



Promoting Pollinators in Public Places

Habitat Conservation Workshop

September 22, 2004

Co-sponsored by National Park Service, University of Maryland, and the U.S. National Arboretum

8:00 – 8:30	Registration	Administration Bldg Auditorium
8:30 – 8:45	Welcome and Introduction Dr. David Inouye (UMD) Dr. Giselle Mora-Bourgeois (NPS)	
8:45 – 9:15	The Importance of Pollinators and the Problems They Face Dr. Steve Buchmann (Beeworks)	
9:15 – 9:45	Case Studies in Pollinator Conservation Matthew Shepherd (Xerces Society)	
9:45 – 10:10	The Local Pollinators Dr. Edd Barrows (Georgetown University)	
10:10 – 10:30	Break	
10:30 – 11:00	Monarchs – Migratory Pollinators Dr. David Inouye, substituting for Dr. Orley Taylor (University of Kansas)	
11:00 – 11:20	Native Wildflowers for Local Use Karyn Molines (Maryland Native Plant Society) Dr. Sara Tangren (Chesapeake Native Nursery)	
11:20 – 11:40	Golf Courses and Pollinators Dr. Kimberly Erusha (US Golf Association)	
11:40 – 12:00	Powerline Right of Way and Pollinators Steve Genua (PEPCO)	
12:00	Lunch	
1:00 – 2:30	<u>Concurrent Session 1</u> The Making of A Meadow at River Farm Peggy Bowers (American Horticultural Society) How to Census Pollinators Dr. Sam Droege (USGS) Making Bee Blocks and Bee Houses Dr. David Inouye (University of Maryland) Native Plant Collection Tour Joan Feely (US National Arboretum) USFWS Schoolyard Habitat Program Carolyn Kolstad & Karen Kelly (USFWS)	Auditorium Arbor House Meeting Room Cafe Terrace Willow Terrace Classroom
2:30 – 3:00	Break	
3:00 – 4:30	<u>Concurrent Session 2</u> – Repeat of above sessions	

NATIVE PLANTS FOR CENTRAL MARYLAND LANDSCAPES PIEDMONT AND INNER COASTAL PLAIN

(Washington / Baltimore Corridor)

Compiled by Louisa Thompson for the Maryland Native Plant Society; May 1999
P.O. Box 4877; Silver Spring, Maryland 20914; www.mdflora.org

This is not an exhaustive list, but contains some of the common, reasonably ornamental trees, shrubs, and other flowering plants, plus some uncommon but especially beautiful ones, and a few that have special wildlife value. (In general, all native plants have some value to wildlife.)

In each section, the common species are listed first, in alphabetical order by scientific name, followed by the uncommon ones.

RIVERBANK, WETLAND, AND BOTTOMLAND PLANTS

Tall Trees

Red Maple, *Acer rubrum*
Silver Maple, *Acer saccharinum*
River Birch, *Betula nigra*
Bitternut Hickory, *Carya cordiformis*
White Ash, *Fraxinus americana*
Sycamore, *Platanus occidentalis*
Swamp White Oak, *Quercus*
Pin Oak, *Quercus palustris*
American Elm, *Ulmus americana*

Medium Trees

Box Elder (Maple), *Acer negundo*
Persimmon, *Diospyros virginiana*
Green Ash, *Fraxinus pennsylvanica*
Sweetgum, *Liquidambar styraciflua*
Black or Sour Gum (Tupelo), *Nyssa sylvatica*
Willow Oak, *Quercus phellos*
Black Willow, *Salix nigra*
Slippery Elm, *Ulmus rubra*

Small Trees

Pawpaw, *Asimina triloba*
Ironwood/Hornbeam, *Carpinus caroliniana*
Serviceberry, *Amelanchier canadensis*
Hackberry, *Celtis occidentalis*
Fringetree, *Chionanthus virginicus*
Sweetbay Magnolia, *Magnolia virginiana*

Shrubs

Smooth Alder, *Alnus serrulata*
Buttonbush, *Cephalanthus occidentalis*
Sweet Pepperbush, *Clethra alnifolia*
Hazelnut, *Corylus americana*
Silky Dogwood, *Cornus amomum*
Witch Hazel, *Hamamelis virginiana*
Inkberry, *Ilex glabra*
Winterberry, *Ilex verticillata*
American Elderberry, *Sambucus canadensis*
Southern Arrowwood, *Viburnum dentatum*
Swamp Azalea, *Rhododendron viscosum*
Swamp Rose, *Rosa palustris*

Emergent Herbaceous Plants

(stems emerge from water, roots are submerged)
Sweet Flag, *Acorus calamus*
Hardy Hibiscus, *Hibiscus moscheutos*
Blue Flag, *Iris versicolor*
Yellow Pond Lily, *Nuphar advena*
Fragrant Water Lily, *Nymphaea odorata*
Lotus Lily, *Nelumbo lutea*
Pickerelweed, *Pontederia cordata*
Arrowhead, *Sagittaria latifolia*
Lizard's Tail, *Saururus cernuus*

Herbaceous Plants for Wet Soil

(all are ornamental)
Green Dragon, *Arisaema dracontium*
Wild Ginger, *Asarum canadense*
Swamp Milkweed, *Asclepius incarnata*
New England Aster, *Aster novae-angliae*
Trout Lily (Dogtooth Violet), *Erythronium americanum*
Boneset, *Eupatorium perfoliatum*
Joe Pye Weed, *Eupatorium fistulosum*, *E. maculatum*, *E. purpureum*, *E. dubium*
Cardinal Flower, *Lobelia cardinalis*
Virginia Bluebells, *Mertensia virginica*
Wild Blue Phlox, *Phlox divaricata*
Green Coneflower, *Rudbeckia laciniata*
New York Ironweed, *Vernonia noveboracensis*
Yellow Violet, *Viola pennsylvanica*
Golden Alexanders, *Zizia aptera*

TREES FOR RICH, MOIST WOODS

Tall Trees

White Oak, *Quercus alba*
Southern Red Oak, *Quercus falcata*
Northern Red Oak, *Quercus rubra*
Black Oak, *Quercus velutina*
Red Maple, *Acer rubrum*
Mockernut Hickory, *Carya tomentosa*
American Beech, *Fagus grandifolia*
White Ash, *Fraxinus americana*
Tulip Poplar, *Liriodendron tulipifera*

Medium Trees

Persimmon, *Diospyros virginiana*
American Holly, *Ilex opaca*
Black Gum or Tupelo, *Nyssa sylvatica*
Black Cherry, *Prunus serotina*
Sassafras, *Sassafras albidum*

Shrubs

Spicebush, *Lindera benzoin*
Red Chokeberry, *Aronia arbutifolia*
Strawberry Bush, *Euonymus americanus*
Virginia Sweetspire, *Itea virginica*
Smooth Arrowwood, *Viburnum recognitum*

Small Trees

Dogwood, *Cornus florida*
Redbud, *Cercis canadensis*
Black Haw, *Viburnum prunifolium*
Serviceberry, *Amelanchier canadensis*
Hackberry, *Celtis occidentalis*
Fringetree, *Chionanthus virginicus*

HERBACEOUS PLANTS FOR SHADE

Ferns

Maidenhair Fern, *Adiantum pedatum*
Sensitive Fern, *Onoclea sensibilis*
Common Polypody, *Polypodium virginianum*
Christmas Fern, *Polystichum acrostichoides*
New York Fern, *Thelypteris noveboracensis*

Evergreen Groundcovers

Partridgeberry, *Mitchella repens*
Golden Ragwort, *Senecio aureus*

Summer Wildflowers

Black Cohosh, *Black Snakeroot*, Bugbane,
Cimicifuga racemosa

Spring Wildflowers

Jack in the Pulpit, *Arisaema triphyllum*
Spring Beauty, *Claytonia virginiana* -
Cut-leaved Toothwort, *Dentaria laciniata*
Slender Toothwort, *Dentaria heterophylla*
Dutchman's Breeches, *Dicentra cucullaria*
Squirrel Corn, *Dicentra canadensis* -
Wild Geranium, *Geranium maculatum*
Round- and Sharp-lobed Hepatica, *Hepatica*
americana, *H. acutiloba*
Virginia Waterleaf, *Hydrophyllum*
virginianum
Showy Orchis, *Orchis spectabilis*
Smooth Sweet Cicely, *Osmorhiza longistylis*

Mayapple, *Podophyllum peltatum*
Solomon's Seal, *Polygonatum biflorum*
Bloodroot, *Sanguinaria canadensis*
False Solomon's Seal, *Smilacina racemosa*
Star Chickweed, *Stellaria pubera*
Perfoliate Bellwort, *Uvularia perfoliata*
Common Blue Violet, *Viola papilionacea*,
and other blue and white violets

Fall Wildflowers

(these will be found at the edge of the woods,
along trails, and in clearings)
Common Blue Wood Aster, *Aster cordifolius*
Upland Boneset, *Eupatorium sessifolium*
Blue-stem Goldenrod, *Solidago caesia*

PLANTS FOR STEEP, ROCKY SLOPES

Tall Trees

Chestnut Oak, *Quercus prinus*
Pignut Hickory, *Carya glabra*
American Beech, *Fagus grandifolia*

Medium Trees

Sassafras, *Sassafras albidum*

Small Trees

American Chestnut, *Castanea dentata*
Redbud, *Cercis canadensis*

Shrubs

Huckleberries, *Gaylussacia* species
Witch Hazel, *Hamamelis virginiana*
Mountain Laurel, *Kalmia latifolia* - PLEASE
BUY THE SPECIES, NOT CULTIVARS,
which will seriously skew the gene pool.
Pinxterbloom, Wild Pink Azalea,
Rhododendron periclymenoides (formerly
R. nudiflorum)
Blueberries, *Vaccinium* species (most
common is Lowbush Blueberry, *V.*
vacillans; Highbush Blueberry, *V.*
corymbosum, from which our cultivated
blueberries are bred, is common; Maine
Lowbush Blueberry, *V. angustifolium*, is
more common in the mountains but is
sometimes found here)
Maple-Leaf Viburnum, *Viburnum*
acerifolium

Groundcovers

Striped or Spotted Wintergreen, *Chimaphila*
maculata
Trailing Arbutus, *Epigaea repens*

Herbaceous Plants

(all are ornamental)
Maidenhair Fern, *Adiantum pedatum*
Rue Anemone, *Anemonella*
Alumroot, *Heuchera americana*
Christmas Fern, *Polystichum acrostichoides*
Wild Stonecrop, *Sedum ternatum*
Wild Pink, *Silene caroliniana*
Star Chickweed, *Stellaria pubera*

PLANTS FOR DRY RIDGETOPS AND SUNNY SITES

Tall Trees

Scarlet Oak, *Quercus coccinea*
Tulip Poplars and Red Maples without having
to plant them. They are pioneer trees,
brought by the wind

Medium Trees

Black Cherry, *Prunus serotina*
Post Oak, *Quercus stellata*
Red Mulberry, *Morus rubra*,

Small Trees

Redbud, *Cercis canadensis*
Dogwood, *Cornus florida*
Black Haw, *Viburnum prunifolium*

Shrubs

Pasture Rose, *Rosa carolina* and *R. virginiana*

Herbaceous Plants

Butterflyweed *Asclepias tuberosa*
Bee balm, *Monarda didyma*
Horse balm, *Monarda punctatum*
Hardy ageratum, *Eupatorium coelestinum*
American Columbine, *Aquilegia canadensis*
Goldenrods, *Solidago* species
Indian hemp, *Apocynum cannabinum*
Violets, *Viola* species
Moss Phlox, *Phlox subulata*
Native grasses

Sources of Native Plants for the Middle Atlantic Region

This is a list of nurseries whose stock is made up partially or entirely of native plant species.

It is a list of suppliers -- not endorsement by the Maryland Native Plant Society.

There is a list of plants native to Prince George's County obtainable by calling the Maryland National Capital Park & Planning Commission at 301/952-3195 (\$2/copy).

Lists of plants suggested for conservation, restoration and landscaping in Virginia and lots of other relevant information can be found care of Virginia's Natural Heritage Program

<http://www.state.va.us/~dcr/dnh/native.htm>.

There is a list of Maryland plant communities care of Maryland's Natural Heritage Program.

<http://www.dnr.state.md.us/wildlife/>

There is also a list of Chesapeake Bay region native plant sources from U.S. Fish and Wildlife

<http://www.fws.gov/r5cbfo/Nursery.htm>

Retail and Wholesale

(H) = herbaceous plants only

Botanique Nursery (carnivorous plants) Robert Sacilotto / Butch Bailey 387 Pitcher Plant Lane Stanardsville VA 02297 http://www.pitcherplant.com kbailey@mail.rlc.net	Fiddler's Green Nursery 3907 Old Taneytown Road. Taneytown MD 21787 (410) 751-0424 Ernst Conservation Seeds Calvin Ernst 9006 Mercer Pike Meadville PA 16335 (814) 336-2402 (800) 873-3321 fax (814) 336-5191 cernst@gremlan.org	Natural Landscapes Jim Plyler 354 North Jennersville Road West Grove PA 19390 (610) 869-3788 Noback's Farm Nursery (H) Millie Noback RD 1 P.O. Box 1698 Brodbeck PA 17329 (717) 235-0419 Redbud Native Plant Nursery 1214 Middletown Road, Glen Mills, PA 19342 (610)358-4300, (No mail order) Richard Schubach 3703 Stepping Stone Lane, Burtonsville, MD 20866 (301) 672-1562 Sunshine Farm & Garden (H) Barry Glick Route 5 IR Renwick WV 24966 (304) 497-2208 Toadshade Wildflower Farm Randi V. Wilfert Eckel 53 Everittstown Road Frenchtown NJ 08825 (908) 996-6658 Virginia Natives (H) Mary Painter Box 18 Hume VA 22639 (540) 364-1665	WaterWays Nursery (H) Sally Kurtz 13015 Milltown Road Lovettsville VA 20180 (540) 822-5994 http://members.aol.com/wwnursery/index.html Wild Earth Native Plants Richard Pillar 49 Mead Avenue Freehold NJ 07728 (732) 308-9777 Wildlife Landscapes Daryl Dutrow 14812 Jarrettsville Pike Monkton MD 21111 (410) 667-9453 wildland@erols.com Wings and Wildflowers Denise Gibbs (301) 253-6903 monarch301@starpower.net Specializing in nursery- propagated native butterfly nectar and host plants for Mostly herbaceous. By appointment only. Yellow Springs Farm Al Renzi 1165 Yellow Springs Road, Chester Springs, PA 19425 610-827-9204
Doyle Farm Nursery (H) Jacqueline Doyle Christina Boitel 158 Norris Road Delta PA 17314 (717) 862-3134 Edge of the Woods Nursery Louise Schaefer 8718 Claussville. Rd. Fogelsville, PA 18051 (610)442-2496 lschaefer@edgeofthewoods.biz www.edgeofthewoods.biz Elk Ridge NatureWorks (H) Lizabeth A. McDowell 283 Elk Ridge Lane Grantsville, MD 21536 (301) 895 3686 www.elkridgenatureworks.com info@elkridgenatureworks.com only 10 species but more to come! Enchanter's Garden Peter Heus HC77 Box 108 Hinton WV 25951 (304) 466-3134	Jay's Native Trees Leo and Diane Jay RD# 1 Box 1369 Beavertown PA 17813 (570) 658-7568 jayleodi@ptd.net Kollar Environmental Service Stanley A. Kollar Jr. 520 West Heaps Road Pylesville MD 21132 (410) 836-0500 Lower Marlboro Nursery Mary Stuart Sierra P.O. Box 1013 Dunkirk MD 20754 (301) 812-0808 mssierra@lowermarlboronursery.com www.lowermarlboronursery.com Native & Aquatic Nursery Church Road Harleysville PA 19438 (610) 584-6302		

