The Vocalizations of Cetaceans in the Mediterranean Sea are correlated to the Level of Noise Pollution.

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Abstract

While stationed on the Toftevaag, during August 21 through August 29, 1999, I demonstrated that the cetaceans in the Mediterranean Sea off the coast of Spain vocalize more when there is a higher incidence of noise from ships.

The data collected shows that 80% of the time when there is excessive ship noise, the vocalization of Mediterranean cetacean increases. This research shows that there is in fact a correlation between noise pollution and cetacean vocalization.

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Introduction

The research was conducted from August 21 to August 29, 1999, on board the research vessel, Toftevaag. The Toftevaag is a restored Norwegian fishing vessel. It functions now as a research ship in the Mediterranean Sea for the Alnitak Marine Environment Research and Education Centre.

I am sincerely grateful to my mentor, Dr. Ana Canadas of the Universidad Autonoma de Madrid. I would also like to thank her husband, Ricardo Sagarminaga van Buiten and the Earthwatch Institute for all their help and support.

Review of Literature

The articles in my list of references that have provided insight to my research were mainly written in the recent publications of the Journal of the Acoustical Society of America. These articles talk about what the Navy and other organizations are currently researching with regard to noise pollution and how it effects behaviors in various cetaceans. In the article entitled *"Groups demand United States Navy to stop tests on Whales"*, many active

animal rights groups fought to have the Navy stop transmitting sounds underwater that would reach 215 decibels. These groups believe it is inhumane to create sound underwater that would be a "thousand times louder than a 747 jet engine" just to see how it effects the Humpback whales breeding habitat. Many of the debates about this project came about because of the article entitled; *"United States Navy begins disputed tests on Whales."* This research was testing behavioral changes in cetaceans brought about by noise pollution in excess of 215 decibels. These and the other articles I have sighted in my list of references were instrumental in the design of my hypothesis.

List of references:

Berman, M. (1998). *United States Navy begins disputed tests on whales.* Journal of the Acoustical Society of America.

Berman, M.(1998). *Groups demand United States Navy stop tests on whales.* Journal of the Acoustical Society of America.

Costa, D., Crocker, D., and Croll, D. (1996). *Effects of the California ATOC experiment on marine mammals.* Journal of the Acoustical Society of America.

Erbe, C., Farmer, D., and Yedlin, M. (1996). *Auditory masking of whale communication by ship noise.* Journal of the Acoustical Society of America.

Tyack, P.L. (1993). *Reactions of bottlenose dolphins, and migrating gray whales to experimental playback of low - frequency man-made noise.* Journal of the Acoustical Society of America.

Hypothesis

My hypothesis is to prove that cetaceans* in the Mediterranean Sea, off the coast of Spain, vocalize more when there is a higher incidence of noise from ships. I arrived at my hypothesis by seeing that the cetaceans in the Mediterranean Sea appeared to vocalize more frequently and with other members of their group when there were more ships in the area, including Toftevaag.

In my conclusion I will discuss why there is a need for further research in the field of noise pollution and

how it directly effects cetacean vocalization and other members of the marine community. I will also talk about my beliefs regarding the need for more vocalization during times when ships are in the neighboring area.

*Includes Striped Dolphins, Common Dolphins, Bottlenosed Dolphins, Pilot Whales, and Sperm Whales.

Materials

The Microprocessor Conductivity Meter was used to measure the salinity in parts per million in the Mediterranean Sea.

The MaGree Towarray 2βAQ4 Element Hydrophone was used to detect sound under water. During this research it was used to listen to the whistles and clicks emitted from the various types of sea life (i.e. shrimp, Striped Dolphins, Common Dolphins, Bottlenosed Dolphin, Pilot Whales, and Sperm Whales).

The Sony DAT Digital Recorder was used to record all the clicks and whistles emitted by the cetaceans in the Mediterranean Sea.

Global Positioning System was used to give the exact coordinates of where the ship was in relation to the Mediterranean Sea and the Spanish coast. It does this by giving the degrees, the minutes and the seconds of the position.

The barometer was used to measure the air pressure in millibars.

The binoculars were used to survey the surrounding sea for ships and cetaceans.

The Ship's Compass was used as course indicator.

The thermometer was used to measure the air and water temperature in degrees Celsius.

Two Video Cameras were used. One recorded events above the water level and one recorded events underwater.

A Still-frame Camera was used to take photographs for identification purposes.

A Dry-Erase Board used to relay sighting information.

Logbook- consists of taking the salinity, water temperature, air pressure, speed, course, longitude, latitude, and any activity that is currently going on.

