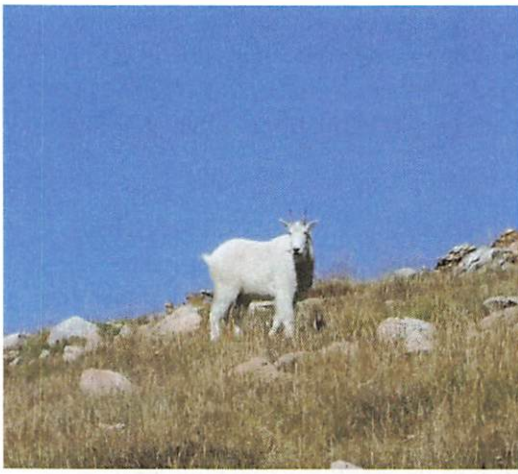
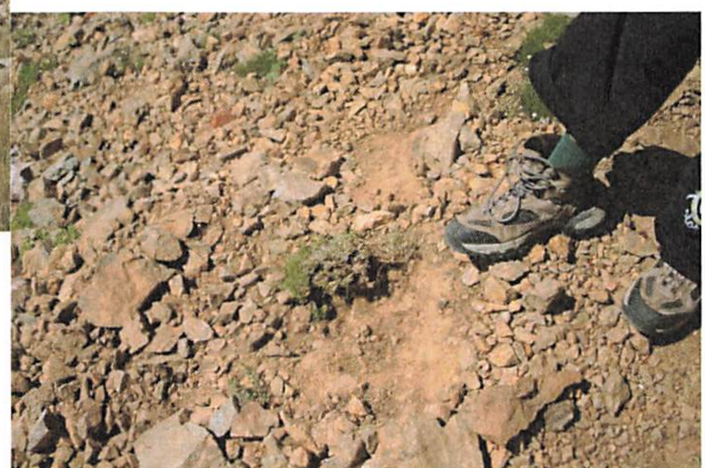
La Sal Mountain alpine arthropod communities: establishing baseline conditions

2016 Annual Report to Canyonlands Natural History Association





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All 2014 and 2015 pitfall traps, and 2016 pollinator cup traps have been cleaned; initial sorting of all 2014 pitfall samples and about 50% of the 2015 pitfall traps was completed prior to the beginning of the 2017 field season. All pollinators we netted during the 2016 summer season (not what fell into the pollinator cup traps) have been identified to genus (and some to species) or been assigned a morphospecies epithet. This collection also provides the base for sorting the pollinator cup trap samples, which is progressing now. I will continue with analyses of these two datasets over the winter, comparing results of captures on flowers with captures in the comparable colored traps, as well as comparisons of what species are recorded in each capture method, with an assessment of efficiency for capture of various taxa (e.g., few Lepidoptera and bumble bees are caught in the traps, while gnat-like flies are not well-represented in net samples).

Work on the pitfall trap samples continues; all 2014 samples and about 80% of the 2015 samples have been through the initial cleaning and sorting process and are ready to have specimens assigned to morphospecies (or actual genera and species). I hope to have some preliminary analyses included in the 2nd 2017 interim report planned for this winter.

We captured 711 potential pollinator specimens assigned to almost 200 taxa caught on 46 species of flowers or on bare ground, rock or plant foliage, or were swept out of the air. More Hymenoptera (83) taxa were caught than either Diptera (62) or Lepidoptera (49). It is likely that the actual number of Hymenoptera species is less than 83 since I probably have classified workers and queens as different morphospecies. I will be taking the bees to the USDA Bee Lab at Utah State University in December for assistance with species identification.

Chi square tests comparing numbers of insects captured on each color class of flower to the number of flower species of each color were not significant for any comparison pooling insects within each family. There were some comparisons that approached classic statistical significance (i.e., $P < 0.05$), but most indicated little to no discrimination among flower colors. Additional analyses of these data are warranted; parsing the data to finer taxonomic levels may reveal floral preferences. The pie charts in Figures 1-14 represent proportional captures on the different flower colors for different taxa at each site and pooled across sites. Visual comparisons among the charts provide a rough assessment of differences and similarities among pollinators and sites. Further analyses will be made this winter and more detailed discussion of the results, including comparisons over the 2 years of work thus far will be included.

Proportional representation of different taxa based on these captures probably does not reflect the true proportions at the sites because of biases inherent in our sampling methods. Some aspects of the data, such as the limited captures of moths at Mt Peale in 2016 are probably the result of sampling effort or search image biases rather than actual abundance patterns, but some likely do reflect characteristics of the sites or the particular taxa. For example, few swallowtail butterflies or sphinx moths were seen at any of the sites over the summer, and these species are particularly difficult to catch because they rarely land on a flower for very long. I think there was a tendency for some volunteers to concentrate on butterflies or bumblebees, or to ignore particular flowers, and some taxa were more difficult to catch (e.g., microlepidoptera and tiny flies that show up in the pollinator cup traps but are very rare in net samples). However, these data do provide a list of taxa documented to be present at the sites, as a representation of the La Sal Mountains alpine pollinator community, shortly after mountain goats were introduced. This list can be compared to lists prepared in the future based on similar efforts to provide an assessment of possible mountain goat impacts on the alpine ecosystem of the La Sals.

Data on which pollinator species were found on each flower species, and which flower species were used by each pollinator species have been compiled and an ordination pollinator community analysis completed on these data. Nonmetric Multidimensional Scaling (NMS) ordination did not result in stark separation of flower use by particular taxa, from either the individual pollinator or individual plant perspective. I interpret this to mean that most of the pollinators are fairly catholic in their choice of flowers to feed on, and most flowers are visited by a wide range of insects. The two axes shown only account for about 53% of the variation in the data, which is not a strong solution, but it does provide some guidance on how the arthropod communities are structured in the La Sal alpine zone which will be very useful for assessing how these communities have changed over time. NMS is used primarily as an exploratory tool to indicate whether there are patterns in a dataset; further analyses will hopefully elucidate some patterns.

Ordination of flowers as sites and pollinators as "site characteristics" did generate 4 groupings of flowers on which pollinators were captured (Figure 15). There does not appear to be any unifying characteristic of the flowers within each group. Each group includes at least three floral colors and at least two floral structural types (e.g., tubular, large platform, small platform). Frequency of capture for different pollinators does appear have played a role in structuring the ordination. No Diptera were caught on any of the flowers Group 1; at least one Hymenopteran was caught on each flower species in this group. Lepidoptera captures were mixed for Group 1. Group 2 flowers accounted for most captures in each order of pollinator; the position of this group over the center of the ordination space indicates this group encompasses much of the variation in the dataset. Almost half of the flower species are represented in this single group, at least twice the number of any of the other 3 groups. The 4 flower species in Group 3 had very different capture histories. Achillea millefolia and Potentilla spp. were favored by all 3 orders of pollinators, while captures on Aquilegia coerulea and "plant foliage" were in the range of 0-2 captures per order except for Lepidoptera on foliage; most small moth captures were on foliage. An explanation for why the latter 2 "taxa" were in such close proximity to the former 2 taxa in ordination space is not immediately obvious. Group 4 was also a fairly mixed group of flowers. The character that seems to be most common among all of them is that there were a few captures on each, but not many pollinators were documented on any of the species. The 2 flowers somewhat isolated in the upper right quadrat were documented hosting only Lepidoptera, and only a total of 5 of the 719 captures recorded during pollinator surveys at the 3 sites in 2016 were on these two species.

Joint plots indicate the primary influences in generating the ordination space (i.e., separating 'sites,' in this case flower species, from each other) are capture data for bumblebees, the Lepidopteran families Nymphalidae (butterflies) and Sphingidae (moths), and Diptera (flies). All of these vectors are directed to the lower right quarter of the ordination space except for Sphingidae. The presence of Sphingidae captures among the significant vectors is surprising as there was only 1 capture across all sites and all sampling times.

