Mad River Dynamics

Understanding the Science of River Processes and Flooding

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November 10, 2011

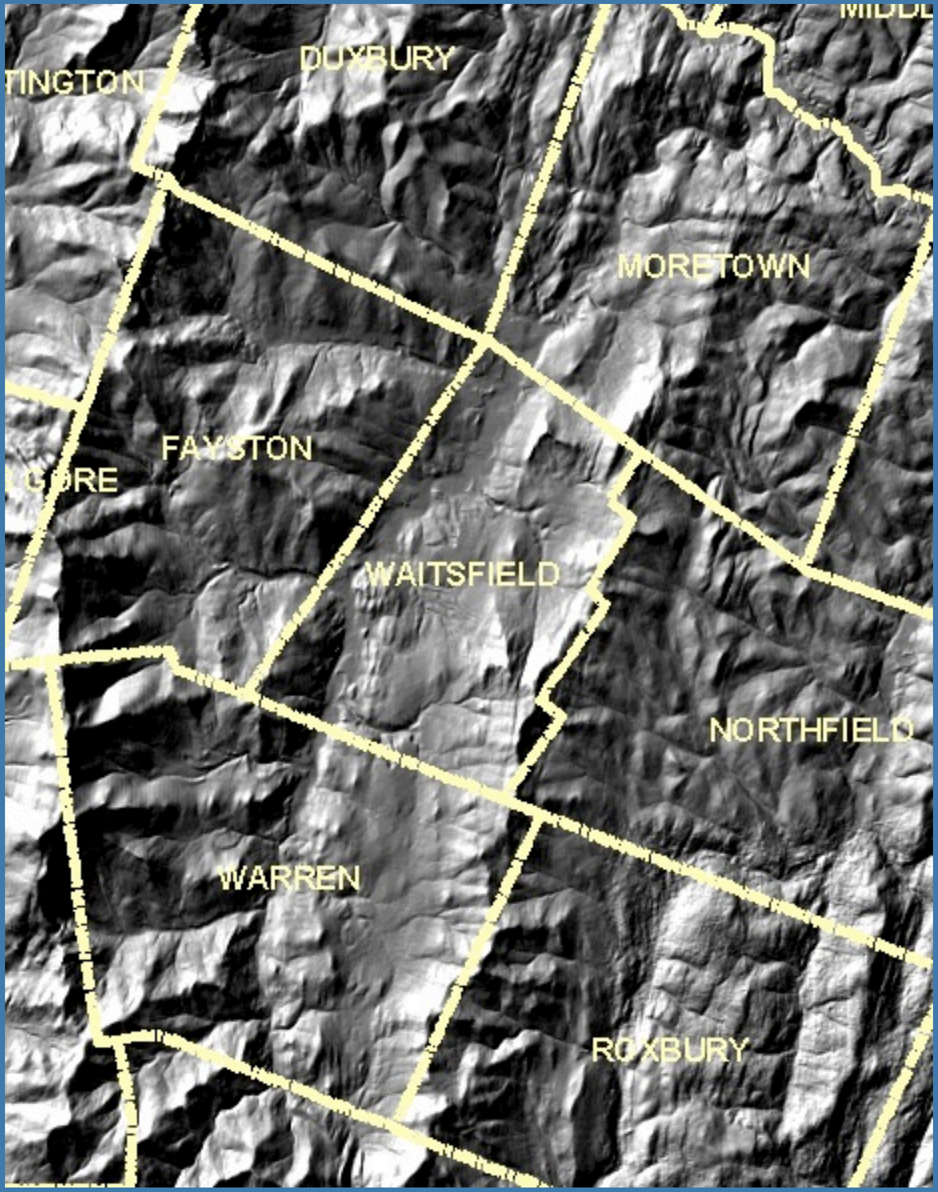
Flooding

- Common natural phenomenon

- Caused by:
  - Rain
  - Melting Snow
  - Ice Jams
  - Debris jams

Waitsfield Elementary School, August 29, 2011
Photo Credit Myndy Woodruff

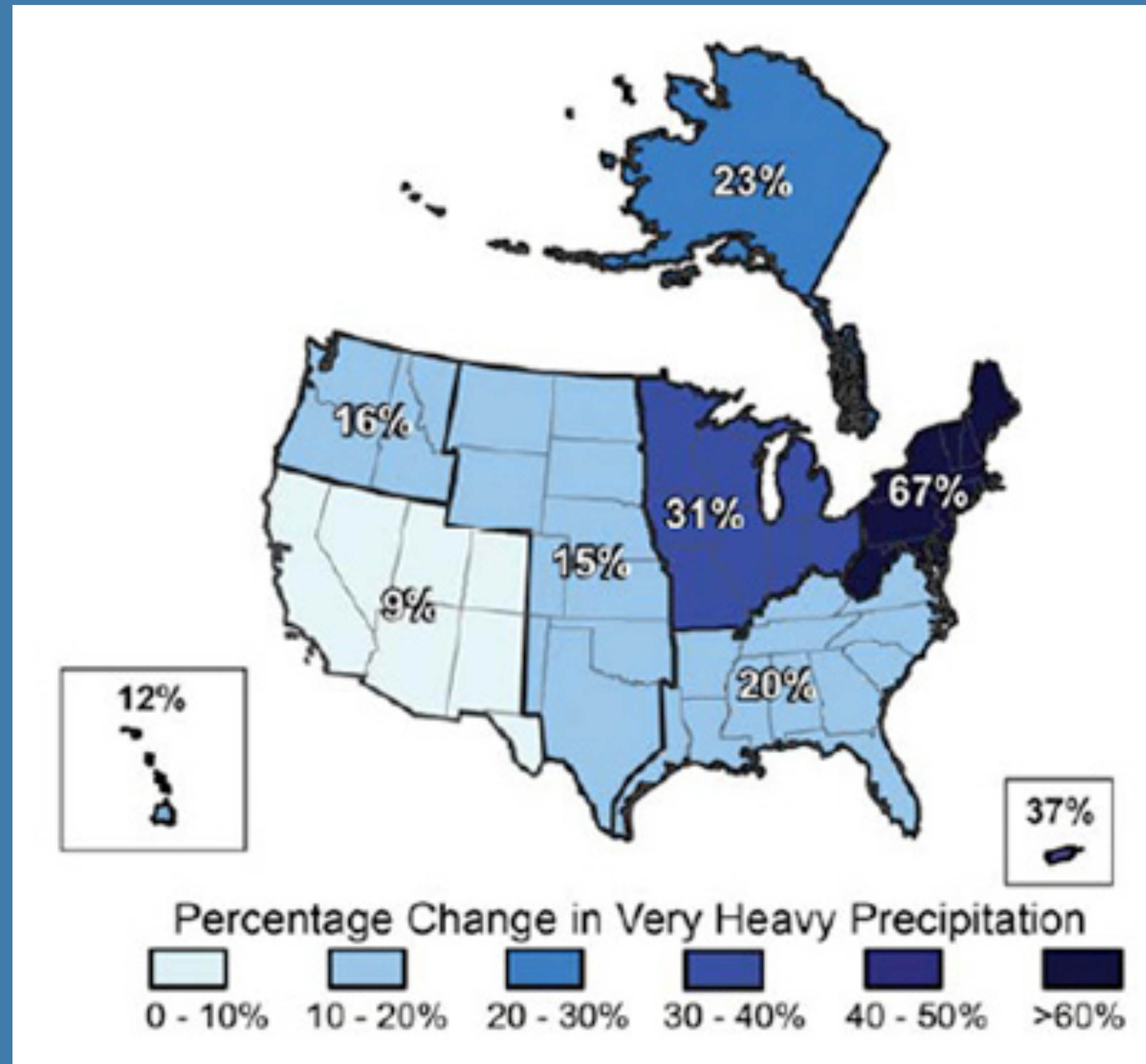
Mad River Landscape



Runoff is delivered to the drainage network *quickly*

Plan for Flooding

- Historic flooding
- Changing climate



Map: [Progress Report of the Interagency Climate Change Adaptation Task Force]: Recommended Actions in Support of a National Climate Change Adaptation Strategy, October 5, 2010.

