DAMS & MIGRATORY FISH

Charles River Watershed Association

May 1, 2023

Agenda

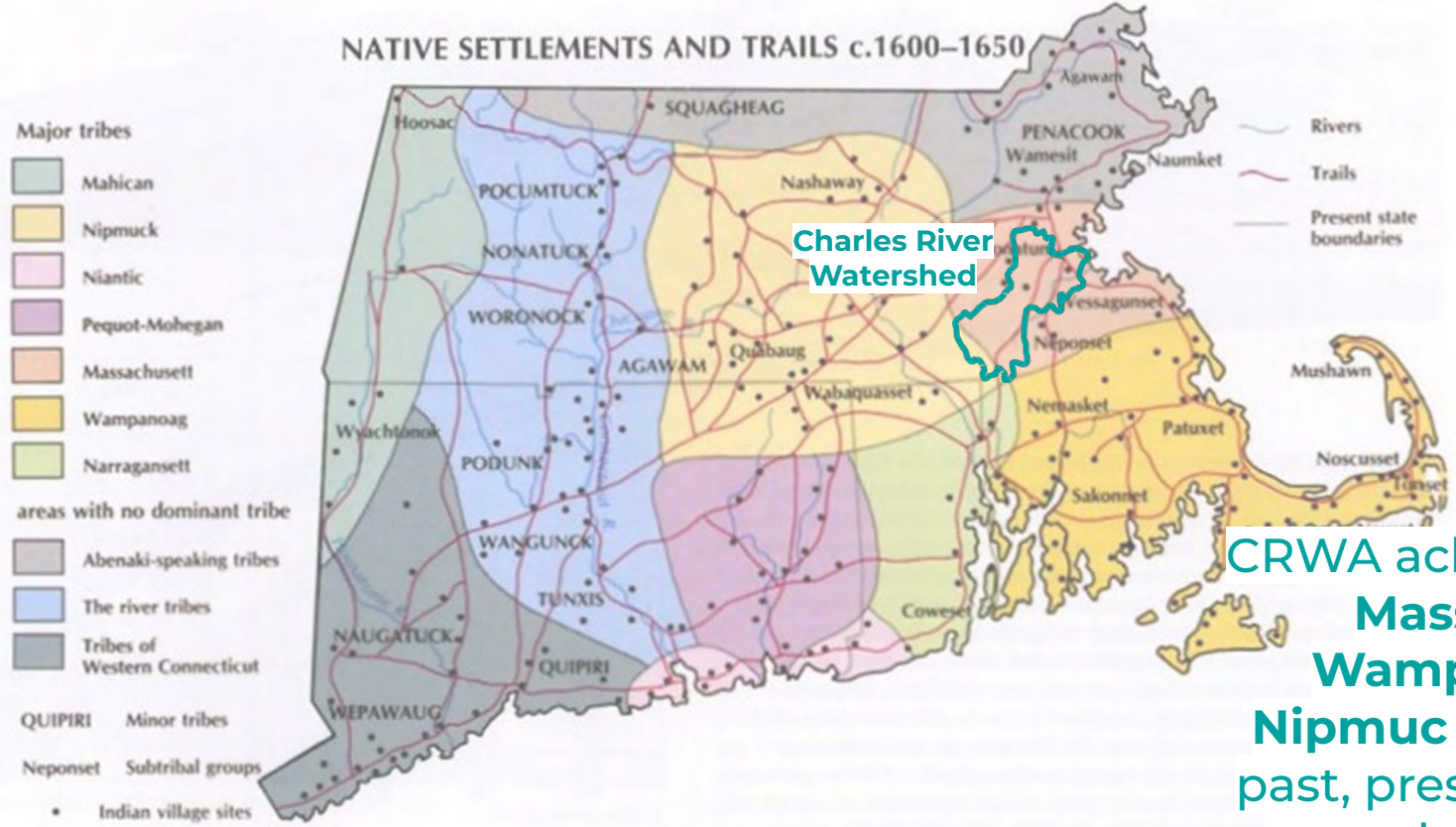
Charles River Watershed Association

12:00 - 12:10	Introduction
12:10 - 12:25	Mill River Restoration
12:25 - 12:40	Merrimack Village Dam
12:40 - 12:45	CRWA Initiatives
12:45 - 1:00	Questions* & Answers

*Please type your questions in the Chat, and we will go through them at the end!

Land Acknowledgement

Charles River Watershed Association



CRWA acknowledges the **Massachusett, Wampanoag, and Nipmuc Nations** as the past, present, and future caretakers of this land

Charles River Watershed Association

We protect, restore, and enhance the Charles River and its watershed through **science, advocacy, and the law.**

We develop science-based strategies to **increase resilience, protect public health, and promote environmental equity** as we confront a changing climate.

Program Areas:

- Climate Resilience
- River Science
- **River Restoration**
- Stormwater Solutions
- Education & Outreach





Speakers

Charles River Watershed Association

Alison Bowden

The Nature Conservancy

Noah Snyder

Boston College

Mill River Restoration

Charles River Watershed Association

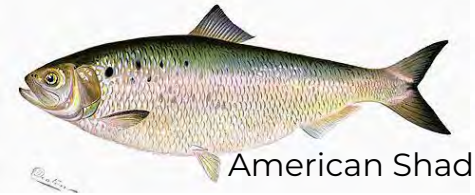
Merrimack Village Dam Removal

Charles River Watershed Association

CRWA Dam Removal Initiatives

Charles River Watershed Association


American Eel


American Shad


Rainbow Smelt


Blueback Herring


Alewife

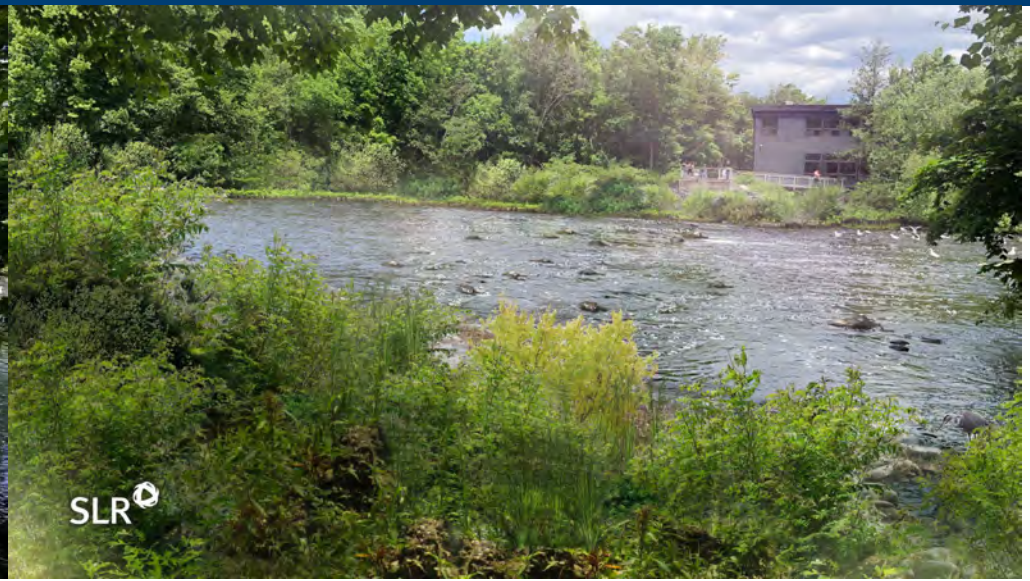
Watertown Dam

South Natick Dam

Wrentham Eagle Dam

Watertown Dam

Charles River Watershed Association



Sign up to count herring!
crwa.org/fish-count

South Natick Dam

Charles River Watershed Association

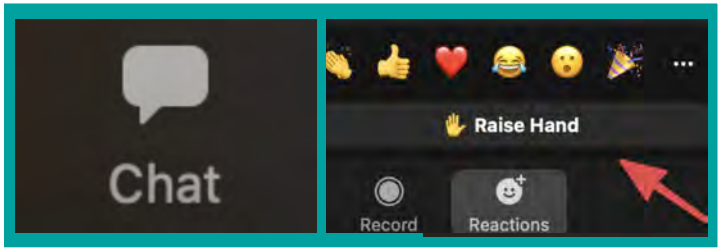
Eagle Dam

Charles River Watershed Association

Photo No. 12.: Downstream slope from near Sta. 0+80 looking right.

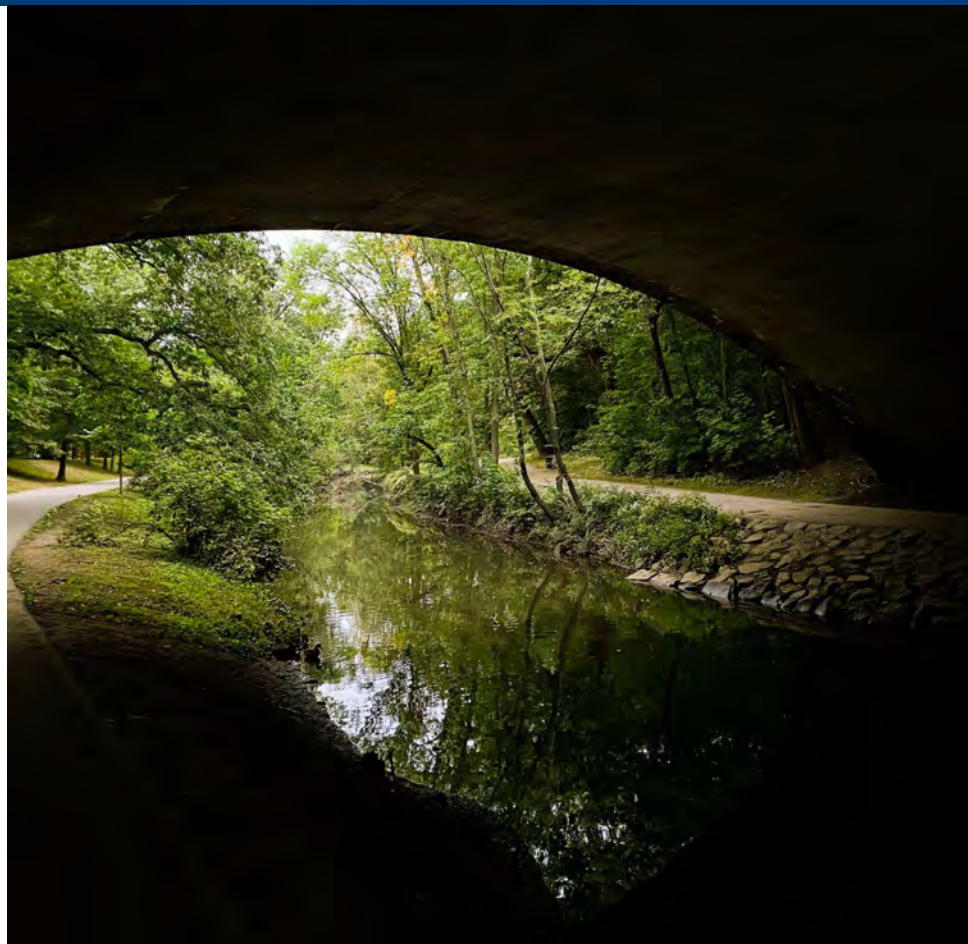
Question & Answer

Charles River Watershed Association



Please submit questions through the chat, or raise your hand!

LEARN MORE >
crwa.org/dam-removal



Stay Connected!

Charles River Watershed Association

Email
charles@crwa.org

River Current Newsletter
crwa.org/river-current

Robert Kearns, CRWA
rkearns@crwa.org

Lisa Kumpf, CRWA
lkumpf@crwa.org

The Nature Conservancy

Multiple Benefits of Restoring the Mill River

Alison Bowden

May 1, 2023

A WORLD WHERE PEOPLE AND NATURE THRIVE

There are two paths forward for our world. The choices we make today will define the legacy we leave behind for future generations.

