Plugging Students into Nature through Butterfly Gardening: A Reconciled Ecological Approach to Insect Conservation

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Citation: Clayborn, J., Koptur, S., & O'Brien, G. (2020). "Plugging students into nature through butterfly gardening: A reconciled ecological approach to insect conservation. *Children, Youth and Environments, 30*(2), 30-71. Retrieved from http://www.jstor.org/action/showPublication?journalCode=chilyoutenvi

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Abstract

This study implemented an active-learning curriculum unit involving butterfly conservation and gardening at three schools in south Florida. An experimental group of classes received plants to take home; students maintained their plants and observed insect activity for two months. The control group of classes did not receive take-home items. Students who maintained plants at home retained their knowledge of butterflies, ecosystems and environmental stewardship significantly more than those who did not. Surveys revealed all students demonstrated favorable interest in animals and plants; however, both groups reported lower interest in insects. After project completion, more students in the experimental group had new gardens at home than students in the control group (29 percent increase vs. 5 percent decrease).

Keywords: active learning, flagship species, place-based education, reconciliation ecology

Introduction

We are in a distinctive chapter in history: scientists have suggested we are undergoing a geological transition from the Holocene to the Anthropocene epoch (Crutzen, 2002; Lewis & Maslin, 2015), a time when humans have a profound impact on Earth's systems and living species (Dirzo et al., 2014). Humans have eliminated or severely reduced populations of many species worldwide (Barnosky et al., 2011). Most attention has been focused on imperiled vertebrates such as birds and mammals; however, many invertebrates have experienced significant declines as well (Taki & Kevan, 2007). Global monitoring of 452 invertebrate species has recorded a 45 percent decline in the past 40 years (Dirzo et al., 2014). Development, agricultural activities, and invasive species are the top three major threats to federally endangered and threatened insects in the United States (Wagner & Van Driesche, 2010).

Since the early 1900s, south Florida has experienced extensive development at the expense of natural ecosystems (Giannini & Heinen, 2014). Historically, subtropical rockland ecosystems—dry forests and pine rocklands—covered a vast portion of Miami-Dade and Monroe counties (Snyder, Herndon, & Robertson Jr., 1990). Subtropical dry forests are dense, evergreen forests dominated by broad-leaved trees with leaf litter covering a limestone rocky substrate (Snyder et al., 1990). Pine rocklands are fire-dependent, open habitats with pine trees in the overstory and a partially exposed limestone rocky substrate (Snyder et al., 1990). Both ecosystems have been reduced drastically in size because they are situated at relatively higher elevations and highly valued for human habitation and use (Alonso & Heinen, 2011; Giannini & Heinen, 2014). Development can modify the natural environment by loss of species (habitat simplification), increased matrix habitat (unsuitable habitat between remaining natural areas), and distance from viable habitats (loss of corridors). Consequently, many butterflies and other organisms of south Florida's dry forest and pine rockland ecosystems have experienced significant population reductions with some species going extinct. Many imperiled species are now confined to state and federal parks and preserves, which are often underfunded and threatened by pollution, invasive species, and reduced natural buffer habitats. The protection of natural habitats and restoration of modified areas are two important ways to protect south Florida's and Earth's biodiversity (Giannini & Heinen, 2014; Hoekstra, Boucher, Ricketts, & Roberts, 2005; Mathew & Anto, 2007; Oliver, Roy, Hill, Brereton, & Thomas, 2010).

Reconciliation ecology is the study and strategy of conservation biology in human-dominated landscapes (Rosenzweig, 2003). For example, rehabilitating green spaces at schools, community centers, and neighborhoods in urban areas by planting native plants, removing invasive plants, and minimizing pesticide application can provide viable habitats that shelter common and rare butterflies (Brown Jr. & Freitas, 2002). Imperiled butterfly species depend on specific host plants in natural areas that are often imperiled themselves (McElderry, Salvato, & Horvitz, 2015; Salvato, 2003; Schultz & Dlugosch, 1999). Outreach programs using butterfly gardening, growing and establishing host plants in backyards, parks, and schoolyards, can help rare and endemic butterflies through species awareness and providing suitable habitat beyond natural areas (Mathew & Anto, 2007; Ramírez-

Restrepo, Koi, & MacGregor-Fors, 2017; Revathy, Mathew, & Narayanankutty, 2014).

Schools provide an opportunity to capitalize on integrative, place-based, botanical education by modifying their green spaces (Sobel, 2005; Waliczek & Zajicek, 1999). Teachers can use the school's surroundings as a framework where students build their own learning and improve local environmental quality (Lieberman & Hoody, 1998; Sobel, 2005; Tatarchuk & Eick, 2011). Younger students are often receptive to nature (Fisher-Maltese, 2016; Pyle, 2002), and elementary educators can align state standards with activities incorporating gardens (Culin, 2002; Tatarchuk & Eick, 2011), leading to greater environmental awareness later in students' lives (Culin, 2002; Grunova, Brandlova, Svitalek, & Hejcmanova, 2017; Miller, 2005).

Many studies have demonstrated the importance of school gardens as effective teaching tools inside and outside of classrooms (Klemmer, Waliczek, & Zajicek, 2005; Libman, 2007; Sobel, 2005). The hands-on, active-learning approach connects students with the environment as they learn about their surroundings (Pyle, 2002; Waliczek & Zajicek, 1999). For example, edible gardens can change students' attitudes toward foods, particularly unpopular vegetables (Libman, 2007). Similarly, the capacity to raise butterflies at schools can make inconspicuous invertebrate species salient and facilitate potential action to protect them (Cutting & Tallamy, 2015; Ramírez-Restrepo et al., 2017). Teachable moments and garden failures eventually transform to garden success if teachers scaffold their students to work through adversity and "fail forward" (Culin, 2002; Lieberman & Hoody, 1998; Settlage & Southerland, 2007; Waliczek & Zajicek, 1999).

South Florida is a promising place to integrate butterfly gardens and conservation into the school curriculum. Unlike other regions in the U.S., the subtropical climate of south Florida allows people to observe butterfly activity year-round (Hammer, 2015; Minno & Emmel, 1993). Developing native plant butterfly gardening at schools in Miami-Dade County creates an ecological schoolyard (Feinsinger, Margutti, & Oviedo, 1997), an opportunity to apply textbook material to the real world, promote conservation (Caro, Mulder, & Moore, 2003), and reduce "plant blindness" (Wandersee & Schussler, 1999). Plant blindness, the inability to recognize plants in one's own environment, leads to the inability to appreciate and understand plants as important components in an ecosystem and for people (Allen, 2003; Balick & Cox, 1996; Wandersee & Schussler, 1999). Native plant butterfly gardens can both remediate plant blindness and promote insect conservation. Native plant diversity, especially host plants for butterflies, benefits butterfly populations and other insects dependent on native plants (Koh & Sodhi, 2004).

The Schaus' swallowtail butterfly (*Heraclides aristodemus ponceanus*) was deployed as the flagship butterfly species and ambassador for butterfly and insect conservation in south Florida (Figure 1). In 1976, the Schaus' swallowtail was the first butterfly federally listed as endangered, and was declared in danger of extinction in 1984 (Smith, Miller, Miller, & Lewington, 1994; USFWS, 2017). Concerned scientists and staff at the National Park Service South Florida Caribbean Network initiated the Schaus' swallowtail butterfly habitat enhancement project

(Whelan & Atkinson, 2015). The habitat enhancement project restored degraded sections of subtropical dry forests on two islands in Biscayne National Park (by planting host plants: sea torchwood [*Amyris elemifera*] and wild lime [*Zanthoxylum fagara*]), where Schaus' swallowtail butterflies still occur (Clayborn, Koptur, O'Brien, & Whelan, 2017; Whelan & Atkinson, 2015).

Figure 1. The federally endangered Schaus' swallowtail butterfly (*Heraclides aristodemus ponceanus*) inhabits subtropical dry forests in the Florida Keys

photo: Susan Kolterman

Conservation projects for rare and threatened species are more effective when combined with educational programs in local communities (Grunova et al., 2017; Guiney & Oberhauser, 2009). We sought to make such a connection by developing a three-month curriculum unit to teach 5th-grade students about the endangered Schaus' swallowtail butterfly and the dwindling coastal hardwood hammock habitat (also known as tropical dry forest). The "Schaus and Coastal Hardwood Hammock" curriculum unit was developed and refined for this study with the aid of veteran teachers, following educational best practices (Clayborn, Koptur, O'Brien, & Whelan, 2017). Part of this curriculum unit was a hands-on "gardening for butterflies" activity for children aged 10–11 years (5th graders). Creating a schoolyard butterfly garden let the students apply some principles highlighted in the lessons about one rare butterfly endemic to south Florida and experience the joy of seeing butterflies

and their plants firsthand using common butterflies visiting a variety of nectar and host plants.
The objectives of our study were to: 1) incorporate a curriculum unit designed to address the plight of a rare butterfly, insect conservation, and forest ecosystems; 2) facilitate the construction of native plant butterfly gardens in school yards; 3) increase the number of butterfly gardens in the extended community; and 4) assess both changes in attitudes and gains in content knowledge from the sequenced lessons in the curriculum unit. We also looked at the influence of personal involvement, via an experimental intervention in which students in the experimental group were given plants to take home, care for, and observe, while control group students did not have that additional involvement.

We applied a mixed-methods approach (Cook & Campbell, 1979; Creswell, 1994; Morse, 1991; Tashakkori & Teddlie, 1998) in this study to better understand the impact of extending the classroom experience to the home environment through the applied project of nurturing butterfly plants at home. While knowledge gained can be measured by a content exam, and changes in attitude can be measured through surveys, adding a qualitative component to the study (the interviews) provided a detailed perspective on why students were responding to the surveys in the ways they did (Hanson, Balmer, & Giardino, 2011).

