Stream Habitat Management: Assessing Stream Condition & Identifying Management Options

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An apology…

- The following information assumes some familiarity with concepts of hydrology, fluvial geomorphology, and river ecology.
- "River Science (Hydrology and Fluvial Geomorphology) for Non-engineers: Basic principles, terms, and tools to aid conservation planning"—July 25, 2012.

River Systems

West Fork Greenbrier River


Near Granville, NY
Sept. 12, 2011

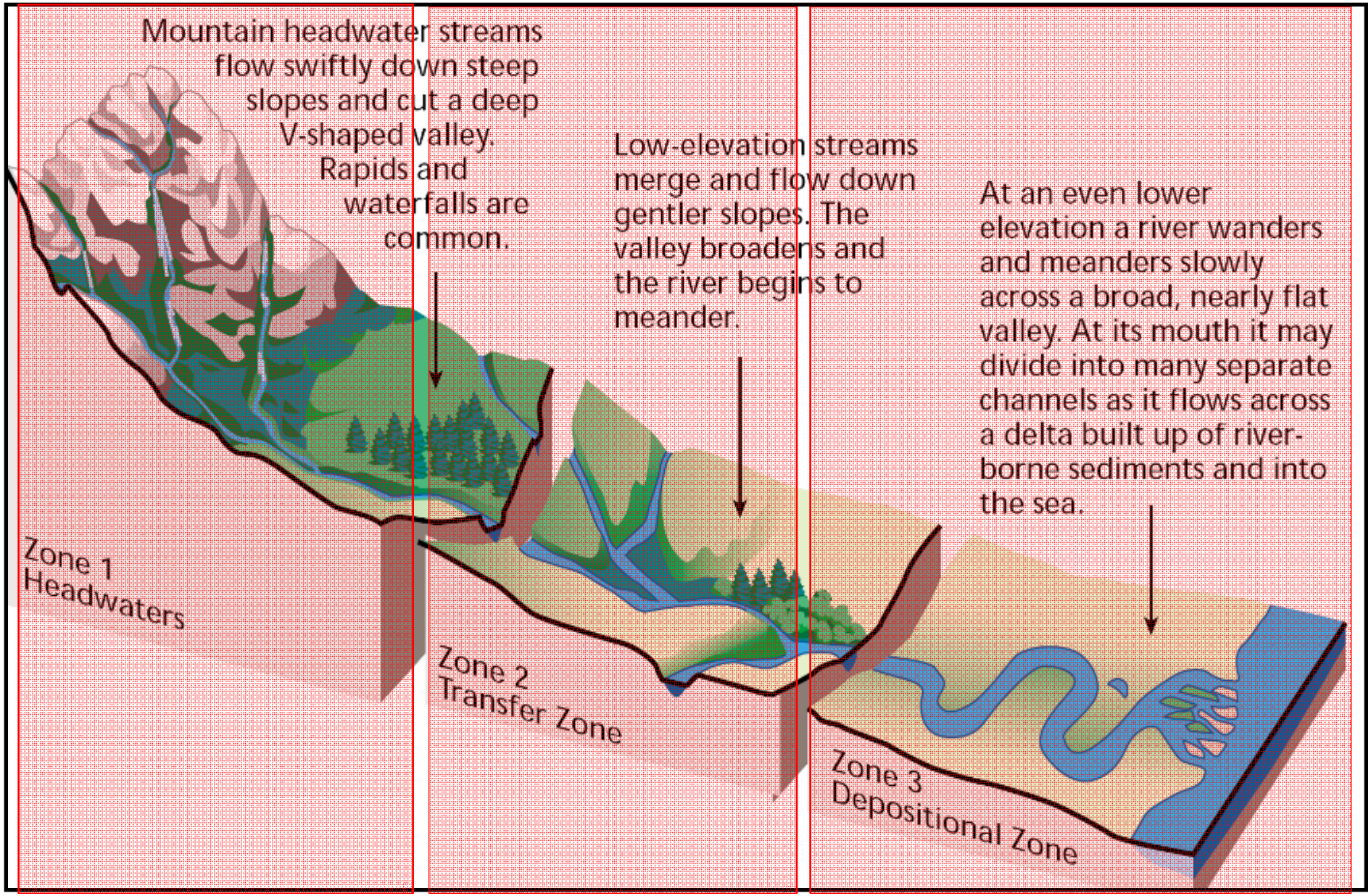

Kiger Gorge, OR BLM Photo

Governing Variables

- Climate, geology, topography, vegetation, and land use govern streamflow, large wood, and sediment balance.

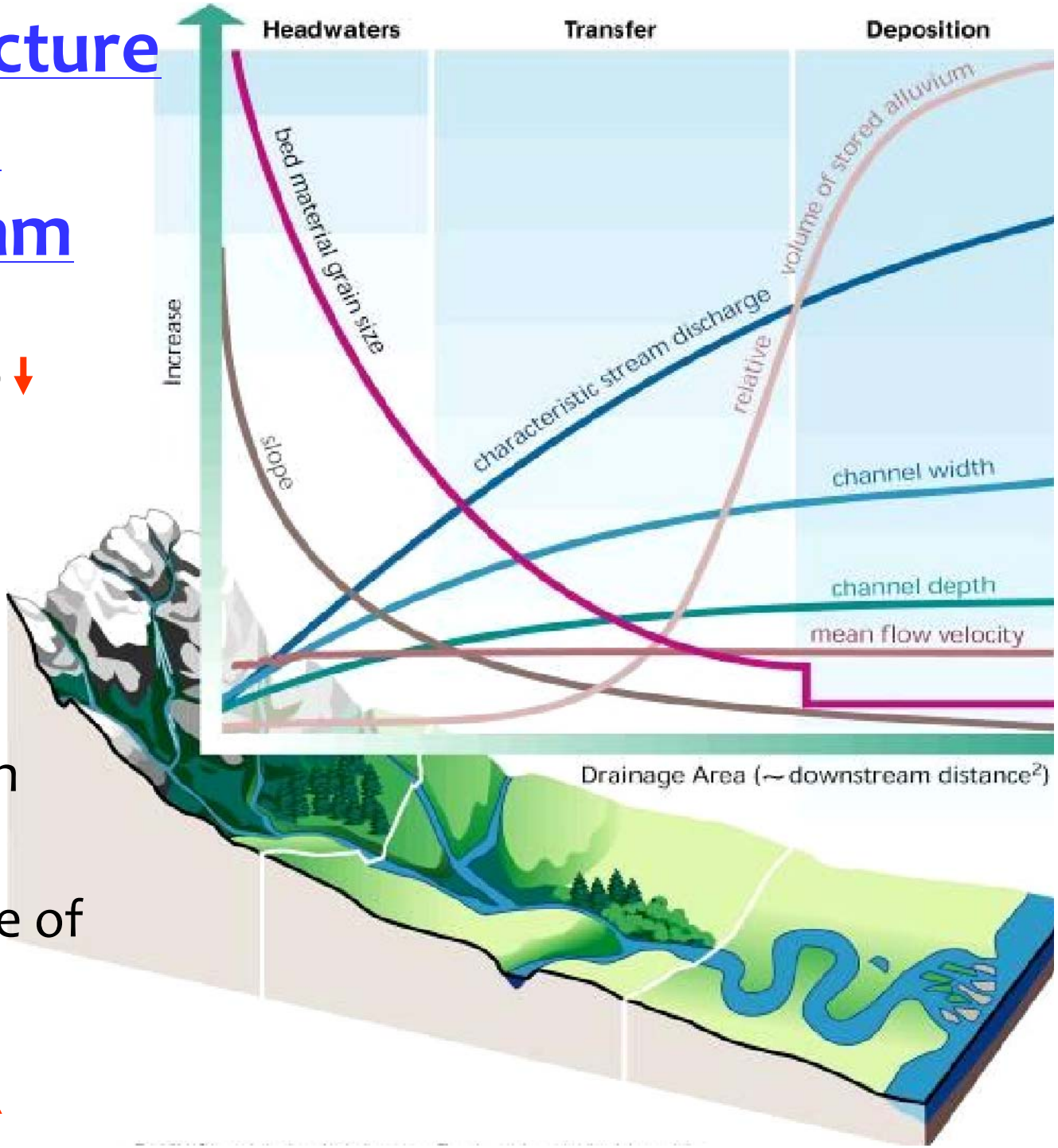
- River channel and floodplain morphology (width, slope, depth, pattern, etc.) adjusts to prevailing regime. Vegetation moderates adjustments.

River Systems and Processes

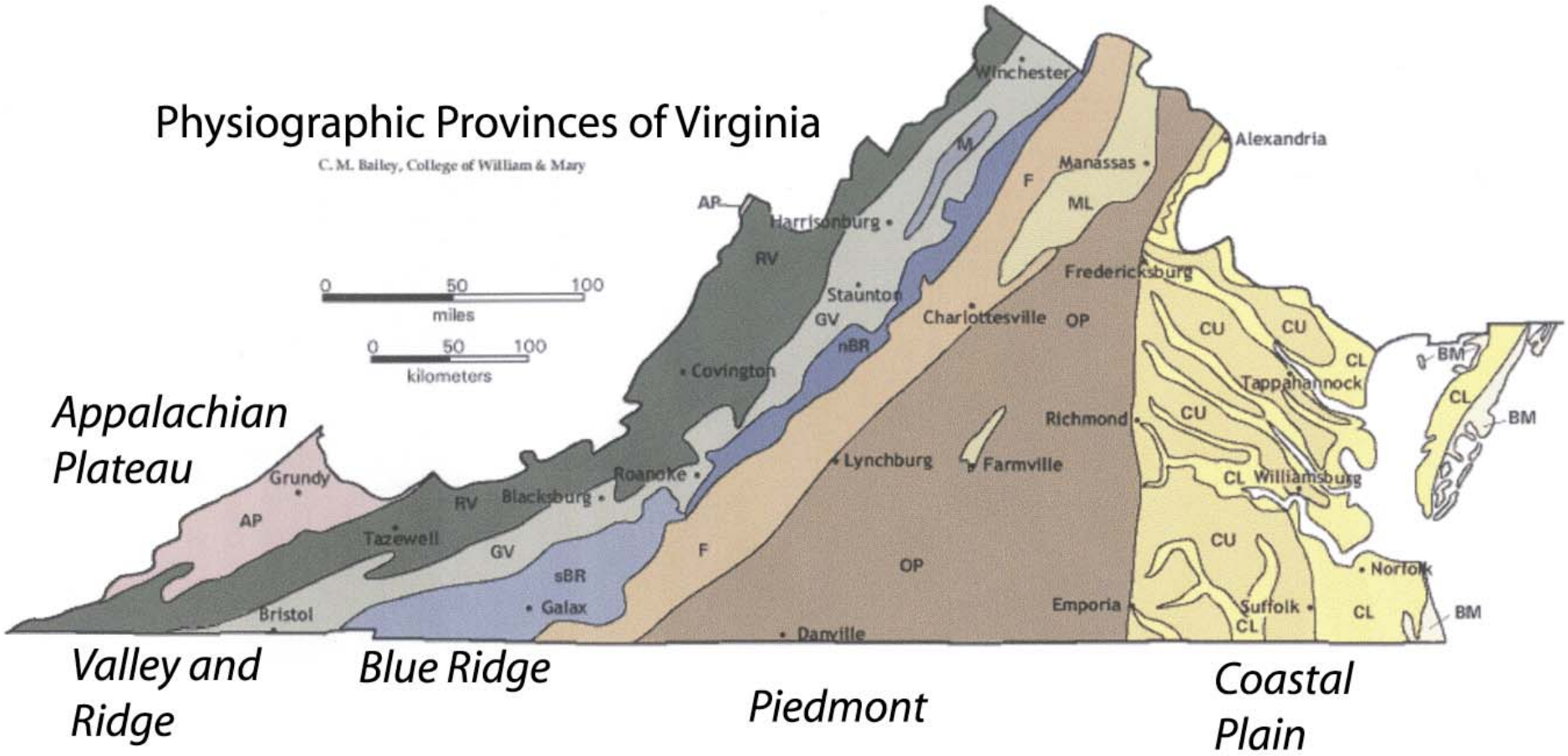


River Architecture Changes Downstream

- Slope ↓
- Bed material size ↓
- Streamflow ↑
- Channel width ↑
- Channel depth ↑
- Flow velocity ↑
- Material stored in floodplains ↑
- Relative influence of vegetation on channel and floodplain form ↑

