Plant-Pollinator Networks in Fire-Maintained Sandhills

Research Study (2019-2020)

River Rise Preserve

Site-specific results

Plot RR1

Plot RR2

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Plant: Solidago odora
Pollinator: Ammophila procera

Introduction

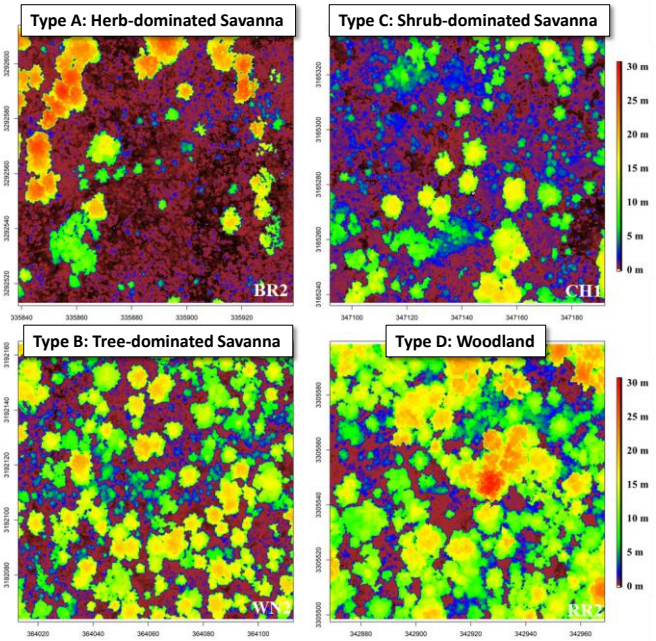
In Florida's fire-dependent longleaf pine savannas, as in terrestrial ecosystems worldwide, the mutualistic interaction networks formed by flowering plants and pollinators are of fundamental importance for the maintenance of biodiversity (Bascompte and Jordano 2007). Florida is part of the North American Coastal Plain floristic province, which is considered a global biodiversity hotspot due to unusually high vascular plant diversity and endemism (Noss et al. 2015). The pollinating insects of longleaf pine savannas likely play a central role in maintaining this high overall biodiversity, and they are also a diverse group in their own right, representing several prominent insect orders: Lepidoptera (butterflies and moths), Hymenoptera (bees and wasps), Coleoptera (beetles), and Diptera (flies) (Spiesman & Inouye 2013). Despite their ecological importance, the plant-pollinator networks of longleaf pine savannas have received little study (Spiesman & Inouye 2013). The purpose of this project is to begin filling critical baseline data gaps regarding plant-pollinator networks in Florida's fire-maintained uplands and their relationships to vegetation management.

Methods

24 1-hectare (2.5-acre) study plots were located at nine different fire-managed sandhill preserves in North-Central Florida: Ft. White WEA, Bell Ridge WEA, River Rise Preserve State Park, Jennings State Forest, Black Creek Ravines Conservation Area, Ordway-Swisher Biological Preserve, two separate tracts of Withlacoochee State Forest, and Chassahowitzka WEA. The study sites were carefully selected according to several criteria, including: 1) Frequent and ongoing prescribed fire, in most cases upwards of 20 years; 2) No history of intensive agriculture or plantation forestry; 3) Old growth species in the understory indicative of low soil disturbance (i.e. wiregrass, various wildflowers); and 4) Approximately one year since the last prescribed fire.

Within each preserve, two to three 1ha sampling plots were established at least 1km apart. Plant species composition was assessed in a grid of 25 5m x 5m quads. Species-specific flower abundance counts were conducted monthly from March 2019 – October 2019 along two transects (E-W and N-S) and in five 10m x 10m quads. Plant-pollinator interactions were sampled monthly using a 2hr timed transect sampling method. Every time the observer encountered an insect interacting with a flower, he or she captured the insect for identification and noted the plant species upon which it was encountered. Vegetation structure and surrounding landscape composition were assessed using LiDAR and aerial imagery via the GatorEye Unmanned Flying Laboratory.

One of the primary objectives of this study was to identify relationships between fire, vegetation structure, and plant-pollinator networks. To that end, we used LiDAR-derived Leaf Area Index (LAI) values to assess the density of four canopy strata beginning at 0.5m, which is the lowest height at which LAI can be reliably calculated from LiDAR: understory (0.5m – 1m), lowstory (1m – 3m), midstory (3m – 6m), and overstory (6m+). We used these data in conjunction with ground-collected percent herbaceous cover estimates to approximate the overall structure of each plot.

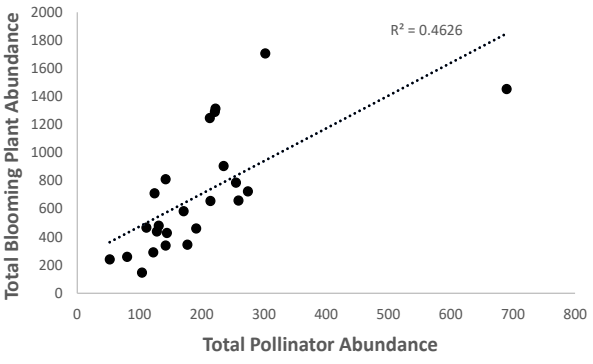


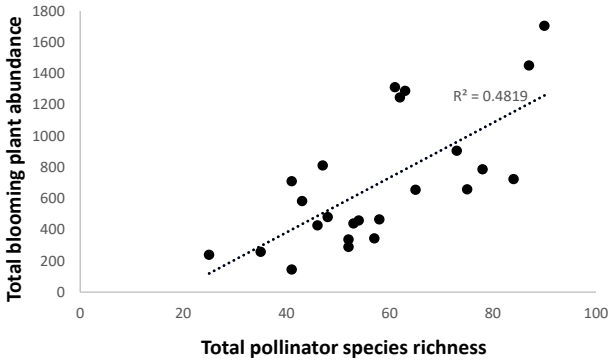
Overall Study Results: Vegetation Structure

