Re-assessment of Known Occurrences and Additional Surveys for Rare Species at Camp Grayling Maneuver Training Center

Prepared by:
Phyllis J. Higman
David L. Cuthrell
Michael Monfils

Michigan Natural Features Inventory
P.O. Box 30444
Lansing, MI 48909-7944

For:
Michigan Department of Military and Veterans Affairs
Camp Grayling, Michigan 49739

Report Number 2005-07

April 8, 2005

Cover Photos: Near Howe's Lake, Kalkaska County, Michigan, June 2004. **Lower left:** Hill's Thistle (*Cirsium hillii*) Crawford County, MI., September 2004.
Lower right: Dusted skipper *(Atrytonopsis hianna)* adult near Howe's Lake, Kalkaska County, MI., June 2004. All photos by David L. Cuthrell, MNFI.

Recommended Citation: Higman, P.J., D.L. Cuthrell, and M. Monfils. 2005. Re-assessment of Known Occurrences and Additional Surveys for Rare Species at Camp Grayling Maneuver Training Center. Report number MNFI 2005-07. Report to Michigan Department of Military and Veterans Affairs, Camp Grayling, MI. 49739. 16 pp + appendices.

Executive Summary

Surveys were conducted in 2004 at the Camp Graying Maneuver Training Center to re-assess the status of previously documented rare plant and animal occurrences and to search for additional occurrences of these or other rare species. Twenty-one plant species, ten birds, and three insects were targeted for survey in twelve natural community types.

All but three previously known occurrences of Hill's thistle, rough fescue, and Alleghany plum were re-confirmed during the 1995 surveys, and numerous new clusters of these species were documented. Houghton's goldenrod, prairie dropseed, Vasey's rush, Clinton's bulrush and New England violet were found flourishing in the large northern wet-mesic prairie wetland complex identified in 1992-93. A second small occurrence of Houghton's goldenrod along the north side of M-93 was destroyed by an ORV trail; however additional colonies were located nearby. The single isolated co-occurrence of Houghton's goldenrod and prairie dropseed found in 1993 in some dirt mounds along a Portage Creek tributary, was not re-discovered, nor were occurrences of Canada rice grass, prairie moonwort, whorled pogonia, or northern appressed clubmoss. It is quite likely, however, that these latter species still persist at the Camp near their original location or in similar habitat near-by. No additional listed plant species were discovered in 2004.

Four occurrences of Red-shouldered Hawk and one occurrence each of Common Loon and American Bittern were found in 2004, all species that had not been previously documented at the Camp. In addition, two Kirtland's Warbler occurrences were reconfirmed and updated. Seven occurrences of the dusted skipper, also a species new to the Camp, were discovered. One secretive locust site was newly documented, and one previously known locust occurrences was expanded significantly in extent.

Implementation of a large-scale pine barrens restoration plan, using a carefully designed prescribed fire protocol will benefit at least three rare plant, one bird, and two insect species. Protection and management of the northern wet-mesic prairie complex will benefit at least six rare plants and two rare insects. Monitoring the results of management activities for these two significant landscape areas will also provide valuable information to the scientific community and inform future management decisions.

Surveys should be conducted periodically for the rare plant species not rediscovered in 2004, to assess their status and mitigate potential threats. It is recommended that this be done annually for the fleshy stitchwort occurrence which is one of only two known in the state. Additional surveys are also recommended for American Bittern, Prairie Warbler, Black-backed Warbler, Common Loon, several rare grassland songbirds, and blazing star borer moth.

Table of Contents

List of Figures

List of Tables

List of Appendices

Introduction

The Camp Grayling Maneuver Training Center (Camp Grayling), located in the northern Lower Peninsula of Michigan, is known to harbor habitat for the federal and state endangered Kirtland's Warbler, the federal and state threatened Houghton's goldenrod, Federal candidate eastern massassauga rattlesnake (*Sistrurus catenatus catenatus*), 16 additional state threatened, endangered or special concern plant and animal species, 14 high quality natural communities, and two highly significant landscape areas. The extent and distribution of these natural features were documented during a two-year inventory conducted by Michigan Natural Features Inventory (MNFI) in 1992-93 (Higman et al. 1994), providing baseline data for use in developing an integrated management plan for the Training Center. Management recommendations were provided upon completion of the inventory, framed by the ecological requirements of individual features, to the extent they are known, and the natural processes that maintained the circa 1800 communities of the landscape.

The current study was initiated to re-assess the status of the documented rare plant and animal occurrences and to conduct additional surveys for rare species, with particular emphasis on animal species that were not previously targeted for survey. The components of this study fulfill a key principle of ecosystem management whereby results of management activities and current threats to conservation targets are evaluated and used to inform future management strategies. These studies were also conducted to support compliance with the Sikes Act (INRMP), EO 13112 and Part 365 of the Natural Resources and Environmental Protection Act, Act 451 of the Michigan Public Acts of 1994.

.

Study Area

The Camp Grayling Maneuver Training Center is located in the north-central region of the Lower Peninsula of Michigan, extending across portions of Crawford, Kalkaska, and Otsego counties. Encompassing 147,640 acres, it is divided into a North and South Camp, lying approximately northeast and southeast of the City of Grayling and Interstate 75, respectively (Figure 1).

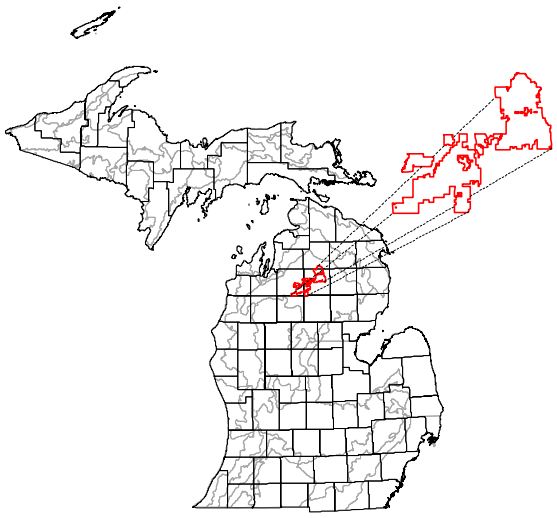


Figure 1. Location of Camp Grayling Maneuver Training Center in Northern Lower Michigan.

Methods

Field Preparation

All previously gathered data showing location, extent, and habitat requirements of rare plant and animal occurrences at Camp Grayling were reviewed, as were habitat requirements for species that were previously targeted for survey, but not yet found there. Additionally, the state and federal threatened and endangered species list, updated in 1997, and under review during the writing of this report, were examined to determine if additional species could potentially occur there. Circa 1800 and current land cover maps (Comer et al. 1995, MDNR 1993) and black and white infrared 1998 aerial imagery (1:15,840, MDNR) were studied along with previous natural community data collected during the 1992-93 surveys (Higman et al. 1994), to assess the range of habitats available. A list of all rare species known to occur in a nine-county region surrounding the Camp was used to help guide this inquiry.

Several important changes have occurred since the original natural features surveys were conducted. Further work on the MNFI natural community classification system (MNFI 2004) resulted in a reclassification of the ecologicially significant landscape identified in 1993 as mesic sand prairie, to northern wet-mesic prairie. This better reflects the landscape setting, species composition, and hydrology of the community. Further comments on this and other natural community occurrences at the Camp are provided in a separate report (Kost, 2005). Two plant species targeted in 1992-3, long-leaved aster (*Aster longifolius*) and James' monkey-flower (*Mimulus glabratus* var. *jamesii*), were de-listed in the 1997 Technical Committee review, thus were not included as targets during the current study. Vasey's rush (*Juncus vaseyi*) and prairie dropseed (*Sporobolus heterolepis*) were reclassified from state threatened to state special concern in the 1997 review, and the status of fleshy stitchwort (*Stellaria crassifolia*) was recommended for change in status from state threatened to state endangered during the current 2005 review (Holgref pers. comm.). Also, Clinton's bulrush (*Scirpus clintonii*) is now referred to as *Trichophorum clintonii* and the taxon previously described as appressed bog clubmoss (*Lycopodium appressum*) is now referred to as northern appressed clubmoss (*Lycopodiella subappressa*). These changes better reflect current taxonomic understanding.

The above information was used to identify a list of target species and the range of natural community types providing suitable habitat for each. These data and optimal survey times for each target species were summarized to aid the development of an efficient survey strategy. Twenty-one plant species, ten bird species, and three insect species associated with twelve natural community types were targeted. Some highly disturbed areas were also surveyed for selected species. Fourteen plant , two bird, and one insect species had been previously documented at the Camp, while the remainder were new targets or had not been discovered during previous surveys (Table 1-2). The eastern massasauga rattlesnake was also known from the Camp, however, reptile and amphibian surveys were conducted by others in 2004 and were not targeted during our study.

The aerial imagery and USGS 7.5 minute topographic maps of survey sites showing locations for all known rare species occurrences were downloaded from the MNFI statewide GIS database, Biotics, for use in the field. Original survey notes were also copied, where needed, for reference.

Table 1. Plant species targeted for survey, suitable natural communities, and optimal survey times at Camp Grayling Maneuver Training Center.

Common Name	Species	Suitable Natural Communities	Status	Optimal Survey Window
Alleghany plum	*Prunus alleghaniensis*	dry sand prairie pine barrens	SC; G4T 3Q; S3	April-May July-August

Table 1 cont.

calypso orchid	*Calypso bulbosa*	rich conifer swamp	T; G5; S2	May-June
Canada rice-grass	*Oryzopsis canadensis*	pine barrens dry northern forest	T; G5; S2	July-August
Clinton's bulrush	*Trichophorum clintonii*	northern wet-mesic prairie intermittent wetland	SC; G4; S3	late May-July
false violet	*Dalibarda repens*	dry-mesic northern forest	T; G5; S1S2	Vegetative: - June Fl: July-Aug
Prairie dropseed	*Sporobolus heterolepis*	northern wet-mesic prairie	SC; G5; S3	August-early September
ginseng	*Panax quinquefolius*	mesic northern forest	T; G4; S2S3	June-October
goblin moonwort	*Boltrychium mormo*	mesic northern forest	T; G3; S1S2	July- October
Hill's thistle	*Cirsium hillii*	dry sand prairie pine barrens	SC; G3; S3	June-August
large toothwort	*Dentaria maxima*	mesic northern forest	T; G5Q, S1S2	mid-May-mid-June
limestone oak fern	*Gymnocarpium robertianum*	rich conifer swamp	T; G5; S2	June-August
New England violet	*Viola novae-angliae*	northern wet-mesic prairie	T; G4Q; S2	May-June
fleshy stitchwort	*Stellaria crassifolia*	emergent marsh rich conifer swamp northern shrub thicket	T; G5; S1S2	July-August
northern appressed club-moss	*Lycopodiella subappressa*	intermittent wetland poor conifer swamps	SC; G2; S2	August-November
pale agoseris	*Agoseris glauca*	dry sand prairie pine barrens	T; G5; S2	late May-October
Houghton's goldenrod	*Solidago houghtonii*	northern wet-mesic prairie	LT; T; G3; S3	August-September
prairie moonwort	*Botrychium campestre*	dry sand prairie artificial disturbance	T; G3G4; S2	May-early June
rough fescue	*Festuca scabrella*	dry sand prairie pine barrens	T; G5; S2S3	June-August
showy orchis	*Galearis spectabilis*	mesic northern forest	T; G5; S2	late May-June
Vasey's rush	*Juncus vaseyi*	northern wet-mesic prairie	T; G5?; S1S2	July-September
whorled pogonia	*Isotria verticillata*	dry-mesic northern forest	T; G5; S2	late May

Table 2. Animal species targeted for survey, suitable natural communities, and optimal survey times at Camp Grayling Maneuver Training Center.

Birds				
American Bittern	*Botaurus lentiginosus*	emergent marsh northern shrub thicket northern wet meadow	SC; G4; S3S4	May-June
Black-backed Woodpeck	*Picoides arcticus* er	pine barrens dry northern forest	SC; G5; S2	May-July
Common Loon	*Gavia immer*	inland lakes large emergent marshes bogs	T; G5; S3S4	May-July
Grasshopper Sparrow	*Ammodramus savannarum*	dry sand prairie	SC; G5; S3S4	June-July
Henslow's Sparrow	*Ammodramus henslowii*	dry sand prairie	T; G4; S2S3	June-July
Kirtland's Warbler	*Dendroica kirtlandii*	pine barrens	LE, E; G1; S1	June-July
Northern Goshawk	*Accipiter gentilis*	mesic northern forest dry northern forest	SC; G5; S3	May-June
Prairie Warbler	*Dendroica discolor*	pine barrens	T; G5; S1	June-July
Red-shouldered Hawk	*Buteo lineatus*	mesic northern forest dry-mesic northern forest hardwood-conifer swamp	T; G4; S3S4	April-May
Western Meadowlark	*Sturnella neglecta*	dry sand prairie northern wet meadow	SC; G5; S4	June-July

Table 2 cont.

Insects				
blazing star borer	*Papaipema beeriana*	dry sand prairie	SC; G3; S1S2	September
dusted skipper	*Atrytonopsis hianna*	dry sand prairie pine barrens	T; G4G5; S2S3	Late May-June
secretive locust	*Appalachia arcana*	intermittent wetland pine barrens	SC; G2G3; S2S3	August-September

Survey Strategy and Techniques

Target species were grouped according to optimal survey times and within each window of time, surveys were conducted first in previously documented occurrence locations, second in suitable high quality natural communities, and lastly in representative suitable natural communities, as time permitted. High quality and representative natural community survey sites were selected for survey by reviewing known natural community occurrences in conjunction with aerial imagery, circa 1800 vegetation maps, and current land cover maps. Although selected species were targeted, surveyors kept an eye out for any rare species everywhere they went on the Camp.

Rare Plant Species

Plant surveys were conducted by meandering through the survey site focusing deliberately on the micro-habitat of the target species. Common plant species observed were recorded for each natural community type surveyed.

Rare Bird Species

Bird surveys were focused in dry northern forest, dry-mesic northern forest, dry sand prairie, northern wet meadow, pine barrens, and poor conifer swamp. Several inland lakes and some highly disturbed areas were also visited. Surveys were conducted by meandering through suitable habitat looking for the targeted species and listening for their calls. Additionally, for American Bittern, Red-shouldered Hawk, and Northern Goshawk con-specific calls were broadcast using electronic equipment to elicit responses from territorial individuals. All bird species observed during these targeted surveys were recorded and their preferred natural community type noted.

Rare Insect Species

Surveys for the dusted skipper were conducted by meander surveys through likely habitat. All skippers were observed either with close focusing binoculars or were netted with an aerial insect net, identified, and released or collected as voucher specimens. Secretive locust surveys were conducted in a similar fashion but survey efforts focused on searching the tree trunks of small (2-8" diameter) jack pine, red pine, white pine, and oaks. Black lighting was used to survey for the blazing star borer moth. This consisted of standard mercury-vapor and UV lights, powered by a portable Honda generator. A 2m x 2m metal conduit frame supporting a large white sheet was used as a collecting surface. The frame was placed in close proximity to large patches (>10 flowering plants) of larval host plants, blazing star (*Liatris* spp.). All insect vouchers are currently in the MNFI Insect Reference Collection, Rose Lake Research Center.

Data Management

When rare species occurrences were documented, MNFI field survey forms were completed and spatial locations were mapped using either a Garmen 12 GPS unit or an iPAQ handheld computer running ESRI ArcPad mapping software, interfaced with a GlobalSat Bluetooth

GPS. Data were later transcribed into Biotics using Mapper and Tracker, NatureServe's standardized data-entry programs for spatial and descriptive natural feature occurrence information. Plant, bird, and insect species lists generated during surveys were combined for each natural community type to generate master species lists.

Results and Discussion

Rare Plant Species

All but three previously known occurrences of Hill's thistle, rough fescue, and Alleghany plum were re-confirmed during the 1995 surveys, and numerous new clusters of these species were documented. Houghton's goldenrod, prairie dropseed, Vasey's rush, Clinton's bulrush and New England violet were found flourishing in the large northern wet-mesic prairie wetland complex identified in 1992-93. A second small occurrence of Houghton's goldenrod along the north side of M-93 was destroyed by ORV activity that has created a well worn trail running directly across the site. Remnants of this population were discovered on the south side of M-93, as well as northeast of the original occurrence on private property. The single isolated co-occurrence of Houghton's goldenrod and prairie dropseed found in 1993 in some dirt mounds along a Portage Creek tributary, was not rediscovered, nor were occurrences of Canada rice grass, prairie moonwort, whorled pogonia, or northern appressed clubmoss. It is quite likely, however, that these latter species still persist at the Camp near their original location or in similar habitat near-by. No additional listed plant species were discovered at the Camp in 2004.

These occurrence data are summarized in Table 3. In addition, all listed species found on the Camp to date, are grouped by natural community type and discussed separately below, including a summary of their status and general management considerations. Maps generated from Biotics, showing all listed plant occurrences known to date are provided in Appendix A and species lists for each natural community type surveyed are provided in Appendix B. Abstracts with more detailed information on targeted species for which abstracts have been completed, are included in Appendix C.

Table 3. Summary of known rare plant occurrences at Camp Grayling Maneuver Training Center.

Common name	Scientific name	New occurrences	Reconfirmed 2004	Total observed since 1992
Alleghany plum	*Prunus alleghaniensis var. davisii*	1	2	3
Canada rice grass	*Oryzopsis canadendis*	--	--	1
Clinton's bulrush	*Trichophorum clintonii*	--	1	1
fleshy stitchwort	*Stellaria crassifolia*	--	1	1
Hill's thistle	*Cirsium hillii*	4	7	11
Houghton's goldenrod	*Solidago houghtonii*	--	1	3
New England violet	*Viola novae-angliae*	--	1	1
northern appressed clubmoss	*Lycopodiella subappressa*	--	--	1
prairie dropseed	*Sporobolus heterolepis*	--	1	2
prairie moonwort	*Botrychium campestre*	--	--	1
rough fescue	*Festuca scabrella*	5	3	8
Vasey's rush	*Juncus vaseyi*	--	1	1
whorled pogonia	*Isotria verticellata*	--	--	1

Pine Barrens

Rough fescue

Rough fescue was first discovered at Camp Grayling during the 1992-3 surveys, when two meta-populations and one isolated small colony were documented in North Camp. In 2004, the meta-populations were found to be thriving and five new localities were identified, three in North Camp and two in South Camp. One small isolated colony was not relocated and has likely succumbed to increased shading from succession. Four of the newly located occurrences were small remnants within openings in disturbed pine barrens-prairie-forest mosaics. The fifth was larger, comprised of several hundred cespitose clumps dispersed within a recently burned area just south of Range 30.

In Michigan, this fescue is found only in Crawford, Oscoda, Montmorency, Otsego, Roscommon, and Ogemaw counties in the central northern Lower Peninsula, where it is disjunct from its primary range in the western prairies of North America. Although known from 23 locations in northern Lower Michigan, the size and quality of these sites vary, and this region is the only place in the state where it occurs. The Camp Grayling occurrences are significant because of their relative quality and extent, and the opportunity for large-scale restoration efforts. They are currently vulnerable to succession whereby growth of young jack pine decreases the availability of suitable openings required by the species. Invasive species, particularly spotted knapweed (*Centaurea maculosa*) and common St. John's-wort (*Hypericum perforatum*) also pose a significant threat. Restoration efforts using prescribed burning are recommended.

Hill's thistle

Four new occurrences of Hill's thistle were documented during the 2004 surveys, while nine occurrences were reconfirmed, six of which were expanded in size from their original delineation. One of these extended from pine barrens habitat into the northern wet-mesic prairie complex. This was the only wetland occurrence documented for this species at the Camp. Two isolated occurrences were not relocated, and one occurrence experienced loss of at least one of it clusters of individuals. Unlike rough fescue, which is restricted to northern Michigan pine barrens, this species is also found in dry sand prairies in southern Lower Michigan and alvar communities in the Upper Peninsula. However, the jack pine barrens of northern Lower Michigan are a stronghold for the thistle. It is vulnerable to succession and the invasion of exotic species, and will benefit concurrently with rough fescue and Alleghany plum, if restoration efforts using prescribed fire are implemented.

Alleghany plum

The large meta-population of Alleghany plum, previously documented in 1992 along Stephan Bridge road, appeared to be flourishing, however spotted knapweed and common St. John's-wort were abundant in the ground layer of the largest colony. Two new clusters of plants were added to the second known occurrence along North Down River Road and one new occurrence was discovered along Stephan Bridge Road, approximately one mile north of Buck's East and West Truck trail. This highly shade-intolerant species will benefit from pine barrens restoration activities that maintain open conditions. However, since its biology and ecology, particularly its response to fire, are less well known, it should be afforded special attention. Alleghany plum is primarily an east coast species, and its disjunct Michigan occurrences are currently considered a separate taxon, var. *davisii*. It is recommended that Alleghany plum occurrences be assessed annually and specific monitoring be conducted if prescribed fire is implemented.

Canada rice grass

This distinctly awned grass has been found in Michigan in early successional habitat with sandy, acid soils that are seasonally inundated. It was discovered at Camp Grayling in 1992 along an old logging two-track through second growth jack pine within a pine barrens landscape. Multiple surveys were conducted at the well known site it 2004, but it was not rediscovered there. In the eleven years since its original discovery, canopy cover has increased significantly at the site, possibly creating unsuitable conditions. Other apparently similar openings with less canopy cover are quite common at the Camp and further surveys are recommended to ascertain if any remnants of this population still persist.

The Camp Grayling occurrence is one of only two known in the northern Lower Peninsula, and represents the southern-most occurrence in the State. As one of only 21 occurrences overall in Michigan, the Grayling site is fairly significant. If documented, measures should be taken to protect the site and maintain a mosaic of openings for colonization sites. Since cutting is a likely treatment option in the future, care should be taken to avoid methods that could harm the species.

Poor Conifer Swamp (Moist, Acid, Sandy Openings)

Northern appressed clubmoss

Known as appressed bog clubmoss (*Lycopodium appressum*) at the time of our previous inventory (Higman et al. 1994), this species is now considered its own taxon, *Lycopodiella subappressa*. It is distinct from the southeastern Atlantic coastal plain species appressed bog clubmoss, now referred to as *Lycopodiella appressa*. It is also considered distinct from northern prostrate clubmoss (*Lycopodiella marqueritae*), with which it often co-occurs in Michigan. Its full distribution is currently not known, although it has been reported from northeastern Indiana and northern Ohio. Typically found on moist, acidic, peaty sands in early successional habitat, this species was found at Camp Grayling in 1993 along a two-track road through a conifer swamp. It was not rediscovered in 2004 despite multiple surveys at its previous location, however, many of its common associates were observed including round-leaved sundew (*Drosera rotundifolia*), St. John's-wort (*Hypericum boreale*), lance-leaved violet (*Viola lanceolata*), and fragrant goldenrod (*Solidago remota*).

Reliant on disturbance to maintain open conditions, this species is vulnerable to succession, whereby habitat conditions are changed by differing species composition and structure, and increased canopy closure. It is quite likely to persist at Camp Grayling in disturbed areas somewhere throughout the conifer swamp, if not in other similar locations where old logging roads are still plentiful. As the only northern Lower Peninsula site known in Michigan, the Camp Grayling occurrence is highly significant. It is recommended that further intensive surveys be conducted in an attempt to locate any existing colonies. If discovered, measures should be taken to ensure its protection by maintaining openings that provide colonization sites.

Dry-mesic Northern Forest

Whorled pogonia

Whorled pogonia was first documented at Camp Grayling in 1992, in a second growth dry-mesic northern forest, dominated by white and red oak. It has been observed there at least once since then (Chittenden pers com 2004), however, in spite of multiple intensive surveys at the known location, it was not re-located in 2004. This species is notoriously difficult to find because flowers are often produced by only a portion of the population (Homoya 1993) and last for only 3-4 days, the dates of which vary from year to year (Case 1987). Non-blooming plants usually appear later and are very similar to its common associate, cucumber root (*Medeola virginiana*), making detection very difficult. Vegatatively it can also be hard to discern amidst

fringed polygala (*Polygala paucifolia*), which it superficially resembles and which is also common at the site. It is also possible that it did not appear above ground at all in 2004, as many orchid species do go through periods of dormancy. Whorled pogonia quite likely persists at the site and on-going surveys to check its status are recommended.

Although common in parts of its North American range, whorled pogonia is rare in the Great Lakes region (Case 1987). It's occurrence at Camp Grayling it particularly significant, as it is one of only two known occurrences in northern Lower Michigan, disjunct from the nearest southern Michigan occurrences in Gratiot in Saginaw counties. The second northern occurrence is in Montmorency County where a colony was found near a lake under red maple, aspen, and white pine (Case 1987). This orchid is almost certainly vulnerable to changes in forest structure, particularly overstory removal, as well as damage of shoot buds and above ground shoots. It is recommended that direct forest management treatments be postponed at the site and that it be buffered from any adjacent cuts or other management activities, until further knowledge of the colony and potential impacts are determined.

Northern wet-mesic prairie

Houghton's goldenrod

Of the three occurrences noted during 1992-93 surveys, the large meta-population of Houghton's goldenrod occurring in the Portage Creek-Howes Lake northern wet-mesic prairie complex has fared the best. It was flourishing in 2004 near Howe's Lake and was found in local abundance in portions of the wetland drainage extending to Portage Creek. Leafy spurge (*Euphorbia esula*) was found in several pockets of the wetland complex and poses a serious threat. Immediate control measures are recommended (Higman 2005) as well as continued protection of the hydrology of this site. Houghtons' goldenrod is also vulnerable to increased shading by succession and the role of prescribed fire in the wetland complex should also be explored.

The small colony found along M-93 had experienced local extirpation, by the development and entrenchment of snowmobile trail running directly across the location where it was originally discovered. Further survey in the area resulted in the location of a small number of plants on the south side of M-93 in the roadside ditch bordering a rich conifer swamp. A few more plants were observed south of the original colony, just beyond the Camp border and a large colony was observed on private property to the west. Clearly, habitat still persists in the vicinity of the M-93 occurrence, and the ORV trail should be re-routed or closed. This site should be carefully reviewed so that potential re-routing of the trail does not create further negative impacts to the site and adjacent wetlands. Since the area is experiencing development almost to the edge of the Camp boundary, attempts should be made to contact property owners so that the entire site can be carefully delineated. Cumulative impacts to any one site are often difficult to detect, if the site is not looked at in its entirety.

The third previously discovered occurrence, which consisted of only a few plants on mounds of dirt along a tributary of Portage Creek, was not relocated, despite careful searching. It is not clear whether the mounds of dirt at this site were local or from off-site, however it is possible that plants could still occur in the area.

The occurrence of Houghton's goldenrod at Camp Grayling is highly significant, since it is the only known inland occurrence of this federal and state threatened species, otherwise known only from the Great Lakes shoreline. Furthermore, these plants differ from the coastal occurrences by having eight chromosome sets (octoploids) instead of six (hexaploid). Although not yet certain, it may be considered for species status.

Prairie dropseed

Prairie dropseed was found flourishing in approximately the same distribution in the wetland complex as it was in earlier surveys. It is locally abundant in some of the southern most wetland fragments near the small arms ranges, but has not yet been discovered northeast of the intersection of Arrowhead Road and the railroad grade, or in the vicinity of Howe's Lake. Since our 1992-93 surveys, the status of prairie dropseed was changed from state threatened to special concern, because additional occurrences had been documented, primarily in prairie fens in southern Lower Michigan and alvar communities in the Upper Peninsula. Its primary range is in the prairies of western North America and its occurrence in the northern wet-mesic prairie complex at Camp Grayling is unique. Protection of this occurrence will ultimately depend upon active management and monitoring of the complex. Immediate control measures for leafy spurge are recommended (Higman 2005) as well as continued protection of the hydrology. The potential use of prescribed fire to inhibit succession should be also explored.

The second previously discovered occurrence of prairie dropseed, which consisted of only a few plants on mounds of dirt along a tributary of Portage Creek, was not relocated, despite careful searching. It is not clear whether the mounds of dirt at this site were local or from off-site. However, as for the Houghton's goldenrod, it is possible that this species may yet be re-discovered here.

Vasey's rush

This species was located in several locations throughout the Howe's Lake-Portage Creek complex, in very low numbers, similarly to its original discovery. It was found near Howe's lake, in a wetland pocket just north of the railroad grade east of Arrowhead road, and in the largest wetland pocket south of railroad grade and east of Arrowhead Road. Often occurring in small numbers, this species is difficult to detect and there are likely other local colonies within the complex. It is often confused with the very similar, Green's rush (*Juncus greenii*), which was much more frequently encountered in the wetland. Although its status was changed from state threatened to state special concern in 1997, this predominantly boreal species, is a relatively rare disjunct species in Michigan and several other states of similar latitude. The occurrence at Camp Grayling is one of only 16 documented occurrences in the state. Immediate control measures for leafy spurge are recommended (Higman 2005) as well as continued protection of the hydrology and potential use of prescribed fire to inhibit succession.

Clinton's bulrush

This bulrush was found thriving in the wetland complex, with two major foci, one at Howe's Lake, the other along the perimeter of the largest wetland fragment nearest Portage Creek. It is the only known northern Lower Michigan occurrence and likely the largest in the state. Of the remaining 23 occurrences known in Michigan, five are from Schoolcraft County in the central Upper Peninsula and the rest are centered in several counties in the southeast Lower Peninsula. Little is known about the biology and ecology of this species, although it appears to prefer sites that exhibit a seasonal fluctuating water table and possibly periodic wildfires. Immediate control measures for leafy spurge are recommended (Higman 2005) as well as continued protection of the hydrology of the site. The potential use of prescribed fire to inhibit succession should be also explored.

New England violet

New England violet was documented in two local clusters within the wet-mesic prairie complex, one just north of Howe's Lake and one at the mid-southern edge of the large fragment bordering Portage Creek. About a dozen individuals were observed in total, but it is possible

that other colonies could be discovered with further survey. Both of these clusters experience seasonal flooding and are open to direct sunlight as is typical for this species, however, they are not acidic, or xeric as are many other sites - throughout its range (Ballard 1989). It is currently known from only six sites in Michigan and it would be useful to engage in further study of this species at Camp Grayling. Immediate control measures for leafy spurge are recommended (Higman 2005) as well as continued protection of the hydrology of the site. The potential use of prescribed fire to inhibit succession should be also explored.

Emergent Marsh (streamside)

Fleshy stitchwort

The discovery of the circumboreal fleshy stitchwort in a cold seep along the north branch of the Au Sable River in Crawford County in 1993, was a particularly notable find. It is the only northern Lower Michigan occurrence known to date, among only eight ever recorded in the state, one in Luce County, last observed in 1988 and six in southwestern Lower Michigan, dating from 1890 to 1945. It doubtful that any of the latter occurrences still persist and the species was recommended for change of status from state threatened to state endangered during the 2005 Technical Committee review. The Grayling occurrence was re-discovered during our survey 1994, thriving in a cool seep with James' monkey-flower (*Mimulus glabratus*, var. *jamesii*) as it was in 1993, eleven years ago. It was not observed flowering in 1993 or 2004, and it remains a very small, isolated colony. It did not appear as if there were any immediate threats to the occurrence, and it seemed undisturbed from its original discovery. It is recommended that the occurrence be visited on an annual basis to assess its status, and mitigate any observed threats.

Artifically Disturbed Sites

Prairie moonwort

This species was thought to have been located at two sites at Camp Grayling in 1992, only one of which was tentatively confirmed, pending complete taxonomic review the of existing specimens of the genus *Botrychium*. Surveys were conducted at both sites in 2005, but the inconspicuous prairie moonwort was not uncovered at either place. It typically inhabits perched dunes along the Great Lakes shoreline, where seven Michigan occurrences have been recorded along the northern Lake Michigan coast and one in Grand Sable dunes along the Lake Superior coast. Throughout its range, it is also known from dry prairies, and sandy, disturbed sites such as old fields and roads. The two putative sites at Camp Grayling were in an old orchard and a road right-of-way along 612, both of which were disturbances of historically mesic northern forest. Sandy soils occur at both sites, so there is some possibility of finding the fern at either location. Due to its tiny size and the subtle characters distinguishing it from other species of grape fern, it is a difficult species to survey for. This is compounded by the fact that it sometimes persists in a dormant state, without producing aerial shoots each year. It is recommended that occasional surveys be conducted in May through early June to ascertain if the species does occur at either site. It would be a noteworthy occurrence if it were definitively confirmed at Camp Grayling.

Rare Bird Species

A total of 75 bird species were recorded at Camp Grayling during all bird surveys. Twenty species were observed in dry-mesic northern forest, six in dry northern forest, 49 in dry sand prairie, 18 in northern wet meadow, and 42 species were recorded in pine barrens (Appendix B). Four occurrences of Red-shouldered Hawk, a species not previously recorded for the Camp, were documented. Additionally one Common Loon and one American Bittern occurrence were

newly documented and two Kirtland's Warbler occurrences were updated.

These occurrence data are summarized in Table 4. In addition, all targeted bird species found on the Camp to date, are grouped by preferred natural community type and discussed separately below, including a summary of their status at Camp Grayling and general management considerations. Maps generated from Biotics, showing all occurrences of targeted bird species known to date, are provided in Appendix A. Species lists for each natural community type surveyed are provided in Appendix B and abstracts with more detailed information on targeted species for which abstracts have been completed, are included in Appendix C.

Table 4. Summary of known listed bird occurrences at Camp Grayling Maneuver Training Center.

Common name	Scientific name	New occurrences	Reconfirmed 2004	Total observed since 1992
Birds				
American Bittern	*Botaurus lentiginosus*	1	--	1
Common Loon	*Gavia immer*	1	--	1
Kirtland's Warbler	*Dendroica kirtlandii*	--	2	4
Red-shouldered Hawk	*Buteo lineatus*	4	--	4

*Includes merged data from 2004 annual Kirtland's Warbler surveys.

Pine Barrens

Kirtland's Warbler

Singing males were observed at three locations in Camp Grayling, all of which were within Kirtland's Warbler management areas located in South Camp. Two singing males were seen and heard north of M-72 and west of Goose Creek Road, and two breeding pairs with territorial males and one singing male were observed south of the Manistee River and northeast of Sunset Trail Road. The third site was found south of the Manistee River and north of Sharon Truck Road, where a minimum of seven singing males were recorded. All of these observations were at or very near previously known locations of this species and were merged with two previously existing element occurrences. Data from annual Kirtland's Warbler surveys, were also assessed and appropriately merged and mapped, resulting in a total of four documented occurrences for the Camp. The management occurring for this species at Camp Grayling appears to be providing suitable nesting habitat, as indicated by the presence of singing males and breeding pairs.

Prairie Warbler

Although this species is known to occur in pine barrens and areas managed for the Kirtland's Warbler, the Prairie Warbler was not observed during surveys of these habitats on Camp Grayling. These areas should be monitored for this species, especially during annual surveys conducted for the Kirtland's Warbler. Habitat management for the Kirtland's Warbler should provide suitable habitat for the Prairie Warbler; however, the habitat needs of the Prairie Warbler in Michigan are not well known, and the species may have narrower requirements than are currently known (Walkinshaw 1991).

Large Open Grasslands

Grassland Songbirds

The three rare grassland songbirds targeted for survey, Henslow's Sparrow, Grasshopper Sparrow, and Western Meadowlark, are known from large open prairies and wet meadows

where trees and shrubs are absent or infrequent. Openings in pine barrens are typically not large enough to provide suitable habitat. Although none of these species were observed during surveys, some potential habitat was identified. The two most likely locations for these species were Range 13 and the air-to-ground firing range. Because access to these areas is prohibited, we were limited to conducting surveys along the periphery of these sites from outside of the fence. The dry sandy soils support only sparse vegetation in these areas, probably making much of the habitat marginal for these species. However, the presence of associated species, such as Upland Sandpiper, Bobolink, and Eastern Meadowlark, indicates that these targeted grassland birds could occur at these sites.

Dry-mesic Northern Forest

Red-shouldered Hawk

Four new occurrences of Red-shouldered Hawk were discovered in 2004, each of which was an active nest. The first occurrence was located in the South Camp in dry-mesic northern forest just east of Big Cannons Creek, south of the Village of Sharon, and near the edge of the military installation boundary. The female was incubating at the time the nest was found at this location, but during a later check in early June no activity was observed and the nest was probably not successful. The second nest was found in mesic northern forest located west of Black Creek in the South Camp. Two chicks were seen in the nest during a later visit. The third occurrence was also found in the South Camp in a forest south of the Manistee River. The forest at this location was a mix of dry and dry-mesic northern forest and young bottomland, hardwood forest. The nest was placed in a red pine tree and three chicks were found at the site during a subsequent visit. The fourth nest was found in the North Camp in mesic northern forest located west of Section One Lake. This nest was placed in a white birch and was also successful, with at least one chick observed in the nest during a second visit.

The above nests should be monitored annually to determine if the territories remain occupied and to track productivity. The *Draft Management Guidelines for Red-shouldered Hawks on State-owned Lands in Michigan* (Appendix D) should be followed to maintain the habitat near nests and minimize disturbance.

Mesic Northern Forest

Northern Goshawk

A territorial adult Northern Goshawk and possible nest were observed in mesic northern forest during spring surveys of the South Camp. The adult bird responded to broadcast conspecific calls and a decorated nest was found nearby. However, the nest site was not active during several subsequent visits, so the observation was not considered an element occurrence. This site should be monitored for breeding Northern Goshawks in the future. Substantial potential habitat (mesic northern forest and dry northern forest) exists for this species at Camp Grayling, and additional surveys for Northern Goshawk would be useful to determine if nesting is occurring.

Red-shouldered Hawk

Red-shouldered Hawk occurrences were documented in mesic, dry-mesic and dry northern forest. See dry-mesic northern forest above, for detailed findings.

Dry Northern Forest

Black-backed Woodpecker

Several locations of potential habitat for Black-backed Woodpecker were surveyed, including forest stands of various ages dominated by jack pine, recently logged dry northern forest with standing snags, and jack pine barrens. None were observed during these or other rare animal surveys; however, Black-backed Woodpeckers are relatively inconspicuous and difficult to survey for, so it could occur at Camp Grayling given the presence of potential habitat. Black-backed Woodpeckers are also associated with open and closed black spruce-tamarack bogs, northern white cedar swamps, and mixed forests with eastern hemlock (Evers 1991).

Red-shouldered Hawk

Red-shouldered Hawk occurrences were documented in mesic, dry-mesic and dry northern forest. See dry-mesic northern forest above, for detailed findings.

Northern Wet Meadow

American Bittern

One calling individual was observed on two occasions in wetland dominated by sedges and shrubs along Black Creek in the South Camp. The repeated calling of this bird indicates that a breeding pair was likely present at this site and it was mapped and transcribed as an element occurrence. Although no other American Bitterns were observed during rare animal surveys, substantial habitat for the species is present along the North Branch Au Sable River at the northern edge of the North Camp. Additional surveys in these wetlands would be beneficial.

Lakes

Common Loon

One new occurrence was located on Bear Lake in the North Camp of the facility. An adult and two pre-fledged young were observed, indicating that nesting occurred on the lake. One adult was also observed on the largest of the Frog Lakes, also in the North Camp; however, because neither a breeding pair nor young were seen, this was not considered an element occurrence. Camp Grayling contains several additional small lakes with potential for this species.

Rare Insect Species

Seven dusted skipper and one secretive locust occurrence were newly documented at the Camp during 2004 surveys. In addition, one of five previously documented occurrences of secretive locust was reconfirmed and expanded significantly in extent, while no individuals were captured at two sites. These occurrence data area summarized in Table 5 below. All listed insect species found on the Camp to date, are grouped by natural community type and discussed separately below, including a summary of their status at Camp Grayling and general management considerations. Maps generated from Biotics, showing all targeted listed insect occurrences known to date, are provided in Appendix A. Species lists for each natural community type surveyed are provided in Appendix B and abstracts with more detailed information on targeted species for which abstracts have been completed, are included in Appendix C.

Table 5. Summary of listed insect species known from Camp Grayling Maneuver Training Center.

Common name	Scientific name	New occurrences	Reconfirmed 2004	Total observed since 1992
dusted skipper	*Atrytonopsis hianna*	7	--	7
secretive locust	*Appalachia arcana*	1	1	9

Pine Barrens/Dry Sand Prairie

Dusted skipper

This state threatened species was not recorded from Camp Graying during the 1992-93 inventory (Higman et al. 1994), however, adult dusted skippers were found at seven sites during early June 2004. All sites were either dry sand prairie, pine barrens, or northern wet-mesic prairie habitat and contain the dusted skipper's larval host plant, little bluestem (*Andropogon scoparius*) or big bluestem (*Andropogon gerardii*). The first site which contained the skipper is west and northwest of Howe's Lake. Between Howe's Lake and the Manistee River a series of small, grassy openings occur on the landscape and all have the potential to contain the skipper. A single adult was seen just west of the impact area along Grayling Moorestown Road and three adult specimens were recorded from a large grassy area between Black Creek and the Manistee River on June 15. The last location within South Camp is an extension of a previously known occurrence off Fletcher Road near Ruins. On the North Camp, locations of the skipper include, areas off Jones Lake Road Truck Trail, an area west of the Frog Lakes, and east of Wakeley Bridge Road.

