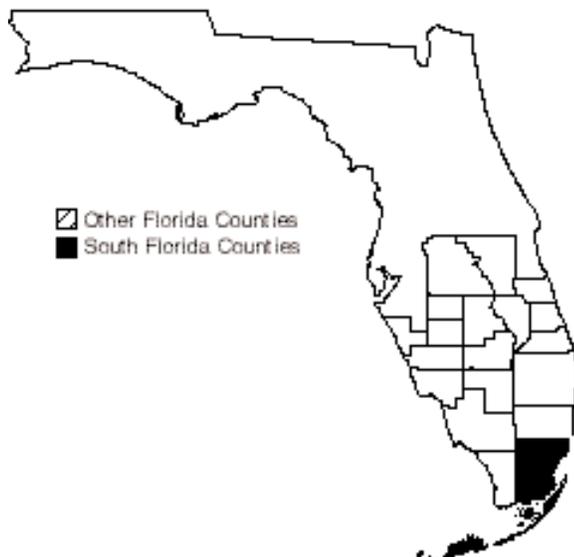

Schaus Swallowtail Butterfly

Heraclides aristodemus ponceanus

Federal Status:	Endangered (August 31, 1984)
Critical Habitat:	None Designated
Florida Status:	Endangered
Recovery Plan Status:	Revision (May 18, 1999)
Geographic Coverage:	Rangewide

Figure 1. County distribution of Schaus swallowtail butterfly.



The Schaus swallowtail butterfly (*Heraclides* (= *Papilio*) *aristodemus ponceanus*) is a large dark brown and yellow butterfly which historically occurred in hardwood hammocks from South Miami to Lower Matecumbe Key, Florida. The Schaus swallowtail butterfly was originally listed as a threatened species because of population declines caused by the destruction of its tropical hardwood hammock habitat, mosquito control practices, and over-harvesting by collectors. It was reclassified to an endangered species because its numbers and range had declined dramatically since the original listing.

This account represents a revision of the existing recovery plan for the Schaus swallowtail butterfly (FWS 1982).

Description

The Schaus swallowtail butterfly is a large blackish-brown swallowtail butterfly with contrasting markings that are mostly dull yellow (Klots 1951, Pyle 1981, Opler and Krizek 1984). The male's antennae are black with a yellow knob, while the female's antennae are all black. Their forewings have a dull yellow median band from the apex to about midpoint of the inner margin, with a short side branch to costa about one-third the distance from the apex. Their subterminal and terminal lines consist of lunular yellow spots from apex to anal angle. Their hindwings have a yellow median band continuing that of the forewing, and a submarginal row of large yellow lunular spots; the concavities of a deeply scalloped outermargin have yellow edging. Their blackish "tail" is straight-edged (not teardrop-shaped), and is bordered with yellow. The tails have a hollow red spot along the anal margin just above the anal angle, with bluish scaling. A small, inconspicuous red dash is sometimes present toward the base of the second yellow lunule from the anal angle (between vein M2 and Cu1).

The underside of a Schaus swallowtail's wings is yellow with black shading mostly in the median and submarginal areas of the forewing and in the terminal area and tails of the hindwing. A dull brownish-red median band extends from costa to inner margin of the hindwing, narrowing before touching these margins. When perched and fluttering its wings, the Schaus is distinctive in its extensive russet-brown to magenta scaling bordered by iridescent blue scales, on the ventral hind wing surface (T. Emmel, University of Florida, personal communication 1998). The wingspan is 8.6 to 9.5 cm (Klots 1951, Pyle 1981).

Schaus swallowtail butterfly is most easily confused with the giant swallowtail [*Papilio cresphontes* (Cramer)], which is widespread in eastern North America and also occurs in habitat occupied by the Schaus swallowtail butterfly. The two butterflies are separated by size and color. The giant swallowtail is larger than the Schaus swallowtail and is more nearly coal-black with brighter yellow lines, although this butterfly species, color may fade to brown after several days of flight (T. Emmel, University of Florida, personal communication 1998). The giant swallowtail butterfly has a broader median forewing band that is more broken into spots, and is less separated from the submarginal band toward the apex; the antennae are solid black; and its tail is teardrop-shaped, yellow inside bordered with black edging. The reddish markings on the underside of its wings are less brownish and much less extensive than on the Schaus swallowtail butterfly (Opler and Krizek 1984). The surest differentiation between the two species in the field is the tail coloration and flight behavior. The giant swallowtail flies with a more rapid fluttering flight and in a straight line, compared to the Schaus swallowtail's slower, more hesitant flight. Additionally, the giant swallowtail has more protruding forewings in flight, whereas the Schaus swallowtail has a more boxlike shape in flight (T. Emmel, University of Florida, personal communication 1998).

Taxonomy

The Schaus swallowtail butterfly is a member of the Lepidoptera, family Papilionidae. In its original description (Schaus 1911) the Schaus swallowtail was considered to be a full species, *Papilio ponceana*, with the type locality Miami, Florida. Schaus noted that it was "allied to *P. aristodemus* from Haiti, and *P. temenes* Godt. from Cuba." It was first placed as a subspecies of *aristodemus* Esper in 1917 (Barnes and McDunnough 1917), and has been cited as such since that time except for Holland's (1931) revised version of *The Butterfly Book*. Now considered an Antillean species with high propensity to vary geographically, *P. aristodemus* consists of five subspecies (Clench 1978): Nominate *P. aristodemus* (Hispaniola), *P. aristodemus temenes* Godart (Cuba), *P. a. ponceanus* Schaus (Florida), *P. a. driophilus* Clench (Bahamas), and *P. a. bjordalae* Clench (Bahamas). The validity of some of these subspecies has been questioned (FWS 1982); however, it is believed that the Schaus swallowtail may

Schaus swallowtail butterfly.
Original photographs by
Thomas Emmel.



represent a distinct species (Emmel 1986a). Molecular studies are needed to determine the relationships between these five subspecies and whether each represents a truly separate genetic entity.

Orthography of the specific name was “*ponceana*” in the original description (Schaus 1911) and in some earlier references (Barnes and McDunnough 1917, Bates 1934, McDunnough 1938). Widespread use of the “*ponceanus*” spelling resulted from its first major appearance in *The Butterfly Book* (Holland 1931). Both subspecies status and the “*ponceanus*” orthography have been stable since 1951 (Klots 1951).

Generic usage has fluctuated recently, with North American species traditionally placed in *Papilio* Linnaeus grouped into three genera, one of which is *Heraclides* Hubner (Miller and Brown 1981). This usage has been followed by some recent workers (Pyle 1981, Loftus and Kushlan 1984), but not by others (Opler and Krizek 1984, Hower 1975, Emmel 1985, FWS 1982). These conservative workers retain *Papilio*, considering *Heraclides* to be at most a subgenus. *Heraclides* (*Papilio*) *aristodemus ponceanus* has been used incorrectly since *Papilio* is not a subgenus. *Heraclides* (= *Papilio*) *aristodemus ponceanus* is the correct representation.

