Habitat and Healthy Functional Watersheds are the Key to Healthy Trout Populations

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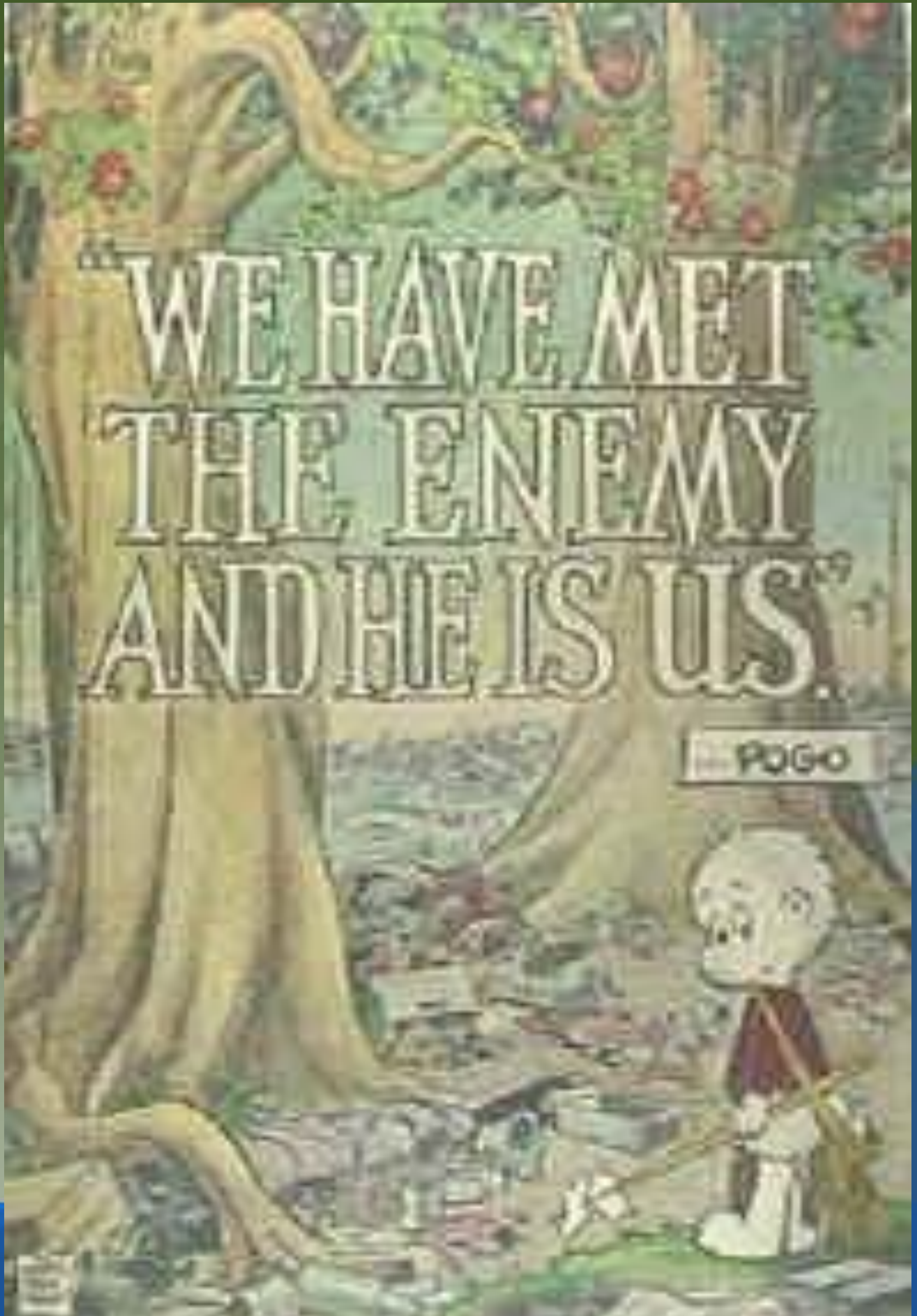
Presentation Outline

- The overarching issue
- What is a watershed?
- How do watersheds work?
- Relationship between watersheds and their rivers
- Human uses and Climate Change impacts
- Brook Trout and the watershed
- Moving towards sound solutions

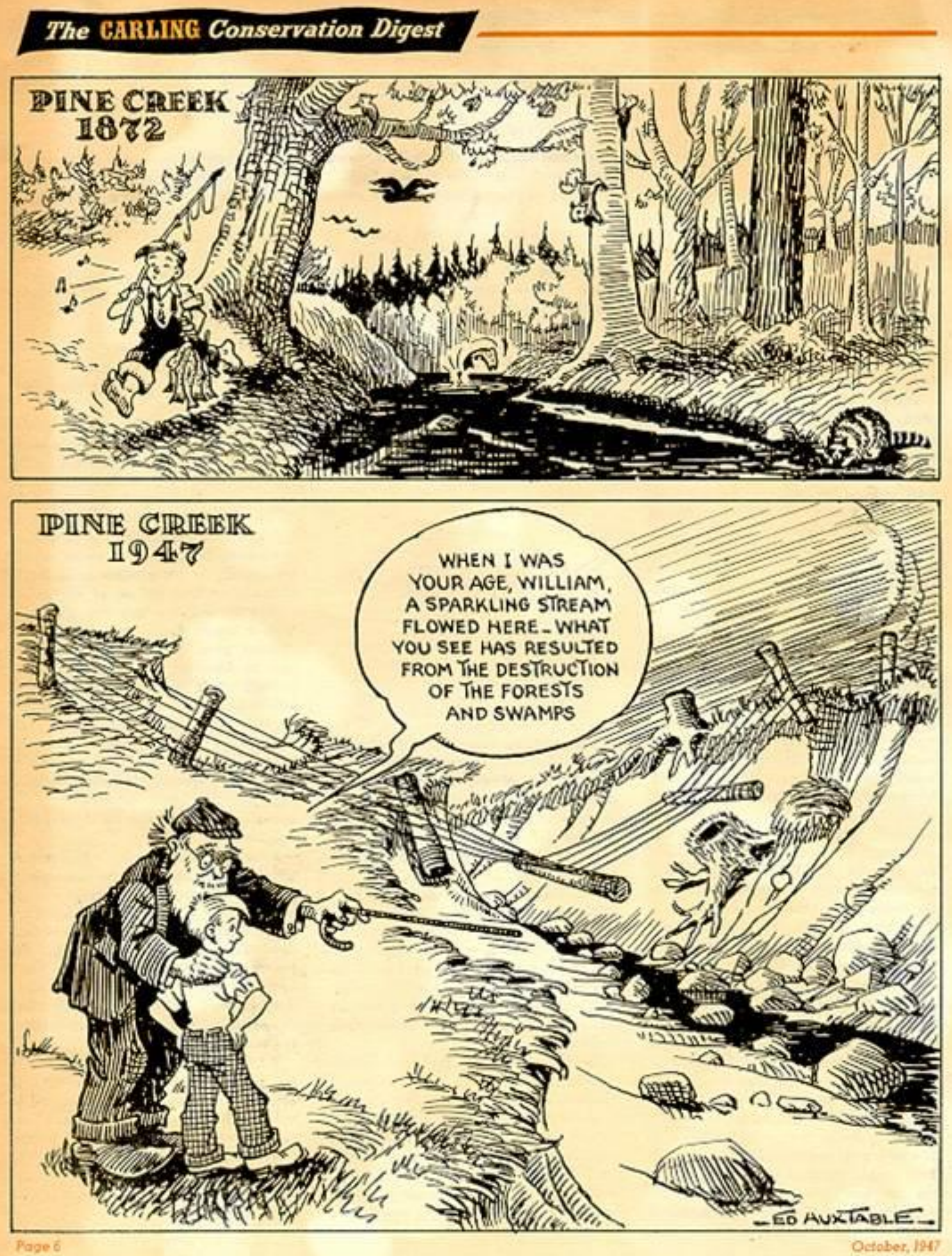
THE CHALLENGE…



Who says we don't know any better?

What do we need to know to move forward?

(Carling Conservation Digest – October 1947)



What Is A Watershed?

