



PISCES LECTURE RESOURCES

The Ecology of Freshwaters

LECTURE 1 – Types of freshwater bodies - from mountain streams to inland seas.

Introductory remarks:

About 70 percent of the globe is covered with water, but only 3 percent of that is freshwater. Only one percent of the world's land surface is made up of freshwater ecosystems, and approximately half the world's population live near those freshwater ecosystems. Plants and animals flourish wherever freshwater is to be found and these lectures give us a glimpse of the many forms of life that make use of freshwater and how we go about sampling them and understanding their ecology.

Slide One: Title slide.

Slide Two: Introduces Classification, and the notion that all water types are part of a continuum of types. Classifications can be imposed according to any defining characteristic. Our illustration uses water body size and nutrient status as examples.

Slide Three: Examples of water bodies of differing sizes and types.

Slide Four: Examples of waters on the continuum of nutrient status, showing the main factors that contribute to that status. As water bodies age their nutrient status tends to move in the direction of oligotrophic to eutrophic. Rarely does it move in the other direction.

Slide Five: A striking example of two water bodies, with very different physical characteristics, meeting but not mixing. Although it looks like cloud shadow on the water's surface, the two rivers that meet at this point are indeed of very different colours, largely related to the sediment load.

Slide Six: Introductory – Section 1, Running Water types, this is the Rio Japurá, Brazil. Introduces the idea that rivers change as we move downstream, also of artificial water types.

Slide Seven: What's at the top of a river? Where does the water originate? Meltwater and mountain streams, commonly.

Slide Eight: Some characteristics of mountain streams and rivers.

Slide Nine: A reminder of the seasonal and diurnal variation of such streams.

Slide Ten: The (maximum) speed of the current determines the bed type, and consequently the types of animals and plants that inhabit the river.

Slide Eleven: At lower altitudes, slower water speeds, shading by trees, nutrient inputs and disturbance all contribute to create a very different freshwater environment from the mountain stream. In many parts of the world streams flow through forest. This slide of a small New Forest stream in England can be compared with the following slide of an Amazonian forest stream. There are many similarities in structure and the main insect groups present.

Slide Twelve: The same influences operate in the Amazon as in the New Forest. This slide illustrates the huge variability in lowland freshwater systems. This variation is caused by seasonal rainfall patterns, and to some extent meltwater, several thousand kilometres away in the Andes. The Amazon basin is largely flat and the water depth increases as it 'backs-up' due to the comparatively slow discharge of water into the Atlantic Ocean.



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Slide Thirteen: It is often assumed that tropical forest streams show little seasonality this is wrong. The graph shows the seasonal variation in water depth in the Amazon. This will be shown in pictures in the following slides. Flooding also takes place in the New Forest, but on a much less predictable basis.

Slide Fourteen: A view of a tree in the Mamiraua Reserve, Amazonia at high water (October). This shows how adaptable all inhabitants of the forest must be to live with annual inundation. This annual inundation is caused by rainfall in the Amazon headwaters in the Andes. Because the Amazon flows through a large basin with little elevation above that of the Atlantic Ocean the water backs up flooding great areas of forest.

Slide Fifteen: A view of a tree in the Mamiraua Reserve, Amazonia at low water (May). As above.

Slide Sixteen: Introduces groundwater springs as the source for many rivers. Spring fed rivers and streams often have important features such as steady flows and water temperatures that do not change greatly with the seasons. This is particularly the case with chalk-stream rivers introduced in the next slide.

Slide Seventeen: Chalk streams evolve from such springs and have well-defined characteristics, all evident in these pictures. Species names are provided where known.

Slide Eighteen: A typical lowland river...

Slide Nineteen: ... and another, placing the river in the context of its landscape. The flow in the lowland area is much slower than in headwater streams.

Slide Twenty: ... and another, indicating that inputs may affect the river's nutrient status and health.

