Water From a Global Perspective

Water covers ~70% of the earth's surface

97.1% of that is in the oceans

2.24% frozen in ice caps/glaciers

0.61% is groundwater

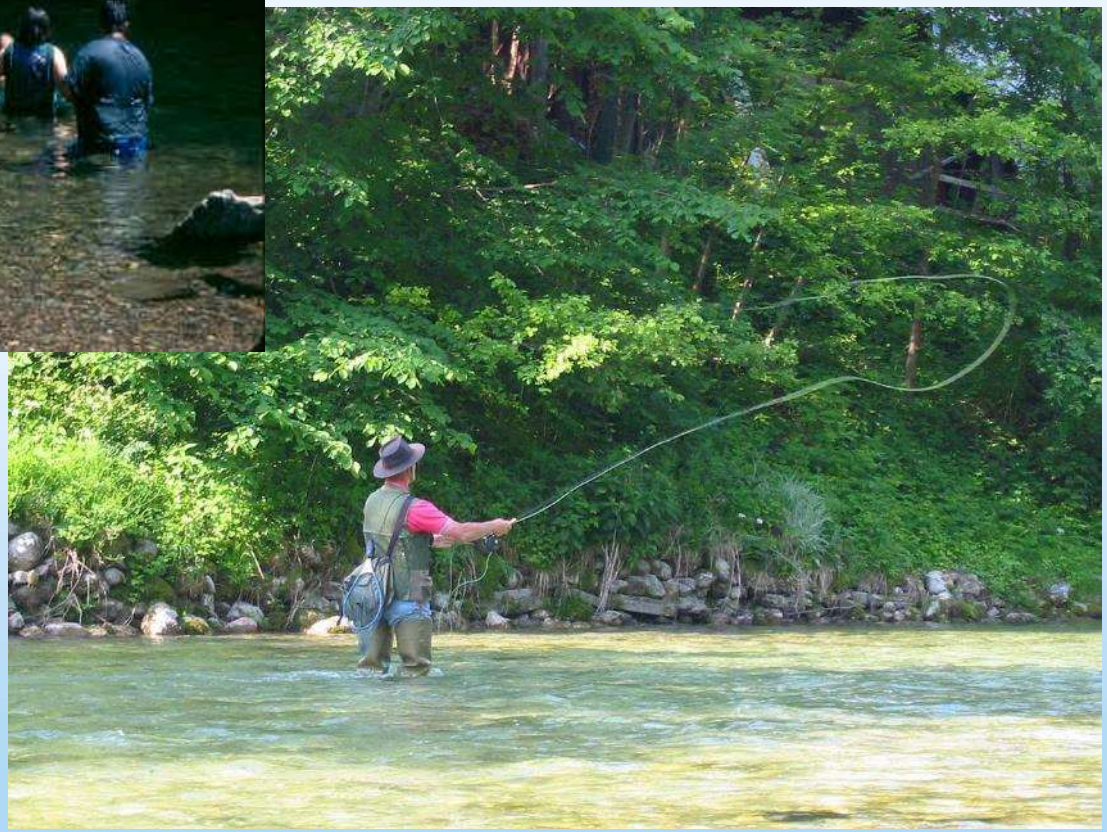
So less than 0.05% of global water is surface freshwater

40% of which is in the Great Lakes and Lake Baikal

a *tiny* fraction of all freshwater is in rivers and streams

So why do (or should) we care about streams?


Nomad




FIRE

Stream Ecology? What's that?

Ecology = the study of how organisms are related to their environment and to other organisms

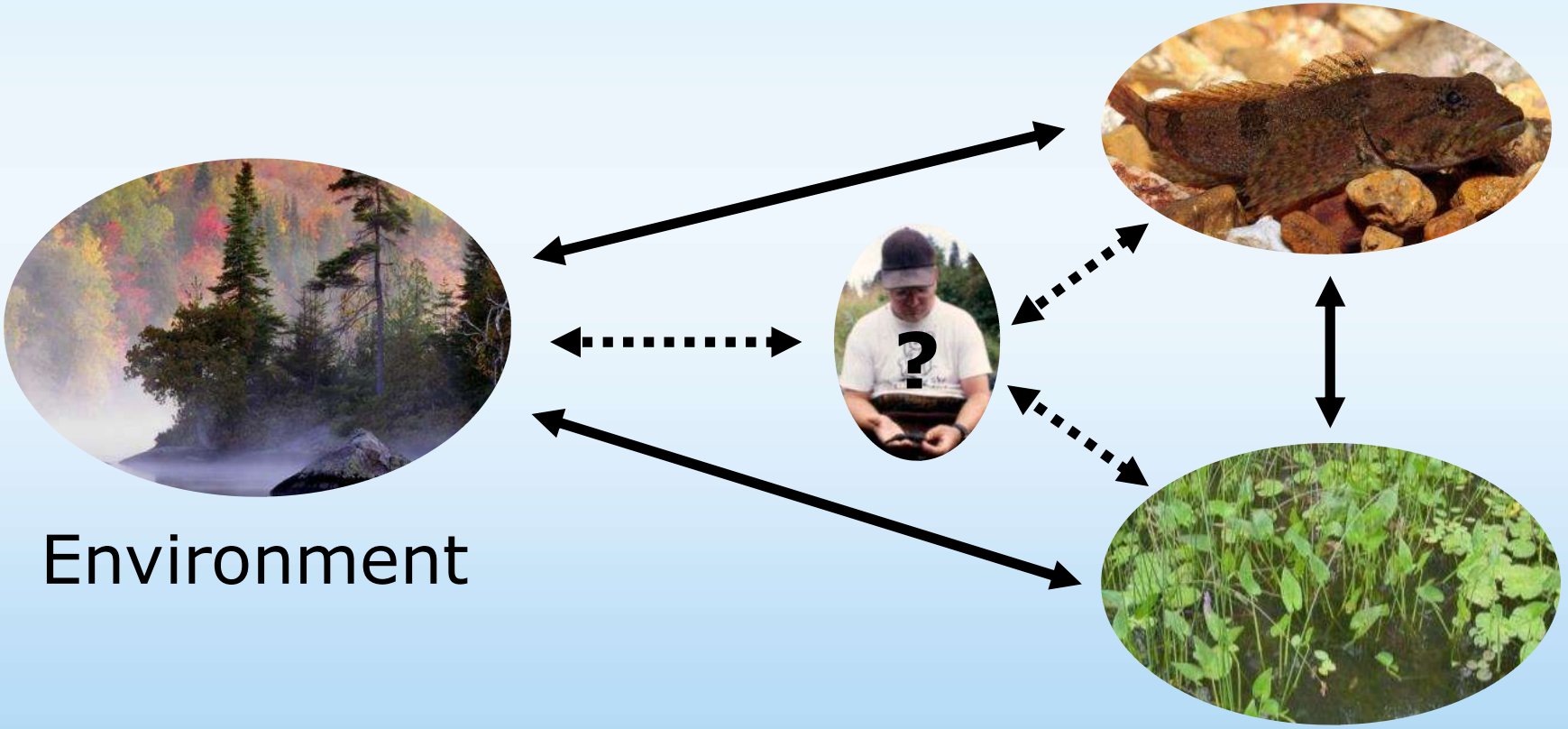
Organisms

Environment

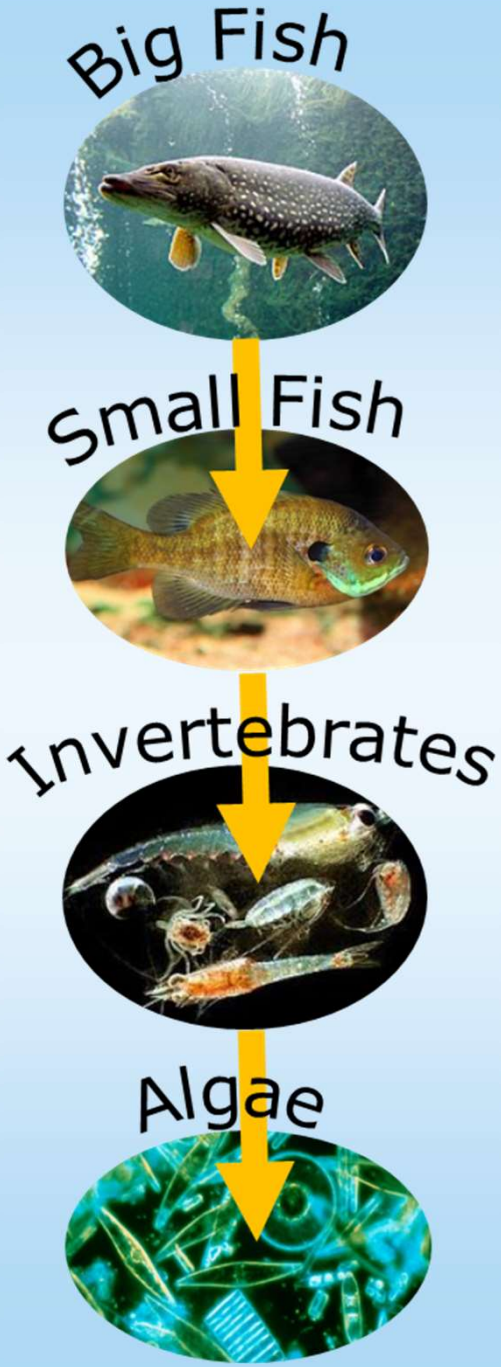
Organisms

Stream Ecology? What's that?