©Nathan Lane Calver

© Ken Geiger

© Kevin Arnold

© Karine Aigner

© Tim

The Nature Conservancy's 2030 Goals

Our ambitious plan to secure a thriving planet – for people and nature

TACKLING CARBON EMISSIONS **3Gt** CO_2e AVOIDED OR SEQUESTERED

HELPING PEOPLE ON THE FRONT LINES OF THE CLIMATE CRISIS **100M** PEOPLE BENEFITTED

DEEPENING SOLUTIONS FOR OUR OCEAN **4B** HECTARES CONSERVED

SAVING HEALTHY LANDS FOR A HEALTHIER PLANET **650M** HECTARES CONSERVED

CONSERVING THE WORLD'S FRESHWATER **1M** KM OF RIVERS CONSERVED

30M HA OF LAKES AND WETLANDS CONSERVED

WORKING ALONGSIDE LOCAL LEADERS LIGHTING THE WAY **45M** PEOPLE SUPPORTED

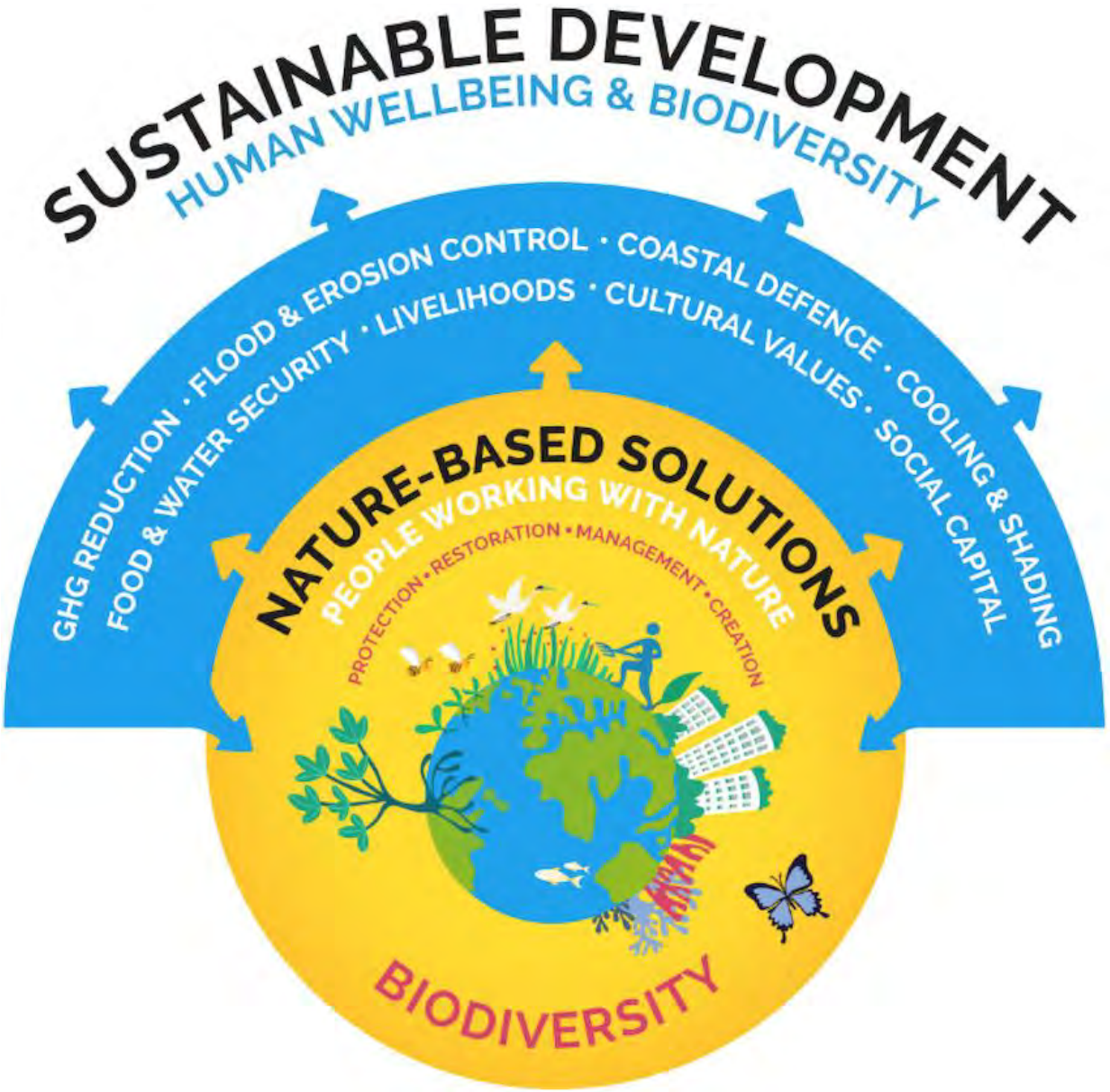
NATURE GOALS IN CONTEXT

We will eliminate carbon dioxide emissions equal to taking **650 million cars off the road every year**

We will conserve more than **10% of the world's ocean area**

We will conserve a **land area twice the size of India**

We will conserve enough **river length alone to stretch across the globe 25 times**



Global Change Biology, First published: 01 February 2021, DOI: (10.1111/gcb.15513)


EARTHSAT

CBS NEWS NEWS SHOWS VIDEO CBSN MORE

By GINA PACE | CBS/AP | October 18, 2005, 11:13 AM

Massachusetts Town Fears Dam Break

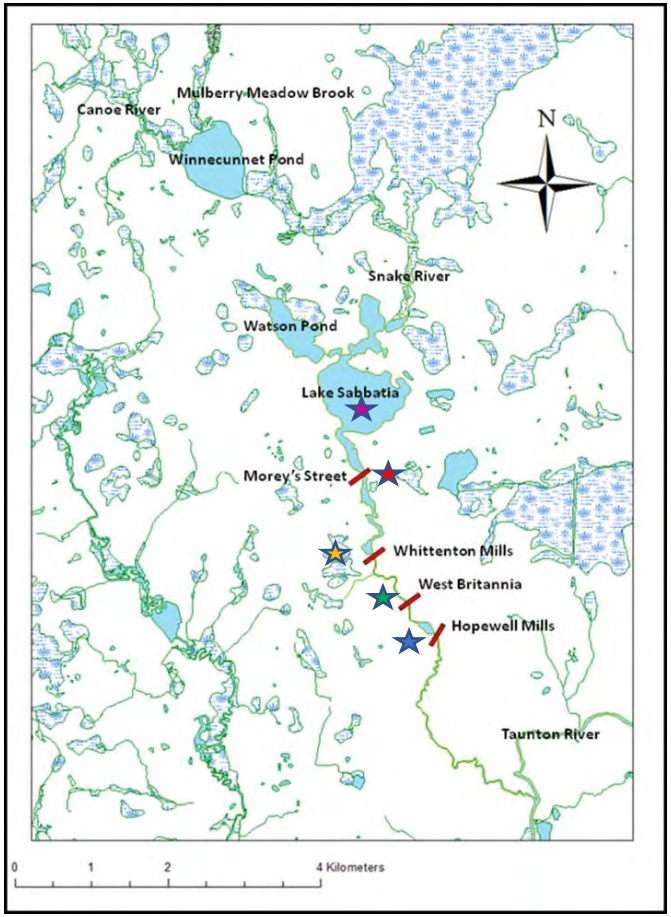
State officials along with Taunton Emergency Management Agency personnel inspect the Whittenton Pond Dam on the Mill River in Taunton, Mass., Monday, Oct. 17, 2005. / AP PHOTO

Share / Tweet / Reddit / Flipboard / Email

"Since it is badly polluted by manufacturing wastes and obstructed by dams, the re-establishment of the old [Mill River] fishery is an impossibility."

-D. Belding, 1921

Mill River Restoration, Taunton Massachusetts, USA



NBS increase safety

Whittenton Dam Removal

Taunton, MA

Costs

- Estimated Cost of Dam Repair = $1.9 Million
- Ongoing Cost of Dam maintenance = variable
- 2005 Evacuation Costs = $1.5 Million
- Dam Removal Costs = $440,000

Benefits

- Reduced risk of residential & commercial flooding
- Increased revenue from river based recreation
- Avoided costs of future evacuation and/or repair
- Increased property values
- Water quality benefits

Enhanced Safety

Avoided Costs

Taunton Emergency Management Agency

January 10 ·

History is Made Today

Earlier this morning, workers removed the main structure of the Reed and Barton dam. This dam was the last dam to be removed within the last twelve years on the Mill River. Congratulations to the many state and federal agencies who participated in this very important project. Today, Taunton becomes a safer city as a result of this dam's removal and the outstanding efforts made to mitigate the risk of flooding in the city. Thank you, Nick Nelson, for the photo.


