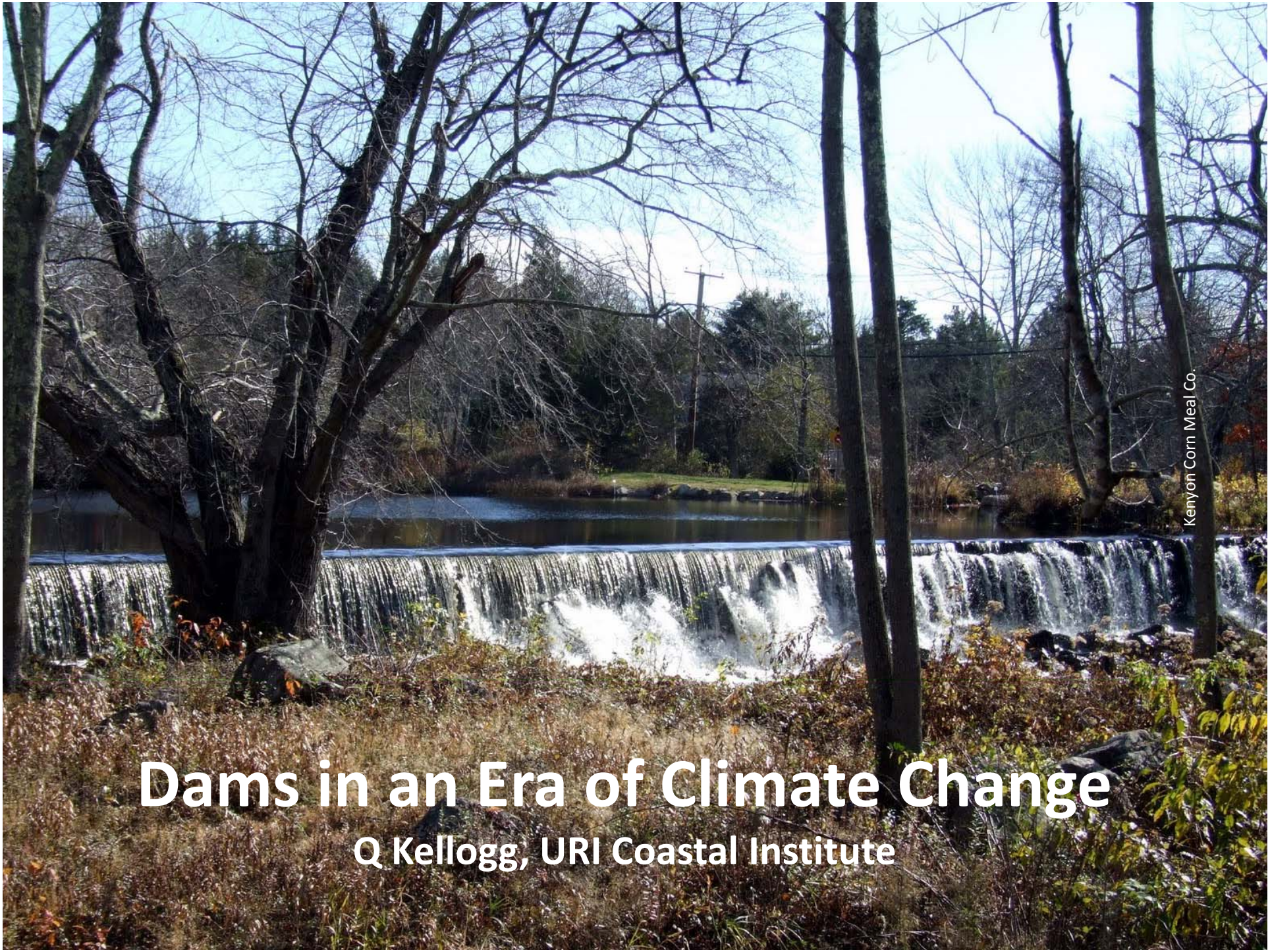
