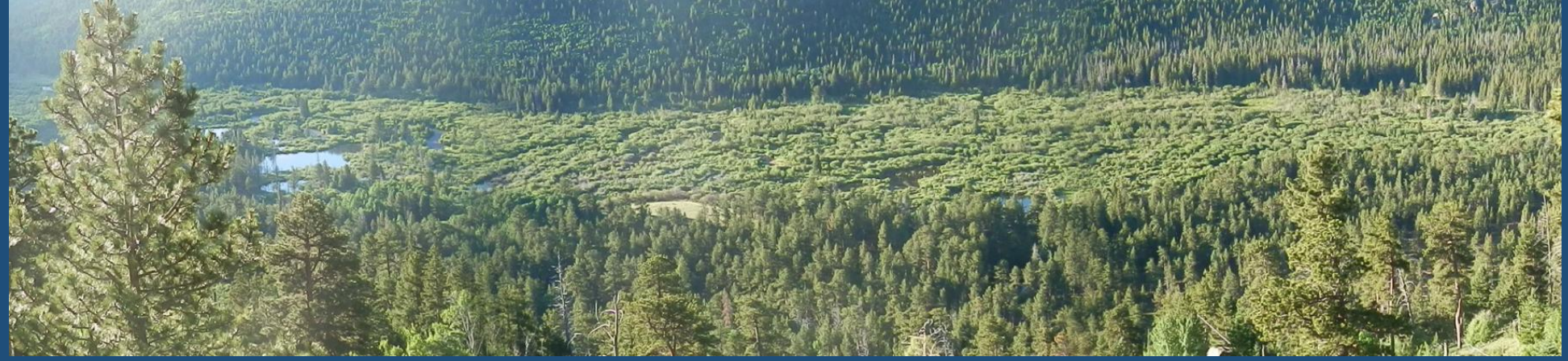


Biophysical Interactions that Sustain Healthy River Ecosystems

Ellen Wohl, Colorado State University

Thinking About Rivers –

river corridors, riverscapes, river ecosystems

Biophysical Interactions in the River Corridor –

fluxes, physical context, & biota

Rivers are Dynamic –

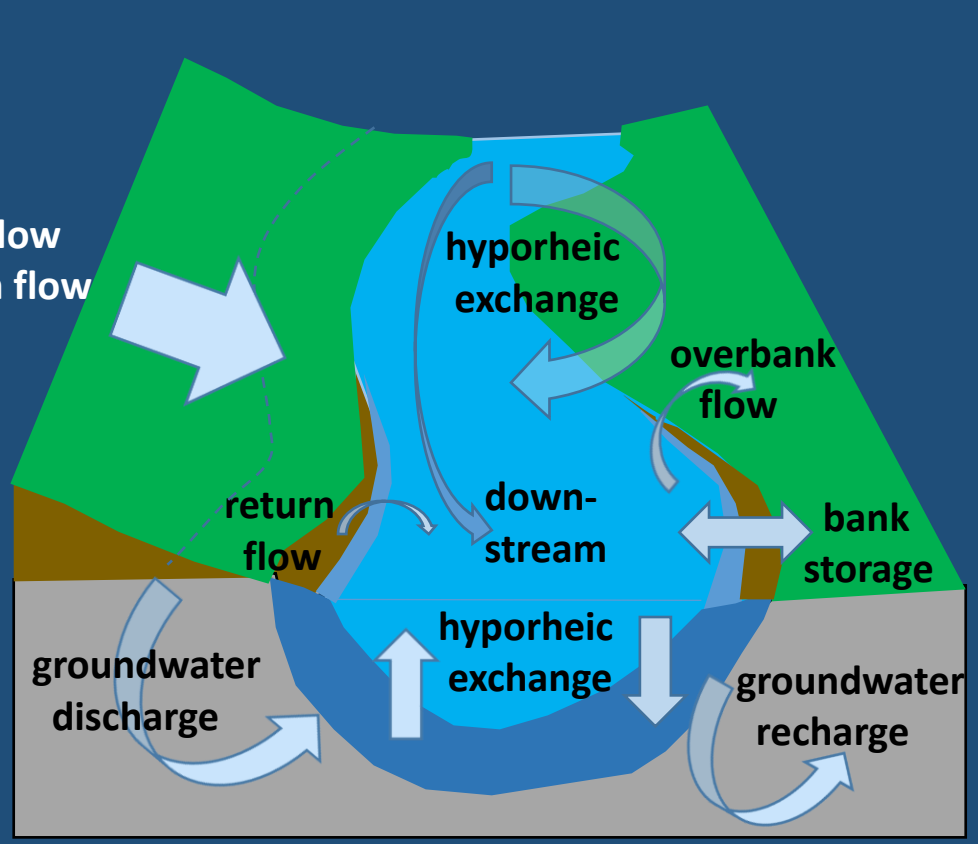
spatial & temporal heterogeneity

Legacies of Human Activities –

homogeneity & simplicity, sediments, contamination

Thinking About Rivers

A river corridor includes the active channel(s), floodplain, & underlying hyporheic zone



