Nest Composition and Architecture of the Curve-billed Thrasher in Central Arizona

by

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ABSTRACT

The nests of the Curve-billed Thrasher (*Toxostoma curvirostre*) were studied across the greater Phoenix area from 2020-2022 in order to assess any significant relationships between their composition and the composition of their environment. Nests were collected and measured, and the vegetation was surveyed to 100 m for potential nest material type. In the lab, nests were separated by material type and tallied. The dense cores of the nests received a 100-piece sampling, with the first hundred pieces plucked from the structure, sorted by type, and massed. Ordinary least squares (OLS) and binomial regression analyses were performed on the body tallies and their corresponding site tallies. Core material weights and their corresponding site tallies only received OLS regression analyses. Beta regression analyses were also performed on the mass proportions of core samples and their corresponding environmental tallies. OLS regression yielded a significant relationship between the spiny body material tally and its site tallies at 25 and 100 m. While failing the assumption of normality, the tally of barrel cactus in a nest body yielded significant p-values in OLS and binomial regression, as well as the Spearman’s correlation test, supporting a strong correlation with the 100m site tally. The tally of anthropogenic materials and the distance to the nearest man-made structure failed the test of normality, but yielded significant p-values in binomial regression and the Spearman’s correlation test. OLS regression of log anthropogenic tally and log distance to nearest structure failed normality but yielded a significant p-value as well. In beta regression analyses, only the spiny core mass proportion yielded a significant relationship at the 100 m site tally.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The Curve-billed Thrasher (*Toxostoma curvirostre*) is a member of the family Mimidae (which includes mockingbirds) and is a common sight in Arizona's Sonoran Desert (Ricklefs 1965). The species range stretches from Arizona east to Texas and Oklahoma (Ault III 1984), and reaches as far south as Oaxaca, Mexico (Zink 2000). The species has historically been separated into three groups, with the thrashers found in Arizona belonging to the *palmeri* clade (Rojas-Soto 2007).

In southern Texas the thrasher has been documented nesting, "in a variety of spiny shrubs and trees" (Fischer 1980). While it has been known to nest in genera like *Ziziphus*, *Yucca*, *Lycium*, and even *Platanus* (Willard 1923), the Arizona thrasher prefers to make its home in the infamously spiny cholla (*Cylindropuntia*) genera of cacti (Gilman 1909). While its neighbor the Cactus Wren will also use the cholla for its globular enclosed nests (Bailey 1922), the thrasher nests are of a more traditional open cup style, the concave bowl shape most think of when imagining a bird nest (Ricklefs 1966). Because of this open, more exposed nest style, the thrasher has been known to nest in the shadier portions of the cholla (Ricklefs 1969). Concealing of the nest is also valuable in mitigating the risk of predation to fledgling thrashers (Smith 1971). This spiny nest site provides security for the thrasher; however the species' nests are constructed of twigs, wood, and grasses of the surrounding desert vegetation (Gilman 1909). In place of grasses, even horse hair will be used in the nest construction (Clark 1904). Sometimes these cholla nests will be built up and reused by the thrasher for several breeding seasons (Bent 1948).

This spiny home is utilized by the thrasher not only in native desert sites, but also in urban sites where residents have chosen to grow this aggressive variety of cactus (Fokidis 2011). As the greater Phoenix area has continued to expand, more and more natural desert, the thrasher's native home, has been converted for human use (Redman 2008). This behavior begs the question; are there any factors in the surrounding environment that are being considered when a thrasher chooses a nest site? Can we find examples of the urban thrasher's plasticity when it comes to utilizing man-made materials in the composition of its nest? Is there a relationship between the contents of a nest and the materials' availability in the immediate area? There have been several studies that have investigated the relationship between nest composition and the surrounding nest environment in other species of birds.

Some studies utilize nest-boxes, where the researchers can closely observe the nest creation process from the beginning. One 2013 study of the great tit (*Parus major*) used nest-boxes to monitor the species, collect the nest once nestlings fledged, and compare composition across sites (Álvarez 2013). The study found that the composition of a tit nest did indeed vary between habitats. Another study in 2020 utilized nest boxes to compare nest composition across three different species of tits, ultimately finding that the smallest of the three species utilized more thermoregulatory materials when constructing its nest (Alambiaga 2020).

With regards to research performed on birds living in both urban and native sites, a 2009 study of the Chinese Bulbul (*Pycnonotus sinensis*) investigated the proportion of anthropogenic materials used in the species' nests across nest sites of increasing urbanization, finding that use of said materials by the bird trended positively with urbanization, and the rising availability of the materials (Wang 2009). Another study of the great tit from 2017 utilized nest boxes across a variety of urban sites with varying degrees of vegetative cover; ultimately finding that vegetative cover had no association with differences in nest mass or dimension (Lambrechts 2017). The study did however find evidence that nest composition may be impacted by the plants present in the surrounding environment. A 1974 study in Tucson, Arizona surveyed bird density in a patch of developed land, as well as an undeveloped patch of desert (Emlen 1974). The study found that in the case of the Curve-billed Thrasher and Cactus Wren, population density declined with urbanization. The paper goes on to theorize that the decline could be caused by competition for nesting sites between the two species, as cholla could become more and more scarce in an urban environment.

With these previous studies in mind we decided to investigate the nest composition and surrounding environmental vegetation of the Curve-billed Thrasher throughout the greater Phoenix area. A null hypothesis was proposed that there is no correlation between the composition of a thrasher's nest and the composition of its surrounding vegetation, with an alternative hypothesis that evidence of such a correlation does indeed exist.

Additionally, we hypothesize a correlation between the amount of anthropogenic materials utilized by thrashers in nest construction, and the amount of urbanization in the nesting site, with a null hypothesis that there is no correlation, and an alternative hypothesis that there is evidence of a correlation

CHAPTER 2

METHODS

The study and its methodology were reviewed and approved by Arizona State University's Institutional Animal Care and Use Committee (IACUC).

Work began by searching the greater Phoenix area for cholla containing the thrasher's cup-style nest. Through the website ebird.org, recent sightings of thrashers were able to be displayed on a map of the city. These sighting maps helped discover new areas where cholla and with luck, thrasher nests would be found. Researchers also drove hundreds of miles across the city searching residential properties for cholla and potential nests. When a nest was found on a property the address was documented and a physical letter was sent through the United States Postal Service. The letter's contents described the study, its IACUC approval, and asked for the resident's permission to collect the nest. The Phoenix chapter of the Arizona Native Plant Society was contacted regarding the study. The chapter was able to inform its members about the study, who were encouraged to share information regarding any known nest sites.

Once a nest was found, a series of measurements were performed; height of nest, maximum and minimum diameters of the nests, height of nest off ground, direction of the nest cup's tilt, and direction in the plant relative to the trunk. Part of this methodology, nest diameter and external nest depth (height) came from the Crossman 2011 study of bird nest structure in Canada (Crossman 2011). Certain measurements like thickness of the nest wall weren't possible due to the position of the thrasher nest among cholla branches. All measurements were taken while the nest was in the host plant, as the dimensions of the nest change when removed from the cholla branches suspending them.

The species of cholla being used as a host plant were also documented. Species include chain-fruit cholla (*Cylindropuntia fulgida*), buck-horn cholla (*Cylindropuntia acanthocarpa*), and teddy-bear cholla (*Cylindropuntia bigelovii*). Nests were then removed from the host-plant using a rubber tipped grabber arm tool and placed into a labeled bag. The researcher verified that the nests were not currently in use by the bird. Additionally all collections were performed outside of breeding season.

Two other species of thrasher are found in Phoenix and its surrounding area. Bendire's Thrasher (*Toxostoma bendirei*) is occasionally found in the few desert brushlands within the city's limits. In these areas the species has the potential to nest in chollas. Ebird sighting maps for the Bendire's Thrasher show little to no recent sightings in the residential areas where cholla nests were found. Similarly, the Crissal Thrasher (*Toxostoma crissale)* can be found in the desert foothills surrounding Phoenix. While ebird sighting maps for the species show their presence at some of the nest sites in the southeast valley, the species is more known for nesting in spiny shrubs and trees than cholla (Finch 1982).

The GPS location of the nest was documented, and several photos and videos of the surroundings were taken. Through the Maricopa County Assessor's Office parcel visualization tool, a map was created for each nest site, consisting of concentric rings 25, 50, 75, and 100 meters around the nest (Figure 3). These maps were utilized in the field to tally immediate surrounding vegetation. The 25m ring would later be used in data analysis to represent the nests immediate surroundings. While all four of the rings were used in the tally of the total 100 m surroundings, the distinct 50 m and 75 m rings aided in the site survey, breaking up the large tally into more manageable chunks.

Nest that received vegetation surveys were kept at minimum 200 m from each other. This was done to ensure each site had its own independent 100 m circle, where no individual plant was being counted in a survey for two different nests. This avoided the statistical error of pseudoreplication.

Site survey data fell into four categories: Spiny, Wood, Barrel Cactus (*Ferocactus)*, and Graminoid. Examples of spiny plants that were commonly encountered include mesquite (*Prosopis juliflora*), palo verde (*Parkinsonia microphylla*), acacia (*Acacia greggii*), ocotillo (*Fouquieria splendens*), and lotebush (*Ziziphus obtusifolia*). These spiny species contained thorns, spines, or prickle-like structures unlike genera in the wood category. Commonly encountered wood plants include creosote (*Larrea tridentata*), brittlebush (*Encelia farinosa*), turpentine bush (*Ericameria laricifolia),* jojoba (*Simmondsia chinensis*), jacaranda (*Jacaranda* sp.) pine (*Pinus* sp.), and oleander (*Nerium oleander*).

The other two categories used in the body analysis could not be quantified in the field. Anthropogenic material lacks a specific measureable source in the site; a passing car or hiker could deposit material into the ecosystem at random. Instead a measurement was taken from each nest site to the nearest man-made structure, to serve as an independent variable in later analysis. Additionally fiber could not be quantified in the field; bark from any type of plant could be stripped off into nesting materials.

Collected nests were taken to the ASU Natural History Collections Facility. There the nests were frozen for at least ten days in an industrial freezer to kill any potential insects or parasites living within. Nests were then sorted by material type. Material making up the body of the nests fell into six categories: Spiny, Wood, Barrel Cactus, Graminoid, Fiber, and Anthropogenic. Pieces were tallied by category, and the longest individual piece of each category was recorded.

When a core was present in a nest, it was separated from the body and placed in a separate bag. Cores were then massed, and samples of 100 random pieces were taken. The pieces fell into the same six categories as the body analysis. Tallies were taken of each category, as well as longest individual piece of each category. The samples were then individually bagged and massed. Cores were analyzed separately from bodies because they were more often than not a distinct, tightly bound structure loosely contained within the nest body. Additionally cores often contained thousands more pieces than the surrounding nest material, making the methodology used in body sorting infeasible.

These measurements were then entered into Microsoft Excel 2010 and saved as a .CSV file. All statistical analysis was performed in RStudio 2022.02.0+443 "Prairie Trillium" Release on a Microsoft Windows 10 operating system with a significance level of 0.05.

In R, one-factor analysis of variance (ANOVA) tests were run on the four nest dimensions: height of nest, maximum and minimum diameters of the nests, and height of nest off ground. These analyses tested whether there were significant differences in the means of the measurements across the three species of cholla. The R packages “car” and “mosaic” were utilized in this analysis.

Statistical analysis of the tally data began with an ordinary least squares (OLS) regression test of nest body tally vs. nest site tally. The numbers of plants of a specific nest material were counted for the immediate 25 meter zone as well as the total 100 meter zone. These were compared to the tallies taken for that type of material in the body of a nest; with body tally being the dependent variable (y) and site tally being the independent variable (x). OLS analysis was also performed on the masses of material taken during the 100 piece core sample; with the mass of each sampled material type being the dependent variable and the site tally being the independent variable. Data in the OLS analysis was tested for the assumption of normality using the Shapiro-Wilk normality test. In cases where data failed the assumption, a non-parametric Spearman's rank correlation analysis was also performed.