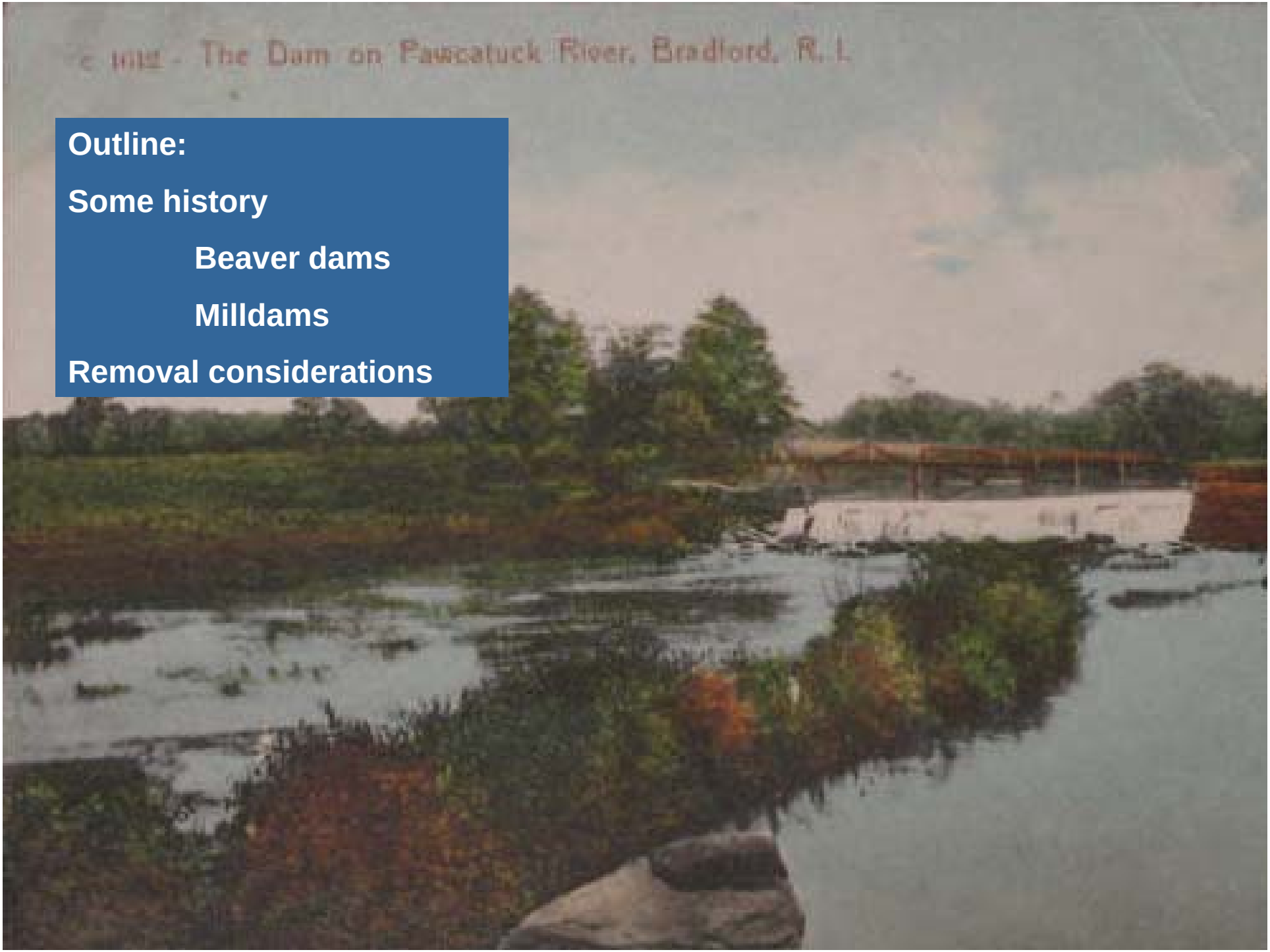


