

Relative Bed Stability – Using ‘R’ to Calculate Quantitative Physical Habitat Metrics

Emma Jones, Larry Willis,
and Jason Hill



Workshop Resources:

<http://www.deq.virginia.gov/programs/water/waterqualityinformationtmdls/waterqualitymonitoring/probabilisticmonitoring/probmondatasources.aspx>

Virginia.gov Agencies | Governor Search Virginia.Gov

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Search GO

My DEQ | Permits | Laws & Regulations | Programs | Locations | About Us | Connect With DEQ

For Businesses | For Virginia Residents | For Educators | For Localities | For Vendors

Environmental Quality
P.O. Box 1105
Richmond, VA 23218

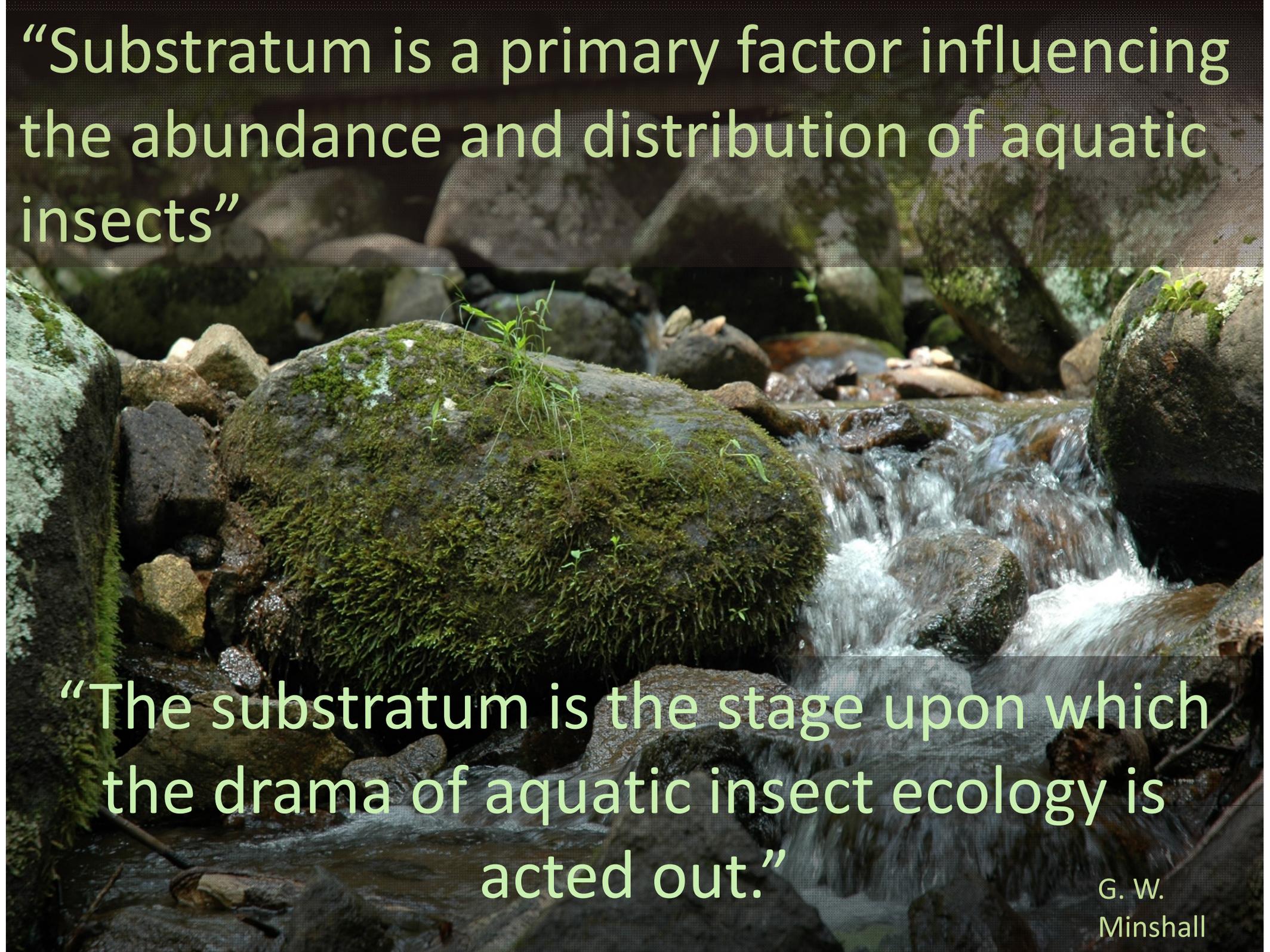
Contact Us:
1-(804) 698-4000
1-800-592-5482 (Toll Free in VA)

View Department of Environmental Quality Expenses

ation & TMDLs | Water Quality Monitoring | Probabilistic Monitoring | ProbMon Data Sources

Probabilistic Monitoring - Data Sources

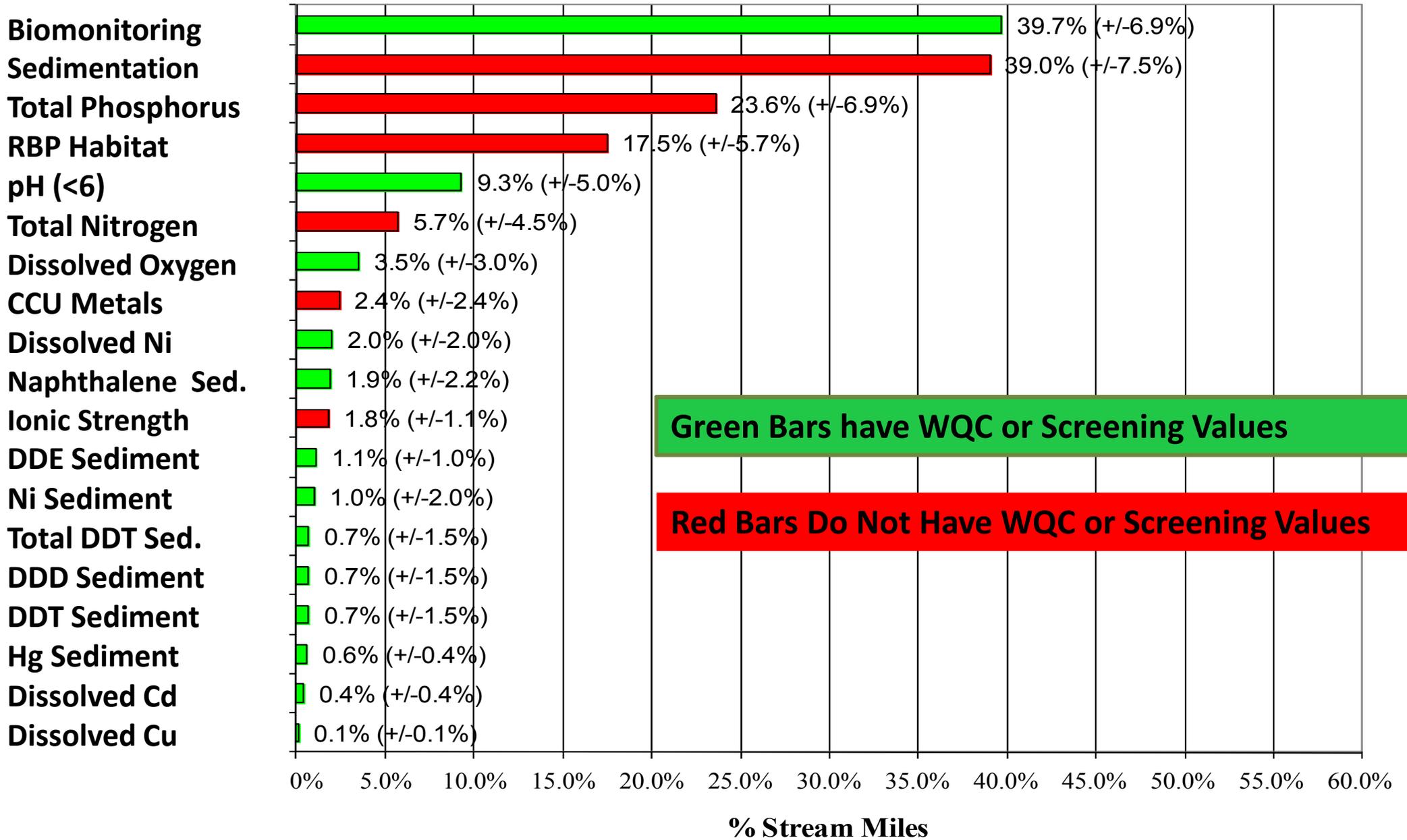
- Freshwater Probabilistic Monitoring Sampling Frame
- Family Macroinvertebrate EDAS Database (Updated April 2016)
- Genus Macroinvertebrate EDAS Database (Updated April 2016)
- Fish EDAS Database (Updated April 2016)
- ProbMon Phab Database (Updated April 2016)
- ProbMon Phab Tools (Updated April 2016)
- Algae EDAS Database
- ProbMon Data Set (2001-2009)

A photograph of a small stream flowing over dark, moss-covered rocks in a forest. The water is clear and creates small white rapids as it flows over the rocks. The surrounding environment is lush with green moss and small plants growing on the rocks.

