

DRAFT MANAGEMENT PLAN

MIAMI BLUE BUTTERFLY

Hemiargus [Cyclargus] thomasi bethunebakeri

August 22, 2003

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MANAGEMENT PLAN MIAMI BLUE BUTTERFLY

August 22, 2003

EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) proposes to classify the Miami blue butterfly, *Hemiargus [Cyclargus] thomasi bethunebakeri*, as an endangered species pursuant to the procedural requirements embodied in Rule 68A-27.0012, Florida Administrative Code (F.A.C.). The proposed change in classification will continue the prohibition of direct take except through permit authorized by the executive director or his delegate.

This management plan provides the framework for conserving and managing the Miami blue butterfly and includes (1) an assessment of the threats responsible for the species' apparent status as endangered, (2) a clear statement of the conservation goal and objective targeted by the management plan, and (3) the conservation actions believed necessary to achieve the stated goal and objective. An implementation approach for the management plan, a monitoring plan for assessing future status, and areas for future research also are included.

The FWC conservation goal for the Miami blue butterfly is to secure and maintain a stable or increasing population of Miami blue butterfly at a level that does not meet the criteria defining an Endangered species. Based on the premise that if additional Miami blue butterfly colonies are not located or established outside the remaining 1 square mile area the species will not meet the criteria for downlisting to a Threatened species, the conservation objective is to secure and maintain, by the year 2012 and beyond, colonies of Miami blue butterflies across at least a 40 square mile area, while simultaneously securing and maintaining a net increase in the number of mature adults from the year 2002 status level.

This management plan fulfills the requirements of Rule 68A-27.0012, F.A.C., which went into effect June 29, 1999. The emergency listing process for the Miami blue butterfly was initiated in November 2002 by FWC acceptance of a valid petition for listing action. FWC staff reviewed the status of the Miami blue butterfly relative to Florida's listing criteria and summarized the results in a Final Biological Status Report. Based on that report, in January 2002, the Commission determined that listing the Miami blue butterfly as endangered was warranted and directed FWC staff to develop a species management plan for consideration during the November 2003 meeting.

Public comments and outside review were formally solicited and incorporated at several junctures during the listing process. Public comment periods were noticed in the Florida Administrative Weekly (1) to solicit information on the biological status of the Miami blue butterfly to be considered during the development of the Final Biological Status Report, (2) to solicit information on the conservation needs of the Miami blue

butterfly and any economic and social factors that should be considered in its management, and (3) to solicit public input on the Draft Management Plan, including any information regarding the anticipated regulatory and social impacts of management plan implementation. The Commission meeting at which the management plan is presented will provide an additional opportunity for public comment relative to this management plan.

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SPECIES MANAGEMENT PLAN

INTRODUCTION

The Miami blue is a small blue butterfly with a forewing length of 10-13 mm. Males and females are both bright blue dorsally but females have an orange eyespot near the hindwing outer angle. Both sexes have a tawny gray underside with 4 black spots on the basal and postbasal areas and a bright orange spot on the hindwing (Minno and Emmel 1993; 1994, Gerberg and Arnett 1989, Glassberg et al. 2000). The Miami blue butterfly occurs at the edges of tropical hardwood hammocks, beachside scrub, and occasionally on pine rocklands (Minno and Emmel 1993, Smith et al. 1994, Glassberg et al. 2000). Larval hostplants include the non-native balloonvine (*Cardiospermum halicacabum*), gray nicker bean (*Caesalpinia bunduc*) and a non-native nicker bean (*C. pulcherrima*) (Smith et al. 1994, Calhoun et al. 2002). The eggs are laid on flower buds and the larvae feed within the flowers and developing seeds (Smith et al. 1994). The larvae are green with a black head capsule, a red-brown mid-dorsal line and white lateral lines. The pupa are brown. Miami blue caterpillars are occasionally tended by ants (*Camponotus* spp.) that provide protection in exchange for a honeydew substance the ants feed on (Minno and Emmel 1993). Primarily a South Florida coastal species, the Miami blue's historical distribution ranged as far north as Hillsborough County on the Gulf Coast and Volusia County on the Atlantic Coast and extended south to the Florida Keys and the Dry Tortugas (Klots 1964, Howe 1975, Calhoun et al. 2002). Prior to the 1990s, the Miami blue butterfly was most common in South Florida and the Florida Keys especially around Biscayne Bay, Key Largo, and Big Pine Key.

The Miami blue butterfly was thought to be extirpated following Hurricane Andrew in 1992. The last confirmed report before the hurricane was on Big Pine Key on March 1992 (Glassberg et al. 2000, Calhoun et al. 2002). The butterfly was finally observed on November 1999 at Bahia Honda State Park in the Florida Keys (Ruffin and Glassberg 2000). A current research project by the University of Florida's McGuire Center for Lepidoptera Research estimates the Miami blue butterfly population at Bahia Honda State Park contains between 51 and 66 individuals (Emmel and Daniels 2002a,b).

