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Bees (Hymenoptera: Apoidea) of the Kitty Todd Preserve, Lucas County, Ohio

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Abstract

A survey of the bees occurring on the The Nature Conservancy's Kitty Todd Preserve in the Oak Openings region of Lucas County Ohio was conducted in 2002-2004, using hand-netting techniques. Collecting effort totaled 24.5 hours spread over 11 different days in the three years. All sampling was done in natural communities. One hundred twenty-four species of bees were identified from fifty-one species of flowering plants, including several bee species poorly known or infrequently collected. Comments are provided about the faunistics, bee-plant relationships, oligolecty, management, and natural community dependency of the bees found on the Kitty Todd Preserve.

Established on the deep sands and clays deposited by post-glacial Lake Warren, the Oak Openings in northwest Ohio has long been recognized as a unique biological region (Moseley 1928, The Nature Conservancy 2000, Grigore 2004). Early European settlers encountered a mosaic of natural communities here, including oak savanna, oak woodland, oak barrens, floodplain forests and wet prairie, maintained by a shallow water table, drought and fire (Moseley 1928, Abella et. al. 2001, Brewer and Vankat 2004). Today, five globally rare plant communities are recognized in the Oak Openings, supporting more state-listed species than any other area in Ohio, clearly signifying the region's biological richness as well as its sensitivity to fragmentation and urbanization (Abella et.al. 2001, Grigore 2004). Nearly 10% (slightly more than 9,000 acres) of the 130 square mile Oak Openings is currently protected and managed by various agencies (Ohio Department of Natural Resources, Metroparks of the Toledo Area, The Nature Conservancy of Ohio) and additions to the public land base are continuing through the Metroparks of the Toledo Area land acquisition program (Abella et. al. 2007).

Much of the Oak Openings' biodiversity is well-documented (Abella et.al. 2001), but its insect fauna has yet to be thoroughly inventoried. Several state and federally-listed butterflies are known from the area (Shuey et. al. 1987, Iftner et. al. 1992, Grigore 2004), as well as a number of other rare or natural community-dependent species including several moths (Rings et.al. 1992, Metzler 1999), a cricket and a grasshopper (Ballard, Jr. 1991), at least one wasp (Kurczewski 1998), a histerid beetle (David Horn, pers. comm.) and several ants (Coovert 2005). Some bee collections have been made in association with pollination studies of *Lupinus perennis* L. (Randy Mitchell, pers. comm.), but Oak Openings bee diversity has never been surveyed in any detail. In fact, little is known about Ohio bee diversity in general. Mitchell (1960, 1962) recorded only 190 species from the state, and there have been no subsequent published surveys of Ohio bees. Bees are a critical group in the Oak Openings (and elsewhere) because of their primacy as pollinators of many flowering plants. For example, plant species obligately or predominantly bee-pollinated in the Oak Openings include those hosting rare, threatened or endangered insects, e.g., *L. perennis*, sole larval host for three listed butterfly species, the Karner

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Blue (*Lycaeides melissa samuelis* Nabokov; Lepidoptera: Lycaenidae), Frosted Elfin (*Callophrys irus* (Godart); Lepidoptera: Lycaenidae), and Persius Dusky Wing (*Erynnis persius persius* (Scudder); Lepidoptera: Hesperidae), plant species that are state-listed (e.g., *Rhexia virginica* L., *Agalinis skinneriana* Wood, *Epilobium angustifolium* (L.)), and more common species that provide food for various species of wildlife, like blackberries, blueberries and cherries.

An inventory of the bees of the Oak Openings was begun by the author in the 1990s to establish a baseline of bee diversity in the region, to assess the importance of natural communities to bee diversity, and to identify plant species that contribute to regional bee diversity. In 2002-2004 most collecting effort was concentrated on one of the largest and most diverse remnants of the Oak Openings, the Kitty Todd Preserve, owned and managed by The Ohio Chapter of The Nature Conservancy.

Study site

Kitty Todd Preserve is located in Lucas County, Ohio, near the Toledo Express Airport, at the southern edge of the Great Lakes ecoregion (The Nature Conservancy 2000; see location map online at: http://oakopen.org/maps/). The Kitty Todd Preserve encompasses approximately 700 acres of Oak Openings plant communities, including black oak/lupine barren, Midwest sand barren, mesic sand tallgrass prairie, twig rush wet prairie, oak/blueberry forest, and Great Lakes pin oak-swamp white oak wetland, and the edges and ecotones associated with these communities (Gardner and Haase 2004). Most of these communities are managed with prescribed fire, mowing, cutting and herbicide treatments, and are in various stages of restoration and recovery (Gary Haase, pers. comm.). Exotic plant species are infrequent, and limited to peripheral areas, usually adjacent to roads.

The Kitty Todd Preserve is surrounded by an altered and fragmented landscape including houses and lawns, row crop fields, pastures, old fields, business parks, small degraded Oak Openings remnants, the Toledo Airport, and other developments. Asphalt roads border and transect the Kitty Todd Preserve, dividing it into several sections. The majority of the bee survey effort was concentrated within the section bordered by Old State Line Road on the south, Irwin Road on the east, Schwamberger Road on the west and Angola Road on the north. This area (approximately 80 acres) was referred to as the HQ (Headquarters) unit. Plant communities within the HQ unit include black oak/lupine barren, Midwest sand barren, and mesic sand tallgrass prairie (Gardner and Haase 2004). Other parts of the Kitty Todd Preserve sampled less intensively included the 130 acre Patton unit (a wetland just to the west of the HQ unit), which included twig rush wet prairie and Great Lakes pin oak-swamp white oak wetland, and the 20 acre Moseley Barrens unit (a Midwest sand barren). See Gardner and Haase (2004) for a detailed description of the plant communities.

Methods

A Kitty Todd Preserve plant list (The Nature Conservancy, available online at http://www.nature.org/wherewework/northamerica/states/ohio/preserves/art162.html) was the primary planning tool for the survey. The list was examined for “bee plants”, i.e., plant species known to attract bees, and then separated into plant species known or expected to host oligolectic bees (species known to collect pollen only from a restricted set of plants, usually at the genus or family level), and polylectic bees (species that visit a wider variety of unrelated plants for pollen). From this list was generated an “expected” bee species list; i.e., a list of species expected to be found, given the presence of particular plant species, the geographic location of the Kitty Todd Preserve, and published and unpublished records of bees from eastern North America (see section on Faunistics for references). The Kitty Todd Preserve manager Gary Haase generously shared his extensive knowledge of flowering phenologies and locations throughout the study, allowing more time for bee collecting rather than plant searching. Plants were identified in the field by the author, in a few cases only to genus level. A few similar-appearing *Solidago* and *Aster* species (*Aster pilosus* Willd. and *A. lateriflorus* (L.) Britt., and *Solidago canadensis* L. and *S. gigantea* Aiton), were lumped as "pairs" of species and are so designated in Table 1. Plant nomenclature follows Voss (1985, 1996); author names of plant species are provided in Table 1. Ecoregion units and nomenclature are taken from The Nature Conservancy (2006).

Sampling methods consisted of watching and collecting bees at blooming plants for various periods of time (usually 10-20 minutes), moving on to a different plant species, and so on (see Evans 1986). The goal was to sample as many different bee-visited plant species as time allowed. Roughly similar periods of time were spent observing and collecting bees at most plant species. Only a few plant species were sampled in more than one year. Some nesting areas were located and monitored for parasitic bee species, and patrolling points were watched (many male bees mark and patrol non-flowering plants and other objects). Malaise traps, pan traps and other passive sampling techniques were not used because of the possibility of collecting the federally-protected Karner Blue butterfly and other state-listed butterflies. Sampling dates were chosen to coincide with clear, sunny, warm weather (i.e, "bee days").

