



Aquatic Science and Wetland Management (Biol 3091)



01519903 © Bruno D'Amicis / naturepl.com

1.Introduction to aquatic and wetland ecosystem

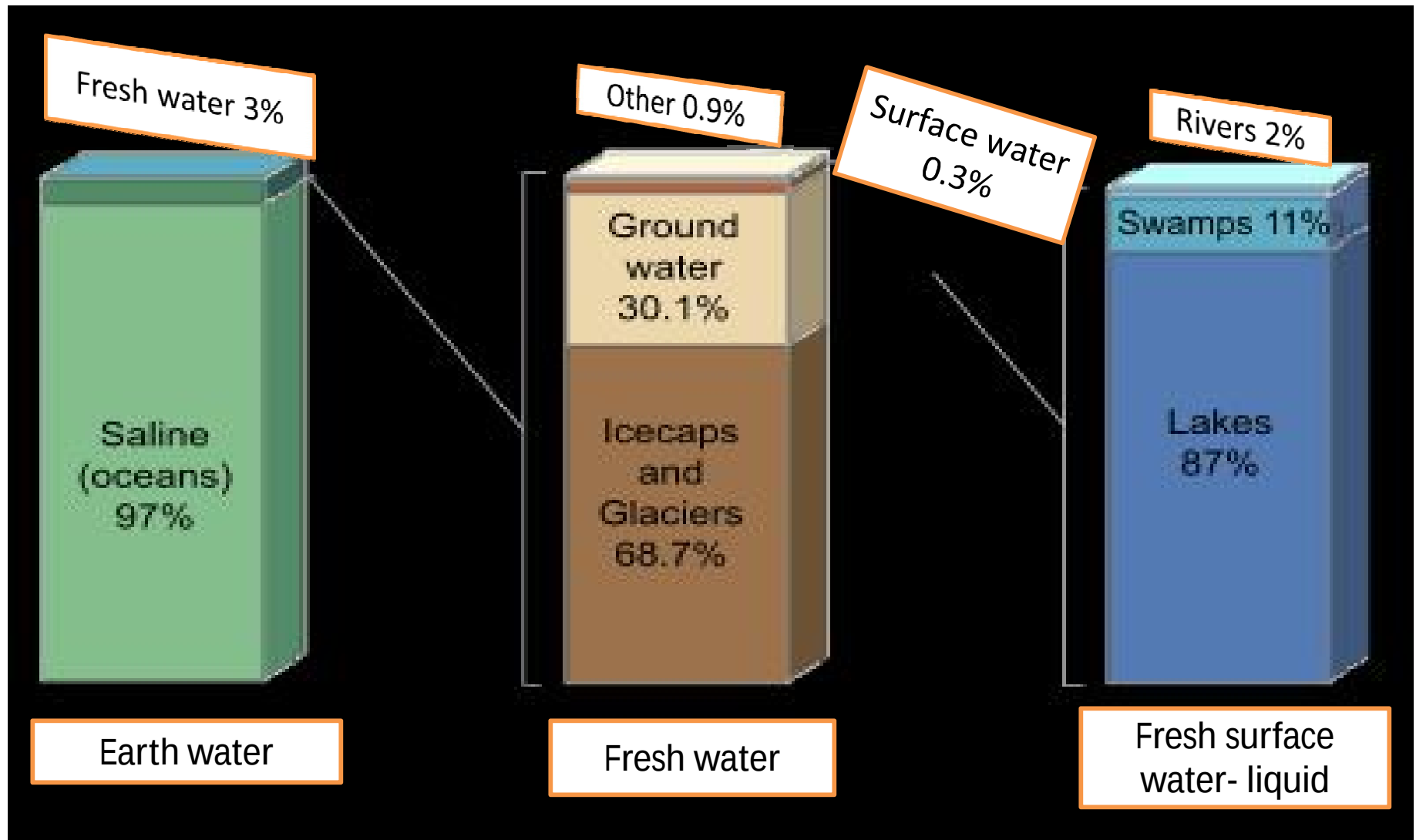
- All systems that encompass interacting biotic and abiotic components may be considered as an ecosystem.
- A drop of polluted water may for instance be considered an ecosystem, because it contains microorganisms, organic matter, and inorganic salts and
- these components are interacting.
- Aquatic Ecosystem is a biological community in aquatic habitat, of interacting organisms and their physical and chemical environment

1.Introduction to aquatic and wetland ecosystem

1.1. Definition

- Aquatic ecosystems perform many important environmental functions for recycling of nutrients, water purification, recharging of ground water, providing habitats for wildlife, for human recreation and are important to the tourism industry
- A stress on an aquatic ecosystem can be a result of physical, chemical or biological alteration of the environment
- An aquatic ecosystem is composed of biotic communities and abiotic environmental factors
- The world aquatic ecosystems are grouped into fresh water & marine ecosystems

Distribution of Earth water



1.2. Global proportion of water

- About **75%** of the earth covered by water
- Marine covers about **71%** of the earth or **97% OF THE TOTAL WATER**
- Inland water about **3% OF THE TOTAL WATER**
- About **68.7%** of **fresh water** is either frozen or ice
- **30.1%** is buried in aquifers as ground water
- The remainder is found as surface water(lakes, ponds, rivers,streams) and moisture
- Lakes account **87%** of the surface water

1. 3. The major Types of aquatic ecosystem

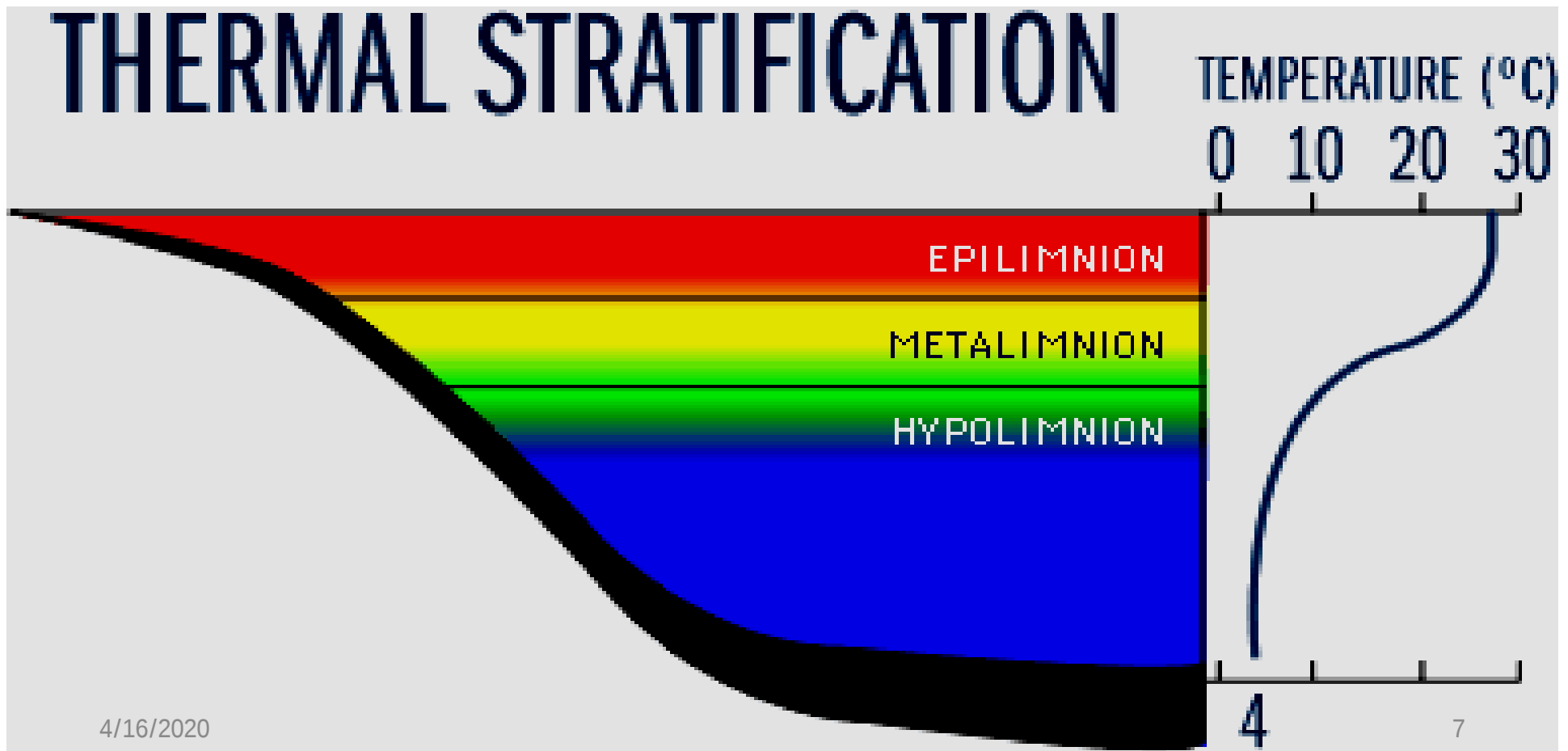
1. 3. 1. Inland aquatic ecosystem

- Land locked, fresh water ecosystem with salinity of about 10 gm/L
- Generate nearly **3%** net production, contain nearly **41%** of the fish species
- There are **three** types of inland aquatic ecosystem
 - a. Lentic (lakes, ponds)
 - b. Lotic (rivers, streams)
 - c. Wetland ecosystem



Inland aquatic ecosystem

- a. **Lentic (lakes, ponds)** exhibit **thermal stratification** during summer & winter
- ✓ Sunlight heated the top one and the bottom remained cold



Epilimnion

- is the top-most layer in a thermally [stratified lake](#)
- It is warmer and typically has a higher [pH](#) & high [O₂](#) concentration
- This layer receives the most sunlight & contains the most [phytoplankton](#)
- As they grow and reproduce they absorb nutrients from the water, when they die they sink into the hypolimnion resulting in the epilimnion becoming depleted of nutrients

metalimnion)

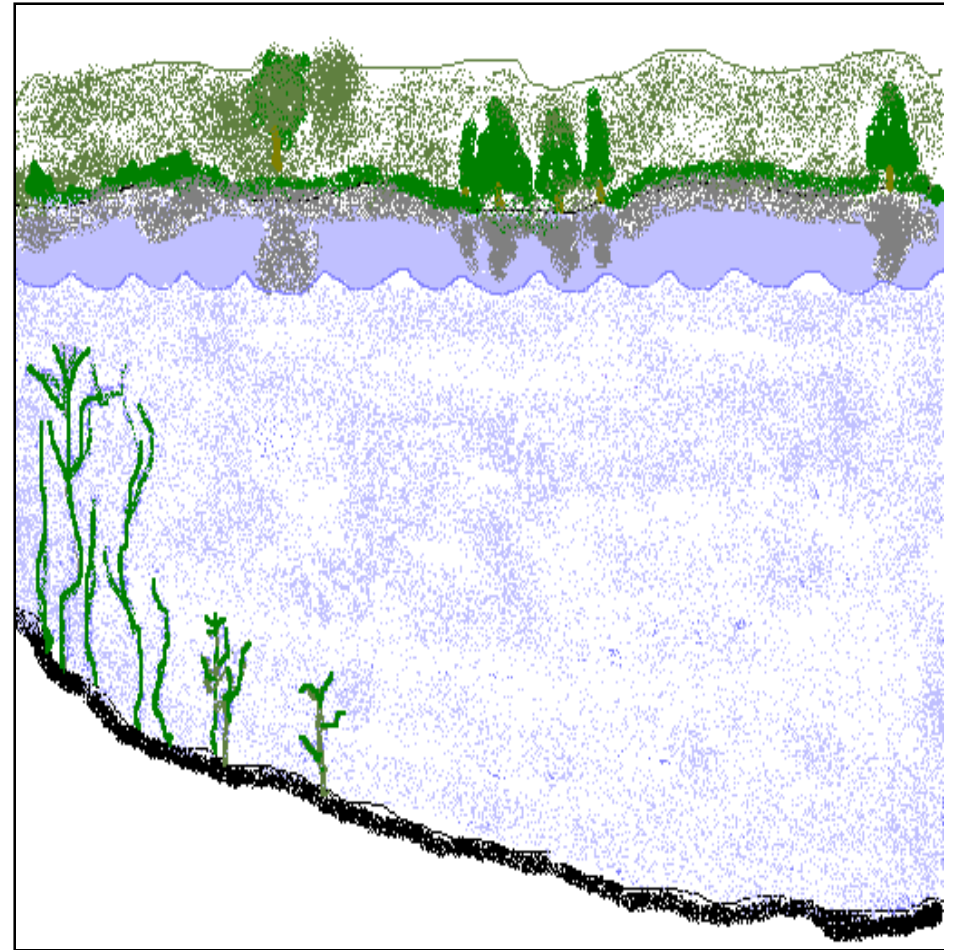
- is a thin but distinct layer in a large body of water, such as lake
- temperature changes more rapidly than it does in the layers above or below.

