Jesse Cole

The Insulative Properties of Bird's Nests

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Abstract This study will examine the insulative effectiveness of bird's nests from Mockingbirds, Bluebirds, Red Winged Blackbirds, and Tree Swallows. The idea of the study is based on biomimicry, a field of science which studies the use of nature to find solutions to man-made problems. While many studies have examined the physical characteristics of bird's nests, very few have examined the materials that the nests are built out of and how effective those nests are as insulators. This study hopes to examine that void. Eight different nests were utilized, two from each species of bird listed above. The nests were weighed initially for their total mass. Then, their surface area, volume, and percent by mass composition of the materials that made up the nest were measured. Approximate r-values were taken from an online table.(1) The percent by volume of the nests were calculated and the composite r-values of the nests were calculated. The specific r value per thickness of each nest was calculated. This study hopes to develop an effective and natural alternative to modern man-made insulation through the utilization of the material composition of the bird's nests. Results demonstrate that the nests used were less effective insulators than fiberglass.

Keywords Bird's Nests; Biomimicry; R-Values; Insulation; Ornithology.

1. Introduction

Birds frequently build nests that use various materials such as human garbage, grasses, roots, and mud. It is considered a natural wonder that birds are able to create such effective insulating dwellings in order to hatch and raise their chicks. As these materials are effective in insulating birds and are made from mostly natural materials, this could present a promising alternative to artificial insulators used in houses. This study will ascertain the effectiveness of these materials as insulators and will determine three characteristics:

1. The r-value per inch of each bird's nest.
2. The effectiveness of a bird's nest as an insulator versus other man-made insulators.
3. The materials that make up the birds nest.

2. Review of Literature

The study conducted by Holcomb and Twiest involves the ecological factors that affect nest building for the Red-Winged Blackbird.[1] This study aided in the determination of some notable materials that have been previously found in the nests of Red-Winged Blackbirds and when it would be appropriate to harvest the nests from the surrounding areas so as not to disturb the nesting process of the birds. The study by Caccamese illustrated nest site characteristics of the Red-Winged Blackbird.[2] This aided in the determination of where to search for the nests of the Red-Winged Blackbird. The study by Lombardo et al. illustrated the effects of feathers on nest insulation and helped to characterize the effectiveness of feathers in Tree Swallow nests used during this experiment.[3] The study by Winkler served to do the same as the study by Lombardo et al. in that it demonstrated the effectiveness of feathers in nest insulation.[4] The behavior of Mockingbirds during nesting times was explored in a study by Breitwisch et al.[5] This study aided in the determination of when to harvest the nests of Mockingbirds. The study by Skowron and Kern was influential in that it provided a basis for this experiment as it examined a number of factors having to do with nest insulation but did not examine the particular r-values for each nest.[6] The natural behaviors of Red-Winged Blackbirds in relation to their young and their nests were examined in the study by Peek et al.[7] This study served to give a better understanding of the behavioral characteristics of female Red-Winged Blackbirds during the time that they construct and live in those nests. The study by Goddard and Board examines the reproductive success of Red-Winged Blackbirds.[8] In doing so, it provides a basis for why the Red-Winged Blackbird's nests were effective in insulating and sheltering fledgling birds. In another study conducted by Holcomb, the degree of variation in Red-Winged Blackbird's nest material between wet and dry materials was examined.[9] This allowed for a basis for the types of materials utilized by the Red-Winged Blackbird during its nesting period. In the study conducted by Albers, the location of the Red-Winged Blackbird's nest was discussed.[10] This was useful in that it gave habitats in which it was possible to locate Red-Winged Blackbird nests. In the study by Visscher, the nest locations and nesting periods were discussed.[11] This aided in determining where mockingbird nests could be located and in the identification of a mockingbird's nest. The study by Li and Martin discussed the nest site selection and success of cavity nesting birds.[12] As the Bluebird is a cavity nesting bird, this aided in determining possible nest site locations and what characteristics of the nest allowed for the nests to be successful. The study by Ramsay et al. illustrated nest site selection by female Black-Capped Chickadees.[13] This gave a greater insight into the habitat a cavity nesting bird, like the Bluebird, might like to build a nest in. In the study by Wilson, the types of food that would be most beneficial to nesting Red-Winged Blackbirds was illustrated.[14] This illustrated what the bird ate and therefore what environment it would be prone to building its nest in. The study by Pinkowski illustrates the types of food young Bluebirds consume and similarly to the study by Wilson, it illustrates what environment the adult bluebird would be likely to build its nest in.[15]

3. Limitations

The following aspects of this study were uncontrollable and affected the outcome of the study; the small sample of birds nests, the accuracy of the gram scale used, the accuracy of the r-values collected from the table in comparison to the true r-values of the materials.

4. Questions

1. Does the inclusion of human garbage improve the insulative effectiveness of the nests?
2. Will the nests be more effective insulators than that of fiberglass?
3. What are the compositions of the materials of each of the nests being studied?

5. Hypothesis

The analysis of these aforementioned questions led to the following three-tiered hypothesis:

-Some nests will be more effective insulators than fiberglass, but most will not be.
-The nests with garbage will be more effective insulators than those that do not contain garbage.
-The nests will be composed mostly of grass and mud and will not be composed mostly of sticks, human garbage, and moss.