Statistical analysis continued with a test of binomial regression. In this analysis, a model was created using the total number of pieces of a tallied body, the number of pieces of a given material, and the vegetation survey count of said material.

Finally, beta regression analysis was performed to compare the mass data from the core sampling. The proportion of a given material's mass to the total mass of the core sample was compared to the counts of that material in the 25m and 100m vegetation survey. The R package "betareg" was used in this analysis.

CHAPTER 3

RESULTS

Of the 68 nests collected and measured, 72.1% utilized chain-fruit cholla as a host plant. 17.7% of the nests were in buck-horn cholla and 10.3% used teddy-bear.

Nests on average had a maximum and minimum diameter of 35cm (SD = 9.0cm) and 26.01cm (SD = 6.90cm) respectively (Figures 15a and 15b). When separated by cholla species the largest average diameter was buck-horn cholla with 38cm (SD =9.7cm). Chain-fruit was the species of cholla with the smallest average minimum diameter at 25.5cm (SD = 6.93cm). One-factor ANOVAs for the maximum and minimum diameters passed the assumptions of normality and equal variance. At a significance level of 0.05, we do not reject the null hypothesis that mean maximum nest diameter is the same across the three species (ANOVA: F = 1.3, df = 2 and 65, p = 0.28). At a significance level of 0.05 we do not reject the null hypothesis that mean minimum nest diameter is the same across the three species (ANOVA: F = 0.718, df = 2 and 58, p = 0.492).

Nest structures had an average height of 24cm (SD=11cm) (Figure 17). When separated by species teddy-bear had the tallest nests with an average of 25cm (SD = 6.9cm), followed by chain-fruit with 24cm (SD = 12cm), and buck-horn with 23cm (SD = 8.6cm). One-factor ANOVA of nest height failed the assumption of normality, and the data was log transformed. The ANOVA of log height among species passed the assumptions of normality and equal variance. At a significance level of 0.05 we do not reject the null hypothesis that there is no difference in mean log nest height among species (ANOVA: F = 0.20, df = 2 and 65, p = 0.82).

Nests were on average 122 cm (SD = 41.7cm) off the ground. When separated by species chain-fruit cholla had the highest average measurement with 132cm (SD = 41.8cm), followed by teddy-bear with 110cm (SD = 20.9cm), and buckhorn with 87.3cm (SD = 29.8cm). One-factor ANOVA yielded a p-value supporting a significant difference among the means of the species. The ANOVA failed the assumption of normality, so the measurement of height off ground was log transformed, and the new ANOVA passed the assumptions of normality and equal variance. This ANOVA of log height off ground too supported a difference among means by species. The Tukey's Honest Significant Difference test was performed to find which species' means were different from which (Figures 18a and 18b). At a significance level of 0.05, we reject the null hypothesis that there is no difference in mean log height off ground among the species (ANOVA: $F = 8.79$, $df = 2$ and 64, $p = 0.000424$). Specifically, chain-fruit cholla has a higher average height than teddy-bear, which has a larger average than buck-horn.

The Shapiro-Wilk test of normality was performed on the nest dimensions. Two dimensions: maximum and minimum diameter passed the test of normality, while the other two dimensions: nest height and nest height off ground failed to have a P-value above the 0.05 alpha. The data was then log transformed, causing the two dimensions to meet the assumptions of normality. When separated by cholla species, these two values passed the tests of normality, with only chain-fruit height requiring a log transformation.

Physical analysis of the nests revealed some common trends across the various sites. Bodies of the nest were primarily comprised of spiny pieces (mean body percentage 76.3%, SD = 19.6%), followed by wood pieces (18.7%, SD = 17.5%). The third most common material forming the body was the spines of the barrel cactus (2.1%, SD = 6.1%).

By comparison, in the immediate 25 meter zone surrounding a nest, the most common type of vegetation were wood plants (mean site percentage 73.1%, SD = 28.9%), followed by spiny plants (25%, SD = 28.4%), and then barrel cactus (1.9%, SD = 5.1%). In the entire 100 meter nest site, the most common vegetation types were still wood (75.5%, SD = 24.2%) followed by spiny (23.4%, SD = 24%) and barrel cactus (0.7%, SD = 1.2%).

The proportions of materials that made up the cores of thrasher nests differed greatly from that of the body. Of the 100 piece tallies taken the most common material found were small diameter fibers (mean core percentage 58.8%, SD = 25.8%). These fibers can come from a variety of sources; bark stripped from wood, small roots, or even hair off of animals. The next most common material in the tally was graminoid (17.9%, SD = 20.8%). Third most common were spiny twigs (16.0%, SD =12.01%).

Throughout the physical analysis of the nests, several anthropogenic materials were discovered in both the bodies and cores. Fourteen of the 48 bodies dissected contained man-made materials. Materials ranged from refuse like small strips of paper and plastic wrapping, to heavier material like rusted metal and plastic coated electrical wire. One nest collected from a residential front yard contained a piece of woven string measuring over one and a half meters long. Anthropogenic materials were more common in the core of a nest compared to the body, as most of the material was small in diameter. Twelve of the 35 cores dissected contained man-made materials. On average only 0.354% of a nest's body contained anthropogenic materials (SD = 0.733%). In comparison, man-made materials comprised 2.63% of materials in our 100 piece core sample tally (SD = 7.13%).

With regards to the tilt of nests in their host cholla, a "level" plant with no cup tilt was the most common type recorded (33 out of total 66 nests) followed by South (eight), then North and East (six each). For the placement of the nest relative to the cholla trunk, the most common direction was North (17 out of total 67 nests) followed by South (fourteen) and Southwest (eight).

OLS regression analysis yielded a few significant results. Two regression models that had residuals meeting the assumption of normality were body spiny tally as a function of 25m site spiny tally, and body spiny tally as a function of 100m site spiny tally. These models yielded OLS p-values below our 0.05 alpha (Figures 1 and 2). These two interactions also yielded significant p-values in the binomial regression analyses. At a significance level of 0.05, there is evidence of a significant relationship between the amount of spiny material in a nest body and the amount of spiny vegetation in the surrounding 25 meters (OLS Regression Estimate = 6.004, SE = 2.356, t = 2.548, p = 0.0142) (Binomial Regression Estimate = 0.0453, SE = 0.0024, z = 18.98, p = 2e-16). At a significance level of 0.05, there is evidence of a significant relationship between the amount of spiny material in a nest body and the amount of spiny vegetation in the surrounding 100 meters (OLS Regression Estimate = 0.440, SE = 0.1311, t = 3.385, p = 0.00146) (Binomial Regression Estimate = 0.0029, SE = 0.00017, z = 17.14, p = 2e-16).

One OLS regression model: body barrel cactus tally as a function of 100m site barrel cactus tally (Figure 7) failed its test for normality. However the data yielded a p-value that was significant in the OLS regression, the binomial regression test, as well as the Spearman correlation test. At a significance level of 0.05 there is a strong association between the amount of barrel cactus materials in a nest body and the amount of barrel cacti in the surrounding 100 meters (OLS Regression Estimate = 0.7231, SE = 0.2063, $t = 3.505$, $p = 0.001$) (Binomial Regression Estimate = 0.05, SE = 0.003, $z = 17.77$, $p = 2e-16$) (Spearman's $r = 0.34$, $S = 12229$, $p = 0.019$).

OLS regression of the tally of anthropogenic materials and the distance to the nearest man-made structure failed the test of normality, but yielded significant p-values in binomial regression and the Spearman's correlation test. OLS regression of log anthropogenic tally and log distance to nearest structure failed normality but yielded a significant p-value as well. In beta regression analyses, only the spiny core mass proportion yielded a significant relationship at the 100 m site tally. At a significance level of 0.05, there is evidence of a significant negative relationship between log anthropogenic body composition and log distance to the nearest man-made structure (OLS Regression estimate = -0.3898, SE = 0.15324, $t = -2.544$, $p = 0.0144$).

All other OLS regression tests failed the assumption of normality and lacked significant p-values across all three tests.

In the beta regression tests of the site tallies and core mass proportions, only one interaction yielded a significant result. At a significance level of 0.05, there is evidence of a significant relationship between the proportion of spiny material in the mass of a core, and the amount of spiny material in the surrounding 100m environment (Beta Regression Estimate = 0.0018, SE = 0.00087, $z = 2.048$, $p = 0.0406$).

CHAPTER 4

DISCUSSION

In the end most of the results seem understandable. With regards to the prevalence of materials in bodies vs. cores, it makes sense that more flexible components like grasses and fibers are used for the intricate weaves of the core. At the same time, it also makes sense that the thicker tree - wood and barrel cactus are used in the weight bearing body of a nest. The interlocking geometry of the barrel areoles and spiny branches make for a structure that’s more difficult to become separated in the field.

It is interesting how spiny materials make up such a large part of the nest, yet aren’t the dominant vegetation in the immediate surroundings. Additionally, wood materials in the nest didn’t show a significant relationship with the amount of wood in the environment, despite being the most prevalent type of vegetation in the survey. This would support the notion that the species has an ideal nest material that it actively seeks out. Perhaps a future study could monitor a captive thrasher in a controlled environment, where twigs both spiny and non-spiny could be introduced and the bird’s choice could be documented.

While we saw evidence of a significant negative relationship between anthropogenic material and the degree of urbanization for the site, anthropogenic material did not play very much of a role in the actual composition of the nest. As we saw, less than one percent of a nests body was anthropogenic. It does not seem to play a key role in understanding the thrasher’s biology. It is not an indicator that the thrasher is unaffected by an urbanizing Phoenix; that analysis would have to come from a study of nestling health in nests either containing or lacking anthropogenic materials. While it is a brief example of the species plasticity in a changing world, it still shows the significant importance of having the highly utilized spiny material available to the bird.

It was understandable that ANOVA for the nest diameters and heights failed to show a distinct difference in means among the species of host plant. In all three cholla, it is the same species of thrasher constructing that nest, with generally the same distribution of thrasher body sizes that the nest is being tailored to. Any additional expansion of the nest beyond the thrasher's required dimensions would be an expenditure of energy that could have gone towards finding a mate, searching for food, or development of eggs.

Another understandable result from the analysis of nest dimensions was that the "height off ground" measurement had been failing a normality test when all data was grouped together. This is likely due to the differences in heights of the three species of cholla sampled, as a buckhorn is often a much shorter plant compared to the large tree-trunked structure that is a chain-fruit cholla. Once data was separated by host plant, the measurements passed the normality test, and the ANOVA/Tukey tests showed the distinct means for each species.

Outside of documenting the construction of these nests from the beginning, there is no reliable way to tell the age of the nest; how many years' worth of re-use, material loss, and additional construction have been performed. Because of this there could be the potential for error in our measurements of nest dimensions, as these structures are the results of different years' worth of efforts.

It was interesting how the regression p-values for the barrel cactus bodies and sites came back significant, as there were data points where the 100m site had zero barrel cacti, yet the nest bodies contained them. This supports that the birds are traveling beyond their 100 meter surroundings to collect materials. Perhaps a future study could tally dead barrel cactus in the surrounding environment, as a thrasher isn't capable of plucking a spiny areole from a live barrel cactus. Researchers would encounter the same issue that arises from nests being re-used for several years; the landscape at the moment of measurement isn't an exact reflection of the landscape when the nest was constructed. The dead barrel cacti that were utilized by the bird could already be decomposed. There is also the possibility that the bird is taking materials (including barrel cactus areoles) from a long abandoned nest. A study could investigate this by placing a trail camera at an established nest, checking for visits by thrashers, who do not end up using it as the season's nest site.

