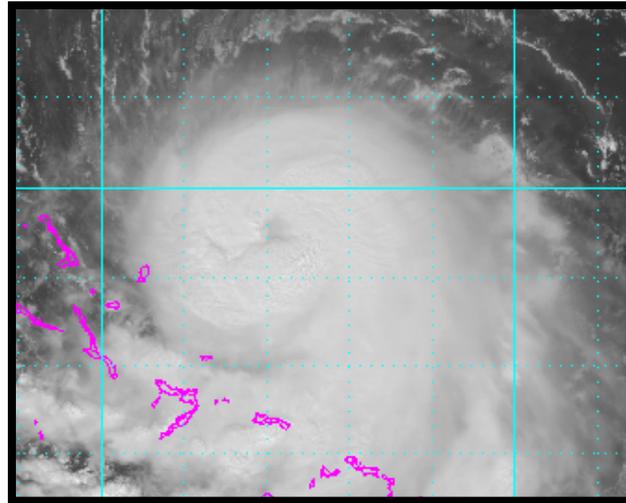


Hurricane Threat

New England Perspective

New England? – Just a Matter of Time



May 26, 2016

Bob Thompson
Weather Forecast Office – Taunton, MA

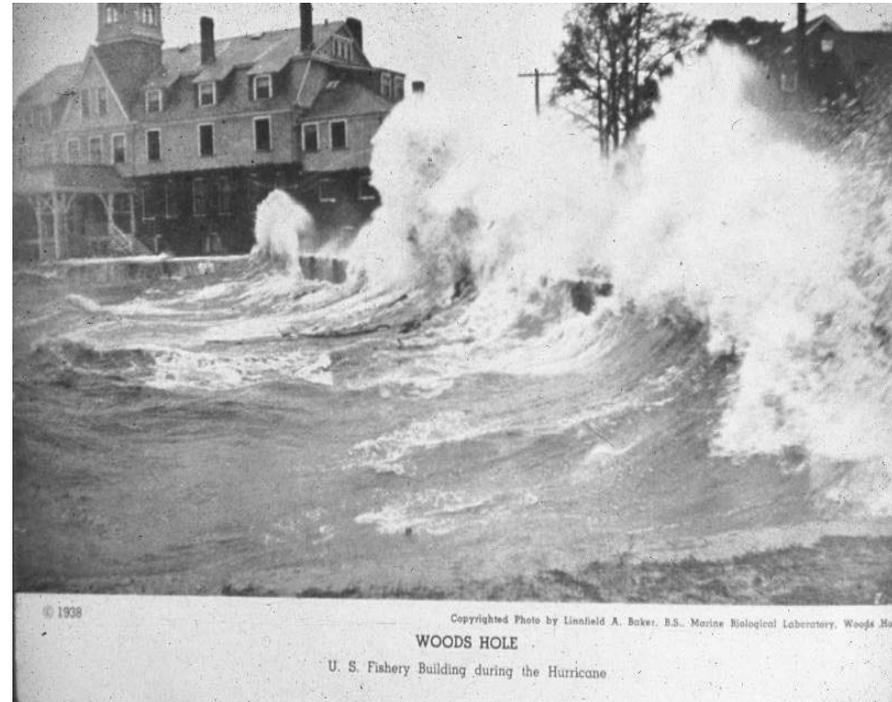
New England Hurricane Threat

- Implications of a low frequency, high impact event
- Our history illustrates the hurricane impacts
 - Wind
 - Coastal flooding from storm surge
 - Flooding rains
- Local Information
 - A few products
 - Decision Support Services
- Take Aways

NEW ENGLAND HURRICANES

Low Frequency, High Impact!

- **Category 3 hurricanes**
 - Great Colonial Hurricane of 1635
 - Hurricane of 1815
 - Hurricane of 1869
 - Great New England hurricane of 1938
 - Carol in 1954
- **Strong Category 2 hurricanes (20th Century)**
 - Great Atlantic Hurricane of 1944
 - Edna in 1954
- **Last land-falling hurricane**
 - Bob in August 1991

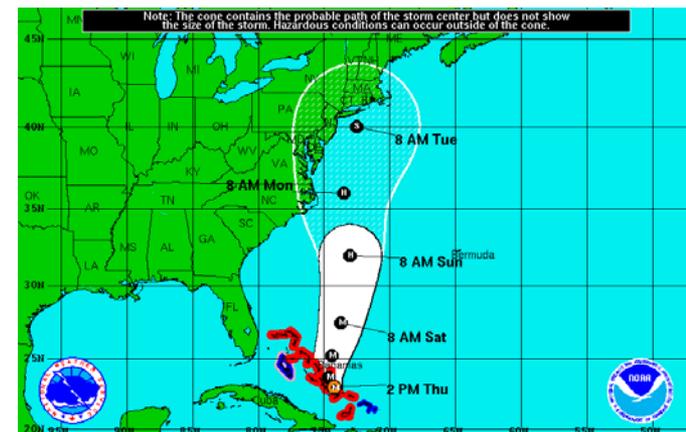


A Preparedness Challenge

- **No Category 3 hurricanes have made landfall in southern New England since 1954**
 - And no hurricane at all since 1991!
- **Buildup in coastal population and infrastructure presents a high risk for life and property**
- **Most New Englanders have not experienced a worst case scenario and many no hurricane at all!**
 - Inexperienced population!

