

Purpose of the Plan

This plan outlines objectives, strategies and techniques for recovery of the Karner blue butterfly (*Lycaeides melissa samuelis*) in Ohio during 1998-2010. Revised in 2005, the plan includes current protocol and procedural modifications, and revised responsibilities.

Background

Taxonomy

The Karner blue (*Lycaeides melissa samuelis*) is in the lepidopteran family Lycaenidae, the gossamer wing butterflies. This family is the most diverse in Northwest Ohio and second only to the skippers in numbers (Opler 1984). Lycaeninae is the subfamily and Lycaenini the tribe to which the Karner blue is assigned. There are nine genera in the eastern half of the United States. The genus *Lycaeides* contains two species in the northeast; Nabokov's blue (*Lycaeides argyrognomon nabokovi*) and the melissa blue (*Lycaeides melissa*). *L. melissa* itself is divided into five subspecies; the most distinct of which is *L. m. samuelis* (Nabokov 1944 in Packer 1987).

There are color and pattern differences between males and females of the species. Dorsally, both male and female fore wings exhibit fuscous dusting with a narrow dark marginal border. On the dorsal hind wing, however, females have orange sub-marginal lunules. Males of the species lack these. The ventral surface of the hind wing of both male and female exhibit sub-marginal orange marks inside a row of metallic sky-blue spots. There are no tails on the hind wings. There are a number of species with which the Karner blue may be confused.

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The Karner blue was known from 21 Ohio localities in 1975. However, since that time, the number of populations has been drastically reduced (Packer 1987). Extant populations occur in New York, Indiana, Wisconsin, Michigan and New Hampshire. The Karner blue is critically endangered in New Hampshire and extirpated in Illinois, Massachusetts, Pennsylvania and Ontario, Canada. It is thought to be secure in Michigan and Wisconsin. The Karner blue butterfly was extirpated in Ohio as of 1988 until its reintroduction in 1998.

In Ohio, the Karner blue butterfly was historically limited to the northwestern portion of the state, along a sandy belt of soil known as the Oak Openings geologic area (Shuey et al. 1987 b). This area is 22 miles long, six miles wide (Weber and Huffman 1989) and extends into lower Michigan. Grasses and prairie forbs grew in the sunlit herbaceous layer of these openings. Hazel thickets and scrubby oak trees were thinned by frequent fires, set either by lightning or by Native Americans (Gordon 1969). A map of the Oak Openings Region is provided in Figure 1.

Historically, fire played an important role in maintaining these openings (Gilbert 1873 a, b). Lupine, the only known host plant for the Karner blue butterfly, flowered heavily after a burn and thrived in the fire maintained openings. But while the Karner blue butterfly would not survive a hot fire, it is believed to have re-colonized burned areas by immigrating from nearby populations. Eventually, fire suppression after settlement allowed woody plants to invade the openings and shade out the lupine.

The water table was lowered by ditching beginning in the 1870s (Hehr 1970) and the oak savannas and wet prairies were converted to pastures and farms. Farmed-out areas were planted in pines in the 1930s to keep sand from blowing across roads and against houses. Pockets of wet prairies and savanna survived, along with the Karner blue butterfly, into the 1980s. Currently, massive housing developments and sand mines threaten to irretrievably change the Oak Openings.

The decline of the Karner blue butterfly in the Oak Openings tracks that of the oak savanna community. Records compiled by the Ohio Lepidopterists show that in the 1930s and early 1940s, John Thomas and Homer Price collected Karner blue butterflies from several locations in the Oak Openings. In 1983, John Shuey, while inventorying the Oak Openings for the Nature Conservancy, reported a seemingly viable population of Karner blue butterflies on and adjacent to a Nature Conservancy Preserve in the Oak Openings (Shuey 1986). It was, he felt, the only healthy population left in the Oak Openings. In 1986, after a summer of intensive survey, Shuey reported only one male Karner blue in the entire area.

The Karner blue butterfly is listed as a federally (U.S. Fish and Wildlife Service 1992) and state (Ohio Department of Natural Resources 1992) endangered species.

Biology

The Karner blue is bivoltine. In Ohio, the adults fly from mid-May through mid-June and again from early July to mid-August (Shuey, pers. comm.). Characteristically, the second generation is more abundant in numbers than the first (Packer, 1987).

The egg is very small, greenish-white, echinoid with a reticulated surface (Rittner 1976, Savignano 1987). They are laid singly on the petiole of a lupine leaf, generally low to the ground (Packer 1987). Second generation eggs are deposited on dry lupine stems and adjacent grass plants (Savignano 1987; Schweitzer 1989). Eggs hatch in seven to eight days (Rittner 1976). Packer (1987) indicates that females prefer shaded lupine plants for oviposition. The Karner blue over-winters as eggs (Schweitzer 1989). Other reports indicate that it also over-winters as larvae (Rittner 1976), but these reports have not been substantiated.

Larvae are dorsoventrally flattened, slug-like and covered with fine, dense hair. Coloration is pale green. Most sources report five instars (Opler 1984). Anatomical studies by Savignano (1987) reveal four distinct instars. Larvae are myrmecophilous, producing a sweet secretion from three glandular organs, which in some instances is utilized by ants. Ant attendance, however, has been documented only in third and fourth instar larvae, which possess fully mature organs (Savignano, 1987). Savignano's study of ant attendance in the Albany Pine Bush population revealed that ants from several genera tend Karner blue larvae. Overall effects of ant attendance on Karner blue survival, however, are still inconclusive and it is unlikely that one particular ant species is critical to the survival of the Karner blue.

The eating pattern of the Karner blue larvae is distinct. Both the young instars and the later instars eat away the ventral epidermis. This leaves a characteristic opaque 'window' in the leaf. Larvae mature in 18-21 days (Rittner 1976).

Chrysalides are pea green in color with a yellow-tinged abdomen (Opler 1984). Packer (1987) reports them hanging from stems and twigs near the host plant. Dirig (1976) however, states that pupation occurs in leaf litter adjacent to the plant. Eclosion occurs in 7-11 days. Total development time from oviposition to eclosion is 31-42 days.

First generation adults begin to emerge in the middle of May and are in flight through the middle of June. Second generation adults emerge beginning the first week in July and continue through the first week in August. Adults are diurnal and generally fly from about 8:00 AM to 7:00 PM. Activity ceases in very hot weather and on rainy or cloudy days when the temperature drops below 75°F (Schweitzer 1989). The average life span of the adult is approximately five days. Neither sex disperses very far from the home site, but may occasionally move up to one kilometer (Fried, 1987). Dispersal is probably more frequent when the habitat is of a very poor quality (Schweitzer 1989).

Restoration Potential And Limiting Factors

Habitat

Success of the Karner blue butterfly recovery effort in the Oak Openings area will depend on the quality and quantity of habitat found within the oak savanna communities. To date, the ODNR, Division of Natural Areas and Preserves, Division of Forestry, and Division of Wildlife, the Metropolitan Park District of the Toledo Area, The Nature Conservancy, and the Toledo-Lucas County Port Authority have collaborated in an effort to manage for the oak savanna communities. Several of their areas support degraded but viable oak savanna communities. With continued active management, oak savanna communities can provide the essential and the specific habitat requirements necessary to accomplish the objective of establishing self-sustaining populations of Karner blue butterflies in the Oak Openings.

Lupine. The Karner blue is closely associated with the legume, wild lupine (*Lupinus perennis*). Lupine is the only known host plant for the Karner blue. In Ohio, wild lupine is most abundant in the area near Toledo known as the Oak Openings. This region is characterized by sandy soils, relicts of sand beaches and ridges that were deposited in glacial Lake Warren, preceding the formation of Lake Erie. When the beaches were first formed, they were fairly level. When the water dropped, the sand quickly dried and was subsequently blown into dunes. Today, these dunes represent perched regions surrounded by low topography. The dunes are very dry while the low spaces between are waterlogged. Wild lupine is characteristic of the perched areas which have little moisture.

Wild lupine is a member of the family Fabaceae, the peas. The flower color varies from white to purple and pink but is usually a violet-blue. Flowers may occur on one or more dense racemes on each plant. The plants themselves usually are found in dense clumps of several dozen plants, and are strikingly showy when in bloom. Bloom time in Ohio is mid-May through the first week of June. The leaf is compound with seven to eleven leaflets per leaf. The plant color is a grayish-green.

Lupine has rather exacting habitat requirements. It grows best in very dry, sandy soil and in situations where it is exposed to direct sunlight for most of the day (Packer 1987). The plant does not thrive in shady locations. In fact, lupine will fail to bud and flower if shade persists.

Prior to settlement and the onset of agriculture, the Oak Openings area was subjected to occasional wildfires. These fires were important to the long-term survival of lupine. Thin barked trees and shrubs were killed by the fires, permitting much needed sunlight to reach the lupine plants beneath. Thus, the lupine was able to survive.

However, the practice of fire suppression, concurrent with urbanization and agriculture, caused a drastic decline in lupine populations. Certainly many populations were eliminated. Consequently, localities where the Karner blue could reproduce and flourish declined as well.

Today, lupine is found predominantly in highly disturbed areas of the Oak Openings. Railroad rights-of-way, power line rights-of-way, pipeline rights-of-way, abandoned agricultural areas, borrow pits and ATV trails are all excellent areas to find lupine. Likewise, agencies and other landowners are now managing areas specifically for lupine.

Nectaring Plants and Roosting Areas. Besides the obvious need for adequate sources of lupine to use as host plants, Karner blues also require adequate nectar food sources for both the first and second generations. Habitat that contains a large number of lupine plants but no nectar sources is not suitable to support the Karner blue. Generally, Karner blues are not particularly fussy about the species of plant they will visit to obtain nectar. They do, however, seem to have preferences when certain plant species are available. Species providing nectaring sources are listed in Tables 1 and 2.

Adult Karner blues also require roosting areas for resting and escaping from the heat. Tall grasses such as big bluestem (*Andropogon gerardi*) seem to provide the preferred roosting sites (Schweitzer 1989).

Ant Attendance. Myrmecophilous associations with Lycaenid butterflies are well noted in the literature (Webster and Nielson 1984). It is thought that the ants increase the survival rate of Lycaenid larvae through a relationship that may be facultative. Throughout the range of the Karner blue, a clear pattern of ant association has not been documented. Savignano (1987) found nine species of ants tending Karner blue larvae at two sites in Albany County, New York. However, no clear trend of increased survivorship was found among those larvae that were tended by the ants.

