

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

SCIENTIFIC NAME: *Anaea troglodyta floridalis*

COMMON NAME: Florida leafwing butterfly

LEAD REGION: 4

INFORMATION CURRENT AS OF: April 2007

STATUS/ACTION

Species assessment - determined we do not have sufficient information on file to support a proposal to list the species and, therefore, it was not elevated to Candidate status

New candidate

Continuing candidate

Non-petitioned

Petitioned - Date petition received:

90-day positive - FR date:

12-month warranted but precluded - FR date:

Did the petition request a reclassification of a listed species?

Listing priority change

Former LP:

New LP:

Date when the species first became a Candidate (as currently defined): September 12, 2006

Candidate removal: Former LPN:

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, Nymphalidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, U.S.

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, Miami-Dade and Monroe Counties, U.S.

LAND OWNERSHIP: There are two populations of Florida leafwing butterfly, one on the mainland and one in the Florida Keys. The mainland population is within Long Pine Key in Everglades National Park (ENP). Total acreage including land and water of ENP in Miami-Dade, Monroe, and Collier Counties is 610,684 hectares [ha] (1,509,000 acres). On the mainland, pine rockland fragments in Miami-Dade County, in public and private ownership, may still retain the potential to support some small, localized, and sporadic populations of the butterfly (Salvato and Hennessey 2003). In the Keys, the butterfly occurs on Big Pine Key within the National Key Deer Refuge (NKDR) and on private, State, and other lands (Salvato 1999, M. Salvato, Service, pers. comm. 2006). The NKDR is 3,723 ha (9,200 acres).

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BIOLOGICAL INFORMATION

Species Description: The Florida leafwing is a medium-sized butterfly approximately 2.75 to 3 inches (in) (76 to 78 millimeters [mm]) in length with a forewing length of 1.3 to 1.5 in (34 to 38 mm) and has an appearance characteristic of its genus (Comstock 1961, Pyle 1981, Opler and Krizek 1984, Minno and Emmel 1993). The upper-wing (or open wing) surface color is red to red-brown, the underside (closed wings) is gray to tan, with a tapered outline, cryptically looking like a dead leaf when the butterfly is at rest. The Florida leafwing exhibits sexual dimorphism, with females being slightly larger and with darker coloring along the wing margins than the males. The species also appears to demonstrate seasonal polymorphism (Salvato and Hennessey 2003). Comstock (1961) employed the terms “summer” and “winter” morph to differentiate between seasonal forms within the genus. The length of photoperiod exposure experienced by fifth-instar larvae (several days prior to pupation), as well as the influence of seasonal moisture have been identified as key factors in determining the seasonal forms within members of this *Anaea* genus of leafwing butterflies (Riley 1980, 1988a, 1988b; Salvato and Hennessey 2003). The summer form (wet-season or long-day form), occurring in late May to September, tends to have forewing margins that are blunt and a hind-wing with a less pronounced tail; colors also tend to be brighter. The winter form (dry-season or short day form), occurring in October to early May, tends to have the opposing characters, with pronounced tails and crescent-shaped forewings (Comstock 1961, Salvato 1999, Salvato and Hennessey 2003).

Eggs are spherical and light cream-yellow in color (Worth et al. 1996). The first three instars begin what continues throughout the larval development to be a remarkable co-evolved cryptic mimicry of the hostplant, pineland croton (*Croton linearis*) (Euphorbiaceae). These stages appear like dead leaves, with a brown color and resting on a dead part of the plant during the day (Salvato 1999, 2003). These instars tend to eat the leaves to the mid-vein and then dangle from them in camouflage. The two later instars are light green in color, with a tapering body from the

cephalad (head capsule) to the caudal end, so that when at rest, it also appears like a croton leaf in the spiral fashion of the terminal end (Worth et al. 1996). The head capsule during all stages bears many tiny setae, presenting the granular appearance of croton seeds (Worth et al. 1996).

Taxonomy: The Florida leafwing butterfly (*Anaea troglodyta floridalis*) was first described by Johnson and Comstock in 1941. The Florida leafwing is a taxon considered to be both endemic to south Florida and clearly derived from Antillean stock (Comstock 1961, Brown and Heineman 1972, Miller and Brown 1981, Minno and Emmel 1993, Smith et al. 1994, Salvato 1999, Hernandez 2004). Some authors (Comstock 1961, Smith et al. 1994, Hernandez 2004) place the Florida leafwing as a distinct species, *A. floridalis*. Others (Brown and Heineman 1972, Miller and Brown 1981, Minno and Emmel 1993, Salvato 1999) consider the Florida leafwing as a subspecies of *Anaea troglodyta* Fabricius. Smith et al. (1994) suggest that further comparison between immature stages of the Florida leafwing and its Antillean relatives may aid in determining whether or not the Florida leafwing is distinct at the species or subspecies level. Miller and Brown (1981) consider *Anaea troglodyta floridalis*, not *A. floridalis*, as the scientific name for the Florida leafwing. The Miller and Brown (1981) checklist is currently under revision; however, no changes will be indicated for *A. troglodyta floridalis*.

We have carefully reviewed the available taxonomic information regarding the Florida leafwing. While there is some disagreement as to whether this butterfly is distinct at the species level (Comstock 1961, Smith et al. 1994, Hernandez 2004) or at the subspecies level (Brown and Heineman 1972, Miller and Brown 1981, Minno and Emmel 1993, Salvato 1999), there is no question that the Florida leafwing is a valid taxon and entity that could be listed pursuant to the Endangered Species Act (ESA).

Habitat/Life History: The Florida leafwing occurs only within pine rocklands that retain its hostplant, pineland croton. Pineland croton, a subtropical species of Antillean origin, is the only known host plant for the leafwing (Opler and Krizek 1984, Schwartz 1987, Minno and Emmel 1993, Smith et al. 1994). Therefore, the leafwing is restricted to pine rocklands that contain pineland croton.

