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Authors: Addison, David S., Bartoszek, Ian, Booher, Vanessa, Deyrup, Mark A., Schuman, Melinda, et al.

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Baseline surveys for ants (Hymenoptera: Formicidae) of the western Everglades, Collier County, Florida

David S. Addison[1], Ian Bartoszek[1], Vanessa Booher[1], Mark A. Deyrup[2], Melinda Schuman[1], Jeffrey Schmid[1], and Kathy Worley[1,]*

Abstract

Baseline surveys for ants were conducted in hydrologically disturbed and undisturbed preserves in the western Everglades in Collier County, Florida, by using baited vials and sweep nets. The 50 sampling sites were selected based on 1) major plant communities and 2) whether or not the site was located in an area that is expected to be affected by the hydrologic restoration of Picayune Strand State Forest. Forty-eight species were collected, of which 33 were native and 15 were exotic. The surveys revealed that approximately half of the species identified were associated with specific plant communities. As these surveys were site specific and can be repeated at a later date, shifts in the distribution and frequency of the ant species can be used to assess successional changes in the plant communities resulting from the hydrologic restoration of the Picayune Strand State Forest and adjacent preserves.

Key Words: hydrologic restoration; exotic species; plant communities

Resumen

Se realizaron sondeos de referencia de hormigas de reservas hidrológicamente perturbadas y no perturbadas en el occidente de los Everglades en el Condado de Collier, Florida, mediante el uso de viales cebados y redes entomologicas. Se seleccionaron los 50 sitios de muestreo basado en 1) Las principales comunidades de plantas y 2) si el sitio se encuentra en una zona que se espera que sea afectada por la restauración hidrológica de Bosque Estatal de Picayune Strand. Se recogieron cuarenta y ocho especies; de los cuales 33 son nativas y 15 fueron exóticas. Los sondeos revelaron que aproximadamente la mitad de las especies identificadas se asociaron con las comunidades específicas de plantas. Dado que estos sondeos fueron específicos del sitio y se pueden repetir en una fecha posterior, los cambios en la distribución y frecuencia de las especies de hormigas se puede utilizar para evaluar los cambios de sucesión en las comunidades de plantas resultantes de la restauración hidrológica del Bosque Estatal de Picayune Strand y las reservas adyacentes.

Palabras Clave: restauración hidrológica; especies exoticas; comunidades de plantas

Florida contains the largest known assemblage of ant species of any state in eastern North America (Deyrup 2003). Systematic surveys for ants have been conducted throughout Florida; however, surveys for ants in south Florida have focused on the East Coast. They have been conducted in the Florida Keys (Deyrup et al. 1988; Wetterer & O'Hara 2002; Moreau et al. 2014) and Everglades National Park (Ferster & Prusak 1994; Clouse 1999). There is a lack of corresponding published data on species of ants found on the lower West Coast of Florida. This report presents the results of a series of baseline ant surveys conducted within conservation areas in the region known as the western Everglades. The preserves where these surveys were performed included Picayune Strand State Forest (SG), Collier Seminole State Park (CS), Ten Thousand Islands National Wildlife Refuge (TT), Fakahatchee Strand Preserve State Park (FS), and Florida Panther National Wildlife Refuge (FP) (Fig. 1).

Over half of SG was once part of an enormous (14,974 ha), speculative real estate development known as Southern Golden Gate Estates. The hydrology of SG was significantly altered by construction of 4 drainage canals and an extensive grid of mostly dirt roads that were built between 1963 and 1971 (Ramsey & Addison 1996). The hydrology of CS and TT was also altered by the roads and canals in SG. In 1996, the South Florida Water Management District developed a hydrologic restoration plan for SG and, in 2006, began removing roads and filling canals. The objective of these surveys was to obtain baseline data on existing assemblages of ant species within SG, CS, and TT prior to hydrologic restoration. The hydrology in FP and FS more closely mirrors historic conditions. The ant surveys conducted in those preserves were performed to obtain baseline data on ant assemblages in areas with more natural hydrology. As the collection method used is repeatable, the same sites could be sampled again after restoration is completed. Changes in the distribution and frequency of ant species present in the preserves could be used to assess ecosystem changes resulting from the hydrologic restoration.

