



HABITAT SUITABILITY FOR AN ENDANGERED BUTTERFLY, BARTRAM'S SCRUB HAIRSTREAK, AND IMPLICATIONS FOR MANAGEMENT

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INTRODUCTION

Bartram's Scrub Hairstreak, *Strymon acis bartrami*, (Bartram's) is a small but strikingly beautiful butterfly (Figure 1) that lives exclusively in the pine rocklands of Miami-Dade and Monroe Counties. It is closely associated with its caterpillar food plant, pineland croton (*Croton linearis*), and rarely seen more than 5 meters from the plant.

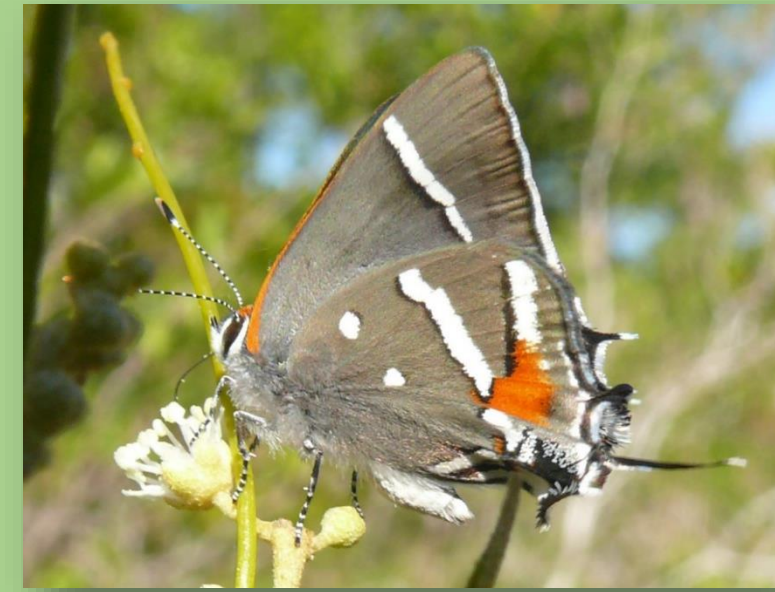


Figure 1. The endangered Bartram's Scrub Hairstreak nectaring on pineland croton, its caterpillar food plant.

With less than 2% of pine rocklands remaining today, Bartram's populations, as well as other species that live in that ecosystem, have been declining. The pine rocklands is a fire-dependent ecosystem that relies on periodic prescribed burns to prevent succession to rockland hammock.

Bartram's was listed as a federally endangered species by the U. S. Fish and Wildlife Service (USFWS) on September 11, 2014. With this new designation, resource managers must consider their prescribed burning regime. If not implemented properly, these imperiled species could be negatively impacted.

STUDY OBJECTIVES

1. Determine what patch-scale factors affect the suitability of habitat for Bartram's populations.
2. Determine what landscape-scale factors affect the suitability of habitat for Bartram's populations.
3. Determine if the current pine rocklands management affects habitat suitability for Bartram's populations and how the landscape can be managed to facilitate Bartram's colonization.

STUDY SITE SELECTION

The Richmond Complex in North Miami and Navy Wells in Florida City are the largest areas of pine rocklands outside of Everglades National Park. A total of 40 plots will be selected with 20 at each site. To determine the ratio of herbaceous to shrub vegetation, high resolution Digital Orthophoto Quarter-Quadrangles (DOQQs) and LiDAR data will be fused and segmented in eCognition. In ArcMap, a supervised classification will be conducted to classify areas as bare ground, herbaceous vegetation, shrubby vegetation and canopy. Once classified, percent cover for each management unit will be calculated. Sites will be selected based on ratio of herbaceous to shrub vegetation, croton abundance and presence of Bartram's (see Preliminary Data Collection below).

In early 2013, Fairchild Tropical Gardens conducted a study, funded by the U. S. Fish & Wildlife Service, to assess and map croton distributions in the pine rocklands of Miami-Dade County (Maschinski, Hodges, Magnaghi, & Possley, 2013). Their study focused on edges, using mostly fire breaks and paths to collect the data. To supplement their data, I collected data along interior transects throughout the properties at both Navy Wells and the Richmond Complex (Zoo Miami, Larry and Penny Thompson Park and Martinez Pinelands). I followed Fairchild's data collection methodologies where transects were walked. When a croton was encountered, a 2.5 meter radius was surveyed. Using a Garmin eTrex® 20 GPS unit, the number of individuals was counted and mapped. In Figure 2, each yellow point represents from one to a cluster of plants within a 5 meter diameter area. When Bartram's were encountered, they were also mapped and are indicated by the green stars. These data will be used in conjunction with the fused ortho-imagery and LiDAR data to select the study plots.