Understanding of how rivers function can guide our planning efforts

Fluvial Geomorphology

Fluvial =

Geo =

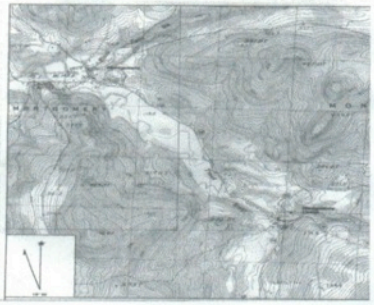
Morphology =

Fluvial Geomorphology = The study of how moving water shapes the land

Vermont Stream Geomorphic Assessment Protocols

Vermont Stream Geomorphic Assessment
Phase 1 Handbook

WATERSHED ASSESSMENT



USING MAPS, EXISTING DATA, AND WINDSHIELD SURVEYS

Vermont Agency of Natural Resources
April, 2003

Phase 1

Remote Sensing

Vermont Stream Geomorphic Assessment
Phase 2 Handbook

RAPID STREAM ASSESSMENT

FIELD PROTOCOLS

Vermont Agency of Natural Resources
April, 2003

Phase 2

Qualitative & Rapid Field Assessment

Vermont Agency of Natural Resources
River Corridor Planning Guide

to Identify and Develop
River Corridor Protection and Restoration Projects

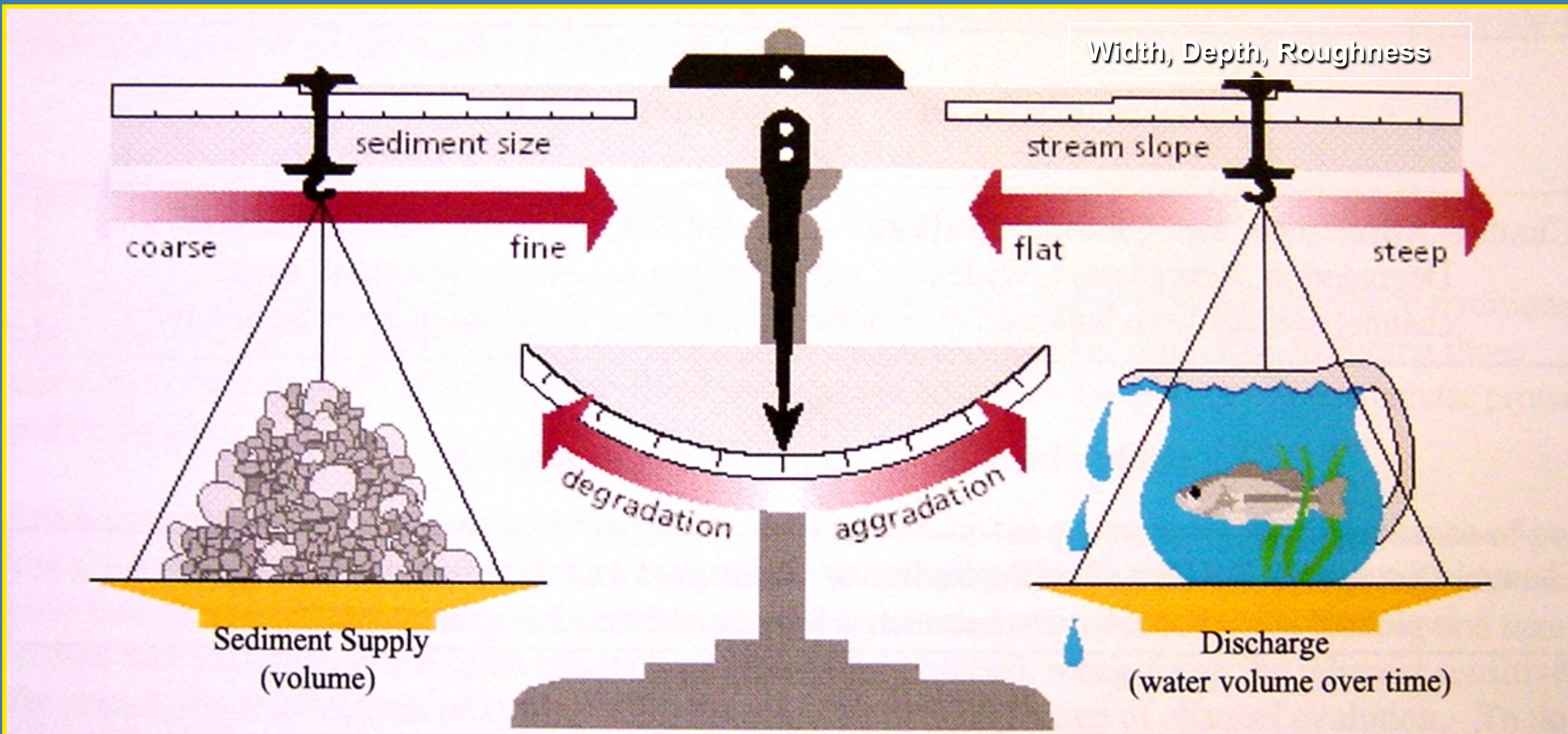
Partially Drafted
River Management Program
July 11, 2007

River Corridor Planning

Channel Equilibrium

Sediment Load

Transport Capacity

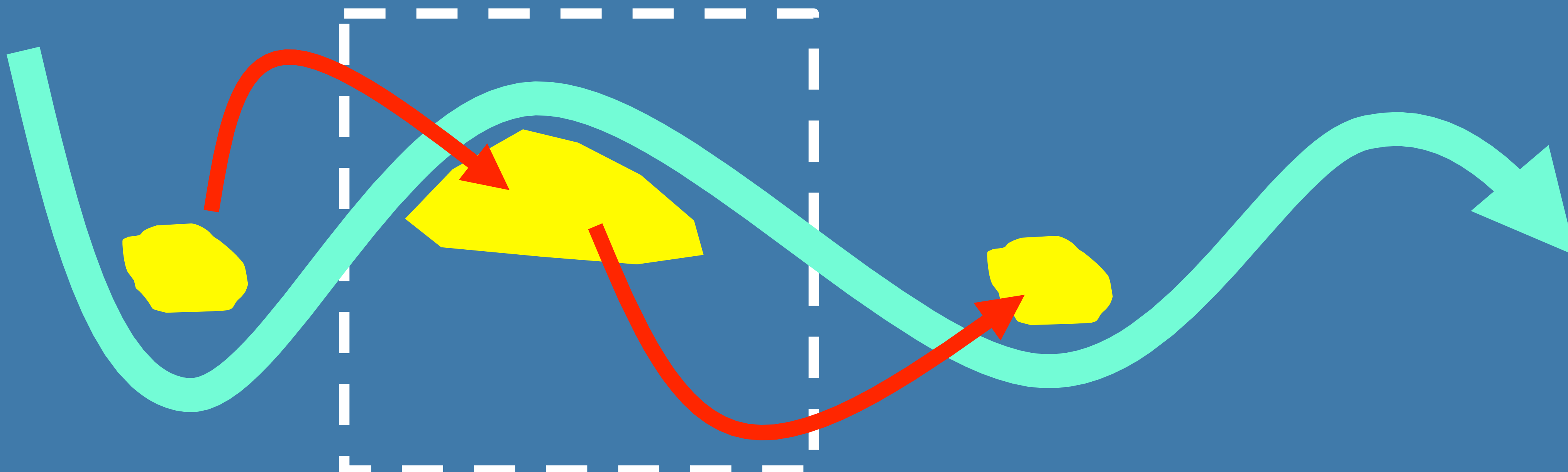


Lane (1955)

Rivers carry water and…

SEDIMENT!