Dams in an Era of Climate Change

Q Kellogg, URI Coastal Institute



Outline:

Some history

Beaver dams

Milldams

Removal considerations

A brief history of beavers (and beaver dams) in New England

Before the arrival of Europeans in North America, the beaver population was estimated at 60 – 400 million individuals

Geographic range of 15 million km^2

Found in nearly all aquatic habitats from arctic tundra to deserts of northern Mexico

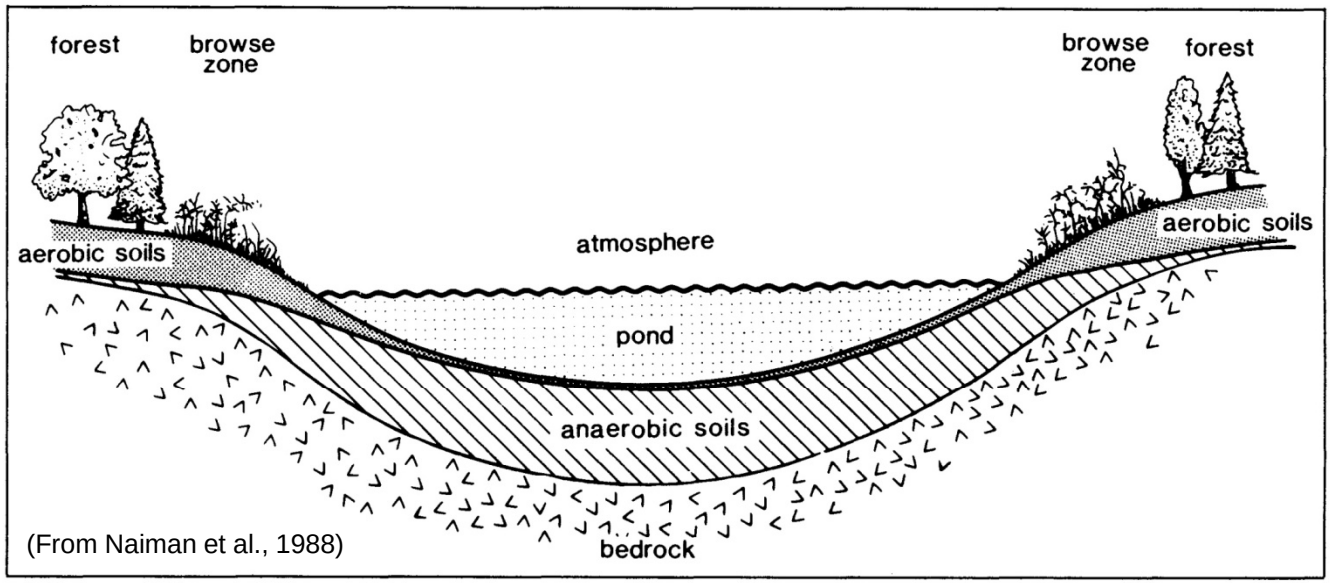
In New England, nearly every body of water was occupied by beaver

