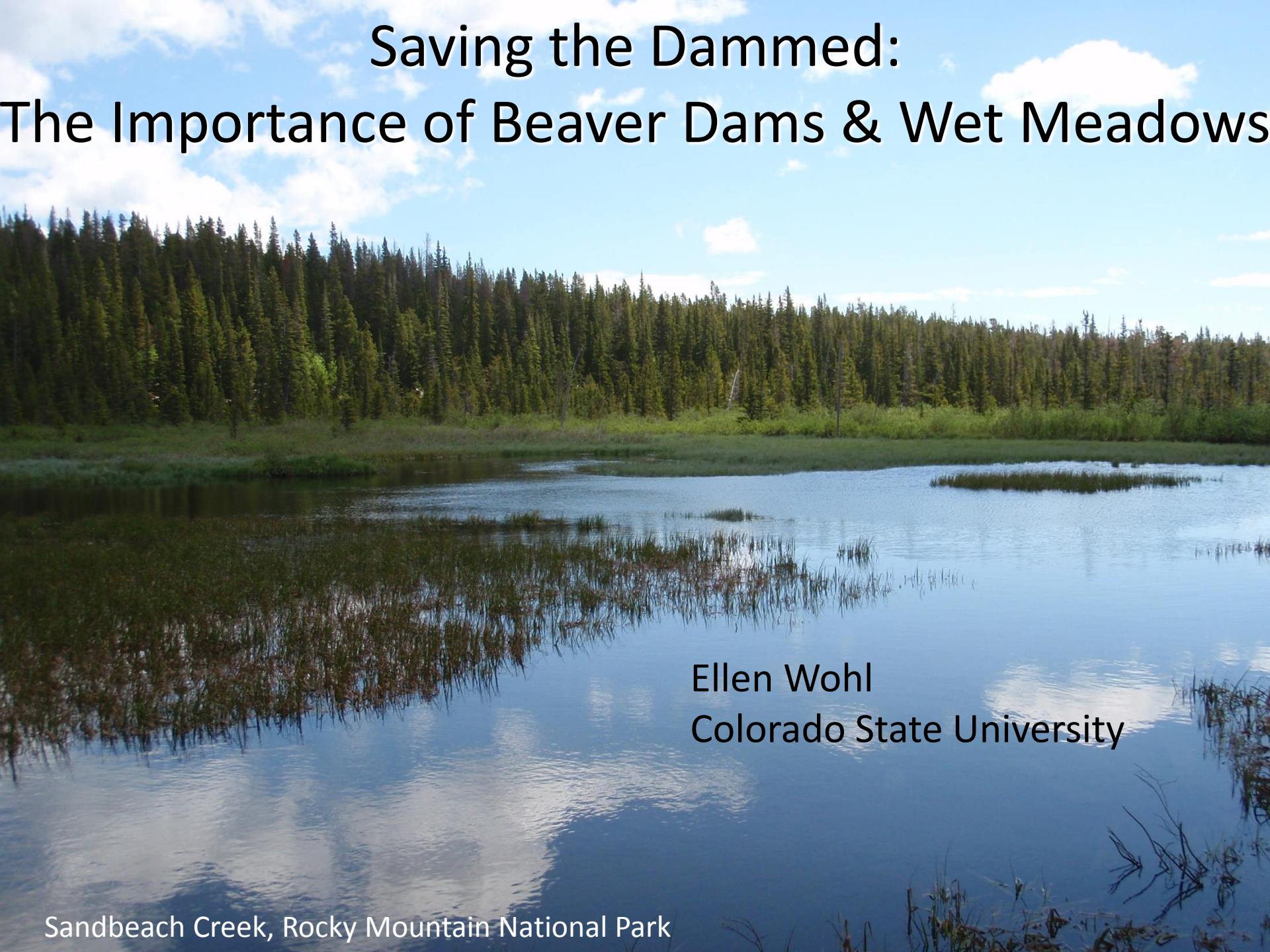
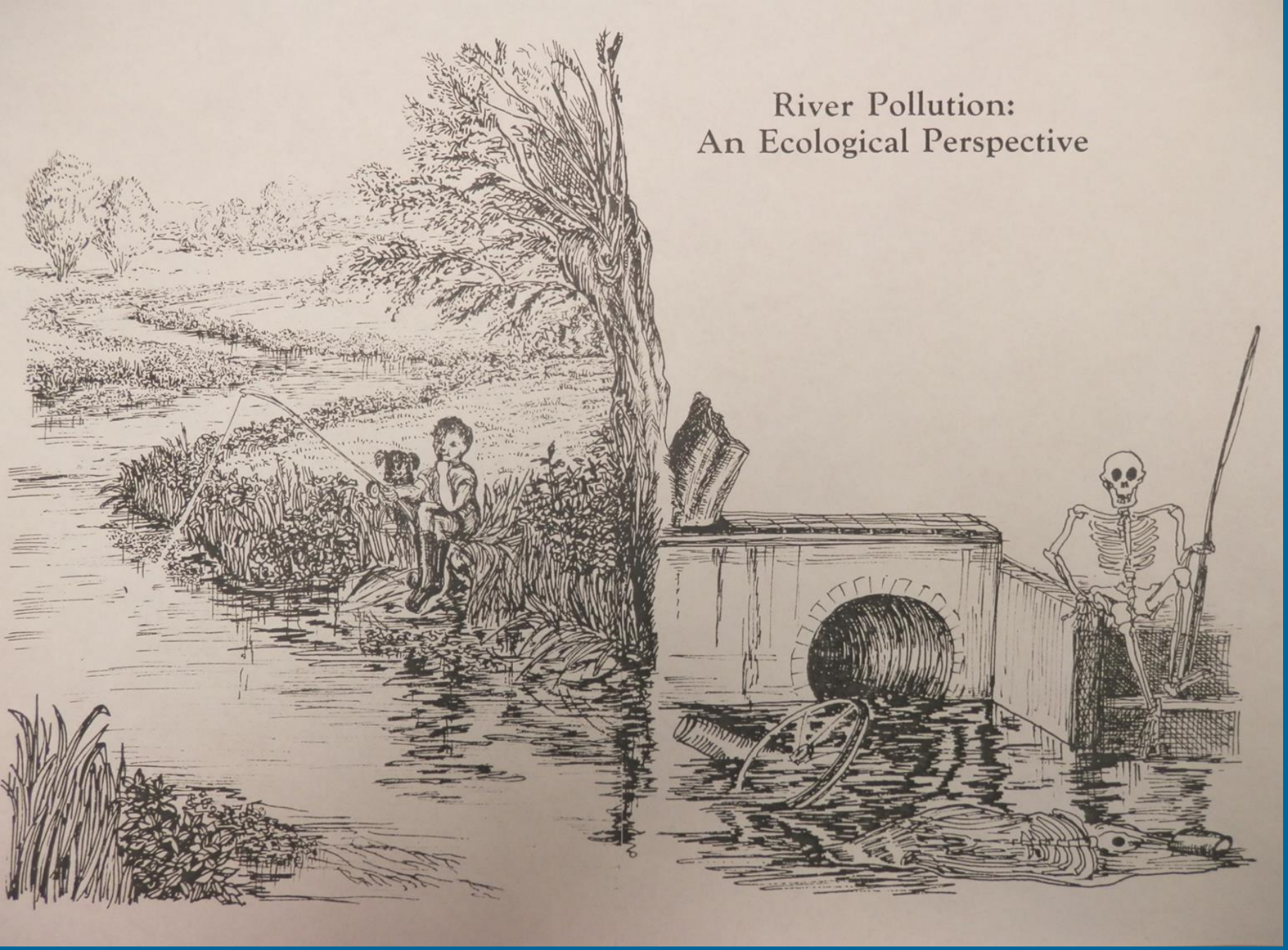
Saving the Dammed:
The Importance of Beaver Dams & Wet Meadows