In the beta regression test of core mass proportions, the only significant p-value involved the spiny wood core mass proportion and the 100m zone spiny tally. There is a potential source of error as a piece of wood from a spiny plant is typically of a greater mass than a piece of grass or a thin fiber, causing a discrepancy in the mass proportions. Similarly in the OLS regression of raw core material masses, the mass of anthropogenic materials found during the 100 piece sample were used. The classification of material as anthropogenic includes a wide range of content, often of very different weights. In nests rusted iron wire was discovered, as well as thin plastic wrappers. The presence of that heavier iron in a tally can become an outlier, and is more likely to cause the data to fail the assumption of normality, as the data indeed did. Now that this study has identified a variety of man-made materials that are utilized by the bird, future composition studies could split the category between materials of generally smaller (plastic) and larger (metal) mass.

While this analysis of the thrasher and its nest was interesting, the thrasher is only one member of its ecosystem. I think it would be worthwhile to perform a similar study on the nest composition of another cholla nesting bird, the cactus wren. If any regression analyses yield the same relationships as the thrasher, then it would raise the question of there being potential competition between species for materials. I would also be interested in a comparative study between the nest composition of Curve-billed Thrashers who utilize cholla as the host plant, and those who utilize spiny shrubs. Does the geometry of the host plant cause any difference in the dimensions of the nest or the amounts of materials required for support?

The variation in host plants raises another question; while thrashers in Phoenix are known to vastly prefer cholla, is there evidence that it yields better health in nestlings? A future study could monitor clutch size and nestling health among Curve-billed Thrashers in a variety of host plants. Should the cholla nesting individuals fare better, it could become a consideration for land managers.

Cholla is a notoriously aggressive species, and it seems few landscapers choose to plant it. In my search across Phoenix, virtually none of the recent master-planned communities had any of the species of cholla that were analyzed in this study. In these recently transitioned sites, it seems to be worth documenting where thrashers are making their nests, and as mentioned previously, monitor nestling health to that of nests in more naturally vegetated sites.

While the thrasher currently has a “least concern” rating on the IUCN Red List, it is beneficial to perform these analyses now, when potential threats to the species can be discovered, and efforts to mitigate impact can be implemented.

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APPENDIX A

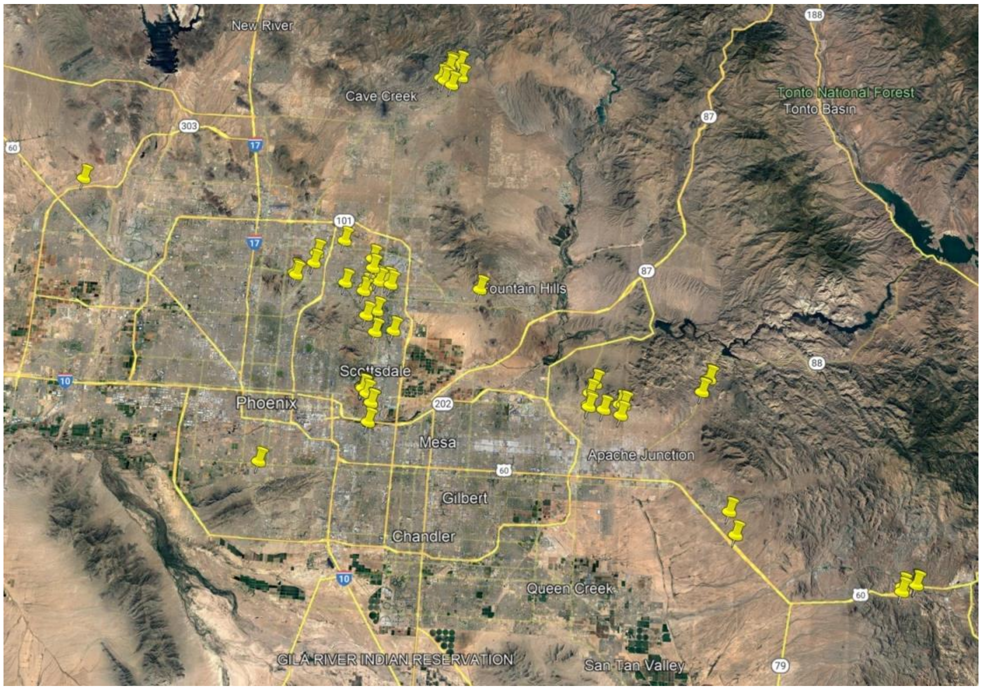
FIGURES

Figure 1

Figure 1A: Photograph of Curve-billed Thrasher. Photo by Anthony Motta

Figure 1B: Photograph of Curve-billed Thrasher nest in cholla. Photo by Anthony Motta

Figure 2



Map of the greater Phoenix area. Pins are placed at locations where Curve-billed Thrasher nests were collected. Map made in Google Earth Pro Version 7.3.4.

Figure 3

Site vegetation map created on 4/7/22 using the Maricopa County Assessor's Office parcel visualization tool. Rings 25, 50, 75, and 100 m away from the nest site are created over a 2021 aerial basemap.
https://maps.mcassessor.maricopa.gov/?esearch=30190023&slayer=0&exprnum=0

Figure 4

Body Spiny Tally as a Function of 25m and 100m Spiny Tally

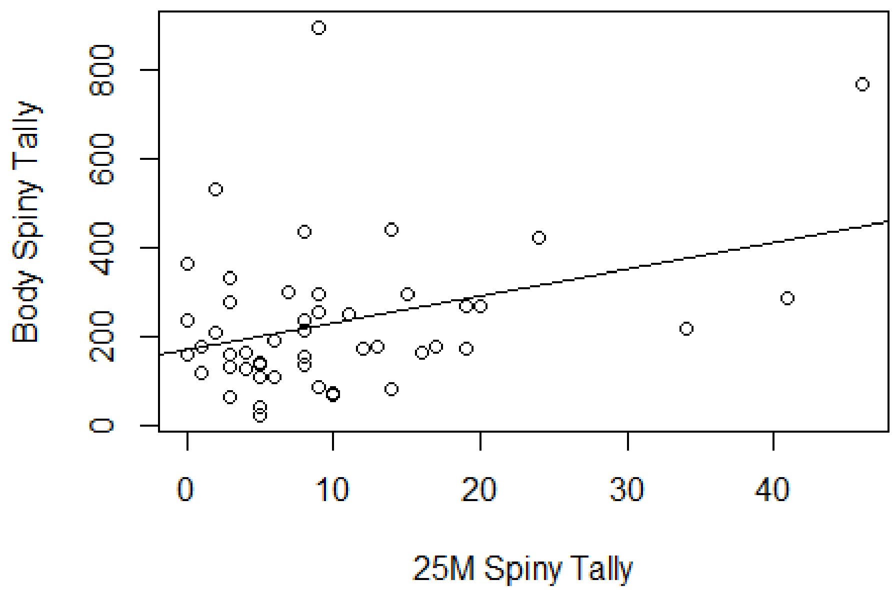


Figure 4A: P-value was statistically significant. (OLS Regression Estimate = 6.004, SE = 2.356,
$t = 2.548$, $p = 0.0142$).

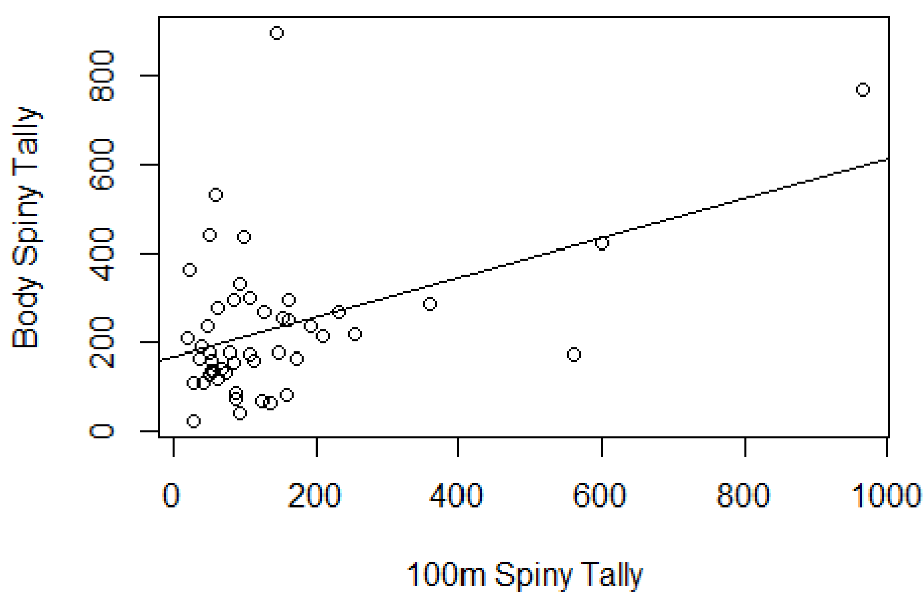


Figure 4B: P-value was statistically significant. (OLS Regression Estimate = 0.4440, SE = 0.1311,
$t = 3.385$, $p = 0.000146$).

Figure 5

Body Wood Tally as a Function of 25m Wood Tally

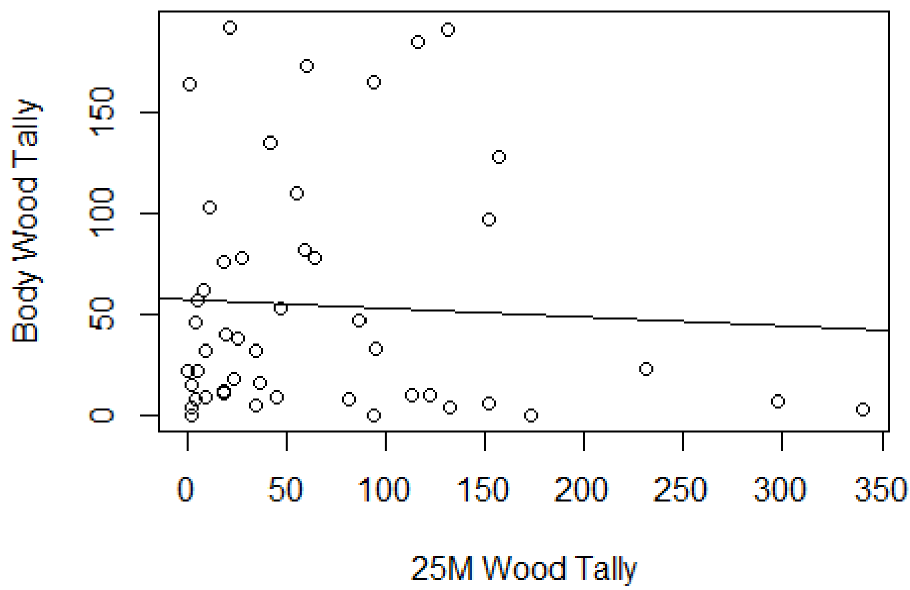


Figure 5A: OLS model failed assumption of normality and lacked significant p-value.

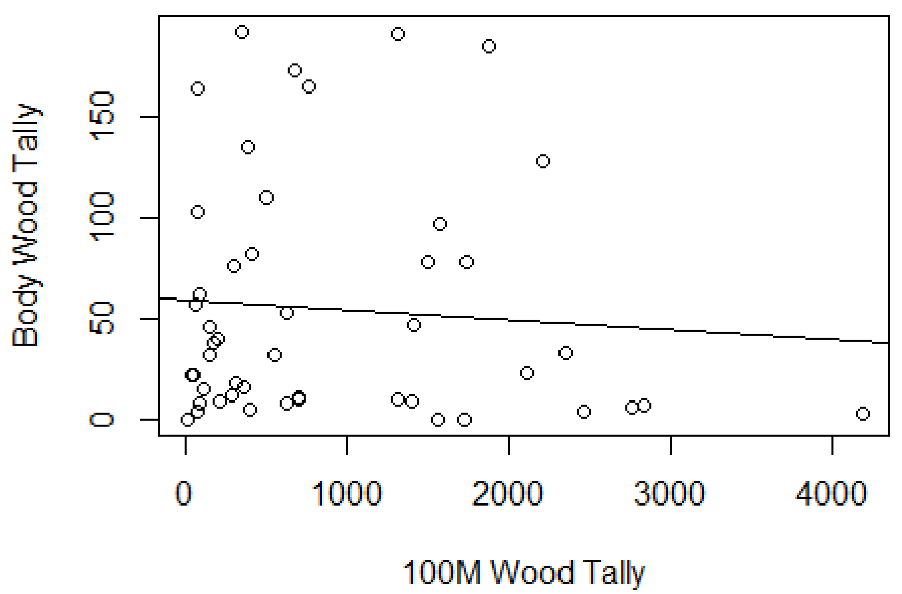


Figure 5B: OLS model failed assumption of normality and lacked significant p-value.