FPS: 30.60 4/11/2013 10:17:34 AM

Canoe River, October 2014

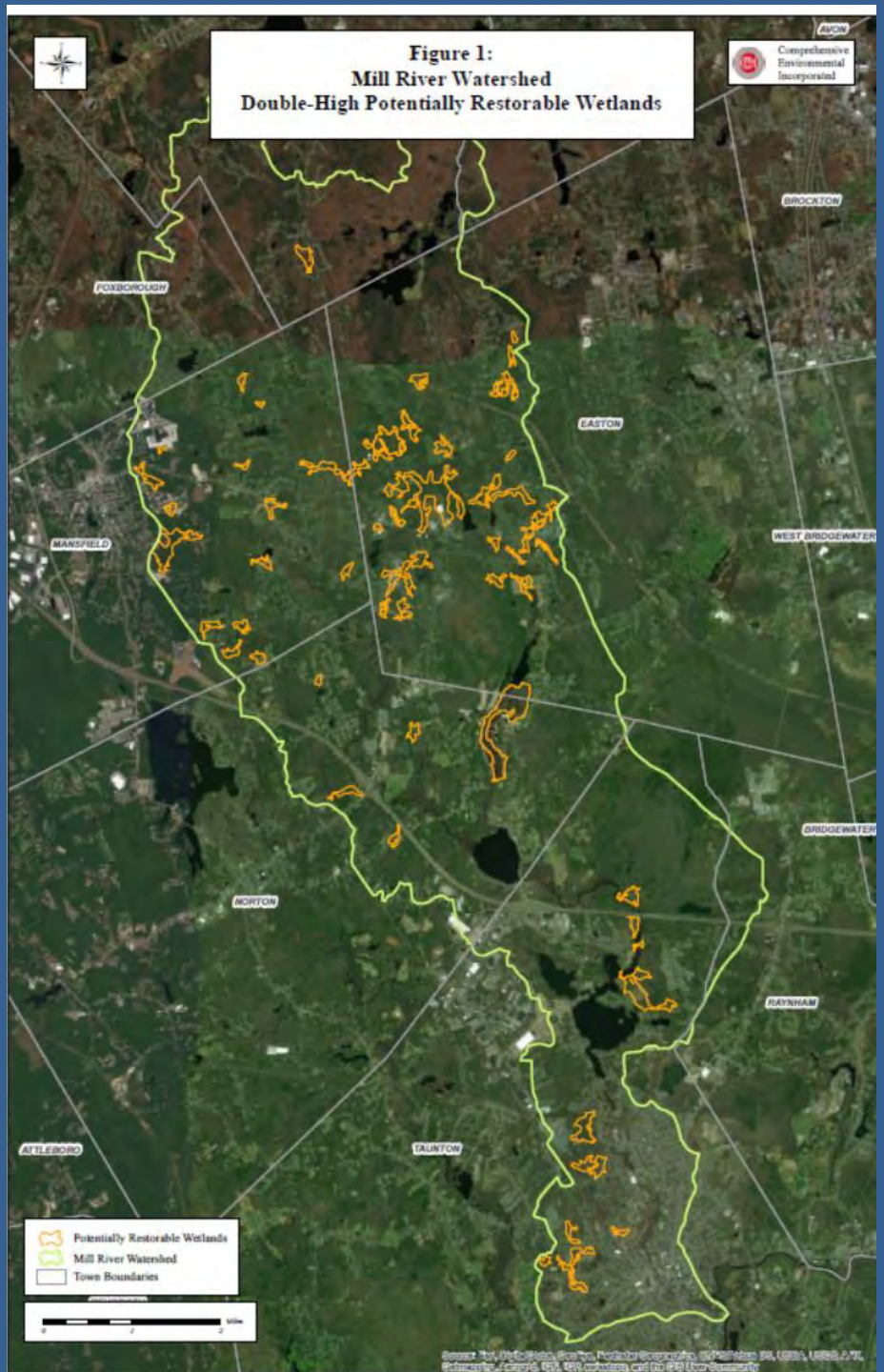


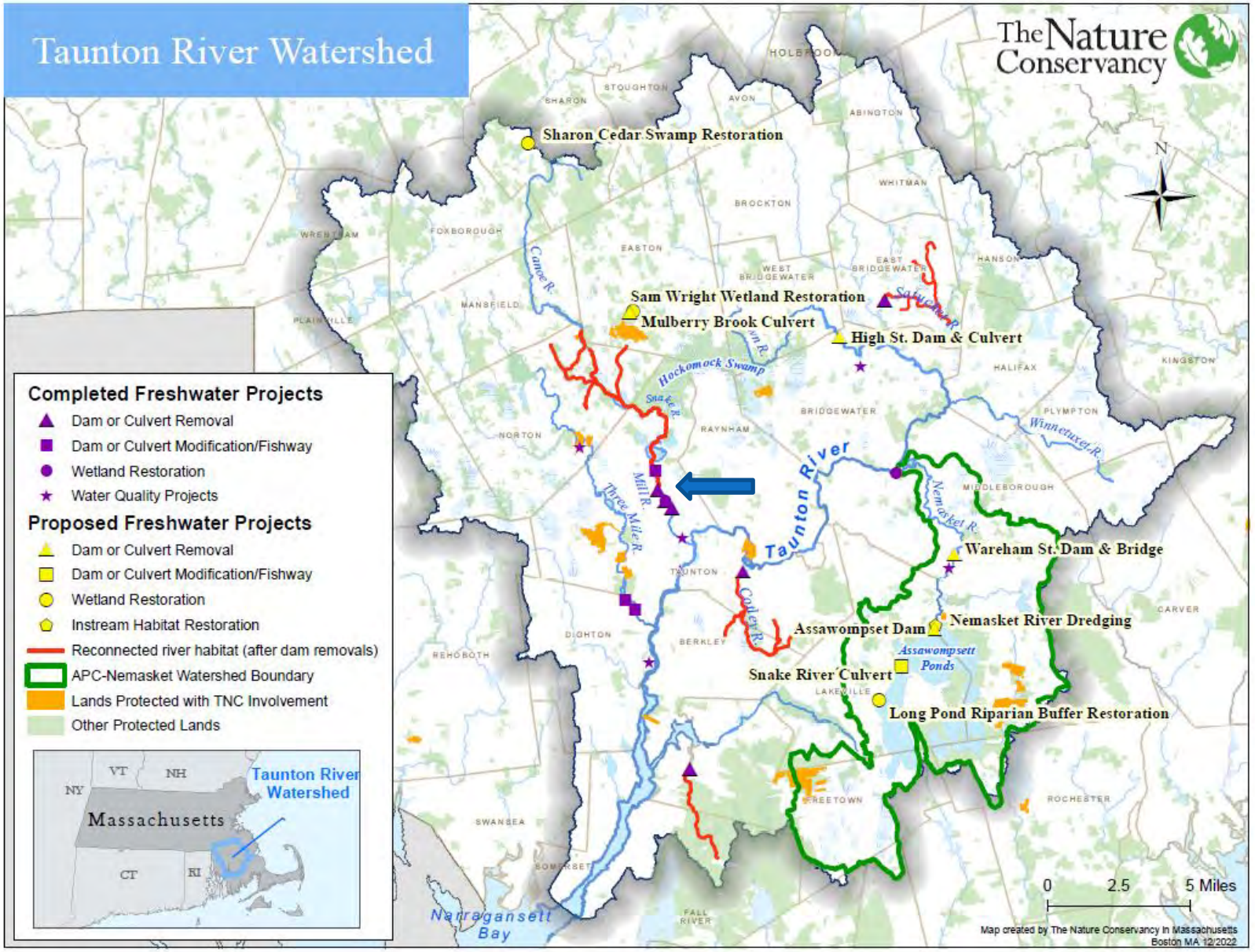
Figure 1:
Mill River Watershed
Double-High Potentially Restorable Wetlands
Comprehensive Environmental Incorporated
AVON
BROCKTON
FOXBOROUGH
EASTON
MANSFIELD
WEST BRIDGEWATER
BRIDGEWATER
NORTON
RAYNHAM
ATTLEBORO
TAUNTON
Potentially Restorable Wetlands
Mill River Watershed
Town Boundaries


DANGER
ROAD
CLOSED
BRIDGE CLOSED
AHEAD
LOCAL TRAFFIC ONLY

Resilient Taunton Watershed Network

– *Working together for a better future*

MA Municipal Climate Vulnerability and Preparedness Program

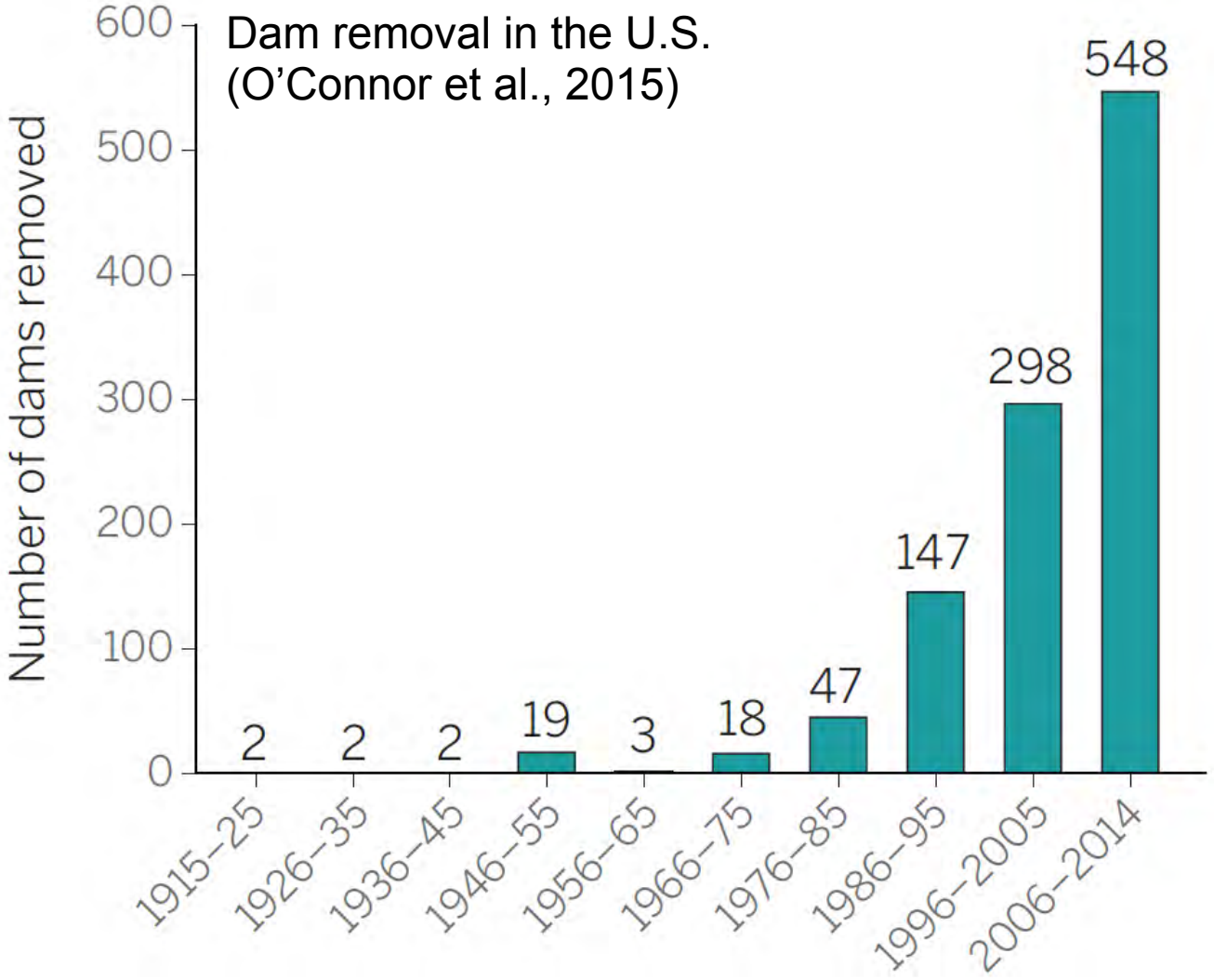

Taunton River Watershed
The Nature Conservancy
Sharon Cedar Swamp Restoration
Sam Wright Wetland Restoration
Mulberry Brook Culvert
High St. Dam & Culvert
Wareham St. Dam & Bridge
Assawompset Dam
Nemasket River Dredging
Assawompset Ponds
Snake River Culvert
Long Pond Riparian Buffer Restoration
Taunton River
Hockomock Swamp
Cedar R.
Snake R.
Mill R.
Three Mile R.
Cole R.
Nemasket R.
Winnetuxet R.
Satucket R.
Lun R.
Narragansett Bay
HOLBROOK
STOUGHTON
SHARON
AVON
ABINGTON
WHITMAN
BROCKTON
FOXBOROUGH
WRENTHAM
EASTON
WEST BRIDGEWATER
EAST BRIDGEWATER
HANSON
MANSFIELD
PLAINVILLE
HALIFAX
KINGSTON
BRIDGEWATER
PLYMPTON
NORTON
RAYNHAM
MIDDLEBOROUGH
TAUNTON
CARVER
DIGHTON
BERKLEY
REHOBOTH
LAKEVILLE
FREETOWN
ROCHESTER
SWANSEA
SOMERSET
FALL RIVER
N
0
2.5
5 Miles
Completed Freshwater Projects
Dam or Culvert Removal
Dam or Culvert Modification/Fishway
Wetland Restoration
Water Quality Projects
Proposed Freshwater Projects
Dam or Culvert Removal
Dam or Culvert Modification/Fishway
Wetland Restoration
Instream Habitat Restoration
Reconnected river habitat (after dam removals)
APC-Nemasket Watershed Boundary
Lands Protected with TNC Involvement
Other Protected Lands
VT
NH
NY
Massachusetts
CT
RI
Taunton River Watershed
Map created by The Nature Conservancy in Massachusetts
Boston MA 12/2022

Merrimack Village Dam Removal (2008)

Noah Snyder (noah.snyder@bc.edu)
Boston College
Earth and Environmental Sciences Department

Some motivations for dam removal

- Public safety
- Owner liability
- Maintenance expense
- Stream restoration
- Fish passage
- Research opportunity: river response to a change in sediment load



