What is the richness of species of flies in the areas? Done

How well do bottle traps compare to sweep nets in collecting flies in taverns? Done

Compare the community structure of Taverns to Eatriess. Done

Does the community composition of the fly collection change with distance? Done

**RESULT**

A total of 2,813 individual dipterans (flies), representing seven distinct taxa across six genera, were collected during this study. These included Musca domestica, Muscina spp., Phaenicia cuprina, Phaenicia sericata, Drosophila spp., Fannia canicularis, and Sarcophaga spp. Among them, M. domestica was the most dominant species in collections from both bottle traps and sweep nets, with recorded abundances of 383 and 1,901 individuals, respectively. Following in abundance were P. sericata and P. cuprina, while F. canicularis was notably rare, with only a single individual collected throughout the entire sampling period. Overall, seven fly species were identified across the two collection methods, with sweep nets capturing significantly higher numbers of most species. For instance, P. sericata was more abundant in sweep net samples (270) than in bottle trap samples (14), and similar trends were observed for P. cuprina (113 vs. 12), Sarcophaga spp. (82 vs. 3), and Muscina spp. (28 vs. 2). F. canicularis occurred solely in sweep net samples, while Drosophila spp. were found in equal numbers (2 individuals) across both methods.

In tavern sites, a total of 635 individual flies were collected using sweep nets, while 416 were captured using bottle traps. Notably, several fly species showed marked differences in abundance between the two collection methods (Figures 1 and 2). A G-test revealed a statistically significant difference in the abundance of fly species collected between methods (G(6):14.742; *p* = 0.02), indicating that the method of collection influenced sample abundance. This pattern is particularly evident for species such as Phaenicia sericata, Phaenicia cuprina, Musca domestica, and Muscina spp., which deviate strongly from the diagonal in Figure 1. Figure 1 illustrates the proportion of species collected based on raw abundance, highlighting that M. domestica was more frequently captured using sweep nets (549 individuals) than bottle traps (383 individuals). However, when assessed by relative abundance within each trap type, M. domestica accounted for a higher proportion of the bottle trap captures (92%) compared to the sweep net captures (86%), as shown in Figure 2. Despite the differences in absolute and relative abundance, both perspectives produce similar patterns in species rankings and dichotomous groupings, suggesting consistency in the comparative effectiveness of the two methods across taxa.

Across the sampled fly species, sex ratios varied between species and collection methods (Table 1). Most species exhibited female-biased sex ratios, particularly in Musca domestica, which was the most abundant species. For M. domestica, a significant deviation from a 1:1 sex ratio was observed under both bottle trap and sweepnet methods (χ² = 19.76 and 38.29, respectively; P < 0.001), with females consistently more abundant. In contrast, other species showed no significant deviation from a 1:1 ratio or had counts too low for reliable inference. For example, P. cuprina and P. sericata showed slight female biases, though these differences were not statistically significant. Species like *F. canicularis* and *Muscina* spp. had low or zero captures, precluding meaningful analysis. Fisher’s exact tests assessing the independence of sex distribution between collection methods yielded non-significant results across all species, suggesting that the relative proportions of males and females did not differ substantially between bottle traps and sweep nets. Overall, while M. domestica exhibited clear and statistically supported sex ratio bias, most other species either conformed to expected ratios or had insufficient data for robust analysis.

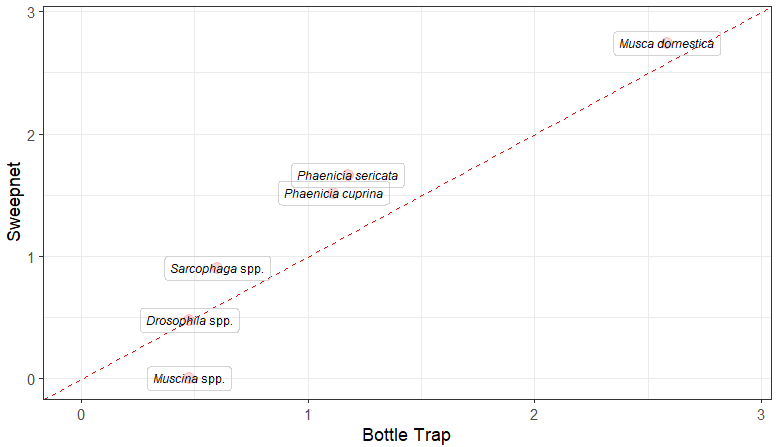


Figure 1: Diagonal chat scaled to 1:1. Sweepneet and Bottle trap are based on Log10 (X +1) transformation of the fly abundance for each species, with the monotonicity of the species preserved. Where species abundance matches a 1:1 ratio for both collection methods, the species are seen on the diagonal (broken red) line. *F. canicularis* was intentionally not considered for this plot because the sample size is less than 2.