Switching the data to treat pollinators as sites and the flowers each visited as "site parameters" provided a relatively robust ordination, accounting for about 82% of the variation in the data. As the pie charts also indicated, most pollinator visits in general were to yellow flowers. In ordination space, yellow flower use was indicated with negative axis 1 scores. The flies and bees (both bumblebees and other bees) were located in the upper left quadrat of the ordination, which was characterized by a concentration on four yellow species (*Hymenoxys grandiflora*, *Senecio crassulus*, *S. fremontii*, and *Taraxacum officinale*) of the Asteraceae (sunflower family), but also on two purple flowers (*Phacelia sericea* and *Polemonium viscosum*). The lower left quadrat appears to reflect heavy use of yellow and orange flowers or captured on non-floral substrates, but low use of purple, blue or pink flowers. The wasps and most butterflies were located in this space. Most moths were placed in the lower right quadrat; these taxa were commonly captured on foliage, rocks or in sweeps, which apparently is what distinguishes the taxa in this part of the ordination space. Only one sphinx moth, Hylea lineata, was caught and it was on blue columbine (*Aquilegia coerulea*); this unique combination defined the upper right quadrat of the ordination.

Notable observations

Thanks to extensive help from Robb Hannawacker, an employee at Arches in 2016 with extensive knowledge of butterflies, I was able to make more progress with the pollinator capture data for this report. In addition to the analyses presented here, there are a few items of interest to mention related to the butterflies we found last year.

Robb caught one individual of *Lycaenus cupreus*, a Lustrous copper (Figure 0A), at the Mt. Peale site in early July 2016. This is a new record for the species; the nearest reports of specimens of L. cupreus are from about 100 km (60 mi) to the east, near Olathe, CO and about 190 km (120 mi) north, near the Ouray National Wildlife Refuge. Robb said that discussions with other Lepidopterists leads him to believe that this specimen is somewhat atypical and that if there is a La Sal population it might be disjunct and be diverging from more contiguous populations across western North America.

Figure 0A. *Lycaenus cupreus*; Lustrous copper.

Figure 0B. *Parnassius smintheus,* Rocky Mountain Parnassian.

Parnassius smintheus (Figure 0B)is another species that we recorded in 2016; two specimens were captured and two other individuals were seen at Manns Peak. Robb caught one on 26 July 2016, and I caught one and observed two others at Manns Peak the next day. This species is fairly common in the central Rocky Mountains, but I didn't find any museum records of specimens collected within about 65 km (40 mi) of our records, which may mean this is another disjunct butterfly population in the La Sals.

I have documented at least one specimen of the bumblebee Bombus balteatus from our Manns Peak site, and probably have collected others from Manns Peak and Mt. Peale at least. This is another species that apparently has a disjunct population on the La Sals. The nearest specimens reported from museum records to the Manns Peak specimen were collected over 200 km from the La Sals site.

The isolated alpine zone of the La Sals provides the potential for disjunct populations to diverge genetically from the larger population surrounding the La Sals. As we get more specimens identified, we may find other species with disjunct distributions isolated on the La Sals. There is also potential for undescribed species to be found among the samples collected thus far. Until we know more about the arthropod communities and the species that make up these communities, it would be prudent to proceed with caution when considering manipulations of the limited alpine environment of the La Sals.

Thus far, mountain goat activity on my study sites has varied from no discernible activity at Manns Peak to moderate effects, mostly small wallows and browsed flowers at Beaver Basin, to more extensive impacts at the Dark Canyon/Mt. Peale site, with more extensive wallows, and goats observed every day of every visit in 2015 and 2016. Given that the study did not begin until after the first introduction of goats, having one study site that has remained in relatively pristine condition through four field seasons provides us with a longer period of relatively goat-free data with which to eventually evaluate goat impacts on the alpine arthropod communities of the La Sals.

Figure 1

Proportion of all flowers species of each color (n = 46)
pooled across sites and dates 2016

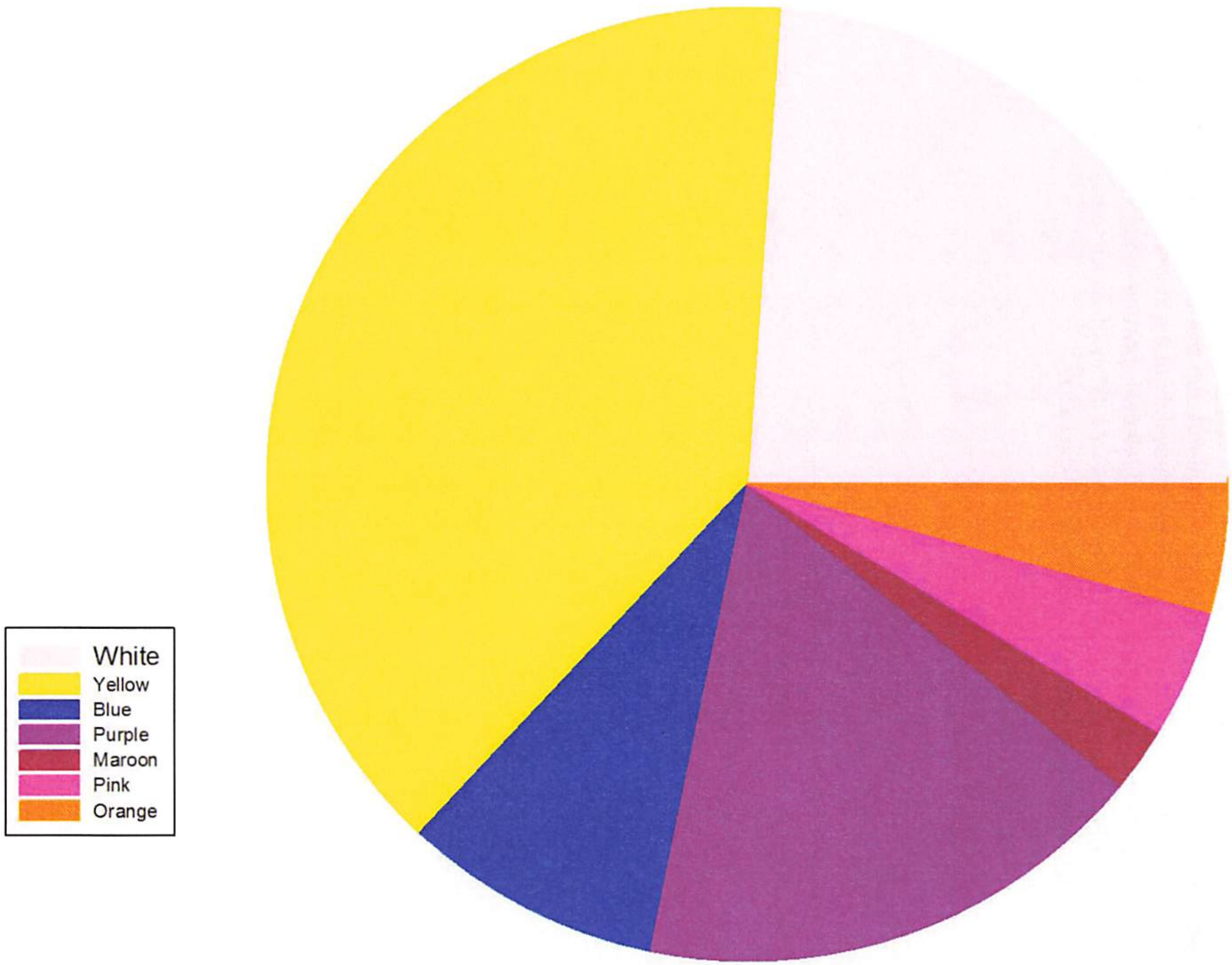


Figure 2

Proportional use of flowers by color for all pollinators (n = 711) pooled across sites and dates 2016

