Business

- Meteorologic monitoring
- Field trip?
- Reader
- Other?

Streams

- Classification
- Characterization
- Discharge measurements

Why classify stream channels?

Why Classify Stream Channels?

- Provides a common language for researchers and managers;
- Provides a basis for stratified sampling and monitoring;
- Allows extrapolation and generalization;
- Help evaluate current condition relative to some standard;

Why Classify Stream Channels?

- Use to predict:
  - Biological characteristics;
  - Sensitivity to management and future behavior;
  - Restoration potential;

Channel classification

- Classification system really depends on purpose:
  - Hydroelectric potential?
  - Fisheries?
  - Stream chemistry?
  - Sensitivity to bank erosion?
  - Likelihood of flooding?
  - Spatial and temporal scale;

Spatial scales of interest

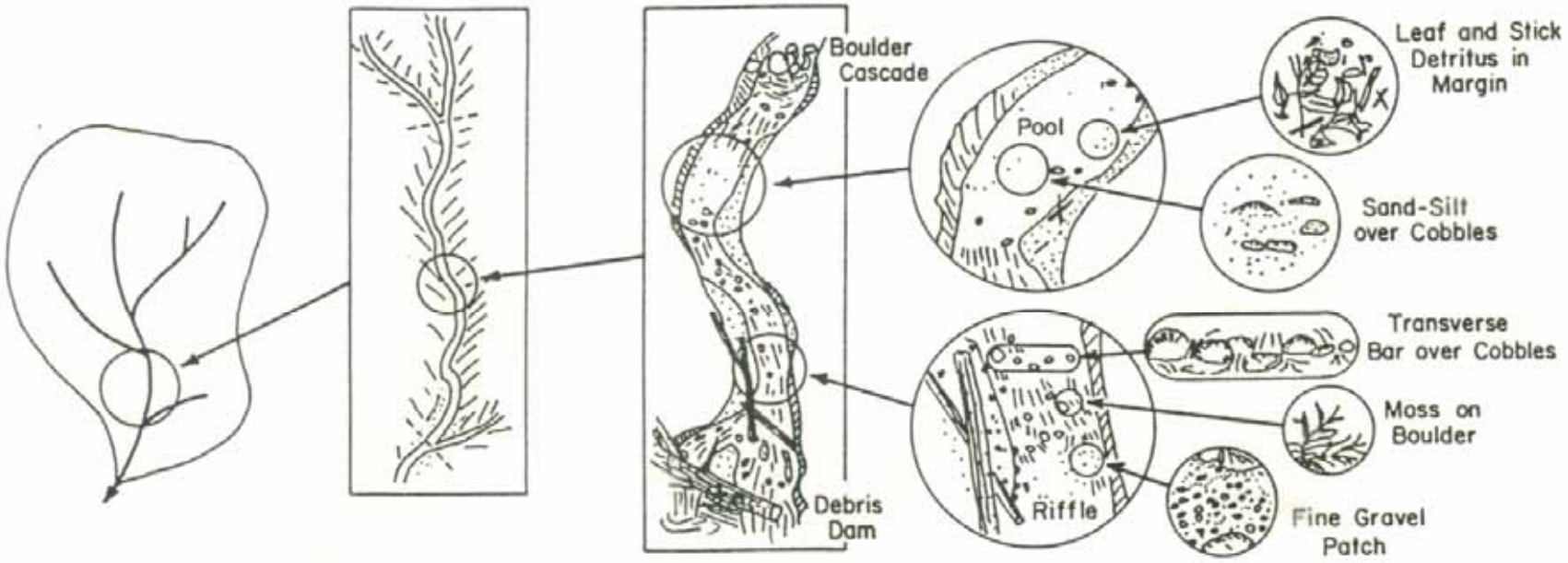
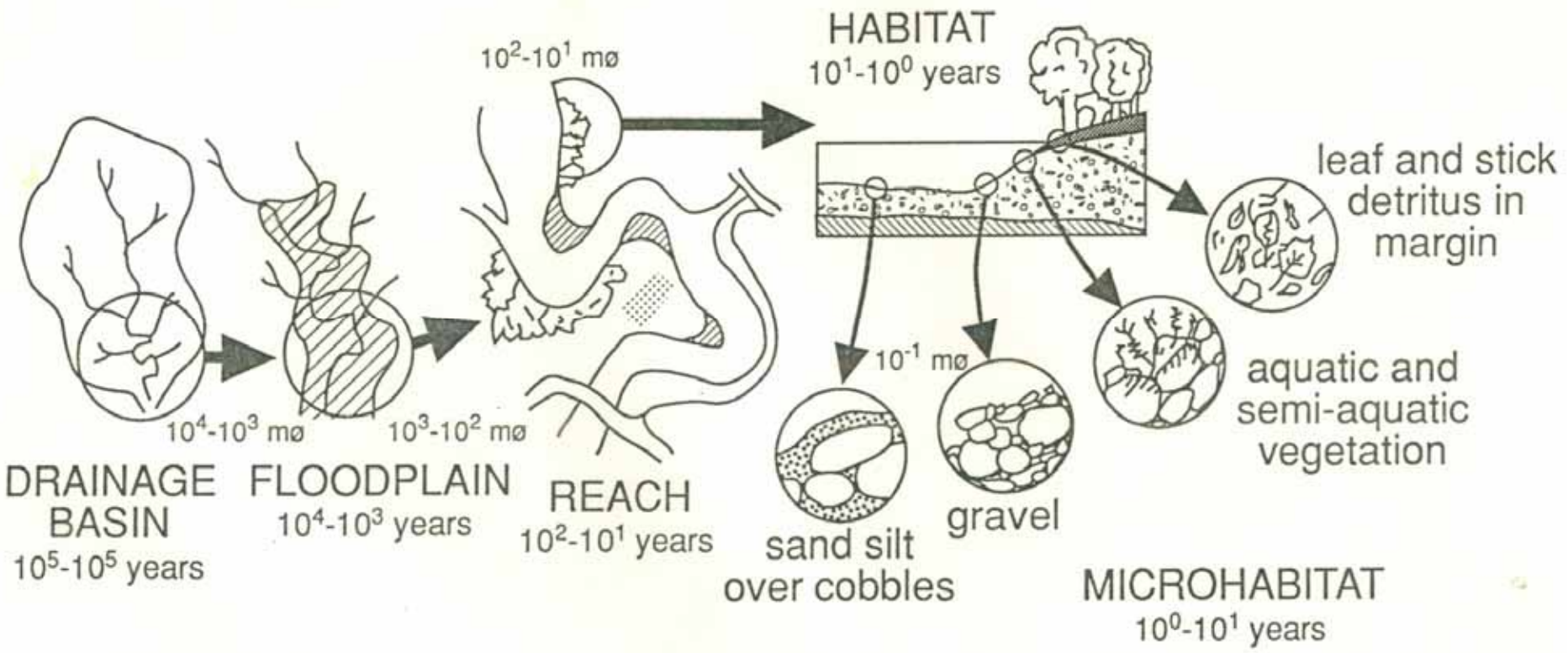
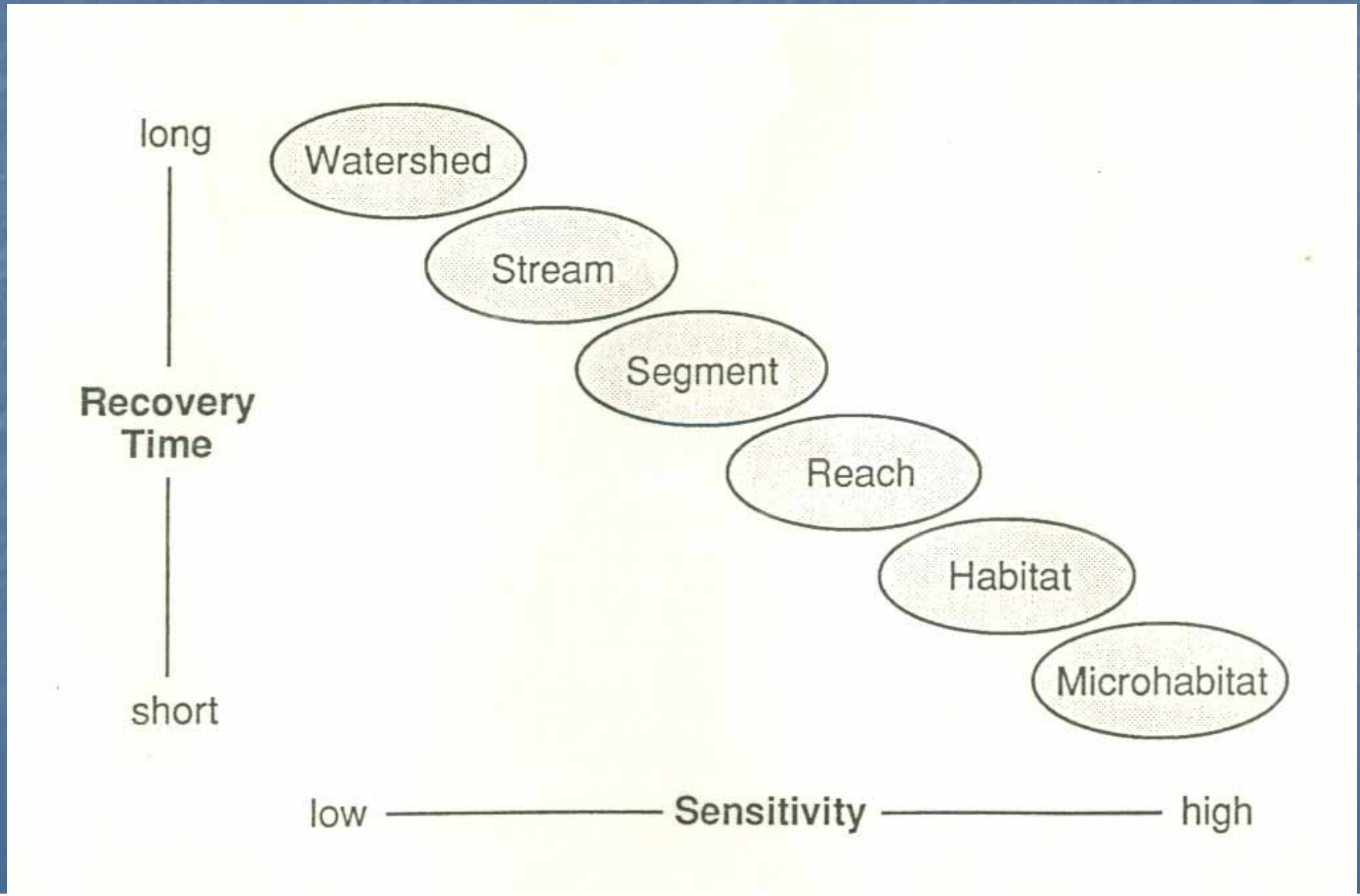


Figure 2. Hierarchical organization of a stream system and its habitat subsystems. Approximate linear spatial scale, appropriate to second- or third-order mountain stream, is indicated.

Time and spatial scales interact



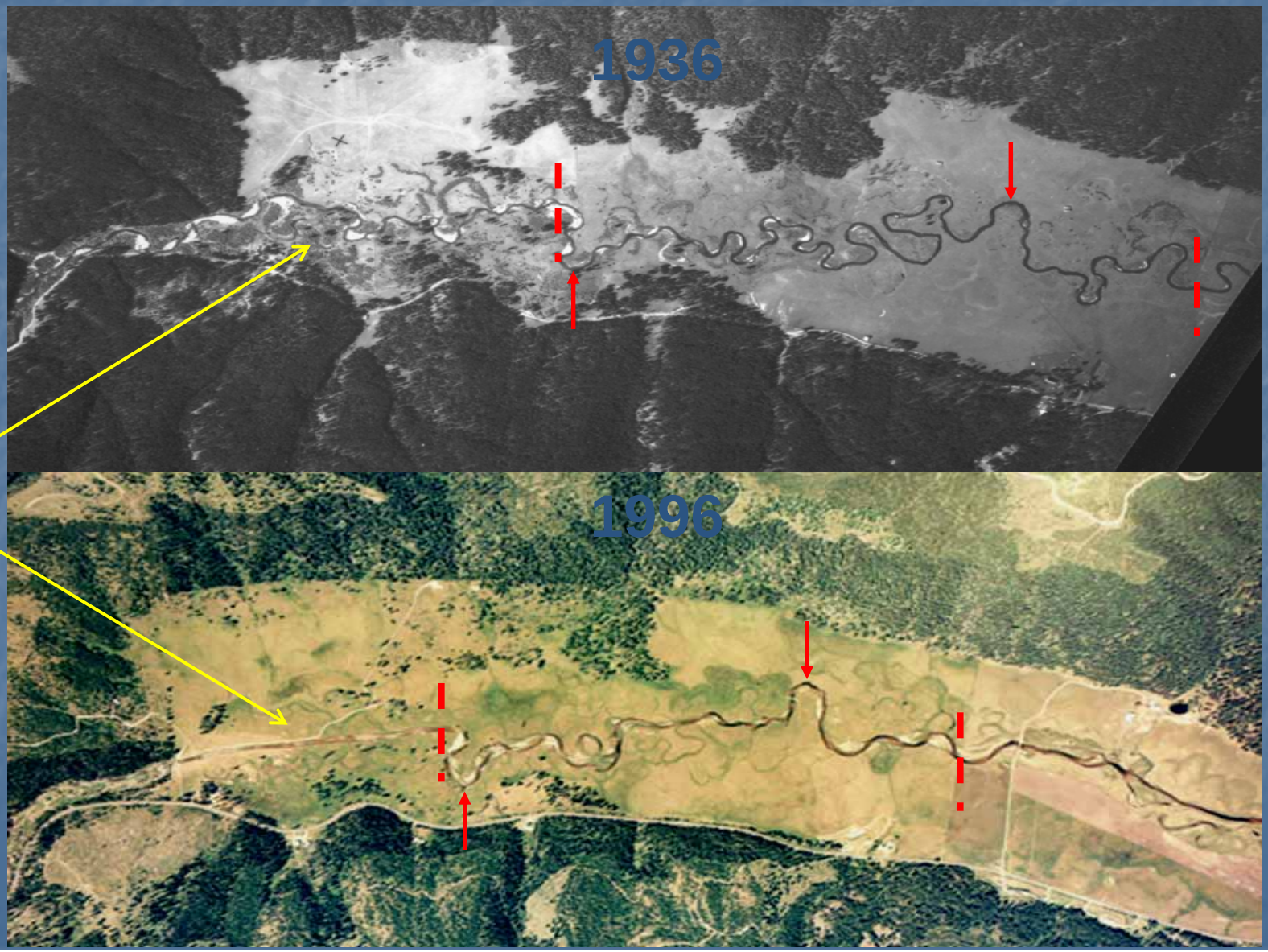
Time and space scales interact



Channel classification

- Classification system really depends on purpose:
  - Hydroelectric potential?
  - Fisheries?
  - Stream chemistry?
  - Sensitivity to bank erosion?
  - Likelihood of flooding?
  - Spatial and temporal scale;
  - Current condition or potential condition?

