population at or above 1000 pairs, regardless of the species' legal protection under the Act. Mechanisms by which this agreement will be implemented have not yet been fully developed.

State and Provincial Protections

The State of Michigan lists the Kirtland's warbler as endangered, pursuant to Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended. Part 365 prohibits take, possession, transportation, importation, exportation, processing, sale, offer for sale, purchase, or offer to purchase, transportation or receipt for shipment by a common or contract carrier of Kirtland's warblers or their parts. However, this protection does not extend to habitat nor would it provide protection of Kirtland's warblers outside of Michigan. The States of Florida, Georgia, Indiana, North Carolina, Ohio, and Virginia also list Kirtland's warbler as endangered under their respective state endangered species regulations. Similar to Michigan's law, those protections are applicable only within their respective states and generally do not protect the bird's habitat.

The Kirtland's warbler is provincially listed as endangered under Ontario's Endangered Species Act of 2007. This Act extends protection to living or dead individuals or the parts of the provincially-listed species. It likewise does not extend protection to habitat.

International Protections

The Kirtland's warbler was declared federally endangered in Canada in 1979. Similar to the Act in the U.S., Canada's Species at Risk Act of 2003 (SARA) is the primary law protecting the Kirtland's warbler in Canada. Canada's SARA bans killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling, or trading of individuals that are federally listed. In addition, SARA also extends protection to the residence (habitat) of individuals that are federally listed.

Canada's Migratory Bird Convention Act of 1994 also provides protection of Kirtland's warblers. Under Canada's Migratory Bird Convention Act, it is unlawful to be in possession of migratory birds or nests, or to buy, sell, exchange, or give migratory birds or nests, or to make them the subject of commercial transactions. Similar to the MBTA, Canada's Migratory Bird Convention Act provides significantly less protection than does SARA, and does not extend protection to the bird's habitat.

In The Bahamas and the Turks and Caicos Islands, the Kirtland's warbler is recognized as a globally Near Threatened species, but has no federally listed status. In The Bahamas, the Wild Birds Protection Act (Chapter 249) protects all wild birds, with limited exceptions, from killing and capture or attempts to kill or capture. It also allows the Minister of Wild Animals and Birds Protection to establish and modify reserves for the protection of any wild bird. The species is also protected in The Bahamas by the Wild Animals (Protection) Act (Chapter 248) that prohibits the take or capture, export, or attempt to take, capture, or export any wild animal from The Bahamas. Caribbean pine, a potentially important component of wintering Kirtland's warbler habitat, is also protected from harvest in The Bahamas under the Conservation and Protection of the Physical Landscape of The Bahamas (Declaration of Protected Trees) Order of 1997. The Bahamas National Trust Act of 1959 and the National Parks Ordinance of 1992 established non-government statutory roles to the Bahamas National Trust and the Turks and Caicos Islands National Trust, respectively. These acts empower these organizations to hold and manage environmentally important lands in trust for their respective countries.

Summary
Collectively, existing regulatory mechanisms provide significant protection to Kirtland's warblers from direct impacts throughout the species' range. In addition, impacts to essential nesting habitat have been successfully regulated under the Act, and legislation in The Bahamas enables government officials to protect winter habitat. Migratory stopover habitat is less well protected, reflecting an inferior understanding of migratory ecology. In the absence of the Act, other regulatory mechanisms are in place that would protect individuals from direct impacts, but not breeding habitat. This would likely have significant impacts on the Kirtland's warbler population as the species' primary threat, loss of breeding habitat, would no longer be adequately addressed. Mechanisms that would ensure the conservation of essential nesting habitat into the foreseeable future, regardless of the species legal protections under the Act, are not fully developed.

2.3.2.5 Other natural or manmade factors affecting its continued existence

Climate Change

Climate change was not identified as a threat in the final rule listing or in the updated recovery plan (Byelich et al. 1985). Yet, the potential impact of climate change has gained widespread recognition as one of many pressures that influence the distributions of species, the timing of biological activities and processes, and the health of populations. Although impacts to the Kirtland's warbler or its breeding or wintering habitats have not yet been demonstrated, climate change has the potential to decrease and shift suitable breeding habitat outside of its current range (Prasad et al. 2007), decrease the extent of wintering habitat, and decouple the timing of migration from food resource peaks that are driven by temperature and are necessary for migration and feeding offspring (van Noordwijk et al. 1995; Visser et al. 1998; Thomas et al. 2001; Strode 2003).