“Substratum is a primary factor influencing the abundance and distribution of aquatic insects”

“The substratum is the stage upon which the drama of aquatic insect ecology is acted out.”

G. W.
Minshall

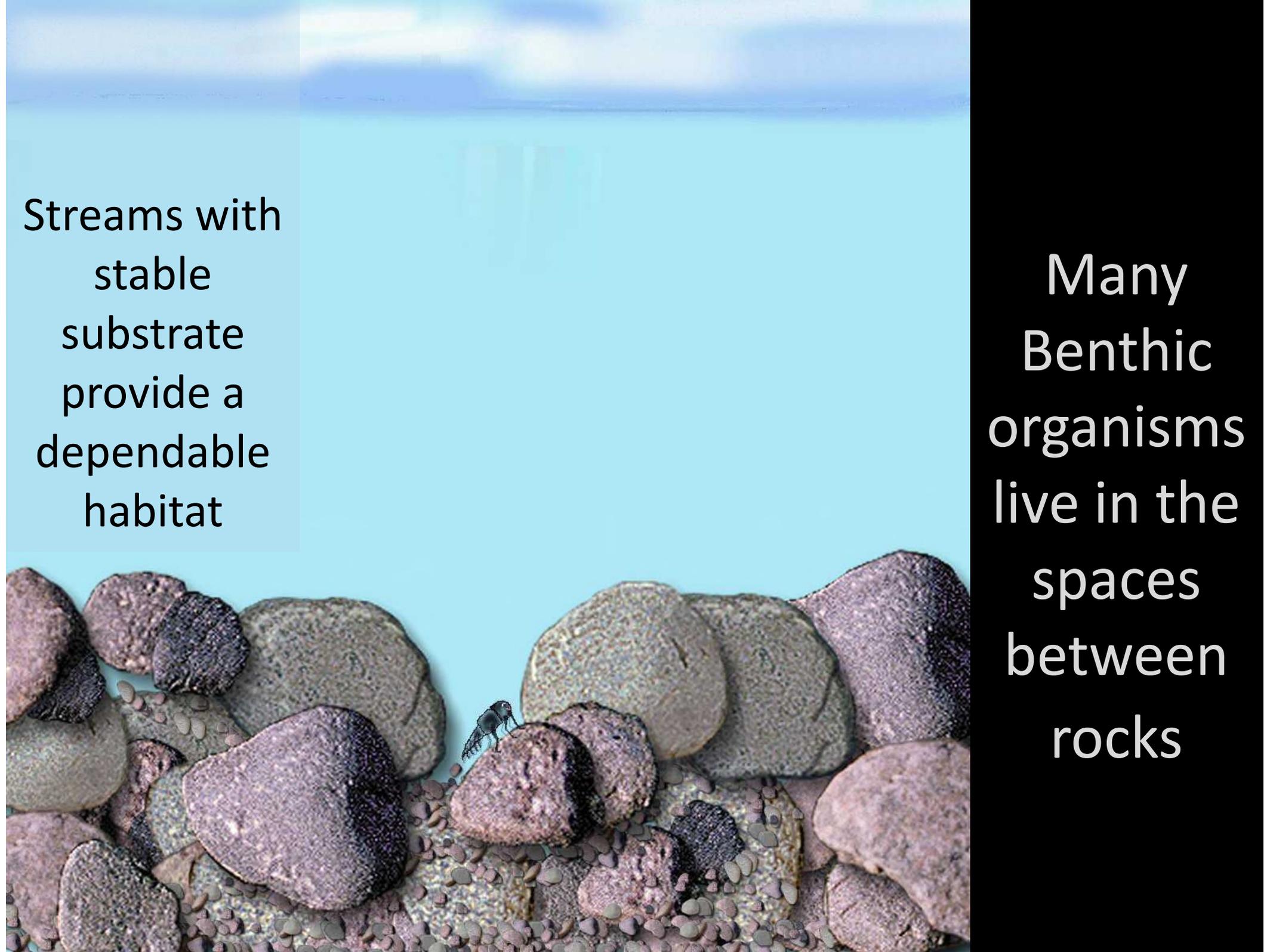


Percent of rivermiles not meeting expectations for aquatic life and the most common stressors in Virginia streams

Virginia 2012 305(b).

One of the most basic needs of any living thing is a place to live





Streams with
stable
substrate
provide a
dependable
habitat

Many
Benthic
organisms
live in the
spaces
between
rocks



Mobile sediments cause spaces to be filled and is an unstable habitat.

Unstable substrate is constantly moving
and fills important space





Sediment Knee-deep on a
mayfly is too deep!

Stream Diversity

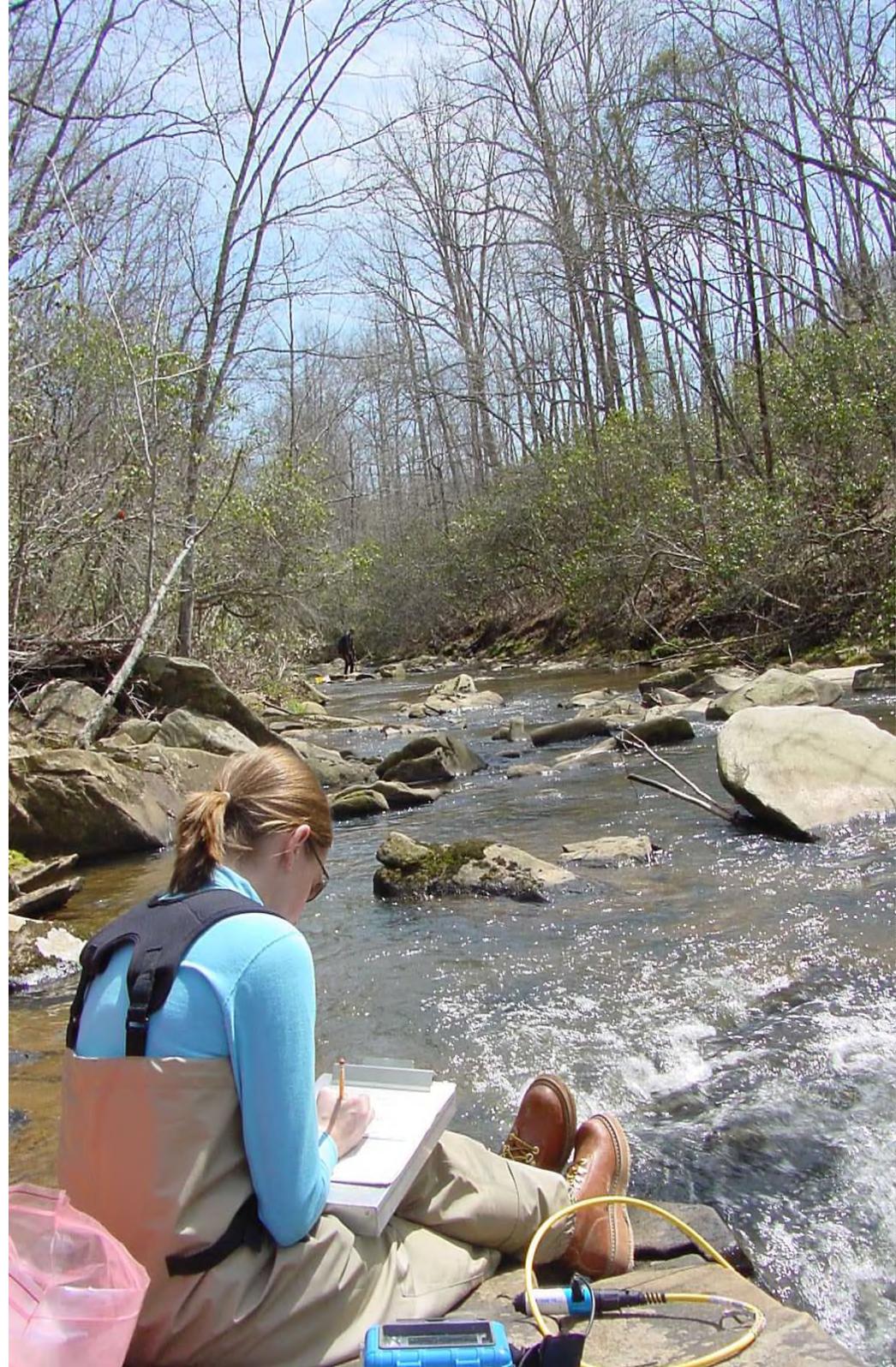


Are sediment problems natural or man-made?



