# Physical and Chemical Stream Ecology

## Major differences between lakes and streams

*How does the direction of major water movements differ between lakes, reservoirs, streams, and wetlands?*

*How do the land forms differ to create a stream versus a lake?*
(Globally, lakes hold 100X more water than rivers and streams)

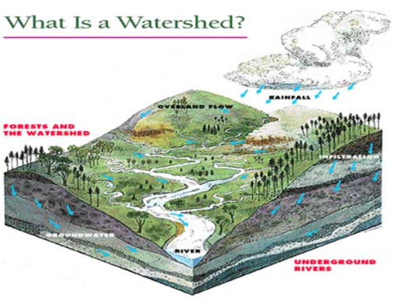
1) **Hydrological** - high velocity, unidirectional flow.

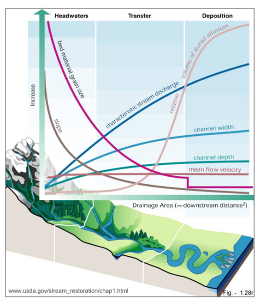
**Current velocity** = distance/time
Velocity is a function of **depth**, **slope**, **roughness** of the stream bed, and **hydraulic radius**.

**Discharge** = volume/time *How is this measured?*
Discharge is a function of width, depth and velocity.

*Can velocity vary greatly within a few meters along a stretch of stream? If no other water is entering or leaving that same stretch of stream, will discharge vary greatly over that same stretch?*

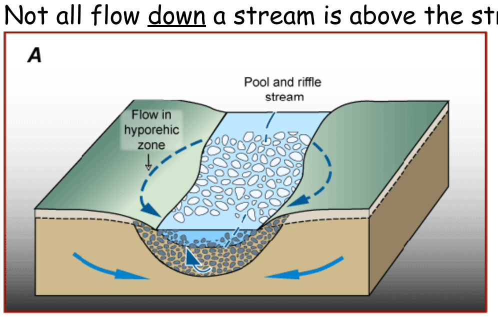
*How must discharge vary from upstream to downstream?*



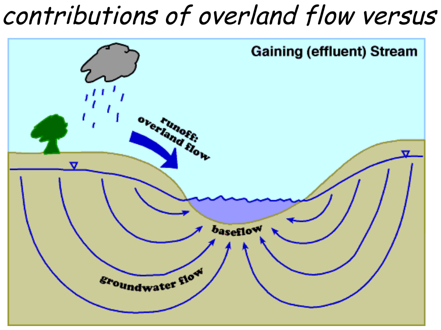



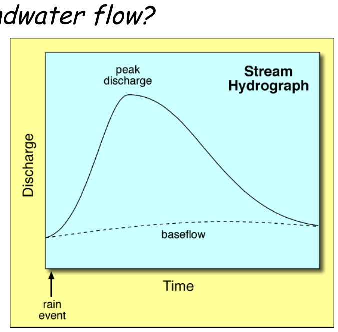

*Surprisingly, flow velocity does not decrease downstream despite the decrease in slope (gradient). Why?*

Not all flow <u>down</u> a stream is above the stream bottom: **Hyporheic zone**




Nor is all flow <u>into</u> the stream directly from surface runoff (overland flow)
Some moves into streams as groundwater (explaining perennial streams). *What factors might effect the relative contributions of overland flow versus groundwater flow?*

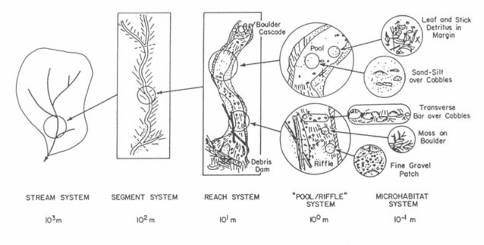


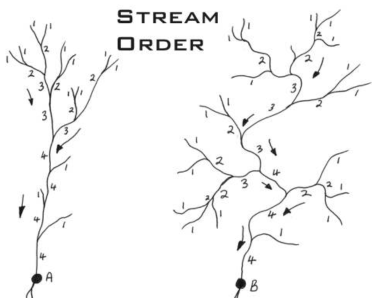
*What happens if the water table is below the deepest part of the stream?*

*How might temporal **variability** in physio-chemical properties of stream water differ between overland flow versus base flow?*

2) **Stream morphometry** - more predictable than lakes which are formed several ways.