A Watershed is the area drained by a specific river system.

It includes both the land and water drained by the river system and in many cases includes the shallow groundwater table as well.

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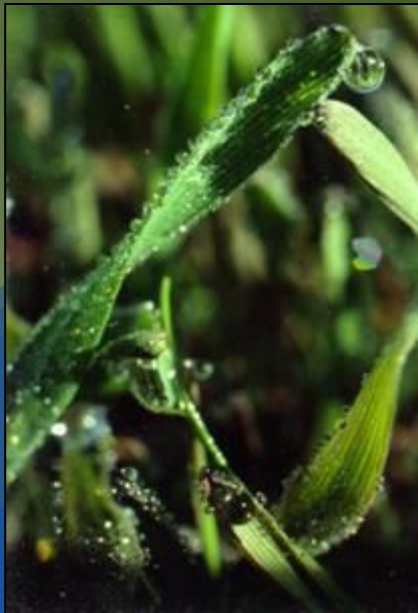
Geology provides the rock and structure

Climate creates the weather, weathering and water

Vegetation modifies water flow over and through the watershed

The site creates the channel form that provides habitat and stability

The valley directs and concentrates surface and groundwater



All These Pathways And Interactions Result In:

- The character of our local water resources and;
- The health of our local streams

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Geology And Fish Communities

Warmwater Communities

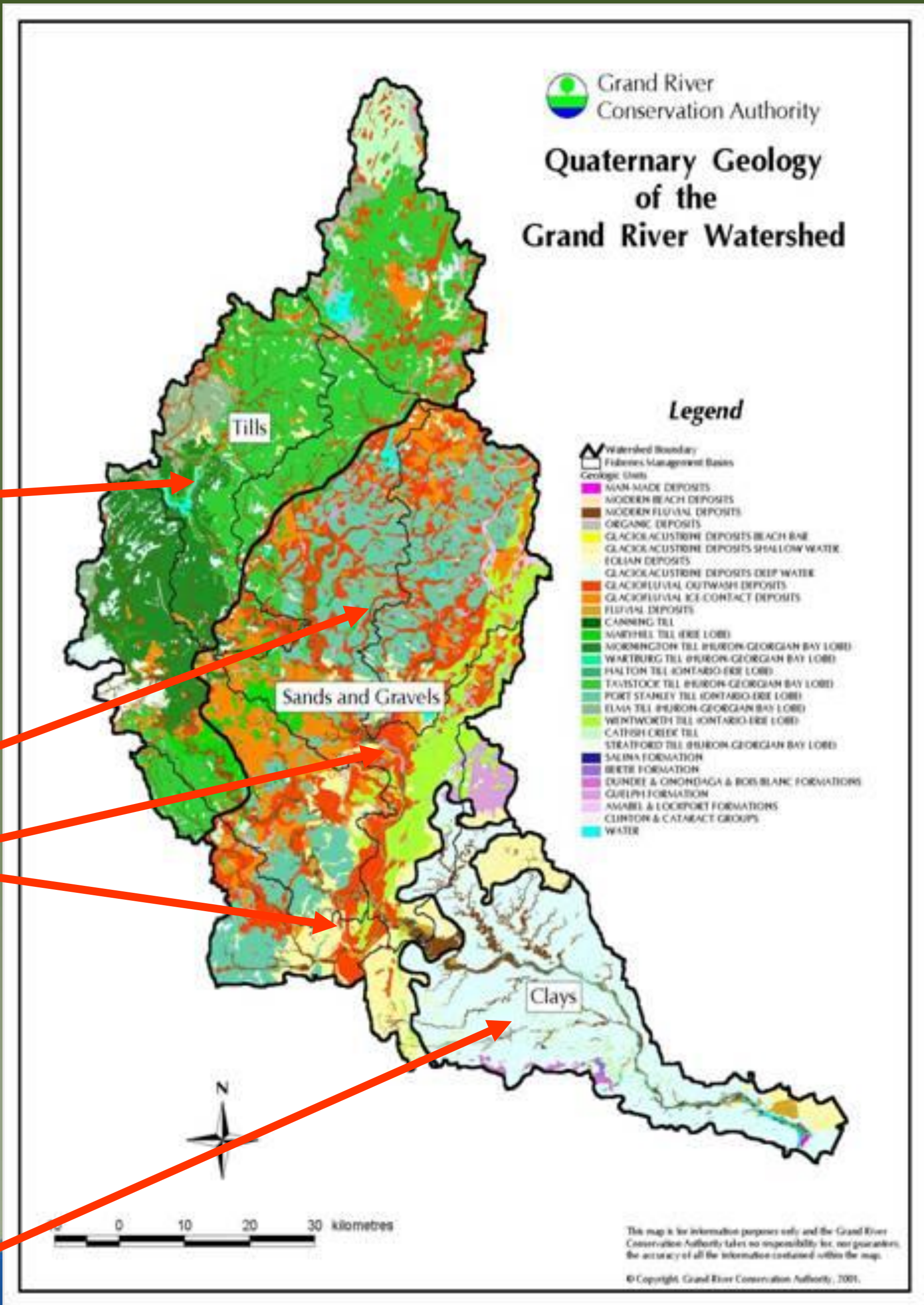
Geology creates the potential for the distribution of specific fish communities

Mixed Water

Coldwater Communities

(information from Grand River Fisheries Management Plan document 1998)

Warmwater Communities



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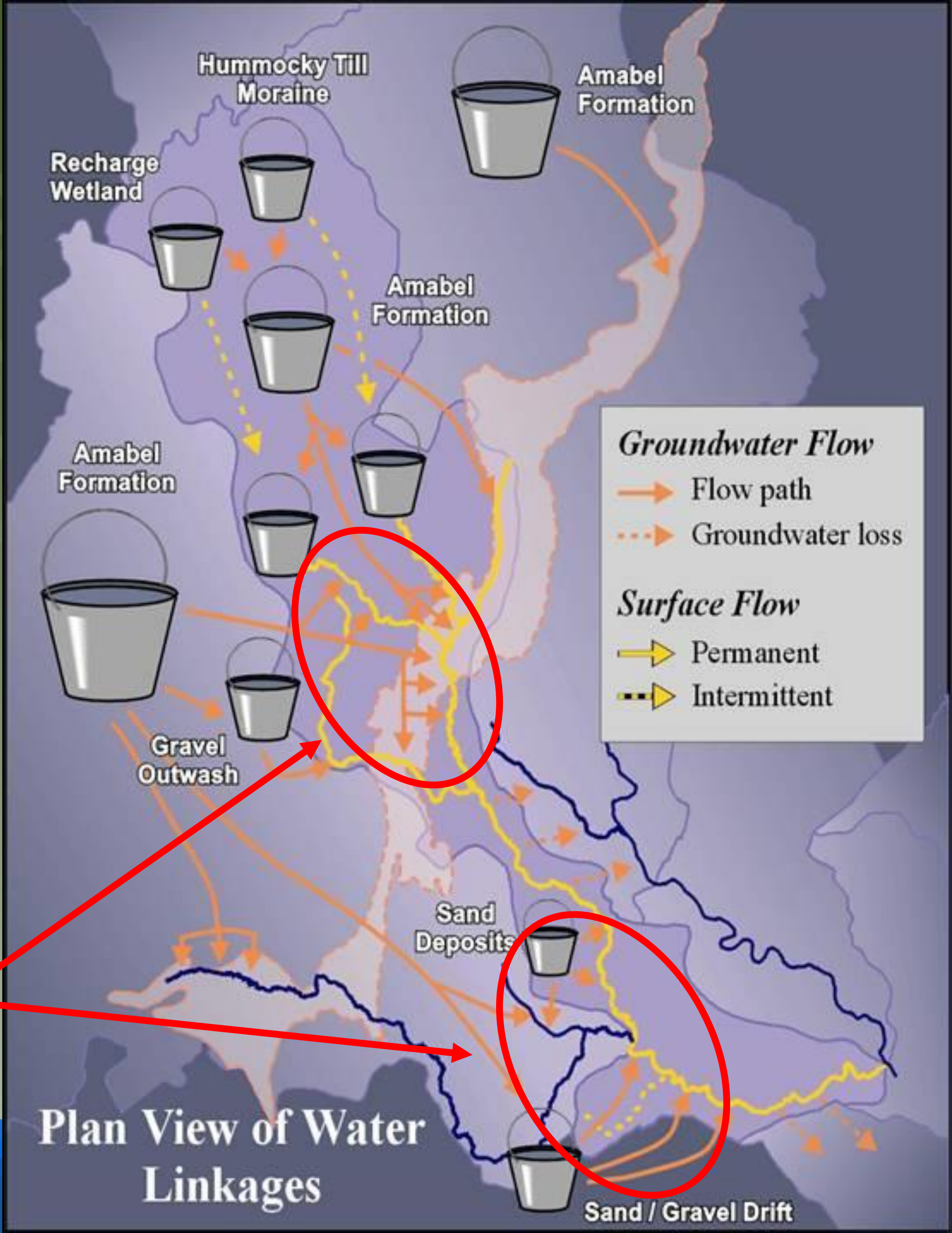
Buckets And Pipes