Once occurring throughout the pine rocklands of the lower Florida Keys (Dickson 1955, Folk 1991, Hennessey and Habeck 1991, Salvato 1999), pineland croton now occurs only on Big Pine Key. The last reports of the hostplant from other keys were from No Name in 1992 (Carlson et al. 1993) and from Little Pine (Folk 1991). Recent surveys of relict pineland throughout the lower keys by Salvato (1999, pers. comm. 2006) failed to locate the plant from any island other than Big Pine. Hennessey and Habeck (1991) and Salvato (1999) estimated that approximately 80 ha (198 acres) of appropriate hostplant-bearing pine rockland habitat occur within NKDR. Another 1,068 ha (2,639 acres) of pine rockland habitat with appropriate hostplant occur within ENP (Hennessey and Habeck 1991, Salvato 1999).

Numerous authors have observed and documented the behavior and natural history of this species (Lenczewski 1980, Pyle 1981, Baggett 1982, Opler and Krizek 1984, Schwartz 1987, Hennessey and Habeck 1991, Smith et al. 1994, Worth et al. 1996, Salvato 1999, Salvato and Hennessey 2003). Adults are rapid, wary fliers. The species is extremely territorial, with both sexes flying out to pursue other butterflies (Baggett 1982, Worth et al. 1996, Salvato and

Hennessey 2003). The Florida leafwing is multivoltine (i.e., produces multiple generations per year), with an entire life cycle of about 60 days (Hennessey and Habeck 1991), and maintains continuous broods in south Florida throughout the year (Salvato 1999). The precise number of broods per year remains unknown, but the leafwing has been recorded in every month (Baggett 1982, Opler and Krizek 1984, Minno and Emmel, 1993, Salvato 1999, Salvato and Hennessey 2003). Females lay eggs singly on both the upper and lower surface of the host leaves, normally on developing racemes (Baggett 1982, Hennessey and Habeck 1991, Worth et al. 1996, Salvato 1999). Worth et al. (1996) and Salvato (1999) visually estimated that females may fly more than 30 m (98 feet) in search of a suitable host and usually require less than a minute to oviposit each egg.

Adults are not frequently attracted to flowers (Baggett 1982, Opler and Krizek 1984, Worth et al. 1996), but have been observed feeding on rotting fruit and dung (Baggett 1982, Opler and Krizek 1984, Minno and Emmel 1993). Devries (1987) reported that both sexes of the tropical leafwing feed on rotting fruits and dung, while males engage in puddling. Hennessey and Habeck (1991) observed an adult feeding at senescent flowers of saw palmetto (*Serenoa repens*) in Watson's Hammock. Salvato (1999) observed an adult leafwing feeding on a sliced orange. Lenczewski (1980) observed Florida leafwings at the edges of mud puddles. Salvato and Hennessey (2003) reported several observations of the Florida leafwing puddling behavior, by males on Big Pine Key and in the Everglades. Adults reared and kept in captivity have not been reported to feed on flowering plants, but have been recorded to frequently feed on various artificial sources (e.g., beer) (Salvato 1999, Salvato and Hennessey 2003).

Historical Range/Distribution: The Florida leafwing is endemic to south Florida and the lower Florida Keys. The other subspecies of *A. troglodyta* occur allopatrically throughout the West Indies.

The Florida leafwing was locally common within the widespread pine rockland habitat that once occurred within Miami-Dade and Monroe Counties, less common and sporadic within Collier, Martin, Palm Beach, and Broward Counties (Baggett 1982, Smith et al. 1994, Salvato 1999, Salvato and Hennessey 2003). Historically, pine rockland habitat covered 65,450 ha (161,730 acres) within Miami-Dade County (Loope and Dunevitz 1981, Service 1999). However, development has removed and/or fragmented pine rocklands from the majority of the leafwing's former range on peninsular Florida and the lower Keys (Service 1999, Salvato 1999). This rapid loss of habitat and the resulting increased distance between substantial populations of hostplants in the remaining pine rocklands is the most likely cause for the disappearance of the leafwing from the mainland and keys.

As a result of declining habitat and hostplant availability, there is little recent evidence that the Florida leafwing ventured further north than southern Miami-Dade to make use of localized relict populations of hostplants that still persist as far north as Martin County (Salvato 1999, Salvato and Hennessey 2003). Furthermore, although the leafwing was widely reported from several locations in southern Miami until the mid-20th century, Salvato (1999) has found few documented field sighting records or museum collection specimens from areas north of Monroe and Miami-Dade Counties, suggesting that it may not have been common further north historically (Salvato and Hennessey 2003).

Current Range/Distribution: Populations of Florida leafwing have become increasingly localized as pine rockland habitat has been lost or altered through anthropogenic activity (Baggett 1982, Hennessey and Habeck 1991, Schwarz et al. 1996; Salvato 1999, 2001, 2003). Long Pine Key contains the largest remaining coverage of pine rockland habitat (8,029 ha) (19,840 acres) on peninsular Florida (Salvato 1999, Service 1999, Salvato and Hennessey 2004). However, Hennessey and Habeck (1991) and Salvato (1999) estimated that approximately 1,068 ha (2,638 acres) of appropriate hostplant-bearing pine rockland habitat occur within Long Pine Key (all within ENP) for use by the Florida leafwing.

In Miami-Dade County, outside of ENP, there are approximately 375 pine rockland fragments remaining totaling approximately 1,780 ha (4,398 acres) (Department of Environmental Resource Management 1995). Although several of these pine rockland fragments, particularly ones that are adjacent to ENP, such as Navy Wells Pineland Preserve and Camp Owaissa Bauer Hammock, appear to maintain small, localized populations of pineland croton, Salvato and Hennessey (2003) and Salvato (pers. comm. 2006) have failed to observe the leafwing in these or other mainland areas outside ENP. A GIS analysis conducted by the Service using 2004 data indicates that 65 pine rockland fragments containing pineland croton remain in private ownership in Miami-Dade County totaling approximately 190 ha (470 acres) (The Institute for Regional Conservation [IRC] unpublished data). Another 12 fragments totaling 180 ha (446 acres) contain croton and are in public ownership (IRC unpublished data). The more recent analysis likely under-represents leafwing habitat because it only involved areas where access was allowed and only examined fragments containing croton.

