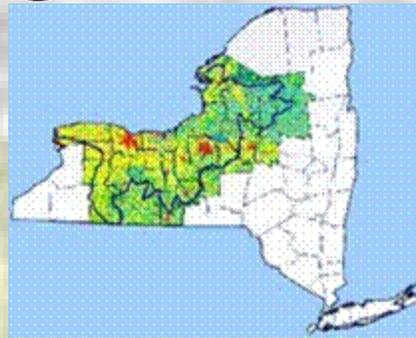


STREAM PROCESSES

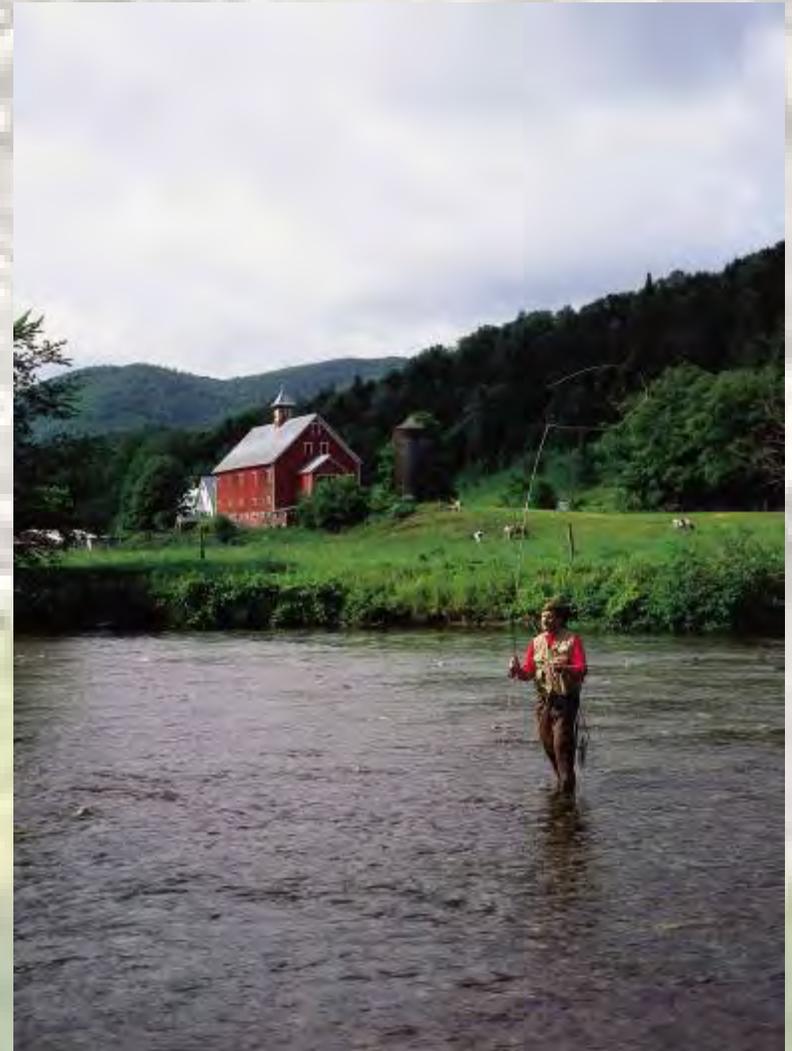
A Guide to Living in Harmony with Streams



Southern Tier Central
Regional Planning &
Development Board

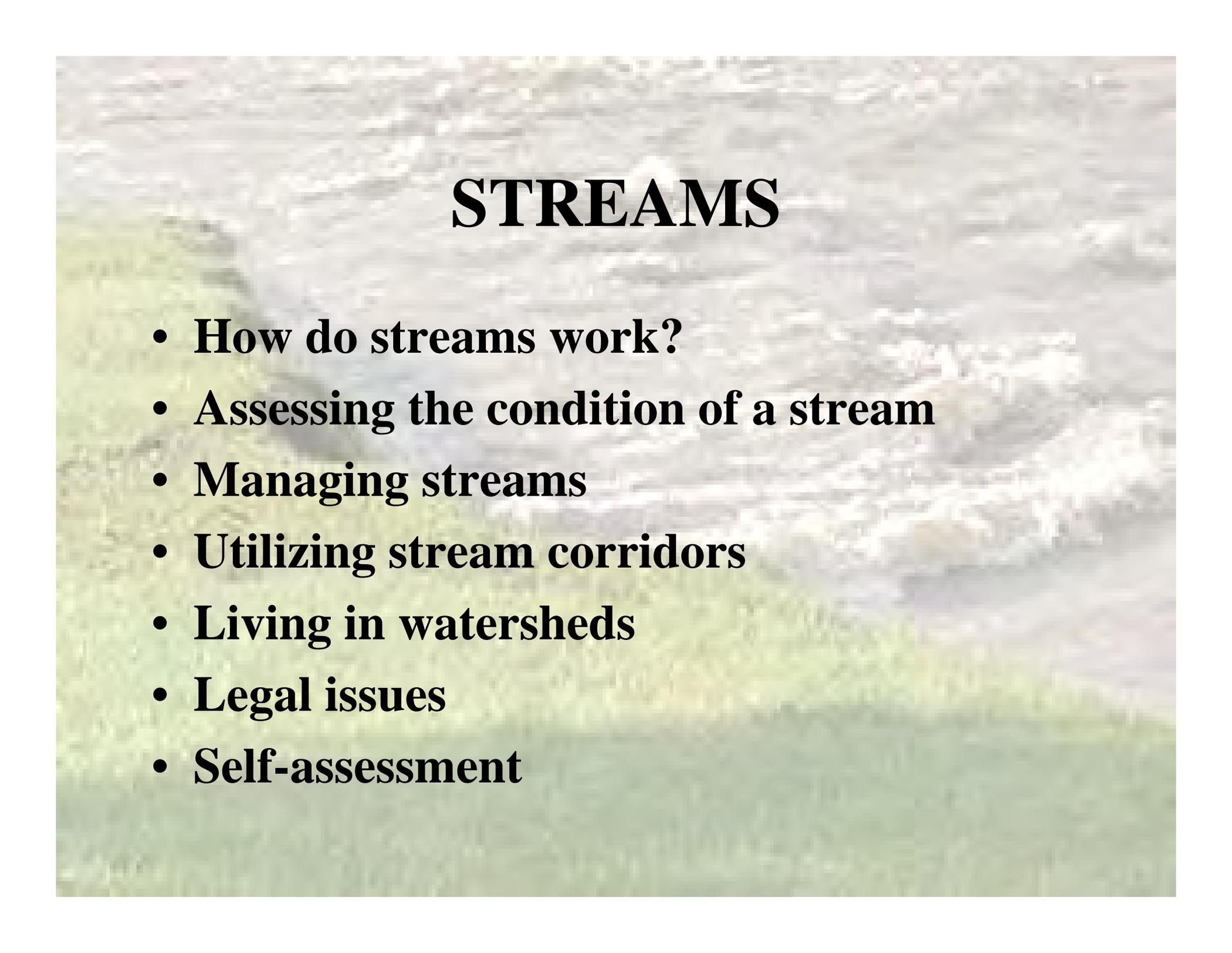


We love our streams



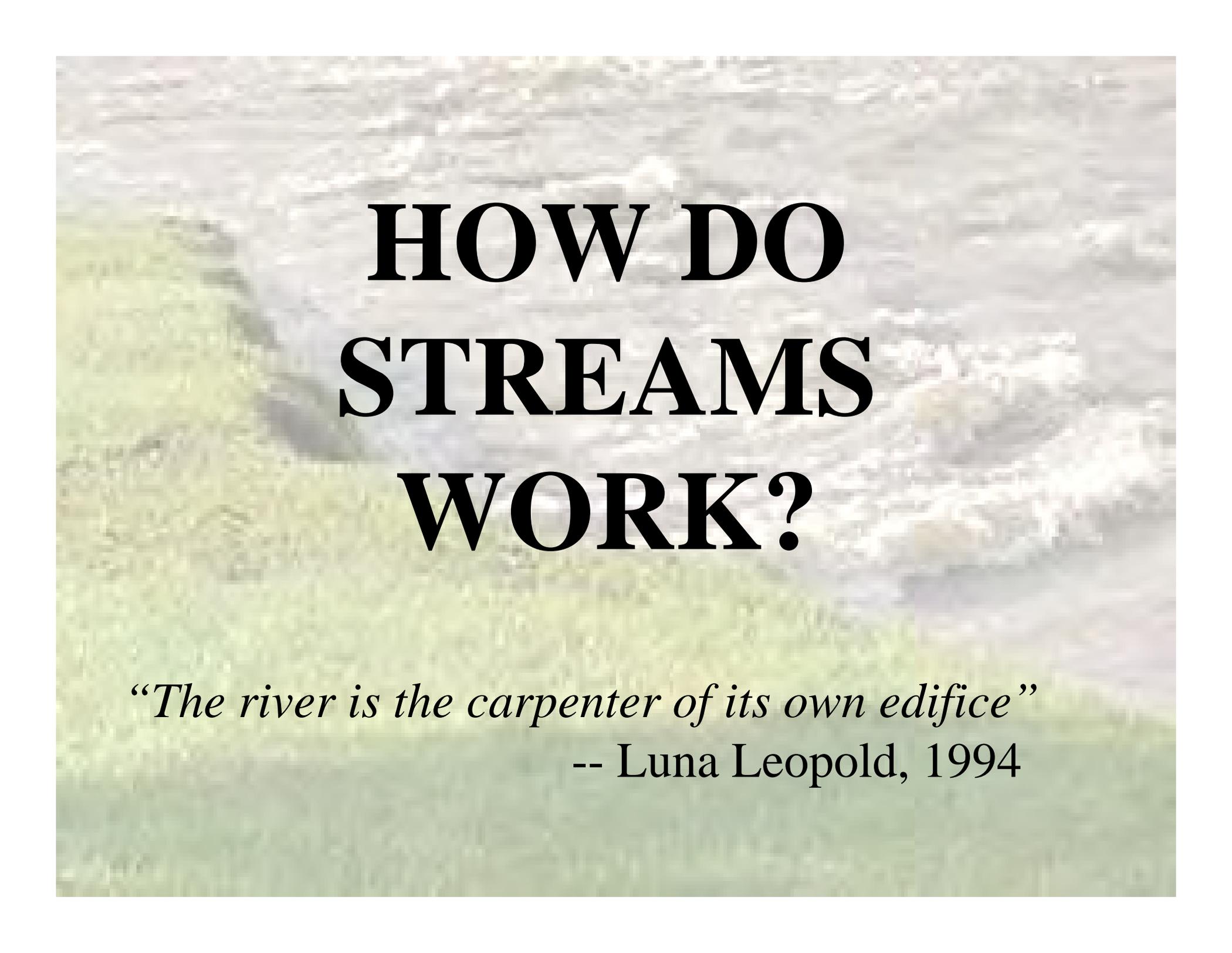
We hate our streams



A background image of a stream flowing through a grassy field. The stream is in the center, with white foam from the water's movement. The grass is green and slightly out of focus. The overall scene is bright and natural.

STREAMS

- **How do streams work?**
- **Assessing the condition of a stream**
- **Managing streams**
- **Utilizing stream corridors**
- **Living in watersheds**
- **Legal issues**
- **Self-assessment**

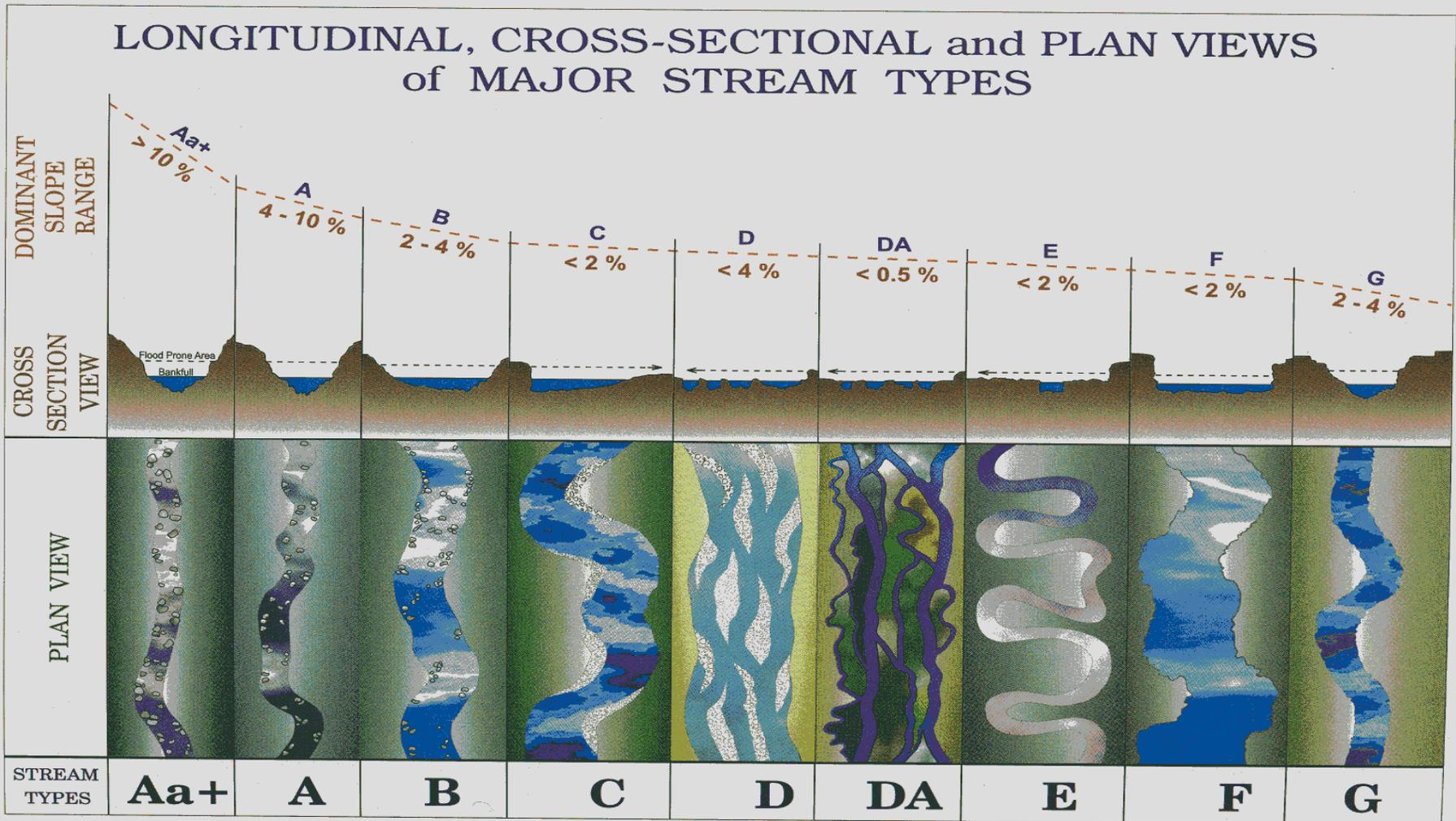


HOW DO STREAMS WORK?