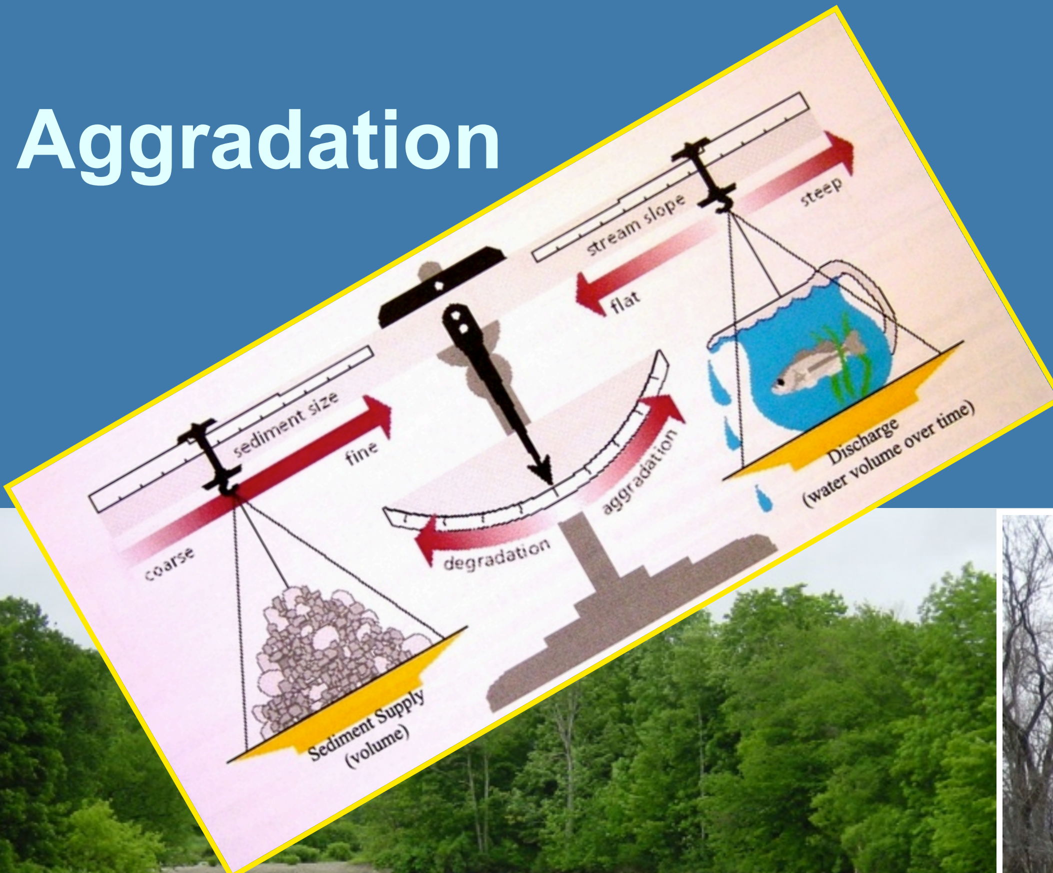
In equilibrium condition, in = out



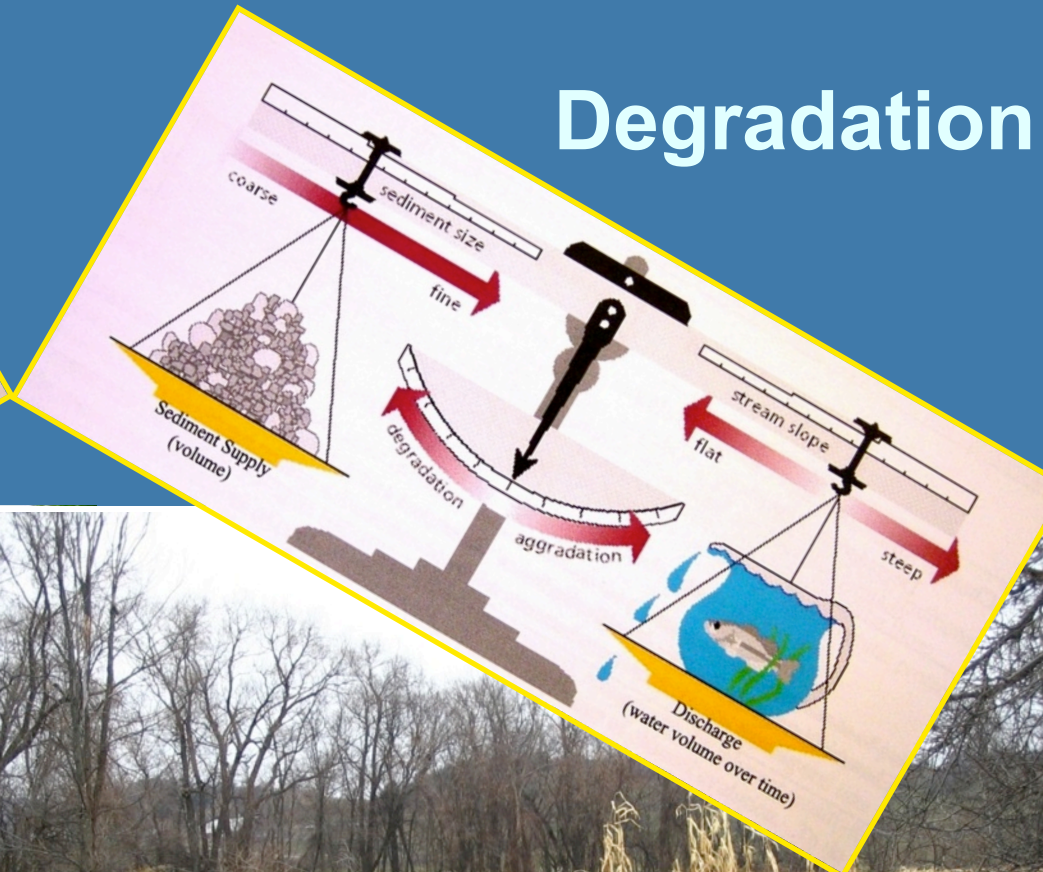
In equilibrium condition, channel bed and bars will neither degrade nor aggrade

Channel Instability

Aggradation

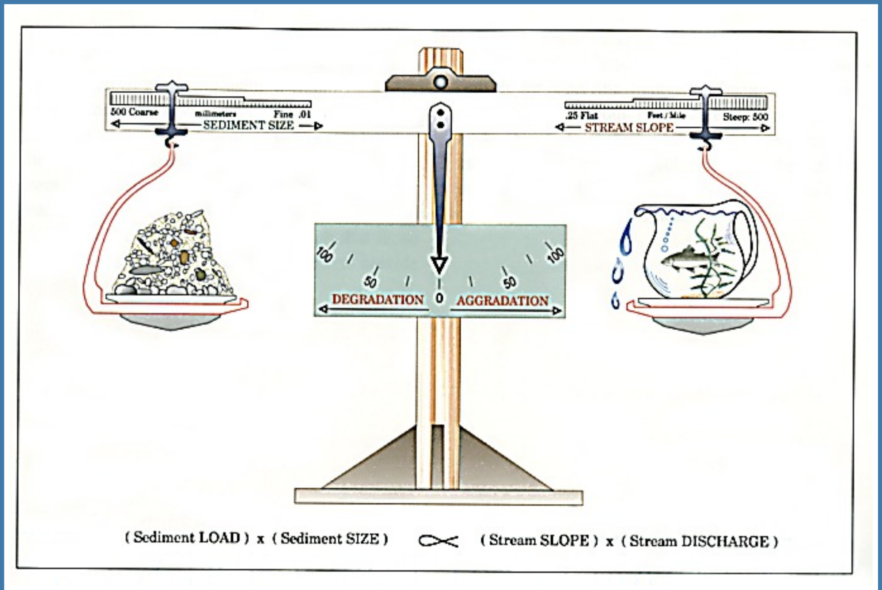


Degradation



We have an impact!

The balance of water and sediment gets upset by land use choices



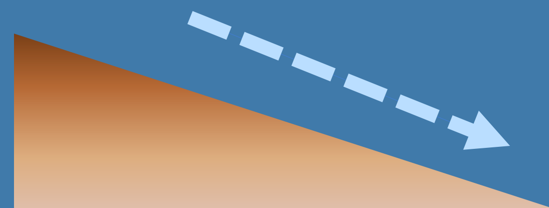
Sedimentation
Deforestation

Straightening
Loss of Wetlands
Lack of Buffers
Berming
Stormwater
Floodplain filling

Dynamically Stable

River Maintains:

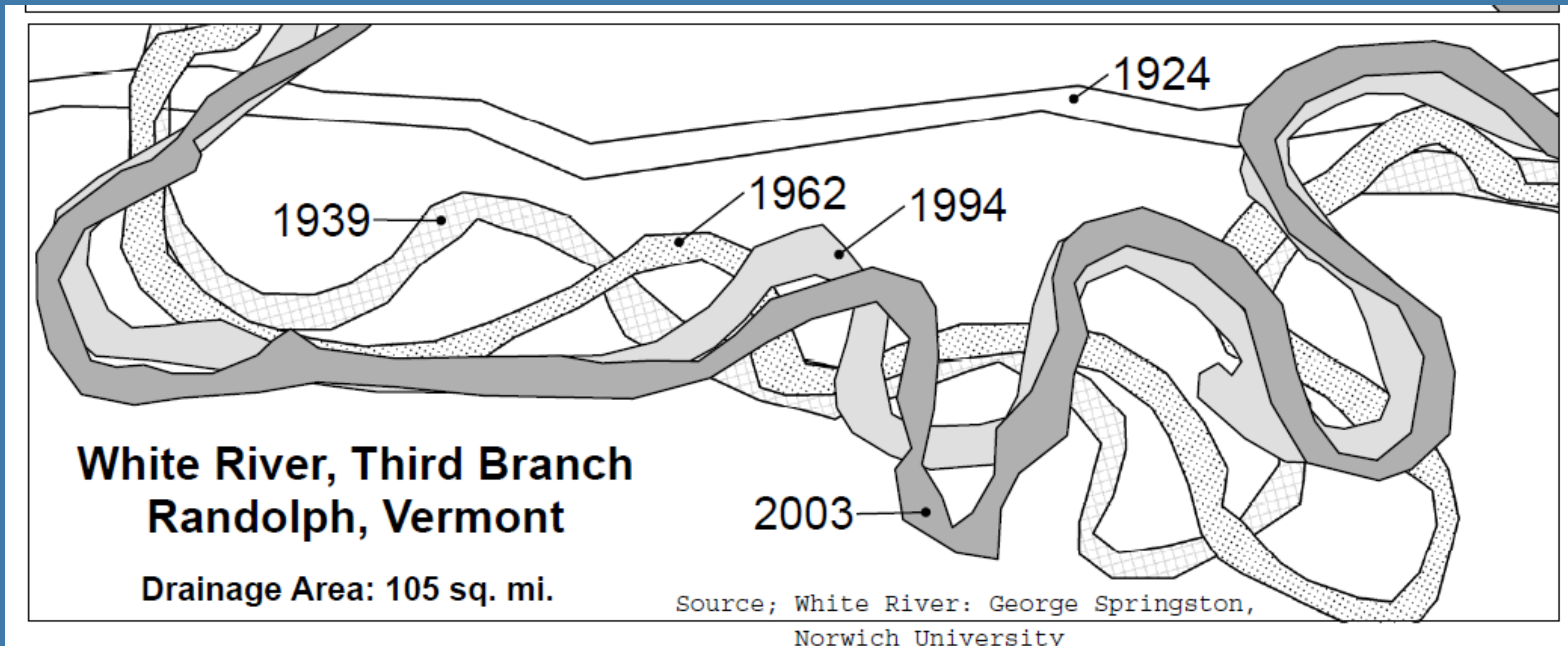
Slope

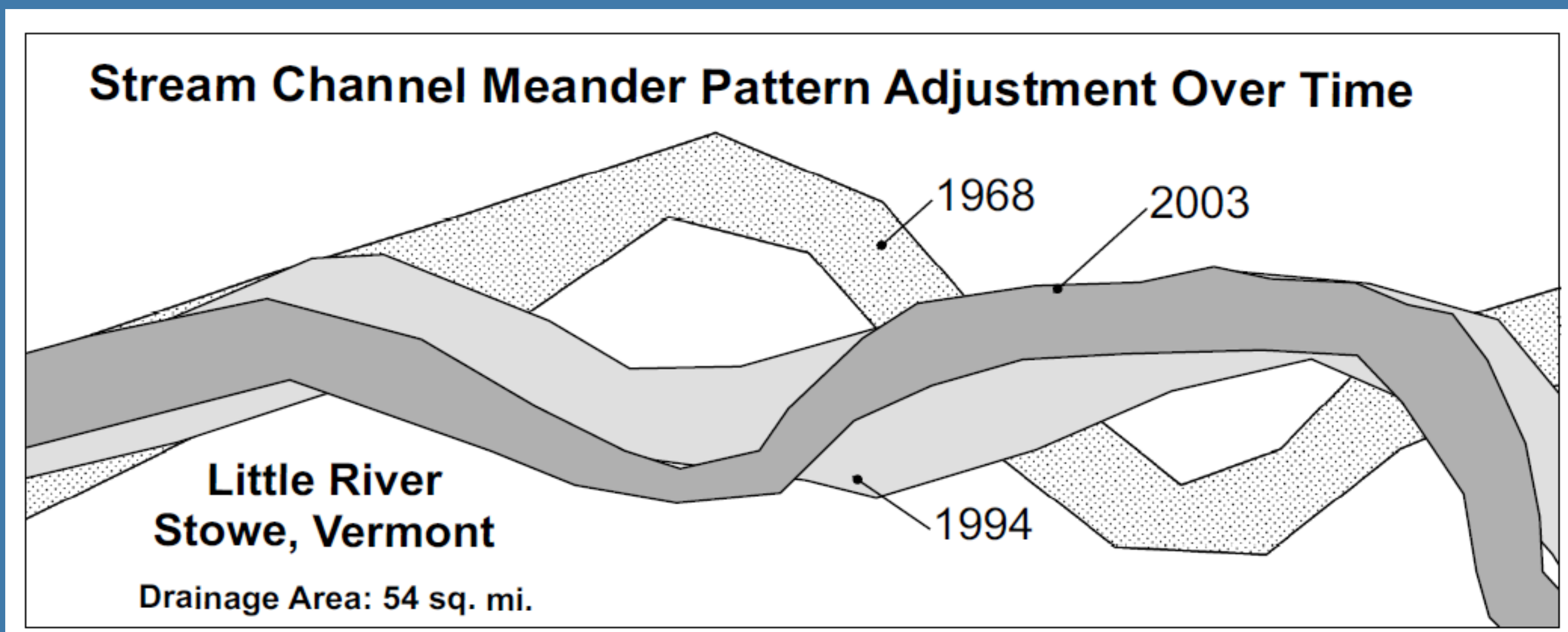


Profile

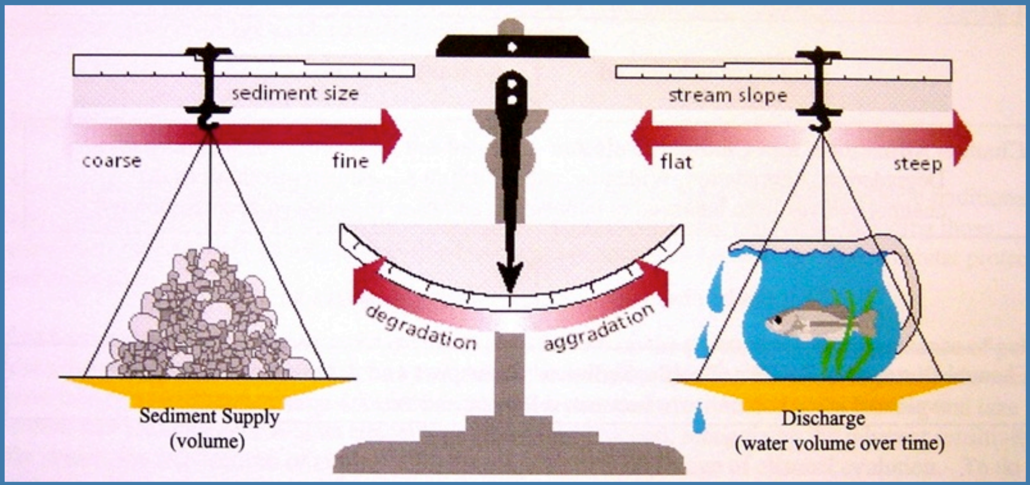
Pattern

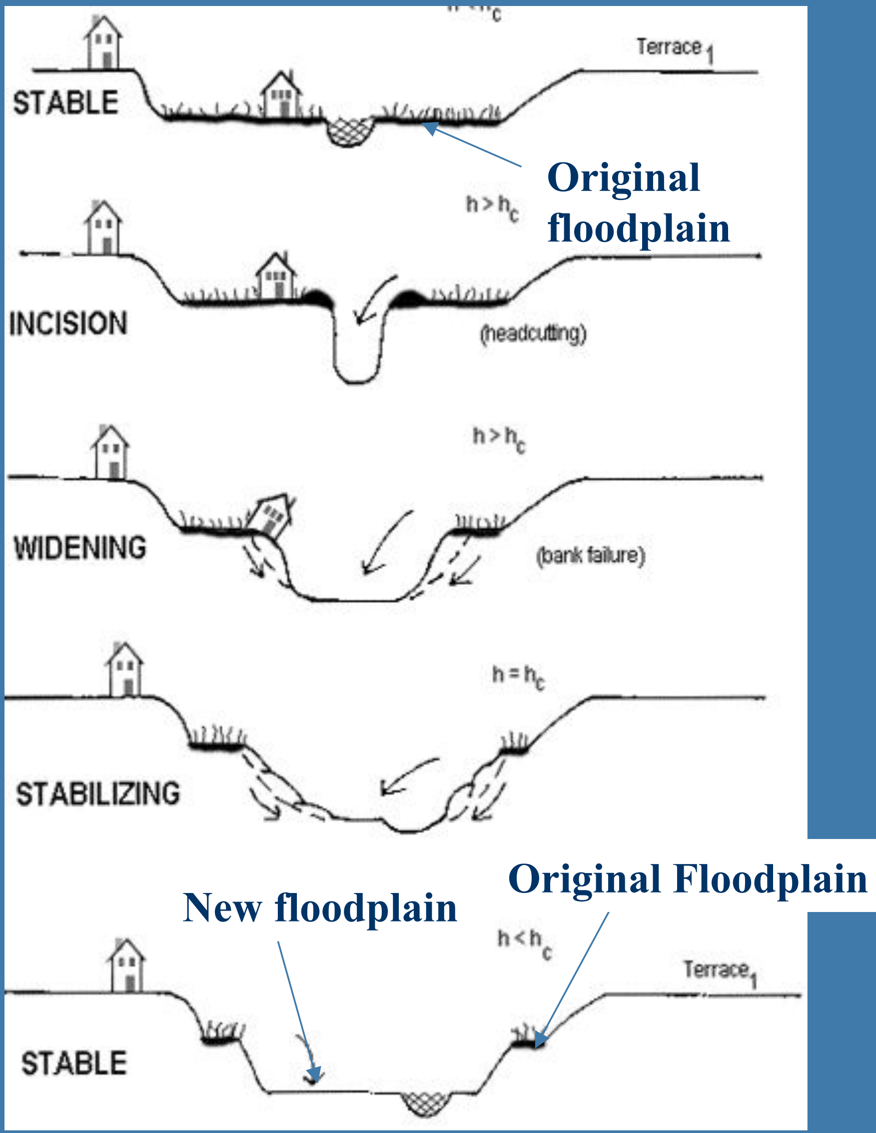
Stable does not mean Static!