Ellen Wohl
Colorado State University

Sandbeach Creek, Rocky Mountain National Park



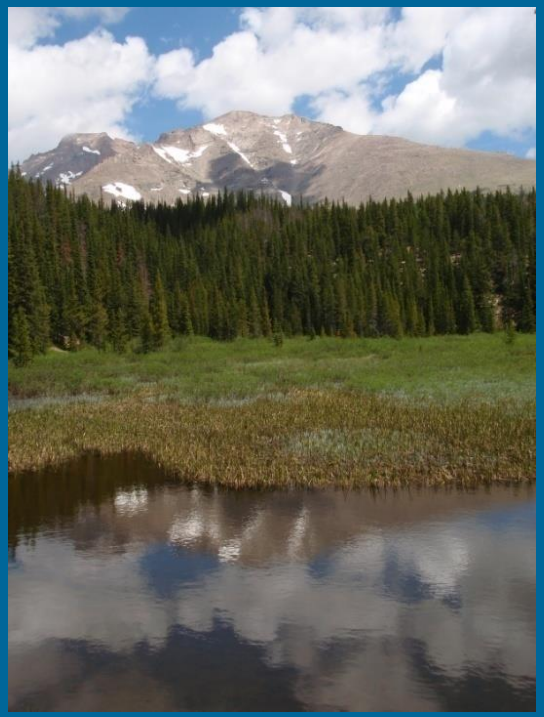
Haslam (1994)

Introduction

sources of physical complexity

implications for
- hydrology
- channel form
- nutrient dynamics
- aquatic organisms
- riparian organisms

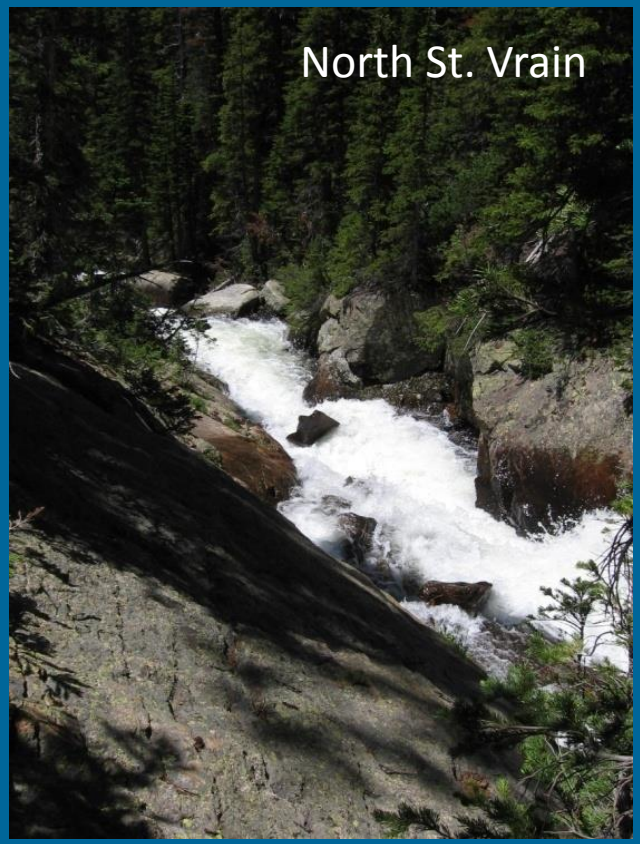
historical changes



Sandbeach Creek

Front Range valleys alternate downstream between

steep, narrow *and* gentler, wider



majority of network is steep & narrow

associated differences in channel morphology

differences in rock erodibility, glacial history & biotic drivers

Biotic drivers of physical complexity

forest age & type, beaver

jams
dams

physical complexity

North St. Vrain Creek

avulsion/
multiple channels

bank erosion,
overbank flow

wood
recruitment

treefall

upstream backwater for length
of > 2X channel width

ramped piece

shallow, wide valley
logjams persistent

logjam

threshold based on gradient , wood diameter
& channel width/valley-bottom width

steep, narrow valley
logjams transient

upstream backwater for length
of 1-2X channel width

old growth (large, abundant wood) + wide valley bottom =

channel-spanning logjams =

overbank floods
high water table
multiple channels
sediment storage
nutrient storage
biotic diversity

