Distribution of various pigeon color morphs in multiple habitats in Southern California over an 18 year period

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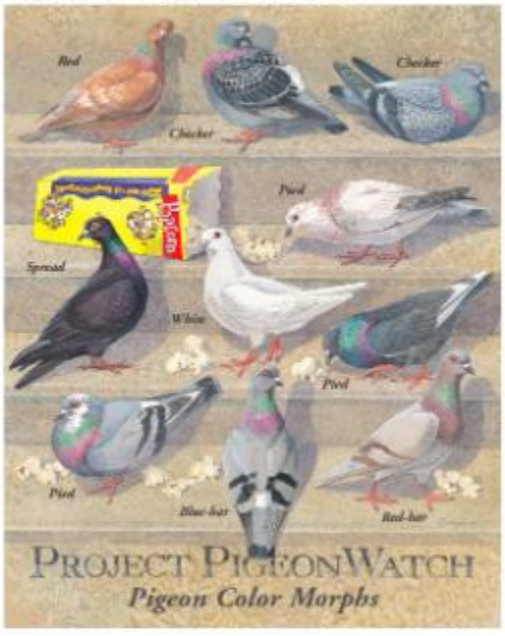
Introduction

While pigeons are present in nearly every urban area of the world, there is little research on these feral birds (*Columba livia domestica*). In the 1990s, Cornell Lab of Ornithology started a citizen science project, Project PigeonWatch, aimed to get many different communities involved in observing feral pigeons. PigeonWatch primarily collected data on the distribution of various pigeon morphs and courting occurrences in downtown, industrial, commercial, urban residential, suburban, and beach areas. Feral pigeons survive in urban areas as they are fed by people, and this food source allows handicap pigeons to survive, as well (Haag-Wackernagel, *et al.*, 2006, p.163). These feral pigeons have descended from their ancestor Rock Pigeons, *Columba livia*, and the most closely related morph is the blue-bar (wild type) (Haag-Wackernagel, *et al.*, 2006, p.163).

This research gives insight to signals of natural selection of pigeons affecting their distribution in varying habitats; sexual selection is also being studied by ESP330 students at California State University Long Beach, but that is not included in this research. According to natural selection, traits allowing an organism to survive until reproduction are inherited by offspring. Stabilizing selection penalizes morphs that diverge from a common pattern, enforcing greater uniformity in prey species; this can be a key influence in our pigeon distribution. Our

Figure 1 - Pigeon Morphs



study follows Cornell's protocol, but analyzes data consisting of the seven pigeon morphs observed in three main categories: urban, residential, and "natural" habitats in Southern California, including blue-bar, red-bar, spread, red, checker, pied, and white (See Figure 1). **Null hypothesis:** There is no significant difference in pigeon morph distribution between urban, natural and residential habitats. **Alternate hypothesis:** There is a significant difference in pigeon morph distribution between urban, natural and residential habitats.

Data and Methods

Data used for this lab was archival data collected by students of Biogeography at California State University Long Beach. Data for this project focused on numbers collected from Fall 2000 until Spring 2018. Data for the pigeon project was collected as follows: Count the total number of pigeons, record this Flock Count on the data form, and count the number of pigeons of each color morph and record these Color Counts on the data form. These counts were then repeated for accuracy. Using Cornell Lab of Ornithology's Habitat Form various environmental characteristics were recorded. This included the date of the observation, time, address of the site, GPS coordinates, and temperature. Within these habitats important characteristics such as land cover, vegetation, and available food and water were noted. This is important to note for our analysis because these are factors that could affect what types of color morphs could be found in each habitat.

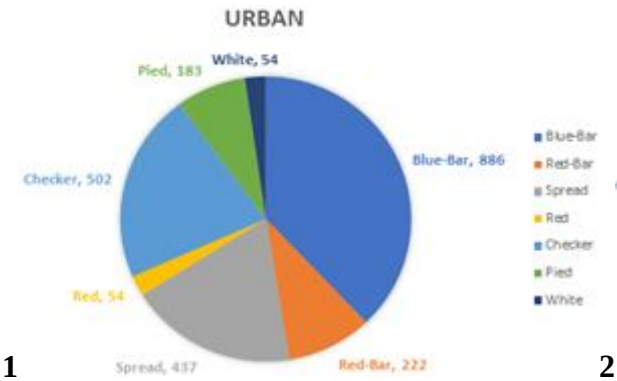
Data was then analyzed using chi-square distribution in OpenOffice spreadsheets. In this case chi-square was the best qualified method since chi-square excels at analyzing counts that are divided into categories. The chi-square was conducted in order to find the p-value and to compare that to the alpha value (o.o5), with 12 degrees freedom. We also found the effect size in order to understand the strength of the relationship of our variables, in this case it is the spread of morphs

and habitat. We calculated the power as well to know whether we have enough data (backing) to find a significant difference in pigeon morphs distribution and habitat, if there is one to be found.