Channel Evolution





Caused by changes to:

- Flow regime
- Sediment regime
- Slope
- Cross section
- Boundary condition
- Channel Roughness

Temporal Scale of Fluvial Response
Channel Evolution Model

Stage

1 — **Pre-1800** — **Equilibrium condition**

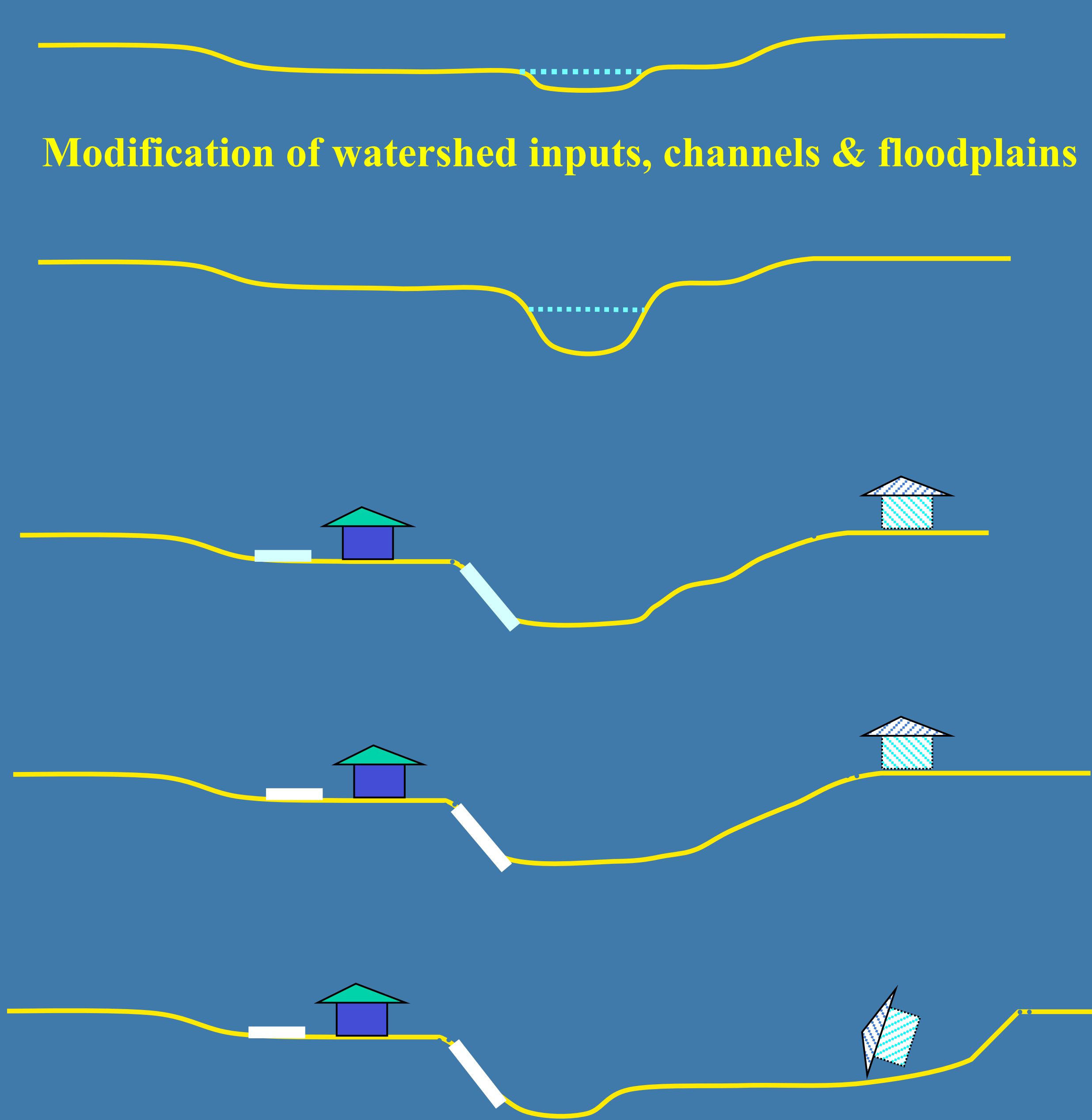
Modification of watershed inputs, channels & floodplains

2 — **Pre-1900** — **Geomorphic response begins**

3 — **1927** — **Widening to balance energy with boundary conditions**

4 — **1973** — **Developing new flood plain**

5 — **2011** — **Equilibrium condition**



After Shumm, et.al.

Floodplain Function

Floodplain access during flood critical for:

Dissipating energy of water

- reduce destructive force of water

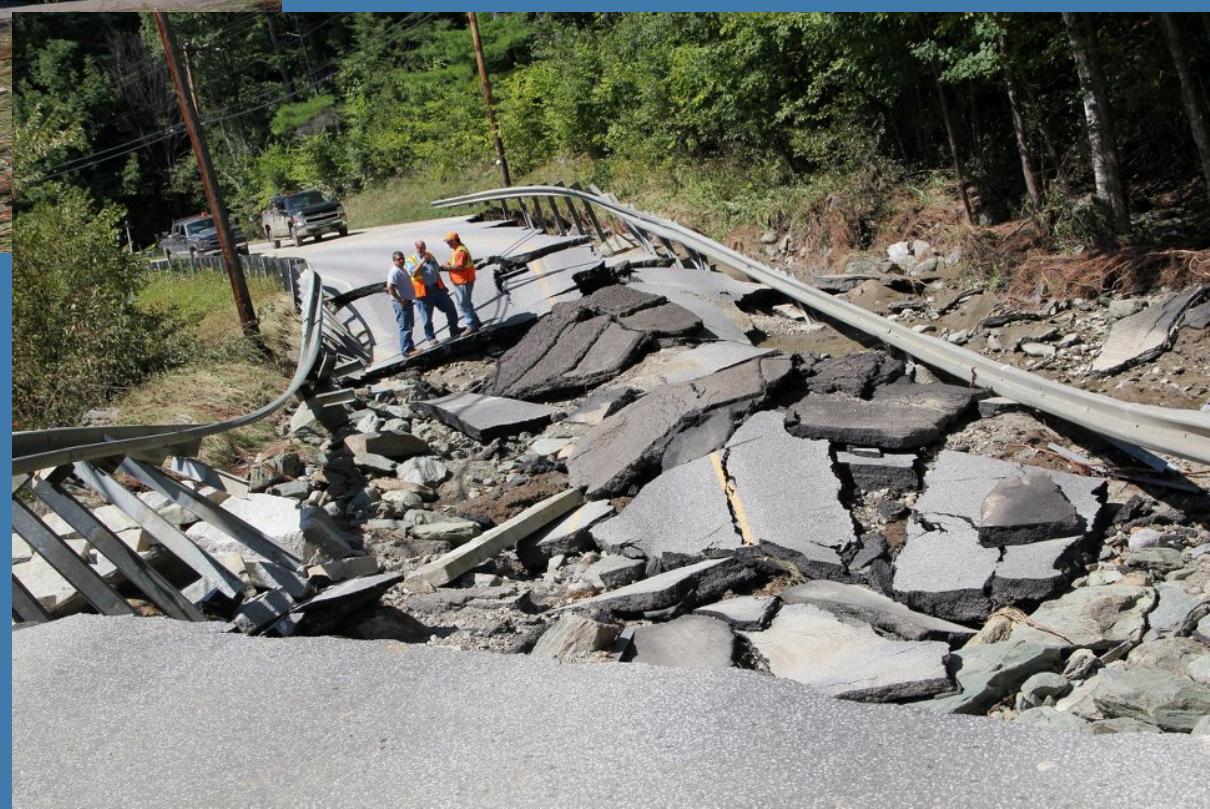
Reduce flashiness

- reduce peak flows by storing water on floodplain

Necessary for maintaining Dynamic Equilibrium

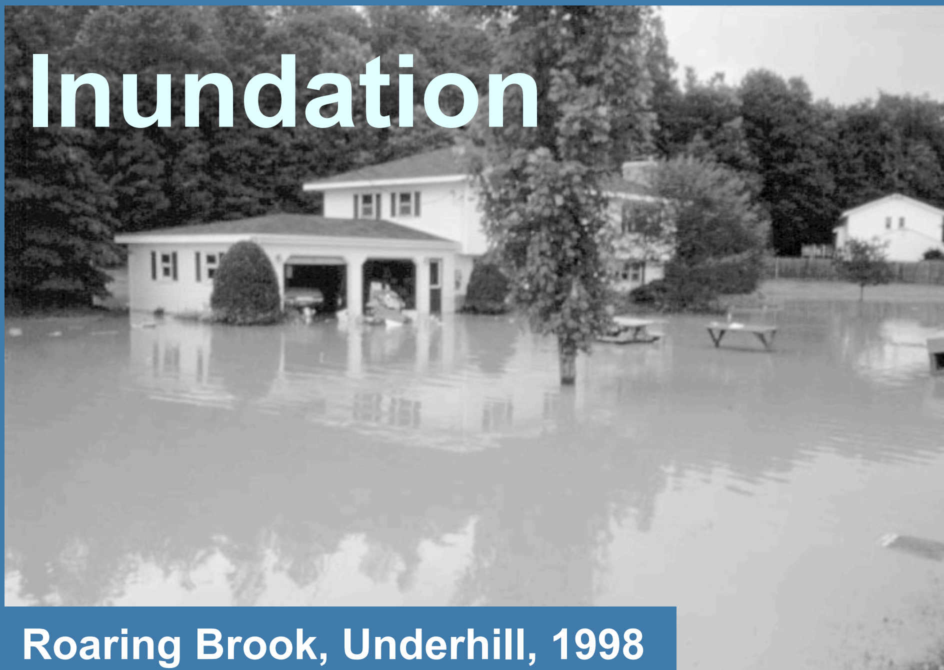
Mad River, Moretown, during and after Irene
Photo Credit: David Cain

