Texas Riparian and Stream Ecosystems

Nikki Dictson
Texas Water Resources Institute
http://texasriparian.org and
http://www.facebook.com/TexasRiparianAssociation

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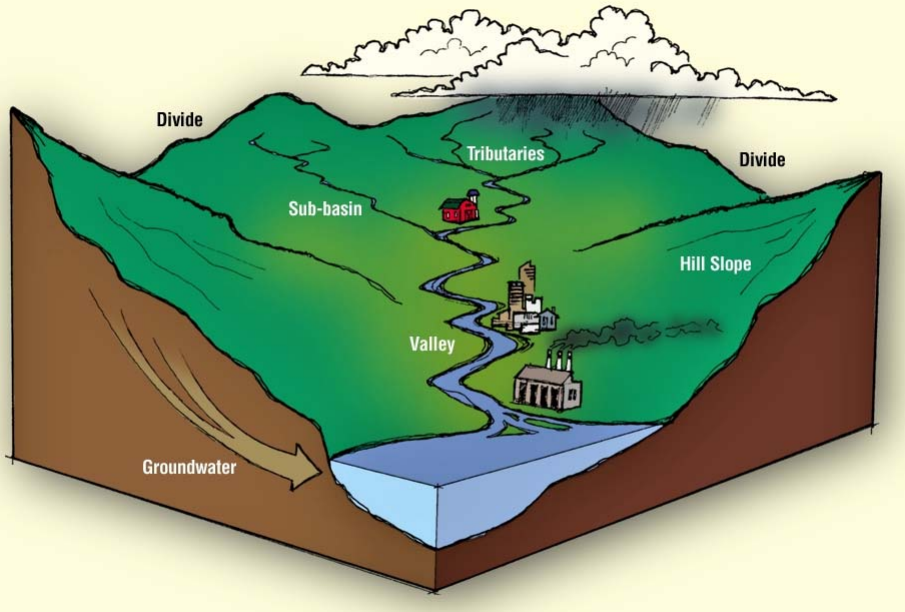
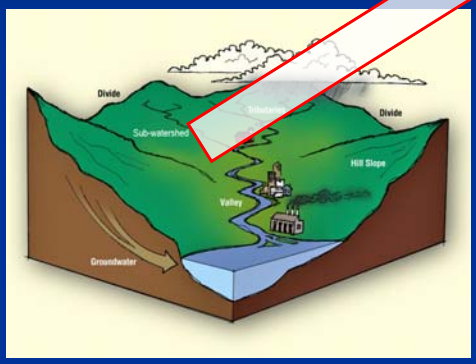
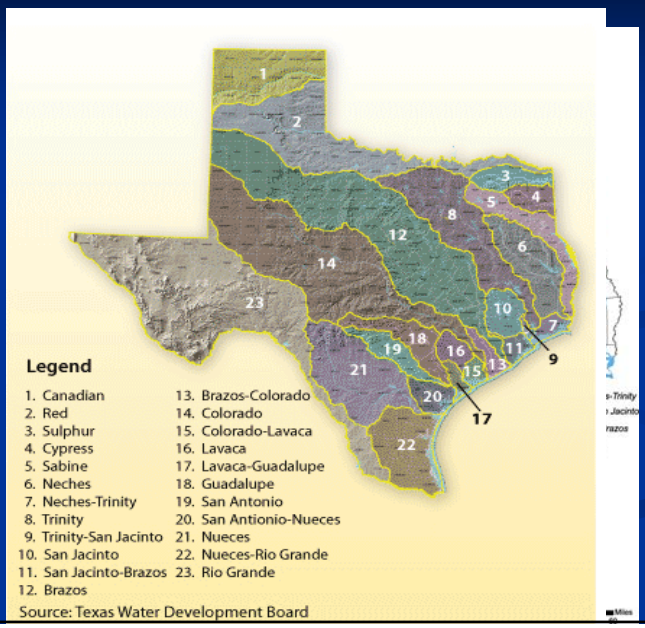
What is a WATERSHED?





WATERSHED

Texas Rivers



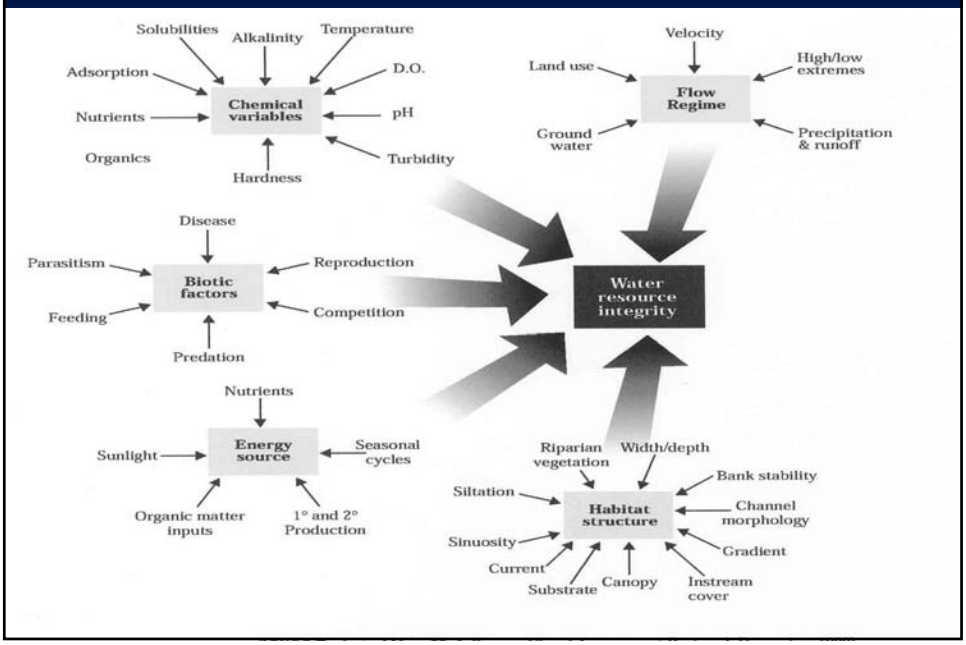
Watershed

A Watershed can be characterized as consisting of:

- Upland
- Riparian zone and
- stream system

Each watershed functions as an ecosystem, i.e., each component affects the rest of the system including the benefits or negative impacts. As water flows through the system the impacts are cumulative.

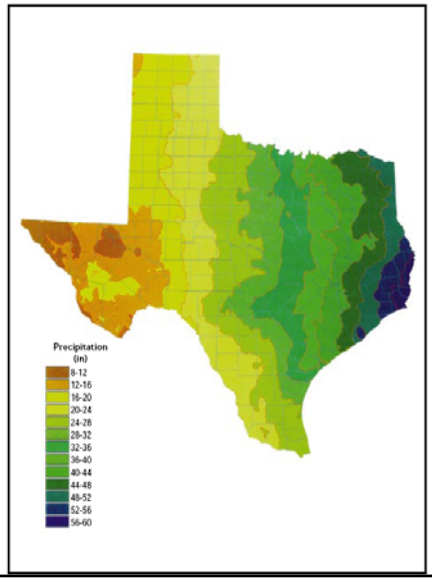
Watersheds are Complex Systems



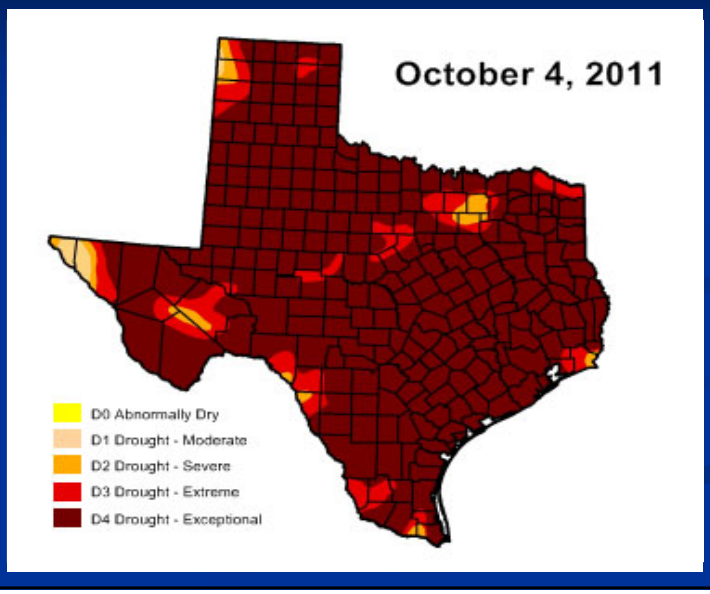
Watershed form is influenced by:

1. Climate
2. Geology & Soils
3. Fluvial Geomorphology
4. Vegetation
5. Land Uses

Long-Term Average Annual Rainfall Across Texas from 1961-1990



The Drought



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Geology and Soil Types




Increase in Impervious Surface

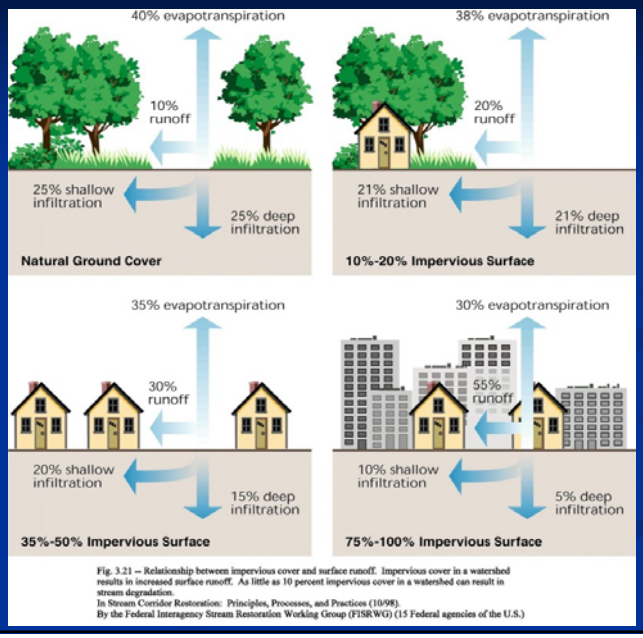
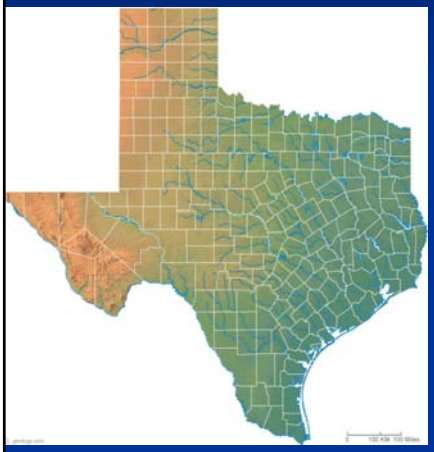


Fig. 3.21 -- Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.
In Stream Corridor Restoration: Principles, Processes, and Practices (10/98).
By the Federal Interagency Stream Restoration Working Group (FISRWG) (15 Federal agencies of the U.S.)

Topography



- Derives slopes of stream segments and watershed areas to identify unstable areas and to characterize segments or subwatersheds to model
- Evaluate altitude changes
- Topo Maps - http://topomaps.usgs.gov http://www.tnris.org/

Vegetation

Land Uses

Rain is Precious: Factors Affecting the Fate of Rainfall

Many factors determine what happens to the rainfall received. Some of the primary factors include:

- type, quantity, and density of vegetative cover;
- storm intensity and duration;
- soil moisture prior to the storm event;
- soil water holding capacity;
- and slope.

