

**U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM**

SCIENTIFIC NAME: *Cyclargus thomasi bethunebakeri*

COMMON NAME: Miami blue butterfly

LEAD REGION: 4

INFORMATION CURRENT AS OF: May 2009

STATUS/ACTION:

☐ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status

☐ New candidate

☒ Continuing candidate

☐ Non-petitioned

☒ Petitioned - Date petition received: June 13, 2000

☒ 90-day positive - FR date: December 21, 2001

☒ 12-month warranted but precluded - FR date: May 11, 2005

☐ Did the petition request a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:

a. Is listing warranted (if yes, see summary of threats below)? yes

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? yes

c. If the answer to a. and b. is "yes," provide an explanation of why the action is precluded. We find that the immediate issuance of a proposed rule and timely promulgation of a final rule for this species has been, since publication of the last CNOR, and continues to be, precluded by higher priority listing actions (including candidate species with lower LPNs) because most of our national listing budget has been consumed by work on various listing actions to comply with court orders and court-approved settlement agreements, meeting statutory deadlines for petition findings or listing determinations, emergency listing evaluations and determinations, and essential litigation-related, administrative, and program management tasks. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures. For information on listing actions taken, see the discussion of "Progress on Revising the Lists" in the current CNOR, which can be viewed on our Internet website (<http://endangered.fws.gov/>).

☒ Listing priority change

Former LP: 6

New LP: 3

Date when the species first became a Candidate (as currently defined): May 11, 2005

___ Candidate removal: Former LP: ___

___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

___ U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

___ F – Range is no longer a U.S. territory.

___ I – Insufficient information exists on biological vulnerability and threats to support listing.

___ M – Taxon mistakenly included in past notice of review.

___ N – Taxon does not meet the Act's definition of "species."

___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Insects, Lycaenidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, U.S.A. and Bahamas (recorded in Bimini Islands [Smith et al. 1994, p. 129]).

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, Monroe County, U.S.A.

LAND OWNERSHIP: There are two distinct wild metapopulations. One occurs within Bahia Honda State Park (BHSP), owned by the State of Florida and administered by the Florida Department of Environmental Protection (FDEP) (Emmel and Daniels 2002a, p. 1–3; 2002b, p. 1–6; 2003, p. 1–6; 2004, p. 1–38; Edwards and Glassberg 2002, p. 1–2, 9). Of the suitable habitat at BHSP, approximately 85 percent or 1.3 acres (0.5 hectares [ha]) are occupied by the Miami blue (Emmel and Daniels 2004, p. 12). Two larvae were documented on West Summerland Key (Spanish Harbor Keys), approximately 1 mile (1.6 kilometers [km]) west of BHSP in November 2003 (Emmel and Daniels 2004, p. 3), but none have been seen there since. The other metapopulation is within the Service's Key West National Wildlife Refuge (KWNWR) (Cannon et al. 2007, p. 1–24). The Marquesas and Boca Grande at KWNWR have a land area of approximately 1,398 acres (566 ha) and 193 acres (78 ha), respectively, including areas that lack suitable habitat.

Reintroduction efforts have been underway since May 2004 using captive-reared individuals. Reintroduction attempts have been conducted at Everglades National Park (ENP) (1,399,078 acres [566,188 ha]), Biscayne National Park (BNP) (171,000 acres [69,201 ha] including open water), both of which are National Park Service (NPS) lands; and Dagny Johnson Key Largo Hammock Botanical State Park (DJSP) (2,400 acres [971 ha]), which is FDEP land (Emmel and Daniels 2006, p. 4; 2008, p. 4; 2009, p. 4–5). Reintroduction efforts have so far been unsuccessful.

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LEAD FIELD OFFICE CONTACT: Paula Halupa, South Florida Ecological Services Office,

BIOLOGICAL INFORMATION:

Species Description: The Miami blue is a small, brightly colored butterfly approximately 0.8 to 1.1 inches (1.9 to 2.9 centimeters) in length (Pyle 1981, p. 488) with a forewing length of 0.3 to 0.5 inches (8.0 to 12.5 millimeters) (Minno and Emmel 1993, p. 134). Wings of males are blue above (dorsally), with a narrow black outer border and white fringes; females are bright blue dorsally, with black borders and a red and black eyespot near the anal angle of the hindwing (Minno and Emmel 1993, p. 134). The underside is grayish with darker markings outlined with white and bands of white wedges near the outer margin. The ventral hindwing has two pairs of eyespots, one of which is capped with red (Minno and Emmel 1993, p. 134). The basal and costal spots on the hindwing are black and conspicuous (Minno and Emmel 1993, p. 134). The winter (dry season) form is much lighter blue than the summer (wet season) form and has narrow black borders (Opler and Krizek 1984, p. 112). Seasonal pattern variation may be caused by changes in humidity, temperature, or length of day (Pyle 1981, p. 489). Miami blue larvae are bright green with a black head capsule, and pupae vary in color from black to brown (Minno and Emmel 1993, p. 134-135). The larvae and pupae of the nickerbean blue closely resemble the Miami blue (Calhoun et al. 2002, p. 15). Lycaenids in general appear to have a high degree of subspecific variation (Cushman and Murphy 1993, p. 41).

The Miami blue is very similar in appearance to three other sympatric butterflies, cassius blue (*Leptotes cassius theonus*), ceraunus blue (*Hemiargus ceraunus antibubastus* or *Hemiargus hanno antibubastus*), and nickerbean blue (ammon blue) (*Cyclargus ammon ammon*). The Miami blue is slightly larger than the similar ceraunus blue (Minno and Emmel 1993, p. 134), but the ceraunus has a different ventral pattern and flies close to the ground in open areas (Minno and Emmel 1994, p. 647). The cassius blue often occurs with the Miami blue, but has dark bars rather than spots on the undersides of the wings (Minno and Emmel 1994, p. 647). The Miami blue can be distinguished from the ceraunus blue and cassius blue by its very broad white ventral submarginal band, the dorsal turquoise color of both sexes, and the orange-capped marginal eyespot on the hind wings (Opler and Krizek 1984, p. 112). The nickerbean blue is also similar to the Miami blue in general appearance but considerably smaller (Calhoun et al. 2002, p. 15).

Reproduction—A single Miami blue female can lay 300 eggs (T. Emmel, UF, pers. comm. 2002). However, high mortality may occur in the stages preceding adulthood (T. Emmel, pers. comm. 2002). Eggs are laid singly near the base of young pods or just above the lateral buds of balloonvine (*Cardiospermum* spp.) and the flowers of leguminous trees (Opler and Krizek 1984, p. 113; Minno and Emmel 1993, p. 134). Rutkowski (1971, p. 137) observed a female laying one egg just above the lateral bud on snowberry (*Chiococca alba*). Carroll and Loye (2006, p. 18) never observed individual females to lay more than a single egg near a balloonvine fruit (capsule). However, 24 out of 54 capsules with eggs attached had more than one egg. This indicated that the same or other females subsequently added an egg to such capsules. On nickerbean (*Caesalpinia* spp.), oviposition occurs throughout the day with females often seeking terminal growth close to the ground (< 1 m) or in locations sheltered from the wind (Emmel and Daniels 2004, p. 13).

The period from egg to pupation was estimated to be approximately 19.5 days, and egg to adult

emergence was estimated to be 30 days (Carroll and Loye 2006, p. 19). On balloonvine, newly hatched larvae chew a distinctive hole through the outer wall of the capsule to access seeds (Minno and Emmel 1993, p. 134). After consuming seeds within the natal capsule, the caterpillars must crawl to a sequence of two or three balloons before growing large enough to pupate. Attending ants follow them through the same holes. Miami blues were also observed to commonly pupate within mature capsules (sometimes with ants in attendance within the capsule) (Carroll and Loye 2006, p. 20).

Adults can be found every month of the year (Opler and Krizek 1984, p. 112-113; Minno and Emmel 1993, p. 135; 1994, p. 647; Emmel and Daniels 2004, p. 9). The Miami blue has been reported to have multiple, overlapping broods year round (Pyle 1981, p. 489). Opler and Krizek (1984, p. 112-113) reported that there is one long winter generation from December to April, during which time the adults are probably in reproductive diapause (a period during which growth or development is suspended and physiological activity is diminished). From May through November, there is probably a succession of shorter generations, the exact number of which is unknown (Opler and Krizek 1984, p. 113). At BHSP, a marked decrease of adults is observed from November through February, indicative of a short diapause (Emmel and Daniels 2004, p. 9; Daniels 2007, p. 3). Nectar sources were also believed to be depressed in that season. Data from mark-recapture efforts by Emmel and Daniels indicates that adults may live a maximum of 9 days (J. Daniels, UF, pers. comm. 2003a). The observed decline coupled with a parallel decline in adult nectar source availability and larval hostplant quality strongly suggests that the species is not continually brooded, and adults do not have extended longevity in winter, but instead pupae undergo diapause from about December to early February (Emmel and Daniels 2003, p. 3; 2004, p. 9).

Interspecific relationships—As in many lycaenids world-wide, Miami blue larvae associate with ants (Emmel 1991, p. 13; Minno and Emmel 1993, p. 135; Carroll and Loye 2006, p. 19-20) in at least four genera in three subfamilies of Formicidae (Saarinen and Daniels 2006, p. 71). Miami blues in nickerbean at BHSP and ENP (introduced population) were variously tended by *Camponotus floridanus*, *C. planatus*, *Crematogaster ashmeadi*, *Forelius pruinosus*, and *Tapinoma melanocephalum* (Saarinen and Daniels 2006, p. 71). *C. floridanus* was the primary ant symbiont in both areas. All of the ants ingested honeydew from Miami blues. Ants palpate the posterior of the larva, stimulating it to exude nutritious honeydew, which the ants collect and carry back to their nests. The researchers found that “Late instars were always found in association with ants but early instars, prepupae, and pupae were frequently found without ants present.” *Forelius pruinosus* and *Tapinoma melanocephalum* were observed to derive honeydew from Miami blues they tended, but were not observed to actively protect them from any predator. However, Saarinen and Daniels (2006, p. 71-72) suggested that the mere presence of ants on nickerbean in the vicinity of larvae may provide some predator deterrence function. Saarinen and Daniels (2006, p. 70) identified two additional ants, *Paratrechina longicornis* and *Paratrechina bourbonica*, as potential associates of Miami blue. *P. longicornis* was found near Miami blues and appeared to tend them and *P. bourbonica* tended martial scrub-hairstreaks (*Strymon martialis*) at BHSP. In the 1980s, Miami blue larvae that fed on balloonvine in the upper Keys were also tended by ants (*C. floridanus* and *C. planatus*) (Carroll and Loye 2006, p. 19-20). Cannon et al. (2007, p. 16) observed two ant species attending Miami blues on KWNWR. Based on photographs, the ants appeared to be *C. inaequalis* and *P. longicornis*. *C.*

planatus was observed on Florida Keys blackbead (*Pithecellobium keyense* [*P. Pithecellobium guadalupense* var. *keyense*]), the Miami blue's hostplant on KWNWR.

