



Stream Crossings and Climate Resilience

Alison Bowden
Jessica Levine
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Themes

- Changing the conversation to include resilience in decision making
- Case study: FHWA Resilience Project
 - economic and social dimension of resilience
- Goals & linkages in current (Federal?) policy opportunities



Discussion Questions

- What still needs to change, at what level(s) of organization, to incorporate risk and resilience in decision making?
- How critical is economic data, and how do you make decisions about risk and resilience with incomplete information about costs & risks?



Ecological Integrity



...the long-term capability of an ecological community to sustain its composition, structure and function and its resiliency to stress

Flow Regime
(lows, high pulses, floods)

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graph TD; A["Flow Regime<br/>(lows, high pulses, floods)"] --> B["Physical Habitat"]; A --> C["Water Quality"]; A --> D["Connectivity"]; A --> E["Energy Supply"]; A --> F["Species Interactions"]; B --> G["Ecological Integrity<br/>Ecosystem Services"]; C --> G; D --> G; E --> G; F --> G;
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Physical
Habitat

Water
Quality

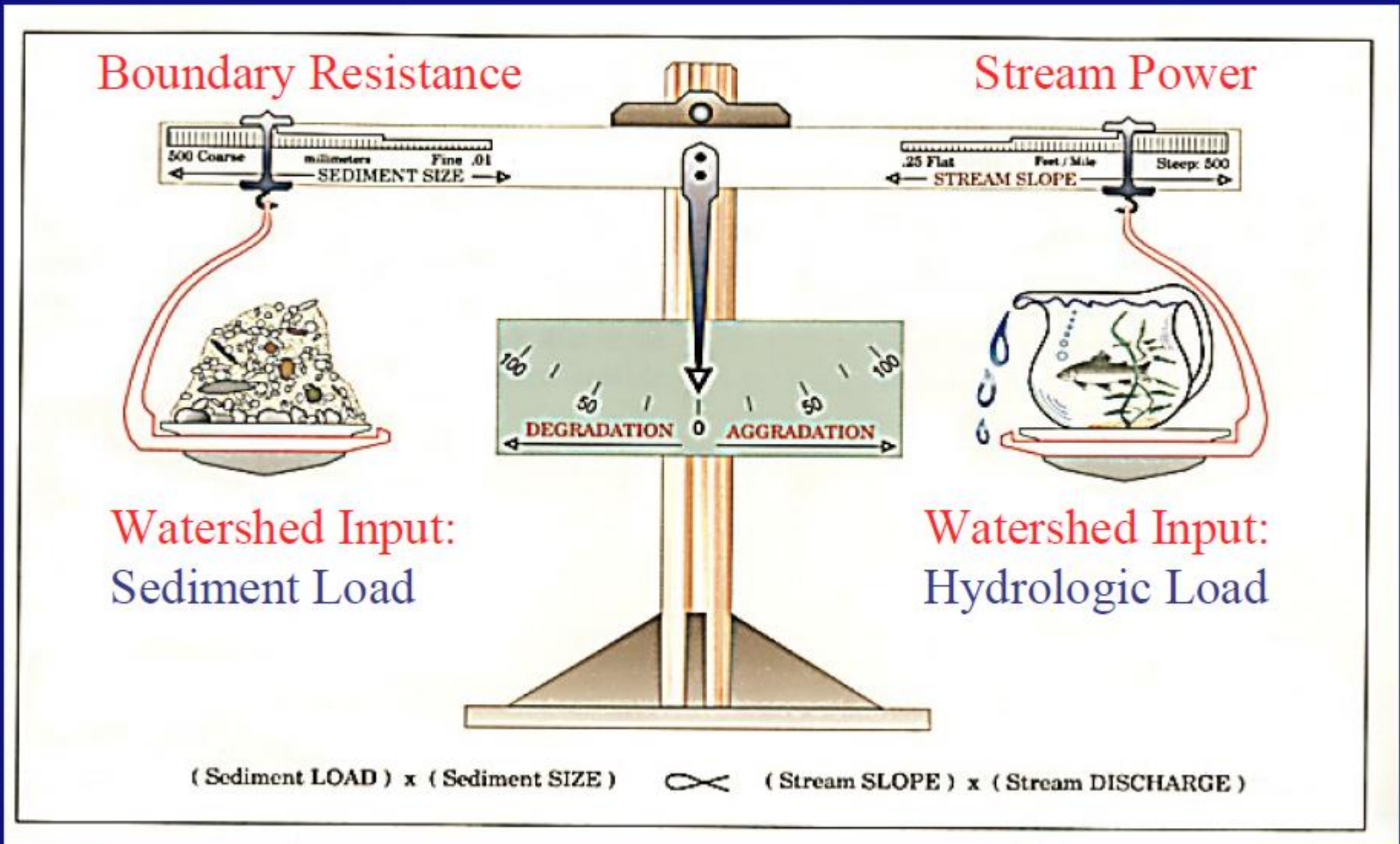
Connectivity

Energy
Supply

Species
Interactions

Ecological Integrity
Ecosystem Services

The range and distribution of hydraulic units is a function of the **dynamic** equilibrium of a stream.



The Climate Challenge



BY J. CURT STAGER AND MARY

Climate Change in the Champlain Basin

What natural resource managers can expect and do

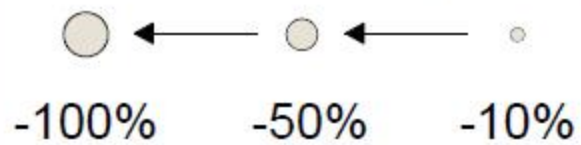
Prediction:
temperature
increases ranging
between 6 and
11°F

- more summer droughts
- warmer stream conditions
- more stress on brook trout

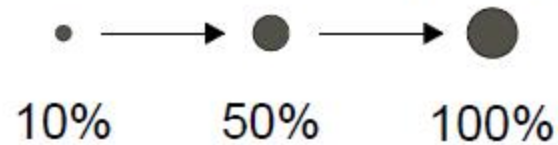
Prediction:
precipitation
increases between
10 and 15% and
more frequent and
intense storms

- more high water events
- more stress on infrastructure
- human communities more at risk

