

**Pine Rockland Restoration in
Miami-Dade and Monroe Counties, Florida**

Grant Agreement #F16AP00865
Final Report

September 30, 2016 through September 30, 2021

June 8, 2022

George D. Gann, Executive Director
Alex Seasholtz, Ecological Restoration Team Leader
Michelle Smith, Field Biologist



Submitted by:

The Institute for Regional Conservation
100 East Linton Boulevard, Suite 302B
Delray Beach, FL 33483
www.regionalconservation.org



Submitted to:

Kevin Kalasz
Coastal Program Coordinator - South Florida/Everglades
U.S. Fish and Wildlife Service
28950 Watson Blvd, Big Pine Key, FL 33043

Executive Summary

The pine rocklands of southeastern Florida contain one of the highest concentrations of federally listed plants and animals in the United States and are considered Globally Imperiled by NatureServe. Highly fragmented and reduced in extent outside of Everglades National Park, this critical habitat suffers from extensive management challenges including fire suppression, invasive species, sea level rise, and the continued destruction of unprotected parcels. Nevertheless, a network of protected pine rocklands has been established including federal, local, and private conservation areas that provide key habitat for myriad species protected at the federal, state, and local levels. With this Coastal funding and through its [Pine Rockland Initiative](#), from 2017 to 2021 The Institute for Regional Conservation (IRC) designed and implemented cutting edge pine rockland restoration activities at 20 sites in Miami-Dade and Monroe counties. IRC exceeded the cumulative project extent goals of 188 acres by performing work on 255 acres of pine rockland habitat. This work led to the discovery of a new population of the federally listed Everglades bully and improved habitat for at least 22 species of federally listed plants and animals. IRC also conducted extensive public outreach and played a key role in a large collaborative effort to significantly increase the body of knowledge underpinning the restoration of pine rocklands that have been highly degraded or destroyed, including the development of techniques that can be deployed in lieu of and to prepare for successful prescribed burning. This project leveraged other substantial federal, local, and private funding and in-kind support for the Pine Rockland Initiative.

Introduction

In 2016, The Institute for Regional Conservation (IRC) was awarded Grant #F16AP00865 for Pine Rocklands Restoration in Miami-Dade and Monroe counties, Florida¹. This grant provided five years of support for IRC's [Pine Rockland Initiative](#) (PRI), which has been restoring privately and publicly owned parcels of pine rockland habitat in Miami-Dade and Monroe counties since 2005. This report summarizes work completed from September 30, 2016, through September 30, 2021. All work was coordinated with Kevin Kalasz, U.S. Fish and Wildlife Service (FWS).

Background

The pine rocklands of southeastern Florida contain one of the highest concentrations of federally listed plants and animals in the United States. Pine rocklands are globally rare, occurring only in southern Florida and the Bahamas, and the South Florida Slash Pine Rockland ecosystem is considered Globally Imperiled by NatureServe². In southern Florida, pine rocklands are primarily limited to Miami-Dade and Monroe counties and provide habitat for more than two dozen federally listed and more than 100 state listed species of plants and animals. In Miami-Dade County, less than 2% of the pine rocklands remain outside of Everglades National Park due to extensive urban and agricultural development³, and unprotected parcels continue to be destroyed. Pine rocklands in the Florida Keys are also fragmented and highly threatened by sea level rise, tropical cyclone storm surges, and other climate change factors. Most of the remaining pine rockland patches outside of Everglades National Park are degraded by one or more of: the direct and indirect effects of fragmentation, fire suppression, invasive species, native hardwood and palm expansion, overly dense pine canopy, and other degradation drivers (e.g., illegal dumping, wildlife poaching⁴). Many federally listed species can benefit from the restoration of this critically important habitat (Table 1). Since 2005, IRC in partnership with the US Fish and Wildlife Service and others, has implemented its Pine Rockland Initiative to provide technical support and to actively restore degraded pine rocklands on public

¹ Modification #2 added an additional component (Post-storm Pine Rocklands Restoration), which was initiated and completed in 2018 and reported elsewhere.

² https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.833194/Pinus_elliottii_var_densa_-_Coccothrinax_argentata_-_Sideroxylon_salicifolium_Woodland_Group

³ Gann 2018, unpublished, presented in Expanding the Pine Rockland Footprint - To Protect We Must Restore, Pine Rockland Working Group Conference, November 1, 2018.

⁴ Songbird poaching was documented at IRC's George N. Avery Pineland, where adjacent property owners hung traps over their fence into the protected area, until the FWS intervened. See also this [article](#).

and private lands in Miami-Dade and Monroe counties. Prior to this project, a substantial body of knowledge about pine rockland restoration and management had been developed but important gaps remained. Up to 2016, most of the emphasis of the PRI had been on invasive species control, as this was the priority for funders and land managers. However, by the mid-2010s there was a growing awareness that the lack of regular fire in remnant pine rocklands fragments was causing species declines equal to or more severe than those caused by invasive species. However, there was no consensus as to what actions to take nor on appropriate management targets.

Table 1. Examples of federally listed species found in pine rocklands in Miami-Dade and Monroe counties that could benefit from ecological restoration.

	Vascular Plants	Common Name	Status
1	<i>Amorpha herbacea</i> var. <i>crenulata</i>	Crenulate leadplant	Endangered
2	<i>Argythamnia blodgettii</i>	Blodgett's silverbush	Threatened
3	<i>Brickellia mosieri</i>	Florida brickell-bush	Endangered
4	<i>Chamaecrista lineata</i> var. <i>keyensis</i>	Big Pine partridge pea	Endangered
5	<i>Dalea floridana</i>	Florida prairie-clover	Endangered
6	<i>Digitaria pauciflora</i>	Florida pineland crabgrass	Threatened
7	<i>Euphorbia deltoidea</i> ssp. <i>deltoidea</i>	Deltoid spurge	Endangered
8	<i>Euphorbia deltoidea</i> ssp. <i>pinetorum</i>	Pineland sandmat	Threatened
9	<i>Euphorbia deltoidea</i> ssp. <i>serpyllum</i>	Wedge spurge	Endangered
10	<i>Euphorbia garberi</i>	Garber's spurge	Threatened
11	<i>Galactia smallii</i>	Small's milkpea	Endangered
12	<i>Linum arenicola</i>	Sand flax	Endangered
13	<i>Linum carteri</i> var. <i>carteri</i>	Carter's small-flowered flax	Endangered
14	<i>Polygala smallii</i>	Tiny polygala	Endangered
15	<i>Sideroxylon reclinatorum</i> ssp. <i>austrofloridense</i>	Everglades bully	Threatened
	Animals		Status
1	<i>Anaea troglodyta floridalis</i>	Florida leafwing	Endangered
2	<i>Cicindelidia floridana</i>	Miami tiger beetle	Endangered
3	<i>Drymarchon corais couperi</i>	Eastern indigo snake	Threatened
4	<i>Eumops floridanus</i>	Florida bonneted bat	Endangered
5	<i>Odocoileus virginianus clavium</i>	Key deer	Endangered
6	<i>Sylvilagus palustris hefneri</i>	Lower Keys marsh rabbit	Endangered
7	<i>Strymon acis bartramii</i>	Bartram's scrub-hairstreak	Endangered

Project Goals

Three primary goals were described in the initial project scope: 1) treat and retreat FLEPPC Category I and Category II invasive plant species⁵ on as many acres as funding allowed, on both public and private lands; 2) conduct outreach, including workshops, volunteer days, and presentations to the public to increase landowner and public support for pine rockland conservation; 3) explore methods for restoring and managing pine rocklands in lieu of fire. The total funding authorized was \$504,000 and the total extent goal was 188 acres.

