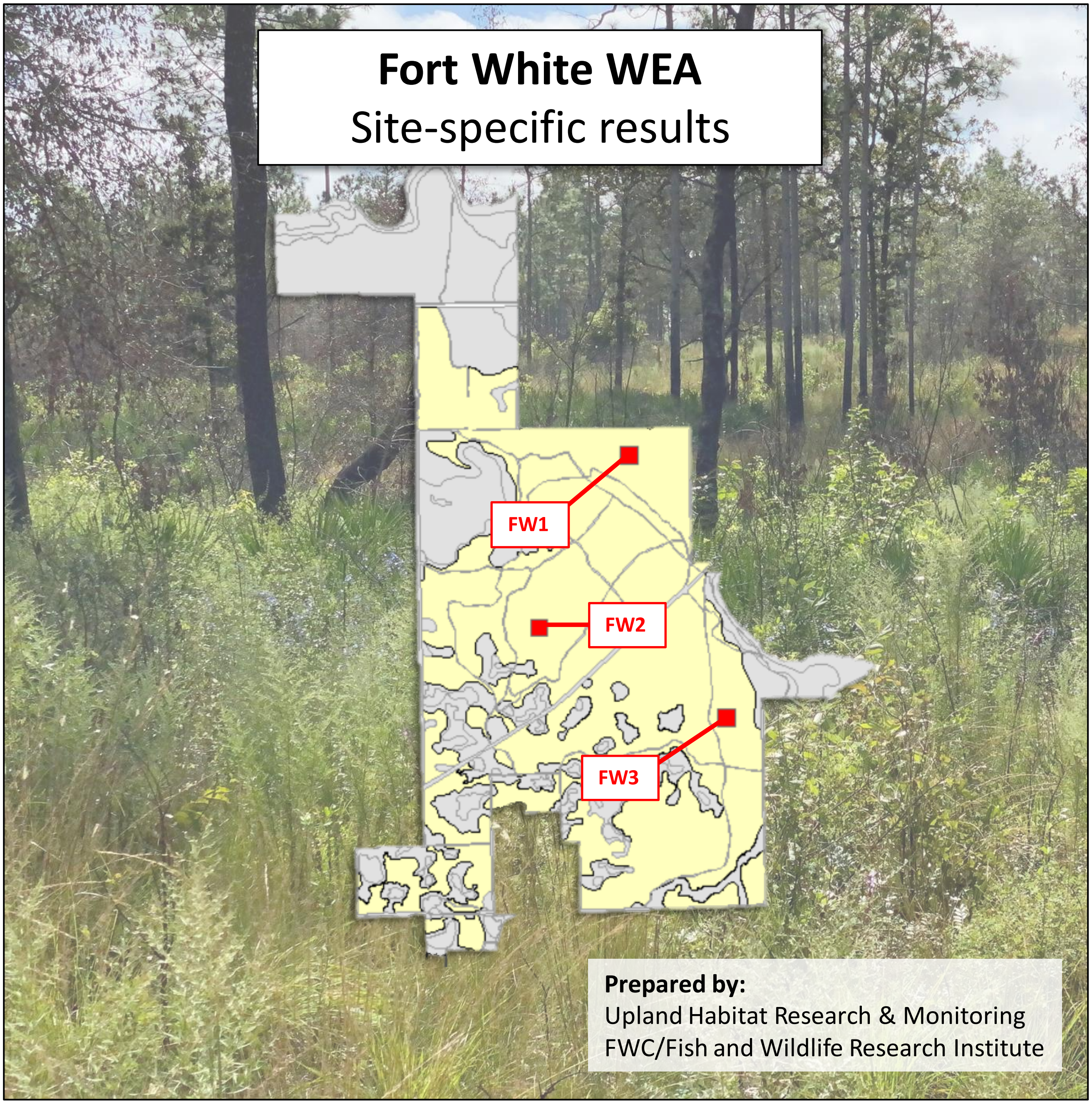
Plant-Pollinator Networks in Fire-Maintained Sandhills

Research Study (2019-2020)

Fort White WEA

Site-specific results



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Introduction

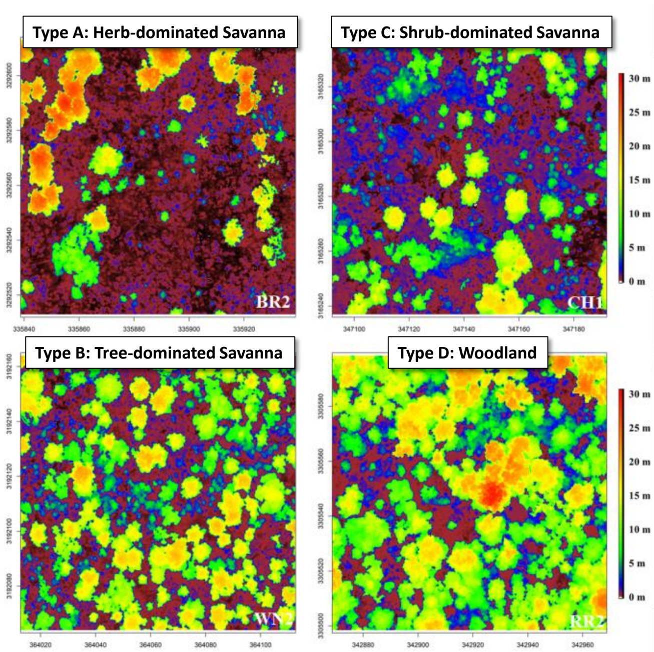
In Florida's fire-dependent longleaf pine savannas, as in terrestrial ecosystems worldwide, the mutualistic interaction networks formed by flowering plants and pollinators are of fundamental importance for the maintenance of biodiversity (Bascompte and Jordano 2007). Florida is part of the North American 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.

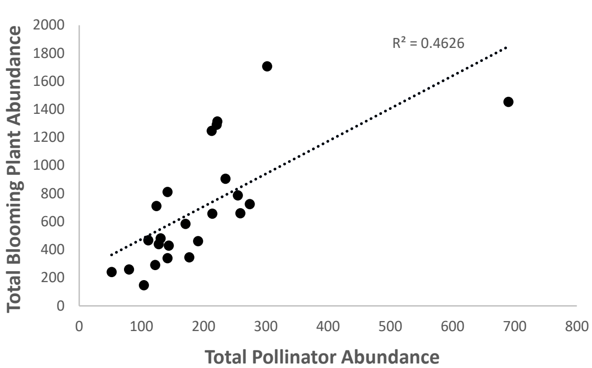
Within each preserve, two to three 1ha sampling plots were established at least 1km apart. Plant species composition was assessed in a grid of 25 5m x 5m quads. Species-specific flower abundance counts were conducted monthly from March 2019 – October 2019 along two transects (E-W and N-S) and in five 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.