Bees were collected with a hand net and killed in a jar with ethyl acetate fumes. A separate jar was used for each plant species (or other object) bees were collected from. Management unit, date and time were also included. Jars and specimens were processed locally into separate paper packets with data attached, and stored in chlorocresol humidors. Specimens were prepared (mouthparts pulled, mandibles spread, genitalia extruded) and pinned under a dissecting scope, and labeled with state, county, study site, unit (see above), date, flower or other object collected at or on, and collector. All specimens were collected, prepared, labeled and identified by the author. Nomenclature follows Giles and Ascher (2006), Michener (2000), and Gibbs (2010). Family and authority names for bee species are provided in Table 2.

Representative specimens have been deposited in the Ohio State University collection, the American Museum of Natural History, and the author's collection. Remaining material will be placed in the American Museum of Natural History collection.

Results

A total of 24.5 hours were spent collecting on the Kitty Todd Preserve in 2002-2004 on a variety of dates between 10 May and 21 September each year (Table 3). A total of 124 species of bees (in six families and 29 genera) were identified during that time (Table 2). Four hundred eighty-six specimens representing 116 species were collected from 51 different species of plants (in 42 genera and 21 families; Table 1); five additional bee species were collected from nest areas and patrolling points, and three others were field-identified but not vouchered. Fifty-five species (44%) were represented by only one or two specimens. Four introduced (exotic) species were among those collected or recognized in the field. Of the native species, 67 (56%) were polyleges (this includes eusocial taxa), 28 (23%) were oligoleges, and 24 (20%) were cleptoparasites, according to published sources (but see Bee-plant associations section). Most species were characteristic of the Great Lakes ecoregion (at least its southern portion) as well as other ecoregions in the midwestern US, but 23 species appear to be at or near the edge of their ranges in the Oak Openings (see Faunistics section). Plant species from which the greatest number of bee species were collected include *Rubus flagellaris* (30 species), *Baptisia tinctoria* (17 species), *Rubus allegheniensis*, *Asclepias tuberosa* and *L. perennis* (15 species each, Table 1).

Table 1. Plant species (flowers) from which bees were collected at Kitty Todd Preserve, 2002-2004. f= females; m=males; w=workers; x= introduced (non-native) plant sp.

Plant species	No. bee species collected; numbers in brackets refer to Table 2
Rubus flagellaris Willd.	30 [5m, 7m, 8m, 15f, 23f, 28f, 32f, 34f, 36f, 38f, 40f, 45f, 46f, 49f, 55f, 65m, 66f, 68f, 71m, 72f, 82m, 86m, 87f, 88m, 90m, 97f, 100f, 101f, 119f, 122w]
Baptisia tinctoria (L.) R.Br.	17 [46f, 64f, 73f, 75m, 78f, 79f, 82f, 83fm, 84f, 88fm, 90m, 92f, 93fm, 106m, 120w,121w, 122w]
Rubus allegheniensis Porter	15 [17f, 22f, 23f, 24f, 28f, 38f, 49f, 55f, 59f, 66f, 68f, 70f, 72f, 97f, 103m]
Asclepias tuberosa L.	15 [34f, 37m, 49fm, 52f, 78fm, 79f, 83m, 88m, 89m, 92fm, 93m, 102m, 105f, 106fm, 121w]
Lupinus perennis L.	15 [3f, 32f, 46f, 49f, 58f, 60f, 63f, 66f, 67f, 68f, 70f, 72f, 84f, 96m,118w]
Ceanothus americanus L.	13 [7m, 35f, 38f, 46f, 48f, 49f, 53f, 54m, 61m, 62f, 82f, 93m, 122w]
x *Melilotus alba* (Desr.)	12 [5m, 6m, 7fm, 8m, 46fm, 79f, 82m, 84f, 89m, 91fm, 118m, 122w]
Aronia prunifolia (Marsh.) Rehder	12 [7m, 11m, 17fm, 18f, 22m, 34f, 39f, 43f, 46f, 50f, 66f, 95m]
Aster pilosus/lateriflorus	11 [1f, 2m, 12f, 32m, 35m, 47m 55m, 95m, 107m, 108m, 117f]
Aster novae-angliae L.	9 [2m, 12f, 32f, 38f, 51m, 85f, 88m, 117f, 122w]
Aster praealtus Poiret	9 [12m, 25f, 30f, 32f, 33m, 40m, 57m, 95m, 117f]
Coreopsis tripteris L.	9 [9fm, 10fm, 31f, 45f, 88fm, 94m, 109m, 114m, 116m]
Penstemon digitalis Sims	9 [34f, 48f, 50f, 63f, 66f, 68f, 74fm, 98f, 118w]
Solidago canadensis/gigantea	8 [1f, 4f, 12f, 14f, 21f, 25f, 119m, 120m]
Vernonia sp.	8 [46f, 74m, 86f, 88fm, 94m, 111f, 112fm, 120m]
x *Alliaria petiolata* (Bieb.) C. and G.	7 [18f, 41f, 43f, 45f, 60f, 95m, 97m]
Prunus virginiana L.	7 [3f, 11m, 13f, 17m, 24f, 28f, 44f]
Potentilla simplex Michaux	6 [5m ,46f, 60f, 63f, 96m, 97f]
Spiraea alba Duroi	6 [7m, 8m, 34f, 57f, 75m, 89m]
Vaccinium angustifolium Aiton	6 [7m, 16f, 40f, 66f, 84m, 90m]
Solidago nemoralis Aiton	6 [14fm, 27fm, 30f, 55m, 81f, 82f]
Liatris aspera Michaux	6 [88m, 111f, 119m, 121w, 122w, 123w]
Solidago rugosa Miller	5 [7f, 52f, 82f, 86f, 110m]
Rudbeckia hirta L.	5 [45f, 77m, 89m, 110m, 115f]
Senecio aureus L.	5 [34f, 35f, 69f, 97f, 99m]
Gaylusaccia baccata (Wangenh.) K.Koch	4 [16f, 23f, 40f, 95m]
Aletris farinosa L.	4 [63f, 64f, 66f, 79m]
Lysimachia lanceolata Walter	4 [34f, 41f, 46f, 61f]

Table 1. Continued.

Plant species	**No. bee species collected; numbers in brackets refer to Table 2**
Lythrum alatum Pursh	4 [50f, 63f, 64f, 66f]
x *Lonicera morrowi* A.Gray	4 [67f, 95m, 96m, 97m]
Geranium maculatum L.	4 [18f, 40f, 50f,97m]
Monarda punctata L.	3 [86m, 89f, 95m]
x *Vicia villosa* Roth	3 [29f, 40f, 88m]
Helianthus divaricatus L	4 [9f,10f, 81m, 88m]
Cornus stolonifera Michaux	3 [18f, 26m, 48f]
Agalinis tenuifolia (Vahl) Raf.	2 [33f, 80f]
Aster laevis L.	2 [46m,117f]
Cicuta maculata L.	2 [7fm, 8m]
Krigia biflora (Walter) S.F.Blake	2 [38f, 46f]
Liatris spicata Willd.	2 [33m, 89m]
Lobelia spicata Lam.	2 [64f, 97f]
Monarda fistulosa L.	2 [49f, 84f]
Salix petiolaris J.E.Smith	2 [9f, 20f]
Sisyrinchium sp.	2 [7f, 50f]
Euthamia graminifolia (L.) Nutt.	1 [36f]
Fragaria virginiana Miller	1 [66f]
Lysimachia quadrifolia Sims	1 [61f]
Pedicularis lanceolata Michaux	1 [67fm]
Polygala sanguinea L.	1 [88m]
Rosa setigera Michaux	1 [50f]
Viola sagittata Aiton	1 [67f]

Table 2. Annotated list of bees at Kitty Todd Preserve. Bee species with an * were not recorded by MacKay and Knerer (1979), Evans (1986), or Grixti and Packer (2006), see Discussion. Exotic species are labeled "X". Species numbers (for bees) are used in Table 1.