“The river is the carpenter of its own edifice”

-- Luna Leopold, 1994

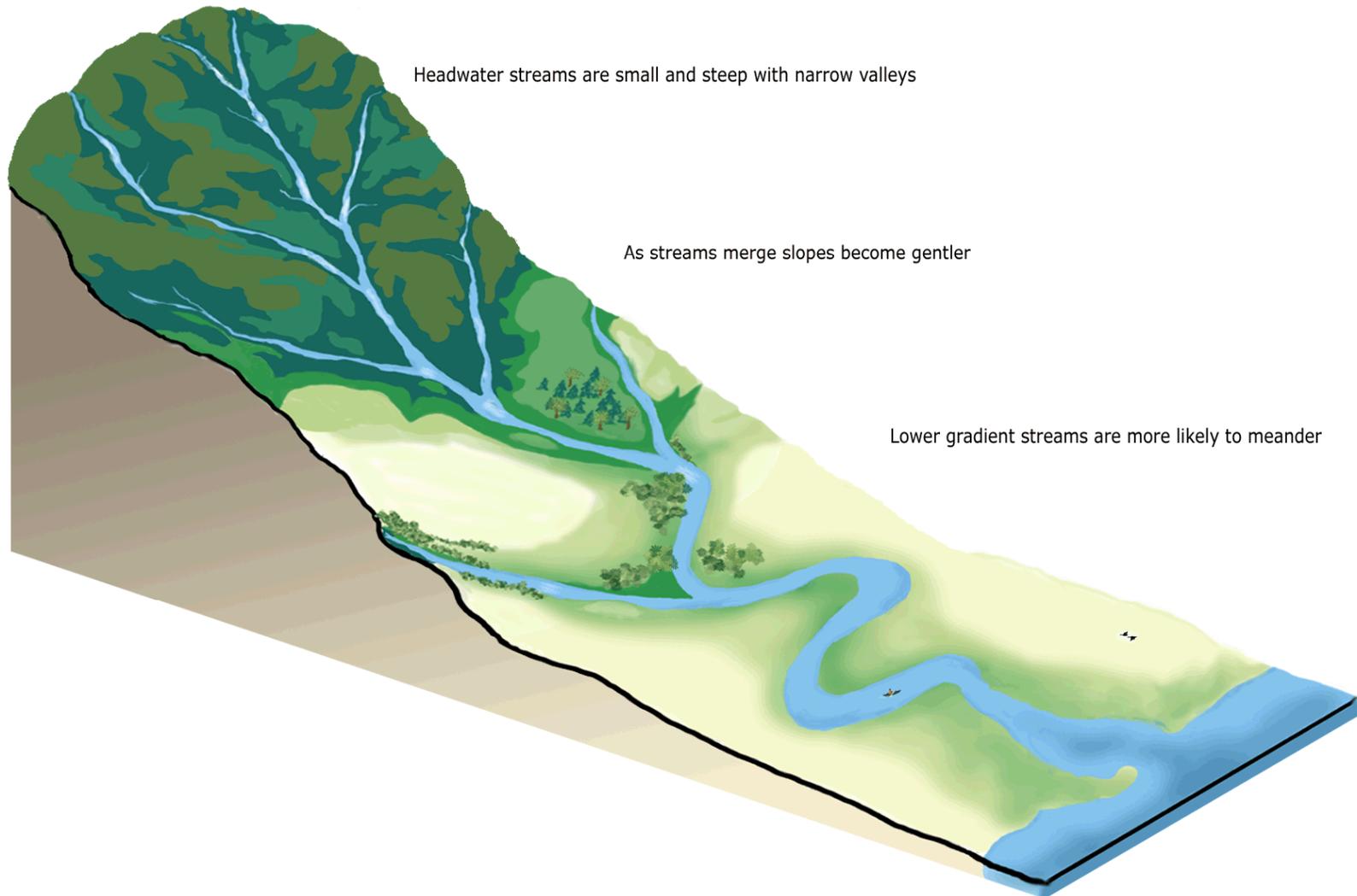
Streams come in many shapes and sizes



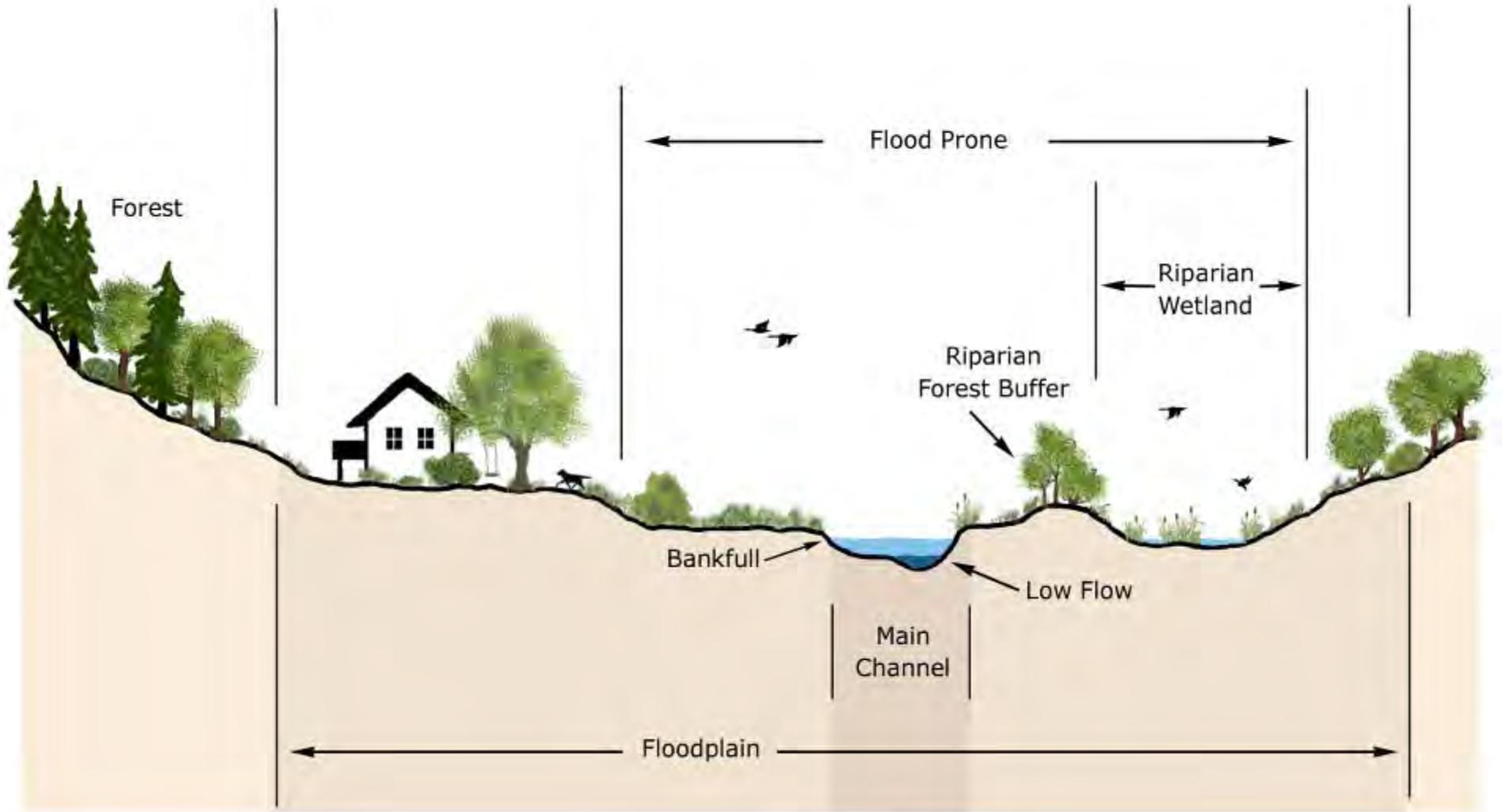
FIELD GUIDE FOR STREAM CLASSIFICATION

FIGURE 2. Broad level stream classification delineation showing longitudinal, cross-sectional and plan views of major stream types. (from Rosgen, 1994)
© 1996 Wildland Hydrology, Inc.

Streams come in many shapes and sizes



STREAM CHANNEL



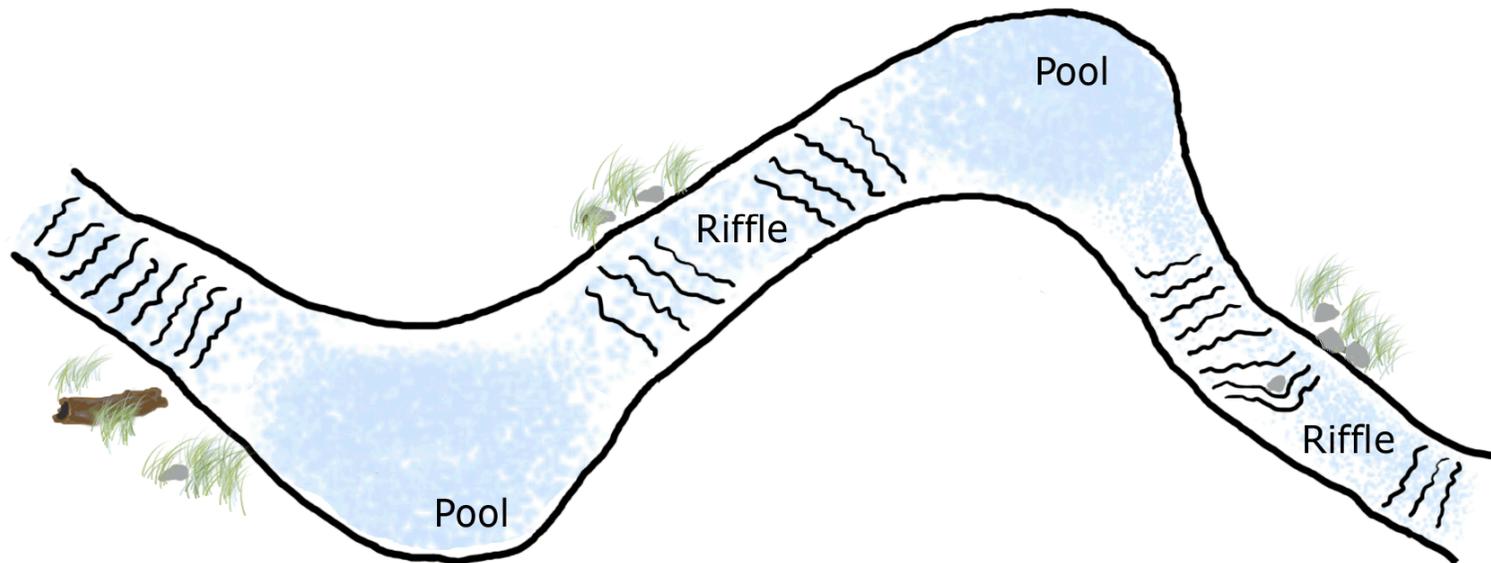
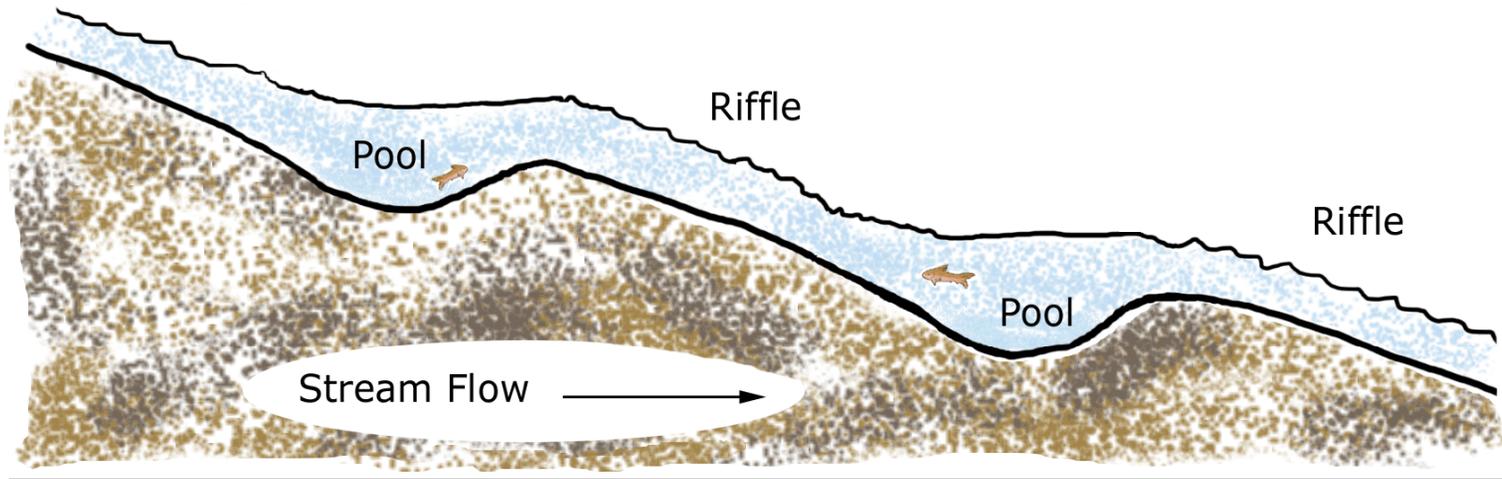
FLOODPLAIN



FLOODPLAIN



RIFFLES AND POOLS



MEANDERS



BRAIDED CHANNEL

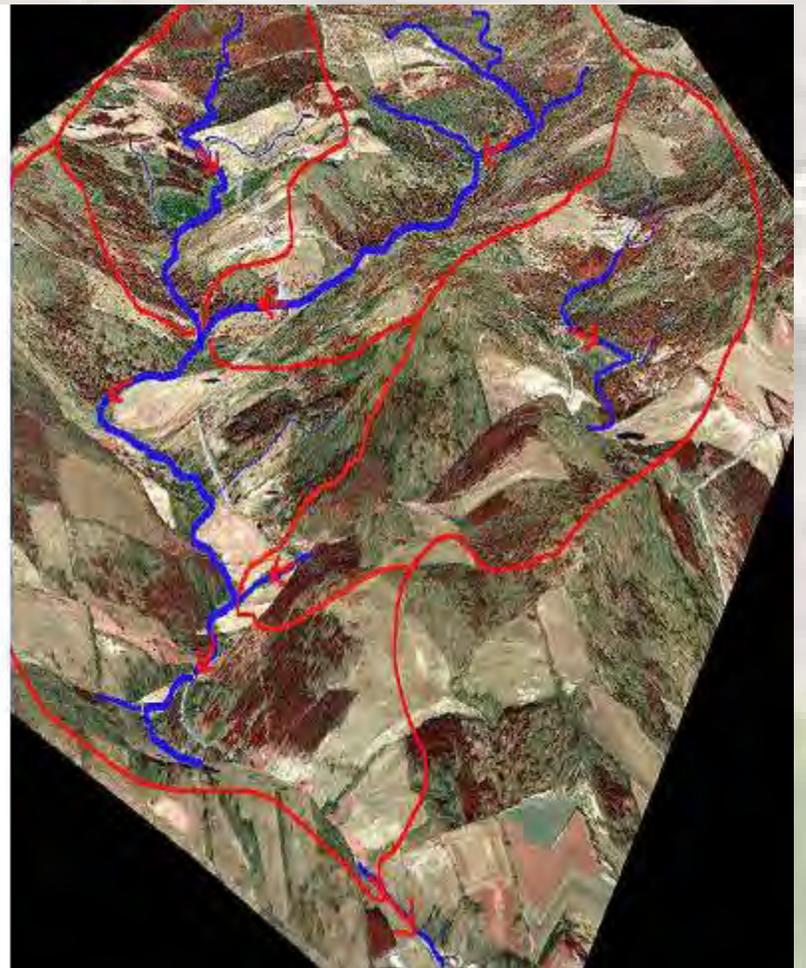


WHAT DO STREAMS DO?

