A standardized method for monitoring Bee Populations – The Bee Inventory (BI) Plot.

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Considerable attention is currently being focused on evaluating the "status" of various animal populations. Most of this work has focused on vertebrate wildlife or endangered species. Recent evidence suggests that data from vertebrates does not predict change patterns in invertebrate taxa (Rubinoff 2001). In addition, even vertebrate data collected at fine scales does not predict insect species richness or the number of endemic species (Reid 1998). In fact, we know little about population trends in invertebrate species even though they are integral to critical ecosystem functions such as pollination. Even for the economically important native bee taxa patterns of diversity across habitats or the current status and population trends of these essential pollinators remain unknown. A standard method to monitor bee species is needed to maximize our ability to address these needs.

An ideal method would be simple, repeatable, and easily incorporated into other concurrent research objectives. It would provide consistency for collaborating researchers who would like to: 1) initiate monitoring studies and track population trends; 2) evaluate species richness across a range of landscapes; and 3) make comparisons across projects. The standards should allow many researchers, educators, and other interested individuals to implement a monitoring program. In addition, access to this data should be available via the web.
Data generated from this collaborative effort will be useful for 1) conservation planning 2) local and regional assessments of species richness; 3) evaluations of population trends in different habitat types (e.g. agricultural versus wilderness sites); 4) testing hypotheses regarding bee-habitat relationships and 5) developing methods for sustainable agriculture. Through this effort we can learn how to effectively monitor bees, whether we need to increase or decrease our sampling efforts, how species richness varies among plots, community overlaps, etc. It should generate a lot of interest and hypotheses for expansion of bee monitoring. This information can then be used to develop regional or habitat-based sampling schemes representative of the larger landscape. Because there would, by then, be a lot of pilot data around we would also be in good shape to justify our designs statistically and biologically

Establishment of BI plot

Location of plot.

Location of a plot is critical for avoiding biased estimates of both trend and habitat associations. Since we are interested in habitat specific associations, it is preferable to locate plots within a single distinctive habitat type. To minimize captures of bees from other habitat types plots should be located away from the edge of adjacent habitat types.

Size of plot.

Plots should be 1 hectare in area. If possible, the plot should be 100 m in length and 100min width. If this is not possible due to the configuration of the patch, the plot dimensions may be modified but should still maintain an area of 1 hectare.

Plot Description

This information should be included in a database as described below. At a minimum, we suggest recording the following data for each plot:

Nation
State or province
County
Locality, (use place names, not roads or highways, 4.2 km S Boulder; E slope Mt. Hilliers, etc.)
Estimate of the total size of the habitat surrounding the plot
Aspect, slope, latitude, longitude (degrees, minutes, seconds) and elevation
Dimensions of the plot
Habitat Description--all vegetation including the dominant tree, shrub and herbaceous species present and their percentage cover once per year.
Copy of a 7.5' topographic map of the area with the plot marked and photographs from each end of the plot into the interior and from the center of the plot towards each end.
Name and Address of Plot Coordinator
Optional additional information which will add to the value of the study

Aspect
Slope
Elevation
Soil

Vegetation surveys.

We suggest a choice from among three different levels of vegetation analysis. You should choose what is appropriate for your time and funding availability. We urge you to always try to pick the most detailed survey.

Level 1: At a minimum, a list of species in bloom for the quadrat for each date sampled should be recorded. This should include both bee-pollinated and other plants in the quadrat.
Level 2: The second level of vegetation survey would consist of counting octave or quintile series of abundance for each sampling date.
Level 3: The optimal vegetation survey will be a quadrat based plant survey of abundance and richness. Up to 30 sub-quadrats may be placed in each bee quadrat and all individuals counted and identified to species. The number of quadrats appropriate will depend on the variance in richness across quadrats. Excellent guidelines are given in Elzinga et al. 2001

Data Management

Over time, we would like to develop a web-based data entry program. At the moment, we suggest you follow the suggested database design below to facilitate entry into the established USDA Bee database.

