September 26th & 27th, 2016
Marriott Gateway on the Falls
Niagara Falls, Ontario

NATURAL CHANNELS Linking Processes to Practice

NCS Design Approach

Biology/Ecology Primer

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Biology/Ecology

- Key biological principles that are applied
- Need to speak the same language
- Link between geology, watershed dynamics, the channel and aquatic habitat
- How fish use channel morphology and hydrology for their life stages
- Importance of the stream corridor to aquatic habitat

Biological Processes – Points to Remember

- Animals are intrinsically linked to the physical, abiotic and biotic system they live in
- Simple cause:effect relationships are rare
- Temporal conditions and specific channel features play a significant role in biotic life cycles

Temporal = related to a length of time. Can be over years, seasons, months etc…

Comparing Two Major Types Of Ecologists

- Bio-ecologists;
  - Perceive and define an ecosystem based upon the use by the organism (bio-centric);
- Geo-ecologists
  - Perceive and define an ecosystem based upon the geo-physical system that defines the opportunities for an organism (geo-centric)

Using Different Language

- Aquatic Biologist Parameters
  - Species, length, weight, scale count, velocity, food composition, substrate size, instream cover, spawning substrate composition, maximum/minimum/optimum temperatures
- Geomorphologist Measurement Parameters
  - Width:depth ratio, bankfull discharge, radius of curvature, meander geometry, amplitude, stream slope, D_{50}/D_{84}, bedload transport
- Engineers Measurement Parameters
  - Hydraulic radius, Reynolds Number, Froude Number, stream power, shear stress, flow frequency, magnitude, etc.

BUT……

ALL THESE VARIABLES CAN APPLY TO THE SAME STREAM!.....

And all could be relevant in the management and restoration of a particular stream….

therefore we must create context in order to link these variables

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

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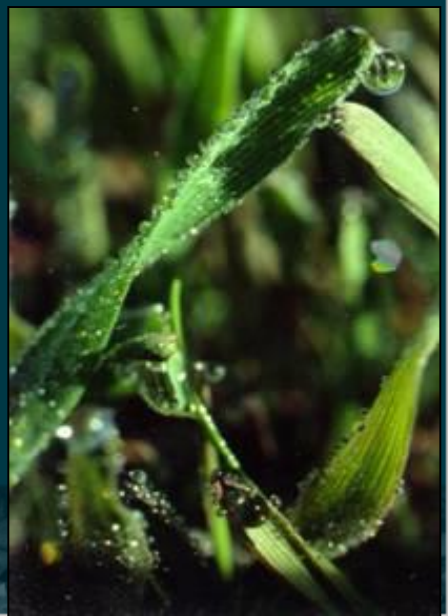
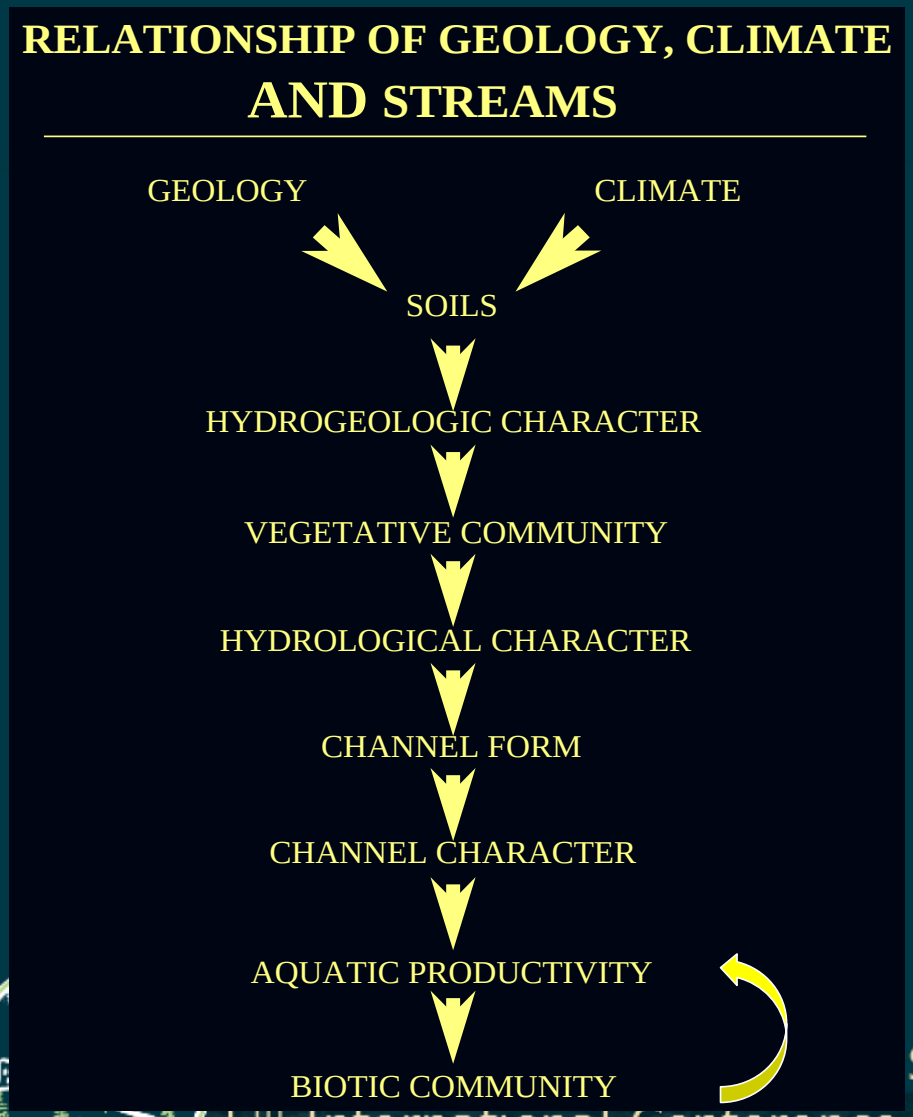