On November 15, 2002, Florida Fish and Wildlife Conservation Commission (FWC) staff received an emergency petition (Glassberg 2002) to classify the Miami blue butterfly as an endangered species. Staff evaluated the submitted petition and determined that it did meet the emergency standard in Rule 68A-27.0012(1)(d) F.A.C. On December 10, 2002 the Executive Director issued an Executive Order that listed the Miami blue as an endangered species in Florida under Rule 68A-27.003 (1) F.A.C. to prevent imminent extinction. At their January 2003 meeting, the agency's Commissioners approved the emergency listing action and directed staff to undertake a comprehensive assessment of the Miami blue's biological status pursuant to the criteria and definitions embodied in Rule 68A-1.004 F.A.C. and to summarize the results in a Final Biological Status Report (FWC 2003) Based upon that report, at the May 2003 Commission meeting, the FWC directed staff to develop a species management plan for consideration during the

November 2003 Commission meeting. This management plan fulfills that directive pursuant to Rule 68A-27.0012 F.A.C.

Public comments and outside review were formally solicited and incorporated at several junctures during the listing process. The following public comment periods were noticed in the Florida Administrative Weekly: (1) January 24, 2003 - March 10, 2003 to solicit information on the biological status of the Miami blue butterfly to be considered during the development of the Final Biological Status Report; (2) May 30, 2003 – July 13, 2003 to solicit information on the conservation needs of the Miami blue butterfly and any economic and social factors that should be considered in its management; and (3) August 22, 2003 – October 10, 2003 to solicit public comment on the Draft Management Plan, including any information regarding the anticipated regulatory economic and social impacts of the management plan implementation. No public comments were heard at the January 22 – January 24, 2003 FWC meeting, when the petition to emergency list the Miami blue butterfly was presented, or at the May 28 –May 30, 2003 FWC meeting, when the results of the biological status assessment were reported. The Commission meeting at which the management plan is to be presented will provide an additional opportunity for public comment relative to the proposed listing action.

The Miami blue butterfly management plan includes (1) an assessment of the threats responsible for the species' status as an Endangered species, (2) a statement of the conservation goal and objective targeted by the management plan, (3) conservation actions, incentives, and regulations recommended to achieve that goal and objective, (4) a monitoring plan to assess Miami blue butterfly status, (5) anticipated economic and social impacts, (6) an implementation approach for the management plan, and (7) suggested areas for future research.

DEFINITIONS

The following glossary defines scientific terms as they pertain to Miami blue butterfly assessment, conservation, and research described in this management plan.

Area of Occupancy	The geographic area inhabited by all individuals in a population. Typically, the amount of habitat in which individuals are known to occur.
Augmentation	Moving animals to supplement existing populations.
Extent of Occurrence	The geographic area encompassing all locations of individuals of a species, including intervening areas of unoccupied habitat. Synonymous with range.
Generation	The average age of breeders in a population. The estimated generation time for Miami blue butterfly is between 1 month and 1 year (FWC 2003).

Known Site	A location where Miami blue butterflies have been verified within the last generation (i.e., 1 month to 1 year).
Long-term	An extended period of time relative to the life span of individuals in a population. Length is based on commonly used viability procedures and practicality, but is typically at least 100 years.
Metapopulation	A collection of local populations connected by occasional dispersal in which there are local extinctions and colonizations.
Population	Individuals of the same species that occur in a defined area at the same time and regularly interact or interbreed. For the purpose of this management plan, a population is defined as an aggregate of known colonies separated by barriers such as water, highways, or urban areas with little to no host plants or nectar sources.
Range-wide	All individuals of the species throughout the entire extent of its area of occurrence. For the Miami blue butterfly, the range-wide population includes individuals historically found from Hillsborough and Brevard counties south to Key West in Monroe County.
Reintroduction	Moving Miami blue butterflies to re-establish populations in formerly occupied habitat
Translocation	The intentional human-assisted movement of Miami blue butterflies from one location to another.
Viable Population	A stable, self-sustaining population with a high probability (e.g., more than 95%) of surviving for a long-term period (e.g., 100 years).

THREAT ASSESSMENT

FWC staff examined the population parameters that put the species at risk in relation to the criteria used to define listed species in Florida (Rule 68A-1.004 F.A.C). The Final Biological Status Report for the Miami blue butterfly (Appendix 4) specified 3 criteria underlying the proposed designation as an endangered species.

1. **Population reduction.** A range-wide population reduction of > 80% over the last 10 years is suspected based on a > 99 percent decline in area of occupancy from 1992 to 2002.

2. **Area of occupancy.** The Miami blue butterfly's extent of occurrence is not completely known but is likely not more than 158 square miles. Its area of occupancy is far less than 158 square miles based on surveys, and (a) the species is currently found in only one location and (b) it has undergone a 99% decline in area occupied.
3. **Population Size and Trend.** The number of mature individuals is far less than 250 individuals and all individuals are contained within a single subpopulation.

Then, FWC staff examined threats, past and present, potentially responsible for the range-wide decline of the Miami blue butterfly. The following factors have been proposed by 1 or more researchers or have been suspected in the decline of species utilizing similar habitats.