What About Us?

- Lack of experience by most New England meteorologists and emergency managers
- Most significant weather hazard we potentially face
 - Large regional impact
 - Potential large threat to lives and livelihoods
 - Next Category 3 hurricane will probably exceed anything we've experienced
 - And for some beyond anything imagined



What History Tells Us for Impacts

- Wind
- Coastal Flooding/Damage from Storm Surge
- Flooding Rains

Wind Damage in Keene, NH



Keene, NH after 1938 Hurricane



Edgewater Yacht Club during Carol



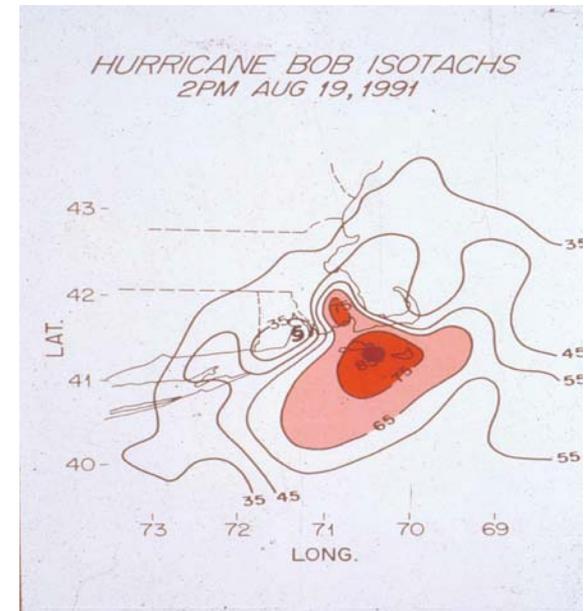
Quinebaug R. in Putnam, CT - Dianne

WIND

- **Fast moving hurricane produces wind damage far inland**
- **Strongest to right of track**
- **Damage begins with arrival of tropical storm force winds**
 - When preparations need to be complete
 - Also build in some time for faster than expected arrival
- Highest reported in southern New England: 186 mph on top of Blue Hill during 1938 Hurricane



Wind damage in Keene, NH from 1938 Hurricane



TRAFFIC!



End Game

When Tropical Storm Force Winds Arrive

Tree taken down on weaker side of Hurricane Bob

- Sustained wind = 40 mph
- Gusts = 60 mph



TREES DOWNED BY COUNTY
Hurricane, Sep 1938

Tolland County	29 million
Windham County	91 million
New London County	97 million
Middlesex County	14 million
Hartford County	7 million
Total	238 million

Source: Connecticut Forest and Park Association Report,
November 1938

Hurricane Debris



Providence Journal



Falmouth tree damage from Hurricane Bob



**ESTIMATED DEBRIS CLEANUP
AFTER A MAJOR HURRICANE
47 MILLION TONS
EQUALING 1,900,000 TRUCK
LOADS
(Equal to all the trash Generated in
Connecticut in 1 Year)**



COMPARISON OF TROPICAL STORM IRENE VS. A MAJOR HURRICANE

TROPICAL STORM IRENE

Wind Gusts from Irene reached a maximum of 67 MPH.

T.S. Irene downed approximately 1 – 2% of the State's Trees

T.S. Irene resulted in over 800,000 power outages requiring 9 days to fully restore.

Total damages estimated at 200 Million Dollars

Governors S.T.O.R.M. Briefing

MAJOR HURRICANE

Instantaneous Maximum Wind Gusts in a fast moving major hurricane can reach close to 200 MPH.

A major hurricane may down up to 70 - 80% of the State's trees.

A major hurricane may black out the entire state, some areas for an extended period of time (over a month).

Total damages estimated in the tens of billions of dollars.