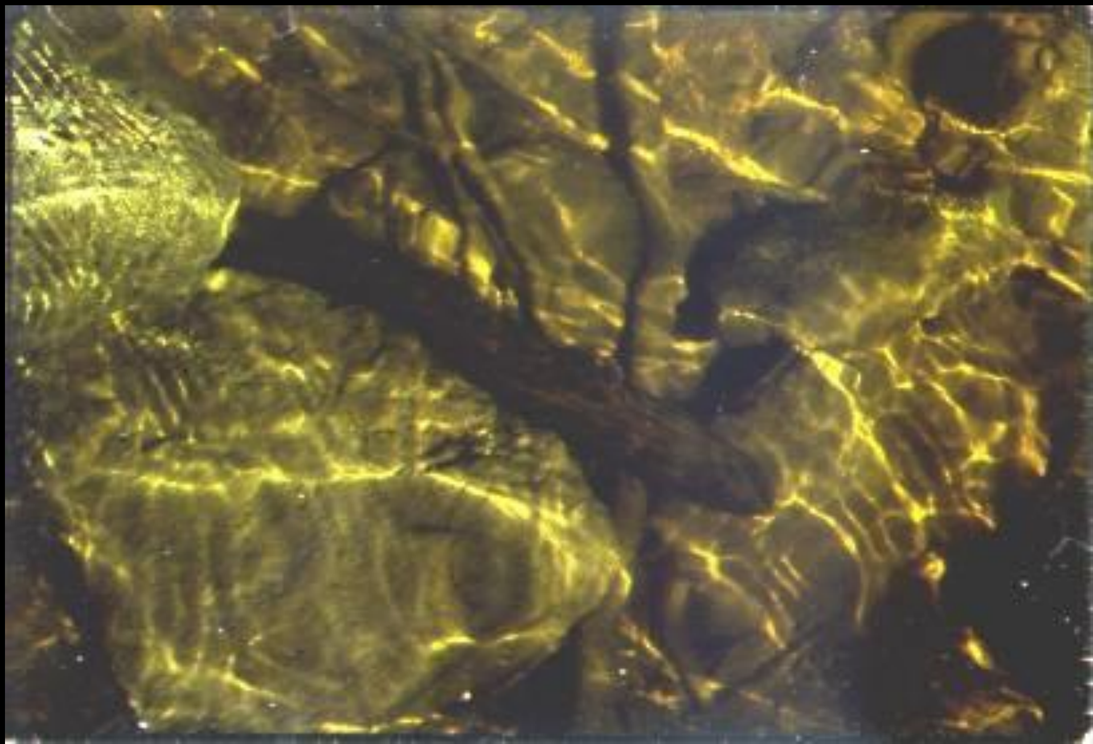
We can use buckets and pipes to represent the storage structures and pathways by which water moves over and through the Silver Creek Watershed a coldwater stream in Halton Hills, ON.

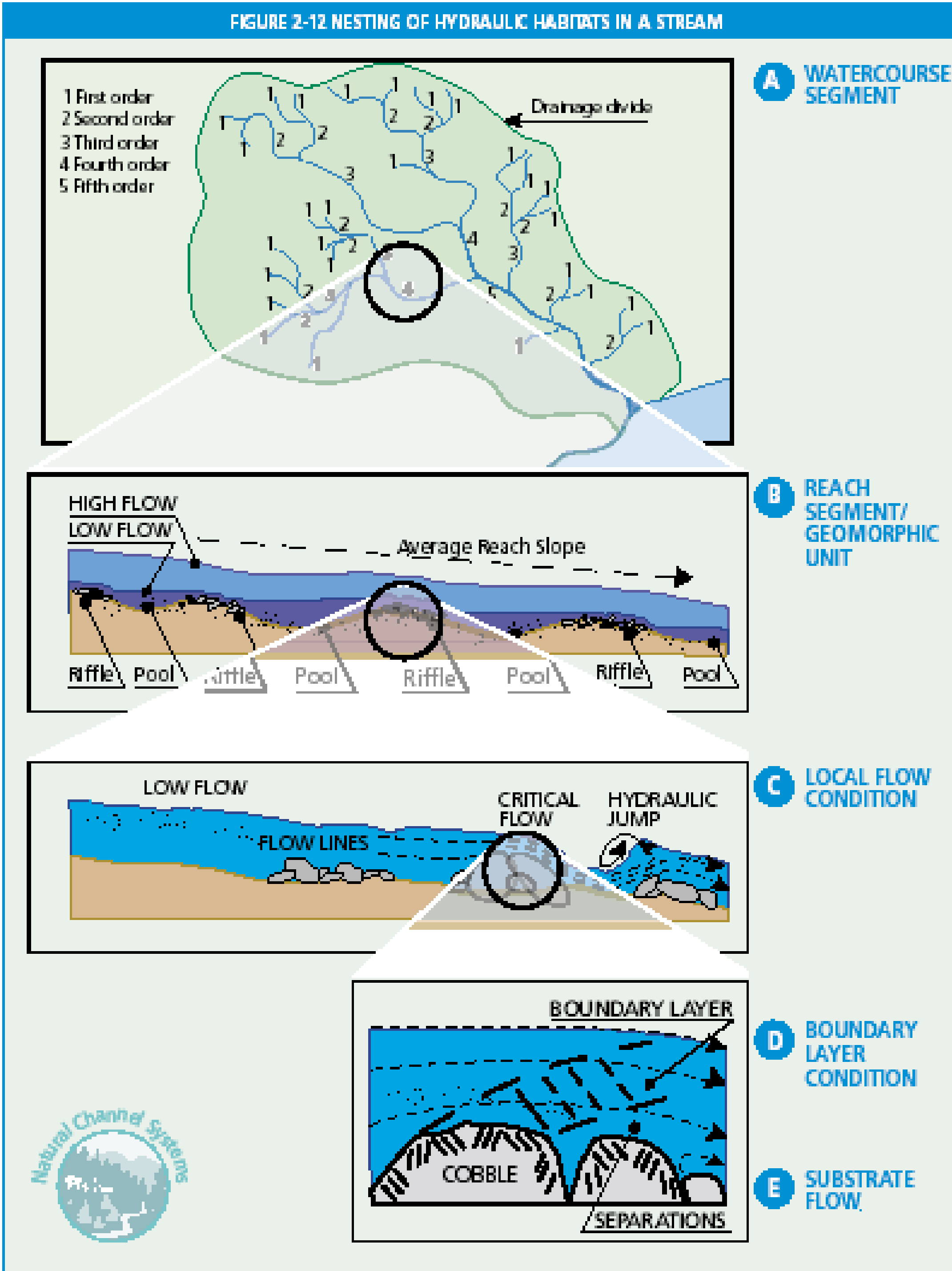
Major discharge areas and Major Brook Trout Spawning Areas



Rivers are the Children of the Watershed.

Fish are the Children of the River.





ANIMALS OPERATE AT MULTIPLE SCALES (e.g. migration, feeding, reproduction).

At a site or local level, look upscale to understand the reach and location in the watershed and downscale to examine the specific hydraulic features

From: Newbury and Gaboury 1993

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Streams and Their Corridors

Most people think of river habitat at low flow, however…..