1. **Habitat loss**, resulting from intense development and urbanization along Florida's coastline and an estimated human population increase of 900 persons to Florida every day (Mulrennan 1991, Glassberg 2002, Calhoun et al. 2002).
2. **Habitat degradation and/or unsuitability of remaining habitats especially through the following practices:**
 - a. **Introduction of exotic plants**, which may out compete the native hosts of the butterflies as well as result in the loss of open areas (New 1993).
 - b. **Introduction of exotic butterflies**, which may lead to hybridization with native species and lead to loss of genetic fitness (New 1993).
 - c. **Introduction of exotic pathogens**, which may have deleterious effects on the host plants and nectar sources (New 1993).
 - d. **Off-road vehicle use and human traffic**, which threatens the integrity of habitats by fragmentation, introduction of exotics in disturbed areas, and causing direct loss of hosts plants and nectar sources (USFWS 1998).
3. **Habitat fragmentation and group isolation**, which increases the species' vulnerability to local extirpations due to adverse genetic, demographic, and environmental events (Saccheri et al. 1998). Isolation results in lowered probabilities of recolonization following local extinctions in species with limited dispersal abilities (Cushman and Murphy 1993).
4. **Pesticide and herbicide spraying**, which may be responsible for direct mortality of larvae and adults and the reduction of host plants and nectar sources (Eliazar and Emmel 1991, Hennessey et al. 1992, Salvato 1999).
5. **Fire suppression**, which increases the dominance of woody plants and may lead to rapid succession of open habitats and the exclusion of host plants and nectar sources (Scott 1986, New 1993, Kwilosz and Knutson 1999, Glassberg 2002).

6. **Natural catastrophes such as hurricanes and fires**, which may eliminate all individuals from small population as well as their host and nectar plants (Calhoun et al. 2002, Emmel and Daniels 2002a,b).
7. **Inbreeding**, which will cause decreased heterozygosity and contribute to extinction risks in small or highly fragmented populations (Saccheri et. al. 1998).
8. **Native butterfly species**, which may compete for available host plants and nectar sources (Emmel and Daniels 2003b).
9. **Red imported fire ants**, which may negatively impact *Camponotus* (Formicidae) ants that occasionally tend Miami blue butterfly larvae and offer it some degree of protection from predators and parasitoids. Fire ants may also directly depredate Miami blue butterfly larvae (Emmel and Daniels 2003b).
10. **Unethical or illegal collection**, which may further stress small local populations and lead to the loss of individuals and genetic variability (Pyle 1976, Emmel 1995a,b, USFWS 1998, Alexander 2003).

CONSERVATION GOAL AND OBJECTIVE

Miami Blue Butterfly Conservation Goal

The most ambitious and optimistic conservation goal, and the one toward which this management plan is aimed, is to secure a stable or increasing population of Miami blue butterflies at a level that does not meet the criteria defining an endangered species. If that goal was met, the Miami blue butterfly could be downlisted to threatened status. Future population declines in Florida or elsewhere may necessitate a less optimistic goal of maintaining the Miami blue butterfly as an endangered species, with a minimum conservation goal being of ensuring the Miami blue butterfly population at Bahia Honda State Park does not decline.

Miami Blue Butterfly Conservation Objective

A measurable conservation objective for the Miami blue butterfly was developed to assess progress on achieving the conservation goal. This conservation objective is to secure and maintain, by the year 2012 and beyond, colonies with Miami blue butterflies across at least a 40 square mile area, while simultaneously securing and maintaining a net increase of at least 184 mature adults from the year 2002 status level. This would constitute a 98% increase in the species' minimum confirmed extent of occurrence and a 74% increase in the current Miami blue butterfly population over the next 10 years (2002-2012).

The distribution and status of the Miami blue butterfly in the year 2002 and the FWC listing criteria for a threatened species were the primary factors considered in the

derivation of the conservation objective. Appendix 1 presents a complete discussion of these factors and the process used to develop the objective. The main points in deriving the objective were:

1. In the year 2002, the minimum confirmed extent of occurrence (i.e., range) of the Miami blue butterfly was estimated at a maximum of 1 square mile, the same as the area of occupancy (FWC 2003). This does not meet the minimum 40 square mile range requirement for downlisting the Miami blue butterfly to threatened status.
2. In the year 2002, the distribution of the Miami blue butterfly was restricted to one remaining colony. Given the area's continued human population growth and development, it is highly unlikely that the species' distribution will become less fragmented or less restricted over time.
3. In the year 2002, the Miami blue butterfly was estimated to range between 51 and 66 mature individuals in one colony (Emmel and Daniels 2002a,b).

It was concluded that to meet minimum downlisting criteria the extent of occurrence would have to be increased to at least 40 square miles and the number of mature individuals would have to be increased to at least 250 individuals over the next 10 years.

RECOMMENDED CONSERVATION ACTIONS

Proposed FWC Regulations

FWC staff recommend the following rules be adopted to protect Miami blue butterflies and facilitate their conservation while efforts to secure the species in Florida are underway.

1. List the Miami blue butterfly as an endangered species.
2. Prohibit the take, harassment, possession, selling, or transport of Miami blue butterfly and their eggs, larvae, or pupae except as authorized by permit from the executive director, with such permits being issued for activities that further the goals and objectives of the species' management plan.

Management Actions

1. Monitor existing colonies of Miami blue butterflies and survey potential habitat.
 - a. Monitor annually the population status, distribution, and trends during the species most active season (spring and summer) at existing colonies.
 - b. Implement surveys and repeat surveys at appropriate habitats in their former range but with emphasis on South Florida and the Florida Keys.

