LEARNING FROM SANDY
Webinar 1

Sandy Overview:

What we've learned

March 5, 2013

Beth A. Leonard
Director of Technical Services
BoatU.S.

BoatU.S.
Boat Owners Association of The United States

Association of Marina Industries

BoatU.S. Catastrophe (CAT) Teams

- First deployed after Hurricane Alicia hit Houston in 1983
- Team of experienced surveyors, salvors, and claims adjustors
- On the ground after every major weather event where large numbers of boats were destroyed for the past 30 years
- Debrief after the fact to develop hurricane preparation best practices
- First members reached marinas in NY and NJ less than 24 hours after Sandy made landfall; CAT Teams in the field through Christmas
- Past two months debriefing to determine what we can learn from this storm

BoatU.S.
Boat Owners Association of The United States

Webinar objective

To share lessons coming out of Sandy that will help marine facilities in storm-damaged areas rebuild smarter and those in other areas prepare better for future storms

This webinar will focus on:

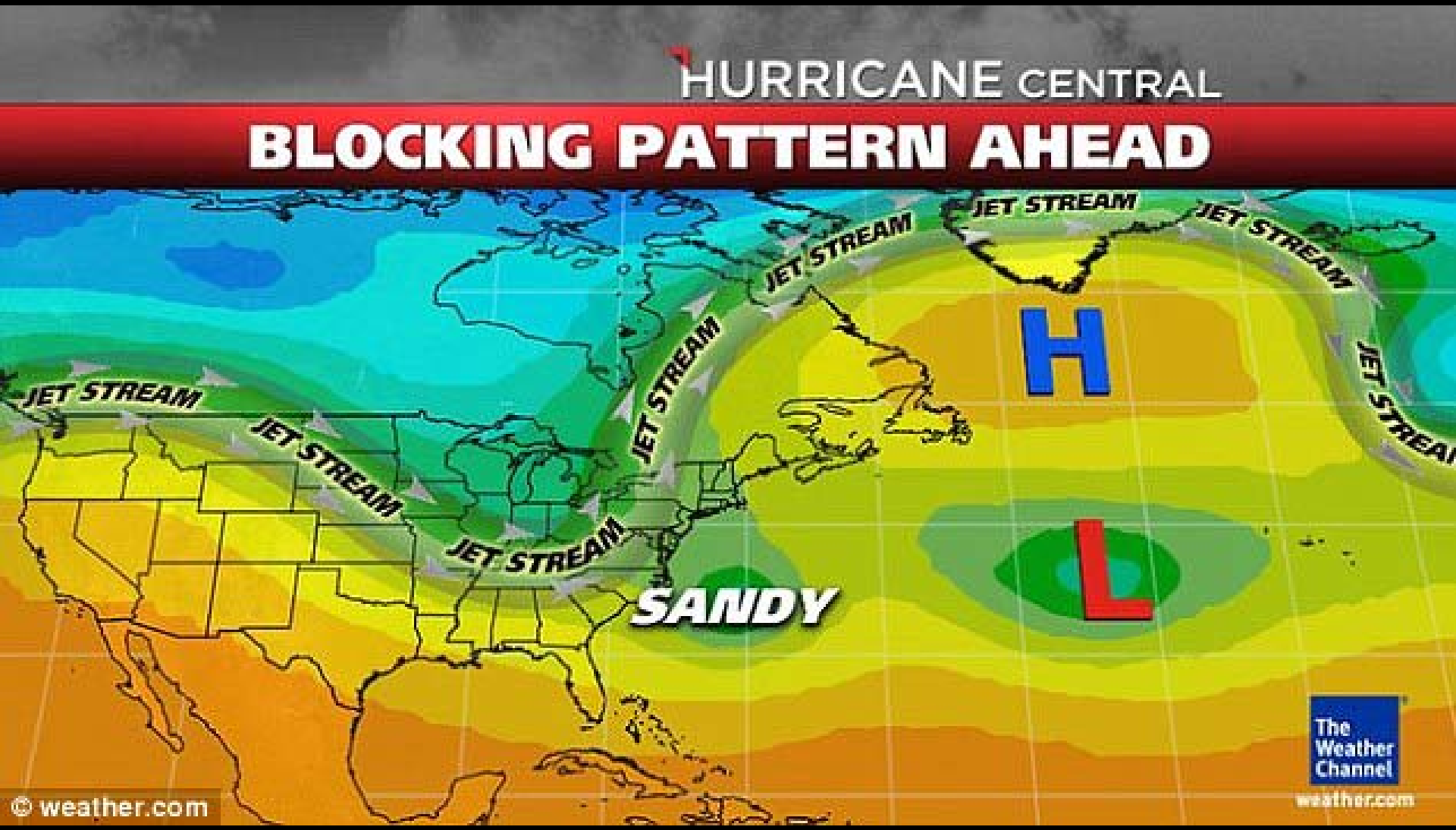
1. Why were so many boats and so much marina infrastructure destroyed DESPITE good forecasting and days of preparation based on industry "best practices?"
2. How did the various methods of securing boats fare in Sandy's high surge?
3. What are the key lessons learned for marine facilities?