Pesticides. Herbicide use is not expected to pose a significant threat to the recovery of the Karner blue butterfly at sites in the Oak Openings selected for its reintroduction. The use of herbicides has had its most serious impacts on lupine and the Karner blue along railroad rights-of-way. Historically, wild lupine and the Karner blue butterfly existed alongside the railroad during the time when mechanical means, instead of herbicides, were used to control encroachment of woody growth. By the mid-1970s, the Karner blue butterfly no longer existed along this railroad site. Utility rights-of-way and transportation avenues traverse the Oak Openings region. Such areas, if they fulfill the necessary habitat requirements, may prove beneficial as corridors for future Karner blue dispersal. Indiscriminate use of herbicides to control woody vegetation in these areas would reduce or eliminate this potential.

Insecticides and pesticides are used to combat conflicts between areas of human concern and the presence of certain insect species. Unfortunately, the existence of non-target species like the Karner blue butterfly can be jeopardized by the methods used to control insect species considered undesirable. Monitoring and coordination of insect control programs will be necessary to prevent conflicts with Karner blue reintroduction and restoration. Spray and other treatment programs can be adjusted through establishment of "no spray" zones to minimize or eliminate potential impacts on Karner blue recovery efforts in Ohio.

Presently, the most notable treatment program for insects in the Oak Openings is that of mosquito control. It is likely that treatment programs for mosquito control will continue into the future.

Another insect species of concern, the gypsy moth (*Lymantria dispar*), is found in the Oak Openings of northwest Ohio. Areas with noticeable caterpillar populations and experiencing defoliation may be subject to mandatory treatment to eradicate the gypsy moth. The use of the naturally occurring bacterium Btk. (*Bacillus thuringiensis*) to kill gypsy moth larvae is gaining in popularity in Ohio. While proven effective against the gypsy moth caterpillar, B.t. will also kill caterpillars of the Karner blue. The Recovery Team will work to help inform the public about the history and life cycle of the gypsy moth, the pros and cons of some of the biological and chemical treatments available, and the moth's inevitable range expansion through Ohio.

Deer

The white-tailed deer (*Odocoileus virginianus*) is the largest native herbivore found in the Oak Openings region. In situations where deer numbers are not controlled, the biological carrying capacity of their habitat may be exceeded. Even low deer densities can exceed carrying capacity. One result can be overgrazing which alters plant species composition, distribution, and abundance. In severe cases, the structural diversity of understory plants may be reduced to the extent that seedlings are unable to establish themselves. This scenario has occurred and been documented in Ohio and other areas of the Midwestern United States. There exists the distinct potential for rapid growth of the deer population in portions of the Oak Openings that contain Karner blue habitat. Local occurrences where deer have heavily browsed lupine and other nectar-producing plants have been observed (Michelle Grigore pers. comm.). Deer management options must be explored and implemented should deer populations in the Oak Openings threaten Karner blue reintroduction and establishment. One deer management option, that of controlled hunting, has been initiated at one preserve in the Oak Openings by the ODNR, Division of Natural Areas and Preserves.

Land Use

Land use change in the Oak Openings is one of the many factors that contributed to the demise of the Karner blue butterfly in Ohio. A number of estimates dealing with land use patterns in the Oak Openings have been made. One recent study suggests that approximately 60 percent of the Oak Openings land base is now dedicated to agriculture and development combined (Terry Seidel pers. comm.). About 13 percent of this total is under development for housing, industry and the like, and is on the increase. While agricultural land has the potential for habitat restoration, developed land is generally irretrievable. Growing development will contribute to further habitat loss, degradation, and fragmentation. Other side effects of development such as increased efforts at drainage improvement are less measurable, but contribute to habitat degradation. Although a serious problem, adverse impacts on habitat from current land use patterns are partially offset by management of Karner blue habitat on public/private land holdings. Limited acquisition of land by these entities has restored some land to Karner blue habitat. One objective of this plan is to increase awareness among private landowners in the Oak Openings in order to promote effective management of oak savanna on lands that they own.

Restoration Goals

- To reestablish viable populations of the Karner blue butterfly within its historic range in Ohio, and maintain and restore associated species of oak savanna lepidoptera.
- Increase the quantity and quality of oak savanna habitat within the Oak Openings Region.
- Increase public awareness of the Karner blue butterfly and associated lepidoptera, as well as the Oak Openings Region.

Restoration Objectives

- To establish a self-sustaining population of the Karner blue butterfly with a minimum of three metapopulations within the Oak Openings Region, and increase associated lepidoptera in the process.
- To expand current management of oak savanna, and increase the amount of acreage of this habitat under management and protection.
- To produce and distribute educational material for the general public regarding the Karner blue butterfly, associated lepidoptera, and the importance of the Oak Openings Region.

Restoration Needs and Strategies

Re-establishment of Karner blue butterflies will require reintroduction.

Five strategies will be developed and employed: a) establish criteria to evaluate and select release sites; b) develop a source of Karner blue butterflies for reintroduction; c) determine a protocol necessary to establish Karner blue butterflies at reintroduction sites; d) release Karner blue butterflies into selected sites; e) monitor to evaluate release results.

Prior to 1998, establishment of the Karner blue butterfly by reintroduction has never been attempted elsewhere in the United States. Potential reintroduction sites will be ranked based on their estimated ability for sustaining reproducing populations of the Karner blue. A microhabitat analysis will be conducted to procure additional data on Karner blue habitat at Ohio reintroduction sites. Data on habitat site conditions at an area in Michigan where a reproducing population of the Karner blue butterfly exists will be measured and analyzed. Similar data will be taken at potential Karner blue release sites at a preserve located in the Oak Openings Region of Ohio. From this, comparisons between the two sets of data can be made to determine optimum release sites in Ohio. Initially, Karner blues must be obtained from a source out-of-state. The source of Karner blues will be Allegan State Game Area, Michigan. Once obtained, a pool of captive reared Karner blues can be made available for initial and subsequent releases. The Toledo

Zoological Society developed captive rearing breeding protocol procedures using *Lycaeides melissa melissa*. These procedures have shown promise of application to captive breeding of the Karner blue. Karner blue populations after release will be monitored for survivorship and reproduction. Protocols addressing Captive Rearing and Propagation are included and described in this plan.

Oak savanna, which is essential habitat for the Karner blue butterfly, needs to be increased in quality and quantity for the success of Karner blue reintroduction and establishment in Ohio.

Three areas need to be addressed: a) develop management and monitoring guidelines for oak savanna habitat and lepidoptera associated with Karner blue butterfly; b) implement and expand habitat management and monitoring practices; c) identify and acquire appropriate oak savanna to promote protection and management of this habitat. NOTE: Management and monitoring guidelines have already been developed and the expansion of habitat management and monitoring is in progress.

Generally, when managing for Karner blue habitat, standard management practices like prescribed burning, chemical treatment, and mowing are employed. Timing considerations are critical in employing habitat management practices in Karner blue habitat. Suggested habitat management practices for use by land managers can be found in Appendix A, Management Recommendations for Karner Blue Butterfly Habitat. The techniques recommended provide uniform guidelines for use by land managers in areas where Karner blues are to be released or at sites occupied by the Karner blue butterfly. In addition, the management recommendations are useful for agencies and private landowners who desire to manage oak savanna habitat for Karner blues. Two checklists to assist with identifying site potential suitability for Karner blue habitat management have been developed. A Site Coversheet and Unit Checklist along with attachments are located in Appendix B.

Once identified and evaluated, areas of oak savanna will be considered for acquisition. Land acquisition activities will be guided by availability from willing sellers, cost, and money available for purchase. Donations of land may play a role in increasing oak savanna habitat under agency ownership and management. Several agencies involved with Karner blue habitat management are active or interested in acquiring oak savanna through such means as acquisition, donation, or agreement. Activities related to Karner blue habitat management and acquisition are further described in the section of this plan entitled Responsibilities.

Public awareness and support for Karner blue reintroduction efforts are important for successful recovery.

Three educational needs were identified: a) produce educational materials and programs for distribution and presentation; b) identify and work with interested groups to increase public support; c) continue and promote additional partnerships among public and private agencies and organizations.

The general public, especially residents of the Oak Openings, need to be informed of the importance of restoring the Karner blue butterfly to its former native range in Ohio. Promotion of the recovery effort can be partially accomplished through production and distribution of educational materials. This action would likely assist in locating others willing to participate in the recovery effort of the Karner blue butterfly and its habitats. Working partnerships are necessary if recovery efforts for the Karner blue in Ohio are to succeed. Important partnerships working toward that goal include the Ohio Karner Blue Butterfly Recovery Team, The Green Ribbon Initiative Committee, and the Natural Areas Stewardship, Inc.

Threats which could negatively impact Karner blue recovery efforts need to be identified and addressed.

Three main areas of concern were identified: a) address the potential impacts of gypsy moth and other insect control programs; b) evaluate the effects of white-tailed deer populations on oak savanna habitat and, if necessary, implement measures to control over population; c) address negative impacts associated with land use development and increasing urbanization.

Large scale insect control programs employ the use of insecticides to control insects that are not desirable to humans and those that can severely damage native vegetation. The most notable insect control program of consequence to Karner blue reintroduction occurring in the Oak Openings is for control of mosquito populations. The Toledo Area Sanitation District regularly controls adult mosquitoes using "mist" or "fog" machines. There is currently a treatment program to control the gypsy moth in the Oak Openings. The Ohio Department of Agriculture has imposed a quarantine on Lucas County due to the presence of the gypsy moth. It is known that white-tailed deer populations graze on lupine and other nectar plants. The effect of deer grazing on Karner blue habitat has not been quantified. Studies may be necessary in order to better understand the impacts of deer on Karner blue habitat. Development and urbanization are serious limiting factors that compete for available Karner blue habitat. Discussion of negative impacts of pesticides, deer, and development can be found under the section of this plan entitled Restoration Potential and Limiting Factors.

Outline of Strategy. Several surveys of the Oak Openings region of Northwest Ohio indicate that the Karner blue is extirpated in Northwest Ohio (Magdich 1993). It is highly unlikely that any new naturally occurring populations will be found. If the Karner blue is to return to Ohio, the likely scenario will involve a two-phase approach culminating in reintroduction through artificial means.