Restoration Activity Planning and Coordination

All components of the project were planned in collaboration with Kevin Kalasz, Coastal Program Coordinator – South Florida/Everglades, U.S. Fish and Wildlife Service. Descriptions of and justifications for each site proposed for work were provided to and approved in advance by Mr. Kalasz. Appropriate records were kept, and periodic reports were submitted. Occasional field visits by senior staff and Mr. Kalasz were conducted. IRC worked closely with the Miami-Dade County Environmentally Endangered Lands (EEL) program senior staff and its preserve managers, conservation botanists with Fairchild Tropical Botanic Gardens (FTBG), private landowners, and many others (see also Acknowledgements below).

Overview of Restoration Activities Conducted

From November 2017 to September 2021, substantial ecological restoration activities were conducted on 255 acres over 20 sites in Miami-Dade and Monroe counties (Fig. 1). This exceeded our acreage goal by 35%. Activities

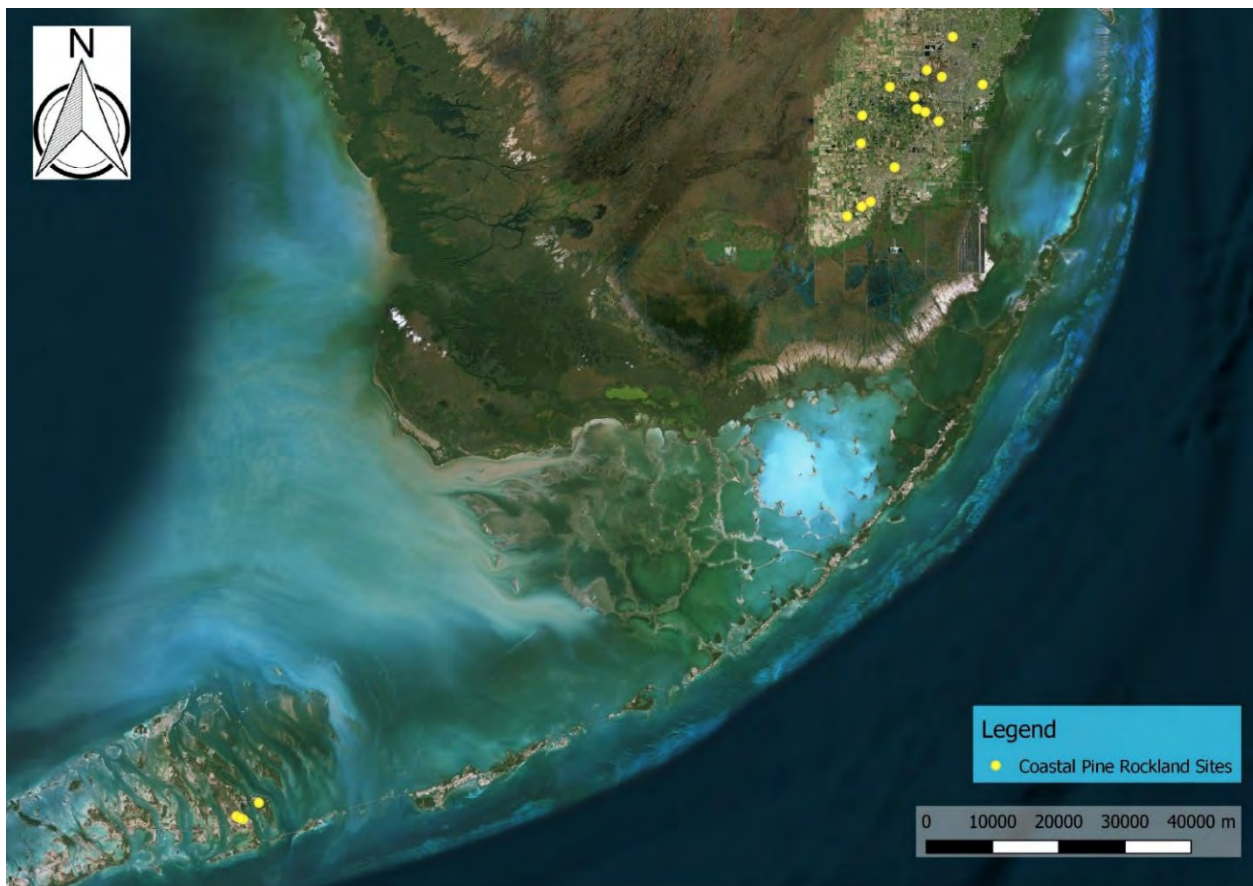


Figure 1. Yellow dots indicate sites of Coastal funded restoration in Miami-Dade and Monroe counties, Florida, 2017-2021.

⁵ The Florida Exotic Pest Plant Council is now the Florida Invasive Species Council (FISC) - <https://floridainvasivespecies.org/index.cfm>.

included treatment and retreatment of invasive species consistent with Goal 1, the development and implementation of fire surrogate techniques consistent with Goal 3, as well as facilitating preparation for and leveraging prescribed fire and wildfire management by Miami-Dade County Natural Areas Management. With two exceptions, we continued adding acreage each year while following up and building on our work in previously treated areas.

Miami-Dade County. Substantial work was conducted on 213.3 acres at 14 sites (Fig. 2, Table 2). The 14 sites include 188.6 acres at six public sites, all part of the Miami-Dade County EEL program, one Miami-Dade County School Board property (1.6 acres at Robert Morgan Educational Center), and 23.1 acres at seven voluntarily protected private pine rockland sites. Invasive species control occurred at all sites, and other activities, such as native pine, hardwood, and palm reduction, and the control of weedy species along disturbed edges were deployed as needed. Additional work was completed at eight private sites with matching funds and in-kind effort.