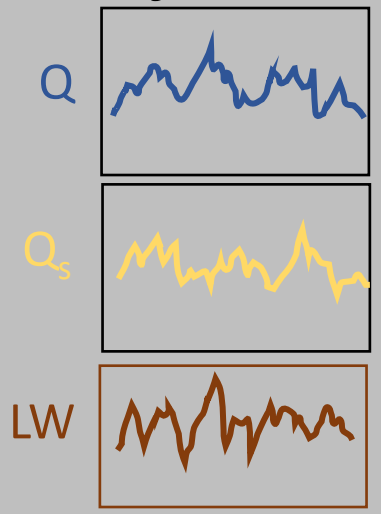
water & solutes

Harvey & Gooseff, 2015, Water Resources Research

Biophysical Interactions in the River Corridor

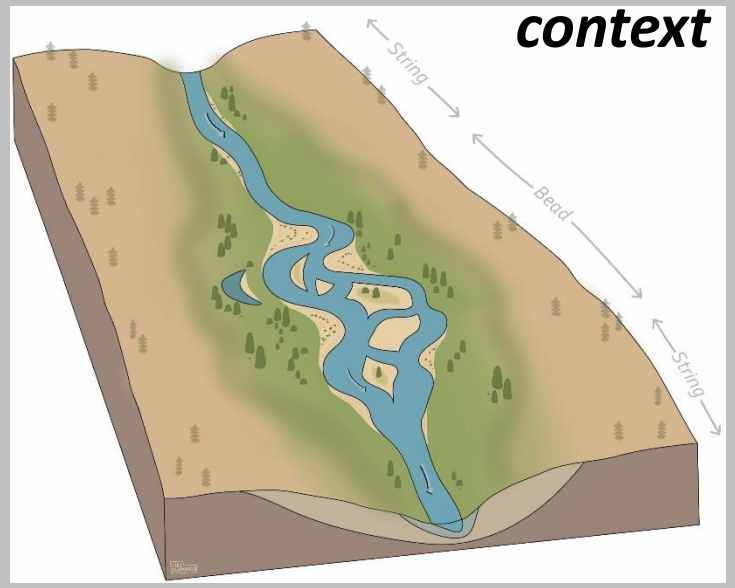
Configuration & (in)stability of river corridor

fluxes



flow, sediment, & large wood regimes

context



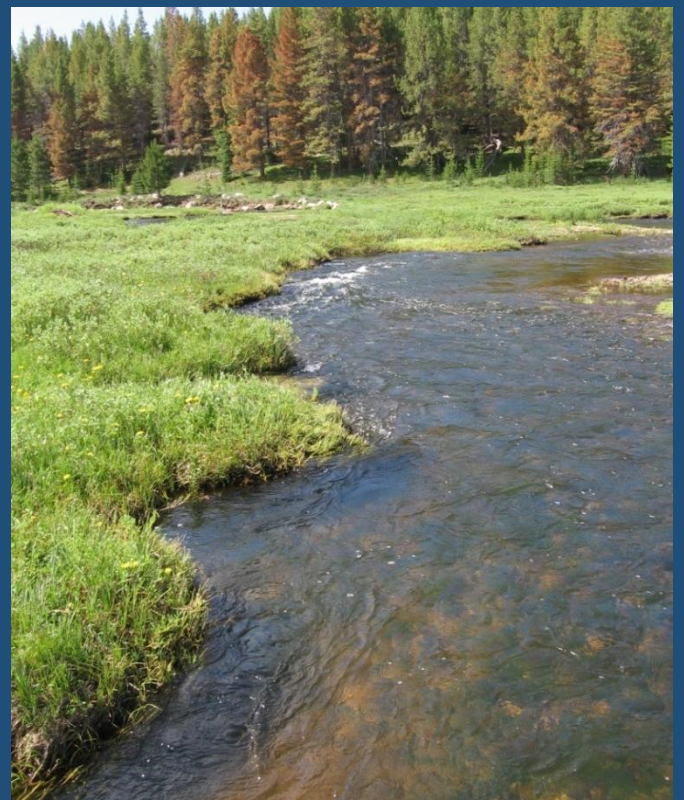
valley floor lateral confinement & gradient

biota

spatial heterogeneity, connectivity, resilience, geomorphic & ecological integrity

Forms of Spatial Heterogeneity in River Corridors

- stream bed (sediment, bedforms, wood)
- stream banks (vegetation, sediment, other)
- cross-sectional form (bedforms, meander bends)
- planform (channel & floodplain) (sinuosity, no. of channels)



Rivers are Dynamic

Sources of spatial heterogeneity (influence configuration & stability)

Geologic controls

Vegetation & biota

Fluxes of water, sediment, & large wood

Lateral channel movement & overbank inundation

Spatial & temporal variation in
bedforms/substrate
cross-sectional geometry
planform

Implications of Spatial Heterogeneity in River Corridors

1) habitat abundance & diversity

ELSEVIER

Science of The Total Environment

Volume 838, Part 4, 10 September 2022, 156509

Freshwater fish biodiversity restoration in floodplain rivers requires connectivity and habitat heterogeneity at multiple spatial scales

