(Over)Analysis of Imminent Sharknados

- Jesus Rodriguez

Consider the Following

Sharks can be described by many as terrifying

Those who aren’t familiar with tornadoes may fear their potential for the decimation of houses and cities

Consider the Following

Combine both…

Could this occur tomorrow or the near future?

Should the people that live on the coasts of the United States be afraid?

Is a sharknado imminent?

Outline

The following topics will be analyzed in order to solve this burning question

- Introduction
  - Brief information about tornadoes, waterspouts, and sharks
- Evaluations
  - Analysis and distribution of tornadoes and sharks
- Results
  - How common tornadoes with potential for shark-terror are
- Recommendations
  - Should the people of the United State’s coastal cities live in fear or be rest assured of sharks raining from the sky

Introduction

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

Information needed:

- Can Tornadoes form over Water?
- How Strong does a Tornado Need to be in Order to Hurl Sharks from the Skies
- Distribution of Shark Population in the United States

Intro - Tornado Data (2020-2025)

Five datasets each containing information for a different year, were analyzed

Data was collected by trusted source: The National Oceanic and Atmospheric Association’s National Center for Environmental Information (NOAA’s NCEI)

Data from recent years were considered to better relate to current and future weather trends

Intro - Shark Data

Four Datasets, each from a different source, were chosen for analysis

- NOAA’s Southeast Fisheries Science Center (SEFSC) :
  - Blacktip Shark Biological Data
  - Bottomlongline Survey Data
- Pacific Islands Ocean Observing System (PACIOOS)
  - Tiger Shark Tracking Data
- California Department of Fish and Wildlife
  - Shark Incident Data

Intro - Coastal Data

Only one dataset for coastal data was utilized in this analysis

It comes from the the U.S. Geological Survey (USGS) and it is mainly used to highlight what are considered the coasts of the United States.

Intro - How Strong will a Tornado Need to be?

The Enhanced Fujita Scale (EF Scale) is used to assign a tornado a rating based on estimated wind speeds.

Table 1: 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
EF3	136 - 165 mph

Since EF4 and EF5 tornadoes are capable of flinging cars that weigh up to 2000 lbs with ease, these will be considered to have potential to capture sharks in their vortex

Table 2: 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

Intro - Can Tornadoes Form Over Water?

Tornadoes can form over water, but these are classified as a different phenomenon: Waterspouts

There are two types:

- Fair-weather Waterspouts
- Tornadic Waterspouts
    - These are more closely related to tornadoes and can be accompanied by thunderstorms or hail

Waterspouts have no classification similar to the EF Scale, therefore there is no concrete way to compare a tornado and waterspout

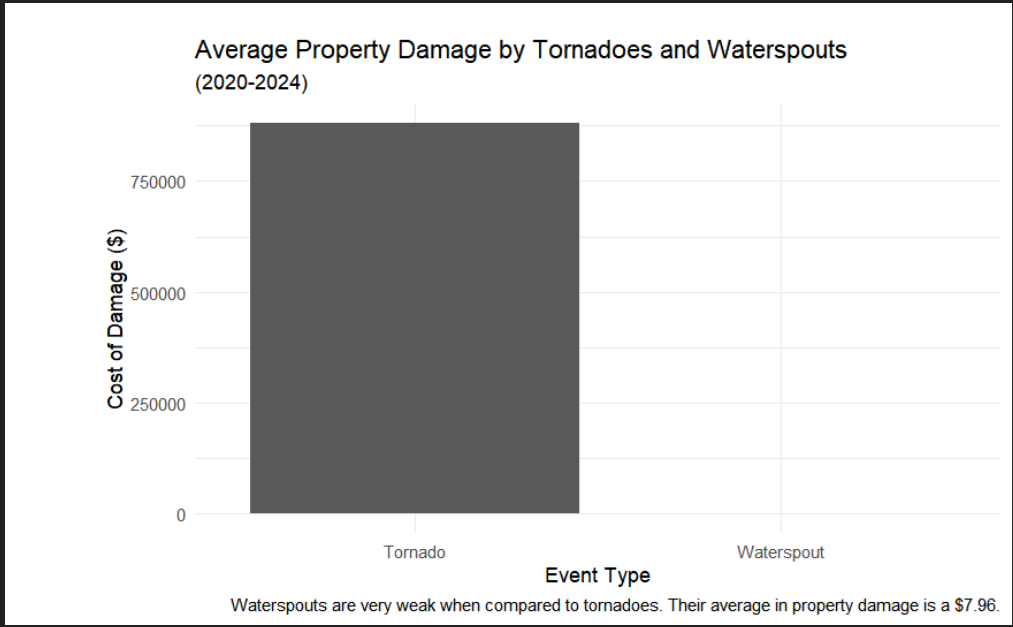
Evaluations - Tornadoes vs Tornadic Waterspouts

Due to no concrete classification of power for Waterspouts

The Average Property Damaged caused by Tornadoes and Waterspouts was compared

Results show that they lack in comparison when it comes to destroying property

Figure 1.



According to the data, the average property damage caused by Tornadic Waterspouts is less than $8

Evaluations - Tornadoes in the US by EF Scale

The tornadoes with the most potential are also the least common.

