LECTURE 1

1. Which freshwater lake on Earth is the largest by surface area, which one is the largest by volume?

Surface: Superior

Volume: Baikal

2. Why do more lakes occur farther from the equator?

Most lakes are glacial lakes - near the poles.

3. Why is a lake with a high shoreline factor (D) value likely to have smaller waves than a lake of comparable surface area with a D close to 1?

Circular (D=1) lake has an even fetch, so the waves are similar no matter the direction.

D>1 has an irregular shoreline (and different fetch sizes) and wave size depends on the direction.

4. Why are reservoirs often characterized by a higher catchment area?

They drain a larger watershed.

5. Would you expect a reservoir with large catchment area and a small volume to be eutrophic or oligotrophic?

Eutrophic (watershed area/volume: high)

6. Imagine you were asked to judge the trophic level of a lake based on the total phosphorus content. When and where would you take the sample?

During winter (water column well mixed, primary production low); from the fucking lake sediments

7. Would you expect a lake with high terrestrial carbon input to be net- autotrophic or netheterotrophic?

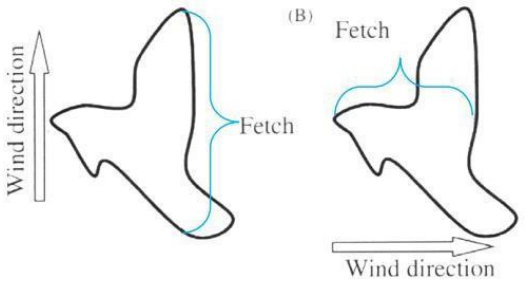
Net-autotrophic

8. Why are eutrophic lakes more prone to anoxia in the hypolimnion than oligotrophic lakes?

Algae & other organisms decompose and use up the oxygen.

9. Explain the relationship between fetch and wave height.

Long fetch = higher waves.



10. Langmuir circulation cells produce parallel foamlines on the lake surface. Explain why.

Positively buoyant particles accumulate at the surface and form foamlines.

LECTURE 2

11. Why does 4 °C cold water sink to the bottom of a lake?

It's at its max density.

12. How does stratification of a lake occur? What are the two decisive influencing variables here?

Water of different densities (temperatures) stratifies at different depths.

Solar radiation, wind

13. Why do not all lakes mix completely?

The wind can only attack the surface, so the greater the density differences between water bodies, the harder it is for wind to mix the lake.

14. Why does the oxygen content in the deep water of eutrophic lakes decrease in summer? How does new oxygen get into the deep water?

Oxygen consumption.

Decreasing temperatures allow mixing and transport of O_2 Into the hypolimnion.

15. Why is the depth at which 1% of the surface light intensity is still present important?

It is used to estimate the max. depth at which net oxygen production (photosynthesis) can occur.

16. How to determine the vertical attenuation coefficient?

$k_d = \frac{\ln(I_0) - \ln(I)}{z}$

z – depth

I_0 - light intensity at water surface

17. Why does photosynthetic activity first increase and then decrease with depth?

Increases with depth up to a maximum (light intensity is too high at the surface) and then decreases with depth because of increasing light limitation.

18. How do some phytoplankton manage to form chlorophyll maxima in deeper water layers?

Some phytoplankton species are adapted to low light availability in deeper water layers.

19. Which are usually the dominant ions in freshwater in terms of quantity?

Calcium, Magnesium, Bicarbonate/Carbonate, Sulfate

20. Why does the pH value of the water increase during intensive photosynthesis?

CO_2 decreases, less carbonic acid is produced, less bicarbonate & carbonate can be kept in solution, protons are more likely to be bound causing pH value to increase.

21. What is calcite precipitation?

Calcium combines with carbonate and forms calcium carbonate – lime (*pl: wapno*), it's insoluble in water and can precipitate as calcite crystal, if carbonate concentration is high & there's not enough carbonic acid – as a result of photosynthesis – leads to precipitation of calcium.

LECTURE 3

22. Which habitat zones can be distinguished in standing water?

Littoral, profundal, benthic, pelagic.

23 .Name 5 typical representatives of the macrozoobenthos.

Insect larvae, crustacea, mollusca, annelids, leeches.

24. What is meant by functional feeding groups? Which groups can be distinguished?

Groups based on the feeding habits.