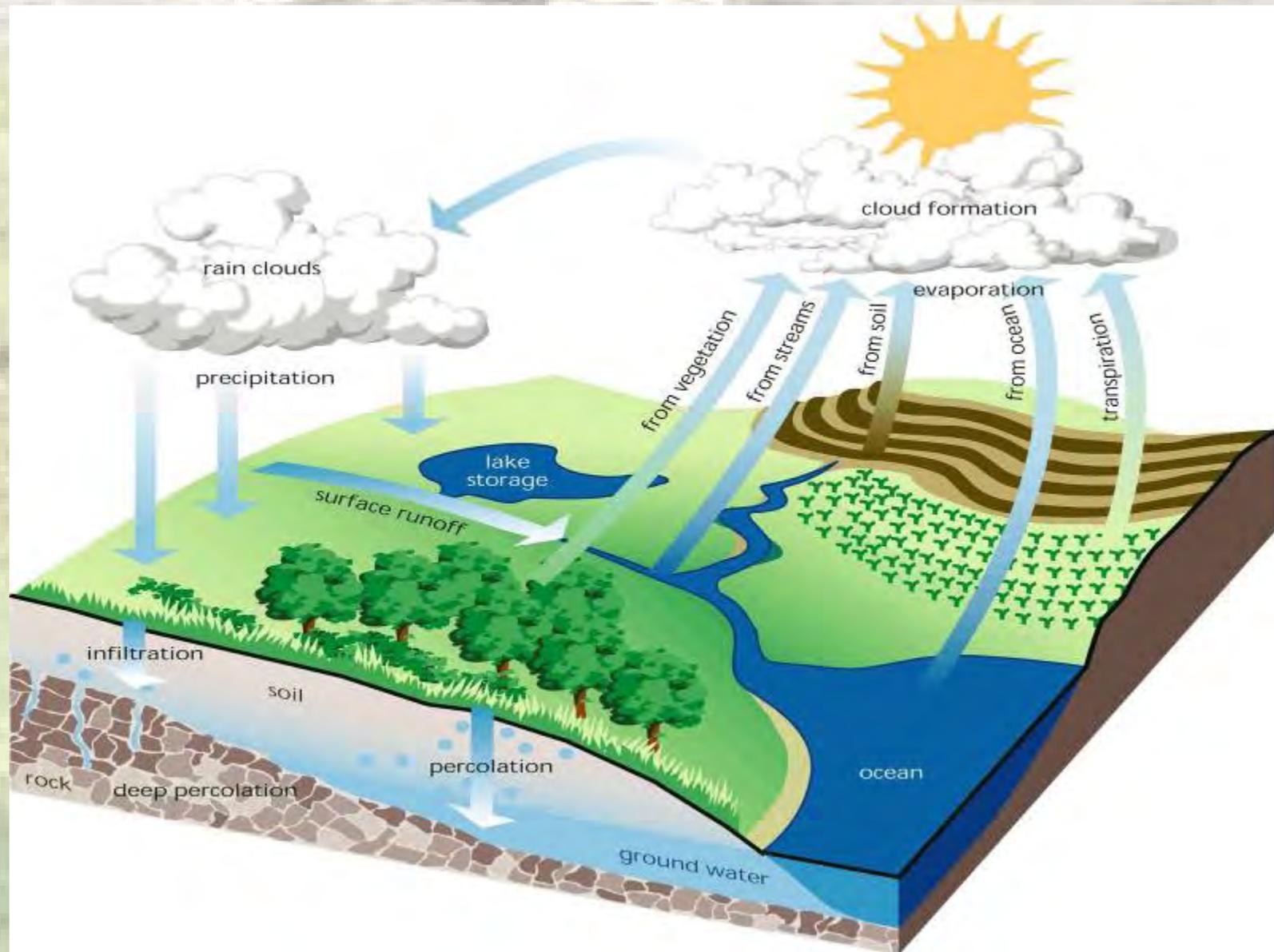
- **Collect water from the watershed**
- **Convey varying amounts of water**
- **Dissipate energy**
- **Transport and redistribute sediment**
- **Seek dynamic equilibrium**
- **Change in response to changing conditions**

WATERSHED

A watershed is an area of land from which surface and subsurface waters drain to a common receiving body or outlet.



HYDROLOGIC CYCLE



FLOW PATHS

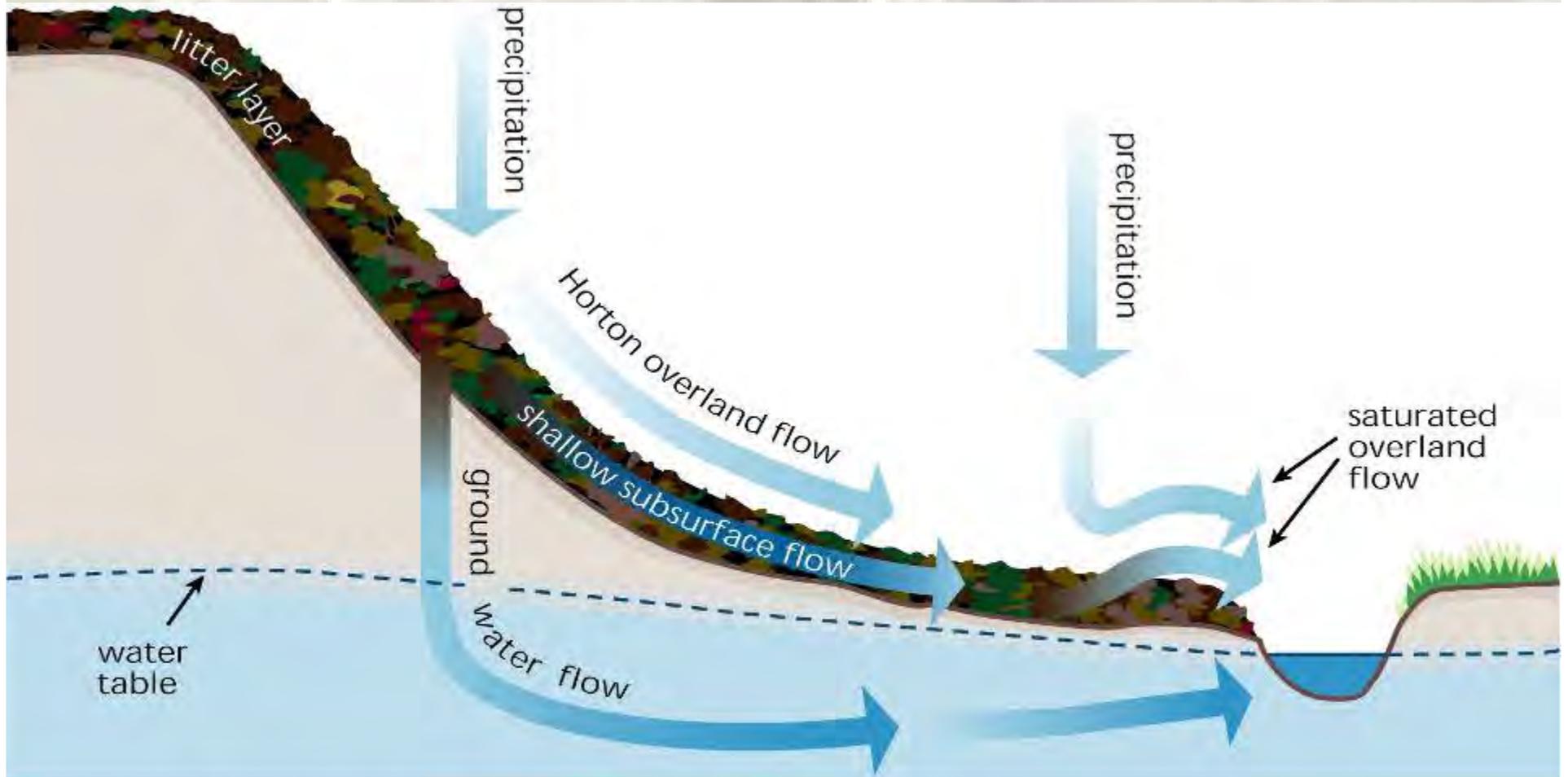
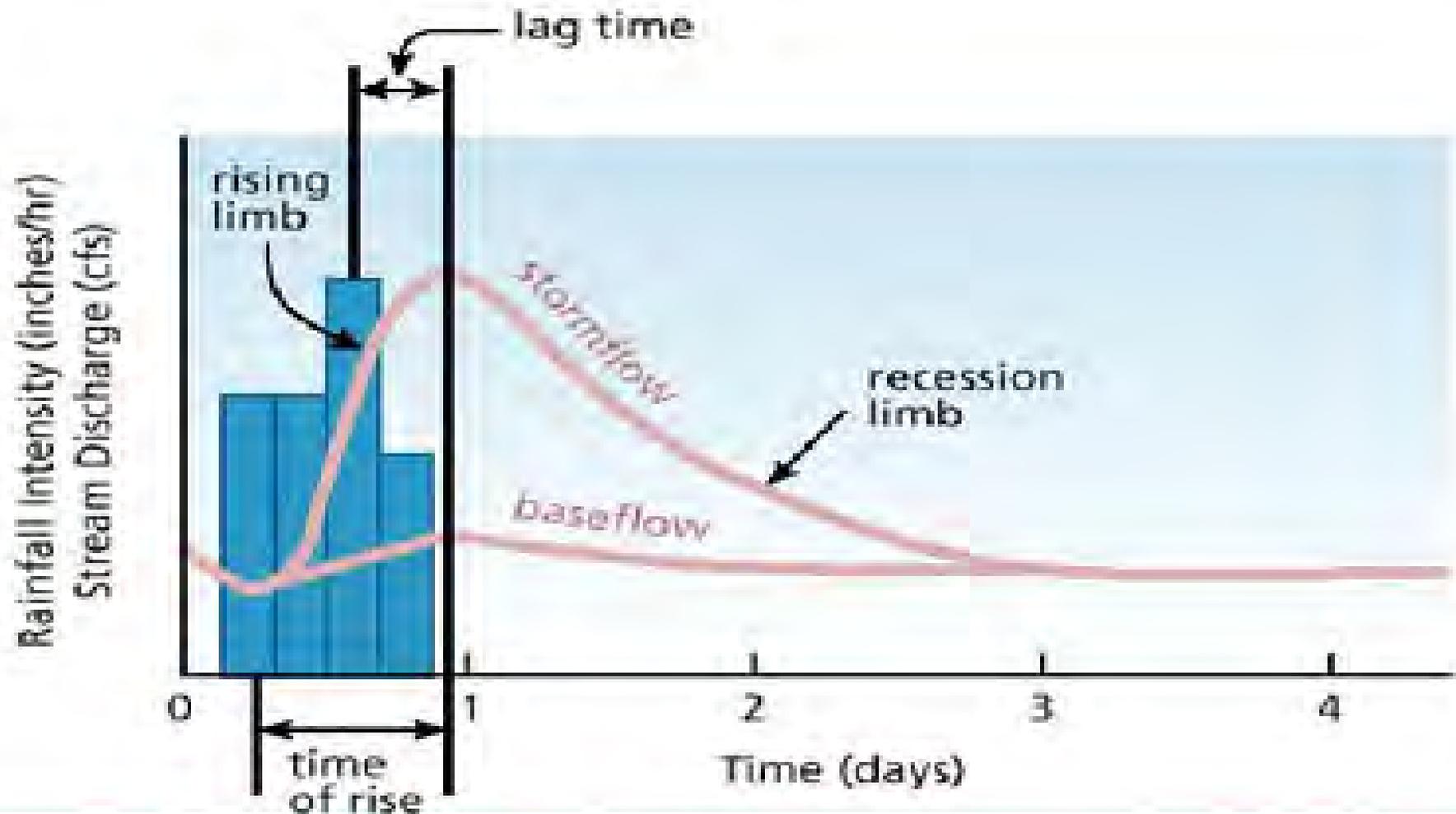


Fig. 2.10 -- Flow paths of water over a surface. The portion of precipitation that runs off or infiltrates to the ground water table depends on the soil's permeability rate; surface roughness, and intensity of precipitation. In Stream Corridor Restoration: Principles, Processes, and Practices (10/98). Interagency Stream Restoration Working Group (15 federal agencies)(FISRWG).

STORM HYDROGRAPH



A hydrograph shows how long a stream takes to rise from baseflow to maximum discharge and then return. Blue bars indicate rainfall amount and timing relative to flow changes.



HIERARCHY FOR DISSIPATING ENERGY

- **Kinetic energy – energy of motion**
- **Friction – bed and channel**
- **Sediment transport**
- **Erosion – bed and channel**

THE ENERGY OF A FLOOD



VALLEY



EROSION AND DEPOSITION

It is not unusual for human actions to disturb the balance between a stream's energy and its sediment load, resulting in increased erosion and/or increased deposition.