Hypolimnion

- is the dense, bottom layer of water in a thermally-[stratified lake](#)
- It is the layer that lies below the [thermocline](#).
- it is the coldest layer of a lake in summer, and the warmest layer during winter

Classification of lakes

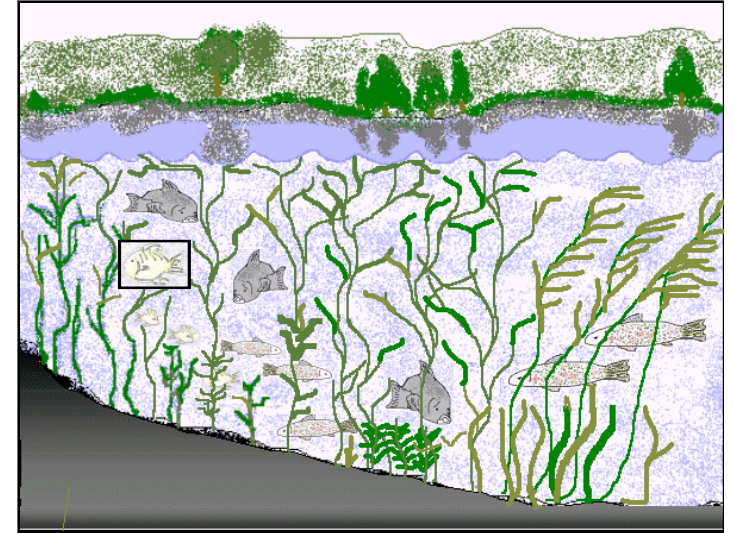
- Based on the concentration of **chlorophyll a** (gm/L) lakes can be
- Ultra-oligotrophic <1
- Oligotrophic <2.5
- Mesotrophic <8
- Eutrophic b/n 8 & 25
- Hyper-eutrophic >25



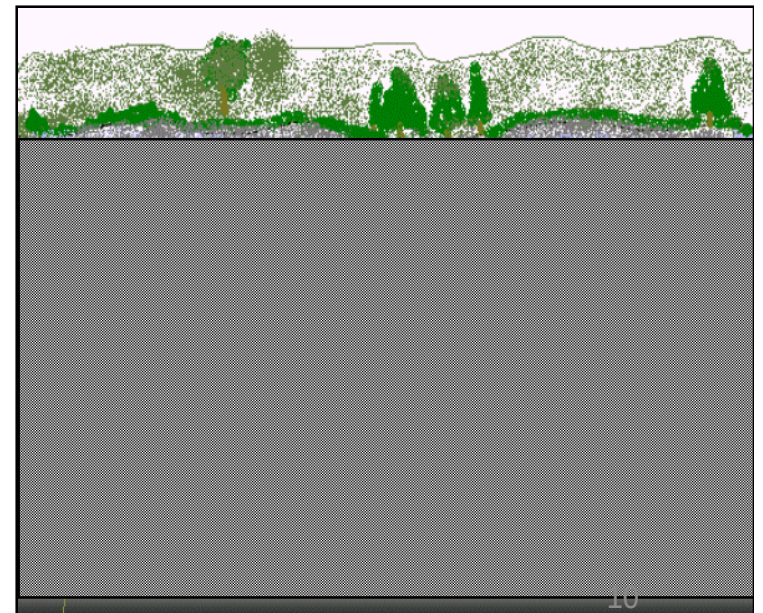
Oligotrophic – low nutrients and “productivity;” usually high clarity

Classification of lakes

Mesotrophic – moderate nutrients,
“productivity” and clarity

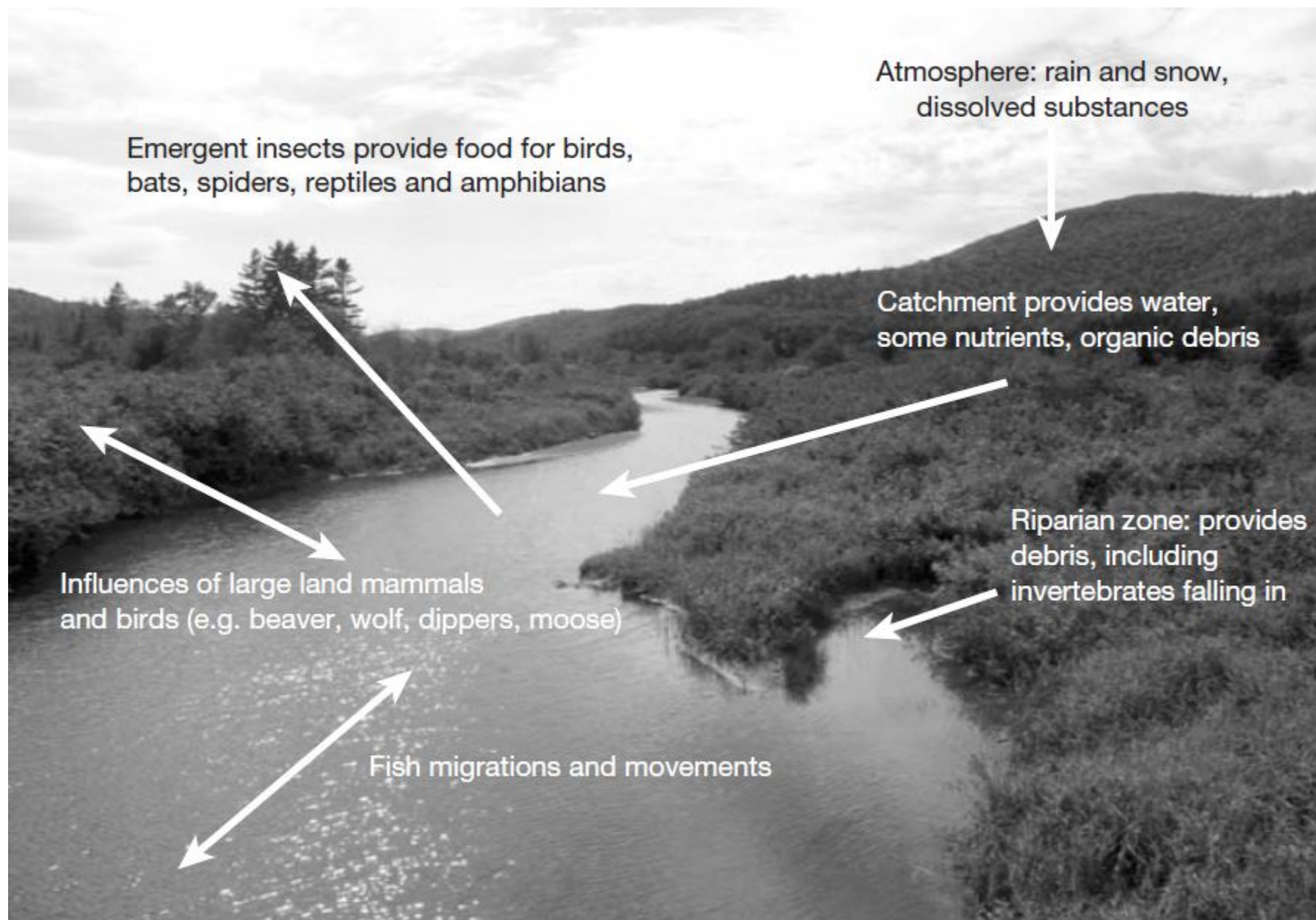


Eutrophic – high nutrients and
“productivity;” low clarity



b. Lotic fresh water ecosystem _ Rivers and streams

- Moves in one direction
- The starting point is the head water, the end point is the mouth
- ➡ **At head water the water is**
 - Cold and clear
 - Carries little sediment
 - Few mineral materials
 - Narrow channel and rock substance
 - The water flows turbulently



4/16/2020

Some features and processes within a headwater stream system



FLOW AND DISCHARGE

- Water flow is never stable except during a prolonged dry period
- During such a period, the flow, if any, will be the base flow maintained by what runs out of the soils and the ground water, and this will often decrease as a dry period is prolonged.
- In rainy periods, the flow will change by the hour
- The discharge, which is the volume flowing down the channel per unit time, can be measured as the product of flow rate (current velocity) and cross-sectional area of the channel
- Flow rate varies with depth within the channel and proximity to the bottom and edges where friction delays the flow, so a mean flow has to be determined using a flow meter from measurements at several locations across the profile of the stream

LAMINAR AND TURBULENT FLOW

- At base flows it is most likely to have a large laminar (smooth) component, but as discharge increases it will become more turbulent
- Turbulent flow sets in above a critical velocity and is promoted by ‘rough’ beds with projecting boulders and is characterized by chaotic movements, swirls and eddies
- **COMMUNITY COMPOSITION IN STREAMS**
- In streams, communities are predictable to some extent but the individuality is extreme because of the frequent disturbance
- there are four distinctive groups generally present for which there is reasonable information: the algae on stones (the epilithon), the plants, the macroinvertebrates and the fish. This is not to say that other groups are absent or unimportant

Near the mouth the water

- Moves slowly
- More turbid
- Nutrient contents is higher
- But as the river gets larger, it somewhere switches from being an erosive, headwater river to a depositional river, leaving behind more silts, sands and gravels, than it erodes
- Some persist in the main channel, smoothing it, for although current speed increases on average downstream, the range of velocities within the greatly increased profile is greater and there are quite low speeds at the edges and at the bottom.



Floodplains support high biodiversity not only because they are wet but because they have many different physical features, created by the movements of the river channels, the laying down and redistribution of sediments, the ponding of water and the frequent fluctuations in these.

- Depth will increase, and the water may then bear enough silt from erosion of the catchment to prevent much light penetration to the bottom, so the submerged plants may disappear
- Secondly, at the edges, rooted or floating plants, which cope with the turbid water by emerging into the air above it, may start to form permanent swamps

Vegetation Types

- Due to relatively high water current, plankton are less in rivers

► **Rivers with rough & shallow bottom** have turbulent flow__ Riffles

so **periphyton**, typically **filamentous & tufted algae** that can attach themselves to objects



periphyton

4/16/2020

► **Smooth deep bottom** has slower & smooth flow__ slackened current

submerged or emergent plants usually occur



Common water hyacinth i

C. Wetland ecosystems

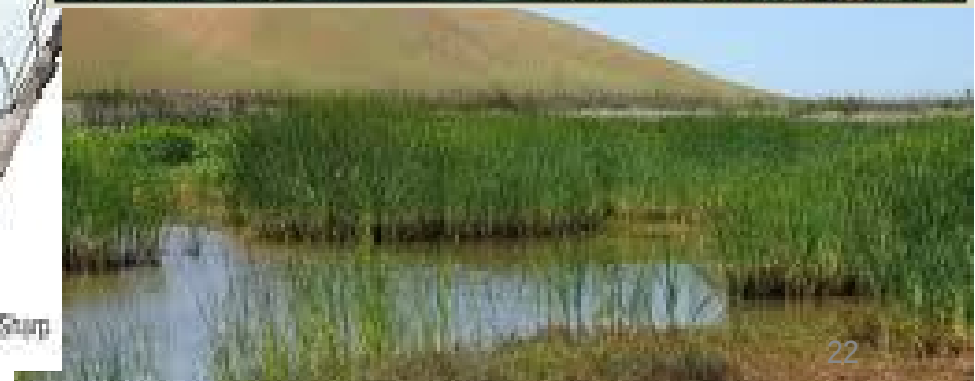
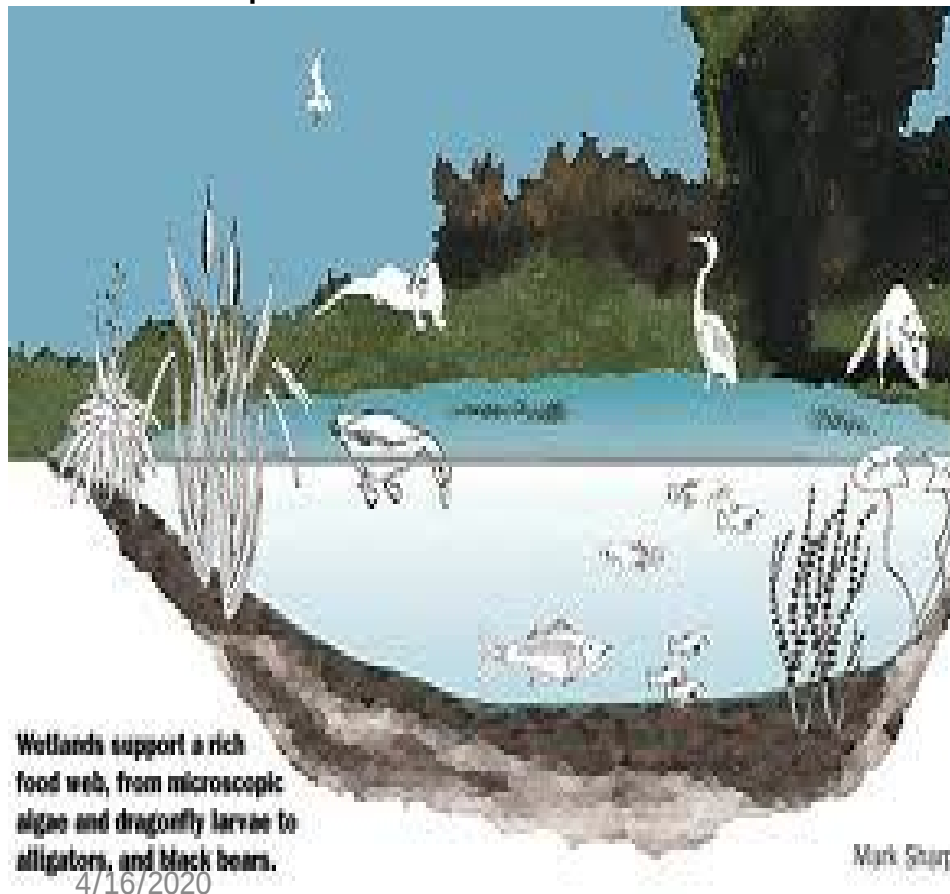
- A wetlands are defined as: “areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed **six** metres”.
- Or “may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands”

Defination

- Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.... Wetlands must have one or more of the following three attributes:
- 1) at least periodically, the land supports predominantly hydrophytes,
- 2) the substrate is predominantly undrained hydric soil, and
- 3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.”
- Note that this definition addresses both vegetation characteristics and physical attributes of wetlands.
- It also includes the three features of wetlands that are widely used today – **hydrology, wetland soils and wetland vegetation.**

Soils are saturated & waterlogged and anaerobic condition

- They are transitional areas b/n aquatic and terrestrial environment
- Global coverage is not exactly known due to seasonal and spatial variability's
- But they are estimated nearly 6%
- In Ethiopia -2%



Benefits

- Wetlands are among the world's most productive and valuable ecosystems on earth, they have many **socio-economic** and **ecological benefits**
- Wetland functions
 - A. Hydrologic processes
 1. Flood control
 2. Protection against storms and tsunamis
 3. Groundwater recharge
 4. Storage of surface water
 5. Erosion control
 - B. Water quality improvement
 1. Removal of pollutants
 2. Protection of drinking water
 3. Wastewater treatment
 - C. Wildlife habitat
 1. High net productivity
 2. Habitat for endangered species
 3. Habitat for marine species
 4. Vernal pools and isolated wetlands

Ecosystem Services

Wetlands Ecosystems



Provision Services

Food, fuel, fibre, fresh water,
and genetic resources

Support Services

Primary production, provision of
habitat, water and nutrient cycling,
soil formation and retention

Culture Services

Spiritual and religious values,
educational and inspiration,
recreation and aesthetic values,
ecotourism

Regulate Services

Pollination, invasive retention,
climate regulation, water
purification, natural hazard
control, pest disease control

Local Communities





rice fields of the west coast, Sri Lanka.