Blazing star borer moth

The blazing star borer moth inhabits dry sand prairie and pine barrens habitat in close association with its only known larval host plants, blazing star (*Liatris* spp.). Three locations were surveyed by black lighting during mid-September 2004, however, the only moth species recorded within the genus *Papaipema* were *P. pterisii*, the bracken fern borer moth. Although mosty known from southern Lower Michigan, potential habitat and host plants for the blazing star borer moth are scattered throughout the Camp and further surveys are recommended.

Secretive locust

This species was recorded from eight sites previously, and we located an additional occurrence in 2004 at the north end of Frog Lake. In addition, we extended the known location of a site off the Buck's East-West Truck Trail. The occurrence now stretches from the road, north to the south end of Duck Lake. Two secretive locust occurrences (Howe's Lake, The Doughnut) were re-visited in 2004 and we were unsuccessful in locating any specimens. The habitat still persists at these sites and it is very likely they still occur here. Overall, the species has been found in pine barrens, northern wet-mesic prairie, and intermittent wetlands. Additional searches are needed however to confirm their continued existence at all sites identified.

Northern wet-mesic prairie

Dusted skipper

Dusted skipper was found within this wetland complex as well as in dry sand prairie and pine barrens. See pine barrens above for detailed findings.

Secretive locust

Secretive locust was found in northern wet-mesic prairie as well as in intermittent wetlands and pine barrens. See Pine Barrens above for detailed findings.

Intermittent Wetlands

Secretive locust

Secretive locust was found in intermittent wetlands, as well as in northern wet-mesic prairie and pine barrens. See Pine Barrens above for detailed findings.

Summary and Conclusions

All rare plant species found at Camp Grayling are significant occurrences, representing disjunct populations, strongholds for the species, only known locations in northern Lower Michigan, or one of few occurrences in the state. All known populations should be protected and surveys should be conducted periodically for those that were not relocated in 2004. Particular attention should be paid to state endangered fleshy stitchwort, which is one of only two known extant occurrences in Michigan. It is recommended that the identified colony be monitored regularly.

Many of the rare animals documented for the first time at the Camp are significant, including four nesting territories of the state threatened Red-shouldered Hawk and seven locations of the state threatened dusted skipper. It is recommended that the Red-shouldered Hawk territories be monitored on a yearly basis to determine both occupancy and productivity. The Kalkaska County location for the dusted skipper is the only known location in the county for this insect. Further surveys are recommended for the dusted skipper in South Camp.

The two most significant threats noted at the Camp were succession of naturally open communities to more closed canopy condition, and the invasion of non-native species. These threats can be addressed for a large number of rare species, by implementing management in the pine barrens and the northern wet-mesic prairie landscape complexes first identified in 1993 (Higman et al. 1994).

The pine barrens complex contains some of the best remaining remnants in the state which provide habitat for at least three rare plant species and two rare insects, in addition to the Kirtland's warbler. It also encompasses several high quality intermittent wetlands that are utilized by the secretive locust. This area provides an excellent opportunity to conduct large scale restoration of pine barrens using a combination of prescribed burning and manual cutting of trees and shrubs (Kost et al 2000). Such efforts are likely to be effective in minimizing or deterring exotic species invasion as well.

The ecology of the unique northern wet-mesic prairie complex is less well understood, however, plant succession will undoubtedly result in long-term degradation of the site for the five rare plant species known to occur there, and possibly the dusted skipper, secretive locust, and eastern massassauga. Leafy spurge, a particularly troublesome invasive species that is very difficult to control once established, was documented in several of the southern wetland fragments. The highly invasive spotted knapweed, along with common St. John's-wort and numerous other non-native plant species occur in abundance around the periphery of the complex. Attempts to eradicate the leafy spurge should be taken immediately and a long-term strategy to control other invasive species in a 300 foot upland buffer surrounding the wetland fragments is recommended (Higman et al. 2005). Activities in the buffer zone should be minimized and we suggest that serious consideration be given to road closure around the complex. These measures will help protect the sensitive hydrological regime of the wetland as well as the rare species that occur there.

Acknowledgements

Funding for this project was provided by a grant from the Michigan Department of Military and Veterans Affairs. We are appreciative of the opportunity and help provided by DMVA staff, Greg Huntington, John Hunt, and Larry Jacobs. We thank Josh Cohen, Mike Kost, and Peter Pearman, for their assistance with field work. Thanks to Lyn Scrimger for administering the grant, and to Sue Ridge, Connie Brinson, and Patrick Brown for administrative support. Thanks also to Helen Enander and Rebecca Boehm for managing data projections and map production, and to Kristin Konath, Mike Sanders, and Kim Borland for help with digitizing element occurrences and general database assistance.

References

Ballard, H.E. 1989. Status survey and taxonomic study of *Viola novae-angliae* (Vidaceae). Unpublished report to USFWS. 36. pp.

Case, Frederick W., Jr. 1987. Orchids of the Western Great Lakes Region. Revised Edition. Cranbrook Institue of Science. Bulletin 48.

Chittenden, Elaine 2004. Botanist. Michigan State University. Lansing, MI

Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner, and D.W. Shuen (map interpretation). T.R. Leibfried, M.B. Austin, C.J. Delain, L. Prange-Gregory, L.J. Scrimger, & J.G. Spitzley (digital map production). 1995. Michigan's presettlement vegetation as interpreted from the General Land Office surveys, 1816-1856. Michigan Natural Features Inventory, Lansing, Michigan.

Evers, D.A. 1991. Black-backed Woodpecker species account . In: R. Brewer, G.A. McPeek, and R.J. Adams, editors. The Atlas of Breeding Birds of Michigan. Michigan State University Press, East Lansing. p. 270.

Higman, P.J., P.J. Comer, M.R. Penskar, M.L. Rabe, D.A. Albert, J.T. Legge, T.R. Leibfreid, L.J. Scrimger, and M.B. Austin. 1994. Final Report of a Floristic and Natural Features Inventory of Camp Grayling Military Reservation, Grayling, Michigan. Report prepared for Michigan Department of Military and Veterans Affairs and Michigan Department of Natural Resources. 112. pp. + Appendices 190 pp. Michigan Natural Features Inventory. Lansing, Michigan.

Higman, P.J., E. Schools, H. Enander, M.R. Penskar. 2005 (in prep). Invasive Plant Species Survey and Management Recommendations for Camp Grayling Maneuver Training Center. Michigan Natural Features Inventory, Lansing, MI.

Hogrefe, Todd. 2005. Endangered Species Coordinator, Michigan Department of Natural Resources. Lansing, MI>

Homoya, Michael A. 1993. Orchids of Indiana. Indiana Academy of Science. Hong Kong

Kost, M.A., P.J. Higman, D.L. Cuthrell, and J.L. Cooper. 2000. North Camp Grayling Pine Barrens Management Plant. Report prepared for Michigan Department of Military and Veterans Affairs. 28 pp. + Appendices 39.pp.

Kost, Michael A. 2005 (in prep). Reassessment of High Quality Natural Communities at Camp Grayling Maneuver Training Center. Report to the MDMVA. Michigan Natural Features Inventory. Lansing, MI

Michigan Department of Natural Resources - Wildlife Bureau, MDNR - Land and Mineral Services Division. 1993. Gap Northern Lower Peninsula Land Cover. Remote sensing image. Land cover classified from Landsat 5 satellite imagery. Michigan Department of Natural Resources, Land Cover Maps

Michigan Natural Features Inventory. 2003. Michigan's Natural Communities; Draft List and Descriptions. Michigan State University Extension. Lansing, MI.

Michigan Natural Features Inventory. 2004. Statewide Biotics 4 Database. Lansing, Michigan.

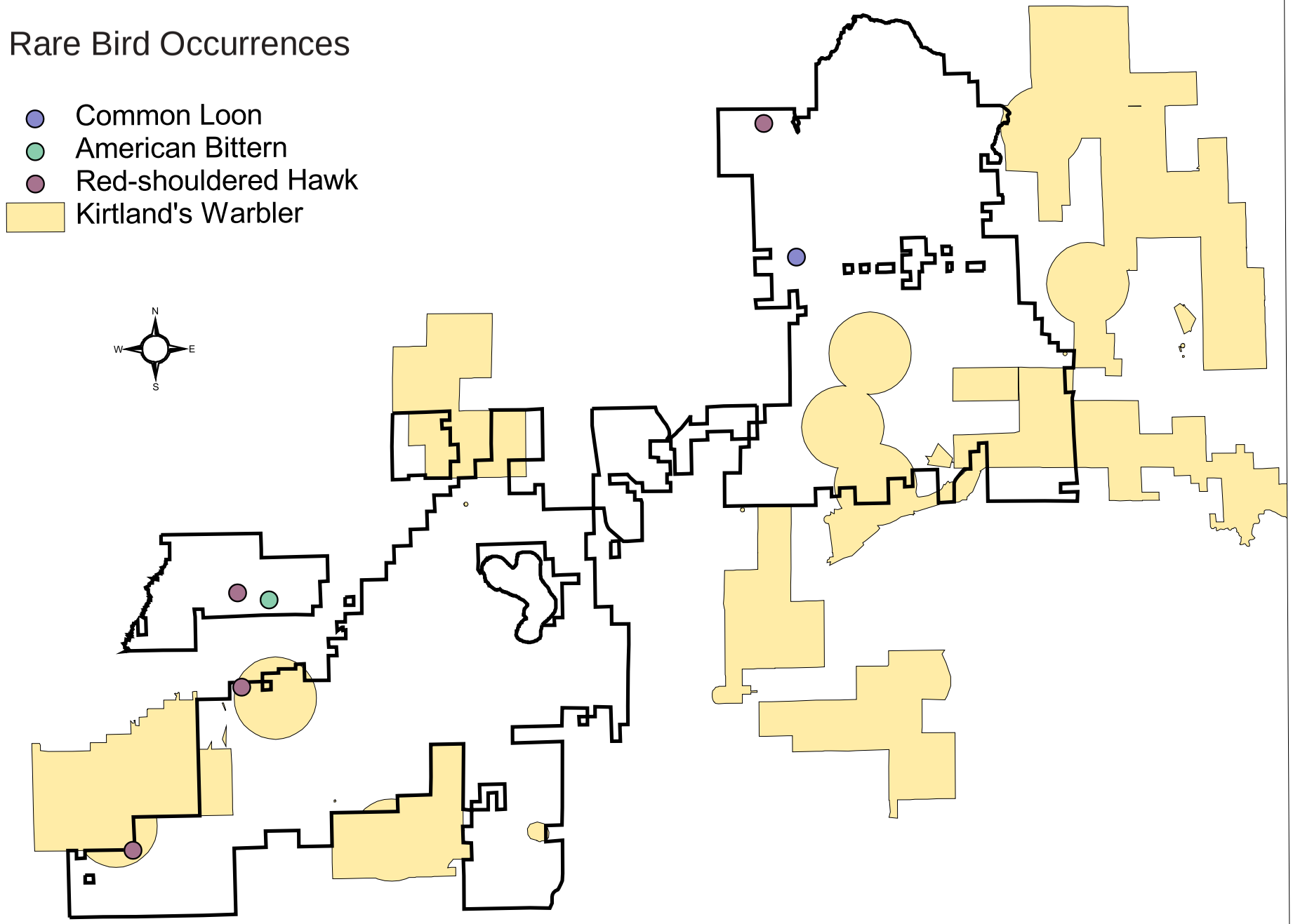
Walkinshaw 1991. Prairie Warbler species account . In: R. Brewer, G.A. McPeek, and R.J. Adams, editors. The Atlas of Breeding Birds of Michigan. Michigan State University Press, East Lansing. p. 418.

Appendix A

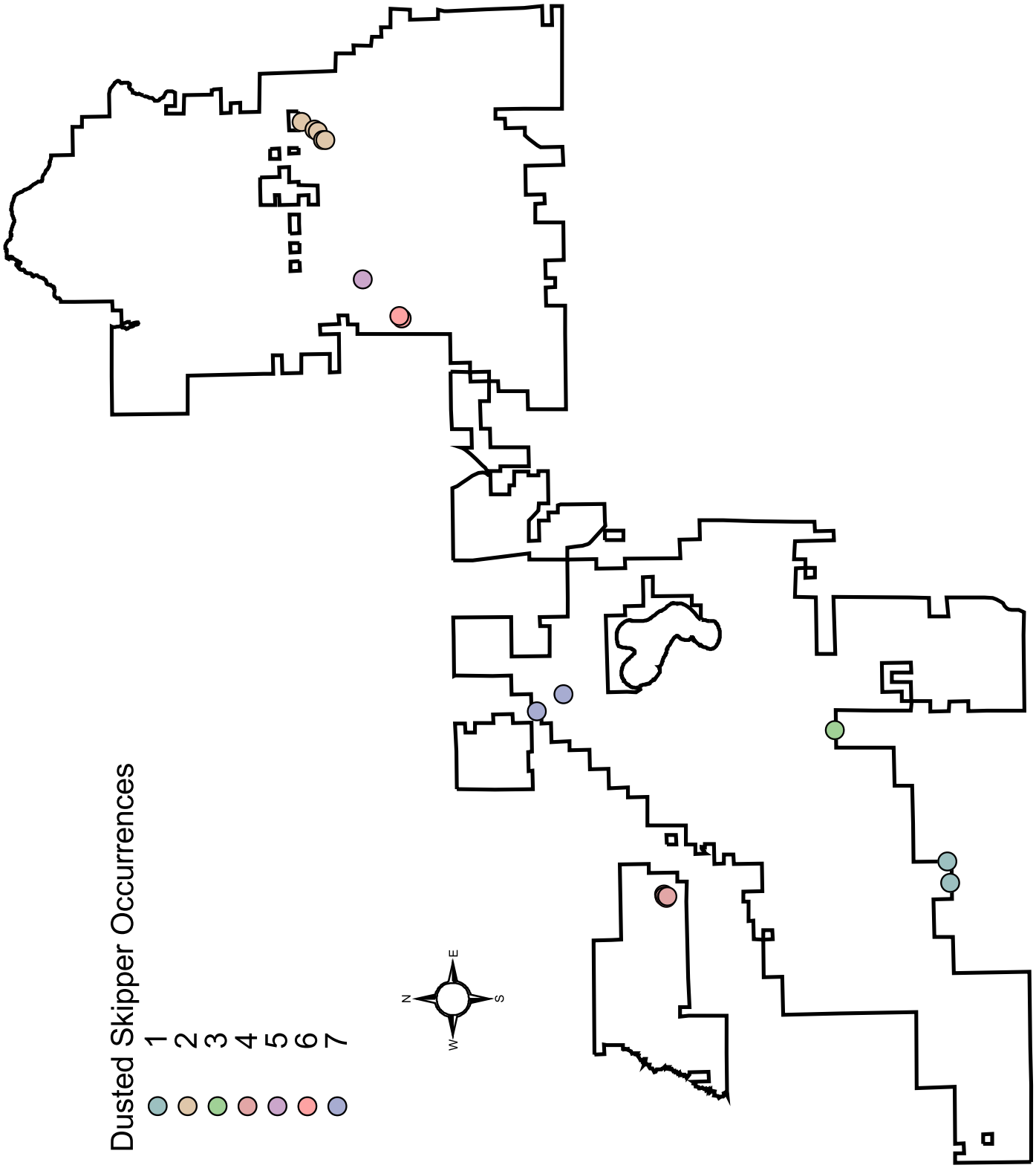
Rare Plant, Bird, and Insect Occurrences at Camp Grayling Maneuver Training Center

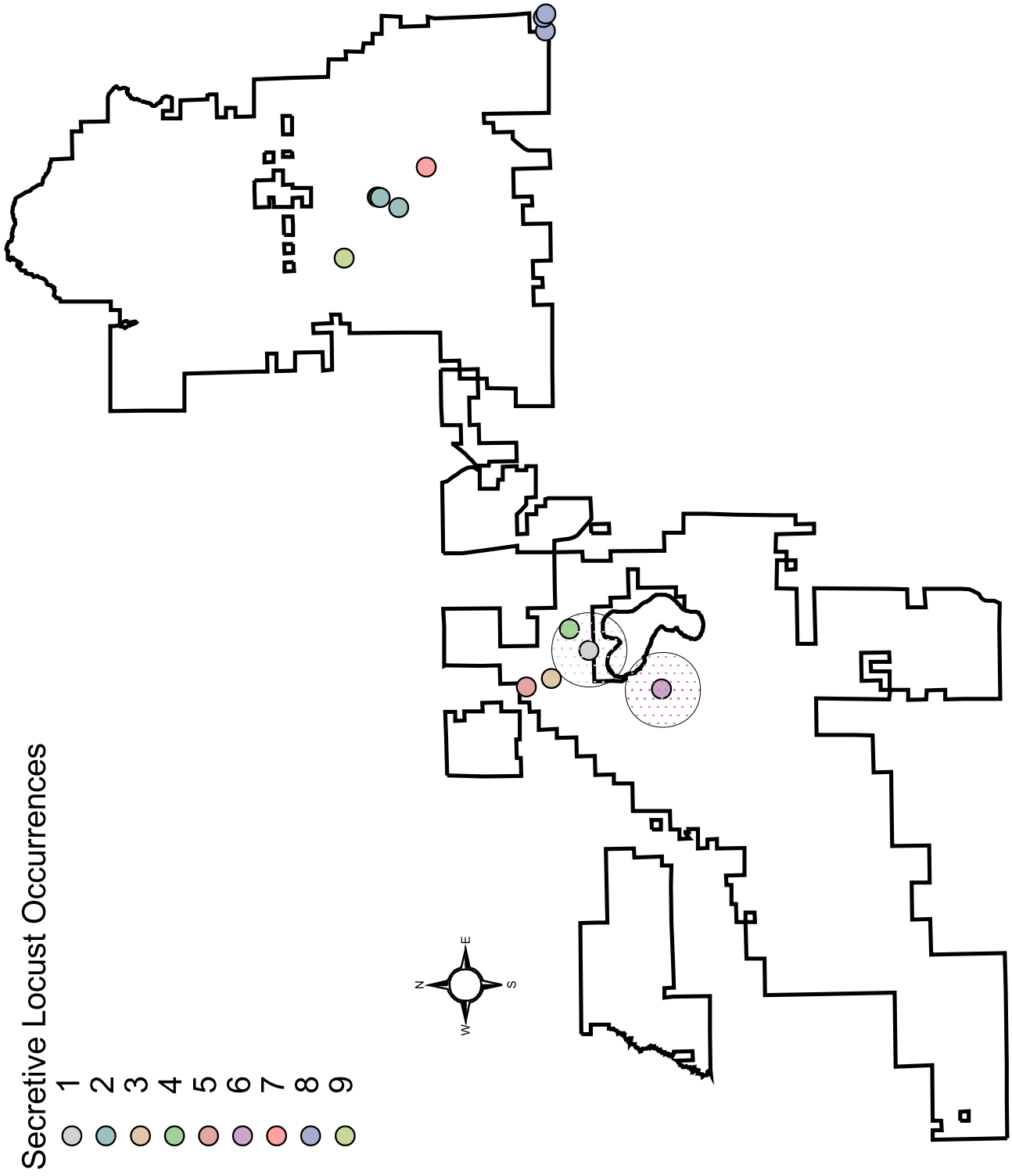
Rare Species Occurrence Maps

The following maps are generated from the MNFI statewide, GIS database, Biotics. Occurrences that are precisely located using a GPS unit, are represented by dots that have been enlarged so as to be visible by the reader. In some cases, several dots may comprise a single element occurrence. Occurrences for which we have less precise location information, are represented by irregular shapes or buffered dots, reflecting the level of uncertainty. Protocols for determining how far apart two separate observations must be to be considered separate element occurrances (minimum separation distance) are specific to the taxon under consideration and are standardized througout the NatureServe network.

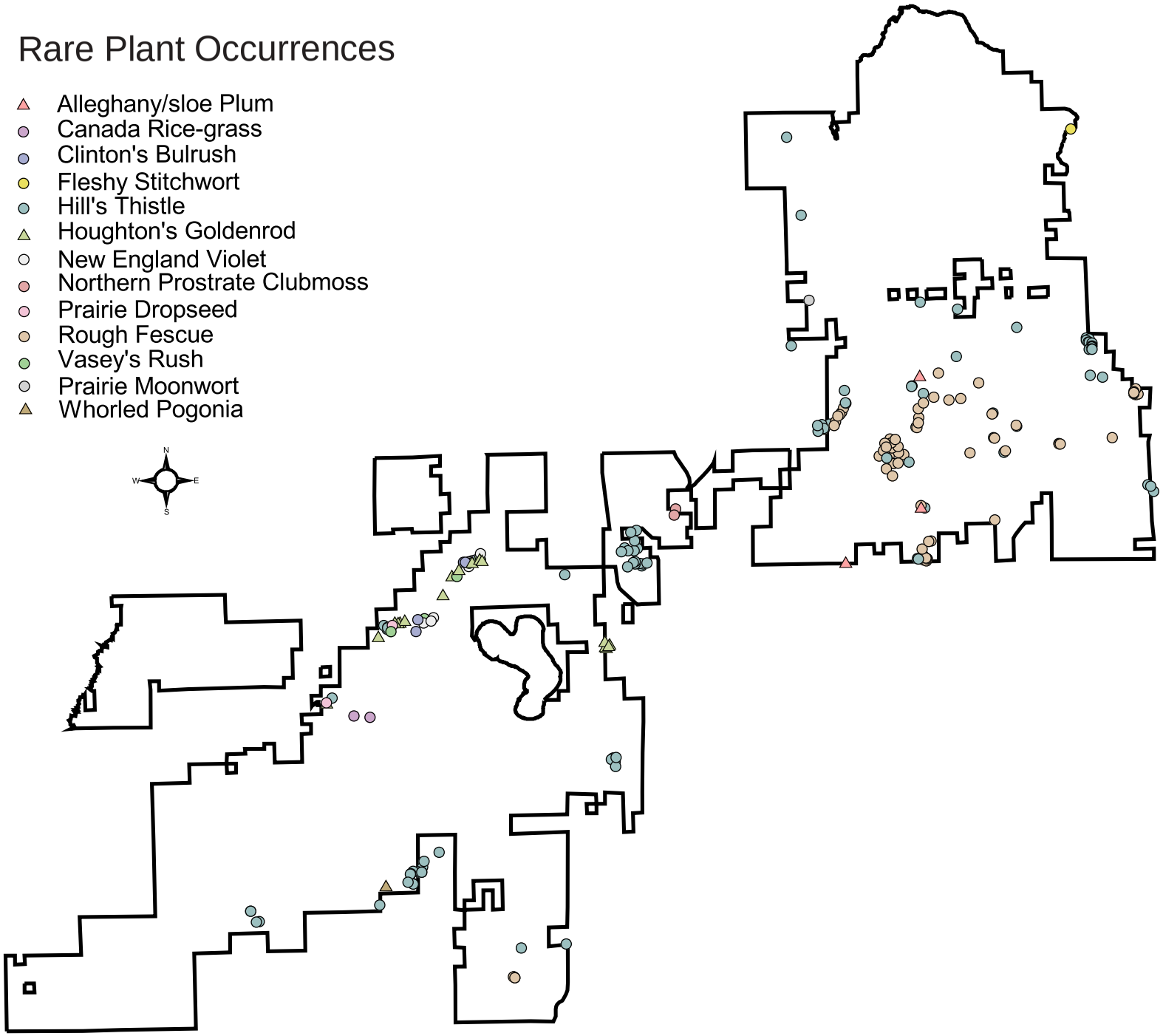


Surveys for rare species - A-3


Dusted Skipper Occurrences
1
2
3
4
5
6
7
N
E
S
W


Secretive Locust Occurrences
1
2
3
4
5
6
7
8
9
N
E
S
W

Rare Plant Occurrences



Appendix B.

Natural Community Species Lists

Bog

Insects	Common Name	Scientific Name
	Secretive Locust	*Appalachia arcana*
	Dusted Skipper	*Atrytonopsis hianna*
Plants		
	arrow grass	*Scheuchzeria palustris*
	beak rush	*Rhynchospora alba*
	beak rush	*Rhynchospora capitellata*
	black chokeberry	*Aronia prunifolia*
	black spruce	*Picea mariana*
	blue joint grass	*Calamagrostis canadensis*
	blueberry	*Vaccinium angustifolium*
	bog rosemary	*Andromeda glaucophylla*
	bog sedge	*Carex limosa*
	brown fruited rush	*Juncus pelocarpus*
	buckbean	*Menyanthes trifoliata*
	bulrush	*Trichophorum alpinum*
	canada blueberry	*Vaccinium myrtilloides*
	canadian rush	*Juncus canadensis*
	great bladderwort	*Utricularia vulgaris*
	green keeled cotton grass	*Eriophorum viridi-carinatum*
	horned bladderwort	*Utricularia cornuta*
	jack pine	*Pinus banksiana*
	labrador tea	*Ledum groenlandicum*
	leatherleaf	*Chamaedaphne calyculata*
	pitcher plant	*Sarracenia purpurea*
	round leaved sundew	*Drosera rotundifolia*
	sedge	*Carex buxbaumii*
	sedge	*Carex lasiocarpa*
	sedge	*Carex livida*
	sedge	*Carex oligosperma*
	small cranberry	*Vaccinium oxycoccos*
	sundew	*Drosera intermedia*
	swamp dewberry	*Rubus hispidus*
	swamp laurel	*Kalmia polifolia*
	sweet scented waterlily	*Nymphaea odorata*
	tamarack	*Larix laricina*
	tawny cotton grass	*Eriophorum virginicum*
	wild blue flag	*Iris versicolor*
	wool grass	*Scirpus cyperinus*

Dry-mesic Northern Forest

Birds	Common Name	Scientific Name
	American Redstart	*Setophaga ruticilla*
	American Robin	*Turdus migratorius*
	Black-and-white Warbler	*Mniotilta varia*
	Blackburnian Warbler	*Dendroica fusca*
	Black-throated Blue Warbler	*Dendroica caerulescens*
	Blue Jay	*Cyanocitta cristata*
	Brown-headed Cowbird	*Molothrus ater*
	Common Raven	*Corvus corax*
	Eastern Wood-pewee	*Contopus virens*
	Indigo Bunting	*Passerina cyanea*
	Least Flycatcher	*Empidonax minimus*
	Mourning Dove	*Zenaida macroura*
	Northern Flicker	*Colaptes auratus*
	Ovenbird	*Seiurus aurocapillus*
	Pine Warbler	*Dendroica pinus*
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*
	Red-eyed Vireo	*Vireo olivaceus*
	Scarlet Tanager	*Piranga olivacea*
	Wood Thrush	*Hylocichla mustelina*
	Yellow-bellied Sapsucker	*Sphyrapicus varius*
Plants		
	balsam fir	*Abies balsamea*
	big leaved aster	*Aster macrophyllus*
	big toothed aspen	*Populus grandidentata*
	blueberry	*Vaccinium angustifolium*
	bracken fern	*Pteridium aquilinum*
	broad leaved panic grass	*Panicum latifolium*
	bunchberry	*Cornus canadensis*
	canada blueberry	*Vaccinium myrtilloides*
	canada bluegrass	*POA COMPRESSA*
	canada mayflower	*Maianthemum canadense*
	common st. john's wort	*HYPERICUM PERFORATUM*
	cow wheat	*Melampyrum lineare*
	gay wings	*Polygala paucifolia*
	goldthread	*Coptis trifolia*
	hair grass	*Deschampsia flexuosa*
	harebell	*Campanula rotundifolia*
	huckleberry	*Gaylussacia baccata*
	juneberry	*Amelanchier arborea*
	large leaved shinleaf	*Pyrola elliptica*
	maple leaved arrow wood	*Viburnum acerifolium*
	partridge berry	*Mitchella repens*
	pink lady's slipper; moccasin flower	*Cypripedium acaule*
	quaking aspen	*Populus tremuloides*
	red maple	*Acer rubrum*
	red oak	*Quercus rubra*
	red pine	*Pinus resinosa*
	redtop	*AGROSTIS GIGANTEA*
	rough leaved rice grass	*Oryzopsis asperifolia*
	running ground pine	*Lycopodium clavatum*
	sedge	*Carex pensylvanica*
	slender wheat grass	*Agropyron trachycaulum*

spreading dogbane	*Apocynum androsaemifolium*
sweet fern	*Comptonia peregrina*
trailing arbutus	*Epigaea repens*
white goldenrod	*Solidago hispida*
white oak	*Quercus alba*
white pine	*Pinus strobus*
wild black cherry	*Prunus serotina*
wild columbine	*Aquilegia canadensis*
wintergreen	*Gaultheria procumbens*
witch hazel	*Hamamelis virginiana*

Dry Northern Forest

Birds	Common Name	Scientific Name
	Blackburnian Warbler	*Dendroica fusca*
	Black-throated Green Warbler	*Dendroica virens*
	Hermit Thrush	*Catharus guttatus*
	Ovenbird	*Seiurus aurocapillus*
	Pine Warbler	*Dendroica pinus*
	Red-breasted Nuthatch	*Sitta canadensis*
Plants		
	autumn bent grass	*Agrostis perennans*
	bastard toadflax	*Comandra umbellata*
	bearberry	*Arctostaphylos uva-ursi*
	blueberry	*Vaccinium angustifolium*
	bracken fern	*Pteridium aquilinum*
	canada mayflower	*Maianthemum canadense*
	cow wheat	*Melampyrum lineare*
	false melic	*Schizachne purpurascens*
	goldthread	*Coptis trifolia*
	hair grass	*Deschampsia flexuosa*
	hill's oak	*Quercus ellipsoidalis*
	huckleberry	*Gaylussacia baccata*
	jack pine	*Pinus banksiana*
	maple leaved arrow wood	*Viburnum acerifolium*
	northern dewberry	*Rubus flagellaris*
	old field cinquefoil	*Potentilla simplex*
	paper birch	*Betula papyrifera*
	pin cherry	*Prunus pensylvanica*
	poverty grass; oatgrass	*Danthonia spicata*
	prairie willow	*Salix humilis*
	quaking aspen	*Populus tremuloides*
	rough leaved rice grass	*Oryzopsis asperifolia*
	sedge	*Carex pensylvanica*
	smooth aster	*Aster laevis*
	spreading dogbane	*Apocynum androsaemifolium*
	stiff clubmoss	*Lycopodium annotinum*
	sweet fern	*Comptonia peregrina*
	trailing arbutus	*Epigaea repens*
	white pine	*Pinus strobus*
	white spruce	*Picea glauca*
	wild bergamot	*Monarda fistulosa*
	wintergreen	*Gaultheria procumbens*

Dry Sand Prairie (includes old fields and active firing ranges)

Birds	Common Name	Scientific Name
	American Crow	*Corvus brachyrhynchos*
	American Goldfinch	*Carduelis tristis*
	American Kestrel	*Falco sparverius*
	American Robin	*Turdus migratorius*
	Black-billed Cuckoo	*Coccyzus erythropthalmus*
	Black-capped Chickadee	*Poecile atricapillus*
	Brown-headed Cowbird	*Molothrus ater*
	Blue Jay	*Cyanocitta cristata*
	Bobolink	*Dolichonyx oryzivorus*
	Brewer's Blackbird	*Euphagus cyanocephalus*
	Brown Thrasher	*Toxostoma rufum*
	Clay-colored Sparrow	*Spizella pallida*
	Cedar Waxwing	*Bombycilla cedrorum*
	Chipping Sparrow	*Spizella passerina*
	Common Nighthawk	*Chordeiles minor*
	Common Raven	*Corvus corax*
	Common Yellowthroat	*Geothlypis trichas*
	Chestnut-sided Warbler	*Dendroica pensylvanica*
	Eastern Bluebird	*Sialia sialis*
	Eastern Kingbird	*Tyrannus tyrannus*
	Eastern Meadowlark	*Sturnella magna*
	Eastern Towhee	*Pipilo erythrophthalmus*
	Eastern Wood-pewee	*Contopus virens*
	European Starling	*Sturnus vulgaris*
	Field Sparrow	*Spizella pusilla*
	Great Crested Flycatcher	*Myiarchus crinitus*
	Hairy Woodpecker	*Picoides villosus*
	Hermit Thrush	*Catharus guttatus*
	Indigo Bunting	*Passerina cyanea*
	Least Flycatcher	*Empidonax minimus*
	Lincoln's Sparrow	*Melospiza lincolnii*
	Mourning Dove	*Zenaida macroura*
	Nashville Warbler	*Vermivora ruficapilla*
	Northern Cardinal	*Cardinalis cardinalis*
	Northern Flicker	*Colaptes auratus*
	Ovenbird	*Seiurus aurocapillus*
	Pine Warbler	*Dendroica pinus*
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*
	Red-eyed Vireo	*Vireo olivaceus*
	Red-tailed Hawk	*Buteo jamaicensis*
	Scarlet Tanager	*Piranga olivacea*
	Song Sparrow	*Melospiza melodia*
	Upland Sandpiper	*Bartramia longicauda*
	Vesper Sparrow	*Pooecetes gramineus*
	White-breasted Nuthatch	*Sitta carolinensis*
	Yellow-bellied Sapsucker	*Sphyrapicus varius*
	Yellow-billed Cuckoo	*Coccyzus americanus*
	Yellow-rumped Warbler	*Dendroica coronata*
	Yellow Warbler	*Dendroica petechia*

Insects		
	Canadian Tiger Swallowtail	*Papilio canadensis*
	Olympia Marblewing	*Euchloe olympia*
	Pink-edged Sulphur	*Colias interior*
	American Copper	*Lycaena phlaeas americana*
	Northern Spring Azure	*Celastrina lucia*
	Meadow Fritillary	*Boloria frigga*
	Chryxus Arctic	*Oeneis chryxus*
	Monarch	*Danaus plexippus*
	Dusted Skipper	*Atrytonopsis hianna*
	Roadside Skipper	*Amblyscirtes vialis*
	Cobweb Skipper	*Hesperia metea*
	Duskywing Skipper	*Erynnis sp.*
	Secretive Locust	*Appalachia arcana*
	Grizzly Grasshopper	*Melanoplus punctulatus puntulatus*
Plants		
	See pine barrens species list	

Intermittent Wetland

Insects	Common Name	Scientific Name
	Northern Wingless Grasshopper	*Booneacris glacialis canadensis*
	Secretive Locust	*Appalachia arcana*
Plants		
	autumn bent grass	*Agrostis perennans*
	big bluestem	*Andropogon gerardii*
	black spruce	*Picea mariana*
	blue joint grass	*Calamagrostis canadensis*
	blueberry	*Vaccinium angustifolium*
	bog lobelia	*Lobelia kalmii*
	bulrush	*Trichophorum alpinum*
	canadian rush	*Juncus canadensis*
	common boneset	*Eupatorium perfoliatum*
	common st. john's wort	*HYPERICUM PERFORATUM*
	common water horehound	*Lycopus americanus*
	cordgrass	*Spartina pectinata*
	daisy fleabane	*Erigeron strigosus*
	fringed brome	*Bromus ciliatus*
	golden seeded spike rush	*Eleocharis elliptica*
	grass leaved goldenrod	*Euthamia graminifolia*
	great bladderwort	*Utricularia vulgaris*
	hardstem bulrush	*Schoenoplectus acutus*
	horned bladderwort	*Utricularia cornuta*
	jack pine	*Pinus banksiana*
	labrador tea	*Ledum groenlandicum*
	large cranberry	*Vaccinium macrocarpon*
	leatherleaf	*Chamaedaphne calyculata*
	marsh st. john's wort	*Triadenum virginicum*
	meadowsweet	*Spiraea alba*
	northern st. john's wort	*Hypericum boreale*
	pale spiked lobelia	*Lobelia spicata*
	panic grass	*Panicum depauperatum*
	pondweed	*Potamogeton gramineus*
	pondweed	*Potamogeton natans*
	purple gerardia	*Agalinis purpurea*
	quaking aspen	*Populus tremuloides*
	rattlesnake grass	*Glyceria canadensis*
	red pine	*Pinus resinosa*
	reed canary grass	*Phalaris arundinacea*
	rush	*Juncus balticus*
	sand cherry	*Prunus pumila*
	sand coreopsis	*Coreopsis lanceolata*
	sedge	*Carex flava*
	sedge	*Carex hystericina*
	sedge	*Carex livida*
	sedge	*Carex oligosperma*
	sedge	*Carex viridula*
	sheep laurel	*Kalmia angustifolia*
	silverweed	*Potentilla anserina*
	slender willow	*Salix petiolaris*
	swamp dewberry	*Rubus hispidus*
	swamp laurel	*Kalmia polifolia*
	sweet scented waterlily	*Nymphaea odorata*

tag alder	*Alnus rugosa*
tall goldenrod	*Solidago altissima*
tamarack	*Larix laricina*
three way sedge	*Dulichium arundinaceum*
tufted loosestrife	*Lysimachia thyrsiflora*
twig rush	*Cladium mariscoides*
water shield	*Brasenia schreberi*
water smartweed	*Polygonum amphibium*
white pine	*Pinus strobus*
white spruce	*Picea glauca*
wild blue flag	*Iris versicolor*
wild mint	*Mentha arvensis*
wood sage	*Teucrium canadense*
wool grass	*Scirpus cyperinus*

Mesic Northern Forest

Plants	Common Name	Scientific Name
	American beech	*Fagus grandifolia*
	American fly honeysuckle	*Lonicera canadensis*
	basswood	*Tilia americana*
	beech drops	*Epifagus virginiana*
	bellwort	*Uvularia grandiflora*
	big leaved aster	*Aster macrophyllus*
	bishop's cap	*Mitella diphylla*
	blue beech	*Carpinus caroliniana*
	blue cohosh	*Caulophyllum thalictroides*
	bottlebrush grass	*Hystrix patula*
	Canada bluegrass	*POA COMPRESSA*
	Canada mayflower	*Maianthemum canadense*
	Canada violet	*Viola canadensis*
	Carolina spring beauty	*Claytonia caroliniana*
	choke cherry	*Prunus virginiana*
	cinnamon fern	*Osmunda cinnamomea*
	common trillium	*Trillium grandiflorum*
	doll's eyes	*Actaea pachypoda*
	downy solomon seal	*Polygonatum pubescens*
	dutchman's breeches	*Dicentra cucullaria*
	enchanter's nightshade	*Circaea lutetiana*
	evergreen woodfern	*Dryopteris intermedia*
	false spikenard	*Smilacina racemosa*
	foamflower	*Tiarella cordifolia*
	fragrant bedstraw	*Galium triflorum*
	hairy sweet cicely	*Osmorhiza claytonii*
	helleborine	*EPIPACTIS HELLEBORINE*
	hemlock	*Tsuga canadensis*
	indian cucumber root	*Medeola virginiana*
	ironwood; hop hornbeam	*Ostrya virginiana*
	jack in the pulpit	*Arisaema triphyllum*
	lady fern	*Athyrium filix-femina*
	large leaved shinleaf	*Pyrola elliptica*
	long spurred violet	*Viola rostrata*
	maidenhair fern	*Adiantum pedatum*
	New York fern	*Thelypteris noveboracensis*
	nodding fescue	*Festuca subverticillata*
	partridge berry	*Mitchella repens*
	prickly or wild gooseberry	*Ribes cynosbati*
	rattlesnake fern	*Botrychium virginianum*
	red baneberry	*Actaea rubra*
	red maple	*Acer rubrum*
	rose twisted stalk	*Streptopus roseus*
	round lobed hepatica	*Hepatica americana*
	royal fern	*Osmunda regalis*
	sedge	*Carex albursina*
	sedge	*Carex arctata*
	sedge	*Carex argyrantha*
	sedge	*Carex deweyana*
	sedge	*Carex gracillima*
	sedge	*Carex intumescens*
	sedge	*Carex pedunculata*

sedge	*Carex plantaginea*
sensitive fern	*Onoclea sensibilis*
sharp lobed hepatica	*Hepatica acutiloba*
spotted coral root	*Corallorhiza maculata*
squirrel corn	*Dicentra canadensis*
sugar maple	*Acer saccharum*
white lettuce	*Prenanthes alba*
wild sarsaparilla	*Aralia nudicaulis*
witch hazel	*Hamamelis virginiana*
wood millet	*Milium effusum*
yellow birch	*Betula alleghaniensis*
yellow trout lily	*Erythronium americanum*
yellow violet	*Viola pubescens*
yellow wild licorice	*Galium lanceolatum*