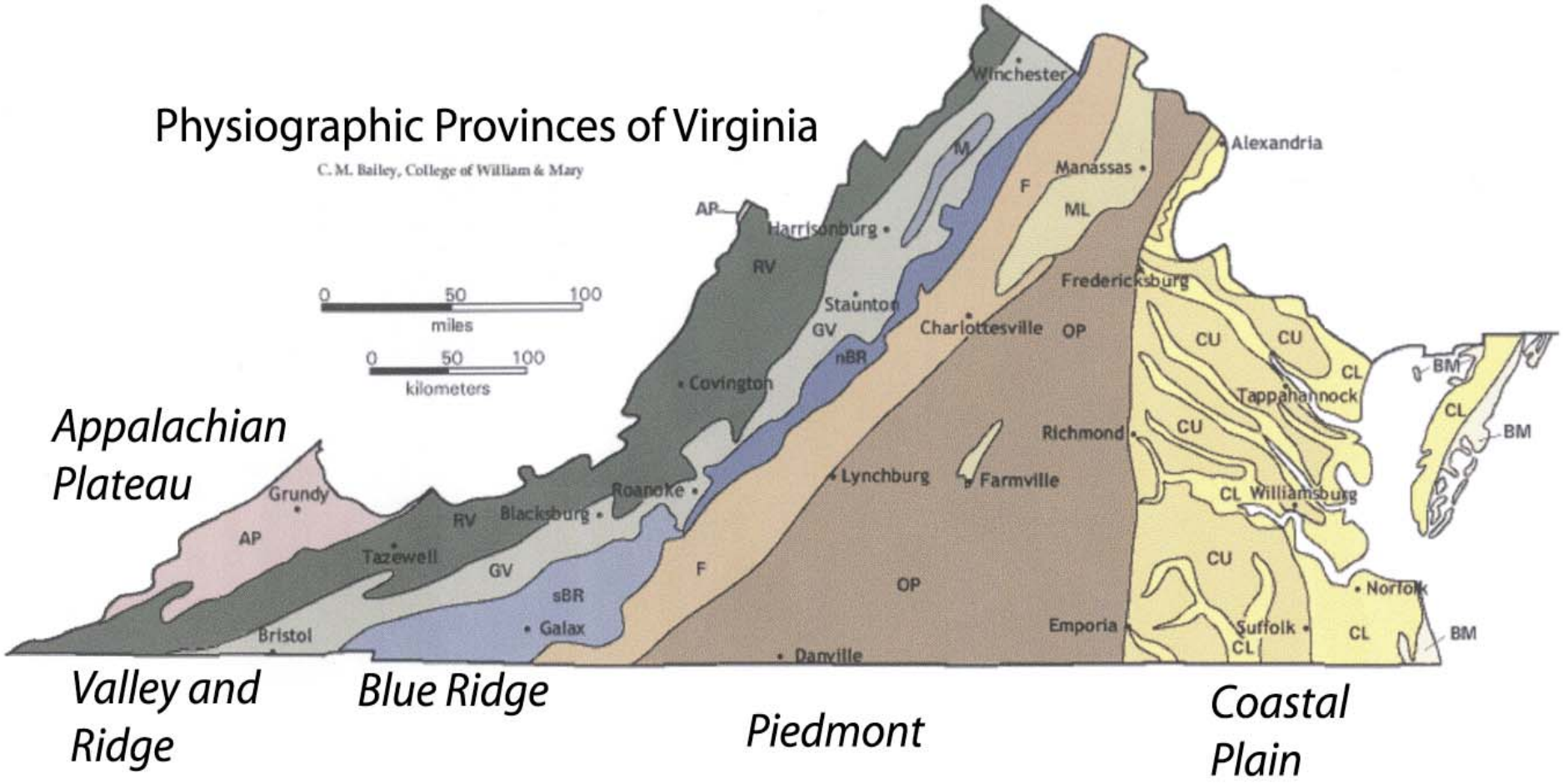


Virginia's River Systems



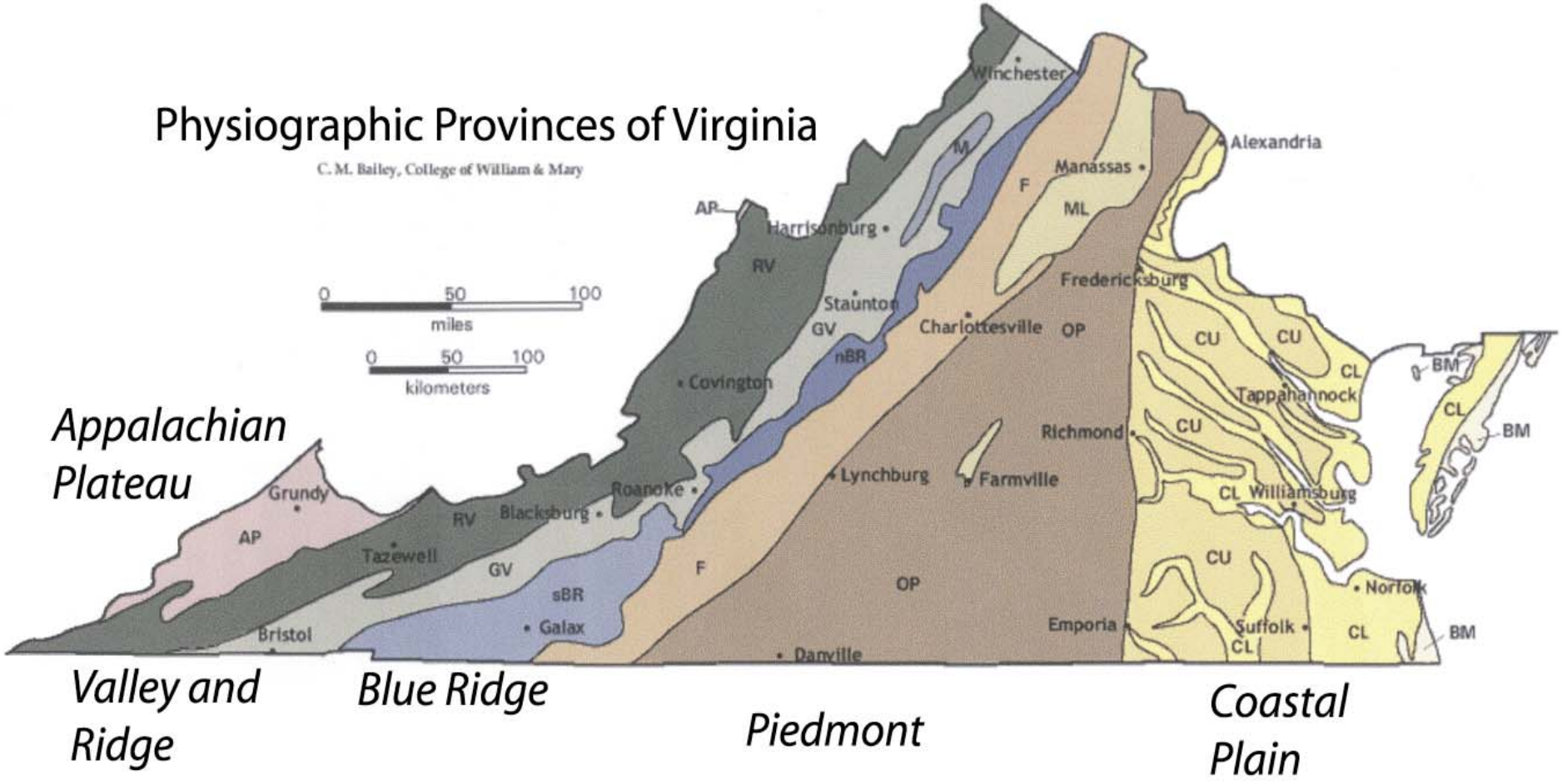
Erosion (Supply) → **Transport (Response)** → **Deposition (Response)**

Sediment Template



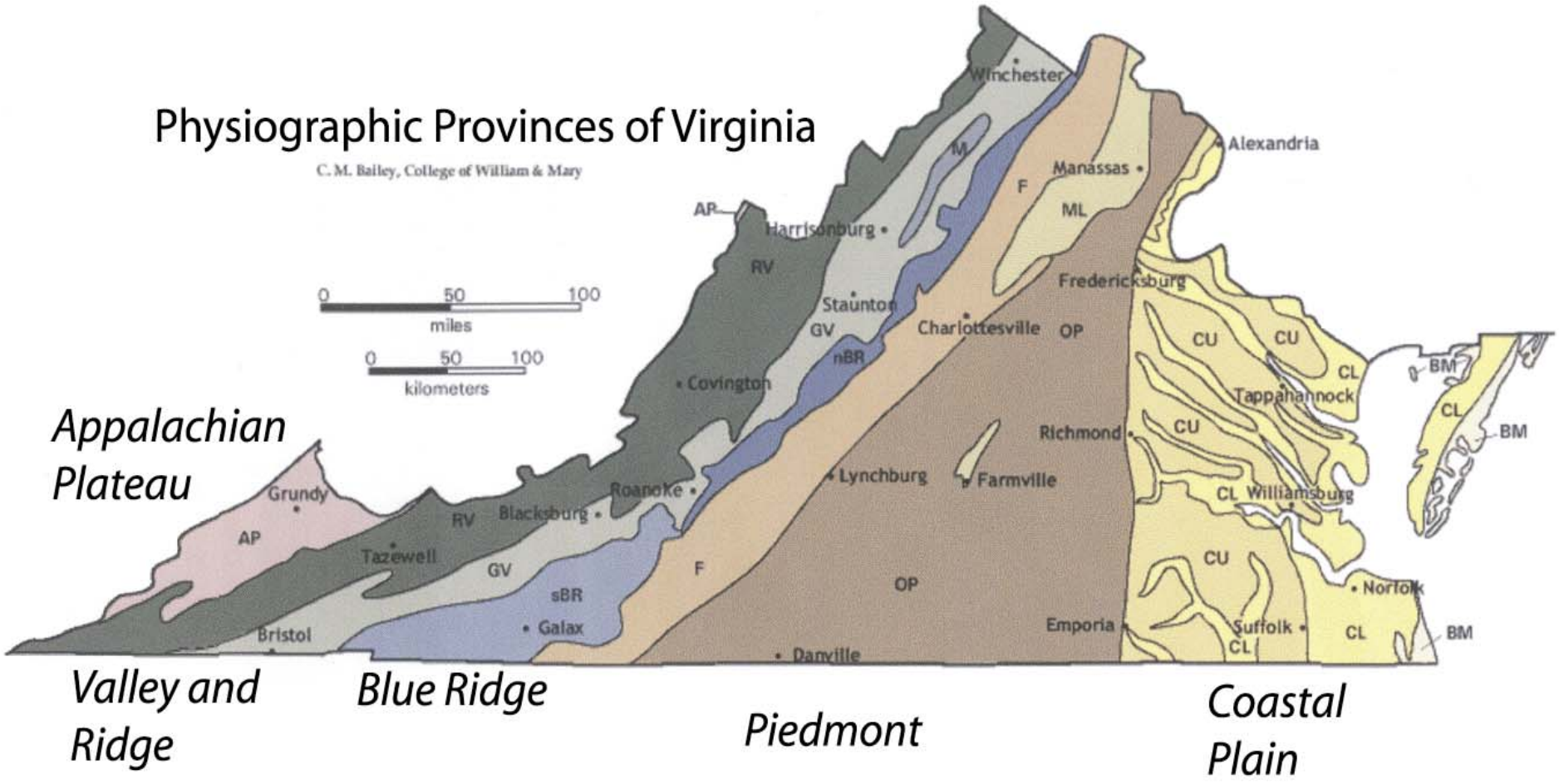
Boulder-Gravel → Cobble-Sand → Gravel-Silt

Channel Slope & Width Template



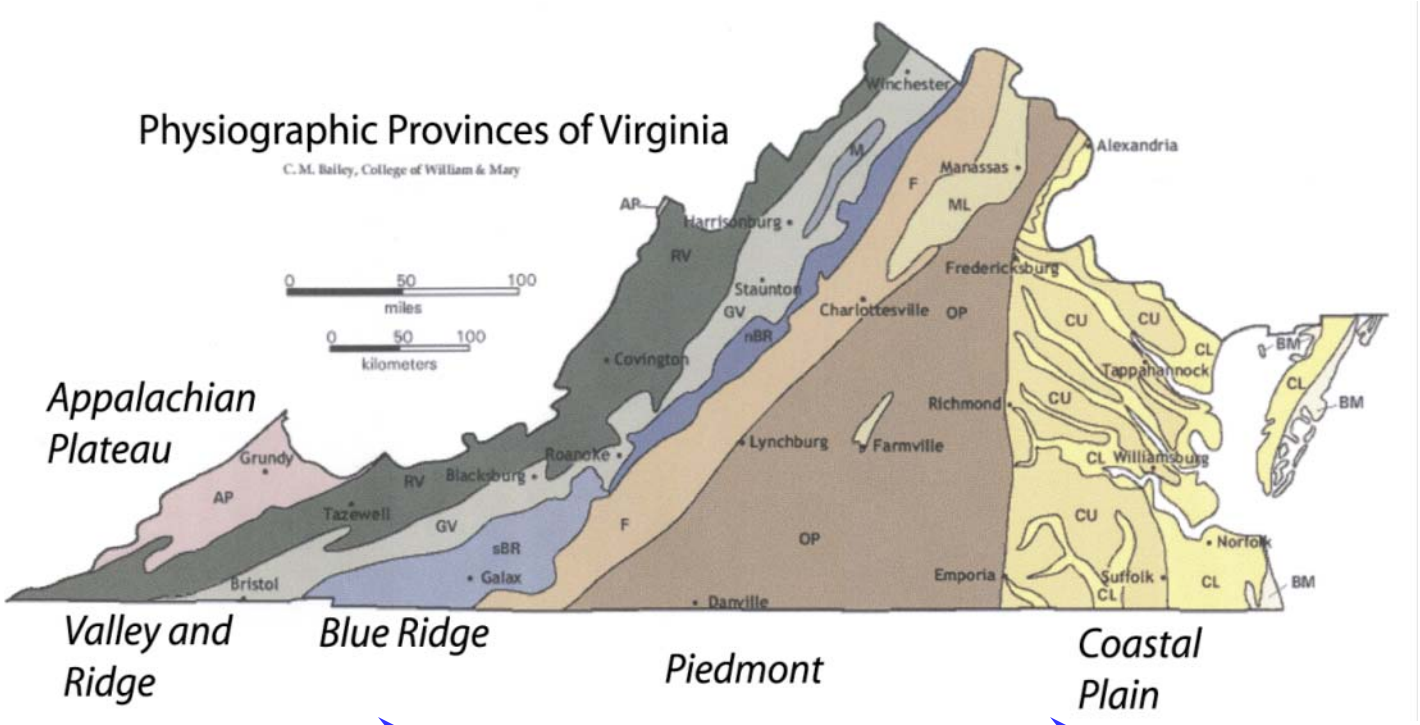
Steep & Narrow → **Medium S & W** → **Flat & Wide**