The last recorded EF5 Tornado in the US was in Moore, Oklahoma, tornado May 20, 2013

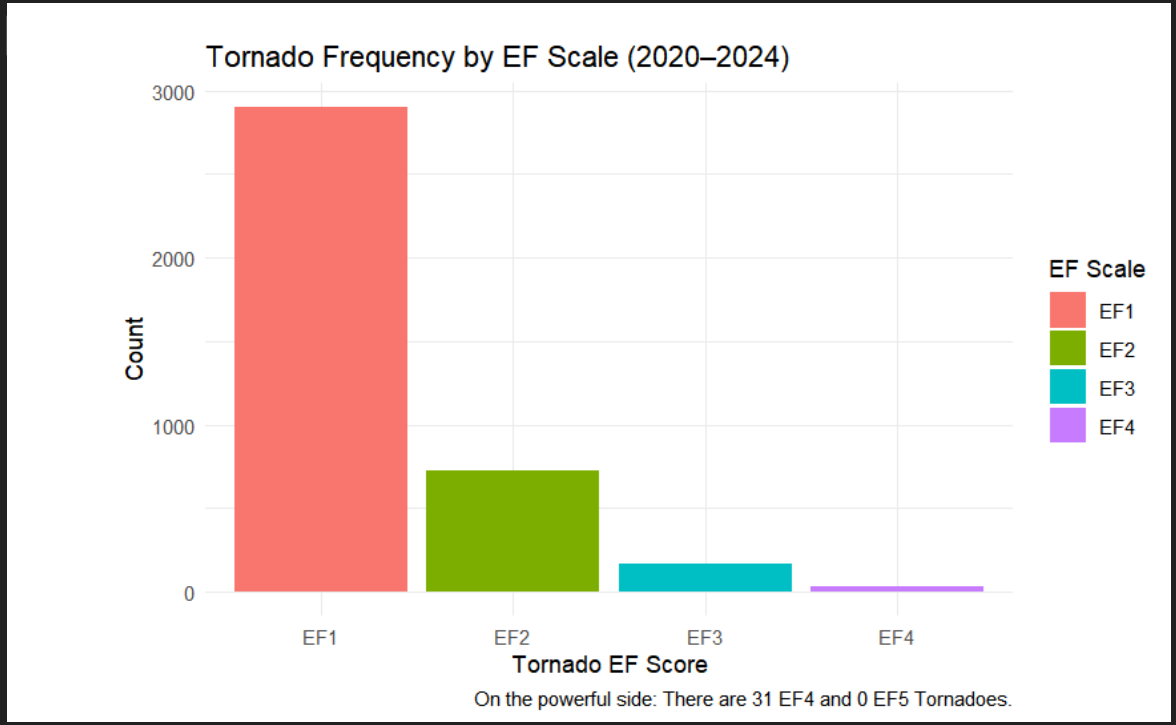


Figure 2.

Evaluations - Tornadoes and Sharks in the US

Figure 3.