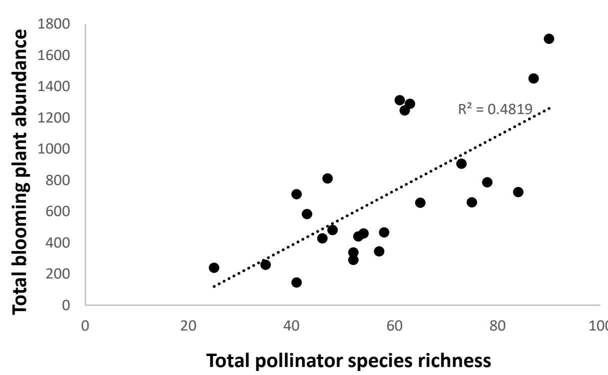
One of the primary objectives of this study was to identify relationships between fire, vegetation structure, and plant-pollinator networks. To that end, we used LiDAR-derived Leaf Area Index (LAI) values to assess the density of four canopy strata beginning at 0.5m, which is the lowest height at which 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.



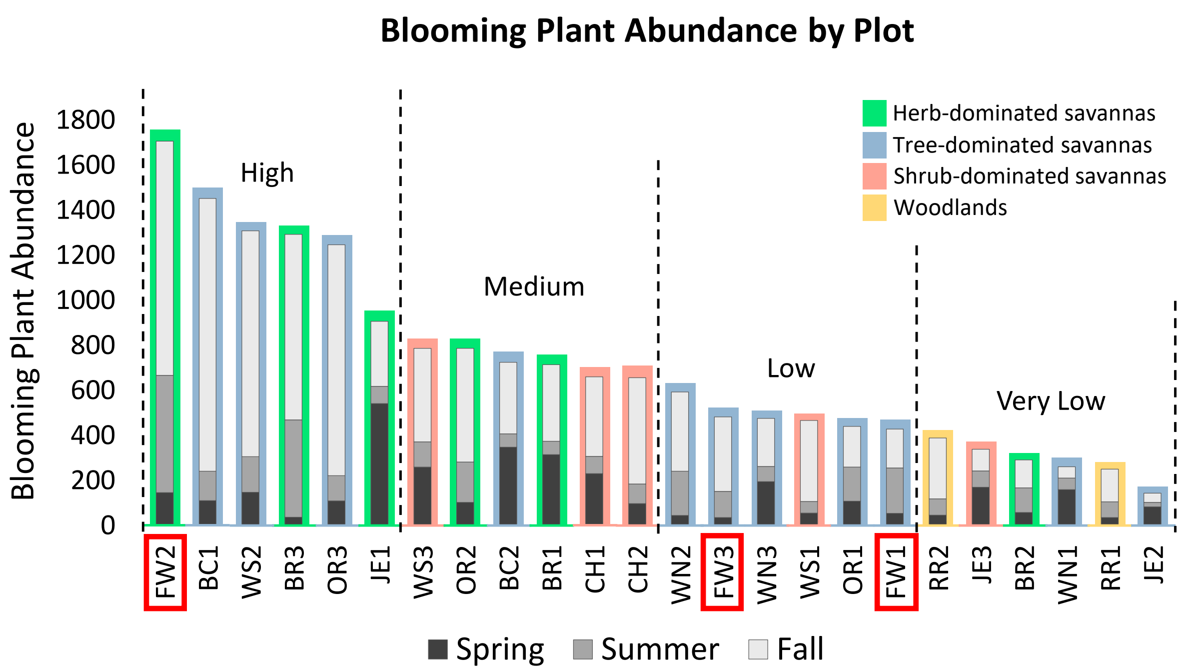


Flower and Pollinator Abundance cont'd

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/.

Fort White Results: Stand Structure and Flower Abundance

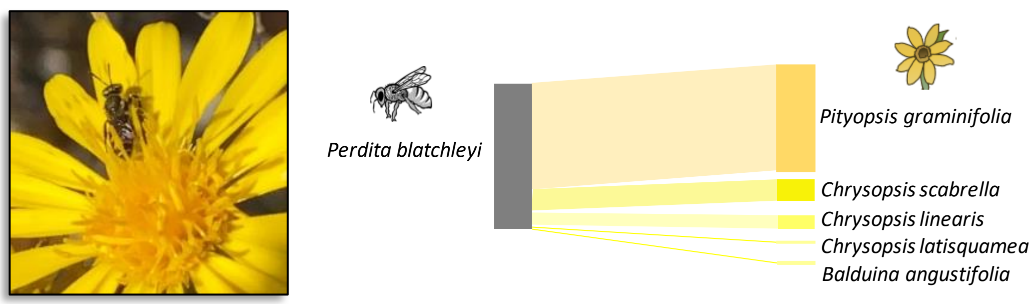
Fort White had one herb-dominated plot and two tree-dominated plots: **Plot FW2** is an herb-dominated savanna, and **Plot FW1** and **Plot FW3** are tree-dominated savannas. Plot FW2, an herb-dominated savanna, had the highest blooming plant abundance in the whole study, while Plot FW1 and Plot FW3 (both tree-dominated savannas) were in the Low flower abundance quantile. Plot FW2 was particularly notable for its high abundance of *Dalea pinnata*, a legume that is highly attractive to many pollinator species.



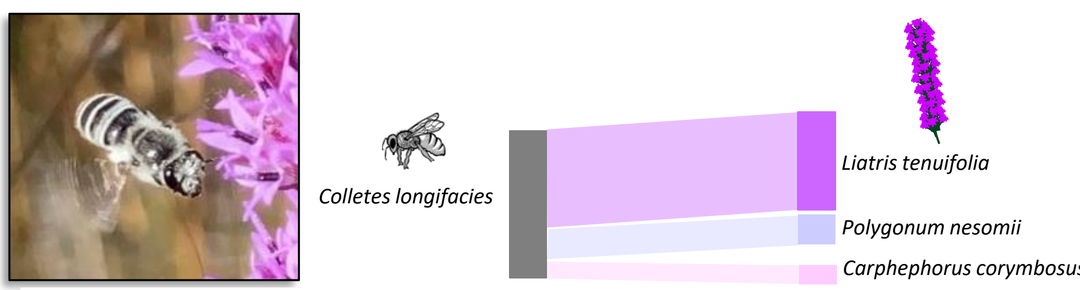
Fort White Results: Pollinator Overview

Pollinator abundance and species diversity varied dramatically between plots at Fort White, with herb-dominated plot FW2 generally having much higher abundance and diversity of pollinators than the tree-dominated plots FW1 and FW3. This pattern was most pronounced for Hymenoptera (Bees & Wasps) and Lepidoptera (Butterflies & Moths); Diptera (flies) had relatively high abundance and diversity across all plots, while Coleoptera (beetles) had relatively low abundance and diversity across all plots. Order-specific pollinator results are presented in greater detail on the following pages, followed by plant-pollinator network diagrams for each plot.

