Partnering with Nature's River Restorers

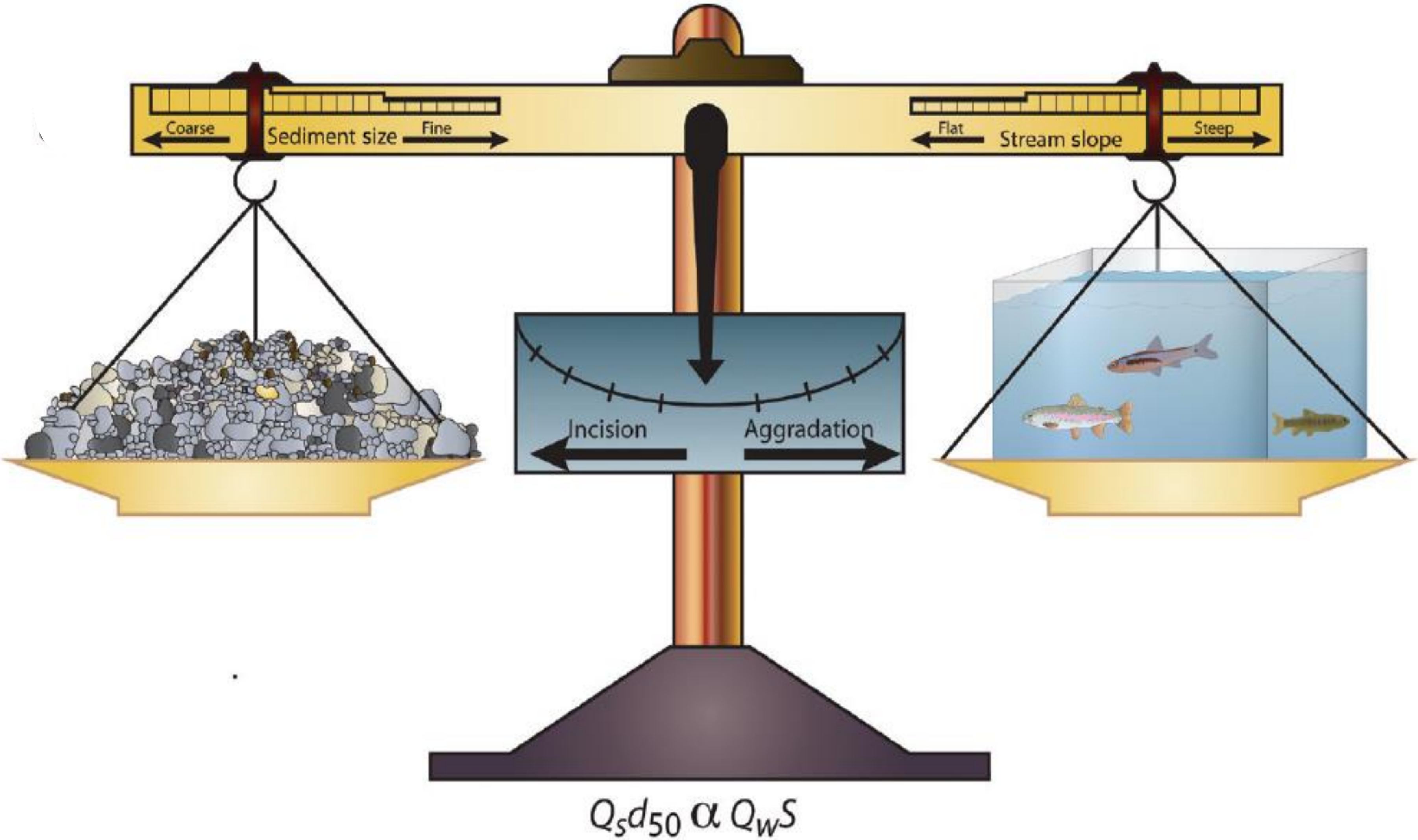
Colin Thorne,
Chair of Physical Geography,
University of Nottingham, UK
Colin.thorne@nottingham.ac.uk

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

NATURAL CHANNEL SYSTEMS
5th International Conference
September 26 & 27, 2016
Niagara Falls, Ontario

Contributors

- Janine Castro, US Fish and Wildlife Service
- Matthew Johnson, University of Nottingham
- Stephen Rice, University of Loughborough
- Cherie Westbrook, University of Saskatchewan
- Stuart Rood, University of Lethbridge
- David Cooper, Colorado State University
- Christopher Anderson, Centro Austral de Investigaciones Científicas
- Kelley Jorgensen, Wapato Valley Restoration Mitigation Bank
- Brandon Sansom, State University of New York at Buffalo

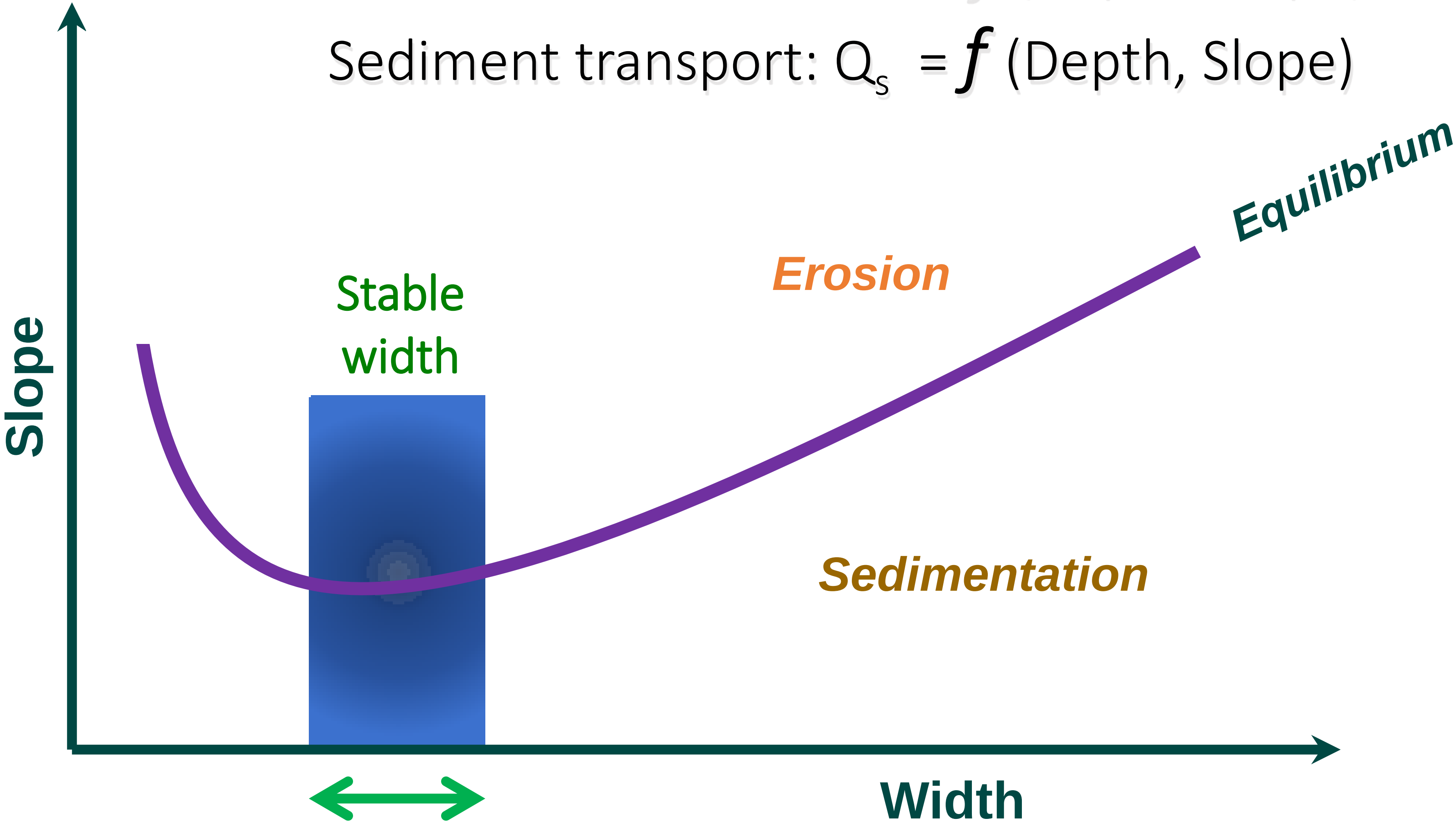


Lane Balance as adapted by Pollock et al., 2014

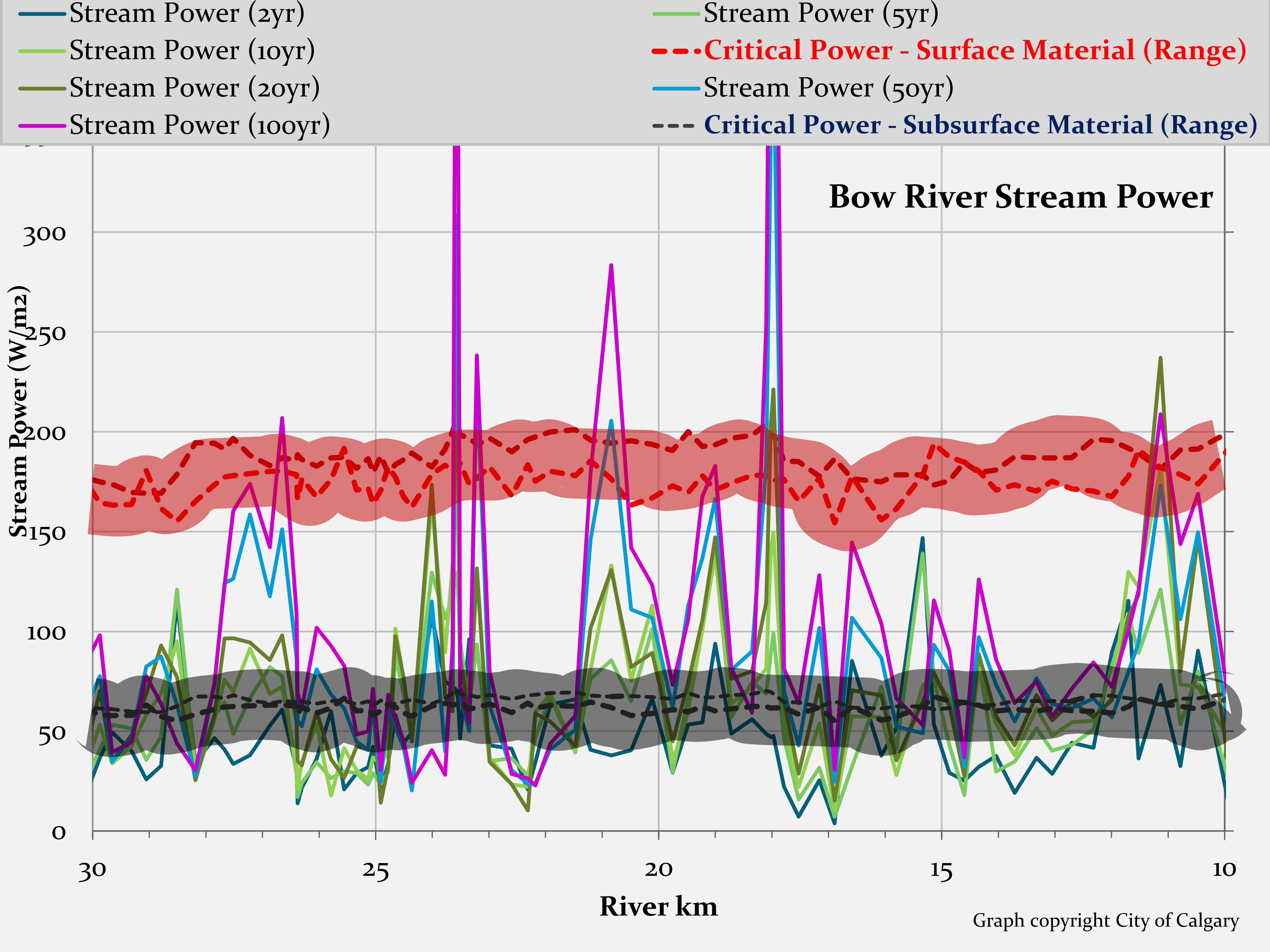
Copeland Method: for a given Width:

Flow resistance: $Q = f\,(\text{Depth, Slope})$

Sediment transport: $Q_s = f\,(\text{Depth, Slope})$

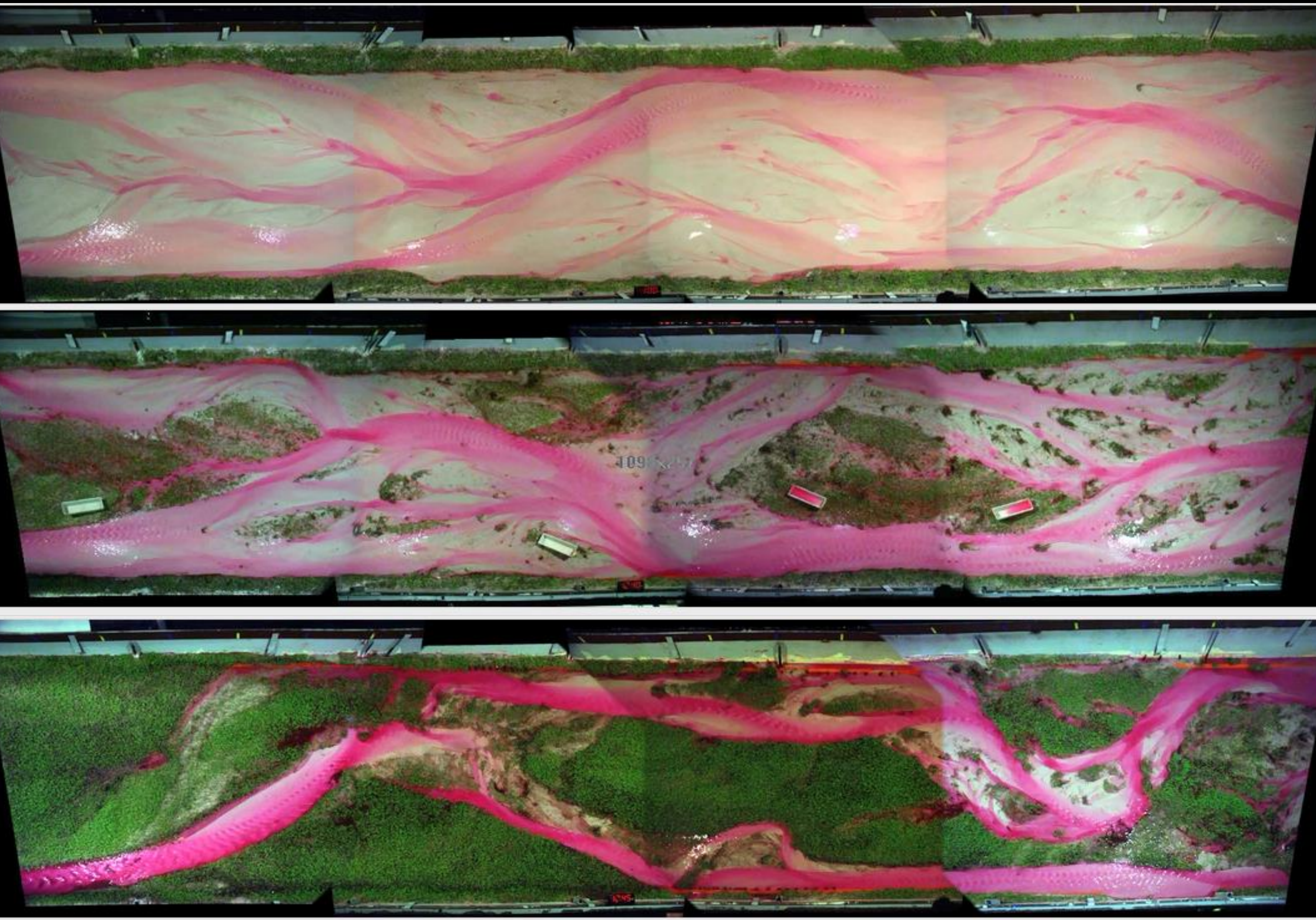


SAM = Stable Analytical Method


Stream Power (2yr)
Stream Power (5yr)
Stream Power (10yr)
Critical Power - Surface Material (Range)
Stream Power (20yr)
Stream Power (50yr)
Stream Power (100yr)
Critical Power - Subsurface Material (Range)
Bow River Stream Power
Stream Power (W/m2)
300
250
200
150
100
50
0
30
25
20
15
10
River km
Graph copyright City of Calgary

