Chapter 3: The Environment

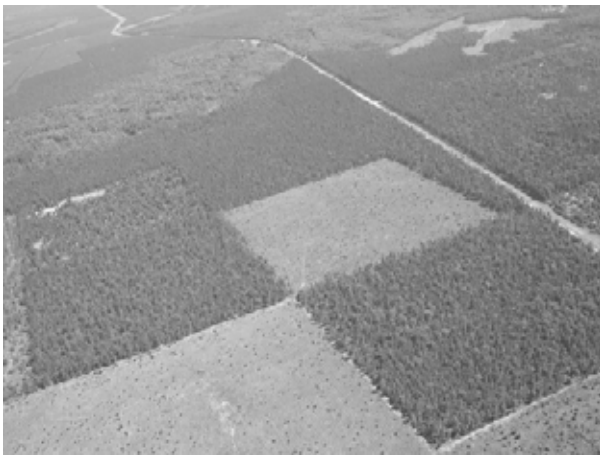
Kirtland's Warbler Wildlife Management Area

Introduction

Kirtland's Warbler WMA was established in 1980 in response to the need for more land dedicated to the recovery of this species. The U.S. Fish and Wildlife Service established the WMA, in part, due to recommendations of the Kirtland's Warbler Recovery Team. The original goal was to acquire 7,500 acres of land on which habitat would be managed for the benefit of Kirtland's Warbler. At present, the area contains 125 separate tracts totaling 6,684 acres. Most of these tracts are located within or adjacent to state forest lands also managed for the Kirtland's Warbler (Figure 2). While management for Kirtland's Warbler is paramount, the WMA provides habitat for a diversity of wildlife species, both migratory and non-migratory.

Climate

Due to its inland location, northern latitude and relatively high elevation, the Kirtland's Warbler WMA is characterized by a relative severe climate. The growing season ranges from 70 to 130 days, with spring freezes common. Extreme temperatures recorded range from minus 50 degrees Fahrenheit to over 105 degrees Fahrenheit. Snowfall is heavy, with up to 140 inches recorded annually in some localities. Average annual precipitation is relatively uniform across the area, between 28 inches and 32 inches (Albert 1995).



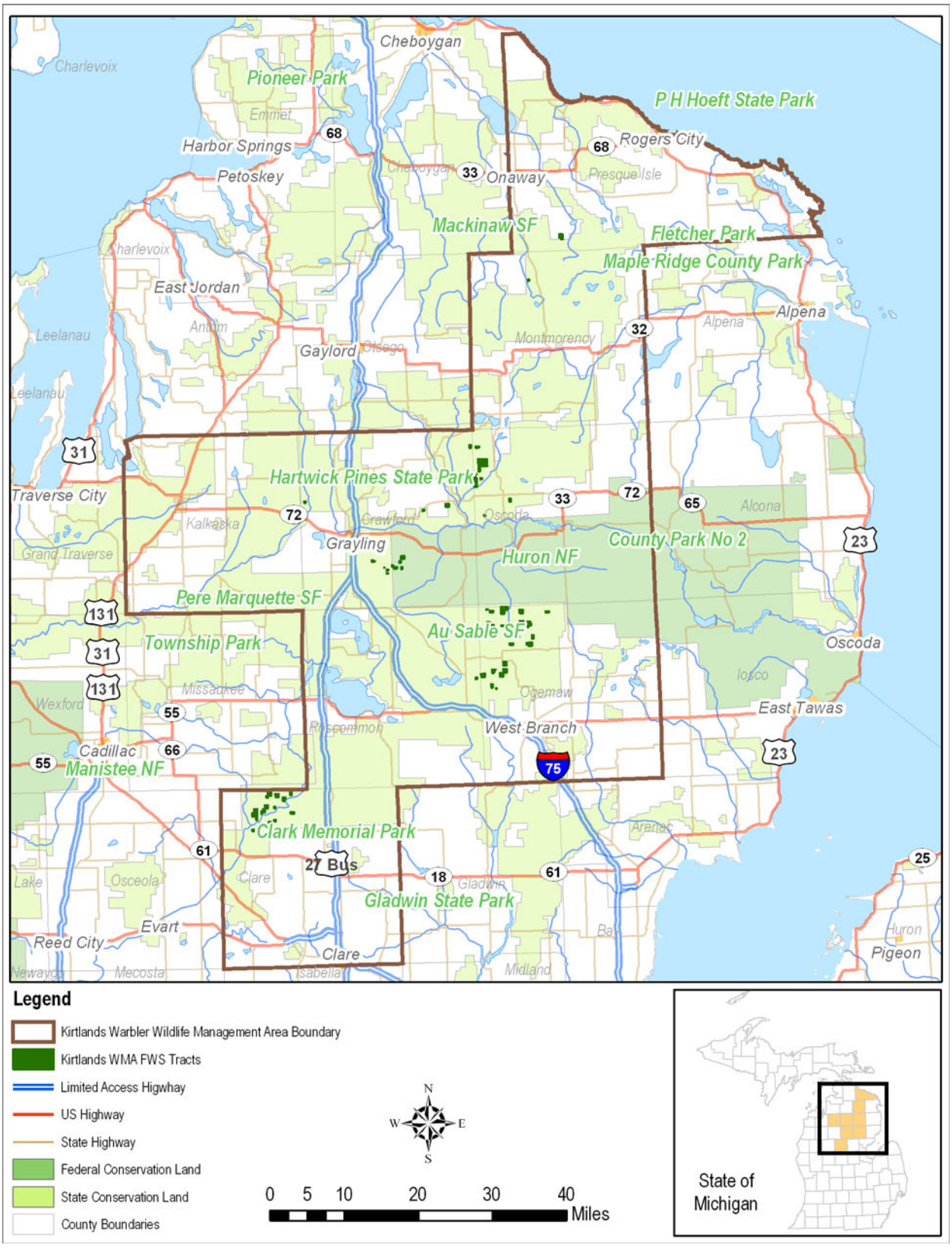
Patch-cutting of jack pine to diversify age structure. U.S. Fish & Wildlife Service photo.

Climate Change Impacts

The U.S. Department of the Interior issued an order in January 2001 requiring federal agencies under its direction that have land management responsibilities to consider potential climate change impacts as part of long range planning endeavors.

The increase of carbon dioxide (CO2) within the earth's atmosphere has been linked to the gradual rise in surface temperature commonly referred to as global warming. In relation to comprehensive conservation planning for national wildlife refuges, carbon sequestration constitutes the primary climate-related impact that refuges can affect in a small way. The U.S. Department of Energy's "Carbon Sequestration Research and Development" defines carbon sequestration as "...the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere."

Figure 2: Conservation Ownership in the Northern Lower Peninsula of Michigan



Vegetated land is a tremendous factor in carbon sequestration. Terrestrial biomes of all sorts – grasslands, forests, wetlands, tundra, and desert – are effective both in preventing carbon emission and acting as a biological "scrubber" of atmospheric CO2. The Department of Energy report's conclusions noted that ecosystem protection is important to carbon sequestration and may reduce or prevent loss of carbon currently stored in the terrestrial biosphere.

Conserving natural habitat for wildlife is the heart of any long-range plan for national wildlife refuges and management areas. The actions proposed in this CCP would conserve or restore land and habitat, and would thus retain existing carbon sequestration on the WMA. This in turn contributes positively to efforts to mitigate human-induced global climate change.

One Service activity in particular – prescribed burning – releases CO2 directly to the atmosphere from the biomass consumed during combustion. However, there is actually no net loss of carbon, since new vegetation quickly germinates and sprouts to replace the burned-up biomass and sequesters or assimilates an approximately equal amount of carbon as was lost to the air (Boutton et al. 2006). Overall, there should be little or no net change in the amount of carbon sequestered at Kirtland's Warbler WMA from any of the proposed management alternatives.

Several impacts of climate change have been identified that may need to be considered and addressed in the future:

- Habitat available for cold water fish such as trout and salmon in lakes and streams could be reduced.
- Forests may change, with some species shifting their range northward or dying out, and other trees moving in to take their place.
- Ducks and other waterfowl could lose breeding habitat due to stronger and more frequent droughts.
- Changes in the timing of migration and nesting could put some birds out of sync with the life cycles of their prey species.
- Animal and insect species historically found farther south may colonize new areas to the north as winter climatic conditions moderate.

