Red Hot Turf

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Red Hot Turf!

Does the heat from the artificial turf affect the number of bacteria in the surrounding soil?

Understanding the definition of ecology provides knowledge on why the study of soil is so essential. “Ecology is the scientific study of interactions of organisms with one another and with the physical and chemical environment.” (What is Ecology?)

The existence of bacteria in the soil is important to the earth. Although bacteria can have a negative effect on some organisms, bacteria can also be beneficial. One of bacteria's most important jobs is to break down and decompose dead organisms. If decomposition did not take place, the earth’s surface would be clustered with dead organisms, thus harming the environment and living organisms in the environment. During the process of decomposition, bacteria allow nutrients to seep into the soil. Having nutrients in the soil provides a more sustainable environment for trees and plants to grow, which ultimately helps the ecosystem function properly and efficiently. Bacteria population is by the millions and it is usually difficult to kill off an entire population.*"Some years ago, scientists blocked off a small section of forest soil in New York state and removed the top layer of earth to a depth of one inch. In all, there was an average of 1,356 living creatures present in each square foot...Had an estimate been made of the microscopic population, it might have ranged up to 2 billion bacteria and many millions of fungi, protozoa and algae - in a mere teaspoonful of soil."* (Forestry, 2009) Bacteria are extremely important to the soil because not only does it keep the surface of the earth balanced, but it also makes a way for the soil to get the nutrients it needs.

Temperature effects the growth and population of bacteria. Some bacteria grow best in warm areas, but can also grow in cooler areas. For example, thermophilic bacteria are bacteria that grow in extreme heat such as deep, undersea volcanoes, while mesophilic bacteria grow in cases of extreme cold such as an iceberg in Antarctica. "Bacteria isolated from soil and plants often grow best at 20 to 30 degrees Celsius. Bacteria isolated from hot rotting grass or hay is often thermophilic and grows best at 45 degrees Celsius, 55 degrees Celsius, or 65 degrees Celsius." (Harold Eddleman, 1998)

Finding if there is a temperature difference in our plots will help us to find the first part of our hypothesis: heat radiation from the turf will negatively affect the bacteria population in the surrounding soil. We wanted to find out if the temperature affects the number of bacteria in the soil at different distances from the turf field. We think that the high heat radiation temperatures from the turf will negatively affect the number of bacteria in each plot, depending on different distances the plots are from the turf.

Turf is a synthetic material that can be substituted for grass. Turf is most often found at schools and stadiums on sports fields, but can also be used for yards, landscaping, and air-landing mats at large airports (FieldTurf, n.d.). The turf that is being tested in this experiment, is a multi-sport turf made by FieldTurf. It was installed approximately two years ago at Roland Park Country School, an all girl’s school located in Baltimore, MD. This turf contains silica sand and cryogenic rubber as its infill. The infill provides safety, durability, and longevity to the field. The green fiber bits or the “grass” of the turf field are sewn to a polypropylene fabric to increase durability, drainage, and stability. (FieldTurf, n.d.). Since turf contains black rubber infill, the temperature of the turf is normally higher by about 2 degrees Celsius. (FieldTurf, n.d.) Because black rubber is used as the turf's infill, the temperature of the air directly above the turf is usually about 2 degrees Celsius warmer than surrounding air. This rise in temperature occurs because of two reasons. The rubber used in the turf is black. Black as a dark color attracts more sunlight than a lighter color such as yellow would, causing the turf to hold more heat. Another reason a rise in temperature occurs is because rubber, being a conductor, attracts heat from the sun. Conductors pass heat quickly through the rubber, then releasing the heat back into the atmosphere, creating a cloud of heat over the turf (FieldTurf). The turf is warmer than natural grass because the turf does not have water running through it unlike natural grass. According to a study conducted at Brigham Young University, an extreme temperature that has been read off of a FieldTurf soccer field states that the temperature was 47 degrees Celsius, and 2 inches below the turf in the soil the temperature read 35 degrees Celsius. On grass the surface of the bare soil, the temperature was 37 degrees Celsius. Two inches deep into the soil, the temperature was marked as 32 degrees Celsius (Pulley, 2002). The temperatures of the turf may have drastic peaks, but it cannot harm humans if it is watered and cooled, though it does not happen at Roland Park Country School (FieldTurf, n.d.). Although these increased temperatures in air while on the turf field may be uncomfortable, the heat does not impose negative health effects on an athlete, or anybody else using the turf field. This difference in temperature of about 10 degrees Celsius at Brigham Young University compares to our experiment of 1.84 degrees Celsius at RPCS. This is not a direct comparison because they conducted this experiment in the summer and we conducted ours in the spring. Also, they took the surface temperature of the turf and the soil temperature right beneath the turf, while we took the temperature of the soil at different distances from the edge of the turf.