6. Methods

Eight abandoned nests were tested for their insulative properties between August and early September, the time of year after fledgling birds leave the nest. The entire experiment was conducted in the same location and thereby under the same temperature and pressure conditions. Using a gram scale, the mass of each nest was calculated and converted to pounds. Using a ruler, the approximate surface area of

each nest was calculated in in^2 using the formulas for the surface area of a rectangular prism, a pipe, and a sphere. Then, the volumes of each nest were calculated in in^3 through displacement using rice in a solid rectangular container. The container was filled up to a certain volume and the change in rice level was measured for each nest. Finally, the percentage by mass composition of each nest was calculated for each material utilized by the bird to create the nest. Using densities found from online sources, the percent by volume amounts were found for each material for each nest using the formula mass/volume = density. Then, using the specific r-values found online, the composite r-values of each nest were calculated using the formula:
$R_{Total} = (R_{Material\ 1})(Volume_{Material\ 1}) + (R_{Material\ 2})(Volume_{Material\ 2}) + (R_{Material\ 3})(Volume_{Material\ 3}) + \ldots$. The r-value will be measured in $ft^2 \cdot °F \cdot h/Btu$.

7. Results

Table 1 shows the types of nests used during the experiment and in what habitat they were constructed. Figure 1 illustrates the initial masses of the nests. The y-axis represents the mass of each nest in pounds and the x-axis represents the nest. Nests are numbered from 1 to 8. Figure 2 illustrates the calculated surface areas of each of the nests. The y-axis represents the surface area of each nest in square inches. The x-axis represents the nest. Figure 3 illustrates the calculated volumes of each nest. The y-axis represents the volume and the x-axis represents the nest. Figure 4 illustrates the composite r values for each nest. The y axis represents the composite r value of the nesting material per inch in $ft^2 \cdot °F \cdot h/Btu$ and the x-axis represents the nest. Charts 1 through 8 represent the percent by mass composition of each nest.

Table 1

Nest number	Species of bird	Environment Nest was Constructed in
Nest 1	Red Winged Blackbird	Outside
Nest 2	Bluebird	Nest Box
Nest 3	Mockingbird	Outside
Nest 4	Bluebird	Nest Box
Nest 5	Tree Swallow	Nest Box
Nest 6	Tree Swallow	Nest Box
Nest 7	Red Winged Blackbird	Outside
Nest 8	Mockingbird	Outside