Acoustics Form- is filled out by listening to the clicks, whistles and ship noise in the surrounding area.

Human Activities form- is completed by observing the types of ships/vessels that are visible from the research vessel in the surrounding area.

Cetacean Behavior- consists of taking the longitude, latitude, water depth, water temperature, salinity, and total number of cetaceans in the group, the intensity of their clicks and whistles and the Cetaceans behaviors.

Methods

General Procedure:

1. The Toftevaag leaves the port at 7:30AM and departs for open sea.
2. At approximately 200 meters from the shoreline the

MaGree Towarray 2βAQ4 Element Hydrophone is lowered into the water. The hydrophone is not raised until we reach 200 meters from the shoreline on our return trip.

3. Every twenty minutes after the hydrophone has been placed in the water the research vessel is stopped. The Acoustics and Human Activities Forms are recorded during this time. The Acoustics Form is filled out by listening to the clicks, whistles and ship noise in the surrounding area, which the hydrophone is picking up. The Human Activities Form is completed by observing the types of ships/vessels that are visible from the research vessel in the surrounding area.
4. Every hour logbook was taken. Logbook consists of taking the salinity, the water temperature, the air pressure, the speed, the course, the longitude, the latitude, and any activity that is going on. The longitude, latitude, speed, and course are all taken from the Global Positioning System. The salinity is taken by lowering a bucket into the Mediterranean Sea and pulling out a sample of water to be tested. The Microprocessor Conductivity Meter measures the salt content of the sample of water.
5. During hour intervals there are three watchers looking

for any signs of cetaceans. There is a portside watch, a starboard watch and a crow's nest watch.

Sighting Procedure:

1. Instead of the Acoustics and Human Activities Forms being taken every twenty minutes they are now taken every ten minutes. The only difference is that between the ten-minute intervals the Sony DAT Digital Recorder is constantly recording the clicks, whistles and ship noise.
2. The Logbook is now taken every ten minutes instead of every hour.
3. During this time the Cetacean Behavior Form is filled out. This occurs every five minutes. The Cetacean Behavior consists of taking the longitude, latitude, water depth, water temperature, salinity, total number of cetaceans in the group, and the intensity of their clicks and whistles. Cetacean behaviors are also observed. Behaviors we look for are the activity level of the group, the synchrony of the group, and aerial behavior. We also note interaction with the ship, if they approach it or if they appear evasive and if the group is cohesive or dispersed.

4. Throughout the sighting photographs and videos are taken. These include video observations above and below the water level as well as photographs used to identify the cetaceans. For each photograph we record the counter number on the camera along with the picture composition for identification purposes. When a video is taken, we first video the Dry-Erase board, which identifies specific sighting information.
5. During a sighting all the responsibilities stated in the general procedure are kept. The only difference is that new responsibilities required for a sighting are added to the general procedure.

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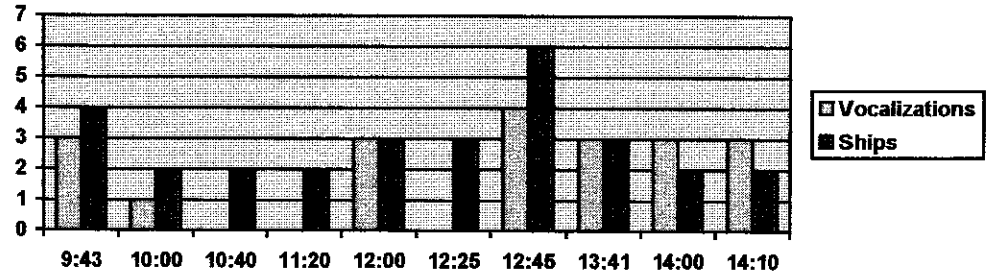
Results

The following graphs show a comparison of the incidence of vocalization as correlated to the high incidence of noise pollution from ships in the area. I have selected the incidence of two or more ships in the area to be considered a high level of noise pollution.

August 21,1999 **#1**



On August 21st, there are six out of ten data entries that show 2 or more vocalization when there is an incidence of 2 or more ships. These times are 9:43, 12:00, 12:45, 13:41, 14:00 and 14:10.