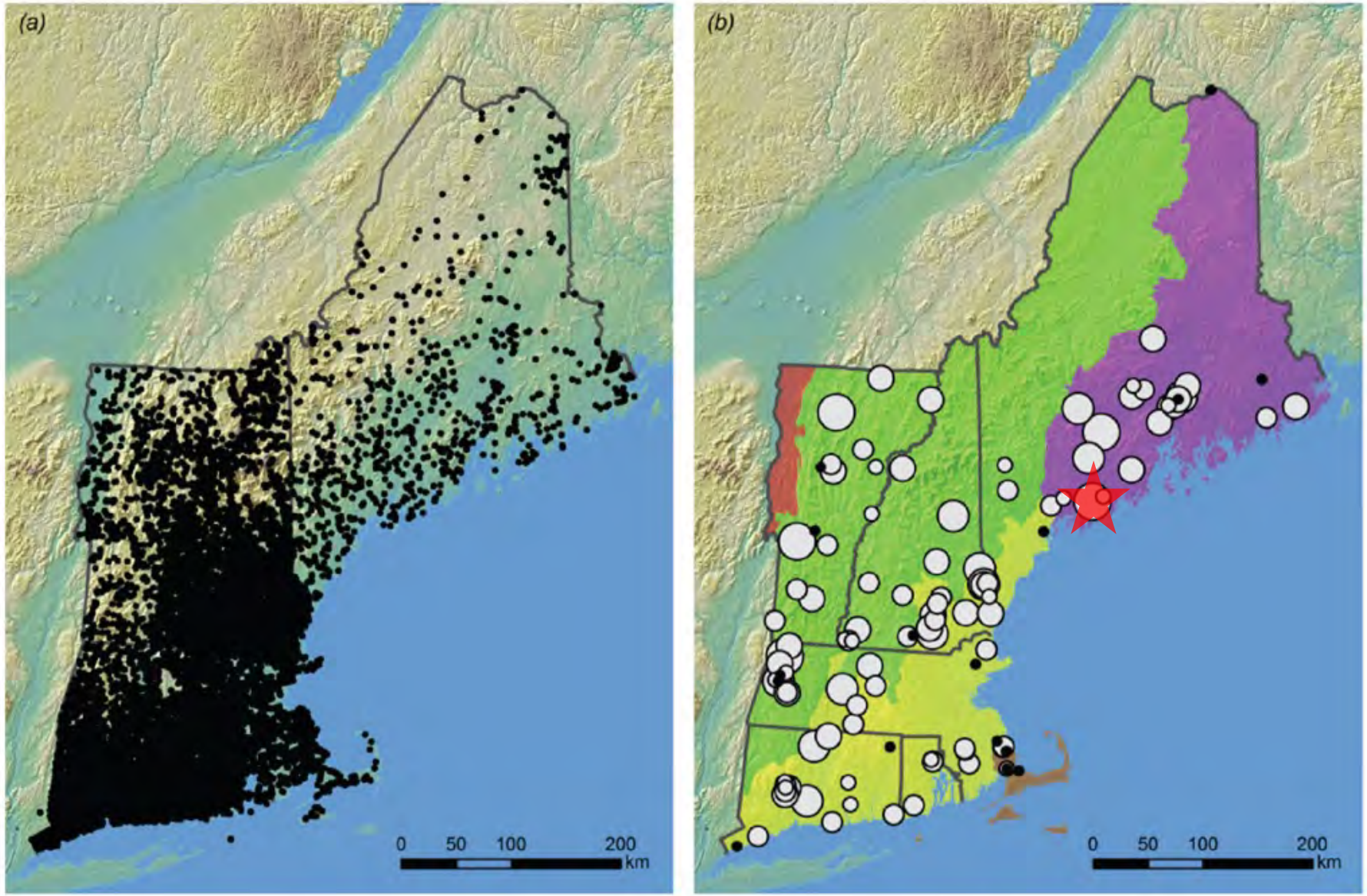


Figure 1

Location map of existing and removed dams.

(A) All dams in New England, (B) Removed dams mapped by height and ecoregion.

doi: 10.12952/journal.elementa.000108.f001

(Magilligan et al., 2016)

ELEMENTA
Science of the Anthropocene

River restoration by dam removal: Enhancing connectivity at watershed scales

F.J. Magilligan[1*] • B.E. Graber[2] • K.H. Nislow[3] • J.W. Chipman[1] • C.S. Sneddon[4] • C.A. Fox[4]

[1]Department of Geography, Dartmouth College, Hanover, New Hampshire, United States
[2]American Rivers, Northampton, Massachusetts, United States
[3]USDA Forest Service, Northern Research Station, Amherst, Massachusetts, United States
[4]Department of Geography and Department of Environmental Studies, Dartmouth College, Hanover, New Hampshire, United States
*magilligan@dartmouth.edu

Edwards Dam removal, Kennebec River, Augusta, Maine, July 1999 (NRCM)

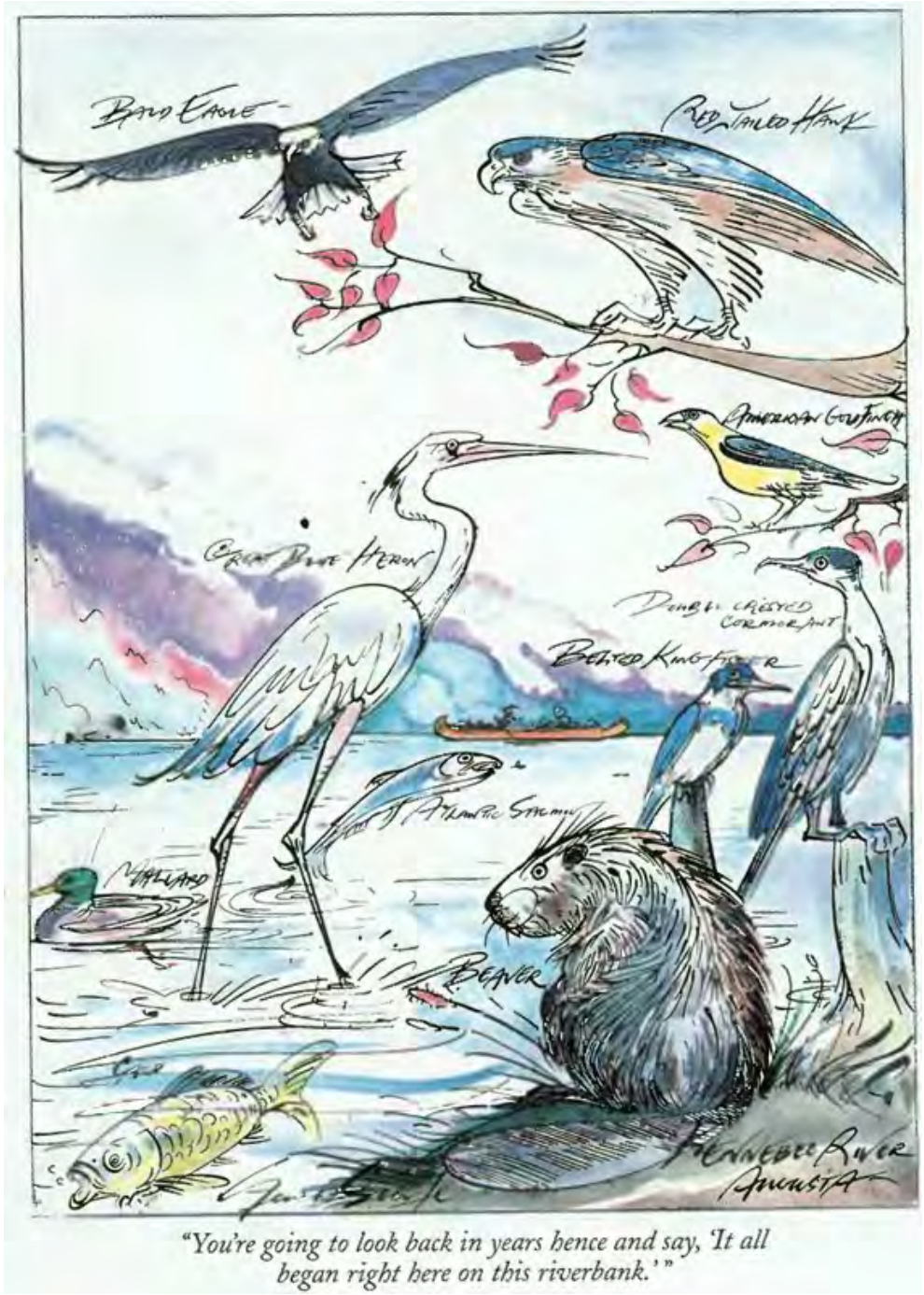
Price $3.00 THE NEW YORKER Sept. 27, 1999

THE CONTROL OF NATURE

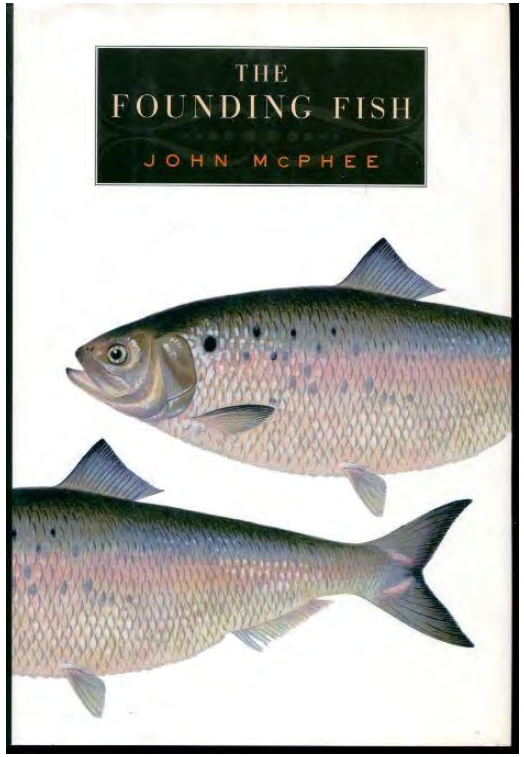
FAREWELL TO THE NINETEENTH CENTURY

The breaching of Edwards Dam.

BY JOHN McPHEE



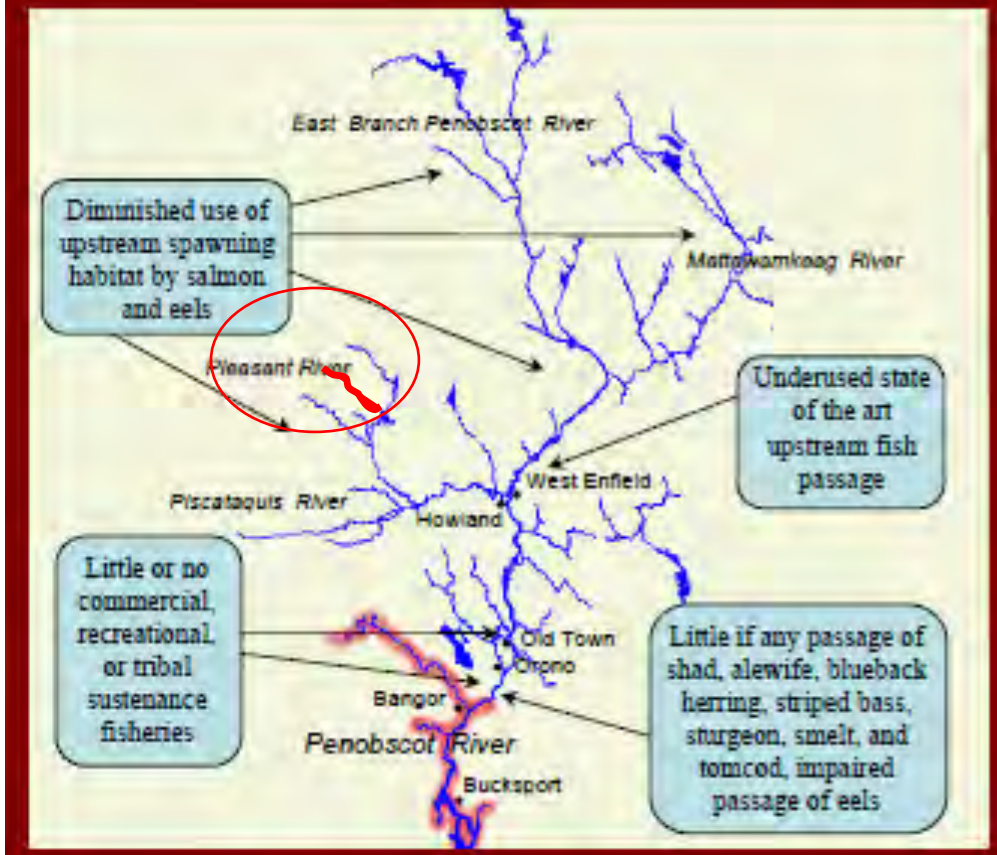
"You're going to look back in years hence and say, 'It all began right here on this riverbank.'"