Using multivariate statistical techniques to analyze the relative proportions of ground layer, shrub layer, and tree layer LAI, we identified four significantly different types of fire-maintained sandhill structures: Type A (herb-dominated savannas), Type B (tree-dominated savannas), Type C (shrub-dominated savannas), and Type D (woodlands). The images at left are visualizations of the LiDAR data, showing representative 1-ha plots belonging to each category.

Overall Study Results: Flower and Pollinator Abundance

Across the whole study, we found that flowering plant abundance was strongly correlated with total annual pollinator abundance and total pollinator species richness, and varied greatly across plots and seasons, with total flower abundance ranging from 145 to 1,707 blooming plants per plot.

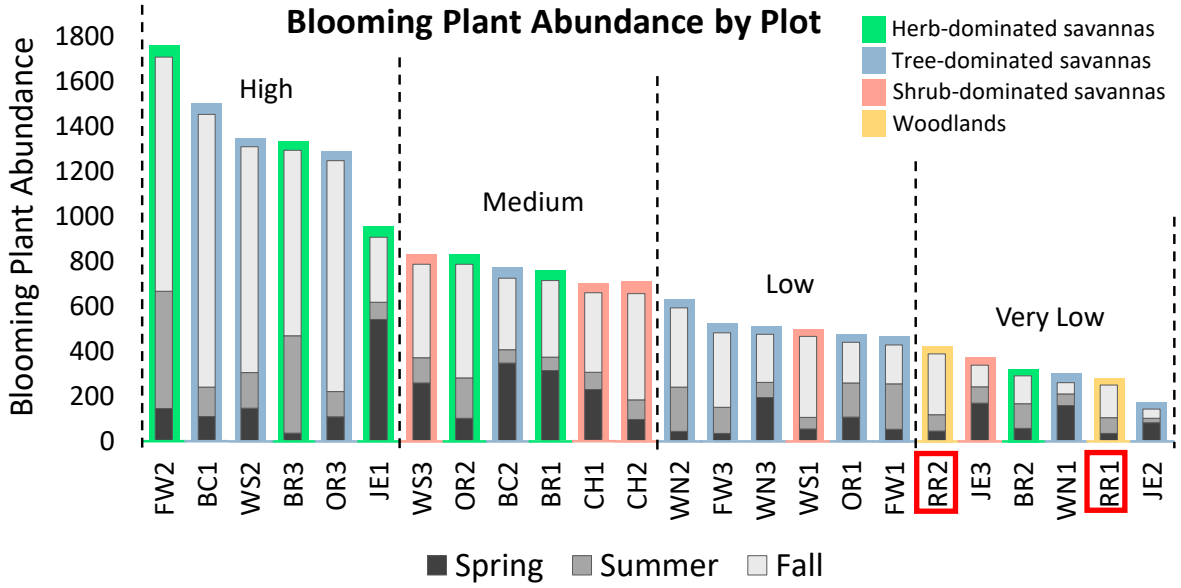




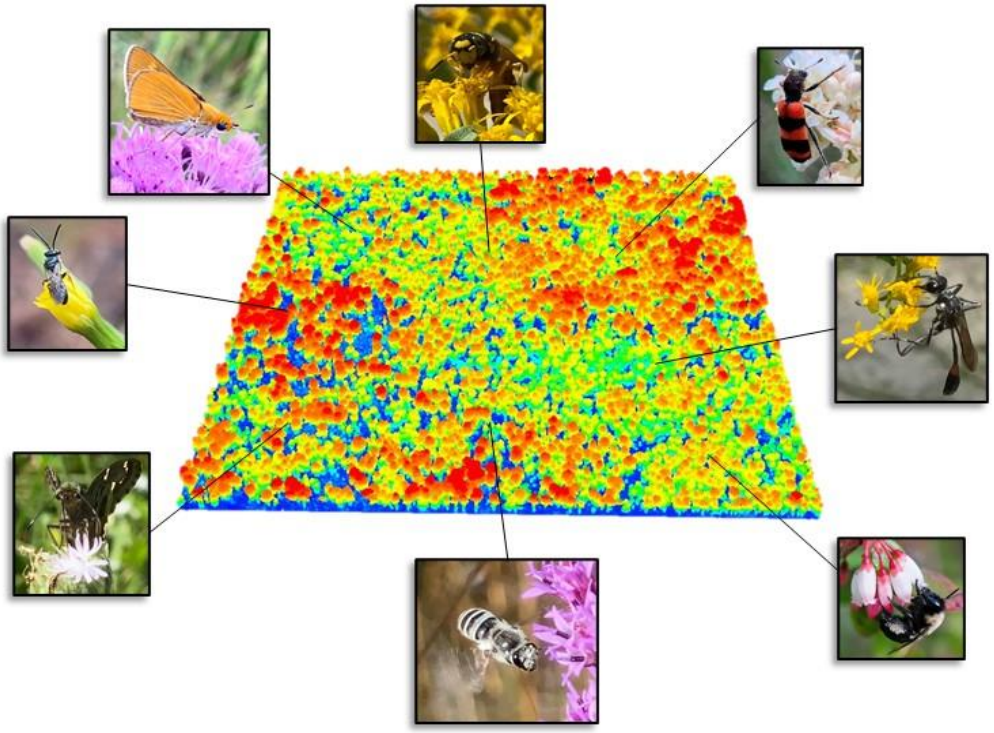
We found that the spring bloom season in longleaf pine sandhills is dominated by shrubs (particularly saw palmetto and blueberries), while the fall bloom season is dominated by herbaceous plants (especially members of the Asteraceae or sunflower family). Most of the herb-dominated plots in the study fell at the moderate to high end of the flower abundance range. Tree-dominated savanna plots had highly variable flower abundance, ranging from the lowest flower abundance to the second-highest, while shrub-dominated and woodland plots were somewhat less variable, ranging from very low to moderate flower abundance. Our habitat models showed that the abundance of individual flower-producing plants was only one predictor of actual flower production; tree-layer LAI had a significant negative influence on flower production, suggesting that even where appropriate understory plants are present, their flower production may be suppressed by higher levels of tree canopy LAI. *For a more detailed accounting of data analysis, conclusions, and management recommendations, check our FWRI/Upland Habitat website for publications and reports, which will be uploaded* https://myfwc.com/research/habitat/upland/.