Wholesale Only

Appalachian Nurseries, Inc.
P.O. Box 87, Waynesboro, PA 17268
(717) 762-4733

Bluemount Nursery
2103 Bluemount Road,
Monkton, MD 21111
(410) 329-9226

Bobtown Nursery
16212 Country Club Road,
Melfa, VA 23410
(757) 787-8484

Chesapeake Native Nursery
Sara A. Tangren, Ph.D.,
326 Boyd Avenue #2,
Takoma Park MD 20912
(301) 270 4534
(703) 675 3673 cell phone
(plants and seeds, Chesapeake
watershed ecotypes only)

Clear Ridge Nursery Inc.,
Joseph R. Barley,
217 Clear Ridge Road
Union Bridge, MD 21791
(410) 848-4789
fax (410) 848-5806

Coldwater Pond Nursery
600 S. Marbletown Rd.
Phelps, NY 14532
(315) 331-8068
fax (315) 331-9106
(woody only)

Heartwood Nursery
Sue Dieter,
2121 Blue Mount Road,
Monkton, MD 21111
(410) 343-0390
fax (410) 357-8799
(woody only)
www.heartwoodnurseryinc.com

Maryland Natives
Roy List and Mike McConnell,
9120 Hines Road,
Baltimore, MD 21234
(410) 529-0552
fax (410) 529-3883
mdn@qis.net

North Creek Nurseries, Inc. (H)
Dale Hendricks,
RR 2, Box 33,
Landenberg, PA 19350
(610) 255-0100
fax (610) 255-4762
ncreek@dca.net

Octoraro Native Plant Nursery
Jim MacKenzie,
6126 Street Road,
Kirkwood, PA 17536
P.O. Box 24,
Oxford, PA 19363
(717) 529-3160
fax (717) 529-4099
octoraro@epix.net

Pinelands Nursery
Don Knesick,
323 Island Road,
Columbus, NJ 08022
(609) 291-9486
fax (609) 298-8939
sales@pinelandsnursery.com

Signature Horticultural Services (H)
Kevin Fabula, Freeland, MD
(410) 329-6466
fax (410) 329-2156

Sylva Native Nursery & Seed Co.
Mike Hollins,
3815 Roser Road,
Glen Rock, PA 17327
(717) 227-0486 Fax (717) 227-0484
(woody only)
sylvanative@aol.com
www.sylvanative.com

Three Springs Nursery
4320 Damascus Road;
Laytonsville, MD 20879
301-570-0556
fax 301-774-7406
threespg@erols.com
(mostly woody)

Water's Edge Nursery (H)
Scott Haschen
6526 Dion Road;
Federalsburg, Maryland 21652
410-479-9037
(wetland plants)

Non-Profits

Adkins Arboretum,
12610 Eveland Road,
Ridgely, MD 21660
410-634-2847
www.adkinsarboretum.org
adkinsar@intercom.net

Environmental Concern, Inc.
201 Boundary Lane,
P.O. Box P,
St. Michaels, MD 21663
(410) 745-9620, (410) 745-3517 fax
horticulture@wetland.org
www.wetland.org

Meadowview Biological Research
Station
Phil Sheridan,
8390 Fredericksburg Turnpike,
Woodford, VA 22580
(804) 633-4336
meadowview@pitcherplant.org
(only Drosera and Sarracenia)

Temple University
Native Plant Propagation
580 Meetinghouse Road,
Ambler, PA 19002
(215) 283-1330

Please send updates, corrections, and suggestions to
Maryland Native Plant Society
PO Box 4877
Silver Spring, MD 20914
mnps@toad.net
www.mdflora.org

MNPS - member native plant professionals

from information supplied in membership application

Member Name and Contact Information	Sorted by County	propagater or grower	supplier	landscaper or gardener
Aislinn Adams 1420 Court Street NE Salem, OR 97301	county:	H: 503-363-7308 W: 503-378-0780		YES
Nancy Lee Adamson 1142 Mill Park Dr. Charlottesville, VA 22901	county:	H: 434 978-7537 W:	YES	YES
Jacquelin Doyle 158 Norris Road Delta, PA 17314	Doyle Farm Nursery county:	H: 717-862-3134 W: 717-862-3134	YES	YES
Alan Kettler 6923 Duke Drive Alexandria, VA 22307	Kettler Ecological Design county:	H: 703-721-1560 W: 703-721-1560		YES
Jim MacKenzie 6126 Street Road Kirkwood, PA 17536	Octoraro Native Plant Nursery county:	H: W: 717-529-3160	YES	
Virginia Lee Provenzano 1121 Hollida Lane Martinsburg, WV 25401	Virginia Provenzano Landscape Designs and Gardens county:	H: 304-267-6924 W:	YES	YES
Rebecca J. Wertime 207 Leitersburg Road Greencastle, PA 17225	Alliance for the Chesapeake Bay (Bayscapes Program) county:	H: 717-597-2213 W: 717 737-8622		YES
Carolyn E. Blakeney 3253 Henson Avenue Annapolis, MD 21403	county: Anne Arundel	H: 410-263-2593 W: 410-263-8266	YES	
Joan Casey 313 Cedar Lane Annapolis, MD 21403	county: Anne Arundel	H: 410 268-0333 W: 410 224-3990		YES
Rick Moreland 39 Mill Swamp Road Edgewater, MD 21037	RF Moreland, Ltd county: Anne Arundel	H: 301-261-4784 W: 240-274-3715		YES
Eileen M. O'Brien 620 Cedarwood Lane Crownsville, MD 21032	county: Anne Arundel	H: 410-923-3505 W: 410-923-3505		YES
Deborah M. Schwab 409 Washington St. Annapolis, MD 21403	Deborah M. Schwab, LA county: Anne Arundel	H: W: 410-268-5291		YES
Kathleen Spry 699 Windingstream Way Odenton, MD 21113	# 104 county: Anne Arundel	H: 410 672-6420 W: 410 271-4152		YES

MNPS does not endorse the people on this list. Please check references before agreeing to any work. Please let MNPS know about your experiences with this list. Please let the providers know you found them through MNPS.

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Member Name and Contact Information	Sorted by County	propagater or grower	supplier	landscaper or gardener
James Urban 915 Creek Drive Annapolis, MD 21403	H: W: 410-263-4838 county: Anne Arundel			YES
Russell J. Balge 25 Northhampton Road Timonium, MD 21093	H: 410-252-5593 W: county: Baltimore			YES
Daryl C. Dutrow 14812 Jarrettsville Pike Monkton, MD 21111	Wildlife Landscapes H: 410-667-9452 W: 410-667-9453 county: Baltimore		YES	YES
Kevin Fabula 19960 Gore Mill Road Freeland, MD 21053	Signature Horticultural Services H: 410-357-4838 W: 410-329-6466 county: Baltimore	YES	YES	YES
Robert Keller Natural Plantscapes Baltimore, MD 21236	2 Sylvanburst Ct H: 410 256-4335 W: 410 790-2416 county: Baltimore			YES
Tony Lhotsky 329 Worton Road Baltimore, MD 21221	Enviro-Art Horticultural Services, Inc H: 410 686-1843 W: 410 335-9444 county: Baltimore		YES	YES
Josephine J. Owen 308 Merrie Hunt Drive Lutherville, MD 21093	Watershed Protection Coalition H: 410-252-5515 W: 410-252-5515 county: Baltimore			YES
Mike Sherlock 2205 Chilham Rd. Baltimore, MD 21209	Hyperion Designs Mt. Washington Arboretum H: 410-367-2265 W: 410-321-8822 county: Baltimore			YES
Jeffrey Wolinski 38643 Morrisonville Rd. Lovettsville, VA 20180	Consulting Ecologist H: 240 882-4947 W: 410-274-7678 county: Baltimore			YES
Ann P. Lundy P.O. Box 16222 Baltimore, MD 21210	Landscapes by Design H: W: 410-366-9365 county: Baltimore City			YES
Zolna Russell 307 Cedarcroft Rd. Baltimore, MD 21212	Zolna Environmental Design H: 410-532-8650 W: county: Baltimore City			YES
Mary M. Alves 11895 Little Cove Point Road Lusby, MD 20657	H: 410-326-9622 W: 240 895-4964 county: Calvert			YES
Peter T Atkinson P.O. Box 61 Barstow, MD 20610	H: 410 535-9812 W: county: Calvert			YES
Mary-Stuart Sierra P.O. Box 1013 Dunkirk, MD 20754	Lower Marlboro Nursery H: 301-855-7654 W: 301-812-0808 county: Calvert	YES	YES	

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Member Name and Contact Information	Sorted by County	propagater or grower	supplier	landscaper or gardener
Frank Vleck 1690 Wakefield Valley Rd New Windsor, MD 21776	Wakefield Valley Nursery H: 410 751-7337 W: 410 635-2169 county: Carroll		YES	YES
Amy Pollock 8541 Gunston Road Welcome, MD 20693	H: 301 934-1026 W: county: Charles			YES
Deborah Herr-Cornwell 402 Talbot Avenue Cambridge, MD 21613	Herr Landscape Architecture H: 410-228-7468 W: 410-228-4533 county: Dorchester			YES
Gary Rzepecki 3710 Willey Rd Hurlock, MD 21643	H: 410 943-8046 W: 302 645-7202 county: Dorchester			YES
James W. Gallion 123 Challedon Drive Walkersville, MD 21793	H: 301-898-0678 W: 301-898-7025 county: Frederick	YES		YES
Audrey Hillman 15339 Sixes Bridge Road Emmitsburg, MD 21727	Windy Meadow Landscape Design and Garden Consultation H: 301-447-2220 W: 301-447-2220 county: Frederick			YES
Lizabeth A. McDowell 283 Elk Ridge Lane Grantsville, MD 21536	Elk Ridge Natureworks, LLC H: 301-895-3686 W: 301-895-3686 county: Garrett	YES	YES	
John B Slater 5560 Sterrett Place #302 Columbia, MD 21044	Slater Associates, Inc. H: 410-997-1138 W: 410-992-0001 county: Howard			YES
Miles Barnard 10810 Cliff Rd. Chestertown, MD 21620	South Fork Studio H: 410 778-4576 W: 410 778-1098 county: Kent			YES
Ann Hedgepeth PO Box 95 Still Pond, MD 21667	Speakman Nurseries, Inc. H: 410 348-5282 W: 410 778-5838 county: Kent	YES	YES	
Roger W. Galvin 18400 Fairweather Dr. Olney, MD 20832	H: 301-570-1136 W: county: Montgomery			YES
Denise Gibbs 8619 Hawkins Creamery Road Gaithersburg, MD 20882	Wings and Wildflowers H: 301-253-6903 W: 301-916-0220 county: Montgomery	YES	YES	
Larry Hurley 10320 Saint Albans Dr. Bethesda, MD 20814	Benke Nursery Company H: 301-530-3568 W: 301-937-1100 county: Montgomery		YES	
Joan M Janssen 9905 Dilston Rd Silver Spring, MD 20903	Cityscapes Landscaping, Inc. H: 301 252-3672 W: 301 408-2560 county: Montgomery			YES

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Member Name and Contact Information	Sorted by County	propagater or grower	supplier	landscaper or gardener
Marjorie O. Litman 6903 Hillmead Road Bethesda, MD 20817	county: Montgomery	H: 301-469-446 W:	YES	
Fran McClure 11526 Highview Avenue Silver Spring, MD 20902	county: Montgomery	H: 301-933-2587 W: 301-933-2587		YES
Robert W. Pickett 10713 Meadowhill Road Silver Spring, MD 20901	county: Montgomery	H: 301-681-1511 W:		YES
Dominic Quattrocchi 2210 Colston Drive, Apt. 301 Silver Spring, MD 20910	county: Montgomery	H: 301-237-8733 W: 301-495-1323		YES
Jenny Reed 402 Boyd Ave. Takoma Park, MD 20912	Gardens by Design county: Montgomery	H: 301 891-1569 W:		YES
Sara Tangren 326 Boyd Avenue Suite 2 Takoma Park, MD 20912	Bloomin' Natives / Natural Heritage Rescue county: Montgomery	H: 301-270-4534 W: 301-270-4534	YES	YES
William R. Boone Jr. 10101 Old Franklin Avenue Seabrook/Lanham, MD	county: Prince George's	H: 301-731-4350 W: 301-731-4350	YES	YES
Brenda Skarphol 3814 Oliver Street Hyattsville, MD 20782	Green Spring Gardens county: Prince George's	H: 301-927-0043 W: 703-642-5173		YES
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Sydney Vallentyne 7711 Hillmeade Road Bowie, MD 20720	St. John's Botanicals, Inc. county: Prince George's	H: 301-262-8661 W: 301-262-5302	YES	YES
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Edward Hazlett 12808 Draper Road Clear Spring, MD 21722	county: Washington	H: 301 766-8138 W: 391 766-8138		YES

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Member Name and Contact Information	Sorted by County	propagater or grower	supplier	landscaper or gardener
Clint Allen 1100 Queen St NE Washington, DC 20002	H: 202 396-1718 W: 202 895-0432 county: Washington, DC	YES		
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Barbara L. Franklin 4330 Forest Lane, NW Washington, DC 20007	Pine Island Designs H: 202-686-0882 W: 202-686-0882 county: Washington, DC			YES
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Irene S. Sinclair 5805 Potomac Avenue, NW Washington, DC 20016	Garden Designs H: 202-966-5204 W: county: Washington, DC			YES
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Promoting Pollinators in the Public Places

Habitat Conservation Workshop

September 22, 2004

**Co-sponsored by:
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Powerline Right-of-way and Pollinators

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POTOMAC ELECTRIC POWER COMPANY TRANSMISSION LINE RIGHT-OF-WAY AND POLLINATORS

INTRODUCTION

The Potomac Electric Power Company (PEPCO) is headquartered in the Nation's Capital, and serves the electrical energy needs of Washington, D. C. and the surrounding metropolitan area. The service area is supplied through a network of transmission lines on 330 miles of rights-of-way, which covers approximately 10,000 acres. Pepco's overhead transmission line rights-of-way are purchased in "fee simple" with the exception of small portion that transverses state and federal property, where easements are obtained.

One of these rights-of-way passes through the U. S. Department of the Interior's, U. S. Fish and Wildlife Service's, Patuxent Wildlife Research Center. The PWRC is world renowned for their extensive research and educational programs. Part of the PWRC is open to the public at the multi-million dollar Visitors Center. Pepco contributed to the success of this facility and there is a field observation area that depicts an optimum electric utility corridor.

For decades Pepco and PWRC has had a very successful partnership managing the vegetation in a fashion consistent with the mission of the wildlife center. The program that was established on the PWRC became the primary method of vegetation control throughout the Pepco system.

Pepco's Transmission Strategic Business Unit will continue to incorporate and be proactive in environmental stewardship as part of the integrated vegetation management program in maintaining the transmission line rights-of-way. These efforts are in joint sponsorship with Pepco's Natural Resource Management Department.

One of Pepco's environmental stewardship initiatives is the Butterfly Enhancement Project.

I. SYSTEM WIDE

PEPCO'S INTEGRATED VEGETATION MANAGEMENT PROGRAM

Potomac Electric Power Company's rights-of-way (ROW'S) are essential for the safe and reliable transmission of electricity. Tall growing trees, commonly referred to as undesirables, naturally invade and can eventually dominate ROW'S, posing a threat to electric service reliability and safety. The principal vegetation management objective is to remove these undesirable plants and promote the growth of low-growing, relatively stable plant communities. Desirable plants are compatible with electric system reliability (needing relatively little

maintenance over the life of the ROW) and, we believe, are aesthetically appealing and beneficial to wildlife.

