# Cetacean Mortality Along the US East Coast Attributed to Morbillivirus

by

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This thesis was prepared under the direction of the candidate's thesis advisor, Dr. James Wetterer, and has been approved by the members of her/his supervisory committee. It was submitted to the faculty of The Honors College and was accepted in partial fulfillment of the requirements for the degree of Bachelor of Arts in Liberal Arts and Sciences.

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ABSTRACT

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In 2013-2014, bottlenose dolphins (*Tursiops truncatus*) experienced unusually high mortality along the East Coast of the US. Many deaths were attributed to Cetacean Morbillivirus (CeMV). My thesis research examined whether this high mortality could be attributed to the virus spreading more easily due to pollution, being picked up from a specific location, or unusual weather events. I found no evidence that pollutants or location corresponded with CeMV. There was the expected percentage of strandings based on the percentage of coastline therefore ruling out any linkage to location. Weather patterns appeared to have an effect on CeMV. When the temperatures were low, there were minimal strandings due to CeMV. Whereas, when temperatures were at their highest, there were also record numbers of CeMV. Thus, I concluded that high temperatures may have allowed increased spread of CeMV, which was compounded by increased movement of dolphins when waters are warmer.

To Dad, Mom, Eileen, and Sofa, I would not be where I am without any of you

To my family, Mami, Pito, Tia Brigida, Aunt Brigida, Uncle Danny, Titi, Uncle Ricky, Maritza, and JC, who have been rooting for me and supporting me every step of the way

To my most amazing friends: Jonathan, Christine, Christine, Rylan, Katie, Kristina, and Nicholas, thank you for joining me in procrastination, late night studying, and memories of a lifetime

To all the teachers who have inspired me from learning how to tie my shoes to falling in love with Calculus

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Introduction

There are 89 living species of cetaceans (Order Cetacea), which includes dolphins, narwhals, porpoises, and whales. Cetacea are classified by having paddle-shaped forelimbs, no hind limbs, one or two nares on the head, and a horizontally flattened tail (Geraci and Valerie, 2005). Many of these species are considered endangered. Each year, about 300 cetaceans are found stranded on beaches off the eastern coast of the US (NOAA, 2013). These strandings are commonly attributed to infections, toxins, human interactions, and malnutrition. My thesis focuses on understanding the causes of strandings along the East coast of the United States.

Bottlenose dolphins (*Tursiops truncatus*) are the most common cetacean found stranded on the East Coast of the US. Bottlenose dolphins are found along the entire eastern coast due to their migration patterns. Bottlenose dolphins exhibit many types of migration including "1) seasonal migrations, 2) year-round home ranges, 3) periodic residency, and 4) a combination of occasional long range movements and repeated local residency" (Wells and Scott. 1999, 2009). Dolphin strandings are particular common in the summer due to dolphins spending much of the summer in waters that are an average of 20m deep (Barco, et al., 1999). This increases the likelihood that a dolphin carcass washes up on shore rather than sinking to the bottom of the ocean. On average, 300 bottlenose dolphins are founded stranded each year along the East Coast (NOAA, 2013). However, in 2013, over 1000 strandings were recorded (Vergakis, 2013). My thesis examines the causes of the strandings of 2013 and the years that follow.

Weather events have a major impact on dolphin migration. Therefore, strandings will also need to factor in that of weather events. Hurricanes and severe temperature changes could cause bottlenose dolphins to follow an unusual migratory path. Thus, major weather changes will be looked at specifically during the times of the strandings to see if they made a difference in the locations of the strandings and possibly to see if there is correlation between the spread of viruses and the major weather events.

Large strandings of cetaceans known as Unusual Mortality Events (UMEs), most often occur among bottlenose dolphins along the coasts of California and Florida. UMEs are defined as “A stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response” (Marine Mammal Protection Act) (Figure 1). Most UMEs are shown to be attributed to infections, bio-toxins, human interactions, and malnutrition. Though, the cetacean morbillivirus (CeMV) (Figure 2) has been most recently shown to be the most common cause (Figure 3) of UMEs in the bottlenose dolphin.

Different forms of morbillivirus can be found in many mammals, including humans, where it causes a form of measles. There are currently five types that have been documented as being found in marine animals. CeMV affects the lungs and brain. It produces symptoms such as: skin lesions (Figure 4), pneumonia, brain infections, and secondary infections. CeMV is spread via respiratory particles and direct contact between two individuals. CeMV has proven to not be zoonotic; no cases have been found of CeMV spreading to humans. In certain populations, previous exposure have produces antibodies, allowing many individuals to produce immunity. The dolphin populations most at risk of massive die-offs are those in which CeMV is introduced with no previous exposure, or those in which immunity has disappeared due to either mutation of the virus or a new generation of dolphins that do not have the antibodies needed, such as shore dolphins (Geraci and Valerie, 2005).

The last outbreak of CeMV happened in 1988 (Vergakis, 2013). Since then, many of the bottlenose dolphins that were believed to have immunities to CeMV have died off (Bossart et al., 2009). For years, those individuals with immunities acted as a barrier of protection against virus transmission to the younger members of the herd. Since many of them have died or left, that barrier is gone, leaving the younger non-immune dolphins more susceptible to contracting CeMV (Bossart et al., 2009).

Documenting these strandings and specifically those due to cetacean morbillivirus strandings (Figure 3) is important in terms of looking at the seasonal distribution and locations of the species; along with their diets, any disease outbreaks, and their reproductive patterns. Strandings also correlate with many types of pollution, including noise pollution. While dolphins may have a “protective mechanism that reduces harmful physiological noise damage at shorter duration exposures” (Mooney et al. 2006). Dolphins can still experience temporary ear damage and disorientation (Mooney et al. 2006). Noise pollution has been shown to cause “cochlear damage, changes in individual and social behavior, altered metabolisms, hampered population recruitment, and can subsequently affect the health and service functions of marine ecosystems” (Peng et al., 2015).

