

DRAFT MIAMI BLUE BUTTERFLY REVISED MANAGEMENT PLAN

Cyclargus thomasi bethunebakeri

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FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
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- Anne Morkill, USFWS, Florida Keys national wildlife refuges
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EXECUTIVE SUMMARY

The Miami blue is a small blue butterfly endemic to Florida. Primarily a south Florida coastal species, the Miami blue's distribution historically ranged as far north as Hillsborough County on the Gulf Coast and Volusia County on the Atlantic Coast. By the 1980s, the Miami blue was extirpated from mainland Florida and restricted to the Keys. After Hurricane Andrew in 1992, the butterfly was believed to be extirpated, only to be rediscovered in 1999 at a single colony of approximately 50 individuals in Bahia Honda State Park. In 2002, following an emergency petition, the Florida Fish and Wildlife Conservation Commission (FWC) listed the Miami blue as an endangered species. In 2003, the FWC prepared a biological status report that provided justification for the listing, and led to the approval of a Miami blue management plan the same year. This document is a revision of the 2003 plan, updated to include new information and to adjust the conservation goal, objectives, actions, and implementation strategy.

The most exciting new information is that in 2006 the Miami blue was also discovered at the Key West National Wildlife Refuge by the U.S. Fish and Wildlife Service. This increased the number of known metapopulations to two. Other updated information concerns captive propagation and reintroduction attempts. In 2003, a captive propagation program was developed by the University of Florida and sponsored by the FWC and U.S. Fish and Wildlife Service. This program has been very successful at captive breeding Miami blues using stock from the Bahia Honda metapopulation. However, attempts at reintroducing captive-bred Miami blues to the wild have not been successful. Determining why reintroduction efforts have not succeeded is a research priority for the near future.

The conservation goal of this revised management plan is to secure multiple viable self-sustaining wild metapopulations of Miami blues throughout all or parts of its historic range so that it no longer requires listing. The conservation objectives for the Miami blue are: 1) maintain the two known existing metapopulations at Bahia Honda State Park and Key West National Wildlife Refuge; 2) establish a network of at least three additional viable self-sustaining metapopulations, with at least 50 adults each, in Monroe and Miami-Dade counties, allowing adequate connectivity for natural gene exchange, within ten years; and 3) to establish at least ten additional viable self-sustaining metapopulations, with at least 50 adults each, in the remainder of the historic range within 15 years. Priority actions include: maintaining, protecting, and monitoring known populations; maintaining the captive population for reintroduction and research to reduce risk of extinction due to environmental catastrophe; conducting research on reintroduction techniques; identifying and securing sites for reintroduction; and establishing partnerships that lead to funding and logistical support for reintroduction, research, and public outreach to support Miami blue conservation.

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Appendix 1. Definitions

LIST OF ACRONYMS

BHSP	Bahia Honda State Park
BNP	Biscayne National Park
DEP	Department of Environmental Protection
ENP	Everglades National Park
EQIP	Environmental Quality Incentives Program
FAC	Florida Administrative Code
FAMU	Florida A&M University
FCCMC	Florida Coordinating Council on Mosquito Control
FDACS	Florida Department of Agriculture and Consumer Services
FIU	Florida International University
FKMCD	Florida Keys Mosquito Control District
FWC	Florida Fish and Wildlife Conservation Commission
HCP	Habitat Conservation Plan
IBWG	Imperiled Butterfly Working Group
IPCC	Intergovernmental Panel on Climate Change
KWNWR	Key West National Wildlife Refuge
LIP	Landowner Incentive Program
NABA	North American Butterfly Association
NPS	National Park Service
PVA	Population Viability Analysis
UF	University of Florida
USCCSP	United States Climate Change Science Program
USFWS	United States Fish and Wildlife Service
WHIP	Wildlife Habitat Incentives Program

1 CHAPTER 1: INTRODUCTION

2 Overview

3
4 The Miami blue (*Cyclargus thomasi bethunebakeri*) is a Florida endemic butterfly and
5 one of six subspecies of *Cyclargus thomasi*. These subspecies range from Florida to the Lesser
6 Antilles (Figure 1). The Miami blue was severely reduced in range across the southern mainland
7 of Florida during the 1980s and was restricted to the Keys by the early 1990s. There were no
8 confirmed or published reports of Miami blues after Hurricane Andrew in 1992 (USFWS 2009).
9 Subsequently, a single colony was discovered in 1999 at Bahia State Park (BHSP) and a second
10 colony was found in 2006 at Key West National Wildlife Refuge (KWNWR). A variety of
11 anthropogenic and biological factors have been implicated as potential causes of the butterfly's
12 decline. These include urban development, mosquito control pesticides, high mortality and
13 physical disturbance of host plants, nonnative species, disruption of existing ant-larval
14 associations, along with an assortment of demographic, genetic and environmental influences on
15 the persistence of small, widely separated populations (FWC 2003b, Carroll & Loye 2006,
16 Saarinen & Daniels 2006, Daniels 2009, USFWS 2009).

17
18 On November 15, 2002, Florida Fish and Wildlife Conservation Commission (FWC)
19 staff received an emergency petition (Glassberg 2002) to classify the Miami blue as an
20 Endangered species. On December 10, 2002 the Executive Director issued an Executive Order
21 that listed the Miami blue as an Endangered species in Florida under Rule 68A-27.003 (1) F.A.C.
22 to prevent imminent extinction. The agency's Commissioners approved the emergency listing
23 action and directed staff to undertake a comprehensive assessment of the Miami blue's biological
24 status and to summarize the results in a final biological status report (FWC 2003a). The
25 biological assessment indicated that the Miami blue meets the criteria for listing as an
26 Endangered species (Rule 68A-1.004, F.A.C.). On May 11, 2005, the U.S Fish and Wildlife
27 Service (USFWS) added the Miami blue butterfly to the list of federal candidate species. As of
28 November 9, 2009, the Miami blue had a USFWS Listing Priority Number of 3 due to the
29 overall magnitude of threats (high) and immediacy of threats (imminent) (USFWS 2009).

30
31 This management plan is a revision of the 2003 Miami blue butterfly management plan
32 (FWC 2003b) which was a culmination of the species listing process (Rule 68A-27.0012,
33 F.A.C.). It is a comprehensive guide for the management and conservation of the Miami blue.
34 The management plan includes 1) a summary of available biological information on the Miami
35 blue, 2) an assessment of the threats responsible for the species' status as an Endangered species,
36 3) a conservation goal and quantitative objectives, 4) conservation strategies and actions to
37 achieve the goal and objectives, 5) an implementation and monitoring strategy, and 6)
38 anticipated economic, social, and ecological impacts.

39 40 Taxonomic Classification

41
42 The scientific names applied to the Miami blue have changed over time (M. Minno pers.
43 comm.). It was not until 1941 that Clench described *Hemiargus catalina thomasi*. The Miami
44 blue in Florida had previously been mistaken for *Hemiargus ammon* or some authors called it
45 *Hemiargus catalina*. Comstock and Huntington (1943) described the Florida population of the

46 Miami Blue as *Hemiargus thomasi bethunebakeri*. The FWC and the USFWS both were
47 petitioned to list the Miami blue subspecies as Endangered under the scientific name *Hemiargus*
48 *thomasi bethunebakeri*. However, subsequent to its emergency listing in December 2002 by
49 FWC, three independent taxonomists contracted by the USFWS have verified the species at
50 BHSP as belonging to the genus *Cyclargus* (Calhoun 2003, FWC 2003b, Miller 2003, Opler
51 2003). Nabokov (1945) first placed *thomasi bethunebakeri* under the genus *Cyclargus* based
52 primarily on male morphological features. Further documentation corroborating this
53 differentiation was provided by Johnson and Bálint (1995). According to Johnson and Bálint
54 (1995) many authors have incorrectly considered *Cyclargus* a synonym of *Hemiargus*, an error
55 that was initiated by N.D. Riley (Riley 1975). Current literature as well as recent genetic studies
56 all now confirm that the Miami blue butterflies found at BHSP and KWNWR are *Cyclargus*
57 *thomasi bethunebakeri* (Pelham 2008, Saarinen and Daniels 2006, Saarinen 2009, Saarinen et al.
58 2009).
59

60 **Life History and Habitat**

61
62 The Miami blue is a small blue butterfly with a forewing length of 10-13 mm. Males and
63 females are both bright blue dorsally, but females have an orange eyespot near the hindwing
64 outer angle. Saarinen (2009) found a significant difference in wing chord length between males
65 and females. Adult males are smaller than females and their coloration is also different. Males
66 are bright blue dorsally with a narrow black margin. Females have reduced blue scaling with
67 broader dark margins and an orange-capped black eyespot near the hindwing outer angle. Both
68 sexes have a tawny gray underside with 4 black spots on the basal and postbasal areas and a
69 bright orange spot on the hindwing (Minno and Emmel 1993, 1994; Gerberg and Arnett 1989;
70 Glassberg et al. 2000).
71

72 The blue-white eggs are laid on flowers, flower buds, and terminal growth of the host
73 plants. The larvae have a sluglike shape and are primarily green with a black head capsule, a
74 red-brown mid-dorsal line and white lateral lines. However, multiple color forms exist (Daniels,
75 unpublished). The larvae have a facultative symbiotic relationship with a number of ant taxa
76 (Saarinen & Daniels 2006). Specifically, seventeen ant species have been recorded tending
77 Miami blue larvae either in wild populations, in reintroduction sites following releases of captive
78 raised larvae, or in the laboratory. Furthermore, no ant species has been observed to regularly
79 attack Miami blue larvae or to ignore their presence. These results are notable for the large
80 number of potential ant partners, the consistency of behaviors toward larvae among distantly
81 related ant taxa, and the nearly complete lack of obviously antagonistic interactions (Trager and
82 Daniels 2009). Despite the high diversity of potential ant partners, regular field observations
83 suggest that only a small subset of ant species accounts for the vast majority of interactions with
84 Miami blue butterfly larvae, specifically *Camponotus floridanus* and *Camponotus planatus*
85 (Trager and Daniels 2009). Although protection from predators and parasitoids is thought to be
86 the primary benefit of ant tending, ants may also influence larval growth in the absence of these
87 natural enemies.
88

89 The pupae are dark brown to black and attached to a substrate with a silken button and
90 silken girdle. The mean development time from egg to adult is approximately 30 days under
91 laboratory conditions (J. Daniels unpublished). The average survival rate of adult Miami blues is

92 less than 5 days in the wild. Captive adults, particularly females, can survive for significantly
93 longer (J. Daniels pers. comm.).