Elk were reintroduced to the northern Lower Peninsula Michigan in 1918. U.S. Fish & Wildlife Service

The managers and resource specialists responsible for the WMA need to be aware of the possibility of change due to global warming. When feasible, documenting long-term vegetation, species, and hydrologic changes should become a part of research and monitoring programs on the WMA. Adjustments in land management direction may be necessary over the course of time to adapt to a changing climate.

The following paragraphs are excerpts from the 2000 report: *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, produced by the National Assessment Synthesis Team, an advisory committee chartered under the Federal Advisory Committee Act to help the US Global Change Research Program fulfill its mandate under the Global Change Research Act of 1990. These excerpts are from the section of the report focused upon the eight-state Midwest region.

Observed Climate Trends

Over the 20th century, the northern portion of the Midwest, including the upper Great Lakes, has warmed by almost 4 degrees Fahrenheit (2 degrees Celsius), while the southern portion, along the Ohio River valley, has cooled by about 1 degree Fahrenheit (0.5 degrees Celsius). Annual precipitation has increased, with many of the changes quite substantial, including as much as 10 to 20 percent increases over the 20th

century. Much of the precipitation has resulted from an increased rise in the number of days with heavy and very heavy precipitation events. There have been moderate to very large increases in the number of days with excessive moisture in the eastern portion of the Great Lakes basin.

Scenarios of Future Climate

During the 21st century, models project that temperatures will increase throughout the Midwest, and at a greater rate than has been observed in the 20th century. Even over the northern portion of the region, where warming has been the largest, an accelerated warming trend is projected for the 21st century, with temperatures increasing by 5 to 10 degrees Fahrenheit (3 to 6 degrees Celsius). The average minimum temperature is likely to increase as much as 1 to 2 degrees Fahrenheit (0.5 to 1 degree Celsius) more than the maximum temperature. Precipitation is likely to continue its upward trend, at a slightly accelerated rate; 10 to 30 percent increases are projected across much of the region. Despite the increases in precipitation, increases in temperature and other meteorological factors are likely to lead to a substantial increase in evaporation, causing a soil moisture deficit, reduction in lake and river levels, and more drought-like conditions in much of the region. In addition, increases in the proportion of precipitation coming from heavy and extreme precipitation are very likely.

Midwest Key Issues:

1. Reduction in Lake and River Levels

Water levels, supply, quality, and water-based transportation and recreation are all climate-sensitive issues affecting the region. Despite the projected increase in precipitation, increased evaporation due to higher summer air temperatures is likely to lead to reduced levels in the Great Lakes. Of 12 models used to assess this question, 11 suggest significant decreases in lake levels while one suggests a small increase. The total range of the 11 models' projections is less than a one-foot increase to more than a five-foot decrease. A five-foot (1.5- meter) reduction would lead to a 20 to 40 percent reduction in outflow to the St. Lawrence Seaway. Lower lake levels cause reduced hydropower generation downstream, with reductions of up to 15 percent by 2050. An increase in demand for water across the region at the same time as net flows decrease is of particular concern. There is a possibility of increased national and international tension related to increased pressure for water diversions from the Lakes as demands for water increase. For smaller lakes and rivers, reduced flows are likely to cause water quality issues to become more acute. In addition, the projected increase in very heavy precipitation events will likely lead to increased flash flooding and worsen agricultural and other non-point source pollution as more frequent heavy rains wash pollutants into rivers and lakes. Lower water levels are likely to make water-based transportation more difficult with increases in the costs of navigation of 5 to 40 percent. Some of this increase will likely be offset as reduced ice cover extends the navigation season. Shoreline damage due to high lake levels is likely to decrease 40 to 80 percent due to reduced water levels.

Adaptations: A reduction in lake and river levels would require adaptations such as re-engineering of ship docks and locks for transportation and recreation. If flows decrease while demand increases, international commissions focusing on Great Lakes water issues are likely to become even more important in the future. Improved forecasts and warnings of extreme precipitation events could help reduce some related impacts.

2. Agricultural Shifts

Agriculture is of vital importance to this region, the nation, and the world. It has exhibited a capacity to adapt to moderate differences in growing season climate, and it is likely that agriculture would be able to continue to adapt. With an increase in the length of the growing season, double cropping, the practice of planting a second crop after the first is harvested, is likely to become more prevalent. The CO2 fertilization effect is likely to enhance plant growth and contribute to generally higher yields. The largest increases are projected to occur in the northern areas of the region, where crop yields are currently temperature limited. However, yields are not likely to increase in all parts of the region. For example, in the southern portions of Indiana and Illinois, corn yields are likely to decline, with 10-20% decreases projected in some locations. Consumers are likely to pay lower prices due to generally increased

yields, while most producers are likely to suffer reduced profits due to declining prices. Increased use of pesticides and herbicides are very likely to be required and to present new challenges.

Adaptations: Plant breeding programs can use skilled climate predictions to aid in breeding new varieties for the new growing conditions. Farmers can then choose varieties that are better attuned to the expected climate. It is likely that plant breeders will need to use all the tools of plant breeding, including genetic engineering, in adapting to climate change. Changing planting and harvest dates and planting densities, and using integrated pest management, conservation tillage, and new farm technologies are additional options. There is also the potential for shifting or expanding the area where certain crops are grown if climate conditions become more favorable. Weather conditions during the growing season are the primary factor in year-to-year differences in corn and soybean yields. Droughts and floods result in large yield reductions; severe droughts, like the drought of 1988, cause yield reductions of over 30 percent. Reliable seasonal forecasts are likely to help farmers adjust their practices from year to year to respond to such events.

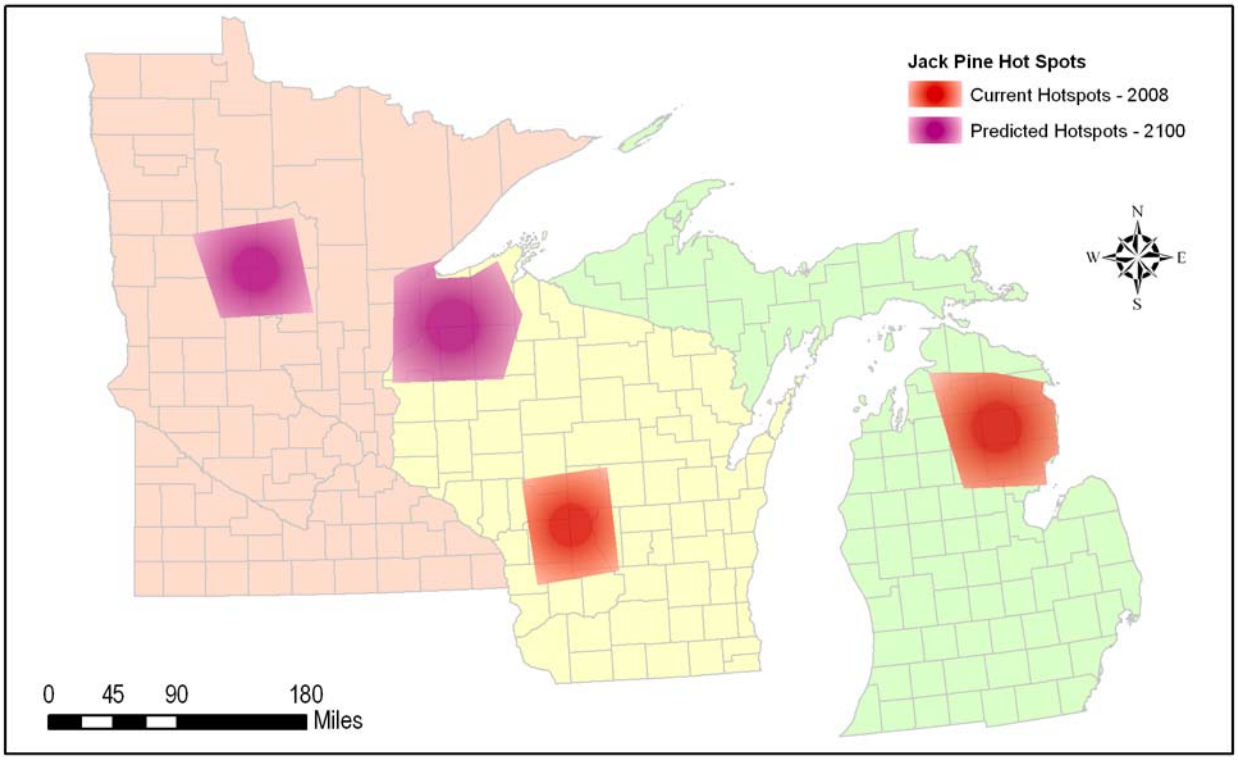
3. Changes in Semi-natural and Natural Ecosystems

The Upper Midwest has a unique combination of soil and climate that allows for abundant coniferous tree growth. Higher temperatures and increased evaporation will likely reduce boreal forest acreage, and make current forestlands more susceptible to pests and diseases. It is likely that the southern transition zone of the boreal forest will be susceptible to expansion of temperate forests, which in turn will have to compete with other land use pressures. However, warmer weather (coupled with beneficial effects of increased CO2), are likely to lead to an increase in tree growth rates on marginal forestlands that are currently temperature-limited. Most climate models indicate that higher air temperatures will cause greater evaporation and hence reduced soil moisture, a situation conducive to forest fires. As the 21st century progresses, there will be an increased likelihood of greater environmental stress on both deciduous and coniferous trees, making them susceptible to disease and pest infestation, likely resulting in increased tree mortality.