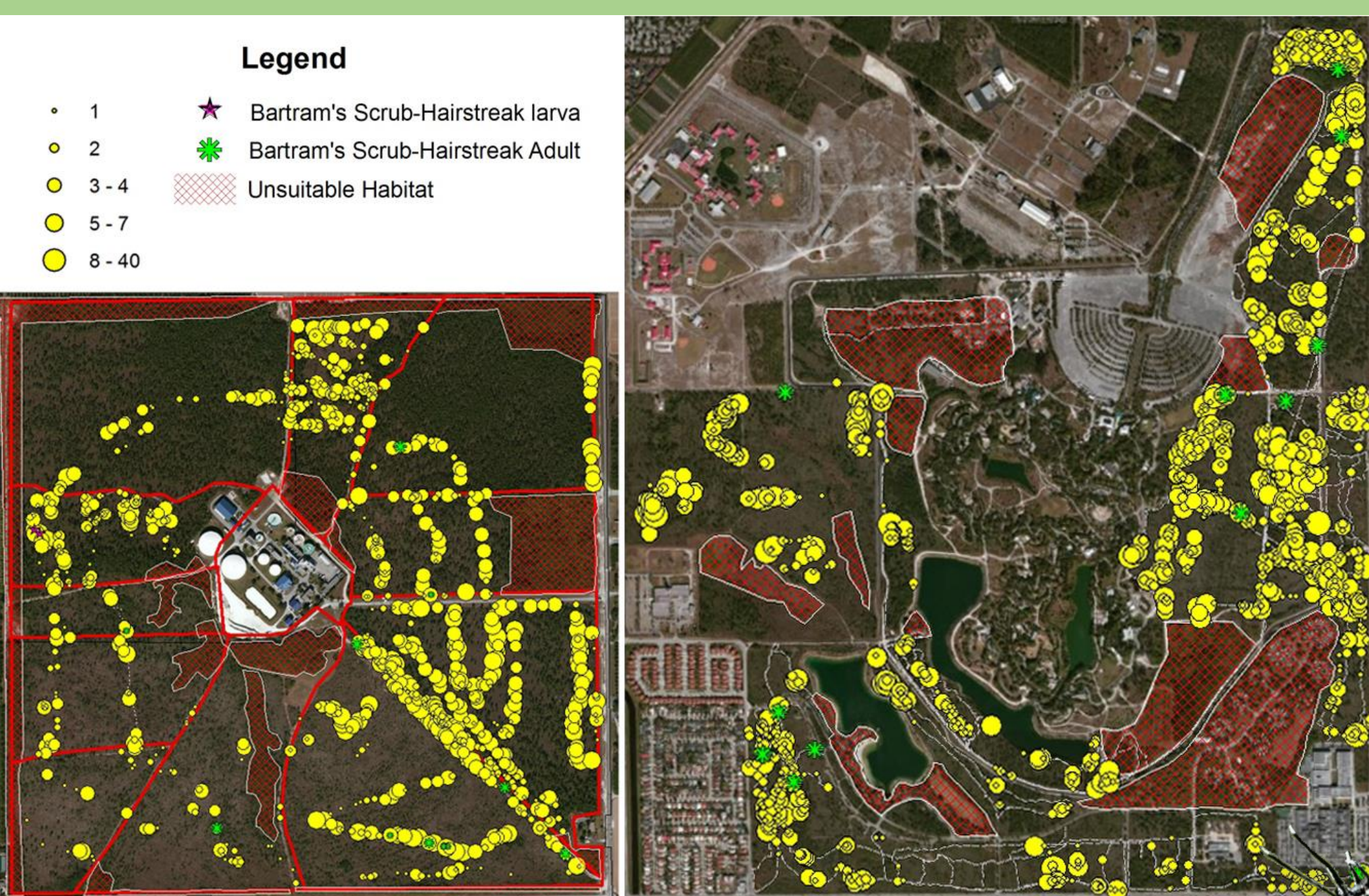


Figure 2. Croton distributions at Navy Wells (left) and The Richmond Complex (right).