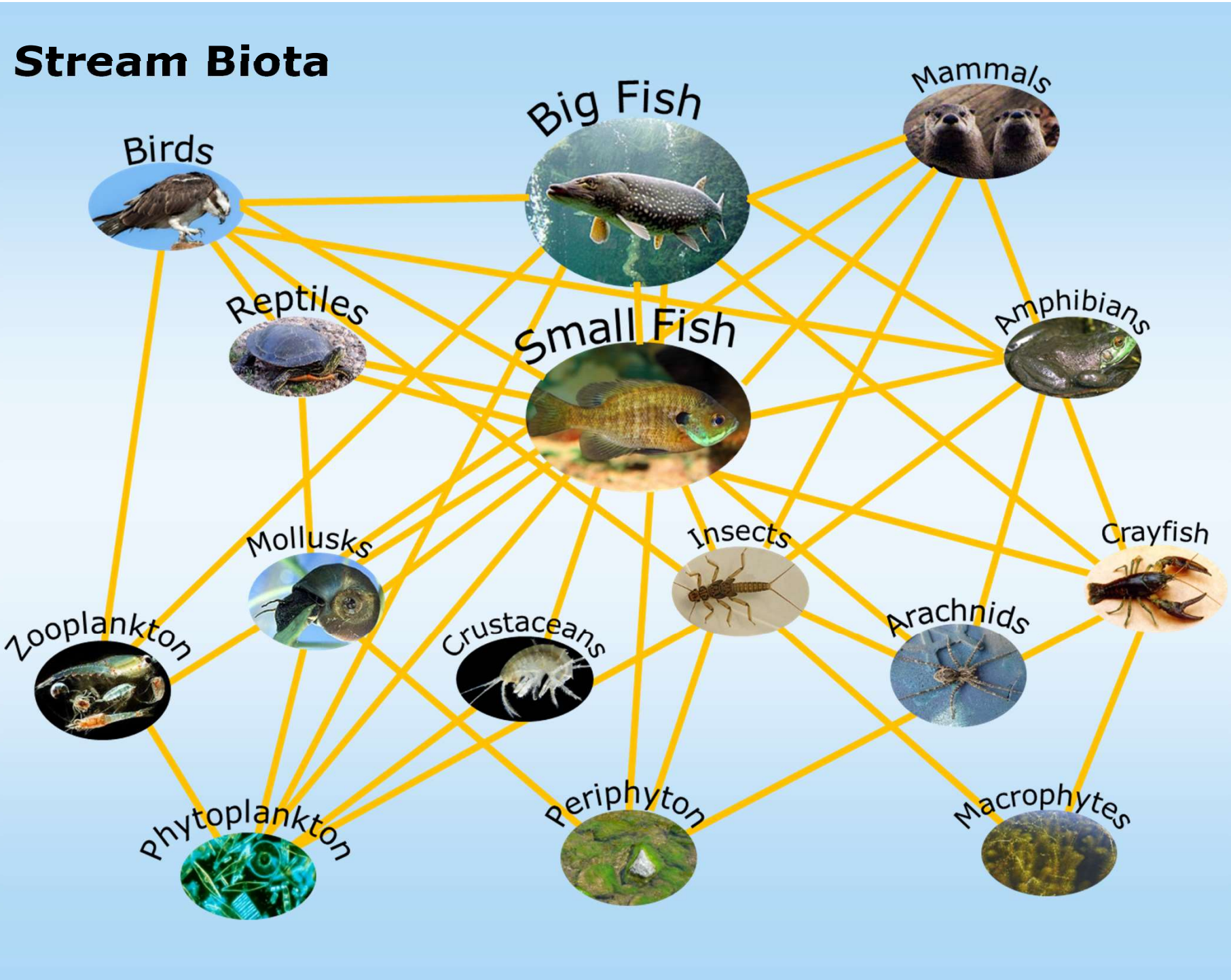
Ecology = the study of how organisms are related to their environment and to other organisms



Stream Biota



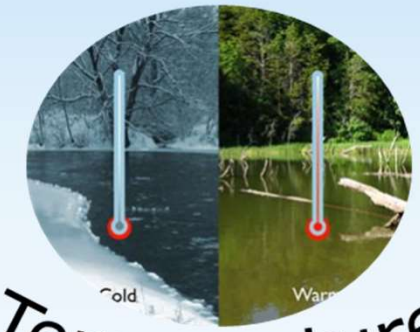
Stream Biota



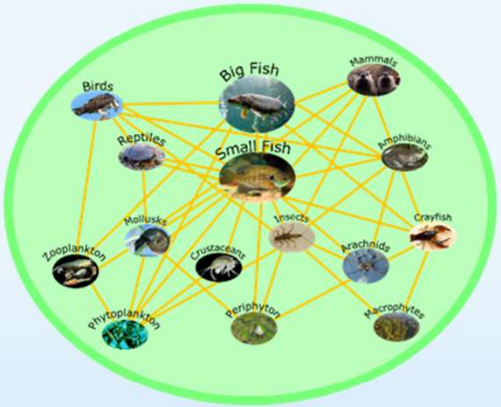
5 Factors Influencing Stream Communities

Light

Flow



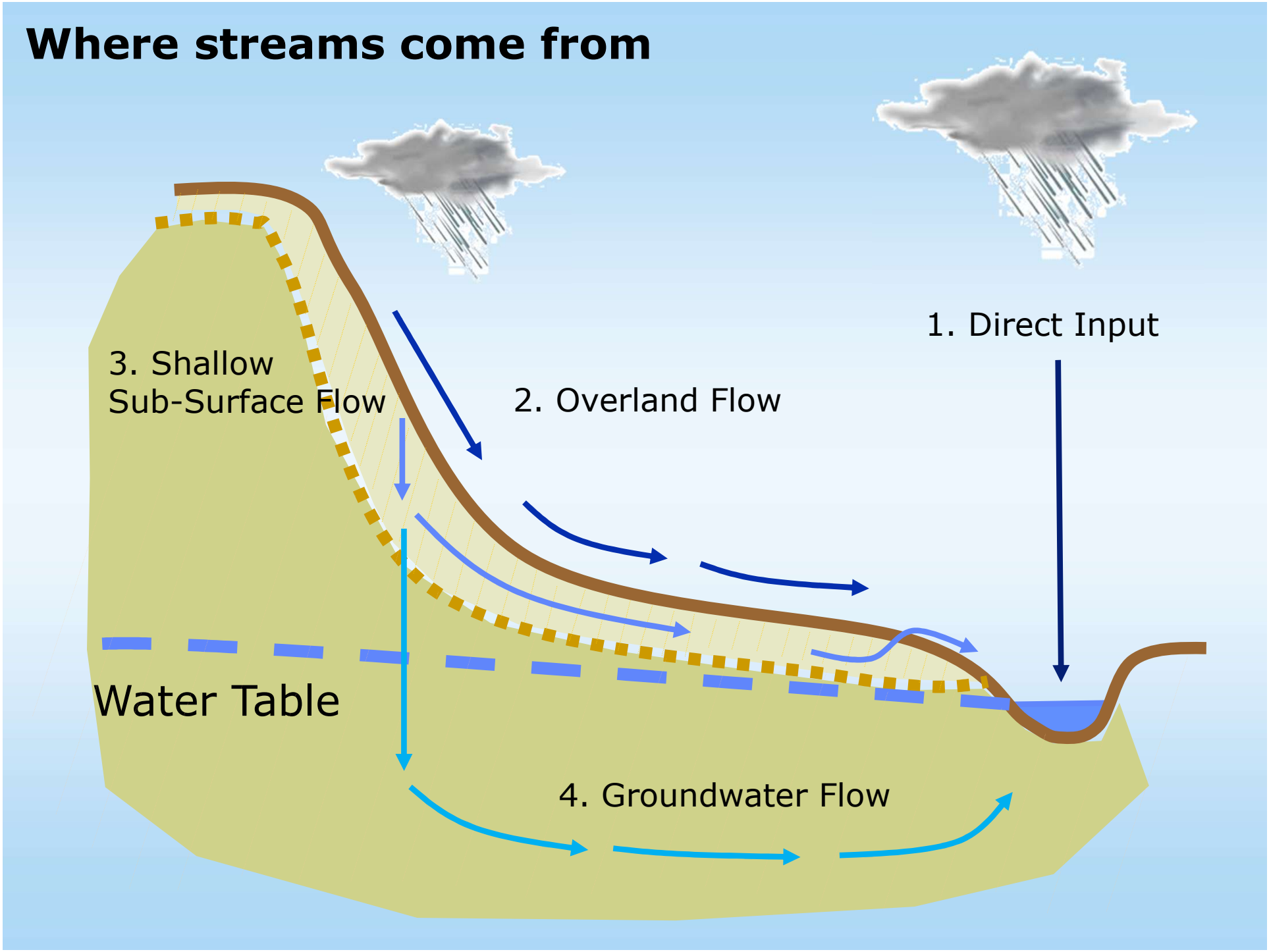
Temperature



pH

Dissolved Oxygen

Where streams come from



Flow Terminology

Velocity: simply the speed of water as it travels from point A to point B (distance/time)

