The Relationship between Sea Height and Sea Surface Temperature on Strandings of Harbor Porpoise along the North Carolina Coast

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***Abstract*- Interns for the summer of 2004 assisted with determining whether an unusually high number of strandings of harbor porpoise during the winter of 1999 was due to an unusual juxtaposition of oceanographic features in the western the mid-Atlantic. The goal were to investigate whether a narrow band of cold water near shore followed by a strong warm water front results in higher numbers of stranded harbor porpoise than when the front is further offshore. This question has been a concern because an alternative explanation for unusually high numbers of strandings is entanglement of porpoises in gillnets along the mid-Atlantic coast.**

The interns worked on compiling extracted sea surface temperature (SST) and sea level data, created graphs and GIS plots, and assisted with analysis of the data. Only one other episode of alarming numbers of strandings of harbor porpoise in North Carolina has occurred in recent times and that was in 1977. Interns used SST and sea level data for years when it was available to ensure that the convergence of oceanographic events seen in 1999 did not occur in other years when high numbers of strandings also did not occur. Although comparable data do not exist for the 1970's, oceanographic sampling cruises did collect data that may be useful. Access to these results required a literature search.

I. INTRODUCTION

Harbor Porpoise (*phocoena phocoena)* are the most familiar cetaceans distributed in the Northern Hemisphere [3]. Figure 1 shows the worldly harbor porpoise distribution. Harbor porpoise are not well understood as far as biology and ecology. They are hard to study in the wild and are also not easy to keep alive in captivity. In 1991 Harderwijk Marine Mammal Park was opened as a place where small cetaceans can adapt to sea conditions before returning to the wild. The staff kept records of techniques used and responses of the animals to their treatment. After improvement, porpoises were obtainable for research on their sensory capabilities and response to types of fishing nets.

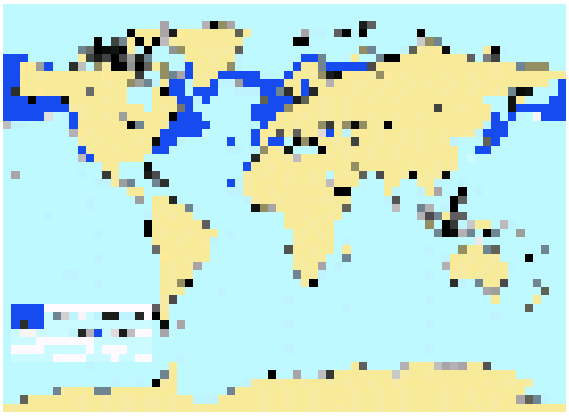


Figure 1

There are several reasons that these marine mammals are interesting for study purposes. One reason is that they are one of the smallest of the cetaceans and face unusual set of problems dissimilar to most dolphins or other whales. Another reason is that their robust body shape and thick blubber layer allows them to adapt to cold water conditions [3]. More than 40% of their body is composed of blubber and skin to keep them warm. The average size of a harbor porpoise is 2m long and because of the small size, not much energy can be stored in the animal [3]. They have no beak or no defined pigmentation pattern. The dorsal fin is triangular and is located in the mid-body [2]. Figure 2 is a picture of a harbor porpoise.

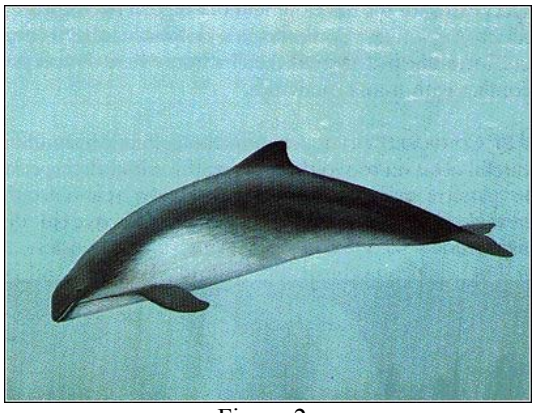


Figure 2

Harbor porpoise must stay close to their source of food or starve. Along the east coast of the USA, newly weaned calves appear stranded on beaches from Massachusetts to North Carolina due to not maintaining a good source of food [3]. When calves are separated from their mother, they are faced with the challenge of survival on their own. Some are unable to feed on their own and therefore become emaciated and die [3]. This brings us to the project in determining the relationship between sea height and sea surface temperature on strandings of harbor porpoise.