Naiman et al., 1988

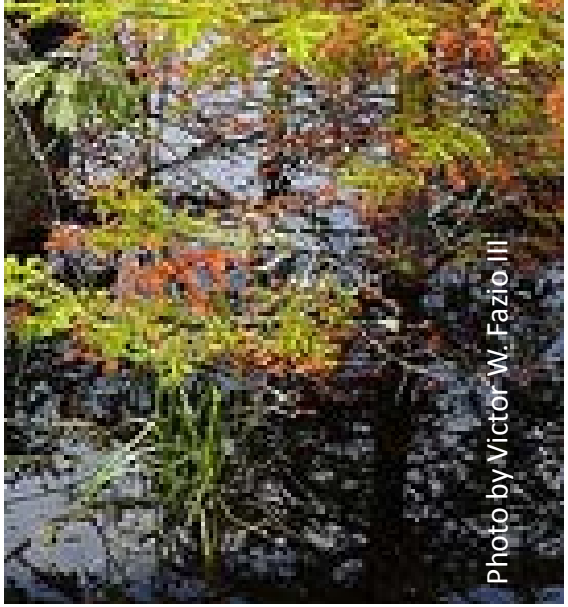
National Geographic

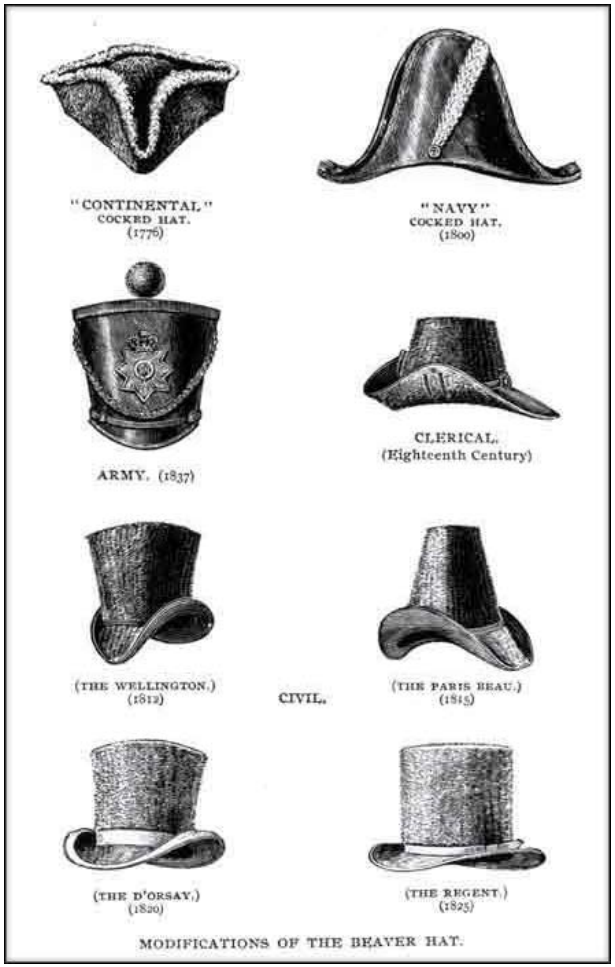
Beaver dam characteristics

- Generally < 10 ft high
- Impound water, expanding wetlands
- Change annual stream discharge regimes
- Decrease velocity
- Give channel gradient a stair-step profile
- Increase retention of sediment and organic matter
- Mostly on smaller streams (1^{st} to 4^{th} order)



(From Naiman et al., 1988)