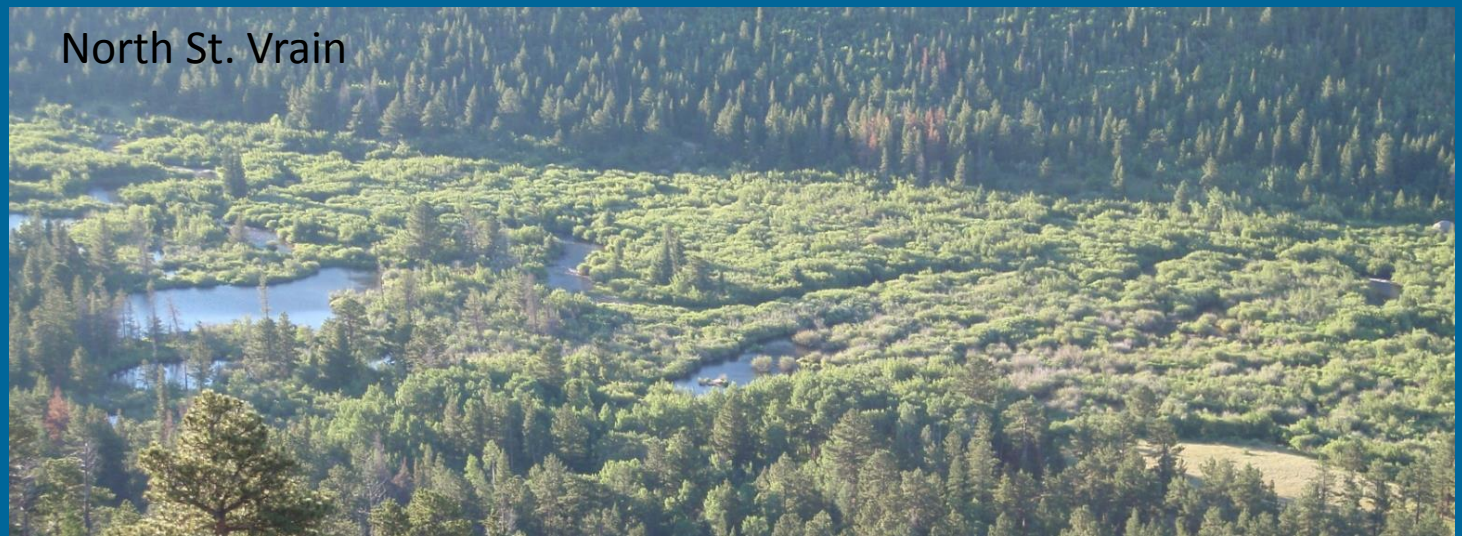
Big Thompson

beaver

ecosystem engineer or keystone species

beaver dams =

overbank floods
high water table
multiple channels
sediment storage
nutrient storage
biotic diversity



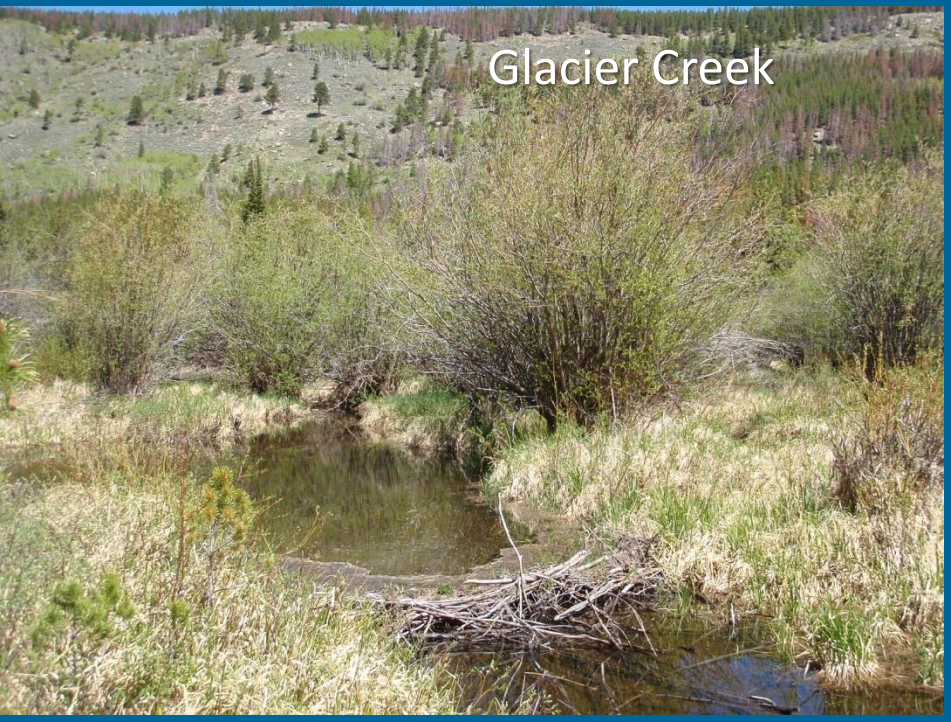
Beaver meadows

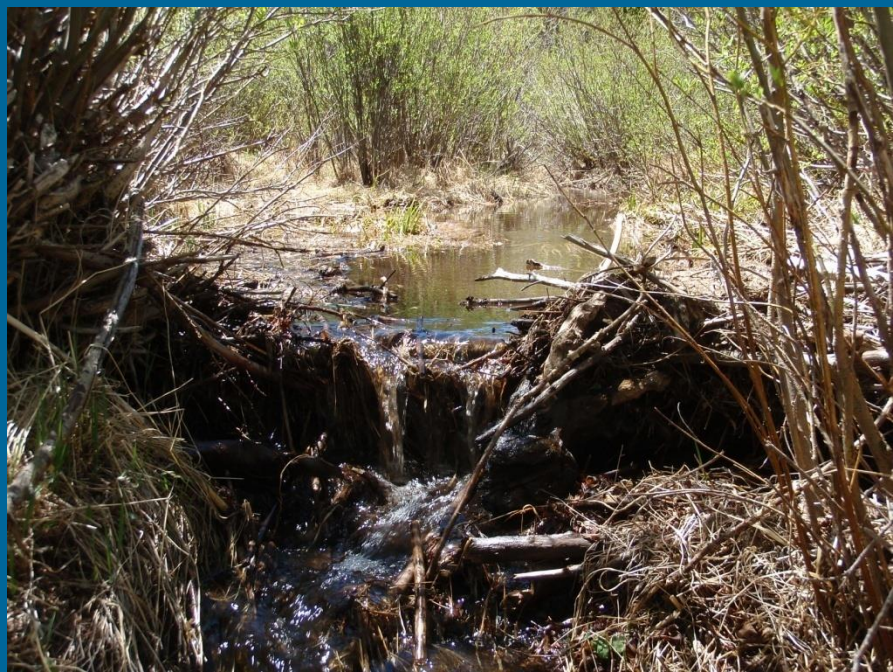
more heterogeneous habitat

greater species richness (e.g., plants not found elsewhere)

