

SECOND PROGRESS REPORT

Submitted to:
US Fish & Wildlife Service
South Florida Ecosystem Office
Department of the Interior
1360 US Highway 1, Suite 5
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**DETERMINATION OF THE DISTRIBUTION OF THE SCHAUS' SWALLOWTAIL
THROUGHOUT ITS HISTORIC RANGE AND SUITABILITY OF ITS REMAINING HABITAT
FOR RECOVERY OF THE SPECIES**

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August 1, 1999

INTRODUCTION

The Schaus swallowtail is a subspecies of *Heracles* (= *Papilio*) *aristodemus* Esper, the dusky swallowtail of the greater Antilles (Smith et al, 1994). The Schaus swallowtail is commonly believed to be endemic to Florida. However, according to The Butterflies of the West Indies and South Florida published in 1994, the Schaus Swallowtail *Heracles* (= *Papilio*) *aristodemus ponceanus* Schaus (= *driophilus* Clench, TL: Cat Isl., Bahamas) is also present in the Bahamas on Cat, New Providence and Andros. The butterfly's habitat is tropical hardwood hammocks. Most adults remain close to their natal location, although some have been recorded as far as 3.5 miles away (Emmel 1995a,b). The adult lifespan is usually 3-4 days with a maximum recorded at 22 days. The flight season is usually in May but has been recorded as early as March 31 and as late as September 25. The Schaus swallowtail butterfly, *Heracles* (= *Papilio*) *aristodemus ponceanus*, has been listed federally as an endangered species since 1984.

The Schaus swallowtail butterfly, like many rare butterflies, is univoltine and is restricted to a few host-plants. However, the likely causes for the endangered status of the butterfly are habitat fragmentation and destruction and the use of pesticides. At the beginning of this century, the Schaus swallowtail was recorded in the hammocks of the Miami Rock Ridge to Lower Matecumbe Key. By 1984, the Schaus was only known to exist on three small keys in Biscayne National Park and on north Key Largo. In June 1992, a captive-breeding program was begun in the laboratories of Thomas Emmel of the University of Florida (Emmel 1995c). Since then, the butterfly has been reintroduced to Deering Estate (Emmel 1997) and other locations in the Florida Keys (Emmel 1995c). The most recently published data on its population size indicates no single colony with a population greater than 1,000 in any given year (Emmel 1995c, Emmel 1997).

Many butterflies and their host-plants are closely co-evolved (Futuyma 1976); particularly the Swallowtail butterflies tend to be restricted to a few families of host plants (Feeny 1987) and in any one site they often specialize on particular species (Thompson 1993). Such host specialization is likely to greatly limit the ability of an individual species of butterfly to colonize new patches of habitat. Oviposition on a suitable host-plant has important implications for butterflies, as they obtain most the resources needed for adult maintenance and reproduction during the period of larval feeding (Boggs 1981, 1990). Additionally, larvae are not particularly mobile and cannot readily move from the natal host-plant if the nutritional quality of the plant proves to be poor or if the foliage has been consumed. High distances between host-plants may result in larval mortality (Holdren and Ehrlich 1981). Host-plant choice by female butterflies may have pronounced effects on growth and survival of offspring (Scriber 1981, Nylin and Janz 1993, Stoyenoff et. al. 1994). Natal host-plant may alter life cycle transitions in addition to temperature and photoperiod (Wedell et al. 1997). For example, the risk of extinction of herbivorous moths is more affected by host-plant characteristics than by characteristics of the moths themselves (Niemens 1996).

The Schaus swallowtail's primary host-plants are thought to be torchwood, *Amyris elemifera* and wild lime, *Zanthoxylum fagara* (Stiling, 1987; Emmel, 1995a). Alternate host-plants proposed include: *Citrus aurantifolia*, Key lime; *Zanthoxylum flavum*, yellow wood; *Z. coriaceum* and *Z. clava-herculis*; *Amyris balsamifera* and *Ptelea trifoliata*, hop tree (Emmel,

