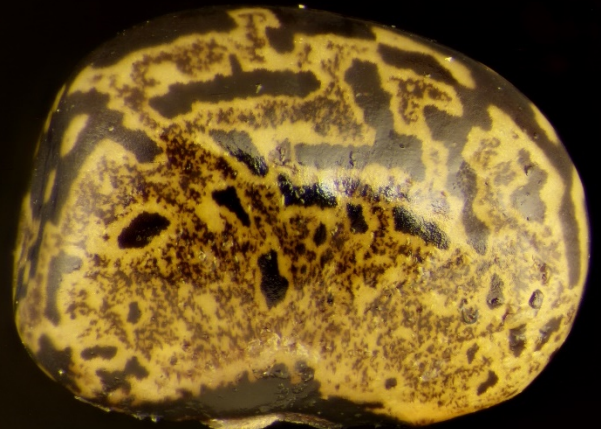
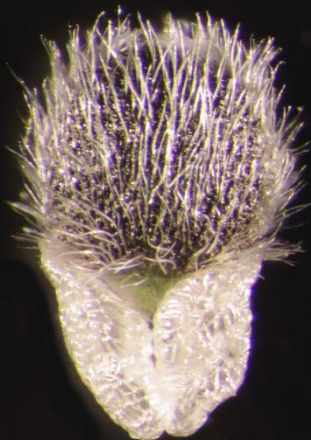




**Conservation of South Florida
Endangered and Threatened
Flora Program**

2019-2020

**Final Report
Contract #026286**

Submitted to:
Florida Department of Agriculture & Consumer
Services, Division of Plant Industry
July 30, 2020

Croton linearis

Guettarda scabra

*Cienfuegosia
yucatanensis*
FL-Endangered

Passiflora pallens
FL-Endangered

*Amorpha
herbacea
var. crenulata*
US-Endangered

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Brickellia mosieri
US-Endangered

Clematis baldwinii

Ipomoea tenuissima
FL-Endangered

Polygala incarnata

Centrosema virginiana

Conservation of South Florida Endangered and Threatened Flora Program

at

**Fairchild Tropical Botanic Garden
2019-2020**

Contract #026286

**Final report submitted to the Florida Department of Agriculture and Consumer
Services, Division of Plant Industry, Gainesville, FL**

**Submitted by: Jennifer Possley, Lydia Cuni, Sabine Wintergerst, Jimmy Lange, and Brian
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EXECUTIVE SUMMARY

Since 2001, support from the Florida Department of Agriculture and Consumer Services' "Endangered and Threatened Native Flora Conservation Grants Program" has been a crucial component of Fairchild Tropical Botanic Garden's nationally recognized, award-winning rare plant conservation program. Through our cooperative efforts, this grant program directly helps to recover dozens of Florida listed plant species. Our long-term monitoring allows us to provide up-to-date information on rare species, which often influences local, state, and federal protection. Experimental trials for cultivation and for long-term seed storage ensure that the protocols for propagating rare species are known and that propagules can be effectively stored long-term. Field research offers insights into the biology of rare species and assists land managers with evaluating restoration practices. Rare species reintroductions increase the total number of plants in the wild thereby reducing their extinction risk.

For all of us, 2020 has been an unusually challenging year. The global COVID-19 pandemic began to seriously affect South Florida in late March and, as this report is completed, shows little sign of abating. We canceled many events such as the Florida Rare Plant Task Force, a BioBlitz for City Nature Challenge, and an evening presentation and expert panel discussion for private pine rockland landowners. Like all departments at Fairchild Garden, the conservation department relies on the assistance of our amazing volunteers to help us in the nursery and in the field. The pandemic meant few/no volunteers for much of the past few months, which has both reduced our work volume and meant that we were occasionally asked to help with other aspects of Fairchild operations. Despite adversity, we were able to complete all proposed activities for this grant and even do additional work.

Below we have summarized notable activities conducted in 2019-2020, based upon our original proposal and the revised work plan sent to FDACS on 7/26/2019. Note that because the funds we received were 35% less than those requested for the proposed work we narrowed the scope of the proposal, excluding any work with *Aristolochia pentandra*, *Colubrina cubensis* var. *floridana*, and *Zanthoxylum flavum* as well as eliminating proposed reintroductions of the endangered air plants *Catopsis berteroniana* and *Guzmania monostachia*.

Objective 1. Continue long-term demographic monitoring of wild and reintroduced populations of the rare plants of South Florida, *in situ*.

- We monitored both wild populations and the both introductions of *Amorpha herbacea* var. *crenulata*. Indications are that this taxon will become extinct in the next few decades if more aggressive management—especially more frequent prescribed fires—is not implemented. Due in part to our urging, in the past 6 months, Miami-Dade County preserve managers implemented sabal palm removal in all four locations, and prescribed fire in two locations.
- By combining funding from this FDACS-DPI grant with USFWS funding to conduct 5 translocation actions of South Florida's newly listed pine rockland species, we were able to conduct 11 total translocations with these 5 taxa: *Brickellia mosieri*, *Chamaecrista lineata* var. *keyensis*, *Chamaesyce deltoidea* ssp. *serpyllum*, *Linum arenicola*, and *Linum carteri* var. *carteri*. In addition, we explored aspects of seed and seedling biology beyond what the USFWS grant funded. Perhaps most notably was a project completed with our BioTECH high school interns whereby we researched the effects of different salinity levels on seed germination and seedling growth of *Chamaecrista lineata* var. *keyensis*. This study showed that seed germination and

seedlings tolerate salt-water concentrations up to 10% but solutions with higher concentration impede germination and growth.

- We conducted an experimental introduction of *Argythamnia blodgettii*. As with the USFWS funding, we also had funding with this species to translocate the population. However, the FDACS-DPI funding enabled us to do much more, determining the best methods for dormancy breaking, vegetative propagation, and more. While it is still early (10 months), nearly 100% of the plants that were planted in new preserves have survived.
- We conducted an experimental introduction of *Ctenitis submarginalis* to the Deering Estate, with much support from Deering Estate and Miami-Dade County staff, who helped with frequent watering that was required for months. Early on, this augmentation also has nearly 100% survival.
- We monitored introductions of the aforementioned taxa, as well as introductions conducted in previous years for *Pilosocereus robinii*, *Jacquemontia reclinata*, and *Dalea carthagenensis* var. *floridana*. Introductions of *Jacquemontia* and *Dalea* have had several generations of recruitment and require regular habitat management to maintain open habitat conditions. Introduced *Pilosocereus* have yet to flower and are gradually declining, much like the wild populations of that species.
- We re-assessed *Polygala smallii* at the US Coast Guard Richmond Station. It had not been surveyed in a comprehensive manner in more than a decade. This pine rockland site has not burned in at least 30 years and the population has decreased by an order of magnitude.
- We re-assessed *Bourreria cassinifolia* at Camp Owaissa Bauer, which also had not been surveyed in over a decade. While the population is small (<200 plants, with <20% being reproductive), we noted that plants were flowering, fruiting, and recruiting and new seedlings in an area where the County recently conducted aggressive hardwood reduction.

Objective 2. Continue ex situ seed collections and seed research

- We collected seed of more than 70 native species from the wild and from ex situ collections for propagation, germination testing, and long-term storage. Seeds we have deposited into long-term storage are summarized in Table A2, which is an Appendix at the end of this report.
- We tested the storage capability of *Guzmania monostachia* and *Linum arenicola* seeds and found that they withstand desiccation and freezing and thus can be stored long-term.
- We performed viability and dormancy-breaking germination trials with seeds of several listed South Florida species, including *Argythamnia blodgettii*, and *Bourreria cassinifolia*.
- We tested experimentally how an increase in soil salinity effects seed germination and seedling survival of *Chamaecrista lineata* var. *keyensis* and found that both, seeds and seedlings can tolerate salt concentrations up to 10‰ without loss of viability.

Objective 3. Continue to expand the Connect to Protect Network

- The Connect to Protect Network (CTPN) continues to grow rapidly. As in the previous year, we gained more than 300 members in the 12 months. As of July 2020, membership includes 817 homeowners, 131 schools and 32 other members (typically churches, non-profits, etc.). All members have installed at least 5 native pine rockland plants on their property in an effort to connect urban Miami's remaining pine rockland fragments for pollination and seed dispersal across developed areas.
- We distributed more than 1300 free pine rockland plants to Miami homes and schools through CTPN. This number is lower than last year by more than 1000 plants, but we were able to

resume plant distributions to CTPN members in May, with strict social distancing guidelines in place.

Objective 4. Promote conservation of Florida rare species through displays and public outreach.

- We made 7 oral and presentations to public and scientific audiences at local and regional meetings, led 4 educational field trips, and taught three native plant-related classes through Fairchild's continuing education program.
- We published 7 peer-reviewed manuscripts and submitted 3 for review.
- We wrote three popular articles about native plants for Fairchild's The Tropical Garden magazine.
- We mentored two students from Miami's BioTECH magnet high school.
- We regularly shared rare native plant news and updates on social media.

Additionally, we wrote a Conservation Action Plan (CAP) for *Argythamnia blodgettii*. This document summarizes all information that is known about the taxon and is included as an appendix to this report.

The Endangered and Threatened Native Flora Conservation Grant has enabled us to further the conservation of many of South Florida's native plant species. We would like to thank FDACS and DPI for their longstanding support, which is truly foundational to our conservation program.

Objective 1. Continue to monitor and conserve the rare plants of Florida *in situ*
and

Objective 2. Continue to collect and curate *ex situ* conservation collections of the rare plants of South Florida

Taxa included:

Amorpha herbacea var. *crenulata*, *Argythamnia blodgettii*, *Brickellia mosieri**, *Bourreria cassinifolia*, *Catopsis berteroniana*, *Chamaecrista lineata* var. *keyensis*, *Chamaesyce deltoidea* ssp. *serpyllum*, *Ctenitis submarginalis*, *Dalea carthagenensis* var. *floridana*, *Guzmania monostachia*, *Jacquemontia reclinata*, *Linum arenicola**, *Linum carteri* var. *carteri**, *Pilosocereus robinii*, and *Polygala smallii*

* Not required by contract

***Amorpha herbacea* Walter var. *crenulata* (Rybd.) Isley**

Amorpha herbacea var. *crenulata* (hereafter “*Amorpha*”) is an endangered pine rockland shrub endemic to Miami-Dade County. It occurs in communities that were historically associated with seasonally hydrated soils and frequent burning, including: wet pinelands, transverse glades and hammock edges. By 1984, nearly all these communities in urban Miami-Dade County had been destroyed, and development continues today. In addition, fire suppression, invasion by non-native plant species, and hydrological changes have all contributed to the decline of *Amorpha* (USFWS 1999, Gann et al. 2002). The U.S. Fish and Wildlife Service listed *Amorpha* as federally endangered in 1985 (USFWS 1985). Fairchild has been studying and monitoring *Amorpha* since the early 1990s and has conducted three outplantings, one of which (Campbell Drive) was removed after more than a decade. We have cold-stored thousands of *Amorpha* seeds, both at Fairchild and in the USDA National Laboratory for Genetic Resources Preservation (NLGRP). We report below on the status of the two wild and the two remaining introduced populations.

Update on Introduced Populations

Deering Estate

In 1995, Fairchild introduced 190 juvenile *Amorpha* plants clustered into 7 groups into pine rockland at The Deering Estate. We do not have monitoring records from 1995 to 2000, but we began tracking plants closely in the early 2000s and continue to do so. At 25 years, this is one of the oldest surviving plant introductions in the United States! We monitored plants on March 17, 2020. Of the original 190 outplants, 31 (16%) were still alive (**Fig. 1, left**). Two died in the past year. Two of the seven clusters had no surviving plants. The majority of surviving outplants were at Clusters 1 and 4. Areas with surviving plants had sandier soil, as opposed to more rocky soil.

In addition to surviving outplants, we documented 199 recruits. The majority of these were tiny “Stage 2” seedlings and were only a few centimeters tall (**Fig. 2**). Our monitoring history shows that very few Stage 2 *Amorpha* seedlings will survive to the next year. Only a single recruit was an “F1” that we had documented years ago; it was in stage 4 (i.e., a woody plant >20cm tall), and none were in Stage 5, the adult/reproductive stage. Average litter depth at each of the plants was 4 cm, which is too deep for the population to persist (*Amorpha* seeds need litter depth to be <2cm to germinate and survive (Wendelberger and Maschinski 2008)).

Unfortunately, the rate at which new adult *Amorpha* plants are becoming established at the Deering Estate is much lower than the attrition rate; this reintroduction will likely not last two more decades without intervention. Clearly, *Amorpha* is a fire-adapted species that flowers, fruits, and recruits new seedlings prolifically post-fire, as we documented in 2008 (**Fig. 1, right**) Reinstatement of regular prescribed fire in the Deering Estate pineland will be critical to the persistence of this introduced population.

We are considering the possibility of further augmenting this introduction. Toward that end, we are starting seedlings and hoping to conduct an augmentation in 2022 or 2023. We would introduce plants into low-lying sandy areas in the Deering Estate pineland, as low-lying sandy areas are where the introduced plants have performed best thus far.

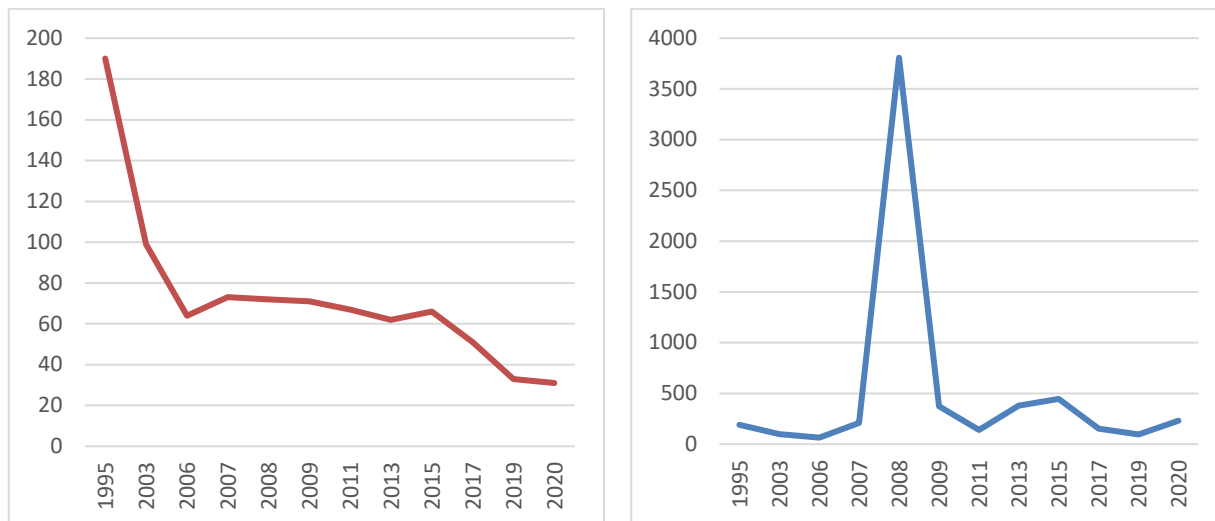


Figure 1. Left: Number of *Amorpha* outplants at the Deering Estate from 1995 (190 plants) to 2020 (31 plants). **Right:** Total population size of the introduced Deering *Amorpha* population over time, including recruits. The peak of nearly 4000 plants in 2008 happened after a prescribed fire.

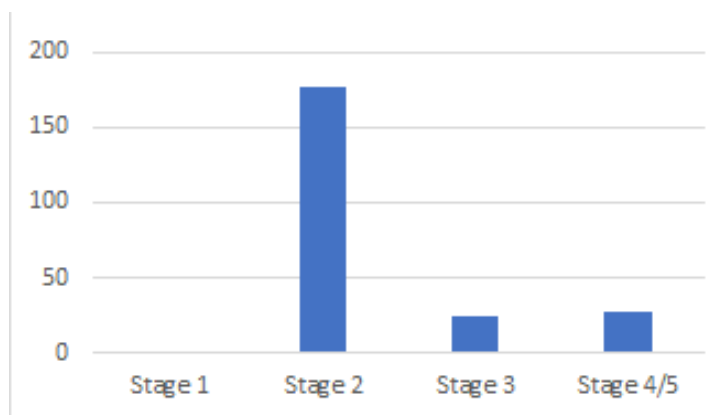


Figure 2. Size class distribution of 229 *Amorpha* (31 surviving outplants + 199 recruits) at the Deering Estate in March 2020. Stage 1 seedlings are fresh germinants with cotyledons still present. Stage 2 are seedlings 2-10cm. Stage 3 are 10-20cm. Stage 4 is >20cm but not reproductive. Stage 5 is reproductive adult.

Martinez Preserve

In 2006 and 2007, Fairchild conducted two plantings of *Amorpha* totaling 344 individuals at Martinez Preserve. We originally introduced plants to four different habitat types (pineland, grassy glade, pine/glade ecotone, and a restoration glade) for which we collected environmental data (see Roncal et al. 2012). Since introduction, visual distinction between the different habitat types has essentially disappeared and most areas can be described as fire-suppressed pine rockland, though some grassy prairie remains as such.

We monitored the 2006/2007 introductions of *Amorpha* at Martinez Preserve in May 2020. Currently, 118 of the original 344 plants (34%) have survived. We documented 32 seedlings beneath 3 plants; all

these were in the habitat originally classified as “ecotone.” We measure plant volume, but do not report those data here. In the past, mean canopy volume had been highest in the “restored glade” until 2018 when volumes were markedly higher in the “ecotone.”

Without prescribed fire, this introduction will likely continue to decline. We are part of an ongoing conversation with Miami-Dade NAM and The Institute for Regional Conservation to guide habitat management around this introduced population.

Update on Wild Populations

AD Barnes and Tropical Parks

The trajectories of the last remaining wild populations of *Amorpha* at AD Barnes and Tropical Parks are similar to one another, thus we are combining our discussion of these populations for this report. At both pine rockland fragments, which are located just one mile apart, years of fire suppression combined with impacts of fragmentation and hydrological changes are a serious issue that has negatively impacted *Amorpha* (**Fig.3**) as well as many other pine rockland and marl prairie understory species. Native and non-native vegetation as well as fallen pine needles blanket the pineland understory and have nearly erased any marl prairie habitat that was once present. While a few wild or prescribed fires have occurred, they have been too infrequent. Fuel and moisture have now increased to the point where fires are unlikely to ignite and carry through these fragments.

We monitored *Amorpha* at AD Barnes and Tropical Park in fall 2019, finding 138 plants at AD Barnes and 70 at Tropical Park. The population size classes were unevenly distributed, with both populations being dominated by non-reproductive adults, with few seedlings. Mean litter depth at plants was 2.7 cm at Tropical Park and 5.7 cm at AD Barnes. Litter depth should be below 2.5 cm for the population to recruit new seedlings, thus the leaf litter buildup is especially problematic at AD Barnes.

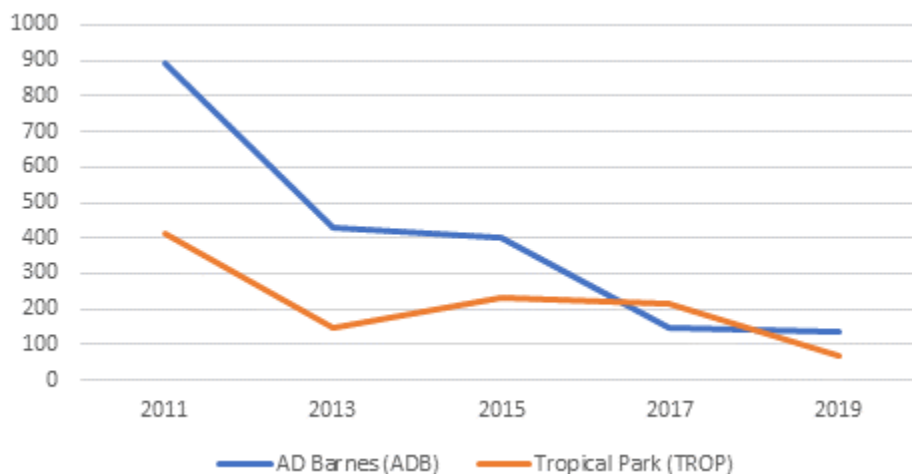


Figure 3. *Amorpha* population totals at AD Barnes and Tropical Parks, 2011-2019.

Because of the above circumstances, and due in large part to urging from Fairchild biologists, Miami-Dade County preserve managers began more aggressive vegetation thinning in these fragments in late 2019. Natural Areas Management crews removed the majority of sabal palms, which had become extremely dense. This will increase light, greatly reduce duff in the form of palm fronds, and decrease moisture in the fragment understory. Our monitoring of these efforts has been hampered by COVID-19

park closures, but early indications show that the *Amorpha* is responding quite well, with new growth, flowering and fruiting. We predict that our next monitoring event will show increased seedling recruitment.

Ex situ collections

We continue to maintain a small collection of *Amorpha* in Fairchild's nursery of 4 plants. They represent two extirpated populations. Dr. Raul Moas donated 3 seed-grown plants that are descendants of plants he rescued in the 1980s from a remnant population in unincorporated Miami-Dade County (near Schoolhouse Road and 84th Street). The remaining plant is from the "Pino" population that was immediately adjacent to A.D. Barnes Park but is now gone (many of these plants were used in the Martinez reintroduction).

In addition to the plants at the nursery, 4 well-established plants are in Fairchild's pine rockland display plot. These plants not only serve as an important educational tool, but are also a valuable seed source for plants distributed via the Connect to Protect Network.

In cultivation in our display garden, *Amorpha* requires very little care. We cut them back to the ground every year to mimic fires that would naturally occur in their native habitat (**Fig. 4**). Our team of volunteers also removes nearby fronds of *Sabal palmetto* and *Serenoa repens* to provide adequate sunlight. Plants in our ex-situ nursery collection are planted in large 30-gallon pots to accommodate their tap root. The planting mix is composed of 1/3 coarse Turface, 1/3 crushed limestone, and 1/3 potting soil with an addition of organic matter + mycorrhizae to facilitate drainage and good root development. The plants are fed minimally with 1-2 tablespoons of slow release Nutricote 18-6-8 per year. Plants reside in full sun and are under a daily water regime. In addition, we have 100+ newly germinated seedlings to distribute through the Connect to Protect Network.



Figure 4. An *Amorpha* in Fairchild's pine rockland display garden, responding vigorously after heavy pruning.

***Argythamnia blodgettii* (Torr.) Chapm.**

Argythamnia blodgettii (Blodgett's silverbush) is a federally threatened (USFWS 2016) plant in the spurge family that is endemic to pine rocklands, hammocks, coastal rock barrens, and disturbed uplands in Miami-Dade and Monroe Counties (Gann et al. 2020). The species' form varies widely throughout its South Florida range, from small herb to suffrutescent shrub. In Miami-Dade County, where it is present in just eight protected natural areas, Blodgett's silverbush is generally a sparsely branched herb to 1.5 feet tall. Flowers are small, inconspicuous, and yellow-green. Fruits are 3-lobed capsules to 0.7 mm wide which contain up to three hard round black seeds (**Fig. 5**).

In 2018, Fairchild was hired by AECOM to rescue and translocate *A. blodgettii* from the EEL preserve Owaissa Bauer Addition (OBA), where the widening of Krome Avenue was slated to impact the population. We incorporated the project into our existing rare plant conservation program and were able to use FDACS DPI funds to do even more than was required, for the benefit of the rare species. A report on these efforts follows, extracted from the final report to AECOM. That full report is available upon request.

In order to maximize the collection of genetic diversity for Blodgett's silverbush from within the project footprint, Fairchild proposed a multifaceted approach combining seed collection, seed banking, propagation trials, rescue, and translocations to multiple recipient sites. Work occurred over a 13-month period, from October 2018 through November 2019. Methods, results and discussion for each task are described briefly below, in approximate chronological order.