Channelization can change classification



Channel classification

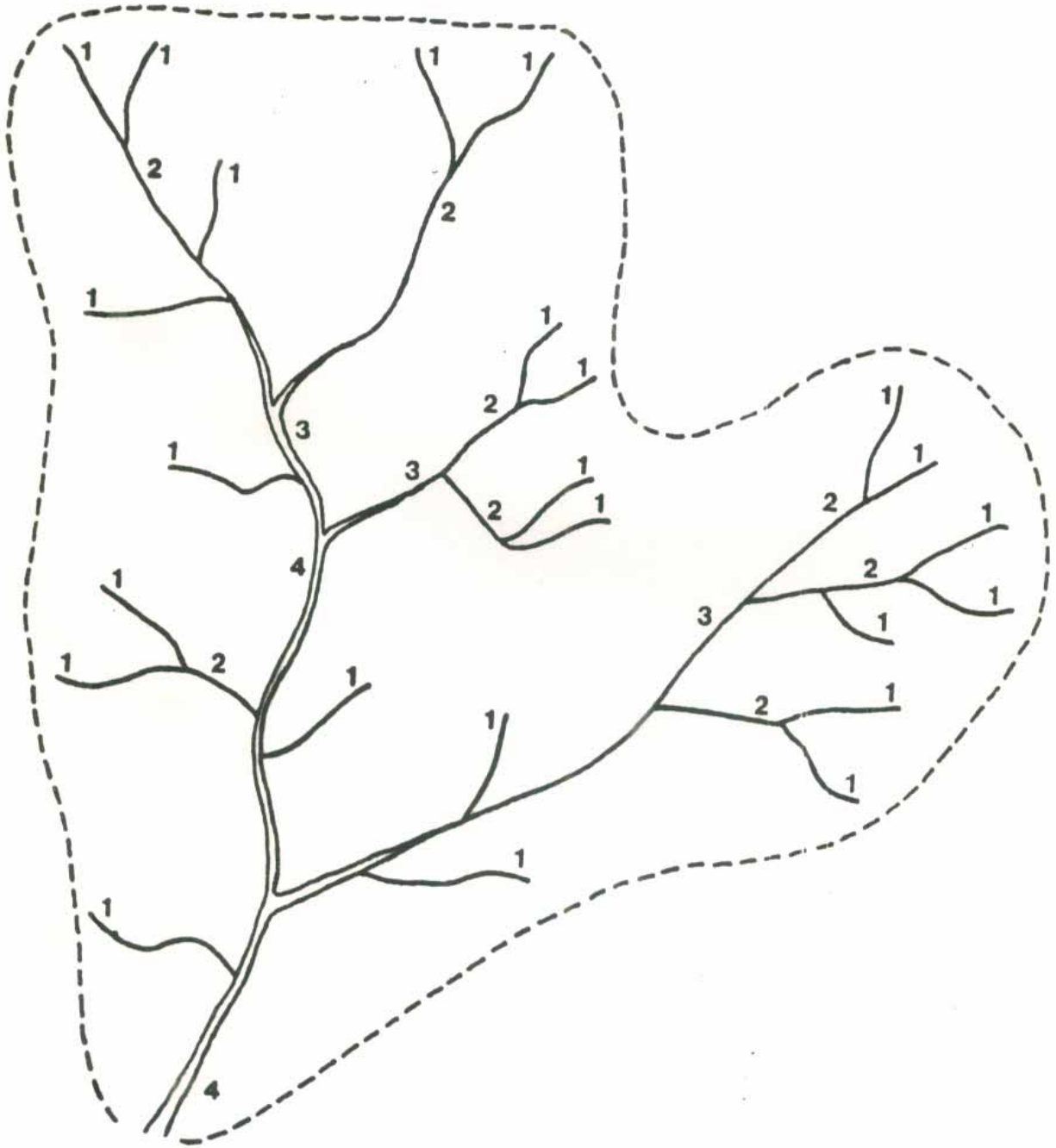
- Classification system really depends on purpose:
  - Hydroelectric potential?
  - Fisheries?
  - Stream chemistry?
  - Sensitivity to bank erosion?
  - Likelihood of flooding?

⇒ Numerous classification schemes

Three most common channel classification schemes

- Strahler stream order
  - Developed in 1950s;
- Rosgen
  - Widely used by management agencies;
- Montgomery and Buffington
  - More process based;

Strahler stream order



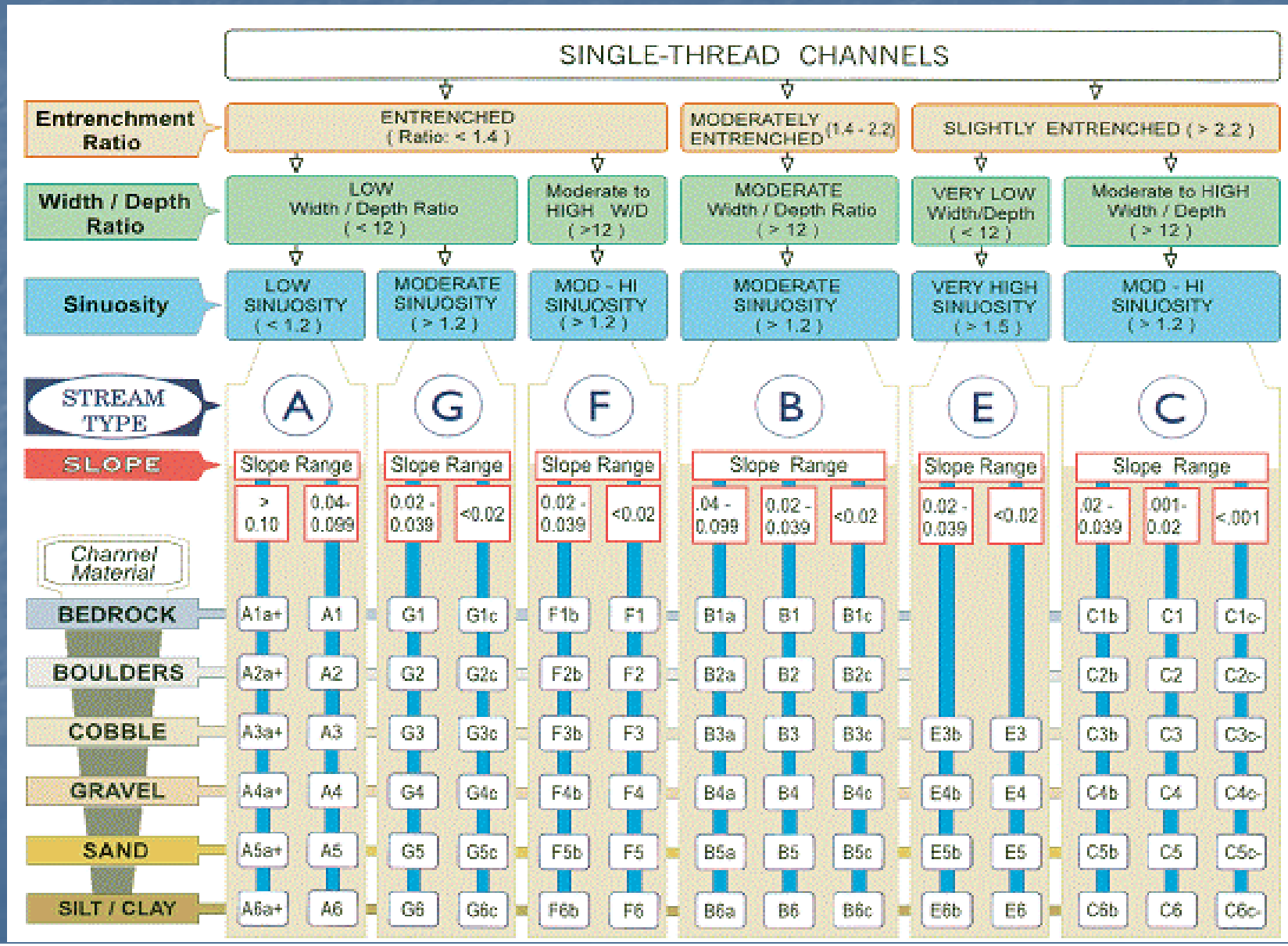
Three most common channel classification schemes

- Strahler stream order
  - Developed in 1950s;
  - Simple, but scale dependent!
- Rosgen

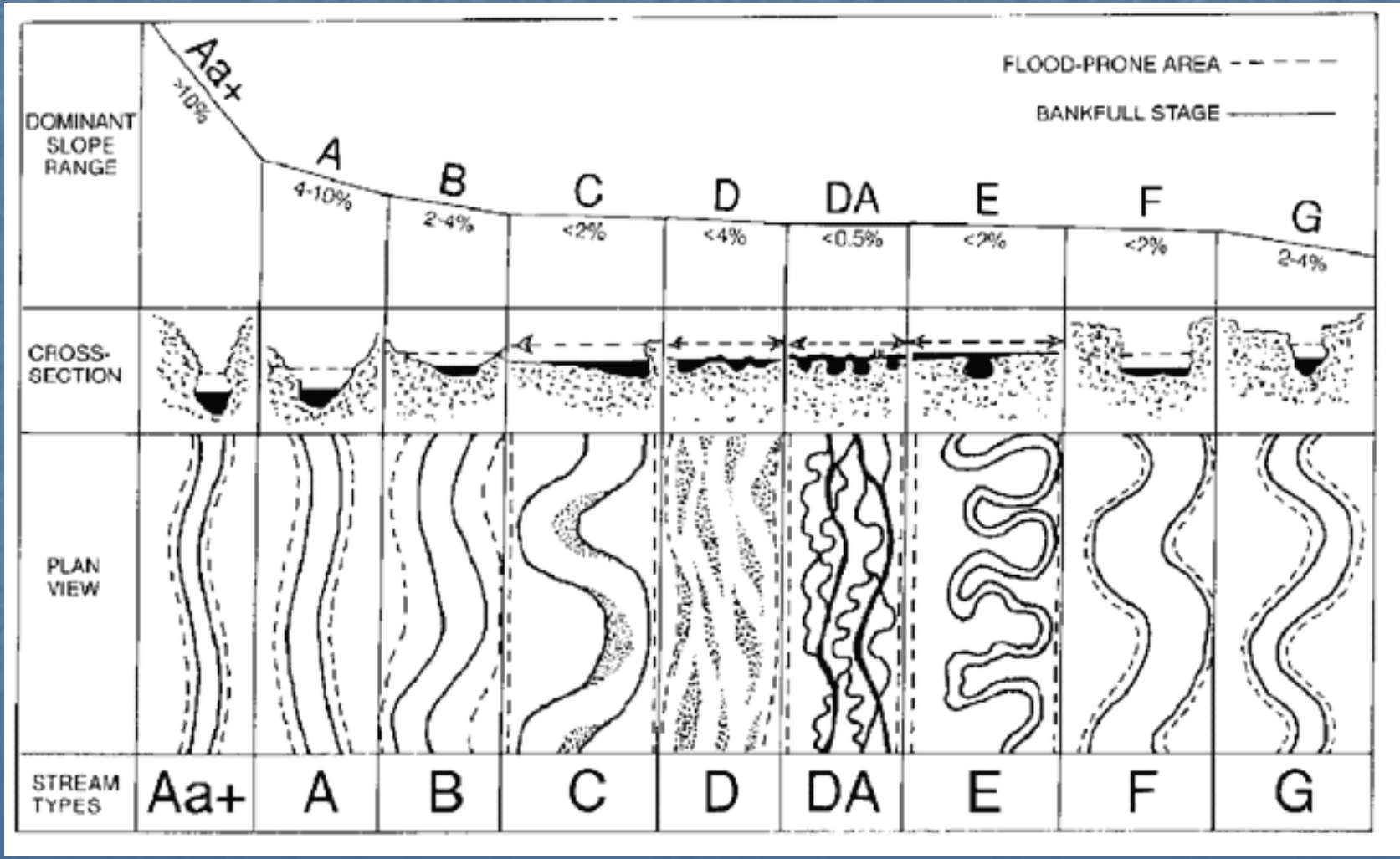
Rosgen uses six characteristics:

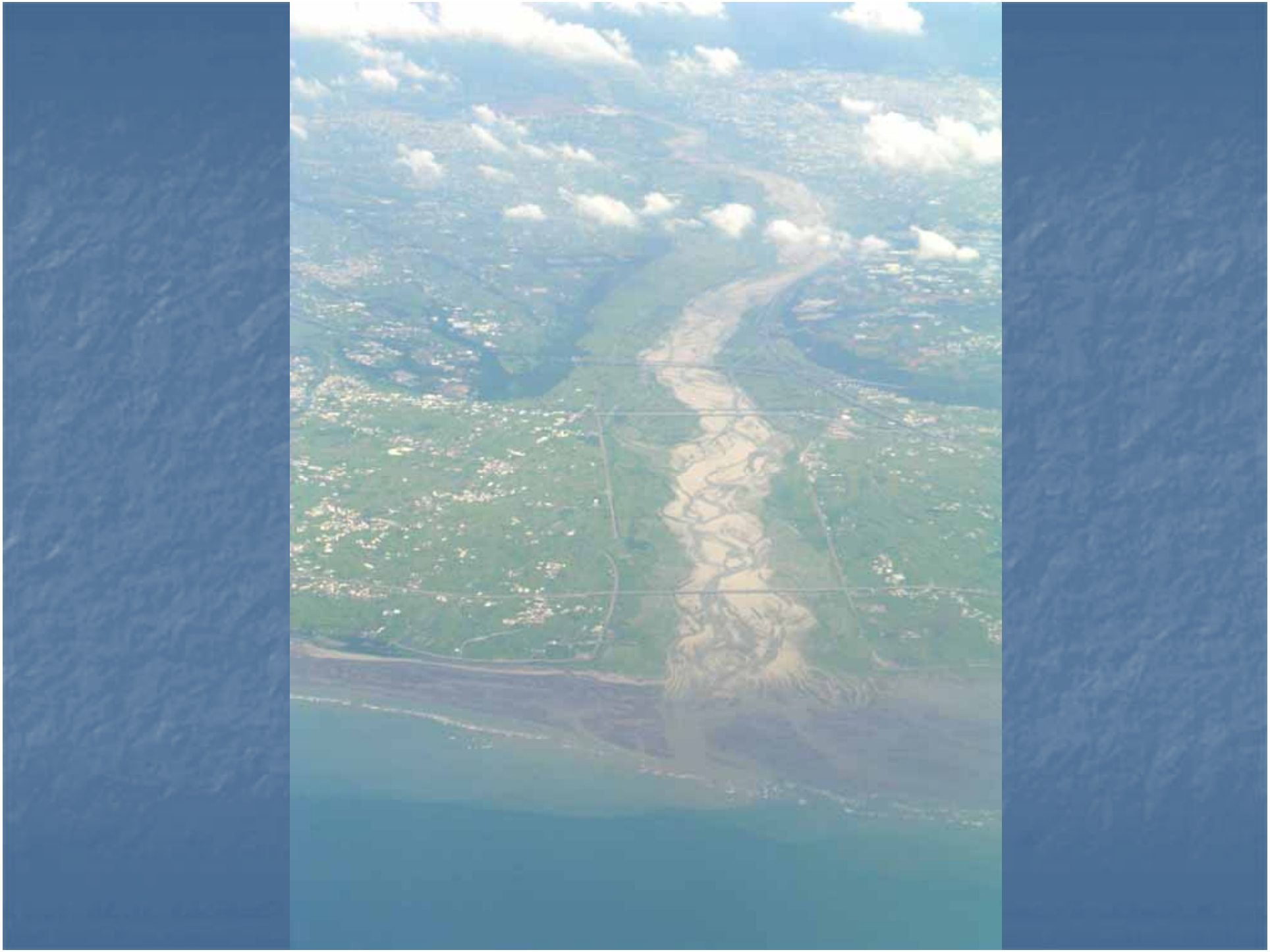
1. Single- vs. multiple thread channels;
2. Entrenchment ratio;
3. Width/depth ratio;
4. Sinuosity;
5. Gradient (slope);
6. Particle-size of the bed material.

Rosgen Stream Classification



Single vs. multiple (braided) channels: Rosgen

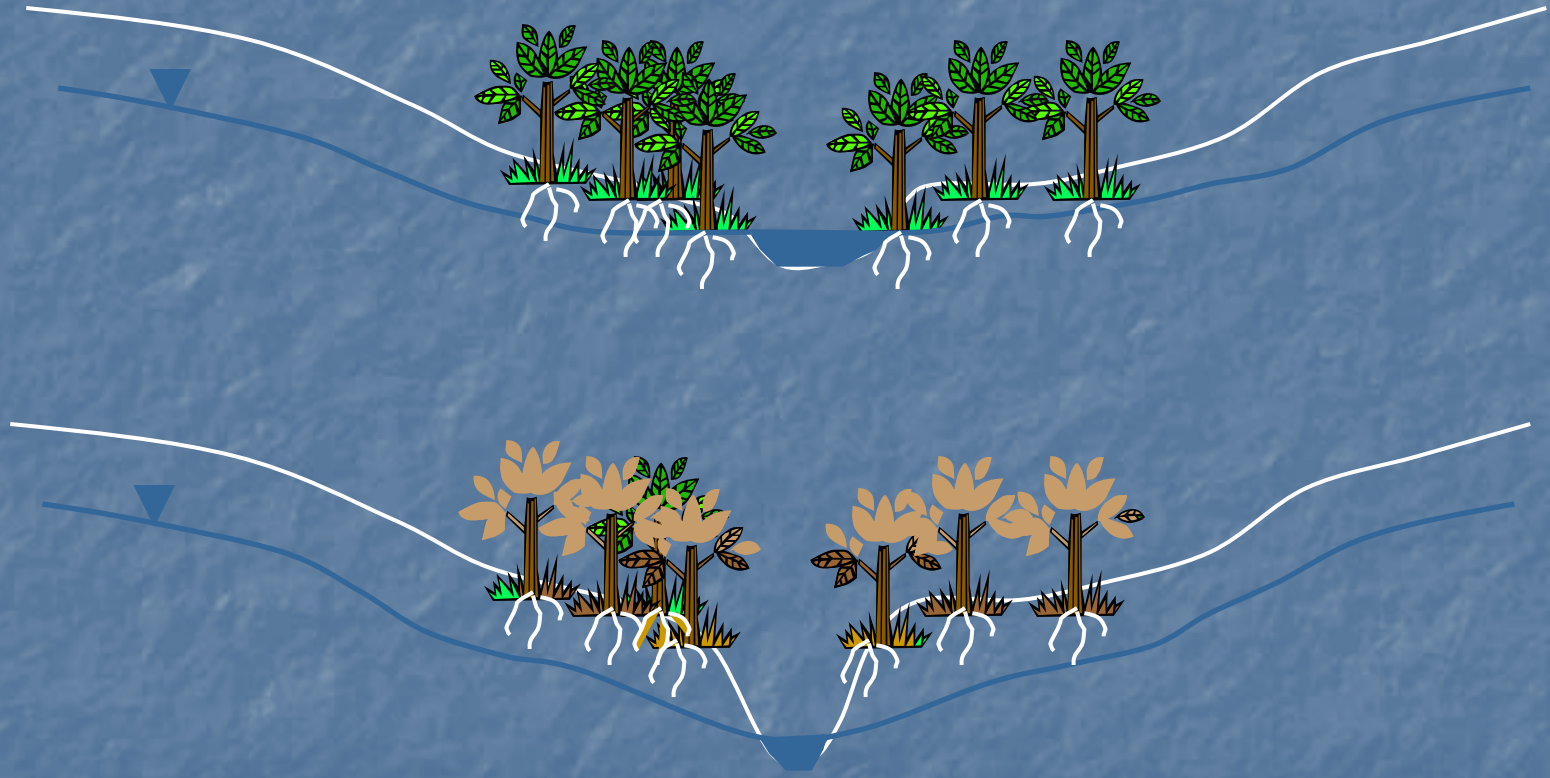




Entrenchment

- Generally defined as the vertical containment of a stream channel;
- At high flows, can the stream spread out?
- Can the stream migrate laterally over time?

Channel incision leads to a change in entrenchment



In an incised channel, the stream cannot spread out at high flows, so it is entrenched (**lower** Rosgen entrenchment ratio)

Entrenchment

- Generally defined as the vertical containment of a stream channel;
- Rosgen's entrenchment ratio:
  - Width of flood-prone area divided by the bankfull width;
  - Flood-prone area is defined as the width at twice the maximum bankfull depth;

Bankfull

- D&L (p. 654) define bankfull by change in:
  - Slope (from steep bank to flat floodplain);
  - Vegetation
    - Bare to grass;
    - Grass to shrubs or trees;
    - Aquatic to terrestrial plants;
  - Particle size (usually coarse to fine);

Bankfull

- Again, bankfull defined by change in:
  - Slope (from steep bank to flat floodplain);
  - Vegetation;
  - Particle size (coarse to fine);
- Floodplain is the flat area adjacent to the stream that is being formed by sediment from the stream under present climate and flow regime;
- Bankfull is at the top of the floodplain;

Entrenchment, bankfull, and flood-prone area

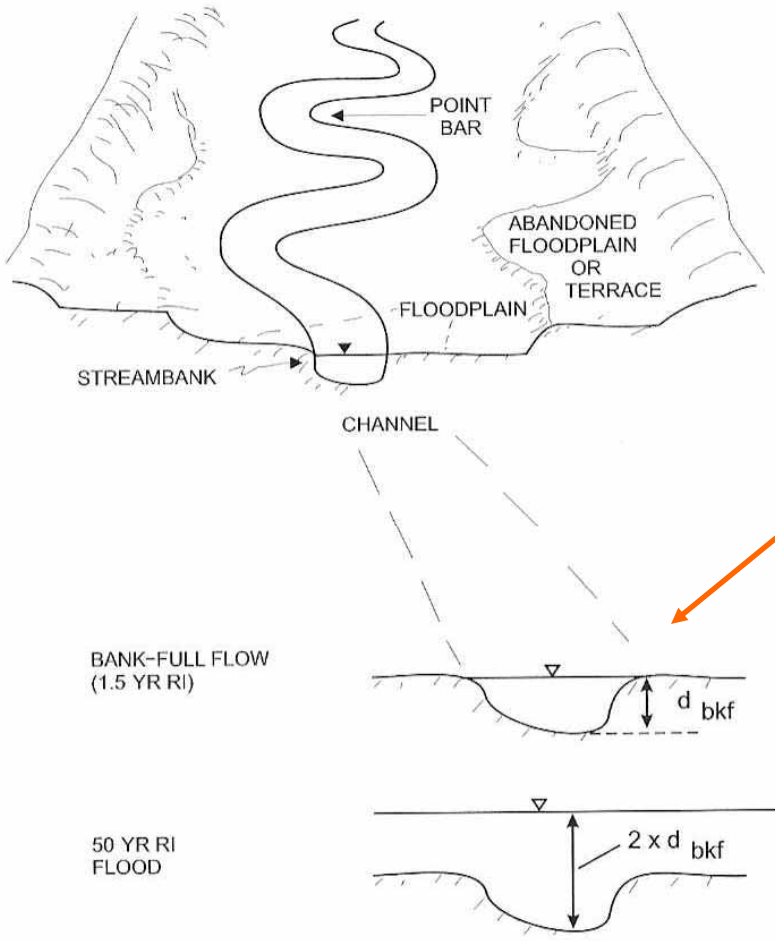
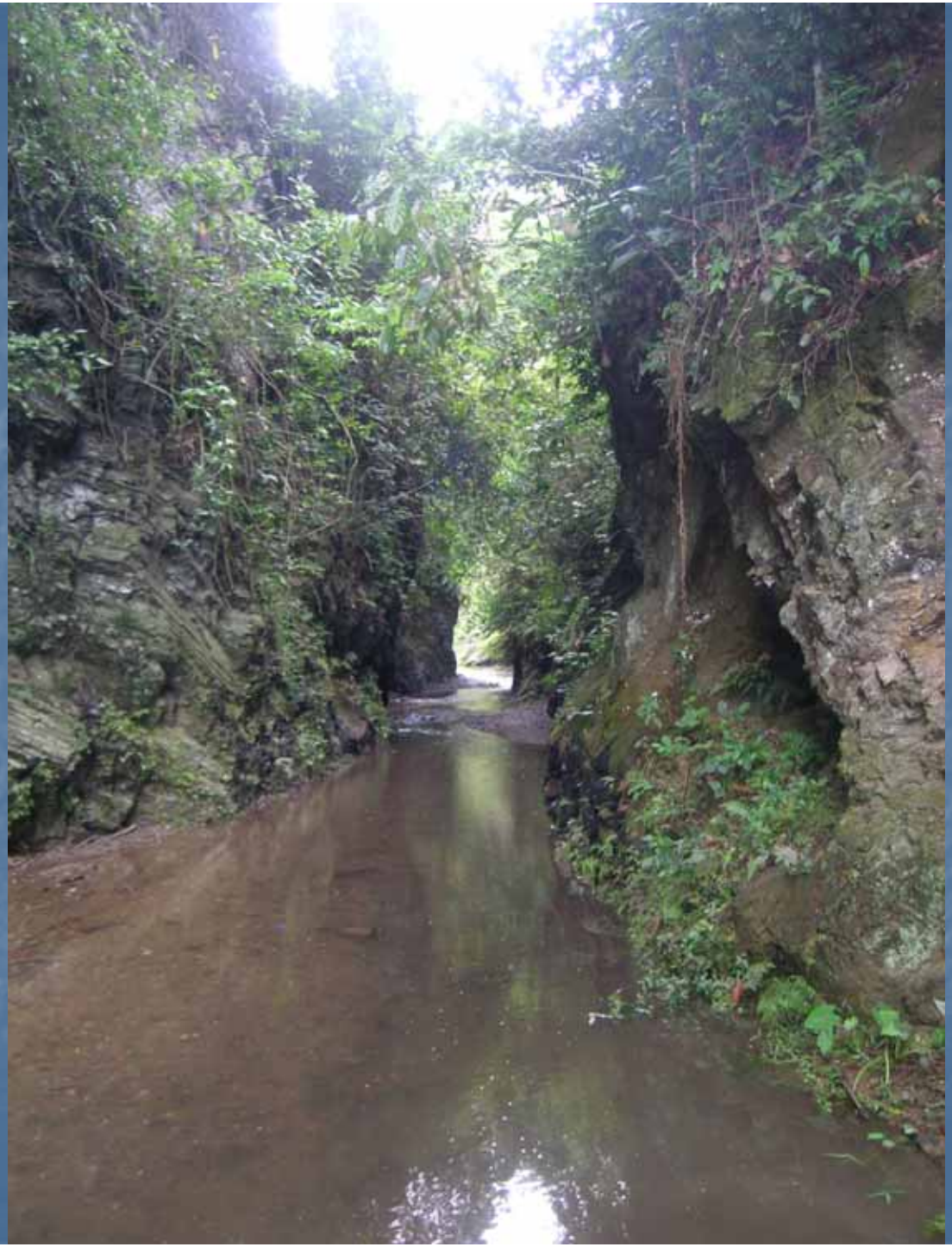


FIGURE 10.1. Landforms in a river valley and flow conditions in a channel for bank-full and the 50 yr recurrence interval (RI) flood (modified from Fitzpatric et al. 1999 and Verry 2000).

