The Effect of Temperature on Porpoise Whale Presence

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Abstract

Temperature changes have always had an affect on the migration patterns of animals throughout the world, ocean and land dwelling. This project determines the effect of temperature on the presence of porpoise whales in a particular area. If temperature affects the presence of harbour porpoise and harbour porpoise density is measured year-round along the coast of maryland, then porpoise whale density will be less at lower temperatures: 1.9°C, 3.6°C, 8°C, 13.6°C, 4.1°C; and be higher at higher temperatures: 18.8°C, 24.4°C, 27.2°C, 26.1°C, 22.2°C, 15.5°C, 10.2°C. The density of harbour porpoise whales on the coast of Maryland was collected year-round at two different sites by Duke University. Data was gathered by averaging the density for each month over a period of two years. Linear regression analysis was then used to find how much of an effect temperature had on the presence of harbour porpoise on the coast of Maryland. The linear regression analysis found that site one had a correlation coefficient of 0.6247 and site 2 had a correlation coefficient of 0.5944. This concludes that there is some correlation. The hypothesis was supported because the data shows that harbour porpoises prefer to live in warmer temperatures of water.

Introduction

The massive oceans of earth contain various species of marine life, with the exact amount unknown but estimated to be as high as 2 million, each with different behaviour (Doyle, 2015). Many sea creatures migrate through the vast oceans for many different reasons. It may be because they prefer a specific temperature or a certain species of prey.

Background Research:

In order to understand this experiment and the data collection, it is necessary to have some knowledge of certain concepts. The first concept mentioned in the experiment is migration. Migration is defined as "The seasonal movement of a complete population of animals from one area to another" ("migrate"). A whopping 80% of marine species migrate around the world. Methods of migration vary widely among species. Some species use currents and some make large circles around islands or continents to allow food to replenish (Putman, 2018). Porpoise whales currently have a very spontaneous and unsure migration, being that they usually appear in random places, but in some instances the porpoise whale location relates to the temperature in the sighting area (Koschinski, 2011). These migration patterns can be caused by many different factors, including but not limited to temperature. Some of the other factors are predator numbers, prey numbers, and human activity. Temperature caused migration is being noticed more often due to the world wide problem, global warming. "As ocean water temperatures warm, the distribution of many marine species—including those we rely on for food—will shift due to their dependence on specific water temperatures and nutrient availability" (Bradford). Mass marine migration can negatively affect those living in the area where the mass migration took place because they may be losing a food source or other factor in their ecosystem. This global warming caused migration is noticed with multiple species so far, and this experiment could demonstrate if this trend is the same with porpoise whales. This is expected to affect porpoise whales as they have a specific temperature that they find suitable to live in, that temperature being 15°C ("Harbor Porpoise").

It is also important to understand the species that is being studied. Porpoises are marine mammals, much like dolphins and whales. These creatures are quite small for mammals and are actually one of the smallest marine mammals. There are seven different kinds of porpoises known today. The one being studied in this experiment is the harbour porpoise, or the phocoena phocoena. The harbour porpoise are one of the commonly known porpoise species that often live in small pods near shore (Kennedy, 2012). A pod is a term used to define a group of porpoises ("What is a Group of Porpoises Called"). Porpoises fall into the cretecean category of marine mammals, along with whales and dolphins. The harbour porpoise is usually hard to detect because it is a shy creature that rarely breaks the surface of the ocean and, as stated earlier, travels in small pods. These petite creatures are also prone to human disturbances, such as pollution or underwater noise, due to the fact that they live so close to the shore. According to WWF nature conservation "100,000 marine mammals die every year as a result of plastic pollution. This includes whales, dolphins, porpoises, seals, and sea lions" (WWF, 2018). This data shows that ocean pollution may be a leading cause of porpoise migration along with temperature.