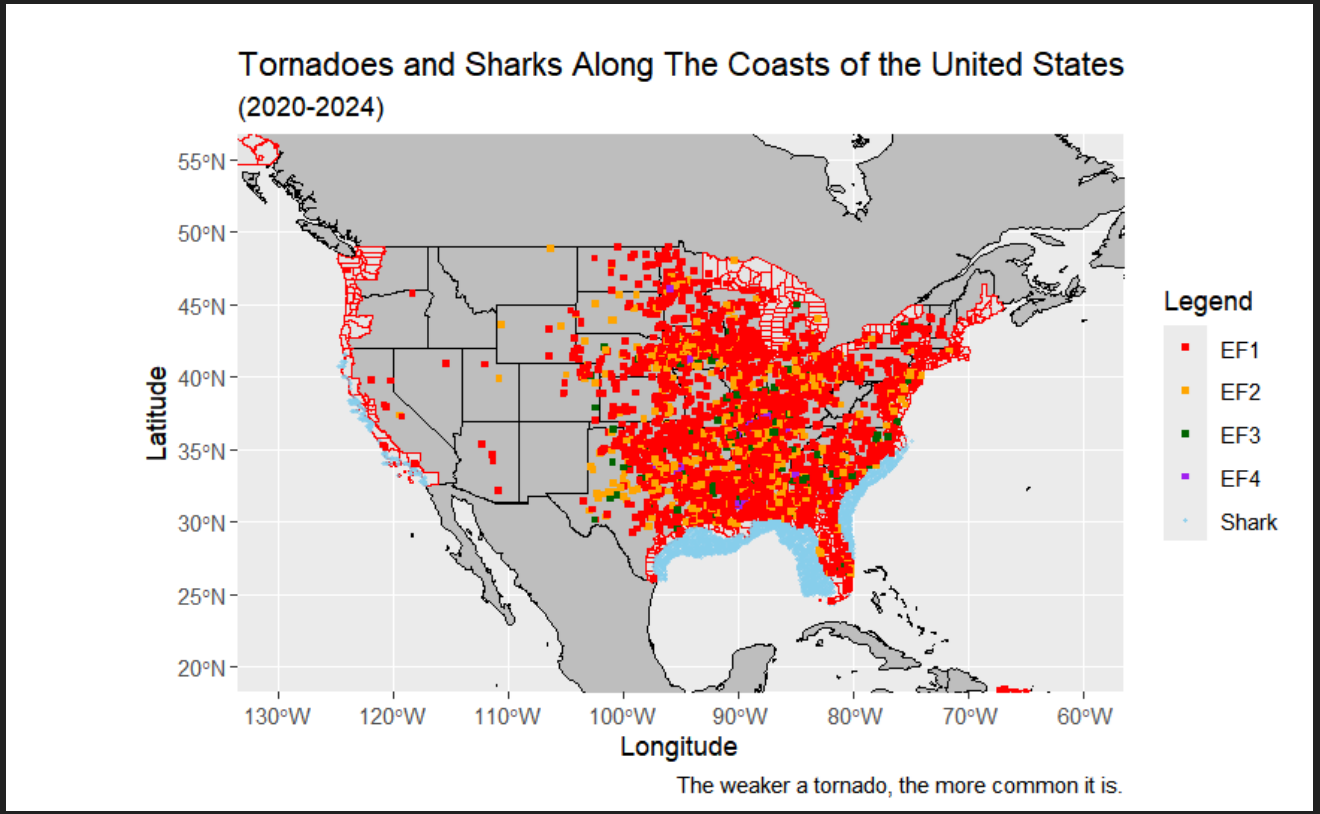


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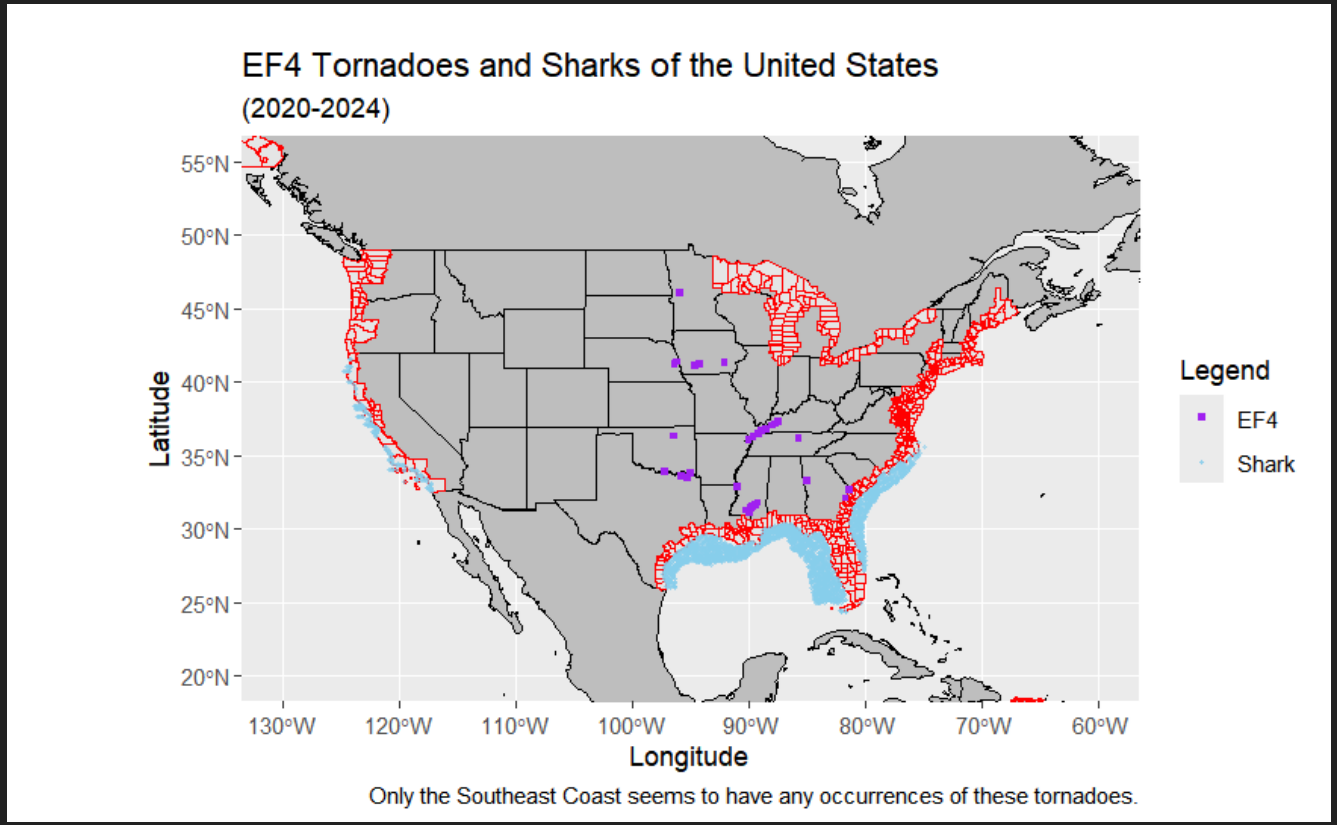
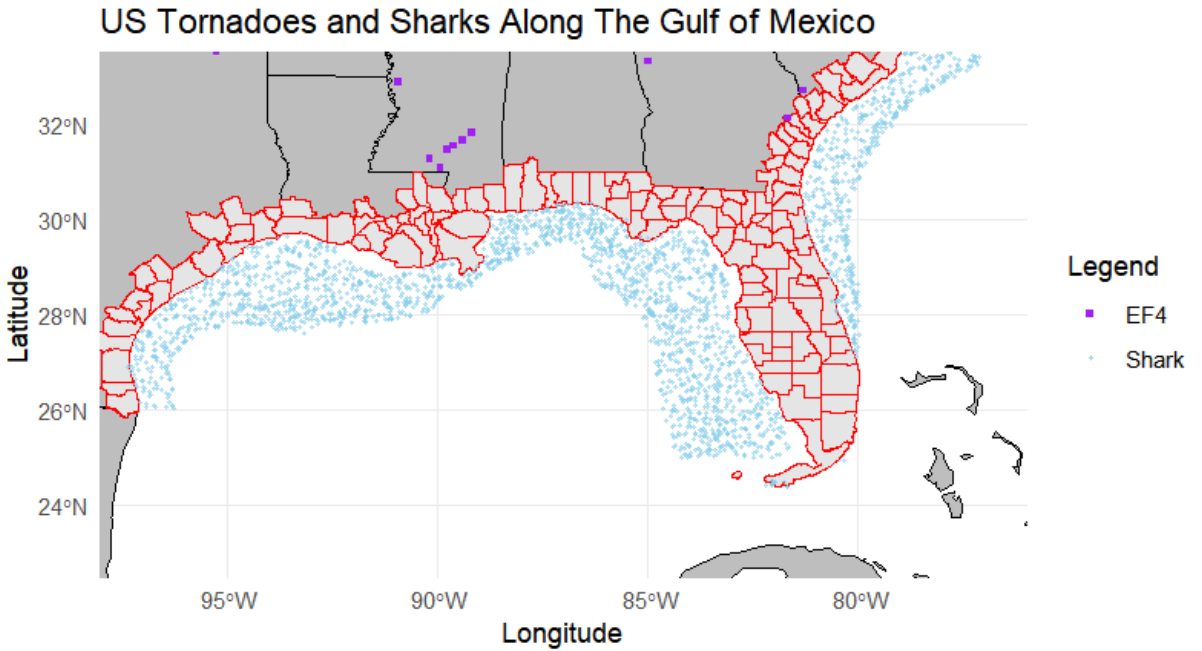
Figure 4.