Table 1. Parameters for Assessing Patch-Scale Habitat Suitability for Bartram's.

UNIT	Interior				Edges				Ratio of interior to edge	Years since burn	# of burns since 1985	Average Elevation
	# of Croton	Total area (Square meters)	Croton Density per sq. meter	# of Croton	Total area Covered (Square meters)	Croton Density per sq. meter	Ratio of interior to edge					
1	312	8052	0.03875	42	3694	0.02112	0.54496	15.74	1	6.99		
2	48	1555	0.03087	137	5645	0.01789	0.57961	13.40	1	6.93		
3	151	3348	0.04510	43	2982	0.05433	1.20467	5.24	1	6.97		
4	1153	8452	0.09098	241	7236	0.01686	0.18532	0.52	3	6.61		
5	422	8935	0.04723	272	5400	0.05037	1.06649	5.24	4	6.66		
6	51	7304	0.00698	8	2813	0.00284	0.40726	0.44	3	6.57		
7	36	5871	0.00613	1	1496	0.00067	0.10904	30+	0	7.06		
8	148	6132	0.02413	3	1496	0.00201	0.08311	5.25	1	7.22		
9	246	4831	0.03746	not surveyed		N/A	N/A	6.73	1	data not available		
10	90	5870	0.01533	9	1599	0.00563	0.36705	6.73	1	data not available		

PRELIMINARY OBSERVATIONS & RESULTS



Figure 3. Bartram's caterpillar skeletonizing leaves of croton.

❖ Previous research suggests that croton resprouts 1-3 months after fire, but seems undesirable to Bartram's up to 5-8 months post-burn (Lenczewski, 1980; Hennessey & Habeck, 1991; Salvato & Hennessey, 2004). However, if suitable habitat exists nearby with Bartram's populations, it would seem likely that they could colonize the newly burned area as soon as Croton re-sprouts. On Jan. 10, 2015, a caterpillar was found feeding on Croton in an area that had been burned on Oct. 27, 2014.

❖ Previous research suggests that croton densities are highest near edges (Worth, Schwartz & Emmel, 1996). Data collected in the preliminary studies suggest that croton densities at Navy Wells are generally higher along the interior transects than along the edges. (See Table 1 and Figure 4). However, croton size was not included in the Fairchild croton study and it was noted during surveys that croton size was larger on edges than in the interior. Future surveys including plant size would be beneficial.

