

Impacts of Tropical Storm Irene on Streams in Vermont

George Springston and
Kristen Underwood

Norwich University Dept. Geology and Environmental Science
South Mountain Research and Consulting

Photo: Staci Pomeroy, Vt. Rivers Program

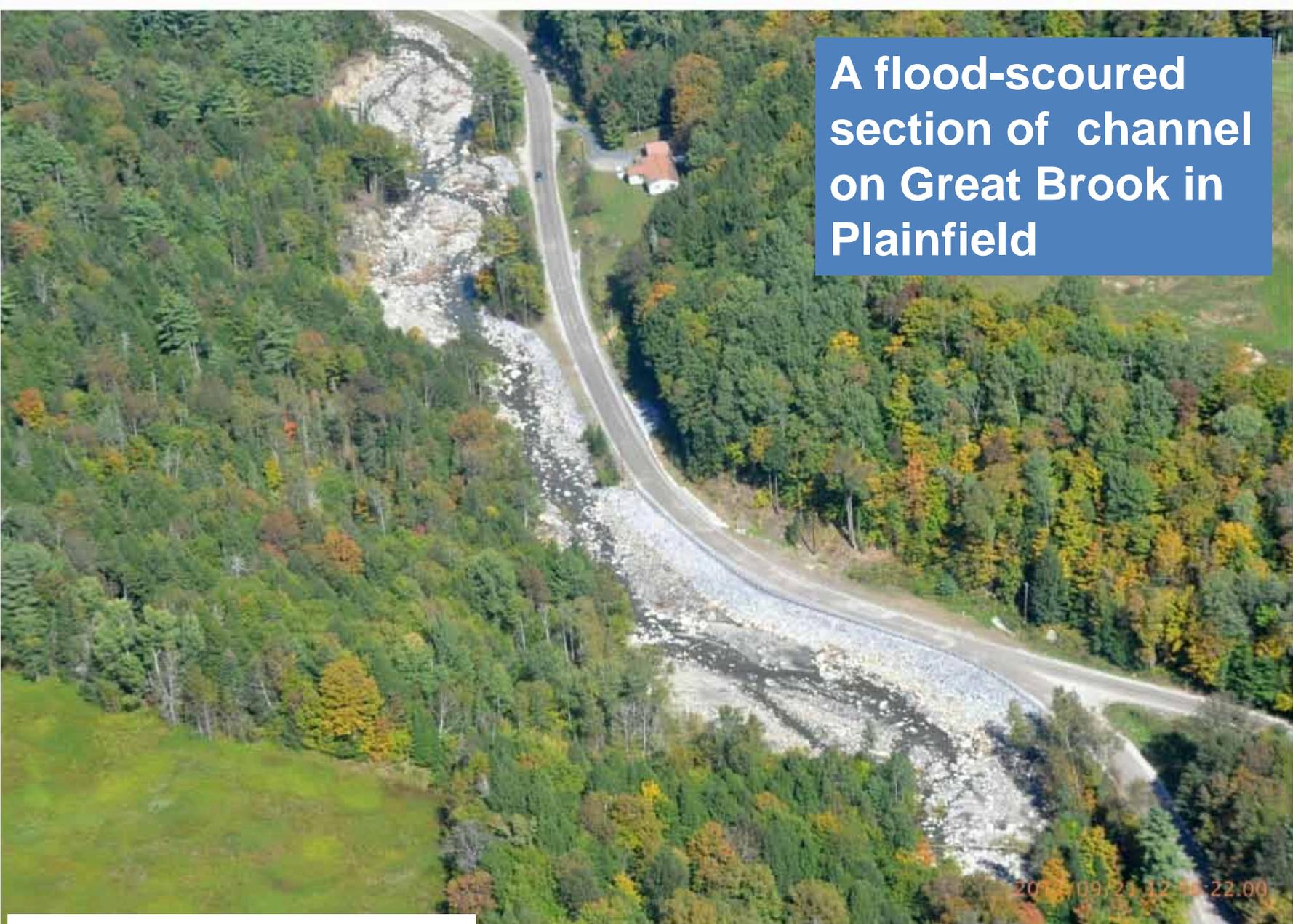


Outline

- Geomorphology and stream erosion
- Statewide patterns of rainfall, stream runoff, and road damage
- Examples of geomorphic impacts from around the state

Geomorphology

- The study of landforms
- Many processes operate, but in general,
Streams Shape the Land!
- Shaping occurs during floods \geq bankfull



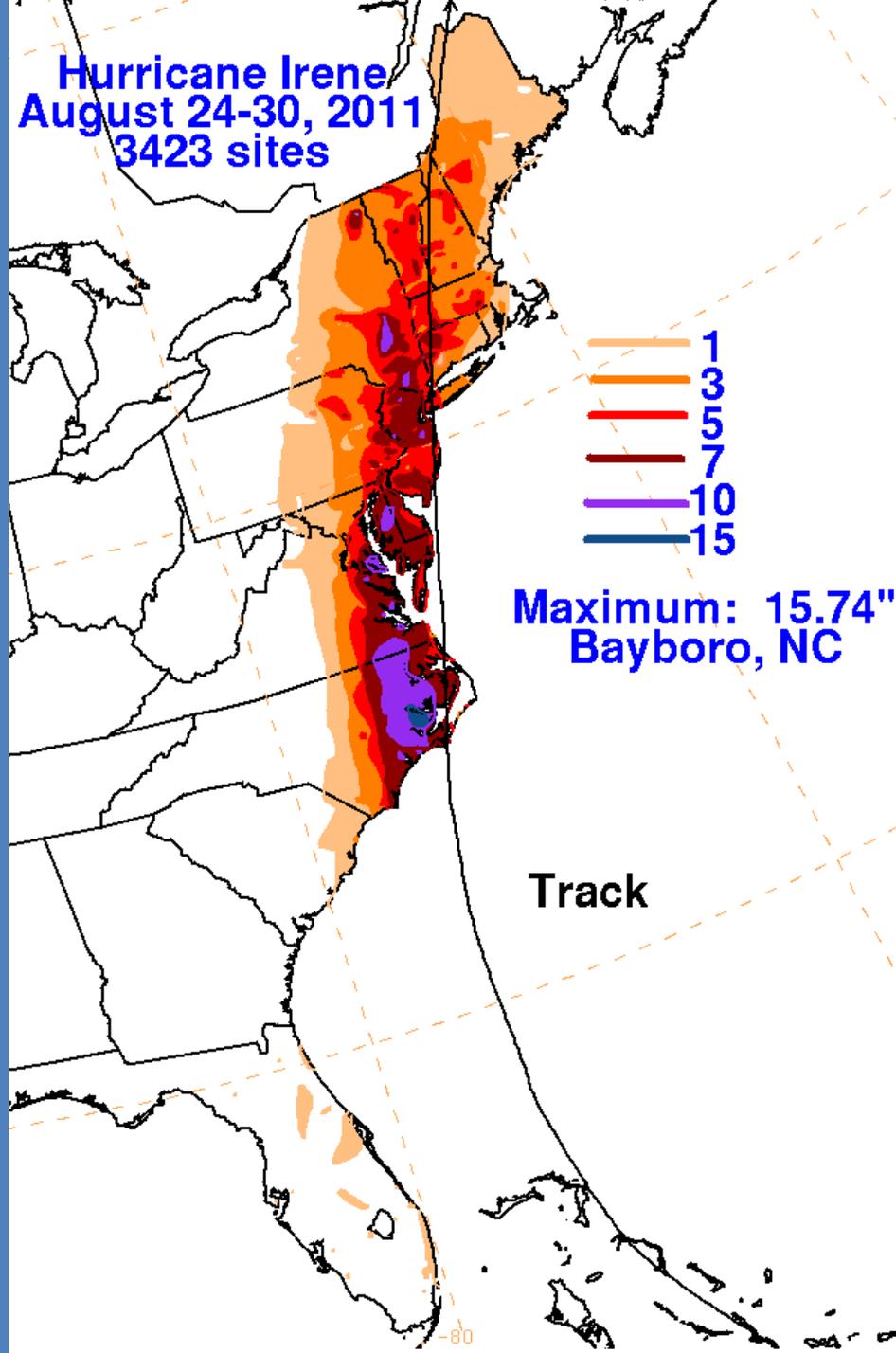
A flood-scoured section of channel on Great Brook in Plainfield

Photo: Staci Pomeroy, Vt. Rivers Program

DSC_0130.JPG, 2011/09/21 12:56:22.00

Latitude: N 44°15.158' (44°15'9.5"), Longitude: W 72°24.836' (72°24'50.2"), Altitude: 707.00m