Distribution

The present distribution of the Schaus swallowtail extends from southern Miami-Dade County through the Keys in Biscayne Bay and north to southern Key Largo in the Upper Keys, to Lower Matecumbe Key in the Middle Keys. Schaus swallowtail butterfly distribution is limited to tropical hardwood hammocks and is concentrated in the insular portions of Miami-Dade and Monroe counties, from Elliott Key in Biscayne National Park (NP) and associated smaller Keys to

central Key Largo (Figure 1). The species is currently known from 13 areas on the mainland and the Upper and Middle Keys, following reintroduction efforts undertaken between 1995 and 1997 (T. Emmel, University of Florida, personal communication 1998).

There have been two possible, but unverified, sightings of Schaus swallowtail butterflies in the Lower Keys. One Schaus swallowtail butterfly was seen on Big Pine Key in 1966 (FWS 1982). Another Schaus swallowtail butterfly was sighted on Lignumvitae Key in 1973 (Covell 1976). The sighting on the latter Key seems possible because the butterfly's foodplant torchwood (*Amyris elemifera*), is present on Lignumvitae Key (Covell 1976, 1977). A 1984 survey from Elliott Key to Key West found no Schaus swallowtail butterflies south of north Key Largo (Emmel 1985); although a verified sighting occurred on Upper Matecumbe Key in 1986 (Emmel 1986a). In 1985, over 400 Schaus swallowtail butterflies were seen in Biscayne NP, and a few were spotted at four sites in northern Key Largo. In 1986, the population of adult Schaus swallowtail butterflies on Elliott Key was estimated at 750 to 1,000 individuals; in the same year, there were an estimated 50 to 80 individuals (adults and immatures) on each of Old Rhodes, Totten, and Adams Keys (Emmel 1986a).

The Schaus swallowtail butterfly was described by Schaus in 1911 from specimens collected in May 1898, in the south Miami area. The last known mainland specimen was collected at Coconut Grove, Miami-Dade County, in May 1924 (FWS 1982). One older specimen was reportedly collected at Key West (FWS 1982). A colony on Lower Matecumbe Key flourished from 1935 to 1946 (FWS 1982, Grimshawe 1940), with a single capture recorded there in 1964 (FWS 1982). The Schaus swallowtail butterfly has been known to occur on northern Key Largo from 1940 to present, although rare since the mid-1970s (FWS 1982). The Schaus swallowtail butterfly has been known to exist on the larger islands of Biscayne NP from a survey conducted in 1972 (Brown 1973, Covell and Rawson 1973).

Habitat

The Schaus swallowtail butterfly occurs exclusively in subtropical dry forests (hardwood hammocks) including areas that were formerly cleared and farmed, but have since regrown. Hardwood hammocks are now extensive only in the Upper Keys in Miami-Dade and Monroe counties (FWS 1982). Adults of this species may fly in clearings and along roads or even out over the ocean for short distances (Rutkowski 1971, Brown 1973). The males prefer trails and hammock edges while the females more often fly within the hammock, occasionally venturing out to feed on flowers but typically staying within the hammocks proper (Rutkowski 1971). Nectaring activity usually occurs on blossoms of cheese shrub (*Morinda royoc*), blue porterweed (*Stachytarpheta jamaicensis*), sea grape (*Coccoloba uvifera*), wild sage (*Lantana involucrata*), wild coffee (*Psychotria nervosa*), or guava (*Psidium guajava*) along the margins of these hammocks. However, up to 30 different wild plant species may be exploited (Emmel 1988, 1995a). This species rarely feeds in areas open to direct sunlight (FWS 1982, Rutkowski 1971).

Other characteristics of Schaus swallowtail butterfly habitats are that they are relatively high elevation (3.0 to 4.6 m above sea level), away from tidal waters, and have a mature overstory of trees such as gumbo-limbo (*Bursera simaruba*), pigeon plum (*Coccoloba diversifolia*), black ironwood (*Krugiodendron ferreum*), West Indian mahogany (*Swietenia mahagoni*), and wild tamarind (*Lysiloma latisiliquum*) (Covell 1976). These plants grow on a substrate of Key Largo limestone, which characterizes the Upper Keys.

Dense, mature, subtropical hardwood hammock habitat on well-drained substrate with dappled sunlight penetration is essential for the continued survival of both the Schaus swallowtail butterfly and its primary food plant, torchwood (Emmel 1985, FWS 1982, Covell 1976, Rutkowski 1971, Brown 1973, Loftus and Kushlan 1984). The minimum area of tropical hardwood hammock required for a successful butterfly population is not known, though viable wild populations have been noted over a 14-year period in areas as small as 4 ha (T. Emmel, University of Florida, personal communication 1998). Similarly, the optimum density of primary and secondary food plants is not known.

Behavior

The Schaus swallowtail butterfly is territorial only to the extent that males patrol constantly for females and may investigate other butterflies entering their territories within hardwood hammocks (Emmel 1985). The flight pattern is usually rapid and erratic at about 1 to 2 m off the ground. Male butterflies have also been reported as they “patrolled the tree tops at a height of 10 feet or more” during the “hot afternoon” on “bright days,” sometimes “descending into open spaces to investigate any other *Ponceamus*” (Rutkowski 1971). Emmel (1985) also notes that male Schaus swallowtail butterflies are remarkably adapted to flight within hardwood hammocks and are able to pick their way among branches and around spider webs.

The Schaus swallowtail butterflies spend much of their time within hammocks, particularly where sunlight penetrates to give a dappling effect (Emmel 1985). Courtship has been observed along narrow trails cut through the hammock (Rutkowski 1971). Open areas such as trails or clearings within or near the dense hammock are requisite for courtship activity and nectaring. These open areas may be natural or man-made.

The Schaus swallowtail butterfly appears to be strictly diurnal but may fly from as early as 7 am. to as late as 7 pm. Rutkowski (1971) observed two female Schaus swallowtail butterflies on different days visiting cheese shrub blossoms as early as 9 am. Another female hovering over cheese shrub at 5 pm comprised his last observation (Rutkowski 1971). He found both sexes “within the hammocks, fluttering in diffused light about a foot above the ground at blossoms of Guava...” during the hottest part of the day (from 1 to 2 pm).

While no mass migration of the Schaus swallowtail butterfly has ever been reported, movement is common on individual islands and some movement between islands which are closely situated has been noted. The butterflies are

capable of flying as far as 5.8 km miles in a day and marked specimens have traveled between Keys, including Elliott and Adams Keys in Biscayne NP and from Elliott or Adams Keys south to Upper Key Largo (T. Emmel, University of Florida, personal communication 1998). One Schaus was followed as it crossed a 0.8 km expanse of Biscayne Bay between two islands (Brown 1973). In 1986, a Schaus swallowtail butterfly was seen crossing about 360 m from Old Rhodes Key to Swan Key (Emmel 1986a). These observations indicate that these butterflies can travel across open water for a considerable distance among the Upper Keys and may be able to travel to and from the mainland.

