Communicating Probabilities and Risk

(and weather)

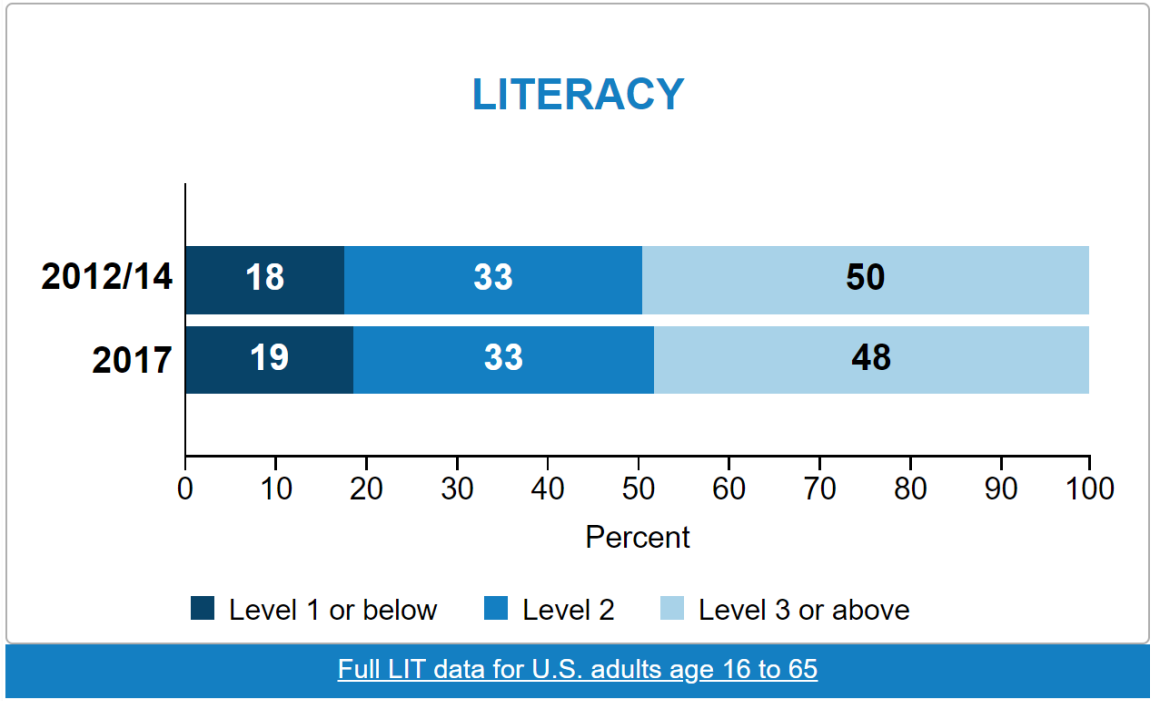
"Medicine is a science of uncertainty and an art of probability."

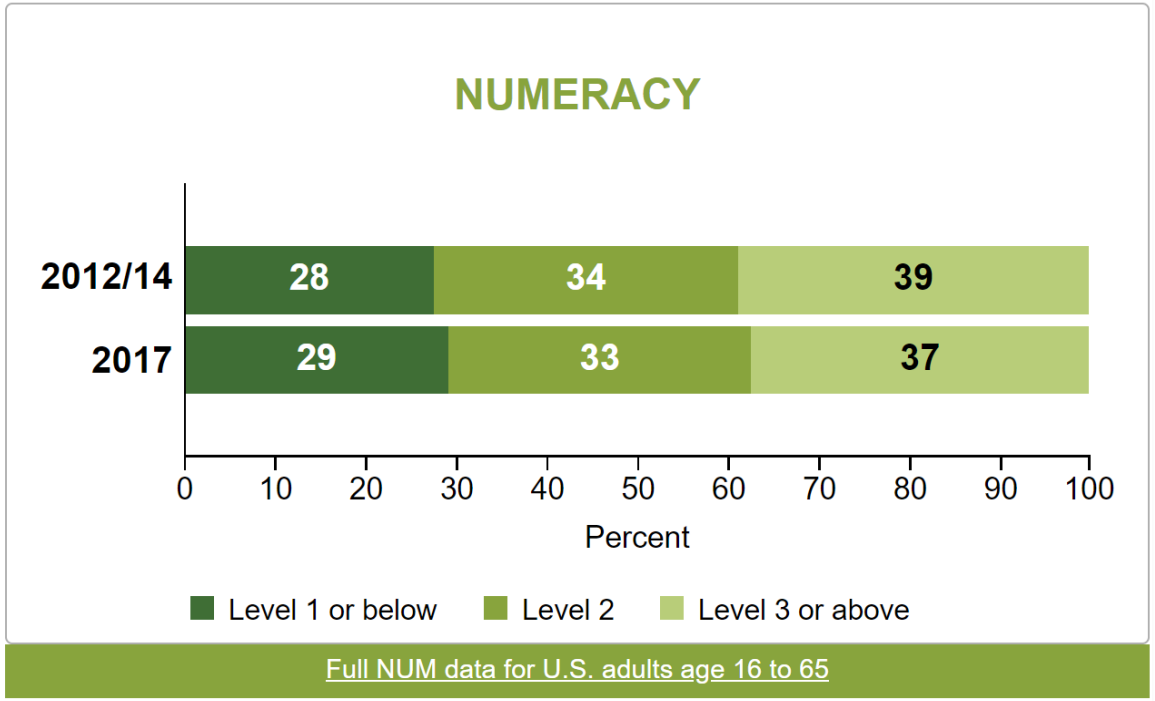
-- Sir William Osler (1849-1919)

Robbie Berg, NHC Senior Hurricane Specialist
WMO RA-IV Workshop on Hurricane Forecasting and Warning
March 8, 2023

Parallels Between Literacy and Numeracy

Why is it difficult to communicate probabilistic information?