1995a), although the natural distribution of the latter plant is outside the historic range of the butterfly. The Schaus is reported to use the new growth of torchwood preferentially in the Florida Keys (Emmel 1995b). However, torchwood is not present in the mainland reintroduction site, the Deering Estate, nor many of the hardwood hammocks of its historic range. However, this is not likely to have been the case for long. J.K. and G.K. Small made an herbarium specimen of an *Amyris elemifera* collected between Miami and Coconut Grove in 1913. In this same area, the Old Brickell Hammock, one individual is currently known from the hammock outside Vizcaya Park (personal observation, Linda McDonald personal communication). *Amyris elemifera* is also still on the species list for Simpson Park, a fragment of the Old Brickell Hammock near downtown Miami. Forests in the Miami area also contained *Amyris balsamifera*, a species that is even less common than torchwood (Avery 1969, Garber 1877). This leads to questions relating to the causes for torchwood's near disappearance from Dade County. One answer would be habitat destruction. Torchwood is found in coastal hammocks, virtually all of which have been destroyed in the last 100 years. The remaining coastal hammocks have been subjected to further disturbances. In the last 50 years, the historic water flow in Dade County has been altered resulting in the reduction of water available in forests. Once full solution holes are frequently dry. Additionally, exotic plants have invaded natural areas and have negatively impacted the recruitment and survival of native plants in all the remaining coastal hammocks in Dade County. The effect of such drastic reduction of both habitat and primary host plant in Dade County on the Schaus' swallowtail can not be quantified, as there were no pre-disturbance estimates of population size. The preferred microhabitat of the primary host plant must be determined in order for resource managers to make informed decisions concerning management of the remaining habitat of the Schaus' swallowtail in Dade and Monroe counties.

Insecticide usage is proposed to have a deleterious effect on populations not only of the Schaus swallowtail but other insects and the animals that feed on them (Emmel 1995c). Pesticide usage by Monroe County has historically included Dibrom, Baytex and Tecknar, all of which have a demonstrated potential to kill both larvae and adults of *Heraclides* (= *Papilio*) *aristodemus ponceanus* (Emmel 1995a, 1995b, 1995c). However, historic and current information on the location, frequency and identity of pesticides applied on a large scale in tropical hardwood hammocks in the historic range of the Schaus swallowtail has not been compiled.

ORIGINAL OBJECTIVES

The original goals of this project were to: (1) to determine the distribution of *Heraclides* (= *Papilio*) *aristodemus ponceanus* throughout its historic range; (2) to determine the habitat requirements of *H. a. ponceanus*; (3) to determine the suitability of the remaining hardwood hammocks in Southeast Florida for recovery of the species; (4) to obtain information on the population structure of the Schaus swallowtail; and (5) to provide specific recommendations to resource managers aimed at successfully managing the remaining habitat to maximize the success of the species in recolonizing its habitat.

PRELIMINARY REMARKS ON ALTERATION OF THE SCOPE OF WORK

The current progress report will focus on (a) changes in the scope of work since the original proposal, (b) progress to date on the revised scope of work and (c) summary of findings to date, for each section of the scope of work. Before turning to the details, we report that, after a year's work on this project, we find that some of the original objectives were not feasible for us to pursue. Instead, our main focus has been on locating patches of host plants throughout the historic range of the butterfly. The idea underlying this effort is that a minimal requirement for habitat suitability is the presence of host plants. Also our own background is very strong in plant-based ecological research and it became clear that this lab's best contribution to understanding the habitat of the butterfly would come from our focusing on the host plants of the butterfly.

Our protocol for observing butterflies during the flight season was drastically changed after close consultation with site managers, with USFWS personnel (Dawn Jennings) and in accord with the wishes Dr. Tom Emmel (the researcher with the long term MRR data on the Schaus). We restricted our activities to observational strip censuses for adults and censuses of new shoots of host plants for immatures. Site managers were reluctant to permit us for work that they perceived to be in conflict in any way with work of Dr. Tom Emmel, with whom they have a long-term relationship. To be sure to not be in any conflict, we agreed to not handle any butterflies and to not even visit particular habitat patches during the flight season; most significantly we agreed to not enter the state-owned side of North Key Largo, the North Key Largo Botanical Site. We also restricted our work in Biscayne National Park to Elliott Key, and there only after the MRR census by Dr. Emmel's team was complete (although we did overlap a few days with them). These restrictions meant that we spent most of the flight season outside the established, known population patches of the butterfly. Thus, even during the flight season, our observations tended to be host-plant based. Our strip censuses include observations of all swallowtail butterflies in flight throughout the likely peak flight season along transects and/or trails where host-plants were found. New shoots of host plants were systematically censused for immatures of all species of swallowtails throughout the potential flight season along transects and/or trails. These observations spanned a large proportion of the historic range of the butterfly, from the mainland to the middle Keys.

Our very cooperative attitude has been rewarded. We expect to work in areas with denser butterfly populations in 2000, based on current constructive relationships with Dr. Emmel and site managers. Dr. Emmel recently (phone conversation July 27, 1999) expressed his full agreement with us conducting strip censuses in patches of habitats where he will conduct MRR in 2000. Thus, we expect to have many more observations of Schaus Swallowtail butterflies 2000.