Seed collection (Oct. 2018 – Jun. 2019)

One of the firsts tasks we conducted at the onset of work was to map and tag all Blodgett's silverbush in the project footprint (total = 65 individuals along the preserve's west edge). Subsequently, we visited the site every 1-2 weeks from October 2018 through June 2019, for a total of 30 visits in which we collected (or attempted to collect) seed from tagged plants. All seed were placed into paper coin envelopes and separated by maternal line with the unique tag number from the source individual written on each envelope. This allowed us to determine how well our seed collecting represented the actual population.



Figure 5. Blodgett's silverbush fruits. **Left:** two immature capsules. **Center:** a ripe capsule that has burst open, revealing 3 seeds. **Right:** an organza bag fastened around developing fruits on the end of a branch (B. Harding, K. Wendelberger).

Seed collection efforts on the west edge of OBA resulted in 546 total seeds from 37 maternal lines. This represented slightly more than half of the 65 tagged plants that were present. The number of seeds recovered during each visit ranged from 0 to 76, with a strong effect of season (**Fig. 6**). Many of the genetic lines ($23/37 = 62\%$) collected are from plants that did not survive extraction. The genetic lines are not represented equally in the seed collected. Nearly $1/3$ of all lines contributed just 3 or fewer seeds. The most productive line contributed 146 seeds, which was 27% of all recovered seed.

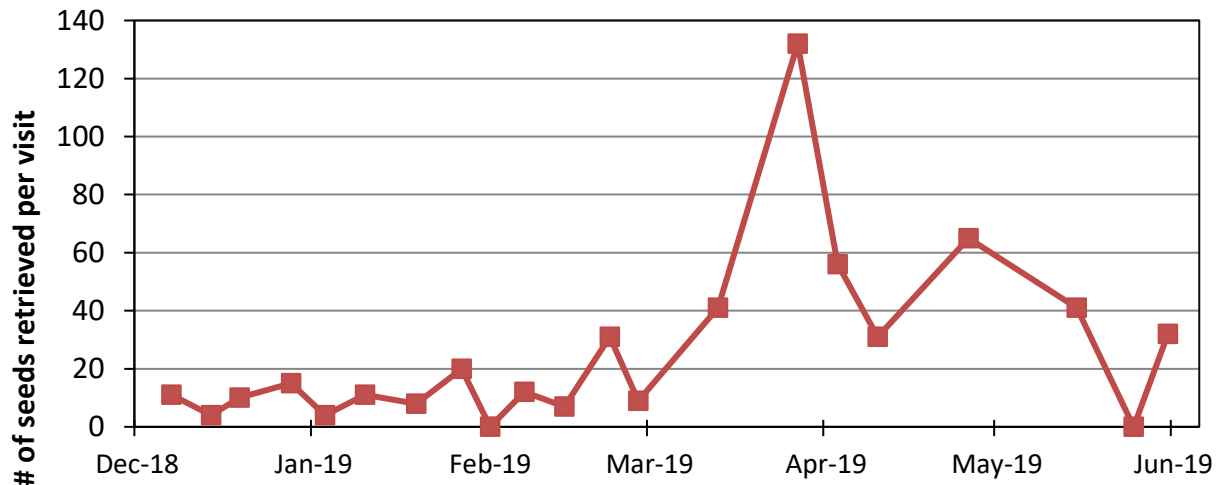


Figure 6. The number of Blodgett's silverbush retrieved on each visit. Eight visits made in October through December that yielded 0 seeds (due to unexpected mowing and to lack of seed bags) are not shown. Seed production increased in early spring, and we were also able to visit less frequently due to the use of organza bags to capture seeds.

Seed germination (Nov. 2018 – Nov. 2019)

Prior to germinating Blodgett's silverbush seed from the project area, we collected seed from plants growing in the interior of OBA to assess germination rates. We sowed 200 seeds into pots in a greenhouse using standard methods (seeds were buried just beneath the surface in medium-grit Turface and watered daily). Seeds were exposed to the following pre-treatments: Desiccation for 0, 48, 72, or 96 hours. Only two of these seeds germinated (one without pre-treatment and one after 72 hours of desiccation). Because this initial trial showed very low rates of seed germination, we determined that we would need to develop a dormancy-breaking method to penetrate the very hard seed coat.

For initial dormancy breaking trials, we used 164 ungerminated Blodgett's silverbush seeds that we recovered from the initial germination trial described above. With these, we tested three different seed scarification methods to break dormancy:

- (1) boiling water for 0, 0.5, 2, 5 or 10 minutes [N=90 seeds; 18 per treatment];
- (2) soak in sulfuric acid (5% (v/v)) for 15 minutes or 5 hours [N=30 seeds, 10 and 20 per treatment, respectively]; and
- (3) soak in water for 72 hours then nick with a razor blade [N=44 seeds].

Both treatments (1) and (2) resulted in no germination and the trials were terminated due to mold. Treatment (3) was successful with a germination rate of 33% (10 out of 30 seeds germinated). However, the process of nicking each seed was difficult since the seed coat of Blodgett's silverbush is extremely hard. Due to the high pressure needed to cut through the seed coat, the razor blade often damaged the

seed embryo (14 seeds were lost in this process). Therefore, we determined it was necessary to do further germination trials in order to find an alternative method to break dormancy.

To obtain more seeds for further dormancy-breaking trials, we sowed 95 of the seeds collected from the west edge of OBA. Seed from lines #270, #5268 and #287 were sown in May 2019. We soaked these seeds in water for 11 days prior to sowing. During this time, 7 seeds germinated in the water (**Fig. 7**). Ungerminated seeds had softer seed coats which were more easily nicked with a razor blade, but there was still substantial loss due to seed embryo damage during the process. Eventually 41 seeds germinated and within four months, 40 plants were flowering and producing seed in the nursery, where Fairchild staff, interns, and volunteers collected seed with the use of organza drawstring bags (**Fig. 8**).



Figure 7. Germinating Blodgett's silverbush seed (B. Harding).



Figure 8. Fairchild BioTech @Richmond Heights intern Jennay Bailey fastens organza bags to Blodgett's silverbush plants in Fairchild's nursery (B. Harding).

As part of a project aiming to increase the seed germination of more challenging pine rockland species funded by the Association for Zoological Horticulture we created a smoke solution. Since Blodgett's silverbush grows in a fire-dependent habitat we hypothesized that seed germination of this species might be triggered by chemical signals from smoke. The smoke solution was created by burning pine straw in a bee smoker and guiding the smoke through a heater hose into a side-arm flask fill with water as described in Coon et al. 2014 (**Fig. 9**).

To test the effect of the smoke solution and other dormancy breaking methods on the germination rate of Blodgett's silverbush seeds we conducted an experiment with the following treatments:

- (1) 24h soaking in smoke solution at three different concentrations. Smoke solution was diluted 1:2, 1:10 and 1:100 with water [N=300 seeds; 100 per treatment, 5 replicates with 20 seeds each];
- (2) 24h soaking in 0.5% potassium nitrate (KNO_3) solution [N=100 seeds, 5 replicates with 20 seeds each];
- (3) 24h soaking in water [N=100 seeds, 5 replicates with 20 seeds each];
- (4) No treatment (Control) [N=100 seeds, 5 replicates with 20 seeds each].

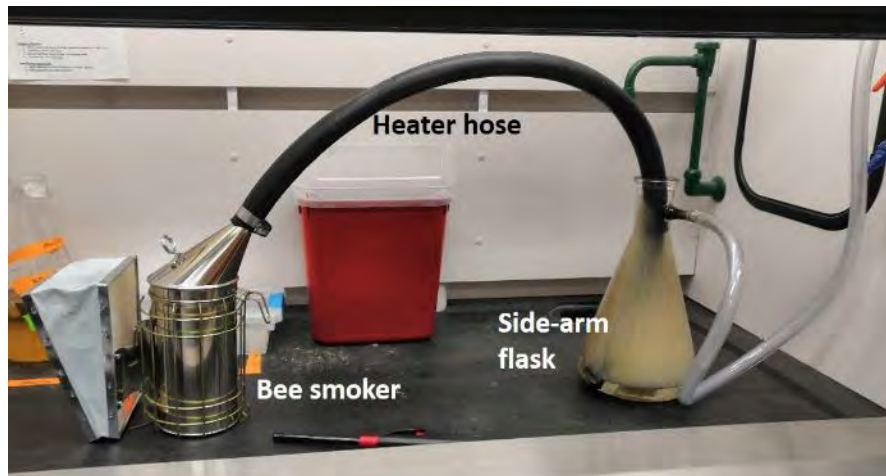


Figure 9. Pine straw was burned in a bee smoke and guided into water to create a smoke solution.

The treatment with different concentration of smoke solution increased the mean rate of germination substantially (**Fig. 10**), especially when the smoke solution was diluted 1:10 (germination rate $81 \pm \text{SE}4\%$) and 1:100 (germination rate $76 \pm \text{SE}4\%$). Treating seeds with smoke solution diluted 1:2 or with 0.5% KNO₃ solution also improved germination rates ($54 \pm \text{SE}3\%$ and $51 \pm \text{SE}7\%$ respectively) when compared to soaking in water and no treatment ($15 \pm \text{SE}3\%$ and $11 \pm \text{SE}3\%$ respectively).

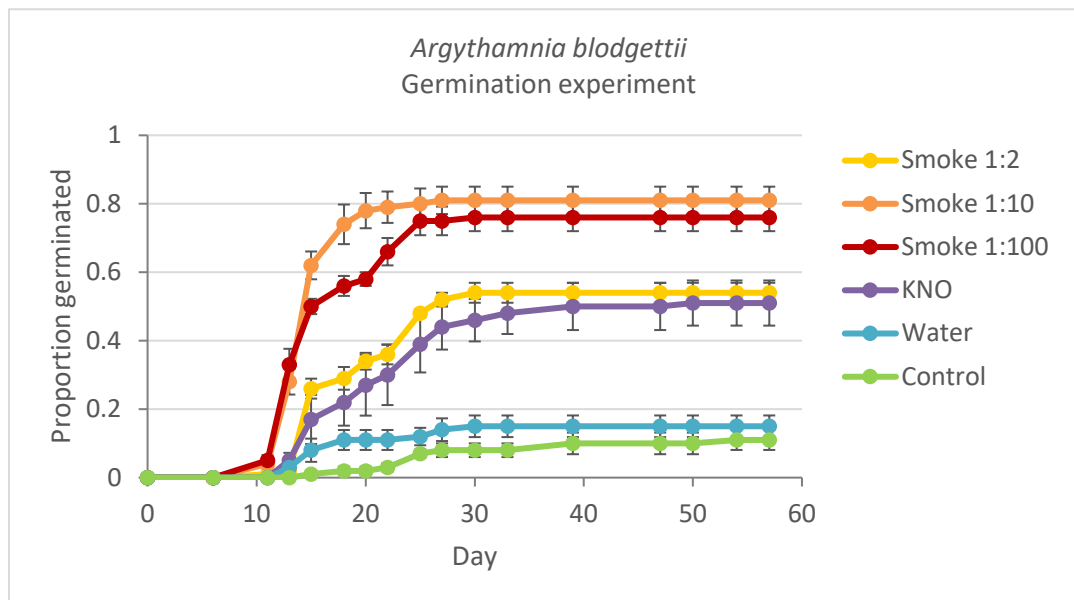


Figure 10. Mean germination rate of Blodgett's silverbush seeds after different treatments across time (SE is displayed).

Vegetative cuttings (Oct. 2018 – Jun. 2019)

Because seed collection and germination were initially difficult, we determined it was necessary to attempt to propagate Blodgett's silverbush by vegetative cuttings. Vegetatively propagated plants could serve as a fail-safe if seed collection and rescue had poor results. To develop vegetative propagation methods, we first collected 33 cuttings from plants in the interior of OBA in October 2018. We subjected the lower node of each 3-node cutting to one of three different treatments: Hormondin 3 powder (0.8%

IBA), Hormondin 2 powder (0.3% IBA) and Dip 'N Gro liquid (1:5 ratio). We did not use a control group, since this is a federally listed species and we did not expect untreated cuttings to survive. All cuttings were inserted into perlite and placed on intermittent mist, 8 seconds every 2 minutes, for several months. In this initial trial, Hormondin 3 produced the best results with 11 of 12 well-branched rooted cuttings. Dip 'N Gro 1:5 also performed well, with 9 of 11 cuttings rooted. Hormondin 2 resulted in rooting of only 5 of 10 cuttings, most of which were poorly developed (**Fig. 11**).



Figure 11. Results of Blodgett's silverbush vegetative propagation trials using three different rooting hormones. Left to Right: Dip 'N Gro 1:5, Hormondin 2, and Hormondin 3 (B. Harding).

On June 19, 2019, we collected 92 (3-node) cuttings representing 17 maternal lines from the west edge of OBA. Immediately upon collection, we wrapped cut ends in wet paper towel and placed the cuttings in a plastic bag for transport. Within 3 hours, each cutting was dipped in Hormondin 3, inserted into perlite, and placed on intermittent mist for several weeks. As with seeds, we carefully tracked maternal lines.

Cuttings made from plants extracted in June had a much lower success rate than those made during the initial trials in October of 2018. Of the 92 vegetative cuttings we collected from the west edge OBA transplants in June 2019, only 17 (18%) rooted, representing only 8 of the maternal lines extracted. Of the 17 rooted cuttings, only a single plant developed a well-branched root system comparable to the roots developed by cuttings in our original trial, made in October 2018.

While it initially appeared that vegetative cuttings might be a viable way to rescue Blodgett's silverbush, this method did not prove to be as effective at propagating plants as seed collection or even as direct extraction, as vegetatively-propagated plants proved less vigorous than seed-grown ones. It was notable that our success rate for cuttings was higher in the October trial (92% rooting with Hormondin 3) compared to the June trial (18% rooting). This was likely due to Blodgett's silverbush having much higher root carbohydrate stores in the South Florida dry season compared to the wet (=growing) season, when carbohydrates are moved to the shoot system, which in turn is not favorable for root development.

As of November 2019, only two cutting-grown Blodgett's silverbush are still alive in Fairchild's nursery. Both are from OBA; one is from the west edge and the other is from an interior plant.

Plant extraction (Jun. - Aug. 2019)

On June 25, 2019, staff and volunteers from multiple agencies extracted 75 Blodgett's silverbush plants from the west edge of Owaissa Bauer Addition (**Fig. 12**). We used digging bars and pickaxes to loosen the rocky soil around the base of each plant, and then put each plant immediately into a 5-gallon bucket with a few inches of water. Plants were transported to Fairchild's nursery and potted within 3 hours of extraction. To cultivate the extracted plants, we cut the shoot system back to approximately 10 cm to

avoid excess surface area for transpirational water loss during the plant's root development period. The root system for all plants was minimal and poorly branched. To encourage root development, each plant was potted separately in a pint pot in a potting mix consisting of peat moss, coir, and perlite with added 18-6-8 Nutricote time release fertilizer to provide fertility throughout the rooting/growing period. They were watered using reverse osmosis water and kept in our on-site glass house in 40% shade to reduce stress. Fairchild's conservation staff, EEL preserve managers, Fairchild's conservation volunteers, and Fairchild's Conservation Student Scholars all helped to cut back and pot plants to reduce the amount of time between extraction and potting.



Figure 12. Extraction of Blodgett's silverbush from Owaissa Bauer Addition. **Left:** Rob McMullen from FDOT and Mike Breiner from AECOM working on the west edge of OBA. **Center:** Fairchild intern Logan Taylor uses a digging bar to extract Blodgett's silverbush. **Right:** After extraction, Kirk Linaje and Robert Feder from Miami-Dade EEL and Fairchild volunteer Nathan Osborne help to pot up extracted silverbush at Fairchild's nursery (J. Possley).

On August 2, 2019, we extracted 78 additional Blodgett's silverbush from the north edge of Owaissa Bauer Addition and processed them using the same methods as described above. Of the 153 total plants extracted, 87 (57%) survived the extraction process and were available to translocate to wild habitat. Survivorship was slightly higher in west edge transplants (60%) than in the north edge transplants (54%). We did not measure the heights of individual plants that were extracted, but we noted that plants from the west edge tended to be larger than those from the north edge; many of the northern plants appeared to be young plants that had not yet developed woody stems and were under 10 cm tall.

Translocation (Aug. – Sep. 2019)

On August 7, 2019--43 days after extraction--we installed the 46 surviving Blodgett's silverbush from the OBA west edge at Seminole Wayside Park and EEL Addition. While we initially intended to split plants between this preserve and West Biscayne Preserve, staff and time constraints made it necessary to concentrate on one recipient site at a time. Plants were divided into two equal groups which were planted in two different units in the south end of Seminole Wayside. All plants were mapped with a handheld Garmin eTrex GPS, assigned to a size class, and tagged with a unique numeral. Supplemental watering was only needed twice due to regular rainfall during the entire month of August.

On September 10, 2019--39 days after extraction--we installed the 42 surviving plants from the OBA north edge at West Biscayne Pineland. All plants were GPS mapped, assigned to a size class, and tagged with a unique numeral. Overall, these plants were smaller than the ones extracted from the west edge of OBA. Supplemental watering was provided to all plants on September 11, a light rain fell on Sept 12, and then it rained all day on September 13 and 14. Continual excavation by animals (likely raccoons) was

problematic at this site. Outplants that were disturbed quickly desiccated and died. To assist us in mitigating this, we hired part-time help to check on the West Biscayne populations twice a week for the first few weeks, ensuring that uprooted plants were replanted and watered more quickly.

Overall survival of transplants at the time of this report (June 2020) is 63%, with 56 of 88 plants remaining. Survival is higher in Seminole Wayside Park and EEL Addition ($37/46 = 80\%$) than in West Biscayne Pineland Preserve ($19/42 = 45\%$). At Seminole Wayside, 97% of plants were reproductive when last monitored in June 2020, as opposed to only 84% of the West Biscayne plants. Higher fitness at Seminole Wayside was likely due to larger size at installation. But another unexpected factor played a role in reduced survival at West Biscayne Preserve: repeated excavation by animals (likely raccoons) was an issue at that preserve. After planting, a total of 20 transplants were partially or completely dug up and replanted. Only 3 of these individuals survived to date.

Conclusion

As this project draws to a close, early results suggest a successful rescue and translocation of Blodgett's silverbush from the impacted edges of Owaissa Bauer Addition. Of the 153 plants extracted from the donor site, 57% survived extraction and 39% are established in recipient sites. Perhaps more significant in the long term was the collection of 546 seeds from 37 maternal lines along the preserve's west edge, which includes germplasm from 23 plants that have since died.

In several instances, this work was more difficult than anticipated. This was especially true for collecting seed and breaking seed dormancy. Yet by trying different collection methods and running experimental trials with seed scarification methods, we were able to develop best practices for these methods, as well as for vegetative propagation and transplanting. Our intentions are to share what we have learned through a peer-reviewed publication, which could serve as a resource for persons working with Blodgett's silverbush or with similar species or situations in the future.

Through Fairchild's ongoing conservation program for rare native plants of South Florida, efforts to safeguard Blodgett's silverbush will continue in perpetuity. We will bank seeds from cultivated plants for use in research and propagation, install plants in Fairchild's pine rockland display garden, and share plants with other botanical institutions in South Florida such as Key West Botanical Garden and/or Naples Zoo and Botanic Garden. We will also be able to offer Blodgett's silverbush to select members of our Connect to Protect Network. This outreach and citizen science program, which has over 800 members, encourages South Florida citizens to grow native plants in home and school gardens in order to return some of the pine rockland diversity that has been lost through rapid development.

This project serves as an example of how agencies can and should reach across jurisdictional borders in order to cooperate successfully to reduce biodiversity loss.

Ex situ collections

With the help of our volunteer corps, we potted all seedlings generated as a result of the germination experiments. We have an ex-situ population at the nursery of approximately 350 plants. *Argythamnia* grows robustly in cultivation. Plants were potted in potting soil in 3" pots and received a single application of 1 teaspoon time release Nutricote 18-6-8 for fertility and additional fertility, at the rate of 30 ppm 20-10-20, once a month or as needed. Plants are sited in full sun and are under a regular watering regime.

***Bourreria cassinifolia* (A.Rich.)Griseb.**

Bourreria cassinifolia, the little strongbark, is a short- to medium-sized shrub native to Cuba and pine rocklands of Miami-Dade and Monroe Counties, though it may be extirpated in Monroe County (Gann et al. 2020). In Miami, it is known from Everglades National Park and 7 Miami-Dade County EEL preserves. The species is not abundant in any of these locations; several populations have fewer than ten plants. Over this past year, we made several visits to three of the seven MDC EEL preserves with *B. cassinifolia*. For the upcoming year, this species will continue to be included in our work plan as part of this FDACS-DPI grant. We will conduct population update surveys in the four remaining preserves where it is found and continue to build ex situ collections.

Update on wild populations

Camp Owaissa Bauer

At Camp Owaissa Bauer, *B. cassinifolia* is scattered through the pine rockland in clumps ranging in size from 1 to 15 plants. Plants are especially prevalent in the pine rockland-hardwood hammock ecotone. There are at least 45 woody individuals (**Fig. 13**) currently mapped in the preserve, along with several dozen nearby seedlings. We trimmed hardwood vegetation around shaded plants and discussed further hardwood vegetation management with the preserve manager.



Figure 13. Lydia Cuni and Chris Migliaccio flank the largest, most robust *B. cassinifolia* at Camp OB.

Bill Sadowski Park

The two adult *B. cassinifolia* at Bill Sadowski are flowering and fruiting after land management crews removed surrounding overgrown vegetation (a practice which they have conducted here for years, in response to our recommendations). We will cultivate the few seeds we collected to start an ex situ collection for this tiny wild population.

Seminole Wayside Park

At Seminole Wayside Park, only 10 *B. cassinifolia* are present. These are not flowering or fruiting due to being shaded by tropical hardwoods. As with the other populations, we are working with Miami-Dade Preserve managers to thin the broadleaf vegetation away to allow more sunlight to reach *the B. cassinifolia*. Once plants produce flowers and fruit, we will collect seed for ex situ conservation.

Update on seed biology

Conservation efforts for *Bourreria cassinifolia* have been hampered by the fact that, despite significant efforts, we have been unable to determine how to best germinate seed for propagation and likewise have not yet been able to determine whether its seed are capable of orthodox storage. Thus, we have drawn on our Connect to Protect Network membership to obtain large quantities of seed from cultivated plants in order to conduct a battery of germination tests. If we are able to determine optimal

germination methods, and if we learn that seeds are capable of orthodox storage, we will begin to bank seeds from the small populations located in Miami's urban preserves.

In an attempt to improve germination rates, *Bourreria cassinifolia* seeds were subject to the following pre-treatments:

- (1) Soaked in a smoke solution for 24h at three different concentrations: 1:2, 1:10 and 1:100 with water [N=300 seeds; 100 per treatment, 5 replicates with 20 seeds each];
- (2) Heated in an oven at 100°C for 5 minutes [N=100 seeds, 5 replicates with 20 seeds each];
- (3) Heated in an oven at 80°C for 30 minutes [N=100 seeds, 5 replicates with 20 seeds each];
- (4) Soaked in 0.5% potassium nitrate (KNO₃) solution for 24h [N=100 seeds, 5 replicates with 20 seeds each];
- (5) Soaked in water for 24h [N=100 seeds, 5 replicates with 20 seeds each];
- (6) No treatment [N=100 seeds, 5 replicates with 20 seeds each];

All seeds were sown into pots filled with Turface (a clay product). All pots were placed in the propagation greenhouse at Fairchild's nursery since preliminary experiments showed that germination was better in the greenhouse than in the germination chamber. 20 seeds were sown into each pot. The results show that although seeds treated with smoke solution of all three concentrations (1:2, 1:10, and 1:100) germinate at a higher rate ($20 \pm \text{SE}3\%$, $25 \pm \text{SE}2\%$ and $16 \pm \text{SE}4\%$ respectively) (**Fig. 14**) compared to seeds soaked in water ($4 \pm \text{SE}2\%$), soaked in 0.5% potassium nitrate ($12 \pm \text{SE}3\%$) and heated in the oven at different temperatures ($5 \pm \text{SE}3\%$ and $3 \pm \text{SE}2\%$), the highest germination rate occurred with no seed pre-treatment ($40 \pm \text{SE}7\%$). Only after the experiment it was realized that the seeds for the control came from a different source and therefore this result indicates that seed source might play an important role in how well seeds germinate in this species.