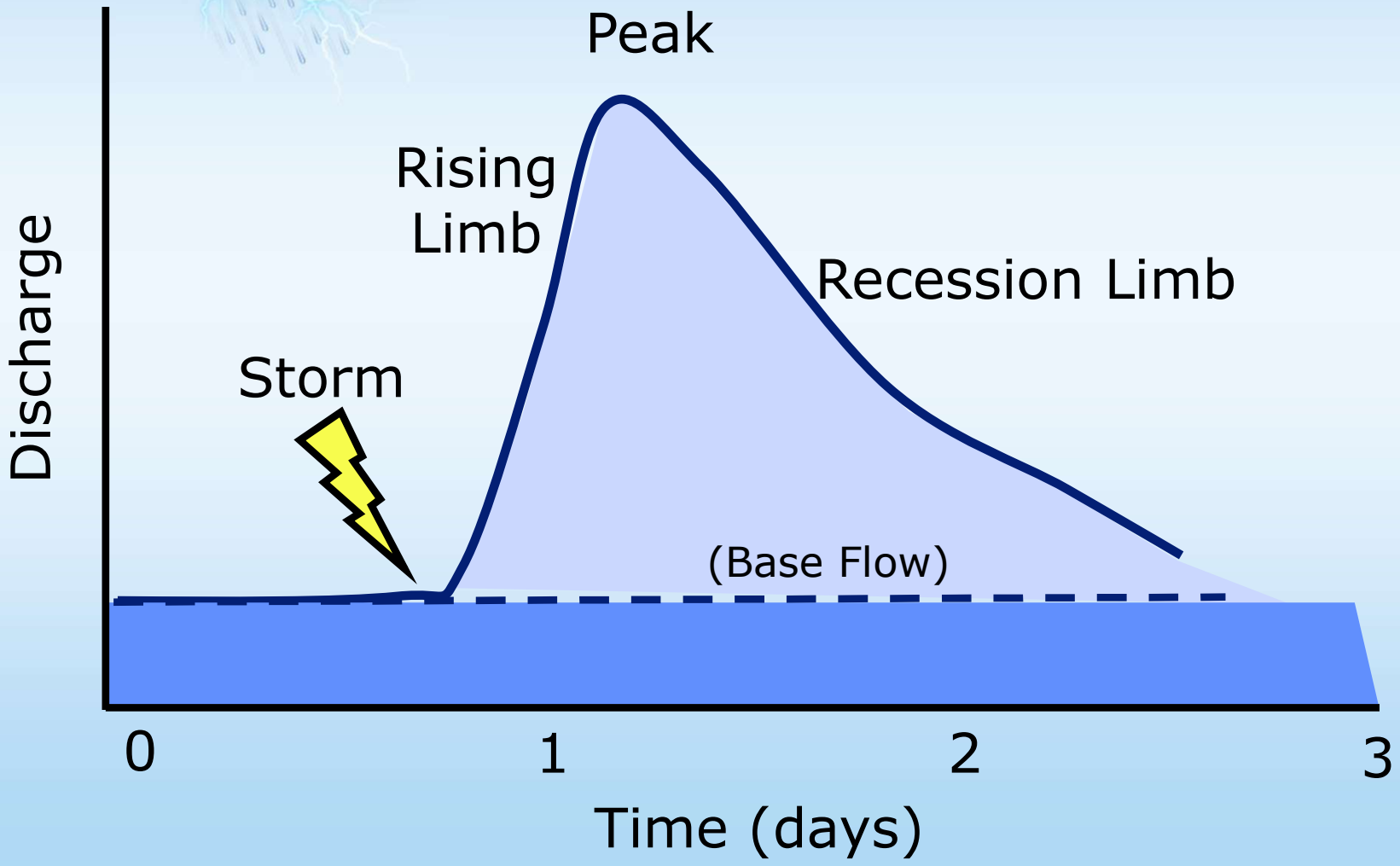
Discharge: the amount of water that passes a given point over time (volume/time)

Power: the ability to do work (e.g., transport sediment, move boulders, etc.)

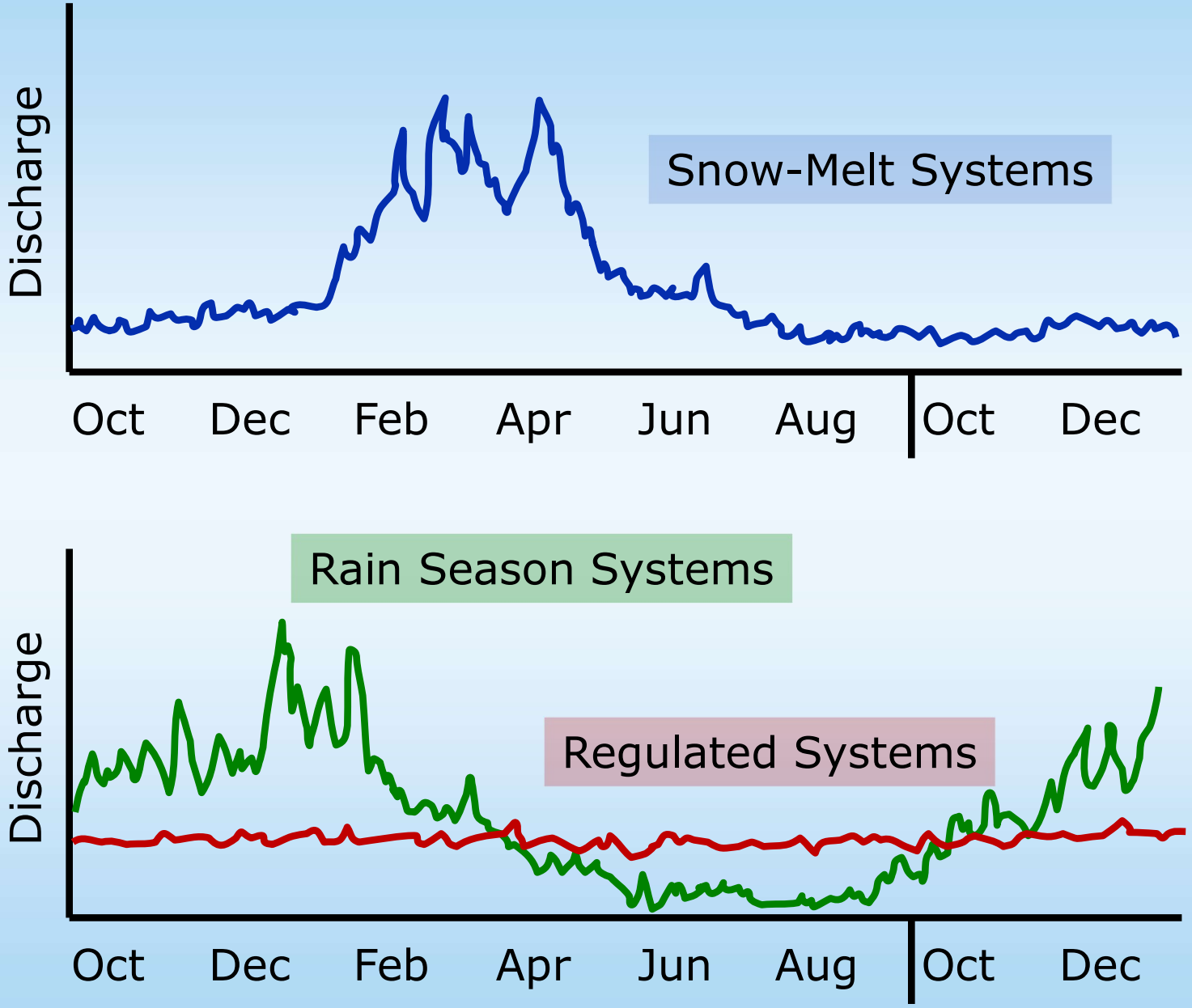
-Power typically increases with increasing velocity and/or discharge