A pre-requisite to all the work was obtaining appropriate permits. Thus we begin our report with a summary of the permits applied for and obtained to date.

PERMITS

To our knowledge, this is the first attempt to examine the habitat of the butterfly throughout its historic range. One benefit of taking this broad a view is to provide resource managers with data about how the habitat may vary over a larger scale than a single-area study. However, this broad view necessitates a study which spans nearly 60 miles, and involves interaction with four different federal, state, county and municipal agencies. Below, find a table summarizing our permit application history to date:

Agency	Applied	Permit Received
USFW	Yes	Yes
Biscayne National Park	Yes	Yes
Crocodile Lake National Wildlife Refuge	Yes	Yes
Natural Areas Management (Miami-Dade County)	Yes	Yes
Florida DEP	Yes	Yes

At this time, we have all permits we require to complete the work we have scheduled through December 1999. We will apply for renewals in November 1999.

PROPOSED AND REVISED SCOPE OF WORK: PROGRESS ON TASKS AND FINDINGS TO DATE

GEOGRAPHIC INFORMATION/HOST-PLANT POPULATIONS

Proposed

- Determination of the location and size of hammocks in the historic range of the Schaus Swallowtail
- Visits to sites to determine presence of host-plants
- Detailed studies of host-plant presence, density and location, distance between plants, and distance to nectar sources
- Creation of a GIS layer of patch locations and habitat suitability.

Revision, progress on tasks and findings to date

- The preliminary list of 48 hammock locations in both Dade and Monroe County submitted with the March 1, 1999 report has been revised. Only coastal hammocks have been retained, and more sites have been added for Monroe County. The list now contains 32 sites. This list is still preliminary, but will be updated as information on privately and publicly held lands in Monroe County is obtained. (Appendix 1).

- b) To date, fourteen site visits have been completed. A site visit consists of walking the available trails, or running a transect where necessary, to observe the presence of host plants.
- c) Detailed studies include mapping plants in particular plots and/or transects at some of the study sites. Two pilot studies took place before the flight season and the main study took place during the flight season, at which time we also closely monitored shoot production and butterfly usage of plants and habitat

First pilot study -- In the first pilot study, as many *Rutaceous* plants as could be located in the Charles Deering Estate were mapped with a GPS unit. Approximately 90 host-plants were mapped. Data collected included reproductive status of the plant, size class of the plant, and butterfly use, identity and life history stage. Preliminary data strongly suggest that the majority of the *Zanthoxylum fagara* at the Deering Estate are relatively small (< 5 cm diameter at breast height). A small population of larger trees is located in the area known as the shell midden, which has a more open canopy than other areas of the hammock. *Z. fagara* tends to be found in areas that are more open such as edges and gaps; this apparent habitat preference has yet to be quantitatively investigated. *Amyris elemifera* is not present in the Deering Estate. The majority of populations of the host plants were located with the assistance of Jack Stewart, the exotic-removal-crew chief for Natural Areas Management at the Deering Estate. One result from this pilot study is that following such a protocol throughout the historic range of the butterfly is not logistically feasible. Thus, in the second year of the project, instead of attempting to map all individual plants at each site, we plan to map a sample of patches of plants at each site. We will run transects through each target site and then map the center of each patch with the GPS unit. This should still provide resource managers with the information that they need and allow us to examine a larger proportion of the habitat of the butterfly.

Second pilot study -- In the second pilot study, the locations along a transect in the CLNWR of the two host plants, *Amyris elemifera* and *Zanthoxylum fagara*, were examined to assay techniques for determination of habitat characteristics. It is our working hypothesis that in the sites where the two most common host plants co-occur, the species have different patterns of distribution. In an Ecological Site Classification by Ross et al. (1992) torchwood was characteristic of upland forest vegetation, or ESU 12, found primarily in the upper to middle keys. In an ordination study of successional age of hammock patches with tree species Ross et al. (1998) found that torchwood was characteristic of slightly older hammock (78.3 years) than wild lime (60 years). Our hypothesis is that *Amyris elemifera* is more commonly located in more closed canopy while *Zanthoxylum fagara* is likely to be found in more open habitat. We laid a transect running from the road toward the mangrove fringe for 100 meters. All specimens of both species were mapped. A total of 77 individuals were mapped, with all but two being *Amyris elemifera*. The elevation at each point was recorded from a Stanley Compulevel. The light environment at each point was recorded with a fish-eye lens and analyzed at the lab. Several observations were made from the data collected. Clusters of torchwood seedlings were found in small pockets in the limestone and soil. The terrain, which appeared very flat, sloped down from the crown of the road by 1.25 meters over the course of the transect, which was only 100 m in length. Nearest neighbor distances

were calculated and examined for deviations from expected distances to determine if the individuals were clumped (Krebs 1989, pg. 126). The individuals averaged 1.2 m distance between individuals, and exhibited a strong tendency toward clumping.