In the lower keys, Big Pine Key retains the largest undisturbed tracts of pine rockland habitat totaling an estimated 701 ha (1,732 acres) (Folk 1991, Hennessey and Habeck 1991, Salvato and Hennessey 2004). Although relict pine rocklands can still be found on several other islands within NKDR, only Big Pine Key maintains pineland croton (Salvato 1999; Salvato and Hennessey 2003, 2004). As a result, the leafwing is present only on Big Pine Key. Hennessey and Habeck (1991) and Salvato (1999) estimated that approximately 80 ha (198 acres) of appropriate hostplant-bearing pine rockland habitat occur within NKDR.

Population Estimates/Status: Based on results of all historic (Baggett 1982, Schwartz 1987, Hennessey and Habeck 1991, Worth et al. 1996, Schwarz et al. 1996) and recent (Salvato 1999, 2001, 2003; Salvato and Hennessey 2003; M. Salvato, pers. comm. 2006) surveys and natural history studies for this species, there are two populations of Florida leafwing. Surveys of the Florida leafwing by Hennessey and Habeck (1991) and Salvato (1999, 2001) indicated that, while present in many pine rockland locations on Big Pine Key and Long Pine Key, the species was most often encountered in the Watson's Hammock area of NKDR and Gate 4 within Long Pine Key. Hennessey and Habeck (1991) reported an estimate of 3.7 adult leafwings per ha (1.5 per acre) during 1988-1989 from survey transects at both Watson's Hammock and Long Pine Key. During 1997-1998, Salvato (1999) recorded higher densities of this species at an estimated 3.6 and 2.6 adults per ha (1.5 and 1.1 per acre) at Watson's Hammock and Gate 4, respectively, than what was found on survey transects elsewhere in the study.

As of early 2007, Salvato (pers. comm. 2007) recorded an average of 5.0 adult leafwings per ha

(2.0 per acre) in the Watson's Hammock area, while other locations in NKDR have yielded an average of 0.2 to 2.7 adults per ha (0.1 to 1.1 per acre) during 1997-2007. The higher densities of leafwings in Watson's Hammock have been attributed to the fact this is the only pine rockland area within NKDR restricted from chemical pesticide applications for mosquito control (Hennessey and Habeck 1991; Hennessey et al. 1992; Salvato 1999, 2001). However, analysis of survey data collected from mid-2003 through March 2007 indicate a substantial decline in leafwing numbers on NKDR, even within Watson's Hammock (M. Salvato, pers. comm. 2007). Salvato (pers. comm. 2007) has recorded estimates of 6.7 adult leafwing per ha (2.7 per acre) over the duration of his long-term study on Long Pine Key.

Salvato (pers. comm. 2007) generally finds about 1 leafwing per ha (0.4 per acre) during his surveys. Assuming the leafwing is uniformly distributed throughout available habitat within NKDR and ENP, this would translate into a population size of approximately 1,134 butterflies. Salvato (pers. comm. 2007) estimated that the leafwing population collectively at Big Pine Key and Long Pine Key ranges from roughly 100–800 adults at any given time.

Marc Minno (Eco-Cognizant, Inc., pers. comm. 2007) believes that the Florida leafwing is either extremely rare or extirpated from the Keys and the Navy Wells site near Florida City Based upon surveys since August 2006. He has only seen a few individuals in ENP (Minno pers. comm. 2007). Minno indicates that this species was common on Big Pine Key in the 1980s, but the habitat has changed dramatically in recent years. In short, Minno (pers. comm. 2007) believes that this species has declined greatly since the 1980s and is not likely to survive without special efforts.

The leafwing has a rounded global status of T1, critically imperiled because of extreme rarity (i.e., 5 or fewer occurrences of less than 1,000 individuals) or because of extreme vulnerability to extinction due to natural or manmade factors (NatureServe 2006). The basis for this ranking stems from the overall threats of destruction of habitat on Big Pine Key, mosquito spraying, fire, and lack of fire, which make this taxon highly vulnerable to extinction (NatureServe 2006). The leafwing is also considered threatened by the Florida Committee on Rare and Endangered Plants and Animals (Deyrup and Franz 1994). However, these designations provide no legal authority or protection. The leafwing is recognized in Florida's Comprehensive Wildlife Conservation Strategy as one of Florida's species of greatest conservation need (FWC 2005). The Florida leafwing is not listed in Florida and there is no wildlife management plan for this species.

THREATS

A. The present or threatened destruction, modification, or curtailment of its habitat or range.

The pine rockland community of southern Florida is globally endangered. Destruction of the pinelands for economic development has reduced this community by 90% on mainland south Florida (O'Brien 1996) and to 918 ha (2,268 acres) in the lower keys (Ross et al. 1994). The threat of habitat loss of remaining unprotected pine rocklands continues. Pine rockland fragments outside of ENP contain pineland croton and can provide occupied and suitable habitat for the Florida leafwing. Salvato and Hennessey (2003) and Salvato (pers. comm. 2006) have failed to observe the leafwing in these or other mainland areas outside ENP, but potentially suitable habitat appears to exist on private lands. A recent GIS analysis for

Miami-Dade County indicates that 65 pine rockland fragments containing croton remain in private ownership, totaling approximately 190 ha (470 acres) (IRC unpublished data). In short, sporadic populations of Florida leafwing occurring on unprotected lands remain threatened by habitat destruction or modification.

Similarly, while NKDR retains the largest undisturbed tracts of pine rockland habitat in the lower keys, other areas on Big Pine Key containing occupied and suitable habitat for the Florida leafwing remain unprotected. Therefore, suitable habitat for Florida leafwing outside of NKDR boundaries remains at risk. Residential and commercial development has degraded essential components of Florida leafwing habitat and continues to pose a threat to remaining habitat.

