

DRAFT VERSION 2.0
**Karner Blue Butterfly
Michigan Recovery Implementation Plan**

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This Plan

The Michigan Recovery Implementation Plan takes direction from the Recovery Plan and is intended to address the accomplishment of Michigan-based objectives in the Karner Blue Butterfly Recovery Plan (Service 2003). Fragile and often isolated Karner blue butterfly (KBB) populations are scattered across a broad landscape in Michigan. Numerous independent land management efforts to meet a variety of objectives, most of which are unrelated to the KBB, are ongoing in a disconnected manner often without

regard for KBB. The cumulative effect of these often benign efforts is potential harm to KBB and missed opportunities for coordinated landscape recovery.

The intent of this plan is to function strategically in linking the various independent land management and KBB population management activities into a positive force with regard to recovery of KBB and perpetuation of the natural community complex that supports this and other imperiled species. This will take the form of coordinating with existing land management and population management plans, suggesting management direction particularly on private lands that do not benefit from developed land management or species plans, and enlightening people to the plight of the butterfly and the plight of the habitat resource on which KBB depend.

This plan addresses accomplishment of objectives in the Recovery Plan in part by addressing the recovery of the Oak Savanna Ecosystem in Michigan. It is generally accepted that habitat for the KBB is supported within the natural communities that are a part of this ecosystem (Service 2003). It is also well accepted that this ecosystem has declined dramatically in extent and become increasingly fragmented in recent decades as a result of human activity (Leach and Ross 1995). Perpetuating this ecosystem is key to recovering the KBB and several other imperiled species that also depend on the Oak Savanna Ecosystem.

Utilizing coordinated monitoring efforts, this plan will also chart the intended recovery progress that is envisioned for the butterfly, other species of concern, and the ecosystem in Michigan. This charting will better enable recovery planning across political boundaries as other states and provinces partner with Michigan to improve conditions for the butterfly and its habitat over a greater extent of its global range. This charting will also facilitate the budgeting of resources needed to meet plan objectives and to direct those resources to where they will be needed on the landscape. Finally, the plan will provide a means to measure progress in light of expectations so accomplishment of objectives is assured within a needed timeframe.

This plan is written to be compatible with the Michigan Habitat Conservation Plan, the Land and Resource Management Plan for the Huron-Manistee National Forests, the Midwest Oak Ecosystem Recovery Plan, and land management plans for various discrete properties including the Allegan, Muskegon, and Flat River State Game Areas. It is written from a strategic perspective to facilitate incorporation into other planning efforts yet to come and to easily integrate within differing planning approaches. Finally, it is written from both a quantitative and qualitative sense to permit application to management regardless of geographic scale.

Thus, the vision for this planning effort involves both the development of a product and the recognition of a process for plan development that includes a number of elements:

- An ecosystem-based, habitat-referenced, comprehensive, holistic statewide plan, with biological goals and objectives that hierarchically incorporates other planning efforts.

- A partner-driven process that incorporates both public input and focus group participation throughout plan development.
- A structured public participation strategy that solicits and incorporates input throughout the process of plan development.
- Provisions within the plan that require tracking of progress on plan objectives and promote plan changes supported by monitoring and principles of adaptive management, especially as they integrate with contingency planning.
- A means to integrate with other resource management efforts on behalf of KBB to meet objectives identified in the KBB Recovery Plan.
- A means to integrate the plan elements specifically directed to benefiting KBB with efforts to recover and maintain the oak savanna ecosystem.
- A means to shift the management focus from avoiding KBB take to proactive conservation to manage and maintain habitat within a viable ecosystem.

Authority

This plan recognizes the authority vested with the US Fish and Wildlife Service in management of species listed under the federal Endangered Species Act of 1973, as amended (ESA; that being 87 Stat. 884, as amended; 16 USC 1531, et seq.). This plan also recognizes the authority vested with the Michigan Department of Natural Resources through Constitutional intent to manage and provide comprehensive planning for wildlife species and associated habitats throughout the State. It is acknowledged that this authority does not preclude constitutionally conferred rights including property rights. Thus, this plan builds on authority conferred to the Department to build a strategic planning direction and invites voluntary participation by Management Partners in operational accomplishment of strategic planning goals.

The Butterfly

The Karner blue butterfly (*Lycaeides melissa samuelis*) is a member of the gossamer winged butterflies (*Lycaenidae*) that is restricted through its habitat requirements to Oak Savanna. The decline in the Oak Savanna Ecosystem has also lead to a decline in populations of KBB. Recognizing the plight of this species, the US Fish and Wildlife Service (Service) acted in 1992 to designate this butterfly as Federally Endangered under authority of the ESA. No critical habitat has been designated for this species. The Service also completed a KBB Recovery Plan in 2003 (Service 2003). The Recovery Plan is replete with information on this small butterfly which persists in greatest numbers in Wisconsin and Michigan.

The ecology of the KBB is closely tied to its habitat; sparsely treed openings containing lupine and a diversity of other sun-loving plants. KBB, in their larval stage, feed exclusively on the leaves of the wild lupine (*Lupinus perennis*). Adults nectar on a host of nectar-producing flowers but usually within 200 meters of lupine, and females lay eggs on or very near lupine plants. In addition because they are poor fliers, adults make extensive use of roost sites on which to bask both within the habitat patches that support KBB and in the sunlit dispersal corridors that link the patches together. These roosts include grasses, shrubs, and taller forbs exposed to the afternoon sun. (Rabe 2001, Service 2003)

Habitat patches tend to be droughty. Encouraging enough woody plants to shade a portion of the patch adds structural diversity to the habitat. The protection of shade ensures that at least some lupine plants will not prematurely dry out or senesce in exceptionally dry years. Several of these patches occurring close to each other, connected by dispersal corridors, provide the spatial structure necessary (a habitat mosaic) to support a KBB metapopulation.

The population dynamics of KBB throughout their annual life cycle have decided management implications. KBB produce 2 generations each year. KBB overwinter as eggs which are laid in late summer by the second generation. These eggs do not develop but immediately enter diapause or dormancy. KBB do not overwinter as adults. The vast majority of these eggs in diapause are typically lost overwinter largely as a result of desiccation or early emergence from diapause. Additionally, as many as half of those who begin to develop are lost in one of their life stages before they can successfully reproduce. Less than 1% of the overwintering eggs typically survive to reproduce as adults. (Andow and others 1994, Gill 2003)

The first generation of KBB adults emerges in late spring. These adults immediately lay eggs and die. Average adult lifespan is 5 days. Their eggs result in a second generation of adults that emerges in the summer. This second generation, often producing 4 times more adults than the first generation, also immediately lays eggs and dies. Through this process, variable weather conditions and the availability of nectar sources couple with the extent and quality of habitat to result in highly variable KBB populations. Thus, the population dynamics of this species can be characterized by very large and variable productivity coupled with very large and variable losses in population size.

Butterfly Populations

KBB occur on the landscape as populations, and management is often directed toward populations rather than individuals. The smallest KBB population unit recognized in management is the subpopulation which is supported within a single habitat site. Often these habitat sites, while independent, are situated close enough to each other that regular movement or dispersal of KBB individuals occur between habitat sites. This proximal spatial structure of sites that promotes regular between-site dispersal of KBB physically defines a KBB metapopulation or a population of populations. The Recovery Plan provides guidance on the number and association of subpopulations desirable within a metapopulation and thereby contributes to the biological definition.

The between-site dispersal of KBB within a metapopulation serves 3 important population-enhancing functions. The addition of KBB to an occupied habitat site (augmentation) adds robustness to the subpopulation at that site. The addition of KBB to an unoccupied but suitable habitat site (colonization) initiates a subpopulation at that site. The addition of KBB to an occupied habitat site also allows the sharing of genetic material (genetic enhancement). The operation of these 3 population-enhancing functions, together with local extirpation at the subpopulation level, functionally defines a KBB metapopulation.

KBB populations are considered independent from each other when there is an absence of between-site dispersal. This condition occurs as a result of a combination of intervening physical distance and barriers to dispersal (e.g. forest, major watercourses, cities). Because documenting the absence of dispersal events is problematic, some qualitative assessment of distance and barriers is often considered in judging population independence, relating that assessment to conditions where dispersal has been known to occur.

Other Species of Concern

Accomplishment of this plan will involve several natural communities and a number of different species. Major strategy elements of this plan include providing suitable habitat to support viable populations of KBB and maintaining oak savanna through maintenance of its constituent natural communities within which this suitable KBB habitat is supported. This landscape approach will result in impacts to a number of species. Of particular concern are those specialist species that are restricted through habitat requirements to the constituent natural communities that comprise oak savanna. These species will be tracked as a part of this plan, and habitat will be provided to ensure viable populations for them as well. Providing for their habitat needs is expected to add diversity to these natural communities, and viable populations of these species are viewed as indicators of health of these natural communities and the ecosystem in which they are a part.