Goals of hurricane preparation

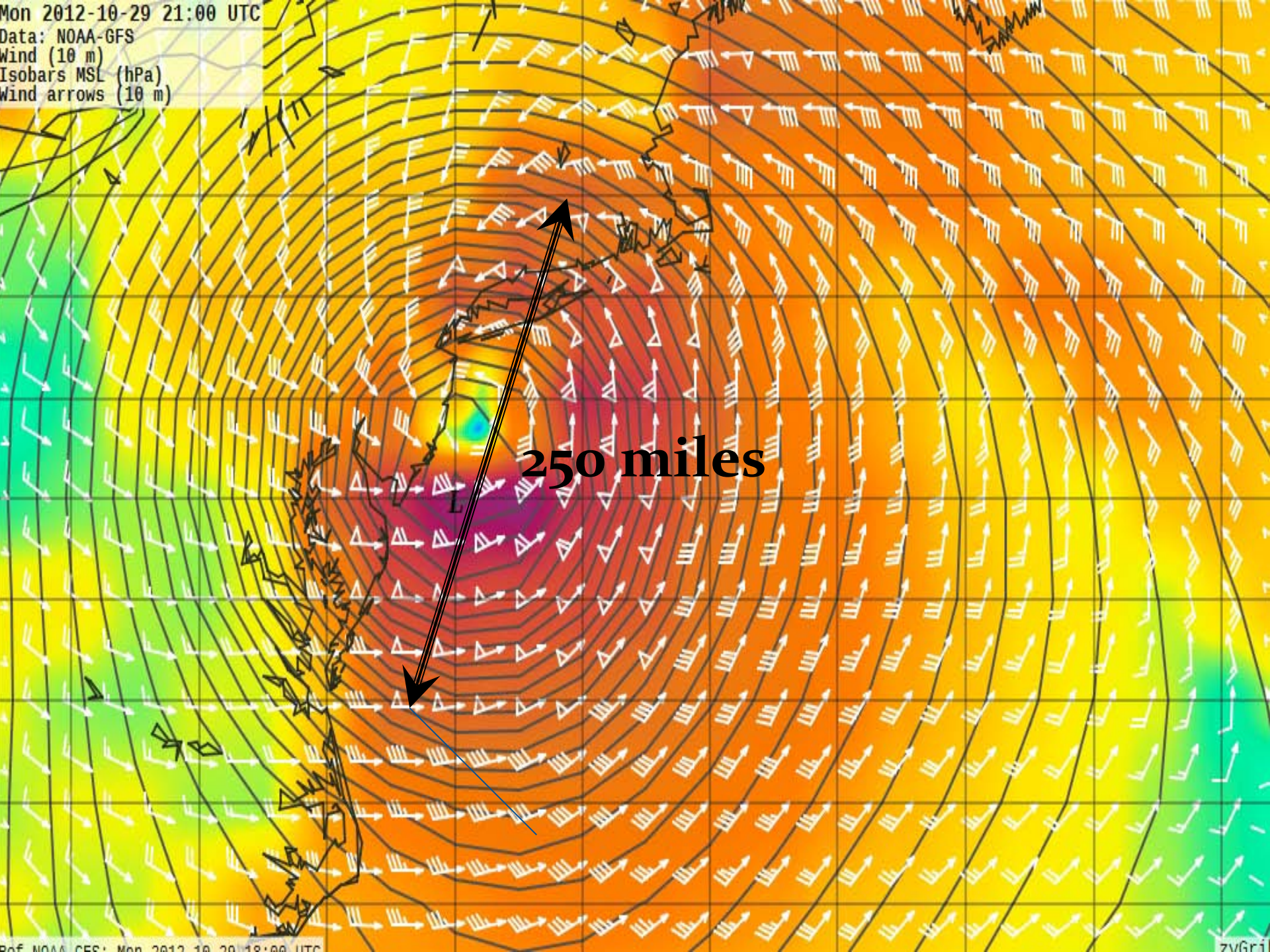
- Prevent loss of life
- Limit damage to boats
- Limit damage to marina infrastructure
- Limit damage to other infrastructure
- Limit damage to the environment