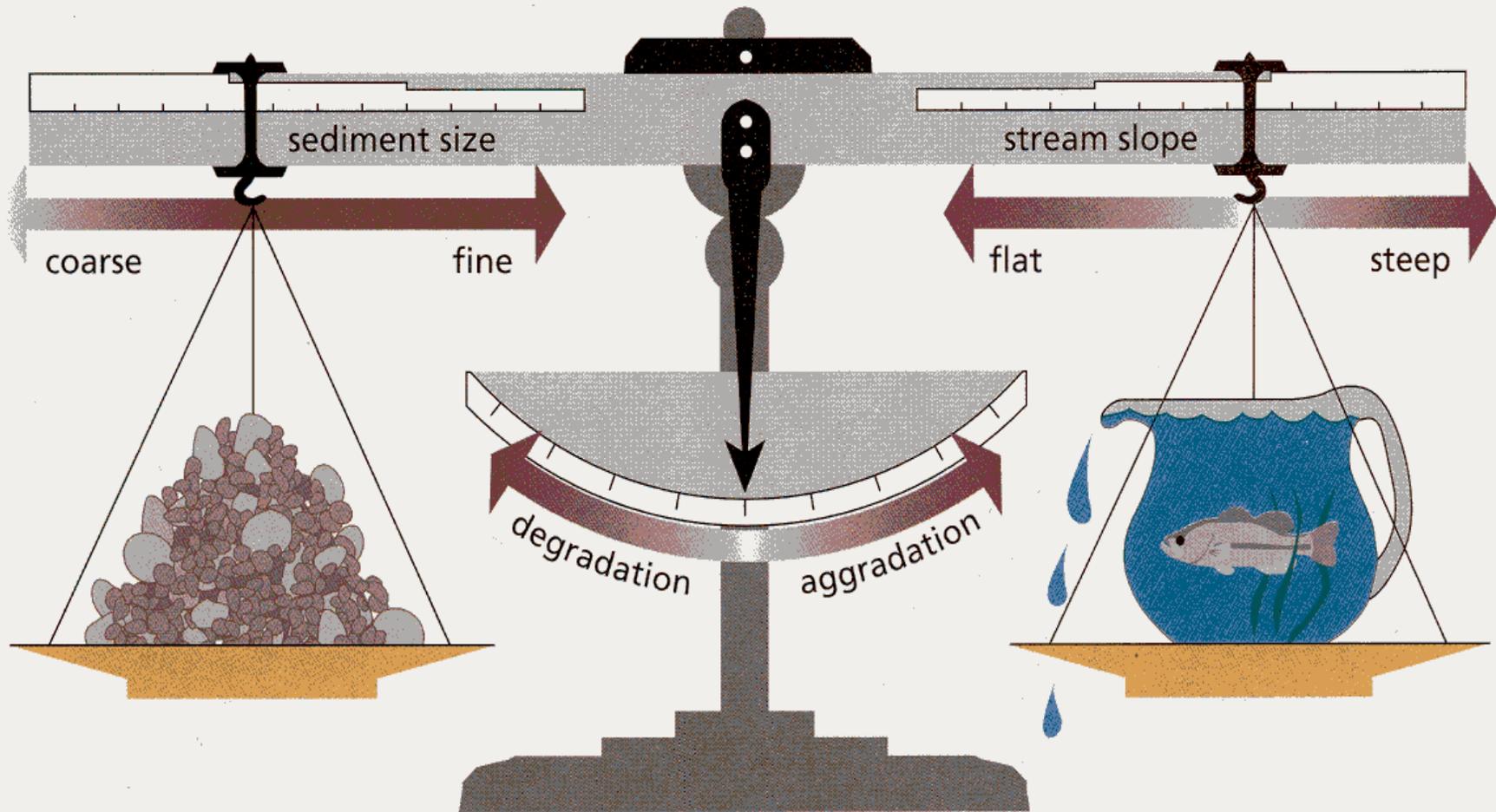
POINT BARS



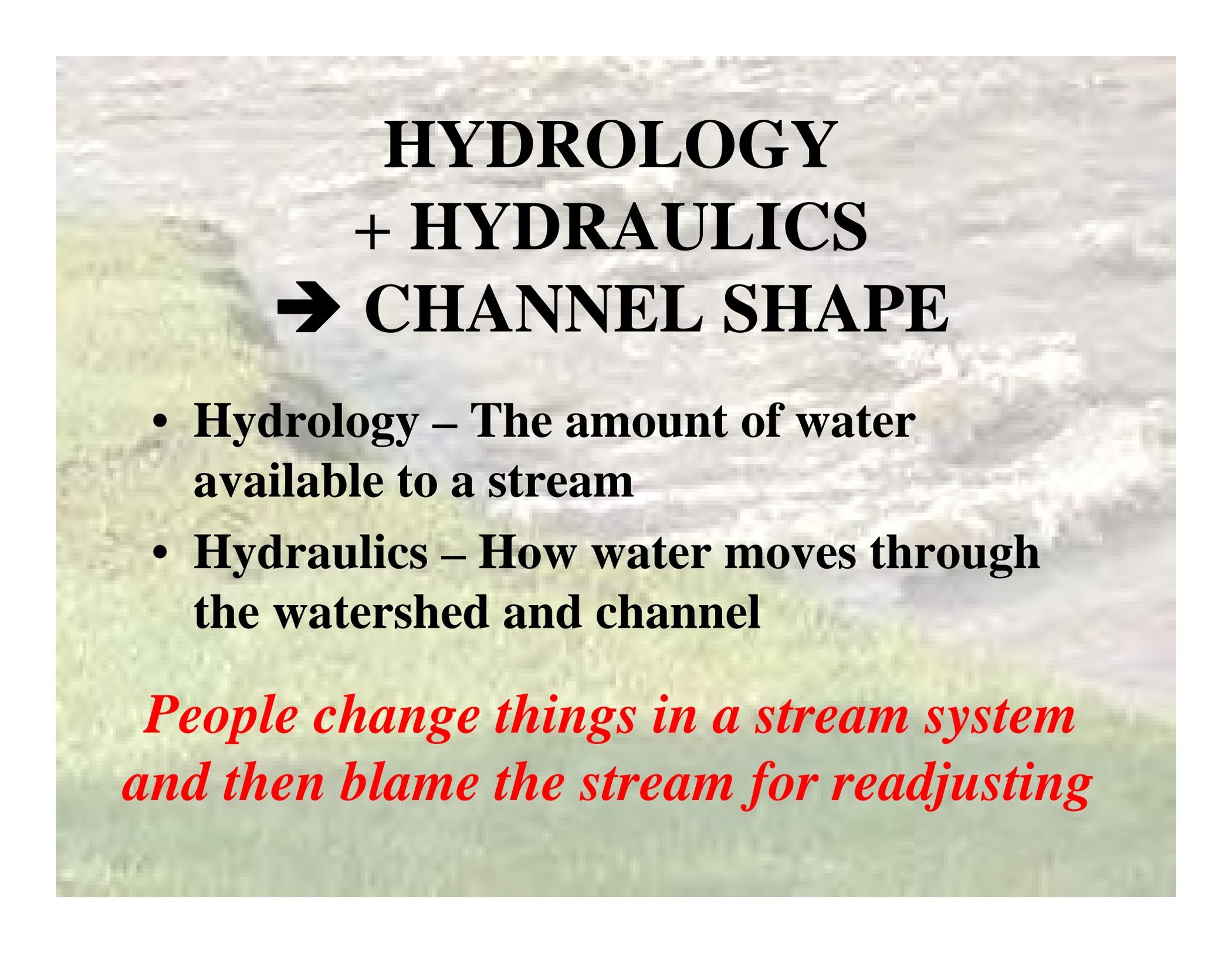
DYNAMIC EQUILIBRIUM

Dynamic equilibrium means that the stream moves and adjusts in such a way as to minimize the energy of the system. The change is what makes the equilibrium dynamic.

DYNAMIC EQUILIBRIUM



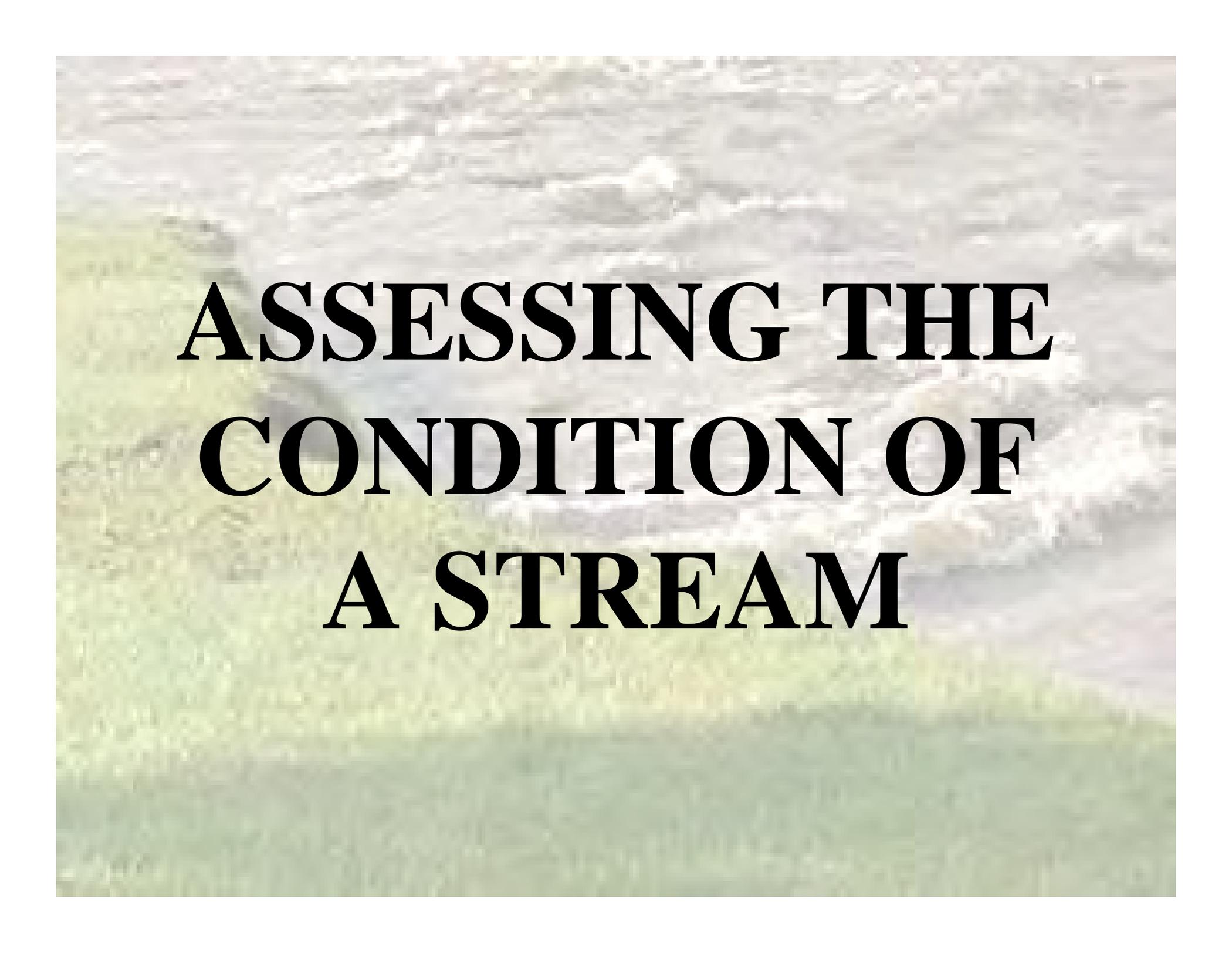
$$Q_s \cdot D_{50} \propto Q_w \cdot S$$



HYDROLOGY + HYDRAULICS → CHANNEL SHAPE

- **Hydrology – The amount of water available to a stream**
- **Hydraulics – How water moves through the watershed and channel**

*People change things in a stream system
and then blame the stream for readjusting*

A photograph of a stream flowing through a grassy field. The water is clear and reflects the surrounding greenery. The text is overlaid on the center of the image.

**ASSESSING THE
CONDITION OF
A STREAM**

A background image of a stream flowing through a grassy field. The stream is in the center, with white water rapids. The grass is green and the sky is overcast.

“TRIAGE”

- **Physically inspect the condition of the stream and its tributaries**
- **Identify sources of instability**
- **Develop and prioritize appropriate remediation strategies**

STREAM INVENTORY AND EVALUATION FORM

Watershed:		County:		Date:	
Stream:			Assessor:		
Site #	Photo#:	WP Start:	WP End:	Time:	
Valley Type:		Length of site:	Structure Type:		Distance to:
<input type="checkbox"/> Left Bank		<input type="checkbox"/> Both Banks	<input type="checkbox"/> Right Bank		<input type="checkbox"/> Gravel Bar

Erodibility Variables				
Bank Height (ft)	Bankfull Height (ft)	Root Depth (ft)	% Root Density	Bank Angle
% Surface Protection	Materials Adjustment (1-10)		Stratification Adjustment (1-10)	

Depositional Features	
<input type="checkbox"/> Point Bars	<input type="checkbox"/> Point Bars with few Mid-Channel Bars
<input type="checkbox"/> Numerous Mid-Channel Bars	<input type="checkbox"/> Side Bars
<input type="checkbox"/> Diagonal Bars	<input type="checkbox"/> Channel Branching/numerous mid bars
<input type="checkbox"/> Side bars & channel bars L > 2/3 widths	<input type="checkbox"/> Delta Bars

Estimated Near Bank Stress Prediction		
<input type="checkbox"/> Very Low	<input type="checkbox"/> Low	<input type="checkbox"/> Moderate
<input type="checkbox"/> High	<input type="checkbox"/> Very High	<input type="checkbox"/> Extreme

Cause of Instability	
<input type="checkbox"/> Entrenched _____ #	<input type="checkbox"/> Incised _____ #
<input type="checkbox"/> Poor Vegetation	<input type="checkbox"/> Radius of Curvature too tight
<input type="checkbox"/> Too Straight	<input type="checkbox"/> Human Influences
<input type="checkbox"/> High W/D	<input type="checkbox"/> High Bank
<input type="checkbox"/> Low W/D	<input type="checkbox"/> High Velocity
<input type="checkbox"/> Other Explain:	<input type="checkbox"/> Material to Small

Visual Stream Classification Level II	
Current Type _____	Potential _____
Bed Materials	<input type="checkbox"/> Flat & Platey
	<input type="checkbox"/> Rounded-Sub Rounded
	<input type="checkbox"/> Blocky
	<input type="checkbox"/> Other _____

Riparian Vegetation	
Deciduous Overstory _____%	Evergreen Overstory _____%
Bare _____%	High Brush _____%
	Low Brush _____%
Deciduous w/ Brush & Grass _____%	Grass & Brush _____%
	Forbs _____%
	Perennial Grass _____%
Wetland Vegetation _____%	Annuals w/ Forbs _____%
Perennial Overstory _____%	Rhizomatous Grasses _____%

Flow Regime	
<input type="checkbox"/> Perennial	<input type="checkbox"/> Subterranean
<input type="checkbox"/> Intermittent	<input type="checkbox"/> Ephemeral

Landuse	
<input type="checkbox"/> Pasture	<input type="checkbox"/> Hay/Fallow
<input type="checkbox"/> Residential	<input type="checkbox"/> Woods
<input type="checkbox"/> Cultivated Ag.	<input type="checkbox"/> Commercial/Industrial
<input type="checkbox"/> Farmstead	<input type="checkbox"/> Brush
<input type="checkbox"/> Woods w/ grass	<input type="checkbox"/> Construction

Debris and Blockage		
<input type="checkbox"/> None	<input type="checkbox"/> Numerous	<input type="checkbox"/> Beaver Dams Few
<input type="checkbox"/> Infrequent	<input type="checkbox"/> Extensive	<input type="checkbox"/> Beaver Dams Frequent
<input type="checkbox"/> Moderate	<input type="checkbox"/> Dominating	<input type="checkbox"/> Human Influences

Meander Pattern		
<input type="checkbox"/> Regular	<input type="checkbox"/> Tortuous	<input type="checkbox"/> Irregular
<input type="checkbox"/> Truncated	<input type="checkbox"/> Unconfined Scrolls	<input type="checkbox"/> Confined Scrolls
<input type="checkbox"/> Distorted Loops	<input type="checkbox"/> Irregular / Oxbows	

Remediaiton Approach	Permit	Access

Comments:

STREAM OBSERVATIONS

- **Lack of riparian vegetation**
- **Signs that the stream has been altered**
- **Lack of access to floodplain**
- **Constriction at a bridge or culvert**
- **Road/structure encroachment**
- **Culvert outlets**
- **Bank erosion**
- **Sediment deposition**
- **Woody debris**
- **Garbage**
- **Rock riprap**

DEGRADATION



AGGRADATION



STREAMBANK EROSION



STREAMBANK EROSION



CHANNEL MIGRATION



REMEDIATION STRATEGIES

- **No action**
- **Remove development from the stream corridor**
- **Debris removal**
- **Planting**
- **Energy dissipation**
- **Streambank protection (such as riprap)**
- **In-stream structures (such as stream barbs)**
- **Natural stream channel design**
- **Watershed solutions**

DEBRIS REMOVAL



PLANTING



ENERGY DISSIPATION



STREAMBANK PROTECTION



IN-STREAM STRUCTURES



CHANNEL RESTORATION



Flood Damage



After Restoration

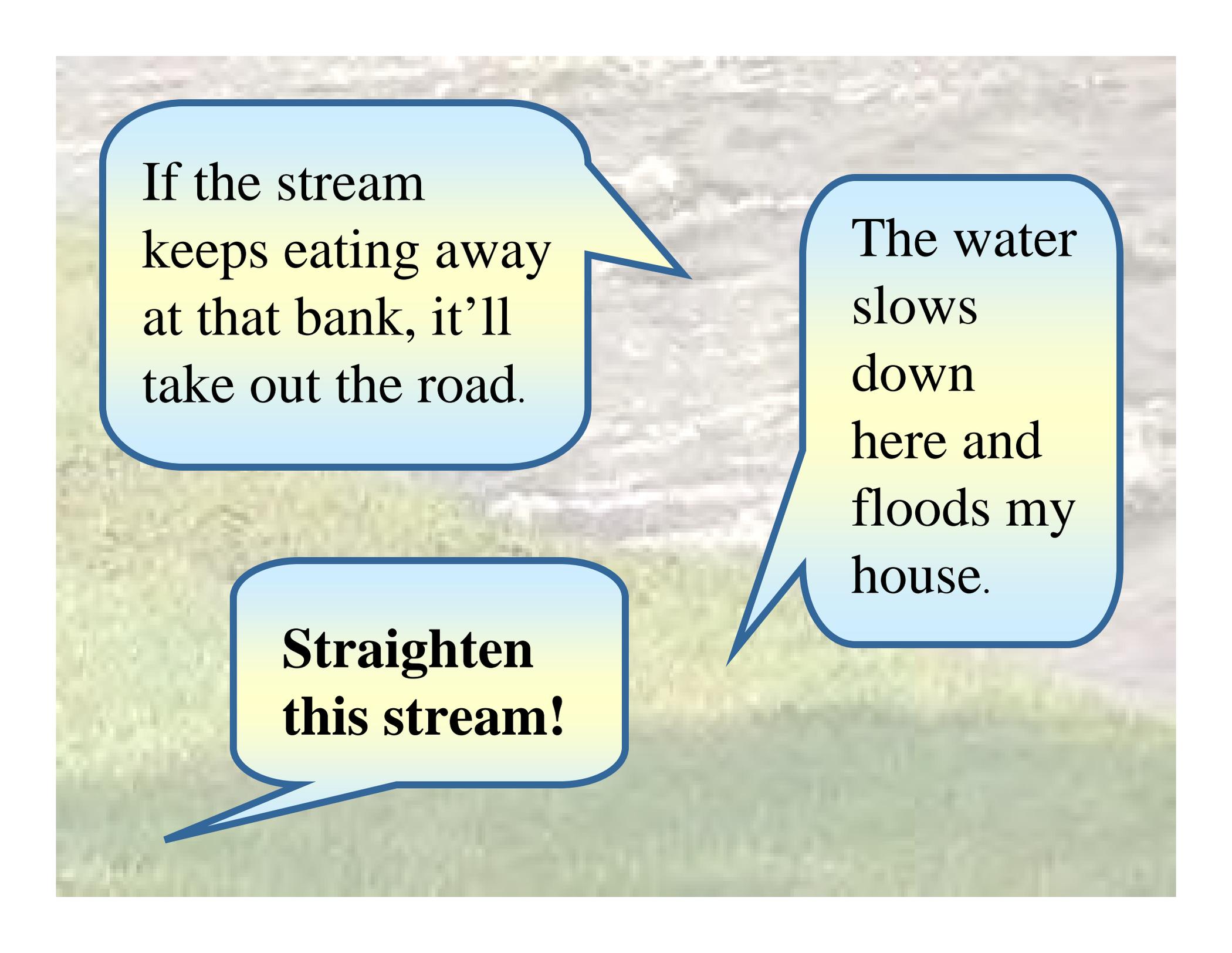
NATURAL STREAM DESIGN



MANAGING STREAMS

“...ten thousand river commissions, with the mines of the world at their back, cannot tame that lawless stream, cannot curb it or define it, cannot say to it ‘Go here,’ or ‘Go there,’ and make it obey; cannot save a shore which it has sentenced, cannot bar its path with an obstruction which it will not tear down, dance over, and laugh at.”