October 25th, 2011



STORM SURGE/COASTAL FLOODING

- *Historically cause for most fatalities (e.g. 1938 Hurricane)*
- Highest to right of track along land falling coastline
 - More often New England south coast
- Extreme values can occur Buzzards and Narragansett Bays
- Storm surge along MA east coast can be comparable to severe nor'easter (consider Sandy a wake-up call for our east coast)

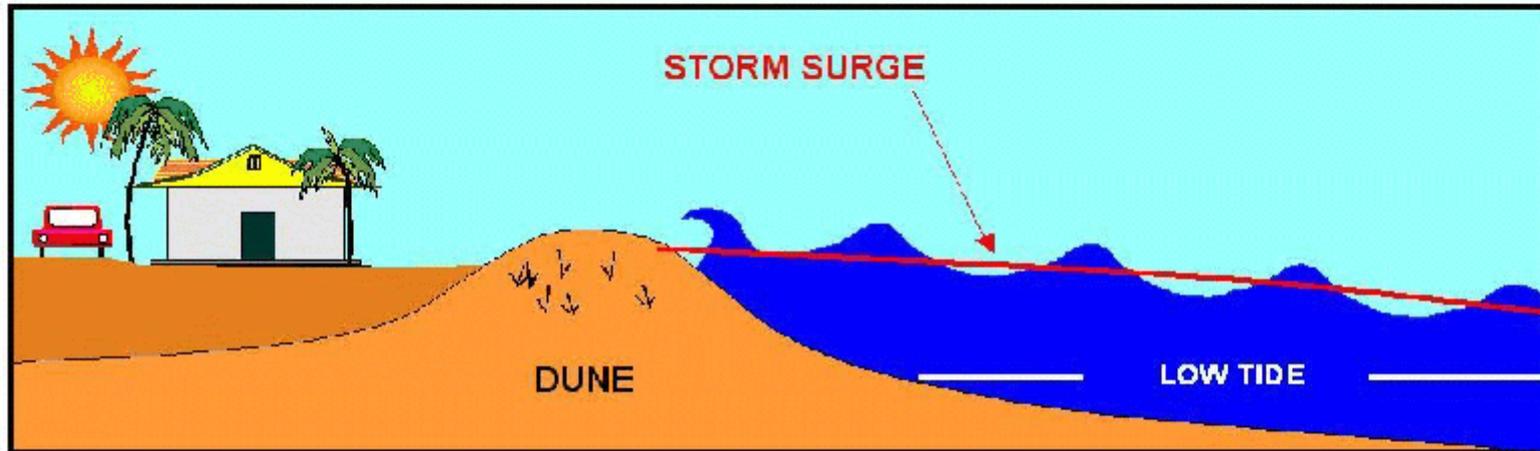


Providence during 1938 Hurricane

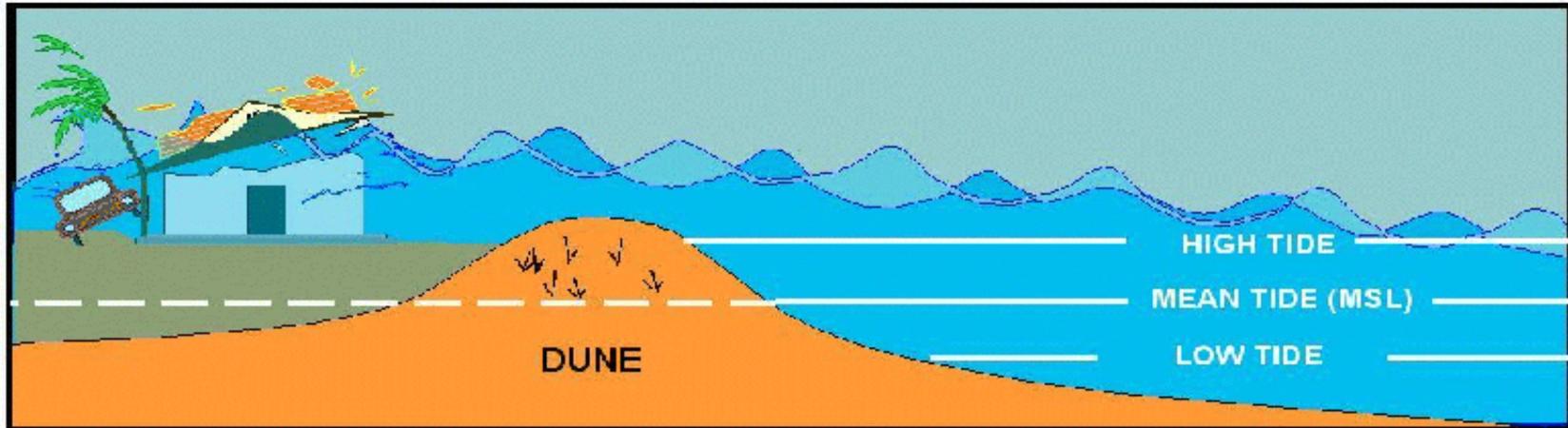


Woods Hole during 1938 Hurricane

Timing Matters - LOW TIDE