Slide Twenty-one: An aerial view of the Amazon, indicating some of its major features. These islands are covered with Varzea, or white water inundation, forest, typical of river systems such as the main stem of the Amazon River. At high water, only the tops of the trees will be seen. This photograph was taken over 2000 km from the sea near a town called Tefe. The river occasionally inundates all the land visible in the picture.

Slide Twenty-two: Many rivers in industrialised countries have this type of development along their banks, often with dire consequences for their ecology. Marshland is lost, tributaries are placed in culverts, waste water discharges consume oxygen and migratory animals are stopped by weirs and other obstructions from undertaking their seasonal movements to feeding and breeding grounds.

Slide Twenty-three: The Grand Canyon is perhaps the most graphic example of the erosive power of rivers anywhere on the planet. The annual snow-melt from the Rocky Mountains swells the Colorado River enormously, carrying 44,400,000 tons of sediment per year, according to one estimate. The opening of the Hoover Dam in 1942 has interfered greatly with the sediment transport in the river.

Slide Twenty-four: Erosion of a different type, related to water and rock chemistry.

Slide Twenty-five: Man-made water courses can be found virtually everywhere in lowland habitats. Their water quality probably varies hugely and their ecological contribution to the body of aquatic habitats is not always easy to establish.



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Slide Twenty-six: A brief description of the canal structure and common features. The role of the UK canal system in particular has switched from purely industrial, when constructed, to largely recreational today. During the quiet season canals may provide useful habitat for some species but disturbance during the tourist season is likely to be considerable.

Slide Twenty-seven: Canals do not usually replicate the habitats present in natural rivers. They may be heavily managed, with regular draining and dredging.

Slide Twenty-eight: At high altitudes, waterfalls provide little in the way of aquatic habitat, although continual spray may enable certain species to survive, e.g. mosses and lichens and some insects.

Slide Twenty-nine: Large waterfalls create much river disturbance, they aerate the water and generate large spray plumes. All these factors mean that the ecological conditions downstream are likely to be very different to those upstream.

Slide Thirty: Most waterfalls prevent upstream migration of fish. If the river carries migratory fish it is likely therefore that populations up and downstream of the falls may well be different. They also create uncharacteristic deep pools in otherwise shallow rivers, which may be used as refugia for fish in times of drought. This is the case at the Dangar Falls which are situated in Queensland, Australia where drought is a regular occurrence.

Slide Thirty-one: Spray plumes create unique habitats that harbour unusual species.

Slide Thirty-two: Introductory – Section II. The lake at Beaulieu is man-made and controlled by sluices.

Slide Thirty-three: Some temporary ponds and puddles appear every year whereas others are the result of extreme events.

Slide Thirty-four: The rate of drying is likely to be very weather-dependent.

Slide Thirty-five: Even small pools or puddles may contain abundant life. These species are usually able to fly or have some other means of rapid dispersal.

Slide Thirty-six: An important feature of small ponds is their lack of fish that allows a unique invertebrate fauna of crustaceans such as ostracods, tripos etc to evolve (pictures in Lecture 4). The image is of a pool drying in the flood basin of the Amazon which trapped fish during the flood season. The catfish tried to escape back to the river across the hot sand.

Slide Thirty-seven: The nutrient status of marshes and bogs depends on local conditions and soil-type. If sphagnum can develop as it does in the New Forest, Hampshire, where this picture was taken, the water can become acidic and poor in dissolved nutrients. The low levels of decomposition result in the build-up of peat and the further isolation of the water bodies from the bedrock.

Slide Thirty-eight: This upland flush has enabled a large population of rushes to survive. Note the complete absence of trees, all cleared for sheep grazing over several centuries and the clear zonation on the hillside.

Slide Thirty-nine: Ponds are temporary and unstable habitats. They can change greatly in temperature and nutrient status and are almost never long-lived. This picture shows a pond on the edge of the Rio Japura, Upper Amazon, Brazil. It will disappear during the next annual flood.



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Slide Forty: In flood plains, the lakes and ponds left by receding water are of many different sizes...