Hydrographs: graphs used to examine changes in discharge over time

Hydrograph of a Storm Event



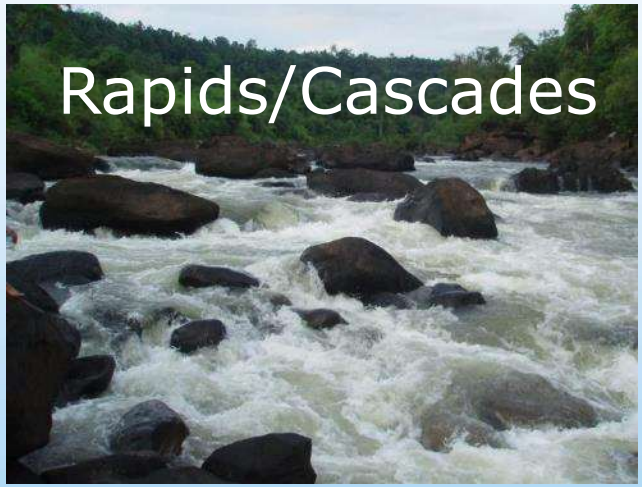
Annual Hydrographs



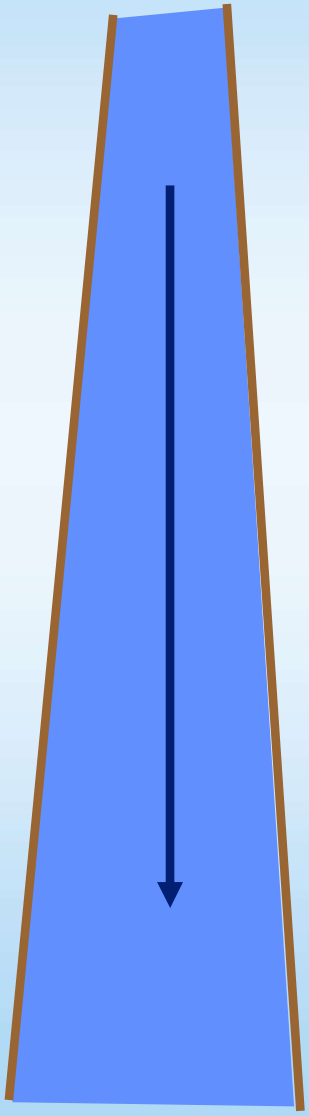
Habitats in Stream Systems

Slow moving

Fast moving



Why aren't streams all straight?



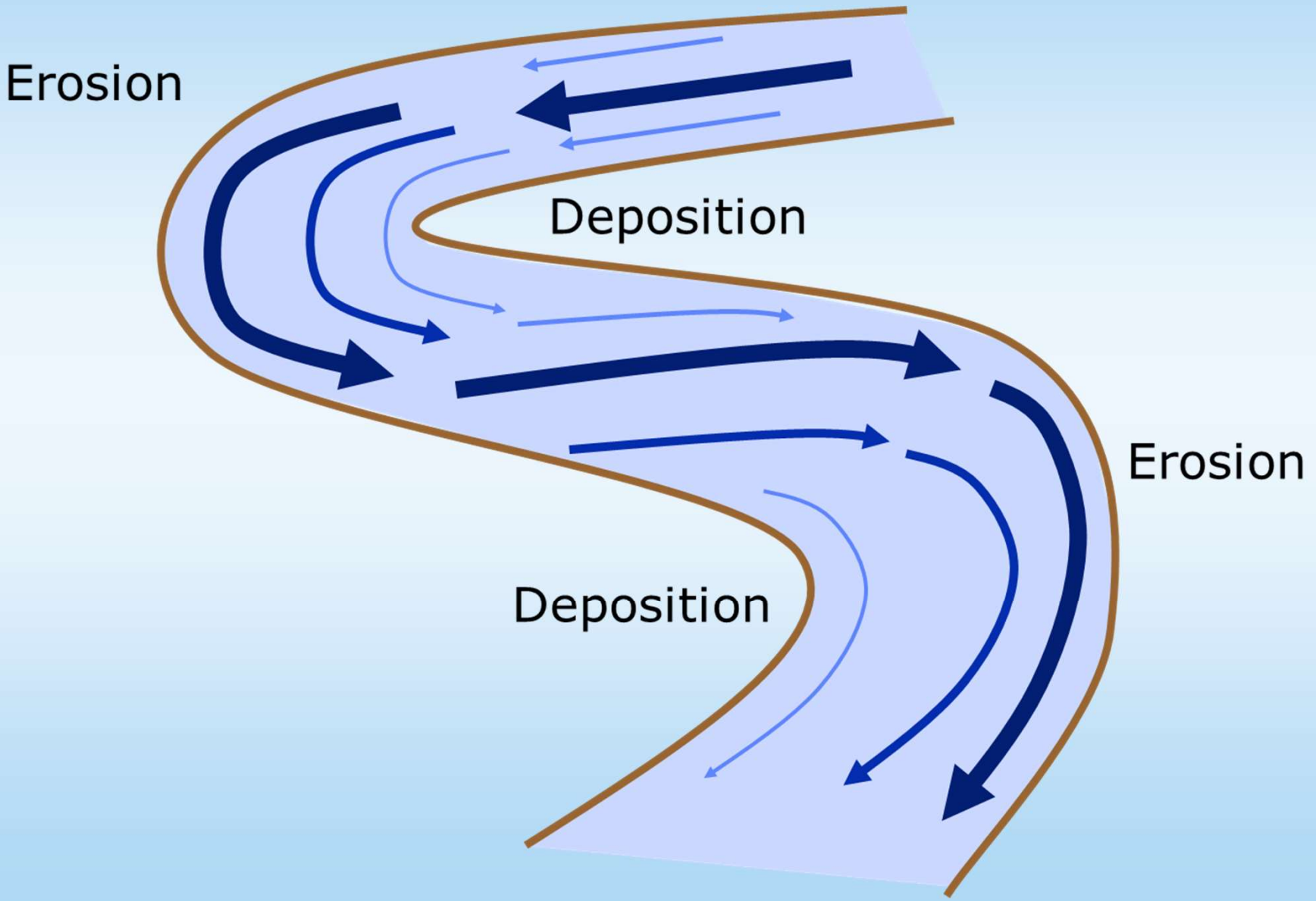
1. Valleys and floodplains are not smooth, level, or evenly sloped.