No.	Species	Notes
Colletidae		
1.	*Colletes americanus* Cresson	oligolege of *Aster, Solidago;* females collected in September 2003 at *Aster pilosus/lateriflorus* and *Solidago canadensis/gigantea*, HQ unit.
2.	*Colletes compactus* Cresson	oligolege of *Aster, Solidago;* males collected in September 2003 at *Aster pilosus/lateriflorus* and *Aster novae-angliae,* HQ unit.
3.	*Colletes inaequalis* Say	polylege, females collected in May 2003, 2004 at *Lupinus perennis* and *Prunus virginiana*, and at a nest aggregation; HQ and Patton units.
4.	*Colletes simulans* Cresson	oligolege of *Aster, Solidago*; female collected in September 2003 at *Solidago canadensis/gigantea*, HQ unit.
5.	*Hylaeus affinis* (Smith)	polylege, males collected in June and July 2002 at *Potentilla simplex*, *Rubus flagellaris* and *Melilotus alba*, HQ unit.
6.*	*Hylaeus illinoisensis* (Robertson)	polylege, males collected in July 2002 at *Melilotus alba*, HQ unit.
7.	*Hylaeus mesillae* (Cockerell)	polylege, collected on most dates in May, June and July, all three years; males at *Aronia prunifolia.*, *Vaccinium angustifolium, Ceanothus americanus, Cicuta maculata, Melilotus alba, Rubus flagellaris*, and *Spiraea alba*; females at *Melilotus alba, Solidago rugosa, Sisyrinchium sp.*, and *Cicuta maculata:* HQ and Patton units.
8.*	*Hylaeus species nr. modestus*	a common species in the midwest US whose name is uncertain at present: polylege, males collected on most dates in May, June and July, all three years, at *Rubus flagellaris, Cicuta maculata, Spiraea alba* and *Melilotus alba*, HQ and Patton units.
Andrenidae		
9.	*Andrena algida* Smith	polylege, female collected in May 2004 at staminate *Salix petiolaris*, Patton unit.
10.*	*Andrena aliciae* Robertson	oligolege of Asteraceae; females and males collected in August 2002 at *Coreopsis tripteris* and *Helianthus divaricatus*, HQ unit.
11.	*Andrena alleghaniensis* Viereck	polylege, males collected in May 2003, 2004 at *Aronia prunifolia*. and *Prunus virginiana,* HQ and Patton units.
12.	*Andrena asteris* Robertson	oligolege of *Aster*, *Solidago*; females and males collected in September 2003 at *Aster novae-angliae, Aster pilosus/lateriflorus, Aster praealtus* and *Solidago canadensis/gigantea,* HQ unit.
13.	*Andrena barbilabris* (Kirby)	polylege, female collected in May 2004 at *Prunus virginiana*, Patton unit.

Table 2. Continued.

No.	Species	Notes
14.	*Andrena canadensis* Dalla Torre	oligolege of *Aster, Solidago*; females and males collected in September 2003 at *Solidago nemoralis* and *Solidago canadensis/gigantea*, HQ unit.
15.	*Andrena carlini* Cockerell	polylege, female collected in June 2002 at *Rubus flagellaris*, HQ unit.
16.*	*Andrena carolina* Viereck	oligolege of *Vaccinium, Gaylusaccia*; females collected in May and June 2002 and 2003 at *Gaylusaccia baccata* and *Vaccinium angustifolium*, HQ unit.
17.	*Andrena crataegi* Robertson	polylege; females collected in May and June, 2002 and 2003 at *Rubus allegheniensis* and *Aronia* prunifolia., males collected in May 2003 and 2004 at *Aronia prunifolia* and *Prunus virginiana*. HQ, Patton units.
18.	*Andrena cressonii* Robertson	polylege, females collected in May 2003 and 2004 at *Alliaria petiolata, Aronia prunifolia, Cornus stolonifera*, and *Geranium maculatum,* HQ and Patton units.
19.*	*Andrena erigeniae* Robertson	oligolege of *Claytonia*, female collected in May 2003 in flight, HQ unit.
20.	*Andrena hippotes* Robertson	polylege, female collected in May 2004 at staminate *Salix petiolaris* flowers, Patton unit.
21.	*Andrena hirticincta* Provancher	oligolege of *Solidago*, females collected in September 2003 at *Solidago canadensis/gigantea*, HQ unit.
22.	*Andrena imitatrix* Cresson	polylege, females collected in June 2002 at *Rubus allegheniensis*, male collected in May 2003 at *Aronia prunifolia,* HQ unit.
23.	*Andrena miranda* Smith	polylege, females collected in June 2002 at *Rubus flagellaris* and *R. allegheniensis,* in May 2003 at *Gaylusaccia baccata;* HQ unit.
24.*	*Andrena nuda* Robertson	polylege, females collected in June 2002 at *Rubus allegheniensis* HQ unit, in May 2004 at *Prunus virginiana*, Patton unit.
25.	*Andrena nubecula* Smith	oligolege of Asteraceae, females collected in September 2003 at *Solidago canadensis/gigantea* and *Aster praealtus*, HQ unit.
26.	*Andrena platyparia* Robertson	oligolege of *Cornus (Svida)*, male collected in May 2004 at *Cornus stolonifera*, Patton unit.
27.	*Andrena placata* Mitchell	oligolege of Asteraceae, male and female collected in September 2003 at *Solidago nemoralis,* HQ unit.
28.	*Andrena vicina* Smith	polylege, females collected in June 2002 at *Rubus allegheniensis* and *R. flagellaris*, in May 2004 at *Prunus virginiana*; HQ and Patton units.
29.	*Andrena wilkella* (Kirby)	X, oligolege of Fabaceae; female collected in June 2002 at *Vicia villosa*, Moseley Barrens unit.

Table 2. Continued.

No.	Species	Notes
30.	*Pseudopanurgus nebrascensis* (Crawford)	oligolege of Asteraceae; females collected in September 2003 at *Solidago nemoralis* and *Aster praealtus*, HQ unit.
31.*	*Pseudopanurgus rugosus* (Robertson)	oligolege of Asteraceae, female collected in August 2002 at *Coreopsis tripteris,* HQ unit
Halictidae		
32.	*Agapostemon sericeus* (Forster)	polylege, females collected in June 2002 at *Lupinus perennis* and *Rubus flagellaris;* in May and September 2003 at *Lupinus perennis,* and *Aster novae-angliae* and *A. praealtus*, respectfully; male collected in September 2003 at *Aster pilosus/lateriflorus* HQ unit.
33.	*Agapostemon splendens* (Lepeletier)	polylege, females collected in August 2002 at *Agalinis tenuifolia*, males in July 2002 at *Liatris spicata* and September 2003 at *Aster praealtus*; HQ unit.
34.	*Halictus confusus* Smith	polylege, females collected in June and July 2002 at *Rubus flagellaris*, *Spiraea alba, Asclepias tuberosa* and *Lysimachia ciliata;* in May 2003 at *Aronia prunifolia*, and in May and June 2004 at *Senecio aureus* and *Penstemon digitalis*; HQ and Patton units.
35.	*Halictus ligatus* Say	polylege, females collected in July 2002 at *Ceanothus americanus*, in May 2004 at *Senecio aureus*; male collected in September 2003 at *Aster pilosus/lateriflorus*; HQ and Patton units.
36.	*Halictus parallelus* Say	polylege, females collected in June and August 2002 at *Rubus flagellaris* and *Euthamia graminifolia*, respectively; HQ unit.
37.	*Halictus rubicundus* (Christ)	polylege, male collected in July 2002 at *Asclepias tuberosa*, HQ unit.
38.	*Lasioglossum coriaceum* (Smith)	polylege, females collected June 2002 at *Rubus allegheniensis, R. flagellaris* and *Krigia biflora*, in July and September 2003 at *Ceanothus americanus* and *Aster novae-angliae;* HQ unit.
39.	*Lasioglossum foxii* (Robertson)	polylege, female collected May 2003 at *Aronia prunifolia*, HQ unit.
40.*	*Lasioglossum fuscipenne* (Smith)	polylege, females collected May and June in all three years at *Geranium maculatum*, *Rubus flagellaris*, *Vaccinium angustifolium*, *Gaylusaccia baccata* and *Vicia villosa,* all units; male collected September 2003 at *Aster praealtus*, HQ unit.
41.	*Lasioglossum lineatulum* (Crawford)	polylege, females collected July 2002 at *Lysimachia lanceolata*, HQ unit, in May 2004 at *Alliaria petiolata*, Patton unit.
42.*	*Lasioglossum lustrans* (Cockerell)	oligolege, male collected in June 2004 flying over sand on Moseley Barrens unit.
43.	*Lasioglossum nigroviride* (Graenicher)	polylege, females collected in May 2003 at *Aronia prunifolia* (HQ unit), in May 2004 at *Alliaria petiolata* and *Prunus virginiana*, Patton unit.
44.	*Lasioglossum oblongum* (Lovell)	polylege, female collected in May 2004 at *Prunus virginiana*, Patton unit.