plants, insects, fish, amphibians, reptiles, birds, mammals

store carbon, nitrogen, phosphorus in sediments & in solution





on abandonment, meadows can persist for decades

lack of ectomycorrhizal fungi in soils limits conifer invasion

Abies & *Picea* require fungi in their roots for growth & survival

small mammals like voles disperse fungal spores in feces

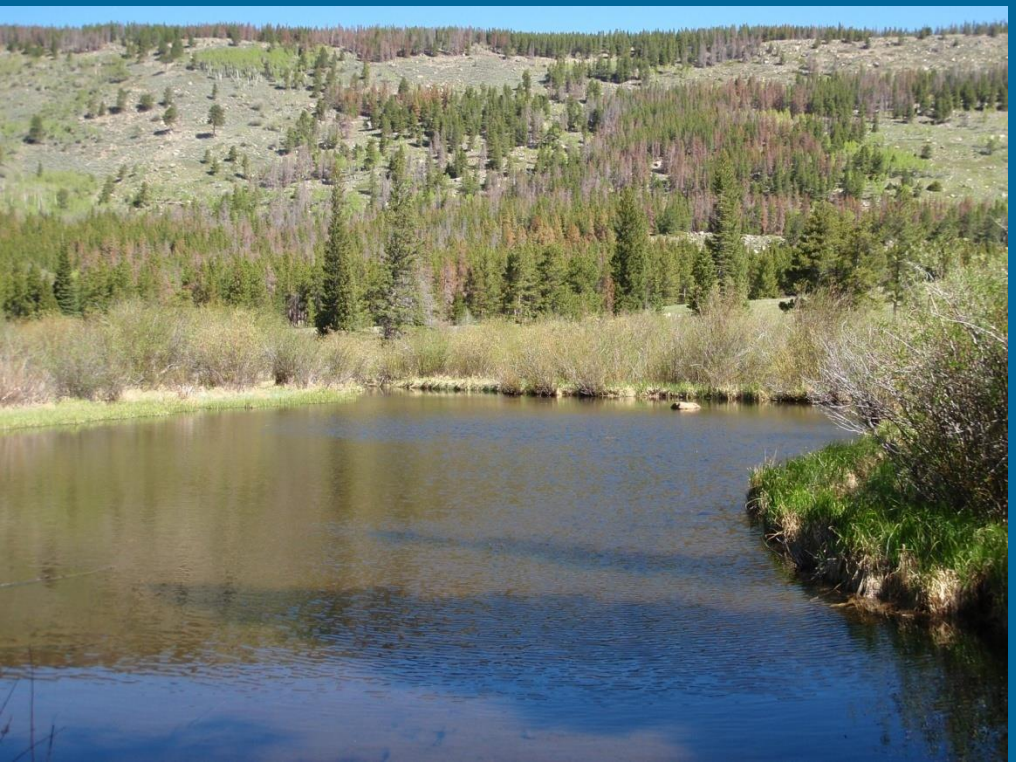
prior to intensive human manipulation of forests & rivers, beavers & patches of old-growth more widespread

