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Determining the Effect of High Voltage Power Lines on the Magnetoreception of Grazing Animals

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Table of Contents

Abstract

Magnetoreception is a widespread sensory ability that is used by many animals to determine location and for navigation, and has recently been reported in grazing animals. In this study, the orientation of individual animals were studied in herds of grazing animals using images from Google Earth. It was hypothesized that if high voltage power lines are located near herds of grazing animals, then their ability to sense magnetic North will be adversely affected. To test this hypothesis Google Earth, PowerPoint, Excel,and a protractor were used. First, 10 pastures were selected, 5 having close proximity to power lines, and 5 without proximity to power lines. Thereafter, the pastures were examined and compared to the orientation of the grazing animals to magnetic north. If magnetoreception was present, a higher percentage of animals were expected to be between 0 and 45 degrees of magnetic north, and fewer animals to be between 45 and 90 degrees. After the experiment was carried out to completion, the data showed that in pastures close to power lines, 65% of grazing animals that were oriented between 45-90 degrees and 35% situated between 0-44 degrees. In pastures without proximity to power lines, 37.75% of grazing animals were situated between 45-90 degrees and 62.5% situated between 0-44 degrees. The experimental results therefore, support my hypothesis that power lines adversely affect the magnetoreception of grazing animals. Using the Unpaired t test, the two-tailed P value equals 0.0161, which is considered to be statistically significant.

Introduction

Our senses provide us with information about our environment. They help us find food and shelter, and to avoid danger. Magnetoreception is the ability to detect a magnetic field to perceive direction, altitude, or location. This sense is used by a surprising number of animals, including honeybees, sharks, sea turtles, rays, homing pigeons, migratory birds, tuna, and salmon. The question of whether large mammals are capable of magnetoreception has been a topic of research.

Recently, research has suggested that large mammals, such as deer and cows, do, in fact, have the ability to sense Earth's magnetic field. Dr. Sabine Begall, and colleagues in Germany and the Czech Republic, published a paper in the Proceedings of the National Academy of Sciences (PNAS), entitled "Magnetic alignment in grazing and resting cattle and deer". The authors reported results of over 8500 grazing animals and concluded that grazing animals do have magnetoreception.

If grazing animals do align themselves with the magnetic field of Earth, there may be certain geographic features that can disrupt this alignment, such as the presence of high-voltage power lines. Electric and magnetic fields occur naturally and as a result of power generation, power transmission, power distribution and use of electric power. Magnetic fields result from the motion of the electric charge or current, such as when there is a current flowing through a power line. Such factors may be detrimental to the orientation of the grazing animals to the magnetic north

Grazing animals have been reported to have magnetoreception and will align themselves with magnetic north. High voltage power lines generate a magnetic field, so the presence of high voltage power lines near pastures may interfere with magnetoreception. The purpose of this report is to determine if close proximity to power lines affects the alignment of a grazing animal to the magnetic north.

Acknowledgements

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Purpose

This study of the magnetoreception on grazing animals has been under extreme controversy for the past decade about whether or not grazing animals have magnetoreception, and the possibility of interference from power lines. This project was specifically made to test this mind blowing theory. Essentially, if a wild animal knows where it is and where it's going, its ability to survive will be improved dramatically. For example, the ability of bees to forage food and the ability of dogs to find their way home are classic examples of the positive impacts of magnetoreception. Understanding the mechanism of navigation could also help humans by providing the knowledge to develop new navigation tools. Humans have compasses and GPS, but perhaps there is something better in the future that this research will lead to.

Problem

The presence of magnetoreception has recently been reported in grazing animals such as cows based on their orientation to Earth's magnetic north. High voltage power lines emit an electromagnetic field due to the voltage being transmitted on the power lines. For this experiment, the effect of high voltage power lines on the magnetoreception of grazing animals was investigated.

Hypothesis

If high voltage power lines are located near herds of grazing animals, then their ability to sense magnetic North will be adversely affected.

Variables

1. Independent Variable: The presence of power lines.

2. Dependent Variable: The angle of alignment relative to magnetic north.

3. Control: The alignment of grazing animals in pastures without power lines.

Materials

- Computer with PowerPoint®, Excel®, and Google Earth
- Protractor
- Ruler
- Lab notebook
- Declination Calculator
- T-test Calculator

