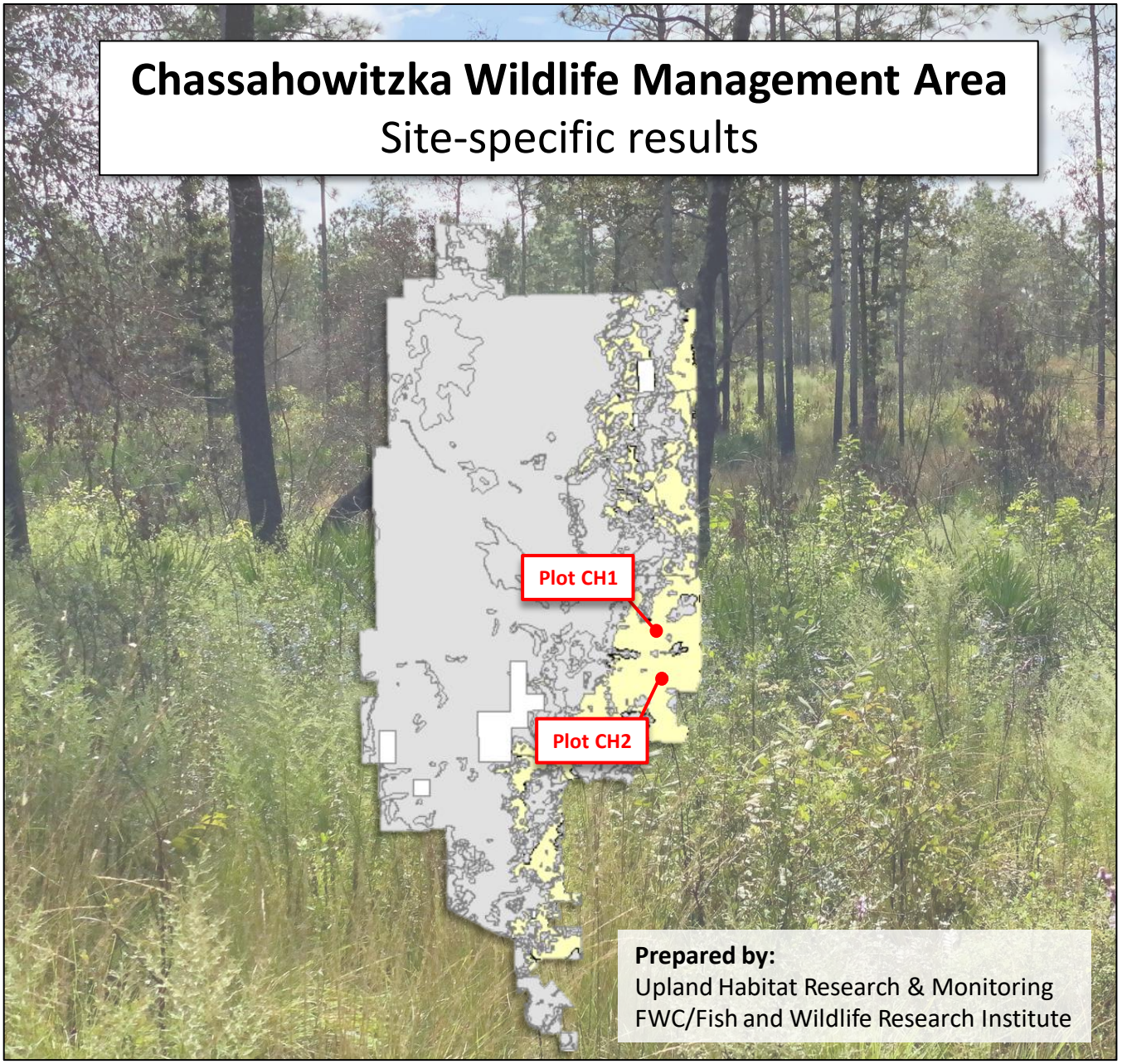
Plant-Pollinator Networks in Fire-Maintained Sandhills

Research Study (2019-2020)

Chassahowitzka Wildlife Management Area

Site-specific results



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Introduction

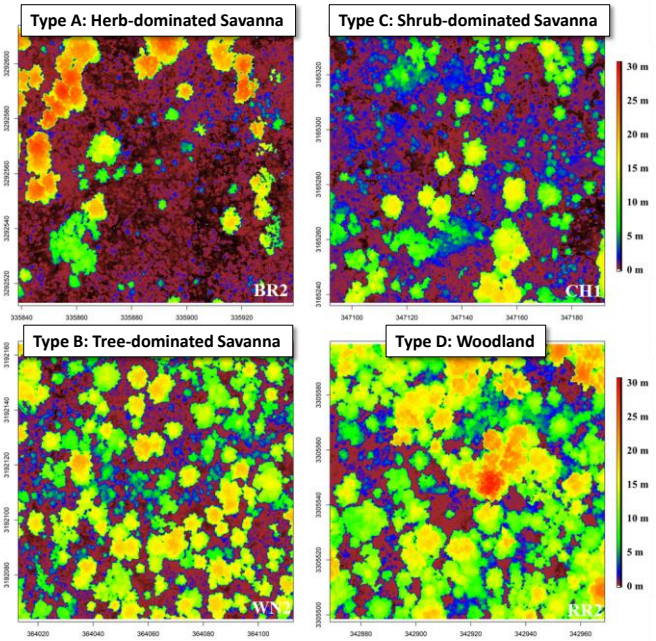
In Florida's fire-dependent longleaf pine savannas, as in terrestrial ecosystems worldwide, the mutualistic interaction networks formed by flowering plants and pollinators are of fundamental importance for the maintenance of biodiversity (Bascompte and Jordano 2007). Florida is part of the North American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