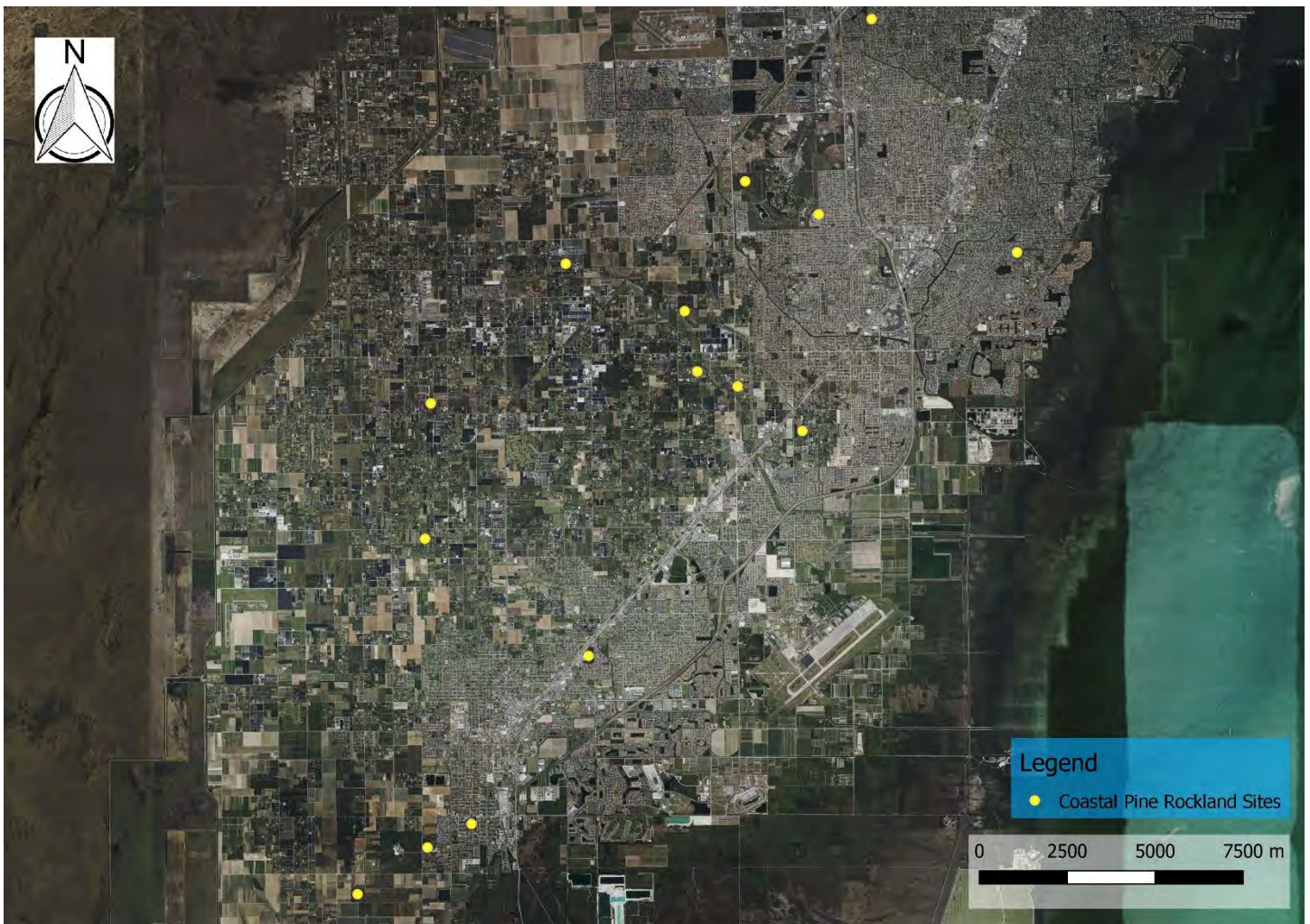


Figure 2. Yellow dots indicate sites of Coastal funded restoration in Miami-Dade County, Florida, 2017-2021.

Table 2. Project Sites in Miami-Dade County. Sites with an asterisk are part of our current '50/50 Match' program.

Site Name	Date Initiated	Acres Treated Under This Program
George N. Avery Pineland (IRC)	November, 2017	2.5
John Kunkel Small Pineland (IRC)	November, 2017	0.9
Medlock Pineland (Private)	December, 2017	3.3
Ned Glenn Nature Preserve (EEL)	January, 2018	11.4
Florida City Pineland (EEL)	March, 2018	17.8
Moon Pineland (Private)	June, 2018	3.5
Pine Shore Pineland Preserve (EEL)	June, 2018	7.8
Sunny Palms Pineland (EEL)	July, 2018	32.7
Quail Roost Pineland (EEL)	Nov, 2018	28.7
Martinez Pineland (EEL)	Nov, 2019	90.2
Robert Moreno (Private*)	July, 2020	4.3
Robert Morgan Educational Center (School Board*)	December, 2020	1.6
Colleen Boggs (Private*)	January, 2021	5.7
Robert Grant/ Blakeslee (Private*)	March, 2021	2.9
Totals		213.3

Monroe County. Substantial work was conducted on 41.4 acres at six sites on No Name Key and Big Pine Key within the National Key Deer Refuge (Table 3, Fig. 3). Invasive species control and hardwood reduction occurred at all sites, and other activities were deployed as needed. New techniques to respond to wildfire following decades of fire exclusion were developed at Hibiscus Drive Pineland (see Accomplishments below).

Table 3. Project Sites in Monroe County.

Site Name	Date Initiated	Acres Treated Under This Program
No Name Key Rockpit	October, 2018	10.0
Hibiscus Drive Burned Pineland	November, 2018	10.5
19 th Street	May, 2019	3.1
Fence Lane	May, 2019	7.9
Raccoon Run North	May, 2019	5.6
Raccoon Run South	December, 2019	4.3
Totals		41.4

Outreach

At total of 25 volunteer restoration events, workshops, presentations, and other outreach events were held, all in Miami-Dade County. Nine volunteer restoration events were held in collaboration with Miami-Dade County EEL, Florida International University (FIU), Miami-Dade College, the Girls Scouts of Tropical Florida (Table 4). Sixteen workshops, presentations, and other outreach events were held in collaboration with the Dade Chapter of the Florida Native Plant Society (DC-FNPS), FTBG, the Miami Blue Chapter of the North American Butterfly Association, Miami-Dade County, and the Dade Chapter of the Florida Native Plant Society (DC-FNPS) (Table 5, Figure 4). Additional outreach was conducted as part of FWS Partners funding for private owners of pine rocklands (see [Gann 2021](#)), through the FWS funded Pine Rockland Business Plan development, and other activities.



Figure 2. Yellow dots indicate sites of Coastal funded restoration in Monroe County, Florida, 2017-2021.