Figure 1

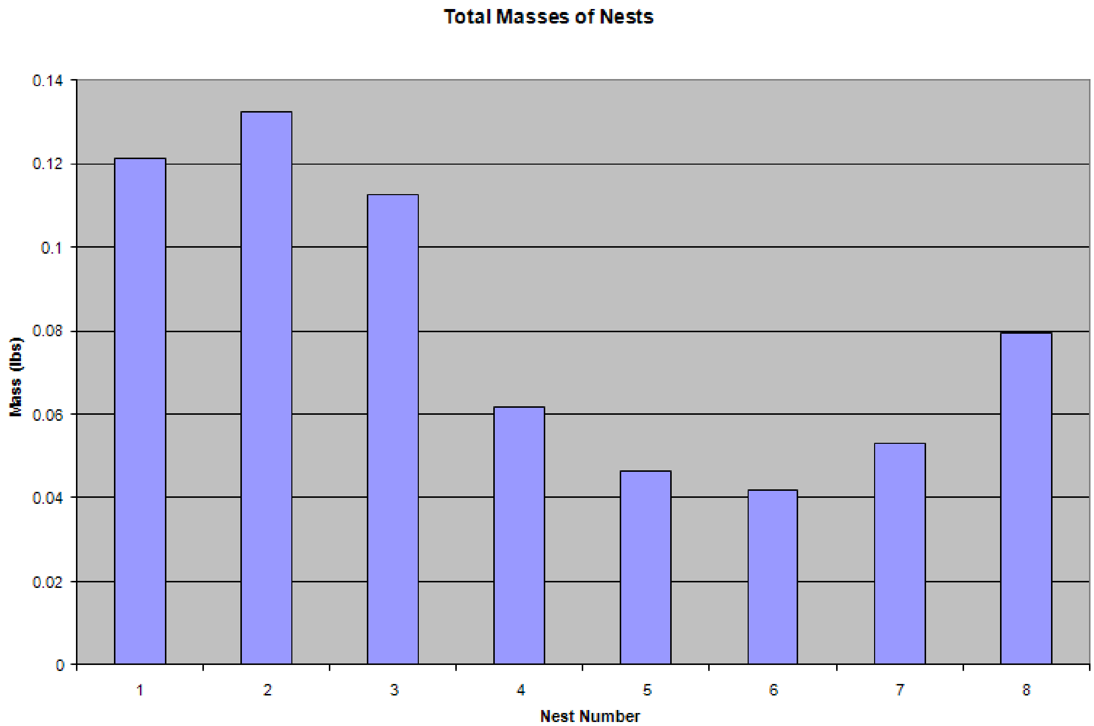


Figure 2

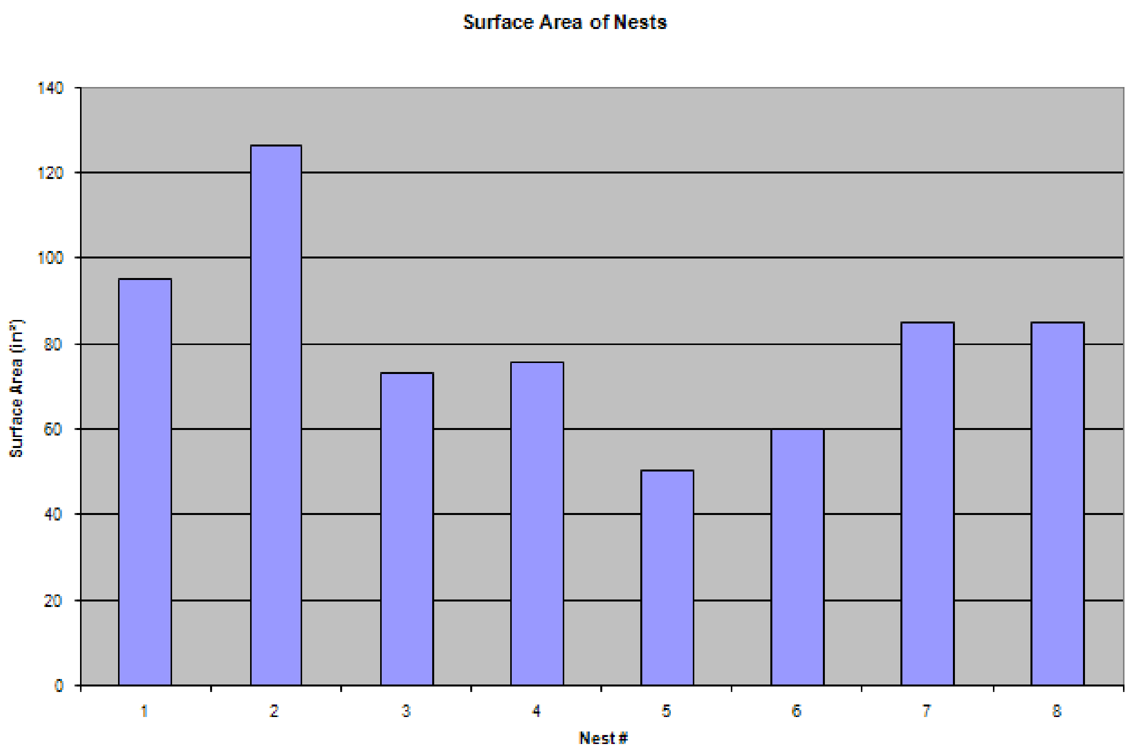


Figure 3

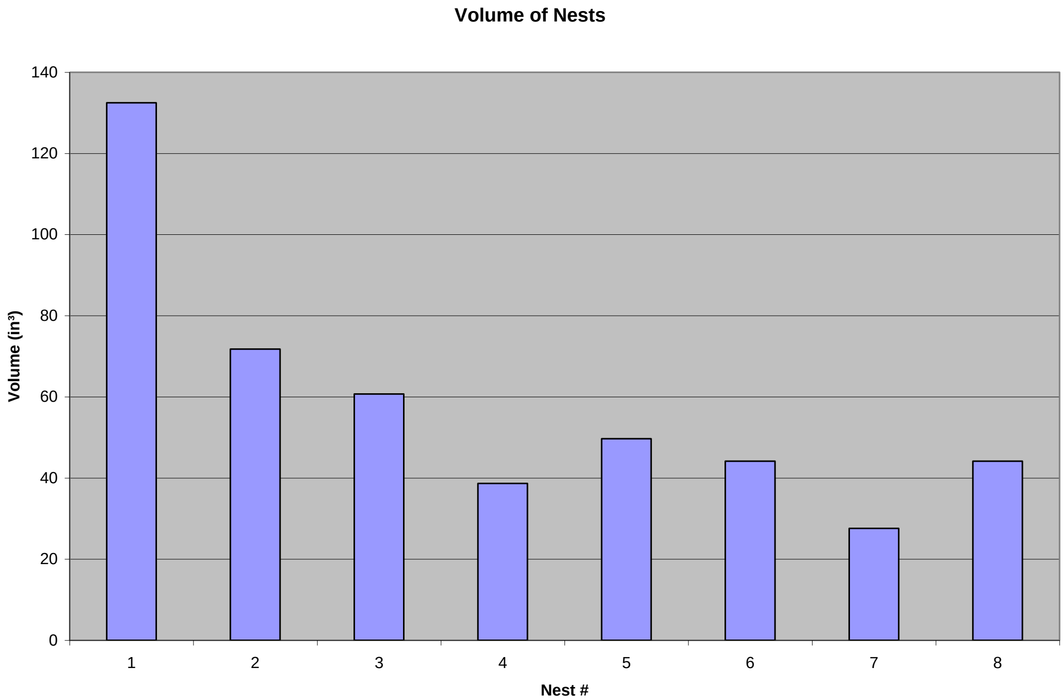