Through tracking the cetacean strandings and marking those specifically related to morbillivirus, I hope to find some correlation in the morbillivirus through location, seasons, or species. This research will help in gathering information to better understand morbillivirus and to help decrease the spread of the virus if possible through the correlations found.

## Methods

Using NOAA's bottlenose dolphin stranding data, analysis was done to look for trends. The number of strandings compared to the total number of strandings was converted into a percent to give way to a more accurate comparison.

## Results

Along the eastern shoreline of the United States, the three states with the largest amount of tidal shoreline are Virginia, North Carolina, and Florida, all at ~15% (Table 1; Cascadia, 2016). Therefore, it would be assumed that these three states should have the largest amount of strandings. In fact, Virginia had the highest percent of strandings at 24%, Florida had 20% of the strandings, while North Carolina was third with 18% (Table 1). The states with the lowest percent of tidal shore are Delaware, New Jersey, and New York with 2%, 8%, and 8% respectively (Table 1). Comparatively, the percent of strandings for the lowest states are New York at 3%, Delaware at 4%, and Georgia and Maryland at 5% (Table 1). This could be attributed to weather events and temperature of the water, along with migration patterns.

I compared areas using percentages of strandings in each area to the available area of the tidal shoreline in which it is possible for a stranding to occur. Tidal shoreline will be used as opposed to general coastline. The general coastline strictly shows the line at which the state meets the ocean, whereas the tidal shoreline follows specifically all the land of the state that touches the ocean (Cascadia, 2016). This includes small islands and inlets that gave shores of which a stranding can occur. I found a correlation coefficient comparing the number of strandings to the number of miles (Table 1). This coefficient was found to be .65. Thus, showing that there is significance in terms of the amount of tidal shore available and the number of strandings that occurred on the beach (Graph 1).

The percentages of strandings compared to weather events were compared to look for any trends in weather events affecting strandings. These weather events include major temperature changes, hurricanes, snow storms, etc. First, a list of notable weather events from each year was made, further dividing it by each month to allow a more specific comparison. The first noteworthy observation to be made on the weather events is the number of high temperature and low temperature records that were broken during 2013-2015(NOAA, 2014-2016). This includes records held by individual states as well as world records.

In terms of weather events, 2013 was a record-breaking year (Table 2; Levin, 2014). Many monthly world high temperatures were broken along with 2013 being named the 4$^{th}$ warmest year in recorded history (Levin, 2014). While May was the warmest May in world history (Levin, 2014) and June had two tropical storms (Blake, 2014), the eastern coast of the United States saw virtually no strandings (2 in May and 4 in June) (NOAA, 2014-2016). This is seen as the beginning of the CeMV UMEs. July showed the complete opposite with a total of 97 documented strandings (NOAA, 2014-2016). During July, extreme flooding occurred along the eastern coast, with Florida seeing the wettest summer in the US eastern coast history (Levin, 2014). August consisted of two tropical storms and a grand total of 339 strandings (Figure 7) (Levin, 2014). Within this month, every single day had multiple strandings in every state. September was significantly less at 183 (Figure 7) (NOAA, 2014-2016) even though it boosted two hurricanes, a tropical depression, and a tropical storm (Levin, 2014). October was roughly the same number at 126 strandings (Figure 7) (NOAA, 2014-2016) with three tropical storms. November was the warmest November in world history with a tropical storm (Blake, 2014) and tornado outbreaks (Levin, 2014). It had a grand total of 139 strandings across all states (Figure 7) (NOAA, 2014-2016). December also had roughly the same amount of 125 strandings as well (Figure 7) (NOAA, 2014-2016). This month had 2 significant snow storms in the northeast (Table 2) (NOAA, 2016). Looking at the hurricane patterns, there are 3 in which they follow the Atlantic coast relatively close (Figure 5) (Blake, 2014). In all, 2013 ended up being the 4th warmest year in world history with the artic and Antarctica sea ice shrinking the most in history (Levin, 2014).

The year 2014 boosted significant weather events as well. These weather events could be a variable in the number of strandings and possible location of strandings. January had a significant snow storm, major snow storm, and notable snow storm during the month (Table 3) (NOAA, 2016). This lead to a total of 54 strandings (Table 7) (NOAA, 2014-2016). February had 38 strandings (Table 7) (NOAA, 2014-2016) that could be partially attributed to 2 major snow storms (Table 3) (NOAA, 2016). March through June had no significant weather events but did have strandings as well (March: 43, April: 61, May: 57, June: 52) (Table 7) (NOAA, 2014-2015). July had 61 strandings (Table 7) (NOAA 2014-2016), very close to the average, even considering the month showed a hurricane and a tropical depression (Pasch, 2015). August had the one of the most amount of hurricanes during the year featuring two, one at the beginning of the month and one at the end of the month (Table 3) (Pasch, 2015). Besides the lack of weather events, only 47 strandings were reported in August (Table 7) (NOAA, 2014-2016). The number of strandings were significantly lower in September at only 32 (Table 7; NOAA, 2014-2016) even with a major hurricane and tropical storm (Table 3) (Pasch, 2015). This is almost half of July even with the same category of weather events (Pasch, 2015). October showed less with only 24 (Table 7; NOAA, 2014-2016) despite two hurricanes and a tropical storm (Table 3) (Pasch, 2015). November had a notable snowstorm (NOAA, 2016) and only 20 strandings (Table 7) (NOAA, 2014-2016). The last month of the year also had the least amount of strandings with only 11 (Table 7), most of which were in the southern half of the coast (NOAA, 2014-2016). This could be attributed to the record breaking temperatures of the winter and a notable snowstorm (NOAA, 2016). This could have caused all the strandings to be south plus less dolphin activity on the coast due to the water's temperature being too cold. Even with the lack of hurricanes, the national hurricane tracking chart shows 5 hurricanes roughly following the eastern coast of the United States (Figure 6) (Pasch, 2015).