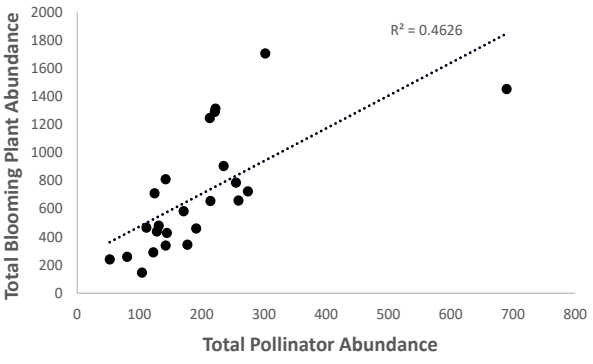


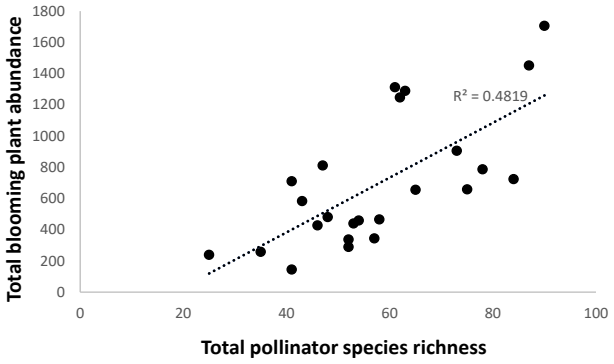
Overall Study Results: Vegetation Structure

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.

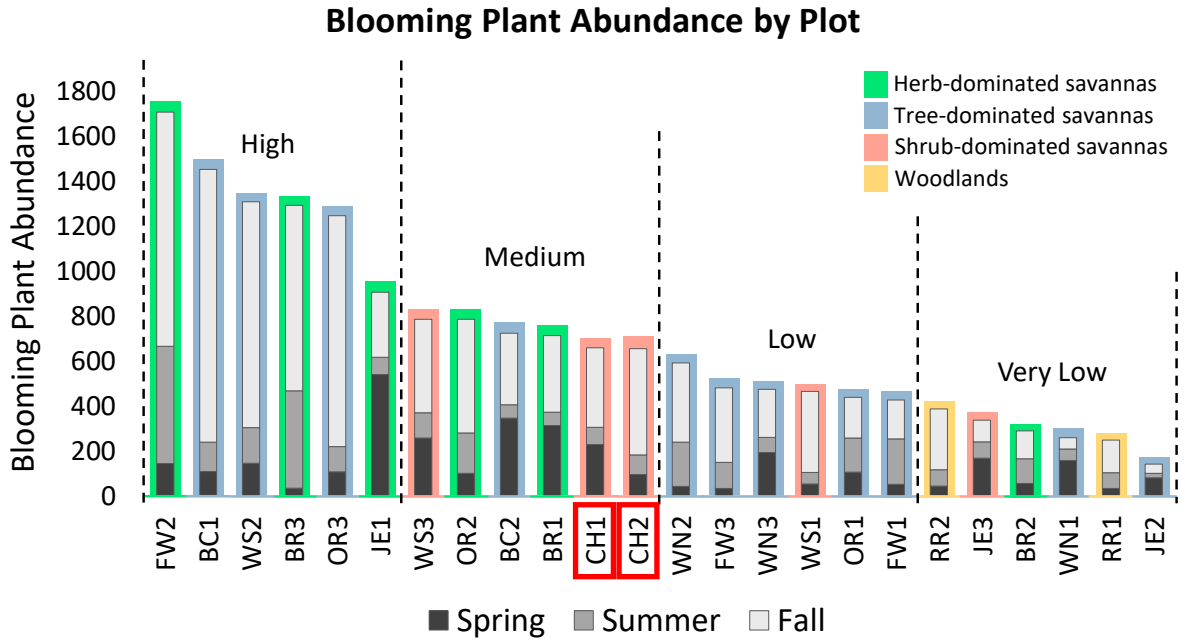




We found that the spring bloom season in longleaf pine sandhills is dominated by shrubs (particularly saw palmetto and blueberries), while the fall bloom season is dominated by herbaceous plants (especially members of the Asteraceae or sunflower family). Most of the herb-dominated plots in the study 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/.

Chassahowitzka Results: Stand Structure and Flower Abundance

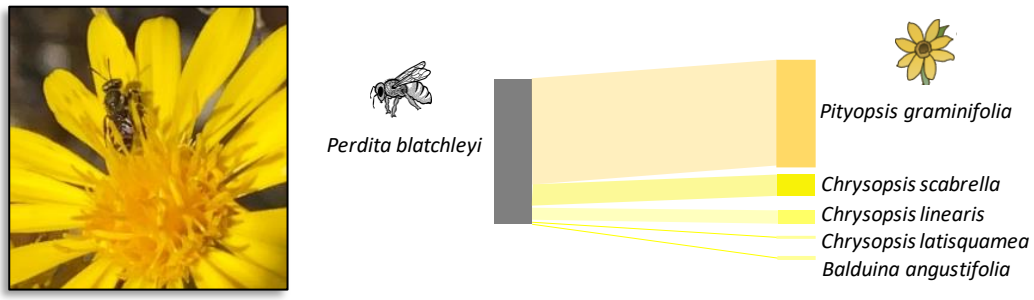
Plot CH1 and **Plot CH2** at Chassahowitzka are both shrub-dominated savannas. Both CH1 and CH2 had moderate overall blooming plant abundance, with the highest number of blooming plants in the fall. Saw palmetto *(Serenoa repens),* Darrow's blueberry *(Vaccinium darrowii)*, and Netted pawpaw *(Asimina reticulata),* were among the most abundant shrubs in both Chassahowitzka plots. Unlike oaks, these shrubs produce flowers that are highly attractive to pollinators, and at Chassahowitzka they were prominent components of the plant-pollinator networks. CH1 and CH2 also contained many herbaceous flowering plants, albeit in lower numbers than most of the herb-dominated plots.