Gulliver “awoke to find that his arms and legs were tightly fastened to the ground”

http://www.engliterarium.com/2007/12/swifts-gullivers-travels-social-satire.html

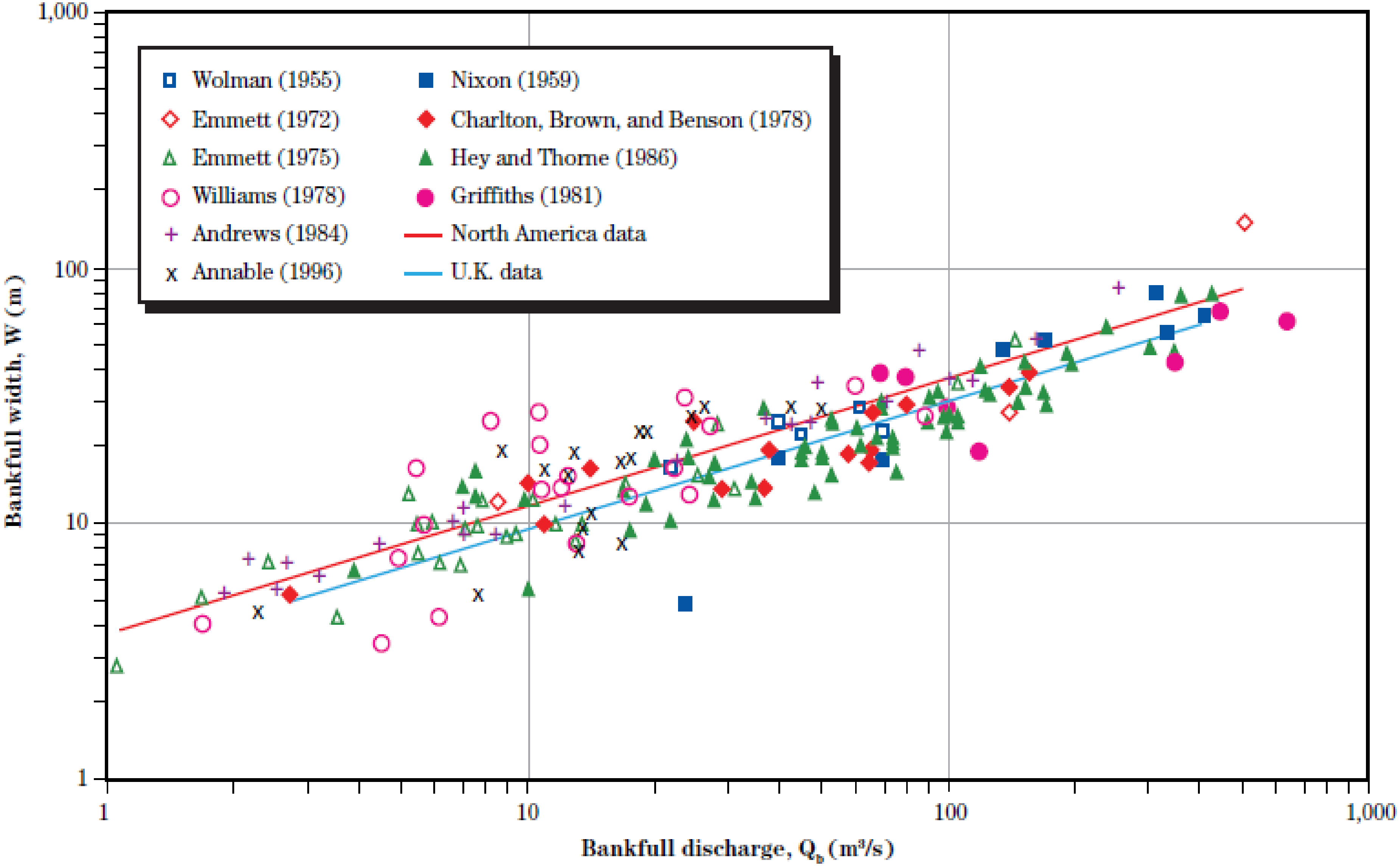


Mical Tal: Interactions between vegetation and braiding leading to a single-thread channel

"Fight the enemy where he isn't"

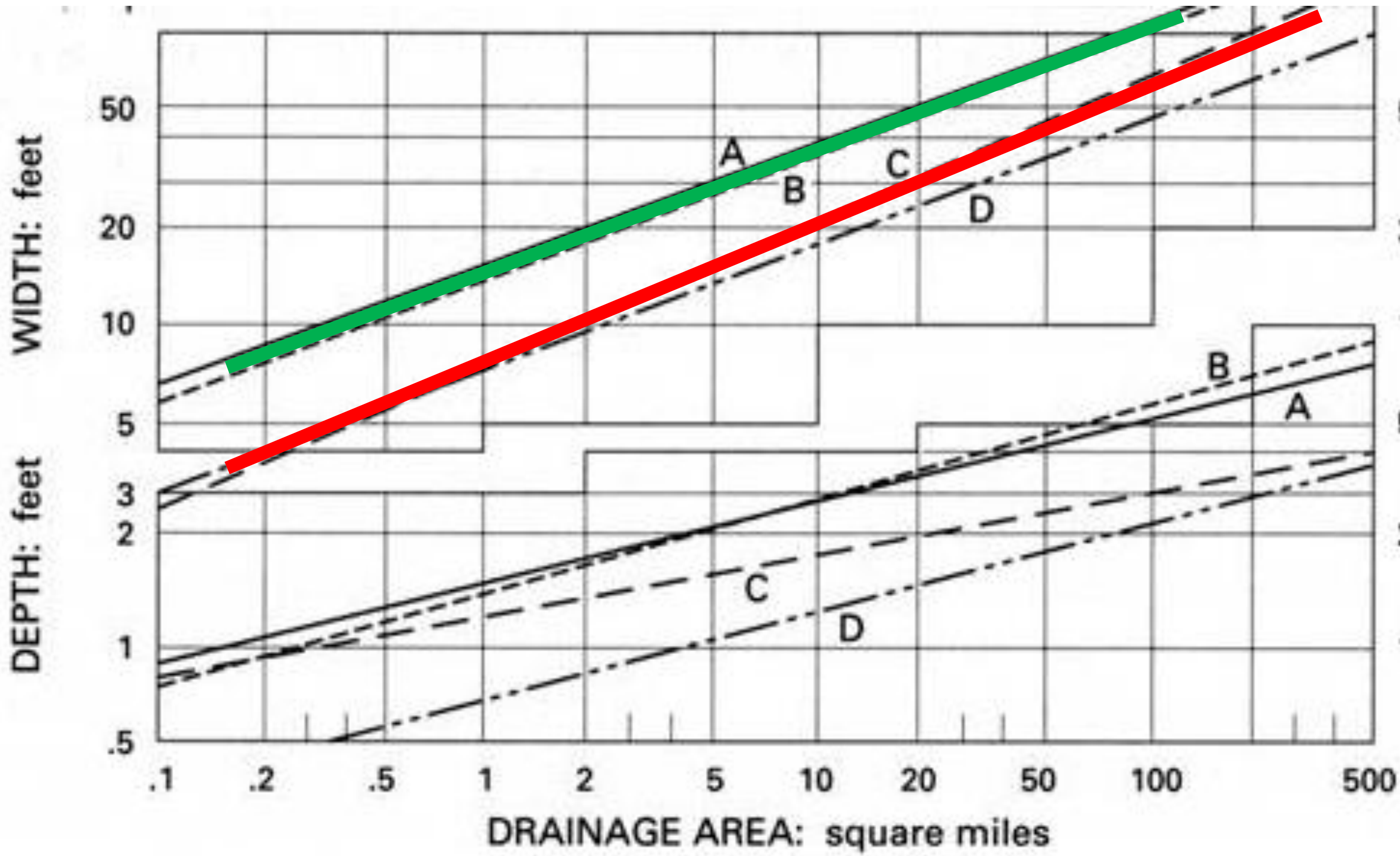
General Sun Tzu - 'The Art of War' (512 BC)

Mical Tal: Interactions between vegetation and braiding leading to single-thread channel - PhD thesis



Hydraulic Geometry: Width as a function of Discharge, USA and UK

Soar and Thorne (2001)



A San Francisco Bay region at 30" annual precipitation
B Eastern United States
C Upper Green River, Wyoming
D Upper Salmon River, Idaho (Emmett 1975)

Level III Ecoregions of the Continental United States

(Revised April 2013)

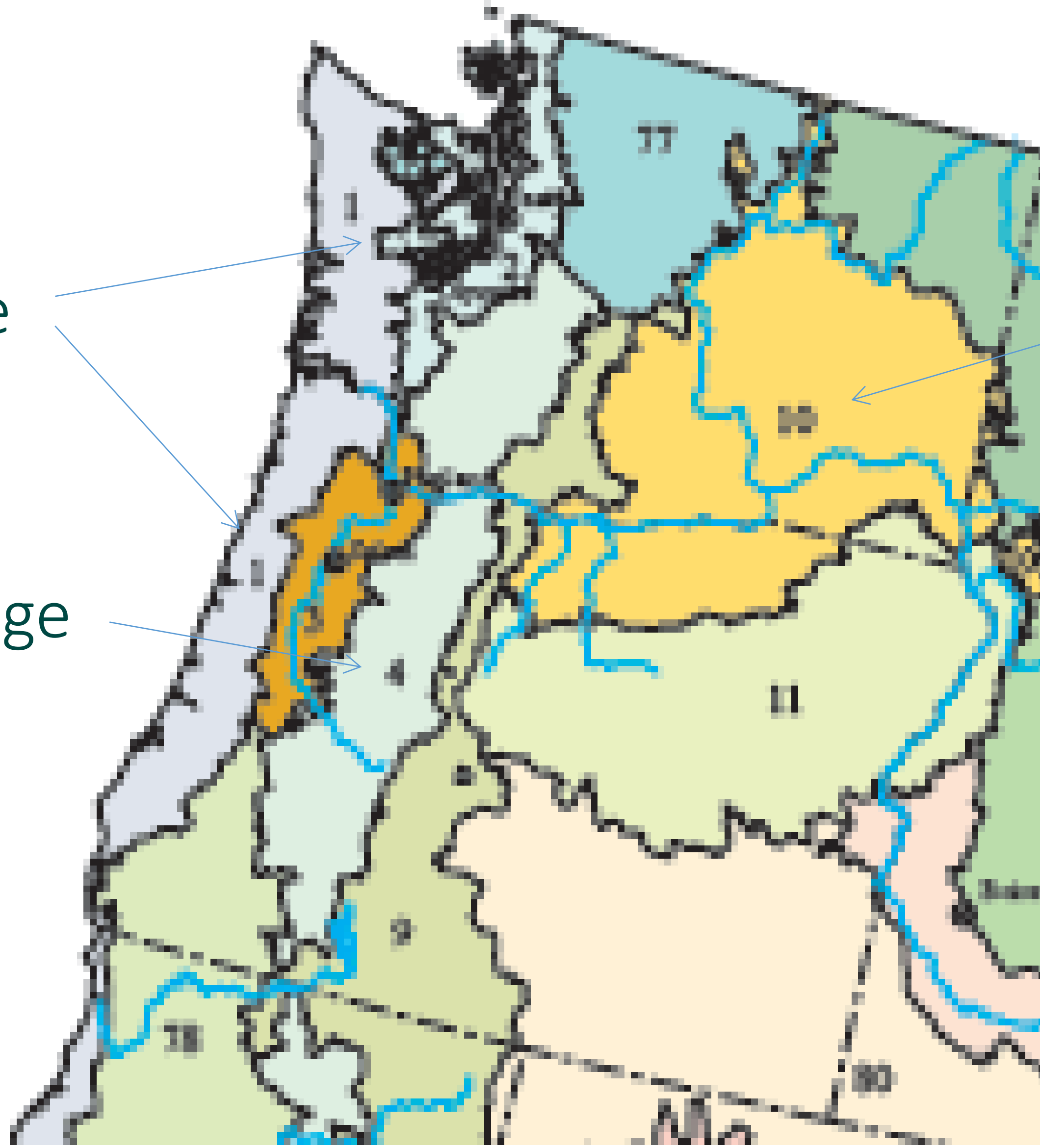
National Health and Environmental Effects Research Laboratory

U.S. Environmental Protection Agency

J.M. Omernik (1987)