*--Mark Twain, *Life on the Mississippi**

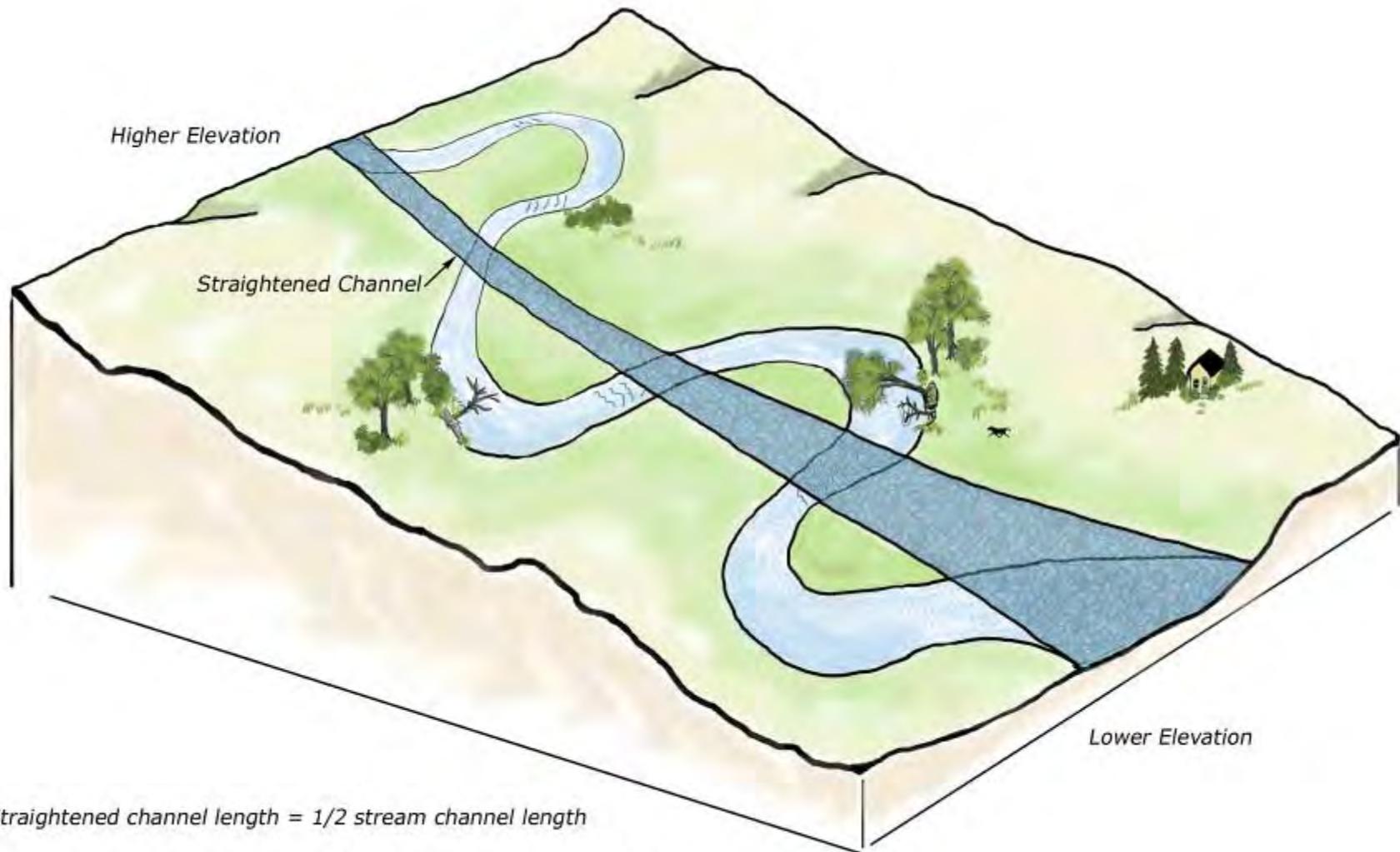


If the stream
keeps eating away
at that bank, it'll
take out the road.

The water
slows
down
here and
floods my
house.

**Straighten
this stream!**

CHANNEL STRAIGHTENING



Straightened channel length = 1/2 stream channel length

Straightened channel slope = 2 times stream channel slope

CHANNEL STRAIGHTENING



1944



1954

ORIGINAL STREAM LOCATION 2004



PAVED CHANNEL



CHANNELIZATION



That culvert's too small.
It floods the road.

They put in a big culvert.
Now the creek's eating
away at my yard.

The bridge is
washing out.

A tree got
caught on
that bridge
and flooded
my house.

Fix the culvert!
Fix the bridge!

BRIDGES & CULVERTS



CONSTRICTED FLOW



ICE JAM AT A BRIDGE



NARROW BRIDGE



DOWNSTREAM EROSION





BRIDGE REPLACEMENT



SUCCESS STORY



FLOODPLAIN CULVERT





PIER ALIGNMENT

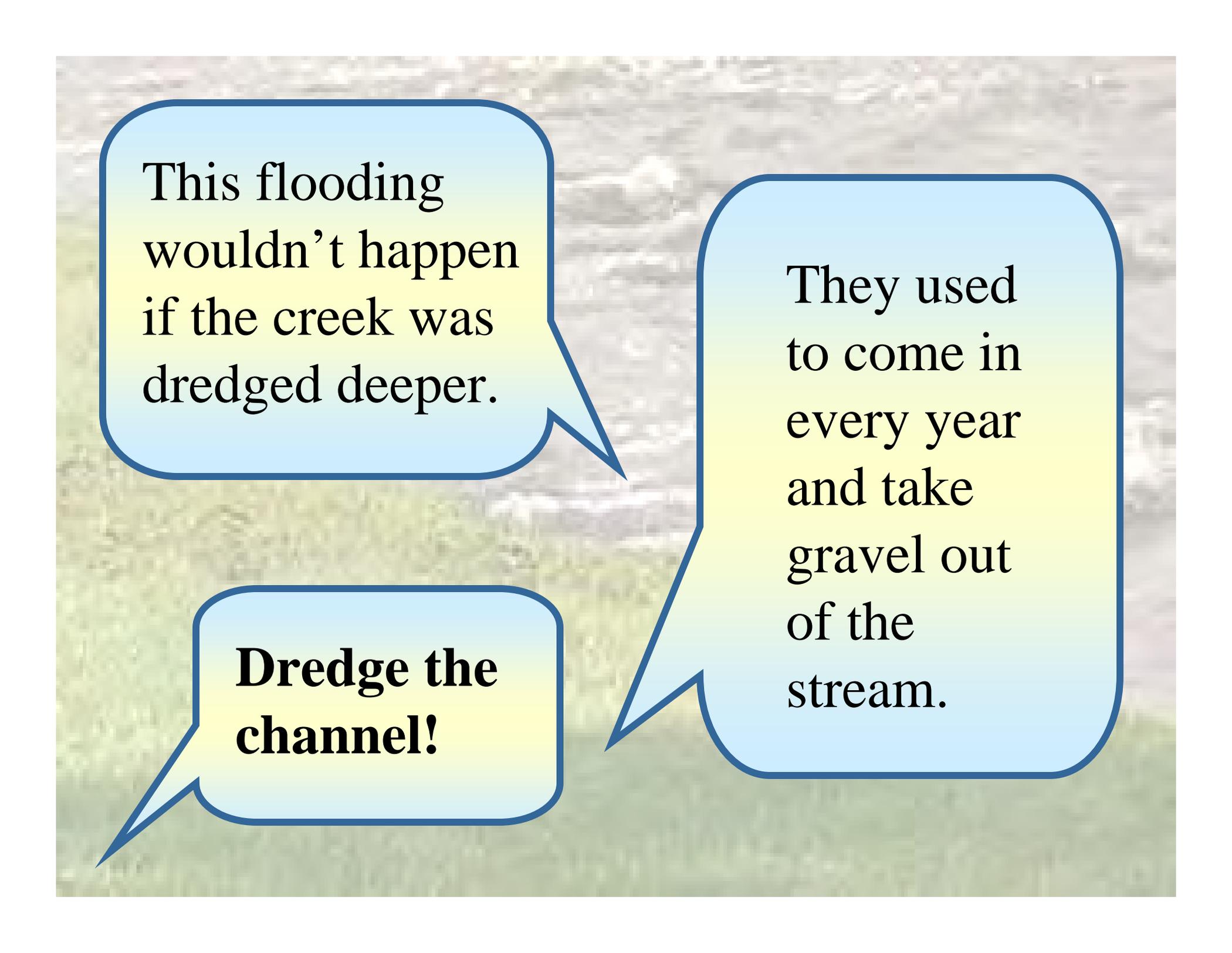


STREAM CHANGES





When a stream crossing is on a private drive, all risks, expenses, and liability associated with the structure belong to the property owner.



This flooding
wouldn't happen
if the creek was
dredged deeper.

**Dredge the
channel!**

They used
to come in
every year
and take
gravel out
of the
stream.

GRAVEL BARS



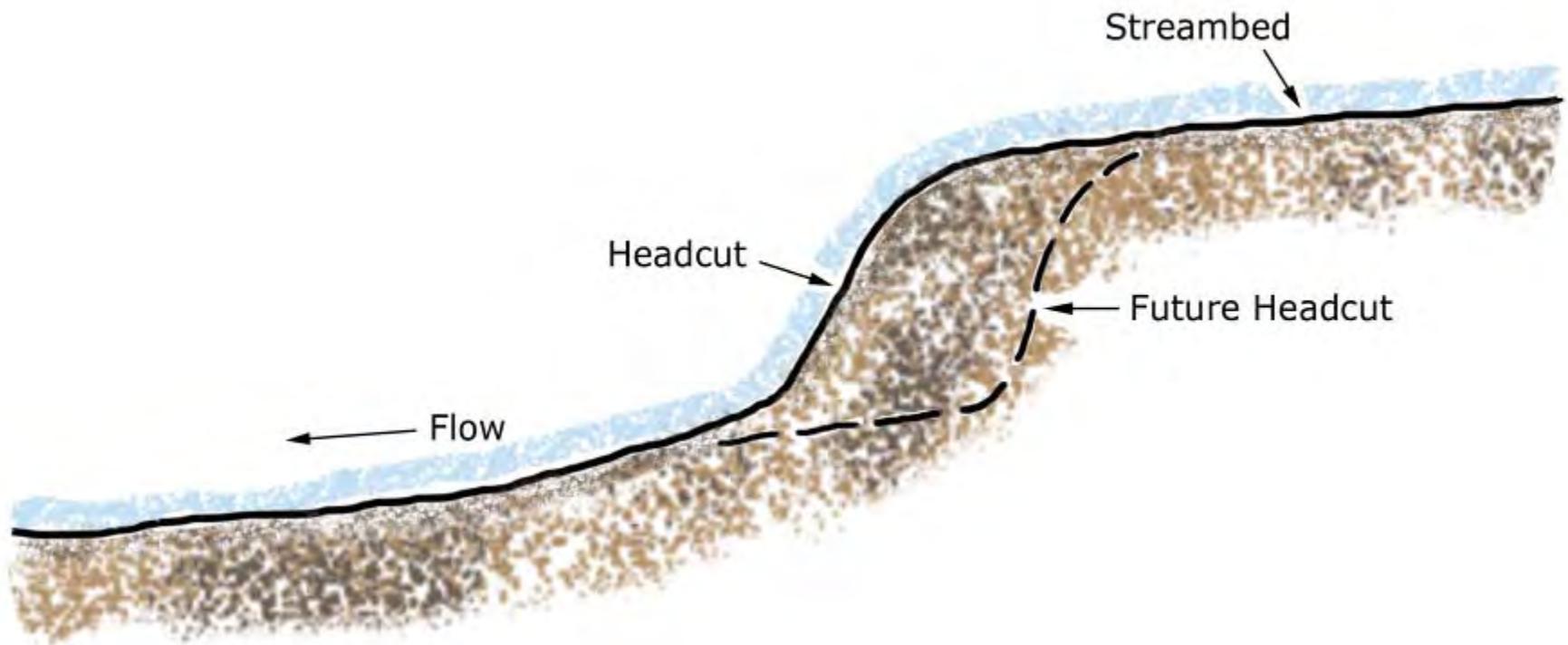
GRAVEL BARS



DREDGING



HEAD CUT



INADEQUATE SEDIMENT TRANSPORT



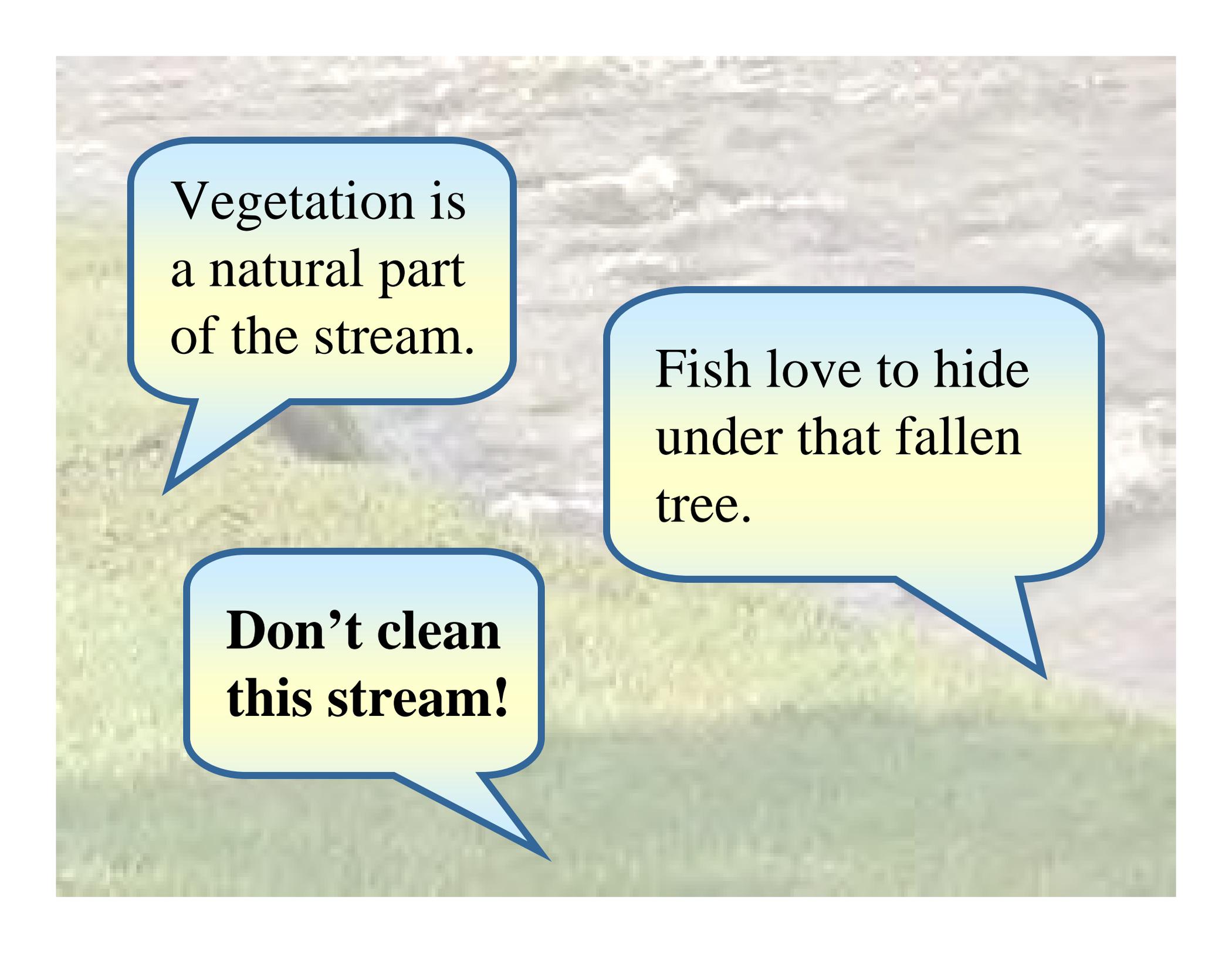
This stream segment was overwidened with bulldozers to make room for floodwater.