Bird trap sign at Kirtland's Warbler WMA. U.S. Fish & Wildlife Service photo.

As water temperatures in lakes increase, major changes in freshwater ecosystems will very likely occur, such as a shift from cold water fish species, such as trout, to warmer water species, such as bass and catfish. Warmer water is also likely to create an environment more susceptible to invasions by non-native species. Runoff of excess nutrients (such as nitrogen and phosphorus from fertilizer) into lakes and rivers is likely to increase due to the increase in heavy precipitation events. This, coupled with warmer lake temperatures, is likely to stimulate the growth of algae, depleting the water of oxygen to the detriment of other living things. Declining lake levels are likely to cause large impacts to the current distribution of wetlands. There is some chance that some wetlands could gradually migrate, but in areas where their migration is limited by the topography, they would disappear. Changes in bird populations and other native wildlife have already been linked to increasing temperatures and more changes are likely in the future. Wildlife populations are particularly susceptible to climate extremes due to the effects of drought on their food sources.

Figure 3: Jack Pine Habitat Suitability Hot Spots of Current and Modeled Importance Values (A.D. 2100)



The figure shows hot spot patches of the current and modeled distribution and the average of three. Hot spots are defined as the top 10 percent of importance values (Matthews et al. 2004)

Climate Change Impacts to Kirtland's Warbler Habitat

The predicted climate change scenarios for the Midwest Region include a shift in forested ecosystems as well as hydrologic factors. The future of the Kirtland's Warbler is in a large part tied to the extent and availability of suitable jack pine forests. These forests will likely change in extent over time due to global climate change.

The U.S. Forest Service, Northern Research Center, modeled and mapped 134 tree species from the eastern United States for potential response to several scenarios of climate change (Prasad et al. 2007). The scenarios, built upon three independent climate models, predicted for both low and high intensity CO^2 emissions through the year 2100. The model only depicted potential suitable habitats of species and not actual changes in ranges of the species. Factors that influence actual migration of a tree species include fragmentation of landscapes, competition with other species, and other possible inhibiting and accelerating factors. These factors are beyond the scope of the model.

Of the 134 species, approximately 66 species would gain and 54 species would lose at least 10 percent of their suitable habitat under climate change. In general, the results show that species will have a lot less pressure to move to more suitable habitats if lower emission of greenhouse gases occurs. Under the lower emission scenario, jack pine might well persist within its current range although the extent and quality may be reduced by an unknown amount. Under the highest emissions scenario, we may see a greater reduction in the current extent of jack pine in Michigan and a shift in environmental conditions suitable for jack pine growth and development to the west in Wisconsin and Minnesota.

Table 1: Soils of the Kirtland's Warbler WMA

Soil Mapping Units/ Associations	Acres	% of WMA
Grayling- Graycalm- Au Gres	2,286.00	34.7
Rubicon- Grayling- Croswell	2,217	33.7
Grayling- Rubicon- Au Gres	1,340	20.4
Graycalm- Kalkaska- Montcalm	307	4.7
Rubicon- Graycalm- Montcalm	226	3.4
Rubicon- Croswell- Au Gres	202	3.1
Menominee- Markey- Montcalm	4	0.1

The two scenarios, when averaged, show that jack pine will have approximately the same potential habitat value, with some changes in distribution, within the eight-state Midwest Region. Current jack pine forests of the Lower and Upper Peninsula of Michigan, including the Kirtland's Warbler WMA, could decrease in extent and/or quality. However, new areas of potential habitat for jack pine will be found to the west of Michigan in western and north-western Wisconsin and at the prairie-boreal forest transition area in northwest Minnesota (Figure 3).

Several national wildlife refuges and wetland management districts are located in or near these new potential "hotspots." Thus, if climate scenarios play out as predicted, there may be reduction in the current distribution and quality of jack pine forests in Michigan and an expansion in the distribution of suitable environmental conditions for jack pine forests in west Wisconsin and west-central Minnesota. Service lands in these regions that host remnant jack pine stands might allocate some management effort into preserving these trees and hence seed sources. Should conditions for jack pine improve this will provide a basis for future stand development. If the population of Kirtland's Warbler continues to rise, there is greater potential for individuals to disburse into new areas of suitable habitat or serve as source populations for transplants to new habitats.

Geology and Glaciation

Michigan's northern Lower Peninsula is underlain by Paleozoic bedrock and was completely glaciated during the Late Wisconsinan period. The underlying bedrock, which was deposited in marine and near-shore environments, includes sandstone, shale, limestone and dolomite (Dorr and Eschman 1984). Limestone bedrock is locally exposed along the Lake Huron and Lake Michigan shorelines, but the sandy glacial deposits over most of the ecoregion are generally thick; the thickest deposits are 600-1,100 feet near Cadillac and Grayling. Common glacial landforms include lake plain, outwash plain, end moraine and ground moraine.

Soils

The physical characteristics of the Kirtland's Warbler WMA are consistent with most of the northern half of the Lower Peninsula of Michigan. Topographically, the land is flat to gently rolling and landforms are glacially derived. In terms of physiography and land classification, the majority of the stands (94 percent) are in the Highplains Landtype Association with 6 percent in the Presque Isle Landtype Association. Three soil associations dominate the tracts namely Grayling – Graycalm - Au Gres (35 percent), Rubicon – Grayling - Croswell (34 percent), and Grayling – Rubicon - Au Gres (21 percent). All of the soil series in the three soil associations are sands (Goebel et al. 2007). See Table 1.

Surface Hydrology

All of the parcels within the Kirtland's Warbler WMA are located on well-drained upland soils (Table 1). However, the northern Lower Peninsula has a variety of surface waters. Interior open wet-

lands found within this ecoregion include intermittent wetlands, bogs, northern wet meadows, northern fens, and poor fens. Coastal wetlands include interdunal wetlands, wooded dune and swale complexes, and Great Lakes marshes.

Archeological and Cultural Values

The Service has almost no information about cultural resources (in this case historic and prehistoric archeological sites, buildings and structures, places of historic events or persons, traditional cultural properties including sacred sites, and properties on or eligible for the National Register of Historic Places) within these eight counties of Michigan. For example, some counties have no historic properties on the National Register of Historic Places listed and the total of historic properties in the eight counties is 15. Furthermore, none of the historic properties are archeological sites and none are on or in the vicinity of current Kirtland's Warbler WMA tracts. Even the chronology of prehistoric cultures and historic settlements is absent.

The Service has records of 37 historic period sites, mostly cabin sites, on Service land and no recorded prehistoric sites. A number of 19th and early 20th century logging camps and related logging facilities are expected to be located in the area and if any are on Service land they likely would be considered eligible for the National Register. The Service has no archeological collections from the Kirtland's Warbler WMA.

Social and Economic Context

The eight counties in the Michigan's northern Lower Peninsula that encompass the Kirtland's Warbler WMA are primarily rural in nature. The economy is limited by a lower population, few industries and reduced agriculture compared to southern Michigan. Seasonal and tourism related employment is significant. For example, Ogemaw County is typical of the region and has the most Kirtland's Warbler WMA parcels and acreage. As of the census of 2000, there were 21,645 people, 8,842 households, and 6,189 families residing in the county. The population density was 38 people per square mile (15/km^2).