This pilot study helped us select field techniques that will allow us to examine the question of species distribution patterns in greater detail. These questions are being investigated by Annemarie Jameson, the graduate research assistant, as the main focus of her master's thesis research. She is investigating the hypothesis that the two host plants are differentially distributed according to a suite of abiotic variables: successional age, rainfall gradient, edaphic characteristics, and microtopography. There are three components to the study. The first component is an examination of the germination rates of torchwood and wild lime under controlled conditions, including two light environments, two microtopographies, and two substrate types, Key Largo or Miami Oolitic limestone. The second phase of the project involves delineating the scales at which each species is segregated and aggregated, and an investigation to determine if the two species are negatively or positively associated. The third, and final component, involves creating a multivariate picture of the environment in which the two species occur.

The results of this research should help resolve questions about the microhabitat of each host plant species, which can be used by resource managers in three ways. First, the microhabitat preference of the host plants can be used when searching for patches of torchwood and wild lime. Secondly, greater understanding of the microhabitats of the two larval host food species will assist managers in decisions to augment natural populations of the plants. Thirdly, a greater understanding of the factors influencing the distribution of the larval host plants can then be used to understand the habitat requirements of the Schaus' swallowtail that depends on them for both sustenance and habitat structure.

Main study during the flight season – During the 1999 flight season (3 May- 13 July), host plants were located and repeatedly censused along trails and/or transects in hammocks throughout the historic range of the butterfly in Florida, from the mainland (Matheson Hammock, the Deering Estate and Bill Sadowski Park), to the upper Keys (Elliott Key in BNP, North Key Largo) and the middle Keys (Windley Key and Long Key). Our work in 1999 was largely restricted to habitat patches that have recently not been occupied by Schaus swallowtail butterflies, but that were near to occupied sites. The two notable exceptions were Elliott Key and the Deering Estate, with Elliott Key having an order of magnitude denser population of butterflies than the Deering Estate (T. Emmel, personal communication). In the unoccupied patches, our goal was to detect Schaus colonists from nearby occupied patches. In occupied patches, our goal was to detect the presence of Schaus with the strip census method, and if possible calibrate in relation to the MRR. On our first visit to each site, we noted the locations of plants so we could return to them for repeated censuses. At Matheson, Deering, and Bill Sadowski Park, we located plants throughout the Parks near trails. An extensive search at the Charles Deering Estate resulted in the location of over 100 plants, both on and off trails. Three 300-m transects were laid out in the hammock on Elliott Key, BNP. Three 300-m transects were laid out in hammock areas of Crocodile Lakes National Wildlife, one each at power poles 94, 184, and 244. We also censused wild limes that had been planted as a habitat restoration project (personal communication, S. Klett) in five

disturbed sites (known as the Cock-fighting Arena, the Nike Missile Site, the Harrison Tract, the Keystone Tract and Port Bougainville) in Crocodile Lakes National Wildlife Refuge. At Windley and Long Key State Parks, we located plants near the trails of the hammock areas. It took 37 field days to accomplish these censuses. Most field days lasted about 10 hours (including travel to sites and logistics) for a two-person team. The PI, RA and an undergraduate research intern (Lisa Davis) did the bulk of the work, but volunteers also participated, which provided the opportunity for us to cover more days and sites; so that a total of about 850 person hours were invested in the census.

During the strip censuses, we collected three kinds of data: data to assay the production of new shoots per branch, data to assay the number of immature stages (eggs and larvae) of swallowtail butterflies (only those that feed on wild lime and torchwood) per shoot, and data on the number of sightings of adult swallowtail butterflies during our walks of particular transects/trails over known periods of time. We recorded immatures of both the Giant Swallowtail and the Schaus Swallowtail; we recorded adults of the Giant, the Schaus, the Palamedes and the Gold Rim Swallowtails. The two latter species use different host plants that were not part of our study. We would have recorded the Bahamian Swallowtail immatures or adults, but we did not see any of them. Additionally, we kept records of the sizes and approximate locations of host plants and their reproductive status. These data have been entered into two databases: one for the shoots and immatures and another for the adult butterflies. Data entry is complete and error-checking protocols have been run on the immatures database. The data analysis is not complete, but we can report some summary statistics here very briefly.