Hurricane Irene
August 24-30, 2011
3423 sites



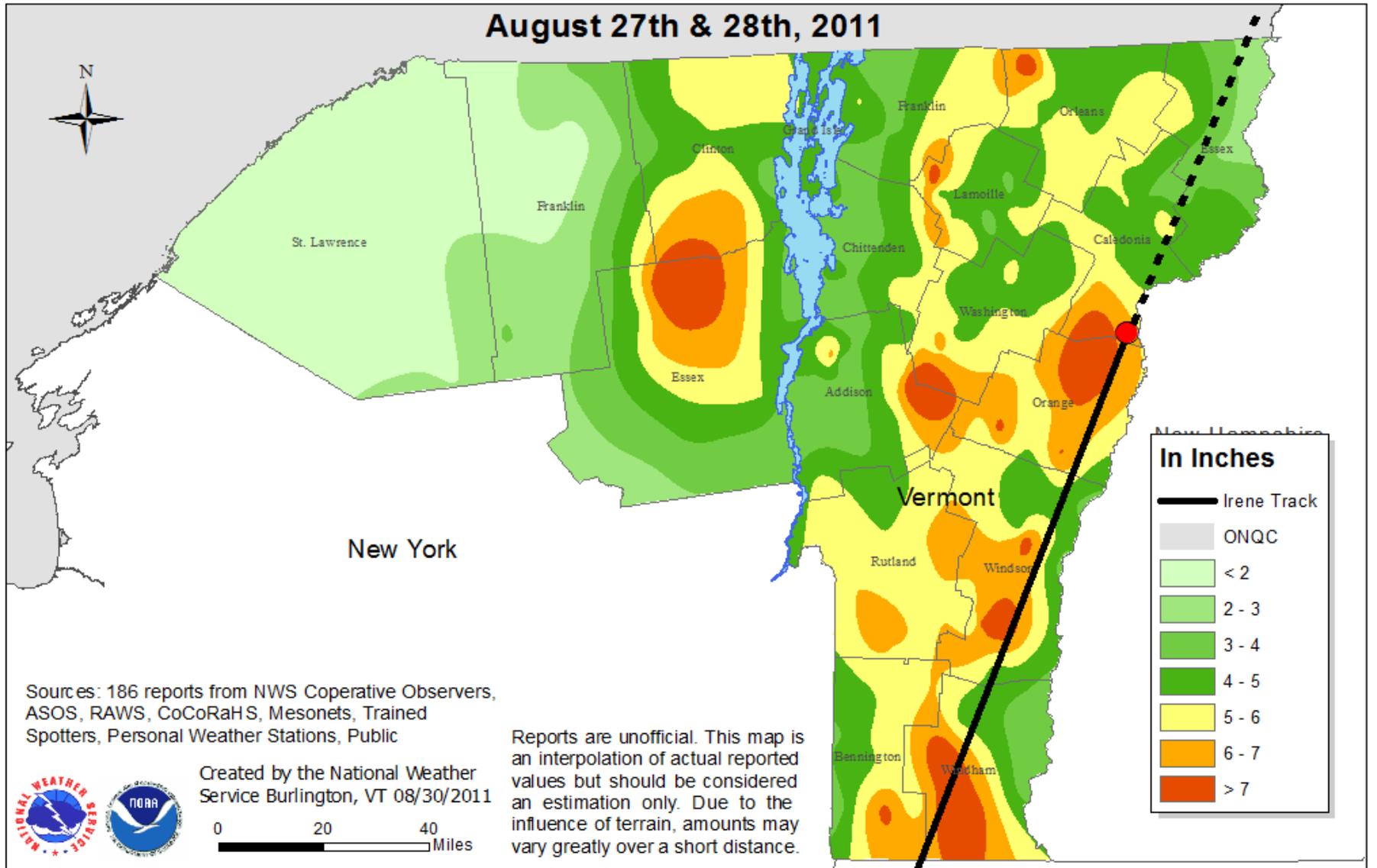
Maximum: 15.74"
Bayboro, NC

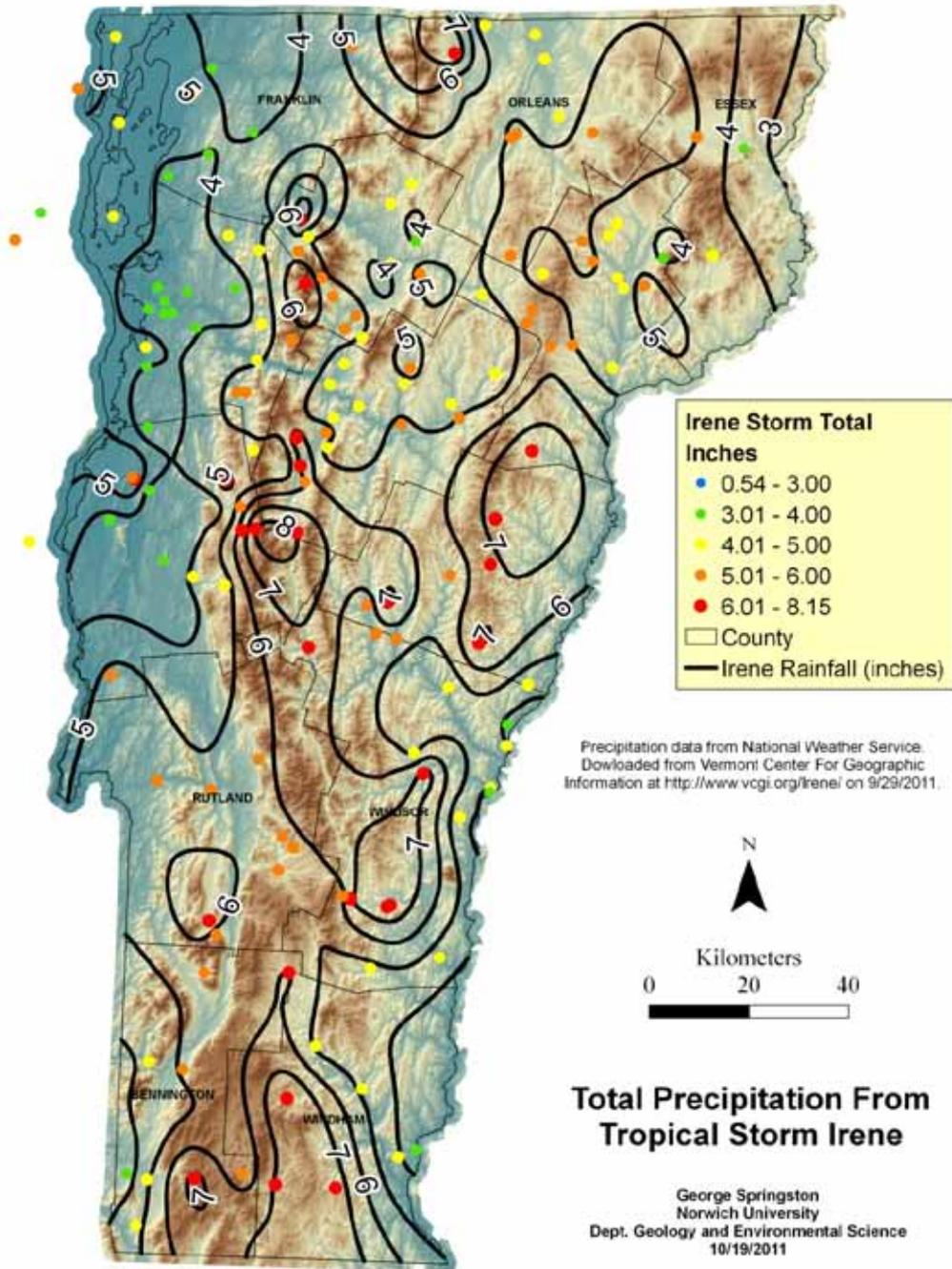
Track

From:
<http://www.hpc.ncep.noaa.gov/tropical/rain/>
Accessed
1/30/2012

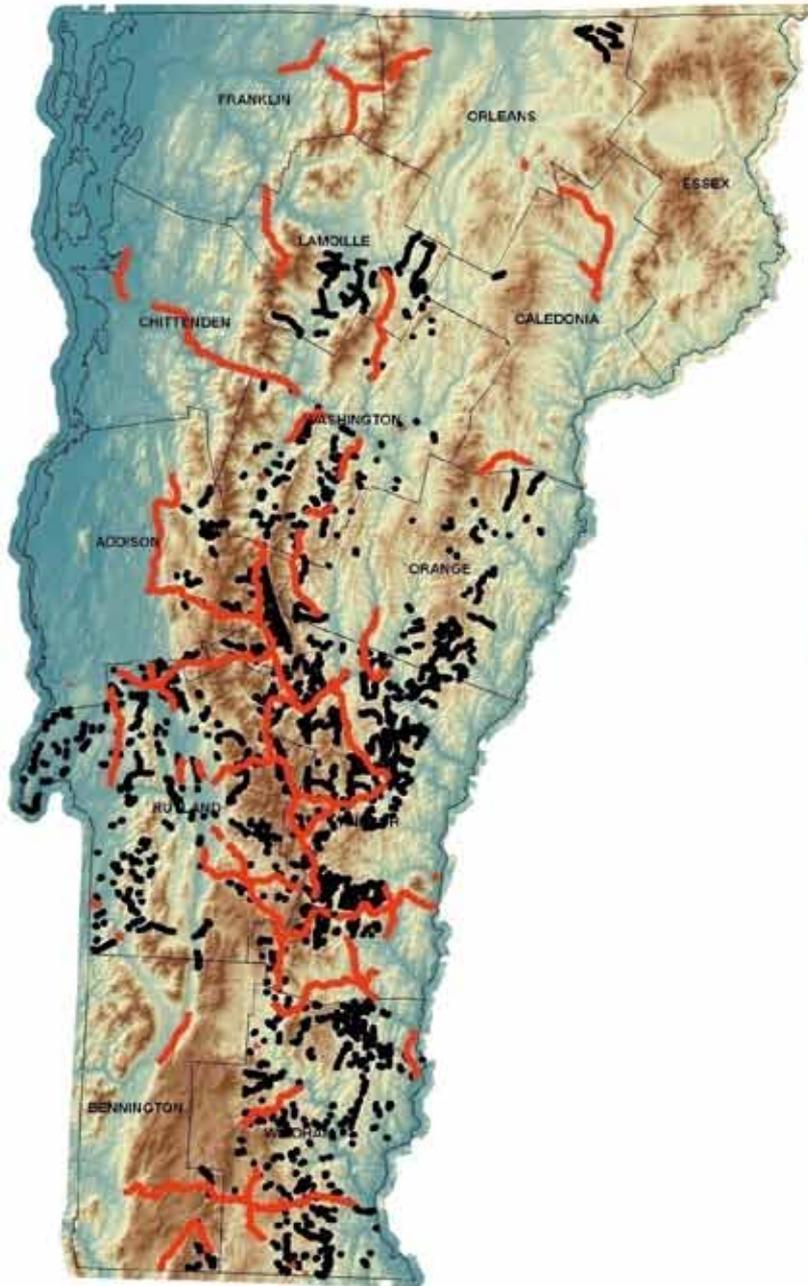
Tropical Storm Irene Total Rainfall - Northern New York & Vermont

August 27th & 28th, 2011

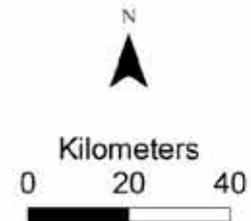




Precipitation data from National Weather Service.
Downloaded from Vermont Center For Geographic
Information at <http://www.vcgi.org/irene/> on 9/29/2011.
State road and bridge data (draft products) is from
Johnathan Croft, VTrans, 1/4/2011. Local road data (draft
products) is from Pam Brangan, CCRPC, 1/11/2012.