Dry season irrigation of vegetables on the Limpopo floodplain, Mozambique



Lesser Flamingos feeding in Lake Abijata



Papyrus boat (Lake Tana)

Wetland Values

Value may be assigned to wetlands as a result of:

- their location in the landscape
- the functions they perform
- the uniqueness of their plant and animal communities
- their aesthetic qualities
- as sites for education and scientific research
- as locations of historical or archaeological significance
- as repositories for water during floods

Values of wetland

- “ecosystem services”
- **Gas regulation – carbon and methane sequestration**
- **Disturbance regulation – storm protection, flood control, drought recovery**
- **Water supply – storage and retention of water**
- **Nutrient cycling - storage, cycling processing of nutrients (especially N and P)**
- **Soil erosion control**
- **Commodities – production of wood fiber, minerals, materials, crops, fish and game**
- Commercial and recreational fisheries, for example, support an industry that contributes \$111 billion annually to the national economy, employing nearly 2 million people.
- **Biodiversity – e.g., genetic resources, pollination, refuges for desirable species**
- **Recreation – hunting, fishing, hiking, wildlife viewing, etc**

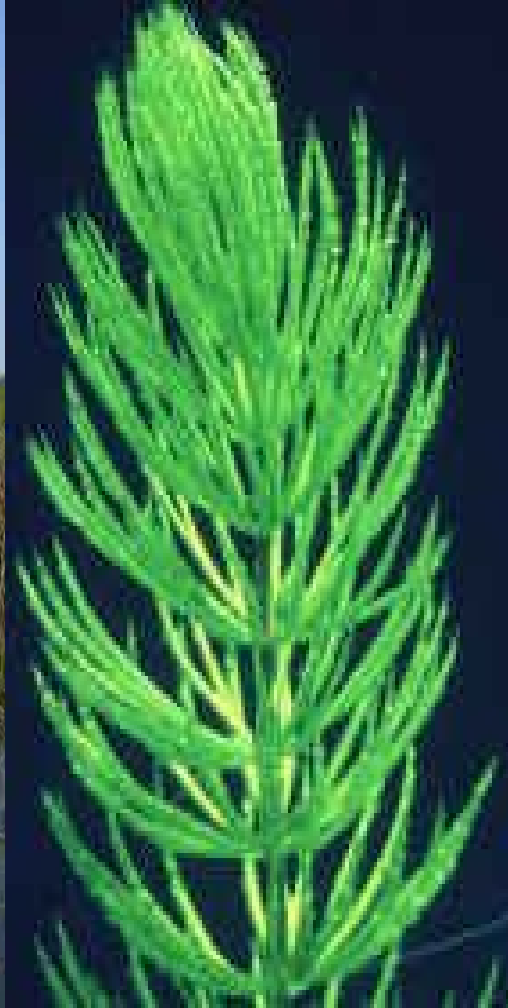
■ Classification of wetlands based on Ramsar convention. [..\..\wetland classification.docx](#)

- **Marine wetland** –coastal, rocky shore ,coral reefs etc
- **Estuarine wetland-** tidal marshes,mangroves
- **Lacustrine wl-** associated with lakes
- **Riverine wetlands** –associated with rivers

Wetland plants

Common Name	Botanical Name
Common cattail	<i>Typha latifolia</i>
soft-stem bulrush	<i>Scirpus validus</i>
common reed	<i>Phragmites australis</i>
Horn wort	<i>Ceratophyllum demersum</i> L.
Star wort	<i>Callitriche stagnalis</i> Scop.
Pond weed	<i>Potamogeton spp</i>
Water lily	<i>Nymphaea spp</i>

Wetland plants



Common cattail, *Typha latifolia*

Joe Emerick

Wetland classification

- Wetlands can be categorized according to several distinctive characteristics,
- E.g. **soil type**: wetlands with mineral soils vs. with peat (organic) soils
 - **hydrology**: seasonally or continually flooded wetlands
 - **water source**: rainfall, groundwater, or surface flow
 - **vegetation type**: wetlands dominated by woody vegetation vs. those dominated by reeds, or grasses and sedges, or mosses
 - **salinity**: freshwater (mostly inland) vs. brackish/seawater (coastal) wetlands
 - **pH**: wetlands with neutral pH vs. more acid wetlands. Most acid wetlands occur in the northern hemisphere of the world
 - **origin**: natural vs. artificial. Artificial (or constructed) wetlands are human-made structures often with a very specific goal.

threats of the wetland

- Despite the benefits gained from wetlands they are under threat from the conversion of wetlands for;
- intensive irrigation agriculture
- the expansion of human settlements,
- industrial pollution,
- agricultural pollution by pesticides, use of fertilizers,
- water diversion for drainage and the construction of dams

HUMAN THREATS TO ECOSYSTEMS

POPULATION

Consumption growth

INFRASTRUCTURE DEVELOPMENT

Dams, urban growth, highways

LAND CONVERSION

Deforestation, agriculture

OVER EXPLOITATIO N

Overfishing

RELEASE OF POLLUTANTS

Human, agricultural and industrial wastes

INTRODUCTION OF EXOTIC SPECIES

Replacing indigenous species

Threats to Wetlands

- drainage and filling
- building of dams
- channelization of riverbeds
- overexploitation of wetlands resources
- introduction of invasive species
- water pollution



Source: www.bspb.org



13

Febr.2nd 2004, Central European University

The loss and degradation of wetlands



Installing drain tile



A dredging operation



Extensive coastal development

Wetland management principles and interventions

Wetland management should practice within and around the wetland

Management types

- a. **Protection**- Minimizing human influence on wetland
- b. **Restoration**- Re-establishing the degraded one
- c. **Enhancing**-modification of wetlands for better value
- d. **Creation**-construction of new wetland

1.3.2 Marine ecosystem (oceans, seas and estuaries)

- Marine ecosystems are the largest of Earth's aquatic ecosystems and are distinguished by waters that have a high salt content
- In addition to these, marine ecosystems also include the salt marshes and wetlands located along the shores and river mouths
- Provide most of the planets rainfall through evaporation

1.3.2 Marine ecosystem (oceans, seas and estuaries)

- The world climate and wind pattern affected by ocean temperature
- Generate **32%** of the world net primary production
- Marine algae produce the worlds highest O_2 & consume high CO_2
- Characterized by higher salinity(370mg/L)

Marine ecosystem cont'd...

- Generally, water bodies particularly marine ecosystems can be divided into the following
- zones: oceanic- the relatively shallow part of the ocean that lies over the continental shelf; profundal- bottom or deep water; benthic- bottom substrates; intermodal- the area between high and low tides; estuaries; salt marshes; coral reefs and hydrothermal vents
- Classes of organisms found in marine ecosystems include brown algae, dinoflagellates, corals, cephalopods, echinoderms, and sharks
- Environmental problems include;
 - ✓ **unsustainable exploitation**
 - ✓ **pollution**
 - ✓ **climate change**
 - ✓ **and building on coastal area**

Types of Marine ecosystems

- Marine ecosystems include **near shore** systems, such as the salt marshes, mudflats, sea grass meadows, mangroves, rocky intertidal systems and coral reefs
- They also extend outwards from the coast to include **offshore** systems, such as the surface ocean, pelagic ocean waters, the deep sea, oceanic hydrothermal vents, and the sea floor

Classification Cont'd...

- ✓ **Salt marsh**; coastal wetlands that are flooded and drained by salt water brought in by the tides
- ✓ **Mangroves**; a compilation of different mangrove tree species living together near the coastline to create a forest
- ✓ **Intertidal zones**; areas that are visible during low tide and covered up by saltwater during high tide
- ✓ **Estuaries**; occur where there is a noticeable change in salinity between saltwater and freshwater sources

Classification Cont'd...

- ✓ **Lagoons**; a "shallow body of water protected from a larger body of water (usually the ocean) by sandbars, barrier islands, or coral reefs."
- ✓ **Coral reefs**; are one of the most well-known marine ecosystems in the world, with the largest being the Great Barrier Reef. These reefs are composed of large coral colonies of a variety of species living together.
- ✓ **The deep sea** or deep layer is the lowest layer in the ocean, existing below the thermocline and above the seabed, at a depth of 1000 fathoms (1800 m) or more





4/16/2020

Classification cont'd...

- A **hydrothermal vent** is a fissure on the seafloor from which geothermally heated water issues
- Hydrothermal vents are commonly found near volcanically active places, areas where tectonic plates are moving apart at spreading centers
- **Benthos** is the community of organisms that live on, in, or near the seabed, also known as the benthic zone.
- This community lives in or near marine sedimentary environments, from tidal pools along the foreshore, out to the continental shelf, and then down to the abyssal depths
- The **pelagic zone** consists of the water column of the open ocean, and can be further divided into regions by depth

Ocean

- is a major body of saline water, and a principal component of the hydrosphere
- The World Oceans are the huge volumes of sea water belonging to the hydrosphere.
- Oceans cover more than 70 per cent of the earth's surface. About 97 per cent of all the water available on the earth are in the oceans.
- The primary role of oceans and seas lie in maintaining the global climate by regulating the air temperature and by supplying the moisture for rainfall. Without oceans, life would not have originated in our planet.

- The major oceanic divisions are defined in part by the continents, various archipelagos, and other criteria
- **Pacific Ocean-** it separates Asia and Australia from the Americas
- **Atlantic Ocean-** it separates the Americas from Eurasia and Africa
- **Indian Ocean-** it separates Africa and Australia
- **Southern Ocean-** it has no landmass separating, it the southern portions of the Pacific, Atlantic, and Indian Oceans
- **Arctic Ocean-** sometimes considered a sea of the Atlantic, which covers much of the Arctic and washes upon northern North America

- Based on the intensity of light the water body of marine ecosystems can be differentiated into three zones.
- They are
- **Euphotic zone** -extends upto 100 m depth, illuminated zone production zone , rich with phytoplankton, primary consumers and secondary consumers.
- is the uppermost layer of the world's oceans
- **Disphotic zone** - lies between 100 and 200 m depth, weakly lighted, secondary consumers live with a few primary consumers, Rare plant life.
- **Aphotic zone** - above 200m depth , No light, no producers, no photosynthesis, secondary consumers, feed on other animals also.

- the marine ecosystems have certain unique features.
- They are:
- 1. the oceanic environment is very **wide**, covering 75% of the earth's surface.
- 2. The oceanic systems are very deep in which life extends to all depths.
- 3. The water masses of sea and oceans are **continuous**.
- 4. The water is in continuous movement in both vertical and horizontal dimensions.
- 5. The water is salty with an average salt content of 35 g/litre.
- 6. The concentration of dissolved nutrients is low.

- The Temperature fluctuation is minimum in oceanic waters.
- Arctic waters are colder.
- Tropical waters are warmer.
- The variation is seasonal and diurnal.
- Ocean animals show a varied response to the temperatures.
- There are two kinds of animals.
- 1. Stenothermal animals – the ones which live within 20°C
- 2. Eurythermal animals – the animals which can withstand the wide range of temperature variations

Sea

- A sea is a large body of water that is smaller than an ocean
- The Divisions of Marine environment included in the study of open sea are:
 - a) pelagic environment,
 - b) epipelagic environment,
 - c) mesopelagic zone,
 - d) bathypelagic zone,
 - e) abyssopelagic zone, and
 - f) benthic environment- sea bottom
- **E.g**
 - Andaman Sea
 - Arabian Sea
 - Amundsen Sea
 - Bellingshausen Sea
 - Red sea

Estuarine ecosystem

- Estuary is a partly enclosed coastal body of water with one or more rivers or streams flowing into it, and with a free connection to the open sea
- The inflow of both seawater and freshwater provide high levels of nutrients in both the water column and sediment, making estuaries among the most productive natural habitats in the world



- Estuaries offer good fishing grounds as the water column is shallow and easily approachable. These are the breeding habitat for a variety of Shrimp and Prawn species, oysters and fishes.
- They also provide sheltered harbours for ships and their traffic. Estuarine waters are used for cooling of water in power generation plants.
- An estuary is a semi-enclosed coastal body of water that has a free connection with the open sea at one side and a river on the other side.
- Estuarine waters are therefore **salty** or **brackish** in quality. Structurally, they are deep funnel shaped mouths

Estuarine ecosystem

- Estuaries are amongst the most heavily populated areas throughout the world
- As a result, estuaries are suffering degradation by many factors
- **Classification of estuaries**
- Most commonly, estuaries are classified according to their geomorphology or water circulation
- **Classification based on geomorphology**
- Drowned river valleys, Lagoon-type or bar-built estuaries, Fjord-type estuaries and Tectonically produced estuaries

➤ **Classification based on water circulation**

- Salt wedge estuaries, Partially mixed estuaries, Vertically homogenous estuaries, Inverse estuary and Intermittent estuaries

Important Biotic and abiotic factors in marine ecology

- Marine ecosystem is characterized by the many biotic and abiotic components.
- **Biotic** components are:
 - Organisms and their species
 - Predators, Parasites, Competitors and
 - Mates.
- The **Abiotic** Components (Physical and Chemical) are:
 - Temperature , Concentration of Nutrients
 - Sunlight, Turbulence, Salinity and density.

- The following are the properties affecting the life in the seas and oceans:
 - 1. Quality of sea water
 - 2. Skeleton shape and size of organisms
 - 3. Buoyancy
 - 4. Gravity
 - 5. Temperature of water
 - 6. Density of water
 - 7. Light penetration in water
 - 8. Availability of Nutrients
 - 9. Water turbulence and
 - 10. Hydrostatic pressure.

CHAPTER TWO : Major Fresh Bodies and Wetland of Ethiopia

Drainage Basins of Ethiopia

- Called the water tower of northeast Africa
- The drainage patterns are the result of the topographic features formed by the recent geographic activity of the Cenozoic Era during the Tertiary Period
- Broadly divided into three

The western drainage system

- Abay
- Baro-akobo
- Gibe-Omo
- Lake Tana
- Rivers are flow into Mediterranean sea (Exorheic system)

✓ **The South-eastern drainage system**

- Wabishebele and Ghenale
- Drain into the Indian Ocean

✓ **The Rift valley drainage system**

- Awash drainage basins
- Lake Ziway
- Lake Shala
- Lake Abijata
- Lake Hawassa
- Lake Abaya and Chamo
- This is generally an endorheic system

Cont'd...

1. **Lakes** is a body of fresh or salt water of considerable size that is surrounded by land
 - Natural lakes are generally found in mountainous areas, rift zones, and areas with ongoing or recent glaciation
 - In the daytime a lake can cool the land beside it with local winds, resulting in a sea breeze; in the night it can warm it with a land breeze
- **Distribution and types of Ethiopian lakes**
 - There are more than 30 major lakes that are located in different ecological zones
 - The surface area of the lakes varies considerably from less than 1 km² to over 3600 km²

Cont'd...

- the major lakes that are of economic importance are concentrated in the Rift Valley and high land regions

I. The Ethiopian Rift Lakes

- Rift Valley lakes occupy the floor of the rift valley between the two highlands
- Most of the Ethiopian Rift Valley lakes do not have an outlet, and most are alkaline

II. Crater lakes

- These lakes are five in number, namely Lake Arenguade, Bisoftu, Chitu, Babugaya, Hora and Cheleleka
- The crater lakes are generally circular in shape

Fig 1. Distribution of Ethiopian lakes

Lakes of Ethiopia



LakeNet Explorer

Map Sources: Lehner, B. P. Doll (2003); Birkett, C.M. & I.M. Mason (1995); USDA (2002)
Base map: ESRI (2003)

Cont'd...