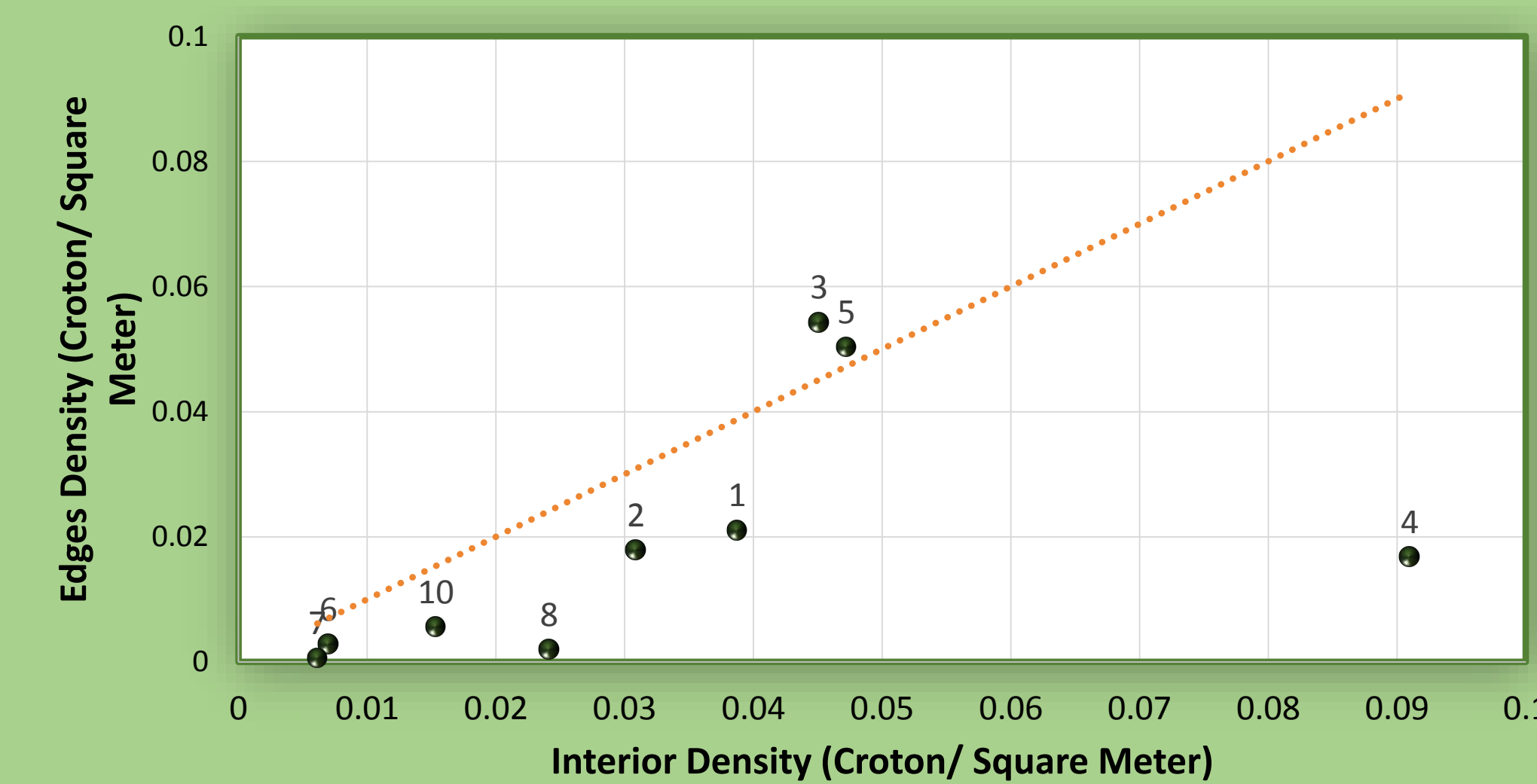


Figure 4. Ratio of interior to edge croton density per square meter.

OBJECTIVE 1 – DETERMINE WHAT PATCH-SCALE FACTORS AFFECT THE SUITABILITY OF HABITAT FOR BARTRAM'S POPULATIONS.

In order to quantify habitat suitability at the patch-scale, it is necessary to survey for both the butterfly and the plant resources upon which the butterflies depend. These plants would include not only the host and nectar plants at a site but could also include those used by adult butterflies for roosting, mate-location and basking (Dennis, Shreeve, & Dyck, 2006).

Monthly butterfly surveys will be conducted per Kadlec, et al (2012). A total of 40 circular quadrats (diameter 10 m) will be placed at Navy Wells (20) and within the Richmond Complex properties (20). When Bartram's are encountered, their behaviors will be observed and the extreme points of their observed flight will be geolocated. Table 2 below lists all parameters that will be assessed in these surveys.

Table 2. Parameters for Assessing Patch-Scale Habitat Suitability for Bartram's.

Factors relating to:	Parameters to be Assessed
Host Plant (Caterpillar food)	Abundance, size (width, height), sex
Nectar Plants (Food for Adults) & Habitat (Locations for adult roosting and mating)	Species abundance, diversity, richness, mean inflorescence, mean vegetation height, NMS axis scores, percent cover, tree DBH
Abiotic parameters	Light intensity, temperature, wind speed, wind direction, precipitation
Predation	Number of ant mounds near caterpillar plants, types of ants or other predators near/on caterpillar plants, evidence of predation
Mosquito spraying	Aerial spraying and ground spraying

Expected Results

As a result of these field surveys numerous active Bartram's populations are expected to be found and the habitat characteristics in those areas quantified. A negative relationship is expected between the percentage of shrubby vegetation and Bartram's, croton and nectar sources. Suitable patches (HSI threshold to be determined) are expected to include not only croton and nectar plants but also taller vegetation that would serve as a roost for adult Bartram's. The presence of one or more ants in the quadrats is likely but heavy predation on the caterpillars is not anticipated.