U.S. Department of Education, National Center for Education Statistics
Program for the International Assessment of Adult Competencies (PIAAC)

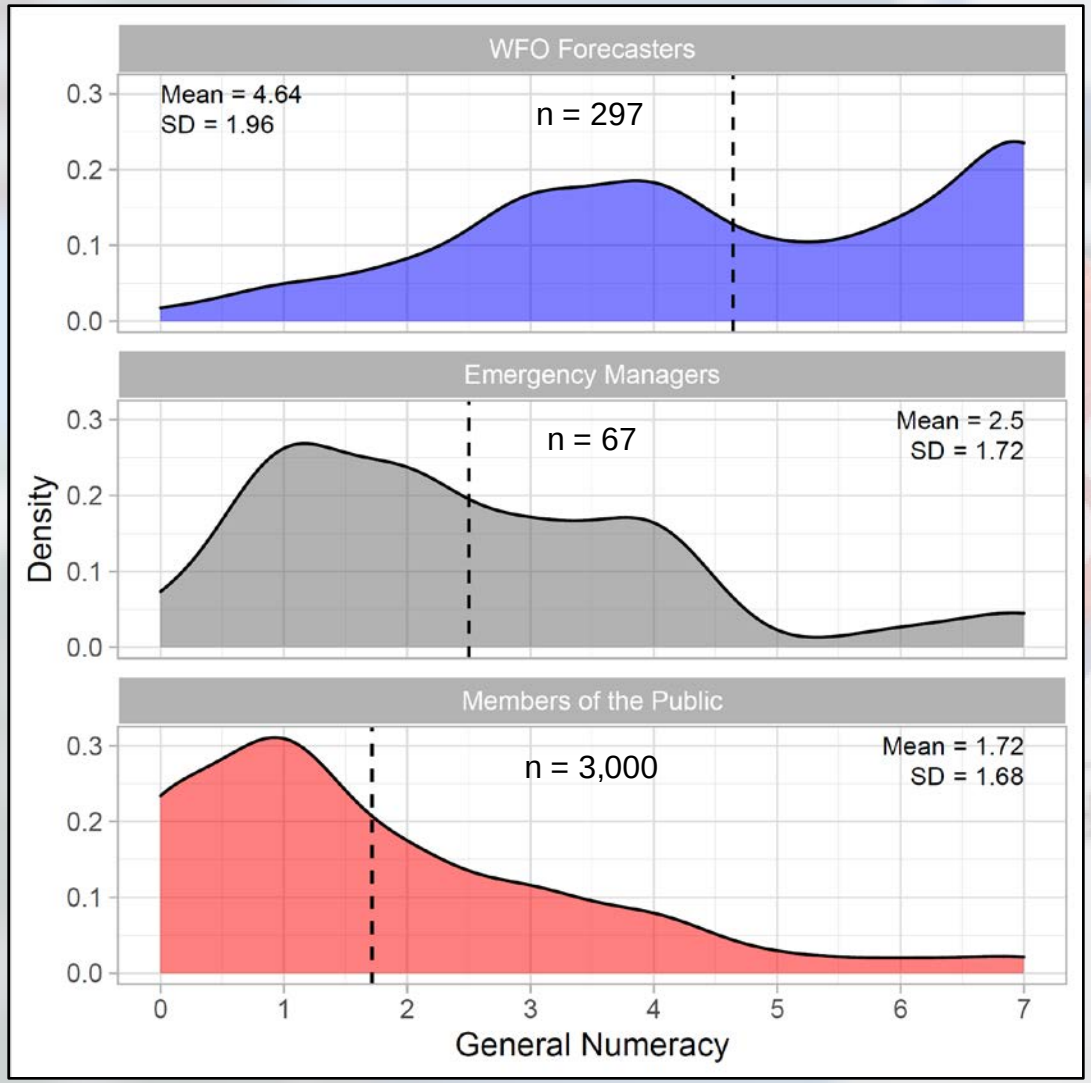
Literacy: the ability to understand, use, and respond appropriately to written texts

Numeracy: the ability to use basic mathematical and computational skills

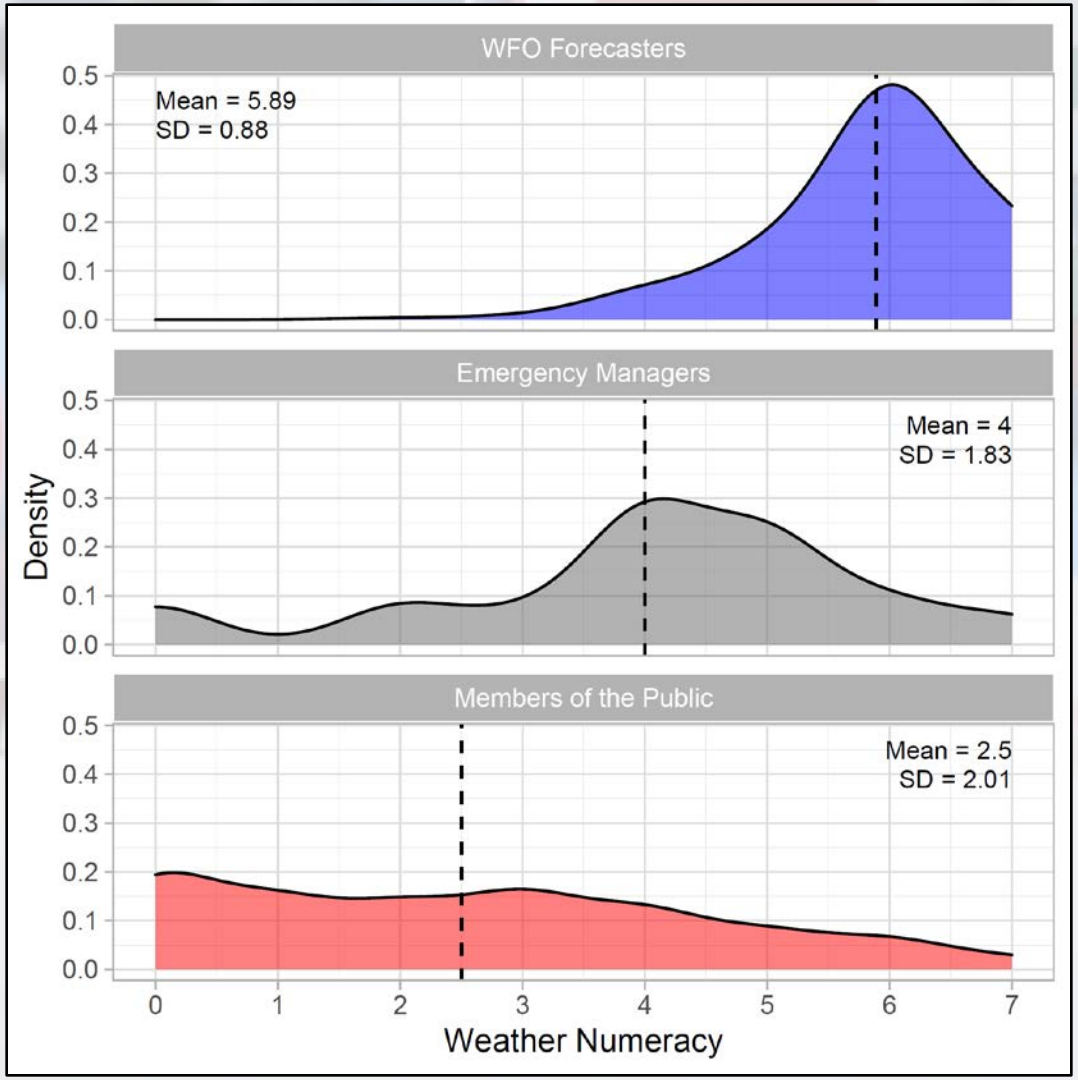
Numeracy Among Forecasters, Emergency Managers, and the Public