What we've learned

- **Why was this storm so devastating?**
- Securing boats: What worked… and what didn't?
- What has Sandy taught us?

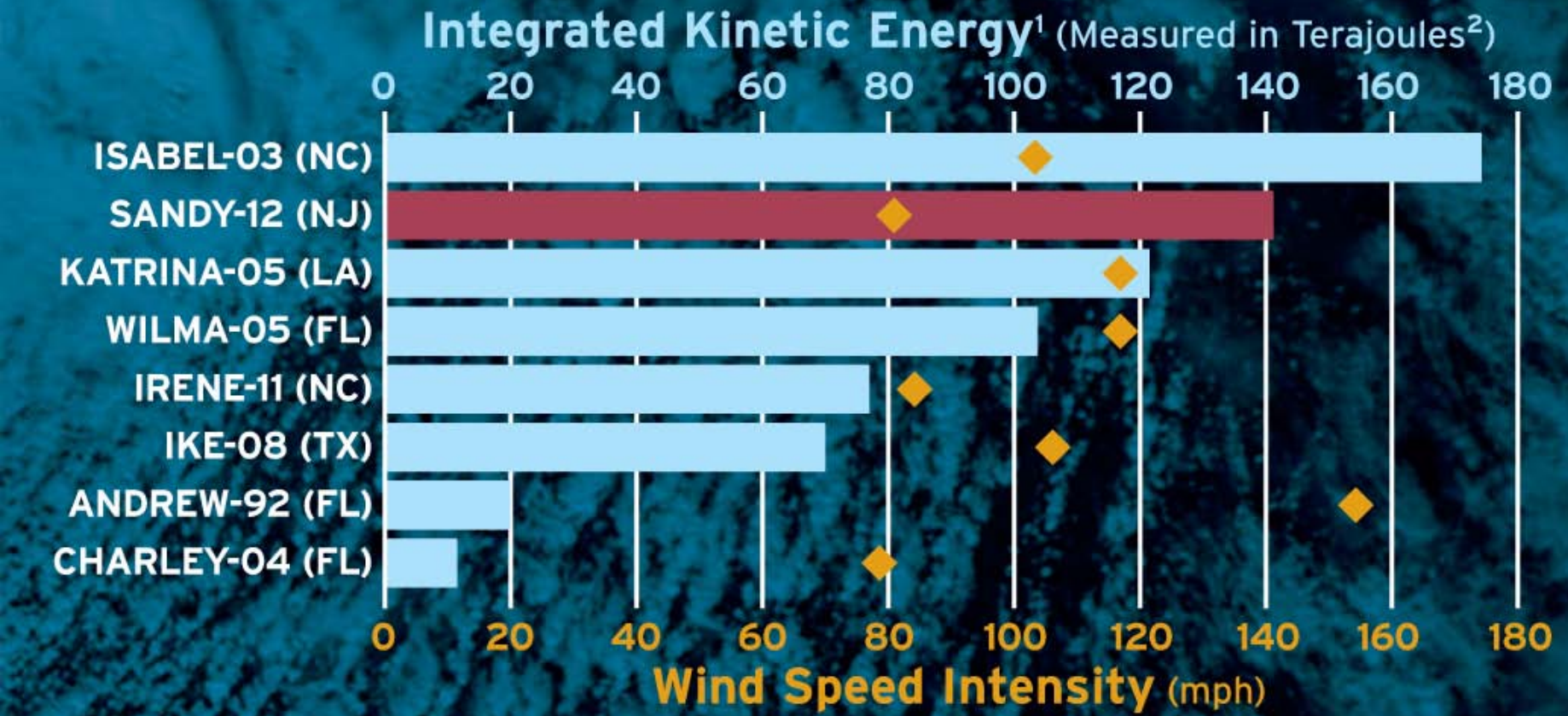


October 26, 2012


Mon 2012-10-29 21:00 UTC
Data: NOAA-GFS
Wind (10 m)
Isobars MSL (hPa)