A photograph of a river flowing through a dense forest. The water is clear and reflects the surrounding greenery. A person wearing a dark jacket and waders is standing in the shallow water on the left side of the frame. The riverbed is rocky and covered with fallen leaves and twigs. The trees are tall and lush, creating a canopy over the river. The sky is blue with some white clouds. The text "What is natural?" is overlaid on the right side of the image in a white, sans-serif font.

What is
natural?



Relative Bed Stability (RBS)

Measurements of channel shape, roughness and slope can be used to predict a particle size moved at bankfull flow.

RBS = Observed/Predicted

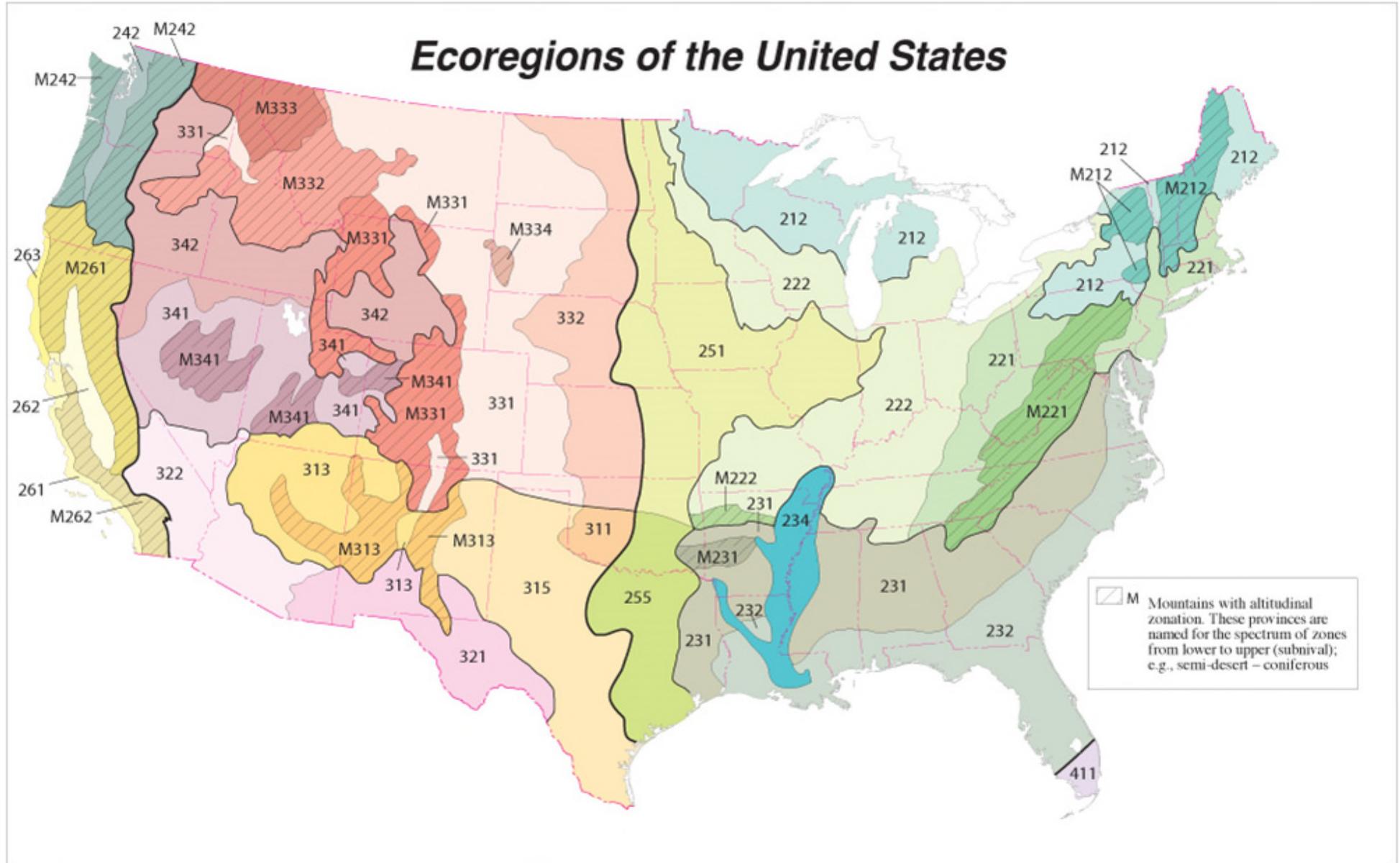
Relative Bed Stability

$$\begin{aligned}\mathbf{RBS} &= \mathbf{D}_{50} / \mathbf{D}_{cbf} \\ &= \text{Observed} / \text{Predicted}\end{aligned}$$

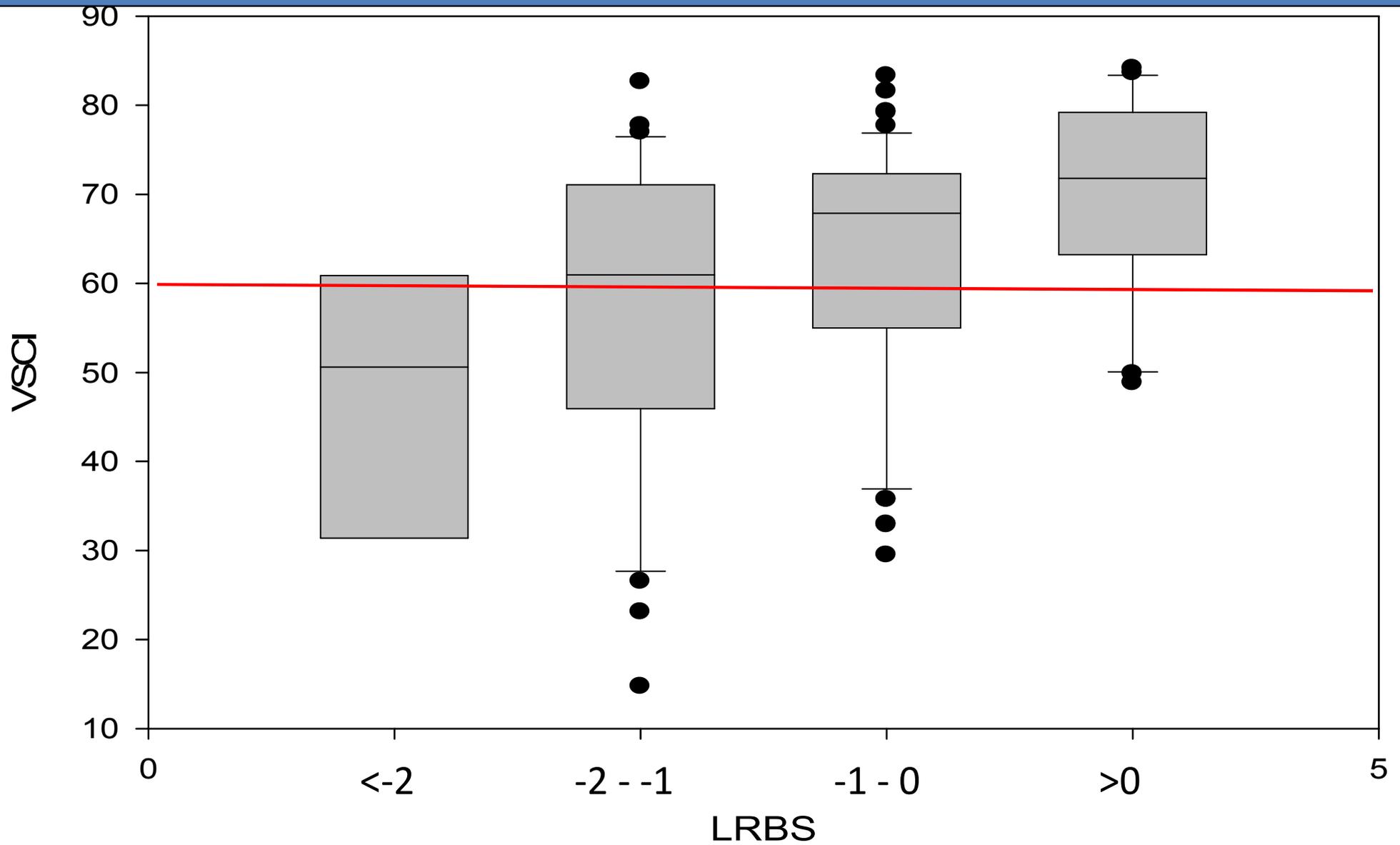
if Observed = Predicted then RBS = 1
and LRBS = 0