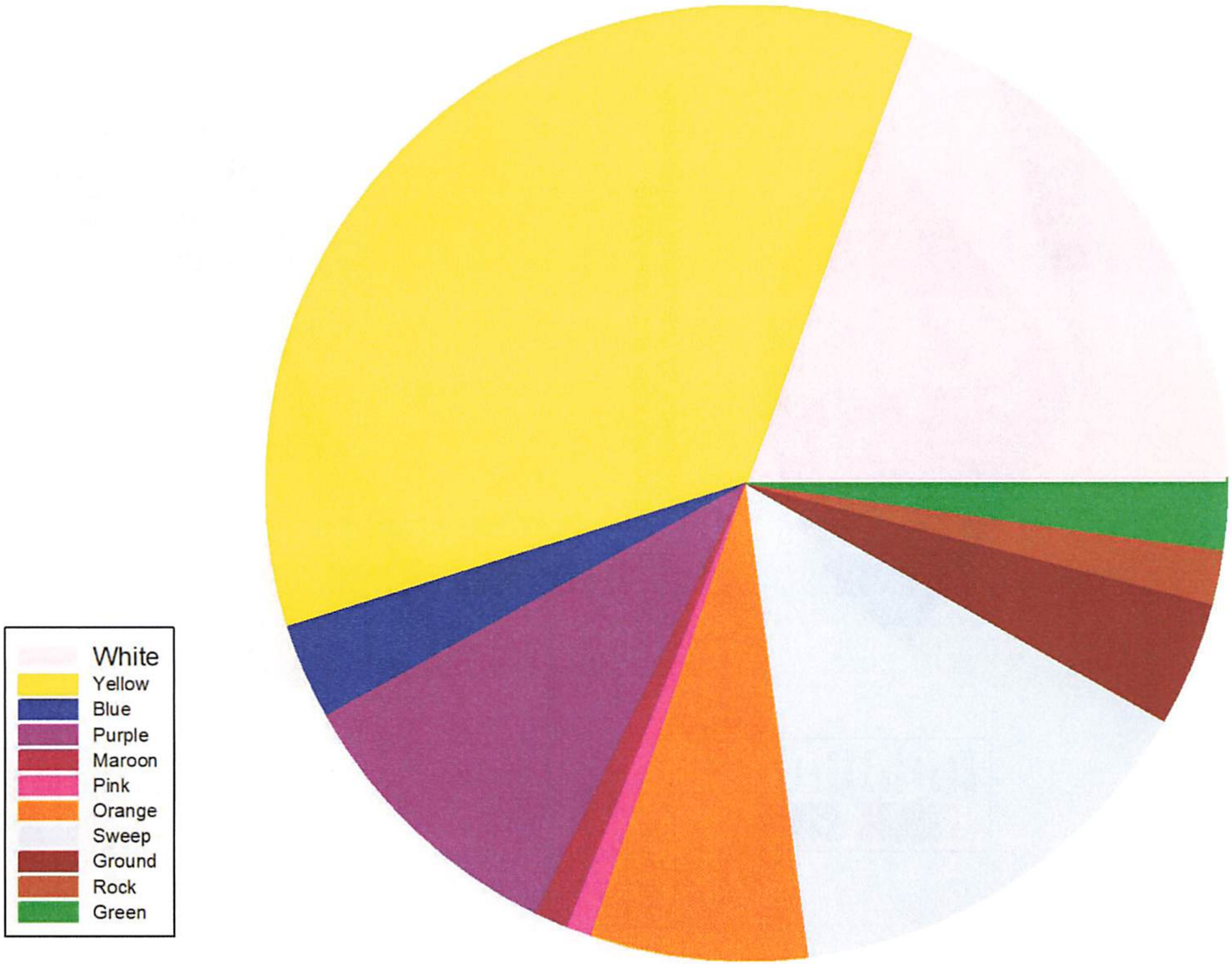


Figure 3

Proportional use of flowers by color for all Hymenoptera (n = 319) pooled across sites and dates 2016

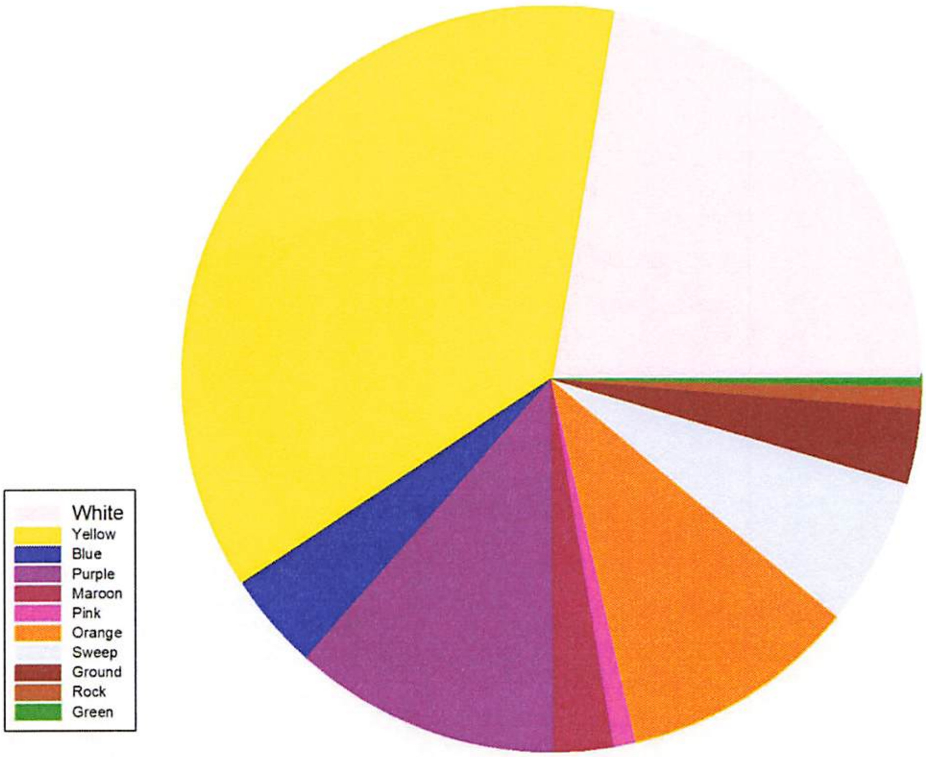


Figure 4

Proportional use of flowers by color for all Lepidoptera (n = 205) pooled across sites and dates 2016

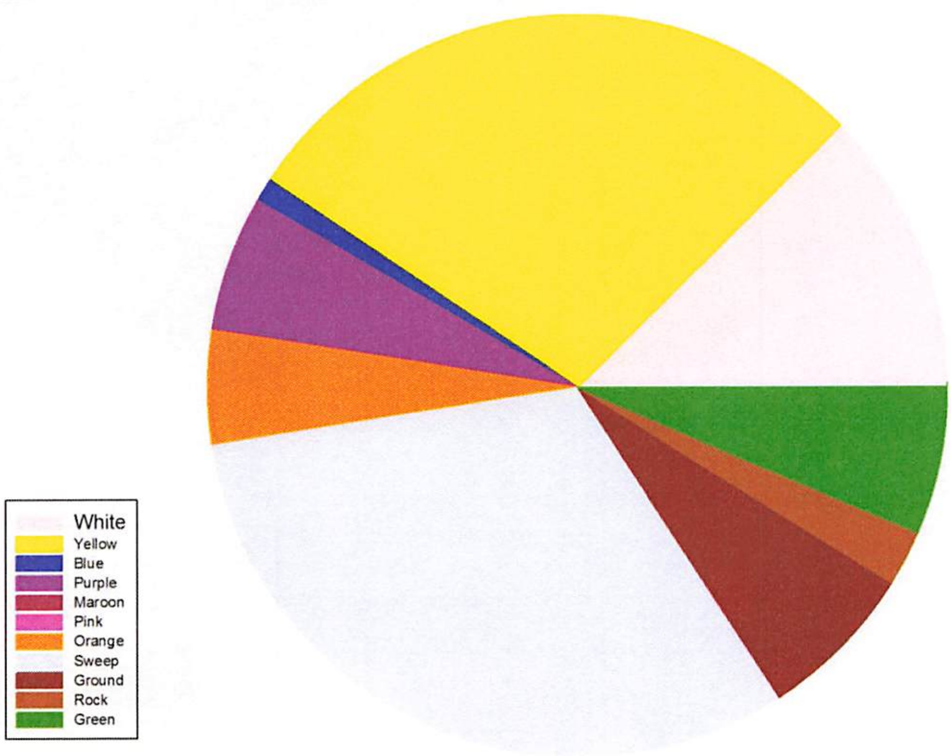


Figure 5

Proportional use of flowers by color for all Diptera (n = 197) pooled across sites and dates 2016