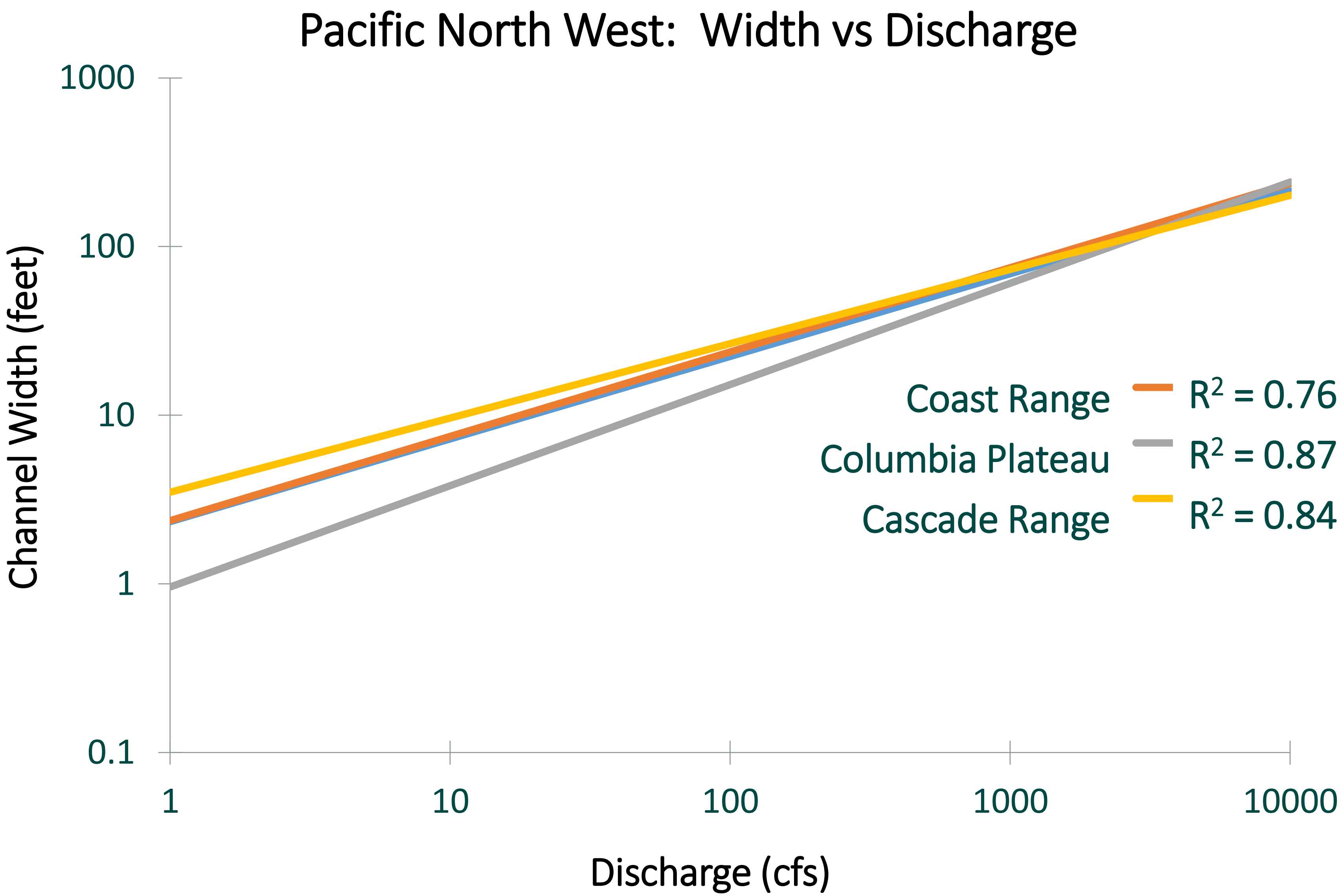
Coast Range

Cascade Range

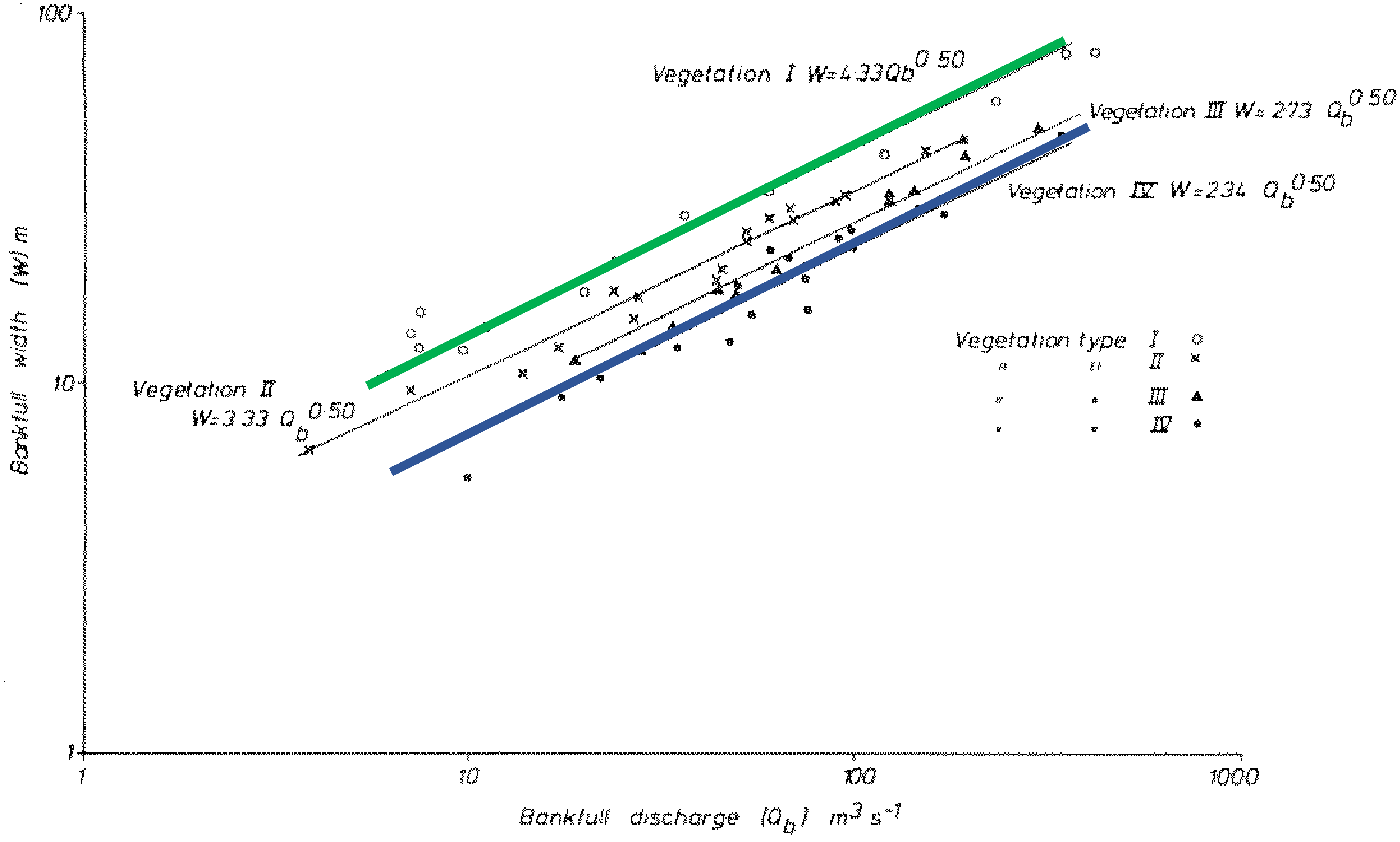


Columbia
Plateau

From: Castro (1996)



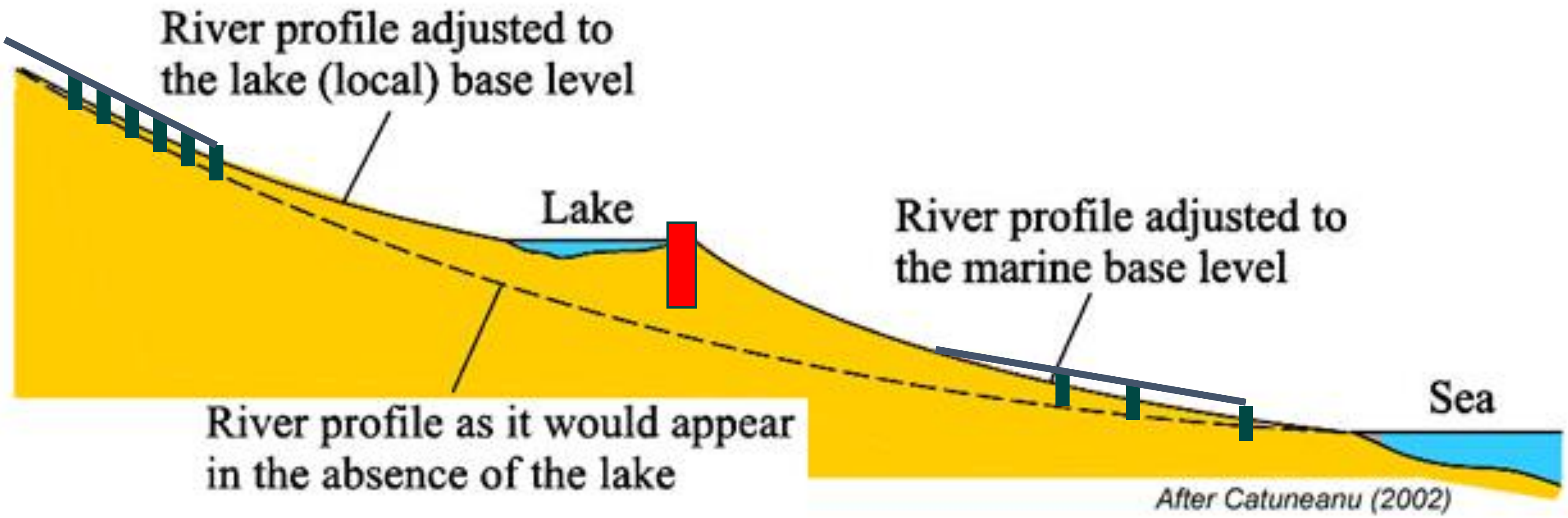
From: Castro (1996)



Hey and Thorne (1986)


Methow Beaver Project photo

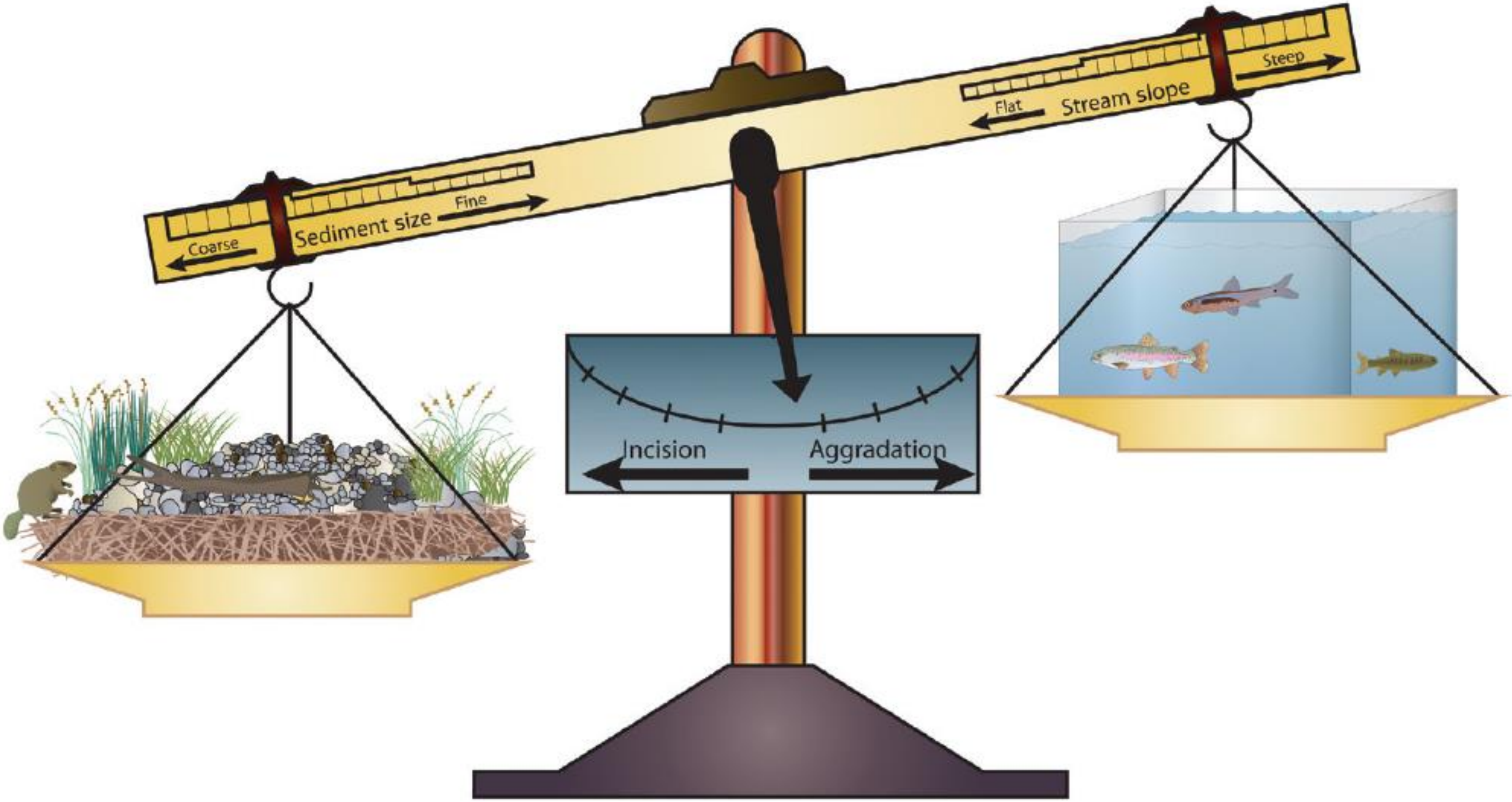

Base
Level
Control
brightsea.co.uk



Modified from: sepmstrata.org

From: TU.org

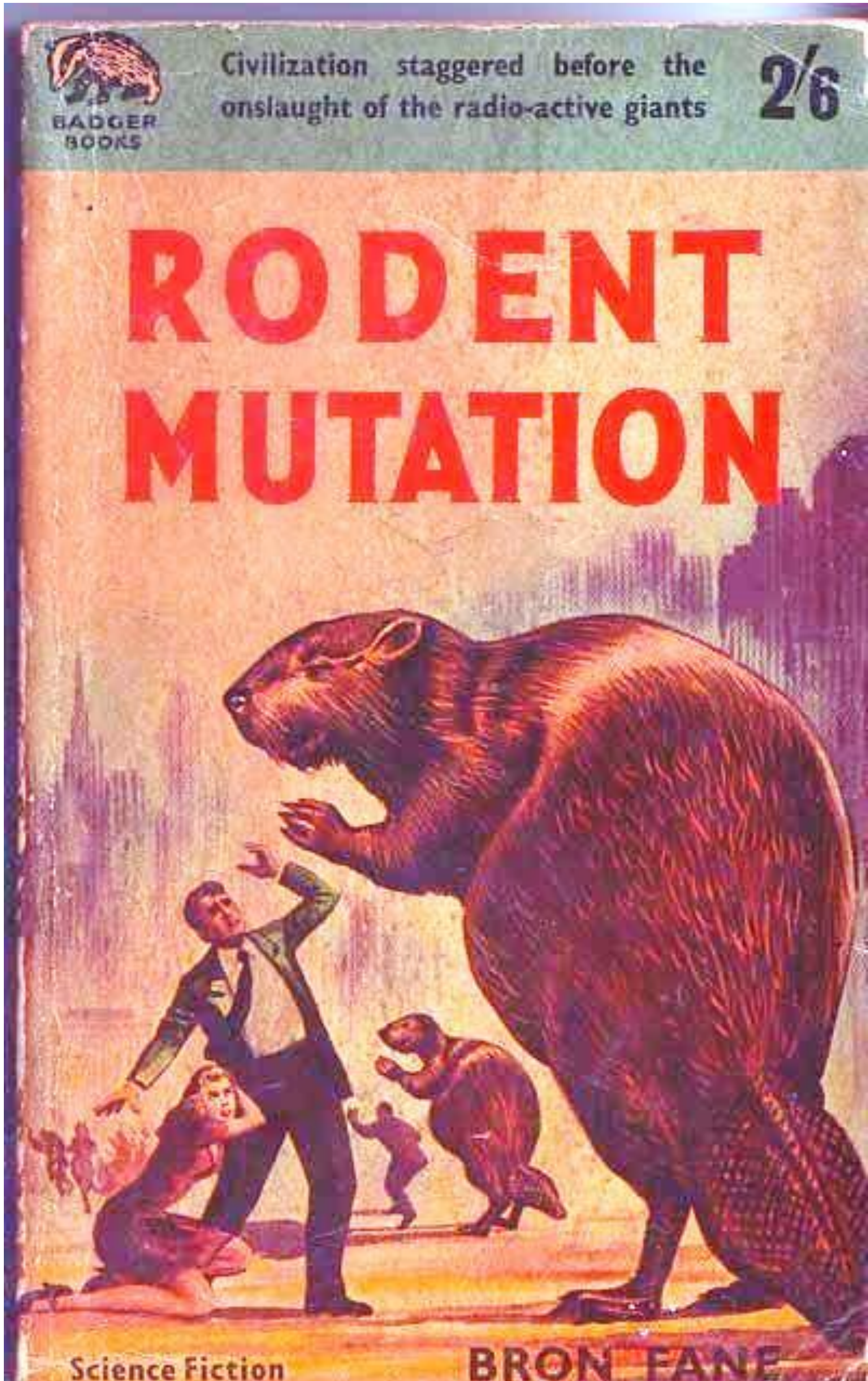
Colorado River, Rocky Mountain National Park

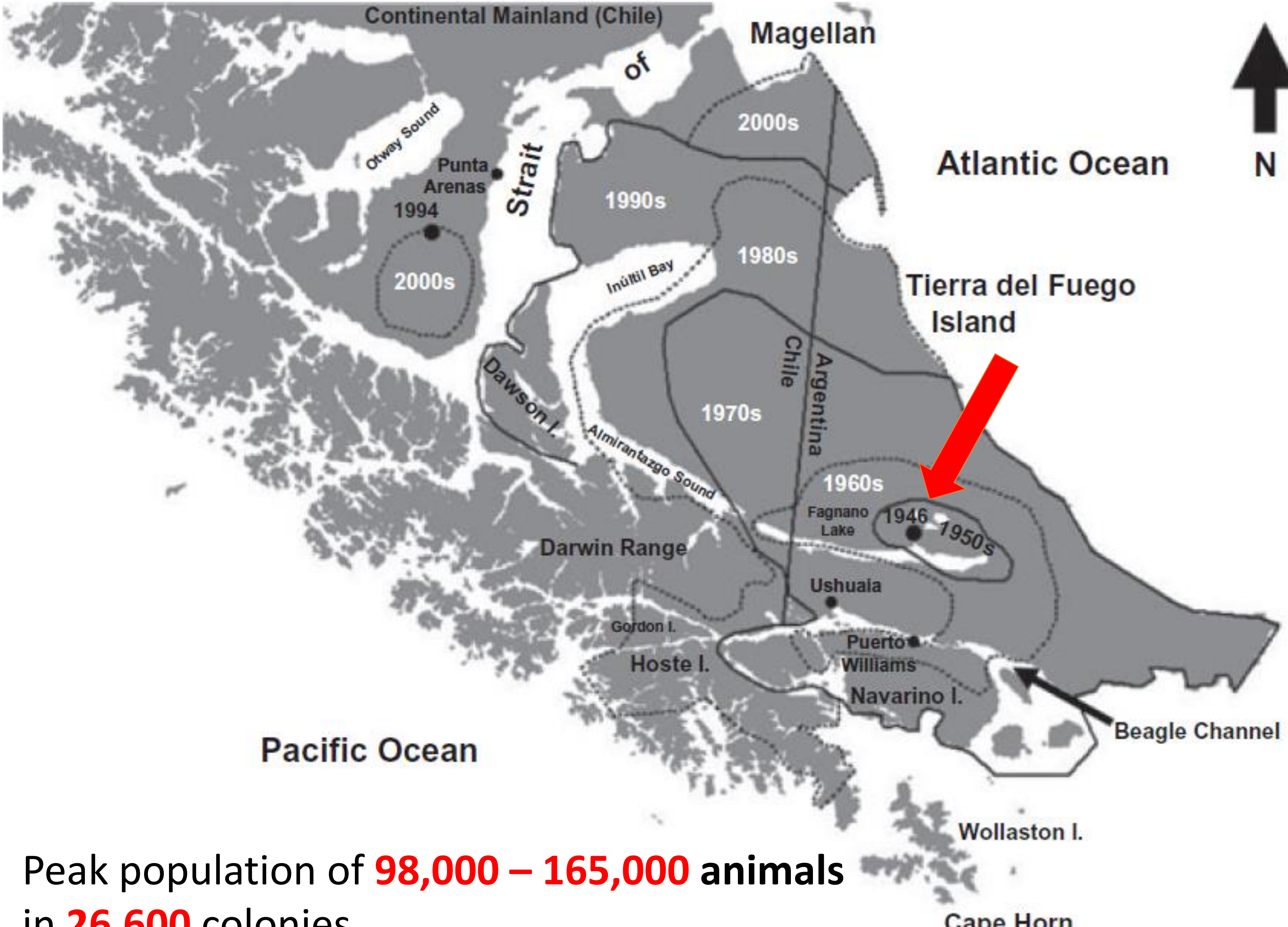


$$nQ_s d_{50} \,\alpha\, hS$$

Lane Balance as adapted by Pollock et al., 2014

Purposeful introduction of 20 beaver in the southern Andes in 1946





Peak population of **98,000 – 165,000 animals** in **26,600** colonies

Whitfield et al. (2015) Ambio

Beavers are capable of devastating ecosystems (inset).