Phase one will involve intensive management to restore habitat that will support Karner blues. This approach will be community based using a strategy that will benefit other rare lepidoptera, other fauna, and related plant communities. For instance, preliminary findings from 1994 and 1995 transect counts suggest that intensive Karner blue habitat restoration and management work at the Kitty Todd Preserve has had a positive impact on the distribution of the frosted elfin, *Incisalia irus* (Magdich pers. comm.).

Phase two will involve *ex situ* captive breeding that will emphasize reintroduction of the Karner blue into restored habitat. Since the Karner blue is no longer likely to be found in Ohio, no amount of habitat restoration will directly lead to the return of the butterfly. At least two artificial methods are available for restoring an extirpated population. One method involves the direct transference of Karner blues (at any life stage) from a source to restored habitat. A more sound approach, however, relies on *ex situ* captive breeding and reintroduction. This method has been used in at least two other instances involving endangered lepidoptera; the large copper (*Lycaena dispar*) and the large blue (*Maculenea arior*). Both efforts proved to be very successful (Dresser et. al., 1988; Magdich 1995).

A number of concerns are inherent with any captive-breeding program. These concerns have been addressed at length by the Captive Breeding Specialist Group (CBSG) of the International Union for the Conservation of Nature (IUCN). The CBSG has established strict guidelines that address these concerns (IUDZG 1993, Magdich 1995). These guidelines will be adhered to in formulating an *ex situ* captive breeding strategy for the Karner blue.

Captive Propagation and Reintroduction

A large problem in long-term maintenance of any small animal population in captivity is the constant erosion of genetic diversity by genetic drift. This problem is exacerbated to a very great degree when longevity of the managed population is low and generation time is short. However, the great advantage of producing animals for reintroduction through captive breeding is the prospect of lowered mortality at nearly every stage of the life cycle. In the case of the KBB, significantly lower mortality (as compared to wild populations) can be expected for eggs, larvae, and pupae. Lane and Welch (1994) reported 5% survival of released KBB larvae, compared to 80% survival of KBB larvae raised in captivity. In a study of egg mortality, Spoor and Nickles (1994) found that from 66-95% of unprotected wild eggs monitored in their study were damaged or lost. This contrasts strongly to an egg loss in captivity of 12% as reported by Lane and Welch (1994).

If captive breeding is to be used, the most prudent course of action to take with the KBB is a short-term captive breeding program with a duration of +/- five years designed to maximize numbers of KBBs released into the wild. The short duration of the program, combined with yearly infusions of new founder stocks would minimize erosion of genetic variability and limit the artificial selection for butterflies bred and reared under captive conditions. When population numbers of the reintroduced population reach 1000 first flight adults and 3000-4000 second flight adults, the remaining butterflies in captivity would be released and the breeding program terminated.

Propagation of the host plant- *Lupinus perennis*

Local lupine seed is collected in July before dehiscence is complete. Seed is stored dry in a freezer until the following spring. Immediately before planting seeds are given a tiny nick with a single-edged razor blade and are placed in hot water for 5-10 minutes. Seeds

are strained from the water and mixed with a slurry of *Rhizobium* inoculate and milk (chlorinated water kills the bacteria), type H (Prairie Moon Nursery, Winona, MN) and placed in a clear plastic box for 24 hr. in sunlight. The next day, seeds are planted in starter cells in Bacto™ seed mix. One seed is planted in each cell at a soil depth of ¼ inch. Seeds are watered thoroughly every day in summer. When the first true leaves appear, the plants are transferred to 2-gallon plastic pots in the following soil mix:

- 3-4 parts sand
- 1 part potting soil
- 1 part sphagnum peat
- 1 part small pine bark chips

Plants are maintained under shaded poly in open air, and are fertilized every week throughout growing season to increase protein content for larvae. Seedlings are fertilized with fish oil emulsion, while older plants are fertilized using Miracid™ 30-10-30 fertilizer. Some recent research has also suggested that protein deficiency reduces lifespan in certain pollen and nectar feeding insects (Schmidt 1998) and that fecundity in some Lepidoptera may be limited by protein obtained as larvae (Stamp et al. 1993) or adults (Labine, 1986; Pierce 1985; Dunlap-Pianka 1995). Spider mites commonly infest these plants. In the event of spider mite or white fly infestation the foliage is cleansed with a solution of dish soap (1/4 tsp./cup) and water applied with a spray bottle. Each leaflet is gently scrubbed by hand and the plant thoroughly rinsed with tap water. The treated plants should be set aside for several days. In stubborn infestations the plants are sprayed with a dilute solution of household bleach (2 tsp. Bleach in 32 oz. water), scrubbed, and rinsed with tap water as described above.

Collection

The Karner blue 1st brood flight period usually begins the second week in May at our latitude and lasts for three weeks. We consult with the Michigan Department of Natural Resources staff biologists at the Allegan State Game Area in early May to learn when the flight has commenced. Our first collection begins on a morning one-week after the first KBB sighting in the spring. Then a collection date is scheduled one morning each week after that until the adequate number of females has been obtained. A collection of wild caught females is assembled from several different locations to insure genetic diversity. The females also collected on different dates, spaced approximately one week apart to insure that the majority of the females collected were recently emerged and gravid. Our greatest egg production has always been from females collected during the second week of the flight. The females are captured with a large butterfly net and transferred to a 10 cm x 10 cm x 18 cm transparent, plastic container (AMAC Plastics Products Corp., Sausalito, CA) marked with the date and capture locality. An artificial nectar source is fastened inside of each plastic container consisting of a rubber-capped florist tube with a cotton wick protruding through the cap filled with a 10% clover honey/water solution. This allows the butterflies to have access to some nourishment and prevents dehydration during the transport. This is especially important, as recently emerged females may not have had a chance to feed.

Transport

The plastic containers are placed within thick-walled 32 quart Styrofoam coolers that contain a single ice pack separated from the butterfly containers by bubble-pack insulation. The temperature inside the cooler was maintained at $<20^{\circ}\text{C}$ (because of the chill and darkness the butterflies are less active and therefore less likely to batter themselves en route). A data logger is placed inside of the cooler to record the temperature. A digital electronic thermometer with a probe is used to monitor the cooler temperature in real time. Readings are taken every 30 minutes. Following collection and storage the butterflies are immediately brought back to the holding area at the zoo. We have maintained a 100% survival rate for collection and transport using this method.

Holding and care of adults

Upon arrival at the Zoo the butterflies are placed into an enclosure consisting of a mesh-covered potted lupine plant in a 2-gallon plastic pot. This covering is a cylinder of white poly mesh netting # 65-50 (Jason Mills, Westwood, NJ) sewn together with the seams arranged on the outside of the enclosure to assure that none of the butterflies can become trapped in the seam and harm themselves. Lycaenids tend to walk into corners and crevices and may become trapped. The nets fit snugly over the pot rim, and are secured with a # 107 (7" x 5/8" x 1/16") rubber band to prevent escape of butterflies and to deny entrance to predators. Each pot is numbered with a stamped metal tag identifying each butterfly with a studbook number. It is extremely important that the plants be pesticide-free before exposing butterflies to them. A nectar source is provided from a rubber-capped florist tube with a cotton wick protruding through the cap filled with a 10% clover honey/water solution (the same unit used as artificial nectar source in transport). This is placed in the soil of the potted plant. The artificial nectar source is refilled every day and replaced and disinfected in diluted common household bleach every other day. Disinfected tubes and wicks are rinsed 10x in tap water and 5x in distilled water before being reused. We have discontinued the use of nectar plants in the holding pots and instead recommend daily hand feeding of adults to maximize longevity. In this process, adults are encouraged to climb on the honey-moistened wicks of the feeding tubes. They are then gently placed with the tubes in one of the 10 cm x 10 cm x 18 cm transparent plastic containers used for transport. After the proboscis is withdrawn, the butterflies are placed back into their netted enclosures. For breeding males, a slurry of animal dung should be provided to help provide essential nutrients for the sperm packet.

Wild caught females are monitored every day for egg laying. An official egg count is performed every 2nd day. Eggs are counted by visually inspecting each leaflet and stem of the lupine plant. The undersides of the leaflets are viewed with a dentist mirror. One must make sure that the nectaring plants are adequately watered to insure that they are producing nectar. The condition of the host plant and nectar plant is also monitored every other day. We have estimated the ideal carrying capacity of each healthy host plant to be between 10-12 larvae/lupine. When 10 eggs have been laid the female is moved to a new host plant. However, some females may lay over 50 eggs in a single night. Nectar plants that are replaced when the flower heads are spent should be also checked for eggs. We prefer to remove eggs by simply clipping off the area of foliage containing the egg/s

and placing it in the host plant pot. In the event that a host plant should become infected with spider mites, the foliage supporting eggs can be gently washed, clipped from the infected plant, and transferred to a healthy host plant. Loose eggs, such as those oviposited on the substrate, can be gently transferred with a damp #2 camel hair artist brush.

It is important to maintain humidity in the enclosures. To prevent dehydration the mesh-covered enclosures are misted by hand or, during periods of heat and low humidity, by an Ecologic Technologies Rainmaker misting system (Ecologic Technologies, Pasadena, MD). The Rainmaker was set up to mist for a 2-minute duration every 15 min. from 1100-1800 h. In extremely hot weather ($> 30^{\circ}$ C) a garden soaker hose is placed on the cement pad near the enclosures to provide added humidity through evaporation.

Cool temperatures and low light intensity may prevent females from oviposition. The enclosures are arranged on shelves in an area with high light intensity and on overcast days quartz lighting was provided. In years when there are low temperatures in late May and early June a large propane heater is also employed to warm the polyhouse.

Inventory and holding of larvae/pupae

The wild-caught females are assigned a house studbook number maintained in an informal Microsoft Excel[®] studbook with such information as their capture location, capture date and fecundity. A running total is kept for all eggs, larvae, pupae, and adults produced by a given female in the studbook. In addition to the studbook, a data sheet is produced for each female each time the eggs, larvae, pupae, or 2nd flight adults are counted. Examples of a studbook page and the data sheets are provided in Appendix A. A numbered metal tag is attached to the pot of the first mesh-covered lupine plant used. When that lupine plant is replaced for a given female, a secondary number is assigned to the next pot to identify the founder of each individual set of eggs. For example, the first pot for female # 45 would have a numbered metal tag reading "45". After 10-12 eggs/lupine have been laid then the next pot used for that female would be affixed with a plastic tag reading "45A", then, for the next "45B", and so on. This enables us to easily keep individualized founder information on each set of eggs. This also allows us to look back and attempt to determine why a certain set of eggs did not hatch, or why certain pupae lived and others, in a different pot from the same female, did not. See Table I.