Table 2. Continued.

No.	Species	Notes
45.	*Lasioglossum pectorale* (Smith)	polylege, females collected in May 2004 at *Alliaria petiolata* (Patton unit), in June and August 2002 at *Rubus flagellaris* and *Coreopsis tripteris*, HQ unit; male in July 2002 at *Rudbeckia hirta*, HQ unit.
46.	*Lasioglossum leucocomum* (Lovell)	polylege, females collected on all dates, HQ and Moseley Barrens units, at *Aronia prunifolia, Rubus flagellaris, Krigia biflora, Lupinus perennis, Ceanothus americanus, Melilotus alba, Baptisia tinctoria, Lysimachia lanceolata, Potentilla simplex,Vernonia sp.;* males in July and September 2002 and 2003 at *Melilotus alba* and *Aster laevis,* HQ unit. The very similar *L. pilosum* (Smith) (Gibbs, 2010) occurs elsewhere in the Oak Openings but was not found at Kitty Todd Preserve.
47.	*Lasioglossum bruneri* (Crawford)	polylege, male collected September 2003 at *Aster pilosus/lateriflorus,* HQ unit.
48.	*Lasioglossum versatum* (Robertson)	polylege, females collected in July 2004 at *Ceanothus americanus* (HQ unit), in May and June of 2004 at *Cornus stolonifera* and *Penstemon digitalis* respectively (Patton unit).
49.	*Lasioglossum vierecki* (Crawford)	polylege, females collected in May, June and July, all years, (HQ and Moseley Barrens units) at *Asclepias tuberosa, Monarda fistulosa, Rubus allegheniensis, R. flagellaris, Lupinus perennis* and *Ceanothus americanus*; males (HQ unit) at *Asclepias tuberosa.*
50.	*Lasioglossum viridatum* (Lovell)	polylege, females collected in May and June all three years, at *Sisyrinchium sp., Aronia prunifolia, Geranium maculatum, Lythrum alatum, Rosa setigera*, and *Penstemon digitalis*, HQ and Patton units.
51.	*Lasioglossum zephyrum* (Smith)	polylege, male collected in September 2003 at *Aster novae-angliae*, HQ unit.
52.*	*Sphecodes banksii* Lovell	cleptoparasite, females collected in May 2003 and July 2002 patrolling sandy areas and at *Asclepias tuberosa* and *Solidago rugosa;* HQ unit.
53.	*Sphecodes confertus* Say	cleptoparasite, female collected in July 2002 at *Ceanothus americanus*, HQ unit.
54.	*Sphecodes cressonii* (Robertson)	cleptoparasite, males collected in July 2002 at *Ceanothus americanus*, HQ unit.
55.	*Sphecodes davisii* Robertson	cleptoparasite, females collected in May and June 2002 and 2003 patrolling sandy areas, and at *Rubus allegheniensis* and *R. flagellaris;* males collected inSeptember 2004 at *Aster pilosus/laterflorus* and *Solidago nemoralis;* all HQ unit.
56.	*Sphecodes ranunculi* Robertson	cleptoparasite, female collected searching mesic forest floor, May 2004, Patton unit.
57.	*Sphecodes stygius* Robertson	cleptoparasite, females collected in May and July 2002 and 2003, patrolling sandy areas and at *Spiraea alba*; male at *Aster praealtus*, September 2003; all HQ unit.

Table 2. Continued.

No.	**Species**	**Notes**
58.	*Augochloropsis metallica* (Smith)	polylege, females collected in May 2003 at *Lupinus perennis* (HQ unit) and in June 2004 flying over sand at Moseley Barrens.
59.	*Augochlora pura* (Say)	polylege, females collected in June 2002 at *Rubus allegheniensis*, and in June 2004 flying over sand at Moseley Barrens.
60.	*Augochlorella aurata* (Smith)	polylege, females collected in May and June of all years on all units; flower records include *Potentilla simplex*, *Lupinus perennis* and *Alliaria petiolata*.
Melittidae		
61.*	*Macropis ciliata* Patton	oligolege of *Lysimachia* (perhaps only *quadrifolia);* females collected in July 2003 at *Lysimachia quadrifolia*, male at *Ceanothus americanus*, HQ unit.
Megachilidae		
62.	*Heriades carinatus* Cresson	polylege, female collected in July 2003 at *Ceanothus americanus*, HQ unit.
63.	*Hoplitis pilosifrons* (Cresson)	polylege, females collected in June and July all three years in HQ and Patton units, at *Lupinus perennis, Potentilla simplex, Penstemon digitalis, Lythrum alatum* and *Aletris farinosa*
64.	*Hoplitis producta* (Cresson)	polylege, females collected in June and July all three years in HQ and Patton units at *Lythrum alatum*, *Aletris farinosa*, *Lobelia spicata* and *Baptisia tinctoria*
65.*	*Hoplitis truncata* (Cresson)	polylege, male collected in June 2002 at *Rubus flagellaris*, HQ unit.
66.	*Osmia atriventris* Cresson	polylege, females collected in May, June and July all three years, all units, at *Fragaria virginiana, Aronia prunifolia, Lupinus perennis, Rubus allegheniensis, R. flagellaris,*
67.*	*Osmia bucephala* Cresson	polylege, females collected in May of 2003 and 2004 at *Lupinus perennis,Viola sagittata, Pedicularis canadensis* and *Lonicera morrowi*, Patton unit.
68.	*Osmia distincta* Cresson	polylege (see Discussion); females collected in June of 2002 and 2004 at *Lupinus perennis, Rubus allegheniensis, R. flagellaris* and *Penstemon digitalis;* all units.
69.	*Osmia georgica* Cresson	oligolege of vernal Asteraceae; females collected in May 2004 at *Senecio aurea*, Patton unit.
70.	*Osmia pumila* Cresson	polylege, females collected in May and June, 2002 and 2003 at *Lupinus perennis* and *Rubus allegheniensis*, HQ unit.
71.	*Osmia simillima* Smith	polylege, male collected in June 2002 at *Rubus flagellaris*, HQ unit.
72.*	*Osmia michiganensis* Mitchell	polylege, females collected in May and June of 2002 and 2003 at *Rubus flagellaris, R. allegheniensis* and *Lupinus perennis*, HQ unit.
73.	*Anthidiellum notatum* (Latreille)	polylege, female collected in July 2002 at *Baptisia tinctoria*, HQ unit.

Table 2. Continued.