Interpret by Reference Condition

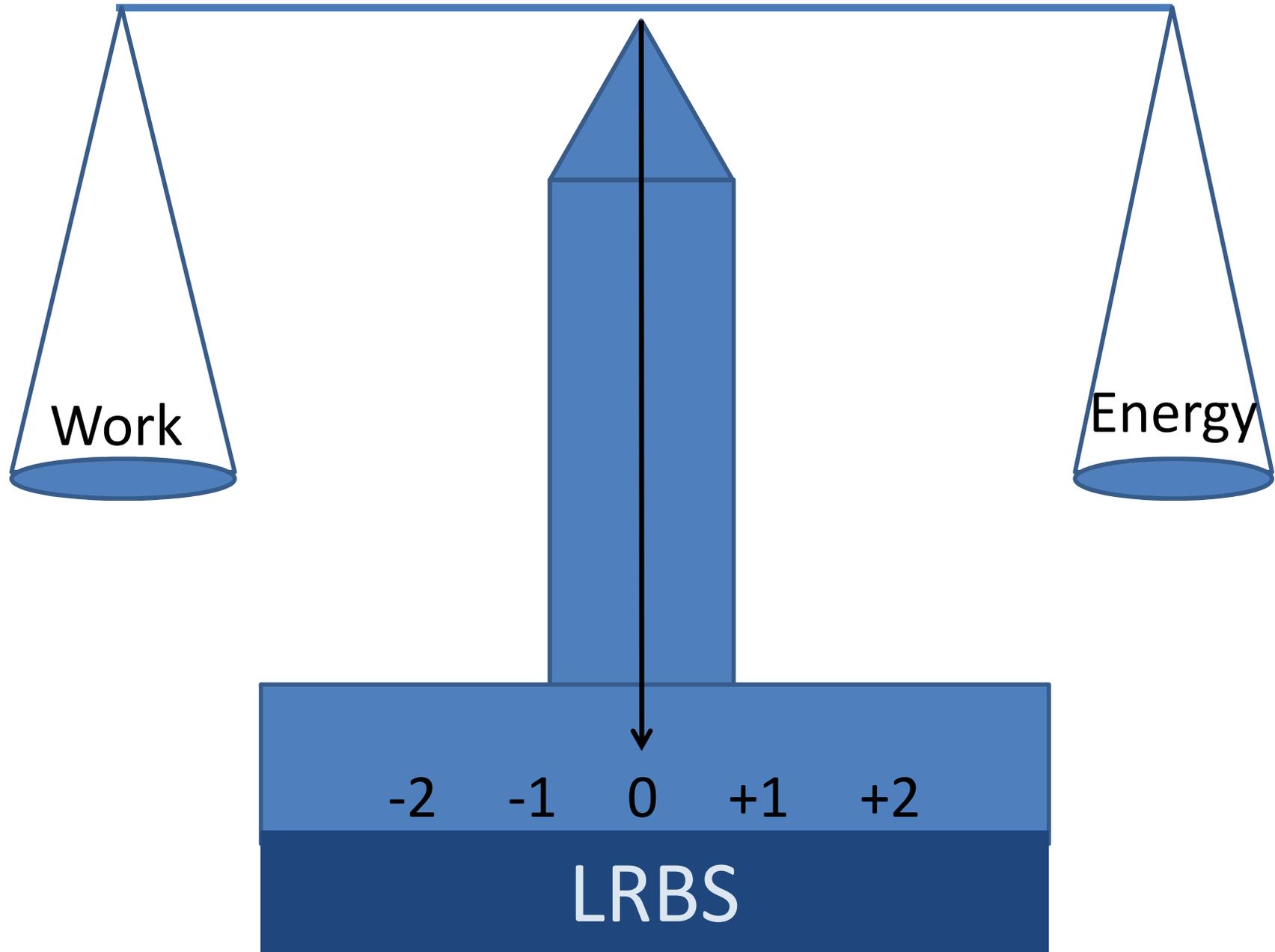
NRSA does this for some regions .