The problem in this research project was to determine what may have caused the high number of strandings during the winter of 1999 and compare it with other years ranging from a period of January to May from the years 1995-2001. Sea surface temperature (SST) and sea level data was only available for the years 1995-2001. Only one other episode of alarming numbers of stranding of harbor porpoise in North Carolina occurred in recent times and that was in 1977. Also in the year 1999, where there were a high number of stranding, a combination of oceanographic events were seen that contributed to the high number of strandings. In order to compare data of the 1970's a literature research was required that allowed a comparison of the data collected by oceanographic sampling cruises during the 1970's period. The goal was to use sea surface temperature (SST) and sea level data for the years when it was available to ensure that those same events did not occur in the years where high number of strandings did not occur.

II. REVIEW OF LITERATURE

Strandings: A Glimpse into the Lives of Marine Mammals

William A. McLellan published an article the lives of marine mammals and how they are affected by strandings. Its focus was mainly on strandings. The author begins the article describing the thoughts of a stranded dolphin before it takes its last breathe. The author gives the reader certain sensory words so that it makes the atmosphere of being stranded real to the reader. In this

article you will learn about stranded marine mammals and how scientists find them very useful in research.

Stranded marine mammals are more that just a smelly nuisance found on a beach, they have had the attention of natural historians for thousands of years [1]. Again thousands of years ago, beach-cast cetaceans were considered a bonus to early residents of the Barrier Islands of the mid-Atlantic coast. Meat, oil, hide to be tanned, and other uses were just a few representations of rich resources that most stranded whales were used for [1]. With the development of a national stranding network, intended to react to all marine mammal strandings, the career of investigating stranding has grown very much since early on.

If you happen to be on a beach one sunny afternoon and spot a stranded marine mammal, you should report it to a local or state agency as soon as possible. The agency would at that time inform the stranding network. If a stranding occurred near or on the central east coast, the Marine Mammal Program of the National Museum would be notified. For over seventeen years, this program has been investigating cetacean strandings. With these strandings scientists can better understand the species.

The article then goes on to describe how the stranding team thoroughly examines the cetacean. By conducting this exam a lot can be observed about the animal dating back to its birth. As part of the exam a necropsy, an animal autopsy, is performed and is intended to tell the final cause of death and how the animal made its living on a day to day basis [1]. When the strandings team first arrive on the beach the species, sex, an estimate of the age are determined as well as how fresh the carcass is. Numerous photographs and measurements of the body are taken also. With most of the external work done, it is now time to dig in.

To begin a necropsy the first thing that should be done is a measure of the blubber thickness. This indicates whether the animal had been “deficit spending” from its reserves [1]. Next, all the organs in the body are examined for any abnormalities with notes made as the procedure goes along. Everything is not visible to the naked eye so tissues are collected and other samples are sent to labs for forensic examination [1]. As the procedure continues other important organs and reproductive tracts are investigated. The purpose of collecting tissue samples during the necropsy is so they can be sent to museums for collection and other purposes.

In conclusion the article seemed to be very informative and precise about the procedures a strandings team goes through in case of a stranded marine mammal. It also explains how data collecting is important for research usage.

III. DATA AND METHODS

Sea Surface Temperature

Sea surface temperature (SST) and sea level data were obtained for this project. SST was derived from an Advanced Very High Resolution Radiometer (AVHRR) sensor on

board a National Oceanographic and Atmospheric Administration (NOAA) Orbview-2 satellite. Satellite (SST) provides both a better view of the ocean and a high frequency of repeated views. SST shows many of the world's major currents and it can also show current-related anomalies such as cold and warm core eddies. A particular area may be viewed four or more times per day, and the resolution of the imagery is 1 to 4 kilometers.

The satellite measures two or more wavelengths in the infrared part of the spectrum. This method of measurement represents the temperature of the "skin" of the ocean, approximately the surface one millimeter (1 mm) or less, and it may not represent the whole temperature of the upper meter of ocean. SST data was provided from the Oregon Inlet for years 1995-2001. Transect lines were taken from this area to help with analysis of the data.

Sea Height

Sea level data, which is the level of the ocean halfway between the mean high and low tide, was also used this project. These data served as a means of estimating land elevation of sea depth during the years of 1995-2001. The data were provided by the University of Hawaii Sea Level Center (UHSLC). This center is a research facility with the University of Hawaii/NOAA Joint Institute for Marine and Atmospheric Research (JIMAR). The center also provides three on-line databases; the research quality database, the GLOSS/CLIVAR “fast delivery” database, and the JCOMM Sea Level in the Pacific map database. The research quality database was used in this project for analysis which allowed daily data to be obtained from Duck Pier, NC, for the years of study.