- In the Bale Mountains, East of the Ethiopian Rift Valley, there are about fifteen lakes and ponds located at altitudes above 4000masl
- Some of the Bale mountain lakes are Lake Garba Guraca, Hora Orgona, Tarn, Tarn 2 etc
- The most popular Ethiopian High land lakes are Lake Tana. It is Lake Tana, is the source and from where the famed Blue Nile starts its long journey to Khartoum and on to the Mediterranean
- It is the largest lake in Ethiopia with total area of 3,600,000 hectares having the maximum width, length and depth of 67, 75 km and 14m, respectively
- papyrus *Echinochola spp*, filla, Grasses and Polygonum with other several aquatic plants including the water Lilly are present

Lake characteristics

- Changes in the level of a lake are controlled by the difference between the input and output compared to the total volume of the lake
- Lakes can be also categorized on the basis of their richness in nutrients
- ✓ **Oligotrophic lakes** are characterized by relatively low productivity and are dominated by cold-water bottom fish such as lake trout
- ✓ **Mesotrophic lakes** have good clarity and an average level of nutrients
- ✓ **Eutrophic lakes**, which are shallower, are more productive and are dominated by warm-water fish such as bass
- ✓ **Hypertrophic** that have been excessively enriched with nutrients
- Lakes also divides into three zones (**littoral zone, photic & benthic zone**)

How lakes disappear

- A lake may be in-filled with deposited sediment and gradually become a wetland such as a swamp or marsh
- Some lakes can disappear seasonally which we called intermittent lakes
- Intermittent lakes are the result of above-average precipitation in a closed basin, usually filling dry lake beds
- Some lakes disappear because of human development factors

iii. Reservoirs

- A few reservoirs are found in Ethiopia.
- Koka, at about 1589m, formed on the Awash River Southeast of Addis in the Rift Valley.....

Threats



Threats



Threats



Uses and values

- This ecosystem has vital importance as the major source for domestic and industrial water supply of the nation
- In addition, the Ethiopian water bodies are a “natural laboratory” for education and scientific research
- Generally the Rift Valley Lakes of Ethiopia serve as important sources of food for a good number of local inhabitants.
- Some of the commercial fishing areas, are also known to support a high number of waterfowls
- The economic importance of aquatic ecosystem is significant in the areas of hydroelectric power generation, irrigation and transportation

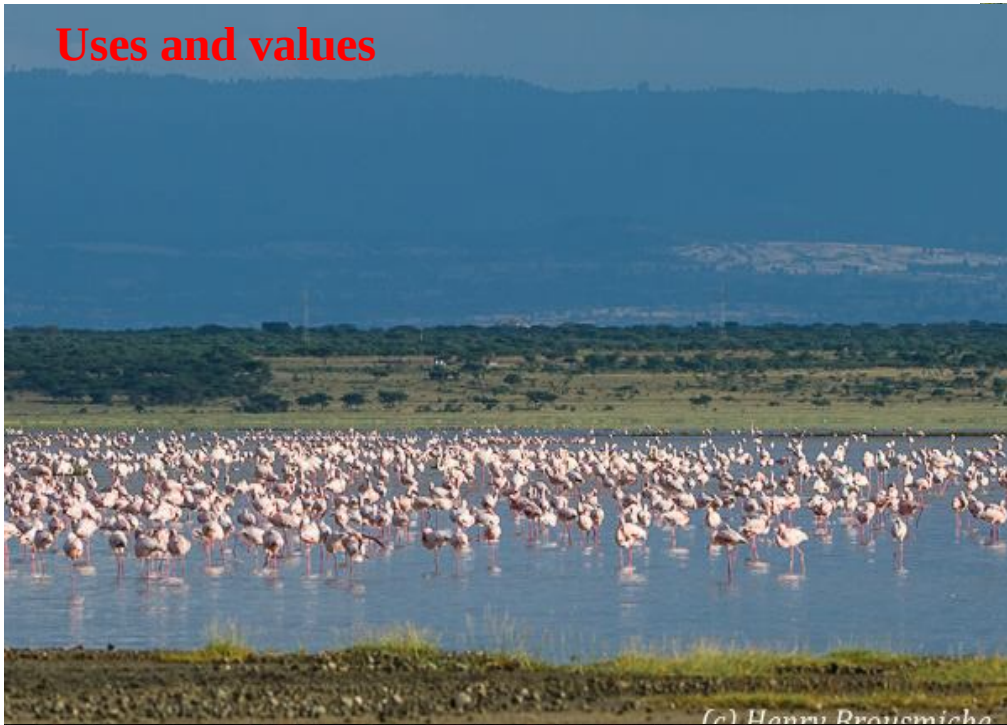
Uses and values



Uses and values



Uses and values



(c) Henry Bräusmiche



2. Rivers

- River is a natural watercourse, usually freshwater, flowing toward an ocean, a lake, a sea, or another river
- In a few cases, a river simply flows into the ground or dries up completely before reaching another water body
- A river is part of the hydrological cycle. Water within a river is generally collected from precipitation through surface runoff, groundwater recharge, springs, and the release of stored water in natural ice and snow packs

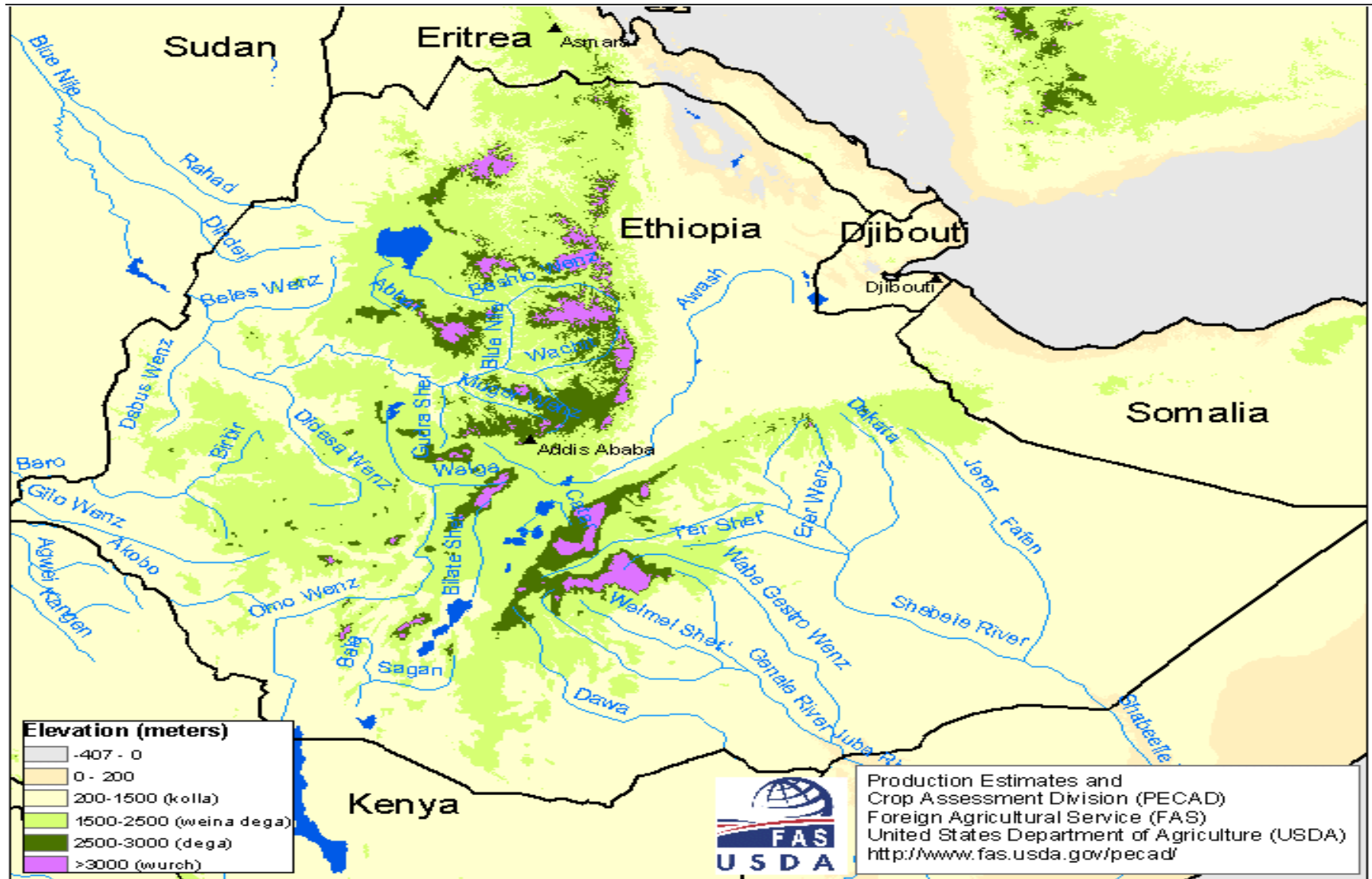
Distribution of Ethiopian Rivers

- Ethiopia is endowed with over 7000 km of rivers, whose drainage basins cover almost the whole country including the semi-arid lowlands
- There are 12 major river basins with total annual surface runoff of **110 billion m³**

Cont'd...

- Ethiopian rivers are characterized by
 - Extreme seasonal fluctuations
 - Steep flow and profiles
 - Have high erosive power
- Many Ethiopian rivers are difficult for fisheries due to
 - i. Steep gorge
 - ii. Presence of crocodile
 - iii. Many tributaries dry or reduced volumes during dry season

Fig 2. Major Ethiopian Rives



Uses and values

- ✓ a source of water
- ✓ for obtaining food
- ✓ for transport
- ✓ as a defensive measure
- ✓ as a source of hydropower to drive machinery
- ✓ Irrigation and for bathing

Threats and rates of change

- Land and water development, pollution, introduction of exotic species, over exploitation of fish stocks, etc are some of these activities
- Direct human effects such as damming and diversion of rivers, channelling and building water distribution facilities, and indirect influences such as removal of vegetation, industrial expansion have played a great role in changing the habitat

Cont'd...

- Farming of the catchments contributes to enhanced nutrients and particulate runoff where grasslands are overgrazed or fields are fertilized
- shortage of rainfall

3. Wetlands

- Wetlands are defined as areas of marsh, fen, peat land, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt
- in Ethiopian context marshy areas, swamp lands, flood plains, natural and artificial ponds, volcanic crater lakes, high mountain lakes and upland bogs are treated collectively as wetland ecosystems
- There are wetlands at various parts of the country that covers a total of 18,587 Km² (1.5% of the country's area)

Cont'd...

- Wetland ecosystem has been considered as wasteland that have little or no value at all, and converted to agriculture and grazing through drainage
- Often, they are considered as breeding sites and sources for several water borne diseases both to human and domestic animals
- However, wetland ecosystem is considered to be more productive than the adjacent area because of the periodic inflow of nutrients

Types of Ethiopian wetlands

➤ **Swamp**

- It is a wetland featuring flooding of large areas of land by shallow water bodies
- It is a wetlands dominated by trees or shrubs, and marshes as wetlands dominated by emergent herbaceous vegetation

Cont'd...

- The two main types of swamp are forest and shrub swamps
- Swamps are characterized by rich biodiversity and specialized organisms such as frogs

➤ Marsh

- It is a type of wetland that is subject to frequent or continuous flood
- Typically the water is shallow and features grasses, rushes, reeds, typhas, sedges, and other herbaceous plants.
- Marshes are critically important wildlife habitat, often serving as breeding grounds for a wide variety of animal life, particularly including ducks and geese
- has a greater proportion of open water surface

➤ **Bogs**

- It is a wetland type that accumulates acidic peat, a deposit of dead plant material-usually mosses and lichens
- Bogs occur where the water at the ground surface is acidic, either from acidic ground water, or where water is derived entirely from precipitation
- The most common type of bog is Peat swamp forest
- Peat swamp forests are tropical moist forests where waterlogged soils prevent dead leaves and wood from fully decomposing
- Flood plains wetland: it defined as land adjacent to an active river channel which are occasionally flooded by those bodies of water and remain dry for varying portion of the growing season

Wetlands...

- ✓ Major wetlands of Ethiopia
- ✓ L.Tana.Fogera,Dembia ,Dangila and the surrounding wetland
- ✓ Ashengie and Logo lakes
- ✓ Wetland of Bale Mountain
- ✓ The alpine lakes –Gebregurecha
- ✓ Swamps and flood plain
- ✓ Wetlands of Western highlands
- ✓ Kefa, Benchi,Maji and Sheka, Illibabur, Jimma etc

Wetlands....

- Lakes of Bisheftu
 - Hora, Bisheftu,Babaguya etc
- Lakes and associated wetlands of SRV and NRV lakes
- Lakes and Swamps of the Awash river
 - Abasamuel, L. Abe, Borkena flood plain
- Lakes of Afar Depression
 - L. Afera, L. Asale and L. Abe
- Western river flooded plain
 - Alwero, baro, Akobo, Gilo,Dabas,Beles flood plain
- L. Alemaya and the associated wetlands

Uses and values

- Their function as ecological and hydrological is several fold, for example, flood control, water purification, sediment and nutrient retention, dry season grazing, agriculture, microclimate, recreation and cultural values, water supply, construction, flood, medicine, Important Bird Areas (IBA) as well as provision of flyways for migrant birds
- During famine and food insecurity people also rely heavily on wild plants from wetlands and the associated areas
- In Ethiopia
- Provision of clean water
- For roofing and making various crafts
- Medicinal purpose (Hygrophila)
- Cattle grazing and to cultivate maize, and other edible plants during dry season

Threats and rates of change

- Wetlands are altered by conversion, over utilization and unregulated management
- Deforestation and heavy decline in swamps of the Awash Valley were observed in connection with change in land use practices including heavy cattle grazing, clearing of the vegetation, construction of dams and irrigation channels and frequent fire
- Environmental pollution

CHAPTER THREE: Aquatic Ecosystems

- **Aquatic ecosystems and community structure**
- An aquatic ecosystem is an ecosystem located in a body of water
- Communities of organisms that live in aquatic ecosystems are dependent on each other and on their environment for nutrients and shelter
- In addition, aquatic ecosystems contain a wide variety of life forms including bacteria, fungi, and protozoans; bottom-dwelling organisms; freefloating microscopic plants and animals known as plankton; large plants