Evaluations - Tornadoes and Sharks in the Southeast Coast

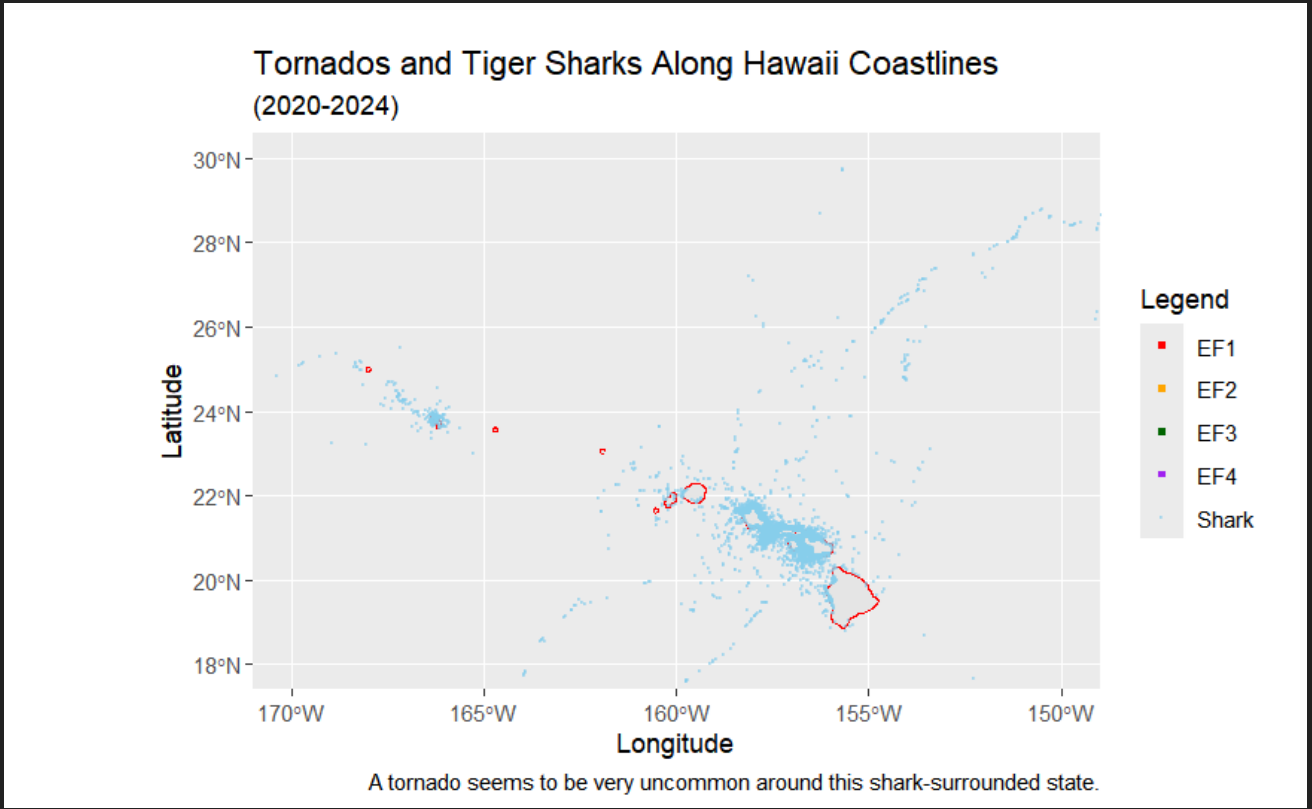
Figure 5.