Schaus swallowtail butterflies have a single annual flight season, primarily in May and June, where adults are active; most sightings have been recorded between mid-April and mid-July (FWS 1982). Post flight season emergences in August or September are extremely rare, but do occur in both the wild and captively propagated populations (T. Emmel, University of Florida, personal communication 1998).

There is only one generation of Schaus swallowtail butterfly per year and adults are short-lived (Emmel 1985). There is some evidence from rearing that diapause may extend for at least 2 years (Grimshawe 1940). If this occurs in natural populations, the Schaus swallowtail butterfly could survive extreme droughts in the season following its larval development by delaying emergence, perhaps until July-September or later (Rutkowski 1971). Some adults are active during July-September as well as during the normal flight period of late April through early July (Brown 1976).

Reproduction

The courtship of Schaus swallowtail butterflies has been partially described in the following observation: “At 10:15 am in a dimly-lit trail through brushy hammock I saw a female and two male *ponceanus* visiting flowers at opposite ends of a guava tangle. The fresher of the two males eventually approached this slightly worn female while she was still feeding. He hovered over her. She then settled on the ground with wings flattened and vibrating, raising her abdomen. The male fluttered on the ground behind and then rose over her before flying away” (Rutkowski 1971).

Three courting pairs of Schaus swallowtail butterflies were observed in 1982 on Elliott Key by Covell and photographed; details were not recorded. During part of the flight, the males were flying behind the females very low to the ground (1 to 3 m). In the pair photographed, the male was worn and heavily damaged, but the female seemed fresh and whole.

Mating has been observed in the wild and in captivity by research groups. The swallowtail rests with its wings spread open; after coupling, the pair rests facing away from each other with wings open. If disturbed, the female flies while the male holds on with his claspers and presses the wings together ventrally (M. Minno, personal communication, 1998). The Schaus swallowtail butterfly uses torchwood and wild lime (*Zanthoxylum fagara*) to deposit its eggs (Grimshawe

1940, Rutkowski 1971, Brown 1973, Loftus and Kushlan 1984). These food plants are either at the edge of hammocks along trails sheltered by the canopy or they are in the hammocks proper, at the edge of a clearing or where a fairly large opening in the canopy exists. Females deposit single eggs on the upper surface of the tips of the leaves; however, there is one record of two eggs on a leaf (FWS 1982). Eggs and larvae are not found on plants in open sunlight; however, in contrast, the giant swallowtail, *Heraclides cressphontes*, has been observed ovipositing on wild lime growing in the open (FWS 1982).

Survival rate of adults in the wild averages 3.3 days for males and 3.6 days for females (Emmel, 1988,1995b). The Schaus swallowtail butterfly may suffer damage more quickly than similar species that live in more open areas because of hazards of life in the dense brush of the hammock (Emmel 1985b). Ideal conditions in the laboratory can enhance survival and extend this time period to as long as 34 days (T. Emmel, University of Florida, personal communication 1998).

No studies on sex ratio have been published, but generally males are seen in more abundance than females. Of 245 adult *ponceanus* in collections, 136 were males, 41 females, and 68 had no sex indicated. If these figures were indicative of natural sex ratios, males would outnumber females by more than 4:1. Female butterflies are typically more secretive than males, and in the case of Schaus swallowtail butterflies, a skewed distribution might be explained by the patrolling of males in more visible areas of the hammock edges where they are more easily captured by prey or collectors. Lab-reared offspring typically have 50:50 sex ratios (M. Minno, personal communication, 1998).

While the reproductive potential for females is high, able to lay several hundred eggs, egg survival in the field is low. A survival rate of 29.7 percent (11 of 37) was cited in one case for a group of eggs collected in the wild. Further mortality of hatching larvae resulted in a survival rate of only 5 percent in the group studied (Emmel 1995).

Development from egg to adult was described by Grimshawe (1940) and Rutkowski (1971). Eggs take 3 to 5 days to hatch. Grimshawe also describes pupation:

“When ready to transform, the larva seeks a place of seclusion, each for itself, and fastens its anal extremity with a button of silk, and throws a heavy girdle around the thorax, supporting the body in an upright, or vertical, position for the long sleep. The encased segments of the body of some of the chrysalides are rusty-brown color; others are gray, etched with moss-green and conforming generally with that of their supporting object. They take on a rigid cast and show no signs of life throughout the entire period of their sleep. Unlike the double and triple-brooded related species of neotropical Florida, our butterflies remained in the chrysalis stage either 1 or 2 years. As an example, half the caterpillars transforming into the chrysalis stage July 7, 1935, emerged May 8, 1936; the other half remained, hatching May 13, 1937.”

Rutkowski (1971) also noted the white osmeteria on the larvae, and drinking of water droplets by fifth-instar caterpillars.

Foraging

Torchwood is the primary source of food for the Schaus butterfly. Young caterpillars use tender, young leaves of the wild lime and will avoid older leaves, although fifth (final) instar larvae have been observed eating tougher older leaves of torchwood (FWS 1982) and, in a laboratory, prickly-ash (Rutkowski 1971). Adults have been observed taking nectar from blossoms of guava, cheese shrub, and wild coffee (FWS 1982, Rutkowski 1971). Guava, although an exotic, seemed to be the nectar source preferred by individuals observed by Rutkowski (1971) and he suggested that Schaus swallowtail butterflies will fly some distance from their hammock haunts to find blooming guava flowers. Emmel (1986a) observed frequent nectaring at seven plant species on Elliott Key: cheese shrub; blue porterweed (*Stachytarpheta jamaicensis*); sea grape (*Coccoloba uvifera*); dog's tail (*Heliotropium angiospermum*); lantana (*Lantana involucrata*); salt-and-pepper (*Melanthera nivea*); and wild coffee.

Relationship to Other Species

The survival of the Schaus swallowtail butterfly depends on survival of sufficient stands of its primary food plants, torchwood and wild lime, in appropriate tropical hardwood hammocks in the upper Florida Keys. These two rutaceous species are the only known foods for this species in nature (Emmel 1985, FWS 1982). The butterfly occasionally oviposits on individuals of Key lime (*Citrus aurantifolia*), a non-native, but it is not a normal food plant for this species in the wild (T. Emmel, University of Florida, personal communication 1998). The butterfly uses wild lime at least as frequently as torchwood, and wild lime is generally a more common food plant in its present population areas as noted by Emmel 1986, 1988, 1995a. No direct competition with other butterfly or moth species for food plant utilization has been observed. The giant swallowtail does use wild lime, but oviposits on plants in open sunlight and not on shaded plants as in the case of the Schaus swallowtail (FWS 1982, Rutkowski 1971). The relationship between birds and butterflies is important since predation by birds appears to be the most reasonable explanation for high pupal mortality rates (Emmel 1995b).