New shoot production may be significant, because new shoots comprise the resource for oviposition by females. Any phenological constraints on new shoot production would have a direct constraint on the Schaus, with its extremely short adult life span and its extremely sensitive annual emergence date. To assay the production of new shoots, we chose 3 branches per individual at each census and, along a 50-cm length, of each branch we counted the number of new shoots. A shoot is defined as a set of leaves emerging together from the same point, where new leaves are distinguishable by usually a much lighter color and definitely a softer, more tender texture than the fully-expanded older leaves. Some plants did not have 3 accessible branches, and we had to count fewer branches. For each plant at each date, we obtained a mean number of shoots per branch for that plant, and then we analyzed that data. Thus, there was one observation of shoot production per plant per date. The two host plants differed in shoot production, with a mean $\pm$ SE of 1.4 ± 0.08 shoots per branch for torchwood ($N = 415$ observations) and 2.68 ± 0.10 shoots per branch of wild lime ($N = 916$ observations). We will analyze these data for phenological differences, investigating the hypothesis that the timing of new shoot production of the two plant species differs.

The assay of the number of immature stages (eggs and larvae) of swallowtail butterflies per shoot provides some information on immature biology. For this data, we not only searched the shoots counted above for eggs and larvae, but we also searched many additional new shoots per plant to increase our sampling effort. When we counted larvae, we also noted the instar. In this case the interesting number of observations is the total number of shoots observed. We observed 2,244 shoots of torchwood and 10,828 shoots of wild lime.

For this massive number of new shoots observed, our rewards were modest. We observed a total of 71 eggs and 41 larvae of the Giant Swallowtail and only 1 egg and 10 larvae of the Schaus Swallowtail. All the Schaus immatures were seen on one species of host plant at one site; they were all on torchwood at Elliott Key. Further, they were all from a single transect on Elliott Key, near Petrel Point. How many shoots did we observe at this transect? At this transect, on Elliott Key, we observed 476 shoots (all torchwood); the ratio of 11/476 immatures: shoots more informative probably than the ratio of 11/2,244 immatures to shoots, as the latter includes observations from many unoccupied patches. Additional analyses of data on immatures will focus more on Giant Swallowtails (as part of the senior thesis of the undergraduate research intern). We hope to have an opportunity to relate our data on immatures to MRR data on adults (Emmel) from the same site, if possible. This will be more meaningful in 2000, when we will be able to do a strip census in many sites occupied by butterflies.

The number of sightings of adult swallowtail butterflies during our walks of particular transects/trails over known periods of time may have potential for future assays of population densities, at least as a rough estimate. The strip census technique is much easier to learn and perform than the intensive MRR techniques, and it may be one that site managers could employ in future estimates. The total numbers of adult swallowtail sightings that we recorded were 159, 8, 19, and 58, for the Giant, the Schaus, the Palamedes and the Gold Rim, respectively. All 8 sightings of the Schaus were on Elliott Key, 4 on Jun 2, 3 on Jun 9 and 1 on Jun 15, all dates past the peak date this year (T. Emmel and P. Elazar, personal communication). We did not work on Elliott Key earlier in the season, to respect this year's agreement. The strip census technique did not reveal the presence of Schaus at the Deering Estate. At the Deering Estate, the strip census did give reasonable numbers of sightings for the Giant, the Palamedes and the Gold Rim, with 93, 19 and 57 sightings, respectively. The density of Schaus at Deering is an order of magnitude lower than it is at Elliott (T. Emmel, personal communication). The strip census technique appears to be most useful in higher density populations. We hope to have an opportunity to relate our data on adults to MRR data on adults from the same sites, if possible. This will be more meaningful in 2000, when we will be able to do a strip census in many sites occupied by butterflies.

d) GIS layers of hardwood hammock locations have been obtained for Dade County, courtesy of the Environmentally Endangered Land Programs, Goodlife Nmekini of the Department of Environmental Resources Management, the Department of Parks and Recreation, Britt Keith of the University of Miami, Dr. Mike Ross of Florida International University, and Dr. Phil Frank of USFW.