Pepco utilizes various management tools to control and maintain the vegetation on the rights-of-way. Many factors affect the prescriptive analysis for the care taking of 10,000 acres of transmission line right-of-way. The following are the primary programs used to monitor and maintain the rights-of-way throughout the Pepco overhead transmission system:

AERIAL INSPECTION - A contractor patrols the designated transmission and sub-transmission (circuits) by air. The patrol occurs twice a year, during the spring and winter. The contractor inspects the facility for unauthorized activity, erosion and vegetation problems, as well as for broken insulators and wires.

BARRICADE AND DEBRIS - This program is used for removing illegally dumped debris from Company property, the construction of barricades to prevent vehicles from trespassing onto Company property and soil restoration to prevent erosion.

BRUSH CONTROL - The primary purpose of this program is to control undesirable trees with herbicide application. In addition to the herbicide work there will be other vegetation control work, both manual and mechanical. This also includes some tree trimming and other miscellaneous work.

CONFLICT TREE - This work is primarily the trimming and removal of those trees which are outside the bounds of the transmission line rights-of-way that, if the tree fell toward the transmission facilities within the next 10 years, could damage those facilities or cause an interruption in service.

TRACTOR MOWING - In this program, the contractor mows the grass and weeds on Pepco's rights-of-way. This is usually in the more urban areas or where housing developments are adjacent to the rights-of-ways. The work is typically performed with a farm tractor pulling a "bush-hog" mower.

THE 230,000 VOLT OUTAGE

During 1998, we experienced an electrical outage on one of the 230kV circuits due to a single tree that grew into the wires. Six other trees were found burning in the wires. After a system wide aerial and ground inspection, approximately 350 trees were considered too close to the wires and had to be removed before the next growing season. The entire vegetation management program was re-evaluated and we concluded that more intensive (control of the vegetation) ROW maintenance practices must be achieved. The vegetation density of undesirable species was too high. The test plots revealed in many locations 25,000 to 30,000 stems per acre. A reasonable manageable level of 2,000 stems per acre is acceptable. The heights of a majority of the undesirable species were over 10 feet, upwards to 35 feet. The dense, high growing vegetation could fuel an out of control fire resulting in damage to the towers and wires. Pepco would be unable to transmit electricity and a major power outage would occur.

In order to successfully recapture our ROW'S, three goals must be achieved:

- 1) Reduce the stem density of undesirable species and undergrowth, which makes our ROW'S inaccessible *and more costly to maintain*.
- 2) Reduce the height of all species to less than 10 feet, thereby increasing reliability.
- 3) Extend all management practices to the edge of our property, thereby recapturing the full extent of the ROW and reducing the encroachments of vegetation onto our property.

To reach our goals, we developed the program of "meadow management - a low profile shrub/scrub plant community." The initial phase of this program is to mow, a **one-time** process, all vegetation and treat the area with a herbicide to limit the undesirable type of woody species from resprouting. The rights-of-way are then maintained on a four-year cycle. Henceforth, only a selective basal application of herbicide will be used to treat the undesirable species and any undesirable species over ten feet will be removed. Thus, creating a low profile shrub/scrub plant community that is beneficial to wildlife habitat and compatible with providing safe and reliable electric service.

This "meadow management" approach was presented to a jointly sponsored Edison Electric Institute and U.S. Fish & Wildlife Service seminar that was held at the Patuxent Wildlife Research Center on October 26, 1998. Participants were from EEI, BGE, Connectiv, AEP, Fish and Wildlife Service-National Conservation Training Center, PWRC and Pepco.

The development of the Integrated Vegetation Management Plan (IVMP) is critical to the success of the Company's goal in providing safe and reliable electric service. The IVMP is a dynamic management tool. Over the years, we have maintained our ROW'S consistent with corporate direction. The rights-of-way had established a mini-forest underneath the high voltage power lines. This management practice had to change.

I. BUTTERFLY ENHANCEMENT PROJECT

In western Montgomery County Pepco is enhancing an area on the Dickerson to Potomac River 230kv transmission line right-of-way, to provide for butterfly habitat. Transmission line rights-of-way consist of many ecosystems as they transverse across the country.

Butterfly populations are an integral part of this complex community in that they are the great pollinators of flowers and provide food for wildlife and add to the beauty of nature's surroundings. In developing the Butterfly Enhancement Project (BEP), Pepco's meadow management program is to remove all of the trees under the transmission lines in selected areas, bushhog everything near ground level and use selective herbicides to prevent rapid regeneration of all woody perennials the first year. This permits the dormant annual and perennial seeds of grasses and herbaceous plant material to germinate and grow. The second year, and thereafter, all woody perennial seedlings of taller growing species are spot treated with a selective herbicide. The low growing wildlife habitat can be reestablished and maintained in this manner.

The BEP is a joint partnership with the Washington Area Butterfly Club (Pat Durkin), the International Butterfly Breeders Association (Jay McRoberts), Maryland-National Capital Park and Planning Commission (Dennis Gibbs) and Pepco.

We will selectively introduce as many native butterfly nectar and larva host plants as possible, along with the naturally occurring herbaceous vegetation. One area will be maintained as a control section and allow only the natural low growing vegetation to germinate. There is approximately six acres on the right-of-way that was timbered, mowed and treated in the spring of 1999 (See attached drawing). Only a partial growing season elapsed from the time of mowing and treatment, thus germination did not reach its full extent. However, the herbaceous growth, even with the severe drought, was impressive.

Jay McRoberts said, "Pepco's approach to these scrublands is impressively butterfly friendly, and might be something IBBA could advocate with other power companies once we become more informed of the details." Pat Durkin of the WABC has already begun contacting other electric utility companies in the pursuit additional butterfly habitat.

Pepco continues to strive to be good stewards of the environment. Several other initiatives the company has embarked on are riparian enhancement, bayscapes and raingardens, bog conservation/preservation, wild turkey habitat enhancement and seeking recognition in a program called Project Habitat by BASF (Co-sponsor is the Butterfly Lovers International).

The potential conservation value of unmowed powerline strips for native bees

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Abstract

The land area covered by powerline easements in the United States exceeds the area of almost all national parks, including Yellowstone. In parts of Europe and the U.S., electric companies have altered their land management practices from periodic mowing to extraction of tall vegetation combined with the use of selective herbicides. To investigate whether this alternate management practice might produce higher quality habitat for native bees, we compared the bee fauna collected in un-mowed powerline corridors and in nearby mowed grassy fields at the Patuxent Wildlife Research Center (MD). Powerline sites had more spatially and numerically rare species and a richer bee community than the grassy fields, although the difference was less pronounced than we expected. Powerline sites also had more parasitic species and more cavity-nesting bees. Bee communities changed progressively through the season, but differences between the site types were persistent. The surrounding, non-grassland landscape likely has a strong influence on the bee species collected at the grassland sites, as some bees may be foraging in the grasslands but nesting elsewhere. Improving habitat for native bees will help ameliorate the loss of pollination services caused by the collapse of wild and managed honeybee populations. This study suggests that powerline strips have the potential to provide five million acres of bee-friendly habitat in the U.S. if utilities more generally adopt appropriate management practices.

Keywords: native bees, powerline corridors, rights-of-way, vegetation management, species richness, nesting habitat

Running title: *Native bees and powerlines*

1. Introduction

1.1 Importance of wild bees

There are roughly 20,000 species of bees described to date (Michener, 2000), and this number is likely to continue to grow as biodiversity collections intensify in the developing world. Based on species number alone, this group represents a substantial component of biodiversity worldwide. Additionally, bees are widely recognized as one of the main providers of pollination services. Second only to wind as transporters of pollen, bee activities not only provide a necessary component of reproduction for many flowering plants, but also enhance fruit set and size, seed production and viability, seedling vigor, and genetic diversity. This alone is sufficient cause for interest in the health of bee populations, but they are also critically important economically. Bees are responsible for the propagation of many garden flowers, most consumable fruits and vegetables, many fiber crops like flax and cotton, and forage crops such as alfalfa and clover. More than 66% of the world's 1500 crop species have one or more cultivars requiring visits by bees (Roubik 1995), and it has been estimated that bees are required in some way for 15–30% of worldwide food production (McGregor, 1976). In 1980, the total value of bee-pollinated crops in the U.S. was estimated at \$18.9 billion (Levin, 1983). Evidence suggests that crop pollination in North America is

accomplished by some combination of managed honeybees, wild honeybees and native bees (Michener, 2000; McGregor and Levin, 1970), though the relative contribution of each remains controversial. Based on a model by Southwick and Southwick (1992), the estimated value of non-honeybee pollinators to American agriculture is between \$4.1 and \$6.7 billion annually (Nabhan and Buchmann, 1997).

1.2 Bees in decline?

The number of managed colonies of honeybees reported on agricultural land in the U.S. declined 57% from 1985 to 1997 (Nabhan and Donovan, 2000). Managed colonies in general have declined by almost 50% since 1945, by 25% during the 1990's alone (Allen-Wardell et al., 1998) and by 6.1% from 1999 to 2002 (www.usda.gov/nass/pubs/estindx2.htm). Information on feral honeybee colonies is rare and only available from small scale studies. One such study documented an 85% decline in colonies over a ten-year period (Loper, 1995). Although much of the decline of honeybees in this country and elsewhere can be attributed to species-specific causes such as mite infestations, disease, and the invasion from South America of Africanized honeybees, as well as increased efficiency in colony management and the ageing of the bee keeper population, it is likely that land alteration and pesticide use also play an important role. Regardless of the causes of the decline, it is no longer prudent to rely on a single species to provide the bulk of the pollination services required for agriculture and the reproduction of native plants. Just as we have perhaps given managed honeybee populations too much credit in terms of their contribution to agriculture in the U.S., we cannot assume that native bee populations will be able to spontaneously pick up the slack left by dwindling honeybee populations. It is likely that land-use changes and pesticides are having an effect on native bees as well. Evidence from Great Britain, Germany, Austria, Poland and Russia suggests that wild bee populations are in a state of serious decline, driven most likely by the intensification of agriculture and related activities (see O'Toole, 1993 for a review). Due to a lack of baseline data their status in North America has not been adequately documented, though it seems unlikely that the decline is a strictly European phenomenon.

1.3 Bees' needs

To thrive, bees need adequate floral resources in the form of pollen and nectar, an appropriate site to nest, and for some species, access to specific nest-building materials. These requirements are rarely all found in the same habitat, so bee species tend to make use of parts of multiple habitats within a landscape (Westrich, 1996). Historical farming practices were not necessarily a problem for most bees, as small crop fields provided additional foraging resources and abundant hedgerows, fencerows and field margins could provide much needed nesting habitat. However, modern agricultural practices have likely caused and will continue to cause much more severe obstacles for healthy bee populations, due to differences in the spatial aspect of modern fields (larger monocultures with less area conducive to nesting bees) as well as modern reliance on pesticides (Banaszak, 1996; Steffan-Dewenter et al., 2002, O'Toole, 1993). In addition to changes in the spatial arrangements of fields and the resultant decrease in the amount of suitable nesting habitat, the expansion of agricultural land devoted to grain crops—which are wind pollinated—greatly reduces the forage for wild bees in these areas (Cane and Tepedino, 2001). This is likely to be particularly relevant in parts of the midwestern United States where approximately 20% of the total land area is planted with these crops (www.nass.usda.gov). Certainly, wild bees in many areas are faced with reduced nesting and/or foraging options. On top of this, pesticide use is probably taking its own toll. There have been a few studies in North America that relate the application of insecticides to substantial reductions in seed and fruit production of local crops through the decimation of local bee populations (Johansen, 1977; Kevan and Plowright, 1989). Also, Kremen et al. (2002) found that the diversity and abundance of native bees was too low to effectively pollinate water-melon fields in areas either far from natural habitat or which made use of pesticides—only the fields of organic farms near refuge sites had adequate visitation. Though small in scale, these studies suggest that pesticide use and nest site availability can have a measurable effect on bee populations and therefore pollination. As wild bee populations are highly variable, it is likely that only a diverse fauna will offer the necessary redundancy to ensure adequate pollination from year to year (Cane and Payne, 1993; Roubik, 2001). This

idea was corroborated by the study conducted in the Californian watermelon fields, where annual variability in species composition did not appear to affect pollination success in areas with high bee diversity (Kremen et al., 2002).

Outside of the agricultural landscape, urban development and sprawl is another likely cause of bee declines, through fragmentation effects and general reduction in habitat. A number of studies have documented declines in pollinator services in isolated natural habits (Pavlik et al., 1993; Percy and Cronk, 1997; Aizen and Feinsinger, 1994a,b; Steiner and Whitehead, 1996). It should be noted, however, that certain types of development may not be equally bad for all bee guilds (Cane, 2001) and therefore changes may not be immediately apparent when only considering species richness.

To summarize: bees need a diversity of foraging and nesting habitats, and flowering plants, either wild or planted, require a diverse bee community to ensure their reproduction. Numerous threats to the health of bee communities have been identified and so we have cause for concern. Supplementation of bee-friendly habitats should become a priority both for those interested in conserving native plants, those interested in agricultural productivity, and those interested in conserving the bees themselves.

1.4 Bee-friendly spaces?

The good news is that many bees do well in marginal and/or degraded habitats. Linear rights-of-way such as powerline easements have traditionally been thought of as an ecological negative. But in landscapes that lack sufficient early-successional habitat, due to either re-forestation, agriculture or intensive development, such land could provide a valuable resource. Studies in Europe have concluded that bee diversity can be high in abandoned fields, roadsides, hedgerows, railway lines and other similar habitats (see Matheson et al., 1996), and that these areas can host source populations of many bee species, even if relatively small and surrounded by inhospitable development.

Although we are unaware of any studies directly addressing the effect of powerline rights-of-way on bee abundance and diversity, there is a growing body of evidence to suggest that they provide regionally important foraging and nesting sites for early-successional bird and mammal species (Marshall and VanDruff, 2002; King and Byers, 2002; Marshall et al., 2002; Confer, 2002; Litvaitis, 2001; Macreadie et al., 1998; Knight and Kawashima, 1993; Johnson et al., 1979). The data on invertebrates are much less extensive. Despite many anecdotal reports indicating the value of powerline rights-of-way for insect species (entomologists and enthusiasts know to visit powerline ROW during collecting trips), quantitative data are sparse (but see Lanham and Nichols, 2002; Barbour, 1997; Lowell and Lounsbury, 2002). Survey work suggests that rare species of insects in the Northeast are often, and sometimes only, found in utility corridors (D. Wagner, personal communication; T. Lautzenheiser, personal communication).

Some studies have found that powerline rights-of-way promote fragmentation and serve as barriers for certain vertebrate groups, but even in these cases, it is generally found that these effects are mitigated in areas where the vegetation is allowed to reach a certain density and/or the corridor is kept to a smaller width (Goldingay and Whelan, 1997; Goosem and Marsh, 1997). Within rights-of-way, bird abundance has been correlated with vegetation complexity (Kroodsma, 1982; Marshall and Van Druff, 2002), and a greater density and diversity of birds has been found in sites treated with selective herbicides compared to those that are periodically mowed (Confer, 2002). Finally, Marshall et al. (2002) concluded that although mowed sites had slightly higher avian density and nesting success compared with sites treated with selective herbicides, ultimately the mowed sites would be less valuable due to their lack of stability (the study was conducted several years after mowing, and the sites were due to be mowed again within the next two years, thereby destroying existing nesting habitat).