Over the past 100 years, the global temperature has increased by approximately 0.6 degrees Celsius (IPCC 2007), and the timing of spring events has shifted significantly earlier for many species (Root et al. 2003). Sea levels have risen approximately 10-25 centimeters on average across the globe over the past 100 years (Rahmstorf et al. 2007), a rate that is an order of magnitude greater than that seen in the past several thousand years (Hopkinson et al. 2008). The intensity of precipitation has also increased in the Midwest over the last century (Kling et al. 2003). However, climate change has been more pronounced in some areas than others, and in general, higher latitudes have warmed more than lower latitudes in the past half century (Root et al. 2003). In the Midwest, northern sites have warmed by almost 2 degrees Celsius and are experiencing earlier springs, while the southern sites have cooled by about 0.5 degree Celsius and are experiencing later springs (NAST 2000). Recent climate change projections for the Great Lakes region indicate that the area will become warmer (3 to 6 degrees Celsius) and drier during the 21st century (NAST 2000).

The extent and availability of suitable habitat within jack pine forests may change over time due to global climate change. Heat tolerance is the primary factor expected to limit growth of jack pine (Botkin et al. 1991). Continued increases in temperature and evaporation will likely reduce jack pine forest acreage (NAST 2000), as well as increase the susceptibility of current jack pine forests to pests and diseases (Bentz et al. 2010; Cudmore et al. 2010; Man 2010; Safranyik et al. 2010). Competition with deciduous forest species is also expected to favor an expansion of the deciduous forest into the southern portions of the boreal forest (USFWS 2009) and affect interspecific relationships between the Kirtland's warbler and other wildlife (Colwell and Rangel 2009; Wiens et al. 2009). However, warmer weather and increased levels of carbon dioxide could also lead to an increase in tree growth rates on marginal forestlands that are currently temperature-limited (NAST 2000). Additionally, higher air temperatures will cause greater evaporation and in turn, reduce soil moisture, resulting in conditions conducive to forest fires (NAST 2000) that favor jack pine propagation. Under different greenhouse gas emission scenarios, there may be a reduction of suitable Kirtland's warbler breeding habitat in Michigan, as well as an expansion of suitable habitat in western Wisconsin and Minnesota (Prasad et al. 2007).

Climate change could also affect Kirtland's warbler wintering habitat. Rising sea levels caused by the melting of glaciers were implicated in the decline of the Kirtland's warbler population, due to a reduction in the size of the islands on which they winter (Amadon 1953; Mayfield 1992). The Bahamas archipelago is mainly composed of small islands, and more than 80% of the land surface is only one meter or less above the mean sea level (The Bahamas Environment, Science and Technology Commission 2001). This makes The Bahamas particularly vulnerable to future rises in sea level, which could further reduce the extent of winter habitat and negatively impact the Kirtland's warbler.

Projections of drier conditions in the Caribbean are also associated with global warming (Neelin et al. 2006), and a drying trend has already been documented within The Bahamas (Martin and Weech 2001). Rainfall declined by roughly 10% on Inagua Island from 1959 to 1990 and by nearly 14 percent on Long Island (Martin and Weech 2001). A drying trend on the wintering grounds is of concern, given evidence for a lower than expected annual return of Kirtland's warblers to the breeding grounds after dry winters in The Bahamas between 1972 and 1980 (Ryel 1981).

Rockwell (unpubl. data) recently found that male Kirtland's warblers arrive on the breeding grounds later after drier winters. Arrival of male Kirtland's warblers on the breeding grounds was delayed by an average of 3.6 days among second-year males and 0.3 day among after-second-year males for every inch of reduction below the average amount of rainfall in March (Rockwell, unpubl. data). These delays ultimately impacted the reproductive success of individuals, which averaged 0.6 fewer offspring fledged per Kirtland's warbler male for every inch reduction in average March rainfall (Rockwell, unpubl. data).

Delays in the spring migration of closely related American redstarts have also been directly linked to variation in March rainfall and arthropod biomass (Studds and Marra 2007, 2011) and have also resulted in fewer offspring produced per summer (Reudinck et al. 2009). These results strongly indicate that environmental conditions modify the phenology of spring migration, which likely carries a reproductive cost. If The Bahamas continue along a winter drying trend, Kirtland's warblers may be pressured to delay spring departures, while simultaneously contending with warming trends in their breeding range that pressure them to arrive earlier in the spring.

Overall, the magnitude of threats posed to the Kirtland's warbler by climate change is unknown. The impact of regional changes across the species' distribution will have to be monitored closely, and continued research may help clarify this issue.