Bankfull flow: 1.5 year return interval

Flood-prone area = width at 2x bankfull depth



Bankfull

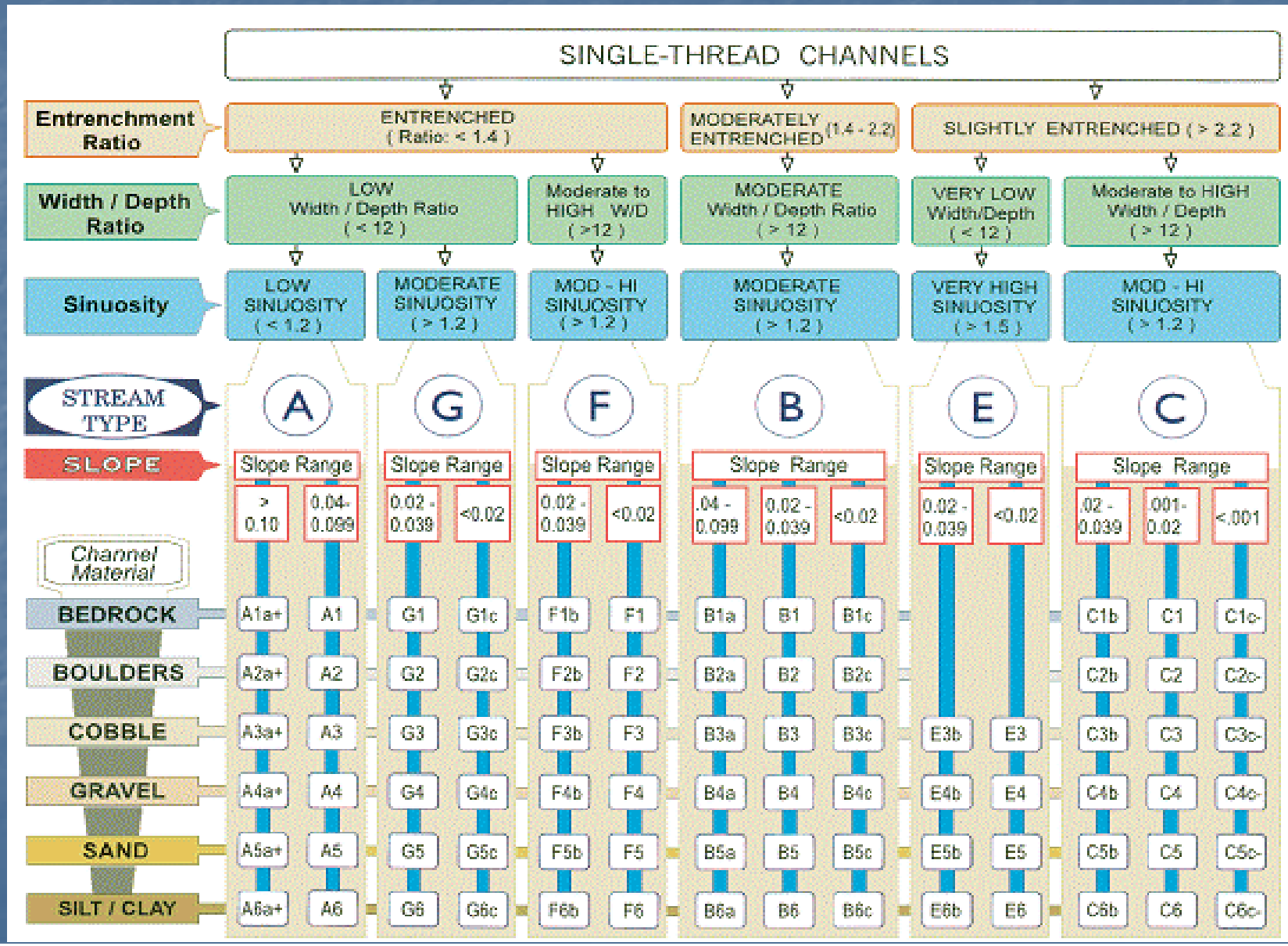
- Commonly believed to be the elevation of the 1.5-year flood (i.e., occurs every 1.5 years on average);
- This is not always the case, but it is a useful guide.

Bankfull

"Meaningful reliance on bankfull as an indicator of flow and for classification depends on a rigorous and diligent application by the field hdyrologist. Less than a rigorous application will provide haphazard results that discredit the method and observer."

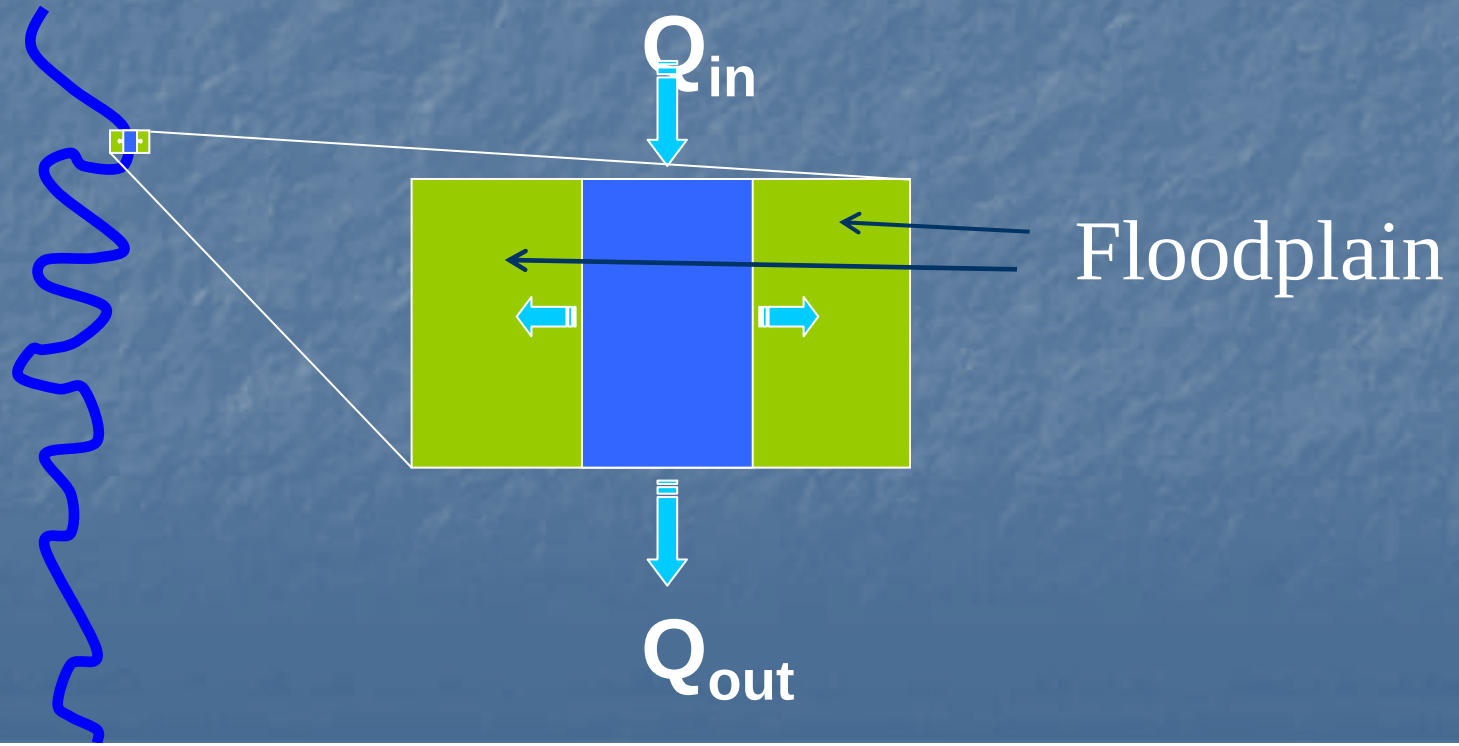
(USDA Forest Service)

Rosgen Stream Classification



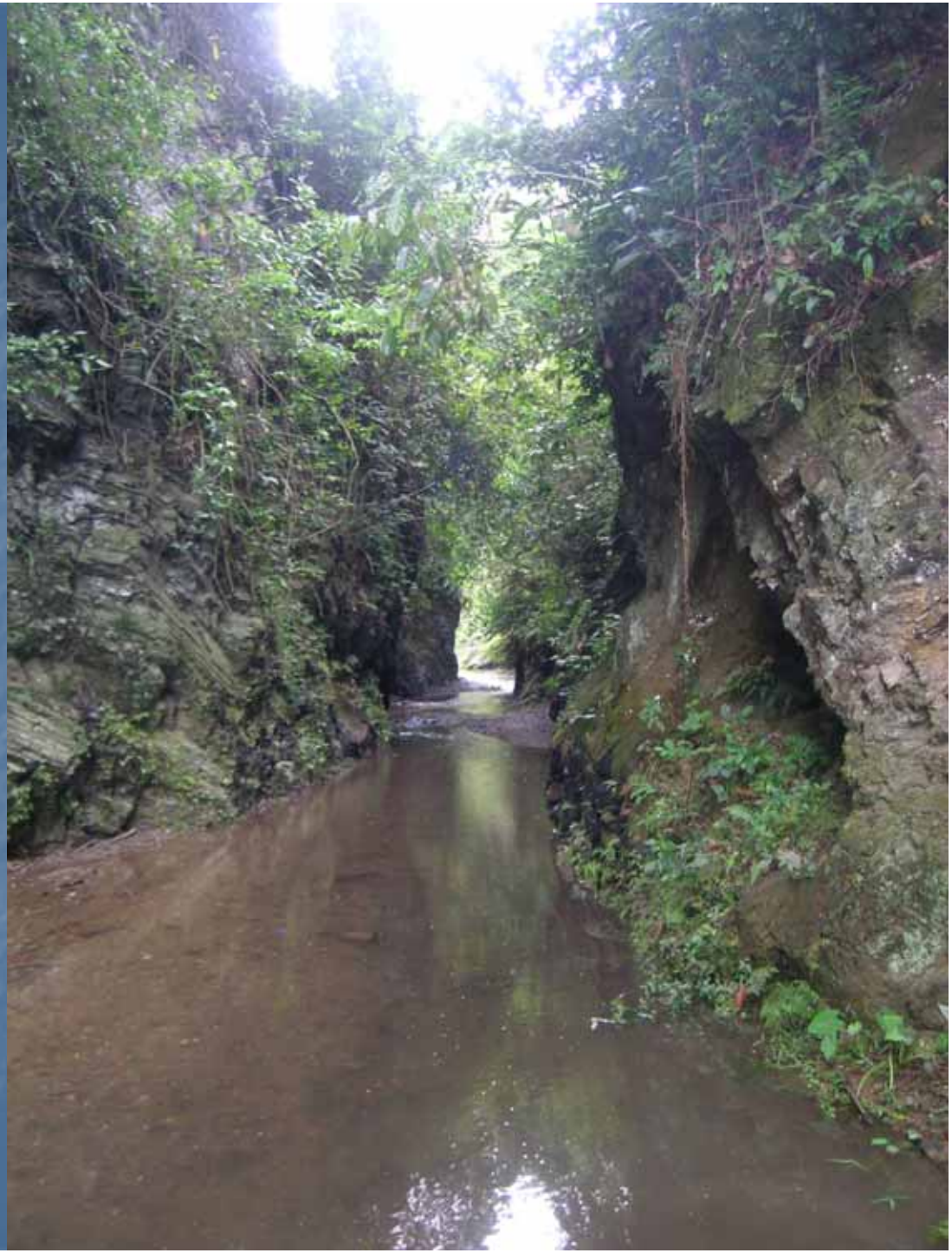
Width/depth ratio

- Width of the stream/mean depth
- For Rosgen classification:
  - Bankfull width/mean bankfull depth;