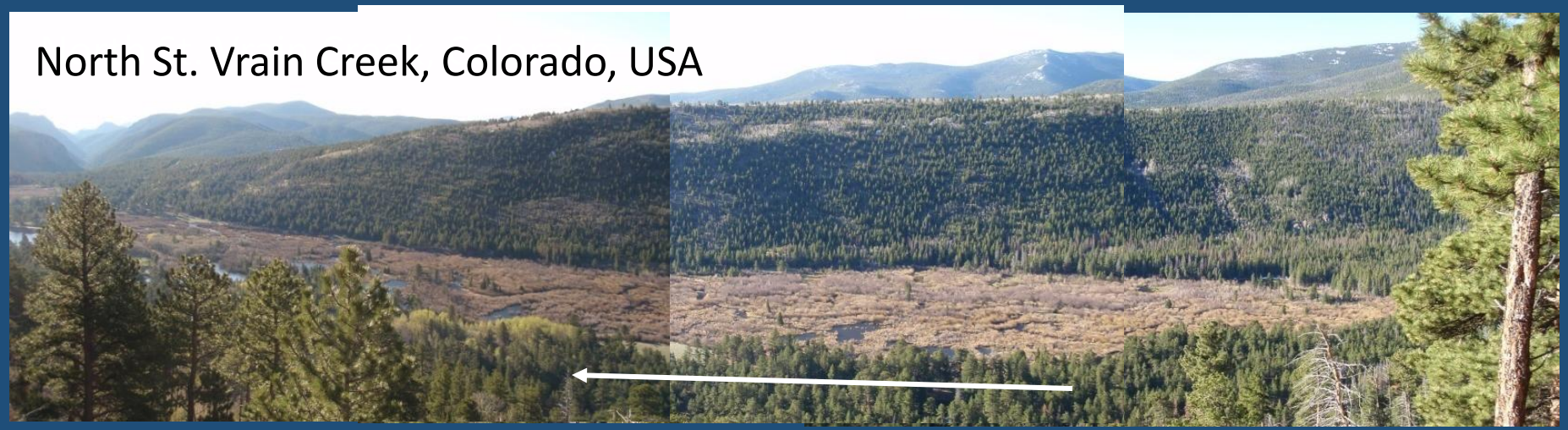
T. Stoffers [a], A.D. Buijse [a b], G.W. Geerling [b c], L.H. Jans [d], M.M. Schoor [d], J.J. Poos [a e], J.A.J. Verreth [a], L.A.J. Nagelkerke [a]

Yukon River, Alaska, USA
dr A 508,000 km²

Implications of Spatial Heterogeneity in River Corridors

2) resistance & resilience

(fire, flood, drought – climate change, resource use)



Baugh Creek, Idaho, USA
(photo courtesy of Joe Wheaton, Utah State University)

ECOLOGICAL APPLICATIONS
ECOLOGICAL SOCIETY OF AMERICA

Communications | Free Access

Smokey the Beaver: beaver-dammed riparian corridors stay green during wildfire throughout the western United States