Figure 4

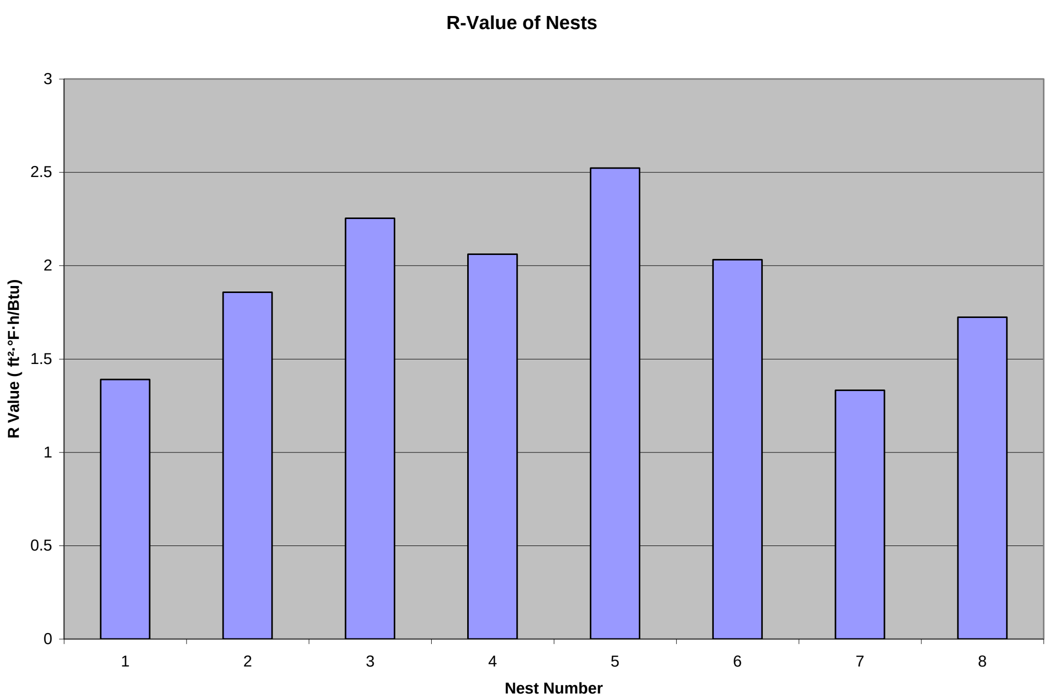


Chart 1

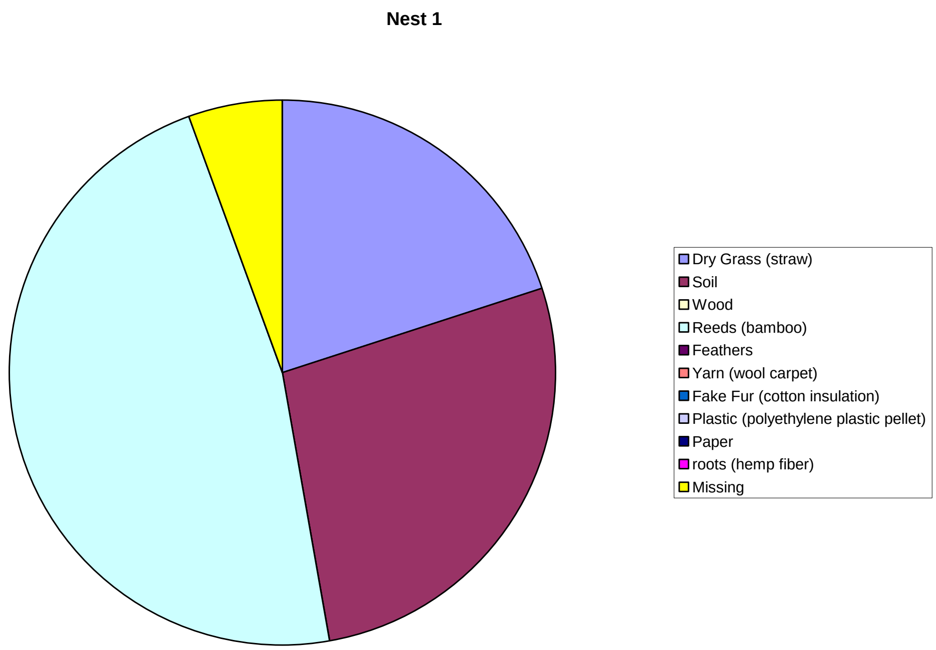


Chart 2

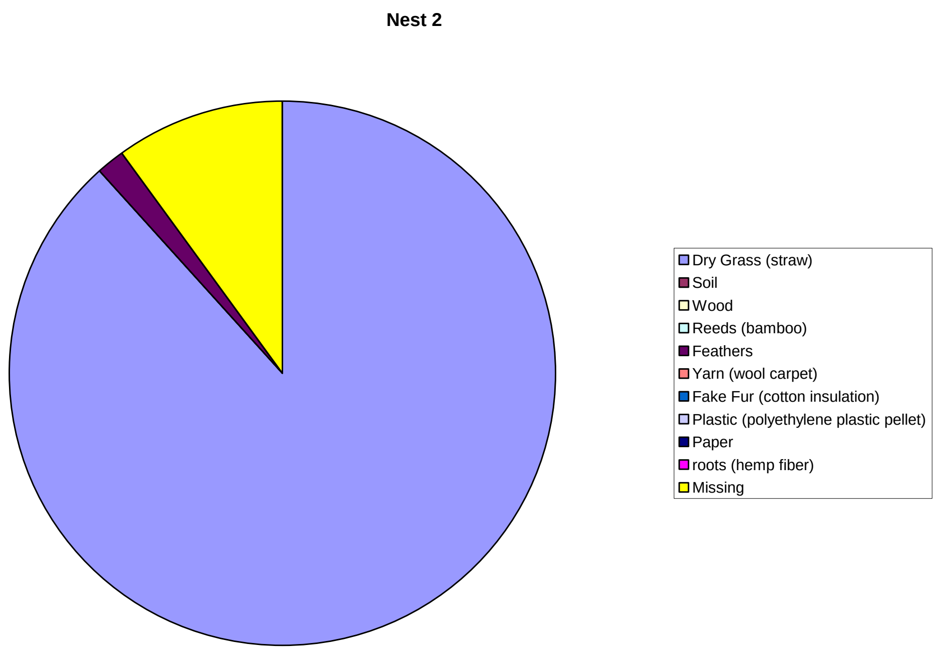