Currently, there is substantial variation in management practices in the U.S., as it is up to individual power companies how they manage their own land. Most powerline rights-of-way are periodically cleared of all vegetation either by mowing, herbicide application, or bush-hogging (mowing

down of tall vegetation). In reaction to the backlash against the use of chemicals in the 70's, most utilities initiated management strategies that involved periodic mowing exclusively. Recently many companies are attempting to move away from mowing and towards the use of *selective* herbicides and manual extraction of tall vegetation. This management strategy is ultimately more cost-effective, as site visits become less frequent over time due to the tree-repellant nature of the resulting dense scrub communities (Calvin Layton, NSTAR Senior Arborist, personal communication).

A recent study in Israel by Potts et al. (2003) found that the three most important determinants of local bee diversity were diversity of flower species, nesting substrate diversity and number of years post fire. Based on the availability of floral resources and potential nesting sites, we would predict that bee diversity would be highest in the stable, dense scrub habitat of the un-mowed rights-of-way. To investigate the utility of power-line rights-of-way as quality habitat for bees, we measured the bee communities of sites under powerlines located on the Patuxent Wildlife Research Center (PWRC) in Laurel, Maryland. Because only small sections of the rights-of-way on the refuge are mowed, we also surveyed bees in nearby, annually mowed fields as a point of comparison.

2. Methods

2.1 Study area

All sampling areas were located on the Patuxent Wildlife Research Center, a 5,160 hectare National Wildlife Refuge surrounding the Patuxent and Little Patuxent Rivers between Washington, D.C. and Baltimore, MD. The reserve was developed specifically for wildlife research and encompasses a wide range of habitat types, including forest, meadow and wetland areas. Specifically, study sites were located in Anne Arundel County and Prince Georges County, Laurel, Maryland.

Two power companies have overhead transmission lines on Patuxent land. In the 1960's, Potomac Edison Power Company (PEPCO) constructed a 5.6 kilometer overhead transmission line and in the early 1970's, Baltimore Gas and Electric (BG&E) constructed a new, 8.9 kilometer overhead transmission line on Patuxent land adjacent to an existing facility. In conjunction with Patuxent scientists, BG&E and PEPCO developed vegetation management plans for the rights-of-way that would be least likely to negatively impact the resident or migrant wildlife community. These plans, though complex in detail, generally prohibit the use of non-selective herbicides and periodic mowing of the majority of land under the lines. Instead, management consists of periodic (every 4–5 years) selective basal spraying of tall growing trees, and the removal of all trees and topping of all shrubs greater than three meters. As a consequence, the habitat beneath the powerlines at Patuxent can be characterized as dense scrub in most areas, although there is considerable variation due to soil type and drainage. We did not conduct vegetation surveys in our study plots, but a general survey of the vegetation of the rights-of-way in the southern and central tracts of PWRC was conducted in 2000 (Bridgeland, 2001). The following 11 species were most commonly recorded: *Viburnum dentatum* (51), *Smilax rotundifolia* (49), *Vitus* spp. (30), *Gaylussacia frondosa* (29), *Gaylussacia baccata* (25), *Lyonia ligustrina* (19), *Rhus copallinum* (17), *Rosa multiflora* (17), *Ilex opaca* (16), *Eleagnus commutata* (16). Additional commonly occurring species with high stem densities were: *Vaccinium corymbosum*, *Lonicera japonica*, and *Amerlanchier arborea* (the figure in parentheses is the percentage of the 66, 1x10m transects in which the species was detected).

The goal of the present study was to see if powerline rights-of-way managed for scrub could provide quality habitat for bee species and whether or not the quality of this habitat is superior to that provided by mowed powerline rights-of-way. We decided to restrict our sampling to the refuge for practical reasons and also because a secondary goal of this work was to compile a species list of bees for the area. Because of this decision, we did not have access to annually or bi-annually mowed powerline rights-of-way and so as a surrogate, we chose nearby annually mowed fields of comparable width. Fields were mowed shortly before sampling began in April.

2.2 Sampling design

Using a grid map of PWRC, we numbered all the available powerline sites along the two rights-of-way found on Patuxent property. We did the same for all known mowed field areas. We used a random number generator to select two powerline sites and two grassland sites in April, and three powerline and three grassland sites in each of May and June, for a total of sixteen study sites (Figure 1). It should be noted that although the eight powerline sites were located along only two different sets of transmission lines, that the sites were considerably separated in space, often with roads or fences separating them. No two sites sampled in the same sampling period were ever within sight of each other.

The probability of bees foraging, and thus of being sampled, varies considerably with weather conditions (Vicens and Bosch, 2000). Thus, in order to legitimately make faunal comparisons between sites, it was necessary to survey all sites within a consistently narrow window of time on a single day. This limited the number of sites we could reasonably visit during each sampling round, which is why the sixteen sites were spread over three sampling periods. Collecting over three months, however, has the added benefit of enabling us to measure changes in the bee community over time, and to evaluate whether differences between sites are consistent over the season.

When we began this study, there were no widely accepted methods for standardized, quantitative sampling of bees. Most bees are nearly impossible to identify to species in the field, and so collections typically involve killing the bees for transport and examination in the laboratory. Perhaps the most common method for collecting bees is sweep netting, but this method is very time-intensive, and results likely vary significantly with experience level of the collector. Although we could not find published evidence for bees, studies on other arthropods have demonstrated significant differences in collector efficiency (Coddington et al., 1996; Dobyns, 1997) and in particular demonstrated that certain sampling methods such as sweep netting and hand collection can be more susceptible to collector bias than others such as pitfall trapping and litter extraction (Norris, 1999). One of the secondary goals of this study was to evaluate a potentially unbiased and time-efficient method of bee collecting that would be more amenable to cross-site comparisons. To this end, we made use of modified pan traps. Pan traps, while not impacted by observer bias, do not sample all bees in proportion to their occurrence as trappability varies with species. Pan traps do allow you to sample throughout the day, and to sample simultaneously in a wider area than would be possible with sweep netting. Our pan traps, hereafter referred to as “bee bowls”, consisted of brightly-colored plastic party bowls, six inches in diameter, filled with water mixed with a small amount of unscented Ivory soap (Kirk, 1984; Kearns and Inouye, 1993; McIntyre and Hostetler, 2001). The soap breaks the surface tension, preventing insects that land on the surface from flying off again. Bees that are attracted to the bowls slip into the water and quickly drown. Four colors of bowl were used: light blue, dark blue, yellow and white. These colors are common in bee-pollinated flowers. The bowls at each site were arrayed in five sets of eight bowls each, for a total of 40 bowls. The eight bowls in each set were arranged in a circle of approximately 7m radius, and the five sets were distributed along a linear transect with 25m between sets (Figure 2). The transects were placed in the center of each site, which meant directly under the transmission lines in the powerline strips and in the area maximizing the distance from bordering vegetation in the grassland sites. The bowls were cleared once a day for five consecutive days during each sampling period. Due to constraints on time and resources, bees were not separated based on bowl color, but instead were lumped by sampling location (i.e., all bees collected in each set of 8 bowls were combined into one collection unit). Initially, some sweep net collecting was conducted at each site but yield was so comparatively low and effort comparatively high that we abandoned this method after the April collections. Interestingly, there was a high degree of overlap between the sweep net samples and bee bowl samples in April, thus we feel that eliminating this method did not likely affect our results significantly.

Bees were kept in 70% alcohol until they were pinned. Bees were sorted to genus using Michener et al. (1994) and then to morphospecies. Approximately 75% of the morphospecies were then identified to species using Mitchell (1960, 1962) and other sources including museum collections. Although we are

confident in all our genus identifications, there is likely some error in our species designations as none of the authors were officially trained in bee taxonomy. Still, the error was entirely blind (analysis did not begin until the identifications were finished), and the time cost of waiting for confirmation of all identifications by the relevant specialists in each group outweighed the desire for 100% accuracy.

2.3 Data Analysis

Analysis of variance was used to look for differences in bee abundance and species richness between the site types. We performed a two-way crossed ANOVA with site type (powerline and grassland) and month (April, May, June) as treatments. We performed an ordination (Canonical Correlation Analysis) to see if site types would fall out together based on the relative abundance of species collected. To further explore the differences between the two site types in terms of species identity, we considered the distribution of species across sites with respect to rarity, nesting preference and trophic level (parasitic vs. nonparasitic). Bees were classified with respect to nesting preference and trophic level based primarily on genus membership (Table 1). Finally, to assess the degree of species overlap between the site types, we calculated species turnover (following Russell et al., 1995) and Jaccard Similarity (following Magurran, 1988) for all pair-wise comparisons within a sampling period. ANOVAs were performed using JMP software (3.2.1) and ordinations were performed using Mathematica (4.2), following the techniques in Legendre and Legendre (1998). Estimates of richness and diversity were calculated using EstimateS software (Colwell, 2000, version 6.0b1). Turnover and similarity indices were calculated using Matlab and EstimateS, respectively.

Morphospecies were included in all analyses unless indicated otherwise. However, in cases where there were male and female morphospecies within a genus collected at different sites and times, these data were eliminated because it was impossible to tell if the male and female morphospecies represented one or two species. In addition, two species in the genus *Ceratina* were combined into one, as there is no reliable method to distinguish females of this group.

Within each sampling period, we looked for reduced yields over time as an indication that we were depleting the local population. If depletion did occur, we could use this information to form a less biased estimate of the relative numbers of individuals living in the local area based on the shape of the depletion curve. Because the population was not closed and the sampling radii that the bowls collected from were undefinable, these values must be thought of as corrected relative abundance rather than density. Some evidence for depletion was seen, but there were reversals (Figure 3). Reversals could be caused by changes in weather, the emergence of new species, or other stochastic events. Powerline sites exhibited more consistent declines in individuals caught across a 5-day sampling period than did grassland sites, particularly in April and June. Despite the lack of consistent declines, we presumed the curves provided a less biased portrait of the abundance of bees at these sites and used these numbers in addition to the raw abundance measurements to see if they produced different results.

Just as depletion curves can be used to correct for sampling bias, richness estimators can be used to predict the richness of a site based on a sample. Richness estimators can be useful when trying to compare areas sampled using different methods or with different intensity. However, results show that most richness estimators perform badly with small sample sizes (Melo et al., 2003; Cao et al., 2002; Walther and Morand, 1998; Chazdon et al., 1996). In addition, our sampling methods were standardized in space and time, so raw richness estimates should at least be comparable, even though they fall short of the true richness of the sites. Still, as a point of comparison with the analyses performed on the raw richness values, we decided to calculate richness estimates using those methods recommended in various reviews on the subject (Colwell and Coddington, 1994; Keating et al., 1998; Chazdon et al., 1996; Walther and Morand, 1998). We calculated Chao 1 and Chao 2, Bootstrap, first and second order Jackknife and Michaelis-Menton estimators using EstimateS (Colwell, 2000, version 6.0b1).

3. Results

A total of 2924 individuals were collected during the study and of those, 2887 individuals in 24 genera and 107 species were used in the analyses (Table 2).

Powerline and grassland sites did differ significantly in the number of species collected, with powerline sites having more species on average than grassland sites (32.5 species versus 23.2 species; 2-Way ANOVA, $n = 16$, $F = 8.1463$, $p = 0.0171$). There was also a significant effect of month, with the number of species declining with month from April to June ($F = 10.9301$, $p = 0.003$). There was not a significant interaction between these two factors. We re-ran this analysis using the richness estimates calculated by the methods listed above. For the estimates that produced normally distributed data (Bootstrap, first and second order Jackknife and Michaelis Menton), the results did not differ appreciably from those based on raw richness (Table 3). Richness estimates based on Chao1 and Chao2 showed no treatment effect but this was due to a single richness estimate for Site 13 that was far outside the range of the other estimates (135 species vs. 28 to 50 for the others), and therefore suspect. With site 13 eliminated from the analysis, the results were again similar to those based on raw richness (Table 3). Because of the relative uncertainty of many of our species identifications, we decided to repeat the analyses using genus richness instead of species richness. Though the whole model fell short of significance ($p = 0.1$), the data showed a similar pattern with powerlines exhibiting higher genus richness than grassland sites (12.6 vs. 10, respectively; site type effect test: $F = 6.2863$, $p = 0.03$).

There was no difference found in the total number of individuals caught between grassland and powerline sites (2-way ANOVA; $F = 1.7871$, $p = 0.2109$), although this did vary significantly by month ($F = 11.2294$, $p = 0.0028$), with most individuals collected in May (Table 2). Again, there was no interaction. Results based on abundance estimates calculated from the depletion curves were essentially the same as those based on the raw numbers (type: $F = 1.316$, $p = 0.278$; month: $F = 13.5916$, $p = 0.0014$). Although in some of the grassland sites, the vegetation had grown up substantially since being mowed in April, the fact that the decrease in abundance of bees from May to June was consistent across site types, we felt the bulk of the decline was likely due to seasonal variation rather than change in vegetation structure (and hence bowl visibility) in the grassland sites. It's possible that the large decline in bee abundance across sites was due to changes in regional floral resources. In the mid-Atlantic region of the Northeastern U.S., floral resources are most abundant in April and May, as many bulk flowering trees, understory plants and shrubs are in flower at the same time (Shetler and Wiser, 1987). As summer progresses in late May and early June, many of these resources disappear, as these plants put their energies into fruit production.

In April, floral resources in the grassland sites were sparse, consisting mostly of clover. In May and June, we observed only a few different species of flowering plants at the grassland sites, at fairly low abundance. In contrast, the scrub habitat of most powerline sites had consistently diverse and abundant flowering plants throughout the sampling season, with a moderate decrease in June. In addition, the grassland sites were structurally simple, offering fewer nest site choices. Although we did not quantify these differences, these observations led us to expect that grassland sites on their own could not support a rich fauna of bees (See Potts et al., 2003). We were surprised that the difference in richness between the site types, though significant, was not larger in magnitude. Therefore, we decided to examine more closely how the bee communities differed between the two site types. First, we looked at spatially rare species, defined as species collected at only one out of the sixteen sites. There were 28 species meeting this requirement and we wanted to know if they were randomly distributed with respect to site type. In fact, rare species were much more likely to be found in powerline sites than in grassland sites (21 vs. 7 out of 28, respectively). The consequence of this is that if you removed all the grassland sites and only collected in the powerline sites, you would lose 8% of the species, whereas in the reverse situation, you would lose 30% of the species collected. Results were similar with numerically rare species, defined as species with fewer than five individuals each. Of the 47 such species, 38 occurred in powerline sites compared to 18 in grassland sites (with nine species occurring in both).