Specimen Database

Field	Type	Length	Description

Tech	Text	4	Either “Net” or “Bowl”, captures for each technique MUST be kept separately
Date	Date	8	Sampling Date
Genus	Text	25	Bee Genus
Species	Text	25	Bee Species
Subsp	Text	25	Bee Subspecies (if pertinent)
Auth	Text	25	Authority for Species/Subspecies Characterization
Det	Text	25	Individual who identified the specimens
Number	Numeric	4	Number of individuals of that species/subspecies captured on that date with that technique
Ex	Text	25	Where individual was captured e.g. type of flower, at nest, etc…

Site Database

Field	Type	Length	Description
Nation	Text	8	Nation
State	Text	8	State or province
County	Text	15	County
Loc	Text	25	Locality, (use place names, not roads or highways, 4.2 km S Boulder; E slope Mt. Hilliers, etc.)
Size	Numeric	8	Estimate of the total size of the habitat surrounding the plot in hectares
Aspect	Text	2	Aspect
Slope	Numeric	2	Degrees
Latitude	Numeric		
Longitude	Numeric		

Elevation	Numeric	4	in meters

Conditions database

Date	Date	8	Sampling Date
High	Numeric	2	Highest Celsius Temperature Recorded When collecting
Low	Numeric	2	Lowest Celsius Temperature Recorded When Collecting
Wind	Numeric	1	Prevailing Beaufort Wind Code For That Date
Cloud	Numeric	3	Percentage Cloud Cover for That Date
Obsnet	Text	25	Individual who netted that day
Firstnet	Numeric	4	Military time of start of first netting period.
Secdnet	Numeric	4	Military time of start of second netting period
Obsbowl	Numeric	25	Individual who bowled that day
Bowlst	Numeric	4	Military time of when bowls set out
Bowlfin	Numeric	4	Military time of when bowls picked up
Sunrise	Numeric	4	Military time of sunrise
Bloom	Memo	-	Notes on which species were in heavy bloom that day on the plot

Timing of sampling of plot.

Plots should be sampled every 2-4 weeks from mid-March to the end of October. The starting and ending dates will depend on the first and last major flight periods of bees at the particular site.

If logistics restrict sampling to only one season (e.g., Spring – Mar 1-Jul 1 or Fall – Jul 1-Nov 1), a minimum of 4 samples must be made per plot preferably spread across the whole season.

Pan traps should be placed in a plot prior to 9:00 am and picked up from the plot between 3:00 pm and 5:00 pm. Netting should be done for a total of one hour the morning (9 am-12 pm) and one hour in the afternoon (12 pm-3 pm).

Placement of pan-traps.

In the plot, two 50 m. transects should be established. 15 pan traps (described below) should be placed on each transect. The transects should form an X reaching the corners of the plot. Pan trap colors should be randomly assigned each time the pan traps are placed out. The start and finish of the transect should be marked to ensure that the same transect is used in subsequent samples. We suggest using red flags.

Type of pan trap

Pan traps should be small, white Solo brand stock number PB6-0099 (6 oz). The easiest thing to do is to contact a local distributor. Call Solo at 800-367-2877 if you have trouble finding a local distributor.

1/3 of the pan traps should be painted fluorescent blue, 1/3 should be painted fluorescent yellow and 1/3 should be left White. A standard fluorescent spray paint color has been chosen. Information is available from Sam Droege about the details of the spray paint. You only need to paint the inside and top edges of the bowls.

Pans should be filled with a solution made up of 1 Tsp per gallon of Dawn brand blue soap. This solution can be made ahead of time and easily transported in a backpack sprayer or gallon plastic jugs

Pans should be placed on level ground.