Processing of Data

In order to fully analyze the extracted sea surface temperature (SST) and sea level data; histograms, text files, ArcView Geographical Information (GIS) plots, and Mat Lab were used to assist in the analysis of the data. Harbor porpoise stranding data was created in American Standard Code for Information Interchange (ASCII) text files for the years 1995-2001 in Microsoft Excel. In these files the Field Name, Date, Location, Longitude, and Latitude were column heading for the stranding data. This information was very useful because it gives the date and location of harbor porpoise stranding along the North Carolina coast. Thses data were assessable from the NOAA Beaufort Laboratory P:\ drive folder.

Each year was grouped and saved individually as a data-based file (dbf) so that it could be viewed in ArcView GIS.

FieldNum	Date	Location	Latitude	Longitude
GPM014	22-Feb-95	Duck	36.19000	-75.75667
GPM19	24-Mar-95	Nags Head	35.88167	-75.58167
GPM20	27-Mar-95	Nags Head	35.79167	-75.53667
GPM22	3-Apr-95	Nags Head	35.79000	-75.53670
GPM24	10-Apr-95	Nags Head	35.77500	-75.53500
VMSM951(	11-Apr-95	Corolla	36.36102	-75.81984
VMSM951(	11-Apr-95	Corolla	36.33265	-75.81154
GPM29	18-Apr-95	Avon	35.43833	-75.48167
GPM33	28-May-95	Nags Head	35.98000	-75.63667

Table 1

Once the data was saved as dbf files, ArcView GIS was used to

manipulate and create plots of each stranding bimonthly for each year. The North Carolina coast was displayed in ArcView GIS as a basis to show the location of each plotted stranding. The dbf files created in Excel were converted in to shape files (shp) so that ArcView could read them. This allowed each stranding to be displayed graphically in ArcView GIS. Once the dbf file was converted, it was them deleted from the project.

After creating the GIS plots different points were observed to be out of place or outside of the studied area. These points were identified by field number, date and location. This allowed the problem to be located and fixed in Arcview GIS. Stranding record books available in the NOAA lab allows the corrected latitude and longitudinal values to be identified so that the plotted points would be in the correct location. Bathymetry, which is the depth of the water, was added to the GIS plots up to 20m to serve as a bound in examining harbor porpoise locations and movements. Figure 2.1 show a GIS plot of the North Carolina coast of harbor porpoise stranding in April of 1999.

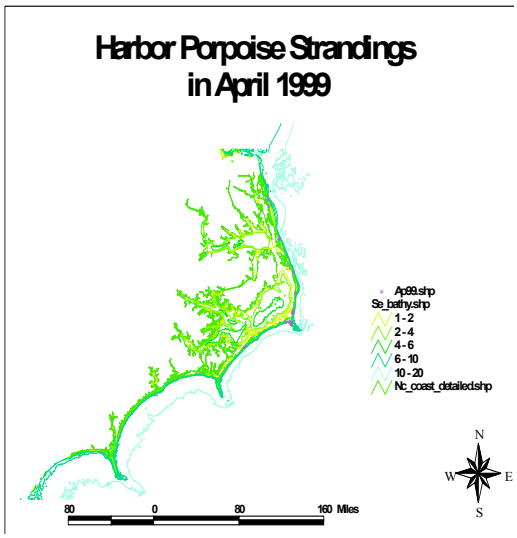


Figure 3

Histograms were formulated for each year (1995-2001) to examine stranding that occurred in each week from January to June. Mat Lab is software that was used to manipulate text files and create programs to plot and display the SST, sea level data, and histograms for each studied year for amore in depth analysis of what actually occurred in high/low stranding years. Figures 2.2-2.9 show relative graphs ranging from January 1- May 1 created in Mat Lab for each year. SST temperature degree lines of 5°C, 15°C, and 25°C are shown in a graph to help in understanding the divergence in temperature.