- Streams widen as tributaries come together

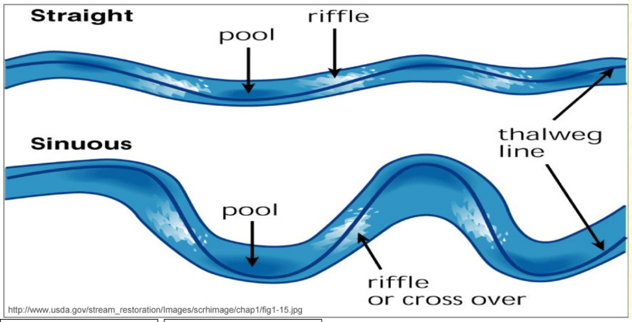


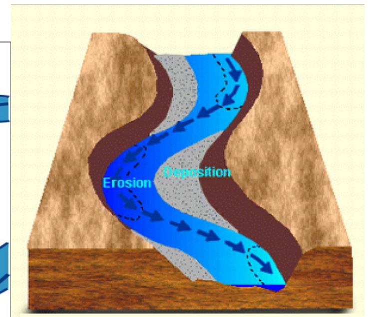

*Why does the shape of branching patterns differ?*

*Given that streams widen, what happens to the amount of light striking the stream surface as one moves downstream?*

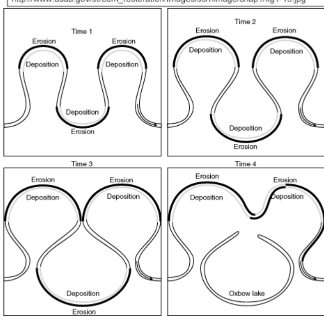
*How would [bottom sediment size] change from upstream headwaters to downstream rivers?*

- [Meander] (wave) lengths [7-10 stream widths]. *Which bank is [erosive and which is depositional]? What then happens to the amplitude of meanders over time?*

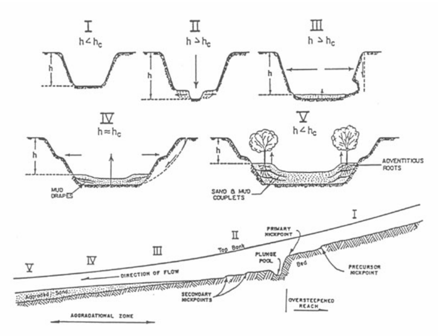


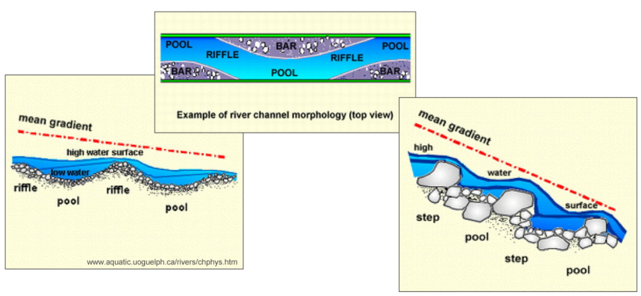
A meander becomes more pronounced as the streamline shifts between the river banks.




*What happens to [cross-sectional morphology over time]? When does most erosion occurs?*

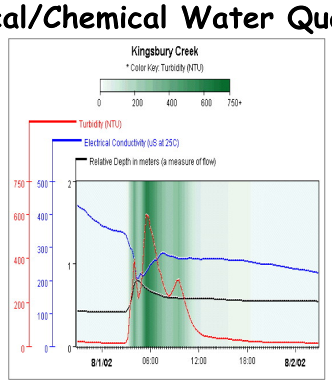


- Alternating riffles and pools (sections of high and low current) with riffles 5-7 stream [widths] apart.