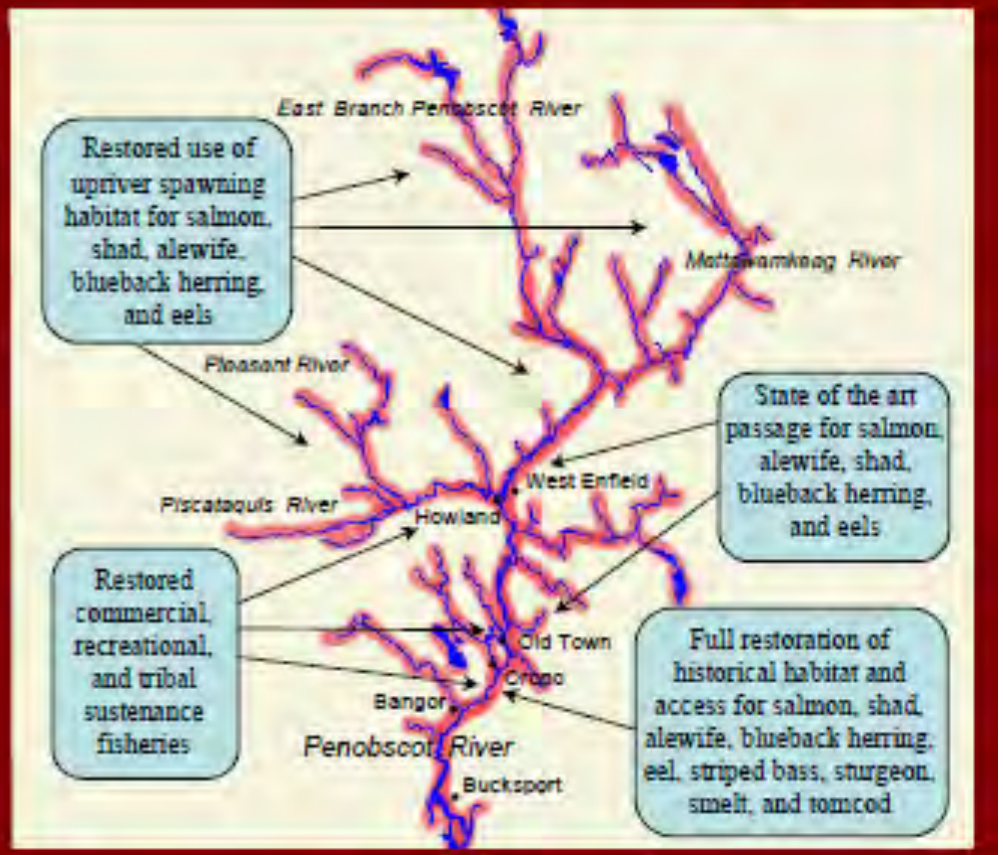


From Friends of the Kennebec Salmon: “On 10 June 2004 we observed a large number blueback herring, a native sea-run fish of the Kennebec River, spawning in Messalonskee Stream in Waterville, Maine. To our knowledge, this is the first documentation of these fish spawning in Messalonskee in nearly two centuries.”

Penobscot River Restoration Project

Before and After Habitat Access





Existing Access for Sea-Run Fish

Significantly Improved Access for Sea-Run Fish to Nearly 1,000 Miles

Source: PRRT/penobscotriver.org

PENOBSCOT RIVER RESTORATION PROJECT

Penobscot River Restoration Accomplishment - Great Works Dam Site

Before and after photos

June 11, 2012

September 7, 2012

Photos by: Monty Rand/Gyro Geo

Partners in the Penobscot River Restoration Project include the Penobscot River Restoration Trust, the Penobscot Indian Nation, American Rivers, Atlantic Salmon Federation, Maine Audubon, Natural Resources Council of Maine, The Nature Conservancy and Trout Unlimited, working with the U.S. Department of Interior, US. Department of Commerce, the State of Maine, PPL Corporation and Black Bear Hydro.

Veazie Dam, Penobscot River, Maine (July 2013)

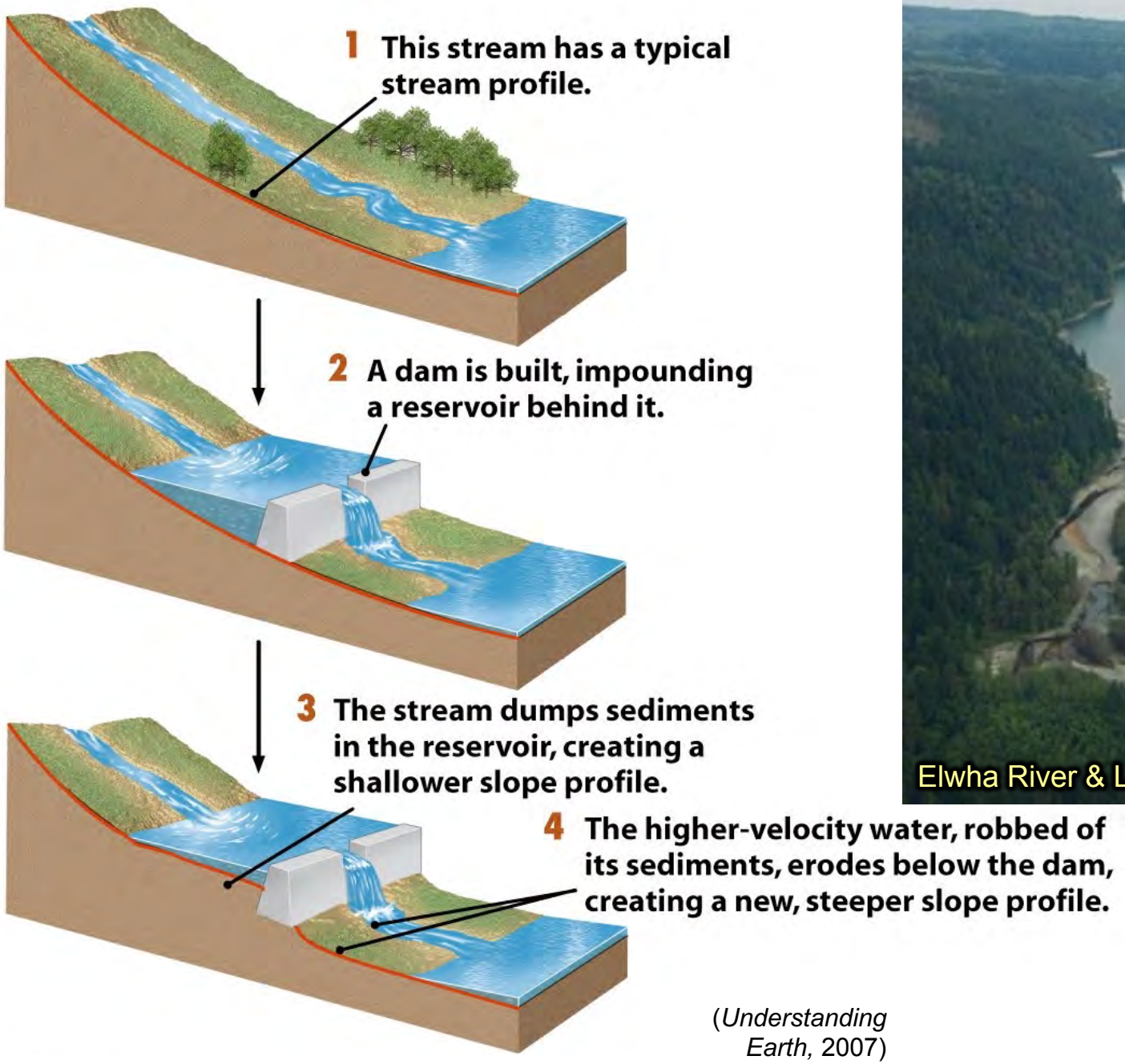
Breaching of dam, restoring salmon's passage unite many

The Boston Globe

By Alyssa Botelho | GLOBE CORRESPONDENT JULY 23, 2013

JESSICA RINALDI FOR THE GLOBE

Joseph Dana watched from a traditional handmade birch canoe on the Penobscot as the Veazie Dam was breached.



(*Understanding Earth*, 2007)


Elwha River & Lake Aldwell, Washington

(Foley et al., 2017, *WRR*)