Materials and Methods

The sampling sites corresponded to major plant communities identified by Burch et al. (1998) and Barry & Woodmansee (2006) (Table 1). The majority of the sampling sites were located in SG (n = 27). The

[1]Conservancy of Southwest Florida, Naples, Florida 34102, USA; E-mail: davea@conservancy.org (D. A.), ianb@conservancy.org (I. B.), vanessab@conservancy.org (V. B.), melindas@conservancy.org (M. S.), jeffs@conservancy.org (J. S.), kathyw@conservancy.org (K. W.)
[2]Archbold Biological Station, Lake Placid, Florida 33852, USA; E-mail: mdeyrup@archbold-station.org (M. D.)
*Corresponding author; E-mail: kathyw@conservancy.org (K. W.)

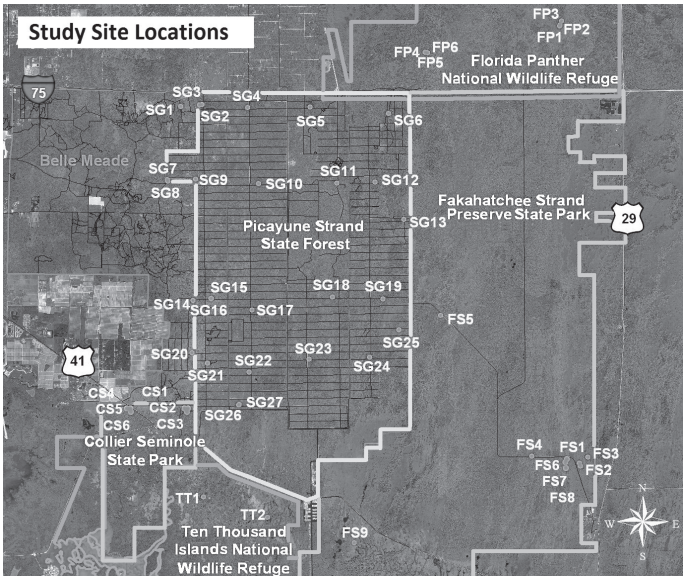

Fig. 1. Sampling sites in western Everglades. CS – Collier Seminole State Park, FP – Florida Panther National Wildlife Refuge, FS – Fakahatchee Strand Preserve State Park, SG – Picayune Strand State Forest (Southern Golden Gate Estates), and TT – Ten Thousand Islands National Wildlife Refuge.

remaining 23 sites were located in FS (n = 9), CS (n = 6), FP (n = 6), and TT (n = 2). The longitude and latitude of each site was recorded with a Magellan Explorist 500 GPS. The locations were then archived at the Conservancy of Southwest Florida. For the purposes of this study, the conservation areas with altered hydrology, SG, CS and TT, were defined as being "hydrologically impacted" (HI). The adjacent less impacted conservation areas, FS and FP, were characterized as being "hydrologically unaltered" (HU).

Ants were collected using sweep nets and baited vials. Sweep netting was conducted in Aug 2005, 2006, 2009, and 2010. An aerial insect net with a 30 cm diameter was used to collect the specimens. For sampling consistency, all the sweep netting was done by the same individual. Starting from a predetermined center point at each sampling site, sweeps were conducted along 5 transects in the north, south, east, west, and southeast directions. Along each 20 m transect, the net was swept through an arc of 180° 20 times. The data were pooled for each sampling event. All the sampling sites were >30 m from roads to avoid sampling terrestrial species living on road shoulders. Ants were field sorted, preserved in 70% ethanol, and returned to the laboratory for identification. Conservancy biologists conducted the initial taxonomic identifications, which were later verified by Mark Deyrup at Archbold Biological Station's Entomology Laboratory.