The threat of habitat destruction or modification is further exacerbated by lack of prescribed fire and suppression of natural fires. Natural fires are an important part of maintaining an ecosystem's gradual succession and are important in maintaining the herbaceous layer of pine rocklands of which pineland croton is a part (Loope and Dunevitz 1981, Carlson et al. 1993, Olson and Platt 1995, Bergh and Wisby 1996, Platt et al. 2000). In pine rockland habitat, frequent fires in the dry season burn back the overgrowth of the herbaceous layer, allowing native shrubs to re-sprout from secondary roots under the slash pine canopy. Re-sprouting after burns is the primary mechanism allowing for the persistence of perennial shrubs in pine habitat (Olson and Platt 1995). Without fire, successional climax from tropical pineland to hardwood hammock is rapid, and displacement of native species by invasive exotic plants often occurs. 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. The conversion of pine rockland into hardwood hammock is continuing on northeastern Big Pine, No Name, and Little Pine Keys. Pineland croton is now absent from these locations.

Prescribed fire is used throughout the pine rocklands of Long Pine Key and has been consistently used for the past 50 years (Loope and Dunevitz 1981, Salvato 1999). Historically, however, when prescribed burns were conducted in Long Pine Key, the majority of the pine rockland habitat was burned in its entirety. This pattern of burning likely forced populations of leafwings to the fringes of Long Pine Key, fragmenting the species' distribution.

Since 1989, prescribed fires at Long Pine Key have been conducted every 2-3 years to mimic natural fire regimes historically ignited by lightning strikes (Robertson 1953, Slocum et al. 2003, Salvato and Hennessey 2004). Although this has resulted in restoration of species-rich, herbaceous-dominated pine rocklands in many areas, including resurgence of pineland croton, the populations of croton remain fragmented. The leafwing, with its strong flight abilities, can disperse to make use of adjacent patches of hostplant and then quickly recolonize the burned areas following hostplant resurgence although populations of croton remain fragmented (Salvato 1999, in press; Salvato and Hennessey 2003).

Since 2001, prescribed fire in FMU 3, a fire management unit in Long Pine Key, has been planned on a landscape scale versus unit scale (National Park Service [NPS] 2005). Current

prescribed fire of select portions of pine rockland habitat at Long Pine Key aids the leafwing in two ways. First, partial and systematic prescribed burns allow adult butterflies a corridor (refugia) to flee within during the fires. Second, it allows for faster re-colonization by maintaining adult butterflies in areas adjacent to burn sites. In the past, numerous populations of leafwings were likely lost as they fled large-scale prescribed burns and were unable to find appropriate refugia to sustain their numbers within during the burns.

The NPS acknowledges that endangered and threatened species and their habitats are the principle natural values at risk within FMU 3 (NPS 2005). ENP is working on incorporating considerations for life histories of select butterfly species into its management, but there may be some inconsistencies between implementation of the plan and meeting the needs for select species. For example, low numbers of butterflies in the pinelands are partially attributed to burning too soon following hurricanes and flooding and before host plants were fully recovered, as well as other factors (S. Perry, NPS, pers. comm. 2007). In May 2005, select portions of Long Pine Key were prescribed burned, and resurgence of vegetation within these burned areas was then set back due to storm damages caused by Hurricanes Katrina and Wilma later that year (M. Salvato, pers. comm. 2007). By mid-2006, these had not recovered, yet burns adjacent to these areas continued, removing available host plants (M. Salvato, pers. comm. 2007). Although management in ENP in recent years has benefited the leafwing, adaptive management needs to be implemented during instances where recovery of recently burned areas is slowed. If future management activities are not carefully conducted, populations of this butterfly could be depressed further (S. Perry, pers. comm. 2007; M. Salvato, pers. comm. 2007).

The objectives of the current NKDR fire management program are to: (1) protect human life, property, and other resources from unwanted fire; and (2) restore and maintain biological diversity using fire as a viable ecological process (Service 2000). The latter includes maintaining biological diversity in fire-maintained plant communities by prescribed fire and also controlled natural fire under Service guidelines and maintaining habitat for trust resources, including endangered and threatened plant and animal species, especially the Key deer, through prescribed fire and controlled natural fire (Service 2000). The fire management plan for NKDR mentions Florida leafwing and its reliance on its fire-dependent host plant and indicates that “Concern has been raised that fire suppression is contributing to the decline of these species as the host plant requires a fire maintained open pineland to persist (Emmel et al. 1995).” However, no specific details are provided to enhance habitat or avoid / mitigate impacts to Florida leafwing. In addition, management of pine rocklands by NKDR is made particularly difficult by the pattern of land ownership and development; private homes and light commercial uses are embedded within or in close proximity to the fire-sustained pineland habitat (Service 2000).

Limited fire management within Watson’s Hammock of NKDR has not curtailed populations of the leafwing, as burns provide resurgent hostplants and the area’s relatively small size is not a detriment to this butterfly given its dispersal abilities, which allow it to seek out refugia in adjacent pine rocklands. However, Salvato (1999, in press) has indicated that burns are not being administered as thoroughly in Watson’s Hammock as is needed to prevent loss of pine rocklands. As a result much of the pine rocklands within northern Watson’s Hammock

are being compromised by hardwood hammock (Salvato and Hennessey 2004). In addition, fire breaks leading into Watson's Hammock have been expanded; these expansions included cutting back and removing large quantities of native vegetation, including croton (M. Salvato, pers. comm. 2007). Therefore, fire and fire management continues to be a threat for this species at NKDR and surrounding lands on Big Pine Key.

In summary, despite substantial habitat losses, the threat of habitat destruction or modification of remaining unprotected pine rocklands continues today. Sporadic occurrences of the butterfly and suitable habitat on unprotected pine rocklands outside of ENP and NKDR largely remain at risk to development. Habitat loss, fire suppression, and lack of fire management in the past have led to the current fragmentation and degradation of remaining habitat. The threat of destruction, modification, or curtailment of habitat due to wildfire and fire management appears to have been lessened on ENP but continues on NKDR and on surrounding private lands. Additional habitat loss could result in a significant further reduction in the range of this species.