J. ETCHEVERRY/ALAMY

Tierra del Fuego: the beavers must die

Industrious, shy herbivores they may be, but the beavers of the Tierra del Fuego archipelago on the southern tip of South America are such a menace that scientists are planning the largest eradication project ever attempted.

In the 1940s, 50 North American beavers (*Castor canadensis*) were introduced to the area by the Argentine government to help start a fur industry — their numbers have now swelled to an estimated 100,000. The aquatic rodents, which have thrived in the absence of native predators, have invaded roughly 16 million hectares of unique, indige-

"We will move in on the beavers in a rolling front."

areas become meadows that then invite exotic species. "The change in the forested portion of this biome is the largest landscape-level alteration in the Holocene — that is, approximately 10,000 years," Anderson says.

The Argentine and Chilean governments are now reviewing a feasibility study on a total eradication of these beavers, which was undertaken by an international team including Donlan. It would be an eradication over the largest area ever attempted "by an order of magnitude", Donlan says. Beaver-control projects, such as killing traps, are now being ramped up in a

he says, citing the recent eradication of some 140,000 goats from more than 500,000 hectares in the Galapagos Islands. The most likely scenario would be to go in with trappers and dogs using helicopters and boats, and adapting techniques from beaver control in the United States and Canada, Donlan says. "We'll have to move in on the beavers in a rolling front, going from watershed to watershed to remove them, with a massive monitoring programme behind it to make sure they have all been eradicated."

Anderson, who reviewed the feasibility study, also thinks eradi[illegible]
"The beavers only live

TH/HEDGEHOG HOUSE/MINDEN PICTURES/GETTY

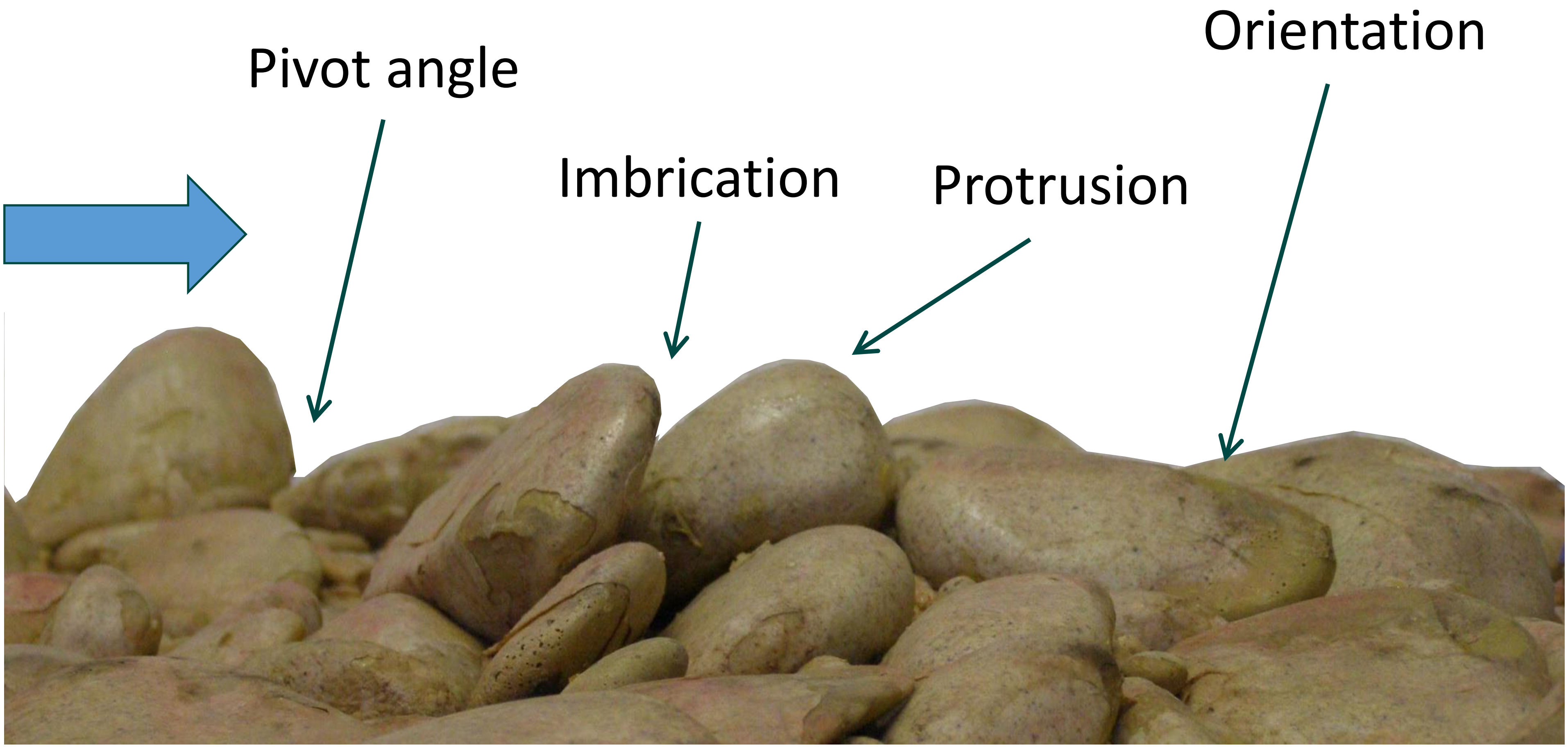
Nature 453: 7198 (Choi 2008)

Small animals -- Big impacts:

The cumulative effects of the other guys

Bed roughness and bed sediment transport

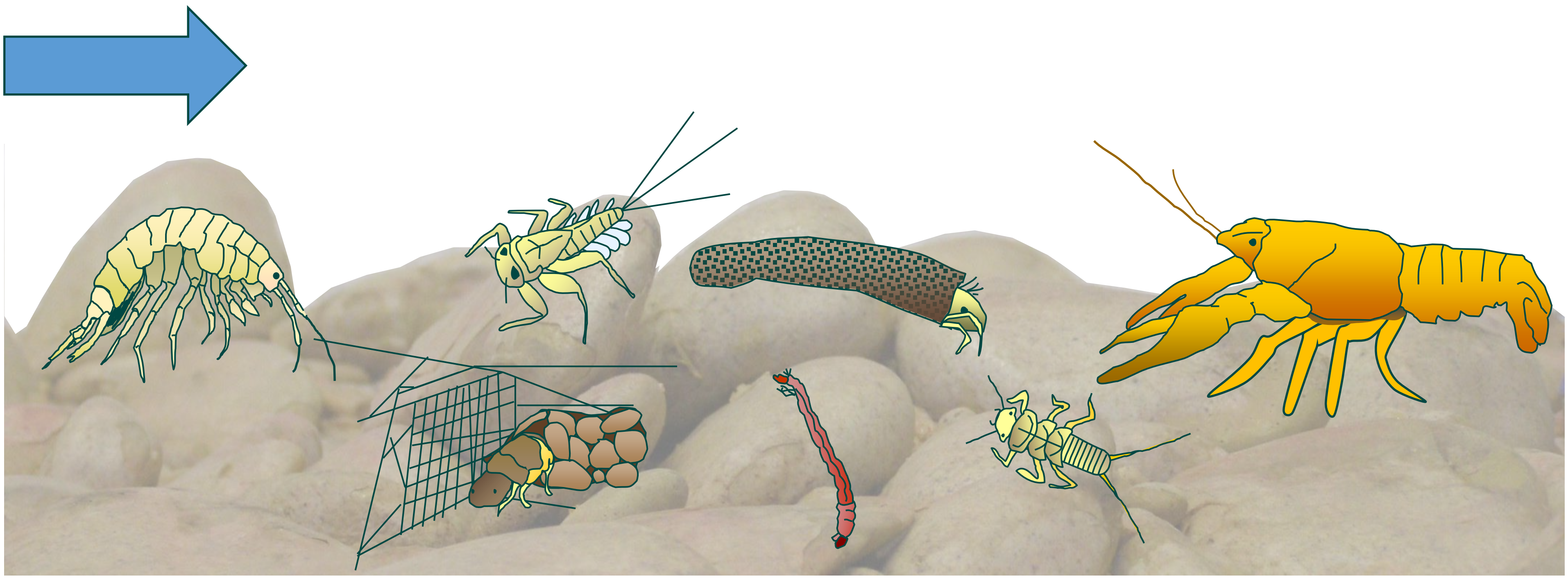
Sediment characteristics known to be related to grain-scale processes and micro-topography of the bed



Benthic life – animals live in and work on the bed

Relatively little is known about their impacts:

- Despite their known significance elsewhere
- Despite their great diversity and abundance
- Despite the known importance of grain-scale processes

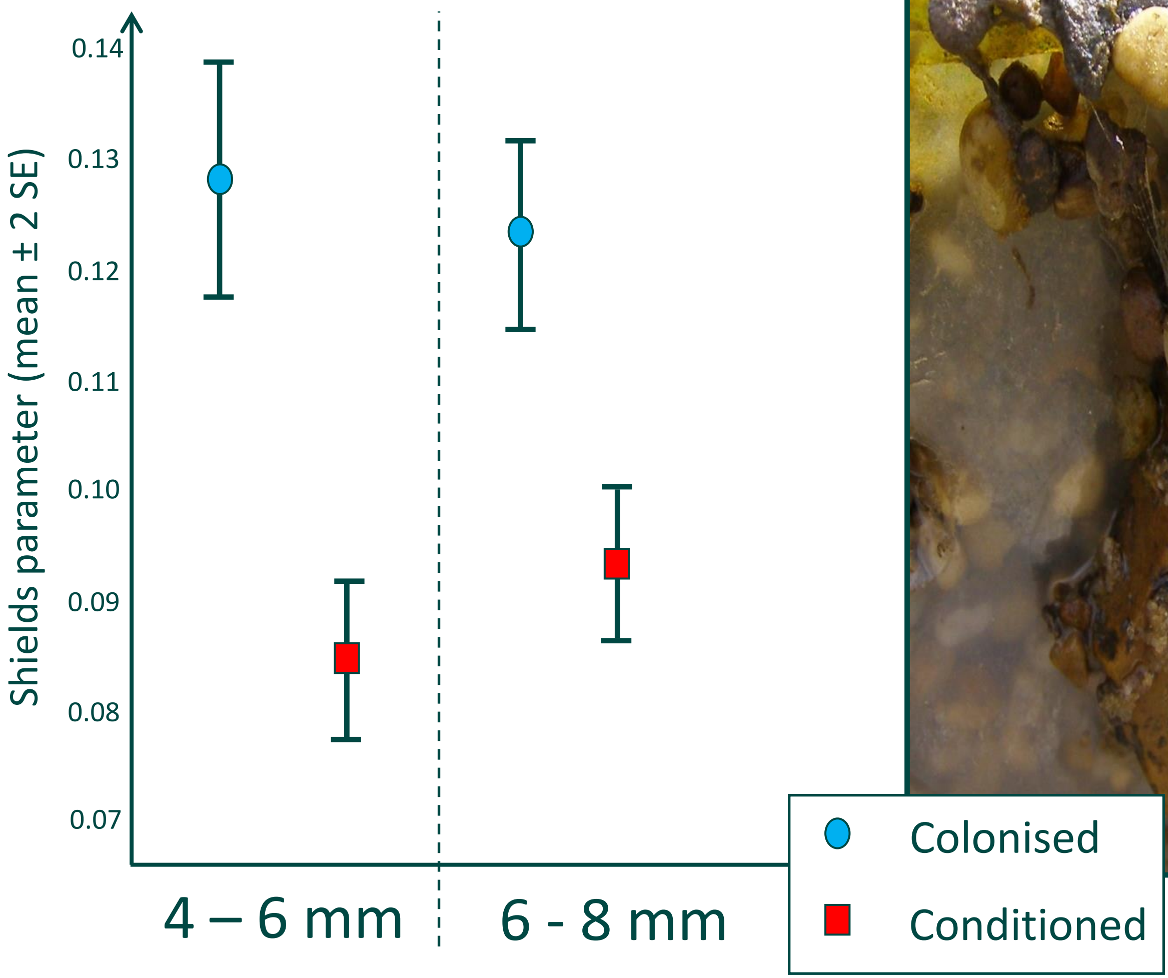


Caddisfly nets

- Dominate biomass
- Densities: 1,000s m^{-2}
- Km's of silk each year




Caddisfly nets



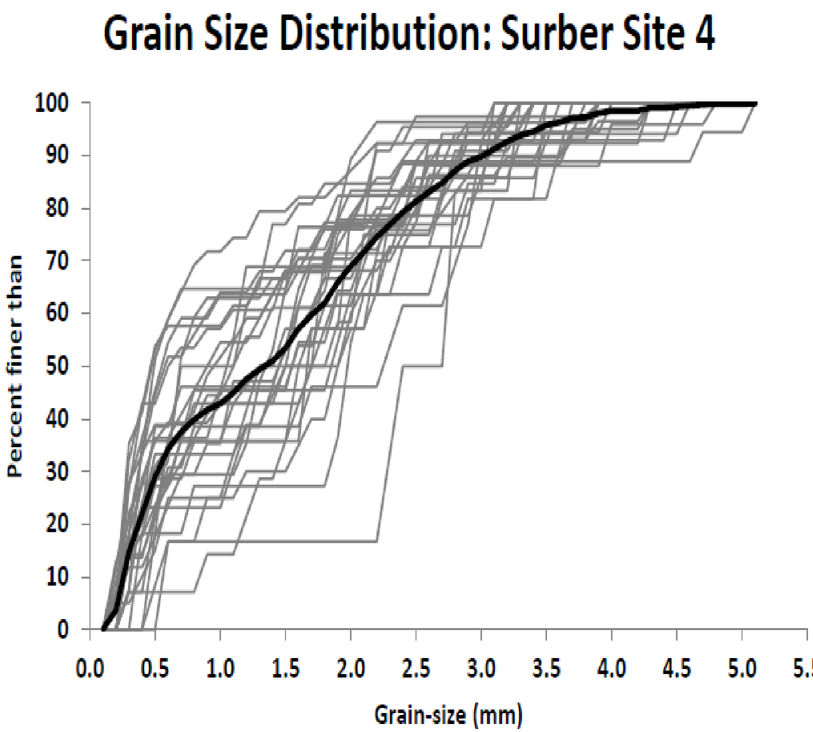
33 – 45% increase in critical dimensionless shear stress