Ant species were sampled using baited vials during Jan to Feb of 2006 and 2007 and during May to Jun of 2006, 2007, 2009, and 2010. At each site, the sampling array consisted of nine 45 mL plastic snap-cap vials. One vial was placed at an established center-point and 2 vials (1 at 20 m and 1 at 40 m) were set along transects located in the north, south, east, and west cardinal directions. According to the methods of Kaspari et al. (2000), the vials were baited with pieces of pecan sandy cookies, and deployed for approximately 2 h before retrieval. Ants in the vials were preserved with 70% isopropyl alcohol for later sorting and taxonomic identification and verification. The long hydroperiods at the saltwater marshes precluded terrestrial sampling at these sites.

Frequency of occurrence for individual species and species richness were tabulated by plant community code and whether the sampling site was classified as HI or HU. Frequency of occurrence by species (x) was defined as $x \approx n_x / n_t * 100$, where n_x is the number of times an individual species occurred in a given habitat and a given hydrological classification and n_t is the number of times sampled within a given habitat and hydrological classification. All data collected from sweeps and baited vials were combined separately.

Results

Forty-eight species of ants representing 22 genera were collected from combined sampling sites (Table 2). Nineteen species nest in trees, herbaceous plant stems, or other above-ground vegetation, hereafter called plant-nesting species. Twenty-five were ground-nesting species. This includes species that nest underground as well as those that nest on or in material on the ground. Four more species were identified as being capable of nesting either on the ground or in plants.

Three plant-nesting and 2 ground-nesting species were found in all or all but 1 of the plant communities surveyed (Table 2). *Pseudomyrmex ejectus* F. Smith, a native arboreal species, was present in all plant communities surveyed within the conservation areas. This ubiquitous native species is widely distributed throughout Florida. *Crematogaster atkinsoni* Wheeler, a native plant-nesting ant, was found in all plant communities with the exception of hardwood hammocks. *Pseudomyrmex gracilis* (Santschi), the elongate twig ant, was found in all plant communities with the exception of saltwater marshes. This is an exotic plant-nesting species that inhabits a wide range of vegetative associations from mangroves to hammocks. *Camponotus floridanus* (Buckley), the Florida carpenter ant, was found in all surveyed plant communities with the exception of saltwater marshes. *Solenopsis invicta* Buren, the red imported fire ant, an aggressive invasive exotic species, was found in all plant communities with the exception of saltwater marshes.

Species richness at HU sites was highest in hydric pine flatwoods, followed by cypress and graminoid (grasses & sedges) plant communities, whereas saltwater marshes had the lowest richness (Table 2). Thirteen out of 32 species collected at the HU sites are considered to be plant-nesting. Species richness at HI sites was highest within mesic pine flatwoods, followed by cypress, cypress with graminoid, and graminoid-only plant communities, whereas freshwater marshes had the lowest richness. Nineteen out of 47 species collected at HI sites were considered to be plant-nesting. The greater number of species recorded in the SG may be a function of the man-made hydrological disturbance that occurred there as opposed to more natural conditions in HU sites, summarized below. Additionally, 4 species, 1 of which was collected in HI sites and 3 of which were collected in both HU and HI sites, were considered to be both plant- and ground-nesting.

Frequency of occurrence is tabulated in Table 2. *Solenopsis invicta* was the most frequently collected species at approximately 40% of the individual HU sites. Interestingly, *S. invicta* was absent at FP1-Cg, FS4-C, and FS9-Ms and was found once at HU site FS6-Cg. At these sites, either the native species *Pheidole dentata* Mayr or *C. atkinsoni* was collected with the highest frequency or another exotic species, *Pheidole moerens* Wheeler, dominated. The native species *P. dentata* and *Pheidole floridana* Emery accounted for the highest occurrence at the HU sites FP1-Cg, FP6-Ph, FS3-Ph, and FS8-Ph. *Solenopsis invicta* occurred in higher frequencies (>50%) within graminoid and hydric pine flatwood communities and at lower frequencies (<25%) in cypress habitats in the HU sites.