We are all too familiar with the impacts of flooding

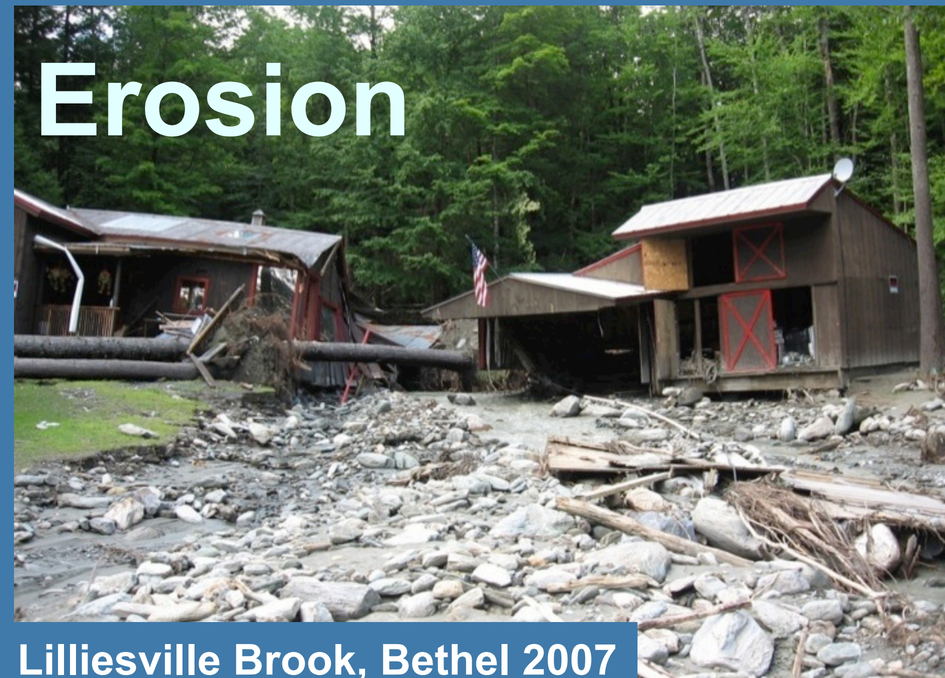


Mad River, Moretown, August 2011
Photo Credit: Virginia Farley

Flood Damages can occur due to:



Roaring Brook, Underhill, 1998



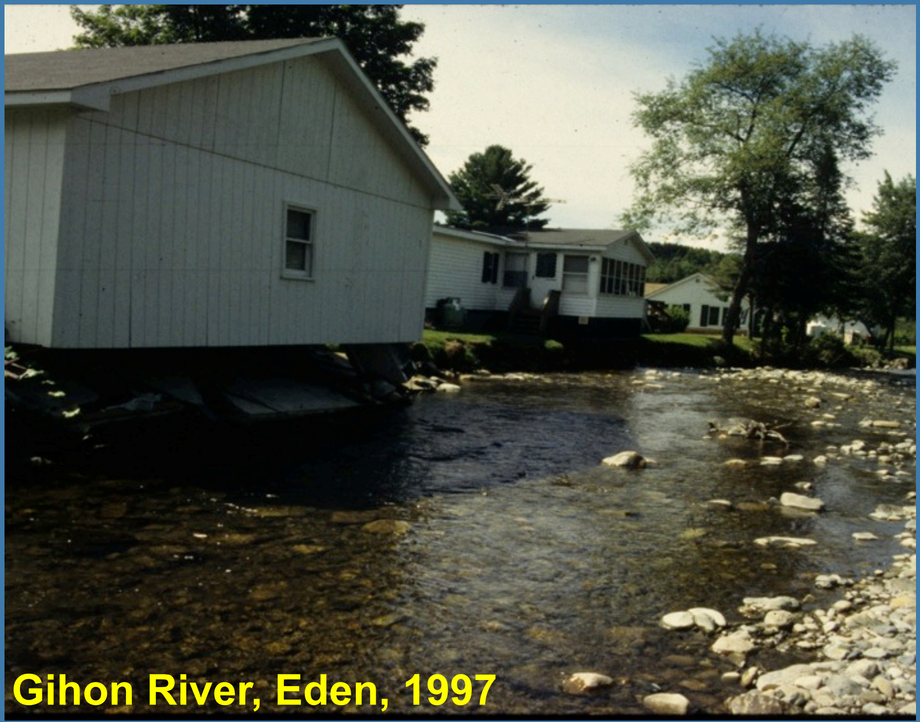
Lilliesville Brook, Bethel 2007

Passumpsic River, Lyndonville, 2002

Unnamed Tributary, White River, 2007

Five Floods in ’90s

Resulting in Over $60 Million in Damages


Gihon River, Eden, 1997

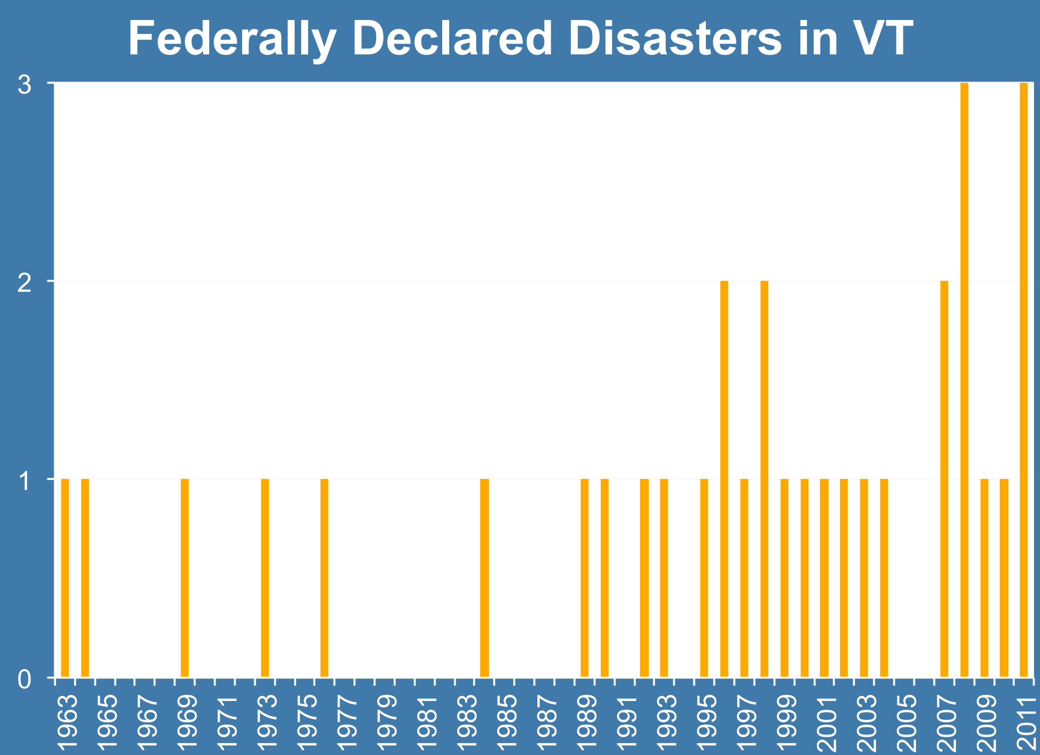

Tyler Branch, Enosburg, 1997

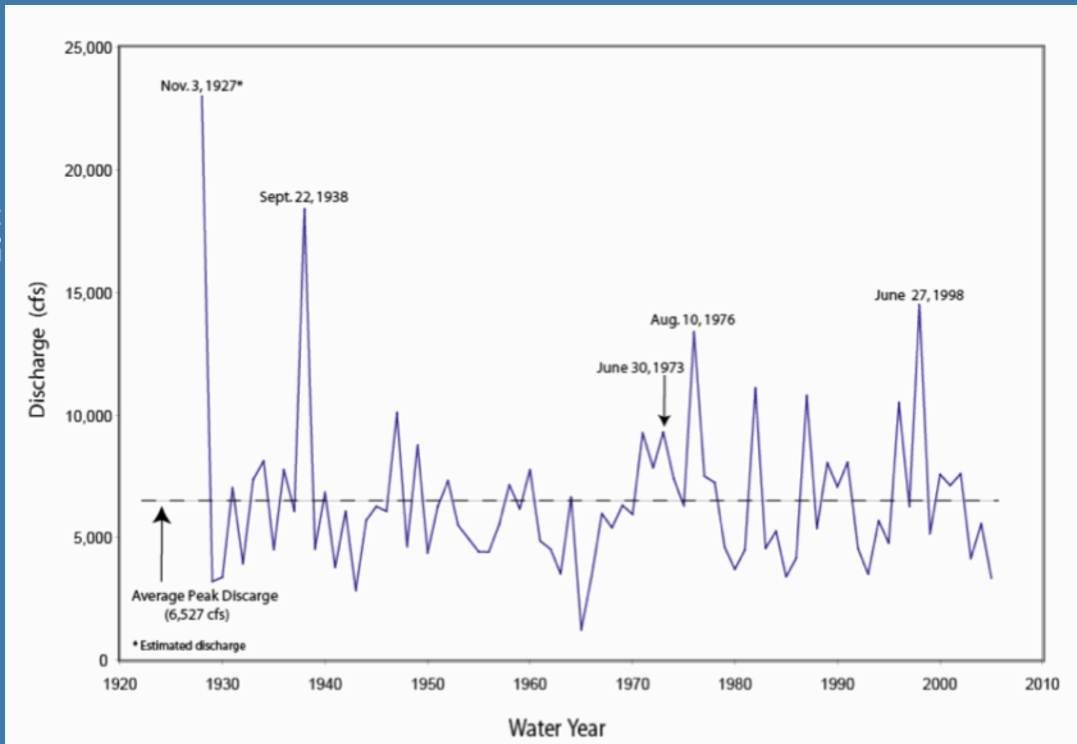

Trout River, Montgomery, 1997


West Hill Brook, Montgomery, 1997

Major Flood Frequency Increasing

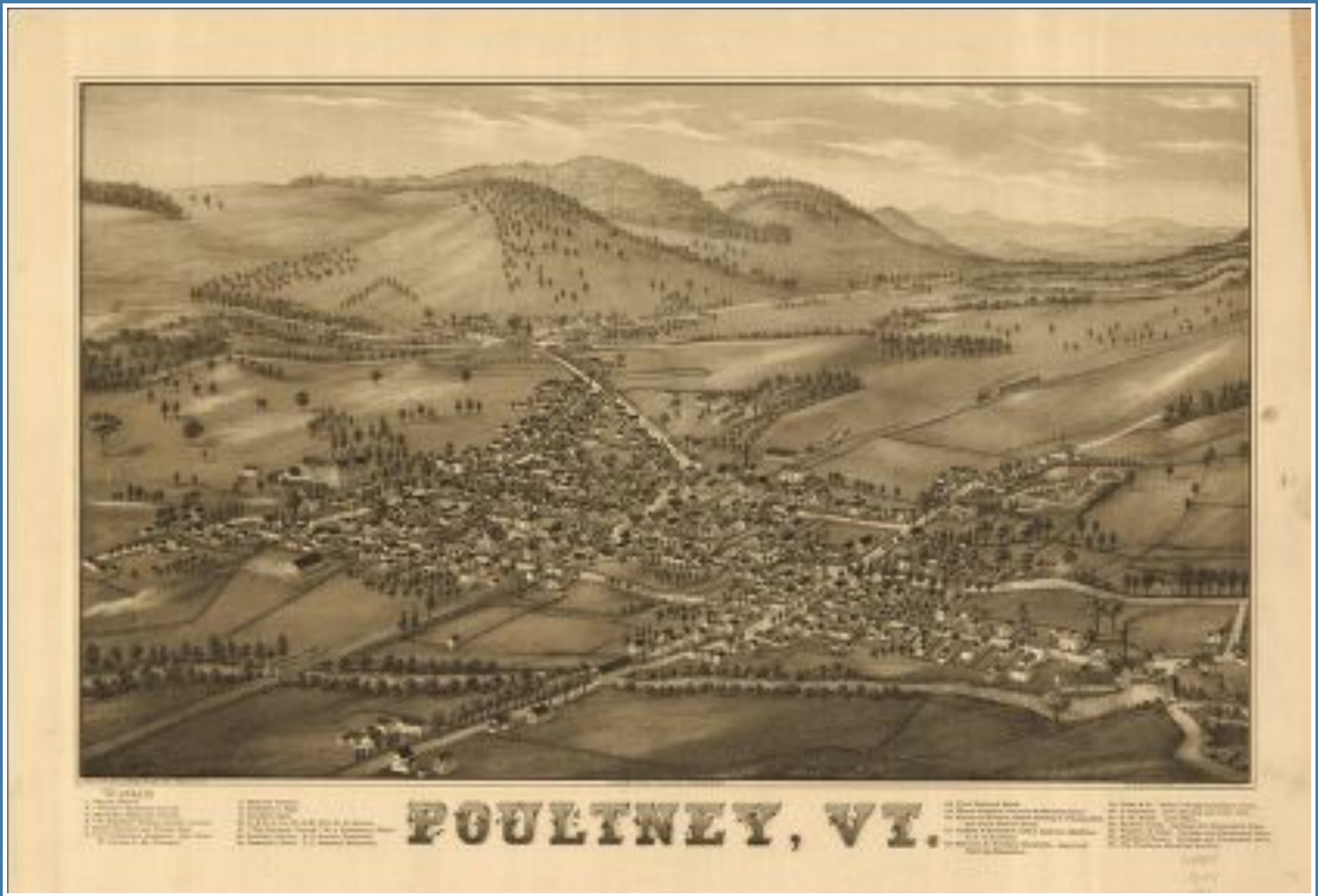
- 19 Federally declared disasters in VT in 15 years





How have we impacted flooding?

Present-day channel adjustments date back to watershed changes associated with early settlement

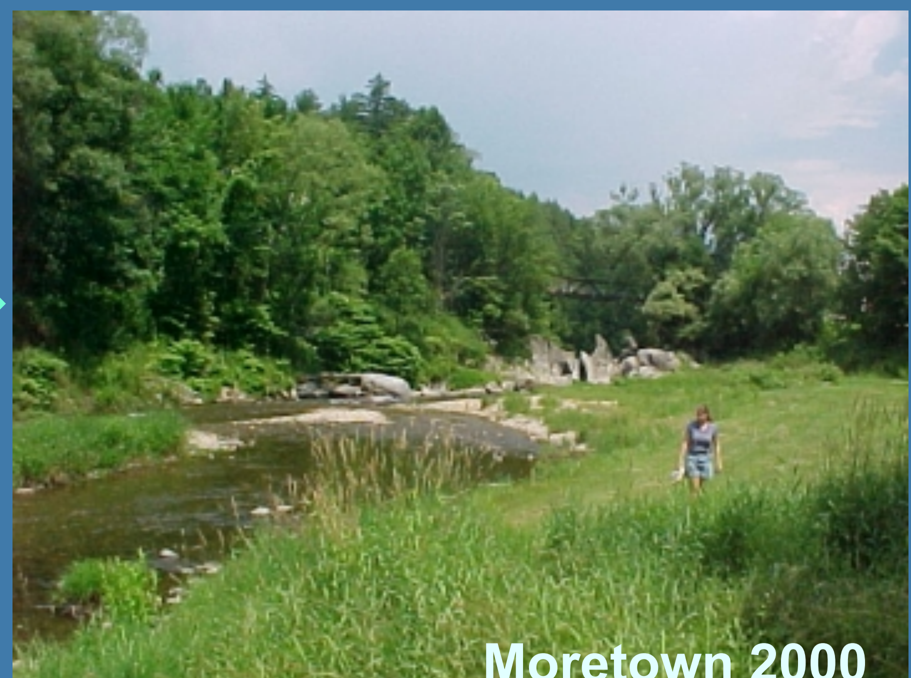


Landscape Change in the Mad River Valley

Waitsfield circa 1900

Waitsfield 1994

Moretown circa 1900



Moretown 2000

Photos from UVM Landscape Change Program

Traditional Approach to River Management:

Contain flows within the straightened channel

Result

High flows result in high erosive power kept in the channel,

instead of allowing the energy of the water to flow onto floodplain

Channel adjustments during floods can have devastating consequences

Lilliesville Brook, Bethel 1997

Jones Road, Wolcott 1995

Great Brook, Plainfield, 1990

Unnamed Tributary, Braintree, 2007

Gravel Extraction

Consequences that lead to channel instability through channel degradation:

- Creation of headcuts
- Sediment discontinuity

Came under regulation in 1986

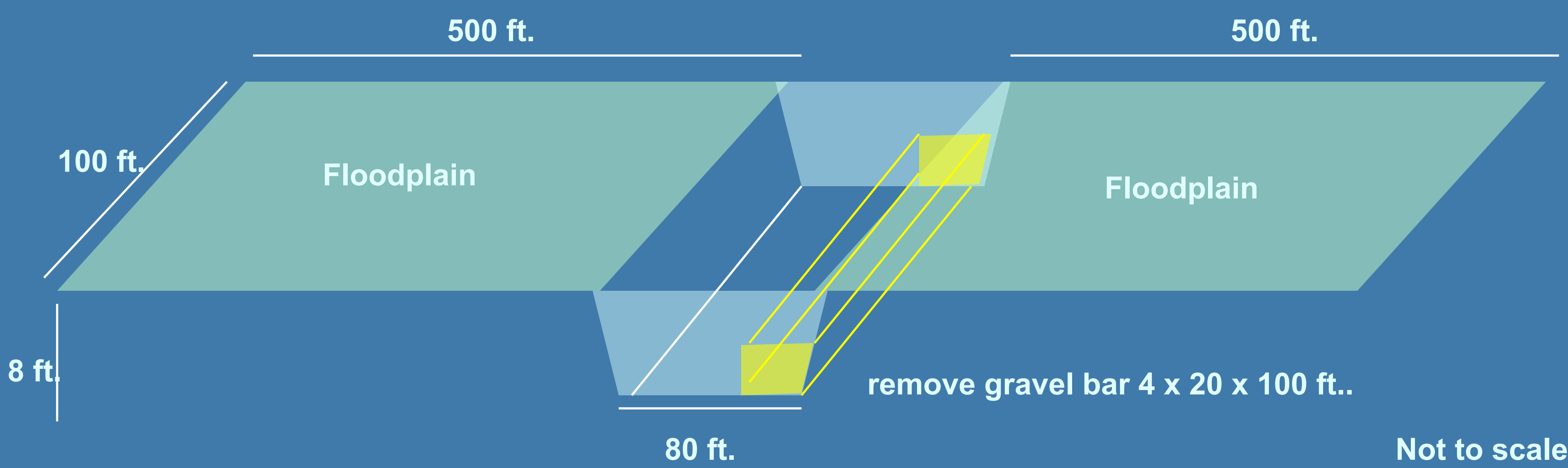
http://www.youtube.com/watch?v=mDqpbwR_ILY&feature=player_embedded#!