We worked with three schools, with two 5th-grade classrooms at each school assigned to either the experimental group, which received an intervention (extended home activities), or the control group, which did not receive extended home activities. We wanted to discern how the extent of student personal involvement with the subject, including extended home activities, would affect their knowledge retention and attitude toward butterflies and environmental stewardship. Our three research questions were:

1) Will students retain more knowledge about butterflies, ecosystems, and environmental stewardship after participating in the intervention (extended home activities)?
2) Will students report and voice more favorable attitudes towards butterflies, ecosystems, and environmental stewardship after participating in the intervention?
3) Is the intervention an effective model for increasing the number of butterfly gardens at home?

Our questions led to three testable hypotheses:

- **Hypothesis 1**: Students receiving the intervention (extended home activities) will retain more knowledge about butterflies, ecosystems, and environmental stewardship than students with the same classroom experiences but no intervention.
- **Hypothesis 2**: Students receiving the intervention will report and voice stronger affinities towards butterflies, ecosystems, and environmental stewardship than students with the same classroom experiences but no intervention.

- **Hypothesis 3**: The number of home butterfly gardens in the experimental group will increase during the study, whereas the control group will not show this increase.

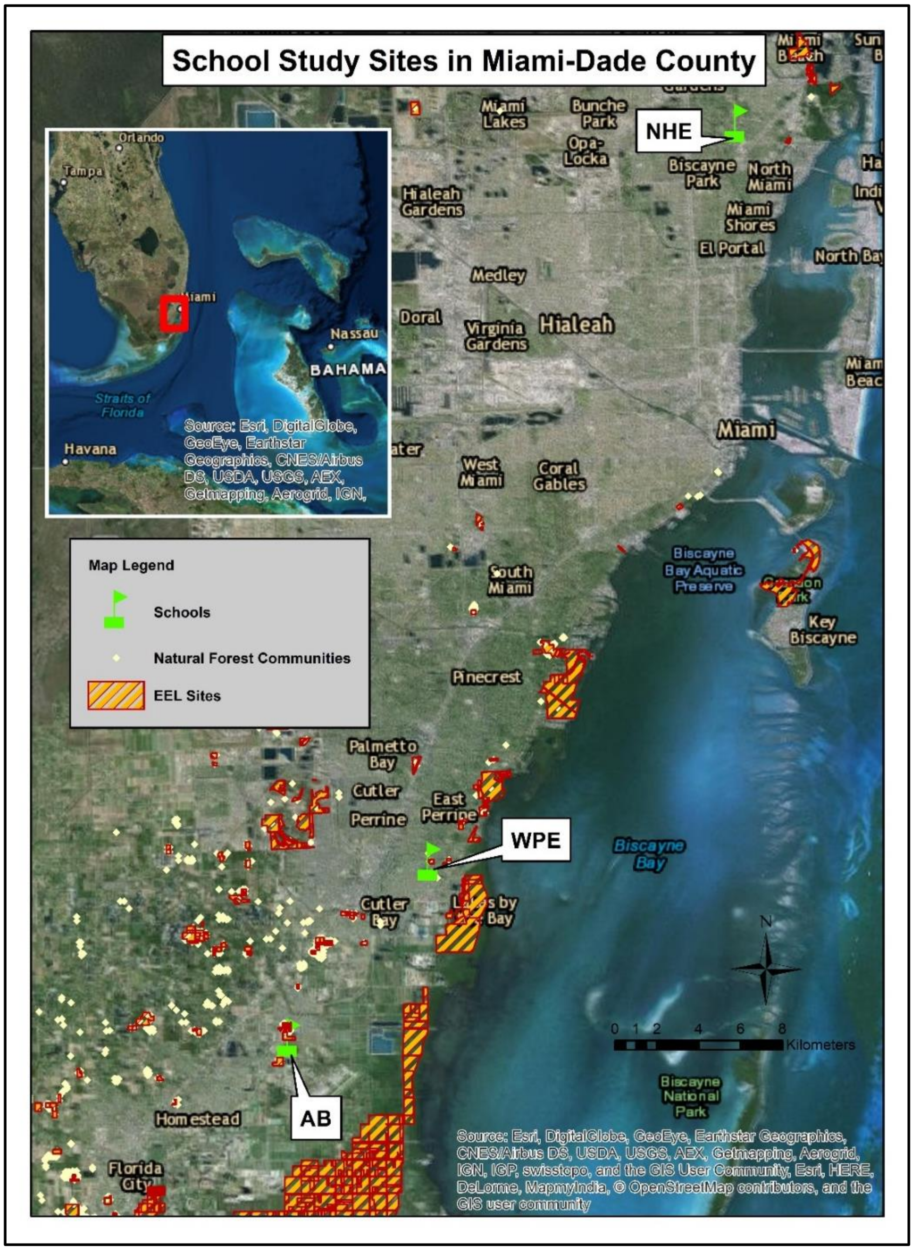
Methods

Study Area

Miami-Dade County is the southernmost county on the United States mainland. The subtropical climate and proximity to the Lucayan Archipelago and Greater Antilles have contributed to south Florida's diverse flora and fauna. Many tropical species of Lepidoptera (butterflies, moths, and skippers) reach their northern limits in south Florida, specifically Miami-Dade and Monroe Counties (Smith et al., 1994).

Miami-Dade County is ecologically and demographically diverse, with dominant Spanish-speaking populations from numerous countries in the Caribbean and South America. Three schools in Miami-Dade County participated in the study (Figure 2): North Hialeah Elementary, in a densely packed urban, residential area with no natural areas and minimal green space near the school; Air Base K-8 Center, and Whispering Pines Elementary, both adjacent to natural areas of the pine rockland ecosystem, and located within a region harboring protected environmentally endangered lands and natural forest communities (Giannini & Heinen, 2014). Despite being near these natural areas, at the time of this study, neither Air Base K-8 Center nor Whispering Pines Elementary educators actively engaged their students in outdoor learning activities there.

Figure 2. Map of school locations and their proximity to natural forest communities and environmentally endangered lands



AB = Air Base K-8 Center; WPE = Whispering Pines Elementary; NHE = North Hialeah Elementary

Study Preparation

The study employed a mixed-methods quasi-experimental design that combined elements of quantitative and qualitative approaches (Creswell, 1994; Morse, 1991; Tashakkori & Teddlie, 1998). The qualitative assessment—the interview—was complementary to the quantitative assessments—the tests and surveys. Interviews often provide more detailed information about a topic beyond surveys (Hanson, Balmer, & Giardino, 2011). We deployed simultaneous triangulation, using quantitative and qualitative methods at the same time, for this study (Morse, 1991).

We selected two 5th-grade classrooms (~20 students per class) from each school based on teachers' willingness to participate in the study, a form of convenience sampling. At each school, we designated one class as the experimental group, the other class as the control group. Both groups followed the same protocol for the duration of the study, except for one difference: the experimental group at each school was given butterfly and plant identification guides, butterfly host and nectar plants, and a data sheet (for observations) to take home as part of the intervention portion of the study. All participants in the study completed consent forms approved by the Florida International University Institutional Review Board (#IRB-15-0080). Teachers used the signed consent forms to randomly select eight students from each classroom for pre-study and post-study interviews (n = 48 students; n = 96 interviews).

We administered interviews, surveys, and tests at both the beginning and the conclusion of the study. Pre-study surveys and post-study surveys were identical and consisted of 28 statements, which were pilot tested to measure students' attitudes about wildlife and the environment. Pre-study tests and post-study tests were isomorphic, with similar style questions and concepts selected from a test bank. Tests consisted of 18 questions or statements, which were designed to measure present and gained knowledge about the environment and wildlife. In addition to the general themes, the tests focused on butterflies. Subsequently, we asked 11 identical pre-study and post-study interview questions to capture relevant information not easily acquired through the surveys and tests (Hanson, Balmer, & Giardino, 2011; Peshkin, 1993). (See Appendices A, B, and C for the text of the tests, survey statements, and interview questions.)

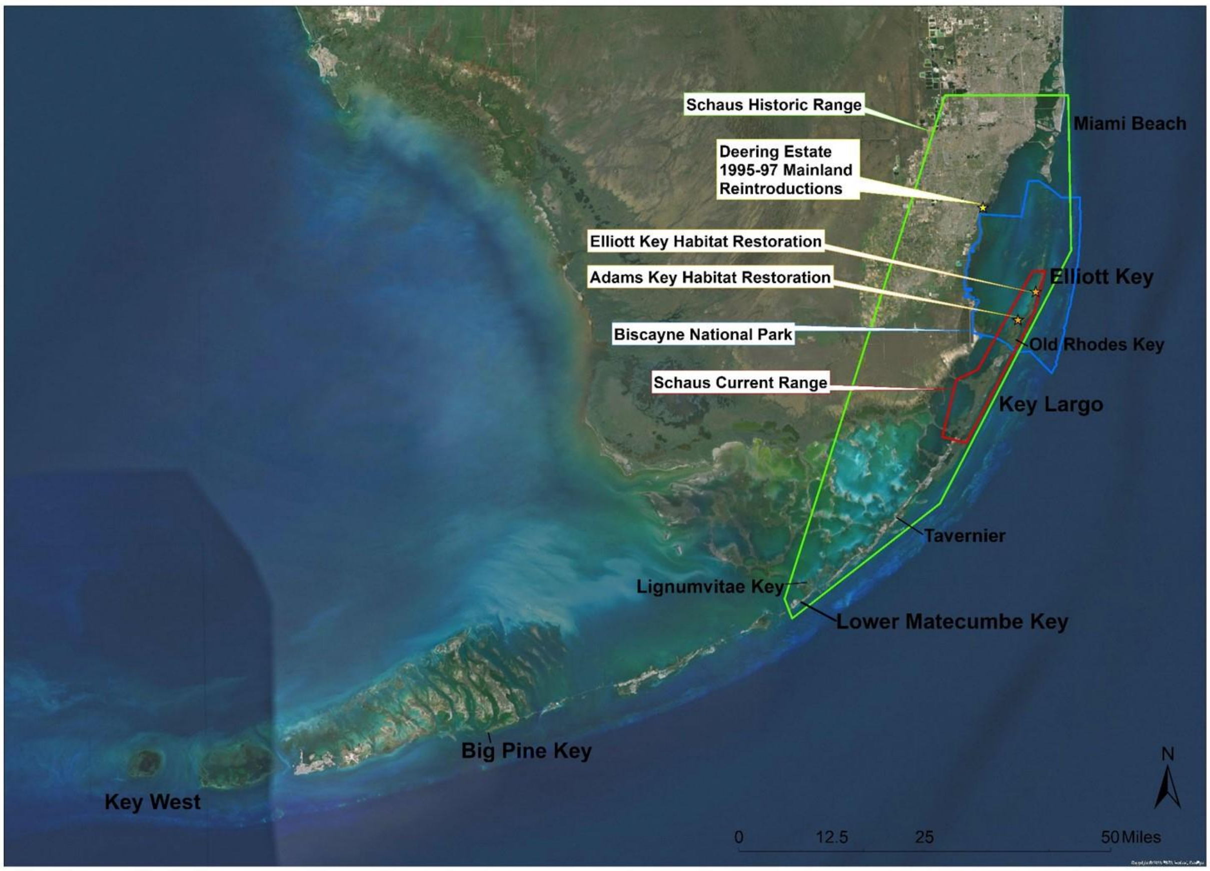
Initial Assessments (Week One; September 2015)