The racial makeup of the county was 97.48 percent White, 0.13 percent Black or African American, 0.60 percent Native American, 0.38 percent Asian, 0.03 percent Pacific Islander, 0.13 percent from other races, and 1.25 percent from two or more races. Just 1.16 percent of the population was Hispanic or Latino of any race and 97.9 percent spoke only English at home.

In the county, the age of the population was spread out with 23.50 percent under 18, 6.40 percent from 18 to 24, 24.40 percent from 25 to 44, 27 percent from 45 to 64, and 18.80 percent who were 65 years of age or older. The median age was 42 years. For every 100 females there were 98.40 males.

The median income for a household in the county was $30,474, and the median income for a family was $34,988. Males had a median income of $31,003 versus $20,544 for females. The per capita income for the county was $15,768. About 11 percent of families and 14 percent of the population were below the poverty line, including 18.50 percent of those under age 18 and 9.90 percent of those age 65 or over (U.S. Census Bureau 2005).

Environmental Contaminants

In national maps, the northern Lower Peninsula of Michigan is not located in an area of high deposition of many substances (pH, Hg, NOx) that are elevated further south and east in the Great Lakes Basin.

Due to remote locations, most Kirtland's Warbler WMA parcels are not near any point-sources of pollution. Therefore, most parcels are not at risk from spills or other releases from facilities. However, at least seven of the parcels are encumbered with oil and gas leases and some may have active wells. The level of oil and gas production is relatively low on these isolated sites. However, petroleum spills are a possibility on any active site.

The landscape is likely to be impacted from air pollution that may originate from other, ore industrialized, areas of the Great Lakes basin and beyond.

Natural Resources

Historic Habitat Conditions

Historical evidence indicates that prior to European settlement pine barrens of the northern Lower Peninsula of Michigan were large, relatively open, xeric tracts with clusters of jack pine and red pine of varying density scattered throughout. Common shrubs and herbaceous plants included cherry, *Amelanchier* spp., sweet fern, and bluestem. Fire, both anthropogenic and other, and biotic factors like jack pine budworm (*Choristoneura pinus*) acted as the primary disturbance mechanisms that maintained these ecosystems and created the diverse pattern of thickly forested conifer stands scattered among openings (Figure 4).

Wildfire History

Fire always has been an important disturbance factor in the jack pine barrens. The young jack pines upon which the Kirtland's Warbler depends for nesting habitat grow after fire removes older trees and rejuvenates the forest. Heat from fire opens jack pine cones to release seeds. Fire also prepares the ground for the germination of the seeds.

Historically, the jack pine barrens were maintained by naturally occurring wildfires that swept through the region. The jack pine held little value for the lumbermen who came in search of white pine. Once logging activity ended in the 1880s, the continuing forest fires helped increase the area of jack pine in the northern Lower Peninsula, creating more potential nesting habitat.

Plant Communities and Habitat Types

Landcover in the northern Lower Peninsula of Michigan is primarily forest (67 percent) and wetlands (20 percent). Agricultural land use covers 4 percent and urbanization covers approximately 2 percent (Figure 5 on page 20). The remainder of the landcover consists of open grasslands, sparsely vegetated areas, beaches and rock areas. This region is characterized by diverse topography with extensive outwash plains and large moraines. The ecoregion remains predominantly forested with northern hardwoods, early successional aspen forest, pine systems, and lowland conifer (Michigan DNR 2005).

Wetlands

Approximately 2 percent of the Kirtland's Warbler WMA, or 137 acres, is characterized by wetland ecosystems and 0.6 percent is classified as lakes. No detailed inventories or research have been conducted within these habitat types, however.

Uplands

According to the assessment of Goebel et al. (2007), 41 percent of the stands (2,695 acres) are between 5-23 years old, while 14 percent (959 acres) are less than 5 years old and 45 percent (2,298 acres) are greater than 23 years old. It is important to note that many of the stands have multiple cohorts; to determine the age of each stand the most extensive cohort was considered indicative of the overall stand age.

Seventeen overstory (stems greater than 4 inches dbh) tree species have been found at Kirtland's Warbler WMA, with jack pine, red pine, scarlet oak, trembling aspen, black cherry, black oak, northern red oak, and bigtooth aspen as common overstory species. Other less common species include eastern white pine, red maple, balsam fir, green ash, black ash, white spruce, northern pin oak and fire cherry

The younger stands are dominated by several species including jack pine, trembling aspen, and black cherry, while the 5-23 year old stands are dominated by jack pine. In some instances, the 5-23 year old stands occur under sparsely distributed canopy of older red pine. The older stands (greater than 23 years old) have variable composition, but for the most part are dominated by mature jack pine.

The understory (stems less than 4 inches dbh and greater than 1 inch dbh) included 23 species, the most frequent being:

- jack pine
- red pine
- white pine
- black cherry
- fire cherry
- white oak
- scarlet oak
- northern pin oak
- northern red oak
- black oak

Figure 4: Pre-European Settlement Cover Types of the Northern Lower Peninsula, Michigan