Results

Per Table 1.0, the calculated test statistic (P-value) is lower than the critical test statistic (alpha (0.05)), indicating a significant difference in the distribution of counts between the three habitats. Thus, we reject the null hypothesis, that there is no significant difference in the distribution of pigeon morphs in urban, residential, and natural habitats and accept the alternate hypothesis. The calculated effect size was exceedingly small, meaning the magnitude of differences in distribution was not strong between these two variables (pigeon morphs distribution in the varying habitats). The calculated power was high, and mitigates a Type-Two Error of falsely rejecting the null hypothesis. Given the low P-value, small effect size, and high power, it is a sound decision to reject the null hypothesis and accept the alternate hypothesis.

Pigeon morph distribution is critical in determining the magnitude and relevance of stabilizing selection across differing habitats. Most observations took place in natural habitats (3,131), then urban environments (2,338) and lastly, residential (872). Distribution among the environments are similar in the following ways: order of most common sighting [% = frequency of morph in total habitat population]— blue bar (37.9% natural, 37.9% urban, 37.3% residential), checker (24.1% natural, 21.5% urban, 24.3% residential), spread (18.94% natural, 18.7% urban, 14.91% residential) [see Figures 2-4], though residential habitats have considerably less spread pigeons than natural and urban areas. The trend diverges here— the 4th and 5th common sighted morphs for natural environments is pied and red-bar, and more red-bar than pied pigeons were sighted in urban and residential areas. However, natural and residential habitats host more red than white pigeons, while urban environments witnessed exact equal amounts.



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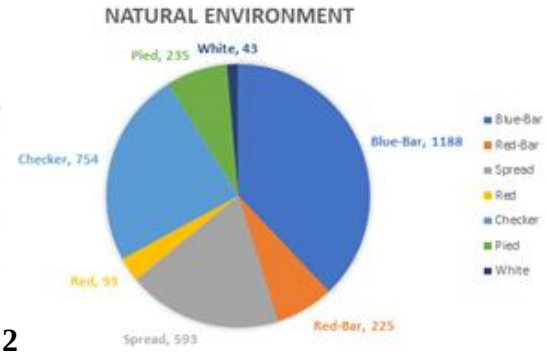

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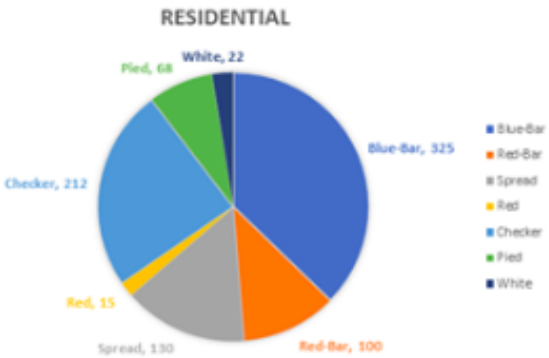

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Figures 1-3. Pigeon morph distributions in urban (1), natural (2), and residential (3) habitats

Alpha	**0.05**
P-value	**0.00**
Effect Size	**0.058**
Power	**0.904**

Table 1.0 Statistical analysis of data

Discussion and Conclusion

Similar to this research, other studies have found that the most common pigeon morphs are the blue-bar and checker. A study in Bangladesh counted 492 pigeons in urban areas, and this included rock pigeons, some domestic and tumbler breeds. Morph distribution of these counts were 74.59% blue-bar, 10.77% checker, 5.98% pied, 2.64% spread, 2.24% white, and 1.22% mealy bar (Kabir, 2016, p.45). As a significant portion of these pigeon counts were rock pigeons,

it explains the high wild-type pigeon morph counts. In urban environments in Vienna, Austria, 29.9% of the pigeon counts were blue-bars and 27.5% were blue checkers of 7,682 total pigeon counts; both of which are most similar to the coloration of wild rock pigeons (Haag-Wackernagel, *et al.,* 2006, p.166) This study also took into account if the pigeons were juvenile (14.8%) or adults (85.2%), which is telling of the pigeon morphs that have a higher chance of survival. Research implies that plumage can affect survivability of pigeons, and therefore stabilizing selection may be reflected in the high frequency of wild-type pigeon morphs.

Feral pigeons can be found in most areas with a constant food source from humans, yet our understanding of the distribution of their diverse color morphs is limited. It was predicted that there is a significant difference in the distribution of various pigeon morphs in urban, natural, and residential habitats. Statistical analysis, using Chi-square distribution, effect size, and power, proved this to be true. However, it is important to mention that many of the pigeons counts conducted were in similar areas; the beach and park counts were much higher than the urban and residential counts. It would also be beneficial to split up the natural habitats, beach and park, into separate habitats for further research. This could give insight to compare the distribution between these two habitat sites and see how pigeon morphs vary.

References

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