During the first week of the study, teachers administered the pre-survey to their students. Surveys were based on Likert's five-point scale (Likert, 1932) and coded for student confidentiality. After survey completion, students were given a break before taking the pre-test. Students were allotted 25 minutes to complete the test. Later that day, we individually interviewed eight students, randomly selected from each class. The protocol for initial tests, surveys, and interviews was the same for each class at each school.

Interactive Classroom Lecture and Activities (Week Two; September 2015)

All classes participated in an interactive presentation titled "Imperiled Butterflies of South Florida: Plight of the Schaus' Swallowtail and Other Butterflies," specifically designed for students of south Florida. The presentation was led by the first author and covered several topics: 1) south Florida's ecosystems, 2) butterfly and insect conservation, and 3) native plant butterfly gardening. Students were engaged during the presentation with visual games and brief discussions, prompted by questions. Afterwards, students played a map game, "Place the Schaus' swallowtail butterfly in the right habitat" (Figure 3; Clayborn, Koptur, O'Brien, & Whelan, 2017).[1] Finally, students observed living butterfly eggs, caterpillars, and native host and nectar plants.

Figure 3. Map of south Florida depicting the historic (outlined in green) and current range (outlined in red) of the federally endangered Schaus' swallowtail butterfly. The largest populations exist on islands in Biscayne National Park (outlined in blue)



Native Plant Butterfly Garden Construction (Week Three; September 2015)
The participating classes at each school were given an outdoor space (≈ 8 m^2) on the school grounds to construct a native plant butterfly garden, which they worked on as separate classes (Figure 4). With input from teachers and principals, the researchers chose garden plants for their ability to serve as caterpillar host plants and nectar sources for adult butterflies. By providing floral resources and host

[1] The objective of the activity was to navigate a magnetic Schaus' swallowtail butterfly to suitable habitat (outlined in red) on a 5' x 3' enlargement of the map in Figure 3. One blind-folded student was selected to hold the butterfly and placed at a random location in the classroom. The rest of the class had to non-verbally navigate the student to the map and the butterfly's habitat. Classmates were given five to seven minutes to brainstorm and execute a plan to use toy instruments and sounds to assist the blind-folded student.

plants, we hoped to attract butterflies common in nature that might venture into an urban area. We presented information about each plant to each class, including species name, preferred natural habitat, morphology, and ecological significance in the garden and ecosystem. Students were assigned garden tasks, including weed removal, soil preparation and supplementation, planting of native plants, adding mulch to help in water conservation, and marking plants with small, labeled flags. Students added rocks from the local area to demarcate their garden space and protect against lawn mowers and weed trimmers. Under the supervision of their teachers, students watered and weeded their garden periodically during the entire three months of the study.

Figure 4. Teacher and 5th-grade students working together to construct the butterfly garden at North Hialeah Elementary School

Experimental Group Home Project (Week Four; October 2015)

Students in the experimental group (one class from each school) participated in the home project. Each student was given one native butterfly host plant (*Passiflora suberosa*), which served as a host plant for three butterflies: the zebra longwing [*Heliconius charithonia*], gulf fritillary [*Agraulis vanilla*], and Julia [*Dryas iulia*]; all three species are common, inhabit wild and urban spaces, and exist in the same habitats as the Schaus' swallowtail butterfly. Students also received one nectar plant (*Salvia coccinea*—a hardy, attractive plant with red, tubular flowers) to maintain at home. Plants were kept in one-gallon pots with soil and mulch and labeled with both their common and scientific names. Both of the take-home plant species are easy to grow and attract many butterfly species. Each student received two identification guides, *Butterflies of Southeast Florida: A Guide to Common and Notable Species* (Minno, 2014) and *Wildflowers of Southeast Florida Including the*

Florida Keys and Everglades National Park: A Guide to Common Native Species (Hammer, 2012). The user-friendly, picture-based laminated guides displayed pictures of butterfly, skipper, and plant species in southeast Florida with specific habitat requirements (Figure 5).

Figure 5. Two students at Whispering Pines Elementary School reading *Butterflies of Southeast Florida: A Guide to Common and Notable Species* (Minno, 2014)

Students in the experimental group also received verbal and written instructions for how to care for their plants, directing them to place plants outside in partial shade, watering them as needed (they were taught to feel 3 centimeters deep to gauge soil moisture). Once a week, students (using their guides) were asked to look for butterflies on and around their plants, as well as eggs, caterpillars, and chrysalises on the plants. They were also instructed to observe other animal activity on or near both plant species. Plant maintenance and observations lasted approximately two months.

Wrap-Up (Final Week; December 2015)

The study concluded in the classroom, where post-surveys, post-tests, and post-interviews paralleled week one of the study. Students in the experimental group kept their plants and identification guides. Students in the control group received butterfly and plant identification guides for their participation in the study.

Data Analysis
We performed a Shapiro-Wilk test for normality on pre-test and post-test scores, and analyzed pre-tests and post-tests with paired sample *t*-Tests. We performed an ANCOVA to assess the influence of the intervention (students in the experimental group maintaining plants at home) on post-test scores with pre-test scores as the covariate.

To identify strongly correlated survey statements, which were loaded into factors, we performed an exploratory factor analysis (EFA). Factors with only one statement were eliminated; factors with two or more statements were retained. Students' response scores from strongly correlated survey statements were averaged for each factor. We utilized a Quade's rank analysis of covariance to assess the influence of (1) gardens present at the place of residence before the study commenced, (2) the intervention of taking host and nectar plants home, and (3) the type of students' residence for each factor, with pre-survey scores as the covariate (Quade, 1967). All data analyses were conducted using IBM SPSS Statistics 24. Home garden counts were derived from surveys administered at the beginning and end of the study (pre- and post-surveys) in which students self-reported whether they had a home garden or not. If they did, they were then asked what kind of garden (see Appendix C). Garden data reported in the pre- and post-surveys were interpreted and summarized.

We recorded interview responses and later transcribed them by hand. An inductive thematic analysis approach was applied to identify themes that emerged from the data (Boyatzis, 1998; Braun & Clarke, 2006). We followed a six-step theme identification and analysis process: 1) detailed notes were taken on all responses; 2) initial codes were generated from relevant pieces of information; 3) candidate themes were developed for further analysis; 4) candidate themes, initial codes, and detailed notes were reviewed by multiple people for coherence; 5) themes were defined, named, quantified, and analyzed; and 6) findings were described and reported (Boyatzis, 1998; Braun & Clarke 2006). If 20 percent or more of the students from each group (control or experimental) gave a response that fit a theme, then that theme was reported in the results section.