Partnerships and In-Kind Contributions

This project was implemented in collaboration with many partners and benefited from significant in-kind contributions and synergies, in terms of direct restoration impact, economic efficiency, and knowledge development. Major partners included the Miami-Dade County EEL Program, Miami-Dade County Natural Areas Management (NAM), and Fairchild Tropical Botanic Garden. Our partnership with EEL was critical, in terms of EEL being the steward of large restoration sites in Miami-Dade County, as the funding agency for NAM at our restoration sites, and in terms of our collaboration with preserve managers who reviewed and provided essential feedback on both our proposed work plans and our progress. NAM provided key support and in-kind contributions including hauling of excess vegetative debris hauled from Florida City Pineland, Ned Glenn Nature Preserve, and Pine Shore Preserve (Fig. 5). Significantly, due in large part to IRC’s prior restoration efforts, NAM was able to conduct several prescribed burns and maximize opportunities from wildfires at five sites (Fig. 6, Table 6). In some cases (e.g., Ned Glenn, Florida City), prescribed burning or wildfire management (versus suppression) would not have been possible without significant investment of resources by others, and conservation impacts would have been significantly reduced. At others (e.g. Pine Shore Preserve, Quail Roost Pineland, Sunny Palms), direct benefits of fire were increased due to prior restoration actions. In addition, at all sites we were able to follow up and efficiently treat invasive species responding to fire (in some cases exploding in growth), as well as more efficiently conduct palm and hardwood reduction due to increased physical access.

Table 4. Volunteer restoration events.

Date	Location	What was done	No. of Attendees
3/24/2018	Florida City Pineland	Field trip and workday with FIU's Restoration Ecology Lab	18
5/11/2018	Medlock Pineland	Hand pulled and bagged <i>Tradescantia spathacea</i> .	6
9/8/2018	Girl Scouts of Tropical Florida, Camp Choee	Scavenger hunt for native plants and animals. Hand pulled and bagged <i>Tradescantia spathacea</i> , filling 26 trash bags. Girl Scouts earned their Clean Jeans patch.	15
9/26/2018	George N. Avery Pineland	Field trip and workday with Miami-Dade College class, including soil sampling.	13
3/2/2019	Sunny Palms Pineland	Field trip and workday with FIU's Restoration Ecology Lab. Hand pulled and bagged <i>Pteridium caudatum</i> .	13
4/20/2019	Quail Roost Pineland	Workday in collaboration with Miami-Dade County EEL. Hand pulled and bagged <i>Lantana camara</i> and <i>Nephrolepis cordifolia</i> .	7
2/1/2020	Pine Shore Pineland	Workday in collaboration with Miami-Dade County EEL. Hand pulled and bagged <i>Nephrolepis cordifolia</i> . Miami-Dade County Commissioner (now Mayor) Daniella Levine Cava participated.	63
3/7/2020	Florida City Pineland	Workday in collaboration with Miami-Dade County EEL. Removed trash from north end and west side. Hand pulled and bagged <i>Neyraudia reynaudiana</i> and other nonnative invasive plants.	40
4/17/2021	George N. Avery Pineland	Field trip and trash and vegetation debris pickup.	6

Table 5. Workshops, presentations, and other outreach events

Date	Venue	What was done
February, 2018	Everglades Day at Arthur R. Marshall Loxahatchee National Wildlife Refuge	Provided outreach on the importance of pine rocklands, rare and listed species, restoration of the ecosystem, and long-term management.
March, 2018	DC-FNPS Native Plant Day at AD Barnes Park	Provided outreach on the importance of pine rocklands, rare and listed species, restoration of the ecosystem, and long-term management.
March, 2018	Ned Glenn Nature Preserve	Participated at Miami-Dade County EEL Program outreach event.
May, 2018	Expanding the Footprint Workshop at FTBG	First meeting to explore the concept of Expanding the Footprint. Attending were representatives from IRC (George Gann), FWS (Kevin Kalasz), Miami-Dade County (Janet Gil, Craig Grossenbacher, Dallas Hazelton), and FTBG (Jennifer Possley).
May, 2018	FNPS Annual Meeting, Miami	IRC staff (Michelle Smith, Alex Blochel) presented posters on the PRI and the Bartram's scrub-hairstreak larval host <i>Croton linearis</i> .
November, 2018	Pine Rockland Working Group Conference at FTBG	Theme of the biannual meeting was "Expanding the Footprint" and George Gann was keynote speaker.
February, 2019	FIU, upper-level Restoration Ecology class (Dr. Hong Liu)	George Gann gave two lectures, the first covered the Society for Ecological Restoration's International Principles and Standards for the Practice of Ecological Restoration, and the second was titled <i>Restoring Globally Imperiled Pine Rocklands: To Protect We Must Restore</i> . This gave students exposure to ecological restoration at two very different scales and demonstrated how the two are connected.
May, 2019	Rockdale Pineland	Participated at Miami-Dade County EEL workday, and assisted FTBG in planting out the federally endangered Florida Brickell-bush and Sand Flax.
August, 2019	Ned Glenn Nature Preserve	Assisted Miami-Dade County in installing a restoration collaboration sign funded by Jacksonville Zoo and Gardens.

December, 2019	Butterfly and Bird Day, Castellow Hammock Preserve and Nature Center	Provided outreach to event hosted by Miami Blue Chapter of the North American Butterfly Association and Miami-Dade County Parks, Recreation, and Open Spaces. IRC Associate Sandy Koi was a guest speaker.
January, 2020	Imperiled Butterflies of Florida Work Group meeting, IFAS Extension Homestead	George Gann presented <i>Thinking Big: Large Scale Restoration of Pine Rocklands for Rare Species</i> . He discussed the history of pine rockland loss and strategic opportunities to restore this critical native ecosystem.
March, 2020	FIU, upper-level Restoration Ecology class (Dr. Hong Liu)	Same format as February 2019.
June, 2020	IRC special pandemic webinar series	George Gann gave a special IRC webinar on <i>The Pine Rockland Initiative: Biodiversity, Restoration, and Thinking Big to Save a Globally Imperiled Ecosystem</i> . We had 120 people attend, and additional subsequent views on YouTube.
October, 2020	Pine Rockland Working Group virtual meeting	George Gann presented <i>Beyond Business as Usual – Transforming our Thinking about Pine Rocklands</i> during the 2020 Pine Rockland Working Group Virtual Symposium and also participated in the <i>Update on the Pine Rockland Business Plan</i> , jointly presented by the US Fish and Wildlife Service, The Nature Conservancy, Miami-Dade County, Fairchild Tropical Botanic Garden, IRC, and other collaborators.
March, 2021	DC-FNPS Native Plant Day field trip, Pine Shore Preserve	Field trip discussing restoration progress at Pine Shore.
April 2021	BioBlitz, Ingram Pineland, Quail Roost Pineland	Hosted by Miami-Dade County EEL. Recorded plant and animal species and discussed restoration of pinelands.
June 2021	Florida City Pineland	Field trip and discussion of pine rockland restoration.



Figure 4: Event at Florida City Pineland, June 2021.



Figure 5. Miami-Dade County NAM hauling debris, Florida City Pineland, March 2018.