River Rise Results: Stand Structure and Flower Abundance

The two plots at River Rise are classified and managed as Upland Mixed Woodland (UMW). We chose to include them in this sandhill study because their geographic location and fire history were a good fit for our northwest region, and we were interested in seeing the quanititative differences between that community and upland pine/sandhill. What we found was that the soil moisture and plant community composition in our plot RR1 (OL-3Ge) were very different from the range of sandhill conditions in the rest of the study (indicating that this is a quantifiably different community), whereas the soil moisture and plant community in RR2 (OL-3D) were within the range of the rest of the study plots (meaning that this plot is continuous with the sandhill/upland pine spectrum, albeit at the most mesic end). Both were structurally distinct from the other 22 plots in the study, and were classified as "woodlands" by our multivariate analysis. We will be doing a Phase II continuation of this research with Upland Pine and UMW sites in the eastern panhandle in 2022, creating one large dataset that includes more woodland plots and will put RR1 and RR2 in better context. The results from this first round of the study suggest that woodlands do not provide as much habitat for pollinators as more open savannas, due to a relative lack of flower production in the understory. Plots RR1 and RR2 ranked in the "Very Low" quantile for blooming plant abundance.

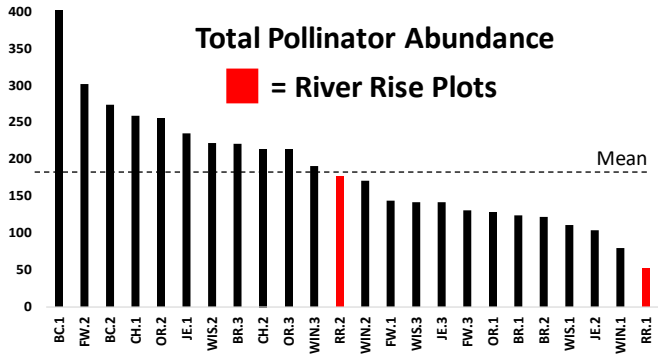


River Rise Results
Pollinator Abundance and Species Richness



Overall Pollinator Abundance and Species Richness

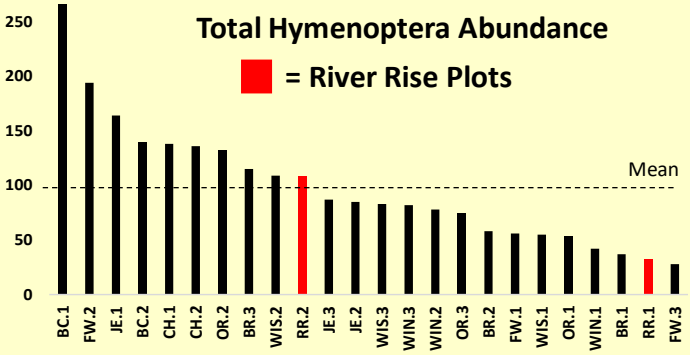
	Abundance (# of individuals)		Species Richness	
	Total	Rank	Total	Rank
Plot RR1	**52**	**Low**	**25**	**Low**
Plot RR2	**177**	**Med-Low**	**57**	**Med-High**
Study Average	181.6		57.6	
Study Range	52 - 402		25 - 90	



The above table shows the total pollinator abundance (number of individual insects caught) and total pollinator species richness for the three study plots at River Rise, along with their rank relative to the entire 24-plot study. Plots within one Standard Deviation (SD) above the mean were ranked "**Medium-High**," and plots within one SD below the mean were ranked "**Medium-Low**." Plots >1 SD above the mean were ranked "**High**," and >1 SD below the mean were ranked "**Low**." Despite having relatively low flower abundance, plot RR2 had medium-high pollinator species richness and slightly below average pollinator abundance. This is likely due to the species of plants present, which included several important pollinator attractors. In the following sections, the same method is used to assess pollinator abundance and species richness within insect groups (Bees/Wasps, Butterflies/Moths, Beetles, and Flies).