Frequency in HI sites are given in Table 2. *Solenopsis invicta* had the highest frequency of occurrence within approximately 51% of the HI sites but was not collected at HI sites TT1-Ms, CS6-C, and SG26-C. It was documented once at sites TT2-Ms, SG4-Pm, and SG12-C. At these sites *C. atkinsoni, P. dentata, Dorymyrmex bureni* (Trager), and *Forelius pruinosus* (Roger) were collected with the highest frequency.

Table 1. Vegetative community descriptions along with sampling locations categorized by hydrologically unaltered vs. hydrologically impacted. CS – Collier Seminole State Park, FP – Florida Panther National Wildlife Refuge, FS – Fakahatchee Strand Preserve State Park, SG – Picayune Strand State Forest (Southern Golden Gate Estates), and TT – Ten Thousand Islands National Wildlife Refuge. NA – not applicable.

Vegetative community	Major community type	Hydrologically unaltered	Hydrologically impacted
Cypress slough (C)	Forested community dominated by *Taxodium distichum*. Occasional hardwoods (*Acer rubrum*, *Fraxinus caroliniana*, *Annona glabra*) form <30% of the canopy. Sparse groundcover often emergent in standing water. Epiphytic bromeliads and orchids present. Understory commonly has ferns.	FP4, FS4	CS2, CS6, SG10, SG12, SG15, SG19, SG24, SG26
Cypress with graminoid (Cg)	Moderately dense forest to open scrubby "dwarf cypress"	FP1, FS1, FS6	SG1, SG14, SG17, SG20, SG23
Wet prairie (G)	Open prairie landscape dominated by graminoids and occasional herbs. Occasional *Pinus elliottii* and *Taxodium distichum* form <30% of the canopy.	FP2, FP5, FS2, FS5, FS7	CS3, CS5, SG3, SG7, SG11, SG13, SG22, SG25, SG27
Hydric hammocks (Hh)	Forested community dominated by hardwoods (*Acer rubrum*, *Sabal palmetto*, *Quercus laurifolia*). *Taxodium distichum* occurs, but uncommon. Sparse to moderate understory containing small hardwoods (*Rapanea punctata*, *Ilex cassine*). Epiphytes common. Groundcover variable. Ferns dominant.	NA	SG16
Mesic hammocks (Hm)	Forested communities dominated by *Quercus virginiana* and *Sabal palmetto*. Moderate to dense understory containing small hardwoods (*Myrsine floridana*, *Psychotria nervosa*, *Randia aculeata*, *Serenoa repens*). Sparse groundcover. Epiphytes and ferns common.	NA	SG2, SG18
Freshwater marshes (Mf)	Community with prolonged freshwater hydroperiod. Emergent graminoids or herbs commonly associated with wetlands, dominate (often obligate wetland species).	NA	SG5-Mf
Saltwater marshes (Ms)	Tidal communities with prolonged hydroperiods. Dominated by graminoids (*Spartina bakeri* and *Eleocharis cellulosa*). Mangroves occur but are not common.	FS9	TT1, TT2
Hydric pine flatwoods (Ph)	Woodland community, open canopy dominated by *Pinus elliottii* and *Taxodium distichum*. Understory is open, with dense groundcover dominated by graminoids.	FP3, FP6 FS3, FS8	CS1, SG21
Mesic pine flatwoods (Pm)	Woodland community, open canopy dominated by *Pinus elliottii*. Understory dominated by *Serenoa repens* and sparse groundcover. Woodland community, open canopy dominated by *Pinus elliottii*. Understory dominated by *Serenoa repens* and sparse groundcover.	NA	CS4, SG4, SG6, SG8, SG9

Table 2. Frequency of occurrence for ant species collected in the western Everglades, categorized by habitat and hydrologic condition (HI = hydrologically impacted, or HU = hydrologically unaltered). * = exotic species; ( ) = number of sites; [ ] = nesting preference; S.R. = species richness.