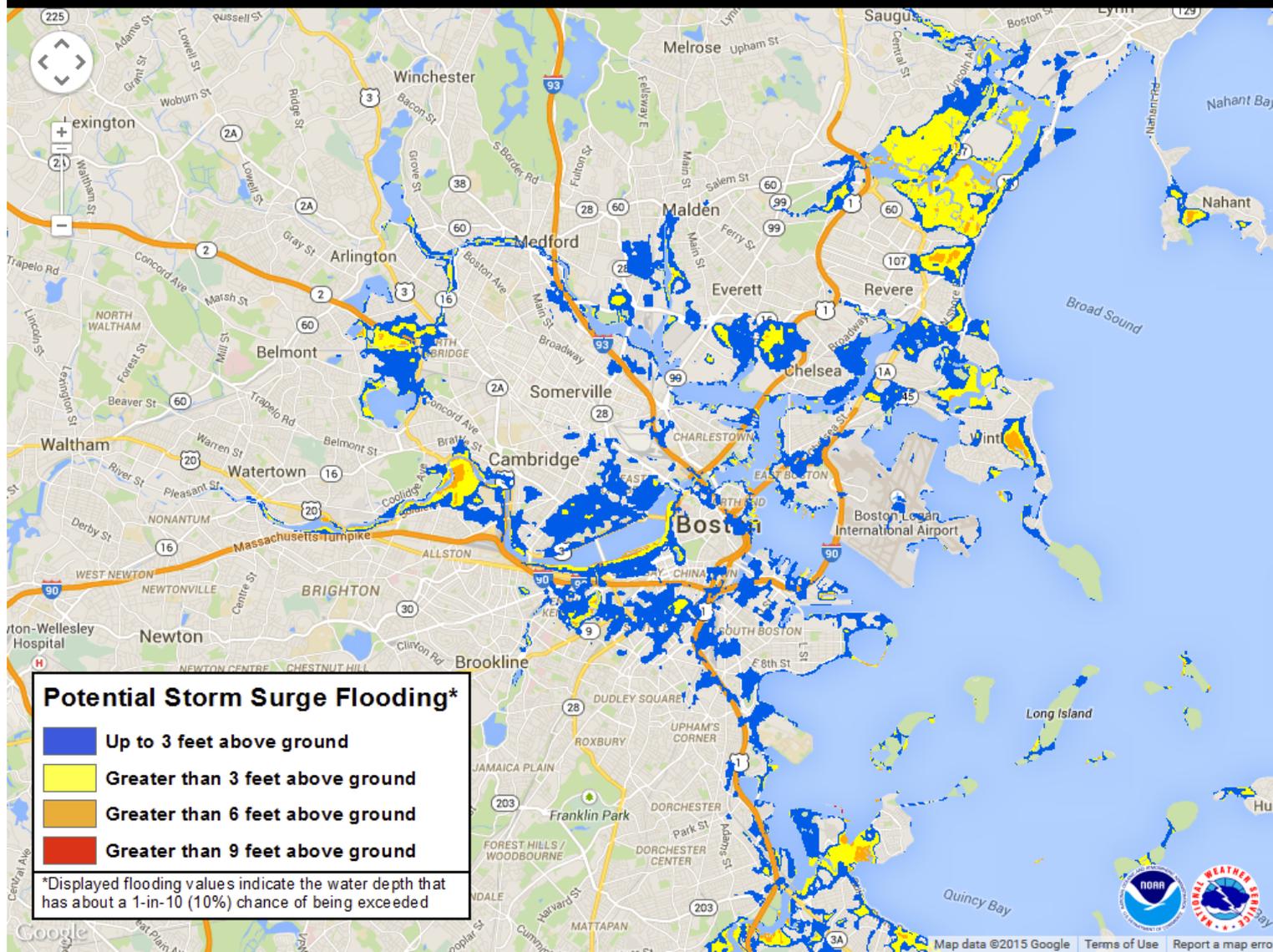


Timing Matters - HIGH TIDE



A Storm like Sandy Can Wreak Havoc along the Massachusetts east coast including Boston

Hurricane TRAVIS - Advisory 18 - EXPERIMENTAL MAP



History Suggests South Coast Especially Vulnerable to Storm Surge Flooding!



1938 Hurricane – 13 foot surge



Hurricane Bob (1991) – 6 foot surge



Near worst case storm surges for Narragansett and Buzzards Bays

Don't Forget the Power of Waves



Andrea Hotel and Resort after Sandy

Including Erosion from Waves



Misquamicut Beach – Westerly, RI (2 days after Sandy)

