Evaluation of Possible Sharknados

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Preface

You are a data scientist for a mid-sized business, in a small group of 3-4 data scientists. You've been tasked with creating a report evaluating a scenario for your business. Your colleagues will also be evaluating the same scenario, and your reports will be used in aggregate to determine a consensus (or lack thereof) on the company's action. The reports will also be used to inform downsizing that is rumored to be coming - you want to ensure your report is better than your peers so that you aren't as easy to cut.

You may talk to your peers who are assigned the same scenario, but you do not want to collaborate too closely, lest you both become targets of the rumored layoffs.

I've scaffolded this report for you to make this process easier - as we talk about different sections of a report in class and read about how to create similar sections, you will practice by writing the equivalent section of your report.

The basic steps for this task are as follows:

- Identify the research question from the business question

What is the frequency of tornadoes that form in shark infested waters on the coastline happen to move inwards, and how common is it that these same tornadoes also have the strength to lift sharks from those waters?

- Identify data set(s) which are (1) publicly available (you don't have a budget to pay for private data) and (2) relevant to your task
  - (HW Week 6) Document your data sets in `draft-data-doc.qmd`
- Conduct a statistical analysis to support your answer to your research and business questions
  - Write a methods section for your business report corresponding to your statistical analysis
  - (HW Week 9) Draft of results section of business report with relevant graphics/visual aids in `draft-results.qmd`

- Write your report
  - (HW Week 10) Draft of Intro/Conclusion sections in `draft-intro-conclusions.qmd`
  - (HW Week 11) Draft of Executive summary section in `draft-exec-summary.qmd`
- Revise your report
  - (HW Week 12 – not turned in) Revise your report
  - (HW Week 13) - Rough draft of report due. Create one or more qmd files for your report (you can overwrite or delete intro.qmd and summary.qmd), include the names of each file (in order) in `_quarto.yml`. You should use references (edit references.bib and use pandoc citations). Make sure your report compiles and looks reasonable in both html and pdf.
  - Develop a presentation to go along with your report (Week 13). Create slides for your report using quarto.
- Peer revise reports
  - Peer revise reports
  - (HW Week 14) - Make edits to your report from comments received from peer review
- Final report & presentation due

1 Introduction

1.1 Big Picture

1.1.1 Who is my audience

1.1.1.1 Boss who is scared of a sharknado could occur in real life

1.1.1.1.1 Talk about what Tornadoes that form over water are called

1.1.1.1.2 Discuss the differences between Tornadoes and Waterspouts

1.1.1.1.2.1 Explain why these differences matter

1.1.1.1.2.2 IRL a sharknado would be classified as a Waterspout that transitions into a tornado when it moves over land

A waterspout would then be classified as a tornado

1.1.1.1.3 Discuss basic information about the shark population around coastal areas

1.2 Establish a niche

1.2.1 Problem : Can we predict if a sharknado will ever be possibe to occur IRL using exisiting data about sharks and tornadoes

1.2.2 Gap in Knowledge

1.2.2.1 Waterspouts are not classified as tornadoes, so many do not have a Tor F Scale to judge how powerful they are

1.2.2.2 Using shark data that is from a different time period of our Tornado Data??

1.3 Occupy a Niche

1.3.1 How does the work approach the niche that's been identified

1.3.2 What approaches are being used

1.3.2.1 Not detailed methods, but past literature on how those methods were established may be useful

1.3.3 How does the answer solve the open problem

1.4 State central question/approach OR Summary of results

This is a book created from markdown and executable code.

See Knuth (1984) for additional discussion of literate programming.

2 Summary

In summary, this book has no content whatsoever.

References

Knuth, Donald E. 1984. "Literate Programming." *Comput. J.* 27 (2): 97–111. https://doi.org/10.1093/comjnl/27.2.97.

A Draft: Data Documentation

Here is some databases I've found that may be able to help answer this question

https://www.fisheries.noaa.gov/inport/item/46426

```
######### shark data
library(readr)
Biological_Data_SBK <- read_csv("Datasets/Shark Datasets/Biological _Data_SBK.csv")
```

```
New names:
Rows: 99 Columns: 26
-- Column specification
-------------------------------------------------------- Delimiter: "," chr
(14): Shark_Number...1, Gear_code, Gear_Description, Location_Code, Loca... dbl
(12): Month, Day, Year, Latitude, Longitude, Fork_length, Stomach Weight...
i Use `spec()` to retrieve the full column specification for this data. i
Specify the column types or set `show_col_types = FALSE` to quiet this message.
* `Shark_Number` -> `Shark_Number...1`
* `Shark_Number` -> `Shark_Number...16`
```

Who collected the data: The first dataset is from the Southeast Fisheries Science Center which is a part of NOAA Fisheries and National Ocean Services database.

Why was the data collected: The data was collected to investigate the foraging ecology of early life stages of blacktip sharks in Florida, to determine levels of resource overlap.

What is the data about: The data is about analyzing the biological information and diet information of blacktip sharks in Florida to examine foraging ecology, bioenergetics, and trophic level.

When was the data collected: The data was collected from 2008 to 2010

Where was the data collected: The data was collected at Crooked Island Sound and Gulf of Mexico side of St. Vincent Island, Florida

How was the data generated: The data was generated by using either a gillnet or bottom longline and bait to sample sharks and record their biological informaiton and diet information

Structure: .csv file

Formatting descisions: Day, Month, and Year each have their own separate columns

Data Validation / Quality control: This is from a government site so it will hopefully be of good quality some missing values

License: There is no Data Access Policy or Use Constraints listed

https://catalog.data.gov/dataset/shark-and-red-snapper-bottom-longline-survey

```r
# NOAA
# given from Dr. VanderPlas
library(readxl)
```

```
Warning: package 'readxl' was built under R version 4.4.3
```

```r
NMFS_BLL_data_Susan_V <- read_excel("Datasets/Shark Datasets/NMFS BLL data Susan V.xlsx")
```

Who collected the Data: The Southeast Fisheries Science Center which is a part of NOAA

Why was the data collected: Provide standardized, fisheries-independent information on the abundance and distribution of shark, snapper, and grouper species

What the data is about: It includes details such as species identification, measurements, weights, and life history data related to age, growth, and reproduction

When the data was collected: The data was collected from 2010 to 2024

Where the data was collected: The data was collected on survey sites around the coasts of the Southeast of the United States and in the Gulf of Mexico

How was the data generated: The data was generated by using a bottom longline to collect sharks. Sampling occurred during both day and night. Live sharks were typically tagged and released unless biological samples were needed.

Structure of the Data: excel file

Formating desicions in the data: Station Date is formatted : YYYY,MM,DD HH:MM:SS Species name is listed as its scientific name

Data Validation / Quality Control: This is from a government site so it will hopefully be of good quality

License: No specific license is provided

https://data.ca.gov/dataset/shark-incident-database-california

```r
# California Department of Fish and Wildlife
library(readxl)
shark_incidents_california <- read_excel(
  "Datasets/Shark Datasets/SharkIncidents_1950_2022_220302.xlsx")
```

Who collected the Data: The California Department of Fish and Wildlife

Why was the data collected: Data are added whenever a shark incident occurs, this can be more or less frequent

What the data is about: It includes details such as information on the date, time, location, water depth, human activity, injury (if any), species of shark, and source information.