	Cypress		Cypress with graminoid		Wet prairie		Hydric hammock	Mesic hammock	Freshwater marsh	Saltwater marsh		Hydric pine flatwood		Mesic pine flatwood
	HU	HI	HU	HI	HU	HI	HI	HI	HI	HU	HI	HU	HI	HI
Species	(2)	(8)	(3)	(5)	(5)	(9)	(1)	(2)	(1)	(1)	(2)	(4)	(2)	(5)
Aphaenogaster miamiana Wheeler [ground]	0	20.6	0	14	0	3.8	10	35	0	0	0	20.6	0	9.1
*Brachymyrmex obscurior*_cf [ground]	0	0	0	2	2.3	0	10	0	0	0	0	0	0	0
Camponotus decipiens Emery [arboreal]	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Camponotus floridanus (Buckley) [ground]	31.6	16.2	8.3	20	2.3	14.1	20	35	20	0	12.5	17.6	14.3	25
Camponotus impressus (Roger) [arboreal]	0	0	4.2	2	0	0	0	0	0	0	25	0	0	0
Camponotus inaequalis Roger [ground]	0	0	0	0	0	0	0	0	0	0	0	0	0	2.3
*Camponotus planatus** Roger [arboreal]	5.3	0	0	0	0	1.3	0	25	0	0	0	0	0	6.8
*Cardiocondyla emeryi** Forel [ground]	0	0	0	2	0	1.3	0	5	0	0	0	2.9	0	9.1
*Cardiocondyla nuda** (Mayr) [ground]	0	0	0	2	0	2.6	0	0	0	0	0	0	0	2.3
*Cardiocondyla obscurior** Wheeler [arboreal]	0	0	0	2	0	0	0	0	0	0	0	0	0	0
*Cardiocondyla wroughtonii** (Forel) [ground]	0	2.9	0	0	0	0	0	5	0	0	0	0	0	0
Crematogaster ashmeadi Mayr [arboreal]	5.3	26.5	20.8	24	4.5	15.4	0	20	0	25	0	2.9	0	2.3
Crematogaster atkinsoni Wheeler [arboreal]	15.8	20.6	12.5	20	50	26.9	0	20	50	100	100	41.2	7.1	25
Crematogaster pilosa Emery [arboreal]	0	1.5	0	2	0	0	0	0	0	0	0	0	7.1	0
Crematogaster pinicola Deyrup & Cover [arboreal]	0	0	0	0	0	0	0	0	0	0	0	0	0	2.3
Cyphomyrmex minutus Mayr [ground]	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Dolichoderus pustulatus Mayr [arboreal]	0	0	12.5	0	11.4	1.3	0	0	10	0	0	2.9	0	0
Dorymyrmex bureni (Trager) [ground]	0	2.9	0	14	4.5	11.5	0	5	0	0	0	2.9	0	43.2
Forelius pruinosus (Roger) [ground]	5.3	1.5	4.2	24	6.8	17.9	0	0	0	0	50	35.3	50	68.2
Formica archboldi M.R. Smith [ground]	0	0	0	0	0	0	0	0	0	0	0	2.9	0	6.8
Hypoponera opaciceps (Mayr) [ground]	0	1.5	0	0	0	0	0	0	0	0	0	2.9	0	0
*Monomorium floricola** (Jerdon) [arboreal]	5.3	1.5	4.2	0	0	2.6	10	0	0	0	12.5	14.7	0	13.6
Monomorium viride Brown [ground]	0	0	0	0	0	0	0	0	0	0	0	0	7.1	2.3
*Nylanderia bourbonica** (Forel) [ground]	0	10.3	0	10	0	2.6	30	5	0	0	0	0	0	2.3
Nylanderia concinna (Trager) [ground]	26.3	8.8	29.2	12	11.4	1.3	10	0	0	0	0	26.5	7.1	2.3
*Nylanderia steinheili** (Forel) [ground]	26.3	22.1	0	16	2.3	0	30	45	0	0	0	5.9	0	4.5
Nylanderia wojciki (Trager) [ground]	0	0	0	0	0	1.3	0	0	0	0	0	0	0	0
Odontomachus brunneus (Patton) [ground]	47.4	2.9	4.2	0	2.3	2.6	10	5	0	0	0	2.9	7.1	6.8
*Odontomachus ruginodis** M.R. Smith [ground]	0	2.9	0	0	0	0	0	0	0	0	0	0	0	0
*Paratrechina longicornis** (Latreille) [both]	0	0	0	2	0	0	0	0	0	0	0	0	0	4.5
Pheidole dentata Mayr [ground]	10.5	44.1	37.5	12	4.5	14.1	50	60	10	0	0	47.1	21.4	22.7
Pheidole floridana Emery [ground]	31.6	29.4	25	12	2.3	6.4	60	25	0	0	0	32.4	0	25
*Pheidole moerens** Wheeler [both]	68.4	50	50	42	18.2	11.5	50	55	40	0	0	26.5	21.4	18.2
Platythyrea punctata (F. Smith) [both]	5.3	1.5	0	0	0	0	0	0	0	0	0	0	0	0
Pseudomyrmex ejectus (F. Smith) [arboreal]	26.3	23.5	20.8	28	4.5	10.3	40	15	30	25	12.5	17.6	7.1	6.8
Pseudomyrmex elongates (Mayr) [arboreal]	0	2.9	0	0	0	0	0	0	0	0	0	2.9	0	2.3
*Pseudomyrmex gracilis** (Santschi) [arboreal]	10.5	29.4	25	30	2.3	16.7	20	30	30	0	12.5	23.5	7.1	20.5
Pseudomyrmex pallidus (F. Smith) [arboreal]	10.5	8.8	0	16	4.5	16.7	0	0	10	0	87.5	11.8	21.4	20.5
Pseudomyrmex seminole Ward [arboreal]	5.3	1.5	4.2	12	6.8	7.7	0	0	20	0	25	2.9	7.1	2.3
Pseudomyrmex simplex (F. Smith) [arboreal]	10.5	1.5	0	4	0	1.3	0	0	0	0	12.5	0	0	2.3