These factors affect how much evaporates, infiltrates, moves through vegetation, and the amount and velocity of overland flow which may erode the soil surface and enter the stream.

Characteristics of a Healthy Upland Watershed

A Healthy Watershed is a catchment, i.e., rainfall is captured on-site. It acts as a sponge storing water to later release.

"High" infiltration rates due to good vegetation cover and soil organic matter/structure and depth.

Water flowing from the uplands as runoff & subsurface flow to springs and aquifers is "clean" and is slowly released down slope.

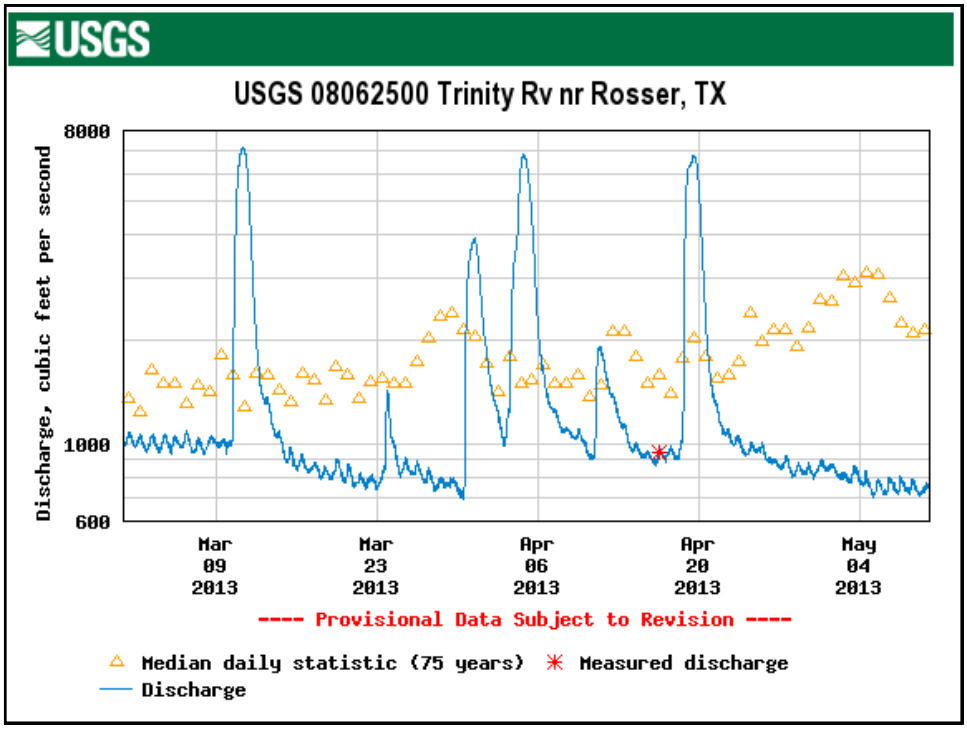
Why should we be concerned about the health of the stream and riparian areas?

- Cumulative impacts of natural and man induced disturbances in the drainage area.
- Management not only affects the individual landowner but everyone else downstream.
- Stream and riparian systems are the water pipeline.
- They are one of the most important resources found on private and public lands in Texas.

Unhealthy Watersheds?

Most streams and rivers in Texas have been adversely affected by past natural and human activities resulting in:

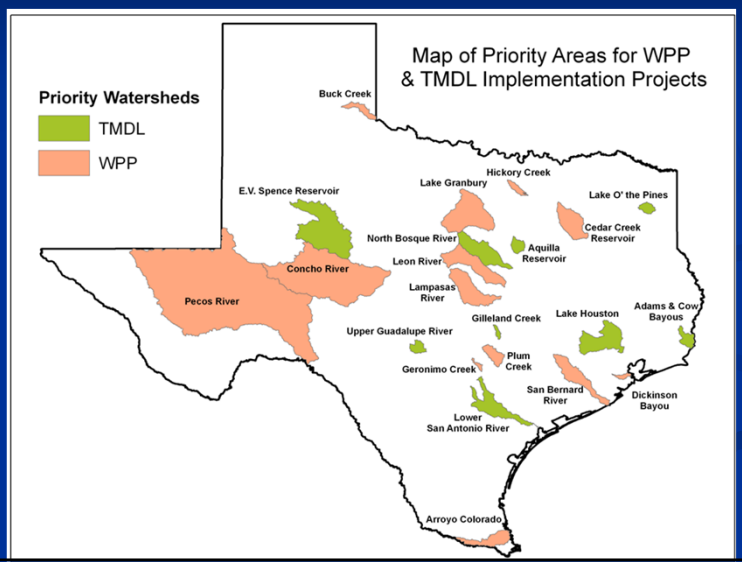
- Increasingly damaging floods
- Lower base flows
- High sediment loads
- Reduced reservoir storage capacity
- Invasion of exotic species
- Loss of natural riparian habitats
- Degraded water quality



Creeks and Riparian Areas are Important

- Texas has more than 200,000 miles of rivers and streams with riparian zones and floodplains that comprise corridors of great economic, social, cultural, and environmental value.
- The 2012 303d List has **568** impaired water bodies on it.
- Many WPP and TMDL Implementation projects are ongoing across the state to improve WQ in watersheds.
- Bacteria is the cause for over 50% and low dissolved oxygen (nutrients) and organics in fish tissue at 15% each.
- Creeks / Riparian Areas are special places that need preferential treatment.
- To manage or restore creeks you must understand them and then address the issues that are inhibiting natural restoration.

Map of Watershed Protection Plans and Total Maximum Daily Loads Implementation Projects



Point Source Pollutant Sources

- Point Source
  - Permitted Discharges
    - Wastewater Treatment Plants
    - Industrial Facilities
    - Confined Animal Feeding Operation
- Stormwater Permit

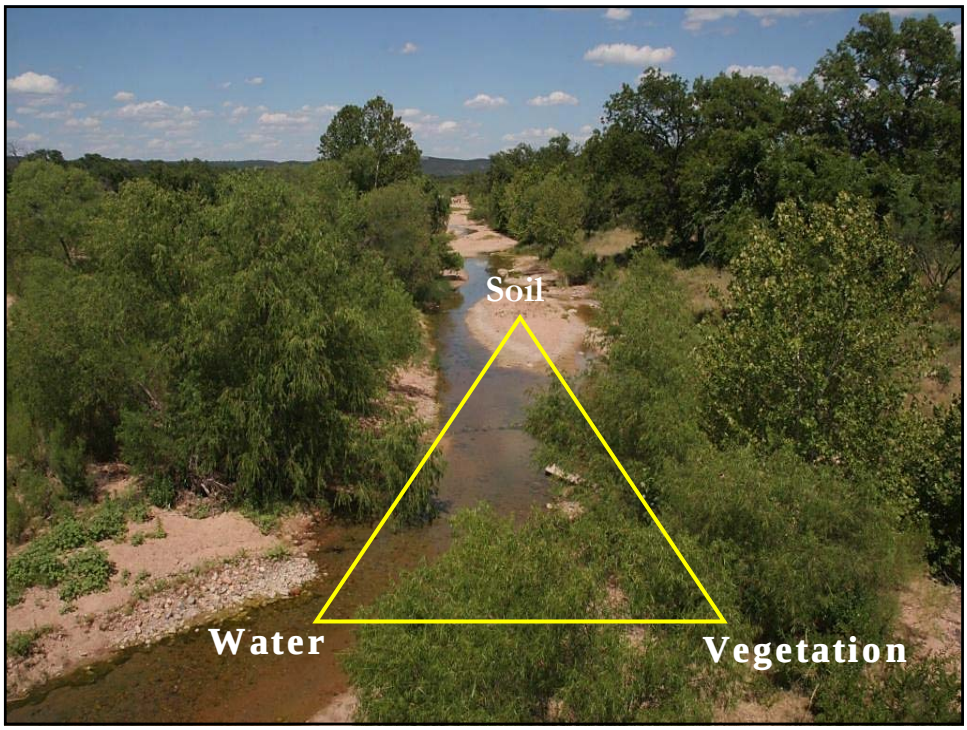
Nonpoint Sources

- Urban
- Wildlife
- Feral Hogs
- Livestock
- Crops
- Onsite Septic Facilities

Functions of a Stream

- Transport water
- Transport & deposit sediment
- Transport & replenish nutrients
- Biological functions (food, shelter, shading, movement, etc.)


What is a Riparian Area?
25


Soil
Water
Vegetation

Properly Functioning Riparian Area

Adequate vegetation, landform or large woody material to:

- Dissipate stream energy
- Stabilize banks
- Reduce erosion
- Trap sediment
- Build / enlarge floodplain
- Store water
- Floodwater retention
- Groundwater recharge
- Sustain baseflow

- Water quality
- Water quantity
- Forage
- Aquatic habitat
- Wildlife habitat
- Recreational value
- Aesthetic beauty

Physical Function → **Values**

Watershed
vs.
Catchment


Water Shed
Water Catchment

An Overlooked Opportunity

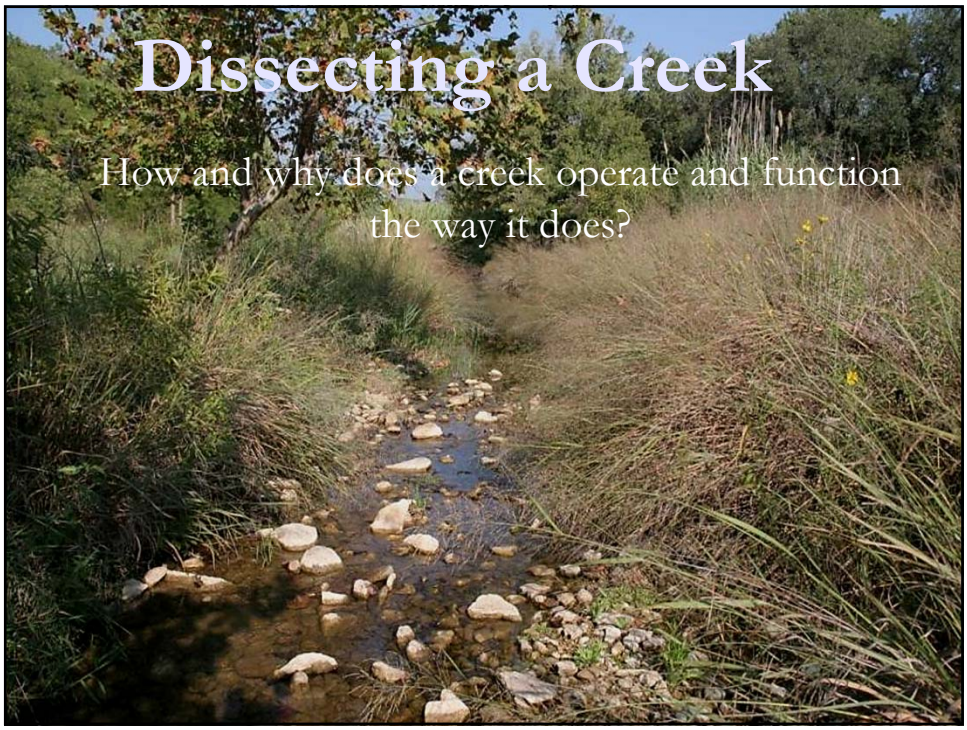
Catching the water

Storing the water in the land

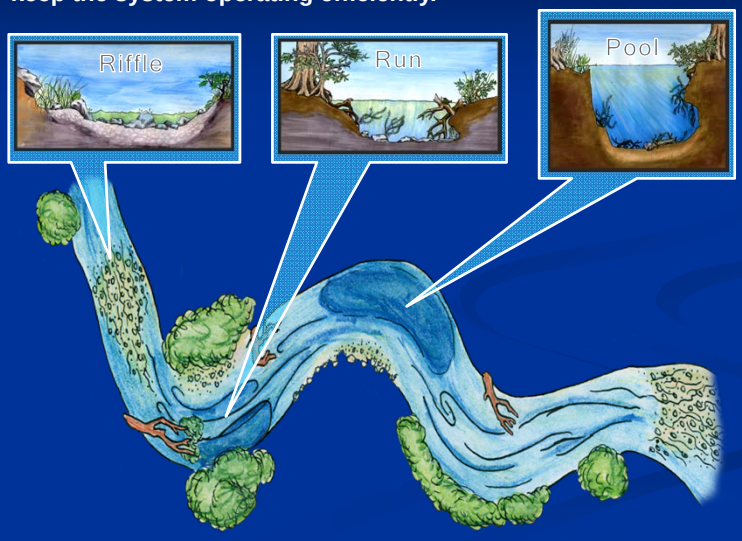
Keeping Water on the Land Longer

"Riparian Sponge"