94

95 The Miami blue occurs at the edges of tropical hardwood hammocks, beachside scrub,
96 and occasionally on pine rocklands (Minno and Emmel 1993, Smith et al. 1994, Glassberg et al.
97 2000).

98

99 Larval hostplants include (Matteson 1930):

100

- balloonvine (*Cardiospermum corindum*)
- gray nickerbean (*Caesalpinia bonduc*),
- Florida Keys blackbead (*Pithecellobium keyense*),
- catclaw blackbead (*Pithecellobium unguis-cati*)
- garden ornamental pride-of-Barbados (*Caesalpinia pulcherrima*)

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Rutkowski (1971) observed an oviposition on snowberry (*Chiococca alba*). The Bahia
Honda population currently utilizes gray nickerbean while the populations located in KWNWR
feed on Florida Keys blackbead (Ruffin and Glassberg 2000, Emmel and Daniels 2002, Cannon
et al. 2007, Daniels 2008).

111

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Adults are reported (Gerberg and Arnett 1989, Minno and Emmel 1994, Cannon et al. 2007,
Daniels 2008) to feed on a variety of flowering plants including:

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- Spanish needles (*Bidens pilosa*)
- cat tongue (*Melanthera nivea*)
- scorpiontail (*Heliotropium angiospermum*)
- gray nickerbean (*Caesalpinia bonduc*)
- coastal searocket (*Cakile lanceolata*)
- black torch (*Erithalis fruticosa*)
- wild sage (*Lantana involucrate*)
- fogfruit (*Phyla nodiflora*)
- other primarily weedy herbaceous flowers

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Nectar sources are generally near host plants because Miami blue butterflies have poor
dispersal abilities. Adult Miami blues are found in all months of the year. Peak abundance is
between June and September on Bahia Honda and generally between November and March in
KWNWR (Emmel and Daniels 2002a,b; Cannon et al. 2007; Daniels 2008).

128 **Distribution and Population Status**

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Five subspecies of *Cyclargus thomasi* are found in the Bahamas and the Greater and
Lesser Antilles (Smith et al. 1994) (Figure 1). The sixth subspecies, the Miami blue, *C. t.*
bethunebakeri, is a Florida endemic. Primarily a south Florida coastal species, the Miami blue's
historical distribution ranged as far north as Hillsborough County on the Gulf Coast and Volusia
County on the Atlantic Coast and extended south to the Florida Keys and the Dry Tortugas
(Klots 1964, Howe 1975, Calhoun et al. 2002) (Figure 2). Collection records indicate the
butterfly was most abundant on the extreme southeastern mainland and Upper Florida Keys

137 (primarily Key Largo), becoming increasingly rare at the periphery of its range (Carroll & Loye,
138 2006); however, preference for certain south Florida sites among collectors has likely biased this
139 trend. Small colonies also reportedly occurred on Marco Island, Sanibel Island, and
140 Chokoloskee on the southwest coast (Minno and Emmel 1993, Glassberg et al. 2000, Calhoun et
141 al. 2002).

142
143 The overall distribution and numerical abundance of the butterfly have been significantly
144 reduced over the last three decades, and by the early 1990s the Miami blue was presumed
145 extirpated. The last confirmed report was on Big Pine Key on March 1992 (Glassberg et al.
146 2000, Calhoun et al. 2002). From 1992-1999, numerous surveys for the Miami blue at historical
147 locations as well as within other suitable habitat were conducted by qualified individuals and
148 biologists, but no Miami blues were sighted (Calhoun et al. 2002, Edwards and Glassberg 2002,
149 Glassberg 2002). The butterfly was finally observed on November 1999 at Bahia Honda State
150 Park in the Florida Keys (Ruffin and Glassberg 2000). Subsequent visits by numerous observers
151 after 2000 have found the population to generally range between 50 and 150 individuals
152 (Calhoun et al. 2002, Emmel and Daniels 2007). Emmel and Daniels (2007) and Daniels (2009)
153 found that the population numbers at Bahia Honda State Park were severely impacted by the
154 hurricanes of the 2005-2006 seasons. In 2007, numbers rebounded in late June but peak
155 population numbers remained below those found prior to the 2005 hurricane season. Similar
156 depressed numbers were found in 2008; such low numbers were likely the result of severe
157 drought and impacts to the nickerbean host plant from green iguanas (*Iguana iguana*) feeding on
158 the terminal nickerbean growth. Bahia Honda survey results from 2002-2009 are presented in
159 Figure 3.

160
161 Extensive surveys for the Miami blue have been conducted between 1990 and 2007 at no
162 fewer than 40 locations in mainland Florida and the Keys. These surveys, conducted by multiple
163 qualified individuals, failed to detect other metapopulations of this butterfly (Daniels 2009b;
164 Edwards and Glassberg 2002; Emmel and Daniels 2002a, b; Minno 2009). An unconfirmed
165 report of ten adult individuals on Sugarloaf Key in the Florida Keys in 2002 was investigated but
166 yielded no butterflies during five separate surveys later that year (Emmel and Daniels 2002b). In
167 2006, additional populations were discovered within the Key West National Wildlife Refuge by
168 refuge staff and volunteers (Cannon et al. 2007). These populations occur on Boca Grande and
169 the islands of the Marquesas. Follow-up surveys in 2007 recorded Miami blues occurring on
170 multiple islands in KWNWR. Recent surveys by the University of Florida (UF) and FWC have
171 found a maximum of 25 individuals. No adults have been recorded on Boca Grande since 2008
172 (Daniels 2008, T. Wilmers pers.comm.). The current distribution of known metapopulations is
173 shown in Figure 4.

175 **Historic and Ongoing Conservation Efforts**

176
177 Several conservation efforts were initiated by FWC and the USFWS prior to the Miami
178 blue butterfly being listed as an Endangered Species in Florida. The 2003 Miami blue butterfly
179 management plan (FWC 2003b) outlined conservation strategies necessary to meet the
180 conservation goal and objectives. Several of these strategies have been met, with others still
181 ongoing. The FWC, USFWS, UF, Florida Department of Agriculture and Consumer Services
182 (FDACS), Department of Environmental Protection (DEP), the North American Butterfly

183 Association (NABA), the National Park Service (NPS), Florida Keys Mosquito Control District
184 (FKMCD), and Florida A&M University (FAMU) have all contributed funds, staff, and/or
185 resources towards these efforts.

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1. *Survey and Monitoring*

189 In June 2002, UF conducted a one-year status monitoring study of the Miami blue
190 throughout its historic range and conducted a mark-recapture study on the Bahia Honda
191 population. The University of Florida continued to monitor the BHSP metapopulation regularly
192 from 2002 through the 2009 field season. Surveys at KWNWR were initially conducted by
193 refuge staff and volunteers during 2006-2007 (Cannon et al. 2007). Subsequently, UF
194 researchers with assistance from FWC and refuge staff will continue regular surveys through
195 April 2010 (Daniels 2008, J. Daniels pers. comm.). Minno and Minno (2009) conducted
196 butterfly surveys in the Florida Keys and southern Florida from August 2006 through June 2009
197 but did not find any other metapopulations of Miami blues besides those at BHSP and KWNWR.
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199
200

2. *Captive Propagation and Reintroduction*

201 In 2003, the FWC authorized UF to initiate a captive breeding program in Gainesville,
202 Florida. A total of 100 eggs was collected from 10 randomly captured female Miami blues
203 originating at a combination of 7 colony sites within Bahia Honda State Park over a 4-month
204 period from February 2003 to May 2003. The resulting 100 eggs were used as the foundation for
205 building the captive colony at the University of Florida. To avoid inbreeding, a rigorous
206 breeding protocol was established along with the regular addition of butterflies from BHSP. The
207 captive population has been extremely successful since its inception, yielding over 23,000
208 captive bred organisms for research, colony maintenance, and reintroduction (J. Daniels pers.
209 comm.). Butterfly reintroductions were initiated in April 2004 and continued through the 2009
210 field season. Reintroductions have taken place at Everglades National Park, Biscayne National
211 Park, and Dagny Johnson Key Largo Hammocks State Park. Since 2004, approximately 7,140
212 organisms have been released (J. Daniels pers. comm.). Unfortunately, work still needs to
213 continue to determine why the reintroductions have not taken hold. Miami blue larvae and adults
214 released at these sites have failed to reproduce and persist over time.
215

216
217

3. *Research*

218 Multiple research projects have been conducted by several agencies and universities in
219 Florida. The University of Florida conducted research on the genetic diversity of wild and
220 captive populations in order to maximize the genetic diversity of the species and for directing
221 pairings of butterflies in captivity. Genetic microsatellite markers were developed, and are used
222 in combination with non-invasive wing fragment sampling to monitor the diversity of the captive
223 and wild populations over time (Saarinen and Daniels 2006, Saarinen 2009).
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Florida A&M University conducted research to examine the effects of aerially applied
mosquito control pesticides on the Miami blue (Zhong et al. 2009). Mortality of Miami blues
was significantly different between treated areas and drift zones. Currently, Mote Marine
Laboratory and Florida International University are looking at the effects of ground-based