Northern Shrub Thicket

Plants	Common Name	Scientific Name
	alder leaved buckthorn	*Rhamnus alnifolia*
	arbor vitae	*Thuja occidentalis*
	balsam fir	*Abies balsamea*
	bittersweet nightshade	*SOLANUM DULCAMARA*
	black raspberry	*Rubus occidentalis*
	black spruce	*Picea mariana*
	bog birch	*Betula pumila*
	bog lobelia	*Lobelia kalmii*
	bulrush	*Scirpus atrovirens*
	bulrush	*Trichophorum alpinum*
	canadian rush	*Juncus canadensis*
	cinnamon willow herb	*Epilobium coloratum*
	common arrowhead	*Sagittaria latifolia*
	common boneset	*Eupatorium perfoliatum*
	crested shield fern	*Dryopteris cristata*
	dudley's rush	*Juncus dudleyi*
	eastern lined aster	*Aster lanceolatus*
	fen willow herb	*Epilobium leptophyllum*
	fowl manna grass	*Glyceria striata*
	fringed brome	*Bromus ciliatus*
	golden seeded spike rush	*Eleocharis elliptica*
	grass leaved goldenrod	*Euthamia graminifolia*
	great bladderwort	*Utricularia vulgaris*
	great water dock	*Rumex orbiculatus*
	green fringed orchid	*Platanthera lacera*
	green keeled cotton grass	*Eriophorum viridi-carinatum*
	hardstem bulrush	*Schoenoplectus acutus*
	indian paintbrush	*Castilleja coccinea*
	jack pine	*Pinus banksiana*
	labrador tea	*Ledum groenlandicum*
	leatherleaf	*Chamaedaphne calyculata*
	marsh cinquefoil	*Potentilla palustris*
	marsh fern	*Thelypteris palustris*
	marsh marigold	*Caltha palustris*
	marsh st. john's wort	*Triadenum fraseri*
	meadowsweet	*Spiraea alba*
	monkey flower	*Mimulus ringens*
	nodding spurge	*Euphorbia maculata*
	northern bugle weed	*Lycopus uniflorus*
	northern dewberry	*Rubus flagellaris*
	northern panic grass	*Panicum boreale*
	paper birch	*Betula papyrifera*
	purple meadow rue	*Thalictrum dasycarpum*
	red osier dogwood	*Cornus stolonifera*
	redtop	*AGROSTIS GIGANTEA*
	reed canary grass	*Phalaris arundinacea*
	round leaved sundew	*Drosera rotundifolia*
	royal fern	*Osmunda regalis*
	sedge	*Carex aquatilis*
	sedge	*Carex bebbii*
	sedge	*Carex comosa*
	sedge	*Carex flava*

sedge	*Carex hystericina*
sedge	*Carex lasiocarpa*
sedge	*Carex stricta*
sensitive fern	*Onoclea sensibilis*
shrubby cinquefoil	*Potentilla fruticosa*
slender willow	*Salix petiolaris*
small duckweed	*Lemna minor*
spike rush	*Eleocharis acicularis*
spotted touch me not	*Impatiens capensis*
swamp milkweed	*Asclepias incarnata*
swamp rose	*Rosa palustris*
swamp thistle	*Cirsium muticum*
sweet gale	*Myrica gale*
sweet scented waterlily	*Nymphaea odorata*
tag alder	*Alnus rugosa*
tall goldenrod	*Solidago altissima*
tall northern bog orchid	*Platanthera hyperborea*
tamarack	*Larix laricina*
three way sedge	*Dulichium arundinaceum*
water hemlock	*Cicuta bulbifera*
water smartweed	*Polygonum amphibium*
wheat grass	*Agropyron dasystachyum*
white pine	*Pinus strobus*
wild black currant	*Ribes americanum*
wild blue flag	*Iris versicolor*
wild mint	*Mentha arvensis*
wool grass	*Scirpus cyperinus*
yellow pond lily	*Nuphar variegata*

Northern Wet Meadow

Birds	Common Name	Scientific Name
	Alder Flycatcher	*Empidonax alnorum*
	American Bittern	*Botaurus lentiginosus*
	American Robin	*Turdus migratorius*
	Blue Jay	*Cyanocitta cristata*
	Cedar Waxwing	*Bombycilla cedrorum*
	Common Grackle	*Quiscalus quiscula*
	Wilson's Snipe	*Gallinago delicata*
	Common Yellowthroat	*Geothlypis trichas*
	Golden-winged Warbler	*Vermivora chrysoptera*
	Nashville Warbler	*Vermivora ruficapilla*
	Red-winged Blackbird	*Agelaius phoeniceus*
	Sedge Wren	*Cistothorus platensis*
	Song Sparrow	*Melospiza melodia*
	Swamp Sparrow	*Melospiza georgiana*
	Veery	*Catharus fuscescens*
	Winter Wren	*Troglodytes troglodytes*
	Wood Duck	*Aix Sponsa*
	White-throated Sparrow	*Zonotrichia albicollis*
Plants		
	blue joint grass	*Calamagrostis canadensis*
	bog birch	*Betula pumila*
	bog goldenrod	*Solidago uliginosa*
	canadian st. john's wort	*Hypericum canadense*
	common boneset	*Eupatorium perfoliatum*
	common skullcap	*Scutellaria galericulata*
	common water horehound	*Lycopus americanus*
	flat leaved bladderwort	*Utricularia intermedia*
	fowl manna grass	*Glyceria striata*
	fowl meadow grass	*Poa palustris*
	fringed brome	*Bromus ciliatus*
	great bladderwort	*Utricularia vulgaris*
	hoary willow	*Salix candida*
	long awned wood grass	*Brachyelytrum erectum*
	mad dog skullcap	*Scutellaria lateriflora*
	marsh bellflower	*Campanula aparinoides*
	marsh cinquefoil	*Potentilla palustris*
	marsh fern	*Thelypteris palustris*
	marsh st. john's wort	*Triadenum fraseri*
	meadowsweet	*Spiraea alba*
	northern bog aster	*Aster borealis*
	pale spiked lobelia	*Lobelia spicata*
	red osier dogwood	*Cornus stolonifera*
	redtop	*AGROSTIS GIGANTEA*
	reed canary grass	*Phalaris arundinacea*
	rough bedstraw	*Galium asprellum*
	rough goldenrod	*Solidago rugosa*
	sedge	*Carex flava*
	sedge	*Carex hystericina*
	sedge	*Carex lacustris*
	sedge	*Carex lasiocarpa*
	sedge	*Carex stricta*
	shrubby cinquefoil	*Potentilla fruticosa*

slender willow	*Salix petiolaris*
small duckweed	*Lemna minor*
soft stemmed rush	*Juncus effusus*
swamp candles	*Lysimachia terrestris*
swamp dewberry	*Rubus hispidus*
swamp red currant	*Ribes triste*
swamp thistle	*Cirsium muticum*
sweet gale	*Myrica gale*
tag alder	*Alnus rugosa*
tall goldenrod	*Solidago altissima*
tamarack	*Larix laricina*
tawny cotton grass	*Eriophorum virginicum*
water hemlock	*Cicuta bulbifera*
wild black currant	*Ribes americanum*
wild blue flag	*Iris versicolor*
wild mint	*Mentha arvensis*

Northern Wet-Mesic Prairie

Insects	Common Name	Scientific Name
	Secretive Locust	*Appalachia arcana*
	Dusted Skipper	*Atrytonopsis hianna*
Plants		
	alder leaved buckthorn	*Rhamnus alnifolia*
	arbor vitae	*Thuja occidentalis*
	arrow leaved violet	*Viola sagittata*
	autumn bent grass	*Agrostis perennans*
	balsam ragwort	*Senecio pauperculus*
	big bluestem	*Andropogon gerardii*
	black chokeberry	*Aronia prunifolia*
	black spruce	*Picea mariana*
	blue joint grass	*Calamagrostis canadensis*
	blueberry	*Vaccinium angustifolium*
	bog goldenrod	*Solidago uliginosa*
	bracken fern	*Pteridium aquilinum*
	canada bluegrass	*POA COMPRESSA*
	cat's foot	*Antennaria neglecta*
	clinton's bulrush	*Trichophorum clintonii*
	common rockrose	*Helianthemum canadense*
	common water horehound	*Lycopus americanus*
	crested shield fern	*Dryopteris cristata*
	dwarf raspberry	*Rubus pubescens*
	eastern lined aster	*Aster lanceolatus*
	false melic	*Schizachne purpurascens*
	fen willow herb	*Epilobium leptophyllum*
	fowl manna grass	*Glyceria striata*
	fringed brome	*Bromus ciliatus*
	golden seeded spike rush	*Eleocharis elliptica*
	grass leaved goldenrod	*Euthamia graminifolia*
	great lakes gentian	*Gentiana rubricaulis*
	greene's rush	*Juncus greenei*
	hair grass	*Deschampsia cespitosa*
	houghton's goldenrod	*Solidago houghtonii*
	indian paintbrush	*Castilleja coccinea*
	jack pine	*Pinus banksiana*
	kalm's st. john's wort	*Hypericum kalmianum*
	lawn prunella	*PRUNELLA VULGARIS*
	leafy spurge	*EUPHORBIA ESULA*
	long awned wood grass	*Brachyelytrum erectum*
	long leaved aster	*Aster longifolius*
	long leaved bluets	*Houstonia longifolia*
	marsh fern	*Thelypteris palustris*
	marsh wild timothy	*Muhlenbergia glomerata*
	meadowsweet	*Spiraea alba*
	mountain blue eyed grass	*Sisyrinchium montanum*
	muhly grass	*Muhlenbergia uniflora*
	new england blue violet	*Viola novae-angliae*
	nodding spurge	*Euphorbia maculata*
	northern adder's tongue	*Ophioglossum pusillum*
	northern bog aster	*Aster borealis*
	northern bugle weed	*Lycopus uniflorus*
	northern dewberry	*Rubus flagellaris*

old field goldenrod	*Solidago nemoralis*
orange hawkweed	*HIERACIUM AURANTIACUM*
pale spiked lobelia	*Lobelia spicata*
panic grass	*Panicum columbianum*
poverty grass; oatgrass	*Danthonia spicata*
prairie dropseed	*Sporobolus heterolepis*
purple avens	*Geum rivale*
purple meadow rue	*Thalictrum dasycarpum*
red osier dogwood	*Cornus stolonifera*
redtop	*AGROSTIS GIGANTEA*
rough goldenrod	*Solidago rugosa*
scouring rush	*Equisetum hyemale*
screw stem	*Bartonia virginica*
sedge	*Carex bebbii*
sedge	*Carex buxbaumii*
sedge	*Carex castanea*
sedge	*Carex flava*
sedge	*Carex leptalea*
sedge	*Carex stricta*
shrubby cinquefoil	*Potentilla fruticosa*
slender wheat grass	*Agropyron trachycaulum*
slender willow	*Salix petiolaris*
small sundrops	*Oenothera perennis*
smooth aster	*Aster laevis*
soft stemmed rush	*Juncus effusus*
swamp dewberry	*Rubus hispidus*
swamp rose	*Rosa palustris*
sweet fern	*Comptonia peregrina*
switch grass	*Panicum virgatum*
tag alder	*Alnus rugosa*
tall flat top white aster	*Aster umbellatus*
tamarack	*Larix laricina*
ticklegrass	*Agrostis hyemalis*
vasey's rush	*Juncus vaseyi*
white pine	*Pinus strobus*
wild black cherry	*Prunus serotina*
wild blue flag	*Iris versicolor*
wool grass	*Scirpus cyperinus*

Northern Fen

Plants	Common Name	Scientific Name
	beak rush	*Rhynchospora alba*
	black spruce	*Picea mariana*
	blue joint grass	*Calamagrostis canadensis*
	bog birch	*Betula pumila*
	bog lobelia	*Lobelia kalmii*
	bog willow	*Salix pedicellaris*
	buckbean	*Menyanthes trifoliata*
	bulrush	*Trichophorum alpinum*
	common skullcap	*Scutellaria galericulata*
	common water horehound	*Lycopus americanus*
	creeping snowberry	*Gaultheria hispidula*
	crested shield fern	*Dryopteris cristata*
	eastern lined aster	*Aster lanceolatus*
	fringed brome	*Bromus ciliatus*
	hardstem bulrush	*Schoenoplectus acutus*
	jack pine	*Pinus banksiana*
	kalm's st. john's wort	*Hypericum kalmianum*
	large cranberry	*Vaccinium macrocarpon*
	leafy satin grass	*Muhlenbergia mexicana*
	leatherleaf	*Chamaedaphne calyculata*
	mad dog skullcap	*Scutellaria lateriflora*
	marsh bellflower	*Campanula aparinoides*
	marsh fern	*Thelypteris palustris*
	marsh st. john's wort	*Triadenum fraseri*
	meadowsweet	*Spiraea alba*
	northern bog aster	*Aster borealis*
	northern panic grass	*Panicum boreale*
	one sided pyrola	*Orthilia secunda*
	pitcher plant	*Sarracenia purpurea*
	reed manna grass	*Glyceria grandis*
	rough bedstraw	*Galium asprellum*
	rough goldenrod	*Solidago rugosa*
	royal fern	*Osmunda regalis*
	sedge	*Carex buxbaumii*
	sedge	*Carex flava*
	sedge	*Carex lasiocarpa*
	sedge	*Carex leptalea*
	sedge	*Carex livida*
	sedge	*Carex stricta*
	shrubby cinquefoil	*Potentilla fruticosa*
	slender wheat grass	*Agropyron trachycaulum*
	stiff bedstraw	*Galium tinctorium*
	swamp dewberry	*Rubus hispidus*
	sweet gale	*Myrica gale*
	tag alder	*Alnus rugosa*
	tamarack	*Larix laricina*
	ticklegrass	*Agrostis hyemalis*
	water hemlock	*Cicuta bulbifera*
	water smartweed	*Polygonum amphibium*
	white pine	*Pinus strobus*
	wild blue flag	*Iris versicolor*
	wild mint	*Mentha arvensis*

Pine Barrens

Birds	**Common Name**	**Scientific Name**
	American Crow	*Corvus brachyrhynchos*
	American Goldfinch	*Carduelis tristis*
	American Kestrel	*Falco sparverius*
	American Robin	*Turdus migratorius*
	Black-and-white Warbler	*Mniotilta varia*
	Black-capped Chickadee	*Poecile atricapillus*
	Brown-headed Cowbird	*Molothrus ater*
	Blue Jay	*Cyanocitta cristata*
	Brown Thrasher	*Toxostoma rufum*
	Cedar Waxwing	*Bombycilla cedrorum*
	Chipping Sparrow	*Spizella passerina*
	Common Nighthawk	*Chordeiles minor*
	Common Raven	*Corvus corax*
	Common Yellowthroat	*Geothlypis trichas*
	Dark-eyed Junco	*Junco hyemalis*
	Downy Woodpecker	*Picoides pubescens*
	Eastern Bluebird	*Sialia sialis*
	Eastern Towhee	*Pipilo erythrophthalmus*
	Eastern Wood-pewee	*Contopus virens*
	Field Sparrow	*Spizella pusilla*
	Great Crested Flycatcher	*Myiarchus crinitus*
	Hermit Thrush	*Catharus guttatus*
	House Wren	*Troglodytes aedon*
	Indigo Bunting	*Passerina cyanea*
	Kirtland's Warbler	*Dendroica kirtlandii*
	Least Flycatcher	*Empidonax minimus*
	Lincoln's Sparrow	*Melospiza lincolnii*
	Mourning Dove	*Zenaida macroura*
	Nashville Warbler	*Vermivora ruficapilla*
	Northern Flicker	*Colaptes auratus*
	Ovenbird	*Seiurus aurocapillus*
	Pine Warbler	*Dendroica pinus*
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*
	Red-winged Blackbird	*Agelaius phoeniceus*
	Scarlet Tanager	*Piranga olivacea*
Insects		
	Canadian Tiger Swallowtail	*Papilio canadensis*
	Chryxus Arctic	*Oeneis chryxus*
	Cobweb Skipper	*Hesperia metea*
	Duskywing Skipper	*Erynnis sp.*
	Dusted Skipper	*Atrytonopsis hianna*
	Eastern Pine Elfin	*Incisalia niphon*
	Meadow Fritillary	*Boloria frigga*
	Monarch	*Danaus plexippus*
	Northern Spring Azure	*Celastrina lucia*
	Olympia Marblewing	*Euchloe olympia*
	Pink-edged Sulphur	*Colias interior*
	Roadside Skipper	*Amblyscirtes vialis*
	Secretive Locust	*Appalachia arcana*
Plants		
	balsam ragwort	*Senecio pauperculus*
	bearberry	*Arctostaphylos uva-ursi*

big bluestem	*Andropogon gerardii*
birdfoot violet	*Viola pedata*
blueberry	*Vaccinium angustifolium*
bracken fern	*Pteridium aquilinum*
bush honeysuckle	*Diervilla lonicera*
butterfly weed	*Asclepias tuberosa*
cat's foot	*Antennaria neglecta*
choke cherry	*Prunus virginiana*
common blackberry	*Rubus allegheniensis*
common evening primrose	*Oenothera biennis*
common milkweed	*Asclepias syriaca*
common st. john's wort	*HYPERICUM PERFORATUM*
cow wheat	*Melampyrum lineare*
cut leaved grape fern	*Botrychium dissectum*
cylindrical blazing star	*Liatris cylindracea*
daisy fleabane	*Erigeron strigosus*
drummond rock cress	*Arabis drummondii*
early goldenrod	*Solidago juncea*
false dandelion	*Krigia biflora*
false melic	*Schizachne purpurascens*
green sorrel	*RUMEX ACETOSA*
hair grass	*Deschampsia flexuosa*
harebell	*Campanula rotundifolia*
hill's oak	*Quercus ellipsoidalis*
hill's thistle	*Cirsium hillii*
indian grass	*Sorghastrum nutans*
jack pine	*Pinus banksiana*
june grass	*Koeleria macrantha*
lawn prunella	*PRUNELLA VULGARIS*
little bluestem grass	*Andropogon scoparius*
long leaved bluets	*Houstonia longifolia*
low bindweed	*Calystegia spithamea*
marsh wild timothy	*Muhlenbergia glomerata*
northern dewberry	*Rubus flagellaris*
old field cinquefoil	*Potentilla simplex*
old field goldenrod	*Solidago nemoralis*
orange hawkweed	*HIERACIUM AURANTIACUM*
poverty grass; oatgrass	*Danthonia spicata*
prairie brome	*Bromus kalmii*
prairie willow	*Salix humilis*
quaking aspen	*Populus tremuloides*
rattlesnake weed	*Hieracium venosum*
red fescue	*FESTUCA RUBRA*
red pine	*Pinus resinosa*
rice grass	*Oryzopsis pungens*
rough blazing star	*Liatris aspera*
rough fescue	*Festuca scabrella*
rough leaved rice grass	*Oryzopsis asperifolia*
sand cherry	*Prunus pumila*
sand violet	*Viola adunca*
sedge	*Carex pensylvanica*
shadbush serviceberry	*Amelanchier spicata*
sheep fescue	*FESTUCA OVINA*
showy goldenrod	*Solidago speciosa*
slender wheat grass	*Agopyron trachycaulum*
smooth aster	*Aster laevis*

spotted bluet	*CENTAUREA MACULOSA*
spreading dogbane	*Apocynum androsaemifolium*
sweet fern	*Comptonia peregrina*
timothy	*PHLEUM PRATENSE*
trailing arbutus	*Epigaea repens*
western sunflower	*Helianthus occidentalis*
white goldenrod	*Solidago hispida*
wild bergamot	*Monarda fistulosa*
wild black cherry	*Prunus serotina*
wild strawberry	*Fragaria virginiana*
wood lily	*Lilium philadelphicum*
wormwood	*Artemisia campestris*
yarrow	*Achillea millefolium*

Poor Conifer Swamp

Plants	Common Name	*Scientific Name*
	arbor vitae	*Thuja occidentalis*
	autumn bent grass	*Agrostis perennans*
	balsam fir	*Abies balsamea*
	black ash	*Fraxinus nigra*
	black spruce	*Picea mariana*
	blue joint grass	*Calamagrostis canadensis*
	bog birch	*Betula pumila*
	bog goldenrod	*Solidago uliginosa*
	canada blueberry	*Vaccinium myrtilloides*
	canada mayflower	*Maianthemum canadense*
	cinnamon fern	*Osmunda cinnamomea*
	common water horehound	*Lycopus americanus*
	creeping snowberry	*Gaultheria hispidula*
	crested shield fern	*Dryopteris cristata*
	dewberry	*Rubus canadensis*
	fowl manna grass	*Glyceria striata*
	goldthread	*Coptis trifolia*
	grass leaved goldenrod	*Euthamia graminifolia*
	hooked crowfoot	*Ranunculus recurvatus*
	lawn prunella	*PRUNELLA VULGARIS*
	long awned wood grass	*Brachyelytrum erectum*
	meadowsweet	*Spiraea alba*
	nodding trillium	*Trillium cernuum*
	partridge berry	*Mitchella repens*
	pussy willow	*Salix discolor*
	racemed milkwort	*Polygala polygama*
	rattlesnake grass	*Glyceria canadensis*
	red maple	*Acer rubrum*
	red osier dogwood	*Cornus stolonifera*
	rough bedstraw	*Galium asprellum*
	rough goldenrod	*Solidago rugosa*
	round leaved sundew	*Drosera rotundifolia*
	royal fern	*Osmunda regalis*
	sedge	*Carex flava*
	sedge	*Carex gracillima*
	sedge	*Carex intumescens*
	sensitive fern	*Onoclea sensibilis*
	spinulose woodfern	*Dryopteris carthusiana*
	swamp dewberry	*Rubus hispidus*
	swamp goldenrod	*Solidago patula*
	swamp laurel	*Kalmia polifolia*
	swamp thistle	*Cirsium muticum*
	tag alder	*Alnus rugosa*
	tamarack	*Larix laricina*
	wild blue flag	*Iris versicolor*
	wild red raspberry	*Rubus strigosus*
	wild strawberry	*Fragaria virginiana*
	woodland horsetail	*Equisetum sylvaticum*

Rich Conifer Swamp

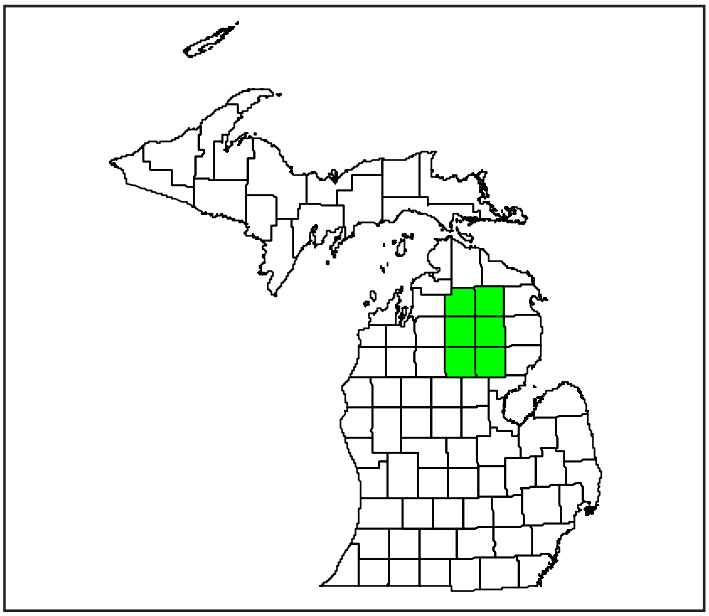
Plants	Common Name	Scientific Name
	alder leaved buckthorn	*Rhamnus alnifolia*
	annual bedstraw	*Galium aparine*
	arbor vitae	*Thuja occidentalis*
	balsam fir	*Abies balsamea*
	big leaved aster	*Aster macrophyllus*
	bittersweet nightshade	*SOLANUM DULCAMARA*
	black ash	*Fraxinus nigra*
	black spruce	*Picea mariana*
	bluebead lily; corn lily	*Clintonia borealis*
	blueberry	*Vaccinium angustifolium*
	bracken fern	*Pteridium aquilinum*
	broad leaved cattail	*Typha latifolia*
	bulrush	*Scirpus atrovirens*
	bunchberry	*Cornus canadensis*
	bush honeysuckle	*Diervilla lonicera*
	canada mayflower	*Maianthemum canadense*
	canadian yew	*Taxus canadensis*
	cinnamon fern	*Osmunda cinnamomea*
	cinnamon willow herb	*Epilobium coloratum*
	common blackberry	*Rubus allegheniensis*
	common boneset	*Eupatorium perfoliatum*
	common horsetail	*Equisetum arvense*
	creeping snowberry	*Gaultheria hispidula*
	crested shield fern	*Dryopteris cristata*
	cut grass	*Leersia oryzoides*
	dwarf raspberry	*Rubus pubescens*
	false mayflower	*Smilacina trifolia*
	fowl manna grass	*Glyceria striata*
	fragrant bedstraw	*Galium triflorum*
	fringed brome	*Bromus ciliatus*
	gay wings	*Polygala paucifolia*
	goldthread	*Coptis trifolia*
	great water dock	*Rumex orbiculatus*
	green keeled cotton grass	*Eriophorum viridi-carinatum*
	heart leaved twayblade	*Listera cordata*
	hemlock	*Tsuga canadensis*
	joe pye weed	*Eupatorium maculatum*
	labrador tea	*Ledum groenlandicum*
	lady fern	*Athyrium filix-femina*
	lawn prunella	*PRUNELLA VULGARIS*
	long awned wood grass	*Brachyelytrum erectum*
	mad dog skullcap	*Scutellaria lateriflora*
	marsh fern	*Thelypteris palustris*
	marsh marigold	*Caltha palustris*
	marsh willow herb	*Epilobium palustre*
	michigan holly	*Ilex verticillata*
	mountain holly	*Nemopanthus mucronata*
	naked miterwort	*Mitella nuda*
	narrow leaved cattail	*TYPHA ANGUSTIFOLIA*
	nodding bur marigold	*Bidens cernuus*
	northern bugle weed	*Lycopus uniflorus*
	oak fern	*Gymnocarpium dryopteris*

one flowered pyrola	*Moneses uniflora*
one sided pyrola	*Orthilia secunda*
paper birch	*Betula papyrifera*
partridge berry	*Mitchella repens*
purple avens	*Geum rivale*
purple meadow rue	*Thalictrum dasycarpum*
rattlesnake fern	*Botrychium virginianum*
red maple	*Acer rubrum*
rough bedstraw	*Galium asprellum*
rough goldenrod	*Solidago rugosa*
round leaved dogwood	*Cornus rugosa*
round leaved sundew	*Drosera rotundifolia*
royal fern	*Osmunda regalis*
rue anemone	*Anemonella thalictroides*
sedge	*Carex brunnescens*
sedge	*Carex comosa*
sedge	*Carex crinita*
sedge	*Carex cryptolepis*
sedge	*Carex disperma*
sedge	*Carex gracillima*
sedge	*Carex hystericina*
sedge	*Carex interior*
sedge	*Carex intumescens*
sedge	*Carex leptalea*
sedge	*Carex stipata*
sedge	*Carex stricta*
sedge	*Carex trisperma*
sensitive fern	*Onoclea sensibilis*
showy or queen's lady slipper	*Cypripedium reginae*
skunk cabbage	*Symplocarpus foetidus*
small purple fringed orchid	*Platanthera psycodes*
small yellow lady's slipper	*Cypripedium calceolus var. parviflorum*
spotted touch me not	*Impatiens capensis*
starflower	*Trientalis borealis*
stiff clubmoss	*Lycopodium annotinum*
swamp aster	*Aster puniceus*
swamp dewberry	*Rubus hispidus*
swamp red currant	*Ribes triste*
swamp thistle	*Cirsium muticum*
tag alder	*Alnus rugosa*
tall goldenrod	*Solidago altissima*
tall northern bog orchid	*Platanthera hyperborea*
tall white bog orchid	*Platanthera dilatata*
tamarack	*Larix laricina*
trailing arbutus	*Epigaea repens*
turtlehead	*Chelone glabra*
twinflower	*Linnaea borealis*
water hemlock	*Cicuta bulbifera*
water plantain	*Alisma plantago-aquatica*
wild black currant	*Ribes americanum*
wild sarsaparilla	*Aralia nudicaulis*
wild strawberry	*Fragaria virginiana*
woodland horsetail	*Equisetum sylvaticum*
wool grass	*Scirpus cyperinus*

Appendix C.

Species Abstracts

Festuca scabrella Torrey — rough fescue



Best Survey Period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					■	■	■				

Status: State threatened

Global and state rank: G5/S3

Family: Poaceae (grass family)

Synonyms: *F. altaica* Trin. ssp. *scabrella* (Torrey) Hultén; *F. altaica* Trin ssp. *altaica*; *F. altaica* ssp. *hallii* (Vasey) Harms; *F. hallii* (Vasey) Piper; *F. campestris* Rydberg var. *major* (Vasey) Gleason.

Taxonomy: Michigan plants were included in the western cordilleran variety *major* Vasey by Hitchcock (1951). *F. scabrella* is considered to be a subspecies of the transcontinental *F. altaica* by some authors (Harms 1984; Pavlick & Looman 1984) and Ontario plants have been assigned by various authors to *F. hallii* (Pavlick & Looman 1984; Aiken & Lefkovitch 1984), which is considered by Harms (1984) to be a subspecies of *F. altaica*.

Total range: *Festuca scabrella* ranges in the west from North Dakota and Colorado to Alaska. In the east it is found in isolated portions of Newfoundland, Quebec, Ontario, and Michigan. It is considered rare in Colorado (as *F. altaica* ssp. *scabrella*) and in Quebec and Ontario (as *F. hallii*).

State distribution: *F. scabrella* is narrowly restricted in the north central Lower Peninsula to adjacent areas of Crawford, Oscoda, Montmorency, Otsego, Roscommon, and Ogemaw Counties. It has not been collected in Roscommon County since the 1950s.

Recognition: Rough fescue usually forms **large, dense tussocks** with fertile stems reaching 3 to 8 dm in height. Its leaves, which are mostly basal, are narrow (1.5-4 mm) with **sometimes inrolled margins and the lowermost blades breaking off easily to leave stiff, persistent sheaths**. The few inflorescence branches are erect to somewhat curving, bearing narrow spikelets 8-10 mm long in which the second glume is nearly as long as the spikelet itself and the **lemmas are finely scabrous**. This species can usually be readily distinguished from other fescues by its robust, strongly tufted growth habit and its leaves that break off at the sheath. *Bromus kalmii* (prairie brome) may superficially resemble rough fescue in overall aspect, but the former has more drooping inflorescence branches and longer spikelets (15-25 mm), with the second glume much shorter in length than the spikelet. The similar looking *Schizachne purpurascens* (false melic) can be distinguished by its long awns and dense beard of hairs at the base of the florets.

Best survey time/phenology: Rough fescue is best identified when inflorescences are developed, such that it can be definitively distinguished from other tussuck-forming species. With experience, this species may also be sought during other periods of the growth season using detailed characteristics of the leaf as well as growth habit.

Habitat: *F. scabrella* grows in openings of sandy jack pine barrens with *Andropogon gerardii* (big bluestem), *Comptonia peregrina* (sweet-fern), *Deschampsia flexuosa* (hair grass), *Prunus pumila* (sand cherry), *Vaccinium angustifolium* and *V. myrtilloides* (blueberries), *Andropogon scoparius* (little bluestem), and *Agoseris glauca* (pale agoseris). It is often found growing at logged and burned sites which are now reverted to savanna. In the

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

western portion of the range, rough fescue inhabits prairies, hillsides, open woods, pine plains, peaty or rocky meadows and barrens, and mountain slopes from foothills to montane areas. In many of these sites it is often the dominant, turf-forming grass species.

Biology: This perennial grass often develops short rhizomes, and individual plants tend to form characteristic round clumps or "stools". The spikelets mature in July. Rough fescue has a C-4 metabolism, and completes most of its growth in the cooler weather prior to midsummer.

Conservation/management: Many Michigan localities for rough fescue occur on state and federal lands. This species probably benefits from active management that promotes semi-open or savanna vegetation (such as that used to create Kirtland's warbler habitat). Since this is a cool-season grass and commences growth early in the season, late spring burns should be avoided. Studies of aspen parkland in Alberta, where rough fescue often dominates, indicate that repeated fire does not favor this species, reducing both its cover and inflorescence production (Anderson and Bailey 1980; Bailey and Anderson 1978). In addition, it is highly palatable to cattle, and may be grazed out in the main portion of its range (Looman 1983). The species may be best managed by protecting it from excessive grazing and employing prescribed burns, where fire is suppressed, to determine the most appropriate fire regimes.

Comments: Johnston (1958) suggests that Michigan's disjunct *F. scabrella* is a relict of the xerothermic post-glacial period, and migrated to our state via the Prairie Peninsula. Dore and McNeill (1980) regard Michigan's *Festuca scabrella* as introduced, after inspection of an Otsego County site in 1964. They do, however, entertain the possible validity of an Ontario record from north of Lake Superior in "jack pine land" with "a few other species of prairie affinity"—habitat at least generally similar to that of rough fescue in Michigan. The fact that this species was first collected in Michigan in 1951 has also cast some doubt on its status as a native member of our flora.

Research needs: The primary research need concerning this species in Michigan is to determine the effects of various management practices. In particular the use of prescribed fire to maintain vigorous, viable colonies and the open, early successional habitat this species requires to perpetuate itself, should be investigated.

Related abstracts: dry northern forest, jack pine barrens, Alleghany plum, Hill's thistle, pale agoseris, secretive locust

Selected references

Aiken, S.G. and L.P. Lefkovitch. 1984. The taxonomic value of using epidermal characteristics in the Canadian rough fescue complex (*Fescue altaica*, *F. campestris*, *F. hallii*, "*F. scabrella*"). Can. J. Bot. 62: 1864-1870.

Aiken, S.G. and J.L. Riley. 1984. *Festuca hallii* (Vasey) Piper in G.W. Argus and C.J. Keddy, Eds. Atlas of the rare vascular plants of Ontario, Part 3. Natl. Mus. of Nat. Sciences, Ottawa.

Anderson, H.G. and A.W. Bailey. 1980. Effects of annual burning in the aspen parkland of east-central Alberta. Can. J. Bot. 58: 985-996.

Bailey, A.W. and M.L. Anderson. 1978. Prescribed burning of a *Festuca-Stipa* grassland. J. Range Man. 31:446-449.

Dore, W.G. and J. McNeill. 1980. Grasses of Ontario. Can. Dept. Agr. Monogr. 26.

Harms, V.L. 1984. A reconsideration of the nomenclature and taxonomy of the *Festuca altaica* complex in North America. Madroño [ ].

Hitchcock, A.S. 1951. Manual of the grasses of the United States. Ed. 2, rev. by Agnes Chase. USDA Misc. Publ. 200.

Johnston, A. 1958. Note on the distribution of rough fescue (*Festuca scabrella* Torr.). Ecology 39:536.

Looman, J. 1983. 111 range and forage plants of the Canadian prairies. Publ. No. 1751, Research Branch, Agriculture Canada.

Palvick, L.E. and J. Looman. 1984. Taxonomy and nomenclature of rough fescues, *Festuca altaica*, *F. campestris* (*F. scabrella* var. *major*), and *F. hallii*, in Canada and the adjacent part of United States. Can. J. Bot. 62:1739-1749.

Abstract citation

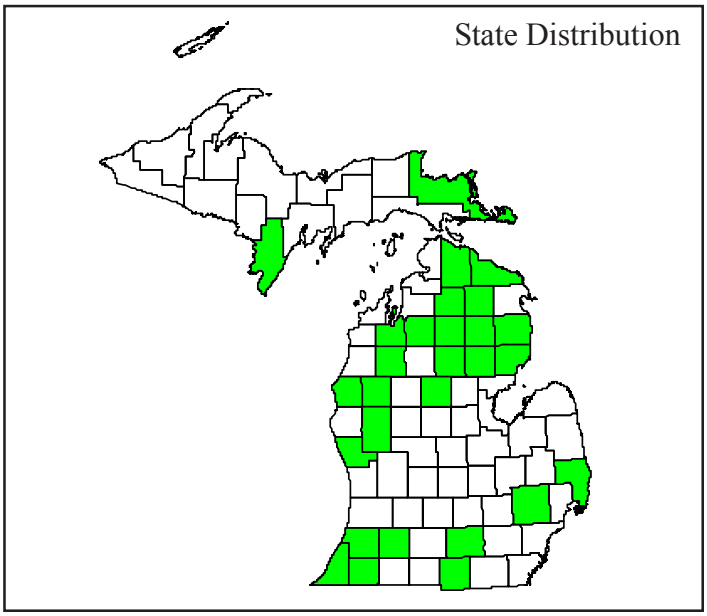
Higman, P.J. and M.R. Penskar. 1996. Special plant abstract for *Festuca scabrella* (rough fescue). Michigan Natural Features Inventory, Lansing, MI. 2 pp.

Funding for abstract provided by Michigan Department of Natural Resources - Forest Management Division and Wildlife Division, Non-Game Program.

7-99/pjh

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Cirsium hillii (Canby) Fern. — Hill's thistle



Best Survey Period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					■	■	■				

Status: State special concern

Global and state rank: G3/S3

Other common names: hollow-rooted thistle

Family: Asteraceae (aster family)

Synonyms: *Cirsium pumilum* (Nutt.) Sprengel

Total range: Hill's thistle is centered in the Great Lakes region, ranging from South Dakota and Minnesota to southern Ontario and Pennsylvania.

State distribution: Hill's thistle is concentrated in three areas the state; the Shakey Lakes oak savanna region of Menominee County in the Upper Peninsula, the jack pine barrens of northern Lower Michigan, and in alvar habitat on Drummond Island. Its stronghold is in the jack pine barrens of the northern Lower Peninsula in Crawford County. It has been documented in other widely scattered locations throughout the Lower Peninsula, particularly in former oak savanna habitat in the southern tiers of counties. Due to the highly disturbed nature of the majority of former oak savanna communities, the status of Hill's thistle in these locations is likely very poor if it is extant at all. It is also known from Beaver Island and other scattered locations.

Recognition: Hill's thistle is a generally short (25-60 cm tall), perennial thistle with a **deep, hollowed, and thickened taproot**. The **leafy stems** are soft, ridged and **sparsely pubescent or tomentose** (with woolly hairs), with 1-2 short branches near the top terminating with a **single, large, pink flower head 4-7 cm high**. The outer bracts at the base of the flower head are tipped by slender, short, and appressed spines. The elliptic-oblong leaves form a **basal rosette** with only a few progressively smaller leaves on the stem. The **leaf margins are typically undulating to very shallowly lobed** and sometimes slightly tomentose below, but often smooth on both surfaces.

Best survey time/phenology: Surveys are best conducted during the flowering period from June through August, however with experience this species can be recognized throughout the season both by the distinctive basal rosettes and fruiting heads.

Habitat: Throughout its range Hill's thistle is known from dry, sandy, gravelly soils in prairies, jack pine barrens, oak savanna, and open woods. In Michigan and Wisconsin, it is also known from limestone pavement communities known as "alvar". Species associates include typical prairie/savanna grasses such as big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium* [*Andropogon*] *scoparius*), Indian grass (*Sorghastrum nutans*), poverty grass (*Danthonia spicata*), hair grass (*Deschampsia flexuosa*), June grass (*Koeleria macrantha*), and a variety of goldenrods, asters, and other prairie forbs.

In the pine barrens communities of Michigan jack pine (*Pinus banksiana*) and Pennsylvania sedge (*Carex pensylvanica*), in addition to the state threatened rough fescue (*Festuca scabrella*), state special concern Cooper's milk-vetch (*Astragalus neglectus*), and state threatened pale agoseris (*Agoseris glauca*) are also frequent associates.

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Biology: This perennial species blooms from June through August and persists from about two to five years. Flowering occurs one or two seasons after the establishment of the rosette, most typically in three-year-old plants. Seed production generally is abundant; however, both flowers and seeds are vulnerable to insects and fungi. Seed are dispersed by wind, with often the entire fruiting head often being broken off and blown away. *Cirsium hillii* also reproduces vegetatively by adventitious buds that form along the lateral roots. The primary taproots die with the remainder of the plant after flowering. Several lateral shoots may be produced by a single plant. Suppression of the natural fire regime in historical *Cirsium* habitat has resulted in increased litter accumulation which is thought to be responsible for poor seedling establishment. This is likely one of the primary causes for the rarity of this species.

Conservation/management: Conservation and management of this species should be directed along two major approaches. One is to make a concerted effort to locate extant populations and prevent further direct destruction of their habitat which, in addition to disruption of the natural fire regime, is a major cause of the species decline. The second approach is to address the problem of poor seedling establishment due to increased accumulation of litter. This concern is primarily an issue within the dry jack pine, savanna, and prairie habitats where lack of fire has allowed considerable encroachment of successional plants. Management in theses areas with the use of prescribed fire is recommended. The accumulating duff layer is effectively removed by fire, opening up germination sites in the ground layer. Fire management may not be necessary in alvar communities where the harsh conditions appear to act as a natural check to woody species encroachment and resultant litter accumulation. In addition, in more mesic prairie/savanna communities, fire may actually have a negative effect. In these communities where lush prairie growth results from fire management, the thistle may actually be shaded out or out-competed by other species.

Research needs: The primary research needs for this species include more intensive inventory work to more adequately assess its status in Michigan, and further research on its basic life history, particularly the requirements for seed germination, seedling establishment, and vegetative reproduction, as well as the specific role of fire.

Related abstracts: alvar, pine barrens, dry sand prairie, oak savanna, Alleghany plum, pale agoseris, rough fescue, secretive locust

Selected references

Moore, R.J. and C. Frankton.1966. An evaluation of the status of *Cirsium pumilum* and *C. hillii*. Can. J. Bot. 44:581-595.

Cusick, A.W. 1995. Report on the status of Cirsium hillii (Hill's pasture thistle) in Ohio. Status report submitted to USFWS, Region 3, Minneapolis, MN. Ohio DNR - Div. of Natural Areas and Preserves, Columbus, OH. 6 pp.

Moore, R.J. and C. Frankton. 1974. The thistles of Canada. Can. Dept. of Ag., Monograph 10. 111 pp.