For the year 2015, data is only shown for the first three months. January had only 12 strandings (Table 8) (NOAA, 2014-2016) despite a record breaking winter and two snowstorms (Table 4) (NOAA, 2016). February was the second coldest February in US history and one of the coldest months in US history with another two snowstorms (Table 4) (NOAA, 2016) yielding a total of 8 strandings (Table 8) (NOAA, 2014-2016). March was the warmest in Florida history and was the highest recorded temperature in

Antarctica (Table 4) (O'Connor, 2015). The number of strandings were counted at nine (Table 8) (NOAA, 2014-2016). The first few months of the year saw no hurricanes even though many followed the coast later on during the year (Figure 7) (Stewart, 2016).

The percent of strandings was also shown in comparison to each of the seasons. Through all the years, the summer season shows a significant increase in the amount of strandings at 48% (Table 5). While fall is the second highest amount of strandings at 29% and spring and winter almost tying with 11% and 12% respectively (Table 5). Due to bottlenose dolphins enjoying the warmer waters, during the summer, dolphins exemplify the most movement during this season (Barco et al., 1999). Dolphins will live in water anywhere from 10° to 32°C (50°-90° F) but tend to prefer the warmer waters over the colder waters (Henderson, 2007). Due to this movement to warmer waters, bottlenose dolphins not only follow temperature changes more so than other seasons but can also be seen more widespread along the coast. Since the waters are warm throughout the entire eastern coast, dolphins can be found throughout the entire coast. This is extremely contrary to the winter season when the waters are too cold in the northern part of the coast for dolphins to habituate in this area. Thus, with higher numbers of travelling populations of cetaceans, it may yield higher stranding occurrences.

## Discussion

Recent data on the number Unusual Mortality Events (UMEs) among dolphins in different states along the East coast of the US, very much coincided with the amount of shoreline available (Table 1). UMEs showed a strong correlation between the cold weather and lack of strandings. There is also a correlation between hurricanes and a lack of strandings. Summer shows the seasons in which most strandings occur and which most bottlenose dolphins migrate the most along the coast of the eastern United States.

Given the amount of available shoreline and the percent of strandings in each state. The t-test showed a correlation between percentages of shoreline of the total eastern shoreline to the percentage of strandings per state. This shows an even dispersal of bottlenose dolphins following the eastern coast. This exemplifies the dolphin migration patterns. Dolphins tend to swim in the more shallow warm water (Barco et al., 1999). They follow the temperature of the water as opposed to other types of animals that follow migratory paths within the ocean to reach places that have an ideal food supply (Bearzi, 2009).

Weather also has a major impact on where strandings occur along the shoreline. When there are low temperatures, dolphins will avoid these waters and head towards the southern half of the coastline (Henderson, 2007). This causes the increase in strandings in the southern states and decrease of strandings along the northern coasts. During the warmest parts of 2013, there were significantly more strandings reported than any other time or any of year.

The warmer weather can cause a significant amount of movement and thus once a dolphin contracts CeMV, it is easier to pass it along to other members of the herd and other herds when they come into contact with the herd carrying the virus (Sanino et al., 2005). Warmer waters could also be an incubator for the virus allowing it to spread and manifest faster.

## Conclusion

Strandings within occurring within an Unusual Mortality Event have been attributed to that of Cetacean Morbillivirus. Based on the data at hand, strandings are spread evenly between the states and along the coastline. Thus, CeMV wasn't specific to any one location. Therefore, the outbreak that occurred, occurred within many and most herds and cannot be tracked to a single source. However, a major factor that can be looked into is the effect of weather on the spread of CeMV. During the colder months and winter season, the amount of strandings along the coast were significantly less. When the shorelines were significantly warmer, there was an influx of the amount of strandings due to CeMV. This could be due to the fact that the warm weather allows for better transmission of the virus through bacteria that thrives in the warmer environment (Stephens et al., 2014). Bacteria and viruses tend to be found together due to the fact that when one weakens the immune system, the other is readily available to attack the body as well (Kim, et al., 2011). This is only helped by bottlenose dolphin migration patterns. Given that bottlenose dolphins seem to spend much of their time in warm, shallower waters and tend to move around more when the water is warmer, this movement would allow more contact between herds and different individuals (Sanino et al., 2005). This increased contact would lead to the virus spreading faster than normal (Sanino et al., 2005).