When the data was collected: The data was collected from 1950 to 2022

Where the data was collected: The data was collected on the coasts of California

How was the data generated: The data is generated whenever a shark incident occurs, this can be more or less frequent

Structure of the Data: excel file

Formating desicions in the data: Date is formatted : YYYY-MM-DD Time is formatted : 0.___ hrs Species name is listed as its common name, there are two blue sharks, one blue and one blue*

Data Validation / Quality Control: This is from a government site so it will hopefully be of good quality

License: No specific license is provided There are no restrictions on public use

https://geo.pacioos.hawaii.edu/geoserver/web/npmv1UZSWswBsFRdH0hAuV6DPDdMGJhqufNuSr_FyK6pxa

```r
library(sf)
```

```
Linking to GEOS 3.13.0, GDAL 3.10.1, PROJ 9.5.1; sf_use_s2() is TRUE
```

```r
shark_hawaii <- st_read("Datasets/Shark Datasets/PACIOOS_WMS_ONLY-hi_pacioos_all_shark_tiger
```

```
Reading layer `hi_pacioos_all_shark_tiger' from data source
  `C:\Users\jesus\Downloads\Spring 2025\STAT 349\HW\Week 5\business-report-jesusrod44\Datase
  using driver `KML'
Simple feature collection with 7036 features and 2 fields
Geometry type: POINT
Dimension:     XY
Bounding box:  xmin: -175.757 ymin: 13.6315 xmax: -146.933 ymax: 33.408
Geodetic CRS:  WGS 84
```

Who collected the Data: The Pacific Islands Ocean Observing System

Why was the data collected: Data was collected in order to track Behavioral and Oceanographic Data of tiger sharks

What the data is about: The movements of tiger sharks

When the data was collected: The data was collected from 2016 to the present

Where the data was collected: The data was collected on the ocean coasts of Hawaii

How was the data generated: The data is generated when a tiger shark is tagged by the data collectors

Structure of the Data: KML file

Formating desicions in the data: Spatial KML Data, any desciption of an observation is in a spatial column that is hard to read

There is only one species recorded and that is tiger sharks

Data Validation / Quality Control: This is from an educational site so it will hopefully be of good quality

License: No specific license is provided

These datasets contain tornado information such as latitude, longtitude, magnitude, and category : https://www.ncdc.noaa.gov/stormevents/

```
######## tornado data

# NOAA / NCEI
StormEvents_details_ftp_v1_0_d2024_c20250216 <- read_csv("Datasets/Tornado_Datasets/StormEve
```

```
Rows: 67036 Columns: 51
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (26): STATE, MONTH_NAME, EVENT_TYPE, CZ_TYPE, CZ_NAME, WFO, BEGIN_DATE_T...
dbl (25): BEGIN_YEARMONTH, BEGIN_DAY, BEGIN_TIME, END_YEARMONTH, END_DAY, EN...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
(StormEvents_details_ftp_v1_0_d2024_c20250216)
```

```
# A tibble: 67,036 x 51
   BEGIN_YEARMONTH BEGIN_DAY BEGIN_TIME END_YEARMONTH END_DAY END_TIME
             <dbl>     <dbl>      <dbl>         <dbl>   <dbl>    <dbl>
 1          202405        23       1947        202405      23     1947
 2          202411        16        230        202411      18     1421
 3          202405        19       1839        202405      19     1902
 4          202405        23       2155        202405      23     2155
 5          202411        22        400        202411      22     1100
 6          202411         1          0        202411       1     1600
 7          202411         1          0        202411       1     1600
 8          202411        22        300        202411      22     1000
 9          202411        22        200        202411      22     1000
10          202411        17       1100        202411      18     2100
# i 67,026 more rows
# i 45 more variables: EPISODE_ID <dbl>, EVENT_ID <dbl>, STATE <chr>,
#   STATE_FIPS <dbl>, YEAR <dbl>, MONTH_NAME <chr>, EVENT_TYPE <chr>,
#   CZ_TYPE <chr>, CZ_FIPS <dbl>, CZ_NAME <chr>, WFO <chr>,
#   BEGIN_DATE_TIME <chr>, CZ_TIMEZONE <chr>, END_DATE_TIME <chr>,
#   INJURIES_DIRECT <dbl>, INJURIES_INDIRECT <dbl>, DEATHS_DIRECT <dbl>,
#   DEATHS_INDIRECT <dbl>, DAMAGE_PROPERTY <chr>, DAMAGE_CROPS <chr>, ...
```

```
StormEvents_details_ftp_v1_0_d2023_c20250216 <- read_csv("Datasets/Tornado_Datasets/StormEve
```

```
Warning: One or more parsing issues, call `problems()` on your data frame for details,
e.g.:
  dat <- vroom(...)
  problems(dat)
```

```
Rows: 75596 Columns: 51
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (26): STATE, MONTH_NAME, EVENT_TYPE, CZ_TYPE, CZ_NAME, WFO, BEGIN_DATE_T...
dbl (24): BEGIN_YEARMONTH, BEGIN_DAY, BEGIN_TIME, END_YEARMONTH, END_DAY, EN...
lgl  (1): CATEGORY

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
StormEvents_details_ftp_v1_0_d2022_c20241121 <- read_csv("Datasets/Tornado_Datasets/StormEve
```

```
Rows: 69886 Columns: 51
```

```
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (26): STATE, MONTH_NAME, EVENT_TYPE, CZ_TYPE, CZ_NAME, WFO, BEGIN_DATE_T...
dbl (25): BEGIN_YEARMONTH, BEGIN_DAY, BEGIN_TIME, END_YEARMONTH, END_DAY, EN...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
StormEvents_details_ftp_v1_0_d2021_c20240716 <- read_csv("Datasets/Tornado_Datasets/StormEve
```

```
Warning: One or more parsing issues, call `problems()` on your data frame for details,
e.g.:
  dat <- vroom(...)
  problems(dat)
```

```
Rows: 61389 Columns: 51
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (26): STATE, MONTH_NAME, EVENT_TYPE, CZ_TYPE, CZ_NAME, WFO, BEGIN_DATE_T...
dbl (24): BEGIN_YEARMONTH, BEGIN_DAY, BEGIN_TIME, END_YEARMONTH, END_DAY, EN...
lgl  (1): CATEGORY

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
StormEvents_details_ftp_v1_0_d2020_c20240620 <- read_csv("Datasets/Tornado_Datasets/StormEve
```

```
Rows: 61279 Columns: 51
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (26): STATE, MONTH_NAME, EVENT_TYPE, CZ_TYPE, CZ_NAME, WFO, BEGIN_DATE_T...
dbl (25): BEGIN_YEARMONTH, BEGIN_DAY, BEGIN_TIME, END_YEARMONTH, END_DAY, EN...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

Who collected the Data: The data was collected by the NCEI which is a port of NOAA

Why was the data collected: To document tornadoes that cause harm, property damage, or economic disruption

What the data is about: The description, location, and magnitude of tornadoes in the United States

When the data was collected: The datasets listed here are from 1950, and from 2020-2024. The NCEI has been documenting tornadoes since 1950. Each year is contained in its own dataframe before any data cleaning is done

Where the data was collected: The United Sates

How was the data generated: The National Weather Service is the main source of tornado data, which they collect through their network of weather forecast offices

Structure of the Data: .csv file

Formating desicions in the data: Dates are listed as YEARMONTH: YYYYMM, and Days are listed as Start Day and End Day

Data Validation / Quality Control: This is from a government site so it will hopefully be of good quality There are some missing values in the data

License: No specific license is provided

Here is the dataset I chose to plot coastal data: https://pubs.usgs.gov/of/2013/1284/title_page.html