Emily Fairfax ✉, Andrew Whittle

Implications of Spatial Heterogeneity in River Corridors

3

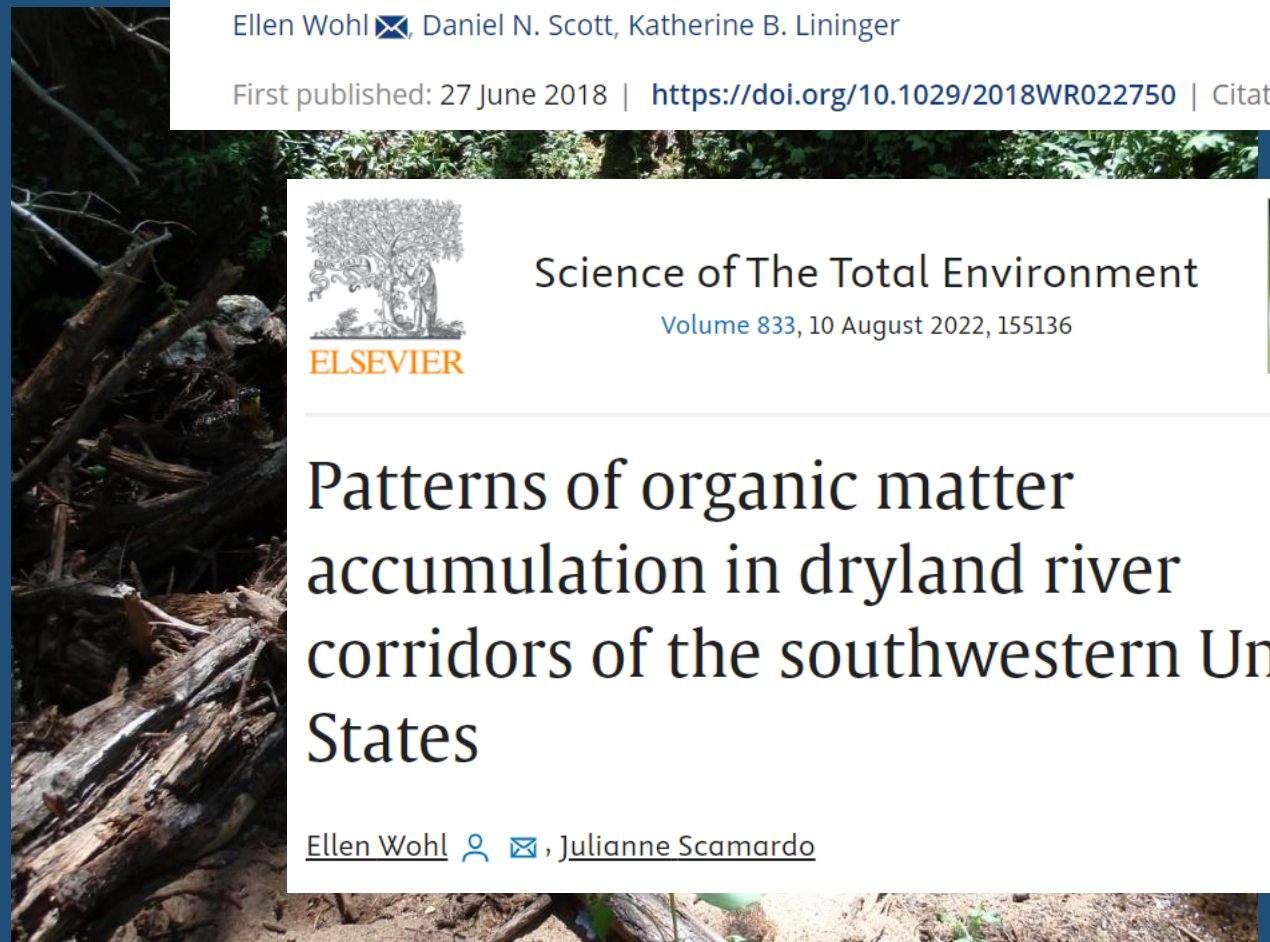
Water Resources Research

Research Article | Free Access

Spatial Distribution of Channel and Floodplain Large Wood in Forested River Corridors of the Northern Rockies

Ellen Wohl, Daniel N. Scott, Katherine B. Lininger

First published: 27 June 2018 | https://doi.org/10.1029/2018WR022750 | Citations: 25



ELSEVIER

Science of The Total Environment

Volume 833, 10 August 2022, 155136

Patterns of organic matter accumulation in dryland river corridors of the southwestern United States

Ellen Wohl, Julianne Scamardo

Implications of Spatial Heterogeneity in River Corridors

4) co

(chan ream)

Freshwater Biology

Full Access

Connectivity and biocomplexity in waterbodies of riverine floodplains

C. AMOROS, G. BORNETTE

First published: 03 April 2002 | https://doi.org/10.1046/j.1365-2427.2002.00905.x | Citations: 645

The River Discontinuum: Applying Beaver Modifications to Baseline Conditions for Restoration of Forested Headwaters

Denise Burchsted, Melinda Daniels, Robert Thorson, Jason Vokoun

Author Notes

BioScience, Volume 60, Issue 11, December 2010, Pages 908–922, https://doi.org/10.1525/bio.2010.60.11.7

East Inlet Creek, Colorado

Legacies of Human Activities

Global loss of old-growth forest & active wood removal from river corridors
(reduced forest cover by half & nearly eliminated old growth)

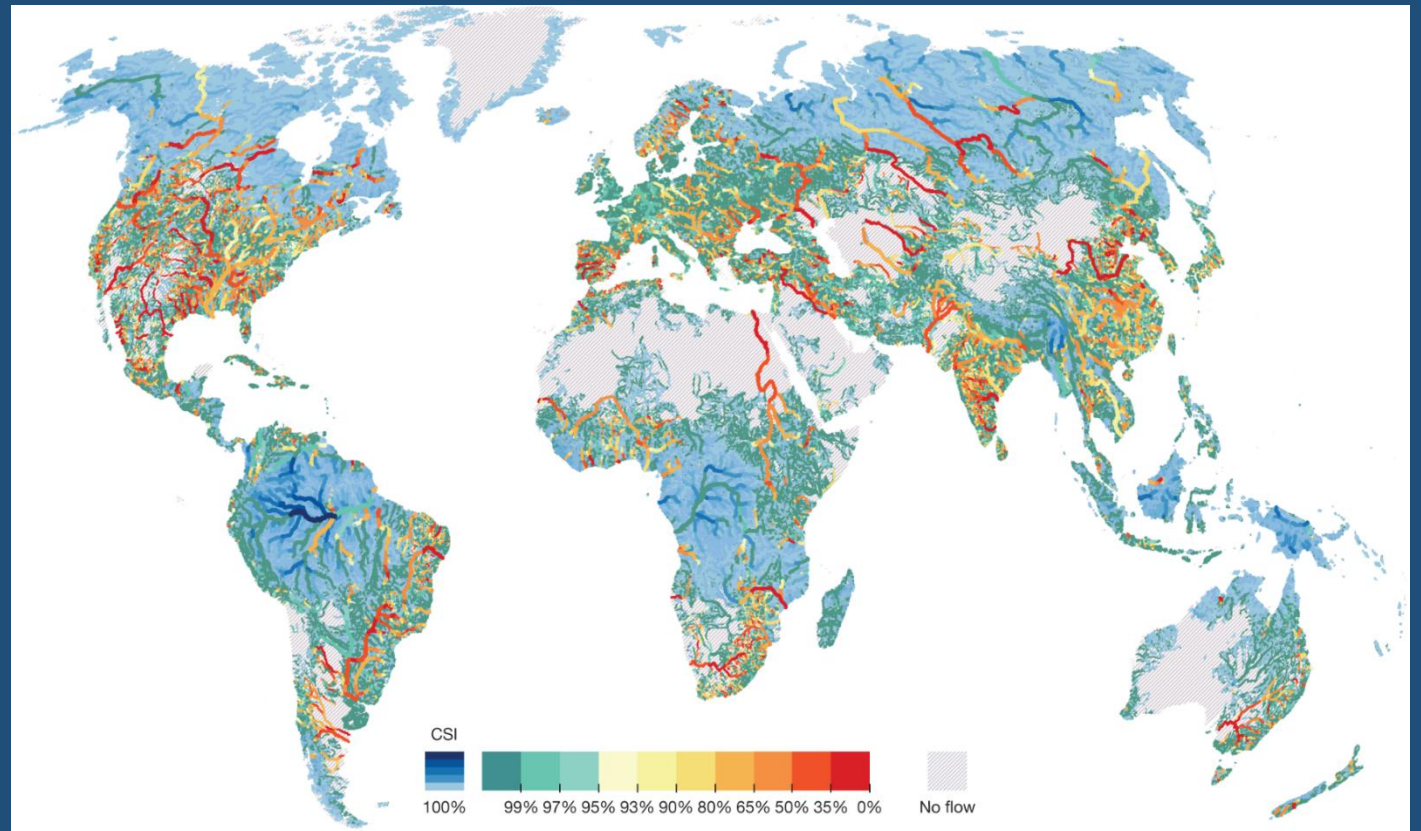
Currently 6-12 million beaver in North America; historically, more like 60-400 million