Penskar, M.R. 1997. Rangewide status assessment of Cirsium hillii (Canby) Fern. Report to USFWS, Region 3 Field Office. Michigan Natural Features Inventory, Lansing, MI. 17 pp.

Roberts, H.A. and R.J. Chancellor. 1979. Periodicity of seedling emergence and achene survival in some species of *Carduus*, *Cirsium*, and *Onopordum*. J. of Applied Ecol. 16:641-647.

Schwegman, J. 1990. Preliminary results of a program to monitor plant species for management purposes. pp. 113-116. In, Ecosystem Management: Rare Species and Significant Habitats. New York State Mus. Bull. 471.

Stephenson, S.N. 1983, Maxton Plains, prairie refugia of Drummond Island, Chippewa County, Michigan. In, Richard Brewer (ed.), Proceedings of the 8th North American Prairie Conference, Western Mich. U., Kalamazoo, MI.

Van Norman, K. 1990. Status report on *Cirsium hillii* (Hill's thistle) in Minnesota. Minn. DNR Biological Report No. 19. USFWS, Twin Cities, MN.

Abstract citation

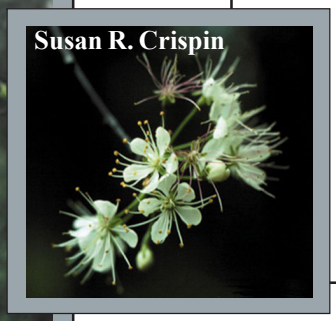
Higman, P.J. and M.R. Penskar. 1996. Special plant abstract for *Cirsium hillii* (Hill's thistle). Michigan Natural Features Inventory, Lansing, MI. 2 pp.

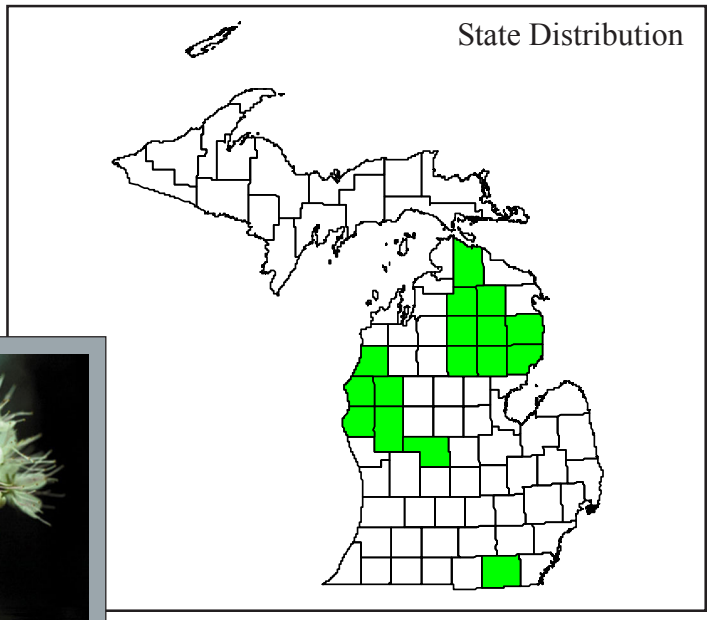
Funding for abstract provided by Michigan Department of Natural Resources - Forest Mangement Division and Wildlife Division, Non-Game Program.

7-99/pjh

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Prunus alleghaniensis var. *davisii* (Wight) Sarg. Alleghany plum





Best Survey Period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■		■	■				

Status: State special concern, Federal species of concern

Global and state rank: G4T3Q/S2

Other common names: sloe plum

Family: Rosaceae (rose)

Total range: *Prunus alleghaniensis* is distributed from central Pennsylvania through western Maryland to West Virginia, with outlying localities in Connecticut, Virginia, and eastern Tennessee. This species has also been reported as occurring in New York. Disjunct populations referred to as the endemic var. *davisii* (Wight) Sarg. are located in northern Lower Michigan and west-central Lower Michigan (Voss 1985; Wight 1915).

State distribution: This species is known from approximately 40 occurrences within the state, with a major concentration in the northern Lower Peninsula in Oscoda and Crawford counties. A second center of concentration occurs in the Manistee to Newaygo county region, where approximately 15 of the localities within the state are known. Three occurrences were recently documented in Lenawee County.

Recognition: Alleghany plum is a **straggly, thorny shrub**, or occasionally a small tree (to ~3 m), often characterized by the **persistence of dead, thorny blackish branches**. It occurs singly or forms large, dense clones that can result in fairly extensive thickets (Wight 1915). The **leaves are narrowly elliptic to oblanceolate**, 3-6 cm long with **acute or short acuminate tips**. They are smooth and shining above with **finely toothed, glandless margins**, and are scarcely developed when the flowers are fully expanded. The flowers are white petaled with **stamen filaments that turn dark pink with age**. The ovary and fruit are glabrous, while the **glandless sepals are slightly pubescent** near the base. Fruits are ~15 mm in diameter when fresh and ~10 mm when dry with hard stones that are ~5-8 mm broad. The similar *Prunus americana* Marsh (American wild plum) can be distinguished from Alleghany plum by its leaves that are conspicuously prolonged at the tip and by its larger flowers and fruits. The also similar *Prunus nigra* Aiton (Canada plum) can be distinguished by the presence of glands on the leaves and margins of the sepal lobes.

Best survey time/phenology: This species is most easily recognized at maturity during June when the darkened pink stamen filaments are a striking contrast to other similar species. Another good time for easier recognition is in April when it first begins flowering as it usually does so before the other early flowering *Prunus* and *Amelanchier* species with which it is most easily confused. Once into the peak of flowering, it can be distinguished by the pubescent sepal lobes that are glandless, in addition to the glandless teeth of the acute to acuminate-tipped leaves. During fruit it can be distinguished again by its leaves and by the smaller fruits.

Habitat: In the west-central portion of the Lower Peninsula, Alleghany plum occurs in old fields and remnant dry sand prairies. In the northern Lower Peninsula, it occurs in remnant openings in jack pine barrens. In both of these portions of the state, the soils are well drained, acid Grayling sands. It also tends to persist

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

along roadsides. Typical associates include, *Prunus serotina* (black cherry), *P. virginiana* (chokecherry), *P. pensylvanica* (fire cherry), *Carex pensylvanica* (sedge), *Amelanchier spicata* (shadbush), *Vaccinium angustifolium* and *V. myrtilloides* (blueberries), C*omptonia peregrina* (sweetfern), *Salix humilis* (prairie willow), *Prunus pumila* (sand cherry), *Gaultheria procumbens* (wintergreen), *Maianthemum canadense* (Canada mayflower), and State special concern *Cirsium hillii* (Hill's thistle). In the pine barrens system, two other State listed species *Agoseris glauca* (pale agoseris, State threatened) and *Festuca scabrella* (rough fescue, State threatened) are also frequent associates.

Biology: Taylor (1990) indicates that this species is highly shade intolerant and prefers sites with morning sun and afternoon shade, particularly east-facing slopes. It has been found frequently on roadsides where the suppression of woody plants as a maintenance procedure has created openings that act as refugia for the plum. Since it is found in both dry sand prairie and jack pine plain communities which are systems that were historically dependent on natural fires to maintain their open character, it is likely that fire is an important disturbance factor for this species. It also has excellent soil holding ability which can assist in controlling erosion of the loose Grayling sands. It is known to flower early, typically in April and the seeds are dispersed generally during July and August by birds and mammals that eat the fleshy fruits.

Conservation/management: Alleghany plum is declining primarily because of loss of habitat through succession as a result of fire suppression. In addition, even though cleared roadsides appear to provide refugia for this species, other maintenance activities in these areas, such as herbiciding and construction, have been known to completely extirpate clonal populations. Management strategies must focus on the re-creation of suitable habitat for this species. The use of fire or mechanical overstory removal to create a mosaic of openings in the barrens or prairies is a potential management tool. An additional potentially good management technique is that of the re-introduction of this species into historical sites. A U.S. Forest Service tree nursery in the Huron National Forest in northern Michigan is currently exploring this option and has recently experienced some success in increasing its seed germination rate.

Research needs: Of primary concern is the location of additional occurrences of Alleghany plum in Michigan. Systematic surveys should be conducted in remnant dry sand prairies and jack pine plains and in regions that historically contained these communities. Research regarding nursery propagation of this species and reintroduction into historical sites should be continued. In addition, research regarding important disturbance factors that maintain the open conditions necessary for this shade-intolerant species are critical.

Related abstracts: dry sand prairie, jack pine barrens, Hill's thistle, pale agoseris, rough fescue, secretive locust

Selected references

Fernald, M.L. 1950. Gray's Manual of Botany. 8th ed., illus. D. Van nostrand Company. lxiv + 1632 pp.

Gleason, H.A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern U.S. and Adjacent Canada. 2nd ed. N.Y. Bot. Garden. Bronx, N.Y. lxxv + 910 pp.

Taylor, S.M. 1990. The Alleghany plum of Michigan's jack pine plains. Mich. Acad. XXII:381-384.

Voss, E.G. 1985. Michigan Flora Part II: Dicots (Sauruaceae-Cornaceae). Bull. Cranbrook Inst. Sci. 59 and U. of Mich. Herb. xix + 724 pp.

Wight, W.F. 1915. Native American species of *Prunus*. U.S. Dep. Agr. Bull. 179. 75 pp.

Abstract citation

Higman, P.J. and M.R. Penskar. 1996. Special plant abstract for *Prunus alleghaniensis* var. *davisii* (Alleghany plum). Michigan Natural Features Inventory, Lansing, MI. 2pp.

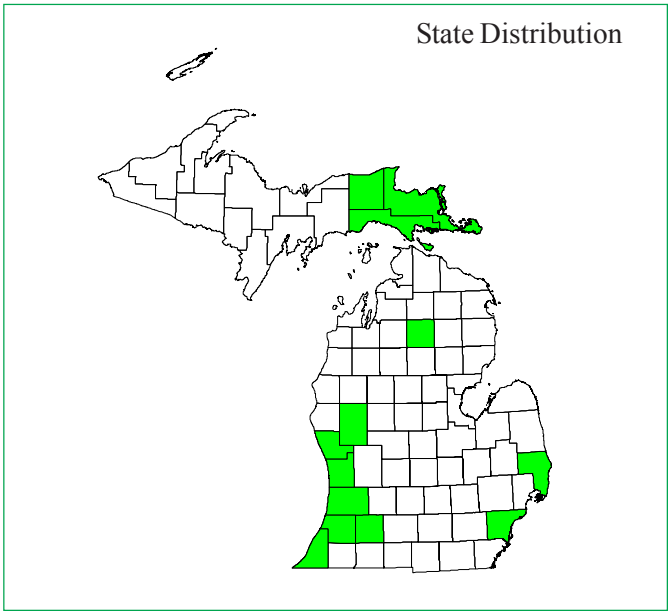
Funding for abstract provided by Michigan Department of Natural Resources - Forest Management Division and Wildlife Division, Non-Game Program.

2-00/pjh

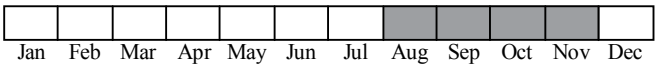
Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Lycopodiella subappressa J.G. Bruce, W.H. Wagner, & J.M. Beitel northern appressed clubmoss


Photo by Michael R. Penskar



Best Survey Period



Status: State special concern

Global and state rank: G2/S2

Other common names: southern appressed clubmoss

Family: Lycopodiaceae (club-moss family)

Synonyms: This taxon has previously been referred to as *Lycopodium appressum* (Chapman) F.E. Lloyd & L. Underwood (see below.)

Taxonomy: The previously used name, *Lycopodium appressum*, actually constituted a complex of two tetraploid species, now referred to as *Lycopodiella subapppressa* Bruce, Wagner, & Beitel and *L. margueritae* Bruce, Wagner & Beitel (Bruce et al. 1991.) These taxa are distinct from the true *Lycopodiella appressa* of the southeastern Atlantic Coastal Plain.

Total range: Now considered distinct from *Lycopodiella appressa* of the Atlantic Coastal Plain, the full geographic distribution of *L. subappressa* is not known. Specimens of this taxon have been collected from Michigan, and specimens from northeastern Indiana and northern Ohio have been reported.

State distribution: Putative occurrences of *Lycopodiella subappressa* are primarily along Lake Michigan in several southwestern counties, although it is now thought to occur in Crawford, Saginaw, Midland, and Jackson Counties as well. Specimens thought to be this taxon have also been recently collected from St. Clair and from Mackinac, Chippewa, and Luce counties of the eastern Upper Peninsula.

Recognition: Michigan's *Lycopodiella subappressa* is a trailing, clone-forming plant characterized by its **relatively tall, upright stems (to about 15 cm)** and **its appressed (erect and close) leaves on both the upright and horizontal stem leaves, which usually lack marginal teeth.** The upper portion of the unbranched shoots consists of a slender **strobilis** (the terminal cone-like, spore-bearing portion of the upright stem) that is **only slightly thicker (0-2 mm) than the upright stem and comprises 1/5-1/3 of its total length.**

The similar *L. margueritae* (northern prostrate club-moss) is typically a taller plant (13-17 cm) with spreading horizontal stem leaves that have 3-4 marginal teeth per side. The strobilis is thicker (usually 3-6 mm more than the upright stem,) and larger, comprising 1//3-1/2 of the upright shoots. The common and widespread *L. inundata* (bog clubzmoss) which frequently occurs with *L. subappressa* and *L. margueritae*, can be distinguished by its relatively short stature (3.5-6 cm), the widely spreading upright and horizontal stem leaves,

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

and the large strobilis that comprises the majority of the upright stem.

Best survey time/phenology: *Lycopodiella subappressa* is best identified during late summer when the strobili are fully developed. Since it is often found growing near or amongst the more common *L. inundatazz*, it is advisable to search thoroughly those sites where the latter species are found.

Habitat: This species is usually found on moist, acidic (pH 5-6.5), peaty sands in early successional, herb-dominated communities. Early records report it from inland lake shores and interdunal swales along Lake Michigan, but most post-1970 localities lie in shallow excavations or "borrow pits" along old beach ridges near Lake Michigan. (Some of these may represent disturbed coastal plain marsh communities). *Lycopodiella appressa* frequently occurs and hybridizes with *L. inundata*, a common associate in most sites. Other typical and indicator associates include *L. margueritae, Agalinis purpurea* (purple false foxglove), *Drosera intermedia* (narrow-leaved sundew), *Hypericum boreale* (St. Johns-wort), *Euthamia remota* (fragrant goldenrod), *Viola lanceolata* (lance-leaved violet), *Spiraea tomentosa* (steeplebush), *Aristida* species (three-awn grass), *Bulbostylis capillaris* (sedge), *Eleocharis elliptica* (spike-rush), J*uncus acuminatus* (rush), *J. canadensis* (rush), *Panicum clandestinum* (panic-grass), *Rhynchospora capitellata* (beak-rush), and *R. macrostachya* (large beak-rush) (MNFI 1996). On the Atlantic Coastal Plain, "true" appressed bog clubmoss typically inhabits acidic, sandy pond shores, wet meadows, and sphagnum bogs (Beitel 1979).

Biology: Unlike several other Michigan clubmosses, the aerial shoots of this species (and *L. inundata*) die back in the fall. The rhizomes overwinter and bear new shoots in the spring, with strobili developing in late summer and persisting through November. The trailing stems usually spread to form extensive clones. This taxon and *L. margueritae* are tetraploids (2n=312) unlike all other North American *Lycopodiella* taxa which are diploids (2n=156.)

Conservation/management: The primary threat to this species may be vegetative succession within disturbed habitats and a consequent lack of available colonization sites. It may best be conserved by preserving natural coastal plain marsh habitats and by maintaining the open character of borrow pit habitats by preventing invasion of woody species. At least four stations lie within interstate rights-of-way and one colony is in a Michigan Nature Association sanctuary. New localities for appressed clubmoss in Michigan also include intermittent wetlands in the eastern Upper Peninsula, where this species is associated with such Atlantic Coastal Plain disjuncts as *Bartonia paniculata* (panicled screw-stem) and *Rhexia virginica* (meadow-beauty).

Research needs: The complete geographical distribution of this species needs to be resolved by close examination of putative specimens by qualified taxonomists. Further research on the taxonomy of this species is also needed in order to determine its relationship to the 'true" appressed bog clubmoss of the Atlantic Coastal Plain.

Related abstracts: Coastal plain marsh, lakeplain wet prairie, meadow-beauty, panicled screw-stem.

Selected references:

Ballard, H.E. Jr. 1986. Numerical taxonomic studies of the *Lycopodium* "*appressum*"-*inundatum* complex in Michigan. Unpublished report submitted to Michigan Natural Features Inventory, Lansing, MI. 40 pp.

Beitel, J.M. 1979. Clubmosses (*Lycopodium*) in North America. Fiddlehead Forum 6(5):1-8.

Bruce, J.G., W.H. Wagner, Jr., and J.M. Beitel. 1991. Two new species of bog clubmosses, *Lycopodiella* (Lycopodiaceae), from southwestern Michigan. Mich. Bot. 30:3-10.

Bruce, J.G. 1975. Systematics and morphology of subgenus Lepidotis of the genus *Lycopodium* (Lycopodiaceae). Ph.D. Thesis, Univ. of Mich., Ann Arbor, MI.

Lellinger, D.B. 1985. A field manual of the ferns and fern-allies of the United States and Canada. Smithsonian Inst. Press. Washington, D.C. 389 pp.

Michigan Natural Features Inventory. 1986. Element occurrence record .018. Biological Conservation Database. Lansing, MI

Penskar, M.R. 1998. Global Element Summary for *Lycopodiella subappressa* and *Lycopodiella margueriteae*. Michigan Natural Features Inventory. Lansing, MI. 3 pages.

Wagner, W.H., Jr. and J.M. Beitel. 1993. Lycopodiaceae Mirbel, club-moss family. Pages 18-37. In: Flora of North American North of Mexico, Vol. 2. Morin et al. Oxford Press, New York. 474 pp.

Abstract citation:

Penskar, M.R. and P.J. Higman. 1996. Special plant abstract for *Lycopodiella subappressa* (northern appressed clubmoss). Michigan Natural Features Inventory, Lansing, MI. 3 pp.

Updated August 2001.

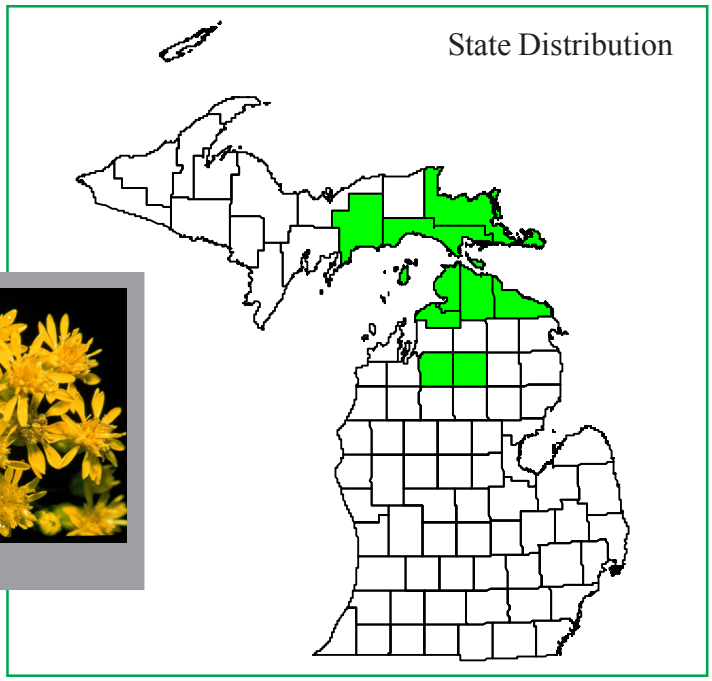
Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

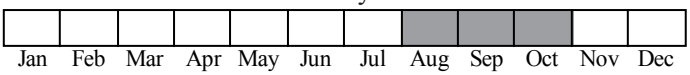
Solidago houghtonii A. Gray — Houghton's goldenrod

Photo by Phyllis J. Higman

Photo by Doug Moore



Best Survey Period



Status: State threatened**,** federal threatened

Global and state rank: G3/S2S3

Family: Asteraceae (Aster family)

Taxonomy: Although *Solidago houghtonii* is widely accepted as a distinctive species, its origin and affinities are disputed. Morton (1979) theorizes that a hybrid of *S. ptarmicoides* (Nees) Boivin (long known as *Aster ptarmicoides* (Nees) T. & G.) and *S. ohioensis* Riddell backcrossed with *S. ohioensis* to form a sterile triploid (three sets of chromosomes); a subsequent doubling of chromosomes resulted in the fertile hexaploid (6x = 54) known as *S. houghtonii*. Semple & Ringius (1983), among others, disagree, concluding that *S. riddellii* Frank, not *S. ptarmicoides*, is the second parent. Most anomalous in the *S. houghtonii* "complex" is a population identified in Crawford County within Camp Grayling. These plants are reportedly octoploids, apparently the only such ploidy level known for a *Solidago* species, and differ somewhat from shoreline populations, thus possibly representing a different taxon. A reported disjunct station in Genesee County, New York (Bergen Swamp), is now believed to represent hybrids between *S. ptarmicoides* and *S. uliginosa.*

Total range: Houghton's goldenrod occurs primarily along the northernmost shores of Lakes Michigan and Huron, ranging east to the Bruce Peninsula in Ontario. Isolated inland stations of what some authors believe to be this species occur in Crawford and Kalkaska counties, Michigan, more than 100 km south of the Mackinac Straits region. A second disjunct station of what is currently considered to be this species occurs in western New York.

State distribution: The greatest concentrations of *S. houghtonii* lie in Chippewa, western Mackinac, northern Emmet, Cheboygan, and northern Presque Isle counties. Each of these areas has large populations extending over at least a mile of shoreline, as well as several scattered smaller populations. About 60 occurrences are known overall.

Recognition: Houghton's goldenrod has smooth, slender, often somewhat reddish stems that reach 3-6 dm in height. The well-scattered, pointed **leaves are long (to 1.3 dm), narrow (less than 1 cm), and often folded along the midrib** (conduplicate), **tapering to a slightly clasping base**. Terminating the stem is a more or less **flat-topped, branched inflorescence consisting of relatively few, showy, large flower-heads** that may number from 5-30 and not uncommonly more (standard manuals, basing their description on the wrong nomenclatural type, incorrectly state the number of flower-heads to be only 5-15). **The branches and pedicels** (flower stalks) of the inflorescence are **finely hairy**, at least sparsely so, with **fine upcurving hairs**, and the achenes are smooth and ribbed.

This species is most likely to be confused with the

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
517-373-1552

widespread *Euthamia graminifolia* (grass-leaved goldenrod) and *S. ohioensis* (Ohio goldenrod*). Euthamia graminifolia* can be distinguished by its more leafy stem lacking basal leaves when in flower. It also has narrower 3-5 nerved leaves, and an inflorescence composed of distinctly smaller flower heads with short ray flowers and hairy achenes. *Solidago ohioensis*, the goldenrod most similar to *S. houghtonii* in northern Michigan, is a more robust species with leafier stems. It usually has broader, more flattened, ovate-lanceolate leaves and a dense, many-headed inflorescence. Other features include **smooth branches and pedicels, smaller ray flowers,** and smooth, unribbed achenes.

Best survey time/phenology: *Solidago houghtonii* is best identifed during peak flowering, when it is most easily distinguished from the extremely similar *Solidago ohioensis*. Flowering occurs from about early August through early September, with plants often blooming into October.

Habitat: *Solidago houghtonii* occurs primarily along the northern shores of Lakes Huron and Michigan, restricted to calcareous beach sands, rocky and cobbly shores, beach flats, and most commonly the shallow, trough-like interdunal wetlands that parallel shoreline areas. This species also occurs on seasonally wet limestone pavement, its more typical habitat in the eastern portion of its range, primarily in Ontario (Morton 1979; Semple and Ringius 1983). Common plant associates include *Parnassia glauca* (grass-of-Parnassus), *Lobelia kalmii* (Kalm's lobelia), *Calamintha arkansana* (Arkansas mint), *Tofieldia glutinosa* (false asphodel), *Potentilla fruticosa* (shrubby cinquefoil), *Gentiana procera* (fringed gentian), *Carex crawei* (sedge), *C. garberi* (sedge), *Eleocharis pauciflora* (spikerush), *Euthamia graminifolia* (grass-leaved goldenrod), *Solidago ohioensis* (Ohio goldenrod), and *Myrica gale* (sweet gale). In the Crawford and Kalkaska county localities, Houghton's goldenrod occurs in an unusual northern wet prairie habitat within the jack pine barrens. There it occupies seasonally indundated areas and old interdunal depressions in a sandy glacial outwash landscape, where it occurs with such species as *Pinus banksiana* (jack pine), *Andropogon gerardii* (big bluestem), *Lobelia spicata* (lobelia), *Castilleja coccinea* (Indian paintbrush), *Eleocharis elliptica* (spikerush), *Potentilla fruticosa*, *Carex conoidea* and *C. flava* (sedges), and several other rare plant species, including *Juncus vaseyi* (Vasey's rush), *Scirpus clintonii* (Clinton's bulrush), and *Viola novae-angliae* (New England violet).

Biology: Houghton's goldenrod is a perennial, frequently forming small clumps (clones) produced vegetatively by means of relatively short rhizomes (underground stem). Flowering occurs primarily in August and early September, but some plants may flower well until October.

Conservation/management: The shoreline habitat of *S. houghtonii* is strongly threatened by residential development and heavy recreational use. Recreational vehicles pose an ever present and increasing threat, as do heavy foot traffic and wetland alterations during the course of shoreline development. Four populations thought to be the largest in existence are currently under protective ownership, one on a Nature Conservancy preserve and three on state land. About fifteen other substantial populations lie on State Forest, National Forest, and State Park lands, receiving some form of protection. Several populations occur partly within Michigan Department of Transportation rights-of-way, in designated and signed protected areas.

Comments: This species is named in honor of Douglass Houghton, Michigan's first State Geologist, whose survey team discovered this Great Lakes endemic on the north shore of Lake Michigan during an 1839 expedition.

Research needs: Investigation of nearly all aspects of the biology and ecology of *Solidago houghtonii* is desirable to determine the smallest colony necessary to maintain a viable population. This includes research on demography, reproductive biology, genetic variability, and basic life-history strategies. Biosystematic and genetic research is also needed to determine the true origin of this taxon and its closest affinities. An understanding of colonization requirements and population dynamics is vital to the conservation of this rare Great Lakes endemic.

Related abstracts: Limestone pavement, open dunes, pine barrens, English sundew, Lake Huron tansy, Pitcher's thistle, Pumpelly's brome grass, zig-zag bladderwort, Caspian tern, dune cutworm, eastern massasauga, Hine's emerald dragonfly, Lake Huron locust, piping plover.

Selected references:

Argus, G.W. and D.J. White (eds.). 1983. Atlas of the Rare Vascular Plants of Ontario: Part 2. Nat. Mus. Nat. Sci., Ottawa. 191 pp. + maps.

Guire, K.E. and E.G. Voss. 1963. "Distributions of distinctive shoreline plants in the Great Lakes region." Mich. Bot. 2:99-114.

Mitchell, R.S. and C.J. Sheviak. 1981. "Rare plants of New York state." Bull. No. 45. New York State Mus., Albany, NY.

Morton, J.K. 1979. "Observation's on Houghton's goldenrod (*Solidago houghtonii*)." Mich. Bot. 18:31-36.

Semple, J.C. and G.S. Ringius. 1983. The goldenrods of

Ontario: Solidago L. and Euthamia Nutt. Univ. Waterloo Biol. Ser. #26. 82 pp.

Abstract citation:

Penskar, M.R., P.J. Higman, and S.R. Crispin. 1996. Special plant abstract for *Solidago houghtonii* (Houghton's goldenrod). Michigan Natural Features Inventory, Lansing, MI. 3 pp.

Updated September 2000.

Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
517-373-1552

Sporobolus heterolepis (Gray) Gray — prairie dropseed

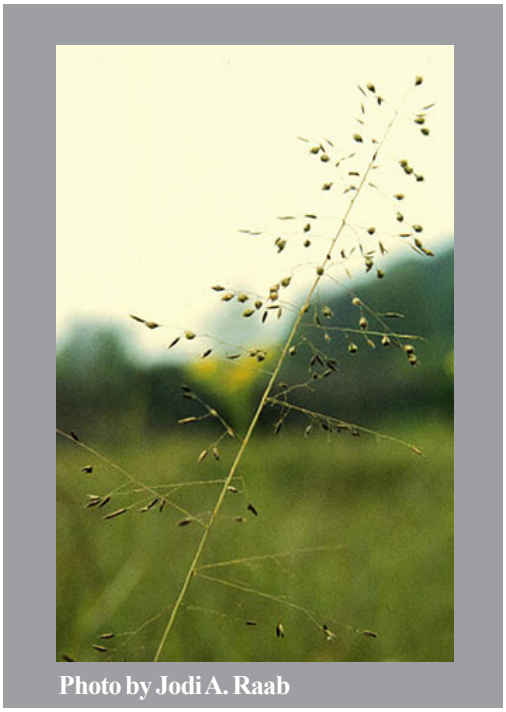
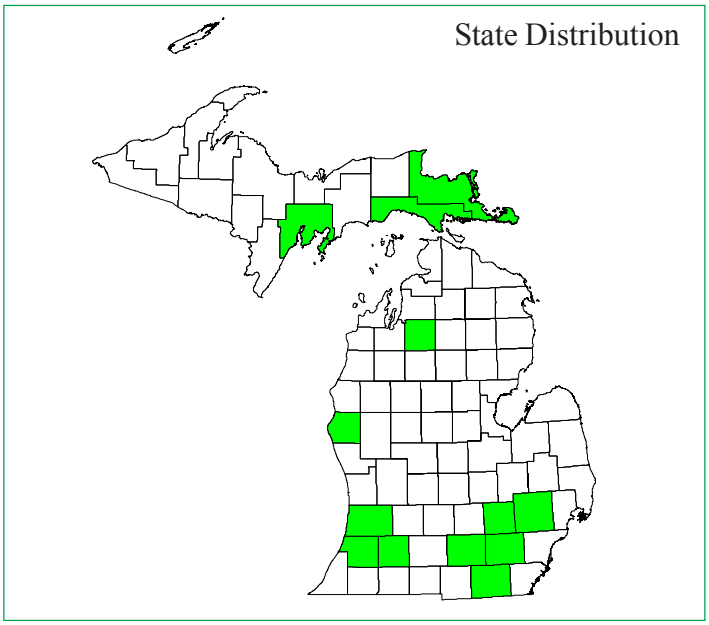
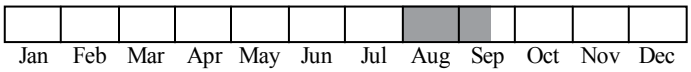


Photo by Jodi A. Raab



Best Survey Period



Status: State special concern

Global and state rank: G5/S3

Other common names: Northern dropseed

Family: Poaceae (also known as Graminae; grass family)

Total range: A prairie species at the heart of its range in central United States, prairie dropseed ranges north into Saskatchewan and Manitoba, south to Texas and Arkansas, and west to Colorado and Wyoming. Widely scattered, localized populations occur eastward from Ontario, Quebec, and New York to Michigan, Ohio, Kentucky, North Carolina, and Louisiana.

State distribution: Prior to 1994 in the Lower Peninsula, this grass was known only from a dozen or so sites in the southern three tiers of counties where it is frequent to locally common. In 1994, a large population was discovered in Crawford County, in northern Lower Michigan, during an intensive floristic inventory of Camp Grayling Military Reservation (Higman et al. 1994). Upper Peninsula occurrences of prairie dropseed are restricted to highly localized areas where it is a dominant component of the bedrock grassland (alvar) communities along the Escanaba River and on the expansive exposed bedrock on Drummond Island.

Recognition: *Sporobolus heterolepis* **grows in dense, roundish clumps** or tufts, forming a turf when abundant. The tall, waist-high stems, reaching 4-10 dm in height, bear **elongate, usually narrow and somewhat inrolled leaves**, the basal ones up to one-half as long as the stems. The **ligule** (at the inner juncture of leaf sheath and blade) consists of **a fringe of short hairs**. Fertile stems are terminated by an open to ovoid inflorescence with spreading to ascending branches. Each one-flowered spikelet is about 3.5-6.5 mm in length, and the glumes (tiny, leaf-like scales at the base of the spikelet) are distinctly unequal, the first about one-half as long as the second. The lemma and palea (tiny bracts at the base of an individual floret) are glabrous and lack lateral nerves. Perhaps most distinctive of this species is the **characteristic fruit, a somewhat shiny, yellowish, spherical grain** (2 mm in diameter) that when mature splits the palea and spreads open the parts of the spikelet. *Panicum virgatum* (switchgrass) superficially resembles prairie dropseen in general aspect, but the glumes are conspicuously nerved and it lacks spherical fruits.

Best survey time/phenology: The characteristic spherical fruits are unmistakable in this species, thus the optimal survey time is when the species is fruiting, typically during August and into early September. With experience, one can learn to distinguish the dense basal tufts of narrow, inrolled leaves characterized by a short fringe of hair at the ligule. For the very experienced, the rather delicate inflorescence, prior to fruiting, can also be keyed in on, noting characteristics of the glumes, lemma, and palea, within the context of appropriate habitat.

Habitat: In the Upper Peninsula, prairie dropseed is characteristic of alvar, becoming a dominant, turf-forming plant of that thin-soil, limestone and dolomite bedrock community. On Drummond Island, prairie dropseed was found to be the most abundant species of the Maxton Plains

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

alvar, dominating in pavement and other grassland sites (Stephenson and Herendeen, 1986). Its common associates include *Carex scirpoidea* (bulrush sedge), *Eleocharis compressa* (flattened spike-rush), *Senecio pauperculus* (ragwort), and *Andropogon scoparius* (little bluestem). The northern Lower Michigan population consists of hundreds of plants that occur in pockets along a linear, mesic sand prairie-like wetland. It appears to follow a pro-glacial lakeplain resulting from the receding Wisconsin glaciation. This rather unique site includes other rarities such as *Solidago houghtonii* (Houghton's goldenrod), *Scirpus clintonii* (Clinton's bulrush), and *Juncus vaseyi* (Vasey's rush), *Viola novae-angliae* (New England violet) as well as additional species characteristic of the Great Lakes shore such as *Deschampsia cespitosa* (hair grass) and *Castelleja coccniea* (Indian paintbrush). In southern Michigan, *S. heterolepis* occurs primarily in calcareous wetlands (prairie fens), where it may be a frequent to dominant plant with *Andropogon gerardii* (big bluestem), *Andropopgon scoparius*, *Sorghastrum nutans* (Indian grass), *Muhlenbergia richardsonis* (mat muhly), *Carex stricta*, and a number of other prairie fen associates. Within the main body of its range, prairie dropseed occurs in upland and lowland mesic prairies, dry open ground, and in open woods.

Biology: Prairie dropseed is a perennial, fruiting primarily during August, though fruiting specimens have been collected from early July through September. As with many other prairie plants, fire is an important component of this species' biology and ecology. Research conducted on burned and unburned prairies sites, where *S. heterolepis* was a dominant component, has demonstrated that fire greatly enhances productivity, both in biomass and flowering (Ehrenreich and Aikman, 1957; Dix and Butler, 1954). The beneficial effects of fire largely result from the removal of deep litter layers, improving nutrient cycling, raising soil temperatures (which stimulates nitrifying bacteria), and eliminating competing vegetation (Wright, 1980). In the alvar communities of Upper Michigan, however, fire may not be a critical environmental factor. Stephenson (1983) suggests that drought rather than fire has prevented the succession of invading vegetation, particularly competing woody plant species. Stephenson and Herendeen (1986) found drought to have profound effects on the alvar species of the Maxton Plains, where following a significant decrease in rainfall, prairie dropseed failed to grow and successfully flower over large portions of the communities it dominated.

Conservation/management: Much of the Maxton Plains alvar is under protection of The Nature Conservancy and the DNR with a portion of the state land proposed for Natural Area dedication. One southern Michigan population also lies within a Nature Conservancy preserve (Ives Road Fen), and at least portions of two other localities are in Michigan Nature Association sanctuaries (Harvey's Rocks and Little Goose Lake Fen). A fifth locality is within a Washtenaw County park. Hydrologic alterations can degrade or destroy prairie dropseed's habitat, as can woody encroachment due to fire supression in southern Michigan fens.

Research needs: Attempts to locate additional inland locations in northern Lower Michigan, similar to the Camp Grayling site, may provide insight into the ecological requirements of this species and could possibly lead to the discovery of additional rarities.

Related abstracts: Prairie fen, English sundew, mat muhly, prairie Indian plantain, small white lady's-slipper, Eastern massasauga, Mitchell's satyr.

Selected references:

Dix, R.L. and J.E. Butler. 1954. The effects of fire on dry, thin-soil prairie in Wisconsin. J. Range. Mgt. 7:265-269.

Ehrenreich, J.H. and J.M. Aikman. 1957. Effect of burning on seedstalk production on native prairie grasses. Iowa Acad. Sci. 64:205-211.

Higman, P.J., P.J. Comer, M.R. Pendkar, M.L. Rabe, D.A. Albert, J.T. Legge, T.R. Leibfeid, L.J. Scrimger, and M.B. Austin. 1994. Final Report for a Floristic and Natural Features Inventory of Camp Grayling Military Reservation, Grayling, Michigan. Michigan Natural Features Inventory, Lansing, MI. 112 pp. + appendices.

Hiltunen, J.K. 1962. Notes on the flora of Chippewa County, Michigan. Mich. Bot. 1:23-26.

Stephenson, S.N. and P.S. Herendeen. 1986. Short-term drought effects on the alvar communities of Drummond Island, Michigan. Mich. Bot. 25:16-27.

Stephenson, S.N. 1983. Maxton Plains, prairie refugia of Drummond Island, Chippewa County, Michigan. In, Proc. 8th N. Am. Prairie Conf. R. Brewer (ed). Western Mich. U., Kalamazoo, MI. vii + 175 pp.

Wright, H.A. and A.W. Bailey. 1980. Fire ecology and prescribed burning in the Great Plains: A research review. USFS - Intermountain Forest & Range Exp. Sta. USDA General Technical Report INT-77. 161 pp.

Abstract citation:

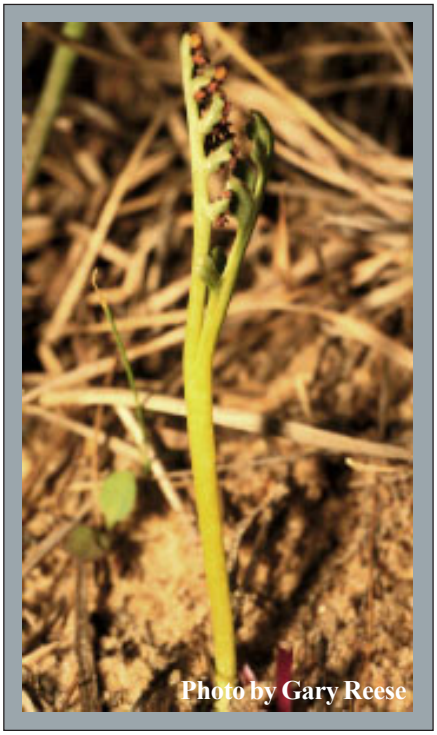
Higman, P.J. and M.R. Penskar. 1999. Special plant abstract for *Sporobolus heterolepis* (prairie dropseed). Michigan Natural Features Inventory, Lansing, MI. 2 pp.

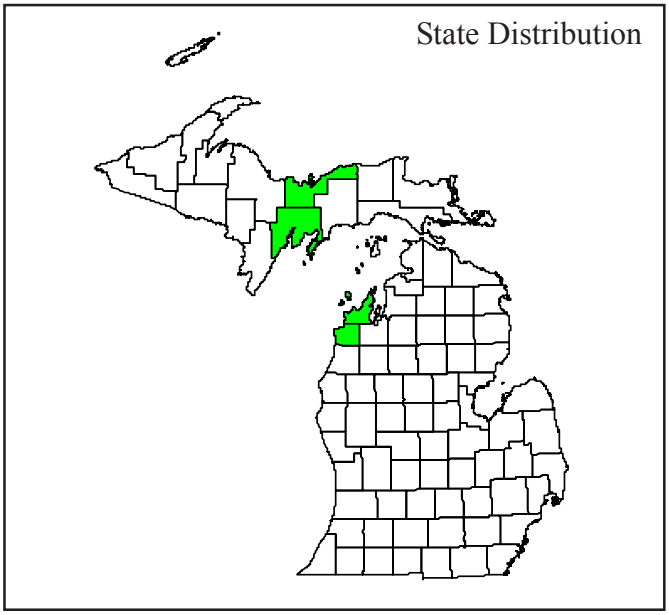
Updated September 2000.

Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division

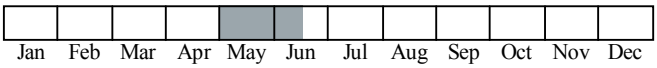
Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Botrychium campestre W.H. Wagner & Farrar — prairie moonwort





Best Survey Period



Status: State threatened

Global and state rank: G3/S2

Other common names: dunewort, moonwort, grape-fern

Family: Ophioglossaceae (adder's-tongue)

Synonyms: *Botrychium matricariifolium* A. Br.