Nest parasitism
Nest parasitism can depress reproduction of avian hosts in several ways, including direct removal or predation of eggs or young, facilitation of nest predation by other nest predators, reduction of hatching or fledging success, altering of host population sex ratios, and increases to juvenile and adult mortality beyond the nest (Elliot 1999, Hoover 2003; Smith et al. 2003; Zanette et al. 2005; Hoover and Reetz 2006; Hoover and Robinson 2007; Zanette et al. 2007; Reetz 2008). The brown-headed cowbird is the only nest parasite within the Kirtland's warbler breeding range.

Although brown-headed cowbirds were historically restricted to prairie ecosystems, forest clearing and agricultural development of Michigan's Lower Peninsula in the late 1800s facilitated cowbird expansion into Kirtland's warbler nesting areas (Mayfield 1960). Wood and Frothingham (1905) found that brown-headed cowbirds were already common within the Kirtland's warbler breeding range by the early 1900s. Strong (1919) later reported the first known instance of nest parasitization of a Kirtland's warbler nest in Crawford County in 1908. Shortly thereafter, Leopold (1944) related the scarcity of Kirtland's warblers to brown-headed cowbird parasitism. Mayfield (1960) supported this hypothesis with empirical data, and further recognized that cowbird parasitism threatened the survival of the warbler.

Between 1903 and 1971, researchers observed parasitism rates ranging from 48% to 86% of Kirtland's warbler nests (reviewed in Shake and Mattson 1975). In addition, brown-headed cowbirds also exerted greater pressure on Kirtland's warblers than other potential hosts within the same area. Walkinshaw (1983) reported that 93% of all the cowbird eggs he found among suitable host nests within jack pine habitat were located in Kirtland's warbler nests.

The Kirtland's warbler is particularly sensitive to brown-headed cowbird nest parasitism. The warbler's limited breeding range exposes the entire population to cowbird parasitism (Mayfield 1960; Trick, unpubl. data). In addition, the peak egg-laying period of the cowbird completely overlaps that of the warbler, and the majority of birds produce only one brood each year (Mayfield 1960; Radabaugh 1972; Rockwell, unpubl. data). Kirtland's warblers have limited evolutionary experience with brown-headed cowbirds compared to other hosts and have not developed effective defensive behaviors to thwart nest parasitism (Walkinshaw 1983). Brown-headed cowbirds also appear to exert greater pressure on Kirtland's warbler nests than other passerines within the same breeding habitat. Walkinshaw (1983) reported that 93% of all the cowbird eggs he found in jack pine habitat were located in Kirtland's warbler nests compared to all other host species combined. Kirtland's warbler fledging rates averaged less than 1 young per nest prior to the initiation of cowbird control (Walkinshaw 1972).

The effect of cowbird parasitism exacerbated negative impacts associated with habitat loss in the decline of the Kirtland's warbler population (Rothstein and Cook 2000). Nicholas Cuthbert and Bruce Radabaugh (Cuthbert 1966) demonstrated that trapping brown-headed cowbirds within Kirtland's warbler nesting areas decreased parasitism rates and increased Kirtland's warbler nesting success. Accordingly, intensive cowbird removal was recommended on major Kirtland's warbler nesting areas as one of the necessary steps for the recovery of the Kirtland's warbler (Shake and Mattsson 1975).

Since 1972, the Service in conjunction with the MDNR and USFS has implemented an intensive cowbird control program within major Kirtland's warbler nesting areas. Cowbird traps are constructed using a modified crow trap design, and are baited with live cowbird decoys, fresh water, and white millet seed. During March and early April, biologists from the United States Department of Agriculture-Wildlife Services in Ohio collect brown-headed cowbirds which are then transported to northern Michigan by Service biologists and placed in traps. Traps are placed at locations within Kirtland's warbler nesting areas as determined by the previous year's singing male census (approximately one per square mile within occupied habitat). Traps remain open and are checked daily from mid-April through late-June. The numbers of traps operated each year has ranged from 15 traps to 70 traps, averaging 46 traps per year, over the lifetime of the program. All non-target birds are released and newly caught cowbirds are euthanized. The control program annually removes approximately 3,800 cowbirds from occupied Kirtland's warbler habitat in the northern Lower Michigan (Elbert and Mensing 2010; Figure 9).