↓

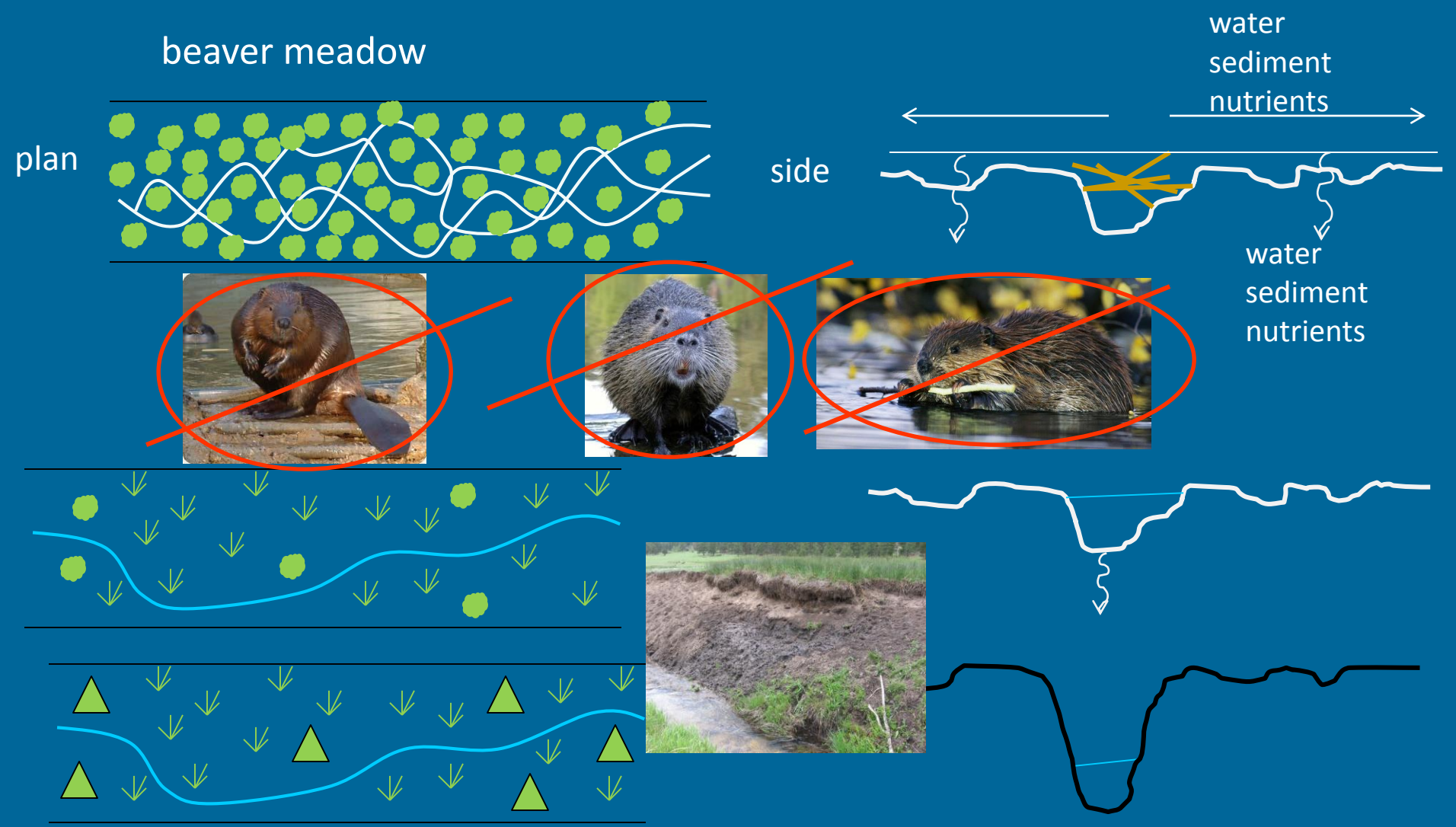
headwater multiple channels more common

↓

greater complexity & retention

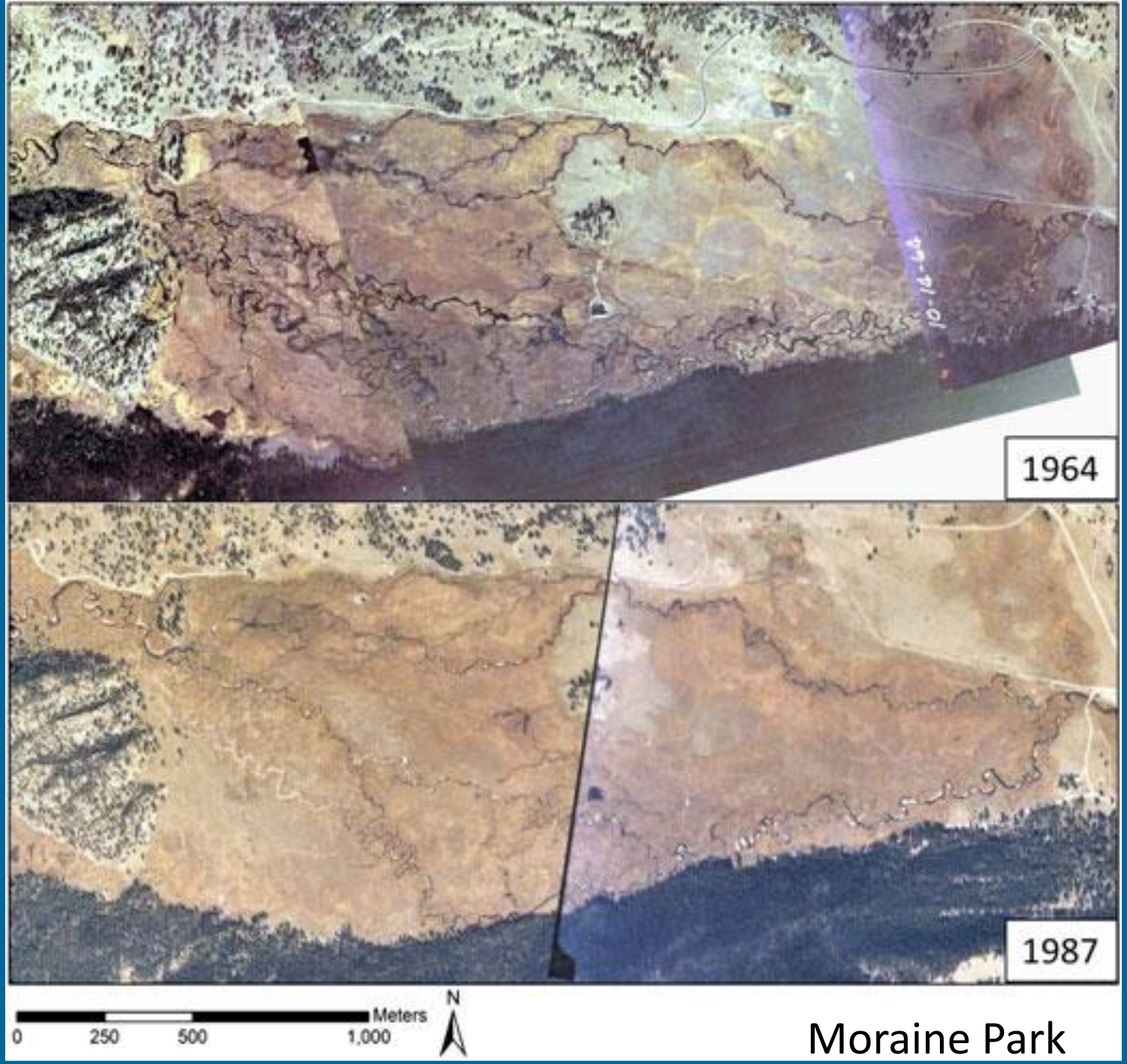


Without biotic drivers, valley geometry does not change, but channel-valley bottom interactions change & carbon in living and dead biomass changes

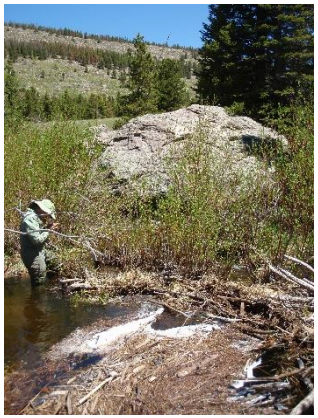


active beaver meadow on North St. Vrain Creek

inactive beaver meadow on Beaver Brook



Moraine Park



Beaver food & habitat

More dams & ponds

Beaver meadow

Backwater
(> 2X channel width)
Overbank flow
(> 4x channel width)

