Summary of Bumble Bee Floral Survey Pilot Results from 2021

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This is a brief summary of the pilot data collected during the testing phase of a bumble bee floral survey. Associated with this document is the most recent version of the survey instructions and an Excel spreadsheet showing all the data collected during the pilot phase.

Overall Data Summary:

Ninety-seven half-hour bumble bee floral surveys were completed in six states plus Washington DC (Table 1). Within those states 11 different counties were surveyed (Table 2) and observations were completed by 12 different collectors. Observation spanned five months (June through October) and documented 445 plant taxa (specificity ranging from cultivars to families, see spreadsheet for total taxa listings) and eight species of bumble bees (Table 4).

Analysis And Commentary

As described in the instructions, surveyors counted not only all bumble bees within a 10-foot radius of their transect, but also all the blooming plant species irrespective of bumble bee visitation (even plants with 0 bees). Bumble bees were identified to sex and species when possible and associated with the plants they visited. Virginia Carpenter bee (*Xylocopa virginica*) was included in the survey because it is a similar size to a large bumble bee, so it needed to be clearly differentiated during the counts.

Along with counts of bumble bees, observers also documented floral dispersal and abundance using the number of sectors (out of 25) occupied by each species of blooming plant and the floral rank of those blooming plant species (see the instructions on how both were defined to the observers). Note: The main reason it took 14 different versions and numerous focus groups in the field to develop the survey technique was difficulty in coming up with measures of dispersion and abundance for flowers that a volunteer untrained in ecology could understand and use.

There are many possible ways to analyze these data. For this simple summary we sought to present information only on bumble bees as a group, we did not separate them into species, nor did we analyze Carpenter Bee data. With vastly more data expected in 2022 our ability to look at these data by species, geographic area, time of year, and other factors will increase and any analysis we do now will be subsumed.

However, to get a feel for both how to do the analysis and what the results might look like, we did process the information for all bumble bee species, all times of year, and all surveys from 2021. Since number of bumble bees and number of flowering plant species vary among the surveys, we created a relative measure by simply dividing the results for an individual survey by the total number of plant

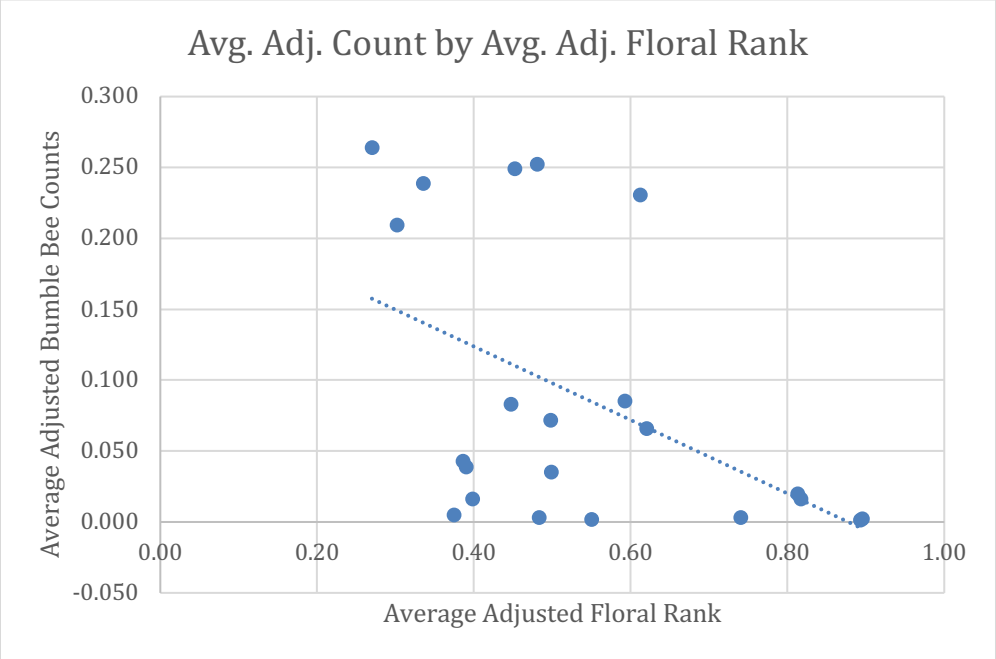
taxon or the total number of bumble bees (carpenter bees were removed from the analysis) found on an individual survey.

To ensure at least some semblance of utility in this initial analysis, we only used plant taxon that occurred on 10 or more surveys (Table 5). Table 5 includes a list of the plants that met that criterion, the average count of bumble bees on those plants, the average adjusted bumble bee count, the average adjusted floral rank for that plant taxon, and a weighted bumble bee count (a simple multiplication of the adjusted floral rank by the adjusted bumble bee count).