Table 2. (Continued) Frequency of occurrence for ant species collected in the western Everglades, categorized by habitat and hydrologic condition (HI = hydrologically impacted, or HU = hydrologically unaltered). * = exotic species; ( ) = number of sites; [ ] = nesting preference; S.R. = species richness.

	Cypress		Cypress with graminoid		Wet prairie		Hydric hammock	Mesic hammock	Freshwater marsh	Saltwater marsh		Hydric pine flatwood		Mesic pine flatwood
	HU	HI	HU	HI	HU	HI	HI	HI	HI	HU	HI	HU	HI	HI
Species	(2)	(8)	(3)	(5)	(5)	(9)	(1)	(2)	(1)	(1)	(2)	(4)	(2)	(5)
Solenopsis geminata (Fabricius) [ground]	0	0	0	0	2.3	0	0	0	0	0	0	0	0	0
Solenopsis globularia (Smith) [ground]	0	0	0	0	0	3.8	0	0	0	0	0	0	0	0
*Solenopsis invicta** Buren [ground]	21.1	26.5	41.7	74	72.7	66.7	30	55	90	0	12.5	61.8	85.7	43.2
Solenopsis picta Emery [arboreal]	0	0	0	2	0	0	0	0	0	0	0	0	0	0
*Tapinoma melanocephalum** (Fabricius) [arboreal]	5.3	2.9	4.2	4	0	0	10	5	0	0	12.5	2.9	7.1	0
Tapinoma sessile (Say) [ground]	0	2.9	0	4	9.1	5.1	0	0	0	25	50	2.9	0	4.5
*Wasmannia auropunctata** (Roger) [both]	15.8	0	0	0	0	1.3	0	0	0	0	0	0	0	0
Xenomyrmex floridanus Emery [arboreal]	0	0	0	0	0	0	0	0	0	0	0	0	0	2.3
S.R.	21	28	17	28	20	27	15	20	10	4	13	25	15	31