Figure 6

Body Graminoid Tally as a Function of 25m and 100m Graminoid Tally

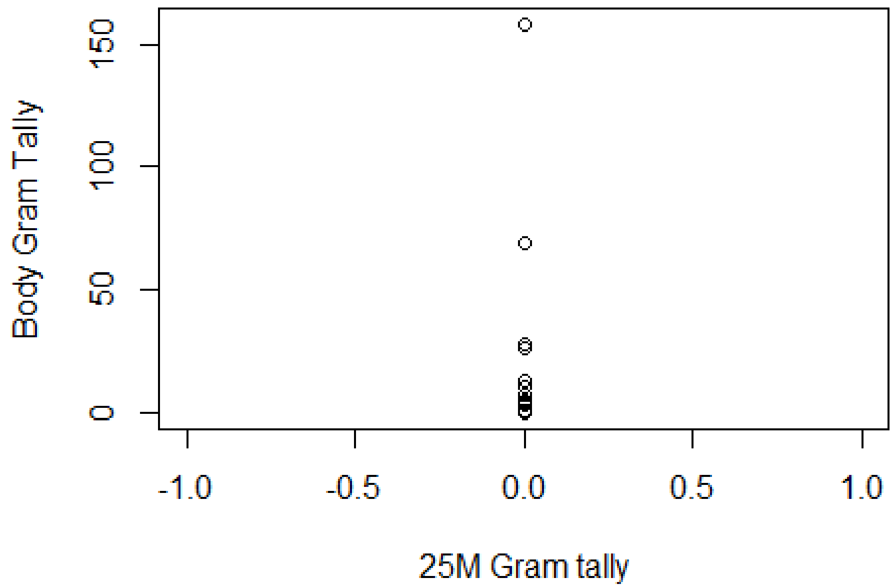


Figure 6A: 25m site data for graminoid was zero at every site, thus causing an N/A p-value in OLS.

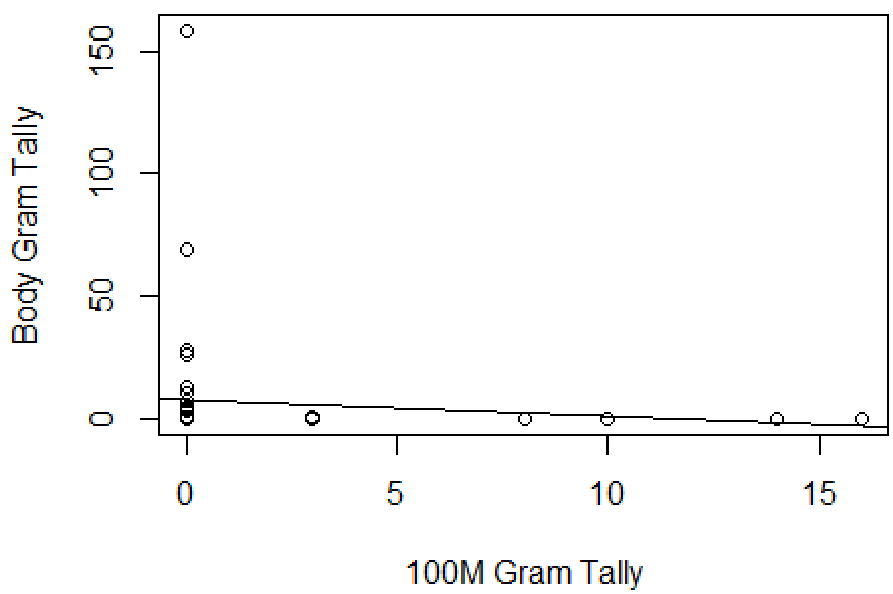


Figure 6B: OLS model failed assumption of normality and lacked significant p-value.

Figure 7

Body Barrel Cactus Tally as a Function of 25m and 100m Barrel Cactus Tally

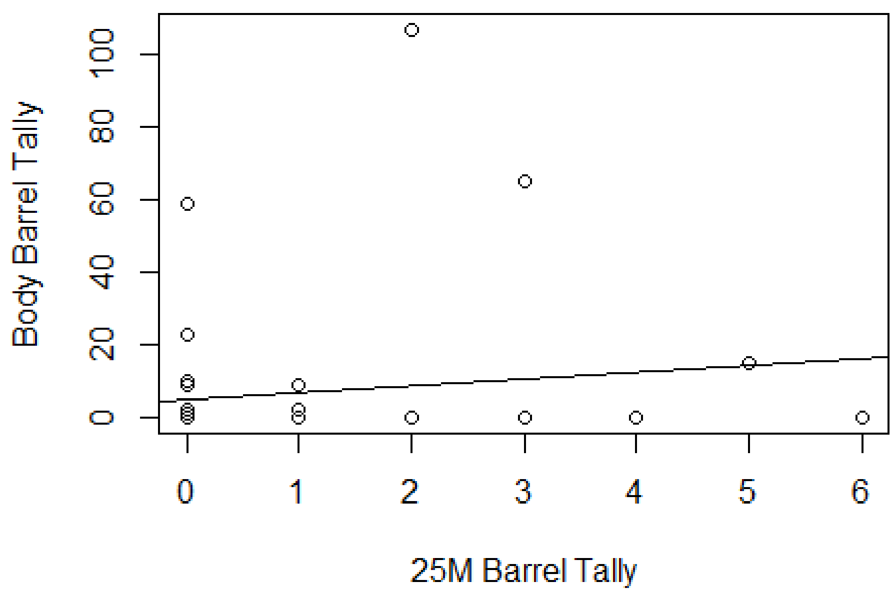


Figure 7A: OLS model failed assumption of normality and lacked significant p-value.

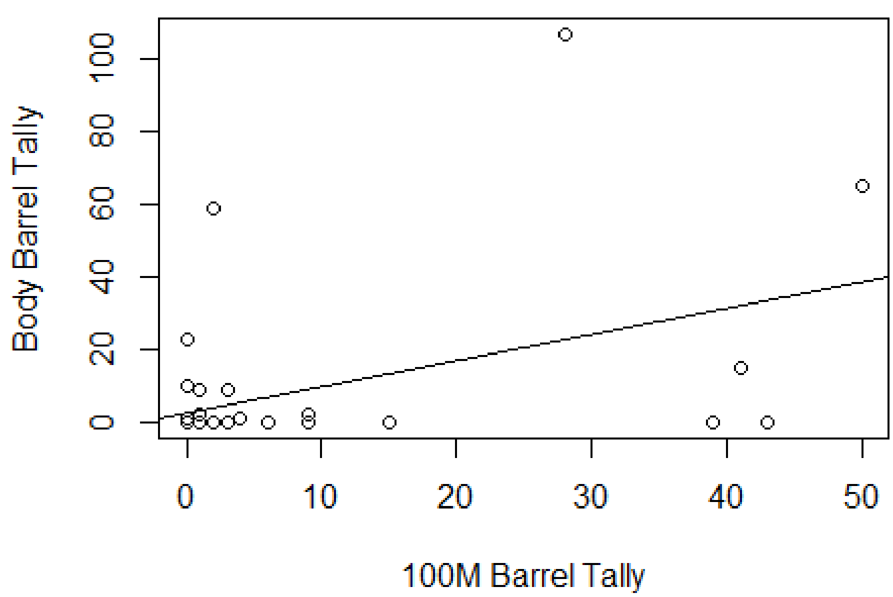
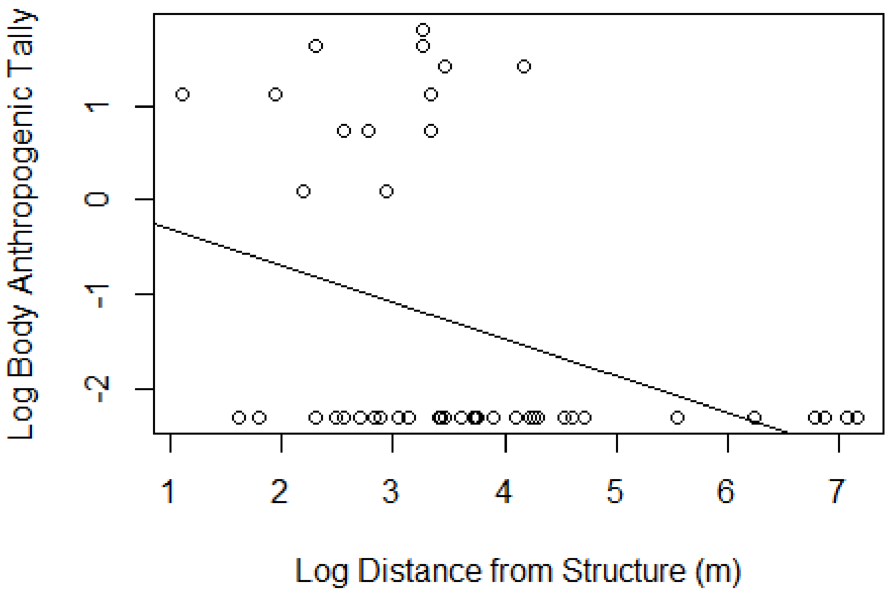


Figure 7B: OLS model failed assumption of normality but had significant p-value. (OLS Regression estimate = 0.7231, SE = 0.2063, t = 3.505, p = 0.00103).

Figure 8

Log Body Anthropogenic Tally as a Function of Log Distance from Nearest Man-Made Structure (m)



OLS model failed assumption of normality but had significant p-value. (OLS Regression estimate = -0.3898, SE = 0.15324, t = -2.544, p = 0.0144).

Figure 9

Core Spiny Mass (g) as a Function of 25m and 100m Spiny Tally

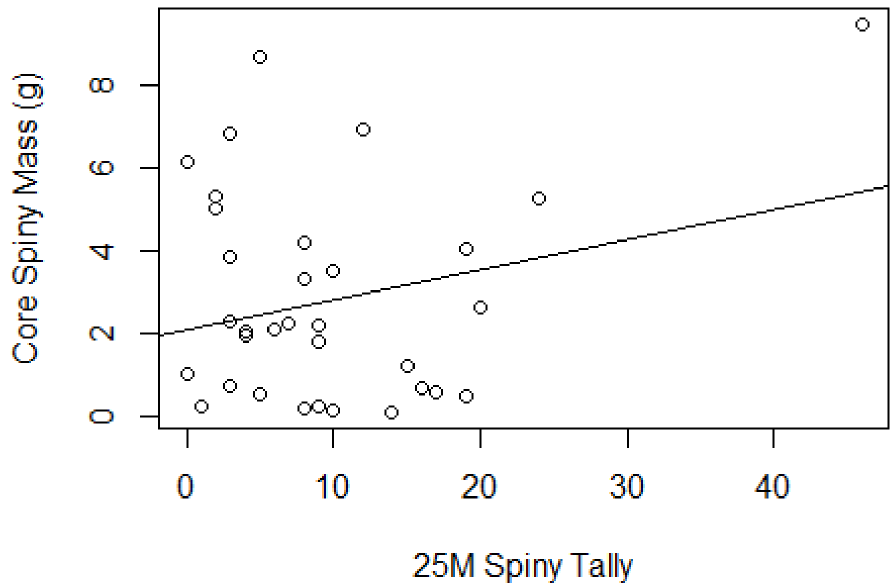


Figure 9A: OLS model failed assumption of normality and lacked significant p-value.