Global flow regulation (dams, diversions) – considering just dams, only 23% of rivers flow uninterrupted to the ocean

Channelization

Floodplain drainage

levees (17,000 km^2 floodplain alteration in CONUS)



Grill et al., 2019, Nature, Fig. 1

Legacies of Human Activities – homogeneity & simplicity

River Metamorphosis

heterogeneous to homogeneous

driven by presence or absence of

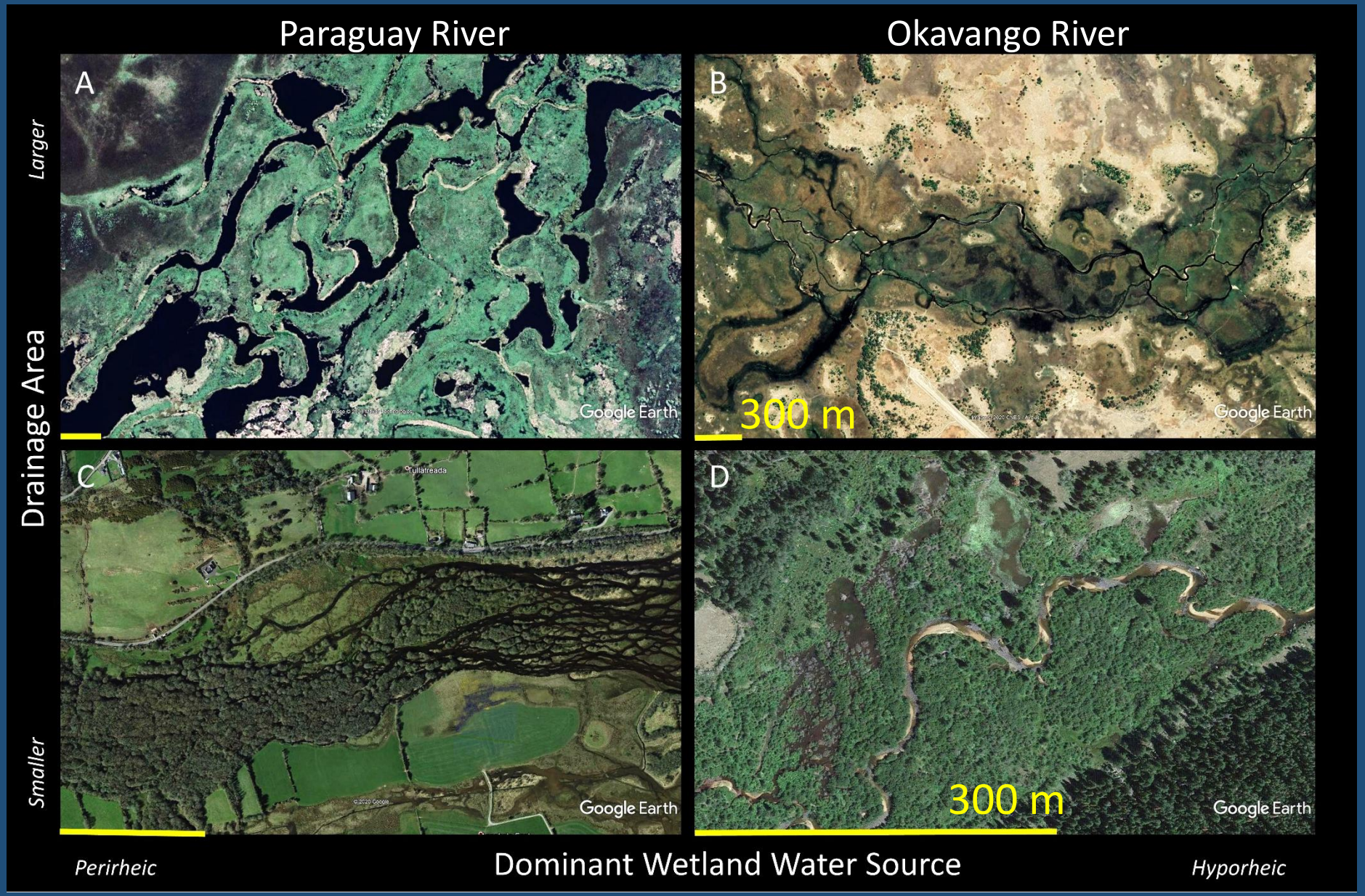
spatial & temporal variations in inputs & biota

geomorphic integrity (ability to adjust to variations)