When my neighbor's tree fell in the creek, it started eating away at my yard.

Every time it rains, debris plugs up that culvert and then I get flooded.

Clean out this stream!



Vegetation is
a natural part
of the stream.

Fish love to hide
under that fallen
tree.

**Don't clean
this stream!**

DEBRIS

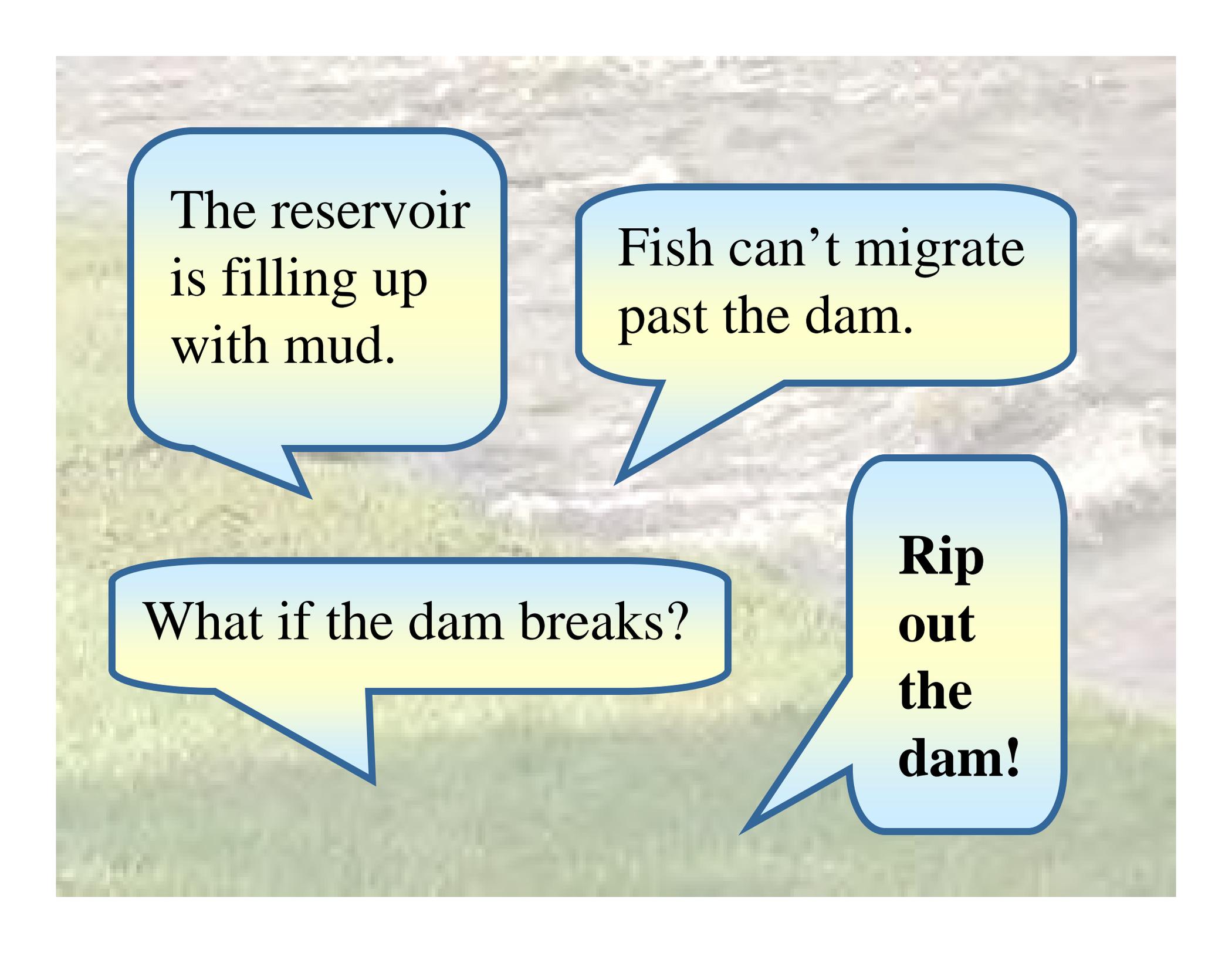




We need
dams to stop
all this
flooding.

Let's create a lake
for recreation.

**Dam
the
river!**



The reservoir
is filling up
with mud.

Fish can't migrate
past the dam.

What if the dam breaks?

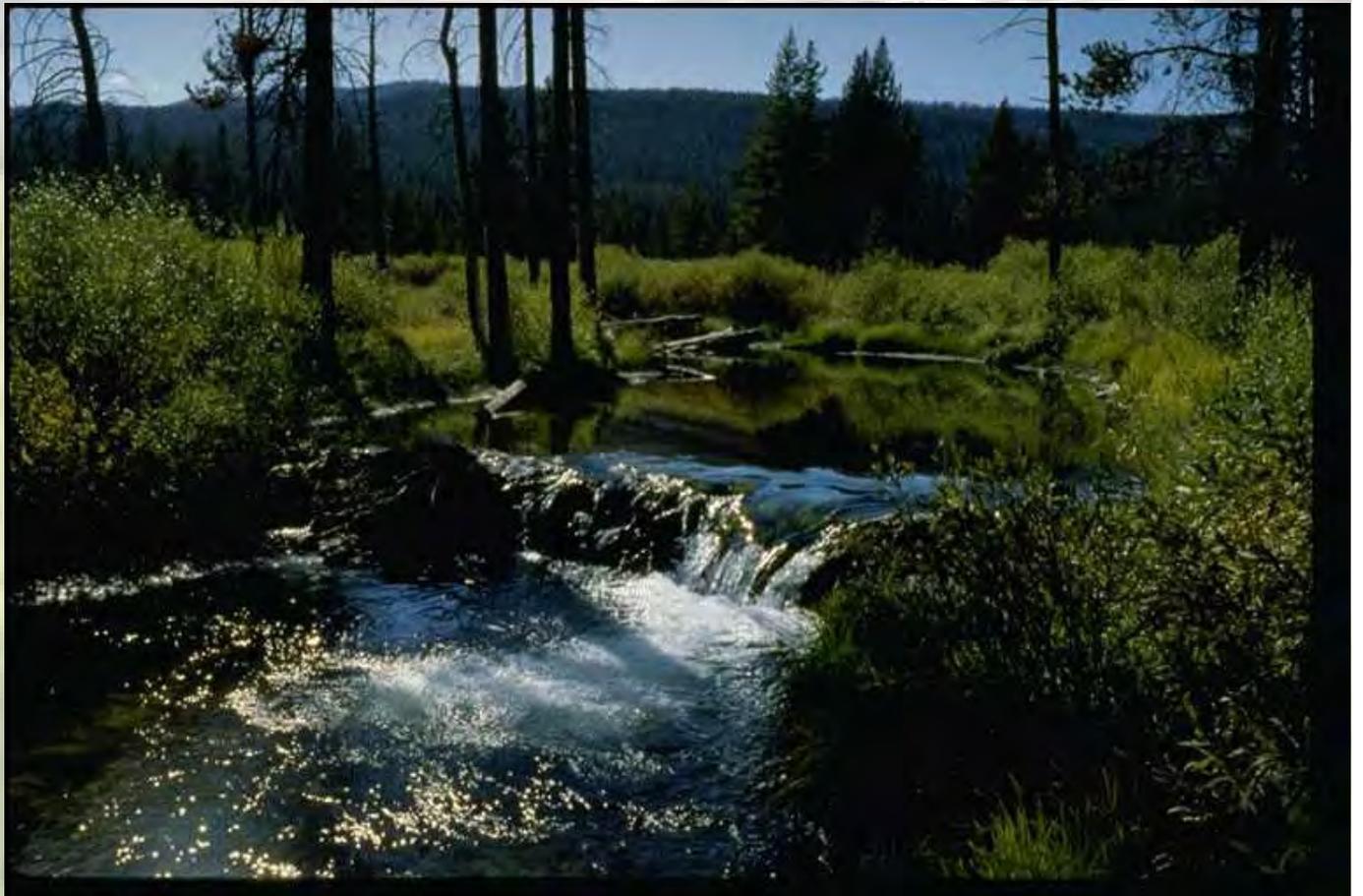
**Rip
out
the
dam!**

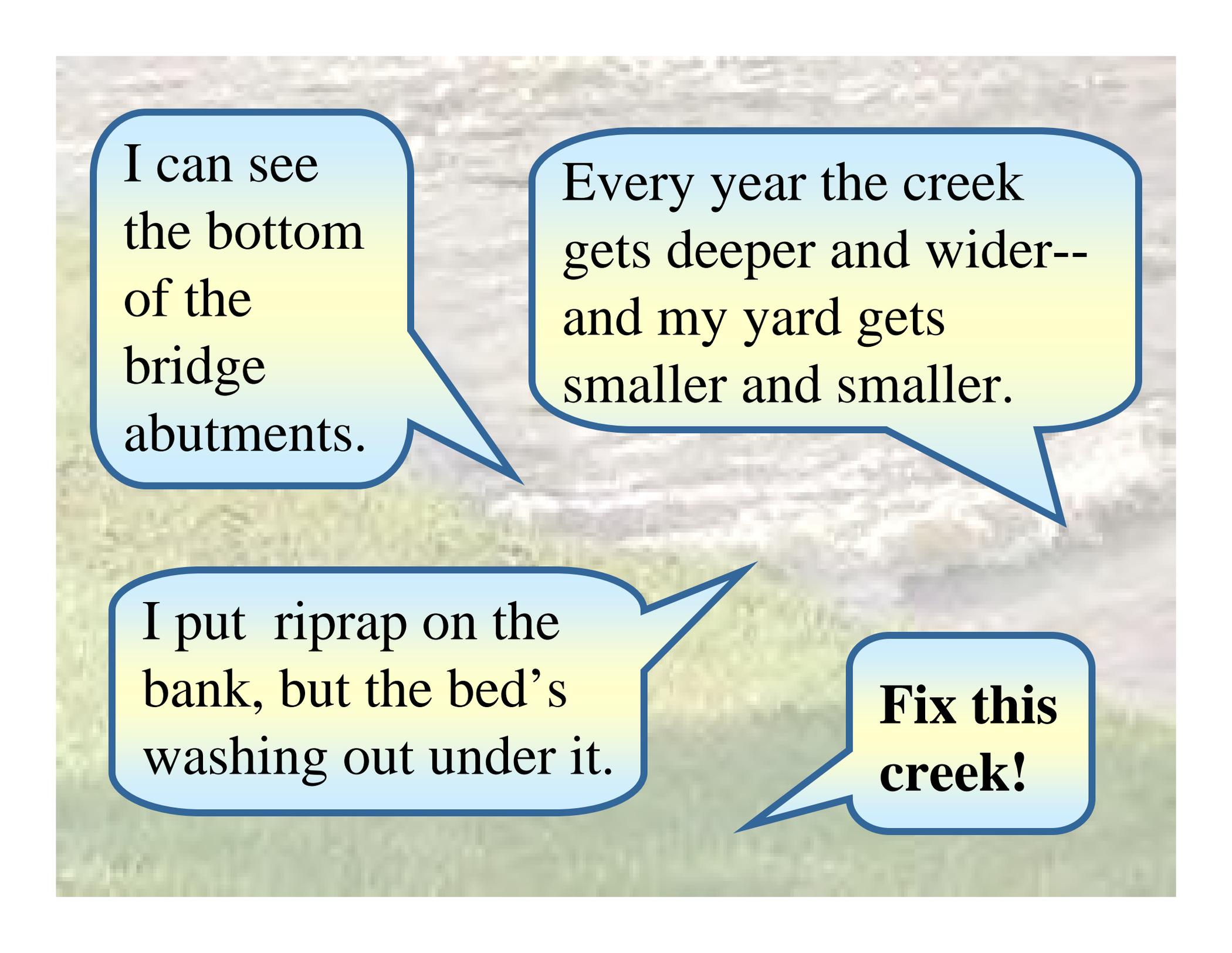
FLOOD CONTROL DAM



Beavers are making a mess of the stream. **Trap them!**

I love watching the beavers. **Leave them!**





I can see
the bottom
of the
bridge
abutments.

Every year the creek
gets deeper and wider--
and my yard gets
smaller and smaller.

I put riprap on the
bank, but the bed's
washing out under it.

**Fix this
creek!**

GRADE STABILIZATION

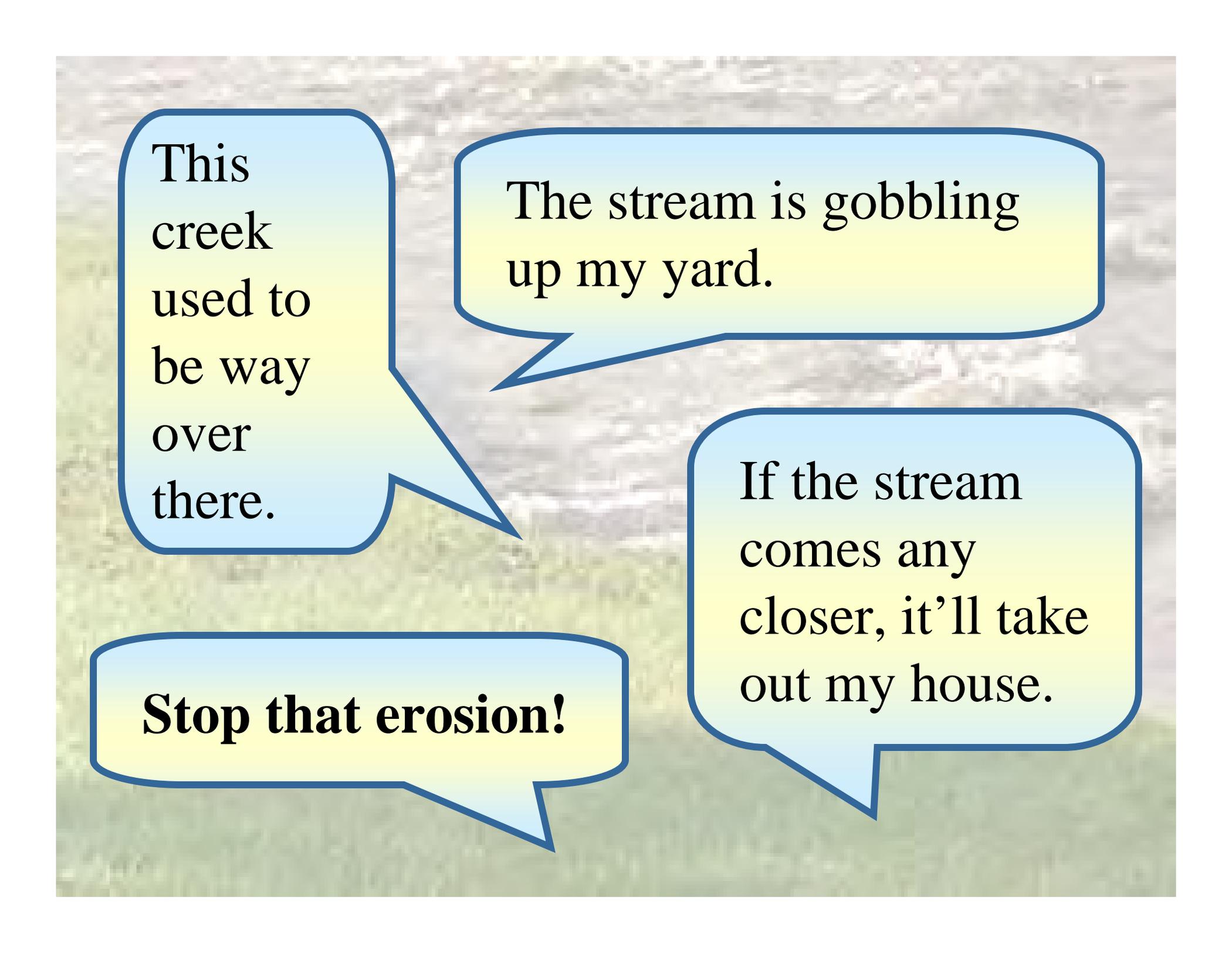


GRADE STABILIZATION



GRADE STABILIZATION





This creek used to be way over there.