Wind arrows (10 m)
250 miles
L

OVERALL STORM POWER AT LANDFALL

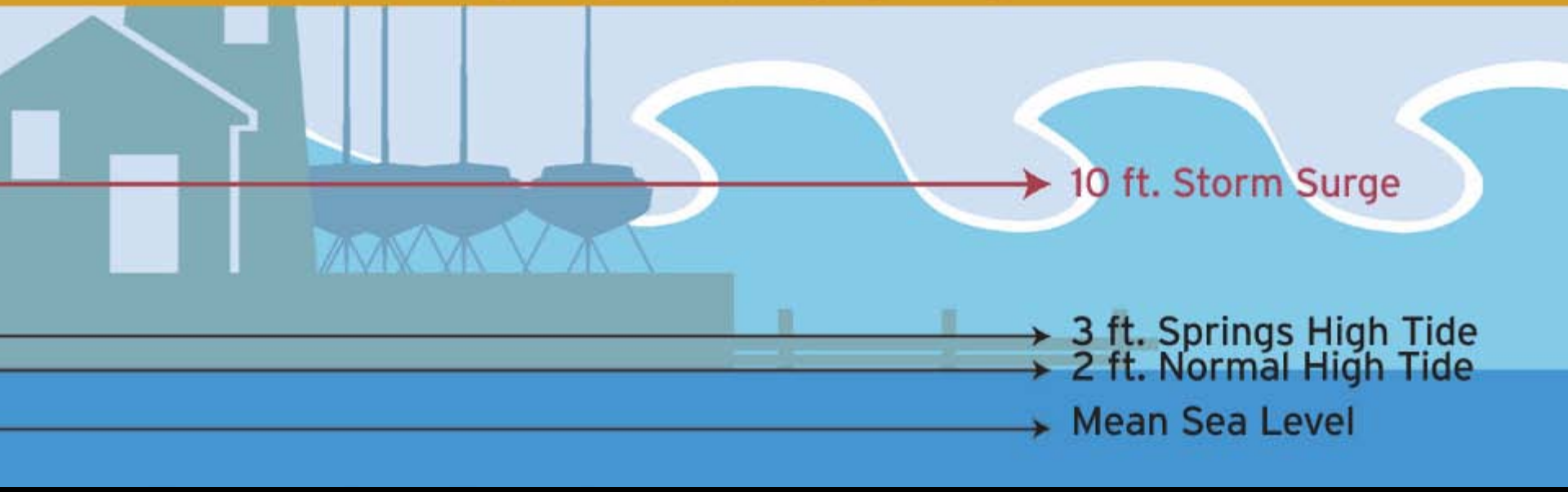
The most powerful storms are not necessarily the windiest. The energy in Sandy was equivalent to the power used by 40,594 U.S. homes in one month.



