

PHYSICAL: Types, morphometry, and origins of lakes and streams
(read: pp 164; 265-288 in Dodson)

WATER IN THE BIOSPHERE

- There is very little accessible fresh water in the biosphere

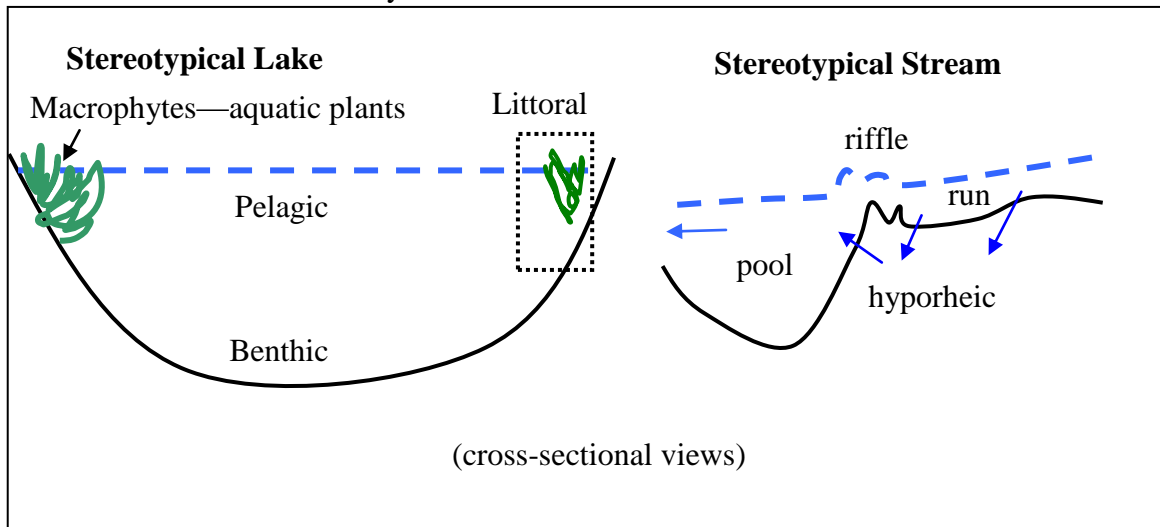
	Volume (km ³ * 1000)	Percent of Total	Percent of available freshwater	Renewal time (years)
Oceans	1,370,000	97.61	0	3100
Polar ice, glaciers	29,000	2.08	0	16,000
Groundwater	4000	0.29	95.4	300
Freshwater lakes	125	0.009	3.0	1-100
Saline lakes	104	0.008	0	10-1000
Soils	67	0.005	1.6	280 days
Rivers	1.2	0.00009	0.03	12-20 days
Atmosphere	14	0.0009	0	9 days

Table modified from Wetzel (2001)

- Surface water
 - Lakes
 - Fresh
 - Saline
 - Reservoirs
 - Streams that are blocked by a dam
 - Streams
 - Wetlands—regions of shallow and slow surface flow that have rooted and emergent aquatic plants (*macrophytes*)
- Ground water—water below the surface of the earth
 - Important source of drinking water
 - 50% of world population
 - 95% of rural America
 - Easily depleted (renewal time ~ 300 years)
 - Aquifers—deep reservoirs of ground water.

MAJOR AQUATIC COMMUNITIES (pp 164 in Dodson)

- Lentic—standing water (lakes)
- Lotic—flowing water (streams)
- Lakes
 - Pelagic zone—open water
 - Littoral zone—near shore
 - Benthic community—located at the bottom of the lake



- Streams
 - Main channel—main watercourse of a stream
 - Riffles—areas of fast-flowing water over coarse substrate
 - Hyporheic—area in substrate that has contact with the stream
 - Run—areas with fast-moving water that has smooth flow
 - Pools—areas of stream that are relatively deep and low flow
 - Riparian—land area along the banks of the stream

WATER IN LANDSCAPES (pp 265-288)

- There has been increasing appreciation of the importance of the larger landscape to freshwaters. For example, “The lake as a microcosm” by Forbes 1887 describes the lake as separate from the surrounding world. In reality, freshwaters are controlled by the landscapes around them, as proposed by “The stream in its valley” (Hynes 1975)