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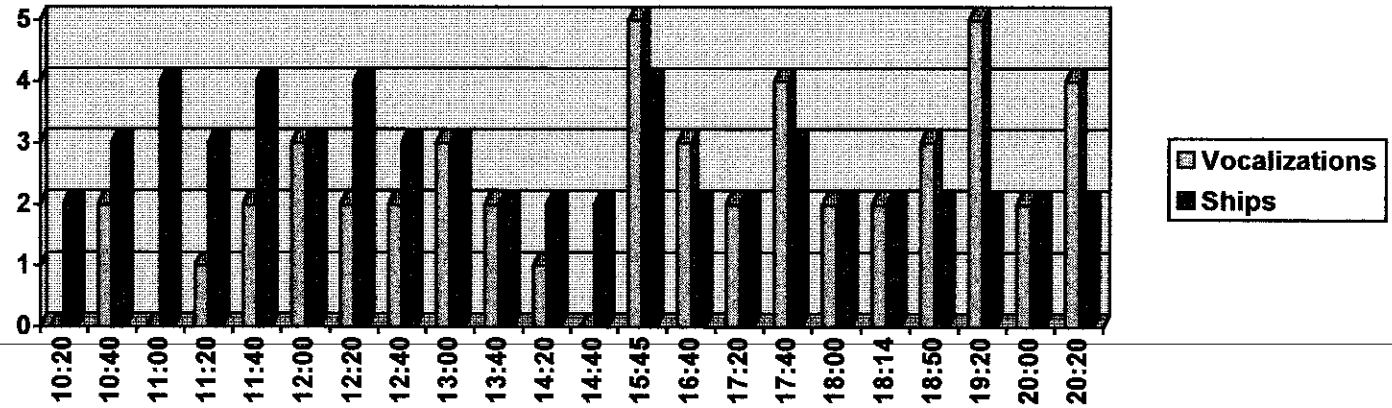
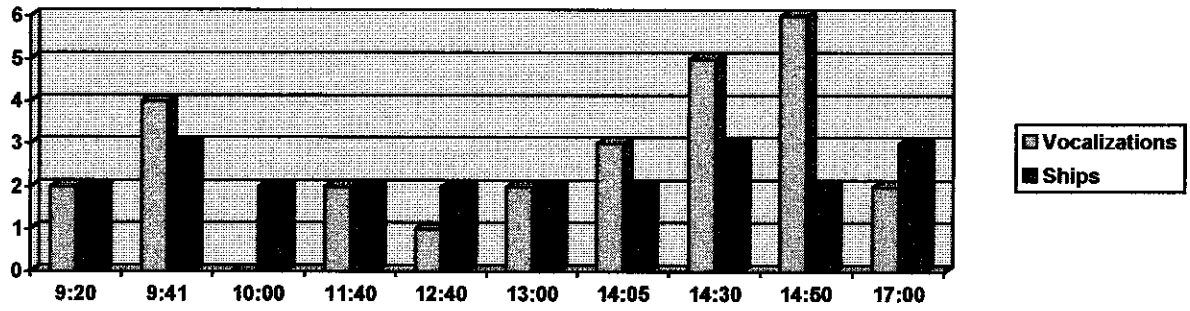
August 22,1999 **#2**



On August 22nd, there are seventeen out of twenty two data entries that show 2 or more vocalization when there is an incidence of 2 or more ships. These times are 10:40, 11:40, 12:00, 12:20, 12:40, 13:00, 13:40, 15:45, 16:40, 17:20, 17:40, 18:00, 18:14, 18:50, 19:20, 20:00, 20:20.

August 23,1999 **#3**



On August 23rd, there are eight out of ten data entries that show 2 or more vocalization when there is an incidence of 2 or more ships. These times are 9:20, 9:41, 11:40, 13:00, 14:05, 14:30, 14:50,17:00.