[1]Energy of storm based on extent of tropical storm force winds
[2]One terajoule = 277,777 kW = energy used by 290 U.S. homes in one month

Source: Washington Post

A DEADLY STORM SURGE



Why was this storm so devastating?

Storm Dynamics:

- Power of a hurricane with the size and duration of a nor'easter
- Largest storm ever in the Atlantic basin
- Confluence of easterly wind direction and Long Island geography
- Intensity, extent, and duration of winds
- Arrival with lunar tide and duration across multiple high tides

Coastal Configuration:

- High population and marina density
- Many marinas only a few feet above MHW levels
- Prevalence of older marina infrastructure not designed to withstand surge in excess of 6 feet

BoatU.S.
Boat Owners Association of The United States


Surge heights
In excess of 10 feet
8-10 feet
5-8 feet
Connecticut
Long Island Sound
New York
New Jersey
Maryland

Additional Sandy challenges

- Not a dozen damaged marinas, but hundreds across 400 miles of coastline
- Challenging logistics for almost three weeks: gas rationing, no electricity, no hotel rooms, traffic jams, blocked roads
- Second Nor'easter ten days after Sandy brought freezing temperatures to devastated region
  - Many boats not yet winterized
  - Many engines not pickled
- First access to parts of the barrier islands didn't occur until three weeks after Sandy

BoatU.S.
Boat Owners Association of The United States

COSTLIEST HURRICANES

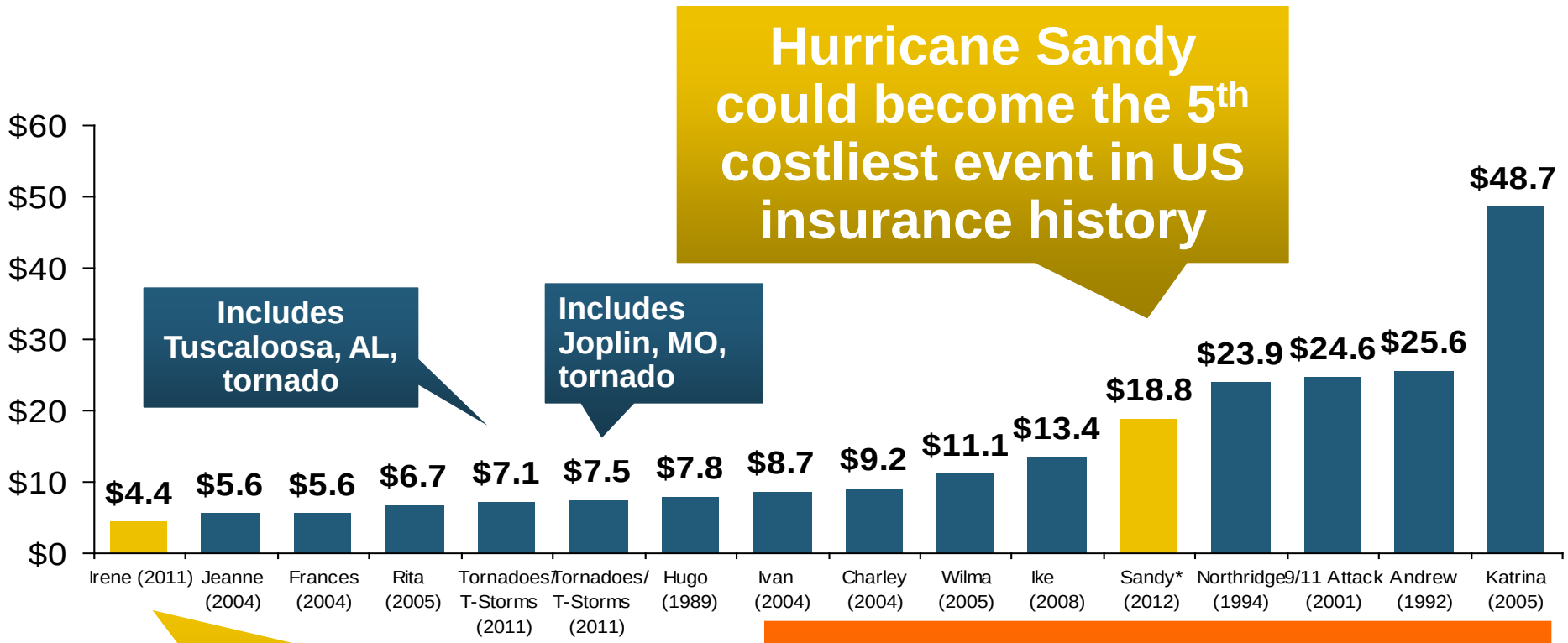
	YEAR	LANDFALL	TOTAL (in billions)[1]	DIAMETER (miles)[2]	TOP WINDS (mph)[3]
KATRINA	2005	LA	$128	200	110
SANDY	2012	NJ	~$60-70	940	94
ANDREW	1992	FL	$44	90	140
IKE	2008	TX	$32	240	95
WILMA	2005	FL	$25	250	105