Pheidole moerens, an exotic species, had the highest frequency of occurrence at HI sites SG15-C, SG19-C, and SG26-C, and *Crematogaster ashmeadi* Mayr, a native arboreal species, had the highest occurrences at SG26-C and SG24-C. Other native species that occurred most often were *Aphaenogaster miamiana* Wheeler at SG18-Hm; *F. pruinosus* at SG7-G, SG8-Pm, and SG9-Pm; and *D. bureni* at SG4-Pm; *P. dentata* was collected most frequently at sites CS4-Pm, CS6-C, SG2-Hm, and SG12-C; as was *P. floridana* at sites CS5-G and SG16-Mf; *C. atkinsoni* occurred frequently at sites TT1-Ms, TT2-Ms, SG24-C, SG26-C, and CS5-G. *Solenopsis invicta* occurred at higher frequencies (>50%) within graminoid, cypress with graminoid, freshwater marsh, and pine hardwood communities. This species occurred less often (<25%) in saltwater marsh habitat in the HI sites.

Sites where ground-nesting ants were most frequently collected had a high occurrence of *S. invicta*, or, if fewer *S. invicta* were present, *Pheidole* spp. were more commonly found. In contrast, HU sites where plant-nesting ants were more frequently encountered had higher occurrences of *C. atkinsoni* in graminoid, saltwater marsh, and hydric pine flatwoods. *Camponotus floridanus* and/or *Pseudomyrmex* spp. were also commonly found within cypress and cypress with graminoid communities in HU sites. In HI sites where plant-nesting ants were more frequently collected *C. ashmeadi* and/or *Pseudomyrmex* spp. were most commonly found within the cypress and hardwood hammock communities. *Crematogaster atkinsoni* was most often present in graminoid, marsh, and pine flatwood communities whereas some HI sites in the SG harbored *C. atkinsoni* as a common plant-nesting component. The most frequently collected plant-nesting ants were *Pseudomyrmex* spp.

Discussion

Distribution of ant species in any given plant community is typically a function of habitat suitability, behavioral traits, and competitive interactions among species (Rosengren 1986; Hölldobler & Wilson 1990). Ants have proven to be good indicator taxa because many species have narrow tolerances and often respond quickly to environmental changes (Kaspari & Majer 2000). Terrestrial macroinvertebrate surveys in Picayune Strand State Forest indicated that approximately half of the ant species sampled was associated with specific plant communities (Addison et al. 2006; Bartoszek et al. 2007, 2011). Of the 48 species of ants documented during this study, certain taxa were clearly more abundant than others; future changes in abundance will help indicate ecological responses to hydrologic change. These abundant species are likely to be better indicators of hydrologic change than those that were collected only occasionally.

The availability of nest sites for individual species is likely to change post-restoration. If hydrologic restoration results in the expected higher water tables and longer hydroperiods, nests of ground-nesting species would likely be inundated. Species tolerant of wet conditions could immigrate into previously over-drained wetlands. If their sources of forage are impacted, plant-nesting species may be affected by higher water levels that change plant communities.

Hydrologic restoration of PSSF is expected to result in successional changes in the plant community structure that should be reflected in changes in ant distributions. Ant surveys in PSSF revealed that approximately half of the ant species had affinities to specific plant communities.

The 48 species of ants collected during these surveys are a representative example of the ants occurring in Collier County, Florida. Time and funding prevented us from using additional collection methods. The use of aspiration, pit-fall traps, and soil sampling and utilizing

different baits in the vials likely would have documented additional species. Two studies within Everglades National Park done by Clouse (1999) and Ferster & Prusak (1994) found 77 species, 28 of which were exotics, compared with this study that identified 48 species, 15 of which were exotics. Eleven species were identified in Collier County that were not identified in these previous studies.