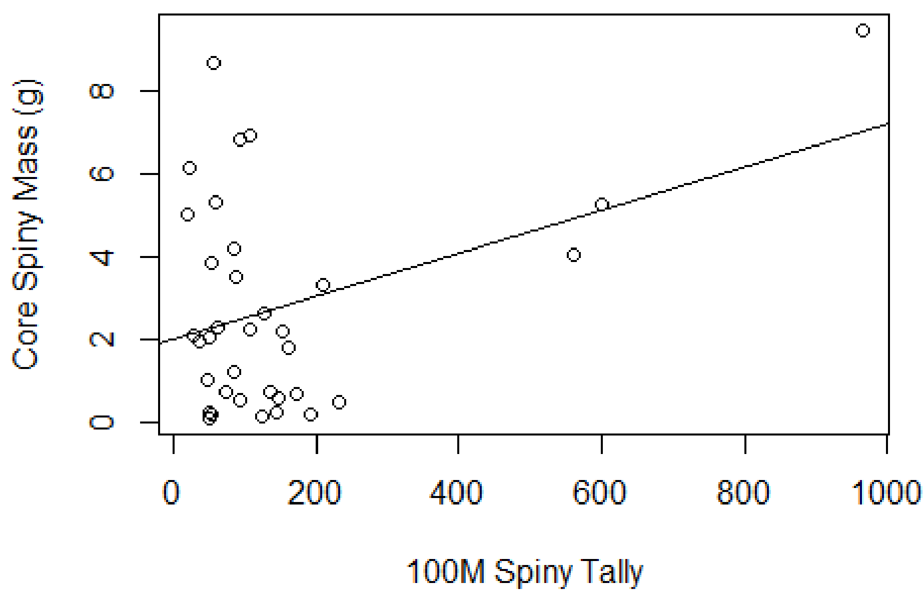


Figure 9B: OLS model failed assumption of normality but had a significant p-value. Spearman test failed to have significant p-value so no strong conclusions can be reached. (OLS Regression Estimate = 0.005, Se = 0.0022, t = 2.387, p = 0.0228) (Spearman's r = 0.019, S = 7273, p = 0.9154).

Figure 10

Core Wood Mass (g) as a Function of 25m and 100 m Wood Tally

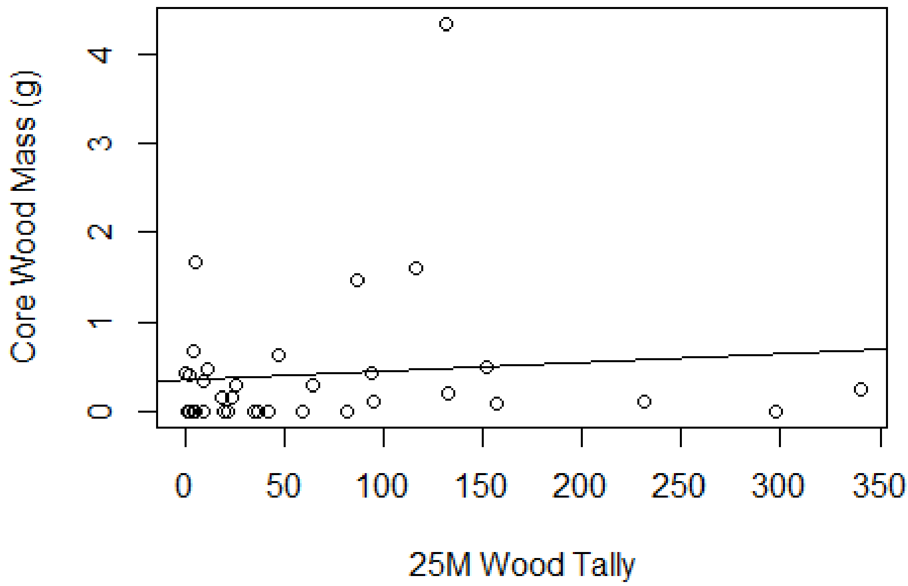


Figure 10A: OLS model failed assumption of normality and lacked significant p-value.

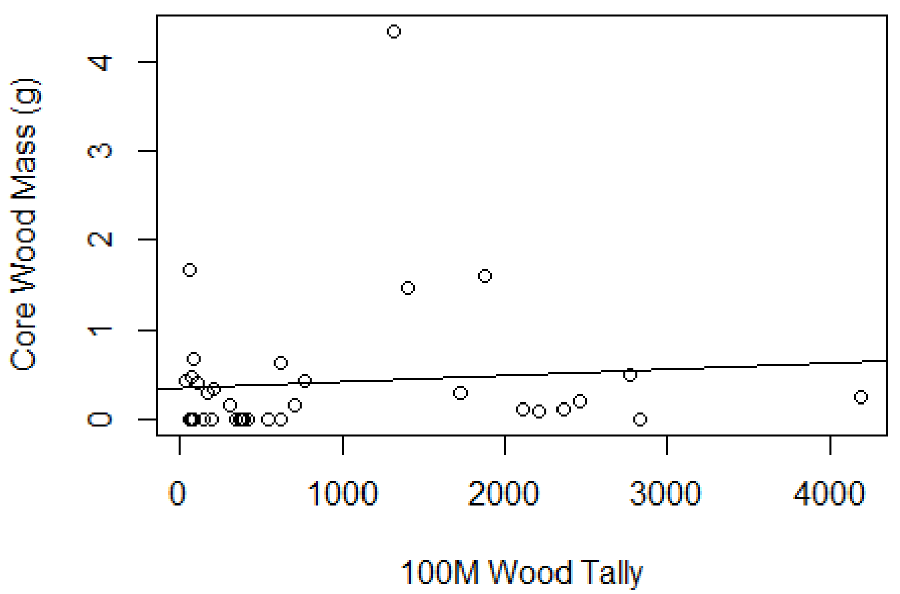


Figure 10B: OLS model failed assumption of normality and lacked significant p-value.

Figure 11

Core Graminoid Mass (g) as a function of 25m and 100m Graminoid Tally

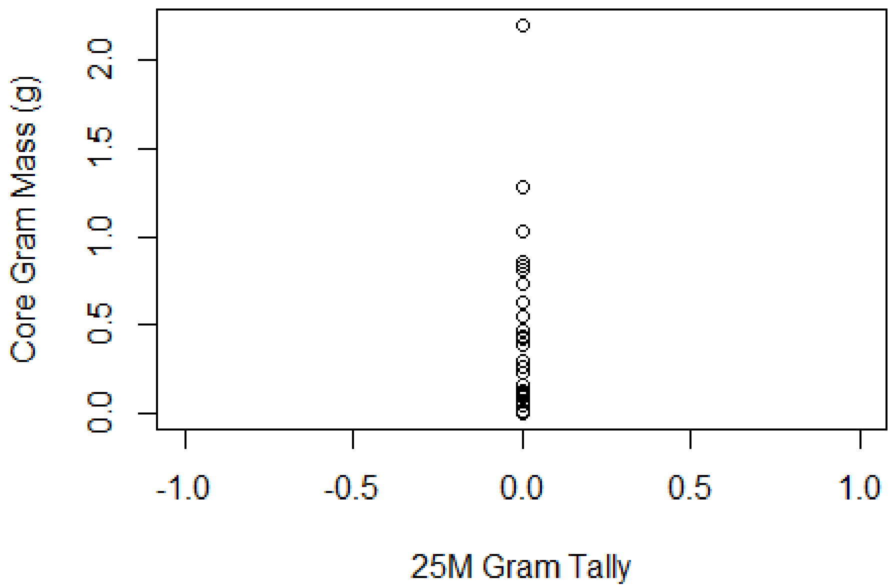


Figure 11A: 25m site data for graminoid was zero at every site, thus causing an N/A p-value in OLS.

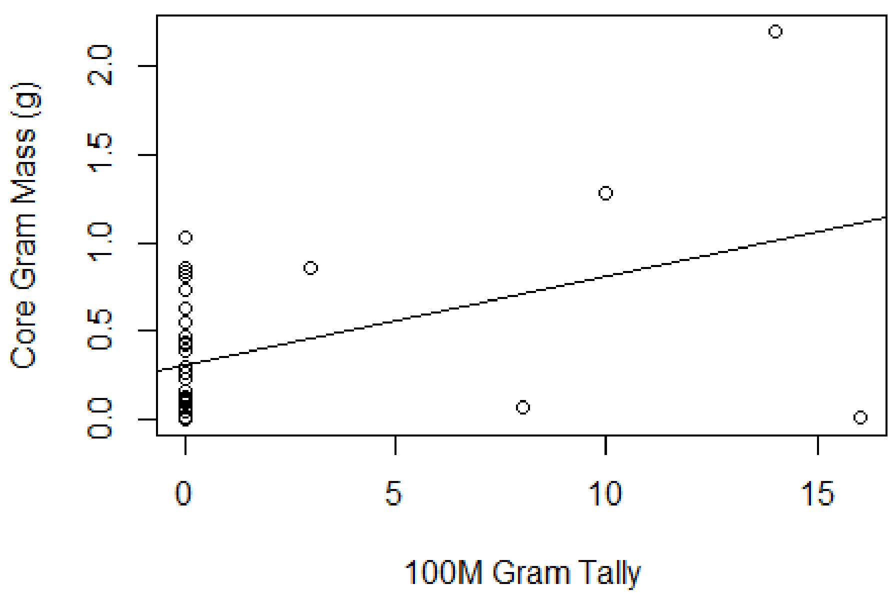


Figure 11B: OLS model failed assumption of normality but had a significant p-value. Spearman test failed to have significant p-value so no strong conclusions can be reached. (OLS Regression Estimate = 0.05, SE = 0.019, t = 2.703, p = 0.011) (Spearman's r = 0.222, S = 5553.1, p = 0.1994).

Figure 12

Log Core Anthropogenic Mass (g) as a Function of Log Distance from Nearest Man-Made Structure (m)

OLS model failed assumption of normality and lacked significant p-value.

Figure 13

Average Maximum and Minimum Diameters of Nest (cm) by Species

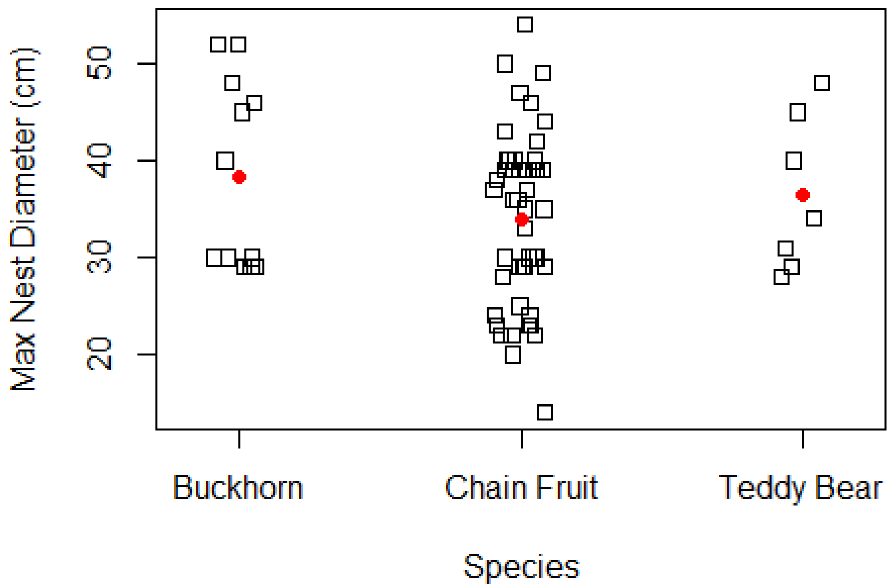


Figure 13A: Stripchart of max nest diameter (cm) by cholla species. Red dot is mean max nest diameter (cm). ANOVA p-value fails to reject the null hypothesis that there is no difference in means.