[1]2012 dollars [2]Of tropical storm-force winds at landfall [3]Sustained, at landfall

Top 16 Most Costly Disasters in U.S. History

INSURANCE INFORMATION INSTITUTE

(Insured Losses, 2012 Dollars, $ Billions)



*Estimate as of 12/09/12 based on average of range midpoints from AIR, RMS and Eqecat..

Sources: PCS; Insurance Information Institute inflation adjustments.

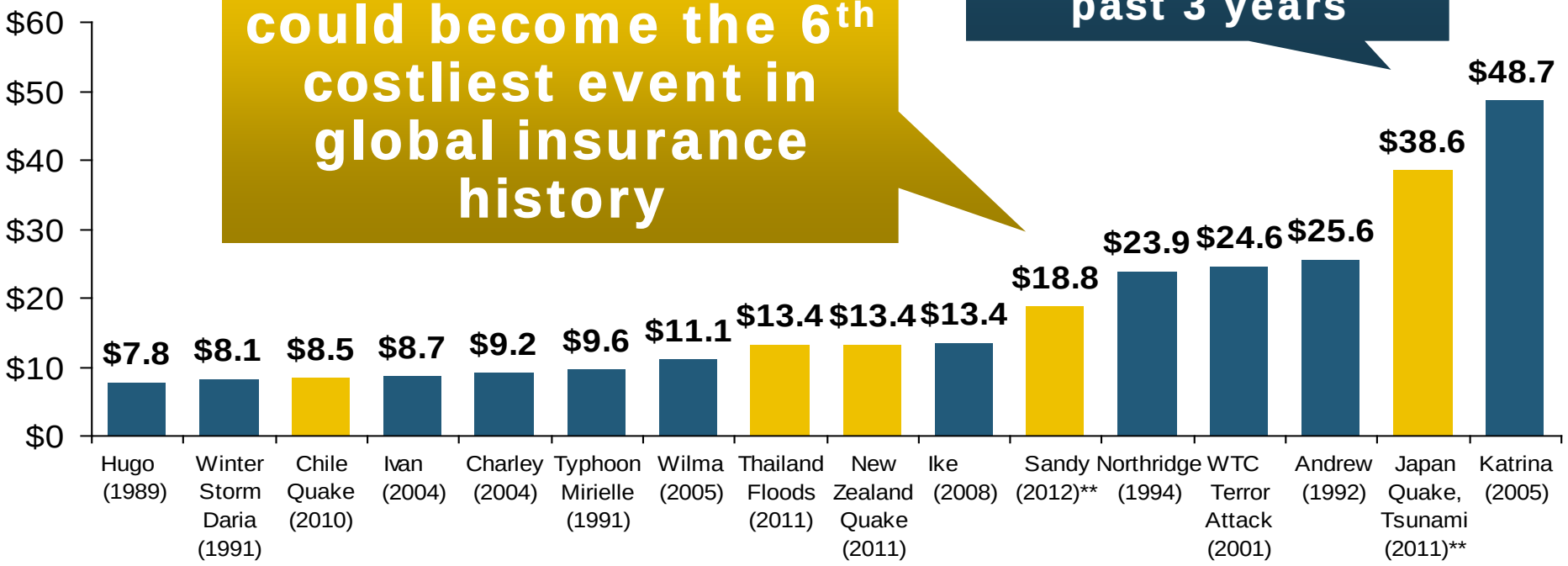
Top 16 Most Costly World Insurance Losses, 1970-2012*