Figures

**Figure 1: Dolphin Stranding Due to Cetacean Morbilivirus**

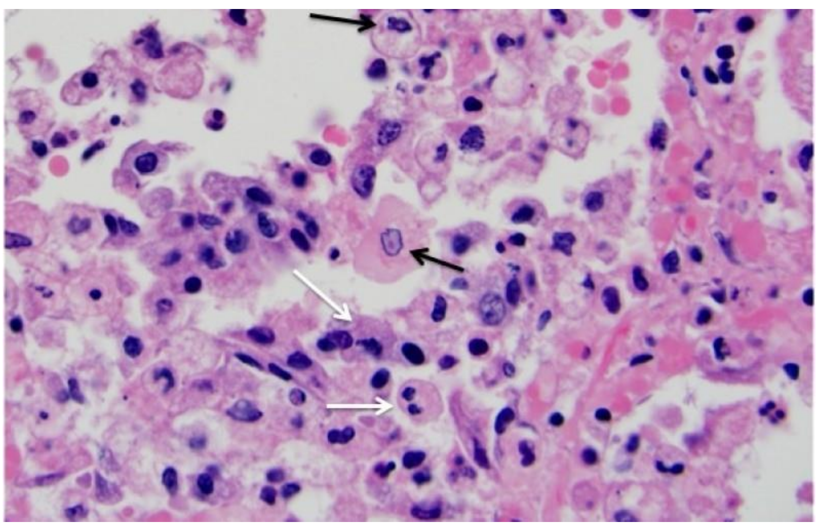


**Figure 2: Cetacean Morbilivirus**

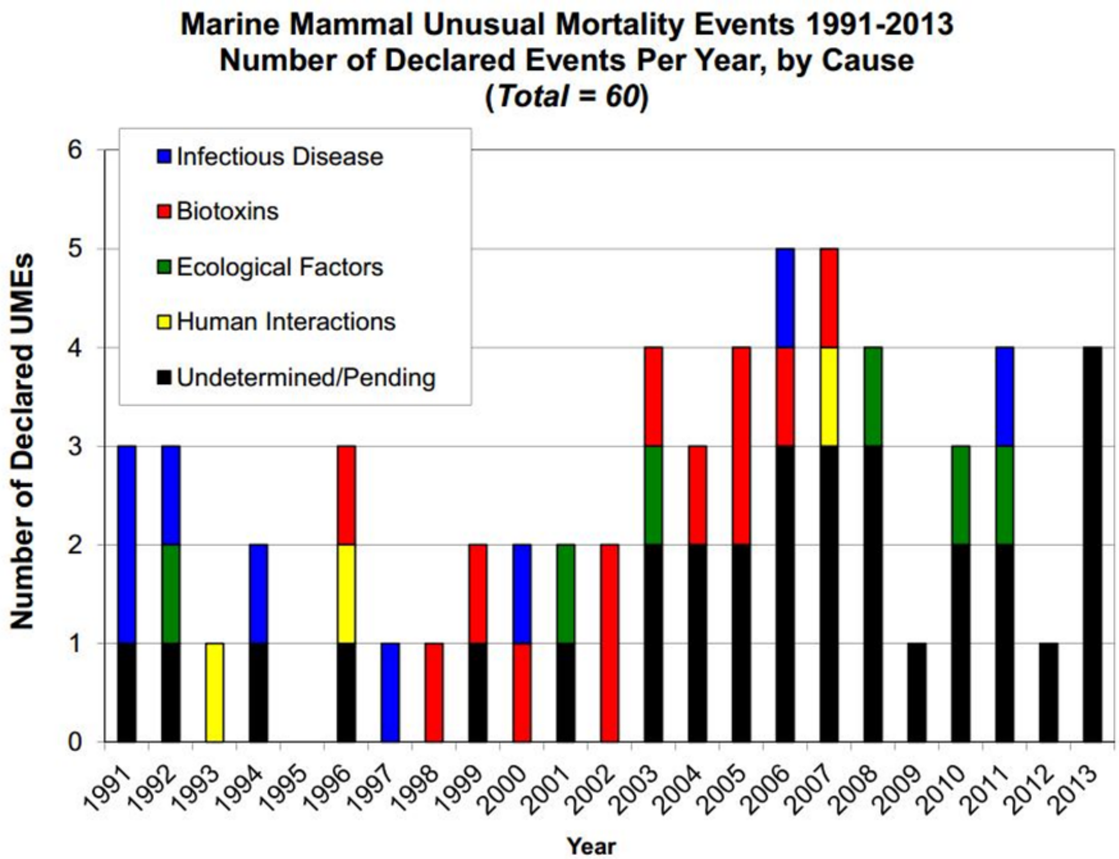



**Figure 3: Causes of Unusual Mortality Events (UMEs) for Bottlenose Dolphins**

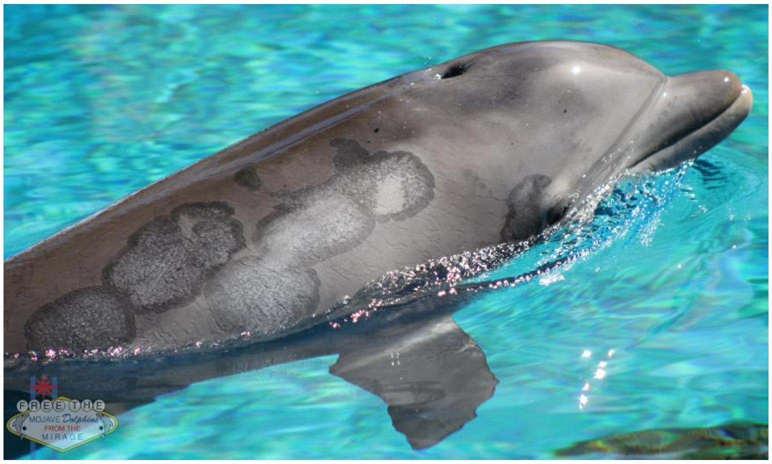


**Figure 4: Mild Cetacean Morbilivirus**

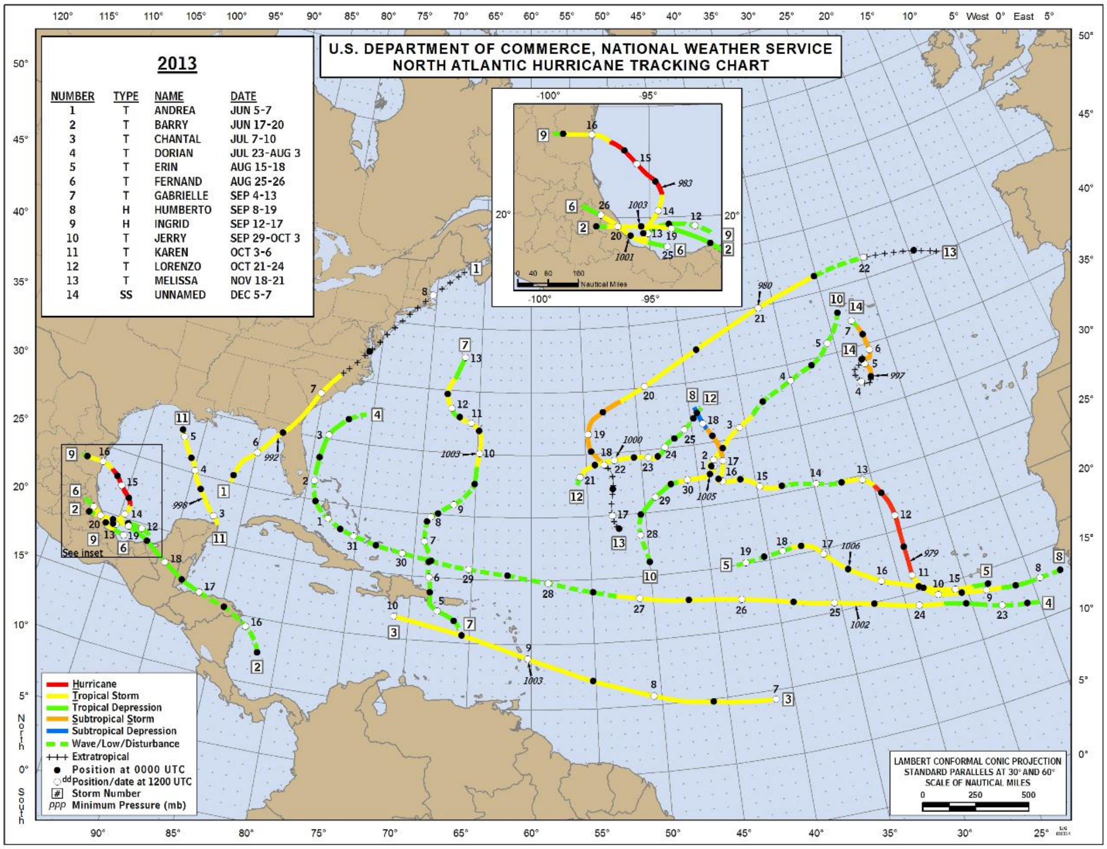



**Figure 5: Map of 2013 Hurricane Tracking Chart**

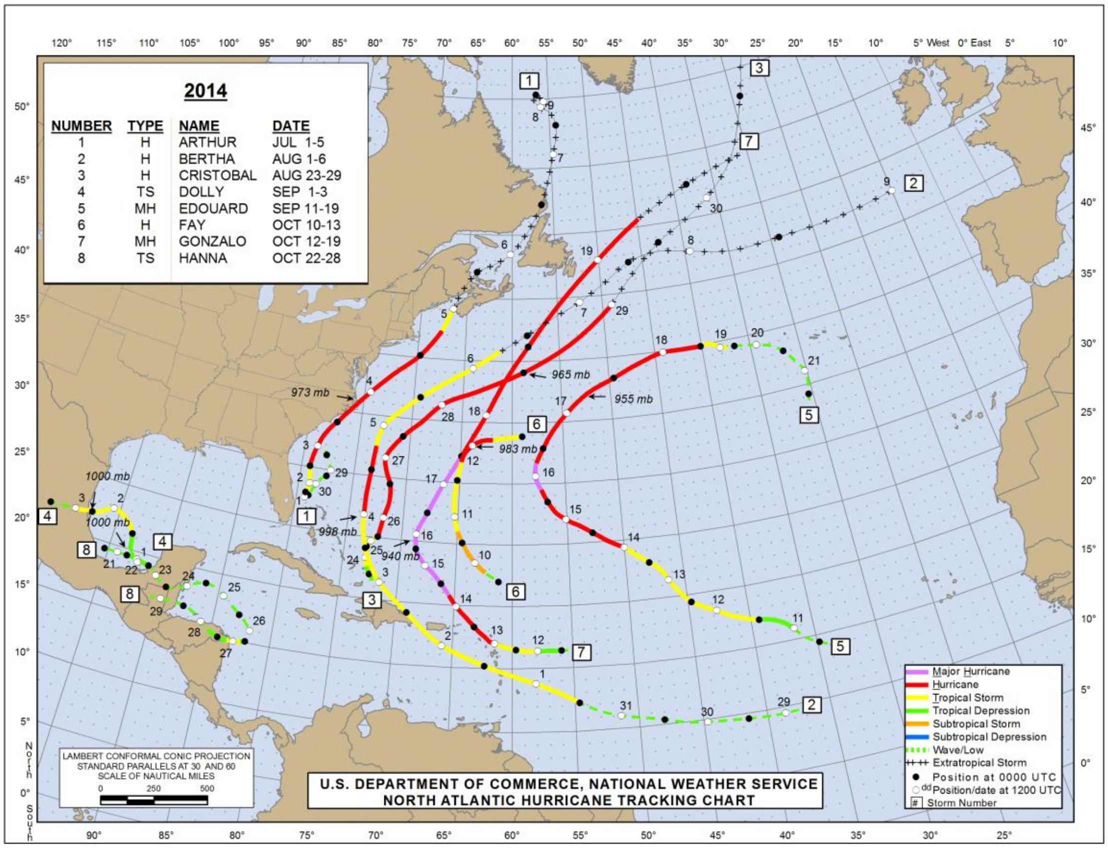



**Figure 6: Map of 2014 Hurricane Tracking Chart**

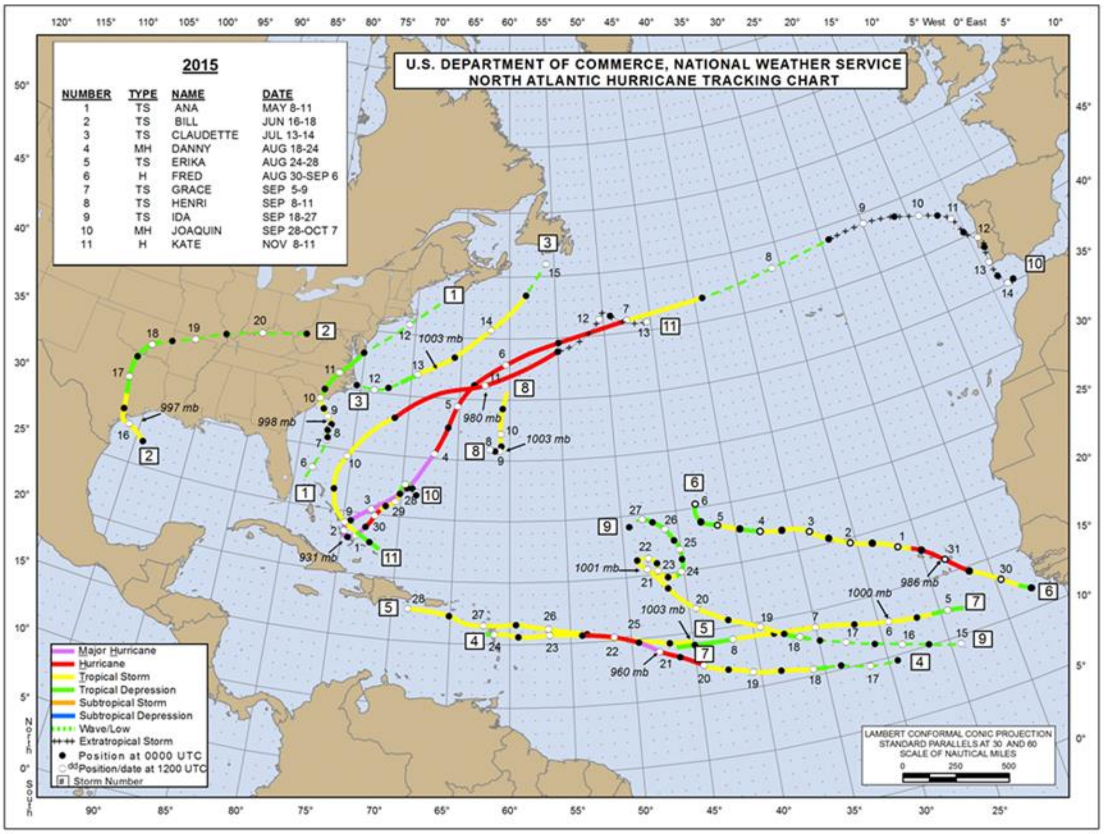



**Figure 7: Map of 2015 Hurricane Tracking Chart**

Tables

**Table 1: Tidal Shorelines Versus Bottlenose Dolphin Strandings**

| ***State*** | ***Tidal Shore Amount (Miles)*** | ***Number of Strandings*** |
|---|---|---|
| ***Delaware*** | 381 | 64 |
| ***Florida*** | 3331 | 306 |
| ***Georgia*** | 2344 | 84 |
| ***Maryland*** | 3190 | 72 |
| ***North Carolina*** | 3375 | 272 |