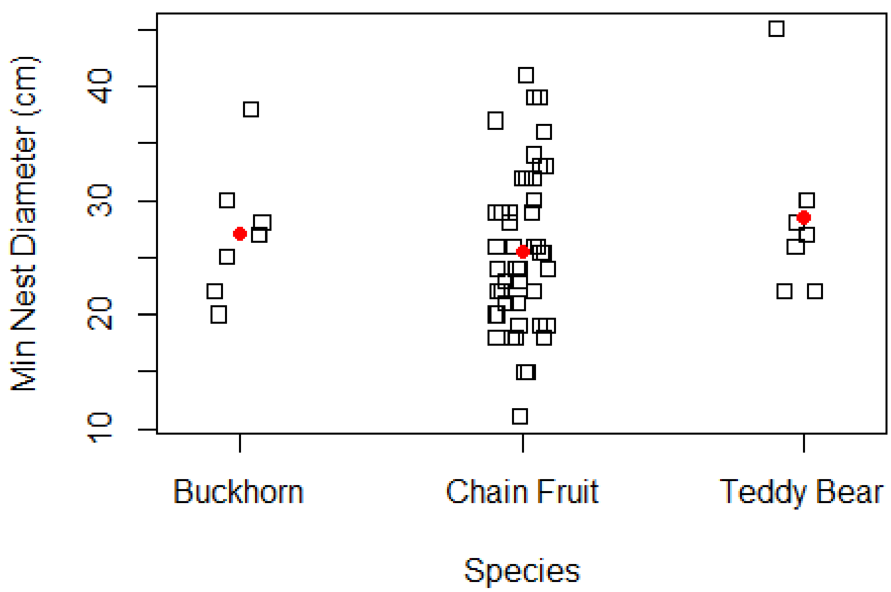


Figure 13B: Stripchart of minimum nest diameter (cm) by cholla species. Red dot is mean minimum nest diameter (cm). ANOVA p-value fails to reject the null hypothesis that there is no difference in means.

Figure 14

Average Nest Heights from Ground (cm) by Species

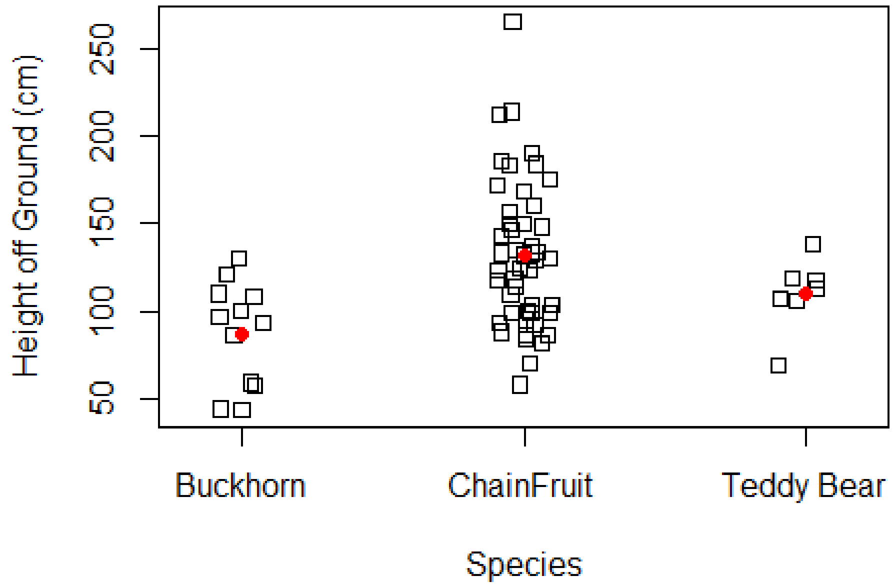


Figure 14A: Stripchart of nest height off ground (cm) by cholla species. Red dot is mean nest height off ground. ANOVA p-value rejected null hypothesis, indicating significant difference in means, but failed normality test.

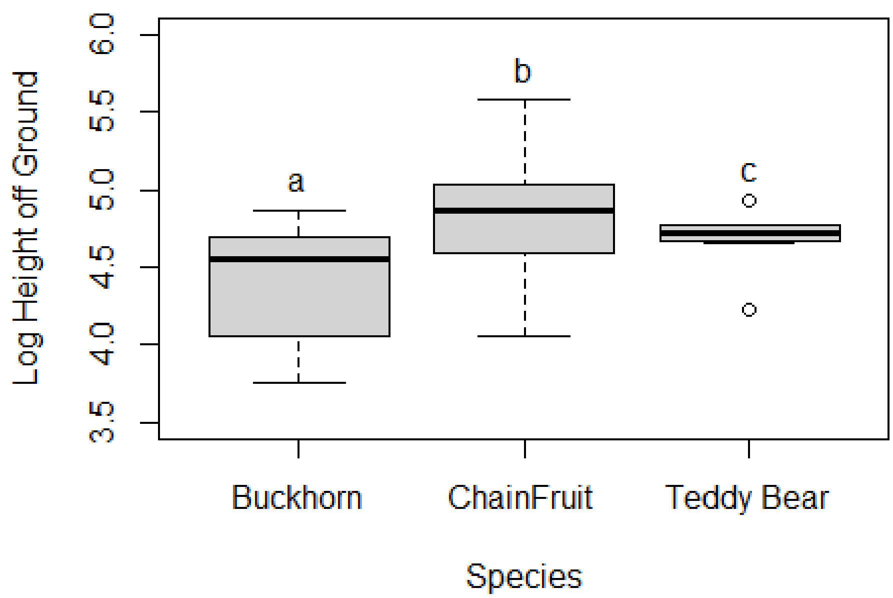


Figure 14B: Boxplot of log height off ground by species. ANOVA rejected null hypothesis indicating significant difference in means. Tukey's Honest Significant Difference test revealed 3 different means for the species. At a significance level of 0.05, we reject the null hypothesis that there is no difference in mean log height off ground among the species (ANOVA: $F = 8.79$, $df = 2$ and 64, $p = 0.000424$).

Figure 15

Average Nest Height (cm) by Species

Stripchart of nest height (cm) by cholla species. Red dot is mean nest height (cm). ANOVA model failed assumption of normality and data was log transformed. ANOVA p-value of log nest height fails to reject the null hypothesis that there is no significant difference in means.

APPENDIX B

TABLES

Table 1

OLS Regression

Interaction	Estimate	SE	t	p
Body Spiny As Function of 25m Spiny	6.004	2.356	2.548	0.0142
Body Spiny As Function of 100m Spiny	0.444	0.1311	3.385	.00146
Body Wood As Function of 25m Wood	-0.044	0.113	-0.39	0.696
Body Wood As Function of 100m Wood	-0.005	0.009	-0.53	0.602
Body Graminoid As Function of 100m Graminoid	-0.635	1.05	-0.60	0.549
Body Barrel As Function of 25m Barrel	1.948	1.742	1.118	0.269
Body Barrel As Function of 100m Barrel	0.723	0.21	3.51	0.00103
Body Anthropogenic As Function of Distance to Structure (m)	-0.001	0.0008	-1.44	0.158
Core Spiny Mass (g) As Function of 25m Spiny Tally	0.073	0.049	1.496	0.144
Core Spiny Mass (g) As Function of 100m Spiny Tally	0.005	0.0022	2.387	0.023
Core Wood Mass (g) As Function of 25m Wood Tally	0.001	0.002	0.61	0.546
Core Wood Mass (g) As Function of 100m Wood Tally	7.1e-05	1.3e-04	0.533	0.598
Core Graminoid Mass (g) As Function of 100m Graminoid Tally	0.05	0.018	2.703	0.0108
Core Anthropogenic Mass (g) As Function of Distance To Structure (m)	-0.0002	0.0004	-0.51	0.612

Results of OLS regressions, including estimated slope (Estimate), standard error (SE), t-value (t), and p-value (p).

Table 2

Binomial Regression

Interaction	Estimate	SE	z	p
Body Spiny Tally, 25m Spiny Tally	0.045	0.002	18.98	<2e-16
Body Spiny Tally, 100m Spiny Tally	0.003	0.0002	17.14	<2e-16
Body Wood Tally, 25m Wood Tally	0.0002	0.0003	0.459	0.647
Body Wood Tally, 100m Wood Tally	-2.5e-08	2.6e-05	-0.001	0.999
Body Graminoid Tally, 100m Graminoid Tally	-0.97	0.331	-2.933	0.003
Body Barrel Tally, 25m Barrel Tally	0.208	0.027	7.818	5.3e-15
Body Barrel Tally, 100m Barrel Tally	0.049	0.003	17.77	<2e-16
Body Anthropogenic Tally, Distance To Structure (m)	-0.026	0.009	-2.804	0.005

Results of binomial regressions, including estimated slope (Estimate), standard error (SE), z-value (z), and p-value (p).

Table 3

Beta Regression

Interaction	Estimate	SE	z	p
Core Spiny Mass Proportion, 25m Spiny Tally	0.022	0.018	1.174	0.24
Core Spiny Mass Proportion, 100m Spiny Tally	0.002	0.0009	2.048	0.0406
Core Wood Mass Proportion, 25m Wood Tally	0.001	0.002	0.675	0.50
Core Wood Mass Proportion, 100m Wood Tally	0.0002	0.0001	1.343	0.179
Core Graminoid Mass Proportion, 100m Graminoid Tally	0.027	0.035	0.778	0.437
Core Anthropogenic Mass Proportion, Distance To Structure (m)	-0.0003	0.0004	-0.713	0.476

Results of beta regressions, including estimated slope (Estimate), standard error (SE), z-value (z), and p-value (p).