Can not dig out of a flood

Gravel extraction for increasing channel capacity is ineffective at best, and dangerous at worst, when aggradation is not the cause of flooding

- Provides little relief in overbank events
- Increases power of water during floods

Hypothetical example



- Assume flood depth of 3ft.
- Remove 8,000 cubic feet of gravel (~11 dump trucks = a lot!)
- Lower floodwater depth by 0.8 inches (not much!)
- Channel would need to be 48 feet deep to contain all of floodwater! (not feasible, and DANGEROUS)

Gravel bars provide:

Channel roughness

- Slows velocity of floodwater

Aquatic habitat

- Heterogeneity of velocity/depth combinations (fast, slow, deep, shallow)

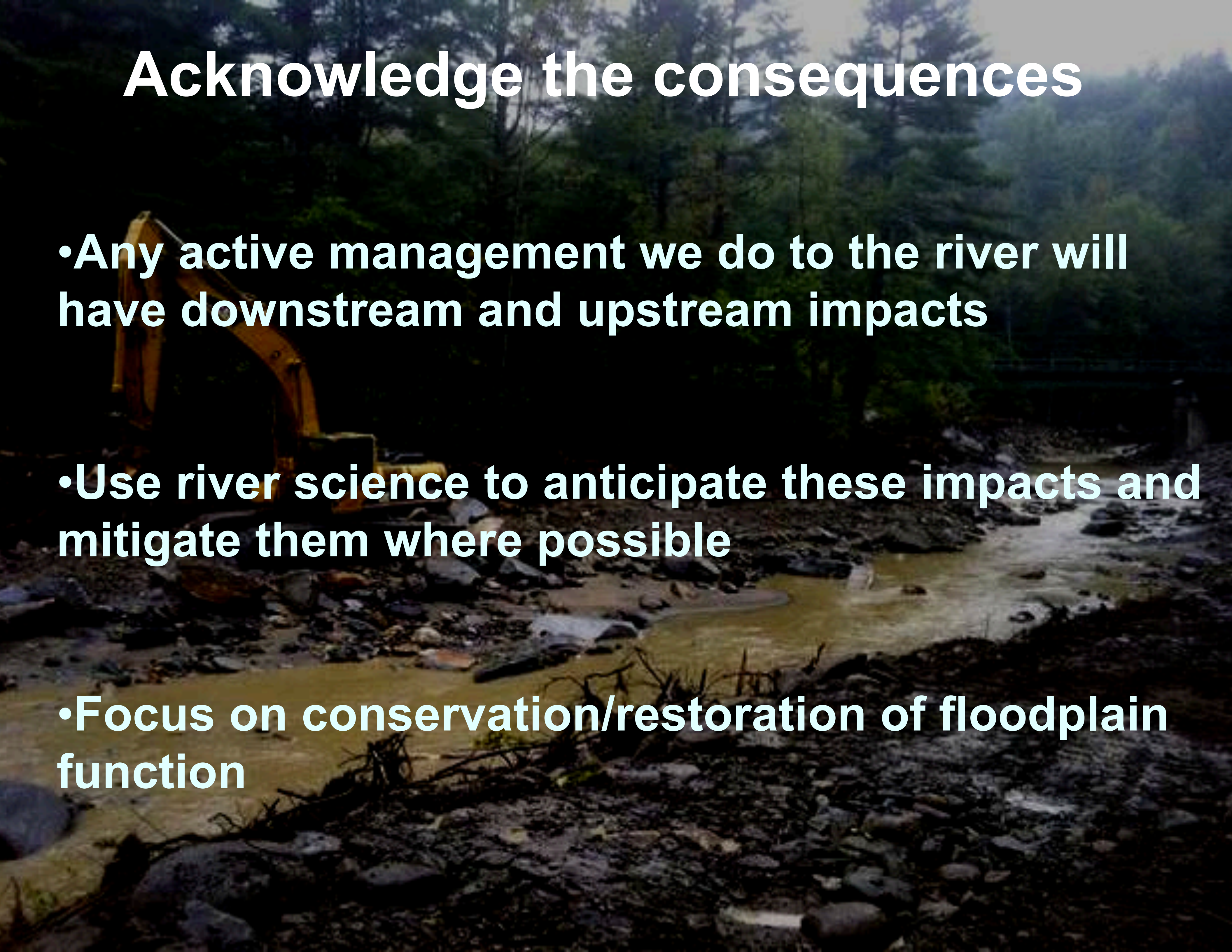
When do we need gravel extraction?
Post flood aggradation that:

photo credit: CVPS, Route 4, Mendon, VT August 2011

- threatens infrastructure
- significantly reduces channel capacity

Restoring stable channel dimensions

photo credit: US Forest Service



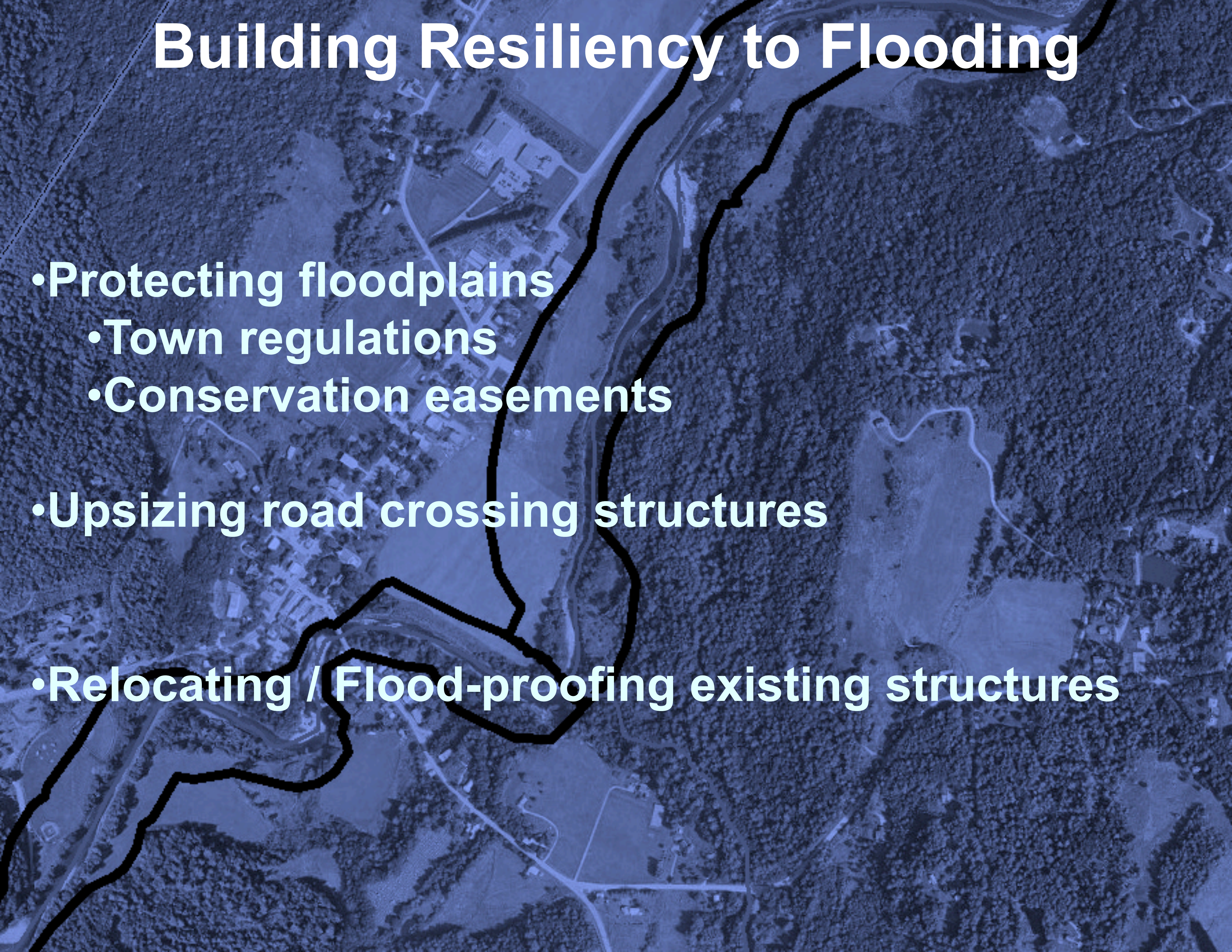
Acknowledge the consequences

- Any active management we do to the river will have downstream and upstream impacts

- Use river science to anticipate these impacts and mitigate them where possible

- Focus on conservation/restoration of floodplain function

Building Resiliency to Flooding



- Protecting floodplains
  - Town regulations
  - Conservation easements
- Upsizing road crossing structures
- Relocating / Flood-proofing existing structures

Contacts

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