2. Soils, sediments, and deposits in floodplains are highly variable.

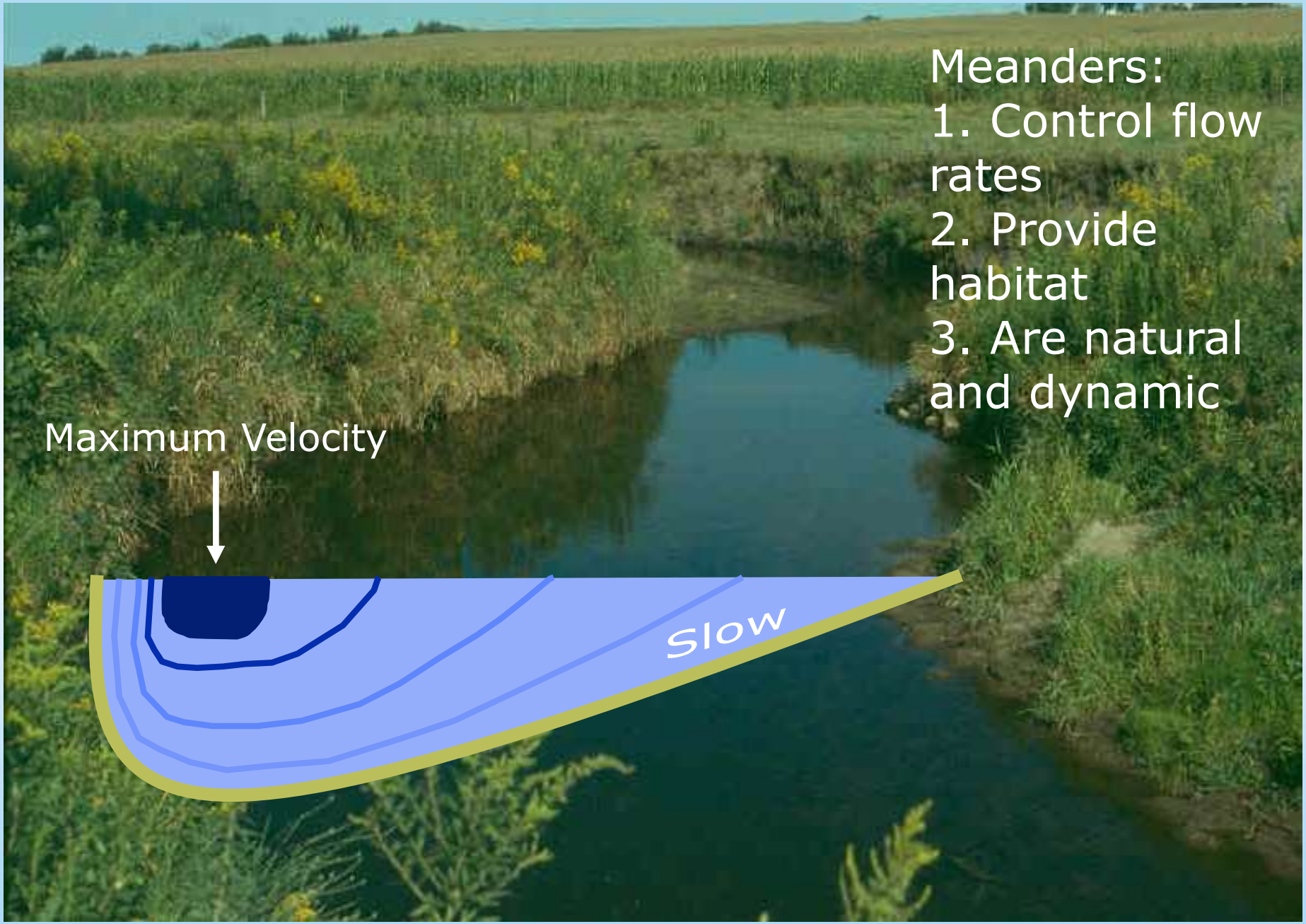
-i.e. resistance is not consistent

3. Streams will always take the path of <u>least resistance</u>, not necessarily the most direct

Dynamics of The Meander



The Meander

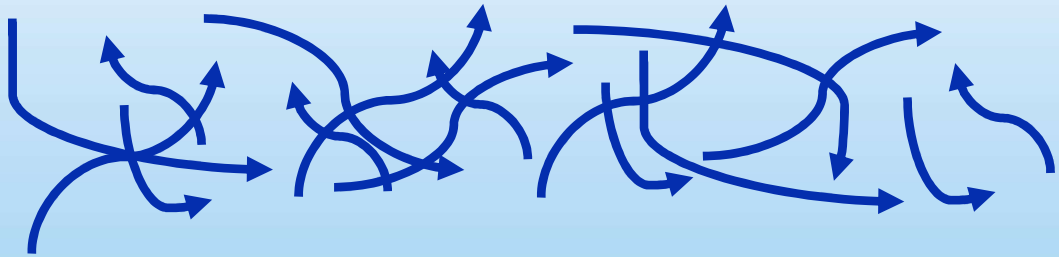

Meanders:
1. Control flow rates
2. Provide habitat
3. Are natural and dynamic
Maximum Velocity
Slow

The Flow of Water

Flowing water can be classified into 2 types:

Laminar Flow: Smooth flow that is like parallel sheets moving together.

Turbulent Flow: Chaotic flow that is rough and unorganized. (most common)



Organisms and Flow

To deal with drag and lifting forces of turbulent flow, organisms may:

Adapt "streamlined" body forms to create more laminar-like flows

Brook Trout

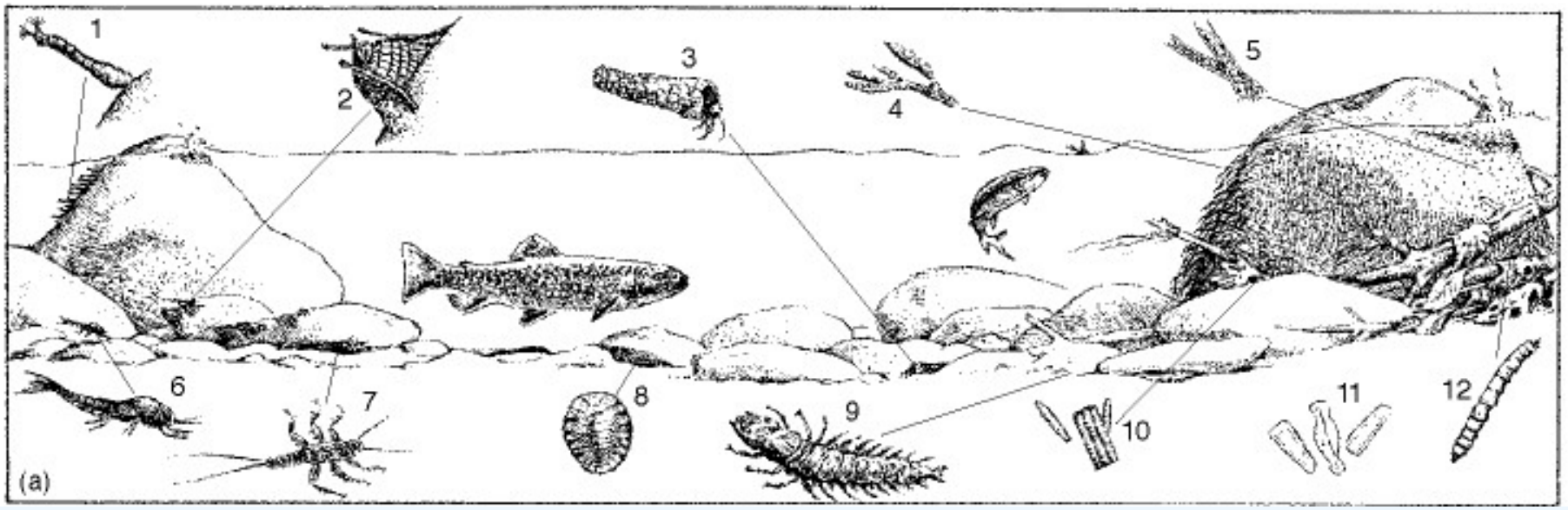
Baetis larva

Adapt body forms or life styles that use the low velocity layer near the bottom.