2. Maintain and protect active colonies in existing populations.
 - a. Protect existing colonies from illegal collecting and intrusion.
 - b. Encourage the natural establishment of Miami blue host plants and nectar sources.
 - c. Remove exotic vegetation and minimize the removal of native plants.
 - d. Minimize or eliminate the use of herbicides or pesticides in and around colonies.

3. Determine ecological requirements, population constraints, and management needs of the Miami blue butterfly.
 - a. Identify dispersal patterns (distances, direction, habitat needs).
 - b. Clarify the ecological relationship between ants and the larvae of the Miami blue butterfly.
 - c. Determine predators, parasitoids, and other factors which cause mortality or limit population growth.
 - d. Investigate adult behavior: mating, oviposition cues and sites, and activity rhythms.
 - e. Investigate the ecology of food plant species.

4. Enhance and restore suitable Miami blue butterfly habitat.
 - a. Remove noxious or exotic vegetation.
 - b. Promote natural establishment of foodplants and other natural vegetation.
 - c. Revegetate with native host plants and nectar sources.
 - e. Minimize or eliminate the use of herbicides and pesticides on or near potential habitat.
 - f. Conduct prescribed burns in tropical pinelands to reduce overgrowth of the herbaceous layer and promote the resprouting of native shrubs.

5. Initiate a Miami blue butterfly captive propagation and release program.
 - a. Determine and implement methods for captive breeding and rearing of the Miami blue butterfly.
 - b. Determine and implement methods for the release of captive bred Miami blue butterflies into existing populations or unoccupied suitable habitat.
 - c. Identify, evaluate, and rank recipient locations for reintroduction or augmentation of captive bred Miami blue butterflies.
 - d. Monitor all reintroduction sites after release of captive bred for the presence of adults and immatures individuals for a period of 6-12 months (Emmel and Daniels 2003b).

6. Eliminate or minimize mosquito control pesticide spraying at existing Miami blue butterfly populations or potential habitat.
 - a. Establish no spray zones on public lands with existing populations of Miami blue butterflies.
 - b. Minimize mosquito adulticide and larvicides on private lands with existing populations of Miami blue butterflies.

- d. Establish a no-spray buffer zone > 750 m in width around ecological sensitive areas to minimize the probability of accidental adulticide drift effects on nontarget species (Hennessey et al. 1992).
 - e. Employ less-damaging alternatives in mosquito control such as source reduction, biological control agents, and suspending or reducing spraying during the breeding seasons of nontarget species (Emmel 1991).
7. Increase public awareness and outreach.
- a. Place informational signs at existing populations (unless there is a risk of illegal collection or intrusion).
 - b. Conduct interpretive tours, if secure sites permits without causing additional problems.
 - c. Establish a Miami blue butterfly work group to exchange information between and among agencies, managers, biologists, mosquito control districts, and private landowners. This approach has proven to be successful with other endangered lycaenidae (Sferra and Ewert 1994).
 - d. Develop and implement an outreach program to inform private landowners and the general public of Miami blue butterfly conservation efforts and land-use incentive programs.

Private Lands and Conservation

Although most management actions target lands under public ownership, private lands will play an important role in the long-term conservation of Miami blue butterflies in Florida. Mark-recapture studies of North American lycaenids indicate that these species are relatively sedentary. The endangered Karner blue butterfly (*Lycaeides melissas samuelis*) and Mission blue butterfly (*Plebejus icariodes missionensi*) both exhibit highly restricted movements of less than 100 m (Cushman and Murphy 1993, Knutson et al. 1999). Maximum single dispersal events were between 1 and 2 km (Cushman and Murphy 1993, Knutson et al. 1999). Emmel and Daniels (2003a) have similarly observed sedentary behavior in the Miami blue butterfly at Bahia Honda State Park.

Movement of individuals within a metapopulation is important for maintaining genetic diversity and for recolonizing areas following local extinctions (Knutson et al. 1999). The probability of recolonization increases with patch size and distance to the nearest occupied patch (Thomas et al. 1992). Private lands are located between most of the proposed reintroduction sites on public lands. These private lands might not meet all the above criteria for selection as a reintroduction site; however, even marginal habitat can act as “stepping stones” to larger optimal sites (Shreeve 1995). The following private land incentive programs may prove useful in the event Miami blue butterflies are found on private property or become established naturally or through reintroduction. To promote the enhancement and restoration of Miami blue butterfly habitat on private lands in their historic range, FWC staff will:

1. **Inform private landowners of existing land-use incentive programs.** These include the Florida Forestry Stewardship Program, the Wildlife Habitat Incentives Program, the Environmental Quality Incentives Program, the Landowner Incentive Program, and the Private Stewardship Grants Program. FWC staff will review these and other programs to determine which provide the best incentives for managing Miami blue butterfly habitat and populations on private lands and disseminate their findings through brochures, pamphlets, and/or the FWC's home page on the Internet (<http://www.floridaconservation.org>). FWC staff also will seek to identify and/or develop other innovative programs to encourage the conservation of Miami blue butterflies on private lands if they become established there. To the extent possible, FWC staff will work with private property owners on a case-by-case basis to develop the best management practices for the Miami blue butterflies on their lands.
2. **Investigate other Federal programs that may provide incentives to private landowners to manage for Miami blue butterflies in Florida.** Other Federal programs to be investigate include Candidate Conservation Agreements, Safe Harbor, and Habitat Conservation Plans.