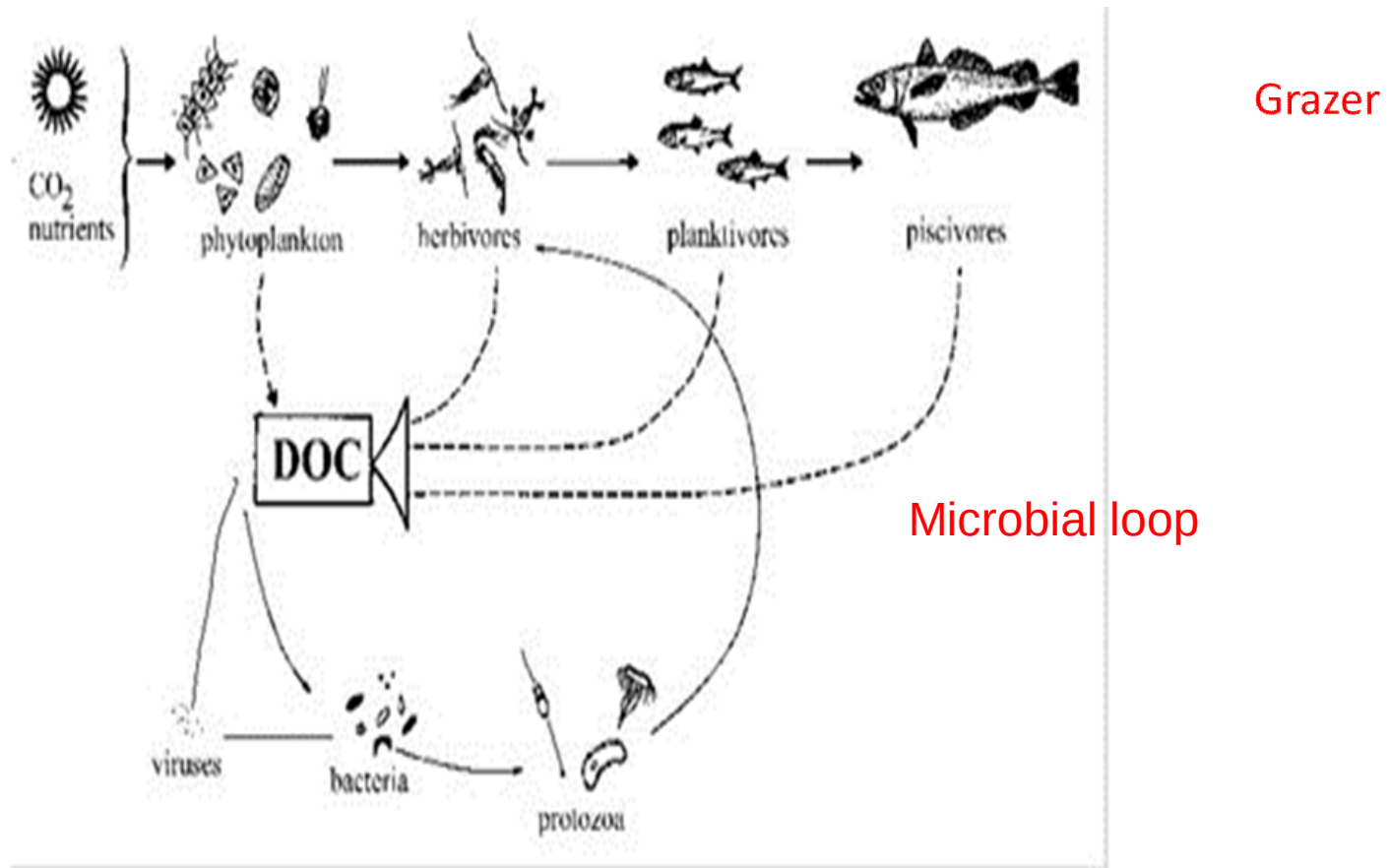
❑ Community structure

- A community is the set of all populations that inhabit a certain area
- An ecosystem is a higher levels of organization the community plus its physical environment
- Early attempts at describing community structure were based on a linear model in which organisms at different trophic levels were linked in a food chain
- Plants would be eaten by herbivores, herbivores would be eaten by primary carnivores, and primary carnivores would be eaten by secondary carnivores
- The food chain concept has been replaced by the more complex food web for a typical aquatic community

■ **Fresh-water community**

- Fresh-water organisms are classified by the areas in which they occur, the manner in which they move, and the roles that they occupy in trophic webs
- In the shallow areas close to the shores, plants and animals are abundant
- This nutrient-rich area is known as the littoral zone
- Farther out from the shore, the open water that gets enough sunlight for photosynthesis is dominated by tiny plants and animals known as phytoplankton and zooplankton

Food chains



Cont'd

- Plankton organisms occur in open water and move primarily with general water motion
 1. Phytoplankton (plant plankton) comprises at least eight major taxonomic groups of algae, most of which are microscopic
 - They exhibit a diversity of forms ranging from one-celled organisms to complex colonies. E.g. Algae; Bacillariophyceae
 2. Zooplankton (animal plankton) comprises protozoans and three major groups of eukaryotic organisms: rotifers, cladocerans, and copepods
 3. Animals, such as fishes and swimming insects, which occur in the water column and can control their position independently of water movement, are termed nekton
 4. Benthic organisms are a diverse group associated with the bottoms of lakes and streams

5. Bacteria: play a major role in biogeochemical cycling

☐ **Marine water community**

- Classes of organisms found in marine ecosystems include brown algae, dinoflagellates, corals, cephalopods, echinoderms, fish and sharks
 - Fish caught in marine ecosystems are the biggest source of commercial foods obtained from wild populations
- i. Phytoplankton
 - ii. Zooplankton [zoopl.docx](#)
 - iii. Baleen Whales; feed by filtering plankton
 - iv. Killer Whales; is one of the top predators in the ocean. They eat lots of different things, and are not hunted by anything
 - v. Decomposers; Predominantly bacteria and fungi
 - vi. Scavengers; are any of the creatures that eat dead plants and animals

■ Identification of aquatic Organisms

➤ Identification of phytoplankton

- Phytoplanktons are mainly unicellular plants known as algae
- The most important phytoplankton that is presently recognized is those 2-20 mm in size, which are classified as Nanno plankton
- The major nanno plankton size groups in the oceans are the diatoms and the dinoflagellates, both unicellular forms of phytoplankton

➤ **Identification of zooplankton**

- The zooplanktons are more varied than the phytoplankton
- are either grazers on phytoplankton (herbivores), feeders on other members of the zooplankton (carnivores) or feeders on both (omnivores).
- The most ecologically important groups are multicellular (metazoans)

➤ **Identification of crustaceans**

- are characterized by five pairs of head appendages (two pairs of antennae, one pair of mandibles, and two pairs of maxillae)
- Three main body regions are the head, followed by the thorax, then the abdomen and the terminal tail appendage

➤ Identification of fish larvae

- Bilaterally symmetrical cylindrical or leaf-like body shapes
- Two, large round eyes
- Undifferentiated fin folds

➤ Identification of different fish species

- length–weight, length-length relationships and morphometric measurements
- The following fishes are identified using morphometric measurements [zoopl.docx](#)
 - i. Ray finned fishes
 - ii. Sharks and Rays
 - iii. Chimaeras
 - iv. Lobe-finned fishes
 - v. Lampreys
 - vi. Hag fishes

Identification of Macrophytes

- ❖ Observe on stand live in the field
- ❖ Cut sample of macrophytes, leaves and flowers using identification key

Major categories of wetland plants

- Floating-water lily, nymphae, duck weed, spirodela, pond weed, potamogeton
- Submerging – *Ceratophyllum demersum*
- Emergent - *Typha latifolia*



4/16/2020

Ceratophyllum demersum

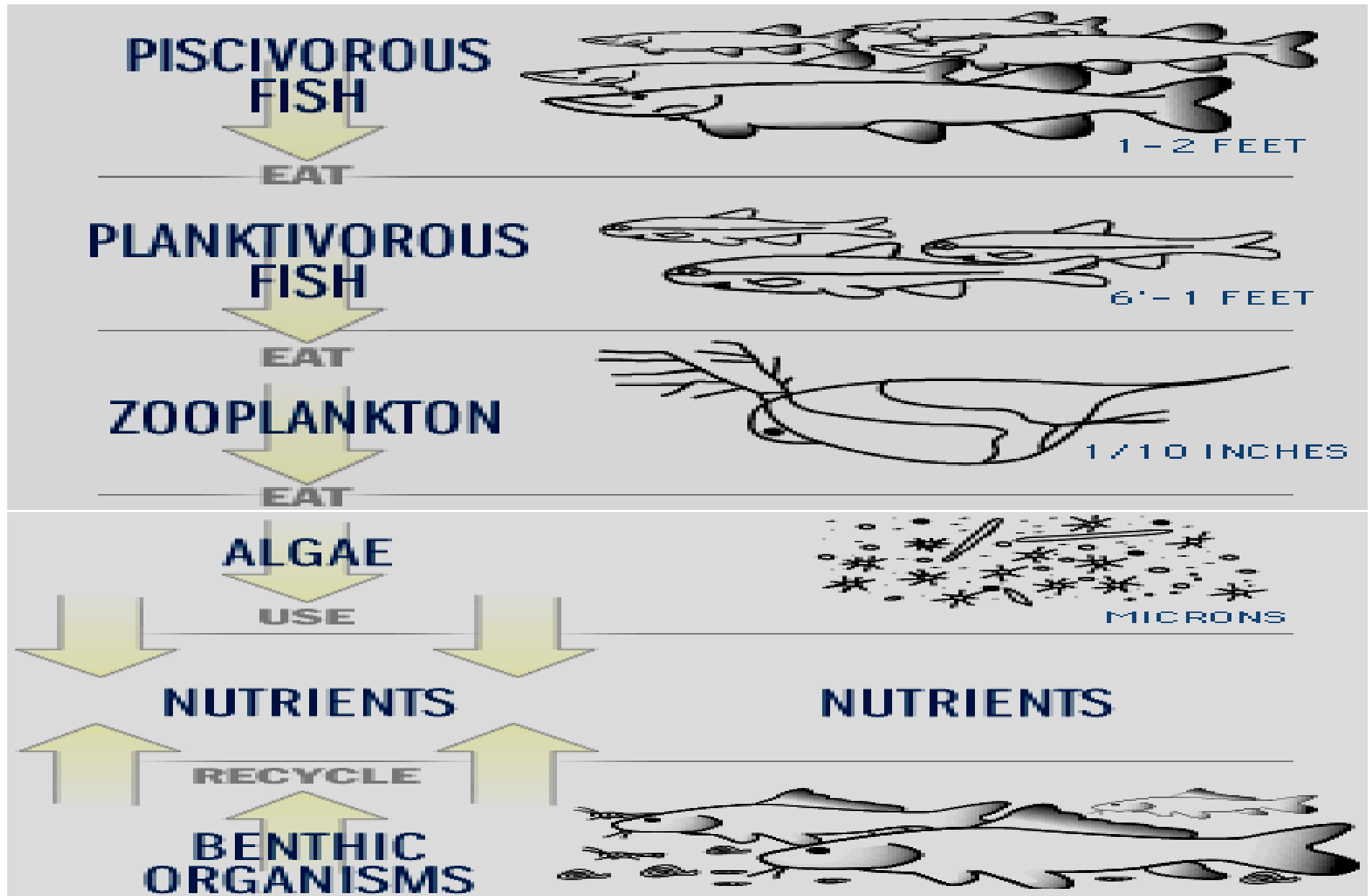


Cyperus papyrus

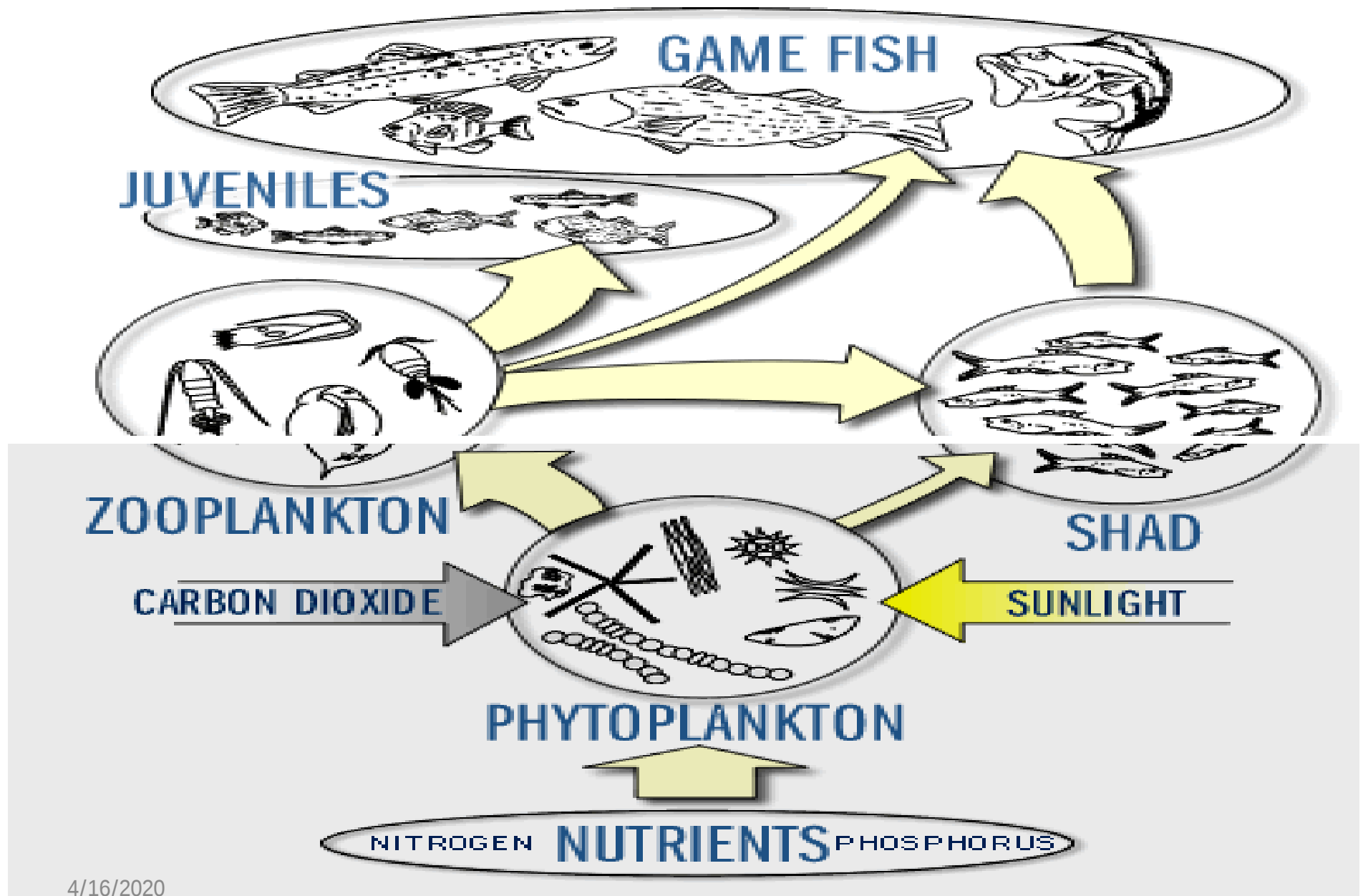


Typha latifolia
(Common cattail)