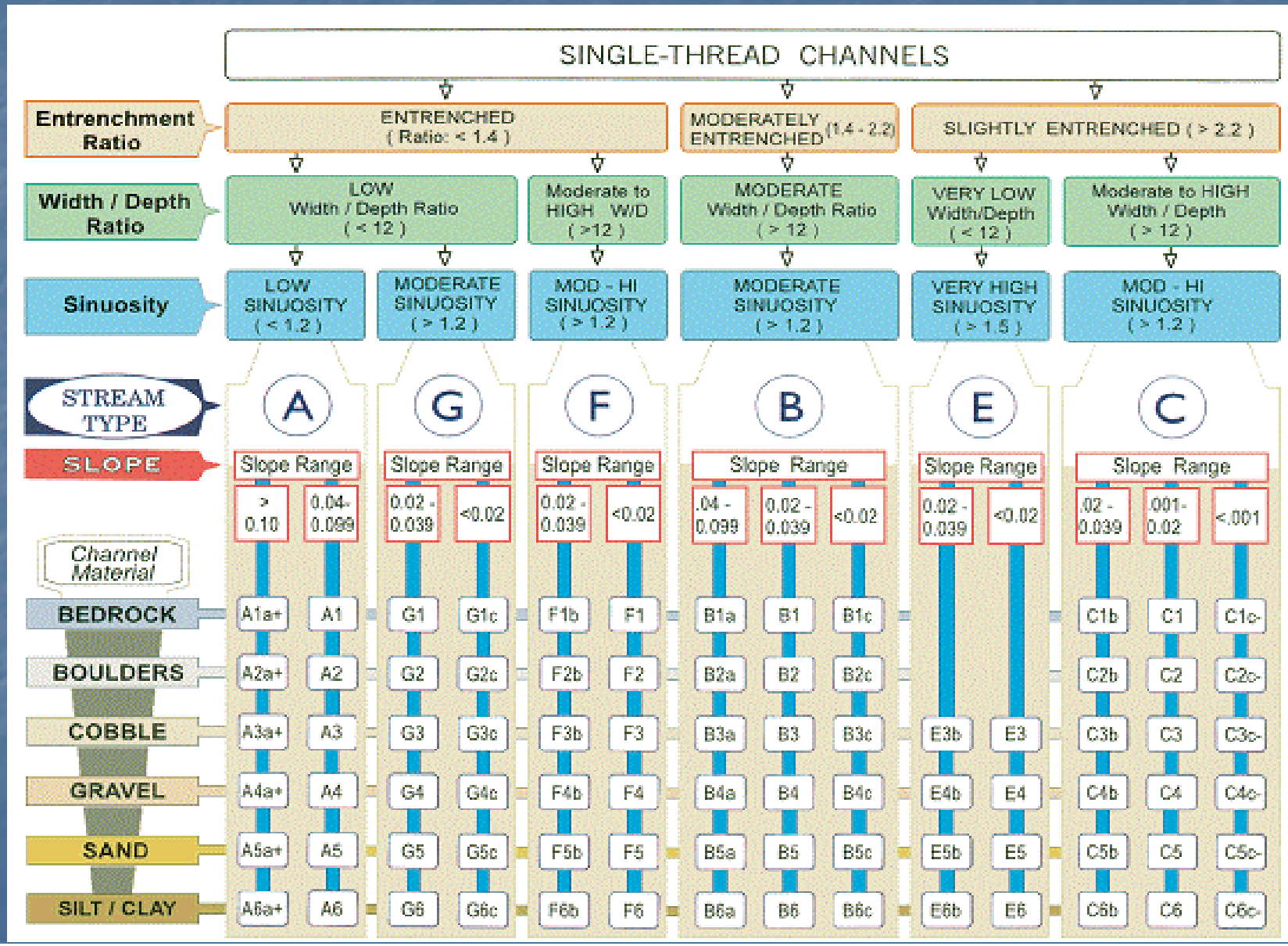


High width/depth ratio

Low width/depth ratio



Rosgen Stream Classification



Sinuosity

- Stream length along the thalweg/valley or straight line length;
- Thalweg is defined as the deepest portion of the channel;

High sinuosity

Low to moderate sinuosity

Low sinuosity (often true for confined streams)

No sinuosity: is this a natural channel?

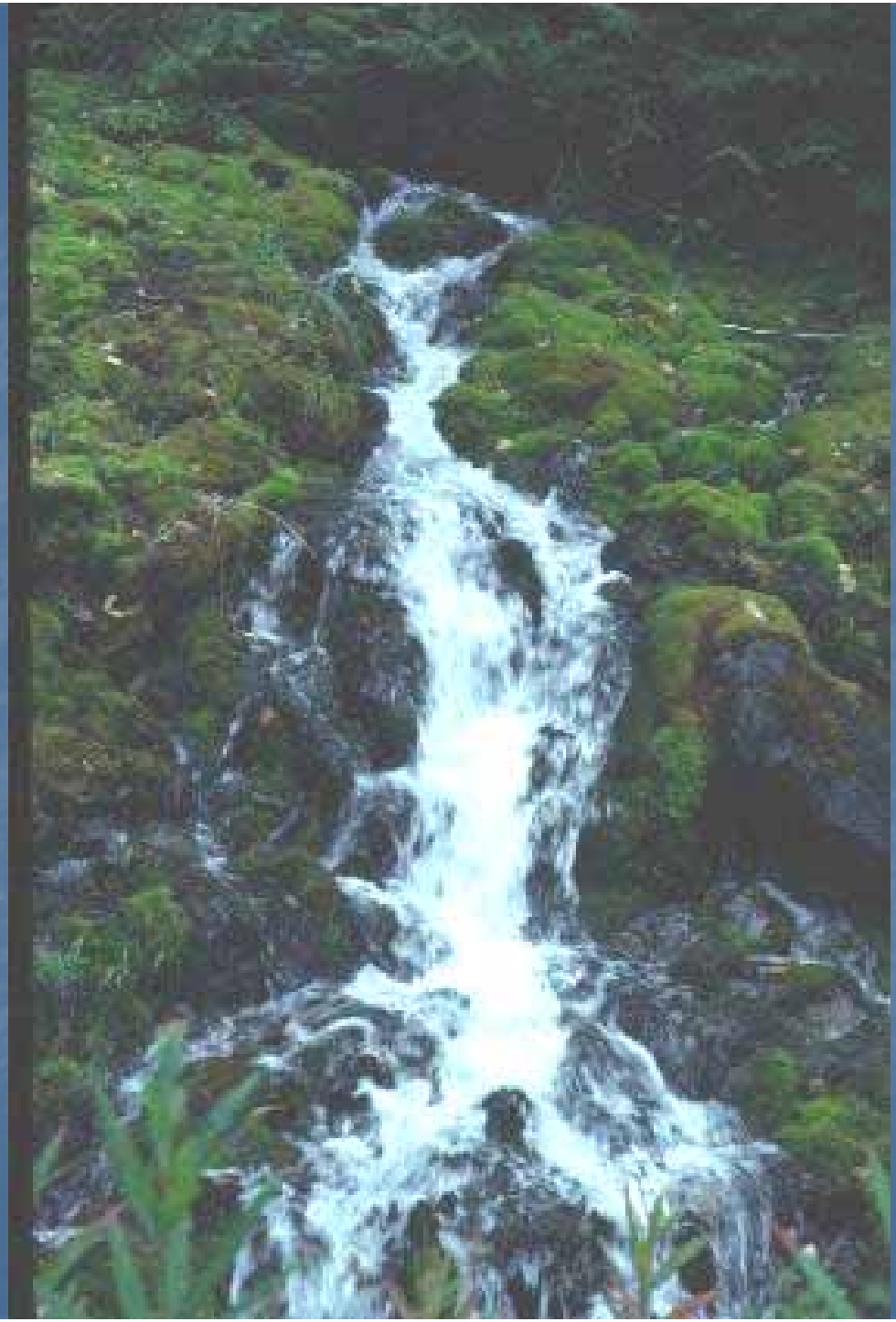
Very high sinuosity

Gradient

- Stream length along the thalweg/change in elevation;
- Usually measure along the edge of the water;
- Also assumed to equal the energy gradient, as p=0 at the edge of the water;
- Arguably the most important control on stream channel morphology;

High gradient

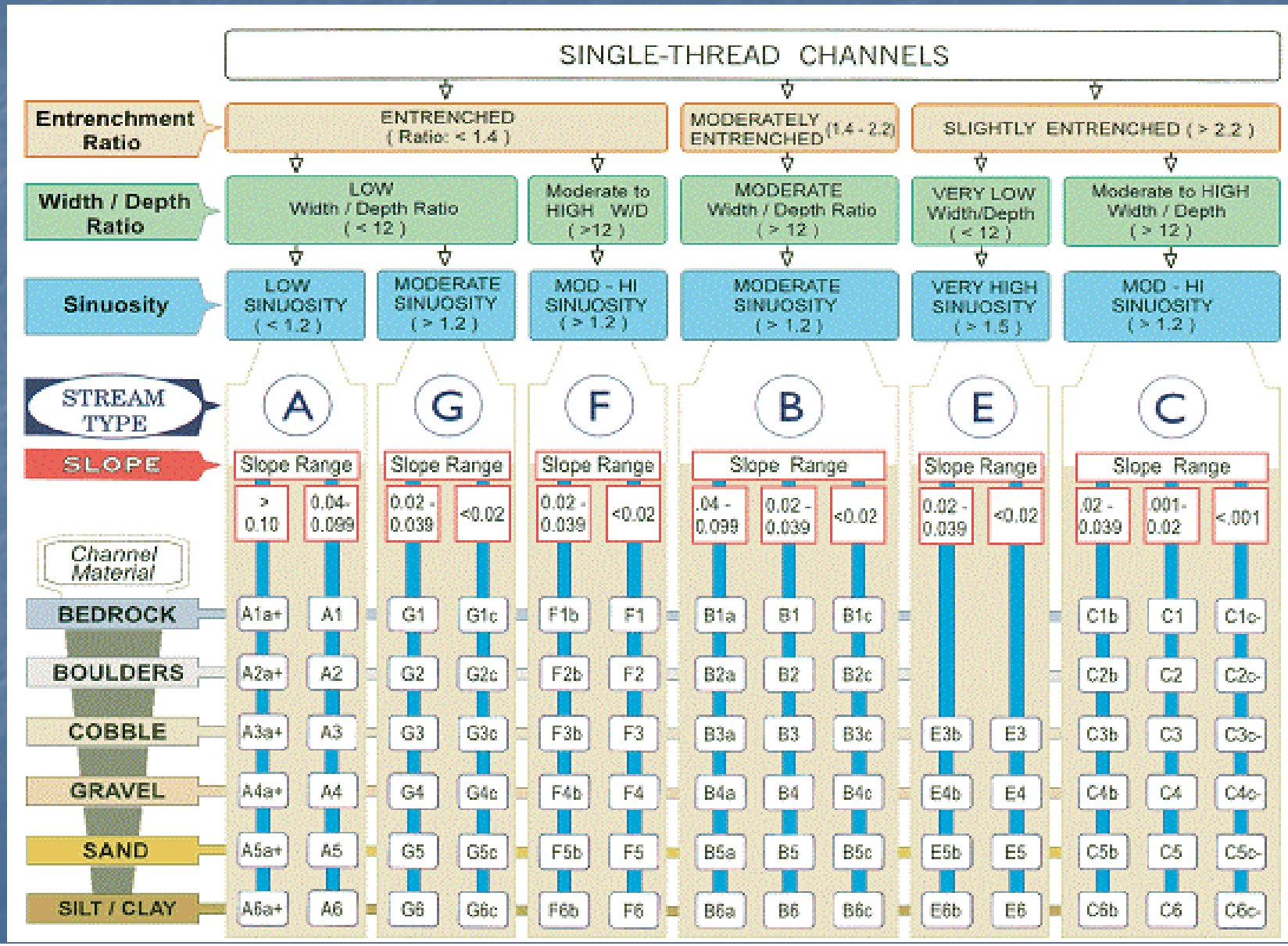
(>10%)



Low to moderate gradient (1-2%)

Low gradient (<1%)

Rosgen Stream Classification



Particle-size distribution of the bed material

- Systematically sample individual particles within the bankfull channel;
- Use a grid so that each point represents a portion of the area being sampled;
- Pick up the particle at exactly each point on the grid, and measure or classify its secondary or intermediate axis;
- Usually sample at least 100 particles;

Particle-size distribution of the bed material

- Plot the data on a log scale and the distribution often becomes normal;
- Usually plot as a cumulative frequency distribution, and then identify the D_{50}, D_{84}, and D_{16} (D_{50} is the median particle size; D_{84}, means that 84% of the particles are smaller, and D_{16} means that 16% of the particles are smaller
- Why the D_{84} and D_{16}?

START HERE

Business

- Meteorologic monitoring
- Field trip?
- Reader
- Other?