Monitoring Plan

Monitoring will be necessary to measure the success of management actions undertaken for Miami blue butterfly conservation in Florida. The primary purpose of monitoring will be to detect changes in abundance and trends in the population. A monitoring protocol should be established that 1) has an acceptable level of accuracy, 2) is repeatable over time and across observers, and 3) has a low impact on the Miami blue butterfly and its habitat (USFWS 1998).

Three different types of surveys are used with Lepidoptera to assess changes in abundance, evaluate effectiveness of management actions, and determine distribution and dispersal patterns: (1) meandering surveys, (2) Pollard transects, and (3) mark-recapture techniques. Meandering surveys or timed area searches involve observers walking in a meandering pattern looking forward, to the sides, and behind them and recording all butterflies of the species of interest (Hyde et al. 2001). Pollard transects require observers to walk established transects and record all butterflies within 5 m of the transect on each side and in front of the observer (Pollard 1977). In large colonies, flags can be placed every 25 m along the transect to record the location of the butterfly (Lane and Dana 1994). Transects can be divided into sections related to habitat or management units. Pollard (1977) recommends at least one count per week to estimate an index of abundance that can be used to assess changes in abundance of butterflies from year to year. Mark-recapture surveys require the observer to capture the butterfly with a net and mark the butterfly on the outer hind wing with a fine non-toxic permanent marker. The more recaptures obtained the greater the precision of the estimate (Pollard 1977). The Jolly-Seber capture-recapture model for open populations is used to estimate population size (Knutson et al. 1999).

Surveys should be conducted in the late morning or afternoon preferably during sunny conditions or warm temperatures (Pollard 1977). Meandering and transect surveys should use established paths or game trails to avoid trampling butterfly habitat (Hyde et al. 2001). The less invasive transect and meandering surveys are recommended for endangered species or species in declines (Opler 1995). However, it is often difficult to differentiate between the common blue and the Miami blue butterfly unless captured (Daniels pers. commun). Experienced observers can sometimes identify butterflies through their flight patterns or with the use of close focus binoculars (Lane and Dana 1994). Furthermore, dispersal and mobility studies require mark-recapture surveys (Knutson et al. 1999). It is recommended that only highly experienced researchers use the mark-recapture technique on Miami blue butterflies.

The following variables will be monitored and assessed to detect change in range-wide Miami blue butterfly population status:

1. **Number of individuals at all existing populations.** This is the primary variable for assessing the status of the Miami blue butterfly.
2. **Number of known sites.** A known site is one where Miami blue butterfly has been verified within the past generation (i.e., 1 month to 1 year). This is the secondary variable for assessing the status of the Miami blue butterfly.

If monitoring reveals increased populations and distributions such that the Miami blue butterfly may no longer meet one of the 5 criteria defining an endangered species, FWC staff could petition to downlist the butterfly. Any decrease in the area of occupancy or number of mature individuals from the 2002 level may require emergency action and immediate revisions in the management plan.

Areas of Future Research

There are many facets of Miami blue butterfly life history and ecology that remain poorly understood or are as yet unknown. Active pursuit of research on the following topics, and on others as they arise, is critical to our understanding of this species, and the results will help guide and refine recommended conservation actions and the management plan as a whole:

1. Effects of pesticide on larvae and adults. A few studies have been conducted on the effects of pesticides on lepidoptera in South Florida and the Keys (Eliazar and Emmel 1991; Salvato 1999). However, none have examined the effects of mosquito-spraying on the larvae and adult Miami blue butterflies.
2. Genetic analysis. Information on the genetic diversity of wild and captive populations is needed for maximizing genetic diversity of the species and for directing pairings of butterflies in captivity (Emmel and Daniels 2003b).

3. Larval host plants. It is not known why this species now only uses gray nicker bean (*Caesalpinia bunduc*) when balloonvine (*Cardiospermum halicacabum*) was the most frequently reported host plant in the last thirty-years (Calhoun et al. 2002). The butterflies in captivity have similarly rejected *C. halicacabum* as a host plant (Daniels pers. commun).
4. Nectar sources. Minno and Emmel (1993) have documented *Bidens alba*, *Melanthera aspera*, *Heliotropium angiospermum*, *Lantana involucrata*, *Phyla nodiflora*, *Caesalpinia bonduc*, *Pithecellobium keyense*, *Coreopsis leavenworthii*, *Coccoloba uvifera*, and *Plucea spp.* as nectar sources. However, little information exists on the distribution and abundance of these nectar sources throughout the butterfly's historic range.
5. Competition from other butterflies. The arrival of the ammon blue (*Hemiargus* [*Cyclargus*] *ammon*) to Florida was accompanied by the decline of the Miami blue butterfly (Calhoun et al. 2002). The larvae of ammon blue have been found to feed on the developing seeds within the pods of *Cardiospermum halicacabum* and *C. conrundum* (Emmel and Daniels 2003b). The West Indian hairstreak (*Chlorostrymon simaethis*) has also become established in South Florida (Minno and Emmel 1993). This species has been recorded ovipositing on *C. bonduc* (Emmel and Daniels 2003b).
6. Role of fire on their habitat. It has been reported that Miami blue butterflies once inhabited the pine rocklands of Big Pine Key in the Florida Keys (Minno and Emmel 1993). Fire suppression has led to the overgrowth of the herbaceous layer and the suppression of shade-intolerant native forbs and shrubs (Bergh and Wisbey 1996). No studies have examined the role fire has on the host and nectar sources of Miami blue butterflies.
7. According to Cushman and Murphy (1993), the following ecological differences among the butterfly families could be responsible for the disproportionate number of lycaenids listed in North America. Fifty percent of listed butterfly taxa are lycaenids. These traits suggested by Cushman and Murphy (1993) as possible causes for their decline, merit further research:
 - a. Mobility. Little is known on their movement patterns and dispersal abilities. Most Lycaenidae species tend to be sedentary. The distance they are able to move could have an effect on their colonizing of suitable habitat or recolonizing habitats where they were extirpated.
 - b. Host specificity and successional stages. As with the Miami blue, all lycaenids currently protected in the U.S. are specific to one or just several related host plant species. Most of these host plant species are found largely in early successional communities that are temporary and unpredictable.