Hymenoptera (Bees & Wasps)

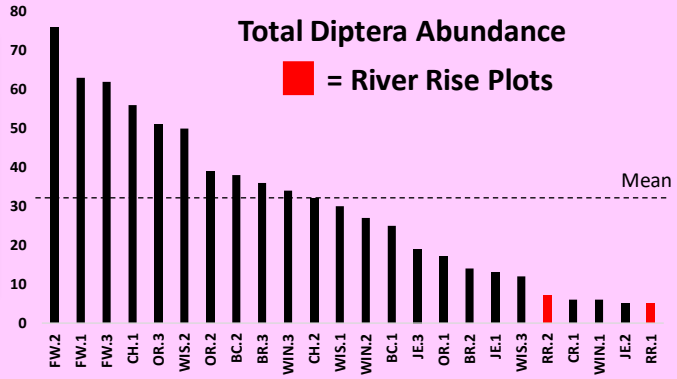
	Abundance (# of individuals)		Species Richness	
	Total	Rank	Total	Rank
Plot **RR1**	33	**Low**	12	**Low**
Plot **RR2**	109	**Med-High**	39	**Med-High**
Study Average	98.1		33.6	
Study Range	28 - 266		12 - 61	



Bee & wasp abundance and species richness were very low relative to the study average in Plot RR1, but were medium-high in plot RR2. Among the most abundant Hymenoptera species at River Rise were *Lasioglossum alachuense* (a Sweat Bee), *Augochlorella gratiosa* (a Sweat Bee), *Perdita sp.* (a Fairy Bee), *Eremnophila aureonotata* (Gold-marked Thread-waisted Wasp), and *Paracyphononyx funereus* (a Spider Wasp). *Credits for non-FWRI photos on last page.

Results: Diptera (Flies)

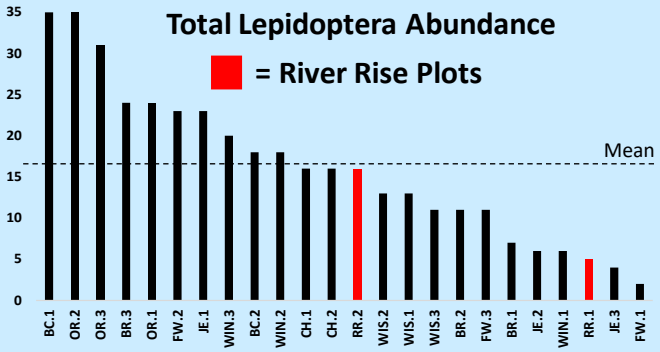
	Abundance # of individuals		Species Richness	
	Total	Rank	Total	Rank
Plot RR1	5	**Low**	2	**Low**
Plot RR2	7	**Low**	3	**Low**
Study Average	32.1		8.0	
Study Range	5 - 79		2 - 18	



Fly abundance and species richness were very low in both plots at River Rise. Three types of fly were collected at River Rise: an unidentified species of Muscoid fly, the naturalized species *Plecia nearctica* (Love Bugs), and *Ocyptamus fuscipennis* (Dusky-Winged Hover Fly). *Credits for non-FWRI photos on last page.

Lepidoptera (Butterflies & Moths)

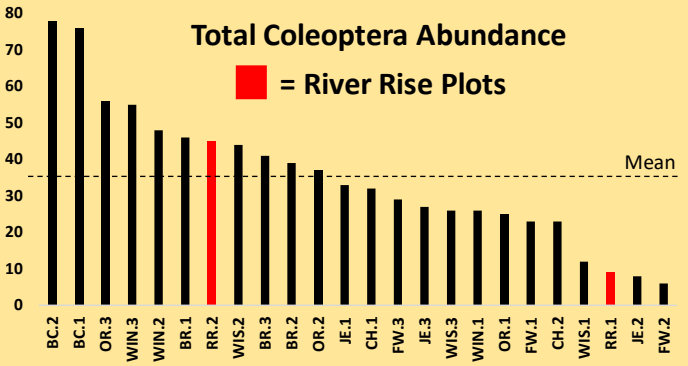
	Abundance # of individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **RR1**	5	**Low**	5	**Med-Low**
Plot **RR2**	16	**Med-Low**	9	**Med-High**
Study Average	16.2		8.1	
Study Range	2 - 35		2 - 14	



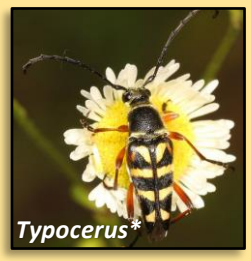
Lepidopteran abundance was low to medium-low in both plots, but Lepidopteran species richness was medium-high in plot RR2. Among the most abundant Lepidoptera species were *Battus philenor* (Pipevine swallowtail), *Erynnis horatius* (Horace's Duskywing), *Pyrisitia lisa* (Little Yellow), *Papilio Troilus* (Spicebush Swallowtail), and *Hylephila phyleus* (Fiery Skipper). *Papilio troilus* is a Species of Greatest Conservation Need. *Credits for non-FWRI photos on last page.