Status and Trends

Although population numbers of the Schaus swallowtail butterfly fluctuate year to year, between 1924-1981 there had been a general decline in range and numbers. The Schaus swallowtail butterfly has been considered as rare on north Key Largo since the mid-1970s. This species was listed as threatened on April 28, 1976, because of population declines caused by the destruction of its tropical hardwood hammock habitat, mosquito control practices, and over-harvesting by collectors (41 FR 17740). The Schaus swallowtail butterfly was reclassified to an endangered species on August 31, 1984, because its numbers

and range had declined dramatically since its first listing (49 FR 34504).

Suitable habitat remaining for this species is estimated as 43 percent in Biscayne NP and 17 percent for north Key Largo. The decline has been attributed primarily to habitat destruction. North Key Largo contains one of the last remaining protected areas of tropical hardwood hammock habitat. The majority of the Schaus swallowtail butterfly population is found on Adams, Elliott, Old Rhodes, Swan, and Totten Keys within Biscayne NP. Between 1985 and 1990, the Elliott Key population fluctuated between 600 to 1,000 adults annually, with smaller populations of at least 50 to 100 individuals on each of the other Keys. Hurricane Andrew temporarily reduced the Biscayne NP's population in 1992 to 58 identified individuals; however, in 1994 the population rebounded to over 600 and is presumed stable (Emmel 1995a).

Within the major keys of Biscayne NP (Elliott, Old Rhodes, Totten, and Adams Keys) and on northern Key Largo, the two food plants of the Schaus swallowtail butterfly seem adequate to support a healthy population. High numbers of individuals sighted in 1985 indicate that the Schaus swallowtail butterfly's population is still capable of periodic peaks. Following 3 years of reintroductions, results of a 1997 flight season census indicate that the total annual population in the wild has increased to at least 1200 butterflies (J. Daniels, University of Florida, personal communication 1999).

Prior to human influences, populations of this butterfly were probably subject to naturally occurring population depressions caused by hurricane damage, drought, and rare freezes (Covell 1976). The influence of the Labor Day Hurricane of 1935 on the Lower Matecumbe Key population was documented by Grimshawe (1940), though the claim that the species became extinct was incorrect (it was found there and on Key Largo in succeeding years) (Henderson 1945). The results of Grimshawe's careful searching were negative; however the before and after surveys demonstrated that the hurricane had a detrimental effect on the biota of the keys southwest of Key Largo.

Threats

The principal future threats to Schaus swallowtail butterfly survival and recovery are, in descending order: loss of habitat for residential and commercial construction; introduction of pesticides and other hazardous chemicals; road kills; extreme climatic conditions, such as hurricanes, freezes, and droughts; and death by predators, parasites, and collectors.

Clearing of habitat for urban and agricultural purposes in and around Miami and Lower Matecumbe Key certainly were instrumental in eliminating the Schaus swallowtail butterfly at the extremes of its historic range. Food plants were probably either eliminated or reduced to small stands incapable of sustaining Schaus swallowtail butterfly populations (FWS 1982). Similar clearing has occurred within its known north Key Largo habitat, but litigation has slowed development of the area (Covell 1976) and many areas have been acquired by DEP. Slight alteration of habitat, such as dirt roads and trails

through the hammocks, seem to be harmful only in that they permit easy access to collectors, who can catch butterflies when they fly low along these trails. However, small clearings and trail edges seem to promote proliferation of torchwood plants. Natural succession in such places, particularly following hurricanes and fires, could account for population increases in the species and its food plants. But large fires and extensive forest clearing are detrimental to the species. Paved roads through Schaus swallowtail butterfly habitat, particularly C.R. 905 on northern Key Largo, permit road kill of adults, one case of which is documented (Covell 1976).

The use of commercial pesticides has also contributed to the decline of the Schaus swallowtail butterfly. Monroe County currently operates an active mosquito control program. Although agreements with the county to avoid sensitive habitat areas in north Key Largo have been discussed, spraying in these areas still occurs. The pesticides Dibrom, Baytex, and Teknar, used in the keys for mosquito control, are toxic to the related giant swallowtail (*Heraclides cressphontes*) in the laboratory (Emmel 1986b). Mortality of Schaus swallowtail butterfly occurs from the use of these chemicals directly, and indirectly, by application to food sources and other components of the habitat. Pesticides can also cause behavioral modification and impaired reproduction and it is very likely that the extensive use of mosquito control pesticides has greatly reduced butterfly populations.

Collecting of immature stages as well as adults may have reduced numbers on Key Largo in the period from 1969-1974 and earlier; but again the lasting effects cannot be gauged (Covell 1976). Collection of specimens has been illegal since the early 1970s and today, there is no known poaching activity.

Little is known about predation by spiders, lizards, birds, or other predators. Damage to wings occurs soon after adult emergence, and beak marks on some individuals indicate frequent bird attacks (Emmel 1985). Flight behavior among the many obstacles in hammock habitat seems unusually deliberate, in that the butterflies can fly slowly and painstakingly to avoid the many large orb spider webs and branches to a remarkable degree (Emmel 1985). Emmel also observed that butterflies seem able to follow the same flight paths through hammocks repeatedly. Ants and lizards are the most likely predators of the immatures (M. Minno, personal communication 1998). Larval predation is probably minimized by oviposition behavior (one egg per leaf and few per food plant), lizard-dropping appearance of the larvae (as in other *Papilio* larvae), secretive behavior of larvae, and bad-smelling scents from the osmeteria when larvae are disturbed (Grimshawe 1940, Rutkowski 1971). Crypsis in the pupa (Grimshawe 1940) as in other swallowtails is also a factor in avoiding predation. Nothing is known about parasites of this species. No information is available regarding diseases of the Schaus swallowtail butterfly; however, high egg mortality has

been observed at times (FWS 1982, Rutkowski 1971).

Management

According to the FWS's Recovery Team (FWS 1996), recovery actions for the Schaus swallowtail butterfly should focus on acquiring additional hardwood hammock habitat and protecting those areas and existing hammock from development. As part of the recovery tasks identified for the Schaus swallowtail butterfly, 760 pupae were released in 1995 on seven protected sites. Depredation by birds accounted for an estimated 85 to 90 percent mortality rate. In 1996, this effort involved the release of 248 female and 155 male adult Schaus swallowtail butterflies on those same seven sites (Figure 2). All females were mated prior to release. An additional release of adults to those same areas was undertaken in 1997. Results of these reintroductions appear to have been very successful, however, monitoring will continue through at least 1999.