Results

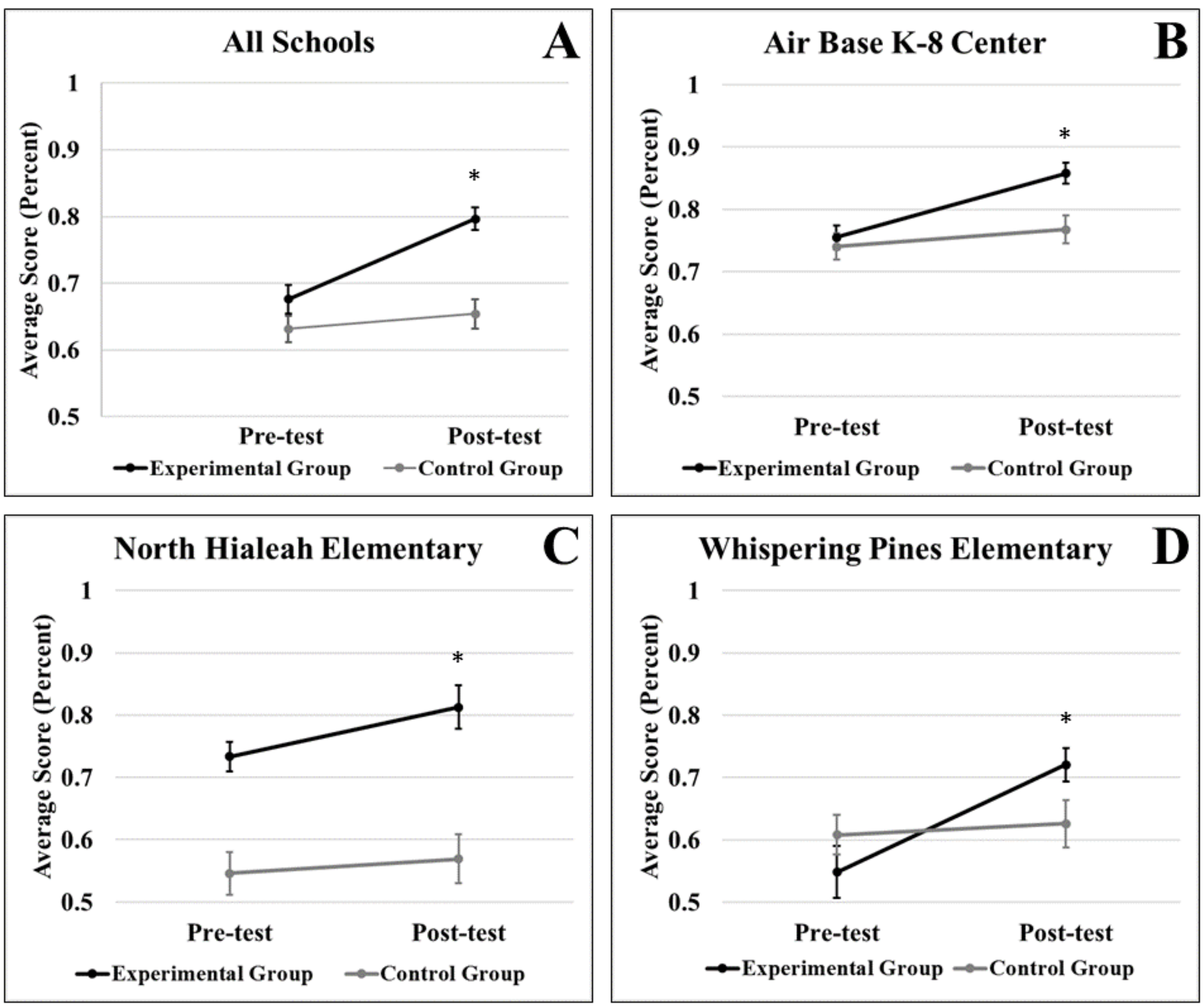
Knowledge Retention
Across all schools, students in the experimental group had post-test scores that were significantly higher than pre-test scores (pre-test mean = 0.68, SD = 0.16; post-test mean = 0.80, SD = 0.13; paired sample *t*-tests: $t = -6.301$, $p < 0.001$, $n = 60$; Figure 5A), while there was no significant increase in the control group (pre-test mean = 0.63, SD = 0.15; post-test mean = 0.65, SD = 0.17; paired sample *t*-tests: $t = -1.239$, $p = 0.220$, $n = 60$; Figure 6A). The same trend was seen for each school, separately, as well:

- Air Base K-8 Center: experimental group, pre-test mean = 0.75, SD = 0.09; post-test mean = 0.86, SD = 0.08; control group, pre-test mean = 0.74, SD = 0.09; post-test mean = 0.77, SD = 0.10; paired sample *t*-tests,

<u>experimental group</u>: $t = -3.871$, $p < 0.001$, $n = 21$; <u>control group</u>: $t = -0.937$, $p = 0.360$, $n = 20$; Figure 6B;

- North Hialeah Elementary: <u>experimental group</u>, pre-test mean = 0.73, SD = 0.10; post-test mean = 0.81, SD = 0.15; <u>control group</u>, pre-test mean = 0.55, SD = 0.15; post-test mean = 0.57, SD = 0.17; paired sample *t*-tests, <u>experimental group</u>: $t = -2.403$, $p = 0.028$, $n = 18$; <u>control group</u>: $t = -0.573$, $p = 0.573$, $n = 20$; Figure 6C; and
- Whispering Pines Elementary: <u>experimental group</u>, pre-test mean = 0.55, SD = 0.19; post-test mean = 0.72, SD = 0.12; <u>control group</u>, pre-test mean = 0.61, SD = 0.14; post-test mean = 0.63, SD = 0.17; paired sample *t*-tests, <u>experimental group</u>: $t = -4.705$, $p < 0.001$, $n = 21$; <u>control group</u>: $t = -0.701$, $p < 0.492$; $n = 20$; Figure 6D.

Figure 6. Comparison of pre-test and post-test scores (mean ± SE) for experimental and control groups of students at the three participating elementary schools



* indicates significant differences ($p < 0.05$) between pre-test and post-test scores for each group using paired sample *t*-tests

The intervention applied to the experimental groups—i.e., students nurturing and observing their personal host and nectar plants at home—had a significant effect on post-test score gains as demonstrated by the results of ANCOVA (Table 1). Overall, experimental groups' post-test scores were significantly higher compared to the control groups for all schools combined (experimental group mean = 3.721, SD = 4.574; control group mean = 0.708, SD = 4.427; *df* = 1, *F* = 25.771, p < 0.001; Table 1). Post-test scores were also significantly higher for the experimental group at individual schools:

- Air Base K-8 Center: experimental group mean = 3.190, SD = 3.777; control group mean = 0.850, SD = 4.056; *df* = 1; *F* = 9.926, p = 0.003; Table 1;
- North Hialeah Elementary: experimental group mean = 2.458, SD = 4.341; control group mean = 0.725, SD = 5.660; *df* = 1, *F* = 6.203, p = 0.018; Table 1; and
- Whispering Pines Elementary: experimental group mean = 5.333, SD = 5.195; control group mean = 0.550, SD = 3.509; *df* = 1, *F* = 10.986, p = 0.002; Table 1.

Table 1. Summary statistics of post-test scores (dependent variable) using Analysis of Covariance

Source	Sum of Squares	*df*	Mean Square	F	Significance
All Schools					
Intercept	0.918	1	0.918	57.985	0.001*
Pre-test	0.870	1	0.870	54.953	0.001*
Intervention	0.408	1	0.408	25.771	0.001*
Error	1.853	117	0.016		
Air Base K-8 Center					
Intercept	0.360	1	0.360	43.615	0.001*
Pre-test	0.001	1	0.001	0.026	0.873
Intervention	0.082	1	0.082	9.926	0.003*
Error	0.314	38	0.008		
North Hialeah Elementary					
Intercept	0.209	1	0.209	9.089	0.005*
Pre-test	0.145	1	0.145	6.304	0.017*
Intervention	0.143	1	0.143	6.203	0.018*
Error	0.804	35	0.230		
Whispering Pines Elementary					
Intercept	0.440	1	0.440	31.052	0.001*
Pre-test	0.297	1	0.297	20.976	0.001*
Intervention	0.156	1	0.156	10.986	0.002*
Error	0.539	38	0.014		

* significance

Attitudes before and after: Survey Results
After performing the EFA, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.688, including a significant Bartlett's test for Sphericity (χ = 946.401, *df* = 378, p < 0.001). The KMO Test measures how suited the data are for a factor analysis. The KMO value of 0.688 is adequate to justify additional analyses. Fourteen of the 28 statements loaded into 6 factors: 1 – Stewardship; 2 – Learning Interest [Nature]; 3 – Insects; 4 – Interconnectedness [Bees and Plants]; 5 – Interconnectedness [Animals]; and 6 – Anthropogenic Harm. One factor comprised only one statement and was removed from the analysis (5 – Interconnectedness [Animals]; Appendix D).

Quade's test revealed no significant changes in attitudes for any of the factors based on intervention, type of residence, or presence of gardens at home for all schools combined (Appendix D). However, the intervention was significant regarding post-survey score changes between experimental and control groups at one school, Whispering Pines Elementary, for factor 4 (Interconnectedness [Bees and Plants]: *F* = 8.213, p = 0.007) and factor 6 (Anthropogenic Harm: *F* = 6.155, p = 0.018; Appendix D). At Whispering Pines, post-survey scores for factor 4 - Interconnectedness (Bees and Plants) reported an increase for the control group (pre-survey mean = 3.816, SD = 0.831; post-survey mean = 4.237, SD = 0.547; Table 2) and a decrease for the experimental group (pre-survey mean = 4.476, SD = 0.732; post-survey mean = 4.238, SD = 0.453; Table 2). Post-survey scores for factor 6 - Anthropogenic Harm reported a decrease for the control group (pre-survey mean = 4.404, SD = 0.453; post-survey mean = 4.123, SD = 0.594; Table 2) and an increase for the experimental group (pre-survey mean = 3.635, SD = 0.981; post-survey mean = 4.175, SD = 0.985; Table 2). Neither Air Base K-8 Center nor North Hialeah Elementary students showed significant changes in attitude for any of the factors based on intervention, type of residence, or presence of gardens at home before the study began (Appendix D).