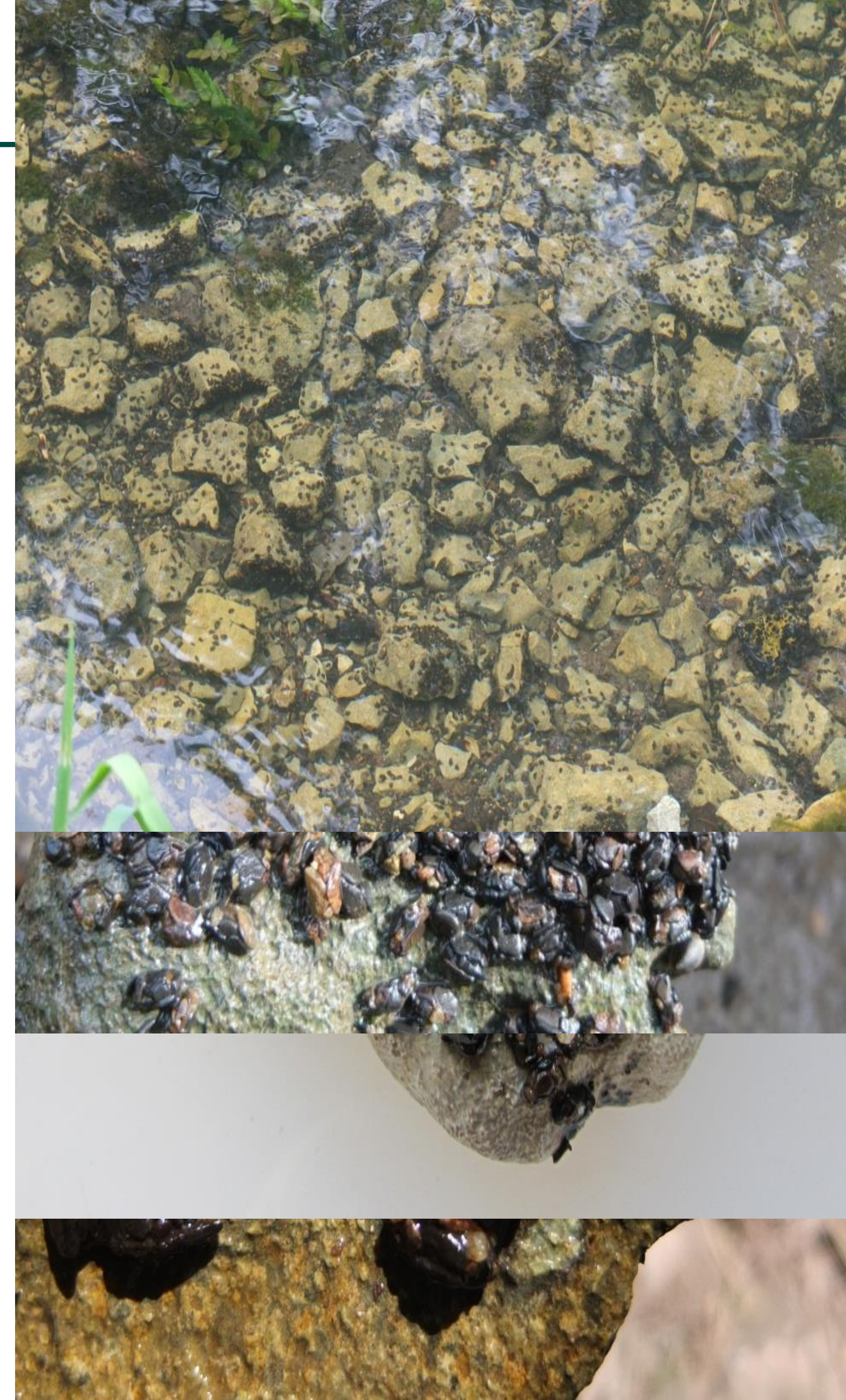
Caddisfly shell cases

12 million cases in a 5 km reach

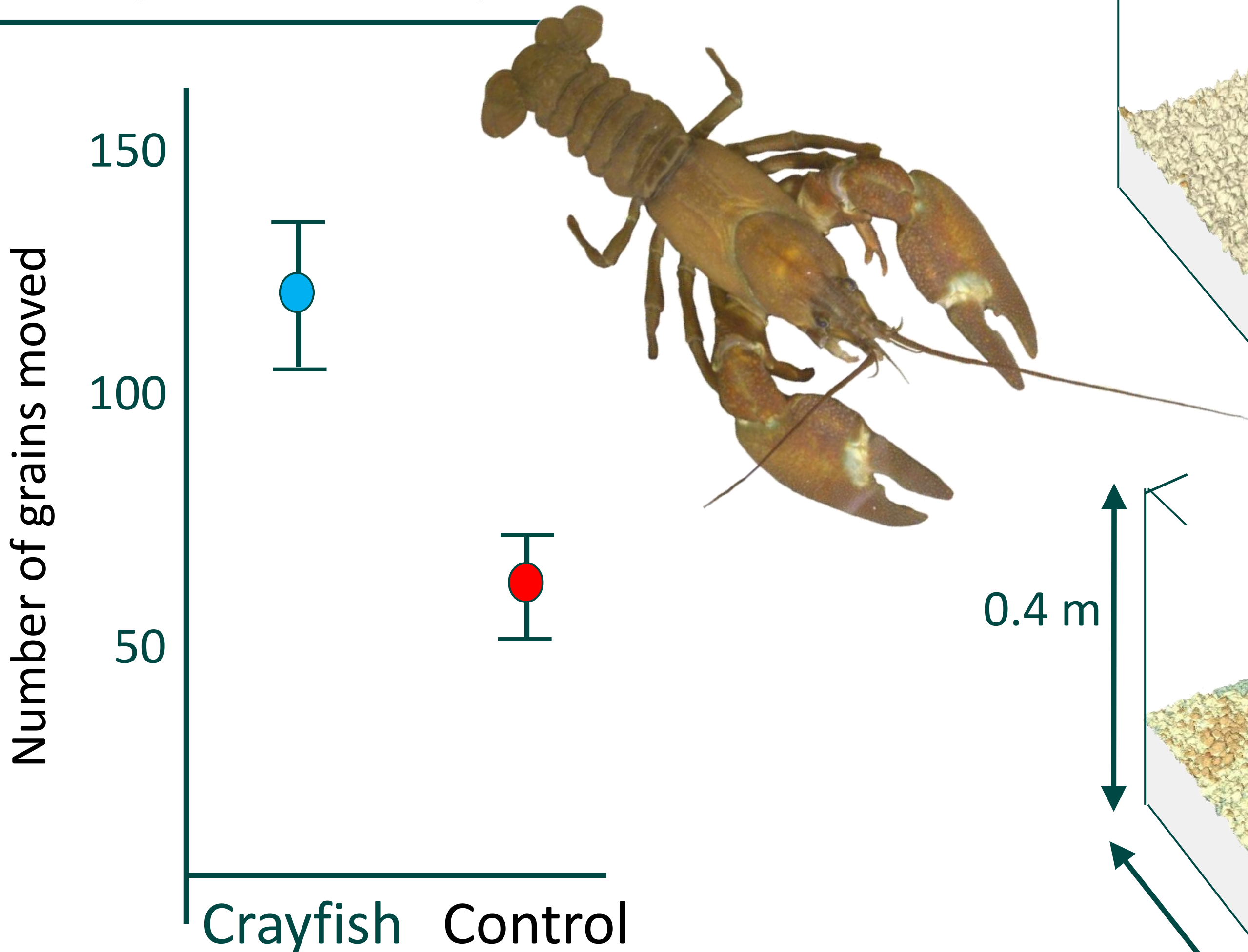
240 million grains (0.2– 5 mm)

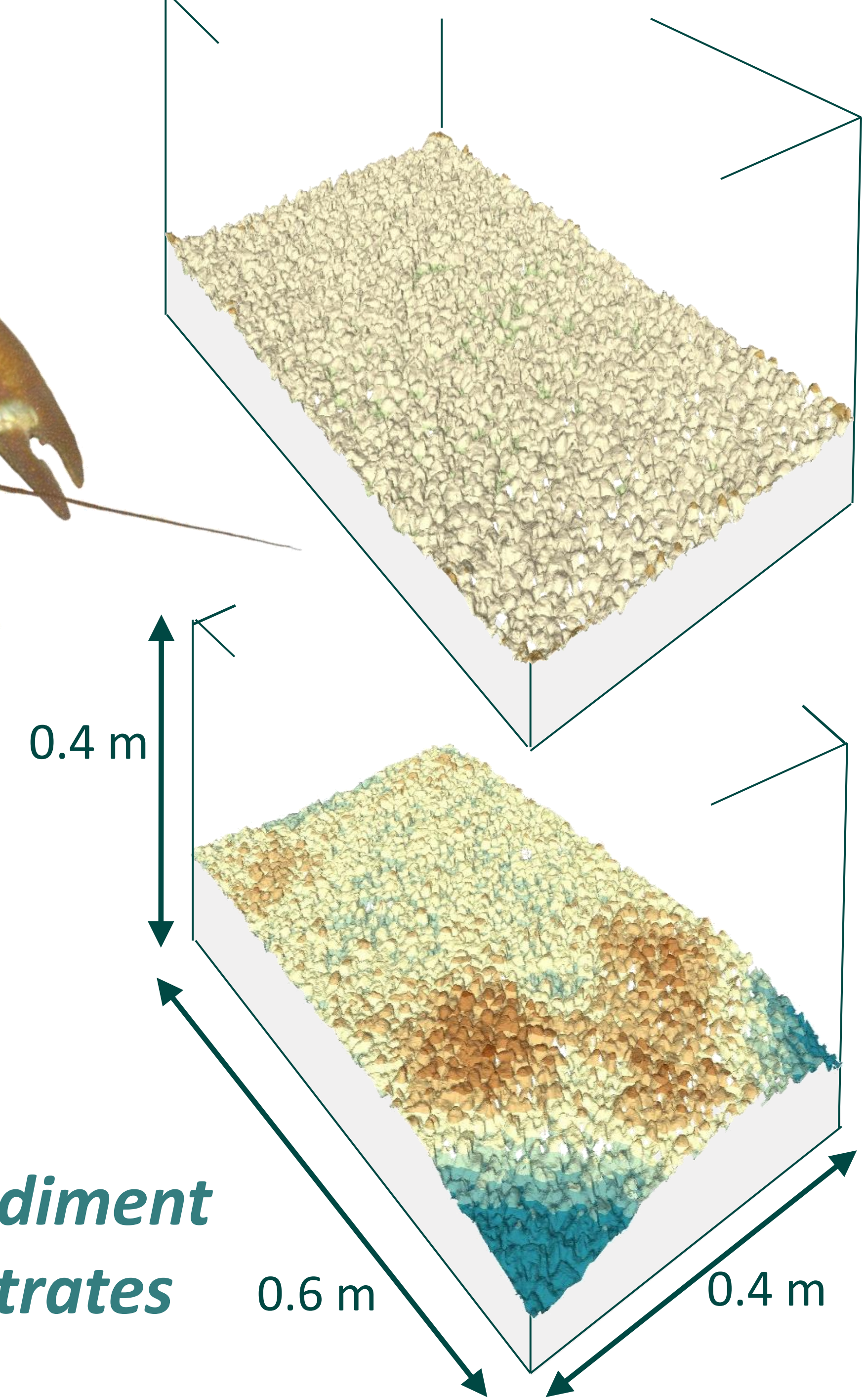
8 metric tonnes





Signal Crayfish



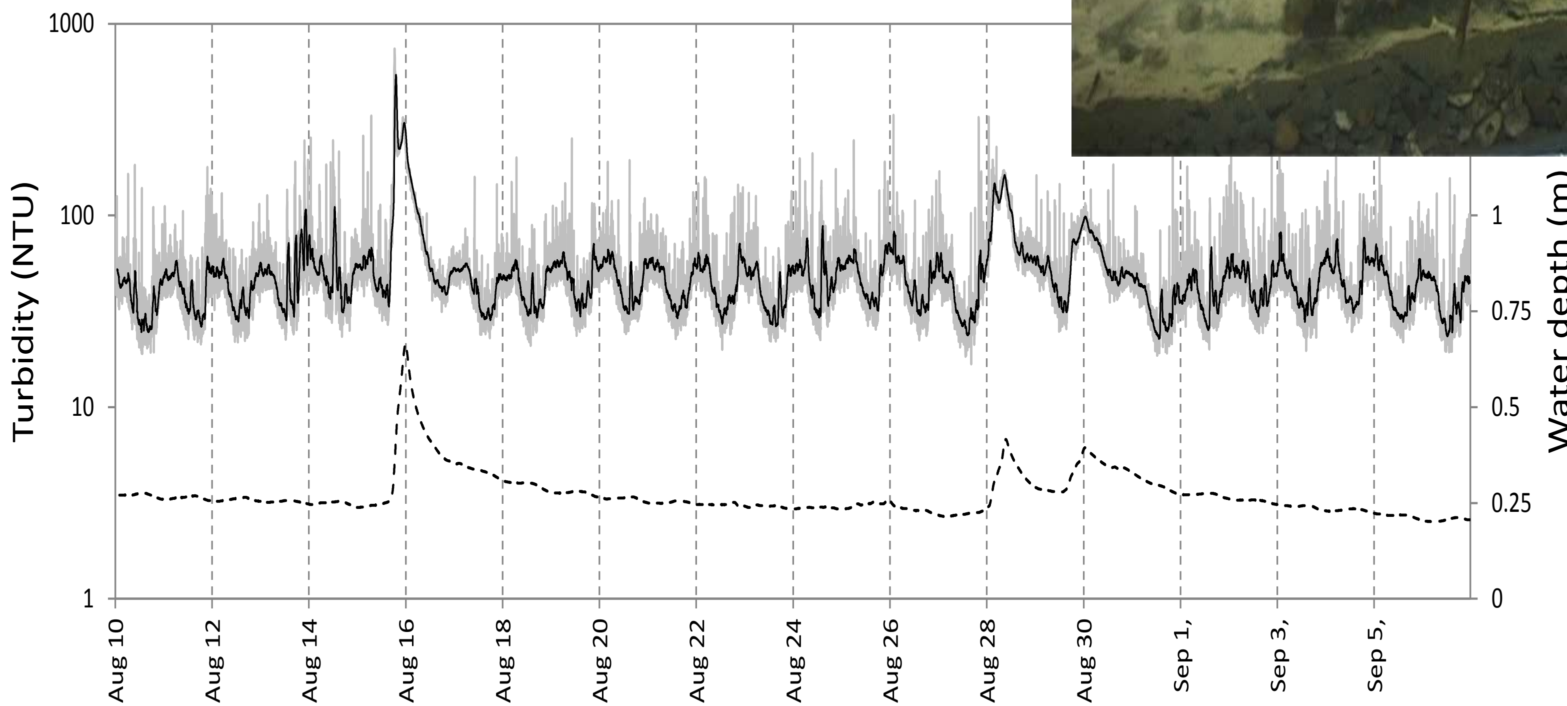


6-hours activity doubled bed sediment yield from water-worked substrates

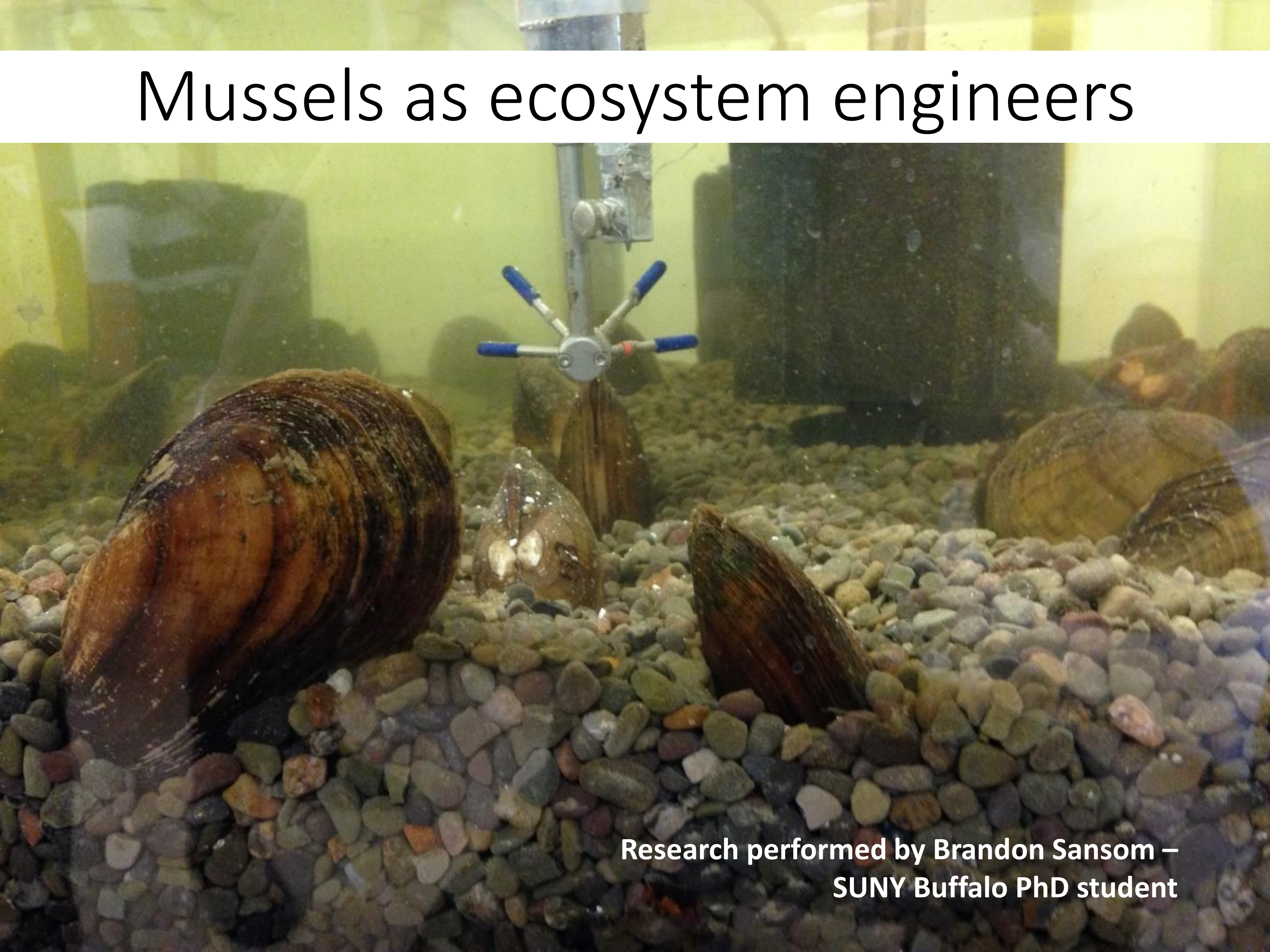
Crayfish

Turbidity peaks coincide with nocturnal peaks in crayfish activity.