The stream is gobbling up my yard.

If the stream comes any closer, it'll take out my house.

Stop that erosion!

STREAMBANK PROTECTION

Rock Riprap



STREAMBANK PROTECTION?



Failing
Rock
Riprap



STREAMBANK PROTECTION

Retaining Wall



STREAMBANK PROTECTION

Sheet Piling



STREAMBANK PROTECTION?



STREAMBANK PROTECTION

In-Stream Rock Structure



STREAMBANK PROTECTION

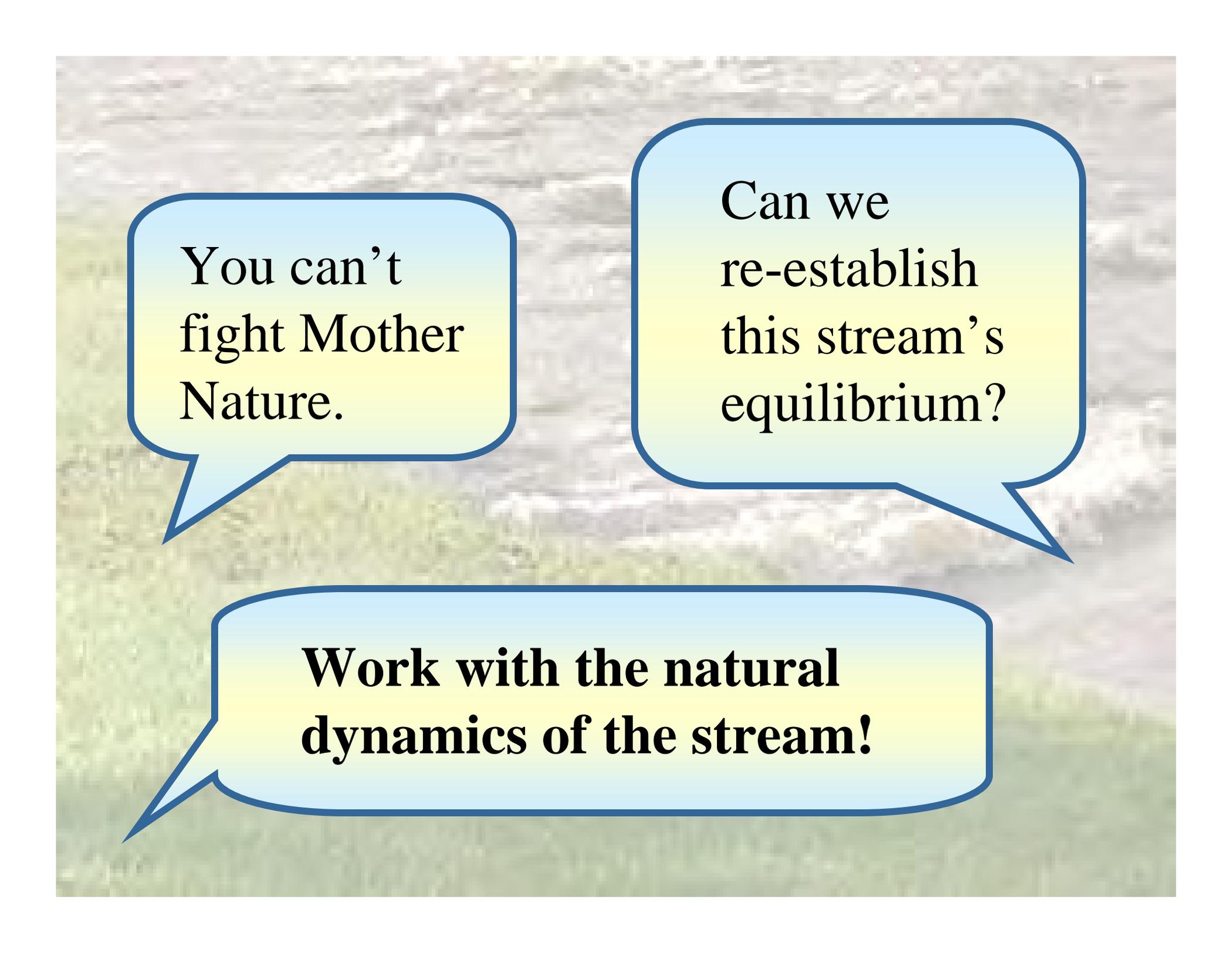
Root Wads



STREAMBANK PROTECTION

Vegetation





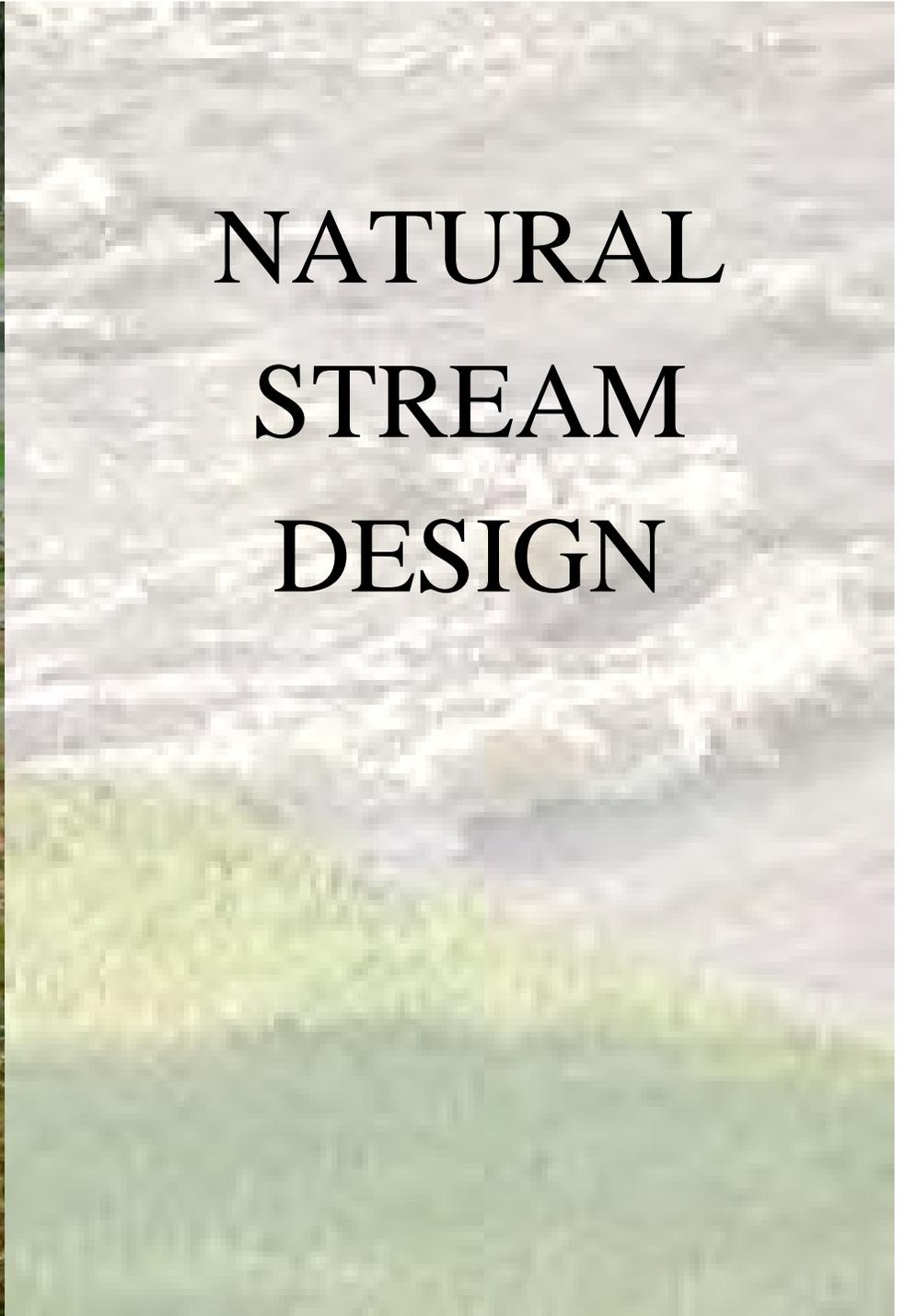
You can't
fight Mother
Nature.

Can we
re-establish
this stream's
equilibrium?

**Work with the natural
dynamics of the stream!**



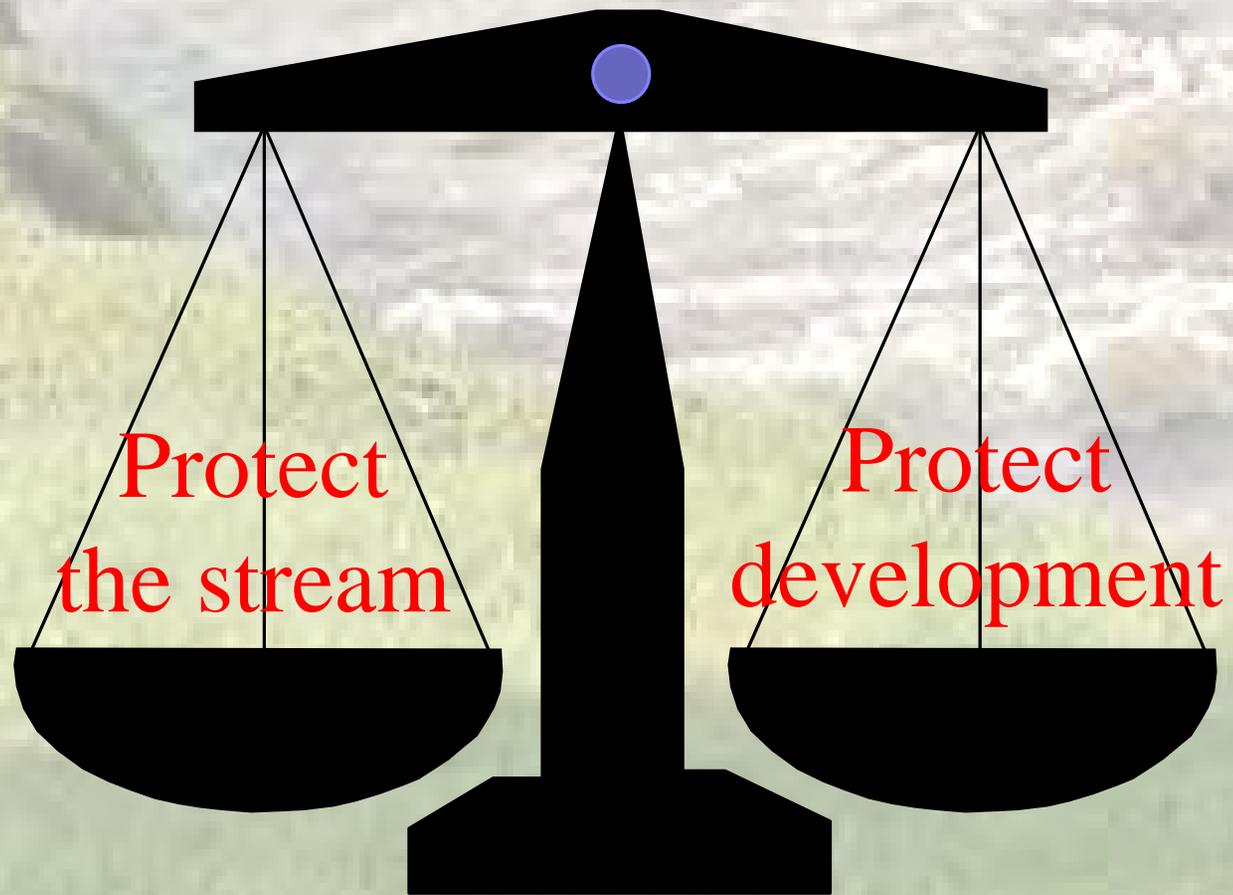
NATURAL STREAM DESIGN





UTILIZING STREAM CORRIDORS

STREAM CORRIDOR MANAGEMENT



MANAGEMENT STRATEGIES

- **Assess the opportunities and hazards**
- **Protect existing streamside vegetation**
- **Restore streamside vegetation**
- **Keep livestock, vehicles, and people away from the streambank**
- **Protect wetlands**
- **Locate buildings away from the stream**
- **Protect development from flood and erosion damage**

STREAM CORRIDOR HAZARDS



STREAM CORRIDOR HAZARDS



STREAM CORRIDOR HAZARDS



STREAM CORRIDOR HAZARDS



STREAM CORRIDOR HAZARDS



RIPARIAN BUFFER



The easiest, most effective way to protect a stream is to maintain a strip of plants along the bank.

The background of the slide is a photograph of a river. In the foreground, there is a lush green grassy bank. The river flows from the left towards the right, with white water rapids visible in the middle ground. The sky is overcast and grey.

RIPARIAN BUFFER FUNCTIONS

- **Slow water**
- **Stabilize banks**
- **Reduce erosion**
- **Deposit sediment**
- **Filter nutrients/pollutants**
- **Moderate water temperature**
- **Provide wildlife habitat/corridors**
- **Enhance the scenic beauty**

NO RIPARIAN BUFFER





**NO
RIPARIAN
BUFFER**



NO RIPARIAN BUFFER



INVASIVE PLANT SPECIES



Japanese
knotweed

FLOOD CONTROL LEVEE



*A gravel berm is **not** a flood control levee!*



FLOODPLAINS

Rivers were here long before man, and for untold ages every stream has periodically exercised its right to expand when carrying more than normal flow. Man's error has not been the neglect of flood-control measures, but his refusal to recognize the right of rivers to their floodplain..."

--Engineering News-Record, 1937

FLOODPLAINS



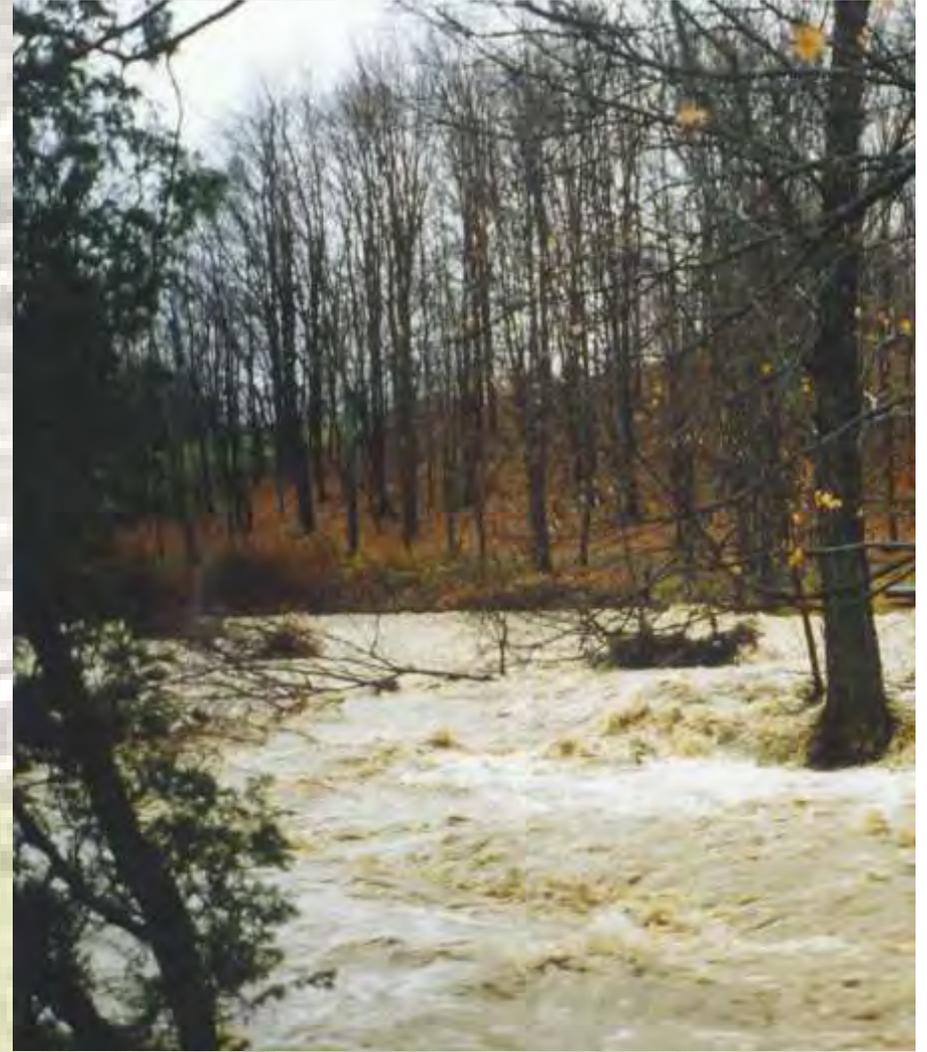
FLOODPLAIN DEVELOPMENT



FLOODPLAIN MANAGEMENT

- **Modify flooding**
- **Modify susceptibility to flood damage and disruption**
- **Modify the impact of flooding on individuals and the community**
- **Preserve and restore the natural resources and functions of floodplains**

Floodplain management strategies from *A Unified National Program for Floodplain Management*, 1994, by the Federal Interagency Floodplain Management Task Force.