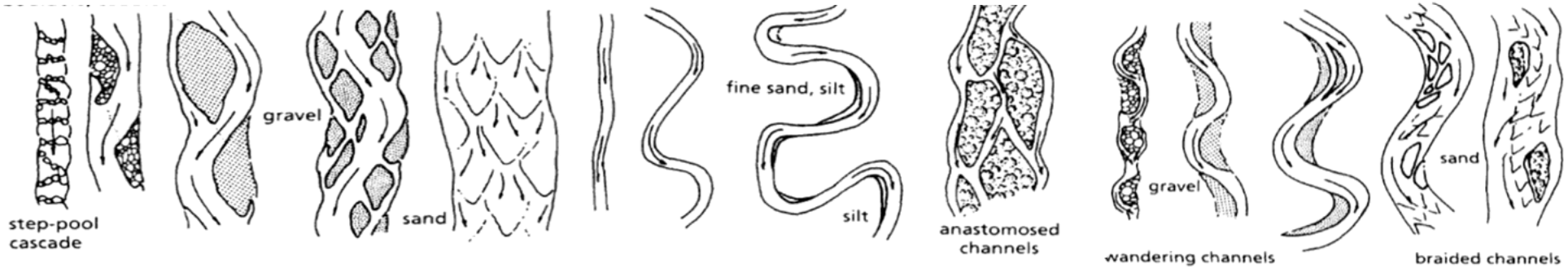
Floodplain and Riparian Template



Small and "Simple" → **Moderate and Complex** → **Extensive and Complex**

Channel Pattern Template





Floodplain and Riparian

Rivers connected to their floodplains interact with riparian vegetation, which influences channel processes

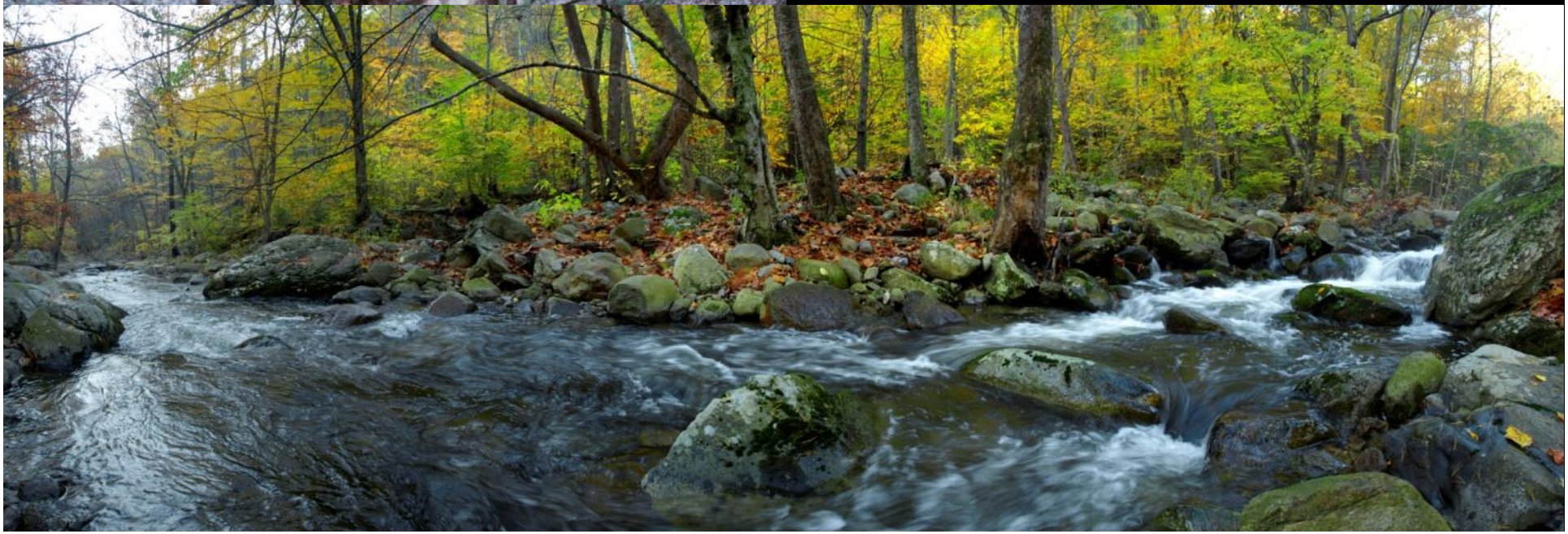
K. Gullett Photo

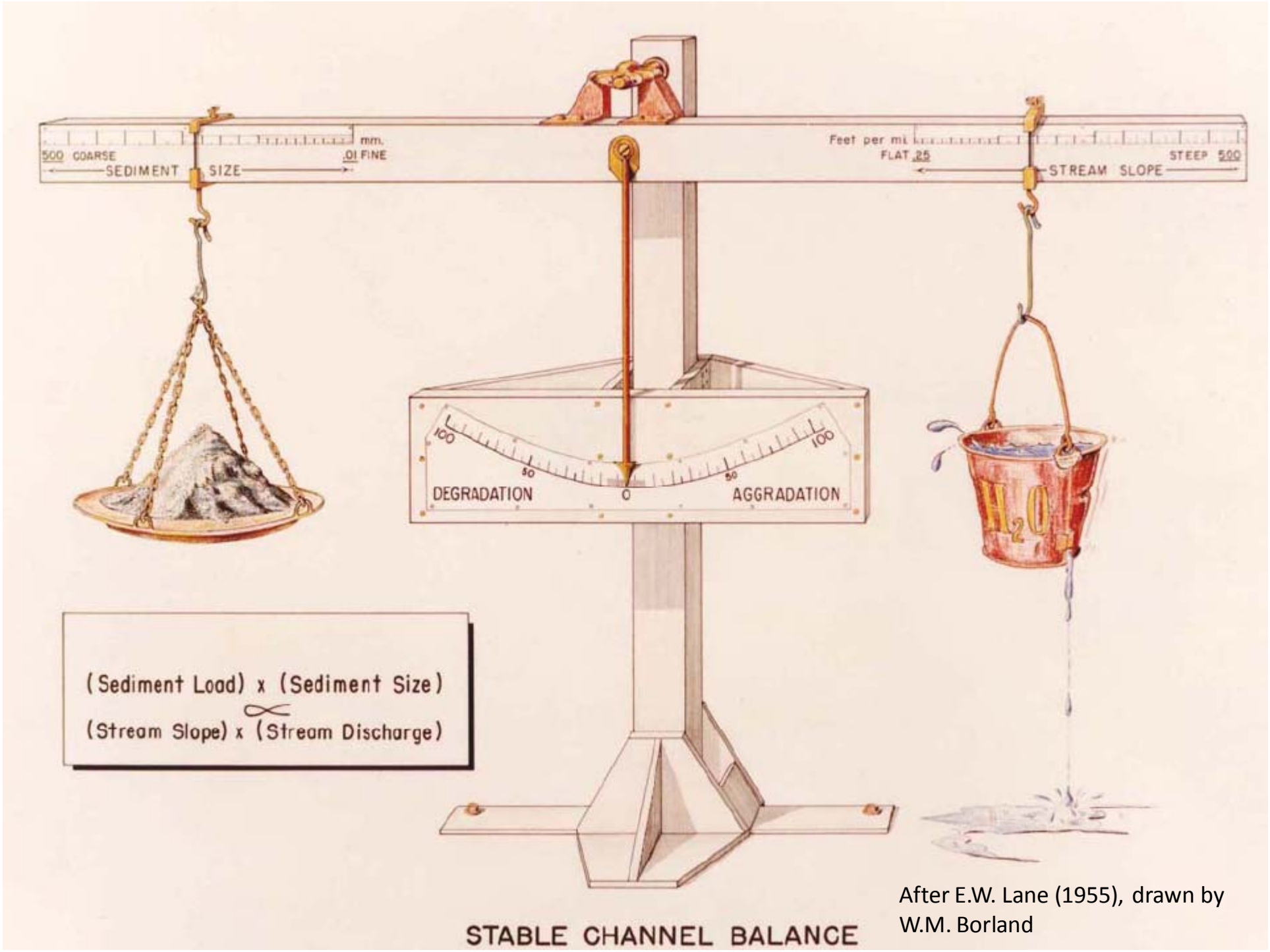

TROUTNUT.COM

River Classification Schemes

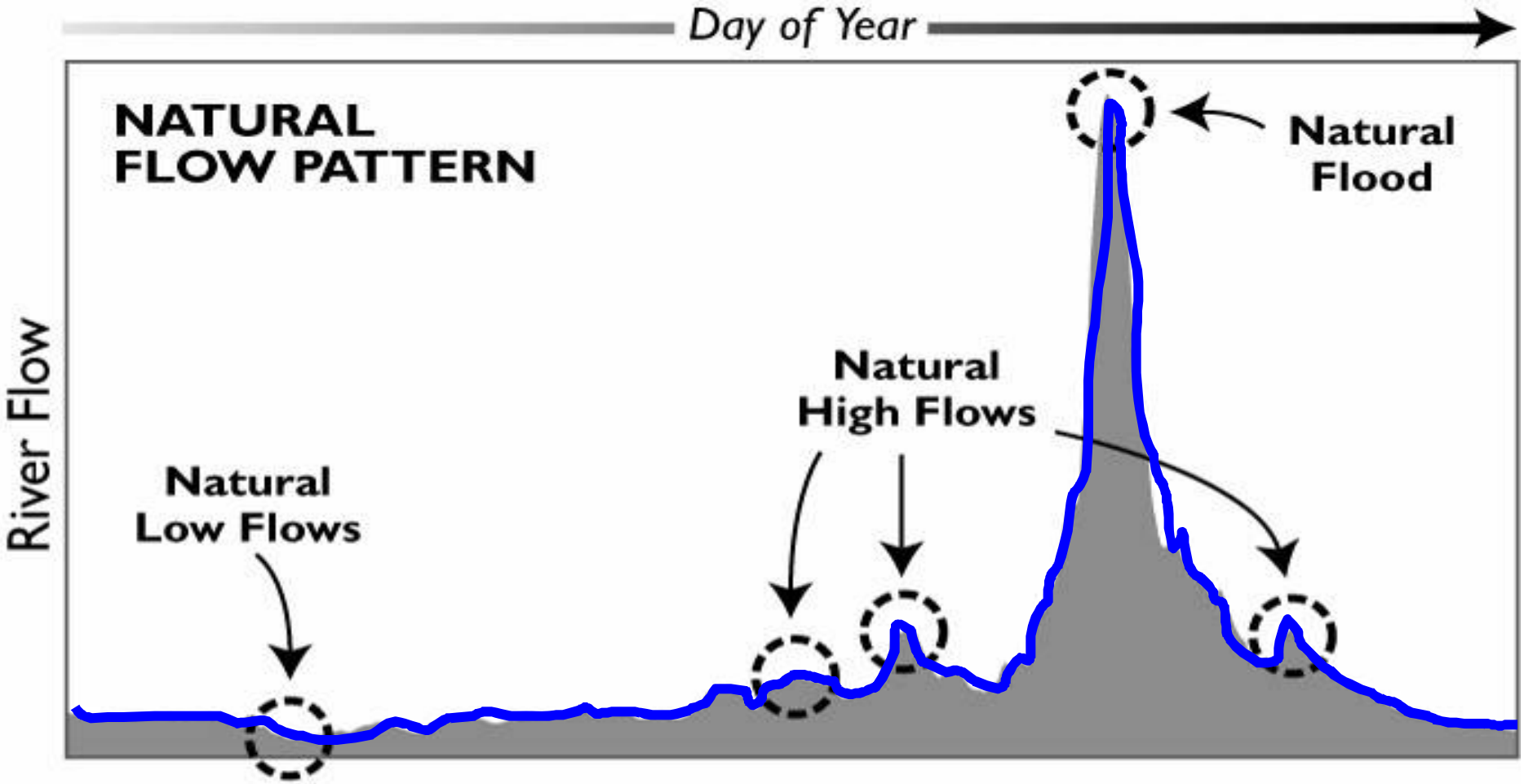
- **Schumm, Harvey and Watson (1984)**—"Incised channels: morphology, dynamics, and control"
- **Rosgen (1994)**—"A classification of natural rivers"
- **Montgomery and Buffington (1997)**—"Channel-reach morphology in mountain drainage basins"
- **Brierley and Fryirs (2000)**—"River Styles…"