In addition, habitat improvement, through the planting of hundreds of wild lime trees, is being conducted within selected colonies on Key Largo. This effort should serve to increase the breeding habitat for Schaus swallowtail butterflies, and hopefully result in a natural population increase (J. Daniels, University of Florida, personal communication 1999).

Biscayne NP is also being managed to provide adequate cover for both Schaus swallowtail butterfly adults and food plants (Emmel 1985, FWS 1982). This cover includes mature and well-drained tropical hardwood hammock with some natural and man-made openings such as narrow trails and clearings where nectaring and courting behavior can take place close to the more

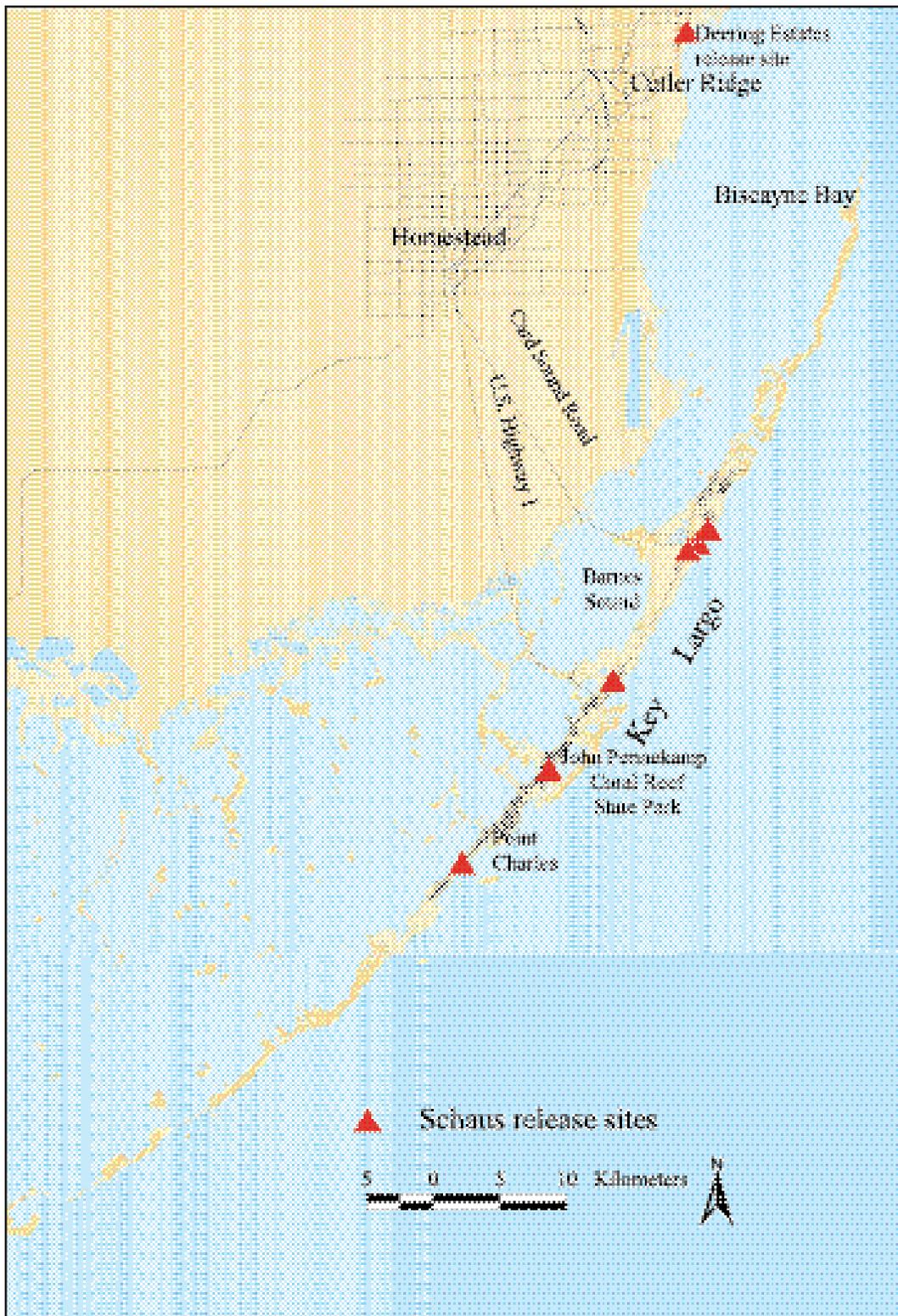


Figure 2. Release sites for Schaus swallowtail butterfly in Miami-Dade and Monroe counties.

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Recovery for the Schaus Swallowtail Butterfly

Heraclides aristodemus ponceanus

Recovery Objective: RECLASSIFY TO THREATENED, then delist.

Recovery Criteria

The Schaus swallowtail butterfly has always been a rare species in its historic range of Miami-Dade and Monroe counties. The destruction and degradation of Schaus swallowtail habitat and other human activities, such as collecting and mosquito spraying, increased the vulnerability of this rare species to extinction. Management actions such as acquiring and restoring habitat, enforcing prohibitions against take, reducing the effects of mosquito spraying, and increasing our biological understanding of the butterfly's biology and ecology have helped stabilize this species. Due to the effectiveness of management actions to help its recovery, the objective of this recovery plan is to delist the Schaus swallowtail butterfly. This objective will be achieved when: further loss, fragmentation, or degradation of suitable, occupied habitat within the butterfly's historic range in the Upper Florida Keys and Miami-Dade County has been prevented; when breeding sites of the Schaus swallowtail butterfly have been protected from mosquito spraying; when mosquito spraying in other areas used by the Schaus swallowtail butterfly has been reduced by 90 percent; when all suitable, occupied habitat on priority acquisition lists for the Schaus swallowtail butterfly is protected either through land acquisition or cooperative agreements; when the hardwood hammocks that form the habitat for the Schaus swallowtail butterfly are managed, restored, or rehabilitated on protected lands; and when stable populations of the Schaus swallowtail butterfly are distributed throughout its historic range. These populations will be considered demographically stable when they exhibit a rate of increase (r) equal to or greater than

Species-level Recovery Actions

- S1. Determine the distribution and status of wild Schaus swallowtail butterfly populations.** Schaus swallowtail butterflies are known to occur in hardwood hammock forests in Miami-Dade and Monroe counties. Their exact distribution in these counties is known, but is not being publicized due to the possible adverse effects of collectors visiting the sites while populations are still small. From 1995-1997, captively bred butterflies were released in new areas to re-establish populations. Annual monitoring of the status, location, and distribution of pre-existing wild population sites has been carried out in Biscayne NP and on Key Largo since 1984. Additional surveys to determine the distribution and status of the wild Schaus swallowtail butterfly populations are necessary in subsequent years to follow the fate of both the wild populations and the reintroduced populations.