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OBJECTIVE 2 – DETERMINE WHAT LANDSCAPE-SCALE FACTORS AFFECT THE SUITABILITY OF HABITAT FOR BARTRAM'S POPULATIONS

While studying Bartram's at the patch scale may be necessary for understanding their specific habitat needs, it is important to consider the dynamics of a species' ecological interactions and processes at larger scales. To accomplish this objective, data analysis of the fused and segmented ortho-imagery/LiDAR data will follow a multi-step process which will iterate through data extraction from the remotely sensed data and statistical analysis until the best fitting model is determined.

The optimized kernel size of the best model will be used as the moving window size for calculating continuous HSI values, based on the regression equation and model coefficient values, across the pine rockland landscape covered by the DOQQ and LiDAR imagery. The result of this process will be a continuous landscape-scale probability map showing the extent of suitable habitat for Bartram's. The minimum habitat suitability threshold will be determined based on the qualitative scale in Table 3 and the correspondence of these scores with actual observations of habitat use within the study plots. Because a HSI score of 60 is the lowest value associated with active Bartram's reproduction, the minimum area of suitable habitat will be determined based on the smallest suitable habitat patch with HSI scores 60 or greater.

Table 3. Criteria for determining habitat suitability scores and threshold.

Scores	Biological interpretation of Habitat Suitability Scores
100	Both adult and immature stages encountered on more than one occasion
80	Both adult and immature stages encountered on one occasion
60	Female observed laying eggs
40	Adult observed and signs of previous feeding damage on leaves
20	Adult observed or signs of previous feeding damage on leaves
0	No life stages observed or evidence of previous feeding damage on leaves

Expected results

Land managers in Miami-Dade County suggest that the proper ratio of shrubs in the pine rocklands is approximately 25%, with the herbaceous layer filling in the remaining gaps (Miami-Dade County Natural Areas Management Working Group, 2004). Areas with a higher percentage of shrubs are expected to have less *C. linearis* and Bartram's populations than areas with a lower percentage of shrubs. Areas with large patches of herbaceous vegetation that include *C. linearis* are expected to improve chances of encountering Bartram's populations. Similar HSI values when comparing the patch and landscape scales are anticipated. The results of these models are expected to predict other suitable habitat for Bartram's populations that have not been found previously.

OBJECTIVE 3 – DETERMINE IF CURRENT MANAGEMENT AFFECTS HABITAT SUITABILITY AND HOW THE LANDSCAPE BE MANAGED

Fire management regimes in the various management units on these sites will be examined by calculating: 1) The mean HSI value for each management unit from the output of the landscape scale HSI assignment procedure discussed in Objective 2, and 2) The percentage of suitable habitat (threshold determined in Objective 2 and outlined in Table 3) for each management unit also based on the output of the landscape scale HSI assignment procedure. Data regarding number of burns since management implementation, season of burn, and burn return interval will also be included in the analysis.

In addition to fire, exotic plant management may affect butterfly populations and the removal of exotic plants could contribute to suitable Bartram's habitat. Consequently, the amount of exotic plant removal within management units in relation to the presence of Bartram's populations will be investigated and analyzed.

A generalized linear model (GLM) with a logit link and binomial family with robust standard errors and model selection will be used for this analysis where the independent variables will concern the various management techniques employed and the dependent variables will be the percentage of suitable habitat in each unit and the average HSI for each unit.

Expected Results

Without fire in the pine rocklands, the ratio of shrubby to herbaceous vegetation becomes imbalanced. Therefore, I expect to find a correlation between number of burns, time-since-burn, and season of burn in relation to HSI values. Areas that have not had a proper burn rotation recently implemented will have a higher percentage of shrubby vegetation and, therefore would not be determined as suitable habitat; Exotic plants species may also have negative impacts on this herbaceous layer and therefore, management units that have had increased exotic plant management are expected to have a greater habitat suitability.

RESEARCH IMPLICATIONS

With the recent federal listing of the Bartram's (Endangered Status for the Florida Leafwing and Bartram's Scrub-Hairstreak Butterflies, 2014), there is now increasing urgency to understand the management needs of this butterfly. Currently, MDPR is in the process of planning for and implementing an aggressive prescribed burn regime over the next several years for these properties as a result of funding received from USFWS. The results of this study will be an HSI that will provide land managers with helpful information, such as the minimum threshold for suitable habitat required for Bartram's populations. This new information could guide their efforts in developing management plans that promote suitable BSH habitat in the pine rocklands of Miami-Dade County.