Building on work conducted with the FWS Partners program with private owners of pine rocklands, we collaborated with several landowners who supported their own restoration work (Table 7), either through payment for service, or through their own labor, equipment, and supplies (Fig. 7). In June 2020 we utilized the federal PPP⁶ program during the pandemic to offer subsidized services to private landowners, which led to the development of a 50/50 match program with our Coastal funding for exceptional sites (Table 2). Jacksonville Zoo and Gardens provided \$15,000 in funding to support restoration at Ned Glenn Nature Preserve (Fig. 8), the Miami Beach Garden Club and many private donors provided general support for the PRI, and many volunteers contributed personal time at volunteer restoration events. In total, more than \$200,000 in match and in-kind support was received for this project.

⁶ Paycheck Protection Program.



Figure 6. Prescribed burn conducted by NAM at Ned Glenn Pineland Preserve in urban Miami-Dade County. Image from Town of Cutler Bay Facebook page, August 12, 2020.

Table 6: NAM conducted prescribed burns and wildfire responses

Site Name	Date of fire
Sunny Palms Pineland (north section)	November, 2018
Sunny Palms Pineland (south section)	December, 2018
Pine Shore Preserve	September 26, 2019
Quail Roost Pineland	January 16, 2020
Quail Roost Pineland	March 3, 2020
Ned Glenn Nature Preserve	March 27, 2020
Ned Glenn Nature Preserve	August 12, 2020
Florida City Pineland (wildfire)	March, 2021
Sunny Palms Pineland (wildfire)	April, 2021

Table 7. Private property owners contributing their own resources to restore pine rocklands

Site Name	Date Initiated	Acres Treated Under This Program
Joal Thompson and Pat Thompson (Private)	February, 2020	2.28
Steve Kirkland (Private)	March, 2020	0.7
Todd and Diane Lary (Private)	March, 2020	1.7
Keith Fleri (Private)	June, 2020	0.75
Tropical Audubon Society (Nonprofit)	June, 2020	0.5
Girl Scouts Little House, South Miami (Nonprofit)	June, 2020	0.125
Anne Gorden Vega (Private)	July, 2020	0.25
Roberta Lovett (Private)	August, 2020	0.50
Assurant (Private)	October, 2020	0.28

Programmatic Synergies

This project was built on the strong foundation of IRC’s Pine Rockland Initiative, which was founded in 2005, and a powerful collaborative network within the greater southern Florida pine rockland conservation community. Since 1998, the [Pine Rockland Working Group](#) (PRWG), a loose network of agencies, academic institutions, and nonprofit conservation organizations has met every other year to discuss pine rockland science, policy, education, conservation, and restoration. In 2018, we assembled key members of the PRWG members to launch the Expanding the Footprint concept, which became the Keynote Theme of the 2018 PRWG meeting (see Table 5). We leveraged other funding with the FWS Partners program to reengage and reenergize the private pine rockland owners’ community, which directly led to an increase in investment in restoration by pine rockland owners. In 2019, we collaborated with FWS, The Nature Conservancy, Miami-Dade County EEL, FTBG, and other partners to begin development of a Pine Rockland Business Plan. This process led to the integration of best practices from the Society for Ecological Restoration’s 2019 International Principles and Standards for the Practice of Ecological



Figure 7. Joel Thompson (r) and Pat Thompson (l) restoring the family pine rockland by hand with technical assistance provided by IRC, including the treatment of hardwood trees >20' in height.

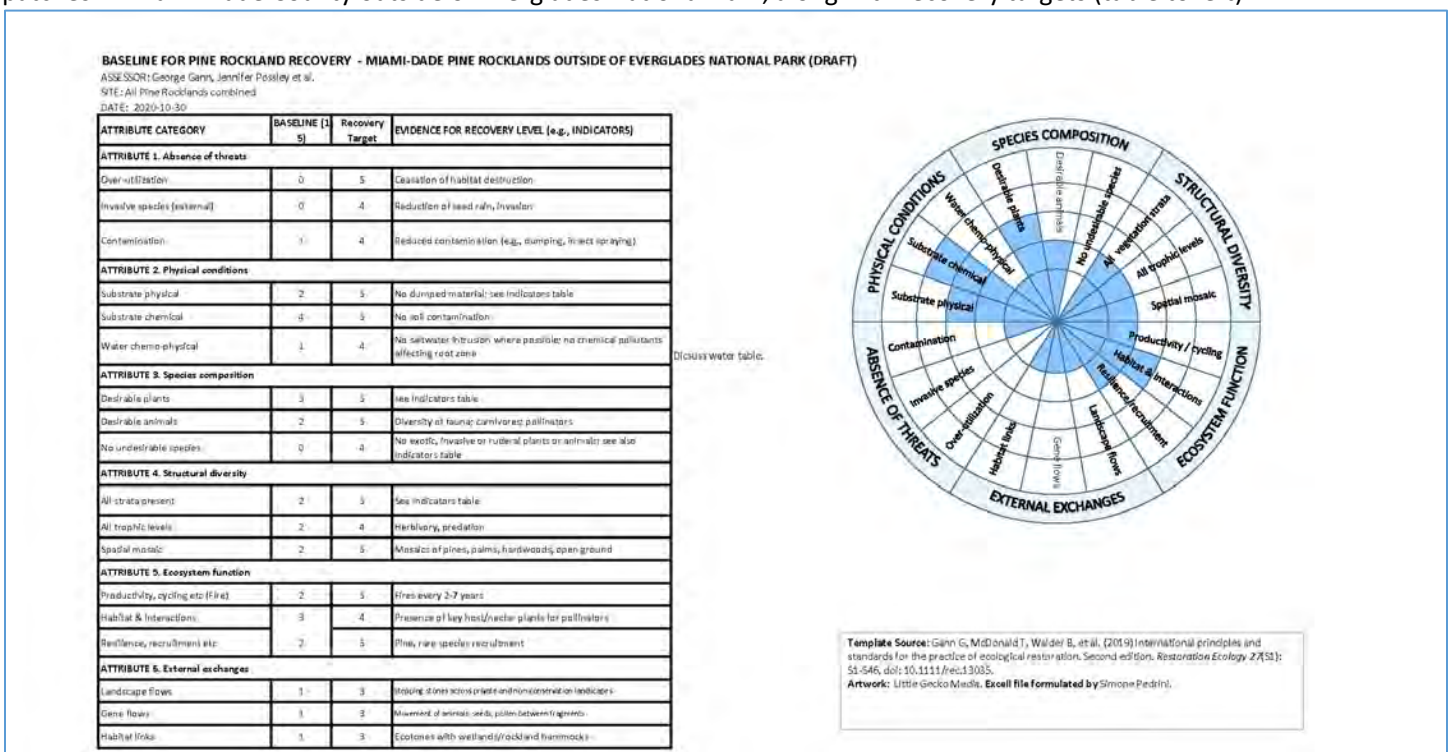


Figure 8. Miami-Dade County EEL Preserve Manager Kirk Linaje and IRC Field Biologist Michelle Smith at Ned Glenn Nature Preserve with educational sign funded by Jacksonville Zoo and Gardens.