No.	Species	Notes
74.	*Anthidium manicatum* (Linnaeus)	X, polylege, males collected in August 2002 and June 2004 at *Vernonia sp.* and *Penstemon digitalis* respectively, HQ and Patton units; females collected in June 2004 at *Penstemon digitalis*, Patton unit.
75.*	*Stelis louisae* Cockerell	cleptoparasite, males collected in July 2002 at *Spiraea alba* and *Baptisia tinctoria*, HQ unit.
76.	*Stelis lateralis* Cresson	cleptoparasite, female collected in May 2003 patrolling *Quercus velutina* sprout, HQ unit.
77.	*Coelioxys alternata* Say	cleptoparasite, male collected in July 2002 at *Rudbeckia hirta*, HQ unit.
78.	*Coelioxys modesta* Smith	cleptoparasite, females collected in July 2002 from *Asclepias tuberosa* and *Baptisia tinctoria*, male from *Asclepias tuberosa*, all HQ unit.
79.	*Coelioxys octodentata* Say	cleptoparasite, females collected in July 2002 and 2003 from *Asclepias tuberosa, Melilotus alba, Baptisia tinctoria*, and patrolling sandy areas; male collected in July 2003 at *Aletris farinosa;* all HQ unit.
80.*	*Coelioxys porterae* Cockerell	cleptoparasite, female collected in August 2002 at *Agalinis tenuifolia*, HQ unit.
81.	*Coelioxys sayi* Robertson	cleptoparasite, females and males collected in 2002, the former at *Solidago nemoralis*, the latter at *Helianthus divaricatus*, HQ unit.
82.	*Megachile brevis* Say	polylege, collected in 2002 and 2003, HQ unit: females in July and August at *Baptisia tinctoria*, *Ceanothus americanus*, *Solidago rugosa* and *S. nemoralis*, males in June and July at *Rubus flagellaris* and *Melilotus alba.*
83.	*Megachile campanulae* (Robertson)	polylege, females collected in July 2002 at *Baptisia tinctoria*, males in July 2002 at *Baptisia tinctoria* and *Asclepias tuberosa,* HQ unit.
84.	*Megachile gemula* Cresson	polylege, females collected in June and July 2002 and 2003 at *Lupinus perennis*, *Baptisia tinctoria*, *Monarda fistulosa* and *Melilotus alba*; male collected in June 2002 at *Vaccinium angustifolium*, all HQ unit.
85.*	*Megachile inimica* Cresson	oligolege of Asteraceae; female collected in September 2003 at *Aster novae-angliae*, HQ unit.
86.	*Megachile latimanus* Say	oligolege of Asteraceae; females collected in July and August 2002 at *Solidago rugosa* and *Vernonia sp.,* males collected in June and July 2002 at *Rubus flagellaris* and *Monarda punctata*, HQ unit.
87.*	*Megachile mucida* Cresson	polylege, female collected in June 2002 at *Rubus flagellaris*, HQ unit.

Table 2. Continued.

No.	Species	Notes
88.	*Megachile mendica* Cresson	polylege, collected in 2002 and 2003, HQ unit; females collected in July and August at *baptisia tinctoria, Vernonia sp.*, and *Coreopsis tripteris*, males in June, July, August and September at *Rubus flagellaris, Vicia villosa, Polygala sanguinea, Baptisia tinctoria, Asclepias tuberosa*, *Coreopsis tripteris, Vernonia sp., Helianthus divaricatus, Liatris aspera* and *Aster novae-angliae*.
89.	*Megachile pugnata* Say	oligolege of Asteraceae; female collected July 2002 at *Monarda punctata*, males collected in July 2002 and 2003 at *Melilotus alba, Asclepias tuberosa, Rudbeckia hirta, Spiraea alba* and *Liatris spicata*, all HQ unit.
90.	*Megachile relativa* Cresson	poylege, males collected in May, June and July 2002 and 2003 at *Vaccinium angustifolium*, *Rubus flagellaris*, *Baptisia tinctoria*, and patrolling a *Quercus velutina* sprout, HQ unit.
91.	*Megachile rotundata* (Fabricius)	X, oligolege of Fabaceae, male and female collected in July 2003 at *Melilotus alba*, HQ unit.
92.*	*Megachile rugifrons* (Smith)	polylege, females and males collected in July 2002 at *Baptisia tinctoria* and *Asclepias tuberosa*, HQ unit.
93.	*Megachile texana* Cresson	polylege, females collected in July 2002 at *Baptisia tinctoria*, males collected in July 2002 and 2003 at *Baptisia tinctoria, Asclepias tuberosa, Monardapunctata*, and *Ceanothus americanus*, HQ unit.
Apidae		
94.	*Xylocopa virginica* (Linnaeus)	polylege, females and males field-identified all three years, HQ unit.
95.	*Ceratina calcarata* Robertson	polylege, males collected in May and September of 2003 at *Aronia prunifolia, Gaylusaccia baccata, Aster praealtus* and *A. pilosus/lateriflorus*, HQ unit, and in May 2004 at *Alliaria petiolata* and *Lonicera morrowi*, Patton unit.
96.	*Ceratina dupla* Say	polylege, males collected in all three years; in May and June 2002 and 2003 (HQ unit) *at Lupinus perennis* and *Potentilla simplex*, and in May 2004 at *Lonicera morrowi* (Patton unit).
97.*	*Ceratina strenua* Smith	polylege, collected in May and June of 2002 and 2004 on HQ and Patton units: females at *Senecio aurea*, *Potentilla simplex*, *Rubus flagellaris*, *R. allegheniensis* and *Lobelia spicata,* males at *Alliaria petiolata, Geranium maculatum* and *Lonicera morrowi*.
98.	*Anthophora terminalis* Cresson	polylege, females collected in June 2004 at *Penstemon digitalis*, Patton unit.
99.	*Nomada bella* Cresson	cleptoparasite, male collected in May 2003 at *Senecio aureus*, Patton unit.
100.	*Nomada cressonii* Robertson	cleptoparasite, female collected in June 2002 at *Rubus flagellaris*, HQ unit.
101.	*Nomada cuneata* (Robertson)	cleptoparasite, female collected in June 2002 at *Rubus flagellaris*, HQ unit.

Table 2. Continued.