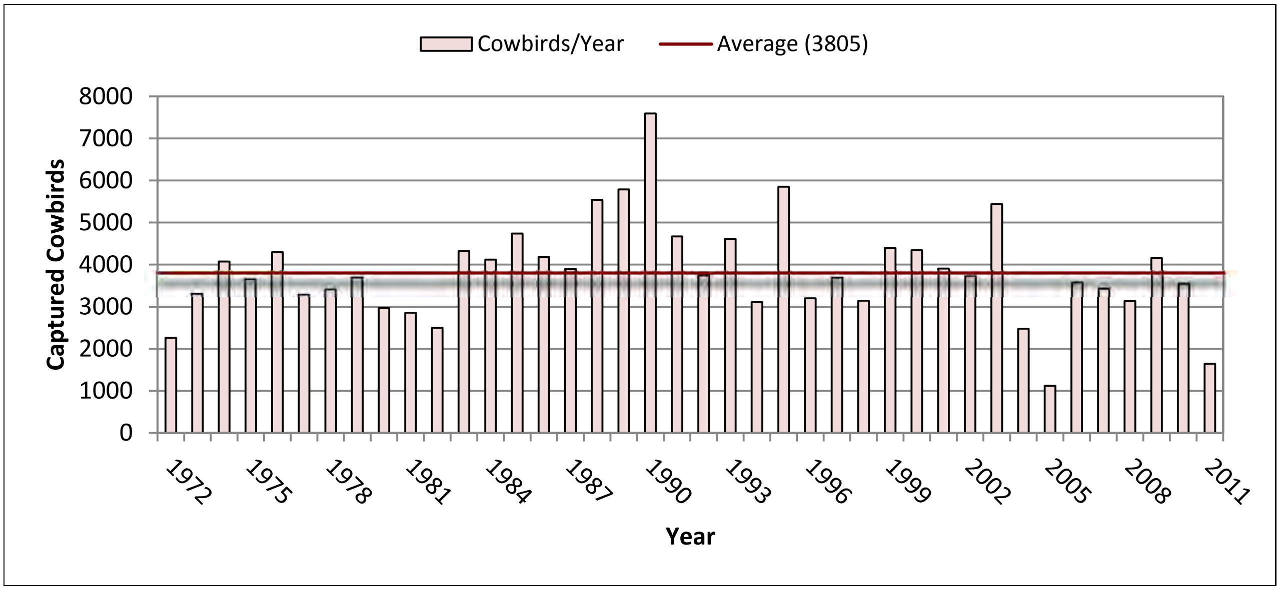

Figure 9. Number of brown-headed cowbirds captured from Kirtland's warbler nesting areas in northern Lower Michigan, 1972-2011.

Following the initiation of cowbird control in northern Lower Michigan in 1972, nest parasitism dropped to 6.2%, and averaged 3.4% between 1972 and 1981 (Kelly and DeCapita 1982). Kirtland's warbler fledging rates simultaneously increased from less than 1 per nest to 2.84 per nest, and averaged 2.76 young fledged per nest between 1972 and 1981 (Kelly and DeCapita 1982). Had cowbird parasitization not been controlled, Mayfield (1975) calculated that Kirtland's warbler would have gone extinct by 1980.

The effectiveness of the cowbird control program in relation to Kirtland's warbler nest productivity has not been evaluated since the early 1980s. Anecdotal observation since then, however, has indicated very low levels of nest parasitism within Kirtland's warbler nesting areas (Bocetti 1994; Rockwell, unpubl. data). De Groot and Smith (2001) found that cowbirds were nearly eliminated in areas directly adjacent to a trap and cowbird densities were affected 5 km and beyond, from cowbird removal areas. Cowbird densities significantly increased at distances greater than 10 km from cowbird removal areas, further demonstrating the localized effect of cowbird control (De Groot and Smith 2001). Although cowbird density increased as distances beyond 5 km of cowbird traps increased, cowbird densities were still low in those areas compared to other parts of North America (De Groot and Smith 2001). At these low densities, it is unlikely that brown-headed cowbirds are able to parasitize Kirtland's warbler nests at a rate that would pose a danger to the population.

Nest parasitization rates of Kirtland's warblers breeding in Wisconsin appear to be much higher than rates assumed for Kirtland's warblers breeding in Michigan. Despite the implementation of a cowbird control program similar to that used in Michigan, nest parasitization rates in Wisconsin have also fluctuated substantially between years (66% in 2007, 20% in 2008, 22% in 2009, 40% in 2010) (Trick, unpubl. data). However, the abundance of singing males has continued to increase each year since 2007 (Trick, unpubl. data).

After 40 years of trapping, the threat of nest parasitism has been greatly reduced but not eliminated. Brown-headed cowbirds are able to parasitize at least 220 host species (Friedmann and Kiff 1985), and the effect of cowbird parasitism is therefore not density-dependent on any one host. Cowbirds are noticeably present in jack pine habitat away from cowbird traps, regardless if that area had been trapped in previous years (DeGroot and Smith 2001; Bailey 2007). Female cowbirds are highly prolific, known to produce up to 40 eggs in a breeding season (Scott and Ankney 1980). Successful cowbird reproduction outside of Kirtland's warbler nesting areas compensates for losses created by the trapping program and maintains an abundance of adult brown-headed cowbirds that could return in subsequent years with the ability to parasitize Kirtland's warbler nests. Without trapping, it is likely that brown-headed cowbird nest parasitism would again threaten the Kirtland's warbler. A sustainable Kirtland's warbler population requires maintaining an annual cowbird control program.