Floodplain wetland
Deciduous riparian trees
Multithread channel

Extensive
Persistent
Retentive

beaver dam

threshold based on presence of beavers & dams

Local
Transient

Removal of beavers eliminates dams & backwaters, reduces overbank flows

Drier floodplain
Single channel
Elk grasslands

Cumulative effects

rivers & the global carbon cycle

2.7

1.2

0.6

0.9

Headwaters are important

significantly contribute to CO_2 outgassing via microbial activity

transient storage affects nutrient uptake & retention in channels, logjams, beaver dams, floodplain sediments

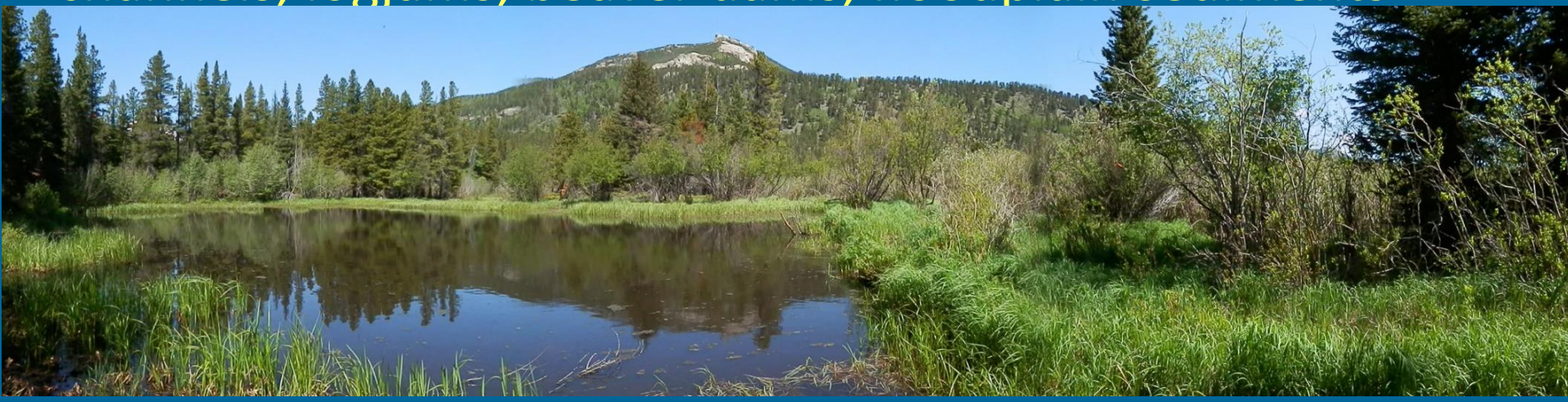
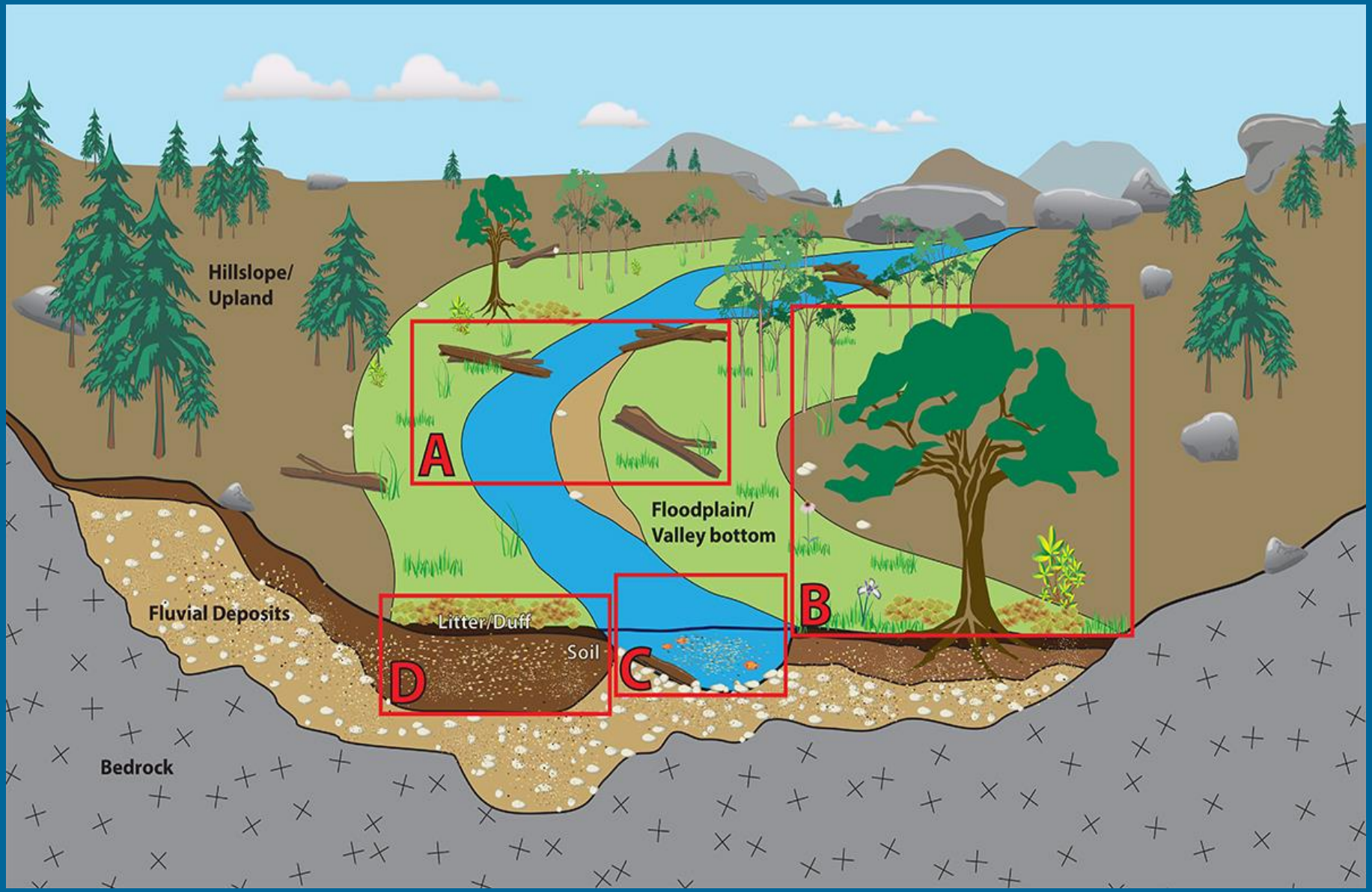