It is the high flow events that create the habitat we see at low flow.

The Formative flows cumulatively adjust the shape and structure of the channel.

The structure and shape of the channel at lowflow confines and controls the relative quality of habitat for fish.

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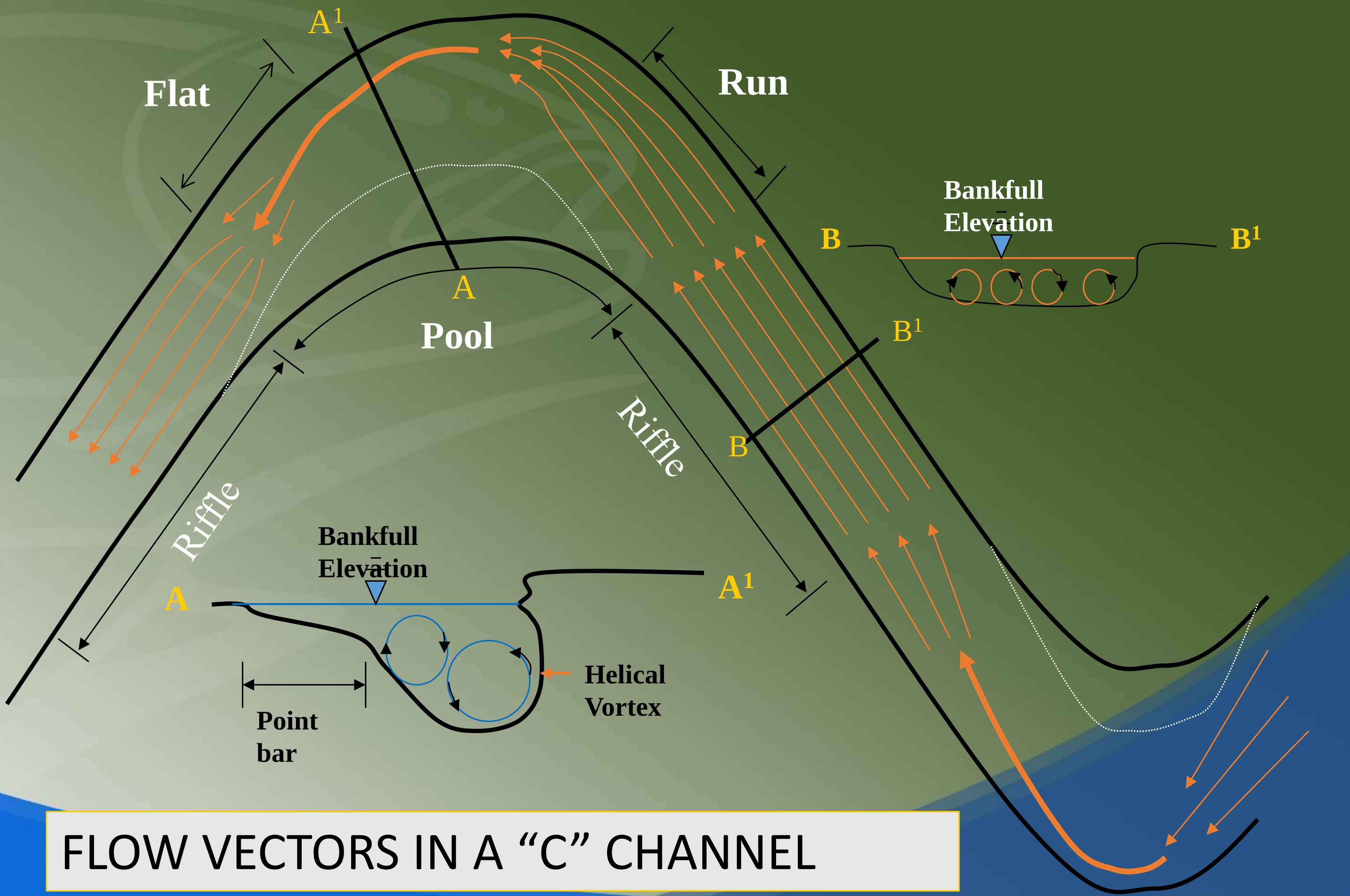

FLOW VECTORS IN A "C" CHANNEL

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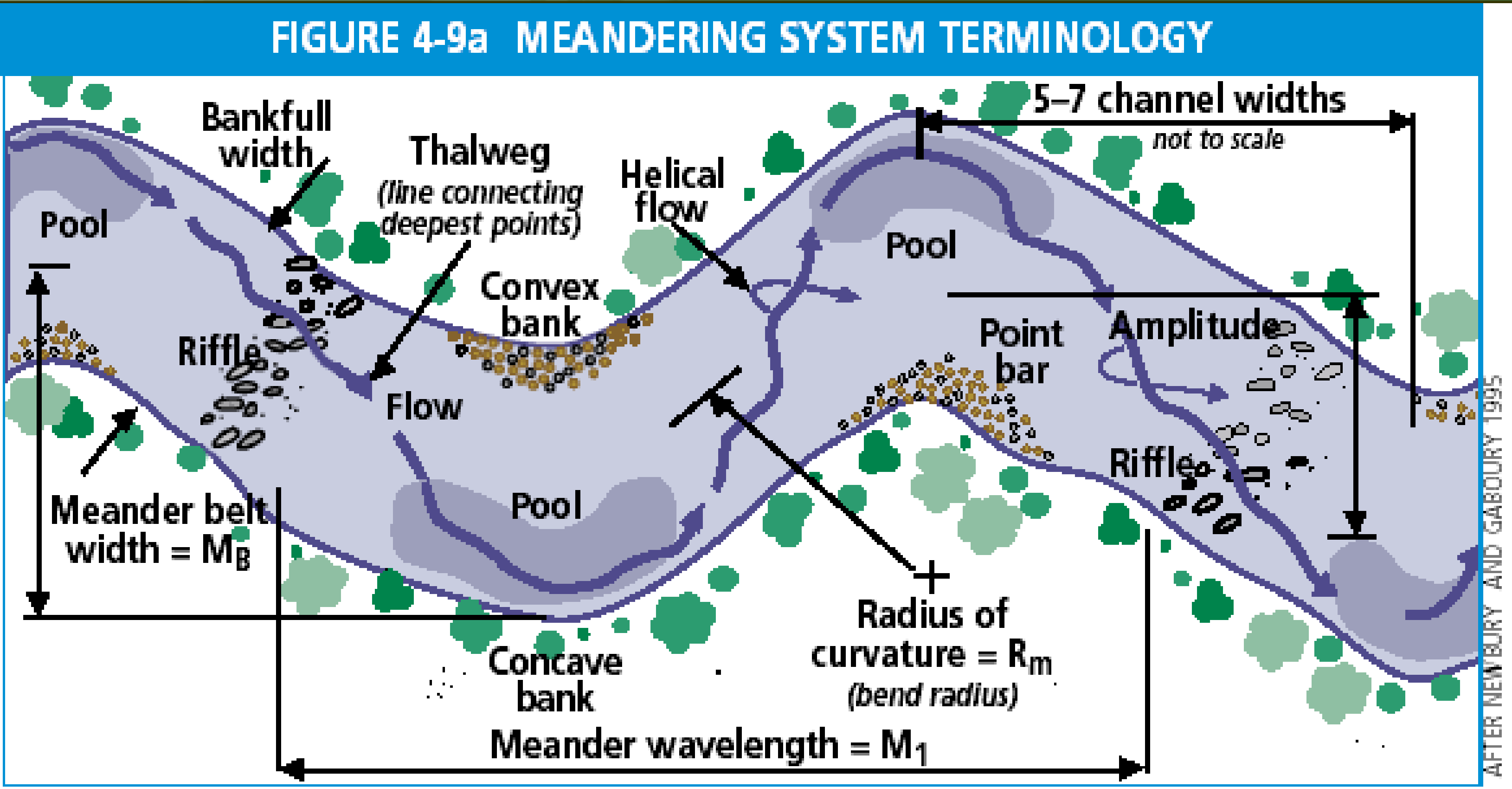
Rivers Create Repeating, Physical Sequences