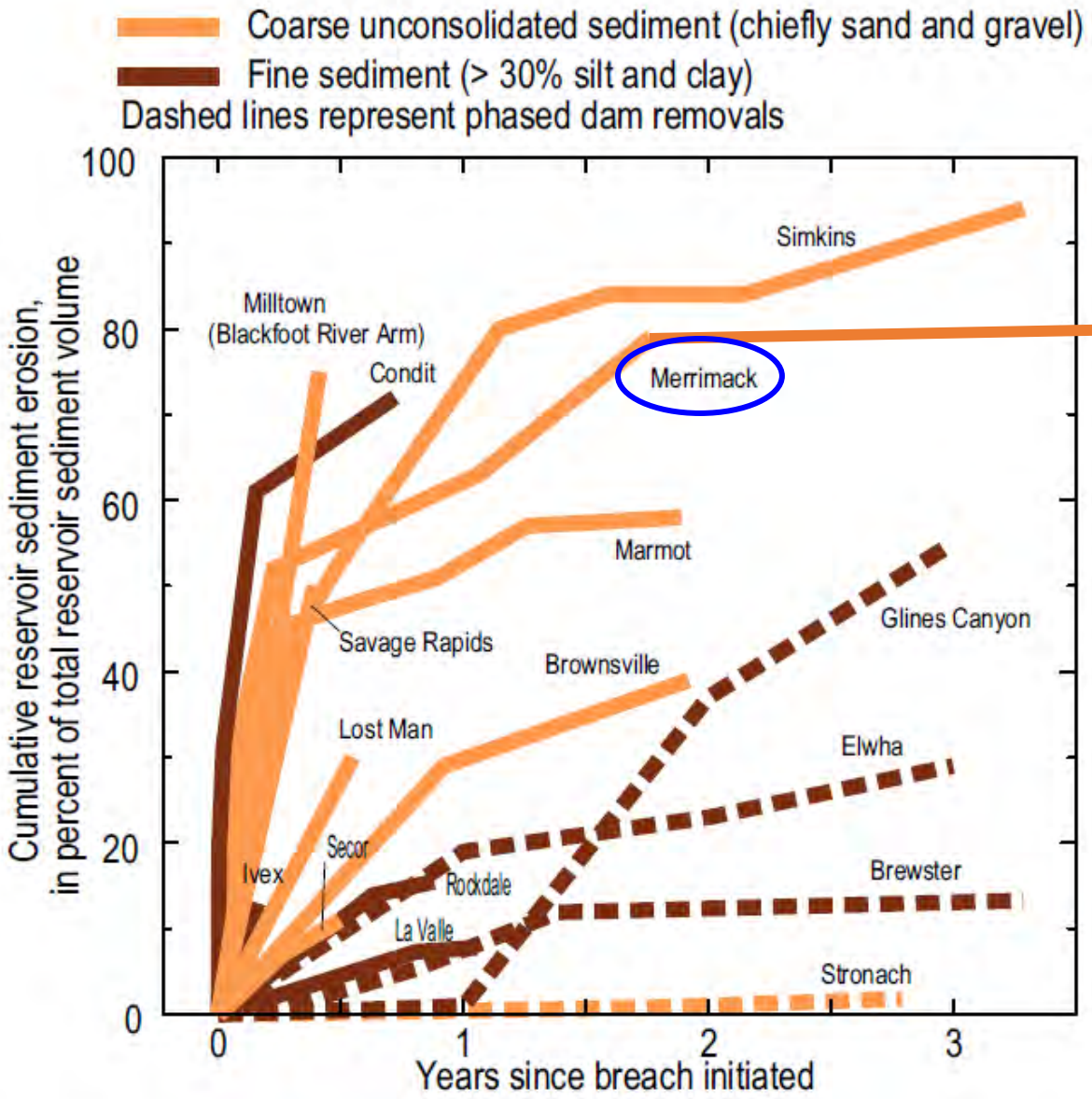


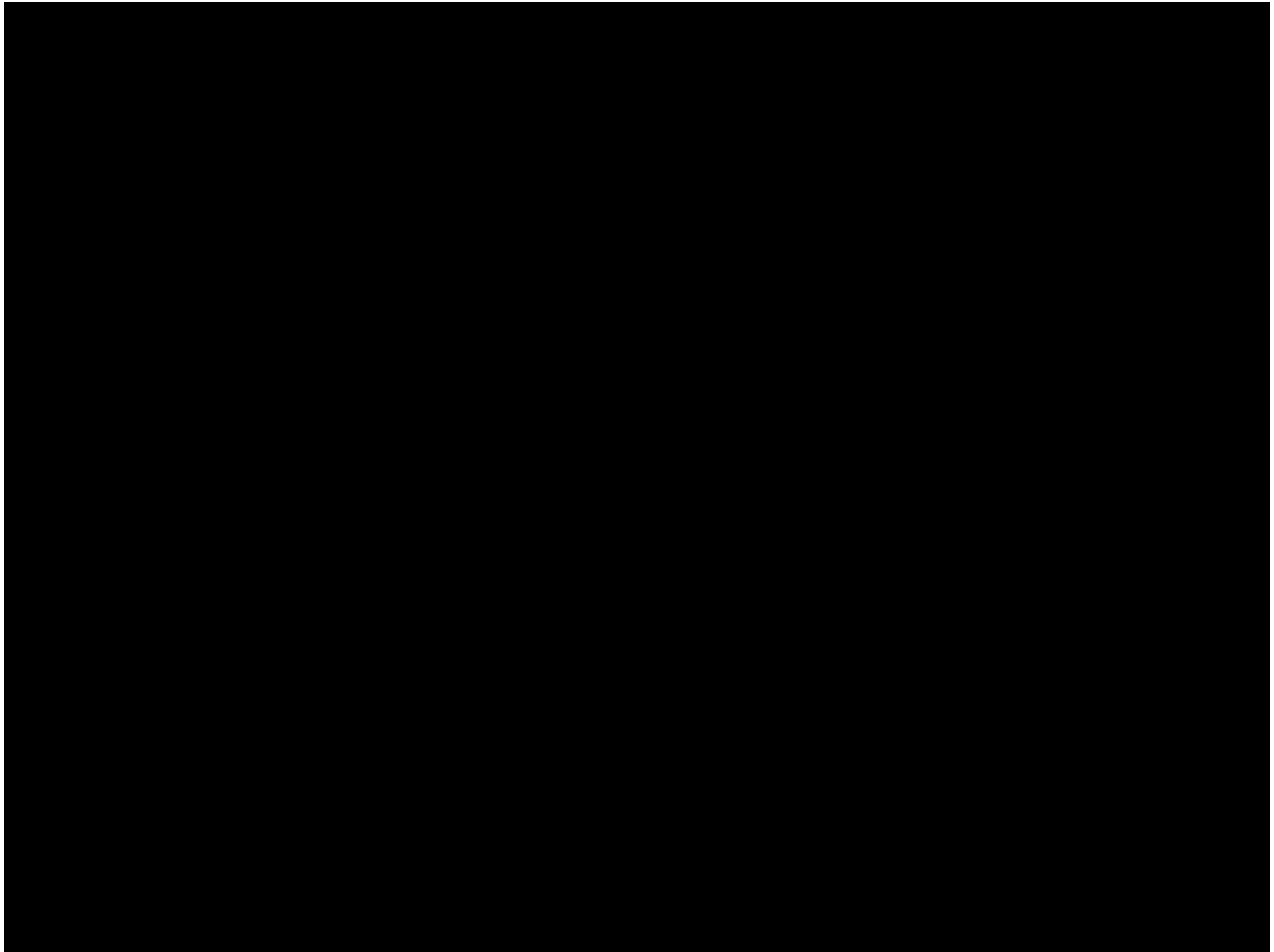
Figure 3. Percentage of reservoir sediment eroded with time after dam removal. Modified from *Major et al.* [2017], *Sawaske and Freyberg* [2012], and *Grant and Lewis* [2015].

Merrimack Village Dam, Souhegan River, NH

- First dam built in ca. 1734, likely multiple breaches over the next ~2 centuries
- Modern concrete structure built on top of an existing dam in 1907, spray skirt added in 1934
- Stored ~62000 m^3 of sediment (Gomez and Sullivan Engineers, 2006) in the reservoir
- Removed in August 2008, 3.9 m base-level drop
- We conducted 10 repeat surveys from 2007 to 2018

More: Pearson et al., *WRR*, 2011; Conlon, BC MS thesis, 2013; Santaniello et al, GSA book chapter, 2013; Collins et al., *WRR*, 2017; Lisius et al., *RRA*, 2018

Merrimack Village Dam removal: June 2008 – March 2009, Souhegan River, NH




amazonstudent


April 1947


May 2005
100
m


April 2010
100
m

Aerial video of the former MVD impoundment, Souhegan River, June 2018


Upstream from MVD03, April 2008


Upstream from MVD03, October 2008

sediment budget:
input from Souhegan River = ΔUS storage + ΔDS storage + output to Merrimack River