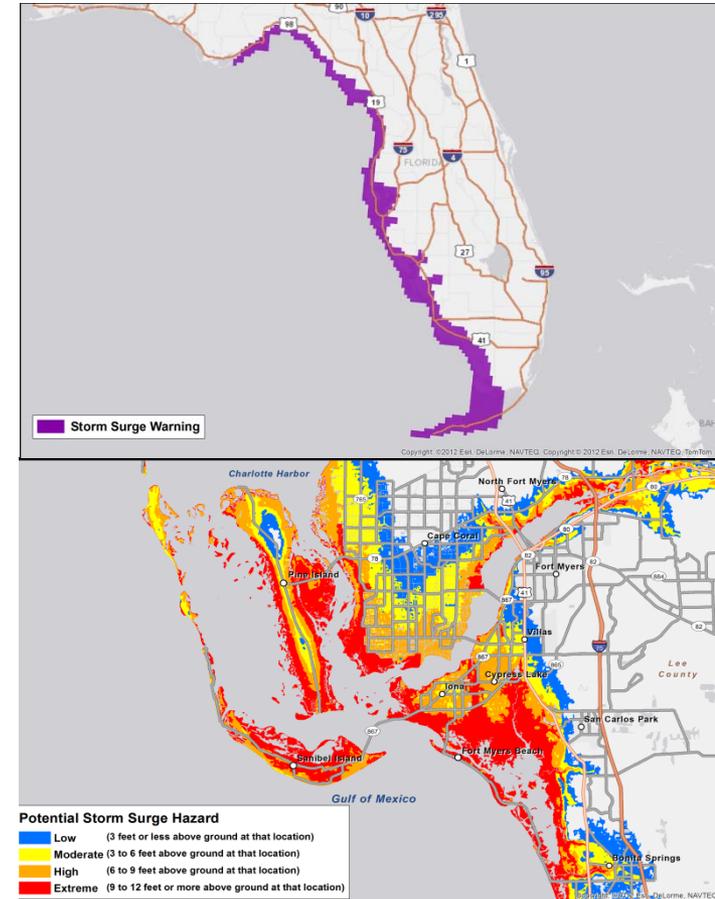


New Developments from National Hurricane Center

- Storm Surge Warnings
 - Explicit Storm Surge Warning
 - versus implicit by a Hurricane Warning
 - Recommended by social scientists

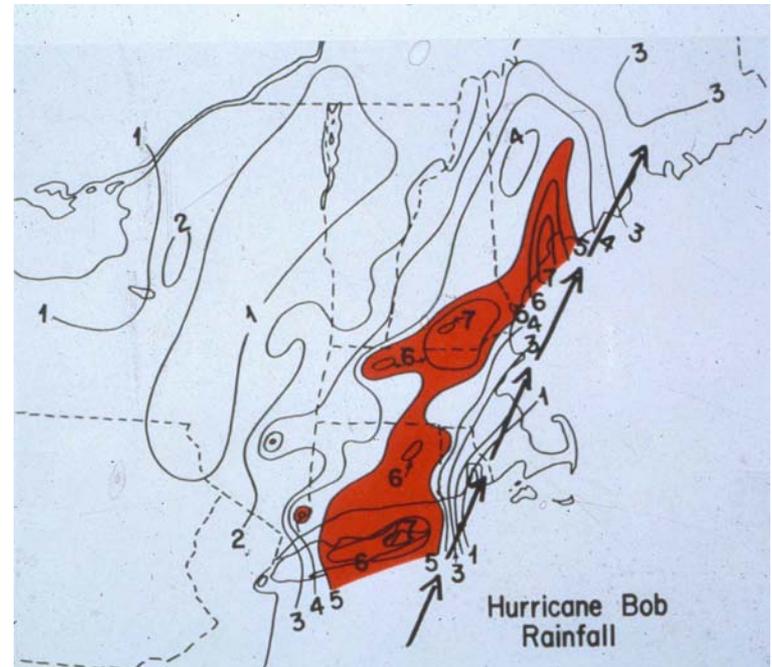
- **Inundation mapping**

- Visualization of inundation **possible** from a specific storm
- *Represents plausible worst case scenario for a specific location*
 - For any given location on map, 90% chance that flooding will be less than shown
- **Depicts where risk too high *not* to take action**
 - **Not** what we expect or think most likely to happen!
- Need to provide careful, consistent messaging to public



Flooding Rains

- Can be underappreciated risk
- Heaviest rain usually to left of track and leading part of storm
- Even weak tropical cyclones can bring devastating rains