This sequencing is called the rivers Hydraulic Geometry

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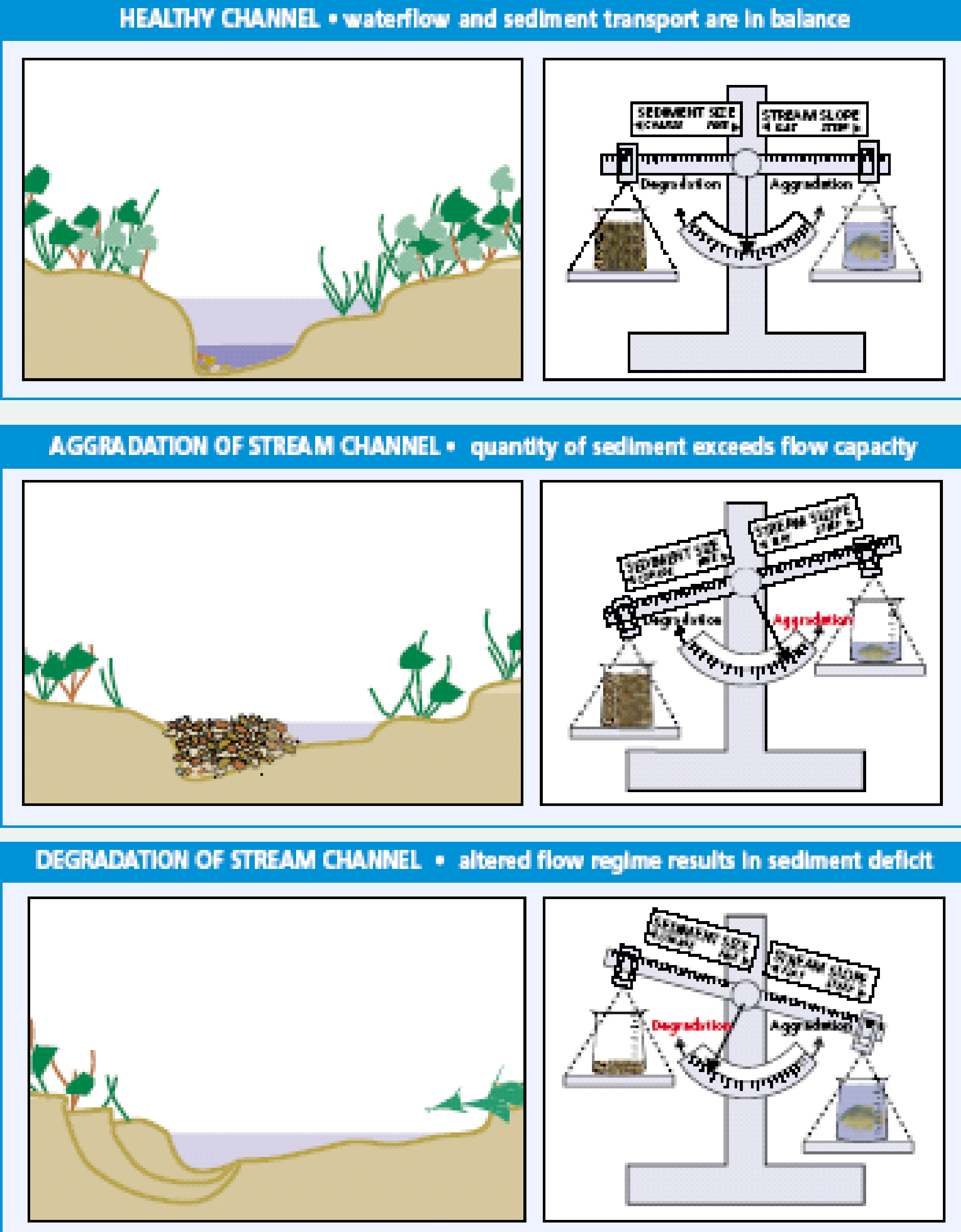

A “Stable” river channel is one in which features change over time, but the form remains constant. These Channels should be said to be in “Steady-state Equilibrium”.

In these circumstances, water and sediment loads are in balance.

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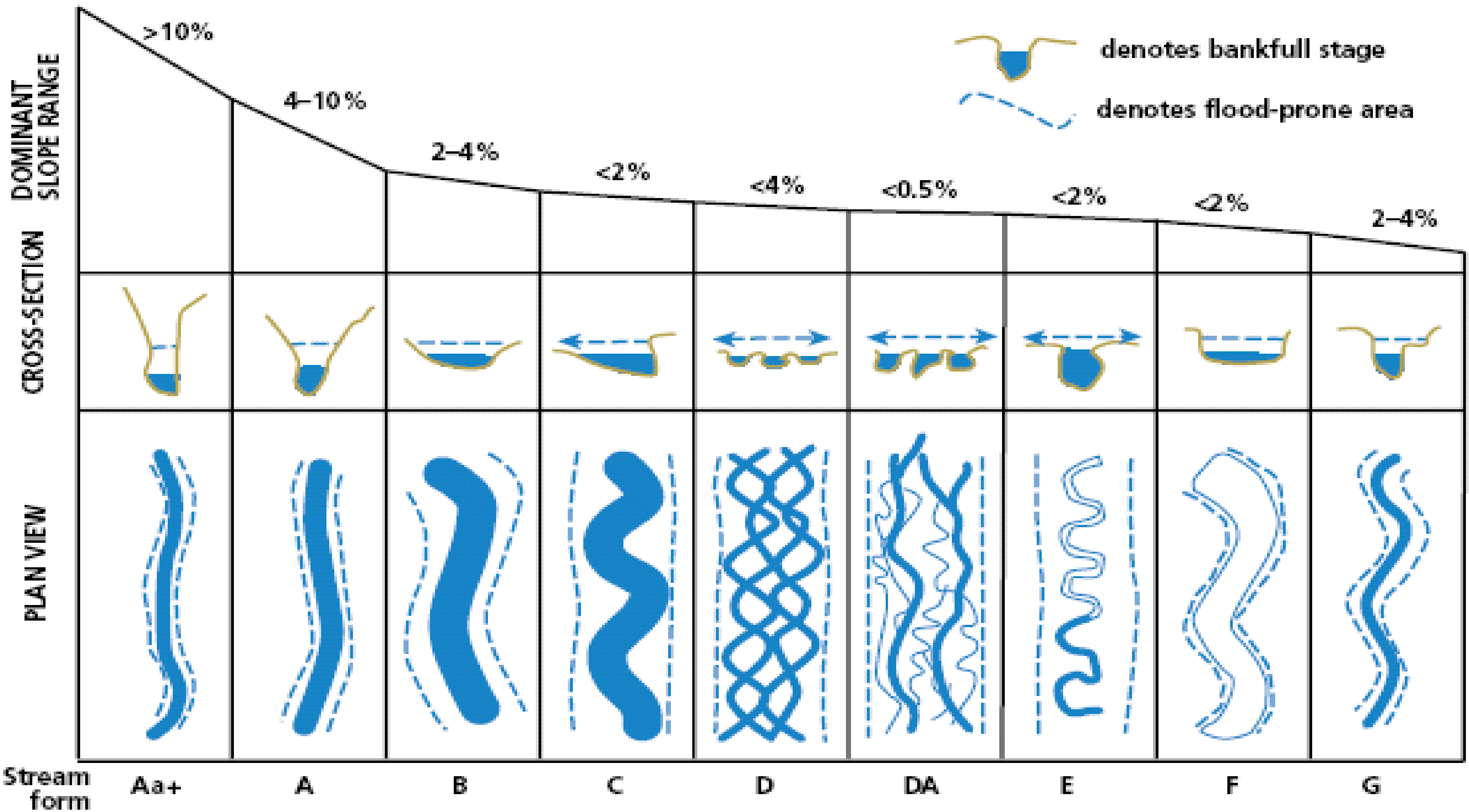
FIGURE 4-9b: ILLUSTRATION OF STREAM CLASSIFICATION TYPES (ROSGEN 1996)