- c. Relationship with ants. Roughly half of lycaenid species world-wide associate with ants. There is a great variability in the degree that lycaenids associate with ants. Most of these associations are mutualistic. The ants often help protect the larvae against parasitoids (Pierce and Easteal 1986). The exact relationship that Miami blue butterflies have with *Camponatus* ants is not known.

ANTICIPATED ECONOMIC AND SOCIAL IMPACTS

The parties potentially affected by the Miami blue butterfly management plan include private landowners, public land managers, scientific researchers, and citizens of the state of Florida. An assessment of the anticipated economic and social impacts of implementing the plan was based on the rules proposed herein and on issues raised through the public comment process. No comments specifically related to the economic and social impacts of the plan were received. In the absence of public input, social and economic impacts related to the plan's implementation are difficult to assess.

Economic Impacts

1. **Cost of implementing the proposed rules**
 - a. **Estimated cost to FWC.** The proposed rules will necessitate a commitment of staff time to review permit applications for direct and indirect take; to develop, implement, and oversee landowner incentive programs; to coordinate with the USFWS on development and implementation of Candidate Conservation Agreements or other Federal programs; to develop and implement appropriate outreach programs; and to review permit applications for incidental take under these programs. It is anticipated that these activities can be handled by existing staff.
 - b. **Estimated cost to potentially affected parties of implementing and not implementing the proposed rules.** Overall, the proposed rules should not increase the costs incurred by parties affected by their implementation. There are no fees associated with the permits issued by FWC. Implementing a rule that authorizes incidental take if in furtherance of the management plan goal and objective would not cost private landowners additional money and could be beneficial by facilitating options not previously available to landowners.
2. **Cost of implementing the management plan.**
 - a. **Estimated cost to FWC.** Implementation of the management plan will require recurring funds for personnel, travel, meetings, equipment, research, and a captive propagation and reintroduction program. The full scope of the FWC's commitment will depend, in part, on agreements with

the USFWS, the number of populations reintroduced to FWC-managed areas, and the success of the captive propagation and reintroduction plan. It is anticipated that at least one part-time temporary biologist will be needed to perform survey, monitoring, and management activities on existing populations and targeted reintroduction sites pre- and post-release of butterflies. Specific budget needs are difficult to project and will be addressed on an annual basis as part of the FWC's operational planning process.

- b. **Estimated cost to other agencies and land managers.** Implementation of the plan will have a financial impact on numerous public agencies. The USFWS is currently funding the survey and monitoring of the existing Miami blue butterfly population as well as surveys on potential habitat. It is expected that they will list the Miami blue butterfly as a candidate species or as an endangered species and continue to fund research and captive propagation (U.S. Fish And Wildlife Service 2002b). The National Park Service and the Florida Park Service may incur costs to manage for Miami blue butterflies if they become established naturally or are reintroduced to their lands.
- c. **Estimated cost to the tourism and healthcare industries.** Implementation of the plan has a potential economic cost to the tourism and healthcare industries if mosquito-borne diseases were to become epidemic as a result of decreased mosquito control and no-spray zones in areas where the Miami blue butterfly is present or reintroduced. In 1989, Florida was visited by over 65 million people who spent over 30 billion dollars (Mulrennan 1991). A St. Louis encephalitis (SLE) epidemic in Florida in 1990 is thought to have been responsible for a 15% decrease in tourist related business in the last quarter of that year (Mulrennan 1991). The recent outbreak of West Nile Virus (WNV) throughout the state of Florida has increased the demand for mosquito control. Health care costs to treat WNV and SLE cases could also increase as a result of decreased mosquito control. Local economies at popular tourist destinations such as the Florida Keys could suffer if mosquitoes become unbearable even without disease transmission.

Social Impacts

Potentially positive social effects include increased public awareness of the Miami blue butterfly and habitat as well as other butterfly species which are in decline in Florida, public recognition and support of the FWC for taking a comprehensive approach to Miami blue butterfly management, and the development of integrated working relationships among the various public agencies and private landowners involved with the species' management. Conversely, if the plan is not implemented there could be negative social impacts. Continued loss of the species and its habitat could erode public

confidence in the FWC's ability to manage and conserve the wildlife resources of the state. Furthermore, there would be fewer opportunities to encounter and study the species.