- S1.1. Determine the status of wild butterflies within current range.** Survey hardwood hammocks in Deering Estate (and other suitable areas in Miami), Biscayne NP, and north Key Largo to determine the status of wild butterfly populations. Quantitatively determine the number and distribution of larvae, juveniles, and adult butterflies. The Crocodile Lake NWR is planning on conducting annual wild butterfly surveys during peak adult emergence from April through June.
- S1.2. Determine the status of captive reared Schaus swallowtail butterflies.** Compile all information on the locations in which captive-reared Schaus swallowtail butterflies were released and determine the reproductive success of these populations. Surveys to determine interactions between captive reared and wild populations of the Schaus swallowtail butterflies may be critical to determining possible genetic effects of captive reared individuals on wild populations. Investigate how butterflies are spatially distributed within habitat patches and their relation to other occupied habitat patches.
- S1.3. Survey natural butterfly habitat and determine habitat characterization and use by both wild and captive-bred butterflies.** Identify occupied and unoccupied habitat patches. Quantify habitat structure including canopy structure, species composition and diversity, and distribution, and assess the condition. Determine why butterflies are absent in areas with suitable habitat.
- S1.3.1. Survey butterflies along ecotonal regions.** Survey populations along edges of roads, housing developments, and other habitat types (mangroves). Evaluate status of butterflies in remote contiguous habitat as compared to fragmented habitat or areas near human habitation.
- S1.3.2. Survey the amount of light or closed canopy and its effects on species numbers, etc.**
- S1.3.3. Determine species composition and abundance between different stands of forest.**
- S1.3.4. Survey hammock microclimate during breeding and flight time.** Previous surveys extrapolated physical environmental conditions from historic records. Survey microclimate (rainfall, temperatures, photoperiod, humidity, *etc.*) of occupied habitat during breeding and flight times.
- S1.3.5. Survey the distribution of adult butterflies and the distribution of host plants.**
- S1.4. Determine the status of habitat at release sites.** Captively bred butterflies have been released at seven different sites in Monroe and Miami-Dade counties. For each site, survey spatial coordinates, spatial relation to other patches, abundance of host plants, canopy structure, open and semi-open habitat, amount of habitat degradation (*e.g.*, exotics, trash), and susceptibility to human impacts.
- S1.5. Survey other butterfly populations in occupied Schaus swallowtail butterfly habitat.** Identify additional butterfly species that occur in occupied Schaus swallowtail butterfly habitat. Select a species that is relatively common, yet is habitat-specific. Survey the presence/absence of these species to determine population dynamics and habitat interaction. Surveying other selected species will provide information to help assess habitat quality.

- S1.6. Maintain and improve the GIS database for butterflies information.** Compile additional survey information into existing FWS GIS database. Use GIS to identify spatial relationships between occupied and unoccupied habitat patches.
- S1.7. Conduct presence/absence surveys for Schaus swallowtail butterfly in suitable habitat throughout the Florida Keys.** Historic reports suggest butterflies may have occurred in such areas as southern of Key Largo, Key West, Lower and Upper Matecumbe, Big Pine Key, and Lignumvitae Key. Because many of these reports are old or unconfirmed, these surveys are of lower priority. Conduct butterfly surveys in these other areas in conjunction with other listed species recovery work.
- S2. Protect and enhance existing, wild populations of the Schaus swallowtail butterfly.**
- S2.1. Assign a biologist responsibility for implementing recovery actions for the threatened or endangered species of the Upper Florida Keys and Miami-Dade County (Deering Estate and Biscayne NP).** Recovery actions that benefit one of the threatened or endangered species in the Florida Keys (such as actions to recover the Schaus swallowtail butterfly) will benefit other threatened or endangered species in the same area. At the same time, the number of actions that will be necessary to recover threatened or endangered species in the Florida Keys and Miami-Dade County will require the attention of a biologist or similarly trained professional who is dedicated to addressing these recovery needs.
- S2.2. Utilize Federal regulatory mechanisms for protection.** Conduct section 7 consultations on Federal activities that may affect the Schaus swallowtail butterfly and determine a jeopardy threshold. Coordinate with law enforcement to prevent take under section 9. Identify what activities could result in take of butterflies, such as habitat loss and collecting.
- S2.3. Provide Schaus swallowtail butterfly information to Federal, State, county, and city agencies.** Provide information including GIS information regarding the presence of butterflies, their protection under the ESA, and ways to minimize impacts. Non-Federal agencies that may influence the Schaus swallowtail butterfly include DEP, DCA, GFC, DACS, Florida Keys Aqueduct Authority, and Monroe County government.
- S2.4. Reduce human-related mortalities of Schaus swallowtail butterflies.** Levels of Schaus swallowtail butterfly mortality have not been quantified, although sources of mortality are documented. Implement management actions that reduce causes of mortality. Mortality is primarily a result of habitat modification such as clearing for residential and commercial construction, fires, introduction of pesticides and other hazardous chemicals, and deaths from vehicular collisions, predators, parasites, and collectors.
- S2.4.1. Eliminate the negative effects of pesticides and other biocides.** One of the greatest current threats to butterflies is the negative effect from mosquito spraying and other biocides. Develop a Memorandum of Agreement with Miami-Dade and Monroe county mosquito control groups to eliminate mosquito spraying effects on the Schaus swallowtail butterfly. Enforce regulations that prohibit spraying over Federal and State lands. Eliminate any adverse affects on the Schaus swallowtail butterfly.

- S2.4.2. Reduce the effects of habitat loss, destruction, and modification on Schaus swallowtail butterflies in the Florida Keys.** Several areas in north Key Largo are in private ownership and subject to habitat modification. Acquire suitable habitat to prevent mortality of butterflies. Coordinate with landowners to reduce habitat modification effects on the Schaus swallowtail butterfly.
- S2.4.3. Eliminate illegal collecting of the Schaus swallowtail butterfly.** Enforce regulations that prohibit the collection of adults, larvae, or eggs of the Schaus swallowtail butterfly.
- S2.4.4. Minimize the effects of contaminants on the Schaus swallowtail butterfly.** Investigate the effects of contaminants around the old missile site on the refuge, the firing range at Harbor Course, and illegal dumpsites. Remove contaminants that pose a threat to the Schaus swallowtail butterfly.
- S2.5. Develop a captive propagation protocol for the Schaus swallowtail butterfly and implement as warranted.** Methods to breed and raise Schaus swallowtail butterflies in captivity have been established. Although several releases of captive bred butterflies have been conducted, the effects of these animals on wild Schaus swallowtail butterfly populations are still being examined. Develop captive propagation and release guidelines.
- S2.6.1. Develop criteria for captive propagation protocol.** Use the IUCN/SSC Guidelines for Reintroductions, if appropriate, as a basis for developing criteria that determine the type of release to be conducted, the selection of a release site, the source and health of release stock, short and long-term success indicators, and monitoring protocol.
- S2.6.2. Develop threshold criteria to act as a trigger for future captive propagations.** These criteria, based on a variety of biological factors (*e.g.*, population number, distribution, habitat), would be used to ensure that the Schaus swallowtail butterfly range and population status was sufficient to ensure that a catastrophic event, such as a hurricane, would not lead to the extinction of the species in the wild.
- S2.6.3. All future efforts to captively breed Schaus swallowtail butterflies should be conducted *in situ* in as natural conditions as possible.** Preferably, butterflies should be raised in enclosures in suitable habitat within the historic range. Captive propagation efforts closer to release sites are preferable for many species. This would limit transport time and possible difficulties in achieving a successful release.
- S2.6.4. Conduct appropriate health screenings of all release stock prior to reintroduction.** IUCN guidelines recommend individuals should not be removed from a wild population until the effects of translocation on the donor population have been assessed and after it is guaranteed that these effects are not negative. Ensure all captive stock are free of possible health problems.