Table 2. Results from the Likert scale (5 – Strongly Agree to 1 – Strongly Disagree) pre- and post-surveys

All Schools				AB			NHE			WPE	
	Mean	**SD**		**Mean**	**SD**		**Mean**	**SD**		**Mean**	**SD**
Stewardship											
Pre-con	4.260	0.713		4.317	0.703		4.117	0.777		4.351	0.626
Post-con	4.119	0.726		4.033	0.788		4.250	0.752		4.070	0.598
Pre-ex	4.131	0.871		4.238	0.676		4.386	0.522		3.794	1.148
Post-ex	4.202	0.710		4.333	0.600		4.386	0.533		3.904	0.843
Learning Interest (Nature)											
Pre-con	4.040	0.762		4.067	0.892		4.300	0.730		3.737	0.491
Post-con	4.136	0.664		4.033	0.690		4.433	0.528		3.930	0.654
Pre-ex	4.093	0.864		4.000	0.756		4.526	0.487		3.794	1.056
Post-ex	4.137	0.718		4.111	0.786		4.316	0.501		4.000	0.777
Insects											
Pre-con	3.051	1.092		3.400	1.079		3.375	1.023		2.342	0.796
Post-con	3.331	0.977		3.300	1.030		3.65	0.808		3.026	0.980
Pre-ex	3.139	1.083		3.476	1.229		3.211	0.922		2.738	0.921
Post-ex	3.172	0.923		3.357	0.902		3.342	0.744		2.833	0.992
Interconnectedness (Bees and Plants)											
Pre-con	4.144	0.798		4.650	0.421		3.950	0.805		**3.816**	0.831
Post-con	4.263	0.653		4.450	0.610		4.100	0.735		**4.237**	0.547
Pre-ex	4.418	0.691		4.357	0.600		4.421	0.730		**4.476**	0.732
Post-ex	4.393	0.544		4.476	0.663		4.474	0.443		**4.238**	0.453
Anthropogenic Harm											
Pre-con	3.983	0.824		4.200	0.653		3.367	0.888		**4.404**	0.453
Post-con	4.175	0.645		4.35	0.499		4.050	0.769		**4.123**	0.594
Pre-ex	3.858	0.779		3.984	0.613		3.965	0.620		**3.635**	0.981
Post-ex	4.186	0.861		4.095	0.880		4.298	0.657		**4.175**	0.985

Bold indicates significant changes in students' attitude. Pre-con = Pre-survey control treatment group; Post-con = Post-survey control treatment group; Pre-ex = Pre-survey experimental treatment group; Post-ex = Pre-survey experimental treatment group.
AB = Air Base K-8 Center; WPE = Whispering Pines Elementary; NHE = North Hialeah Elementary.

Attitudes before and after: Interview Results

Although eight randomly selected students were interviewed from each class twice (pre- and post-interviews) during the study (n = 48 students, n = 96 interviews), some recorded interviews were corrupted due to technical difficulties. As a result, in the experimental group only, sample size was reduced by six for North Hialeah Elementary (post-interview) and by two for Whispering Pines Elementary (pre- and post-interview). The remaining recorded interviews were used for analysis and interpretation (*n* = 48 students, *n* = 86 interviews). Responses to the most important questions are explained in detail here.

1) What kind of activities do you enjoy doing outdoors?

Three themes derived from this question: 1) Sports, 2) Random Play, and 3) Gardening/Yard Exploration. More students in the control group (pre: 67 percent, post: 63 percent) engaged in "Sports" than the experimental group (pre: 41 percent, post: 50 percent). The percentage of students in the experimental group engaged in "Random Play" increased 19 percent during post-interviews (pre: 50 percent, post: 69 percent), but remained the same in the control group (pre: 58 percent, post: 58 percent). Responses regarding "Gardening or Yard Exploration" in the control group increased (pre: 25 percent, post: 38 percent), but responses decreased (pre: 50 percent, post: 31 percent) for the experimental group in post-interviews.

2) Name some things you need to attract butterflies to a garden.

From the control group, we derived three themes: 1) Flowers, 2) Plants, and 3) Host Plants. "Flowers" and "Plants" were considered basic responses as they displayed rudimentary understanding of components attracting butterflies. The theme "Host plants" was considered an advanced response because it demonstrated a more specific understanding of plants used to attract butterflies, namely that butterflies need particular plants upon which to lay their eggs. More than 50 percent of the respondents mentioned "Flowers" during both interviews (pre: 58 percent, post: 54 percent). Thirty-eight percent of the respondents mentioned "Plants" during both interviews. Twenty-five percent more respondents mentioned "Host Plants" during post-interviews (pre: 13 percent, post: 38 percent).

From the experimental group, we derived five themes: 1) Flowers, 2) Plants, 3) Host Plants, 4) Nectar Plants, and 5) Milkweed. The most prevalent responses during pre-interviews were "Flowers" (50 percent) and "Nectar Plants" (45 percent). The percentage of students that mentioned "Flowers" declined substantially during post-interviews (pre: 50 percent, post: 13 percent). There was a modest decrease for "Nectar Plants" (pre: 45 percent, post: 38 percent). Thirty-two percent of respondents mentioned "Host Plants" during pre-interviews, increasing to 44 percent during post-interviews. The percentage of respondents mentioning "Plants" (pre: 10 percent, post: 38 percent) and "Milkweed" (pre: 10 percent, post: 25 percent) also increased substantially during post-interviews. As before, the themes "Host plants" and "Nectar Plants" were considered advanced responses because they demonstrated complex understanding of relationships between plants and butterflies. Both groups mentioned "Milkweed" (control group < 20 percent, a higher percentage of respondents in the experimental group) as attractors for butterflies, but no other specific plants were named.

3) Would it be easy or difficult for animals and plants to survive in your neighborhood? Briefly explain.

In the control group, more than half of the respondents reported, "It would be easy" during both interviews (pre: 54 percent, post: 54 percent). Twenty-nine percent stated, "It would be difficult or somewhat difficult" during pre-interviews, but the proportion of responses increased during post-interviews (42 percent). Two themes explained the ease of animal and plant survivorship in their neighborhoods: "Lots of Green Space" and "Lack of Green Space." Twenty-nine percent of respondents mentioned "Lots of Green Space" during pre-interviews, which increased to 38 percent during post-interviews. "Lack of Green Space" also increased during post-interviews (pre: 8 percent, post: 21 percent).

In the experimental group, 59 percent of respondents reported, "It would be easy" during pre-interviews, increasing to 69 percent during post-interviews. Thirty-six percent stated, "It would be difficult or somewhat difficult" during pre-interviews, but the proportion of responses decreased during post-interviews (31 percent). Two themes explained the ease of animal and plant survivorship in their neighborhoods, which were "Lots of Green Space" and "Friendly Neighbors." Forty-one percent of respondents mentioned "Lots of Green Space" during pre-interviews, which increased to 50 percent during post-interviews. "Friendly Neighbors" also increased during post-interviews (pre: 18 percent, post: 25 percent).

4) Describe some reasons butterflies and other insects are disappearing, going extinct.

In the control group, students' responses to this question comprised five themes: 1) No Food, 2) Predators, 3) Pesticides, 4) People Harming Them, and 5) Habitat Loss. During pre-interviews, "No Food" was the most prevalent response (38 percent), declining during post-interviews (21 percent). Students' responses for "People Harming Them" (pre: 33 percent, post: 42 percent) and "Habitat Loss" (pre: 33 percent, post: 42 percent) mirrored each other. Responses for "Predators" remained the same (pre: 21 percent, post: 21 percent), but "Pesticides" markedly increased during post-interviews (pre: 8 percent, post: 25 percent).

In the experimental group, the four response themes were: 1) No Food, 2) Pesticides, 3) People Harming Them, and 4) Habitat Loss. "People Harming Them" was the most prevalent theme during pre-interviews (50 percent), decreasing by 25 percent during post-interviews. Thirty-six percent of respondents reported "Habitat Loss" during pre-interviews, increasing to 56 percent during post-interviews. Thirty-two percent of respondents reported "No Food" during pre-interviews, decreasing to 25 percent in post-interviews. There was a 15 percent increase in the percentage of students reporting "Pesticides" during post-interviews (pre: 10 percent, post: 25 percent).

5) Would you recommend a butterfly garden to a friend? Can you explain?

Most respondents from both groups said they would recommend a butterfly to a friend. While several students in the control and experimental groups said "No" during pre-interviews (control- pre: 8 percent; experimental- pre: 14 percent), all students said "Yes" during post-interviews. Themes derived from the responses included: 1) Increase Butterfly Population, 2) Like Butterflies, and 3) Help Endangered Butterflies. In the control group, the most popular theme was "Like Butterflies" (pre: 50 percent, post: 42 percent). Twenty-five percent of respondents reported "Increase Butterfly Population" during pre-interviews which declined to 17 percent during post-interviews. The theme "Help Endangered Butterflies" greatly increased during post-interviews (pre: 8 percent, post: 21 percent).

In the experimental group, the most popular theme was "Like Butterflies" during pre-interviews, drastically decreasing during post-interviews (pre: 50 percent, post: 19 percent). Twenty-seven percent of respondents reported "Increase Butterfly Population" during pre-interviews which increased during post-interviews (38 percent). The percentage of respondents that contributed to the theme "Help Endangered Butterflies" more than doubled during post-interviews (pre: 14 percent, post: 31 percent).

Butterfly Gardens in the Extended Community

Students in the experimental group (all schools combined) reported a net gain of eight new home gardens (a 29 percent increase), compared to a net loss of two home gardens (a 5 percent decrease) in the control group (Table 3). Almost every student in the control group at North Hialeah Elementary had a garden before this study commenced; however, they reported two fewer gardens at the end of the study (this may have been due to moving or other reasons). The other control groups at Air Base K-8 Center and Whispering Pines Elementary maintained the same number of gardens. Each school in the experimental group increased the number of gardens at home by two (Air Base) or three (North Hialeah and Whispering Pines).

While the experimental groups had an overall net increase of eight gardens, both the experimental and control groups had a net increase of five butterfly gardens after the study. The increase was greater in the experimental groups (the number doubled, 100 percent gain), while the control groups increased by 83 percent. North Hialeah Elementary students in both groups reported a dramatic increase in the number of butterfly gardens at home (Control Group = 5, Experimental Group = 4; Table 3).

Table 3. The number of home gardens reported by students

Schools	**AB**	**NHE**	**WPE**		**AB**	**NHE**	**WPE**
# of Students	**20**	**20**	**20**		**21**	**18**	**21**
Treatment	**Control Groups**				**Experimental Groups**		
# of Gardens (Pre-survey)	10	19	11		11	7	10
# of Gardens (Post-survey)	10	17	11		13	10	13
Net Results (Gardens)	**0**	**-2**	**0**		**+2**	**+3**	**+3**
# of Butterfly Gardens (Pre-survey)	1	1	4		3	0	2
# of Butterfly Gardens (Post-survey)	2	6	3		4	4	2
Net Results (Butterfly Gardens)	**+1**	**+5**	**-1**		**+1**	**+4**	**0**

AB = Air Base K-8 Center; NHE = North Hialeah Elementary; WPE = Whispering Pines Elementary

Discussion

Focusing on butterflies, using the federally endangered Schaus' swallowtail butterfly as the flagship species, we engaged students in a variety of activities that described the work being done to rescue its population while highlighting pragmatic solutions for public participation; this project is an example of reconciliation ecology (Rosenzweig, 2003). Knowledge is essential to the changes needed to protect and preserve butterflies and ultimately biodiversity (Allen, 2003; Miller, 2005; Vickery, 1995), and some changes can take place in our neighborhoods, not just in natural areas.