Netting

Two collectors should net each one-hectare plot for two half hour periods, 1 in the morning (9-12) and again in the afternoon (12-3) because bees differ in their diurnal activity patterns. The collectors should divide the patch up ahead of time so that sampling effort is spread over the entire plot and switch halves halfway through collecting.. Collections by two collectors have the advantage of reducing collector bias and allowing for quantification of any bias.

Alternatively, one collector may sample for one hour at each time period. A collector should sample throughout the plot. A collector should spend no more than 5 minutes at any particular patch of plants. Once the whole area has been sampled, a collector may return to rewarding patches. Bees should be collected on plants, on the ground and in the air, patrolling since males and both sexes of parasitic bees often spend little time on flowers.

Data should be collected on the identity of the host plant or behavior of the bees that are netted. If plant species ID appears onerous, genus would nonetheless be very useful, as even specialist bees rarely use but one single species to the exclusion of other congeneric plants. Floral host records aid identification and are informative about both the bee's biology as well as for future taxonomists and ecologists interested in finding a particular bee again.

Weather conditions

Since cold, rainy and windy conditions decrease the number of bees foraging, samples should only be taken on warm, calm, sunny days.

Collector training.

Collectors should have experience netting. If more than one collector is used, every attempt should be made to evaluate and standardize collecting ability and to randomly assign collectors to sites and sampling dates.

Pinning and labeling specimens.

All bees should be pinned and labeled. Each label should contain the following information:

Country
State
County
Locality
Elevation
Site
Latitude and Longitude
Date
Floral host
Collector

Here is an example:

USA: CALIFORNIA: Napa Co.
Rector Reservoir, 60m
3.2 km NE Yountville
38º26'13"N,122º20'57"W
17 March 2001, ex: Vicia sativa
G.LeBuhn, R.Brooks

Labels should be printed in a small but readable font with a maximum size of label = 0.7 x 1.7 cm. If there is lots of label data, two labels may be required.

Processing pan-trap specimens.

To prepare pan trap specimens follow the following procedure:

1. Strain bees in field (we like metal kitchen strainers that will fit into a whirlpak bag)..
2. Put in whirl-paks of 75% alchohol (1/2 ethanol 1/2 methanol).
3. When ready to process, fill packs with water and dump contents in sieve.
4. Run water over specimens.
5. Dip sieve in warm water with dish detergent in it and swish vigorously.
6. Run water over sieve again.
7. Pat the bottom of the sieve dry on a towel to remove excess water.
8. Dip sieve in 95% alcohol.
9. Pat bottom again.
10. Dump contents on paper towel to soak up much of the alcohol.
11. Roll speciments to dry section.
12. Place the bees in a paper towel, fold it over, putting a dish cloth or old t-shirt on top and rubbing them down quite hard. Move the bees around onto dry spots a couple of times on the paper towel and repeat and finally put them in toilet paper for a final rub down.

Identification of specimens.

Accurate identifications of collections are essential for comparisons across sites. For most bee genera this will be difficult to impossible without access to a strong reference collection. Currently, we have decided to lump all *Dialictus*. If needed, Bob Minckley of the University of Utah or Terry Griswold at the USDA-ARS Bee Biology & Systematics Lab in Logan, Utah will identify specimens. The identifier should be allowed to keep a reference collection. Please contact Bob Minckley or Terry Griswold **PRIOR TO BEGINNING** sampling if you would like to use their services. Only collections that are pinned and labeled and have all of the requested accompanying data

burned onto a cd and accompanying the specimens will be accepted. Since identifications will take a considerable amount of time and effort, we suggest that funds be allocated for identification to support a staff assistant at the USDA lab and whenever possible, those with major involvement in identifications be included in authorship.

In the future, we hope that new species identification software (e.g. DAISY) will be available for facilitating identification.

Data management

Data should be entered into a relational database (e.g. Access, Biota…). A crucial element in developing this collaborative effort is the development of a central repository for the data and specimens and mechanisms for providing data to agencies and researchers for analysis. The USDA-ARS Bee Lab is willing to provide that service.