VSCI by LRBS

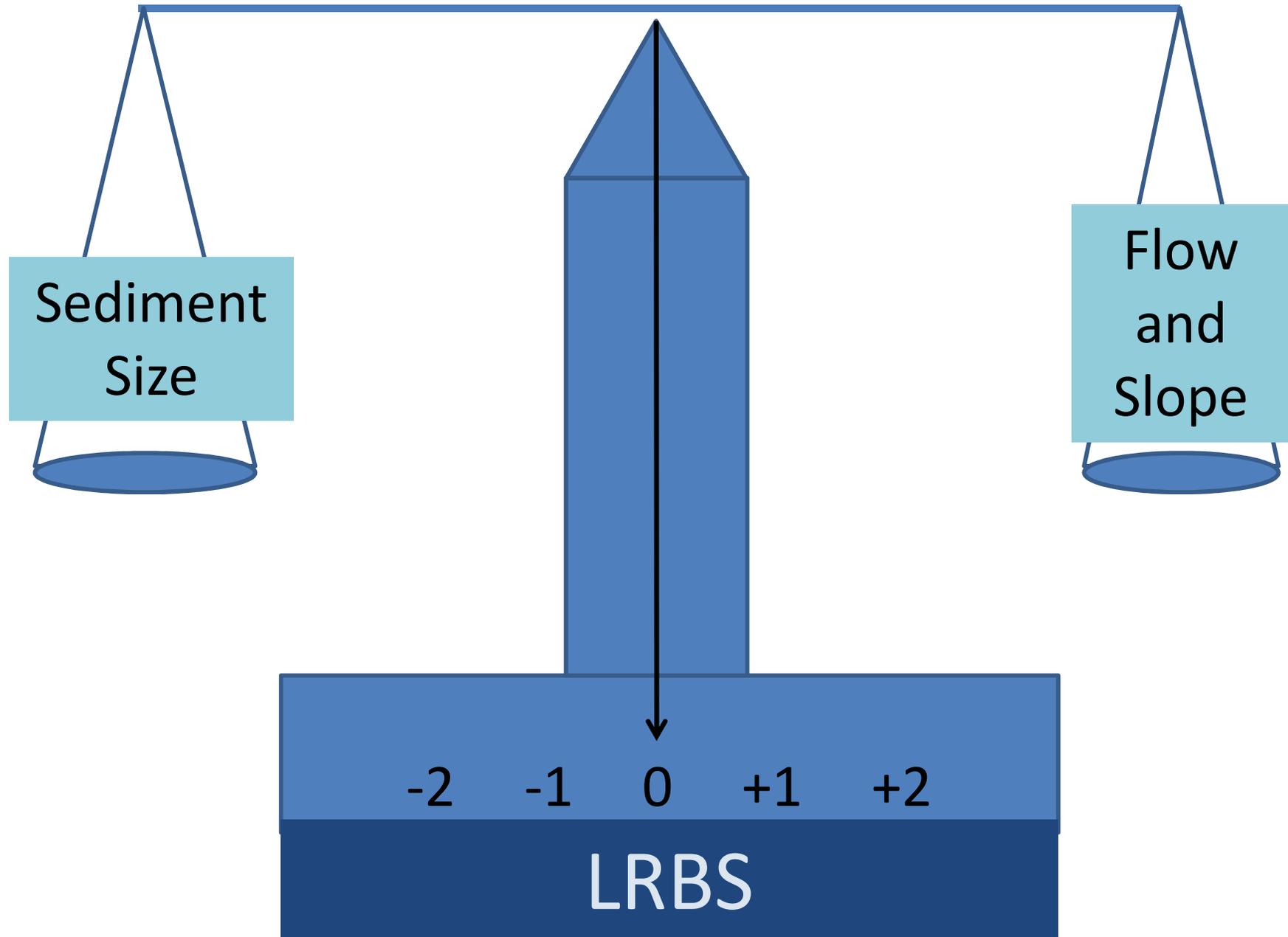


Stream Channels Tend Toward Equilibrium



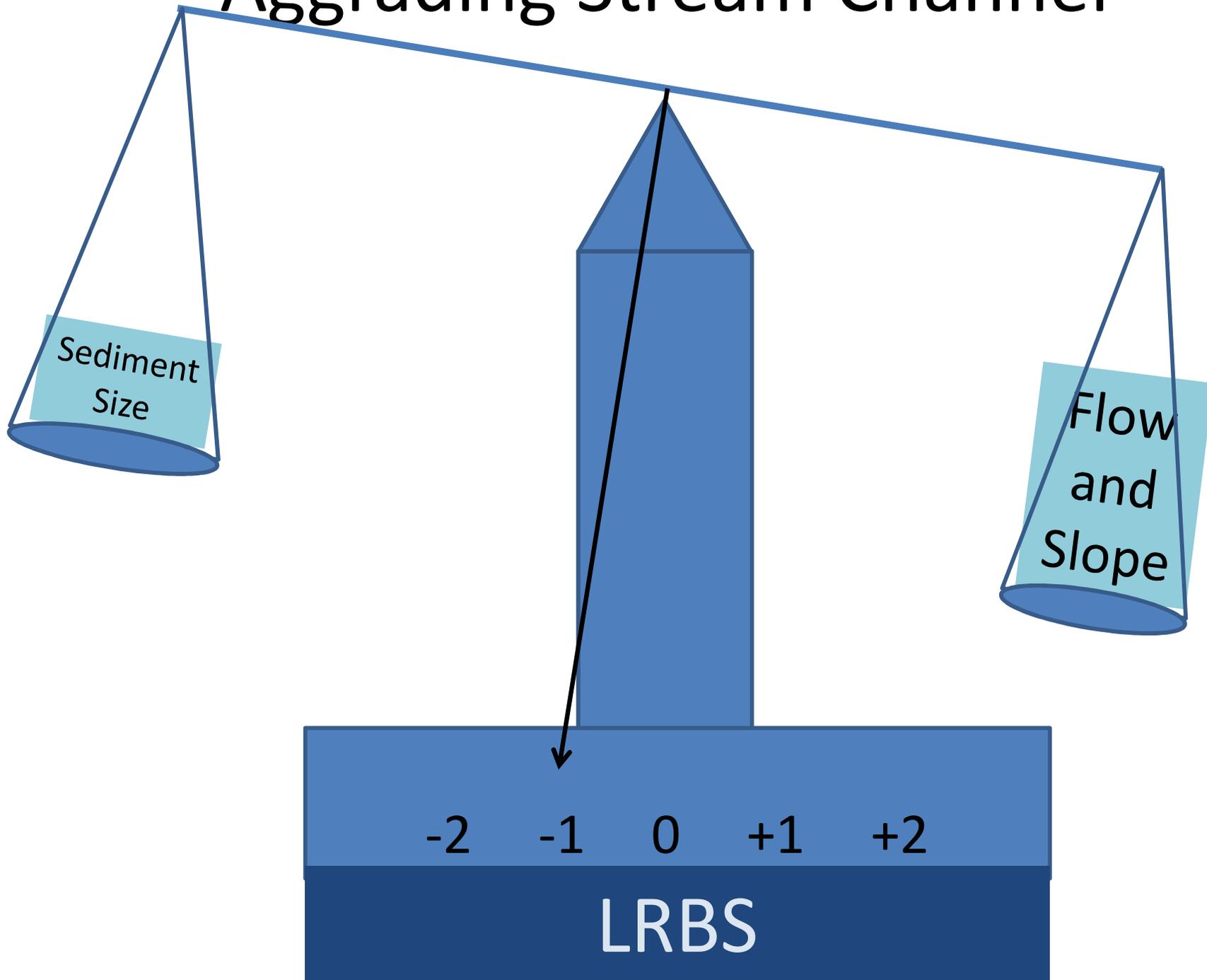
Equilibrium is achieved by adjusting channel shape

Stream Channels Tend Toward Equilibrium



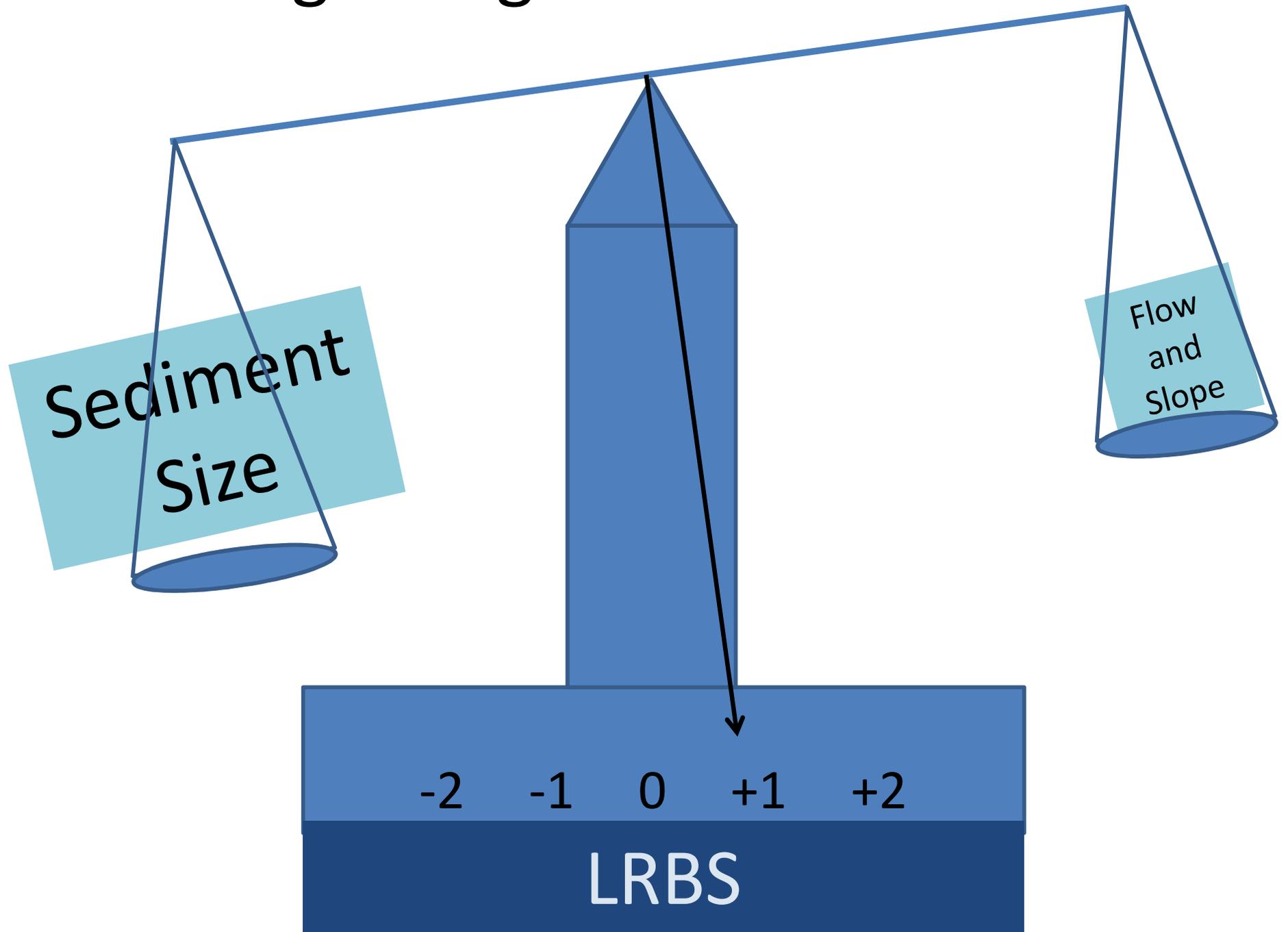
Equilibrium is achieved by adjusting channel shape

Aggrading Stream Channel



Equilibrium is achieved by adjusting channel shape

Degrading Stream Channels



Equilibrium is achieved by adjusting channel shape

**LRBS = 0 is like having a
tornado once every 2 years**



**LRBS = -2 is like
having a tornado
every time it rains!**

Gemomorphological Parameters

• Size and Dimensions

- Order and Area
- Slope
- Bankfull Width
- Bankfull Depth
- W:D
- Incision
- W:Area
- RP100

• Substrate

- LRBS
- Median Size
- Percent Sand
- Percent Fines
- Percent Bedrock
- Percent Hardpan
- Embeddedness
- Boulder/Cobble/Gravel Embeddedness

Two Distinct Problems

1. Aggradation

Sediment Accumulation

Indicators:

LRBS <-1

High sands and fines



2. Degradation

Sediment Erosion

Indicators:

Narrow/deep channel,

High bedrock and hardpan

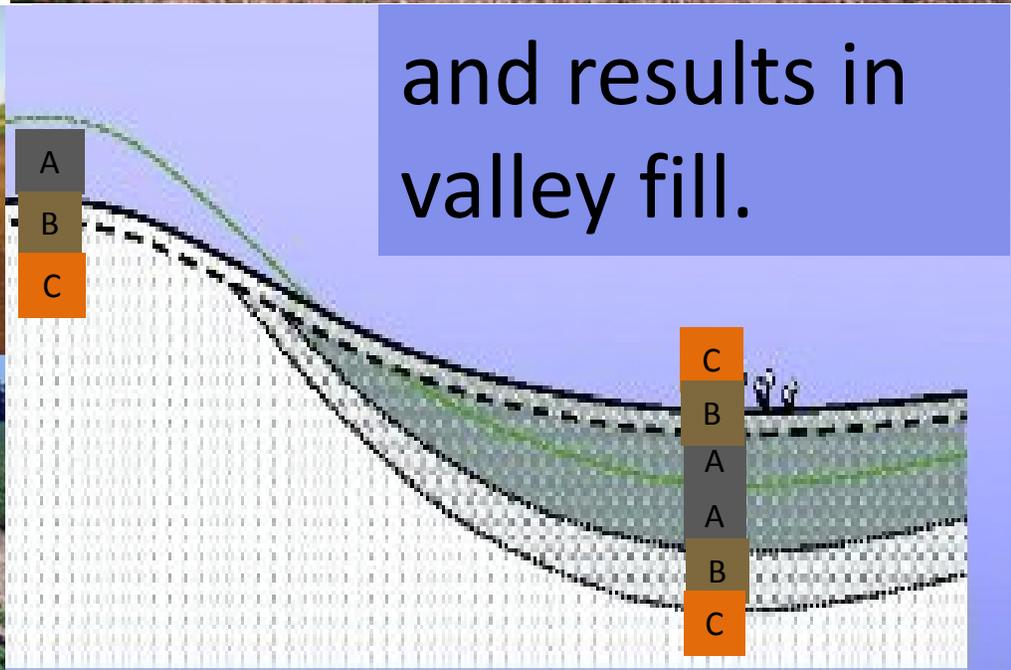
LRBS Variable

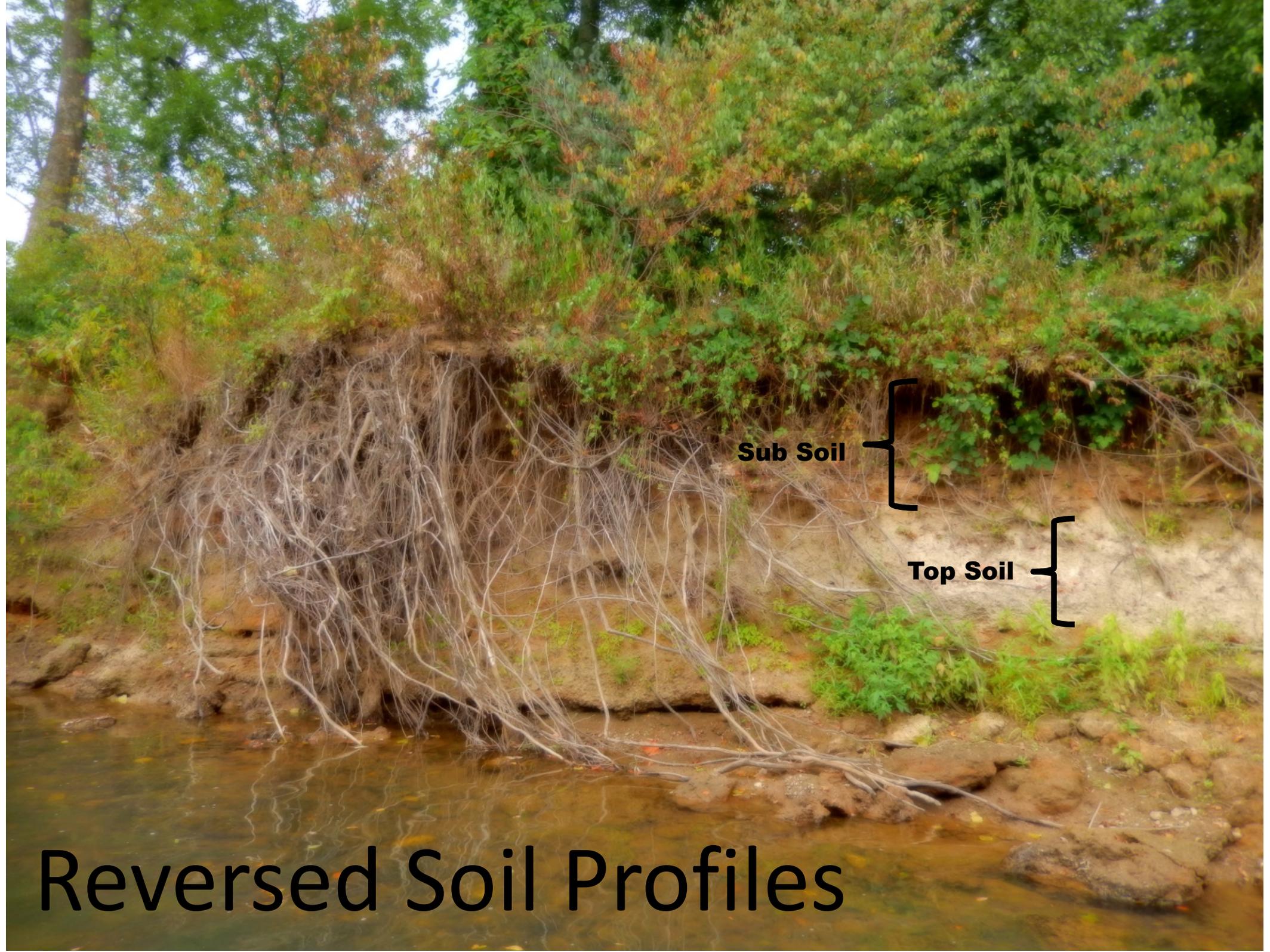


Bad farming practice... Leads to overland erosion



Hill-top erosion



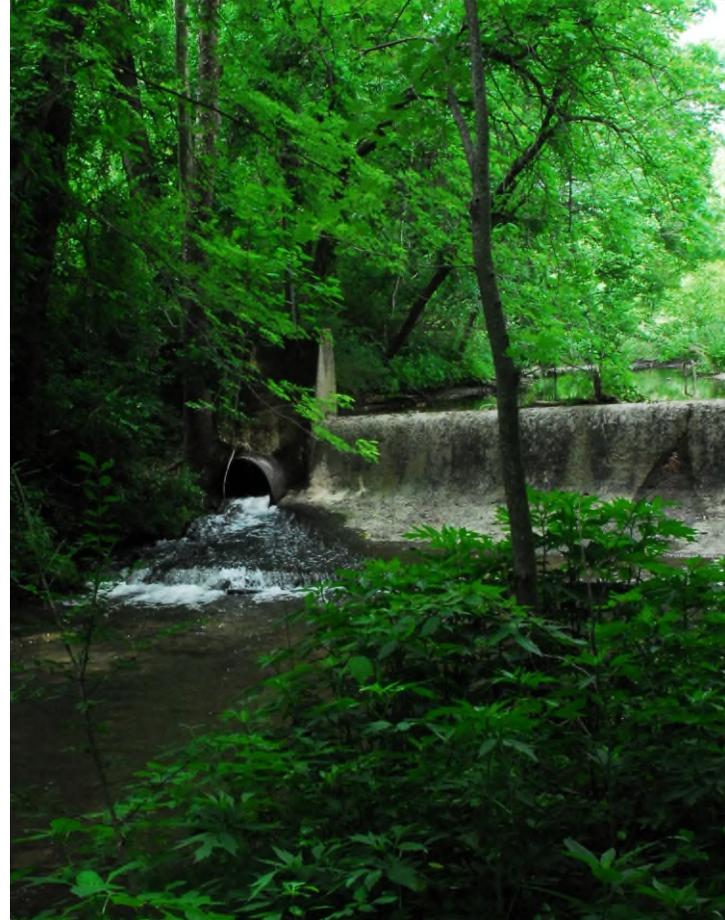
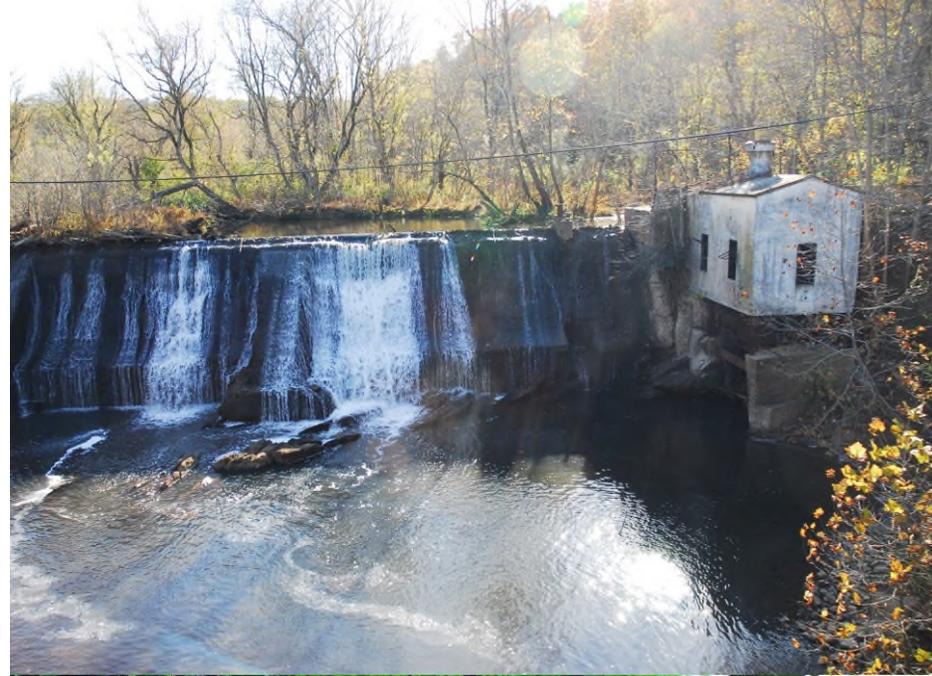