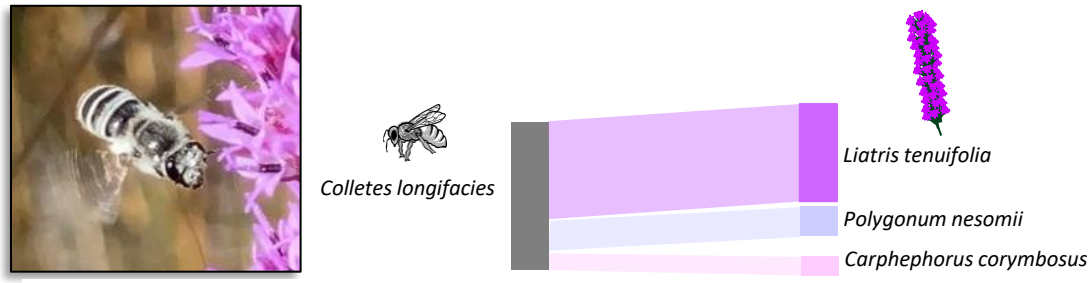
Chassahowitzka Results: Pollinator Overview

Total pollinator abundance and species richness was above average in both Chassahowitzka plots. Broken down into specific insect groups, plot CH1 showed above-average species richness in all groups, and plot CH2 had above-average species richness in all but Hymenoptera (Bees & Wasps). Despite this high species richness, abundance of Lepidoptera (Butterflies & Moths) and Coleoptera (Beetles) was below average in both plots. Order-specific pollinator results are presented in greater detail on the following pages, followed by plant-pollinator network diagrams for each plot.

Three bee species identified as Species of Greatest Conservation Need (SGCN) by Florida's State Wildlife Action Plan were collected at Chassahowitzka: *Perdita blatchleyi*, *Colletes longifacies,* and *Ashmeadiella floridana.* 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.

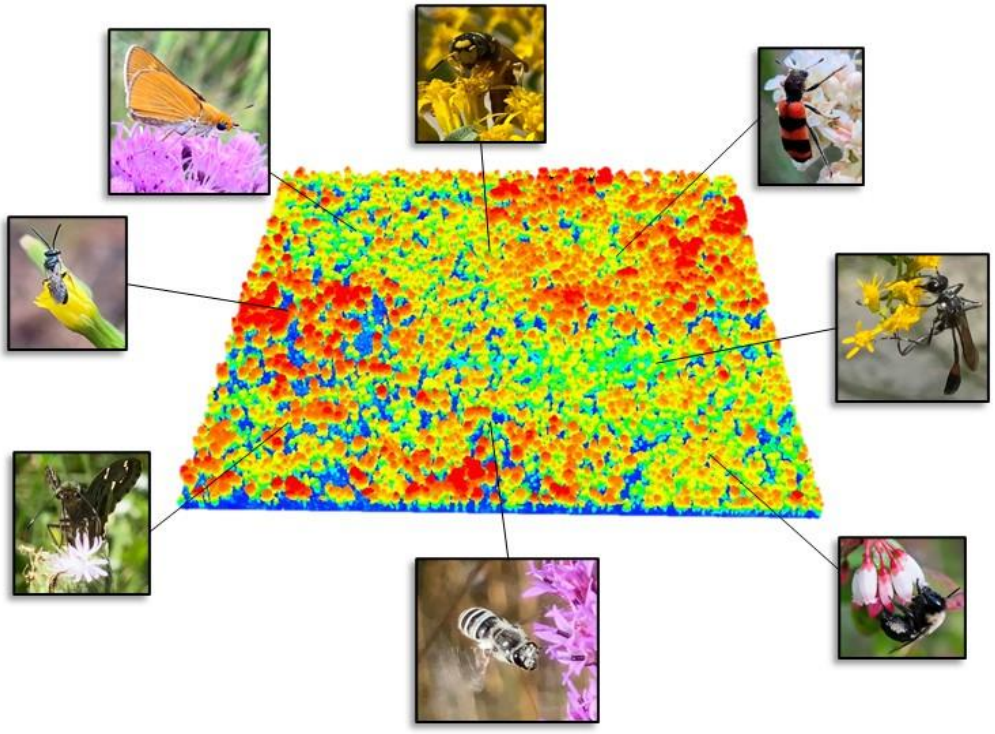


Flower interactions of *Perdita blatchleyi*, based on 103 observations recorded during the project.



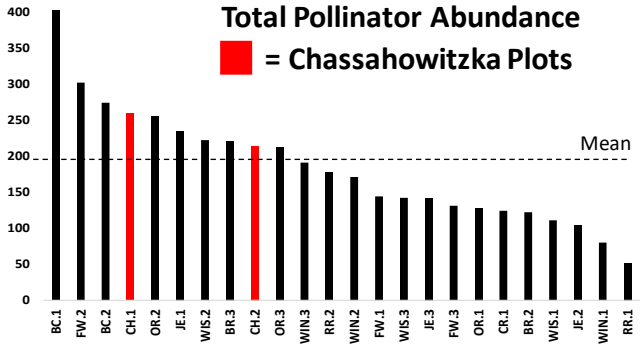
Flower interactions of *Colletes longifacies*, based on 24 observations recorded during the project.

Chassahowitzka Results
Pollinator Abundance and Species Richness



Overall Pollinator Abundance and Species Richness

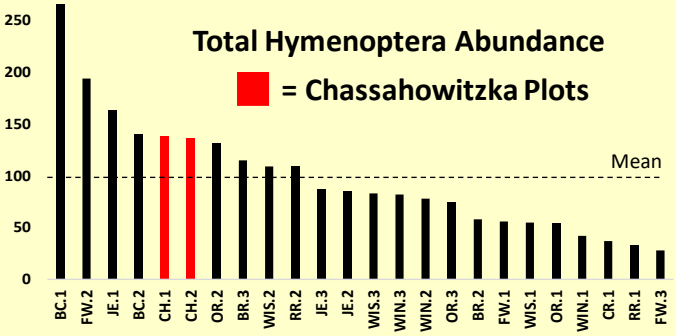
	Abundance # of Individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **CH1**	**259**	**Med-High**	**75**	**High**
Plot **CH2**	**214**	**Med-High**	**65**	**Med-High**
Study Average	181.6		57.6	
Study Range	52 - 402		25 - 90	



The above table shows the total pollinator abundance (number of individual insects caught) and total pollinator species richness for the three study plots at Chassahowitzka, 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 CH1 had very high species richness and medium-high pollinator abundance relative to the overall study, while plot CH2 was slightly lower but also above average. These differences are likely due to the types of flowering plant species present and the amount of flowers they produced, as well as insect populations in the surrounding areas. 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) for each plot.