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, Williams 1996). 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). 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).

We do not have direct evidence of collection of Florida leafwing. Historically, this species has been highly sought after by collectors. It is unlikely that collecting or the threat of collection has ceased. Salvato (pers. comm. 2006) has not seen specimens of the leafwing listed by the wholesale and specialty insect dealers who offer and sell butterflies to museums, artists, and collectors. However, Salvato (pers. comm. 2006) has been contacted by numerous individuals requesting specimens of the leafwing or in regard to locations where they may be collected in the field. Thus, there is an established desire for specimens.

The leafwing's occurrence largely on protected Federal lands may help protect it from collectors. In the past, when this species was more widespread on Big Pine Key and throughout southern Miami-Dade County, collecting likely exhibited little pressure on this species. At present, even limited collection from the small populations in NKDR or ENP could have deleterious effects on the leafwing's reproductive and genetic viability and thus could contribute to its eventual extinction. Illegal collection could occur in ENP or NKDR without being detected since these areas are not actively patrolled. Similarly, in some areas such as Navy Wells, there is no signage indicating collection is prohibited. Consequently, the potential for unauthorized or illegal collection of eggs, larvae, pupae, and/or adults exists and could go undetected, despite the protection provided on Federal or other public lands.

In summary, we have no direct / absolute evidence that collection of Florida leafwing is occurring at present. However, the established interest in specimens and information

requests regarding its location on the part of collectors, researchers, and others suggests that collection may be occurring and has the potential to occur at any time. At present, 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. However, because there are only two small populations remaining, we believe that collection has the potential to be a serious threat to the species at any time.

C. Disease or predation.

Unlike other members of *Anaea*, larvae of the Florida leafwing do not make frass chains or roll plant leaves into tubes to evade parasites and predators. Within the pine rocklands, eggs of the leafwing experience a high level of parasitism from trichogrammid wasps (Hymenoptera: Trichogrammidae). Once attacked by the wasps, leafwing eggs turn black (Muysshondt 1975b, Hennessey and Habeck 1991, Salvato 1999, Salvato and Hennessey 2003). The frequency of these black eggs was noted to be as high as 100 percent in 1988-1989 surveys both in Long Pine Key and Big Pine Key (Hennessey and Habeck 1991). *Trichogramma* sp. near *pretiosum* Riley "Naranja species" was identified as the parasitoid and appears to be a key mortality factor for the leafwing (Hennessey and Habeck 1991, Salvato 1999, Salvato and Hennessey 2003). Hennessey and Habeck (1991) found the larval hatch rate in the field for all survey areas during their 1988-1989 studies, including all mortality sources, ranged from 0 to 33 percent, depending on location and year.

The mite *Balaustium* sp. (Acari: Erythraeidae) has been observed preying upon leafwing eggs within the Everglades (Hennessey and Habeck 1991). Crab spiders (Aranea: Thomisidae) are frequently observed during surveys for the leafwing (Salvato and Hennessey 2003, M. Salvato, pers. comm. 2006). Crab spiders and ambush bugs (Insecta: Phymatidae) feed on leafwing larvae and possibly adults (M. Salvato, pers. comm. 2006). Matteson (1930) recorded ants as predators on leafwing eggs in Miami.

Caldas (1996) found fifth instar larval parasitism by tachinid flies to be as high as 53 percent for *Anaea* (= *Memphis*) *ryphea* Cramer. Devries (1987) indicated that larvae of the tropical leafwing (*Anaea aidea*) experience parasitism from tachinid flies as well as chalcid wasps. Tachinid flies appear to be a parasitoid on the larval stages of the Florida leafwing, laying their eggs on the hostplant, which are subsequently ingested. Hennessey and Habeck (1991) collected a moribund (i.e., in a dying state; near death) fifth-instar of the Florida leafwing at Long Pine Key. The specimen was host to four larvae of *Chetogena* sp. (Diptera: Tachinidae) that emerged from it in the laboratory; these larvae pupated and became adults.

Hennessey and Habeck (1991) encountered a pupa of the Florida leafwing on Big Pine Key that was in the process of being consumed by ants (species not specified). Muysshondt (1975a) suspected heavy predation on larvae *Anaea* (= *Memphis*) *morvus boisduvali* (no common name) from spiders after witnessing spiders in the proximity of leaves where larvae had been feeding. Spiders appear to prey upon adult Florida leafwing as indicated from a photograph in Glassberg et al. (2000) of a lynx spider (Aranea: Oxyopidae) with a captured adult. However, Rutkowski (1971) watched a spider (species not specified) quickly release an adult Florida leafwing from its web after an initial taste. This suggests the Florida leafwing may be chemically protected from certain predatory species. Salvato (pers. comm.

2006) has examined the bite marks on wings of numerous adult Florida leafwing butterflies in the field indicating a variety birds and lizards are among the predators for this species.

At this time, it is not known to what extent predation or parasitism may be a threat to the Florida leafwing. Parasitism and predation are a natural part of the life history of the species and we have no information suggesting that parasitism or predation is causing a decline in the status of the species. Disease is not known to be a threat to the Florida leafwing.

D. The inadequacy of existing regulatory mechanisms.

This species is not listed in the State of Florida. Federal, State, and local laws have not been sufficient to prevent past and ongoing impacts to Florida leafwing or its habitat.

For scientific research on and/or collection of the leafwing at ENP and/or NKDR, a permit is required from the NPS or the Service, respectively. Although the leafwing 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 largely absent. Therefore, potential illegal collection could occur without being detected. Since the leafwing is not listed by the State, it is not protected from being killed and from unauthorized take if encountered outside of NKDR or ENP. Consequently, the potential for unauthorized or illegal collection of the leafwing (eggs, larvae, pupae, or adults) exists, as discussed under Factor B above and could go undetected, despite its occurrence on Federal lands.