```
# coastal data
library(sf)
CZMP_counties_2009 <-
  read_sf("Datasets/Coastal Datasets/CZMP_counties_2009/CZMP_counties_2009.shp")
```

Who collected the Data: The data was collected by the United States Geological Survey

Why was the data collected: The data was collected to create a shapefile of 492 Coastal Zone Management Program (CZMP) counties in the United States and some territories

What the data is about: Coastline data from the United States

When the data was collected: The data is from coastal ground conditions in 2009

Where the data was collected: The United Sates

How was the data generated: The CZMP counties shapefile was created using a three-step process involving the 2008 TIGER/Line shapefile, a NOAA list of CZMP counties, and reconciliation with historical county changes. In 2009, updates were made to align with the latest TIGER/Line data, increasing the dataset to 492 counties and 501 polygons. The shapefile was further revised following Alaska's withdrawal from the CZMP in 2011, but Alaskan county equivalents were retained for geographic reference, with a note that the data reflects 2009 conditions.

Structure of the Data: .shp file There is also a lot of other files that are contained in the Coastal Datasets folder in the Datasets folder

Formating desicions in the data: The 'geometry' column contains shape data on the latitude and longitude of the coasts that will need to be properly formatted when plotting

Data Validation / Quality Control: This is from a government site so it will hopefully be of good quality

License: No specific license is provided From the USGS: "The USGS is committed to and is making every possible effort to ensure that all electronic and information technology developed, procured, maintained, or used by the USGS is accessible to people with disabilities, including both our employees and the customers we serve."