The larvae and pupae in each pot are counted and recorded three times a week on the data sheet and a running total is kept for each instar. Condition of larvae and pupae are noted. For example, pupae are green as pupation occurs, transform to a brown color as they age, and finally become semi-transparent when exclosure is imminent. At this time, the adult coloration, particularly the purple hues of the male, are visible through the semi-transparent cuticle of the pupa.

Larval counts will often fluctuate from day to day, as larvae will disappear, then reappear. They often move in and out of the soil around the root system and between the pot wall and the soil. Larvae are transferred to new host plants as leaves are denuded. It

is important not to overcrowd the larvae or to keep larvae of differing sizes on the same host plant. Larger larvae can and will cannibalize their smaller conspecifics. As the larvae approach the 3rd and 4th instars they tend to become more mobile and will often crawl off the plant.

TABLE 1. Informal Studbook for 1st Flight Female Karner Blue Butterflies

Studbook Number	Capture Date	Death Date	Locality	Pot or Enclosure	Number of Eggs	Number of Larvae	Number of Pupae	Number of Adults	As of
116	22-May	13-Jun	Pipeline	116, A, B, C	6	0	0	0	25-May
				D	14	0	0	0	28-May
					15	0	0	0	30-May
					16	0	0	0	1-Jun
					19	1	0	0	4-Jun
					24	9	0	0	5-Jun
					27	10	0	0	6-Jun
					35	13	0	0	8-Jun
					41	15	0	0	11-Jun
					42	30	0	0	13-Jun
					57	36	0	0	15-Jun
					57	36	1	0	20-Jun
					57	43	5	0	22-Jun
					57	47	13	0	25-Jun
					57	47	17	0	27-Jun
					57	47	23	0	29-Jun
					57	47	27	8.1	2-Jul
					57	47	29	9.5	4-Jul
					57	47	30	13.7	6-Jul
					57	47	32	14.8	9-Jul
					57	47	32	15.14	11-Jul
					57	47	32	15.15	13-Jul
					57	47	32	15.16	16-Jul
					57	48	32	15.17	17-Jul

It appears that in the fourth instar the innate behavior to find a perfect place to pupate will drive them to migrate more than usual. In captivity, they can often be found in dangerous places like the outside pot edge, under the pot, up in the net, or on the substrate near the pot. This makes it extremely easy to inadvertently smash the larvae or pupae. For this reason, extra care should be taken during the 4th instars when moving or handling the netted lupine enclosures. When pupation is imminent, pots are provided with several large pine bark chips. Fourth instar larvae often will pupate under these refugia. As soon as 2nd brood adults emerge they are sexed and recorded in the studbook. However, 2nd flight adults are not assigned their own studbook number- they are only identified by their mother's studbook number and locality. A running total of the 2nd flight adults is also kept under the studbook entry for the mother.

Predator control

Predators threaten KBBs in every stage of the life cycle. Spiders are the primary threats to larvae, pupae, and adults. Centipedes, which live in the soil, are a secondary threat. Ants, particularly the tiny *Monomorium emarginatum*, will predate KBB eggs. They may actually cut the egg almost in half, or cut a hole in the egg through which they pull the larva. They are most active in the morning and in the evening. Although *Myrmica sp.* ants protect KBB larvae in the wild, they will also predate the eggs. Trichogrammid wasps parasitize KBB eggs. Up to 7 wasp larvae may be deposited in each egg (Spoor, pers. comm.).

No pesticides are ever used in the polyhouse or on the host or nectar plants. We depend on vigilance and exclusion tactics to protect our KBBs. Each lupine plant must be thoroughly checked (i.e. examination of each leaflet) for predators before placing a KBB of any life stage upon it. Polyester netting covering the plants excludes predators, but each plant is checked every 2-3 days to ensure that no predators have entered the pots or have hatched from undetected eggs. Any detected predators are simply crushed with our fingers.

Adult care and breeding

Second brood adults are placed into breeding enclosures that are essentially individual camping tents with “no see-um” mesh. (Tropic Screen IIÒ, Bioquip Products, Inc., Gardena, CA). These mesh tents have a nylon floor and are placed approximately 4" off of the cement pad of the polyhouse by plastic shipping pallets to keep them dry and allow ventilation. This prevents the formation of dangerous pools of water (that will catch and drown small butterflies) or harmful mildew growth. The parabolic shape of the tent prevents the adults from getting caught in corners or on the peak as they would with a conventional tent. The breeding enclosure (mesh tent) is equipped with six large, healthy lupine plants, six large *Lantana camara*, *Pentas sp.* or *Asclepias tuberosa* plants, and two large artificial nectar sources placed on pedestals. These are fashioned from disinfected 4" diameter white scrub pads cut to fit into 4" diameter Petri dishes and then saturated with the 10% clover honey/water solution. Elevating the artificial nectar source on a pedestal prevents the attraction of harmful pests like ants to the breeding enclosure and

makes them more visible to the butterflies.

Males and females from the same locality (10.10) are placed within the breeding enclosures for mating and oviposition. Under this system females have the opportunity to serially mate. Serial mating may be important in this species, as we have seen egg fertility decline in subsequent clutches of wild-mated females (See Drummond 1984; Oberhauser 1974; Rutkowski et al 1997; Wannatabe 1988).

The adults are provided with a timed overhead misting system that was previously described under "holding and care of adults". Dead adults are removed from the floor of the tent on a daily basis and replaced by new butterflies. It is difficult to count eggs oviposited in the tents because of the potential harm to the breeding adults. Oviposition is estimated by viewing the host plants through the mesh and determining whether or not adequate numbers of eggs have been laid. After the target numbers of eggs are reached for each locality (usually 50 eggs), the remaining 2nd brood adults are released at the reintroduction site. Deaths and daily releases of 2nd brood adults are recorded on a daily basis and tracked on a separate chart and a tag on each tent.

In the 2001 field season we discovered that adult longevity was significantly increased when the adults were hand fed a 10% clover honey solution daily. Butterflies are encouraged, by gently nudging, to walk on the saturated wick of one of our artificial nectar tubes. They usually will immediately commence feeding. Using this technique, we have increased adult survival to as much as four weeks in the breeding facility.

2nd flight egg over-wintering protocol

Data collected from the field at the Allegan State Game area indicates that over-wintering eggs in the duff are subjected to very high humidity in the winter, usually 98-100% Relative Humidity (RH) with infrequent spikes to lows of 80 % RH in a near-condensing atmosphere. Temperatures under snow cover are remarkably stable- 0° C to – 5° C. Our best 2nd brood hatching success (ca. 40% hatching) has occurred under these conditions. We place our eggs in Mason jars containing a 2" diameter insert constructed from Plexiglas tubing. The tubing has a support of chiffon fabric 1" below the lip of the tubing. To construct this support, a 9 "section of tubing is sawn into two pieces- one of 1" length, and one of 8" length. A circular patch of fabric is glued between these two pieces of tube using Silastic aquarium cement. Replacing the dome lid with a chiffon fabric insert glued into the band with silicone aquarium cement further alters the Mason jar and protects the eggs from marauding ants. Ten to 12 eggs are placed in each jar and the jar is labeled with the number of eggs and the collection locality of the parents. Eggs are whitish green when deposited but change color to a dirty gray as they over-winter. This color change is normal. In the extremely hot and dry months of July and August, ca. 200 ml of distilled water is added to the bottom of each jar to keep humidity levels high for the eggs. Care must be taken to ensure that no water condenses around the eggs as the chiffon fabric insert in the band may inhibit evaporation, particularly under rainy conditions when ambient RH is high. Lids can be removed from jars with condensation to allow condensed water to evaporate. Jars should never be left without tops overnight,

as the eggs may be predated or parasitized. Jars can be placed in a shaded location protected from rain. We prefer to bury the jars, protected by covering them with a sheet of polyfilm, beneath snow cover when possible.

Release numbers. There are clearly differences in opinion of what population numbers constitute a minimum viable population of KBBs, and how resources should be partitioned to optimize the probability of recovery. Schweitzer (1994) is a clear proponent of a triage system, and posits that only populations of >1,000 second-flight adults or >250 first-brood adults have potential for recovery and long-term management. He suggests that the focus of KBB efforts be directed towards these sites. Andow et al. (1994), citing the rapid demise of the large Ontario population in the Point Franks area, point out that population size is not necessarily a predictor of population persistence, and argue that diversity of populations should be preserved, including small populations that are genetically unique, occur in unique habitat, or are geographically disjunct.

In accordance with Schweitzer (1994), restoration efforts should aim for a metapopulation of at least 5 demes with scattered stands of lupine and nectaring plants between them, each with >1,000 first flight adults. Given available resources, it may be impractical to aim for a single release of 1,000 animals during the first reintroduction attempt. A maximum of 40 females may be captured annually from Allegan State Game Area for an additional four years. Annual captures will be dependent upon the abundance of KBBs in Allegan and will be closely coordinated with the Michigan Department of Natural Resources. If assuming a minimum of 10 females and a maximum of 40 females are captured, then for example, 25 females are taken into captivity, and each lays 40 eggs, 800 eggs will be available for the first release attempt in 1998 and 200 would be retained for captive propagation. Assuming a 85% hatch rate, a 80% larval survival rate, and a 90% pupal survival rate (see Lane and Welch 1994), ca. 485 adult butterflies would be expected to survive the first year for a release attempt, well short of the target number proposed by Schweitzer (1994). However, several demes have persisted (many of which are obviously declining) for years at several western localities within Indiana (Martin 1994), Michigan (Wilsman 1994), and Wisconsin (Bleser 1994). The persistence of these small populations is evidence that a reintroduced population may persist at a sub-optimal level until enough augmentation occurs to bring the population to a level >1,000 first flight adults. Assuming a conservative estimate of 50 F₁ gravid captive bred females each laying 20 eggs, ca. 300 captive KBBs would be available for release from the second flight in the first (and each subsequent) year if 50% of the hatch was retained for the next generation. This projection is dependent on many assumptions, which may or may not be met in the field: 1) Production of 600 larvae in captivity each year for release after the first year. 2) Over-wintering wild population survival at a level to produce a population of adult numbers 30% that of the second flight in the previous year. 3) First flight reproduction at a level to yield second flight adult numbers three times as high as those in the lupine and nectaring plants, etc. Augmentation of the released population will have to continue for a minimum of four years to meet Schweitzer's (1994) target numbers for the first flight. The United States Fish and Wildlife Service's KBB Recovery Plan recommends that each viable metapopulation have at least 3000 total first and second brood adults.