- S2.5..5. Monitor introduced populations to determine survival, growth, and reproductive success.** Conduct additional demographic, ecological, and behavioral monitoring of wild and released butterflies. Investigate extent and causes of mortality of released and wild butterflies.
- S3. Conduct research on the biology and life history of the Schaus swallowtail butterfly.** Conduct additional studies on the reproductive success, productivity, longevity, population size, movements, and dispersal of wild populations of Schaus swallowtail butterfly, if needed.
- S3.1. Determine if the total population size is large enough to prevent functional extinction and genetic extinction.** Determine what is the effective population size necessary for survival. Conduct population modeling, (*e.g.*, spatially explicit models, PVA risk assessment) to predict the persistence of this species.
- S3.2. Determine the number of subpopulations necessary to maintain a stable or increasing population.**
- S3.3.1. Determine subpopulations vulnerable to extinction.** Determine which populations are the most critical for survival. Determine if populations on ecotonal areas or near human habitation are more vulnerable to extinction.
- S3.3.2. Determine the necessary number of subpopulations and level of exchange that will enable the Schaus swallowtail butterfly to persist for 100 years.**
- S3.3. Examine factors that affect the abundance and distribution of the Schaus swallowtail butterfly.** Although extensive studies have been undertaken on factors affecting this species' distribution and abundance, the results should be assessed to determine what additional aspects of this species' ecology affects abundance and density and makes it most vulnerable to extinction (*e.g.*, predation, lack of food, inability to find a mate). If this assessment identifies aspects of the Schaus life history and ecology in need of additional investigation, then those investigations should be initiated.
- S3.4. Evaluate the effect of releasing captive-bred butterflies into the wild the persistence of the Schaus swallowtail butterfly.** Determine if augmentation is effective in establishing stable populations throughout the Schaus swallowtail butterfly's range. Investigate if released butterflies are enhancing existing wild populations and the overall stability of the Schaus swallowtail butterfly in the long term. Continuation of existing monitoring programs is essential to assess the effectiveness of this recovery tool.
- S3.5. Investigate the effects of insecticides used for mosquito control on surrogate species closely related to the Schaus swallowtail.** This research is needed to evaluate the exact effects of these chemicals on butterflies in the Keys, and determine toxicity levels.
- S4. Monitor the status of the Schaus swallowtail butterfly and its habitat.** Monitor demographic, ecological, and behavioral studies of wild and released butterflies.
- S4.1. Monitor demographic parameters.** Monitor sex ratios, age class structure, survivorship, home range size, and dispersal distance of the Schaus swallowtail butterfly. Continue development of an adaptable model for biologists and managers to use to survey and monitor the Schaus swallowtail butterfly to help guide management efforts.

- S4.2. Continue long-term monitoring of the Schaus swallowtail butterfly.** Monitor presence/absence and degree of abundance every year until the Schaus swallowtail butterfly is recovered. Investigate extent and causes of mortality in released and wild populations.
- S5. Increase public awareness and stewardship.** Inform public, especially butterfly collectors about the butterfly, its protections under Federal law, and its importance as an integral part of the ecosystem. Have an incentive or reward system to encourage homeowners to plant native host plants and protect butterflies. Inform butterfly collectors on the importance of reducing the amount of illegal butterfly collecting or manipulation. Develop educational materials and host public workshops to increase awareness about butterflies and instill a sense of stewardship for the protection of this endangered species.
- S6. Establish reclassification criteria.** Develop measurable reclassification criteria based on factors that result in a stable or increasing population including total population size, number of subpopulations, sex ratio, age structure, habitat condition and availability, and level of threats. Evaluate and monitor the Schaus swallowtail butterfly's status in relation to reclassification criteria.

Habitat-level Recovery Actions

- H1. Prevent further loss or degradation of existing Schaus swallowtail butterfly habitat.** The primary threat to the Schaus swallowtail butterfly is habitat loss and fragmentation caused by increasing urbanization. Suitable habitat remaining for this species is estimated as 43 percent Biscayne NP and 17 percent for north Key Largo.
- H1.1. Acquire unprotected Schaus swallowtail butterfly habitat.** Identify priority areas for acquisition. The first priority is acquiring unprotected, suitable, occupied habitat, the second priority is suitable, or potentially restorable unoccupied habitat. Unoccupied, but suitable habitat is important for future reintroduction activities. Inholding areas are also high priority.
- H1.1.1. Continue Federal acquisition efforts.** Continue acquisition efforts within the Crocodile Lake NWR. The Crocodile Lake NWR is developing a priority acquisition and restoration list. Priority areas include land-fill, trailer park, cock-fighting ring, and military land.
- H1.1.2. Support State, local, and non-government organizations acquisition efforts.** Support entities to protect Schaus swallowtail butterfly habitat through the use of conservation easements, Florida Conservation's CARL and Recreational Land acquisition program, Monroe County Land Authority, Florida Community Trust, Florida Keys Land Trust, and The Nature Conservancy. Support the acquisition of lands to be incorporated into the Key Largo State Botanical Site.
- H1.2. Protect and manage Schaus swallowtail butterfly habitat.**
- H1.2.1. Protect butterflies on private lands.** Protect Schaus swallowtail butterfly populations on private land through acquisition, conservation easements or agreements, and education of landowners. Develop agreements (*e.g.*, Memorandum of Agreement) between the FWS and private landowners to minimize impacts of exotics, plant or animal species.