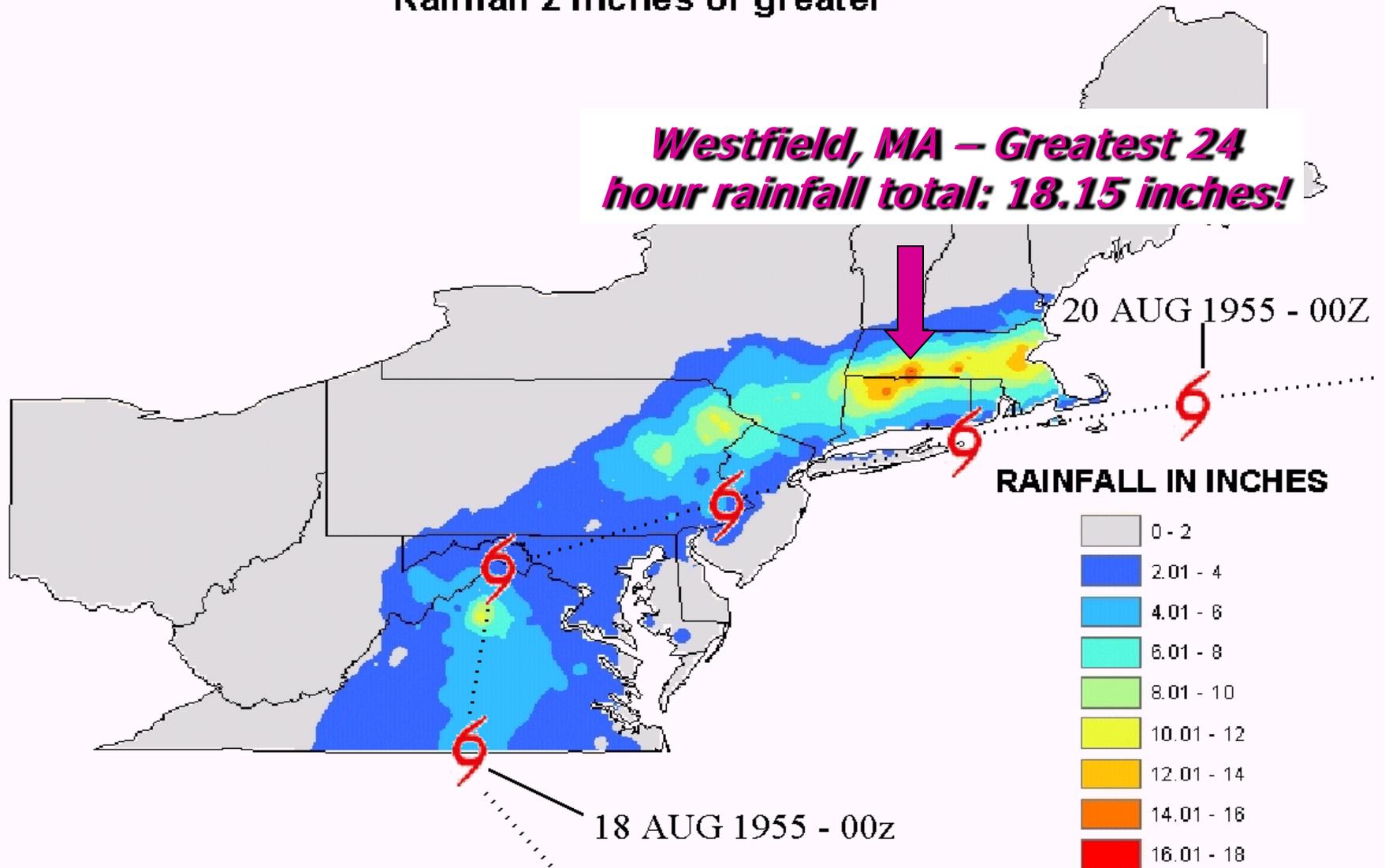
B. SCENE ON MILLERS RIVER AT WINCHENDON, MASS.

Courtesy of International News Photo.