Suggested Data Analysis Methods :

Use the Latitude and Longitude columns to plot the location of each shark When the shapefile for the coastal areas are plotted, we can see where these sharks are compared to the coastal areas Next, plot the torando start points and end points are plotted and find a way to code each tornado to a color or shape to help identify their category strength or magnitude

Finally, we can see if there is a high density of tornadoes that form close to the coast and also near shark infested waters that move inwards towards cities

B Draft: Results2

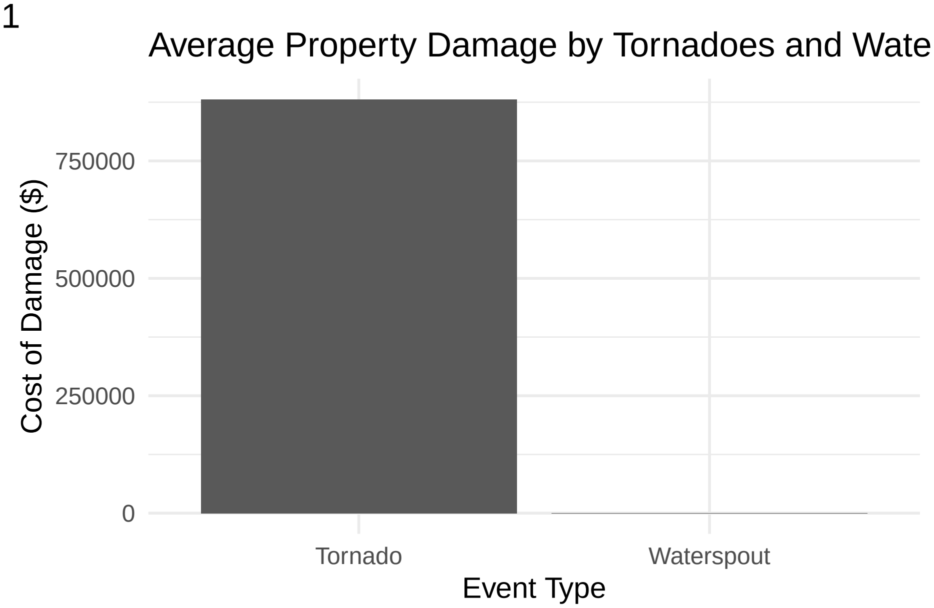
C Results

Tornadoes that form over water (also known as "Waterspouts") in shark-infested waters, *that also* move inwards towards land, do not have the potential to carry sharks over towards mainland cities to cause a disruption similar to the movie 'Sharknado'.

When plotting the data for sharks and waterspouts, it is apparent that waterspouts are not a common occurrence (at least in the past five years). These waterspouts have not caused any major damage to property or crops, and no deaths or injuries have been recorded, they either do not possess the strength to do so and many of these waterspouts do not last longer than an hour. The most action that has happened has been an incident where a waterspout damaged two vehicles and a power line, causing $5000 in damages. But when compared to tornadoes, this is very minuscule. This clearly shows that tornadoes that form on water lack the power necessary to lift sharks. In a perfect world, the better way to compare power is to compare levels on the Tor EF Scale. The scale that ranks how strong a tornado is from EF1 to EF5. However, waterspouts are not considered tornadoes and they do not have a power scale similar to tornadoes.