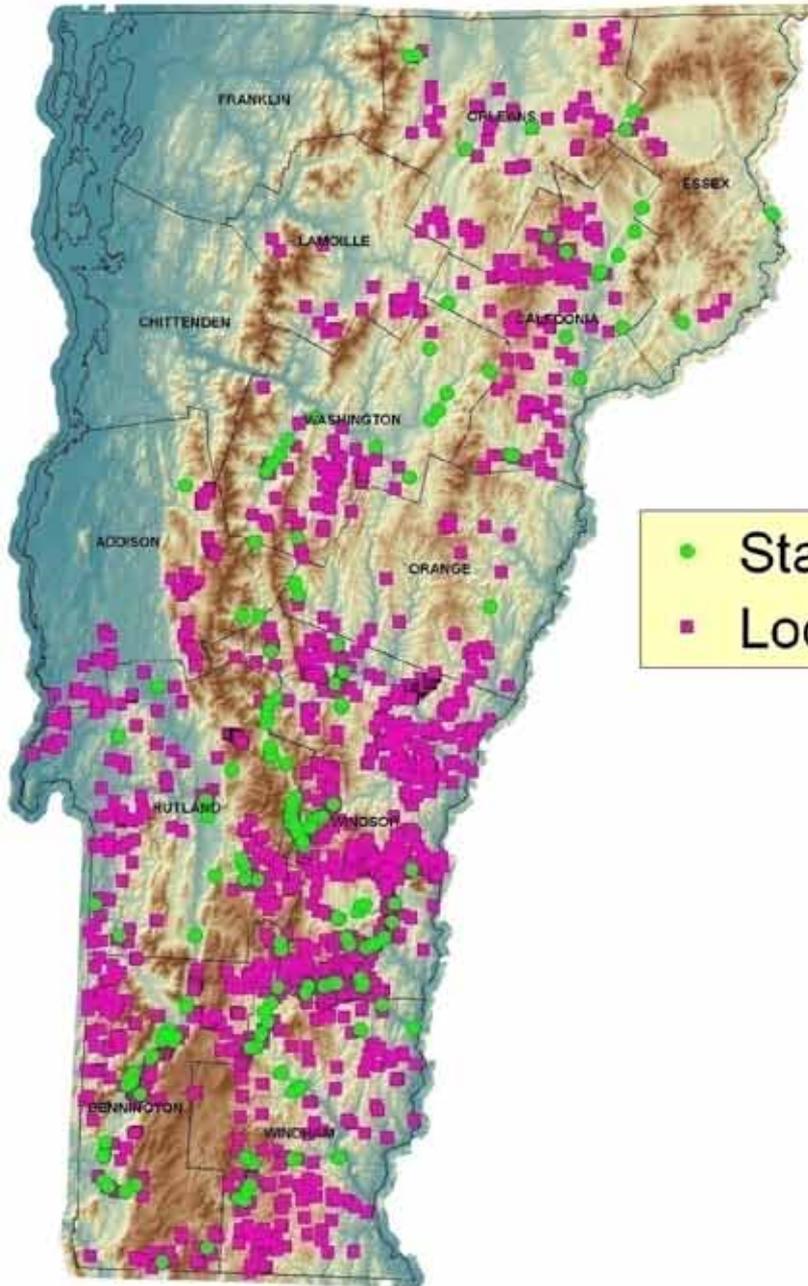


— State Road Closures (draft)
— Local Road Damage (draft)



Damage to Roads From Tropical Storm Irene

George Springston
Norwich University
Dept. Geology and Environmental Science
1/19/2012



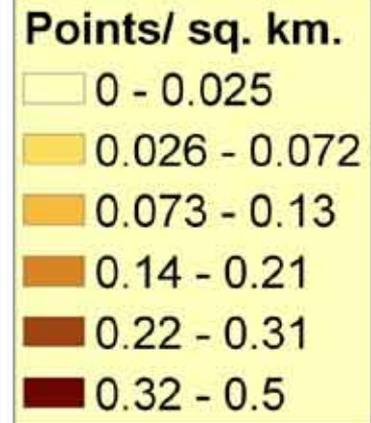
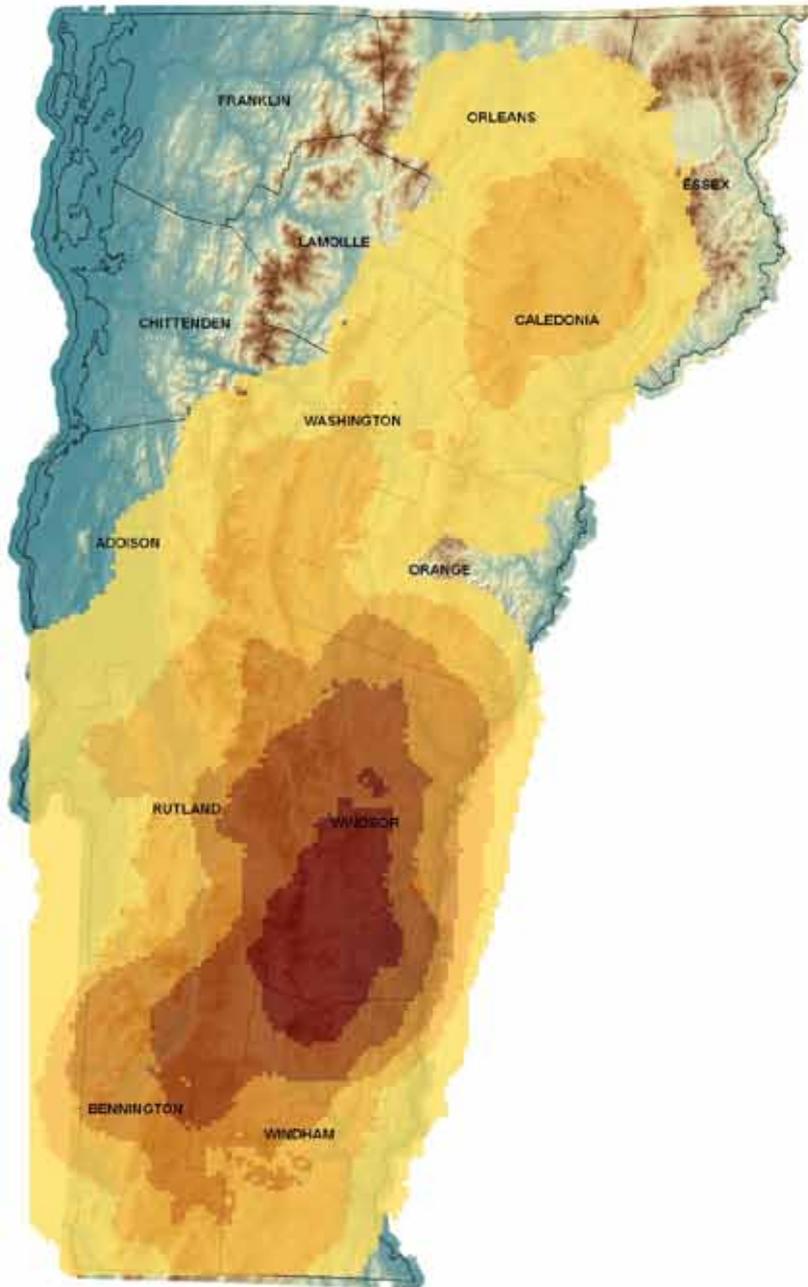
Precipitation data from National Weather Service.
Downloaded from Vermont Center For Geographic Information at <http://www.vcgi.org/irene/> on 9/29/2011.
State road and bridge data (draft products) is from Johnathan Croft, VTrans, 1/4/2011. Local road data (draft products) is from Pam Brangan, CCRPC, 1/11/2012.

- State Bridge, Culvert Damage (draft)
- Local Bridge, Culvert Damage (draft)

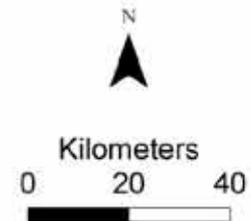


Damage to Bridges and Culverts From Tropical Storm Irene

George Springston
Norwich University
Dept. Geology and Environmental Science
1/19/2012

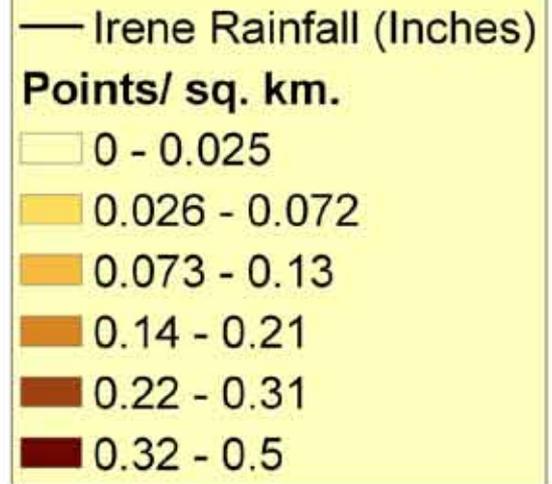
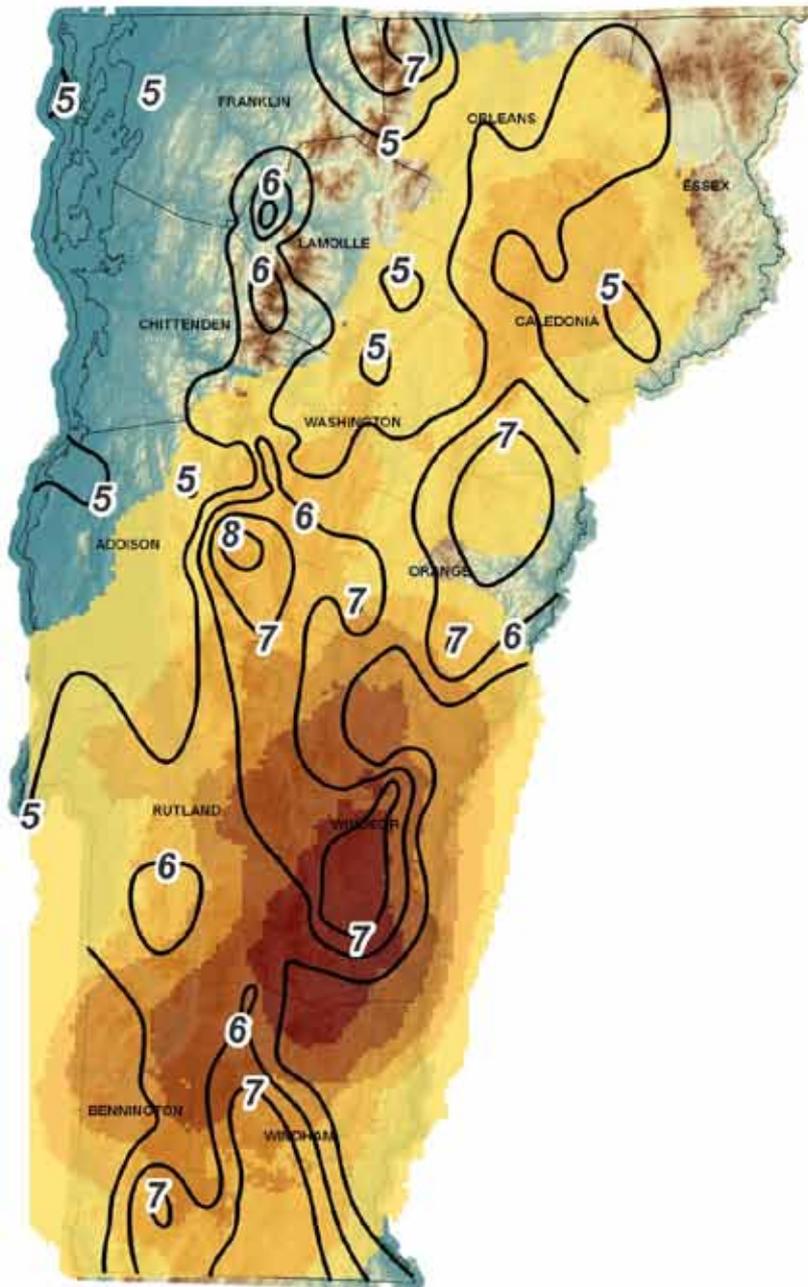