Coleoptera (Beetles)

	Abundance # of Individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **RR1**	9	**Low**	6	**Med-Low**
Plot **RR2**	45	**Med-High**	6	**Med-Low**
Study Average	35.2		8.0	
Study Range	6 – 78		4 - 14	

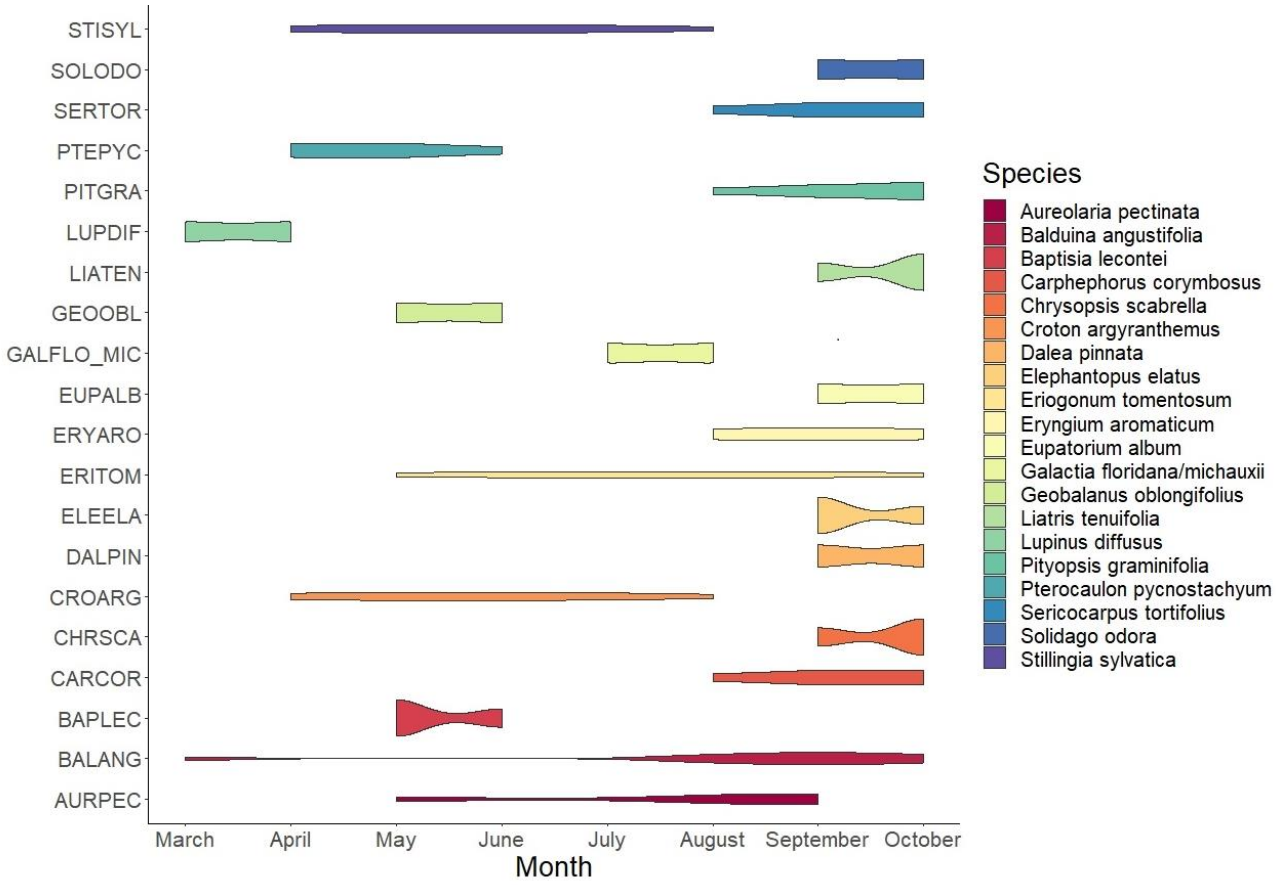


Beetle abundance and species richness was very low in plot RR1. In plot RR2, beetle abundance was above average, but species richness remained very low. The most abundant beetle pollinator species at River Rise were *Mordella atrata* (Tumbling Flower Beetle), *Chauliognathus marginatus* (Margined Leatherwing), *Trigonopeltastes delta* (Delta Flower Beetle), *Nemognatha nemorensis* (a Blister Beetle), and *Typocerus sinuatus* (Notch-Tipped Flower Longhorn).