There is a small amount of EF4 tornadoes and 0 EF5 tornadoes that are close to the coasts.

Evaluations - Tornadoes and Tiger Sharks in Hawaii

Figure 6.



Further Evaluations - Bootstrapping and Randomization of EF Scores

Let’s say given these perfect conditions:

- Tornadoes that form in the perimeter of the coastal data will transform into sharknados

Under these assumptions, will a sharknado now be a possible threat?

Via bootstrapping, each tornado will be randomly assigned with replacement a new EF Score

The average of these bootstrapped tornadoes forming on the coast will be taken from the entire coastal tornadoes

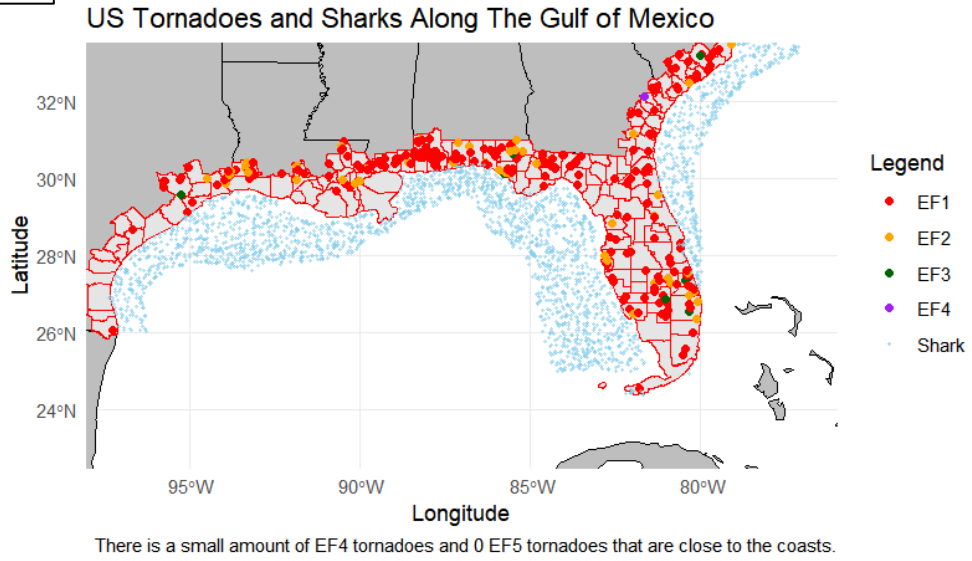
Evaluations - Before Bootstrapping

A coastal tornado is an observation of a tornado point that lies with the coastal dataset's perimeter

In total, there are 473 coastal tornadoes, only 2 are rated EF4

On average, only 0.2% of EF4 tornadoes are coastal

Figure 8.



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Evaluation - Before Bootstrapping

This observation would also be considered sharknados, given the assumed conditions :

Tornadoes that form in the perimeter of the coastal data will transform into sharknados