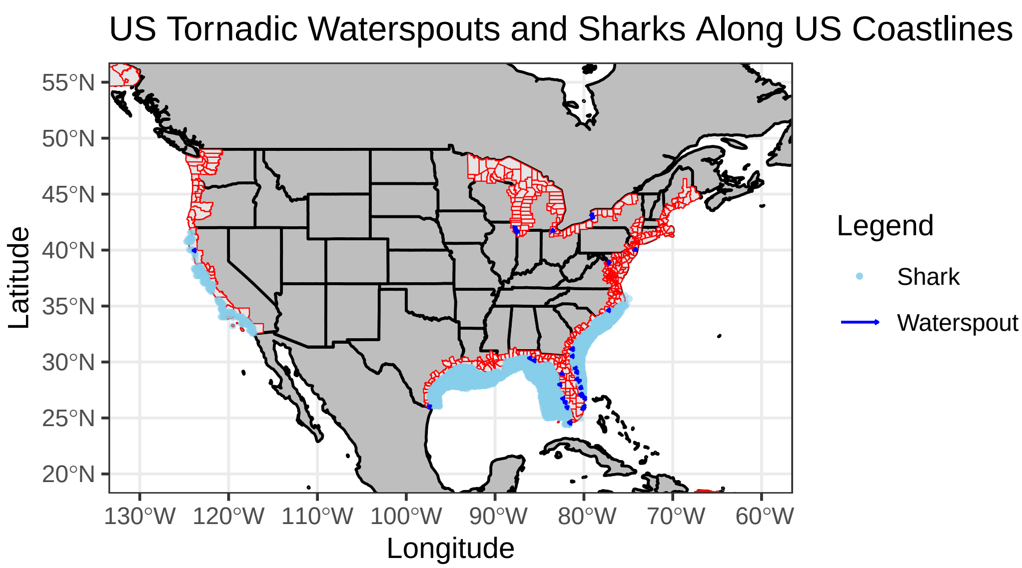
```
ggplot(property_damage_summary, aes(x = EVENT_TYPE, y = Average_Property_Damage)) + geom_col
```

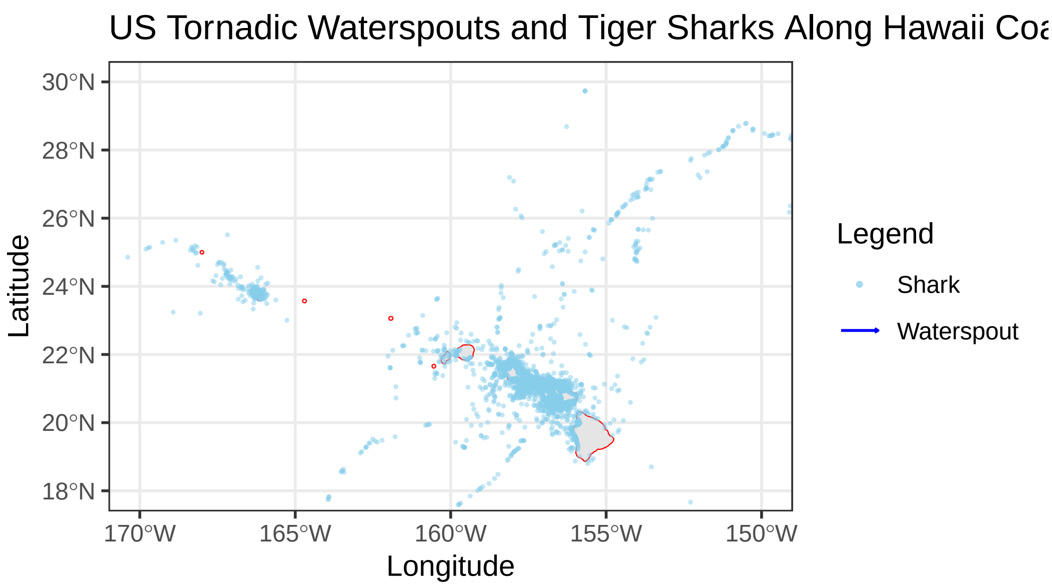
Figure 1

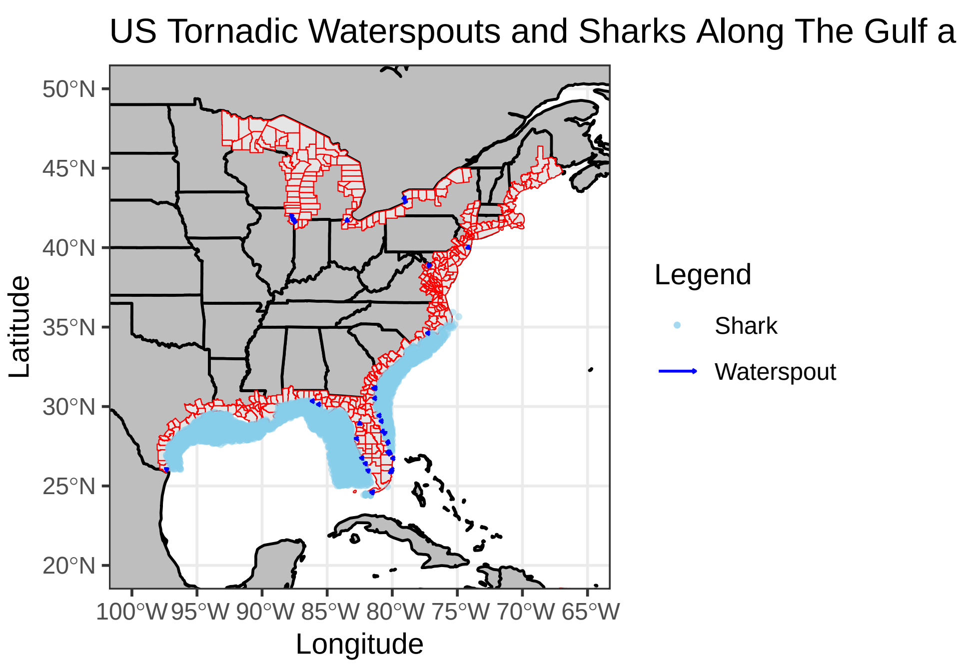


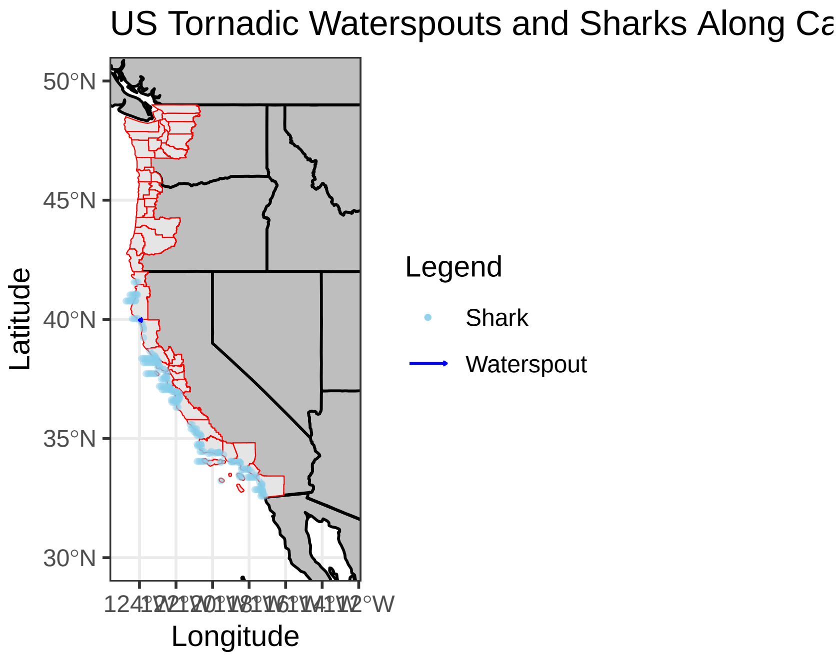
rspouts are very weak when compared to tornadoes. Their average in property damage is a $7.96.

Tornadoes that are strong enough to carry the weight of sharks do not typically form near the coasts.

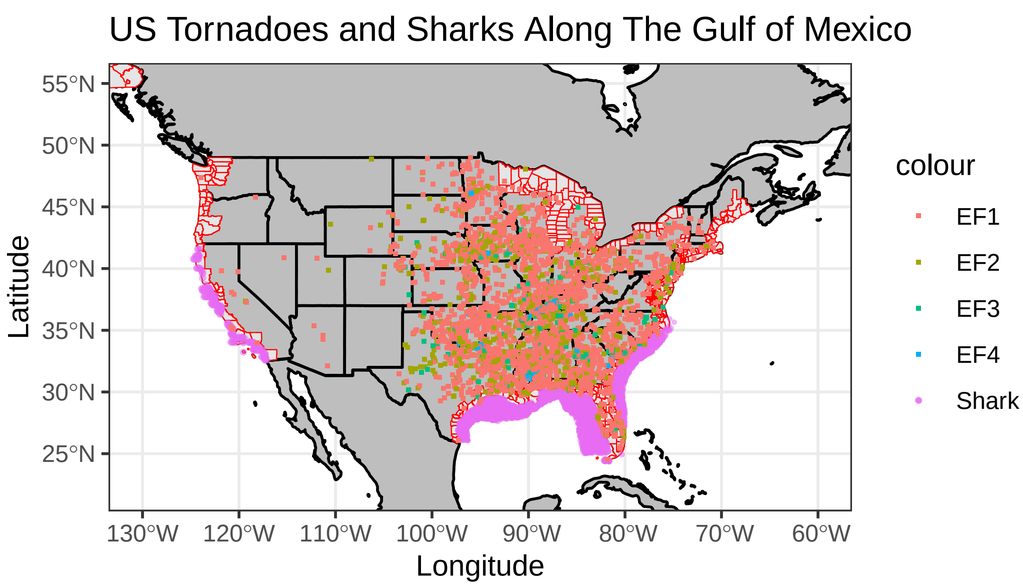



US Tornadic Waterspouts and Tiger Sharks Along Hawaii Coa
Latitude
30°N
28°N
26°N
24°N
22°N
20°N
18°N
170°W
165°W
160°W
155°W
150°W
Longitude
Legend
Shark
Waterspout

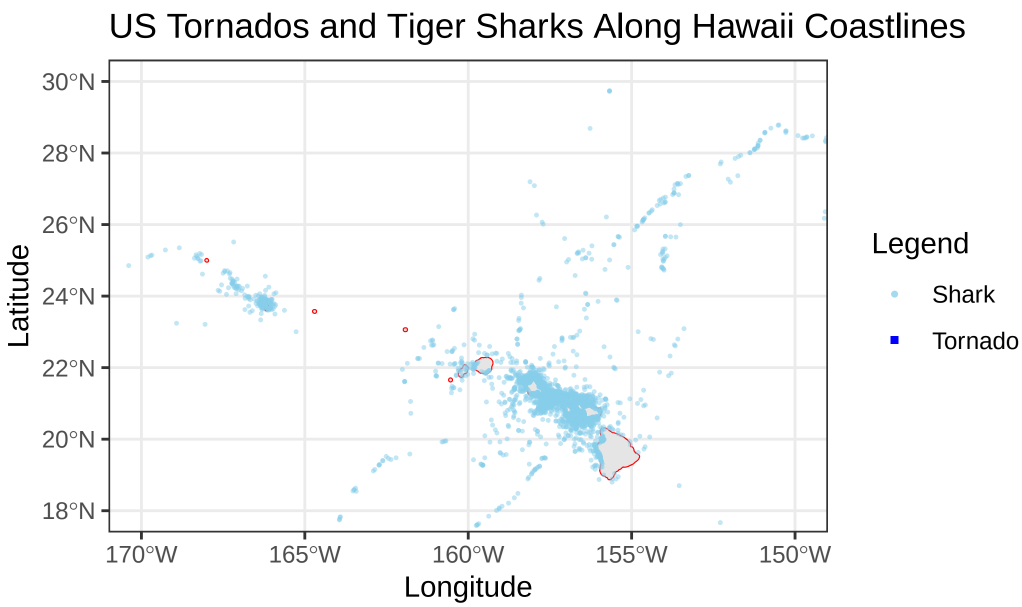

US Tornadic Waterspouts and Sharks Along The Gulf a
Latitude
50°N
45°N
40°N
35°N
30°N
25°N
20°N
100°W
95°W
90°W
85°W
80°W
75°W
70°W
65°W
Longitude
Legend
Shark
Waterspout

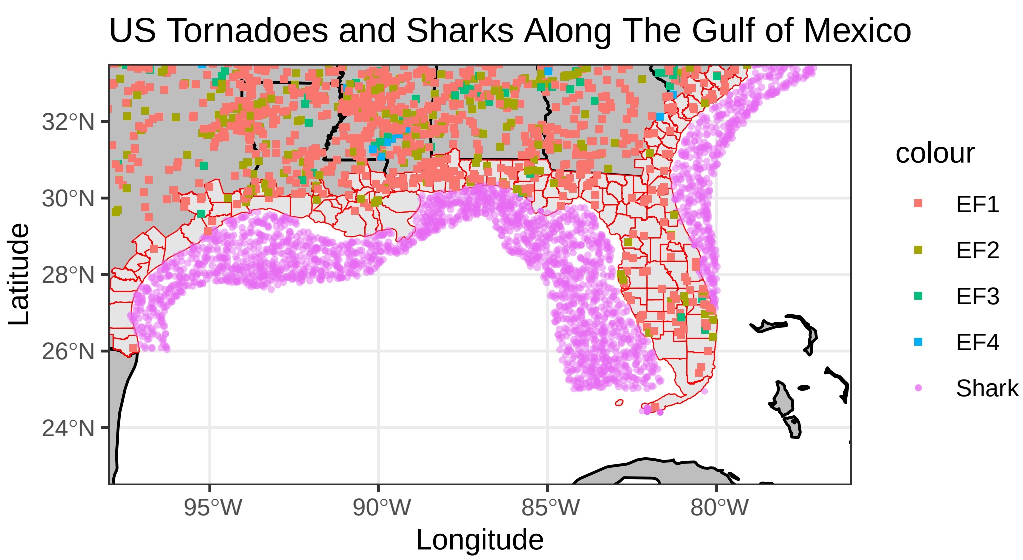


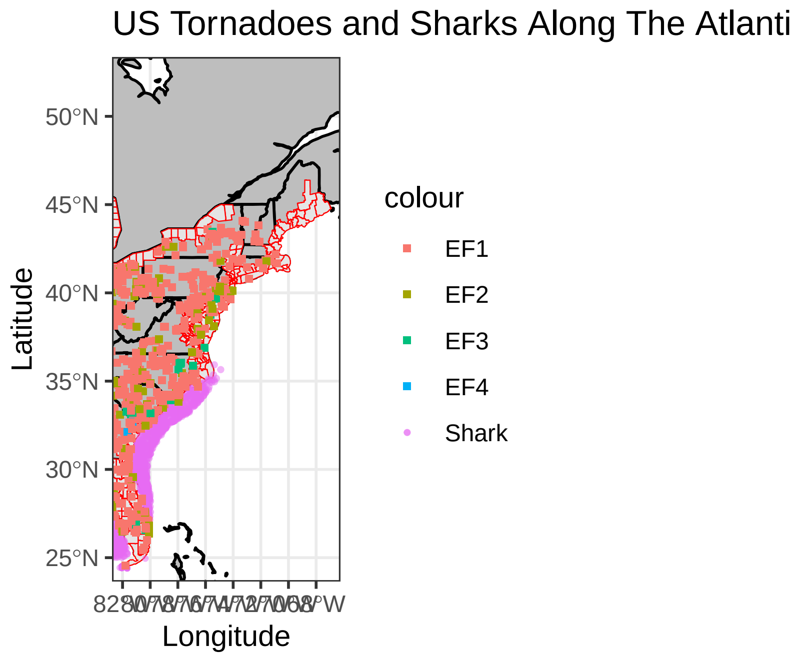
US Tornadic Waterspouts and Sharks Along Ca
50°N
45°N
40°N
35°N
30°N
Latitude
Longitude
Legend
Shark
Waterspout

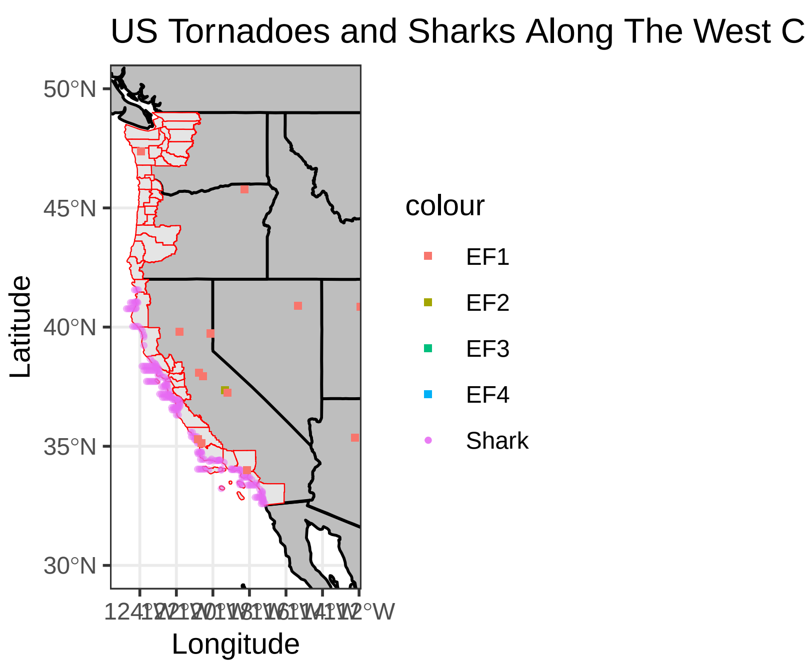


US Tornadoes and Sharks Along The Gulf of Mexico
55°N
50°N
45°N
40°N
35°N
30°N
25°N
Latitude
130°W
120°W
110°W
100°W
90°W
80°W
70°W
60°W
Longitude
colour
EF1
EF2
EF3
EF4
Shark


US Tornados and Tiger Sharks Along Hawaii Coastlines
30°N
28°N
26°N
24°N
22°N
20°N
18°N
Latitude
170°W
165°W
160°W
155°W
150°W
Longitude
Legend
Shark
Tornado

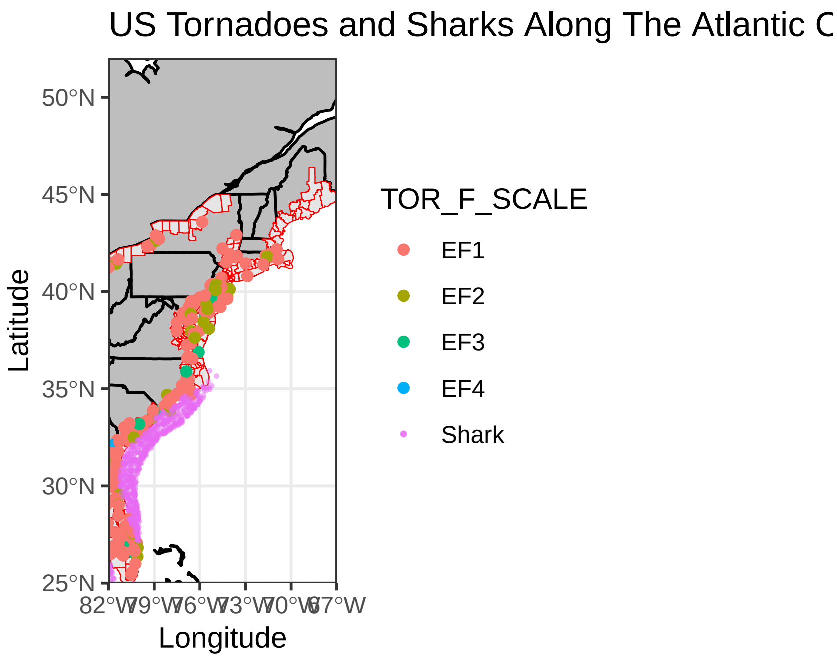

US Tornadoes and Sharks Along The Gulf of Mexico
32°N
30°N
28°N
26°N
24°N
Latitude
95°W
90°W
85°W
80°W
Longitude
colour
EF1
EF2
EF3
EF4
Shark

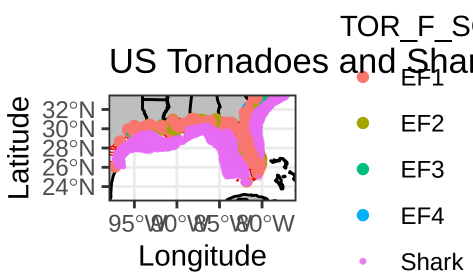


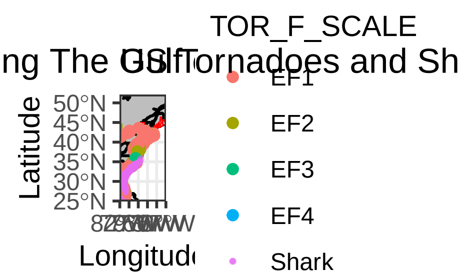


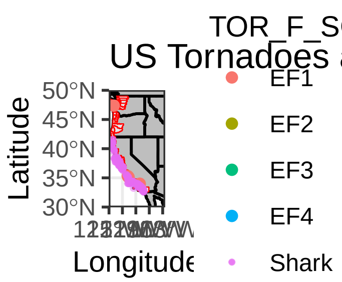