"There's a Chance of What?": National Institute for Risk and Resilience at the University of Oklahoma (Ripberger et al.)

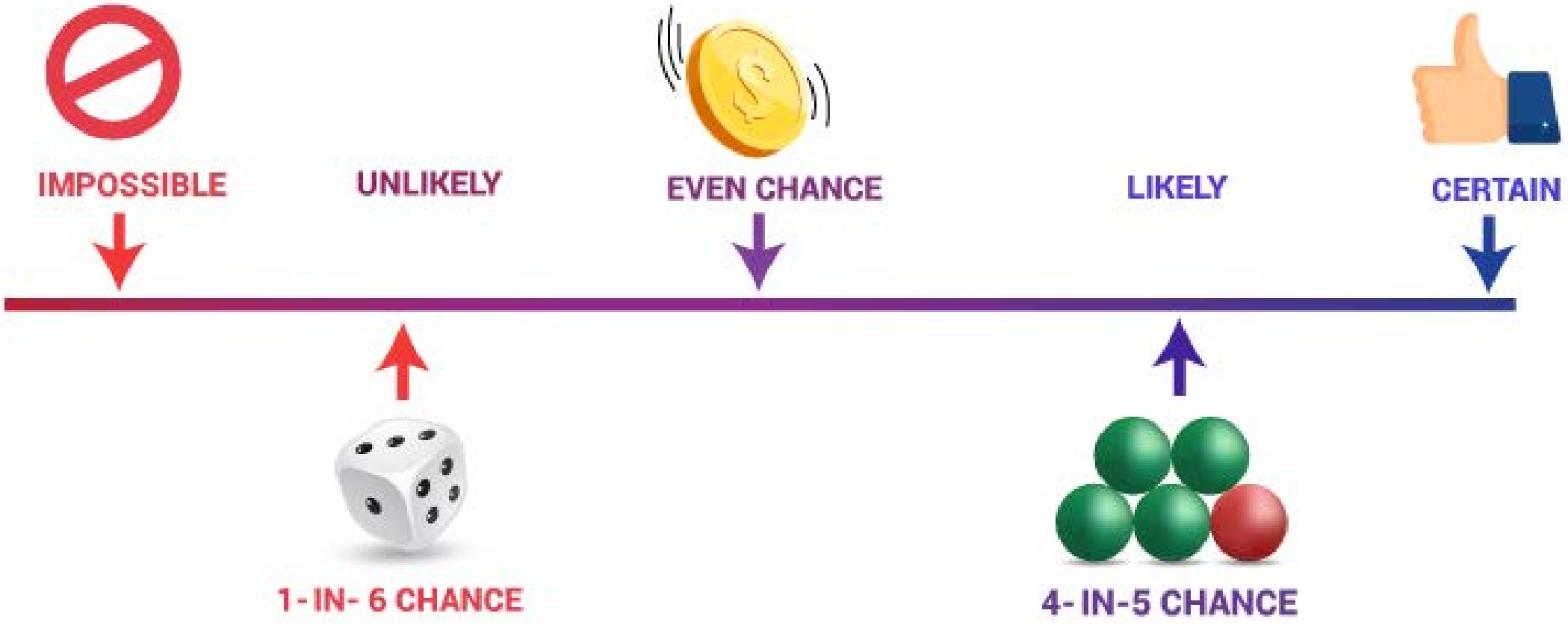
General Numeracy



Weather Numeracy



Probability




BBC one

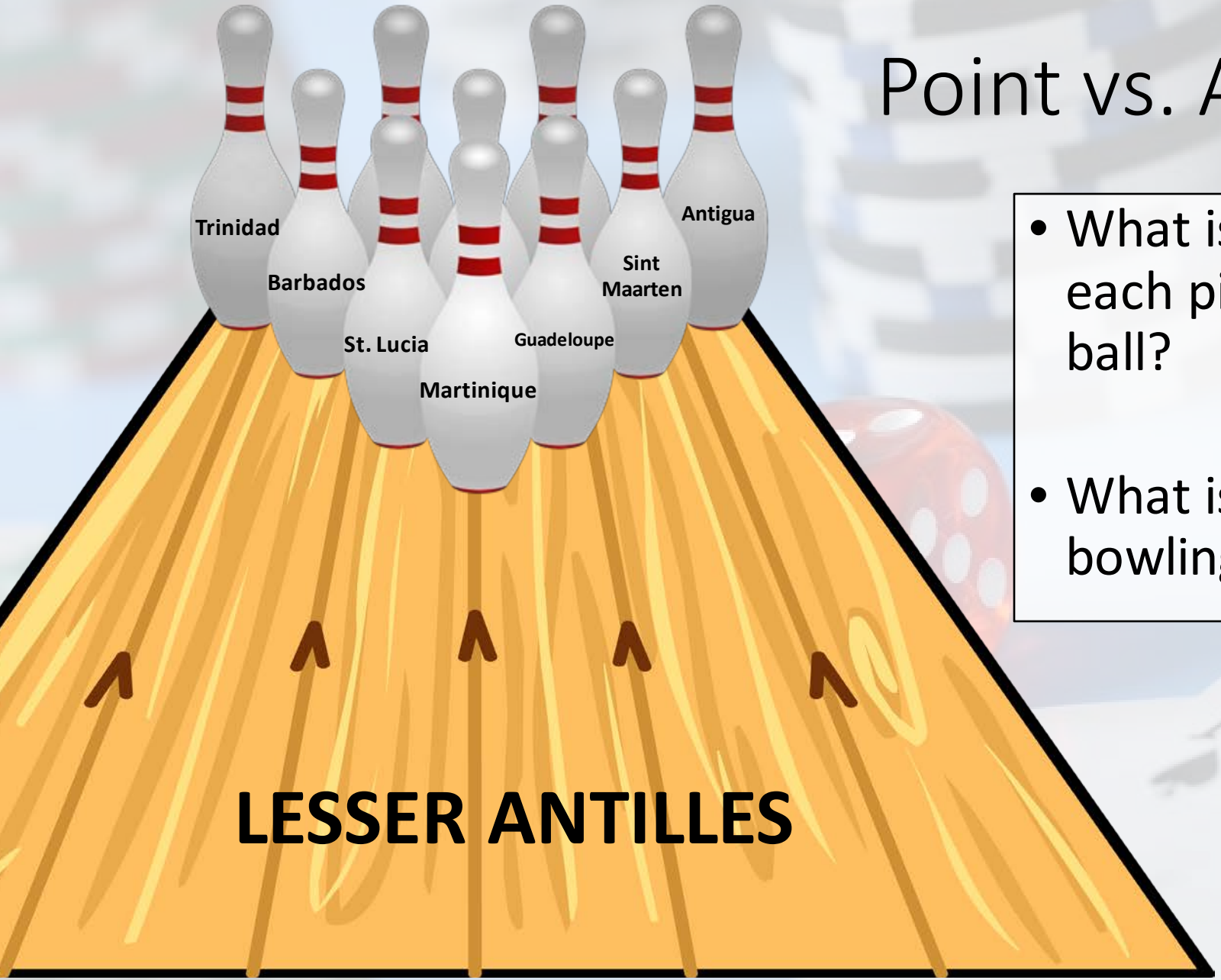
Point vs. Areal Probabilities

- The probability that the dolphins catch ***any fish*** in the bait ball is high.
- The probability that the dolphins catch a ***specific individual fish*** in the bait ball is low.

Even though it's a near certainty that the dolphins will catch at least one fish, the bait ball lowers the probability for each individual fish that it will be the one caught.