No.	Species	Notes
102.*	*Nomada vegana* Cresson	cleptoparasite, male collected in July 2002 at at *Asclepias tuberosa*, HQ unit.
103.	*Nomada pygmaea* Cresson	cleptoparasite, male collected in June 2002 at *Rubus flagellaris*, HQ unit.
104.*	*Nomada rubicunda* Olivier	cleptoparasite, male collected in May 2003 in flight over sand, HQ unit.
105.*	*Triepeolus lunatus* (Robertson)	cleptoparasite, female collected in July 2002 at *Asclepias tuberosa*, HQ unit.
106.	*Epeolus lectoides* Robertson	cleptoparasite, collected in July 2002, males at *Baptisia tinctoria* and *Asclepias tuberosa*, females only at the latter; HQ unit.
107.	*Epeolus scutellaris* Say	cleptoparasite, male collected in September 2003 at *Aster pilosus/lateriflorus*, HQ unit.
108	*Epeolus species* 1	cleptoparasite, males collected in September 2003 at *Aster pilosus/lateriflorus*, HQ unit.
109.	*Melissodes agilis* Cresson	oligolege of *Helianthus*; male collected in August 2002 at *Coreopsis tripteris*, HQ unit.
110.	*Melissodes species* 1	males collected in July 2002 at *Solidago rugosa* and *Rudbeckia hirta*, HQ unit.
111.*	*Melissodes bimaculata* (Lepeletier)	polylege, females collected in August 2002 at *Vernonia* sp. and *Liatris aspera*, HQ unit.
112.*	*Melissodes denticulata* Smith	oligolege of *Vernonia*; males and females collected in August 2002 at *Vernnonia sp.*, HQ unit.
113.	*Melissodes desponsa* Smith	oligolege of *Cirsium*; males and females field-identified in August 2002 on *Cirsium sp.*, HQ unit.
114.	*Melissodes rustica* (Say)	oligolege of Asteraceae; male collected in August 2002 at *Coreopsis tripteris*, HQ unit.
115.	*Melissodes subillata* LaBerge	oligolege of Asteraceae; female collected in July 2002 at *Rudbeckia hirta*, HQ unit.
116.	*Melissodes tincta* LaBerge	oligolege of Asteraceae; male collected in August 2002 at *Coreopsis tripteris*, HQ unit.
117.	*Melissodes wheeleri* Cockerell	oligolege of Asteraceae; females collected in September of 2003 at *Aster praealtus, A. novae-angliae, A. laevis* and *A. pilosus/lateriflorus*, HQ unit.
118.	*Bombus bimaculatus* Cresson	polylege, workers collected in June 2002 and 2004 at *Lupinus perennis* and *Penstemon digitalis* respectively, HQ and Patton units; males in July 2002 at *Melilotus alba*, HQ unit.
119.	*Bombus citrinus* (Smith)	social parasite, female collected in June 2002 at *Rubus flagellaris*, males in August 2002 and September 2003 at *Liatris aspera* and *Solidago canadensis/gigantea*, respectively; HQ unit.
120.	*Bombus fervidus* (Fabricius)	polylege, workers collected in July 2002 at *Baptisia tinctoria*, males in August 2002 and September 2003 at *Vernonia sp.* and *Solidago canadensis/gigantea* respectively; HQ unit.
121.	*Bombus griseocollis* (DeGeer)	polylege, workers collected in July and August 2002 at *Baptisia tinctoria, Asclepias tuberosa* and *Liatris aspera*, HQ unit.
122.	*Bombus impatiens* Cresson	polylege, workers collected in June, July and August of 2002, and in September 2003, at *Melilotus alba, Baptisia tinctoria, Rubus flagellaris, Ceanothus americanus*, *Liatris aspera* and *Aster novae-angliae*; HQ unit.
123.	*Bombus vagans* Smith	polylege, worker collected in August 2002 at *Liatris aspera*, HQ unit.
124.X	*Apis mellifera* Linnaeus	polylege, seen regularly all three years, most dates, all sites.

Table 3. Bee collecting effort (hours) on individual dates (month/day) at Kitty Todd Preserve, 2002 - 2004.

	5/10	5/18	5/19	6/7	6/8	6/26	7/5	7/13	7/14	8/19	9/21
2002	-	-	-	3	1.5	-	-	3	1	1.5	-
2003	-	2	3	-	-	-	2	-	-	-	3.5
2004	2	-	-	-	-	2	-	-	-	-	-
No. spp. Collected	26	5	31	43	8	18	18	26	31	24	28

Discussion

Faunistics. Given the concern about disappearing and declining pollinator populations (National Research Council 2007), global warming (Walther et. al. 2002), and the potential changes in the distribution and abundance of organisms implied by these phenomena, an attempt was made to assemble a relatively current data set on the distribution of bees within the eastern US for comparative purposes, rather than depend solely on older sources such as Mitchell (1960, 1962), Hurd, Jr. (1979), and others. A number of bee surveys in various parts of the eastern US (and adjacent Canada) have been published in the past decade or so, which taken together provide recent data on the distribution of many bees in the eastern US, and approximately 12 of its 33 ecoregions (The Nature Conservancy, 2006). These studies include: Reed (1995), Pascarella et. al. (1999), Deyrup et. al. (2002), Sheffield et. al. (2003), Kalhorn et. al. (2003), Grixti and Packer (2006), Giles and Ascher (2006), Gardner and Ascher (2006), Bartholomew et. al. (2006), and Tuell et. al. (2009). In addition to these published studies, recent unpublished data sets from Robert Jean (northern Indiana, northeastern Illinois), Sam Droege (South Carolina sandhills and Assateague Island), and the author (Missouri) were also incorporated as comparative data. Reference was also made to the distribution maps of bees being compiled by John Ascher (American Museum of Natural History available at http://www.discoverlife.org/mp/20m?kind=AMNH_BEE). Nearly all of these data sets have the advantage of being tied to particular habitats or natural communities, and ecoregions.

Based on these data, all of the named species of bees found at Kitty Todd (121) have been documented in the last decade or so from elsewhere in the eastern US and/or southern Ontario, Canada, and most (95, or 77%) have been documented by four or more of the studies referenced above. The majority of bee species on the Kitty Todd Preserve thus appear to be relatively common, widespread species typical of many ecoregions and habitats in the eastern US. However, these surveys also suggest that as many as 23 of the (native) bee species occurring at Kitty Todd are at, or near, the periphery of their ranges in the Oak Openings. Nineteen of these species barely enter the Great Lakes ecoregion, being more representative of ecoregions to the east, southeast, south and southwest, while four other species are characteristic of the entire Great Lakes ecoregion, and other ecoregions to the north, east and west.

Of these nineteen species that barely enter the Great Lakes ecoregion, seven (*Andrena aliciae, Andrena nubecula, Pseudopanurgus rugosus, Megachile inimica, Osmia georgica, Melissodes tincta* and *M. wheeleri*) are oligoleges of various Asteraceae, four others (*Andrena nuda, Anthidiellum notatum, Megachile mucida* and *M. rugifrons)* are polyleges, and two (*Sphecodes banksii, Stelis louisae)* are cleptoparasites of *Lasioglossum (Dialictus*) and *Megachile (Chelostomoides*) respectfully. Only seven of these nineteen species (*Andrena nubecula, A. nuda, Osmia georgica, Anthidiellum notatum*, *Epeolus lectoides, Melissodes tincta* and *M. wheeleri*) were found by MacKay and Knerer (1979), Evans (1986), Grixti and Packer (2006), and Tuell et. al. (2009) in their intensive studies of bees in southern Michigan and southern Ontario, areas just to the northwest, north and northeast of Kitty Todd (see Bees and Natural Communities below). However, in a recent three year study of bees in black oak savanna communities in northern Indiana (at a latitude, and in habitat, similar to Kitty Todd), Robert Jean found sixteen of these nineteen species (R. Jean, pers. commun.). All of these species occur further to the south and southwest in Indiana (R. Jean, unpubl. Indiana list), and Missouri (M. Arduser unpubl. Missouri list).

The four "northern" species occur throughout the Great Lakes ecoregion, and apparently no further south than the Oak Openings and similar habitats at the same latitude. One of these is an oligolege (*Andrena hirticincta* on *Solidago),* two (*Andrena algida* and *Osmia michiganensis)* are polyleges, and *Coelioxys porterae* is a cleptoparasite (of *Megachile* spp.). *A. hirticincta* was found by

MacKay and Knerer (1979), Evans (1986), Grixti and Packer (2006), and Tuell et al. (2009), and *A. hirticincta*, *O. michiganensis* and *C. porterae* were found by R. Jean (unpubl. Inidiana list).

The occurrence of *O. michiganensis* at Kitty Todd is notable. Virtually nothing has been reported about this bee since its description by T. B. Mitchell from a single male specimen collected in Grand Traverse Co. Michigan (Mitchell 1962). Over the last several decades, females thought to be of this species have been collected by the author and others throughout the Great Lakes ecoregion at a variety of plant species, and in British Columbia, Canada (Arduser, unpubl. data). It has apparently not been reared from trap nests. Males pursuing females and attempting copulation were collected elsewhere in the Oak Openings by the author recently and confirm the identity of the females. It is possible that this species, like *Osmia subaustralis* Cockerell (Rust 1974) and *Dufourea maura* (Cresson) (Arduser 1985), is either disjunct in the Great Lakes ecoregion, or has a transcontinental northern distribution.