IV. RESULTS

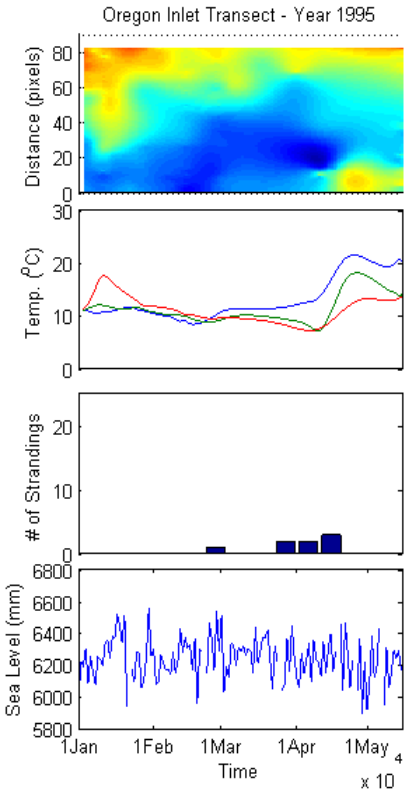


Figure 4

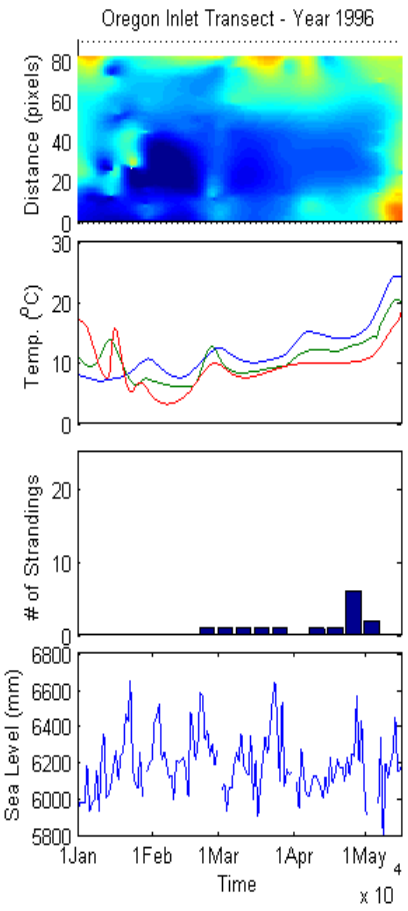
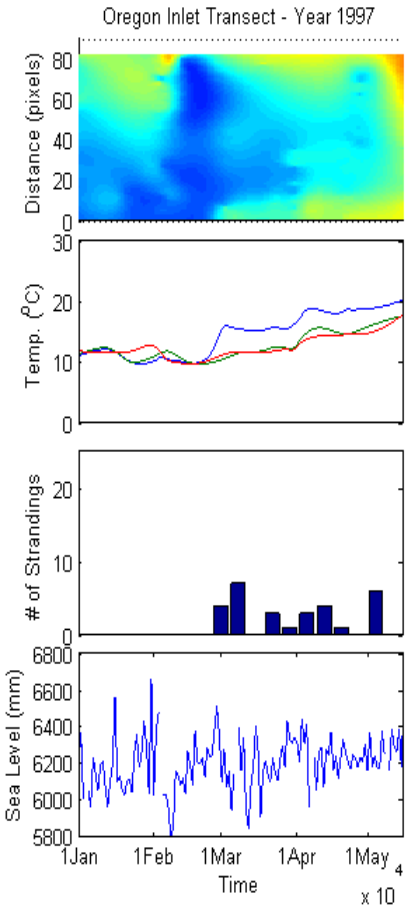


Figure 5



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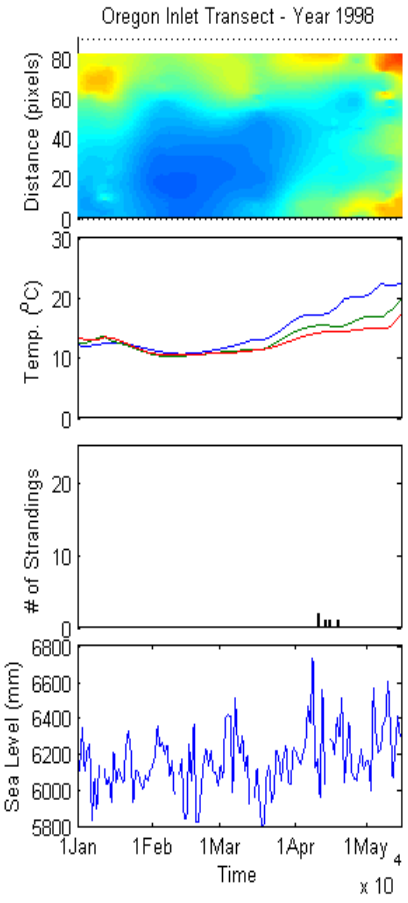