Chart 3

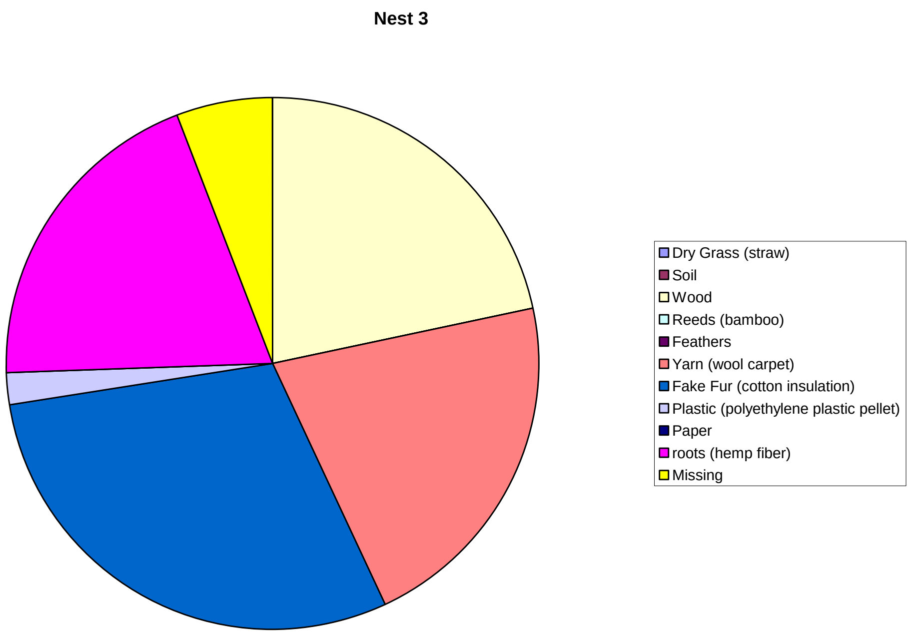


Chart 4

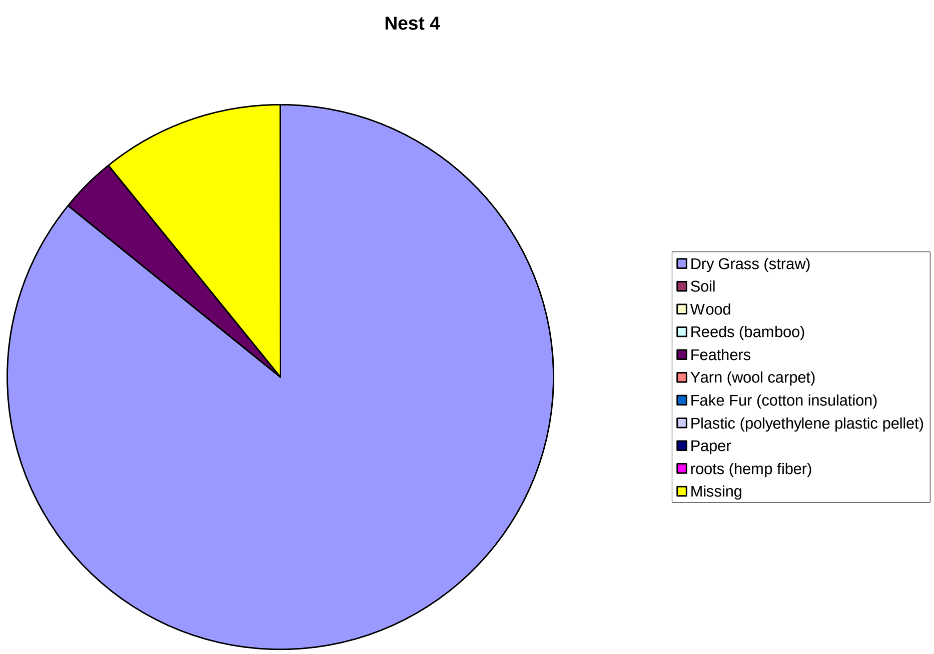


Chart 5

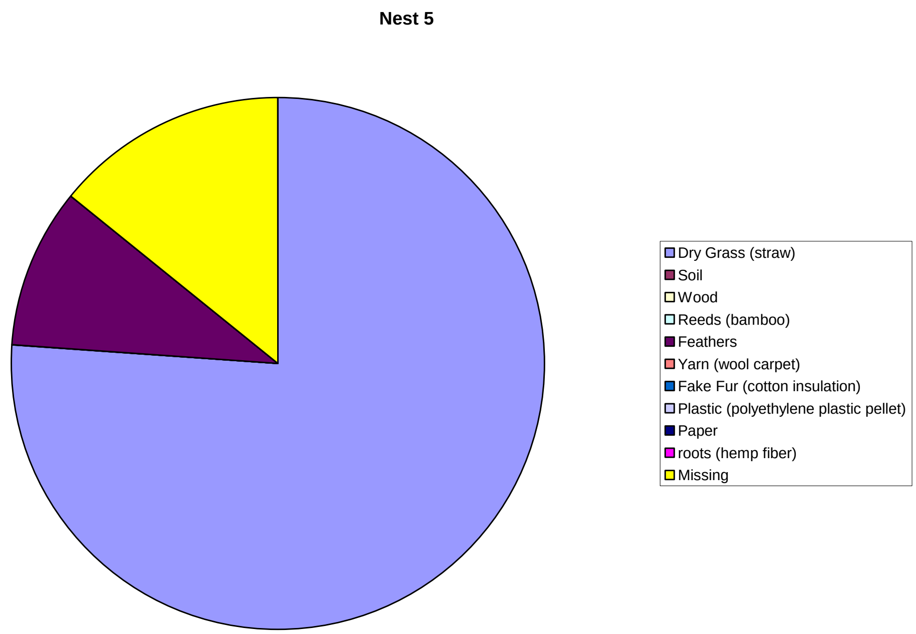