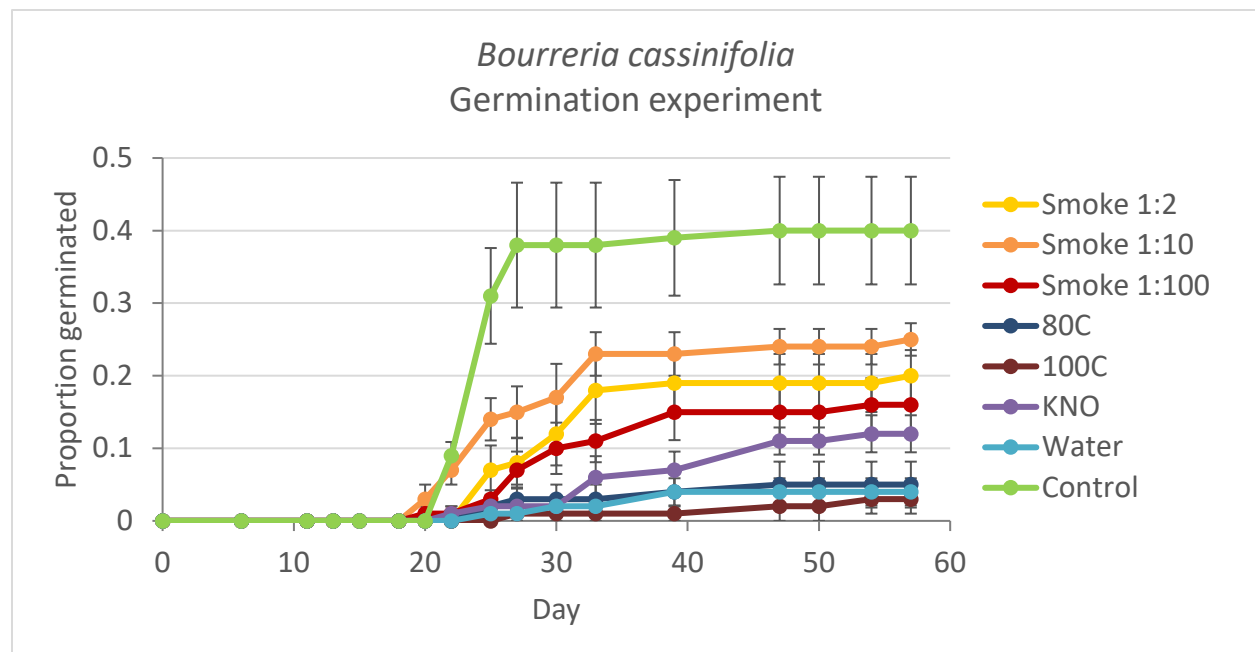


Figure 14. Mean germination rate of little strongbark seeds after different treatments across time (SE are displayed).

We started another germination experiment that is currently ongoing to compare germination rates of seeds from 7 different sources (all from CTPN member yards). Half of the seeds from each source were treated 24h with smoke solution (diluted 1:10) and the other half received no treatment. If results show that germination depends mostly on the seed source, we will do further research to try to determine the underlying cause of this variation.

Ex situ collections

Bourreria flourishes in cultivation and is often reproductive in pots at a young age. There are 120 plants in 1-gallon pots at the nursery destined for distribution to homeowners through the Connect to Protect Network. These plants are planted in potting soil with an addition of 1 tablespoon time release Nutricote 18-6-8 for fertility. Because of its high iron requirement, *Bourreria* often suffers from iron-induced chlorosis in cultivation. In addition to Nutricote, we supplement with a one-time dose of chelated iron to prevent any nutritional deficiencies. We grow our plants in full sun under a regular water regime.

***Brickellia mosieri* (Small) Shinnery**

A perennial suffrutescent herb in the Asteraceae family, *Brickellia mosieri* (Mosier's Brickell Bush) is a federally endangered species endemic to South Florida, where it is found solely in pine rockland communities within Miami-Dade County. It grows at edges of sandy gaps, often rooted very close to palmettos and extending its flowering branches out toward the sun. Plants usually senesce and refoliate in tune with the wet/dry season. According to FNAI, *B. mosieri* (hereafter "*Brickellia*") is extant in 15 protected natural areas, though it is likely extirpated in at least one, and a few other populations may occur on private land.

[Note: the work described here was funded in part by the US Fish and Wildlife Service, through a grant to conduct translocations of some of South Florida's newly listed pine rockland species. However, that funding required only 5 translocation actions. By combining that funding with support from this FDACS DPI grant, we were able to conduct 11 total translocations]

Update on Translocations

Rockdale Pineland

Previous Fairchild surveys determined that the known population of *Brickellia* at Rockdale was fewer than 20 plants. In summer 2019, we augmented the *Brickellia* population at Rockdale with 57 plants and 480 seeds, all of Zoo Miami origin. The nursery-grown transplants have been far more successful than direct seed-sowing. Plants were introduced into two areas with different substrate types; rocky vs. sandy (**Fig. 15**). After one year, outplants in the sandy area had overall greater survival (94%) than those in the rocky substrate (76%).

Though *Brickellia* seeds germinated fairly well in the field (35-42% emergence), approximately half of seedlings perished after record-high temperatures and little/no rainfall. More seeds emerged in the sandy area (56 vs. 3). Of note, seed plots had more germinants when they were not covered with pine. Fewer than 10 *Brickellia* seedlings remained alive at one year post-sowing.



Figure 15. Left: A transplanted *Brickellia* blooms in Rockdale's sandy pineland. Right: *Brickellia* seedlings in the sandy pineland beneath a transplant

Seminole Wayside Park

In summer 2019, we augmented the *Brickellia* population at Seminole Wayside with 21 plants of West Biscayne origin. Survival is 94% to date.

Zoo Miami

In May 2020, we donated 30 *Brickellia* of Zoo Miami and Larry & Penny origin to a pine rockland restoration project at Zoo Miami. This translocation will be assessed in August at the three-month mark.

Ex situ collections

Since 2015, Fairchild has been building an ex situ collection of *Brickellia mosieri* from all known locations for which we could collect, entering over 15,000 seeds of 10 populations into long-term storage.

This species does remarkably well in cultivation. Seeds germinate within 2 weeks and plants can be reproductive within their first year. We currently have an ex situ collection of ~200 plants (**Fig. 16**). There are also some individuals on display in the pine rockland plot at the Garden. *Brickellia* prefers full sun. In containers, plants do best with light fertility (time release Nutricote 18-6-8) and potting medium composed of ½ potting soil and ½ coarse Turface. Multiple flushes of growth occur throughout the year and our volunteers harvest seeds as they're available.



Figure 16. The living collection of *B. mosieri* at the FTBG nursery takes up two tables (one pictured). Stakes and flagging are to deter peacocks.

Catopsis berteroniana

Catopsis berteroniana, the powdery strap airplant, is a carnivorous bromeliad found throughout the New World tropics. Its northern range extends into swamps and hammocks of South Florida, where it is listed as endangered. Its Florida range was never large, and the species is under threat from the Mexican bromeliad weevil in the Fakahatchee Strand Preserve State Park, which was formerly the largest Florida population. The species is still present in Big Cypress National Preserve and Everglades National Park, and is likely extirpated from the Picayune Strand State Forest and several Miami-Dade preserves (Gann et al. 2020). In 2016, biologists Dennis Giardina and Gwen Burzycki discovered a previously undocumented population in buttonwood swamp in the Miami-Dade Environmentally Endangered Lands Program's South Dade Wetlands "Site 17" preserve (**Fig. 17**). The population consists of a few hundred individuals but only a small proportion are old enough to reproduce.



Figure 17. Miami-Dade and SFWMD biologists with *Catopsis berteroniana* population in South Dade Wetlands Site 17 (Photo by Jimmy Lange, August 2017).

Ex situ collections

Fairchild maintains a small ex situ conservation collection of *Catopsis berteroniana* in our nursery, consisting of 10 larger plants grown from seed collected in 2017 and approximately 50 small pups (**Fig. 18**) that were rescued by Miami-Dade and SFWMD staff from a fallen branch in 2019. Our intentions are to maintain the larger plants in the nursery and to introduce the smaller ones to appropriate habitat at Fairchild and/or the Deering Estate once they have grown a little more. These plants are currently about 1" tall. In 2017 we attempted to introduce a few hundred very small plants to buttonwood trees at Fairchild, but none survived; we believe using larger plants may improve survivorship, if we can grow healthy plants.



Figure 18. Small *Catopsis berteroniana* rescued from South Dade Wetlands “Site 17” and delivered to the Fairchild nursery by Miami-Dade County EEL staff in 2020. Plants are suspended over moist sand and in bright light, to try to replicate the bright, humid conditions of their preferred buttonwood forest habitat.

***Chamaecrista lineata* (Sw.) Greene var. *keyensis* (Pennell) H.S. Irwin & Barneby**

A federally endangered, perennial suffrutescent legume, the Big Pine Partridge pea (*Chamaecrista lineata* var. *keyensis*) is endemic to the lower Florida Keys. Currently extant only on Big Pine Key (BPK), it was historically found on several nearby islands (Cudjoe Key, No Name Key, Sugarloaf Key, and Ramrod Key) that once supported high-elevation pineland.

[Note: the work described here was funded in part by the US Fish and Wildlife Service, through a grant to conduct translocations of some of South Florida's newly listed pine rockland species. However, that funding required only 5 translocation actions. By combining that funding with support from this FDACS DPI grant, we were able to conduct 11 total translocations]

Update on Translocation

In August 2019, we introduced 48 nursery-grown *Chamaecrista lineata* var. *keyensis* (hereafter "*Chamaecrista*") to No Name Key. We placed 18 plants, 6 at a time, into 3 Key deer-proof cages (**Fig. 19. Left**). The other 30 plants were not protected from herbivory. As early as 1 month after outplanting, we documented seedling recruitment. At 6 months (March 2020), 200 seedlings are present around 40 transplants. At 8 months (June 2020), survival was 100% for caged plants and 60% for uncaged.

We also conducted a field seed germination trial for *Chamaecrista*. We introduced 720 seeds of four pre-treatments over a total of 36 seed plots using 20 seeds per plot. Plots were either 4" diameter PVC tubing cut into 2" high rounds or small round black nursery pot tops that were also 4" across (**Fig. 19. Right**). Average seed emergence and (survival) rates for the different pre-treatments at 6 months (March 2020) were: fresh – $53 \pm \text{SD}12\%$ ($39 \pm \text{SD}20\%$); frozen – $50 \pm \text{SD}19\%$ ($35 \pm \text{SD}21\%$); desiccated – $39 \pm \text{SD}20\%$ ($27 \pm \text{SD}8\%$); scarified – $31 \pm \text{SD}15\%$ ($22 \pm \text{SD}13\%$). Introducing fresh or frozen seeds produced similar results, strengthening the importance of preserving seeds in frozen seed banks.



Figure 19. Left: One of three cages used to protect *Chamaecrista* outplants from herbivory by Key deer. **Right:** Paired fresh vs. frozen field seed array, 3 months post sow.

Ex Situ Conservation

Since 2016 we have been building our ex situ collection of *Chamaecrista* from seeds collected from many subpopulations on Big Pine Key in National Key Deer Refuge (NKDR). We currently maintain a collection of at least 43 plants at the Fairchild nursery (**Fig. 20**). This species is fairly easy to cultivate. It prefers full sun and light fertility (time release Nutricote 18-6-8). Plants benefit from being cut back to the base once yearly and thrive in potting soil with crushed limestone.



Figure 20. *Chamaecrista lineata* var. *keyensis* in the Fairchild nursery. We cover developing pods with organza drawstring bags to collect seeds. To date we have entered over 4,000 seeds into long-term storage, largely from the robust ex situ living collection at the nursery.

Salinity study

Since *C. lineata* var. *keyensis* is endemic to the Florida Keys an additional threat to this species might be an increase of soil salinity due to more frequent storm surges and sea level rise in general. Together with two student interns from the BioTECH High School at Richmond Heights we investigated how seed germination and seedling establishment might be affected by an increase in soil salinity. To test the effect of different salinity levels on the seed germination rate and seedling survival of *Chamaecrista* we created salt solutions with 6 different concentrations. The salt solutions were prepared using commercially available sea salt. The mean salinity level of sea surface water around the Florida Keys varies between 35 and 40‰ (Wagner et al. 2008). We conducted two separate experiments, one for seed germination and the other for seedling survival.

1. Seed germination trials

For this experiment, 100 seeds per treatment were sown into petri dishes (10 seeds per replicate) filled halfway with silica sand saturated with the respective salt solution. The salt concentrations

were 0‰, 5‰, 10‰, 15‰, 30‰, and 45‰. At the time when this experiment started, we assumed that seeds of *Chamaecrista* need mechanical scarification to reliably germinate. For that reason, we treated all seeds with sandpaper prior to sowing.

The results show that *C. lineata* var. *keyensis* seeds tolerate salt concentrations up to 10‰ (mean germination rate at 0‰ = $95 \pm \text{SE}2\%$, 5‰ = $92 \pm \text{SE}2\%$ and 10‰ = $90 \pm \text{SE}2\%$) (**Fig. 21**). However, a 15‰ salt concentration decreased the mean germination rate significantly to $57 \pm \text{SE}13\%$. Seeds that were treated with higher salt concentrations of 30‰ and 45‰ had very low germination rates of $3 \pm \text{SE}2\%$ and 0%.

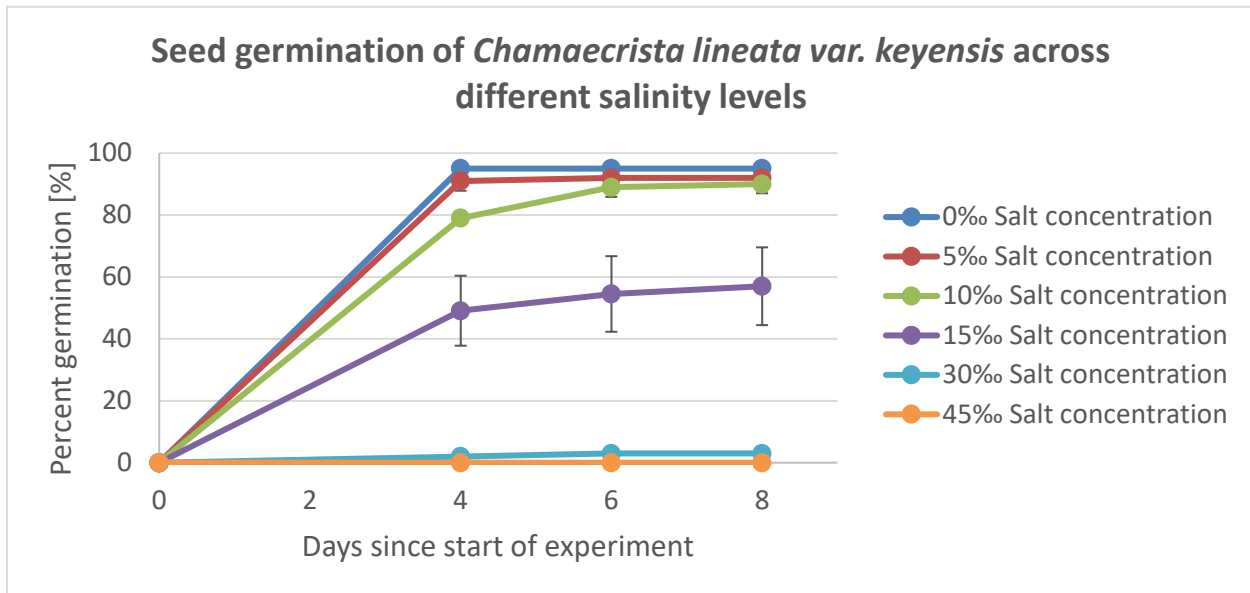


Figure 21. Effect of different salinity levels on the mean germination rate of *C. lineata* var. *keyensis* seeds (SE are displayed).

Although seeds of this species can tolerate low levels of salinity, concentrations above 15% reduce seed viability significantly. However, the seeds used in this experiment were scarified prior to sowing which damaged the seed coat and might have made the seeds even more susceptible to salt stress. Therefore, we intend to repeat this experiment without any scarification.

2. Seedling survival experiment

In total 144 *C. lineata* var. *keyensis* seedlings were grown for ~ 1 month in individual 2.5-inch pots filled with regular potting soil. In order to assess the effect of different levels of salt stress on seedling survival these pots were then placed into trays filled with salt solutions of 6 different concentrations (0‰, 5‰, 10‰, 15‰, 20‰, and 30‰). In a greenhouse at FTBG's nursery 6 pots were placed in each tray and 4 trays in total were setup for each treatment (4 replicates, 24 seedlings per treatment) (**Fig. 22**). Plants were not watered additionally and once a week the salt concentration was of each tray was measured and adjusted if necessary. The experiment run for ~60 days (not all treatments started and finished at the same time due to limited student availability).



Figure 22. Experimental setup to test the effect of salt stress on seedling survival of *C. lineata* var. *keyensis*.

The results of this experiment show that seedlings can tolerate salinity levels up to 10‰ for an extended time period of almost 2 months (**Fig. 23**). The survival rate of seedlings treated with 0‰, 5‰ and 10‰ salt concentrations were 100%, $79 \pm \text{SE}4\%$ and $75 \pm \text{SE}8\%$ respectively. However, the survival rate of seedlings in trays with salt concentrations of 15‰, 20‰ and 30‰ dropped significantly to $16 \pm \text{SE}7\%$, $13 \pm \text{SE}8\%$ and $4 \pm \text{SE}4\%$ respectively. It is interesting to note that seed germination and seedling survival seem to both decrease considerably when salinity levels are higher than 10‰.

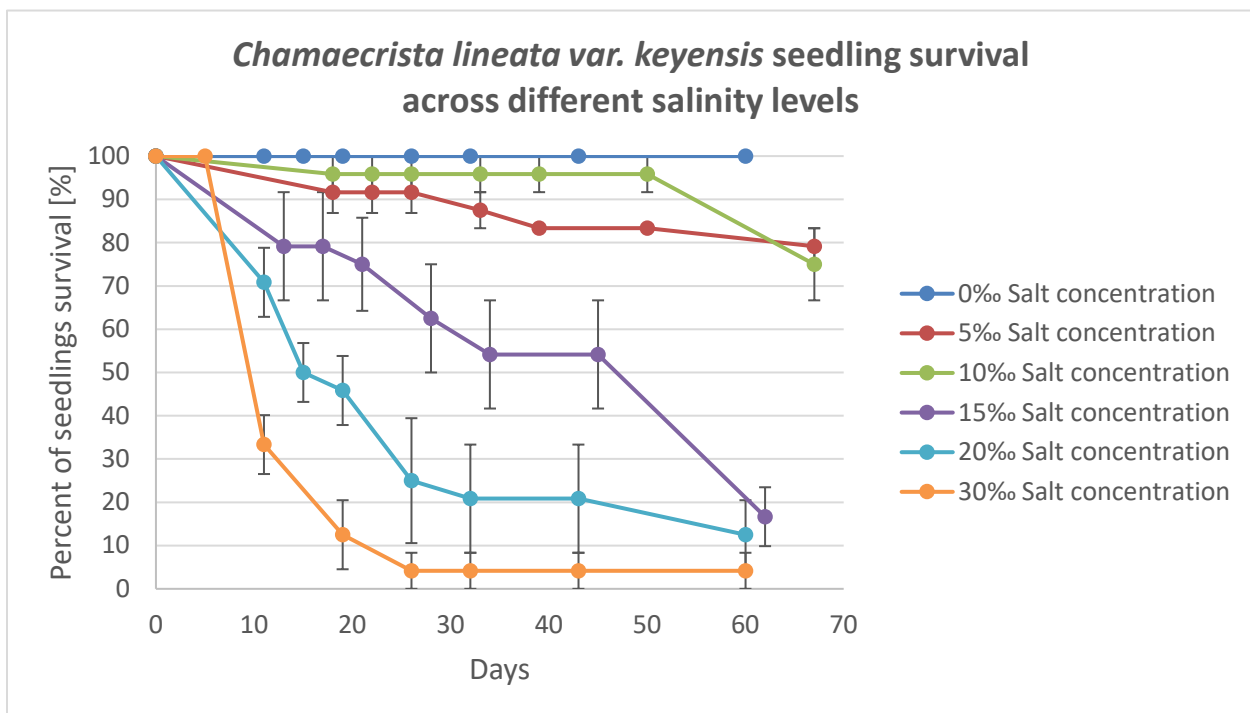


Figure 23. Seedling survival of *C. lineata* var. *keyensis* across different salinity levels (SE are displayed).

Chamaesyce deltoidea* ssp. *serpyllum
(Syn: *Euphorbia deltoidea* ssp. *serpyllum*)

Found only on the island of Big Pine Key (BPK), the Keys wedge spurge is a tiny prostrate perennial herb in the Euphorbiaceae family. The federally endangered taxon can be found is scattered across the island in colonies where it grows in crevices on the limestone bedrock surface in the (relatively) higher elevation pine rockland habitats.

[Note: the work described here was funded in part by the US Fish and Wildlife Service, through a grant to conduct translocations of some of South Florida's newly listed pine rockland species. However, that funding required only 5 translocation actions. By combining that funding with support from this FDACS DPI grant, we were able conduct 11 total translocations]

Update on Translocation

We introduced 320 Keys wedge spurge seeds to No Name Key by direct sowing 20 fresh seeds into 16 plots, which were placed in two clusters of 8, in different parts of the island. Plots were 4" diameter PVC tubing cut into 2" high rounds. We monitored the field seed germination trial at 1 week, and then at 1, 2, 3, 4.5, 6, and 10 months (**Fig. 24**).

Overall peak emergence occurred 3 months after sowing (November 2019). Seeds germinated at twice the rate in the south area (33%, 52 seedlings) vs. the north – (16%, 25 seedlings). At ten months (June 2020), at least 29 seedlings were still present in plots; this is a survival rate of 37%.

Within six months, 22 of the spurge plants were reproductive in 9 plots (8 south plots and 1 north). The next generation is already recruiting (**Fig. 24. Right**); 14 recruits were found near plots in the south area during our latest monitoring (June 2020).



Figure 24. Left to right: 1. Cotyledons and true leaves of seedlings at one month. 2. Some seedlings were reproductive as soon as three months. 3. A very fruity seed plot at 10 months. 4. A Keys wedge spurge recruit in the landscape.

Ex situ collections

Since 2016 Fairchild has been working on ex-situ conservation efforts for this taxon, including entering seeds into long-term cold storage. Seeds of this taxon were previously hypothesized to be recalcitrant and incapable of persisting under long-term cold storage at -18 °C (Kennedy et al. 2012), but a small germination trial we conducted with 10 frozen seeds found that 8 germinated. The taxon germinates quickly from seed, often in less than 1 week.

We also experimented with vegetative propagation using cuttings collected from numerous genetics lines and exposing them to different treatments of rooting hormone to determine the best method to induce rooting. The experiment found vegetative cuttings will root at a high rate, but transplant survival was low and none survived long-term.

Horticulturally we have found that this taxon is difficult to cultivate. We currently have just 1 individual of *C. deltoidea* ssp. *serpyllum* at the Fairchild nursery; it was actually an unintentional recruit from a now-dead potted spurge that seeded into a nearby flat full of sandy limestone medium for growing Key tree cactus.

***Ctenitis submarginalis* (Langsd. & Fisch.)Ching**

The terrestrial fern *Ctenitis submarginalis* is native to Hispaniola, Mexico, Central and South America, as well as Florida and Louisiana in the US (Gann et al. 2019). It is listed as endangered in Florida and has been vouchered in six central- and south-Florida counties (Wunderlin and Hansen 2019). In South Florida it is extirpated from at least half of its historical range, currently known only from Fern Forest Nature Center (Broward Co.), the Fakahatchee Strand (Collier Co.), and The Deering Estate (Gann et al. 2019).