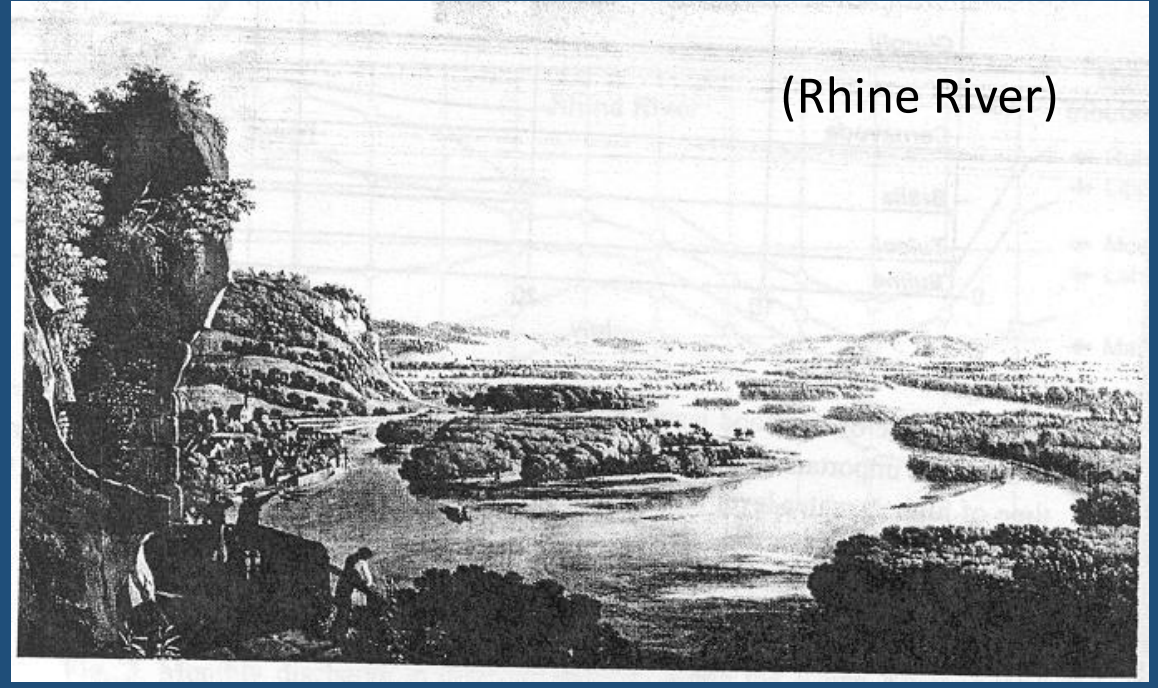
rivers become ‘leaky’ as heterogeneity & retention are lost

River wetland corridors – treed & treeless – historically more abundant

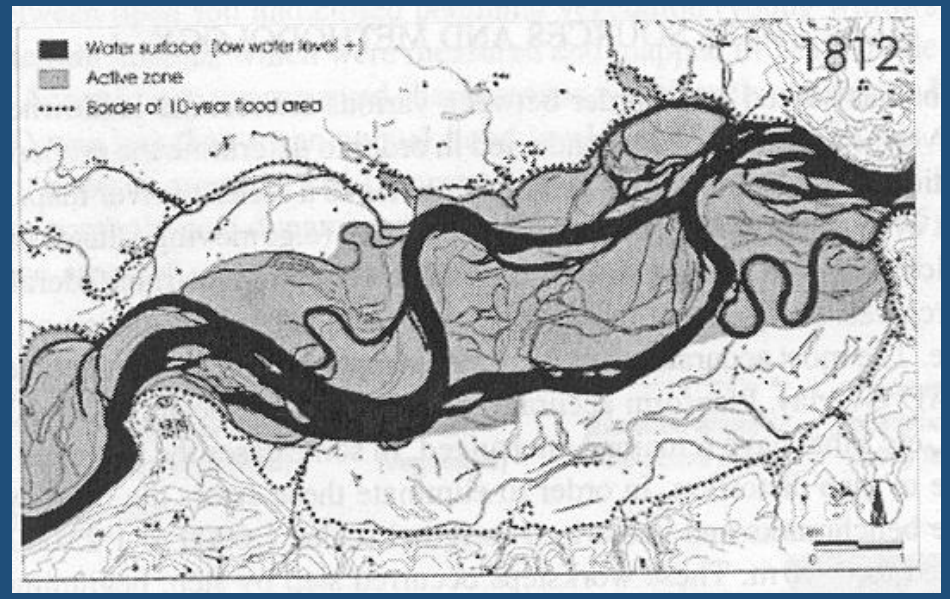
Now rare because of channelization
floodplain land drainage
flow regulation
removal of instream obstacles