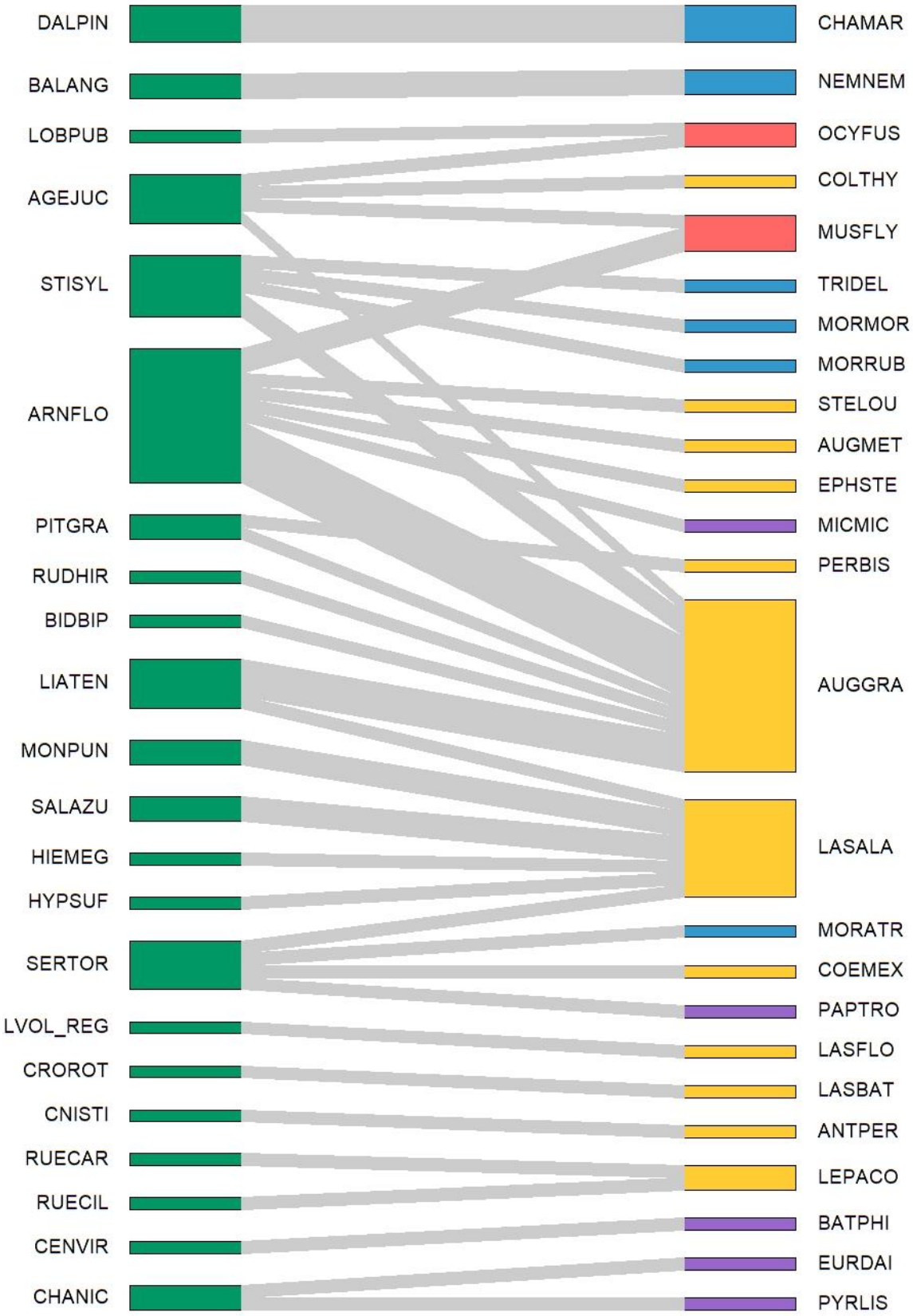
Key flowering plant species

We identified 20 of the most important herbaceous flowering species that were present on multiple sites and had high pollinator interaction rates throughout the study. Many of these species, shown in the graphic below with their blooming time/duration, were prevalent in the River Rise plots.

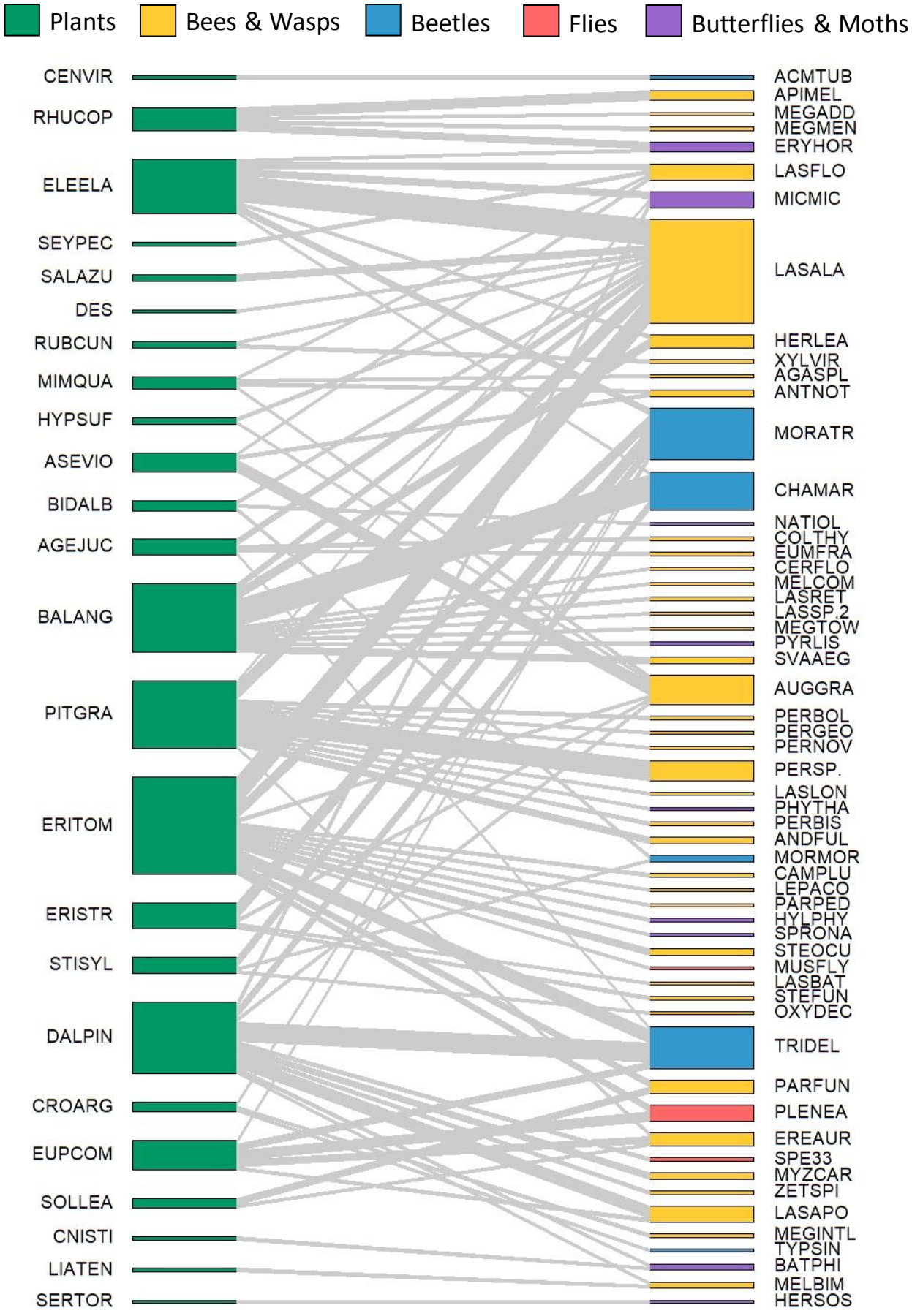


RR1 Plant-Pollinator Network *Plant and insect code key included at end of report