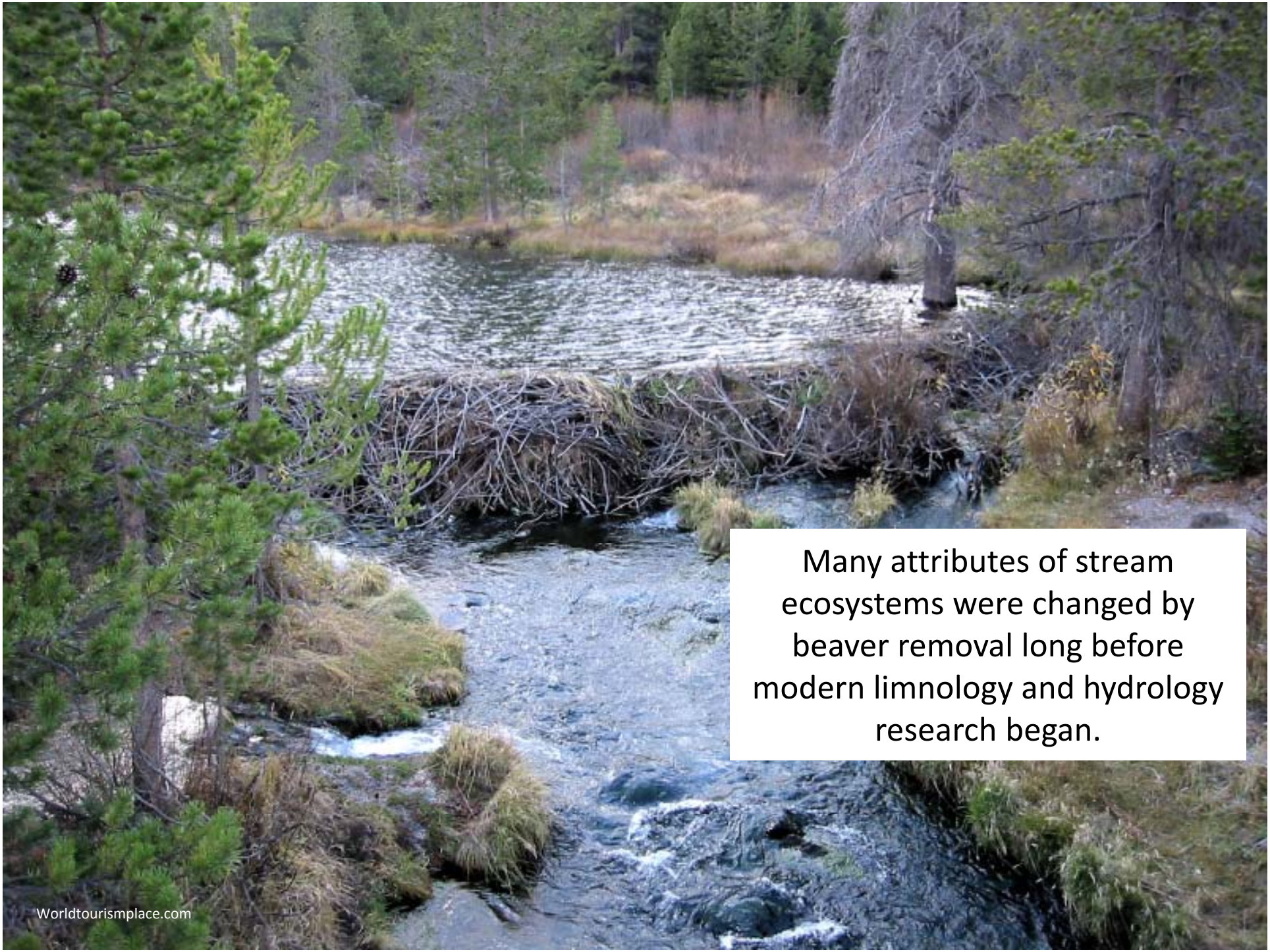


1620 – 1630
10,000/yr taken (CT and MA)

1630 – 1640
80,000/yr taken (Hudson R and western NY)

By 1900
almost extinct in North America

1834 – 1970s
loss of 195,000-260,000 km^2 of U.S. wetlands, much of it beaver habitat



Many attributes of stream ecosystems were changed by beaver removal long before modern limnology and hydrology research began.