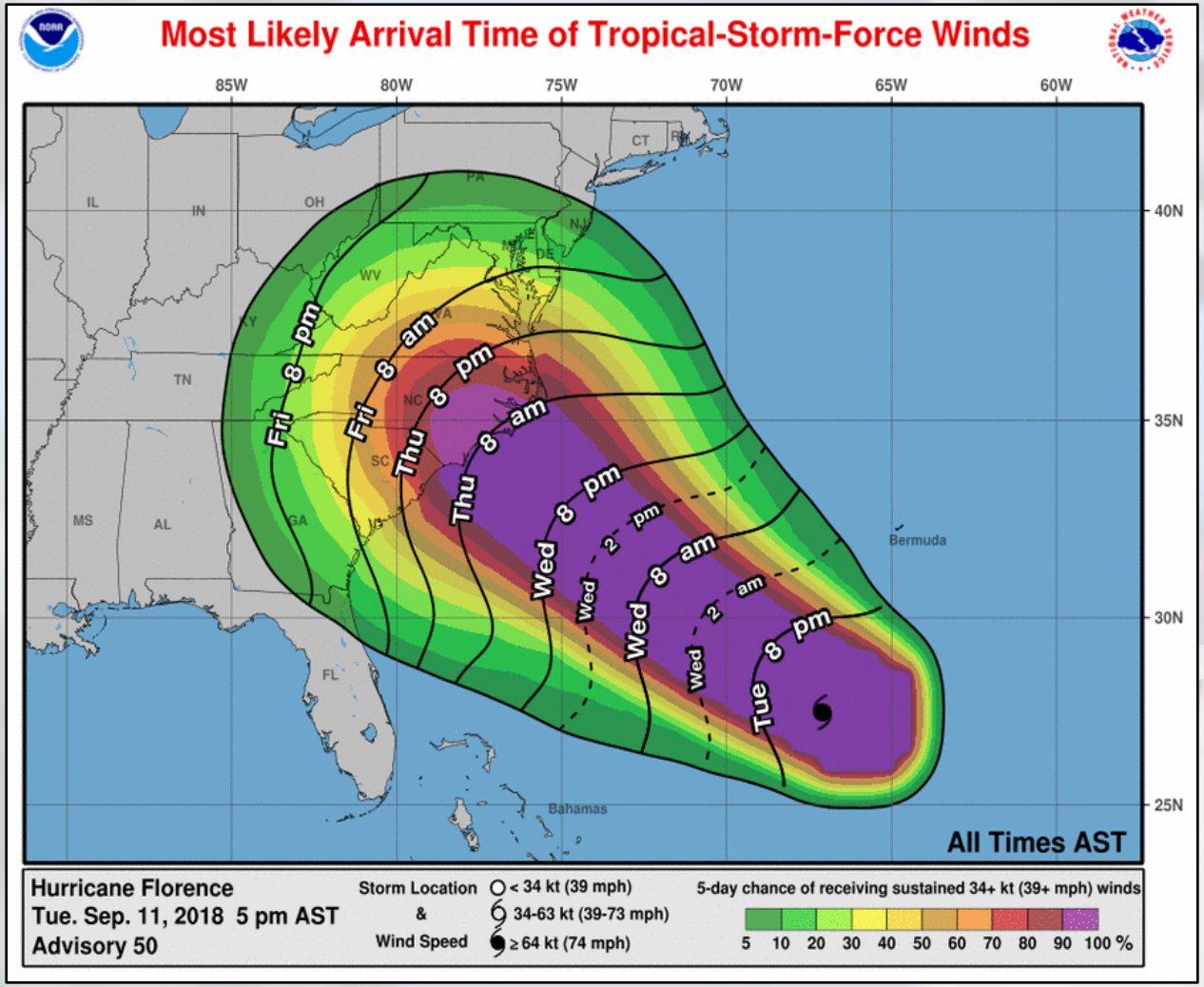

LIVE
JASON BELMONTE
ARSENAL
BALL
HOOK
Lucid
9.5
Defiant Soul
9.0
Reign of Power
8.5
IQ Tour Pearl
7.5
The Wrecker
7.5
Master
NCAAM
4MICH 54 3FLA 38
Men's Basketball Championship
Elite 8 - S