Filter-feeders, collectors-gatherers, scrapers, shredders, predators.

25. Name three factors that contribute to the habitat complexity of the littoral zone.

Species diversity, fish abundance, fish biomass.

26. Why does macrophyte abundance typically decrease with eutrophication?

They can't complete their life cycle before the water becomes too turbid for photosynthesis.

27. What is bioturbation?

Burring activity of organisms (tube-dwelling invertebrates as ecosystem engineers).

28. Name three important zooplankton groups. Why are they so important?

Rotifers, crustaceans, copepods. Most important phytoplankton grazers

29. In which habitat zone would you expect to find a trout or a char during summer?

Pelagic zone.

LECTURE 5

30. Why is the term food chain helpful but also problematic at times?

Communities within lakes are often organized into food chains, by grouping functionally similar organisms. This can help us understand energy fluxes and ecosystem functioning.

But the reality is generally much more complex.

31. Why are omnivorous animals difficult to assign to specific trophic levels?

They eat food from two or more trophic levels.

32. Why is the number of trophic levels within an ecosystem limited?

Because at each step, energy is lost, ultimately limiting the number of trophic levels in a food chain.

33. What is meant by top-down and bottom-up control?

Top-down: predator-controlled

Bottom-up: nutrient-controlled

34. What changes would you expect to see in a lake food web in response to increased pike stocking?

It's a predator so large scale mortality of its prey.

35. Why does phytoplankton biomass increase with phosphorus availability and why is this increase often greater in lakes with fish?

IDK. Fish release high amounts of nutrients while feeding

36. What is meant by the term "microbial loop"? Why is it important?

Microbial loop - trophic pathway where dissolved organic carbon (DOC) is returned to higher trophic levels via its incorporation into bacterial biomass, and then coupled with the classic food chain formed by phytoplankton-zooplankton-nekton

37. How can stable isotopes help to decipher trophic interactions?

They provide important information on the origin of carbon and a consumer, as well as about trophic precision of this consumer in the food chain.

38. What is meant by heavy and light carbon and nitrogen, respectively?

Heavy means with greater atomic mass, light is with smaller atomic mass, e.g. ^{13}C and ^{12}C.

39. Why is a consumer isotopically heavier than its food and how can this help distinguish trophic levels?

Heavy isotopes accumulate in the tissues of organisms so when a consumer eats a prey, the discrimination against the heavy isotope in metabolism leads to an enrichment of ^{13}C and ^{15}N in the body and at the same time the metabolic end products (CO_2, NH_4) are isotopically lighter and thus contain less ^{13}C and ^{15}N than the food.

40. How do tropical and temperate lake food webs differ?

Tropical are on average 1 trophic level shorter than temperate, contain more omnivorous fish that feed more on microphytes/periphyton (not just invertebrates).

41. How might the introduction of a small freshwater shrimp into a lake cause the eagle population around the lake to collapse?

Population crash of kokanee salmon. Salmon runs into incoming rivers and streams stopped so eagles flew elsewhere.

LECTURE 6

42. Name 4 different factors that can affect food quality?

Ingestibility, digestibility, toxins, elemental nutrients.

43. Which organisms are of great importance as toxin producers in aquatic ecosystems?

Cyanobacteria.

44. Which toxin group is the best studied and most widely distributed in aquatic ecosystems?

Microcystines (?)

45. What is meant by seston?

Suspended organic matter (consisting mainly of phytoplankton, dead organic material).

46. Why do Daphnia in particular play a key role in lake ecosystems?

It is a grazer but also an important prey for predatory invertebrates and planktivorous fish.

47. Imagine you have determined the C:P ratio of the seston of a lake and it turned out to be 500. What would that mean for the Daphnia in the lake?

Growth of daphnia is P limited when C:P ratio is above 300.

48. What is meant by essential nutrients?

Cannot be synthesised by consumers, must be taken up with the diet. Lack of them limits growth and reproductive output.

49. What does the abbreviation PUFA stand for?

Polyunsaturated fatty acids

50. Name two essential n-3 and n-6 PUFA. Who primarily produces these PUFA?

n-3: ALA, EPA; n-6: LIN, ARA

Fish.