Precipitation data from National Weather Service, Downloaded from Vermont Center For Geographic Information at <http://www.vcgi.org/Irene/> on 9/29/2011. State road and bridge data (draft products) is from Johnathan Croft, VTrans, 1/4/2011. Local road data (draft products) is from Pam Brangan, CCRPC, 1/11/2012.

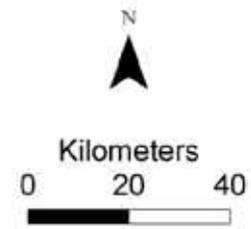


Density of Damage to Bridges and Culverts From Tropical Storm Irene

George Springston
 Norwich University
 Dept. Geology and Environmental Science
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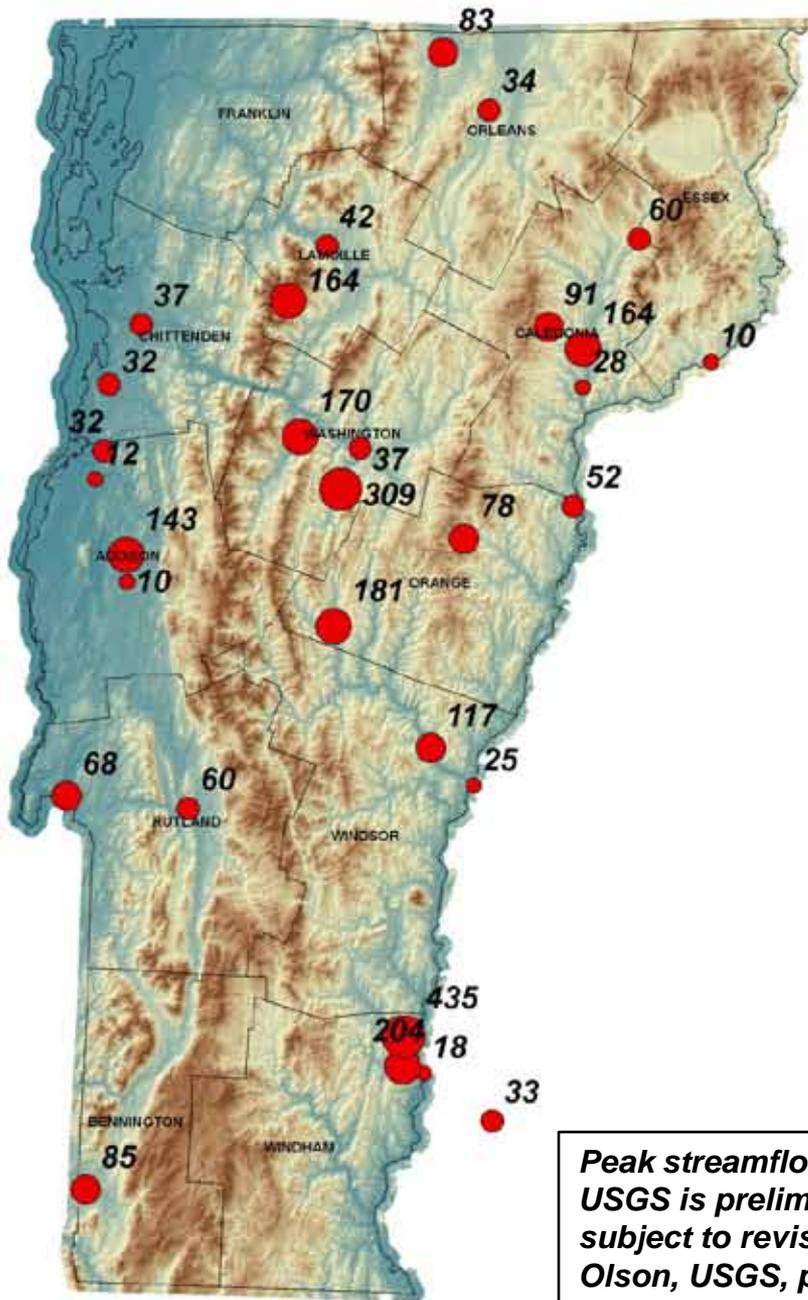


Precipitation data from National Weather Service. Downloaded from Vermont Center For Geographic Information at <http://www.vcgi.org/Irene/> on 9/29/2011. State road and bridge data (draft products) is from Johnathan Croft, VTrans, 1/4/2011. Local road data (draft products) is from Pam Brangan, CCRPC, 1/11/2012.



Density of Damage to Bridges and Culverts From Tropical Storm Irene

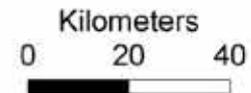
George Springston
 Norwich University
 Dept. Geology and Environmental Science
 1/19/2012



Peak Streamflow from Irene cfs / square mile

- 10 - 28
- 29 - 61
- 62 - 117
- 118 - 204
- 205 - 435

Precipitation data from National Weather Service.
Downloaded from Vermont Center For Geographic
Information at <http://www.vcgi.org/Irene/> on 9/29/2011.
Streamflow data downloaded from USGS website.



Peak Streamflows at USGS Gage Sites From Tropical Storm Irene

George Springston
Norwich University
Dept. Geology and Environmental Science
1/19/2012

*Peak streamflow data from
USGS is preliminary and
subject to revision. (Scott
Olson, USGS, personal
communication, 1/12/2012.)*

Examples of Impacts from Irene around Vermont

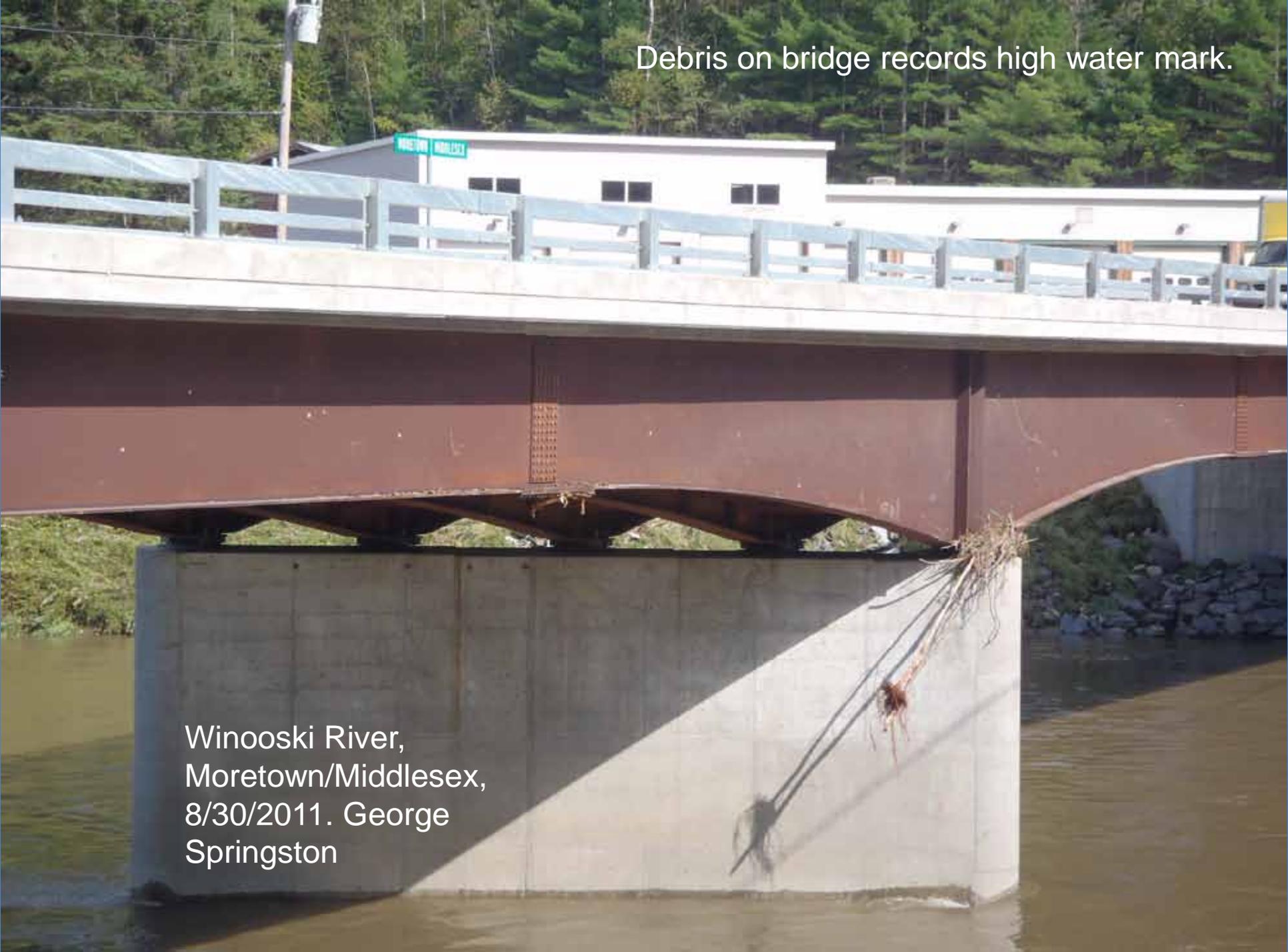
- Three broad categories of impacts to streams:
- 1. Inundation (flooding)
- 2. Fluvial erosion: erosion or scour of bed and banks, landsliding, and channel changes
- 3. Post-flood alterations to channels (human alterations)