Figure courtesy of Nick Sutfin



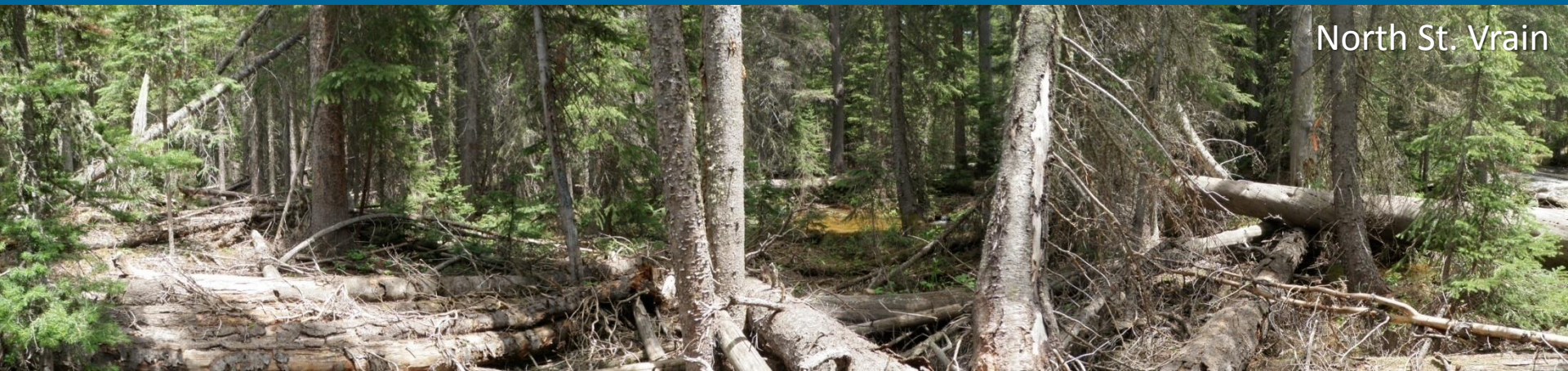
C pools: dead wood (A), riparian vegetation (B), aquatic organisms, fine organic matter (C), and sediment (D)

Organic carbon pools in rivers within Rocky Mountain NP

channel surveys on eastern side of park
> 80 river miles in 16 drainages

Unconfined valley segments < 25% of total river length,
but contain ~75% of the carbon present in valley bottoms

This is ~ 23% of total C in the landscape, although river valleys occupy < 1% of the landscape



Nick Sutfin

How does floodplain storage time vary among valley types? With increasing drainage area?

What is role of disturbance
(fire, flood, debris flow, blowdown, insects)?

Historical changes

loss of old-growth forest

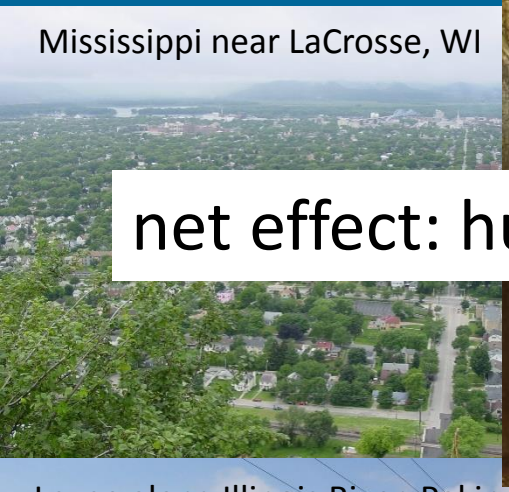
currently 6-12 million beaver in North America
historically, > 125 million

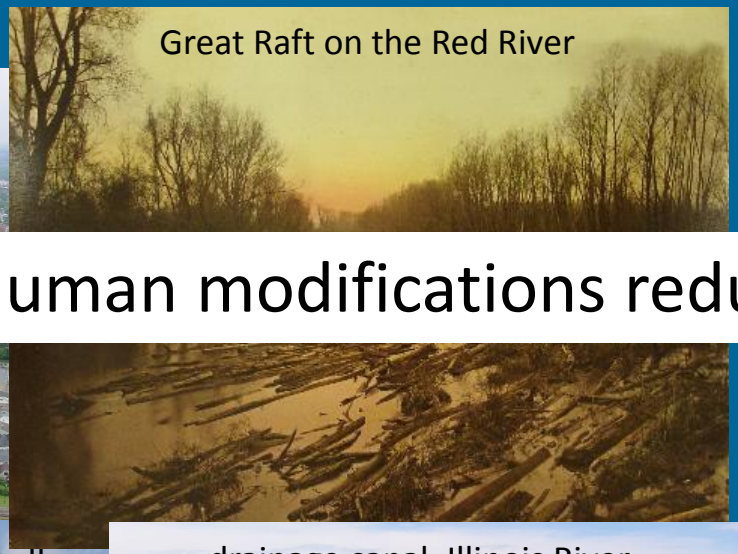
evidence of more extensive beaver activity on east side RMNP

e.g., Upper Beaver Meadows – beaver-induced sedimentation accounts for ~50% of post-glacial sediments

Natural processes vs **human effects**

- less C onto floodplain via terrestrial inputs (changed land cover)
- less C onto floodplain via overbank flooding (levees, flow regulation, channelization, wood removal)
- less C storage on floodplain (land drainage)