Decrease in Frequency

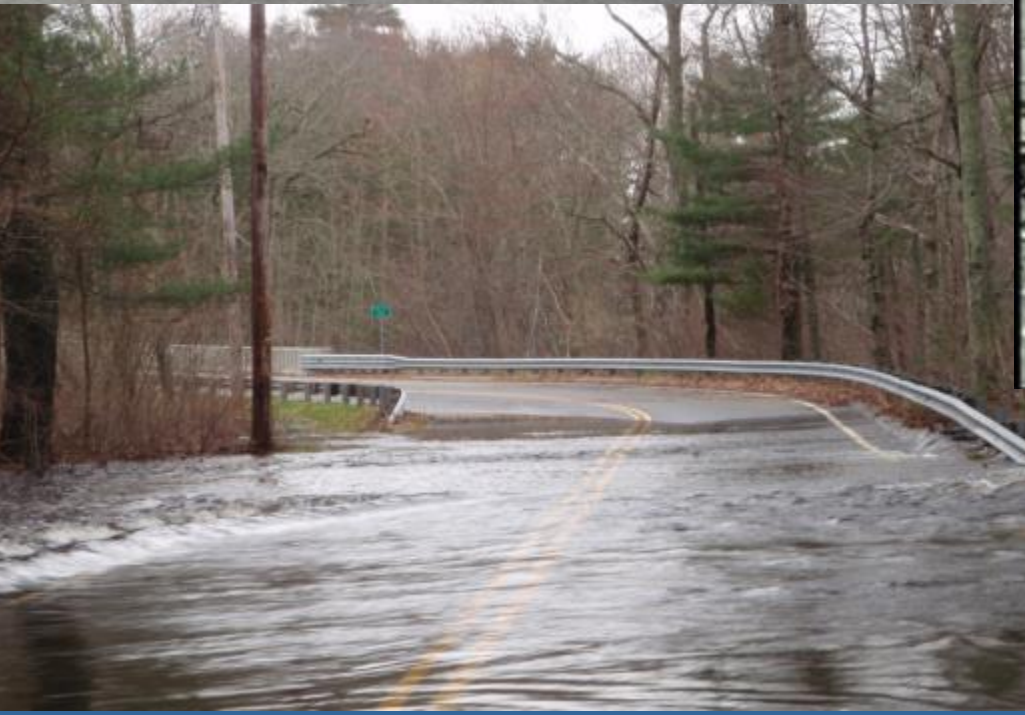


Increase in Frequency

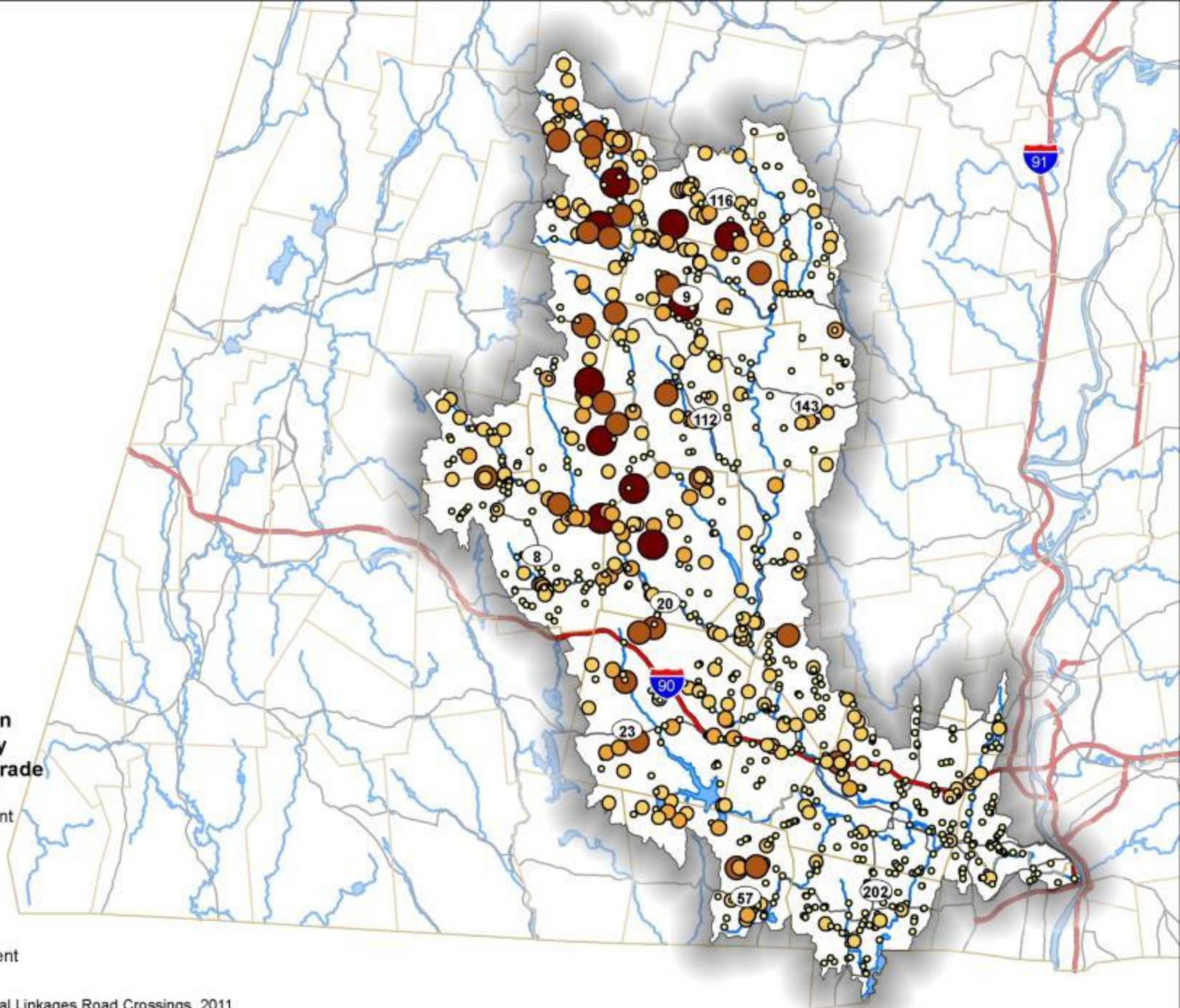
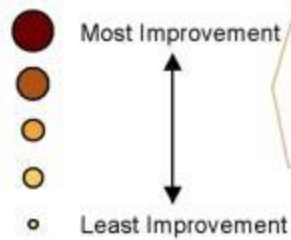


