

Introduction

The human population is continuing to rapidly grow, urbanizing the coastline, which can cause a disturbance within an ecosystem. Animal populations are potentially being affected. Along the Delaware coast one species that might be affected is the Bottlenose Dolphin (*Tursiops truncatus*). The Marine Education, Research, and Rehabilitation Institute, Inc. (MERR) uses volunteers to survey the dolphin population by counting dolphins on the third Saturday in July. As the dolphins migrate more north during the summer months to the warmer water. July is one of the months with the highest densities of the dolphin population within the mid Atlantic area (Rodriguez et al., 2021). The surveys are used to collect data on the dolphin population, vessel activity, human activity, and animal activity. This provides the evidence to ensure necessary conservation measures are in place. Bottlenose dolphins are a keystone species and reveal the condition of the ecosystem. The data collected will allow for scientist to be able to analyze the healthiness of the ecosystem.

Overall, the purpose of the project was to analyze the trends in dolphin sightings along the Delaware coast from 2011 to 2021. The study looks at how the number of vessel activity and animal activity affected the dolphin population. The vessel activity was counting the total number of boats, sailboats, jet skis, and kayaks. The animal activity was documented in yes or no format if birds, fish, or humans were spotted at the location.

Materials and Methods

People volunteer with MERR to participate in their annual dolphin count. Volunteers are given a location, referred to as an observation post, and forms to keep track of specific data including time, location, weather, and water conditions. Then every five minutes the number of dolphins, vessel activity, human activity, and animal activity was tracked for 2 hours. This section of the form is seen in figure 1. Another study that completed the use of citizen science data was Spatial and temporal variation in the occurrence of bottlenose dolphins in the Chesapeake Bay as the dolphin sightings were reported in the Chesapeake Bay by citizens using an app called DolphinWatch (Rodriguez et al., 2021). This allowed for variables of the weather conditions and information about the surrounding area to be documented then used geographic location to track the sightings. The survey conducted by MERR resembles DolphinWatch but uses a paper-based system. To organize all the forms from 2011 to 2021, multiple Microsoft Forms were created.

Materials and Methods (cont.)

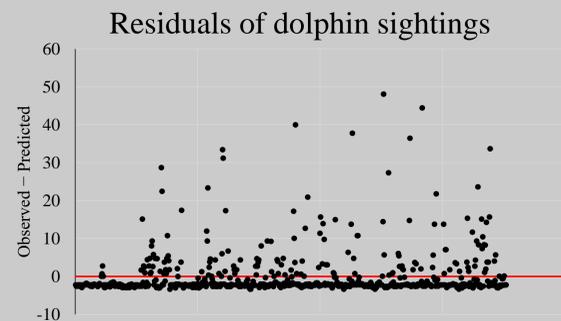
The first form was for data that included the date, location, weather, and water conditions. The second Microsoft Form was in 30-minute intervals, with the number of dolphin sightings, animal activity, and vessel activity. The data was inserted into Excel and bins for the data were created. Using Minitab, the data was inserted then, a Poisson regression test was run.

Figure 1 (right): Complete Dolphin count form for station 6A from 10:00–10:30. During this time two dolphins were spotted. There was a lot of human activity through surfing. Also, as it was an inlet location there was a lot of boat traffic.

Dolphin Count									
Observation Post: 6A		Observer: Allie Berger and Lynn Berger				Date: 7/17/2021			
Time (fill in hour)	# Dolphins (include estimates)	# Vessels	Dir. Of Travel	Wind	Wave	Temp	Humidity	Visibility	Other
			Right = R Left = L In = I Out = O None = N	Max = Maximum Min = Minimum BE = best estimate	Max = Maximum Min = Minimum BE = best estimate	Max = Maximum Min = Minimum BE = best estimate	Max = Maximum Min = Minimum BE = best estimate	Max = Maximum Min = Minimum BE = best estimate	Max = Maximum Min = Minimum BE = best estimate
10:00	0	0	N	Max = 0 Min = 0 BE = 0					
	0	0	N	Max = 0 Min = 0 BE = 0					
	0	0	N	Max = 0 Min = 0 BE = 0					
10:15	0	0	N	Max = 0 Min = 0 BE = 0					
	11	0	R	Max = 0 Min = 0 BE = 0					
	0	0	N	Max = 0 Min = 0 BE = 0					
Comments: Lots of people surfing and fishing. There was a high boat activity.									

Results

A Poisson regression test was used on the count data. When the number of vessels and if there was animal activity was compared to the number of dolphins sighted, it was statistically significant as p values for the constant, vessel activity, and animal activity were all $p < .05$.



Graph 1 (above): There was a total of 703 forms. Many of the data points are below the red line, which reveals many input forms have less than predicted dolphin counts.

Regression equation for the dolphin activity is $dolphin\ activity = e^Y$ while, $Y = 0.81 - 0.10\ vessel\ activity + 0.14\ animal\ activity$. This model is very limited but reveals as the vessel activity increased, the number of dolphins spotted decreased. The animal activity was quantified from zero to three on a scale, based on if there birds, fish, or human activity spotted. Zero represented no bird, fish, or human activity. Three represented when the surveyor detected all three activities. As the animal activity increases, the number of dolphins spotted increases. The majority of the data is zero dolphins sighted, as 70% of the data reported there were zero dolphins sighted.

Conclusion

Overall, when comparing the vessel and animal activity to the number of dolphins sighted there was a significant correlation between the variables. The regression equation revealed as the number of vessels spotted increased then the number of dolphins sighted decreased. The vessel activity included the number of motorboats, sailboats, jet skis, and kayaks. As the animal activity increased the number of dolphins sighted increased. The animal activity variable included if there were birds, fish, and human movement within the designated area. The next step will include researching additional variables such as weather conditions and water conditions. Integrating the other variables allows for the Delaware coast study to be compared to other dolphin count studies. This will allow scientists to be able to observe any inconsistency between the results.

The method that was used to collect the data is known as citizen science. Citizen science is when everyday people participate in the collection of data. It involves the community and allows them to be excited about the research. Citizen science data is an excellent low-cost data collection method. A way to improve citizen science data collection is through creating a mobile app or tablet software. This will allow for specific data to be collected including photos, using a weather app for weather conditions, and using someone's device's GPS location. The software will streamline the data input into the database. Saving multiple hours inputting the data and avoiding human error while inputting the data.

As the data had many inputs of zero, another test to analyze the data would be the zero-inflated Poisson regression test. The zero-inflated Poisson is a test that is used for counting data with a high percentage of zeros. The zero-inflated Poisson test may create a more accurate model. The current model unfortunately limits predicted dolphin counts.

The data was analyzed from the collection of surveys for the number of dolphins spotted. In the end, there was a significant effect on the number of dolphins spotted compared to the vessel activity and animal activity. This data can be used as evidence to be able to put conservation measures in place. The dolphins need to be protected to ensure a healthy marine ecosystem for the Delaware coast.

Reference

Rodriguez, L. K., Fandel, A. D., Colbert, B. R., Testa, J. C., & Bailey, H. (2021). Spatial and temporal variation in the occurrence of bottlenose dolphins in the Chesapeake Bay, USA, using citizen science sighting data. *PLoS ONE*, 16(5). <https://doi.org/10.1371/journal.pone.0251637>