IMPLEMENTATION APPROACH

A prioritized approach to implementation of the management plan will help ensure achievement of the conservation objective for the Miami blue butterfly. Prioritization of strategies and conservation measures also will facilitate the extensive coordination and cooperation necessary to successfully implement the plan. Given the various constraints of the numerous public and private land managers potentially affected by the plan, the budgets, schedules, and tasks associated with its implementation should be both justified and feasible.

Priority Actions

The following conservation actions are of highest priority and should involve primary or significant participation by the FWC:

1. **Implement the proposed rules for the Miami blue butterfly.** These rules will provide a legal basis, at the state level, for regulating take, research, monitoring, and management activities and authorizing incidental take if in furtherance of the management plan goal and objective.
2. **Establish one or more additional colonies *in situ* or *ex situ* through translocation or a captive breeding program.** These colonies should be sufficiently separated to decrease the possibility of local extirpation in case of a catastrophic event such as a hurricane, disease, or pesticide drift downwind of application.
3. **Develop an MOA with the USFWS.** Given the Miami blue butterfly's imminent federal status as a candidate species or endangered species, the USFWS and FWC share responsibility for managing the species in Florida. The MOA will avoid duplication of conservation efforts and clarify how the 2 agencies will work together to prioritize, coordinate, and fund Miami blue butterfly conservation activities in Florida.
4. **Develop a database to assist in monitoring the status of known sites and the range-wide population.** A comprehensive database is necessary to document changes in known sites and in the species' range-wide status. Additionally, the database will help track conservation actions and facilitate implementation of the management plan. The database should include basic information on location, ownership, habitat, and protection efforts.

5. **Establish and convene a meeting of the Florida Miami blue butterfly working group.** This group will be an important medium for exchange of ideas related to Miami blue butterfly conservation. This group should meet at least once a year to discuss management achievements and failures, new techniques, captive propagation and translocation, regulatory issues, and topics as deemed necessary.

Implementation Schedule

It is not possible to establish a firm implementation schedule for priority actions and management actions listed above due to the fact that these tasks will require commitments of time, personnel, and funding from agencies, managers, and landowners not under the control of the FWC. Permits and authorizations for many of these actions are similarly outside the control of FWC. Therefore, FWC staff established a goal of completion of the priority actions within 5 years. Given the current success in breeding and rearing Miami blue butterflies in captivity by the University of Florida's McGuire Center for Lepidoptera Research, reintroduction and/or augmentation could be initiated between July 2003 and June 2004 (Emmel and Daniels 2003b).

Management Plan Review and Revision

The status of the range-wide Miami blue butterfly population will be periodically assessed to ensure steady progress toward the conservation objective. Revision of the plan may be warranted if monitoring reveals a declining trend despite management efforts or successful establishment of translocated individuals. Future research on pesticide effects, habitat requirements, genetic variability, and/or management techniques also could necessitate a revision of the plan.

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Figure 1. Historic range of the Miami blue butterfly.

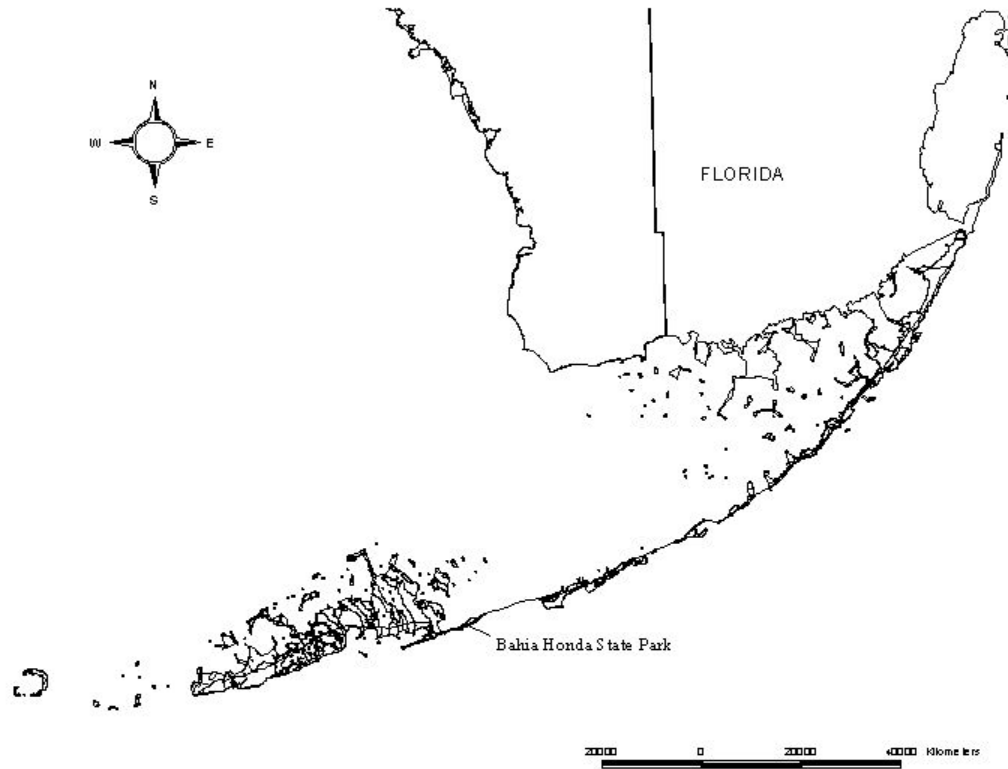


Figure 2. Location of remaining colony of Miami blue butterflies at Bahia Honda State Park, 2002.