Hymenoptera (Bees & Wasps)

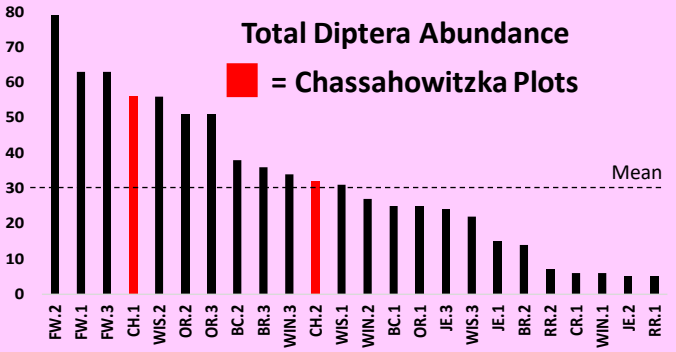
	Abundance # of individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **CH1**	138	Med-High	38	Med-High
Plot **CH2**	136	Med-High	33	Med-Low
Study Average	98.1		33.6	
Study Range	28 - 266		12 - 61	



Bee & wasp abundance was above the study average in both plots. Plot CH1 had above-average bee and wasp species richness, and plot CH2 had slightly below-average species richness. The five most common bee & wasp species at Chassahowitzka were *Perdita blatchleyi* (a Fairy Bee), *Augochlorella gratiosa* (a Sweat Bee), *Myzinum maculatum* (a Flower Wasp), *Augochloropsis metallica* (Northeastern Sweat Bee), *Bombus impatiens* (Eastern Bumble Bee). *Photo credits for non-FWRI photos on last page.

Diptera (Flies)

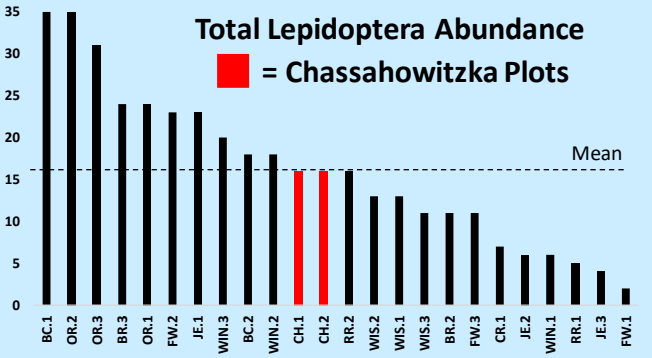
	Abundance # of individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **CH1**	56	High	17	High
Plot **CH2**	32	Med-High	14	High
Study Average	30.1		7.6	
Study Range	5 - 79		2 - 18	



Fly abundance and species richness were above average in both plots CH1 and CH2. Five of the most abundant Dipteran pollinators at Chassahowitzka were *Ogcodocera leucoprocta* (white-tailed bee fly), *Poeciliognathus sulphureus* (Sulphurous bee fly), *Geron vitripennis* (Glassy-winged bee fly), *Exoprosopa fasciata* (Banded bee fly), and *Palpada vinetorum* (Plushback fly). *Photo credits for non-FWRI photos on last page.

Lepidoptera (Butterflies & Moths)

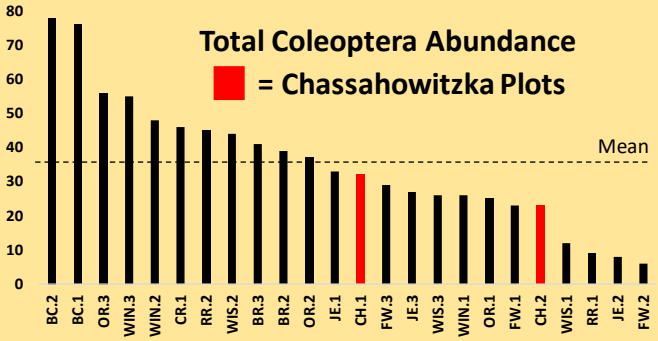
	Abundance # of individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **CH1**	16	Med-Low	9	Med-High
Plot **CH2**	16	Med-Low	9	Med-High
Study Average	16.2		8.1	
Study Range	2 - 35		2 - 14	



Butterfly & moth abundance and species richness were near the study average in both plots. Five of the most abundant Lepidopteran species at Chassahowitzka were *Erynnis horatius* (Horace's Duskywing), *Pyrisitia lisa* (Little Yellow), *Strymon melinus* (Gray Hairstreak), *Panoquina ocola* (Ocola Skipper), and *Hemiargus ceraunus* (Ceraunus Blue). *Photo credits for non-FWRI photos on last page.

Coleoptera (Beetles)