Overall, students in the experimental groups performed better on the post-test than students in control groups over the course of this teaching unit. Looking at each school individually, the knowledge gain derived from the intervention was significantly higher for the experimental groups. This demonstrates that personal experiences with nature, in addition to knowledge about butterflies and ecosystems, are foundational to behavioral changes that can promote insect conservation and environmental stewardship (Broom, 2017; Caro et al., 2003; Cheng & Monroe, 2012; Pe'er & Settele, 2008; Waliczek & Zajicek, 1999). Hypothesis 1 was supported as students in the intervention group showed greater knowledge retention about butterflies, ecosystems, and environmental stewardship.

Post-survey results revealed most students liked and valued animals, plants, and the environment, but showed lower, though neutral, interest in insects. Independent variables such as the presence of established gardens at home before the study, the extended home activity intervention, and type of residence did not significantly influence post-survey results when all schools were grouped together. Individually, the intervention did significantly influence post-survey results for two factors, Interconnectedness (Bees and Plants) and Anthropogenic Harm, at one (Whispering Pines Elementary) of the three schools. For Interconnectedness, the control group score significantly increased while the experimental group score significantly declined. The opposite occurred for Anthropogenic Harm; these disjointed attitude shifts between the experimental and control groups at this school were perplexing, possibly due to factors not measured in this study, leading to more questions.

The surveys did not detect significant explainable trends over time, as significant attitude shifts between the experimental and control groups were minimal. Survey results suggested young students already had a strong appreciation for the environment (Pyle, 2002), which can be harnessed by teachers and educators (Brewer, 2002; Culin, 2002; Tatarchuk & Eick, 2011). Efforts in demystifying insects, often portrayed as "gross," annoying pests, but as essential components to biological processes on Earth, should be taught inside and outside the classroom (Matthews, Flage, & Matthews, 1997; Rader et al., 2016).

Students' interviews provided them an opportunity to share perceptions about themselves, hobbies, butterflies, gardens, and the environment. Exploratory activities and time spent outside often relates to connection to the environment. For example, students engaged in nature (exploring, gardening, and playing) are more likely to advocate for its protection (Broom, 2017; Cheng & Monroe, 2012; Wells & Lekies, 2006). The act of "playing" could be harnessed as an effective means to encourage exploration and inquiry in the butterfly garden, school grounds, and home backyard, promoting environmental stewardship (Fisher-Maltese, 2016; Jacobi-Vessels, 2013; Sobel, 2005).

Most students were familiar with basic components of a butterfly garden, mentioning specific butterfly attractors such as flowers, plants, and host plants. A higher proportion of students in the experimental group mentioned host plants as a butterfly attractor than students in the control group during pre- and post-interviews. Students' recognition of host plants demonstrated a better understanding of enticing butterflies to visit gardens as well as the butterflies' life history. More than half of the students in the control group mentioned flowers. Some flowers are great attractors for butterflies, but the term "flower" is a generic, loose term. The term "nectar plant" is more specific and focuses on plants that produce food resources for various pollinators including butterflies (Allen, 2003; Hammer, 2015). Post-interview responses from the experimental group demonstrated a deeper understanding for attracting butterflies compared to the control group (Mathew & Anto, 2007; Minno & Emmel, 1993).

During the interviews, students made the connection between abundant green space (the presence of herbaceous and woody plants) and wildlife presence. Some students in the experimental group also mentioned their homes were surrounded by friendly neighbors, depicting a positive atmosphere of community and communication. Both are necessary to promote and spread environmental stewardship (Sobel, 2005). During post-interviews, a higher proportion of students in the control group recognized that lack of green space was a reason animals and plants would have a difficult time surviving in their neighborhood. Nature within urban ecosystems is a relatively new concept, although more people are becoming cognizant of synurbization (adaptation of wildlife to urban environments; Andrzejewski, Babińska-Werka, Gliwicz, & Goszczyński, 1978; Ramírez-Restrepo et al., 2017).

During post-interview results, a higher proportion of students in both groups recognized that habitat loss and pesticides were deleterious to butterflies and other insects. Lack of food was a popular response from students in both groups during pre-interviews, but that response decreased during post-interviews. It is likely that the "lack of food" response relates to monarch butterflies and milkweed, the most widely known butterfly story, in which population decline is attributed to fewer milkweed host plants, as well as fewer forests and natural areas, along their migratory route (Guiney & Oberhauser, 2009; Howard & Davis, 2009). Students were also aware people could directly harm butterflies and other insects by collecting them for money, and killing them if, as insects, they are perceived a nuisance.

During the pre-interviews, several students in both groups stated they would not recommend a butterfly garden to a friend because their friends would have no interest in it. Three months later all interviewed students stated they would recommend a butterfly garden to a friend. Interviewed students were conscious of the negative effects on local flora and fauna associated with urban environments and people. People can directly harm insects by squashing them or using pesticides or indirectly through development and removal of viable greenspace. The pre- and post-survey results demonstrated students had a neutral interest towards insects and insects in their space; however, post-interview responses indicated students were willing to advocate for butterflies through butterfly gardening.

School butterfly gardens can excite students to care more about their local flora and fauna; moreover, a reconciled ecological approach extending from schools into communities can transform anthropogenic, sterile landscapes into attractive, plant biodiverse habitats suitable for various wildlife including butterflies (Koh & Sodhi, 2004; Rosenzweig, 2003; Rudd, Vala, & Schaefer, 2002). In summary, survey results did not support Hypothesis 2; on the other hand, interviews provided a deeper understanding into what students already knew and felt at the beginning and end of the project. All students in both groups came to value butterfly gardens and stewardship for the environment.

Did this translate into an increase in gardens at home? There was a net increase of eight gardens of all types in the experimental group and a net loss of two gardens in the control group. An additional two to three gardens were added to neighborhoods outside of each school, potentially benefiting wildlife. Our third hypothesis was not supported because both the experimental and control groups had a net increase of five butterfly gardens, although the percentage increase was slightly higher for the experimental group. In the future, photo evidence of gardens at home could allow more accurate designation of garden type.

Giving students plants to take home presented an opportunity to motivate students to expand gardens beyond the school grounds. Student ownership provided additional care and experiential learning to monitor plant growth and insect activity over time. However, individual plant observations and maintenance at home were likely more successful with parent, teacher, and peer support, which should be integrated into the curriculum (Culin, 2002; Tatarchuk & Eick, 2011). Teacher scaffolding can push the experiential process and teach students how to think critically based on acquired knowledge from the science content and their own observations in butterfly gardens at school and home (Brewer, 2002; Settlage & Southerland, 2007; Tatarchuk & Eick, 2011). Younger students are more subject to the motivation of their guardians; therefore, scaffolding the construction and maintenance of a butterfly garden at home is not mutually exclusive from guardian approval and encouragement. Future studies investigating the impact of nature-based activities in elementary schools should integrate guardians into the study. In addition, follow-through on home garden creation might be further facilitated by providing additional information resources and support (e.g., county extension office contact, web sites of native plant and butterfly groups, etc.).

Conclusion

Insects are smaller and less noticeable than pandas, tigers, and other "charismatic megafauna" (Leader-Williams & Dublin, 2000; Rohlf, 1991). Many people also have unfavorable opinions about insects (Lockwood, 2013; Sumner, Law, & Cini, 2018), even though insects play important roles in ecosystems, serving as pollinators, food producers, nutrient transporters, and decomposers. Of the insects, butterflies are the most attractive to people, and in recent years more attention has been drawn to monarchs, their food plants (milkweed), and their migration (Cutting & Tallamy, 2015; Howard & Davis, 2009). At the same time, scientists have studied imperiled butterflies to better understand their life histories and restore their populations and habitats (McElderry et al., 2015; Ramírez-Restrepo et al., 2017; Salvato, 2003; Schultz & Dlugosch, 1999; Wagner & Van Driesche, 2010). The Schaus' swallowtail butterfly has been the subject of research for decades (USFWS, 2017). Our first-hand experience in habitat restoration for the Schaus' swallowtail (Whelan & Atkinson, 2015) led us to develop its story into attractive and teachable lessons; we used the Schaus' swallowtail as a flagship species to draw in students to become aware of butterflies and care about what happens to them. This approach is applied extensively by zoos and wildlife conservation organizations, teaching the public about rare, charismatic species to instill a sense of compassion and advocacy for their protection and preservation.

In this study, the intervention at home significantly increased students' content knowledge about butterflies and their ecosystems over a two-month timespan. Knowledge about and positive exposure towards a subject can lead to real changes in behavior (Broom, 2017; Caro et al., 2003; Cheng & Monroe, 2012; Waliczek & Zajicek, 1999). Overall, despite negligible shifts in attitudes, students demonstrated high affinities for animals, plants, and the environment. Interviews revealed students had positive experiences from the program. Place-based learning, active participation, and personal involvement are effective strategies to pique students' interest in butterfly conservation and environmental stewardship (Brewer, 2002; Fisher-Maltese, 2016; Sobel, 2005).