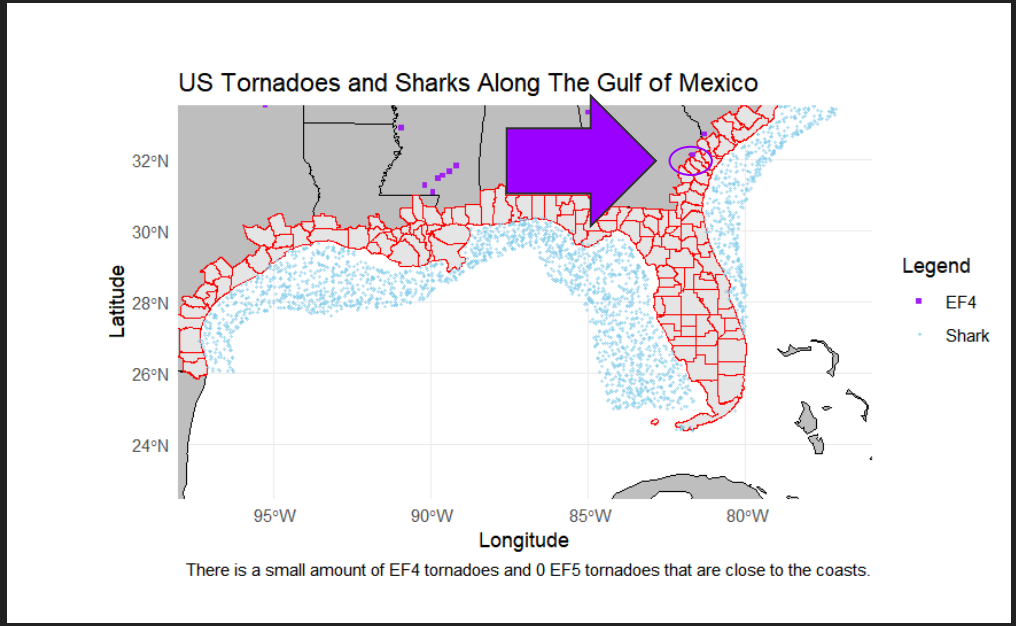


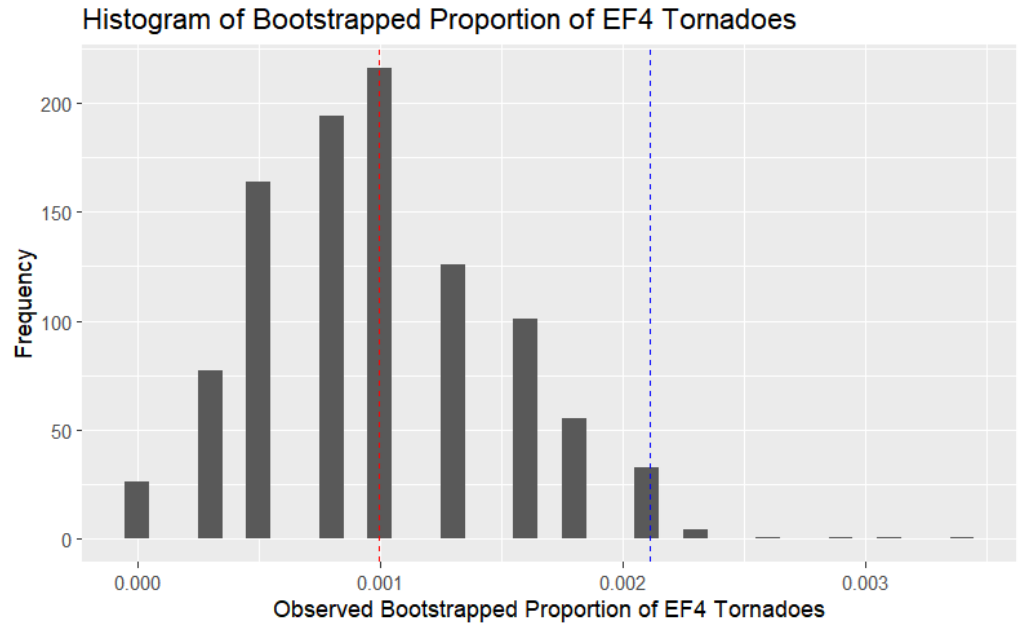
Figure 9.

Evaluations - Bootstrap Histogram

Averages:

- Bootstrapped
  - ~0.001
- Observed
  - 0.0021

Figure 10

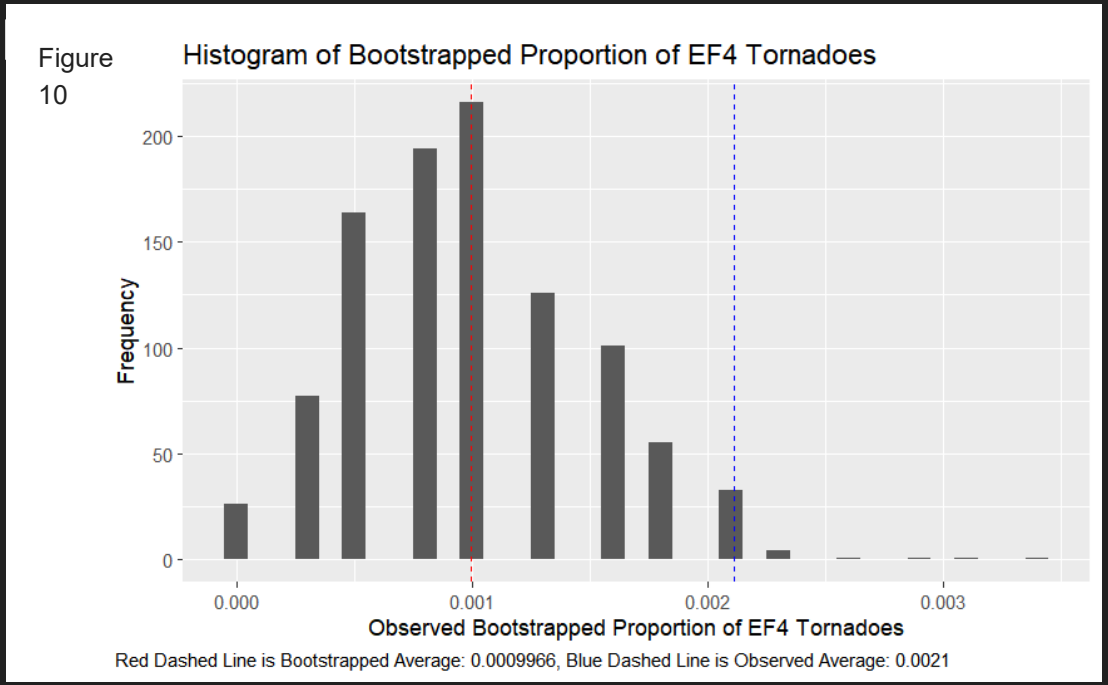


Evaluations - Bootstrap Histogram

Assuming this distribution is approximately normal…

The probability the average amount of EF4 tornadoes on the coast is greater than 0.0021 is **0.014**

Figure 10




```
> 1 - pnorm(observed_proportion_of_EF4, mean = mean_boot, sdboot)
[1] 0.01416679
```

X = Probability of Sharknado, X~Normal(mean = 0.001, sd = 0.0005), P(X > 0.0021) = 0.01416679

Results - Waterspouts are very unlikely to be strong enough to lift sharks

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.