Streams

- Classification
- Characterization
- Discharge measurements

Three most common channel classification schemes

- Strahler stream order
  - Developed in 1950s;
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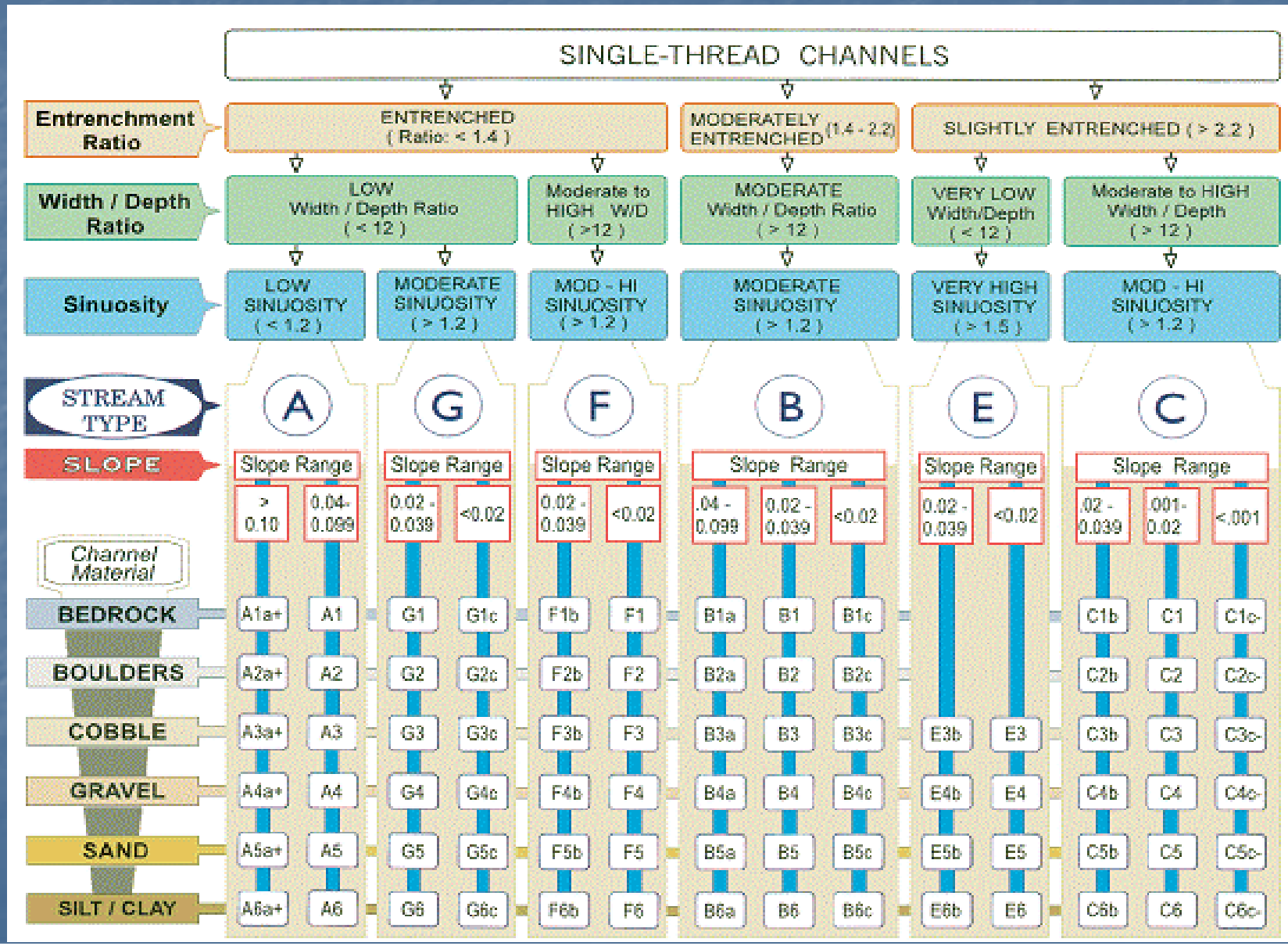
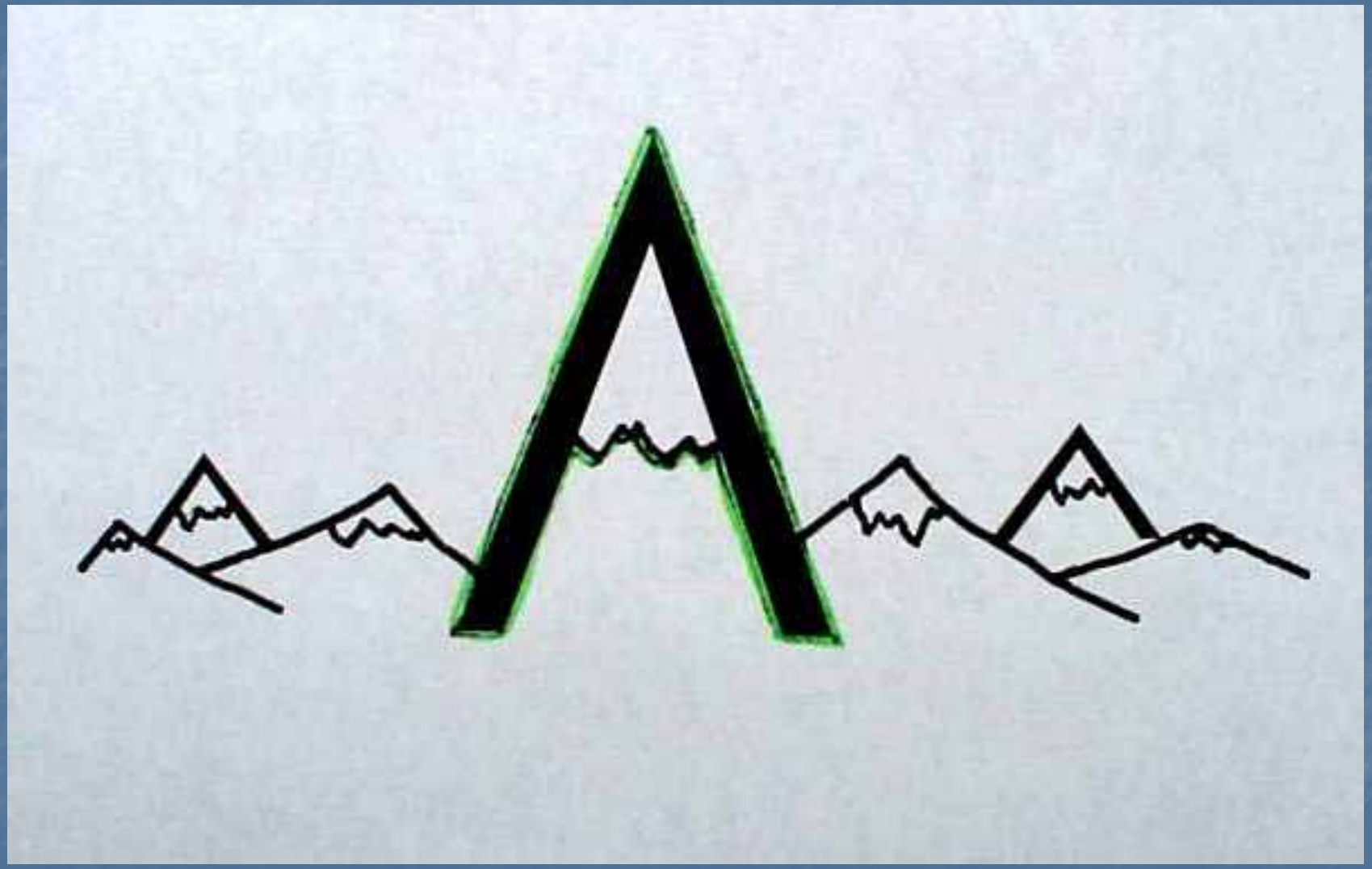
Rosgen Stream Classification





Stream Type: A

W/D < 12 Sinuosity > 1- 1.2 ER < 1.4 S 4 - 10 %

A

Between

C

Stream Type: B

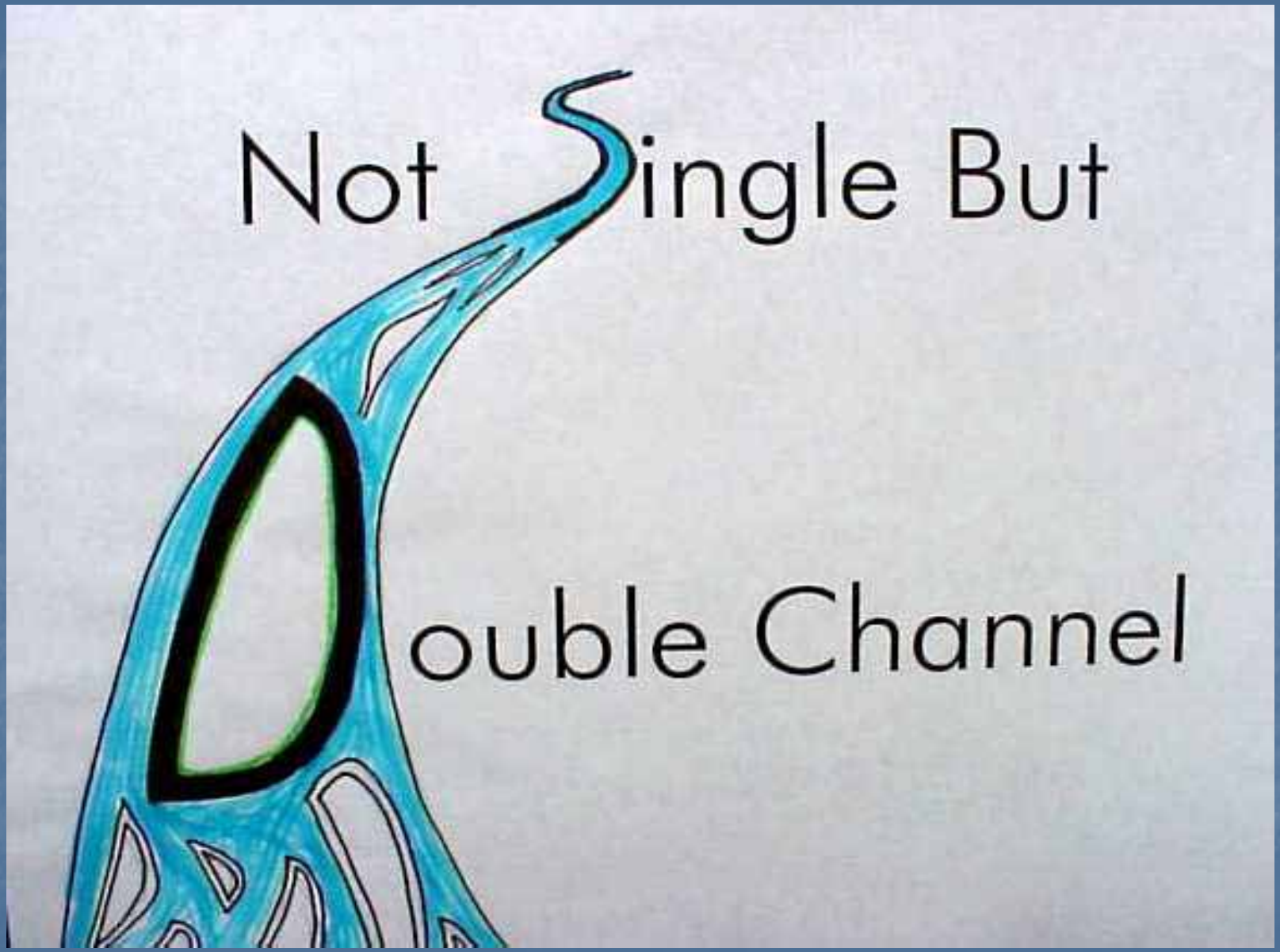
W/D > 12 Sinuosity > 1.2 ER > 1.4 -2.2 S 2-4%