Tasks to be completed:

Mapping large numbers of host-plants in a closed canopy setting is not feasible for future fieldwork. We have decided to modify our sampling protocol. Sites are now grouped into two classes, sites that are currently occupied by or in close proximity to populations of the Schaus Swallowtail and those that are in the rest of the butterfly's historic range. Sites in the latter category will be visited throughout the course of the next year to determine the

presence or absence of host plants, and to identify and map patches of host plants if feasible. Sites in the former category will be subjected to a more intensive sampling protocol. We expect to work in areas with denser butterfly populations in 2000, based on current constructive relationships with Dr. Emmel and site managers. Thus, we expect to have more observations of Schaus Swallowtail butterflies 2000

- a) The list of sites will be refined as additional information on both privately and publicly held lands becomes available.
- b) The remaining sites will be visited over the course of the coming year.
- c) Eight 100-300 meter transects through 60+ year old hammock in North Key Largo State Botanical Site is planned for August-October, 1999. At least an additional four 100-300 meter transects will be placed in Crocodile Lakes National Wildlife Refuge.
- d) Further coverages will be obtained from Monroe County officials to create a comprehensive layer of the publicly owned habitat patches. During the course of the coming year, layers of habitat characteristics will be compiled, resulting in a searchable database.

HOST-PLANT USAGE

Proposed

- a) Where appropriate, we will conduct comparative studies of oviposition preference and larval development on different host plants (during the flight season)
- b) Observation of oviposition on host-plants in the field (during the flight season).

First modification of plan as of March report

In the March report, we proposed feeding trials of larvae of the Schaus Swallowtail on the two main host plants with the idea of obtaining them from the captive-breeding program run by Dr. Thomas Emmel at the University of Florida.

Revision, progress on tasks and findings to date

a+b) This study could not be conducted. We learned that such a study has already been carried out (T. Emmel, personal communication). Thus, it did not seem wise to request larvae from Dr. Emmel to repeat a feeding trial study that he had already done. It would not have been appropriate to collect eggs from the wild for this study due to the low population sizes of wild butterflies.

b) Our observations of eggs and larvae on host plants during the flight season were summarized above (*Main study during the flight season*). Since we were rarely in sites with high densities of butterflies (due to the restrictions described in the opening paragraphs), we were not able to make observations about oviposition (an event that is only rarely observed even in a dense population).

Tasks to be completed

- a) None.
- b) Observations of host use as demonstrated by presence of eggs and larvae will be continued during the 2000 flight season. We expect to work in areas with denser butterfly populations in 2000, based on current constructive relationships with Dr. Emmel and site managers. Thus, we expect to have more observations of eggs and larvae in 2000, although our hopes for observing oviposition events will remain low.

PESTICIDE USAGE

Proposed

- a) Data on the historic and current use of pesticides will be compiled into a GIS layer.

Revision, progress on tasks and findings to date

- a) No progress yet.

Tasks to be completed

- a) This data is scheduled to be gathered after a final list of habitat patches is compiled.

SURVEY

Proposed in March Report

- a) Censuses of previously unoccupied patches in close proximity to occupied patches were proposed. Specifically, Bill Sadowski Preserve, Matheson Hammock and R. Hardy Matheson Preserves, Lignum Vitae State Botanical Site, the Deering Estate South Addition (EEL), and Round Hammock (EEL).

Revision, progress on tasks and findings to date

- a) A list of census locations was selected both in proximity to and within occupied patches after consultation with Dr. Thomas Emmel. We agreed to census (listed north to south): Matheson Hammock Park, the Charles Deering Estate, Bill Sadowski Park, Sands and Elliot Key-BNP, Angelfish Key-Florida State Parks, Crocodile Lakes National Wildlife Refuge, North Key Largo State Botanical Site, Windley Key State Geological Site, and Long Key State Recreation Area. Due to difficulties obtaining access to Sands and Angelfish Keys, these sites were dropped from the surveys. The main results from these censuses were summarized above (*Main study during the flight season*).

Tasks to be completed

- a) A similar survey will be conducted from April 15-July 15, 2000, but we expect to be able to work in more patches of habitat that are occupied by butterflies, especially at North Key Largo State Botanical Site. We expect to work in areas with denser butterfly populations in 2000, based on current constructive relationships with Dr. Emmel and site managers. Thus, we expect to have more observations of Schaus Swallowtail butterflies 2000

MARK-RELEASE-RECAPTURE(MRR):

Proposed:

- a) A combined transect/MRR study will be conducted in as many reference sites as could located in the first two-weeks of the flight season.

Revision, progress on tasks and findings to date

From March report:

- a) A MRR study will be conducted in cooperation with Dr. Thomas Emmel of the University of Florida to ensure comparability of the data collected and to prevent overlap in field efforts. At the present time, we anticipate conducting studies in the Deering Estate and in Crocodile Lake National Wildlife Refuge.

Tasks to be completed

- a) We have abandoned this portion of the study so as not to duplicate or interfere with an ongoing study conducted by Dr. Thomas Emmel of the University of Florida.

INDIVIDUAL MONITORING

Proposed

- a) At least five individuals from each major site will be followed through the course of a day.

Revision, progress on tasks and findings to date

- a) This portion of the study has been abandoned in favor of the strip census technique.