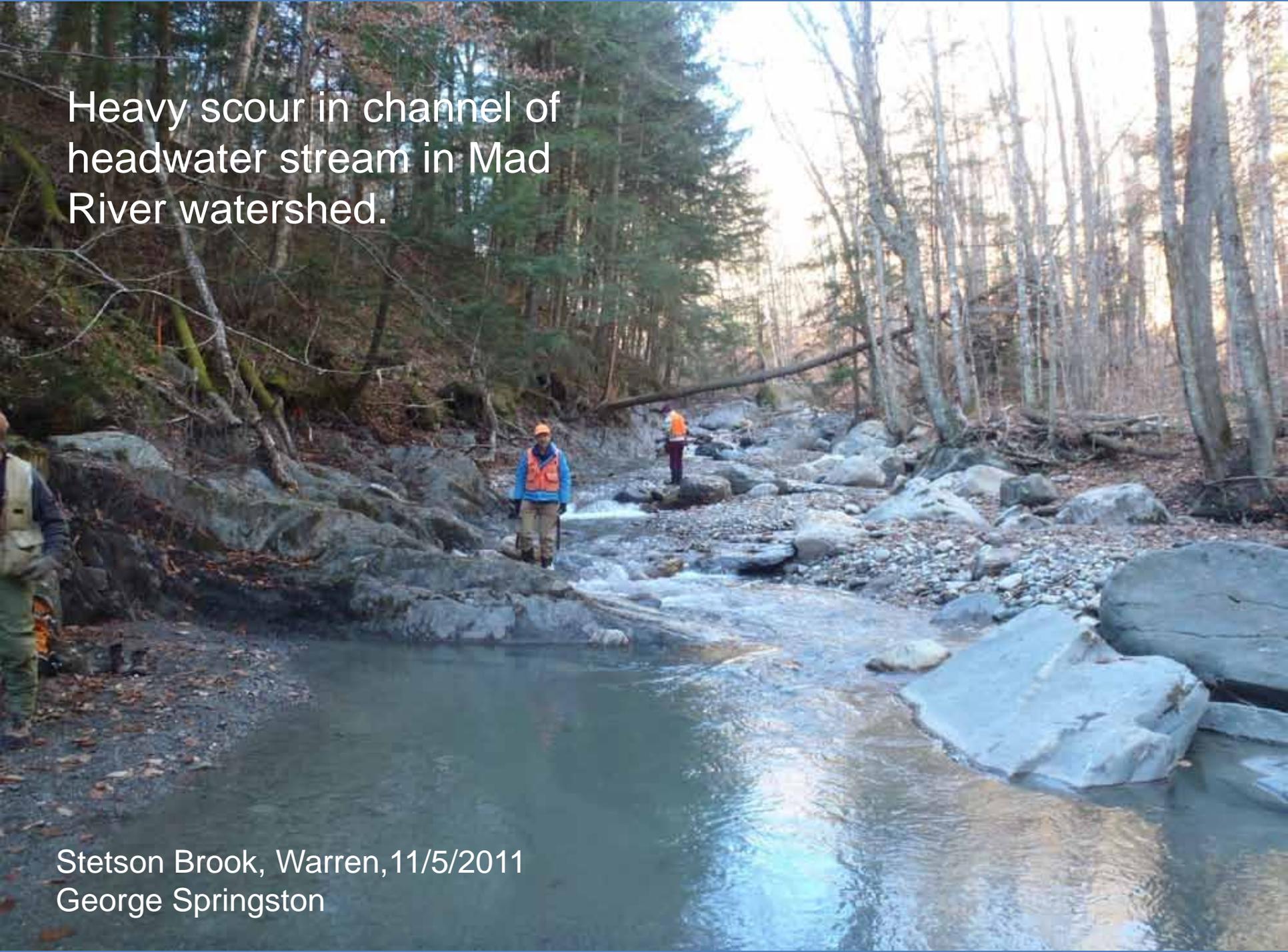
Flood waters of Great Brook in Plainfield Village threatening to overtop bridge (site of washout in May, 2011).

Debris on bridge records high water mark.

Winooski River,
Moretown/Middlesex,
8/30/2011. George
Springston



Heavy scour in channel of
headwater stream in Mad
River watershed.



Stetson Brook, Warren, 11/5/2011
George Springston

House on bank of Great Brook in Plainfield threatened by stream erosion.