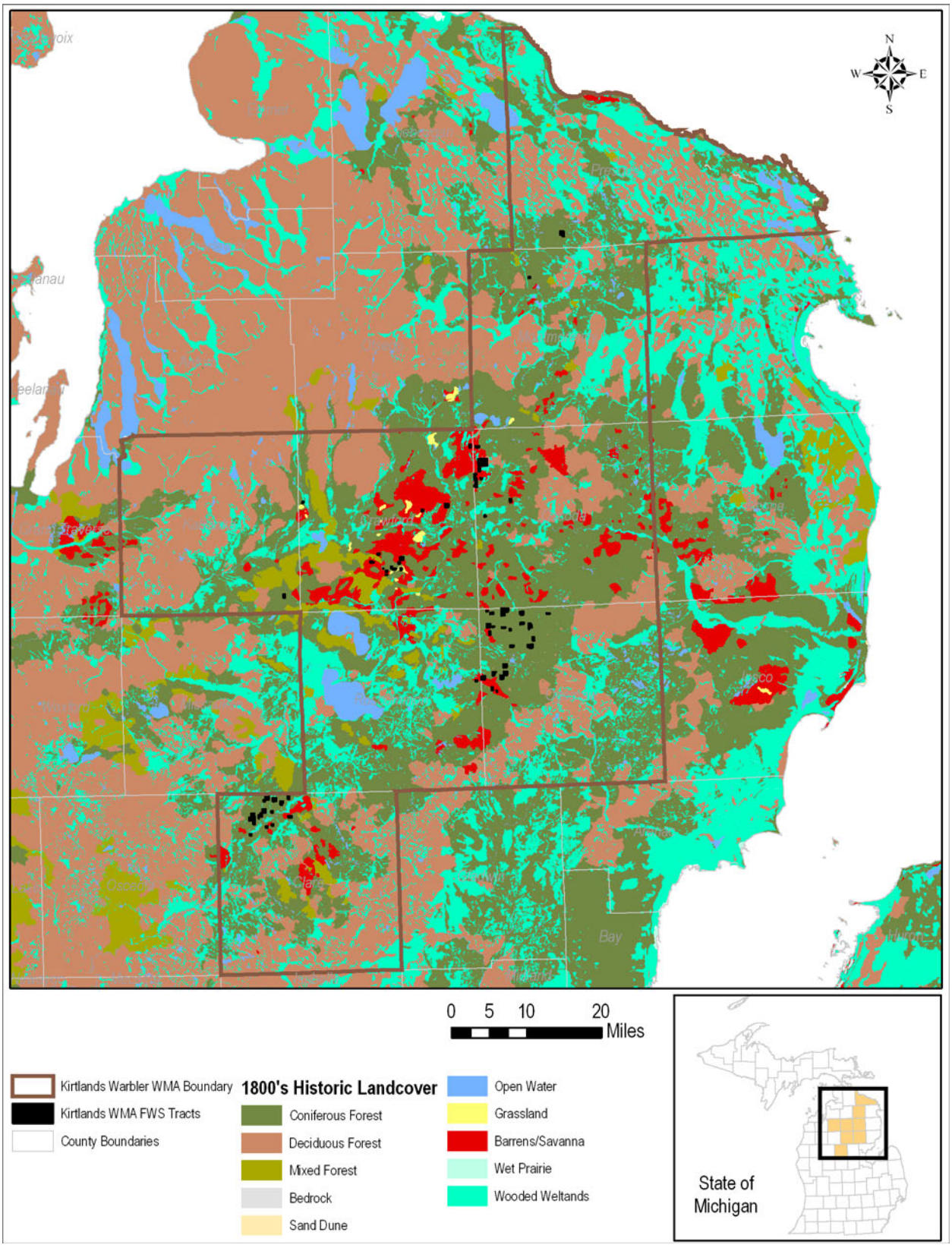
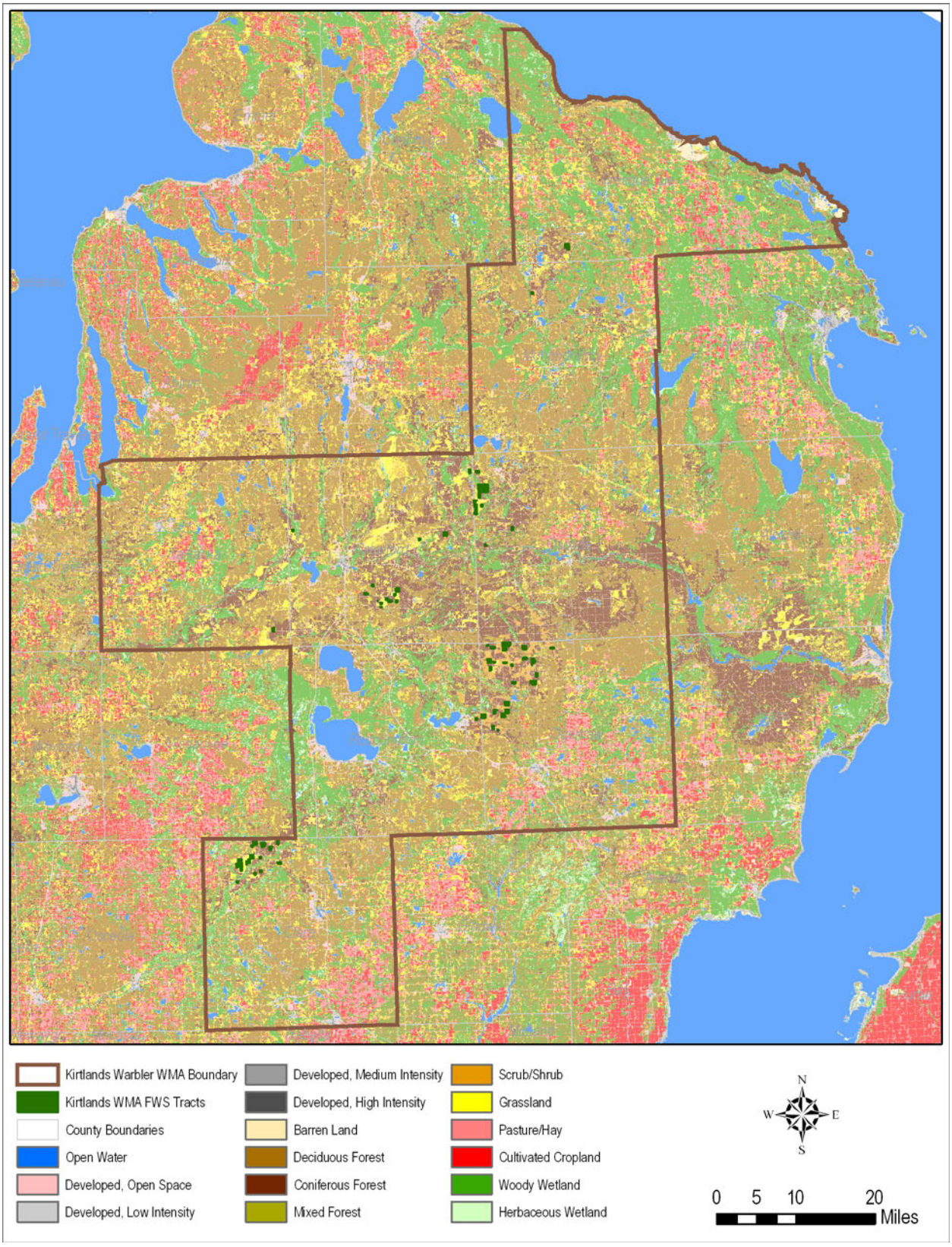


Figure 5: Current Landcover of the Northern Lower Peninsula of Michigan



- trembling aspen
- bigtooth aspen

Although present, red maple, green ash, black ash, white ash, balsam fir, white spruce, tag alder, witch-hazel, serviceberry, hawthorn and birch were less common. Jack pine was the most common understory tree sampled and is characteristic of the understory in all three age classes. Black cherry, trembling aspen, and northern red oak are also common but are generally associated with those stands less than 5 years old and 5-23 years old.

The seedling layer (stems less than 1 inch dbh) is characterized by 29 woody plants including:

- jack pine
- red pine
- eastern white pine
- bigtooth aspen
- trembling aspen
- white oak
- scarlet oak
- northern pin oak
- northern red oak
- black oak
- black cherry
- fire cherry
- choke cherry
- red maple
- green ash
- black ash
- American basswood
- balsam fir
- witch-hazel
- serviceberry
- alternate-leaf dogwood
- dogwood
- hawthorne
- eastern hophornbeam
- willow
- honeysuckle

Clear cuts with reserves at Kirtland's Warbler WMA. U.S. Fish & Wildlife Service photo.

- currant
- gooseberry

In terms of stand structure, the primary interest for Kirtland's Warbler management is jack pine stem density. On the Kirtland's Warbler WMA, overstory stem density is highest in the older age class (greater than 23 years old) than the other two younger age classes, while understory stem density tends to be highest on average in the youngest age class (less than 5 years old). There is also considerable variability in overstory and understory stem density within each age group, especially the youngest age class. This trend is largely due to the range of conditions associated with recent harvest activities where portions of the stands may not have been harvested.

Most importantly to Kirtland's Warbler, mean total stem density in the 5 to 23-year-old stands is lower than is optimal. For instance, average total stem density is 73.1 (10.8) stems per acre in the 5 to 23-year-old stands and 333.0 (14.5) stems per acre in the older stands. Similarly, jack pine densities in the 5 to 23-years-old stands have on average 12.5 (5.2) overstory stems per acre and 24.7 (2.5) understory stems per acre for a total average of 37.2 (6.1) jack pine stems per acre (91.8 (15.0) stems ha-1). While these estimates are indicative of under-stocking in these Kirtland's Warbler WMA stands, it is important to point out that the variability within a tract may "depress" these estimates when mean values are calculated. It is also important to realize that

overstory and understory density tended to be quite "patchy" in many of the Kirtland's Warbler WMA stands.

As observed in the overstory and understory stem density values, seedling densities are also quite variable within age groups, with an average of 1,779 (n=302) total seedlings ac-1 in the young age class (less than 5 years old), 2,514 (155) seedlings ac-1 in the 5-23 year old class, and 2,804 (209) seedlings ac-1 in the oldest age class (greater than 23 years old). Jack pine seedling densities are considerably lower, comprising less than 25 percent of the total seedling community in all three age classes.

The inventory of Geobel et al. (2007) suggests that none of the stands between 5-23 years old in the Kirtland's Warbler WMA appear to have optimal stocking for breeding Kirtland's Warbler (greater than 1,012 stems ac-1). However, as mentioned previously, it is important to keep in mind that there is considerable variation between stands in terms of seedling density. These results suggest that past regeneration efforts, which appear to vary considerably in terms of the methods used, did not always provide the preferred stocking levels of jack pine for Kirtland's Warbler. In the future, other regeneration methods may be advisable, including direct seeding and the use of prescribed fire.

It is also important to point out that the species composition and structure (including age structure) is not only variable among Kirtland's Warbler WMA stands, but also within individual stands. In some areas regeneration methods have left a "patchwork" pattern where small gaps have purposely been left unplanted in an effort to provide foraging habitat for nesting birds or have resulted from failed regeneration efforts. In other stands, natural disturbances (such as wildfire) have left a patchy distribution of overstory and understory stems.