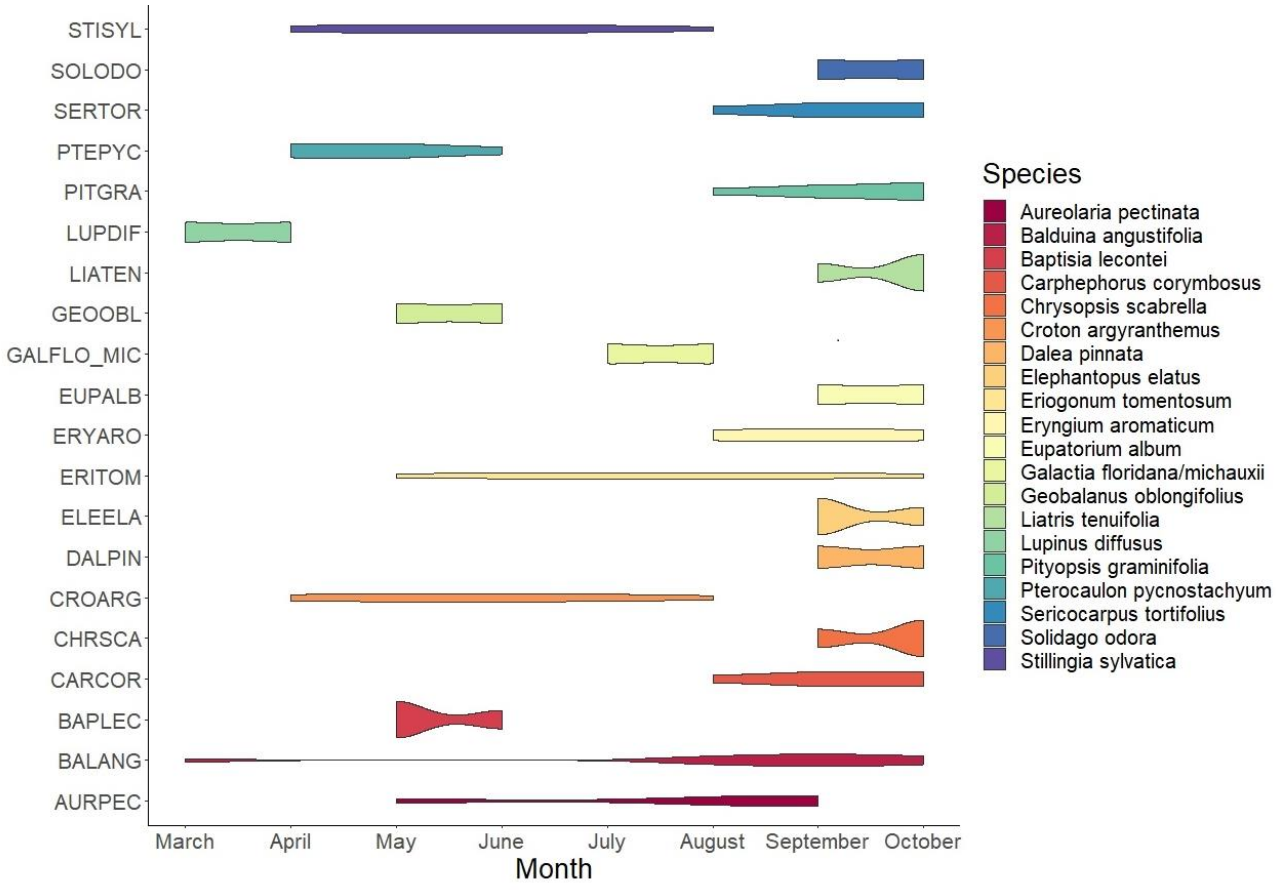
	Abundance # of Individuals		Species Richness	
	Total	Rank	Total	Rank
Plot **CH1**	32	Med-Low	10	Med-High
Plot **CH2**	23	Med-Low	8	Med-High
Study Average	35.2		8.0	
Study Range	6 - 78		4 – 14	



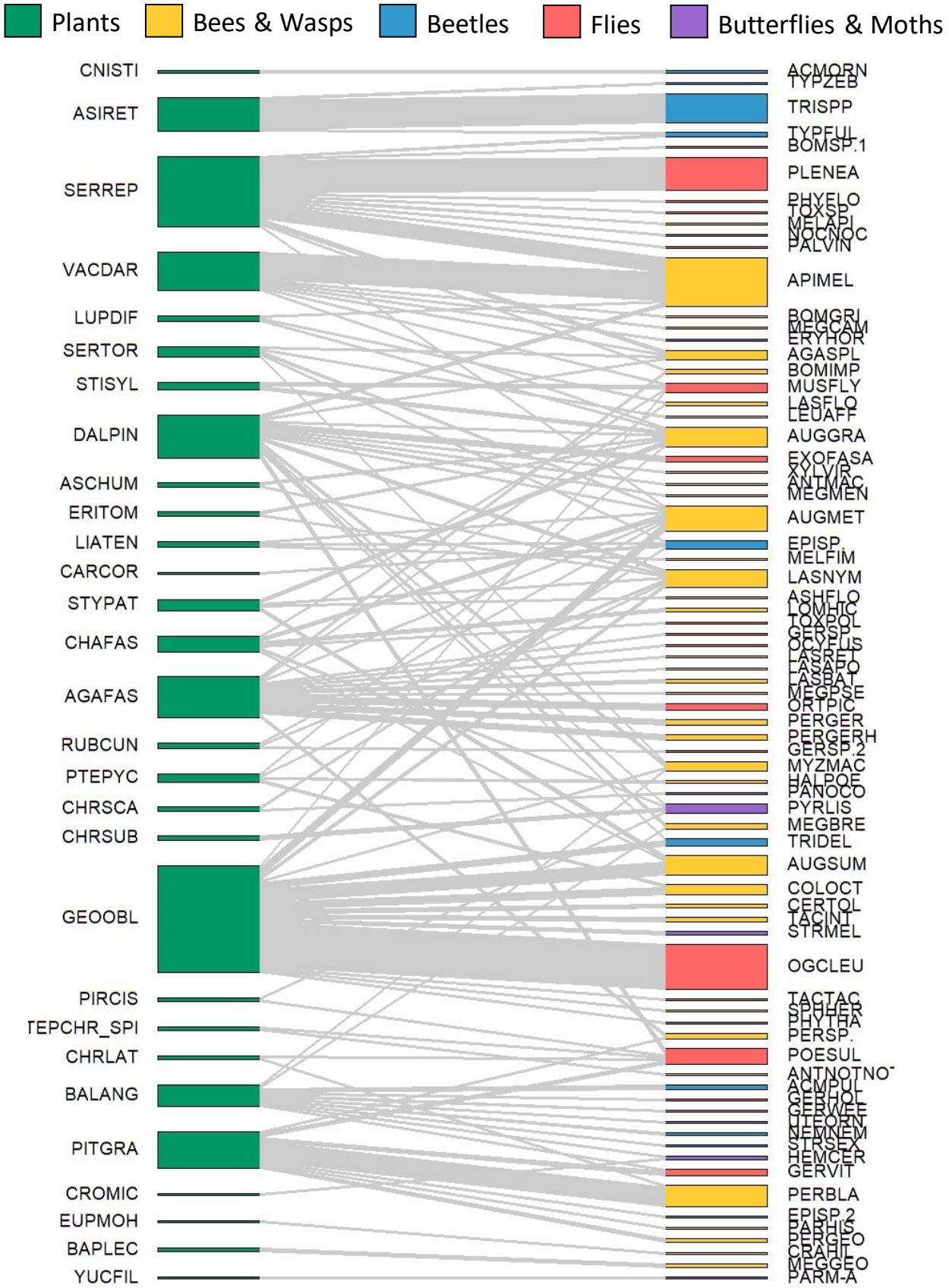
Beetle species richness was above average in both Chassohowitzka study plots, though abundance was lower than average in both plots. Five of the most abundant beetle species at Chassahowitzka were *Trichiotinus sp.* (Flower scarabs), *Epicauta sp.* (Blister beetles), *Trigonopeltastes delta* (Delta Flower Scarab), *Mordella atrata* (Tumbling Flower Beetle), and *Sranglia sexnotata* (Six-spotted Flower Longhorn). *Photo credits for non-FWRI photos on last page.