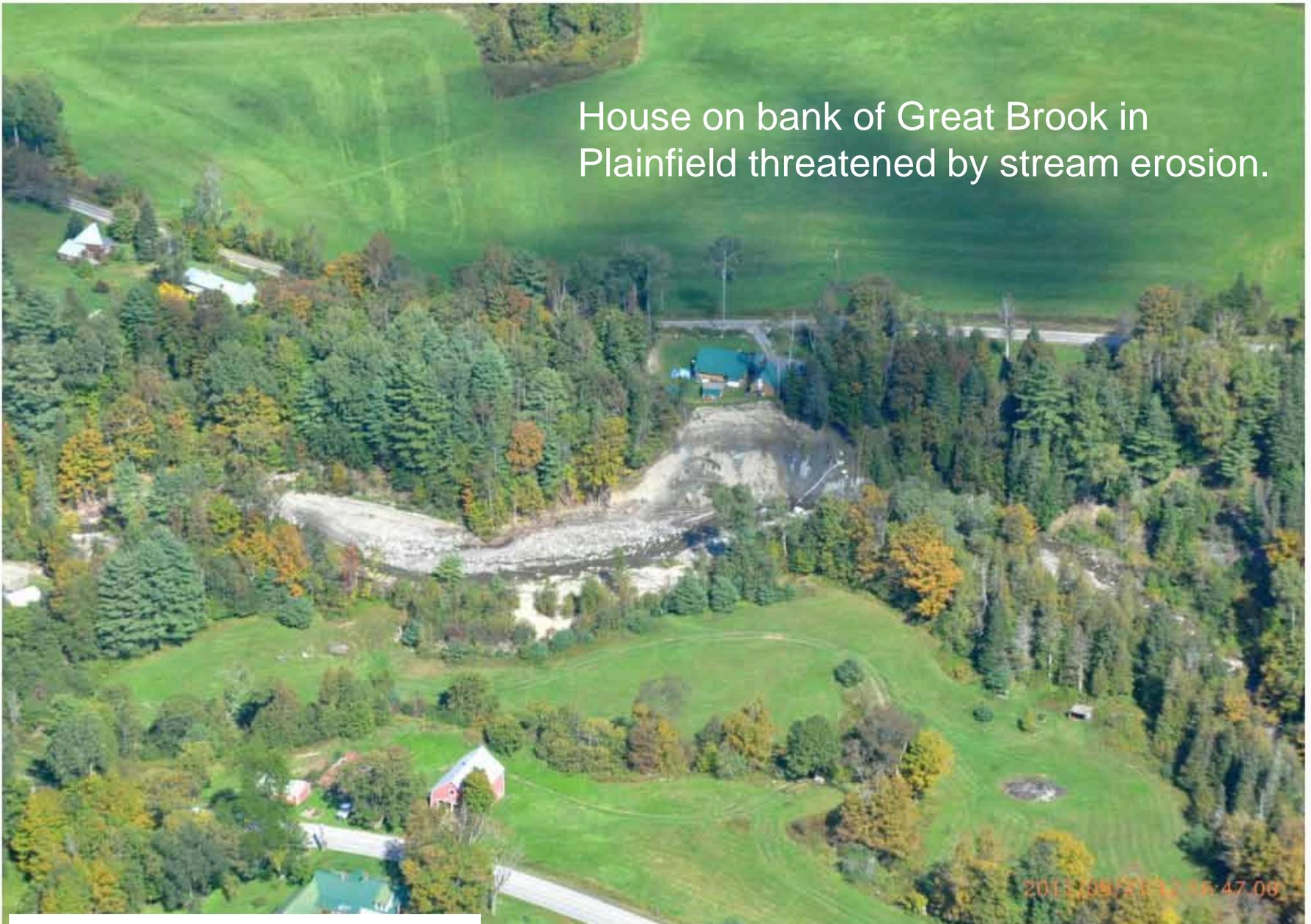


Photo: Staci Pomeroy, Vt. Rivers Program

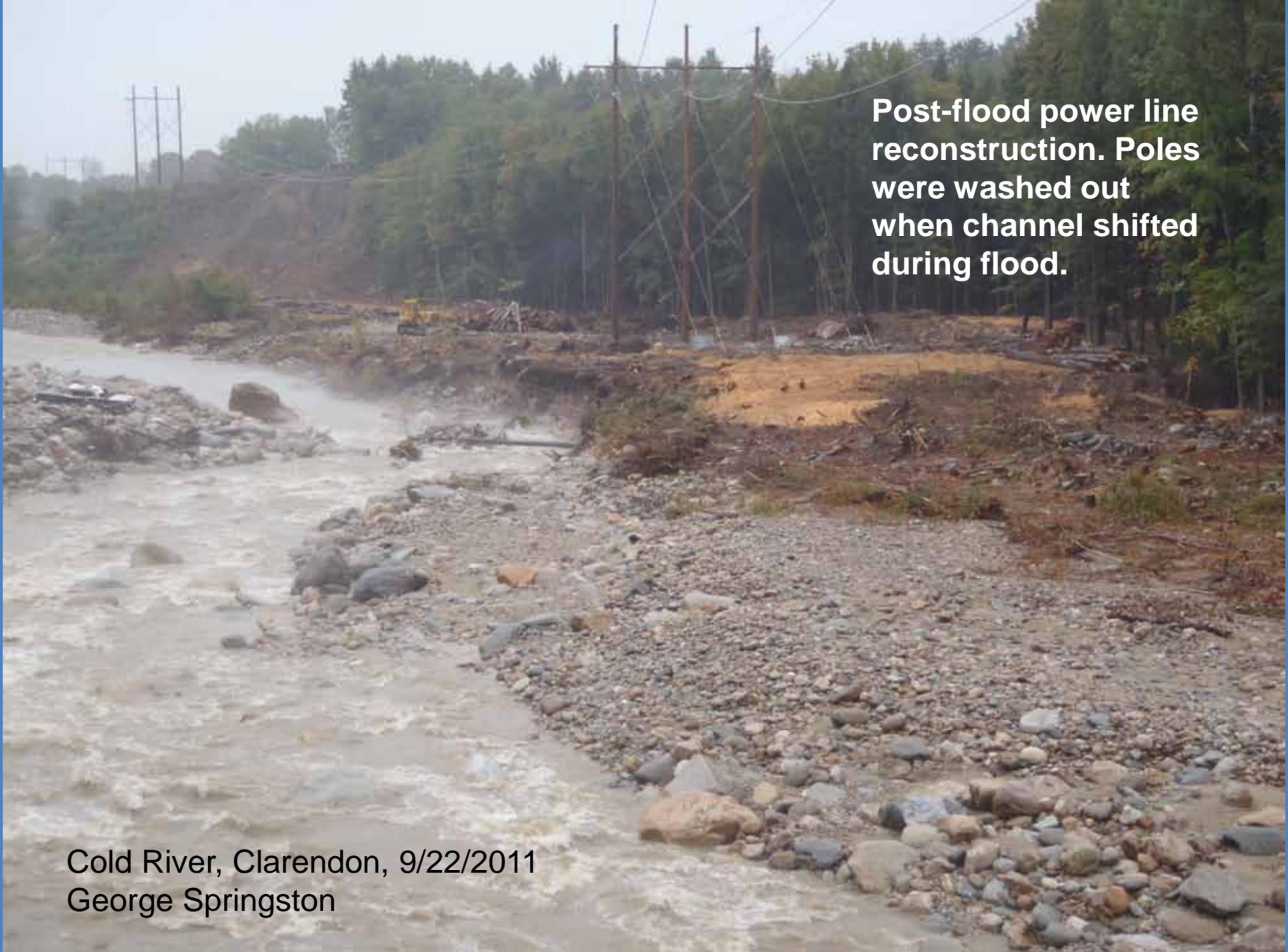
DSC_0136.JPG, 2011/09/21 12:56:47.00

Latitude: N 44°15.770' (44°15'46.2"), Longitude: W 72°25.214' (72°25'12.8"), Altitude: 727.00m

**Severe bank erosion and channel
widening on the Cold River in Clarendon,
Rutland County.**



Cold River, Clarendon, 9/22/2011
George Springston

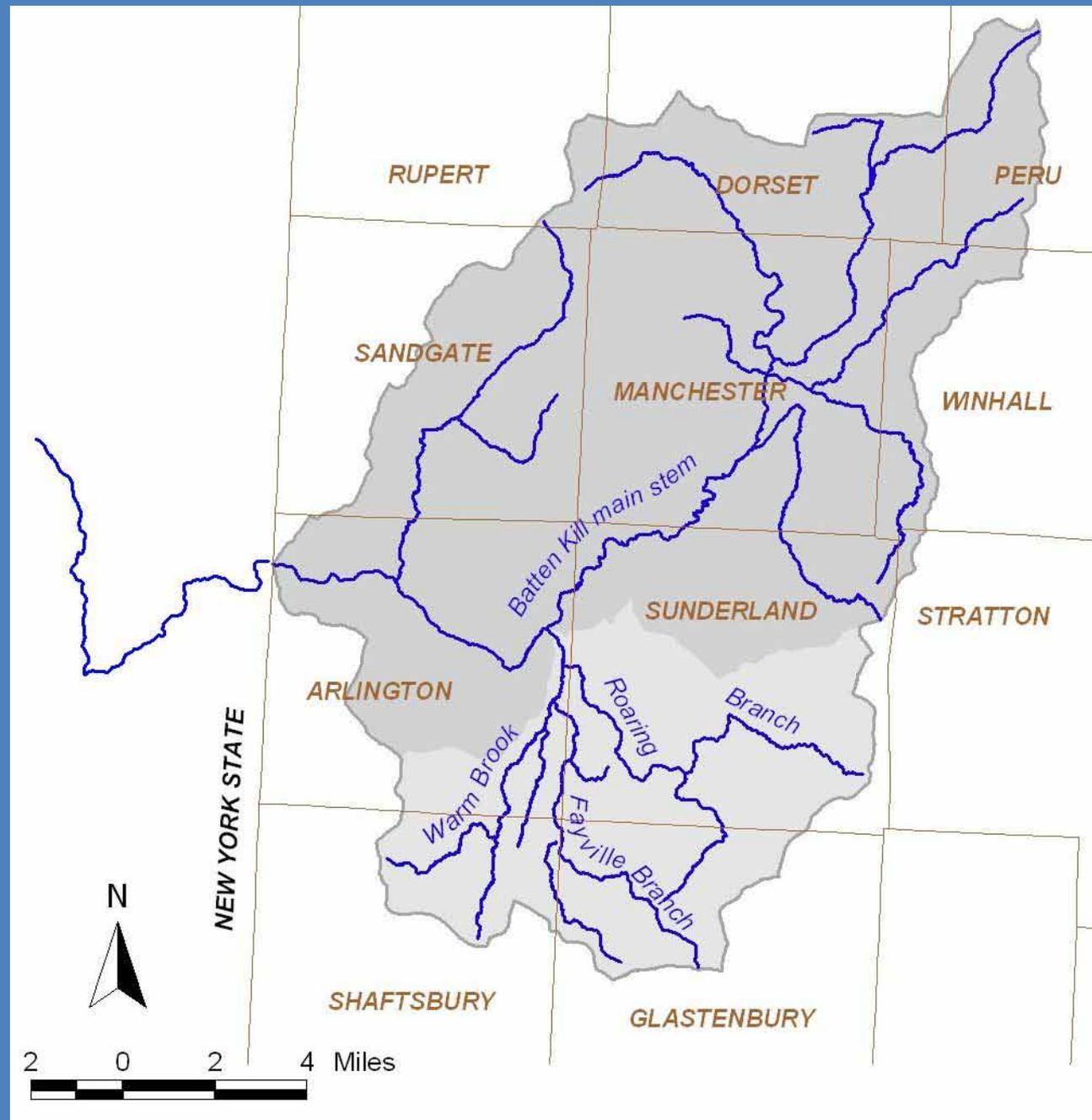
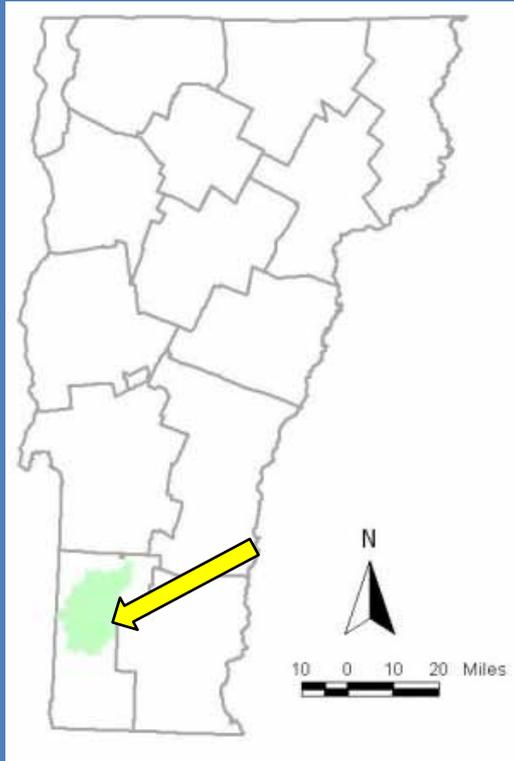