Range size and dispersal—Adult Miami blues appear to be sedentary (Emmel and Daniels 2003, p. 4; 2004, p. 6), as do lycaenids in general (Cushman and Murphy 1993, p. 40). More than 85 percent of recaptured adults were found within 25 feet (7.6 m) of their original capture site (Emmel and Daniels 2003, p. 4). The mean distance moved by adults was 6.53 feet +/- 11.68 feet (1.99 +/- 3.56 m) (Emmel and Daniels 2004, p. 6). Few individuals were found to move between the lower and upper walkway locations of the south end colony sites at BHSP (Emmel and Daniels 2004, p. 6). No movement between any of the smaller individual, isolated colony sites was found (Emmel and Daniels 2004, p. 6). These findings suggest that movements and genetic exchange among colonies are limited (J. Daniels, pers. comm. 2003b). Taxa with limited dispersal abilities may be far more susceptible to local extinction events than taxa with well-developed abilities (Cushman and Murphy 1993, p. 40).

Taxonomy: The Miami blue belongs to the family Lycaenidae (Leach), subfamily Polyommatainae (Swainson). The species *Hemiargus thomasi* was originally described by Clench (1941, p. 407-408) and the subspecies *Hemiargus thomasi bethunebakeri* was first described by Comstock and Huntington (1943, p. 97). Although some taxonomic authorities continue to use *Hemiargus*, Nabokov (1945, p. 14) erected *Cyclargus* for some species, which has been supported by more recent research (Johnson and Balint 1995, p. 1-3, 8-11, 13; Calhoun et al. 2002, p. 13; K. Johnson, Florida State Collection of Arthropods, in litt. 2002). There are differences in the internal genitalic structures of the genera *Hemiargus* and *Cyclargus* (Johnson and Balint 1995, p. 2-3, 11; K. Johnson, in litt. 2002). According to Kurt Johnson (in litt. 2002), who has published most of the existing literature since 1950 on the blues of the tribe Polyommataini, *thomasi* belongs in the genus *Cyclargus* (Nabokov 1945, p. 14), not *Hemiargus*.

During our assessment of the conservation status of the Miami blue, questions about the taxonomic identity of Miami blues from BHSP were raised by a few individuals. Although the best available scientific information indicated that the entity at BHSP is the Miami blue, we sent adult specimens to three independent taxonomists / reviewers (Jacqueline Miller, Associate Curator, Allyn Museum of Entomology, Florida Museum of Natural History; Paul Opler, Colorado State University; and John Calhoun, Museum of Entomology, Florida State Collection of Arthropods) for verification. Adult specimens that died of natural causes within a captive colony were examined. Each reviewer independently confirmed that the identities of the adult specimens examined were *Cyclargus thomasi bethunebakeri*. We received from Lee Miller, Curator, Allyn Museum of Entomology, Florida Museum of Natural History, an additional confirmation that the identities of the adult specimens examined were *Cyclargus thomasi bethunebakeri*.

Habitat: The Miami blue is a coastal butterfly reported to occur in openings and around the edges of hardwood hammocks, and other communities adjacent to the coast that are prone to frequent natural disturbances (e.g., coastal berm hammocks, dunes, and scrub) (Opler and Krizek 1984, p. 112; Minno and Emmel 1994, p. 647; Emmel and Daniels 2004, p. 12), but also tropical pinelands (Minno and Emmel 1993, p. 134) and along trails, using open sunny areas (Pyle 1981, p. 489). In the Keys, it was most abundant near disturbed hammocks where weedy flowers

provided nectar (Minno and Emmel 1994, p. 647). It also occurred in pine rocklands (fire-dependent slash pine community with palms and a grassy understory) on Big Pine Key (Calhoun et al. 2002, p. 18) and elsewhere in Monroe and Miami-Dade Counties. On islands of the KWNWR, Cannon et al. (2007, p. 13), found that “All areas occupied by MBB had a dune bordered by a berm hammock; human impact was minimal,” but these were on remote islands.

Larval hostplants include trees, shrubs, and vines. Reported hostplants are blackbeads (*Pithecellobium* spp.), nickerbeans, balloonvines, and *Acacia* spp. (Kimball 1965, p. 49; Lenczewski 1980, p. 47; Pyle 1981, p. 489; Calhoun et al. 2002, p. 18). Reports of Miami blue using nickerbean date back to 1900 (Dyar 1900, p. 448-449). Gray nickerbean (*Caesalpinia bonduc*) is widespread and common in coastal south Florida. Following disturbances, it can dominate large areas (K. Bradley, The Institute for Regional Conservation [IRC], pers. comm. 2002). Gray nickerbean has been recorded as far north as Volusia County on the east coast, matching the historical range of the Miami blue, and Levy County on the west coast (J. Calhoun, pers. comm. 2003a). The Miami blue is also reported to use peacock flower (*Caesalpinia pulcherrima*) (Calhoun et al. 2002, p. 18), a widely cultivated exotic that has escaped into disturbed sites of south Florida (Matteson 1930, p. 13 - 14) and has been planted in gardens (M. Minno, pers. comm. 2009). Rutkowski (1971, p. 137) and Opler and Krizek (1984, p. 113) reported the use of snowberry. Brewer (1982, p. 22) reported the use of cat’s paw blackbead (*Pithecellobium unguis-cati*) on Sanibel Island in Lee County.

There are no historical reports of Miami blue feeding on balloonvine until the 1970s, when these plants seemed to have become common in extreme southern Florida (J. Calhoun, pers. comm. 2003a). Prior to that time, documented hostplants for the butterfly were nickerbeans and blackbeads. Subsequently, balloonvine (*Cardiospermum halicacabum*), which was considered a widespread, exotic weed species in Florida, was the most frequently reported hostplant for Miami blue (e.g., Lenczewski 1980, p. 47; Opler and Krizek 1984, p. 113; Minno and Emmel 1993, p. 134; 1994, p. 647; Calhoun et al. 2002, p. 18). According to Calhoun (pers. comm. 2003a), a review of the historical range of the butterfly and its hostplants suggests balloonvine was a more recent larval hostplant and probably replaced nickerbeans as the primary hostplant; as native coastal habitats were destroyed, balloonvine readily invaded disturbed environments and the Miami blue utilized what was most commonly available. Carroll and Loye (2006, p. 13-15) “correct the common view that a principal host plant, balloon vine, is an exotic weed.” They found that published reports of Miami blue larvae on balloonvines all identify the host as *C. halicacabum*. However, they determined that Miami blues in their study sites oviposited on *C. corindum*. The native balloonvine (*C. corindum*) is relatively common and widespread in the Keys, but has been commonly mistaken as *C. halicacabum* in the Keys and other sites in south Florida (K. Bradley, pers. comm. 2002).

The recently discovered Miami blue metapopulation at KWNWR was found to rely upon Florida Keys blackbead as the singular hostplant (Cannon et al. 2007, p. 1). Blackbead was also an important nectar plant when in flower. High counts of Miami blues at KWNWR were generally correlated with the emergence of flowers and new leaves on blackbead. All sites that supported Miami blues contained blackbead (Cannon et al. 2007, p. 6). Limited abundance of blackbead on New Beach in KWNWR was thought to limit Miami blue abundance (Cannon et al. 2007, p. 10).

Adult Miami blues have been reported to feed on a wide variety of nectar sources including Spanish needles (*Bidens alba*), Leavenworth's tickseed (*Coreopsis leavenworthii*), scorpionstail (*Heliotropium angiospermum*), turkey tangle fogfruit or capeweed (*Lippia nodiflora*), buttonsage (*Lantana involucrata*), snow squarestem (*Melanthera nivea* [*M. aspera*]), blackbead, Brazilian pepper (*Schinus terebinthifolius*), false buttonweed (*Spermacoce* spp.), and seaside heliotrope (*Heliotropium curassavicum*) (Pyle 1981, p. 489; Opler and Krizek 1984, p. 113; Minno and Emmel 1993, p. 135; Emmel and Daniels 2004, p. 12). Emmel and Daniels (2004, p. 12) reported that Miami blue use a variety of flowering plants species in the Boraginaceae, Asteraceae, Fabaceae, Polygonaceae, and Verbenaceae families for nectar. Miami blues require suitable open habitats containing nectar sources as well as hostplants. Nectar sources must be present in close proximity to potential hosts since the butterflies are sedentary and may not travel between patches of host and nectar sources (Emmel and Daniels 2004, p. 13). This may help explain the absence of the Miami blue from areas in which hostplants are abundant and nectar sources are limited (J. Calhoun, pers. comm. 2003a). Cannon et al. (2007, p. 15) observed Miami blues to nectar on 10 plant species on KWNWR. Those included blackbead, snow squarestem, coastal searocket (*Cakile lanceolata*), black torch (*Erithalis fruticosa*), yellow joyweed (*Alternanthera flavescens*), buttonsage, bay cedar (*Suriana maritima*), sea lavender (*Argusia gnaphalodes*), seaside heliotrope, and sea purslane (*Sesuvium portulacastrum*). Snow squarestem, coastal searocket, black torch, yellow joyweed, and buttonsage were the most commonly used nectar sources on KWNWR.