Intense Rain





**Expected Impact on
Ecological Integrity
with Crossing Upgrade**



Data Source: UMass Critical Linkages Road Crossings, 2011

Stream Simulation Design



opening is large
relative to length

width ≥ 1.2 times bankfull width

culvert bed matches
stream bed

Fisheries

American Fisheries Society • www.fisheries.org

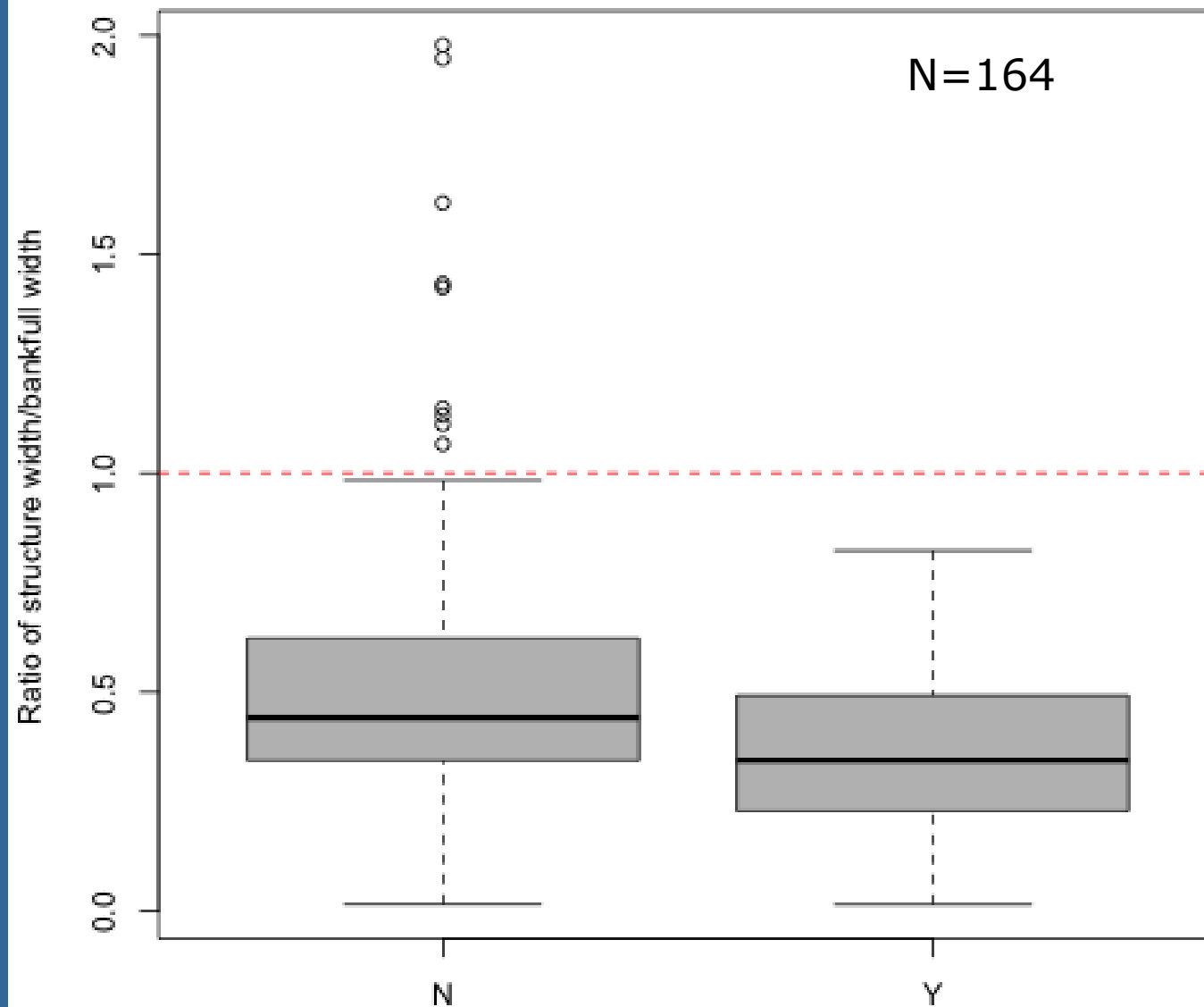


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**Flood Effects on Road–Stream Crossing Infrastructure:
Economic and Ecological Benefits of Stream Simulation
Designs**





Goals in Policy: Army Corps Nationwide Permit

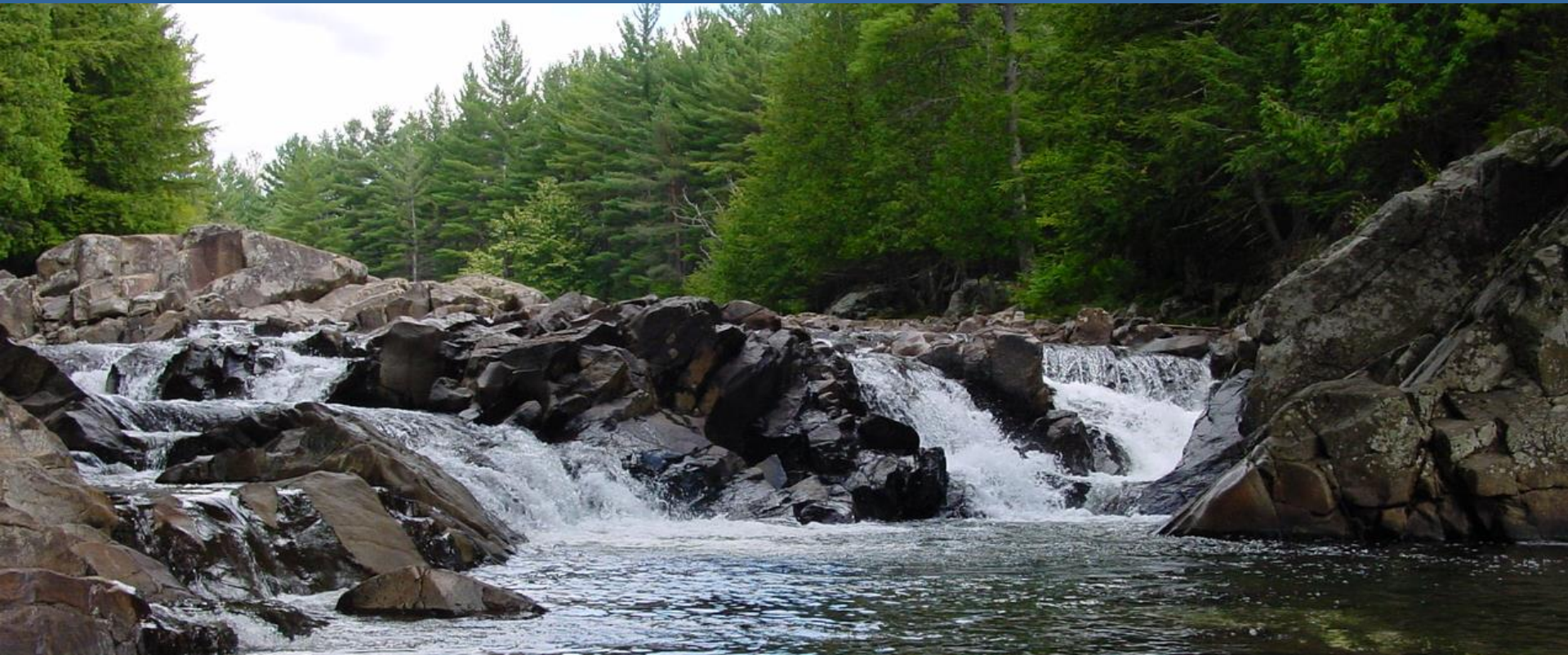
“Stream Crossings and Work

(a) All permanent crossings of streams shall be... designed and constructed to (i) withstand and **prevent the restriction of high flows**, (ii) **maintain low flow conditions**, and (iii) **not obstruct movement of aquatic life...**”





Road-Stream Crossings: Costs & Benefits, New Partnerships



Jessica Levine, TNC Canada
New England Transportation & Wildlife Conference
9/23/14

Multiple Benefits

ECOLOGICAL:

- fish populations with access to cold, upstream waters
- improved habitat
- decreased erosion of banks
- avoided water quality impacts

CULVERTS
can provide
multiple
benefits

SOCIAL:

- Improved safety and mobility, including access to emergency services
- Avoided health impacts

ECONOMIC:

- Avoided flood damage
- Avoided travel delays
- Avoided loss of business/tourism income from road closures
- ROI improves over time

The Economic Case: Costs

- Short-term: Construction costs for stream simulation-like culverts 15-200% more than traditional hydraulic design culverts
- Long-term: Storm-related maintenance and replacement costs can make these culverts cost effective in 25-50 years
- Many design options, costs vary widely (NY, ME, VT, MN, NH, AK)
- Little data collection/retention
- Up-front cost a major obstacle



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What about
the benefits?