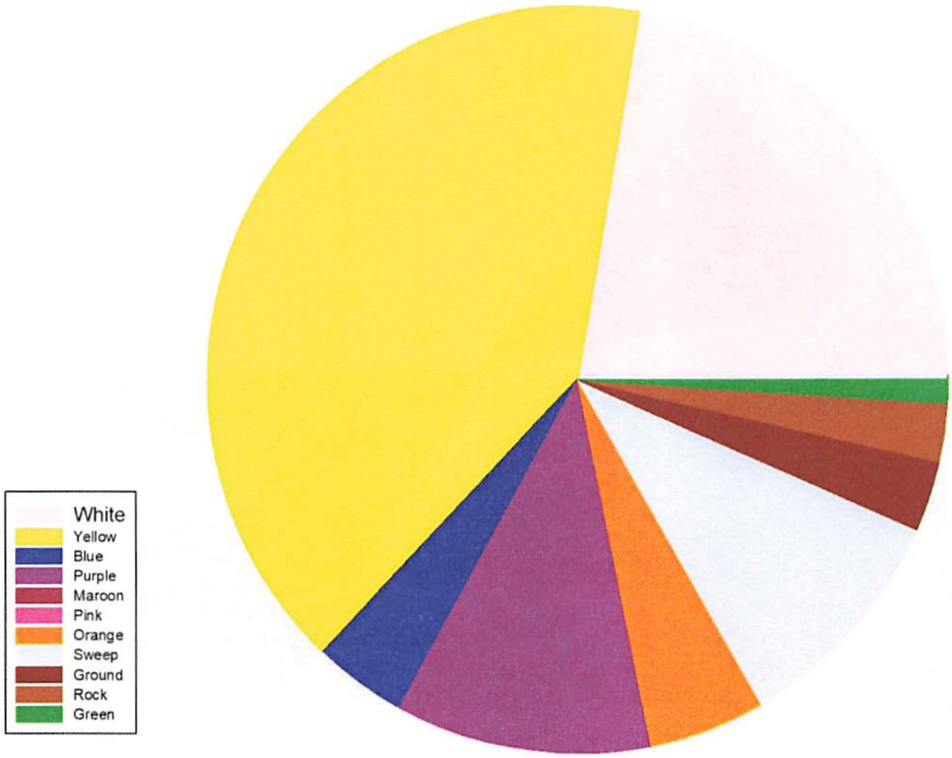


Figure 6

Proportional use of flowers by color for all Apiodea (bees) (n = 240) pooled across sites and dates 2016

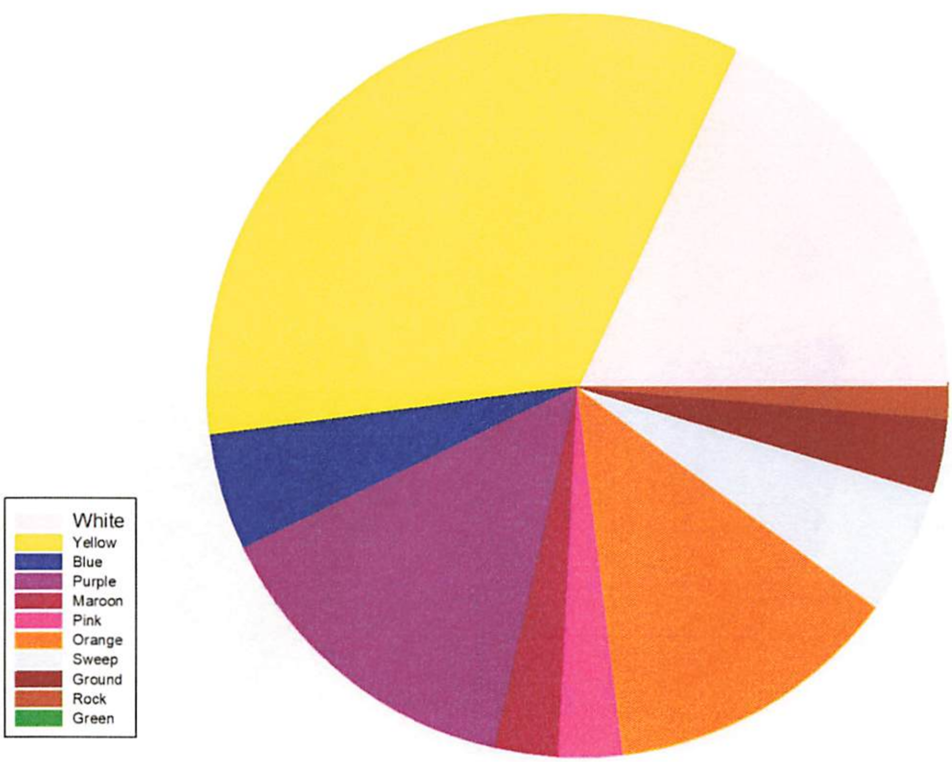


Figure 7

Proportional use of flowers by color for all Butterflies (n = 124) pooled across sites and dates 2016

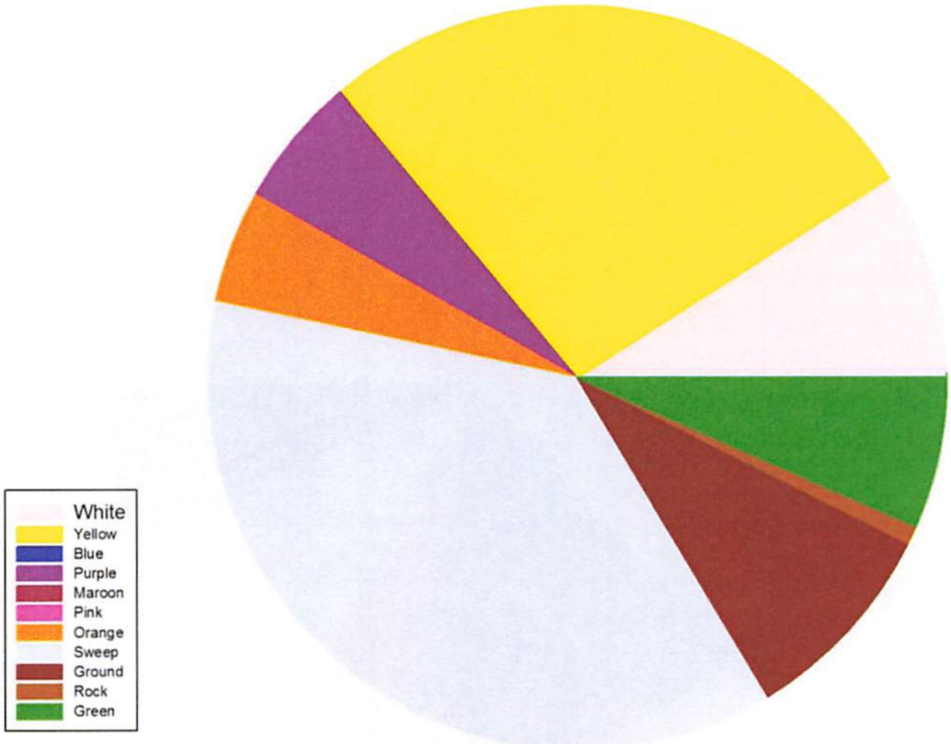


Figure 8

Proportional use of flowers by color for all Moths (n = 81) pooled across sites and dates 2016