Historical Range/Distribution: Field guides and other sources differ as to whether *C. thomasi bethunebakeri* occurs in the Bahamas. Clench (1963, p. 250), who collected extensively in the Bahamas for the Carnegie Museum, listed only Florida. Minno and Emmel (1993, p. 134; 1994, p. 647), and Calhoun (1997, p. 46) considered the Miami blue to only occur in Florida. Riley (1975, p. 110) indicated that the Miami blue of Florida rarely occurs as a stray in the Bahamas. Smith et al. (1994, p. 129) indicated that the Miami blue occurs in southern Florida, but noted it has been recorded from the Bimini Islands in the Bahamas. Regardless, the majority of historical records pertaining to this subspecies distribution are dominated by Florida occurrences, with any peripheral populations in the Bahamas possibly being ephemeral in nature.

Little historical information exists on the abundance and distribution of the Miami blue in Florida. However, it is evident that its historical range has been significantly reduced, with only small remnants remaining. The type series contains specimens ranging from Key West up the east coast to Volusia County (Comstock and Huntington 1943, p. 98; J. Calhoun, pers. comm. 2003a). Kimball (1965, p. 49) stated that it was not rare in the area from Gainesville and Tampa south and was common in Dade and Monroe Counties. It has been collected in the Dry Tortugas (Glassberg and Salvato 2000, p. 2). Lenczewski (1980, p. 47) noted that it was reported as extremely common in the Miami area in the 1930s and 1940s. Opler and Krizek (1984, p. 112) showed its historical range as being approximately from Tampa Bay and Cape Canaveral southward along the coasts and through the Keys. Calhoun et al. (2002, p. 17) placed the historical limits of the species' northern distribution at Hillsborough and Volusia Counties, extending southward along the coasts to the Marquesas Keys (west of Key West).

The Miami blue was most common on the southern mainland and the Keys, especially Key

Largo and Big Pine Key (Monroe County) (Calhoun et al. 2002, p. 17). The species was reportedly more localized on the west coast of Florida and tended to occur on barrier islands of more southern affinities, such as Chokoloskee Island in Collier County (J. Calhoun, pers. comm. 2003a). According to Calhoun et al. (2002, p. 17), the Miami blue occupied areas on at least three barrier islands, Sanibel, Marco, and Chokoloskee Islands, along the west coast into the 1980s (based upon Brewer 1982, p. 22; Minno and Emmel 1994, p. 647-648). Lenczewski (1980, p. 47) reported that the Miami blue was last collected within ENP in 1972. The species had been recorded on at least 10 islands of the Keys (Adams Key, Big Pine Key, Elliott Key, Geiger Key, Key Largo, Lignumvitae Key, Old Rhodes Key, Plantation Key, Stock Island, Sugarloaf Key) (Minno and Emmel 1993, p. 134).

By the 1990s, very few populations were known to persist, and the species has not been seen on the west coast since 1990, where it was last recorded on Sanibel Island (Calhoun et al. 2002, p. 17). The last verifiable report of the Miami blue (prior to rediscovery in 1999) was on Big Pine Key in 1992 (Glassberg et al. 2000, p. 79; Glassberg and Salvato 2000, p. 1; Calhoun et al. 2002, p. 17).

Following Hurricane Andrew in 1992, there were a few unsupported reports from Key Largo and Big Pine Key and the southeastern Florida mainland from approximately 1993 to 1998 (Glassberg and Salvato 2000, p. 3; Calhoun et al. 2002, p. 17). In 1996, four adult Miami blues were observed at the area of DJSP (L. Cooper, listowner of LEPSrUS website, pers. comm. 2002). In May 2001, there was a sighting of a single Miami blue in the hammocks in North Key Largo (Calhoun et al. 2002, p. 17). Many additional Miami blue surveys were conducted throughout the south Florida mainland and the Keys between 1990 and 2003 without success (Glassberg and Salvato 2000, p. 3; Edwards and Glassberg 2002, p. 4-9; Emmel and Daniels 2004, p. 2-6).

Current Range/Distribution: Currently there are two distinct metapopulations of the Miami blue, one at BHSP and one at KWNWR (Glassberg and Salvato 2000, p. 3; Edwards and Glassberg 2002, p. 1-2, 9; Emmel and Daniels 2004, p. 2-6; Cannon et al. 2007, p. 1-24). In 1999, Jane Ruffin observed approximately 50 individuals at BHSP (Ruffin and Glassberg 2000, p. 29), and Miami blues have been observed there consistently since 1999. In November 2003, two fifth instar larvae were documented on West Summerland Key, on unprotected land approximately 2.2 miles (3.6 km) west of BHSP (Emmel and Daniels 2004, p. 3, 24, 26), but none have been seen there since. An adult (or adults) was likely blown to this key from BHSP by a strong wind or at least partially assisted by the wind (J. Daniels, pers. comm. 2003c). In November 2006, Miami blues were discovered on islands within KWNWR (Cannon et al. 2007, p. 2).

Bahia Honda is a small island at the east end of the lower Keys, approximately 7.0 miles (11.3 km) west of Vaca Key (Marathon) and 2.0 miles (3.2 km) east of Big Pine Key. The amount of suitable habitat (habitat supporting available nickerbean and adjacent adult nectar sources) within BHSP is approximately 1.5 acres (0.6 ha). Of the suitable habitat available at BHSP, approximately 85 percent or 1.3 acres (0.5 ha) are occupied by the Miami blue (Emmel and Daniels 2004, p. 12). The BHSP metapopulation is comprised of thirteen distinct colonies. The core of the metapopulation, comprised of three or four colonies, is located at the southwest end of BHSP. This area contains the largest contiguous patch of hostplants, although the size is

estimated to be only 0.8 acres (0.32 ha) (Emmel and Daniels 2004, p. 12). The second largest colony occurs at the opposite (northeast) end of BHSP. The remaining colonies are isolated, with most occurring in close proximity to the main BHSP road (Emmel and Daniels 2004, p. 13, 27). The isolated colonies are vulnerable since the Miami blues at these sites are using very small patches of nickerbean (e.g., one was estimated to be 10.0 by 10.0 feet [3.05 by 3.05 m]) (Emmel and Daniels 2003, p. 3), often adjacent to paved roads (Emmel and Daniels 2004, p. 13, 27).

Efforts to define the limits of the KWNWR metapopulation were conducted from November 26, 2006 to July 30, 2007 (Cannon et al. 2007, p. 10-11). Miami blues were found in 7 sites in the Marquesas Keys, approximately 12.2 miles (19.6 km) west of Key West. An additional colony was located on Boca Grande Key, approximately 11.8 miles (19 km) west of Key West (6.3 miles [10.1 km] east of the Marquesas Keys). The 8 sites occupied by Miami blues ranged from approximately 0.25-37.1 acres (0.1-15 ha) (Cannon et al. 2007, p. 6). Miami blues were not found on Woman Key, approximately 10.1 miles (16.2 km) west of Key West, or Man Key, approximately 6.8 miles (10.9 km) west of Key West (Cannon et al. 2007, p. 5). Woman Key and Man Key had abundant nectar plants, but few hostplants (Cannon et al. 2007, p. 12). Snipe Point and Johnson, Johnston, Porpoise, and Sawyer Keys (northeast and northwest) in Great White Heron NWR were also searched for Miami blues (Cannon et al. 2007, p. 5). These keys are in Florida Bay, equidistant between Big Pine Key and Key West. No Miami blues were found. Sites within Great White Heron NWR variously contained limited amounts of, or were lacking, either hostplants or nectar plants (Cannon et al. 2007, p. 12). The Marquesas and Boca Grande have a land area of approximately 1,398 acres (566 ha) and 193 acres (78 ha), respectively, including mangrove estuaries and other areas that lack suitable habitat.

Population Estimates/Status: The metapopulation at BHSP appears to be restricted to a couple hundred individuals at most. The metapopulation at KWNWR was believed to be several hundred in 2006-2007 with the Miami blue found at eight discrete areas (Cannon et al. 2007, p. 1-24); however, this metapopulation does not appear to be at this level of abundance now.

BHSP: At the south-end Miami blue colony site in BHSP, Pollard transects yielded peak counts of approximately 84, 112, 132, 82, and 81, respectively, in 2003, 2004, 2005 (prior to Hurricane Wilma), 2006, and 2007 (Daniels 2007, p. 3 graph). Population abundance estimates using mark-release-recapture and the Schnabel method ranged from a low of 19.73 in February 2003 to a high of 114.5 in June 2003 (Emmel and Daniels 2004, p. 9). Emmel and Daniels (2004, p. 6) marked a total of 211 individuals (93 females, 118 males) in 2002 and 2003, from September through November. The observed sex ratio was 1.3:1 (males to females) (Emmel and Daniels 2004, p. 11). From June through November 2006, maximum counts were 16, 28, 37, 27, 82, and 26 adults, respectively (J. Daniels, pers. comm. 2007). Absolute abundance figures have not yet been estimated from those data. The investigators believed that habitat conditions had made significant progress toward rebounding from hurricanes in 2005.

Mark Salvato (Service, pers. comm. 2008) conducted monthly counts to attain estimates of abundance at the southwestern colony at BHSP. The monitoring effort covered an area of approximately 2.5 acres (1 ha). The counts suggest a downward trend in numbers. The average of monthly counts for each year, 2003 to 2006, was 129, 58, 46, and 6, respectively. In those

years, 9, 1, 0, and 0 monthly counts, respectively, were above 100. The maximum count was 222 in May 2003. Four hurricanes affected habitat at BHSP in 2005. Salvato believes that some of the subsequent variability in counts may reflect effects from the hurricanes. Count indices exhibited significant variability within and among seasons as would be expected (Van Strien et al. 1997, p. 818, 823, 825) due to life history characteristics, actual fluctuations in abundance, and changes in detectability due to variable weather and other factors. A significant portion of the nickerbean in the census area (roughly greater than 35 percent of the area of nickerbean patches) was damaged by the 2005 hurricanes. Salvato and Salvato (2007, p. 157) visually estimated that as much as 50 percent of the vegetation on the southern side of the island had been heavily damaged, including large stands of host and nectar plants for the Miami blue. Salvato and Salvato (2007, p. 160) indicated that despite a decline in abundance after the hurricanes, the Miami blue had returned to pre-storm abundance by the summer months of 2007. Salvato (pers. comm. 2009) plans to continue monitoring efforts at quarterly intervals.