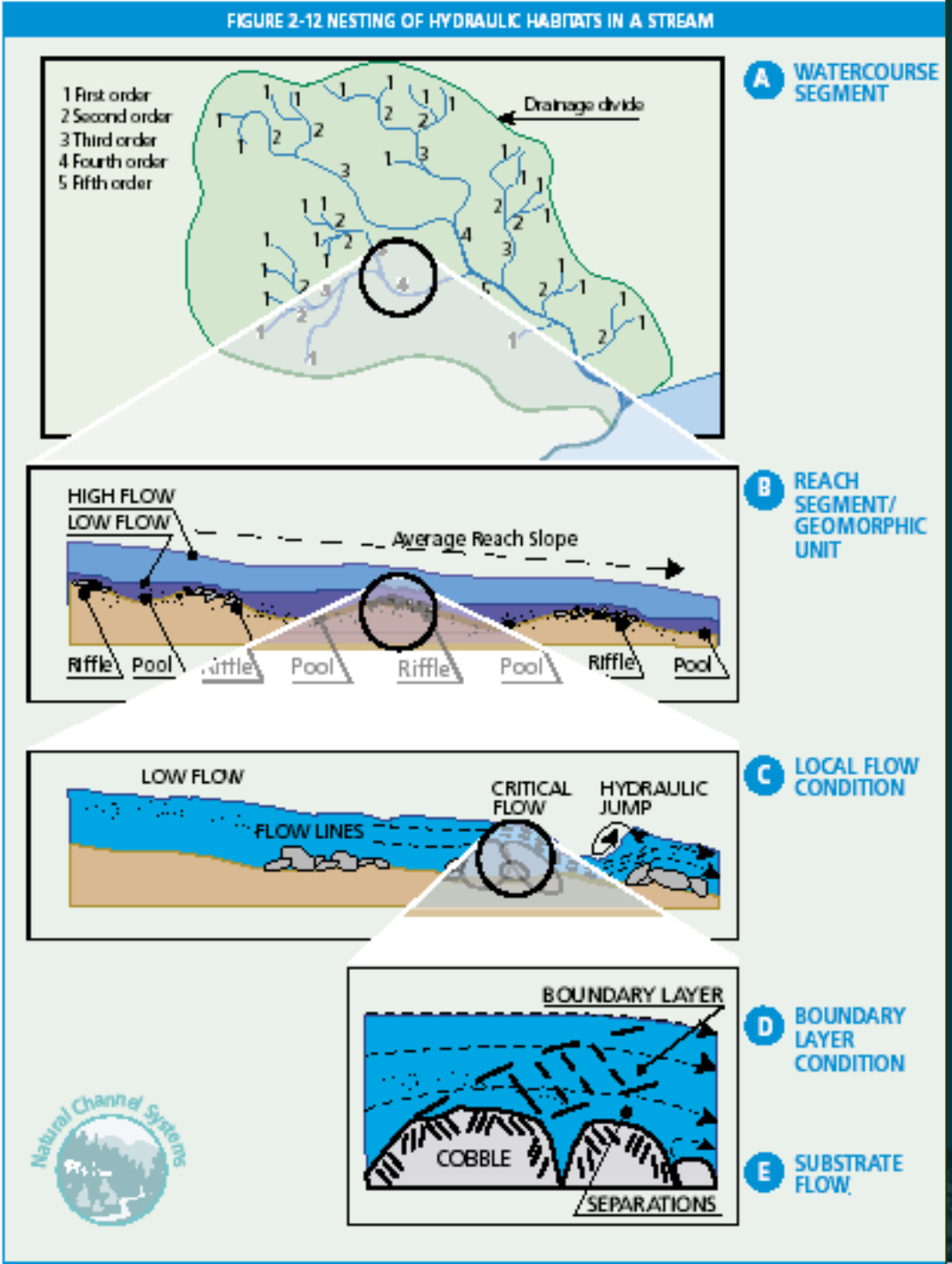
Driving our Aquatic Ecosystems



- At various spatial scales, there are drivers that exert direction and control
- These control conditions at finer scales that ultimately provide for the life of animals in our watersheds

FROM FISH SCALES TO TEMPORAL & SPATIAL SCALES

- **The Role of Geology**
  - Conditions the potential for movement of water over and through the watershed
  - Conditions the chemical make-up of the water
  - Conditions the potential for sediment composition to the river and watershed
  - Conditions the potential fish community distribution
  - Creates the opportunities for various communities of animals and plants