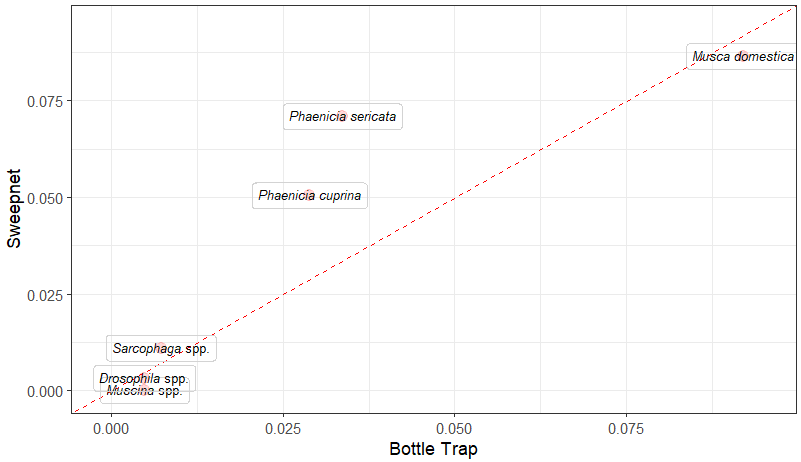


Figure 2: Diagonal chat scaled to 1:1. Sweepnet and Bottle trap are based on the relative abundance (0-1) of the fly species abundance in each collection method. *Musca domestica* was factored by 0.1, due to the high relative abundance it occupies in both the sweepnet and bottle trap samples—monotonicity of the species data is preserved. Where species relative abundance matches a 1:1 ratio in both collection methods, the species are seen on the diagonal (broken red) line. *F. canicularis* was intentionally not considered for this plot because the sample size is less than 3.

Table 1: Comparison of sex ratios of fly species in the taverns collected using bottle traps and sweep nets.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Species** | **Method** | **Female** | **Male** | **Sex ratio** | **Chi-Square (Sig.)** | **P-value**  **(Fisher's exact)** |
| *Drosophila* spp. | Bottle trap | 2 | 0 | 1:0 | 2 | *1* |
| Sweepnet | 2 | 0 | 1:0 | 2 |
| *F. canicularis* | Bottle trap | 0 | 0 | NA | - | *1* |
| Sweepnet | 0 | 0 | NA | - |
| *M. domestica* | Bottle trap | 235 | 148 | 1:0.63 | 19.762\*\*\* | *0.583* |
| Sweepnet | 347 | 202 | 1:0.58 | 38.29\*\*\* |
| *Muscina* spp. | Bottle trap | 2 | 4 | 1:2 | 0.667 | *1* |
| Sweepnet | 0 | 0 | NA | - |
| *P. cuprina* | Bottle trap | 6 | 4 | 1:0.67 | 0.40 | *1* |
| Sweepnet | 7 | 5 | 1:0.71 | 0.333 |
| *P. sericata* | Bottle trap | 5 | 10 | 1:2 | 1.667 | *0.162* |
| Sweepnet | 36 | 30 | 1:0.83 | 0.545 |
| *Sarcophaga* spp. | Bottle trap | 3 | 1 | 1:0.3 | 1 | *0.571* |
| Sweepnet | 3 | 3 | 1:1 | 0 |

N.B.: Female and male counts are shown alongside observed sex ratios and results of chi-square goodness-of-fit tests (expected ratio = 1:1). Fisher’s exact test was used to assess the independence of sex proportions between collection methods for each species. Significant p-values are indicated: \*\*\**P* < 0.001; \*\**P* < 0.01; P < 0.05. NA = Not available/not computable.

Comparing distance with community composition, there was no significant effect (Mantel statistic r: 0.047, p=0.089), meaning that across distance, the community composition did not change significantly with increasing distance. Longitudinally, there was a non-significant negative relationship between the community similarity and longitudinal distance. Communities become more dissimilar with increasing longitudinal distance, but this was not significant according to Mantel’s test (Mantel statistic: r= -0.071, p= 0.977).