INSURANCE INFORMATION INSTITUTE

(Insured Losses, 2012 Dollars, $ Billions)

Hurricane Sandy could become the 6th costliest event in global insurance history

5 of the top 14 most expensive catastrophes in world history have occurred within the past 3 years



*Figures do not include federally insured flood losses.
**Average of range estimates of $35B - $40B as of 1/4/12 adjusted to 2012 dollars; Privately insured losses only.
***Estimate as of 12/09/12, based on average of midpoints from range estimates from AIR, RMS and Eqecat.
Sources: Swiss Re *sigma 1/2011*; Munich Re; Insurance Information Institute research.

What we've learned

- Why was this storm so devastating?
- **Securing boats: What worked… and what didn't?**
- What has Sandy taught us?

Things that could not be changed…

- Height of hardstand area above sea level
- Height of fixed pilings holding floating docks
- Age and condition of fixed and floating docks
- Condition of neighboring marinas' infrastructure
- Number of boats in dry stack storage whose owners no longer have trailers

What worked… and what didn't

- Hauling boats
- Securing on floating docks
- Securing on fixed docks
- Moorings

Hardstand stowage

- Surge lifted boats off jackstands where hardstand stowage was within a few feet of MHW and surge exceeded ~8 feet.
- Confined areas with multiple surge events suffered the greatest damage – “boat stew” at bulkhead consisting of boats, docks, marina equipment, and other debris.
- Where boats did not go over the bulkhead, recovery was far easier than from the water and boats were much more likely to survive.

Outcomes in a high-surge storm

- **Hauling boats wasn't wrong, but it didn't work as well as in high-wind storms.**

What worked… and what didn't

- Hauling boats
- Securing on floating docks
- Securing on fixed docks
- Moorings

Floating docks

- Where pilings were not high enough (and most of them weren't), the outcome was as bad or worse than being on the hard.
- **The only place where a meaningful number of boats survived unscathed was on floating docks with pilings high enough to accommodate the surge.**

Floating docks – other issues

- A half dozen marinas/yacht clubs we know of where the docks were within one foot of the top of the pilings
- Forces on the entire docking system at that water level much higher than normal; if not designed for those forces or if docks are old or not in good repair, can easily destroy pilings
- If Sandy's winds had been Cat 3 or higher, the docks that survived might have failed
- Some boats and floating docks were damaged when debris from other marinas came down on them

Floating docks

- Where pilings were not high enough (and most of them weren't), the outcome was as bad or worse than being on the hard.
- The only place where a meaningful number of boats survived unscathed was on floating docks with pilings high enough to accommodate the surge.
- **BUT… some luck involved even then – debris from other marinas damaged docks, dock age/engineering, wind speed and total forces.**

Outcomes in a high-surge storm

- Hauling boats wasn't wrong, but it didn't work as well as in high-wind storms.
- **Floating docks with sufficiently high pilings were the only place where large numbers of boats survived Sandy unscathed, but in more than a few cases luck played a significant role.**

Outcomes in a high-surge storm

- Hauling boats wasn't wrong, but it didn't work as well as in high-wind storms.
- Floating docks with sufficiently high pilings were the only place where large numbers of boats survived Sandy unscathed, but in more than a few cases luck played a significant role.
- **A higher percentage of boats survived on fixed docks than in high-wind storms, but where they didn't they were often wrecked completely and recovery was harder than from hardstand areas.**