51. What is the physiological significance of sterols? Which is the main sterol in animals?

Structural components of cell membranes, precursors for other bioactive molecules.

Cholesterol.

52. What is meant by maternal effects?

Nutrient limitation affecting offspring of consumers.

53. Why might long-chain PUFAs be limiting, especially at cold temperatures?

IDK

LECTURE 7

54. Define the term Chemical Ecology in your own words in just one sentence

Chemical ecology examines the role of chemical interactions between living organisms and their environment.

55. State the advantages and disadvantages of chemical communication

Advantages: long range, used in darkness, high specificity, low energy cost, high longevity

Disadvantages: slow transmission rate, difficult to locate the sender

56. Explain the terms pheromone, allomone, and kairomone

Pheromone – volatile chemicals used for communication within species Allomone – volatile chemicals used for communication between species Kairomone – volatile chemicals mediating interspecific interactions

57. What is meant by quorum sensing? Would you call the chemical signal molecules that are used here pheromones, allomones, or kairomones?

Cell-to-cell communication.

Pheromones.

58. How do Daphnia sense chemical signals?

Kairomones???

59. Why do some algae, such as the green alga Scenedesmus, form colonies and spines under certain circumstances? What are the advantages and disadvantages of this?

It is induced by several zooplankton species.

Adv.: Grazing resistance

Disadv.: Involves metabolic costs, higher sinking rate

60. What morphological defense strategies are you aware of in Daphnia?

Neckteeth, helmets, enlarged tail spines or crests.

61. How does the presence of fish or Chaoborus, respectively, affect resource allocation to growth and reproduction in Daphnia?

Fish: Resource allocation towards reproduction → earlier reproduction

Chaoborus: Resource allocation shifted towards maternal growth → later reproduction

62. Why do some Daphnia populations perform diurnal vertical migration?

Because it is a behavioural predator avoidance strategy induced by chemical cues released from fish

LECTURE 10

63. Define benthic. Is the benthos different between streams and lakes?

Benthic – associated with the bottom of an aquatic habitat

Yes???

64. Explain heterotrophic state and name its opposite. Which state do most streams fall under?

Heterotrophic – organic carbon respired to inorganic carbon; opposite – autotrophic

Most are heterotrophic.

65. Consider a forested stream: would you expect primary production to be high or low? Consider seasons and stream size in your answer.

IDK

66. What are the advantages and disadvantages to measuring metabolism in an open vs. a closed system?

Advantages open: get whole-system metabolism

Disadvantages open: correction needed for reaeration

Advantages closed: no diffusion correction, more control

Disadvantages closed: representativeness may be low

67. Biofilm biomass is constant throughout the year in a specific stream. Does this mean primary production is also constant? Explain your answer.

Since the biofilm biomass is constant, it means that there's enough nutrients, light and temperature. Those factors also contribute to primary productions so it is also constant.

68. Which are the factors considered in the calculation of metabolism estimate?

Dissolved oxygen/carbon dioxide.

69. Why is it problematic to use nutrient uptake velocity as a measure of nutrient uptake capacity among streams?

IDK

70. If nutrient demand is low, do you expect spiralling length to be short or long? Explain your answer.

Short because IDK

71. Name the four groups of primary producers in streams.

Algae, bacteria, fungi, plants

72. What are the three key resources for biofilm growth. Name potential adaptations to deal with resource limitation and/or flow disturbance.

Nutrient, light, temperature.

IDK

LECTURE 11

73. Name the traditional four ecological trophic groups. How do the macroinvertebrate functional feeding groups differ from these groups?

Herbivores, detritivores, predators, omnivores.

Many stream invertebrates are omnivorous, many taxa don't fit into trophic level.

74. What is the difference between a food web that is considered “brown” vs. one that is considered “green”?

Brown – even number of levels

Green – odd number of levels

75. What elements are necessary to create a flow food web?

Structure, energy flow.

76. Describe and contrast a shredder and collector-based food web. In what type of streams would you expect to find them based on the RCC?

Shredder based (upstream?): leaves fall into streams, shredders eat up these leaves, create finer materials that can be eaten by others, it goes back to microbes (idk what this woman was talking about tbh), microbes colonize the leaves, leaves get to shredders… it’s a cycle.