Release Protocol. Second brood adults that have previously been in breeding enclosures or are freshly eclosed are transported to the reintroduction site in a mesh-covered pot containing lupine and a nectar plant. They are released in early afternoon in fair to good weather conditions in an area where there are adequate nectar and host plants.

Evaluation of Release Sites

Site selection - Sites on KTP were chosen to represent a spectrum of lupine habitat, including mature oak savanna (Oak Dune, Julia's Savanna), lupine partially shaded by secondary forest (Bond Tract) and lupine in full sun on essentially treeless dunes (North Piels, South Piels). These sites included one which formerly supported populations of the Karner blue (Bond Tract), two which were not known to have KBBs but which support populations of the frosted elfin, *Callophrys irus*, and the Persius dusky wing, *Erynnis persius* (Oak Dune, Julia's Savanna), and two which have extensive patches of lupine but which do not support populations of any lupine-dependent butterflies (North Piels, South Piels). Data was collected concurrently in the Allegan State Game Area, Allegan County, Michigan, at three sites that support reproducing populations of the KBB (42nd St., Gun Club, and Pipeline). Sites were chosen in the Allegan State Game Area based on their similarity in vegetation structure and species composition to those sites on the Kitty Todd Preserve that once supported populations of the KBB.

Methodology - Percent canopy cover and density, frequency, and phenology of lupine and nectar plants were quantified at the sites described above. These data were collected in randomly selected 0.5m² quadrats using the transect-quadrat method of Bonham (1989) at the density of one transect/850m² (Papp 1996). Density of lupine was calculated as the number of lupine stems/m² within each quadrat. Brood 1 and brood 2 nectar plant densities were calculated as the number of flowering stems of nectar plants/m² within each quadrat (see Tables II and III for species lists of first and second brood nectar plants at KTP and the ASGA). Canopy cover was calculated using a crown densiometer. The number of hits per transect (one reading for each quadrat) were divided by the total number of quadrats at the site to give the percentage of canopy cover (Tolson 1998).

TABLE II. INVENTORY OF BROOD 1 NECTAR PLANTS AT ASGA AND KTP UTILIZED BY THE KARNER BLUE BUTTERFLY

Species	Common name	Present at ASGA	Present at KTP	Exotic
<i>Amelanchier spicata</i>	Dwarf serviceberry	?	Yes	No
<i>Arabis lyrata</i>	Lyre-leaved rock cress	Yes	Yes	No
<i>Fragaria virginiana</i>	Wild strawberry	Yes	Yes	No
<i>Geranium maculatum</i>	Wild geranium	?	Yes	No
<i>Helianthemum canadense</i>	Frostweed	Yes	Yes	No
<i>Hieraceum pillosella</i>	Mouse-ear hawkweed	Yes	No	Yes
<i>Krigia virginica</i>	Dwarf dandelion	Yes	Yes	No
<i>Lithospermum canescens</i>	Hoary puccoon	?	Yes	No
<i>Lithospermum caroliniense</i>	Golden puccoon	Yes	Yes	No
<i>Lupinus perennis</i>	Wild lupine	Yes	Yes	No
<i>Potentilla sp.</i>	Cinquefoil sp.	Yes	Yes	No
<i>Rosa Carolina</i>	Rose	Yes	Yes	No
<i>Rubus sp.</i>	Dewberry	Yes	Yes	No
<i>Tephrosa virginiana</i>	Goat's rue	Yes	Yes	No

TABLE III. INVENTORY OF BROOD 2 NECTAR PLANTS AT ASGA AND KTP
UTILIZED BY THE KARNER BLUE BUTTERFLY

Species	Common name	Present at ASGA	Present at KTP	Exotic
<i>Achillea millefolium</i>	Yarrow	Yes	Yes	Yes
<i>Asclepias tuberosa</i>	Butterfly milkweed	Yes	Yes	No
<i>Asclepias verticillata</i>	Whorled milkweed	Yes	Yes	No
<i>Baptisia tintoria</i>	Yellow indigo	Yes	Yes	No
<i>Ceanothus americanus</i>	New Jersey tea	Yes	Yes	No
<i>Coreopsis lanceolata</i>	Lance-leaved coreopsis	Yes	Yes	No
<i>Dianthus armeria.</i>	Deptford pink	Yes	Yes	Yes
<i>Erigeron annuus</i>	Daisy fleabane	Yes	Yes	No
<i>Euphorbia corollata</i>	Flowering spurge	Yes	Yes	No
<i>Helianthus divaricatus</i>	Woodland sunflower	Yes	Yes	No
<i>Helianthus occidentalis</i>	Western sunflower	Yes	Yes	No
<i>Hieraceum aurantiacum</i>	Orange hawkweed	Yes	No	Yes
<i>Hieraceum pratense</i>	Yellow hawkweed	Yes	No	Yes
<i>Hypericum perforatum</i>	St. Johnswort	Yes	Yes	Yes
<i>Lespedeza sp.</i>	Bush clover	Yes	Yes	No
<i>Liatris aspera</i>	Blazing-star	No	Yes	No
<i>Liatris cylindracea</i>	Cylindric blazing-star	Yes	No	No
<i>Lotus corniculatus</i>	Birdsfoot trefoil	Yes	?	No
<i>Monarda fistulosa</i>	Wild bergemot	Yes	Yes	No
<i>Monarda punctata</i>	Dotted horsemint	Yes	Yes	No
<i>Polygala polygama</i>	Racemed milkwort	Yes	Yes	No
<i>Rudbeckia hirta</i>	Black-eyed Susan	Yes	Yes	No
<i>Solidago sp.</i>	Goldenrod	Yes	Yes	No
<i>Specularia perfoliata</i>	Venus looking-glass	Yes	Yes	No

Remote computerized data loggers were programmed to take data readings every 30 minutes for surface temperature, solar radiation, and relative humidity at the level of the lupine crowns (i.e. ca. 5.0 cm above soil surface). Equipment used was Onset Computer Corp.'s StowAway temperature logger model STIB-37+46, StowAway relative humidity logger model SRHA-32, and Hobo light intensity logger model HLI. Each site had one each of the listed data loggers. Data were downloaded weekly, using the Onset Computer Corp. Stowaway and Logbook software, to a laptop computer. Percent canopy cover of oak and invasive secondary forest was also quantified at each site. Canopy readings were taken weekly over the season of activity for the KBB (normally May-July) as the canopy emerged.

Analysis - Data on nectar plant resource availability were recorded and analyzed separately for first and second brood KBBs. Comparisons between locations (Michigan and Ohio) were made using an independent measures t-test and analysis of variance (ANOVA). Tests were performed to determine differences among sites within each location. ANOVA was followed up with the Tukey test to determine which sites within ASGS and KTP varied from each other. The two highest potential reintroduction sites on KTP, i.e. those with the highest mean densities of lupine and nectar plants (Bond Tract, Julia's Savanna), were compared with each of the ASGA sites independently using an independent measures t-test.

Site Selection References

Following habitat management recommendations provided (Appendix A) are not only necessary for sites occupied by Karner blue butterflies, but can improve the potential for a given site's occupation by the butterfly. Indications of a site's potential suitability for inhabitation by Karner blue butterflies can be obtained through visual analysis of specific habitat characteristics present.

Site characteristics include, but are not limited to, vegetative qualifiers alone (nectar species presence and abundance, ground and canopy cover, lupine, etc.). Other site characteristics such as protection or preservation and potential general threats to the sites existence, etc., can impact Karner blue butterfly suitability and should be taken into account. Appendix B provides a habitat manager/landowner with a basic technique for evaluating Karner blue butterfly habitat suitability through listing and identifying habitat criteria in a checklist format.

Monitoring

Monitoring for 1st flight KBBs begins approximately the third week in May. The transect area is searched each day except in the rain until no butterflies have been sighted for at least three days. It is then suspended until the 2nd brood adults emerge, approximately 28 days after the 1st flight. Then monitoring resumes again in the same fashion until three days after the last 2nd flight KBB has been seen. Emigration from the release site is determined by carefully walking a transect route for each site in our reintroduction area

with significant stands of lupine. The transect areas are always searched by two spotters. The primary release site is the major transect area. This area has a plot of 120m x 100m with transect widths of 10m. In this primary area a spotter walks every 5m in alternating directions with each other. Secondary transect sites consist of ca.20m wide strips. The route went through the sites, alternating direction from one strip to the next until the entire site was covered. Sightings of KBBs are plotted on a topographic map of the preserve.

Future Release Sites

In order to meet the stated objective of establishing three metapopulations of Karner blue butterflies in the Oak Openings Region, additional release sites throughout the region will be necessary. Site selection of these release sites will be determined using similar methodologies as were used at the current Kitty Todd Preserve release location(s). Currently, three locations are being managed/monitored for potential release of the Karner blue butterfly. In no particular order of rank, these are: the Moseley Barrens (The Nature Conservancy), the Louis Cambell Prairie/South Wilkins (Metroparks of the Toledo Area – Oak Openings Preserve), and the Meilke Road Savanna Wildlife Area (Ohio Division of Wildlife). Other potential release sites may become available through future purchases or response of presently held tracts to oak savanna habitat management.

Responsibilities

The Ohio Karner Blue Butterfly Recovery Team (OKBBRT) will coordinate the strategy for the recovery of Karner blue in Ohio. The Team is represented by several conservation organizations with expertise in habitat management and restoration, wildlife management, community ecology, lepidoptera, entomology, and captive breeding. The Ohio Karner Blue Butterfly Team will act as the Ohio liaison with the Federal Karner Blue Recovery Team that was formed by the United States Fish and Wildlife Service to coordinate all recovery efforts for the Karner blue in the United States. **Currently, the Federal Recovery Team has designated Ohio as a Potential Recovery Unit for the Karner blue butterfly which means that recovery in Ohio is not necessary for delisting of the species.**

UNITED STATES FISH AND WILDLIFE SERVICE



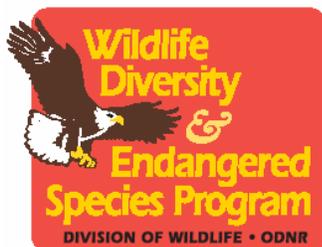
The U.S. Fish and Wildlife Service (FWS, hereafter) and the National Marine Fisheries Service are the two Federal agencies responsible for implementing the U.S. Endangered Species Act (ESA). The FWS implements the ESA through activities that involve listing a species as threatened or endangered (ESA Section 4), recovery of listed species (ESA Section 4), grants to state resource agencies for species projects (ESA Section 6), land acquisition (ESA Section 5), project or program consultations with Federal agencies and their partners (ESA Section 7), law enforcement (ESA Section 9), and permits (ESA Section 10) that sometimes include Habitat Conservation Plans. Thus, the FWS can use its regulatory authority under the ESA to assist Oak Openings area partners in implementing a number of Karner blue recovery activities.