Tasks to be completed

- a) None.

ACKNOWLEDGEMENTS

We would like to thank the many people who have facilitated this research and generously shared their time, insights, knowledge, data and/or GIS layers: Bob Kelley, Lisa

Davis, Gwladys Scott, Walter Gould, Chuck Hubbuch, Bill Perry, Sue Perry, Mary Rose, Paul Neal, Donna Rich, Sonya Thompson, Shannon Forney, and Rachel Beck-King for field assistance; Don Harvey, David Smith, Craig Johnson, Alice Warren, Roger Hammer, Linda McDonald, Jack Stewart, Dallas Hazelton, Sandra Vardamon, Goodlife Nmekini, Carlos Mateo, the Maintenance Crew for Biscayne National Park, Jim Duquesnel, Stewart Schultz, Britt Keith, Brad Bennett, Mike Ross, Phil Frank, Steve Klett, Keith Bradley, the Dade County Chapter of the Florida Native Plant Society and The Florida Native Plant Society for sharing advice, data and logistics assistance.

REFERENCES

- Avery, G.N. (January 22, 1969) *Amyris baslamifera* L. Matheson Hammock Park, Dade County Florida. Collection no. 592. University of South Florida Herbarium.
- Boggs, C.L. (1981) Nutritional and life-history determinants of resource allocation in holometabolous insects. *American Naturalist* 117: 692-709.
- Boggs, C.L. (1990) A general model of the role of male-donated nutrients in female insect's reproduction. *American Naturalist* 136: 598-617.
- Emmel, T.C. (1995a) Habitat requirements and status of the endemic Schaus swallowtail in the Florida Keys. Florida Game and Fresh Water Fish Commission. Nongame Wildlife Program Project Report. 318 pp +xiv. Tallahassee, Florida.
- Emmel, T.C. (1995b) Status survey and habitat requirements of Florida's endemic Schaus swallowtail butterfly. Florida Game and Fresh Water Fish Commission. Nongame Wildlife Program Project Report. 177pp + vi.
- Emmel, T.C. (1995c) Status monitoring of the Schaus swallowtail, *Papilio aristodemus ponceanus*, and experimental reintroduction. Florida Game and Fresh Water Fish Commission. Nongame Wildlife Program Project Report. 24pp + viii. Tallahassee, Florida.
- Emmel, T.E. (1997) Captive propagation and experimental reintroduction of Florida's Schaus Swallowtail. U.S. Fish and Wildlife Service Report. 12pp. Vero Beach, Florida.
- Feeny, P.P. (1987) The roles of plant chemistry in associations between swallowtail butterflies and their host plants. In V. Laeyrie, G. Fabres, and D. Lachaise (Eds.). *Insects-Plants*. W. Junk Publishers, Dordrecht, The Netherlands, Pages 353-359.
- Futuyma, D.J. (1976) Food plant specialization and environmental predictability in Lepidoptera. *Am. Nat.* 110: 285-292.
- Garber, A.P. (May-June 1877) *Amyris balsamifera* L. Miami, Florida. USNH no. 15308. Smithsonian Institution, Washington, D.C.
- Holdren, C.E. and Ehrlich, P.R. (1981) Long range dispersal in the checkerspot butterflies: transplant experiments with *Euphydryas gillettii*. *Oecologia* 50: 125-129.
- Krebs, C.J. (1989) *Ecological Methodology*. Harper & Row, New York.
- Neimans, M. (1996) Risk of population extinction in moths: effect of host-plant characteristics. *Oikos* 76: 475-484.
- Nylin, S. and Janz, N. (1993). Oviposition preference and larval performance in *Polygonia c-album* (Lepidoptera: Nymphalidae): the choice between bad and worse. *Ecol. Entomol.* 18: 394-398.
- Ross, M.S., J.J. O'Brien, and L.J. Flynn. (1992) Ecological Site Classification of the Florida Keys Terrestrial Habitats. *Biotropica* 24(4): 488-502.