Update on Wild Population

The population of *C. submarginalis* at The Deering Estate is located near the Pipeline Trail, approximately 120 meters south of Cutler Creek, in one of the lowest-elevation areas in the hammock. In late 2012, FTBG documented 29 individuals in this area, but soon after completion of the project to restore the hydrology of Cutler Slough, the population began to crash, with the number of fertile individuals dwindling to just one plant by March 2015. Throughout 2013 while plants were declining, we collected spores from 7 genetic lines, sending 3 lines to the Cincinnati Zoo and Botanical Garden's Lindner Center for Research on Endangered Wildlife (CREW) and keeping 4 at FTBG for propagation. Both institutions propagated *C. submarginalis* for *ex situ* conservation collections and for the augmentation reported on below.

In recent years, FTBG has not re-observed any naturally occurring *C. submarginalis* plants in the Cutler Creek area, despite searches. However, extremely dense understory vegetation makes searches very difficult.

Reintroduction

On October 16, 2019, FTBG, Deering and Miami-Dade staff installed 26 *C. submarginalis* plants in three separate locations in the Deering Estate hammock (**Fig. 25**). Container sizes included 2-gallon (10 individuals), 1-gallon (15 individuals), and 1-pint (1 individual). Plant origins included one that was extracted from the Deering Estate in 2013, plants that were propagated from spore collected at Deering, and plants that were propagated from spore of a plant donated to Fairchild in 1997 by local fern collector Don Keller. While this source plant was very likely of Miami-Dade origin, we do not have further information indicating its exact source.



Figure 25. Photos from the Deering Estate hardwood hammock on October 16, 2019, when 26 of the imperiled fern *Ctenitis submarginalis* were planted in hammock, near the slough edge.

We installed *C. submarginalis* plants near where the wild population was previously located, but on higher ground, above the high-water line. Because October is the beginning of the South Florida dry season, we watered ferns frequently for months after planting. During the first month, watering was 2-3 times per week. Thereafter, watering occurred nearly weekly through March 2020. When watering, staff frequently noted that plants were wilted, though no mortality was observed. We conducted full monitoring in mid-April 2020 at six months post-planting. All 26 plants remained alive, however only 5 plants were rated as “good,” and 10 plants were rated “poor,” meaning it was doubtful they would survive. On average, plants had 4.4 fronds; the individual with the most fronds had 10.

Ex situ collections

We continue to maintain a collection of *C. submarginalis* in Fairchild’s nursery. Plants are in 1-gallon pots in 1/2 potting soil and 1/2 perlite with 1 tablespoon time release Nutricote 18-6-8 fertilizer. In addition, we supplement with chelated iron to prevent any iron deficiencies. They reside in our nursery greenhouse under 50% shade and are under a regular water regime (reverse osmosis water system).

***Dalea carthagenensis* (Jacq.) J.F. Macbr. var. *floridana* (Rydb.) Barneby**

The small shrub *Dalea carthagenensis* var. *floridana* (Florida prairie clover, hereafter called “*Dalea*”) is a federally endangered taxon which is endemic to South Florida and found along the ecotone between hammock and pineland as well as calcareous coastal strand habitat. *Dalea* can be found only in five protected areas: Big Cypress National Preserve, Everglades National Park, and three small Miami-Dade County preserves: the Deering Estate, R. Hardy Matheson Preserve, and Crandon. It is also known to be present in two unprotected private properties in the Cutler Bay area of Miami-Dade County.

We recently conducted a range-wide census of *Dalea* and estimated there are 978 plants in South Florida (Lange et al. 2018). During this 2019-2020 grant cycle, we monitored the population at Crandon, the Deering Estate, and R. Hardy Matheson. At Crandon, we continued with the demography study we initiated in 2007.

Update on wild populations

Crandon Park

Background & Methods - To understand patterns of *Dalea* population growth especially related to seed biology and recruitment, in 2007 we began to track annual growth of the population growing in coastal strand habitat at Crandon Park. We installed a 3x10 meter demographic plot that sampled approximately 75% of the population. In 2014 we expanded the demographic monitoring plot to encompass an additional 3x10 m area because a portion of the 2007 plot has not supported many plants for several years.

Each year we tagged new individuals, recorded location along the X- and Y-axes of the plot and measured height, perpendicular widths 1 & 2, and counted the number of inflorescences. We categorized plants into one of four growth stages: 1) seeds in the seed bank; 2) non-woody seedlings with 10 or fewer leaves, 3) juveniles, which were sterile, woody plants, with > 10 leaves, and 4) reproductive adults.

To estimate the seed bank size, we examined the number of viable seed present within 15 inflorescences by visually assessing the proportion of good seeds and testing their germination and viability in the laboratory. We determined that the average proportion of good seeds within an inflorescence was 0.54. We derived values for adult-seed bank cells with and without germination cues from the formula: flowers/adult*average number of good fruits per inflorescence (.54)*average germination or contribution to seedlings with cue (.96) or without cue (.205).

Results - In February of 2020, we recorded 99 individuals, with 83 in the original transect. This is the exact number of individuals documented in 2019, which until now was the lowest aboveground total since monitoring began in 2007. Of the 99 individuals in 2020, 58 were seedlings, 9 were woody but non-reproductive (juveniles), and 32 were flowering adults (**Fig. 26**). This is the lowest number of flowering adults across both transects over the six years that both have been assessed. Among these 32 adults, we counted 4,316 flowers, which is the lowest combined total of flowers from both transects as well. We make this distinction due to the varying average adult reproductive value observed year to year. This year, these results are largely due to a lack of adults in the extension, as flower numbers were actually fairly high in the original transect (**Fig. 27**).

Discussion - The *Dalea* population at Crandon has fluctuated considerably, mostly driven by seedlings. It is difficult to say at this point whether the recent, slight increase in seedlings will serve to replace the downward trend in total adult plants. This year we worked with Miami-Dade County vegetation management crews to reduce hardwoods around the *Dalea* population, which we hope will reverse the downward trend that we've been observing.

This project is an example of how demographic data collection can inform management needs, by both identifying population reductions, as well as noting recent seedbank contributions that could affect restoration outcomes.

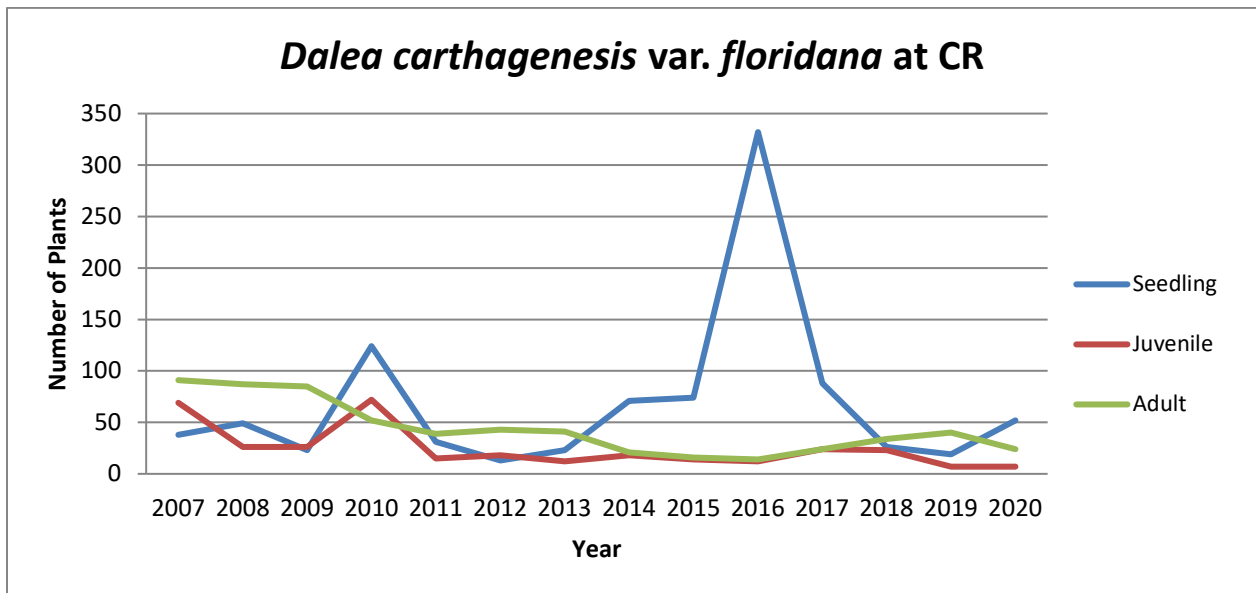


Figure 26: Total number of *Dalea* individuals of each life stage (seedling, juvenile, adult) from original transect between 2007-2020.

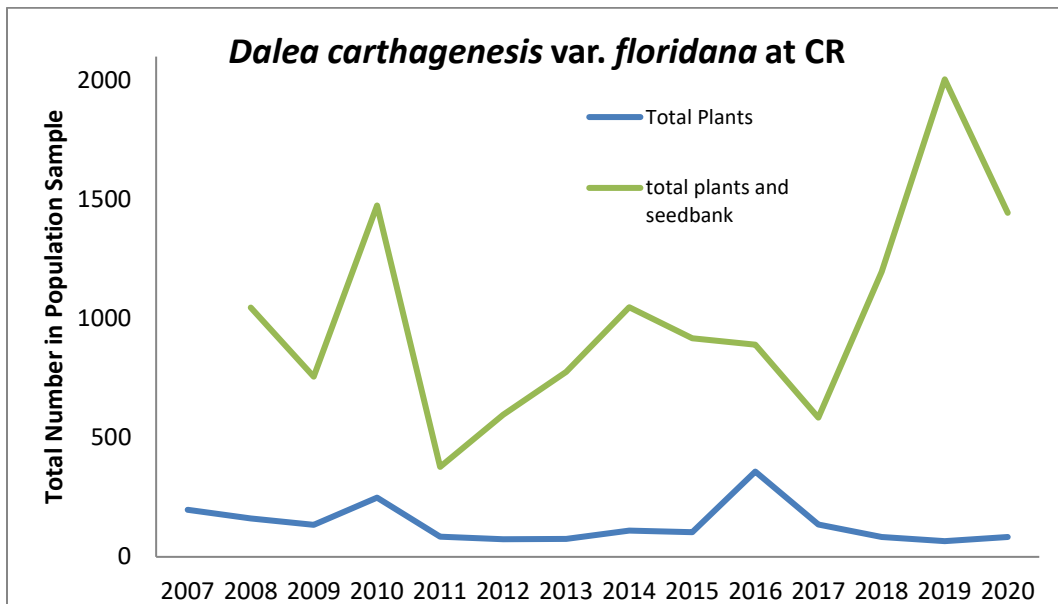


Figure 27: Total number of *Dalea* plants in original transect with and without accounting for the seed bank between 2007-2020.

Deering Estate

In January 2020, we monitored *Dalea* in all three areas of the 400+ acre preserve where it is known to be present. In Deering's north pine rockland, we found a total of 291 individuals (**Fig. 28**). Of these, 109 plants were reproductive, 79 were seedlings and the remainder were non-reproductive woody plants. The south addition pineland had not been surveyed since immediately after a 2015 wildfire, when just six plants were found. Since then, this part of the site has experienced fire one or two more times. This January, we found a total of 81 individuals, in two clusters ~20m apart. Fifteen of these plants were reproductive and 55 were seedlings. Surveys along the southern edge of Deering property have failed to produce any plants since 2011.

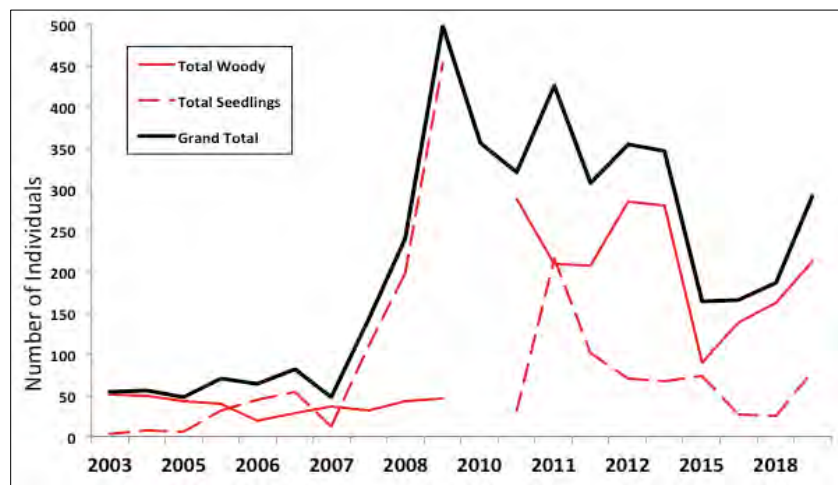


Figure 28. *Dalea* population counts 2003-2020 in the Deering Estate's north pineland.

R. Hardy Matheson

In January of 2020, we found 327 *Dalea* at R. Hardy Matheson Preserve (**Fig. 29**). This includes naturally occurring plants as well as plants resulting from our 2008 seed augmentation. Of the 327 individuals, 133 were reproductive and 82 were seedlings. This population experienced a prescribed burn after the monitoring, but we have yet to re-assess the numbers.

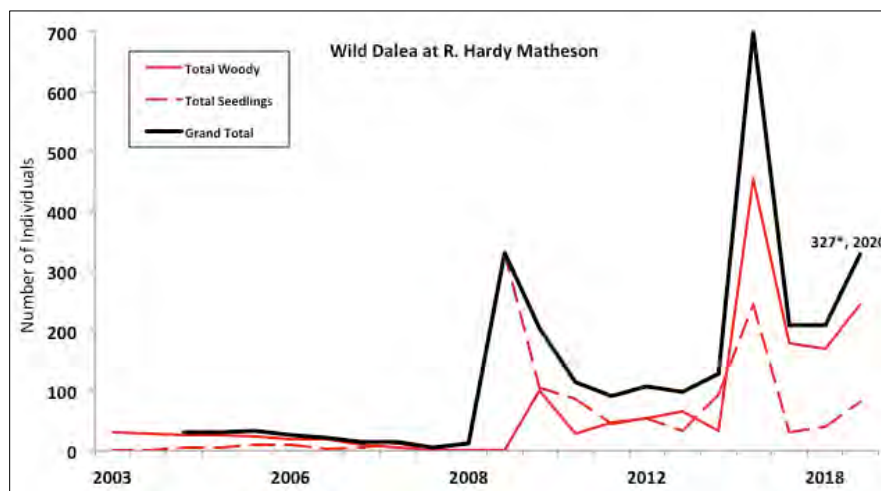


Figure 29. Wild plant population counts at R. Hardy Preserve, 2003-2020. The 2020 count of 327 includes plants which were part of a translocation; earlier counts did not; these data are available upon request. Population peaks in 2009 and 2015 occurred after prescribed fires.

Ex Situ Conservation

We maintain a small ex situ nursery collection of 17 *Dalea carthagenensis* var. *floridana*, as well as a handful of plants in Fairchild's pine rockland plot (Plot 97B). We also make plants available for members of our Connect to Protect Network to plant in their home gardens. Plants were germinated in community pots with no pretreatment and respectively separated into individual 3" pots. They received 1 teaspoon time release 18-6-8 Nutricote and get a supplemental dose 20-10-20 at 30 ppm once a month. They currently reside in our greenhouse but will soon migrate outside to full sun where they'll be under a regular water regime.

***Guzmania monostachia* (L.) Rusby ex Mez**

Guzmania monostachia, the West Indian tufted airplant, is a bromeliad found throughout New World tropics. Like *Catopsis berteroniana*, its range extends into swamps and hammocks of South Florida, where it is listed as endangered and is threatened by the Mexican bromeliad weevil. The species is present in the large preserves Fakahatchee Strand Preserve State Park, Big Cypress National Preserve and Everglades National Park, and is likely extirpated from the Miami-Dade preserves Camp Owaissa Bauer and Silver Palm Hammock (Gann et al. 2020). A very small population persists in Fuchs and Meissner Preserves, which are adjacent preserves that are owned and managed by Miami-Dade's EEL program.

Update on wild populations

We last visited the wild Miami-Dade population of *G. monostachia* in May 2019. On that visit, we collected seed from a plant in Meissner that had just finished flowering. We attached seeds to nearby trees and took some seed back to Fairchild for propagation and long-term storage. Small *G. monostachia* are difficult to identify, but we believe there are fewer than 10 naturally occurring plants at Fuchs and Meissner.

Update on ex situ collections

Fairchild maintains one very large plant in our collections that just finished flowering (**Fig. 30**). Interestingly, this plant, which was gifted to Fairchild from Selby Gardens in 2018, is a pup from a plant that Ron Determann from Atlanta Botanic Gardens collected from Fuchs Hammock in 1984. We will collect and bank all the seeds from this plant once they are available.

We also have approximately 30 small seed-grown plants, of Fuchs/Meissner origin in our ex situ collections. Most of these plants are in Fairchild's nursery, but 3 seedlings are in Fairchild's Rare Plant House; these were seed-sown onto moist cycad trunks in 2019.



Figure 30. *Guzmania monostachia* flowering in Fairchild's nursery in April and May 2020.

In spring 2020, a researcher from University of Florida (Shelby Krupar) has requested material from the Miami-Dade population for a genetics study; she is interested to learn whether the Miami-Dade population is genetically unique. We will cooperate with her to get her some ex situ material from Fairchild so she can pursue her study without impacting the wild population.

Seed storage

We conducted seed germination experiments to assess whether *G. monostachia* seeds can survive desiccation and freezing.

- (1) Control: seeds were stored in a paper bag for ~2 months at room temperature (N=100, 10 seeds per replicate)
- (2) Desiccated: seeds were stored in a paper bag for ~2 months and then desiccated for 5 days at 11% RH (N=100, 10 seeds per replicate)
- (3) Frozen: seeds were stored in a paper bag for ~2 months, desiccated for 5 days at 11% RH and then frozen at -18°C for 48 days (N=100, 10 seeds per replicate)

All seeds were sown into petri dishes on Munktell filter paper and the petri dishes were placed into a germination chamber (settings: 12h/12h, 70% RH, 25C/23C).

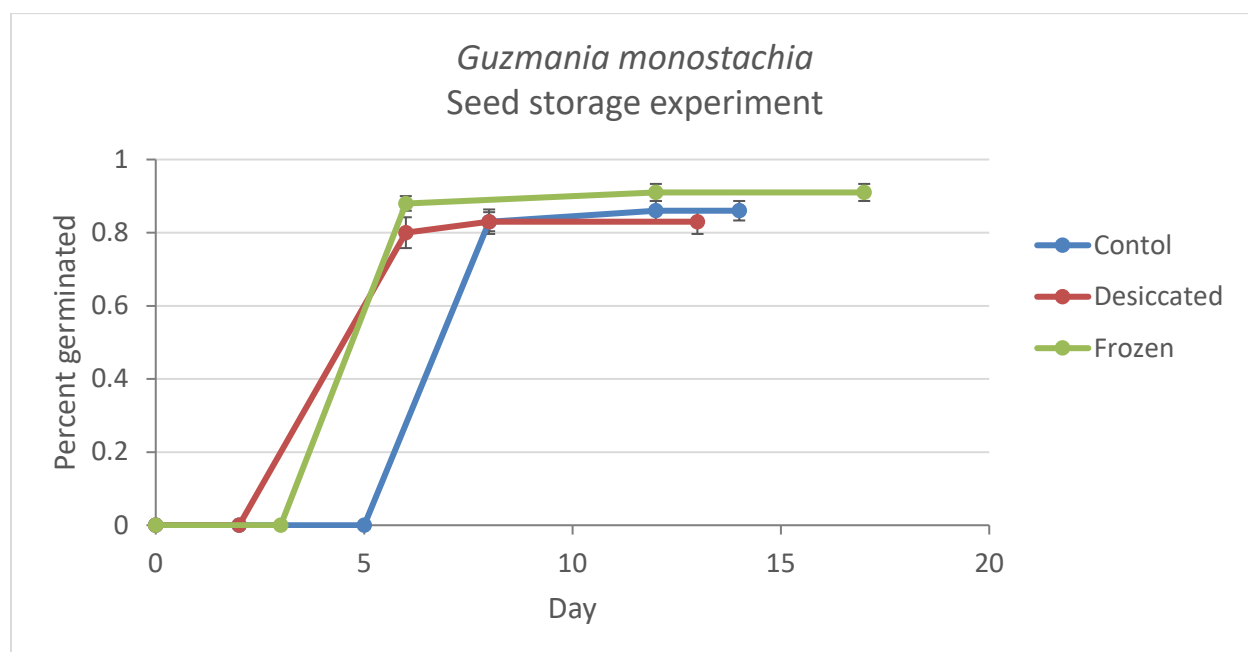


Figure 31. Mean seed germination rate of *G. monostachia* across different treatments (SE are displayed).

The results show that seeds of *G. monostachia* survive freezing for at least 48 days without any viability loss (**Fig. 31**). The mean germination rate for each treatment was $86 \pm \text{SD}2\%$ (Control), $83 \pm \text{SD}3\%$ (Desiccated) and $91 \pm \text{SE}2\%$ (Frozen). The mean germination time was 8, 6 and 6 days respectively. This means seeds of *G. monostachia* are orthodox and are suitable for conventional seed banking at -18°C. By monitoring seed viability over longer time periods, we will assess how long a collection can be stored and at which time interval it should be replaced.

***Jacquemontia reclinata* House**

Jacquemontia reclinata is a long-lived, federally endangered trailing vine of the morning glory family, Convolvulaceae, endemic to the coastal dune and coastal strand plant communities on barrier islands of southeast Florida. Rapid and widespread development and transformation of these coastal communities led to a massive reduction in available habitat, threatening the species with extinction. Fairchild has worked closely on the recovery of this species since 1990. Thanks to USFWS Coastal Program funding, we are expanding our focus to restoration and site maintenance, working with land managers to develop and implement long-term strategies.

Updates on Reintroduced Populations

Hollywood North Beach

We worked with Broward County to develop a strategic plan for restoring coastal strand and backdune habitat at Hollywood North Beach. The plan consists of four phases: 1. Establish *Jacquemontia* populations within currently suitable patches, 2. Restore potential patches to suitable states, 3. Translocate *Jacquemontia* to restored patches, and 4. Monitoring and Maintenance.

To date, we have introduced 12 *Jacquemontia* individuals to two already-suitable patches, and within those patches we have performed some basic maintenance, removing adventive species and trimming back woody species along margins to promote and maintain open habitat (**Fig. 32** and **Fig. 33**). After one month, we have had 100% survival, despite record high temperatures and little precipitation. We thank our partners in Broward County, particularly Michel Therrien for helping us to water plants through this trying period.

We have begun Phase 2 restorations in two patches by treating the invasive *Jasminum fluminense*. When plants have died, we will remove all dead material to reduce nutrient loads. At that time, we will also remove several palms and other woody material as well as non-desirable herbaceous species. We expect to have these patches in maintenance condition within six months. During inventories prior to developing the strategic plan, we documented a single surviving *Jacquemontia* behind the Carpenter House.



Figure 32: Suitable patch before (top) and after (bottom) removal of adventive native plants, e.g. *Bidens alba*, *Parthenocissus quinquefolia*, and *Panicum amarum*. We transplanted six *Jacquemontia* into this patch.



Figure 33: The suitable patch where we planted six other *Jacquemontia*. Maintenance needs were minimal here; we trimmed back some sea grape and removed several *Panicum amarum* individuals.

Virginia Key

On February 1, 2020 we again worked with Dr. Hong Liu's Restoration Ecology course from Florida International University, but rather than monitoring we decided to get the students some hands-on experience with actual restoration work (**Fig. 34. Top and center, Fig. 35. Top and center**). The backdune habitat has been slowly filling in with woody vegetation, and shade and leaf litter were reaching levels that were shifting the habitat toward early-successional hammock. Aside from woody vegetation, weedy species such as *Urochloa maxima*, *Catharanthus roseus*, and even the native *Stylosanthes hamata* had reached troubling abundances. We divided labor among small groups, with some students focusing on trimming or stumping of trees and shrubs- including crews to haul cut material- and others focused on hand-pulling of the aforementioned weedy species. We worked through the morning, piling hundreds of pounds of woody material and weeds along the trail for City of Miami staff to remove the following week.