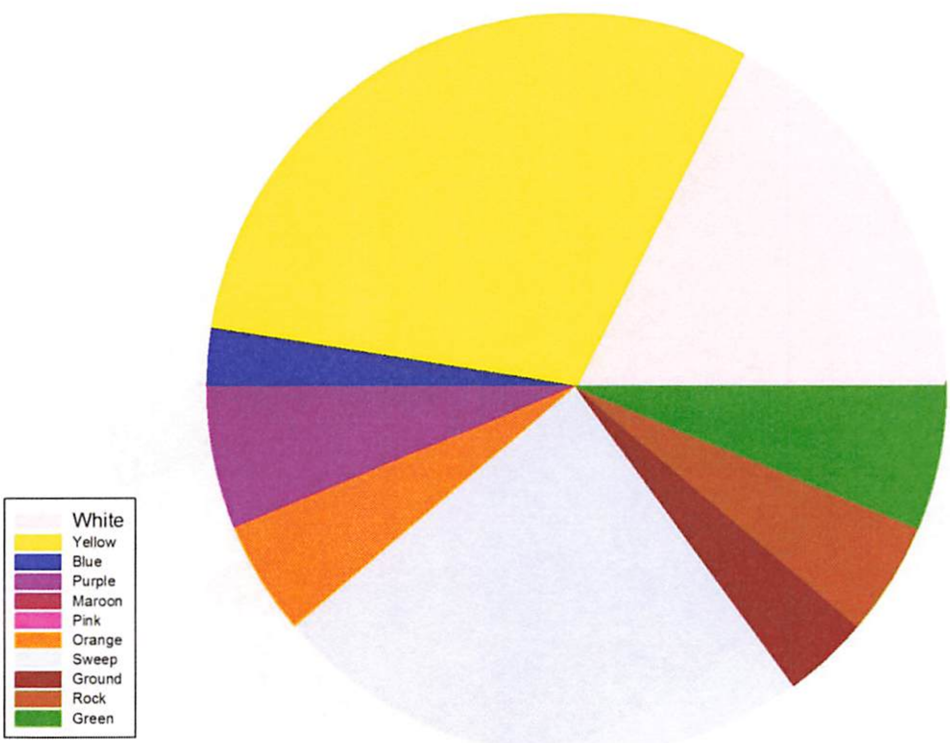


Figure 9

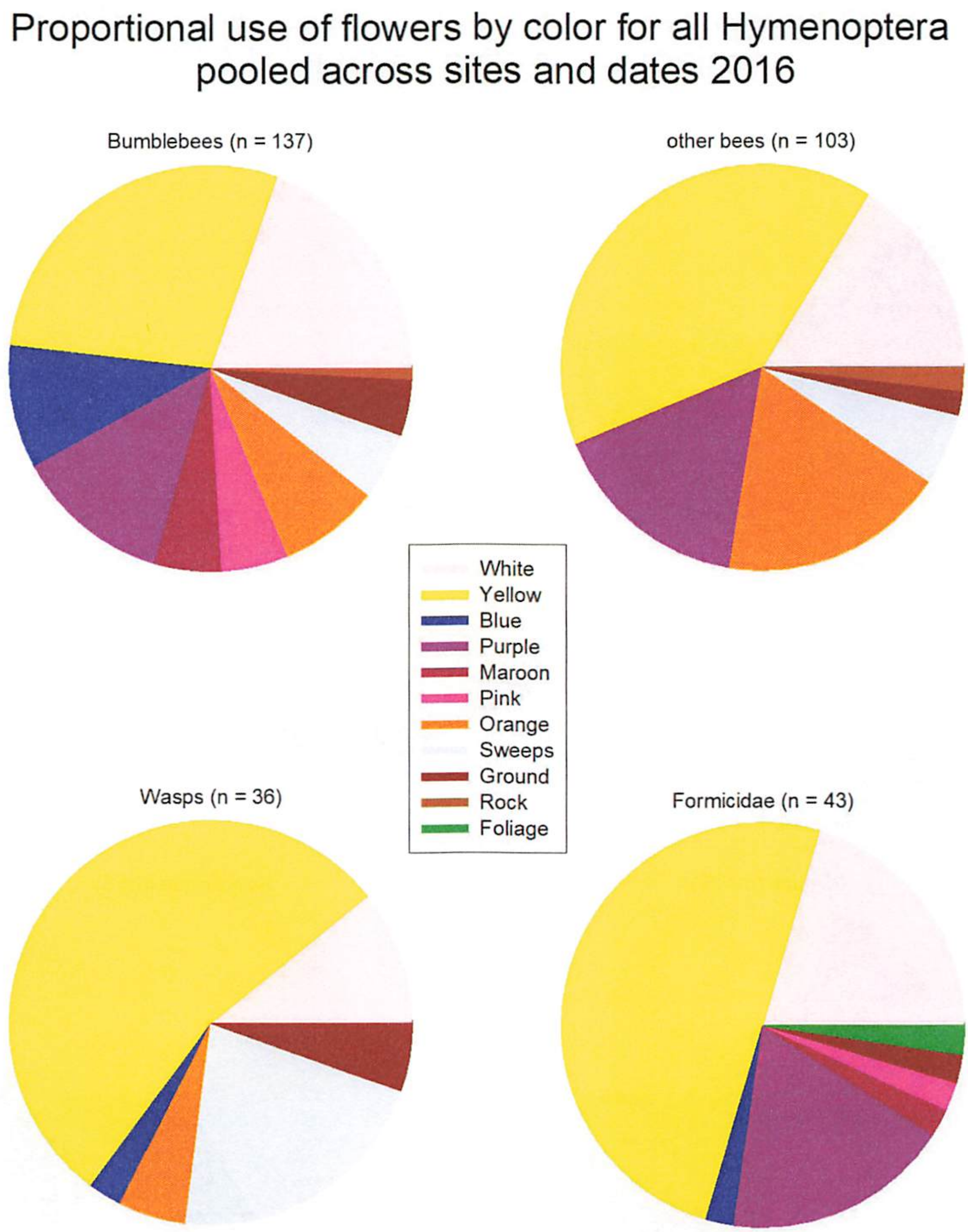
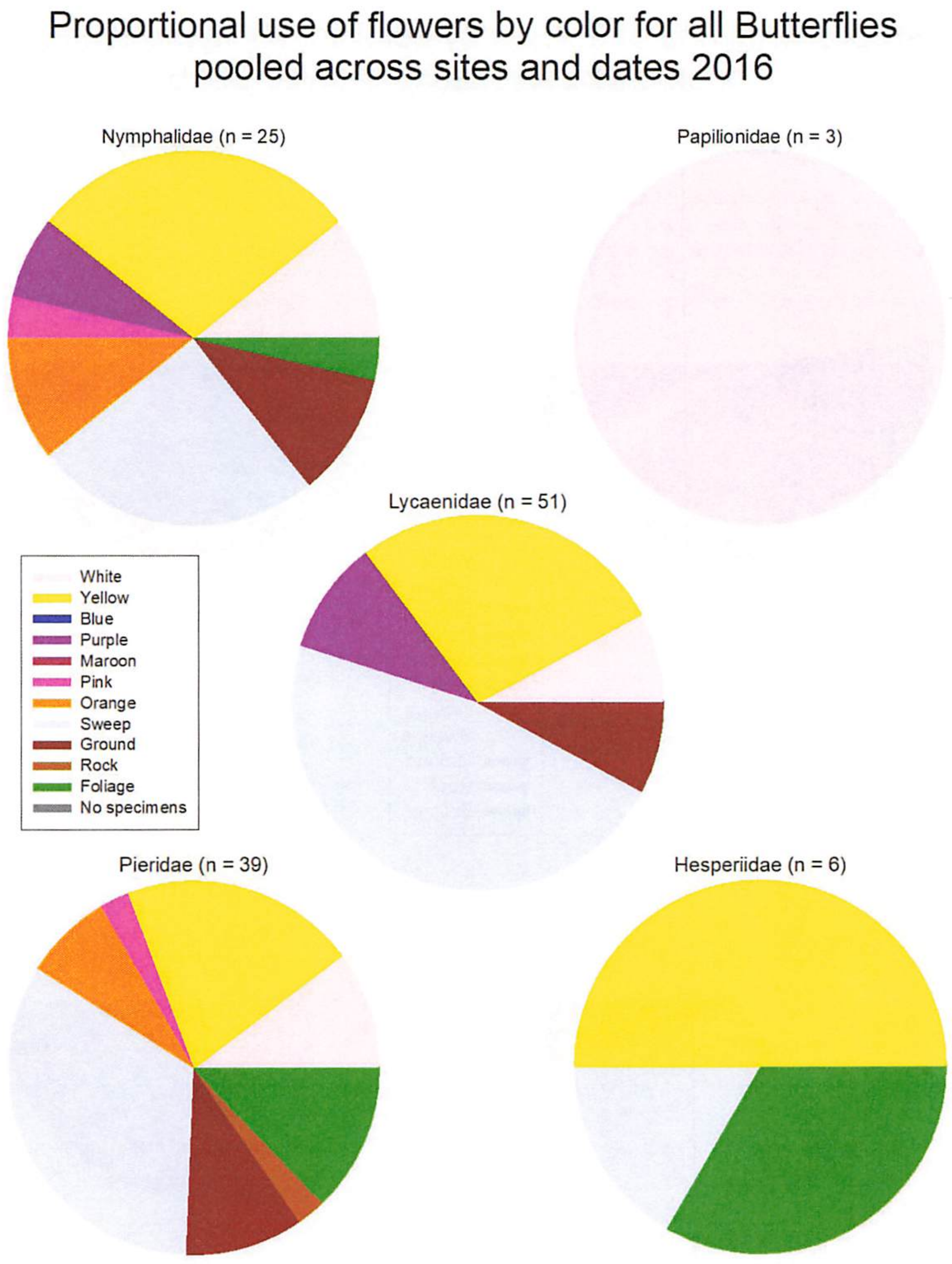