Finally, other stands may have wetland areas or different soil types that do not lend themselves to jack pine forest ecosystems. A good example of this pattern can be found in a stand located in Oscoda County. Using the on-screen digitizing tool in ArcGIS® and 2005 1-m resolution NAIP orthophotography, we estimate that only 116 acres or 15 percent of the 780 acres total is considered Kirtland's Warbler habitat (between 5-23 years old). The remainder of the tract is dominated by wetlands in the interior (200 acres or 26 percent), older jack pine in the northwestern portion of the tract (200 acres or 26 percent), and mixed jack pine and hardwood in the eastern portion of the tract (265 acres or 33 percent). However, due to the heterogeneous nature of some stands, digital imagery should be examined or a site visit be made before making conclusions regarding the composition and structural characteristics of each stand.

Wildlife

Birds

The first known non-Kirtland's Warbler bird surveys conducted on the Kirtland's Warbler WMA occurred as part of the assessment work contracted by the Service in 2006 (Goebel et al. 2007). Sixty bird species were documented during point counts conducted in jack pine-dominated tracts; 75 percent were breeding species recorded on the evidence of singing males.

Whereas jack pine plantations provide food and shelter for a certain suite of species, other jack pine ecosystems offer habitat for a different suite of birds, many of which are either officially listed or of conservation priority (Table 2). Species that use mature jack stands include Black-backed Woodpecker, Spruce Grouse, and Olive-sided Flycatcher. In the younger jack pine stands and more open areas, many openland (grassland and shruland) birds of conservation concern breed. Species found in the early successional stages of jack pine ecosystems include (of course) Kirtland's Warbler, Palm Warbler, Black-billed Cuckoo, Brown Thrasher, Eastern Towhee, Prairie Warbler, and Nashville Warbler. The American Kestrel, Northern Harrier, Upland Sandpiper, and Clay-colored Sparrow can be found in the larger, more open areas.

Mammals

Based on state-wide distribution patterns (Kurta 2001), there are approximately 52 extant mammal species possible within the Kirtland's Warbler WMA (Appendix C). However, range expansion of some species is likely to occur soon. For instance, although not prevalent within the Lower Peninsula of Michigan now, gray wolf (a federally listed endangered species) is likely to become established in the future. Species of high public interest include river otter, beaver, snowshoe hare, and white-tailed deer.

Reptiles and Amphibians

Based on state-wide distribution patterns (multiple authors), 36 species of herptofauna possibly exist within the Kirtland's Warbler WMA and many of these species are of conservation priority (Appen-

Table 2: Bird Species Strongly Associated with Young, KW, and Old, Stands of the Kirtland's Warbler WMA

Young (Less than 5 years old)	KW (5-23 years old)	Old (More than 23 years old)
Indigo Bunting***	Kirtland's Warbler***	Eastern Wood-Pewee***
Eastern Bluebird***	Nashville Warbler***	Hermit Thrush***
Field Sparrow***	Eastern Towhee***	Ovenbird***
Lincoln's Sparrow***	Brown Thrasher**	Rose-breasted Grosbeak***
Black-billed Cuckoo*	Alder Flycatcher**	Red-breasted Nuthatch***
		Red-eyed Vireo***
		Black-capped Chickadee**
		Chipping Sparrow**
		Mourning Dove*

*P < 0.05; ** P < 0.01; *** P < 0.001.
Table 2 provides the results of a statistical procedure that assigns species to each of the three stand ages based on frequency of encounters. It also only shows species whose *P*-value is <0.05. Some species are also highly associated with these stands, but at greater *P*-values. See Figure 6 on page 27.

dix C). Much more inventory work is required at the Kirtland's Warbler WMA. Future considerations should be made to include management appropriate for other species of concern and rare species such as the Massasauga rattlesnake and Blanding's turtle.

Associated Plans and Initiatives

Michigan's Wildlife Action Plan

In 2005, Michigan's Wildlife Action Plan (WAP) was completed to better manage wildlife species and their habitats of "greatest conservation need" in Michigan. The plan was developed with the support of funding from the State Wildlife Grant Program created by Congress in 2001. The goal of the plan is to provide a common strategic framework that will enable Michigan's conservation partners to jointly implement a long-term holistic approach for the conservation of all wildlife species. Members of the partnership include the Michigan Department of Natural Resources, the U.S. Fish and Wildlife Service, the U.S. Forest Service, The Nature Conservancy, Michigan Natural Features Inventory, academics from several Michigan universities, as well as many other agencies and conservation organizations.

The action plan:

- provides an ecological, habitat-based framework to aid in the conservation and management of wildlife;
- identifies and recommends actions to improve habitat conditions and population status of species with the greatest conservation need (SGCN), which are those species with small or declining populations or other characteristics that make them vulnerable;
- recommends actions that will help to keep common species common;
- identifies and prioritizes conservation actions, research and survey needs, and long-term monitoring needed to assess the success of conservation efforts;
- complements other conservation strategies, funding sources, planning initiatives, and legally mandated activities;
- incorporates public participation to provide an opportunity for all conservation partners and Michigan residents to influence the future of resource management;
- provides guidance for use of State Wildlife Grant funds; and

Aerial photo of intensely managed jack pine plantations (left) and prescribed fire jack pine habitat (right).

- provides a clear process for review and revision as necessary to address changing conditions and to integrate new information as it becomes available.

Migratory Bird Conservation Initiatives

Several migratory bird conservation plans have been published over the last decade that can be used to help guide management decisions for the refuges and WMAs. Bird conservation planning efforts have evolved from a largely local, site-based orientation to a more regional, even inter-continental, landscape-oriented perspective. Several trans-national migratory bird conservation initiatives have emerged to help guide the planning and implementation process. The regional plans relevant to Kirtland's Warbler WMA are:

- The Upper Mississippi River/Great Lakes Joint Venture Implementation Plan of the North American Waterfowl Management Plan;
- The Partners in Flight Boreal Hardwood Transition [land] Bird Conservation Plan;
- The Upper Mississippi Valley/Great Lakes Regional Shorebird Conservation Plan; and
- The Upper Mississippi Valley/Great Lakes Regional Waterbird Conservation Plan.

All four conservation plans are integrated under the umbrella of the North American Bird Conservation Initiative. Each of the bird conservation initiatives has a process for designating priority species, modeled to a large extent on the Partners in Flight method of computing scores based on independent assessments of global relative abundance, breeding and wintering distribution, vulnerability to threats, area importance, and population trend. These scores are often used by agencies in developing lists of priority bird species. The Service based its 2001 list of Non-game Birds of Conservation Concern primarily on the Partners in Flight, shorebird, and waterbird status assessment scores.

Conservation Organization Plan

Several non-governmental organizations have implemented planning initiatives in the northern Lower Peninsula region. Plans and publications of note inclue *Michigan Important Bird Areas* (National Audubon Society, 2009), *Great Lakes Ecoregional Plan* (The Nature Conservancy, 2000) and the publication *Conservation Planning for the Grayling Subdistrict of Michigan* (Mulladore et al., 2006)

Nuisance Species Management

No inventories of invasive plants have been done at the Kirtland's Warbler WMA. However, it is known that some of the wetland areas contain purple loosestrife (*Lythrum salicaria*) and that spotted knapweed (*Centaurea maculosa*) can be locally common in the openlands. Autumn olive (*Elaeagnus umbellata*) is not currently found in the jack pine systems, but does occur in richer soils nearby. It is unknown what invasive species may come into jack pine ecosystem due to climate change. However, future planning will likely need to address such an issue and focus on early detection and rapid response efforts, and outreach to owners of nurseries or other potential vectors of invasive species and pathogens.

Control of the Brown-headed Cowbird is a vital part of Kirtland's Warbler management (Probst et al. 2003). Without Cowbird control, up to 70 percent of Kirtland's Warbler nests may be parasitized (Walkinshaw 1972). According to Chris Mensing (U.S. Fish & Wildlife Service, East Lasing Field Office), biologists from the East Lansing Field Office have trapped Brown-headed Cowbirds annually since 1972 in Kirtland's Warbler nesting areas to reduce nest parasitism. Traps are operated each year from mid-April through June, with trapping beginning approximately one month before Kirtland's Warblers arrive to take advantage of cowbird migration chronology and behavior. Cowbirds usually begin arriving in the northern Lower Peninsula of Michigan in April. At that time Cowbirds are in

flocks and tend to exhibit a higher degree of social or gregarious behavior. This behavior seems to make them more susceptible to decoy trapping than later in the season when they disperse across the landscape to breed. Consequently, it is important to initiate trapping at approximately the time cowbirds arrive in the area for optimal trap effectiveness.