Table 4

Nest Site Locations

Nest ID	Longitude	Latitude	Collection Date	Host Plant
Motta 1	33°35'10.3"N	111°47'27.6"W	11/07/20	Chain Fruit
Motta 2	33°25'11.8"N	111°56'02.4"W	11/21/20	Chain Fruit
Motta 3	33°26'33.5"N	111°55'56.0"W	11/21/20	Buckhorn
Motta 4	33°26'34.1"N	111°55'55.9"W	11/21/20	Buckhorn
Motta 5	33°26'34.5"N	111°55'56.2"W	11/29/20	Buckhorn
Motta 6	33°26'34.5"N	111°55'56.2"W	11/29/20	Buckhorn
Motta 7	33°26'34.5"N	111°55'56.2"W	11/29/20	Buckhorn
Motta 8	33°16'19.7"N	111°10'33.6"W	12/12/20	Chain Fruit
Motta 9	33°16'19.0"N	111°10'31.0"W	12/12/20	Chain Fruit
Motta 10	33°16'21.6"N	111°10'35.5"W	12/12/20	Chain Fruit
Motta 11	33°28'10.7"N	111°37'44.6"W	12/18/20	Chain Fruit
Motta 12	33°28'53.2"N	111°37'19.1"W	12/18/20	Chain Fruit
Motta 13	33°28'53.9"N	111°37'20.7"W	12/18/20	Chain Fruit
Motta 14	33°28'44.4"N	111°28'25.3"W	01/16/21	Chain Fruit
Motta 15	33°28'46.2"N	111°28'24.9"W	01/16/21	Chain Fruit
Motta 16	33°29'44.0"N	111°27'52.8"W	01/16/21	Chain Fruit
Motta 17	33°29'41.1"N	111°27'47.2"W	01/16/21	Chain Fruit
Motta 18	33°29'41.1"N	111°27'47.2"W	01/16/21	Chain Fruit
Motta 19	33°27'43.9"N	111°56'48.6"W	02/01/21	Chain Fruit
Motta 20	33°27'43.9"N	111°56'48.6"W	02/01/21	Chain Fruit
Motta 21	33°27'42.9"N	111°56'48.8"W	02/01/21	Chain Fruit
Motta 22	33°27'42.0"N	111°56'46.3"W	02/01/21	Chain Fruit
Motta 23	33°27'37.7"N	111°56'46.6"W	02/01/21	Chain Fruit
Motta 24	33°27'34.7"N	111°56'42.1"W	02/01/21	Chain Fruit
Motta 25	33°27'35.1"N	111°56'39.8"W	02/01/21	Chain Fruit
Motta 26	33°27'37.7"N	111°56'38.7"W	02/01/21	Chain Fruit
Motta 27	33°27'05.4"N	111°36'30.5"W	02/06/21	Chain Fruit
Motta 28	33°27'05.4"N	111°36'30.5"W	02/06/21	Chain Fruit
Motta 29	33°27'14.6"N	111°37'45.4"W	02/06/21	Chain Fruit
Motta 30	33°27'21.9"N	111°37'50.3"W	02/06/21	Chain Fruit
Motta 31	33°27'35.9"N	111°56'35.4"W	02/08/21	Chain Fruit
Motta 32	33°27'37.7"N	111°56'38.7"W	02/08/21	Chain Fruit
Motta 33	33°16'07.7"N	111°11'37.7"W	03/27/21	Chain Fruit
Motta 34	33°15'48.9"N	111°11'39.9"W	03/27/21	Chain Fruit
Motta 38	33°26'45.9"N	111°35'04.1"W	04/11/21	Chain Fruit
Motta 39	33°27'29.8"N	111°34'51.5"W	04/11/21	Chain Fruit
Motta 47	33°36'20.4"N	112°01'46.0"W	11/17/21	Chain Fruit
Motta 48	33°36'55.5"N	111°56'47.8"W	09/20/21	Chain Fruit
Motta 59	33°35'26.0"N	111°56'20.2"W	01/20/22	Chain Fruit
Motta 64	33°35'16.6"N	111°56'07.5"W	01/04/21	Teddy Bear
Motta 75	33°33'08.2"N	111°56'05.6"W	12/12/21	Buckhorn
Motta 77	33°32'45.1"N	111°57'04.8"W	01/20/22	Chain Fruit
Motta 85	33°36'14.4"N	111°56'42.5"W	01/10/22	Chain Fruit
Motta 86	33°35'32.4"N	112°03'19.8"W	01/24/22	Buckhorn
Motta 88	33°35'24.1"N	112°03'12.0"W	01/24/22	Buckhorn
Motta 90	33°31'47.4"N	111°54'32.4"W	01/30/22	Buckhorn
Motta 99	33°34'49.5"N	111°57'11.6"W	01/30/22	Chain Fruit
Motta 101	33°34'31.3"N	111°57'20.0"W	11/14/21	Teddy Bear
Motta 106	33°35'21.4"N	111°55'23.7"W	01/10/22	Teddy Bear
Motta 108	33°35'06.8"N	111°55'04.9"W	01/30/22	Teddy Bear
Motta 110	33°31'35.9"N	111°56'04.8"W	12/12/21	Buckhorn
Motta 116	33°38'07.4"N	111°59'20.3"W	01/03/22	Teddy Bear
Motta 120	33°27'12.1"N	111°56'22.0"W	10/08/21	Chain Fruit
Motta 121	33°35'02.5"N	111°58'57.2"W	01/03/22	Chain Fruit
Motta 122	33°41'32.5"N	112°22'23.5"W	01/08/22	Teddy Bear
Motta 124	33°50'34.6"N	111°51'48.7"W	10/12/21	Chain Fruit
Motta 125	33°50'46.0"N	111°52'09.5"W	10/12/21	Chain Fruit
Motta 126	33°50'53.0"N	111°50'21.7"W	10/12/21	Chain Fruit
Motta 127	33°51'51.9"N	111°50'35.8"W	10/12/21	Buckhorn
Motta 128	33°51'46.4"N	111°51'26.1"W	10/12/21	Chain Fruit
Motta 129	33°51'43.0"N	111°51'33.3"W	10/12/21	Chain Fruit
Motta 130	33°51'36.2"N	111°51'29.6"W	10/12/21	Teddy Bear
Motta 131	33°50'16.3"N	111°51'09.9"W	10/12/21	Chain Fruit
Motta 132	33°21'57.6"N	112°04'47.8"W	01/24/22	Chain Fruit
Motta 135	33°37'05.0"N	112°01'36.1"W	11/17/21	Buckhorn
Motta 136	33°18'59.9"N	111°25'14.2"W	01/15/22	Chain Fruit
Motta 137	33°20'32.1"N	111°25'48.3"W	01/15/22	Chain Fruit
Motta 138	33°27'29.8"N	111°34'51.5"W	01/15/22	Chain Fruit

Nest ID is the number given to every nest discovered by researchers. Not every nest found was collected. Motta 138 is the 138th nest found, not the 138th nest collected.

Table 5

Nest Dimensions

Nest ID	Tilt of Nest	Direction in Plant	Max Diameter (cm)	Min Diameter (cm)	Nest Height (cm)	Height Off Ground (cm)
Motta 1	E	NW	37	N/A	13	123
Motta 2	Nw	SW	24	N/A	8	70
Motta 3	Level	SE	52	N/A	25	93
Motta 4	Level	W	45	N/A	20	121
Motta 5	Level	NW	30	N/A	30	110
Motta 6	Level	Center	40	N/A	15	100
Motta 7	W	W	52	N/A	28	57
Motta 8	Level	E	14	11	14	104
Motta 9	S	N	36	30	30	168
Motta 10	Level	NW	20	18	20	214
Motta 11	Level	E	22	15	15	133
Motta 12	N	E	39	20	11	157
Motta 13	SE	S	36	26	19	137
Motta 14	Level	S	30	22	12	132
Motta 15	N	N	39	25.4	9	100
Motta 16	E	S	40	25.4	20	93
Motta 17	Level	S	33	19	20	58
Motta 18	Level	N	22	18	17	143
Motta 19	E	N	30	26	24	135
Motta 20	E	N	23	20	25	150
Motta 21	W	N	35	22	47	148
Motta 22	N	E	23	15	19	117
Motta 23	Level	E	30	26	18	118
Motta 24	Level	N	24	21	22	175
Motta 25	Tilt	E	40	37	30	183
Motta 26	Level	N	30	20	10	190
Motta 27	SW	S	23	18	12	265
Motta 28	Level	N	40	26	21	N/A
Motta 29	Level	SW	35	28	20	150
Motta 30	S	N	29	24	18	184
Motta 31	Level	N	29	23	27	146
Motta 32	SE	N	46	39	19	92
Motta 33	W	W	39	32	18	99
Motta 34	S	S	44	29	57	95
Motta 38	N	N	40	19	22	129
Motta 39	Level	S	40	23	32	212
Motta 47	Level	W	39	33	44	86
Motta 48	Level	S	50	32	34	86
Motta 59	Level	SW	29	29	18	104
Motta 64	Level	E	31	28	16	113
Motta 75	SW	N	46	38	44	130
Motta 77	S	S	29	24	28	124
Motta 85	N	N	42	29	12	114
Motta 86	SE	NE	29	22	17	108
Motta 88	S	N	30	30	14	86
Motta 90	E	N	29	20	22	97
Motta 99	Level	SW	22	18	16	82
Motta 101	Level	SW	48	45	32	69
Motta 106	SW	SW	34	27	15	119
Motta 108	NW	S	40	30	28	107
Motta 110	Level	NW	29	28	14	43
Motta 116	N	W	45	26	25	138
Motta 120	S	SE	49	36	69	123
Motta 121	Level	W	25	22	29	172
Motta 122	NE	W	28	22	31	117
Motta 124	S	S	43	39	33	84
Motta 125	SE	NW	47	24	23	88
Motta 126	Level	SW	54	41	22	99
Motta 127	Level	SW	30	25	24	59
Motta 128	Level	S	39	33	31	130
Motta 129	E	SSE	38	34	29	133
Motta 130	Level	N	29	22	28	106
Motta 131	Level	NNW	28	24	26	134
Motta 132	Level	NE	29	19	29	99
Motta 135	S	S	48	27	18	44
Motta 136	Level	SE	37	32	46	109
Motta 137	Level	S	39	29	28	186
Motta 138	Level	SE	29	21	18	160

Table 6

Nest Body Composition

Nest ID	Spiny	Wood	Graminoid	Anthropogenic	Barrel	Fiber	Total
Motta 1	249	10	0	0	107	0	366
Motta 2	23	62	0	3	2	0	90
Motta 4	80	12	1	0	0	4	97
Motta 10	286	0	0	0	0	0	286
Motta 11	141	0	0	0	1	4	146
Motta 12	436	0	0	0	65	0	501
Motta 15	218	9	69	0	0	0	296
Motta 16	269	165	28	0	0	0	462
Motta 19	267	53	0	0	0	0	320
Motta 23	177	5	0	0	0	0	182
Motta 27	120	97	158	0	0	0	375
Motta 29	178	78	13	0	59	0	328
Motta 31	235	135	0	0	0	0	370
Motta 33	422	4	0	0	0	0	426
Motta 34	766	8	0	0	0	0	774
Motta 38	156	6	0	0	2	0	164
Motta 39	73	3	0	0	23	0	99
Motta 47	333	191	0	6	15	0	545
Motta 48	439	164	0	1	0	0	604
Motta 59	129	32	0	0	0	0	161
Motta 64	235	103	3	5	9	0	355
Motta 75	533	38	0	5	0	0	576
Motta 77	173	16	0	0	0	0	189
Motta 85	132	22	4	0	0	7	165
Motta 86	174	47	0	0	0	0	221
Motta 88	69	32	0	0	0	0	101
Motta 90	107	15	0	3	0	0	125
Motta 99	111	110	7	2	0	36	266
Motta 101	278	8	0	1	0	0	287
Motta 106	176	46	0	2	0	0	224
Motta 108	164	9	0	0	0	0	173
Motta 110	190	76	11	2	1	7	287
Motta 116	135	22	5	0	0	0	162
Motta 120	896	192	0	2	0	0	1090
Motta 121	136	57	0	3	0	0	196
Motta 122	207	18	0	0	0	0	225
Motta 125	298	128	0	0	10	0	436
Motta 126	254	185	0	0	0	0	439
Motta 127	297	33	0	0	0	0	330
Motta 128	213	23	0	0	0	0	236
Motta 129	162	4	0	0	0	0	166
Motta 130	63	78	0	0	0	0	141
Motta 131	42	82	0	0	0	0	124
Motta 132	294	40	0	0	0	0	334
Motta 135	159	173	26	4	1	0	363
Motta 136	363	11	0	0	0	0	374
Motta 137	88	10	1	0	0	0	99
Motta 138	161	7	0	4	9	0	181

Table 7

Nest Core Composition

Nest ID	Core Mass (g)	Spiny Mass (g)	Wood Mass (g)	Fiber Mass (g)	Gram Mass (g)	Anthro Mass (g)	Organic Mass (g)	Sample Total (g)
Motta 16	114.54	0.49	0.42	0.99	0.23	0	0	2.13
Motta 19	80.75	2.62	0.62	1.5	0.39	0.07	0.05	5.25
Motta 23	21.57	0.57	0	0.19	1.03	0	0.17	1.96
Motta 31	93.3	0.22	0	1.46	0.01	0	0	1.69
Motta 33	110.99	5.29	0	0.41	0.55	0	0	6.25
Motta 34	179.1	9.46	0.68	0.76	0.04	0	0	10.94
Motta 38	45.9	4.21	0.5	0.12	0.81	0	0.15	5.79
Motta 39	22.18	3.5	0.25	0.28	0.73	0	0	4.76
Motta 47	226.24	6.82	4.34	1.15	0.63	4.22	0.08	17.24
Motta 48	79.03	0.11	0	2.1	0.86	0	0.08	3.15
Motta 59	176.29	2.04	0	5.05	1.28	0.04	0	8.41
Motta 64	68.43	1.02	0.47	2.82	0	0.22	0	4.53
Motta 75	403.55	5.33	0.29	1.39	0.1	0.01	0	7.12
Motta 77	64.81	4.03	0	1.54	0	0	0	5.57
Motta 85	18.51	0.72	0	1.2	0.26	0	0	2.18
Motta 86	27.73	6.9	1.47	0.97	0.01	0	0	9.35
Motta 88	5.89	0.13	0	0.99	0	0.12	0	1.24
Motta 90	64.2	2.1	0.4	1.51	0.43	0.43	0.07	4.94
Motta 101	38.22	2.3	0	1.15	0.07	0.05	0	3.57
Motta 106	52.79	0.25	0	2.02	0	0	0	2.27
Motta 108	31.7	1.95	0.34	0.44	2.2	0	0	4.93
Motta 116	15.61	0.19	0.43	1.45	0.83	0	0	2.9
Motta 120a	157.75	0.24	0	1.14	0.13	0.07	0	1.58
Motta 121	77.99	8.69	1.67	2.55	0.11	0	0	13.02
Motta 122	161.8	5.01	0.15	1.71	0	0	0	6.87
Motta 125	187.14	2.24	0.08	0.87	0.01	0	0.01	3.21
Motta 126	171.7	2.18	1.61	0.7	0.42	0.01	0.09	5.01
Motta 127	31.33	1.81	0.11	1.03	0.16	0	0	3.11
Motta 128	24.62	3.33	0.11	1.48	0.05	0	0	4.97
Motta 129	31.37	0.67	0.19	0.79	0.3	0	0	1.95
Motta 130	11.46	0.76	0.3	0.99	0.09	0	0	2.14
Motta 131	23.24	0.55	0	1.76	0.47	0	0	2.78
Motta 132	28.97	1.21	0	0.31	0.13	0.5	0.4	2.55
Motta 136	153.18	6.16	0.15	0.12	0.86	0	0	7.29
Motta 138	43.9	3.87	0	1.04	0.07	0.64	0.22	5.84