Restoration (Gann et al. 2019), including assessments of 2020 baseline conditions for Miami-Dade (Fig. 9) and Monroe counties, and the development of agreed upon draft restoration targets.

In the field, IRC was able to build on federally funded work initiated in 2016 to augment pineland croton (*Croton linearis*), the larval host of the both the Florida leafwing and Bartram’s scrub-hairstreak, in the National Key Deer Refuge (NKDR) on Big Pine Key. Following Hurricane Irma (2017), additional funding became available for mechanical hardwood reduction in the NKDR, which was implemented by IRC in the summer and fall of 2018. Techniques developed during that project were deployed during the Coastal project in fire suppressed pine rocklands on No Name Key within the Refuge. Subsequently, FTBG used these treatment sites on No Name Key to conduct reintroduction trials of federally listed plants with support from FWS. Concurrent with the Coastal project, IRC was working in Miami-Dade County with the US Department of Defense, US Coast Guard, and others. Techniques developed within each project were shared across projects and with partners (Fig. 10).

Figure 9. Preliminary agreed upon ecological recovery wheel showing baseline conditions of the aggregate of pine rockland patches in Miami-Dade County outside of Everglades National Park, along with recovery targets (table to left).



Knowledge Generation

While techniques to safely use prescribed fire and control common invasive species⁷ in pine rocklands had been developed over many decades, little prior work had been done on: 1) the control of lesser-known invasive plants, 2) the management of overabundant pines, native hardwoods, palms, and vines in the absence of regular fire, 3) how to prepare for and optimize use of prescribed fire or wildfire in small pine rockland patches, and 4) the restoration of heavily disturbed edges or prior converted areas dominated by a mix of nonnative and native weeds. During this project, significant knowledge was generated around topics 1-3 (see Fig. 11-14 for examples), while techniques for restoring areas dominated by mixed weedy species were primarily developed on federal projects at SOCSOUTH and adjacent Homestead Air Reserve Base and deployed at Coastal sites. Techniques developed and

⁷ Specifically invasive plants listed by the Florida Exotic Pest Plant Council, now the Florida Invasive Species Council (FISC).

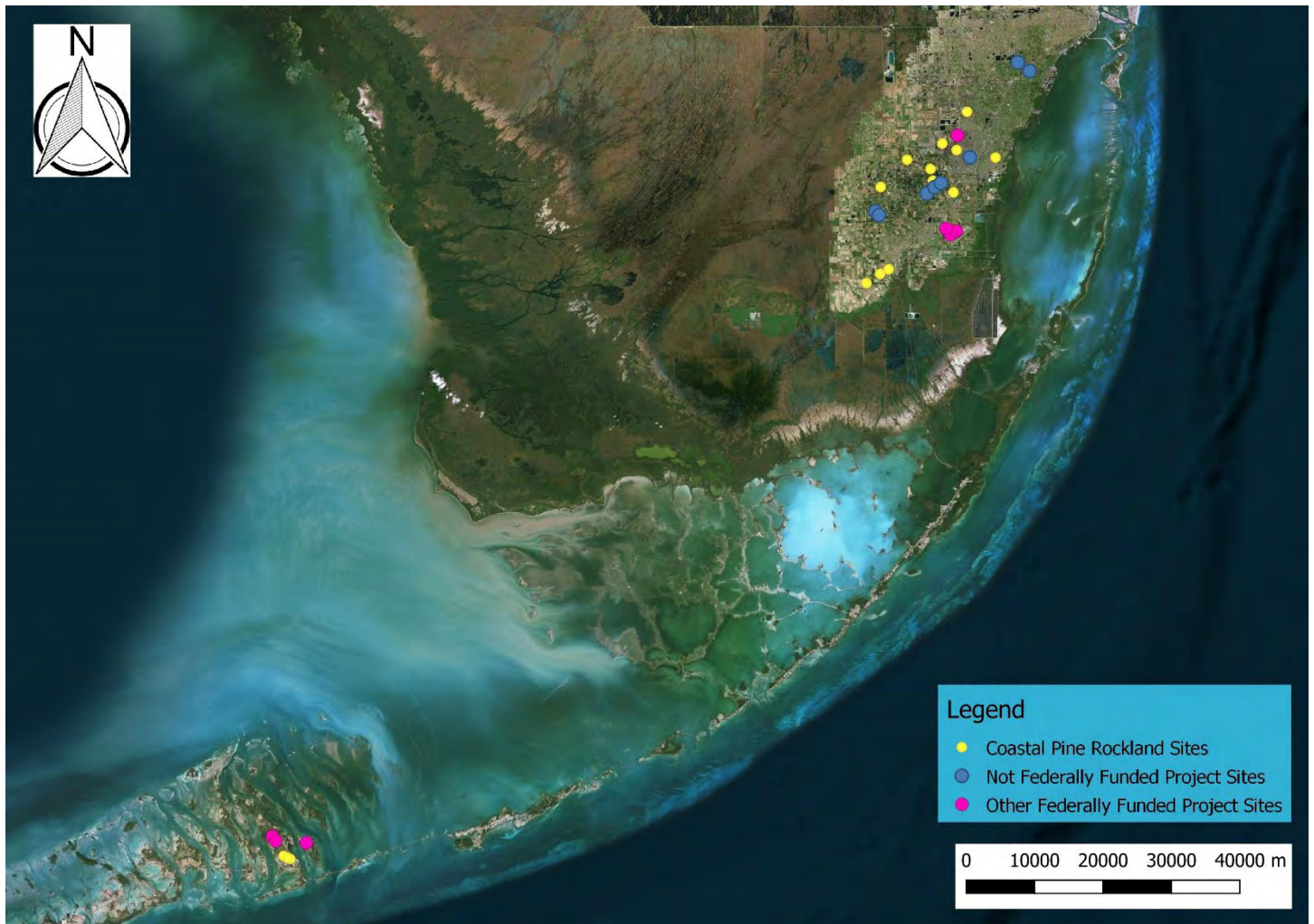


Figure 10. IRC pine rockland projects 2016-2021, showing the matrix of locations and funding sources.

ecological responses observed contributed to the development of ecological targets, and restoration goals and objectives drafted for the Pine Rockland Business Plan (Box 1).

Accomplishments

Ecological restoration work was conducted on more than 250 acres of pine rockland in Miami-Dade and Monroe counties, exceeding project goals of 188 acres. Federally listed species that directly benefited from this work included crenulate leadplant, Blodgett’s brickell-bush, Big Pine Key partridge pea, deltoid spruce, pineland sandmat, wedge spruce, Small’s milkpea, tiny polygala, and Everglades bully. Many other federally listed plant and animal species likely benefited from this work (see Table 1), as well as dozens of state listed plants and animals, some endemic to pine rocklands in southern Florida (e.g. Florida Keys noseburn, *Tragia saxicola*).