Mill dams

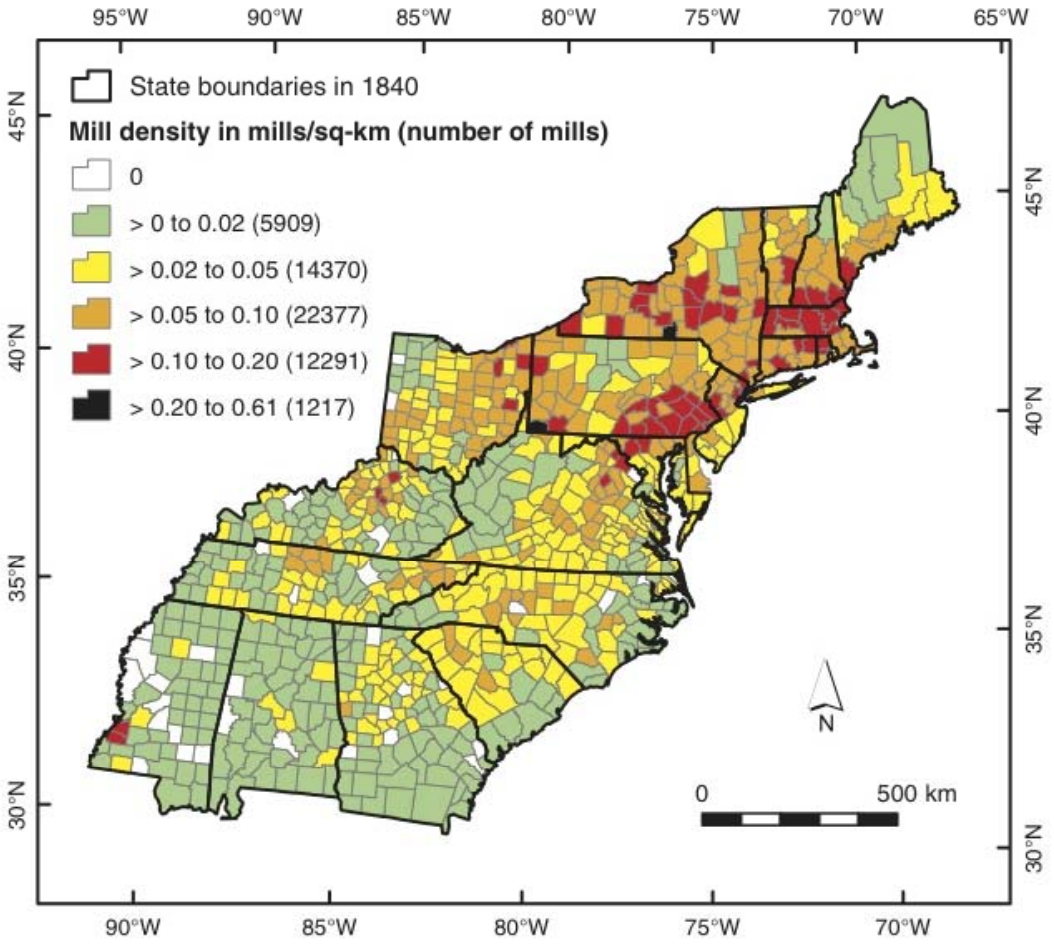
Dam building for water power in the eastern U.S. began in the late 1600s and persisted until the early 1900s

By 1840, >65,000 water-powered mills in 872 counties in the eastern U.S.