Another important aspect of background research is understanding the project by reviewing previous experiments completed on related topics. A study published on May 3, 2017 observed long term harbour porpoise behaviour. Of the many behaviours observed in the experiment, migration was discussed in little depth due to the lack of results. It was noticed that harbour porpoises do not have a migration cycle that is "set in stone". The experiment, however, did notice that the porpoise whales resided in different areas depending on the season. This supports the hypothesis by showing there is a correlation between porpoise migration and the temperatures in that area (Wingfield et al., 2017). Another study, that was completed by the Rutgers University, explored the effect of rising ocean temperatures on the mass migration of fish species.

The experiment was trying to discover how people who rely on these fish for food will be impacted. The results showed that fish populations in certain areas are decreasing and will continue to decrease over the next few decades.

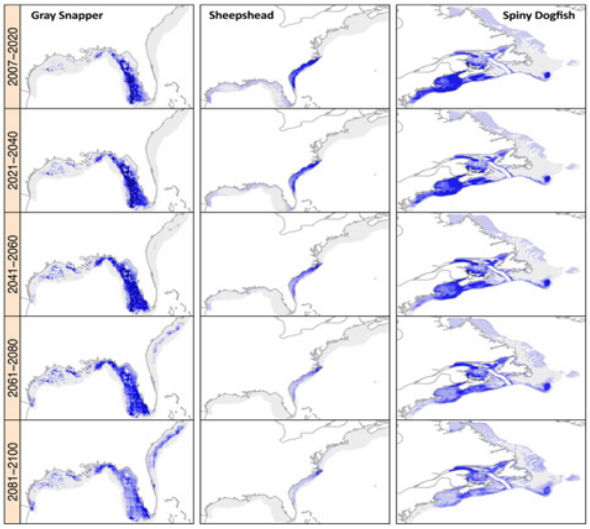

Fig. 1. Examples of east coast species projections. Credit: Morley et al (2018). (Rutgers University, 2018)

In the diagram it is noticed that over the 20 year periods the population density decreases. 2007-2020 data collection is clearly the darkest blue meaning that there are most of the specified fish present at this time. As the years continue there is less space filled with blue and the blue that is still present is very dim (Rutgers University, 2018). This data perfectly exemplifies the likely relationship between temperature and porpoise presence.

The hypothesis for the experiment follows: If temperature is related to the presence of harbour porpoise and harbour porpoise density is measured year-round along the coast of maryland, then porpoise whale density will be less at lower temperatures: 1.9C, 3.6C, 8C, 13.6C, 4.1C; and be higher at higher temperatures: 18.8C, 24.4C, 27.2C, 26.1C, 22.2C, 15.5C, 10.2C because harbour porpoise whales commonly live in warmer temperatures that are around or above 15C ("Harbor Porpoise").

Materials and Methods

Methods

To begin, this experiment was completed using data analysis. The harbor porpoise presence data that was analysed was collected from an experiment that Duke University completed.

Materials:

- Computer
- Excel downloaded on the computer (if using excel to analyze)
- Python downloaded on the computer (if using python to analyze)
- Notebook

Sample/Population:

The porpoise observed by Duke university were located off the coast of Maryland at 2 different sites. This data provided an average amount of porpoise present for each month of the year for both of the sites. Then, average monthly temperatures of Maryland were found for each month of the year. Now that the independent variable, temperature, and the dependent variable, porpoise presence, had been decided, they were put into a data table and a graph on excel. This allowed for initial patterns to be seen.

The Effect of Temperature on Whale Presence (Density)		
Average Temp Monthly (C°)	Average Porpoise Whale Density	
	Site 1	Site 2
1.9 C	0.3818213	0.2315429
3.6 C	0.3900505	0.220603
8 C	0.3598056	0.2088436
13.6 C	0.3555092	0.2086982
18.8 C	0.4167841	0.2771464
24.4 C	0.4312983	0.301522
27.2 C	0.574392	0.5197714
26.1 C	0.6273102	0.6008574
22.2 C	0.5151896	0.4514977
15.5 C	0.4265643	0.3222069
10.2 C	0.4227619	0.3584759
4.2 C	0.3657432	0.2374658