| ***New Jersey*** | 1792 | 157 |
| ***New York*** | 1850 | 45 |
| ***South Carolina*** | 2876 | 166 |
| ***Virginia*** | 3315 | 378 |
| | | |
| ***Total*** | 22454 | 1544 |
| ***Mean*** | 2494.89 | 171.56 |

***Correlation Coefficient:*** .65

**Table 2: Major Weather Events of 2013 By Month**

| SEASON | MONTH | MAJOR WEATHER EVENTS |
|---|---|---|
| **WINTER** (JAN. 1- MAR. 19) | January | |
| | February | • Record snow storms across the northeastern coast and central US<br>• Blizzard classified as major event (Feb. 7-10) in northeast |
| **SPRING** (MAR. 20- JUN. 21) | March | • Significant snowstorm in northeast (Mar. 4-9)<br>• Coldest March in Florida history<br>• Multiple winter storms across northeastern coast |
| | April | • |
| | May | • Widest tornado in US history in Oklahoma<br>• Third warmest May in world history |
| **SUMMER** (JUN. 21- SEPT. 21) | June | • Hottest June in world history<br>• 2 tropical storms (June 5-7, 17-20) |
| | July | • 6th warmest July in world history<br>• Wettest July on record in Florida<br>• Extreme flooding along US eastern coast<br>• 2 tropical storms (July 7-10, 23-Aug. 3) |
| | August | • Wettest summer in US northeastern history<br>• 2 tropical storms (Aug. 15-18, 25-26) |
| **FALL** (SEPT. 22- DEC. 20) | September | • Tropical storm (Sept. 4-13)<br>• Tropical depression (Sept. 6-7)<br>• 2 hurricanes (Sept. 8-19, 12-17) |
| | October | • 3 tropical storms (Sept. 29- Oct. 3, Oct. 3-6, 21-24) |
| | November | • Warmest November in world history<br>• Tornado outbreak in Indiana and Illinois<br>• Tropical storm (Nov. 18-21) |
| **WINTER** (DEC. 21- DEC. 31) | December | • 4th warmest year in world history (since 1880)<br>• Arctic and Antarctica sea ice shrank the most in history<br>• Severe Thunder Storm (Dec. 5-7)<br>• Significant snowstorm in the northeast (Dec. 13- 16)<br>• Significant snowstorm in the northeast (Dec. 30- Jan. 3) |