You'd expect a sharknado to cause serious property damage as well

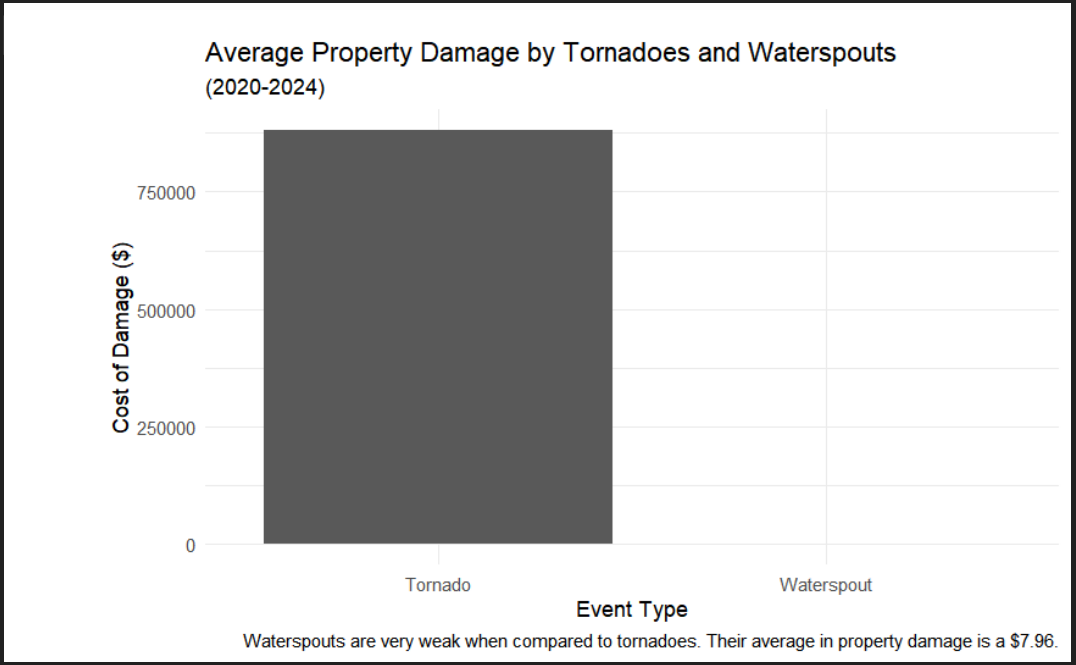


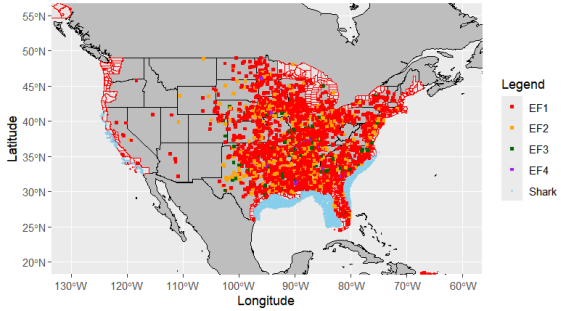
Figure 1

Results - Tornadoes powerful enough to carry sharks do not tend to form close to shark-infested waters

EF1 and EF2 tornadoes are much more likely to form near shark-infested waters

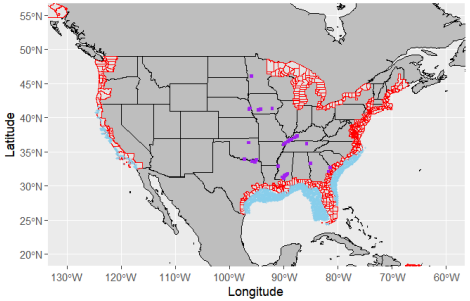
There however are incapable of lifting heavy sharks out of the water

Figure 3 Tornadoes and Sharks Along The Coasts of the United States (2020-2024)



The weaker a tornado, the more common it is.

Figure 4 EF4 Tornadoes and Sharks of the United States (2020-2024)



Only the Southeast Coast seems to have any occurrences of these tornadoes.

Results - Tornadoes powerful enough to carry sharks do not tend to form close to shark-infested waters

Figure 3 Tornadoes and Sharks Along The Coasts of the United States (2020-2024)