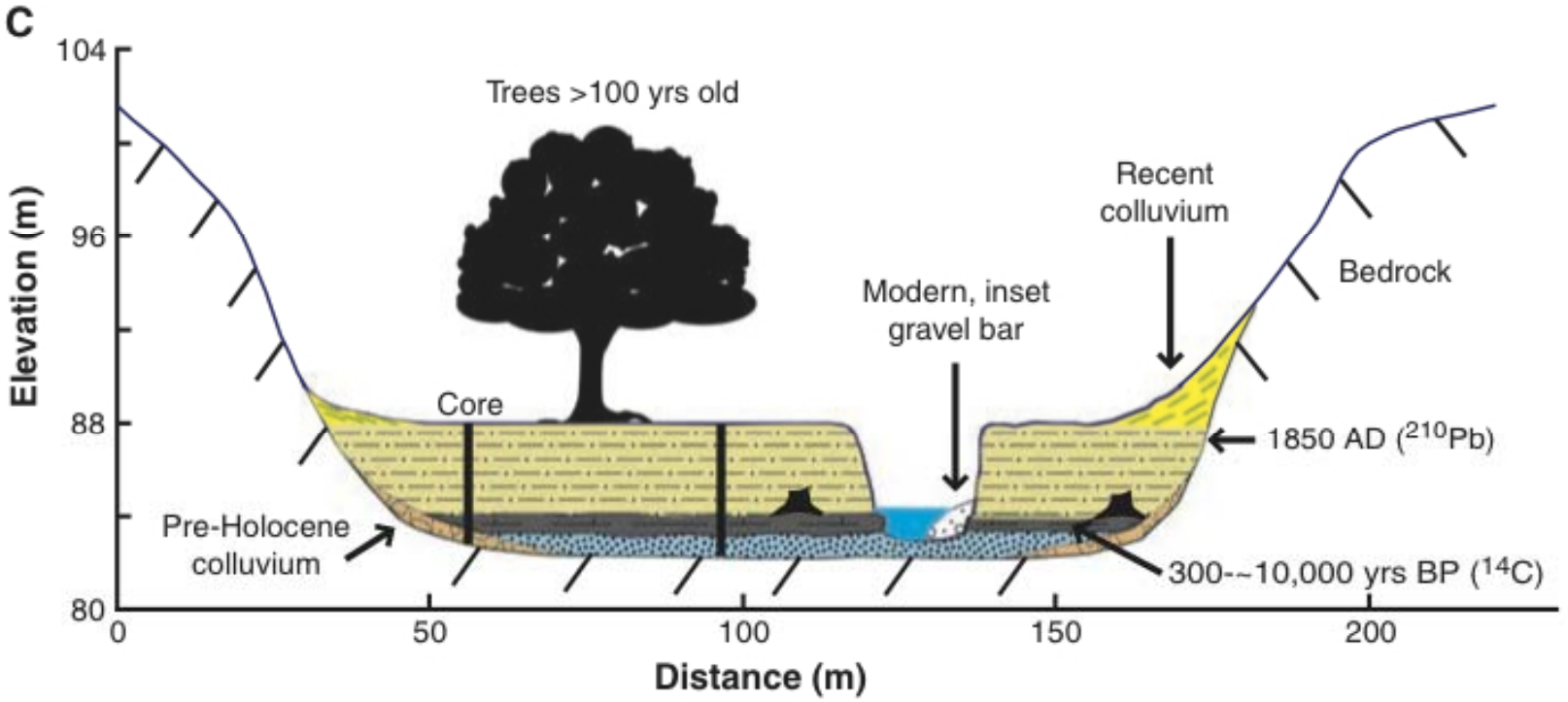
Milldams were frequently built on lower order streams.

Milldam height range 8 to 12 ft.

In 1731, settlers tore down a milldam on the Conestoga because it was ruining the local fishing industry.



From Walter and Merritts (2008)



From Walter and Merritts (2008)

Challenges our notion of what a "natural" stream might look like.

Dam Removal: Issues to consider

1. Goals and trade-offs
2. Habitats – created and lost
3. Invasives
4. High and low flows
5. Sediment
6. Cultural identity
7. Safety & risk

Removing a dam is not a gentle process…

Should be considered a disturbance in the strict ecological sense of a “discrete event in time that disrupts ecosystem, community, or population structure, and changes resources, substrate availability, or the physical environment.”

From Stanley & Doyle (2003)