The BHSP population was monitored somewhat regularly throughout the 2006 through 2009 field seasons (Emmel and Daniels 2009, p. 4). Early season numbers were low in most years and attributed to a persistent south Florida drought (Emmel and Daniels 2009, p. 4). In 2007, the numbers rebounded in late June, but peak population numbers remained below those found prior to the 2005 hurricane season (Emmel and Daniels 2009, p. 4). Depressed numbers were similarly found in 2008 and also attributed to severe drought (Emmel and Daniels 2009, p. 4). In 2008, iguanas, which had previously colonized the island, began to breed prolifically, and the resulting herbivory impacted terminal growth of nickerbean (Emmel and Daniels 2009, p. 4). Such defoliation was mostly limited to the south end colony site below and adjacent to the Flagler railroad bridge (Emmel and Daniels 2009, p. 4). Cooperative eradication efforts resulted in the removal of over 82 iguanas by early 2009 (Emmel and Daniels 2009, p. 4). In all four years, adult or immature Miami blues were found at the several colony sites (i.e., South end, Buttonwood Campground, Sandspur Campground, and Silver Palm Trail); however, the Buttonwood Campground has been relatively unproductive since 2005 (Emmel and Daniels 2009, p. 4). No organisms have been found at any roadway nickerbean patches within BHSP since the 2005 field season (pre-hurricane) (Emmel and Daniels 2009, p. 4). Daniels (pers. comm. 2009) plans to continue monitoring through 2009.

In general, abundance trends on BHSP indicate that there is a marked decrease in the number of individuals during the winter months (November to February) (Emmel and Daniels 2004, p. 9; 2009, p. 4). Higher abundances during the summer wet season may relate to production of a large quantity of new terminal growth on the larval hostplants (nickerbean) and availability of nectar sources from spring rainfall (Emmel and Daniels 2003, p. 3).

KWNWR: Surveys conducted at KWNWR between November 26, 2006 and July 30, 2007 included efforts to attain direct counts as indices of abundance (Cannon et al. 2007, p. 5). Within the 7 sites occupied by Miami blues in the Marquesas Keys, the highest counts were as follows: Main Beach 521 (January 2007), East Cove 12 (January 2007), Long Beach 24 (June 2007), New Beach 8 (January 2007), Short Beach 10 (December 2006), Snook Beach 119 (June 2007), and Third Beach 30 (December 2006). The highest count on Boca Grande was 441 in February 2007 (Cannon et al. 2007, p. 7). Abundance appeared to be highest during December 2006 and January 2007 (Cannon et al. 2007, p. 8). In March and April, blackbead was observed

to yield little new growth and no flowering, and oviposition by Miami blues was not observed (Cannon et al. 2007, p. 8). Partial counts on Main Beach (Marquesas Keys) and Boca Grande in May and June revealed few Miami blues. The Miami blue seasonality observed on KWNWR was different than that described for the BHSP metapopulation (above). Hurricane Wilma (October 2005) heavily damaged blackbead stands at most of the KWNWR sites (Cannon et al. 2007, p. 10). The effects of hurricanes on hostplant-Miami blue seasonality and abundance relationships remain to be assessed.

Periodic surveys of KWNWR were conducted in 2008 and 2009 (Emmel and Daniels 2008, p. 7-10; 2009, p. 9-13). In February 2008, 3 adults (2 females, 1 male) were recorded on Boca Grande; 25 adults (5 females, 20 males) were recorded on Marquesas, Main Beach; 7 adults (2 females, 5 males) were recorded on Marquesas, Long Beach (Emmel and Daniels 2008, p. 7). In February 2008, habitat conditions were extremely poor due to lack of rainfall resulting in very limited adult nectar sources and larval host (Emmel and Daniels 2008, p. 8). In April 2008, 1 adult (male) was recorded on Boca Grande; 0 adults were found at Marquesas, Long Beach; 1 male was recorded at Marquesas, Long Beach; and 0 adults were found at Marquesas, Main Beach (Emmel and Daniels 2008, p. 8). In April, habitat was generally considered to be in good condition (Emmel and Daniels 2008, p. 8). In June 2008, 10 adults (9 males, 1 female) were recorded at Marquesas, Long Beach (northeast portion); 1 adult (male) was recorded at Marquesas, Long Beach (northwest portion); 3 adults (2 male, 1 female) were captured at Marquesas, Main Beach and 13 other individuals were positively identified but not captured; and 0 adults were found on Boca Grande (Emmel and Daniels 2008, p. 9). Habitat conditions were mixed, ranging from very poor (no new growth of hostplant, dieback, and limited nectar sources) to relatively good (new growth of hostplant, some available nectar sources; Emmel and Daniels 2008, p. 9). In August 2008, 5 adults (4 females, 1 male) were recorded at Marquesas, Long Beach; 0 adults were found at Marquesas, Main Beach, and 0 adults were recorded at Boca Grande (Emmel and Daniels 2008, p. 10). Habitat conditions were variable.

In March 2009, 0 adults were recorded on Boca Grande (Emmel and Daniels 2009, p. 12). Habitat conditions were very poor with limited new host growth and available adult nectar resources (Emmel and Daniels 2009, p. 12). In April 2009, 14 adults (3 females, 11 males) were recorded on Marquesas, Main Beach; 8 adults (1 female, 7 males) were recorded on Marquesas, Long Beach (Emmel and Daniels 2009, p. 13). Habitat conditions were mixed (i.e., good condition at Main Beach, poor condition at Long Beach) (Emmel and Daniels 2009, p. 13). Daniels (pers. comm. 2009) plans to continue monitoring through 2009.

Reintroductions: Miami blue reintroductions at ENP have been unsuccessful. Between August 2007 and November 2008, a total of 12 reintroduction events were carried out at BNP and DJSP resulting in the release of 3,553 organisms (276 adults/3,277 larvae) (Emmel and Daniels 2009, p. 4). Monitoring efforts have been limited. A total of 19 days were spent monitoring reintroduction sites (Emmel and Daniels 2009, p. 4). To date, no evidence of colony establishment has been found (Emmel and Daniels 2009, p. 4). Overall, it appears that none of the reintroductions have been successful. Daniels (pers. comm. 2009) is seeking additional support from FWC to continue to maintain the captive colony and conduct experimental releases on the south Florida mainland through 2010.

THREATS:

- A. The present or threatened destruction, modification, or curtailment of its habitat or range. Habitat loss and fragmentation pose significant threats to the Miami blue. Once found on at least 10 of the Keys (Minno and Emmel 1993, p. 134), especially Key Largo and Big Pine Key, the Miami blue was thought to be locally common on the southern mainland and Keys (Calhoun et al. 2002, p. 17, 18) and localized on the west coast of Florida (J. Calhoun, pers. comm. 2003a). Much of this species' original habitat is degraded, fragmented, or lost, especially on the mainland (Lenczewski 1980, p. 47; Minno and Emmel 1994, p. 647; Calhoun et al. 2002, p. 18). In a survey of historical sites where the Miami blue had previously been observed or collected, half were found to be developed or no longer supporting hostplants (D. Fine, pers. comm. 2002). On the east coast of Florida, the entire coastline in Palm Beach, Broward, and Miami-Dade Counties (as far south as Miami Beach) is densely urban, with only small remnants of native coastal vegetation conserved in parks. Most of the Gulf Coast barrier islands that previously supported the Miami blue, including Marco and Chokoloskee Islands, have suffered intense development pressure and lost available habitat (Calhoun et al. 2002, p. 18). Although the Miami blue occurs on public land at two locations in the Keys, the potential for reintroduction elsewhere in the Keys is low. All vacant land in the Keys had been projected to be developed by 2060, including lands not necessarily accessible by automobile (Zwick and Carr 2006, p. 14). Although the economic downturn has temporarily slowed the rate of development, habitat loss and degradation, especially in desirable coastal areas, is expected to continue.

Calhoun (pers. comm. 2003a) believes the Miami blue reached peak abundance when balloonvine invaded clearings associated with the construction boom of the 1970s and 1980s in the northern Keys and southern mainland and became available as a suitable hostplant. If so, this may have represented a change in primary hostplant (from gray nickerbean) for the Miami blue at a time when the species was beginning to suffer a decline due to the continued development and destruction of coastal habitat.

Although extensive loss and fragmentation of habitat occurred as a result of coastal development, significant areas of suitable larval hostplants remain protected for conservation purposes on private and public lands throughout portions of the historic range. According to Calhoun et al. (2002, p. 18), a combination of factors (e.g., development, loss of hostplants following Hurricane Andrew, natural succession, mosquito pesticide application) probably resulted in an acute fragmentation of Miami blue populations, severely diminishing their ability to repopulate formerly inhabited sites or successfully locate hostplants in new areas. Although larval hostplants are still locally common, the disappearance of core populations of the butterfly may now be preventing the species from colonizing new areas (J. Calhoun, pers. comm. 2003a). The Miami blue is sedentary and not known to travel far from pockets of larval hostplants and adult nectar sources (J. Calhoun, pers. comm. 2003a). Therefore, Calhoun (pers. comm. 2003a) suggests that the presence of adult nectar sources in close proximity to larval hostplants is critical to the Miami blue and may help explain its apparent absence from areas that contain high larval hostplant abundance but little-to-no nectar sources.

Land management practices that remove larval hostplants and nectar sources can be a threat to the Miami blue. There is some evidence that land management practices on public conservation lands may have negatively affected Miami blue habitat, but the extent of this impact is not known. For example, the Miami blue had been sighted within the DJSP in 1996, but following habitat restoration to remove invasive exotic species (including balloonvine), no adults were observed (L. Cooper, pers. comm. 2002; J. Calhoun, pers. comm. 2003b; M. Salvato, pers. comm. 2003). In 2001, following the return of balloonvine, a single adult was observed (J. Calhoun, pers. comm. 2003b). The removal of some gray nickerbean as part of trail maintenance and impacts to a tree resulting from placement of a water treatment facility in 2002 may have affected the south colony at BHSP (i.e., the tree had been an apparent assembly area for display during courtship) (P. Halupa, Service, pers. obs. 2002) and further fragmented existing habitat.