Wildlife Species of Concern

Phlox Moth *Schinia indiana*

The Phlox Moth, Michigan endangered, has a historic range from Michigan, Wisconsin, and Minnesota to North Carolina, Arkansas, Nebraska, and Texas. Recent records come only from Michigan, Wisconsin, Iowa, and Minnesota. (Swengel and Swengel 1999). It is known from only 2 locations in Michigan (Balough 1987). Its larval food source is prairie phlox (*Phlox pilosa*). Prairie phlox grows in oak savannas in association with other plant species that define KBB habitat. The State is not well surveyed for this moth.

Ottoo Skipper *Hesperia ottoe*

The Ottoo skipper, Michigan threatened, has a range from southern Manitoba through the continental Midwest to north Texas. It has been reported in southwest Michigan north to Newaygo County. This skipper is very local in occurrence, almost always found close to larval food plants including little bluestem (*Schizachyrium scoparium*) and fall witchgrass (*Leptoloma cognatum*). In Michigan, this skipper occurs in dry sand prairie and oak savanna often in association with lupine. The single-brooded adults are active from late June to early August. Additional information can be found in Wildlife Abstracts (Cuthrell 2001) and Nielson (1999).

Persius Dusky Wing *Erynnis persius persius*

The Persius dusky wing, Michigan threatened, has been reported in southern Michigan north to Lake County. This skipper is local in occurrence in oak savannas, and the larval food source is lupine. The single-brooded adults nectar on a host of plant species and

occur from May through early June. Additional information can be found in Nielson (1999).

Frosted Elfin *Incisalia irus*

The frosted elfin, Michigan threatened, has been reported in southern Michigan north to Mason and Iosco counties. This elfin occurs in oak savannas where larvae feed on lupine. The single-brooded adults nectar on blueberry (*Vaccinium spp.*) from late April to early June. Additional information can be found in Nielson (1999).

Eastern Massasauga Rattlesnake *Sistrurus catenatus catenatus*

The massasauga, Michigan Special Concern and Federal Candidate Species, occurs from southeastern Minnesota, eastern Iowa, and northeastern Missouri east to southern Ontario western New York and northwestern Pennsylvania (Harding 1997). Historically, massasaugas were found throughout the Lower Peninsula and on Bois Blanc Island, Mackinac County. Recent reports come from localized regions in southeast, southwest, and northern Michigan.

Massasaugas are usually associated with wetlands including both wooded communities like swamps and riverine corridors and herbaceous communities including marsh borders and wet prairies. In summer, they will also move into immediately adjacent upland herbaceous communities including grasslands, shrubby old fields, and pastures and hay fields. These snakes usually overwinter in crayfish and mammal burrows and emerge in April.

The eastern massasauga has declined dramatically throughout its range. Michigan remains as a last stronghold for this species. Michigan has embarked on a coordinated effort with the Service to conserve the species that will ultimately incorporate a Candidate Conservation Agreement with Assurances. This plan will incorporate the tenets of that Agreement and ensure that the actions of these two independent conservation efforts do not conflict. Additional information can be found in Harding (1997) and Lee and Legge (2000).

Indiana Bat *Myotis sodalis*

The Indiana bat, a Federal and State Endangered Species, has a midwest distribution that extends south to Kentucky, Missouri, and Oklahoma. Its distribution in southern Michigan is at the northern periphery of its range. This Michigan distribution appears to be primarily confined to the southern 3 tiers of counties although a hibernaculum record exists for Newaygo County. It is considered rare throughout its Michigan distribution, but, it may be under represented because of the difficulty in comprehensively surveying for this species.

This species disperses substantial distances from wintering sites for summer residency. This has been especially noted for pregnant and lactating females. Their preferred foraging areas are around slow moving streams in wooded riparian corridors. However, their night roosts include sun-exposed trees with loose bark that are not always confined

within riparian corridors. Management guidelines protective of the species that have been developed for Michigan will be adopted for implementation in this plan.

2.2.1 Plant Species of Concern

Missouri Rock-cress *Arabis missouriensis* var. *deamii*

The Missouri rock-cress, Michigan Special Concern Species, has a range in the eastern United States from Maine and Georgia to Wisconsin and Oklahoma. It is considered rare throughout its range but may be under represented because of the difficulty in identifying this plant. It has been reported in southern Michigan north to Muskegon County. This plant occurs on dry, sandy soils in open and semi-open conditions including oak barrens and dry-mesic southern forest. This biennial flowers by late May and persists into early July. Additional information may be found in Voss (1985).

Hill's Thistle *Cirsium hillii*

Hill's thistle, Michigan Special Concern Species, has a range from southern Ontario and Pennsylvania to Minnesota and South Dakota. It is currently reported in Michigan from oak savanna in Menominee County, alvar on Drummond Island, Chippewa County, and Jack pine barrens in northern lower Michigan. There are historic records for widely scattered locations in southern Michigan, but few have been recently confirmed. This perennial occurs on dry sandy, gravelly, and limestone pavement (alvar) communities where it flowers from June through August. Additional information may be found in Higman and Penskar (1999) and Voss (1996).

Alleghany Plum *Prunus alleghaniensis* var. *davisii*

Alleghany plum, Michigan Special Concern Plant, has a range from central Pennsylvania and western Maryland to West Virginia, with outlying localities in Connecticut, Virginia, eastern Tennessee and New York. Disjunct endemic variety *davisii* populations are reported in northern Lower and west-central Lower Michigan. Three occurrences have been documented in Lenawee County. A straggly, thorny shrub to 3 meters, it occurs singly or in large, dense clones. Habitat for this shrub is supported in dry sand prairie and openings in jack pine barrens. Additional information may be found in Higman and Penskar (1996).

Current Distribution and Habitat Potential

The KBB is currently distributed, as supported by element occurrence records maintained by Michigan Natural Features Inventory, in oak savanna habitats in west Michigan from Allegan to Lake Counties, which are integral within the KBB current global range from New Hampshire to Minnesota. KBB historically occurred in Monroe County in southeast Michigan until 1986 but was apparently locally extirpated. By 1988, KBB had also been locally extirpated from neighboring Lucas County, Ohio. However, the recent reintroduction of KBB into historic Ohio sites has shown promise. In addition, KBB are present in the dune and swale complexes along the Lake Michigan shoreline in adjacent counties in Indiana. KBB are also present in Wisconsin (NE Morain Sands PRU) within 50 miles of potential habitat in Michigan's western Upper Peninsula.

In west Michigan, current KBB populations can be found clustered within 4 focus areas or Recovery Units (RUs) that have been identified by the Service in the Recovery Plan (Figure 1). These RUs are intended to include all of the KBB populations occurring in west Michigan (Figure 2). The boundaries of these RUs follow ecosystem boundaries offered by Albert (1995). Within these RUs, KBB populations occur largely on public lands. Within the northern 2 RUs, the Muskegon and Newaygo RU, the occupied public land is largely in the Huron-Manistee National Forest where the US Forest Service will take the lead in habitat recovery efforts. On the southern 2 RUs, the Allegan and Ionia RU, the occupied public land is largely on State Game Areas where the Department of Natural Resources will take the lead in habitat recovery efforts. Suitable and potential habitat on public lands is sufficient to meet most of the objectives set forth for recovery in these 4 RUs.

Historic KBB populations in southeast Michigan, north central Ohio, and southern Ontario are thought to have been related. Remnant KBB populations in Monroe County were likely extirpated through a process where they first were isolated from other remnant populations. Habitat within Monroe County was limited and not well linked. Local habitat degradation possibly operated to drive individual populations below viable levels. Currently, the amount of suitable habitat is not sufficient to support a viable metapopulation of KBB in Monroe County.

KBB have never been reported from Berrien County in southwest Michigan even though KBB are known to occur 30 miles southwest along the lakeshore in Indiana. Lupine has been reported from Berrien County, but habitat is so limited that the potential to support KBB populations is slim. The existing suitable and potential habitat is not sufficient to support a viable metapopulation of KBB in Berrien County.

KBB have never been reported from the Upper Peninsula. It remains to be demonstrated that KBB can survive in this environment. However, environmental conditions in the western Upper Peninsula are similar to conditions that support KBB in the NE Morainal Sands Potential RU in Wisconsin. If KBB can survive in the Upper Peninsula, then sufficient potential habitat should exist to support a viable metapopulation especially in the western portion of the Upper Peninsula.