In Table 5 you can inspect the plants that were most favored (these are sorted from high to low by the adjusted count) and the ones at the bottom of the table which had no visits whatsoever. Undoubtedly, if you took enough surveys, every flower would have at least one visit by a bumble bee, so one shouldn't over-interpret the fact that some had zero visits during this pilot work. However, those that had zero counts and those that had very low counts would be expected to continue to have low counts in upcoming years. This will be one of the interesting facets of the upcoming complete data set. Will patterns remain the same across geographic areas and in the face of varying assemblages of plants? Will results shift when you go from highly biodiverse communities of blooming plants to simple ones comprised mainly of weeds? There are many more questions to ask. We are particularly excited by the number of large public botanic gardens and arboretums that are (or can be) interested in the project as those sites will have many often obscure and rare plants competing for the attention of bumble bees. In those extremely rich sites we can see most clearly bumble bee preference.

The list of top-performing plant species may not be much of a surprise to people, but the station of cup-plant at the number one species spot in terms of overall visitations may be interesting, given that many people are unfamiliar with that plant. In the midst of native plant top performers sits red clover; essentially equally attractive to bumble bees but not native to the continent. Further down the list sit some plants that I think people would have expected to be good bumble bee plants but ended up having low to no visitations. Some of these species are Yarrow, Dandelion, Daisy Fleabane, and Queen Anne's Lace. It's also interesting to see that both Black-eyed and Brown eyed Susan's along with Purple Coneflower had fairly low visitation rates yet are included in many "bumble bee" recommended seed mixes. Another surprise is the generally negative relationship between floral rank (this could be viewed as "commonness "on a survey) and bumblebee count. A quick linear correlation analysis (a not very sophisticated approach) showed a strong, significant negative correlation (Figure 1). Thus, the most common flowering plants are not necessarily the most attractive.

Figure 1. Relationship between adjusted average bumble bee count and adjusted average rank.



Note, that we do not wish to see these numbers used at this point by anyone, we present them as analysis teasers and something to think about when you are looking at your plants this coming year (and doing your bumble bee surveys, of course). At this point, our expectations are one thing, and the data may show something else. We look forward to many more such explorations and as the data grow we can look at these things in quite a number of different ways. For example, this technique also constitutes a survey of bumble bees for a particular site and region. Surveys are standardized by time and therefore are amenable to comparisons among sites, regions, and time periods. This hopefully will provide some insights into relationships of bumble bee counts and site aspects such as plant diversity, regional context, associations with management, nearness to pesticide exposures and so forth. There is also a great deal of ecological modeling software that can be used to investigate these patterns further.

A further note: To verify floral IDs, observers took pictures of every plant they recorded and those pictures were reviewed by botanist Jarrod Fowler.

Tables:

Table 1: Number of surveys submitted per state or locality. The vast majority (87/97) were in Maryland.

Location	MD	ME	DE	VA	WV	OH	D.C.	TOTAL
# Surveys	87	2	1	2	1	2	2	97

Table 2: Number of surveys submitted per county or locality. The majority (73/97) were in Prince George's, MD.

County or Location	# Surveys
Arlington, VA	2
Dayton, OH	1
Sussex, DE	1
Knox, ME	1
Lincoln, ME	1
Harford, MD	5
Howard, MD	4
Montgomery, MD	4
Prince George's, MD	73
Talbot, MD	1
Ohio, WV	1
D.C.	2

Table 3: Number of times a flower was assigned a given lot number. E.g., across all 97 surveys, only one flower was distributed across 22 lots. Alternatively, surveyors found that a flower taxon was in only one lot 1065 times. This demonstrates that more plants had narrow distributions than broad distributions on our surveys.

# Lots	Number of Times a Lot # was Assigned
1	1065
2	259
3	161
4	86
5	75
6	47
7	11
8	28
9	12
10	31
11	17
12	17
13	5
14	11
15	29
16	10
17	8
18	10
20	10
21	7
22	1

Table 4: Bee observations by species and sex.