The question remains, however, whether the bees collected at grassland sites are merely a random

subset of bees collected at the powerline sites or if they do actually exhibit differences in community identity. To address this, we considered differences in behavioral diversity. First, we looked at nesting behavior, comparing the distribution of cavity- and ground-nesting bees. Of the 36 species and 735 individuals of cavity-nesting bees, 94% of the species and 66% of the individuals were collected in powerline sites compared with 75% of the species and 34% of the individuals collected in grassland sites. Results of chi-square tests on the number of individuals showed that there were significantly more cavity nesting bees in the powerline sites (expected values based on overall abundance in the two site types = 0.556:0.444; $X^2 = 32.7$, $p < 0.001$). We performed an ANOVA as described previously, but using just the cavity-nesting bees, and found there was a significant difference in richness between grassland sites and powerline sites and a marginally significant difference in abundance ($p = 0.04$ and 0.077 , respectively). There were less pronounced differences using only ground-nesting species; of 71 species and 2151 individuals, 90% of the species and 52% of the individuals were collected in powerline sites compared with 68% of the species and 48% of the individuals collected in grassland sites, though there were significantly more ground nesting individuals in the grassland sites than expected ($X^2 = 11.5$, $p = 0.001$). The ANOVA results indicated that although there was a significant difference in richness of ground nesting bees between powerline and grassland sites ($p = 0.024$), there was no difference in abundance ($p = 0.570$). Next, we looked at trophic level, comparing the distribution of parasitic and nonparasitic species of bee. Of the 16 species and 72 individuals of parasitic bees, 100% of the species and 72% of the individuals were collected in powerline sites, compared with 50% of species and 28% of individuals collected in grassland sites. Chi-square tests on the number of individuals showed that powerline sites have more parasitic bees than expected ($X^2 = 8.1$, $p = 0.004$) whereas nonparasitic species were distributed equally between the two site types ($X^2 = 0.227$, $p = 0.633$).

Certainly there are some differences in the groups of species collected at each of the site types, but do they represent distinct communities of bees? To answer this question, we performed correlation analysis on the log-transformed abundance (plus one) of species. In this unconstrained model, the primary axis was clearly related to time, with sites clustered according to month, indicating that sites sampled in the same month were more similar in species composition than sites sampled in different months and that the change in the community was progressive from April to June. There did not appear to be separation of powerline and grassland sites along any of the next few axes. A canonical correspondence analysis with randomization test, confirmed that month was a significant predictor of species composition ($p < 0.0001$), and subsequent, unconstrained axes still showed no evident partitioning of powerline and grassland sites (Figure 4).

Turnover and Jaccard Similarity were calculated between samples from all sites surveyed in the same month. Results were highly variable, but on average, powerline sites had marginally lower turnover and higher similarity than grassland sites (0.4858 vs. 0.5496; 0.3486 vs. 0.314, respectively), though these differences are not statistically significant (based on a T-test). The range of values for the within-grassland comparisons was much higher than for the within-powerline comparisons (range of 0.42 vs. 0.2 for Turnover and 0.34 vs. 0.19 for Jaccard Similarity, respectively). As expected, cross comparisons (those comparing a grassland site with a powerline site) exhibited higher turnover (0.5628) and lower similarity (0.2881) on average than within-type comparisons. The ten comparisons with the highest turnover and lowest similarity were always either grassland sites or cross-comparisons.

4. Discussion

The scrubby habitat of the powerline rights-of-way on the Patuxent Research Refuge appears to be home to a richer bee community, both in terms of raw richness and community composition, than the tall grass habitat of annually mowed fields. Powerline sites had more spatially rare species, more cavity nesting bees and more parasitic species than grassland sites. But based on the availability of floral resources and diversity of potential nesting sites observed in the two habitat types surveyed in this study, we had predicted a much larger and more consistent difference in observed richness than was apparent.

There are two potentially relevant sampling issues that may have had an impact on our results. Both relate to our choice of sampling method, but in different ways.

First, our use of a passive collecting method instead of searching for nesting bees meant that we had no way of knowing if the bees we collected were residents, foragers, or both. Certainly, hand collecting at flowers would also not allow us to distinguish foragers from residents, but flowers are resources that are definitively present in the site. Our use of floral-colored bee bowls provides an added visual attractant to bees. As mentioned before, these were not closed systems and certainly many bee species are known to fly hundreds of meters or more in search of food and pollen. It is therefore likely that many bees caught were merely on a foraging trip and were attracted to the color of the bowls. On the other hand, the fact that there was some evidence for depletion after five days of collection indicates that neither are these systems entirely open. We believe there is evidence to suggest that these two site types differ in their degree of openness in a way that tempers the differences in the bee communities apparent in the samples. Looking at the depletion curves, it is obvious that particularly in April and June, grassland sites exhibit much less consistent declines in yield over time. This could be because the bowls in the powerline sites were sampling predominantly the local bee community whereas the bowls in grassland sites were sampling from a much larger area and hence a larger community of bees overall. Certainly the bowls themselves are more visible from a distance (or even from above) in the relatively simple architecture of the overgrown fields, compared with the sometimes dense scrub of the powerline habitats. It is likely that many bees traveled to the bowls from surrounding habitats, especially if there was a dearth of floral resources in the fields themselves. Other researchers who collect bees with bowls have noticed that sometimes yield is higher if bowls are placed where floral resources appear scarce, compared with areas with abundant flowers within the same landscape (J. Rozen, personal communication; N. Williams, personal communication). This phenomenon was also observed when researchers placed an artificial island of flowers in an otherwise florally limited area (Steffan-Dewenter et al., 2002)—the flowers received more visits by bees known to travel large distances to forage. It is interesting to note that six of the seven sites where *Apis mellifera* (the European honey bee) was collected in our study were grassland sites. This species is a cavity nester and is known to fly great distances when foraging.

The distance bees will travel away from their nests in search of food varies by species and appears to increase with size (Gathman and Tscharnke, 2002). We would expect, therefore, to have fewer small bees in areas where nesting sites are limited as these bees are less likely to travel far from home. We compared the average size of bees between grassland sites and powerline sites to see if grasslands sites indeed had bigger bees on average, but found no significant differences between the site types. However, we did find that the smallest bee species (those under 5mm in length) appeared to be restricted to the powerline sites, and if we include species up to and including 5mm in length, 32 of 38 of these individuals were collected in powerline sites. Large species were equally abundant in the two site types.

Parasitic bees would be expected to spend less time foraging and more time near potential nesting sites than non parasitic bees because they do not provide for their own eggs, but rather make use of other bees' collected resources and nests. Indeed, we collected many more parasitic bees in the powerline sites than in the grassland sites. Cavity-nesting bees, too, were found to be more abundant in powerline sites than in grassland sites. Though cavity-nesting bees are likely to travel in search of food, we would still expect their numbers to be higher in close proximity to their nesting sites.

Finally, though the turnover and similarity indices were quite variable, the fact that powerline sites were on average more similar to each other than grassland sites is consistent with the idea that the character of the fauna collected in the grassland sites was more dependent on the character of the surrounding landscape. We did not take differences in bordering vegetation into account when we chose our sites. Some grassland sites were surround by woodlands, others by wetlands, others by cleared areas or some combination of the three. If bees were mostly coming to the grasslands to forage from the surrounding areas where they were nesting, then these differences in surrounding vegetation could result in quite different assemblages of bees found in the different grassland sites. Powerline sites, however,

may represent more of a distinct habitat type and therefore would be more similar to each other irrespective of the surrounding vegetation. There was certainly more obvious variation in the nature of the onsite vegetation between powerline sites than between grassland sites (within a sampling period) and yet still the bee communities were more similar in powerline sites. The fact that the indices showed a much greater range of values for the grassland sites than for the powerline sites is also consistent with the idea that the surrounding landscape is having a greater influence on these sites; some grassland sites could be quite similar if they had similar surroundings, others quite different. Powerline sites, being less influenced by the bordering habitats should show more consistency in the indices, as they appear to do. Obviously, it is dangerous to infer too much from these indices, as they were highly variable. Much of this variation was likely due to spatial issues, which we did not factor in to the analysis. Though we did not quantify the distance between sites explicitly, we can say that those sites with the highest similarity and lowest turnover were not consistently in close proximity to one another.

We would argue that if there was a way to close these systems, the differences in richness and diversity of bees would be much greater between these two site types than was observed in this study. This is due to the greater diversity of nesting and floral resources available in the more complex habitat of the powerline scrub. It is clear that bees are using the grassland sites to forage, and certainly some bees are nesting there, but visitation to these sites was likely elevated by the presence of the bowls. We should add that the Patuxent Research Refuge is, overall, a haven for wild bees because it contains such a myriad of habitat types, especially of the early-successional variety. It is likely that a mowed field in a more developed landscape would yield vastly fewer bee species and a lower abundance of bees than what could be found anywhere on the refuge due to a lack of source populations. It would be interesting to compare the bee communities of powerline rights-of-way managed for scrub vs. grassland in suburban or agricultural landscapes to see whether the same patterns emerge.

Despite the difficulties associated with interpreting data from bee bowls, due to the spatial issues described above, we do feel that in terms of overall efficiency, bee bowls are still the preferred method for this kind of study. They allow for easy sampling of large areas without the problem of sampler bias or the time necessary to carry out nest trap surveys. Though we expect that bee bowls sample a somewhat biased subset of the bee community (as any method will), our results indicate that the sub-sample is representative of the wider community. The ordination clearly shows a progressive change in the relative importance of bee species throughout the season, something that we know to be the case generally based on the life history of bees. The fact that the bee bowls picked up this change indicates that they were getting enough of a sample to show this progression despite random variation due to undersampling bias. If the communities were very undersampled, little or no significant progressive change would have been detected. In addition, as we are clearly asking comparative questions, any bias in the bee community sampled becomes irrelevant as long as the different sites were sampled in the same way.

Conclusions

Wild bees are a valuable natural resource whether you consider their economic value, their contribution to the ecosystem service of pollination in natural systems, or simply their contribution to the diversity of life on this planet. We have reason to believe that wild bee populations are being, or are soon likely to be, hit hard by changes in agricultural practices, land development, and the use of pesticides. It is critical that we do all we can to understand and provide for their needs, which include places to forage and places to nest. One small part of this endeavor should include making the most of any habitats that are already off-limits to further development. Already covering between 5 and 8 million acres of land in the continental U.S., and proportionally equivalent areas elsewhere in the world, powerline rights-of-way have the potential to be an invaluable resource. Data from this study indicate that rights-of-way managed for dense scrub can provide both floral and nesting resources for bees. It would be wise to do all we can to encourage power companies to abandon management practices that involve general herbicide application or periodic mowing of all vegetation, and instead to employ more widely the kind of management regime used on PWRC land. This could result in extensive corridors of habitat for bees and other early-

successional species in otherwise inhospitable environments. These habitats will also remain stable over time, as utility companies need to maintain them to keep tall vegetation from interfering with the overhead lines. This is particularly important in highly developed areas where source populations are not readily available to repopulate after mowing. Though it is naïve to think that any single management strategy will benefit all groups equally, this type of management would seem to provide a good starting point. From here, management could be modified to the needs of certain species or species groups on a local or regional basis. Whether we like it or not, powerline rights-of-way are a part of the modern landscape. Why not take the lemons and make lemonade?

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Figure 1. Map of Patuxent Wildlife Research Center. All sixteen sampling locations are marked. Sites one to four were sampled in April, sites five to ten were sampled in May and sites 11 to 16 were sampled in June. Sites were selected randomly using a numbered grid map of PWRC and a random number generator.

Figure 2. Bee-bowl sampling scheme. A total of 40 bowls were placed at each site. Bowls were arranged in a linear transect of five sampling locations. Each sampling location had two each of the following colored bowls: dark blue, light blue, yellow and white.

Figure 3. Collection abundance over time for all sixteen sites plotted by sampling period. Bowls were cleared every 24 hours.

Figure 4. Results of canonical correlation analysis based on the log-transformed abundance of species in each site (constrained by time along axis 1). The progressive change in species composition with time is statistically significant ($p < 0.0001$). Black circles are powerline sites and white circles are grassland sites.

Table 1. Classification of genera by nesting preference and trophic level. Although these traits are not always generalizable to the genus level, in cases where genera were known to have a mixture of species we used the best available information to categorize them accurately based on species identities or the geographic location of our study (Jerome Rozen, Jr., personal communication; Michener, 2000).

Table 2. Summary of collections.

Table 3. Results of two-way crossed ANOVA using the raw richness data and a variety of commonly used richness estimators. No interactions were significant. Unlike the other richness estimators, data based on the Chao1 and Chao2 richness estimators showed no significant treatment effect. However, as stated in the text, this was likely due to a single richness estimate for Site 13 that was far outside the range of the other estimates (135 species vs. a range of 28 to 50 for the others) and nowhere near the raw richness of 22 species measured at the site. Considering this estimate an outlier, we removed it from the analysis (= adjusted Chao1 and Chao2) and the resulting ANOVA produced a significant treatment effect.

Appendix 1. Species list and site totals. Sites one through four were sampled April 19th to April 23rd, sites five through ten were sampled May 7th to May 11th and sites 11 through 16 were sampled June 4th to June 8th. (G) designates grassland sites and (PL) designates powerline sites. Morpho-species are lettered within the appropriate genus. Two species in the genus *Ceratina* (*C. calcarata* Robertson and *C. dupla* Say) were combined into one since females could not be distinguished in the most recent revision (Daly, 1973).

Figure 1

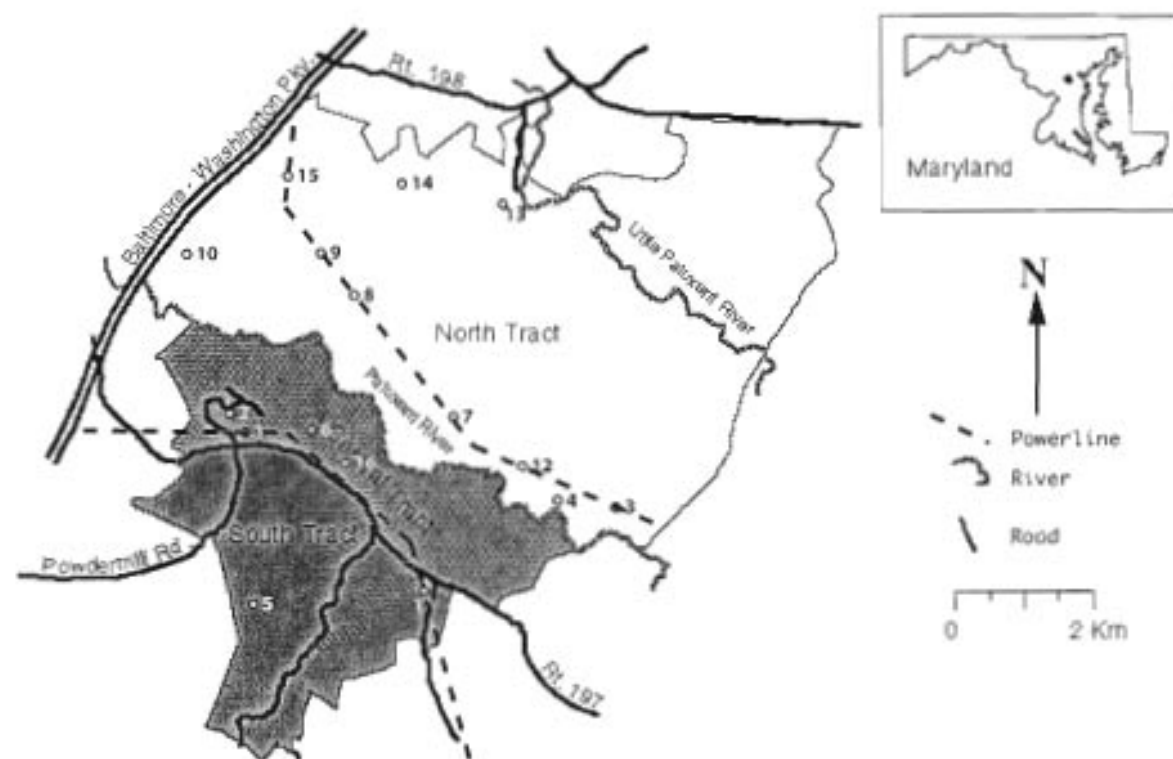
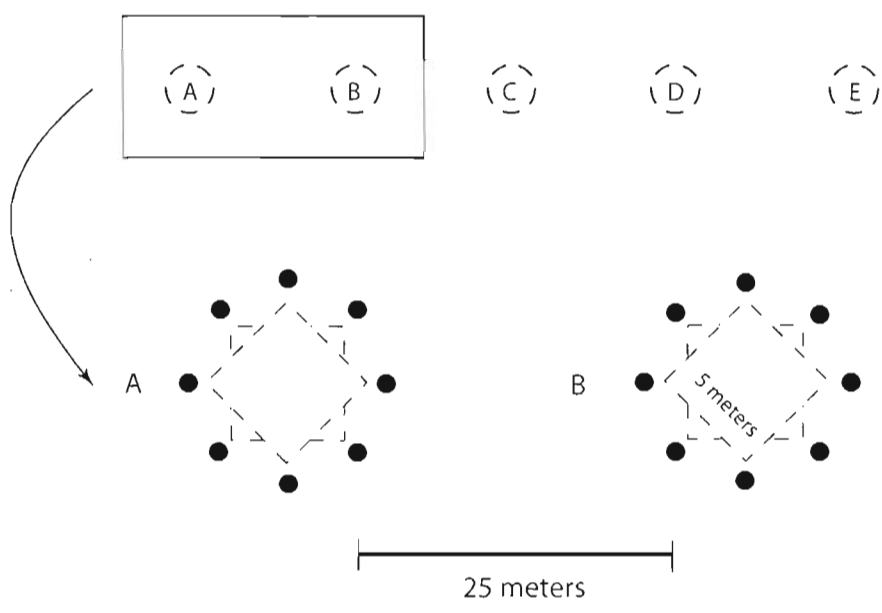