Chart 6

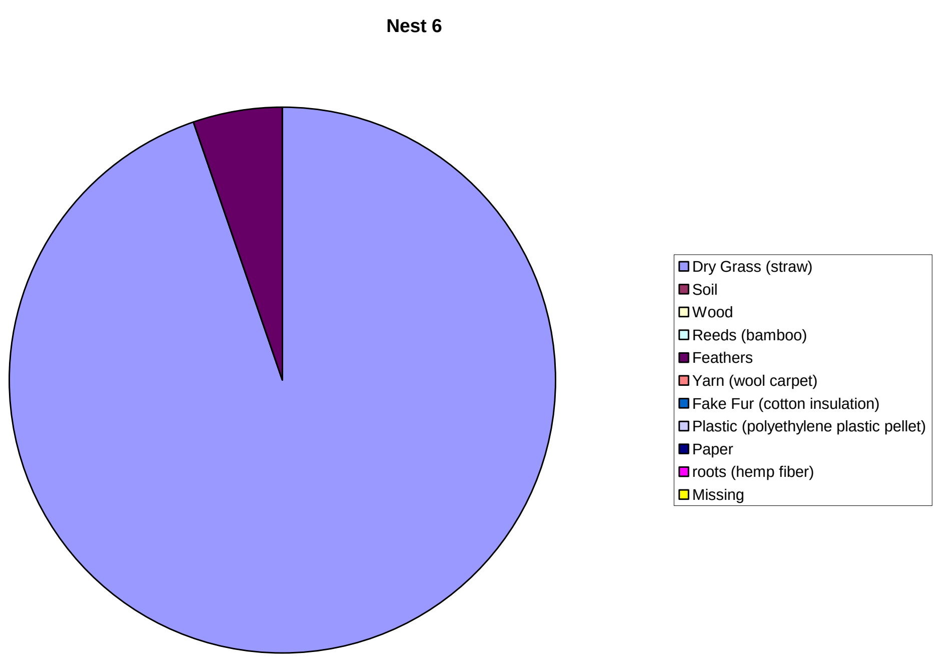


Chart 7

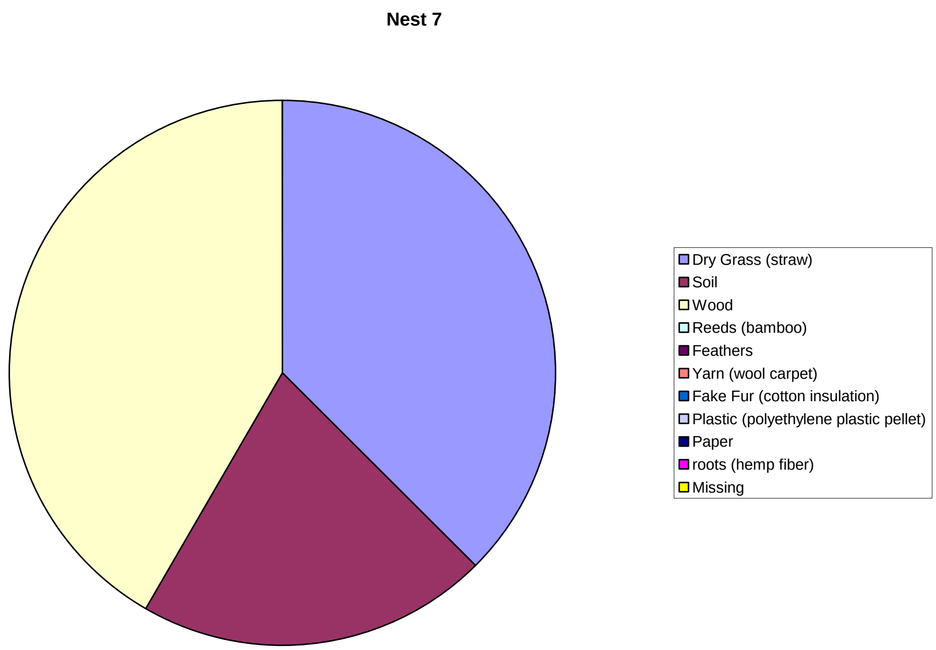
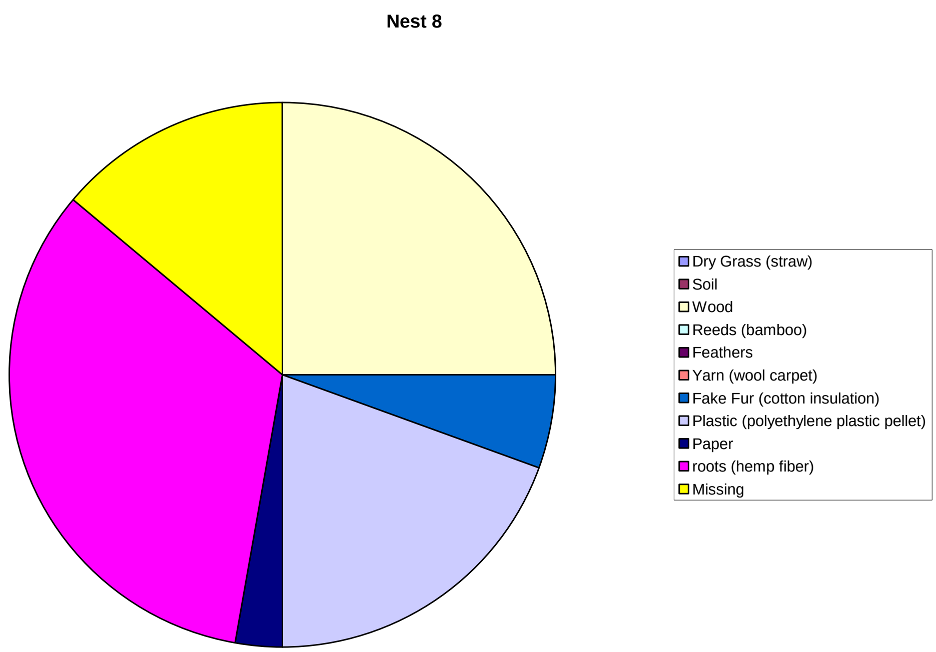