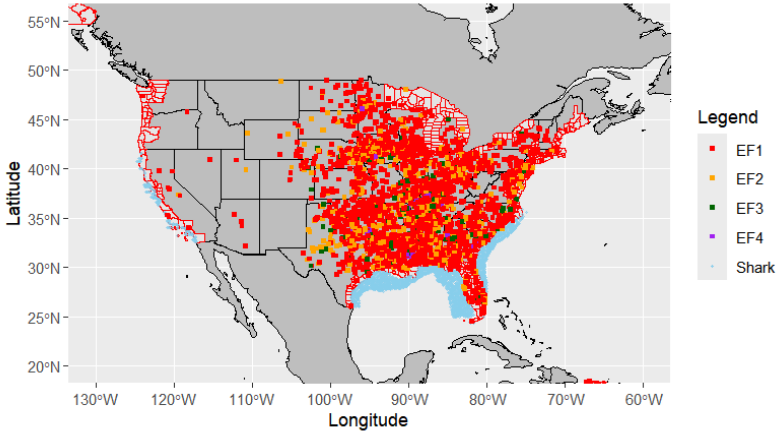


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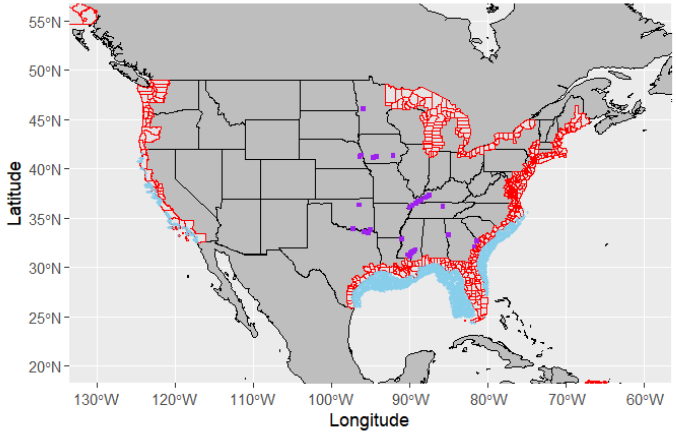
Figure 4 EF4 Tornadoes and Sharks of the United States (2020-2024)



Only the Southeast Coast seems to have any occurrences of these tornadoes.

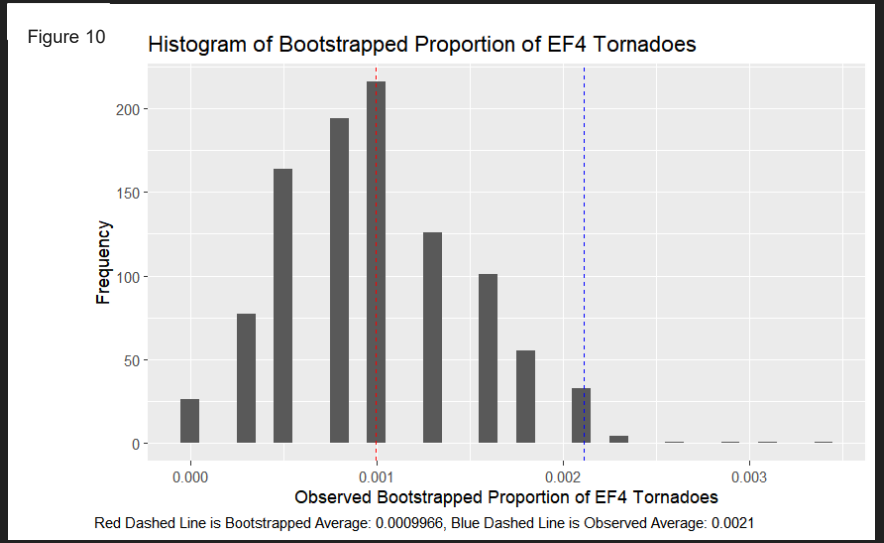
Results - Tornadoes powerful enough to carry sharks do not tend to form close to shark-infested waters

Under the drastic assumption that all EF4 or higher tornadoes that form within the data's coastal perimeters will become sharknados, a long run average of **0.0006** is calculated. This means based on the spatial data from the current tornadoes, had their EF Scales been randomized with replacement, sharknados will form 0.06% of the time.

Assuming, the distribution of these proportions is normal, the probability that EF4 tornadoes form on the coast is greater than 0.21% is **0.014.**

We have enough evidence to state that sharknados are not a probable threat in the near future, based on our tornado data from 2020-2024.

Figure 10



Limitations

Excluded EF Scores

- EF0 Tornadoes were excluded from analysis due to weakness in strength
- Zero EF5 Tornadoes were recorded in data collected

Hurricanes were not considered

- You can argue that a hurricane of great strength and size can carry sharks, but *shark - hurricanes* were ignored whether or not they are able to

No Free Shark Survey or Tracking Dataset (From Trusted Source) with observations on the West Coast or Northeast of U.S.

- 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.

Limitations

Shark population is generalized for observations outside of Hawaii

- In the maps, the shark population is generalized to be one of the species found from that dataset
- Unsure if there are many Great Whites or Hammerheads living near or farther away from the coasts
- Hawaii has data that tracks only Tiger sharks in the area
- Dates measured for each dataset differs

Limitations

Bootstrapping: Coastal Tornado = Sharknado

- This is a very big and unrealistic assumption given that there are only 2 coastal tornadoes and 0 EF5 tornadoes observed in the tornado dataset and they are nowhere near shark-infested waters.
- This is more theoretical, and in this theoretical situation, sharknados were still unable to form
- Other assumptions:
    - Approximately normal bootstrap distribution

Due this limitation, it could still be argued that the probability of sharknados can be either more or less than what was observed.

Recommendations

If you live on the coasts of the United States, sleep peacefully and be clear of mind, a sharknado will not be one of your worries when it comes to weather events such as hurricanes and tropical storms

There is no need to panic or prepare for sharks raining down from the sky

Questions?

Thank you for your time and attention!