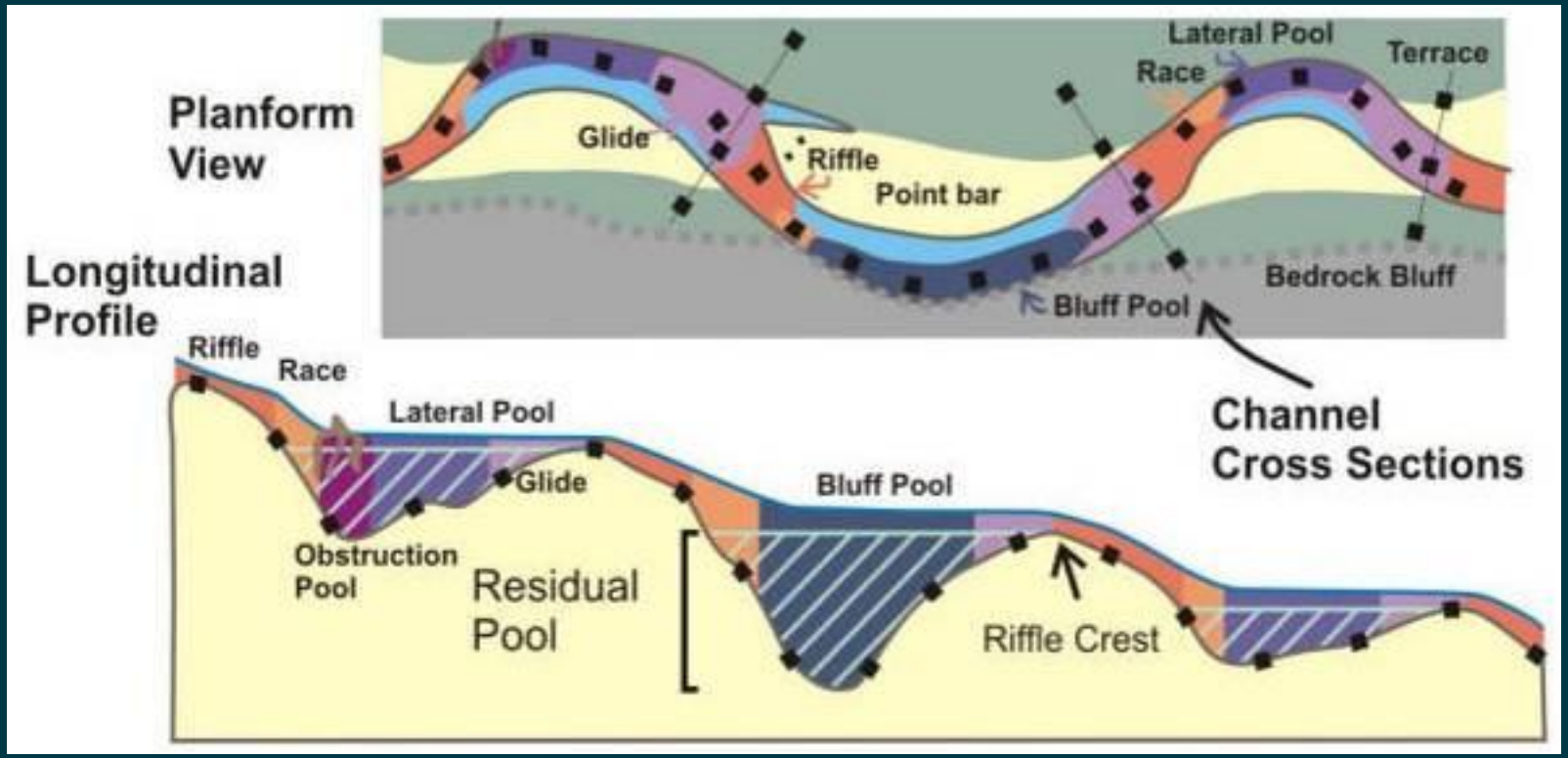


Animals operate at multiple scales (e.g. migration, feeding, reproduction).