Figure 2



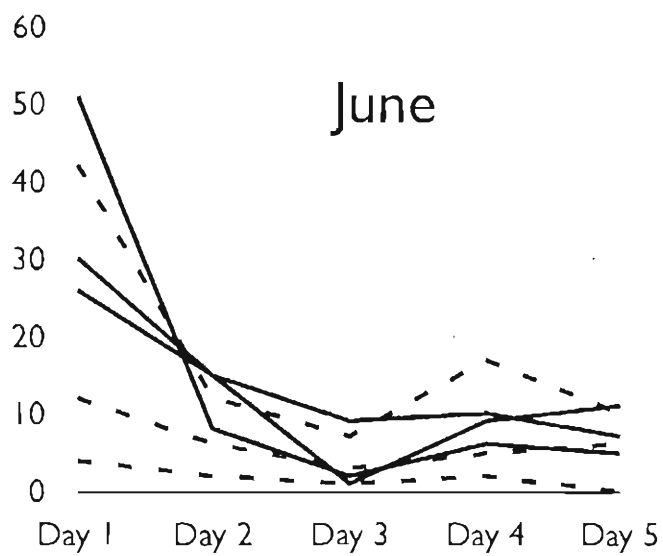
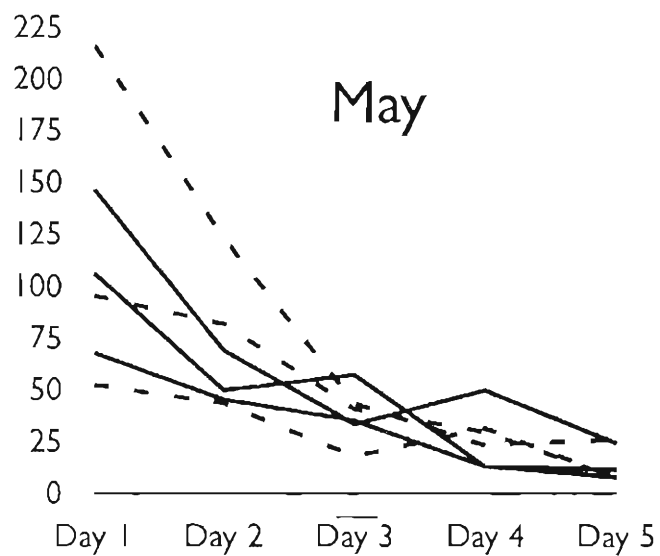
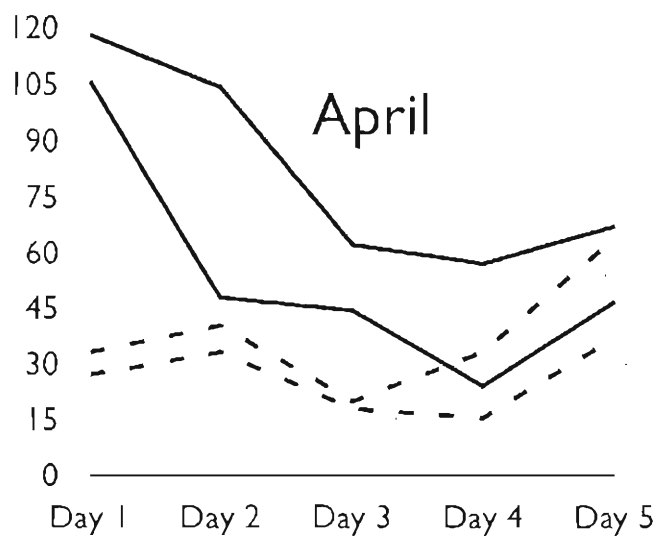


Figure 4

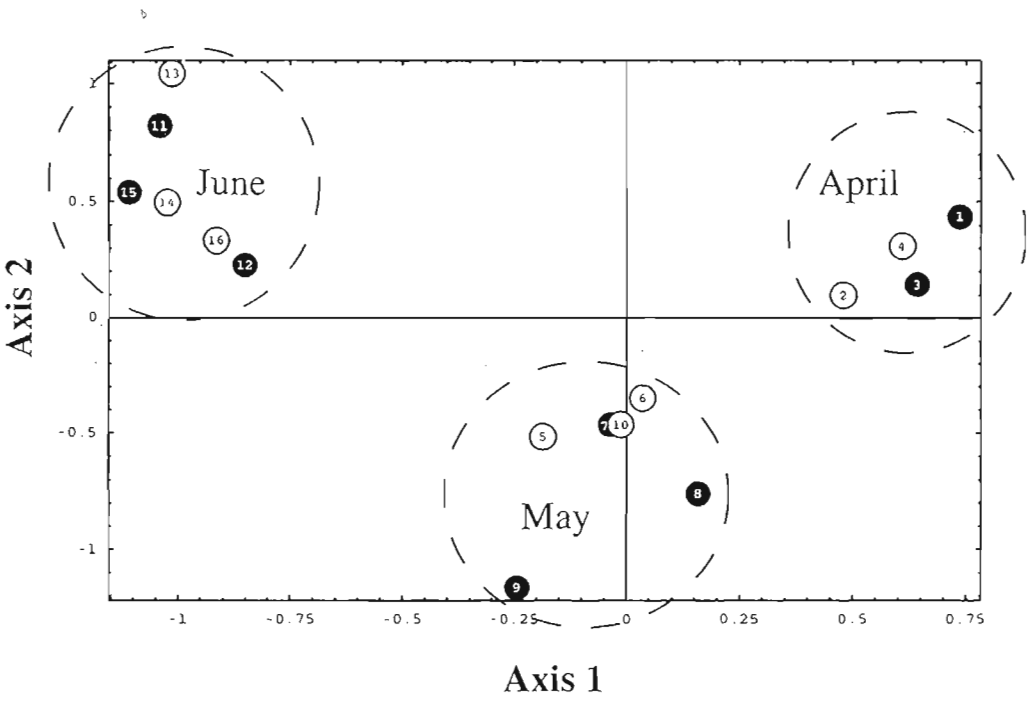


Table 1

GENUS	PARASITIC	NON-PARASITIC	MOSTLY CAVITY/STEM	MOSTLY GROUND
Agapostemon		x		x
Andrena		x		x
Anthophora		x		x
Apis		x	x	
Augochlora		x		x
Augochlorella		x		x
Augochloropsis		x		x
Bombus		x	x	
Calliopsis		x		x
Ceratina		x	x (stem)	
Coelioxys	x		x	
Colletes		x		x
Halictus		x		x
Hoplitis		x	x (stem)	
Hylaeus		x	x (stem)	
Lasioglossum		x		x
Megachile		x	x	
Melissodes		x		x
Nomada	x			x
Osmia		x	x	
Panurginus		x		x
Sphecodes	x			x
Stelis	x		x (stem)	
Xyclopa		x	x	

Table 2

	GRASSLAND SITES	POWERLINE SITES	TOTAL
Individuals	1282	1605	2887
Species	75	98	107
Genera	20	23	24

Table 3

	n	F Ratio (type)	Prob >F (type)	F Ratio (month)	Prob >F (month)
Raw data	16	8.1463	0.0171	10.9301	0.003
Michaelis Menton (mean)	16	10.3374	0.0093	7.3164	0.011
Bootstrap	16	8.9479	0.0135	10.5975	0.0034
First Order Jackknife	16	9.3149	0.0122	8.5937	0.0067
Second Order Jackknife	16	7.7162	0.0195	4.2814	0.0454
Chao1	16		ns		ns
Chao2	16		ns		ns
Chao1 *adjusted	15	12.2665	0.0067	8.6982	0.0079
Chao2 *adjusted	15	10.084	0.0113	3.0768	0.0959

*ANOVA was performed with the estimate for site 13 omitted from the analysis.

Appendix 1

Species	1(PL)	2(G)	3(PL)	4(G)	5(G)	6(G)	7(PL)	8(PL)	9(PL)	10(G)	11(PL)	12(PL)	13(G)	14(G)	15(PL)	16(G)
<i>Agapostemon texanus</i> Cresson	1	0	1	1	3	0	10	1	1	0	1	0	0	0	1	0
<i>Agapostemon virescens</i> (Fabricius)	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2	0
<i>Andrena arabis</i> Robertson	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Andrena arabis</i> Robertson	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Andrena banksi</i> Malloch	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Andrena bradleyi</i> Viereck	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Andrena carlini</i> Cockerell	66	7	17	15	4	2	5	6	6	3	0	0	1	1	0	1
<i>Andrena cressonii cressonii</i> Robertson	6	0	1	1	0	0	0	0	1	3	1	1	4	1	0	0
<i>Andrena erigeniae</i> Robertson	5	30	106	4	25	205	152	122	40	338	0	0	0	0	0	0
<i>Andrena limitatrix</i> Cresson	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
<i>Andrena integra</i> Smith	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
<i>Andrena miranda</i> Smith	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Andrena miserabilis</i> Cresson	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Andrena</i> msp. A	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Andrena</i> msp. B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>Andrena</i> msp. C	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Andrena</i> msp. D	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Andrena</i> msp. E	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Andrena</i> msp. F	0	2	0	0	0	0	1	0	0	0	1	12	7	3	3	2
<i>Andrena</i> msp. G	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0
<i>Andrena</i> msp. H	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Andrena</i> msp. I	5	12	14	8	3	15	5	13	3	12	0	1	0	0	0	0
<i>Andrena personata</i> Robertson	5	0	0	0	0	4	0	0	1	3	0	0	0	0	0	0
<i>Andrena pruni</i> Robertson	10	2	2	7	0	0	0	0	0	0	1	0	1	0	0	0
<i>Andrena rugosa</i> Robertson	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Andrena vicina</i> Smith	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Andrena ziziae</i> Robertson	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0
<i>Anthophora</i> msp. A	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
<i>Apis mellifera</i> Linnaeus	3	1	0	1	11	3	0	0	0	1	0	0	1	0	0	0
<i>Augochlora pura pura</i> (Say)	1	0	3	2	0	0	0	1	0	0	0	0	0	0	0	0
<i>Augochlorella striata</i> (Provancher)	15	2	14	24	16	1	1	0	1	11	1	0	0	0	2	2
<i>Augochlorella metallica fulgida</i> (Smith)	0	0	0	4	0	1	0	0	0	0	1	0	0	0	0	0
<i>Augochloropsis metallica metallica</i> (Fabricius)	0	0	0	2	0	0	3	0	0	0	0	0	0	0	1	0
<i>Bombus bimaculatus</i> Cresson	0	1	1	0	0	1	0	0	0	1	0	1	0	0	0	1
<i>Bombus fervidus</i> (Fabricius)	1	3	6	7	3	4	3	1	0	0	0	2	1	0	0	0
<i>Bombus impatiens</i> Cresson	1	0	1	5	1	0	2	0	0	0	0	2	1	0	0	0
<i>Bombus pennsylvanicus</i> Degeer	1	0	2	0	1	0	0	0	0	0	0	1	0	0	1	0
<i>Bombus vagans</i> Smith	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0
<i>Calliopsis andreniformis</i> Smith	0	0	0	0	0	0	0	0	0	0	2	5	5	4	9	0
<i>Ceratina calcarata/dupla</i>	20	5	1	0	2	1	2	0	0	0	9	6	5	1	0	0
<i>Ceratina strenua</i> Smith	4	1	3	0	0	0	0	0	1	0	22	2	1	0	4	0
<i>Coelioxys sayi</i> Robertson	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

<i>Colletes thoracicus</i> Smith	2	0	1	0	1	0	0	0	167	0	0	0	0	0	0	0
<i>Colletes validus</i> Cresson	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Halictus confusus confusus</i> Smith	0	0	0	0	0	1	0	0	0	0	4	0	43	1	0	1
<i>Halictus ligatus</i> Say	0	0	0	0	20	0	7	0	0	2	2	1	0	0	0	0
<i>Halictus ruficundus</i> (Christ)	9	4	1	3	0	0	1	0	0	0	0	0	0	0	0	0
<i>Hoplitis gleasoni</i> Titus	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0
<i>Hoplitis pilosifrons</i> (Cresson)	0	0	0	0	1	0	4	1	10	0	0	0	0	0	1	0
<i>Hoplitis producta</i> Cresson	0	0	0	0	0	1	0	0	11	0	7	3	5	4	6	0
<i>Hoplitis spoliata</i> (Provancher)	0	0	0	0	0	2	0	2	24	0	0	3	0	0	2	0
<i>Hylaeus affinis</i> (Smith)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
<i>Lasioglossum acuminatum</i> McGinley	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
<i>Lasioglossum bruneri</i> (Crawford)	0	2	0	3	12	0	4	2	12	3	6	8	0	0	2	0
<i>Lasioglossum coriaceum</i> (Smith)	0	0	0	0	3	1	0	0	0	0	2	0	1	0	1	0
<i>Lasioglossum cressonii</i> (Robertson)	1	1	2	0	1	0	2	0	3	0	0	1	0	0	0	0
<i>Lasioglossum forbesi</i> (Robertson)	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0
<i>Lasioglossum msp. A</i>	3	0	2	1	2	1	0	0	0	9	0	0	0	0	0	0
<i>Lasioglossum msp. B</i>	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Lasioglossum msp. C</i>	2	0	4	1	7	0	0	0	0	18	1	1	0	4	1	0
<i>Lasioglossum msp. D</i>	2	0	0	1	0	0	0	0	1	3	0	0	0	1	0	0
<i>Lasioglossum msp. G</i>	1	0	0	0	3	0	1	0	2	11	1	0	1	1	0	0
<i>Lasioglossum nelumbone</i> (Robertson)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Lasioglossum pectorale</i> (Smith)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Lasioglossum pilosum pilosum</i> (Smith)	2	0	0	2	0	0	0	0	0	0	0	0	0	0	13	0
<i>Lasioglossum quebecense</i> (Crawford)	12	0	9	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Lasioglossum tegulare</i> (Robertson)	2	0	0	0	0	0	0	0	2	0	0	2	0	0	2	0
<i>Lasioglossum versatum</i> (Robertson)	0	0	0	1	8	1	0	0	1	3	0	1	0	2	0	0
<i>Lasioglossum vielckii</i> (Crawford)	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
<i>Megachile brevis</i> Say	0	0	0	0	0	0	2	0	0	1	0	0	1	3	0	0
<i>Megachile exilis parvixilis</i> Mitchell	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Megachile mendica</i> Cresson	0	0	0	0	0	0	0	0	0	0	1	1	1	1	5	0
<i>Megachile msp. A</i>	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
<i>Melissodes msp. A</i>	0	0	0	0	0	1	2	1	1	3	0	0	0	0	1	0
<i>Nomada cressonii cressonii</i> Robertson	6	0	3	1	0	0	0	0	0	0	0	0	1	0	0	0
<i>Nomada dentariae</i> (Robertson)	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nomada lepida</i> Cresson	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nomada luteoloides</i> Robertson	3	0	1	0	1	1	1	1	0	1	0	1	0	0	0	0
<i>Nomada maculata</i> Cresson	2	0	2	2	0	0	0	2	0	0	0	1	0	0	0	0
<i>Nomada msp. A</i>	2	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0
<i>Nomada msp. B</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Nomada msp. C</i>	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nomada msp. D</i>	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nomada msp. E</i>	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nomada perplexa</i> Cresson	5	2	0	3	0	2	3	1	1	1	0	0	0	0	0	0
<i>Nomada sayi</i> Robertson	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0