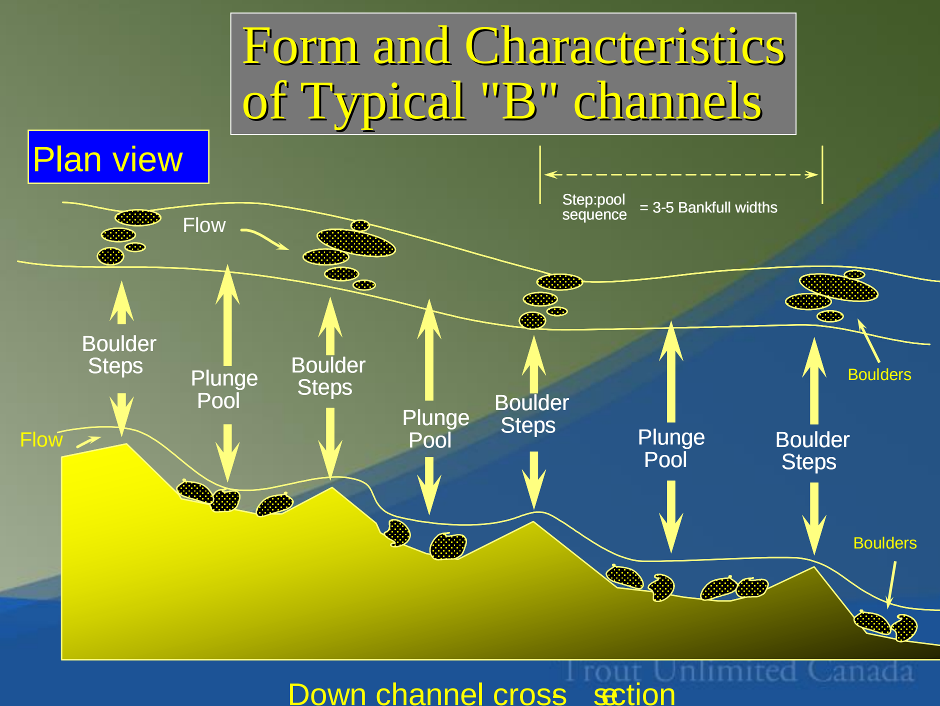
FORM: Slope, width : depth ratio, sinuosity, and entrenchment are the dominant determinants of form.

AVERAGE PARTICLE SIZE: The other part of the classification is the identification of the average substrate size of the riverbed. There are six particle sizes: Type 1 is bedrock; Type 2 is boulder (250 mm +); Type 3 is cobble (62.5–250 mm); Type 4 is gravel (2.0 – 62 mm); Type 5 is sand (0.062 – 2.0 mm); Type 6 is silt (<0.062 mm).

A STREAM TYPE is classified by the form it takes (i.e., A–G) in combination with the average particle size type. Therefore a C4 channel has a modest meander pattern, a mild gradient, active floodplain and a streambed with gravel as the average size particle.

Higher Gradient, “B” Channels provide extensive cover for juvenile and adult brook trout, but rarely spawning habitat

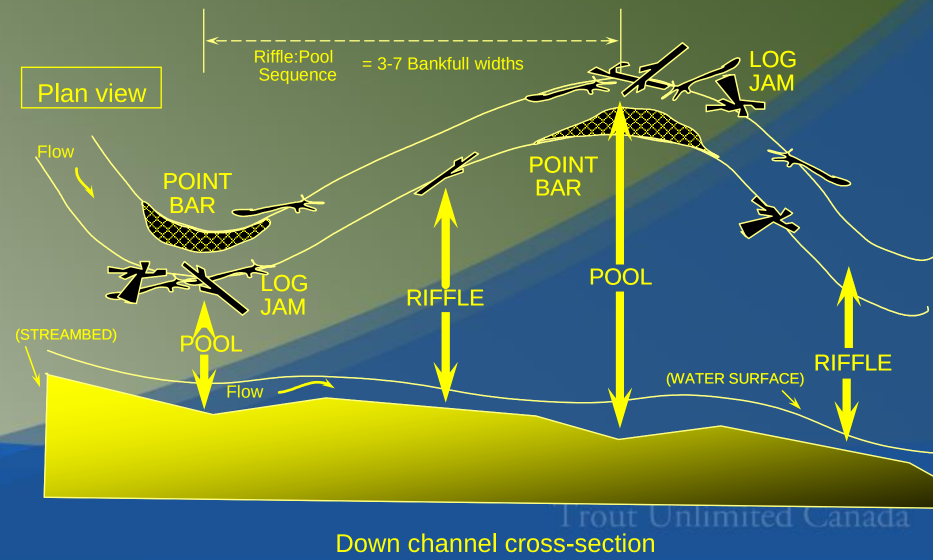
These channel forms dissipate energy, mostly vertically, creating “pocket water”. One main limitation is that they do not provide reproductive habitat for most species of fish.



"C" channel forms are our typical Riffle:Pool streams, providing shallow, long riffles, deep pools with wood debris and diverse, good habitat for brook trout

These stream types dissipate energy in two major directions, vertically and horizontally. Therefore the repeat sequence is longer. These are the most typical forms around the world. Most freshwater fish likely evolved in these types.

Form and Characteristics of Typical "C" Channels



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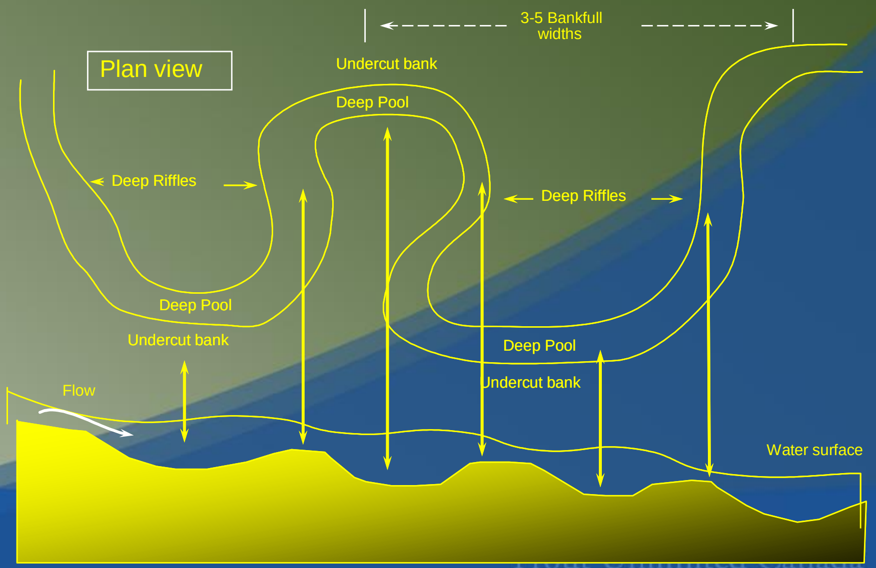
"E" Channels are extremely narrow and deep creating enormous amounts of habitat for juvenile and adult brook trout and often ideal spawning habitat

These channels are found in flat bottomed valleys in wetlands. They dissipate energy purely through lateral roughness at high flows. The channel is held together by the deep roots of wetland shrubs and grasses. They are ideal for only a few specialized fish species (e.g. brook trout in groundwater rich zones).