The decoy traps require live decoys for effective operation. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA-APHIS-WS), at Sandusky, Ohio, capture and temporarily house the necessary cowbirds which arrive in northern Ohio each spring weeks before they arrive in northern Michigan.

In 2008, 3,135 Brown-headed Cowbirds were captured, 8.2 percent fewer birds than last year's total of 3,415. Since 1972, 140,040 cowbirds have been removed from Kirtland's Warbler nesting areas, averaging 3,893 per year. The 54 traps caught an average of 58 cowbirds per trap over 3,647 trap days. The number of cowbirds removed each year has increased 16 times and decreased 20 times during the 37 years of the program. This is likely due to normal fluctuations in the cowbird population, and may indicate that the trapping program has had no long-term effect on the area's Brown-headed Cowbird population.

Although a member of the native faunal community, the dramatic population increase noted in white-tailed deer numbers across much of the northern Lower Peninsula over the last century has resulted in numerous adverse effects to ecosystems, supporting the argument that the effects of over abundant deer may be as substantial as some exotic species. In some area of the Kirtland's Warbler WMA, deer densities are higher than desired. The effects of browsing may be locally intense, especially in the few hardwood stands found at the Kirtland's Warbler WMA. Consideration should be given to liberalizing the take of this game species at the Kirtland's Warbler WMA.

Brown-headed Cowbirds are trapped to reduce Kirtland's Warbler nest parasitism. U.S. Fish & Wildlife Service photo.

Prescribed Fires

Prescribed fire is an effective way to regenerate jack pine stands and maintain younger stands for breeding warblers. In the past, prescribed and natural fires were the primary method of habitat creation used in the area. The first management action at Kirtland's Warbler WMA was a successful prescribed fire in 1992. However, the terrain and climate of the pine barrens, the history and threat of fire escape, and local residents' aversion to burning severely limit the use of fire for jack pine management.

Surveys and Censuses

Endangered and Threatened Species

Kirtland's Warbler WMA tracts are included as part of the annual Kirtland's Warbler census conducted by the Michigan Department of Natural Resources. It is estimated that, on average, 4 percent of the known world population of Kirtland's Warbler have been found on the WMA since 2000 (Table 3 on page 26). In occupied WMA stands, over three singing males have been recorded on average per sampling plot (Table 4 on page 26).

The first known non-Kirtland's Warbler wildlife surveys conducted on the Kirtland's Warbler WMA occurred as part of the assessment work contracted by the Service in 2006 (Goebel et al. 2007). Sixty bird species were documented during point counts conducted in jack pine-dominated tracts; 75 percent were breeding species recorded on the evidence of singing males. Bird communities and individual species abundance and frequency of encounter patterns generally differed among stand age classes (see Figure 6 on page 27 and Figure 7 on page 28).

Studies and Investigations

Research is an integral component of land management for wildlife population preservation, conservation, and restoration and should be incorporated along with future inventory and monitoring. Historically, the majority of research on many refuges pertained to single species of wildlife

Table 3: Number of Kirtland's Warbler Singing Males by Year (2000-2005) at Kirtland's Warbler Wildlife Management Area

Year	Number of Singing Males	Percentage (%) of Total Michigan Singing Male Population
2000	5	0.6
2001	30	2.8
2002	27	2.6
2003	59	4.9
2004	72	5.3
2005	100	7.0
2006	124	8.4
2007	137	8.1
Average (±1SD)	48.8 (34.7)	3.9 (2.3)
Data provided by K. Kintigh (MDNR)		

Table 4: Parcel-level Abundance Values for Kirtland's Warbler Singing Males Recorded at Kirtland's Warbler WMA

Stand Age Class	County	Tract-ID	Sampling Points	Singing KW per sampling point
KW	Clare	CL-08	2	3.00
KW	Clare	CL-11	1	3.00
KW	Clare	CL-18	3	4.33
KW	Clare	CL-21	2	5.00
KW	Crawford	CR-09	1	4.00
KW	Crawford	CR-10	1	3.00
KW	Oscoda	OS-02	6	2.50
KW	Oscoda	OS-03	2	3.50
KW	Oscoda	OS-14	1	2.00
KW	Oscoda	OS-18	1	1.00
KW	Ogemaw	OG-26	3	4.33
KW	Ogemaw	OG-28	4	1.75
YOUNG	Ogemaw	OG-01	1	1.00
YOUNG	Ogemaw	OG-25	1	4.00
		TOTAL	29	3.07

Figure 6: Number of Singing Kirtland's Warbler Males Per Sample Point, Kirtland's Warbler WMA