We found several pollinator Species of Greatest Conservation Need (SGCN) at Ft. White, including three bees (*Perdita blatchleyi, Bombus pensylvanicus*, and *Colletes longifacies*) and two butterflies *(Papilio palimedes* and *Papilio troilus*). We recorded enough observations of *P. blatchleyi* and *C. longifacies* in the overall study to draw conclusions about their flower preferences and make preliminary management recommendations. *P. blatchleyi* is a specialist on the closely-related plant genera *Pityopsis* and *Chrysopsis*, while *C. longifacies* appears to be less of a specialist, as we observed it interacting with the unrelated genera *Liatris* and *Polygonum*. Given the prevalence of interactions for the two SGCN bee species on *P. graminifolia* and *L. tenuifolia*, promoting flowering in these two plant species may be a good conservation target for improving *C. longifacies and P. blatchleyi* habitat. P. graminifolia's flower production and reproductive success are fire-induced and strongly influenced by season of burn, with spring and summer fires stimulating more flowers than winter fires (Brewer and Platt 1994). Both P. graminifolia and L. tenuifolia are sensitive to vegetation structure and become locally extirpated when shrub and tree cover become excessive. Management regimes that emphasize growing season fire and decrease woody dominance can be expected to favor these two SGCN bees.

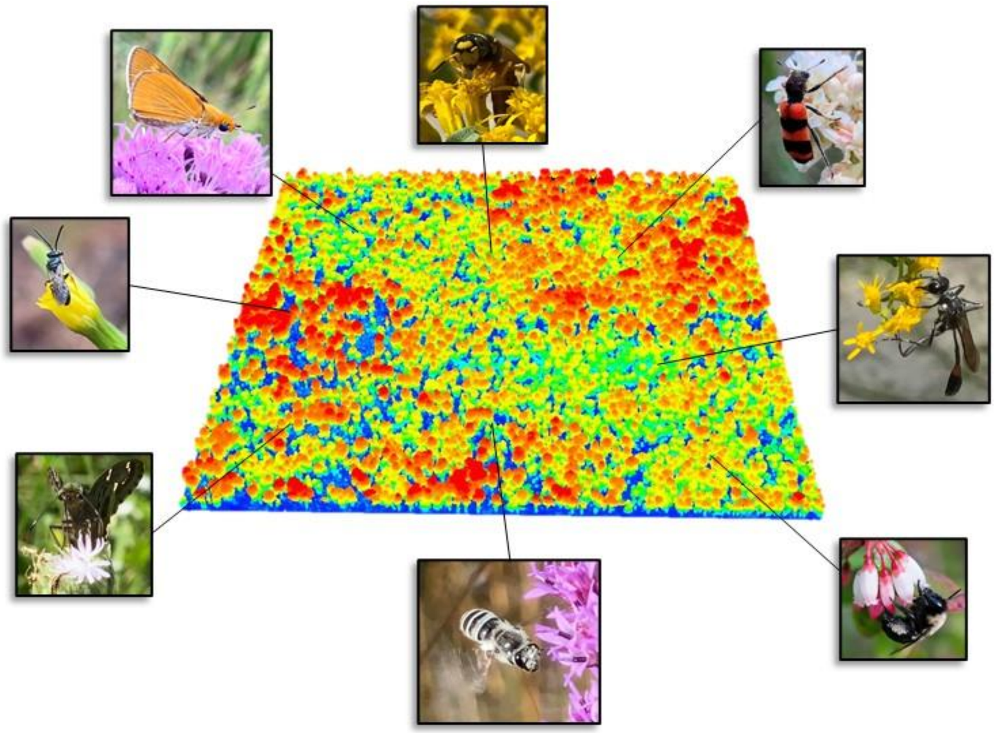


Flower interactions of *Perdita blatchleyi*, based on 103 observations recorded during the project.



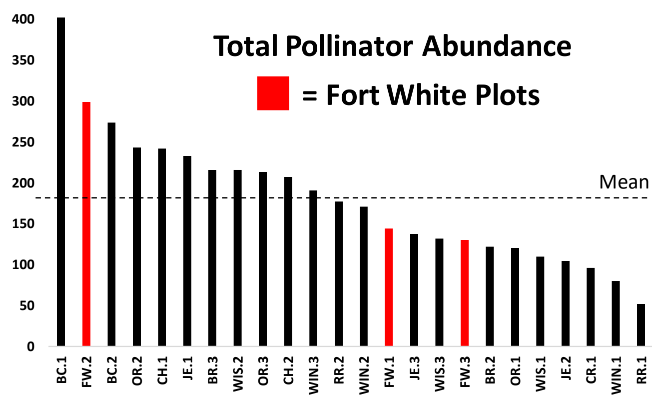
Flower interactions of *Colletes longifacies*, based on 24 observations recorded during the project.

Fort White Results:
Pollinator Abundance and Species Richness



Overall Pollinator Abundance and Species Richness

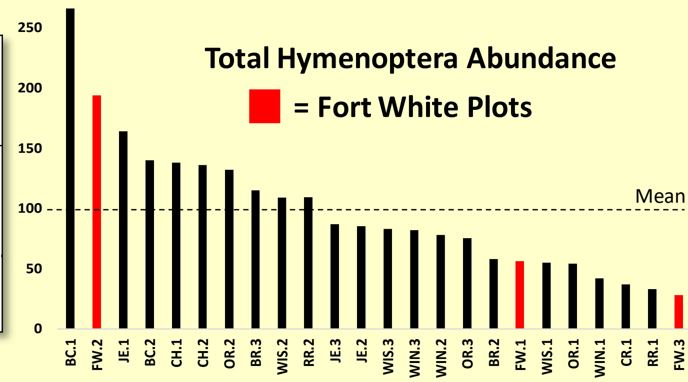
	Abundance # of individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **FW1**	**144**	**Med-Low**	**46**	**Med-Low**
Plot **FW2**	**299**	**High**	**89**	**High**
Plot **FW3**	**130**	**Med-Low**	**45**	**Med-Low**
Study Average	181.6		57.6	
Study Range	52 - 402		25 - 90	



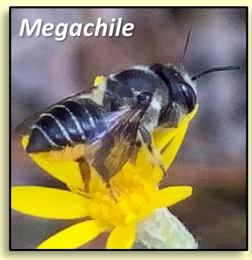
The above table shows the total pollinator abundance (number of individual insects caught) and total pollinator species richness for the three study plots at Fort White, along with their rank relative to the entire 24-plot study. Plots within one Standard Deviation (SD) above the mean were ranked "**Medium-High**," 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**." Plot FW2 had the highest species richness and second-highest pollinator abundance in the whole study, while plots FW1 and FW3 had lower than average pollinator abundance and species richness. These differences are most likely due to the differences in stand structure between plots at Fort White. 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 **FW1**	56	Med-Low	28	Med-Low
Plot **FW2**	194	High	61	High
Plot **FW3**	28	Low	21	Low
Study Average	98.1		33.6	
Study Range	28 - 266		12 - 61	

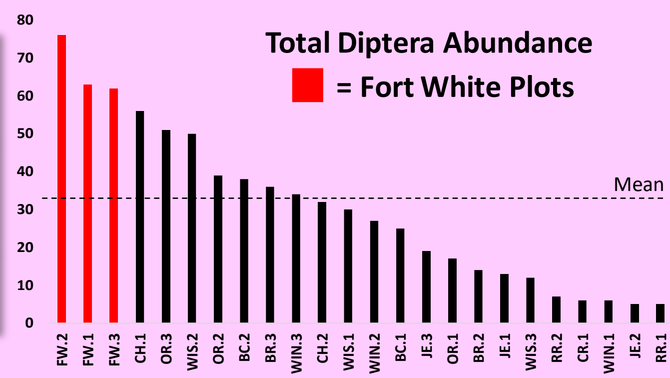


Bee & wasp abundance and species richness were very high in plot FW2, and low to medium-low in plots FW1 and FW3. Among the most abundant native Hymenopteran species were *Megachile mendica* (Beggar Leafcutter Bee), *Lasioglossum nymphale* (a sweat bee), *Bombus impatiens* (Eastern Bumble Bee), *Agapostemon splendens* (Splendid Sweat Bee), and *Myzinum maculatum* (a Thynnid wasp). *Photo credits for non-FWRI photos on last page.