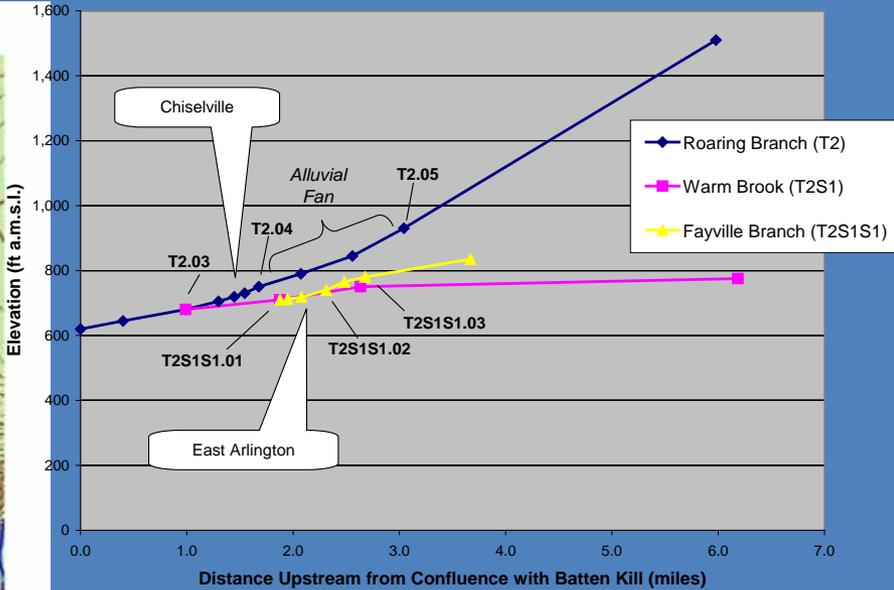
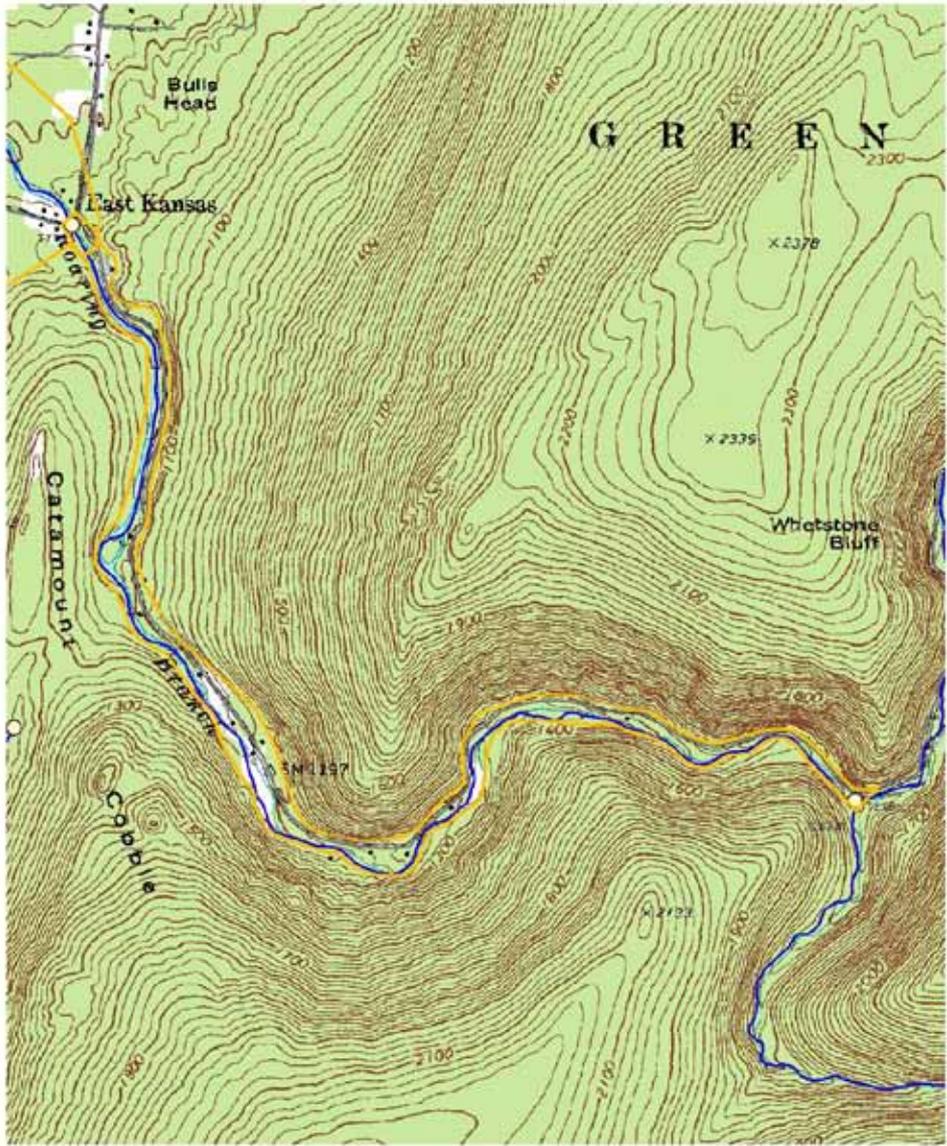
Post-flood power line reconstruction. Poles were washed out when channel shifted during flood.

Cold River, Clarendon, 9/22/2011
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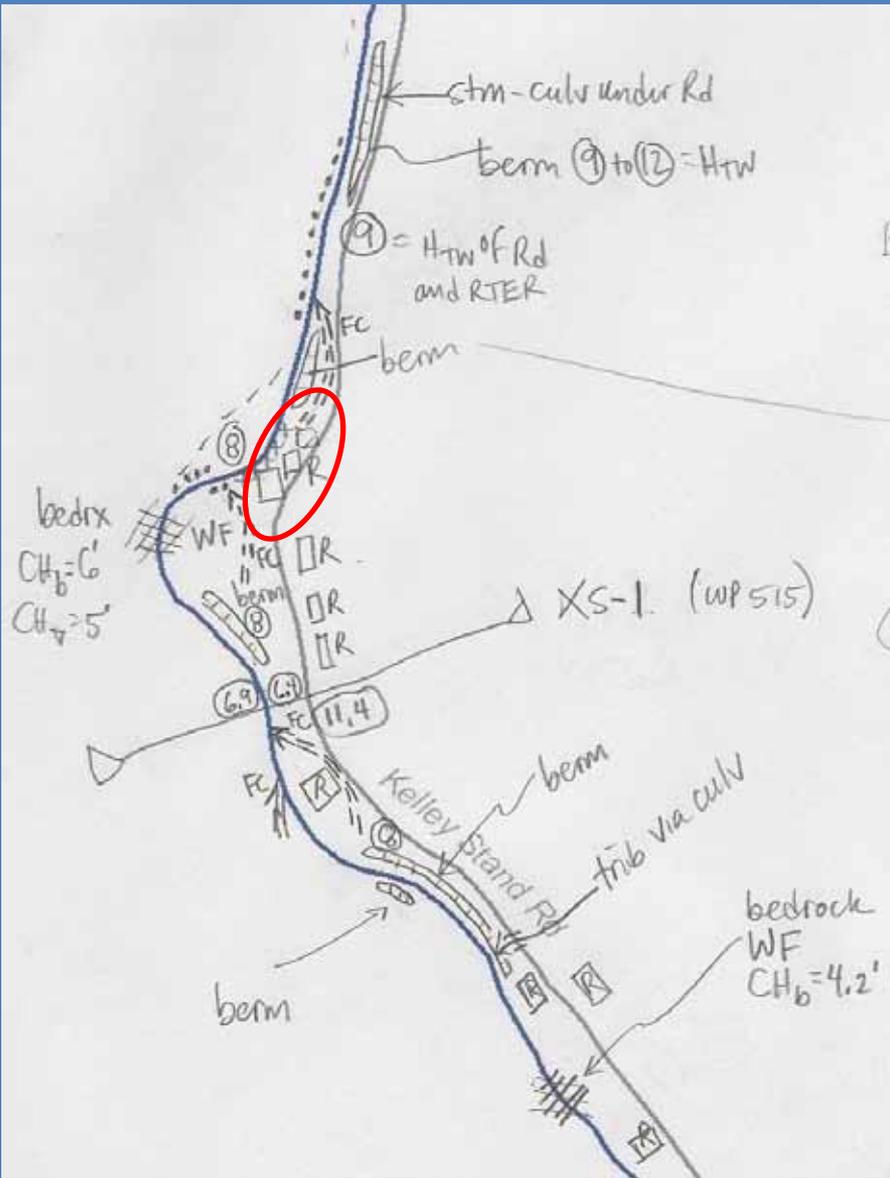
Roaring Branch, Battenkill River

Kristen Underwood,
South Mountain
Research and
Consulting





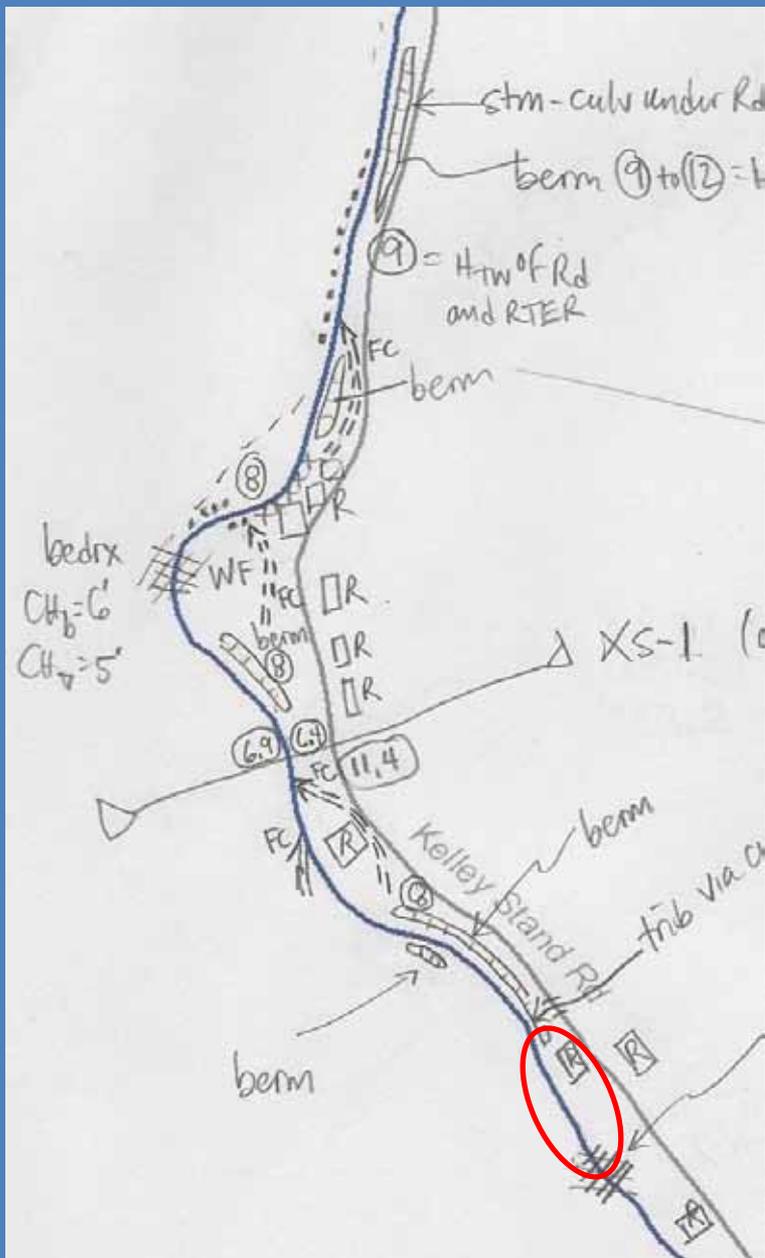
Homes elevated well above flood stage were lost to catastrophic bank erosion