229 applications of pesticides on non-target species and imperiled species of butterflies at Big Pine
230 Key, Florida. The United States Geological Survey is also currently researching cholinesterase
231 inhibition in butterflies following aerial applications of mosquito control pesticides.
232

233 Research has also been conducted by the University of Florida to identify the different
234 taxa of ants that tend Miami blue larvae at BHSP and KWNWR, as well as to examine the
235 mutualistic interactions between them (Saarinen and Daniels 2006, Trager and Daniels 2009).
236

237 **4. Public Awareness and Outreach**

238

239 The Miami Blue Butterfly Work Group was formed in 2004 to coordinate conservation
240 efforts, exchange information, and address concerns that arose during the recovery of the Miami
241 blue. The Work Group was composed of federal, state, and local governments, nongovernmental
242 organizations (such as the North American Butterfly Association) and multiple mosquito control
243 organizations from south Florida. The Work Group later morphed and expanded into two
244 separate entities, the Imperiled Butterfly Working Group (IBWG) and the Florida Coordinating
245 Council for Mosquito Control's (FCCMC) Imperiled Species Subcommittee. The IBWG was
246 formed after the recognition that several other species of butterflies were in decline, primarily in
247 south Florida. Lessons learned in conserving the Miami blue could be applied proactively to
248 other declining species, thus preventing the need for future listing by state or federal government.
249 The Imperiled Species Subcommittee was initially formed to resolve the conflict between
250 mosquito control spraying and the recovery and reintroduction of Miami blues to their historic
251 range. The Imperiled Species Subcommittee has now expanded to include any imperiled species
252 in Florida that is potentially impacted by mosquito spraying operations.
253

254 Other public awareness and outreach efforts include a natural history and identification
255 brochure produced by UF, entitled, "The Miami Blue Butterfly of Bahia Honda State Park."
256 Bahia Honda State Park also created an educational kiosk describing butterflies found at the
257 park. Several articles regarding Miami blue conservation efforts have been written in popular
258 magazines such as *Florida Wildlife* and *National Wildlife*.
259
260

261



Figure 1. Known subspecies of *Cyclargus thomasi* and their geographic distribution.

A. *Cyclargus thomasi bethnebakerei* (Comstock and Huntington, 1943), B. *Cyclargus thomasi thomasi* (Clench, 1941), C. *Cyclargus thomasi bahamensis* (Clench, 1943), D. *Cyclargus thomasi noeli* (Comstock and Huntington, 1943), E. *Cyclargus thomasi woodruffi* (Comstock and Huntington, 1943), F. *Cyclargus thomasi clenchi* (Miller et. al, 1992)

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263

264 Figure to be revised to be larger, show details better.

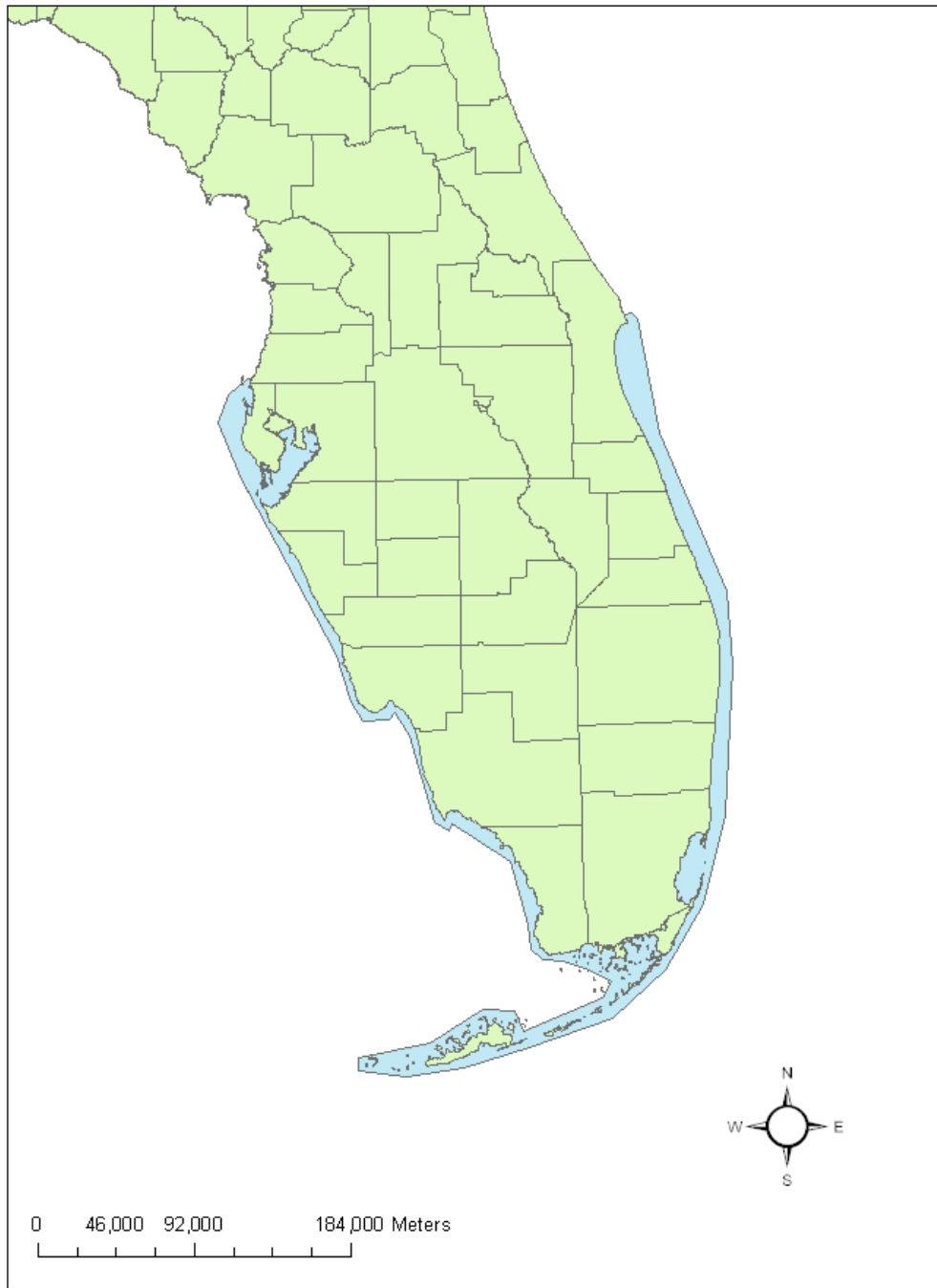
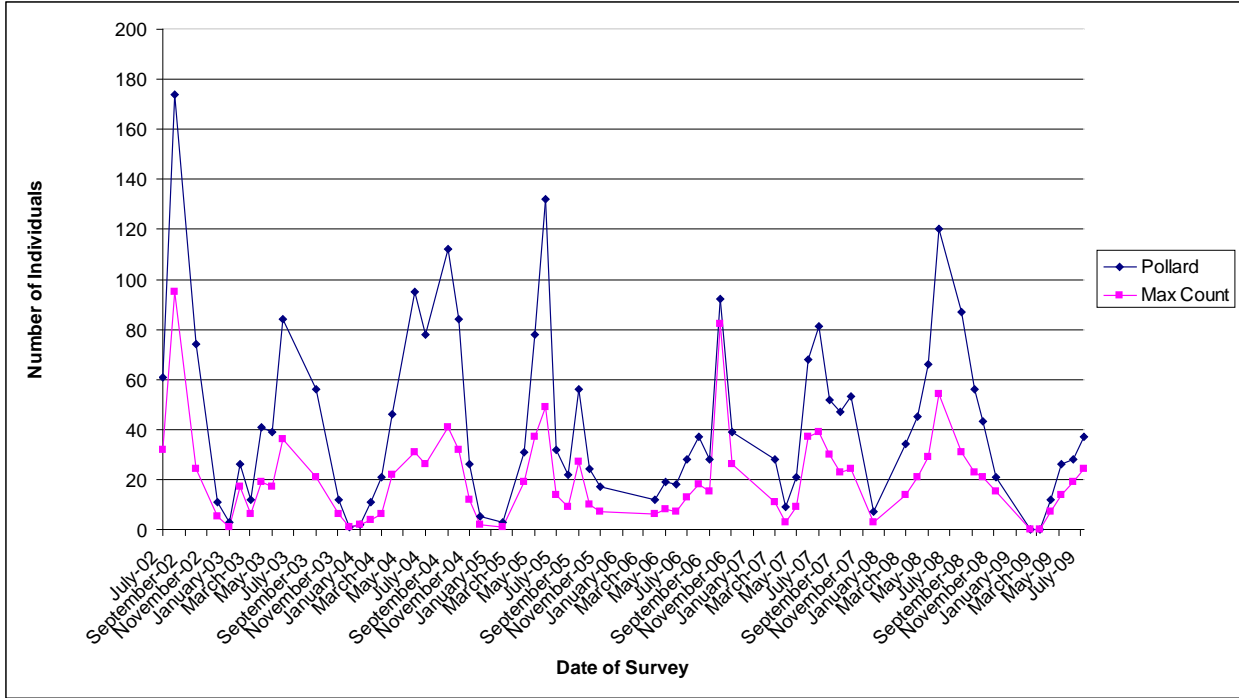


Figure 2. Historic range of the Miami blue butterfly in Florida

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266 Figure to be modified with clear legend to denote historic range (blue on this map).