Supporting Environment

The habitat mosaics that support KBB metapopulations occur on, and are supported within, the Oak Savanna Ecosystem in west Michigan. Savanna has been defined as “a sparsely treed plain supporting drought-tolerant plants.” Oak savanna is a rare and globally imperiled ecosystem that is restricted to the American Midwest. It typically exists as patches or cells, often interconnected by corridors in mosaic fashion, within a forest matrix. Oak savanna has a plant composition that is a mix of species associated with both prairie and forest communities. Thus, savanna is considered an ephemeral or transition community between prairie and forest.

There are natural community attributes in common wherever KBB are present. These include sand and loamy sand alkaline soils on flat to moderately sloping outwash plains

and lake plains supporting a climax forest of white pine and white oak. Attributes also include significant snowfall that persists on the ground through most of the winter. Temperature extremes at ground level in the summer coupled with very well drained soils make these communities very droughty, and site productivity tends to be low. Table 1 provides greater detail on the physical environment.

Table 1. Characterization of physical aspects of the Oak Savanna Ecosystem as it supports Karner blue butterfly habitat in Michigan.*

Subsection*	Allegan	Ionia	Manistee	Newaygo	Combined Savanna
Recovery Unit	Allegan	Ionia	Muskegon	Newaygo	
Growing Season	150-170 Days	130-150 Days	140-150 Days	120-140 Days	120-170 Days
Avg. Annual Precipitation	32-38"	30-32"	32-34"	32"	30-38"
Avg. Annual Snowfall	70-100"	50-70"	100-140"	70-140"	50-140"
Extreme Min. Temperature	-22 to -34 deg F	-26 to -30 deg F	-32 to -42 deg F	-32 to -48 deg F	-22 to -48 deg F
Landforms	Flat Lake Plain	Sloping Ground Moraine	Sand Lake Plain	Outwash Plain	Outwash/Lake Plain
Soils	Sands	Sands/Loamy Sands	Sands	Sands	Sands/Loamy Sands
Presettlement Vegetation	Wh. Pine Wh. Oak	Wh. Pine Wh. Oak	Hemlock Wh. Pine	Wh. Pine Wh. Oak	Wh. Pine Wh. Oak
Glacial Drift Thickness	50-350'	350-400'	400-700'	300-600'	300-700'
Slope	Flat to Gently Rolling	Generally Hilly	Gently to Moderately Sloping	Gently Sloping	Flat to Moderately Sloping
Rare Plant Communities	Savanna			Dry Sand Prairie	Savanna/Dry Sand

* adapted from Albert (1995)

While oak savanna in west Michigan can be at least qualitatively defined by the presence of KBB, the spatial designation of RUs in the KBB Recovery Plan stems from a definition and classification of regional landscape ecosystems completed by Albert (1995) using physical factors and biotic components. This classification system resulted in identification of a multilevel spatial hierarchy of landscapes to which the RUs referenced in the KBB Recovery Plan correspond with Subsections recognized by Albert. Hierarchially in Albert's treatment of landscapes, the Lower Peninsula is divided into a northern and southern Section at the climatic tension zone. The northern Section includes the Muskegon and Newaygo RUs (Manistee and Newaygo Outwash Plain Subsections), and the southern Section includes the Allegan and Ionia RUs (Allegan and Ionia Subsections) (Figure 1). Thus as used in this plan, savanna is not only a qualitative term, it is spatially defined on the landscape from a geographically holistic perspective as well.

The Michigan Natural Features Inventory has added further qualitative definition to the oak savanna type by characterizing its component natural communities from a physiognomic perspective focusing particularly on vegetation. Of these natural communities that support KBB, the Oak Barrens is distributed the furthest south, and south of the climatic tension zone. The Oak-Pine Barrens are centrally located both north and south of the climatic tension zone. This community supports a majority of KBB populations in the State. The Pine Barrens occur in the northernmost portions of the current KBB range. Dry sand prairie is an environmentally extreme condition that occurs as inclusions within all of these barrens communities. Oak Openings are a rare savanna type occurring on dry-mesic sites with sandy loam soils and are best represented in the Ionia RU. Together, these natural communities comprise the Oak Savanna Ecosystem in Michigan where KBB are known to occur.

Noting that savanna is a transition or ephemeral type between prairie and forest, the individual habitat patches that support KBB subpopulations have a limited lifespan in terms of providing suitable habitat for KBB. They are dependent on some form of disturbance like fire, extreme weather event, or insect attack for their formation. They are created, mature, and are replaced by woody plants through natural succession over time, rendering them unsuitable for KBB. Meanwhile, disturbance events prepare different sites for creation of new habitat patches that also follow this process of maturation and succession. A shifting habitat mosaic is maintained when as many patches are formed as are lost. This process creates the illusion of habitat that moves around within this mosaic and provides an appropriate successional array of habitat conditions.

Historical Perspective

Historic records of oak savanna suggest KBB were once distributed over a much greater spatial extent in west Michigan and in southeast Michigan. Historic occurrence of KBB has been extrapolated from limited sightings and museum specimens as no

comprehensive historic surveys for this butterfly have been done. KBB were probably most abundant 4,000 to 6,000 years ago when postglacial climatic conditions were comparatively warm and dry, and the oak savanna that supported them was probably at its greatest geographic extent. Oak savanna no doubt declined, probably by more than an order of magnitude, from this maximum historic extent with a shift to more mesic climatic conditions over successive millennia.

Following this long-term habitat decline attributed to natural forces, the geographic extent of oak savanna prior to European settlement was derived from interpretations of Government Land Office Surveys completed between 1816 and 1856 in Michigan; a baseline for oak savanna was documented. With European settlement, oak savanna underwent a second precipitous and dramatic decline attributed to anthropogenic factors that generally contributed either to savanna loss or degradation and fragmentation. The current extent of oak savanna is a small fraction of the baseline documented in the 1800s and considerably less than its maximum historic extent.

Speciation for the gossamer winged butterflies probably occurred to a significant degree during this period of maximum habitat availability, some 4,000 to 6,000 years ago. It is commonly accepted that species have a degree of plasticity genetically encoded within their makeup, especially as it relates to their adaptation to habitat. Given that speciation may have occurred at a time when available habitat was more common, more contiguous and less patchy, the KBB may not be as adapted to a habitat mosaic that supports a metapopulation structure as is generally assumed.

Oak savanna was historically maintained in large part through repeated wildfires coupled with periodic droughts and frosts during the growing season, especially in the northern part of the KBB range. These wildfires occasionally benefited from increased fuel availability resulting from windthrows. Native Americans are also known to have regularly used fire for a variety of reasons. However, the scope of impact of their actions, especially at the landscape level, is not known. These processes acted to promote open conditions by creating openings in forest and limiting the encroachment of woody vegetation in existing openings.

While all natural communities associated with oak savanna are fire dependent, the scope, intensity, and frequency of fires was greatest in the Pine Barrens and least in the Oak Openings: greater north of the climatic tension zone than south of the tension zone. Regardless of how fire effect may be modified by the nature and moisture content of available fuels, fire is generally accepted as the historic natural force having the greatest impact in shaping and maintaining these natural communities. Fire on the landscape historically operated to promote fire-adapted systems like oak savanna.

Fire suppression policies instituted in the 1920s reduced the incidence and spatial extent of fires, and thus the impact of fire on the landscape, by an order of magnitude. The regrowth of cut-over forest lands modified local conditions and reduced the potential for intense fires. These changes resulted in succession of these savannas to closed canopy forests and reduced floristic diversity. Some of these lands were converted to other uses

like agricultural cropping, livestock grazing, and establishment of pine plantations. These land use changes provided conditions that were favorable for invasion of exotic plants. The development of roads, building of homes, and expansion of urban areas reduced the extent of savanna. Fire suppression, coupled with changes in land use, resulted in a dramatic decline of savannas and degradation of the savannas that remained.

Notes associated with Government Land Office Surveys completed between 1816 and 1856 in Michigan suggest that historic oak savannas occurred as a result of catastrophic occurrences like wildfire and large-scale windthrow that created savanna and lesser forces that maintained existing savanna. Current management strategies appear to focus to a much greater degree on maintenance of existing savanna. While this strategy is effective in supporting savanna plant communities, the contribution and exhaustion of soils and soil biota in these natural communities is largely unknown.