Mississippi near LaCrosse, WI


Great Raft on the Red River


Danube in Budapest

net effect: human modifications reduce river C storage


Levee along Illinois River, Pekin, IL


drainage canal, Illinois River

Implications & Restoration

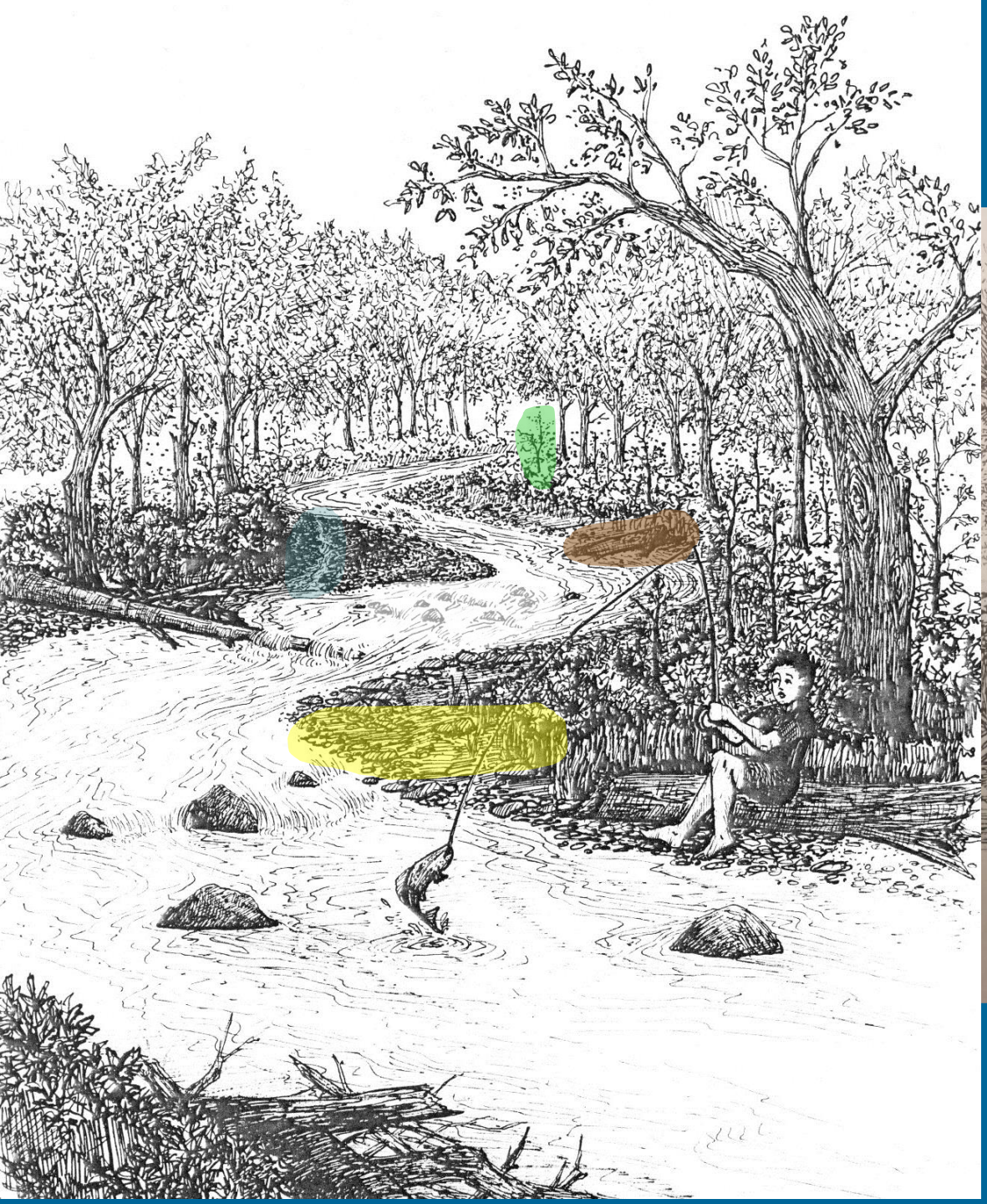
leaky rivers

restoration – can we? should we?

carbon storage (drinking water) & biodiversity

how?

- engineered logjams
- grazing exclosures



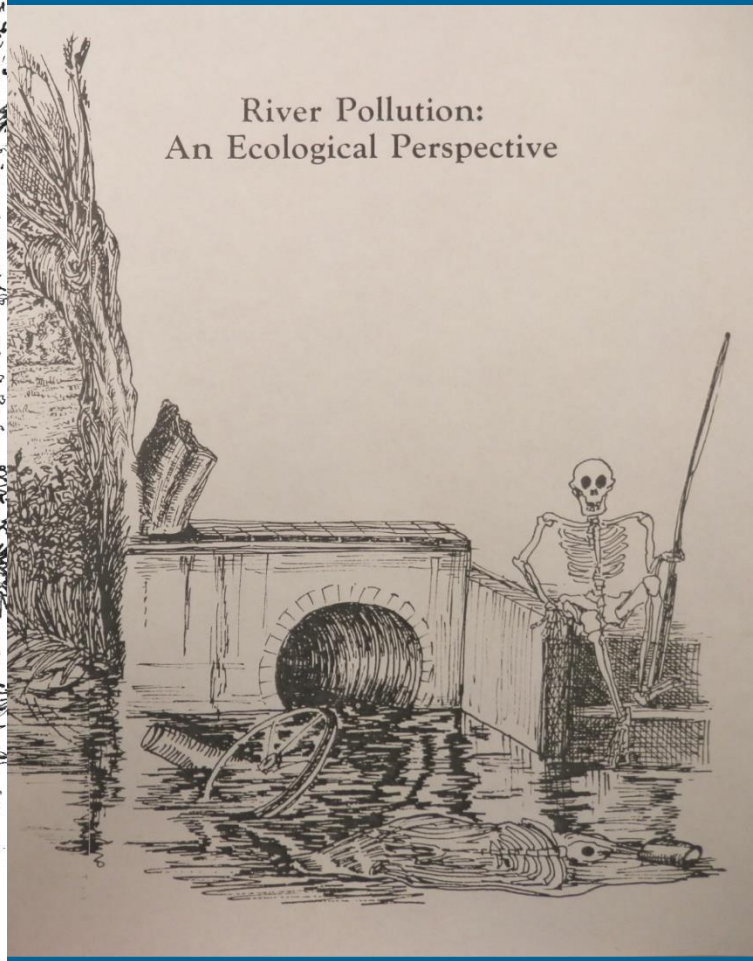


Illustration by Maisie Richards