River Organization takes time…





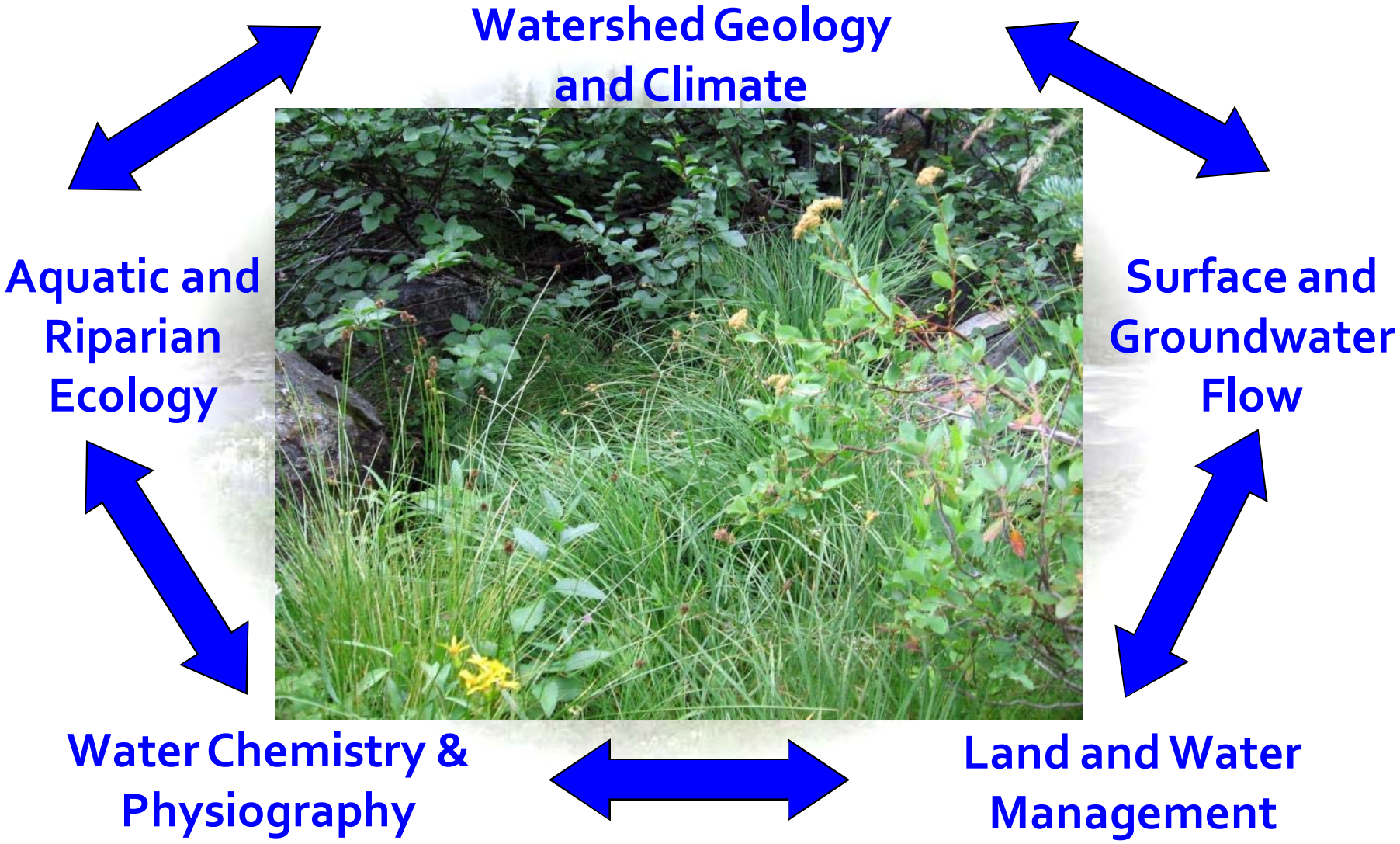
After E.W. Lane (1955), drawn by W.M. Borland


Day of Year
NATURAL
FLOW PATTERN
River Flow
Natural
Flood
Natural
High Flows
Natural
Low Flows

Streamflow Regime

- Streamflow powers the engine that creates and maintains riverine habitat.
- Sediment, riparian vegetation, and watershed metrics govern the amount of work a river can accomplish.
- Groundwater recharge keeps streams and riparia alive during periods of low or no precipitation.

Watershed Processes Create and Maintain River Systems



Stream Habitat: Biological reliance on physical features in a stream…

"Stream Habitat"

- A **collective** term that encompasses various physical, biological, and chemical interactions within a river and its watershed that produce the **spatial and temporal** environs in which aquatic species exist.

River Ecology

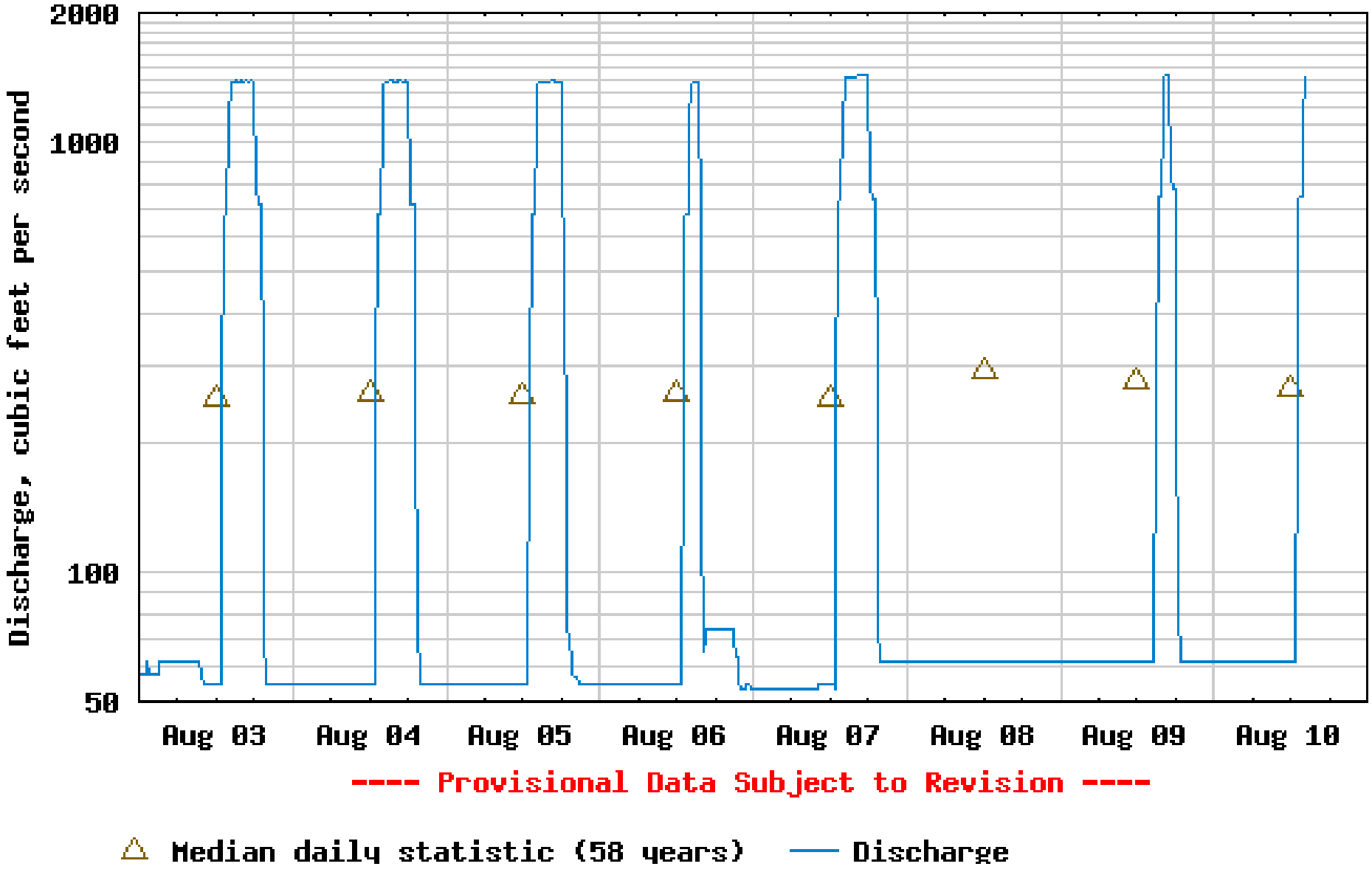
- Relationship between riverine animals, physical habitat, and streamflow.
- Confined to water—can't walk or fly away if conditions deteriorate.
- Streamflow changes

Streamflow Regime and Habitat

- Habitat requirement and usage by aquatic organisms changes by:
  - Life stage (juvenile vs. adult)
  - Time of day (nightime foraging)
  - Season (winter vs. summer)
- Because streamflow changes—naturally or artificially—across a given year.

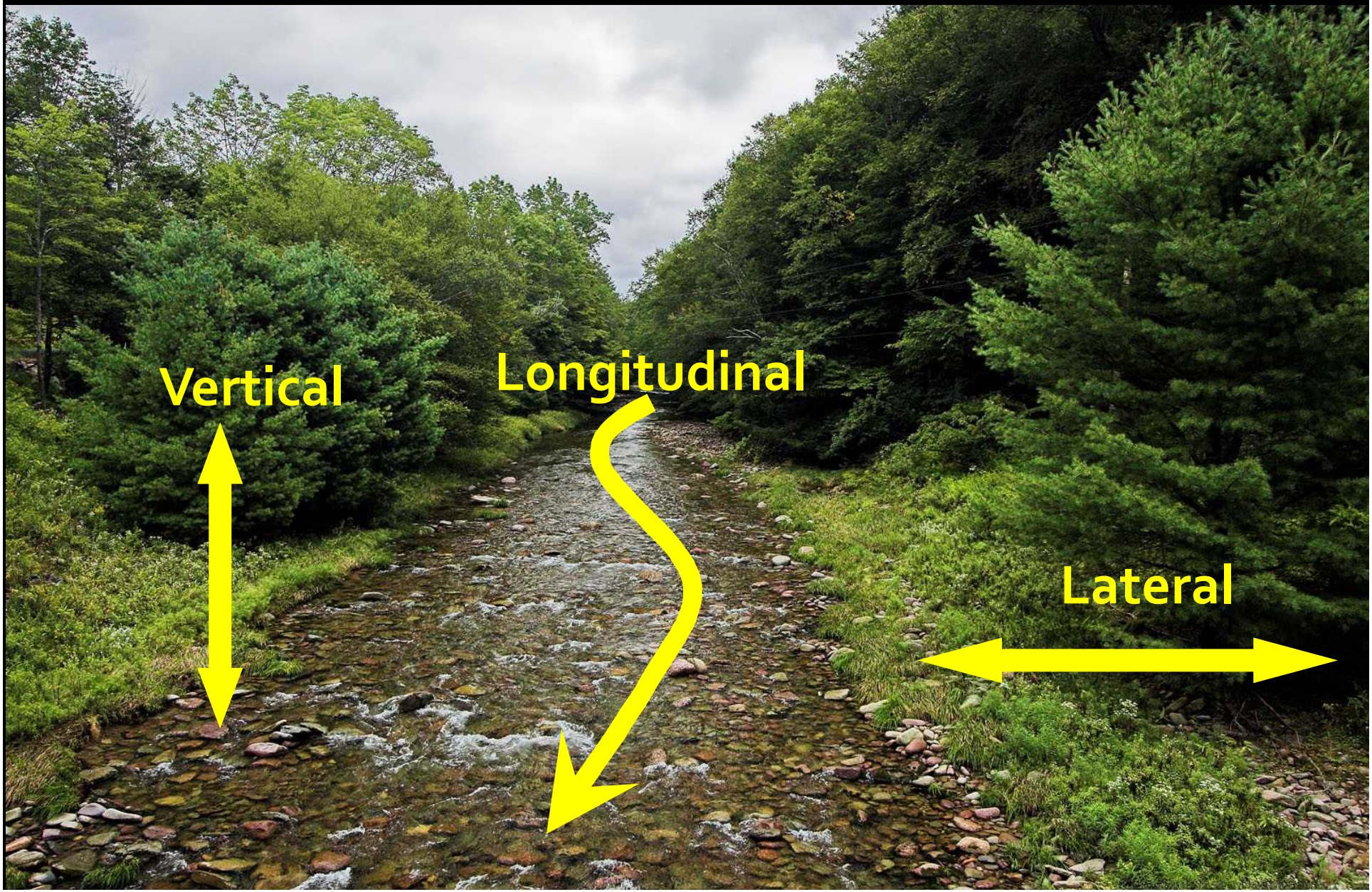
USGS

USGS 02072000 SMITH RIVER NEAR PHILPOTT, VA




8 Hours Later…

River Ecology



River Continuum

- Rivers are dominated by geomorphic and hydrologic factors that create and maintain the drainage network

- Ecological communities are selected in response to these factors in a more-or-less predictable manner