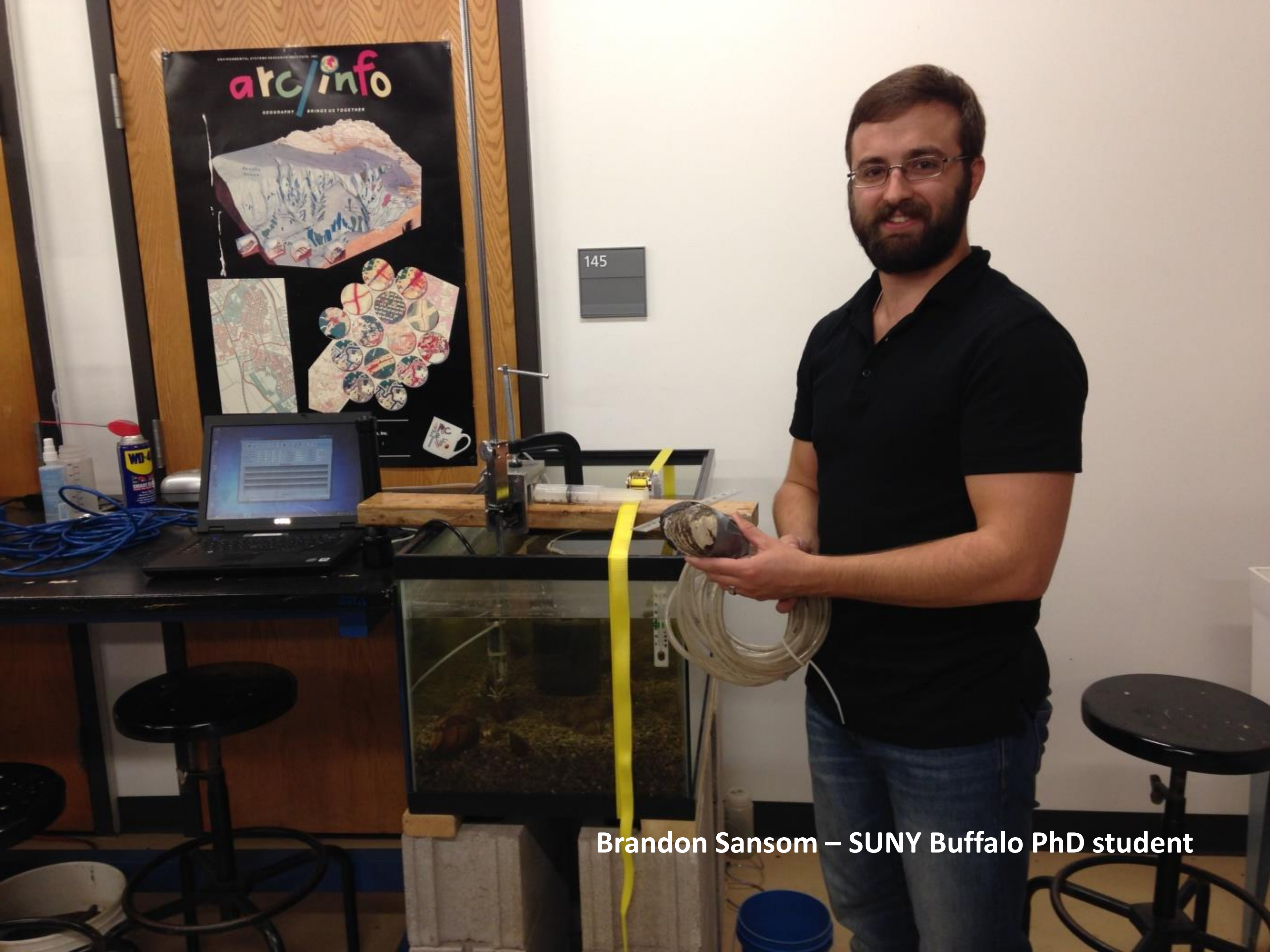
20 to 40% increase in fine sediment leaving the catchment



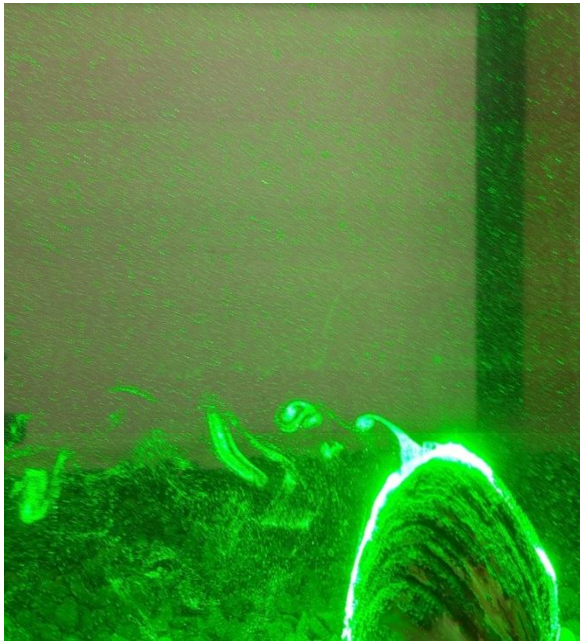
Mussels as ecosystem engineers

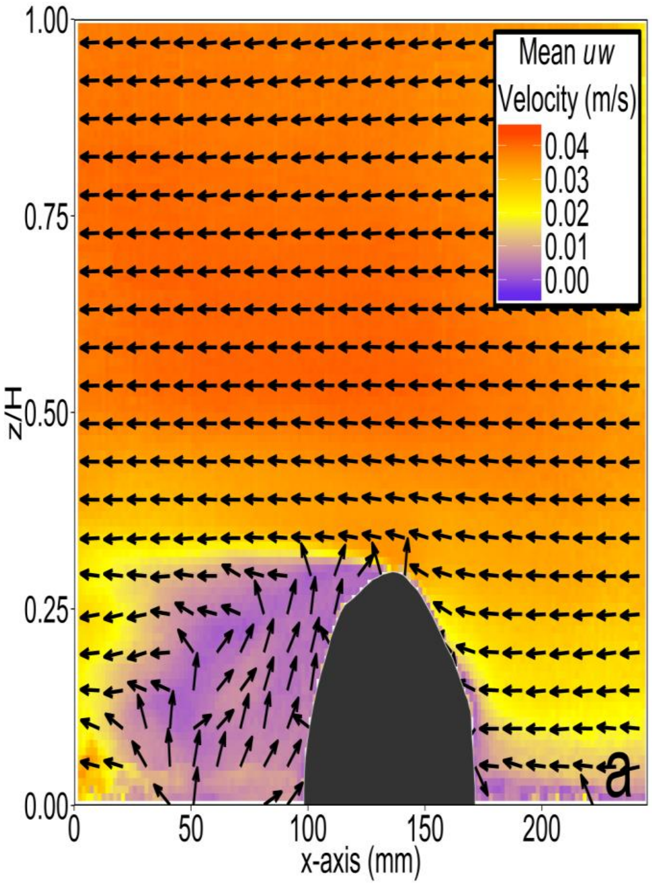


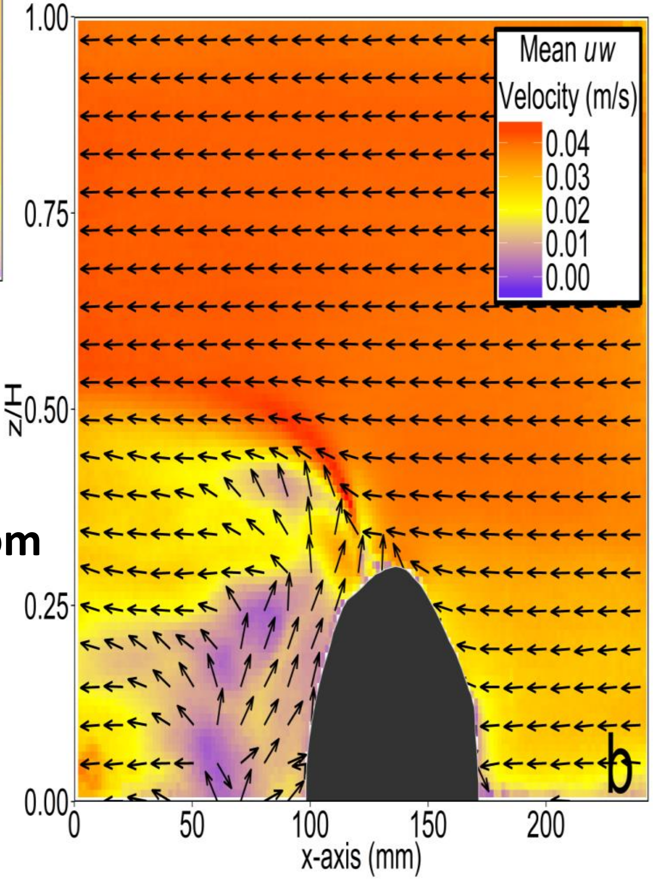
Research performed by Brandon Sansom –
SUNY Buffalo PhD student