Maintenance at BHSP, including pruning of host vegetation along trails and roadsides, use of herbicides, and habitat impact from other projects could lead to direct mortality (Emmel and Daniels 2004, p. 14). The site where immature stages were found on West Summerland Key was extremely vulnerable to mowing as part of road maintenance by FDOT (J. Daniels, pers. comm. 2003c), and available habitat has been impacted by mowing activities (Emmel and Daniels 2004, p. 3). It is believed Miami blues at this roadside site are extirpated. Since Miami blues are sedentary and appear to have poor dispersal capabilities, alteration or modification of small habitat patches may be deleterious.

IRC, who has conducted extensive plant inventories on conservation lands within south Florida, is not aware of any attempts to eradicate balloonvine and notes that gray nickerbean has only rarely been controlled (i.e., purposefully removed or pruned, followed with herbicide treatment) (K. Bradley, IRC, pers. comm. 2002). Nickerbeans are reported to occur in all of the State parks in the Keys. They are not removed, but where they are a safety hazard for visitors such as when overgrowing trails, they are trimmed (J. Duesquenel, FDEP, pers. comm. 2003). Overall, we are not aware of any active efforts to eradicate nickerbean or balloonvine within conservation areas. Removal of these species on a large-scale does not appear to be occurring at this time. However, removal of hostplants in or near occupied habitat remains a concern, given the species' low population size, isolated occurrences, and limited dispersal capabilities (see Factor E).

Climatic changes and sea level rise are major threats to south Florida, including this species and its habitat. The Intergovernmental Panel on Climate Change (IPCC) reports that the warming of the world's climate system is unequivocal based on documented increases in global average air and ocean temperatures, unprecedented melting of snow and ice, and rising average sea level (IPCC 2007, p. 2; 2008, p. 15). Sea-level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the sub-tropical ecoregion of southern Florida (U.S. Climate Change Science Program [CCSP] 2008, p. 5-31, 5-32). The long-term record at Key West shows that sea level rose on average 0.088 inches (0.224 cm) annually between 1913 and 2006 (National Oceanographic and Atmospheric Administration [NOAA] 2008, p. 1). This equates to approximately 8.76 inches (22.3 cm) over the last 100 years (NOAA 2008, p. 1).

IPCC (2008, p. 28) emphasized it is very likely that the average rate of sea-level rise during the 21st century will exceed that from 1961 to 2003 (i.e., 0.071 inches [0.18 cm] per year), although it was projected to have substantial geographical variability. Partial loss of the Greenland and/or Antarctic ice sheets could result in many feet (several meters) of sea-level rise, major changes in coastlines, and inundation of low-lying areas (IPCC 2008, p. 28-29). Low lying islands and river deltas will incur the largest impacts (IPCC 2008, p. 28-29). According to CCSP (2008, p. 5-31), much of low-lying, coastal south Florida “will be underwater or inundated with salt water in the coming century.”

IPCC (2008, p. 3, 103) concluded that “climate change is likely to increase the occurrence of saltwater intrusion into coastal aquifers as sea level rises” and that “sea-level rise is projected to extend areas of salinisation of groundwater and estuaries, resulting in a decrease of freshwater availability for humans and ecosystems in coastal areas.” Since the 1930s to 1950s, increased salinity of coastal waters contributed to the decline of cabbage palm forests in southwest Florida (Williams et al. 1999, p. 2056-2059), expansion of mangroves into adjacent marshes in the Everglades (Ross et al. 2000, p. 9, 12-13), and loss of pine rockland in the Keys (Ross et al. 1994, p. 144, 151-155). Hydrology has a strong influence on plant distribution in these and other coastal areas (IPCC 2008, p. 57). Such communities typically grade from salt to brackish to freshwater species. In the Keys, not only are elevation differences between such communities very slight (Ross et al. 1994, p. 146), but the horizontal distances are small as well. Human developments will also likely be significant factors influencing whether natural communities can move and persist (IPCC 2008, p. 57; CCSP 2008, p. 7-6).

In summary, all known occurrences are at some risk to habitat loss and modification. Although occupied sites are protected, development pressure will make the potential for recolonization throughout the Keys or elsewhere in south Florida unlikely. Some land management practices on public conservation lands are threats. The threats of development and incompatible land management practices are considered moderate and imminent. Known occurrences are in low-lying areas and will be affected by rising sea level. Overall threat level of habitat loss from sea-level rise is currently low, but expected to become severe in the future. Sea-level rise is considered nonimminent because we do not have evidence that this threat is impacting the species or its habitat at this time.

- B. Overutilization for commercial, recreational, scientific, or educational purposes. Rare butterflies and moths are highly prized by collectors and an international trade exists in specimens for both live and decorative markets, as well as the specialist trade that supplies hobbyists, collectors, and researchers (Morris et al. 1991, p. 332-334; Williams 1996, p. 30-37). The specialist trade differs from both the live and decorative market in that it concentrates on rare and threatened species (U.S. Department of Justice 1993, p. 1-3). In general, the rarer the species, the more valuable it is, and prices may exceed U.S. \$2,000 for rare specimens (Morris et al. 1991, p. 332).

We do not have evidence of collection of the Miami blue. However, the potential for unauthorized or illegal collection of the Miami blue (eggs, larvae, pupae, or adults) exists, despite the protection provided on State land, listing actions on the part of the State, and

protection provided on Federal lands. The localized distribution of the Miami blue and the small size of the colonies in the heavily visited BHSP and KWNWR render this butterfly vulnerable to collection. BHSP is heavily used and continual monitoring of the colony sites is not practical. Therefore, illegal collection could occur without being detected.

In summary, we do not have an adequate basis to conclude that the species is currently threatened by overutilization for commercial, recreational, scientific, or educational purposes at this time. Overall threat level is unknown. However, because there are only two small metapopulations we believe that collection has the potential to be a serious threat to the species at any time.

- C. Disease or predation. The population-level effects of disease or predation on the Miami blue are not known. Potential predators, including spiders, small birds, and ant species were observed in and near Miami blue colonies at BHSP (J. Daniels, pers. comm. 2003d). However, while monitoring those colonies, egg, larval, or adult mortality due to predation or disease was not observed (J. Daniels, pers. comm. 2003d; Emmel and Daniels 2004, p. 12). On several occasions, Cannon et al. (2007, p. 16) observed unidentified wasps eating Miami blue larvae, as well as adults trapped in the webs of silver orb spiders (*Argiope argentata*).

Various ants that occur in Monroe County are potential predators. These include several species of *Pseudomyrmex* (with at least two species observed at BHSP) (Saarinen and Daniels 2006, p. 71). Additionally, the little fire ant (*Wasmannia auropunctata*) and red imported fire ant (*Solenopsis invicta*), both invasive exotic species, were observed at BHSP (Saarinen and Daniels 2006, p. 71). Saarinen and Daniels (2006, p. 70) did not observe these ants to prey upon Miami blues, but considered them to be cause for concern. Fire ants may also have an indirect effect on the Miami blue by affecting native ant populations, which may impact the health or mortality level of developing larvae (Emmel and Daniels 2004, p. 14). It is not known if *Campanotus* ants provide some level of protection for Miami blue larvae or if a lack of ants renders the larvae any more or less susceptible to predation, but anti-predator benefits from ants, particularly *Crematogaster* species, has been found in other lycaenids (Pierce and Eastal 1986, p. 451, 456-457). *Crematogaster ashmeadi* was found to tend Miami blues at BHSP, and this species is “equipped with a flexible abdomen and attached sting; despite their small size they are potentially capable of defending larvae from other ants or harmful invertebrates” (Saarinen and Daniels (2006, p. 71).

Because the Miami blue is restricted in range and abundance, disease and predation could pose a threat to its survival. At this time, it is not known to what extent predation or parasitism may be a threat. Parasitism and predation are natural parts of the species’ life history, but nonnative ants are a potential source of significant threats due to predation on Miami blues and or impacts to their symbiont complex. Although threat level is unknown, predation and parasitism are potential threats given the species’ small population size and few occurrences. Disease is not known to be a threat.

- D. The inadequacy of existing regulatory mechanisms. Even though there are protection measures in place, Federal, State, and local laws have not been sufficient to prevent past and ongoing impacts to Miami blue habitat within its historical range.

On December 10, 2002, the Florida Fish and Wildlife Conservation Commission (FWC) declared the Miami blue butterfly (*Hemiargus thomasi bethunebakeri*) an endangered species in the State of Florida and afforded the emergency protective provisions specified in Rules 68A-27.0011 and 68A-27.003. This order was ratified at the FWC meeting on January 23, 2003, protecting the species for 240 days, until September 2003; this temporary protection was subsequently extended until November 2003. On November 19, 2003, the FWC declared the Miami blue butterfly (*Cyclargus [= Hemiargus] thomasi bethunebakeri*) endangered (68A-27.003). This designation prohibits any person from taking, harming, harassing, possessing, selling, or transporting any Miami blue or parts thereof or eggs, larvae or pupae, except as authorized by permit from the executive director, with permits issued based upon whether issuance would further management plan goals and objectives. Although these provisions prohibit take of individuals, there is no substantive protection of Miami blue habitat or protection of potentially suitable habitat. The FWC has completed a biological status review and management plan for the species as part of its listing process (FWC 2003, p. 1-26). Although the management plan is a fundamental step in outlining initial conservation needs of the species, it may be inadequate for achieving long-term protection.

The Miami blue is afforded protection within BHSP. All FDEP property and resources are generally protected from harm in Chapter 62D-2.013(2) and animals are specifically protected from unauthorized collection in Chapter 62D-2.013(5) of the Florida Statutes. Exceptions are made for collecting permits, which are issued, “for scientific or educational purposes.” However, the potential for unauthorized or illegal collection and take of Miami blue eggs, larvae, pupae, and adults exists.

For scientific research on and/or collection of the Miami blue at ENP, BNP, and / or KWNWR, a permit is required from the NPS or the Service, respectively. Although the Miami blue occurs on Federal land which offers protection, these areas are vast and open to the public. Public lands can be heavily used, with signage prohibiting collection often lacking and patrolling / monitoring of activities limited. Therefore, potential illegal collection could occur without being detected.