Proportional use of flowers by color for all Hymenoptera pooled across sites and dates 2016
Bumblebees (n = 137)
other bees (n = 103)
Wasps (n = 36)
Formicidae (n = 43)
White
Yellow
Blue
Purple
Maroon
Pink
Orange
Sweeps
Ground
Rock
Foliage

Figure 10



Proportional use of flowers by color for all Butterflies pooled across sites and dates 2016
Nymphalidae (n = 25)
Papilionidae (n = 3)
Lycaenidae (n = 51)
White
Yellow
Blue
Purple
Maroon
Pink
Orange
Sweep
Ground
Rock
Foliage
No specimens
Pieridae (n = 39)
Hesperiidae (n = 6)

Figure 11

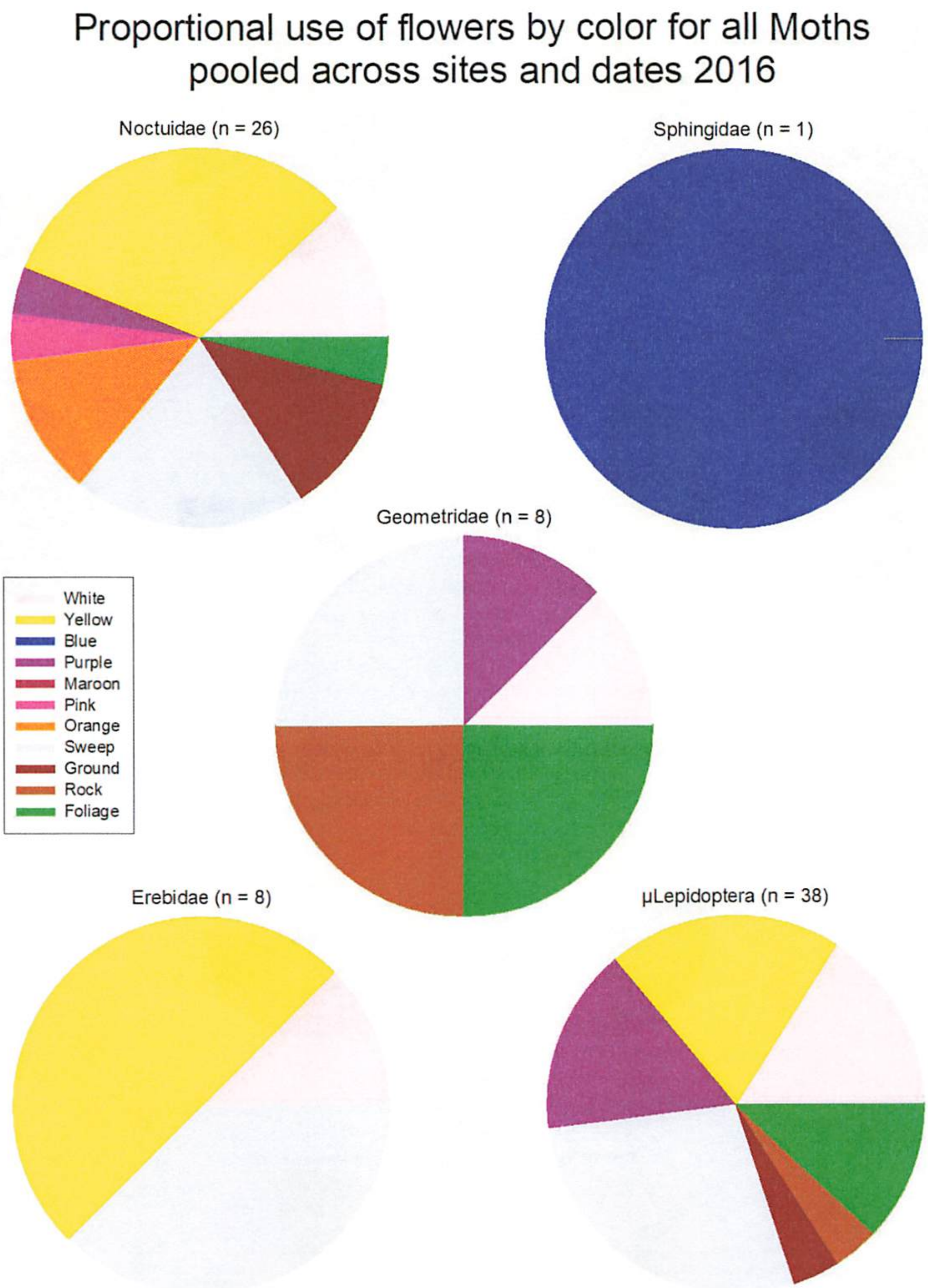
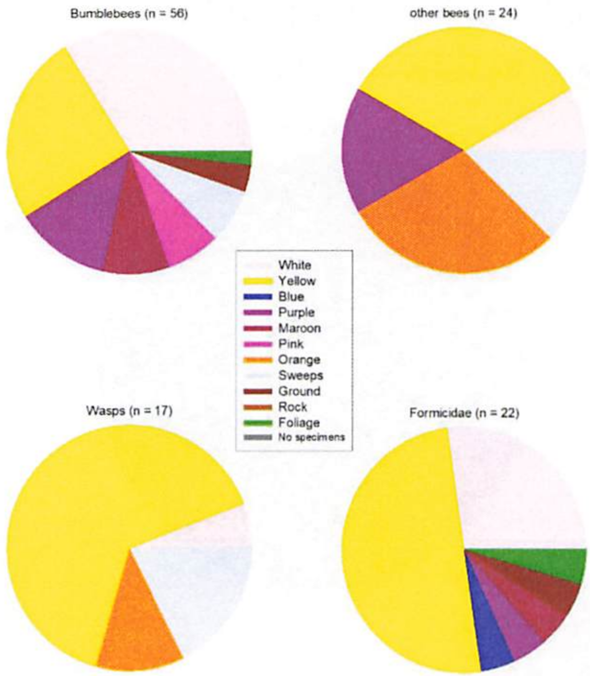
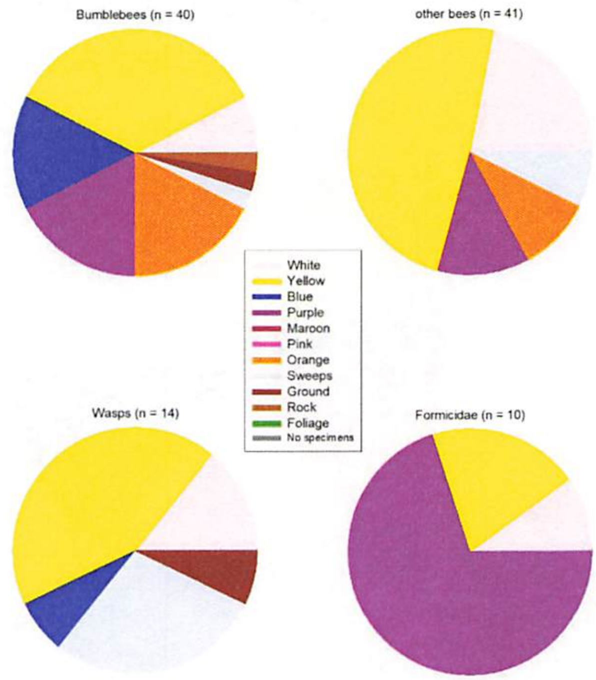