Brandon Sansom – SUNY Buffalo PhD student




Mean uw
Velocity (m/s)
0.04
0.03
0.02
0.01
0.00
z/H
x-axis (mm)
a

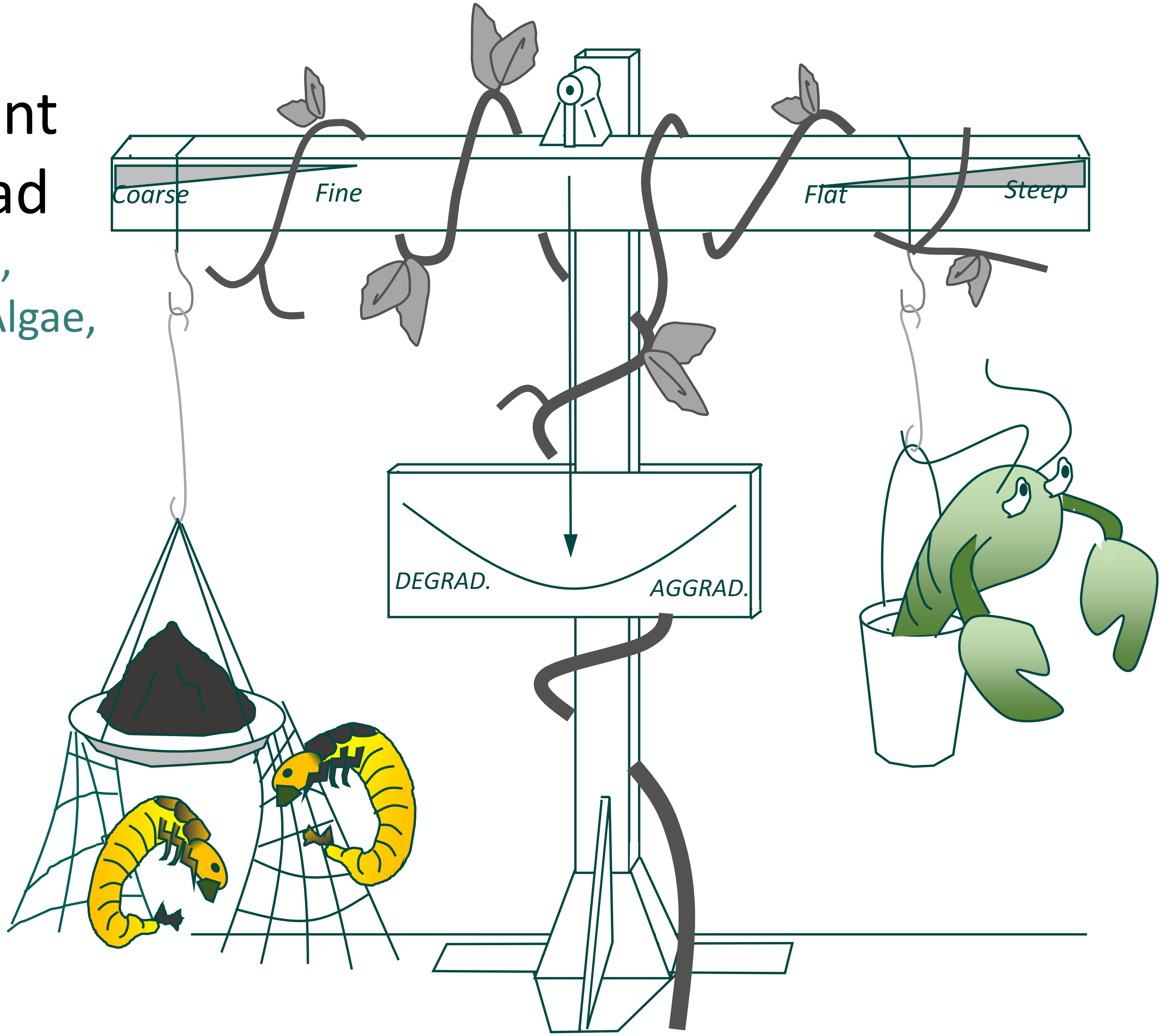

Mean uw
Velocity (m/s)
0.04
0.03
0.02
0.01
0.00
z/H
x-axis (mm)
b

Sediment size, load

Silk, Roots, Mucous, Algae, Biofilms

Slope, Discharge

Burrowing, foraging, redd construction



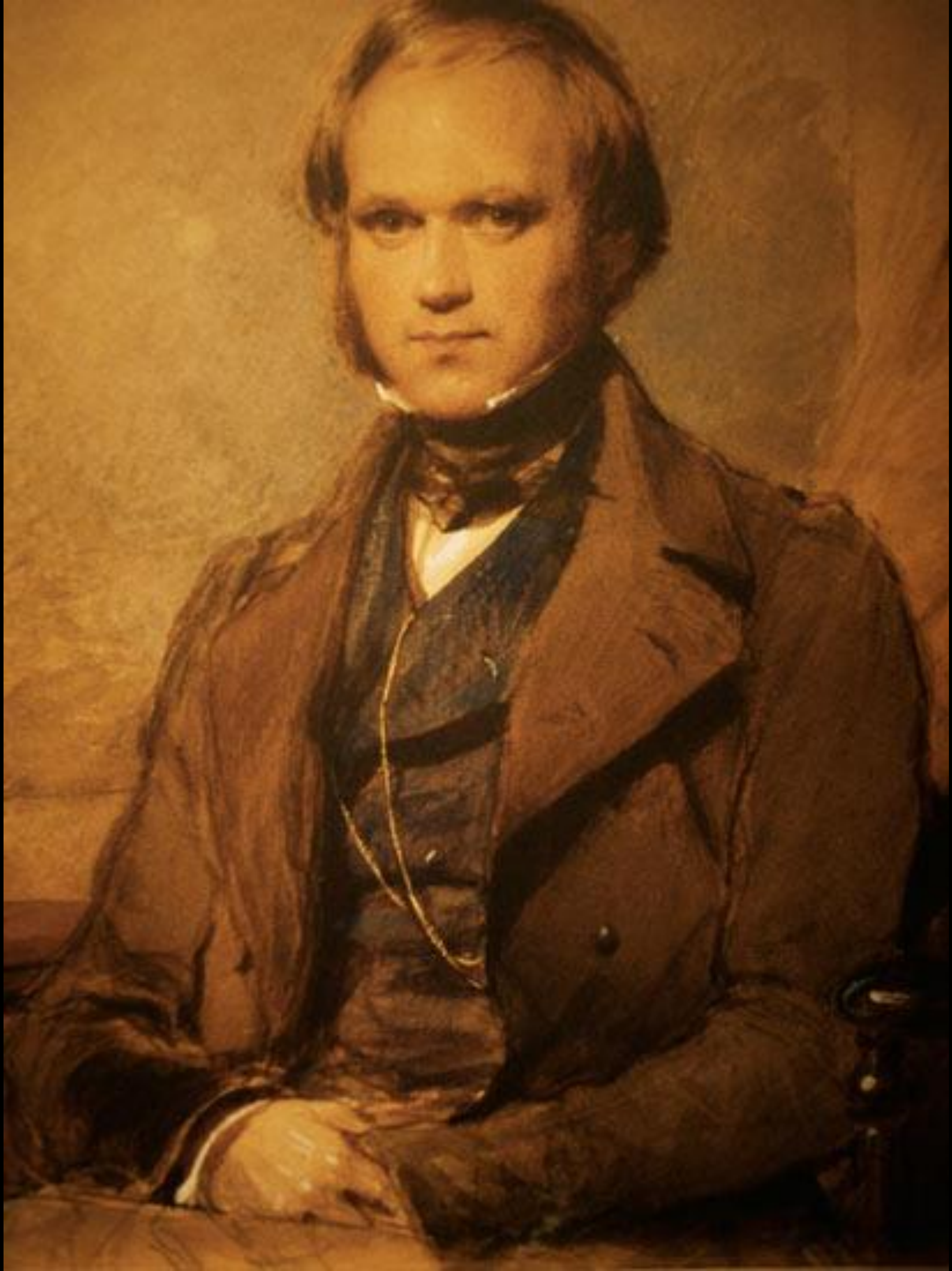


Diagram drawn by Kelley Jorgensen and copyrighted to Plas Newydd Farm.

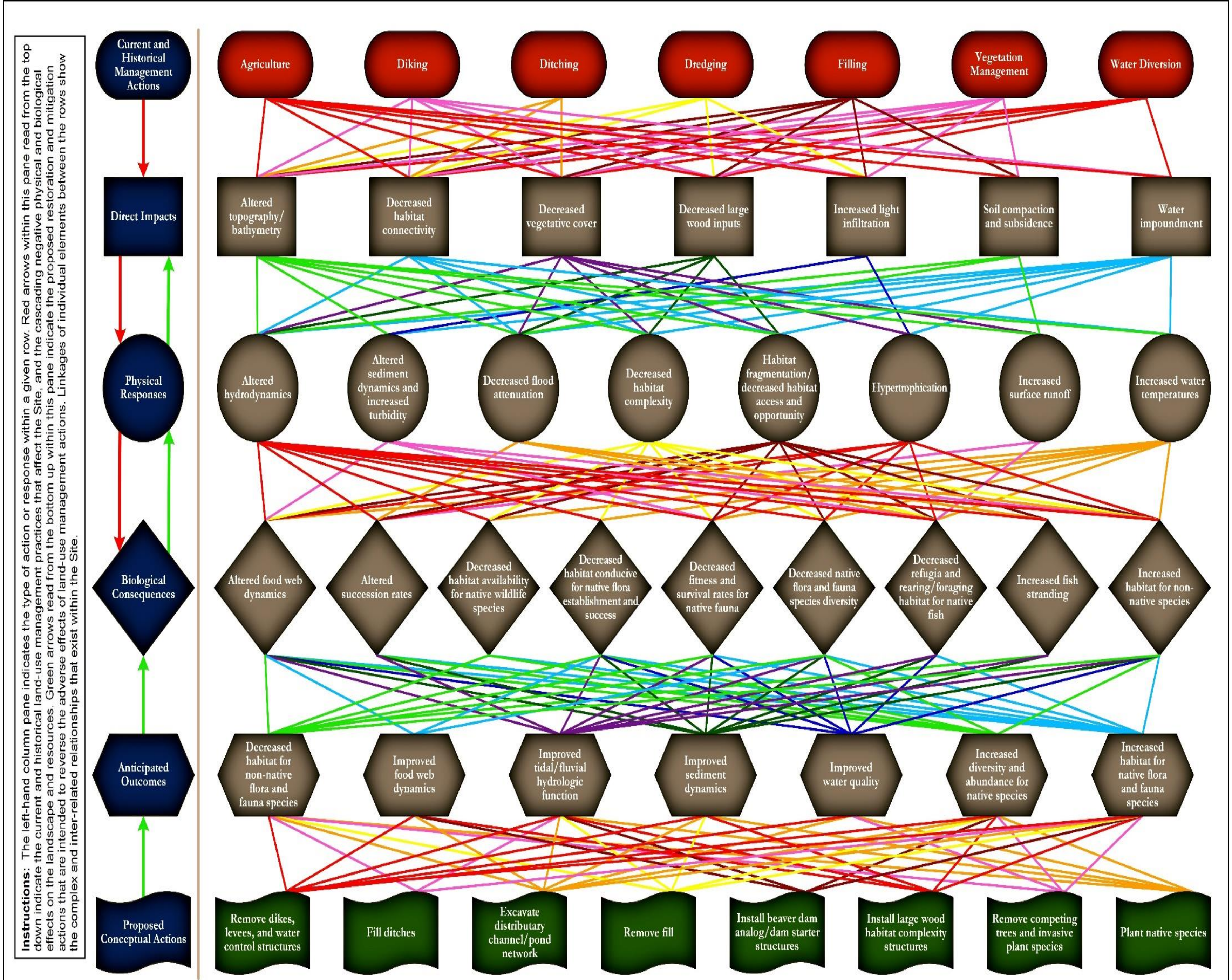
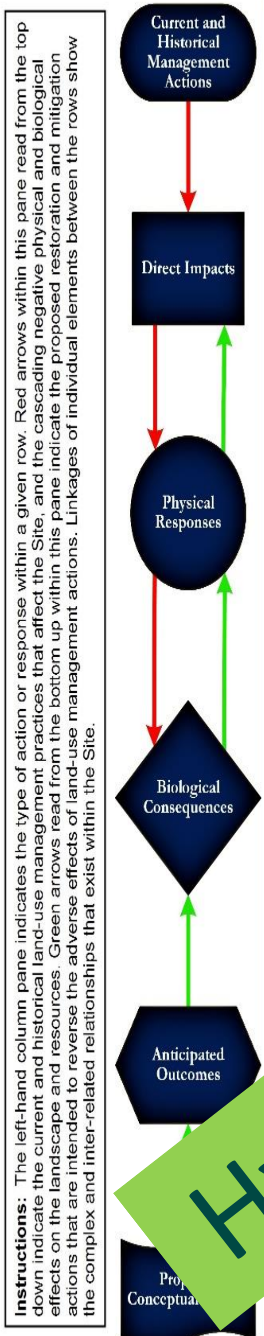


Figure 14. Conceptual Model for the Proposed Bank Site - Wapato Valley Mitigation and Conservation Bank



Current and Historical Management Actio

Direct Impacts

Physical Responses

Biological C nces

ted Outcomes

Proposed Conceptual Actions

Hydroengineeringecomorphaulics?

Diagram drawn by Kelley Jorgensen and copyrighted to Plas Newydd Farm.

PLAS NEWYDD FARM
EST. 1941
CONSERVATION PROGRAM

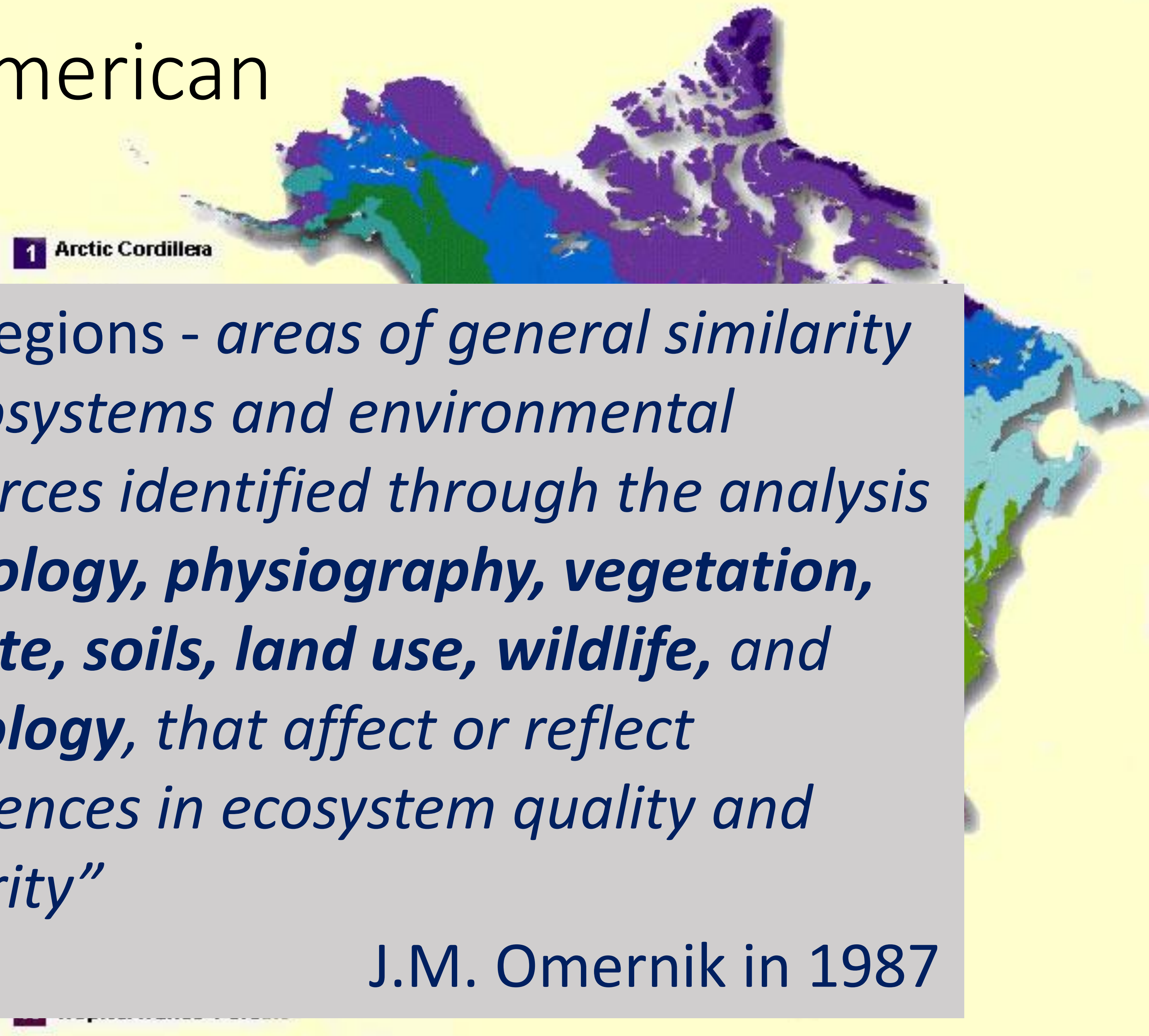
http://pnfarm.com/contact-us/

Figure 14. Conceptual Model for the Proposed Bank Site - Wapato Valley Mitigation and Conservation Bank

North American Biomes

http://www.morning-earth.org/Graphic-E/BIOSPHERE/Bios-PL-Intro.htm

North American Biomes

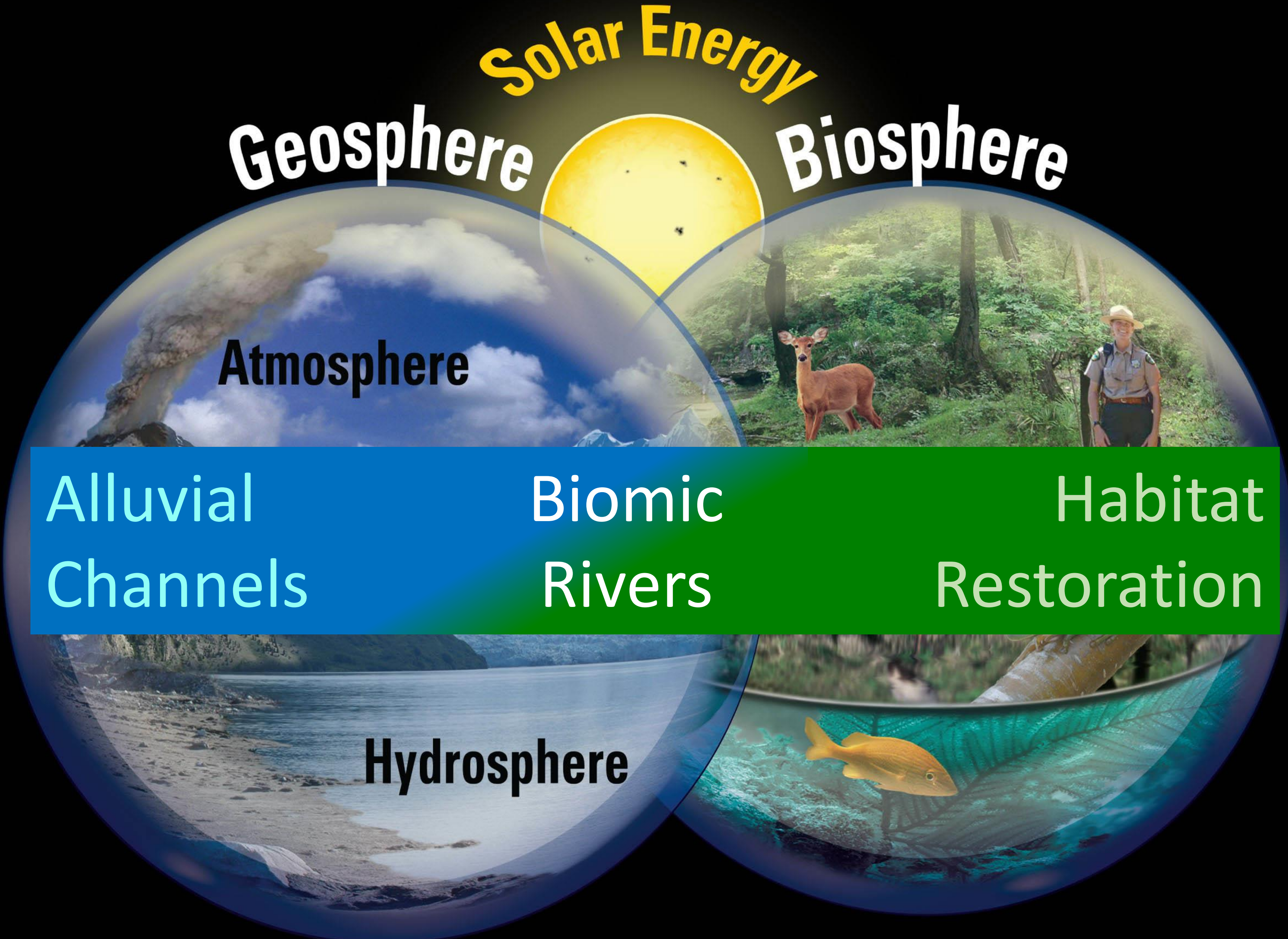


"ecoregions - *areas of general similarity in ecosystems and environmental resources identified through the analysis of* ***geology, physiography, vegetation, climate, soils, land use, wildlife,*** *and* ***hydrology****, that affect or reflect differences in ecosystem quality and integrity"*