SPORTSCENTER

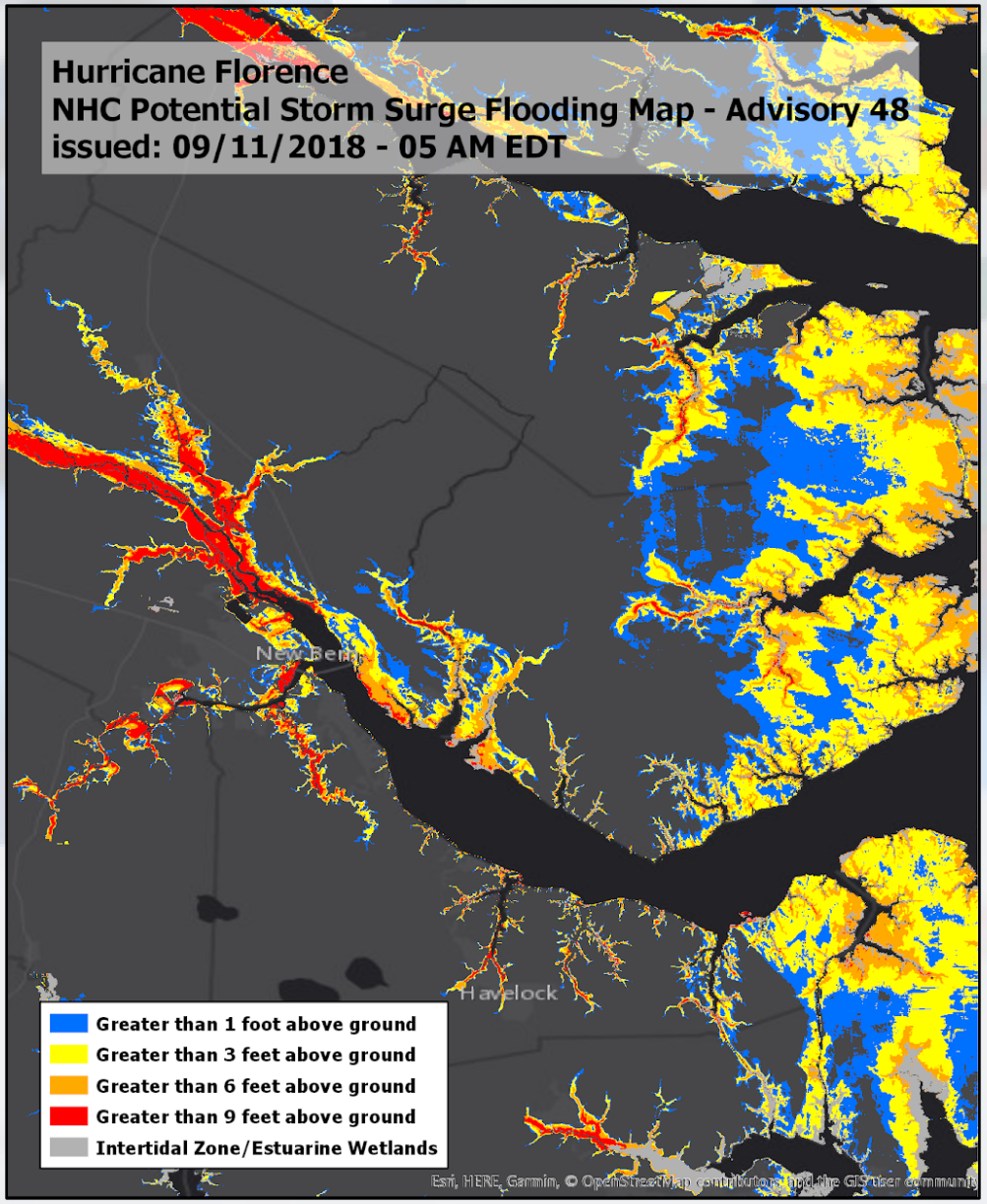
Point vs. Areal Probabilities



- What is the individual probability of each pin being hit by the bowling ball?
- What is the probability that the bowling ball hits any of the pins?