Proportional use of flowers by color for all Moths pooled across sites and dates 2016
Noctuidae (n = 26)
Sphingidae (n = 1)
Geometridae (n = 8)
White
Yellow
Blue
Purple
Maroon
Pink
Orange
Sweep
Ground
Rock
Foliage
Erebidae (n = 8)
μLepidoptera (n = 38)

Figure 12

Proportional use of flowers by color for all Hymenoptera at Beaver Basin, pooled across dates 2016



Proportional use of flowers by color for all Hymenoptera at Manns Peak, pooled across dates 2016



Proportional use of flowers by color for all Hymenoptera at Mt. Peale, pooled across dates 2016

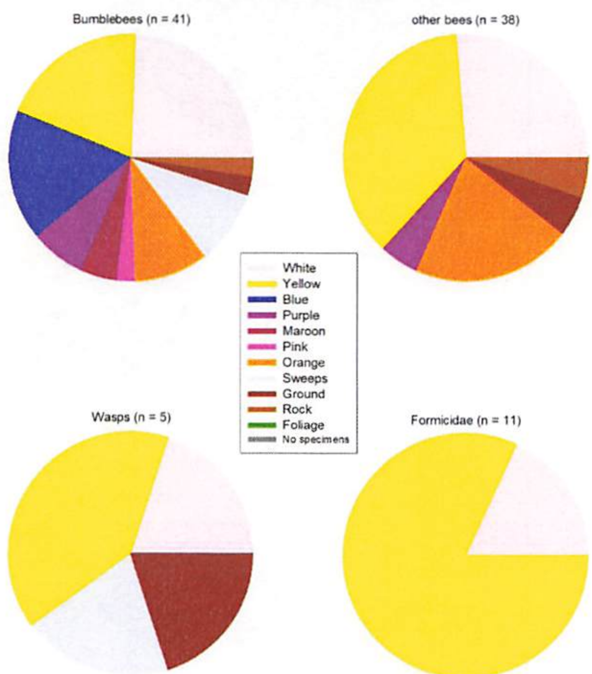
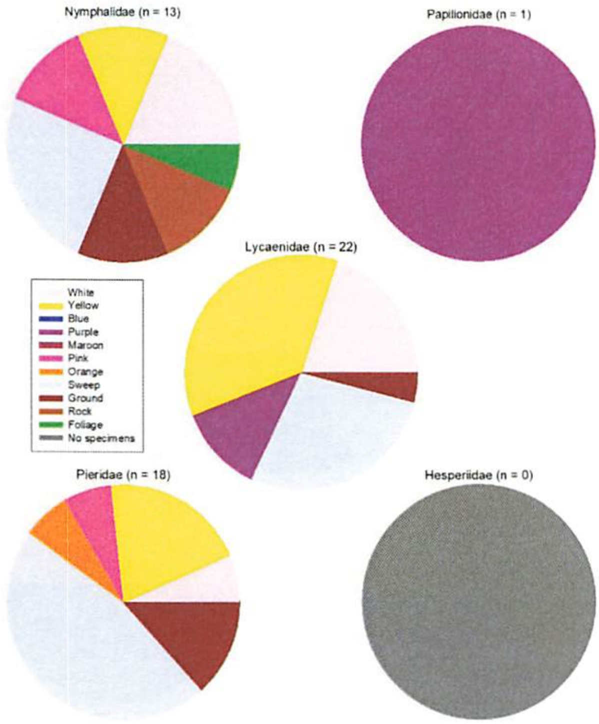
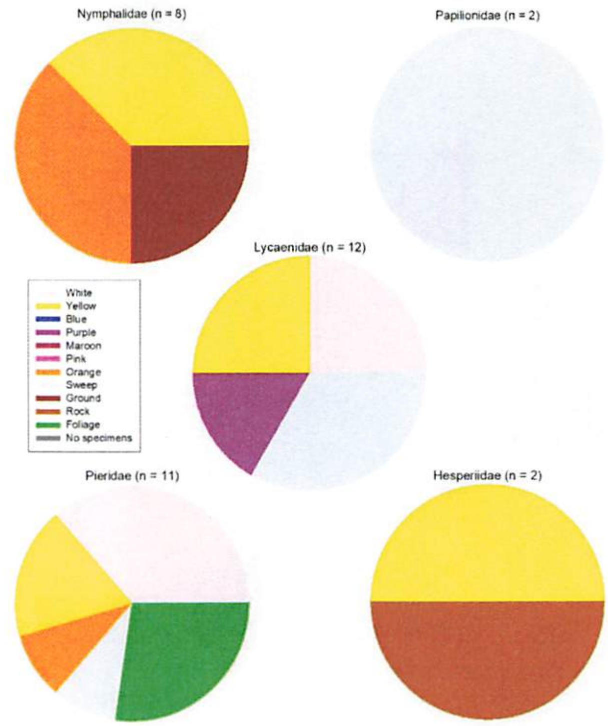


Figure 13

Proportional use of flowers by color for all Butterflies at Beaver Basin, pooled across dates 2016



Proportional use of flowers by color for all Butterflies at Manns Peak, pooled across dates 2016



Proportional use of flowers by color for all Butterflies at Mt. Peale, pooled across dates 2016