The 1979 Master Plan is the plan of record for ENP, however the NPS is currently preparing a new General Management Plan for ENP, which is still two to three years from completion (F. Herling, NPS, pers. comm. 2006). The current plan for ENP indicates one goal as “Natural and cultural resources and associated values are protected, restored and maintained in good condition and managed within their broader ecosystem and cultural context.” However, the Master Plan is not regulatory and its implementation is not mandatory.

Similarly, the Comprehensive Conservation Plan is the principal guiding document for National Wildlife Refuges and the Service is in the process of developing one for NKDR. Although still in the development phase, this plan will likely focus on management of natural communities, Service trust resources, and threatened and endangered species. It is unknown to what degree the plan will address the needs of other imperiled species or the extent to which NKDR will have the resources necessary to meet its management needs.

At this time, the protection currently afforded the leafwing is limited, provides little protection to the species’ occupied habitat, and includes no protection of unoccupied habitat. Current management plans for Federal lands do not specifically address the leafwing and land management practices do not currently incorporate specific life history needs for this species. Therefore, we conclude that the existing regulatory mechanisms are inadequate to protect the leafwing and its habitat.

E. Other natural or manmade factors affecting its continued existence.

As the amount of human activity and size of the human population has increased in south

Florida, so has the control of salt marsh mosquitoes (*Aedes sollicitans* (Walker) and *A. taeniorhynchus* (Wiedemann)). To suppress mosquitoes, second-generation organophosphates (naled) and pyrethroid (permethrin) adulticides are used year-round throughout south Florida and from May to November in the Keys by mosquito control districts (Hennessey et al. 1992, Salvato 1999). Malathion is used elsewhere in the State, but it has not been used by the Florida Keys Mosquito Control District (FKMCD) since 1994 (Hribar and Fussell 2005; L. Hribar, pers. comm. 2006). It is the FKMCD's policy to conduct source reduction before larviciding, and larviciding before adulticiding (Hribar and Fussell 2005). Despite the improved mosquito control practices, the use of adulticides applied using both aerial and ground-based methods to control mosquitoes presents collateral effects on non-target species.

The lethal effect of second-generation organophosphate pesticides, such as naled and fenthion, on non-target Lepidoptera was well noted initially in south Florida and the Keys, with the demise of the endangered Schaus swallowtail butterfly (*Papilio aristodemus ponceanus*) (Emmel and Tucker 1991, Eliazar 1992). This species' dramatic decline in the early 1970s coincided with the expanded use of chemical pesticides by the Monroe County Mosquito Control District (MCMCD), now known as the FKMCD on the northern Keys (Emmel and Tucker 1991, Eliazar 1992). When spraying was halted during two periods (1987 and 1989-1992), the species began to recover (Emmel and Tucker 1991, Eliazar 1992). The swallowtail's immediate decline when applications resumed clearly suggested the adverse effect chemical pesticides have on non-target species. Studies conducted by Hennessey et al. (1992) illustrated the presence of spray residue long after application in the habitat of the Schaus swallowtail and several other imperiled butterflies. Baggett (1982) also suggested that the rapid decline in several populations of butterflies in the Keys was directly attributable to mosquito control pesticide applications.

Eliazar (1992) conducted intensive testing on the effects of the chemical pesticides naled and fenthion on several south Florida butterfly species. His results indicated that chemical pesticide and their field application rates, particularly those of naled, were extremely toxic to non-target Lepidoptera and were being administered in the field at levels above the dosage required to kill target *Aedes* mosquitoes. Eliazar's naled experiments, conducted in the laboratory, included several butterfly species (not Florida leafwing) likely to be found in the lower Keys. His results suggest that naled or fenthion used at the field application rates would have lethal or at least sublethal effects on Florida leafwing. Salvato (1999, 2001) also measured the toxicity of naled and permethrin on a number of surrogate species and these adulticides were highly toxic towards these butterflies in both immature and adult stages.

Spraying practices by the FKMCD at NKDR have changed to reduce pesticide use over the years. According to the Special Use Permit issued by the Service, the number of aerially applied naled treatments allowed on NKDR has been reduced to a specified allotment (i.e., 9 per mosquito season, no closer than 5 days apart [R. Frakes, Service, pers. comm. 2006]). These changes were made after the Service reviewed the toxicity of naled on federally listed species that occur within NKDR; however, this analysis did not include species of Lepidoptera, since none on NKDR are listed. Since insects are more sensitive to organophosphates than the vertebrate species considered in the analysis, negative impacts to

Florida leafwing and other Lepidoptera from continued naled applications will likely occur, despite the reduced use of this insecticide. The Service plans to use information from pesticide studies that are currently underway (see Conservation Measures) to more fully analyze effects to listed species and candidate species on federal lands.

The small outlying areas of NKDR have been designated no-spray zones by agreement between the Service and MCMCD. Essentially all of the pine rocklands within NKDR except Watson's Hammock on Big Pine Key are sprayed with naled (aerially applied adulticide); additionally, residential areas and roadsides across Big Pine Key are treated with permethrin (ground-based applied adulticide) (Salvato 1999). In short, basically all areas of Big Pine Key, except Watson's Hammock and Cactus Hammock, are sprayed with naled or permethrin. Therefore, Florida leafwing and its occupied and suitable habitat on Big Pine Key are directly exposed to adulticides used for mosquito control.

Designation of no-spray zones does not mean a lack of chemical intrusion. When these zones were created in 1989, pesticide drift downwind into them had not been documented. However, Hennessey et al. (1992) detected naled residues 750 m (2,460 feet) into the no-spray zone at Watson's Hammock and 150 m (492 feet) at Cactus Hammock. Truck-applied ultra-low-volume (ULV) fenthion, sprayed primarily in residential areas, did not appear to drift into non-target areas. This study indicated that naled remained in the habitat well into midday, posing risk to diurnally active non-targets, such as the leafwing. In a more recent study by Florida A&M University involving the candidate Miami blue butterfly (*Cyclargus thomasi bethunebakeri*) in north Key Largo, substantial amounts of drift have also been reported. Preliminary results of that study have demonstrated drift up to four miles from the application site; however, it is not yet known if adverse impacts occur at the residue level detected at that distance from the application zone (T. Bargar, Service, pers. comm. 2007). Therefore, the leafwings utilizing Watson's Hammock are exposed to chemical residues despite its location within a no-spray zone.