Key flowering plant species

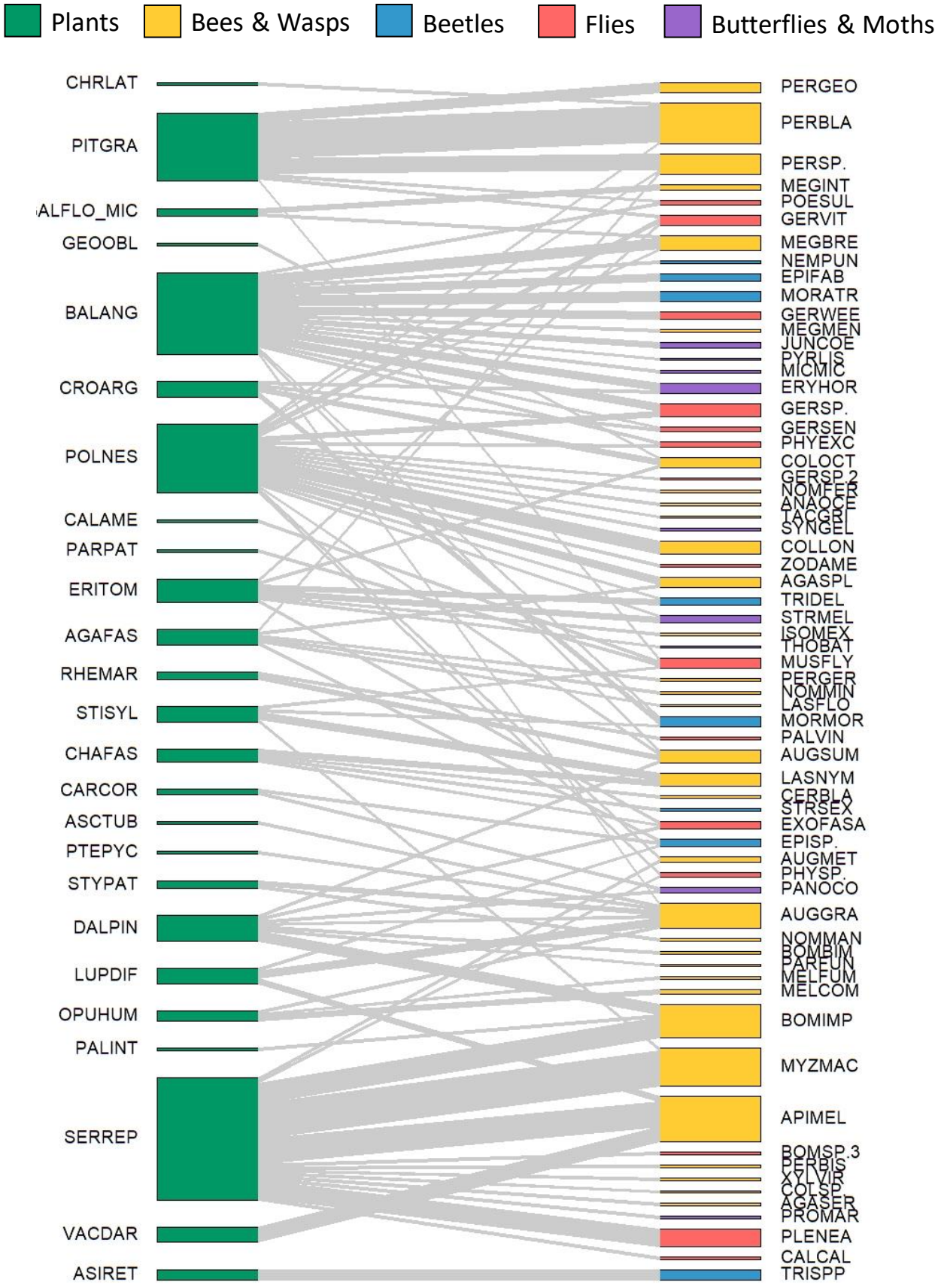
We identified 20 of the most important herbaceous flowering species that were present on multiple sites and had high pollinator interaction rates throughout the study. Many of these species, shown in the graphic below with their blooming time/duration, were prominent in the Chassahowitzka sandhill plant-pollinator networks.