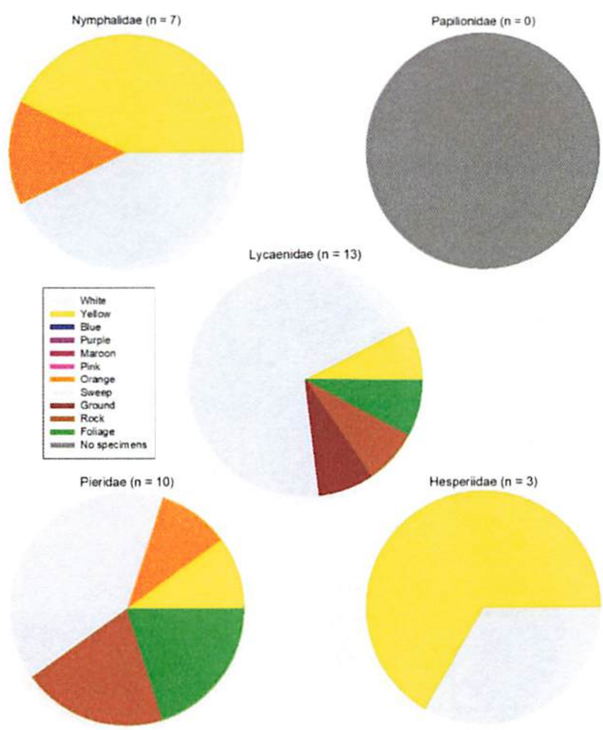
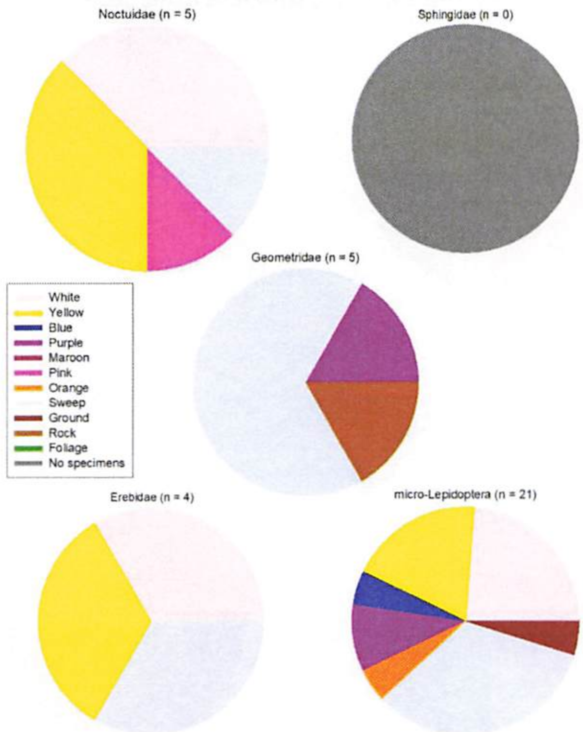
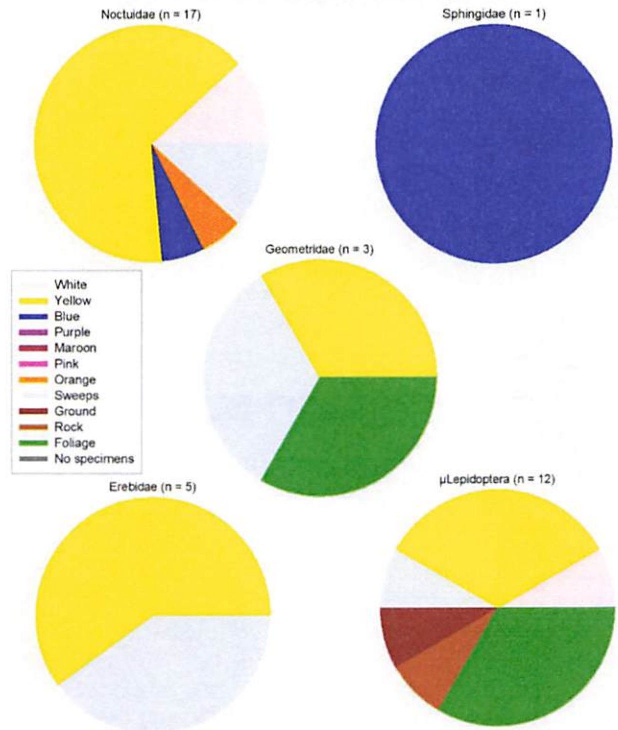


Figure 14

Proportional use of flowers by color for all Moths at Beaver Basin, pooled across dates 2016



Proportional use of flowers by color for all Moths at Manns Peak, pooled across dates 2016



Proportional use of flowers by color for all Moths at Mt. Peale, pooled across dates 2016

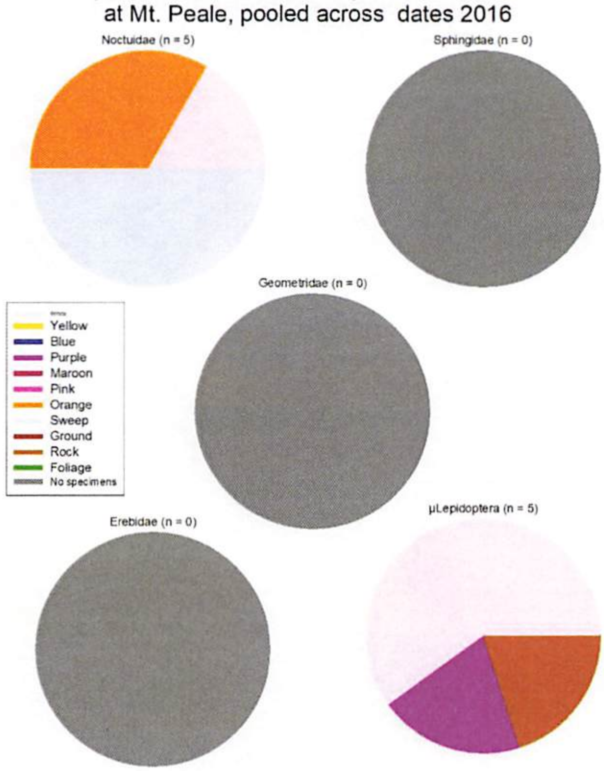


Figure 15

NMS of pollinators on flowers with each flower species treated as a separate study site, pollinators only included as lower taxa (e.g., families).

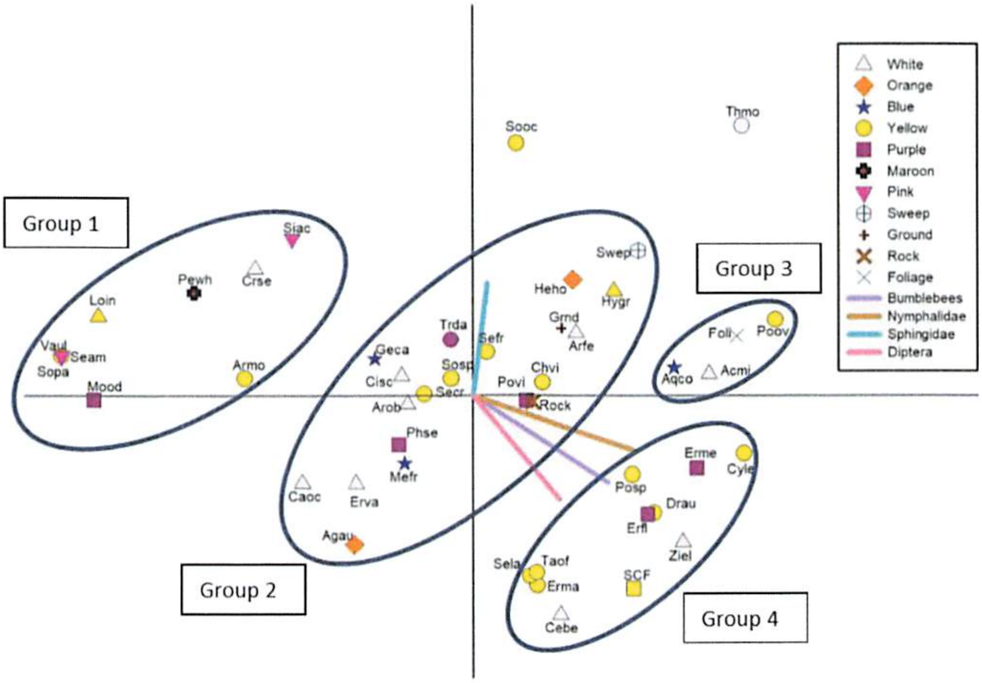


Figure 16

NMS of flower use patterns of pollinators treated as a separate study site, pollinators only included as lower taxa (e.g., families).