Collector based (downstream?): FPOM gets filtered out by the collectors, they have feces that can contribute “here again” (where? Fuck knows) then we have inputs from e.g. shredders that create FPOS.

Both are not independent from each other.

77. Define “top-down control” in terms of food web regulation.

Predators have primacy

78. Herbivory leads to reciprocal effects between grazers and biofilms. Name at least two effects of grazers on biofilms and biofilms in response to grazers.

Grazers on biofilms: reduced standing crops, increased production per biomass

Biofilms in response: select for specific species of grazers, changes in movement

79. A stream food web lost the top predator through anthropogenic exploitation. How do you expect the food web to change and why?

Since the top predator is lost, its prey grows in size (no one to limit it), so the thing that the prey feeds on is overexploited ??? Kinda my thinking, no answer in slides.

80. Describe the semi-aquatic life cycle of macroinvertebrates.

Adults lay eggs, eggs live in streams, grow into larvae, larvae crawl/move to water's edge, then turn into adult.

81. Imagine a macroinvertebrate species whose larvae mature in the floodplain of a river. Describe a possible life history going from egg to larvae to adult and back to egg.

The same as 80???? Idk man

82. Name the three critical environmental factors for adaptation to live in streams. Name at least three types of adaptations.

Current, substrate, temperature.

Flattened body, hydraulic suckers, silken attachments.

Lecture 12

83. Why does or doesn't the River Continuum Concept apply to streams in Brandenburg?

Base assumptions

Large higher order continuous rivers

Unimpacted streams

Problems:

Many mountain streams above tree line

Large catchments divided among countries

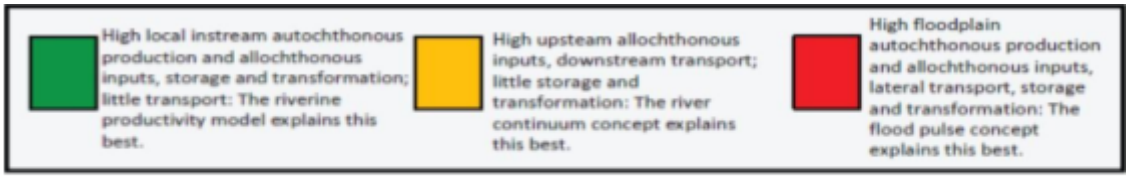
Many streams have impoundments/reservoirs

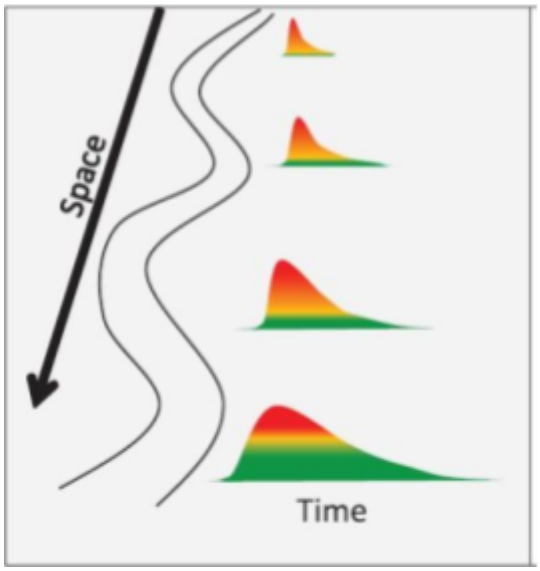
84. Name key differences between bottom-release dams and lakes in their effect on downstream ecosystems.

IDK

85. The River Wave Hypothesis includes spatial and temporal aspects in the prediction of ecosystem responses. Why is this important?

Floods and their impact on the productivity of stream.





86. You are tasked with creating a freshwater carbon budget for a stream network. What effect may the presence of lakes have on said budget?