- H1.2.2. Protect butterflies on public lands.** Develop a habitat management plan that outlines priority habitat for acquisition and methods to protect, restore, and minimize impacts on butterflies and their habitat.
 - H1.2.3. Utilize Federal mechanisms to protect and prevent degradation of Schaus swallowtail butterfly habitat.** Coordinate with all Federal agencies to ensure Federal actions do not impact Schaus swallowtail butterfly habitat.
 - H1.2.4. Coordinate with State and Monroe County agencies and private entities to develop management actions to protect Schaus swallowtail butterfly habitat.** Coordinate with these entities to ensure proposed construction activities that result in land clearing or alteration do not impact the Schaus swallowtail butterfly and its habitat. Coordinate with the Audubon Society to develop a management plan for Parcel 22. Coordinate with the Trailer Park to protect and manage habitat and minimize impacts to the Schaus swallowtail butterfly.
 - H1.2.5. Avoid clearing or disturbing hammocks.** Prevent direct clearing of hardwood hammock. Direct new construction activities to areas already cleared or previously disturbed.
 - H1.2.6. Restrict access to Schaus swallowtail butterfly habitat.** Restrict access to remote habitat areas to prevent damage caused by campers, homesteaders, trash dumpers, and vehicular traffic.
 - H1.2.7. Establish and protect 500 m buffers around priority habitat.** The necessity for 500 m protection buffer zones is based on the likelihood that human influences encroach and impact the Schaus swallowtail butterfly.
 - H1.2.8. Prevent fires.** Wildfires can quickly destroy large areas of hardwood hammocks. Develop effective fire management plans. Prohibit fires and smoking in or near hardwood hammocks.
 - H1.2.9. Eliminate exotic vegetation.** Remove exotic vegetation in Schaus swallowtail butterfly habitat and in adjacent upland buffers. Use deed restrictions, covenants, or other means to minimize the likelihood that exotic plants will invade hardwood hammocks. Special consideration may be necessary for guava (*Psidium guajava*) which is listed by the State as one of Florida's most invasive exotic species, but has also been shown in recent studies to be a preferred nectar source for Schaus butterflies (R. Hammer, personal communication 1998). Eradication of this pest species by resource managers in Schaus habitat may adversely affect recovery of the butterfly.
- H2. Restore both suitable occupied and unoccupied Schaus swallowtail butterfly habitat.** Several areas are suitable for restoration. Restoration efforts will benefit the hammock habitat, existing butterfly populations, and future released populations. Conduct and support restoration activities in Schaus swallowtail butterfly habitat.
- H2.1. Restore Schaus swallowtail butterfly habitat.** Restore Crocodile Lake NWR habitat near the missile site, borrow pit, gun range, cock fighting ring, and radio tower. Support the restoration of habitat on State and county lands.

- H2.2. Improve habitat by planting or encouraging native plant species.** Plant native vegetation in areas that have been scarified or degraded. Restore habitat along ecotones by planting early successional vegetation along ecotonal areas to encourage use by the Schaus swallowtail butterfly.
- H2.3. Improve habitat by conducting selective trimming.** Manage habitat to provide open spaces to encourage courtship, mating, and foraging behaviors.
- H2.4. Remove exotic vegetation.** Remove exotic vegetation in refuge boundaries. Support the removal of exotics in other Schaus swallowtail butterfly habitat including Port Bougainvillea and Ocean Forest Tract (Ocean side of Harrison Tract).
- H2.5. Remove trash debris.** Several old roads into the Crocodile Lake NWR are littered with trash and debris. Remove trash and debris from these and other areas in Schaus swallowtail butterfly habitat.
- H3. Conduct research to determine habitat needs for the Schaus swallowtail butterfly.** Develop a spatially explicit or incidence function model (Hanski *et al.* 1996) to predict metapopulation dynamics and evaluate habitat patches important for the survival of the Schaus swallowtail butterfly.
- H3.1. Investigate how butterflies use different habitat components for survival.** (*e.g.*, food, shelter, nesting, traveling). Investigate habitat preferences and adaptations to local ecological conditions.
- H3.1.1. Determine minimum area requirements.** Determine optimum and suboptimal hammock size, character, and configuration for colony viability.
- H3.1.2. Identify host plants, their status and role in the hammock community, effects from natural factors, and how the Schaus swallowtail butterfly is dependent on them.** Previous work provides data on relative abundance of host plants and not quantitative data of density and distribution. Investigate the distribution, extent and status of host plants of Schaus swallowtail butterfly. Determine if Schaus swallowtail butterflies are facultative or obligatory users of host plants.
- H3.1.3. Determine the effects of forest canopy structure and light conditions on the Schaus swallowtail butterfly.** Investigate optimal amounts of diffuse and direct light. Determine if management regimes (*e.g.*, thinning, opening canopy layer) can benefit Schaus swallowtail butterfly populations.
- H3.1.4. Investigate the effect of habitat change.** Determine how the Schaus swallowtail butterfly's distribution and abundance is affected by habitat or microclimate modification and forest maturation.
- H3.2. Determine an index of habitat fragmentation.** Determine optimum landscape design for long-term survival of the Schaus swallowtail butterfly.
- H3.2.1. Investigate flight patterns and the spatial utilization of habitat to identify important core areas and corridors.**
- H3.2.2. Determine if the amount and configuration of habitat is sufficient to support a stable or increasing population of Schaus swallowtail butterflies.** Investigate the number and size of habitat patches, both

occupied and unoccupied as well as any barriers, and determine if habitat patches are interconnected or isolated. Investigate the capacity of habitat patch networks to support populations of Schaus swallowtail butterflies and determine if some fragmented habitats may be too isolated or small to allow for adequate recolonization. Determine rates of recolonization in different habitat patches. Determine the minimum number of habitat patches necessary for long-term survival of the Schaus swallowtail butterfly.

- H4. Monitor the status of Schaus swallowtail butterfly habitat and examine ecological processes.** Conduct yearly monitoring evaluations of the status of the Schaus swallowtail butterfly's habitat. Overlay habitat quality with GIS mapping of habitat locations, including habitat alteration and loss each year. Monitor the availability of Schaus swallowtail butterfly habitat through GIS by updating the loss or change of habitat due to residential or commercial construction.
- H4.1. Conduct long-term monitoring of habitat patches.** Determine the rate and sequence of vegetative composition in maturing or regenerating forests.
- H4.2. Monitor primary and edge forest habitat.** Determine how different habitat compositions affect the distribution and abundance of the Schaus swallowtail butterfly within primary forest and along edged habitat.
- H4.3. Monitor ongoing and proposed habitat restoration efforts.** Restoration efforts in north Key Largo include efforts to remove and eradicate exotic species, remove trash debris, recreate habitat in scarified or degraded areas, and open canopy layer. Monitor habitat response from restoration efforts and determine the response of Schaus swallowtail butterfly.
- H5. Increase public awareness of Schaus swallowtail butterfly habitat and instill stewardship.** Conduct workshops with the public to inform private landowners on appropriate management practices to preserve Schaus swallowtail butterfly habitat. Encourage private landowners to remove exotics, plant native vegetation, refrain from destroying butterfly habitat, and restore disturbed areas. Prepare literature to provide information regarding the Schaus swallowtail butterfly's habitat and ways to protect and conserve it.