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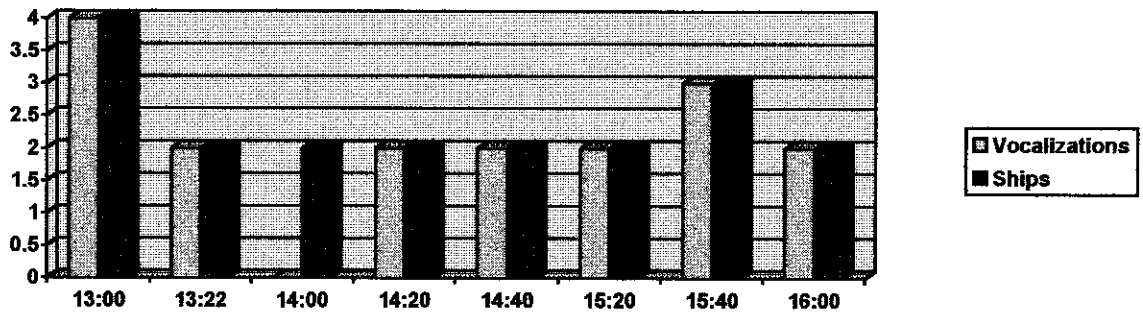
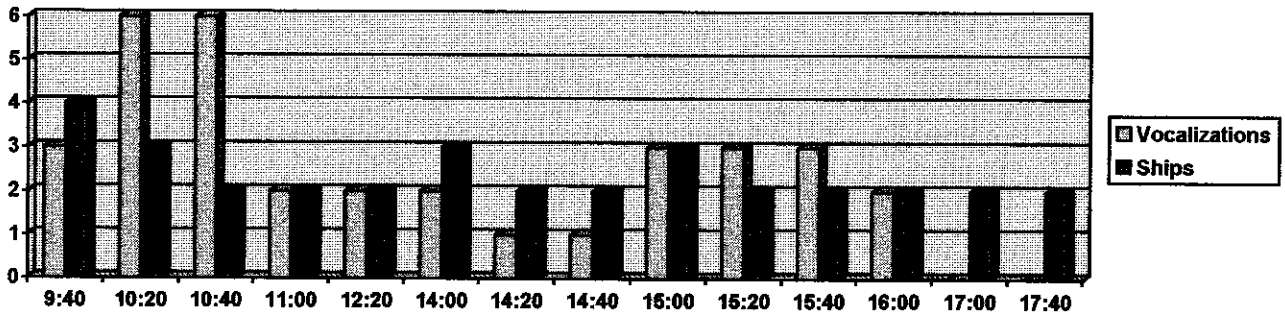
August 24,1999 **#4**



On August 24th, there are seven out of eight data entries that show 2 or more vocalization when there is an incidence of 2 or more ships. These times are 13:00, 13:22, 14:20, 14:40, 15:20, 15:40, 16:00.

August 25,1999 **#5**



On August 25th, there are ten out of fourteen data entries that show 2 or more vocalization when there is an incidence of 2 or more ships. These times are 9:40, 10:20, 10:40, 11:00, 12:20, 14:00, 15:00, 15:20, 15:40, 16:00.

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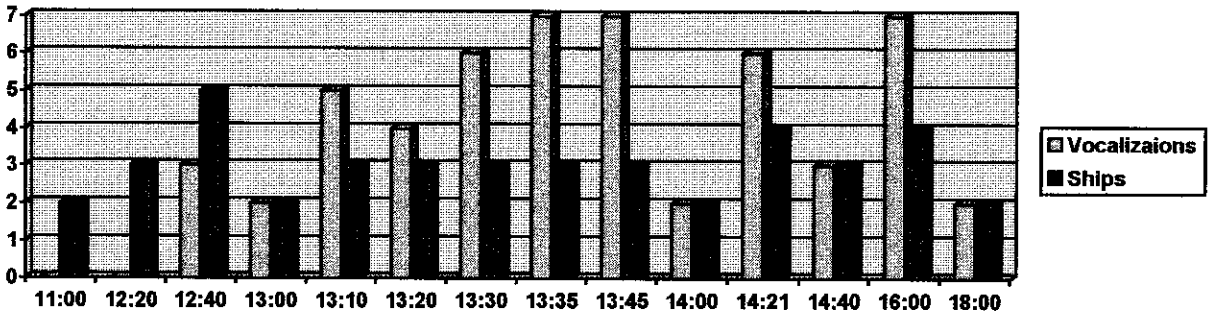
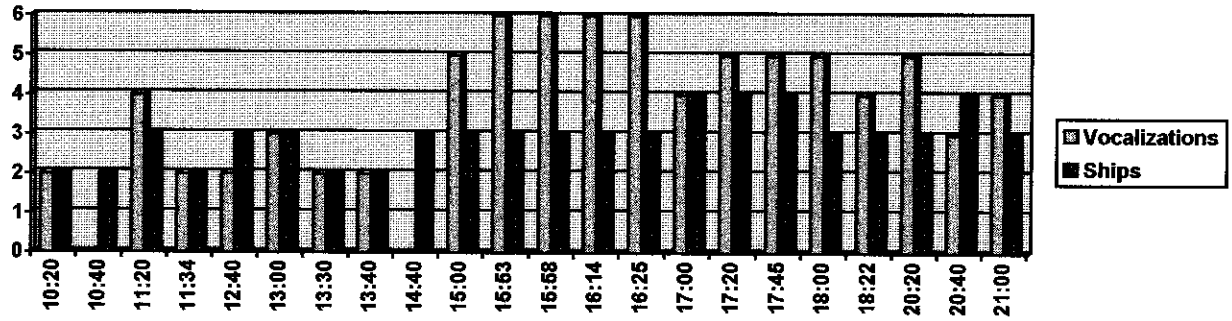
August 26,1999 **#6**



On August 26th, there are twelve out of fourteen data entries that show 2 or more vocalization when there is an incidence of 2 or more ships. These times are 12:40, 13:00, 13:10, 13:20, 13:30, 13:35, 13:45, 14:00, 14:21, 14:40, 16:00, 18:00.