J.M. Omernik in 1987

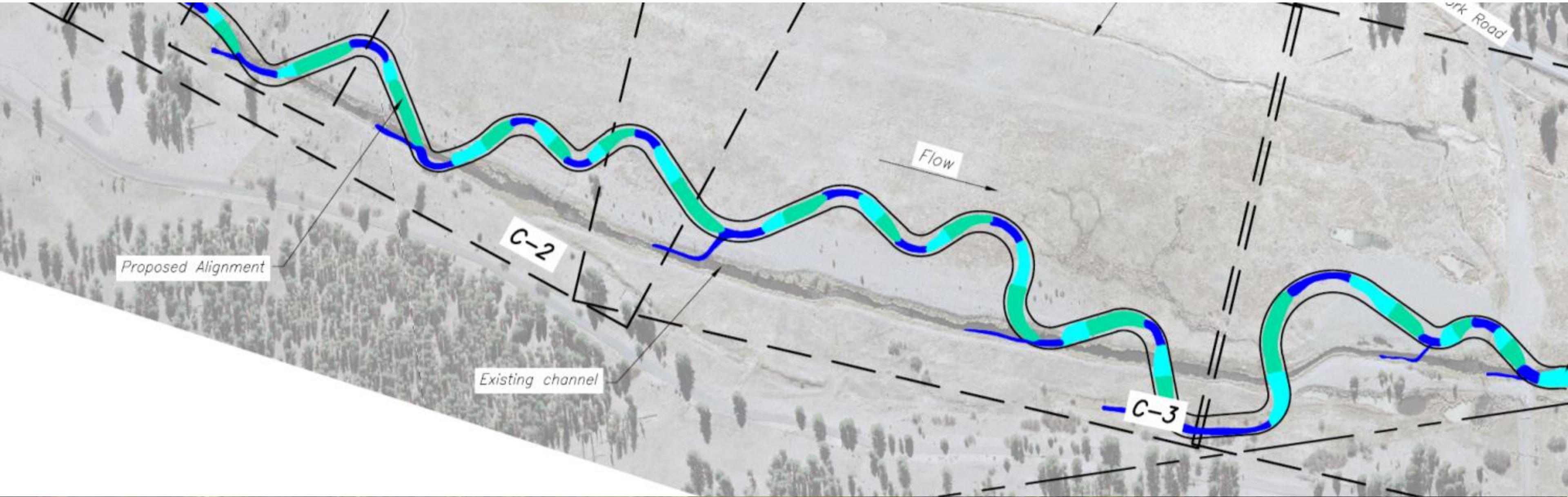
http://www.morning-earth.org/Graphic-E/BIOSPHERE/Bios-PL-Intro.htm

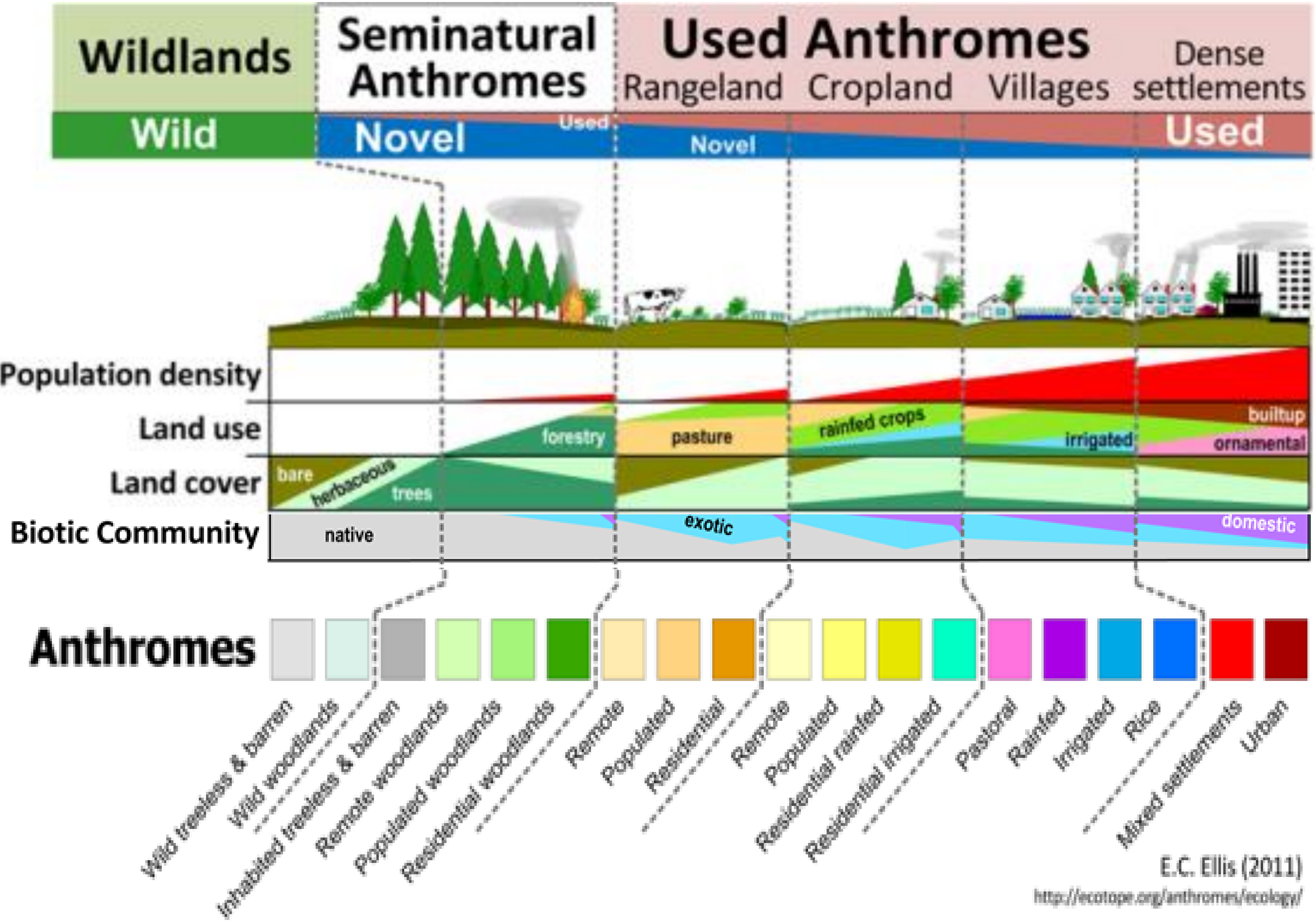
Source(s): Wiken, E.B., D. Gauthier, I. Marshall, K. Lawton and H. Hirvonen, 1996, *A Perspective on Canada's Ecosystems: An Overview of the Terrestrial and Marine Ecozones*, Canadian Council on Ecological Areas, Occasional Paper, no. 14, Ottawa. Fisheries and Oceans Canada, 2009, *Development of a Framework and Principles for the Biogeographic Classification of Canadian Marine Areas*, Fisheries and Oceans Canada Canadian Science Advisory Secretariat, Scientific Advisory Report 2009/056.



USGS Professional Paper 1386

From Oxbow Tailings Restoration, Middle Fork John Day, BOR





Wildlands
Seminatural Anthromes
Used Anthromes
Rangeland
Cropland
Villages
Dense settlements
Wild
Novel
Used
Novel
Used
Population density
Land use
Land cover
Biotic Community
forestry
pasture
rainfed crops
irrigated
builtup
ornamental
bare
herbaceous
trees
native
exotic
domestic
Anthromes
Wild treeless & barren
Wild woodlands
Inhabited treeless & barren
Remote woodlands
Populated woodlands
Residential woodlands
Remote
Populated
Residential
Remote
Populated
Residential rainfed
Residential irrigated
Pastoral
Rainfed
Irrigated
Rice
Mixed settlements
Urban
E.C. Ellis (2011)
http://ecotope.org/anthromes/ecology/

So what?

A Biomic Restoration Project is not only a Design Exercise because:

Natural channels are not designed:

they Evolve……

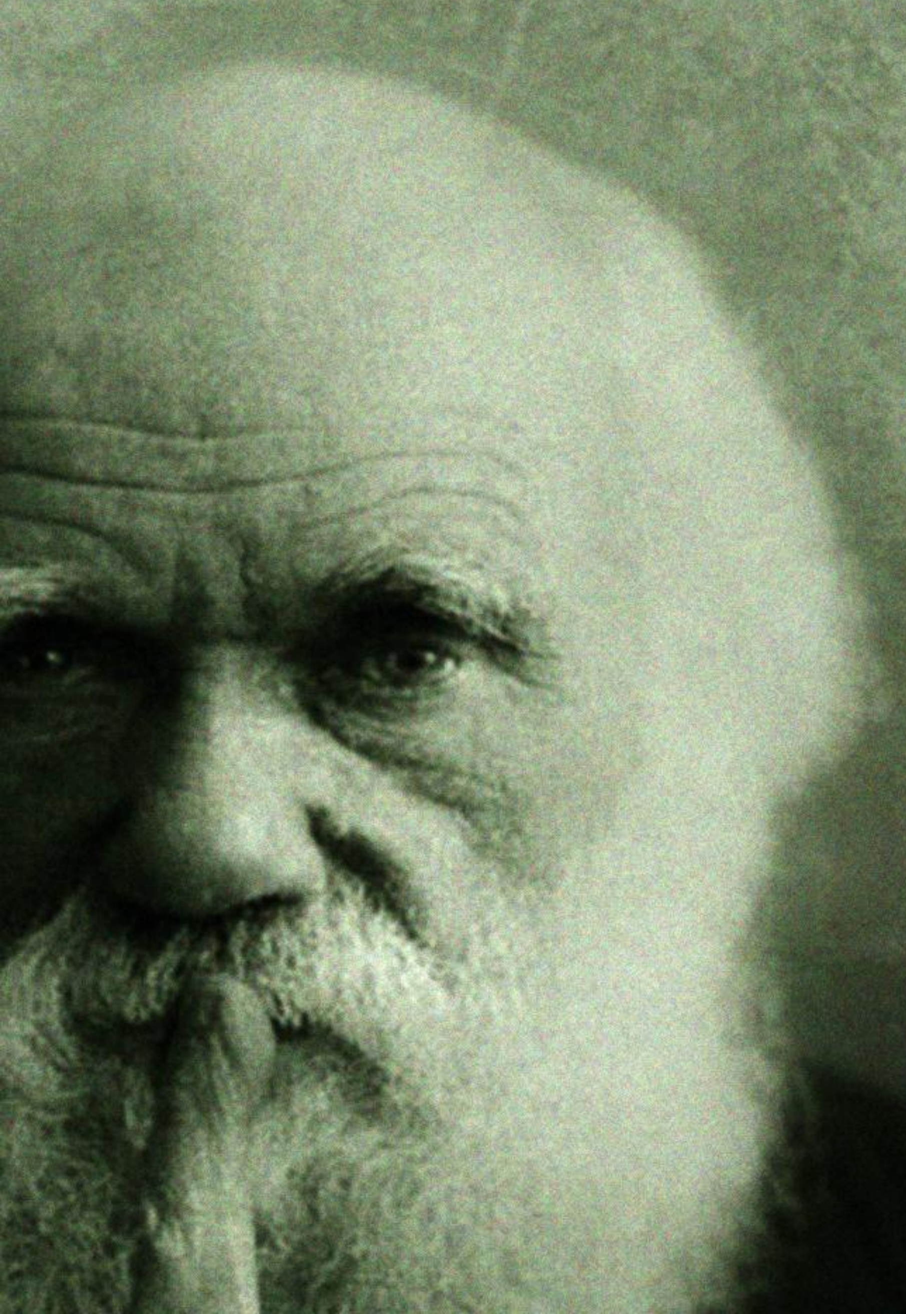
Plan river restoration that can adapt to future land-use and climate changes however they unfold:

Planning evolutionary restoration is more like organising and hosting a successful house party…………..

- *Location, location, location*
- *Venue – how much space have you got: how many friends can you accommodate comfortably and safely?*
- *Invitation list - who to invite and who not to – given the purpose of the event?*
- *Catering – there must be enough food and it must meet guests' dietary needs.*
- *Behaviour – will there be a lot of noise and disruption, will your friends get along?*
- *Breakables – do you have heirlooms and treasures that you need to protect?*
- *Neighbours – you must inform them, or better yet invite them too?*
- *The Authorities – from whom do you need permission and if so from whom?*

Think long-term: like the organisers of the Natural Channel Systems conference….


coloradoguy.com



"It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to *change.*"

~Charles Darwin, 1809

Biomic/Anthromic River Restoration

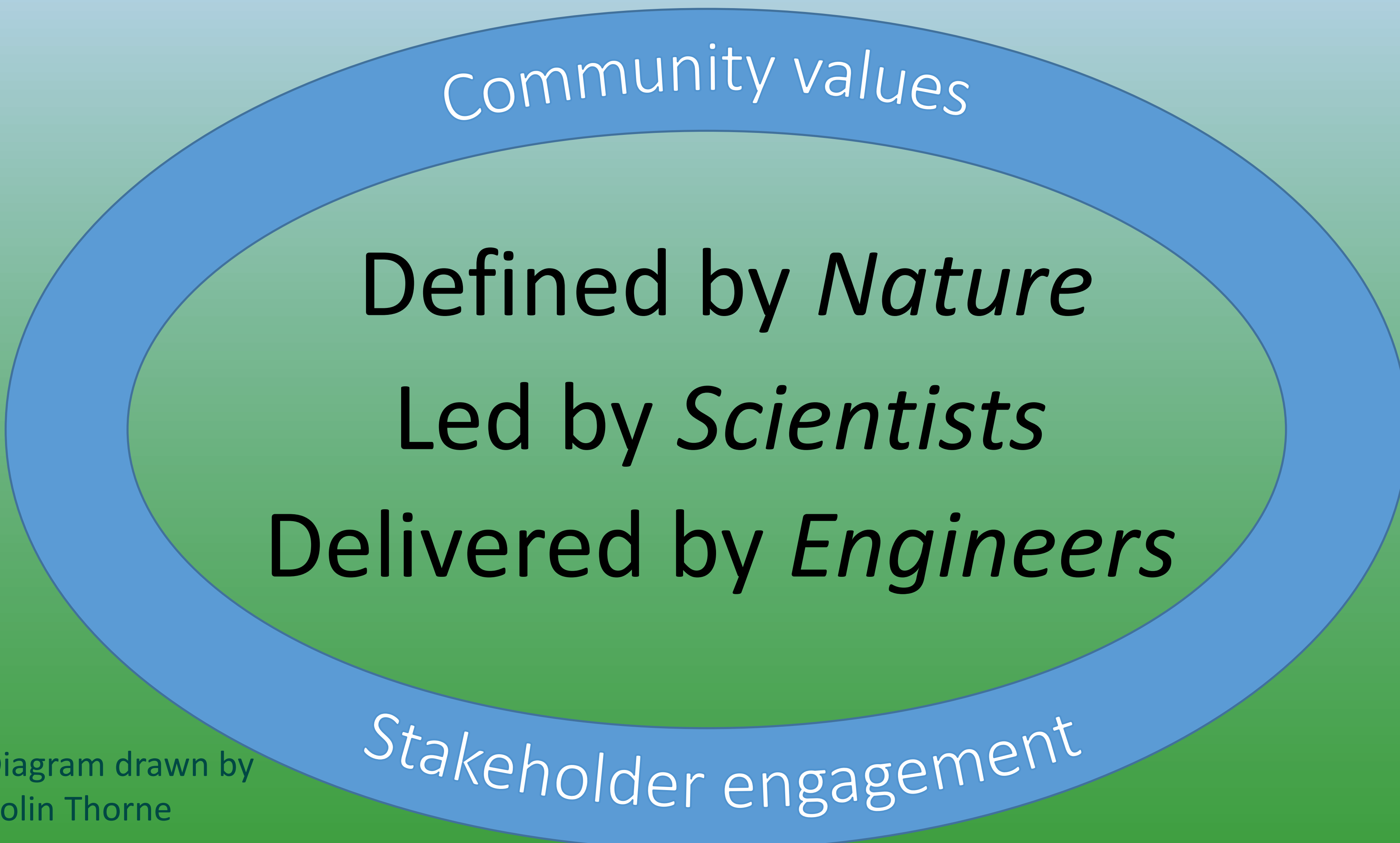


Diagram drawn by
Colin Thorne