Sub Soil

Top Soil

Reversed Soil Profiles

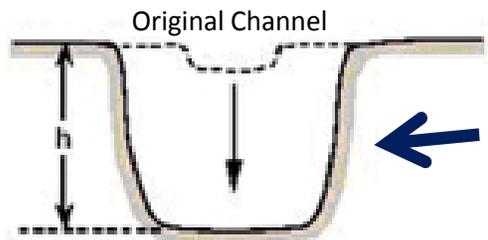
Mill Pond Dams Retain Sediment



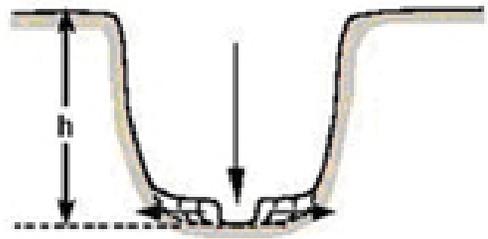
Effects of Impervious Surfaces



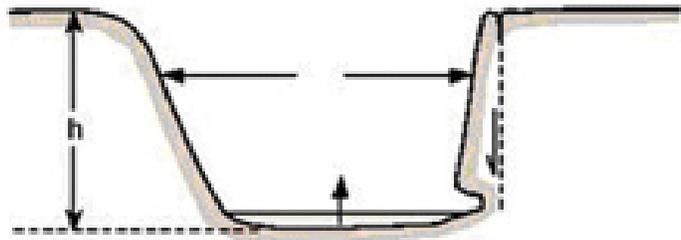
DEGRADATION AND ARMORING



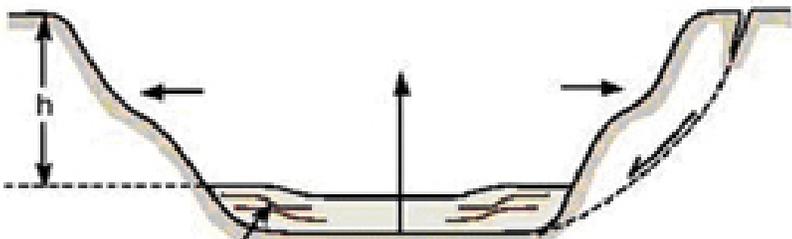
Stage I
Stable channel
Initial incision
 $h < h_{crit}$



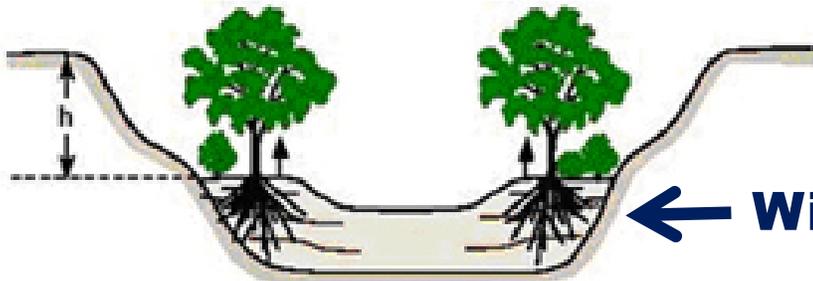
Stage II
Bed degrading
Banks stable
 $h > h_{crit}$



Stage III
Bed aggrading
Banks unstable
 $h > h_{crit}$



Stage IV
Bed aggrading
Banks unstable
 $h = h_{crit}$



Stage V
Slow aggradation
Banks stable
 $h < h_{crit}$

← **Wide-shallow channel**

Classic Stream Channel Evolution Models

Adapted from Schumm et al. 1984
See Cluer and Thorne 2015 for updated version

Man-made
Channels are often
narrow and deep





Stage 2 Channel

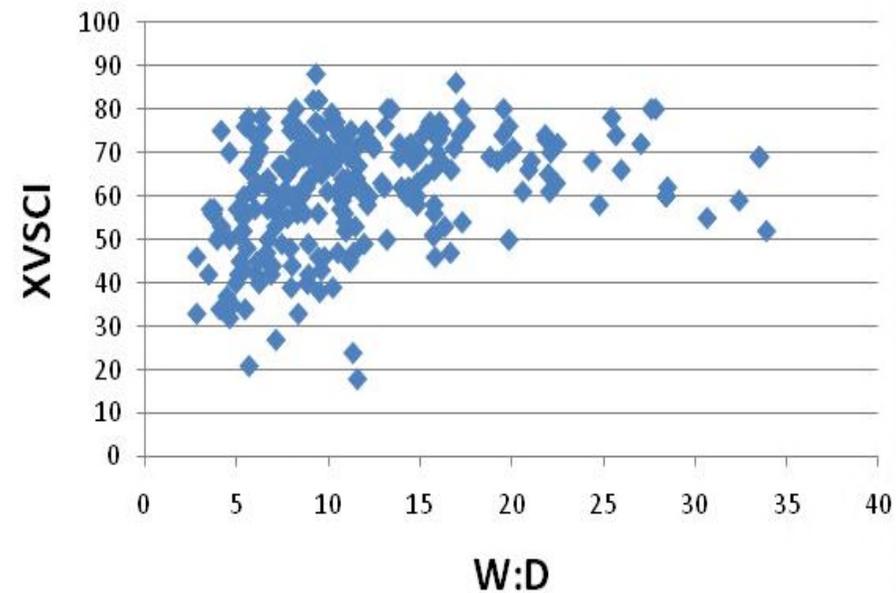
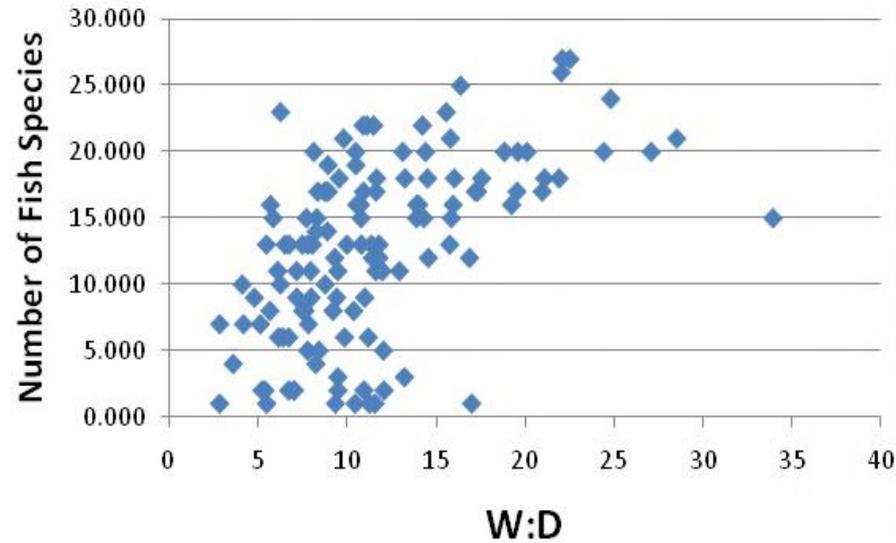
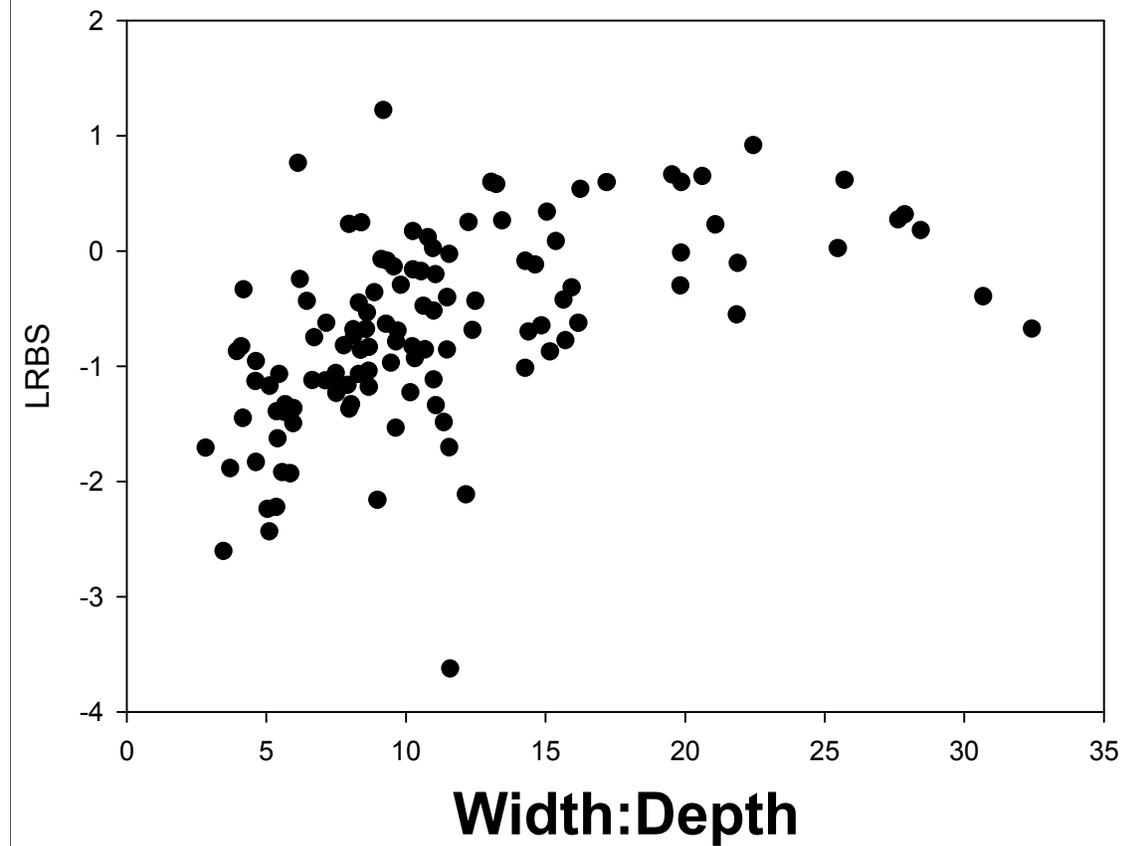