We returned to the site in June and were thrilled with the results of our restoration work (**Fig. 34. Bottom, Fig. 35. Bottom**). Leaf litter seemed to be almost completely decomposed and the areas remained largely open and free of weeds. *Jacquemontia* coverage in treated areas nearly doubled and we counted 14 new seedlings that recruited, seemingly from our efforts.

We are currently working with the City of Miami staff to include periodic restoration efforts in their management plan—along with existing efforts to monitor *Jacquemontia*—to ensure the continued persistence of open coastal strand habitat that will promote *Jacquemontia* and other herbaceous species and wildlife that depend on this habitat.



Figure 34: The Virginia Key *Jacquemontia* project area before (**TOP**) and after (**CENTER**) restoration activities. Here *Coccoloba diversifolia*, *Ficus aurea*, *Schinus terebinthifolius*, and *Sabal palmetto* were the main targets of hardwood removal. The ‘Periwinkle patrol’ also hand-pulled *Catharanthus roseus* and *Panicum maximum*. (**BOTTOM**) *Jacquemontia* is abundant in the understory four months post-treatment (photo from other side of pigeon plum to better show plants). These photos only show roughly 1/3 of the footprint that we treated in this area.



Figure 35. Coinvine (*Dalbergia ecastaphyllum*) removal on the backdune at Virginia Key (**TOP**) before and (**CENTER**) after removal. Note large *Jacquemontia* in the foreground (**BOTTOM**) was photographed on our return in June, where the area displays flourishing populations of *Jacquemontia*, *Echites umbellata*, and *Okenia hypogaea*.

Wild populations

Crandon

Coastal dune habitat at Crandon continues to be impacted by hardwood encroachment and patches of *Jacquemontia* have been shrinking over the last several years. In November, we worked with Miami-Dade County biologists and eradication crews to target areas for hardwood removal to benefit *Jacquemontia* populations (**Fig. 36**). Using our spatial database, we went with crews and identified *Jacquemontia* populations and patches that needed removal with special care not to impact plants. Poisonwood (*Metopium toxiferum*) was a prime target along with *Sabal palmetto*, *Randia aculeata* and others. Crews treated patches across several acres ensuring the prolonged survival of wild *Jacquemontia* populations at this site. We will return to monitor these populations later in 2020 and work with the County to develop an official long-term strategy.



Figure 36: Patch of *J. reclinata* in Crandon Park where hardwood thinning took place. Notice areas of leaf litter deposition where trees and shrubs were present.

Mizell-Eula Johnson State Park

We visited the site on 1/14/20 and observed a total of 24 adults and 13 seedlings for a total of 37 living individuals. Plants were separated into localized clusters and named following protocols of previous assessments by John Frosbutter and Laurie Sheldon in 2018., i.e. JL1, etc. We removed all flags and tags of long-dead individuals and added pin flags to every new individual.

As can be seen from the map (**Fig. 37**), JL1-3 are all being overtaken by woody vegetation despite largely-successful management efforts to control invasive species such as *Colubrina asiatica*. The woody encroachment consists mainly of native species: Gumbo limbo, wild coffee, coinvine, false mastic, and snowberry, among others. This is a common theme throughout remaining *Jacquemontia* habitat. The areas that remain open are largely dominated by weedy species such as Madagascar periwinkle, *Euphorbia blodgettii*, *Conyza canadensis*, and others.

By our estimation, it will take a considerable amount of effort to maintain this population even over the next ten years. We have already seen the total population and spatial extent thereof reduced by half

over the last five years. We do think that these efforts should be made, but resources should also be put into developing populations at more suitable, easier to access sites throughout the Park. The only other known individual from the site, found in dune habitat has died. We are currently working with the park to develop a translocation plan for several more suitable areas of the Park.



Map Marker	Comments
JL 1	1 small adult in deep shade and heavy litter
JL 2 = LS2 from 2018	5 adults and one seedling in shade and heavy litter
JL 3 = LS2 from 2018	3 adults in shade and heavy litter
JL4 = LS1 from 2018	15 adults and 12 seedlings, mostly open.

Figure 37: Locations of *J. reclinata* at Mizell-Eula Johnson State Park on 1/14/20. The table includes descriptions for each subpopulation. Coordinates were provided to Park in separate report.



Figure 38: “JL2” at Mizell-Eula Johnson State Park. **Left:** *Jacquemontia* plants in foreground beneath a large Gumbo Limbo in a shaded growing environment with heavy leaf litter. No plants in either JL2 or JL3 showed signs of reproduction and are all thin and breakable when compared with more robust plants in JL4. **Right:** the single seedling observed in this patch.

Red Reef and South Beach Parks

We donated several mature *Jacquemontia reclinata* for educational displays at Gumbo Limbo Nature Center. We have continued to meet with officials from the City of Boca Raton to move forward with the restoration and translocation plans that we proposed last year. This is a multi-phase plan that will begin with restoring habitat for existing populations, followed by restoration and translocations in areas where *Jacquemontia* once existed. To that end, we will be partnering with IRC to break ground with restoration, likely in August, 2020. Since IRC is focusing on dune habitat, we will likely be expanding our original footprint to focus on restoration of foredune populations that have been encroached upon by woody vegetation.

Ex situ collections

We continue to maintain a collection of 30 *Jacquemontia reclinata* at Fairchild's nursery. All plants are in 1 gallon pots and receive 1 tablespoon time release Nutricote 18-6-8 fertilizer once per year. Because *Jacquemontia* suffers from iron-induced chlorosis, we supplement our plants with chelated iron to prevent nutritional deficiencies as needed. Plants are sited in full sun and are under a regular water regime.

***Linum arenicola* (Small) Winkl.**

Linum arenicola, the sand flax, is a thin and wiry perennial herb in the flax family Linaceae. Singly branched yellow flowers that are much smaller than those of *L. carteri* precede capsular fruits that can house a maximum of 10 seeds. *Linum arenicola* is endemic to the South Florida mainland and lower Florida Keys, and can be found growing in sunny limestone substrate, regardless of whether the site is intact, disturbed, or restored.

[Note: the work described here was funded in part by the US Fish and Wildlife Service, through a grant to conduct translocations of some of South Florida's newly listed pine rockland species. However, that funding required only 5 translocation actions. By combining that funding with support from this FDACS DPI grant, we were able to conduct 11 total translocations]

Update on Translocations

Rockdale Preserve

In summer 2019, we introduced 6 *Linum arenicola* and 900 seeds to a scraped restored area within Rockdale Pineland Preserve. While the species was not previously known from Rockdale, the preserve lies within its historic range. Plants we introduced were of L-31E canal germplasm. Our experimental introduction was intended to develop best methods for future introductions with *L. arenicola*, including whether the season of seed sowing had any effect on seed germination and establishment.

Though 4 of 6 outplants survived two months, only a single plant lived for a full year to May 2020 (**Fig. 39**). However, this plant has remained reproductive. Since outplanting, the 6 *L. arenicola* plants have likely produced over 75 fruits (~750 seeds) in the outplanted area. We are hopeful for recruitment, but seedlings of this tiny, hair-thin plant may be difficult to identify in the grassy planting area until they are reproductive.



Figure 39. The sole surviving sand flax outplant at Rockdale after one year.

For the *L. arenicola* seed introduction, we added a grand total of 900 seeds of different pre-treatments from at least 50 maternal lines, 20 seeds each, into a total of 45 seed plots.

Seed plots were the same short PVC tubes as previously described for the *Brickellia*, *Chamaecrista*, and *Chamaesyce* seed introductions. First, in June 2019, we sowed 500 seeds (400 – desiccated and 100 – 2 years ambient) into 25 plots. Second, in August 2019, we sowed 400 desiccated seeds across 20 total plots, in the same area. Germination did not start in either the June-or August-sown plots until December 2019.

For August-sown plots, just 6 *L. arenicola* seeds germinated by three months (December 2019). The very next month, both sowings experienced a large spike in germination with 14 new June and 37 new August seedlings emerging. By March 2020, June-sowing overall emergence and survival rates were 17/500 (3%) and 11/17 (65%), respectively, while August-sowing overall emergence and survival rates were 48/400 (12%) and 35/48 (73%). At 1 year (June 2020), no June-sown seedlings were still alive and just 2 remained in the August-sown plots, and both were reproductive, holding 11 capsules.

No Name Key

In August 2019, while simultaneously conducting translocations for *Chamaecrista lineata* var. *keyensis* and *Chamaesyce deltoidea* ssp. *serpyllum*, we introduced 320 *Linum arenicola* seeds to No Name Key using germplasm from Big Pine Key. We applied the seeds, half of which had been desiccated, into 8 seed plots in two different areas of the island, “Spanish Channel” and “Quarryside South.”

We monitored monthly for the first three months, but did not see germination until 4.5 months after sowing (January 2020), when all but 1 plot had seedlings (Fig. 40). This is consistent with the timing of germination in wild populations. At this point, overall seedling emergence was 40/160 (25%) for fresh seeds vs. 54/160 (34%) for desiccated seeds. At last monitoring (10 months, June 2020), a total of 13 seedlings were still alive, (3 desiccated and 10 fresh) (Fig. 41).



Figure 40. A sand flax seed plot six months after sowing on No Name Key with 5 seedlings visible.

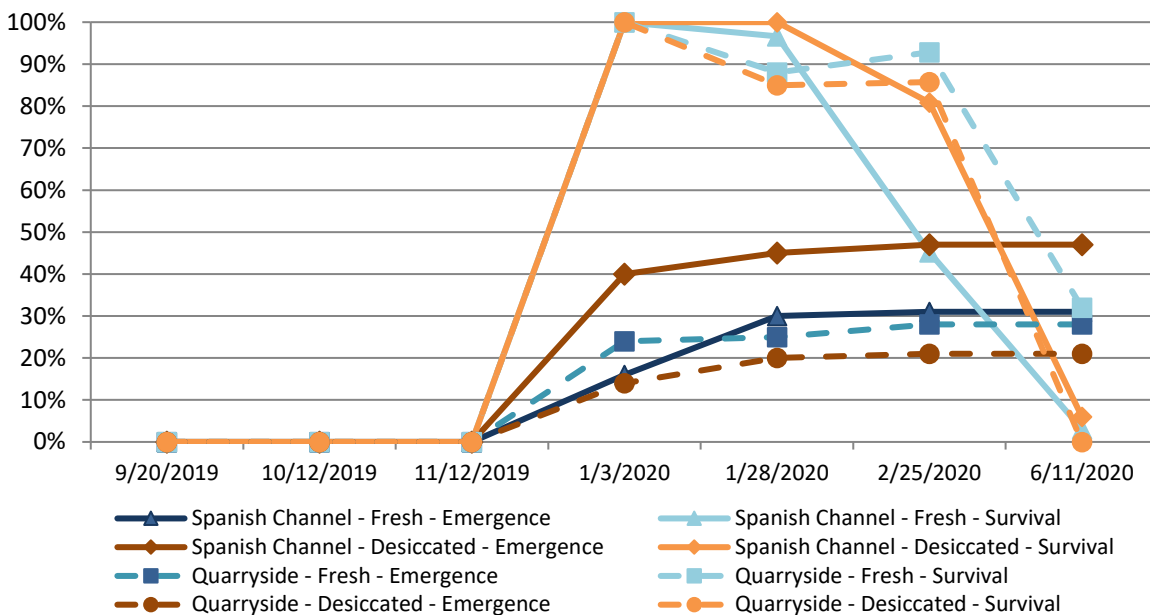


Figure 41. Introduced *Linum arenicola* seed emergence and survival rates on No Name Key over ten months for each seed pre-treatment (blue - fresh vs. orange - desiccated) and introduction area (solid - Spanish Channel vs. dashed - Quarryside) on No Name Key.

Seed storage

We conducted a small seed germination experiment in order to assess if *L. arenicola* seeds can survive desiccation and freezing.

- (1) Control: no treatment (N=20, 10 seeds per replicate)
- (2) Desiccated: seeds were desiccated for 1 month at 11% RH (N=20, 10 seeds per replicate)
- (3) Frozen: seeds were desiccated for 1 month at 11% RH and then frozen at -18°C for 42 days (N=20, 10 seeds per replicate)

All seeds were sown into petri dishes on Munktell filter paper and the petri dishes were placed into a germination chamber (settings: 12h/12h, 80% RH, 25C/23C).

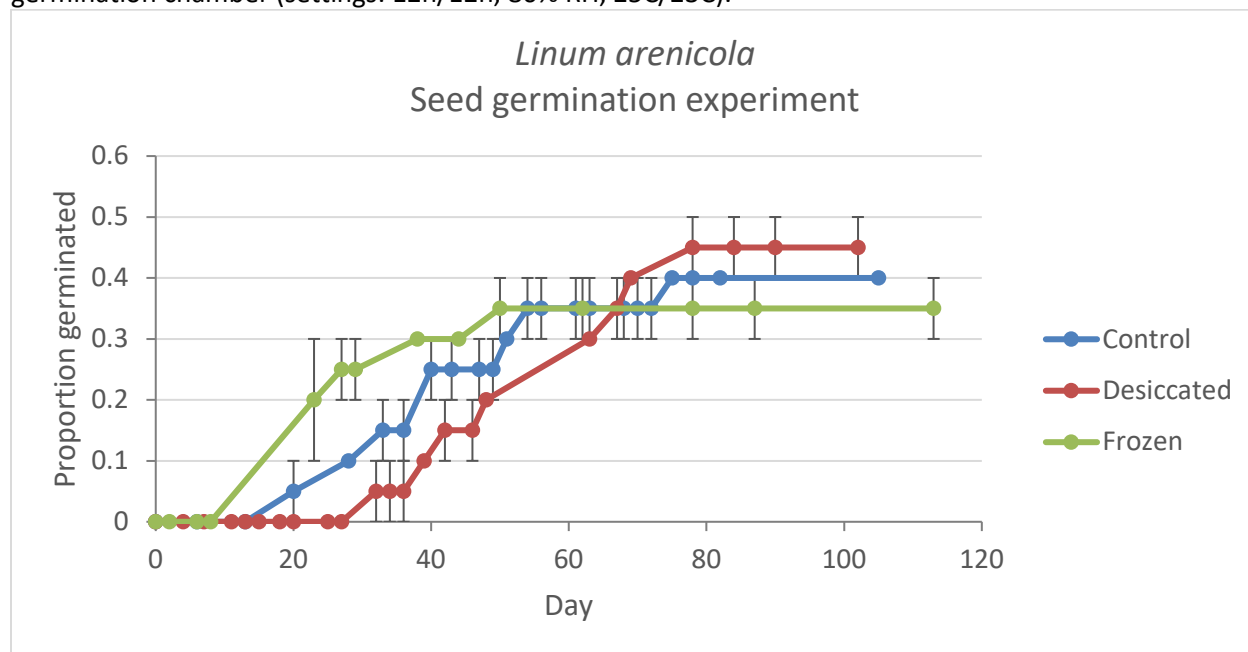


Figure 42. Mean seed germination rate of *L. arenicola* across different treatments (SE are displayed).

The results show that seeds of *L. arenicola* can survive freezing for at least 42 days without any viability loss (**Fig. 42**). The mean germination rate for each treatment was $40 \pm \text{SE } 0\%$ (Control), $45 \pm \text{SE } 5\%$ (Desiccated) and $35 \pm \text{SE } 5\%$ (Frozen). The mean germination time was 43, 56 and 30 days respectively. This means seeds of *L. arenicola* are orthodox and are suitable for conventional seed banking at -18°C. However, this experiment was conducted with a small number of seeds per treatment due to limited availability. We will repeat this experiment once more seeds become available. By monitoring seed viability over longer time periods, we will assess how long a collection can be stored and at which time interval it should be replaced.

Ex Situ Conservation

Since 2016 we have been building our ex-situ collection of *L. arenicola* and have banked nearly 2,500 seeds from 8 populations. Over 1,400 seeds are stored locally in the FTBG seed lab, and in October 2019 we sent nearly 1,200 seeds to the NLGRP. At the moment we have no living plants in Fairchild's nursery. In the past however, we found that *Linum arenicola*, performs beautifully when planted in a mix composed of 1/2 coarse Turface and 1/2 potting soil supplemented with 1 teaspoon time release Nutricote 18-6-8 per 3" pot. They prefer to be sited in full sun under a regular water regime.

Linum carteri* Small var. *carteri

Carter's flax, *Linum carteri* var. *carteri* is a short-lived perennial herbaceous plant in the flax family, Linaceae with sunny yellow flowers about 1" wide that precede capsular fruits which can house a maximum of 10 seeds. This taxon is restricted to South Florida's Miami Rock Ridge, where it grows in intact, disturbed, and restored pineland and marl prairie habitat fragments.

[Note: the work described here was funded in part by the US Fish and Wildlife Service, through a grant to conduct translocations of some of South Florida's newly listed pine rockland species. However, that funding required only 5 translocation actions. By combining that funding with support from this FDACS DPI grant, we were able to conduct 11 total translocations]

Update on Translocations

In summer 2019, we introduced 18 *Linum carteri* var. *carteri* plants and 240 desiccated seeds to a restored area at Rockdale Pineland Preserve. Although Rockdale already has a sizeable population of *L. carteri*, our purpose in reintroducing additional plants was to develop best methods for conducting translocations with this species. All seeds and plants we introduced were collected onsite at Rockdale pineland. Seeds were introduced into the circular PVC rounds as previously described for *Brickellia mosieri* and *Linum arenicola*. The reintroduced population was spatially separated from the wild population by several hundred meters, so it was unlikely we would confuse seedlings from outplants with those from wild plants.

One month after planting (June 2019), outplant survival was just 39%, or 7 of 18 plants, with 3 of the 7 plants reproductive. By three months, four surviving outplants had produced 13 capsules (potentially 130 seeds). After one year (May 2020), three outplants (17%) survived, all of which were reproductive. Surprisingly, we found 13 new seedlings that recruited from outplants (**Fig. 43. Left**). Together, these 13 recruits produced 22 capsules (potentially 220 seeds).

The introduction of 240 seeds was in the same restoration area. Plots were placed in 3 clusters so that each of the 3 clusters held four PVC rounds containing with 20 *L. carteri* seeds that had received a different treatment:

- 1) desiccated + added pine straw,
- 2) desiccated, no pine straw
- 3) fresh + added pine straw
- 4) fresh, no pine straw.

Seeds began germinating as soon as two days post sowing. As with the *Brickellia* seed introduction, many *L. carteri* seedlings succumbed to drought stress. At two weeks, 31 of 240 seeds had germinated (13%) and 15 of those survived. At six months (December 2019), new seedlings were still emerging, overall germination was at 20% (47/240) and survival was 34% (16/47). At 1 year (June 2020), a total of 50 seedlings had emerged (or 21% field germination). Six of 9 surviving seedlings were reproductive and holding 16 fruits (potentially 160 seeds) (**Fig. 43. Right**).



Figure 43. Left: This *Linum carteri* recruited from seed that was produced by an introduced plant. Right: a plant that grew from introduced seed has reached reproductive status.

Ex Situ Conservation

Since 2016 we have been building our ex situ seed collection of *Linum carteri* var. *carteri* from all known locations for which we could obtain permission to collect. We have deposited nearly 900 seeds into long-term cold storage. This reporting period alone, we deposited nearly 400 seeds from 46 genetic lines (across 6 populations, including our ex situ living collection) into the FTBG seed bank, and 167 seeds of 21 genetic lines (2 populations) were sent to NLGRP.

This species can be cultivated with extreme care. Plants can grow in plug trays with limited root space, in a mixed media of $\frac{1}{3}$ fine turface, $\frac{1}{3}$ potting soil, and $\frac{1}{3}$ crushed limestone, with minimal added fertility (time release Nutricote 18-6-8). Plants initiate the strongest growth and flower in full sun to 10-20% shading. We currently have no living plants in the collection.

Pilosocereus robinii (Lem.) Byles & G.D. Rowley

Pilosocereus robinii is a federally endangered columnar cactus endemic to the Florida Keys, northwest Cuba, and parts of The Bahamas. The name *Pilosocereus* describes the pilose hairs that arise from areoles of new growth and reproductive portions of the stem. Growing at elevations below 2.15 m in the Florida Keys, *Pilosocereus robinii* has declined precipitously since the first detailed population census (Adams and Lima 1994). Fairchild is collaborating with USFWS, FDEP, and others to recover the species. We maintain an ex situ collection and monitor the wild populations yearly. In addition, we reintroduced the species to two higher elevation Keys sites and monitor them regularly.

While exact reasons for this species' decline in the Florida Keys remains elusive, what is clear is that hurricanes can have a substantial negative impact on populations and that maintaining *ex situ* collections of the Key tree cactus and continuing reintroduction efforts are essential.

Update on Wild Populations

P. robinii is present on just 4 islands: Big Pine Key, Long Key, Upper Matecumbe Key, and Lower Matecumbe Key. In addition, there is a population of *P. millspaughii* (= *P. polygonus*) on Key Largo, which we also monitor. We no longer visit the privately owned Lindstrom (formerly Frisbee) property on Lower Matecumbe Key, after finding only 3 unhealthy, unrooted fragments on the site in 2016. During this grant period, we visited all known wild *Pilosocereus* populations to assess the number of individuals, survival, and signs of reproduction or disease (**Table 1**). This year we did not observe signs of fruiting or flowering in any population. Brief updates on each population follow. We report on the number of living stems, but that is not always the best indicator of the population health—for example, one tall healthy cactus may be broken into 20 stems which can then root separately. For this reason, we usually report on the total vertical height for each population. However, we did not have those data prepared in time for this report.

Table 1. Number of living stems (including rooted fragments which lack vertical growth) of wild *Pilosocereus* cacti in Florida, from 2007 to present. A double-dash indicates years for which we did not conduct full sampling for that site. Note that the number of stems can increase due to fragmentation from wind events or other damage).

Site code	2007	2009	2010	2011	2013	2014	2015	2016	2017	2018	2019	2020
NKDR W	26	14	10	10	16	15	9	10	15	10	12	11
NKDR E	28	19	17	21	33	--	31	32	35	23	23	20
LKGOT	78	--	87	--	--	37	--	44	--	--	14	34
LKLT	13	13	--	18	14	--	10	--	8	--	7	6
LM	59	--	--	--	--	--	--	3	--	--	--	--
KTCP	83	50	52	44	38	43	31	35	25	26	39	31
UMLVK	25	21	28	29	22	--	23	24	24	24	25	25
KL	273	98	--	308	125	--	60	28	14	11	6	6

National Key Deer Refuge (NKDR)

The population of Key Tree Cactus (*Pilosocereus robinii*) in the National Key Deer Refuge on Big Pine Key consisted of thousands of healthy living stems as recently as 1994. By the time Fairchild began annual monitoring of the population in 2007, it had experienced a dramatic die-off, which continues today. The number stems counted during each monitoring year is shown in **Table 1**, above. "NKDR W" is the portion of the population that is west of Long Beach Rd. All large stands of *P. robinii* are dead on the west side. We are aware of three remaining subpopulations which have 11 separately rooted plants. Total vertical height of *P. robinii* on the west side is 712 cm.

In the east hammock, there is one large stand of *P. robinii* remaining, and a total of 20 separately rooted plants. Total vertical height of *P. robinii* on the east side is 1026 cm.

Long Key – Golden Orb Trail (LKGOT) and Layton Trail (LKLK)

The *P. robinii* on Long Key were severely impacted by Hurricane Irma in 2017. From 2017 to 2019, the combined total vertical height of all cacti was reduced by over 30 meters. In 2020, we documented approximately 80 separate rooted fragments in the population along the Golden Orb Trail. Of these, only 11 were rooted with vertical growth exceeding 10 cm (our criterion for attaching a monitoring tag). 69 were fragments scattered around the area where the large standing cacti used to be. Of these, 23 were beginning to produce vertical growth <10 cm. Total vertical height at this subpopulation was 1490, excluding stems <10 cm tall.