Chart 8



8. Discussion

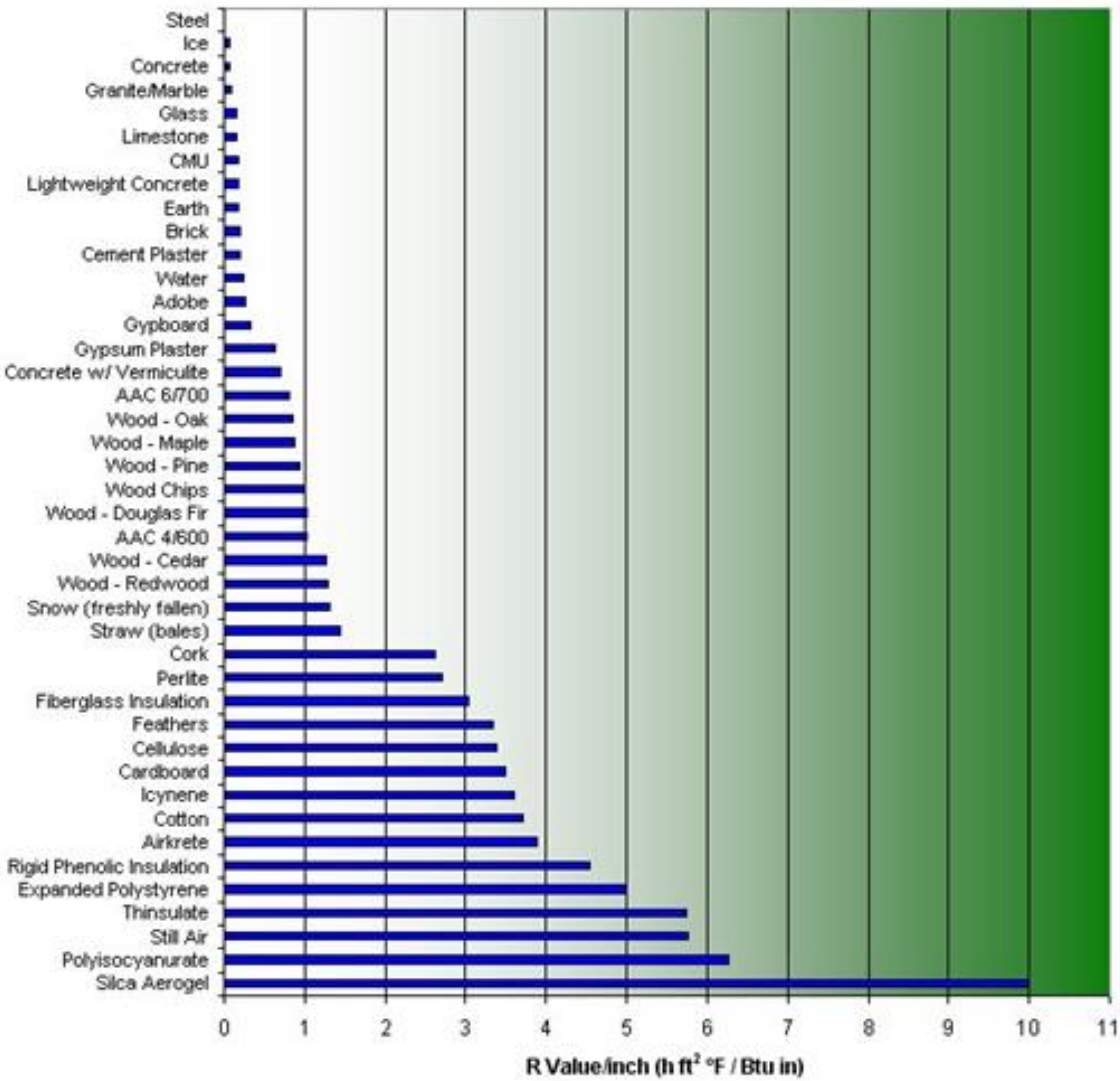
These results show no correlation between the building site of the nest and the nest's insulative properties. The r-value per inch of the nests demonstrated no trends of higher insulative value for the nests constructed outside or in nest boxes. As the most insulative nest, Nest 5, had an r-value comparable to that of fiberglass insulation, that combination of materials is applicable for use in building insulation. The results also show that mass had no correlation with the nest's insulative value as Nest 2, the nest that weighed the most, had an r-value of only 1.85 and the nest that weighed the least, Nest 6, had an r-value of 2.03. The total volume of the nest had little correlation with the r-value of the nest in that nests with the smallest volumes did not necessarily have the highest r-values. This is best demonstrated by Nest 7, the nest with the smallest volume and the smallest r-value and Nest 1 which had the largest volume and second smallest r-value. The nest composition that was the most insulative included copious amounts of feathers, as they yielded the highest r-value per inch of all of the nesting materials in question. As the r-value of the nest increases as surface area decreases, nests containing large amounts of sticks and reeds (which add greatly to the surface area of the nests) had the lowest r-values of all of the nests (see Figure 5 and Charts 1 and 7). Nests containing yarn and fake fur (resembling fiberglass insulation) demonstrate a higher r-value amount than nests without these materials.