Morphometry—the size and shape of lakes and streams

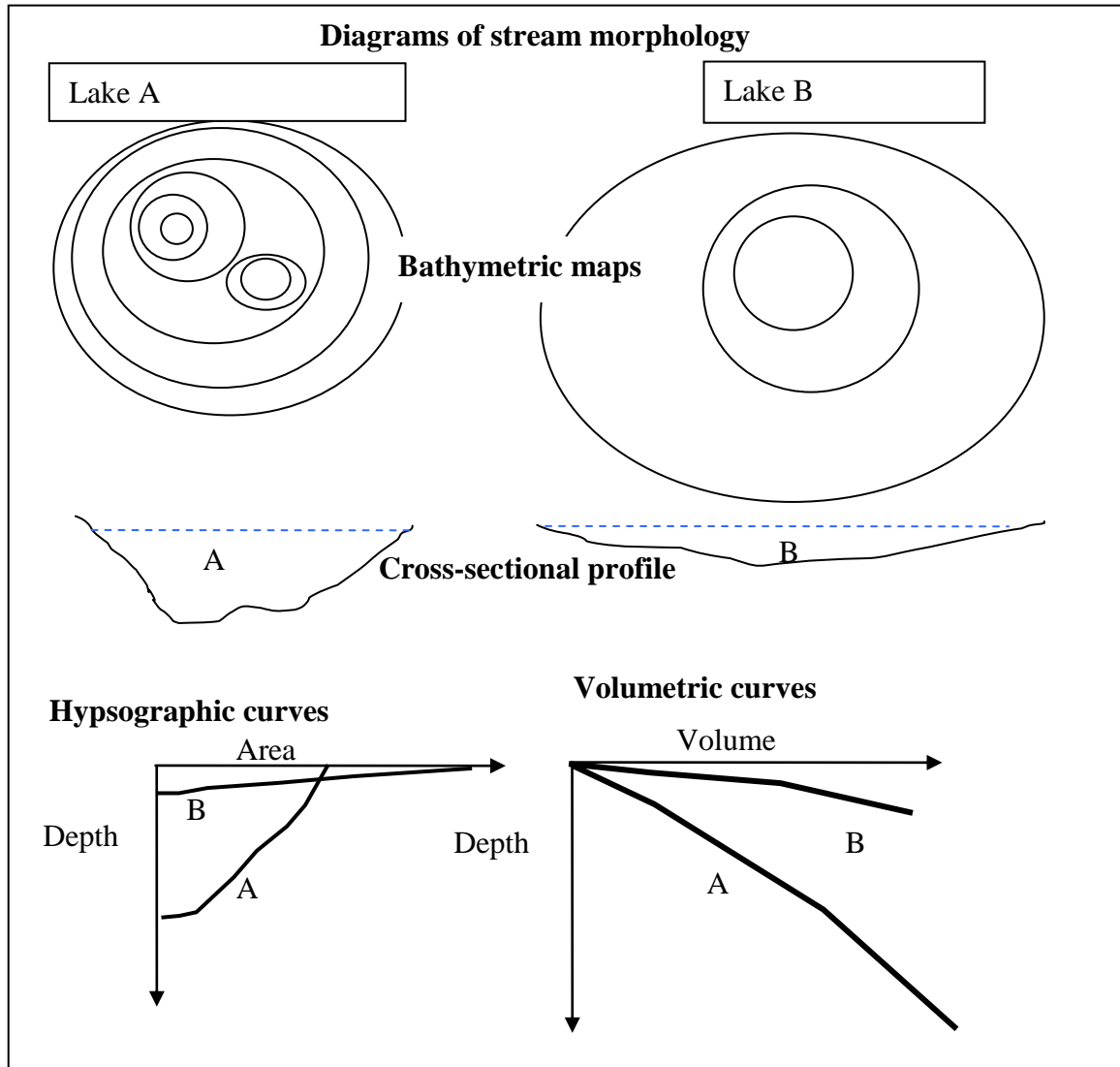
- Controlled by surrounding geology
- Mountain vs. lowland
- Origin of stream/lake

Aspects of Lake Morphology

- Shape (unit-less ratio D_L)
 - Shore length
 - Index of *Shoreline Development index* (D_L)
 - The ratio of the observed shoreline length to circumference of circle of area equal to that of the lake.
 - When $D_L = 1$, the lake is a circle.
 - $$D_L = \frac{L}{2\sqrt{\pi A_0}}$$

(where L = observed length of the shoreline, and A_0 = the area of the lake)
 - Influences:
 - Potential for interactions between land and water
- Surface Area (m^2)
 - Influences:
 - Sunlight
 - Evaporation
 - Wind effects
 - *Fetch*—the distance over which the wind acts
 - Gas exchange between lake and atmosphere
- Depth (m)
 - Z_{max} —maximum depth
 - Z_{mean} —average depth, volume divided by surface area
 - Influences:
 - Vertical mixing
 - Distribution of biotic and resultant processes
- Volume (L or m^3)
 - Influences:
 - How much material (water, nutrients, etc.) is in lake
 - *Residence times* of materials in lakes

- Quantifying lake morphology
 - *Bathymetric maps*
 - *Hypographic curve*—depth-area curve
 - Depth-volume curves
 - See diagrams below



Stream Morphometry

- Velocity (m/s)
 - rate of movement
- Gradient (m/km or %)
 - drop in elevation over a distance

- Cross-sectional area (m^2)
 - area of the stream perpendicular to main flow
- Discharge (m^3/s)
 - rate of water movement
 - influences:
 - substrate conditions
 - disturbance of biota
- Stream order
 - Increases in stream order occur when two streams of the next lower order are joined.
 - Eg. A second order stream is formed when two first order streams are joined.

LAKE ORIGINS

Lakes are formed when depressions are created in the ground which fills with water.

Most lakes are “young” and temporary features of the landscape.

Lakes and streams are continuously evolving.

- Lakes gradually fill with sediments
- Streams move and migrate (laterally and down)

Major processes and types of lakes include the following:

- Glaciation
 - Glacial dams and moraines
 - Kettle pond—holes left from blocks of melted ice
 - Glacial scour—glaciers carve out basins
 - Plunge basin—melting glaciers can produce deep plunge basins
- Riverine
 - Oxbow lakes
- Sinkholes
- Rock pools
- Frost polygons
- Tectonic activity
 - Rift lakes
 - Graben lakes (multiple faults)
- Volcanic activity

- Caldera (craters)
 - Dammed lakes
- Meteorites
- Coastal processes
- Biological activity
 - Beavers
 - Wallows
 - Humans—human creation of various types of lakes has been a major alteration of the global landscape
 - Reservoirs
 - Salterns
 - Livestock ponds

Lake Factoids

Largest lake (surface area)	Caspian Sea	394,299 km ²
Deepest lake	Lake Baikal (Siberia)	1,637 m
Largest freshwater lake	Lake Superior	82,414 km ²