ommonly

EE **S shape**

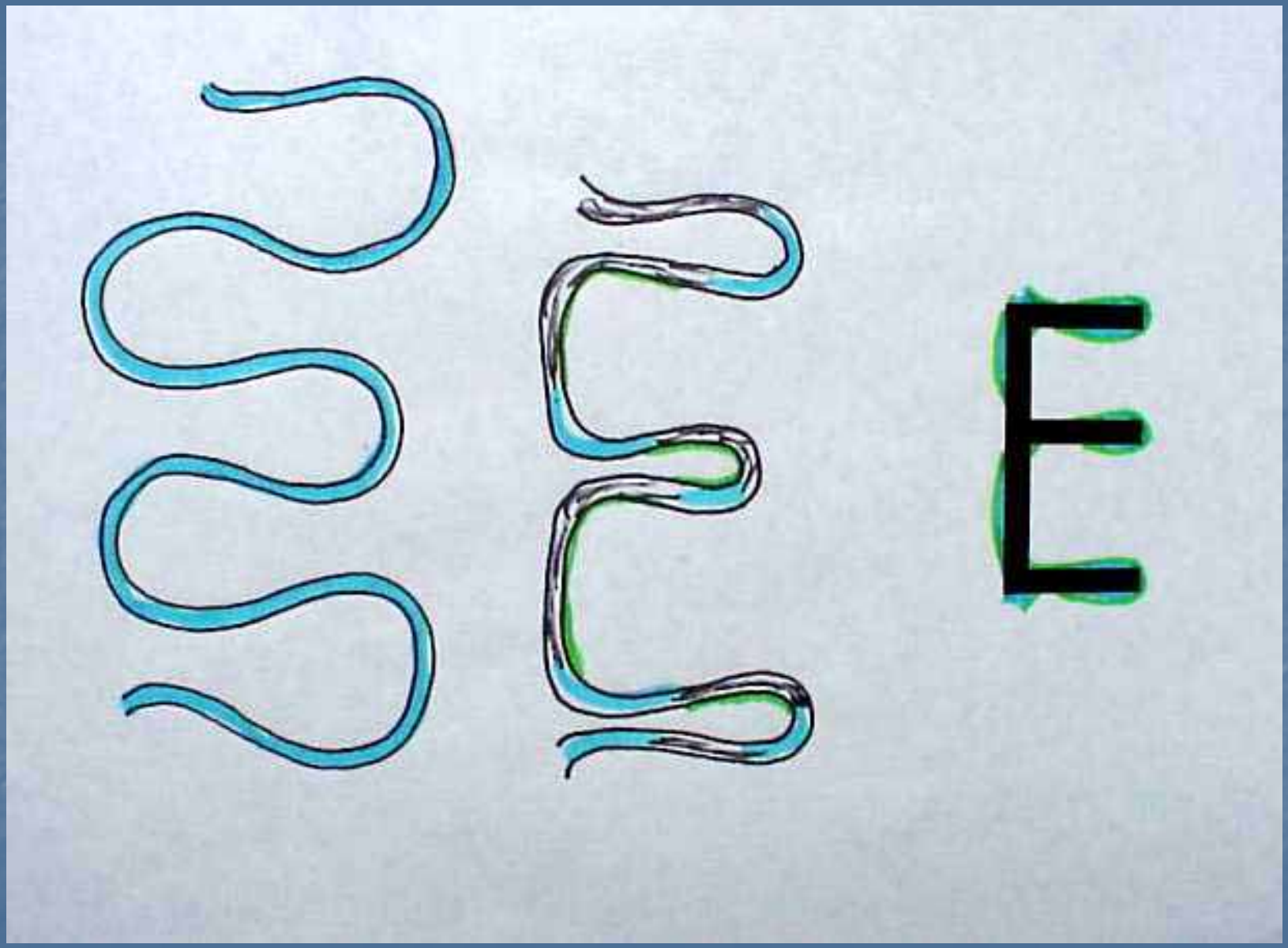
Stream Type: C

W/D > 12 Sinuosity > 1.2 ER > 2.2 S < 2%


Not Single But
Double Channel

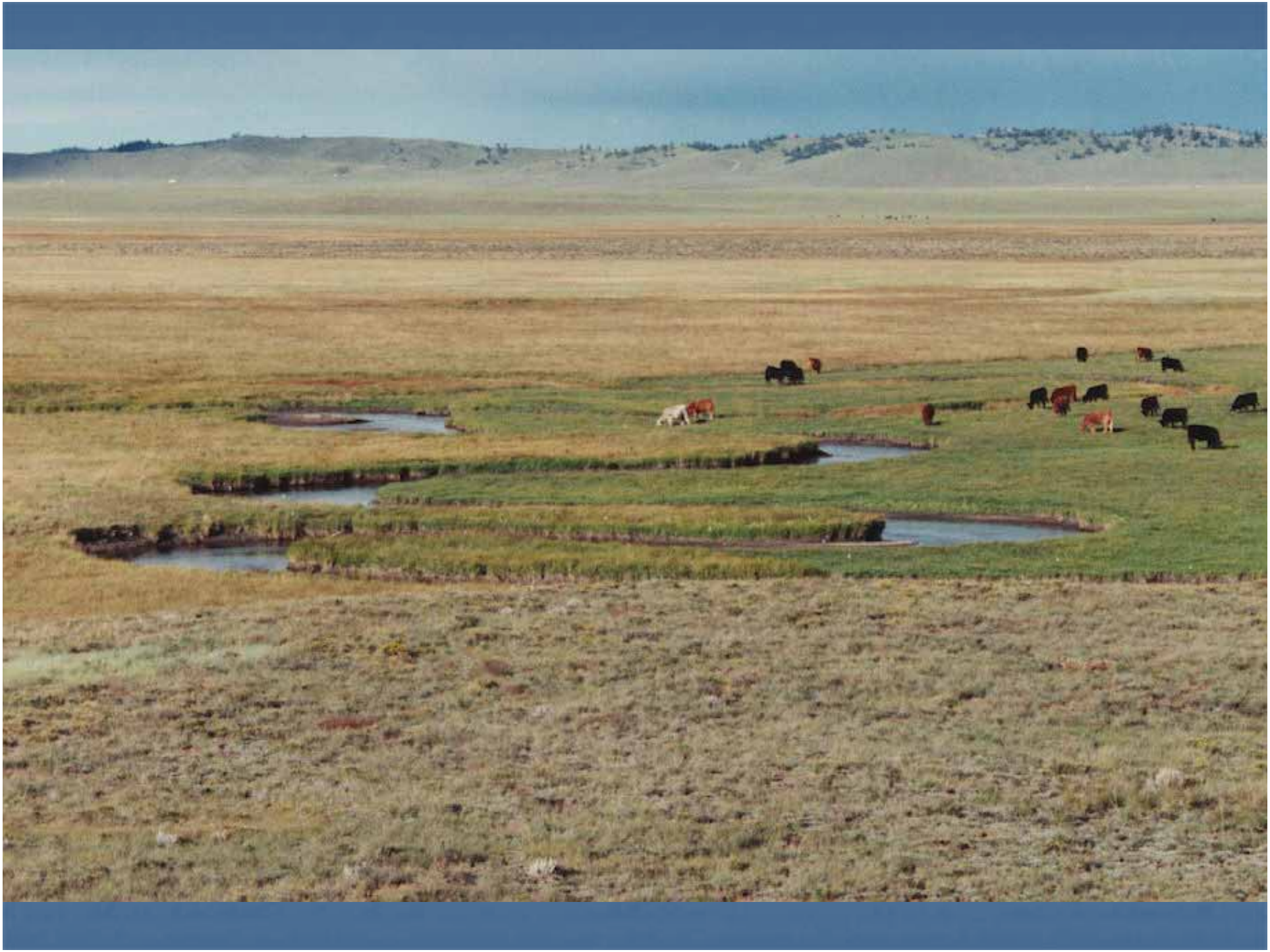
Stream Type: D

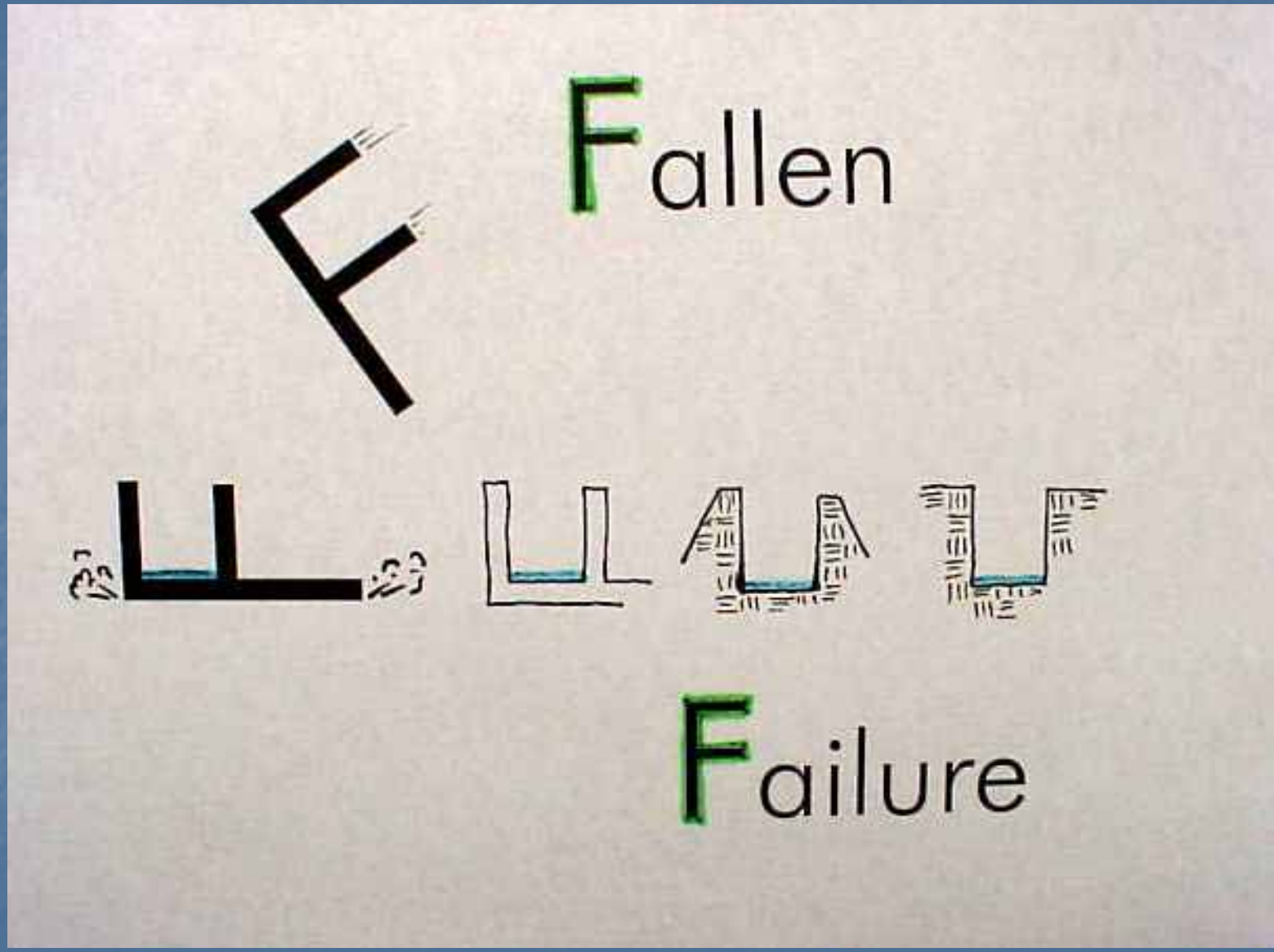
W/D > 40 Sinuosity > 1.2 ER n/a S < 2%



Stream Type: E

W/D < 12 Sinuosity > 1.5 ER > 2.2 S < 2%




Fallen
Failure

Stream Type: F

W/D >12 Sinuosity >1.2 ER <1.4 S <2%


Gully

Stream Type: G

W/D < 12 Sinuosity > 1.2 ER < 1.4 S 2-4%

Three most common channel classification schemes

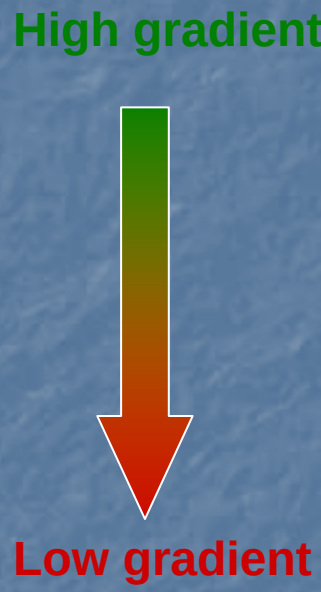
- Strahler stream order
  - Developed in 1950s;
  - Simple, but scale dependent!
- Rosgen
  - Widely used by management agencies;
  - Claimed to be useful for everything!

Montgomery and Buffington

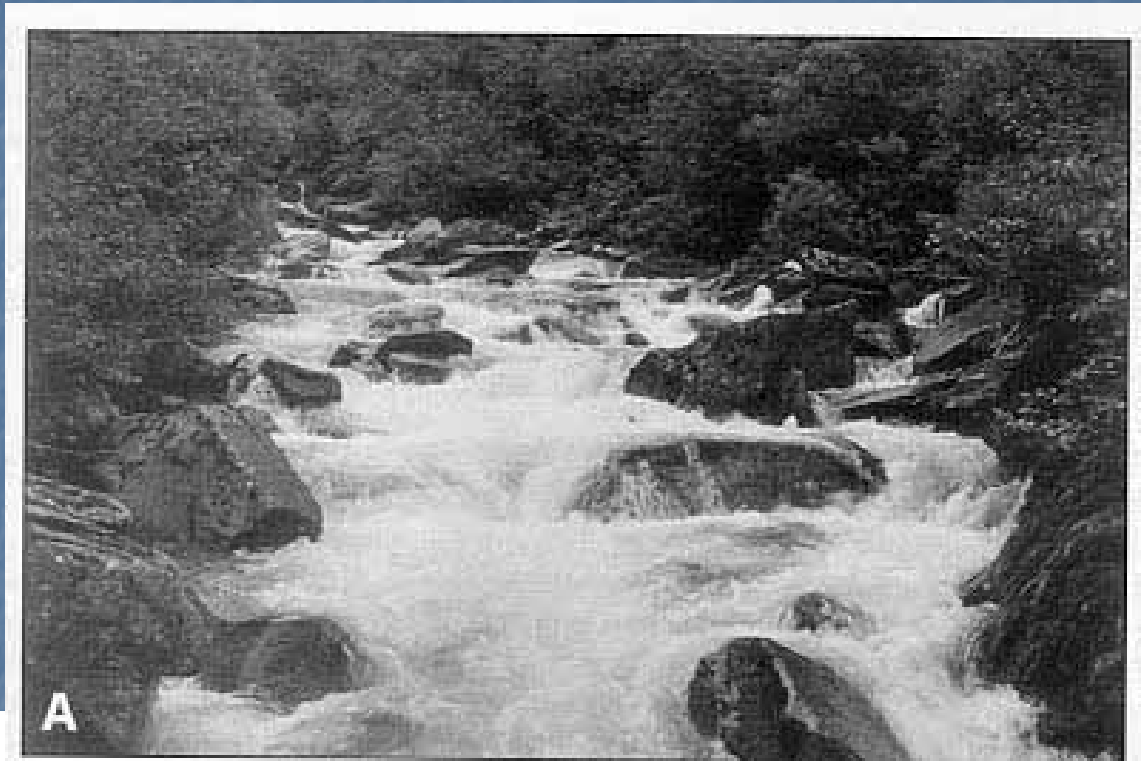
- Developed for the Pacific Northwest;
- Classifies rivers across a continuum, primarily gradient;
- More applicable to mountain rivers;
- Primarily alluvial channels (not bedrock as channel is able to form its bed with available sediment;

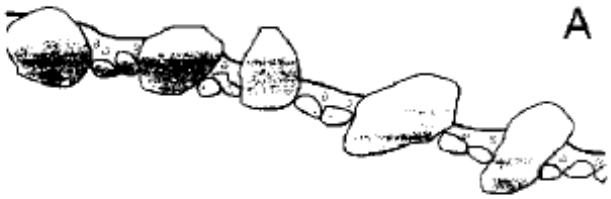
Montgomery and Buffington

- **Cascade**
- **Step-pool**
- **Plane bed**
- **Pool-Riffle**
- **Dune-Ripple**