Food chain

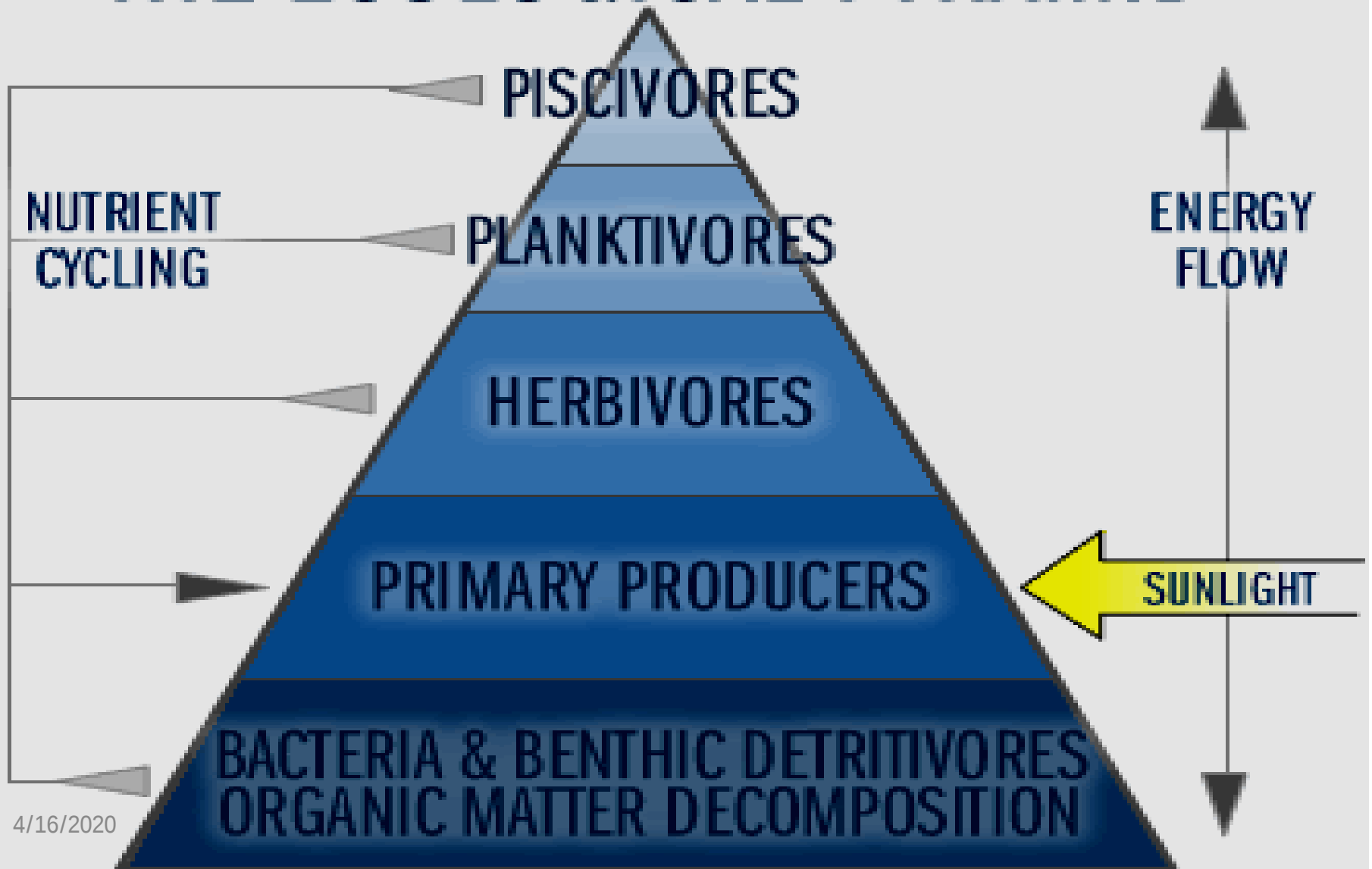


Food web



The ecological pyramid

THE ECOLOGICAL PYRAMID



Allochthonous and autochthonous inputs

➤ Allochthonous inputs

- Inputs from **watershed**, **natural** and **man** made sources & **weathering** of soil

- E.g. P, HCO_3^- , SO_4^{2-} , Ca^{2+} , Na^+ , NO_3^- , Si, Cl^- , Mg^{2+} , K^+

- **Autochthonous inputs**

- Internal inputs from **decay of organism** from bottom chemistry
- Phytoplankton extract nutrient from water and zooplankton fed on phytoplankton
- Nutrients are redistributed from upper to lower as dead plankton gradually sink to lower depth and decompose

Habitat zonation

1. Zonation in fresh water Ecosystem

- Zonation in fresh water Ecosystem_ E. g. Lakes

1.1 Horizontal Zonation

I. Littoral zone: Along shore, well lighted, warm water close the shore

Characterized by Producers: rooted & floating Plants & algae

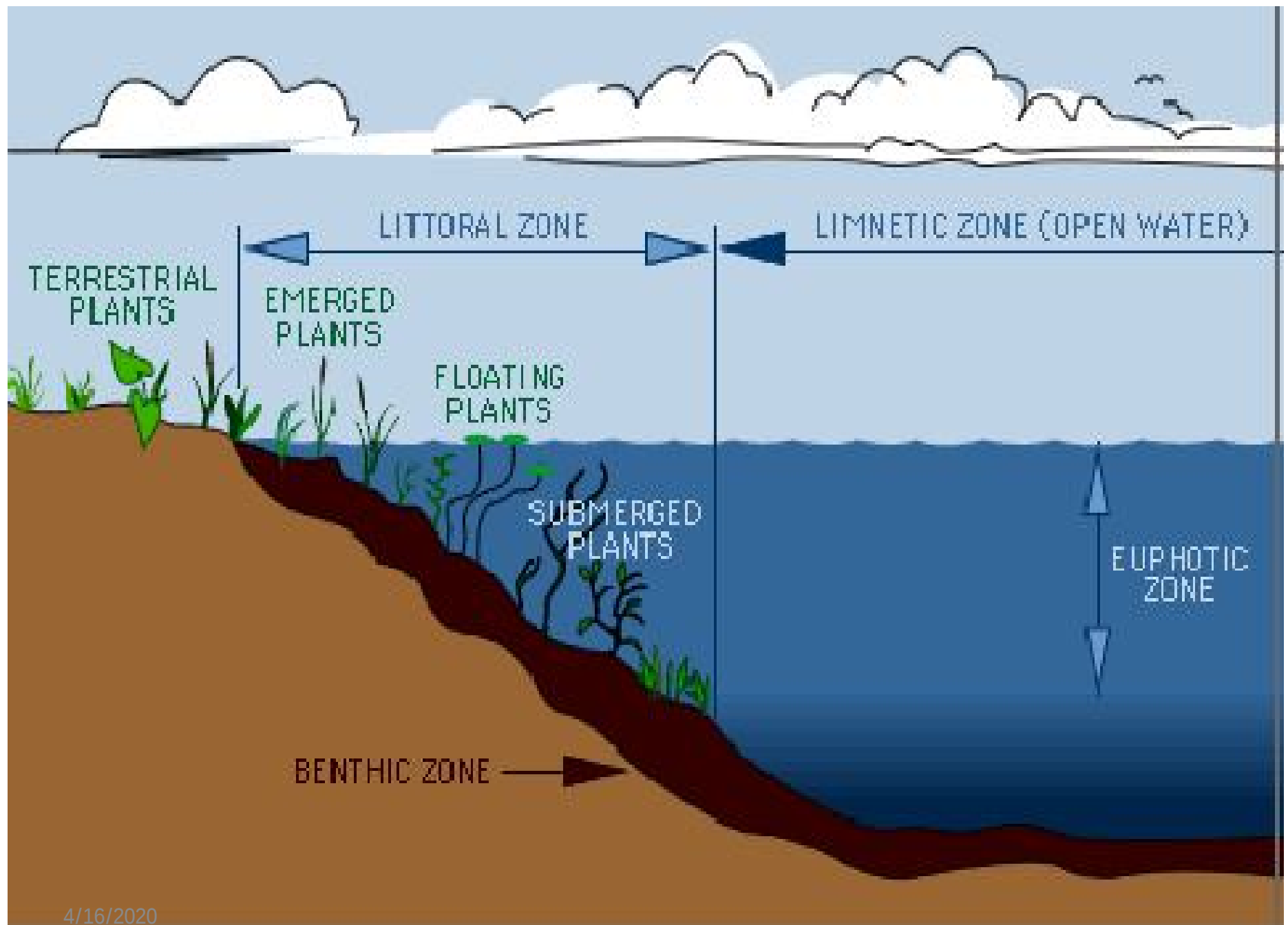
Fauna- snails, Insects, crustaceans, Fishes, Amphibians, Reptiles, Mammals

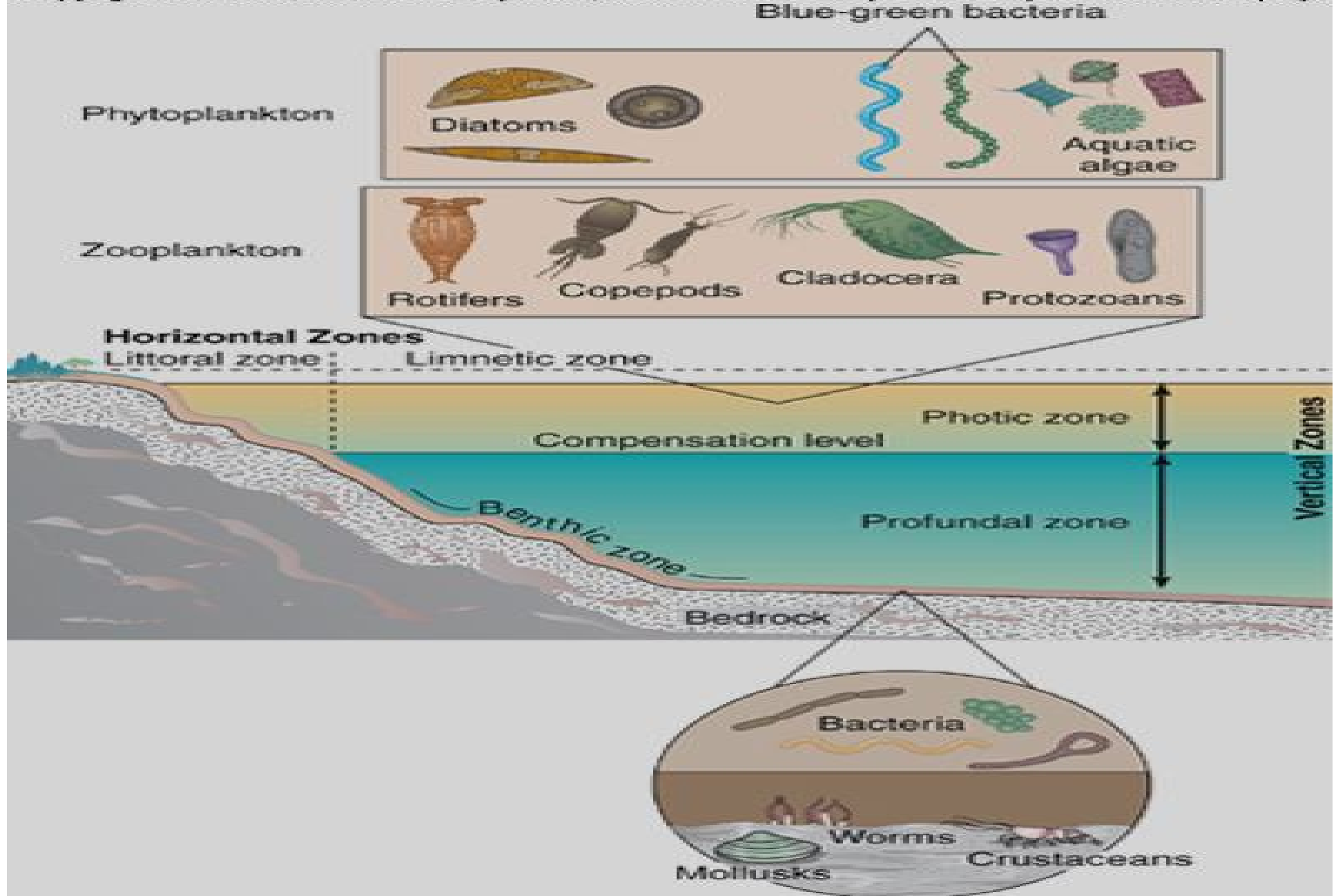
I. Limnetic zone: open water, Well lighted away from shores

- Organisms type varied with **strata**
- Have three layer, Photic, Profundal & Benthic zones

1.2 Vertical Zonation

- **Photic zone**— surface to lowest limit of sunlight penetration, upper layer in limnetic
 - high rate of photosynthesis to exceed respiration
 - Producers: Algae and cyanobacteria are dominant
 - **Profundal zone**: Deeper water, under limnetic zone
 - Site of decomposition of detritus
 - O_2 is due to aerobic decomposition, Nutrients released
 - Because of density differences related to T° , water does not mix with upper layer
 - Mixing occurs twice in temperate — nutrient recycling & O_2 mixing
 - **Producers**: Anaerobic purple and green sulfur bacteria
 - **Benthic zone**: Bottom sediment often no light and little O_2
- Dominant with benthos organisms, are *species* of *Desulfovibrio*, Methanogens, *Clostridium* & invertebrates + vertebrates





4/16/2020

The zone of a typical lake & representative organisms of each zone



4/16/2020

Factors affecting the distribution & abundance of aquatic organisms

- Sunlight
- temperature
- aeration (DO)
- contents of dissolved nutrients
- **Light** is **more important resource** in fresh water bodies
- B/se photosynthetic algae are the main source of OM & energy
- Heterotrophic bacteria, protozoa, fish & others are supported by them
- **Oxygen** _ not diffuse well in water
- Aerobic dominate in limnetic zone

eg. Algae, cyanobacteria, Pseudomonas, Caulobacter, Cytopayga

- If oxygen less in water bodis, fish die, bad odor from anaerobic activity
- Wave action + water movement improve the oxygen concentration

2. Zonation in marine Ecosystem

The two major marine region:

- the *benthic* (**bottom**)
- the *pelagic* (**oceanic zone, water column**)

A. The **benthic environment** is divided by depth into the following zones:

Littoral	(<1%)	intertidal- between the tides
Sublittoral	(8%)	low tide to edge of cont. shelf, 0-200m
Bathyal	(16%)	200 – 2000 m
Abyssal	(75%)	2000 – 6000 m
Hadal	(1%)	> 6000 m

B. **The *pelagic* environment_** is divided by depth into the following zones:

- o **Neritic** Shallow water overlying cont. shelves.

- o **Oceanic** Deep water beyond shelf edge.