Fig. 2. The table displays the data collected from Duke University

Analysis Methods:

The data will be analyzed using linear regression analysis. Linear regression analysis is a form of data analysis that allows for one to see how strong of a relationship there is between the independent variable and the dependent variable ("What is Linear Regression"). This is completed by making a scatter plot and then placing a trendline on the scatter plot. A scatter plot is a graph that has all of the dependent variables plotted without any lines connecting them. The trendline is placed so that there is an equal amount of dots on each side of it. For example, if you collected 10 pieces of data, there would be 5 dots on each side of the line. Excel can then use this trendline to find an R-squared value. This value will be a number in between 1 and -1. The R-squared value is also called the correlation coefficient. The closer the correlation coefficient is to 1 or -1, the stronger the relationship between the independent and dependent variable is. For example, if the correlation coefficient is 0.2, then there is a weak relationship between the independent and dependent variable. This analysis can be completed using many different systems. Excel was used for this specific experiment.

Results

Data Findings:

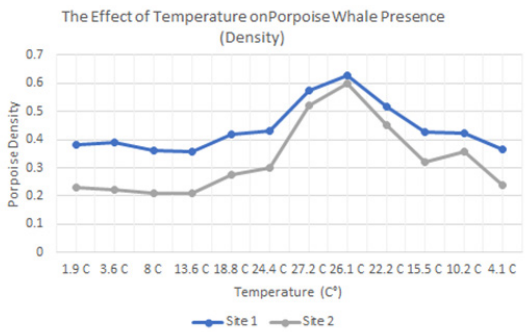

Fig. 3. The graph displays the relationship between temperature and porpoise presence at site 1 and site 2 based one the data from Duke University.

The most porpoise whales are present at the 26.1℃ level of the independent variable and the least are present in the lower temperatures such as 1.9℃, 3.6℃, 8C, and 13.6℃. Both of these trends are noticed in sites 1 and 2. Also, as there is decrease in temperature, the data showed a decrease in porpoise presence as well. The way the graph is formated allows for the relation between temperature and presence to be seen along with the year-round presence of porpoise whales. This is because each temperature corresponds to a month. The order of the temperature is matched to the order of the months from January to December (eg: 1.9℃ = January, 3.6℃ = February, 8℃ = March, etc.). Through this, it is noticeable that porpoise whales are mostly present during august.

Analysis Findings:

A scatter plot was made for sites 1 and 2 combine, site 1 alone, and site 2 alone:

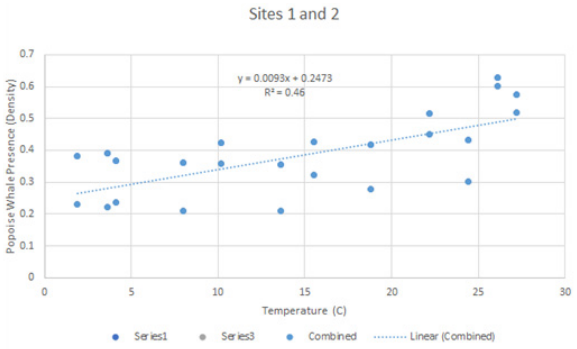

Fig. 4. The graph displays the correlation coefficient and trendline for both sites