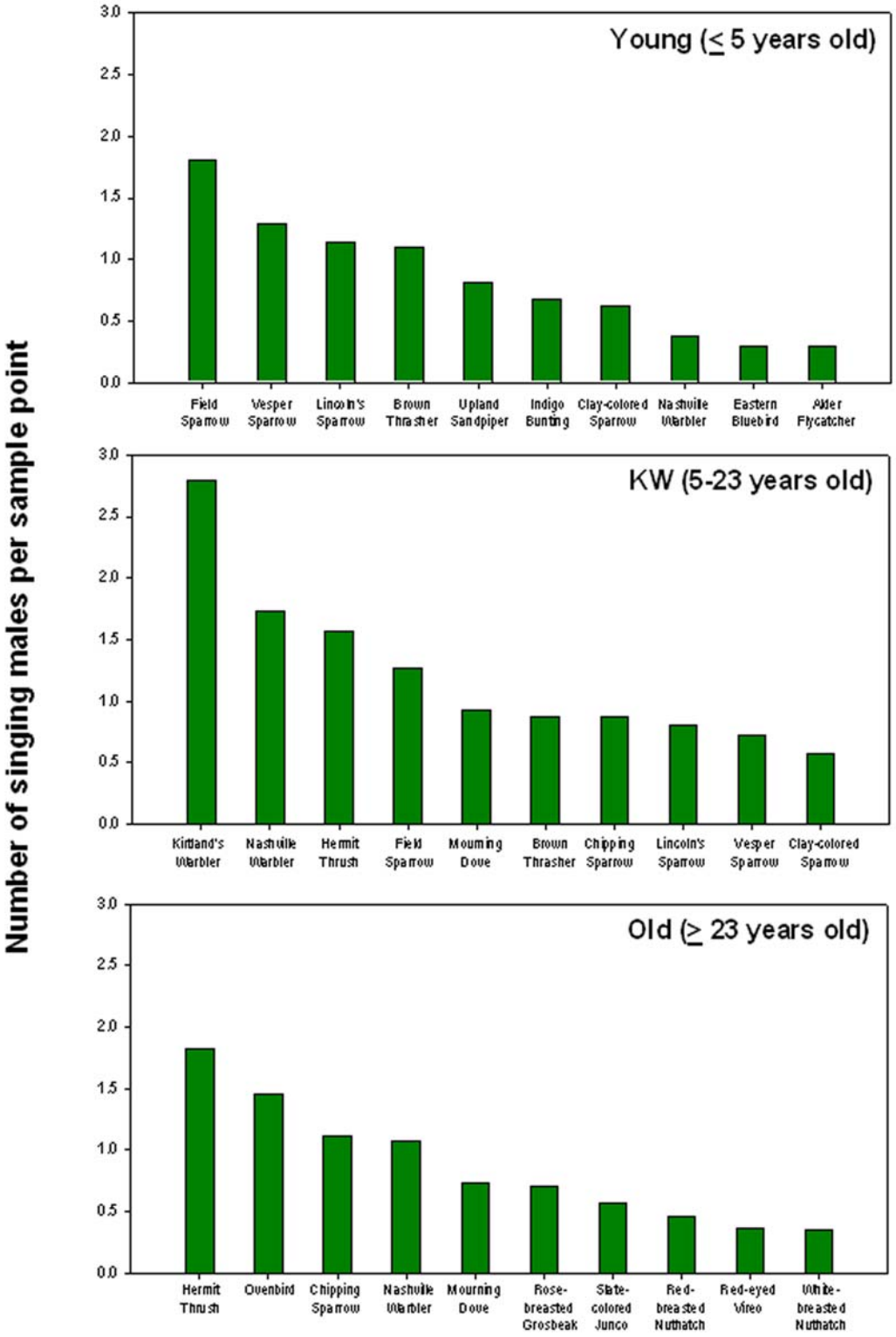
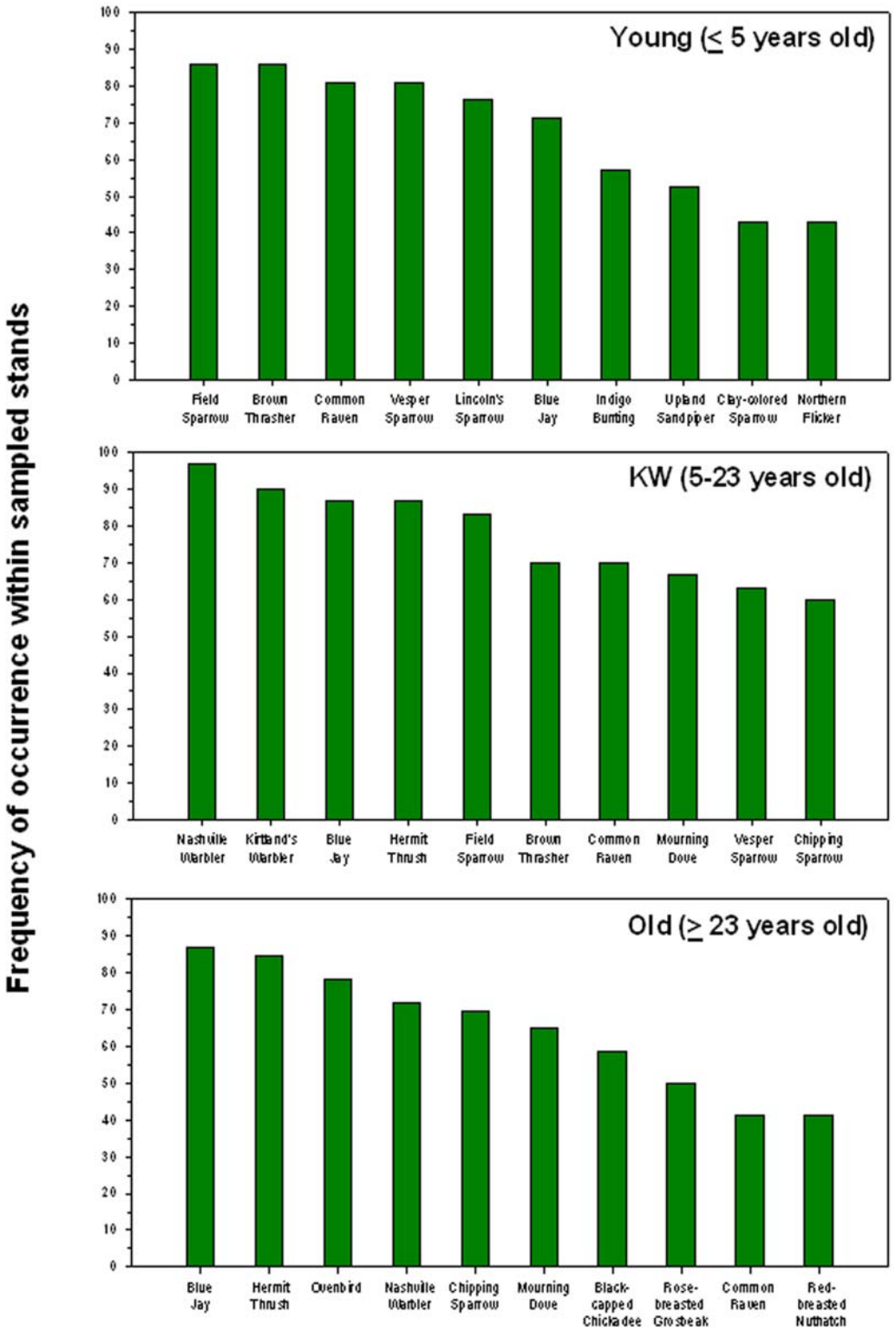


Figure 7: Frequency of Bird Occurrence Within Sample Stands, Kirtland's Warbler WMA



and their habitats. However, as theories and concepts regarding wildlife and habitat management have changed, so too should the focus of research. For instance, in recent years, upland research in the region has increasingly been focused on ecosystem patterns and processes, such as the ecological disturbance history of forest stands in the context of restoration of stand composition and structure in stands altered by past human activities. Future research should continue to pursue aspects of disturbance ecology, restoration ecology, landscape ecology, forest ecology, and conservation biology and related fields in the context of wildlife habitat conservation, preservation, and restoration at the Kirtland's Warbler WMA. Other future research should examine the effects of invasive species and climate change on ecosystem patterns and processes.

Coordination Activities

The Seney NWR staff who manage Kirtland's Warbler WMA invest a significant amount of energy and time representing the WMA in its role as a partner with other resource agencies and non-government organizations. The Refuge Manager serves as a member of the Kirtland's Warber Recovery Team and the Refuge Forester participates as a team member on various committees and groups.

Visitor Services

The 1997 National Wildlife Refuge System Improvement Act emphasizes wildlife management and that all prospective public uses on any given unit of the Refuge System must be found to be compatible with the wildlife-related purposes before they can be allowed. The Refuge System Improvement Act also identifies six priority uses of national wildlife refuges that in most cases will be considered compatible uses:

- wildlife observation
- wildlife photography
- hunting
- fishing
- environmental education
- interpretation of nature

Black bear. U.S. Fish & Wildlife Service photo

Opportunities to participate in all of these wildlife-dependent activities, with the exception of fishing, exist at Kirtland's Warbler WMA.

Hunting

Kirtland's Warbler WMA is open for hunting of all legal game species in Michigan per state regulations. However, little is known regarding the statistics regarding hunting use. Due to the nature of the habitats at the Management Area, the species most likely hunted are white-tailed deer, Wild Turkey, Ruffed Grouse, snowshoe hare, American Woodcock, and black bear. In early successional stands (recent clear cuts waiting regeneration for Kirtland's Warbler) hunting is probably limited to Wild Turkey and white-tailed deer. As stands mature and become close-canopy with more mature trees, more species are hunted and more hunting likely occurs. The use of bait, snowmobiles, or ATVs is prohibited.

Fishing

Although a few parcels of the Management Area are adjacent to streams, most parcels do not have fishable waters. Fishing is likely not a very common event at Kirtland's Warbler WMA.

Photography, Wildlife Observation, Environmental Education and Interpretation

The majority of the Visitor Services that are provided by the Kirtland's Warbler WMA are interwoven into the yearly Kirtland's Warbler tours conducted by the Service's East Lansing Field Office, Michigan Audubon Society and the U. S. Forest Service. According to Service records, during 2008 a total of 775 people from 40 states and three foreign countries attended a tour to see Kirtland's Warbler and hear about habitat management. These tours occur yearly from May 15 to July 4.

Although parcels inhabited by Kirtland's Warbler during the breeding season are closed to entry, uninhabitated areas and the network of two-track roads that connect them afford photographers of all skill levels opportunities to photograph wildlife and excellent hiking and biking opportunities.

Archaeological and Cultural Resources Management

No active cultural resources management occurs on the Kirtland's Warbler WMA. In general, cultural resources management in the Service is the responsibility of the Regional Director and is not delegated to field managers for the Section 106 process when historic properties could be affected by Service undertakings, for issuing archeological permits, and for Indian tribal involvement. The Regional Historic Preservation Officer advises the Regional Director about procedures, compliance, and implementation of cultural resources laws. The field manager assists by informing the Regional Historic Preservation Officer about Service undertakings, by protecting archeological sites and historic properties, by monitoring archeological investigations by contractors and permittees, and by reporting violations.

Law Enforcement

Kirtland's Warbler WMA is dedicated to safeguarding the resources under its jurisdiction, including natural resources, cultural resources, and facilities. Resource management on the WMA includes both protective and preventive functions. Protection is safeguarding the visiting public, staff, facilities and natural and cultural resources from criminal action, accidents, negligence and acts of nature such as wildfires. Preventing incidents from occurring is the best form of protection and requires a known and visible law enforcement presence as well as other proactive steps to address potential threats and natural hazards.

Over the years, the most common violations on the Kirtland's Warbler WMA have been vandalism and trespass. Vandalism incidents have included damage to signs and other structures and dumping on side roads.