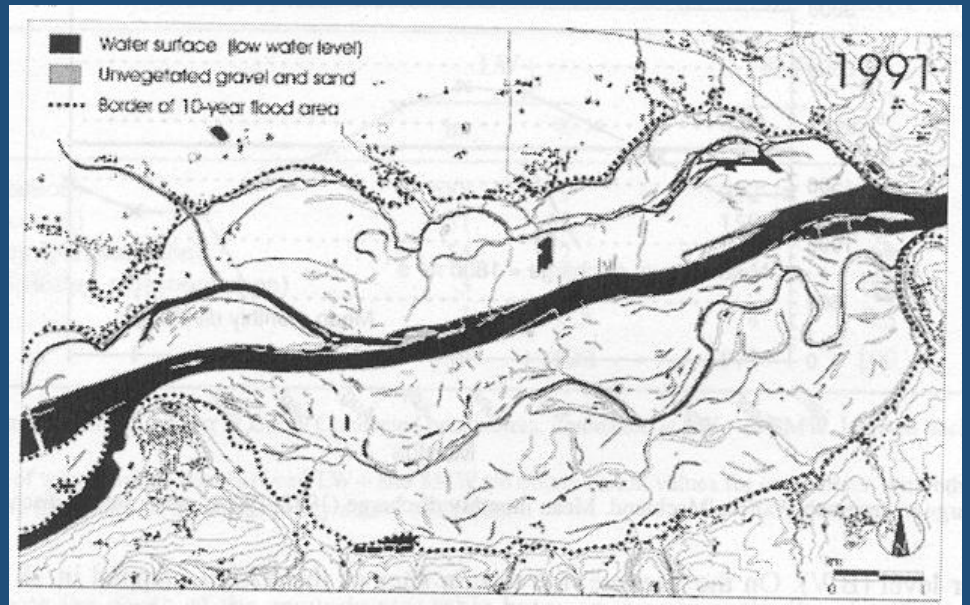


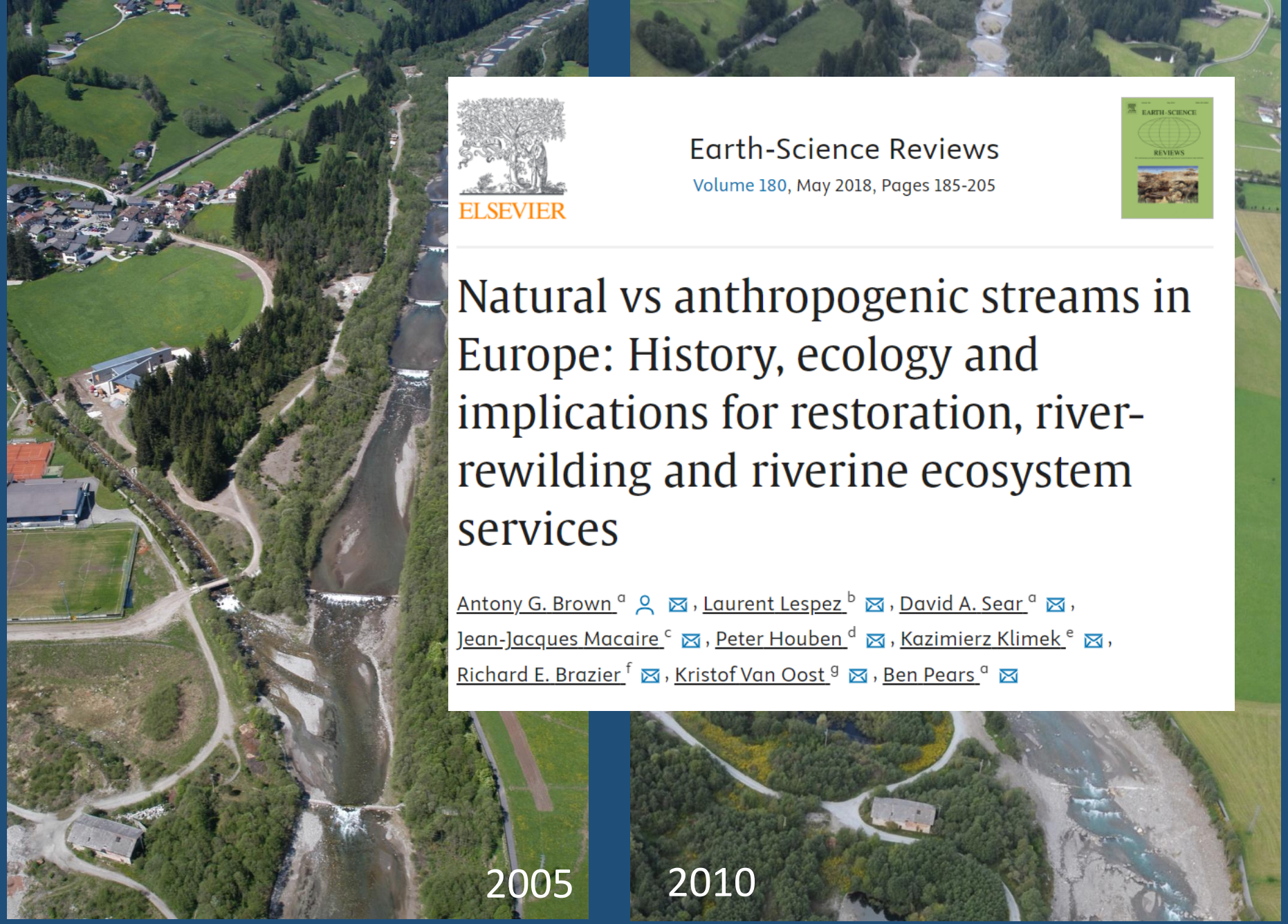
Wohl et al., 2021, Frontiers in Earth Science, Fig. 1



Danube near Linz, Austria *(Hohensinner et al., 2004, River Research & Applications)*