Along the Layton Trail, there are 6 separate stems. We rescued one unrooted fragment in June 2020 (**Fig. 44**); this piece was in fair health with some brown spots. Total vertical height at this subpopulation was 557 cm.



Figure 44. Cactus fragment #4325, an unrooted fragment we collected

Upper Matecumbe - Lignum Vitae Key – Choate Tract (UMLVK)

The Choate Tract population of *P. robinii* has remained fairly stable, compared to populations on Big Pine and Long Keys. In 2020 we counted 25 separate living plants; the same number as last year. One large individual remains in the tract; it appears to be very healthy and grew nearly a meter in the past year (it is clearly >4m tall, and difficult to measure with precision). Ten cacti grew in the past year (1-14cm). Ten had no change and four actually shrunk, from die-off or breakage. Total vertical height at this population was 565 cm. We rescued two small pups from unrooted fragments (**Fig. 45**); these are now part of Fairchild's ex situ collections.



Fig. 45. Left: Fairchild field biologist Lydia Cuni and intern Natalia Herrera-Blittman with cactus #406. Note that the hammock interior is fairly dark. **Right:** We rescued two tiny pups; this one, from #4319.

Key Tree Cactus Preserve (KTCP)

The number of tagged living individuals at the City of Islamorada's Key Tree Cactus Preserve declined from 39 plants in 2019 to 31 in 2020. Total centimeters of vertical cactus likewise declined, from 1458 to 918. Despite this bad news, it is encouraging that much of the material that remains looks healthy and has grown substantially in the past year. This was especially true of fragments that had fallen from 2017's Hurricane Irma and were moved to a nearby sunny gap in 2018 (**Fig. 46**). Total vertical height of *P. robinii* at the preserve was 918 cm.



Fig. 46. *P. robinii* that were moved in 2018 (as unrooted fragments) from the trail to a hammock light gap. Rooting and all of the vertical growth visible here occurred after moving. These moved plants all increased in height by at least 12 cm from 2019 to 2020.

Key Largo (KL)

We previously reported (Lange et al. 2019) only 6 living stems at this wild population within John Pennekamp Coral Reef State Park; this is the only known population of *Pilosocereus polygonous* (Syn: *P. millspaughii*) in the United States. We monitored the population again in February 2020 and relocated 5 of the 6 stems, still alive, and noted another stem that was alive but not accounted for last time. This piece was not connected to the ground but was producing new pseudocephalia at the yellowed growth tip (**Fig 47**). The rooted, living material at this population consisted of one portion that is more than 3 meters tall and has at least 20 branches, but this is a small remnant of what used to be a huge clump, and the base is very damaged. The other 4 rooted sections all had horizontal growth, with increases in the past year ranging from 1 cm to 28 cm (average increase was 13.5cm). We estimated total vertical height of the *Pilosocereus* to be 488 cm.



Figure 47. This unrooted section of *P. polygonous* cactus was producing pseudoccephalia in February 2020 and could produce flowers—but not necessarily.

As interesting side note, we mapped and photographed *Pleopeltis polypodioides* in the same area as the tree cactus (**Fig. 48**). We were unaware this taxon was present in Florida until Dr. Alan Franck of FIU brought it to our attention. Franck intends to nominate this species to Florida’s list of endangered and threatened species.



Figure 48. The tropical resurrection fern, *Pleopeltis polypodioides*, is found in Key Largo but (to our knowledge) nowhere else in Florida. It is differentiated from *P. michauxii* by the presence of scales on the upper surface of leaves, as well as on the lower surface.

Update on Reintroduced populations

To date, we have conducted four *Pilosocereus robinii* introductions into two preserves of the Florida Keys: Windley Key Fossil Reef State Park and Crocodile Lake National Wildlife Refuge. There are currently 69 surviving individuals of the 210 we introduced

Windley Key

We monitored all three Windley Key subpopulations of *P. robinii* with Janice Duquesnel, Florida Park Service.

- WK1 – We planted 36 cacti at this subpopulation into low elevation hammock in 2012. There was one new death this year and 13 individuals (36%) remain. Other than one individual which fell over, the other remaining individuals displayed large relative growth this year, averaging over 17 cm.
- WK2 – We planted 36 cacti into the ecotone between hammock and mangrove (the habitat typical of *P. robinii*) in 2012. There was one new death this year and 19 individuals (53%) remain. Two large individuals were broken, with their heights being reduced by a total of 201 cm combined, but other individuals averaged roughly 12 cm of new growth.
- WK3 – We planted 89 additional *P. robinii* within gaps of higher elevation, mature hammock in 2015. As of February 2020, 25 plants (28%) survive. Average height increased from 49 to 55 cm but we continue to lose a few cacti each year, and many of the remaining plants do not appear to be very healthy. No signs of fruiting or flowering were observed.

Crocodile Lake (CL)

We visited this introduced population in February 2020. There are 12 surviving individuals of the original 49 individuals we planted in 2016. Two or three of the surviving cacti appear to be unhealthy. Six were in very good health, having grown more than 10cm in the past year. We did not observe any signs of sexual reproduction.

Ex situ collections

We continue to maintain our ex situ collection of 175 *Pilosocereus robinii* plants at the Fairchild nursery. Approximately 1/3 of this material consists of older plants with the potential to flower; the remainder are young seed-grown plants (**Fig. 49**). When flower buds begin to form on larger plants in the nursery, we watch them closely. In this past year, we have not had more than one plant bloom at once, so we could not attempt any cross-pollination. We are hopeful that much of this material will be used for introductions and augmentations into appropriate Keys habitat in 2021. In addition, we have more than 8000 seeds from this species in frozen storage at Fairchild, and several thousand seeds stored at the USDA NLGRP.



Figure 49. The left photo is from our previous report (Lange et al. 2019), showing *P. robinii* that were the result of hand pollinations done by Fairchild staff in 2016. In the past year, these plants graduated to single pots and were moved to full sun. We hope to outplant this material in 2021.

***Polygala smallii* R.R.Sm. & D.B.Ward**

Polygala smallii is a federally endangered annual herb that is endemic to sandy pinelands of southeast Florida, from flatwoods in St. Lucie County south to pine rocklands in Miami-Dade County. It requires open patches of quartz sand with little or no leaf litter and is thus prone to decline with fire suppression. Fairchild and others have monitored Miami-Dade populations every few years since the 1990s. In general, populations are declining across all sites. Fairchild does not have any seeds of this species safeguarded in long-term storage, nor have we (or anyone to our knowledge) determined whether *P. smallii* seeds are capable of orthodox storage.

Update on wild populations

During the previous grant year, we monitored *Polygala smallii* at Zoo Miami (**Fig. 50**), Pineshore Preserve (**Fig. 51**), and the US Coast Guard Richmond Station. We also attempted to relocate plants at the Deering Estate (**Fig. 52**) and the Ludlam FPL easement, but we did not find any. Population numbers in this species can vary widely from year to year, and annual surveys may fail to catch the population at its peak. Nevertheless, there was a discernable downward trend at Pineshore and populations at Zoo Miami (**Fig. 50**) and the US Coast Guard have both been much higher in the past.

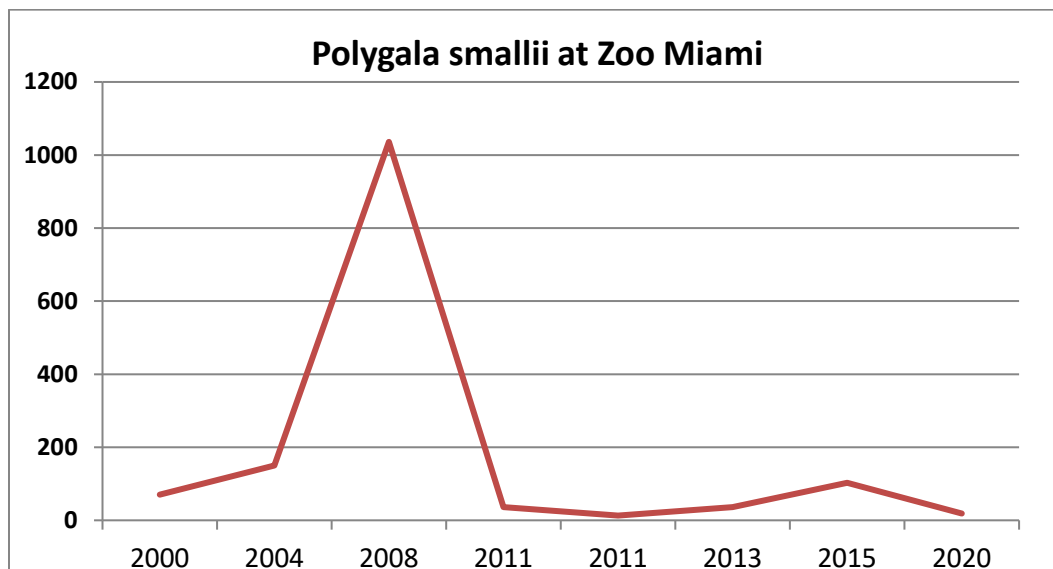


Figure 50. *Polygala smallii* population counts at Zoo Miami. The 2008 peak of more than 1000 plants happened after a 2007 prescribed fire.

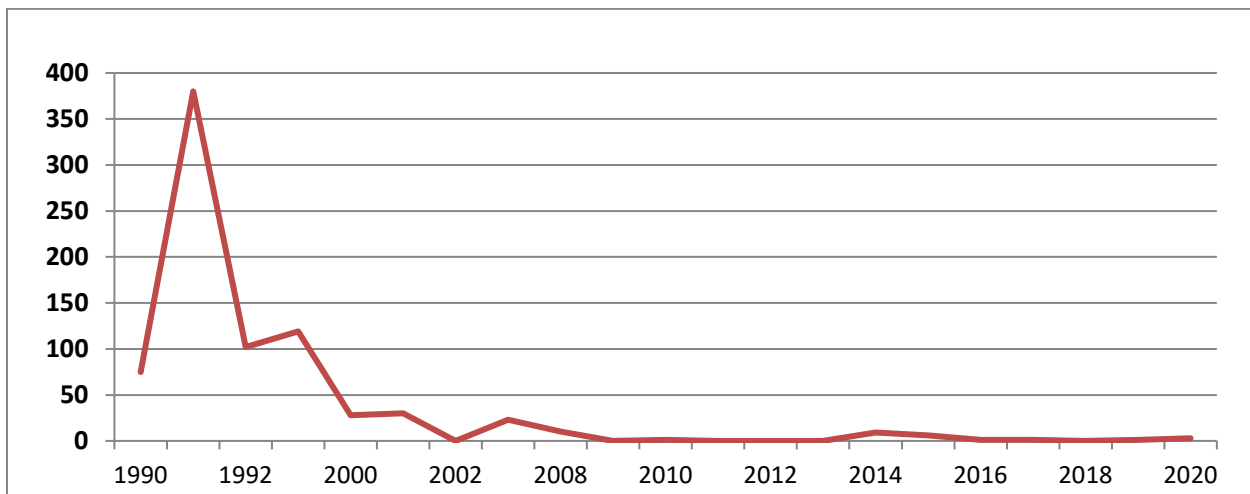


Figure 51. *Polygala smallii* population counts at Pineshore Preserve. Surveys in the early 1990s recorded hundreds of plants in this tiny preserve. The highest count in the past 20 years was 23 plants in 2004.

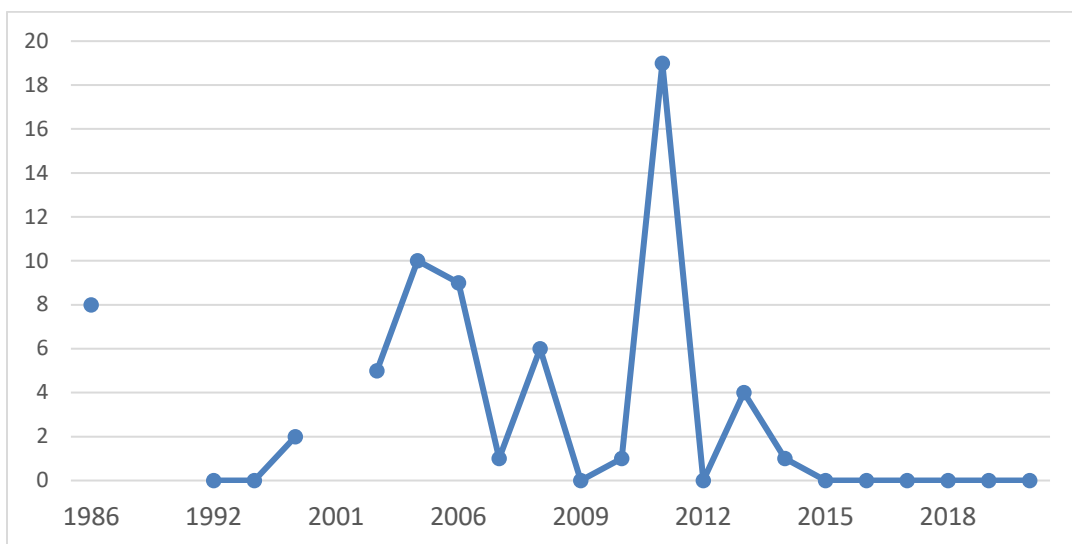
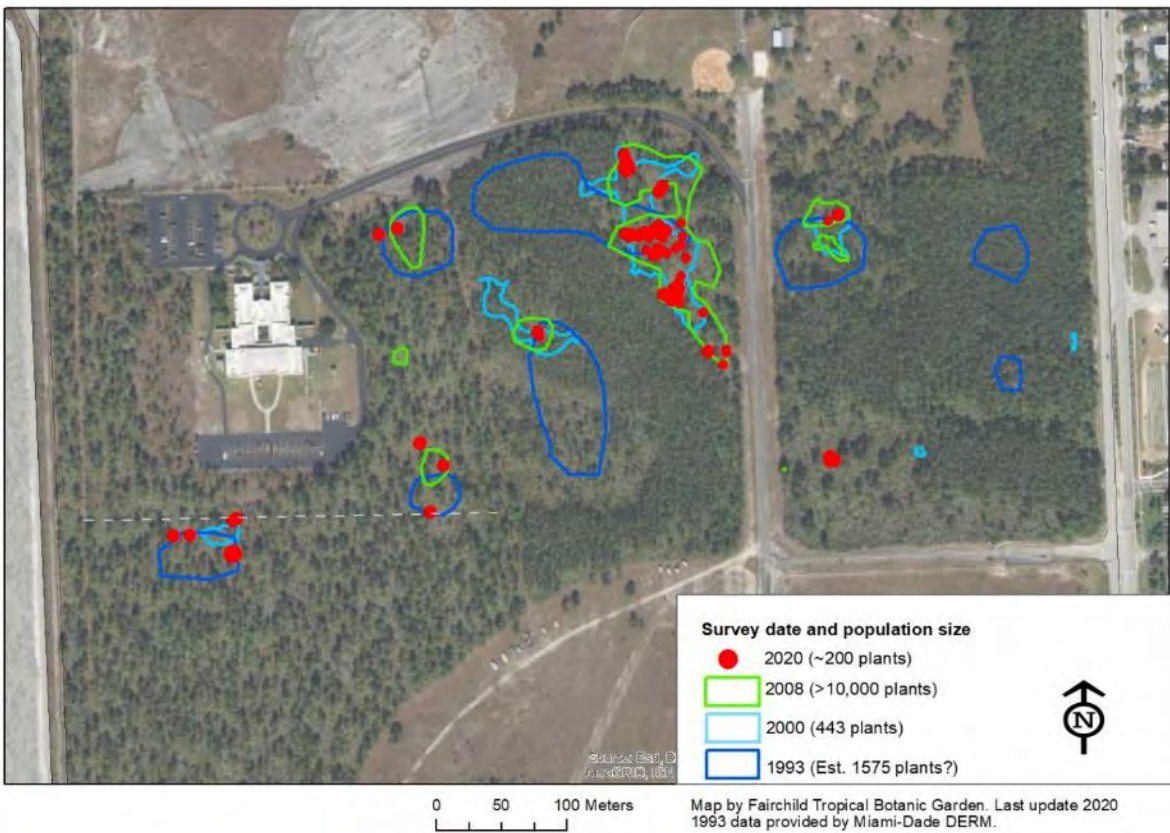


Figure 52. *Polygala smallii* population counts the Deering Estate. While this population has always been small, a peak clearly happened in 2011 -- after a 2010 prescribed fire.

Surveys for *Polygala* at the USCG Richmond Station have been less frequent than those in Miami-Dade County preserves due to access restrictions in some years, but by overlaying data layers from the four populations surveys, a decrease in the spatial extent of the population is visible (**Fig. 53**) as fire suppression at the site has allowed the pine density and leaf litter to increase dramatically. Open sandy patches are increasingly rare.



Other ferns

Florida is a native fern diversity hotspot within the continental US, more than 120 native species, many of which are listed as endangered or threatened by the state of Florida. Due to the high numbers of rare native ferns, our plant conservation program has a strong fern focus. In this section, we briefly report on work with other rare native fern species which were not part of our FDACS agreement during the 2019-2020 grant period.

We maintain a healthy ex situ collection of several rare fern species from wild sources in Florida, including *Adiantum melanoleucum*, *Asplenium dentatum*, *Asplenium erosum*, *Asplenium verecundum*, *Asplenium x biscaynianum*, *Campyloneurum angustifolium*, *Ctenitis sloanei*, *Ctenitis submarginalis*, *Dennstaedtia bipinnata*, *Lomariopsis kunzeana*, *Microgramma heterophylla*, *Sphenomeris clavata*, *Tectaria fimbriata*, *T. heracleifolia*, *Thelypteris grandis*, *T. patens*, *T. reptans*, *T. reticulata*, *T. sancta*, *T. sclerophylla*, and *T. serrata*. These plants are used in reintroductions, displays at Fairchild, and in lectures/demonstrations. We also frequently donate ferns to partner organizations. For example, we donated several ferns for planting at Kendall Indian Hammocks Park and continue to maintain a relationship with invasive plant scientists researching biocontrol of *Lygodium* spp., providing rare native ferns for off-target feeding trials. We also periodically provide native ferns for Fairchild plant sales; they always sell out.

The following is a brief report on rare native fern species that we worked with in this past grant year, but which were not required elements of our grant proposal.

Adiantum melanoleucum & *Thelypteris sclerophylla*

- We hired a subcontractor Nathan Osborne to plant 24 additional *A. melanoleucum* and 31 *Thelypteris sclerophylla* into the Miami-Dade Environmentally Endangered Lands preserve, Silver Palm Hammock. Whereas we previously planted 102 ferns and had very low survival 5 years later, this time, plants were installed in drier soils and Osborne was able to visit ferns with more frequency than we could to water, to replant them when they were uprooted by raccoons, and to build a raccoon enclosure for some (he also tried pepper-based raccoon repellent but it did not work!)

Asplenium erosum

- We reported previously (Lange et al. 2018) on obtaining *A. erosum* spores from Colleen Werner, DEP biologist with Withlacoochee State Park, but no germination was observed at the time of reporting. Later in 2018 we documented germination, the presence of healthy gametophytes, and then the presence of healthy sporophytes (**Fig. 54**). We hope to have material to reintroduce or augment wild populations by 2021.

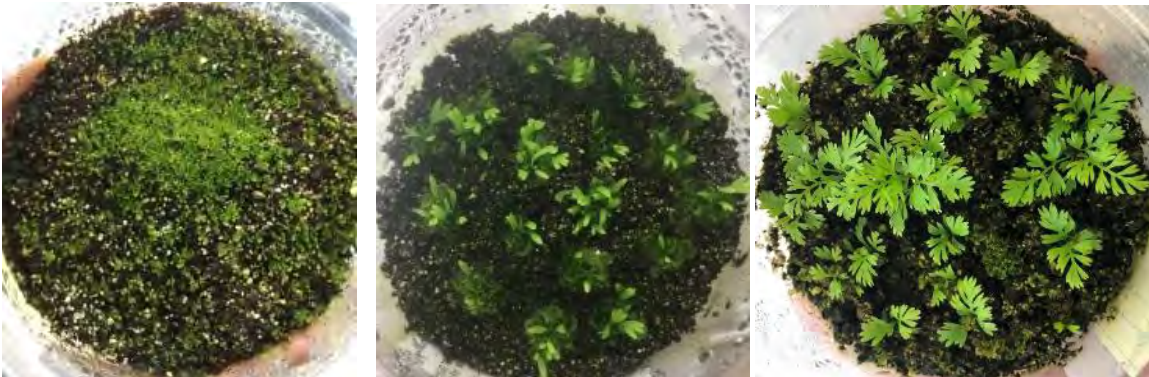


Figure 54. Gametophytes and sporophytes of *Asplenium erosum* in October 2018, April 2019, February 2020.

Asplenium verecundum

- In the past year we have successfully acclimated several *A. verecundum* ferns from terraria to ambient conditions in Fairchild's nursery, bringing our total nursery ex situ collections to approximately 20 plants. In early July we intend to do a pilot planting of two individuals at the Deering Estate. We are working with preserve manager Dallas Hazelton to install them with a covering of protective wire mesh, since past experience shows that raccoons tend to remove the ferns.

Thelypteris patens

- We monitored plants at the Deering Estate which Fairchild introduced in 2014. Amazingly, the number of plants was again 68 of 211 (32%); this is the same as the previous year. Some plants did die in the past year, but 3 new plants have recruited in the Deering Estate's Pipeline Trail. These are extremely robust and have grown very quickly, reaching heights of 3 feet since 2019.

OBJECTIVE 3

Continue to expand the Connect to Protect Network

THE CONNECT TO PROTECT NETWORK

For more than twelve years, Fairchild's Connect to Protect Network (CTPN) has inspired South Florida residents to plant native pine rockland plants in order to connect the few remaining isolated fragments of pine rockland--a globally critically imperiled (G1S1) plant community. Installing native pine rockland plants in Miami's urban areas increases the probability that bees, butterflies and birds can find and transport seeds and pollen across developed areas that separate pine rockland fragments, improving gene flow and genetic health of native plant species.

During the 2019-2020 grant year, CTPN continued to grow and develop rapidly. Throughout the remainder of this section of the report, we provide further details on operations, membership, and more. Plans for a BioBlitz and an evening lecture and panel discussion had to be scrapped due to the COVID-19 outbreak, but we continued to engage members via social media and our newsletter, and we resumed plant distributions in late May, with many new restrictions in place to enforce social-distancing guidelines.

Operations update

While CTPN has grown, we have continued to adapt and improve our operations. Last year we reported the success of finalizing a logo, which has been wonderful to maintain brand consistency in an eye-catching way; the logo is prominently featured on yard signs and all our materials. This year, we worked with Fairchild's graphic artists to develop a professional "rack card" to help with outreach (**Fig. 55**).



Figure 55. Front and back of the Connect to Protect Network rack card

In the 2019-2020 grant year, we emailed 11 monthly newsletters to members, with open rates of 36-49%. The standard open rate for non-profit organization emails is 20.4%, according to our email service, Mailchimp.

Membership update

As of June 2020, Connect to Protect Network membership includes 1153 separate individuals (**Fig.56**); this is an increase of 317 in the past 12 months. Because we have some email-only members and because we require multiple contacts for schools, this does not represent 1153 gardens, but rather 980 gardens; this is an increase of 251 gardens in the past 12 months. Our membership includes:

- 817 homeowners (83% of gardens)
- 131 schools (13% of gardens)
- 32 other organizations (3% of gardens)
- 44 email-only members

We continue to utilize social media and other means to recruit new CTPN members and to spread the word about the program and about native plants in general. Our website (www.fairchildgarden.org/CTPN) continues to serve as a one-stop-shop for information on pine rockland plants as they relate to the Network.