Slopes toward banks often alternate

3) **Physical/Chemical Water Quality**- temporally less predictable than lakes. *Why?*



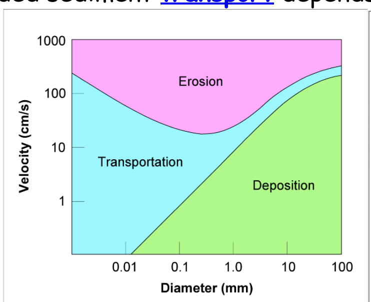
**Load = concentration (mass/volume) * discharge (volume/time)**, *so might load of a given substance vary over time?*

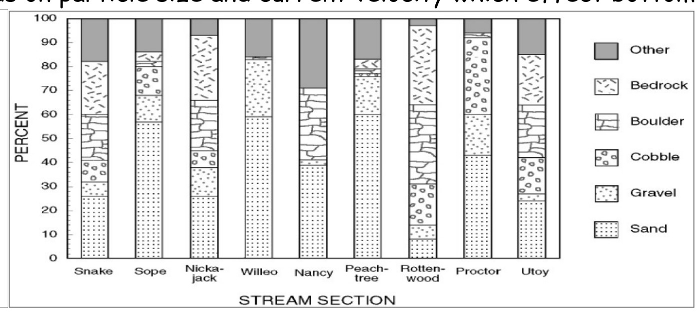
*Could load of a substance increase but concentration decrease after a rain event?*

*Why might load increase after a rain event?*

*How might load of a pollutant vary between "[point" and "non-point" sources]?*

Suspended sediment **[transport]** depends on particle size and current velocity which effect bottom substrate:



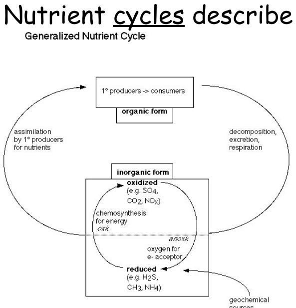

*Which nutrient would you expect to flucuate more, nitrogen or phosphorus as a function of sediment transport?*

Several factors affect the diffusion of gases into and out of the stream including stream slope and velocity, and water temperature. *Would dissolve gases be nearer to equilibrium with the atmosphere in a lake or a stream?*

*What would strong diel fluctuations in oxygen and carbon dioxide within a stream suggest?*
*How might we explain a stream that consumes more oxygen than it produces over its length over a given 24 hour period?*

**Nutrient spiraling:**

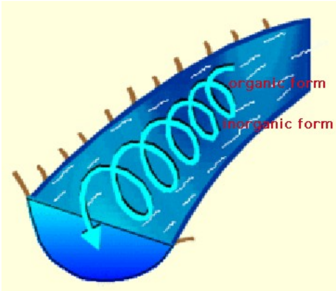
Nutrient cycles describe changes in nutrient states through time and usually do not consider a spatial component:




But water in streams have a strong spatial component!
Because these nutrient cycles occur simultaneously with downstream transport nutrient transformations in streams are conceptualized to as nutrient "spiraling", so that the state that a nutrient is in is also a function of its distance downstream:

(don't take this diagram literally)

"The spiraling length represents the distance over which the average nutrient atom travels as it completes one cycle of utilization from a dissolved available form, passes through one or more metabolic transformations and is




returned to a dissolved available form." (from http://www.stroudcenter.org/research/nyproject/SpiralingMetabolism.htm)

Spiralling length = distance transported in its inorganic state (often as a dissovled ion in stream water) + distance transported in its assimulated state within organisms

The spiral length is usually shorter (and hence rate of downstream transport is slower) if:

- the nutrient is retained longer in particulate form (i.e. it is less transportable). *What type of conditions might favor this?*
- the utilization of the nutrient is more efficient/intense. *What type of conditions might favor this?*

So if ecosystem function has **not** been impaired (i.e. uptake is not reduced and/or load has not been increased):

- the stream retains (stores) nutrients longer (b/c nutrients are more often in a less available and less transportable state)
- may even lose more nutrients to the atmosphere through diffusion (denitrified $N_2$ and respired $CO_2$).

*So what are the implication of impaired streams on eutrophication of lakes?*