9. Conclusion

The results only partially supported the hypothesis. Of the two nests that contained garbage, only one demonstrated a higher r-value than most of the nests that were analyzed. The r-value per inch of the most insulative nest was less than the r-value of fiberglass (3.04).(1) Only half of the nests were composed mostly of grass and mud. Chart 1 illustrates a nest with the largest volume and demonstrates that a composition of mostly reeds leads to a small r value. Chart 2 illustrates a nest with the largest total mass but an r-value of only 1.85 as it also had the largest surface area and thereby lost lots of heat. Chart 3 illustrates a nest that had the second highest r-value, in part because it was composed mostly of feathers nests because of its composition, but its surface area was higher in proportion to the nest's mass than that of other nests. Chart 4 illustrates a nest that had the third highest r-value because it was composed mostly of dried grass and, like Nest 3, had a small surface area and moderately large mass in comparison to other nests. Chart 5 illustrates the most insulative nest. It was the most insulative because of its high content of feathers and its very low surface area. Chart 6 illustrates a nest composed entirely of feathers and dried grass. This nest had a moderately high r-value in comparison to other nests because of its composition, but its surface area was higher in proportion to the nest's mass than that of other nests. Chart 7 illustrates a nest that has fairly balanced composition of wood, dry grass, and soil. Its low volume and high surface area caused the nest to have the lowest r-value of all of the nests. Chart 8 illustrates a nest that included some human garbage and fake insulation. Although its mass was greater than that of most other nests, its surface area was high and its volume was low in comparison. Therefore, its r-value was lesser than more than half of the other nests. Future research on this topic might include increasing the r-value per inch of the nest materials above the r-value of fiberglass, making the nest materials more suitable for architectural insulation in buildings, and examining the nest insulations of birds that live in colder environments.

10. Addendum

(1) http://thinkorthwim.com/wp-content/uploads/2008/02/rvalues.jpg



Other r-values

http://www.carpet-rug.org/pdf_word_docs/UnderstandingRvalues.pdf wool carpet r value (2.19)

http://files.buildsite.com/dbderived-f/teragren/derived_files/derived382071.pdf Bamboo r value (.96)

http://edis.ifas.ufl.edu/aa212 polyethylene film r value (.85)

http://www.uoregon.edu/~hof/W09HOF/SM20RValue_poster.pdf Building paper (.06)

Densities

White pine 22 – 31 lb/ft^3 http://www.engineeringtoolbox.com/wood-density-d_40.html

Bamboo 19 – 25 lb/ft^3 http://www.engineeringtoolbox.com/wood-density-d_40.html

Wool 82 lb/ft^3 http://www.rfcafe.com/references/general/density-building-materials.htm

Cotton Insulation .25-10 lb/ft^3 http://www.inspectapedia.com/interiors/Insulation-Values-Table.htm

Cotton, flax, hemp 92.4 lb/ft^3 http://www.watlow.com/reference/files/nonmetallic.pdf

Straw Bales- www.grisb.org/publications/pub21.doc

Polyethylene Pellet, Paper, Goose Feathers- http://www.engineeringtoolbox.com/density-materials-d_1652.html

11. References

[1] Holcomb, Larry C.; Twiest, Gilbert. *Ecological Factors Affecting Nest Building in Red-Winged Blackbirds*, 1968, Bird-Banding. Vol. 39, No. 1, Pgs 14-22

[2] Caccamise, Donald F., *Breeding Success and Nest Site Characteristics of the Red-Winged Blackbird*, 1977, The Wilson Bulletin Vol. 89, No. 3, Pgs. 396-403

[3] Lombardo, Michael P.; Bosman, Ruth M.; Faro, Christine A.; Houtteman, Stephen G.; Kluisza, Timothy S., *Effect of Feathers as Nest Insulation on Incubation Behavior and Reproductive Performance of Tree Swallows (Tachycineta bicolor)*, 1995

[4] Winkler, David W. *Use and Importance of Feathers as Nest Lining in Tree Swallows (Tachycineta bicolor)*, 1993, The Auk, Vol. 110, No. 1, Pgs. 29-36

[5] Breitwisch, Randall; Gottlieb, Natasha; Zaias, Julia, *Behavioral Differences in Nest Visits between Male and Female Northern Mockingbirds*, 1989, The Auk, Vol. 106, No. 4, Pgs. 659-665

[6] Skowron, Carol; Kern, Michael, *The Insulation in Nests of Selected North American Songbirds*, 1980, The Auk, Vol. 97, No. 4, Pgs. 816-824

[7] Peek, Frank W.; Franks, Edwin; Case, Dennis, *Recognition of Nest, Eggs, Nest Site, and Young in Female Red-Winged* Blackbirds, 1972, The Wilson Bulletin, Vol. 84, No. 3, Pgs. 243-249

[8] Goddard, Stephen V.; Board, Veryl V., *Reproductive Success of Red-Winged Blackbirds in North Central* Oklahoma, 1967, The Wilson Bulletin, Vol. 79, No. 3 Pgs. 283-289

[9] Holcomb, Larry C., *Red-Winged Blackbird Nestling Development*, 1966, The Wilson Bulletin, Vol. 78, No. 3, Pgs. 283-288

[10] Albers, Peter H., *Habitat Selection by Breeding Red-Winged Blackbirds*, 1978, The Wilson Bulletin, Vol. 90, No. 4, Pgs. 619-634

[11] Visscher, J. Paul, *Notes on the Nesting Habits and Songs of the Mockingbird*, 1928, The Wilson Bulletin, Vol. 40, No. 4, Pgs. 209-216

[12] Li, Pingjun; Martin, Thomas E., *Nest-Site Selection and Nesting Success of Cavity-Nesting Birds in High Elevation Forest Drainages*, 1991,The Auk, Vol. 108, No. 2, Pgs. 405-418
[13] Ramsay, Scott M. et al., *Nest-site Selection by Female Black-Capped Chickadees: Settlement Based on Conspecific Attraction?*, 1999, The Auk, Volume 116, No. 3, Pgs 604-617
[14] Wilson, Stephen W. *Food Size, Food Type, and Foraging Sites of Red-Winged Blackbirds*, 1978, The Wilson Bulletin, Vol. 90, No. 4, Pgs. 511-520
[15] Pinkowski, Benedict C., *Feeding of Nestling and Fledgling Eastern Bluebirds*, 1978, The Wilson Bulletin, Vol. 90, No. 1, pp. 84-98