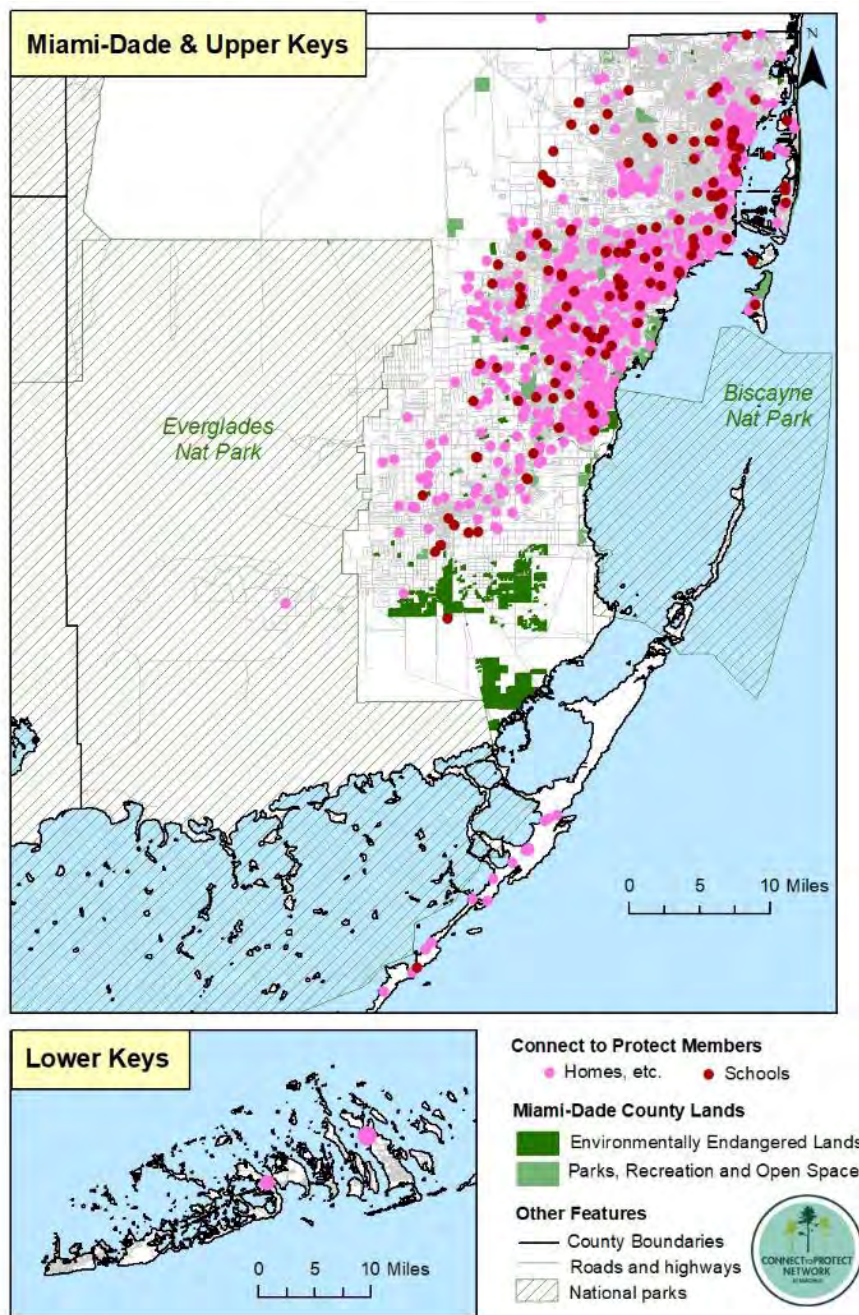


Figure 56. Connect to Protect Network Membership as of June 2020.

Plant distributions

During this 2019-2020 grant cycle, we donated more than 1300 plants of more than different pine rockland taxa to Miami homeowners, schools, and organizations, as part of the Connect to Protect Network. This number was higher last year (2400), but we held monthly distribution events nearly every month. In 2020 we did not distribute plants in March, April, or June due to the coronavirus pandemic. When we resumed distributions in late May, social distancing guidelines were in place (**Fig. 57**). These included a new online pre-ordering system whereby Fairchild staff and volunteers could set aside plants ahead of time for rapid pickup. Guests were scheduled to ensure no more than two were present in the planting area at any one time. Masks were required.

In addition to donations to homeowners and schools, we donated more than 400 pine rockland plants to partner organizations, including 389 plants to Miami-Dade County parks and preserves.



Figure 57. Connect to Protect plant distribution in the era of COVID-19. **Left:** “Starter Kits” of 5 pre-selected pine rockland plants are lined up and ready to go to the member who selected them. **Right:** cones and tape signal the one-way circuit for members to stop at tables, pick up a yard sign and ask (masked, distant) staff and volunteers any questions.

OBJECTIVE 4

Promote conservation of Florida rare species through displays and public outreach.

RECENT PUBLICATIONS, PRESENTATIONS, AND WORKSHOPS BY FAIRCHILD CONSERVATION STAFF

Newsletters

- We emailed 11 Connect to Protect newsletters to network members.

Peer-Reviewed Publications

- Franck, A., D. Barrios, K.E St. E. Campbell, **J. Lange**, Z. Rigerszki, J. Haakonsson, G. Gann, W. Cinea, N.M. Howe, J. St. John, S. Moreno, and C.C. Clark. 2019. Revision of *Pilosocereus* (Cactaceae) in the Caribbean and Northern Andes. *Phytotaxa* 411 (3): 129-182.
- Weakley, A.S., R.K. Schoonover McClelland, H.C. Medford, D.B. Poindexter, R.J. LeBlond, K.A. Bradley, J.F. Matthews, C. Anderson, A.R. Franck, **J. Lange**. 2019. Studies in the Vascular Flora of the Southeastern United States Vol 5. *J. Bot. Res. Inst. Texas*. 13 (1): 107-129.
- Krings, A., A. Franck, R. Hammer, **B. Jestrow**, R. Renfro, **J. Lange**. *Gonolobus taylorianus* (Apocynaceae, Asclepiadoideae, Gonolobinae) in Florida. *J. Bot. Res. Inst. Texas*, 13 (1): 315-317.
- **Lange, J.** and C. Angelo. 2020. *Goniopteris moranii* (syn.: *Thelypteris guadalupensis*; Thelypteridaceae), New to Florida and the Continental United States. *Am. Fern. Jour.* 110 (2): 75-78.
- Noblick, L., S. Wintergerst, D. Noblick, J. T. Lima (2020). *Syagrus coronata* (Arecaceae) phenology and the impact of fire on survival and reproduction of the licuri palm. *SITIENIBUS série Ciências Biológicas*, 20. doi: 10.13102/scb4908
- **Possley, J.**, J. Duncan, J. Gil and C. Grossenbacher. 2020. Too precious to lose: managing and protecting the Richmond pine rockland tract in Miami-Dade County, South Florida. *Cities and the Environment* 13(1).
- Prince C.M., Quincy K.H., Enloe S.F., **Possley J.**, and Leary J. 2019. Cut-stem treatments using graminicides for burmameed (*Neyraudia reynaudiana*) invasions in Pine Rocklands, South Florida, USA. *Invasive Plant Sci. Manag.* 12: 236–241. doi: 10.1017/inp.2019.30.

Popular Articles (see Appendix III)

- **Cuni**, L. 2019. Saving rare endemics. *The Tropical Garden* 74(2):34-35.
- **Harding**, B. 2019. Using our underappreciated native grasses in the home landscape. *The Tropical Garden* 74(2):37-39.
- **Possley**, J. 2019. 35 years of conserving: Fairchild's Conservation Team, by the numbers. *The Tropical Garden* 74(2):30-33.

Manuscripts submitted for peer-review

- von Wettberg, E., J. Sadle, E. Ogutcen, **J. Possley**, **J. Lange**, N. Carrasquilla-Garcia, and P. Chang. Distribution and genetic diversity of South Florida *Tephrosia* shed light on past cultural use and potential for Neodomestication. *Submitted to Front. In Gen.*
- Angelo, C., D. Rosen, and **J. Lange**. *Eleocharis mutata* (L.) Roem. & Schult. (Cyperaceae), New to the Flora of Florida, U.S.A. *Submitted to J. Bot. Res. Inst. Texas* May 2020.
- Figueroa, A., **J. Lange**, S. Whitfield. *In Press*. Seed consumption by gopher tortoises (*Gopherus polyphemus*) in globally imperiled pine rockland ecosystem of southern Florida, USA. *Chelo. Cons. and Biol.*

Presentations

- Lange, J. Updating Plant Occurrence Records in Broward County Preserves. Presentation for the Everglades Cooperative Invasive Species Management Area (ECISMA) Summit. July 17, 2019.
- Lange, J. YEAR 1 REPORT: Biological Monitoring Program for Rare Plant Conservation in Broward County Natural Areas. Annual presentation to County staff. December 12, 2019.
- Possley, J. Update on work in Miami-Dade County Preserves. Zoo Miami. July 23, 2019.
- Possley, J. Update on DPI Grant. Gainesville, FL. October 2019.
- Possley, J. About Fairchild's Conservation Program. Conservation volunteer awards luncheon, Fairchild Tropical Botanic Garden. January 9th, 2020.
- Possley, J. Updates on the Connect to Protect Network. Imperiled Butterfly Working Group annual meeting, UF/IFAS Extension Office in Homestead, FL. January 24, 2020.
- Possley, J. Fairchild's Conservation Team and the Connect to Protect Network. Professional Training for MDCPS teachers. Fairchild Garden. February 1, 2020.

OTHER OUTREACH AND EDUCATION

Mentoring

We worked with interns Melissa Rivera and Jennay Bailey from BioTech@Richmond High School. Sabine oversaw their research project, "Effects of increased soil salinity on seed germination and seedling establishment of the Big Pine partridge pea." On many occasions, the students assisted Brian with nursery tasks such as seed collecting and repotting.

Research collaborations

Jimmy continues to work with Broward County and the Institute for Regional Conservation to identify vascular plants that have been extirpated from the urbanized portion of the County.

Field Trips

- Jimmy led a field trip to Lakeside Sand Pine Preserve for the Broward chapter of the FNPS. (11/23/2019)
- Jimmy led a restoration workday with Broward County staff and volunteers from USDA- APHIS removing *Tectaria incisa* from sensitive, rare fern habitat at Fern Forest Nature Center. (12/6/2019).
- Jimmy led a restoration workday at Virginia Key with FIU's undergraduate Restoration Ecology Course (02/01/2020)
- Jimmy led a field trip to Deerfield Highlands Natural Area for Deerfield Middle School. We were working with the school and the County to learn about native plants and restore scrub habitat. The day was split into nature walks and weed pulling. (03/10/2020)

Workshops & Classes

- Harding, B., Wintergerst, S. Propagation in Conservation. Classes at Fairchild. 12 October 2019.
- Harding, B., Wintergerst, S. Propagation in Conservation. Class for Bound by Beauty. 9 March 2020.
- Lange, J. ECISMA EDRR Plant Identification. Workshop for the ECISMA Summit training local biologists in identification of EDRR plant species and their native lookalikes. July 18, 2019.
- Possley, J. The art and science of ferns. Virtual Classes@Fairchild. May 30, 2020.

Websites

We maintained up-to-date content on two pages hosted by Fairchild. One page features the work of the South Florida Conservation Team; the other is about the Connect to Protect Network.

- o www.fairchildgarden.org/Science-Conservation-/Plant-Collections/Florida-Native-Plant-Collection
- o www.fairchildgarden.org/CTPN

Social media

We used social media (Facebook, Twitter and Instagram) to promote Connect to Protect and rare Florida native plants at least once a week.

Board Membership

Jimmy Lange

- Chair (now Past Chair as of March) of the Florida Exotic Pest Council
 - o Merchandise Committee, Editorial Committee member, Strategic Planning committee member, and member of Plant List Committee.
 - o forwarding the message of exotic species management, a primary issue facing rare plants in South Florida.
- Temporary board member of the Florida Rare Plant Conservation Endowment
 - o Working to increase sustained funding opportunities for work relating to rare plant research and conservation in Florida.

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APPENDIX I: EX SITU COLLECTIONS

Fairchild maintains ex-situ collections to safeguard species from extinction, to provide plants for reintroduction or augmentation, and for use in studies of rare species' biology. Our ex-situ collection is comprised of both plants and seeds, which we collect with permission from landowners, county, state and federal governments. Below is a summary of Fairchild's plant (**Table A1**) and seed (**Table A2**) ex situ collections as of July 1, 2020.

Table A1: All Florida listed species in ex situ conservation (plants only)

Listed Taxon	FL Rank	Whole Plants	
		Nursery	Garden
<i>Alvaradoa amorphoides</i>	E	X	X
<i>Amorpha herbacea</i> var. <i>crenulata</i>	E	104	X
<i>Anemia wrightii</i>	E	X	
<i>Argythamnia blodgettii</i>	E	350	
<i>Aristolochia pentandra</i>	E	3	
<i>Asplenium dentatum</i>	E	X	
<i>Asplenium erosum</i>	E	X	
<i>Asplenium verecundum</i>	E	X	
<i>Basiphyllaea corallicola</i>	E	X	
<i>Bourreria cassinifolia</i>	E	120	X
<i>Bourreria succulenta</i>	E		X
<i>Brickellia mosieri</i>	E	200	X
<i>Byrsonima lucida</i>	T	X	X
<i>Chamaecrista lineata</i> var. <i>keyensis</i>	E	43	
<i>Chamaesyce garberi</i>	E	X	
<i>Chromolaena frustrata</i>	E	X	
<i>Cienfuegosia yucatanensis</i>	E	X	
<i>Consolea corallicola</i>	E	X	
<i>Crossopetalum ilicifolium</i>	T	X	X
<i>Crossopetalum rhacoma</i>	T	X	
<i>Ctenitis sloanei</i>	E	X	X
<i>Ctenitis submarginalis</i>	E	2	
<i>Dalea carthagenensis</i> var. <i>floridana</i>	E	17	X
<i>Guaiacum sanctum</i>	E		X
<i>Harrisia aboriginum</i>	E	X	
<i>Harrisia fragrans</i>	E	X	
<i>Harrisia simpsonii</i>	E	X	
<i>Ipomoea microdactyla</i>	E	5	
<i>Ipomoea tenuissima</i>	E	X	
<i>Jacquemontia curtissii</i>	E	1	X
<i>Jacquemontia reclinata</i>	E	X	
<i>Jacquinia keyensis</i>	T	X	X
<i>Koanophyllon villosum</i>	E	X	
<i>Lantana depressa</i> var. <i>depressa</i>	E	X	X
<i>Metastelma blodgettii</i>	T	1	X
<i>Microgramma heterophylla</i>	E	X	X
<i>Mosiera longipes</i>	T	X	
<i>Opuntia abjecta</i>	E	X	
<i>Opuntia ochrocentra</i>	E	X	

<i>Phyla stoechidifolia</i>	E	4	
<i>Pilosocereus robinii</i>	E	X	X
<i>Pteris bahamensis</i>	T	1	X
<i>Scutellaria havanensis</i>	E	X	X
<i>Senna mexicana</i> var. <i>chapmanii</i>	T	X	X
<i>Sphenomeris clavata</i>	E	X	X
<i>Tectaria fimbriata</i>	E	X	
<i>Tectaria heracleifolia</i>	E	103	X
<i>Tephrosia angustissima</i> var. <i>corallicola</i>	E	3	X
<i>Thelypteris grandis</i>	E		X
<i>Thelypteris patens</i>	E	X	
<i>Thelypteris reptans</i>	E	X	
<i>Thelypteris reticulata</i>	E	X	X
<i>Thelypteris sancta</i>	E	X	
<i>Thelypteris sclerophylla</i>	E	X	
<i>Tripsacum floridanum</i>	T		X
<i>Vallesia antillana</i>	E		X

Table A2: All Florida listed species with seeds in long-term storage at Fairchild and/or at the USDA NLGRP. Total number of taxa shown is 71.

Taxon	FL Rank	Quantity	Years Deposited	Location
<i>Adiantum melanoleucum</i>	E	mass	2011-2017	NLGRP
<i>Aeschynomene pratensis</i>	E	132	2019	FTBG
<i>Ageratum maritimum</i>	E	5000	2018,2019	FTBG
<i>Aletris bracteata</i>	E	6,500+6300	2009, 2019	NLGRP, FTBG
<i>Alvaradoa amorphoides</i>	E	2,745	2007	NLGRP
<i>Amorpha herbacea</i> var. <i>crenulata</i>	E	32,038+1878	2004, 2015, 2019, 2020	NLGRP, FTBG
<i>Anemia wrightii</i>	E	mass	2016	NLGRP
<i>Angadenia berteroi</i>	T	300, 13	2008, 2019	NLGRP, FTBG
<i>Argythamnia blodgettii</i>	E	568+7600	2007, 2015, 2020	NLGRP, FTBG
<i>Aristolochia pentandra</i>	E	245	2018,2019	FTBG
<i>Asplenium dentatum</i>	E	mass	2016	NLGRP
<i>Asplenium verecundum</i>	E	mass	2012	NLGRP
<i>Basiphyllaea corallicola</i>	E	mass	2011, 2016	NLGRP,
<i>Bourreria cassinifolia</i>	E	1,880 + ~2000	2007-2008	NLGRP, FTBG
<i>Brickellia mosieri</i>	E	5,869+3447	2008-2016,2019,2020	NLGRP, FTG
<i>Byrsonima lucida</i>	T	612+371	2008,2017,2019	NLGRP, FTBG
<i>Chamaecrista lineata</i> var. <i>keyensis</i>	E	773+523	2016, 2019	NLGRP, FTG
<i>Chamaesyce deltoidea</i> ssp. <i>pinetorum</i>	E	730	2007	NLGRP
<i>Chamaesyce deltoidea</i> ssp. <i>serpyllum</i>	E	504+48	2016, 2019	NLGRP, FTG
<i>Chamaesyce garberi</i>	E	4,440	2007, 2015	NLGRP
<i>Chromolaena frustrata</i>	E	~6000+398	2007-2016,2019	NLGRP, FTG
<i>Colubrina cubensis</i> var. <i>floridana</i>	E	~3000	2007, 2016	NLGRP, FTG
<i>Conradina grandiflora</i>	T	25	2019	FTBG
<i>Crossopetalum ilicifolium</i>	T	398	2008	NLGRP
<i>Crossopetalum rhacoma</i>	T	403	2008	NLGRP
<i>Ctenitis sloanei</i>	E	mass	2013-2016	NLGRP
<i>Ctenitis submarginalis</i>	E	mass	2016	NLGRP
<i>Cynanchum blodgettii</i>	T	334	2008	NLGRP
<i>Dalea carthagenensis</i> var. <i>floridana</i>	E	32,703+44	2008-2013,2019	NLGRP, FTBG
<i>Digitaria pauciflora</i>	E	16,908	2007	NLGRP
<i>Evolvulus grisebachii</i>	E	487	2018	FTBG
<i>Galactia smallii</i>	E	5,559+2733	2008, 2015	NLGRP, FTBG
<i>Harrisia aboriginum</i>	E	~13000	2019	FTBG
<i>Harrisia fragrans</i>	E	24,522+~7600	2008, 2015	NLGRP
<i>Harrisia simpsonii</i>	E	1,470+274	2015-2016,2019	NLGRP, FTG
<i>Ipomoea microdactyla</i>	E	4	2009	NLGRP
<i>Ipomoea tenuissima</i>	E	300+566	2019	NLGRP, FTBG
<i>Jacquemontia curtisii</i>	T	1303+1459	2008,2018	NLGRP,FTBG
<i>Jacquemontia reclinata</i>	E	39,582+679	2004-2013,2018,2019	NLGRP,FTBG

<i>Jacquinia keyensis</i>	T	32	2009	NLGRP
<i>Koanophyllum villosum</i>	E	2,000+200	2015, 2020	NLGRP, FTBG
<i>Lantana canescens</i>	E	24,172	2006-2013	NLGRP
<i>Linum arenicola</i>	E	587+175	2016	NLGRP, FTG
<i>Linum carteri</i> var. <i>carteri</i>	E	~5000+131	2004-2017-2019	NLGRP, FTG
<i>Linum carteri</i> var. <i>smallii</i>	E	438	2009	NLGRP
<i>Melanthera parvifolia</i>	T	908+19	2008, 2020	NLGRP, FTBG
<i>Mosiera longipes</i>	T	2647	2008	NLGRP
<i>Passiflora pallens</i>	E	300		NLGRP
<i>Pilosocereus polygonus</i>	E	217	2008, 2017	NLGRP, FTG
<i>Pilosocereus robinii</i>	E	>17,000 + 2400 *	2008-2016,2019	NLGRP, FTG
<i>Pithecellobium keyensis</i>	T	1077	2009	NLGRP
<i>Polygala smallii</i>	E	1,282	2008	NLGRP
<i>Pteris bahamensis</i>	T	mass	2016	NLGRP
<i>Sachsia polycephala</i>	T	443	2018	NLGRP, FTBG
<i>Scutellaria havanensis</i>	E	62	2008	NLGRP
<i>Senna mexicana</i> var. <i>chapmanii</i>	T	3586+244	2008, 2019	NLGRP, FTBG
<i>Smilax havanensis</i>	T	53	2008	NLGRP
<i>Sphenomeris clavata</i>	E	mass	2016	NLGRP
<i>Tectaria fimbriata</i>	E	mass	2016	NLGRP
<i>Tectaria heracleifolia</i>	T	mass	2012, 2016	NLGRP
<i>Tephrosia angustissima</i> var. <i>corallicola</i>	E	29,146+1179+248	2004, 2013,2018, 2020	NLGRP,FTBG
<i>Tephrosia curtisii</i>	E	436+ 38	2019, 2020	FTBG
<i>Tetrazygia bicolor</i>	T	7710	2009	NLGRP
<i>Thelypteris grandis</i>	E	mass	2014	NLGRP
<i>Thelypteris patens</i>	E	mass	2011-2012	NLGRP
<i>Thelypteris reptans</i>	E	mass	2011-2016	NLGRP
<i>Thelypteris reticulata</i>	E	mass	2011-2014	NLGRP
<i>Thelypteris sancta</i>	E	mass	2016	NLGRP
<i>Thelypteris sclerophylla</i>	E	mass	2012-2016	NLGRP
<i>Tropidia polystachya</i>	E	mass	2017	NLGRP, FTG

APPENDIX II: CONSERVATION ACTION PLAN

Argythamnia blodgettii (Torr.) Chapm.



Species Name: *Argythamnia blodgettii* (Torrey) Chapman

Common Name(s): Blodgett's wild mercury, Blodgett's silverbush

Synonym(s): *Argythamnia argoethamnoides* (Bertero ex Spreng.) J.W. Ingram, *Ditaxis blodgettii* (Torr. ex Chapm.) Pax

Family: Euphorbiaceae

Species/taxon description: *A. blodgettii* is an erect, suffrutescent perennial plant to 60-150 cm tall with oval to elliptic leaves covered with bifurcate hairs. Leaves are to 4cm long and distinctly 3-nerved. Flowers are small, yellow-green and inconspicuous. Fruit is a dehiscent, 3-seeded capsule 4-5mm wide. Some authors (e.g. Wunderlin et al. 2020) lump the taxon with the more widely distributed *Argythamnia argoethamnoides*, present in northern South America.

Legal Status: USFWS: Threatened. State of Florida: Endangered

Conservation status: Native

Prepared by: Sabine Wintergerst, Fairchild Tropical Botanic Garden

Last Updated: S. Wintergerst, June 2020

Range-wide distribution – past and present

Florida

(Historical) Central Miami-Dade County, Long Pine Key in Everglades National Park and Florida Keys (Monroe County) from Totten Key south to Key West (Bradley and Gann 1999)

(Current) Central Miami-Dade County south to Boca Chica Key (Hodges and Bradley 2006).

According to Bradley and Gann (1999) the species lost approximately 12 miles at the northern end of its range in Miami-Dade County. The range of *A. blodgettii* in the Florida Keys (Monroe County) currently stretches from Dove Creek Hammocks in Key Largo south to Boca Chica Key (Hodges and Bradley 2006).