```
Observed Proportion of EF4 tornadoes: 0.0021

Observed Percentage of EF4 tornadoes: 0.21 %
```

Under the assumption that if an EF4 or EF5 tornado forms near the coast, they will become sharknados, the likelihood that would happen is very low









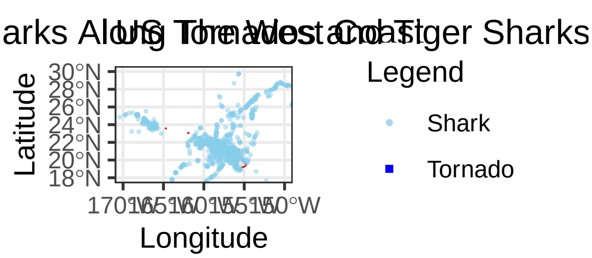
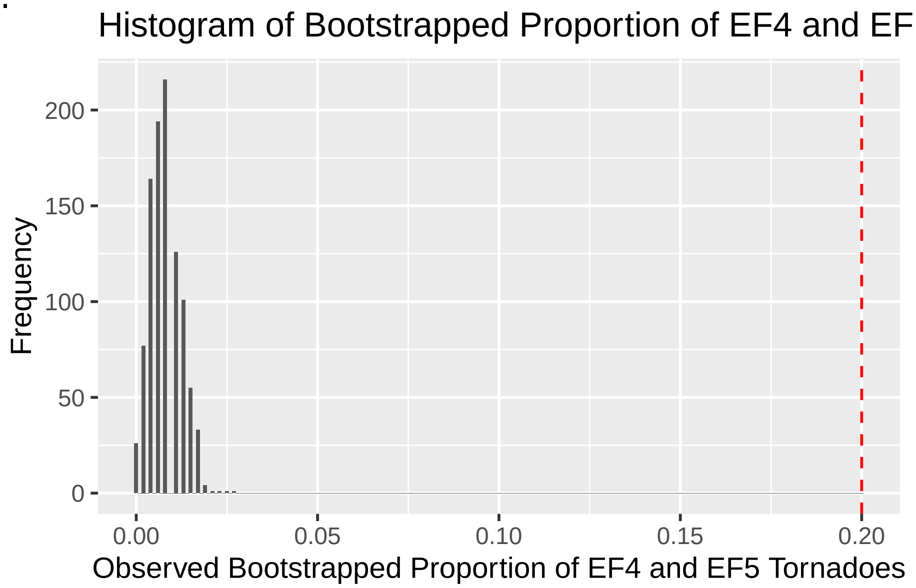


Figure 2.



The Red Dashed Line shows the probabilty of each EF scale occuring evenly, p=0.2