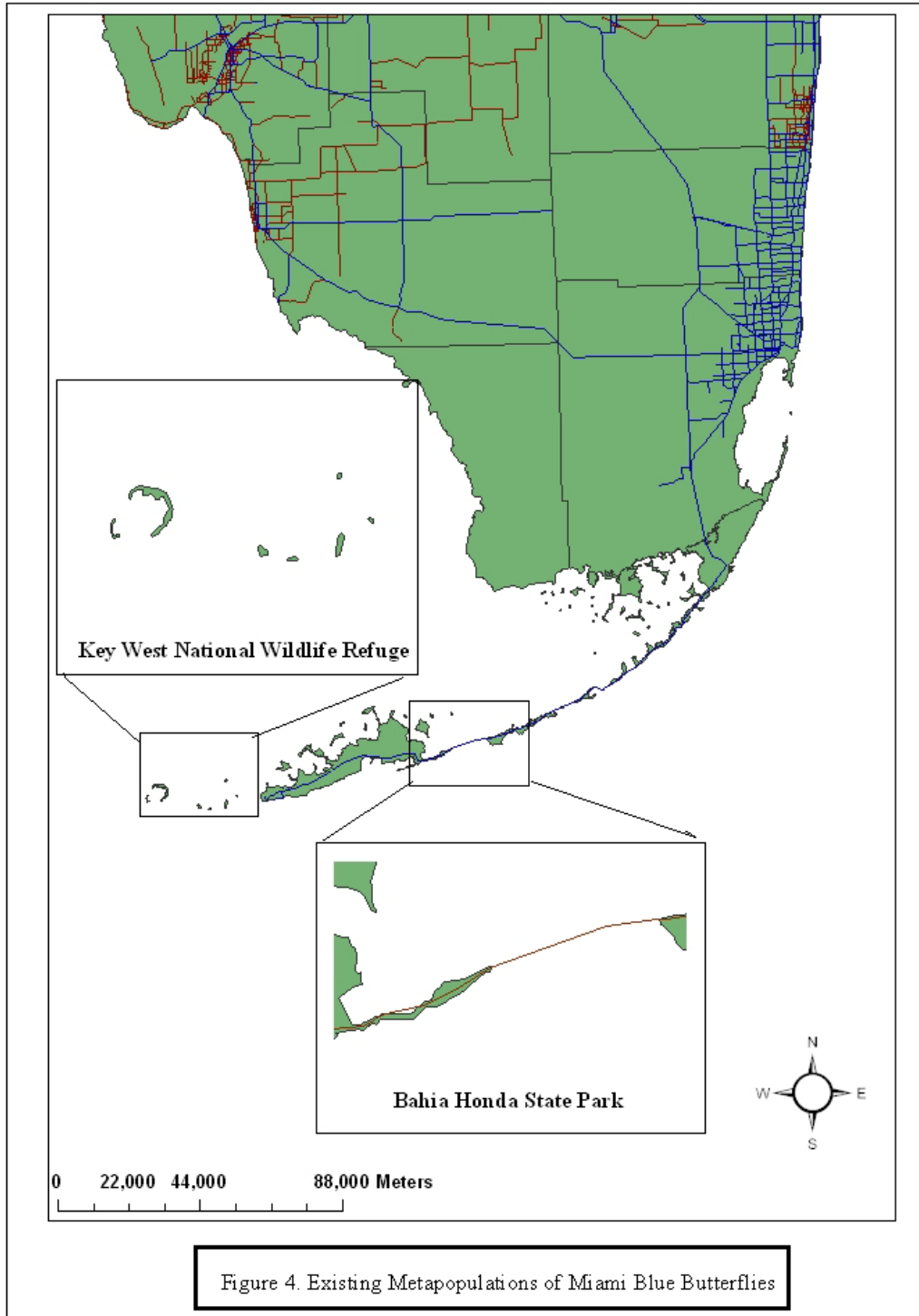
267
 268 **Figure 3.** Total number of adult Miami blue butterflies observed using Pollard transect and max counts
 269 in the south-end colony site of Bahia Honda State Park, Monroe County, Florida from July 2002 to July
 270 2009 (J. Daniels unpublished).
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277 Figure to be modified to be clearer.

278 **CHAPTER 2: THREAT ASSESSMENT**

279

280 **Reasons for Listing**

281

282 In 2003, the Miami blue met three of the five criteria for listing as an Endangered species
283 under Rule 68A-1.004, F.A.C. (FWC 2003a, b). As stated in the final biological status report
284 (FWC 2003a), the primary reasons for listing this species as Endangered were:

285

286 ***Population reduction***

287

288 A range-wide population reduction of > 80% during the previous ten years was
289 suspected based on a > 99% decline in area of occupancy from 1992 to 2002.

290

291 ***Extent of occurrence, area of occupancy***

292

293 The Miami blue's extent of occurrence was not completely known, but potentially could
294 be the entire Florida Keys, or approximately 158 square miles. The documented extent of
295 occurrence equaled the area of occupancy, which was less than one square mile. Thus the Miami
296 blue's documented extent of occurrence was less than 40 square miles and its area of occupancy
297 was less than 4 square miles. Additionally, the species was found in only one location and had
298 undergone a 99% decline in area occupied.

299

300 ***Population Size and Trend***

301

302 The number of mature individuals was far less than 250 individuals and all individuals
303 were contained within a single subpopulation.

304

305 In 2010, data available on the range-wide Miami blue population since the initial status
306 review were evaluated relative to each of the five criteria for state listing under Rule 68A-1.004
307 F.A.C. In order to qualify for state listing as either Endangered, Threatened, or Species of
308 Special Concern, the Miami blue must meet at least one of the five criteria for one of the
309 categories. The Miami blue butterfly population at Bahia Honda State Park remained stable
310 during the period between 2002 and 2009 (Fig. 4) and a new metapopulation was discovered in
311 the Key West National Wildlife Refuge (Cannon et al. 2007). While a formal status review was
312 not conducted, the total number of adults at both metapopulations combined is still below 250
313 individuals, so the Miami blue still qualifies as an endangered species.

314

315 **Present Threats**

316

317 Four threats are suspected in the range-wide population decline of the Miami blue.
318 Although specific data demonstrating cause and effect for Miami blue declines due to these
319 threats are limited, they have been proposed by one or more researchers or have been suspected
320 in the decline of species living in similar habitats:

321

322 **1. *Habitat Loss and Degradation***

323
324 Much of the remaining Miami blue habitat along Florida's coastlines is subject to intense
325 development pressure and urbanization or has already been developed. The resident Florida
326 human population in 1980 was estimated at 9.9 million and grew to 15.2 million by 2000 (U.S.
327 Census Bureau 2003). By 2060, Florida's population is projected to more than double in size
328 (Zwick and Carr 2006).

329
330 Climate change is also a major threat to south Florida resulting in sea level rise and
331 possible destruction of Miami blue habitat. Webster et al. (2005) found the number of Category
332 4 and 5 hurricanes to have doubled in the last 30 years, possibly due to global climate change.

333
334 **2. *Habitat Fragmentation and Group Isolation***

335
336 Imperiled species are faced with an assortment of demographic, genetic, and
337 environmental influences that challenge the persistence of small, widely separated populations.
338 Remaining Miami blue habitat is extremely fragmented by highways, cities, and unsuitable
339 habitat. Isolation as a result of habitat fragmentation lowers the probability of recolonization in
340 species with limited dispersal abilities (Cushman and Murphy 1993). Isolation may severely
341 limit gene flow and increase the probability of inbreeding, leading to decreased genetic diversity
342 over time. Genetic diversity is essential to species conservation (Frankham 1996). As habitat
343 fragmentation expands and populations become smaller and more isolated, genetic diversity
344 tends to erode. The corresponding loss of genetic diversity reduces future evolutionary potential
345 and brings about a decline in individual fitness, both of which can increase the risk of extinction
346 among populations and species (Saccheri et al. 1998, Reed and Frankham 2003).

347
348 The small size of remaining populations of Miami blues makes them susceptible to
349 demographic and environmental impacts, long before genetic influences are felt. Extinction risks
350 include natural occurrences such as drought and large-scale disasters such as tropical cyclones
351 and catastrophic wildfires. These incidents may completely eliminate small or isolated Miami
352 blue populations, their host plants, and their nectar sources (Calhoun et al. 2002; Emmel and
353 Daniels 2002a, b).

354
355 **3. *Mortality***

356
357 Spraying of insecticides to control adult mosquito populations may be responsible for
358 mortality of Miami blue larvae and adults. Application of herbicides may cause direct harm to
359 butterflies or reduce their host plants and nectar sources (Eliazar and Emmel 1991, Hennessey et
360 al. 1992, Salvato 1999, Russell and Schultz 2009).

361
362 Butterfly collecting, though generally not detrimental to butterfly populations, may stress
363 small local populations and lead to the loss of individuals and genetic variability (Pyle 1976;
364 Emmel 1995a, b; USFWS 1998; Alexander 2003).

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4. *Invasives*

Invasive exotic species can alter the population dynamics of native species in a number of ways, most notably through competitive exclusion, niche displacement, or predation (Keeler et al. 2006, Mooney and Cleland 2001). Additionally, habitat disturbance and herbicide application for control and management of invasives may negatively impact butterfly populations (Russell and Schultz 2010). Similarly, exotic insect predators or parasitoids can dramatically impact native insect populations causing severe declines (Boettner et al. 2000, Benson et al. 2003). Imported red fire ants may negatively impact *Camponotus* ants that occasionally tend Miami blue larvae and offer them some degree of protection from predators and parasitoids. Fire ants also may directly depredate Miami blue larvae (Emmel and Daniels 2003). Nonnative green iguanas (*Iguana iguana*) pose a threat because they feed on the Miami blue's host plants, most notably in Bahia Honda State Park. The nickerbean stands have received significant damage which has prompted the park to move forward with eradication efforts to remove the iguanas. Additional surveys and research are needed to better determine potential impact of invasive species on existing populations of the Miami blue butterfly.

DRAFT

CHAPTER 3: CONSERVATION GOAL AND OBJECTIVES

The intent of this plan is to set a scientifically defensible, reasonable, and explicit conservation goal and objectives for the Miami blue. The conservation goal provides broad direction for management of the species, while the conservation objectives establish numerical benchmarks by which success in achieving that goal can be measured. The goal and objectives have been developed based on the species' current population status, reasons for listing, and underlying threats to the species' continued survival.