CH1 Plant-Pollinator Network *Plant and insect code key included at end of report



CH2 Plant-Pollinator Network *Plant and insect code key included at end of report



Insect Code Key for network diagrams, with plot occurrence data

		Number caught		
Code	*Species*	CH-1	CH-2	Insect Type
ACMORN	Acmaeodera ornata	1	0	Beetles
ACMPUL	Acmaeodera pulchella	2	0	Beetles
AGASER	Agapostemon sericeus	0	1	Bees & Wasps
AGASPL	Agapostemon splendens	5	4	Bees & Wasps
ANAOCE	Anacabro ocellatus	0	1	Bees & Wasps
ANTMAC	Anthidium maculifrons	1	0	Bees & Wasps
ANTNOTN	Anthidiellum notatum nota	1	0	Bees & Wasps
APIMEL	Apis mellifera	25	18	Bees & Wasps
ASHFLO	Ashmeadiella floridana	1	0	Bees & Wasps
AUGGRA	Augochlorella gratiosa	10	10	Bees & Wasps
AUGMET	Augochloropsis metallica	13	2	Bees & Wasps
AUGSUM	Augochloropsis sumptuosa	10	5	Bees & Wasps
BOMBIM	Bombus bimaculatus	0	1	Bees & Wasps
BOMGRI	Bombus griseocollis	1	0	Bees & Wasps
BOMIMP	Bombus impatiens	2	13	Bees & Wasps
BOMSP.1	Bombyliidae sp. 1	1	0	Flies
BOMSP.3	Bombyliidae sp. 3	0	1	Flies
CALCAL	Calliphoridae	0	1	Flies
CERBLA	Cerceris blakei	0	1	Bees & Wasps
CERTOL	Cerceris tolteca	2	0	Bees & Wasps
COLLON	Colletes longifacies	0	5	Bees & Wasps
COLOCT	Colpa octomaculata	5	4	Bees & Wasps
COLSP.	Colletes sp.	0	1	Bees & Wasps
CRAHIL	Crabro hilaris rufibasis	1	0	Bees & Wasps
EPIFAB	Epicauta fabricii	0	3	Beetles
EPISP.	Epicauta sp.	4	3	Beetles
EPISP.2	Epicauta sp. 2	1	0	Beetles
ERYHOR	Erynnis horatius	2	4	Butterflies & Moths
EXOFASA	Exoprosopa fasciata	3	3	Flies
GERHOL	Geron holosericeus	1	0	Flies
GERSEN	Geron senilis	0	2	Flies
GERSP.	Geron sp.	1	5	Flies
GERSP.2	Geron sp. 2	1	1	Flies
GERVIT	Geron vitripennis	3	4	Flies
GERWEE	Geron weemsi	1	3	Flies
HALPOE	Halictus poeyi	1	0	Bees & Wasps
HEMCER	Hemiargus ceraunus	2	0	Butterflies & Moths
ISOMEX	Isodontia mexicana	0	1	Bees & Wasps

		Number caught		
Code	*Species*	CH-1	CH-2	Insect Type
JUNCOE	Junonia coenia	0	2	Butterflies & Moths
LASAPO	Lasioglossum apopkense	1	0	Bees & Wasps
LASBAT	Lasioglossum batya	2	0	Bees & Wasps
LASFLO	Lasioglossum floridanum	2	1	Bees & Wasps
LASNYM	Lasioglossum nymphale	9	5	Bees & Wasps
LASRET	Lasioglossum reticulatum	1	0	Bees & Wasps
LEUAFF	Leucopsis affinis	1	0	Bees & Wasps
LOMHIC	Lomachaeta hicksi	2	0	Bees & Wasps
MEGBRE	Megachile brevis	3	6	Bees & Wasps
MEGCAM	Megachile campanulae	1	0	Bees & Wasps
MEGGEO	Megachile georgica	2	0	Bees & Wasps
MEGINT	Megachile integra	0	2	Bees & Wasps
MEGMEN	Megachile mendica	1	1	Bees & Wasps
MEGPSE	Megachile pseudobrevis	1	0	Bees & Wasps
MELAPI	Melissodes apicatus	1	0	Bees & Wasps
MELCOM	Melissodes communis	0	2	Bees & Wasps
MELFIM	Melissodes fimbriatus	1	0	Bees & Wasps
MELFUM	Melissodes fumosus	0	1	Bees & Wasps
MICMIC	microlep	0	1	Butterflies & Moths
MORATR	Mordella atrata	0	4	Beetles
MORMOR	Mordellidae	0	4	Beetles
MUSFLY	muscoid fly	5	4	Flies
MYZMAC	Myzinum maculatum	5	15	Bees & Wasps
NEMNEM	Nemognatha nemorensis	1	0	Beetles
NEMPUN	Nemognatha punctulata	0	1	Beetles
NOCNOC	Noctuidae	1	0	Butterflies & Moths
NOMFER	Nomada fervida	0	1	Bees & Wasps
NOMMAN	Nomia maneei	0	1	Bees & Wasps
NOMMIN	Nomada miniata	0	1	Bees & Wasps
OCYFUS	Ocyptamus fuscipennis	1	0	Flies
OGCLEU	Ogcodocera leucoprocta	23	0	Flies
ORTPIC	Orthonevra pictipennis	3	0	Flies
PALVIN	Palpada vinetorum	1	1	Flies
PANOCO	Panoquina ocola	1	2	Butterflies & Moths