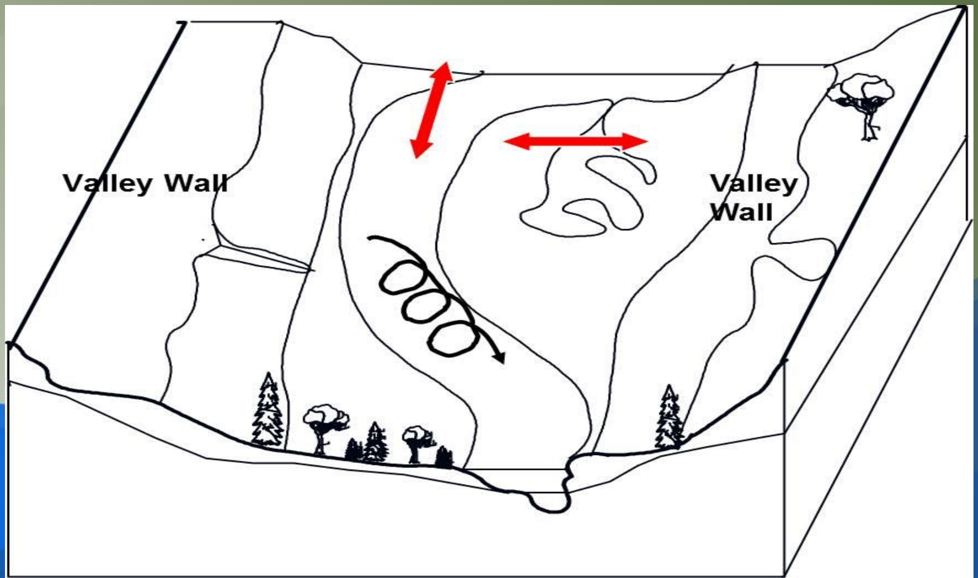
FORM AND CHARACTERISTICS OF TYPICAL "E" CHANNELS



Down channel cross-section

The Stream Corridor

- Critical link between the river and its riparian zone and floodplain;
- Riparian systems improve bank stability’
- Riparian systems provide organic matter for nutrients and structure;
- Riparian systems transform and store nutrients



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STREAM AND ITS' VALLEY

"A stream is only as healthy as the valley through which it flows".

H.B.N. Hynes (1975)
Edgardo Baldi Lecture to SIL

LAND:WATER LINKAGES

Healthy riparian zones encourage the river to develop a narrower, deeper profile creating excellent channel heterogeneity (i.e. deep pools; shallow riffles) and greater competency in moving water AND sediment

Functional Features of Riparian Lands

- Riparian Lands Can Provide a Number of Functions:
  - Flow Management
  - Channel Shape and Bank Stability
  - Capture and Transform nutrients and clean the water
  - Food Source, migration corridors, habitat for the all varieties of life

People and the Watershed

Land Use Activities

- Residential
- Institutional
- Recreational
- Vacant
- Commercial
- Industrial
- Agricultural
- Transportation
- Government

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Various Issues with Landuse

- Nutrient Loading
- Sedimentation
- Channel Widening

- Nutrient Loading
- Pharmaceuticals
- Thermal

- Thermal Heating
- Connectivity
- Sediment Transport Issues

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Major signs of Channel Degradation

Degradation leading to channel widening to create a new floodplain

Fracture Lines/Bank Slumping

channel aggradation leading to braiding and widening

Single thread to multiple channel – aggrading?

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Landuse Changes Potential Consequences

- These create changes in water quality, water quantity, channel health, erosion, flooding, fish communities, etc.
- Results of these transitions on river systems include:
  - Δ Nutrient Cycling
  - Δ Channel Morphology
  - Δ Temperature Regime
  - Δ Habitat Conditions

Thermal Pollution & Watershed Connectivity

Old obsolete mill dams create enormous temperature heating in streams, causing thermal pollution in the summer….

Resulting in degrading water quality and the loss of coldwater streams…

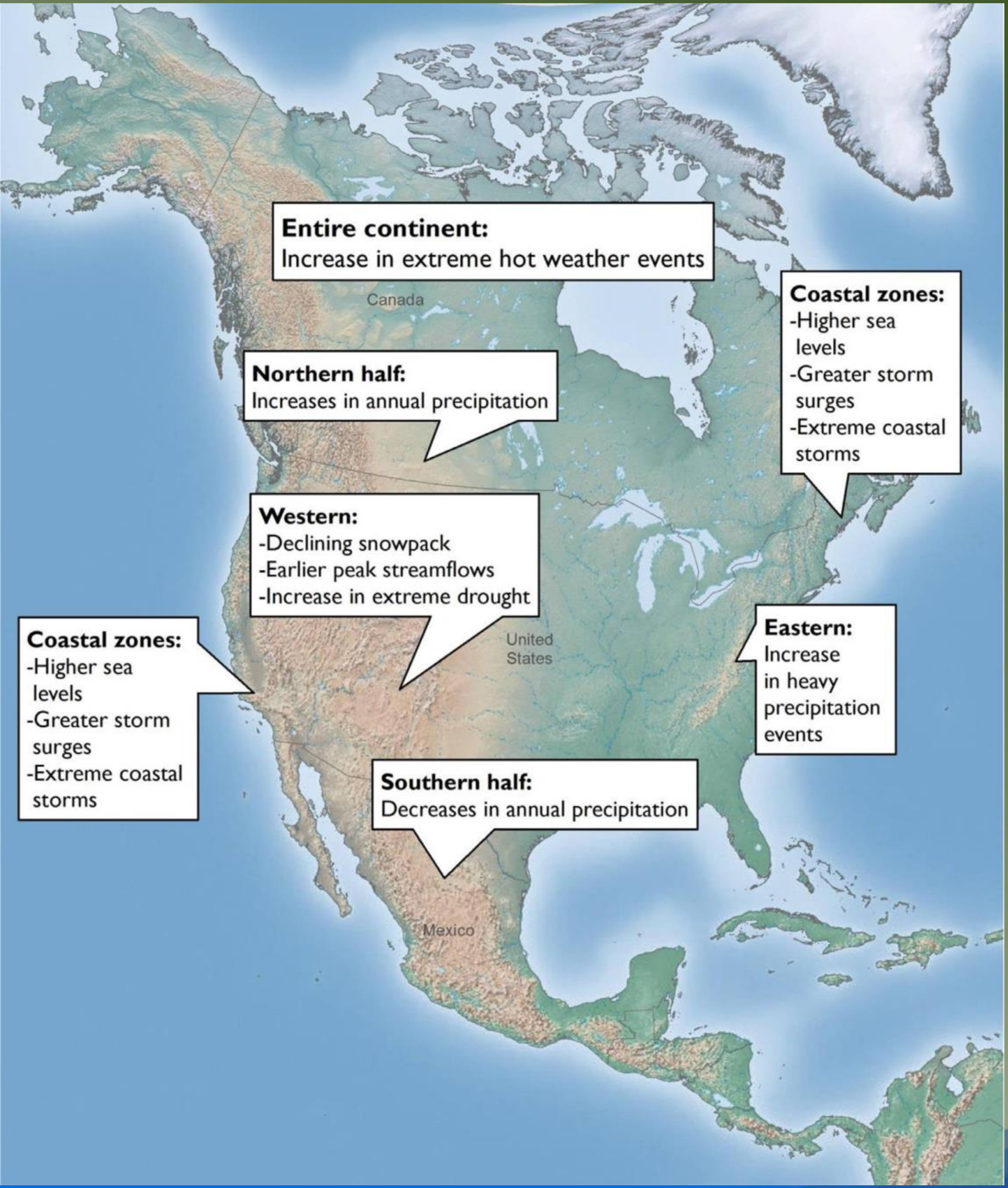
They also disconnect and fragment the stream network, leading to local extirpations of trout and salmon.

Consequences of Change to Fish and Biota

- Δ <u>Channel Morphology</u>
  - Less complexity for species specialists and for all life stages of top-level predators within Trophic system
  - Higher levels of fines in substrate, reducing habitat complexity and reducing link to hyporheic zone
  - Less complexity reducing mixing and affecting DO
- Δ <u>Habitat Conditions</u>
  - Pool:riffle sequencing reduced, leading to lower habitat complexity, less LWD, less undercut banks and specialized habitat areas
  - Reproductive zones may be limited or affected by high fines

Consequences of Change to Fish and Biota

- Temperature Regime
  - Less shading allows for increased temperature extremes, allowing for increased production and constraints on some species
- Δ Nutrient Cycling
  - High levels of P and N driving excess production
  - Less complexity allowing for higher production of lower trophic levels
  - Higher cycling with less retention in higher trophic levels



The Wild Card: Climate Change

For Eastern Canada and Maritimes, milder, wetter winters, drier summers. Increase in evapo-transpiration. Winter precipitation often rain, freezing rain. Higher winter baseflows, lower summer baseflows. <u>Bottom line – More variable critical flows and impacts on groundwater.</u>

From: Williams et al. 2015. Coldwater Fishes and Climate Change in North America.