The Reynoldsburg, Ohio, office of the FWS will assist with Karner blue and Oak Openings recovery in several ways. The Ohio FWS office will serve as a liaison with the Federal Karner Blue Recovery Team, helping to coordinate Ohio activities with the Federal Karner Blue Recovery Plan. The Ohio FWS office can assist the Ohio Division of Wildlife and Ohio Division of Natural Areas and Preserves with ESA Section 6 grants and other Federal funds to implement recovery projects for the Karner blue in northwest Ohio. The Ohio FWS office can help protect Karner blues and their habitat by consulting (ESA Section 7) with Federal agencies or their designees on projects that may affect the Karner blues or their habitat. A Federal designee is an organization that implements the ESA on behalf of the Federal government (e.g., the Ohio Department of Transportation) while partners, or those who consult, implement a project using Federal funds (e.g., a developer building apartments using Federal housing funds). The Ohio FWS office can also assist Oak Openings area agencies and landowners with ESA permit compliance and law enforcement support, if necessary.

The FWS can assist private landowners and local communities in implementing recovery projects through the Private Stewardship Grant Program and Partners for Fish and Wildlife Program. These programs focus on habitat restoration projects which benefit Federally-listed species and/or fish and wildlife habitat, such as oak savanna and the Karner blue butterfly.

OHIO DEPARTMENT OF NATURAL RESOURCES

Division of Wildlife



MISSION STATEMENT

We are dedicated to conserving and improving the fish and wildlife resources and their habitats, and promoting their use and appreciation by the people so that these resources continue to enhance the quality of life for all Ohioans.

The Division of Wildlife is the state agency responsible for management of Ohio's fish and wildlife resources. The Division operates under a broad set of authorities found in the Ohio Revised Code. A portion of the Revised Code states that the Division of Wildlife holds title to all wild animals, which are not legally confined or held in private ownership, in trust for the benefit of all Ohioans. The Revised Code further directs the Division to plan, develop, and institute programs and policies that are designed for the general care, protection, and supervision of the wildlife resource in the state. The Division is also empowered to develop and enforce regulations for the protection, preservation, propagation, management, and wise use of wild animals and specific plant(s).

As part of this direction, the Division of Wildlife created a Strategic Plan to help guide the Division and its activities. One of the broad strategic issues identified in the plan addresses management and restoration of specific habitats such as forest, grassland, wetland, and unique habitats. Oak savannas of the Oak Openings region of northwest Ohio is one of the habitats clearly identified in the Unique Habitats Tactical Plan. The Division plans to “enhance, restore, and connect fragmented oak savanna habitat”, particularly to sustain four endangered wildlife species which are limited to this habitat. The Karner blue butterfly is one of these endangered species.

The Division of Wildlife will coordinate the Karner blue butterfly restoration effort, including assisting with oak savanna habitat restoration and enhancement, obtaining USFWS approval for the reintroduction of Karner blues in Ohio, coordinating with partners, providing funding for the program, obtaining permits for securing and moving Karner blues from Michigan, assisting with preparation of informational and educational materials, preparing all necessary progress and final reports, and providing law enforcement for protection of Karner blue release sites. The Division may also acquire habitat for the Karner blue, such as the Meilke Road Savanna Wildlife Area, which has been identified as a potential reintroduction site for the Karner blue.

Division of Forestry



The Division of Forestry manages the 3,100-acre Maumee State Forest, located in the Oak Openings area. The forest is composed of several parcels located in Fulton, Henry and Lucas Counties. Several populations of wild lupine have been found within the state forest, primarily on exposed sandy soils. The Division of Forestry is part of the Green River Initiative Committee. The Maumee State Forest is managed under a multiple use/ecosystem

management approach for timber, wildlife, recreation, soil and water protection, and for the protection of rare flora and fauna species as well as their habitat. The Division of Forestry has a Cooperative Management Agreement with the Division of Natural Areas and Preserves to manage a 40-acre wet sedge meadow site on the forest, using mowing, manual cutting with stump treatment and controlled burning. The two Divisions plan to work together to review the lupine sites within Maumee State Forest and consider management approaches.

Division of Natural Areas and Preserves



The Division of Natural Areas and Preserves owns and manages two preserves in the Oak Openings, Irwin Prairie and Louis W. Campbell State Nature Preserves. Campbell Preserve, encompassing 170 acres, contains approximately 80 acres of oak woods, savanna, and small sand prairie openings. The Division has been intensively managing these areas to control woody species using manual cutting, herbicide

treatments, and controlled burning since 1984. Four small openings, approximately 5 acres total, contain wild lupine. While these openings are small and need more nectar plants for Karner blue butterfly habitat, the preserve has potential, especially when considered in conjunction with adjacent Toledo Express Airport lands. The Division will continue management efforts to perpetuate the overall diversity of plant and animal species. If the site were chosen as a Karner Blue reintroduction site, additional measures could be undertaken to further enhance the quality of butterfly habitat.

The Division has funded and/or coordinated several efforts involving the Karner blue butterfly since 1988. Three grants were funded by the Division's Natural Areas Research Grants Program: 1) a survey for Karner blues by Mitch Magdich in 1988 documented the last 3 sitings; 2) a follow-up survey for Karner blues by Margaret Bresnahan in 1989; and 3) a propagation project for lupine and nectar plants by The Toledo Zoo in 1993. In addition, during 1989-1992, Division staff and volunteers conducted surveys for the Karner blue at Campbell Preserve and the Toledo Express Airport.

The Division maintains the Ohio Natural Heritage Database, which contains records of rare species, plant communities and natural features in Ohio. This database contains information on many areas in the Oak Openings, including locations of lupine, which is a potentially threatened species in Ohio.

The Division was involved in habitat management at the Meilke Road Savanna, which is approximately 60 acres of oak woods, oak savanna and sand barrens located not far from Kitty Todd Preserve. It contains a large lupine population, and is owned by the Spencer Township Trustees as well as several private landowners. The Division obtained a management agreement with the township for their 15 acres. A small grant was obtained from the US Fish and Wildlife Service to manage for woody species on this property. Management activities included the removal of woody and non-native species using cutting and herbicide treatment. The Division also conducted management activities on one of the privately owned parcels, now owned and managed by the Division of Wildlife as Meilke Road Savanna Wildlife Area as of 2004.

TOLEDO-LUCAS CO. PORT AUTHORITY/TOLEDO EXPRESS AIRPORT



The Toledo-Lucas County Port Authority operates the Toledo Express Airport, which contains approximately 100 acres of sand barren habitat including several large populations of wild lupine. The Port Authority has allowed the Ohio Department of Natural Resources (ODNR) to conduct species inventories on 2,500+ acres of airport lands since 1989 (specifically with the Division of Natural Areas & Preserves during 1989-1997 and recently with the Division of Wildlife since 2002). More than 75 state-listed plants and animals have been recorded from airport lands. The Port Authority has cooperated with ODNR on requests for

inventories, collection of lupine seeds, controlled burns, and some modifications to construction plans. Most recently, the Division of Wildlife has provided habitat management recommendations for specific high-quality areas on airport lands, including the only known site for the state endangered purplish copper butterfly. Several sites on airport lands may be suitable for Karner blue butterfly introduction in the future.

METROPOLITAN PARK DISTRICT OF THE TOLEDO AREA



Past recovery activities: Beginning in 1987, the Metroparks took an active role in monitoring the Karner blue butterfly in Ohio with the formation of a Lupine Hotline and subsequent survey of high quality sites for the butterfly in northwestern Ohio. In 1988-89, the Metroparks assisted in a grant from the ODNR Division of Natural Areas and Preserves (DNAP) to thoroughly survey the potential Karner blue sites and have helped coordinate volunteer and staff surveys for the Karner

blue, lupine strongholds and nectaring sources from 1988 to the present.

The Park District began an intensive land management program of Metropark oak savanna restoration in 1988 using fire and selective cutting to remove canopy cover from the degraded units. The District has been involved in several studies of *Lupinus perennis* on our park lands, attended many of the Karner blue workshops and meetings, and put together documentation, with DNAP and the Ohio Lepidopterist Society, on the history of the Karner blue in Ohio. Metroparks established a long-term community-monitoring program for our oak savanna units and participated in the formation of the EPA's oak ecosystem restoration draft plan as well as annual conferences on this ecosystem in the Midwest. In an attempt to reduce non-target larva viding of Lepidoptera and especially rare butterflies and moths, during the gypsy moth outbreaks, the Metroparks also introduced the fungus, *Entomophaga maimaiga*, as a bio-control in Lucas County.

Current recovery activities: The Park District actively manages its best savanna units as an oak savanna ecosystem. This community type supports many other rare invertebrates birds and plants besides the Karner blue butterfly, such as the antenna waving wasp (*Tachysphex pechumani*), Persius dusky wing (*Erynnus persius*), Edward's hairstreak butterfly (*Safyrium edwardsii*), the lark sparrow (*Chondestes grammacus*). A current list of rare plants monitored is available through the Metroparks and ODNR Division of Natural Areas and Preserves. One third of all rare species in Ohio occur in the Oak Openings region. Metropark research through two butterfly transects (in cooperation with Ohio Division of Wildlife, Ohio Lepidopterists and the Cleveland Museum of Natural History) compliments the Karner blue work. One transect runs through the Campbell Prairie and adjacent units, and the second is located at the last known location of Karner blue before it was extirpated in the park.

Management to increase the extent of oak savanna continues. The 3,700-acre Oak Openings Preserve Metropark is the site of the greatest management activity and is the historic site for the Karner blue in the park district. There are approximately 250 acres of oak savanna currently under management at this site, mostly in 30 to 40 acre units.