IDK

87. A stream enters the lake. How can you determine where the stream water might end up? Explain your reasoning.

Two main metrics: • Discontinuity distance • Parameter intensity

Discontinuity distance determines shift in longitude

Parameter intensity: How far the system moves out of sync

General approaches: • Before-after comparison • Up- to downstream comparison

88. Define “discontinuity distance” and name the concept it is based on.

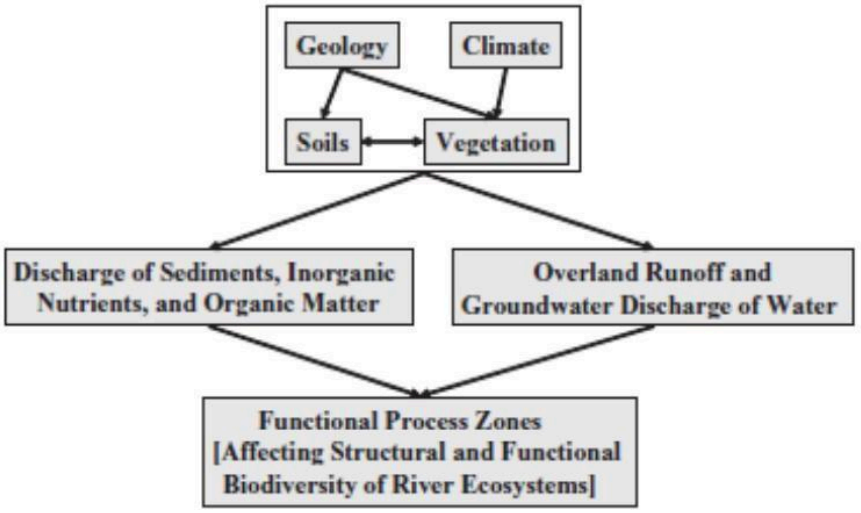
Discontinuity distance (DD), defined as the longitudinal shift of a given parameter by stream regulation, may be positive (downstream shift), negative (upstream shift), or near zero

89. Why will restoring a more natural flow regime below a river can alter community composition? Consider macroinvertebrate adaptations to streams in your answer.

Biology responded to regime shifts – no «recovery»

Experimental floods critical to maintaining a mountain stream biotic community

90. What units does the Riverine Ecosystem Synthesis define for stream ecosystems? How are they defined?



Units:

Geology

Climate

Soils

Vegetation

91. Why and how can riverine concepts be useful in stream management?

Determining where certain species reside in a stream e.g. fish zones concept

River continuum concept determining ratios of shredders, collectors, predators and grazers may be located at different points in the stream

Flood pulse concept explains how the periodic inundation and drought (flood pulse) control the lateral exchange of water, nutrients and organisms.

Riverine productivity model

Riverine synthesis model

92. Name three criteria that are likely important in how lakes influence streams and vice versa?

Discharge and water residence help time critical components of lake-stream interactions. Gradients in temperature, nutrients, organic matter, production

Coupling of lakes and streams – scale?

• Small scale: transition zones

1 Lake littoral where streams enter lakes

2 Lake outflow streams

• Sub-catchment-scale: stream-lake-stream linkage

1 Response of lake to inflow dynamics

2 Inflow vs outflow characteristics

3 Change of common metric over the lotic-lentic linkage

• Catchment-scale: connectivity of freshwater ecosystems

1 Lake chains

2 Going beyond streams and lakes

LECTURE 13

93. Define CPOM, FPOM, and DOM. How does the relative proportion of these change from upstream to downstream based on the River Continuum Concept?

CPOM = Coarse Particulate Organic Matter (> 1 mm)

FPOM = Fine Particulate Organic Matter (< 1 mm AND > 0.45 µmDOM = Dissolved Organic Matter (< 0.45 µm)

Upstream normally forested and the majority of leaf litter enters stream here and travels downstream. The longer a leaf stays in the water the more its breakdown/degrades/decomposes so the dissolved particles (DOM) will be seen downstream and the coarser particles of CPOM are found upstream.

94. Riparian trees are important to stream ecosystems. Name at least three ways in which they influence stream structure and/or function.

Mass and timing of inputs (reach scale)

Retention (reach scale)

Leaf litter decomposition

95. Why are stream carbon budgets so difficult to quantify? Name at least five processes that need to be known for a complete budget.

Respiration

Photosynthesis

Sulphate reduction

Chemoautotrophy

Denitrification

96. How has the view of freshwaters changed within the carbon cycle in the last 20 years? Which is the flux whose estimate change the most because of this changed viewpoint?

IDK

97. Define resource subsidies. Do you think resource subsidies have the same impact across space and time? Justify your answer.

Subsidies support ecosystem functions and link interactions between species.