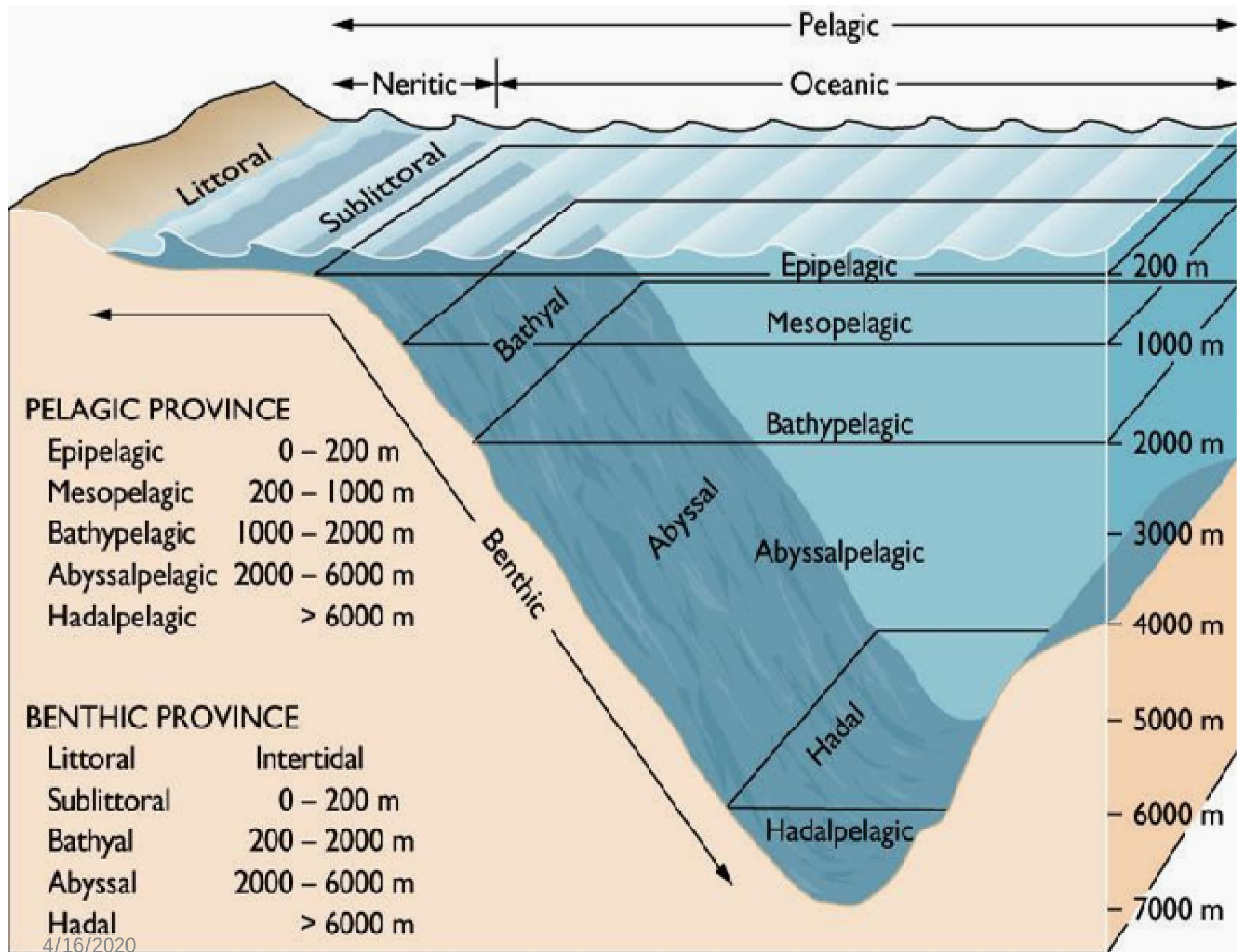
Epipelagic (3%) 0 – 200 m surface, illuminated

Mesopelagic (28%) 200 – 1000m

Bathypelagic (15%) 1000 - 2000 m

Abyssalpelagic (54%) 2000 – 6000 m

Hadalpelagic (<1%) >6000 m In trenches.



I. Littoral (Intertidal) zone: B/n high & low tides

- I. Organisms should adapt to periodic exposure to air & water action
- II. Habitate occurring in this zone includes:
 - a. **Mangrove swamps**_ comprised salt-tolerants (halophytes) plants
 - I. Have **tangle of roots** exposed above water_ named as walking trees
 - II. roots adapted to filter salt water
 - III. Leaves can excrete salt, allowing to survive in this salty environment
 - IV. Provide habtat food, shelters & nursery areas for fishes, birds, crustaceans & others

Zonation in marine ecosystem Cont'd...

b. Sea-grasses_ flowering plants that live in marine or brackish environment

- About 50 spp of plants
- Attached to substratum using roots
- Provides nursery area, shelter & food for aquatic organisms

c. Coral reef_ inhabited by hundreds of coral organisms

_ Majority are in tropics & sub-tropics

d. Rocky intertidal zones_ vertically stratified & inhabited by

4/16/2020

organisms

UNIT FOUR: WATER POLLUTION

4.1 What is water pollution

- substances introduction of to water bodies that interfering the normal function of the aquatic ecosystem

Types of aquatic pollution

- 1) Disease-causing agents: such as bacteria, viruses, protozoa and parasitic worms that enter sewage systems and untreated waste
- 2) Oxygen-demanding waste: wastes that can be decomposed by oxygen-requiring bacteria
- 3) Water-soluble inorganic pollutants such as acids, salts and toxic metals
- 4) Nutrients: such as soluble nitrates and phosphates that cause excessive growth of algae and other water plants and 5) Organic compounds

Cont'd...

- The time variability of pollutant release into the aquatic environment falls into four main categories
 - ✓ permanent or continuous
 - ✓ Periodic
 - ✓ Occasional
 - ✓ and accidental

types of pollutant sources

i. Point source pollution

- are those which have direct identifiable source
- Examples: pipe attached to a factory, oil spill from a tanker, effluents coming out from industries

ii. Non-point source

- those which arrive from different sources of origin and number of ways by which contaminants enter into groundwater or surface water and arrive in the environment from different non identifiable sources
- Examples are runoff from agricultural fields, urban waste, waste disposal sites etc.

Water pollutants

i)Organic and

- insecticides and herbicides, organohalides and other forms of chemicals; bacteria from sewage and livestock farming; food processing wastes; pathogens; volatile organic compounds

ii)Inorganic water pollutant

- heavy metals from acid mine drainage; silt from surface run-off, logging, slash and burning practices and land filling; fertilizers from agricultural run-off which include nitrates and phosphates etc. and chemical waste from industrial effluents

■ **Toxic substances, suspended solids**

- Toxic substances are chemical compounds whose manufacture, processing, distribution, and use or disposal may pose an unreasonable risk or injury to health of the environment
- Once toxic chemicals drain or seep into a water supply, they may be ingested into the human body by drinking, bathing, or breathing them
- Toxic chemicals can impact humans in the following ways;
 - 1) Through carcinogens that cause cancer**
 - 2) By mutagens that may cause a change in the inherited genetic material of a cell, or**
 - 3) By teratogens that can cause birth defects in an embryo as it is developing in the womb during pregnancy**

Cont'd...

- There are generally three types of toxic substances;
- ✓ chemical-include **inorganic** substances such as lead, mercury, asbestos, hydrofluoric acid, and chlorine gas, **organic compounds** such as methyl alcohol, most medications, and **poisons** from living things
- ✓ biological-include those **bacteria and viruses** that are able to induce disease in living organisms
- ✓ And physical- including temperature, light etc
- Toxic substances, which include heavy metals and trace organics, decrease in concentration downstream after discharge due to dilution and removal by precipitation and adsorption

■ **Suspended solids**

- Solids discharged to water settle out downstream
- Suspended and settleable solids are produced by a wide range of industries, and can be classed as either inert or oxidizable

Inert solids

- Inert solids come from mining activity, coal washing, construction sites, particularly road and bridge construction, river channelling and dredging
- The primary effects are as follows:
 - 1) inert particles clog the feeding mechanisms of filter feeders and the gills of aquatic animals
 - 2) stony erosional substrates become coated with the solids, smothering the fauna and replacing them with silty dwelling species
 - 3) with the increased turbidity light penetration is reduced, depressing photosynthesis

Cont'd...

- There are also secondary effects.

These include:

A) the elimination of predators that feed on eliminated organisms;
and

B) The possible loss of macrophytes will result in a loss of shelter, reduction in habitat diversity and an increased loss of animals due to greater predation and scouring

Oxidizable solids

- These settle out in the same way as inert solids but once deposited they decompose
- The effect decreases downstream
- The solids blanket the substrate and undergo anaerobic decomposition releasing methane, sulphide, ammonia and other toxic compounds

■ Deoxygenation

- Oxygen is an important limiting factor for all freshwater organisms and for fish in particular
- Inputs of readily oxidizable organic matter cause the dissolved oxygen concentration to fall downstream due to a gradual increase in bacterial activity
- when the rate of oxygen consumption by the bacteria is greater than that diffusing from the atmosphere, the dissolved oxygen concentration falls and may reach anaerobic conditions

■ Addition of Non-toxic Salts

- The effect of non-toxic salts can be split into two

A, increase in conductivity and salinity due to anions such as Cl^- and SO_4^{2-} cat-ions such as K^+ and Na^+

B, and eutrophication

Salinization

- **is the build-up of salts at or near the surface of a soil, eventually to toxic levels for plants and animals living in this water**
- The main sources of mineral salts associated with salanization are:
 - (a) mining wastewaters;
 - (b) industrial wastewaters; and
 - (c) increased evaporation or evapotranspiration in the catchment

■ Eutrophication and algal toxins

- Eutrophication is the enrichment of an aquatic ecosystem with chemical nutrients

main effects

- ➡ blanketing of substrata resulting
- ➡ reduction of oxygen concentration and light penetration in water
- ➡ species diversity is often reduced with different dominant species
- ➡ salmonids are eliminated;
- ➡ production of algal toxins
- ➡ discoloration of the water
- ➡ and production of offensive tastes and odours
- ➡ it causes organic pollution
- ➡ physical barrier for fish migration and reduce the recreational value of rivers



4/16/2020

123

■ **Algal toxins**

- "harmful algal blooms", are toxic to plants and animals
- Toxic compounds they produce can make their way up the food chain, resulting in animal mortality
- Examples include paralytic, neurotoxic, and diarrhoetic shellfish poisoning
- **Ecological effects**
 - decreased biodiversity, changes in species composition and dominance, and toxicity effects

The ecological effects of eutrophication

- ✓ Increased biomass of phytoplankton
- ✓ Toxic or inedible phytoplankton species
- ✓ Increases in blooms of gelatinous zooplankton
- ✓ Decreased biomass of benthic and epiphytic algae
- ✓ Changes in macrophyte species composition and biomass
- ✓ Decreases in water transparency (increased turbidity)
- ✓ Colour, smell, and water treatment problems
- ✓ Dissolved oxygen depletion
- ✓ Increased incidences of fish kills
- ✓ Loss of desirable fish species
- ✓ Reductions in harvestable fish and shellfish
- ✓ Decreases in perceived aesthetic value of the water body



Types of water pollution & The contaminants

1. Domestic pollution

➤ Municipal wastewater & Sewage

➤ **Sewage**

Is water carried waste in either solid or suspension that is flow away from the community

May Contain pharmaceutical drugs, papers, plastics and other wastes

Cont'd...

- Carries harmful micro-organisms such as viruses and bacteria may cause hepatitis, typhoid, and cholera
- From industries carry chemicals such as heavy metals their concentration increase high up in food chain (bioaccumulation)
- If suitably treated and used in moderate quantities sewage can be fertilizers
- Untreated sewage can contaminate the environment and causes diarrhea.
- Sewage management is a major problem in developing countries (sanitation and clear water problems) in these areas. Dumping sewage into oceans and seas is still a problem in developed countries.

2. Industrial pollution

➤ Commercial wastewaters

- industrial effluents with wide range of inorganic & organic pollutants
 - Tannery waste water
 - Textile waste water
 - Mining waste water
 - Paper & pulp waste water
 - Brewery waste water.....etc
 - Pollutants could be _ toxic heavy metals,

Pollutants could be

- Varied with the type of wastewater

Parameter considered to evaluate:

Solids: density, particle size, level of Volatile Suspended Solids

Biochemical Oxygen Demand

Total phosphorus

Total Nitrogen

Ammonia

Nitrate

Toxic metallic & non-metallic substances

Pathogens_ viruses, Bacteria, Protozoan's, worms.....

Effects of water pollution

➤ **Effect of water pollution on human health**

- Chemicals in water that affect human health:
Some of the chemicals affecting human health are the presence of heavy metals such as *Fluoride, Arsenic, Lead, Cadmium, Mercury, petrochemicals, chlorinated solvents, pesticides and nitrates*

Water borne disease:

- Microorganisms play a major role in water quality and the microorganisms that are concerned with water borne diseases are *Salmonella sp.*, *Shigella sp.*, *Escherichia coli* and *Vibrio cholera*
- All these cause typhoid fever, diarrhoea, dysentery, gastroenteritis and cholera. The most dangerous form of water pollution occurs when faeces enter the water supply.

➤ **Effect of water pollution on plants**

- ✓ *Effects of acid deposition*
- ✓ *Nutrient deficiency in aquatic ecosystem*
- ✓ *Effects of organic matter deposition*
- ✓ *Effects of detergent deposition*
- ✓ *Effects of industrial wastes*
- ✓ *Effects of silt deposition*
- ✓ *Effect of nutrient enrichment*

Classification of Water Associated Diseases

TABLE 5.5 Classification Of Infectious Diseases Associated With Water

Transmission mechanism	Description	Examples of diseases
Waterborne	Oral ingestion of pathogens in water contaminated by urine or feces	Cholera, typhoid, bacillary dysentery, infectious hepatitis
Water-washed	Disease spread enhanced by scarcity of water making cleanliness difficult	Trachoma, scabies, dysentery, louseborne fever
Water-based	Water provides the habitat for intermediate host organisms, transmission to humans through water contact	Schistosomiasis (bilharziasis), dracunculiasis (guinea worm)
Water-related	Insect vectors (e.g., mosquitoes) rely on water for habitat, but human water contact not needed	Malaria, filariasis, yellow fever, onchocerciasis (river blindness), dengue

3. Agricultural pollution

- Cause pollution of water through the addition of pesticides, herbicides, and nutrients with surface run-offs
- High nutrient enrichment cause bloom of algae or plankton (eutrophication)
- Some of effects of eutrophication
 - ✓ **Excessive weed and algae growth Depletion of oxygen**
 - ✓ **Blocking sunlight**
 - ✓ **Some algae produce toxins**

4. Oil pollution

Oil discharge into the surface of sea by way of accident or leakage from cargo tankers carrying petrol, diesel and their derivatives pollute sea water to a great extent. Exploration of oil from offshore also lead to oil pollution in water

Oil can not dissolve in water and form thick layer which result in suffocation effects, blocking sunlight

5. Atmospheric Deposition

Pollution of water caused by air dute anthropogenic activities (coal mining and melting of ores) and lead to acid rain formation

6. Thermal pollution

➤ Changes in water temperature
➤ Majority of the thermal pollution in water is caused due to human activities. Some of the important sources of thermal pollution are nuclear power and electric power plants, petroleum refineries, steel melting factories, coal fire power plant, boiler from industries which release large amount of heat to the water bodies

7. Suspended matter pollution_ Organic and inorganic particles in water

Problems

Sedimentation, may exert oxygen demand, primary transport mechanism for many metals, organics and pathogens, aesthetic, complicates drinking water treatment

8. Radioactive waste pollution

- Nuclear-fuel processing
- Mining of radioactive elements(uranium)
- Nuclear-fuel cycling
- Have serious detrimental effect in aquatic ecosystem and causes for cancer disease

[Doc2.doc](#)

9. Introduction of Alien species

Outside their normal environment, they have no natural predators, so they rapidly spread and dominate the animals or plants that thrive there

10. Climate Change

- Global warming has also an impact on water resources through enhanced evaporation, geographical changes in precipitation intensity, duration and frequency, soil moisture, and the frequency and severity of droughts and floods

Addition of heated water, effect on buffering system

- Thermal pollution is heating surface waters above natural background temperatures
- Effluents may be warmer or cooler than the receiving water; however, the main problem is waste heat from cooling towers or power generation
- Thermal pollution is not only caused by heated effluents and cooling water from power stations, but also from other sources
- Warmer water may not readily mix with colder denser water and so forms a surface plume

Cont'd...