NHC Point Probabilities





Low Probabilities at Long Lead Times

If you get hit by a water balloon, you'll turn into an elephant

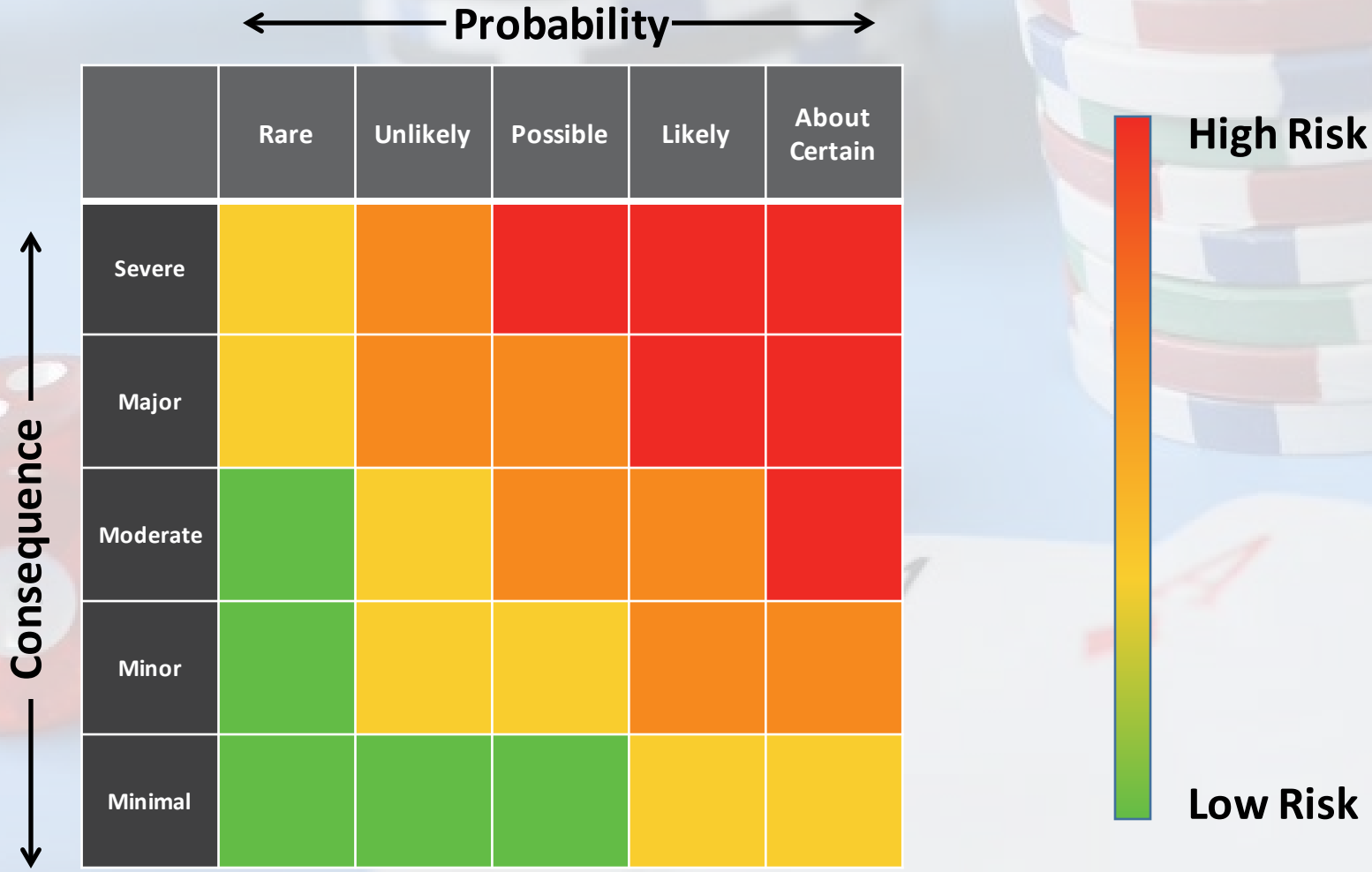
Why Is Risk Communication So Tricky?

Risk, Risk Perception, and Risk Tolerance

- Risk: the potential of gaining or losing something of value

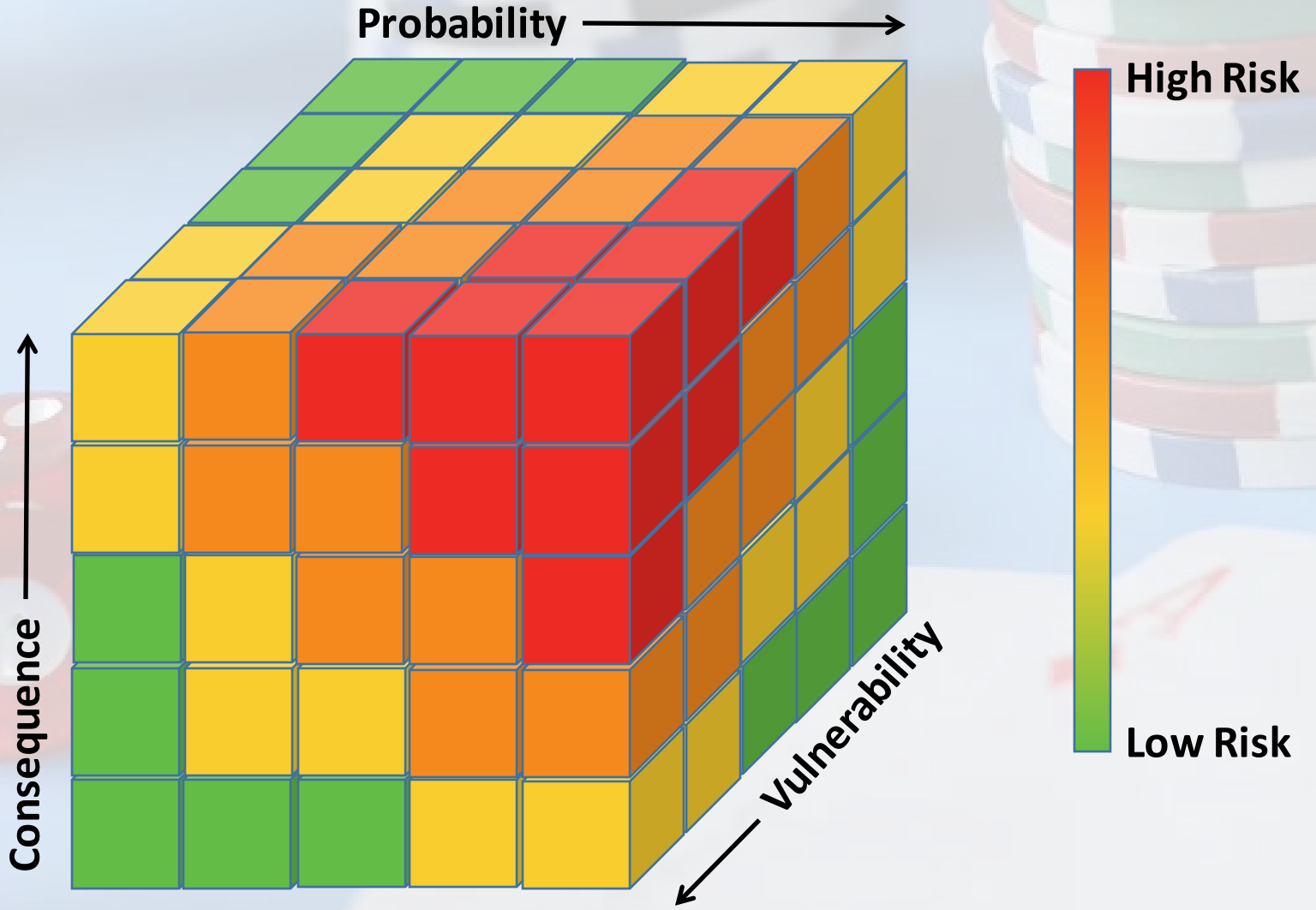
Risk = Probability × Consequence × Vulnerability