On-going research (Koestecke et al. 2009) on Fort Hood Military Reservation in Texas, examining the threat of nest parasitism on the federally endangered black-capped vireo (*Vireo atricapilla*) further demonstrates the necessity of cowbird control for the recovery and continued conservation of federally listed songbirds. The cowbird control program on Fort Hood has been operated since 1988 and has decreased parasitism rates from more than 90% to less than 10% of nests. Starting in 2006, cowbird trapping was stopped on a portion of Fort Hood. Since that cessation of cowbird control, cowbird parasitism rates have increased from 7.9% to 23.1% and vireo nest survival has decreased to unsustainable levels (Kostecke et al. 2009). There are numerous differences between the ecological circumstances of Fort Hood and northern Lower Michigan. Results of this study, however, demonstrate the short-lived effects cowbird control has on cowbird parasitism.

Collision with Lighted and Man-Made Structures

Collision with man-made structures (e.g. tall buildings, communication towers, wind turbines, power lines and heavily lighted ships) threaten millions of migrating songbirds annually with death or injury (reviewed in Drewitt and Langston 2008; Longcore et al. 2008). Factors that influence the likelihood of avian collisions with man-made structures include size, location, the use of lighting, and weather conditions during migratory periods (reviewed in Drewitt and Langston 2008). The presence of artificial light at night and plate-glass windows are the most important factors influencing avian collisions (Ogden 1996; Klem 2009).

There are five confirmed reports of Kirtland's warblers colliding with man-made structures, all of which resulted in death. Two of these deaths resulted from collisions with windows (Kleen 1976; Dan Kramer, Ohio Ornithological Society, pers. comm. 2009), and three resulted from collisions with a lighted structure, including a lighthouse (Merriam 1985), an electric light mast (Jones 1906) and a lighted monument (Nolan 1954). Another report of a Kirtland's warbler that flew into a window and appeared to survive after only being stunned by the collision (Cordle 2005), was not accepted as an official documented observation of a Kirtland's warbler (Maryland Ornithological Society MD/DC Records Committee database).

Some bird species may be more vulnerable to collision with man-made structures than others due to species-specific behaviors. Particularly vulnerable species include night-migrating birds that are prone to capture or disorientation by artificial lights because of the way exposure to a light field can disrupt avian navigation systems, species that habitually make swift flights through restricted openings in dense vegetation, or species that are primarily active on or near the ground (reviewed in Ogden 1996; Gauthreaux and Belser 2006). Of the avian species recorded, the largest proportion of species (41%) that suffer migration mortality at man-made structures belongs to the wood warbler subfamily (Parulinae), of which many species exhibit the above mentioned behaviors (Ogden 1996).

The Kirtland's warbler belongs to the Parulinae subfamily and exhibits many of the behaviors characteristic of other birds considered vulnerable to collision with man-made structures, yet little is known regarding how prone this species is to collision. The general public is largely unaware of the hazards that man-made structures pose to birds, and the majority of collisions go un-detected because corpses land in inconspicuous places or are quickly removed by scavengers postmortem (Klem 2009). Additionally, while most avian collisions take place during migration, detailed information about Kirtland's warbler migration is still limited. The Kirtland's warbler population is also small, reducing the probability of collision observations by chance alone, compared to other species. These factors have inhibited the gathering of information, and in turn, a more comprehensive understanding of the hazards man-made structures pose to the Kirtland's warbler. It is reasonable to presume, however, that more Kirtland's warblers collide with man-made structures than are reported. Expanding wind energy and telecommunication projects across the eastern United States, including the Great Lakes coast, eastern mountain ranges, and southeastern Atlantic coasts, pose a potential threat to migrating Kirtland's warblers (Figure 10).