FHWA Climate Resilience Pilot

Climate Vulnerability and Economic Assessment for At-Risk Transportation Infrastructure in the Lake Champlain Basin, NY

1. Prioritize road-stream crossings and road segments
2. Develop engineering-based design adaptation options
3. Create an economic tool that evaluates the full benefits and costs
4. Incorporate climate vulnerability assessments into existing standards and guidelines



New York State
Department of Transportation



The Nature
Conservancy



Protecting nature. Preserving life.®

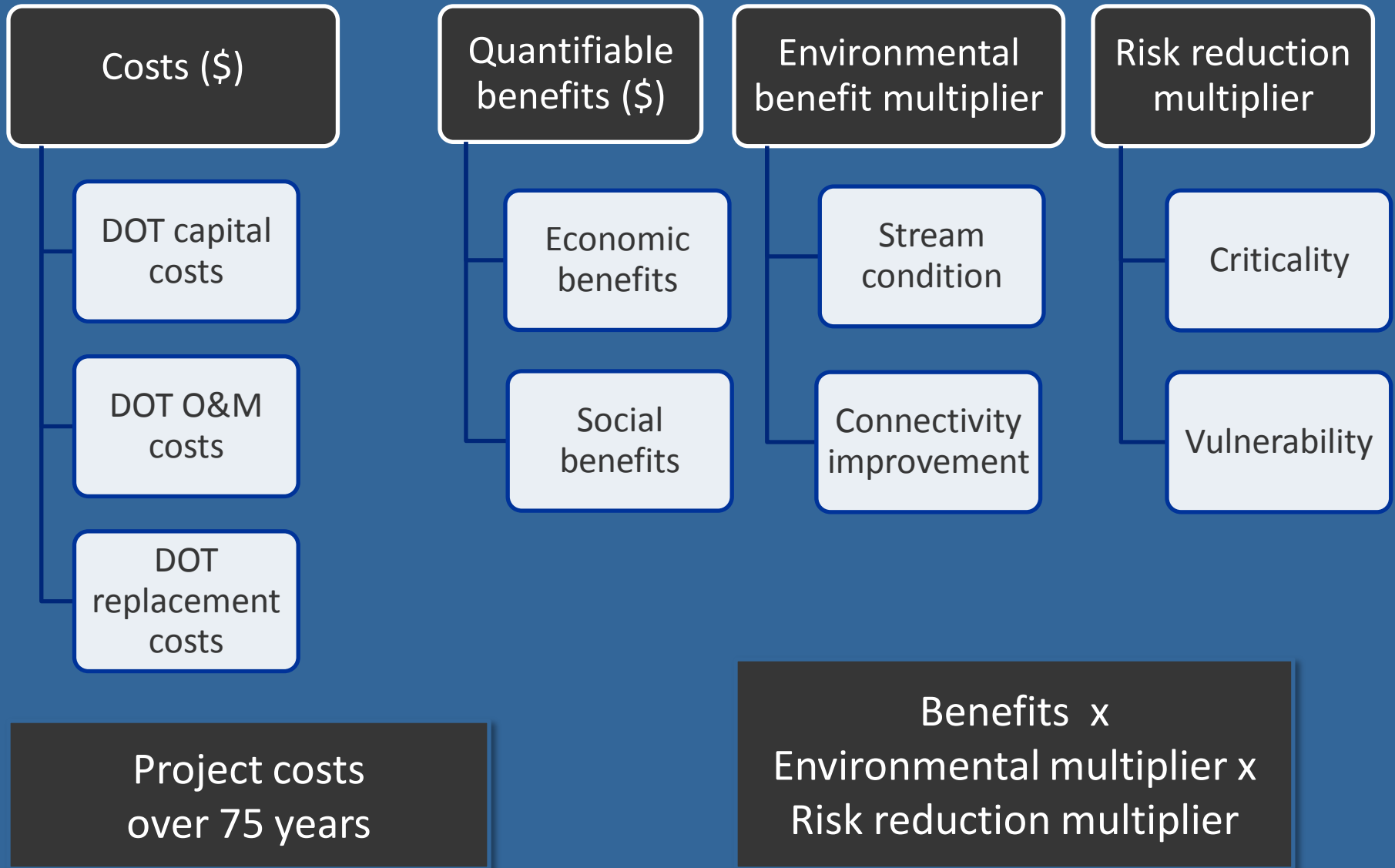
FHWA Economic Tool

A tool to aid NYSDOT in decision making about when it makes sense to invest in improved culverts, by:

- Evaluating costs of different design options for different types of sites
- Including a suite of social, economic, and environmental benefits



Culvert Decision Support Tool



Culvert Decision Support Tool

Results expected
in 2015...

“Quantifiable” benefits

Economic

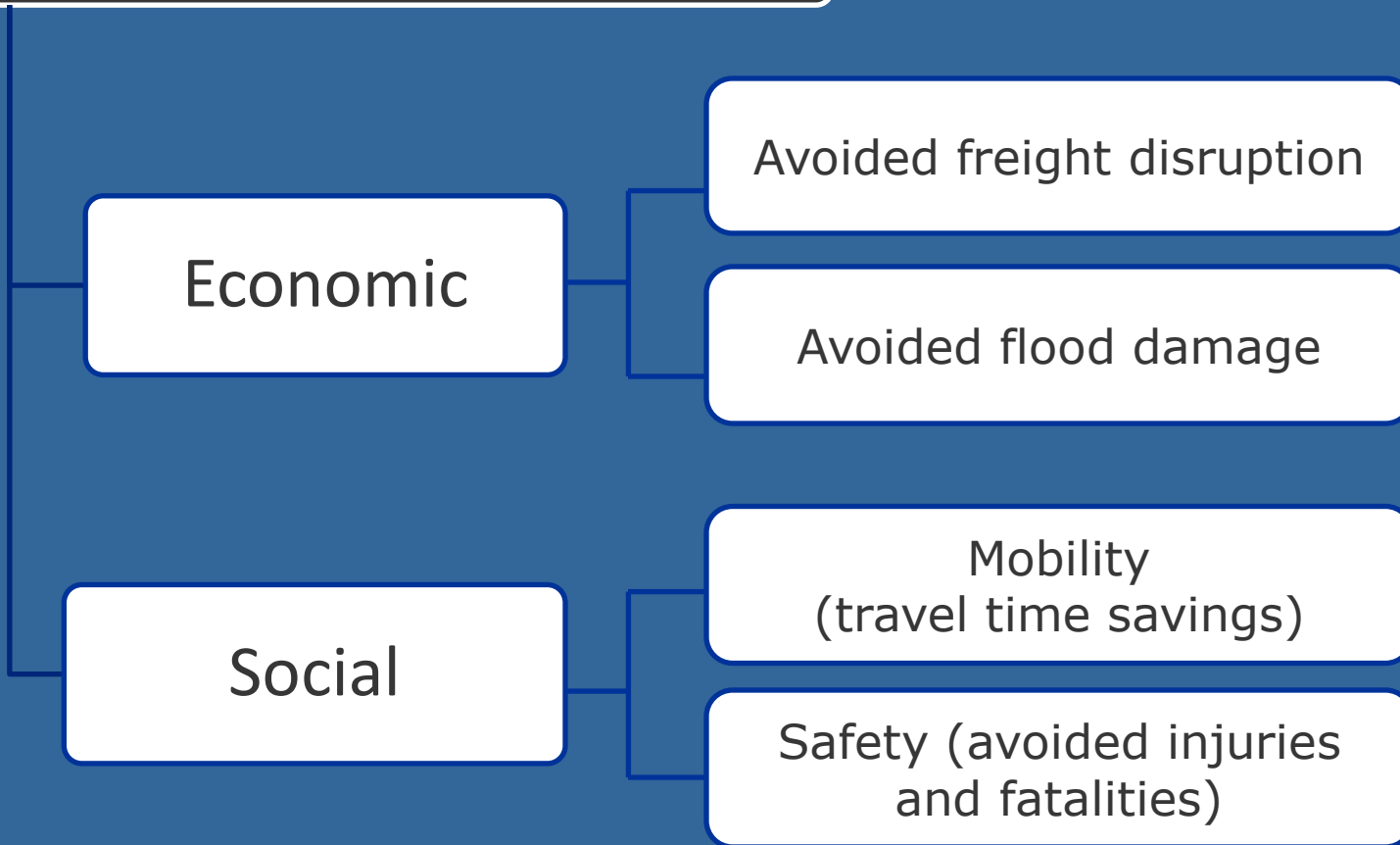
Avoided freight disruption

Avoided flood damage

Social

Mobility
(travel time savings)

Safety (avoided injuries
and fatalities)



Working with Local Highway Departments



New Partnerships, New Funding Models

Fish passage

Climate adaptation

Hazard mitigation

Community resiliency

Local contributions



U.S. Department of Transportation
Federal Highway Administration



Ongoing Work

- Implementation projects :
NY, VT, MA, ME, etc.
- Information gathering and sharing
best practices, lessons learned,
costs

The ultimate goal?