Relationship to Rangewide Occurrence

While the historic distribution of the KBB was likely more ubiquitous across its historic range from Maine to Minnesota, KBB populations currently have a disjunct range with an eastern and western range portion. Current KBB populations are supported in oak systems in the disjunct range portion from Ohio to the west. Pine systems play a more dominant role in supporting eastern range populations. Of the 13 RUs identified in the Recovery Plan, 4 are identified for Michigan and 5 for Wisconsin reflecting the focus of the KBB populations on these 2 States. This identification of RUs also reflects the distribution of habitat that currently remains on the landscape.

Dirig (1994) reports that the northern range of the KBB is ultimately bounded by the northern range of lupine which approximates the 46th parallel traversing through the southern Upper Peninsula. The southern range of the KBB may be bounded by the southern limit of continuous snow cover; approximated at the 41st parallel traversing through northern Ohio and Indiana. However, changing climatic conditions associated with global warming may be forcing this southern boundary northward. The vast majority of KBB losses in their annual life cycle occur in the egg stage over winter largely as a result of desiccation or premature emergence from diapause. Continuous snow cover appears critical to moderating these variables and controlling over winter losses.

Michigan's Recovery Approach

The Department of Natural Resources and the US Forest Service, together with numerous other participating stakeholders, partner with the US Fish and Wildlife Service as lead agency in recovering the KBB in Michigan. The DNR is committed to ensuring perpetuation of the KBB metapopulations identified as needed as minimum for recovery within the Recovery Plan for the Allegan and Ionia Recovery Units. In addition, the DNR is committed to complimenting Forest Service efforts in meeting KBB metapopulation objectives identified as minimum in the Recovery Plan for the Muskegon and Newaygo Recovery Units.

Much of the remnant savanna in Michigan and most of the remaining KBB populations are on public land. The metapopulations noted in the Recovery Plan, needed as minimum for KBB recovery, build on these remaining KBB populations. The public land administration charged with maintaining these remnant savannas is also the management authority charged with recovery of KBB habitat in their respective area.

Coordination of this shared recovery effort occurs through a number of mechanisms. Management efforts for the KBB by all involved organizations draw upon the singular direction offered in the Recovery Plan. All of the partners comply with provisions in the ESA in managing for this endangered species. All are involved in the drafting of this Michigan Recovery Implementation Plan and the DNR-authored Statewide Habitat Conservation Plan. Regular meetings of a scientific advisory group (the KBB Working Group) to track progress in these efforts, to suggest change, and to facilitate networking further this coordination.

The strategy for the Recovery Plan is to maintain extant populations of KBB throughout its range. The RUs for Michigan identified in the Recovery Plan exist because KBB are currently present on those landscapes. The boundaries of these RUs in Michigan were crafted by simply adopting the landscape boundaries (Subsections) proposed by Albert (1995) that included those KBB occurrences consistent with the Recovery Plan strategy. Continuing with that general approach, the rest of the State was identified and assigned to a Potential Recovery Unit or Recovery Unit Annex (Figure 1) to facilitate management action. An objective of this exercise was to pre-assign additional KBB populations yet to be found in the State to a specific Unit where protection and management protocols could be crafted for immediate implementation.

In this manner, the balance of the Northern Lower Michigan Section (the Arenac, Highplains, Leelenau, Grand Traverse, and Onaway Subsections) were annexed to the Newaygo RU for management prescription. Likewise, much of the Southern Lower Michigan Section (the Kalamazoo Interlobate, Huron, and Saginaw Bay Lake Plain Subsections) were annexed to the Ionia RU for management prescription. However in southeast Michigan, the Washtenaw Subsection was assigned to the Oak Openings Potential Recovery Unit together with adjacent areas in Ohio and Ontario because of the affinity of historic populations there. The Upper Peninsula was assigned as a separate Potential Recovery Unit given its isolation from other Michigan RUs. (See Figure 1.)



Figure 1. Karner blue butterfly Units in Michigan

The boundaries separating the Subsections (Albert 1995), and thus the RUs, were identified using variables that could not always be precisely located on the landscape. Thus, the Subsection boundaries should be envisioned as variable-width bands, perhaps

as much as 10 miles wide in places, rather than discrete lines. Similarly, habitat sites on or close to a boundary might appropriately be assigned to either of the adjacent Subsections or RUs. KBB populations within such sites could be used to meet objectives in either RU, but not both.

As already noted, the RP is developed based on delineation of RUs as adapted from Albert (1995) that is cued on terrestrial landforms. This manner of delineation results in inclusion of landscapes occurring on both sides of major river corridors into the same RU. However, it is generally accepted that major rivers and their associated wetland corridors act as barriers to KBB who would cross them. These corridors may also act to predispose the formation and maintenance of suitable habitat adjacent to these corridors. If this is the case, then KBB populations on the same side of a river corridor would logically have a greater genetic affinity for each other than populations separated by river corridors. Also, greater management effort should be expended in maintaining KBB populations that exist as single entities sandwiched between major river corridors and thus isolated if maintenance of genetic diversity is an objective.

Management to meet the Michigan-based objectives identified in the Recovery Plan could be structured to be accomplished on a confined land base (e.g. largely on public land) where management efforts could be more intensive but where the opportunity to accommodate other resource-based objectives would be diminished as a result. Alternatively, these same Recovery Plan objectives could be accomplished on a more extensive land base, permitting less intensive land management applied over a greater geographic area and accommodating other resource-based objectives to a greater degree on the same land base. This alternative approach is more compatible with landscape management and is the selected paradigm to meet Michigan's resource management vision.

In order to achieve species recovery, the Recovery Plan documents the need based upon arguments for redundancy to support a minimum of 2 KBB metapopulations within each Recovery Unit in Michigan. The Recovery Plan is written on the premise that recovery in Michigan will occur naturally with provision of ample quality habitat supported within a robust Oak Savanna Ecosystem and well buffered against environmental catastrophe and anthropogenic intrusions. Assurances for provision of this habitat will come from the Forest Service through Forest Plan revisions and from the Department of Natural Resources through implementation of a strategic Habitat Conservation Plan linked to operational plans implemented by Management Partners managing land units supporting KBB. Species-related recovery objectives are also dealt with in this plan.

This Michigan recovery approach is built from a recognition that the KBB is supported within habitat that is a part of the Oak Savanna Ecosystem and that this Ecosystem supports accomplishment of a number of other resource-based objectives as well as other uses of the land. Thus, KBB recovery efforts are integrated within a vision for perpetuation and management of this Ecosystem that incorporates all uses of the land. Specific management actions are selected to have the best fit on the landscape and are therefore the least ecologically intrusive, most socially acceptable, and most economical

(e.g. prescribed fire in fire-adapted communities; mowing of woody plants on sites where woody plant density is already limited by other forces). KBB objectives are blended with objectives from other resource-based initiatives to assure compatibility of approach. The combined impact of these initiatives is monitored to assure their cumulative impact remains consistent with the goals of all programs drawing upon resources within the Oak Savanna Ecosystem. This system-wide approach also provides greater latitude in addressing catastrophic effects that may occur.

This recovery approach also recognizes the need to assure conservation and sustainability of the composition, structure, function, and processes of the Oak Savanna Ecosystem. KBB objectives are written to compliment ecosystem values of increased biological diversity and ecosystem integrity and to compliment a dynamic condition within the historic range of variability on the landscape. KBB objectives are also written to be compatible with ecosystem management performance measures.

The strategic objectives that are the focus of this plan, applicable at the landscape level, are divided into multiple operational objectives that are applicable at the local level. These operational objectives are accomplished by Management Partners through Partnering Agreements that gain force through local area operation plans. Action triggers are assigned to these operational objectives that suspend or change the management being implemented to accomplish the objective when the observed management outcome varies from the expected management outcome. An example of an action trigger might be where a KBB subpopulation varies in size by more than 50% of its expected outcome for more than a year. Action triggers are intended to prompt changes in management actions before populations are placed in jeopardy.

Habitat management for KBB in Michigan is approached from the knowledge that habitat south of the climatic tension line (Figure 1) occurs within more confined landscapes whereas habitat north of the tension line occurs more extensively. Moreover, south of the tension line, habitat appears to occur in proximity to major rivers. These rivers pass through a sand substrate and characteristically have a substantial river bottom area within which the river channel meanders. This river bottom is often elevationally 10 to 50 feet below the surrounding landscape and is often confined within well defined river escarpments. The ground water table near these rivers is usually lowered closer to the level of the river channel for some distance away from the river. KBB habitat often occurs in a band removed from the river far enough to be outside the area of influence of the airshed flowing down the river corridor but within the influence area resulting from the lowering of the water table resulting from the presence of the river.