The materials in turf itself are less harmful to the environment, because they are made out of 100% recycled and lead free materials. Installers of the turf ensure that they are also energy efficient both during manufacturing and installation of the turf (FieldTurf, n.d.). Installing turf produces no negative impact, nor does it impose any negative effects on air or water during installation or while its being used. Yet another benefit of a synthetic turf field is that the turf surface itself cannot provide a livable environment for harmful bacteria such the MRSA (Methicillin-Resistant Staphylococcus Aureus)/Staph bacteria (FieldTurf, n.d.). Staph can harm humans but is also beneficial to the surrounding soil. It is also a benefit that the turf cannot house Staph, therefore creating less of a chance for a human who uses a turf field rather than real grass to get sick from the bacteria. Pesticides, fertilizers, herbicides, fungicides, and water are not necessary to apply on a FieldTurf field, although FieldTurf can be watered to decrease turf temperature. The temperature on the turf can be hot, but it is not lethal to humans and can often reach a much cooler temperature after waiting 5-10 minutes post watering the turf (FieldTurf, n.d.).

Bacteria play a huge role in the study of ecology. Without bacteria, there would be no decomposition, depriving the soil of nutrients.. Synthetic turf also provides a benefit to life because it does not house harmful bacteria which can harm organisms that live around it. The study of bacteria and turf provides scientists with a better understanding of the earth, making the ecosystem and life overall healthier.

I. Introduction and Problem:

a. Does the distance from the heat radiation off of the turf affect the population of bacteria on surrounding grassy areas

II. Hypothesis:

a. The heat that radiates off the turf field will negatively affect the population of bacteria because the heat makes the bacteria in the surrounding area unable to live.

III. Procedure:

A. Independent Variable

1. Distance from turf

B. Dependent Variable

1. Population of bacteria

C. Negative Control

1. Location with the least number of bacteria

D. List of Controlled Variables

1. Location
2. Time of day
3. Number of plots
4. FieldTurf Multi sport turf

E. Step-by-Step Instructions:

1. Stake out the plots that you would like to research
2. Take the temperature of each plot
3. Record the temperature

4. Average the 10 temperatures together per plot

5. Dig down 15 cm using the soil extractor

6. Take 3 samples for each plot

7. Mix the samples for each plot into the one labeled Ziploc bag

8. There should be 9 bags total

9. You should have made 27 holes with the area that you have mapped out

10. Test for bacteria using the Serial Solutions for Bacteria

11. Use a clean new transfer pipette to add 10 mL to a 15mL culture tube. Label the tube "10^{0}"

12. Use the same pipette to add 9 mL to a second 15 mL culture tube. Label the tube "10^{-1}"

13. Repeat step 2 for all the other 8 plots and label them $10^{-2,}$ 10^{-3} respectively

14. Place 1 cc of your soil sample into the 10^{0} culture tube

15. Cap the tube and shake vigorously

16. Using a clean pipette, remove 1 mL of the soil/water mixture from the 10^{0} and place it in the 10^{-1} tube

17. Cap and shake vigorously

18. Using the same pipette from step 16 remove 1 mL of the soil/water mixture from the 10^{-1} and place it in the 10^{-2} RESPECTIVELY so that you have a TOTAL of 4 culture tubes for EACH PLOT