Low-Probability, High-Consequence Events
(why low probabilities matter)



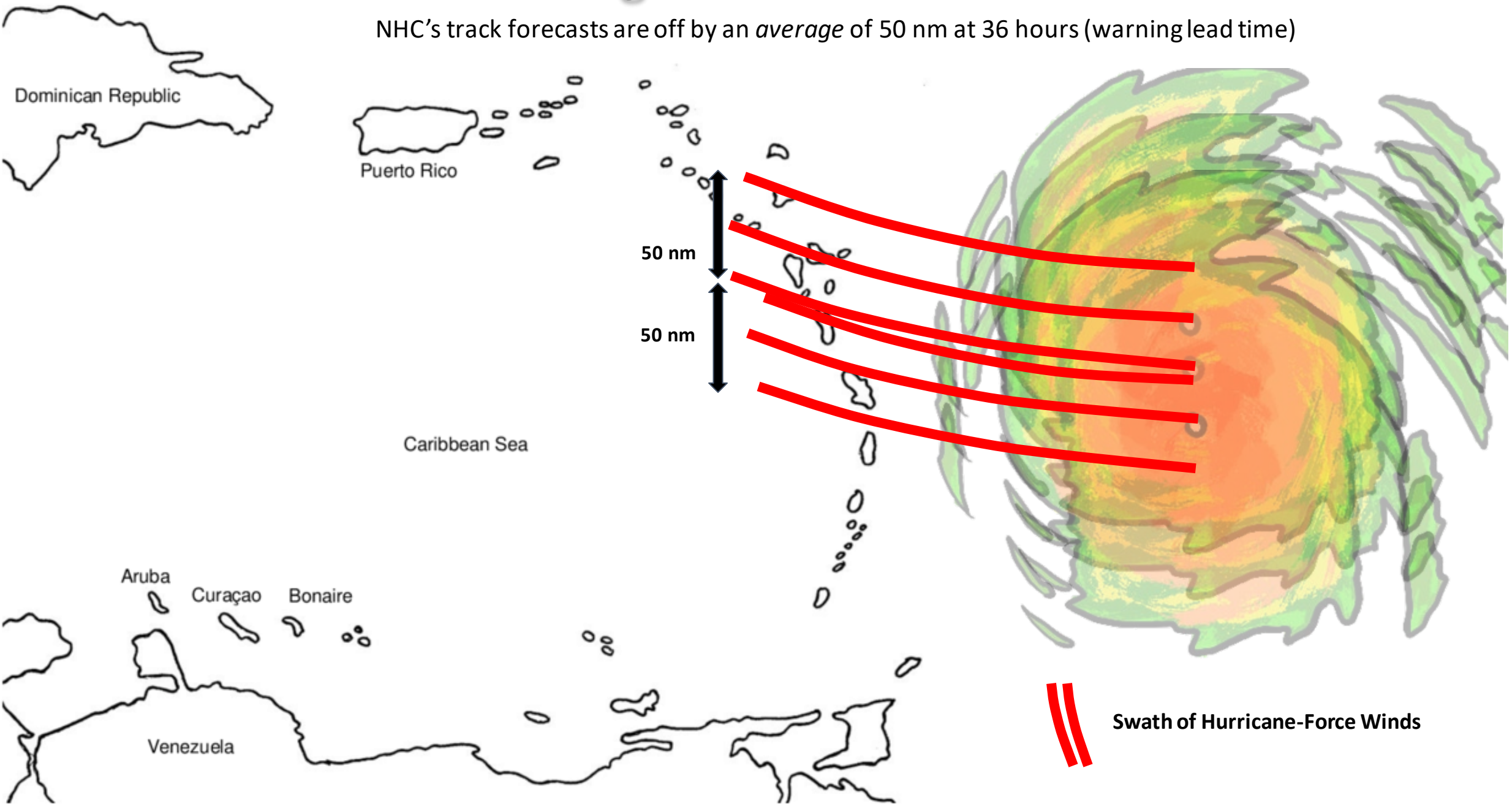
Low-Probability, High-Consequence Events

(why low probabilities matter)



Watches and Warnings as Risk Communication Tools

NHC's track forecasts are off by an *average* of 50 nm at 36 hours (warning lead time)