In summary, the protection currently afforded the Miami blue butterfly is limited. Although take of individuals is prohibited, there is no substantive protection of Miami blue habitat or protection of potentially suitable habitat. Therefore, we conclude that the existing regulatory mechanisms are inadequate to protect the Miami blue and its habitat. Overall, this threat is considered to be moderate in magnitude and nonimminent because some regulatory measures are in place.

- E. Other natural or manmade factors affecting its continued existence. Vegetation management on public land, including lack of prescribed fires, may have adversely affected the Miami blue. In addition to being historically found within hardwood hammocks, the Miami blue was found in open, sunny, disturbed areas, along edges of hammocks, and within pine rockland which is a fire-dependent ecosystem. Calhoun et al. (2002, p. 18) reported that, on Big Pine Key until the early 1990s, the Miami blue most commonly occurred in pine

rocklands and hammocks such as Long Beach.

In pine rocklands of south Florida and the Keys, frequent fires burn back the overgrowth of the herbaceous layer, allowing native shrubs and associated grasses and herbs to re-sprout from roots under slash pine canopy (Carlson et al. 1993, p. 918; Salvato 1999, p. 6). However, due to the proximity of remaining pine rockland habitat to urban areas much of these natural fires have been suppressed, often replaced by inconsistent regimes of managed or prescribed fires. In the absence of fire, pine rockland progresses to hardwood hammock. This process is occurring on parts of Big Pine, No Name, and Little Pine Keys. Similarly, areas on northern Key Largo that contained pineland that has not burned for many decades are now covered with dense hardwood species (Alexander and Dickson 1972, p. 95). On the southern mainland, the process of broad-leaved communities replacing pine rockland takes about 25 to 30 years (Alexander and Dickson 1972, p. 93; Carlson et al. 1993, p. 926). Since the Miami blue is sedentary, increased fragmentation from changes in vegetation due to lack of fire may have exacerbated fragmentation of the species habitat.

Calhoun noted that populations encountered during the late 1970s and 1980s occurred along disturbed roadsides, weedy vacant lots, overgrown beaches (Sanibel), and partially cleared hammocks, none of which represented natural situations, and construction was continuing in the vicinity of these areas at that time. Calhoun (pers. comm. 2003b) suggested that this could help explain the situation on Big Pine Key where there was much land development through the 1980s, after which development slowed. Artificial clearing was curtailed, and previously disturbed sites were not maintained as such, resulting in the reduction of early successional habitat for the butterfly. Sites that were not developed were either maintained in a scarified state or became overgrown, crowding out the hosts and nectar sources. Calhoun suggested that in either case habitat was lost and new sites were not created. In his view, fragmentation occurred and the species started a downward spiral from which it has not recovered due to its sedentary nature. He suggested that events, such as hurricanes, undoubtedly applied additional pressure on surviving populations that could not reach any suitable sites that remained. Calhoun indicated that there are many areas where nickerbean and balloonvine still occur, but most do not support the proper amount of adult nectar sources made more readily available by fire or other disturbances.

Displacement of native plants including hostplants by invasive exotic species, a common problem throughout south Florida, also likely contributed to habitat loss of the Miami blue. In coastal areas where undeveloped land remains, the Miami blue's larval food plants are likely to be displaced by invasive exotic plants, such as Brazilian pepper.

BHSP is heavily used by the public for recreational purposes. Due to the colonies being located along trails, the Miami blue may experience a high level of disturbance from visitors. In December 2002, evidence of trampling of larval hostplants and flowering plants was documented at the south colony site, which may have been detrimental to the Miami blue due to the reduced availability of nectar sources in the winter (P. Halupa, pers. obs. 2002). BHSP has since erected a fence to prevent trampling of hostplants within the south colony. Although this is expected to minimize damage to the largest colony, the other small colonies (i.e., patches of habitat as small as 15.0 by 15.0 feet [4.6 by 4.6 m]) are still vulnerable to

intentional or accidental damage. Fencing small colony sites or patches of available habitat is impractical and would make exact locations of colonies more evident, possibly increasing the risk of illegal collection. KWNWR lacks human developments, but local disturbances result from illicit camping, fire pits, groundings, smugglers, treasure hunters, vandals, poachers, and immigrant landings. These disturbances are generally infrequent for most islands within KWNWR with the exception of Boca Grande, which contains the largest amounts of beach. Recreational visitation is high on Boca Grande, particularly during weekends (Cannon et al. 2007, p. 13). Trampling of dune vegetation has been a long-term problem on Boca Grande, and fire pits have been found many times over the years on both Boca Grande and the Marquesas Keys (Cannon et al. 2007, p. 13). In addition, Cannon et al. 2007 (p. 13) suggested that the large amount of dead vegetation intermingled with hostplant on Boca Grande and the Marquesas Keys makes the threat of fire (natural or human-induced), a significant threat to the Miami blue.

Herbivory of hostplants by iguanas (*Iguana iguana*) was a severe threat to the Miami blue, however actions are now being taken to address this problem. While iguanas have been observed at BHSP for the past several years, sightings became more prevalent recently, and herbivory of hostplants was acknowledged as a larger threat than previously thought. During a site visit in April 2009, nickerbean showed signs of poor vigor, ongoing decline, limited stature, and apparent chronic herbivory (P. Hughes, Service, pers. comm. 2009). Recent observations of iguanas may represent a continuation of a pre-existing (iguana) problem or an increased threat from that chronic problem (accelerated pressure and or accumulating damage from iguanas) (P. Hughes, pers. comm. 2009). In either case, the vigor of the nickerbean stands at the main colony sites at BHSP appear to be in a diminished state and or in ongoing decline (P. Hughes, pers. comm. 2009). In addition to damaging hostplants, it is highly likely that iguanas consume eggs and or pupae. Three iguana tunnels are visible within a chip pile in a nickerbean patch along the north-facing slope of the bridge foundation at BNSP; this pile is an ideal refuge for iguanas and may serve as breeding habitat (P. Hughes, pers. comm. 2009). Removal of the chip pile is recommended.

The State and partners are taking steps to combat the threat of iguanas at BHSP. Cooperative eradication efforts resulted in the removal of over 82 iguanas by early 2009 (Emmel and Daniels 2009, p. 4). FWC acknowledges that the actual iguana population at BHSP is not known and that completely eradicating iguanas from this site or elsewhere in the Keys or south Florida is not feasible (R. Zambrano, pers. comm. 2009). However, FWC believes that removal has significantly decreased the number of iguanas in the core Miami blue area within BHSP and realizes that this management action will need to be an ongoing effort due to the prevalence of iguanas in the surrounding areas (R. Zambrano, pers. comm. 2009).

Iguana tracks were also found on one of the islands occupied by Miami blues in KWNWR (Cannon et al. 2007, p. 16). The authors indicated that the exotic herbivore has the potential to impact host and nectar plants at this site.

Factors relating to pesticides—Efforts to control the salt marsh mosquitoes (*Aedes sollicitans* (Walker) and *A. taeniorhynchus* (Wiedemann)) and others increased as human activity and population increased in south Florida. To suppress mosquitoes, second-

generation organophosphates (naled) and pyrethroid (permethrin) adulticides are applied by mosquito control districts throughout south Florida. The use of pesticides (applied using both aerial and ground-based methods) to control mosquitoes presents collateral effects on non-target species.

Eliazar (1992, p. i-51) collected data on the toxicity of Baytex (fenthion) and Dibrom (naled), pesticides actively used for mosquito control in the 1980s, for both adult and larval stages of butterfly species found throughout south Florida and the Keys. Specifically, these studies demonstrated the extreme toxicity of Baytex and Dibrom on giant swallowtail (*Papilio cresophontes*), a butterfly congeneric to the federally listed endangered Schaus swallowtail butterfly (*Heraclides aristodemus ponceanus*) throughout its historical range. These chemicals were attributed to lethal effects on non-target Lepidoptera in south Florida and the Keys, including direct adverse impacts to Schaus swallowtail populations (Emmel 1991, p. 12-13; Eliazar and Emmel 1991, p. 18-19; Eliazar 1992, p. 29-30).

Nontarget arthropods, in both the adult and immature stages, are negatively impacted from chemical application either by direct contact with the chemical or by ingestion of residue on foliage (Eliazar and Emmel 1991, p. 17-19; Salvato 2001, p. 8-14). Studies conducted by Hennessey and Habeck (1989, p. 1-22; 1991, p. 1-68, figs.) and Hennessey et al. (1992, p. 715-721) illustrated the presence of adulticide spray residue long after application in habitat of the Schaus swallowtail in both the upper Keys (Crocodile Lake NWR, North Key Largo) and the lower Keys (National Key Deer Refuge [NKDR], Big Pine Key). Hennessey et al. (1992, p. 715-721) studied drift residues of naled and fenthion used in mosquito control in pineland and hammock ecosystems in the Keys in 1989. In this study, naled residues were found up to 820 yards (750 m) downwind in a pineland area where spraying does not occur, 6 hours after application to adjacent target areas; similarly, fenthion residues were found up to 55 yards (50 m) downwind in a hammock area 15 minutes after application in adjacent target areas.

In the lower Keys, Salvato (2001, p. 8-14) and Hennessey and Habeck (1991, p. 14) suggested that declines in populations of another candidate butterfly species, the Florida leafwing (*Anaea troglodyta floralis*), was also partly attributable to mosquito control adulticide applications. Salvato (1999, p. i-168; 2001, p. 8-14) conducted field studies in the lower Keys. Densities of both Florida leafwing and Bartram's hairstreak (*Strymon acis bartrami*), in both adult and larval stages, were statistically higher on untreated transects throughout the survey periods. Furthermore, Salvato (2001, p. 14; 2002, p. 56-57) found populations of the Florida leafwing (on Big Pine Key within NKDR) to increase during drier years when adulticide applications over the pinelands decreased, but Bartram's hairstreak did not follow this pattern. Vulnerability to chemical exposure may vary widely between species, and current application regimes do not appear to affect some species as strongly as others (Calhoun et al. 2002, p. 18).