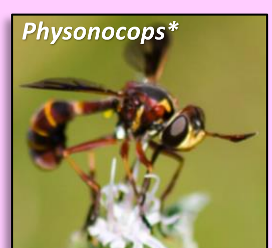


Diptera (Flies)

	Abundance # of individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **FW1**	63	High	10	Med-High
Plot **FW2**	76	High	10	Med-High
Plot **FW3**	62	High	7	Med-High
Study Average	32.1		8.0	
Study Range	5 - 79		2 - 18	

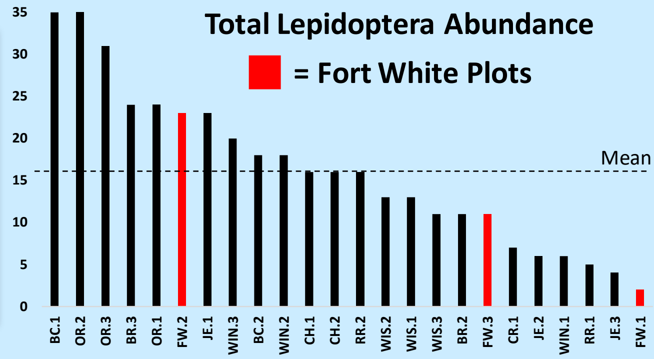


Dipteran abundance was very high in all three plots at Ft. White, and Dipteran species richness was medium-high in all plots. The most abundant native Dipteran pollinators at Ft. White were *Poecilognathus sulphureus* (Sulphurous bee fly), *Poecilognathus punctipennis* (A bee fly), *Exprosopa fasciata* (Banded bee fly), *Geron vitripennis* (Glassy-winged Bee Fly), and *Physoconops excisus* (A thick-headed fly). *Photo credits for non-FWRI photos on last page.



Lepidoptera (Butterflies & Moths)

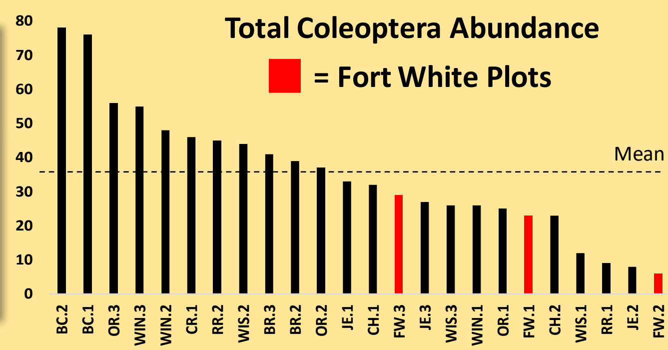
	Abundance # of individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **FW1**	2	Low	2	Low
Plot **FW2**	23	Med-High	14	High
Plot **FW3**	11	Med-Low	8	Med-Low
Study Average	16.2		8.1	
Study Range	2 - 35		2 - 14	



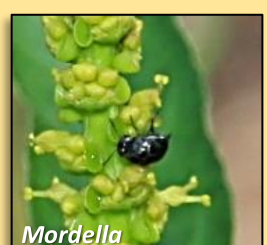
Lepidopteran species richness was very high in plot FW2, and abundance was medium-high in FW2. Both richness and abundance were medium-low in plot FW3, and very low in plot FW1. Five of the most abundant species were *Erynnis horatius* (Horace's Duskywing), *Hemiargus ceraunus* (Ceraunus Blue), *Papilio Palamedes* (Palamedes swallowtail), *Junonia coenia* (Common Buckeye), and *Urbanus proteus* (Long-Tailed Skipper). *Photo credits for non-FWRI photos on last page.

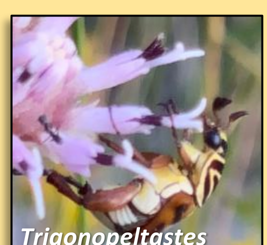
Coleoptera (Beetles)

	Abundance # of Individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **FW1**	23	Med-Low	6	Med-Low
Plot **FW2**	6	Low	4	Low
Plot **FW3**	29	Med-Low	9	Med-High
Study Average	35.2		8.0	
Study Range	6 - 78		4 - 14	