Mooring advantages

- Boats ride bow to the wind and waves, can adjust as conditions change
- With adequate scope, will ride up and down with the surge
- New technology for moorings, lines, and chafe protection have made mooring systems more reliable

Nyack Boat Club mooring outcome

- 97 boats in the water and on moorings for Sandy
- 18 chafed through their pennants
- 1 dragged its mooring
- 25 other boats damaged by the ones that broke loose

Mooring System

- Mooring
- Lower Chain
- Swivel
- Shackles
- Upper Chain
- Mooring Pendant
- Point of Attachment to Boat

The mooring is only so good as its weakest link

Outcomes in a high-surge storm

- Hauling boats wasn't wrong, but it didn't work as well as in high-wind storms.
- Floating docks with sufficiently high pilings were the only place where large numbers of boats survived Sandy unscathed, but in more than a few cases luck played a significant role.
- A higher percentage of boats survived on fixed docks than in high-wind storms, but where they didn't they were often wrecked completely.
- **Moorings offer a viable alternative for keeping boats safe in high-surge storms, but only if ALL moorings in the basin are properly constructed, maintained, and prepared for the actual conditions.**

What we've learned

- Why was this storm so devastating?
- Securing boats: What worked… and what didn't?
- What has Sandy taught us?

Four take aways

1. Surge matters.

Surge matters

- NOAA and NWS are working on new surge forecasting to accompany Saffir-Simpson Scale when hurricanes are forecast
- Tools for assessing YOUR surge risk can provide guidelines for rebuilding (SLOSH model and other tools)
- Next two webinars: ideas for preparing better whether storing boats on land or in the water

Four take aways

1. Surge matters.
2. Preparations matter… but we have to prepare for the real risks.

Analyzing your marina's risks

- Wind risk – exposure
- Wave risk – fetch, breakwalls
- Surge risk – SLOSH models
- Debris risk – 360-degree assessment
- No man's land – insurance coverage

Four take aways

1. Surge matters.
2. Preparations matter… but we have to prepare for the real risks.
3. Hurricane planning needs to become more marina and storm specific.

Four take aways

1. Surge matters.
2. Preparations matter… but we have to prepare for the real risks.
3. Hurricane planning needs to become more marina and storm specific.
4. Lessons from Florida marinas and from Sandy could have reduced the damage in this storm.

Webinar objective

To share lessons coming out of Sandy that will help marine facilities in storm-damaged areas rebuild smarter and those in other areas prepare better for future storms

This webinar has tried to answer three questions:

1. Why were so many boats and so much marina infrastructure destroyed DESPITE good forecasting and days of preparation based on industry "best practices?"
2. How did the various methods of securing boats fare in Sandy's high surge?
3. What are the key lessons learned for marine facilities?

Contact information

Beth Leonard

Director of Technical Services, BoatU.S.

bleonard@boatus.com

Kim Shaw

VP of Underwriting

kshaw@boatus.com

AMI-BoatUS Additional Webinars

- March 12: Hurricane lessons learned: Securing boats on land
- March 26: Hurricane lessons learned: Securing boats in the water

Association of Marina Industries

BoatU.S.
Boat Owners Association of The United States

Boating Resource

Goal: To make sure boaters know what marinas are up and running in storm-damaged areas this summer so business doesn't pass boating facilities by.

- Partnership between BoatU.S., AMI, and Dozier's Waterway Guide
- See web page at: http://www.waterwayguide.com/superstorm-sandy/
- To report updates: superstormsandy@waterwayguide.com

Association of Marina Industries

BoatU.S. Boat Owners Association of The United States

BoatU.S. and AMI want to wish all those who suffered damage from Sandy the best of luck in the coming year.

THANK YOU!

Association of Marina Industries

BoatU.S.
Boat Owners Association of The United States