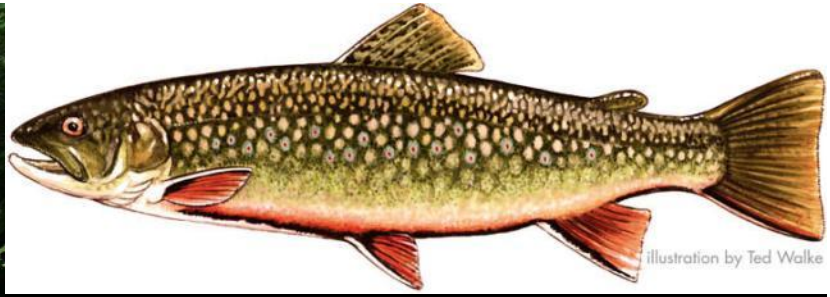
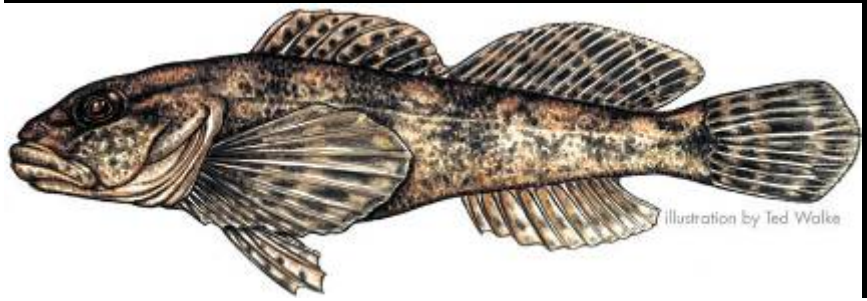


illustration by Ted Walke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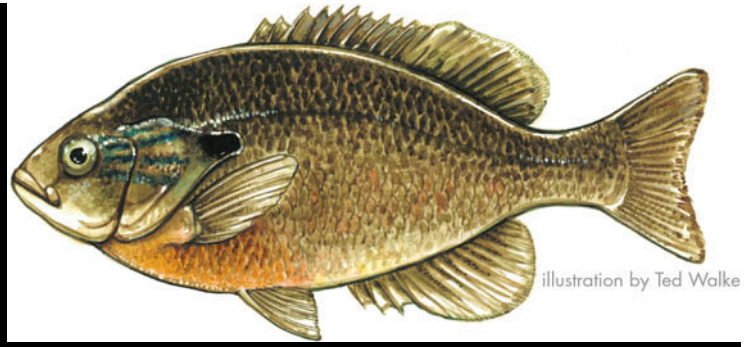
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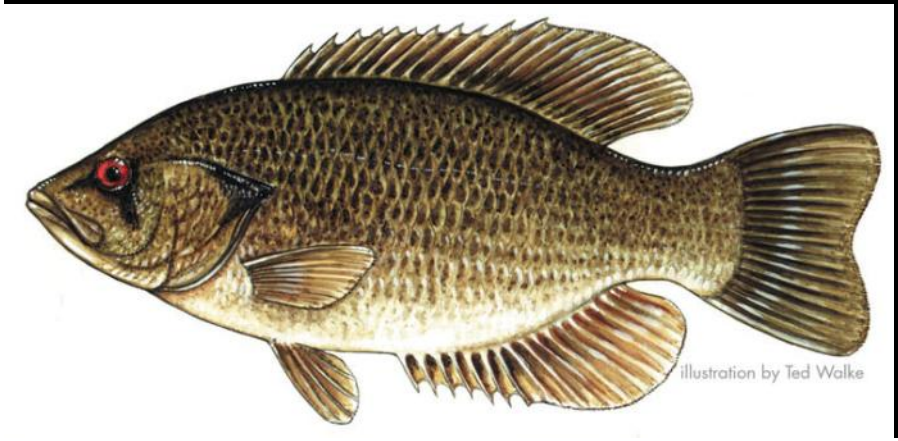
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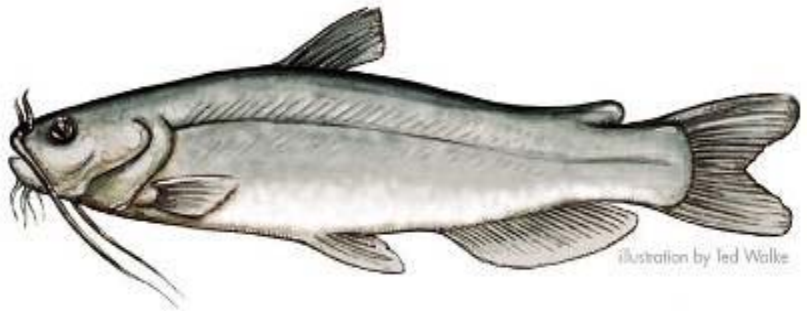
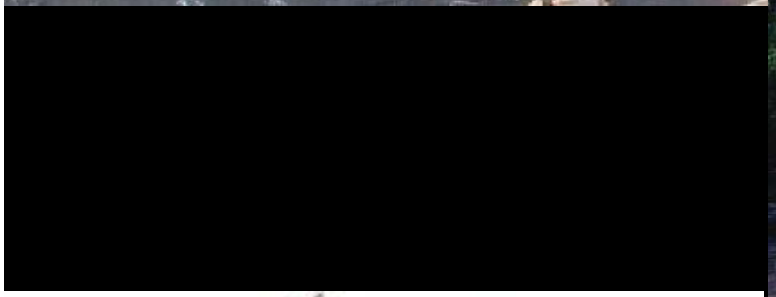


Illustration by Ted Walke



River Continuum

- River function is a gradient (continuum) that changes according to spatial scales

- Stream communities are in dynamic equilibrium with the stream—as the physical characteristics change, so will the biota

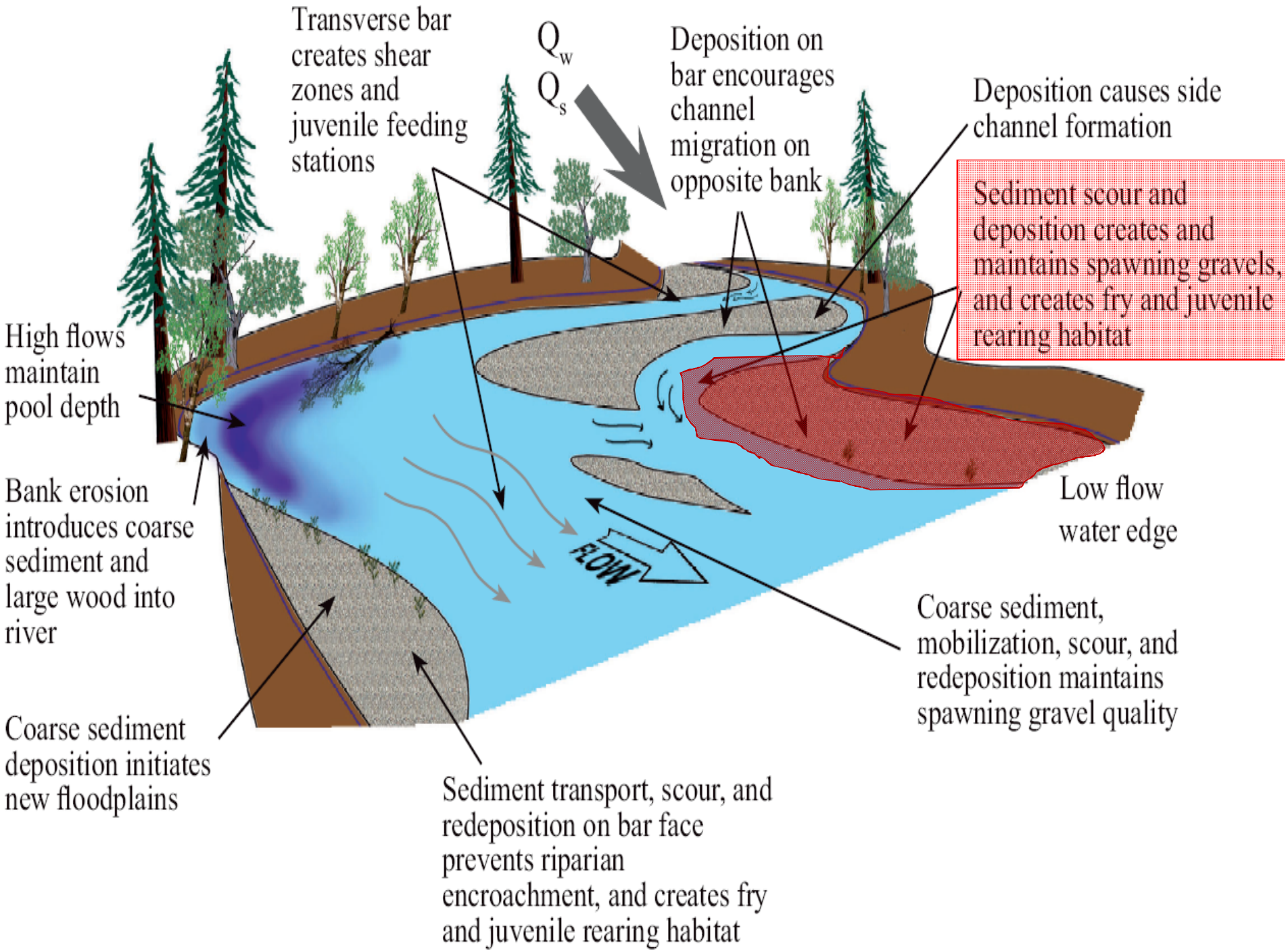
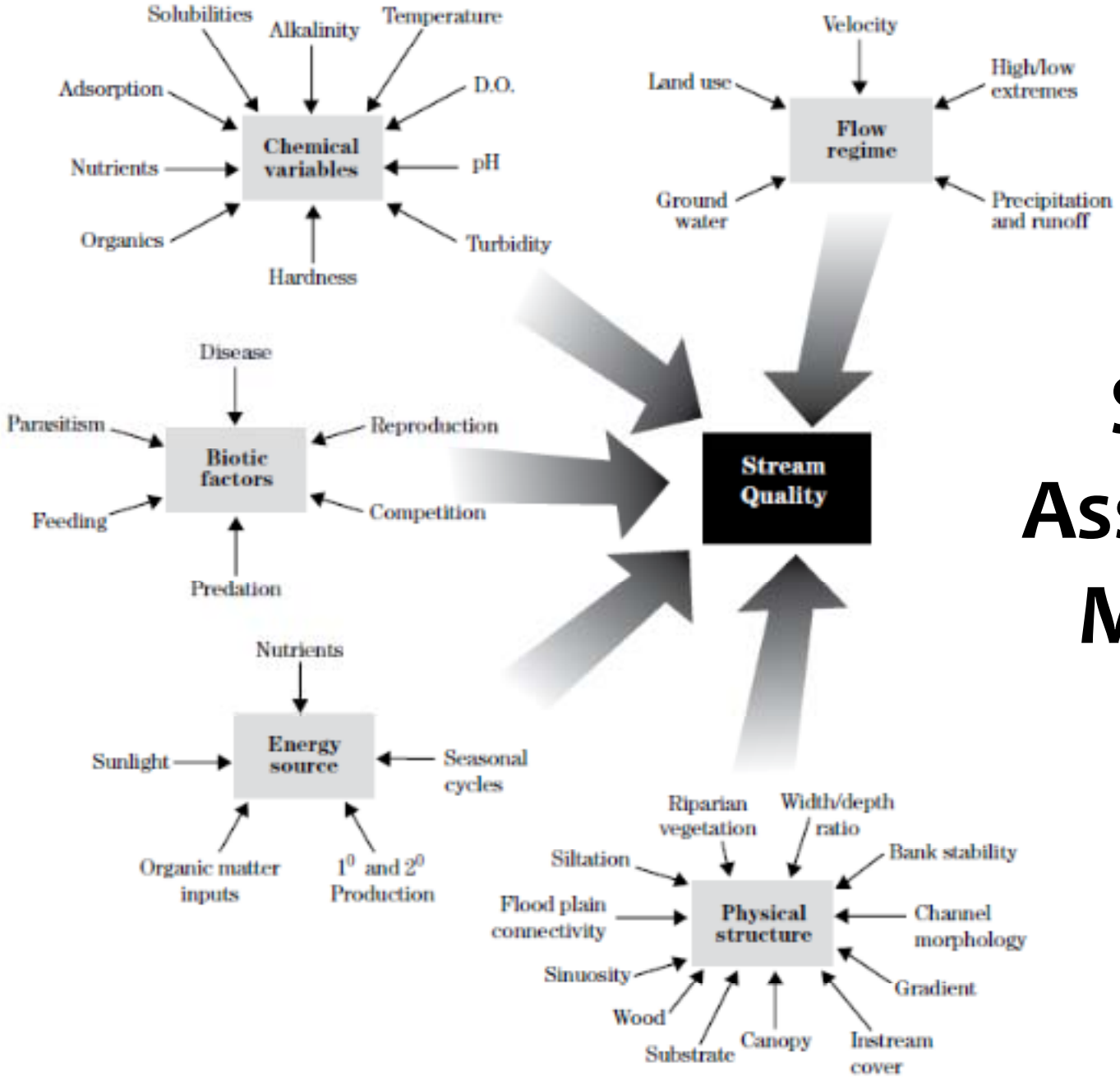
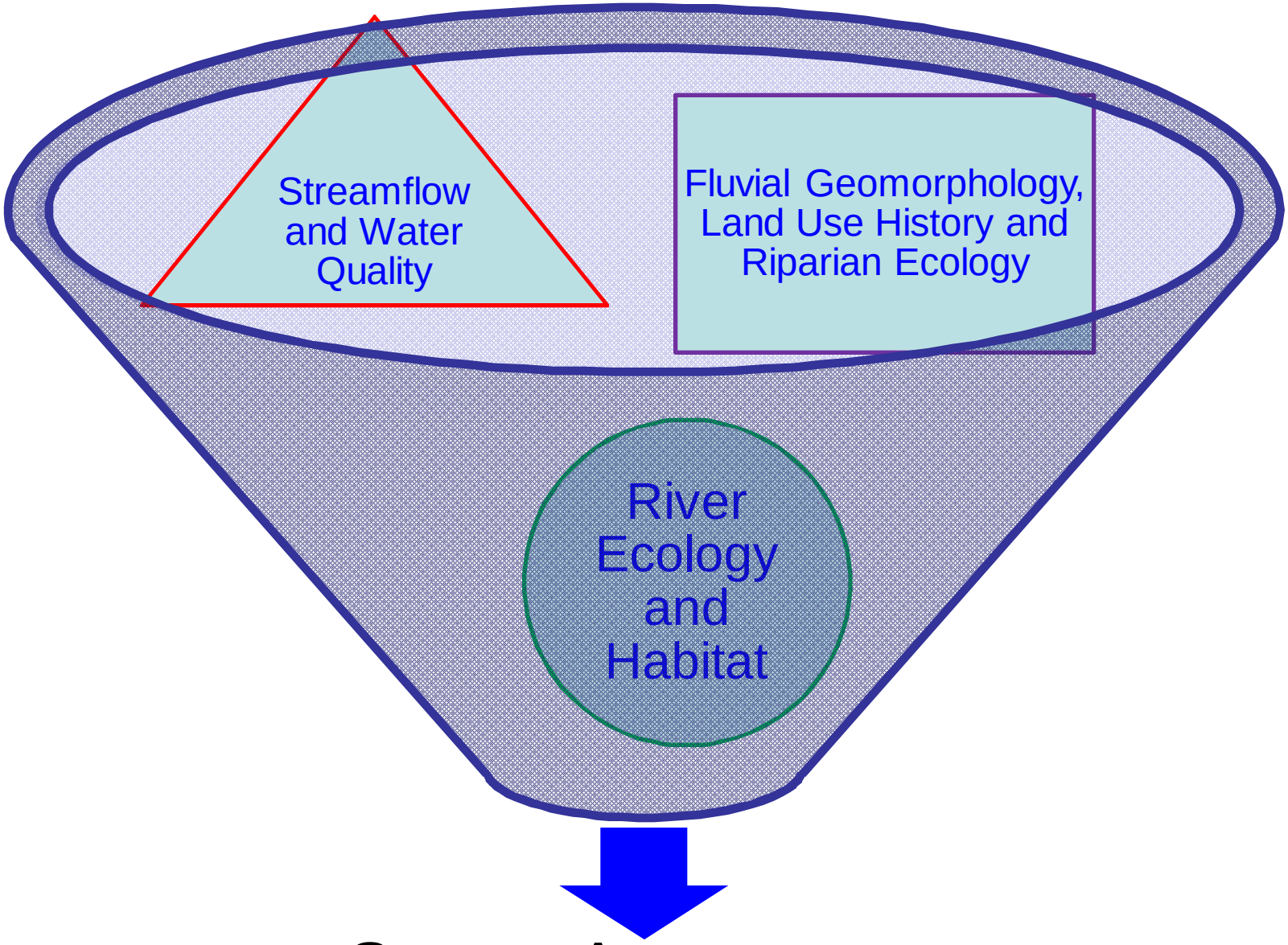