Work by IRC and collaborators has demonstrated that pine rockland sites can be placed onto a trajectory of recovery using innovative approaches focusing on measurable restoration targets (e.g., % cover of invasive plants, native hardwoods, palms, groundcovers; stems per acre of slash pine trees). New occurrences of federally listed species have been recorded (Fig. 15), or reconfirmed (Fig. 16), and populations long suppressed have begun to recover (Fig. 17). Dozens of other rare species have benefited (Fig. 19), as habitat integrity has improved (see Appendices A-C). New techniques that have been tested, and results shared with Miami-Dade

Box 1. Restoration targets and goals developed for the Pine Rockland Business Plan informed by this project

Sample ecological targets

Undegraded pine rocklands have an open canopy of South Florida Slash Pine, a diverse understory layer (1-2 m), and an extremely diverse groundcover layer (<1 m). The understory and groundcover layers comprise a mix of endemic, temperate, and tropical species, the composition of which changes from north to south. Native hardwoods, palms, and vines are an important component of pine rocklands, but comprise less than 50% cover in the understory layer; epiphytes are rarely present but can be encountered there. The groundcover layer comprises a mix of graminoids (grasses, sedges, and similar plants), forbs (non-graminoid herbs, e.g., wildflowers), ferns and allies, and creeping vines that have a cover of at least 50%.

Sample restoration goals (longer term)

- 1) Appropriate regular fire, approximating a fire regime of 2-7 years, planned, and initiated within 10 years
- 2) Wildfires are responded to in an appropriate way (e.g., minimizing damage to substrate, rare species, wildlife) and used to restoration advantage when safe and practical within 3 years
- 3) Alternative techniques are applied as fire surrogates or to facilitate the use of prescribed fire within 10 years, but only if a combination of prescribed fire and wildfire cannot meet fire regime goals
- 4) Slash pines are thinned where needed to achieve the appropriate canopy structure, with 50-70 mature trees per acre (>4" dbh in Miami-Dade, >3" dbh in Monroe), within 10 years
- 5) Palms (e.g., saw palmettos, cabbage palms) are thinned or added where needed to achieve the appropriate structure, ranging from 10-25% cover, within 10 years
- 6) Native hardwoods are thinned or added where needed to achieve the appropriate structure, ranging from 5 to 25% cover within 10 years
- 7) Native pine rockland groundcover is restored to comprise 25-75% cover, and areas of bare ground comprise 5-20% cover within 20 years

Sample restoration objectives (shorter term)

- 1) Fire surrogate techniques and plans are developed as needed for each fragment within 3 years
- 2) Half of the overly dense stands of slash pine are thinned within 5 years
- 3) Half of the overly dense stands of palms are thinned within 5 years, and introductions of palms to sites with no or few palms are initiated within 10 years
- 4) Half of overly dense stands of native hardwoods are thinned within 5 years, and introductions of hardwood shrubs to sites with no or few hardwood shrubs are initiated within 10 years
- 5) Half of potential area of native pine rockland groundcover is restored to 25-75% cover, and areas of bare ground comprise 5-20% cover, within 10 years

County and other collaborators. These outcomes are expected to increase proportionally as pine rockland restoration continues to scale up, and some economies of scale may also be realized.

Discussion

Ecological restoration can take long periods of time depending on the ecosystem and level and types of degradation. Pine rocklands are no exception and, in most cases, degradation has been ongoing for decades. Most prior projects have had short-term objectives of one-off invasive species control. Successful restoration underpinned by agreed targets, goals, and objectives takes a longer view, builds on past work, and plans appropriate actions into the future. Restoration should be viewed as the capital investment in Green Infrastructure required to reverse long-term decline and kick-start the recovery of native biodiversity and ecosystem functionality. Once this investment is made, maintenance costs for pine rocklands can be comparably low, and within the capacity of an urban community like Miami-Dade County and federal and state agencies in the Florida Keys. Current work by NAM and EEL to upgrade Miami-Dade County's prescribed burn program and wildfire



Figure 11. Preliminary cabbage palm (*Sabal palmetto*) and hardwood reduction at Ned Glenn Nature Preserve in February 2018. Note standing swamp bay (*Persea palustris*), a remnant of wetter conditions.

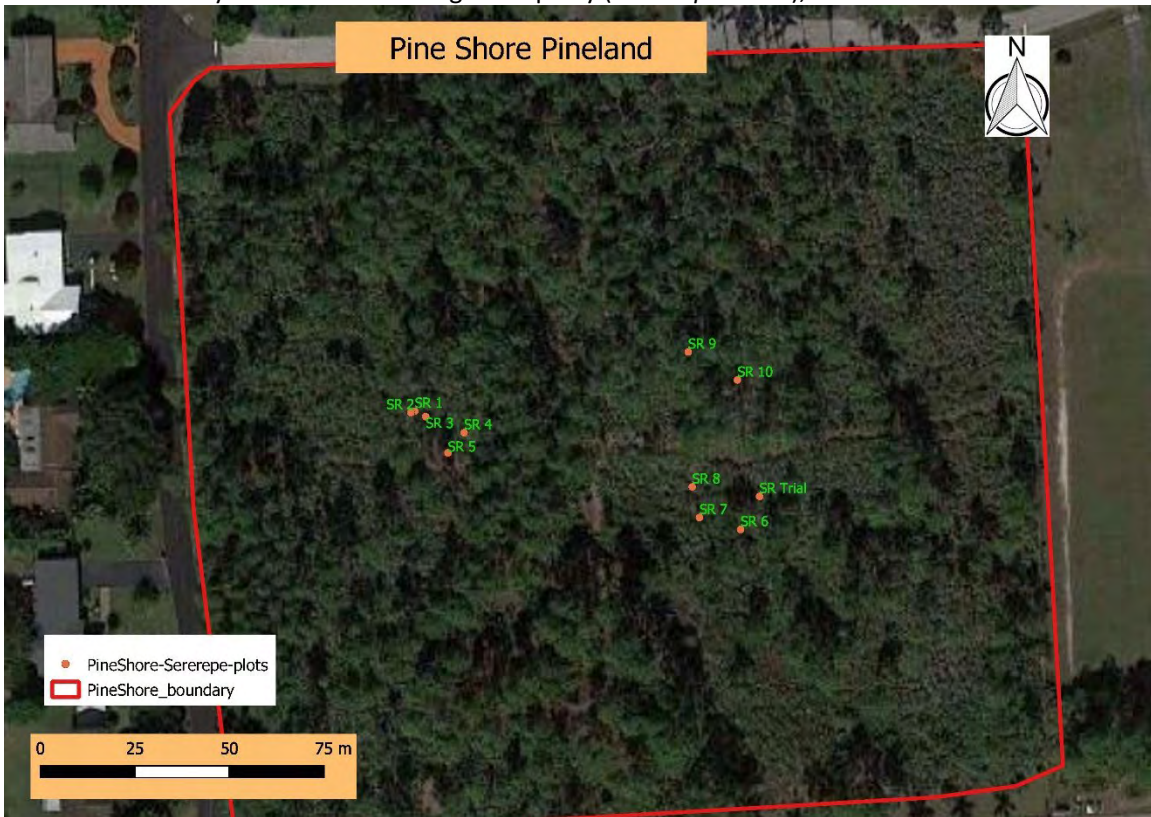


Figure 12. Layout of trial saw palmetto reduction plots at Pine Shore Preserve, July 2018.