In addition to its need for nectar sources (possibly reduced due to collateral effects on pollinators), aspects of the Miami blue's natural history such as its association with ants and occurrence near roadways may increase its susceptibility to collateral impacts from adulticide applications. The Miami blue's hostplants and nectar sources are commonly

found at disturbed sites and often occur along roads within reach of mosquito control products. Loye and Carroll (in prep.) have found that Miami blue larvae using balloonvine in the Keys leave an entrance hole open in the seed pod, allowing *Campanotus* ants to enter and tend larvae, whereas the larvae of a similar lycaenid, the silver-banded hairstreak, weave a silken patch over the opening to seal the balloon. Ants and larvae of the Miami blue on balloonvine were found to die when roadside spraying for mosquito control began in late spring, but larvae of the silver-banded hairstreak apparently survived subsequent spraying (Emmel 1991, p. 13). Some have suggested that since Miami blue larvae leave their entrance holes open, the species may be more susceptible to adulticide spray (Emmel 1991, p. 13; Glassberg and Salvato 2000, p. 7; Calhoun et al. 2002, p. 18).

Mosquito control activities, including the use of larvicides and adulticides, are being implemented at BHSP. At this time, it does not appear that the survival of the Miami blue at BHSP is immediately threatened by mosquito control activities since pesticides are not applied to the two main colony sites. However, mosquito control practices potentially may limit expansion of these colonies within and outside of BHSP, and activities have the potential to affect the colonies if aerial application of adulticides within BHSP occurs. Although the State's management plan suggests that "no-spray zones" become established around populations of the Miami blue and that a 2,460 foot (750 m) buffer be used during aerial applications to minimize accidental drift during nuisance insect adulticide and larvicide applications, there are no specific binding or mandatory restrictions to prohibit such practice. Therefore, the potential effects of mosquito control applications and drift residues remain a threat to the Miami blue. A study to assess the effects of drift on the Miami blue was recently initiated.

Adulticides used for mosquito control can be lethal to butterflies. Mosquito Control Districts conduct aerial and or ground spraying of mosquito adulticides over most of Monroe County (excluding KWNWR and portions of BHSP with Miami blues) and other counties throughout south Florida. The Service currently does not have specific insecticide application records from the Mosquito Control Districts for the vast majority of these areas. Accordingly, mosquito control practices potentially pose a significant threat to the Miami blue, particularly those outside of KWNWR or BHSP. However, research on specific, population level effects on the Miami blue are lacking. Cannon et al. (2007, p. 20) noted the lack of mosquito control pesticide application in the KWNWR where a Miami blue metapopulation was discovered in 2006. However, such single observations alone are not evidence for a causative relationship and do not allow for broader inference.

Two studies were recently implemented to better assess aspects of butterfly toxicology in the Keys. Both confirm that adult mosquito control as practiced in the Keys (both aerial and ground applications) pose some threat to butterflies, and one shows that mortality of experimentally placed Miami blues increases in areas affected by standard aerial adulticiding procedures alone. Pierce (2008, p. 1-5) is conducting a study to determine the concentration and persistence of mosquito control adulticides within NKDR on Big Pine Key. Some preliminary findings are available (Pierce 2008, p. 4). Naled and DDVP were observed to persist on foliage at 12 hours after naled applications, but no residues were detected on foliage 2 weeks after the application. Permethrin was observed to persist on foliage collected

at NKDR for more than 2 weeks after application. Additionally, the control site, monitored during the 2008 studies, was contaminated with permethrin drift from truck applications in near-by residential neighborhoods. These findings suggest that truck-based applications of adulticides on BHSP, even though conducted outside the immediate area of Miami blue colonies, may pose a threat.

Zhong et al. (2009, p. 1-37) conducted a study to directly investigate the impact of naled ultra-low volume (ULV) aerial spray for mosquito control on Miami blue larvae in the field. The study was conducted in North Key Largo in cooperation with the Florida Keys Mosquito Control District and used experimentally placed Miami blue larvae that were reared in captivity. The study involved fifteen test stations: nine stations in the spray target zone, three stations in the spray drift zone adjacent to the target zone, and three field control (reference) stations not subjected to the naled spray drift (Zhong et al. 2009, p. 2). Average survival rates of Miami blue larvae varied from 52 percent to 98 percent in the spray zone (Zhong et al. 2009, p. 12). The overall average survival rate of larvae was 73.9 percent for the spray zones, which was significantly lower than drift zone (90.6 percent) or control zones (100 percent) (Zhong et al. 2009, p. 12, 32). Analysis of naled residue data showed that mortality was a result of exposure to excess residues of naled from the air column and deposition (Zhong et al. 2009, p. 2). Results indicated that increasing naled deposition had a significant negative effect on survival of larvae, particularly at the higher deposition concentrations measured in the spray zone (Zhong et al. 2009, p. 12). High concentrations of naled (i.e., over 1000 $\mu\text{g}/\text{m}^2$) were found at nearly 30 percent of the stations in the target spray zone; such concentrations lie “in the range of exposure that results in rapidly increasing predicted mortality” (Zhong et al. 2009, p. 13). Zhong et al. (2009, p. 13) stated that “Our results indicate that exposure to this level of naled residue is likely to result in high mortality of Miami blue butterfly larvae.” In addition, 9 of 18 samples in the drift zone and 1 of 18 samples in the control zone had detectable concentrations of naled (Zhong et al. 2009, p. 12).

Zhong et al. (2009, p. 14) noted that residue distribution following aerial application of naled can be affected by numerous factors, such as spray altitude, aircraft speed, nozzle size, wind speed, wind direction, landscape architecture, and microscale differences in air flow and turbulence. They found that one of the main variables affecting the actual application outcome was wind speed, which contributed to a large variation of the residue profile for air influx and deposition. Zhong et al. (2009, p. 14) suggested that increasing wind speed may produce more concentrated naled residue; this additional residue did not improve mosquito control efficacy, but significantly reduced butterfly larval survival from over 91 percent to less than 57 percent.

Zhong et al. (2009, p. 15) cautioned that results of their study “were limited to an assessment of the impact of single aerial ULV applications of naled only, while multiple sprays on consecutive nights often can occur.” They pointed to the Miami blue’s extended potential exposure duration in the field (i.e., total development time [egg to adult] of 30 days) and suggested that “multiple ULV naled applications may increase the risk of the butterfly mortality and enhance the likelihood of the lethal impacts”(Zhong et al. 2009, p. 15). In

addition, Zhong et al. (2009, p. 15) acknowledged that their study only assessed ULV application impacts to late instar larvae and stated that the potential impacts of naled on early instar larvae, pupae, and adults still need to be investigated.

Factors relating to small population size—The Miami blue appears to be vulnerable to extinction due to limited range, populations, and abundances. In general, isolation, whether caused by geographic distance, ecological factors, or reproductive strategy, will likely prevent the influx of new genetic material and can result in a highly inbred population with low viability and/or fecundity (Chesser 1983, p. 66-77). Natural fluctuations in rainfall, hostplant vigor, or predation may weaken a population to such an extent that recovery to a viable level would be impossible. Isolation of habitat can prevent recolonization from other sites and result in extinction. The Miami blue is known from only two metapopulations in the lower Keys. The metapopulation at BHSP appears to be restricted to a couple hundred individuals at most; the metapopulation at KWNWR included perhaps several hundred in 2006-2007 and is considered to be less abundant now. The occurrence of this butterfly within its historical range, which once extended from the Keys north along the Florida coasts to about St. Petersburg and Daytona, is now severely reduced. Distance between the metapopulations and the colonies within those metapopulations and the small size of highly sporadic populations make recolonization unlikely if populations are extirpated. Fragmentation of habitat and the limited dispersal capabilities of this butterfly lead us to believe this species is vulnerable due to the small number of populations, their small size, and their relative isolation.

Environmental stochasticity—Variability of environmental factors has the potential to adversely affect the Miami blue. A hard freeze in the late 1980s likely contributed to the decline of the Miami blue (L. Koehn, Miami Blue Butterfly Restoration Project, pers. comm. 2002) possibly due to loss of larval hostplants. Depressed numbers in 2008 were attributed to severe drought (Emmel and Daniels 2009, p. 4).

In 1992, Hurricane Andrew impacted extreme southeastern Florida where many populations of the Miami blue were still found (Calhoun et al. 2002, p. 18). According to Calhoun et al. (2002, p. 18), this hurricane may have negatively impacted the majority of these populations. Storm surges associated with hurricanes result in inundation of plant roots with saltwater for varying durations (Bradley 2006, p. 11). Hurricane Wilma resulted in a storm surge that covered most of lower Keys with seawater. Wilma resulted in extensive impacts on Miami blue habitat at BHSP, but following the onset of regular levels of rainfall in July 2006, the nickerbean has been exhibiting resiliency (J. Daniels, pers. comm. 2007). Alternatively, given enough resiliency in extant populations, certain storm regimes may benefit populations over some time frame if they result in disturbances that favor hostplants and other habitat components.

According to the Florida Climate Center, Florida is by far the most vulnerable state in the United States to hurricanes and tropical storms (http://coaps.fsu.edu/climate_center/tropicalweather.shtml). Based on data from 1856-2008, Klotzbach and Gray (2009, p. 28) calculated the climatological and current-year probabilities for each state being impacted by a hurricane and major hurricane. Of the coastal states

analysed, Florida had the highest climatological probabilities, with a calculated 51 percent probability of a hurricane and the 21 percent probability of a major hurricane. Given the Miami blue's low population size and few isolated occurrences, the species is at substantial risk from hurricanes, storm surges, or other extreme weather. Depending on the location and intensity of a hurricane or other severe weather event, it is possible that the Miami blue could be extirpated or could become extinct. Because it has poor dispersal capabilities, natural recolonization of potentially suitable sites is anticipated to be exceedingly slow at best.

Cushman and Murphy (1993, p. 37, 41) proposed that lycaenids, particularly those species with a strong dependence on ants, are more sensitive to environmental changes and thus more prone to endangerment and extinction than species not tended by ants (and non-lycaenids in general). Their hypothesis is based on the probability that the combination of both the right food plant and the presence of a particular ant species, may occur relatively infrequently in the landscape. Such dual requirements to tended species should result in spatial distributions that are patchier than those from untended species (Cushman and Murphy 1993, p. 41). In addition, selection may favor reduced dispersal by ant-associated lycaenids due to the difficulty associated with locating patches that contain the appropriate combination of food plants and ants (Cushman and Murphy 1993, p. 39-40). Lycaenid traits (sedentary, host-specific, symbiotic with ants) that result in isolated populations of variable sizes may serve to limit genetic exchange (Cushman and Murphy 1993, p. 37, 39-40). The expression of rare recessive deleterious genes from inbreeding can have varying consequences, resulting in death, decreased fertility, loss of vigor, reduced fitness, and smaller body size, among others (Smith 1990, p. 307-311).