World

(Historical) South Florida and Florida Keys (Nature Serve 2020)

(Current) South Florida and Florida Keys (Nature Serve 2020)

Population and reproductive biology/life history

Annual/Perennial: Perennial

Habit: Herb

Short/Long-Lived: Unknown/ at least 3 years.

Pollinators: Unknown

Flowering Period: Flower year-round, peaking in April to June (Possley et al. 2019).

Fruiting: Fruiting year-round, peaking April to June (Possley et al. 2019)

Annual variability in Flowering: Unknown

Growth Period: Likely all year with a peak in the wet/growing season.

Dispersal: Weakly ballistic. capsules split open and eject 3 seeds

Seed Maturation Period: Unknown

Seed Production: Each seed pod contains three seeds.

Seed Viability: ~80% (FTBG seed lab)

Regularity of Establishment: Unknown

Germination Requirements: Fresh seed can germinate readily, 24h soaking in smoke solution yielded 80% germination (11% no treatment, 51% 24h 0.5% KNO₃ solution) in seeds that were stored in ambient conditions for 1 month (Wintergerst, FTBG seed lab, unpublished data, see section above)

Establishment Requirements: Unknown

Population Size: The current population is estimated to consist of fewer than 10,000 individual plants (NatureServe 2020). The largest population exists on Big Munson Island in the Florida Keys (8000-9000 individuals) (Hodges and Bradley 2006)

Annual Variation: Unknown

Number and Distribution of Populations: According to the Institute of Regional Conservation (IRC) there are at least 9 populations in conservation areas in Miami-Dade County and 1 population on Long Pine Key in Everglades National Park (Gann et al. 2001-2019). Several private properties in Miami-Dade contain small populations, including the FPL easement adjacent to Ludlam Pineland Preserve (Possley, pers. obs). and current and former EEL Covenant lands (DERM unpubl. Data). There are 11 occurrences (including occurrences on private land) on 9 islands of the Florida Keys (Monroe-County) (Hodges and Bradley 2006)

Habitat description and ecology

Type: **PINE ROCKLAND, ROCKLAND HAMMOCK, COASTAL BERM.** *A. blodgettii* grows in open sunny areas mainly in pine rockland, but also in edges or openings of rockland hammock and in edges of coastal berm. Sometimes it can be found in disturbed areas close to a natural area (Bradley and Gann 1999). Pine rockland is a fire dependent habitat that burns naturally in 3-10-year intervals (Snyder et al. 1990). The fires help to maintain an open and sunny understory with a minimum amount of hardwoods. *A. blodgettii* seems to tolerate some human disturbance since it can be found along disturbed edges of its habitat and even in completely scarified pine rockland (Bradley and Gann 1999)

Physical Features:

Soil: limestone overtopped with organic soil layer (Snyder et al. 1990)

Aspect: n/a

Slope: nearly 0%

Moisture: Unknown

Light: Unknown

Biotic Features:

Community:

In pine rocklands *A. blodgettii* is associated with southern slash pine (*Pinus elliottii* var. *densa*), a shrub canopy of saw palmetto (*Serenoa repens*), wax-myrtle (*Myrica cerifera*), poisonwood (*Metopium toxiferum*), and willow bustic (*Sideroxylon salicifolium*). Common herbaceous associates include crimson bluestem (*Schizachyrium sanguineum*), wire bluestem (*Schizachyrium gracile*), scaleleaf aster (*Aster adnatus*), and bastard copperleaf (*Acalypha chamaedrifolia*) (Bradley and Gann 1999)

Rockland hammocks and coastal berms where *A. blodgettii* occurs are dominated by a diverse assemblage of tropical tree and shrub species, with a very sparse herbaceous layer. Common hardwood associates include poisonwood (*Metopium toxiferum*), gumbo limbo (*Bursera simaruba*), willow bustic (*Sideroxylon salicifolium*), crabwood (*Gymnanthes lucida*), and wild coffee (*Psychotria nervosa*) (Bradley and Gann 1999). *Argythamnia* is generally associated with forest edges or openings where herbaceous communities persist.

Interactions: unknown

Competition: Unknown

Mutualism: Unknown

Parasitism: Unknown

Host: n/a

Other:

Animal use: Unknown

Natural Disturbance:

Fire: Recommended burn regime for pine rocklands: different parcels every 2-3 to 7 years, summer fires (Bradley and Gann 1999). Rockland hammock populations more likely driven by disturbance events such as hurricanes.

Hurricane: Unknown

Slope Movement: Unknown

Small Scale (i.e. Animal Digging): Unknown

Temperature: Unknown

Protection and management

Summary: *A. blodgettii* is mostly threatened by habitat loss and fire suppression. Fire suppression might be detrimental to this species in two ways. First, *A. blodgettii* grows in sunny and open areas that usually disappear the longer the time passes since the last burn and second, seed research has shown that seeds need chemical cues from smoke in order to germinate. Therefore, fire suppression might also reduce new plant growth due to very low seed germination rates.

Availability of source for outplanting: Fairchild maintains a robust *ex-situ* collection of 42 plants rescued from the Owaissa Bauer Addition preserve (Possley et al. 2019). Additionally, there are around 200 plants grown from *ex-situ* collected seed at Fairchild's nursery. Approximately 480 wild collected seeds and more than 7000 seeds from Fairchild's *ex-situ* collection have been stored at Fairchild's seed lab.

Availability of habitat for outplanting: Fairchild has conducted two translocations in 2019. In both cases plants from Owaissa Bauer Addition preserve that were growing in the impact zone of the Krome Avenue Widening Project were rescued. 46 plants were relocated to Seminole Wayside Park and 42 plants were relocated to West Biscayne Pineland (Possley et al. 2019). After around 10 months ~80% of plants at Seminole Wayside Park and ~ 50% of plants in the West Biscayne Pineland are alive.

Threats/limiting factors

Natural:

Herbivory: Key Deer are known herbivores that may affect survival and seed set (Lange, pers. Obs.)

Disease: Unknown

Predators: Unknown

Succession: Unknown

Weed invasion: Exotic invasives (e.g. *Schinus terebinthifolius* and *Neyraudia reynaudiana*) (Bradley and Gann 1999)

Fire: *A. blodgettii* likely benefits from regular burns

Genetic: Unknown

Anthropogenic

On site: Fence and road construction, general maintenance practices like mowing on preserve edges, urban development, exotic pests, fire suppression (Bradley and Gann 1999),

Off site: Unknown

Collaborators: Florida Dept. of Agriculture and Consumer Services, DPI grant; Miami-Dade County Environmentally Endangered Lands Program; Miami-Dade County Natural Areas Management; AECOM Inc.; Florida Dept. of Transportation; USDSA National Laboratory for Genetic Resources Preservation.

Conservation measures and actions required

Research history: Until now not much research has been done with *A. blodgettii*. At Fairchild's seed lab germination trials have been conducted. It has been found that seeds of *A. blodgettii* are orthodox (capable of withstanding desiccation and freezing) which will facilitate the conservation of the genetic

diversity of the remaining populations by storing seeds in a freezer in our local seed bank. Additionally, germination trials revealed how to break seed dormancy in this species. The germination of seeds is triggered by water soluble compounds of smoke which underlines the importance of fire for this species.

In 2019, Fairchild conducted experimental translocations of *A. blodgettii*, whereby plants of different sizes and different genetic lines were introduced into different habitats. Monitoring is ongoing. Prior to translocations, Fairchild conducted nursery trials to propagate *A. blodgettii* vegetatively using several different rooting hormones. Each hormone treatment resulted in root growth, but the product Hormondin 3 produced the longest and most well-branched roots.

Significance/Potential for anthropogenic use: None, besides the general benefit of conserving the diversity of native plants

Next Steps: Fairchild will continue with regular monitoring of recently translocations. We are also distributing plants through our Connect to Protect Network. Though this species is not showy, we are offering it as sixth “bonus plant” that members may receive in addition to their 5-plant starter kit; thus, it has been popular and we have distributed it to more than 20 homeowners. We will collect seed from wild populations as opportunities arise, to add to long-term storage. Reintroducing populations to historical sites is something we would pursue in the future, time and funding permitted.

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APPENDIX III: ARTICLES FROM *THE TROPICAL GARDEN MAGAZINE*

The following articles from Fairchild's in-house magazine are included at the end of this report:

Cuni, L. 2019. Saving rare endemics. *The Tropical Garden* 74(2):34-35.

Harding, B. 2019. Using our underappreciated native grasses in the home landscape. *The Tropical Garden* 74(2):37-39.

Possley, J. 2019. 35 years of conserving: Fairchild's Conservation Team, by the numbers. *The Tropical Garden* 74(2):30-33.



SAVING RARE ENDEMIC

TEXT AND PHOTOS BY LYDIA M. CUNI

FAIRCHILD'S CONSERVATION TEAM HAS RECENTLY CONDUCTED A SERIES OF ACTIONS DEVOTED TO THE RECOVERY OF THREE FEDERALLY ENDANGERED PLANTS ENDEMIC TO SOUTH FLORIDA, WITH ANOTHER ROUND OF ACTIONS FOR TWO MORE PLANT TAXA UNDERWAY.



At a local pine rockland preserve, the team partnered with Miami-Dade County Environmentally Endangered Lands (EEL) and volunteers to plant more than 70 individuals and 1,000 seeds of three plant species: Florida Brickell-bush (*Brickellia mosieri*), sand flax (*Linum arenicola*), and Carter's flax (*Linum carteri* var. *carteri*).

The planning and implementation for this work was a Conservation Team effort under the "Fab 5" project, a U.S. Fish & Wildlife Service- and Florida Department of Agriculture & Consumer Services-funded proposal to implement safeguarding actions for five recently federally listed South Florida endemic plant taxa.

These translocations were designed as field experiments, with the objective of studying the ecological requirements of these rare plants, while also testing our restoration methods to better inform future efforts of this kind. Preparations are underway to implement similar safeguarding actions at the National Key Deer Wildlife Refuge in the Lower Florida Keys for the two remaining taxa in this project: Big Pine partridge pea (*Chamaecrista lineata* var. *keyensis*) and Keys wedge sandmat (*Euphorbia deltoidea* ssp. *serpyllum*).

Over the next year, the team will monitor the outplantings in Miami-Dade and Monroe Counties, keeping track of ecological variables, and ultimately correlating these with the outplanting results.

We can hardly wait to see what we discover!



PREVIOUS PAGE
The sun sets over Fairchild's rare plant translocation area at a local pine rockland EEL preserve.

LEFT
Newly planted individuals of
1. Florida Brickell-bush, *Brickellia mosieri*. These taxa are found only on the Miami Rock Ridge.
2. *Linum arenicola*



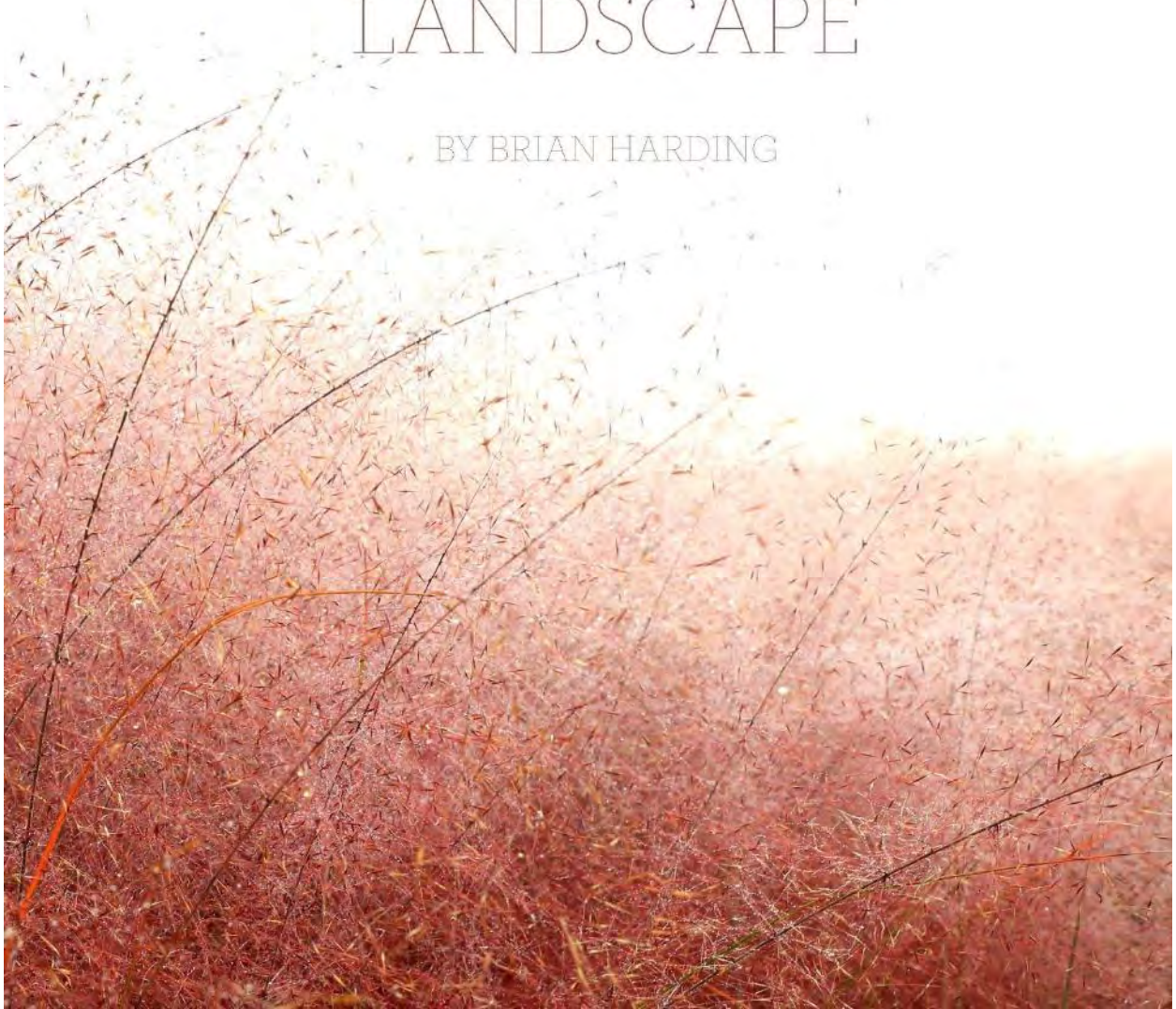
LEFT & BELOW
Apart from planting seed-grown individuals into the wild, Fairchild's Conservation Team also outplanted seeds to study germination, establishment, and reproductive rates in the field.



LEFT
An outplanted Carter's Flax (*Linum carteri* var. *carteri*) surviving and producing seed in the restoration area.

USING OUR UNDERAPPRECIATED *NATIVE GRASSES* IN THE HOME LANDSCAPE

BY BRIAN HARDING





Picture it: Georgia, 1998. On a beautiful evening in the foothills of the northeast Georgia mountains, a timid young man stands before a captive audience of his gardening peers. As his presentation draws to a close, the dread and fear of his first Q&A session shows in the beads of sweat on his brow. Suddenly, from the back of the room, a hand shoots high in the air and that first dreaded question arrives. A sultry-voiced woman asked our young man what he felt was the most underutilized group of plants. Armed with only the knowledge gained in a few short months of retail gardening, he spontaneously answered “ornamental grasses,” reasoning that other plants in the retail environment seemed to sell whereas the grasses did not. Hence, if grasses didn’t sell, then they had to be the most underutilized group of plants. Fast forward a couple of decades, and our young gardener has not only survived his initial Q&A session, but has since found his way through many more. I was that young man.

Now, as a horticulturist in Fairchild’s conservation department, if I were posed that very same question, I would emphatically shout “GRASSES!” No, I’m not referring to your water-guzzling carpet of St. Augustine, but rather another, under-appreciated group of grasses, one that appears right under your nose. Before Miami became the modern Magic City, its magic lay in the flora of its pine rockland. This globally critically endangered habitat—now reduced in size to a mere 1% to 2% of its historic range outside of Everglades National Park—is home to a diverse group of forbs and grasses. Specifically, its grasses occupy a large percentage of understory real estate, and historically served to carry fire across the connected landscape.

Though relegated mostly to County preserves and other wild places, our native pine rockland grasses are now finding their way into Miami’s urban landscapes with the help of Fairchild’s Connect to Protect Network. This program aims to enlist Miami homeowners to install native pine rockland species. The idea is to increase the probability that bees, butterflies, and birds can find and transport seeds and pollen across developed areas that separate isolated pine rockland fragments, improving gene flow and the genetic health of native plant species.

Our native grasses provide critical cover and seeds for wildlife, can soften the look of hardscaped areas, and vary the texture of plant material across the landscape. These species are well adapted to the area’s environmental conditions, tolerating extremes of temperature, humidity, our limestone and sometimes sandy soils, and saline conditions. They exhibit exceptional tolerance to both insect damage and disease pressures, have legendary drought tolerance once established and most require little in the way of fertilization since they naturally occur on nutrient-poor soils. Once established, our native grasses require minimal maintenance. Site them in full sun for at least six hours a day. Most species benefit from being cut to the ground every one to two years at the start of the rainy season. Plants recover quickly and in about three weeks you’ll never know you touched them. Here’s a closer look at a few of our favorite pine rockland species.



Tripsacum floridanum, Florida gamagrass

A robust grass, it grows to between three and four feet high with an equal width. Florida gamagrass hails from extreme southern Florida, the Florida Keys, and West Indies. In the landscape, use en masse to break up the monotony of large islands of mulch, or to soften the edges of limestone hardscaping. This species is tolerant of nutrient-poor soils and requires no supplemental water once established. It's listed as threatened by the State of Florida.



Aristida purpurascens, arrowfeather threeawn

This is a wide-ranging species in the eastern United States, Florida Keys, West Indies, Mexico, and Central America, growing to between one and two feet. Among our featured grasses, arrowfeather threeawn is perhaps the most tolerant of coastal conditions as it tolerates moderate exposure to salt wind. This clumping species grows equally well in wetter soils as in drier, nutrient-poor soils. It has exceptional tolerance to drought once established. This grass serves well as a companion plant to other species especially in hard-to-landscape coastal plantings.



Eragrostis elliottii, Elliott's love grass

A personal favorite of mine, this one-foot to 18-inch, fast-growing grass is native to the eastern United States, down to the Florida Keys, into southern Mexico, and Belize. A highly drought-tolerant, clumping species, Elliott's love grass produces large showy white inflorescences relative to the size of the plant. This species also displays a higher degree of salt wind tolerance and is a favorite of our coastal gardeners. Use Elliott's love grass as a lovely companion plant along paver paths and for wildlife as birds eat the abundant seeds produced.



Muhlenbergia capillaris, muhly grass

The crème de la crème of the native Poaceae is muhly grass. It ranges widely, from eastern and central North America to the Florida Keys, Mexico, Central America, and the West Indies. This highly drought- and salt-tolerant species is well adapted to a range of environmental conditions and even exhibits tolerance to light shade. Its large showy inflorescences emerge in fall, from pale to shocking pink, and stand well above the clump of dark green needle-like blades. Use en masse to create visually stunning landscape displays and to contrast with large broad-leaf plants.



Schizachyrium rhizomatum, rhizomatous bluestem

This southern Florida endemic grows to two feet and spreads by rhizomes to form large patches that can occupy several square feet. It's highly drought tolerant once established and provides excellent cover for wildlife. Site this species in the landscape carefully as it needs room to grow. It's particularly useful for establishing sites where soils are compacted and other plants are difficult to grow and need to compete with weeds.



Schizachyrium gracile, wire bluestem

This beautiful clumping species that grows to one and a half feet is native to extreme southern Florida and the West Indies. It's extremely drought tolerant once established and produces quaint inflorescences in early fall. This grass makes a lovely addition to mixed borders and en masse seems to dance on the slightest breeze. Use its upright, thread-like blades to contrast nicely with broad-leaf foliage or to soften hardscaping within the landscape.

Brian Harding is a horticulturist and part of Fairchild's South Florida Conservation Program. To support Fairchild's efforts to connect pine rockland habitats and add these beautiful grasses to your landscape, join our Connect to Protect Network at www.fairchildgarden.org/CTPN.

Learn more at the Natives for your Neighborhood website from our partners at The Institute for Regional Conservation at www.regionalconservation.org/beta/nfn/default.asp

CONSERVATION



35 YEARS OF CONSERVING FAIRCHILD'S CONSERVATION TEAM, BY THE NUMBERS

By Jennifer Possley
Photos by Fairchild staff



Thirty-five years ago, a wonderful thing happened for South Florida: a native plant conservation program was born. In honor of this milestone, we are looking back at the formation and many accomplishments of Fairchild's Conservation Team, as we have worked to safeguard the native biodiversity of our region.



The first Fairchild staffer dedicated to rare plants of our region, Carol Lippincott, examines a rare plant specimen with renowned botanist George Proctor in Puerto Rico in the late 1980s.

The history of Fairchild's local plant conservation efforts is one of partnerships and cooperation. Not surprisingly, it was a partnership that started it all. In 1984, the Center for Plant Conservation (CPC) was formed to save the diverse array of native plants within the United States. As a founding member of the CPC, Fairchild

pledged to safeguard the rarest native plant species of South Florida, Puerto Rico and the U.S. Virgin Islands. These imperiled plant taxa—now 69 in total—are part of Fairchild's collections and also part of the CPC "National Collection" comprising our nation's most imperiled plant species.



Former Conservation Horticulturist and Connect to Protect Network staffer Devon Powell and Jennifer Possley were happy to be in a pine rockland on this buggy summer day.



The Conservation Team is still as active as ever! Here Jimmy Lange, Lydia Cuni and Dr. Sabine Wintergerst pause from installing a seed germination experiment with the federally endangered Keys wedge sandmat in the Lower Florida Keys.

In 1989, five years after joining the CPC, longtime Fairchild Tropical Garden Director John Popenoe hired the Garden's first staffer entirely dedicated to rare plant conservation. Carol Lippincott, curator of endangered species, was on staff for four years, with funding provided by the CPC, The Nature Conservancy, and MetroDade Parks and Recreation Department. These were unusual times and a lot happened during Dr. Lippincott's term! In 1990, Miami-Dade County residents voted to raise their property taxes to fund the purchase of environmentally endangered lands, and the County's EEL program was born. In 1991, the

County formed its Natural Areas Management (NAM) Division to manage the unique natural resources in its urban parks. In 1992, Hurricane Andrew severely damaged much of South Florida, including the endangered lands and urban parks. The County relied on Fairchild's expertise and connections to help NAM survey the damage and quickly mobilize recovery efforts. It was during these early days of the County's preserve system and post-Andrew restoration that Fairchild's Conservation Team became a critical player in conserving South Florida's rare plants.





Dr. Joyce Maschinski, seen here with longtime volunteers Mary Rose and Patty Phares, was Fairchild's Conservation Ecologist for 13 years. Now at the Center for Plant Conservation, Joyce still collaborates regularly with Fairchild's Conservation Team.



Fairchild's 2019 Conservation Team is stellar! Members include horticulturist Brian Harding, seed lab manager Dr. Sabine Wintergerst, and field biologists Lydia Cuni and Jimmy Lange.

Three and a half decades later, some things have changed (we have gone from typewriters to smartphones!) but Fairchild's Conservation Team remains a fixture in conserving South Florida's rare plants. Our work has expanded from Miami-Dade County preserves into various national parks, state parks, other counties, and even private properties. Our collaborative spirit and ability to reach across political and jurisdictional boundaries allows us to take a holistic approach toward conserving species and habitats rather than particular parcels of land.

Over the years, the ripple effects from our research, surveys, seed banking, horticulture, planning and outreach have made positive change for rare plants in South Florida and beyond. While our work is never done, the Team has accomplished quite a bit over the years. Take a look at some of the numbers and see!

Learn how you can support our conservation efforts at www.fairchildgarden.org/Florida-Conservation



Jennifer Possley is Fairchild's Conservation Program Manager. Carol Lippincott, Joyce Maschinski and Joy Klein provided valuable input in writing this article.

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