Figure 7

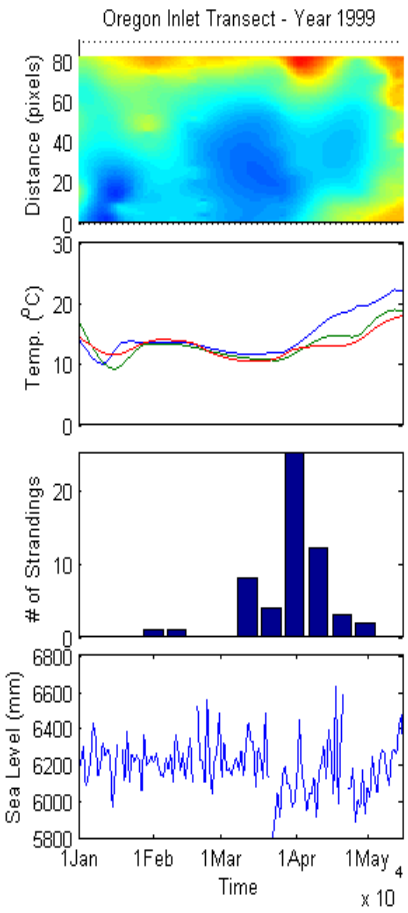

Figure 8

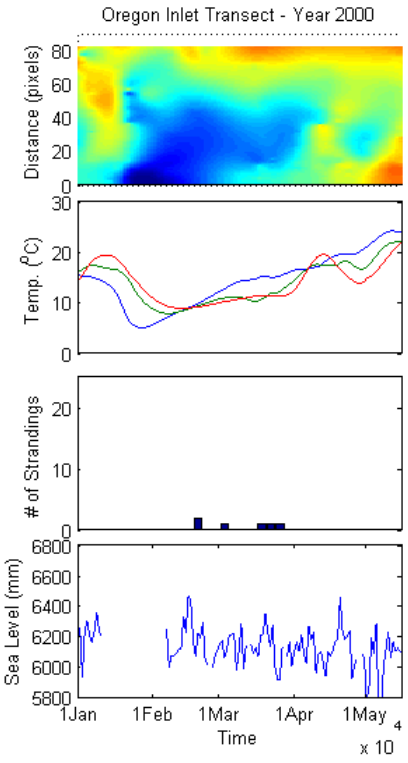

Figure 9

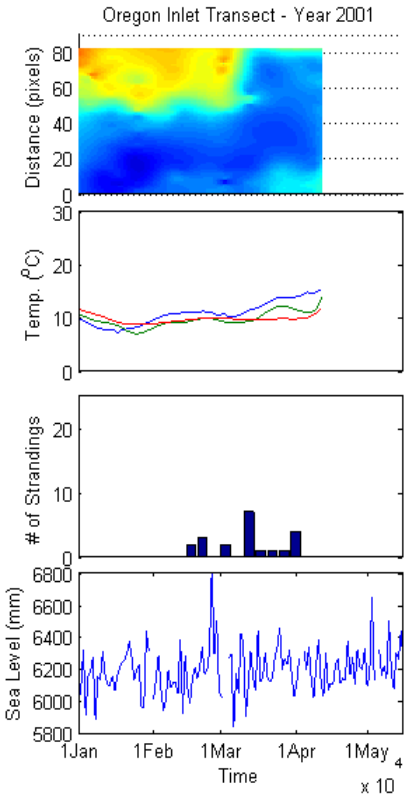

Figure 10

V. DISCUSSION

The variations in sea-surface temperature for each year demonstrated in figures 4-10 were likely to have been occurring during a period of diverging temperatures. As observed each year seemed to have a pattern stranding occurring at the divergence of the temperature lines. The blue pixel line in the temperature graph has a pattern of ending up above the other two lines for each year. There also seemed to be no relationship with sea height and stranding.

In comparison with year 1977, Mountain did a study of oceanographic conditions in subareas 5 and 6 during the years of 1970-79. In his paper he analyzed SST and near-bottom temperatures between Cape Hatteras and the Gulf of Maine. It was suggested that in years 1977-78 there was a cooling that resulted from wintertime negative anomalies [4]. Large negative values were shown in the winter and spring of Georges Bank and Middle Atlantic Bight [4]. In his paper Table 1 showed average SST anomalies by season and the Mid-Atlantic Bight showed the smallest winter temperatures (-0.65°C) between Jan-Mar, which suggested that the later years of the 1970-79 period had extremely cold winters [4].

VI. CONCLUSION

To continue the study of harbor porpoise stranding along the North Carolina coast wind speed and direction data will be used to

examine its effects on SST and harbor porpoise strandings. Helpful outcomes may allow for the development of a model that predicts relative numbers of harbor porpoise strandings. Be cause of this concern an alternative explanation for research of stranding are the entanglement of porpoises in gillnets along the North Carolina Coast.

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