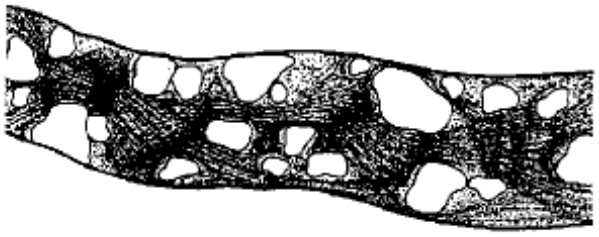


Cascade Channel



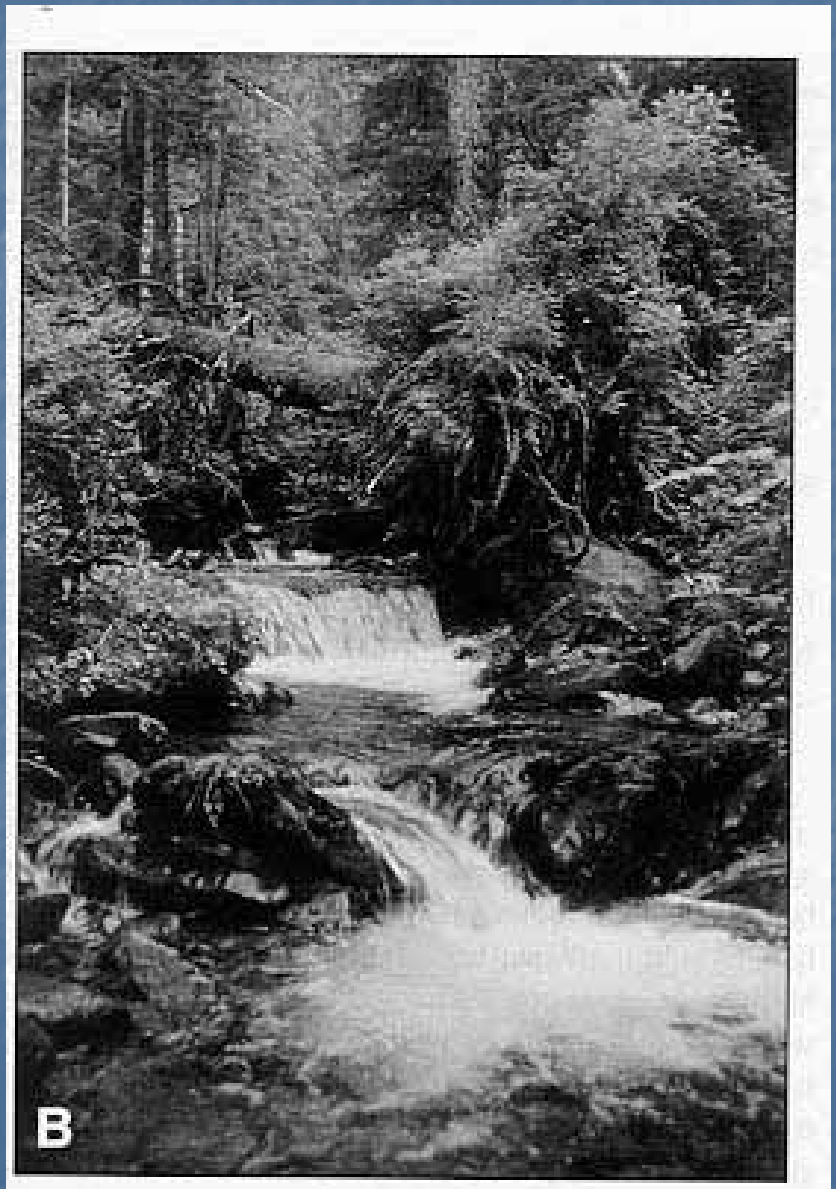


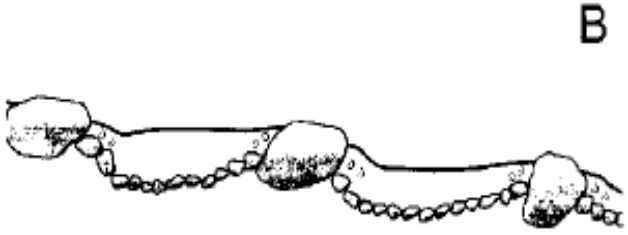
Profile



Plan view

Step-pool Channel

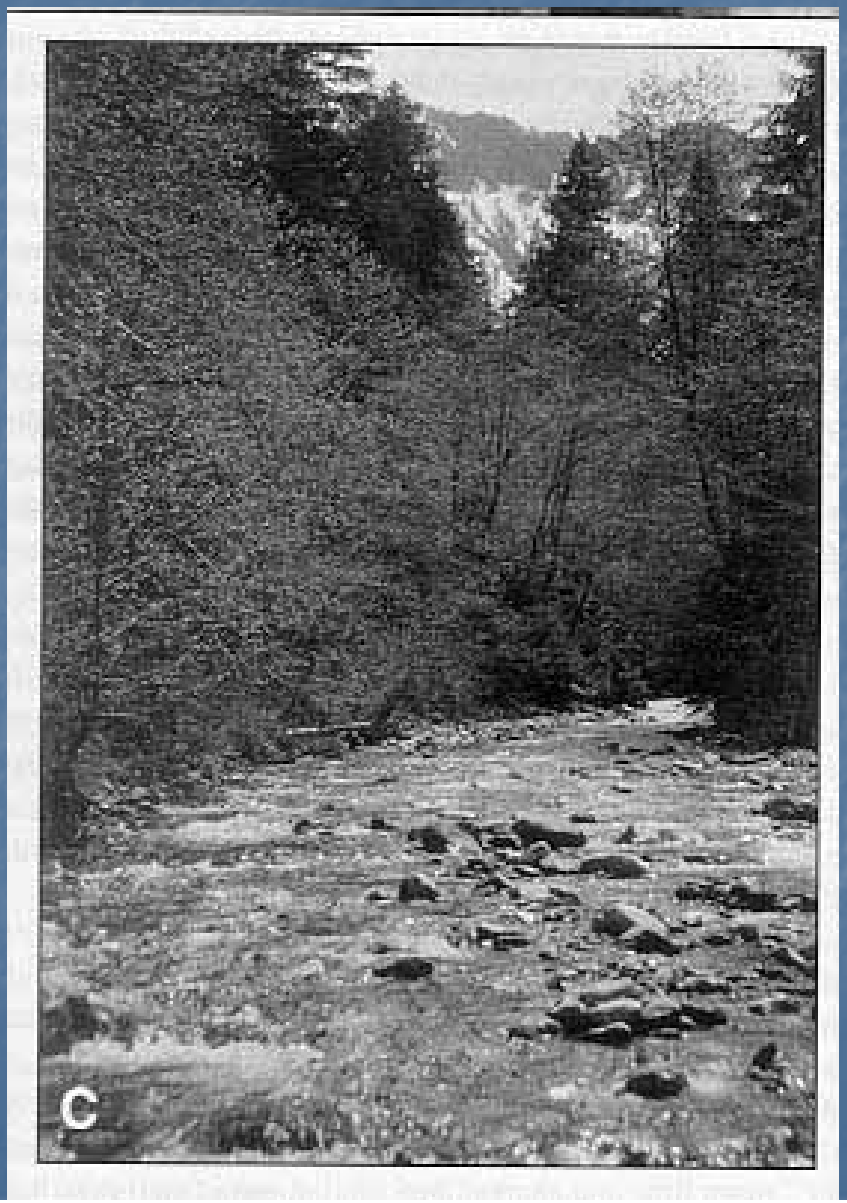


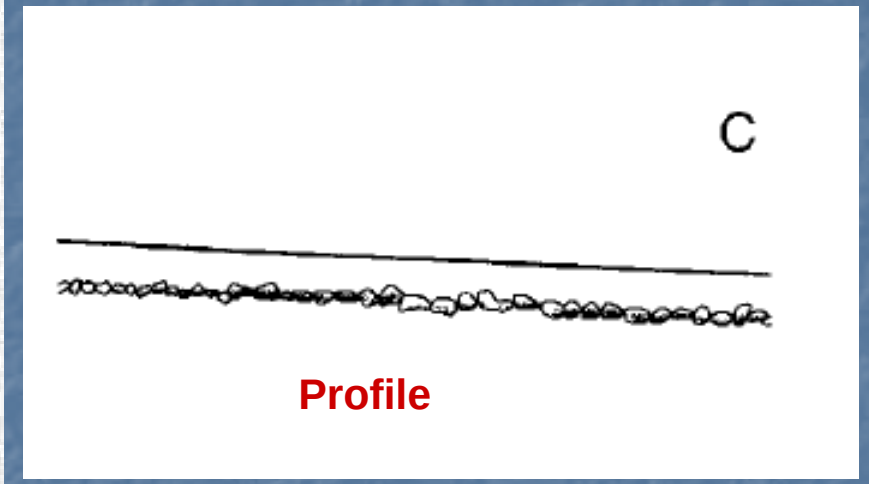


Profile

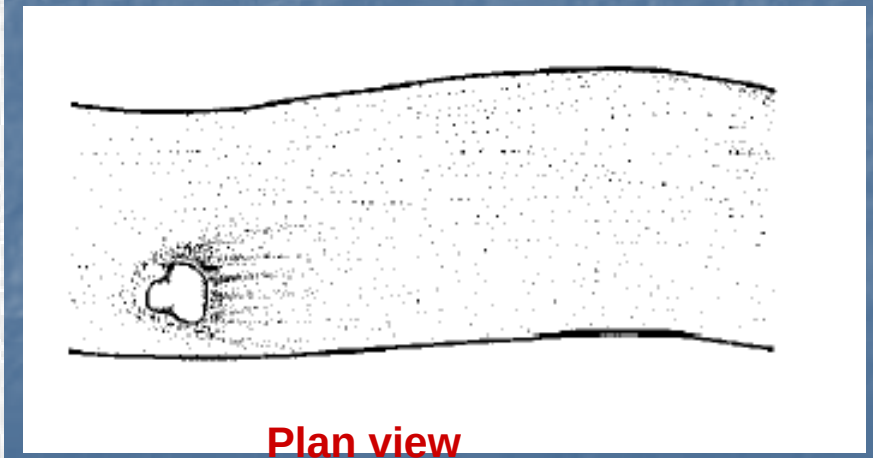
Plan view

Plane-bed Channel





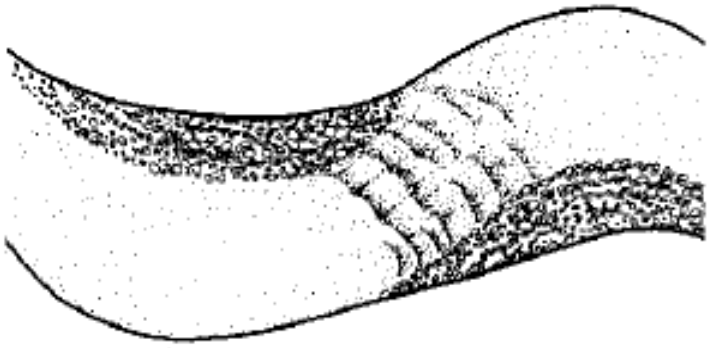
Profile



Plan view

Pool-riffle Channel

Profile



Plan view

Dune-ripple Channel

Profile

Plan view

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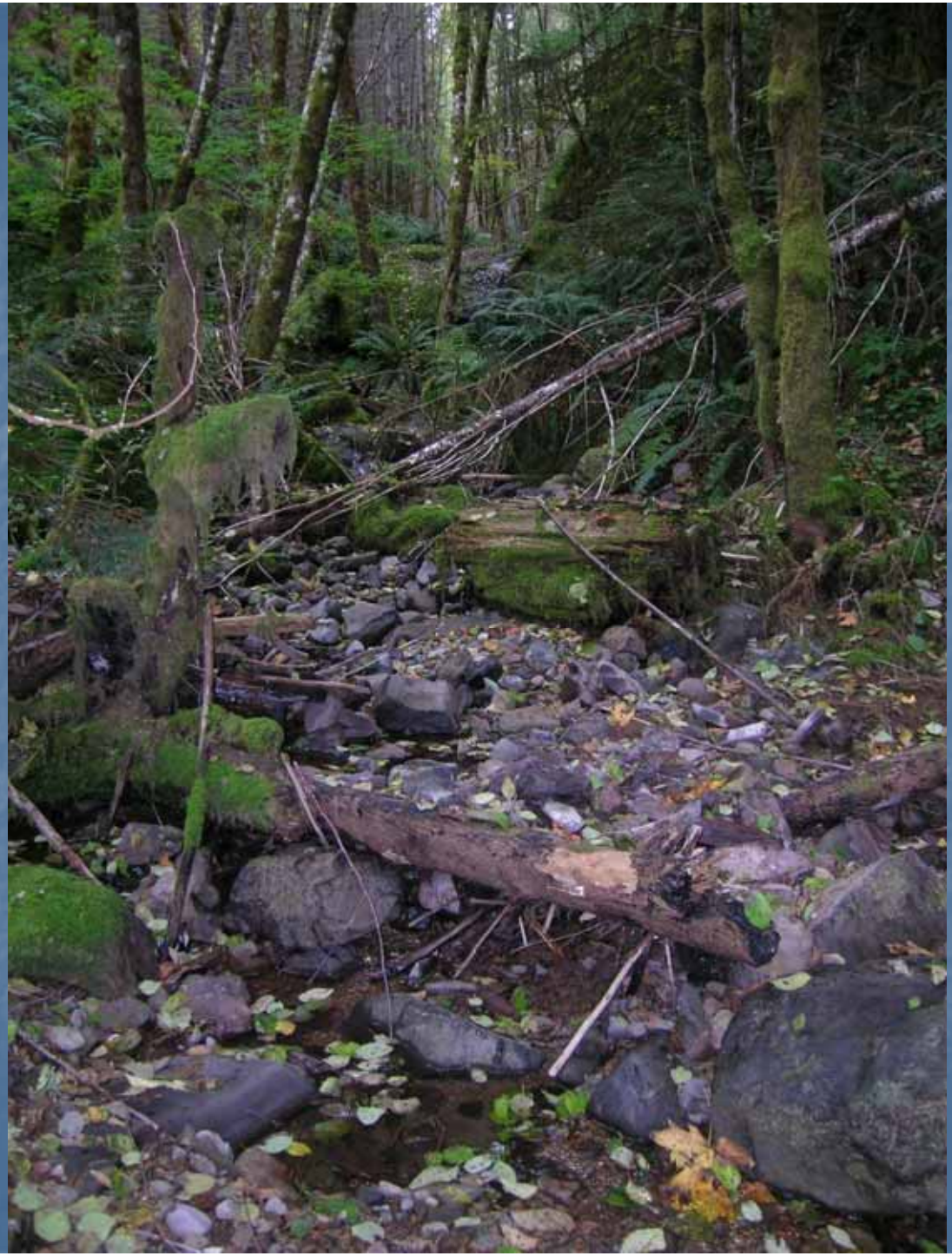


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