		Number caught		
Code	*Species*	CH-1	CH-2	Insect Type
PANOCO	Panoquina ocola	1	2	Butterflies & Moths
PARFUN	Paracyphononyx funereus	0	1	Bees & Wasps
PARHIS	Parancistrocerus histrio	1	0	Bees & Wasps
PARM-A	Parrhasius m-album	1	0	Butterflies & Moths
PERBIS	Perdita bishoppi	0	1	Bees & Wasps
PERBLA	Perdita blatchleyi	11	16	Bees & Wasps
PERGEO	Perdita georgica	2	4	Bees & Wasps
PERGER	Perdita gerardiae	3	1	Bees & Wasps
PERGERH	Perdita gerhardi	3	0	Bees & Wasps
PERSP.	Perdita sp.	3	8	Bees & Wasps
PHYEXC	Physoconops excisus	0	2	Flies
PHYFLO	Physocephala floridana	1	0	Flies
PHYSP.	Physoconops sp.	0	2	Flies
PHYTHA	Phyciodes tharos	1	0	Butterflies & Moths
PLENEA	Plecia nearctica	17	7	Flies
POESUL	Poeciliognathus sulphureus	8	2	Flies
PROMAR	Protographium marcellus	0	1	Butterflies & Moths
PYRLIS	Pyrisitia lisa	5	1	Butterflies & Moths
SPHHER	Sphecodes heraclei	1	0	Bees & Wasps
STRMEL	Strymon melinus	2	3	Butterflies & Moths
STRSEX	Stranglia sexnotata	1	1	Beetles
SYNGEL	Synanthedon geliformis	0	1	Butterflies & Moths
TACGRI	Tachytes grisselli	0	1	Bees & Wasps
TACINT	Tachytes intermedius	2	0	Bees & Wasps
TACTAC	Tachinidae	1	0	Flies
THOBAT	Thorybes bathyllus	0	1	Butterflies & Moths
TOXPOL	Toxomerus politus	1	0	Flies
TOXSP.	Toxomerus sp.	1	0	Flies
TRIDEL	Trigonopeltastes delta	4	3	Beetles
TRISPP	Trichiotinus spp.	15	4	Beetles
TYPFUL	Typocerus fulvocinctus	2	0	Beetles
TYPZEB	Typocerus zebra	1	0	Beetles
UTEORN	Utetheisa ornatrix	1	0	Butterflies & Moths
XYLVIR	Xylocopa virginica	1	1	Bees & Wasps
ZODAME	Zodion americanum	0	1	Flies

Plant Code Key for network diagrams, with plot occurrence data

		Relative Frequency (% of quads in which present)		
Code	Species	**CH1**	**CH2**	Plant Type
AGAFAS	*Agalinis fasciculata*	1	0	Forb
AGAPLU	*Agalinis plukenettii*	0	34	Forb
ASIRET	*Asimina reticulata*	9	5	Shrub
BALANG	*Balduina angustifolia*	23	23	Forb
BAPLEC	*Baptisia lecontei*	1	0	Forb
CALAME	*Callicarpa americana*	0	2	Shrub
CARCOR	*Carphephorus corymbosu*	26	30	Forb
CHAFAS	*Chamaecrista fasciculata*	29	22	Forb
CHRLAT	*Chrysopsis latisquamea*	5	3	Forb
CHRSUB	*Chrysopsis subulata*	3	3	Forb
CNISTI	*Cnidoscolus stimulosus*	27	30	Forb
CONCAN	*Conyza canadensis*	0	2	Forb
CROARG	*Croton argyranthemus*	0	5	Forb
CROCAR	*Crocantheumum carolinia*	3	0	Forb
CROCOR	*Crocantheumum corymbo*	7	2	Forb
CROMIC	*Croton michauxii*	2	3	Forb
CROROT	*Crotalaria rotundifolia*	13	16	Forb
DALPIN	*Dalea pinnata*	21	7	Forb
DIOSVI	*Diospyros virginiana*	1	8	Shrub
ELEELA	*Elephantopus elatus*	0	1	Forb
ERITOM	*Eriogonum tomentosum*	0	1	Forb
EUPCOM	*Eupatorium compositifoliu*	4	13	Forb
GALFLO_MIC	*Galactia floridana/michau*	0	1	Forb
GAYDUM	*Gaylussacia dumosa*	4	0	Shrub
GEOOBL	*Geobalanus oblongifolius*	7	7	Forb
HIEMEG	*Hieracium megacephalon*	5	0	Forb
LESHIR	*Lespedeza hirta*	5	0	Forb
LIATEN	*Liatris tenuifolia*	26	22	Forb
LOBPUB	*Lobelia puberula*	2	0	Forb
LUPDIF	*Lupinus diffusus*	0	1	Forb
OPUHUM	*Opuntia humifusa*	0	5	Forb
PALINT	*Palafoxia integrifolia*	6	1	Forb
PIRCIS	*Piriqueta cistoides*	0	1	Forb
PITGRA	*Pityopsis graminifolia*	62	73	Forb
POLNES	*Polygonum nesomii*	0	16	Forb
POLPIN	*Polygonum pinicola*	17	10	Forb
PTEPYC	*Pterocaulon pycnostachyu*	11	2	Forb

RHEMAR	*Rhexia mariana*	8	6	Forb
RHUCOP	*Rhus copallinum*	4	7	Shrub
RUBCUN	*Rubus cuneifolius*	26	15	Shrub
RUECIL	*Ruellia ciliosa*	2	1	Forb
SCUARE	*Scutellaria arenicola*	8	2	Forb
SCUINT	*Scutellaria integrifolia*	1	1	Forb
SERREP	*Serenoa repens*	77	75	Shrub
SERTOR	*Sericocarpus tortifolius*	34	39	Forb
SMIAUR	*Smilax auriculata*	18	38	Shrub
STISYL	*Stillingia sylvatica*	12	15	Forb
STYBIF	*Stylosanthes biflora*	3	6	Forb
STYPAT	*Stylisma patens*	11	18	Forb
TEPCHR_SPI	*Tephrosia chrysophylla/sp*	47	31	Forb
TEPFLO	*Tephrosia florida*	2	1	Forb
VACARB	*Vaccinium arboreum*	6	0	Shrub
VACMYR	*Vaccinium myrsinites*	39	6	Shrub
YUCFIL	*Yucca filamentosa*	2	1	Shrub

Most frequently observed pollinator genera at Chassahowitzka

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Additional Resources

For more information on the natural history and identification of the insects we found at Chassahowtizka, 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 Chassahowitzka, 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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Credits for photos not taken by Upland Habitat:
Erynnis horiatus: Mary Langlinais, BugGuide*; Palpada vinetorum*: Brett Moyer/BugGuide;
Pyrisitia lisa: Will Cook/CarolinaNature; *Myzinum:* The Bug Lady; *Ogcodocera*: The Diptera Site*;*
Typocerus fulvocinctus: John Lampkin, BugGuide

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