Furthermore, Salvato (1999, 2001, pers. comm. 2006) has been monitoring the populations of the leafwing on survey transects on Big Pine Key and Long Pine Key since 1997 and has found the butterfly to be slightly more abundant in areas where insecticide applications are restricted (i.e., Watson's Hammock, Long Pine Key) than in areas where applications occur.

In general Long Pine Key does not appear to be regularly impacted by mosquito control practices, except for the use of adulticides in residential areas and campgrounds. Housing areas, maintenance areas, outside work areas for park maintenance staff and contractors, and areas near buildings are sprayed (S. Perry, pers. comm. 2007). In addition, there are reports that operators frequently leave the foggers on when traveling from one area to another within ENP (S. Perry, pers. comm. 2007). Spraying is widespread following hurricanes (S. Perry, pers. comm. 2007). Other sporadic leafwing populations adjacent to and outside ENP and other suitable and potential habitat within Miami-Dade County are vulnerable to the lethal and sublethal effects of adulticide applications.

Butterflies in south Florida and the Keys, such as the Florida leafwing, have adapted over time to the influence of tropical storms and other forms of adverse weather conditions (M.

Salvato, pers. comm. 2006). However, given the substantial reduction in the Florida leafwing's historic range in the past 50 years, the threat and impact of tropical storms and hurricanes on the remaining populations of this species is much greater than when its distribution was more widespread. The active hurricane season of 2005 resulted in extensive damages to pine rockland habitats both within NKDR and the Everglades.

According to the National Oceanographic and Atmospheric Administration, Miami-Dade County, the Keys, and western Cuba are the most storm-prone areas in the Caribbean so this threat is expected to continue. In October 2005, Watson's Hammock was heavily damaged from Hurricane Wilma. Native vegetation across much of Watson's Hammock, including croton, has not recovered. The Florida leafwing has not been observed in Watson's Hammock since the storm. Although numbers of the Florida leafwing had substantially declined prior to storm activity across the island, hostplant loss has likely prevented any potential resurgence for the species recovery in areas such as Watson's Hammock.

The Florida leafwing is vulnerable to extinction due to the two populations that are small and isolated. A population of 1,000 has been suggested as marginally viable for an insect, although this is likely highly dependent upon type of species (D. Schweitzer, The Nature Conservancy, pers. comm. 2003). Schweitzer (pers. comm. 2003) has also suggested that butterfly populations of less than 200 adults per generation would have difficulty surviving over the long-term. Therefore, the Florida leafwing population at Big Pine Key (estimated at 80) appears to be at risk.

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). 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 Florida leafwing is largely restricted to two locations, one occurring within pine rocklands of Big Pine Key, a second within Long Pine Key. Distance between these populations and the small size of highly sporadic populations make recolonization unlikely if populations are extirpated. The extent of habitat fragmentation leads us to believe this species is vulnerable due to the small number of populations, their small size, and their relative isolation.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

Fire management practices of pine rocklands within ENP and potentially NKDR may provide benefits for the Florida leafwing. The *Florida Comprehensive Wildlife Conservation Strategy* discusses management of pine rocklands, but has not been implemented or funded (FWC 2005).

The Service has funded a comprehensive laboratory study with Florida International University to refine knowledge of the toxicology and effects of naled and permethrin. Specific objectives of this study are to: (1) determine the toxicity of naled and permethrin to different stages of the life cycle of butterflies at environmentally relevant concentrations of insecticides and (2) conduct a probabilistic ecological risk assessment for butterflies by comparing species sensitivity

distributions for naled, dichlorvos, and permethrin with exposure distributions for each insecticide at different sites. The Service has also provided funding to Mote Marine Laboratory to better estimate toxicological effects in the field. Specific objectives of this study are to: (1) determine mosquito adulticide distribution, concentrations, and persistence in the field following routine mosquito control operations and (2) provide empirical data from field studies for comparison with laboratory toxicity studies of mosquito adulticide effects on lepidopteran species. In addition, a Service representative participates in the field study currently underway in with Florida A&M University, which is testing the effects of adulticides on the Miami blue butterfly, including the amount of deposition and extent of drift. The Service will have a better understanding of the risk to its trust resources by some mosquito control practices following completion of these studies.

SUMMARY OF THREATS

The Florida leafwing and its habitat are vulnerable to a wide variety of natural and human factors. The two small, isolated populations are exposed to extreme weather events (e.g., hurricanes). Mosquito control practices are a threat to the population on Big Pine Key, including the NKDR. Habitat of the leafwing, pine rocklands, is globally imperiled and dependent upon fire. Inappropriate fire management or wildfire could destroy the leafwing and impact the availability of pineland croton, its sole host plant. Further reduction of the populations, especially due to catastrophic weather, mosquito spraying, loss of suitable habitat, or inappropriate fire management could severely reduce the likelihood of this butterfly's survival. Finally, the established interest in specimens of the leafwing and information requests regarding its location on the part of collectors, researchers, and others suggests that collection may be occurring and has the potential to occur at any time. At the present time, there is insufficient information to conclude that the species is currently threatened by overutilization for commercial, recreational, scientific, or educational purposes. 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.

RECOMMENDED CONSERVATION MEASURES

- Address concerns regarding impacts of mosquito control activities in relation to pine rockland habitats on NKDR and adjacent properties. Establish additional no-spray zones and wider buffer areas around these zones.
- Review and adjust fire management practices as needed to help maintain or expand the population sizes or numbers of populations. Coordinate activities among fire crews, biologists, and lepidopterists and use adaptive management as needed.
- Protect remnant patches of pine rocklands and use of prescribed fire to restore native plant diversity.
- Restore pineland croton to relict fragments of pine rocklands within the leafwing's historic range to expand its occupied habitat.