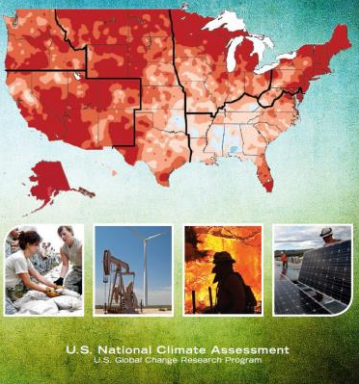
Climate- and fish-friendly culverts
are business-as-usual



Boosting Resilience to Floods Federal Opportunities

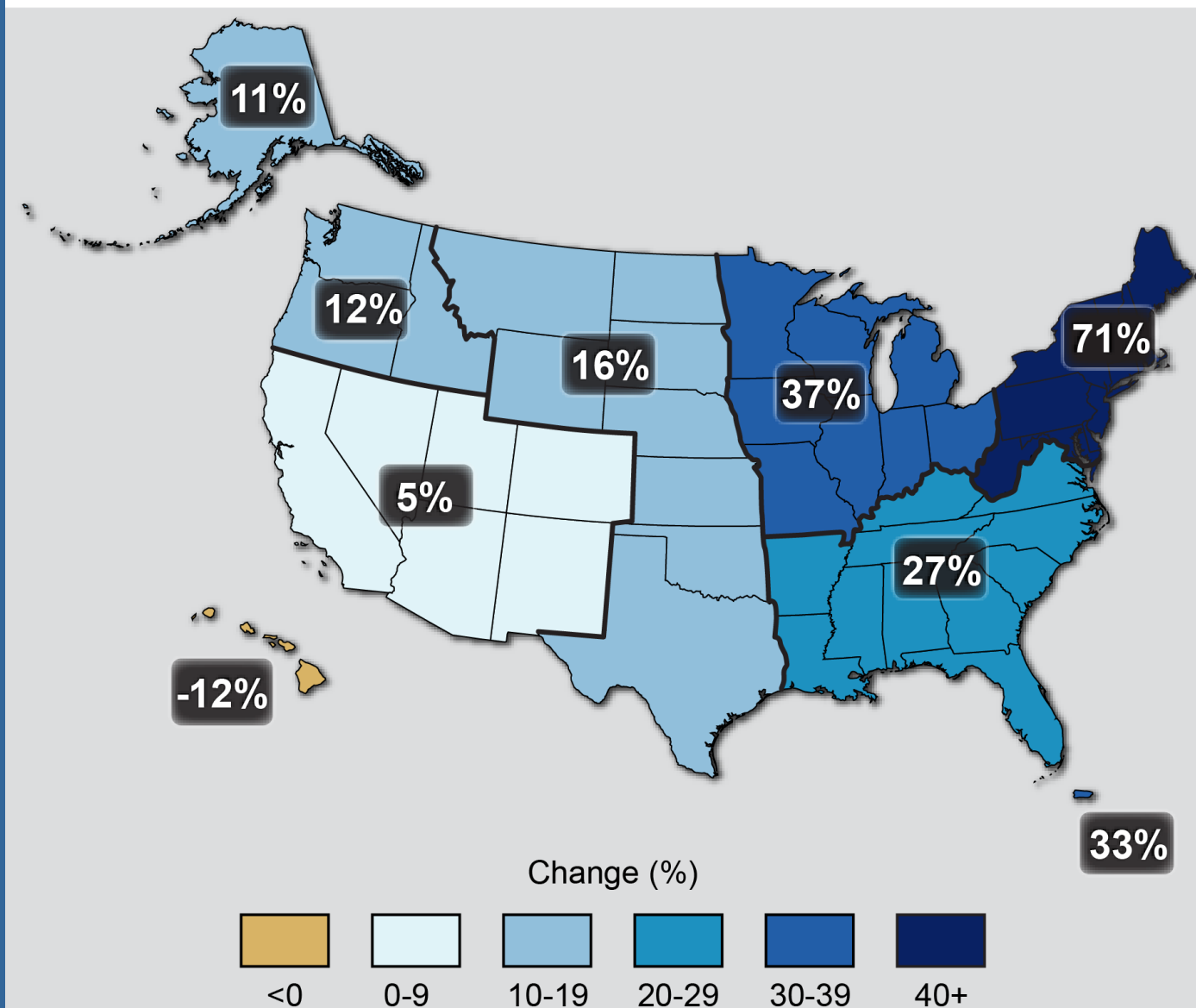


Sarah Murdock, Director US Climate Adaptation Policy
New England Transportation & Wildlife Conference
9/23/14