Plants Bees & Wasps Beetles Flies Butterflies & Moths



RR2 Plant-Pollinator Network *Plant and insect code key included at end of report



Most frequently observed pollinator genera at River Rise

Insect Code Key for network diagrams, with plot occurrence data

		Relative Frequency (% of quads)		
Code	**Species**	**RR-1**	**RR-2**	**Insect Type**
LASALA	Lasioglossum alachuense	8	32	Bees & Wasps
AUGGRA	Augochlorella gratiosa	14	9	Bees & Wasps
MORATR	Mordella atrata	1	16	Beetles
CHAMAR	Chauliognathus marginatus	3	12	Beetles
TRIDEL	Trigonopeltastes delta	1	13	Beetles
LASFLO	Lasioglossum floridanum	1	5	Bees & Wasps
MICMIC	microlep	1	5	Butterflies & Moths
PERSP.	Perdita sp.	0	6	Bees & Wasps
LASAPO	Lasioglossum apopkense	0	5	Bees & Wasps
PLENEA	Plecia nearctica	0	5	Flies
EREAUR	Eremnophila aureonotata	0	4	Bees & Wasps
HERLEA	Heriades leavitti	0	4	Bees & Wasps
MUSFLY	muscoid fly	3	1	Flies
PARFUN	Paracyphononyx funereus	0	4	Bees & Wasps
APIMEL	Apis mellifera	0	3	Bees & Wasps
BATPHI	Battus philenor	1	2	Butterflies & Moths
ERYHOR	Erynnis horatius	0	3	Butterflies & Moths
LEPACO	Leptochilus acolhuus	2	1	Bees & Wasps
MORMOR	Mordellidae	1	2	Beetles
STEOCU	Stenodynerus oculeus	0	3	Bees & Wasps
ANDFUL	Andrena fulvipennis	0	2	Bees & Wasps
ANTNOT	Anthidiellum notatum	0	2	Bees & Wasps
COLTHY	Colletes thysenellae	1	1	Bees & Wasps
LASBAT	Lasioglossum batya	1	1	Bees & Wasps
MELBIM	Melissodes bimaculata	0	2	Bees & Wasps
MYZCAR	Myzinum carolinianum	0	2	Bees & Wasps
NEMNEM	Nemognatha nemorensis	2	0	Beetles
OCYFUS	Ocyptamus fuscipennis	2	0	Flies
PERBIS	Perdita bishoppi	1	1	Bees & Wasps
PYRLIS	Pyrisitia lisa	1	1	Butterflies & Moths
SVAAEG	Svastra aegis	0	2	Bees & Wasps
ACMTUB	Acmaeodera tubulus	0	1	Beetles
AGASPL	Agapostemon splendens	0	1	Bees & Wasps
ANTPER	Anthidiellum perplexum	1	0	Bees & Wasps
AUGMET	Augochloropsis metallica	1	0	Bees & Wasps
CAMPLU	Campsomeris plumipes fossu	0	1	Bees & Wasps
CERFLO	Ceratina floridana	0	1	Bees & Wasps
COEMEX	Coelioxys mexicanus	1	0	Bees & Wasps
EPHSTE	Ephuta stenognatha	1	0	Bees & Wasps
EUMFRA	Eumenes fraternus	0	1	Bees & Wasps
EURDAI	Eurema daira	1	0	Butterflies & Moths
HERSOS	Hermeuptychia sosybius	0	1	Butterflies & Moths

NATIOL	Nathalis iole	0	1	Butterflies & Moths
NEMNEM	Nemognatha nemorensis	2	0	Beetles
OCYFUS	Ocyptamus fuscipennis	2	0	Flies
OXYDEC	Oxybelus decorosus	0	1	Bees & Wasps
PAPTRO	Papilio troilus	1	0	Butterflies & Moths
PARFUN	Paracyphononyx funereus	0	4	Bees & Wasps
PARPED	Parancistrocerus pedestris bil	0	1	Bees & Wasps
PERBIS	Perdita bishoppi	1	1	Bees & Wasps
PERBOL	Perdita boltoniae	0	1	Bees & Wasps
PERGEO	Perdita georgica	0	1	Bees & Wasps
PERNOV	Perdita novaeangliae/krombe	0	1	Bees & Wasps
PERSP.	Perdita sp.	0	6	Bees & Wasps
PHYTHA	Phyciodes tharos	0	1	Butterflies & Moths
PLENEA	Plecia nearctica	0	5	Flies
PYRLIS	Pyrisitia lisa	1	1	Butterflies & Moths
SPRONA	Spragueia onagrus	0	1	Butterflies & Moths
STEFUN	Stenodynerus fundatiformis	0	1	Bees & Wasps
STELOU	Stelis louisae	1	0	Bees & Wasps
STEOCU	Stenodynerus oculeus	0	3	Bees & Wasps
SVAAEG	Svastra aegis	0	2	Bees & Wasps
TRIDEL	Trigonopeltastes delta	1	13	Beetles
TYPSIN	Typocerus sinuatus	0	1	Beetles
XYLVIR	Xylocopa virginica	0	1	Bees & Wasps
ZETSPI	Zethus spinipes variegatus	0	1	Bees & Wasps