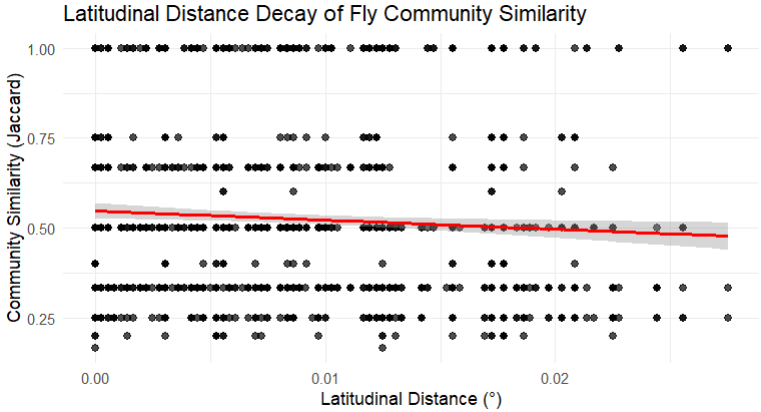


Figure 3: Latitudinal distance decay of fly community (Jaccard) similarity. The red line shows the trend line with 95% confidence intervals.

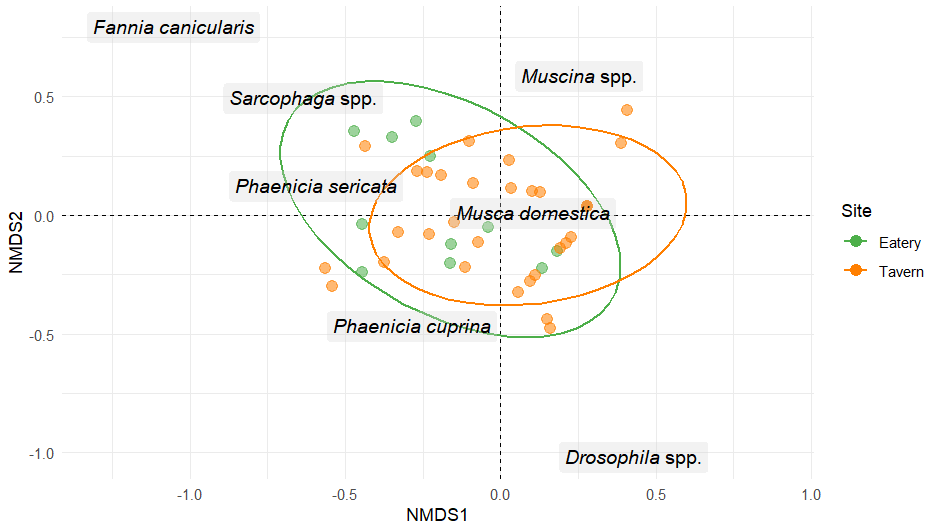
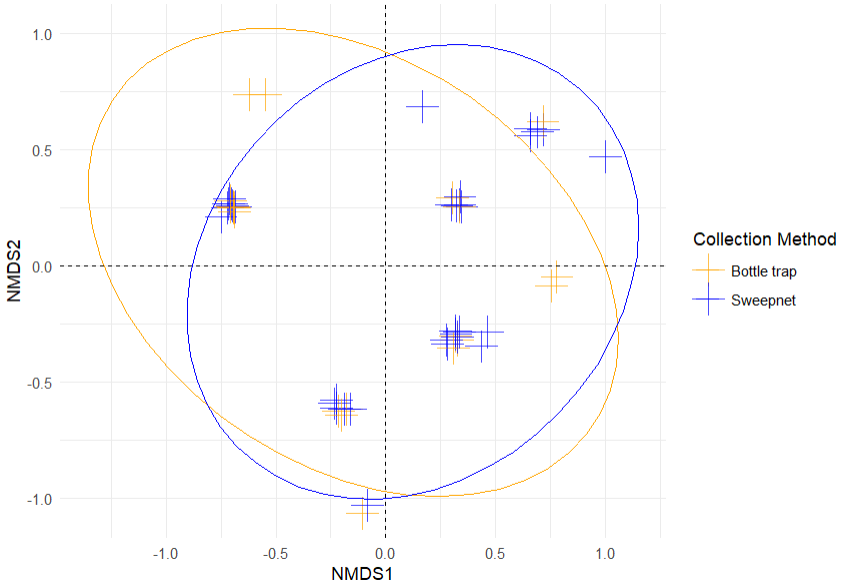


Figure 4: NMDS ordination of fly species assemblages based on two eating areas (Eatery and Tavern), using Bray-Curtis similarity (stress = 0.12; 9999 permutations). Ellipses represent 90% confidence intervals around groupings by collection method. Each point corresponds to a sampling location (N = 52; Tavern: 40, Eatery: 12). Species are represented according to their NMDS score, with similarly occurring species occurring closely in the NMDS ordination.