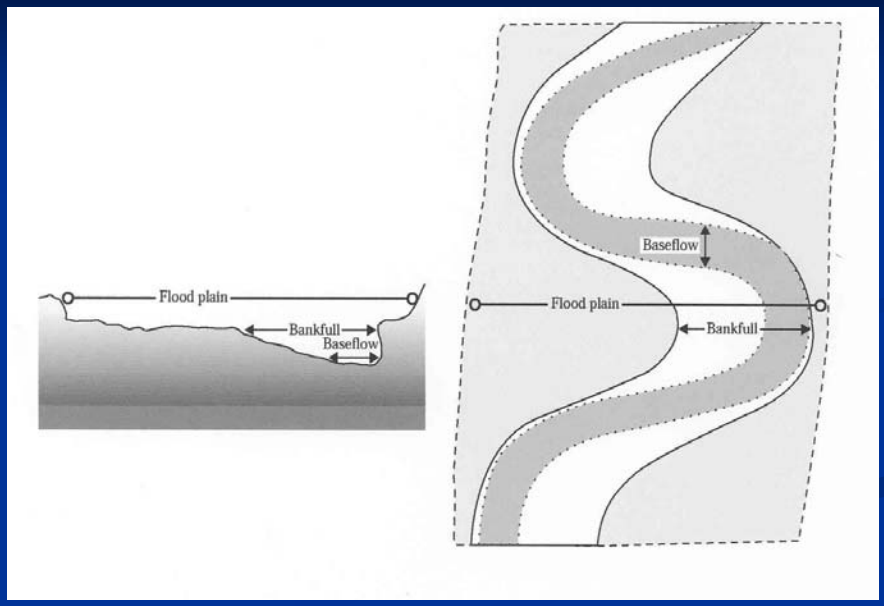

Burro Creek
1981
Burro Creek
2000


Dissecting a Creek
How and why does a creek operate and function the way it does?

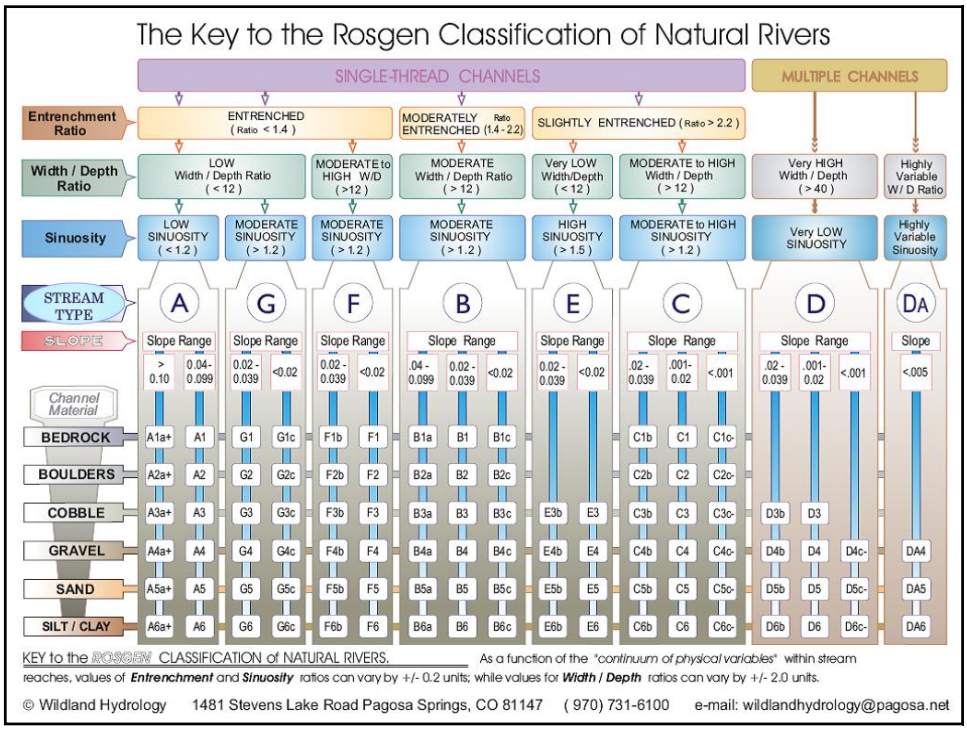
The patterns of rivers are naturally developed to dissipate the energy of the moving water and to transport sediment. The meander geometry and associated riffles and pools adjust to keep the system operating efficiently.



Baseflow, bankfull, and flood plain locations.




Identify the Components of a Creek
Channel / Banks
Floodplain
Sediment
Base flow
Flood flow
Water table
Vegetation
Large wood
Organic debris
The Processes that occur
Erosion / Deposition
Bankfull discharge
Sinuosity
Width : Depth Ratio
Gradient / Velocity
Recruitment
Root density
Channel stability
Channel evolution
Plant succession


The Key to the Rosgen Classification of Natural Rivers
SINGLE-THREAD CHANNELS
MULTIPLE CHANNELS
Entrenchment Ratio
ENTRENCHED (Ratio < 1.4)
MODERATELY ENTRENCHED (1.4 - 2.2)
SLIGHTLY ENTRENCHED (Ratio > 2.2)
Width / Depth Ratio
LOW Width / Depth Ratio (< 12)
MODERATE to HIGH W/D (>12)
MODERATE Width / Depth Ratio (> 12)
Very LOW Width/Depth (< 12)
MODERATE to HIGH Width / Depth (> 12)
Very HIGH Width / Depth (> 40)
Highly Variable W / D Ratio
Sinuosity
LOW SINUOSITY (< 1.2)
MODERATE SINUOSITY (> 1.2)
MODERATE SINUOSITY (> 1.2)
MODERATE SINUOSITY (> 1.2)
HIGH SINUOSITY (> 1.5)
MODERATE to HIGH SINUOSITY (> 1.2)
Very LOW SINUOSITY
Highly Variable Sinuosity
STREAM TYPE
A G F B E C D DA
SLOPE
Slope Range
Slope
Channel Material
BEDROCK
BOULDERS
COBBLE
GRAVEL
SAND
SILT / CLAY
KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS.
As a function of the "continuum of physical variables" within stream reaches, values of Entrenchment and Sinuosity ratios can vary by +/- 0.2 units; while values for Width / Depth ratios can vary by +/- 2.0 units.
© Wildland Hydrology 1481 Stevens Lake Road Pagosa Springs, CO 81147 (970) 731-6100 e-mail: wildlandhydrology@pagosa.net

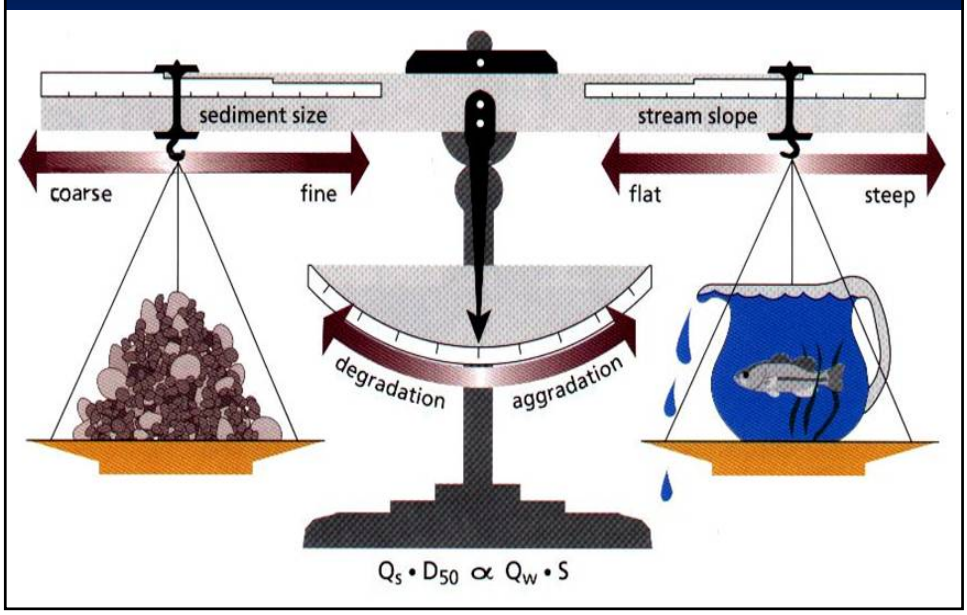
Stream Facts

- Streambank and watershed erosion are natural processes
- A dynamic equilibrium exists in stable stream channels
- Floods have beneficial functions
- When changes are made in the watershed or stream, the stream will adjust to fix itself