Table 8

Environmental Tally – 25 m

Nest ID	25 m Spiny	25 m Wood	25 m Gram	25 m Barrel	25 m Total
Motta 1	11	123	0	2	136
Motta 2	5	9	0	1	15
Motta 4	14	19	0	0	33
Motta 10	41	2	0	1	44
Motta 11	5	94	0	0	99
Motta 12	8	173	0	3	184
Motta 15	34	45	0	0	79
Motta 16	19	94	0	0	113
Motta 19	20	47	0	4	71
Motta 23	17	35	0	0	52
Motta 27	1	152	0	0	153
Motta 29	13	28	0	0	41
Motta 31	8	42	0	4	54
Motta 33	24	2	0	0	26
Motta 34	46	4	0	0	50
Motta 38	8	152	0	0	160
Motta 39	10	340	0	0	350
Motta 47	3	132	0	5	140
Motta 48	14	1	0	0	15
Motta 59	4	10	0	0	14
Motta 64	0	12	0	0	12
Motta 75	2	26	0	0	28
Motta 77	19	37	0	3	59
Motta 85	3	6	0	1	10
Motta 86	12	87	0	0	99
Motta 88	10	35	0	0	45
Motta 90	6	2	0	0	8
Motta 99	5	55	0	0	60
Motta 101	3	82	0	0	85
Motta 106	1	4	0	0	5
Motta 108	4	10	0	6	20
Motta 110	6	19	0	0	25
Motta 116	8	0	0	0	8
Motta 120	9	22	0	0	31
Motta 121	5	6	0	0	11
Motta 122	2	24	0	0	26
Motta 125	7	157	0	0	164
Motta 126	9	116	0	0	125
Motta 127	9	95	0	0	104
Motta 128	8	231	0	0	239
Motta 129	16	133	0	0	149
Motta 130	3	64	0	2	69
Motta 131	5	59	0	0	64
Motta 132	15	20	0	6	41
Motta 135	0	60	0	0	60
Motta 136	0	19	0	0	19
Motta 137	9	113	0	0	122
Motta 138	3	297	0	1	301

Table 9

Environmental Tally – 50 m

Nest ID	50 m Spiny	50 m Wood	50 m Gram	50 m Barrel	50 m Total
Motta 1	32	253	0	8	293
Motta 2	0	15	0	0	15
Motta 4	29	61	0	0	90
Motta 10	55	0	0	3	58
Motta 11	13	312	0	2	327
Motta 12	10	348	0	8	366
Motta 15	56	252	0	0	308
Motta 16	39	136	0	0	175
Motta 19	31	162	0	9	202
Motta 23	40	92	0	0	132
Motta 27	16	310	0	0	326
Motta 29	20	188	0	0	208
Motta31	51	81	10	0	142
Motta 33	108	28	0	0	136
Motta 34	134	11	0	0	145
Motta 38	15	590	0	7	612
Motta 39	13	942	0	0	955
Motta 47	13	198	0	28	239
Motta 48	15	9	3	0	27
Motta 59	5	43	4	0	52
Motta 64	14	9	0	0	23
Motta 75	7	27	0	0	34
Motta 77	43	107	0	0	150
Motta 85	20	5	0	0	25
Motta 86	33	268	0	7	308
Motta 88	36	98	0	0	134
Motta 90	9	6	0	0	15
Motta 99	7	113	0	0	120
Motta 101	13	153	0	0	166
Motta 106	7	29	0	0	36
Motta 108	11	40	3	1	55
Motta 110	5	40	0	0	45
Motta 116	14	4	0	0	18
Motta 120	51	88	0	0	139
Motta 121	8	5	0	2	15
Motta 122	6	60	0	0	66
Motta 125	25	523	0	0	548
Motta 126	34	344	0	0	378
Motta 127	42	341	0	0	383
Motta 128	43	385	0	0	428
Motta 129	34	394	0	0	428
Motta 130	19	247	0	0	266
Motta 131	16	27	0	0	43
Motta 132	19	28	0	2	49
Motta 135	17	129	0	0	146
Motta 136	2	87	0	0	89
Motta 137	13	140	0	0	153
Motta 138	9	541	0	0	550

Table 10

Environmental Tally – 75 m

Nest ID	75 m Spiny	75 m Wood	75 m Gram	75 m Barrel	75 m Total
Motta 1	52	416	0	4	472
Motta 2	10	21	0	0	31
Motta 4	47	91	2	0	140
Motta 10	119	0	0	2	121
Motta 11	25	583	0	2	610
Motta 12	31	511	0	16	558
Motta 15	66	469	0	0	535
Motta 16	76	210	0	0	286
Motta 19	33	191	0	17	241
Motta 23	25	110	0	0	135
Motta 27	13	455	0	0	468
Motta 29	21	484	0	0	505
Motta 31	84	121	6	1	212
Motta 33	204	17	0	0	221
Motta 34	329	27	0	0	356
Motta 38	29	857	0	2	888
Motta 39	30	1359	0	0	1389
Motta 47	35	297	0	8	340
Motta 48	12	25	0	0	37
Motta 59	22	36	6	0	64
Motta 64	16	18	0	1	35
Motta 75	15	28	0	0	43
Motta 77	44	184	0	0	228
Motta 85	25	20	0	0	45
Motta 86	25	400	0	16	441
Motta 88	32	188	0	0	220
Motta 90	9	22	0	0	31
Motta 99	13	144	0	0	157
Motta 101	19	255	0	0	274
Motta 106	17	36	0	0	53
Motta 108	8	75	11	1	95
Motta 110	9	112	0	0	121
Motta 116	8	13	0	0	21
Motta 120	44	103	0	0	147
Motta 121	18	8	0	0	26
Motta 122	5	77	0	0	82
Motta 125	30	614	0	0	644
Motta 126	54	494	0	0	548
Motta 127	50	624	0	0	674
Motta 128	76	704	0	0	780
Motta 129	49	873	0	0	922
Motta 130	54	466	0	0	520
Motta 131	30	61	0	0	91
Motta 132	20	53	0	0	73
Motta 135	48	216	0	0	264
Motta 136	9	262	0	0	271
Motta 137	28	165	0	0	193
Motta 138	16	881	0	0	897

Table 11

Environmental Tally – 100 m

Nest ID	100 m Spiny	100 m Wood	100 m Gram	100 m Barrel	100 m Total
Motta 1	68	524	0	14	606
Motta 2	15	42	0	0	57
Motta 4	68	112	1	0	181
Motta 10	144	2	0	0	146
Motta 11	26	568	0	0	594
Motta 12	51	695	0	23	769
Motta 15	98	638	0	0	736
Motta 16	98	322	0	0	420
Motta 19	45	219	0	9	273
Motta 23	66	155	0	0	221
Motta 27	34	659	0	0	693
Motta 29	25	802	0	2	829
Motta 31	51	135	0	10	196
Motta 33	265	22	0	0	287
Motta 34	456	37	0	0	493
Motta 38	33	1169	0	0	1202
Motta 39	34	1549	0	0	1583
Motta 47	44	685	0	0	729
Motta 48	11	43	0	0	54
Motta 59	20	59	0	1	80
Motta 64	18	31	0	0	49
Motta 75	36	93	0	1	130
Motta 77	456	37	0	0	493
Motta 85	25	21	0	0	46
Motta 86	37	652	0	20	709
Motta 88	48	227	0	0	275
Motta 90	5	77	0	0	82
Motta 99	17	183	0	0	200
Motta 101	27	133	8	0	168
Motta 106	26	79	0	0	105
Motta 108	15	80	0	1	96
Motta 110	19	132	0	0	151
Motta 116	23	11	0	1	35
Motta 120	40	130	0	0	170
Motta 121	25	44	0	0	69
Motta 122	6	148	0	0	154
Motta 125	47	922	0	0	969
Motta 126	57	927	0	0	984
Motta 127	62	1297	0	0	1359
Motta 128	83	789	0	0	872
Motta 129	74	1061	0	0	1135
Motta 130	61	955	0	0	1016
Motta 131	44	266	0	0	310
Motta 132	30	91	0	1	122
Motta 135	48	272	0	0	320
Motta 136	12	335	0	0	347
Motta 137	39	275	0	0	314
Motta 138	25	1122	0	2	1149

Table 12

Environmental Tally – Total

Nest ID	Distance To Nearest Structure (m)	Spiny Total	Wood Total	Gram Total	Barrel Total	Grand Total
Motta 1	68	163	1316	0	28	1507
Motta 2	3	30	87	0	1	118
Motta 4	42	158	283	3	0	444
Motta 10	60	359	4	0	6	369
Motta 11	259	69	1557	0	4	1630
Motta 12	112	100	1727	0	50	1877
Motta 15	888	254	1404	0	0	1658
Motta 16	74	232	762	0	0	994
Motta 19	71	129	619	0	39	787
Motta 23	43	148	392	0	0	540
Motta 27	49	64	1576	0	0	1640
Motta 29	37	79	1502	0	2	1583
Motta 31	37	194	379	16	15	604
Motta 33	972	601	69	0	0	670
Motta 34	1290	965	79	0	0	1044
Motta 38	510	85	2768	0	9	2862
Motta 39	101	87	4190	0	0	4277
Motta 47	26	95	1312	0	41	1448
Motta 48	9	52	78	3	0	133
Motta 59	5	51	148	10	1	210
Motta 64	10	48	70	0	1	119
Motta 75	26	60	174	0	1	235
Motta 77	21	562	365	0	3	930
Motta 85	10	73	52	0	1	126
Motta 86	6	107	1407	0	43	1557
Motta 88	18	126	548	0	0	674
Motta 90	28	29	107	0	0	136
Motta 99	16	42	495	0	0	537
Motta 101	19	62	623	8	0	693
Motta 106	16	51	148	0	0	199
Motta 108	12	38	205	14	9	266
Motta 110	13	39	303	0	0	342
Motta 116	17	53	28	0	1	82
Motta 120	28	144	343	0	0	487
Motta 121	7	56	63	0	2	121
Motta 122	17	19	309	0	0	328
Motta 125	41	109	2216	0	0	2325
Motta 126	32	154	1881	0	0	2035
Motta 127	31	163	2357	0	0	2520
Motta 128	23	210	2109	0	0	2319
Motta 129	15	173	2461	0	0	2634
Motta 130	93	137	1732	0	2	1871
Motta 131	30	95	413	0	0	508
Motta 132	17	84	192	0	9	285
Motta 135	32	113	677	0	0	790
Motta 136	1190	23	703	0	0	726
Motta 137	13	89	693	0	0	782
Motta 138	65	53	2841	0	3	2897