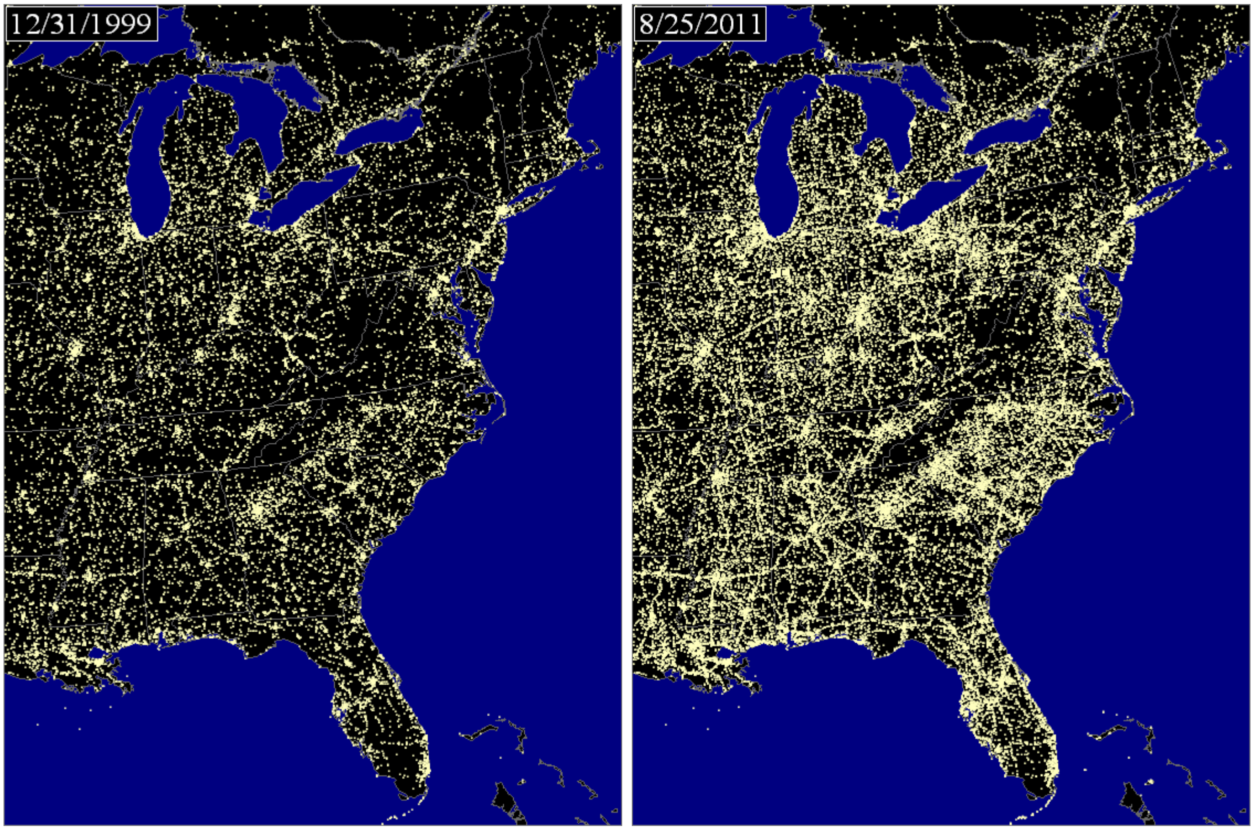

Figure 10. Verified Federal Aviation Administration (FAA) obstacles standing 200 feet or more above ground level. FAA obstacles include communication towers, windmills, cooling towers, buildings, monuments, and other man-made structures that would be of interest to aeronautical information users. FAA obstacles numbered 26,752 prior to January 1, 2000 and expanded 121% to 59,124 by August 25, 2011. Data were gathered from the ORS Digital Obstacle File, Federal Aviation Administration, retrieved December 6, 2011.

Several solutions have been proposed to reduce the hazards that cause avian collisions with man-made structures. Extinguishing internal lights of buildings at night, avoiding the use of external floodlighting, and shielding the upward radiation of low-level lighting such as street lamps are expected to reduce attraction and trapping of birds within illuminated urban areas, and in turn, injury and mortality caused by collision, predation, starvation, or exhaustion (reviewed in Ogden 1996). The Service's Urban Conservation Treaty for Migratory Birds program has worked with several cities to adopt projects that benefit migrating birds flying through urban areas in between breeding and wintering grounds. For example, the cities of Chicago and Indianapolis have "Lights Out" programs, which encourage the owners and managers of tall buildings to turn off or dim exterior decorative lights as well as interior lights during spring and fall migration periods. These programs are estimated to reduce bird mortality by up to 83% (Field Museum 2007). Additionally, migrating birds are not equally attracted to various lighting patterns, and modifying certain types of lighting systems could significantly reduce collision related mortality. Gehring et al. (2009) reported that by removing steady-burning, red L-810 lights and using only flashing, red L-

864 or white L-865 lights on communication towers and other similarly lit aeronautical obstructions, mortality rates could be reduced by as much as 50-70%.