Taxonomy: This grape-fern species was discovered in 1982, when it was found simultaneously in Iowa and in Michigan during early summer surveys (Wagner & Wagner 1990). According to Wagner and Wagner, Michigan's dune-inhabiting plants were first thought to represent a different species or possibly a subspecies of the new taxon, owing to morphological differences observed in early collections. Ultimately, plants of the Great Lakes region and those of Iowa were determined to be the same taxon.

Total range: *Botrychium campestre* is concentrated in the upper Great Lakes region, western Iowa, and western Minnesota, ranging into Nebraska, North Dakota, Saskatchewan, and Manitoba, with isolated disjunct occurrences known in New York and eastern Canada (Wagner & Wagner 1990).

State distribution: Prairie dunewort is known primarily from perched dunes along the northern Lake Michigan shoreline, with one occurrence in southern Benzie County and seven occurrences in Leelanau County, including North Manitou Island, South Manitou Island, and South Fox Island, as well as mainland portions of Sleeping Bear Dunes National Lakeshore. A substantial population is known from Grand Sable Dunes in Pictured Rocks National Lakeshore, and inland populations have been discovered in the Camp Grayling Military Reservation in Crawford County.

Recognition: Wagner & Wagner (1990) note that prairie dunewort can be distinguished from all other moonworts by its combination of characters: **occurrence in exposed prairie or dunes habitats; very early appearance in the spring; the masses of minute round gemmae (vegetative propagules) on the stem, and the usually sessile (stalkless) or subsessile leaves with more or less deeply incised, narrowly and asymmetrically flabellate (fan-shaped) segments.** *Botrychium campestre* is similar to the widespread *B. minganense* Victorin. (mingan moonwort), with which it may commonly occur. *Botrychium minganense* can be distinguished by its generally larger size, its flat (as opposed to longitudinally infolded) leaves with unlobed basal pinnae (lateral division of leaf). If the basal pinnae are unlobed, they are not usually 2-cleft as is characteristic in *B. campestre* (Morin et al. 1993).

Best survey time/phenology: This grape-fern emerges early in comparison to several other botrychiums. This is perhaps the reason it was unnoticed by botanists until the 1980s, when it was discovered on open dunes in the spring. The best period to search for dunewort is May through approximately early June, although during warm springs, this species may senesce and die back by

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

the beginning of June in many coastal sites. It may also be visible through June and into early July in northern sites. Because of its relatively early appearance in the growing season, as well as its diminutive size, this species can be quite easily overlooked.

Habitat: This species occurs in dry prairies and sand dunes, as well as sandy, dry disturbed sites, such as roadsides and old fields. In Michigan, prairie dunewort occurs principally in perched sand dune systems, where it is associated with such species as *Artemisia campestre* (wormwood), *Arctostaphylos uva-ursi* (bearberry), dune grasses (*Ammophila breviligulata* and *Calamovilfa longifolia*), *Arabis lyrata* (lyre-leaved rock cress), and often several other notable grape-ferns, such as *B. hesperium* (western moonwort), *B. lunaria* (common moonwort), *B. matricariifolium* (daisy-leaved grape-fern), *B. minganense*, *B. acuminatum* (pointed moonwort) and *B. simplex*, (least moonwort) (Wagner & Wagner 1990). Several species of botrychiums often co-occur in habitats, forming what Wagner & Wagner (1983) have termed "genus communities."

Biology: As for several other grape-fern species, very little is known of the natural history of this taxon. Long-term monitoring of selected populations in Iowa and Minnesota has only been recently initiated. The few data available indicate that plants may be dormant during the growing season, and apparently do not produce aerial shoots each year. Thus, the leaves visible in colonies do not necessarily represent the number of plants that may actually be present. Farrar & Johnson-Groh (1990) reported the presence of subterranean gemmae in *B. campestre* and three other grape-fern taxa, the first documentation of such structures in any known fern. According to Farrar & Johnson-Groh, the ecological significance of gemmae is related to the advantage conveyed by asexual reproduction in habitats that are often very dry. Prairie moonwort is a spring species, with aerial shoots dying back by early June in Lake Michigan sites.

Conservation/management: Owing to the paucity of information concerning the biology and ecology of this rare and variable moonwort, habitat maintenance and protection is currently the best strategy for perpetuating this species. The open dunes and prairie habitats inhabited by this grape-fern are communities in which natural disturbance (e.g sand movement) is an important factor, and thus it is essential to maintain such regimes in order to maintain appropriate habitat.

Comments: In the Great Lakes region, the majority of occurrences are coastal and found primarily in perched dune areas along Upper Lake Michigan and the Lake Superior shoreline in Pictured Rocks National Lakeshore. Wagner & Wagner (1990) note that as field workers become familiar with this species, its habitat, and phenology, more inland occurrences are likely to be identified.

Research needs: Long term habitat and population monitoring would likely be the most beneficial investigations at this time, in addition to continued inventory along coastal areas and potential inland habitats.

Related abstracts: open dunes, wooded dune and swale complex, acute-leaved moonwort, western moonwort, goblin fern

Selected references

Farrar, D.R. and C.L. Johnson-Groh. 1990. Subterranean sporophytic gemmae in moonwort ferns, *Botrychium* subgenus *Botrychium*. Am. J. Bot. 77(9):1168-1175.

Morin, N.R. et al. 1993. "Ophioglossaceae C. Agardh, Adder's-tongue Family, by W.H. Wagner, Jr. and F.S. Wagner." In, *Flora of North America: Volume 2, Pteridophytes and Gymnosperms*. Oxford Univ. Press, New York, NY. 475 pp.

Wagner, W.H. Jr. and F.S. Wagner. 1990. Moonworts (*Botrychium* subg. *Botrychium*) of the upper Great Lakes region, USA and Canada, with descriptions of two new species. Contr. U. of Mich. Herb. 17:313-325.

Wagner, W.H. Jr. and F.S. Wagner. 1983. Genus communitieis as a systematic tool in the study of New World *Botrychium* (Ophioglossaceae). Taxon 32:51-63.

Abstract citation

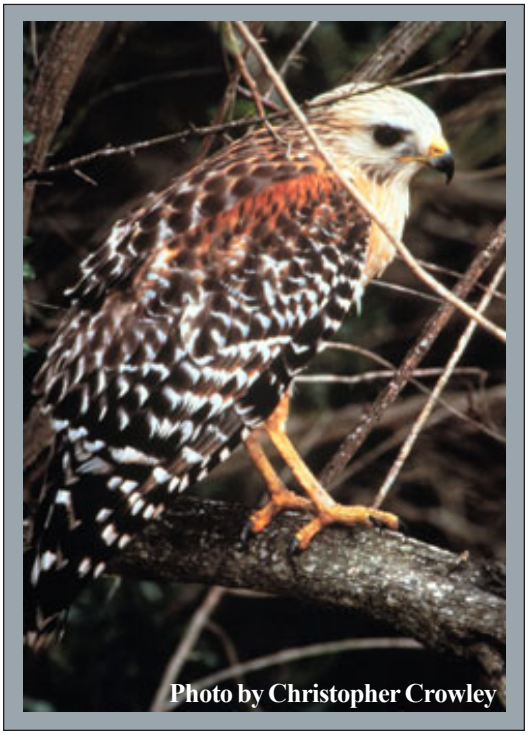
Higman, P.J. and M.R. Penskar. 1999. Special plant abstract for *Botrychium campestre* (prairie dunewort). Michigan Natural Features Inventory, Lansing, MI. 2 pp.

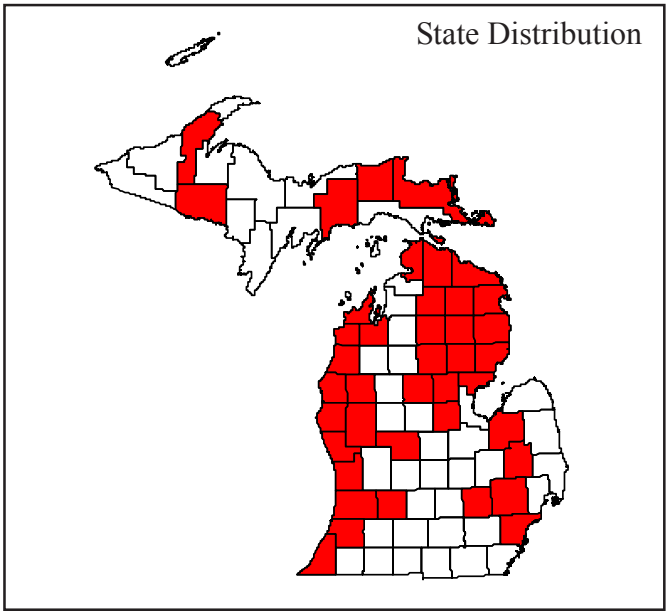
Funding for abstract provided by Michigan Department of Environmental Quality - Land and Water Management Division, Coastal Zone Management Program and Michigan Department of Natural Resources - Wildlife Division, Non-Game Program.

2-00/mrp

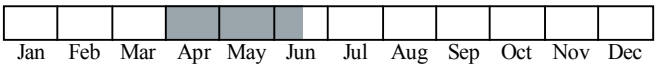
Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Buteo lineatus Gmelin — red-shouldered hawk





Best Survey Period



Status: State threatened

Global and State Rank: G5/S3S4

Family: Accipitridae (hawks)

Total range: Breeding range for eastern populations is from Maine and southern Quebec west to Minnesota, and south to Florida, Texas, and central Mexico (Evers 1994). Wintering range for eastern populations is from Oklahoma, southern Wisconsin, southern Ohio and southern New England south to the Gulf Coast and Mexico (Johnsgard 1990).

State distribution: The distribution of breeding red-shouldered hawks has apparently shifted from their historical range in the southern Lower Peninsula to their present concentration in the northern Lower Peninsula. Breeding records are known from 42 Michigan counties. Currently, however, most breeding activity occurs mainly in two Lower Peninsula regions centering on Manistee County in the northwest and on the Straits area, from Cheboygan and Emmet counties to Alpena County (Ebbers 1991). High concentrations of nesting red-shouldered hawks with good reproductive success have been documented in the Manistee county area (Ebbers 1989). Also, recent survey work in Cheboygon, Emment, and Otsego counties (Pigeon River Country and Indian River forest areas) revealed numerous new nest locations that were highly successful over a two year period (Cooper et al. 1999). The Pigeon River Country and Indian River state forests areas and the Manistee County area provide good habitat for this species and these areas probably are important in terms of maintaining a viable population in Michigan.

Recognition: Adult red-shouldered hawks can be distinguished by the **reddish** coloration of their **underparts and wing linings** and their **five to six narrow, white tail bands**. In flight, they show **crescent-shaped translucent patches** lining the bases of the long, **outermost wing feathers** (the "primaries"). These patches are sometimes referred to as "windows". The bird's red shoulders are often not readily visible. Their **call** during the breeding season is distinctive, a **loud, rapidly repeated "kee-yer"**, though it is closely imitated by blue jays. Immatures have their underparts streaked with brown, teardrop-shaped spots. They may be readily identified by their underwing windows, as in the adults, and by their many narrow tail bands. Red-shouldered hawks can be distinguished from northern goshawks, Cooper's hawks, and sharp-shinned hawks by their shape, with a wider, more rounded tail and broader, longer wings than these other forest-dwelling hawks. The red-tailed hawk, a very common species, can be differentiated by the band of dark feathers running horizontally across its light belly, by the dark feathers lining the leading edge of its underwings, and by its reddish tail, which looks pinkish underneath in flight. The red-shouldered hawk can also be confused with the broad-winged hawk, but that species has three distinct black tail bands and creamy white wings outlined in black.

Best survey time/phenology: The red-shouldered hawk is migratory along the northern edge of its range

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

and generally returns to Michigan in late February to early March, moving north with the retreating snow. Pairs arrive on their northern Lower Peninsula breeding grounds typically in mid-March (Ebbers 1991). Incubation of eggs occurs from late March to mid-April. Most young fledge in June (Craighead & Craighead 1956) and along with the adults remain near the nest site until migration in late fall.

Surveys are best accomplished from mid-April through early May, when birds are exhibiting territorial behavior, roads are relatively accessible, and leaves have not obscured nests. A standard and effective survey methodology for this species is to broadcast a red-shouldered hawk call with a tape recorder or predator caller in suitable habitat. Calling stations can be placed every 0.25 mile through suitable habitat. At each calling station a con-specific red-shouldered hawk call should be broadcast at 60 degrees for 10 seconds, 180 degrees for 10 seconds, and 300 degrees for 10 seconds. This calling sequence should be repeated three times (Kennedy and Stahlecker 1993). If a bird responds observers should look for a nest in the direction the call was initially heard.

Productivity surveys (i.e., nestling counts) can be conducted from early to mid-June. During this time period, young can often be viewed from the ground (Kochert 1986) or white wash (i.e., droppings from young) may be observed below the nest structure, which is evidence that young are or were recently present in a nest (Postupalsky, pers. comm.)

Habitat: In Michigan red-shouldered hawks utilize mature forested floodplain habitat, especially along the Manistee River. However, the majority of nests in Michigan have been found in large (usually >300 acres.), relatively mature deciduous or mixed forest complexes (medium to well stocked pole or saw timber stands). Typically these forest complexes have wetland habitats nearby or wetlands interspersed among these forested habitats (Cooper et al. 1999). Wetland areas such as beaver ponds, wet meadows and lowland forest are used primarily for foraging purposes (Howell and Chapman 1997). Upland openings are also used to some extent for foraging habitat (Evers 1994). Nests are typically placed in mature deciduous trees. American beech is the most commonly documented nest tree in Michigan and the presence of mature beech trees in forest stands may be an important factor that influences hawk utilization (Cooper et al. 1999, Ebbers 1989) However, a variety of nest trees have been utilized in Michigan (e.g., aspen, birch, ash, oak, etc.) which seems to indicate that tree structure and not the type of tree species is the most important factor that influences use of a tree for nest placement (Cooper et al. 1999). Nests are typically placed 35-40 feet above the ground but below the canopy, in a crotch 1/2 to 2/3 of the way up the tree (Ebbers 1989; Johnsgard 1990, Bednarz and Dinsmore 1981, Cooper et al. 1999). Also, nest sites tend to be housed in dense stands of timber with a closed canopy structure and very near wetland habitat (typically within 1/8 mile) (Johnsgard 1990, Cooper et al. 1999).

Biology: The red-shouldered hawk is a highly territorial breeder, and territories and nest sites are often reused for many years (Craighead & Craighead 1956, Bent 1937). In a recent two-year study in Michigan, territorial re-occupancy was high (78% of breeding territories were re-occupied between years) and nest re-occupancy between years was reported at a high rate as well (50% of the same nests were re-used between years) (Cooper et al. 1999). This species is very vocal in territorial defense as well as during its high-flying nuptial displays. The large, bulky nests are built of twigs and are usually "decorated" with greenery and other materials. Two to four eggs are typically laid. Eggs are incubated for about one month primarily by the female, while the male supplies food to her, and later also to the chicks. Great-horned owls and raccoons are common nest predators. The young fledge at about six weeks of age and begin to breed typically at two years old. Prey includes small rodents and birds, snakes, frogs, crayfish, and larger insects, with the proportion taken varying in different locations and possibly over time (Palmer 1988). The bird hunts below the forest canopy and in open, nearby wetlands by perching and waiting for prey. They may also glide low to the ground and surprise prey up close (Palmer 1988).

Conservation/management: The primary threat to this species in Michigan is habitat alteration and destruction due to timber harvest, road construction, and residential development (Evers 1994). Habitat manipulation directly impacts the species by alteration of suitable structure around the nest site and indirectly by influencing the abundance, distribution, and vulnerability of prey species. Fragmentation of forest stands and the creation of larger openings favor the immigration of nest competitors and predators such as the red-tailed hawk (*Buteo jamaicensis*) and great-horned owl (*Bubo virginianus*) (Bryant 1986). These species can either displace a nesting pair or directly depredate young and/or adults from a nest site. Management practices that maintain greater than 70% canopy closure, retain large trees for nesting, and conserve large contiguous blocks of deciduous or mixed forest stands and associated wetland habitat should benefit this species. Currently management has focused on maintaining the critical components of individual home ranges such as the nest area, post fledgling area, and foraging area. However, a more proactive and ecologically sound practice, to ensure conservation of the species on a long term scale, would be to manage large tracts of forest as ecological units. Ecological units should be analyzed and managed across vegetation

types and land ownership pattern in order to maintain the array of ecological processes needed for this species (Graham et al. 1994).

Research needs: There are many research needs concerning this species some of which are listed below. More systematic survey of Michigan is needed in order to gain a better sense of breeding pair density and habitat use, especially in the Upper Peninsula. Further, once breeding territories are located productivity (i.e., the percentage of nests that produced at least 1 young to the fledgling stage) needs to be monitored in order to assess where viable populations occur. Also, little research has been conducted on the impacts of silvicultural practices on habitat use and nest productivity. Other research needs include but are not limited to home range size, movement patterns, analysis of landscape-level habitat patterns, impacts of predation, and investigation of post-fledgling habitat.

Related abstracts: mesic northern forest, Hart's tongue fern, fairy-bells, ginseng, goblin moonwort, large toothwort, showy orchis, walking fern, northern goshawk, woodland vole

Selected references

Bednarz, J.C. and J.J. Dinsmore. 1981. Nest-site and habitat of red-shouldered and red-tailed hawks in Iowa. Wilson Bull. 94:31-45.

Bent, A.C. 1937. Life histories of North American birds of prey. U.S. Nat. History Mus. Bull. 167:1-398.

Bryant, A.A. 1986. Influence of selective logging on red-shouldered hawks, *Buteo lineatus*, in Waterloo region, Ontario, 1953-1978. Can. Field Nat. 100:520-525.

Cooper, J.L., D.L. Cuthrell, and M.L. Rabe. 1999. Red-shouldered hawk inventories and assessment of nest productivity at the Pigeon River and Indian River forest areas. Report submitted to Mich. DNR - Forest Mgmt. Div. Michigan Natural Features Inventory, Lansing, MI. Report #1999-11.

Craighead, J.J. and F.C. Craighead, Jr. 1956. Hawks, owls, and wildlife. Harrisburg, Pennsylvania, Stackpole Company and the Wildlife Mgmt. Inst. (Reprint 1969 Dover Pub.).

Ebbers, B.C. 1989. Relationships between Red-shouldered Hawk reproduction and the environment in northern Michigan. Report to the Mich. DNR - Non-Game Wildlife Fund.

Ebbers B.C. 1991. "Red-shouldered hawk." In, The atlas of breeding birds in Michigan. Brewer, R., G.A. McPeek, and R.J. Adams, Jr. Mich. State U. Press, East Lansing, MI. pp. 170-171.

Evers, D.C., ed. 1994. Endangered and Threatened Wildlife of Michigan. The U. of Mich. Press, Ann Arbor, MI. 412 pp.

Graham, R.T., R.T. Reynolds, M.H. Reiser, R.L. Bassett, and D.A. Boyce. 1994. "Sustaining forest habitat for the northern goshawk: a question of scale." In, Northern Goshawk Ecology and Management. Brock, W.M., M.L. Morrison, and M.H. Reiser (eds.). Cooper Ornith. Soc. Studies in Avian Ecology, No.16.

Howell, D.L. and B.R. Chapman. 1997. Home range and habitat use of red-shouldered hawks in Georgia. Wilson Bull. 109:131-144.

Johnsgard, P.A. 1990. Hawks, Eagles, and Falcons of North America. Smithsonian Inst. Press, Washington, D.C.

Kennedy, P.L. and D.W. Stahlecker. 1993. Responsiveness of nesting Northern Goshawks to taped broadcasts of conspecific calls. J. of Wildlife Mgmt. 57:249-257.

Mosher, J.A., M.R. Fuller, and M. Kopeny. 1990. Surveying woodland raptors by broadcast of conspecific vocalizations. J. of Field Ornith. 61:453-461.

Kochert, M.N. 1986. "Raptors." In, Inventory and Monitoring of Wildlife Habitat. Cooperrider, A.Y., R.J. Boyd, and H.R. Stuart (eds.). USDI - Bureau of Land Mgmt. Service Center, Denver, CO. 858 pp.

Palmer, R.S. 1988. "Red-shouldered hawk, *Buteo lineatus*." In, Handbook of North American Birds, Volume 4: Diurnal Raptors (Part I). Palmer, R.S. (ed.). Smithsonian Inst., Washington, DC. pp. 412-429.

Abstract citation

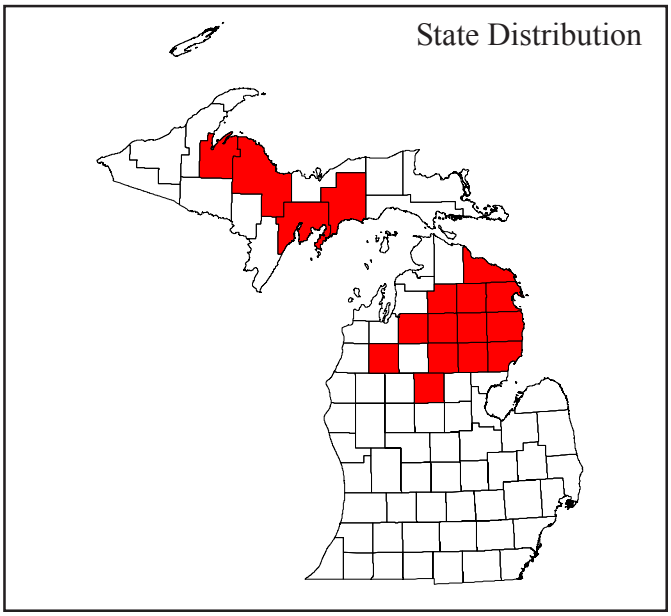
Cooper, J.L. 1999. Special animal abstract for *Buteo lineatus* (red-shouldered hawk). Michigan Natural Features Inventory, Lansing, MI. 3 pp.

Funding for abstract provided by Michigan Department of Natural Resources - Forest Management Division and Wildlife Division, Non-Game Program.

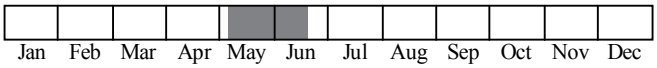
12-99/jlc

Dendroica kirtlandii Baird — Kirtland's warbler

Photo by Ron Austing



Best Survey Period



Status: Federally endangered and state endangered

Global and state ranks: G1/S1

Family: Parulidae (wood warblers)

Total Range: The Kirtland's warbler breeding range currently encompasses ten counties in Michigan's northern Lower Peninsula and four counties in the Upper Peninsula. There is only one confirmed nesting occurrence of the species outside of its present breeding grounds in Michigan. In 1945, a pair was observed feeding a juvenile near Midhurst, Ontario (Speirs 1984). Historically, Wexford, Presque Isle and Alpena Counties in the Lower Peninsula had breeding Kirtland's warbler, but none have been documented since 1977. Singing males without mates have been observed in Wisconsin, Ontario and Quebec (Mayfield 1992). Kirtland's warblers primarily overwinter in the 600 mile Bahama Archipelago, although, individuals also have been observed on surrounding island chains (Evers 1994).

State distribution: In 1951, the first complete census of the Kirtland's warbler located 432 singing males in Michigan (Mayfield 1953). A second survey in 1961 located 502 singing males (Mayfield 1962), but by 1971, the third decennial survey, only 201 singing males were counted (Mayfield 1972). Since 1951, singing males have been documented in seventeen Michigan counties including Alcona, Alpena, Baraga, Clare, Crawford, Delta, Iosco, Kalkaska, Marquette, Montmorency, Ogemaw, Oscoda, Otsego, Presque Isle, Roscommon, Schoolcraft and Wexford. For the first time since annual census data has been collected, the 2001 census documented a record 1085 singing males in Michigan. Singing males were documented in twelve counties including Alcona, Clare, Crawford, Delta, Iosco, Kalkaska, Marquette, Ogemaw, Oscoda, Otsego, Roscommon and Schoolcraft. The bulk of the breeding population, 93% of the singing males in 2001, resides in the northern Lower Peninsula counties of Crawford, Ogemaw, Oscoda, Roscommon, and Alcona.

Recognition: This relatively large wood warbler (adults are 5 ¾ inches in length and weigh 12-15 grams) has a **yellow breast with black streaks confined to the sides**; **two white wing bars**, and a **heavily streaked blue-gray back**. The distinctive **white eye ring is broken at the front and back of the eye**. The adult female is less colorful than the male, having gray cheeks, paler streaked sides and breast and a grayish-brown back. The Kirtland's warbler **persistent tail-pumping** habit is similar to that of the palm warbler *(Dendroica palmarum)* and prairie warbler *(Dendroica discolor)*. Palm warblers are distinguished/ by a brown back, chestnut cap and yellow eyebrow and

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

prairie warblers have an olive back with faint chestnut streaks, and a distinctive black eye line over its yellow cheek. The **song** of the Kirtland's warbler is a series of **loud emphatic notes** sounding like "**chip-chip-tew-tew-weet-weet**." The northern waterthrush *(Seiurus novaboracensis)* has a similar song variation but is not found is the same habitat.

Best survey time: Kirtland's warblers arrive on the breeding grounds in early to mid-May. Males establish relatively large, 6 to 38 acre (J. Weinrich, pers. comm., Walkinshaw 1983, *in lit*. Ennis 2002) territories, which they defend both physically and vocally. Males sing from the date of arrival through the month of June. An annual census of singing males takes place June 6th – 15th, using straight line compass transects or in small areas, meander surveys (M. DeCapita, pers. comm.).

Habitat: During the breeding season, the Kirtland's warbler is dependent upon large, relatively homogeneous stands of jack pine *(Pinus banksiana)* with scattered small openings. Stands less than 80 acres in size are seldom occupied, and nesting success has been found to improve greatly where "colonies" of warblers occupy stands 200 acres and larger (Byelich et *al*. 1976, rev. 1985). As stated in the recovery plan, warblers will start using a jack pine stand when the height of the tree reaches 5 to 7 feet, or at an average tree age of 5-8 years old. Nests are built on the ground, concealed in the low cover of grasses *(Andropogon* spp. and *Danthonia* spp.*)*, sedges *(Carex* spp.*)*, blueberries *(Vaccinium* spp.*)*, sweet fern *(Comptonia peregrina)*, bracken fern *(Pteridium aquilinum)*, blackberry *(Rubus* spp.*)*, trailing arbutus *(Epigaea repens)*, and/or wintergreen *(Gaultheria procumbens)*. Once jack pines reach a height greater than 18 feet (approximately 20 years old), the lower branches begin to die and the ground cover changes in composition, thereby leading to unfavorable nesting conditions (Evers 1994). Jack pines need fire to open the cones and release seeds. All managed jack pine stands are harvested and planted or seeded mechanically to create warbler nesting habitat. Occasionally, harvested sites may be burned prior to planting or seeding.

Kirtland's warblers winter in the Bahama Archipelago. Limited information is available about the warblers wintering habitat. One study from Sykes and Clench (1998) indicates Kirtland's warblers use six broad habitats including: natural scrub/shrub, secondary shrub/scrub, low coppice (broadleaf woodlands less than 15 feet high), pineland understory, saline/upland ecotone, and suburban. Available data are not sufficient to show absolute preference but the majority of observations (i.e.

Photo by Phil Huber

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

based on 98 observations) were made in natural shrub/scrub, secondary shrub/scrub, and low coppice, and saline/upland ecotone (transition zone between the salt marsh and mangrove communities and the upland coppice). Such conditions are abundant and widespread on the islands. Winter observations from February through April 2002 reported Kirtland's warblers in natural shrub/scrub, secondary shrub/scrub, and low coppice (M. DeCapita, pers. comm.).

Biology: This species is a neotropical migrant that breeds in North America and spends its nonbreeding period primarily south of the United States. After a nearly 1,400 mile northward migration, the majority of the male Kirtland's warblers arrive on Michigan breeding grounds between 11-14 May, with females normally arriving less than a week later (Walkinshaw 1983). The earliest record of Kirtland's warbler arriving on the breeding grounds is May 2 (J. Weinrich, pers. comm.). Pair formation normally begins within 1 week after arrival (Mayfield 1992). Kirtland's warblers nest on the ground, sometimes near the base of young jack pines. The nest is typically sunken and well concealed by the surrounding vegetation. The sandy soil on which the jack pines grow permits water to quickly percolate downward, preventing flooding of nests. The first clutch, typically five eggs, may appear the last week of May, but most clutches are not started until the first week in June (Mayfield 1992). If unsuccessful, a second attempt averages four eggs (Walkinshaw 1983). The female incubates the eggs for 13 to 15 days, but both parents care for the young. Food for nestlings and adults consists of flying insects, larvae, and ripe berries. On average, nestlings leave the nest at 9 days old. As the fledglings grow, they continue to receive food from the adults up to 44 days, but by 23 days they appear to be gathering most of their own food (Mayfield 1960). Some pairs with successful first nests initiate a second nest. In those cases the male continues to feed the first brood while the female incubates the second clutch (Walkinshaw 1983). Immatures leave the nesting grounds from mid-August to early September and most adults depart by late September. The latest record for a Kirtland's warbler on the breeding grounds is October 1 (Sykes and Munson 1989).

Conservation/management: The ultimate limiting factor for the warbler is its specific nesting habitat (Byelich et *al*. 1976, rev. 1985). There is persuasive evidence to suggest that the amount of suitable jack pine habitat was at a historic maximum during the 1880's and 1890's, when lumbering and forest fires were rampant. The Kirtland's warbler population appears to have been at its historic peak during the same time based on the large number of specimens taken in the Bahamas during that period (Mayfield 1960). Modern forest fire suppression techniques have been successful at minimizing fire danger to homes, private property, and commercially valuable forests, but as a result, have also reduced the amount of nesting habitat available for Kirtland's warblers. Because habitat is only suitable for about 10 years, habitat maturation forces birds to find new breeding areas (Ennis 2002). Thus, Kirtland's warblers can be maintained or increased only if new breeding habitat is continually established.

The first major effort to provide breeding habitat for the warbler was made in 1957. Three areas, each approximately four miles square, were established specifically as warbler management units on state land in Ogemaw, Crawford and Oscoda counties (Radtke and Byelich 1963, Mayfield 1963). Today approximately 150,000 acres are managed as designated warbler management units on state and national forest lands (Ennis 2002). Each year 2,000-2,500 acres of jack pines are burned (occasionally), seeded, planted, and commercially harvested on a 50-year rotation cycle. This system is designed to provide approximately 38,000 acres of suitable nesting habitat at all times (M. DeCapita, pers. comm.).

Based on a letter written by the Recovery Team in January 2002 (Ennis), approximately 38,000 acres of the appropriate age and density of jack pine are required each year for breeding. This required acreage is based on an average territory size of 38 acres for each singing male; an average based on data collected during the past 20 years. In order to maintain the annual 38,000 acres of breeding habitat requirements, approximately 190,000 of jack pine would have to be managed on a 50-year rotation. This increased number of acres will require identifying and managing additional lands outside of current Kirtland's warbler management units. Kirtland's warbler breeding habitat is short-lived and progresses rapidly to an unsuitable condition as the trees age, so continuous intensive management practices cannot stop once reclassification or delisting occurs.

To extend the occupation of warblers in jack pine stands, Kashian and Barnes (2000) suggest that increased site variation, represented as high elevation and low elevation landforms, be incorporated into management units. Although similar in soil, the multiple landforms have different microclimates as influenced by physiography. Because of a warmer microclimate on higher landforms, jack pines grow faster and are colonized by warblers first. The pines in the cooler low-elevation landform grow more slowly and are colonized later. The result is an extension of Kirtland's warbler use in the area.

A second limiting factor is parasitism of Kirtland's warbler nests by the brown-headed cowbird *(Molothrus ater)* (Byelich et *al*. 1976, rev. 1985). Historically a bird of the prairies, this species reached the warblers nesting range in the late 1800's with the clearing and burning of forests and the development of agriculture in northern Michigan. Cowbirds lay one or more eggs in a host's nest. Their young typically hatch first and overpower the smaller Kirtland's nestlings. This relatively new threat is particularly ominous because the warbler has not evolved the defense mechanisms against cowbird parasitism which are exhibited by many other host songbirds. Walkinshaw (1972) found that 69% of the Kirtland's warbler nests examined during 1966 – 1971 were parasitized. After a 60% decline in the population of Kirtland's warbler between 1961 and 1971 (502 to 201 singing males), the United States Fish and Wildlife Service initiated an annual cowbird trapping program starting in 1972 and continuing today. Cowbirds are captured in large walk-in decoy traps set within management areas. This efficient and successful trapping program has reduced parasitism to nearly negligible levels and warbler fledging success is healthy.

Occupied Kirtland's warbler habitats are closed to visitors during the May 1 through August 15 (September 10 for selected areas) breeding season except for guided tours originating from the Grayling Holiday Inn or U.S. Forest Service District Ranger Office in Mio.

The primary objective in the 1985 Recovery Plan was to "…reestablish a self-sustaining Kirtland's warbler population at a minimum level of 1,000 pairs". In a January 12, 2002 letter to the U.S. Fish and Wildlife Service, the Recovery Team clarified the primary recovery objective. The term "self-sustaining" is believed by the Recovery Team to mean free from intensive management. Today, only intensive management focused on developing appropriate aged stands of jack pine and removal of parasitic brown-headed cowbirds allows the warbler population to persist and increase. It is unlikely that human land use requirements, such as fire suppression, will change in the foreseeable future. Therefore, a true self-sustaining population is not possible and the need for intensive management will continue. The Team clarified the primary objective of the Recovery Plan to state, "The primary recovery objective is to establish and sustain a Kirtland's Warbler population throughout its known range at a minimum level of 1,000 pairs using adaptive management techniques."

Research needs: Population responses to changes in the breeding habitat should be monitored and those results incorporated into habitat management techniques. Foraging requirements and specific food habits remain poorly understood and may be a worthwhile research topic. Kirtland's warblers are seldom observed during migration. Research efforts should focus on possible stop over sites and migration routes. Because this endangered species spends at least 40% - 60% of the year on its wintering grounds (Sykes and Clench 1998), it is important for long-term management and conservation to know more about the warbler's winter habitat requirements and potential threats. Winter population monitoring, winter habitat evaluation, and the identification and evaluation of potential threats in The Bahamas are critical to understanding the factors influencing the Kirtland's warbler. Research is currently being undertaken on the warblers wintering grounds.

Related abstracts: pine barrens, Hill's thistle, pale agoseris, rough rescue, prairie warbler, secretive locust, red-legged spittlebug, blazing star borer.

Selected references:

Byelich, J., M. E. DeCapita, G. W. Irvine, N. I. Johnson, W. R. Jones, H. Mayfield, R. E. Radtke, and W. J. Mahalak. 1976. Rev. 1985. Kirtland's warbler recovery plan. United States Department of Interior, Fish and Wildlife Service. Washinton, D.C.

Ennis, K. 2002. Kirtland's Warbler Recovery Team letter to the U.S. Fish and Wildlife Service dated January 12, 2002.

Evers, D. C. 1994. Endangered and Threatened Wildlife of Michigan. University of Michigan Press, Ann Arbor, MI. Pages 199-205.

Kashian, D. M. and B. V. Barnes. 2000. Landscape influence on the spatial and temporal distribution of the Kirtland's warbler at the Bald Hill burn, northern Lower Michigan, U.S.A. Canadian Journal of Forest Research. 30:1895–1904.

Mayfield, H. F. 1953. A census of the Kirtland's warbler. Auk 70:17-20.

Mayfield, H. F. 1960. The Kirtland's warbler. Cranbrook Institute of Science, Bloomfield Hills, MI.

Mayfield, H. F. 1962. 1961 decennial census of the Kirtland's warbler. Auk 79:173-82.

Mayfield, H. F. 1963. Establishment of preserves for the Kirtland's warbler in the state and national forests of Michigan. Wilson Bulletin 75:216-220.

Mayfield, H. F. 1972. Third decennial census of Kirtland's warbler. Auk 89:263-68.

Mayfield, H. F. 1992. Kirtland's Warbler. *In* The Birds of North America, No. 19 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Radtke, R. and J. Byelich. 1963. Kirtland's warbler management. Wilson Bulletin 75:208-215.

Speirs, D. H. 1984. The first breeding record of Kirtland's warbler in Ontario. Ontario Birds 2:80-84.

Sykes, P. W. and D. J. Munson. 1989. Late record of Kirtland's warbler on the breeding grounds. Jack-Pine Warbler. 67(3): 101.

Sykes, P. W. and M. H. Clench. 1998. Winter habitat of Kirtland's warbler: an endangered nearctic/ neotropical migrant. Wilson Bulletin 110:244-261.

Walkinshaw, L. H. 1972. Kirtland's warbler – endangered. American Birds 26:3-9.

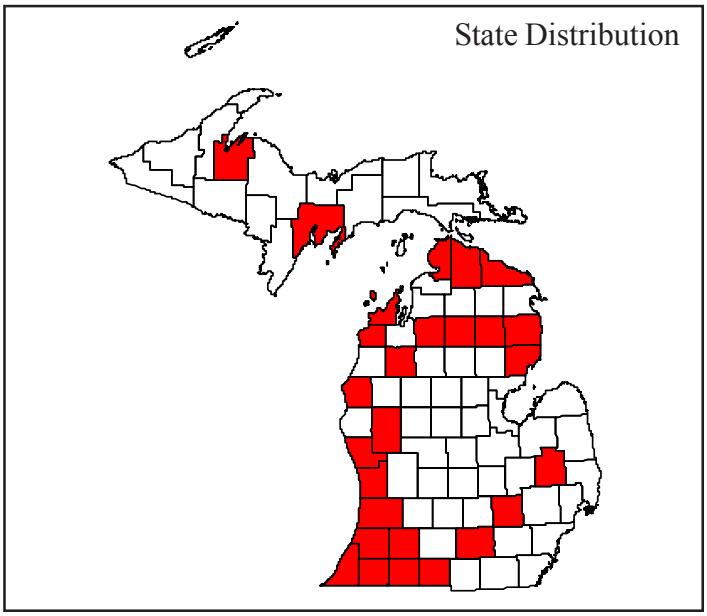
Walkinshaw, L. H. 1983. Kirtland's warbler: The natural history of an endangered species. Cranbrook Institute of Science, Bloomfield Hills, MI.

Abstract citation:

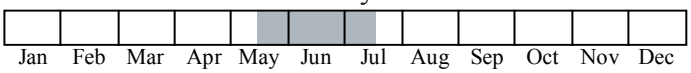
Olson, J. A. 2002. Special animal abstract for *Dendroica kirtlandii* (Kirtland's warbler). Michigan Natural Features Inventory, Lansing, MI. 5 pp.

Funding for abstract provided by Michigan Department of Natural Resources – Forest, Mineral and Fire Management Division.

Dendroica discolor (Viellot) prairie warbler



Best Survey Period



Status: State endangered

Global and state ranks: G5/S1

Family: Emberizidae (warblers)

Range: The prairie warbler primarily breeds in the southeastern United States. Two sub-species are recognized and include *Dendroica discolor discolor* and *Dendroica discolor paludicola* (Evers 1994). The more northern subspecies (*D. d. discolor*) ranges from eastern Oklahoma and northeast Texas; east to the Atlantic coast; and north to New England, southern Ontario, and Michigan. Highest abundances are concentrated in the southern Piedmont Region (Robbins et al. 1986). Midwestern populations are often local, disjunct, or absent from areas of seemingly suitable habitat (Evers 1994). Wintering grounds for *D. d. discolor* occur in southern Florida, the West Indies, Central America, and South America, with small numbers wintering in Mexico (American Ornithologist Union 1983). The southern sub-species, *D. d. paludicola*, is found in mangrove habitats along the southeast coast (primarily in Florida) (Robbins 1986) and typically it is non-migratory (American Ornithologist Union 1983).

State distribution: Michigan is on the northern periphery of the prairie warbler's range (Evers 1994). Breeding activity primarily occurs in the Lower Peninsula. Evidence of breeding in the Upper Peninsula has only been documented in Baraga County (i.e. juvenile birds observed) (Evers 1994 and Walkinshaw 1959) and Delta County (Brewer et al. 1991). Most populations and solitary singing males are confined to dune and shoreline habitats along the Lake Michigan coast (Brewer et al. 1991). Largest populations are located in Mason and Benzie counties, and this species is now scarce in the high plains area, where it was once abundant (Evers 1994). Nesting is confirmed in Benzie and Livingston counties; nesting is probable in Cheboygon, Kalkaska, Crawford, Alcona, Mason, Muskegon, Newaygon, Van Buren (Brewer et al. 1991), Allegan, Presque Isle, Alpena, and Berrien counties (Michigan Natural Features Inventory unpublished data 1999); nesting is possible in Delta, Emmet, Leelanau, Oscoda, Wexford, Lapeer, Ottawa, Kalamazoo, Jackson, Cass, and Branch counties (Brewer et al. 1991).