By spatial (space) subsidy, we mean

• a donor-controlled resource (prey, detritus, nutrients)

• from one habitat to a recipient (plant or consumer) from a second habitat

• which increases population productivity of the recipient, potentially altering consumer- resource dynamics in the recipient system OVER TIME THE IMPACT CHANGES!!!!

98. Which model is used to estimate litter breakdown?

Simple exponential decay model

99. Name the four steps of shredder-based litter breakdown.

1. Leaf enters stream

2. Labile nutrients leach quickly (mass loss)

3. Microbial colonization of leaves (creating the peanut butter layer)

4. Biological and physical fragmentation (Leaf fragmentation) via shredder feeding behavior and flowing water

100. Which functional feeding groups contain detritivores?

Shredders and collectors

101. Resource subsidies can be continuous or pulsed, predictable or unpredictable. Chose an example of a subsidy and explain what type they are.

Terrestrial to freshwater e.g., Serengeti wildebeest drowning in rivers unpredictable as they migrate seasonally but go through different parts of the river each time and pulsed occurring seasonally.

102. The carbon cycle is difficult to quantify. Why? Consider the carbon conversion processes for your answer.

Several important fluxes have been omitted in the cardon cycle

LECTURE 14

103. Describe the bioenergetics of a fish: what do they need, what for, where does the energy go?

Factors such as metabolism, water temperature, and quality of prey regulate the ability of fish to convert energy from food into body mass or growth in weight.

104. Fish are thought to need three types of habitats. Name the types and describe what they are used for.

IDK

105. Both fish and macroinvertebrates drift. What are the difference in the drifting movement between the two?

Fish drift: Passive movement of fish along with water currents

Macroinvertebrate drift: can be active (e.g. escape predators) or passive (e.g. sick/wounded animals)

106. Name the two diadromous migration types. Explain how they differ and what lack in resources lead to each type.

Anadromous and catadromous

Anadromous: marine fishes from sea to fresh water for spawning

Catadromous: fresh water fishes from river to sea for spawning

107. Select an ecosystem engineer and explain what makes that species an engineer.

Salmon builds nests.

108. Beavers are considered a case 4 ecosystem engineer. What does that mean?

They are allogenic engineers, taking materials in the environment (in this case trees), and turning them (engineering them) from physical state 1 (living trees) into physical state 2 (dead trees in a beaver dam). This act of engineering then creates a pond, and it is the pond which has profound effects on a whole series of resource-flows used by other organisms. The critical step in this process is the transformation of trees from state 1 (living) to state 2 (a dam). This transformation modulates the supply of other resources, particularly water, but also sediments, nutrients etc.

109. When and why is it important to include the physical environment directly in the ecosystem engineering effect of certain organisms?

110. Who is considered the first to describe organisms ecosystem engineers? When (approximately) and which organisms?

111. Pacific salmon are considered a resource subsidy and ecosystem engineers. Explain either role and the potential effects on biofilms.

112. Fish are widely distributed. Name five environmental conditions that may influence their distribution along the stream network.

LECTURE 15

113. What is an semi-aquatic/amphibiotic insect?

Insect that has its initial part of life in water and the rest in terrestrial habitat.

114. What are the 4 life stages of a semi-aquatic insect?

Egg, larva, pupa, adult

115. What two ecosystems/food webs are semi-aquatic insects part of?

Terrestrial and aquatic

116. What are some of the predators of semi-aquatic insects in both ecosystems?

Terrestrial: birds, spiders, bats

Aquatic: fish, diving beetles, other insect larvae

117. What is one defense response of Chironomus to fish presence (aka kairomones)?

Digging within 120 minutes of exposure

118. On average, do lakes or streams produce more insect/1 m shoreline?

Streams

119. What is the relationship between depth and amount of insects emerging?

Higher emergence at 0-2 m than 8-13 m depth

120. In the example presented in class, do adult insects travel upstream or downstream?

Upstream

121. Name on terrestrial predator that has been shown to benefit from PUFAs?

Blue tit??

122. What is one toxin that has been found in terrestrial predators?

Cyanotoxins?

123. How does climate change impact the relationship between adult aquatic insects and riparian predators?

Aquatic insect emergence is advancing much faster than bird breeding timing.