Transverse bar creates shear zones and juvenile feeding stations
Q_w
Q_s
Deposition on bar encourages channel migration on opposite bank
Deposition causes side channel formation
Sediment scour and deposition creates and maintains spawning gravels, and creates fry and juvenile rearing habitat
High flows maintain pool depth
Bank erosion introduces coarse sediment and large wood into river
Low flow water edge
FLOW
Coarse sediment, mobilization, scour, and redeposition maintains spawning gravel quality
Coarse sediment deposition initiates new floodplains
Sediment transport, scour, and redeposition on bar face prevents riparian encroachment, and creates fry and juvenile rearing habitat

Figure 1 Factors that influence the quality or condition of streams (modified from Karr et al. (1986))



Stream Assessment Methods



Stream Assessment Methods

Stream Assessment Methods

- RMAP
- WARSSS
- QHEI
- HQI
- IBI
- BEHI
- BVET
- HHEI
- TWALK
- RBP
- HSI
- HAT
- PFC
- HEP
- RSAT
- SQAT
- EMAP
- WHAMS

Stream Visual Assessment Protocol (SVAP)

Version 2

United States Department of Agriculture

Natural Resources Conservation Service

National Biology Handbook

Subpart B—Conservation Planning

Part 614 Stream Visual Assessment Protocol Version 2

(190–VI–NBH, December 2009)

Stream Habitat Assessment

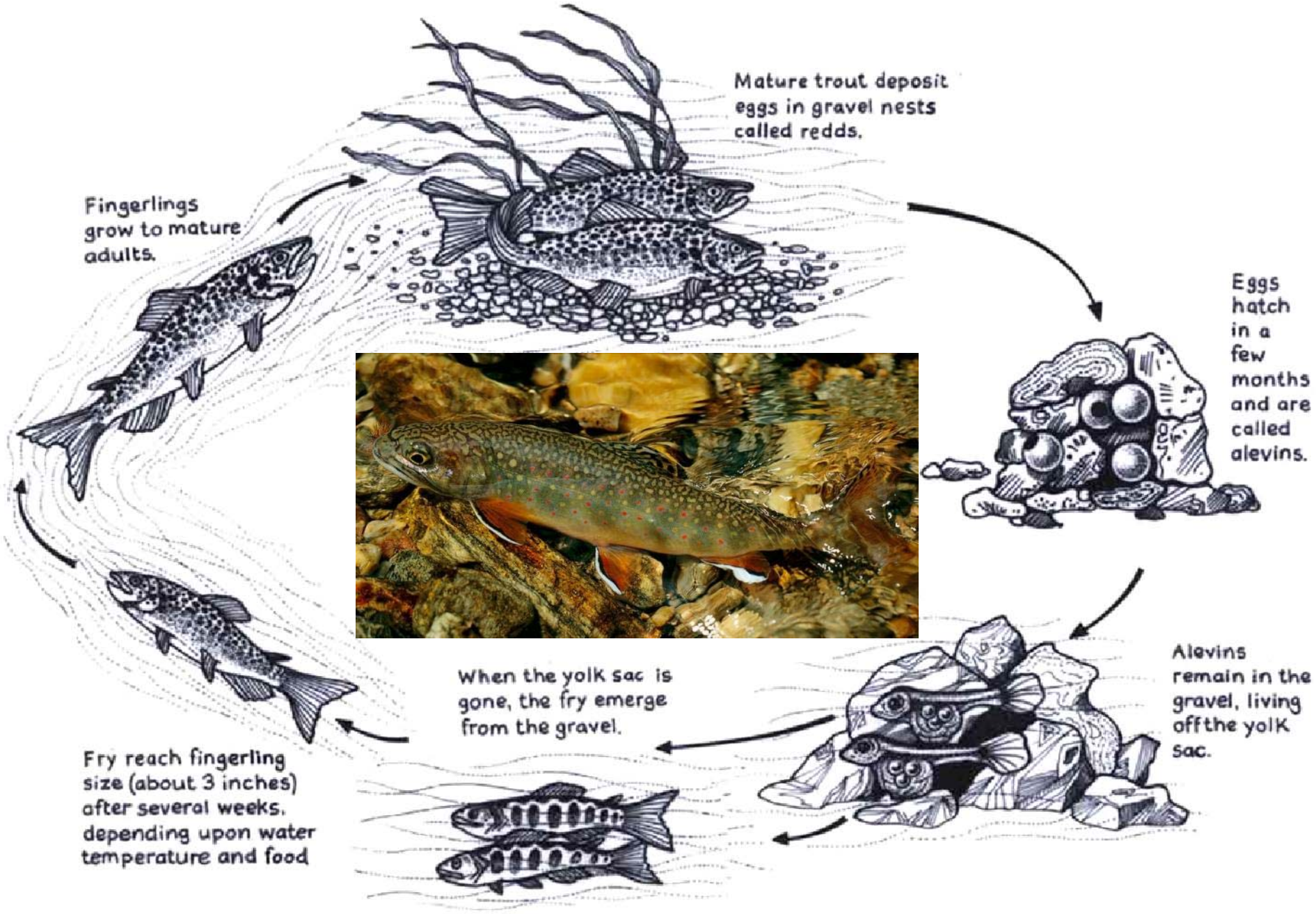
- Channel classification and stream assessment methods like SVAP2 supply a description of condition or relative function
- Don't really tell you the cause of degraded habitat
- Problems arise at the site scale when degraded habitat is noted and solutions are sought

Habitat Quality

- Bank erosion may be problematic
- Low substrate diversity
- Wide, shallow pools
- Fine sediment in riffles
- Little instream and streambank cover

Stream Habitat Management

- Project goal is to improve stream habitat
- Landowner is interested in Eastern brook trout

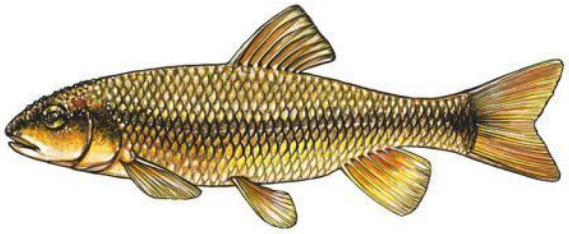

Mature trout deposit eggs in gravel nests called redds.
Eggs hatch in a few months and are called alevins.
Alevins remain in the gravel, living off the yolk sac.
When the yolk sac is gone, the fry emerge from the gravel.
Fry reach fingerling size (about 3 inches) after several weeks, depending upon water temperature and food
Fingerlings grow to mature adults.

Geomorphology & Habitat

- Substrate—upstream supply is retained, diverse and well sorted
- Riffles and pools—bed diversity from stable pattern and planform and/or instream obstructions (LWD)
- Overhead cover—cut and fill balanced, sloped streambanks give vegetation access to water table
- Lateral and Floodplain Access—overbank flow possible, channel not incised

Options

- Change management
- Armor
- Slope back and revegetate
- Redirect scour
- Regrade channel
- Add instream structures



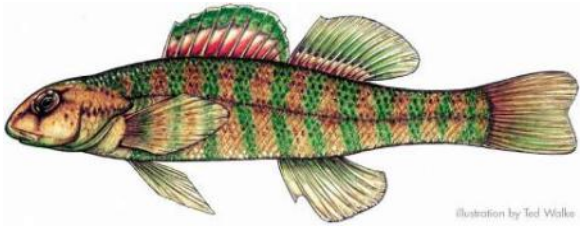
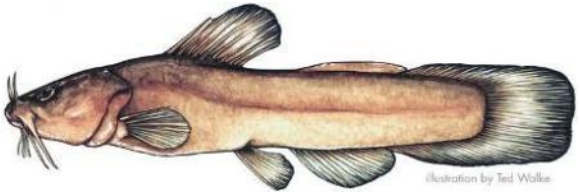


Illustration by Ted Walke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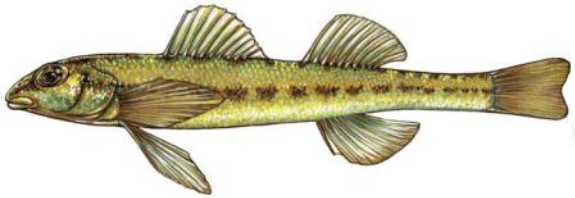

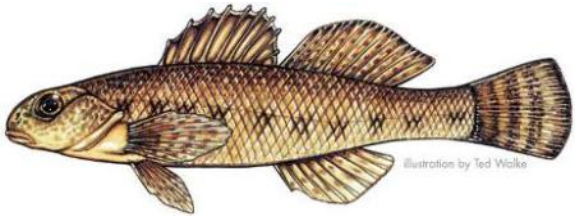
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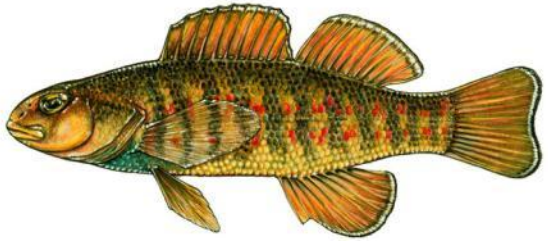