Bee Species	Female	Male	Unknown	Grand Total
Bombus auricomus	2	0	0	2
Bombus bimaculatus	12	2	9	23
Bombus citrinus	1	4	1	6
Bombus fervidus	14	0	5	19
Bombus griseocollis	8	19	8	35
Bombus impatiens	575	24	831	1430
Bombus pensylvanicus	29	2	9	40
Bombus perplexus	0	1	0	1
Bombus species	16	3	761	780
Xylocopa virginica	118	2	233	353
Grand Total	775	57	1857	2689

Table 5 Fields explained:

***# Surveys* -** The number of surveys that a flower species appeared in.

***Avg. Count: Average bumble bee count* -** Total number of bumble bees found on a flower species across all surveys, divided by the number of surveys that the flower species appeared in

Avg. Adj. Count: Average adjusted bumble bee count -The number of bumble bees on a flower species in one survey divided by the total number of bumble bees in that survey. The value shown is the average of this value across all surveys.

Avg. Adj. F.R.: Average adjusted floral rank - Floral rank for a flower species in a single survey divided by the maximum floral rank in that survey. The value shown is the average across all surveys.

Avg. Adj. Count * Adj. Rank: Average of Adjusted bumble bee count times adjusted floral rank - Bumble bee count multiplied by adjusted floral rank on a per survey basis. This value accounts for both floral abundance and bee visitation, with highest numbers representing plants with lots of bees despite low abundance and lowest numbers representing plants with few visitations despite high abundance.

Table 5: Bumble bee floral preferences explored.

Common Name	Scientific Name	# Surveys	Avg. # Bumble Bees	Avg. Adj. Count	Avg. Adj. FR.	Adj. Count *Adj.F.R.
Cup Plant	*Silphium perfoliatum*	11	7.5	0.264	0.27	0.031
Short-Toothed Mtn. Mint	*Pycnanthemum muticum*	18	9.4	0.252	0.48	0.071
Wild Bergamot	*Monarda fistulosa*	11	8.5	0.249	0.45	0.048
Goldenrod sp.	*Solidago species*	24	6.3	0.239	0.34	0.040
Red Clover	*Trifolium pratense*	20	2.5	0.231	0.61	0.092
Late Boneset	*Eupatorium serotinum*	19	1.8	0.209	0.30	0.034
Eutrochium species	*Eutrochium species*	10	4.6	0.085	0.59	0.019
Wingstem	*Verbesina alternifolia*	15	1.6	0.083	0.45	0.028
Porcelain Berry	*Ampelopsis glandulosa*	14	0.1	0.071	0.50	0.029
White Clover	*Trifolium repens*	53	0.8	0.065	0.62	0.009
Black-eyed Susan	*Rudbeckia hirta*	23	1.5	0.043	0.39	0.014
Frost Asters	*Symphyotrichum species*	11	0.3	0.039	0.39	0.012
Purple Coneflower	*Echinacea purpurea*	13	0.7	0.035	0.50	0.006
Narrowleaf Plantain	*Plantago lanceolata*	19	0.3	0.020	0.81	0.013
Carolina Horsenettle	*Solanum carolinense*	25	0.1	0.016	0.82	0.012
Brown-eyed Susan	*Rudbeckia triloba*	14	0.3	0.016	0.40	0.003
Rudbeckia sp.	*Rudbeckia species*	18	0.1	0.005	0.38	0.001
Canada Thistle	*Cirsium arvense*	13	0.1	0.003	0.48	0.001
Bindweed sp.	*Calystegia species*	10	0.1	0.003	0.74	0.002
White Vervain	*Verbena urticifolia*	12	0.2	0.002	0.90	0.002
Fall Phlox	*Phlox paniculata*	13	0.1	0.001	0.55	0.001
Common Dandelion	*Taraxacum officinale*	15	0.1	0.001	0.89	0.001
Low Smartweed	*Persicaria longiseta*	25	0.0	0.000	0.57	0.000
Fleabane species	*Erigeron species*	24	0.0	0.000	0.50	0.000
Queen Anne's Lace	*Daucus carota*	19	0.0	0.000	0.70	0.000
Woodsorrel sp.	*Oxalis species*	19	0.0	0.000	0.88	0.000
Annual Fleabane	*Erigeron annuus*	17	0.0	0.000	0.46	0.000
American Pokeweed	*Phytolacca americana*	16	0.0	0.000	0.68	0.000
Deptford Pink	*Dianthus armeria*	14	0.0	0.000	0.69	0.000
American Burnweed	*Erechtites hieraciifolius*	13	0.0	0.000	0.75	0.000
Rose sp.	*Rosa species*	13	0.0	0.000	0.43	0.000
Common Yarrow	*Achillea millefolium*	12	0.0	0.000	0.64	0.000
Bedstraw sp.	*Galium species*	12	0.0	0.000	0.80	0.000
Wax Begonia	*Begonia cucullata*	11	0.0	0.000	0.34	0.000