19. Plate 100 uL samples from all the culture caps and put them on a petri film together to see which sample will give you the best data

20. Plate 100 uL samples from the 10^{-2} and 10^{-3} onto their own separate labeled petri film that contain nutrient agar - ONLY if these samples work the best, but substitute 10^{-2} and 10^{-3} with the other ones that are best RESPECTIVELY

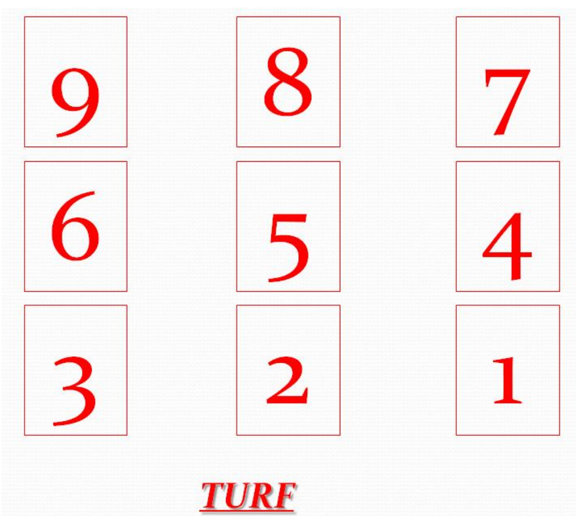
21. Allow to grow for 48 hours for each of the 9 plots

22. Examine the plates for each individual bacteria colonies and chose the one with the fewest colonies to estimate the number of bacterial in the original 1 cc soil sample

23. Number of Microbes in 1 cc of soil = number of colonies on sheet X 100 X $10^{|\text{dilution number at which these colonies were found}|}$

24. If there are not individual colonies but sill a lawn/grouping 10^{-4} dilution repeat step 2 until individual colonies are observed

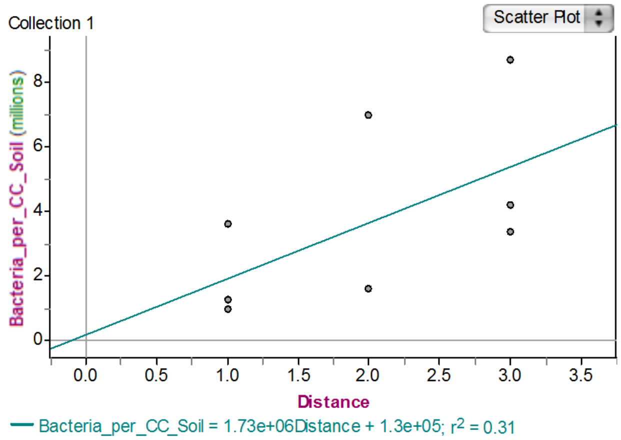
IV. Data Table



Plot Diagram

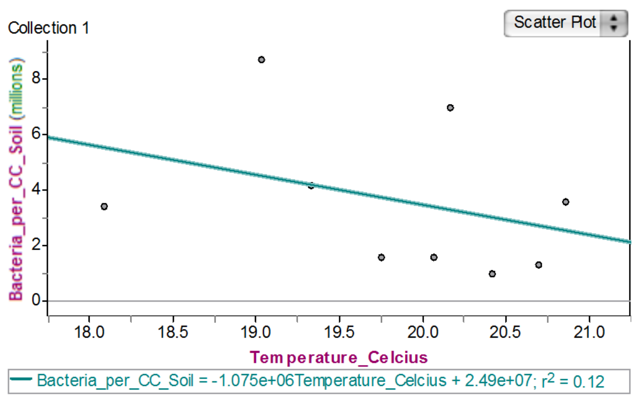
Plot	**Distance from Turf in meters**	**Bacteria per 1 CC of soil in millions**	**Temperature in Celsius**
1	0	1.3	20.70
2	0	1	20.42
3	0	3.6	20.86
Average at 0 meters from turf	0	2.067	20.66
4	1	1.6	20.07
5	1	7	20.17
6	1	1.6	19.75
Average at 1 meter from turf	1	3.4	19.9967
7	2	3.4	18.09
8	2	8.7	19.03
9	2	4.2	19.33
Average at 2 meters from turf	2	5.433	18.8167