Changing Climate

Observed Change in Very Heavy Precipitation



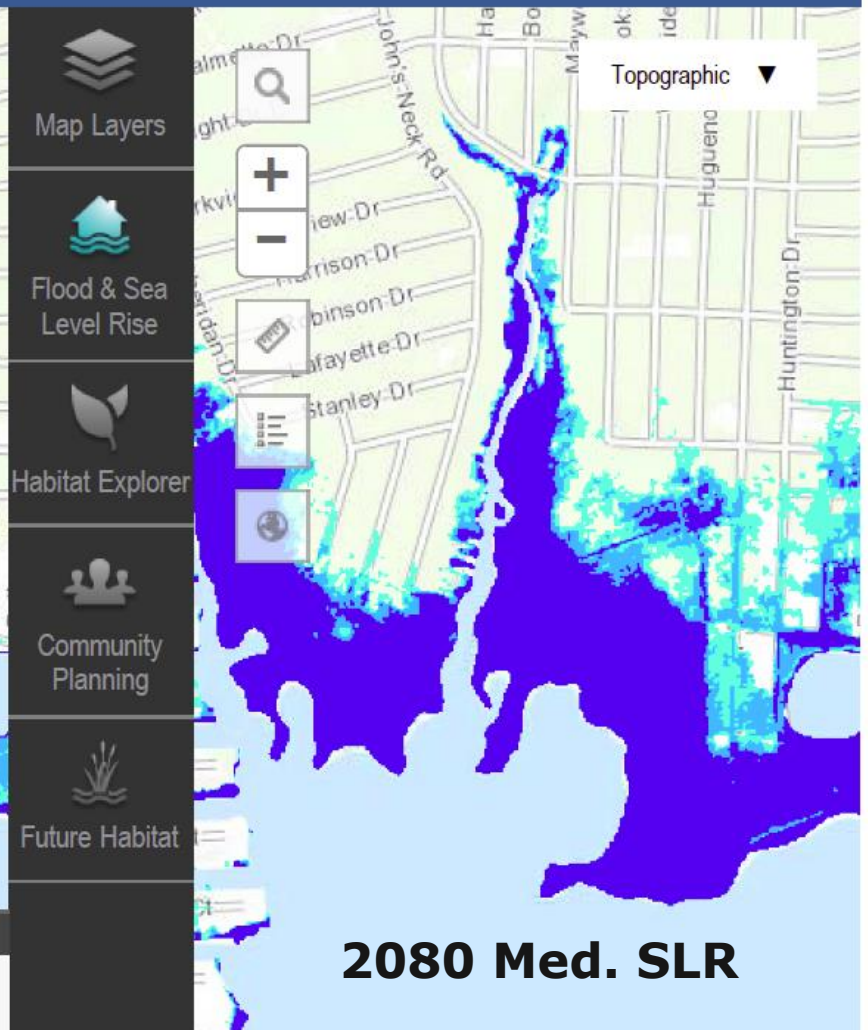
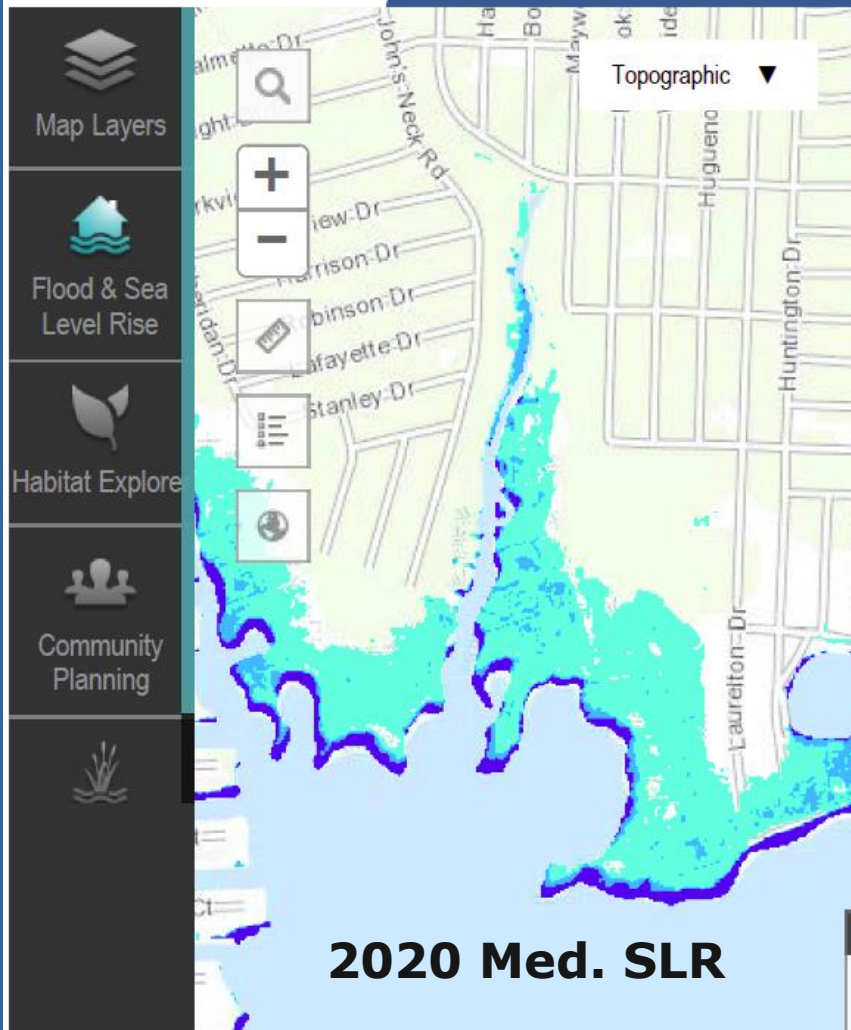
Changing Climate

Growing Sea Level Rise Impact

Coastal Resilience | New York & Connecticut

COASTAL RESILIENCE

NEW YORK & CONNECTICUT



Cost of Disasters Is Increasing

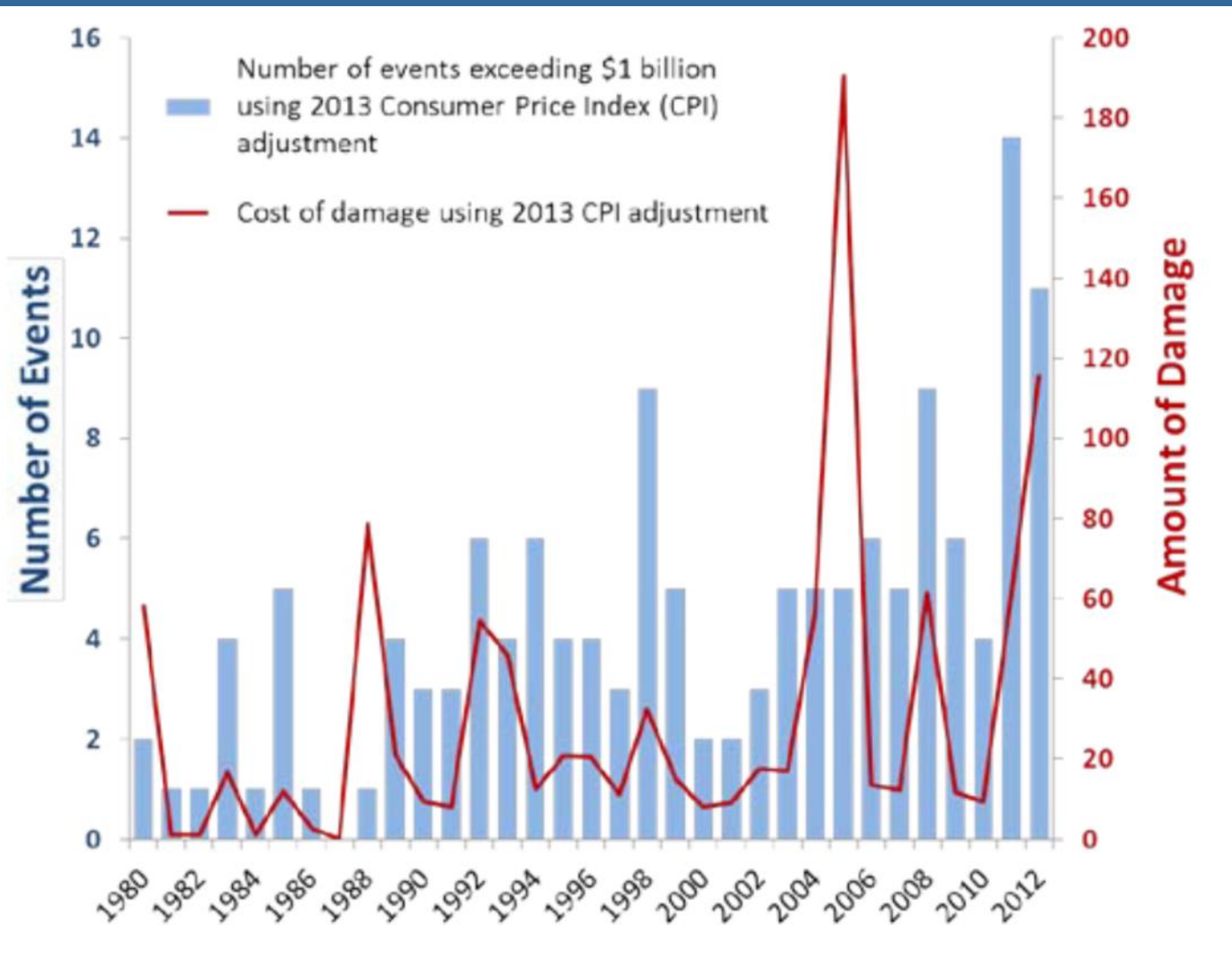


Figure 18. Billion-dollar weather and climate disasters, 1980–2012

Data source: NOAA 2013a

Increasing Impact of Floods



- **FEMA/AECOM 2013 study:** 100-year floodplains will grow by ~45% over the next 90 years, 70% due to climate change & 30% to population growth
- 25% flood insurance claims outside SFHA

Need to Incorporate Future Flood Risk



What matters regarding flood risk is not just next year's flood risk but the integrated flood risk over the lifetime of the project.