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

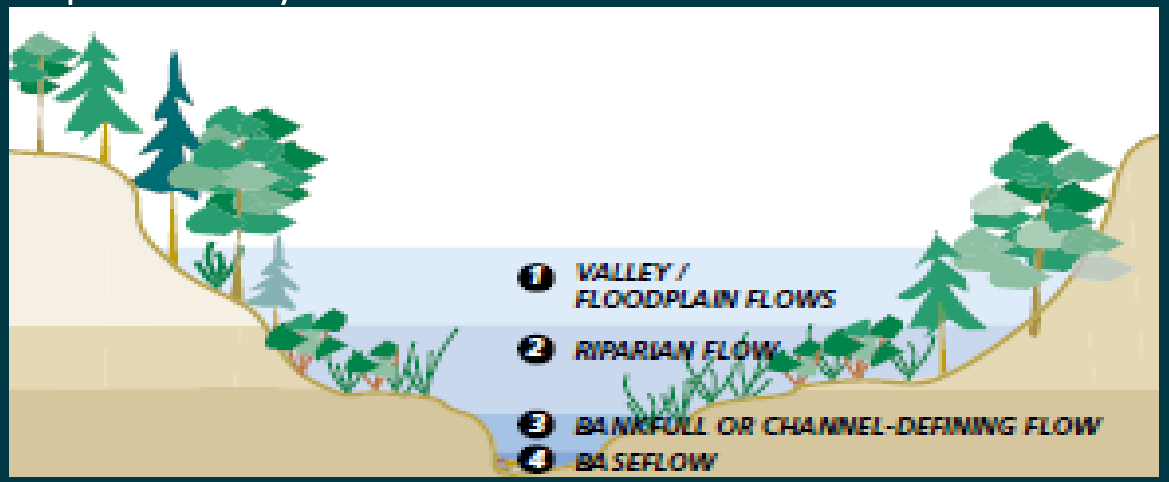
From: Newbury and Gaboury 1993

Species Use Habitat In Four Dimensions And Often Specific To The Species



Flow Stages and Ecological Interactions

1. Baseflow Flow – Minimum living space and limits annual productivity
2. Bankfull Flow – Channel forming flow that creates baseflow channel structure
3. Riparian/Floodplain Flow – Helps influence bankful channel forming flow
4. Valley Flow – Sculpts valley form and function



Habitat Use In Rivers

- There are general elements important to a fishes survival in rivers:
  - Water Quality and Quantity (including temperature)
  - Food
  - Shelter (from water current, predators, etc.)
  - Space (watershed and channel structure and connectivity)

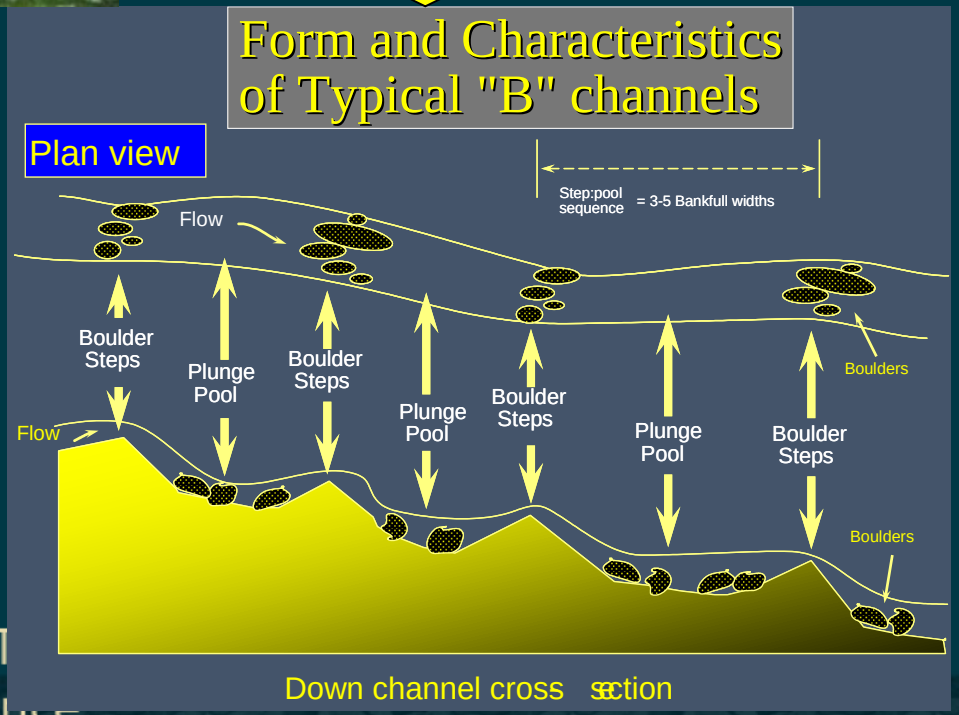
For each element we must understand the habitat requirement of the species or community

All Habitats Are Not Created Equal:

Defined as locations (in space and/or time) which structure or control life cycle dynamics of a community or species (e.g. pike spawning in floodplains)