Recognition: The prairie warbler is a medium sized warbler that has yellowish-green upperparts and a bright yellow under-surface. Prominent **black streaks are confined to the flanks** and chestnut colored streaks are apparent (upon close examination) along the back. **Two black streaks are on the head** (one through the eye, and the other along the jaw). Sexual dimorphism is minor with females having less prominent streaking. Immatures look similar to females. The song of the prairie warbler is a **distinctive buzzy song that ascends in scale (e.g., zee, zee, zee, zee zeet)**. Typical songs consist of 8-14 notes. Prairie warblers are also the only yellowish warbler with a characteristic "tail bob" (Evers 1994).

Best survey time: The best time to survey for prairie warblers is from late May through mid-July. This time period is optimal because breeding males readily sing on their territories and are quite conspicuous. A standard survey methodology for this species is to systematically place observation points every ¼ mile throughout suitable

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

habitat. At each observation point an observer listens for 10 minutes and records all birds observed and/or heard within 50 m and beyond 50 m of the survey point (Ralph et al. 1995). Another simple method is to simply walk a transect through suitable habitat during the breeding season (mid-May to mid-July) and record individuals observed and/or heard (Bibby et al. 1992). All surveys should be conducted between sunrise and 10:30 am during good to fair weather conditions (e.g., low winds, dry).

Habitat: The prairie warbler prefers upland scrub-shrub habitats. Optimal breeding habitats are usually associated with poor soils and include brushy dune/lakeshore communities, fallow fields with scattered trees, young jack pine stands, pine plantations (especially Christmas tree plantings), oak clearcuts, and powerline right-of-ways (Ever 1994). Large openings surrounding or containing clumps of shrubs are typical components of breeding habitat. Populations typically exploit sites for short periods of time because preferred breeding habitat (early seral) coincides with rapid structural change in plant structure and composition (Evers 1994).

Biology: This species is a neo-tropical migrant that breeds in Michigan. Breeding in Michigan typically takes place from late May through mid-July. Prairie warblers place their nests in a shrub or sapling, usually 1-10 ft above the ground. The nest is a compact cup of plant fibers, small dead leaves, grasses, bud scales, fern and seed down, and lined with hair and/or feathers. Eggs are typically laid in June and young hatch within 11 – 15 days after eggs have been laid. Typically, 3-5 eggs are produced and are solely incubated by the female. The young are altricial at the time of hatching and are tended by both parents. Most young fledge between 8 –10 days old and remain dependant on the parents for an additional 30 – 35 days after hatching (Baicich and Harrison 1997). The diet of the prairie warbler consists of a variety of small invertebrates. Adults glean insects and spiders from vegetation and young are primarily fed caterpillars (Evers 1994)

Conservation/management: Populations of the prairie warbler have declined nation-wide (Askins 1993) as well as in Michigan (Evers 1994). Globally this species seems secure but populations in the Mid-west are of moderate to high management concern (Robinson et al. 1999). Historically, prairie warblers in Michigan were common in the north-central (i.e., jack pine plains) and southwestern lower peninsula. Currently, Michigan populations are small and disjunct, which results in isolated populations that are forced to be self-sustaining or dependent on the sporadic immigration of individuals into the population. As a result of the diffuse nature of Michigan prairie warbler populations, it is difficult to assess the relative rarity of this species (Evers 1994). Michigan currently supports large areas of apparently suitable habitat (i.e., jack pine plains), however many of these areas remain unoccupied. The reasons for this are not well understood and some researchers have suggested that the habitat requirements of the prairie warbler may be much more specific than anticipated. Conditions on the wintering grounds also might explain declines in Michigan and throughout the Mid-west (Evers 1994). Major threats to the prairie warbler in Michigan are habitat loss and cowbird parasitism, which significantly lowers nesting success. Further, nesting success is significantly hampered due an extremely high rate of nest predation (which effects nearly 80% of all nesting attempts). Typical nest predators include snakes, chipmunks, and blue jays (Nolan 1978).

Management practices that are beneficial to the prairie warbler include prescribed burning, allowing natural succession to proceed in fields, creating large cut-over areas, maintenance of large thickets in agricultural areas, and establishment of pine plantations (Askins 1993). Dune/shoreline habitats should be protected since they often provide excellent habitat for prairie warblers and apparently support viable populations in Michigan (Evers 1994). Before creating early seral habitats for the prairie warbler in a largely forested area, managers should assess the impacts on other species, such as forest interior birds. Extensive tracts of forest should not be fragmented with numerous open areas, since many species are patch size sensitive and cowbird parasitism increases as habitats become more fragmented. Rather, large contiguous blocks of open habitats and forest should be aggregated into separate areas to abate the adverse effects of fragmentation on open-land and forest interior species (Askins 1993, Petit et al. 1995). Prairie warbler management is most likely compatible with Kirtland's warbler management, pine barrens restoration, and regeneration of upland intolerant tree species such as oak, pines, and aspen.

Research needs: A better understanding of the state's distribution and relative abundance/rarity is needed. Further, research conducted on the habitat requirements such as minimum patch size, vegetation structure, and landscape patterns are needed to better manage this species.

Related abstracts: pine barrens, open dunes, wooded dune and swale, Hill's thistle, pale agoseris, rough fescue, Lake Huron tansy, Pitcher's thistle, Houghton's goldenrod, Kirtland's warbler, piping plover

Selected references

American Ornithologists' Union. 1983. Checklist of North American birds. 6th ed. Am. Ornith. Union, Washington, D.C.

Askins, R. 1993. "Population trends in grasslands, shrublands, and forests in North America." In, Current Ornithology: Vol. 11. Power, D.M. (ed.). Plenum Press, New York, NY.

Baicich, P.J. & C.O. Harrison. 1997. A Guide to Nests, Eggs, and Nestlings of North American Birds. Academic Press, New York, NY. 346 pp.

Bibby, C.J., N.D. Burgess, & D.A. Hill. 1992. Bird Census Techniques. Academic Press, New York, NY.

Brewer, R., G.A. McPeek, & R.J. Adams, Jr. 1991. Atlas of Breeding Birds in Michigan. Mich. State Univ. Press, East Lansing, MI. 590 pp.

Evers, D.C. 1994. Endangered and Threatened Wildlife of Michigan. U. of Mich. Press, Ann Arbor, MI. 412 pp.

Michigan Natural Features Inventory. 1999. Biological and conservation data system. Lansing, MI.

Nolan, V., Jr. 1978. The ecology and behavior of the prairie warbler (*Dendroica discolor*). Ornith. Monogr. No. 26. Am. Ornith. Union, Washington, D.C.

Petit, L.J., D.R. Petit, & T.E. Martin. 1995. Landscape-level management of migratory birds: Looking past the trees to see the forest. Wildl. Soc. Bull. 23(3):420-429.

Ralph, C.J., J.R. Sauer, & S. Droege. 1995. Monitoring bird populations by point counts. Gen. Tech. Rep. PSW-GTR-149. USDA - USFS, Pacific Southwest Research Station, Albany, CA. 187 pp.

Robbins, C.S., D. Bystrak, & P.H. Geissler. 1986. The breeding bird survey: Its first fifteen years, 1965-1979. USFWS Resour. Publ. 157 pp.

Robinson, S.K., E.J. Heske, & J.D. Brawn. 1999. Factors affecting the nesting success of edge and shrubland birds. Report submitted to Ill. Dept. of Nat. Heritage, Springfield, IL. 222 pp.

Walkinshaw, L.H. 1959. The prairie warbler in Michigan. Jack Pine Warbler. 37:54-63.

Walkinshaw, L.H. 1983. Kirtland Warbler: The natural history of an endangered species. Cranbrook Inst. Science, Bloomfield Hills, MI.

Walkinshaw, L.H. 1991. "Prairie warbler." In, Atlas of Breeding Birds in Michigan. Brewer, R., G.A. McPeek, and R.J. Adams, Jr. (eds.). Mich. State Univ. Press, East Lansing, MI. 590 pp.

Abstract citation

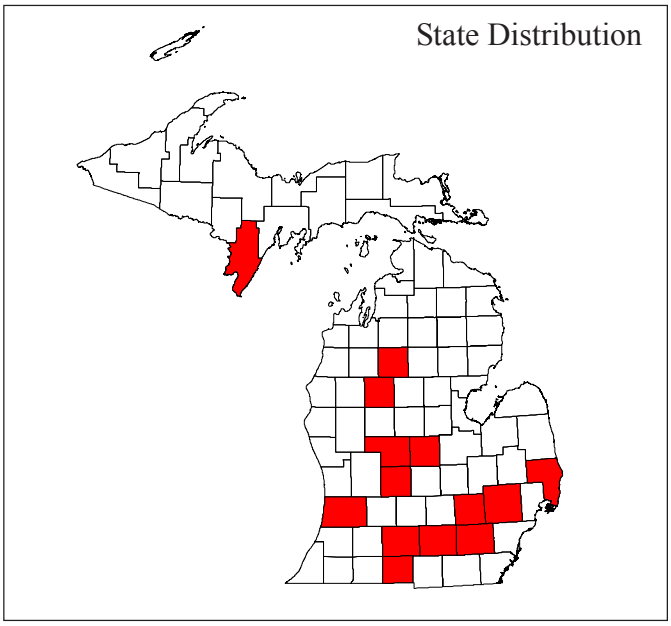
Cooper, J.L. 2000. Special animal abstract for *Dendroica discolor* (prairie warbler). Michigan Natural Features Inventory, Lansing, MI. 3 pp.

Funding for abstract provided by Michigan Department of Natural Resouces - Wildlife Division and Non-Game Program.

1-00/jlc

Ammodramus henslowii Audubon — Henslow's sparrow

Photo by Betty Darling Cottrille
Cornell Lab of Ornithology



Best Survey Period

Status: State threatened

Global and state rank: G4/S2S3

Family: Emberizidae (New World sparrows, towhees)

Total range: Two subspecies are recognized, *A. h. henslowii,* the western form, and *A. h. susurrans,* the eastern form. The western Henslow's sparrow breeds from eastern South Dakota, southern Minnesota through Wisconsin and Michigan into southern Ontario, south to central Kansas, northeastern Oklahoma, central Missouri, Illinois, Kentucky, and central West Virginia. The eastern Henslow's sparrow breeds from northern New York, Vermont, New Hampshire, and northeastern Massachusetts, south to extreme western W. Virginia, eastern Virginia and east-central North Carolina (AOU 1957). Local populations of a possible third subspecies exist in eastern Texas (Brewer et al. 1991).

State distribution: In Michigan, Henslow's sparrows were considered uncommon in the early part of the 1900's. In fact, the first documented record was in 1881 (Brewer et al. 1991). As clearing intensified, Henslow's sparrow populations increased in the southern counties of Michigan. Northward expansion of the species has continued throughout the 20th Century. Upper Peninsula observations were first recorded in 1959 (Dodge 1961). Michigan has Henslow's sparrow records in 14 counties, including Menominee county in the UP (Brewer et al. 1991, Michigan Natural Features Inventory 2001, Ewert 1999). The Nature Conservancy has designated an area near Marion, MI as an Important Bird Area for the Henslow's sparrow. Another location with concentrations of the species is the Allegan State Game Area (Ewert 1999). It should be noted, however, that the species has recently declined dramatically in many southern counties. This decline is due in large part to changes in the amount and suitability of habitat (Brewer et al. 1991).

Recognition: The Henslow's sparrow is among the smallest (4.75-5.25 in.) of sparrows. In adults the sexes are alike. The **large flat head, large gray bill** and **short tail** are characteristic. The **head, nape,** and **most of the central crown stripe are olive-colored**. The **wings are a dark chestnut color**. The **breast is finely streaked** (Smith 1992). The olive head and chestnut wings are diagnostic. Juvenile birds are clay-colored above and streaked with black on the back and head (Roberts 1949). Due to its timid nature, Henslow's sparrows are more likely to be heard than seen. When flushed, birds will often run instead of fly. Even in flight, Henslow's sparrows fly low and quick over the grass in a drooping, zigzag fashion. It has an ordinary, two-syllable song that is quite weak and fine. It is often

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

represented as *tsee-wick* (Roberts 1936).

Best survey time: The best survey time for Henslow's sparrow in Michigan begins during late April and continues through mid-September. Survey time for breeding birds is best between mid-May and late August.

Habitat: Henslow's sparrow is an obligate grassland species. Historically, in the Midwest and Great Plains regions, Henslow's sparrows would breed in tallgrass prairie with some forbs and shrubs. Today, they are restricted to neglected grassy fields, pastures and meadows with a scattered shrub presence, and hayfields with dense cover (Whitney et al. 1978, Johnsgard 1979). They are often found in damp/moist low-lying locations, but can also be found in drier habitats. Regardless of location and type of grassland, the breeding habitat of these birds have several necessary features: tall, dense grass; a well-developed litter layer; standing dead vegetation; available perches; and little to no woody vegetation (Pruitt 1996). Habitat size also is extremely important to Henslow's Sparrows. Herkert (1994) reports that habitat area is the most important factor influencing Henslow's sparrow numbers. They are rarely encountered in grasslands <250 acres in size.

Biology: Henslow's sparrows are short distance migrants with summer and winter ranges within the United States and Canada. Most begin their spring migration north in early March. Interestingly, the earliest arrival dates in Michigan are April 8th in Ann Arbor and April 11th in Battle Creek (Wood 1951). By late April to early May they have reached the breeding range.

Male Henslow's sparrows are in song upon arriving at the breeding grounds (Graber 1968). The species breeds in loose colonies with territories selected by males soon after spring arrival. Individual territories are on average 0.8 acres in size (Robins 1971). The courtship period culminates in a monogamous pair. The female, almost exclusively, builds the nest. Nests are cup-shaped and are made of coarse grass, dead weed leaves and lined with finer grasses and sometimes hair. Material is gathered near the nest site. The nest building process is completed in 4 to 5 days (Graber 1968). Nests are always well concealed and placed near or on the ground located above the base of a dense clump of grass. They are usually attached to stems that arch over the nest creating a partial roof (Graber 1968). In Michigan's southern counties, egg laying starts in mid May (Wood 1951), while in the northern part of the state early June is more likely. Average clutch size for Henslow's sparrows is 3 to 5 eggs, which are incubated by the female only (Smith 1992). The incubation period begins with the last egg laid and lasts approximately 11 days. Young Henslow's sparrows remain in the nest 9-10 days after hatching. The female makes most of the feeding trips during the nestling period, with the nestling diet consisting mainly of grasshopper and butterfly larvae (Robins 1971). Since Henslow's sparrows usually raise two broods during the breeding season, nesting can continue into late August (Hyde 1939).

In Michigan, Henslow's sparrows usually begin southern migration by late September and are usually absent from the state by mid October. Stragglers have been reported as late as October 24th in Jackson County and October 25th in Oakland County (Wood 1951). They return to their wintering locations in the Gulf and Atlantic coast states.

Conservation/management: Henslow's sparrow populations have been declining throughout their range, including drastic declines in the Midwest. Illinois estimates a 94% decline in Henslow's sparrow numbers in the last 40 years (Drilling 1985). The species has been on the National Audubon Society's Blue List since 1974 (Arbib 1979). The U.S. Fish and Wildlife Service has identified Henslow's sparrow as a migratory nongame bird of management concern for Region 3, which includes Michigan (U.S. Fish and Wildlife Service 1987). Henslow's sparrow is now listed as endangered or threatened in 12 states and listed as a special concern species in another four (Pruitt 1996). Michigan now lists the Henslow's sparrow as threatened due to the markedly evident population decline in the state. For example, Kalamazoo County has documented an 80% decline in Henslow's sparrow numbers since surveys began in 1970 (Adams et al. 1981).

The major factor causing Henslow's sparrow population declines is habitat loss (Hands et al. 1989). Changes in agricultural practices, especially in the Midwest, from hay production and grazing to specialized crop production account for a significant portion of this loss in breeding habitat (Drilling 1985). However, other threats

to Henslow's sparrows also contribute to population declines. Urbanization and fragmentation of suitable habitat into smaller and disjunct parcels are affecting populations. Untimely or regular mowing or grazing activity has been shown to reduce population densities too (Herkert 1994). Encroachment or succession by woody vegetation will eventually preclude Henslow's sparrows use of a suitable habitat (Smith 1992). Although tolerance levels to woody vegetation by the species are still inconclusive, estimates of 5% maximum in grassland areas is considered acceptable (Sample and Mossman, 1997). Threats are also present on the wintering grounds. Such threats include reduction or exclusion of fire management practices on southern grasslands, habitat conversion to row crops or plantation, drainage, and urbanization (Pruitt 1996).

Many management options exist to help with Henslow's sparrow population stabilization in Michigan. Three of the most frequently recommended management tools are burning, mowing, and grazing. Periodic burning is necessary to maintain grasslands. However, prescribed burns of Henslow's sparrow habitat should be scheduled in late fall (October and November) in order to keep the burn outside the breeding season (Herkert et al. 1993). Also, entire areas of suitable habitat should not be burned in one season. Henslow's sparrows are usually absent from areas during the first growing season following a fire as leaf litter and herbaceous cover is significantly diminished. Breeding numbers during the second growing season and beyond are consistent with pre-burn densities (Winter 1998). Instead, a rotational burn disturbance regime should be implemented where possible (Zimmerman 1988). Evidence suggests that Henslow's sparrows will nest in hayfields mowed every year (Illinois Natural History Survey 1983), as long as the mowing is done after the breeding season concludes. Grazing is occasionally used as a substitute for mowing. The likelihood of nest, egg, and young destruction by mowing is greatly reduced (Pruitt 1996). However, grazing pressure must be routinely monitored to ensure adequately tall and dense vegetation. Another management recommendation is to provide >75 acres of contiguous grassland if possible. Otherwise, provide a complex of small units located near each other to allow for colonization (Mazur 1996). Removal of encroaching woody vegetation is periodically necessary to prevent conversion of old fields to forest (Drilling 1985). Restriction of insecticide application practices within suitable Henslow's sparrow habitat will protect the prey base (Hands et al. 1989). Finally, incentive programs for landowners involving grassland restoration or maintenance would be beneficial to the continued success of Henslow's sparrows in Michigan (Brewer et al. 1991).

Research needs: Documentation of Henslow's sparrow occurrences, on all existing public and private managed areas, is an extremely high priority. Train land managers to identify the species and recognize suitable Henslow's sparrow habitat. Annual monitoring of all populations in Michigan occurring on preserves must be initiated. Identification and characterization of habitats in Michigan will assist in monitoring projects. Additional study is required to determine site and mate fidelity, annual mortality and reproductive success rates. Studies involving effects of frequency and timing of burns, mowing, and grazing on existing populations is also necessary. Finally, documentation of effects of habitat size and fragmentation on Michigan's Henslow's sparrow population must also be considered (Smith 1992).

Related abstracts: lakeplain wet-mesic prairie, mesic prairie, prairie drop-seed, rough fescue, eastern prairie fringed orchid, grasshopper sparrow, dickcissel, western meadowlark, short-eared owl, northern harrier.

Selected references:

Adams, R., V. Janson, J. Lerg, and D. McWhirter. 1981. Michigan bird watch list. Jack-Pine Warbler 59:123-129.

American Ornithologists' Union (AOU). 1957. Checklist of North American birds. 5th ed. The Lord Baltimore Press, Inc., Baltimore, Maryland. 691pp.

Arbib, R. 1979. The blue list for 1980. Amer. Birds 33:830-835.

Brewer, R., G. A. McPeek, and R. J. Adams Jr., eds. 1991. The Atlas of Breeding Birds of Michigan. Mich. State Univ. Press, East Lansing, MI. 226pp.

Dodge, P. 1961. Birds of the Huron Mountains, Marquette County, Michigan. Jack-Pine Warbler 39:3-33.

Drilling, N. 1985. The Nature Conservancy element stewardship abstract for Henslow's Sparrow. The Nature Conservancy, Midwest Reg. Off., Minneapolis, Minnesota. 8pp.

Ewert, D. 1999. Great Lakes bird ecoregional planning: A final report. Unpubl. Report. Michigan Chapter, The Nature Conservancy. East Lansing, Michigan. 7pp +map and tables.

Graber, J. W. 1968. Passerherbulus henslowii henslowii (Audubon). In Life histories of North American cardinals, grosbeaks, … sparrows and allies, by A. C. Bent et al. (O. L. Austin, Jr., ed.). U.S. Natl. Mus. Bull., 237, Pt. 2:779-788.

Hands, H. M., R. D. Drobney, and M. R. Ryan. 1989. Status report for the Henslow's Sparrow in the northcentral United States. Missouri Cooperative Fish and Wildlife Research Unit, University of Missouri. 12pp.

Herkert, J. R., R. E. Szafoni, V. M. Kleen, and J. E. Schwegman. 1993. Habitat establishment, enhancement and management for forest and grassland birds in Illinois. Illinois Department of Conservation, Division of Natural Heritage, Natural Heritage Technical Publication 1, Springfield, Illinois. 20pp.

Herkert, J. R. 1994. Status and habitat selection of the Henslow's Sparrow in Illinois. Wilson Bulletin. 106(1):35-45.

Hyde, A. S. 1939. The life history of Henslow's Sparrow, Passerherbulus henslowii (Audubon). Univ. Michigan, Mus. Zool., Misc. Publ. No. 41. 72pp.

Illinois Natural History Survey. 1983. The declining grassland species. Illinois Nat. Hist. Surv. Rep. 227:1-2.

Johnsgard, P. A. 1979. Henslow's Sparrow Ammodramus henslowii (Audubon). Pages 469-470 in Birds of the Great Plains: breeding species and their distribution. Univ. of Nebraska Press, Lincoln, Nebraska. 539pp.

Mazur, R. 1996. Implication of field management for Henslow's Sparrow habitat at Saratoga National Historic Park, New York. M.S. thesis. University of New York, Syracuse, New York. 33pp.

Michigan Natural Features Inventory. 2001. Biological and Conservation Data System. Lansing, MI.

Pruitt, L. 1996. Henslow's Sparrow: status assessment. U.S. Fish and Wildl. Serv. Bloomington, Indiana. 113pp.

Roberts, T. S. 1936. The Birds of Minnesota. Univ. of Minnesota Press, Minneapolis, Minnesota. 792pp.

Roberts, T. S. 1949. Manual for the identification of the birds of Minnesota and neighboring states. Univ. of Minnesota Press, Minneapolis, Minnesota. 738pp.

Robins, J. D. 1971. A study of Henslow's Sparrow in Michigan. Wilson Bulletin 83:39-48.

Sample, D. W. and M. J. Mossman. 1997. Managing Habitat for Grassland Birds: A Guide to Wisconsin. Bureau of Integrated Sci. Serv. Dep. of Nat. Res. Madison, Wisconsin. 154pp.

Smith, C. R. 1992. Henslow's Sparrow, Ammodramus henslowii. Pages 315-330 in K. J. Schneider and D. M. Pence, eds. Migratory nongame birds of management concern in the Northeast. U.S. Dep. Inter., Fish and Wildl. Serv., Newton Corner, Massachusetts. 400pp.

U.S. Fish and Wildlife Service. 1987. Migratory nongame birds of management concern in the United States: the 1987 list. U.S. Dep. Inter., Fish and Wildl. Serv., Off. of Mig. Bird Manage., Washington, D.C. 63pp.

Whitney, N. R., B. E. Harrell, B. K. Harris, N. Holden, J. W. Johnson, B. J. Rose, and P. F. Springer. 1978. The birds of South Dakota: an annotated checklist. South Dakota Ornithol. Union, Vermillion, South Dakota. 311pp.

Winter, M. 1998. Nesting biology of dickcissels and Henslow's sparrows in Missouri prairie fragments. Wilson Bulletin 111:515-527.

Wood, N. A. 1951. The Birds of Michigan. Univ. Michigan. Mus. Zool. Misc. Publ. No. 75.

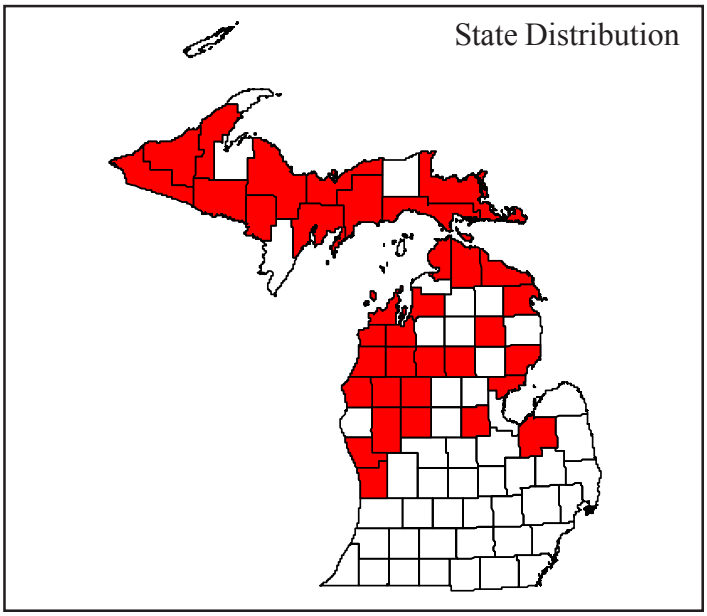
Zimmerman, J. L. 1988. Breeding season habitat selection by the Henslow's Sparrow in Kansas. Wilson Bulletin 100(1):17-24.

Abstract citation:

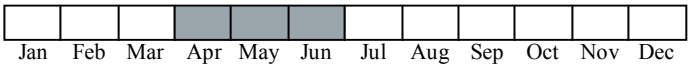
Currier, C. 2001. Special animal abstract for *Ammodramus henslowii* (Henslow's Sparrow). Michigan Natural Features Inventory. Lansing, MI. 4 pp.

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Accipiter gentilis (Linnaeus) northern goshawk



Best Survey Period



Status: State special concern

Global and state rank: G4/S3

Family: Accipitridae (hawk family)

Range: The goshawk breeds from western and central Alaska, northern Yukon, eastern and southern Mackenzie, southern Keewatin, northeastern Manitoba, northern Ontario, eastern Quebec, Labrador, and Newfoundland. Its range extends along the west coast into central California, southern Nevada, southeastern Arizona, and southern New Mexico. In the mid-west it is found from northern Minnesota to central Michigan and eastern populations are found from Pennsylvania and New Jersey northward. Populations extend south along the Appalachian Mountains to Tennessee and North Carolina (Johnsgard 1990).

State distribution: Little is known about the historical distribution of the goshawk in Michigan.

Early accounts indicate that it was found occasionally in the summer and was more common in the north (Gibbs 1879, Cook 1893, Barrows 1912, Brewer et al.1991). During the 1940s breeding records were documented from 7 counties and it was noted that the bird was a local breeder from Roscommon County northward (Brewer et al. 1991). During the 1980s, Breeding Bird Atlas (BBA) surveyors confirmed 73 breeding records documented among 35 counties, mostly in the northern Lower Peninsula (NLP) and Upper Peninsula (UP). Fourteen probable breeding records and 77 possible records were also documented during BBA surveys, most of which were in the NLP and UP (Brewer et al. 1991).

Recognition: The goshawk is a large forest bird with long broad wings and a long tail which is rounded on the end. Females tend to be larger than males. Upperparts of the adult are brown-gray to slate gray. The head has a **black cap** with a pronounced **white eyeline**. Underparts are light gray with fine horizontal vermiculations and vertical streaks. **Undertail coverts are white, showy, and quite fluff**y, especially during the breeding season. **The tail is gray above with numerous broad black bands (3-5)**. The **end of the tail has a rounded tip** which may contain a thin white terminal band. Females look similar to males but are browner above and more coarsely marked below. Immature birds are heavily streaked below and the undertail coverts are spotted. Further, the back on immature birds is heavily mottled, which results in a tawny or buffy appearance. The goshawk may also be identified by its call which is a sharp and **repetitive ki ki ki or kak kak kak**. Also, goshawks disturbed during the nesting stage are very aggressive and have been known to attack humans. Similar species include the cooper's hawk (*Accipiter cooperii*), and the sharp-shinned hawk (*Accipiter striatus*). Both of these species can be distinguished from the goshawk due to their smaller size and lack of a conspicuous white eyeline (Johnsgard 1990).

Best survey time: The best time to survey for active goshawk nests is from late March to early May. The reason this time period is optimal is because nests are more easily observed prior to leaf emergence and pairs become vocal during this time period. A standard survey methodology for this species is to broadcast a goshawk call with a tape recorder in suitable habitat during the breeding season. However, this survey methodology is not always effective.

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Survey routes can be established by utilizing existing roads and trails. Calling stations should be placed at least every 0.5 mi. throughout suitable habitat (Mosher et al. 1990). At each calling station the following sequence can be replicated three times: broadcast goshawk call for 10 seconds in each of the four cardinal directions, followed by 30 seconds of listening (Kennedy et al. 1993).

Productivity surveys (i.e., nestling counts) can be conducted from early to mid-June. A simple method to determine if young were produced by a nesting pair is to re-visit nests during June.

Young can often be viewed from the ground (Kockert 1986) or white wash (i.e., droppings from the young) may be observed below the nest structure, which is evidence that young are present or were recently present in a nest (Postupalsky personal communication 1999).

Habitat: Goshawks prefer large tracts of forest with an intermediate amount of canopy closure, small forest openings for foraging, and an open understory. This species can be found in a variety of forest types such as coniferous stands, deciduous stands, riverine forests, and cultivated conifer stands.

Biology: In Michigan, goshawks are apparently residential but evidently the young will move south in the fall. The goshawk is a highly territorial bird that is thought to maintain pair bonds for life. Typically, goshawks exhibit strong nest site fidelity and may use a nesting area for decades (Ottawa National Forest 1995). Goshawks typically select large deciduous trees to nest in and they usually place nests on horizontal limbs against or quite near the trunk (Johnsgard 1990). Nests are usually placed 40-50 ft. high in a tree with a significant protective canopy above the nest. They construct nests of twigs and sticks and usually decorate the nest with green sprigs. Nest tree species are variable however, birch, maple, and conifers are frequently used (Ottawa National Forest 1995). Nests are usually near a water source and plucking posts (i.e., perches used to pluck feathers or fur from prey) are usually within 50 m of the nest site (Johnsgard 1990).

Eggs are laid in late March or April and the majority of the eggs hatch in May. Goshawks typically produce 2-3 eggs and incubation often lasts for 4-5 weeks. The female is solely responsible for incubation and is fed by the male. Young may fledge from mid-June to mid-July (approximately 35-36 days of age) and remain dependent on their parents until 70-80 days of age (Brewer et al. 1991). The diet of the goshawk is primarily composed of moderate sized birds and mammals. Primary prey items in the Great Lakes Region include ruffed grouse (*Bonasa umbellus*), snow-shoe hare (*Lepus americana*), and the red squirrel (*Tamiasciurus hudsonicus*).

This species hunts primarily by two methods. One is the perch-and-watch technique and the other is searching flights through the forest. They may also make use of vegetation as cover during low ground hunting-flights in order to surprise prey (Johnsgard 1990). Nest productivity and the abundance of active nests has been correlated to prey abundance. Goshawks tend to be more abundant and nests more productive when snowshoe hare and ruffed grouse populations are high. This typically results in ten year population cycles Erdman et al. 1997).

Conservation/management: The primary threat to this species in Michigan is habitat alteration and destruction due to timber harvest (Brewer et al. 1991), road construction (Ottawa National Forest 1995), and residential development. Habitat manipulation directly impacts the species by alteration of suitable structure around the nest site and indirectly by influencing the abundance, distribution, and vulnerability of prey species. Fragmentation of mature forest stands and the creation of larger openings favor the immigration of nest competitors and predators such as the red-tailed hawk (*Buteo jamaicensis*) and great-horned owl (*Bubo virginianus*) (Brewer et al. 1991). These species can either displace a nesting pair or directly depredate young and/or adults from a nest site. Management practices that maintain moderate canopy closure, preserve large trees for nesting, and conserve large contiguous blocks of hardwoods or mixed forest stands should benefit this species. Currently management has focused on maintaining the critical components of individual home ranges such as the nest area, post fledgling area, and foraging area. However, a more proactive and ecologically sound practice, in order to ensure conservation of the species on a long term scale, is to manage large tracts of forest as ecological units. Ecological units should be analyzed and managed across vegetation types and land ownership pattern in order to maintain the array of ecological processes needed for this species (Graham et al. 1994).

Research needs: Numerous research needs exists for the goshawk. In Michigan very little systematic inventory has been completed throughout the state. Inventory is needed to get a sense of distribution patterns across the state. Information is lacking on the productivity and reproductive success of the goshawk and its variability throughout the state. Also, more quantitative research is needed to assess the impacts of forest practices on the birds' abundance and productivity. Other research needs include the impacts of predation and competitors on nesting success, landscape-level analysis of habitat, and analysis of micro-habitat features of the various components of the goshawks home range.

Related abstracts: mesic northern forest, dry-mesic northern forest, red-shouldered hawk, woodland vole, American marten, fasle violet, ginseng, pine-drops, showy orchis.

Selected references

Barrows, W.B. 1912. "Michigan bird life." East Lansing,

MI. Ag. Experiment Station Bulletin. No. 94.

Block, W.M., M.L. Morrison, and M.H. Hildegard. 1994. "Northern goshawk ecology and management". Studies in Avian Biology. No. 16. Cooper Ornith. Society, Sacramento, CA.

Brewer, R., G.A. Mcpeek, and R.J. Adams, Jr. 1991. Atlas of Breeding Birds in Michigan. Michigan State University Press, East Lansing, MI. 590 pp.

Cook, A.J. 1893. Birds of Michigan, 2nd ed. East Lansing, MI. Ag. Experiment Station Bulletin No. 94.

Erdman, T.C., D.F. Brinker, J.P. Jacobs, J. Wilde, and T.O. Meyer. 1997. "Productivity, population, trends, and status of northern goshawks, *Accipiter gentilis atricapillus*, in northeastern Wisconsin." Can. Field Nat. 112:17-27.

Gibbs, M. 1879. "Annotated list of the birds of Michigan." Bulletin of the U.S. Geological and Geographical Survey of the Territories. 5:481-497.

Graham, R.T., R.T. Reynolds, M.H. Reiser, R.L. Bassett, and D.A. Boyce. 1994. "Sustaining forest habitat for the northern goshawk: a question of scale in: northern goshawk ecology and management." W.M. Bock, M.L. Morrison, and M.H. Reiser (eds). Studies in Avian Ecology. No. 16. Cooper Ornith. Society.

Johnsgard, P.A. 1990. Hawks, Eagles, and Falcons of North America. Smithsonian Institution Press, Washington, D.C.

Kennedy, P.L. and D.W. Stahlecker. 1993. "Responsiveness of nesting northern goshawks to taped broadcasts of conspecific calls." J. of Wildlife Mgmt. 57:249-257.

Kochert, M.N. 1986. "Raptors." In Inventory and Monitoring of Wildlife Habitat. A.Y. Cooperrider, R.J. Boyd, and H.R. Stuart (eds.). U.S. Departments of Interior, Bureau of Land Mgmt. Service Center, Denver, CO. 858 pp.

Mosher, J.A., M.R. Fuller, and M. Kopeny. 1990. "Surveying woodland raptors by broadcast of conspecific vocalizations." J. of Field Ornith. 61:453-461.

Ottawa National Forest. 1995. Ottawa National Forest Biologists Consensus Guidelines for Goshawk Management on the Ottawa National Forest. Unpub. manuscript.

Abstract citation

Cooper, J.L. 1999. Special animal abstract for *Accipiter gentilis* (northern goshawk). Michigan Natural Features Inventory, Lansing, MI. 3 pp.

Funding for abstract provided by Michigan Department of Natural Resources - Forest Management Division and Wildlife Division, Non-Game Program.

9-99/jlc

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Picoides arcticus Swainson — black-backed woodpecker

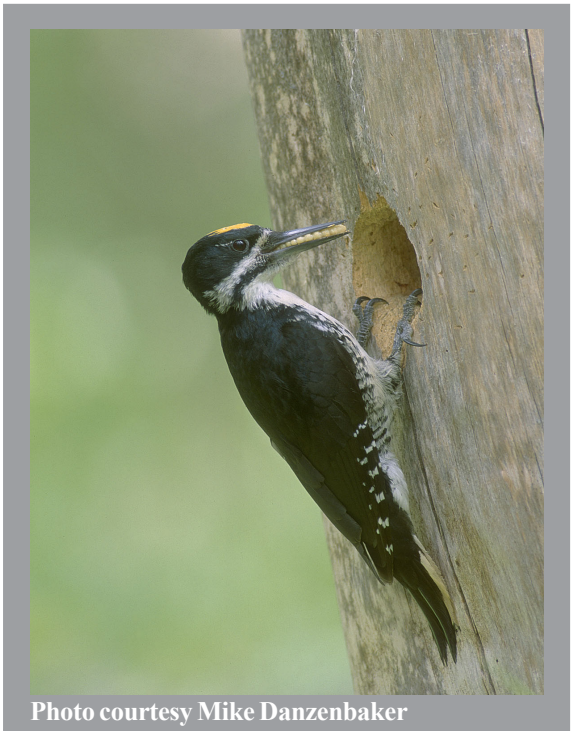
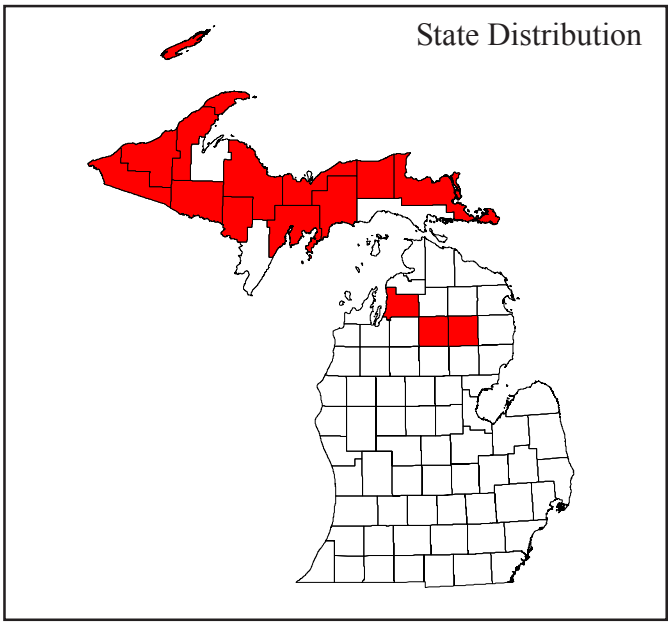
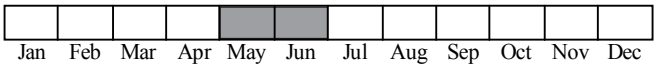


Photo courtesy Mike Danzenbaker



Best Survey Period



Status: Special Concern

Global and state ranks: G5/S2

Family: Picadae (woodpeckerzs)

Total range: Black-backed woodpeckers are year-round residents within boreal and montane forests across northern North America. They breed from central Alaska and northern Canada to montane areas of California and New England. Although the black-backed woodpecker does not migrate south in winter, individuals may move infrequently to areas south of the regular breeding range in response to local insect outbreaks. Movements can vary from a few wandering individuals to irruptions involving many birds. Winter records have occurred as far south as southern Saskatchewan, Iowa, central Illinois, northern Indiana, Ohio, Pennsylvania, West Virginia, New Jersey, and Delaware (Dixon and Saab 2000).

State distribution: A widespread but locally occurring and uncommon species of northern Michigan, the black-backed woodpecker has been confirmed breeding in two Lower Peninsula counties including Crawford and Oscoda. Breeding is probable in Antrim County. Confirmed breeding is known from Alger, Chippewa, Delta, Dickinson, Gogebic, Iron, Marquette and Schoolcraft Counties in the Upper Peninsula. Breeding is probable in Houghton, Keweenaw, Luce and Ontonagon Counties (Evers 1991, Michigan Natural Features Inventory 2002). Winter records of wandering individuals are known south to Kalamazoo and Wayne counties (Wood 1951), although most southern Lower Peninsula observations are prior to the mid 1900s (Zimmerman and Van Tyne 1959). Michigan is at the southern edge of this species range.

Recognition: This relatively large woodpecker has a wingspan of 16 inches and length of 9.5 inches. It is larger than the hairy woodpecker. Black-backed woodpeckers appear large-headed and short-tailed. **Adults** are **all black with a bluish gloss above and a distinct white malar stripe**. The **belly and breast are white** but the **sides and flanks are barred with black**. The **wings are black above with narrow white spot-bars on the primaries**. These spots or bars are reduced or lacking on the secondaries. The **underwing coverts are dusky and barred with white**. The **tail is black in the middle with white outer tail feathers**. The black-backed woodpecker is one of only two woodpecker species with **three toes** (the other species being the three-toed woodpecker, *Picoides tridactylus)*. **Adult males** are distinguished from adult females by their **yellow crown patch**. **Adult females** have an **all black crown**. The **vocalizations**

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

of a black-backed woodpecker are numerous. The call note sounds like **"churt"** or **"kyik"** and is given year-round. The **rattle call** is probably the most distinctive, interesting, and complex call among *Picoides* (Dixon and Saab 2000). In full form the call consists of **three parts: Scream, Rattle, and Snarl**, and it is used as a communication aid in establishing territories. **Drumming is even-paced** and **may drop slightly in volume at the end** (drop not as pronounced as in the three-toed woodpecker) (Stokes et *al*. 1997).