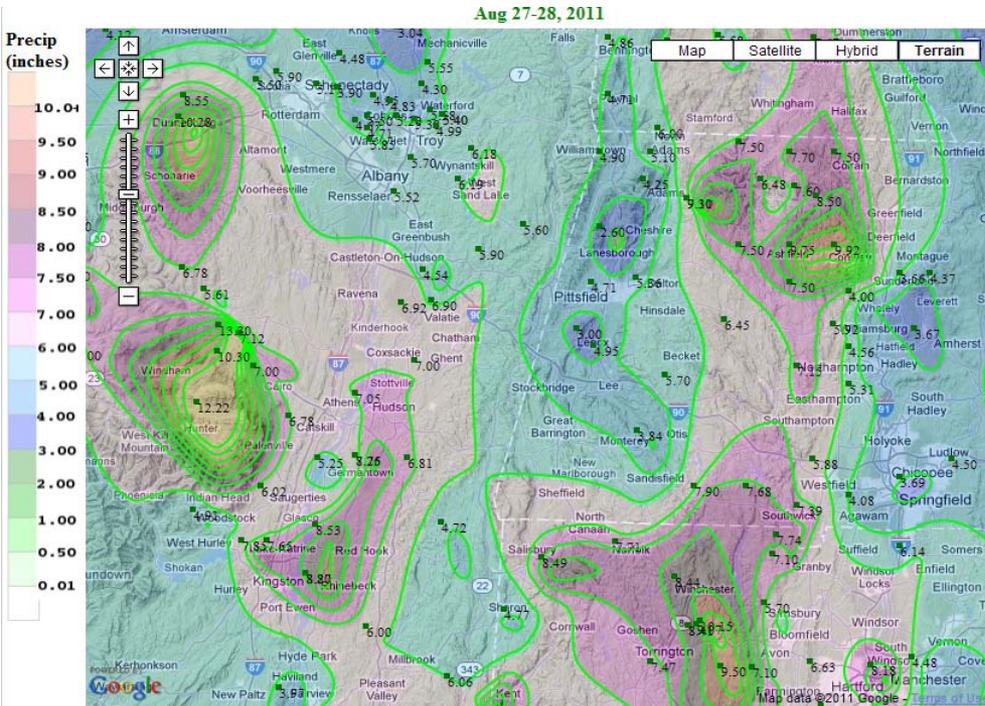
Hurricane Diane - 1955

Rainfall 2 inches or greater

***Westfield, MA – Greatest 24
hour rainfall total: 18.15 inches!***



IRENE – August 2011



Irene Rainfall

Deerfield River in Buckland



Flooding on Conway St., Buckland, MA
Photo: J. Brown

Local Products

- **Hazardous Weather Outlook**
 - Early signal of trouble
 - Look ahead next 7 days
- **Area Forecast Discussion**
 - Early signal of trouble
 - Confidence/alt. scenarios
- **Hurricane Local Statement**
 - Overview of expected impact
 - What's most important
- **Flood/Flash Flood Products**
 - Watches/Warnings
 - River Forecasts

The screenshot shows the National Weather Service website for the Boston, MA office. At the top, there is a navigation bar with links for HOME, FORECAST, PAST WEATHER, SAFETY, INFORMATION, EDUCATION, NEWS, SEARCH, and ABOUT. Below this is a search bar for location forecasts. The main content area features a 'Customize Your Weather.gov' sidebar on the left, a 'News Headlines' section with links to a webinar and training schedule, and a 'NWS Weather Forecast Office - Boston / Taunton, MA' header. A central map shows the region with various weather products overlaid, including a 'Frost Advisory' and a 'Hazardous Weather Outlook'. Below the map is a grid of product icons: Radar, Current Weather, Rivers & Lakes, Satellite, Weather Information Display, Forecast Maps, Hour by Hour Forecast, Beach & Surf, Forecaster's Discussion, Submit Storm Report, Text Bulletins, and Winter Weather. A red arrow points from the 'Hazardous Weather Outlook' bullet point to the 'Hazardous Weather Outlook' link on the map. A blue arrow points from the 'Area Forecast Discussion' bullet point to the 'Forecaster's Discussion' icon. A green arrow points from the 'River Forecasts' bullet point to the 'Rivers & Lakes' icon.

weather.gov/boston

Decision Support Services Information

- PowerPoint Briefings
- Conference Calls
 - NWS initiated (mainly state and federal partners)
 - MEMA initiated (other state and local partners)

The image displays a collection of 18 PowerPoint slides from the National Weather Service (NWS) Taunton office, organized into two rows of nine slides each. The slides provide detailed information on various weather hazards and forecasts.

Row 1 (Left to Right):

- NWS – Taunton Weather Impacts Briefing** (Sept. 30, 2015, 2:15 PM Briefing)
- Highlights - Hazardous Weather** (Table with columns: Day, Main Hazard(s), Other Hazard(s), Marine Hazard)
- Rainfall** (List of bullet points regarding small storm flood warnings and rainfall amounts)
- Total Rainfall from 7 AM Today – 7 AM Next Wed.** (Map showing rainfall distribution)
- Coastal Flood Threat** (List of bullet points regarding coastal flooding and a table of water levels)
- Winds** (List of bullet points regarding wind forecasts)
- Hurricane Joaquin 11:55 PM EDT Wednesday** (Satellite image of the hurricane)

Row 2 (Left to Right):

- Hurricane Joaquin** (Map showing the hurricane's path)
- Highlights - Hazardous Weather** (List of bullet points regarding coastal flooding and wind)
- Coastal Flood Threat** (Map showing coastal flooding threats)
- Winds** (List of bullet points regarding wind forecasts)
- Rainfall** (Map showing rainfall forecasts)
- Major Hurricane Joaquin: Category 4 (130 mph sustained)** (Map showing the hurricane's path and intensity)

TAKE AWAYS

- **Assess vulnerability to hurricane threats**
 - Review or make list in next day or so
- **Assess viability of response plans after today's seminar**
 - Do so soon (hurricane season starts June 1)!
- **Visualize aftermath**
 - On way home today, visualize every other tree blown down
 - Coastal community, visualize worst case scenario per SLOSH inundation maps (re: MEMA website)
 - River community, research record flood and consider whether or not worst case scenario
- **Communicate relevant info to community/organization**
 - Coastal EMDs: Consider ways to convey to community the need to **respond to the risk** (not expected outcome)
- **Preparedness must go on**
 - *especially for low frequency/high impact events like hurricanes*

“Natural calamity strikes at just about the time that one forgets its terror.”