The proposed minimum size of "at least 50 adults" to define a viable, self-sustaining population is based partly on the work of Shaffer (1981), who "obtained number in the range of 50" as a minimum viable population or, in other words, the number needed to prevent population collapse. It is also based partly on the observed seasonal fluctuations for the Bahia Honda metapopulation (J. Daniels unpublished, Figure 3), although more data from additional metapopulations is needed. It should be emphasized that although Figure 3 seems to indicate a metapopulation that periodically approaches zero, Bahia Honda nevertheless is considered to remain a self-sustaining population.

Miami Blue Conservation Goal

The conservation goal is to secure multiple viable self-sustaining wild metapopulations of Miami blues throughout all or parts of its historic range so that it no longer requires listing.

Attainment of this goal would result in removing the Miami blue from Florida's list of Threatened and Endangered species.

Miami Blue Conservation Objectives

- 1) *maintain the two known existing metapopulations at Bahia Honda State Park and Key West National Wildlife Refuge*
- 2) *establish a network of at least three additional viable self-sustaining metapopulations, with at least 50 adults each, in Monroe and Miami-Dade counties, allowing adequate connectivity for natural gene exchange, within 10 years*
- 3) *establish at least 10 additional viable self-sustaining metapopulations, with at least 50 adults each, in the remainder of the historic range within 15 years.*

Attainment of these objectives would constitute a seven-fold increase in the current number of metapopulations (from 2 to at least 15), increasing connectivity and ultimately their long-term resilience and viability. Establishment of additional metapopulations will increase the Miami blue's range, extent of occurrence, and area of occupancy.

429 **CHAPTER 4: RECOMMENDED CONSERVATION ACTIONS**
430

431 **Conservation Strategies and Actions to Achieve the Conservation Objectives**
432

433 **Strategy 1. Implement actions to maintain, protect, and monitor known metapopulations**
434

435 ***Conservation Action 1. Maintain and Protect the Known Metapopulations of Miami Blues***
436

437 **a. Protect, restore, and enhance suitable habitat**
438

439 Invasive vegetation should be removed and the natural establishment of host plants and
440 nectar sources encouraged. The growth of host plants in close proximity to nectar sources should
441 be encouraged wherever possible. Ongoing efforts to eradicate or reduce green iguanas should
442 be continued at sites supporting Miami blues to limit the impact of these nonnative herbivores on
443 Miami blue host plants and nectar plants.
444

445 **b. Eliminate or minimize pesticide and herbicide spraying at or around Miami blue**
446 **populations**
447

448 No-spray zones for all pesticides and herbicides should be established around populations
449 of Miami blues. Particularly, the use of mosquito adulticides should be eliminated or conducted
450 in such a manner that it does not negatively impact Miami blue populations. It has been
451 recommended that aerial no-spray buffer zones > 750 m in width should be established where
452 possible around Miami blue populations to minimize the probability of accidental pesticide drift
453 into the path of Miami blues and other non-target species (Hennessey et al. 1992). Similarly,
454 buffer zones should be established for truck-based applications of adulticides, given the
455 propensity for drift and the persistence of adulticides on foliage for more than 2 weeks (Pierce
456 2008). Following a review of Zhong et al. (2009), the FCCMC (2010) recommended that the
457 appropriate width of mosquito spray buffer zones for Miami blue populations be determined by
458 further research. Lower-impact alternatives to mosquito control should be employed such as
459 source reduction, biological control agents, and suspending or reducing spraying during the
460 breeding seasons of non-target species (Emmel 1991).
461

462 ***Conservation Action 2. Monitor Known Populations***
463

464 **a. Implement appropriate monitoring protocol and survey methods**
465

466 Two variables should be monitored and assessed to detect change in range-wide Miami
467 blue population status. The primary variable for assessing population status is the number of
468 individuals at all existing populations. The secondary variable for assessing population status is
469 the number of known sites.
470

471 Standardized, repeatable survey methods are important for allowing comparisons of
472 population estimation through time for the same site, and for comparisons of survey data for
473 different sites. Three different types of surveys are used with butterflies to determine presence

474 and assess changes in abundance, evaluate effectiveness of management actions, and determine
475 distribution and dispersal patterns. Meandering surveys or timed area searches involve observers
476 walking in a meandering pattern looking forward, to the sides, and behind them and recording all
477 butterflies of the species of interest (Hyde et al. 2001). Pollard transects require observers to
478 walk established transects and record all butterflies within five meters of the transect on each
479 side and in front of the observer (Pollard 1977). Mark-recapture surveys require the observer to
480 capture the butterfly with a net and mark the butterfly on the outer hind wing with a fine non-
481 toxic permanent marker and also recapture (J. Daniels pers. comm.).

482
483 It should be emphasized that the less invasive transect and meandering surveys are
484 recommended for endangered species or species in decline (Opler 1995). However, dispersal
485 and mobility studies require mark-recapture surveys (Knutson et al. 1999). It is recommended
486 that only highly experienced researchers use the mark-recapture technique on Miami blues.

487
488 The most commonly used survey method for Miami blues is the Pollard method (Pollard
489 1977). This method of transect monitoring uses a fixed-rate walk which is uniform with respect
490 to area covered and time spent. The fixed nature of the transects allows for concurrent
491 monitoring of other natural resources such as the plant communities or other species occurrence.
492 Typically, all butterfly species seen within an estimated three meters on either side of the
493 transect, within five meters above the ground and within five meters in front are recorded. The
494 observer records what they see while walking and does not attempt to follow or track down
495 unidentified species. The Pollard method allows the recorder to make field observations that will
496 also provide valuable information on the life history of these species such as host plant use, adult
497 nectar source use, natural mortality factors, territoriality, courtship, mating and oviposition
498 behavior, specific habitat requirements, and specific threats to the species' survival.

499
500 Ideally, transects are visited once a month during hours when there is the most sunlight
501 and less than 50% cloud cover (conditions most suitable for butterfly activity). This is typically
502 between the hours of 10 am and 4 pm, although the butterflies may avoid the heat of the day
503 (between noon to 2 pm). Annual Miami blue activity peaks in the summer at Bahia Honda (J.
504 Daniels unpubl. data, Figure 3), but may peak during the winter months at KWNWR (Cannon et
505 al. 2007). The goal of monthly monitoring is quite feasible at BHSP, which is accessible by car
506 from US 1. Regular monthly monitoring at KWNWR is more problematic and uncertain because
507 access is by boat and thereby dependent on the vagaries of weather, tides, and scheduling issues.

508
509 **b. Develop a comprehensive database to accommodate all monitoring data and to**
510 **track the status and trends of individual metapopulations**

511
512 A comprehensive database is necessary to provide a centralized, accessible means for
513 documenting population changes in extant sites, reintroduction sites, and in the species' range-
514 wide status. Additionally, the database will help track conservation actions and facilitate
515 implementation of the management plan. The database should include basic information on
516 population size, sampling history, voucher specimens, location, ownership, habitat type and
517 condition, and management.

518
519

520 ***Conservation Action 3. Maintain Legal Protections for Miami Blues***

521

522 **a. Maintain current regulations**

523

524 Two rules that directly protect Miami blues were adopted by the FWC in December
525 2003. The first rule listed the Miami blue as an endangered species. The second rule prohibited
526 the take, harassment, possession, sale, or transport of Miami blues, or parts thereof, or their eggs,
527 larvae, or pupae except as authorized by permit from the Executive Director, with such permits
528 only being issued for activities that further the goals and objectives of the species' management
529 plan. These rules continue to provide important legal protection to the Miami blue. It is
530 recommended that they be maintained in effect. No other regulations are proposed at this time.

531

532 In addition to FWC rules, the Miami blue is protected from unauthorized collection at
533 Bahia Honda State Park by DEP, and a permit from the National Park Service (NPS) or FWS is
534 required for scientific research and/or collection in national parks or national wildlife refuges
535 (USFWS 2009). However, there is potential for unauthorized or illegal collection and take of
536 Miami blues on BHSP and KWNWR. The U.S. Fish and Wildlife Service (2009) emphasizes
537 that "...the protection currently afforded the Miami blue butterfly is limited. Although take of
538 individuals is prohibited, there is no substantive protection of Miami blue habitat or protection of
539 potentially suitable habitat."

540

541 **b. Maintain FWC permitting framework**

542

543 A permit is required by FWC for any activity that is expected to result in the take of
544 Miami blues on private or public property. A Scientific Collecting Permit is issued by FWC for
545 research purposes where the proposed activity will result in a net benefit to the Miami blue
546 butterfly. An Incidental Take Permit is required for activities that cause the take of Miami blues
547 or its habitat. These permits are only issued if the take is compensated with action that results in
548 a net benefit to the species. In practice, because Miami blues are currently known to exist only
549 on public lands (Bahia Honda State Park and Key West National Wildlife Refuge), the ongoing
550 habitat management activities on those lands are recognized as generally compatible with Miami
551 blue conservation.