South Florida and the Keys have been ideal locations for human habitation at the expense of native wildlife and habitat (Giannini & Heinen, 2014). Through education, butterflies can be used as flagship species (Guiney & Oberhauser, 2009; Pe'er & Settele, 2008), as most people like butterflies, and they are attractive mascots for conservation (Ramírez-Restrepo et al., 2017). Butterfly gardening goes beyond butterflies, as many other species of animals are also attracted to the garden (Hammer, 2015; Minno & Emmel, 1993). A generational paradigm shift is necessary to ameliorate the continued decline of insect biodiversity and abundance. Recognition of ecosystem services and aesthetics through habitat rehabilitation and enrichment such as butterfly gardening can transcend attitudes of environmental mastery towards environmental harmony between humans and wildlife (Alonso & Heinen, 2011; Rosenzweig, 2003).

Limitations

Findings from this study represent only the study participants and may not necessarily be extrapolated to represent the majority of 5th-grade students in Miami-Dade County, given the dynamics of cultural diversity and experiences in conjunction with socioeconomic factors (Kurlaender & Yun, 2005; Moore 2004). A larger sample size of students (more 5th-grade classes) in both experimental and control groups would have strengthened representation. Miami-Dade County is a large cosmopolitan metropolis with 197 elementary schools and 44 K-8 centers. An extension of the study to include more students and schools would provide more opportunities to elucidate the effects on place-based education and the intervention of native plant home assignment. Logistical and financial constraints involving time commitment, plant resources, and identification guides increases as the sample size scales up; however, detailed preparation and experience can alleviate some of the constraints through timed plant cultivation, collaboration with nurseries, dedicated teacher commitment at each school, and reliable support by the scientific community.

Acknowledgments

We thank the principals at each school: Tamela Brown (WPE), Yanelys Canales (NHE), and Raul Calzadilla, Jr. (AB). The study would not have been feasible without the dedication and support of the teachers involved: Sarah Davio (WPE), Nadia Earl (NHE), Jessica Hernandez (NHE), Sandra Martinez (AB), Carmen Monge (AB), Kamelia Ramnarine (WPE), Vicki Terranova (WPE), and Louis Vazquez (NHE). We thank Dr. Scott Zona for provided FIU greenhouse space and materials. We also thank Leslie Bayas, Lydia Cuni, Darlene Darrican, Michael Foguer, Tanjim Hossain, Eduardo Ibarra, Andrea Salas, and Yadira Reynaldo for leadership roles involved in garden construction, plant care, and transportation. Jennifer Morales provided invaluable consultation on the instruments (tests, survey statements, and interview questions) designed for this study. Constructive comments on the manuscript including statistical support were made by Sarah Eddy.

Financial support was provided by: FIU Center for Leadership Global Civic Engagement Mini Grant, Kelly Foundation Botany Scholarship to the first author, and DonorsChoose.org (through which we raised contributions for supplies at the schools). Many butterfly host and nectar plants donated to the students and schools were provided by Mark Glasser. Additional plants were provided by members in the North American Butterfly Association Miami Blue Chapter and Florida Native Plant Society Tillandsia Chapter. Constructive comments on the manuscript were provided by Adel Peña, Maureen Donnelly, Bradley Bennett, and Jeffrey Wells.

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Appendix A.

Pre-Study Test: Butterflies, Gardens, and Conservation

Use vocabulary from the box below that best completes each statement (1 - 6)

Pine Rockland	Host Plant
Hardwood Hammock	Pesticide
Extinct	Endemic
Invertebrate	Ecosystem

1) A(n) __________ is the combination of living and non-living things and their interactions.
2) When the last animal of a species dies, the species becomes ______________________.
3) A(n) _____________________ is a chemical used to kill harmful insects.
4) An animal without a backbone is a(n) ______________________.
5) Butterflies lay their eggs on ______________________ which provide food for caterpillars.
6) ____________________ are globally imperiled areas found only in south Florida, the Bahamas, and Turks and Caicos.

Short Answers

7) What <u>changes</u> in a habitat would cause butterfly populations to decrease?

8) What would you add to your garden to attract monarch butterflies?

9) What does it mean for an animal to be <u>imperiled</u>?

10) What is the difference between a caterpillar and an adult butterfly?

11) Name two countries near (very close) south Florida that have similar plants and insects.

Multiple Choice

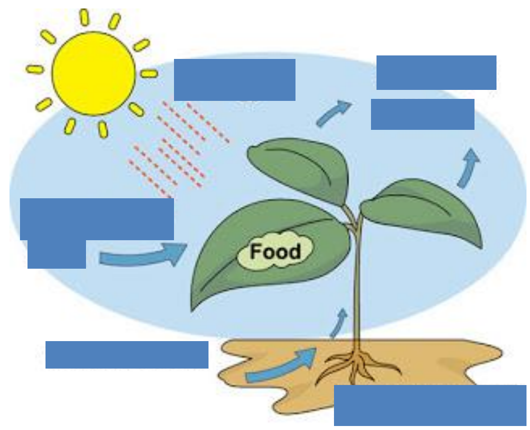
Choose the letter that best completes the statement or answers the question

12) Butterflies are considered pollinators, <u>what are pollinators</u>?
    a. Flight behavior used to escape predators
    b. An animal that transfers pollen from one flower to another flower
    c. Plants that use wind to disperse their pollen
    d. Ascended Saiyan who defeated Cell

13) The host plant for the Florida leafwing (butterfly) is the pineland croton plant which grows in a globally imperiled ecosystem in south Florida known to be rocky, <u>what is the correct name for the ecosystem</u>?
    a. Hardwood Hammock
    b. Pine Rockland
    c. Cypress Dome
    d. Pine Flatwoods

14) What would be <u>harmful</u> to a butterfly in your garden?
   a. Allowing some weeds to grow in the garden
   b. Watering the plants
   c. Releasing snakes into your garden
   d. Spraying the plants with pesticides

15) Photosynthesis is the process plants use ___________ to make sugar for food.

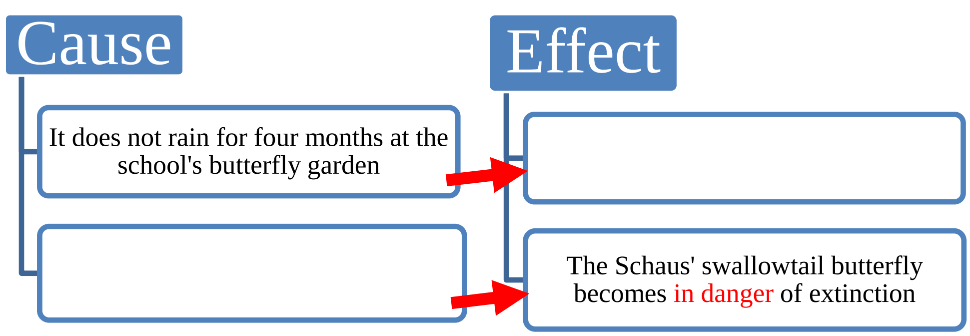


What do plants need to make food and oxygen?

   a. Air, Leaves, Soil, and Roots
   b. Sunlight, Soil, and Clouds
   c. Sunlight, Water, and Carbon Dioxide
   d. Sunlight, Water, Carbon Dioxide, and Oxygen

Cause and Effect

16) Fill in the missing cause and effect



17) Label each picture below in order from beginning to end by writing the different stages (1st Stage, 2nd Stage, 3rd Stage, 4th Stage).




18) Identify which picture below represents a host plant or nectar plant by writing the correct name below each picture (host plant or nectar plant).

A) ____________________ B) ____________________ C) ________________________

Appendix B.

Post-Study Test: Butterflies, Gardens, and Conservation

Use vocabulary from the box below that best completes each statement (1 - 6)

Pine Rockland	Host Plant
Hardwood Hammock	Pesticide
Extinct	Endemic
Invertebrate	Ecosystem

1) When the last animal of a species dies, the species becomes ____________________.
2) A(n) ___________________ species is an organism native or restricted to a certain country or area (found nowhere else).
3) A(n) ___________________ is a chemical used to kill harmful insects.
4) An animal without a backbone is a(n) ____________________.
5) ___________________ are globally imperiled areas found only in south Florida, the Bahamas, and Turks and Caicos.
6) The Schaus' swallowtail butterfly lives in a ________________________ which is a forest habitat characterized by dense stands of hardwood, broad-leafed trees.

Short Answers

7) What changes in a habitat would cause butterfly populations to increase?

8) What would you add to your garden to attract monarch butterflies?

9) The Schaus' swallowtail butterfly population has decreased over time to very low numbers. Should the butterfly be listed as imperiled, briefly explain?

10) What is the difference between a caterpillar and an adult butterfly?

11) Name two countries near (very close) Florida that have similar plants and animals.

Multiple Choice

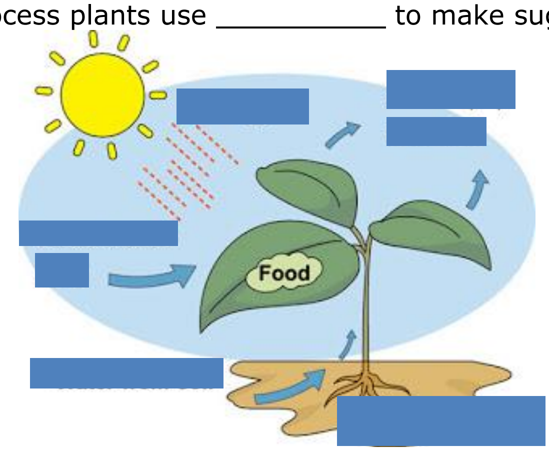
Choose the letter that best completes the statement or answers the question

12) Butterflies are considered pollinators, what are pollinators?
    a. Flight behavior used to escape predators
    b. An animal that transfers pollen from one flower to another flower
    c. Plants that use wind to disperse their pollen
    d. Ascended Saiyan who defeated Cell

13) The host plant for the Bartram's scrub-hairsteak (butterfly) is the pineland croton plant which grows in a globally imperiled ecosystem in south Florida known to be rocky, <u>what is the correct name for the ecosystem</u>?
   a. Hardwood Hammock
   b. Pine Rockland
   c. Cypress Dome
   d. Pine Flatwoods

14) What would be <u>harmful</u> to a butterfly in your garden?
   a. Allowing some weeds to grow in the garden
   b. Watering the plants
   c. Releasing snakes into your garden
   d. Spraying the plants with pesticides

15) Photosynthesis is the process plants use __________ to make sugar for food.