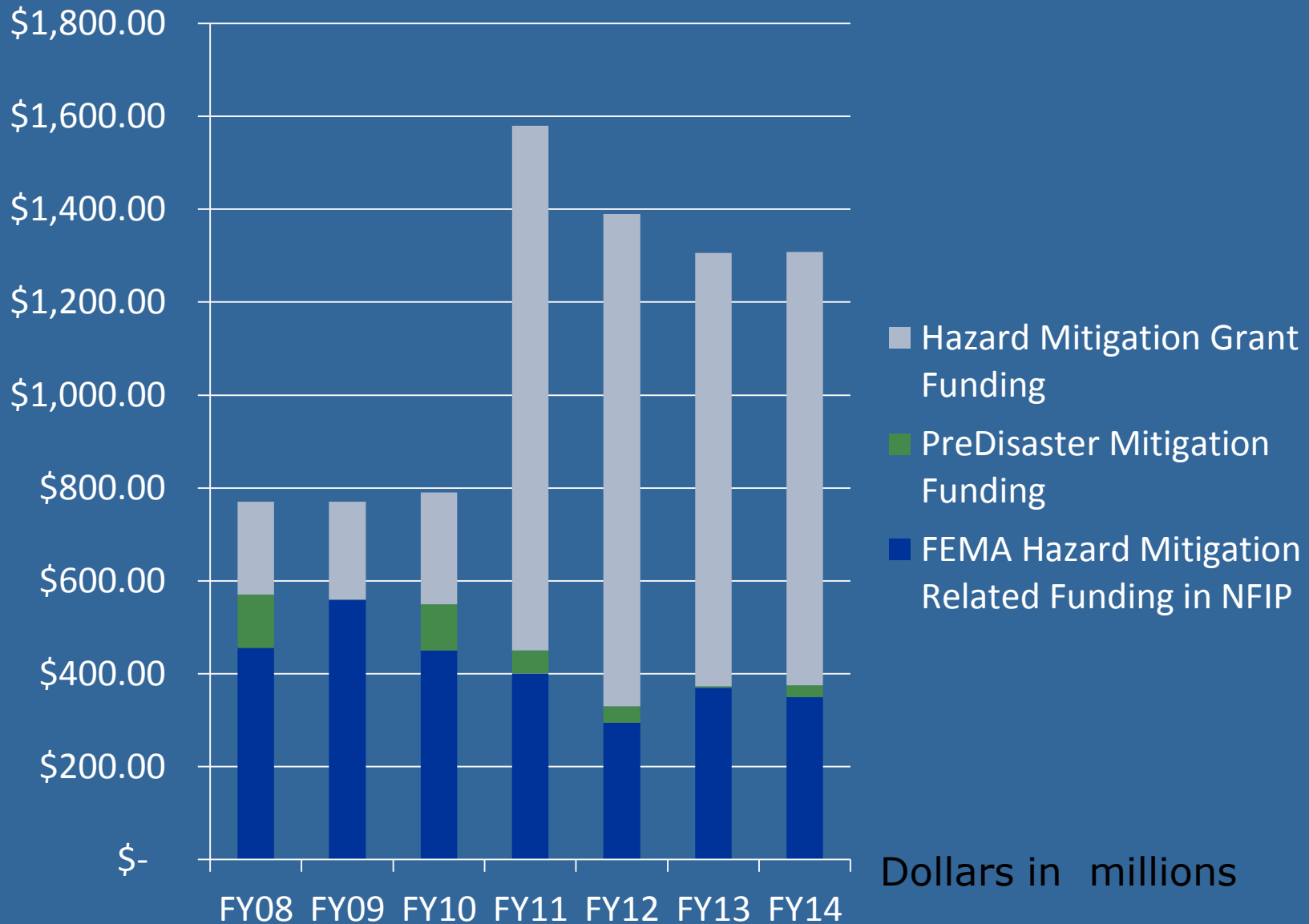
A 2005 storm in **Toronto** caused \$647 million in damages, including destruction of this culvert (left, \$4 million) in losses, which was replaced with a larger, more resilient culvert (right). Source: Toronto Environment Office.

Photo credit for damaged culvert: Jane-finch.com.

Photo credit for new culvert: City of Toronto Transportation Services.

Post Disaster vs. Pre Disaster Funding

FEMA Mitigation Spending





THE PRESIDENT'S CLIMATE ACTION PLAN

Executive Office of the President

June 2013



THE PRESIDENT'S PLAN WILL

PREPARE THE U.S. FOR THE IMPACTS OF CLIMATE CHANGE

WE'VE MADE GREAT PROGRESS



The Administration and partners developed national strategies to help decision makers address the impacts of climate change on freshwater resources — fish, wildlife, and plants — and oceans.

PROGRESS:

In 2013, federal agencies released Climate Change Adaptation plans for the first time, outlining strategies to protect their operations, missions, and programs from the effects of climate change.

PROGRESS:

The US Global Change Research Program, NOAA, USACE, and FEMA developed and released interactive sea-level rise maps and a calculator to aid rebuilding efforts in NY and NJ after Superstorm Sandy.

THERE'S MORE WORK TO DO

Moving forward, the Obama Administration will help states, cities, and towns build stronger communities and infrastructure, protect critical sectors of our economy as well as our natural resources, and use sound science to better understand and manage climate impacts.



SUPPORT CLIMATE-RESILIENT INVESTMENTS

at the community level by removing policy barriers, modernizing programs, and establishing a short-term task force of state, local, and tribal officials to advise on key actions the federal government can take to support local and state efforts to prepare for climate change.

REBUILD AND LEARN FROM SUPERSTORM SANDY

by piloting innovative strategies in the Superstorm Sandy-affected region to strengthen communities against future extreme weather and other climate impacts and building on a new, consistent flood risk reduction standard established for the Sandy-affected region, agencies will update their flood-risk reduction standards for all federally-funded projects.



LAUNCH AN EFFORT TO CREATE SUSTAINABLE AND RESILIENT HOSPITALS

in the face of climate change through a public-private partnership with the healthcare industry.

MAINTAIN AGRICULTURAL PRODUCTIVITY

by delivering tailored, science-based knowledge to farmers, ranchers, and forest landowners to help them understand and prepare for the impacts of climate change.



PROVIDE TOOLS FOR CLIMATE RESILIENCE

including existing and newly developed climate preparedness tools and information that state, local, and private-sector leaders need to make smart decisions.