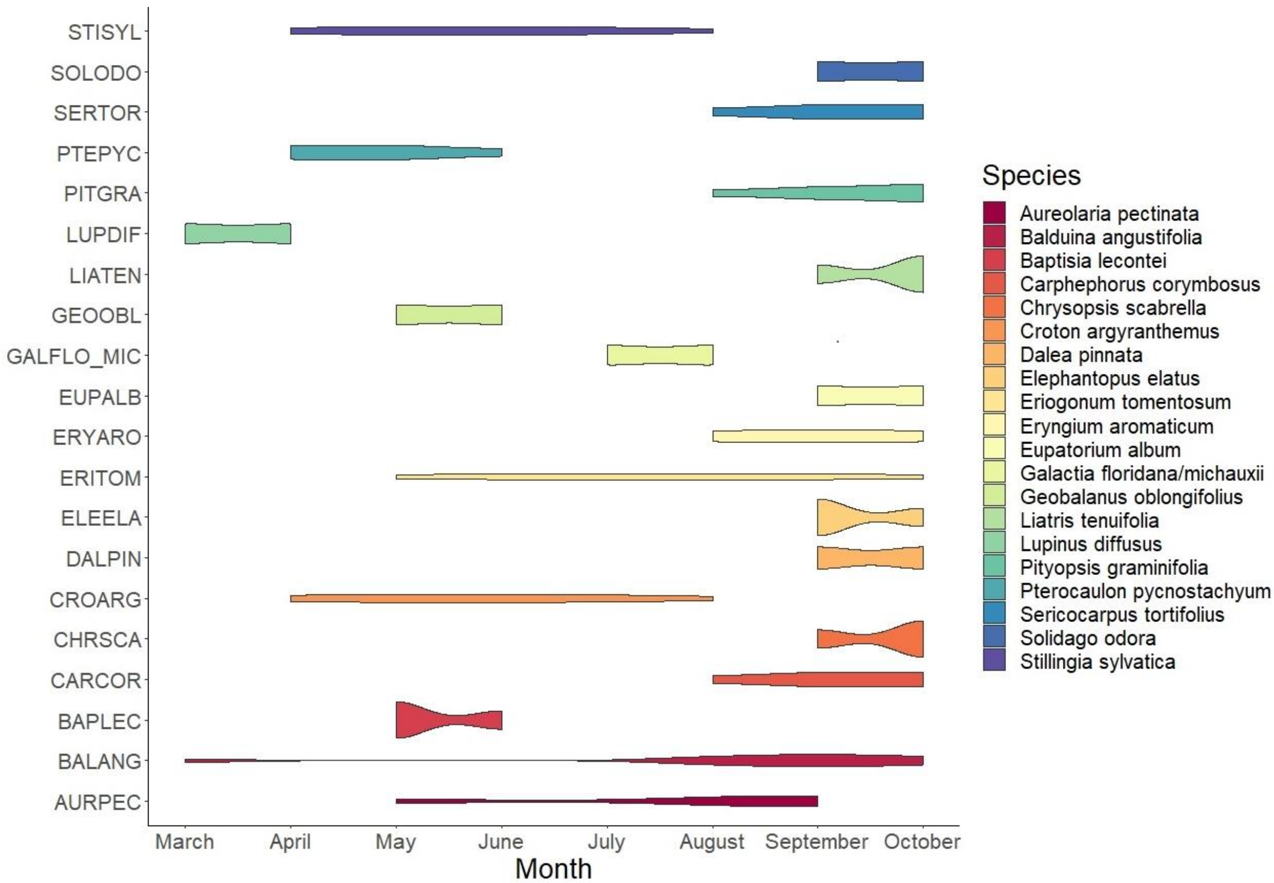
Beetle abundance was low to medium-low in all plots, and beetle species richness ranged from low to medium-high. Five of the most abundant pollinating beetles at Ft. White were *Mordella atrata* (Tumbling Flower Beetle), *Acmaeodera pulchella* (bald-cypress sapwood beetle), *Trigonopeltastes delta* (Delta Flower Beetle), *Chauliognathus marginatus* (Margined Leatherwing), and *Epicauta sp.* (Blister Beetles). *Photo credits for non-FWRI photos on last page.



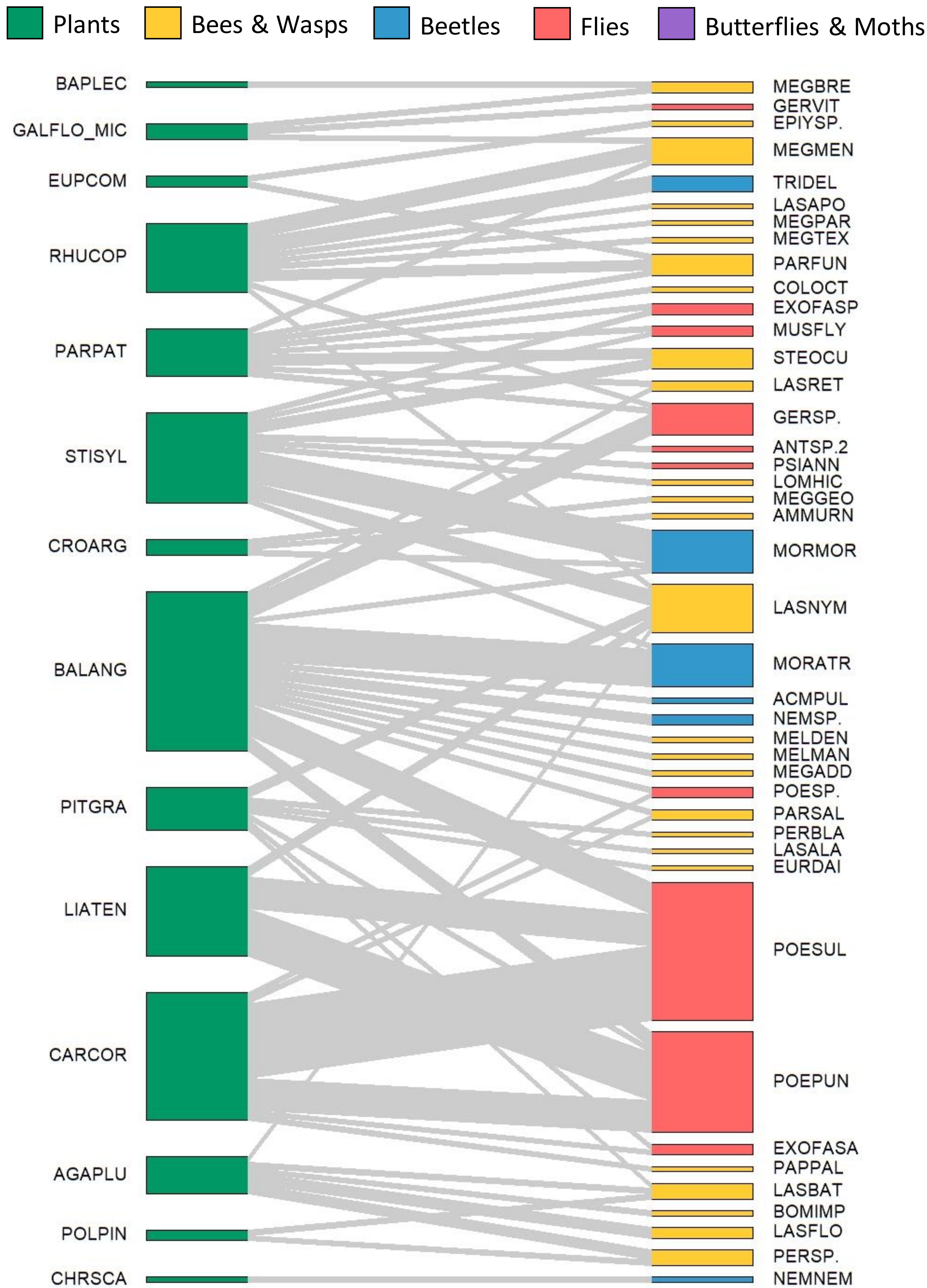


Key flowering plant species

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 Fort White sandhills.