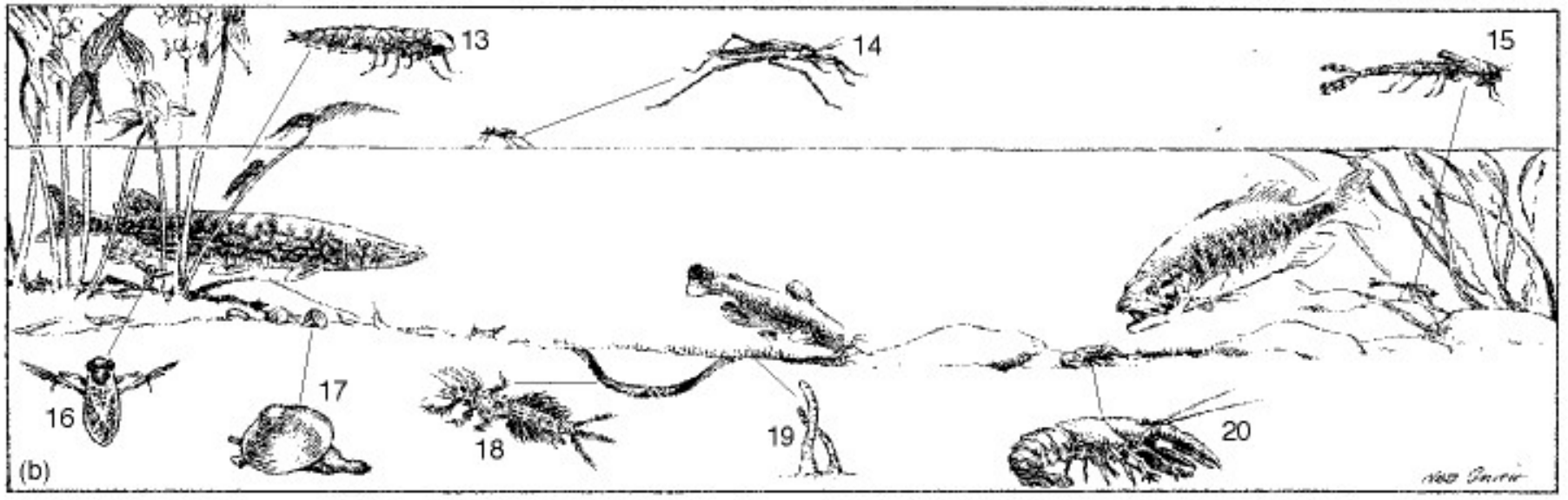
Sculpin

Caddisfly larva

Fast-water streams



Slow-water streams



Light

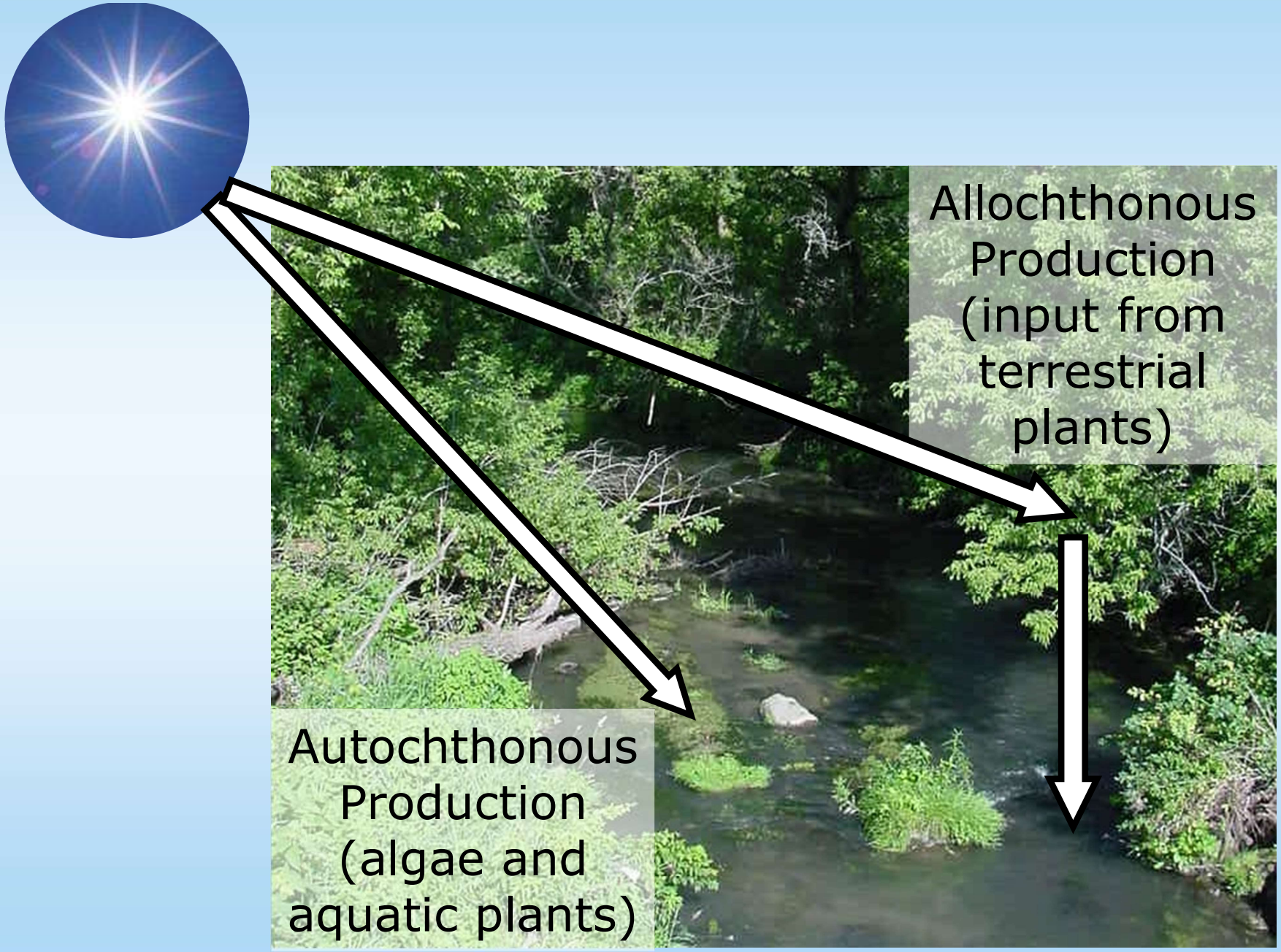
Sunlight is the ultimate source of energy for all stream communities.

-However, this energy enters stream food webs via 2 major pathways:

Autochthonous Production (within the stream)

Allochthonous Production (from outside the stream)

Energy Pathways in Streams



Factors influencing light for in-stream production

Stream-side vegetation
(but used for allochthonous production and regulates temperatures)

Time of day

Water depth

Season & climate

Water clarity

Surface roughness

Turbidity & Water Clarity

Turbidity is generally a measure of the suspended particles in water (living and non-living).

Water Clarity is used to describe turbidity + the presence of dissolved compounds (i.e. color)

Water Clarity influences:

- The ability of sunlight to reach autochthonous producers
- The effectiveness of visual predators
- Temperature

Water Clarity is influenced by:

Erosion

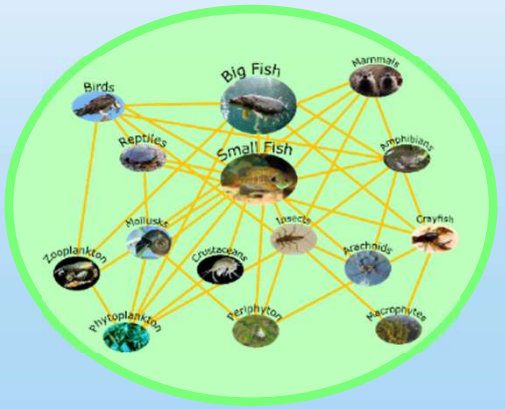
Flows

Litter-fall

Underlying geology

Suspended algae

Biotic community



Temperature

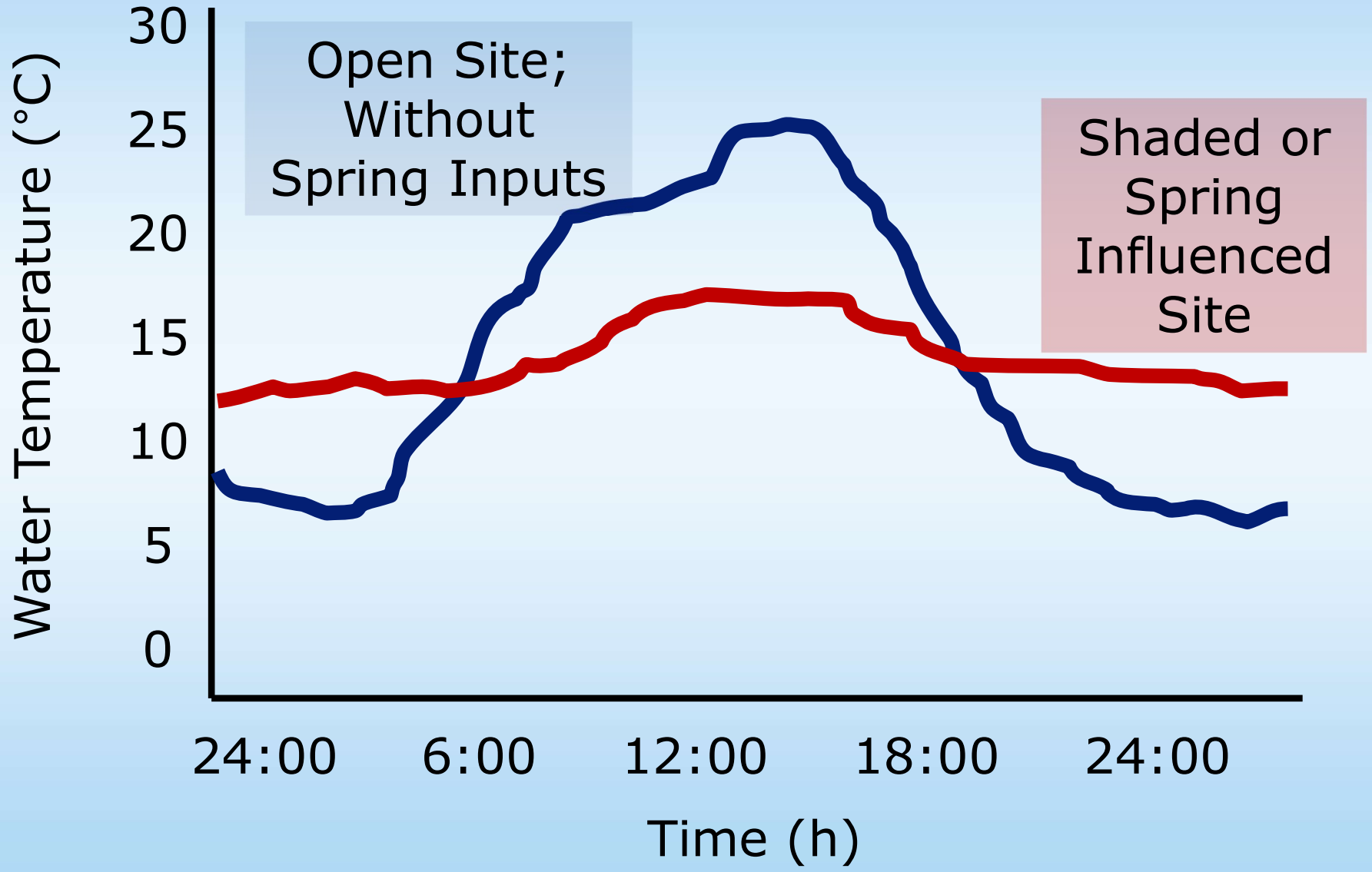
Temperature is important because it regulates:

- rate of chemical reactions
- amount of gases and solutes dissolved in water
- metabolic rates of stream biota
- and more…

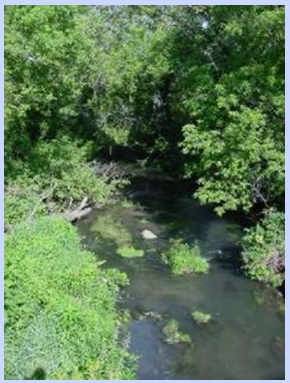
Stream temperature is influenced by:

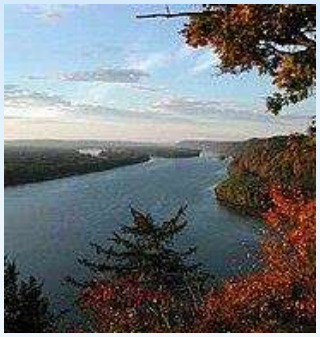
Sunlight
Riparian vegetation
Groundwater inputs
Width and depth
Upstream factors
Water clarity

Daily Patterns of Stream Temperature



Range in Daily Temperature Going Downstream





Maximum Daily Temperature Range (°C)

10
8
6
4
2

0 (Headwaters) 2 4 6 8 10 12 (Mississippi)

Stream Size (order)

From Vannote & Sweeney (1980)

Temperature range and organisms

Stenotherms (often called "cold water species") exist in a narrow range of temperatures.

-e.g., Salmon and trout

Brook Trout

Eurytherms (often called "warm water species") may exist in a wide range of temperatures.

-e.g., Bass and suckers

Smallmouth Bass

Dissolved Oxygen

Dissolved oxygen in a stream is largely a function of:

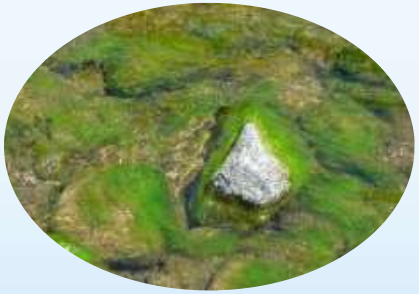
Air exchange at the water surface

-Roughness INCREASES oxygen exchange

Biological activity

-Daytime photosynthesis INCREASES oxygen

-Nighttime respiration from all organisms, DECREASES oxygen



Water temperature

-The colder the water the more oxygen can be dissolved

Dissolved Oxygen Saturation

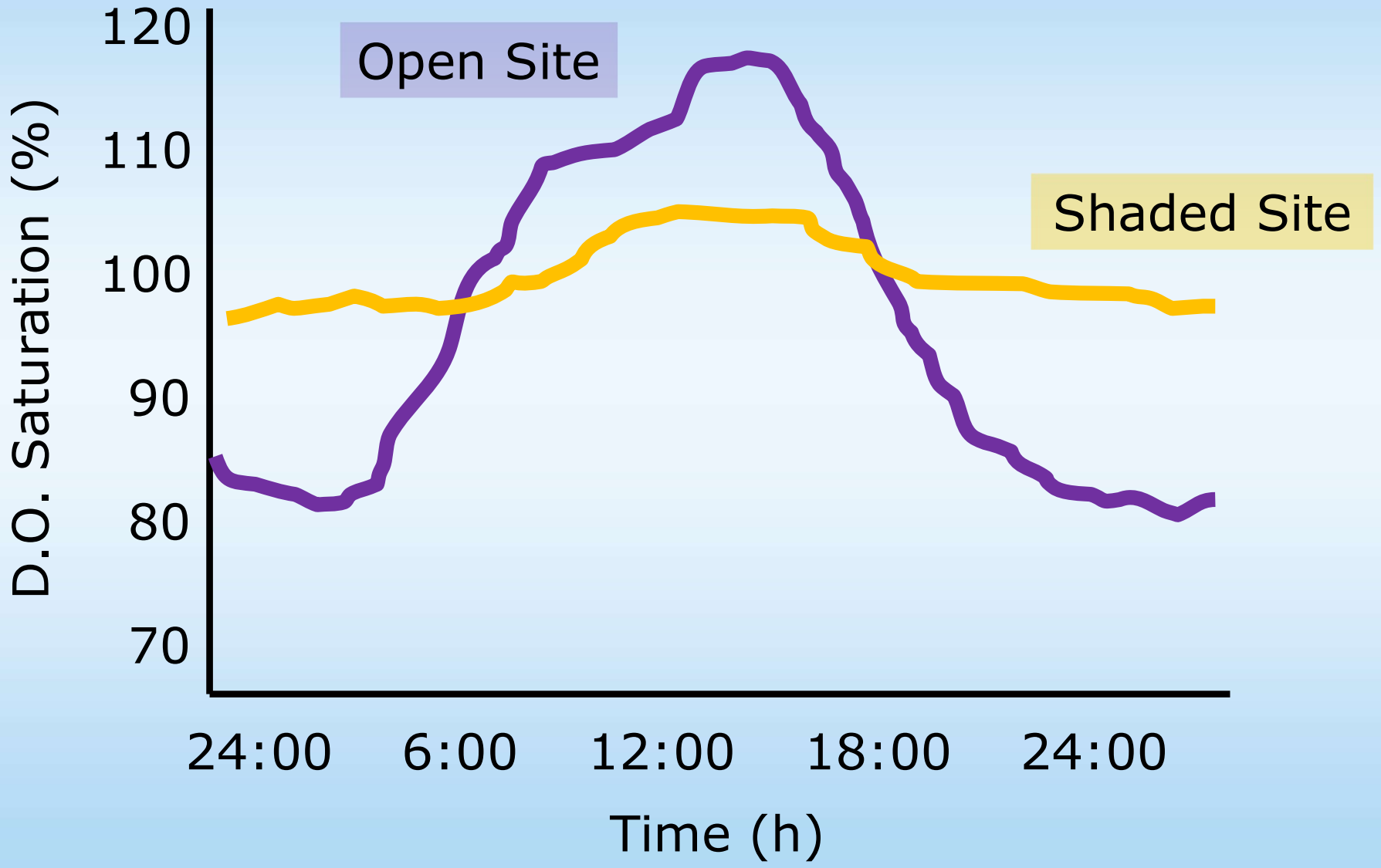
% Saturation compares the amount of oxygen that *is* dissolved vs the maximum amount that *could be* dissolved at a given temperature and pressure

100% means the water is well-aerated

<100% means more oxygen is being used than added

Supersaturation (>100%) occurs when production of oxygen in the water exceeds the rate of loss from the water.

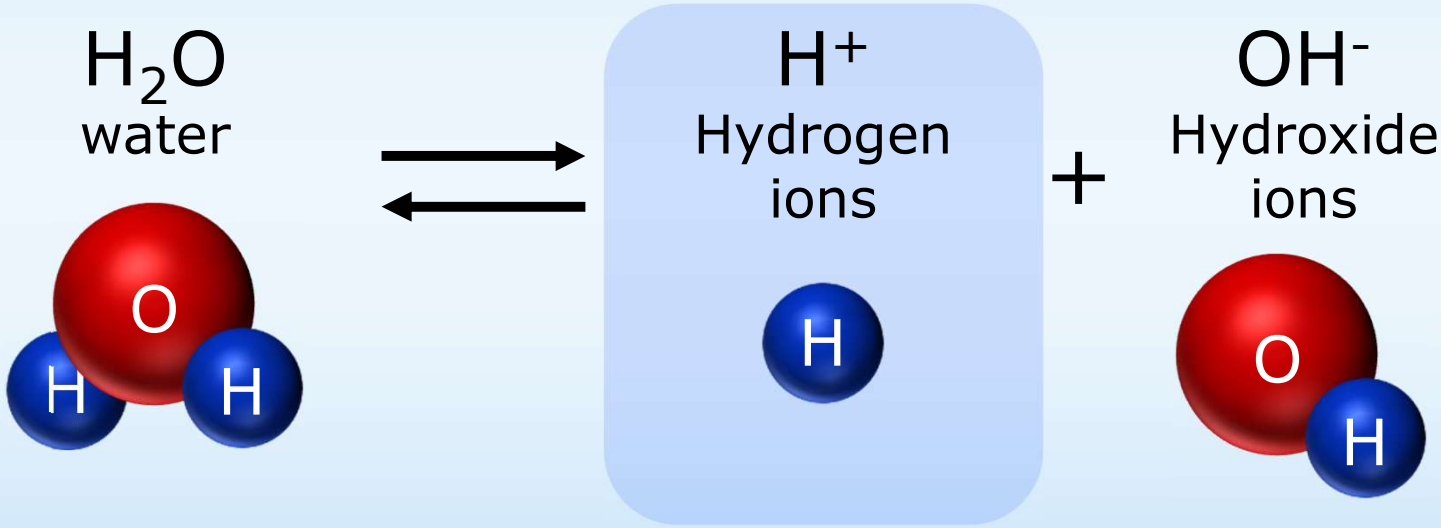
Daily Patterns of Dissolved Oxygen



pH

Measure a liquid's acidity or alkalinity depending on the amount of Hydrogen Ions (H^+)