Procedure

❑ Selecting a Pasture in Google Earth

1. Install and start Google Earth on your computer.
2. Look for suitable grazing animals.
    1. Compromise between resolution and visibility of the cattle.
    2. View initially from approximately 200–600 meters (m), and later, at 80–200 m.
3. Carefully choose 5 pastures with proximity to power lines, and 5 pastures without proximity to analyze. They should *not* be:
    1. On mountain slopes, or
    2. In the immediate vicinity of human settlements.
4. Copy and paste the coordinates of the pastures into the "Fly to" box in Google Earth to see the grazing animals. The angle is given in degrees, minutes and seconds, with a space in between each number. Seconds are given to two decimal places. Latitude is north (N) or south (S) and longitude is east (E) or west (W).
5. Make sure the map has geographic north on the top (click on "N").
6. Take a screenshot of the grazing cattle.
    1. Look at your computer manual for how to take a screenshot.
    2. Make sure you are in full-screen mode.
    3. If a pasture has to be broken up into several PowerPoint slides, label the slides appropriately.
7. Paste the screenshot into PowerPoint, or a similar program.
    1. Note the latitude and longitude in the lower left corner.
    2. **Finding Magnetic North**
    1. Go to the Magnetic Declination Calculator at http://www.ngdc.noaa.gov/geomag-web/.
    2. Enter latitude, longitude, and date. For the model, use IGRF 11.
    3. Click on "Calculate."
    4. Record the declination output in your lab notebook.
    5. Draw a line that shows magnetic north on the PowerPoint image of the pasture.
    6. The next step will be to determine the angle between magnetic north, which you just drew on the image, and the axis of each animal in the image.

❑ Evaluating Body Direction

1. Draw a straight line through the long axis of each cow's body.
    a. Cows in water or on trails should not be evaluated.
    b. Calves should not be evaluated.
2. Number each axis that you use on the PowerPoint image.
3. Use the protractor to determine the angle of the cow's body relative to magnetic north.
    a. Since you are not recording which way the animal is facing (since you may not

be able to distinguish head from tail), do not use a full circle of 360 degrees.

4. Use -90 degrees for west, 0 degrees for north, and +90 degrees for east.
    a. A value of +7, for example, would represent an axis slightly to the right of magnetic north.
5. In your lab notebook, record the angular values you found for each pasture (also record the latitude, longitude, and country) in a data table (one column per pasture).

6. **Analyzing the Data**

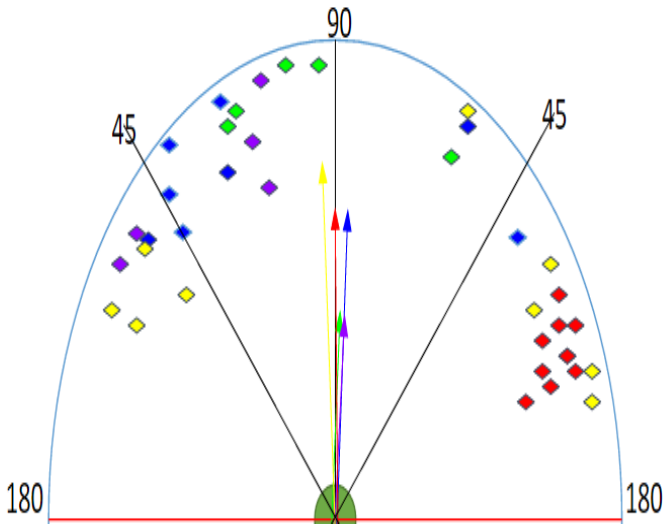
1. Graph the angular values on a half circle, with one point for every animal.
2. Make sure to have the 2 comparisons (with and without power lines) data separated.
3. Is there a clear trend for the animals to align themselves with the magnetic field of Earth?
4. If so, how does the power lines affect the alignment of the animals?

Circular Statistics

Key

Yellow - Nashville, TN
Purple - Purcell, OK
Green - Oklahoma
Red - Franklin, TN
Blue- Wayne Tx

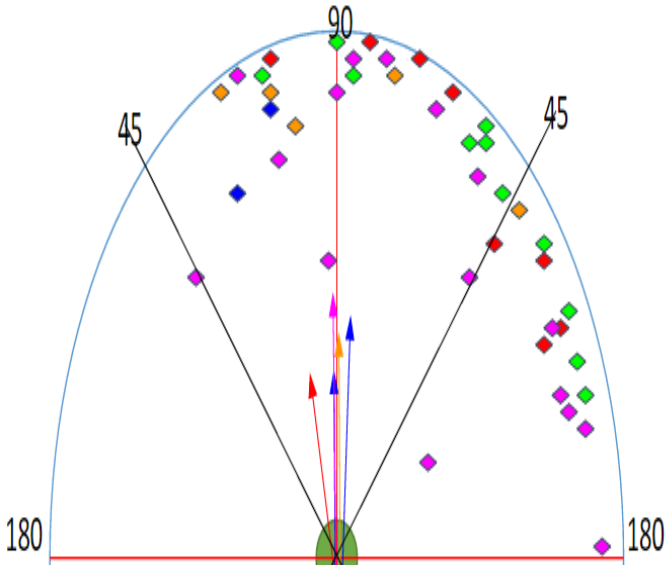
With Power Lines



Key

Pink - Texas
Orange - Germany1
Blue - France1
Red - New York
Green - France2

Without Power Lines



Data Tables

France 1 Without	**Grazing Animal 1**	**Grazing Animal 2**
Angular Values	-30° West	-16° West

France 3 Without	**A1**	**A2**	**A 3**	**A 4**	**A 5**	**A 6**	**A 7**	**A 8**	**A 9**	**A 10**	**A11**
Angular Values	54° E	35° E	36° E	34° E	0°	-19° W	41° E	69° E	74° E	63° E	3° E