The best way to protect development from flooding is to locate it out of the floodplain.

REGULATING FLOODPLAIN DEVELOPMENT



ELEVATED STRUCTURE



ELEVATED STRUCTURE



BUILDING REMOVAL



BRIDGE REMOVAL



BUILDING ELEVATION

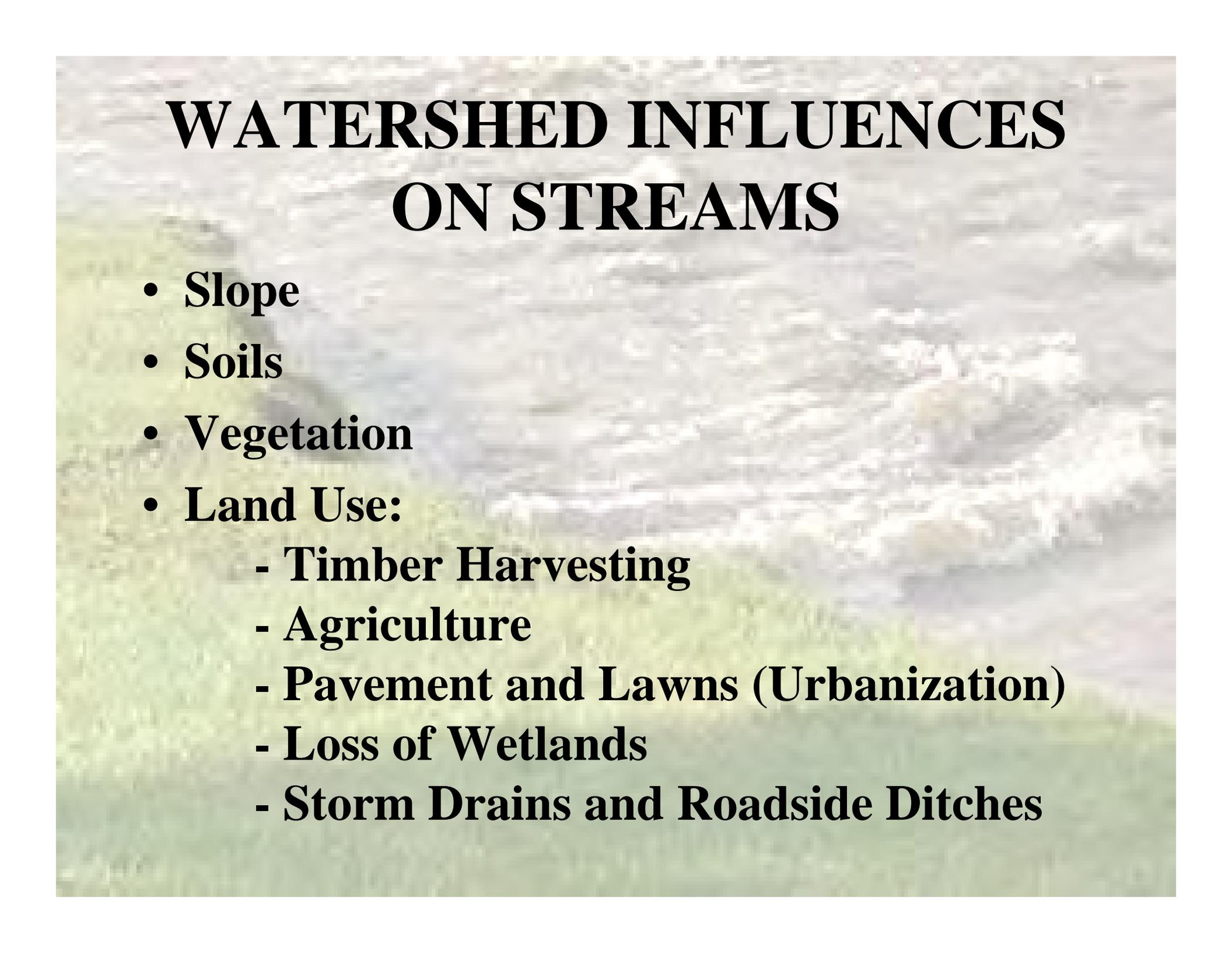


STREAMSIDE WETLAND



A photograph of a river flowing through a lush green landscape. The river is in the center, with white water rapids. The surrounding area is covered in dense green vegetation. The text "LIVING IN WATERSHEDS" is overlaid in the center in a bold, black, serif font.

LIVING IN WATERSHEDS



WATERSHED INFLUENCES ON STREAMS

- **Slope**
- **Soils**
- **Vegetation**
- **Land Use:**
 - **Timber Harvesting**
 - **Agriculture**
 - **Pavement and Lawns (Urbanization)**
 - **Loss of Wetlands**
 - **Storm Drains and Roadside Ditches**

EXPOSED SOIL





© 2002 Adirondack Museum

TIMBER HARVESTING



© 2002 Adirondack Museum

TIMBER HARVESTING



CHEMUNG COUNTY
SOIL AND WATER CONSERVATION DISTRICT

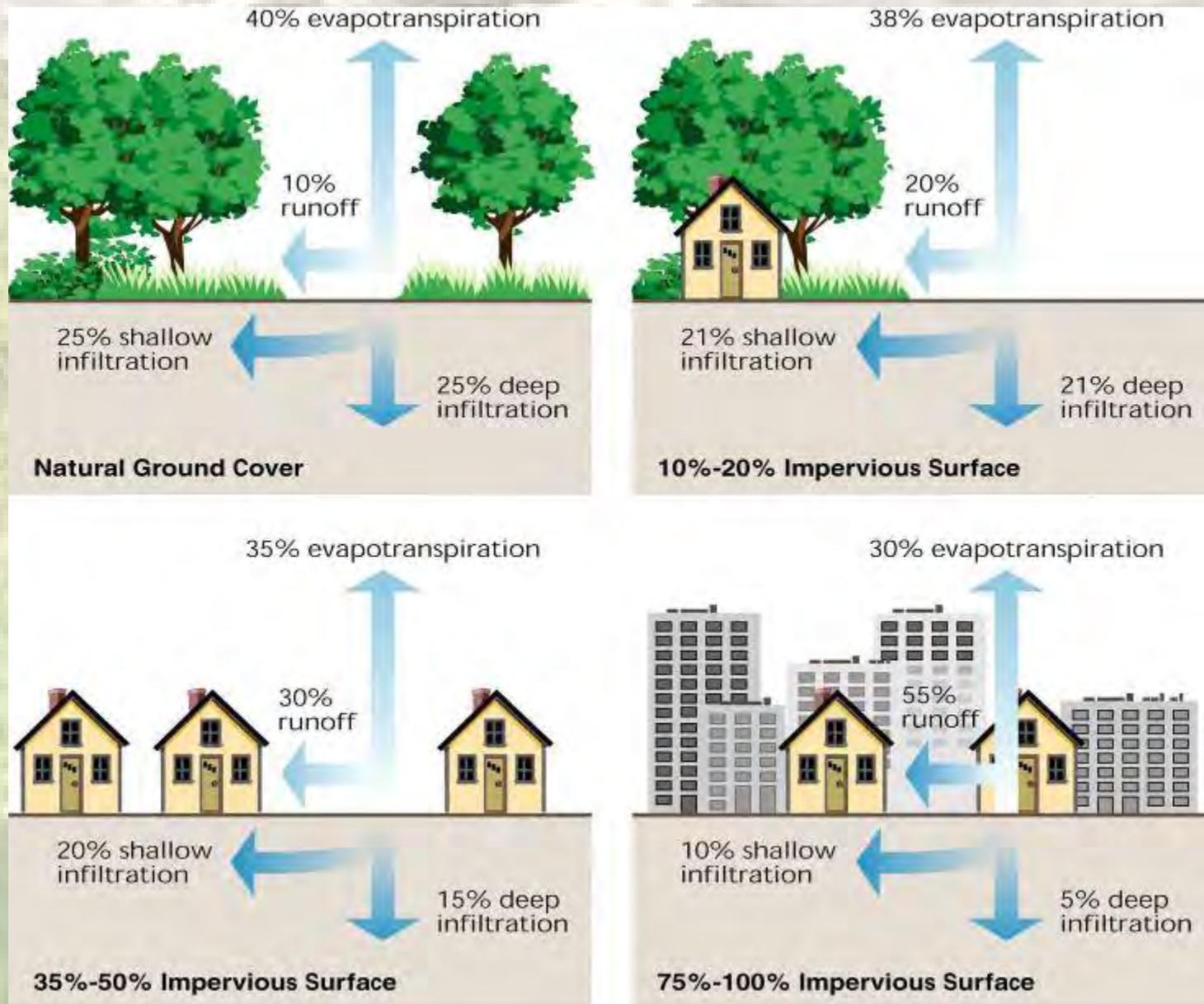
Best Management Practices During Timber Harvesting Operations



AGRICULTURE



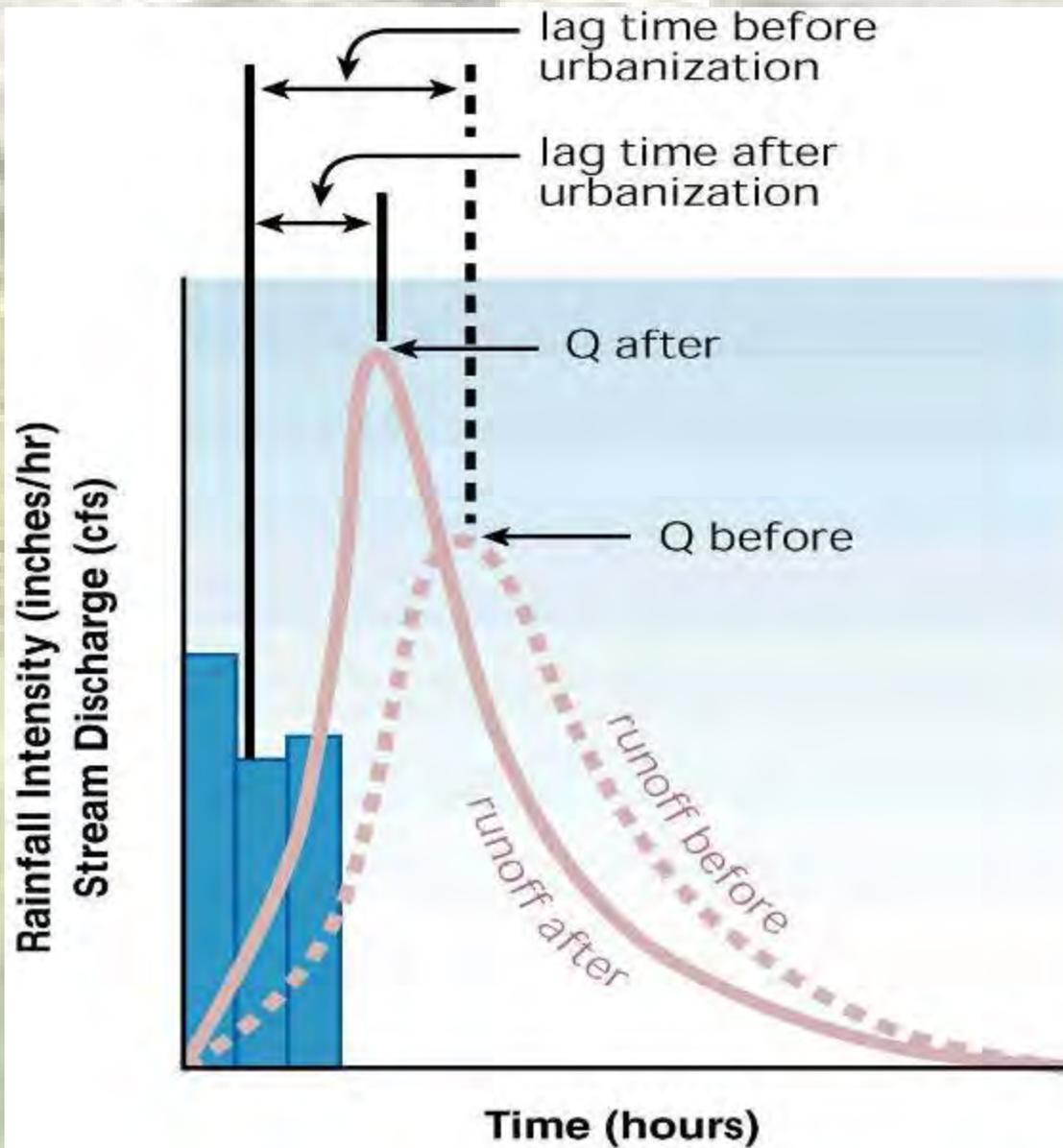
URBANIZATION



URBAN DEVELOPMENT



URBANIZATION



DEVELOPMENT IMPACTS



DEVELOPMENT IMPACTS



STORMWATER MANAGEMENT



ROADWAY DRAINAGE



ROADWAY DRAINAGE



WETLANDS



WATERSHED STEWARDSHIP



We all benefit when private landowners take care of the land and water.

CONSTRUCTED WETLAND



LEGAL ISSUES

The government won't let me do anything with the stream.

DO YOU NEED A PERMIT?

- **NYS Department of Environmental Conservation**
- **U.S. Army Corps of Engineers**
- **NYS Adirondack Park Agency**
- **Local Government – Floodplain Development Permit**
- **Local Government – Land Use Regulations**
- **Property owner**
- **Easement or Right-of-Way**

OWNERSHIP

- **Who owns the streambed?**
 - Navigable -- New York State**
 - Non-navigable -- Riparian land owner**
- **Who owns the water in a stream? No one**
- **Who has the right to use water in a stream?**
 - Riparian property owners**
- **Do river basin commissions grant water rights? No**
- **Who is responsible for the stream?**
 - Landowner**

LIABILITY

- **If flooding occurs or gets worse after a stream has been modified (by diverting flow, modifying the channel, constructing a bridge, etc.), is the person who made the modification liable for damages?**

Yes, quite possibly

- **May someone be held liable for failing to remedy a natural hazard that damages adjacent property?**

Sometimes

LIABILITY

- **Can liability arise from failure to reasonably operate and maintain a bridge, drainage structure, dam, or flood control structure?**

Possibly

- **May a regulatory agency be liable for issuing a regulatory permit for an activity that damages other private property?**

Yes, quite possibly

LIABILITY

- **May governmental units be held liable for refusing to issue permits in floodways or high-risk erosion areas because the proposed activities could damage other lands?**

No

- **What precautions can be taken to avoid liability?**

Be “reasonable”