```
[1] 0
```

```
[1] 0.008071882
```

```
One-tailed p-value: 0
```

Given these very specific conditions: sharks are swimming close to the surface of the ocean. An EF5 tornado is the only tornado would be needed to carry sharks such as the hammerhead, tiger, and white shark. Given that there is no EF5 tornado observed in the data and EF4 tornadoes are also known to launch cars a considerable distance, we can assume that EF4 tornadoes will become sharknados when formed near the coast.

Assuming each tornado is independent of each other, and there EF scales are identically distributed, meaning that the relationship between EF scale and location is random. A bootstrap sample can be done to test that the probability of an EF4 tornado forming on the coast will happen at random, meaning that there is a chance that a tornado powerful enough to carry sharks (given the right conditions) will theoretically happen at random.

A null hypothesis of Ho: $p = 0.20$ is made. This null states that the probability of a EF4 tornado is equal to 20%, that also means all 5 categories have an equal chance of occurring. An alternative hypothesis states Ha: $p < 0.20$, meaning the chance of a tornado being an EF4 tornado on the coast is less than 0.20.

The observed proportion of EF4 tornadoes in our data is 0.0021 meaning, that in our observed sample, it is very unlikely for EF4 tornadoes to form near the coast. When bootstrapping, a bootstrapped observed proportion of EF4 tornadoes is 0.0080719. The tells us that the probability of our observation happening at random is approaching very closely to 0.

We do not have enough evidence to say that these EF4 and EF5 tornadoes appear on the coasts at random, so we must reject that idea and can confirm that it is not likely that tornadoes with the potential to cause shark-infested terror will be a threat people should be worried about in the future.

D Draft: Intro/Conclusions

E Introduction

E.1 A Real Life Sharknado?

There is a growing concern over the possibility of a real life *Sharknado*, a tornado that forms over water, gathers sharks in its powerful vortex, and then travels onto land, carrying the sharks with it. These sharknados wreak havoc all throughout the United States in locations like Los Angeles, New York City, and even Washington D.C. all the way down to Orlando, Florida raining sharks down from the sky. There have been circumstances where tornadoes have picked up animals such as fish and frogs, if one's imagination is not limited, one could see it be possible for tornadoes to carry sharks. Although this concept originates science fiction movie series, it raises serious questions on how thin the line between fiction and reality might be when it comes to such a catastrophic event.

E.2 Tornadoes and Sharks

To help figure out how a *sharknado* would be possible, the strenghts and conditions of tornadoes must be analyzed to see how they could carry these apex marine predators.

E.2.1 How Strong can a Tornado Be?

The Enhanced Fujita Scale (EF Scale), which is used to assign a tornado a rating based on estimated wind speeds. The scores and their estimated wind speeds go as follows:

E.3 Enhanced Fujita (EF) Scale and Wind Speeds

Table E.1: Table: Enhanced Fujita (EF) scale and corresponding wind speeds

EF_Rating	Wind_Speed_Range
EF0 (Weakest)	65 - 85 mph
EF1	86 - 110 mph
EF2	111 - 135 mph

EF_Rating	Wind_Speed_Range
EF3	136 - 165 mph
EF4	166 - 200 mph
EF5 (Strongest)	Over 200 mph

Minor damage such as broken tree branches and roof shingles being blown away can be expected from EF0 tornadoes. While on the other end of the spectrum, EF5 tornadoes can promise wind speeds that can decimate well built homes and infrastructure. These tornadoes can carry objects like cars with no trouble. An EF2 tornado is where we finally see enough force for winds to pick up a small car around 2000lbs, but not enough force for it to be thrown wildly. In the center, an EF3 tornado can remove the roofs off buildings on uproot small trees. An EF4 tornado is where we finally begin to see heavy objects such as trucks, cars, and semis be thrown around considerable distances.

An EF5 tornado will for sure have the potential to be a *sharknado,* and another contender is the EF4 tornado and maybe, if the conditions are just right, an EF3 tornado might be able to, however, this is being very generous. Our *sharknado* would realistically have to be a category EF5 or EF4 tornado in order to cause terror similar to the film.

E.3.1 Tornado or Waterspout?

This *sharknado* would need to have a tornado that forms over shark infested waters. A tornado that forms over water is usually classified as a waterspout. Waterspouts are not classified as tornadoes, so they are not given a score on the EF scale. If a waterspout moves on shore however, The National Weather Service classifies it as a tornado and issues a tornado warning for the area.

Waterspouts are generally broken into two categories: fair weather waterspouts and tornadic waterspouts. Fair weather waterspouts to put it simply are a less dangerous event that form during relatively calm weather and are not associated with thunderstorms. The phenonema of interest are tornadic waterspouts. These have the same characteristics of a land tornado, they are often accompanied by high winds, severe thunderstorms, large hail. It is essentially a tornado that forms over water, but it can also form by a tornado moving from land to water. If a *sharknado* would occur this is how it would form!

E.3.2 Sharks in Infested Waters in the United Sates

Sharks are found in coastal waters along the East Coast, Gulf of Mexico, and the Caribbeans. These waters are where a *sharknado* would have to form.

Sharks vary greatly in size and weight. Some common sharks and their average adult weights include:

Table E.2: Table: Shark species and typical weight ranges

Species	Weight_Range_lbs
Atlantic Sharpnose	15 - 25
Atlantic Blacktip	66 - 200
Tiger	850 - 1400
Hammerhead	500 - 1000
Sandtiger	200 - 350
The Great White	1500 - 2400

The sharks that were commonly seen inside the *sharknado* were the tiger shark, the hammerhead shark, and of course, the great white shark.

E.4 Can a Sharknado Actually Occur?

Is it possible to predict if a *sharknado* can happen in real life using exisiting data about sharks and tornadoes from years past?