State, Local, and Tribal Leaders Task Force on Climate Preparedness

- Recommend how federal programs can best support resilience and what barriers need to be removed

Interagency Council on Climate Preparedness and Resilience

- Modernize Federal Programs to Support Climate Resilience Investments

Potential Administrative Actions



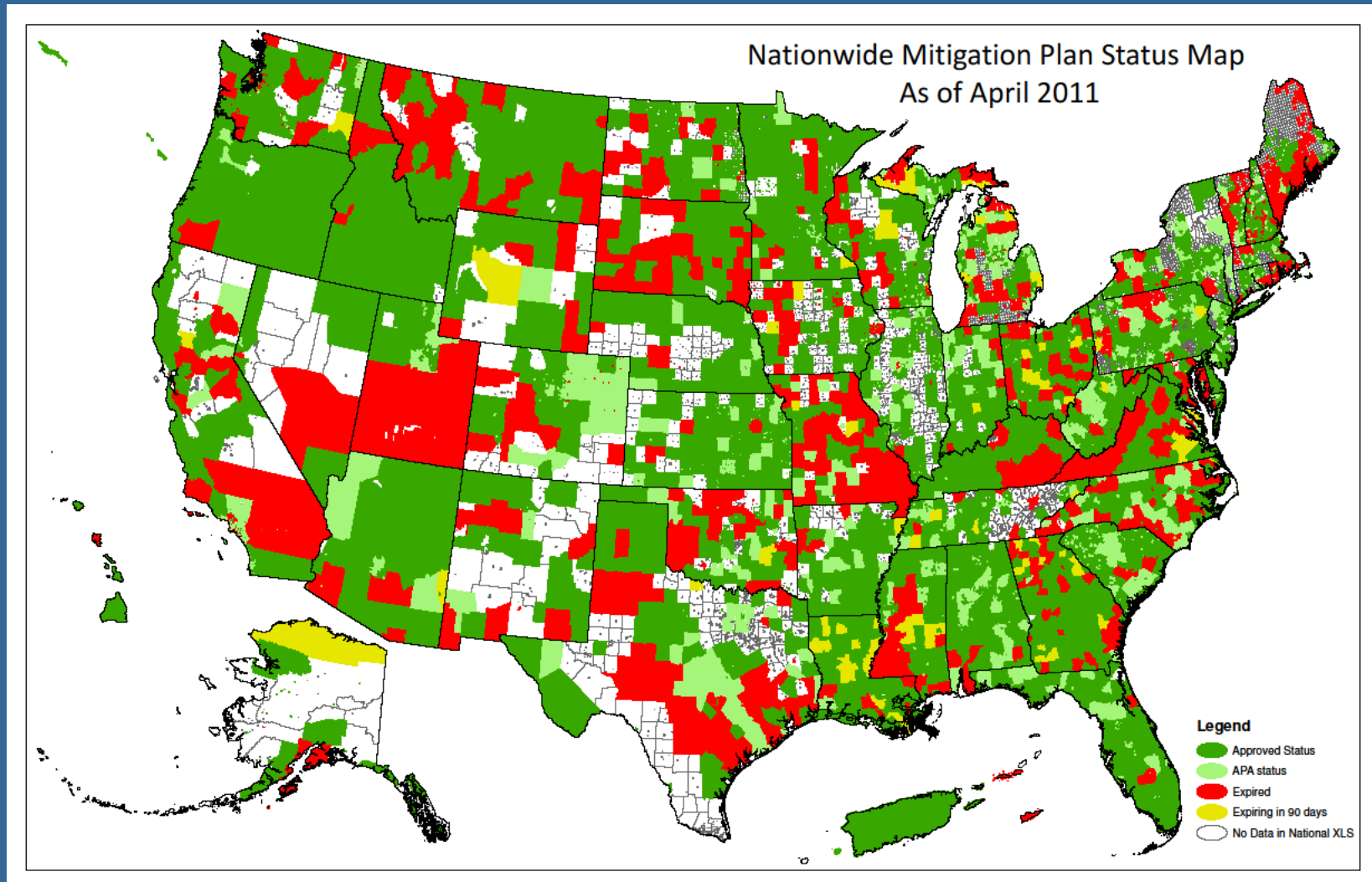
- Federal Interagency Floodplain Management Task Force “FIFMTF” - **Executive Order 11988** (1977) developing in floodplains is *“simply a bad Federal investment and should be avoided. Currently 100-yr flood but should it go beyond...”*
- Mitigation Framework Leadership Group – “MitFlg”. **Federal Flood Risk Management Standard** – 1 foot above best available flood data standard



FEMA

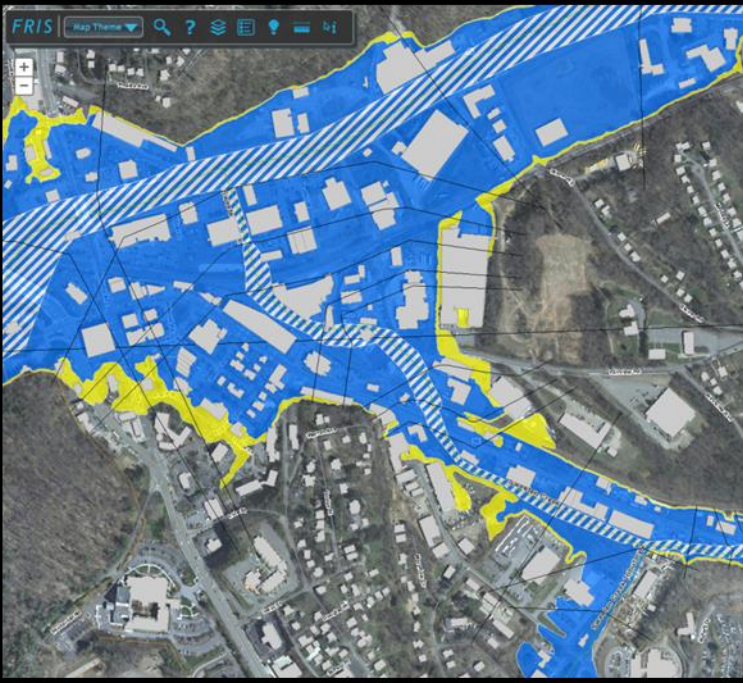
- **Stafford Act (post disaster funding)**
 - Public Assistance program
 - Hazard Mitigation Grant Program
 - Predisaster Mitigation Program
- **National Flood Insurance Program**
 - Mitigation Grant funding
 - Community Rating System

Hazard Mitigation Plans



Approved Hazard Mitigation Plans

Mapping: Opportunities



- Association for State Floodplain Managers estimates **adequate flood mapping for nation** ~\$4.5 - \$7.5 billion & \$116 - \$275 million annually to maintain.
- **National Flood Insurance Program Reauthorization**
 - Created a Technical Mapping Advisory Council “**TMAC**” to make recommendations to FEMA;
 - Included natural resources/non-structural flood mitigation features; requirement to map “future conditions” like sea level rise

Challenges Remain for Access to Flood Mitigation Funds

FEMA WON'T FUND CULVERT PLAN FOR VERMONT
ROADS WASHED OUT BY IRENE

-JOHN HERRICK JUL. 17 2014, 6:39 PM

Question: Can FEMA Public Assistance \$ to help upgrade culverts?

Answer to VT: Plans don't meet uniform 'codes and standards' and therefore don't qualify

TNC's 4 Priorities for the Transportation Bill Reauthorization



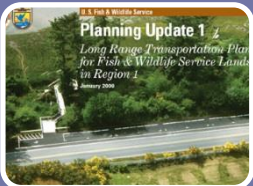
Habitat Connectivity



Resiliency



Mitigation



Federal Road Program

Habitat Connectivity

- Strengthen language on consideration of habitat connectivity.

Resiliency

- Incorporate changing climate and weather impacts on road and infrastructure design.

Mitigation

- Programmatic mitigation plan (expansion of RAMP program). Apply avoid, minimize, offset on regional scale.
- Enabling landscape scale interagency planning and coordination.

Federal Road Program

- Support increased funding for all federal land road programs - BLM, USFS, FWS & NPS

Thank you

Questions and discussion

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