Germany Without	**Grazing Animal 1**	**Grazing Animal 2**	**Grazing Animal 3**	**Grazing Animal 4**	**Grazing Animal 5**
Angular Values	-20° West	-29° West	-15° West	47° East	15° East

New York Without	A 1	A 2	A 3	A 4	A 5	A 6	A 7	A 8
Angular Values	-16° W	55° E	26° E	19° E	45° E	-8° W	64° W	62° W

US - TX Without	A 1	A 2	A 3	A 4	A 5	A 6	A 7	A 8	A 9	A 10	A 11	A 12	A 13	A 14
Angular Values	-45° W	70° E	-16° W	74° E	77° E	45° E	90° E	63° E	25° E	10° E	-23° W	0°	-11° W	-31° W

Wayne TX With	A 1	A 2	A 3	A 4	A 5	A 6	A 7	A 8
Angular Values	-49° West	-40° West	-51° West	31° East	50° East	-45° West	-27° West	-30° West

Oklahoma With	**Grazing Animal 1**	**Grazing Animal 2**	**Grazing Animal 3**	**Grazing Animal 4**	**Grazing Animal 5**
Angular Values	-12° West	-25° West	-24° West	30° East	-5° West

Purcell With	**Grazing Animal 1**	**Grazing Animal 2**	**Grazing Animal 3**	**Grazing Animal 4**	**Grazing Animal 5**	**Grazing Animal 6**	**Grazing Animal 7**	**Grazing Animal 8**
Angular Values	-21° West	-20° West	-17° West	-57° West	-51° West	-73° West	-41° West	-50° West

Franklin TN With	**Grazing Animal 1**	**Grazing Animal 2**	**Grazing Animal 3**	**Grazing Animal 4**	**Grazing Animal 5**	**Grazing Animal 6**	**Grazing Animal 7**	**Grazing Animal 8**	**Grazing Animal 9**	**Grazing Animal 10**
Angular Values	62° East	75° East	66° East	65° East	80° East	74° East	70° East	70° East	66° East	65° East

Nashville TN With	**Grazing Animal 1**	**Grazing Animal 2**	**Grazing Animal 3**	**Grazing Animal 4**	**Grazing Animal 5**	**Grazing Animal 6**	**Grazing Animal 7**	**Grazing Animal 8**	**Grazing Animal 9**
Angular Values	-64° West	'-51° West	57° East	74° East	76° East	32° East	'-50° West	60° East	-61° West

Analysis and Discussion

The results confirm the hypothesis that if grazing animals have proximity to high voltage power lines, then their orientation with the magnetic north is altered. When the control animals are compared to the grazing animals 65% of grazing animals are situated between 45-90 degrees, and 35% situated between 0-45 degrees with power lines, on the contrary 37.75% of grazing animals were situated between 45-90 degrees, and 62.5% situated between 0-45 degrees without proximity to powerlines. It was not possible to control all of the parameters in this experiment due to Google Earth not having the exact identification of the animals. It's usually hard to when dealing with living organisms like grazing animals. If cows, horses, buffaloes, donkeys, and deer are included in the analysis, this could affect if there is a difference in the magnetoreception of different animals. In the future visits selection of pastures will be improved by looking for pastures in dairy farming centers to ensure order and classification of the animals.

Conclusion

The purpose of the experiment was to investigate the effect of high voltage power lines on the magnetoreception of grazing animals. After completing the experiment, it was shown that the data was deemed highly significant using the probability value. As the data table and circular statistic graphs show, grazing animals tend to be more aligned with the magnetic north with the absence of proximity to power lines. Grazing animals near power lines had an average of 49 degrees (65% of grazing animals were situated between 45-90 degrees, and 35% situated between 0-44 degrees), while grazing animals without proximity to power lines had an average of 37 degrees (37.75% of grazing animals were situated between 45-90 degrees, and 62.5% situated between 0-44 degrees. According to the data and results, the hypothesis was supported, i.e, If high voltage power lines are located near herds of grazing animals, then their ability to sense magnetic North will be adversely affected. This experiment relied heavily on attaining data and pasture pictures from Google Earth. Perhaps this experiment could be further improved if the uncontrolled parameters are attended to, such as the type of grazing animal chosen. Additional investigations will be conducted by taking visits to various dairy farms to ensure that there is one type of grazing animal being tested. Also, future analysis could include the comparison of the alignments with the magnetic North of cows, horses, buffaloes, donkeys, and deers and observing the variations.

Applications and Further Research

In the future, further investigations will be carried out in dairy farms throughout North Texas to abstain of the uncontrolled parameters. Gopro cameras attached to drones will be used to achieve pictures with the best resolution possible. While at the dairy farms, the orientation to the magnetic north of many animals such as cows, horses, buffaloes, donkeys, and deers will be observed. The comparisons of the independent variables will also be taken into account and their variations. Further research upon this project will be done to discover any leads to the discovery of new and improved navigation tools. Last but not least, it will be tested whether the presence of power lines affects the internal factors of the grazing animal.

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