All of the recovery efforts will not be possible without the understanding and support of the public. There is significant public interest in butterflies and butterfly biology. Unfortunately, this interest is coupled with a general lack of knowledge about KBB. Yet, many KBB populations occur on private land where complimentary land management will be needed if the butterfly is to persist there. Education and outreach efforts are incorporated into this plan to raise public awareness about KBB. Building on this

awareness, the public is encouraged to provide input into the planning process from their perspective as well.

Michigan's Recovery Strategy

KBB recovery and perpetuation depend on recognition that this butterfly is in decline and will need active, focused management in order to recover it. The Recovery Plan goal is “to perpetuate viable metapopulations of the KBB in the major ecological regions throughout its geographic range.” Achieving this goal is cued to “maintaining extant populations throughout the range and improving and stabilizing populations where the butterfly is imperiled.” The rationale for this goal is to preserve the diversity of current KBB spatial occurrence throughout its geographic range, especially as tied to ecological region, and to preserve any KBB genetic diversity inherent in these current occurrences. The Recovery Plan recognized the value in conducting this perpetuation effort in concert with all stakeholders, on both public and private land within each of the natural community types where the KBB occurs, in building redundancy into the population management design, in managing KBB populations for stability within a metapopulation spatial structure as described in the RP, and in applying adaptive management principles to the management process.

Michigan's recovery strategy follows on this template and includes a goal to perpetuate viable metapopulations of KBB supported within a healthy Oak Savanna Ecosystem throughout the KBB geographic range in Michigan. This goal stems from a belief that KBB cannot be expected to have long-term survival on the landscape unless the hosting ecosystem is also afforded with long-term health and a belief that the needs of other species of concern are best addressed at the ecosystem level. Again, achieving this goal is cued to a focus of maintaining and enhancing extant KBB populations. This achievement is further structured by a target of perpetuating at least 2 viable KBB metapopulations within each of the Michigan RUs. Additionally, other KBB occurrences will also be managed within viable metapopulation spatial structures wherever possible. When attaining this spatial structure is not possible, KBB populations will be managed as viable individual subpopulations. Consideration will be given to linking these subpopulations via corridors or managing them as core populations or high-density (refugia) populations to reduce the likelihood of local extirpation and to enhance population stability.

Metapopulations remain viable when colonization of unoccupied suitable habitat occurs at a greater rate than extirpation of existing habitat. Rates of colonization of unoccupied suitable habitat depend both upon characteristics of source populations and the nature of the connectivity between the source populations and the unoccupied habitat. While colonization rates could theoretically range from low to high, provided extirpation rates are always lower, actual KBB colonization rates in managed metapopulation sites are typically not low. Management of corridors to increase their function in promoting colonization includes improving the habitat character of the corridor itself, reducing the corridor length by locating habitat patches in closer proximity to each other, and increasing the number of corridors that service any given unoccupied habitat patch. Michigan's recovery strategy incorporates all of these management considerations.

Plan Objectives

The objective of this Recovery Implementation Plan is to maintain suitable habitat to perpetuate viable and large viable metapopulations in the Recovery Units supported within a healthy Oak Savanna Ecosystem in Michigan. Objective elements are grouped into those focused on KBB and those focused on oak savanna and other species of concern supported within this ecosystem. These objective elements are interrelated and cannot be accomplished to the exclusion of each other. They are also consistent with Recovery Plan objectives and those from other planning efforts that impact within the KBB geographic range in Michigan. Recovery Implementation Plan objective elements are:

- To maintain a minimum of 2 viable KBB metapopulations within each RU in Michigan specified in the Recovery Plan as minimally needed for KBB recovery.
- To maintain extant KBB populations in Michigan within viable metapopulation spatial structures where possible.
- To maintain all reintroduced KBB populations within viable metapopulation spatial structures.
- To maintain extant KBB populations as viable subpopulations through maintenance of core populations, refugia, or corridors to other subpopulations when maintenance of a viable metapopulation structure is not possible.

Oak savanna recovery objective elements operate from both a spatial and functional perspective. They address themselves to general ecosystem values of increased biological diversity and ecosystem integrity and function dynamically within a historic range of variability. Oak savanna ecosystem objective elements are:

- To maintain oak savanna in cells within a spatial mosaic structure extending throughout its entire geographic range of historic occurrence on the landscape with cells appropriately connected to permit biological exchange and exhibiting the full array of historic savanna condition and function.
- To maintain oak savanna with sufficient extent, diversity, and fineness of spatial structure to support viable populations of other species of concern.
- To maintain ground water recharge capacity involving water that has concentrations of water soluble contaminants within the historic range of variability.
- To maintain a differentiated soil structure on alkaline sand soils that incorporates significant organic materials in the upper horizon and has a significant soil moisture retention capacity within the historic range of variability.
- To maintain relatively high plant and insect biological diversity within a fineness of spatial structure that is within the historic range of variability.
- To maintain savanna with nutrient loss and availability during nutrient cycling that is confined within the historic range of variability.

Oak savanna objectives can be difficult to quantify and track. Thus, direct measurement of objectives can be challenging. Alternatively, a suite of indicator species is sometimes used to indirectly assess the robustness of a natural community that would compliment direct measures of objective attainment. These suites of indicator species either address themselves to fine scale assessment of individual savanna cells or to coarse scale

assessment between savanna cells or between savanna and other associated natural community types. Fine scale indicators are usually specific to the community being assessed and have a home range comparable to the cell size. For oak savanna cells, fine scale indicator species include KBB and other species of concern. Coarse scale indicator species are often generalists whose range includes the range of the ecosystem complex being assessed. For the oak savanna ecosystem, coarse scale indicator species include eastern kingbird, common goldfinch, spicebush swallowtail, and dragonflies.

Translocation

Translocation in any one of its many forms (augmentation, accelerated colonization, reintroduction) can be an effective tool in species recovery. However, its application is appropriate after opportunities for enhancement of existing populations, especially through habitat enhancement, have been exhausted. Translocation efforts should be guided by a plan that is cued to a goal of perpetuating a metapopulation rather than a subpopulation. Additional guidance is provided in appendix xx.

Adaptive Management

Adaptive management is a process that involves examining alternative management strategies for their effectiveness and function in meeting management objectives and adjusting future management actions according to what is learned (Services 1996, 2000). This process necessarily involves monitoring as a part of examining alternative management strategies. Adaptive management is applied in implementing both strategic and operational elements of this plan and employed by all Management Partners.

Monitoring

Monitoring is integrated within various elements of this plan and required of all Management Partners. Effectiveness monitoring is used in the adaptive management process and to assess the overall fitness of the plan in accomplishing goals. Compliance monitoring is focused towards accomplishment of requirements of permits, implementing agreements, and HCP elements that are contingent upon permits and agreements. Compliance monitoring is integral to the auditing process. Monitoring protocols are designed to measure both short-term and long-term change.

Research

Research contributes to this plan when questions arise that cannot be addressed through the adaptive management process. There is often a greater lag time in answering questions through research than through adaptive management. Funding of research can often be problematic. Integration of research findings into management strategies can also be more involved. However, research is better suited to answering basic questions and questions dealing with complex effects. Monitoring is often an element of research, but research monitoring protocols are designed specific to the research questions being pursued.

To better integrate research into KBB recovery, research proposals are reviewed by the KBB Working Group, a scientific advisory group for the KBB. The Working Group also identifies research needs, recruits researchers, and solicits funding for research. This

Working Group also integrates new research findings into the bank of knowledge on the KBB and acts as an information point source for questions on KBB, facilitating interaction between various researchers. Finally, the Working Group assists with integration of research findings into management strategies.

Teaming with Management Partners

This plan is crafted as a strategic plan. Accomplishment occurs at the operational level through teaming with Management Partners. Partnering Agreements define the nature of that teaming as strategic objectives are partitioned into operational objectives appropriate to the capacities of the individual Management Partner. Contributions to the Management Partner from the strategic level include the sharing of Incidental Take Permit authority, sharing of scientific, management, and planning expertise, and coordination with species and habitat management permitting authority.

Allegan Recovery Unit

The Allegan RU is climatically moderated by its proximity to Lake Michigan and supported on sandy lakeplain along southern Lake Michigan from the Muskegon River to Indiana. Most of the land is in private ownership. However, Allegan State Game Area and the south half of Muskegon State Game Area are located within the RU and contain much of the remnant Oak Savanna which exists as confined entities within this RU. This remaining Oak Savanna exists as Oak/Pine Barrens and Oak Barrens with islands of Dry Sand Prairie included within both of the Barrens types. Current Oak Savanna exists in well defined locations typically surrounded by oak forest or land converted to other uses largely within the historic distribution of the type. This oak savanna is among the driest of the savanna types and has a high historic fire frequency. The climax forest type most often associated with savanna in this RU is the white pine/white oak complex. The harvesting of the mature white pines followed by repeated wildfires prior to the 1920s suppressed regeneration of the white pine to a point where it is only now beginning to express its potential in the forest landscape.