Transeau (1935) included the Oak Openings as an eastern outlier of his prairie peninsula, and Metzler (1999) recently documented two species of microlepidoptera from the Oak Openings (both from Kitty Todd) which he considered prairie specialists (i.e., occurring only in prairies or prairie-like habitats east of the Mississippi River; Metzler 1997). None of the bees found at Kitty Todd can be considered prairie specialists, by Metzler's definition; though many of them occur commonly on tall grass prairie natural communities in Missouri, Kansas and Oklahoma (e.g., *Hylaeus mesillae, Andrena cressonii, Megachile inimica,* and *Melissodes agilis*), they occur in other communities and habitats as well (Arduser, 2003).

Bee-plant associations. Both conservative and non-conservative plants (Masters 1997) served as principal resource species (Evans 1986) for polylectic bees at Kitty Todd (Table 1). Conservative plant species (e.g., *Lupinus perennis*) are closely tied to natural communities: the more conservative a species, the less likely it is to occur, or establish itself, outside of a particular natural community or set of communities. None of the principal resource species were pollen hosts for any oligolectic bees. Their attractiveness for many polylectic bees suggests that principal resource species may be useful as "sentinel plants" in monitoring local bee diversity, and perhaps abundance. Monitoring bees at sentinel plants at intervals over the season and across years may provide a valuable index (and reveal trends) of bee diversity at a site, as opposed to extensive and intensive studies attempting to catalog the entire bee fauna at a site, requiring hundreds or thousands of hours of collecting effort and equal amounts of preparation time. For example, the five principal resource species at Kitty Todd (10% of plant species sampled, Table 1) attracted nearly half of all bee species collected at the site (59 species, or 48%). The highly conservative papilionoid legumes *Baptisia tinctoria* and *Lupinus perennis* (Ladd, 1997) were visited primarily by long-tongued bees (e.g., megachilids and apids), while plant taxa with more readily accessible flowers (e.g., *Rubus* spp., *Aronia prunifolia*, *Ceanothus americanus*) were visited by a greater number of short-tongued bees (e.g., colletids, andrenids, halictids). This difference was sometimes quite striking: on the morning of 18 May 18, *L. perennis* and *Aronia prunifolia* were sampled approximately one half-hour apart, in patches about 50 yards from each other. Twenty-two species of bees were collected from these two plant species during that time, but only two of those 22 bee species were captured at both plant species.

The flight periods of bees are generally longer than the blooming period of any particular plant species at a given site. Thus bees collected from *L. perennis* and *A. prunifolia* also visited other plants for pollen and nectar (Table 1) before, during and after populations of these two plants flowered. Bee species that provide pollination services for rare and/or conservative species (like *L. perennis*) are maintained as a "pollinator force" not solely by those rare or conservative plants they service, but by resources obtained from other associated plant species, many of which are non-conservative or even weedy. Management of the Kitty Todd Preserve is often necessarily focused on rare and conservative plant species, but this sometimes comes at the expense of common or non-conservative species, which are often seen as occupying space that might otherwise support Kitty Todd Preserve targets. The abundance of native non-conservative or weedy plants (e.g., *Rubus* spp., Table 1) is clearly important in supporting many bees, at least some of which are important pollinators of rare species (Dieringer, 1999, Larson and Barrett, 1999, Bernhardt, 2000, Saunders and Sipes, 2006). Bee-visited plants that phenologically bracket the blooming period of any particular bee-pollinated rare species play an important but undervalued role as "bridge" species, supporting pollinators on either side of the target species flowering period. These kinds of plants need to be recognized and included in management efforts addressing the rare species.

The vast majority of the native oligolectic bees collected (23 out of 28 species) on the Kitty Todd Preserve were supported by various genera of Asteraceae (see Tables 1 and 2). Undoubtedly more vernal *Andrena* oligoleges, especially *Salix* specialists, occur on the Kitty Todd Preserve than were collected, based on collections elsewhere in the Oak Openings region. Few collections of oligoleges were made from the principal resource species (Table 1). Certain species considered in the literature as range-wide polyleges (e.g., *Andrena crataegi, A. nuda*) appear to be regional or local oligoleges (eclectic oligoleges, sensu Cane and Sipes 2006). Of the many oligolectic species recorded in this study, two, *Lasioglossum lustrans* (Halictidae) and *Osmia distincta* (Megachilidae), are of particular interest. *L. lustrans* is a sand-obligate species of the eastern US. This bee has been considered an oligolege of *Pyrrhopappus* spp. (Asteraceae), (Moure and Hurd 1987), but is more appropriately considered a range-wide oligolege of the Asteraceae Tribe Cichorieae, utilizing both native and introduced taxa (Estes and Thorp 1975). *Pyrrhopappus* does not occur at Kitty Todd or elsewhere in the Oak Openings (Gary Hasse, pers. comm.), nor is there evidence that it has occurred there in recent times (Moseley 1928). Neither does *Pyrrhopappus* occur in Michigan (Voss 1996). Robert Jean (pers. comm.) has found this bee in northern Indiana and northern Illinois in the absence of its putative host plant as well. In these natural community sites a morphologically similar but more conservative genus of plants, *Krigia,* is common. Two co-flowering species occur at these sites, *K. virginica* and *K. biflora*; the former is characteristic of the sandy barrens where *L. lustrans* has been found, and is a state-listed species in Ohio (Ohio Division of Wildlife 2003). Field observations indicate this species is the pollen host of *L. lustrans* at these locations.

Osmia distincta has been considered an oligolege of *Penstemon* (Scrophulariaceae) by most workers (Clinebell and Bernhardt 1998, Clinebell 2003). At Kitty Todd this bee collects pollen from *L. perennis, Rubus* spp. and possibly other plants prior to the flowering of *Penstemon digitalis,* the only *Penstemon* known from the Kitty Todd Preserve. Females of *O. distincta* do collect pollen from *P. digitalis* later in the season at those few sites where the plant occurs, but the bee also occurs in parts of the Kitty Todd Preserve where the plant is apparently absent. *P. digitalis* was not recorded by Moseley (1928), and is extremely local and possibly introduced in the Oak Openings. The occurrence of *O. distincta* at Kitty Todd and elsewhere in the Oak Openings thus appears to be independent of the presence of *Penstemon* species. This bee also occurs throughout much of southern Michigan and into the Upper Peninsula, and of twelve separate Michigan collections of females seen by me, only one is from *Penstemon (P. hirsutus* (L.) Willd.). The others were collected at Fabaceae (*Trifolium hybridum* L., *Trifolium sp., Vicia villosa, Vicia americana* Muhl.) and Rosaceae (*Rubus*) (Arduser, unpubl.data).

The phenomenon of oligolectic bee species utilizing different host plants at the periphery of their ranges, in the absence of their "normal" host plants, may be more common than recognized (see Cane et. al. 1996 and Deyrup et. al. 2002 for additional examples). Host switches may facilitate speciation in solitary bees, and partially explain the abundance and diversification of oligolectic lineages (Wcislo and Cane 1996). Host switches could function as reproductive isolating mechanisms in taxa (like many Andrenidae) that habitually seek mates (and copulate) at host flowers.

Finally, we note for apparently the first time the use of native plants, and the occurrence in natural communities, of the introduced Old World wool-carder bee, *Anthidium manicatum* (Table 2). All other accounts of this species in North America indicate it restricts its flower visitation to Old World plant taxa and does not colonize native communities (Miller et. al. 2002, Cane and Sipes 2006).

Bees and natural communities. Natural communities are assemblages of native plant and animal species occurring in conjunction with particular physical characteristics of the landscape, and vary from high quality to low quality depending on site integrity. Similar in a general way to plant communities, natural communities are defined and recognized by additional organisms and certain elements of the landscape, not by plants exclusively, and are believed to represent what remains of presettlement habitats. Contemporary Oak Openings natural communities (Gardner and Haase, 2004), as well as most other midwestern natural communities, are remnants of formerly larger and more extensive systems. These remnants are embedded in an increasingly fragmented, altered landscape, degraded by invasive exotic plants, changing water tables, and shifts in the types, frequencies, and intensities of the various natural disturbances (e.g., fire and water) that shaped the communities prior to European settlement (Abella et. al. 2001, Grigore 2004).