The reasons for differences in species composition of ants found in the HI and HU sites are not clear. Neither are differences in ant species composition between and among the plant communities sampled; the causes of these differences are beyond the scope of this survey. It is likely that a reduction in abundance of terrestrial species such as *S. invicta* and *P. dentata* will occur after hydrologic restoration of PSSF if this leads to long-seasonal inundation. Plant-nesting species such as *C. atkinsoni*, *Pseudomyrmex pallidus* (F. Smith), *Pseudomyrmex seminole* Ward, and *P. ejectus* might increase in abundance in the restored freshwater wetlands if this leads to an increase in the density of perennial vegetation in the form of trees, shrubs, and large bunch grasses. After the expected ecosystem shifts stabilize in the restoration areas, it would be useful to repeat these surveys to assess any changes in the distribution of the ant species at the sampling sites.

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References Cited

Addison D, Barry M, Bartoszek I, Ceilley D, Schmid J, Schuman M. 2006. Pre-restoration wildlife surveys in the Southern Golden Gate Estates (2001–2004). Final Report for South Florida Water Management District, Florida.

Barry MJ, Woodmansee SW. 2006. Vegetation sampling at Picayune Strand State Forest: Task 2c, PSRA vegetation monitoring 2005–2006. December 18, 2006. Final report submitted to the South Florida Water Management District, Fort Myers, Florida, by The Institute for Regional Conservation.

Bartoszek IA, Schuman MJ, Addison DS, Worley KB, Schmid JR. 2007. Biological monitoring of aquatic and terrestrial fauna for the Picayune Strand Restoration Project (2005–2007). Final Report for South Florida Water Management District, Conservancy of Southwest Florida, Naples, Florida.

Bartoszek IA, Schuman MJ, Worley KB, Schmid JR, Addison DS, Shindle DB, Green VJ. 2011. Western Everglades restoration: biological monitoring and evaluation for the Picayune Strand Restoration Project (2009–2011). Final Report for Florida Department of Environmental Protection. Conservancy of Southwest Florida, Naples, Florida.

Burch JN, Yamataki H, Hendricks G. 1998. Inventory and analysis of biological communities in Southern Golden Gate Estates, a watershed for the Ten Thousand Islands [online]. http://images.library.wisc.edu/EcoNatRes/EFacs/Wetlands/Wetlands26/reference/econatres.wetlands26.jburch.pdf (last accessed 31 Aug 2015).

Clouse R. 1999. Leaf-litter inhabitants of a Brazilian pepper stand in Everglades National Park. Florida Entomologist 82: 303–403.

Deyrup M. 2003. An updated list of Florida ants (Hymenoptera: Formicidae). Florida Entomologist 86: 43–48.

Deyrup M, Trager J, Carlin N, Umphrey G. 1988. A review of the ants of the Florida Keys. Florida Entomologist 71: 163–176.

Ferster B, Prusak Z. 1994. A preliminary checklist of the ants (Hymenoptera: Formicidae) of Everglades National Park. Florida Entomologist 77: 508–512.

Hölldobler B, Wilson EO. 1990. The Ants. Belknap Press of Harvard University Press, Cambridge, Massachusetts.

Kaspari M, Majer JD. 2000. Using ants to monitor environmental change, pp. 89–98 *In* Agosti D, Majer JD, Alonso LE, Schultz TR [eds.], Ants: Standard Methods for Measuring and Monitoring Biodiversity. Smithsonian Institution Press, Washington, District of Columbia.

Kaspari M, O'Donnell S, Kercher JR. 2000. Energy, density, and constraints to species richness: ant assemblages along a productivity gradient. The American Naturalist 155: 280–293.

Moreau CS, Deyrup MA, Davis Jr LR. 2014. Ants of the Florida Keys: species accounts, biogeography, and conservation (Hymenoptera: Formicidae). Journal of Insect Science 14: 1–8.

Ramsey C, Addison D. 1996. Multiparcel land acquisition project in the western Big Cypress Region of Florida. Natural Areas Journal 16: 36–40.

Rosengren R. 1986. Competition and coexistence in an insular ant community—a manipulation experiment (Hymenoptera: Formicidae). Annales Zoologici Fennici 23: 297–302.

Wetterer JK, O'Hara BC. 2002. Ants (Hymenoptera: Formicidae) of the Dry Tortugas, the outermost Florida Keys. Florida Entomologist 85: 303–307.