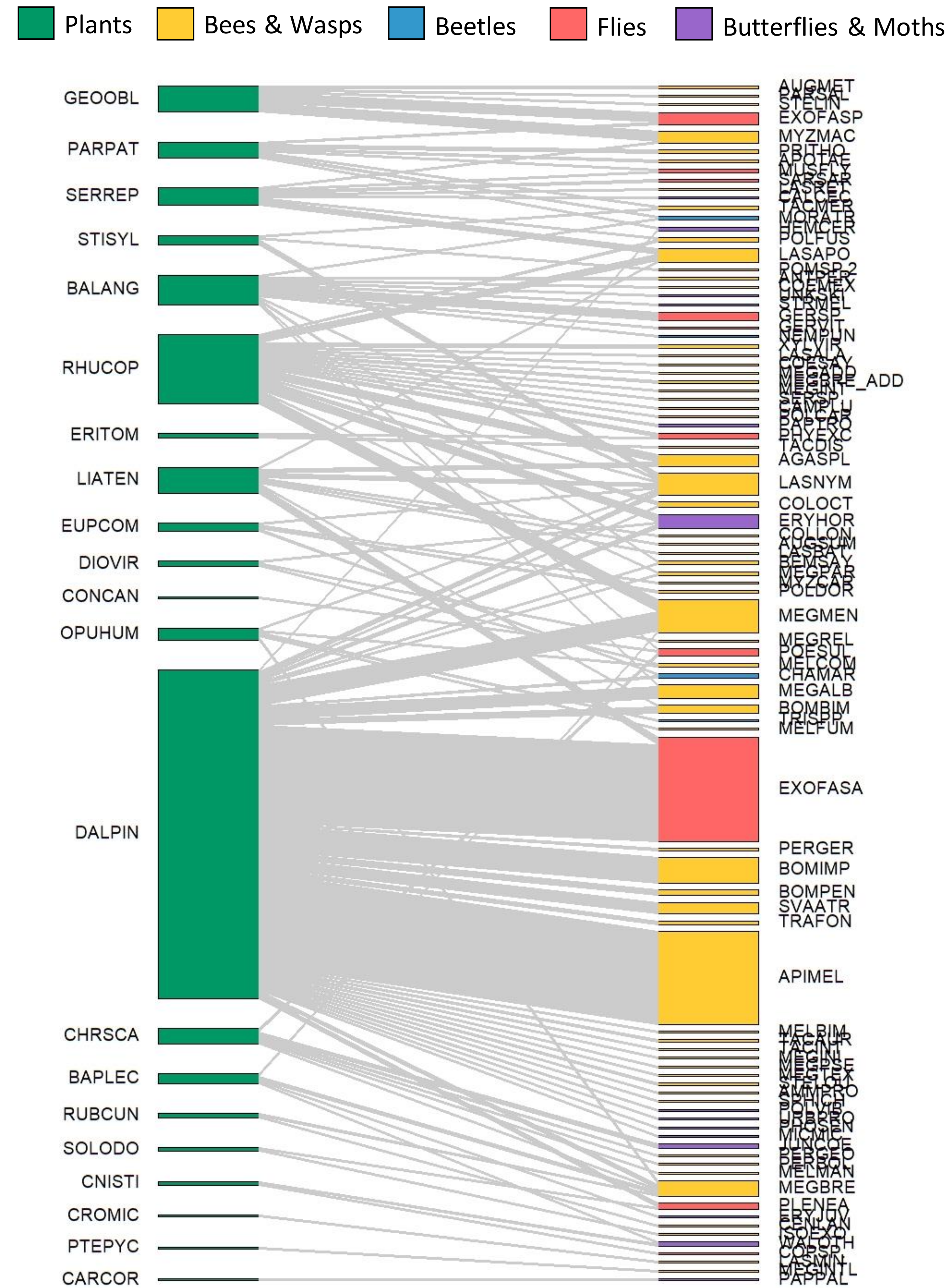


FW1 Plant-Pollinator Network *Plant and insect code key included at end of report

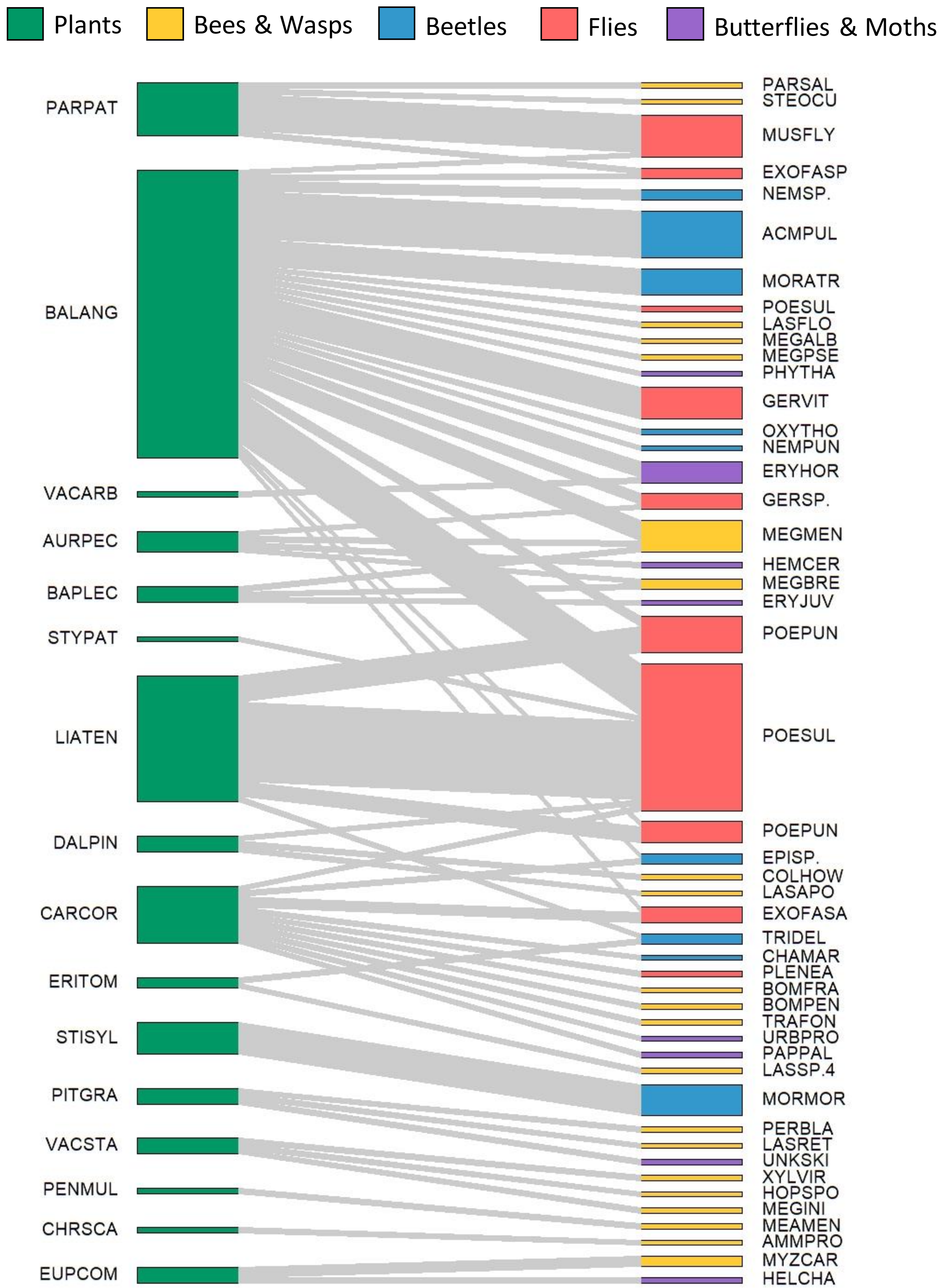


FW2 Plant-Pollinator Network

*Plant and insect code key included at end of report



FW3 Plant-Pollinator Network *Plant and insect code key included at end of report