To answer this burning question, a scrutinizing look at meteorological and marine data must be done.

F Conclusions

F.1 Tornadic Waterspouts Powerful Enough to Carry Sharks *And* Makes Landfall is an Unlikely Event

Key findings suggest that a sharknado is not likely to occur. Waterspouts do tend to form in shark infested waters, but these are not powerful enough to lift sharks that can weight up to 2400 lbs and relocate them to land. From the more powerful of the two types of waterspouts, tornadic waterspouts' power are limited and never seem to make landfall.

F.1.1 There is a Little Amount of Tornadoes with a High Enough EF Scale that form near the coasts

Tornadoes that do form near the coasts typically have an EF rating of EF2 or lower. An EF2 tornado *has* the power to lift a car and move it a ways from where it was, but when trying to find the possibility of lifting sharks throughout a city, a stronger EF4 tornado is very well needed to pull the sharks from the depths of the water. Although there are some EF3 tornadoes present in Florida, and EF3 tornadoes could pick up a car and throw them a considerable distance, the chance that sharks are swimming near the surface of the water to be pulled into the vortex is low. There is an EF4 tornado located in Georgia, however this tornado is not close enough to the ocean coasts that it would be able to make contact with the sharks present there.

F.2 Real World Interpretation

People of the United States that live on the coasts can be clear of mind that a sharknado will not be one of their worries when it comes to weather events such as hurricanes and tropical storms.

F.3 Limitations in Data and Knowledge

F.3.1 No Free Shark Survey Dataset (From a Trusted Source) that Has Observations on the West Coast or Northeast of America

Although our data showed that tornadic waterspouts and tornadoes that form near the coasts of America do not form too often and are not that powerful, there was not much comparison when plotting those events against sharks surveyed or spotted outside of the Southeast or Hawaii. Data for California was found, however that was not survey or tracking data, rather it was shark incident data. This leads to more sharks being plotted in places that have more people, preventing an evenly distribution of shark points on the map. Due to this limitation, our interpretation can only be justified that people on the coasts of the Southeast region of America near the Gulf of Mexico, Hawaii, and California.

F.3.2 Bootstrapping

Our probability observed from our bootstrapped sample of 0.008, only tells us that if the EF scales of the tornadoes in our dataset were randomized, and they were measured on the tornadoes near the coasts, that is the long run proportion of EF4 and EF5 tornadoes that will form near the coasts. However, the way the coastal data is set up, these tornadoes can be technically in the coastal region plotted, but be too far away from the coastline to be able to cause havoc with sharks. Our bootstrap probability is then not really the true average amount of tornadoes that would be able to lift sharks, and in reality it could be greater or it could be less.

F.3.3 Hurricanes?

In this report, only tornadoes were considered. This can be a bit problematic when looking at a place like Hawaii. There are very little tornadoes recorded in Hawaii, yet a lot of sharks. It could be argued, that a hurricane of great strength could be enough to lift the numerous sharks surrounding Hawaii, but in as stated previous, we are not interested in *Shark-icanes*.

F.3.4 Comparing Tornadoes and Waterspouts

Waterspouts do not have any classification of power similar to tornadoes. There in order to compare the differences in power between the two, the observed damage to property was looked at. A problem with this is that waterspouts will most likely be less damaging as they are not near much property at all when forming. This caused the averages to be compared instead, but there is still some limitations on how far the implication of just how strong waterspouts can be.

F.4 Future Directions and Implications

If a budget allows, using private data may be able to help know just how close these coastal tornadoes and tornadic waterspouts are to the shark population of America.

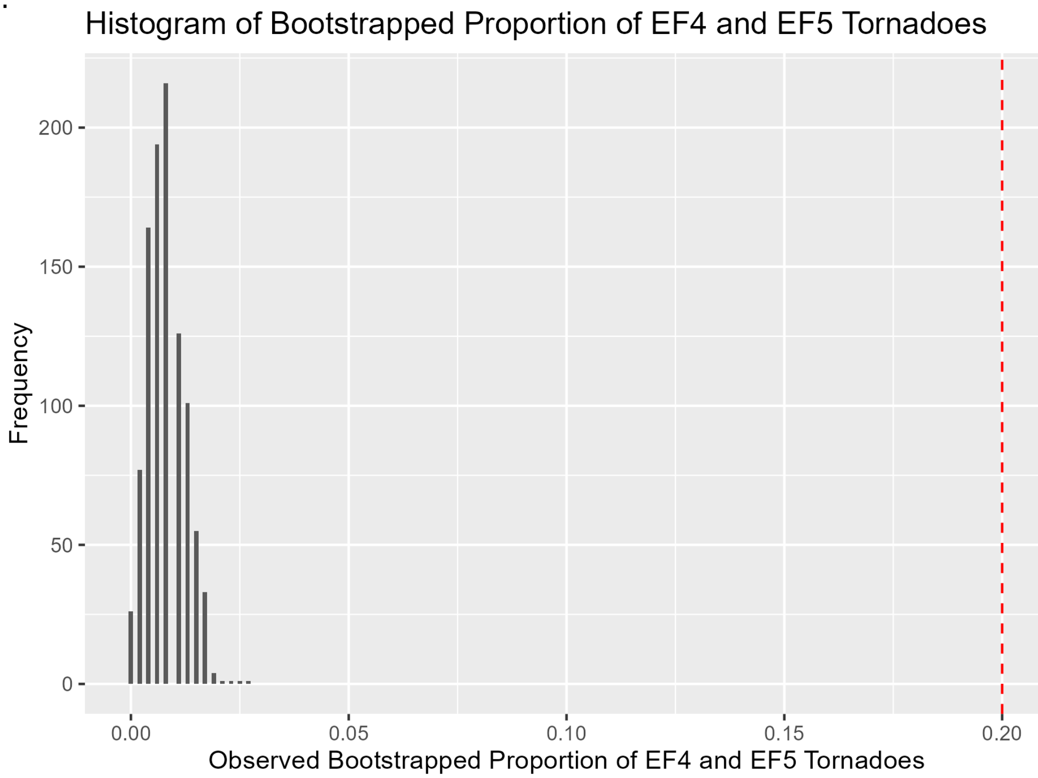
G Draft: Executive Summary

The Sharknado film series takes the idea of tornadoes picking up marine life to a dramatic extreme. While there has not been a documented case of a tornado hurling sharks onto land, we explored whether such an event is even scientifically plausible. We examined whether powerful tornadoes could form over or near coastal shark-infested waters, lift sharks into the air, and carry them inland.

To assess the likelihood of a tornado capturing sharks within its vortex and terrorizing the public, we analyzed tornado data from 2020 to 2024 and shark population data near U.S. coastlines, particularly around the Gulf of Mexico. We defined three key conditions that are required for a Sharknado to occur: (1) a tornado must be strong enough to lift a shark, (2) it must form over or near shark-inhabited waters, and (3) it must move inland.

Our findings indicate that waterspouts, tornadoes that form over water, are generally weaker than their land-based counterparts and are unlikely to lift large animals such as sharks. On the other hand, stronger tornadoes typically do not form directly over water or in close proximity to shark habitats. The two types of tornadoes with the potential to lift sharks from the water are EF4 and EF5 tornadoes given the very specific conditions that sharks are near the surface of the water. Assuming that if tornadoes form relatively near the coasts of the United States and shark-inhabited waters, the observed probability of EF4 and EF5 tornadoes forming on the coast is 0.0021. When bootstrapping under the assumption that each scale of tornado has an equal chance of happening (Null: $p = 0.2$), we get an observed bootstrap average of 0.008.

Figure 2.



The Red Dashed Line shows the probabilty of each EF scale occuring evenly, p=0.2

Therefore, while the Sharknado scenario remains a thrilling fictional concept, the probability of such an event occurring any time soon in real life is extremely low.