**Table 3: Major Weather Events of 2014 By Month**

| | 2014 | MAJOR WEATHER EVENTS |
|---|---|---|
| **WINTER** (JAN. 1- MAR. 19) | January | • Significant snowstorm (Dec. 30- Jan. 3)<br>• Notable snowstorm (Jan. 20-22)<br>• Major snowstorm (Jan. 29- Feb. 4) |
| | February | • 2 Major snowstorm (Jan. 29- Feb. 4, Feb. 11-14) |
| **SPRING** (MAR. 20- JUN. 20) | March | |
| | april | |
| | May | |
| **SUMMER** (JUN. 21- SEPT. 22) | June | |
| | July | • Hurricane (July 1-5)<br>• Tropical depression (July 21-23) |
| | August | • 2 hurricanes (Aug. 1-6, 23-29) |
| **FALL** (SEPT. 23- DEC. 20) | September | • Major hurricane (Sept. 11-19)<br>• Tropical storm (Sept. 1-3) |
| | October | • Hurricane (Oct. 10-13)<br>• Major hurricane (Oct. 12-19)<br>• Tropical storm (Oct. 22-28) |
| | November | • Notable snowstorm (Nov. 26-28) |
| **WINTER** (DEC. 21- DEC. 31) | December | • Record breaking winter (Dec. 2014- Mar. 2015)<br>• Notable snowstorm (Dec. 9-14) |

**Table 4: Major Weather Events of 2015 By Month**

| | 2015 | MAJOR WEATHER EVENTS |
|---|---|---|
| **WINTER** (JAN. 1- MAR. 19) | January | • Record breaking winter (Dec. 2014- Mar. 2015)<br>• Significant snowstorm (Jan. 25-28)<br>• Major snowstorm (Jan. 29- Feb. 3) |
| | February | • Least amount of tornados in month of February in history of US<br>• Record breaking winter (Dec. 2014- Mar. 2015)<br>• Second coldest February in US history<br>• One of the coldest months in US history<br>• Major snowstorm (Jan. 29- Feb. 3)<br>• Notable snowstorm (Feb. 8-10) |
| **SPRING** (MAR. 20- JUN. 20) | March | • Least amount of tornados in month of March in history of US<br>• Record breaking winter (Dec. 2014- Mar. 2015)<br>• Mar. 23 Antarctica experienced warmest temperature in history (63.5 degrees F)<br>• Warmest March in Florida history |
| | April | • Warmest April in Florida history<br>• Warmest April in world history |
| | May | • Third warmest May in history<br>• Second earliest tropical storm on record (May 10) in South Carolina<br>• Warmest May in Florida history<br>• Wettest month in US history |
| **SUMMER** (JUN. 21- SEPT. 22) | June | • Tropical storm (June 16-18) |
| | July | • Snow in Massachusetts finally melts from the winter<br>• Tropical storm (July 13-14) |
| | August | • Major hurricane (Aug. 18-24)<br>• Tropical storm (Aug. 24-28) |
| **FALL** (SEPT. 23- DEC. 21) | September | • Hurricane (Aug. 30- Sept. 6)<br>• 3 Tropical Storms (Sept. 5-9, 8-11, 18-27)<br>• Tropical Depression (Sept. 16-19) |
| | October | • Major hurricane (Sept. 28- Oct. 7)<br>• Category 5 hurricane Patricia hits Mexico<br>• Extreme flooding in South Carolina |
| | November | • Strong tornados in central US (usual for November)<br>• Hurricane (Nov. 8-11) |

| | | |
|---|---|---|
| **WINTER** (DEC. 22-DEC. 31) | December | • Warmest year in world history<br>• 3rd strongest El Nino in world history (Pacific ocean) |

**Table 5: Percent of Strandings Each Season**

| SEASON | NUMBER OF STRANDINGS | PERCENTAGE OF STRANDINGS |
|---|---|---|
| **WINTER** | 182 | 12% |
| **SPRING** | 174 | 11% |
| **SUMMER** | 733 | 48% |
| **FALL** | 454 | 29% |

**Table 6: Number of Strandings In 2013 Per Month**

**Number of Strandings Per Month in 2013**

| *Month* | *Total Number for the month* | *States* |
|---|---|---|
| ***May*** | 2 | New Jersey, New York |
| ***June*** | 4 | Maryland, New Jersey, New York |
| ***July*** | 97 | Delaware, Florida, Maryland, New Jersey, New York, North Carolina, South Carolina, Virginia |
| ***August*** | 339 | Delaware, Florida, Georgia, Maryland, New Jersey, New York, North Carolina, South Carolina, Virginia |
| ***September*** | 183 | Delaware, Florida, Georgia, Maryland, New Jersey, New York, North Carolina, South Carolina, Virginia |
| ***October*** | 126 | Delaware, Florida, Georgia, Maryland, New Jersey, North Carolina, South Carolina, Virginia |
| ***November*** | 139 | Delaware, Florida, Georgia, Maryland, New Jersey, North Carolina, South Carolina, Virginia |
| ***December*** | 125 | Delaware, Florida, Georgia, New Jersey, North Carolina, South Carolina, Virginia |