Early Stage 3 Channel

Examples of channel widening



WIDTH to DEPTH RATIO





Physical Habitat



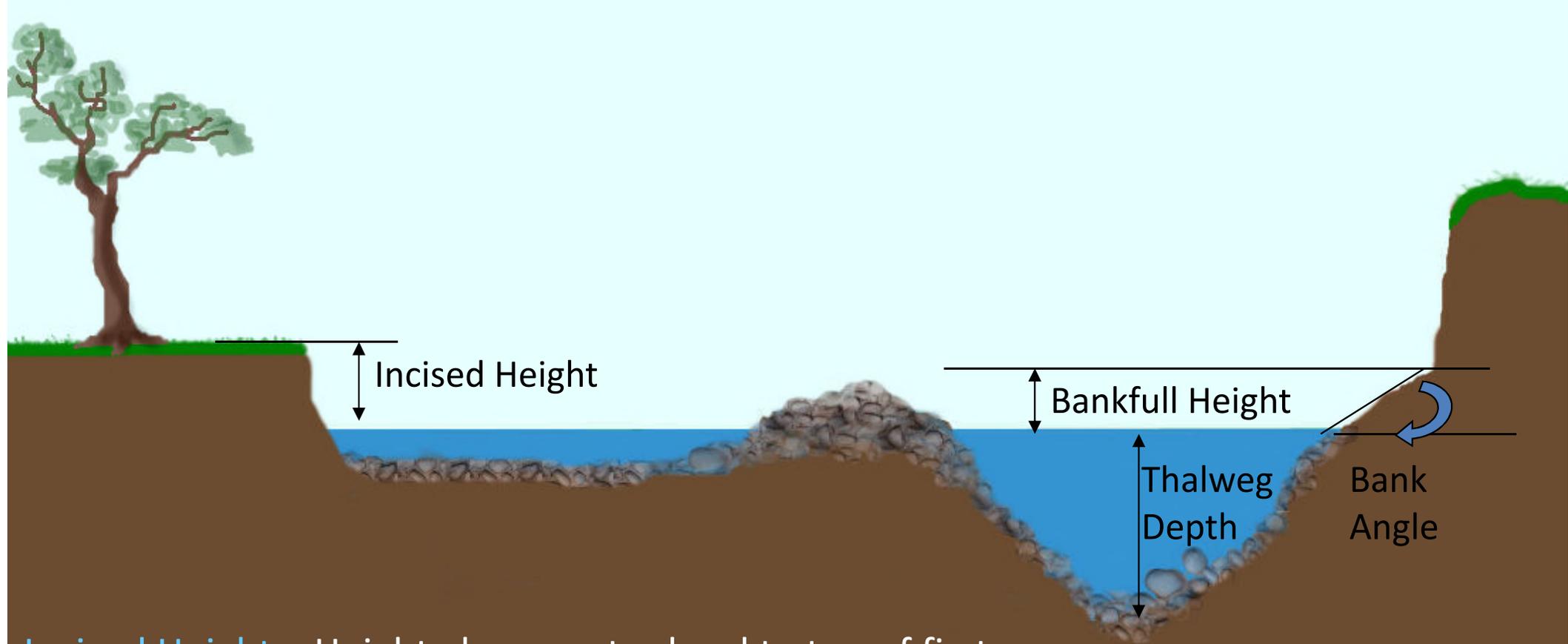
How do we
measure physical
habitat

Rock Castle Creek, Blue Ridge
Parkway National Park

SOMETIMES HUMANS AFFECT STREAM HABITAT QUALITY.



Lick Run, Roanoke, VA



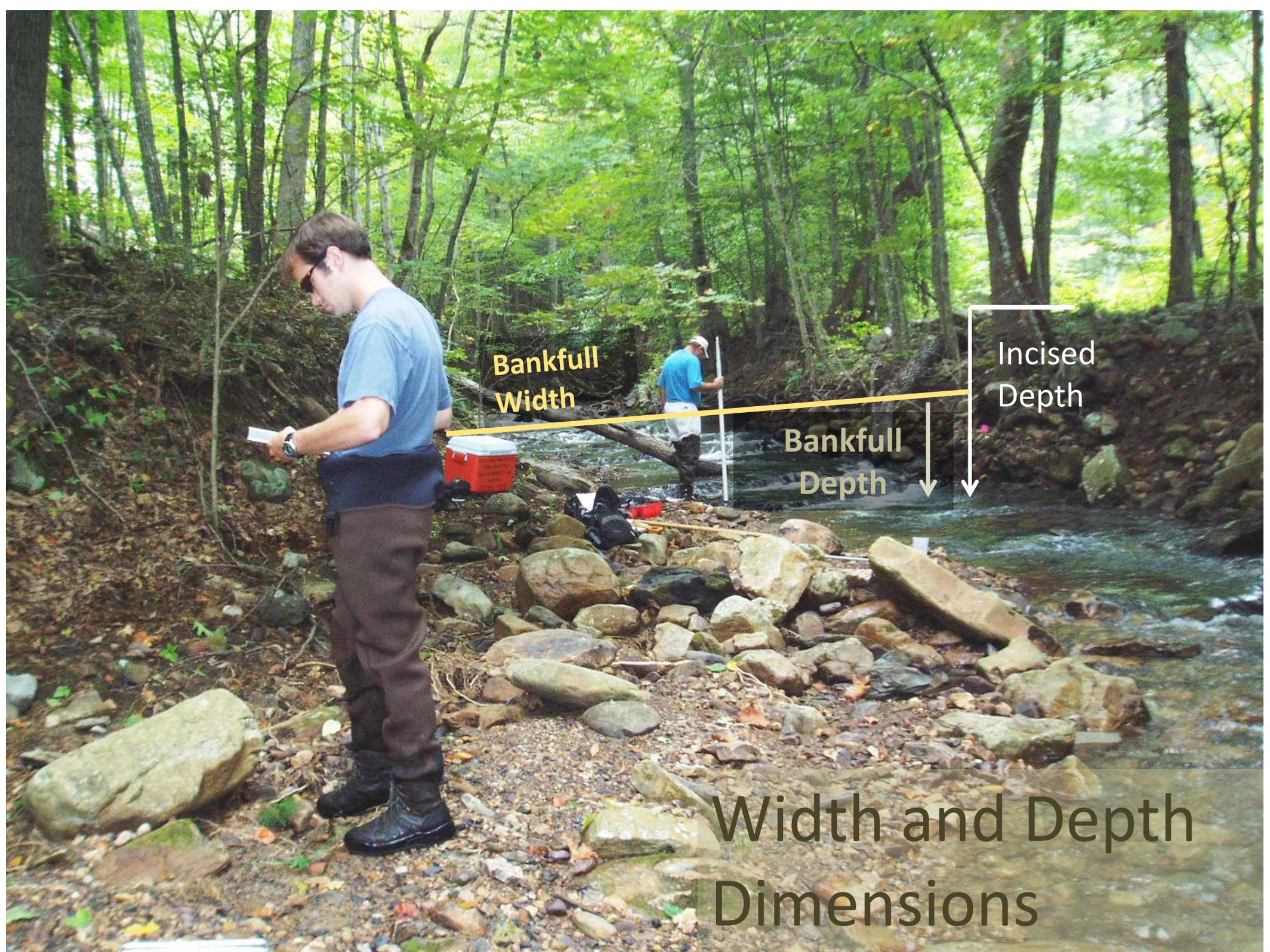
Incised Height – Height above water level to top of first terrace.

Bankfull Height- Height above water level to bank scar marking 1-3 year flood frequency.

Thalweg Depth- Water depth at deepest point following the main water flow.

Bank Angle- Angle of the exposed bank to the water level line extended under the bank.

BANK CHARACTERISTICS		
	X.XX (m)	FLAG
Wetted Width	47.0	
Bar Width	0	
Bankfull Width	75	
Bankfull Height	0.9	
Incised Height		K



**Bankfull
Width**

**Incised
Depth**

**Bankfull
Depth**

**Width and Depth
Dimensions**



emma.jones@deq.virginia.gov
larry.willis@deq.virginia.gov
jason.hill@deq.virginia.gov

QUESTIONS?