-- Japanese Proverb

Hurricane Edition **THE SUN** Local and Shore News
 Vol. 46, No. 30 WESTERLY, R. I., FRIDAY SEPTEMBER 23, 1938 Price Three Cents

Misquamicut Wiped Out; Napatree Point Gone; 50 Dead; Scores Missing

Westerly Paralyzed by Tropical Hurricane; Cottages at Charlestown Beach and Quonochontaug Washed Away; 4 Dead, 4 Missing in Stonington

Misquamicut with 500 cottages, was entirely wiped out and all cottages on Napatree point, which had been damaged and more than 90 people killed and millions of dollars of property damage reached from a tidal wave and hurricane which struck Westerly late Wednesday afternoon.

“Children’s bodies” and “women’s dresses” were dashed.

Westerly and the Rhode Island coast received the brunt of the force as the storm, more death being reported in this locality than any other.

Reports show that 125 to 200 are up in the city, depending on a hurricane which “washed” Pawtucket Overfalls.

The moon looked up the Pawtucket Overfalls.

List of Dead and Missing

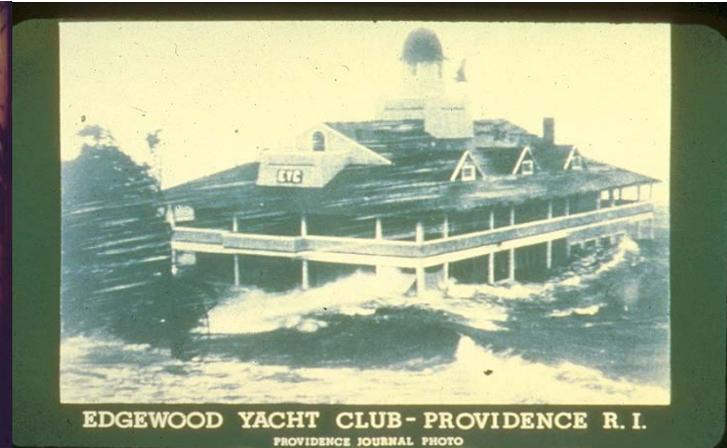
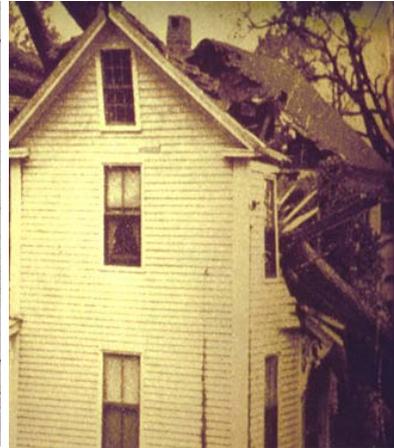
<p>Bodies Recovered</p> <p>Mrs. Harry Bennett, New York City Mrs. Ella Brown Mrs. Frank Brown, Middletown Mrs. Charles Bradley Mrs. Sylvia Brown Mrs. H. N. Brown Mrs. George P. Clark, Stonington Mrs. Harriet Clark, Stonington Mrs. Mrs. Clark, Stonington Miss Frances Clark, Stonington Mrs. Frank J. Clements Mrs. Sarah M. Cook George Cook, Charlestown Mrs. George Davidson Mrs. Dorothy Mrs. Elsie Pender Frank Fitzgerald Mr. James Grant</p>	<p>Persons Reported Missing</p> <p>Mrs. Kingsbury Mrs. Franklin Edwin Brown Mr. Eugene Robert Crocker Frank Prescott Mrs. John Davidson Anna Davidson Mrs. Anne Harriet S. L. Langdon Mrs. William Brown Mrs. John and two children Mrs. John and two children Mrs. P. H. Hoadley James A. Brown Catherine Cuddy Thelma O’Toole Francis O’Toole Edith Averb</p>
--	--

Every one of the approximately 200 houses on Charlestown beach was carried away.

Because of wind and waves on the Charlestown beach area including Charlestown, Charlestown, were destroyed, the few houses left in that area have been saved from a few feet to a quarter of a mile away. A few houses on full pasture are said to be badly damaged. Many people who were staying in that section just barely escaped.

Mrs. David Latham and daughter who were on the beach stayed across the beach on a door, Mrs. Latham packed away—Mrs. Latham was saved, although she is in a poor condition.

Mr. Adams and family were in their car, driving the beach, and almost to reach the “Berkshires” family who were in trouble. The wave





Nature's Awesome Power!

Thank You

Questions?

Atlantic Ocean

HURRICANE ISABEL

Hurricane Isabel - September 2003

New England? - It's just a matter of time