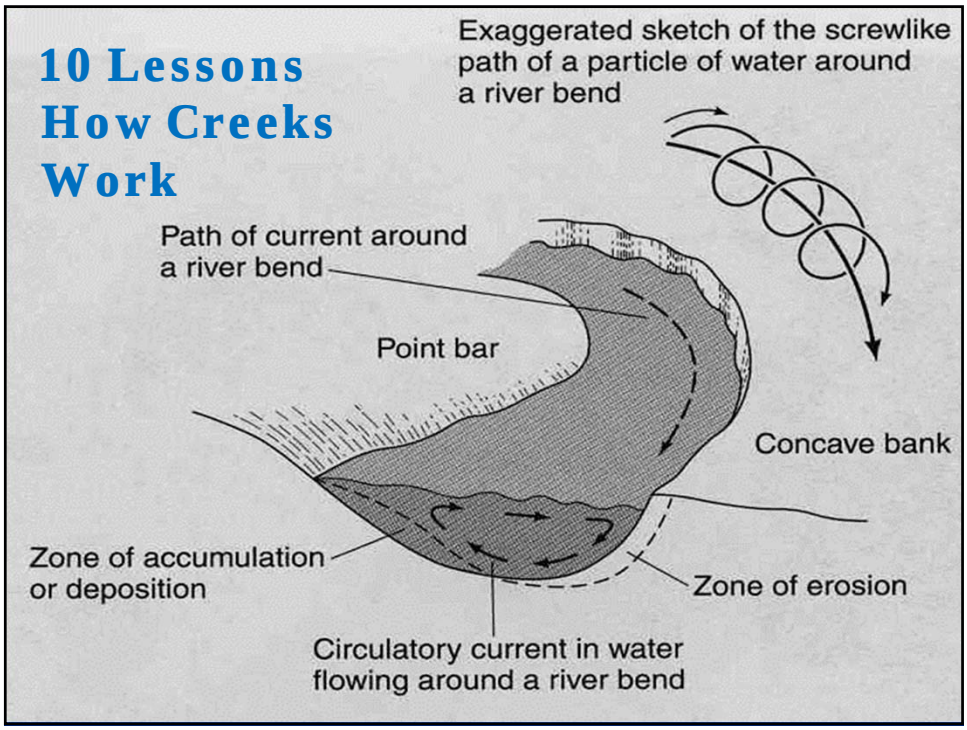
Stable Stream

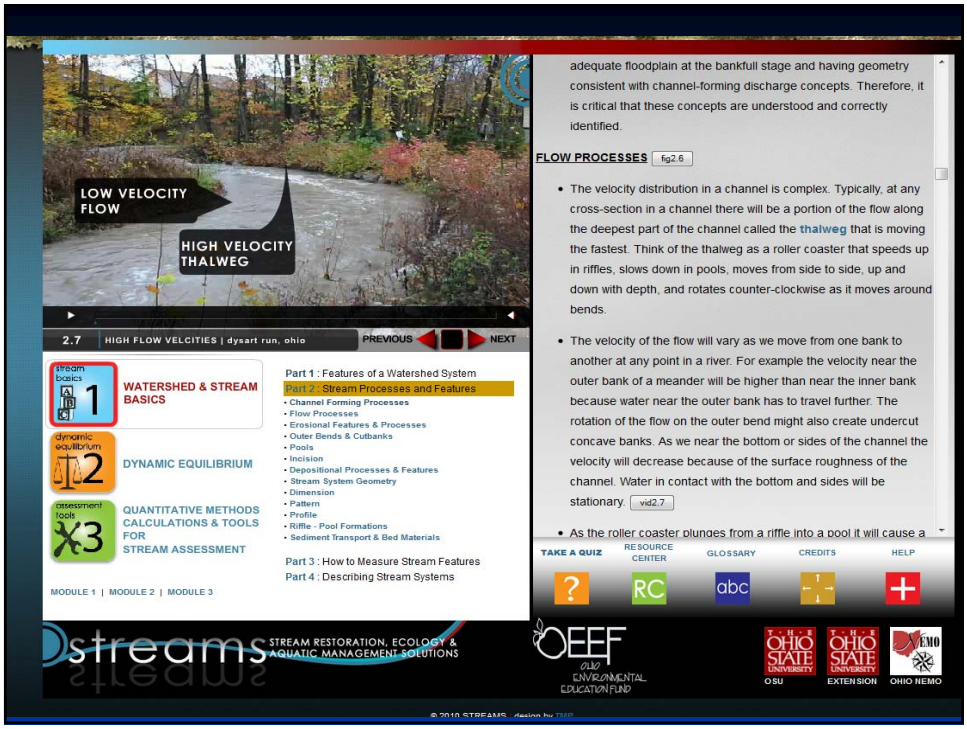
- A stable stream is one that has a stable dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades (deposits excess sediment) nor degrades (erodes excess sediment).
- Lateral migration and erosion do not necessarily indicate instability. Stable streams are also dynamic.