October 22, 2011

July 17, 2008

Kristen Underwood, South Mountain Research and Consulting



Kristen Underwood, South Mountain Research and Consulting

Before



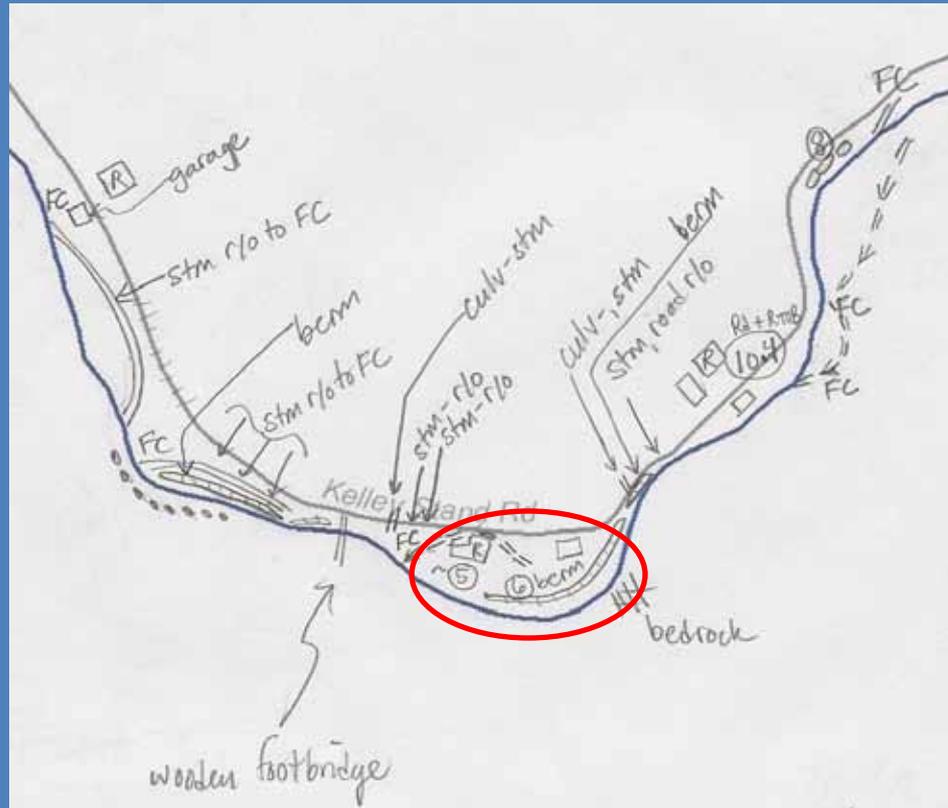
July 17, 2008



October 22, 2011

After

Before



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Research and Consulting

After

Steep mountain streams
easily moved boulders
several feet across.

Below Roundtop Road,
Plymouth



George Springston, 9/22/2011

Gilead Brook, Bethel, 10/12/2011
George Springston

**Newly constructed berm on side of
channel with fresh landslide in
background.**



Broad areas of fresh flood deposits in the floodplain of the White River in South Royalton.



Photo: Staci Pomeroy, Vt. Rivers Program,
9/21/2011

2011/09/21 13:49:46.00

DSC_0302.JPG, 2011/09/21 13:49:46.00

Latitude: N 43°48.851' (43°48'51.1"), Longitude: W 72°30.791' (72°30'47.4"), Altitude: 860.00m

Heavy scour and deposition at a bend of the White River in South Royalton. Repair work underway at bridge.

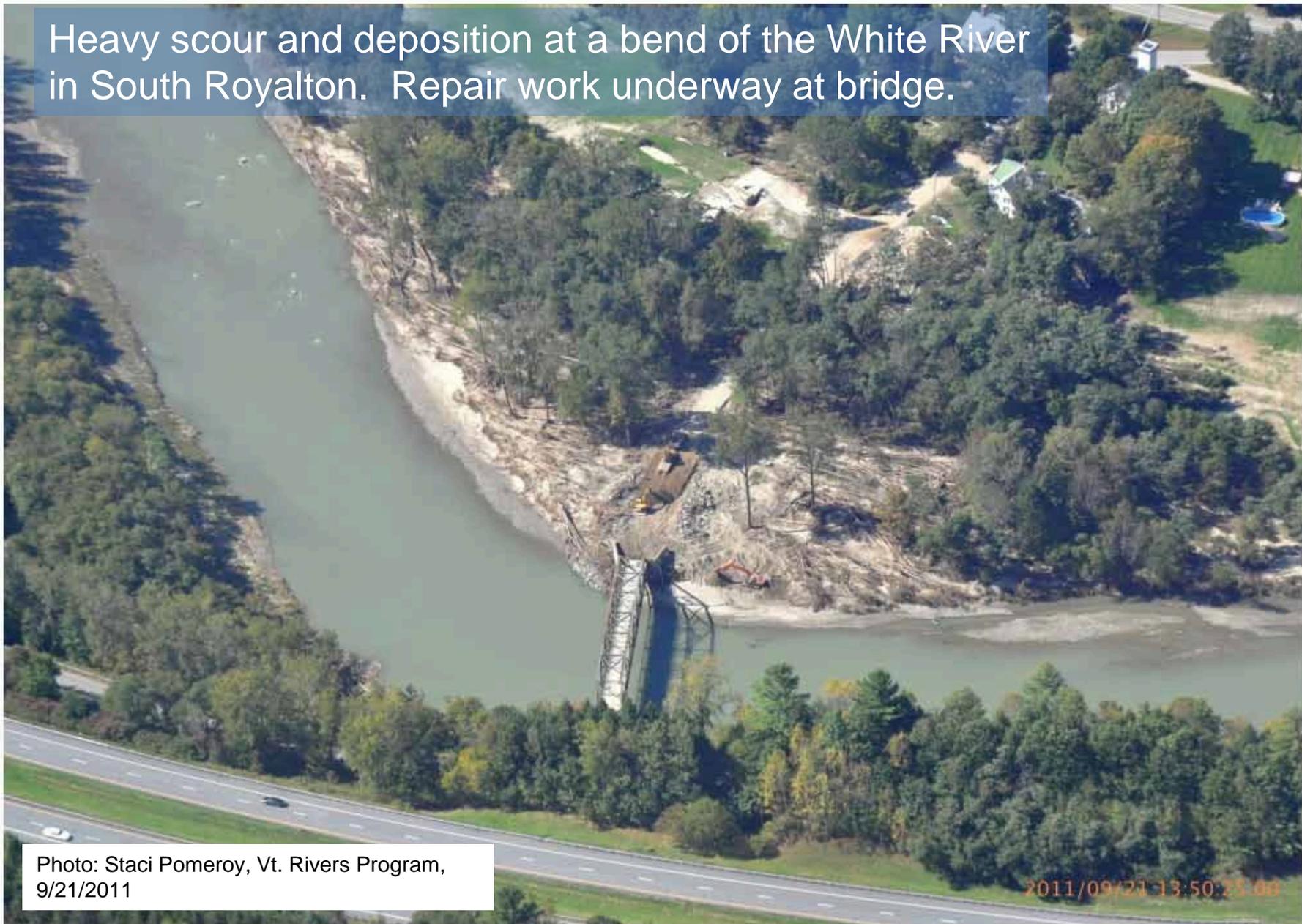


Photo: Staci Pomeroy, Vt. Rivers Program, 9/21/2011

2011/09/21 13:50:25.00

DSC_0308.JPG, 2011/09/21 13:50:25.00

Latitude: N 43°48.654' (43°48'39.2"), Longitude: W 72°31.947' (72°31'56.8"), Altitude: 892.00m

Woody debris on bar and road damage, White River in Stockbridge.



Photo: Staci Pomeroy, Vt. Rivers Program,
9/9/2011

An aerial photograph showing the confluence of the Third Branch (on the right) and the White River (on the left) at Bethel. The river water is a turbid, brownish-grey color, indicating heavy sediment from flooding. Large areas of land, particularly on the right side, are covered in mud and debris, showing significant erosion and destruction of vegetation. A bridge crosses the river in the lower-left quadrant. In the background, a large, light-colored rock outcrop or cliff face is visible. The surrounding area includes residential and commercial buildings, some of which appear to be partially submerged or surrounded by floodwater. A road and a railway line are also visible in the lower-right section of the image.

Heavy flood damage at confluence of Third Branch (comes in on right) with White River at Bethel.

Photo: Staci Pomeroy, Vt. Rivers Program,
9/9/2011

Observations, Part 1

- The widespread heavy rainfall (on already wet soils) and the resulting high stream runoff put this flood in the same league as the largest floods in Vermont's recorded history, such as the 1927 flood and the 1938 hurricane/flood. Many streams had record peak flows.
- Erosion of stream beds and banks was extensive and resulted in severe risks to lives and infrastructure. Streamside landslides were widespread, with most occurring at the sites of pre-existing active or inactive landslides.

Observations, Part 2

- A cycle of stream erosion and slope instability has been initiated by this storm and it appears that it will take many years for some of these stream banks to return to equilibrium conditions.
- The widespread fluvial erosion demonstrates the importance of including such hazards in local and regional planning.

Thanks to:

- Jonathan Croft, Vermont Agency of Transportation, for GIS data on impacts to State roads
- Pam Brangan, Chittenden County Regional Planning Commission, for GIS data on impacts to local roads
- Scott Olson, Vermont-New Hampshire office of U.S. Geological Survey, for preliminary peak discharge data for gaging station at West Hartford on the White River
- Staci Pomeroy, Vt DEC Rivers Program, for numerous aerial photos

Further Reading

Bodin, Madeline, 2011, Understanding how to work with rivers: Barre-Montpelier Times Argus, Sunday, October 9, 2011, p. A6.

Clifford, Deborah, and Clifford, Nicholas, 2007, The troubled roar of the waters: Vermont in flood and recovery: University of New Hampshire Press, Durham, 229 p.

Johnson, L.B., 1928, Vermont in floodtime: Roy L. Johnson. Co., Randolph, 209 p.

Ludlum, David, 1985, The Vermont weather book: Vermont Historical Society, Montpelier, 300 p.

Contacts

George Springston, Dept. Geology and Environmental Science,
Norwich University, 158 Harmon Drive, Northfield, VT 05663
gsprings@norwich.edu

Kristen Underwood, PG, South Mountain Research &
Consulting, 2852 South 116 Rd, Bristol, VT 05443
southmountain@gmavt.net



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