Water naturally exists in a balance:



(mostly this)

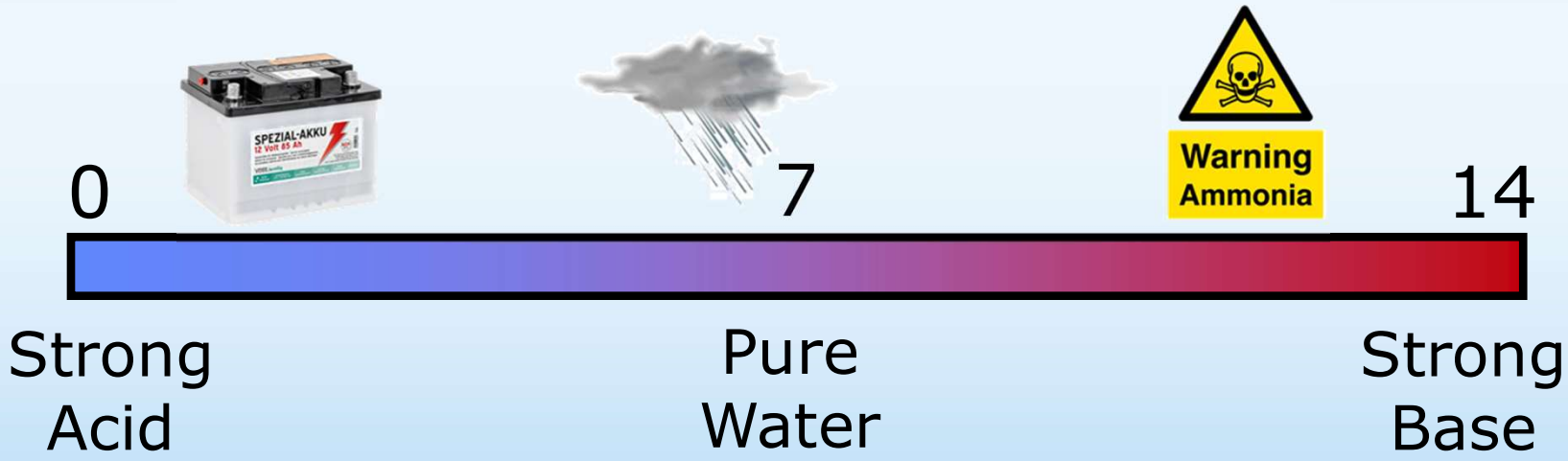
(some of these)

pH

-**Acids** have high concentrations of H^+

-**Bases** have low concentrations of H^+

The pH scale goes from 0 to 14, where 7 represents <u>pure</u> neutral water.



pH

Adding acids (rain, pollution, etc.) increases the amount of H^+, decreasing pH.

-Streams naturally exist between pH 6-8
-At 6 and below, things get rough…

What does pH affect?

rate of chemical reactions

amount of materials dissolved in water

amount of nutrients available to algae

general health/performance of organisms

5 Factors Influencing Stream Communities

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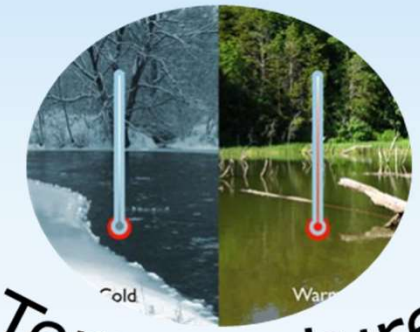
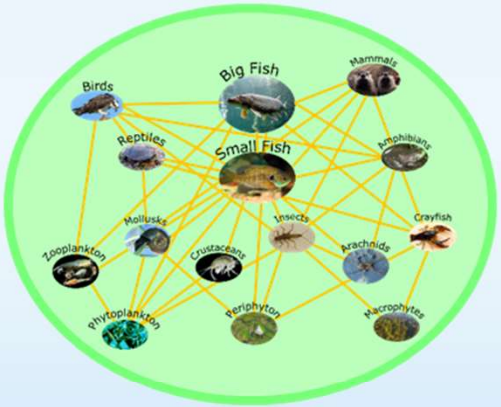
Flow



Temperature



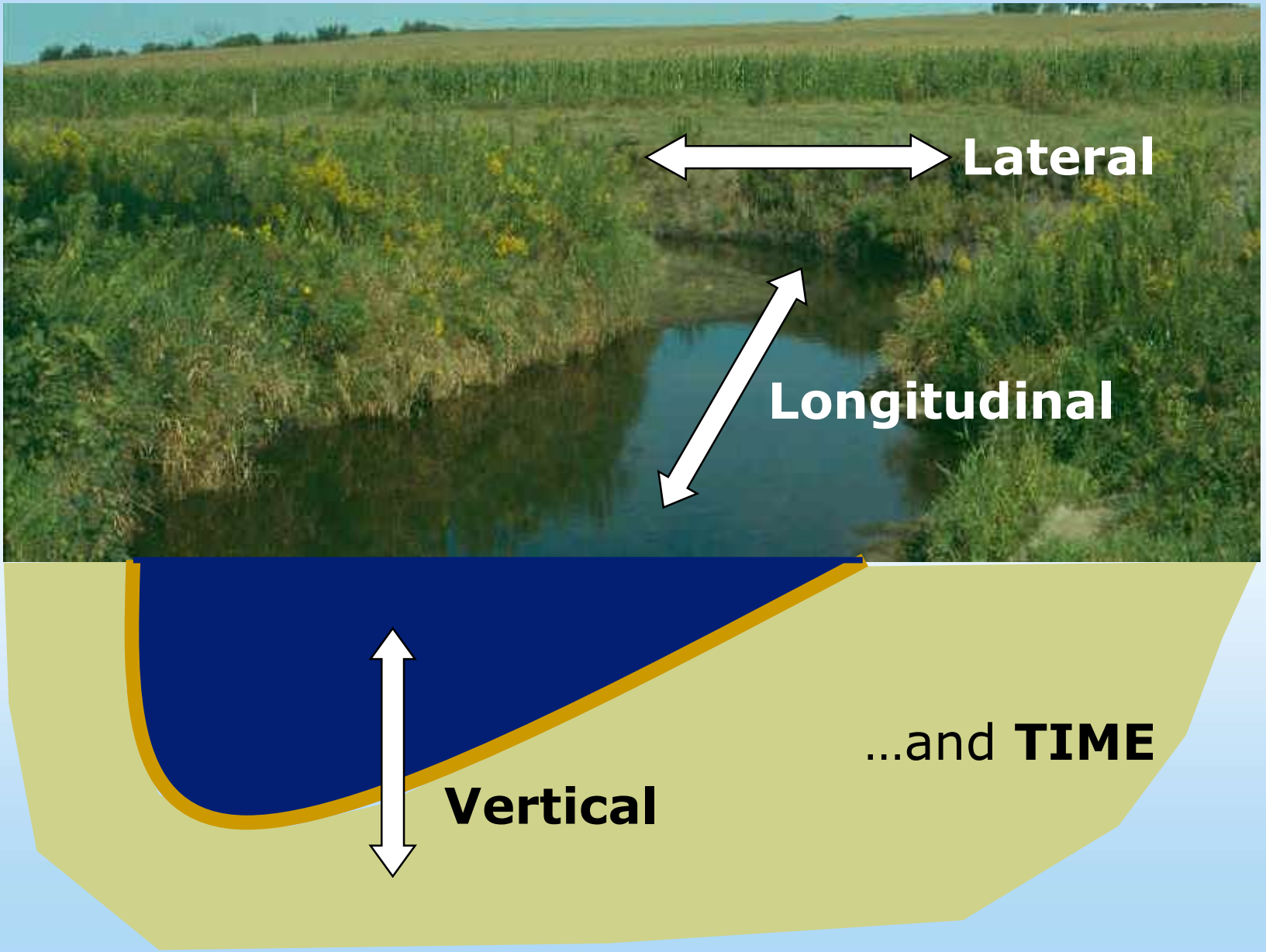
pH

Dissolved Oxygen

Some Big Picture Take-Home Messages

Streams are closely tied to surrounding riparian landscape

Streams Operate in 4 Dimensions



Streams are dynamic!

Stream ecologists and managers must consider how streams change:

- in **SPACE**
- in **TIME**

Streams are dynamic!

Stream ecologists and managers must consider how streams change:

- in **SPACE**
- in **TIME**

Upstream ⟶ Downstream

Streams are dynamic!

Stream ecologists and managers must consider how streams change:

- in **SPACE**
- in **TIME**

“Be The Fish”