552

553 ***Conservation Action 4. Foster Public Support for Miami Blue Conservation***

554

555 **a. Educate the public, land managers, and others about Miami blues**

556

557 Unless this would increase the risk of illegal collection or intrusion, placing informational
558 signs near accessible Miami blue populations provides the public with the special opportunity to
559 see and learn about an imperiled species in close quarters. An example is the educational kiosk
560 on the Miami blue at BHSP. Interpretive tours could also be conducted at such sites, as long as
561 they don't disturb the normal behavior of the butterflies. Printed information on the natural
562 history, status, and conservation needs of the Miami blue could be developed and disseminated
563 to landowners and visitors on-site, as with the Bahia Honda brochure, to conservation
564 organizations, and to the media. In all such materials, key messages could include information

565 on the Miami blue’s specific host plant and habitat needs, the importance of conservation refuges
566 and corridors, and actions that can be taken to help ensure the survival of imperiled species.
567

568 **b. Continue using the Imperiled Butterfly Working Group to exchange information**
569 **between and among agencies, managers, biologists, mosquito control districts,**
570 **and private landowners**
571

572 The IBWG is an important medium for exchange of ideas related to Miami blues and
573 other imperiled butterflies. This group should continue to meet at least once a year to discuss
574 management achievements and failures, new techniques, translocation progress, regulatory
575 issues, and other topics as deemed necessary. This stakeholder meeting approach has proven to
576 be successful with other endangered members of the butterfly family that includes the Miami
577 blue (Sferra and Ewert 1994).
578

579 **c. Continue to discuss mosquito-control related issues through the Imperiled**
580 **Species Subcommittee of the Florida Coordinating Council on Mosquito Control**
581

582 This subcommittee is the appropriate forum to discuss completed, ongoing, and proposed
583 research involving Miami blues (and other imperiled wildlife) and mosquito control pesticides.
584 It is critical to involve this group in consideration of non-target spray drift and appropriate buffer
585 zones for aerial and ground pesticide application.
586

587 As a tangible example of the results of this collaboration, the Florida Coordinating
588 Council on Mosquito Control (FCCMC) adopted three recommendations from its Imperiled
589 Species Subcommittee regarding the Miami blue, mosquito spraying, and permitting issues
590 (FCCMC 2010). FWC participated in the development and adoption of the recommendations.
591 These recommendations read as follows:
592

- 593 1. Require buffers (to be determined by research) for known natural populations and allow
594 for incidental take for those populations that are reintroduced into areas that normally
595 receive mosquito control.
- 596 2. Recommend incidental take permits (from FWC or relevant agencies) to Mosquito
597 Control Districts for Miami blue populations in areas that normally receive mosquito
598 control.
- 599 3. Recommend that additional research be conducted to determine impacts to non-target
600 species and to address mitigation options that reduce risk to sensitive non-target species
601 from mosquito control.
602

603 **d. Identify and engage partners with the funding needed to achieve objectives**
604

605 Establishing partnerships among public agencies, non-profit organizations, private
606 foundations, and other entities interested in financially supporting the conservation of imperiled
607 species is a pivotal action that will help determine the timeliness and effectiveness of Miami blue
608 conservation efforts.
609
610

611 **Strategy 2. Implement actions to establish new metapopulations**

612
613 ***Conservation Action 5. Determine How to Successfully Reintroduce Miami Blues***

614
615 **a. Maintain the Miami blue captive propagation program**

616
617 Captive or controlled propagation of a species is usually the last option when attempting
618 to conserve a species in danger of extinction. With only two known metapopulations in
619 existence, the Miami blue qualifies for such an effort. However, controlled propagation is not a
620 substitute for addressing factors responsible for decline of a threatened species (USFWS 2000).
621 The conditions at recipient sites that led to the demise of the previous population must be
622 eliminated or substantially improved prior to release of captive reared individuals (Gore 2000).
623 Additionally, rigorous protocols must be developed to guard against unintended consequences
624 such as genetic drift from small founder populations, human health impacts from elimination of
625 mosquito control, and decreased personal property rights associated with regulations.

626
627 Emmel and Daniels (2003) and the previous Miami blue management plan (FWC 2003b)
628 proposed the establishment of a captive propagation program and a program to release captive-
629 bred Miami blues into existing populations or unoccupied suitable habitat. A captive breeding
630 program was initiated at the University of Florida in February 2003. Rigorous breeding protocols
631 were established and have resulted in the production of over 23,000 captive-bred organisms since
632 the program's inception. This program should be maintained in order to continue active scientific
633 research and to produce organisms for reintroduction. Current efforts should refine the
634 reintroduction methodology and assessment of organisms following release (see b and c
635 immediately below).

636
637 **b. Conduct field experiments using captive-bred stock**

638
639 Despite many releases of captive-bred Miami blues in protected areas within the taxon's
640 historic range, none of these attempts has led to successful reintroduction. A series of
641 experimental field releases combined with immediate follow-up monitoring is needed to
642 determine the factors that have led to the failure of previous reintroduction attempts. Such
643 controlled field experiments have already been proposed (Daniels 2009c) and will be initiated
644 once target study sites, adequate funding, volunteers, and captive-bred Miami blue stock are in
645 place. One such study site, Bill Baggs Cape Florida State Park on Key Biscayne, is the subject
646 of a pending memorandum of understanding between FWC and DEP.

647
648 **c. Attempt translocations for reintroduction**

649
650 Reintroduction attempts have used captive-bred Miami blues several generations
651 removed from the wild stock originally collected in Bahia Honda State Park. To examine
652 whether there are any inherent differences between wild and captive bred material, some
653 reintroduction attempts should be made using Miami blues translocated directly from wild
654 populations from either BHSP or KWNWR.

657 ***Conservation Action 6. Identify and Establish Sites for Reintroductions or Use as Corridors***

658

659 **a. Identify suitable habitat from previous research and mapping**

660

661 Of the 15 coastal Florida counties that make up the Miami blue’s historic range (Figure
662 2), this butterfly is currently found only in Monroe County. Achievement of the Miami blue
663 conservation goal depends on implementing a comprehensive program to identify public and
664 private lands throughout the historic range with apparently suitable habitat, appropriate
665 management, and landowners willing to contribute to the long-term survival and conservation of
666 the Miami blue. A number of public conservation lands were identified in the original
667 reintroduction plan by Emmel and Daniels (2003), but reintroduction attempts have been
668 unsuccessful to date. Therefore, recommended work should be done concurrently with studies to
669 determine successful reintroduction techniques (Conservation Action 5) and to identify factors
670 that led to the decline and disappearance of Miami blues across most of its historic range (see
671 Strategy 3 below).

672

673 In addition to identifying suitable sites for proposed reintroductions, it will be important
674 to consider the lands between those sites as conservation corridors for Miami blues migrating
675 between metapopulations. Movement of individuals within a metapopulation is important for
676 maintaining genetic diversity and for recolonizing areas following local extinctions (Knutson et
677 al. 1999). The probability of recolonization is a function of patch size and distance to the nearest
678 occupied patch (Thomas et al. 1992). Private lands are located between most of the proposed
679 reintroduction sites on public lands. These private lands might not meet all the criteria for
680 selection as a reintroduction site, but could serve as conservation corridors or “stepping stones”
681 to larger optimal sites (Shreeve 1995). Safeguarding of conservation corridor lands could be
682 accomplished through conservation easement or acquisition.

683

684 These efforts will need to be supported through access to, and interpretation of, aerials
685 and GIS landcover maps that indicate potentially suitable habitat for the Miami blue. Such
686 habitat maps are currently available for the Keys (Dean Jue, Florida Natural Areas Inventory,
687 pers. comm.) and will need to be obtained for comparable areas of mainland Florida. An
688 interactive database of potential sites, landowner contact information, floral and faunal site
689 surveys, and status of reintroduction efforts will need to be established.

690

691 **b. Identify and engage public and private landowners using incentives programs**
692 **and cooperative agreements**

693

694 The first major hurdle to achieving the conservation goal and objectives is the
695 development of successful reintroduction techniques (Conservation Action 5 above). The next
696 step is to foster extraordinary coordination and cooperation among landowners, land managers,
697 volunteers, and other stakeholders across several counties to establish reintroduced populations
698 of Miami blues. The identification and implementation of incentives may be critical to ensure
699 the long-term viability of these newly established metapopulations.

700

701 Incentives may be provided to private and public agencies that conduct activities that reduce
702 or remove threats to, or otherwise improve conditions for, the Miami blue. One such incentive
703 program is a Candidate Conservation Agreement with Assurances (CCAA). CCAs are formal

704 agreements between the USFWS and one or more parties to address the conservation needs of
705 federally proposed or candidate species, or species likely to become federal candidates, before they
706 become listed as endangered or threatened under the federal Endangered Species Act. The
707 participants voluntarily commit to implementing specific actions that will remove or reduce the
708 threats to these species, thereby contributing to stabilizing or restoring the species so that federal
709 listing is no longer necessary. CCAAs provide assurances to nonfederal property owners who
710 voluntarily agree to manage their lands to remove threats to imperiled species. These are assurances
711 that future regulatory obligations by the USFWS, in excess of those the parties agree to at the time
712 they enter into the CCAA, will not be required.

713
714 In addition to CCAAs, other potential federal programs to be investigated include U.S.
715 Fish and Wildlife Service’s Coastal Program and Partners for Fish and Wildlife Program,
716 Candidate Conservation Agreements (without assurances), and Habitat Conservation Plans
717 (HCPs).

718
719 State programs that may benefit private landowners and the Miami blue include the
720 Florida Forestry Stewardship Program, the Wildlife Habitat Incentives Program (WHIP), the
721 Environmental Quality Incentives Program (EQIP), the Landowner Incentive Program (LIP), and
722 the Private Stewardship Grants Program. The Florida Fish and Wildlife Conservation
723 Commission could also pursue initiatives modeled after the federal Safe Harbor program.

724
725 **c. Implement reintroductions on approved, suitable sites**

726
727 Once landowner approval and agreements are in place, reintroductions –using captive-
728 bred or translocated Miami blue stock as deemed appropriate– can commence. These new
729 populations will then be subject to the same rigorous monitoring conducted at the wild
730 metapopulations (Conservation Action 2), and their status updated in the monitoring database.

731
732
733 **Strategy 3. Conduct Additional Research to Support Miami Blue Conservation**

734
735 In addition to the priority research needed to determine how to successfully reintroduce
736 Miami blues (Conservation Action 5 above), there are many facets of Miami blue life history and
737 ecology that remain poorly understood or unknown. Active pursuit of research on the following
738 topics will be critical to improve our understanding of this species, and the results will help guide
739 and refine recommended conservation actions and the management plan as a whole.