APPENDIX 1. Derivation of the conservation objective for the Miami blue butterfly.

The conservation objective is to secure and maintain, by the year 2012 and beyond, colonies with Miami blue butterflies across at least a 40 square mile area, while simultaneously securing and maintaining a net increase in the number of mature adults from the year 2002 status level. FWC staff arrived at this objective after carefully considering 2 main factors: (1) the distribution and status of the Miami blue butterfly population in 2002; and (2) the FWC listing criteria for an endangered species. These factors and the process used to develop the conservation objective are discussed in detail below.

1. **Distribution and Status.** The species was thought to be extirpated prior to 1999. One remaining colony was found in 1999 with approximately 50 individuals (Calhoun et al. 2002). Multiple surveys have failed to find any more colonies. Emmel and Daniels (2002a,b) estimated the population to range between 51- 66 individuals in 2002. In 2002, the suspected range of the Miami blue butterfly was less than 158 square miles if one includes the entire Florida Keys. In reality the current range equals the actual area of occupancy, which is less than 1 square mile. (FWC 2003).
2. **FWC Listing Criteria.** To be listed as an endangered species, a species only needs to qualify for listing under 1 of the 5 designated criteria (Appendix 3). Additionally, to continue to be listed as an endangered species, a species needs to qualify for listing under 1 of the 5 designated criteria (Appendix 3). However, to be downlisted from the Endangered list, a species must meet the requirements for delisting under all 5 criteria. The purpose of this exercise was to determine the minimum population requirements for downlisting the status of the Miami blue butterfly to the threatened level.
 - a. **Criterion A: A range-wide population reduction of less than 80% and greater than 50% over the next 10 years.** To qualify for downlisting under this criterion, the Miami blue population would have to maintain at least 21% of the 2002 population through the year 2012 and beyond. This equates to 10- 14 individuals or a maximum rate of decline of 5 adults per year.
 - b. **Criterion B: A range-wide extent of occurrence between 40 square miles and 2,000 square miles or a range-wide area of occupancy between 4 square miles and 200 square miles.** To qualify for downlisting under this criterion, the range of the population would need to expand from 1 square mile to at least 40 square miles. A site found or established in the Upper Keys would satisfy this requirement. The range-wide area of occupancy would need to increase four fold to 4 square miles. A second or third large colony established or found outside of Bahia

Honda State Park could increase the area of occupancy past 4 square miles.

In addition to qualifying as threatened based on extent of occurrence, the Miami blue butterfly would also need to meet the following required conditions under this criterion: (1) the species' range must not be severely fragmented; (2) the species must not be experiencing declines and/or fluctuations in extent of occurrence, area occupied, habitat quality, number of locations, or number of mature individuals; or (3) the species must not be experiencing extreme fluctuations in extent of occurrence, area occupied, number of locations, or number of mature individuals. If these conditions are not met, downlisting status of the Miami blue butterfly to Threatened may not be warranted. It is unlikely the Miami blue butterfly will ever meet condition 1 due to the fact that most of the potential habitat or reintroduction sites are fragmented by development, ocean, or unsuitable habitat. Conditions 2 and 3 are probably not likely with a captive propagation plan in plan. However, any further declines or extreme fluctuations could easily lead to extinction.

- b. **Criterion C: At least 250 mature individuals in the range-wide population and less than a 25% decline over the next 3 years.** In 2002, there were an estimated 51-66 adults in the range-wide population. In order to qualify for downlisting under this criterion the population would need to increase by more than 74% (184 mature adults) and retain at least 76% of that population over the next three years.
- c. **Criterion D: Between 50 and 250 mature individuals in the range-wide population.** The estimated population of 51-66 individuals in 2002 already meets this criterion for downlisting the Miami blue butterfly to threatened (FWC 2003). The captive population currently exceeds 50+ adults (Daniels pers. commun). If this captive population is taken into account, the number criterion is easily met.
- d. **Criterion E: Between 20% and 50% probability of extinction in the wild within 20 years or 10 years, respectively.** As indicated in the Final Biological Status Report, available data are not sufficient to permit estimation or modeling of the probability of extinction of Miami blue butterflies in the wild.

From a numerical standpoint, if the population remained stable for the next 10 years, the minimum downlisting requirements for an Endangered species would be met under Criteria A and C. However, if the Miami blue butterfly population (1) remained at the year 2002 level or increased from that level over the next 10 years without any increase in the extent of occurrence the minimum requirements for downlisting from Endangered to Threatened under Criterion B and C *would not* be met.

Upon consideration of these factors, FWC staff concluded that in order to meet the minimum downlisting criteria, (1) the extent of occurrence would have to be increased to at least 40 square miles and (2) the number of mature individuals will have to be increased to at least 250 individuals over the next 10 years. Because the population is currently so low and restricted to one colony, a captive propagation and translocation (augmentation and reintroduction) plan will be a requirement to avoid extinction and to achieve the conservation objective within that timeframe.