Examples of savanna also exist on private land. Those hosting KBB are confined to the areas in and around the State Game Area portions that also host KBB. Savanna remnants do occur elsewhere on private lands throughout the RU. However, they are generally degraded, limited in extent, isolated from other such remnants, and fragmented through conversion to other land uses. High quality examples of savanna on these private lands exist as odd corners that have avoided human impact, are therefore typically threatened with forest succession, and are often surrounded by human-degraded habitats. Finding significant acreage of either suitable or degraded habitat on private lands is rare.

KBB populations exist in 2 general locations (metapopulation sites) in Allegan State Game Area and in a metapopulation site supported on a mix of ownerships including the south part of Muskegon State Game Area, the Muskegon County Wastewater Facility, and intervening private lands (South Muskegon Metapopulation Site). KBB historically occurred in a third general location in Allegan State Game Area. Both the 2 occupied locations and the historic location at Allegan State Game Area are sufficiently separated by watercourses that they are managed to support independent metapopulations. Two

other smaller oak savanna locations in the State Game Area (NE Heath Township and Lee Township) contain habitat but no history of KBB. The Allegan RU may be the most thoroughly surveyed Michigan RU for KBB owing to the limited and confined nature of the habitat available. However, additional survey effort in newly identified habitat sites is still warranted.

The remote possibility exists for KBB populations to be discovered in, or for populations from Indiana to colonize, existing isolated habitat supported within dune and swale communities along Lake Michigan in southern Berrien County. However, this habitat is geologically more confined to a narrow strip near the lakeshore than the occupied habitat supported within the dune and swale communities in the Chesterton-Portage area of Indiana. Geologically confined habitat in the Michigan City, Indiana area also has a historic absence of KBB further supporting the remote likelihood of KBB in Berrien County.

The 2 occupied metapopulation sites at Allegan State Game Area are both large enough to support management for large viable KBB metapopulations. The Sand Plains Metapopulation Site, south of the Kalamazoo River and west of Swan Creek, includes over 10,000 acres of State land. The Pine Plains Metapopulation Site, south of the Kalamazoo River and east of Swan Creek, includes over 8,000 acres of State land. Both Sites are well consolidated, and state land ownership in each is largely complete. Initial objectives for each of these metapopulation sites will be to maintain viable metapopulations of KBB and ultimate objectives for each will be to maintain large viable metapopulations of KBB.

The historic KBB location at Allegan State Game Area north of the Kalamazoo River, called the Turkey Farm Metapopulation Site, includes over 3,000 acres of state land. It is well consolidated, and state land ownership is largely complete. KBB were last seen at this location in 1988. This location does not appear to exhibit the diversity and abundance of nectar sources nor soil productivity that other locations at Allegan SGA have. Microsite diversity appears to be reduced which may lead to more uniform and possibly premature lupine senescence in some years. Some of these deficiencies may stem from a history of more intensive agriculture which removed soil organic matter, depleted the native seed bed, and destroyed soil profile structure.

This historic location has the potential to support a viable KBB metapopulation through reintroduction, but local habitat deficiencies must first be comprehensively identified and reduced. Reintroduction of KBB into this Site should only be done after the need for an additional metapopulation has been identified for the RU, the site has received a favorable habitat re-evaluation, and resources have been identified to support perpetuation of this metapopulation. Maintenance of oak savanna is a viable management approach for this location regardless of plans for KBB reintroduction. Many KBB habitat deficiencies will likely abate with time and continued management in the savanna type. The Site should be re-evaluated periodically for its suitability to support KBB and other species of concern or if KBB are rediscovered.

The NE Heath Township and Lee Township locations in Allegan SGA do not contain sufficient acreage to support KBB metapopulations. Oak savanna at these locations is supported on soils that are somewhat more productive than those in occupied sites, increasing the management effort needed to maintain savanna. Maintenance of oak savanna at these locations is a viable management approach, and so doing will enhance the diversity of the oak savanna type on the SGA. These locations should be re-evaluated periodically for their suitability to support KBB and other species of concern or if KBB are discovered.

Certain characteristics common to metapopulation sites at Allegan SGA are considered in risk management strategies. The sites are relatively flat and contiguous and are supported on the same soil type within fire-prone systems. The surrounding forest system is largely dry-site oak that is age and density stressed thereby contributing to fire and insect risk. Fuel loading is generally high and contiguous. Soil structure is generally degraded from a history of agriculture on dry, particularly fragile soils. The local land-use history has contributed to conditions that have promoted colonization and spread of exotic plant species. Private land in-holdings are typically developed with residences and serve as point sources for ignition of fire and release of exotic species. These characteristics heighten concern for and increase risk of environmentally damaging events.

A number of management responses to this increased risk are advised, many of which have already been implemented. Fuel breaks, such as roads, need to be maintained in the landscape both to forestall the unrestricted spread of wildfire and to provide a means of access to fight wildfires that do occur. Metapopulation sites need to be sized larger than the typical wildfire or other damaging event so the chance of impacting an entire metapopulation site is reduced. Prescribed fires need to be conducted both to meet habitat management objectives and to reduce fuel loading so subsequent wildfire control will be easier. Forest management needs to be conducted to diversify the forest character and thereby change wildfire and forest pathogen response. Monitoring and response protocols related to system pathogens and system health need to be developed to provide timely and effective response. Soil disturbance needs to be minimized to permit recovery of soil profile structure and water retention capacity. Adjacent private landowners need to be alerted to the sensitivity of the natural resources resident locally.

The DNR Wildlife Division will be the lead agency in this land management effort, maintaining habitat on State land and coordinating the efforts of other local area partners. Objectives from this plan will be incorporated as operational objectives in the Allegan SGA Master Plan. The Master Plan will prescribe the details of both the individual habitat sites and the connectivity between habitat sites that comprise the habitat mosaic (metapopulation site). The Master Plan will also prescribe the specific management and monitoring protocols that will be required to maintain and evaluate the management effort. Management driven by this Master Plan will supply needed information on both KBB population and habitat extent so that range-wide progress within the State can be tracked. That management entity will also establish specific management action triggers following on general guidelines provided.

The South Muskegon Metapopulation Site south of the Muskegon River in Muskegon County exists as a mix of ownerships including portions of the Muskegon SGA, the Muskegon County Wastewater Treatment System, and intervening private ownerships. Electric power distribution lines in the area are notable in that they support both suitable habitat and KBB. Therefore, they are important in providing both habitat and connectivity between habitat sites. This is the only known occupied metapopulation site between the Grand River corridor and the Muskegon River corridor within the Allegan RU. Suitable and potential habitat are sufficient to maintain a small viable metapopulation. The DNR Wildlife Division will be the lead agency, maintaining habitat on State land and coordinating the efforts of other local area partners. This management entity will supply needed information on both KBB population and habitat extent so that range-wide progress within the State can be tracked. This management entity will also establish specific management action triggers following on general guidelines provided.

Habitat fragmentation drives the overriding concerns for this metapopulation site. The habitat site isolation that potentially occurs with fragmentation, accentuated by the diverse land ownership pattern, predisposes KBB subpopulations to extirpation. Additionally, private land in-holdings serve as point sources for ignition of fire and release of exotic species. Management to counter these effects will focus on close coordination between local partners, attention to corridors linking habitat sites, and public outreach to achieve higher awareness and support of the species.

Ionia Recovery Unit

The Ionia RU is characterized by ice contact geology, moderate topographic relief, and modestly productive soils. It occupies interior reaches within the southern part of the State so the climate is not directly moderated by Lake Michigan. Most of the land is in private ownership. However, Flat River SGA and several smaller SGAs are located within the RU and contain remnant oak savanna as confined entities. Remnant oak savanna exists as oak/pine barrens, oak barrens, and oak openings. White pine and white oak typify the climax community on drier sites. Mixed oak and beech/maple typify the climax community on more mesic sites. The Ionia RU historically had a somewhat longer fire return interval so the communities were shaped more by a combination of catastrophic events, each with a more limited spatial scope.