The Park District also cooperates with The Toledo Zoo and The Nature Conservancy. From research and management techniques to public education, joint on-going efforts about the Oak Openings region and the Karner blue helps solidify the public's awareness and support for recovery. The Karner blue symbolizes the need to preserve and manage the best areas of the Oak Openings.

Metroparks is also part of the Green Ribbon Initiative Committee composed of public and private agencies, who meet to discuss cooperative preservation of and education about the Oak Openings region.

Future recovery activities: Metroparks is committed to managing for the oak savanna community and its dependent species. In 2001-02, research by staff from the Toledo Zoo helped the Metroparks determine habitat quality for Karner blue at the Lou Campbell Prairie unit on S. Wilkins Road. Increased nectaring sources are still needed. The Metroparks have been collecting seeds from adjacent units and planting the needed plants with a goal of re-establishment of the butterfly by 2005. For the Karner blue to fully utilize the current management units with Oak Openings Preserve and adjacent natural areas, corridors have also been created and managed. The Karner blue butterfly existed for many years along a railroad right-of-way and an adjacent 200-acre savanna within Oak Openings Preserve. Metroparks also has a long-term plan to provide a connecting biological corridor between Secor and Oak Openings Metroparks linking Kitty Todd Preserve with the corridor. In addition, Metroparks has acquired additional habitat at West Winds Industrial Area just to the south of Kitty Todd. Additional acreage could be added to the management plan to increase suitable area for demes of a metapopulation of Karner blue as details on minimum acreage for the butterfly become available.

THE OHIO CHAPTER OF THE NATURE CONSERVANCY



The Nature Conservancy's overall objective within the 130-square mile region of Ohio's Oak Openings is to initiate and facilitate the conservation of the natural ecosystem. Our efforts are focused on four primary levels:

Land acquisition: The Conservancy maintains one preserve within the Oak Openings Region, the 700-acre Kitty Todd Nature Preserve. Within the preserve's potential acquisition area is the region's best unprotected contiguous remnant wet prairie, oak savanna, sand barren. The preserve and the surrounding area also supports the best concentration of Karner blue habitat within the region. Approximately 700 acres of the ultimate potential preserve area could, with management, provide Karner blue habitat. Additions to the preserve are actively being pursued from willing sellers.

Habitat management: The Conservancy has been managing the Kitty Todd preserve for oak savanna, sand barren and wet prairie since the initial acquisitions in the 1970s. Management objectives include the restoration and maintenance of all the components that comprise these systems. Habitat requirements for the Karner blue butterfly are considered when management objectives are set and techniques are implemented.

Specific management techniques include prescribed burning, mowing, hand cutting, spot herbicide applications, seeding, hand planting and hydrologic restoration. Currently, approximately 130 acres of the preserve contain suitable Karner blue habitat.

The Karner blue was re-introduced to the preserve's Julia's Savanna Management Unit beginning in 1998 and additional releases have taken place annually through 2003. In 2004, the Ohio Recovery Team decided not to release more butterflies at this site in order to determine if the preserve contained a self-supporting population. Since the initial release, the Karner blue has colonized the South Piels Management Unit where intensive habitat restoration has significantly reduced the amount of the non-native smooth brome (*Bromus inermis*). This has resulted in a dramatic increase in the amount of lupine at that site. Many additional nectar sources have also been planted. In 2004, Karner blues were released on the Bond Dune located within the Bond Management Unit. This site contains a large lupine population and habitat restoration has increased the number of nectar sources. Also in 2004, the Karner blue colonized the Oak Dune located within the Oak Dune Management Unit. This site contains a natural lupine population and abundant nectar sources. Thousands of lupine seeds have been planted in the last several years which has greatly increased the number of lupine at this location.

Intensive restoration work has also taken place at the preserve's Moseley Barrens and Moseley Savanna Management Units within the last several years. The tree canopy has been restored on approximately 100 acres within these units and thousands of lupine and nectar sources have planted to prepare the site for Karner blue re-introduction. The Ohio Karner Blue Recovery Team selected Moseley Barrens as the location to establish a new population of Karner blues and re-introduction took place in 2005.

Several other management units on the preserve contain potential Karner blue habitat including a new parcel that was purchased in 2004. These sites are also being intensively managed for future Karner blue populations.

Monitoring: In order to evaluate the possible impacts and results of our habitat management, The Conservancy utilizes both pre-management and post-management monitoring, which is conducted by staff, volunteers and researches. Savanna butterflies and the plants they depend upon are an important component of the monitoring efforts at the Kitty Todd Preserve.

Region wide education and protection: Outside of the boundaries of the Oak Openings Region's parks and preserves are numerous areas of significant unprotected habitat. Portions of this habitat could be suitable for the Karner blue butterfly. The Conservancy is working with a variety of partners to increase the possibility of protecting more of these through a citizen-based conservation effort known as the Oak Openings Region Green Ribbon Initiative. The general objective of the initiative is to foster local support for conservation of the region and to work to protect an additional 6,000 acres of the region's remaining high quality habitat. This Initiative has the potential to have significant long-term benefits for the Karner blue butterfly.

The Nature Conservancy is committed to the concept of restoring and maintaining a viable population of Karner blue butterflies in the Oak Openings Region of Ohio.

THE TOLEDO ZOOLOGICAL SOCIETY



The Toledo Zoological Society is committed to the recovery of populations of oak savanna butterflies in northwestern Ohio, most notably the Karner blue butterflies. Selected activities will include:

1. Development of protocols for breeding and rearing lupine-feeding Lycaenids in captivity, including the Karner blue butterfly. This information will be used to produce captive-born butterflies for release into suitable Oak Openings habitat.
2. Continued production of lupine and first and second-brood nectaring plants from local stock to be used as food sources for captive populations of endangered butterflies and for transplantation into the wild.
3. Continued habitat management in the Oak Openings to improve conditions for native butterflies, including removal of invasive exotic plants and planting of additional nectaring plants in selected butterfly habitat.
4. Continued surveying and monitoring of endangered butterfly populations in the Oak Openings of Northwestern Ohio and Southeast Michigan, including long-term monitoring of reintroduced Karner blue butterflies.
5. Continued education initiatives for the Karner blue and other endangered Ohio butterflies, including exhibits, public lectures, educational and conservation publications, and materials distributed to local schools.
6. Continued coordination of the oak savanna butterfly recovery activities in Northwestern Ohio, including liaisons with the U.S. Fish and Wildlife Service, the Ohio Department of Natural Resources, and other agencies critical to protection of butterflies and their habitat.

ACTION COMMITTEES

Periodically, it may be necessary to form Action Committees to address specific concerns and issues. These may range from procedural concerns in implementing the plan to ones of much larger magnitude, which may jeopardize reintroduction, and survival of the Karner blue in Ohio (e.g. gypsy moth control). Committees will be composed of members of the OKBBRT or other designated representatives who can contribute to problem or issue resolution.

TIMELINE

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Literature review	☒	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Draft Conservation Plan	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Final Conservation Plan	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Conservation Plan Revisions	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒	☒	☐	☐	☐	☐	☐
Tour KBB habitat sites	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐	☐
Develop protocol - Melissa blue	☐	☒	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Develop KBB monitoring protocol	☐	☒	☒	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Develop habitat management/monitor	☐	☒	☒	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Habitat management/protection/	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Select/evaluate release sites	☐	☐	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Obtain/captive rear KBB	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Initial KBB reintroduction	☐	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional KBB reintroduction	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
KBB population monitor/assessment	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Publish monitor survey results	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Produce/distribute educational	☐	☐	☐	☐	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Annual Progress Report												☒	☒	☒	☒	☒	☒

☒ = Indicates tasks accomplished/planned

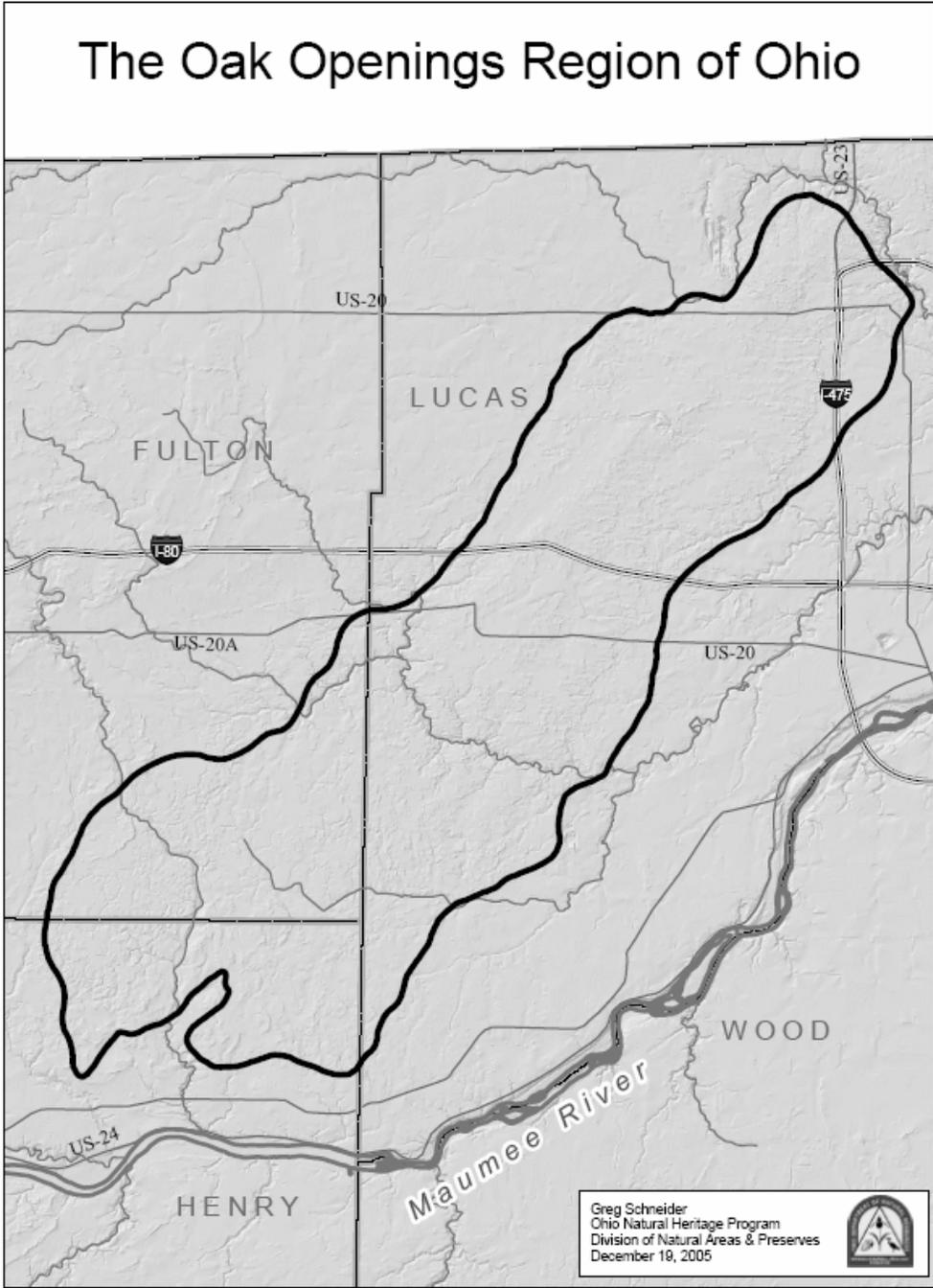


Fig. 1. The location of the Oak Openings Region of Ohio is depicted inside the heavy black line.