**Table 7: Number of Strandings In 2014 Per Month**

**Number of Strandings In 2014 Per Month**

| *Month* | *Total Number for the month* | *States* |
|---|---|---|
| ***January*** | 54 | Florida, Georgia, Maryland, North Carolina, South Carolina |
| ***February*** | 38 | Florida, Georgia, North Carolina, South Carolina |
| ***March*** | 43 | Florida, Georgia, North Carolina, South Carolina |
| ***April*** | 61 | Delaware, Florida, Georgia, North Carolina, South Carolina, Virginia |
| ***May*** | 57 | Delaware, Florida, Georgia, Maryland, New Jersey, New York, North Carolina, South Carolina, Virginia |
| ***June*** | 52 | Delaware, Florida, Georgia, Maryland, New Jersey, New York, North Carolina, South Carolina, Virginia |
| ***July*** | 61 | Florida, Georgia, Maryland, New York, North Carolina, South Carolina, Virginia |
| ***August*** | 47 | Florida, New Jersey, New York, North Carolina, South Carolina, Virginia |
| ***September*** | 32 | Florida, Georgia, New Jersey, New York, North Carolina, South Carolina, Virginia |
| ***October*** | 24 | Florida, North Carolina, South Carolina, Virginia |
| ***November*** | 20 | Florida, North Carolina, South Carolina, Virginia |
| ***December*** | 11 | Florida, Georgia, New Jersey, South Carolina |

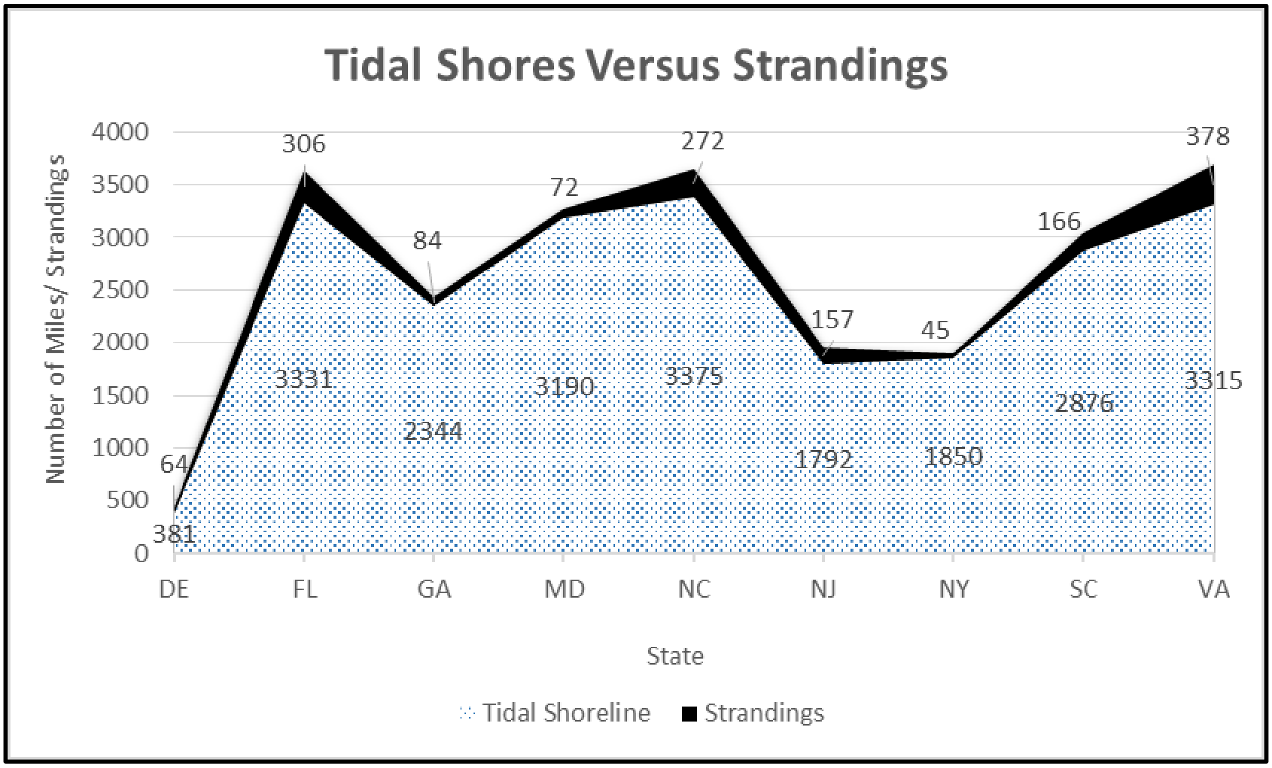
**Table 8: Number of Strandings In 2015 Per Month**

**Number of Strandings In 2015 Per Month**

| *Month* | *Total Number for the Months* | *States* |
|---|---|---|
| ***January*** | 12 | Florida, Georgia, North Carolina, South Carolina |
| ***February*** | 8 | Florida, Virginia |
| ***March*** | 9 | Florida, Virginia |

Graphs

**Graph 1: Tidal Shorelines Versus Bottlenose Dolphin Strandings (2013-2015)**



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