In summary, the Miami blue is vulnerable to a wide array of natural and human factors. The species' small population size, isolated occurrences, and restricted range are serious concerns. These threats are high in magnitude and imminent. The threat of hurricanes is severe and imminent, due to the species' precarious status and its location in storm-prone areas. Herbivory of hostplants by iguanas is a new and significant threat, which is impacting one of two metapopulations remaining. Cooperative efforts to remove iguanas from BHSP have reduced the magnitude of this threat, but it remains imminent. Fire suppression and exotic plants are lesser threats and are considered to be moderate and nonimminent because some corrective actions are being taken. Mosquito control practices have been shown to cause mortality of Miami blue larvae, placing the butterfly at-risk in areas where such pesticides are used; such practices may also reduce the butterfly's ability to expand into otherwise suitable habitat. This threat is considered to be moderate and imminent. Recreational impacts and public use are considered low and nonimminent threats. The Miami blue's environmental sensitivity and dependence on ants is unknown.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

The FWC has completed a management plan for the species (FWC 2003, p. 1–26). The management plan outlines conservation measures under five categories: maintain and protect the remaining population, initiate a captive propagation and release program, conduct scientific research to facilitate management actions, monitor the population, and increase public awareness and outreach. Of these categories, most resources appear to have gone toward the implementation of propagation and reintroduction. Captive propagation and reintroduction

efforts continue. However, various planning and technical facets of the propagation and reintroduction program that were anticipated by the Service have not been implemented. The Florida Park Service, which manages BHSP, is an active partner in Miami blue conservation and implements protection measures to the extent practicable. Studies on the effects of mosquito control pesticides have been initiated. Pierce (2008, p. 1-5) is conducting a study to determine the concentration and persistence of mosquito control adulticides within NKDR on Big Pine Key. Data from the field study will be provided to Dr. Gary Rand of Florida International University. Rand is conducting laboratory-based toxicity studies of at least four butterfly species. The data from the two studies will be combined to produce a probabilistic risk analysis on the impacts of mosquito control activities on Keys butterflies. Research on population genetics and relationships with ants is underway. Monitoring of the BHSP metapopulation and reintroduction sites has continued to various degrees. Public outreach has been implemented to an extent, particularly in the form of numerous press releases surrounding the captive propagation and reintroduction program. Additionally, a brochure that illustrates Miami blue identification and a request for sightings was produced and posted on the internet.

SUMMARY OF THREATS

Habitat loss, degradation, and fragmentation have destroyed habitat throughout much of the Miami blue's range, and many of these threats are continuing. Although the remaining metapopulations occur on conservation lands, the specific habitat requirements of the Miami blue make its continued persistence uncertain. Climatic changes and sea level rise are long-term threats that will continue; these factors are expected to ultimately reduce the extent of available habitat. The Miami blue is inherently vulnerable to extinction due to demographic, environmental, and genetic threats associated with small population size and the small, localized areas that constitute the extant range. There is no evidence that reintroduced populations have become established or self-sustaining. Mosquito control activities, continued habitat loss and fragmentation, displacement of native hostplants by invasive exotic species, human disturbances, detrimental land management practices, and inadequate regulatory protection continue to pose threats. Damage to hostplants by iguanas is now impacting the hostplant at one site (BHSP) and threatening another site (within KWNWR); active steps are being taken to combat this threat at BHSP. Hurricanes are a substantial threat to remaining metapopulations, which are both located on exposed and vulnerable islands in a hurricane-prone area. Illegal collection remains a potential threat. In addition, environmental sensitivity may be a factor since this butterfly may be dependent upon ants. We find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

For species that are being removed from candidate status:

___ Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions (PECE)?

RECOMMENDED CONSERVATION MEASURES

- Conduct surveys on a regular basis.
- Complete a captive propagation, reintroduction, and monitoring plan.
- Complete the reintroduction site selection analysis process and re-assess site selection.

- Prepare a formal management plan for BHSP that accounts for pesticide and herbicide use, protection against collection, and all aspects of habitat management.
- Complete efforts to quantitatively assess any significant population level relationships between mosquito control practices and the Miami blue.
- Assess genetic structure and health of wild and captive populations.
- Research Miami blue habitat relationships including community structure, effects of weather, and factors associated with larval hostplants-adult nectar plant distribution, abundance and interspersions, and how these relate to Miami blue population dynamics.
- Monitor the relationships between population dynamics and abiotic factors in the environment.
- Conduct a review of the biology of larval hostplants to understand potential habitat relationships and management options.
- Assess the effects of prescribed fire and other activities on hostplants in pine rocklands and other habitats.

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/population	3*
	Nonimminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Nonimminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: The Miami blue butterfly is threatened by the combined influences of habitat destruction and modification, hurricanes of increasing frequency and magnitude, herbivory of hostplants by iguanas, and loss of genetic diversity within small, isolated populations. Mosquito control practices have been shown to cause mortality of Miami blue larvae, placing the butterfly at-risk in areas where such pesticides are used; such practices may also reduce the butterfly's ability to expand into otherwise suitable habitat. Climatic changes and sea level rise are long-term threats that will reduce the extent of habitat. Damage to hostplant (nickerbean) from iguanas is a serious threat at BHSP. Accidental harm or habitat destruction, and illegal collection may also pose a threat to the survival due to small population sizes. In addition to

these threats, continued habitat loss and fragmentation, historical and current fire suppression, displacement of native hostplants by invasive exotic species, detrimental land management practices, and inadequate regulatory protection continue to pose threats to the species throughout its range. We find overall that these threats are of high magnitude as they constitute a significant risk to the survival of this subspecies.

Imminence: The Miami blue butterfly is threatened by the combined influences of habitat destruction and modification, mosquito control activities, and potentially ongoing loss of genetic diversity and demographic viability due small population sizes and isolation. Sea level rise is currently occurring and has resulted in the loss of pine rocklands. However, this is considered a future threat since we do not have evidence that it is currently affecting any population. Iguanas continue to impact nickerbean at one location and, without continued management efforts, would threaten one of two remaining metapopulations. Hurricanes (and associated salt-water intrusion, wind, and wave damage) pose a significant threat to this species and may be increasing in frequency. Collection can potentially occur at any time. We believe survival of the Miami blue depends on protecting the species' currently occupied habitat from further degradation and fragmentation; restoring potentially suitable habitat within its historic range; avoiding or removing threats from fire suppression, mosquito control, and accidental harm from humans; increasing the current population in size; and establishing populations at other locations. Multiple stakeholders are involved in efforts to help safeguard the remaining wild populations and establish additional populations on conservation lands. However, the most serious threats are imminent.

Rational for Change in Listing Priority Number: Only two metapopulations remain, and population sizes are small. The Miami blue is declining (M. Minno, pers. comm. 2009). The metapopulation at KWNWR appears less abundant now compared to 2006-2007 estimates. Reintroductions into protected areas have not been successful. The loss of or additional decline in either metapopulation would be detrimental to the status of the species. Any one or several factors in combination could lead to extirpation or extinction. Recent field and laboratory trials examining the toxicity of insecticides to the Miami blue confirm mortality from mosquito control practices. Butterflies occurring where such practices are conducted are at-risk of lethal or sublethal effects. Mosquito control practices may also be limiting the butterfly's expansion into otherwise suitable habitat. Herbivory of hostplants by iguanas is a new and significant threat, which is currently occurring. Iguanas also likely ingest Miami blue eggs and larvae when consuming the tender new shoots on nickerbean. The Miami blue metapopulation at BHSP, one of only two remaining, is now threatened by these herbivores. Iguanas have been reported from KWNWR, and researchers indicate that they have potential to impact host and nectar plants there, as well. Considering the immediacy of this new threat and other imminent threats (e.g., hurricanes, few occurrences, small population size), a change in listing priority is justified. Therefore, we are changing the LPN from 6 to 3.

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No, however, the status needs to be carefully monitored. The status and distribution of the species should be monitored closely to detect changes and any

further decline. The loss of or additional decline in either metapopulation would be detrimental to the status of the species. The Service and its partners need to continue to implement actions to conserve this species, remove threats, and increase viability wherever possible.

DESCRIPTION OF MONITORING: Investigators have largely identified subpopulation areas within the KWNWR metapopulation discovered in 2006. General index values of abundance have been attained for most of those sites. UF researchers and Salvato continue to monitor population fluctuations in the BHSP metapopulation. UF has conducted periodic monitoring at KWNWR during 2008 and 2009. Occasional monitoring at reintroduction sites in DJSP and BNP is being conducted by researchers at UF.

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: The Service requested new information (observations, data, reports) regarding the status of this species and any new information regarding threats to this species from: Florida Department of Agriculture and Consumer Services, Florida Department of Environmental Protection, FWC, National Park Service, Service (Ecological Services and National Wildlife Refuges), FNAI, Archbold Biological Station, The Institute for Regional Conservation, University of Florida, Randolph-Macon College, and other entities. In total, the 2008 assessment was sent to 109 individuals.

The species is included in the Florida's Wildlife Action Plan, Florida's Comprehensive Wildlife Conservation Strategy, as one of Florida's species of greatest conservation need (FWC 2005, p. 159) under the name *Hemiaragus thomasi bethunebakeri*.

Indicate which State(s) did not provide any information or comments: None.

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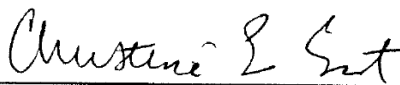
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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve:  June 9, 2009
for Regional Director, Fish and Wildlife Service Date


Acting
Director, Fish and Wildlife Service
Concur: Date October 29, 2009

Do not concur: _____
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: May 4, 2009
Conducted by: Paula Halupa, South Florida Ecological Services Office