Examples of savanna also exist on private land. Those hosting KBB are confined to the western portion of the RU. Savanna remnants do occur elsewhere on private lands throughout the RU. However, remnants throughout the RU are generally limited in extent, isolated from other such remnants, and fragmented through conversion to other land uses. High quality examples of savanna on these private lands exist as odd corners that have avoided human impact and are often surrounded by human-degraded habitats. Examples are rare where a significant acreage of either suitable or degraded habitat occurs on private lands.

KBB populations supported on public lands exist in 3 general locations on the Flat River SGA. They are adjacent to the Flat River and Wabasis Creek wetland corridors. Like many of the larger river corridors in the sand-dominated ecosystems of west Michigan,

the Flat River corridor includes the river channel and associated wooded riverine wetlands that are confined within a well defined drainageway whose bottom is elevationally 10 to 50 feet below the surrounding landscape. As such, this corridor acts as at least a partial barrier to butterflies attempting to cross it. The Wabasis Creek corridor does not have as much wooded riverine wetland associated with it, and it has a less well defined drainageway that is elevationally not as deep. These attributes of the Wabasis Creek corridor call into question the degree to which the corridor acts as a barrier to butterflies attempting to cross it.

Thus, KBB supported on the Flat River SGA are managed with the knowledge that populations in the 3 general locations are not sufficiently isolated to assure metapopulation independence. However, management is prescribed that enhances the robustness of populations within these 3 general locations while deferring management that would increase connectivity across riverine corridors between locations and thereby reduce the impact of the barriers. This approach results in enhancing habitat within each of the 3 general locations while preserving any independence between the respective KBB populations until the nature of that potential independence is better understood.

The KBB Unit east of the Flat River and north of Dickerson Creek, the Railroad Unit, contains a combination of suitable and potential habitat together with potential isolation from other KBB to suggest management as a viable metapopulation. While Wabasis Creek may function as an imperfect barrier to KBB attempting to cross it, a conservative approach to preservation of any independence inherent in the populations both north and south of Wabasis Creek suggests the need to manage them as separate metapopulations. A combination of suitable and potential habitat is available to support viable metapopulations on both the Airport Unit on the north and the Megasite Unit on the south side of Wabasis Creek.

Additionally, both suitable habitat and KBB subpopulations exist on private lands associated with each of these potential metapopulation sites. Resources on private land will contribute to the robustness of existing KBB populations on adjacent public land. Private landowners will be solicited as voluntary Management Partners to participate in this effort. The habitat spatial structure necessary to minimally support the metapopulations will be maintained on public land, and private land contributions will be directed toward spreading the risk associated with concentrating the metapopulation on public land.

KBB populations exist on private land not associated with potential metapopulations on public land. The limited acreage typical of these private holdings is consistent with acreage needed to support KBB subpopulations. Private landowners supporting suitable habitat of KBB will be solicited as voluntary Management Partners to maintain robust suitable habitat, viable subpopulations, and functional connectivity with neighbors who also support KBB resources.

Suitable habitat exists in other locations within the Ionia RU, but no KBB have been found at these locations. Habitat in these locations tends to be limited, variable in

quality, and fragmented. However, additional survey effort at these locations is still warranted. Moreover, these locations contribute to the diversity of oak savanna in southern Michigan.

Characteristics of occupied metapopulation sites within the Ionia RU prompt consideration of risk management strategies. All Units have a longer fire return interval. Thus fire may not play as dominant a role in shaping habitats as it does in other parts of the Michigan KBB range. All Units are supported on more mesic sites where ecological succession occurs at a more rapid rate. Maintenance of oak savanna will need to be more aggressively pursued through increased frequency of treatment applications and increased diversity of treatments. Perpetuation of viable metapopulations will depend upon a positive and functional management relationship among the various public and private Management Partners within these sites.

A number of management responses to this increased risk are promoted, many of which have already been implemented. Co-application of a wide array of land management techniques compatible with KBB (burning, mowing, herbicides, biological control) will reduce dependence on any single technique. More aggressive habitat management will compliment the more rapid rate of ecological succession. Management of KBB metapopulations in a core-satellite spatial structure where possible will counter the heightened risk of KBB extirpation of the small and fragmented satellite subpopulations. Aggressive recruitment of Management Partners will promote continuity of approach.

The DNR Wildlife Division will be the lead agency in this land management effort, maintaining habitat on State land and coordinating the efforts of other local area partners. Strategic objectives from this plan will be incorporated as operational objectives in the Flat River SGA Master Plan. That plan will prescribe the details of both the individual habitat sites and the connectivity between habitat sites that comprise the habitat mosaic (metapopulation site). That plan will also prescribe the specific management and monitoring protocols that will be required to maintain and evaluate the management effort following on general guidelines provided. That management entity will also supply needed information on both KBB population and habitat extent so that range-wide progress within the State can be tracked. That management entity will also establish management action triggers following on general guidelines provided.

Ionia Recovery Unit Annex

This Annex includes much of southern lower Michigan. It has affinities to the Ionia RU in that it has a mesic environment, more fertile ice-contact soils, greater topographic relief, more intensive land use conversion both to agriculture and to residential and commercial development, and a moderated fire return interval. These characteristics create a condition where suitable habitat will be limited, and will be fragmented into savanna remnants, and will occur as small parcels. The chance of KBB occurrence on these habitat patches is very small. However if KBB are found in the Annex, immediate action will be needed to assess population status, to evaluate current land uses for habitat compatibility, to assess and compensate for immediate risk of catastrophic event, and to

assess local public support. Following these actions, DNR Wildlife Division will make management recommendations to the US Fish and Wildlife Service.

Muskegon Recovery Unit

The Muskegon RU is climatically moderated by its proximity to Lake Michigan and supported on sandy lakeplain north of the Muskegon River. The land occurs in a mix of public and private ownership. Much of the public ownership is Federal and included in the Huron-Manistee National forest. Portions of the Pere Marquette State Forest are included in this RU as well. Oak savanna occurs more extensively throughout this RU as either Oak/Pine Barrens or Pine Barrens. Islands of Dry Sand Prairie are included within both of these Barrens types. These savannas are surrounded either by forest or by lands converted to other uses (e.g. residential and industrial development, pine plantations, agriculture, Christmas tree production).

Oak savanna in this RU has a high fire frequency. The climax forest type most often associated with savanna in this RU is the white pine/white oak complex. This savanna is supported on flat to gently undulating sandy lakeplain. Savanna persists in many areas as a result of past land use practices (agriculture, pine plantations) or because of environmental factors (airsheds, heavy snow accumulation areas, frost pockets). It is more contiguous on the landscape occurring on both public and private lands.

KBB populations occur in several general locations within this RU where the Recovery Plan specifies 2 large viable metapopulations as the recovery goal. To meet this goal, the Forest Service identified 2 general locations (White River and Otto Metapopulation Sites in Oceana County) on which to focus management efforts. In addition, KBB occurrences elsewhere on Forest Service lands in the Muskegon RU will be managed with a short-term goal to maintain them as viable subpopulations and a long-term goal to link these subpopulations to achieve a spatial structure suitable to support a viable metapopulation.

Similarly, KBB occurrences on other public lands will also be managed to maintain them initially as viable subpopulations and ultimately as contributions to viable metapopulations. Private landowners supporting KBB will be encouraged either to manage habitat compatible with efforts on adjacent public lands or to manage for viable subpopulations that can ultimately be linked to achieve viable metapopulations.

Both of the 2 metapopulation sites selected by the Forest Service are large enough to support large viable KBB metapopulations. The White River site is over 6,600 acres, and the Otto Site is over 11,000 acres. The majority of both sites are in Federal ownership, well consolidated. Initial objectives for each of these Sites will be to maintain viable metapopulations of KBB and ultimate objectives for each will be to maintain large viable metapopulations on an extensive landscape.

Characteristics of these Sites prompt consideration of risk management strategies. The Sites are relatively flat, contiguous, and are supported on the same soil type within fire-prone systems. The surrounding fire-prone forest system is largely dry-site oak and pine. The soil structure in many places is degraded from a history of intensive agriculture.

Private land in-holdings typically incorporate a greater proportion of cleared land that contributes to degraded soils and greater opportunity for invasion of exotic plants.

Several management responses to this increased risk are advised, some of which have already been implemented. Existing fuel breaks, like roads and trails, need to be maintained in the landscape both to forestall the unrestricted spread of wildfire and to provide a means of access to fight wildfires that do occur. Sites need to be sized larger than the typical wildfire so the chance of consuming an entire metapopulation site is reduced. Prescribed fire needs to be utilized both within the sites and in adjacent forest area to diversify the forest structure and fuel loading and thereby change wildfire and forest pathogen response. Soil disturbance needs to be minimized to permit recovery of soil profile structure.