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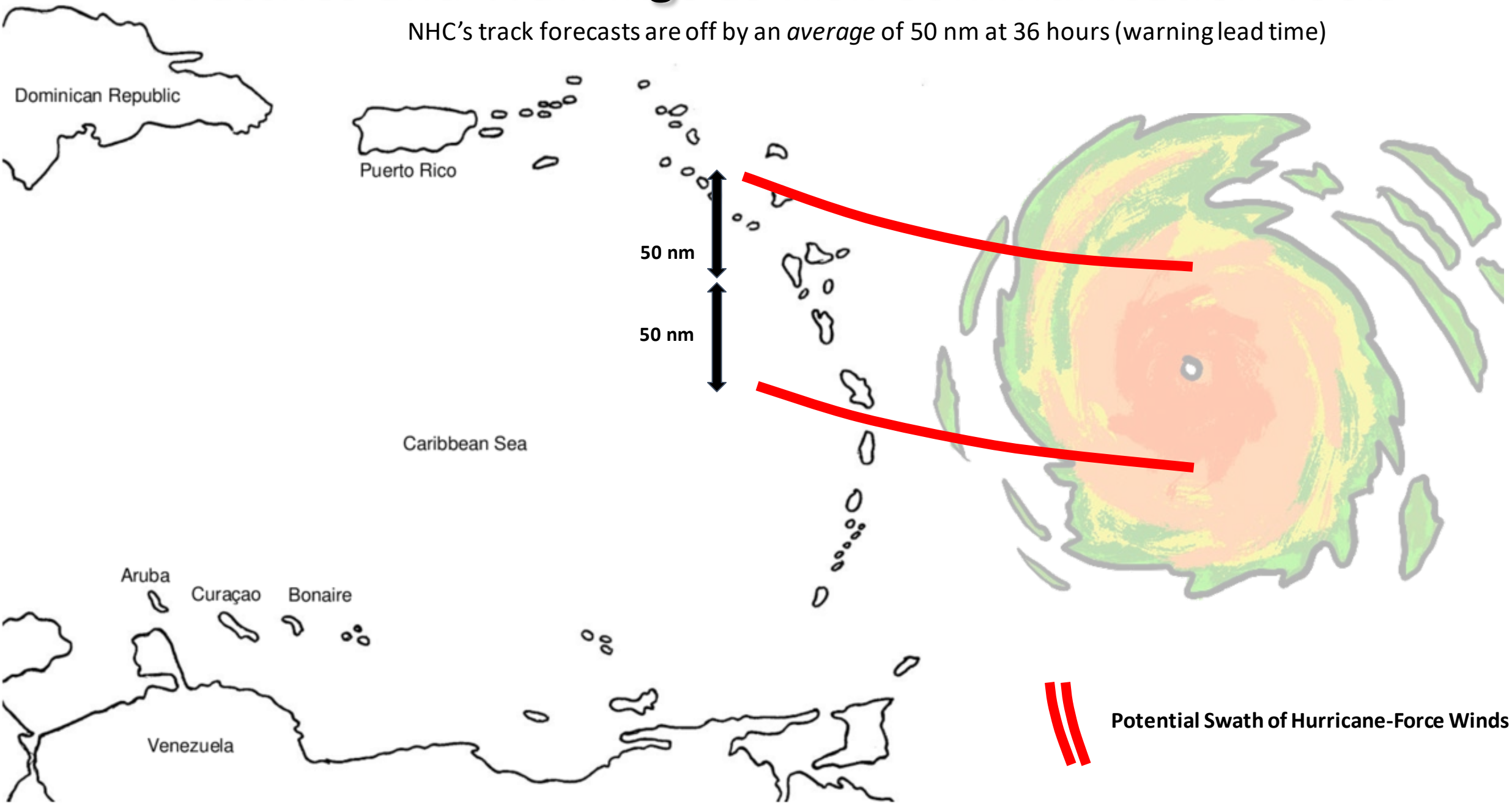

Why Is Risk Communication So Tricky?

Risk, Risk Perception, and Risk Tolerance

- Risk: the potential of gaining or losing something of value

  Risk = Probability × Consequence × Vulnerability

- Risk perception: the subjective judgment people make about probability, consequences, or vulnerability, which may vary from person to person

  Actual Risk ≠ Perceived Risk

- Risk tolerance: how willing people are to "take their chances"

Risk Tolerance

Which choice would you make?

A. Receive $100 guaranteed

B. Flip a coin, "heads" you win $200, "tails" you win nothing

Which choice would you make?

A. Flip a coin, "heads" you lose $200, "tails" you lose nothing

B. Lose $100 guaranteed

Risk Tolerance

People tend to be **risk-averse** when they see themselves as ***gaining*** something

Prefer to take the sure thing (receiving $100), rather than gamble (receiving $200 or nothing)

People tend to be **risk-seeking** when they see themselves as ***losing*** something

Prefer to gamble (losing $200 or nothing), rather take the sure thing (losing $100)

The pain of losing a thing > the pleasure of winning that thing

Recommendations for Communicating Probability Information

(Literature Review by Ripberger et al., OU National Institute for Risk and Resilience)

Use probability information in place of deterministic statements in forecasts

Use probability ranges to emphasize uncertainty when point estimates are not available or appropriate; wide ranges indicate more uncertainty

Include numeric translations next to words/phrases that indicate probability information

If comprehension of probability information is especially important, use numeric probabilities alone or first (before words/phrases)

When using words or phrases to communicate probability information, include rank adjectives (like low, medium, or high) to indicate the magnitude of probability

Use probability (percentage) formats when possible; frequency (fraction) formats can be effective, but the can also generate confusion

When using frequency (fraction) formats, use 1 in X formats in place of X and NX formats

Include information about the reference class when using probability information

Be aware of directionality when using probability information; positive frames can promote comprehension by encouraging people to focus on the events that are most likely to happen whereas negative frames can promote risk aversion by encouraging people to focus on the possibility of negative events, even if they are unlikely

When possible, include probability information in forecast visualizations

Use visualizations to increase comprehension of probability information

Pay attention to the audience