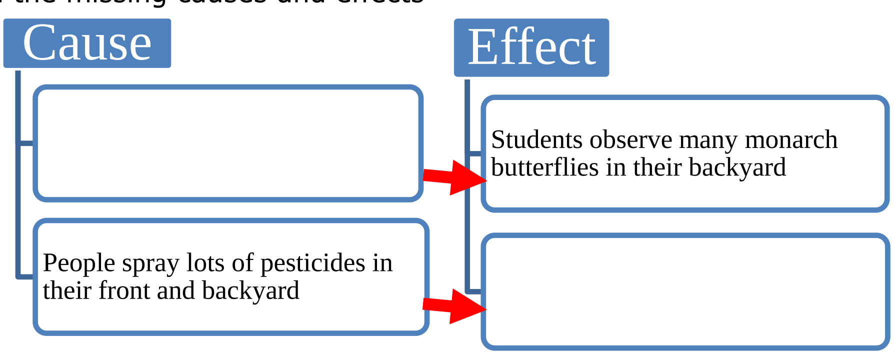


What do plants need to make food and oxygen?

a. Sunlight, Soil, and Clouds
b. Sunlight, Water, and Carbon Dioxide
c. Air, Leaves, Soil, and Roots
d. Sunlight, Water, Carbon Dioxide, and Oxygen

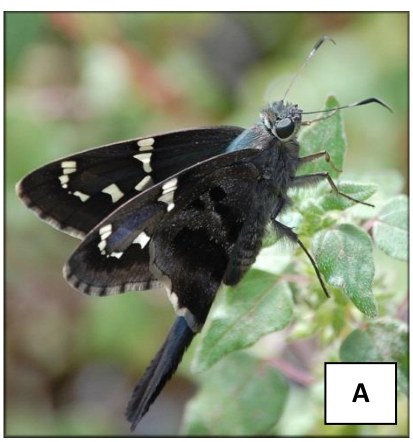
Cause and Effect

16) Fill in the missing causes and effects



17) Label each picture below in order from beginning to end by writing the different stages (1^{st} Stage, 2^{nd} Stage, 3^{rd} Stage, 4^{th} Stage).

18) Identify which pictures below represent a butterfly, moth or skipper by writing the correct name below each picture (Butterfly, Moth or Skipper).



A) ____________________________ B) _______________________________ C) __________________________

Appendix C.

Survey Statements and Interview Questions

All students (n = 120) in the experimental and control groups at each school (Air Base K-8 Center, North Hialeah Elementary, Whispering Pines Elementary) were administered pre-study and post-study survey statements. A total of 48 students (16 students at each school, 8 students per treatment) participated in pre- and post-interviews.

Teacher _______________
What is your age? _______
What is your ethnic background (or origin)?
Do you have a garden outside of school? Yes or No
If yes, what kind (or type) of garden? ____________
What type of place do you live in (please circle one below)?
House Apartment Condo Other ___________

<u>Survey Statements</u>

1) I like to learn about animals.
2) I like to learn about insects.
3) I like to learn about plants.
4) I like to learn about the environment
5) Insects are important to the environment.
6) Plants are important to the environment.
7) Animals are important to the environment.
8) Animals are easily harmed by people.
9) Plants are easily harmed by people.
10) Insects are easily harmed by people.
11) The environment is easily harmed by people.
12) I would give some of my money to help save animals.
13) I would give some of my money to help save insects.
14) I would give some of my money to help save plants and trees.
15) I would give some of my money to help save butterflies.
16) I would give some of my money to help save bees.
17) I like to spend time in places that have bees.
18) I like to spend time in places that have plants.
19) I like to spend time in places that have animals.
20) I like to spend time in places that have insects.
21) I like to spend time in places that have butterflies.
22) It makes me sad to see buildings and homes where plants and animals used to be.
23) I would like to help clean up the environment in my neighborhood.
24) People need animals to live.
25) People need plants and trees to live.
26) People need insects to live.
27) People need butterflies to live.
28) People need bees to live.

<u>Interview Questions</u>

1) What kind of activities do you enjoy doing outdoors?
2) What kind of activities do you like to do indoors?
3) How much time do you spend outside during school?

4) How much time do you spend outside after school?
5) Can you describe a butterfly garden?
6) Name some things you need to attract butterflies to a garden?
7) Do you have a garden outside of school?
8) (If yes to #7) Tell me about some of the plants in your garden.
9) Would it be easy or difficult for animals and plants to survive in your neighborhood, briefly explain?
10) Describe some reasons butterflies and other insects are disappearing, going extinct.
11) Would you recommend a butterfly garden to a friend? Can you explain?

Appendix D.

Quade's rank analysis of covariance was used to analyze survey results. Post-survey score was the dependent variable, pre-survey score was the covariate with the influence of gardens present at the place of residence before the study commenced, intervention of taking host and nectar plants home, and type of students' residence as independent variables. We tested type of residence for all schools; however, we did not test it for individual schools due to small sample size.

Factor 1 – Stewardship	
#12	I would give some of my money to help save animals.
#14	I would give some of my money to help save plants and trees.
#23	I would like to help clean up the environment in my neighborhood.
Factor 2 – Learning Interest (Nature)	
#1	I like to learn about animals.
#3	I like to learn about plants.
#4	I like to learn about the environment.
Factor 3 – Insects	
#2	I like to learn about insects.
#20	I like to spend time in places that have insects.
Factor 4 – Interconnectedness (Bee and Plants)	
#6	Plants are important to the environment.
#28	People need bees to live.
Factor 6 – Anthropogenic Harm	
#8	Animals are easily harmed by people.
#9	Plants are easily harmed by people.
#11	The environment is easily harmed by people.

		All Schools			
Source	**Sum of Squares**	***df***	**Mean Square**	**F**	**Significance**
Stewardship					
Intervention	451.077	1	451.077	0.384	0.537
Residence	3628.042	1	3628.042	1.568	0.213
Garden at Residence	103.698	1	103.698	0.088	0.767
Learning Interest (Nature)					
Intervention	23.124	1	23.124	0.019	0.889
Residence	418.668	1	418.668	0.175	0.840
Garden at Residence	33.724	1	33.724	0.028	0.867
Insects					
Intervention	1048.373	1	1048.373	0.889	0.348
Residence	68.363	1	68.363	0.029	0.972
Garden at Residence	735.246	1	735.246	0.622	0.432
Interconnectedness (Bees and Plants)					
Intervention	1449.649	1	1449.649	1.298	0.257
Residence	2641.917	1	2641.917	1.184	0.310
Garden at Residence	4031.248	1	4031.248	3.683	0.057

Anthropogenic Harm					
Intervention	708.809	1	708.809	0.602	0.439
Residence	3186.678	1	3186.678	1.367	0.259
Garden at Residence	530.940	1	530.940	0.451	0.503
Air Base K-8 Center					
Source	**Sum of Squares**	***df***	**Mean Square**	**F**	**Significance**
Stewardship					
Intervention	183.083	1	183.083	1.329	0.256
Garden at Residence	68.882	1	68.882	0.490	0.488
Learning Interest (Nature)					
Intervention	21.712	1	21.712	0.155	0.696
Garden at Residence	5.393	1	5.393	0.038	0.846
Insects					
Intervention	1.092	1	1.092	0.008	0.931
Garden at Residence	42.212	1	42.212	0.298	0.588
Interconnectedness (Bees and Plants)					
Intervention	2.364	1	2.364	0.019	0.890
Garden at Residence	4.995	1	4.995	0.041	0.841
Anthropogenic Harm					
Intervention	93.283	1	93.283	0.694	0.410
Garden at Residence	106.634	1	106.634	0.795	0.378
North Hialeah Elementary					
Source	**Sum of Squares**	***df***	**Mean Square**	**F**	**Significance**
Stewardship					
Intervention	9.892	1	9.892	0.079	0.780
Garden at Residence	18.018	1	18.018	0.144	0.706
Learning Interest (Nature)					
Intervention	43.925	1	43.925	0.361	0.552
Garden at Residence	20.354	1	20.354	0.166	0.686
Insects					
Intervention	251.296	1	251.296	2.177	0.149
Garden at Residence	13.323	1	13.323	0.109	0.743
Interconnectedness (Bees and Plants)					
Intervention	289.663	1	289.663	2.468	0.125
Garden at Residence	320.376	1	320.376	2.749	0.106
Anthropogenic Harm					
Intervention	55.336	1	55.336	0.445	0.509
Garden at Residence	14.691	1	14.691	0.117	0.734
Whispering Pines Elementary					
Source	**Sum of Squares**	***df***	**Mean Square**	**F**	**Significance**
Stewardship					
Intervention	6.073	1	6.073	2.146	0.151
Garden at Residence	5.654	1	5.654	1.948	0.171

Learning Interest (Nature)					
Intervention	0.011	1	0.011	0.542	0.466
Garden at Residence	0.012	1	0.012	0.550	0.463
Insects					
Intervention	5.125	1	5.125	2.186	0.148
Garden at Residence	0.079	1	0.079	0.033	0.856
Interconnectedness (Bees and Plants)					
Intervention	6.185	1	6.185	8.213	0.007*
Garden at Residence	0.073	1	0.073	0.080	0.778
Anthropogenic Harm					
Intervention	15.608	1	15.608	6.155	0.018*
Garden at Residence	0.487	1	0.487	0.167	0.686