August 27,1999 **#7**



On August 27th, there are twenty data entries that show 2 or more vocalization when there is an incidence of 2 or more ships. These times are 10:20, 11:20, 11:34, 12:40, 13:00, 13:30, 13:40, 15:00, 15:53, 15:58, 16:14, 16:25, 17:00, 17:20, 17:45, 18:00, 18:22, 20:20, 20:40, 21:00.

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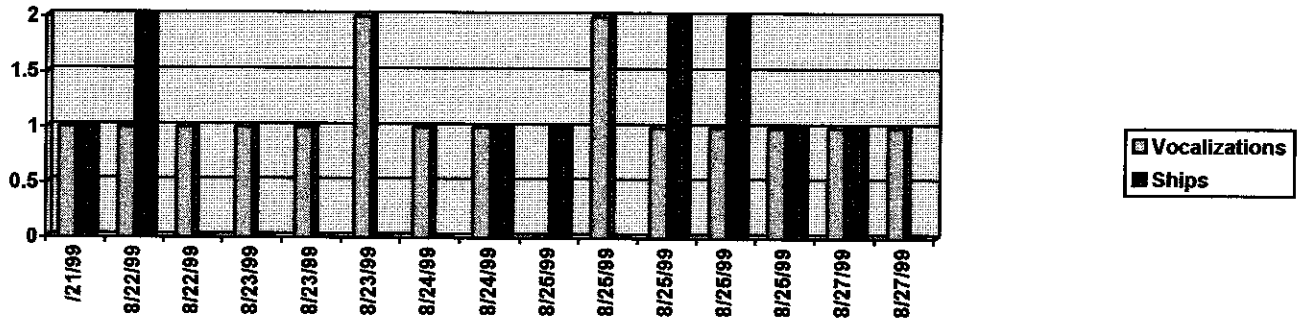
On August 28th and August 29th, the research vessel never reached deep enough water to drop the hydrophone because of bad swells and high winds.

The following graph shows the incidence of vocalizations during times of little or no noise pollution. That is when, one or no ships are in the area.

#8



There was only two days when there was vocalization above a one when there are no ships in the area. These are on August 23rd and August 25th.

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Summary of Results

T= Total number of data entries that consisted of an incidence of two or more ships.

V= Total number of data entries that consisted of two or more vocalizations along with an incidence of two or more ships.

The Formula I used was: Total %= $\frac{V}{T}$

Chart A:

Date	V Value	T Value
August 21	6	10
August 22	17	22
August 23	8	10
August 24	7	8
August 25	10	14
August 26	12	14
August 27	20	22
TOTAL	**80**	**100**

Placing these data into my formula shows that 80% of the time when there was excessive ship noise there was increased cetacean vocalization.

Discussion

The combined data provided by the first seven graphs and Chart A can be interpreted to show that 80% of the time when there is excessive ship noise, the vocalization of these cetaceans increases.

Graph eight shows that during times of low vocalizations there was little or no noise pollution.

Conclusion

The data collected for my research helps support my hypothesis that cetaceans in the Mediterranean Sea, off the coast of Spain, vocalize more when there is a higher incidence of noise from ships. This research shows that there is in fact a correlation between noise pollution and cetacean vocalization.

Analysis of the data collected leads me to believe that the reason for the increase in vocalization produced by these cetaceans may be used to alert the other members of their group. Perhaps they are alerting other members of their population of ships in the area or just communicating information. The dolphins might also just be telling the

other members in the group that they need to change their direction or scatter throughout the water. I believe this because, in the past, the Mediterranean Sea was a site for whaling and dolphin killing. Over the years the killing has decreased but the memory of those times may still remain in the marine community. Bottlenose Dolphins, which were commonly found near the shoreline, are now very scarce in that part of the Mediterranean Sea. The incidence of bow riding has decreased. I suspect that this could be related to the whaling and hunting.

Scientists in the Mediterranean Sea have conducted numerous studies showing how whaling and noise pollution have affected the marine community as a whole. My research shows a relationship between noise pollution and communication behavior in cetaceans in one region of the Mediterranean Sea.

Further research now seems necessary. I would suggest testing certain specific noise pollution such as: sound frequency of boats, types of boats, underwater drilling, underwater construction and sounds from other marine species. Such research could study other specific behaviors that are elicited by these types of noise pollutants.