Considerable evidence indicates that populations of a number of Midwestern insect species representing several functional groups (e.g., phloem feeders and predators; Panzer et. al. 1995), as well as other animals and plants (Sullivan 1999, Nelson 2005), are largely confined to these remnant natural communities. Apparently unable to colonize the altered landscapes around them, populations of these organisms may be potentially at risk and in danger of being extirpated: they depend on natural communities, or what is left of them. Some of these species have been given special conservation status at the state level because of their vulnerability (Ohio Division of Wildlife 2003).

The degree to which Oak Openings, and other Midwestern bee species exhibit "natural-community dependency" [an ecological characteristic similar to remnant-dependency (Panzer et. al. 1997), and conservatism (Masters1997)], appears to be relatively minor, however. Existing data indicate that many Midwestern bees, including oligoleges, polyleges and cleptoparasites, persist in and readily colonize, various habitat fragments containing both native and exotic plants, e.g., old fields, roadsides, utility corridors and rights-of-way, *de novo* restorations, urban areas, etc. (MacKay and Knerer 1979; Evans 1986; Reed 1995; Marlin and LaBerge 2001; Cane 2001, 2005; Clinebell 2003; Grixti and Packer 2006;). For example, Grixti and Packer (2006) sampled a small, late old field site characterized by a large number of introduced (exotic) plant species and a history of disturbance, yet found 150 species of bees (excluding bumblebees), at the site. Fifty-eight percent (68) of the species found in their study were also found at Kitty Todd (this study). Clearly, many Midwestern bee species - probably the great majority of them - are not constrained by, or dependent on, natural communities or their remnants, even though some species may be characteristic of natural communities, and often abundant within them. *Colletes inaequalis* and *Lasioglossum pilosum,* for example, are characteristic of sandy, open natural communities throughout the Oak Openings but also occur in disturbed, sandy sites such as vacant lots, roadsides, recreation fields, etc. throughout much of the Great Lakes region, and were common at the site studied by Grixti and Packer (2006).

On the other hand, some Midwestern oligolectic bees *are* natural community-dependent (NCD) because they either rely exclusively on pollen from conservative plants, or require other resources available only in natural communities. The melittid bee *Macropis ciliata*, for example, is apparently oligolectic on *Lysimachia quadrifolia* (Snelling and Stage 1995; this study), a conservative, obligate wetland plant species (Ladd 1997; Table 1), and *Andrena carolina* is an oligolege of *Vaccinium* and *Gaylusaccia*, which are relatively conservative taxa as well. Overall, however, only a minority of oligolectic bees in the Midwest depend on conservative plant taxa for pollen (Arduser, unpubl. data). Most have a broader host repertoire (at the family level, for example) or have the "good fortune" to rely on plant taxa that are either *not* particularly conservative, or are rife with species, at least some of which are not conservative (*e.g.*, *Solidago, Helianthus, Salix*). Nest habitat requirements (e.g., obligate arenophily), unfortunately known only in general terms for many Midwestern species, are an additional and undoubtedly equally important factor restricting bees to natural communities (Gordon 2000, Cane 2001).

Determining natural community-dependency in bees that are *not* oligoleges of conservative plant taxa requires repeated sampling in natural communities as well as in disturbed or altered habitats across a representative portion of a species' range. Repeated collections or observations of a species in natural communities, coupled with the scarcity or absence of that species in altered habitats, are a strong indication of natural community-dependency (see Westrich 1996 for several European examples), though the reasons may not be immediately clear. Candidate species at Kitty Todd include *Andrena aliciae, Hoplitis truncata, Osmia michiganensis, Megachile rugifrons,* and the parasitic *Nomada vegana*. None of these species has been found outside of natural communities in the Oak Openings region.

Natural community-dependent species are not necessarily rare, nor are rare species necessarily NCD. Species can be rare for many reasons, and the increasing scarcity and degradation of some natural communities is just one possible cause. Natural community-dependency includes a predictable component that rareness lacks: the relatively consistent occurrence of a species in a particular natural community or set of communities, in contrast to that species' infrequency, scarcity or absence *outside* of those communities. There is clearly a range in the degree of natural community-dependency among bee species, some being highly NCD, others moderately so (Arduser, unpubl. data). A caveat is that some bee species, and presumably other NCD invertebrates, vary geographically in their degree of natural-community dependency, much the way some plants vary in their degree of conservatism range-wide (Ladd 1997).

The sporadic and highly mobile nature of some bees may make it difficult to obtain enough information to draw any conclusions about natural community-dependency in all taxa (Williams et.al. 2001). Despite these uncertainties, the inclusion of bees and other ecologically important invertebrates with taxa demonstrating some degree of natural community fidelity (e.g., ants, Coovert 2005; tiger beetles, Knisely and Schultz 1997, Graves and Brzoska 1991; grasshoppers, Kirk and Bomar 2005; and some Lepidoptera, Rings et. al. 1992), will strengthen programs designed to evaluate the integrity of natural community remnants, track the progress of natural community restorations, and monitor the recovery of natural communities following management treatments.

Conclusions. The restricted flight periods and apparent rareness of some bee species, and the temporal nature of flowers and flowering make the process of inventorying a local bee fauna a challenging one (Williams et.al. 2001). Time and travel limitations, and the vagaries of weather limited sampling during this project, thus the results do not provide a complete picture of bee diversity on the Kitty Todd Preserve. However, they do indicate that the Kitty Todd

Preserve supports a high diversity of native bees, including some species that may be largely dependent on Oak Openings natural communities for foraging and nesting, and incapable of colonizing adjacent altered habitats such as old fields. Understanding the degree of fidelity bee species have for natural communities, and the status and management needs of these communities, is an important and overlooked part of understanding pollinator declines and their potential impacts on native plants and the organisms that depend on them. Management efforts that promote populations of both conservative and non-conservative native plant species are critical if bee diversity and its pollination services are to be maintained on Midwestern Preserves.

Undoubtedly, increased collecting effort and additional methods would have resulted in more species of bees, and more records of bees from more plant species. A number of important "bee plant" taxa on the Kitty Todd Preserve were sampled sparingly or only in very small colonies (e.g., *Salix, Cornus, Prunus, Monarda, Helianthus*), or not at all (e.g., *Oenethera, Rhus).* On the other hand, certain species of bees that were expected based on the abundance of their host plants, and searched for repeatedly, were not located (e.g., *Andrena krigiana* Robertson at *Krigia*, *Calliopsis andreniformis* Smith at Fabaceae, certain panurgine andrenids at late-summer Asteraceae, *Megachile addenda* Cresson at *Tephrosia*), though they have been found elsewhere in the Oak Openings region. Extrapolating from data collected at other sites in the Oak Openings region, (Arduser unpubl. data), it is probable that an additional 30 bee species and possibly more, occur on the Preserve.

This appears to be the only published survey of bee diversity in natural communities in the Great Lakes ecoregion, though other promising, more detailed projects are on-going (Robert Jean, pers. comm.). In the absence of more comprehensive, natural community–specific data on southern Great Lakes bees, it would be premature to attach great conservation significance to the Kitty Todd Preserve, and the Oak Openings in general, as a "reservoir" for regional bee diversity and populations. Also, the bee fauna of Ohio is not well-documented, handicapping any state-wide comparative discussion of the significance of Kitty Todd and the Oak Openings to regional bee diversity. Further inventory work on bees in the state's natural communities and other habitats is needed and recommended; it may well reveal a unique signature for the Oak Openings bee fauna and heightened conservation status for some of its species.

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