ΔDS

output

Merrimack River

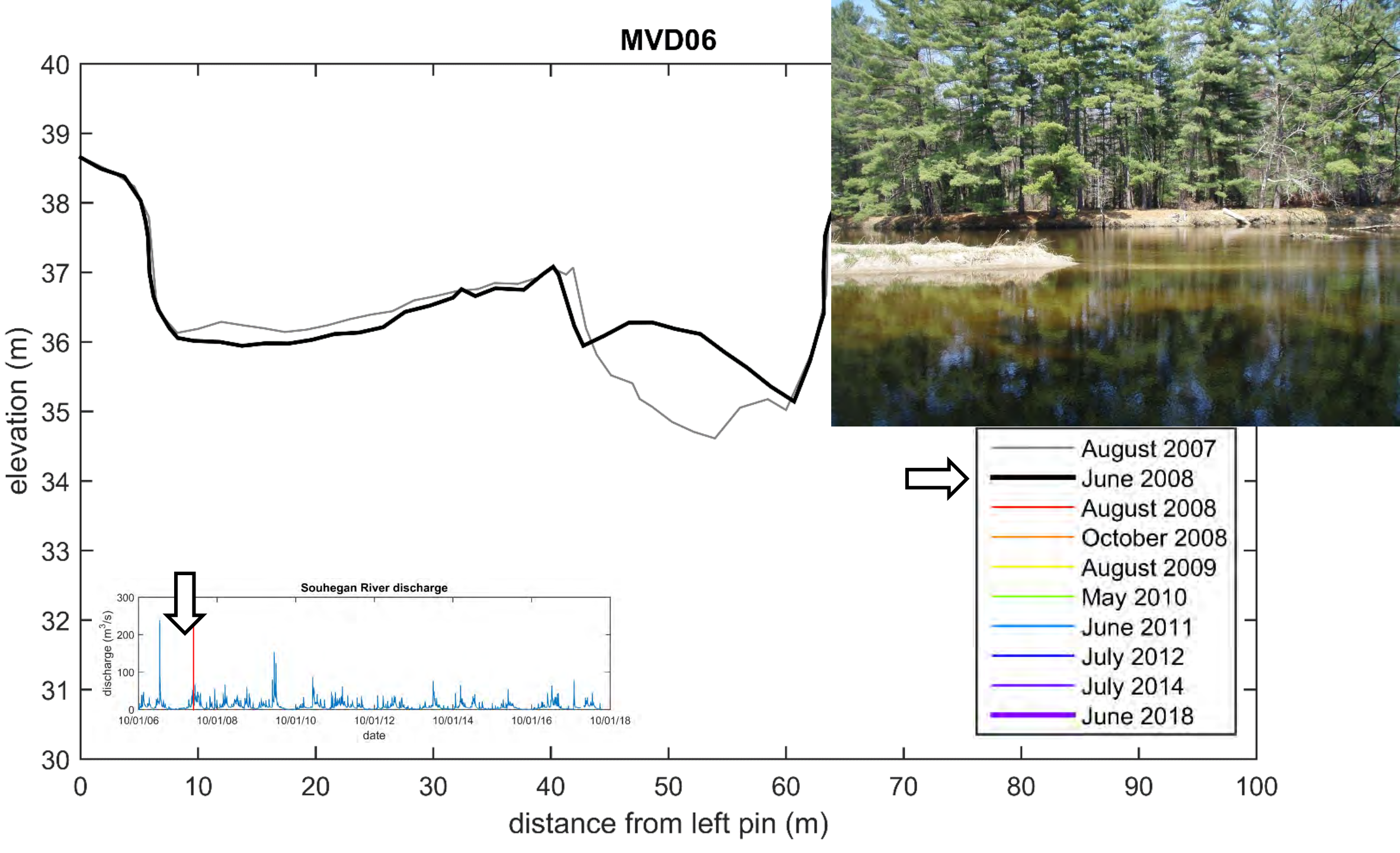
MVD06

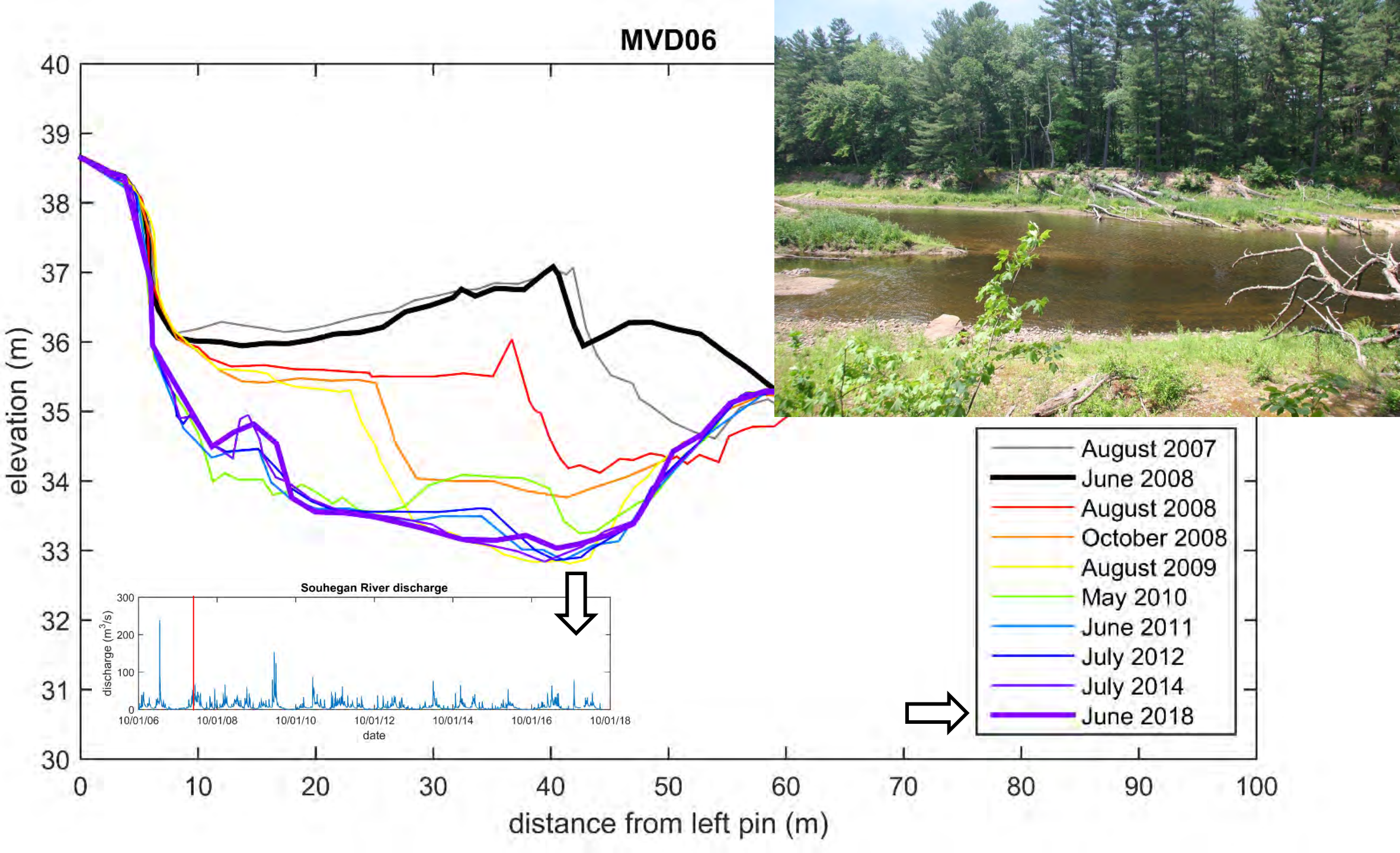
ΔUS

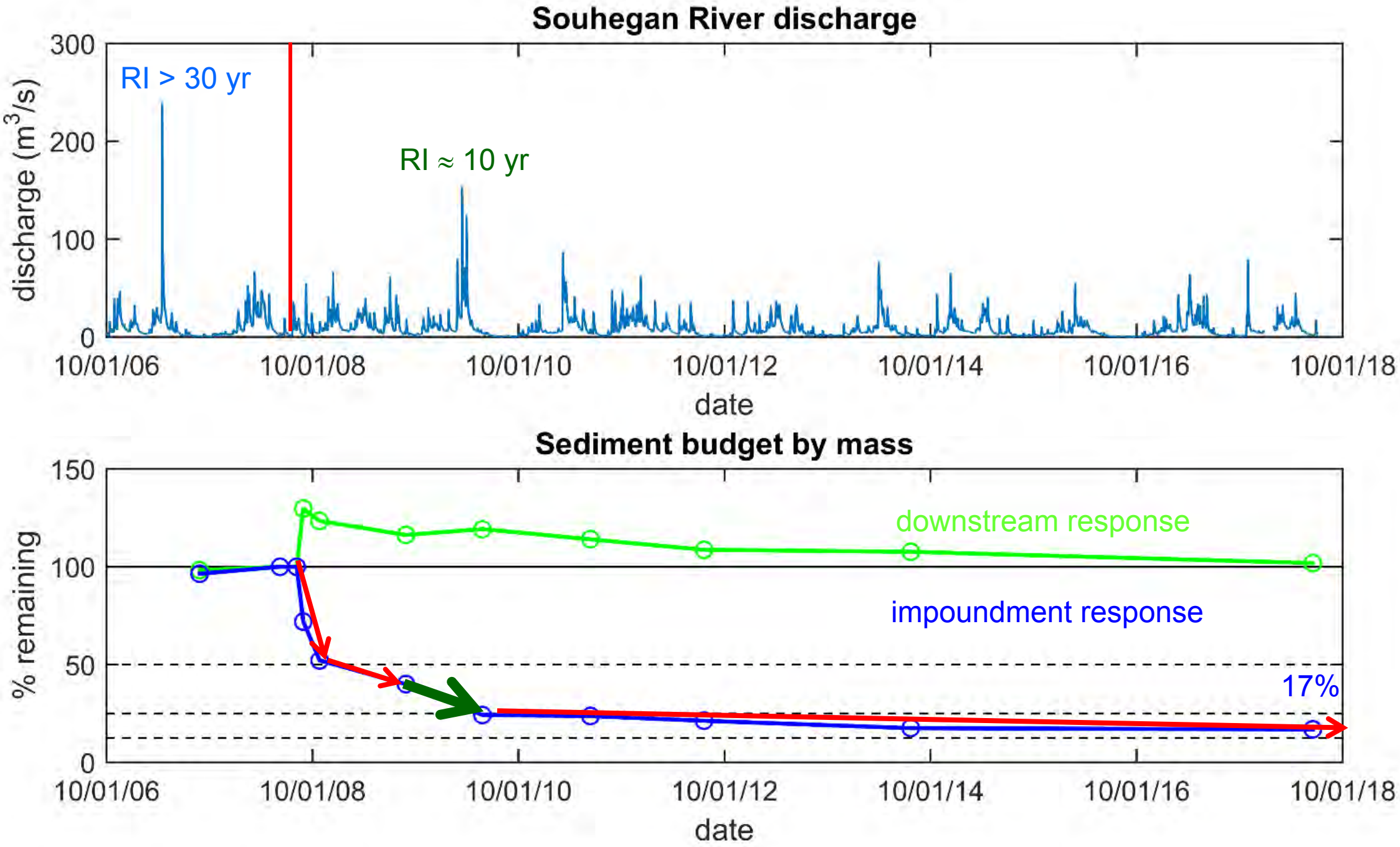
input

100 m

April 2010 (NH GRANIT)

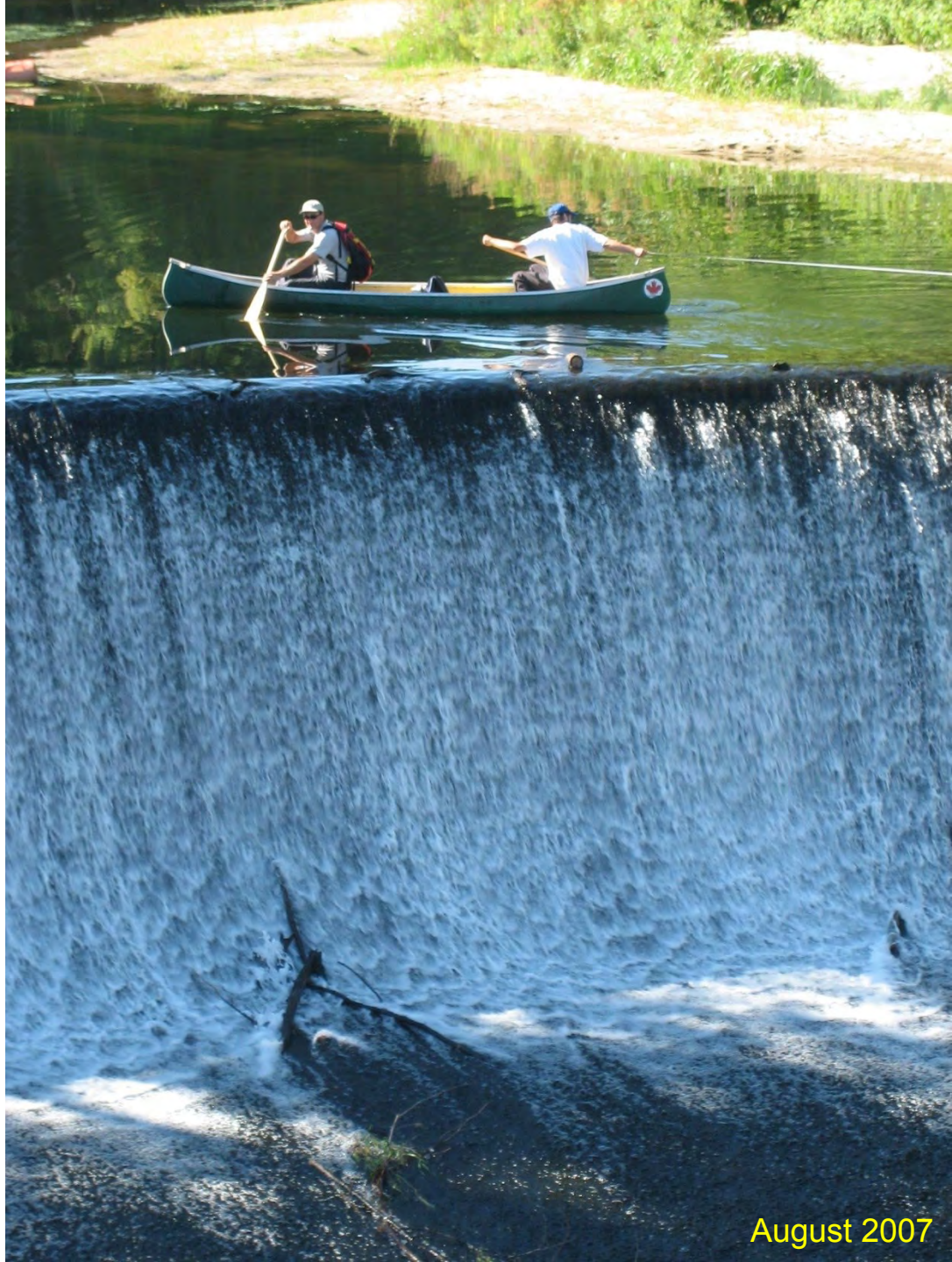

MVD06
elevation (m)
distance from left pin (m)
40
39
38
37
36
35
34
33
32
31
30
0
10
20
30
40
50
60
70
80
90
100
August 2007
June 2008
August 2008
October 2008
August 2009
May 2010
June 2011
July 2012
July 2014
June 2018
Souhegan River discharge
discharge (m3/s)
300
200
100
0
10/01/06
10/01/08
10/01/10
10/01/12
10/01/14
10/01/16
10/01/18
date


MVD06
elevation (m)
distance from left pin (m)
August 2007
June 2008
August 2008
October 2008
August 2009
May 2010
June 2011
July 2012
July 2014
June 2018
Souhegan River discharge
discharge (m3/s)
date

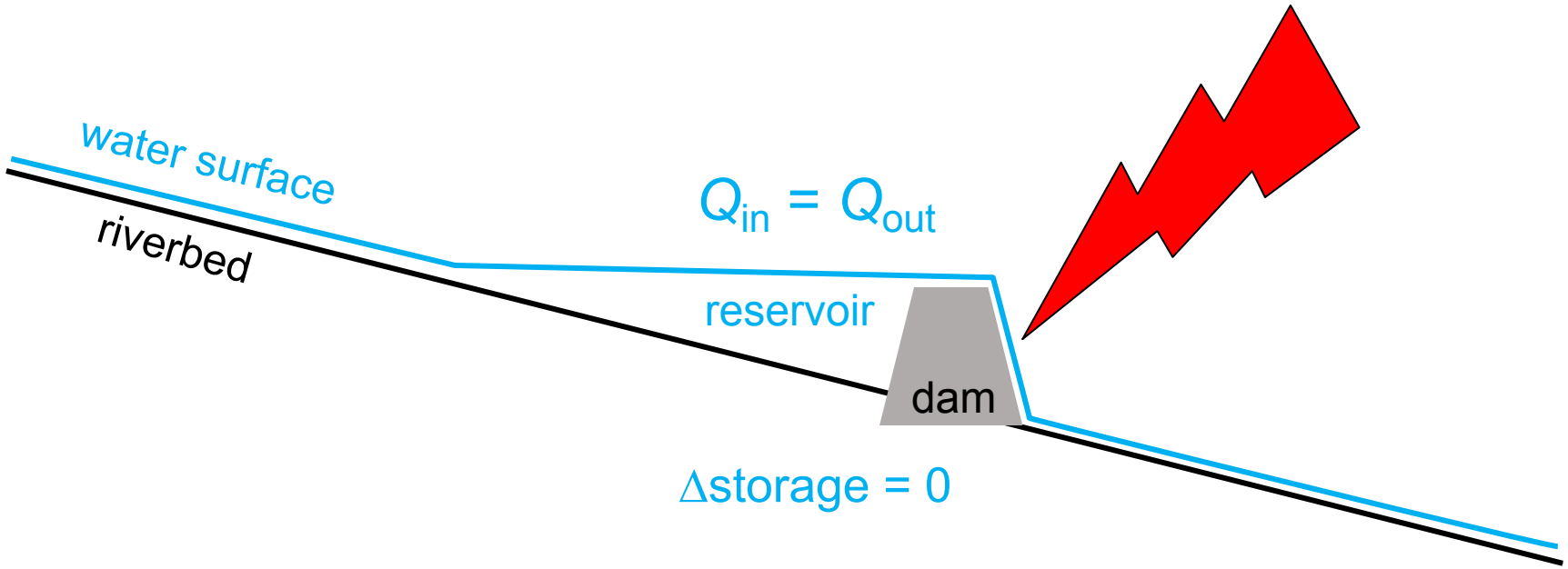

Souhegan River discharge
RI > 30 yr
RI ≈ 10 yr
discharge (m3/s)
300
200
100
0
10/01/06
10/01/08
10/01/10
10/01/12
10/01/14
10/01/16
10/01/18
date
Sediment budget by mass
% remaining
150
100
50
0
downstream response
impoundment response
17%
10/01/06
10/01/08
10/01/10
10/01/12
10/01/14
10/01/16
10/01/18
date

Lessons from the MVD removal

- Two-phase response: initial rapid incision and widening in the channel (months); longer ongoing response driven by flood events, as well as feedbacks with vegetation, floodplain development
- Reservoirs can be sediment sources during flood events, while overbank deposition occurs on adjacent surfaces inundated frequently due to raised base level (April 2007 flood on the Souhegan River at MVD)
- Legacy sediment, stored outside of the former reservoir, extends the event-driven phase, and remains in valley bottoms for decades to centuries, even after dam removal (Johnson et al., 2019; Dow et al., 2020)