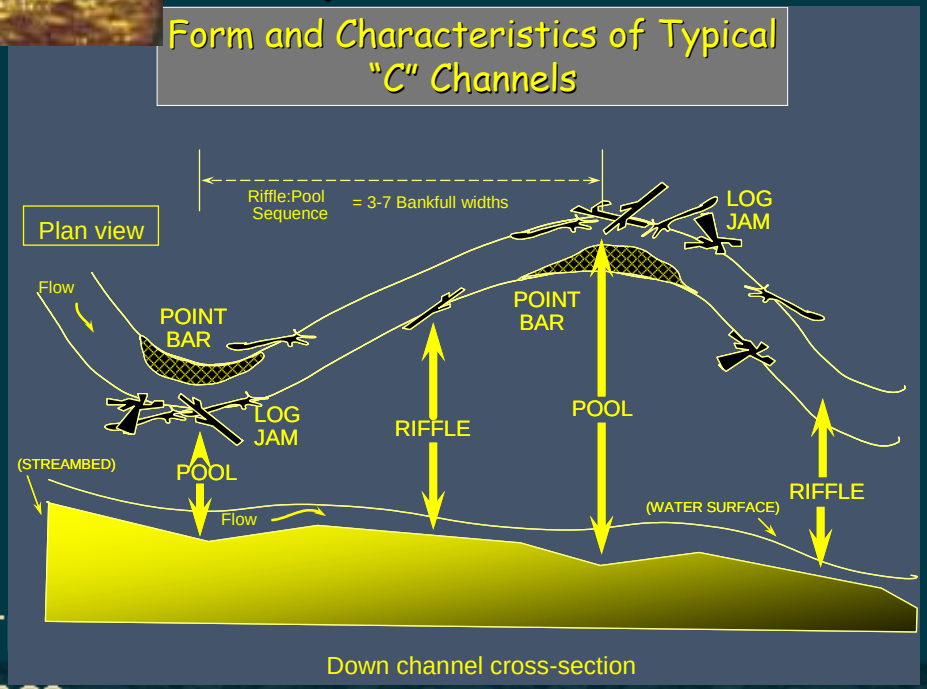
Higher Gradient, “B” Channels provide extensive cover for juvenile and adult fish, especially trout

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 habitat

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.



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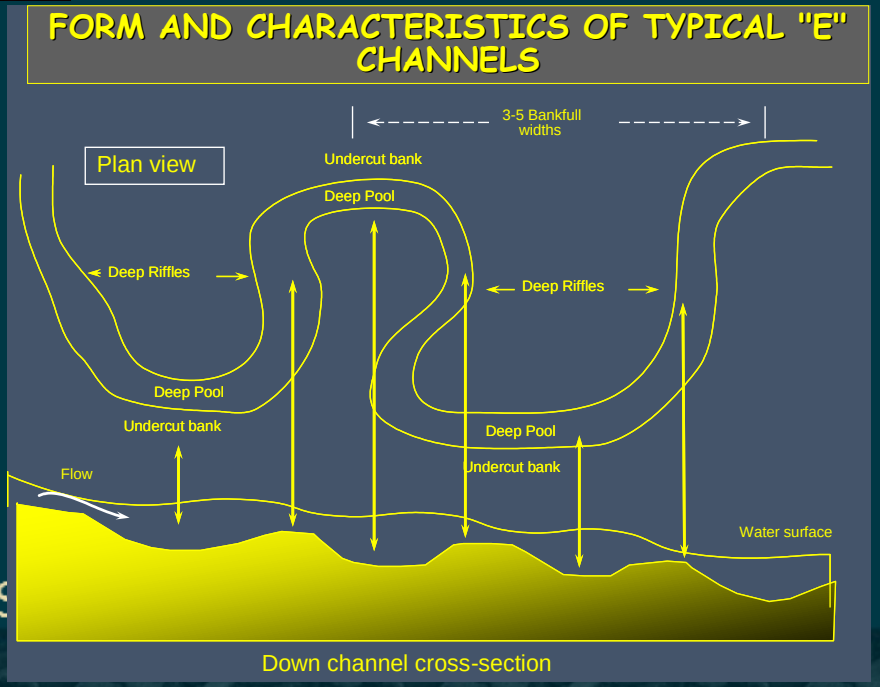
"E" Channels are extremely narrow and deep creating enormous amounts of habitat for juvenile and adult fish

Found in flat bottomed valleys in wetlands. Dissipate energy purely through lateral roughness at high flows. The channel is held together by the deep roots of wetland shrubs and grasses. Ideal for a few specialized fish species (e.g. brook trout or northern pike).