<i>Osmia albiventris</i> Cresson	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Osmia atriventris</i> Cresson	2	0	2	2	1	0	0	1	1	0	0	0	1	1	2	1	0
<i>Osmia bucephala</i> Cresson	5	3	11	2	0	1	1	1	0	0	2	1	1	0	0	0	0
<i>Osmia coerulea</i> (Linnaeus)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Osmia collinsiae</i> Robertson	0	0	4	3	1	0	1	1	1	1	0	0	0	2	0	0	0
<i>Osmia conjuncta</i> Cresson	0	0	0	0	2	0	5	0	0	0	0	4	0	0	0	0	0
<i>Osmia cornifrons</i> (Radoszkowski)	9	1	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Osmia distincta</i> Cresson	12	1	10	7	0	0	2	0	0	0	0	0	0	0	0	0	0
<i>Osmia georgica</i> Cresson	4	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Osmia inspergens</i> Lovell & Cockerell	1	1	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
<i>Osmia lignaria</i> Say	6	1	4	2	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Osmia</i> msp. A	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Osmia pumila</i> Cresson	120	42	27	55	9	2	7	3	3	1	1	2	4	1	3	0	0
<i>Osmia sandhouseae</i> Mitchell	3	0	0	0	1	0	1	0	3	0	0	0	0	0	0	0	0
<i>Osmia subfasciata</i> Cresson	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Osmia taurus</i> Smith	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Panurginus potentillae</i> (Crawford)	0	0	0	0	1	0	1	2	10	0	0	0	0	0	0	0	0
<i>Sphecodes</i> msp. A	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
<i>Sphecodes</i> msp. B	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Stelis lateralis</i> Cresson	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Xylocopa virginica</i> (Linnaeus)	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Total richness	55	26	40	40	31	22	33	24	33	23	24	28	22	16	23	6	
Total individuals	408	130	269	190	150	252	236	168	321	431	72	67	88	32	64	9	

“The Making of a Meadow at River Farm”
Phase I
Plant List

3,024	Rudbeckia ful. ‘Goldstrum’	288	Heliopsis hel.
4,032	Calamag. A. ‘Karl Foerster’		‘Sommersonne’
792	Andro. gerardil ‘Goldstrike’	288	Hibiscus coccineus
792	Andropogon gerardil ‘Kaw’	648	Liatris pycnostachys
792	Androp. gerardil ‘Pawnee’	288	Liatris spicata
792	Androp. gerardil	259	Hystrix patula
	‘Roundtree’	2,016	Sorghastrum nutana
2,016	Bouteloua curtipendula	1,008	Panicum amarum
485	Elymus canadensis	5,040	Andropogon scoparius
360	Liatris spicata	1,008	Bouteloua gracilis
3,024	Andropogon s. ‘Blaze’	288	Erianthus strictus
288	Baptisia australis	504	Achillea pt. ‘The Pearl’
504	Coreopsis grand. ‘Sunray’	288	Aster ‘Raydon’s Favorite’
144	Coreopsis l. ‘Sterntaler’	288	Monarda punctiata ‘Squaw’
72	Eryngium agavifolium	1,008	Oenothera speciosa
288	Eupatorium ruh. ‘Chocolate’	288	Pycnanthemum pilosum
288	Helianthus augustifolius	<u>144</u>	Silphium integrifolium
		32,136	

The Inventory and Monitoring of Native Bees. Sam Droege
Sam_Droege@usgs.gov 301-497-5840. Patuxent Wildlife Research Center,
Laurel, Maryland

- Native bees are found in **EVERY** environment, often in abundance.
- Native bees do the bulk of **POLLINATING** of native plants.
- There are **NO** published inventories of bees in the Mid-Atlantic area. Not even old ones.
- Native bee status in the region is **UNKNOWN**.
- An average Mid-Atlantic park or refuge probably contains more than **150 SPECIES**.
- Bees are associated with plant communities and soil types.
- Specialized habitats almost always have specialized (and rare) bees.
- Several **NON-NATIVE** bees have moved into the region.
- Many species are nest parasites of other bees.
- Bee communities change with the season. In the Mid-Atlantic area there are 3 distinct groups:
 - Spring
 - Summer
 - Fall
- Spring bees are further divided into early and late communities.
- A complete picture of the local bees requires sampling in all seasons.
- **BEE BOWLS**. The most appropriate survey techniques employ the use of very small bowls colored yellow, blue, and white and filled with soapy water. Bees are attracted to the colors and drown in the water.
- Additional netting of bees on flowers or in specialized habitats will be required to get some of the species that rarely come to bowls.
- Bowls are set out in transects and then collected within 24 hours, placed in alcohol, and pinned when convenient.
- Identification of the resulting specimens is currently difficult, but new online guides, pictures, and support will soon be available.
- Transects can be set out in many patterns across a landscape, with hundreds of bowls placed out in a day.
- Data results in estimates of the percentage of area occupied by each species, an estimate of the species richness, frequency and relative abundance for each species, and maps of species occurrence and distribution.
- Inventory and monitoring programs are best designed in consultation with bee biologists and statisticians, but can easily be run by **VOLUNTEERS**.
- **You should sponsor the inventory of bees in your region.**

Tips on How to Use Bee Bowls to Collect Bees

Sam Droege

The Bowl

Bee Bowls are small colored plastic bowls or cups that are filled with soapy water. Bees are attracted to these colors, fly into the water, and drown. Bee bowling has evolved toward the use of smaller and smaller bowl sizes as it was realized that size of bowl was not necessarily correlated with capture rates (see <http://online.sfsu.edu/~beepilot/> for several reports that document those results).

Currently, we are no longer using bowls at all but items that are listed in plastic manufacturer's catalogs as soufflé cups. We are not aware of other manufacturer's lines, but Solo has a large selection of soufflé cups that we have experimented with. These cups usually come in their native translucent plastic color which is not at all attractive to bees. However the 3.25 oz. cup, which is steep sided and stable on the ground, does come in white (model number: p325w-0001) and appears to provide a better color base than the translucent ones.

The 0.75 oz. and perhaps the 2 oz. cups are nice sizes to carry around, but appear to lose too much water in hot, low humidity areas. The 1 oz. cups are more steep-sided and narrow (and therefore more unstable). This model may be worth investigating for use in desert areas. Small cups have the advantages of using much less water, being hard for the general public to see (but not apparently bees), and very cheap.

These cups usually need to be ordered or picked up from a local distributor and are almost always available only in case lots (usually that means about 2500 cups). Solo distributors can be located by calling 1-800-FOR-CUPS. The solo product line catalog is online and can be viewed at: www.solocups.com. The price for a case is usually in the \$50 to \$80 buck line.

Painting Bowls

Originally, when bowls rather than soufflé cups were being used, colored plastic bowls from party stores or other sources were used to capture bees. The usual colors were yellow, white, light blue, and dark blue. Those worked well, but fluorescent yellow and fluorescent blue were found to be much more effective in the East. However, Laurence Packer has found that cactus bees, especially *Macrotera*, seem to be attracted to dark blue and even red colored bowls. He didn't compare these with fluorescent colors, but both those colors collected more *M. texana* than did either white or yellow.

Unfortunately it was found that commercially available fluorescent spray and brush paints varied in their characteristics and availability by brand and location. In 2003 we experimented with creating a standardized fluorescent yellow and blue paint from scratch and have done so with the help of the Risk Reactor Company (800-803-5281) ([Link to](#)

specific pages for bee colors will go here) who can be contacted both for price and ordering information as well as a complete spec sheets that list this paint's components . The current formulation has an acrylic base (water-based). In 2004 we are working on adding surfactants to the base to see if we get better adhesion to the plastic bowls and cups.

Most paint does not stick well to plastic. Many commercial can spray paints have added compounds that do help with adhesion, but as with most commercial paints those formulations are proprietary. Additionally, if many bowls are being painted, a can of spray paint becomes both expensive and wasteful. We also found using liquid paint in compressed air spray guns to not be worth the cost and trouble. The paint inevitably clogged the sprayer (even when thinned) and it was difficult to coat all the sides and bottom uniformly. After much experimentation it was found that an oil-based primer needed to be painted on first before anything but the commercial spray can paints would stick to plastic bowls. We found that white primer looks the best as a base for fluorescent yellow and a gray primer (any good paint shop will tint your primer for free) works best for the fluorescent blue. However, even these primers often will bead up to some extent. Sanding the bowls also allows paint to stick, but takes too much time. We hope to have this more under control soon following our experiments with surfactants.

Using a brush to put on primer worked adequately for bowls, but not so well for cups. Two other techniques seemed to be faster and more complete. One technique was to don latex gloves and dip a bit of rag in the paint and rub it all over the cup or bowl. The other technique was to use a very small foam roller of the type often used in edging to apply the paint. This, in particular, worked well for applying the final coat of fluorescent paint. However, neither of these techniques seemed to consistently produce a particularly pretty paint job, usually there would be places remaining where the paint would not stick. So, if anyone comes up with a better means of painting these bowls we would love to hear about it. In 2003 we completed a series of small experiments that indicated that the amount of surface area painted did influence the number of bees captured. When bowls were placed next to each other the bowl with the more paint caught more bees. This may affect may disappear if bowls were spaced apart.

How to Set a Bowl Trap

A bowl trap is set when it is filled with soapy water and left outside. The soap decreases the surface tension so that even small insects are trapped if they land on the surface. Most insects stop moving within 60 seconds of hitting the water. However, we have found that many of these insects will wake back up if not either placed in alcohol for several hours or put in the freezer prior to pinning. We have noted that unpinned insects that do wake back up never regain normal behavior and usually simply stand or move very slowly following being in the trap.

Experiments have found that as long as there is water in the bowl or cup it will catch bees at about the same rate as one that is full to the top. However, in hot and arid climates bowls can dry out if not filled to the top or if they are too shallow. Currently we advocate

that people use either Blue Dawn Dishwashing soap or laboratory detergent. Lemon-scented detergents and ammonia appear to have decreased catch compared to these soaps. Laundry soaps have been tried and do work, but contain so many other fragrance chemicals that we fear that changes in formulation could easily change the catch. We have found it easiest to add a big squirt of soap directly to a gallon jug of water rather than adding soap to each bowl.

When using bowls to collect rather than monitor, it is often useful to leave them out for longer periods of time. Laurence Packer has found that propyl glycol will remain in the larger bowls for about 3 weeks even in early summer in the southern Atacama Desert. Under those long and windy conditions, digging the bowl into the substrate is necessary. Tenebrionids, scorpions and the occasional lizard may also be collected under these circumstances.

Several people have tried using urine instead of water in the bowls (bees in tropical areas are often attracted to urine soaked soils) but no great increase in catch was noted.

Sunny days are best for setting out bee bowls. The effects of temperature are unclear but catch appears to be reduced in the spring if temperatures are in the 50's F or below. However, in the fall temperature seems to have less impact. Cloudy days catch almost no bees, and rainy ones never catch bees.

Where to Set a Bowl Trap

The best places to put bee bowls are exposed open settings....places where bees are likely to see them. This includes almost all habitats. In North America the exceptions are woodlands once the spring blooming period for forbs and woody vegetation is over, and under any dense vegetation (e.g., thick cool season grasses, leafy shrubs). Open warm season grasslands often have good capture rates of bees if the grass overstory is not too thick. The general rule of thumb is that if you can easily see the bowl then bees can too. Flowers need not be apparent in an area in order for catches to be quite high. However, the presence of a superabundant nectar and pollen source (e.g., creosote bush or mesquite) often appears to lead to low bowl capture rates.

In tropical Central and South America Dave Roubik (Panama), Steve Javorek (Belize), and Gordon Frankie (Costa Rica) have all noticed that soapy water bowls capture almost no bees in closed canopy or canopy top situations (however, more extensive tests are warranted here), but are successful in open habitats. Roubik also has had good success with capturing stingless bees using a honey solution (or sucrose when honey is not available) either in bowls or sprayed on vegetation.

Laurence Packer writes about strategies for collecting bees in bowls: "When attempting to collect Xeromelissinae, some of which are oligolectic, I have often put pans out by suitable looking flowers en route to a different collecting spot. The success rate has been remarkably high and I have found males of species only collected by net as females, and females of species only collected by net as males using this method.

By placing pans adjacent to the flowers visited by oligolectic species. I have managed to collect samples directly into buffered formalin and absolute alcohol for histology and DNA respectively - though capture rates were not high, in a couple of hours a couple of pans of each collected enough for my needs.”

In general small bees are sampled well in bowls, but larger bees often need to be netted.

Most researchers put bowls out in strings rather than as single bowls. Capture rate per unit of field time is much higher this way. Once a location has been chosen in which to place bowls it takes relatively little additional time to place many bowls as compared to just one, particularly when compared to the cost of traveling to a new place. An internal study available from Sam Droege (301 497 5840, sam_droege@usgs.gov) indicated that the variances for characterizing the species richness of a single site may level out after 15- 30 bowls at one site. Bowls placed right next to each other have been shown to have reduced per/bowl capture rates. The specific distances at which capture rates among bowls equalizes or becomes insignificant for bees is unclear, it would appear, however, that per bowl capture rate may stop declining after even distances as short as 5m. In Brazil additional species were captured when bowls were elevated off the ground, but in the Eastern United States no additional species were captured and capture rates were much lower than bowls placed on the ground. In the East, when large black circles were added to the bottom of cups catch was decreased, while adding small *Andrena*-sized markings to a bowl did not change capture rates.

A procedure has been developed for monitoring bees on plots that is available at Gretchen LeBuhn’s bee monitoring web site (<http://online.sfsu.edu/~beeplot/>). A scheme for replicable monitoring or inventory of bees over larger landscapes is being developed by Sam Droege (sam_droege@usgs.gov). That design will likely include the superimposing of a grid over the landscape with numerous individual transects of 12-20 bowls taken within each grid in appropriate habitats and used as replicates. Because a completely random or systematic sampling scheme is impossible in most public/private landscapes, an effort will be made to GPS all points and collect habitat co-variates to permit counts to be adjusted over time.