740
741 **a. Identify factors that caused Miami blue decline and disappearance**

742
743 The cause of the decline of the Miami blue is not known. There is a lot of seemingly
744 suitable habitat that is not occupied. Although mosquito spraying has been blamed for butterfly
745 declines in the Florida Keys, the Miami blue has disappeared from vast conservation lands that
746 are not sprayed, such as Everglades National Park and Biscayne National Park. Some scientists
747 believe that exotic predatory ants or perhaps parasitoids are the main cause of decline (Minno
748 and Minno 2009). Research is needed to determine the factors negatively impacting the Miami
749 blue in Florida.

750

751 **b. Determine suitable habitat characteristics**

752

753 Little is known about the habitat characteristics required to maintain a Miami blue
754 population. More information on native nectar sources is needed. In concert with the needed
755 research on reintroduction and the factors that led to the Miami blue's decline and disappearance
756 across its range (above), additional studies are needed to define optimal habitat which will
757 facilitate release of captive bred Miami blues.

758

759 **c. Study population ecology**

760

761 Additional research on the population dynamics, ecological requirements, and Miami
762 blue behavior is needed for all extant populations as well as any new populations established via
763 reintroduction.

764

765 **d. Conduct additional studies on impacts of pesticides and buffer zones**

766

767 To follow up on the results of previous studies (e.g., Eliazar and Emmel 1991, Salvato
768 1999, Pierce 2008, Zhong et al. 2009), ongoing and additional studies on the effects of pesticides
769 on Miami blues are needed. More information on adequate buffer zones for aerial and ground
770 application is needed to resolve both conservation and public health concerns.

771

772 **e. Study larval host plant preferences**

773

774 Current research trials have indicated that larvae of the Miami blue are capable of
775 utilizing all three known or historic hosts: gray nickerbean, balloonvine, and blackbead (J.
776 Daniels pers. comm.). It is not known, however, if larval developmental time, survival, or fitness
777 varies with a particular host or if adult females show particular preference for individual host
778 species. Additional research is needed to better understand this dynamic.

779

780 **f. Determine impacts of anticipated climate change**

781

782 The FWC has launched an agency-wide initiative to confront the growing evidence of
783 ongoing climate change and to position itself as a lead player to forecast, plan for, and ameliorate
784 the impacts of climate change on Florida wildlife. According to the U.S. Climate Change
785 Science Program (USCCSP), sea-level rise is the largest climate-driven challenge to low-lying
786 coastal areas and refuges in the sub-tropical ecoregion of southern Florida, and much of low-
787 lying coastal south Florida "will be underwater or inundated with salt water in the coming
788 century" (USCCSP 2008, p. 5-31, as cited in USFWS 2009; Intergovernmental Panel on Climate
789 Change 2007, 2008). Faced with this prognosis, research directed toward ensuring the survival
790 of Miami blues and other imperiled fauna of the Keys and coastal South Florida will be critical.

791

792 **g. Investigate the usefulness of a population viability analysis (PVA)**

793

794 Population viability analysis is a set of tools developed to estimate a species' risk of
795 extinction. The methods rely on mathematical theory in conjunction with information about the
796 population makeup and life history attributes (Schultz and Hammond 2003). The data needed to

797 construct a PVA depends on the questions being asked about the population in question.
798 Example questions to pose about the Miami blue include: 1) what is the risk of extinction of
799 different metapopulations; 2) what is the optimum number of Miami blues to reintroduce to a site
800 of a given area; and 3) what is the relative value of one large site as compared to several small
801 sites. As few as six population surveys may be sufficient to estimate extinction rate (Morris et
802 al. 1999 cited in Schultz and Hammond 2003).
803

DRAFT

804 CHAPTER 5: IMPLEMENTATION STRATEGY

805

806 **Priority Actions**

807

808 There has been considerable work on the Miami blue since the first management plan
809 (FWC 2003b) was drafted. Protective regulations have been established, a successful captive
810 breeding program developed, reintroduction attempts made, various research projects completed,
811 and an additional wild metapopulation discovered. These efforts have increased our information
812 on the Miami blue and shifted the priority actions required for its long-term survival and
813 conservation.

814

815 A prioritized approach to this management plan will help achieve the conservation
816 objectives and will facilitate the coordination necessary to successfully implement the plan. The
817 actions in the summary list below are derived from Chapter 4.

818

819 *Priority actions to be undertaken by the FWC*

820

- 821 • Maintain legal protections for Miami blue

822 *Priority actions to be undertaken by other agencies and FWC*

823

- 824 • Maintain and protect known metapopulations of Miami blues on Bahia Honda State Park
825 and Key West National Wildlife Refuge
- 826 • Conduct periodic surveys of known Miami blue populations, including an assessment of
827 the health of host and nectar plants
- 828 • Reduce threats to known populations as needed (e.g., continue iguana eradication
829 program)
- 830 • Conduct controlled field experiments with extensive monitoring to establish methods for
831 reintroduction
- 832 • Attempt translocations from wild populations in reintroduction attempts
- 833 • Identify and engage partners to secure multi-year funding to maintain the captive
834 propagation program
- 835 • Identify and engage partners to secure funding to support research on reintroduction
836 techniques
- 837 • Identify and secure suitable sites for reintroductions or for use as corridors
 - 838 • Compile database of historic and potential sites from previous efforts and habitat
839 mapping
 - 840 • Identify and engage public and private landowners of suitable reintroduction sites
 - 841 • Use incentive programs and cooperative agreements to foster partnerships
- 842 • Implement reintroduction program
 - 843 • Reintroduce Miami blues

- 844 • Regularly monitor reintroduced populations
845 • Manage habitat as appropriate to maintain reintroduced populations

846 ***Priority actions for private citizens***

- 847
- 848 • Report new or previously undiscovered Miami blue populations to the FWC.
 - 849 • Report disturbances or violations to Miami blues to the Wildlife Alert number (1-888-
850 404-3922).
 - 851 • Manage habitats on private lands to benefit Miami blues and other species of
852 conservation concern.
 - 853 • Support Miami blue conservation actions.

854 **Proposed Implementation Schedule**

855

856 Prioritization of strategies and actions will facilitate the extensive coordination and
857 cooperation necessary to successfully implement the plan. The highest priority strategies should
858 be initiated as soon as possible and should be the first consideration of agencies and groups
859 undertaking Miami blue conservation. The following implementation schedule includes the
860 highest priority actions for achieving the conservation goal and objectives over a five-year
861 period.

862 ***Actions that the FWC and partners should begin within the next 12 months***

- 863 • Finalize memorandum of understanding between FWC and DEP for research on
864 reintroduction techniques to be conducted on Bill Baggs Cape Florida State Park
- 865 • Help identify and coordinate funding sources to maintain captive propagation program at
866 University of Florida (to reduce risk from environmental catastrophe, for reintroduction,
867 and for other research)
- 868 • Help identify and coordinate funding sources to support research on reintroduction
869 techniques
- 870 • Draft and finalize other agreements and incentive programs to facilitate reintroduction
871 attempts at different sites

872 ***Actions that the FWC and partners including local governments, other state agencies,
873 universities and non-governmental agencies should continue or implement during the next
874 five years with assistance from outside entities***

- 875 • Maintain, protect, and monitor known metapopulations of Miami blues on Bahia Honda
876 State Park and Key West National Wildlife Refuge
- 877 • Maintain legal protections for Miami blues
- 878 • Continue surveys at Miami blue historic locations
- 879 • Identify and secure suitable sites for reintroductions or for use as corridors

- 880 • Use maps and field visits to identify suitable habitats within historic range and rate
- 881 sites for potential to support Miami blues
- 882 • Identify and engage public and private landowners
- 883 • Implement necessary incentives (e.g., LIP, WHIP, HCPs)
- 884 • Draft agreements (e.g., memoranda of understanding) with partners to secure
- 885 approval for reintroduction
- 886 • Implement reintroduction program
- 887 • Reintroduce Miami blues
- 888 • Regularly monitor reintroduced populations
- 889 • Manage habitat as appropriate to maintain reintroduced populations
- 890 • Develop database to track status and trends of wild and reintroduced populations
- 891 • Encourage the initiation and conduct of additional research projects to support Miami
- 892 blue conservation, including:
- 893 • Mosquito pesticide buffer zones
- 894 • Ant interactions
- 895 • Parasitoid interactions
- 896 • Impacts from invasives (e.g., iguanas)
- 897 • Identification of contributing factors of decline and disappearance of Miami blues
- 898 from most of historic range
- 899 • Investigate the usefulness of a PVA to address specific questions about Miami blues
- 900 • Develop and implement education and outreach messages and materials to further public
- 901 support for Miami blue conservation
- 902 • Continue using the Imperiled Butterfly Working Group to exchange information between
- 903 and among agencies, managers, biologists, mosquito control districts, and private
- 904 landowners
- 905 • Continue to discuss mosquito-control related issues through the Imperiled Species
- 906 Subcommittee of the Florida Coordinating Council on Mosquito Control
- 907 • Manage habitats on county and city lands to benefit Miami blues and other species of
- 908 conservation concern
- 909 • Support Miami blue conservation actions
- 910

911 **Required Resources and Other Costs Associated with Implementation**

912

913 The South Regional Species Conservation Biologist and Invertebrate Taxa Coordinator,

914 both staff in the Division of Habitat and Species Conservation’s Species Conservation Planning

915 Section, will together serve to coordinate implementation of the Miami blue management plan.

916 These positions will be responsible for coordinating and tracking implementation of the plan and

917 for providing an annual report on progress towards plan activities to be included in FWC’s

918 annual legislative report on threatened and endangered species.