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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)

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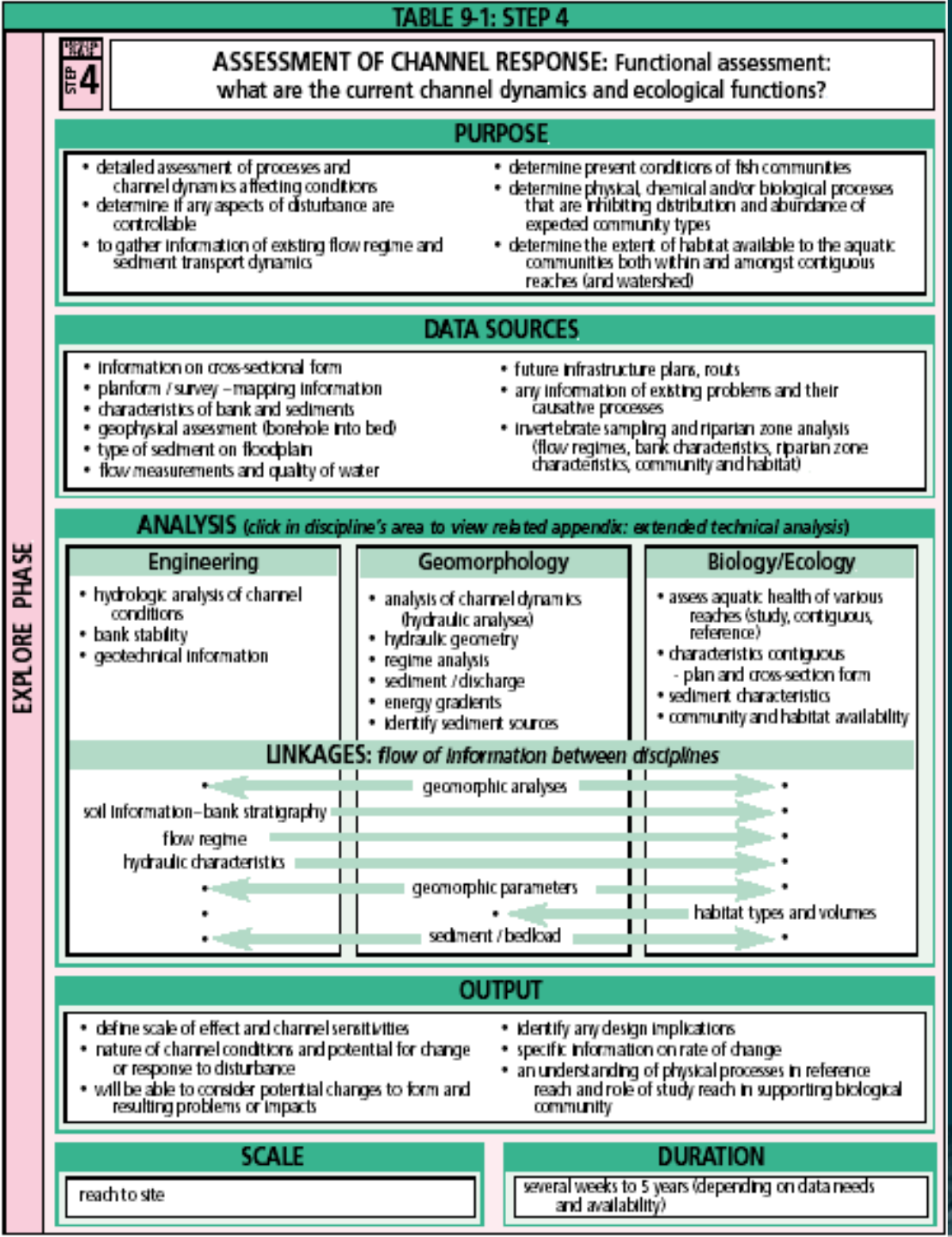

Development of specific design methods for each discipline and an example for each step on how they interact.