Figure 13. First saw palmetto reduction trials using a chainsaw, July 2018.

response is critical and to be commended. The National Key Deer Refuge has also reinvigorated its prescribed fire program capitalizing on the conservation investments made by the Coastal Program. Importantly, investments in pine rockland restoration in the Florida Keys also improves the long-term resilience of the ecosystem to sea level rise. Equally crucial is the growing understanding that fire, sea level rise, and invasive species are not the only challenges for pine rocklands. New investments by the Coastal Program, the National Key Deer Refuge, Miami-Dade County, private landowners, and other partners to continue the work of IRC's Pine Rockland Initiative described in this report give us hope that pine rocklands can be restored and that the many species that depend on them can recover from near extinction. Supporting the Pine Rockland Initiative in this way – with the goal of achieving as near to full recovery as is possible in a fragmented landscape and aiming for maintenance condition – will allow us and our pine rockland community of partners to charge ahead with ambitious plans to not only restore the patches of pine rockland that remain, but to expand the footprint of pine rocklands in the landscape providing ever more opportunity for the recovery of rare and listed species.

Acknowledgements

We thank Kevin Kalasz for his leadership role as the FWS Coastal Program Coordinator; Janet Gil and her staff at Miami-Dade County EEL; Miami-Dade County EEL Preserve managers Tim Joyner, Kirk Linaje, Tiffany Melvin, and Sonya Thompson; Jennifer Possley and colleagues at FTBG and in the PRWG; Hong Liu and Haydee Borrero from FIU, Catalina Aristizabal from Miami-Dade College, and Vandana Gudi from Robert Morgan Educational Center; the many private landowners and volunteers with whom we have collaborated; Jacksonville Zoo and Gardens, Miami Beach Garden Club, any many private donors; IRC restoration crew members Alexander Blochel, Daniel Bomback, Gabriel Caceres, Louis Castillo, Benjamin Durrington, Donald Faughnan, George Guillen, Isabel Marzullo, Adam Newman, Ruben Sola, Cameron Sugar, and Hans van der Heiden; IRC Education and Outreach Coordinator Cara Abbott; and, IRC board member Patty Phares.



Figure 14. First pine/hardwood/palm reduction trial plot at Florida City Pineland, before (t) and after (b) initial treatment, April 2019



Figure 15. A new population of Everglades bully was discovered by IRC in 2018 in hardwood reduction area at Florida City Pineland.



Figure 16: Rediscovery of Blodgett's brickell-bush planted out by IRC at John Kunkel Small pineland in 2008 and 2009.



Figure 17: New tiny polygala recruit (center) following saw palmetto reduction trials at Pine Shore Preserve.

APPENDIX A

Examples of Pre-Treatment Conditions



Figure A-1. Florida City Pineland. Typical view in western section, January 2018.
Diverse groundcover replaced by native hardwood shrubs.



Figure A-2. Florida City Pineland. Another view in western section, January 2018.
A mix of native shrubs and invasive species.



Figure A-4. Florida City Pineland. Smaller patches of higher quality habitat in the southwestern section, with some surviving native grasses and wildflowers. January 2018.



Figure A-3. Florida City Pineland. Typical view in northwestern section, October 2018. Dense slash pines and understory with almost no groundcover surviving.



Figure A-5. Florida City Pineland. FWS Biologist Kevin Kalasz with resprout of Small's milkpea in southwestern corner following micro-wildfire, February 2018.



Figure A-6. George N. Avery Pineland. Hardwood (*Metopium toxiferum*) and nonnative fern (*Nephrolepis cordifolia*) invasion, December 2017.



Figure A-7. Ned Glenn Nature Preserve. Typical view before treatment showing effects of fire exclusion and hardwood invasions (*Swietenia mahagoni*), December 2017.



Figure A-8. Martinez Pineland. Interface between pine rockland and historical marl prairie showing potential transition to pine rockland impeded by native hardwood and cabbage palm invasions, November 2019.

APPENDIX B

Examples of Other Restoration Activities



Figure B-1. Florida City Pineland. Hardwood reduction and invasive treatment at eastern entry point, during (t, March 2018) and after (b, May 2018) initial treatment



Figure B-2. No Name Key. Recovery of hardwood vegetation in extremely fire excluded pine rockland approximately 16 months after cutting with skid steer with forestry mulcher (t) and after re-cutting with weed whacker (b), February 2020.



Figure B-3. Florida City Pineland. Chemical bud treatment of saw palmetto trials, October 2019.



Figure C-4. Effects of controlled wildfire response by Miami-Dade NAM, showing results of fire in area with prior IRC invasive species and native hardwood control (t) and edge of area without treatment (b), illustrating that fire self-extinguished in more highly degraded areas, April 2021.

APPENDIX C

Examples of Before and After Treatment



17 months after fire;
1 year of hardwood, vine, invasives control, no seeding or planting

Figure C-1. PowerPoint presentation of restoration and recovery at Hibiscus Street Pineland in the National Key Deer Refuge presented to National Park Service restoration practitioners' group in May 2022.



Figure C-2. Sunny Palms Pineland. Before (t, July 2018) and after (b, May 2022) invasive species and native hardwood control and prescribed fire.



Figure C-3. Martinez Pineland. Interface between pine rockland and historical marl prairie showing transition to pine rockland following native hardwood control, before (t, November 2019) and after treatments (b, May 2022).



Figure C-5. Florida City Pineland before treatment (t, December 2018) and following invasive species and native hardwood control and controlled wildfire (b, May 2022). Note rapid regrowth of native colonizers like sumac (*Rhus copallina*) and trema (*Trema micrantha*) indicating instability and the need for timely interventions.



Figure C-4. Florida City Pineland in area of invasive treatment and native hardwood control, about one month after wildfire (t, March 2021) and 14 months later (b, May 2022)



Figure C-6. Pine Shore Preserve. Northeastern quadrant following mechanical saw palmetto reduction (t, August 2018) and after prescribed fires and chemical saw palmetto reduction (b, May 2022).