2.4 Synthesis

A recovery plan for the Kirtland's warbler was issued in 1976 and later updated in 1985. The primary objective stated in the recovery plan is to "re-establish a self-sustaining Kirtland's warbler population throughout its known range at a minimum level of 1,000 pairs." As currently stated, the primary objective does not acknowledge the species reliance on perpetual human intervention to sustain a recovered population into the foreseeable future. The Kirtland's Warbler Recovery Team recognizes that a human-altered landscape and fire regime in the Great Lakes Region requires intensive, anthropogenic efforts to sustain and increase the population of Kirtland's warblers. Despite this incongruity, recovery criteria outlined in the recovery plan remain appropriate measures of recovery.

The size of the Kirtland's warbler population is currently at its historical maximum, which is nearly 10 times larger than it was at the time of listing and close to twice as large as the threshold stated in the primary objective. Furthermore, the population size has surpassed recovery goals every year since 2001. Achievement of the primary objective is attributable to successful interagency cooperation in the management of habitat. The amount of suitable habitat has increased by approximately 150% since listing, primarily due to the increased amount of planted habitat generated from adaptive silvicultural techniques. More than 75% of the current extent of suitable breeding habitat in northern Lower Michigan was generated from planted stands and contains 85% of all singing males. The effectiveness of this habitat management strategy is also evident by the reproductive output observed in planted stands, which function as population sources, and indicates that continued survival of Kirtland's warblers will depend largely on the production of managed breeding habitat. Cowbird control has been conducted on an annual basis within Kirtland's warbler nesting areas since 1972, and presumably benefits the Kirtland's warblers. Yet, the prolific reproductive nature of brown-headed cowbirds outside control areas necessitates continued control efforts.

The majority of the breeding population remains heavily concentrated within a small area in northern Lower Michigan, although breeding has expanded into new areas in recent years. Kirtland's warblers now regularly breed in Michigan's Upper Peninsula, Wisconsin, and Ontario, Canada. These breeding populations represent a significant potential for the establishment of source populations outside of northern Lower Michigan.

A clear understanding of Kirtland's warbler migration is still lacking because few observations of Kirtland's warblers in migration have been recorded since the species was first described. Kirtland's warblers may make the journey between their breeding and wintering grounds in one flight, or they may use multiple stopover sites along the way. The shorelines of western Lake Erie, eastern Florida, and Lake Michigan could be important to migrating individuals, but this conclusion could also be biased based on increased survey effort in those areas. Limited amounts of natural habitat in potentially important stopover areas, as well as increased wind-energy and telecommunication development along the migratory pathway could have potentially negative impacts on migrants. The magnitude of these threats remains unknown, but annual survival of adult and juveniles appear to be high enough to maintain population numbers. Increased monitoring and survey effort during migration may help clarify these issues.

The winter range is restricted almost exclusively to the Bahamas archipelago. Only a small proportion of the Kirtland's warbler population has been examined within its wintering range, and the majority of this effort has been restricted to Eleuthera Island. Research indicates that wintering Kirtland's warblers occur in early successional habitats that can result from natural or anthropogenic disturbances. Individuals move widely on the wintering grounds, tracking changes in fruit abundance of snowberry, black torch, and wild sage, in particular. However, little of the land in The Bahamas that is suitable for wintering Kirtland's warblers is protected, which is a source of concern. Return rates of banded birds indicate sufficient amounts of winter habitat, but habitat loss caused by human development, altered fire regime, shifting agricultural practices, rising sea levels due to climate change, drought, and invasive plant species should be monitored to determine the potential magnitude of this threat.

Climate change is a new potential threat for Kirtland's warblers. Impacts to the Kirtland's warbler or its habitat have not yet been demonstrated but could include a decrease and shift of suitable breeding habitat outside of the current breeding range, a decrease in the extent of wintering habitat, as well as a decoupling of migration timing and food resource peaks. The impact of regional changes across the species' distribution will have to be monitored closely, and continued research may help clarify how Kirtland's warbler will respond to climate change. Increased study on the distribution of wintering Kirtland's warblers, in particular, will provide more information to better gauge the magnitude of these threats.