How to Collect the Bees Once Trapped

At each bowl it usually best to pick out all moths, butterflies, and skippers as well as slugs, and very large bodied non-hymenoptera (e.g. grasshoppers and crickets). These groups tend to contaminate the other specimens when placed in alcohol. The next step is to dump the bees either into an aquarium net, sieve, or tea strainer. The key matter when choosing are particular type of bee strainer is that their mesh must be fine enough to catch the smallest of bees some of which may only be 2-4mm. If using an aquarium net, look specifically for brine shrimp rather than regular nets. In general most kitchen sieves are too coarse while most tea strainers have nice fine mesh.



U.S. Fish & Wildlife Service

Chesapeake Bay Field Office

Schoolyard Habitat

The Schoolyard Habitat Program helps teachers and students create wildlife habitat on school grounds. Habitat is the collective term for the food, water, shelter and nursery areas that all wildlife needs to survive. The loss of habitat is one of the greatest threats facing wildlife today.

The U.S. Fish and Wildlife Service provides and coordinates with other agencies to give technical assistance and project guidance; provides teacher training; develops written resources; and works with the state Departments of Education on incorporating habitat issues into new school construction and renovation projects.

Benefits of the Schoolyard Habitat Program include:

Improved habitat

Schoolyard habitat projects provide habitat for local and migratory wildlife including songbirds, shorebirds, small mammals, reptiles, amphibians and insects. In many cases, these habitats also provide a vegetative buffer to nearby streams, reducing pollution reaching these waterways.

Teaching and learning

Schoolyard habitats offer many teaching and learning opportunities in English, science, mathematics, history, geography, social studies and art. The process of planning, creating and using a habitat provides children with unique hands-on experiences. Research shows that using the environment as a focal point of teaching improves student performance.

Stewardship

During the formative years of life, students develop perceptions and values about their environment. If designed and managed properly, schoolyards can provide students a powerful example of land stewardship. Conversely, it is less likely that students will develop a sense of stewardship if attending a barren, poorly managed schoolyard.

Social development

Experts know that young children are driven to explore, discover and play while refining motor skills. A well-designed schoolyard including a diversity of natural areas, allows students to exercise these innate needs leading to a happier and more fulfilled childhood. Older students and adults also benefit. Research shows that most people are more relaxed in a natural landscape.



Photos by Rich Moson, USFWS

*By instilling knowledge and
a sense of stewardship now,
the future of both people and
wildlife is looking brighter.*



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www.fws.gov/r5cbfo/schoolyd.htm

2004



Photo by Jeff Owens

Natural Areas and Native Pollinators

Prepared by the
Xerces Society for Invertebrate Conservation

Pollinators are essential for our environment. The ecological service they provide is necessary for the reproduction of up to 90 percent of the world's flowering plants. This includes at least two thirds of the world's crop species, whose fruits and seeds together provide 15-30 percent of the foods and beverages that we consume. In many places, however, the essential service of pollination is at risk. As with all wildlife, pollinators have suffered as landscapes have changed. Pesticides, urbanization and large scale agricultural development have all had a negative impact on pollinator populations.

Importance of natural areas for native pollinators and agriculture

Natural areas and wildlands serve as refuges for pollinators by providing forage, nest sites, and often protection from insecticide use in the surrounding landscape. From these natural areas, pollinators may visit crops or colonize restored habitat in the surrounding landscape. In the past, the large areas of natural habitat surrounding farms harbored important pollinators that could meet all of the pollination needs of farmers.

Today, research conducted on working farms in the Central Valley of California demonstrated that farms close to natural areas still have greater numbers and diversity of native bees, as well as increased pollination from these wild bees. This shows that protecting areas of natural habitat is important for increasing the pollination contribution of native bees on farms.

Importance of native pollinators to natural areas

Pollinators are also important for natural areas themselves. Pollinators sustain plant communities that provide food and shelter for many other animals. The fruits and seeds pollinators help produce are a major part of the diet of mammals ranging from red-backed voles to grizzly bears, and of approximately 25 percent of birds.



Photo by Gary Braasch

In addition to pollinating flowers, these insects help plants in other ways. The tunneling activities of ground nesting bees, for example, improves soil texture, increases water movement around roots, and mixes nutrients into the soil. Beetle larvae (many of which are pollinators) in old trees help to break down the decaying wood, returning the nutrients locked away in the tree back into the ecosystem.

Managing natural areas with pollinators in mind

For the most part, wildland stewards need not overhaul existing wildlife management plans and goals to address the needs of pollinators. By carefully timing management actions and avoiding or adjusting techniques that do undue harm to pollinator populations, land managers can help protect biodiversity on their land and provide an important source of pollinators for the surrounding landscape. The four land-management practices that have the most impact on pollinators are grazing, fire, herbicide use and insecticide use.

Grazing

Some areas managed for wildlife are grazed and trampled by livestock. This can be highly damaging, reducing both the floral and structural diversity of the habitat, removing forage flowers or host plants, disturbing fragile areas, and giving invasive weeds a foothold. Any grazing should be done with great care to ensure that the resources of pollinators, as well as other wildlife, are taken into account.

Fire

Fire is a valuable technique for wildland management, but if pollinators are not considered in the management plan, especially butterflies and twig-nesting bees, their populations can be devastated. Although adult pollinator insects are mobile and some may be able to avoid fire, their eggs, larvae, and pupae cannot. In a well-designed fire-management plan that considers all of the area's species, managers will burn only a small percentage of the site in any given year, leaving unburned habitat as a source for re-colonization of insects after the fire. At some sites, an extended rotation of ten years or more may be appropriate while in other sites rotations of every three years may be adequate.



Photo by Edward S. Ross

Herbicides

Herbicides can be a valuable tool to control invasive weed species. However, using broad-spectrum herbicides to control weeds and restore native plant communities can indirectly harm pollinators by removing either caterpillar host plants or foraging flowers that provide pollen and nectar for existing populations. Always minimize the extent of the spray area. Where possible, use wicks or handheld sprayers and only spray the target plants. Avoid using herbicides around native flowering plants especially when they are in flower or around butterfly larval host plants when caterpillars are present.

Insecticides

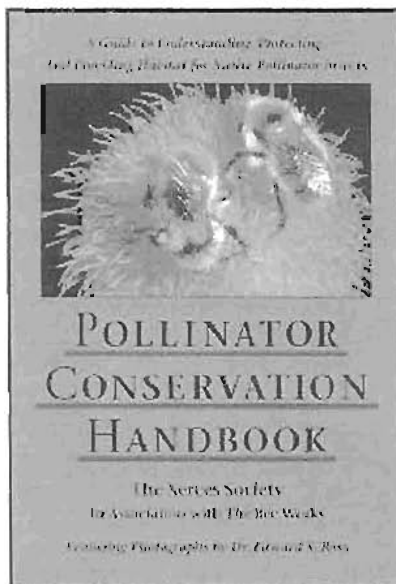
Insecticides are used in wildlands to control both native and non-native species. In forested areas, insecticides have been used to control tussock moth and other native defoliators. On rangelands, large acreages are sprayed every year to control native grasshoppers and Mormon crickets. West Nile virus has renewed efforts to control mosquito populations by using pesticides in some wetland systems. Insecticides are also used to control non-native invasive species such as gypsy moth.

Foraging bees are poisoned by pesticides when they absorb the fast-acting toxins through their exoskeleton, drink toxin-tainted nectar, or gather pesticide-covered pollen or micro-encapsulated poisons. Pesticide drift from aerial spraying can kill 80 percent of foraging bees close to the source and drift can continue to be dangerous for well over a mile.

Given the harm that insecticides inflict both directly and indirectly, we strongly oppose their use. If insecticides must be used, however, you should minimize their damage to pollinators and other beneficial insects. Apply pesticides when pollinators are not active or during those seasons when no blooms are present. Avoid spraying bee nesting areas, caterpillar host plants, and places where fly and beetle larvae are active. Also remember that pesticide labels do not take into consideration the needs of native pollinators, which are often more susceptible to pesticides than honeybees.

FOR MORE INFORMATION

To learn more about providing habitat for pollinators, please see our *Pollinator Conservation Handbook*. In addition, we are producing guide lines specifically for wildland managers. Please contact us for details.



Usually researchers pool all the bowls from one transect or plot rather than keeping individual trap data, as handling time increases greatly when collecting from individual bowls. Many researchers also wash the soap from their catch in the field using a squirt bottle, however, we have found that not to be necessary. Most researchers then store their catch in 70% alcohol in whirlpaks. We usually pick out the mass of insects in the net or strainer with our fingers and dump it into an individual whirlpak. However, Frank Parker uses a larger sized whirlpak along with a small tea strainer and then gives the strainer a sharp rap when in the bag to dislodge all the insects at once.

Isopropyl, ethyl, or denatured alcohols are all appropriate for storing insects, but isopropyl should never be mixed with the other alcohols. These alcohols can be found in drug or hardware stores. You can go to the pharmacy and almost always find small pint bottles of ethyl alcohol, ethanol, or denatured alcohol (they aren't very consistent in what they call them), if not, they will readily order it for you. At the hardware store they have gallon and pint jars of denatured alcohol (these are 100% alcohol and almost always contain a mix of 50% ethanol and 50% methanol). The drug store alcohol seems to be easier to work with as it is often made with a smaller amount of methanol and smells better.

Often the alcohol needs to be diluted to achieve the right percentage (70%). All hardware store alcohol should be considered to be 100% alcohol. Drug store alcohol can be close to 100% but also can be something less so you will have to read the bottle's label to check. To add confusion to the matter drugstores often label the percent alcohol in terms of "proof." Proof is a simple doubling of the percentage. Therefore 100 proof is 50% alcohol and 190 proof is 95% alcohol. To dilute from 100% alcohol to 70%, choose a convenient sized container, such as a pint bottle, then fill it ~70% full with alcohol and the rest with tap water. This measurement doesn't need to be exact.

The process for washing bees after they have been in alcohol is available at:
<http://online.sfsu.edu/~beeplot/>.

Bob Minckley has found that when he does collections from individual bowls it is useful to use clear plastic fishing lure boxes. The compartments can be numbered and individual bees picked out of bowls by hand and placed in the appropriate compartment. Afterwards, he freezes the entire container for at least 10 minutes to keep anything from re-awakening and then pins them straight from the box. Sometimes these specimens are more matted than ones that have been properly washed, but most of the time they are readily identifiable to species.

Another alternative to whirlpaks is to dump the catch into small numbered squares of cloth which are then rolled up and rubber banded together. Once back from the field these are collected, put into Ziploc bags and frozen until ready for pinning.

In all cases each bag, fishing box, or cloth should have a tag listing the sample location and date written on paper with pencil. Do not trust any kind of writing to stay on the outsides of a whirlpak bag as they inevitably get wet with alcohol or water and run.

A Few Little Efficiency Tips

When setting up for a day of putting out bowls we have found that it is helpful to make up your batches of bowls the day before and have them in a tray or box on the passenger seat. Wire flags (very useful for refinding your transects when driving at 60 mph) can be set in the passenger foot well. If working in a 4-door car we have found it fastest to keep the jug of soapy water on the back seat or on the floor of the back seat behind the driver. When the driver gets out they can grab a set of bowls and a flag in their right hand, open the door with their left hand, leap out of the car, pivot and grab the jug through the back window and then sprint off to put out bowls.

We have learned the hard way that getting into and out of the car many times a day to put out bee bowls can be hard on the human body. In particular it is hard on the left leg as it levers you into and out of the car and may lead to some slow healing muscle strains. The best way to get in is to sit down on the seat first and then swing both legs over. Getting out is the reverse operation swinging both legs out and then standing up.

Eastern Bee Genera Pronunciation Guide
Created: Fall 2003

This pronunciation guide is designed to help the beginning bee biologist. What are presented appears to be the most commonly understood pronunciation of the bee genera (and a few important subgenera) occurring in the East. You can expect to hear a number of differing pronunciations as you talk with researchers and taxonomists, as pronunciation is governed by culture rather than set rules. Suggestions for changes or additions are encouraged and can be sent to Sam Droege (sam_droege@usgs.gov).

Agapostemon /ag-uh-PAHST-eh-mon/
Andrena /an-DREE-nuh/
Anthedonia /an-theh-DOE-knee-yuh/
Anthemurgus /an-THEM-erg-us/
Anthidiellum /an-thid-e-ELL-um/
Anthidium /an-THID-e-yum/
Anthophora /an-THAH-for-uh/
Apis /A-pus/
Ashmeadiella /ASH-mead-e-el-uh/
Augochlora /awe-go-KLOR-uh/
Augochlorella /awe-go-klor-EL-uh/
Augochloropsis /awe-go-klor-OP-sis/
Bombus /BOMB-bus/
Calliopsis /KALEE-op-sis/
Caupolicana /kaw-po-LAH-canuh/
Cemolobus /c-moe-LOW-bus/
Centris /SEN-tris/
Ceratina /sera-TIE-na/
Chelostoma /chel-AHST-o-mah/
Coelioxys /sealy-OX-ees/
Colletes /koe-LEE-teez/
Dialictus /die-uh-LICK-tuss/
Dianthidium /die-AN-thid-e-um/
Dieunomia /die-u-NO-mea/
Doeringiella /doer-rinj-e-EL-uh/
Dolichostelis /dole-ih-koe-STEEL-iss/
Dufourea /dew-FOUR-ea/
Epeoloides /e-pee-o-LLOYD-ez/
Epeolus /e-PEE-o-lus/
Ericrocis /air-ih-KROE-sis/
Eucera /u-SIR-uh/
Evylaeus /ev-uh-LEE-us/
Exomalopsis /exo-muh-LOP-sis/
Florilegus /flor-ih-LEG-us/

Habropoda /hab-ro-PODA/
Halictus /hah-LICK-tuss/
Hemihalictus /hem-e-hah-LICK-tuss/
Heriades /her-EYE-uh-deez/
Hesperapis /hes-per-A-pus/
Heterosarus /het-er-o-SAUR-us/
Holcopasites /hole-koe-pa-SITE-ez/
Hoplitis /hop-LIE-tuss/
Hylaeus /hi-LEE-us/
Lasioglossum /laz-e-o-GLOSS-um/
Lithurge /LIH-thurj/
Macropis /ma-CROW-puss/
Megachile /meg-uh-KILE-e/
Melecta /mel-ECK-tuh/
Melissodes /mel-ih-SO-deez/
Melitoma /mel-ih-TOE-ma/
Melitta /mel-IT-tuh/
Metapsaenythia /met-uh-sen-EETH-ea/
Neolarra /neo-LAIR-uh/
Nomada /no-MOD-uh/
Nomia /NO-mea/
Osmia /OZ-me-yuh/
Panurginus /pan-ur-JINE-us/
Paralictus /pear-uh-LICK-tuss/
Paranthidium /PEAR-an-thid-e-um/
Peponapis /pep-o-NAY-pus/
Perdita /per-DIH-tuh/
Prostelis /proe-toe-STEEL-iss/
Protandrena /prot-an-DREE-nuh/
Pseudopanurgus /sue-doe-pan-UR-gus/
Psithyrus /SITH-ih-russ/
Ptilothrix /til-O-thricks/
Sphecodes /sfeck-O-deze/
Sphecodogastra /sfe-kode-o-GAST-ruh/
Stelis /STEEL-iss/
Svastra /SVAS-tra/
Tetraloniella /tet-ruh-LOAN-e-el-uh/
Trachusa /trah-KOOS-uh/
Xenoglossa /zee-no-GLOSS-uh/
Xeromelecta /zero-mel-ECK-tuh/
Xylocopa /zile-low-COPE-uh/