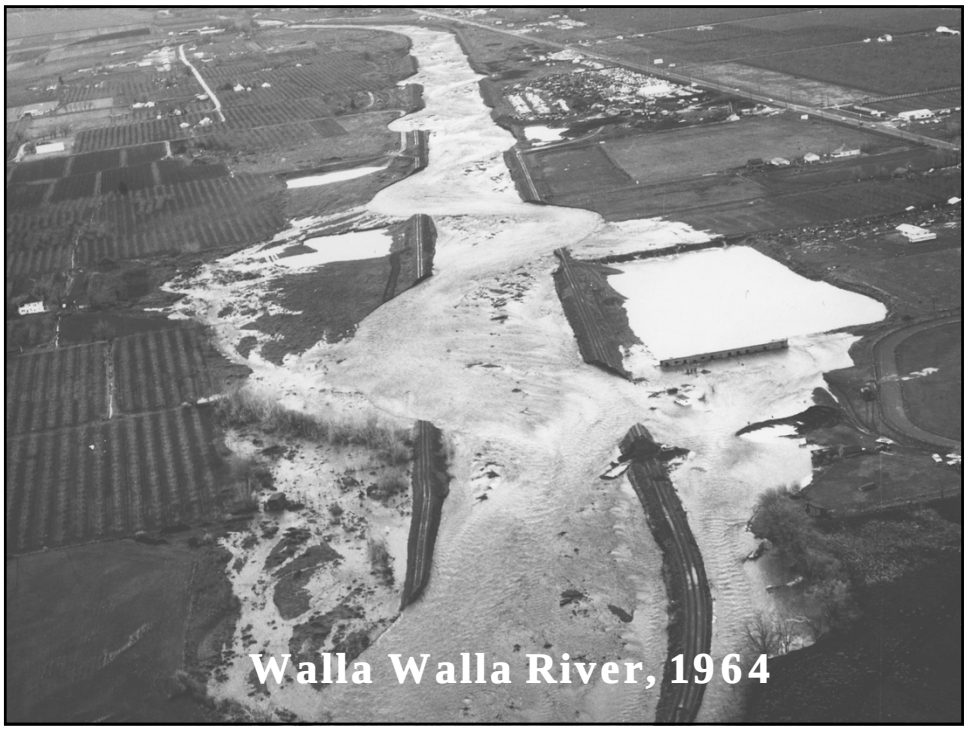
Lane's Relationship, 1950

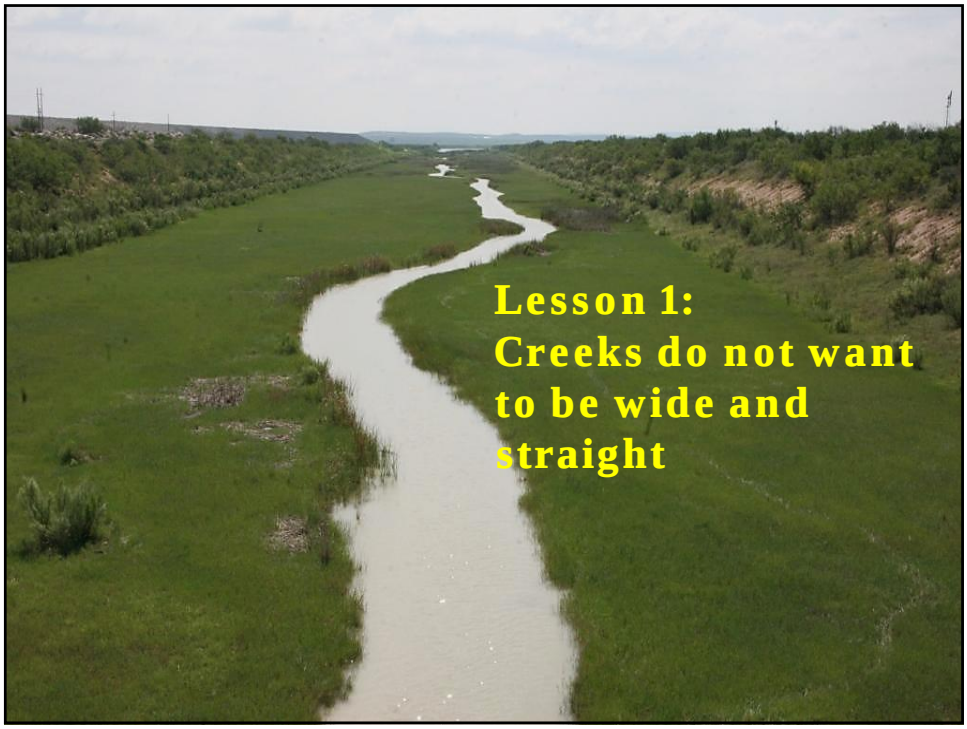


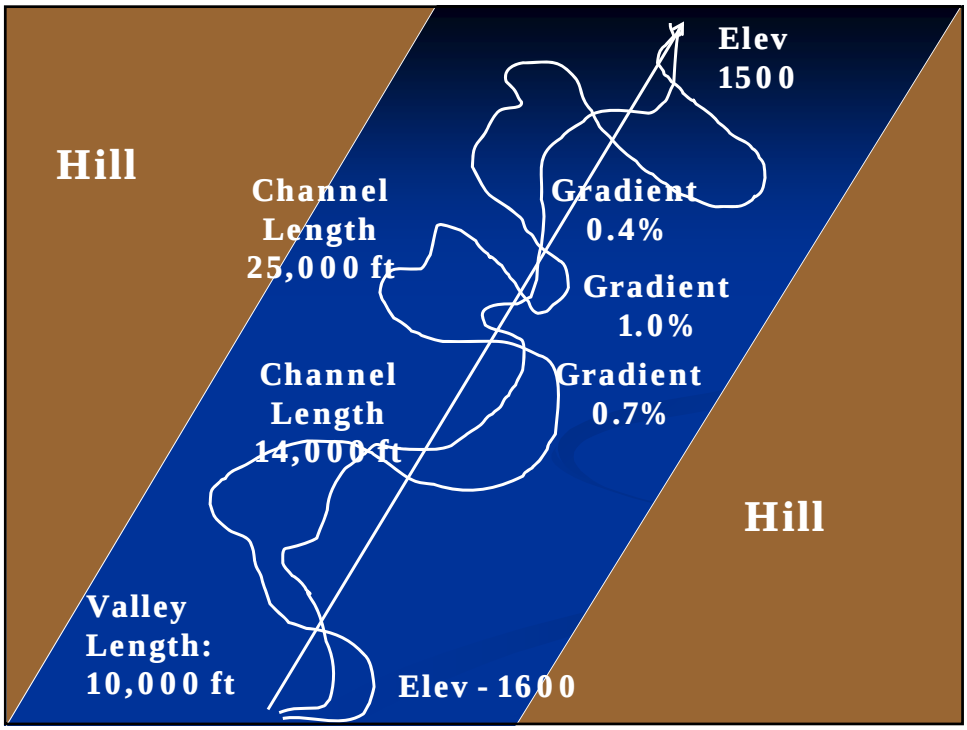
10 Lessons How Creeks Work

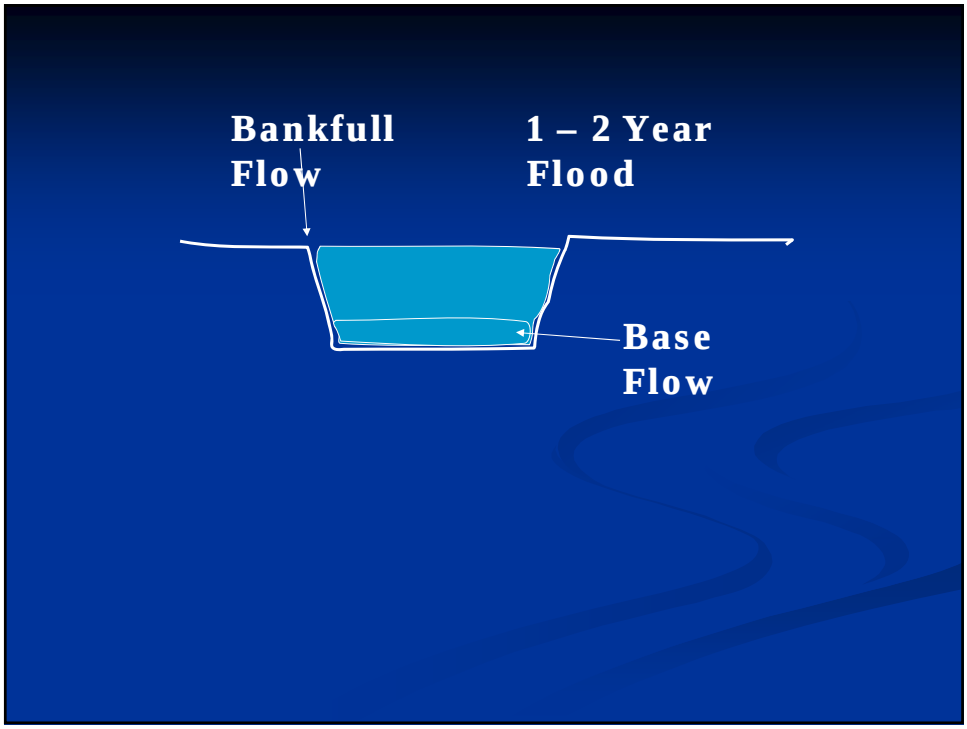


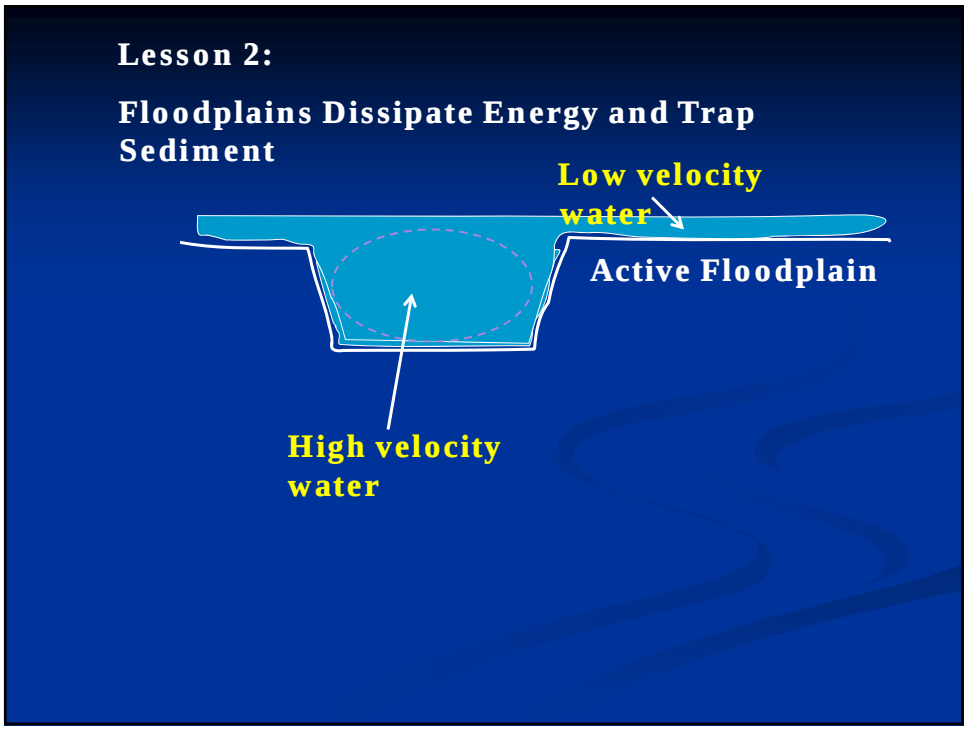

LOW VELOCITY FLOW
HIGH VELOCITY THALWEG
2.7 HIGH FLOW VELCITIES | dysart run, ohio
PREVIOUS
NEXT
WATERSHED & STREAM BASICS
DYNAMIC EQUILIBRIUM
QUANTITATIVE METHODS CALCULATIONS & TOOLS FOR STREAM ASSESSMENT
Part 1 : Features of a Watershed System
Part 2 : Stream Processes and Features
• Channel Forming Processes
• Flow Processes
• Erosional Features & Processes
• Outer Bends & Cutbanks
• Pools
• Incision
• Depositional Processes & Features
• Stream System Geometry
• Dimension
• Pattern
• Profile
• Riffle - Pool Formations
• Sediment Transport & Bed Materials
Part 3 : How to Measure Stream Features
Part 4 : Describing Stream Systems
MODULE 1 | MODULE 2 | MODULE 3
adequate floodplain at the bankfull stage and having geometry consistent with channel-forming discharge concepts. Therefore, it is critical that these concepts are understood and correctly identified.
FLOW PROCESSES fig2.6
• The velocity distribution in a channel is complex. Typically, at any cross-section in a channel there will be a portion of the flow along the deepest part of the channel called the thalweg that is moving the fastest. Think of the thalweg as a roller coaster that speeds up in riffles, slows down in pools, moves from side to side, up and down with depth, and rotates counter-clockwise as it moves around bends.
• The velocity of the flow will vary as we move from one bank to another at any point in a river. For example the velocity near the outer bank of a meander will be higher than near the inner bank because water near the outer bank has to travel further. The rotation of the flow on the outer bend might also create undercut concave banks. As we near the bottom or sides of the channel the velocity will decrease because of the surface roughness of the channel. Water in contact with the bottom and sides will be stationary. vid2.7
TAKE A QUIZ
RESOURCE CENTER
GLOSSARY
CREDITS
HELP
streams
STREAM RESTORATION, ECOLOGY & AQUATIC MANAGEMENT SOLUTIONS
OEEF
OHIO ENVIRONMENTAL EDUCATION FUND
OSU
EXTENSION
OHIO NEMO

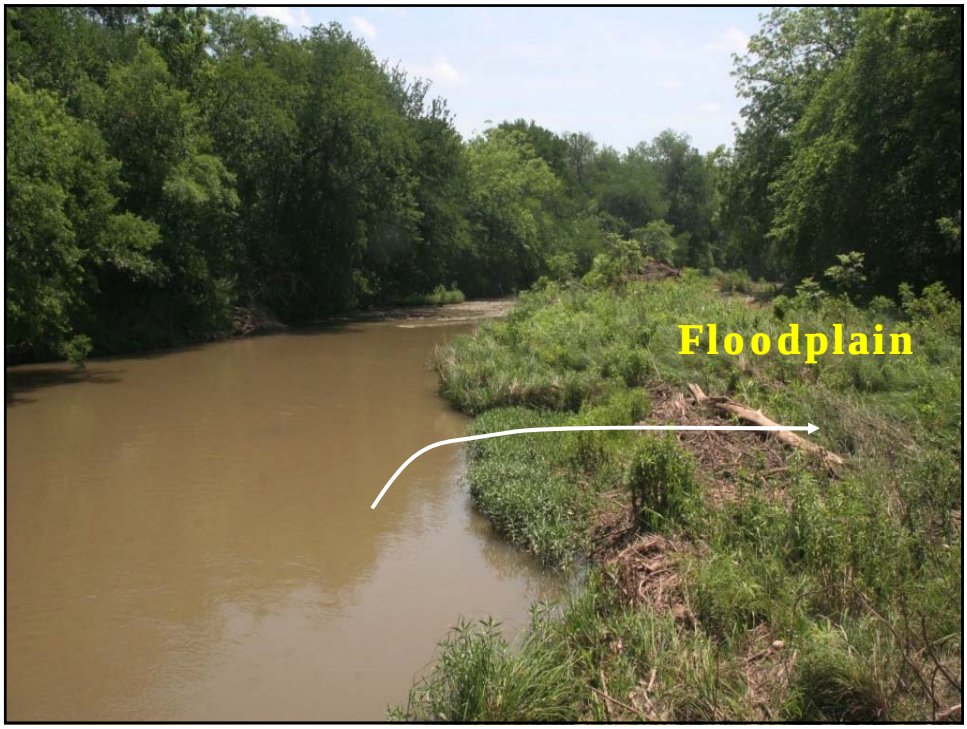

Walla Walla River, 1964

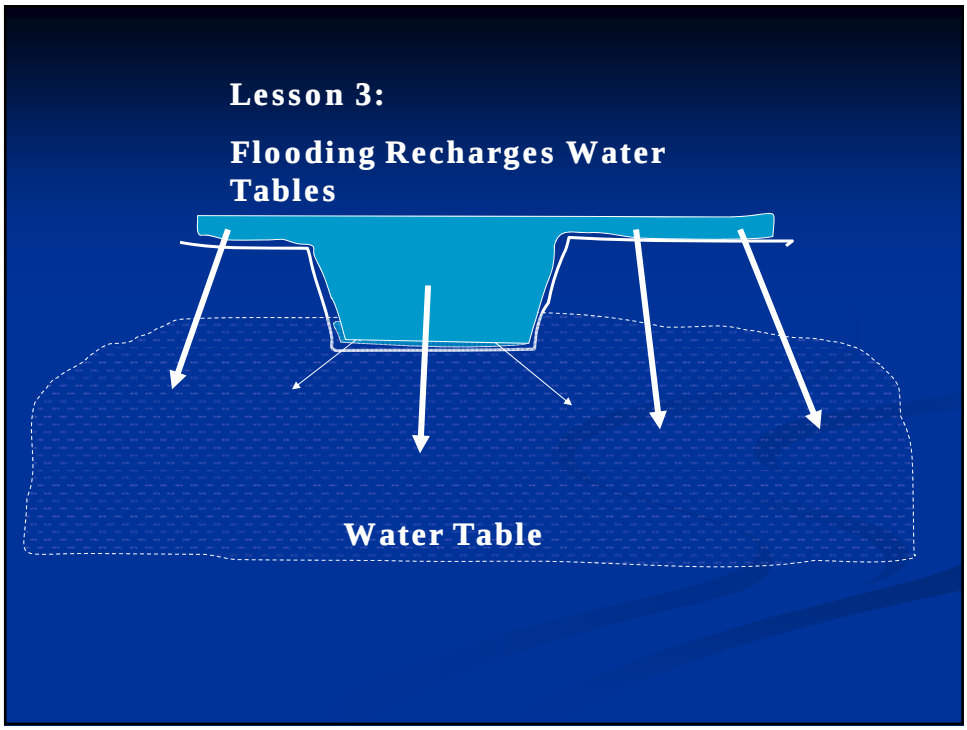

Lesson 1:
Creeks do not want to be wide and straight


Elev
1500
Hill
Channel
Length
25,000 ft
Gradient
0.4%
Gradient
1.0%
Channel
Length
14,000 ft
Gradient
0.7%
Hill
Valley
Length:
10,000 ft
Elev - 1600


Bankfull Flow
1 – 2 Year Flood
Base Flow


Lesson 2:
Floodplains Dissipate Energy and Trap Sediment
Low velocity water
Active Floodplain
High velocity water

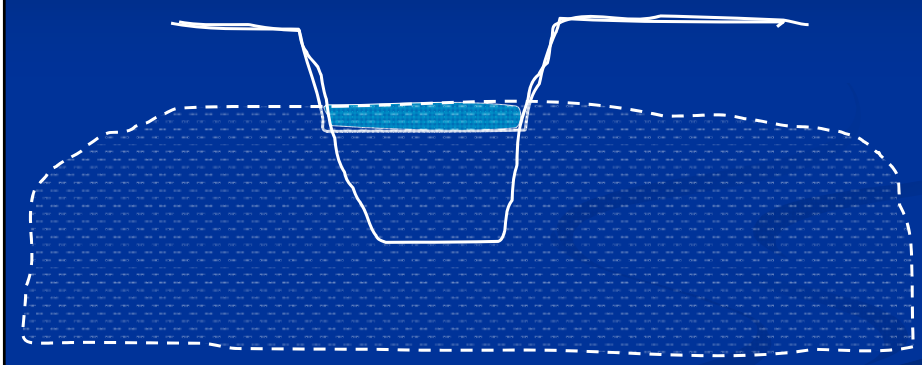

Floodplain


Lesson 3:
Flooding Recharges Water Tables
Water Table

Lesson 4:

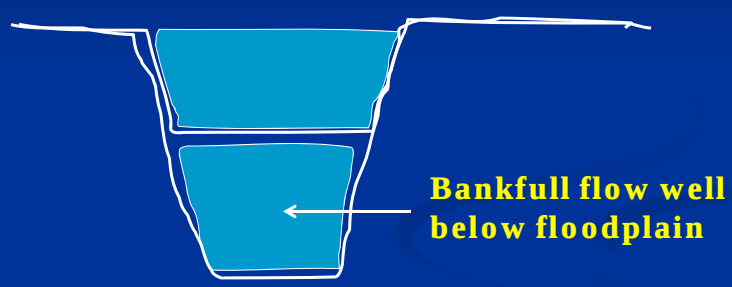
Excessive Erosion Enlarges the Channel

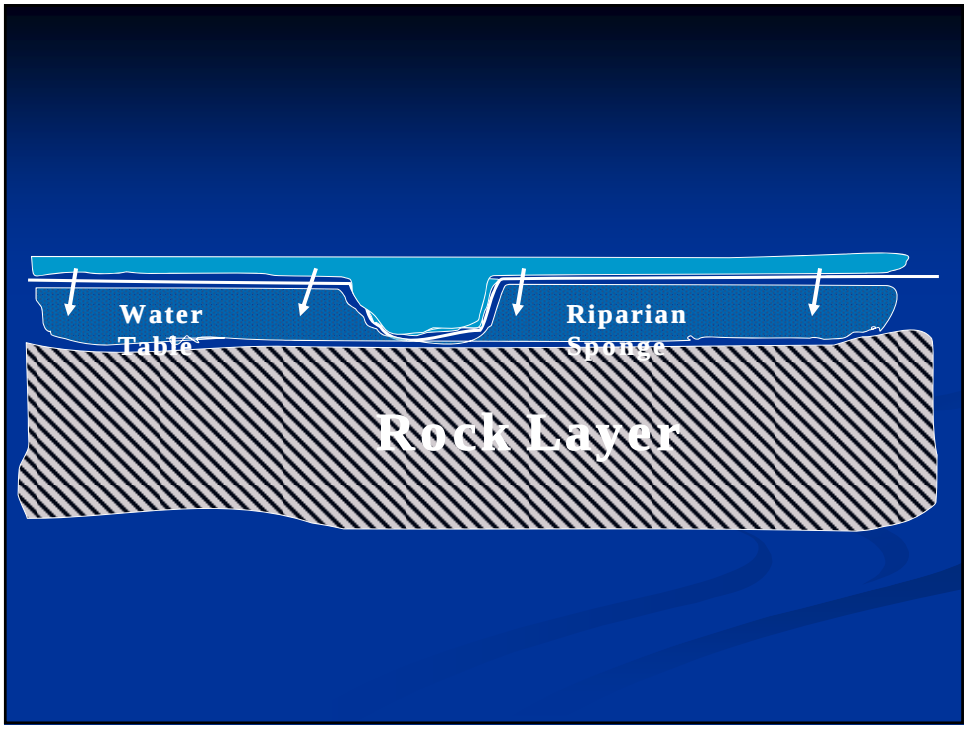
Lesson 5:
Down-cutting Drains the Water Table

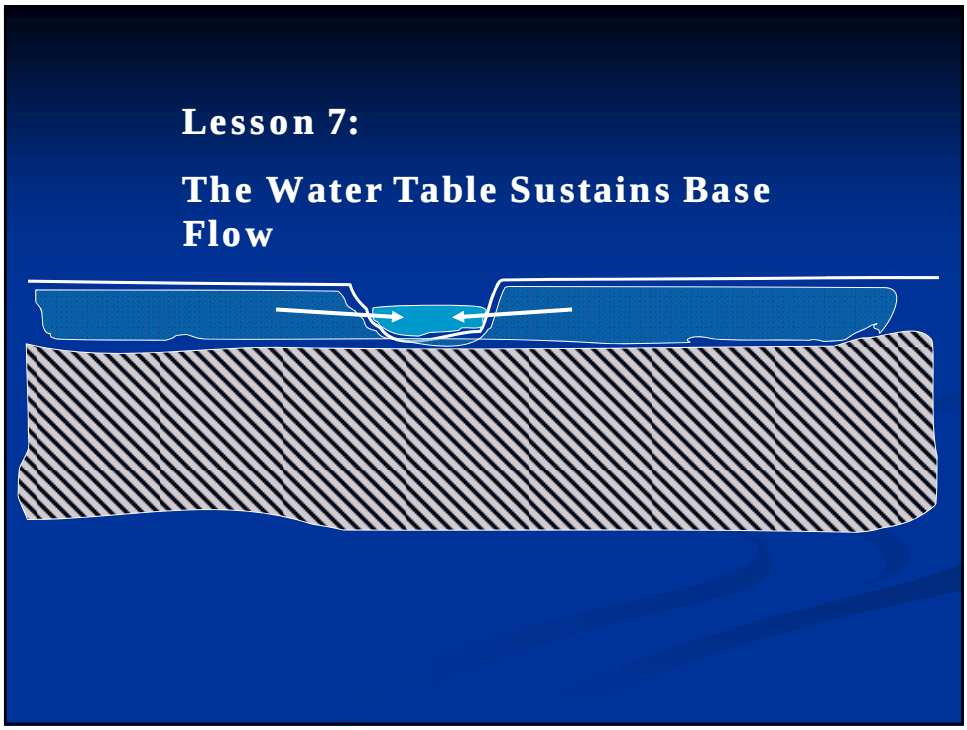


Lesson 6:

Down-cutting: Loose Access to Floodplain

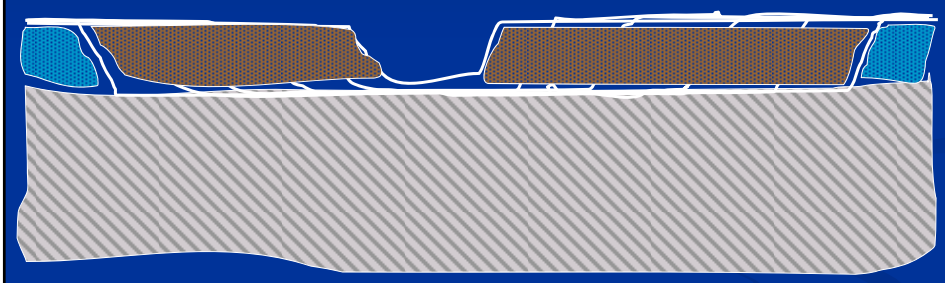



Water Table
Riparian Sponge
Rock Layer


Lesson 7:
The Water Table Sustains Base Flow

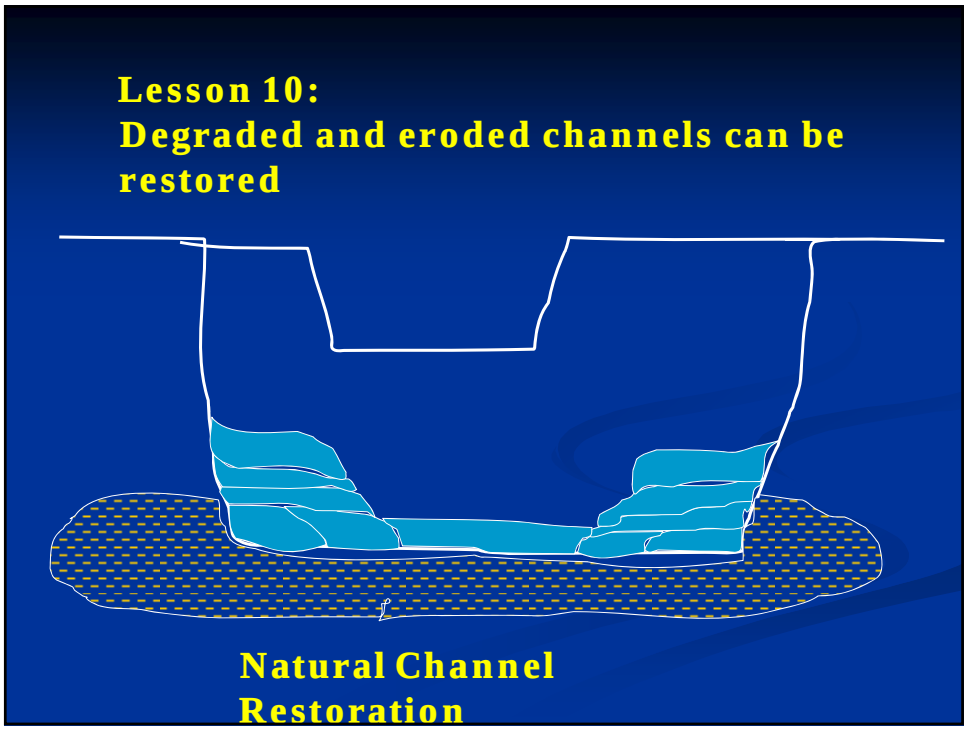
Lesson 8:

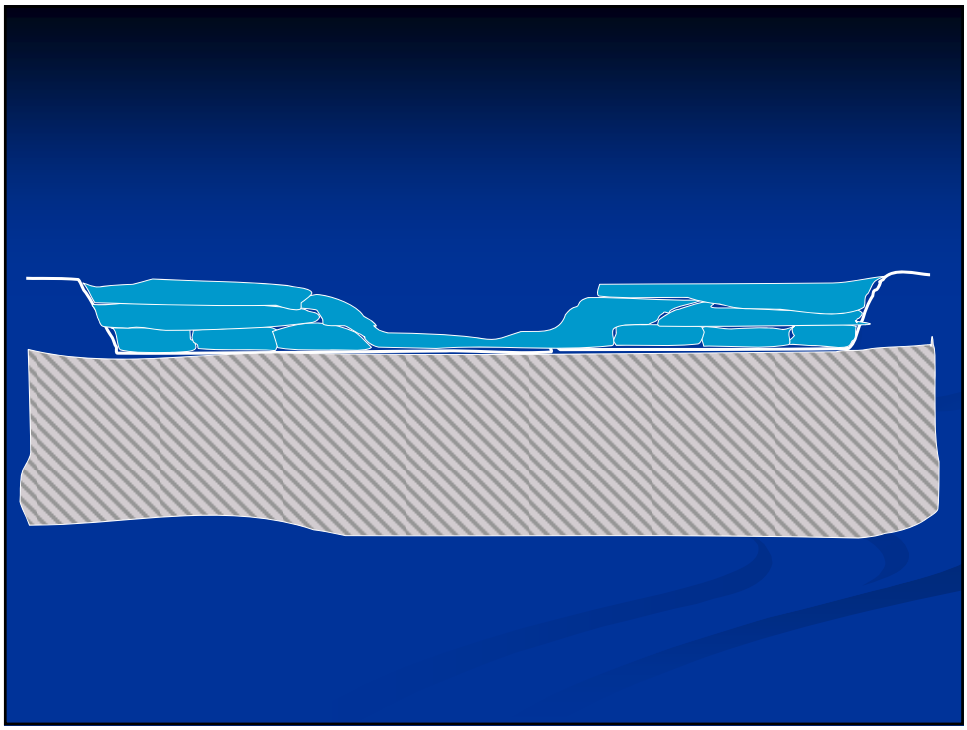
Channel Widening Reduces the Riparian Sponge