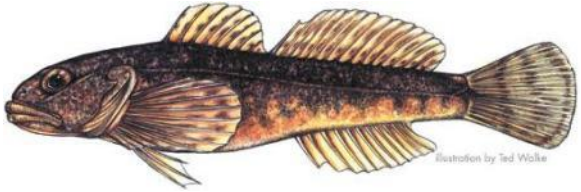
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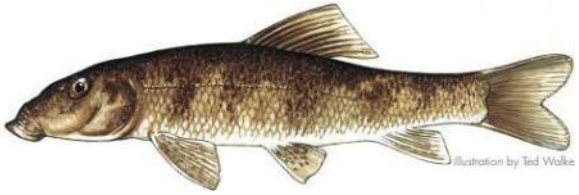
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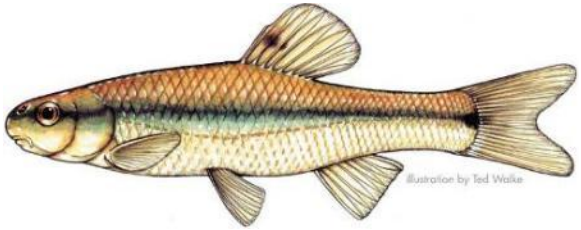
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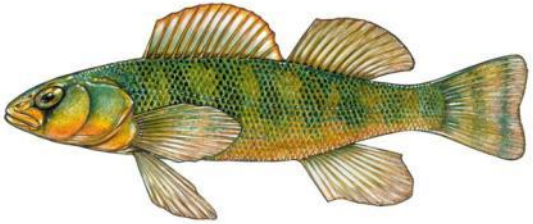

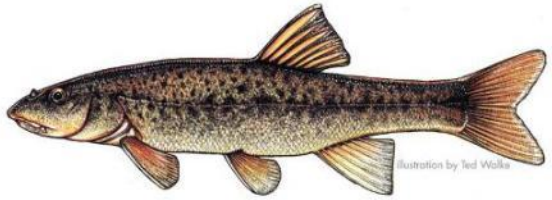
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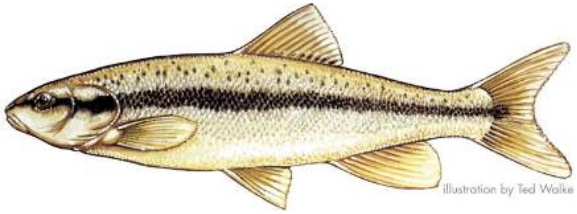
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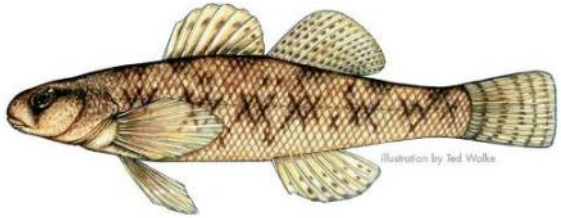
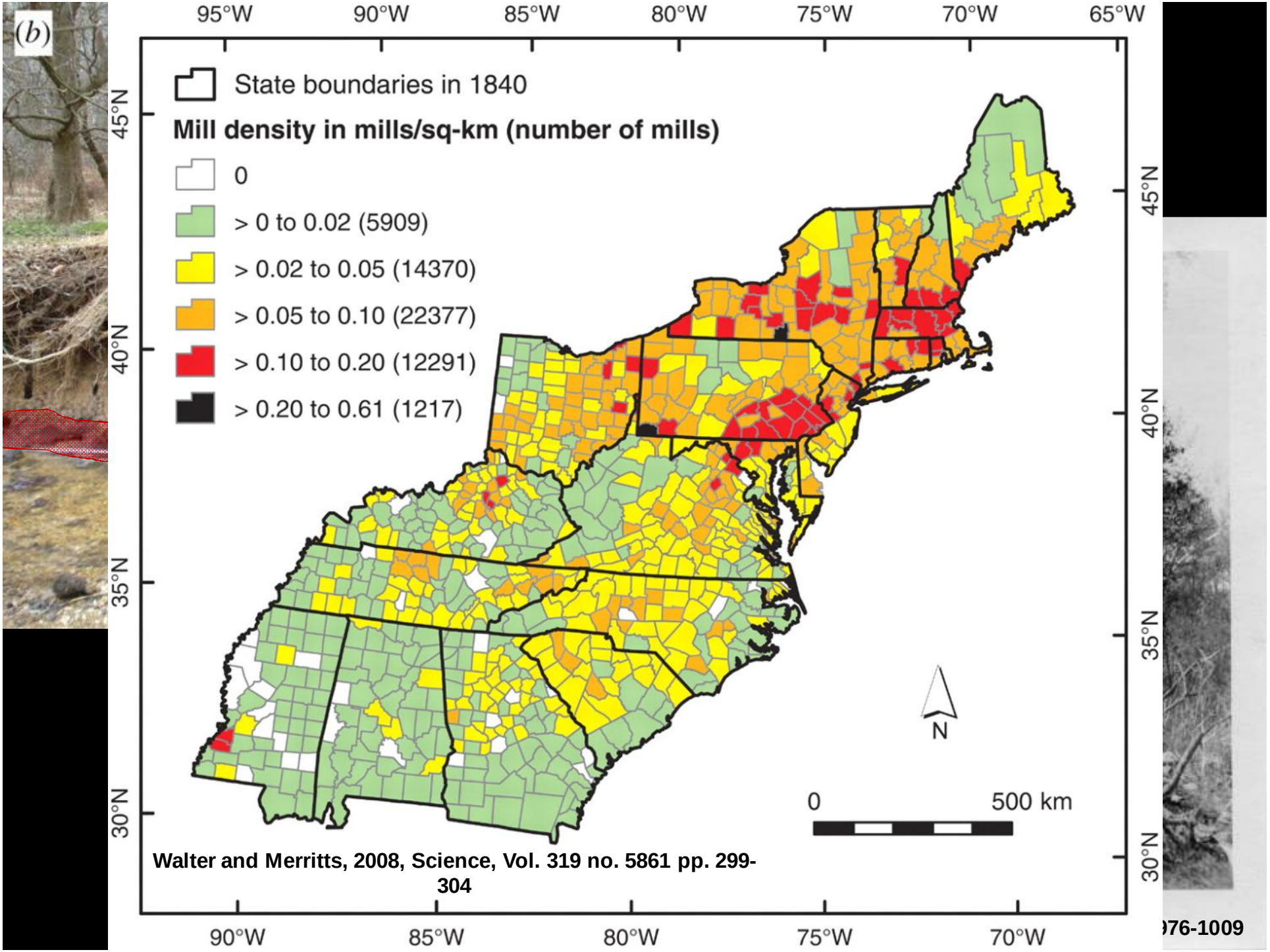


Illustration by Ted Walke

Planning Stream Habitat Management

- Trying to develop a solution that meets the ecological needs of all species will give you a headache.
- Instead, work within the context of the river and its watershed to support all the functions you can.
- Geomorphically functional streams equal quality habitat
- Work with the river (and the landowner) to find the best solution.

- Look upslope, upstream, and downstream
- Try to understand the factors forcing the morphology you're faced with
- Identify watershed context
- Look back in time



Walter and Merritts, 2008, Science, Vol. 319 no. 5861 pp. 299-304

976-1009

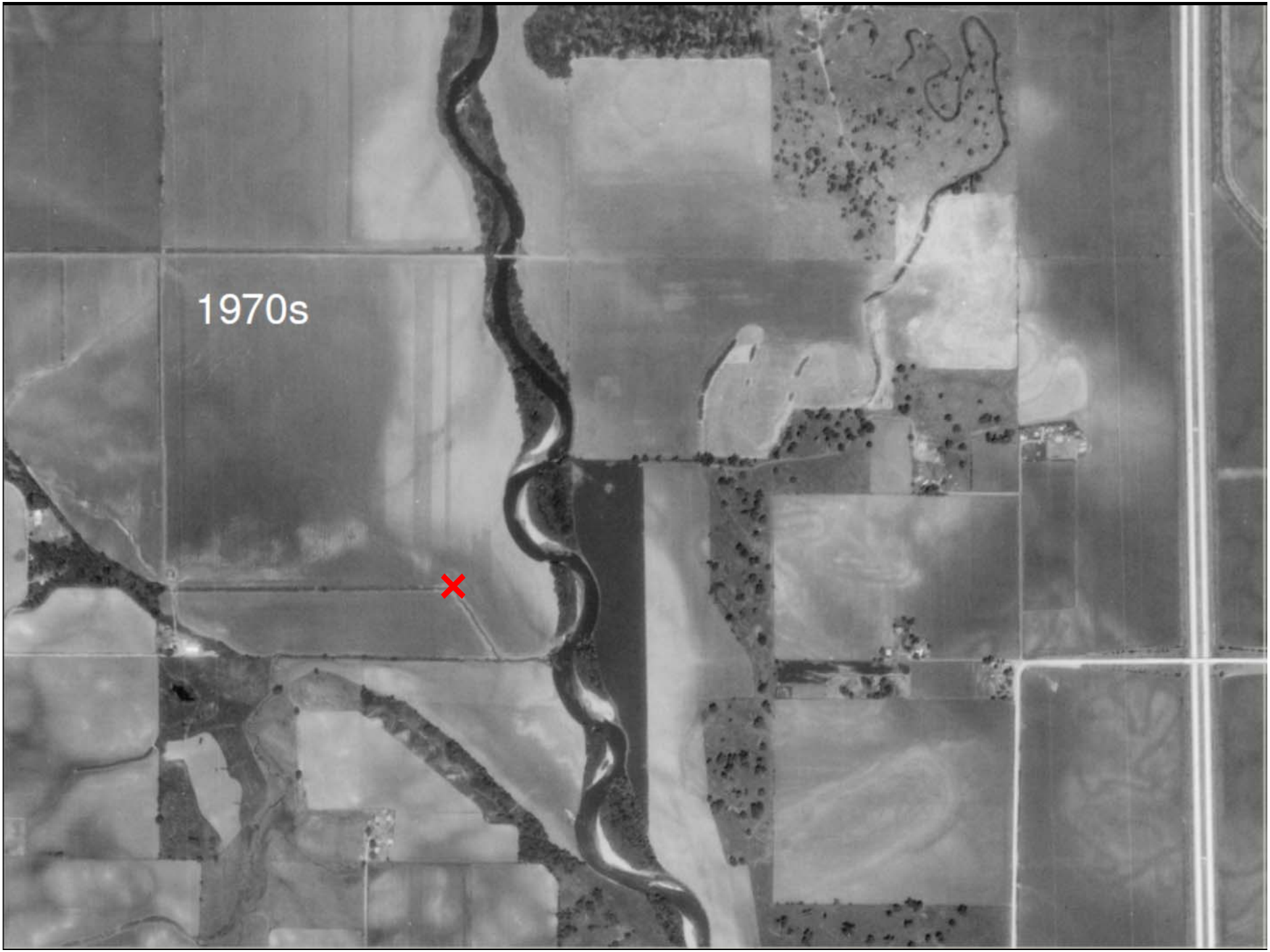
Merritts D et al. Phil. Trans. R. Soc. A 2011;369:976-1009

Planning Stream Habitat Management

- River Context
- Spatial: what kind of stream is this?
  - braided, meandering? cascade, step-pool, pool riffle?
- Temporal: what was the disturbance history?
  - dam? logging? channel management? when?
- Indentify and capitalize on intact processes (work with the river)