Dam removal – Trade-Offs

Dams change rivers and surrounding area over their lifetimes

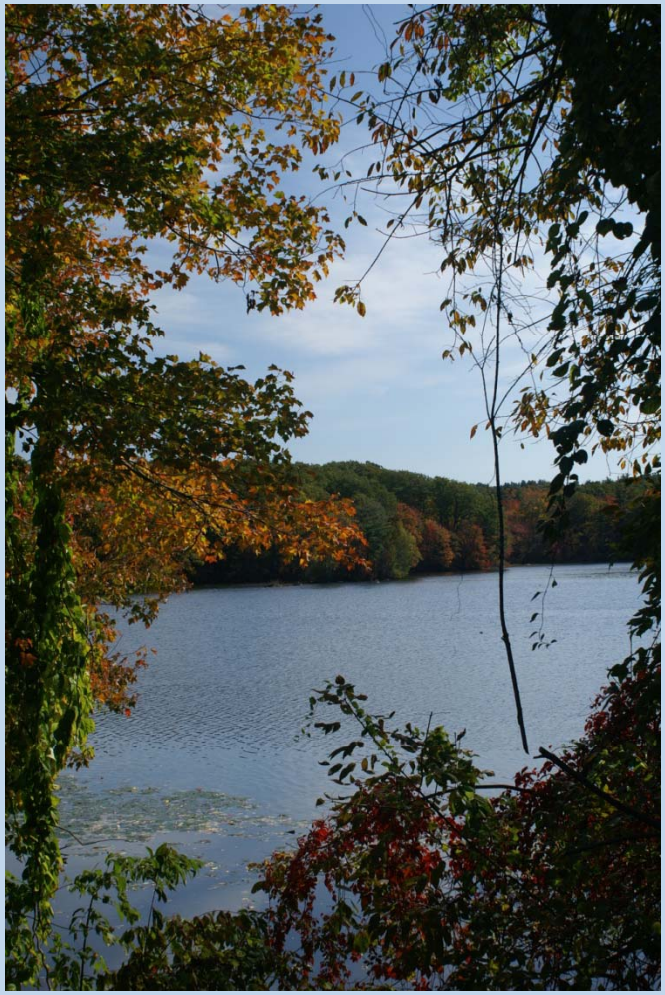
Rather than erasing past environmental legacies, dam removal creates a new ecological template upon which subsequent physical, chemical, and biological processes will be played out (Stanley and Doyle, 2003).

If the goal is stream restoration, what habitats are we hoping to restore?

Photo from NOAA

Dam Removal: Issues to consider

1. Habitats – created and lost
2. Invasives
3. High and low flows
4. Sediment
5. Cultural identity
6. Safety & risk



Reservoir habitat → Riverine habitat
- temperature, nutrients
- anadromous fish migration
- wetlands
- invasive species

Figure 3. *The blank palette: lowering of the water level often exposes vast areas of reservoir sediment.*

(Stanley & Doyle, 2003)

Courtesy of CH Orr

Figure 5. *Exposed reservoir sediments are well suited for invasion by exotic species such as reed canary grass* (Phalaris arundinaceae). *Following removal of the Oak Street Dam, Wisconsin, exposed sediments were seeded with mixtures of native prairie plants. Two years later, reed canary grass has taken over and grows in large stands on former reservoir sediments.*

From Stanley & Doyle (2003)

Dam Removal: Issues to consider

1. Habitats – created and lost
2. Invasives
3. High and low flows
4. Sediment
5. Cultural identity
6. Safety & risk

Sediment

Erosion and incision at dam location

Sediment deposition downstream

physical, chemical, biological consequences

Decrease in macroinvertebrate density, algal biomass, and diatom species richness downstream from dam removal (Thomson et al., 2005).

(Stanley & Doyle, 2003)

Dam Removal: Issues to consider

1. Habitats – created and lost
2. Invasives
3. High and low flows
4. Sediment
5. Cultural identity
6. Safety & risk

Some parting thoughts:

Ecologists face key questions regarding the mechanisms and rates of change after dam removal.

Financial and temporal realities dictate that, regardless of trade-offs, dam removal will become increasingly common.

While the environmental costs of dam removal will never be completely eliminated, management should be able to control some negative effects by carefully choosing the timing and means by which the dam is removed.

(Stanley & Doyle, 2003)

References

Naiman, R.J., C.A. Johnston, and J.C. Kelley. 1988. Alteration of North American streams by beaver. BioScience 38:753-762.

Stanley, E.H. and M.W. Doyle. 2003. Trading off: the ecological effects of dam removal. Frontiers in Ecology and the Environment 1:15-22.

Thomson, J.R., D.D. Hart, D.F. Charles, T.L. Nightengale, and D.M. Winter. 2005. Effects of removal of a small dam on downstream macroinvertebrate and algal assemblages in a Pennsylvania stream. J. N. Am. Benthol. Society 24:192-207.

Walter, R.C. and D.J. Merritts. 2008. Natural streams and the legacy of water-powered mills. Science 319:299-304.