Best survey time: Black-backed woodpeckers are most responsive to tape playbacks of species-specific drumming between May 1 and June 30 (Goggans et *al*. 1988). Barred owl calls may also elicit a response (Huber, pers.com.). Vocalizations and drumming are most readily heard 0.5 hour after sunrise, with a peak about 1-2 hours later. Responses continue throughout the day but are more variable. Just before sunset responsiveness increases, but not to the consistency of morning hours (Goggans et *al*. 1988). The call note is given year-round by both sexes. This bird can be difficult to detect in mature forest stands.

Habitat: The black-backed woodpecker is closely associated with boreal and montane forests, especially where recent burns and windfalls have occurred. In Michigan, it occupies black spruce *(Picea mariana)*-tamarack *(Larix laricina)* bogs, northern white cedar *(Thuja occidentalis)* swamps, mixed forests with eastern hemlock *(Tsuga canadensis)*, jack-pine *(Pinus banksiana)* plains, and conifer clearcuts (Evers 1991). Habitat disturbances which provide a mosaic of openings and an abundance of downed and standing dead timber are preferred foraging areas. Crawford and Oscoda counties contain large expanses of jack pine forest that are regularly disturbed by logging, clearing, and fires to promote suitable habitat for the Kirtland's warbler. These and similar land-use activities have provided habitat to small, disjunct black-backed woodpecker populations (Evers 1991).

Studies suggest there is greater breeding densities in burned than in unburned forests. In a study evaluating bird populations before and after wildfire in a Great Lakes jack pine-black spruce forest, the black-backed woodpecker, which was not present pre-fire, established territories within the first year after the fire and then became one of the three most important species based on importance values (number, distribution and territorial size, and energy required to maintain species) (Apfelbaum and Haney 1981). In Minnesota, birds are more common in trees destroyed by fire 1-2 year post-fire than in mature forests (Heinselman 1973). During the 2-4 year period following a fire, birds were found by Niemi (1978) to increase in abundance, but were rare in non-burned areas surrounding the burned forest. Numbers began declining four years after the fire.

Nesting cavities are drilled in dead or live conifers 3.5 to 15 feet (1.1 to 4.5 m) above ground (Mayfield, 1958, Peck and James 1983). Spruce and pine trees are preferred. Most nest sites overlook openings such as lakes, peatlands, clearcuts, and roads (Evers 1991). Nests are often excavated in sapwood (the outer, softer, living portion of wood), which decays more quickly than heartwood (the inner, hard, nonliving potion of wood). Consequently, this species probably prefers dead conifers for the thicker sapwood layer and small-diameter trees for the higher percentage of sapwood (Bull et *al*. 1986).

Biology: This year-round resident breeds locally in the northern Lower Peninsula and Upper Peninsula. Courtship and nesting are initiated in early to mid-May. Michigan nest records are known from late May to late June (Evers 1991). Both sexes excavate the nest, but the male appears to do most of the work (Short 1974). The nest cavity is constructed in sound or decayed wood. Wood chips are left in the bottom of the cavity (Dixon and Saab 2000). The number of eggs laid (clutch size) varies from two to six, with three or four being most common (Bent 1939, Short 1982). Only one clutch is produced per breeding season, although this species is known to renest if the clutch is lost (Harrison 1978). Both the male and female incubate the eggs for an average of 13 days. The young are altricial and naked at hatching and are tended by both parents. Adults collect insect prey within several hundred meters of the nest (Kilham 1966). Fledging occurs, on average, 24 days after hatching (Baicich and Harrison 1997). Nestlings become aggressive as they develop and sometimes an adult must make several attempts at entering the nest to remove fecal sacs (Short 1974). Typically a new nest cavity is excavated each year (Short 1982).

The diet of the black-backed woodpecker consists mainly of the larvae of wood-boring beetles

(Cerambycidae and Buprestidae) (Bent 1939, Harris 1982, Villard and Beninger 1993, Murphy and Lehnhausen 1998). Engraver beetle larvae (Scolytidae), larvae of the mountain pine beetle *(Dendroctonus ponderosae)*, weevils and other beetles, ants, insects, spiders, vegetable matter, wild fruits, mast, and cambium (Kilham 1965, Goggans et *al*. 1988, Beal 1911) also contribute to the diet. Most foraging takes place on the trunks of dead trees, some of which are standing and some lying on the ground (Mayfield 1958). Pecking is the most common way of obtaining food, followed by gleaning from the tree trunks and then by feeding from the ground (Burt 1930).

This woodpecker does wander from its nesting territory, responding to local insect outbreaks that may require flights covering long distances. Short (1982) attributed irruptions of these woodpeckers to a lack of wood-boring insect prey on their normal range or to overpopulation following an insect outbreak. Irruptions seem to follow a pattern and manifest themselves at irregular intervals involving a several year period and then subside (Yunick 1985).

Conservation/Management: The black-backed woodpecker lives in an environment that is unpredictable and/or ephemeral and its dispersal ability is well developed in order to occupy such a niche (Dixon and Saab 2000). Management for the bird requires large tracts, or patchworks, of habitat that are maintained by fire and other large-scale forest disturbances. Prescribed burning programs of adequate size could improve quality and quantity of invertebrate food resources and nesting sites for the woodpecker. Maintaining viable populations of black-backed woodpeckers will necessitate the delay of salvage logging until several years after a fire.

For successful nesting of black-backed woodpeckers in the lower montane forests of Oregon, Wisdom et *al*. (2000) recommend: 1) conservation of selected forest stands >387 ha (derived from 192 ha / individual and based on home-range size reported by Goggans et al. 1988); 2) where post-fire salvage logging is planned retain snags in clumps rather than evenly spaced distributions and retain >104-123 snags/ha, of dbh size >23 cm; 3) allow wildfires to burn in some forests with high fire risk to produce stand-replacing conditions and subsequent beetle outbreaks; 4) avoid post-fire salvage logging in portions of large burned forests for 5 years after a fire.

North American Breeding Bird Survey (BBS) data for the period 1980-2000 in the Eastern BBS region shows a downward trend of -7.5% (n = 38 routes) for the black-backed woodpecker (Sauer et *al*. 2001). Data are deficient for this species due to limited survey effort and difficulty in detecting the species in mature forest stands. Public lands cannot be expected to provide habitat for all species, thus partnerships to promote sustainable land use practices on private lands would help to maintain habitat for a wide range of species, including those species requiring fire maintained landscapes.

Research needs: Little is known about this species. Because the woodpecker is rare in mature coniferous forests, adequate sample sizes of numbers, productivity, and survival make substantive comparison with populations in recently burned or beetle-killed forests where the species is more abundant, very difficult. Conceptual models of population dynamics may yield the best insights for management of this species in the foreseeable future (Murphy and Lehnhausen 1998).

Detailed studies on movement patterns and demography are recommended in the following areas: 1) movement patterns and demography in green, burned, and unlogged forests, 2) spatial and temporal pattern of stand-replacement fires needed to maintain black-backed woodpecker populations, 3) pre-fire forest structure and post-fire bird communities, and 4) numeric responses of black-backed and three-toed woodpeckers to outbreaks of spruce beetles in the absence of fire.

Related abstracts: dry northern forest, pine barrens, rich conifer swamp, Kirtland's warbler, secretive locust, rough fescue, pale agoseris, Hill's thistle, Alleghany plum.

Selected references:

Apfelbaum, S. and A. Haney. 1981. Bird populations before and after wildfire in a Great Lakes pine forest. Condor 83: 347-354.

Baicich, P. J. and C. J. O. Harrison. 1997. A guide to the Nests, Eggs, and Nestlings of North American Birds. Academic Press, San Diego, CA.

Beal, F. E. L. 1911. Food of the woodpeckers of the United States. U.S. Department of Agriculture. Biological Survey Bulletin 37.

Bent, A. C. 1939. Life histories of North American woodpeckers. U.S. National Museum Bulletin 174.

Bull, E. L., S. R. Peterson, and J. W. Thomas. 1986. Resource partitioning among woodpeckers in northeastern Oregon. U.S. Forest Service Resource Note PNW-444, Portland, OR.

Burt, W. H. 1930. Adaptive modifications in woodpeckers. University of California Publication in Zoology 32: 455-524.

Dixon, R. D. and V. A. Saab. 2000. Black-backed Woodpecker *(Picoides arcticus)*. *In* The Birds of North America, No. 509 (A. Poole and F. Gill, eds). The Birds of North America, Inc., Philadelphia, PA.

Evers, D. C. 1991. "Black-backed Woodpecker" pp. 270-271 *In* The atlas of breeding birds of Michigan. Brewer, R., G. A. McPeek, R. J. Adams, Jr. (eds.). Michigan State University Press, East Lansing, MI. 590 pp.

Goggans, R., R. D. Dixon, and L. C. Seminara. 1988. Habitat use by Three-toed and Black-backed woodpeckers. Oregon Department of Fish and Wildlife. Nongame Report 87-3-02.

Harris, M. A. 1982. Habitat use among woodpeckers in forest burns. Master's thesis, University of Montana, Missoula.

Harrison, C. 1978. A field guide to the nests, eggs, and nestlings of North American birds. Glasgow, Scotland.

Heinselman, M. 1973. Fire in the virgin forests of the boundary waters canoe area. Quaternary Research (New York) 3: 329-382.

Kilham, L. 1965. Differences in feeding behavior of male and female hairy woodpeckers. Wilson Bulletin 77:134-145.

Kilham, L. 1966. Nesting activities of Black-backed Woodpeckers. Condor 68: 308-310.

Mayfield, H. 1958. Nesting of the Black-backed Three-toed Woodpecker in Michigan. Wilson Bulletin 70: 195-196.

Michigan Natural Features Inventory. 2002. Biological and Conservation Data System. Lansing, MI.

Murphy, E. C. and W. A. Lehnhausen. 1998. Density and foraging ecology of woodpeckers following a stand-replacement fire. Journal of Wildlife Management 62: 1359-1372.

Niemi, G. J. 1978. Breeding birds of burned and unburned areas in northern Minnesota. Loon 50: 73-84.

Peck, G. K. and R. D. James. 1983. Breeding birds of Ontario: nidology and distribution. Volume 1. Nonpasserines. Toronto, Royal Ontario Museum, Life Sciences Miscellaneous Publications.

Sauer, J. R., J. E. Hines, and J. Fallon. 2001. The North American Breeding Bird Survey, Results and Analysis 1966 - 2000. Version 2001.2, USGS Patuxent Wildlife Research Center (http://www.pwrc.usgs.gov/), Laurel, MD.

Short, L. L. 1974. Habits and interactions of North American three-toed woodpeckers *(Picoides arcticus* and *Picoides tridactylus)*. American Museum Novit. 2,547: 1-42.

Short, L. L. 1982. Woodpeckers of the world. Delaware Museum of Natural History, Monograph Series no. 4.

Stokes, D., L. Stokes, and L. Elliott. 1997. Stokes Field Guide to Bird Songs. Time Warner AudioBooks, New York, NY.

Villard, P. and C. W. Beninger. 1993. Foraging behavior of male black-backed and hairy woodpeckers in a forest burn. Journal of Field Ornithology 64: 71-76.

Wisdom, M. J., R. S. Holthausen, B. C. Wales, C. D.

Hargis, V. A. Saab, et *al*. 2000. Source habitats for terrestrial vertebrates of focus in the interior Columbia Basin: broad-scale trends and management implications. U.S. Forest Service, General Technical Report, PNW-GTR-485, Portland, OR.

Wood, N. A. 1951. The birds of Michigan. Ann Arbor, University of Michigan Museum of Zoology, Miscellaneous Publication No. 75.

Yunick, R. P. 1985. A review of recent irruptions of the Black-backed Woodpecker and Three-toed Woodpecker in eastern North America. Journal of Field Ornithology 56: 138-152.

Zimmerman, D. A. and J. Van Tyne. 1959. A distributional checklist of the birds of Michigan. Ann Arbor, University of Michigan Museum of Zoology, Occasional Paper No. 608.

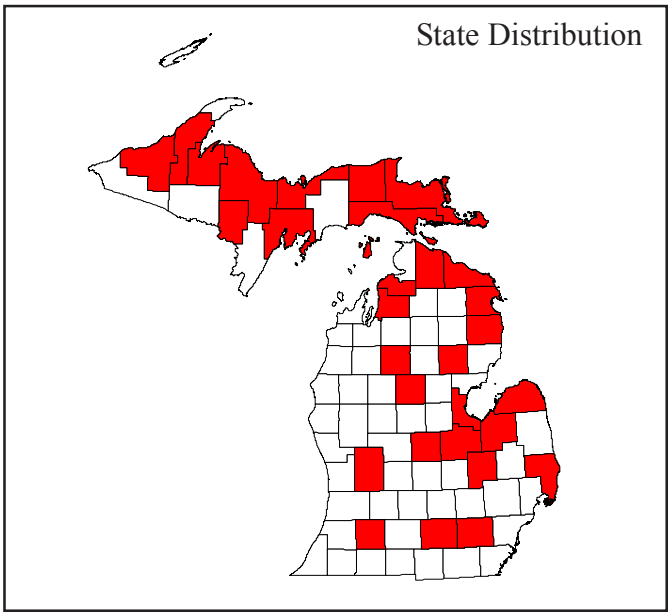
Abstract citation:

Olson, J. A. 2002. Special animal abstract for *Picoides arcticus* (black-backed woodpecker). Michigan Natural Features Inventory, Lansing, MI. 5 pp.

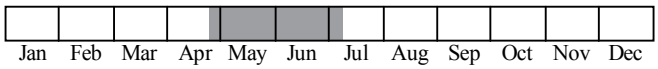
Funding for abstract provided by Michigan Department of Natural Resources – Forest, Mineral and Fire Management Division.

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

Botaurus lentiginosus (Rackett) American Bittern



Best Survey Period



Status: State special concern

Global and state ranks: G4/S3S4

Family: Ardeidae – Herons, Egrets, and Bitterns

Total Range: The American bittern breeds from the mid – U.S. to northern Canada (AOU 1983). Its breeding range runs from British Columbia east to southern Quebec and Newfoundland. Breeding in the U.S. is discontinuous south of Pennsylvania, Ohio, Indiana, Illinois, Missouri, Kansas, Colorado, Utah, Nevada, and California (AOU 1983). Only local breeding is found in Wyoming and surrounding states (Findholt 1984) and in Texas, Louisiana, Florida, and Mexico (Hancock and Kushlan 1984). The winter range includes the west coast from southern British Columbia south through California, the southern U.S. to the east coast, south through Mexico and the Caribbean, and rarely to Central America (AOU 1983). Wintering concentrations occur along the southern Atlantic coast, Gulf Coast, and southern California (Root 1988).

State Distribution: Barrows (1912) commented that the American bittern was one of the most abundant of our waders, and the species was listed as a common summer resident by Wood (1951). Currently, the American bittern breeds throughout the state but is more common in the Upper Peninsula (UP) and northern Lower Peninsula (LP) (Adams 1991). In recent years, breeding has been confirmed or suspected in 30 counties in the state (Adams 1991, Michigan Natural Features Inventory 2003). Michigan Breeding Bird Atlas (Atlas) records of American bitterns were widely scattered, but did reveal concentrations of observations in the northeastern LP and in Jackson, Barry, Van Buren, Oakland, and Tuscola Counties and near Saginaw Bay in the southern LP (Adams 1991). Intensive bird surveys at coastal wetland sites on Saginaw Bay upgraded American bittern breeding status to probable in one township and added a possible breeding record in a second township from what was observed during Atlas surveys (Whitt and Prince 1998). Distribution in the UP was generally more uniform with fewer birds recorded near the lakeshores and in some central counties (Adams 1991). Monfils and Prince (2003) confirmed nesting in coastal wetlands on Munuscong Bay (Chippewa County). Ewert (1999) identified several important bird sites for the American bittern: Houghton Lake marshes (Roscommon and Missaukee Cos.), Lower Manistee River wetlands (Manistee Co.), Seney National Wildlife Refuge (Schoolcraft Co.), Munuscong Bay wetlands, Lake Stella (Alger Co.), and Scott's Marsh (Schoolcraft Co.). The figure above indicates counties with confirmed

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

breeding during Atlas surveys or known occurrences from the Michigan Natural Features Inventory database at the time of writing.

Recognition: This **brown, medium sized heron** is 23 – 33 inches (60 – 85 cm) in length with a **stout body and neck and relatively short legs** (Cramp and Simmons 1977, Hancock and Kushlan 1984). Gibbs et al. (1992) described adults as dark brown above, **heavily streaked brown and white below**, having a rusty crown and white throat, and possessing a **long, black patch extending from below the eye down the side of the neck**, which is a character unique among the herons. American bitterns are sometimes confused with immature black-crowned night-herons (*Nycticorax nycticorax*), which are darker brown, lack the contrast between the dark wingtips and paler coverts and body, and have no black neck patch (Gibbs et al. 1992). Males and females are similar, with the males slightly larger, and juveniles lack the black neck patches. Vernacular names such as "stake-driver" and "thunder-pumper" allude to the resounding call of the American bittern (Gibbs et al. 1992). Previous authors have best described the American bittern's **low, resounding song** as a deep, gulping, pounding **"*BLOONK-Adoonk*"**, which is repeated one to 10 times in succession (Gibbs et al. 1992, Sibley 2000). This species **assumes the "bittern" stance when alarmed** by larger animals: **bill pointed skyward, body stretched vertically, contour feathers compressed, and body swayed with the breeze** (Gibbs et al. 1992).

Best survey time: Because the American bittern is most often concealed in dense herbaceous wetlands, the best time to survey for this species is during the breeding season when it is more apt to call to mark its territory or advertise for a mate. Singing is most often crepuscular and nocturnal, but American bitterns can be heard throughout the day and night early in the breeding season (Gibbs et al. 1992). The best survey period is between their arrival on the breeding grounds and egg laying, which Gibbs et al. (1992) noted is the time when males are most territorial and actively solicit copulations from females. In Michigan, this period ranges from late April to early July depending on latitude. Conspecific call-response techniques have been used successfully to improve the effectiveness of surveys for American bitterns and other waterbirds (Lor and Malecki 2002, Gibbs and Melvin 1993, 1997). Huschle et al. (2002) evaluated a variety of techniques for capturing adult American bitterns, and found mirror traps to be the most efficient method for trapping males and mist nets to be a versatile means of capturing both males and females.

Habitat: American bitterns most often breed in shallow wetlands dominated by tall emergent vegetation, including cattail (*Typha* spp.) marshes, wet meadows, bogs, and shrubby marshes, and occasionally hayfields (Adams 1991). In Maine, American bitterns were observed to use all wetland sizes, but were more abundant on larger wetlands, and preferred impounded and beaver-created wetlands to those of glacial origin (Gibbs et al. 1992). Brown and Dinsmore (1986) only found the species on wetlands > 10 ha, indicating that American bittern may be a wetland area-dependent species. In a study of wet meadows along the northern Lake Huron shoreline, Riffle et al. (2001) found the American bittern to be area-sensitive, with abundance positively related to wet meadow area. When compared to the sympatric least bittern (*Ixobrychus exilis*), the American bittern uses a wider variety of wetland types, less densely vegetated sites, shallower water depths, and exclusively freshwater habitats (Gibbs et al. 1992).

During spring and fall migration, Reid (1989) observed the species using wetlands dominated by river bulrush (*Schoenoplectus fluviatilis*), burreed (*Sparganium eurycarpum*), cattail, and water smartweed (*Polygonum coccineum*) in Missouri. American bitterns winter in areas where temperatures stay above freezing and waters remain open, especially in coastal regions where oceans moderate the climate (Root 1988). Gibbs et al. (1992) noted that although a wider range is used, wintering habitat is similar to breeding habitat. Managed wetlands, such as impoundments at wildlife refuges, are also important to American bitterns (Root 1988). This species will occasionally use brackish coastal marshes (Hancock and Kushlan 1984), and sometimes forage in large numbers in terrestrial habitats such as dry grasslands (Gibbs et al. 1992).

Biology: American bitterns return to southern Michigan during the first two weeks of April and rarely in late March (Wood 1951, Kelley 1978, Walkinshaw 1978), and by late April and early May occur throughout the state (Adams 1991). Adams (1991)

stated that nests are placed on elevated platforms constructed of emergent vegetation, such as cattails, sedges (*Carex* spp.), and grasses (Poaceae), above shallow water or sometimes on land in tall grass. Nests are placed singly, however, males may be polygamous, with several females nesting within a single territory (Baicich and Harrison 1997). Egg dates ranged from May 6 (Wood 1951) to July 11 (Pettingill 1974) and clutch size ranged from 2 to 7, but is typically 3 to 5 (Gibbs et al. 1992). Baicich and Harrison (1997) described the eggs as unmarked and plain buffy brown to deep olive-buff. Incubation is done by the female alone, beginning with the first egg and lasting 24 – 29 days. Although renesting by American bitterns has been suspected, Azure et al. (2000) recently documented renesting for the first time. The young hatch over several days, differ in size, and are semi-altricial with yellowish-olive down at hatching (Baicich and Harrison 1997). Brood rearing and feeding is apparently done by the female alone, and chicks are given partially digested, regurgitated food (Gibbs et al. 1992). Gibbs et al. (1992) stated that the young leave the nest after one to two weeks, but remain near the nest to receive supplemental feedings until two to four weeks of age. Age at fledging is unknown, but occurs at 50 to 55 days in the similar Eurasian bittern (*Botaurus stellaris*) (Gibbs et al. 1992). Little information is available on departure dates, but fall migration is thought to begin in September and continue well into October (Wood 1951, Kelley 1978, Adams 1979). This bittern is a solitary feeder that is most active during dim light and relies on stealth to capture its prey (Gibbs et al. 1992). Kushlan (1978) noted that only four of the recognized heron feeding behaviors are used by this species: standing in place, neck swaying, walking slowly, and walking quickly. Analysis of American bittern specimens collected throughout North America revealed an array of food items, including insects (23%), fish (21%), crayfish (19%), frogs and salamanders (21%), small mammals (10%), and snakes (5%) (Cottam and Uhler 1945).

Conservation/Management: Although North American Breeding Bird Survey (BBS) data should be viewed with caution, they can be useful in elucidating trends in bird populations. Recent analyses of BBS data indicate significant ($P<0.01$) declines in American bittern observations of 14.3 and 5.7 percent/year in the Great Lakes Plain (includes southern Michigan) and Great Lakes Transition (includes northern Lower Michigan) physiographic regions, respectively (Sauer et al. 2003). Adams (1991) noted that the results of Atlas surveys confirmed that American bittern had declined in the State, especially in the southern Lower Peninsula. Habitat loss is cited most often as the likely cause of American bittern declines. Dahl (2000) estimated that less than half of the original wetlands present in the conterminous U.S. at the time of European settlement remain today. Approximately 50% of Michigan's original wetlands have been destroyed since European settlement, which includes about 70% of the State's coastal wetlands (Cwikiel 1998). Many of our remaining wetlands have been severely degraded from their original condition. Gibbs et al. (1992) noted that eutrophication, siltation, chemical contamination, and human disturbance can reduce habitat quality by impacting the prey base. The spread of exotic and nuisance species, such as purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), and common reed (*Phragmites australis*), has also degraded wetlands used by this species, but the overall impact of these changes has not been evaluated. Acid precipitation has been listed as a potential threat to American bitterns due to their dependence on wetlands vulnerable to acidification, the importance of amphibians to their diet, and the large proportion of their breeding range that receives acid rain; however, the emergent wetlands used by this species tend to be circumneutral in pH and chemically buffered against strong shifts in acidity (Gibbs et al. 1992). Although the effects of contamination on American bitterns are largely unknown, Gibbs et al. (1992) believe that agricultural chemicals could have significant indirect effects on the species by entering wetlands through runoff. Should prey items that are vulnerable to pesticides, such as aquatic insects, crayfish, and amphibians, be impacted by contamination, American bittern populations could in turn suffer (Gibbs et al. 1992).

Gibbs et al. (1992) stated that preservation of freshwater wetlands, especially large shallow wetlands with dense growth of robust emergent vegetation, is the most urgent management need for this species. Programs that provide funds for wetland restoration and protection on private and public lands can effectively conserve habitat for this species and need to continue. Such initiatives include Farm Bill programs like the

Wetlands Reserve Program and Conservation Reserve Program, and the North American Waterfowl Management Plan, which uses funding appropriated through the North American Wetlands Conservation Act. Existing wetlands also need to be protected from chemical contamination, siltation, eutrophication, and other forms of pollution that could harm the birds or their prey (Gibbs et al. 1992). Encouraging best management practices, such as filter strips, no-till farming, and conservation tillage, in surrounding watersheds would help protect priority habitats from pollution. Gibbs et al. (1992) also noted that concentrations of nesting and wintering birds on protected and managed wetlands, such as state and federal wildlife areas and refuges, indicate the need to develop and implement management plans that benefit American bitterns.

Research needs: Previous authors have noted that much about the basic biology and ecology of this species remains unknown (Gibbs et al. 1992, Hands et al. 1989). Although survey methodologies have been developed to monitor populations of American bittern and other waterbirds (Lor and Malecki 2002, Gibbs and Melvin 1993, 1997), no large scale surveys or monitoring programs have been implemented. Such surveys are needed to assess the status and trends of this species in North America. Gibbs et al. (1992) indicated that detailed studies of American bittern breeding biology have been lacking, including investigations of diet, home range, habitat requirements, mating systems, ability to renest, sources and rates of mortality in adults, juveniles, nestlings, and eggs, and juvenile dispersal patterns and philopatry. Little work has been done during the migration and wintering periods of this species' life cycle. Research is needed to identify migration routes, major stopover and wintering sites, food habits, and habitat needs (Gibbs et al. 1992, Hands et al. 1989). Several authors have highlighted the need to develop effective strategies for wetland and associated upland management that will conserve habitat for this species during breeding, migration, and wintering (Gibbs et al. 1992, Adams 1991, Hands et al. 1989). A variety of other topics should be explored, including the examination of factors that regulate populations, impact of weather on populations, and the effects of chemical contamination (Gibbs et al. 1992, Adams 1991, Hands et al. 1989).

Related abstracts: least bittern, king rail, black tern, Great Lakes marsh.

Selected references:

Adams, R.J., Jr. 1979. Seasonal distribution and abundance of birds in the Kalamazoo, Michigan area. Jack-Pine Warbler. 57:91-105.

_____. 1991. Species account for American bittern (*Botaurus lentiginosus*). Pages 104-105 *In* The Atlas of Breeding Birds in Michigan. Brewer, R., G. A. McPeek, and R.J. Adams, Jr. (eds). Michigan State University Press, East Lansing, MI.

American Ornithologists' Union. 1983. Check-list of North American birds. 6th ed. American Ornithologists' Union, Washington, DC.

Azure, D.A., W.L. Brininger, J.E. Toepfer, G. Huschle, and R.D. Crawford. 2000. First described renesting attempt by and American bittern. Wilson Bulletin 112(2):271-273.

Baicich, P.J., and C.J.O. Harrison. 1997. A guide to the nests, eggs, and nestlings of North American birds. Second Edition. Natural World, Academic Press, San Diego, CA.

Barrows, W.B. 1912. Michigan bird life. Michigan Agricultural Experiment Station Bulletin No. 94. East Lansing, MI.

Brown, M. and J.J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. Journal of Wildlife Management 50:392-397.

Cottam, C. and F.M. Uhler. 1945. Birds in relation to fishes. U.S. Fish and Wildlife Service Leaflet 272.

Cramp, S. and K. Simmons. 1977. Handbook of the birds of Europe, the Middle East, and North Africa: the birds of the western Palearctic. Vol. 1. Oxford Univ. Press, Oxford, England.

Cwikiel, W. 1998. Living with Michigan's wetlands: a landowner's guide. Tip of the Mitt Watershed Council, Conway, MI.

Dahl, T.E. 2000. Status and trends of wetlands in the conterminous United States 1986 to 1997. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Ewert, D. 1999. Great Lakes bird ecoregional planning: A final report. Unpubl. Report. Michigan Chapter, The Nature Conservancy. East Lansing, MI.

Findholt, S.C. 1984. Status and distribution of herons, egrets, ibis, and related species in Wyoming. Colonial Waterbirds 7:55-62.

Gibbs, J.P. and S. Melvin. 1993. Call-response surveys for monitoring waterbirds. Journal of Wildlife Management 57(1):27-34.

_____ and _____. 1997. Power to detect trends in waterbird abundance with call-response surveys. Journal of Wildlife Management 61(4):1262-1267.

_____, _____, and F.A. Reid. 1992. American bittern. *In* The Birds of North America, No. 18 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Hancock, J., and J. Kushlan. 1984. The herons handbook. Croom Helm, Ltd. Kent, England.

Hands, H.M., R.D. Drobney, and M.R. Ryan. 1989. Status of the American bittern in the northcentral United States. Rep. to the U.S. Fish and Wildlife Service, Federal Bldg., Fort Snelling, Twin Cities, MN.

Huschle, G., J.E. Toepfer, W.L. Brininger, and D.A. Azure. 2002. Capturing adult American bitterns. Waterbirds 25(4):505-508.

Kelly, A.H. 1978. Birds of southeastern Michigan and southwestern Ontario. Cranbrook Institute of Science, Bloomfield Hills, MI.

Kushlan, J.A. 1978. Feeding ecology of wading birds. Pages 249-297 In Wading Birds (Sprunt et al., eds.). National Audubon Society Research Report No. 7, New York, NY.

Lor, S. and R.A. Malecki. 2002. Call-response surveys to monitor marsh bird population trends. Wildlife Society Bulletin 30(4):1195-1201.

Michigan Natural Features Inventory. 2003. Biological and conservation database (Biotics). Lansing. MI.

Monfils, M.J., and H.H. Prince. 2003. Breeding bird use of wetlands in eastern Chippewa County, Michigan. Michigan Birds and Natural History 10(1):1-8.

Pettengill, O.S., Jr. 1974. Ornithology at the University of Michigan Biological Station and the birds of the region. Kalamazoo Nature Center, Kalamazoo, MI.

Reid, F.A. 1989. Differential habitat use by waterbirds in a managed wetland complex. Ph.D. Dissertation, University of Missouri, Columbia, MO.

Riffell, S.K., B.E. Keas, and T.M. Burton. 2001. Area and habitat relationships of birds in Great Lakes coastal wet meadows. Wetlands 21(4):492-507.

Root, T. 1988. Atlas of wintering North American birds, an analysis of Christmas Bird Count data. Univ. of Chicago Press, Chicago, IL.

Sauer, J. R., J. E. Hines, and J. Fallon. 2003. The North American Breeding Bird Survey, Results and Analysis 1966 - 2002. Version 2003.1, USGS Patuxent Wildlife Research Center, Laurel, MD.

Sibley, D.A. 2000. National Audubon Society: the Sibley guide to birds. Alfred A. Knopf, New York, NY.

Walkinshaw, L.H. 1978. Birds of the Battle Creek, Calhoun, Michigan area. University Microfilms International, Ann Arbor, MI.

Whitt, M.B., and H.H. Prince. 1998. The breeding status of least bittern (*Ixobrychus exilis*) and American bittern (*Botaurus lentiginosus*) in Saginaw Bay coastal wetlands. Michigan Birds and Natural History 5(1):1-7.

Wood, N.A. 1951. The Birds of Michigan. University of Michigan, Museum of Zoology Miscellaneous Publication No. 75.

Abstract citation:

Monfils, M.J. 2004. Special animal abstract for *Botaurus lentiginosus* (American bittern). Michigan Natural Features Inventory, Lansing, MI. 6 pp.

Funding provided by the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center via the Great Lakes Commission.

Papaipema beeriana Bird — blazing star borer

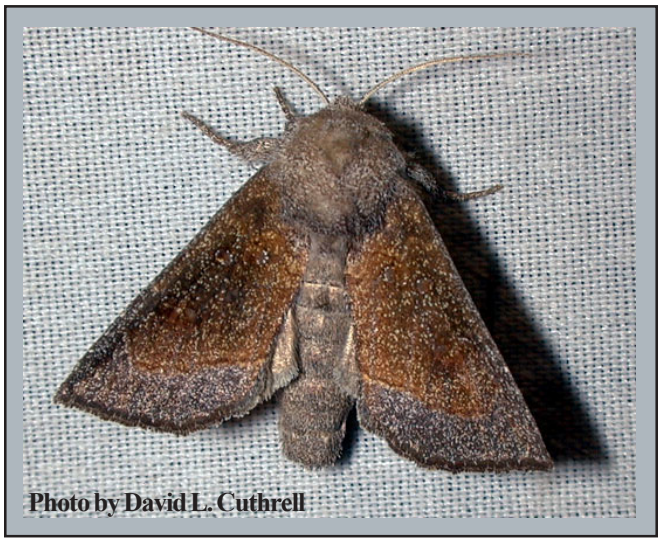
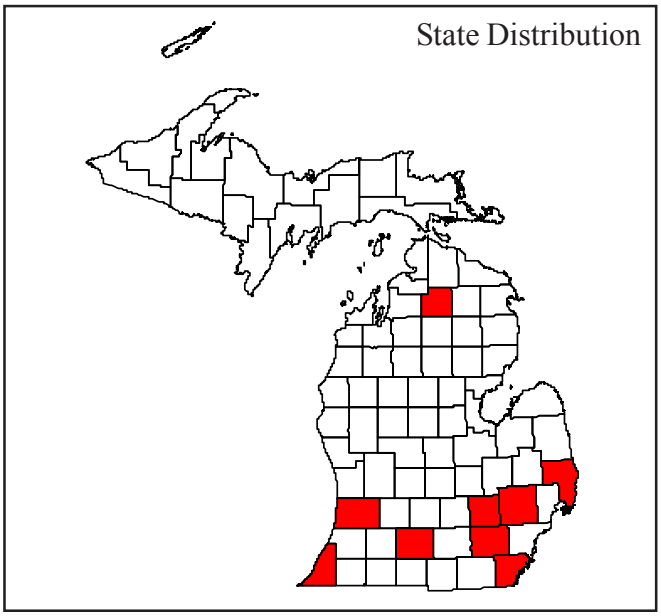
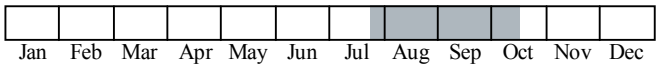


Photo by David L. Cuthrell



Best Survey Period



Status: State special concern

Global and state rank: G3/S1S2

Family: Noctuidae (owlet moths)

Range: The blazing star borer occurs as a series of disjunct populations throughout the midwestern United States having been recorded from the following states: Iowa, Illinois, Indiana, Ohio, Wisconsin, and Michigan.

State distribution: The blazing star borer is known from less than 12 sites in Michigan and has been reported from ten counties. It has been collected from several southern counties (Allegan, Berrien, Calhoun, Washtenaw, Monroe, Livingston, Oakland, and St. Clair) and one county in the northern lower peninsula (Otsego).

Recognition: This moth, in the family Noctuidae, has a wing-span of 31-36 mm (1.2-1.5 in). It has two color forms, both spotted and unspotted. **The unspotted form has forewings which are dull brownish, frosted with whitish scale-bases, and with scattered white scales**; markings practically absent or very faint (Forbes 1954). The hing wings are a paler and more uniform gray. **The spotted form, *lacinariae* Bird, has forewings similar to the unspotted form with the exception of white spots** (Forbes 1954). Many species of *Papaipema* are difficult to identify but most can be sorted into species groups (Rings et al. 1992). These species groups can then be sent to experts for positive identification. Series (5 to 10 individuals from the same location) of specimens are easier to work with because of the large amount of individual variation. In addition, many field-collected specimens can be quite worn (many of the scales missing) giving the specimen a lighter appearance than normal, or eliminating many of the scale characteristics important for identification. To add to the confusion some species, like the blazing star borer, have spotted and unspotted forms, both of which are sympatric (occur at the same location at the same time).

Best survey time: The blazing star borer is a late-season flier with Michigan adult capture dates ranging from 13 September through 5 October. The best way to survey for this species is by blacklighting, a technique where a sheet is stretched across two trees or poles and an ultraviolet light is used to attract moths to the sheet. Moths can be collected directly from the sheet. You also can search for the larvae of many species of *Papaipema* by searching for signs of feeding activity in late July or early August. This includes inspecting blazing star (*Liatris* spp.) plants that are wilted or otherwise stunted, for a small hole near the base of the plant and a pile of frass (caterpillar feces) near this opening. Often times you can see the pile of frass at the base of the plant and then locate the hole in the stem.

Habitat: The blazing star borer occurs with its larval host plant, blazing star or snakeroot (*Liatris* spp.) In Michigan the species has been recorded from a variety of plant communities crossing gradients from wet to dry including lakeplain prairies, prairie fens, and sand prairie or barrens. Many Michigan sites represent only small parcels of what was once widespread habitat. At

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

known sites associated prairie plants typically include big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), common mountain mint (*Pycanthemum virginianum*), tall coreopsis (*Coreopsis tripteris*), Ohio goldenrod (*Solidago ohioensis*), Culver's root (*Veronicastrum virginicum*), and switch grass (*Panicum virgatum*).

Biology: Eggs are laid on or near the food plant in the fall and hatch in the spring around mid-May (Bird 1923). Larvae can be found in the root and lower stem of the host plant in most years from 14 July-7 August. Feeding and tunneling in the root causes the plants to wilt and the leaves can turn brown at the tips. The final instar leaves the root and pupates in the soil near the plant. Pupae can be found from 10 August until the adult flight times of 13 September through 5 October. *Papaipema* moths as a whole fly late in the season, usually late August through October. There is also limited data that suggest prairie *Papaipema* moths are active late in the evening (actually early morning hours) (Schweitzer 1999). Based on our blacklighting observations in southern Michigan, *beeriana* is active for a short period of time beginning around 2300 and ending near 2400 hours EST. Several factors need to be considered including ambient temperatures, humidity levels, precipitation, wind, and moon phase; all of which affect moth behavior. Major natural enemies of *Papaipema* include mammals such as rodents and skunks (Hessel 1954, Decker 1931, Schweitzer 1999), woodpeckers (Decker 1930) as well as numerous parasitoids and predatory insects. Small mammals in some cases can completely eradicate small populations (Hessel 1954). A tachinid fly, *Masicera senilis*, and a braconid wasp, *Apanteles papaipemae*, are probably the most important parasitoids of *Papaipema* (Decker 1930).

Conservation/management: Protection of known populations is essential to protect this species in Michigan. Almost all major workers on the genus have commented on the fire sensitivity of *Papaipema* eggs, and Decker (1930) highly recommends use of fire to control the pest species *P. nebris*. Land managers should heed Dana's (1986) general advice and always assume high mortality of *Papaipema* eggs in fall, winter, or spring burn units. To protect *Papaipema* populations, Schweitzer (1999) recommends protecting an adequate amount of the foodplant and to divide habitat into smaller burn units. No *Papaipema* site should ever be entirely burned in a single year. Foodplants spread over a large area or in several discrete patches reduce the risk from predators and parasitoids as compared to a comparable number of plants in a single dense patch. Most, if not all, of these parasitoids are native species and in most cases they do not need to be controlled. All known sites of *beeriana* on managed lands should be monitored periodically. There is no information to suggest how often this should be done and likely these surveys will be at the level of presence/absence, either of larvae or adults. Schweitzer does believe one could quantitatively sample larvae (or at least larval burrows) to estimate the actual size of a population. Monitoring is especially critical when planning to implement prescribed burns. Keep in mind that distribution of the *Papaipema* population among the various burn units will probably vary from year to year, so current information is needed. Generally decisions will be made on information from the previous growing season, since this is the best information on the distribution of *P. beeriana* eggs within a site.

Research needs: Major research needs, as outlined by Schweitzer (1999), include information on habitat requirements other than foodplants, on conditions under which females disperse, and on presence or absence of *Papaipema* on prairie preserves and other fire managed habitats. The latter is needed before dormant season burn regimens are implemented. Any information on speed of recolonization after prescribed burns would be useful. It would be important to try and document how recovery occurred, i.e., from other burn units, from outside the managed area, from skips in the burn, or from very wet microhabitats. More actual information on survival of *Papaipema* in mid or late summer burns is needed. More precise information as to what date *Papaipema* larvae have moved below ground is needed. This information can be used to better time burns, conduct mowing, or schedule grazing rotations. Information is needed to determine whether adults can locate suitable places for oviposition in foodplant patches burned or grazed earlier in the same season. For example, can adults (which typically occur October 1) find places to lay eggs in habitats burned in July or August. Information on how high eggs are placed on the host plant is needed so that the potential suitability of mowing as a management option can be evaluated.

Related abstracts: lakeplain prairie, prairie fen, pine barrens, culver's root borer moth

Selected references

Bird, H. 1923. New life histories, species and varieties in *Papaipema* (Lepidoptera) No. 22. Canad. Entom. 55:106-07.

Dana, R. 1986. "The Dakota skipper: A now rare prairie butterfly". Nat. Areas J. 3:31-34.

Decker, G.C. 1930. Corn-boring insects of Iowa with special reference to the stalk borer, *Papaipema nebris* (Gn.) and the four-lined borer, *Luperina stipata* (Morr.). Ph.D. Dissertation. Iowa State University, Ames. 174 pp.

Decker, G.C. 1931. The biology of the stalk borer,

Papaipema nebris (Gn.). Iowa Coll. Agric, Expt. Sta. Re. Bull. 143:289-351.