Plant Code Key for network diagrams, with plot occurrence data

		Relative Frequency		
		(% of quads in which present)		
Code	**Species**	**RR1**	**RR2**	**Plant Type**
AGEJUC	Ageratina jucunda	67	36	Forb
ASEVIO	Asemia violacea	6	0	Forb
ASIRET	Asimina reticulata	2	1	Shrub
BALANG	Balduina angustifolia	0	5	Forb
BIDALB	Bidens alba	0	11	Forb
CALAME	Callicarpa americana	25	12	Shrub
CENVIR	Centrosema virginianum	43	21	Forb
CHANIC	Chamaecrista nictitans	9	2	Forb
CHRSCA	Chrysopsis scabrella	1	0	Forb
CNISTI	Cnidoscolus stimulosus	4	22	Forb
COMERE	Commelina erecta	0	2	Forb
CONCAN	Conyza canadensis	1	0	Forb
CROARG	Croton argyranthemus	0	3	Forb
CROCAR	Crocantheumum carolinianum	1	8	Forb
CROCOR	Crocantheumum corymbosum	1	11	Forb
CROROT	Crotalaria rotundifolia	10	4	Forb
DALPIN	Dalea pinnata	0	29	Forb
DIOSVI	Diospyros virginiana	19	31	Shrub
ELEELA	Elephantopus elatus	2	27	Forb
ERISTR	Erigeron strigosus	1	1	Forb
ERITOM	Eriogonum tomentosum	0	13	Forb
EUPALB	Eupatorium album	6	1	Forb
EUPCOM	Eupatorium compositifolium	4	16	Forb
GAYDUM	Gaylussacia dumosa	2	0	Shrub
HIEMEG	Hieracium megacephalon	6	32	Forb
HYPSUF	Hypericum suffruticosum	15	32	Shrub
IPOPAN	Ipomoea pandurata	0	2	Forb
LACGRA	Lactuca graminifolia	7	4	Forb
LESHIR	Lespedeza hirta	0	3	Forb
LIATEN	Liatris tenuifolia	0	6	Forb
LOBPUB	Lobelia puberula	1	0	Forb
LYGAPH	Lygodesmia aphylla	1	1	Forb
MIMQUA	Mimosa quadrivalvis	0	1	Forb
OPUHUM	Opuntia humifusa	0	1	Forb
OXACOR	Oxalis corniculata	2	0	Forb
PALINT	Palafoxia integrifolia	14	22	Forb
PIRCIS	Piriqueta cistoides	1	1	Forb

PITGRA	Pityopsis graminifolia	23	48	Forb
PTEPYC	Pterocaulon pycnostachyum	1	1	Forb
RHUCOP	Rhus copallinum	23	16	Shrub
RHYREN	Rhynchosia reniformis	3	9	Forb
RUBCUN	Rubus cuneifolius	60	15	Shrub
RUECAR	Ruellia caroliniensis	7	16	Forb
SALAZU	Salvia azurea	0	11	Forb
SCUINT	Scutellaria integrifolia	15	8	Forb
SERREP	Serenoa repens	0	1	Shrub
SERTOR	Sericocarpus tortifolius	14	16	Forb
SMIAUR	Smilax auriculata	22	32	Shrub
SOLLEA	Solidago leavenworthii	7	38	Forb
SOLODO	Solidago odora	5	9	Forb
STISYL	Stillingia sylvatica	12	35	Forb
STYBIF	Stylosanthes biflora	0	9	Forb
STYPAT	Stylisma patens	1	7	Forb
SYMCON	Symphyotrichum concolor	3	7	Forb
TEPCHR_S	Tephrosia chrysophylla/spicata	0	5	Forb
TEPFLO	Tephrosia florida	2	21	Forb
VACARB	Vaccinium arboreum	18	16	Shrub
VACMYR	Vaccinium myrsinites	41	1	Shrub
VACSTA	Vaccinium stamineum	42	44	Shrub

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Additional Resources

For more information on the natural history and identification of the insects we found at River Rise, these are good places to start:

BugGuide.net: https://bugguide.net/node/view/15740

Discover Life: https://www.discoverlife.org/

For more information on the natural history and identification of the pollinator plants at River Rise, start with these resources:

Flora of North America: http://floranorthamerica.org/Main_Page

Atlas of Florida Vascular Plants: https://florida.plantatlas.usf.edu/

For a more detailed accounting of data analysis, conclusions, and management recommendations, check our FWRI/Upland Habitat website for publications and reports, which will be uploaded as they are finalized: https://myfwc.com/research/habitat/upland/.

Feel free to contact FWRI's Upland Habitat Research & Monitoring team with plant and pollinator questions any time, if we don't have the answer we can find out or point you in the right direction:

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Acknowledgments

This work was made possible by grants from the U.S. Fish & Wildlife Service/State Wildlife Grants Program and the Fish & Wildlife Foundation of Florida. Many thanks to the experts at the Florida State Collection of Arthropods for their support and assistance with insect identification: Paul Skelley (Director), Gary Steck (Diptera), Elijah Talamas (Hymenoptera), and Kyle Schnepp (Coleoptera). Thanks also to Alexandra Morphew of the USDA/ARS for assistance with *Lasioglossum* identification.