Based on the success that management has had in addressing the major threats to the species, the current overall magnitude of threats is reduced since the time the species was listed. While these management strategies treat the afflictions of habitat loss and introduced nest parasitism, they do not cure them, and transform the Kirtland's warbler into a conservationreliant species. In order to ensure the survival of the Kirtland's warbler, continued habitat management and cowbird control are likely to be necessary for the foreseeable future. The Act, as amended, provides significant protection, funding and oversight to Kirtland's warbler recovery. Kirtland's warbler conservation, however, could be accomplished outside the purview of the Act. The USFS and MDNR have demonstrated long-term commitments to Kirtland's warbler conservation by signing a Memorandum of Understanding that provides assurances that management for the benefit of the species will continue into the foreseeable future. To bolster this commitment, the National Fish and Wildlife Foundation in conjunction with the Service, USFS and MDNR have been working to develop a "Friends of the Kirtland's warbler" non-profit group and endowment fund. The friends group and endowment fund would garner financial and other support to sustain vital conservation actions in the event of any shortfalls in agency funding. A Kirtland's warbler conservation plan is also in development in order to outline a future conservation strategy in the absence of the Act.

The dramatic increase in population size over the past 20 years as well as the reduction in the magnitude of the primary threats is not indicative of a species in danger of extinction within all or a significant portion of its range. Therefore, it is recommended that the species be reclassified from endangered to threatened status. We are not recommending delisting of the warbler at this time because its survival is still dependent on management actions that have not yet been assured throughout the foreseeable future. Mechanisms to ensure the survival of the species regardless of listing status under the Act are being developed that could make delisting possible. Further research is also needed to increase our understanding of migration, wintering habitat, and impacts associated with climate change.

3.0 RESULTS

3.1 Recommended Classification:

_X_ **Downlist to Threatened**

3.2 New Recovery Priority Number

As detailed in this review, the biological and ecological factors limiting the Kirtland's warbler population and the primary threats to the species' existence are well understood. Management actions that effectively address the limiting factors and threats are intensive, but also well documented and have a high probability of success. The primary threats are still considered imminent. The overall magnitude of the primary threats, however, has decreased, the recovery potential is high, and prior conflicts between recovery objectives and the management and use of essential habitat on military lands in northern Michigan have been moderated (Michigan Department of Natural Resources and Department of Military Affairs 1983, 1995; USFWS 1990, 1997). The Endangered and Threatened Species Listing and Recovery Priority Guidelines (48 FR 43104) requires a change in priority number when the degree of threat changes. In order to better prioritize the preparation and implementation of recovery plans under the Act, we recommend that the Kirtland's warbler recovery priority number be changed from 2c (demonstrating a species with a high degree of threat, high recovery potential and conflict between recovery objectives and the management and use of essential habitat) to 8 (demonstrating a species with a moderate degree of threat and high recovery potential). At the time of listing, the warbler's extinction was almost certain within the immediate future because of rapid population decline and habitat loss. Under current conditions, if recovery were temporarily held off, the species would not face immediate extinction although a continual population decline would be expected based on imminent threats to its habitat, and reproductive success.

3.3 Listing and Reclassification Priority Number,

Reclassification (from Endangered to Threatened) Priority Number: __2_

The Kirtland's warbler original classification as endangered has become inappropriate due to circumstances that have changed since listing, as discussed in this review. Based on the Service's guidelines (48 FR 43104) the priority number is 2 for the preparation of regulations to reclassify this species. The impact of management actions in addressing the primary threats to the Kirtland's warbler is high, and these management actions are unlikely to change if the species is downlisted to threatened status. In addition, the Service has not been petitioned to reclassify the Kirtland's warbler.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Maintain current level of habitat management in the northern Lower Peninsula of Michigan
- Expand habitat management into peripheral areas in Michigan’s Upper Peninsula, Canada, and Wisconsin
- Explore alternative jack pine habitat management techniques
- Maintain annual cowbird control program in the Lower Peninsula of Michigan and Wisconsin
- Delineate winter distribution and habitat
- Secure commitments from wintering ground partners to help continue conservation efforts for Kirtland’s warblers in The Bahamas
- Delineate migratory pathway and habitat
- Continue population surveys in Michigan, Canada, and Wisconsin
- Expand surveys in Canada and Wisconsin
- Establish a Kirtland’s warbler / jack pine ecosystem endowment to fund annual conservation measures
- Work with MDNR, USFS, and others to draft a Kirtland’s warbler conservation plan that outlines future conservation strategies to implement in the absence of the Act
- Research potential climate change impacts

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Kirtland's warbler

Current Classification: Endangered

Recommendation resulting from the 5-Year Review
X **Downlist to Threatened**

Appropriate Recovery Priority Number: 8
Appropriate Listing/Reclassification Priority Number, if applicable: 2

Review Conducted By: East Lansing Field Office

FIELD OFFICE APPROVAL:
Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve Scott Hicks Date 8-9-2012
Scott Hicks

REGIONAL OFFICE APPROVAL:
Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Midwest Region

Approve Lynn M. Lewis Date 8/21/12
Lynn Lewis