LISTING PRIORITY

THREAT

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

Rationale for listing priority number:

Magnitude: The Florida leafwing is threatened by the combined influences of habitat destruction and modification from continued loss of unprotected pine rocklands and wildfire or fire management on protected sites. Mosquito control activities are a serious threat to the butterfly at NKDR, one of its two remaining populations, as well as anywhere the species occurs outside of ENP. Loss of genetic diversity may be a problem for the butterfly considering its small, fragmented, and isolated populations. The probability for catastrophic events (e.g., hurricanes) and the possibility of accidental harm or habitat destruction are threats due to the small population sizes / limited numbers at the few remaining locations. In addition to these threats, displacement of native hostplants by invasive exotic species and inadequate regulatory protection continue to pose threats to the species throughout its historic range. Overall, we find that these threats are of high magnitude. We also recognize that illegal collection is a potential threat to the species.

Imminence: The threats of habitat destruction and modification are occurring with the continued loss of unprotected pine rocklands and wildfire or fire management on protected sites. The Florida leafwing continues to be negatively impacted by adulticides used for mosquito control on Big Pine Key and outside of ENP. The threat from loss of genetic diversity within small, fragmented, and isolated populations is expected to continue. The likelihood of extreme weather or catastrophic events (e.g., hurricanes) to both of the remaining populations seriously threatens the survival of this butterfly, and these threats are expected to continue. We find these threats to be currently occurring and imminent. In addition, since there is an established interest in locations and desire for specimens by collectors, researchers, and others, we believe this species may be at risk; collection may be occurring and has the potential to occur unnoticed at any time, since areas are remote and open to the public.

Rationale for Change in Listing Priority Number (insert if appropriate)

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. Emergency listing is not warranted because there are two populations of the Florida leafwing on Federal lands, with the population ranging from 100–800 adults at any given time. Since this butterfly is being regularly monitored, the Service should be aware of any further reduction in the number of populations, changes in size of a population, and degradation of habitat in a timely manner to undertake emergency listing, should it be necessary.

DESCRIPTION OF MONITORING

Surveys for the Florida leafwing butterfly are ongoing. Monitoring began in 1997 and has been conducted either monthly or bi-monthly throughout the butterfly's historic range (Salvato 1999, 2001, pers. comm. 2006; Salvato and Hennessey 2003). In addition, Sue Perry (NPS) surveys for this species periodically within ENP.

The SFESO sent previous versions of this form to FWC, NPS, and NKDR, requesting review and comments. The SFESO sent the Candidate Notice of Review (CNOR) to species experts, land managers, agencies, organizations, and all interested parties on September 12, 2006, when this species became a federal candidate. Only one individual, L. Hribar, provided comments and concerns and the Service provided a response on October 23, 2006. Information provided by Hribar was reviewed and considered during the revision of this assessment.

The Service will continue to send updated forms to species experts, land managers, knowledgeable individuals, and interested parties. We believe this level of monitoring is adequate at this time to update the status of the species, considering that it is being actively monitored throughout its range by Salvato and within ENP by Perry.

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: None.

Indicate which State(s) did not provide any information or comments: Florida. A previous version of this form was sent to FWC. No comments or additional information have been received to date. The Florida leafwing butterfly is listed as on the list of species of greatest conservation need in the State's Wildlife Action Plan, Florida's Comprehensive Wildlife Conservation Strategy (FFWCC 2005).

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Key:

¹Peer reviewed original research based on data

²Peer reviewed secondary research derived

³Grey research based on data

⁴Grey ⁵Other

literature based on literature analysis

Appendix 1. Threats assessment Florida leafwing butterfly

Factor	Stressor	Source	Scope	Immediacy	Intensity	Exposure	Response	Overall Threat Level
A: Destruction, Modification, or Curtailment of Habitat	loss of pine rocklands, habitat degradation, habitat fragmentation	urban, residential, and commercial development	Moderate	Imminent, historic, and future	High	Moderate	Basic need inhibited, reduction in survival and reproduction, abandonment of habitat, mortality	High
	loss / removal of hostplant, conversion to hardwood hammock	suppression of natural fire, lack of prescribed fire, use of prescribed fire before plant recovery (following hurricanes, flooding, or fire), invasive plants	Moderate	Imminent, historic, and future	High	Significant	Basic need inhibited, reduction in survival and reproduction, abandonment of habitat, mortality	High
B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes	collection	collectors, researchers, other interested individuals	Moderate	Future, historic, imminent	Low	Very Significant	Mortality	Low
C: Disease or Predation	Not applicable - no current threat exists	NA	NA	NA	NA	NA	NA	NA
D: Inadequacy of Existing Regulatory Mechanisms	no substantive protection of occupied habitat or suitable habitat	inadequate regulations	Moderate	Imminent, historic, and future	High	Significant	Basic need inhibited, reduction in survival and reproduction, abandonment of habitat, mortality	Moderate
E: Other Natural or Man-made Factors	toxicity of pesticides	mosquito control pesticides	Moderate	Imminent, historic, and future	High	Significant	Basic need inhibited, reduction in survival and reproduction, mortality	High

loss of hostplant	hurricanes, tropical storms, flooding	Moderate	Imminent, historic, and future	Moderate	Very Significant	Basic need inhibited, reduction in survival and reproduction, mortality	Moderate
genetic drift, inbreeding, loss of genetic variability, random or chance changes to environment	small population size, isolated locations	Moderate	Future, unknown	Unknown	Unknown	Reduction in viability	Unknown

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: 
for Regional Director, Fish and Wildlife Service June 11, 2007
Date

Concur: _____
Director, Fish and Wildlife Service Date

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

Director's Remarks:

Date of annual review: March 12, 2007; revised April 30, 2007
Conducted by: Paula Halupa, South Florida Ecological Services Office