Most frequently observed native pollinator genera at Ft. White

Insect Code Key for network diagrams, with plot occurrence data

		Number Caught			
Code	*Species*	FW-1	FW-2	FW-3	Insect Type
ACMPUL	*Acmaeodera pulchella*	1	0	9	Beetles
AGASPL	*Agapostemon splendens*	0	6	0	Bees & Wasps
AMMPRO	*Ammophila procera*	0	1	1	Bees & Wasps
AMMURN	*Ammophila urnaria*	1	0	0	Bees & Wasps
ANTPER	*Anthidiellum perplexum*	0	1	0	Bees & Wasps
ANTSP.2	*Anthracinae sp. 2*	1	0	0	Flies
APIMEL	*Apis mellifera*	0	47	0	Bees & Wasps
APOTAE	*Aporinellus taeniatus*	0	1	0	Bees & Wasps
AUGMET	*Augochloropsis metallica*	0	1	0	Bees & Wasps
AUGSUM	*Augochloropsis sumptuosa*	0	1	0	Bees & Wasps
BEMSAY	*Bembix sayi*	0	2	0	Bees & Wasps
BOMBIM	*Bombus bimaculatus*	0	4	0	Bees & Wasps
BOMFRA	*Bombus fraternus*	0	0	1	Bees & Wasps
BOMIMP	*Bombus impatiens*	1	13	0	Bees & Wasps
BOMPEN	*Bombus pensylvanicus*	0	3	1	Bees & Wasps
CALCEC	*Calycopis cecrops*	0	1	0	Butterflies & Moths
CAMPLU	*Campsomeris plumipes fossul*	0	1	0	Bees & Wasps
CENLAN	*Centris lanosa*	0	1	0	Bees & Wasps
CHAMAR	*Chauliognathus marginatus*	0	2	1	Beetles
COEMEX	*Coelioxys mexicanus*	0	1	0	Bees & Wasps
COESAY	*Coelioxys sayi*	0	1	0	Bees & Wasps
COLHOW	*Colletes howardi*	0	0	1	Bees & Wasps
COLLON	*Colletes longifacies*	0	1	0	Bees & Wasps
COLOCT	*Colpa octomaculata*	1	3	0	Bees & Wasps
COPSP.	*Copestylum sp.*	0	1	0	Flies
EPISP.	*Epicauta sp.*	0	0	2	Beetles
EPIYSP.	*Episyron sp.*	1	0	0	Bees & Wasps
ERYHOR	*Erynnis horatius*	0	7	4	Butterflies & Moths
ERYJUV	*Erynnis juvenalis*	0	1	1	Butterflies & Moths
EURDAI	*Eurema daira*	1	0	0	Butterflies & Moths
EXOFASA	*Exoprosopa fasciata*	2	53	3	Flies
EXOFASP	*Exoprosopa fascipennis*	2	6	2	Flies
GERSP.	*Geron sp.*	6	4	3	Flies
GERVIT	*Geron vitripennis*	1	1	6	Flies
HELCHA	*Heliconius charithonia*	0	0	1	Butterflies & Moths
HEMCER	*Hemiargus ceraunus*	0	2	1	Butterflies & Moths
HOPSPO	*Hoplitis spoliata*	0	0	1	Bees & Wasps
ISOEXO	*Isodontia exornata*	0	1	0	Bees & Wasps
JUNCOE	*Junonia coenia*	0	2	0	Butterflies & Moths
LASALA	*Lasioglossum alachuense*	1	1	0	Bees & Wasps

LASAPO	*Lasioglossum apopkense*	1	7	1	Bees & Wasps
LASBAT	*Lasioglossum batya*	3	1	0	Bees & Wasps
LASFLO	*Lasioglossum floridanum*	2	0	1	Bees & Wasps
LASMIN	*Lasioglossum miniatulum*	0	1	0	Bees & Wasps
LASNYM	*Lasioglossum nymphale*	9	11	0	Bees & Wasps
LASRET	*Lasioglossum reticulatum*	2	1	1	Bees & Wasps
LASSP.4	*Lasioglossum Sp. 4*	0	0	1	Bees & Wasps
LOMHIC	*Lomachaeta hicksi*	1	0	0	Bees & Wasps
MEGADD	*Megachile addenda*	1	1	0	Bees & Wasps
MEGALB	*Megachile albitarsis*	0	7	1	Bees & Wasps
MEGBRE	*Megachile brevis*	2	8	2	Bees & Wasps
MEGBRE_ADD	*Megachile brevis/addenda*	0	1	0	Bees & Wasps
MEGGEO	*Megachile georgica*	1	0	0	Bees & Wasps
MEGINI	*Megachile inimica*	0	1	1	Bees & Wasps
MEGINT	*Megachile integra*	0	1	0	Bees & Wasps
MEGINTL	*Megachile integrella*	0	1	0	Bees & Wasps
MEGMEN	*Megachile mendica*	5	17	6	Bees & Wasps
MEGMEN	*Megachile mendica*	0	0	1	Bees & Wasps
MEGPAR	*Megachile parallela*	1	2	0	Bees & Wasps
MEGPSE	*Megachile pseudobrevis*	0	1	1	Bees & Wasps
MEGREL	*Megachile relativa*	0	1	0	Bees & Wasps
MEGTEX	*Megachile texana*	1	1	0	Bees & Wasps
MELBIM	*Melissodes bimaculata*	0	1	0	Bees & Wasps
MELCOM	*Melissodes communis*	0	2	0	Bees & Wasps
MELDEN	*Melissodes denticulatus*	1	0	0	Bees & Wasps
MELFUM	*Melissodes fumosus*	0	1	0	Bees & Wasps
MELMAN	*Melissodes manipularis*	1	1	0	Bees & Wasps
MICMIC	*microlep*	0	1	0	Butterflies & Moths
MORATR	*Mordella atrata*	8	2	5	Beetles
MORMOR	*Mordellidae*	8	0	6	Beetles
MUSFLY	*muscoid fly*	2	2	8	Flies
MYZCAR	*Myzinum carolinianum*	0	1	2	Bees & Wasps
MYZMAC	*Myzinum maculatum*	0	6	0	Bees & Wasps
NEMNEM	*Nemognatha nemorensis*	1	0	0	Beetles
NEMPUN	*Nemognatha punctulata*	0	1	1	Beetles
NEMSP.	*Nemognatha sp.*	2	0	2	Beetles
OXYTHO	*Oxycopois thoracica*	0	0	1	Beetles
PAPPAL	*Papilio palamedes*	1	1	1	Butterflies & Moths
PAPTRO	*Papilio troilus*	0	1	0	Butterflies & Moths
PARFUN	*Paracyphononyx funereus*	4	0	0	Bees & Wasps
PARSAL	*Parancistrocerus salcularis*	2	1	1	Bees & Wasps
PERBLA	*Perdita blatchleyi*	1	0	1	Bees & Wasps