Run-of-the-river dams



Examples:

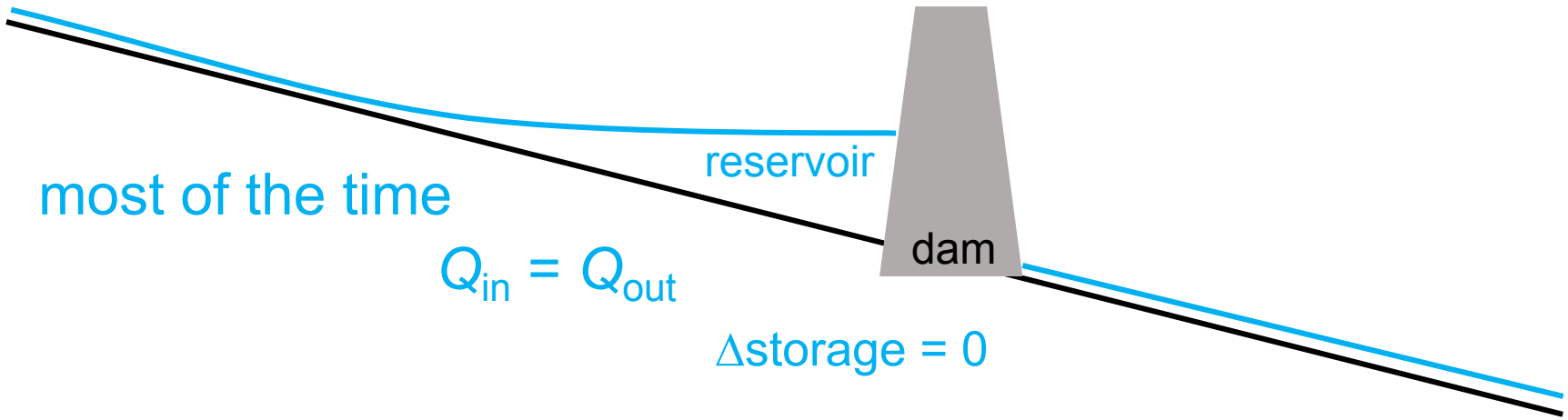
- small dams
- some water supply
- hydropower
- most dams in New England

Jerrey Roberts, Daily Hampshire Gazette, March 19, 2018

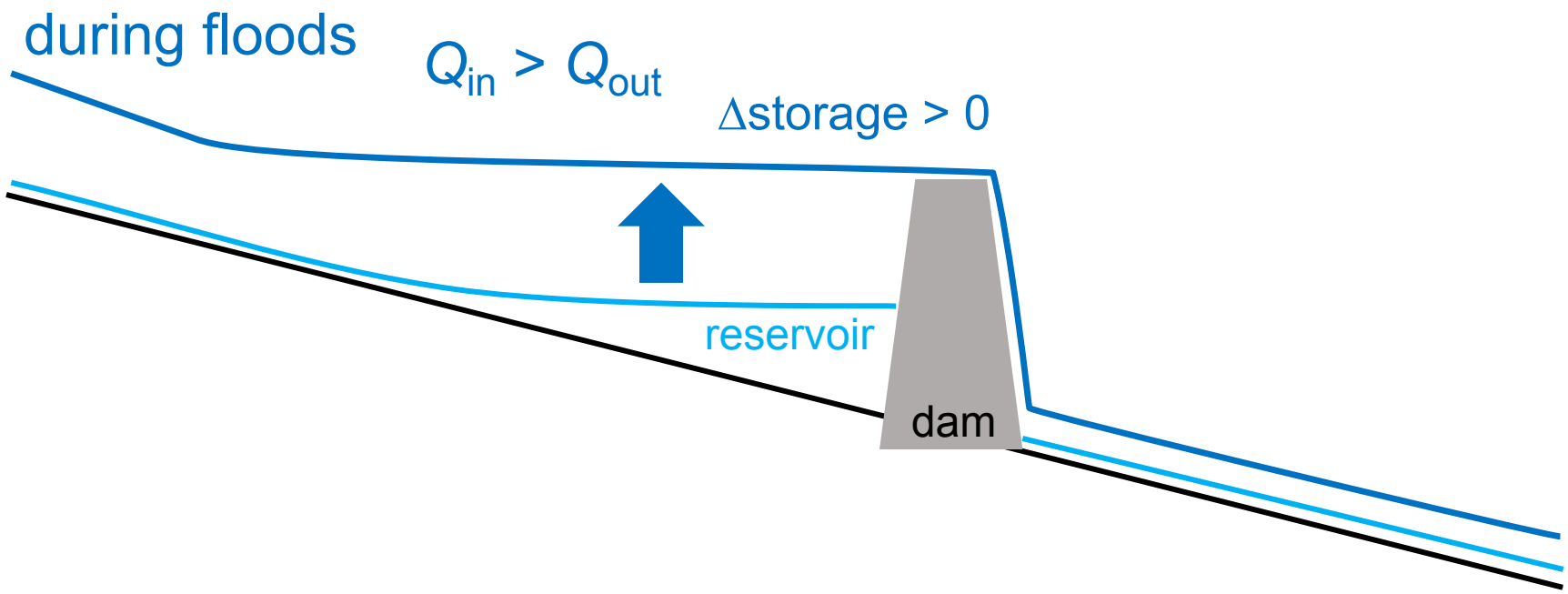
Run-of-the-river dam:
Upper Bondsville Dam, Swift River, MA

1868 from the South Hadley Historical Society

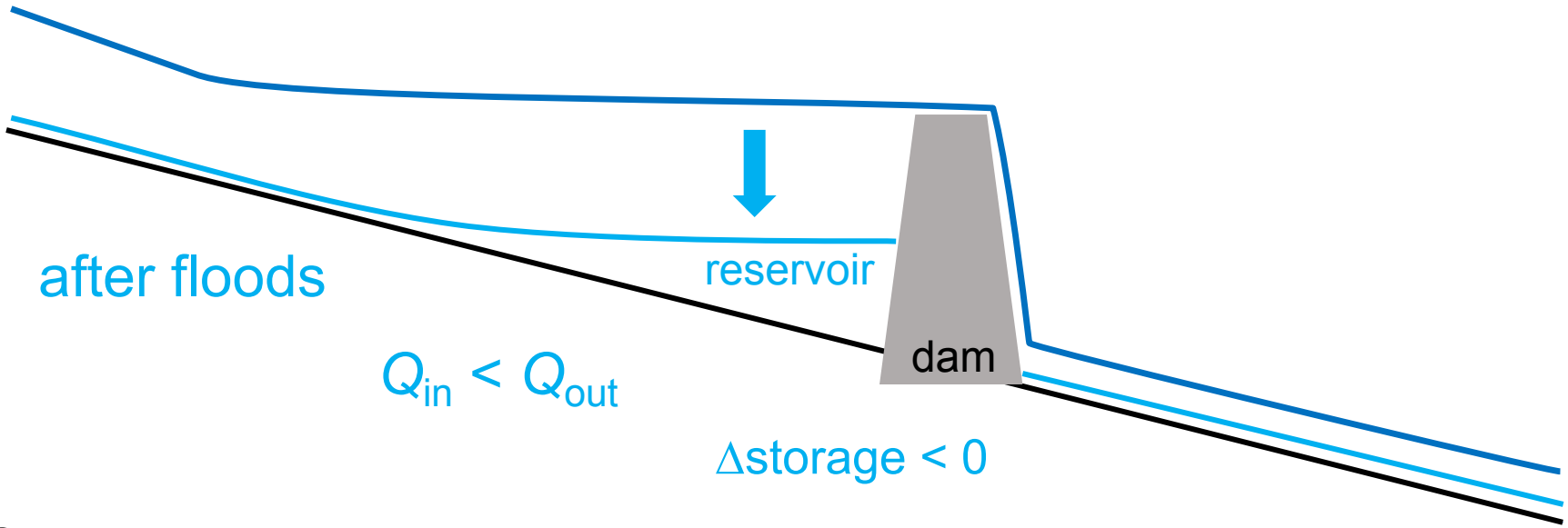
Flood-detention reservoirs



Flood-detention reservoirs



Flood-detention reservoirs



Summary:

- empty until filled with flood water
- mostly run-of-the-river

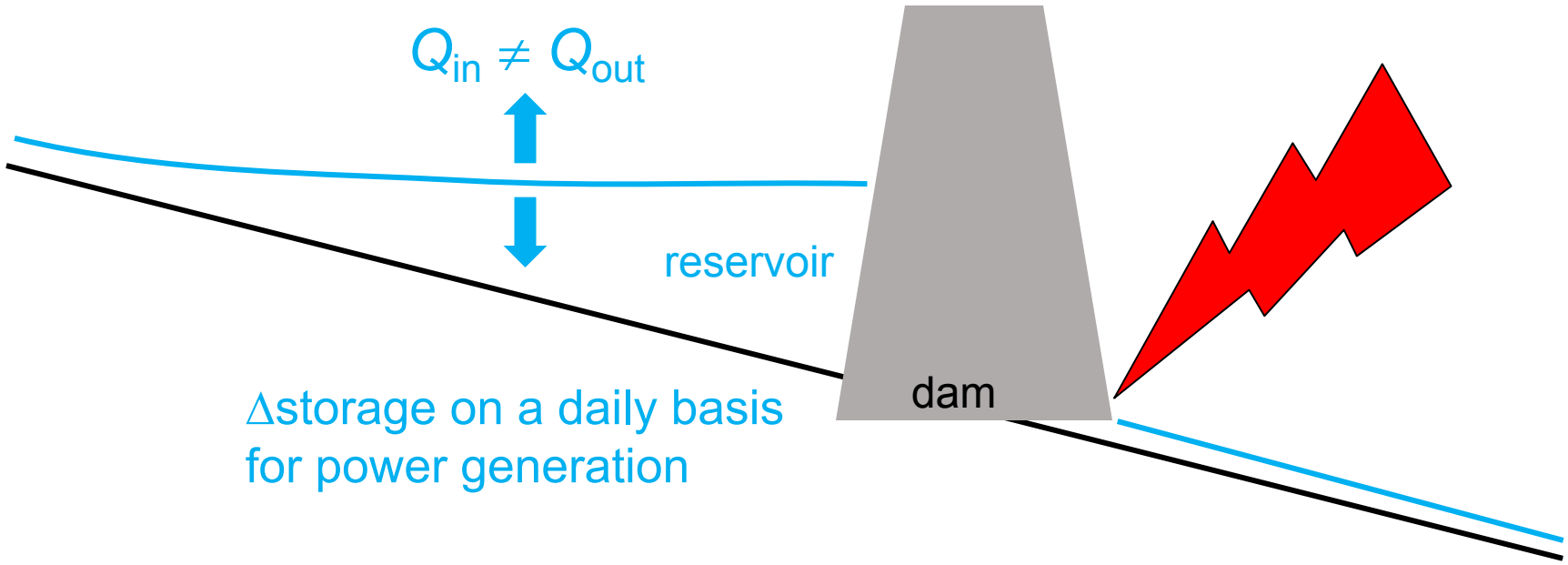
Examples:

- Dams on the Connecticut and Merrimack Rivers
  - US Army Corps of Engineers

Flood control dam:
Tully Lake, MA
(USACE)

Flood control dam:
Ball Mountain Lake,
West River, VT
(USACE, 1999)

Multi-purpose storage reservoirs



Summary:

- store water for supply, power generation
- keep space for flood storage
- requires forecasting of floods and droughts
  - seasonal effects (snowmelt)

Examples:

- Quabbin Reservoir, MA
- Big dams in the western US (e.g., Hoover Dam, Glen Canyon Dam)
  - US Army Corps of Engineers, Bureau of Reclamation
- Three Gorges Dam, China

Quabbin Reservoir and Winsor Dam, Swift River, MA, 1946 (massmoments.org)
170 ft (52 m) high, 412 billion gallons of water storage (1.56 km^3)

Glen Canyon Dam, Colorado River, AZ/UT
316 m tall, 32 km^3 of storage, 1300 MW power generation