921 ***FWC***

922

923 Several FWC staff will assist with the implementation of the plan. The projected annual
924 costs of their salary and other expenditures are presented below.

925

926 \$ 5,000 – 10% time Regional Species Conservation Biologist

927 \$ 1,750 – 5% time Assistant Regional Species Conservation Biologist

928 \$ 5,000 – 10% time Invertebrate Taxa Coordinator

929 \$ 2,800 – 8% time Florida Wildlife Legacy Initiative Biologist

930 \$ 400 – 1% time Public Outreach Staff

931 \$ 400 – 1% time Permitting Staff

932 \$ 1,000 – Field and office equipment and supplies

933 \$ 2,225 – Transportation costs (estimated 5,000 miles/year @ \$0.445/mile)

934 \$ 1,600 – Per diem costs (estimated 20 days @ \$80/day)

935 \$ 300 – Vehicle maintenance

936 \$20,475 – Total annual cost

937

938 ***FWC and Partners***

939

940 Funds from grants and other sources will be needed to support captive propagation
941 facility maintenance (estimated at around \$36,000/year) and to support field research, surveys,
942 reintroduction activities, and preparation of public outreach materials.

943

944 **Management Plan Review and Revision**

945

946 The status of the range-wide Miami blue population should be periodically assessed to
947 ensure progress toward the conservation goal and objectives. Revision of the plan may be
948 warranted if monitoring reveals a declining trend despite management efforts or successful
949 establishment of reintroduced populations. Future research on reintroduction techniques,
950 pesticide effects, habitat requirements, genetic variability, and/or management techniques also
951 could necessitate a revision of the plan. Any decrease in the area of occupancy or number of
952 mature individuals from the 2009 level will require accelerated action from FWC. At a
953 minimum, the management plan should be revisited for potential revision within 5 years of this
954 revision approval.

955

956 **CHAPTER 6: ANTICIPATED IMPACTS**

957
958 The parties potentially affected by the Miami blue management plan include private
959 landowners, public land managers, scientific researchers, and citizens of the State of Florida. An
960 assessment of the anticipated economic, social, and ecological impacts of implementing the plan
961 was based on the management actions proposed herein and on issues raised through the public
962 comment process. No comments specifically related to the social or ecological impacts of the
963 plan were received. In the absence of additional public input, social and ecological impacts
964 related to the plan’s implementation are difficult to assess.
965

966 **Economic Impacts**

967
968 A preliminary assessment of economic impacts was based on the management actions
969 proposed in this management plan.
970

971 *1. Estimated cost to FWC of implementing the proposed management plan*

972
973 Addressing the approved Miami blue rules necessitates a commitment of staff time and
974 resources: to review permit applications for direct and indirect take; to develop, implement, and
975 oversee landowner incentive programs; to coordinate with the USFWS on development and
976 implementation of Candidate Conservation Agreements with Assurances or other Federal
977 programs; to develop and implement appropriate outreach programs; and to review permit
978 applications for incidental take under these programs.
979

980 Implementation of the management plan will require recurring funds for mapping,
981 surveys, travel, meetings, coordination with landowners, and support for captive propagation,
982 reintroduction, and other research projects. For example, FWC staff are needed to continue
983 participating in the IBWG and the FCCMC. The full scope of the FWC’s commitment will
984 depend, in part, on participation and cooperation with the USFWS and other partners, and the
985 success of the captive propagation, translocation, and reintroduction plan. FWC budget for
986 Miami blues will be addressed on an annual basis as part of the FWC’s operational planning
987 process. Management actions proposed in this plan will need to be prioritized along with other
988 agency programs, species’ needs, and available resources.
989

990 It should be noted that one comment received from the public considered that it is a waste
991 of funds to maintain a captive propagation facility and program, and that those funds would be
992 better spent on habitat restoration for wild populations. At present, we consider that captive
993 propagation is critical to (1) provide insurance against the specter of an environmental
994 catastrophe extirpating the wild populations, and (2) to provide stock for reintroduction and other
995 research projects to improve our ability to conserve Miami blues. Should such research result in
996 the successful reintroduction and self-sustaining of Miami blues within the historic range, and we
997 are able to achieve the management plans conservation objectives, then the captive propagation
998 program would have fulfilled its purpose and could be terminated.
999

1000

1001 **2. *Estimated cost to potentially affected parties of implementing the rules***

1002
1003 The permits required under the rules are no-cost permits. However, mitigation and
1004 minimization activities required under these permits might increase costs incurred by permit
1005 applicants. There is also a potential for lost uses on private lands colonized by Miami blues.

1006
1007 **3. *Estimated cost to other agencies and land managers of implementing management***
1008 ***plan***

1009
1010 Implementation of the plan will have financial impact on other public agencies. The
1011 USFWS has funded the survey and monitoring of the existing Miami blue population, as well as
1012 surveys on potential habitat, and mosquito control studies. The Florida Keys Mosquito Control
1013 District has also funded research on effects of pesticides on non-target insects. The National
1014 Park Service, USFWS, the Florida Park Service, counties and municipalities, and private
1015 property owners may incur costs to manage for Miami blues if they become established naturally
1016 or are reintroduced to their lands. In general, however, it is expected that DEP, USFWS, and
1017 other land managers with existing or reintroduced Miami blue populations can maintain them
1018 through normal ongoing habitat management activities. Other potential expenditures could
1019 include signage or other tools to prevent or limit human disturbance to the Miami blues, their
1020 host plants, and nectar plants, and for general outreach to the public about the butterfly.

1021
1022 **4. *Estimated impact on the tourism and health care industries***

1023
1024 Implementation of the plan has potential economic cost to local tourism and health care
1025 industries if mosquito-borne diseases were to become epidemic as a result of decreased mosquito
1026 control and no-spray zones in areas where the Miami blue is present or reintroduced. In 1989,
1027 Florida was visited by over 65 million people who spent over 30 billion dollars (Mulrennan
1028 1991). A St. Louis encephalitis epidemic in Florida in 1990 is thought to have been responsible
1029 for a 15% decrease in tourist-related business in the last quarter of that year (Mulrennan 1991).
1030 Subsequent outbreaks of West Nile virus throughout the state of Florida, and dengue in the
1031 Florida Keys, have increased the demand for mosquito control (L. Hribar pers. comm.).
1032 However, if such outbreaks were ever detected at sites where Miami blues occur, the sites could
1033 be treated with larvicides or adulticides applied by truck, ideally in a manner that would avoid
1034 impacting Miami blue concentrations. If such actions necessitated closing the sites (especially
1035 state parks) to the public, that would be another economic impact.

1036
1037 Implementation of this management plan could have positive economic impacts because
1038 the presence of so rare a species could raise public interest and increase income from local
1039 tourism. Butterfly viewing is rapidly becoming as popular as bird watching (J. Daniels pers.
1040 comm.). Overall, 4.2 million people participated in some form of residential or nonresidential
1041 wildlife-viewing recreation in Florida in 2006, resulting in a total economic benefit of \$5.248
1042 billion (Zwick and Carr 2006).

1043 **Social Impacts**

1044
1045 Potentially positive social effects on the management plan include: increased public
1046 awareness of the Miami blue and habitats as well as other butterfly species which are in decline

1047 in Florida; public recognition and support of the FWC and partners for taking a comprehensive
1048 approach to Miami blue management; and the development of integrated working relationships
1049 among the various public agencies and private landowners involved with the species'
1050 management. Conversely, if the plan is not implemented there could be negative social impacts.
1051 Continued loss of the species and its habitat could erode public confidence in the FWC's ability
1052 to manage and conserve the wildlife resources of the state. Furthermore, with any reduction to
1053 the Miami blue population, society runs the risk of irreplaceably losing biodiversity, with all of
1054 its potential unknown consequences and benefits to nature and humans.
1055

1056 **Ecological Impacts**

1057
1058 We currently do not foresee any negative ecological impacts due to implementation of
1059 the management plan. Implementation of the plan should have positive ecological impacts,
1060 through maintenance and enhancement of habitat, for the Miami blue and other butterflies that
1061 share its habitat, host plant and/or nectar plant needs.
1062
1063
1064

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1361 **APPENDIX 1. DEFINITIONS**

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

- Area of Occupancy** The geographic area inhabited by all individuals in a population. Typically, the amount of habitat in which individuals are known to occur.
- Adulticide** Pesticide used specifically to kill adult (flying) mosquitoes. Can be applied aerially or from the ground.
- Augmentation** Moving animals to supplement existing populations.
- Extent of Occurrence** The geographic area encompassing all locations of individuals of a species, including intervening areas of unoccupied habitat. Synonymous with range.
- Generation** The average age of breeders in a population. The estimated generation time for Miami blue is between one month and one year (FWC 2003a).
- Known Site** A location where Miami blues have been verified within the last generation (i.e., one month to one year).
- Long-term** An extended period of time relative to the life span of individuals in a population. Length is based on commonly used viability procedures and practicality, but is typically at least 100 years.
- Metapopulation** A collection of local populations connected by occasional dispersal in which there are local extinctions and colonizations. For the purpose of this management plan, a metapopulation is defined as an aggregate of populations separated by barriers such as water, highways, or urban areas with little to no host plants or nectar sources.
- Population** Individuals of the same species that occur in a defined area at the same time and regularly interact or interbreed.
- Range-wide** All individuals of the species throughout the entire extent of its area of occurrence. For the Miami blue, the range-wide population includes individuals historically found from Hillsborough and Brevard counties south to Key West in Monroe County.
- Reintroduction** Moving Miami blues to re-establish populations in formerly occupied habitat. This could include both captive-bred stock or those translocated from wild populations.

1407 **Translocation** The intentional human-assisted movement of Miami blues from one
1408 location to another.
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1410 **Viable Population** A stable, self-sustaining population with a high probability (e.g., more
1411 than 95%) of surviving for a long-term period (e.g., 100 years).
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