V. Graph or Summary of Analysis



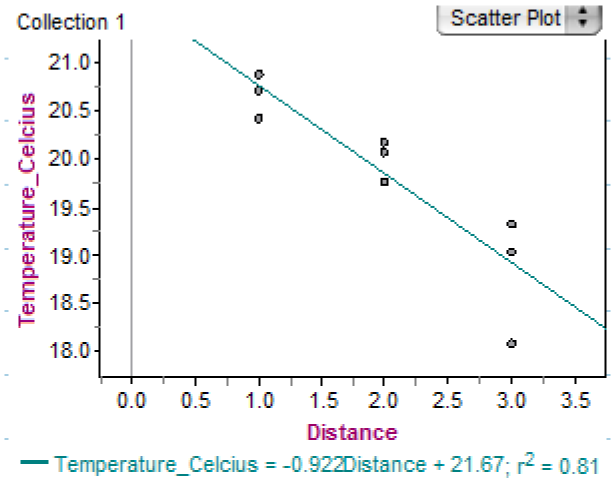
Graph 1

This graph shows that as the distance from the turf increases, the number of bacteria also increases. This is 31% accurate.



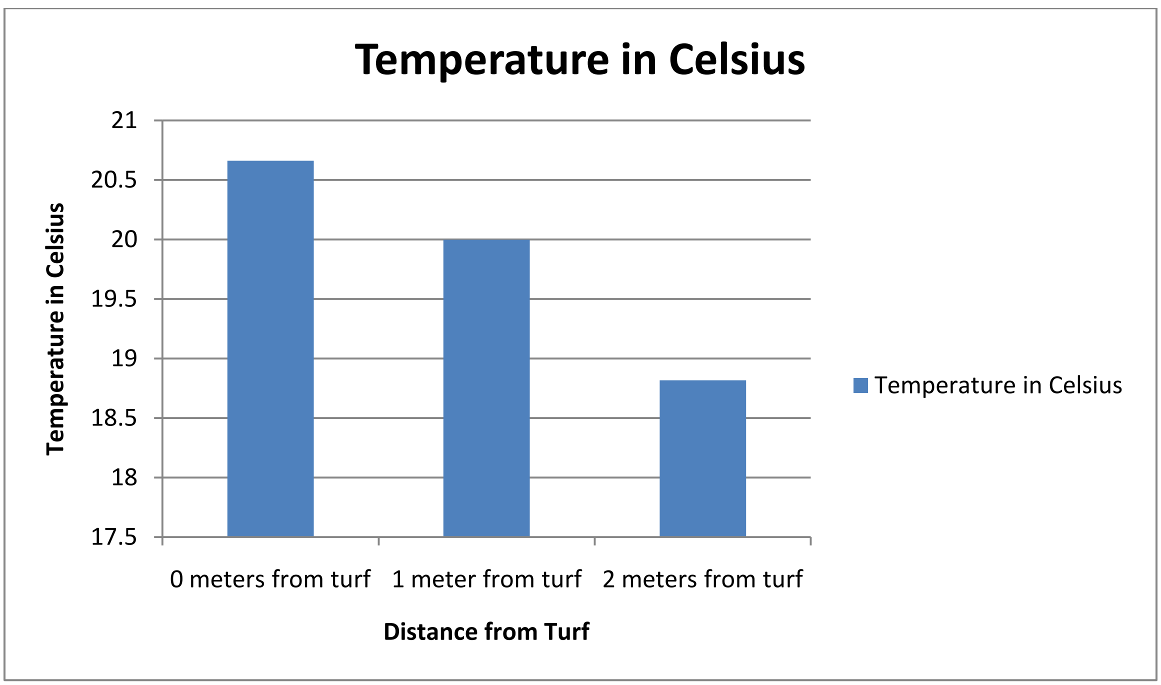
Graph 2

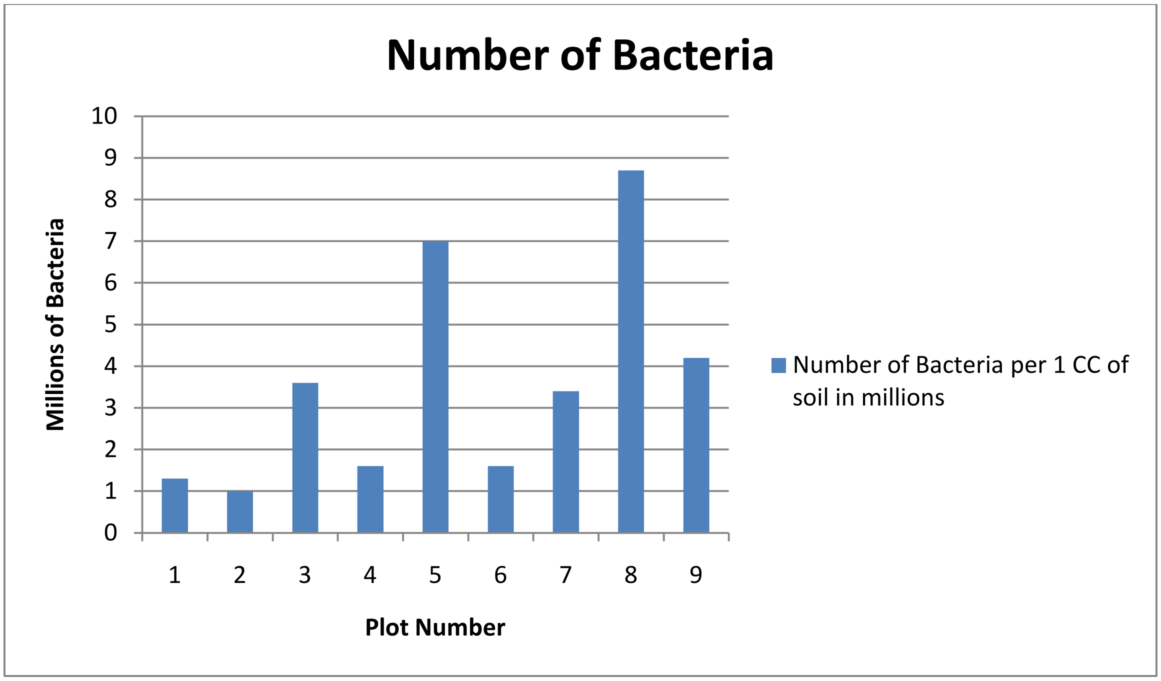
This graph shows that as the temperature increases, the number of bacteria decrease. This is 12% accurate.



Graph 3

This graph shows that as the distance from the edge of the turf increases, the temperature decreases. This is 81% accurate.





VI. Conclusion

Our hypothesis was supported through the evidence that proved the bacteria population went down as temperature increased. We found that the further away from the turf field, the more the temperature decreased. In our hypothesis we stated that the turf field would radiate more heat. We thought this because of the rubber pieces found in the turf field would help conduct heat and make the surrounding soil hotter. Too much heat could kill the bacteria and not enough heat could also kill the bacteria. Bacteria are affected by too much heat, or a warm temperature of 20 C. This could mean that the heat killed the bacteria closer to the field because it was too hot for the bacteria to withstand the heat. This would then affect the bacteria in a way such though their population numbers increase as the distances from the field increases. Although these results supported our hypothesis, the information we concluded is not very accurate and should be redone with more samples to get better end results due to the 12%

(Bacteria/Temperature), 31% (Bacteria count/Distance), and 81% (Temperature/Distance) accuracy.

If we did this experiment another in the future, there should be more samples, more distances from the turf , different locations near the turf (behind goal, corners, sideline), turf that has been installed years ago to see how the bacteria have adapted, and different climates, time of year, and time of day. Our data supported our hypothesis and proved that the temperature from the turf affects the bacteria at different distances from the turf, but further research could prove our hypothesis wrong.

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