Channel Manipulation


1930s


1970s


1990s

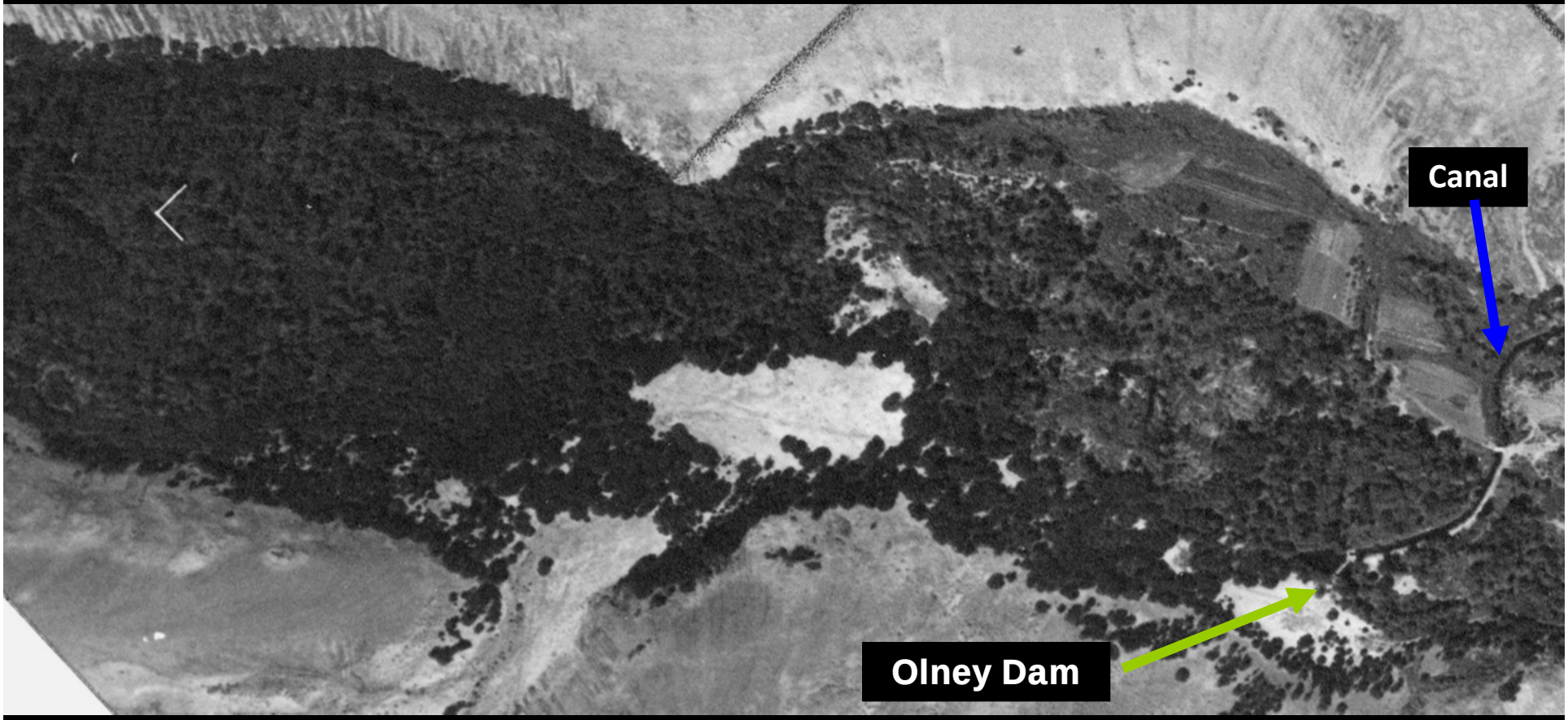

2002


2007

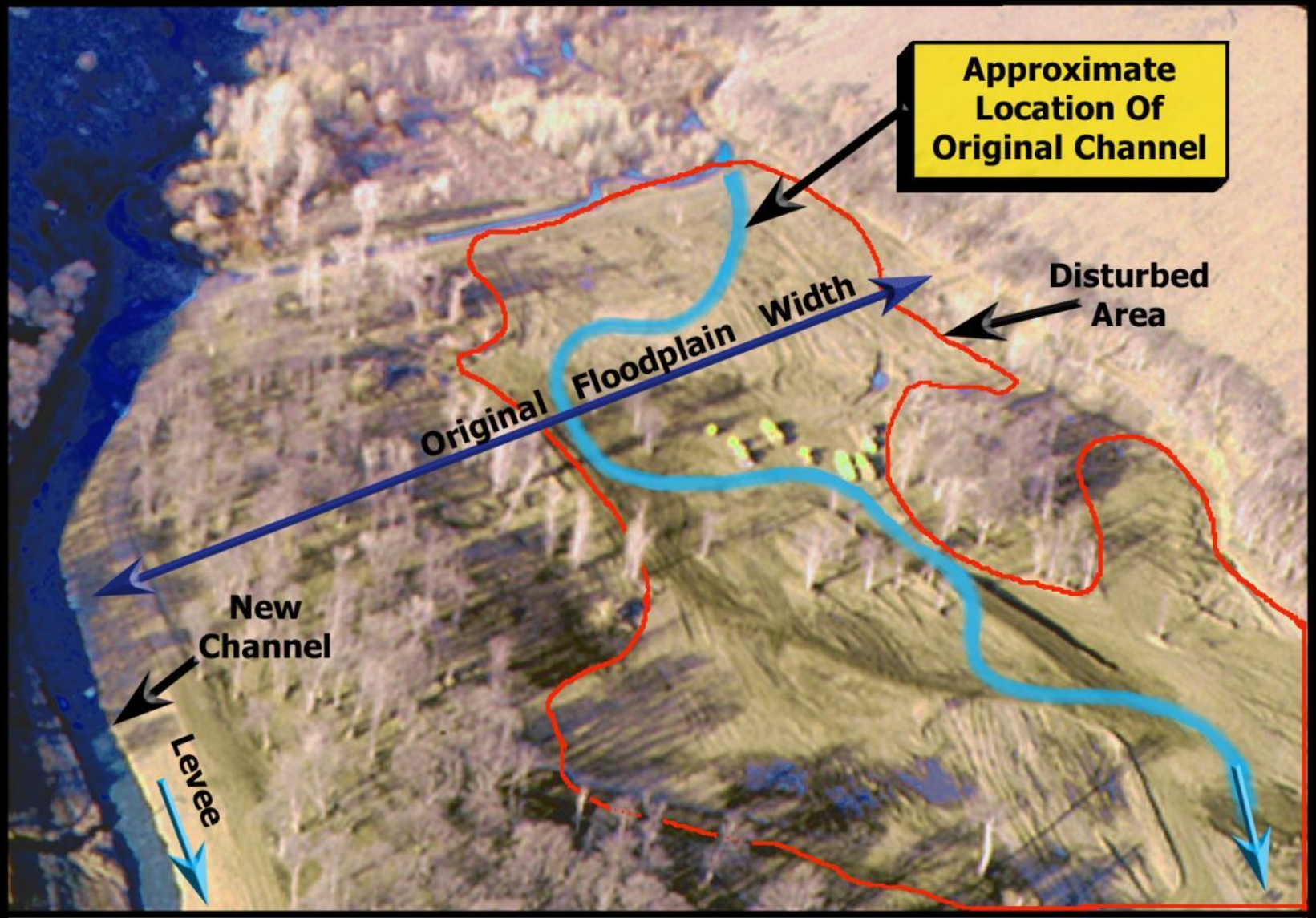

1930s
1970s
2007


Toppenish Creek, Yakama Reservation, White Swan WA
K. Gullett Photo

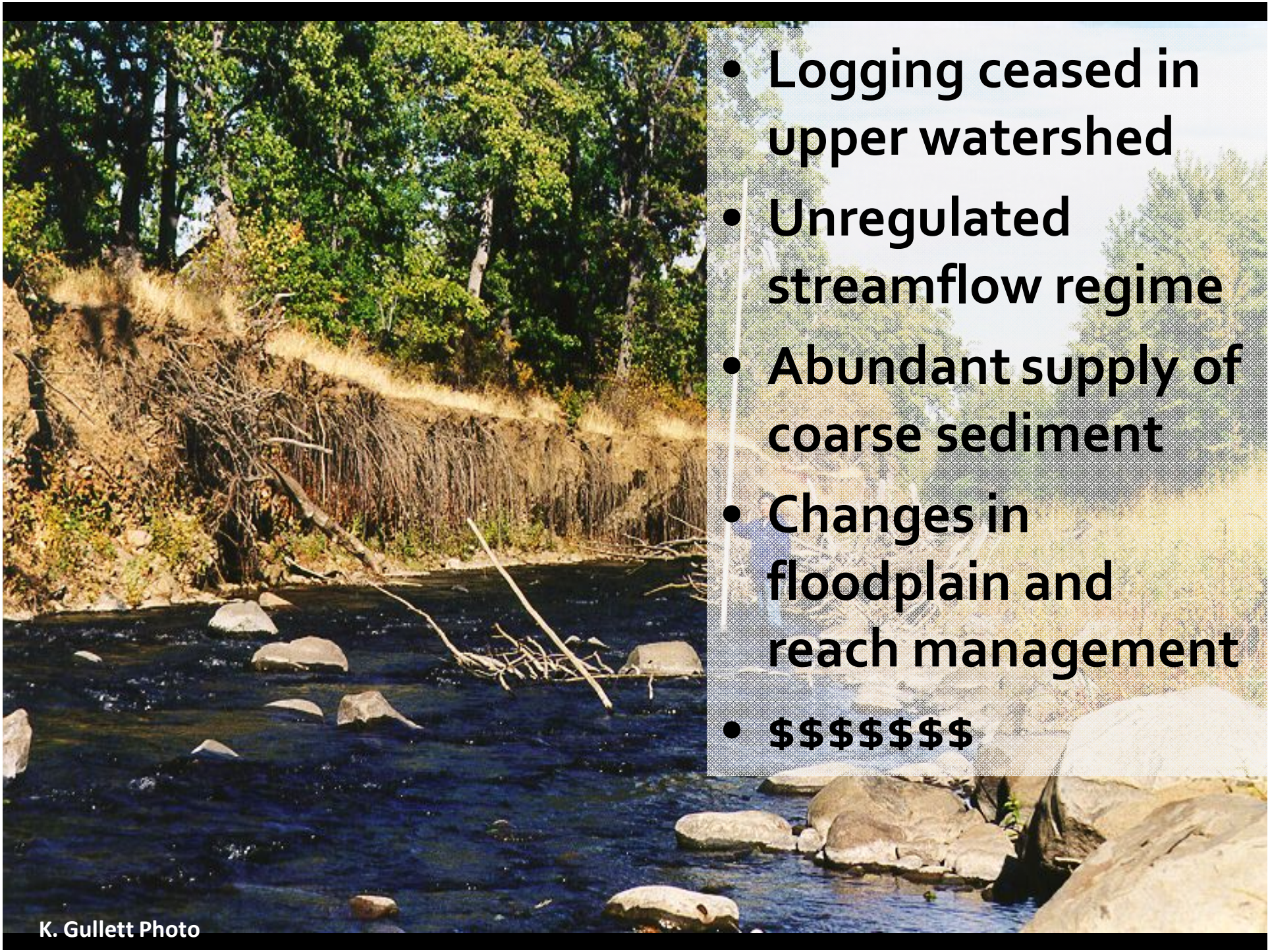
1949 Aerial Photo of Olney Dam Reach, Toppenish Creek near White Swan, WA



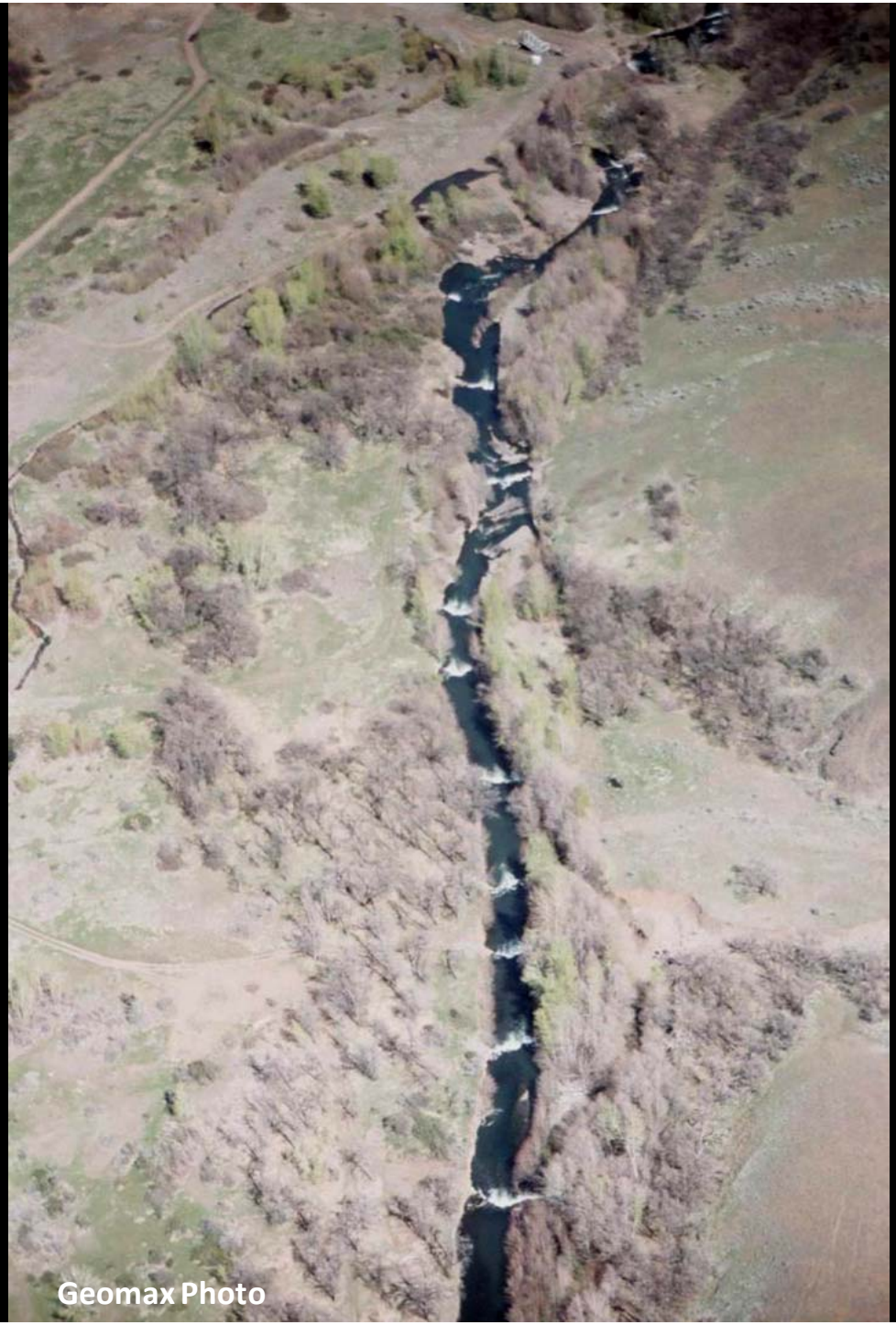
Channelization and Levee



1970's Channelization & Diking Operation



- Logging ceased in upper watershed
- Unregulated streamflow regime
- Abundant supply of coarse sediment
- Changes in floodplain and reach management
- $$$$$$$



Aerial View of 11 Grade Control Structures on Toppenish Creek

Close Aerial View of Drop Structures

Stabilized Degraded Section

Olney Rock Drops At Low Flow


K. Gullett Photo

END

River Science (Hydrology and Fluvial Geomorphology) for Non-engineers

July 25, 2012

Image: www.troutnut.com

United States Department of Agriculture
Natural Resources Conservation Service

USDA NRCS