PERBOL	*Perdita boltoniae*	0	1	0	Bees & Wasps
PERGEO	*Perdita georgica*	0	1	0	Bees & Wasps
PERGER	*Perdita gerardiae*	2	1	0	Bees & Wasps
PERGER_BLA	*Perdita gerardiae/blatcheyi*	1	0	0	Bees & Wasps
PERGERH	*Perdita gerhardi*	2	0	0	Bees & Wasps
PEROCT	*Perdita octomaculata*	1	0	0	Bees & Wasps
PERSP.	*Perdita sp.*	3	0	0	Bees & Wasps
PHOSEN	*Phoebis sennae*	0	1	0	Butterflies & Moths
PHYEXC	*Physoconops excisus*	0	3	0	Flies
PHYTHA	*Phyciodes tharos*	0	0	1	Butterflies & Moths
PLENEA	*Plecia nearctica*	0	3	1	Flies
POEPUN	*Poeciliognathus punctipennis*	20	0	11	Flies
POESP.	*Poecilognathus sp.*	2	0	0	Flies
POESUL	*Poeciliognathus sulphureus*	26	4	29	Flies
POLCAR	*Polistes carolina*	0	1	0	Bees & Wasps
POLDOR	*Polistes dorsalis*	0	1	0	Bees & Wasps
POLFUS	*Polistes fuscatus*	0	2	0	Bees & Wasps
POLVIB	*Polites vibex*	0	1	0	Butterflies & Moths
POMSP.2	*Pompilidae sp. 2*	0	1	0	Bees & Wasps
PRITHO	*Prionyx thomae*	0	2	0	Bees & Wasps
PSIANN	*Psilonyx annulatus*	1	0	0	Flies
SARSAR	*Sarcophagidae*	0	1	0	Flies
SERSP.	*Sericopompilus sp.*	0	1	0	Bees & Wasps
SPHICH	*Sphex ichneumoneus*	0	1	0	Bees & Wasps
STELIN	*Stenodynerus lineatifrons*	0	1	0	Bees & Wasps
STELOU	*Stelis louisae*	0	1	0	Bees & Wasps
STEOCU	*Stenodynerus oculeus*	4	0	1	Bees & Wasps
STRMEL	*Strymon melinus*	0	1	0	Butterflies & Moths
SVAATR	*Svastra atripes*	0	6	0	Bees & Wasps
TACAUR	*Tachytes auricomans*	0	1	0	Bees & Wasps
TACDIS	*Tachytes distinctus*	0	1	0	Bees & Wasps
TACINT	*Tachytes intermedius*	0	1	0	Bees & Wasps
TACMER	*Tachytes mergus*	0	2	0	Bees & Wasps
TRAFON	*Trachusa fontemvitae*	0	2	1	Bees & Wasps
TRIDEL	*Trigonopeltastes delta*	3	0	2	Beetles
TRISPP	*Trichiotinus spp.*	0	1	0	Beetles
UNKSKI	*unknown skipper*	0	1	1	Butterflies & Moths
URBPRO	*Urbanus proteus*	0	1	1	Butterflies & Moths
WALOTH	*Wallengrenia otho*	0	2	0	Butterflies & Moths
XYLVIR	*Xylocopa virginica*	0	2	1	Bees & Wasps

Plant Code Key for network diagrams, with plot occurrence data

		Relative Frequency			
		% of quads in which present			
Code	**Species**	**FW1**	**FW2**	**FW3**	**Plant Type**
AGAPLU	*Agalinis plukenettii*	12	0	2	Forb
AGEJUC	*Ageratina jucunda*	5	4	0	Forb
ASIINC	*Asimina incana*	2	17	12	Shrub
BALANG	*Balduina angustifolia*	13	13	23	Forb
BAPLEC	*Baptisia lecontei*	13	36	11	Forb
CARCOR	*Carphephorus corymbosus*	23	9	32	Forb
CHRSCA	*Chrysopsis scabrella*	5	18	15	Forb
CNISTI	*Cnidoscolus stimulosus*	5	2	7	Forb
COMERE	*Commelina erecta*	0	1	0	Forb
CROARG	*Croton argyranthemus*	7	29	4	Forb
CROCOR	*Crocantheumum corymbosum*	0	1	0	Forb
CROMIC	*Croton michauxii*	30	47	13	Forb
DALPIN	*Dalea pinnata*	6	89	3	Forb
DIOSVI	*Diospyros virginiana*	16	13	22	Shrub
ERITOM	*Eriogonum tomentosum*	4	3	7	Forb
EUPCOM	*Eupatorium compositifolium*	19	43	28	Forb
GALFLO_MIC	*Galactia floridana/michauxii*	92	69	40	Forb
GEOOBL	*Geobalanus oblongifolius*	1	33	1	Forb
HYPSUF	*Hypericum suffruticosum*	0	0	1	Shrub
LESHIR	*Lespedeza hirta*	0	1	0	Forb
LIATEN	*Liatris tenuifolia*	20	24	21	Forb
OPUHUM	*Opuntia humifusa*	2	7	1	Forb
PALINT	*Palafoxia integrifolia*	1	28	47	Forb
PARPAT	*Paronychia patula*	17	13	2	Forb
PEDCAN	*Pediomelum canescens*	0	0	1	Forb
PIRCIS	*Piriqueta cistoides*	0	0	1	Forb
PITGRA	*Pityopsis graminifolia*	24	0	6	Forb
POLPIN	*Polygonum pinicola*	6	6	0	Forb
RHUCOP	*Rhus copallinum*	67	84	21	Shrub
RUBCUN	*Rubus cuneifolius*	12	51	0	Shrub
SERREP	*Serenoa repens*	10	26	15	Shrub
SMIAUR	*Smilax auriculata*	3	5	9	Shrub
SOLODO	*Solidago odora*	2	1	0	Forb
STISYL	*Stillingia sylvatica*	47	25	12	Forb
STYBIF	*Stylosanthes biflora*	1	1	6	Forb
STYPAT	*Stylisma patens*	23	2	11	Forb
TEPCHR_SPI	*Tephrosia chrysophylla/spicata*	79	76	58	Forb
VACARB	*Vaccinium arboreum*	36	16	34	Shrub
VACMYR	*Vaccinium myrsinites*	0	4	0	Shrub
VACSTA	*Vaccinium stamineum*	18	7	17	Shrub

References

Bascompte, J., & Jordano, P. (2007). Plant-animal mutualistic networks: the architecture of biodiversity. Annu. Rev. Ecol. Evol. Syst., 38, 567-593.

Brewer, J.S. and Platt, W.J., 1994. Effects of fire season and herbivory on reproductive success in a clonal forb, Pityopsis graminifolia. Journal of Ecology, pp.665-675.

Noss, R.F., Platt, W.J., Sorrie, B.A., Weakley, A.S., Means, D.B., Costanza, J. and Peet, R.K., 2015. How global biodiversity hotspots may go unrecognized: lessons from the North American Coastal Plain. Diversity and Distributions, 21(2), pp.236-244.

Spiesman BJ and Inouye BD. 2013. Habitat loss alters the architecture of plant-pollinator interaction networks. Ecology 94(12): 2688-2696.

Additional Resources

For more information on the natural history and identification of the insects we found at Fort White, 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 Fort White, 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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