Forbes, W.T. 1954. The Lepidoptera of New York and Neighboring States. Noctuidae, part III. Memoir 329. Cornell Univ. Ag. Exp. Station. 433 pp.

Hessel, S.A. 1954. A guide to collecting the plant-boring larvae of the genus *Papaipema* (Noctuidae). Lepid. News 8:57-63.

Rings, R.W., E.H. Metzler, F.J. Arnold, and D.H. Harris. 1992 The owlet moths of Ohio Order Lepidoptera Family Noctuidae. Ohio Biol. Surv. Bull. New Series Vol. 9, No. 2. vi + 219 pp. (includes 16 pls).

Schweitzer, D. 1999. Draft copy of Element stewardship abstract for *Papaipema* moths. The Nature Conservancy, Arlington, VA. 21 pp.

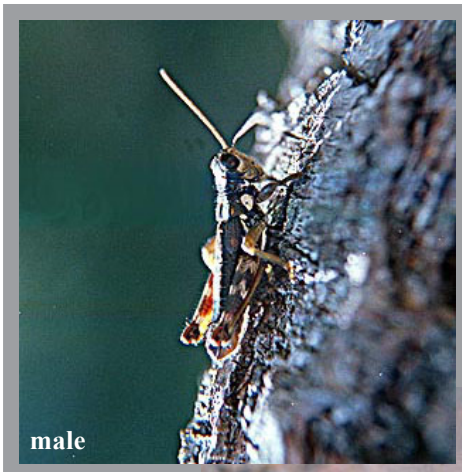
Abstract citation

Cuthrell, D.L. 1999. Special animal abstract for *Papaipema beeriana* (blazing star borer). Michigan Natural Features Inventory, Lansing, MI. 3 pp.

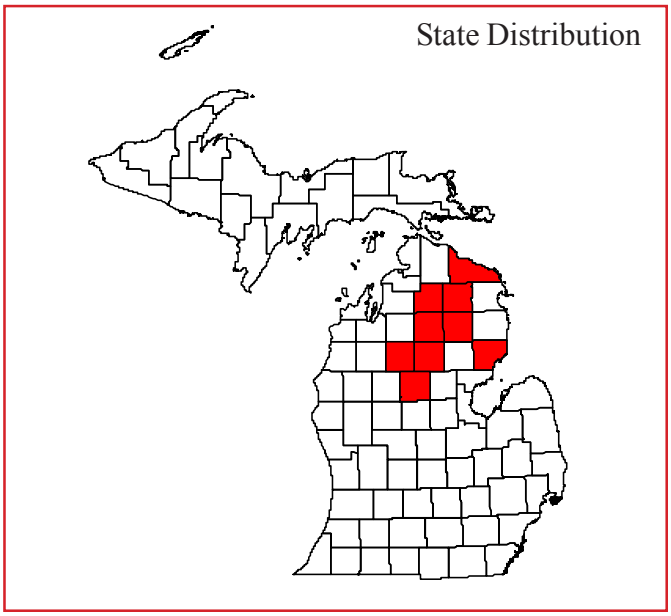
Funding for abstract provided by Michigan Department of Natural Resources - Wildlife Division and Non-Game Program.

12-99/dlc

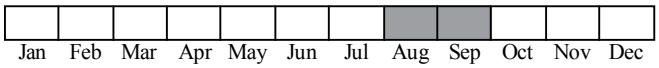
Appalachia arcana (Hubbell and Cantrall) secretive locust



Photos By
David L. Cuthrell



Best Survey Period



Status: State special concern

Global and state rank: G2G3/S2S3

Other common names: Michigan bog grasshopper

Family: Acrididae (short-horned grasshopper)

Range: *Appalachia arcana* is endemic to the northern half of Michigan's lower peninsula (Vickery & Kevan 1985).

State distribution: This species has been collected from 9 Michigan counties; records for 2 of these (Iosco, Missaukee) are known only from the late 1930s or early 1940s.

Recognition: The secretive locust is a relatively small, short-winged grasshopper which does not have the ability to sing or fly. Two field characteristics will confirm a specimen as *Appalachia arcana*. In both sexes, the **undersides of the hind femora are bright red** and the **tegmina (forewings) are reduced to small pads held almost laterally along the body**. *Booneacris glacialis canadensis* (northern wingless locust) can occur in the same habitats at the same time of year, but has yellowish-green on the underside of the hind femora and lacks wings entirely. Female *Booneacris* have a deep olive cast to their bodies with white or bright pink spots on the pronotum (neck) and elsewhere, while the males are significantly smaller, less olive, and more deeply lime green in color. It is critical to check for these characteristics, because these two species are quite similar in appearance (Higman et al. 1994). *Appalachia arcana* **males range in length from 17-19 mm (0.7-0.8 inches) and females from 24-30 mm (1.0-1.2 inches)**. **Males** are brownish gray in color and have a **conspicuous broad pale stripe dorsally**, with contrasting lateral black stripes extending from the head almost to the end of the abdomen. Females are more subtle shades of brown and lack the prominent striping of the males. The **hind femora** of both sexes are **prominently striped laterally with alternating light and dark brown bands**. Though the male's coloration is more noticeable, both sexes can be quite cryptic and difficult to see against the bark of trees and shrubs.

Best survey time: Adults have been observed from early July until November, though typically they are found between August and September. They are most easily seen in the mid-mornings and early evenings when activity peaks.

Habitat: The habitat of this insect may not be fully known. Hubbell and Cantrall (1938) suggest that it may occur in almost any habitat that is shrubby yet open enough for full sunlight exposure through large parts of the day. However, the species is best known from bogs where leatherleaf (*Chamaedaphne calyculata*) and Labrador tea (*Ledum groenlandicum*) typically occur in dense stands underlain by deep, hummocky sphagmum. These bogs often are surrounded by stands of jack pine (*Pinus banksiana*) and some tamarack (*Larix larcina*) which may encroach along the margins of the bog. The species also has been documented on bracken fern

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909
Phone: 517-373-1552

(*Pteridium aquilinum* var. *latiusculum*) and sweetfern (*Comptonia peregrina*) in open groves of aspen and pines (Vickery and Kevan 1985), in early shrub thicket stages of second-growth hardwood forests, in shrubby undergrowth in jack pine barrens (Hubbell and Cantrall 1938), and in northern wet prairies and intermittent wetlands (Higman et al. 1994).

Biology: The best source for life history and ecological data remains Hubbell and Cantrall's species description (1938). As the common name implies, the species is secretive and may only be detected where it is abundant. Hubbell and Cantrall (1938) observed that this insect spends most of the day sunning itself, shifting its position to follow the path of the sun and moving to the undersides of twigs and branches or on the trunks of trees for the night. Males are most commonly observed sunning themselves on the branches of leatherleaf or on the trunks and branches of jack pine and tamarack (Vickery & Kevan 1985). They tend to remain motionless, largely hidden by their cryptic coloration. When they do move, they appear jerky and nervous, leaping two to three times in a rapid zigzag fashion down the tree. If they reach the ground, they may burrow into moss or plant debris. Females typically remain hidden closer to the soil surface.
Mating has been observed in the field in mid to late September, usually on trunks of trees over 5-6' tall (H. Ballard 1989 pers. comm.). Hubbell and Cantrall (1938) noted that pairs have been observed to remain in copula for up to twelve hours. During oviposition, which has only been observed in captivity, eggs were laid on twigs rather than in the soil, and were suspended in a frothy material which hardened into brown globose masses from 8-12 mm in diameter. In the wild, it is thought that the eggs are laid in the soil of surrounding uplands rather than in sphagnum, and that the early instars (immature stages) later migrate to bogs from their margins (Hubbell & Cantrall 1938). Ballard (1995 pers. comm.) suggested that this orthopteran may be more of an arboreal species than a ground-dweller, since most of the individuals he observed were found in the shrubs and trees. He pointed out that oviposition may in fact take place on the branches of shrubs rather than in the soil of adjacent uplands. The secretive locust is univoltine (one generation each year), overwintering in the egg stage. The eggs presumably hatch in early summer.

Conservation/management: The secretive locust may occur in locations affected by gypsy moth defoliation, but the species (like all grasshoppers) is immune to the type of *Bacillus thuringiensis* (Bt) used to control the gypsy moth. They are, however, adversely impacted by Dimilin, a regulated pesticide for restricted use, that is sometimes used by private landowners and which affects growth in orthopterans. The locust also could be affected by development, road construction, and logging at occupied sites. Uncut buffer areas around bogs/wetlands may be necessary to protect oviposition sites. Because habitat needs are unclear, the maintenance of a mosaic of suitable upland and wetland habitats in their natural state is prudent until further research more clearly defines specific habitat requirements.

Research needs: Life history studies are needed to determine oviposition sites, dispersal mechanisms, and other special habitat needs. Field surveys would help determine distribution and abundance. The effects of timber harvest at different intensities, as well as conversion of upland forest to red pine, should be examined. The effects of prescribed burning in nearby habitats on potential oviposition sites, food plants, and recolonization efforts should be assessed. Intensive monitoring from June through October at a number of known sites could provide invaluable information about this species. Mark-recapture studies should be conducted to better estimate population size at several known sites. Studies should be designed to evaluate the degree of habitat fragmentation and isolation tolerated by the secretive locust.

Related abstracts: pine barrens, bog, intermittant wetland, pale agoseris, rough fescue, Kirtland's warbler

Selected references:

Higman, P.J., P.J. Comer, M.R. Penskar, M.L. Rabe, D.A. Albert, J.T. Legge, T.R. Leibfreid, L.J. Scrimger, and M.B. Austin. 1994. Final report for a floristic and natural features inventory of Camp Grayling Military Reservation, Grayling, MI. MDNR - Wildlife Division, Michigan Natural Features Inventory, Lansing, MI. 112 pp.

Hubbell, T.H. and I.J. Cantrall. 1938. A new species of *Appalachia* from Michigan (Orthoptera, Acrididae, Cyrtacanthracridinae). Occ. Pap. of the Mus.of Zoo. U. of Mich. No. 389. 23 pp.

Vickery, V.R. and D.K.M. Kevan. 1985. The grasshoppers, crickets, and related insects of Canada and adjacent regions. Biosystematics Research Inst., Ottawa, Ontario, Canada. Pub. No. 1777. 918 pp.

Abstract citation:
Rabe, M.L., J.T. Legge, and D.A. Hyde. 1996. Special animal abstract for *Appalachia arcana* (secretive locust). Michigan Natural Features Inventory, Lansing, MI. 2 pp.

Updated September 2000

Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

Michigan Natural Features Inventory
P.O. Box 30444 - Lansing, MI 48909
Phone: 517-373-1552

Appendix D.

Draft Management Guidelines for Red-shouldered Hawk

-DRAFT-

Management Guidelines for Red-shouldered Hawks on State-owned Lands in Michigan

PURPOSE

These guidelines were developed through a cooperative effort in the form of the Woodland Raptor Working Group (WRWG). The WRWG was formed in response to apparent decline of red-shouldered hawk habitat on state-owned land. With the DNR Wildlife Division acting as the lead, the group of individuals with hawk expertise and forest management experience was gathered, including personnel from DNR Forest Management Division, USDA Forest Service, The Nature Conservancy, Lake Superior State University, and Michigan Natural Features Inventory. The WRWG established these guidelines for the red-shouldered hawk with the intention of implementation on state-owned lands, to serve as an example to private landowners, and as a pilot for future management guidelines for other community types.

INTRODUCTION

The red-shouldered hawk (*Buteo lineatus*) is listed as threatened in the state of Michigan. The species historically had a statewide distribution but since the early 1900s has not been a common resident of the southern Lower Peninsula. Known nesting areas now exist in the northern Lower Peninsula (NLP). Nesting occurs sporadically in the southern Lower Peninsula, where declines are thought to be due to the loss of extensive, mature lowland forests. Confirmation of nesting in the Upper Peninsula was not recorded until 1978 (Postupalsky 1980). Breeding evidence has been found in eight Upper Peninsula counties since then (Brewer et al. 1991). The Atlas of Breeding Birds of Michigan (1991) reports 119 confirmed nesting sites in Michigan.

Some believe that the primary cause for decline of the red-shouldered hawk in Michigan is due to the reduction of its forest habitat. Other factors involved in declines elsewhere include development of buildings and roads (Bednarz and Dinsmore 1982), forest fragmentation (Morris and Lemon 1983), and possibly pesticide contamination (Campbell 1975). In northeastern Iowa, Bednarz and Dinsmore (1982) recommend maintaining woodlands averaging 304 acres of floodplain forest and 173 acres of upland forest within 3200 feet of a nest. They also suggest that each pair may require a territory as large as 615 acres. The same study also suggested that mature forests be maintained at 370 to 1,000 trees for every 2½ acres with openings comprising around 15% of suitable habitat. In general, disturbance within an

approximate one-half mile radius of a nest or breeding activity center should be kept to a minimum (Evers 1994).

Red-shouldered hawks have traditionally been associated with bottomland or floodplain forests. In the NLP, upland deciduous forest appears to be an important factor in this species' territories. Surveys in the NLP and habitat analyses in 1998 by the Michigan Natural Features Inventory (MNFI) found that most (93%; n~32 nests) of the active nests were located in upland deciduous forests. In southern lower Michigan, where larger tracts of upland deciduous forest are lacking, the species is nearly always restricted to bottomland forests. These analyses also found that wetlands appear to be an important component in the nesting sites; 57% were located within 1/8 mile of a wetland. Forest patch size was >300 acres for 56% of the nest sites; and patches of at least 200 acres held 20% of the remaining nesting sites.

The majority of nesting birds arrive from wintering areas between late February and early April. They are highly territorial and their aggressive vocalizations during the nesting season make nesting areas relatively easy to locate. Territories are utilized for several consecutive years, with pairs often using several nests within the territory (Craighead and Craighead 1969). Red-shouldered hawks are usually on nesting territories by mid-March, with incubation commencing from approximately April 1 to mid-May. Fledglings will leave the nest by July 1 and remain on or near the nesting territory until migration in September.

In northern Iowa, red-shouldered hawks usually obtain most of their prey from openings created by wet meadows within forested areas (Bednarz and Dinsmore 1985). This species appears to depend on both wetland and upland components of its habitat to meet foraging and nesting needs. Foraging use may even shift from year to year, depending upon prey availability in different habitats. It is unclear, at this time, how and when wetland areas are used by red-shouldered hawks in northern Michigan, but management actions that maintain adequate prey base in both uplands and wetlands are presumably desirable.

OBJECTIVES

The objectives of these guidelines are to specifically guide the forester or biologist in management decisions when a hawk nest is found during timber marking. These Guidelines are interim until additional evaluation of the red-shouldered hawk population and nesting areas is done, at which time the Guidelines will be revised as needed. The Guidelines are to, ultimately, provide management recommendations to the Michigan Department of Natural Resources which (a) maintain or increase the

number of successful nesting pairs and (b) define when and where to manage for red-shouldered hawks and associated species on state-owned land.

USE OF GUIDELINES

These management guidelines are intended for upland and lowland hardwood forests in the north portion of the Lower Peninsula. Southern Michigan nesting areas are generally located in bottomland forests and are linear in shape along watercourses, for which these Guidelines would be inappropriate. Currently there are too few nests in the southern population to evaluate nesting situations and for which to develop guidelines.

HABITAT REQUIREMENTS

Red-shouldered hawks require large, relatively mature, well-stocked lowland hardwoods or upland hardwood stands in close proximity to wetlands or other water bodies.

Nesting habitat in northern Michigan

Nesting habitat primarily consists of well-stocked pole or sawtimber stands (stocking densities 6 and 9) with a closed canopy (80 - 100%) and basal area of at least 98 square feet per acre. Canopy closure less than 80% tends to encourage red-tailed hawk (*Buteo jamaicensis*) occupancy. Wetlands are also an important component of red-shouldered hawk nesting habitat. Nesting areas are usually located within 1/8 to ¼ mile of wetlands or other water bodies. Red-shouldered hawks exhibit a high degree of nest site fidelity, and often return to the same nest tree or alternate among several suitable nest sites within the same nesting area from year to year. Suitable nest trees typically exceed 18 inches in diameter and contain a sturdy crotch near the main trunk in the lower portion of the canopy. Nests have been found in a variety of tree species (typically deciduous, e.g., beech and maple), but ultimately tree structure is the limiting or determining factor. Finally, red-shouldered hawks can be sensitive to disturbances in the immediate nesting area, particularly early in the nesting season when prolonged or frequent disturbances can lead to nest abandonment. Fledglings remain in the nesting territory for 8-10 weeks or more after fledging. During this time the parents are still attentive and feed the young infrequently.

Foraging Habitat

Red-shouldered hawks typically forage in wetland habitats such as lowland hardwoods, lowland conifers, lake and stream edges, and a variety of small, wetland openings and upland openings.

MANAGEMENT GUIDELINES

These guidelines describe concentric circles of decreasing management intensity from the nest tree to the outermost zone. The first zone, or Nest Tree Zone, will be that surrounding the nest tree with each successive zone encompassing a larger area (Figure 1). This is surrounded by the Buffer Zone, which is surrounded by the Tertiary Zone. The total acreage of all zones around a nest tree should approximate 385 acres, a figure that was derived from roughly averaging territory sizes cited in the literature and acreage that was considered attainable and maintainable by state forest managers.

Each nest area may contain more than one nest tree and overlapping of zones within a nest area will occur. When nests are located when hawks are not on nesting territories, a judgement call on the part of the forester or biologist will need to be made to determine the activity status of the nest. If the nest is disheveled or in obvious disrepair, it cannot be assumed that it will be used in the next breeding season, and may be ignored. However, if the nest looks as though it has been maintained, an assumption can be made that it will be used and the area should be maintained as active red-shouldered hawk nesting habitat.

Nest Tree Zone

Definition:

- five (5) chain radius from nest tree (from 0 to 330 feet from the nest tree)
- ~8 acres

Guidelines:

- no cutting
- no roads constructed
- no planned activity between March 1 and August 31
- attempt to minimize unplanned activity as much as possible

Buffer Zone

Definition:

- five (5) chain radius beyond Nest Tree Zone (from 330 to 660 feet from the nest tree)
- ~24 acres
- no roads constructed

Guidelines:

- apply “Big Tree Management” as defined by DNR Forest Management Division (see Appendix)

- maintain 85% average canopy closure
- no planned activities between March 1 and August 31
- attempt to minimize unplanned activity as much as possible

Tertiary Zone

Definition:

- northern hardwoods or mixed hardwoods and conifers (from 660 to 2310 feet from the nest tree)
- 25 chain radius beyond Buffer Zone
- ~354 acres
- maintain 80% average canopy closure

Guidelines:

- total openings will not exceed 10% (35 acres) of total area
- no planned activity March 1 through August 31

General Guidelines

The wildlife biologist who is responsible for wildlife management in the area of a nest has the final decision-making responsibility on red-shouldered hawk management in accordance with these guidelines.

Zones should focus on the nest tree (i.e. the nest tree should be as close to the center of the defined zones as possible). Shape of zones need not be maintained in a circle as depicted by Figure 1 if forest or landform structure deems it impractical, in which case acreage recommendations will be applied (Figure 2). However, unsuitable habitat, such as open water, grassland, and, but not limited to, early successional habitat types, should not be included in the total acreage of any zone. If appropriate habitat either extends onto or is otherwise present on adjacent private land, it can be considered part of the zone acreage. If the line of the protection zone passes through a habitat type, the extent of that habitat type should be included in that zone until the maximum acreage of that zone is met (Figure 3).

Multiple nests

If more than one useable nest is found in an area and they are ½ mile apart or less, the zones should encompass both nests and the halfway point between the nests should be considered the center of the zones (Figure 4). The distance to the outside edge of the zones is measured from

this centerpoint and the acreage within the zones can remain the same as if there were only one nest.

The definition of an opening is an area where the height of a cover type is shorter than the surrounding type. Its impossible, and impractical, to more strictly define an opening for hawk management purposes, although two to five year-old (or six to eight feet in height) aspen may function as an opening for red-shouldered hawks.

Planned activity includes, but is not limited to, forest management activities under direct control of the forest manager or wildlife biologist.

Future Directions

While a nest-site approach may provide some immediate protection for this species, a landscape-based management approach may be more appropriate and necessary to ensure long-term population viability of the red-shouldered hawk in Michigan. Red-shouldered hawks, and raptors in general, typically have large territories and use different parts of the landscape for different aspects of their life history. For example, adult red-shouldered hawks in northern Michigan typically nest in relatively mature, upland hardwoods and forested floodplains, but forage in nearby wetlands and adjacent forest stands. Fledgling red-shouldered hawks disperse from the nest, and may use components of their parents' nesting territory or habitat outside the territory. Little information is currently available on habitat use and requirements of fledgling red-shouldered hawks. Also, this species may use alternate nest trees within the same territory from year to year. Distance between alternate nest sites can range from 0.25 mile to 0.50 miles for one pair, depending upon the amount and condition of available habitat. Finally, this species may require certain habitat conditions at the landscape scale. For instance, some portion of the landscape around nesting territories may need to be largely forested to help reduce the risk of predation. A fragmented landscape also could lead to increased competition from other hawks and owls.

A landscape approach would help ensure that habitat required for different components of this species' life history and ecology is provided. This approach would account for some of the uncertainties or gaps in our current understanding of the species' ecological requirements as well as requirements of individual nesting pairs. Providing habitat for red-shouldered hawks at the

landscape scale would also benefit a number of wildlife species with similar habitat requirements (e.g. forest-interior birds).

A landscape-based management approach basically entails management of suitable habitat for red-shouldered hawks at a larger scale than individual nest-sites. Red-shouldered hawk nests appear to be concentrated on the landscape in some parts of the state. Examples of such concentrations include parts of the Indian River State Forest and the Dog Lake area in the Pigeon River Country State Forest area. These types of areas, sometimes referred to as core areas, would be managed to maintain or increase suitable habitat for this species, and would serve as primary management areas for the red-shouldered hawk. Ultimately, a core area would be an area in which red-shouldered hawks occur and successfully reproduce. These core areas would potentially function as source populations for the rest of the state. Timber harvesting may be somewhat limited in core areas, and trade-offs in timber harvest intensity may need to occur. Habitat outside core areas could be more intensively harvested or managed for other forest values (e.g. intolerant tree species, grouse management, elk management, etc.). In some cases, management of large tracts of suitable red-shouldered hawk habitat may not be possible due to land ownership patterns. In these instances, management may be limited to the nest-site approach.

Core areas can be delineated by overlaying nest-site data onto forest area inventory data to identify concentrations of nest-sites located within large mosaics of contiguous, relatively mature deciduous forest with adjacent wetland complexes. Geographic Information Systems (GIS) can be utilized to map existing habitat areas and to identify potential management or core areas. Systematic surveys and monitoring of red-shouldered hawk nest-sites have been initiated to determine the species' distribution and reproductive success on state forestland. Systematic surveys of potential habitat within all forest areas in the northern Lower Peninsula and Upper Peninsula have been proposed for the next five years contingent upon available funding and personnel. In 1999, systematic surveys of the Pigeon River Country and Indian River Forest areas will be completed. Completion of systematic surveys should provide the necessary data for identification of core areas in the state. A variety of management options may be applied in core areas. These may include big tree management, old growth designation, and/or standard operating procedures for northern hardwood management. Nests should be monitored to determine impacts of management strategy. Management of core areas should be evaluated and adapted over time, as necessary.

Southern forest nesting areas (south of the tension line), such as the river corridor in the Manistee National Forest, will continue to be monitored and population growth will be encouraged to the extent possible in the smaller forest tracts. Comprehensive surveys of red-shouldered nesting areas are needed in these areas.

These guidelines are intended to be a living document that can be modified as needed to accommodate new information that will benefit the red-shouldered hawk and associated species. They are currently meant to provide guidance for the management and future expansion of this species in Michigan.

REFERENCES

Barrows, W.B. 1912. Michigan bird life. Mich. Agric. Coll. Spec. Bull., E. Lansing, MI.

Bednarz, J.C. and J.J. Dinsmore. 1985. Flexible dietary response and feeding ecology of the red-shouldered hawk, Buteo lineatus, in Iowa. Can. Field-Nat. 99:262-264.

Brewer, R., G.A. McPeek, and R.J. Adams, Jr. 1991. The atlas of breeding birds in Michigan. Mich. State Univ. Press, E. Lansing, MI.

Campbell, C.A. 1975. Ecology and reproduction of red-shouldered hawks in the Waterloo region, southern Ontario. J. Raptor Res. 9: 12-17.

Craighead, J.J. and F.C. Craighead, Jr. 1969. Hawks, owls, and wildlife. Dover, New York, NY.

Ernst, S.G. 1945. The food of the red-shouldered hawk in New York state. Auk 62:452-453.

Evers, D.C. (ed) 1994. Endangered and threatened wildlife of Michigan. Univ. of Mich. Press, Ann Arbor, MI 412 pp.

Morris, M.M. and R.E. Lemon. 1983. Characteristics of vegetation and topography near red-shouldered hawk nests in southwestern Quebec. J. Wildl. Mgmt. 47: 138-45.

Pettingill, O.S. 1976. The prey of six species of hawks in northern lower Michigan. Jack-Pine Warbler 54:70-74.

Portnoy, J.W. and W.E. Dodge. 1979. Red-shouldered hawk nesting ecology and behavior. Wilson Bull. 91:104-117

Postupalsky, S. 1980. The red-shouldered hawk breeding in Michigan's Upper Peninsula. Jack-Pine Warbler 58:73-76.

Stewart, R.E. 1949. Ecology of a nesting red-shouldered hawk population. Wilson Bull. 61:26-35.

Appendix

"BIG TREE" SILVICULTURE IN NORTHERN HARDWOODS

These guidelines are written for the objective of providing old growth attributes and greater diversity to managed Northern Hardwood stands while continuing to provide quality wood products for human consumption. It is intended to be used in stands to compliment adjacent "old growth" areas and to provide another silvicultural management choice for Northern Hardwood forest cover type.

1) For stands that are best characterized by the 1.3 "Q" curve, maximum BA of approximately 85 ft^2 (trees five inches DBH and greater) and a maximum DBH of 22 inches, follow regular single-tree selection/gap regeneration guidelines with the following modifications:

   A. Retain and Restore (R/R) all native species common to the Northern Hardwood type including some of moderate tolerance.

   B. Work toward a stocking of about 95 ft^2 BA of which about 25 ft^2 should be in trees that exceed the standard 22 inches maximum DBH.

   C. R/R all size classes (no set maximum DBH but no more than 10% of crown cover should be in trees greater than 24 inches DBH).

   D. R/R at least fifty crop trees/acre in size classes six inches and greater (out of a total of about 130 tree/acre).

   E. R/R five to eight trees/acre in the 24 inch or greater size classes. About half of these should be in "super crown" trees (full, dominant crowns sticking above most of the stand). This should total about five to ten percent of the stand crown cover.

   F. R/R dying trees (expected to die within one to ten years) of all size classes with at least an average of two trees per acre total in the ten inch or greater DBH classes (1 to 2% of crown cover). Retain those high-risk trees that provide the least crown competition, have the least value for wood products and have the greatest wildlife and diversity value.

G. R/R den trees and nest trees that have proper structure for this purpose. Include trees that have the potential to develop to develop into den and nest trees.

H. R/R snags and large woody debris. Much of this will be recruited from other categories and remaining trees not specifically relegated to any of these categories. This recruitment will come about from natural death, girdling and other such activities. Residue from logging activities can be designed to provide additional wood debris.

I. R/R regeneration gaps. Provide three to five crown gaps per acre every ten to fifteen years. Gaps should vary in diameter from 30 to 60 feet and should equal approximately eight percent of the crown cover area. For areas to be managed for the red-shouldered hawk, make no more than one regeneration hole per acre.

J. R/R a number of trees of species that have been removed from the Northern Hardwood type. Examples include white pine, oak, hemlock, cedar and ground hemlock. This may require planting in larger regeneration gaps and protection from deer.

2) For stands that are best characterized by the 1.7 "Q" curve, i.e. heavily stocked with trees in the 6, 8, 10 and 12 inch DBH classes:

A. R/R all native species common to the Northern Hardwood type including some of moderate tolerance.

B. Identify 50 crop trees per acre and perform a Crop Tree Release. Trees identified as crop trees should include as many different tree species and as many "super crown" trees as possible.

Additional trees can also be marked as long as the overall percent crown cover does not drop below 80%. While there is no direct correlation between basal area and percent crown cover, residual stocking after marking should be in the 70 ft^2 to 80-ft2 basal area range.

C. R/R dying trees. Between one and five live trees per acre should be marked for girdling in order to hasten the development of snags, dying trees and dead and downed timber.

Also, retain high-risk trees that provide the least crown cover competition, have the least value for wood products and have the greatest wildlife and diversity value.

D. R/R both den and nest trees. In addition, the goal should be to perform a "Crop Tree Release" on one potential Raptor nest tree per acre.

E. Make between one and five 30 to 50 foot regeneration holes per acre. For areas to be managed for the red-shouldered hawk, make no more than one regeneration hole per acre.

F. R/R tree species that have been eliminated from the northern hardwood type, e.g. white pine, hemlock oak, cedar and ground hemlock. This may require planting in larger regeneration gaps and protection from deer.

3) For stands that are best characterized by the 1.5 "Q" curve, i.e. acceptable representation in the 10, 12,14,16 and 18 inch DBH classes but overly stocked in the 6 and 8 inch DBH class, follow the guidelines for the 1.7 "Q" curve given above.

Real-life situations will undoubtedly require modifications to these recommendations.

Also note that it is possible for any specific tree to serve multiple categories and that not all of the trees in a stand will be "categorized." Within most northern hardwood stands, there are more than enough trees to fill the needs of these categories and then some.

Figure 1. Simple diagram of management zones

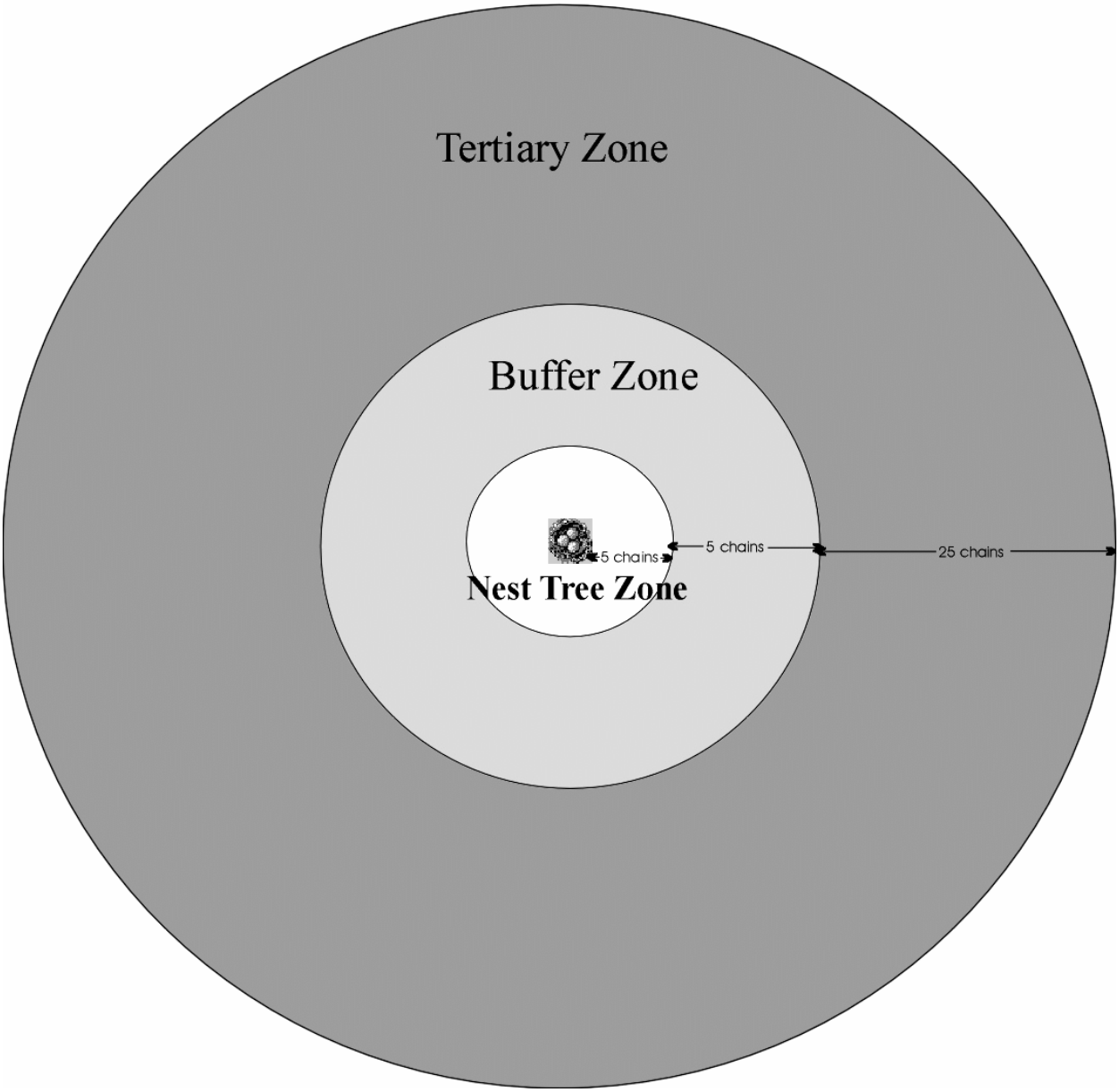


Figure 2. Example of management zone configuration to avoid unsuitable habitat

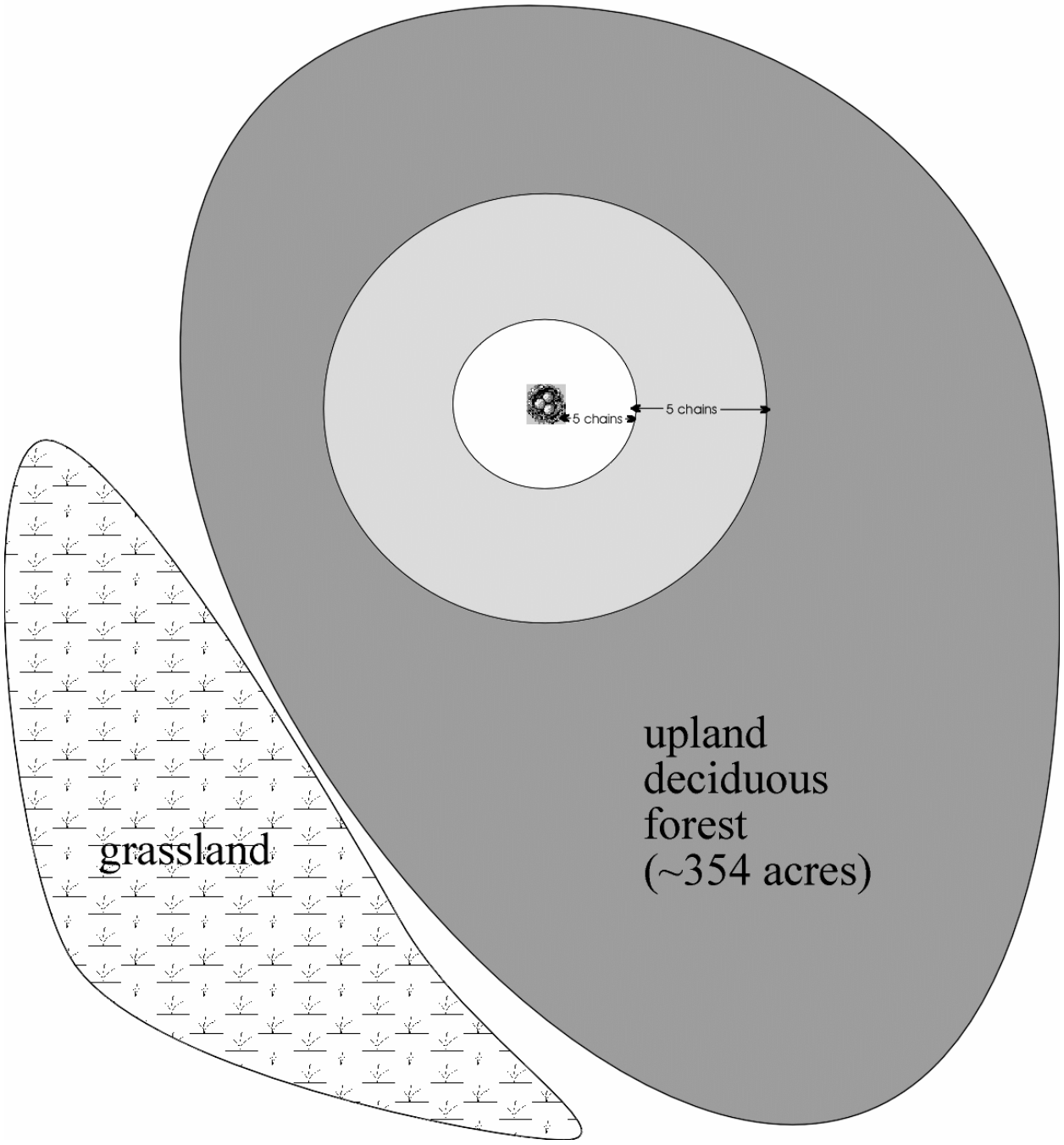


Figure 3. Example of management zone configuration when cutting unit intersects protection zone. The part of the cutting unit that overlaps protection zone (dark hatches) assumes that level of protection.

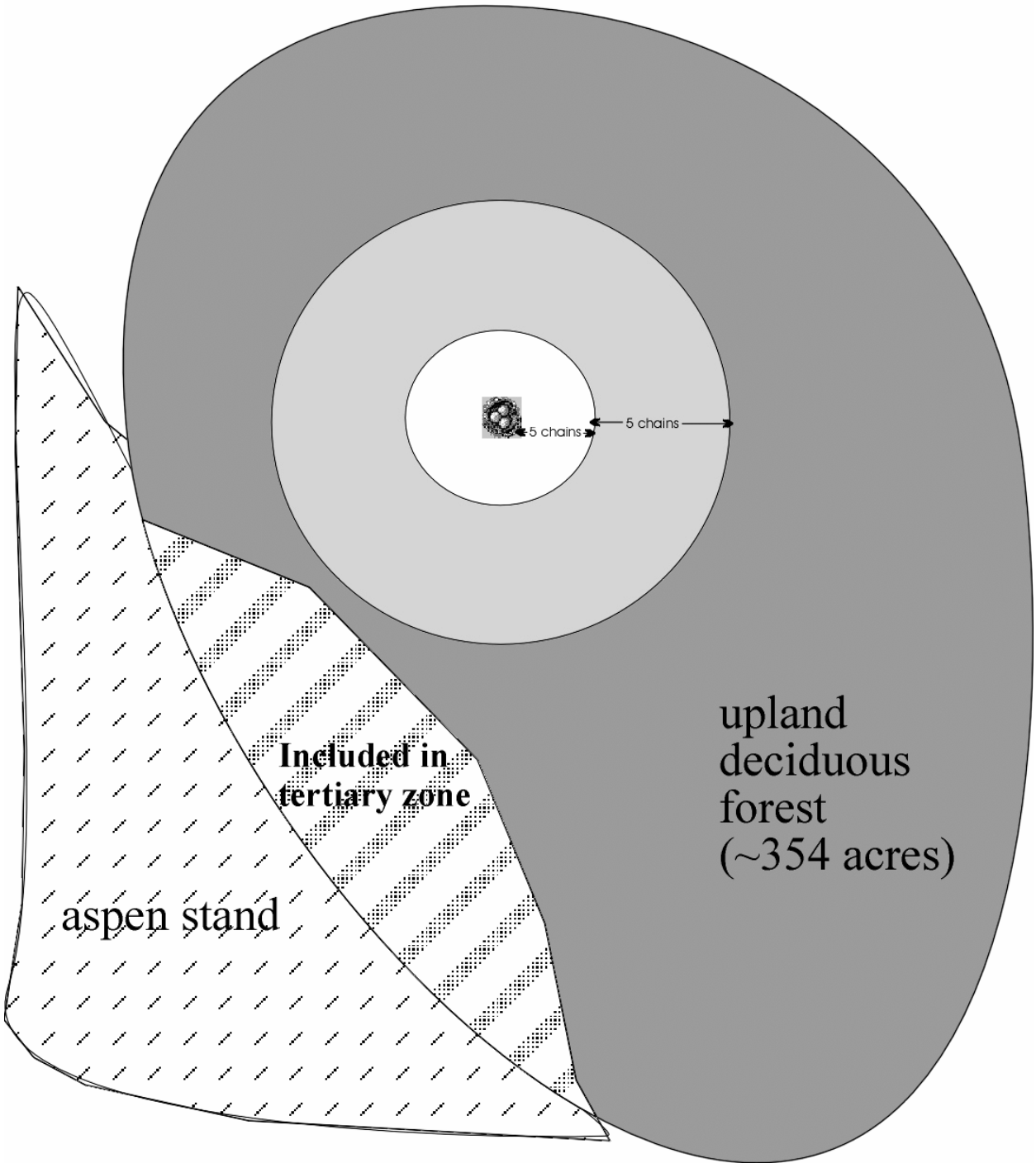


Figure 4. Simple diagram of management zones including multiple nests.