ELSEVIER

Earth-Science Reviews

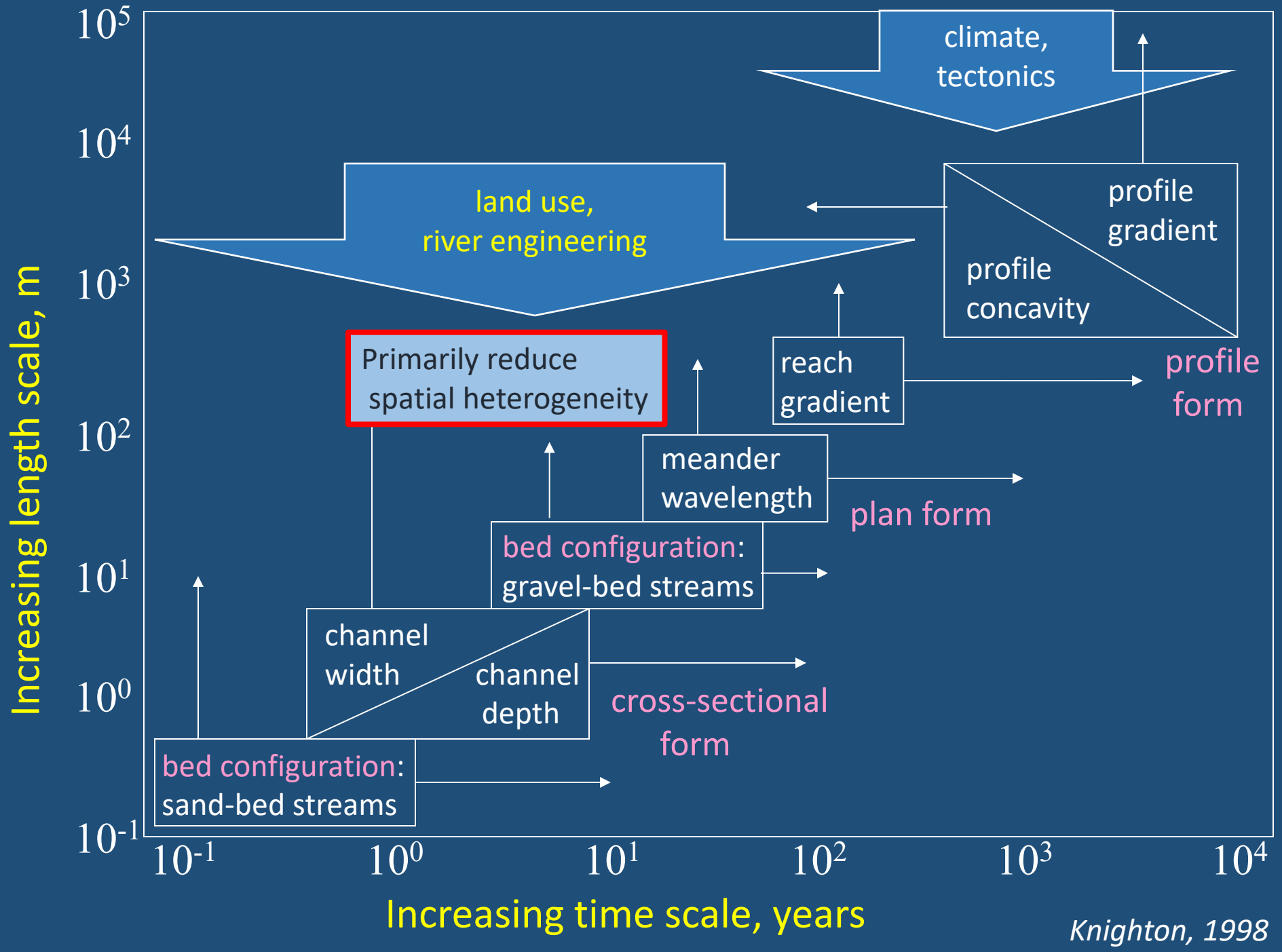
Volume 180, May 2018, Pages 185-205

Natural vs anthropogenic streams in Europe: History, ecology and implications for restoration, river-rewilding and riverine ecosystem services

Antony G. Brown [a], Laurent Lespez [b], David A. Sear [a], Jean-Jacques Macaire [c], Peter Houben [d], Kazimierz Klimek [e], Richard E. Brazier [f], Kristof Van Oost [g], Ben Pears [a]

Scorpio et al., 2020, Earth Surf. Proc. & Landf.

Reconnecting secondary channels along the Mareit River, Italy (courtesy of Francesco Comiti)



Knighton, 1998

Legacies of Human Activities – sediments, contamination

Legacy sediments are those altered by human activities

Alterations include

- human-caused aggradation (and subsequent erosion), such as sediment accumulating upstream from relict or contemporary dams,
- human-caused lack of continuing deposition that results in changing moisture & nutrient levels within existing sediments, such as on floodplains that no longer receive lateral or vertical accretion deposits because of levees, bank stabilization, & other channel engineering
- human-generated contaminants such as PCBs and pesticides that adsorb to fine sediment.

Restoration Options

active vs passive – to restore physical & ecological integrity

active

- reconnecting secondary channels & floodplains
- reintroducing large wood (fixed & mobile pieces)
- reintroducing or mimicking beaver
- valley reset (e.g., Big Spring Run, PA)