Slide Forty-one: ... and the continuum of sizes is very evident on this slide.

Slide Forty-two: Lakes such as this usually fairly species poor, although they make ideal nursery areas for midge larvae. They are nearly always oligotrophic as no nutrients are available from the granitic bedrock.

Slide Forty-three: The development of standing waters from riverine systems is clearly seen here, although all such meander systems are dynamic and lakes and ox-bows may reconnect when the channels change course. The picture is of the confluence of the Rios Solimoes and Japura in the Upper Amazon, Brazil. The Rio Solimoes (also termed the Amazon although the locals use this name after the confluence further downstream with the Rio Negro) is towards the top of the image.

Slide Forty-four: Large mountain lakes such as this have virtually no littoral zone as the banks drop steeply into the water. As a result, there is comparatively little aquatic wildlife around their borders. Lake Como is deep, cool and stratified.

Slide Forty-five: Lowland lakes such as this are formed by the uneven distribution of glacial drift material, causing pockets in the landscape that fill with water but have no exit route. Crosemere now lies in deforested farmland. In many parts of the world lakes now receive large amounts of nitrogen rich runoff from surrounding farmland.

Slide Forty-six: In the Galapagos Islands, this lagoonal lake was created by the trapping of freshwater behind beach accretion. The water is nutrient rich, probably in part derived from the sea and it supports high densities of zooplankton that are food for the flamingos.

Slide Forty-seven: Fraser Island is the largest sand island in the world, over 100 miles in length. Lakes such as these are to be found all over the island, they are very low in nutrients and very clear. The lack of nutrients reflects the lack of bedrock. Very low nutrient waters are also formed in the Amazon forest for similar reasons – the basin was once a large lake or marine basin and the soil in some areas is almost pure sand or fine clay.

Slide Forty-eight: An important feature of large lakes is the temperature stratification, whereby below a certain depth, the temperature remains constant and provides a very stable environment for the inhabitants. Stratification leads to unique subdivisions of habitat.

Slide Forty-nine: The similarity to marine environments is obvious...

Slide Fifty: ... even down to the appearance of the beaches.

Slide Fifty-one: Introduction to the different types of man-made freshwater bodies, all built for different purposes.

Slide Fifty-two: The effect of drawdowns at reservoirs provides a very striking example of deleterious disturbance... Macrophytes and invertebrates cannot establish communities along the edge of reservoirs such as this one in the French Alps because of the constantly changing water levels.



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Slide Fifty-three: Reservoirs built in arid environments are likely to disturb the local ecology considerably, because they provide a resource that, under natural conditions, would not be there at all. This picture of a reservoir in south Spain clearly shows the effect of draw-down during the long dry summer period.

Slide Fifty-four: This picture is the side wall of a flooded chalk quarry in Kent, England. The water is more than 80 feet deep and on the bed there is even a drowned railway locomotive. Where man-made water bodies have steep sides, such as here, their value to aquatic wildlife is reduced because of the lack of rooted macrophytes. However, they can still be used by birds by many birds. The picture shows holes made by sand martins.

Slide Fifty-five: Another steep-sided water body in the making. This is a large gravel pit. In many areas of the world old gravel workings are locally important water bodies.

Slide Fifty-six: Ornamental ponds are usually intensively managed and planted with exotic species. However some native species such as amphibians, dragonflies and birds often make use of them. They increase habitat diversity and in urban areas may be the only patches of standing water available.

Slide Fifty-seven: Bodies like this are pleasant to look at but have no ecological value to speak of, sometimes the water is chlorinated to prevent algal growth. They can however, harbour disease organisms.

Slide Fifty-eight: A closing reminder of the changes that take place in a river as it develops from its source. A river can be viewed as a continuum of habitats.

Take-home message:

There is a wide variety of water types and a wide range of criteria by which they can be classified. The dynamic nature of water bodies, particularly running waters, coupled with seasonal variations in water volume mean that plants and animals need to be adaptable to change. Future lectures will give us an idea of how organisms cope with environmental variation.