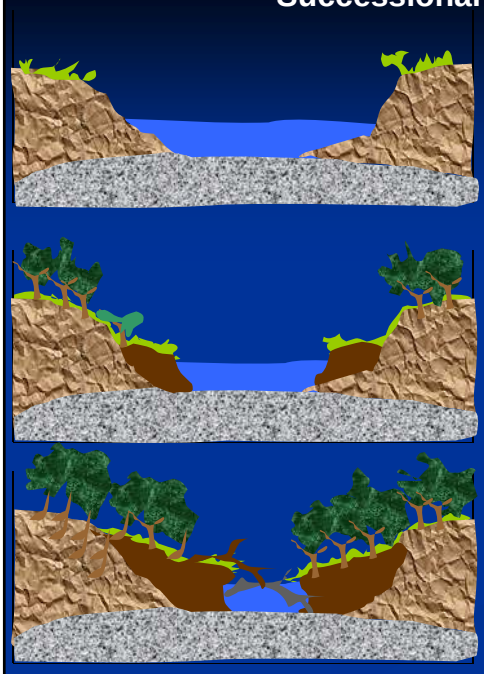
Lesson 9:

Overly Wide Channels Reduce Sediment Transport Ability


Lesson 10:
Degraded and eroded channels can be restored
Natural Channel Restoration



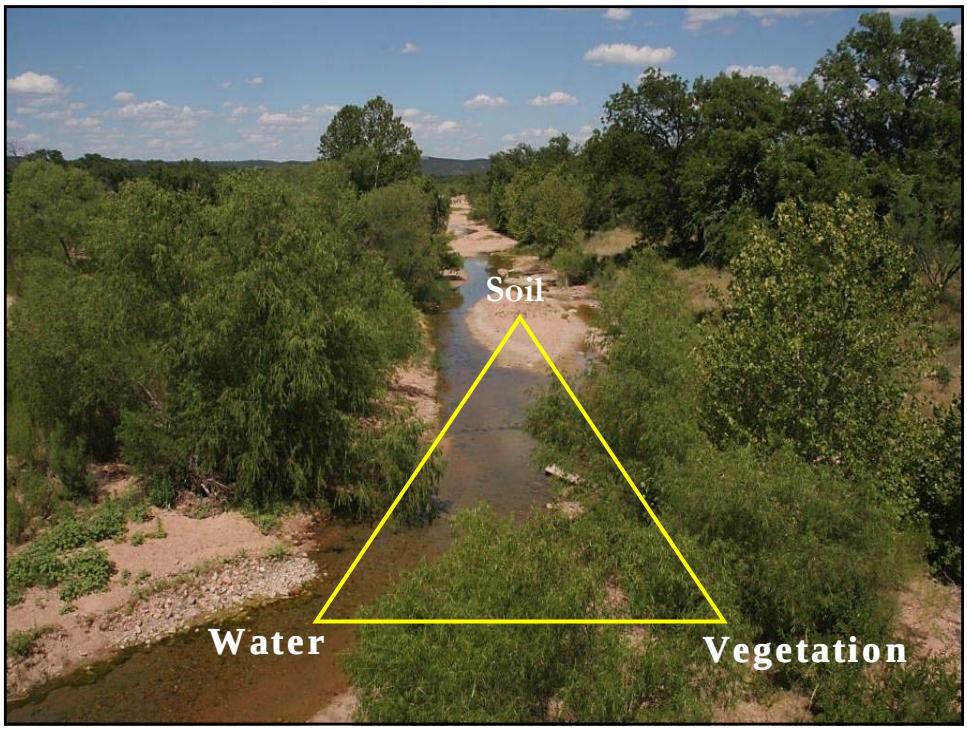
Successional Stages



Early successional stage showing bare stream banks with little vegetative cover. Stream flow unrestricted.

Mid successional stage showing deposition along stream bank with herbaceous and woody cover developing.

Late successional stage showing deposition of sediment along stream banks, good woody and herbaceous cover, woody debris in floodplain and stream.

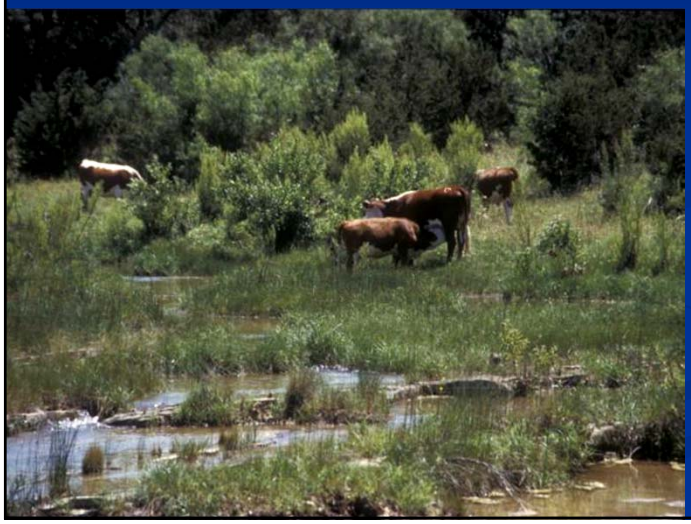


Riparian Chain Reaction

Adequate Vegetation:

Protects banks from excess erosion
Dissipates energy and slows the velocity of floodwater
Sediment dropped
Sediment trapped and stabilized
Floodplain / riparian sponge is enlarged
Increased groundwater recharge
Base-flow is sustained over time

Vegetation Indicators:



Multiple age classes?

Plant diversity?

Plants indicative of wet conditions?

Stabilizing root mass?

Plant vigor?

Amount of plant cover?

Source of large wood?

Two Functional Groups of Riparian Plants:

1. Colonizers
2. Stabilizers

Colonizers

First plants to establish in freshly deposited sediment

Often spread rapidly by stolons or rhizomes or rooting at the nodes

Roots generally shallow and weak

Critical to recovery

Stabilizers

Strong, robust plants

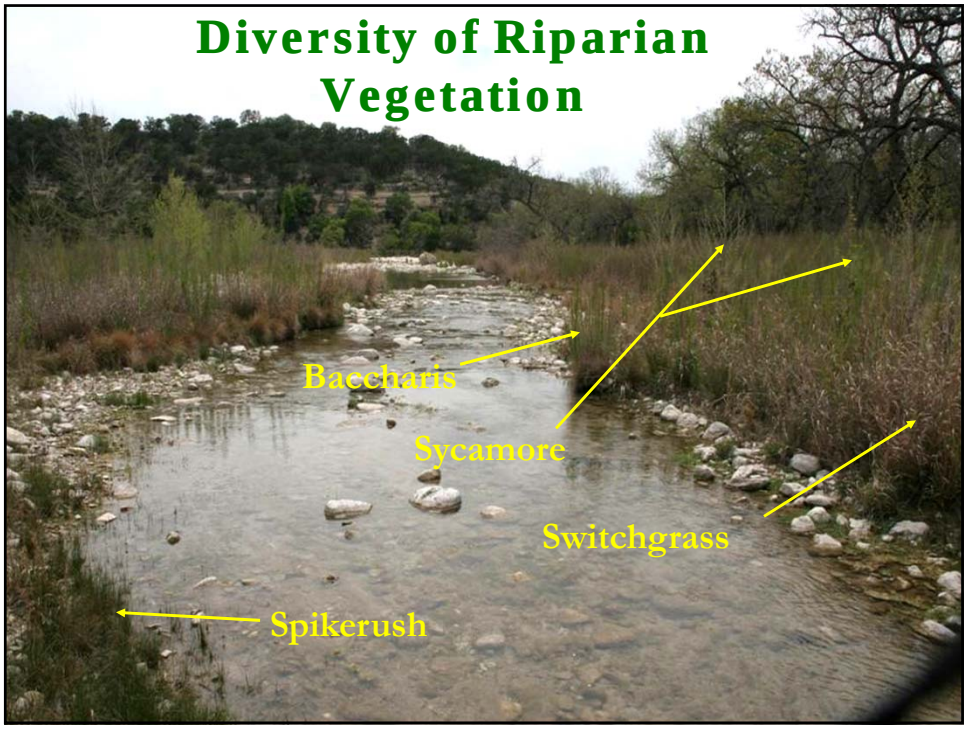
Able to withstand high energy flows

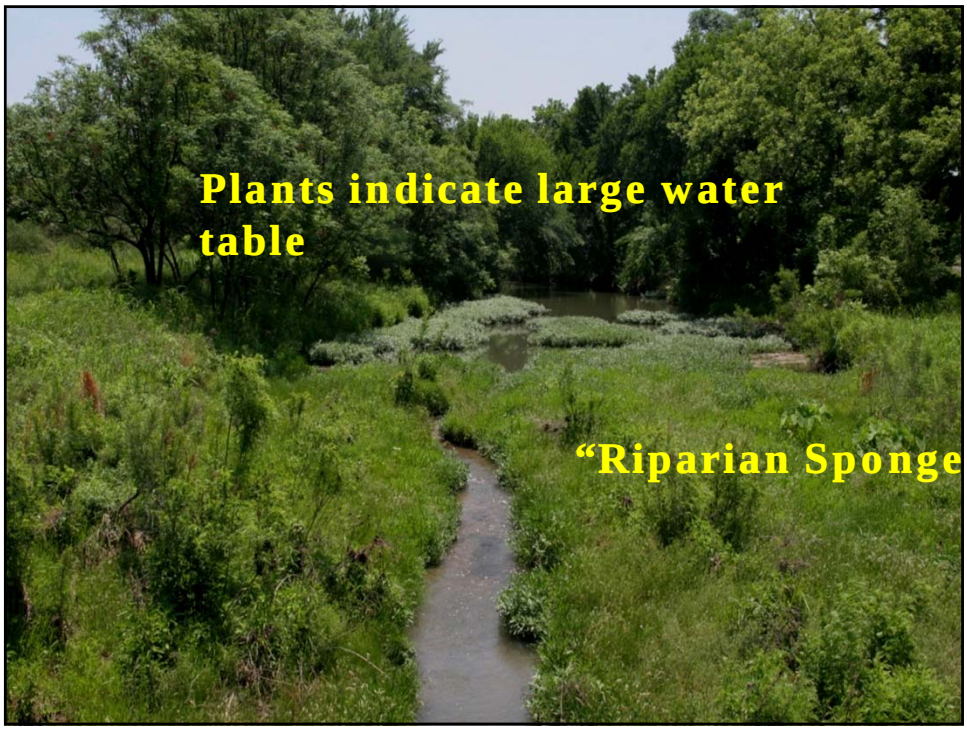
Strong, deep, reinforcing root systems

Provide bank protection and energy dissipation

Stability Ratings of Riparian Plants Scale of 1 - 10

1 = Bare ground
10 = Anchored rock or large anchored logs
6/7 = Acceptable riparian stability *