- Ross, M.S., G. Telesnicki, P.L. Ruiz, and L.J. Flynn. 1998. Hurricane Andrew and Upland Forest Succession in Biscayne National Park. Report to the US National Park Service.
- Scriber, J.M. (1981) Sequential diets, metabolic costs and growth of *Spodoptera eridania* feeding on dill, lima bean, cabbage. *Oecologia* 51: 175-180.
- Small, J.K. and G.K. Small. (Nov. 26-Dec 20, 1913) *Amyris elemifera* L. Dade County Florida. Collection no. 4657. USNH no. 1737830. Smithsonian Institution, Washington, D.C.
- Smith, D.S., L.D. Miller, and J.Y. Miller. 1994. The Butterflies of the West Indies and South Florida. Oxford University Press, New York. 264 pages.
- Stiling, P. (1987) Delicate Balance: Schaus Swallowtail (*Heraclides aristodemus ponceanus*). *Florida Wildlife* 41: 9.
- Stoyenoff, J.L., Witter, J.A., and Montgomery, M.E.(1994) Gypsy moth (Lepidoptera: Lymantriidae) performance in relation to egg hatch and feeding initiation times. *Env. Entomol.* 23: 1450-1458
- Thompson, J. N. 1993. Preference hierarchies and the origin of geographic specialization in host use in swallowtail butterflies. *Evolution* 47: 1585-1594.
- Wedell, N. Soren, N., and Janz, N. (1997) Effects of larval host-plant and sex on the propensity to enter diapause in the comma butterfly. *Oikos*: 78: 569-575.

List of Hammocks in Dade and Monroe Counties

Name	Address	Agency
ANGELFISH KEY	CROCODILE LAKE NATIONAL WILDLIFE REFUGE	FL
BAHIA HONDA	MIDDLE KEYS	FL
BARNACLE ADDITION	3463 MAIN	PRIVATE/EEL
BNP-ADAMS KEY	BISCAYNE NATIONAL PARK	NPS
BNP-SANDS KEY	BISCAYNE NATIONAL PARK	NPS
BNP-SWAN KEY	BISCAYNE NATIONAL PARK	NPS
BNP-TOTTEN KEY	BISCAYNE NATIONAL PARK	NPS
CAPE FLORIDA	KEY BISCAYNE	FL
CRANDON PARK	4000 CRANDON BOULEVARD	NAM
CURRY HAMMOCK	MIDDLE KEYS	FL
INDIAN KEY	MIDDLE KEYS	FL
JOHN PENNECAMP	UPPER KEYS	FL
LIGNUM VITAE STATE BOTANICAL SITE	MIDDLE KEYS	FL
LOWER MATECUMBE KEY	MIDDLE KEYS	(FL)
THE BARNACLE	3485 MAIN HIGHWAY	FL
TORCHWOOD HAMMOCK PRESERVE	MM 28.5, LITTLE TORCH KEY	NAT-CON
TROPICAL CRANE POINT HAMMOCK	MM 50.5, 5550 OVERSEAS HIGHWAY, MARATHON	PRIVATE
UPPER MATECUMBE KEY	MIDDLE KEYS	
VIRGINIA KEY	3701 RICKENBACKER CAUSEWAY	NAM
VIZCAYA HAMMOCK ADDITION	3333 S MIAMI	PRIVATE/EEL
BILL SADOWSKI PRESERVE	17555 SW 79 AVENUE	NAM
BNP-ELLIOT KEY	BISCAYNE NATIONAL PARK	NPS
CHARLES DEERING ESTATE	16701 SW 72 AVE.	NAM
CROCODILE LAKE NATIONAL WILDLIFE REFUGE	NORTH KEY LARGO	USFW
LONG KEY	MIDDLE KEYS	FL
MATHESON HAMMOCK PARK	9610 OLD CUTLER ROAD	NAM
NORTH KEY LARGO STATE BOTANICAL SITE	KEY LARGO	FL
OLD RHODES	BISCAYNE NATIONAL PARK	NPS
R. HARDY MATHESON PRESERVE	11191 SNAPPER CREEK ROAD	NAM
SIMPSON PARK	55 SW 17 RD	COM
VIZCAYA MUSEUM & GARDENS	3251 S. MIAMI AVENUE	NAM
WINDLEY KEY STATE GEOLOGICAL SITE	WINDLEY KEY	STATE

Total of Surveys Conducted Per Site
1999 Flight Season

Site	Deering	Matheson	Sadowski	Crocodile	Long Key	Windley Key	Elliot Key, BNP
Date May	3	16	3	4	4	7	30
	11*	24	18*	10	27	29*	
	18*		24	12	29		
	24*			13			
	25			14			
				15			
				17			
				22			
				23			
				31			
June	3*	3*	5	1	6	6	2
	5	12	12	7	16	17*	8*
	12			8			9
	13			14			15
							21
July	5						7
							13
Total	10	4	5	14	5	5	8

Grand Total of Surveys 51

* = three people in the field, all other days two people per day

Hours Spent in the Field	May	June	July	Totals
Days with Two	20	14	3	
Days with Three	4	3	0	
Personnel Days/Month	44	35	6	85
x 10 Hours per Day	440	350	30	850