Appendix A

Management Recommendations For Karner Blue Butterfly Habitat

Any site managed for potential Karner blue butterfly release or occupied by Karner blues should include some combination of the following management techniques:

Prescribed burning - burning should be used to control woody species and enhance oak savanna habitat

Karner blue habitat should be divided into units:

- units in a site should be burned every 2-5 years when needed, while not burning all units in a single year nor burning any unit every year; if possible, do not burn adjacent occupied units in sequential years
- if Karner blues are introduced to a site, care should be taken not to burn that unit until butterflies are also established in other units or the release is considered unsuccessful
- burn only a third of occupied Karner blue habitat at one time; any one unit should be burned on a 3-year cycle (to allow for recolonization)
- attempt to vary timing of burns (use fall and spring burns)
- if possible, leave dense lupine areas in occupied habitat unburned (use other treatments)

Manual cutting and stump treatment with systemic herbicide - this combination should be used to control woody species, most likely in addition to burning and/or mowing

- cutting and herbicide treatment should be done in the dormant season (October-March) as much as possible to reduce trampling on herbaceous species

Mowing - mowing may be used to control woody species and is best done in the dormant season (October-March). Mowing may be used in place of burning when conditions are not suitable for burning or the site requires more frequent management.

Additional information on management guidelines and recommendations is available from Appendix G. of the U.S. Fish and Wildlife Service's Karner Blue Butterfly Recovery Plan.

Appendix B

Habitat Evaluation for Karner Blue Butterfly: Site Coversheet

When evaluating habitat for the Karner blue butterfly, determine the following qualities present at the site, then use the unit checklist for a more detailed evaluation.

SITE NAME: _____
DATES OF EVALUATION: _____
REVIEWER: _____

Total area of Karner blue butterfly habitat present at the site (estimate acreage):

_____ existing habitat
_____ potential habitat
_____ presence of corridors between units (describe)

Management regime in place:

_____ management techniques being used and frequency (describe)

Level of protection and commitment of landowners (describe):

_____ protected and high level of commitment
_____ protected and moderate level of commitment
_____ protected and low level of commitment
_____ unprotected and high level of commitment
_____ unprotected and moderate level of commitment
_____ unprotected and low level of commitment

Threats to the site:

_____ deer browse
_____ pesticide use
_____ other (describe)

Appendix B

Habitat Evaluation for Karner Blue Butterfly: Unit Checklist

SITE NAME: _____

UNIT: _____

1. Amount of lupine

- _____ < ½ acre of lupine cover; estimate % cover: _____
- _____ ½ acre - 5 acres of lupine cover; estimate % cover: _____
- _____ > 5 acres of lupine cover; estimate total acreage & % cover:

2. Quality of lupine

- _____ estimate % of lupine flowering
- _____ estimate % fruit set in flowering lupine
- _____ estimate % lupine in the sun (describe if necessary, e.g., savanna)
- _____ estimate % lupine in the shade

3. Amount of first generation nectar plants (May-June)

Use attached species list and abundance codes.

4. Amount of second generation nectar plants (July-August)

Use attached species list and abundance codes.

5. Amount of tree/cover/understory

- _____ estimate % canopy
- _____ estimate % cover of shrubs and/or sprouts
- _____ other competing understory species (e.g. bracken fern)

6. Amount of grasses

- _____ estimate % cover of grass species
- _____ list dominant grasses and sedges present

7. Presence of ants and associated Lepidoptera

- _____ evidence of mound-building ants in the unit (describe)
- _____ list any associated Lepidoptera known from the site

8. Amount of bare sand present: _____ estimate % cover

Appendix B

First Generation Nectar Plants (May-June)

Use abundance codes below to record presence of all blooming plants in the unit.

UNIT NAME:

- ___ Wild lupine (*Lupinus perennis*)
- ___ Golden puccoon (*Lithospermum caroliniense* & *L. canescens*)
- ___ Goat's-rue (*Tephrosia virginiana*)
- ___ Dwarf dandelion (*Krigia virginica*)
- ___ Two-flowered cynthia (*Krigia biflora*)
- ___ Frostweed (*Helianthemum canadense* or *H. bicknellii*)
- ___ Wild strawberry (*Fragaria virginiana*)
- ___ Lyre-leaved rockcress (*Arabis lyrata*)
- ___ Bastard toad-flax (*Comandra umbellata*)
- ___ Yellow-eyed grass (*Hyposix hirsuta*)
- ___ Common cinquefoil (*Potentilla simplex*)
- ___ Hawkweed (*Hieracium* sp.)
- ___ Yarrow (*Achillea millefolium*)
- ___ Bladder campion (*Silene cucubalus*)
- ___ Phlox (*Phlox* sp.)
- ___ Columbine (*Aquilegia canadensis*)
- ___ Dewberry (*Rubus flagellaris* & *R. hispidus*)
- ___ Blueberry spp. (*Vaccinium angustifolium* & *V. pallidum*)
- ___ Rose (*Rosa carolina* or *R. setigera*)

List any other blooming species in the unit:

ABUNDANCE CODES FOR PLANT SPECIES:

- 1 = Dominant (one of the most abundant species)
- 2 = Common (non-dominant, but widespread)
- 3 = Frequent (occurring throughout site in low numbers)
- 4 = Scattered (common only in a few locations)
- 5 = Infrequent (few scattered in a few locations)
- 6 = Rare (less than 10 individuals)

Appendix B

Second Generation Nectar Plants (July-August)

Use abundance codes below to record presence of all blooming plants in the unit.

UNIT NAME:

- ___ Butterflyweed (*Asclepias tuberosa*)
- ___ Wild bergamot (*Monarda fistulosa*)
- ___ New Jersey tea (*Ceanothus americanus*)
- ___ Black-eyed Susan (*Rudbeckia hirta*)
- ___ Dewberry (*Rubus sp.*)
- ___ Blazing-star (*Liatris squarrosa* or *L. aspera*)
- ___ Bush-clover (*Lespedeza sp.*)
- ___ Yellow indigo (*Baptisia tinctoria*)
- ___ Flowering spruce (*Euphorbia corollata*)
- ___ Mountain-mint (*Pycnanthemum virginianum*)
- ___ Goldenrod (*Solidago sp.*)

List any other blooming species in the unit:

ABUNDANCE CODES FOR PLANT SPECIES:

- 1 = Dominant (one of the most abundant species)
- 2 = Common (non-dominant, but widespread)
- 3 = Frequent (occurring throughout site in low numbers)
- 4 = Scattered (common only in a few locations)
- 5 = Infrequent (few scattered in a few locations)
- 6 = Rare (less than 10 individuals)

TABLE 1. FIRST GENERATION NECTAR PLANTS

The following are plants Karner blues have been seen feeding on at the Kitty Todd Preserve:

Wild lupine (*Lupinus perennis*)
Plains puccoon (*Lithospermum caroliniense*)
Wild strawberry (*Fragaria virginiana*)
Lyre-leaved rockcress (*Arabis lyrata*)
Common cinquefoil (*Potentilla simplex*)
Yarrow (*Achillea millefolium*)
Common dewberry (*Rubus flagellaris*)
Swamp Dewberry (*Rubus hispidus*)

The following plants are cited in other literature as Karner blue nectar sources, however, Karner blues were not observed feeding on them at the Kitty Todd Preserve:

Dwarf dandelion (*Krigia virginica*)
Two-flowered Cynthia (*Krigia biflora*)
Canada frostweed (*Helianthemum canadense*)
Bicknell's frostweed (*Helianthemum bicknellii*)
Bastard toad-flax (*Comandra umbellata*)
Yellow star grass (*Hypoxis hirsuta*)
Columbine (*Aquilegia canadensis*)
Blueberry spp. (*Vaccinium angustifolium* & *V. pallidum*)
Pasture rose (*Rosa carolina*)

TABLE 2. Second Generation Nectar Plants

The following plants are plants that Karner blues have been seen feeding on at the Kitty Todd Preserve:

Butterfly milkweed (*Asclepias tuberosa*)

Wild bergamot (*Monarda fistulosa*)

Dotted horsemint (*Monarda punctata*)

New Jersey tea (*Ceanothus americanus*)

Black-eyed Susan (*Rudbeckia hirta*)

Dense blazing star (*Liatris spicata*)

Yellow wild indigo (*Baptisia tinctoria*)

Flowering spurge (*Euphorbia corollata*)

Virginia mountain mint (*Pycnanthemum virginianum*)

Early Goldenrod (*Solidago juncea*)

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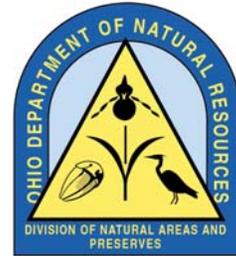
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In 1993, the Ohio Karner Blue Butterfly Recovery Team was formed to develop a plan to return the Karner blue to the state. The team consists of representatives from the Ohio Divisions of Wildlife, Natural Areas & Preserves, and Forestry, The Toledo Zoological Society, The Nature Conservancy, The Ohio Lepidopterist Society, Toledo-Lucas County Port Authority, Metropolitan Park District of the Toledo Area, and the U.S. Fish and Wildlife Service.



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