Diversity of Riparian Vegetation
Baccharis
Sycamore
Switchgrass
Spikerush

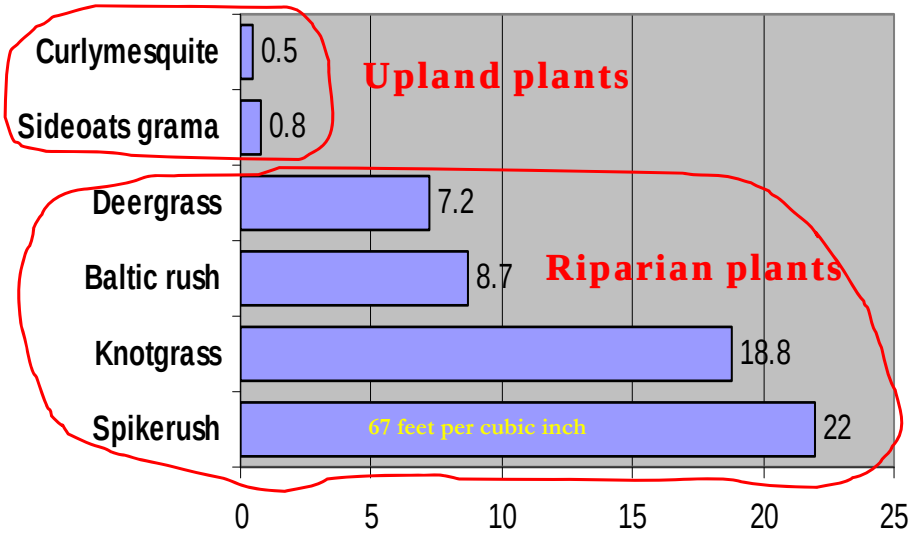

Plants indicate large water table
"Riparian Sponge

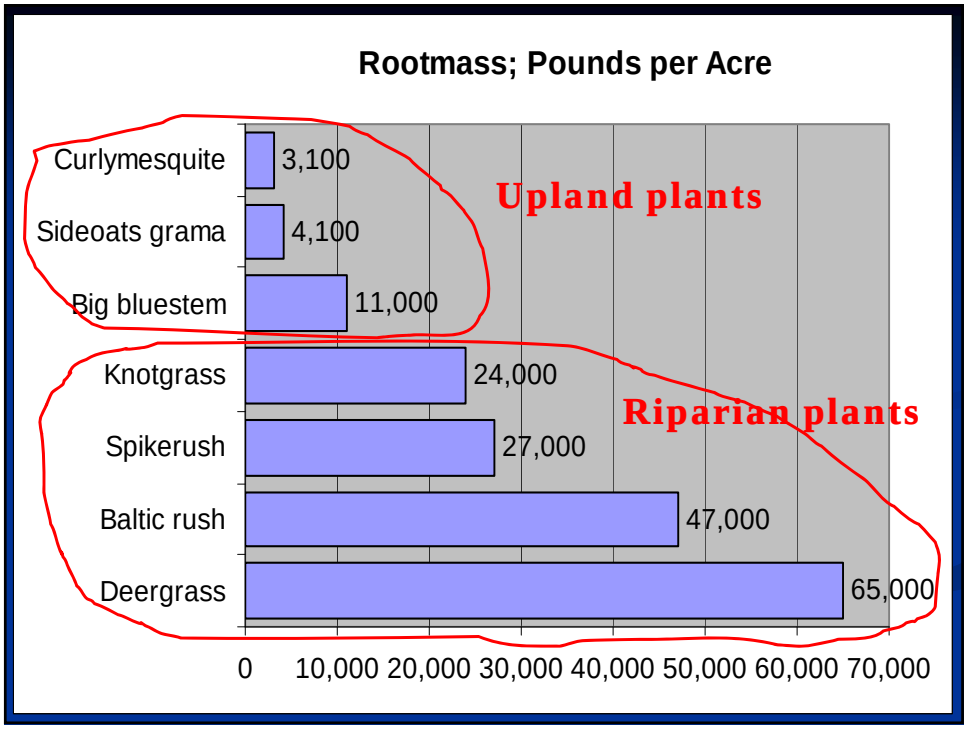
Plant Vigor

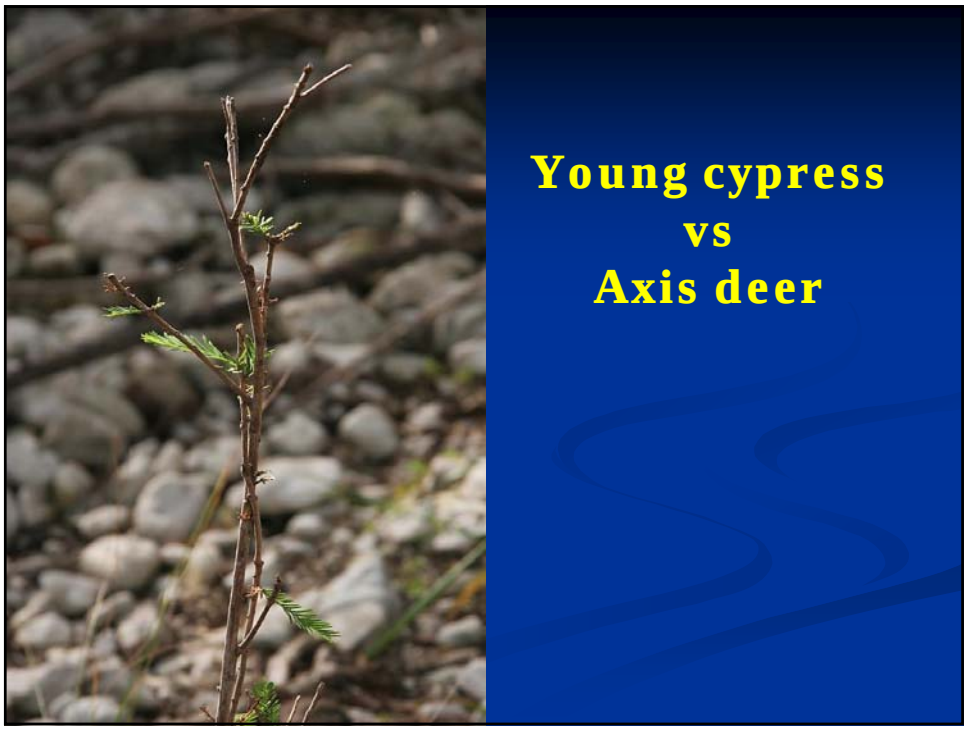
Plant Vigor-Leaves and Roots

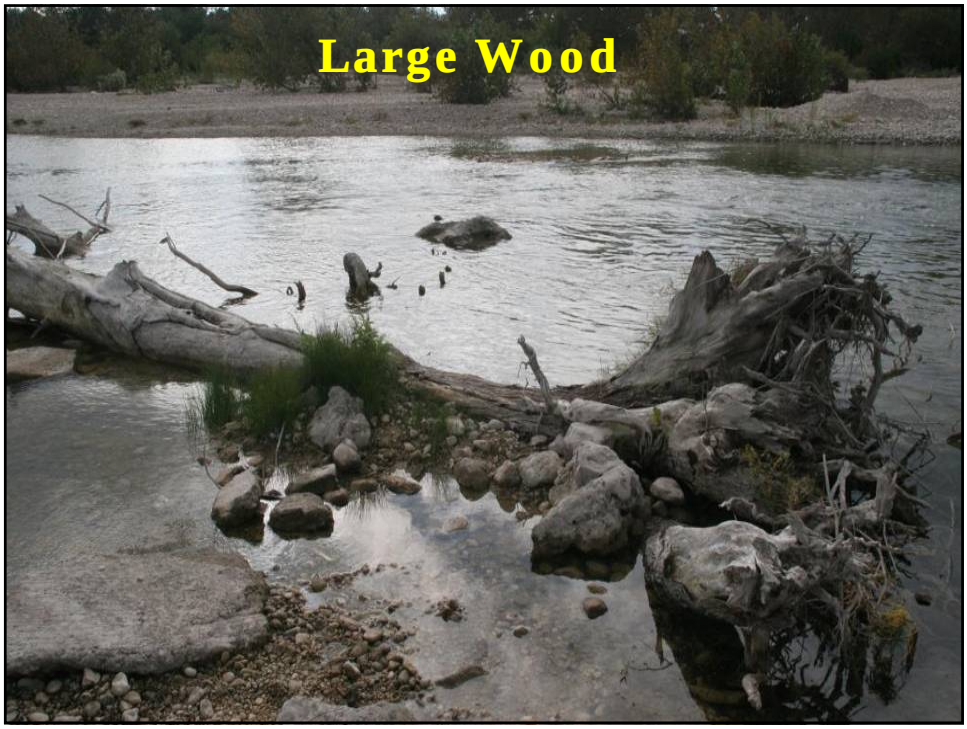
Caring for the Green Zone, Riparian Areas and Grazing Management

Alberta Riparian Habitat Management Project, "Cows and Fish Project"




Rootmass; Pounds per Acre
Curlymesquite
3,100
Sideoats grama
4,100
Big bluestem
11,000
Knotgrass
24,000
Spikerush
27,000
Baltic rush
47,000
Deergrass
65,000
Upland plants
Riparian plants
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000

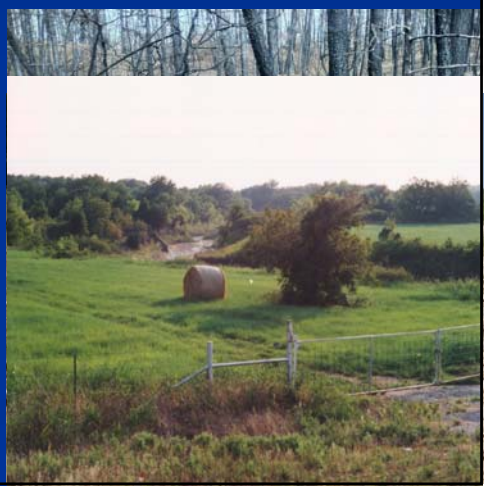

Young cypress
vs
Axis deer


Large Wood


Key Functions of Riparian Vegetation:
Dissipate Energy
Reduce Erosion
Trap Sediment
Help Create / Enlarge Riparian Sponge
Slow Down the Water

Hindrances to Healthy / Functional Riparian Areas:

- Farming too close to the bank
- Mowing, spraying close to the creek
- Manicured landscapes next to the creek
- Chronic grazing concentrations in creek areas
- Excessive deer, exotics, hogs in creek
- Burning in riparian area
- Removal of large dead wood
- Artificial manipulation of banks / sediment
- Excessive vehicle traffic in creek area
- Poorly designed road crossings / bridges
- Excessive recreational foot traffic
- Excessive alluvial pumping or other withdrawals



Management and Stewardship

- The impacts of stream flow and water quality are cumulative as the water moves down the system.
- Management upstream can lead to positive or negative impacts downstream.
- As you assess the stream and riparian ecosystem think about what may be hindering it.
- Has something caused a change in the water, sediment or vegetation?
- Management activities should protect healthy systems or allow recovery to return to a healthy functioning system.

Photo Monitoring

- Repeating photographs at set locations will allow better assessment of current conditions and changes over time.
- Location selection: critical sites along the stream where the force of moving water has the potential for detrimental impacts
  - A tributary or high runoff location
  - Where the stream changes course – point bar or bend
  - Sites that are easily accessible and representative

Permanent Photo Point Method

- Four photographs should be taken at each observation site:
  - 1) upstream showing the nearest bank , stream channel and opposite bank if possible,
  - 2) perpendicular to the stream of the opposite bank,
  - 3) perpendicular to the stream away on the bank where the observer is standing, and
  - 4) downstream showing the channel and both banks if possible.
- With a felt pen and a yellow paper pad (white is too bright), make a sign to include in the photo scene.
- Include some identification (stream name, range site, etc.) concerning the specific scene being photographed and the date.

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Key Locations to Monitor

- Each location should be permanently marked for future evaluations using a steel stake or on-the-ground reference plus GPS coordinates if possible.
- locate the permanent reference point a "safe" distance inland
- Make a map of the stream showing the location of each permanent marker and the monitoring point.