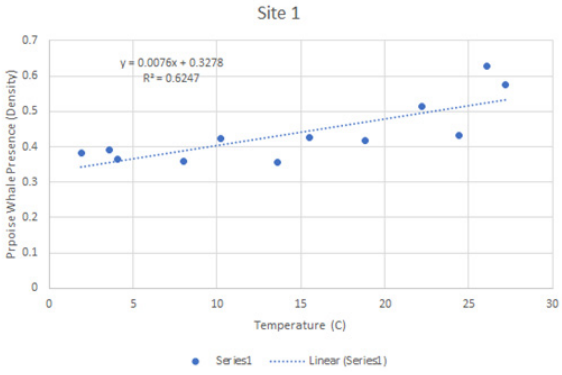

Fig. 5. The graph displays the correlation coefficient and trendline for Site 1

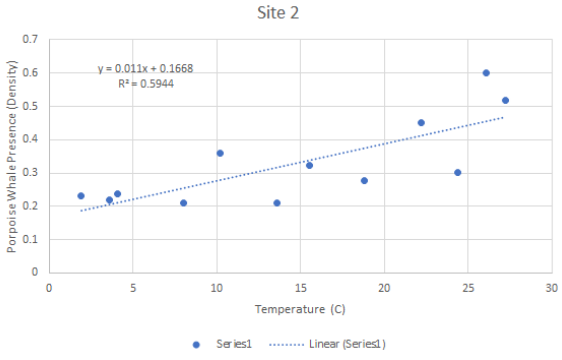

Fig. 6. The graph displays the correlation coefficient and trendline for Site 2

The correlation coefficients for each scatter plot are given below:

Site 1 and 2: 0.46
Site 1: 0.6247
Site 2: 0.5944

Discussion

Data Discussion:

The data revealed that harbor porpoise whales prefer warmer water over colder water. This is supported by the trend of most porpoise whales being present in warmer waters (26.1C, 27.2C, and 22.2C) and least in colder waters (1.9C, 3.6C, 8C, and 13.6C). Hence, be concluded that harbor porpoise prefer temperatures of around 20 degrees celsius to as low as 14 or 15 degrees celsius. This is supported by other studies that conclude that porpoise whales prefer temperatures of around 15 degrees celsius. Also the graph revealed that harbor porpoise were most present in the month of august, which is, on average, a warmer month in Maryland. This further supports the conclusion that was derived from the data. The analysis of the data revealed that site 1 has a somewhat strong relationship between the variables because its correlation coefficient value is above 0.5. The reason the relationship is only semi-strong and not fully strong is because .62 is not close enough to 1. Because the value is 0.6247, temperature must not be the only thing that is affecting porpoise whale density. Temperature makes up around 62% of the variables that are affecting porpoise whale density. So, there are other factors that make up the other 48%. The Correlation Coefficient value for site 2 is close to the value of site 1, being 0.5944, meaning that everything stated about site 1 will closely correspond to statements about site 2. However, when the sites are combined the correlation coefficient value drops to 0.46, which is considered weak because it is less than 0.5. This may be because although the same trends were seen, site two overall had less porpoises present. This may cause the correlation coefficient go down

Conclusion

The hypothesis is: If temperature is related to the presence of harbour porpoise and harbour porpoise density is measured year-round along the coast of maryland, then porpoise whale density will be less at lower temperatures: 1.9℃, 3.6℃, 8℃, 13.6℃, 4.1℃; and be higher at higher temperatures: 18.8℃, 24.4℃, 27.2℃, 26.1℃, 22.2℃, 15.5℃, 10.2℃. The hypothesis was supported because, overall, higher temperatures had a higher porpoise density. The temperature with the highest amount of porpoise whales present was 26.1C. This temperature was the second highest of all the variables. Also, as temperature decreased porpoise whale density decreased. This is exemplified by the decrees in porpoise whale density from 10.4C to 4.1C. The linear regression analysis showed that there is a relationship between temperature and porpoise whale density, although it is not a very strong relationship. The correlation coefficient was 0.6247 for site 1 and 0.5944 for site 2. This means that there are other factors that affect porpoise whale presence in an area. Because the project is based around analyzing data, the data was not collected by the student, it was collected from Duke University. It is unknown if any errors were possible

when Duke University was collecting data. Any other possible errors could have taken place during the analysis such as incorrect use of Excel when analyzing the data. A possible future question for this project could be What are the other factors that play into porpoise whale presence if temperature makes up around 60%? This could be completed by researching other possible factors and then finding data to test these factors and see if they play a significant role in the presence of porpoise whales.

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