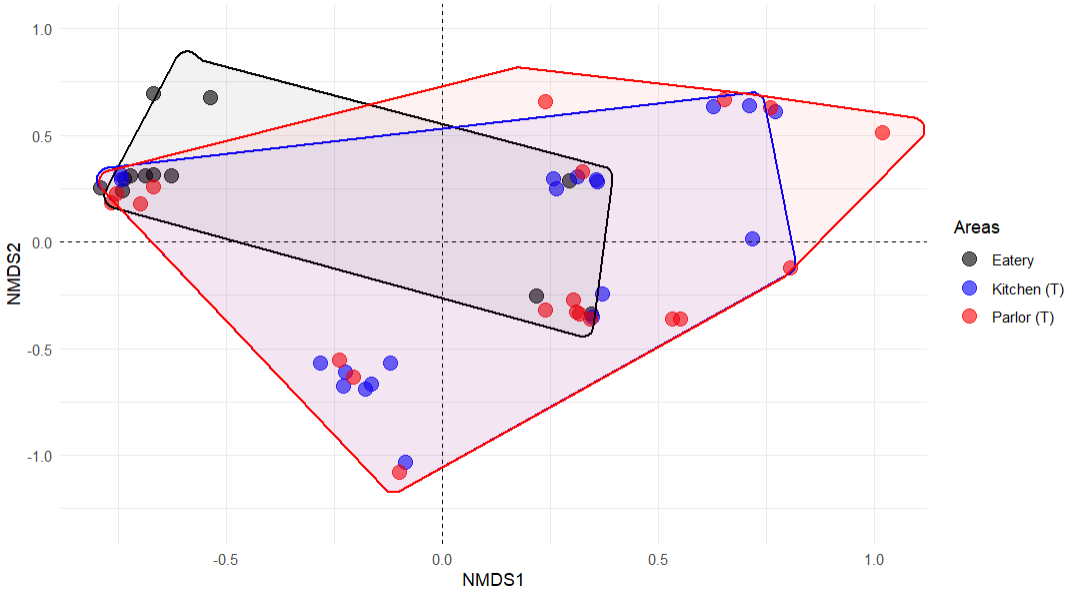
Fly community composition differed significantly across sampling locations categorized by site (Eatery and Tavern). PERMANOVA indicated a highly significant effect (p < 0.001), with site accounting for approximately 30.5% of the total variation in community composition. The non-significant result from the test for homogeneity of group dispersions (PERMDISP; F=0.1068, p = 0.75) suggests that this difference is unlikely to be influenced by variation in within-group dispersion. Additionally, the NMDS plot (Figure \_) reveals a visible spread of species across the ordination space. However, species abundances were highly skewed, with M. domestica and the two Phaenicia species overwhelmingly dominating the samples. This pronounced dominance may compromise the interpretability of the positions of Drosophila spp. and F. canicularis in the plot, as their distant placement may not accurately reflect true co-occurrence patterns due to their extremely low abundances in this study.

Fly community composition differed significantly between collection methods (Bottle trap vs Sweep net), as revealed by PERMANOVA (F=8.296, p < 0.001), with method accounting for approximately 14.2% of the variation in community structure. The test for homogeneity of multivariate dispersions (PERMDISP) was not significant (F= 0.006, p = 0.94), indicating that this result is not confounded by differences in within-group variability.

Fly community composition did not differ significantly among sampling sites (Eatery, Kitchen, and Parlor) based on Jaccard dissimilarity (PERMANOVA: F = 1.50, p = 0.192), with site explaining approximately 5.8% of the total variation. The assumption of homogeneity of multivariate dispersions was met (PERMDISP: p = 0.678), indicating that within-group variation was comparable across sites. Pairwise comparisons revealed a marginally significant difference in community composition between Eatery and Kitchen (p = 0.049), though this was not significant after adjusting for multiple testing with Bonferroni correction (p.adj = 0.146). No significant differences (p> 0.05) were detected between other site pairs.



**Figure 5:** NMDS ordination of hover fly species assemblages based on two collection methods (Bottle traps and Sweep nets), using Jaccard similarity (stress = 0.05; 9,999 permutations). Ellipses represent 90% confidence intervals around groupings by collection method. Each point corresponds to a sampling location (N = 52), with points jittered by 0.04 NMDS units on both axes to improve visual clarity.



**Figure 6:** NMDS ordination of hover fly species assemblages across three sites (Eatery, Kitchen and Parlor of Taverns), based on Jaccard similarity (stress = 0.05; 9999 permutations). Polygons outline groupings of assemblages by site, while individual scatter points represent sampling locations (N = 52). To enhance visibility, points have been jittered by 0.09 NMDS units along both axes.

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