BROOK TROUT *(Salvelinus fontinalis)*

Requirements beginning with cold temperatures, gently changing flow volumes, food, shelter, cover and reproduction

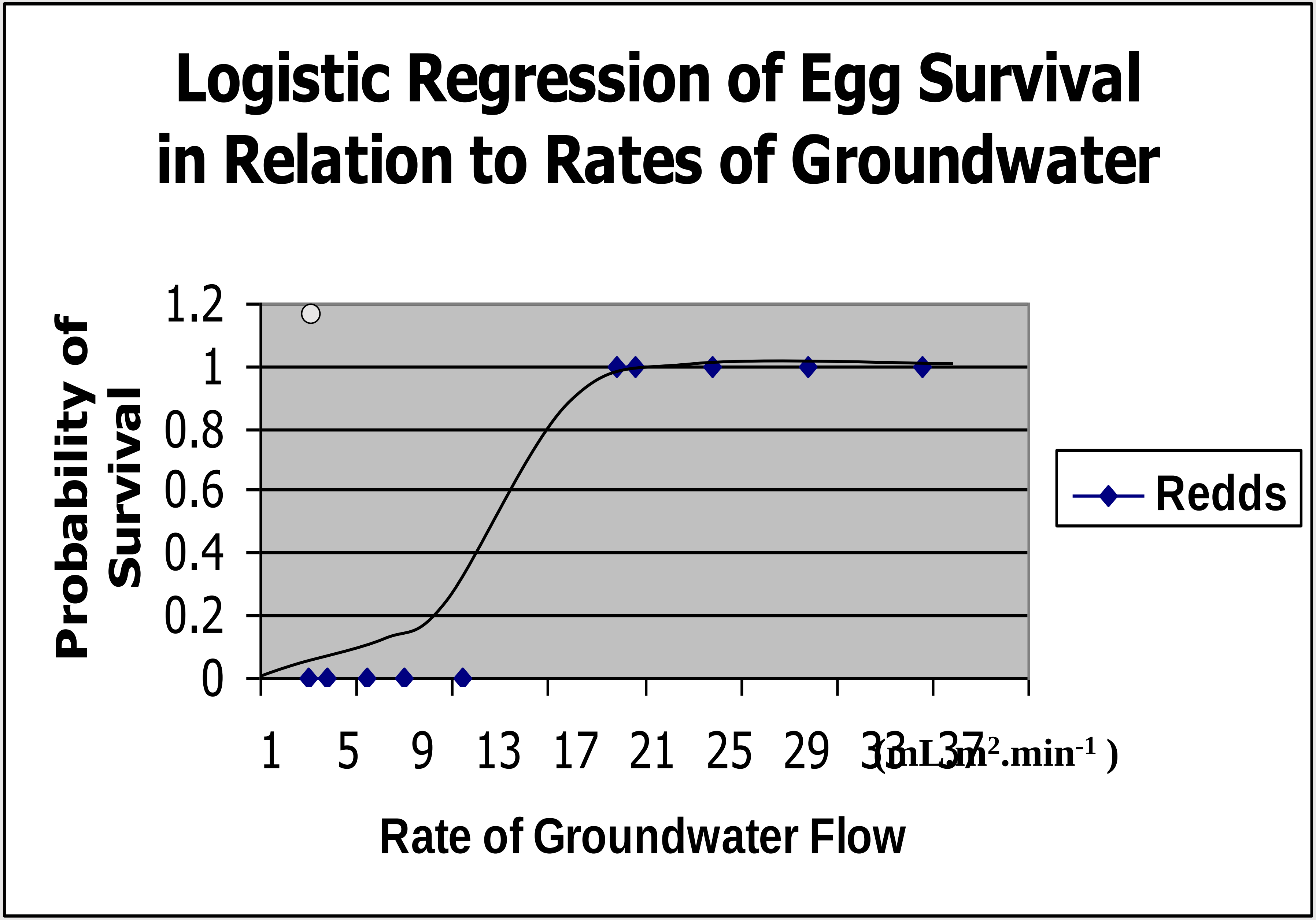
Require groundwater discharge areas for reproductive success, summer and winter survival.

Brook Trout require groundwater seepage in order to successfully incubate eggs.

The potential volume of discharge is controlled by the geology.

The pattern of discharge is controlled in part by morphological processes.

Attraction/Recruitment Thresholds



Factors Potentially Limiting Populations (most inter-related)

- Thermal Regime;
- Channel Form and Type "Stability";
- Groundwater Activity (e.g. over-winter; over-summer and reproduction zones);
- Flow Stability (e.g. rate of change)
- Inter-species interactions
- Over-Harvest

Brook Trout are impacted in the rural landscape by poorly practiced agriculture, forestry and mining that result in:

a) Sediment Inputs and Habitat Loss
b) Changes in Water Quality and Quantity
c) Temperature change
d) Disruption of Connectivity

These impacts are very connected and difficult to separate out

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The Canary In The Mine

Trout, especially brook trout, integrate physical, chemical and biological conditions of the watershed and its river.

If these animals continue to survive AND thrive in your streams, water quality , is in good condition,

the river channel is “stable”

and groundwater supplies

are being maintained…

….these fish truly are

“Canaries in your mine”.

The Stocking Conundrum

- TUC sees stocking as having very limited application as a management tool.
- Must ask yourself what is limiting the population?
  - Habitat – stocking will not solve this problem
  - Temperature changes – stocking will not solve this problem
  - Over-harvest – Stocking will not solve this problem
  - Fragmented landscape – stocking will not solve this problem
  - Re-introduction – stocking may help BUT carries many other problems

Why is stocking so rarely the answer?

Issues with Stocking for Managing Natural Fisheries

- Hatchery stock are often highly inbred therefore fitness for the wild can almost be nil (they rarely survive)
- Hatcheries passively and actively select for those individuals that will do best in a hatchery, not the natural environment
- High numbers of hatchery reared fish when stocked can overwhelm wild fish, displacing them and increasing their morbidity
- Stocking hatchery fish suppresses the wild population potentially weakening genetic vigour
- Nature does a better job of selecting the best for the wild than us

Wild are best and the most adaptable and resilient to natural stream conditions

Ecological Rehabilitation

- It is unrealistic to think that we can return systems to historical conditions;
- Most landscapes no longer have the capability to return to a “pristine state”;
- The key is to try to return the landscape and stream corridor to a healthy, **functional** state

Ecological Rehabilitation

- Context is Everything and is tied to spatial and temporal scales of the issue.
- We must ask the question, “What type of system is this watershed and how can we restore its ability to handle greater variability?”
- At what scale is the cause of system dysfunction?
- Treat the Cause of dysfunction, not its effects

Stream Rehabilitation takes time and perseverance.
Belgrave Creek 1979, 80, 81, 01

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TKChapter – Mill Creek

- Working on stream for almost 7 years to restore habitat to the point where it can sustain brook trout
- Over 2000 hours of volunteer effort
- Summer 2015 – finalized spawning habitat on Emerson Creek tributary of Mill
- Past Two Falls – Total of 36 larger brook trout PIT tagged and transferred to Emerson Creek – found 3 redds in first fall and 10 in second fall plus were able to account for almost all trout released after two years.

2015-17 Release

Role of Context in Watershed Management and Rehabilitation

- Governments currently manage natural systems through policy and programs developed as a result of single issues
- These issues often not connected to other concerns about landscapes
- Therefore to really make a difference…
- Environmental Management and Ecological Restoration MUST Embrace Contextual Thinking <u>since natural systems are inherently inter-connected</u>.

Summary

- People have created the problem, people have to fix the problem.
- We are trying to restore function to our watersheds and their streams
- This provides the BEST, LEAST EXPENSIVE, AND LONGEST LASTING RESULTS
- Understanding the watershed, its functions and processes puts your stream issues into context
- Treat the Cause of the problem not the Effects
- Brook trout are our aquatic indicator of a healthy, resilient watershed and stream
- Avoid short-term fixes, they never work in the long-term
- Habitat is the Key

FINALLY……Remember

“Complex problems often have easy to understand wrong answers".

David Beatty Harn, Retired Engineer with the US Army Corp of Engineers

Merci!

Thank you!