The US Forest Service (Huron-Manistee National Forest) will be the lead agency in this land management effort. Strategic objectives from this plan will be incorporated as objectives within the Forest Plan. This Plan will prescribe the details of both the individual habitat sites and the connectivity between habitat sites that comprise the habitat mosaic (metapopulation site). This plan will also prescribe the specific management and monitoring protocols that will be required to maintain and evaluate the management effort. The Forest Service will supply needed information on both KBB population and habitat extent so that range-wide progress within the State can be tracked. The Forest Service will also establish specific management action triggers following on general guidelines provided.

Newaygo Recovery Unit

The Newaygo RU is characterized by a mix of outwash plain and ice contact geology, moderate topographic relief, and an extensive landscape. It occupies interior reaches within the northern part of the Lower Peninsula so the climate is not directly moderated by Lake Michigan. The land occurs in a mix of public and private ownership. Much of the public ownership is Federal land included in the Manistee National Forest. Portions of the Pere Marquette State Forest and County lands are included in the RU as well. Oak savanna occurs more extensively throughout this RU as either Oak/Pine Barrens or Pine Barrens. Some fairly large remnants of Dry Sand Prairie are included within both of these Barrens types. These savannas are surrounded either by forest or by lands converted to other uses.

Oak savanna in this RU has a more variable fire frequency (containing areas of FR-1 and FR-2; LTA-1 and LTA-2, respectively). The climax forest type most often associated with savanna is the white pine/white oak complex. Savanna in this RU is supported on outwash plain and, to a lesser extent, ice contact slopes. Savanna persists in many areas as a result of past land use practices (agriculture, pine plantations) or because of environmental factors (airsheds, heavy snow accumulation areas, frost pockets). Savanna is more contiguous on the landscape than on other RUs as it occurs on both public and private lands.

KBB populations occur in several general locations on the landscape. The Recovery Plan specifies 1 minimum viable metapopulation and 1 large viable metapopulation as the

recovery goal for this RU. To meet this goal, the Forest Service identified 2 general locations (Brohman and Bigelow Metapopulation Sites in Newaygo County) on which to focus management efforts. In addition, KBB populations occur elsewhere in the RU on both public and private land.

KBB occurrences elsewhere on National Forest System lands in the Newaygo RU will be managed to maintain them as viable subpopulations and to link them via corridors with other neighboring subpopulations with an ultimate objective of achieving a spatial structure suitable to support a metapopulation. Similarly, KBB occurrences on other public lands will also be managed to maintain them as viable subpopulations and to link them via corridors with other neighboring subpopulations with the ultimate objective of achieving a spatial structure suitable to support a viable metapopulation. Private landowners supporting KBB will be encouraged either to manage habitat compatible with efforts on adjacent public lands or to manage for viable subpopulations that can be linked across ownerships to achieve a viable metapopulation structure.

The 2 metapopulation sites targeted to meet RU goals are sufficiently large to meet this intended purpose and are well consolidated. The Brohman site is over 2,300 acres, and the majority is in Federal ownership. The Bigelow site is over 7,400 acres, and the majority is in other ownerships including private and local government property.

Characteristics of these Sites prompt consideration of risk management strategies. The Sites are flat to undulating, contiguous, and are supported on similar soils within fire-prone systems. The surrounding fire-prone forest system is largely dry-site oak and pine. The soil structure in many places is degraded from a history of intensive agriculture. Private land in-holdings typically incorporate a greater proportion of cleared land that contributes to degraded soils and greater opportunity for invasion of exotic plants.

Several management responses to this increased risk are advised, some of which have already been implemented. Existing fuel breaks, like roads and trails, need to be maintained in the landscape both to forestall the unrestricted spread of wildfire and to provide a means of access to fight wildfire. Sites need to be sized larger than the typical wildfire so the chance of consuming an entire metapopulation site is reduced. Prescribed fire needs to be utilized both within the sites and in adjacent forest area to diversify the forest structure and fuel loading and thereby change wildfire and forest pathogen response. Soil disturbance needs to be minimized to permit recovery of soil profile structure on all lands with a history of soil disturbance.

The US Forest Service Huron-Manistee National Forest will be the lead agency in this land management effort. Strategic objectives from this plan will be incorporated as objectives within the Manistee National Forest Plan. That Plan will prescribe the details of both the individual habitat sites and the connectivity between habitat sites that comprise the habitat mosaic (metapopulation site). That plan will also prescribe the specific management and monitoring protocols that will be required to maintain and evaluate the management effort. That management entity will supply needed information on both KBB population and habitat extent so that range-wide progress within the state

can be tracked. That management entity will also establish specific management action triggers following on general guidelines provided.

Newaygo Recovery Unit Annex

This Annex includes much of northern lower Michigan. It has affinities to the Newaygo Recovery Unit in that it has a dry-mesic environment, variably xeric to dry-mesic outwash plain and ice-contact soils, and greater topographic relief. The land occurs in a mix of public and private ownership. Oak savanna occurs as Jack Pine Barrens as well. These characteristics create a condition where habitat may exist in some quantity, but habitat quality in terms of floristic diversity may be reduced. KBB survival in the long term on such sites may be less likely. However if KBB are found in the Annex, immediate action will be needed to assess population status, to assess current land uses for habitat compatibility, to assess and compensate for immediate risk of catastrophic event, and to assess local public support. Following these actions, DNR Wildlife Division will make management recommendations to the US Fish and Wildlife Service.

Oak openings Potential Recovery Unit

The Oak Openings PRU is climatically moderated by its proximity to Lake Erie. Habitat in this Unit is supported on confined sand deposits that are variably up to 50 feet thick overlain on clay-based glacial till. This geologic formation occurs in north central Ohio, southeast Michigan, and neighboring sites along western Lake Erie in Ontario, Canada. Historically, oak savanna likely occurred where these overlaying sand deposits were the deepest, and drainage was sufficient to support mesic to xeric conditions. Savanna probably intergraded with tall-grass prairie as the depth of the overlaying sand deposits decreased. The scarcity of geologic locations that could support savanna likely restricted the maximum historic extent of savanna in southeast Michigan. More variable winter weather conditions, especially as they relate to continuous winter snow cover, may have also impacted KBB populations.

While the Michigan portion of this Unit has a history of supporting KBB, land use conversion has proceeded to a point where existing suitable habitat is no longer sufficient to support a KBB metapopulation in southeast Michigan. The potential for the Michigan portion of the Unit is to compliment efforts in Ohio and possibly in Ontario should a need and realistic management strategy be demonstrated. However if KBB are found in the Annex, immediate action will be needed to assess current land uses for compatibility, to assess and compensate for immediate risk of catastrophic event, and to assess local public support. Following these actions, DNR Wildlife Division will make management recommendations to the US Fish and Wildlife Service.

Upper Peninsula Potential Recovery Unit

No KBB have been reported from the Upper Peninsula. However, lupine does exist within oak savanna habitat especially in the western Upper Peninsula. Habitat potential is greatest in the Lake Michigan watershed in the west end of the UP. There is significant habitat potential in the Unit should a need be demonstrated. That need could be demonstrated if KBB were found or if habitat in Michigan were needed to achieve objectives within the neighboring Wisconsin Northeast Morainal Sands PRU. If KBB

were found in the PRU, immediate action would be needed to assess population status, to assess current land uses for habitat compatibility, to assess and compensate for immediate risk of catastrophic event, and to assess local public support. Following these actions, DNR Wildlife Division would make management recommendations to the US Fish and Wildlife Service.

Indiana Dunes Recovery Unit

As presently configured in the Recovery Plan, the Indiana Dunes RU is contained entirely within Indiana. Oak savanna is contained and KBB are supported within a dune and swale lacustrine community that is unique to this RU. Examples of this lacustrine community also exist along the Lake Michigan lakeshore in Michigan. While no KBB have been found there, if KBB were to be found, the nature of the habitat would suggest an affinity to the Indiana Dunes RU. Management recommendations from MDNR to the US Fish and Wildlife Service would be made with those considerations in mind.

Process for Plan Change

This plan is envisioned as a living document. Thus, the need for plan changes is expected. Changes will be coordinated through the KBB Working Group and will be exposed to public review before implementation. It is expected that this process will be transparent, and opportunity for public input will be continuous throughout the process. Changes are expected to be consistent with both the KBB Recovery Plan and plans for the various land management entities included in this effort. Timeframe for these changes will be as needed but not to exceed 10 years with annual review, as recommended by the USFWS, by the KBB Working Group (scientific advisory group) to consider the need for changes.

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