- Therefore, temperature changes the composition of aquatic ecosystems and affects the buffering systems of the systems, such as invasion by new thermophilic species
- In general, high water temperature causes a number of direct responses:
 - (a) heat stress or death of sensitive species
 - (b) enhanced micro-organism respiration
 - (c) synergistic effect with pollutants
 - (d) the attraction–repulsion of mobile species

Thermal pollution is known to have a number of key metabolic effects on the biota

Afforestation and water quality

- Watershed area has direct relation with lake area in water quality perspective
- Water quality **decreased** with **increasing** of watershed Area to Lake area ratio
- Land use has important impact on quality and quantity of water entering the lake.
- In urban area due to high impervious surface ,the water qualitative entering the lake is high=high erosion
- All other things being equal(Land use, topography)covering the watershed by forest decreased nutrients load by 10 times



Use of water polluted by industrial waste dumping near Saver EPZ has led to the death of paddy (picture inset) in this field in Rairi Pok area near the EPZ.









4/16/2020

145









4/16/2020





4/16/2020





STEPS TO PREVENT WATER POLLUTION

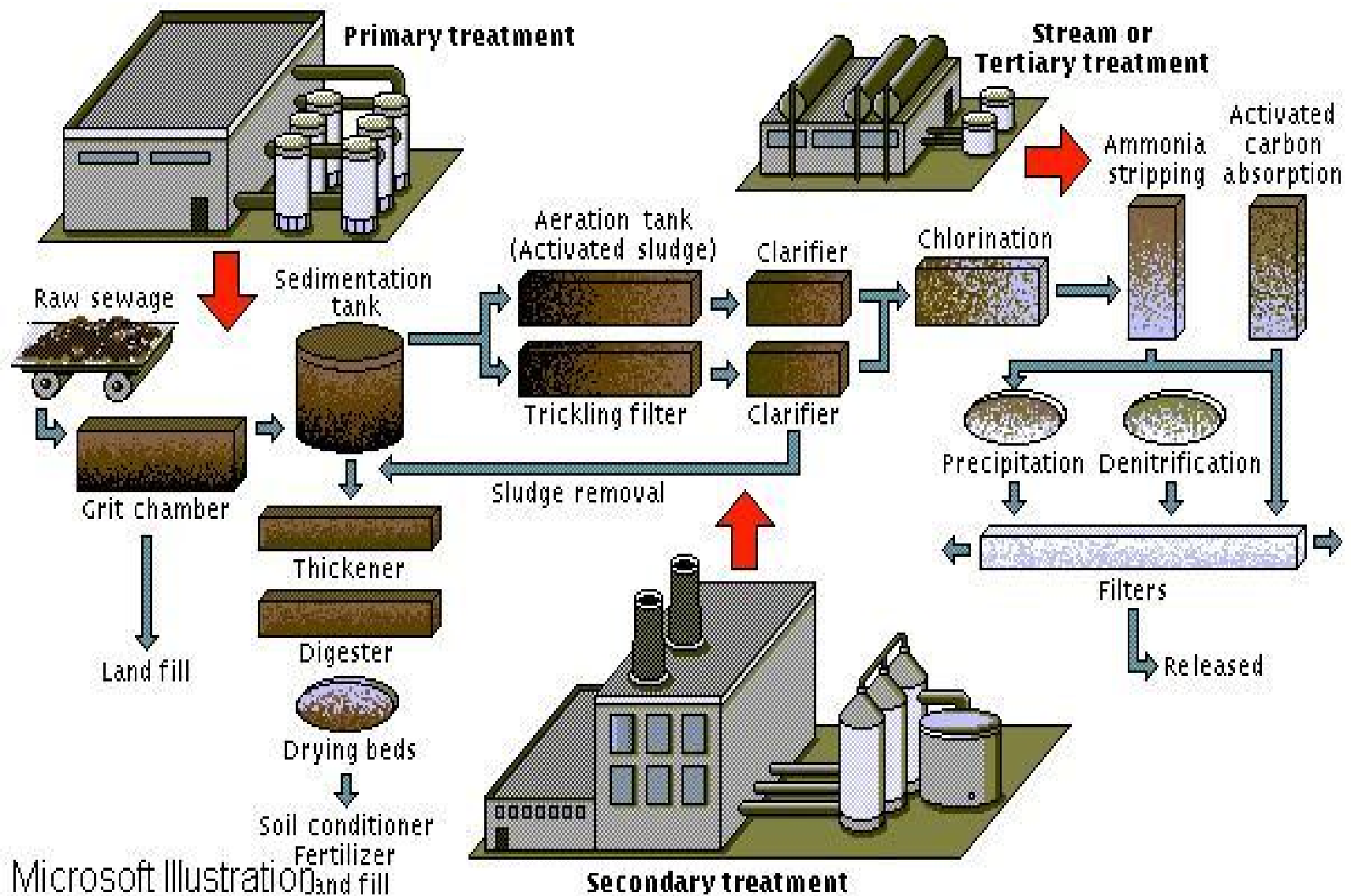
- ✓ Enforcing Laws to Prevent Water Pollution
- ✓ We should strictly follow all the laws regarding water pollution
- ✓ Industries should behave more responsibly
- ✓ Avoiding hazardous material
- ✓ Cleaning of drains
- ✓ Recycling and Reuse of water
- ✓ Preventing soil erosion
- ✓ Cleaning of water ways and the beaches
- ✓ Need for living in harmony with nature
- ✓ Adopting organic farming



Waste water treatment

- For many years, the main goal of treating wastewater was simply to reduce its content of suspended solids, oxygen-demanding materials, dissolved inorganic compounds, and harmful bacteria
- In recent years, however, improving means of disposal of the solid residues from the waste treatment processes
- In a treatment plant, the waste is passed through a series of screens, chambers, and chemical processes to reduce its bulk and toxicity

- **primary** treatment, including grit removal, screening, grinding, and sedimentation;
- **secondary** treatment, which entails oxidation of dissolved organic matter by means of using biologically active sludge, which is then filtered off;
- and **tertiary** treatment, in which advanced biological methods of nitrogen removal and chemical and physical methods such as granular filtration and activated carbon absorption are employed



Microsoft Illustration

Micro-organisms and pollution control

- Micro-organisms have a number of vital functions in pollution control.
- It is the microbial component of aquatic ecosystems that provides the self-purification capacity of natural waters in which micro-organisms respond to organic pollution by increased growth and metabolism
- Apart from containing food and growth nutrients, wastewater also contains the micro-organisms themselves, and by providing a controlled environment for optimum microbial activity in a treatment unit or reactor, nearly all the organic matter present can be degraded

Nutritional classification

- In freshwaters and in wastewater treatment it is the bacteria that are primarily responsible for the oxidation of organic matter
- In order to function properly the microorganisms require a source of energy and carbon for the synthesis of new cells as well as other nutrients and trace elements
- The micro-organisms are classified as either heterotrophic or autotrophic according to their source of nutrients
- Heterotrophs require organic matter both for energy and as a carbon source for the synthesis of new micro-organisms, while autotrophs do not utilize organic matter but oxidize inorganic compounds for energy and use carbon dioxide as a carbon source

Microbial oxygen demand

- It is important to know how much oxygen will be required by micro-organisms as they degrade organic matter present in wastewater for two reasons:
- To ensure that sufficient oxygen is supplied during wastewater treatment so that oxidation is complete
- And to ensure **receiving waters** do not become deoxygenated due to the oxygen demand of these microorganisms, resulting in the death of the natural fauna and flora
- **Self-purification**
- is defined as the restoration, by natural processes of water's natural clean state following the introduction of a discharge of polluting matter
- Self purification is the sum of all those processes which bring a polluted water body back into its normal original state

Oxygen balance

- Oxygen balance is an expression that is used to indicate the degree to which an explosive can be oxidized
- If an explosive molecule contains just enough oxygen to form carbon dioxide from carbon, water from hydrogen molecules, sulfur dioxide from sulfur, and all metal oxides from metals with no excess, the molecule is said to have a **zero oxygen balance**
- The molecule is said to have a positive oxygen balance if it contains **more** oxygen than is needed and a negative oxygen balance if it contains **less** oxygen than is needed
- Dissolved oxygen concentration is affected by factors such as temperature, BOD and salinity
- oxygen depletion is prevented primarily by **re-aeration**, although other sources of oxygen, such as **photosynthesis**, may also be important under certain conditions

Re-aeration

- Oxygen diffuses continuously over the air–water interface in both directions
- In the water, the concentration of oxygen will eventually become uniform due to **mixing** or, in the absence of mixing, by **molecular diffusion**

The oxygen-sag curve

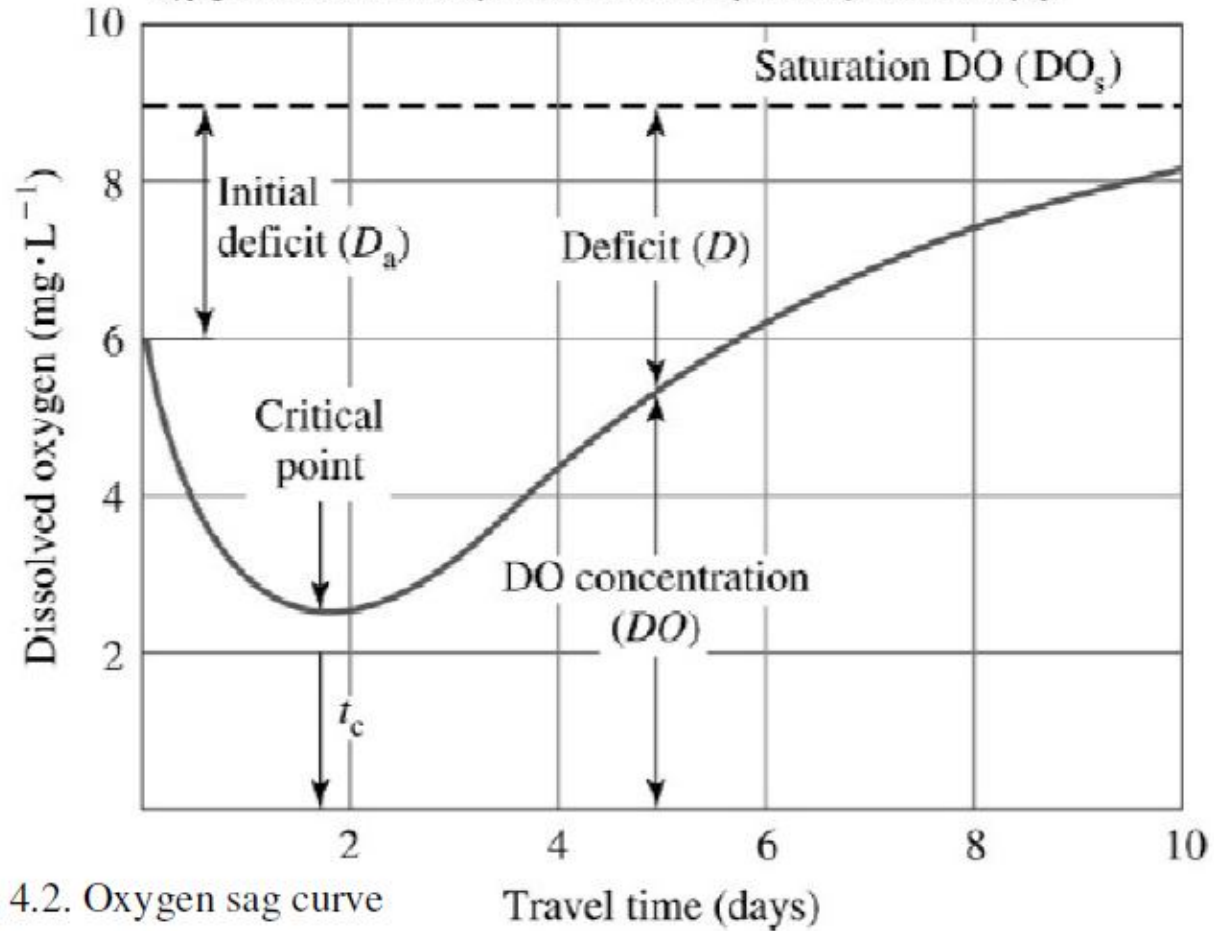
- The characteristic curve, which results from plotting dissolved oxygen against time or distance downstream, is known as the oxygen-sag curve
- The long tail associated with the recovery phase of the curve is due to the rate of mass transfer of oxygen

Cont'd...

- The oxygen-sag curve can be expressed **mathematically** for idealized conditions in terms of the initial oxygen demand, the initial dissolved oxygen concentration in Dissolved oxygen
- so, it is now possible to construct the oxygen-sag curve and to predict the minimum oxygen concentration downstream of a point discharge of organic waste, such as sewage
- A graph of the measured concentrations of Dissolved Oxygen in water samples collected
 - (1) upstream from a significant Point Source (PS) of readily degradable organic material (pollution)
 - (2) from the area of the discharge, and
 - (3) from some distance downstream from the discharge, plotted by sample location

Cont'd...

- The effect of oxygen **sag** is the death of oxygen-breathing animals such as fish, invertebrates and bacteria
- This may be a small, isolated area such as a shallow point of a pond, or may affect entire streams, depending upon the severity of the pollution
- As oxygen-consuming animals die off, carbon dioxide-consuming plants will soon follow as they run out of dissolved carbon dioxide. The result is a "**dead**" body of water



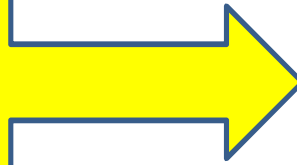
5. Water Quality Assessment

relation to the intended use

Purpose could be to use for

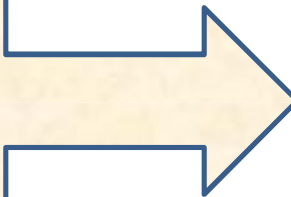
- Drinking
- Irrigation
- Swimming
- Discharging effluents.....
- The quality of water required for prescribed water use is often defined by guidelines or standards or maximum allowable concentrations of the contaminants
- Variables of water quality can also be selected in relations to pollutant sources
- A continuous measurement of water quality parameters is important , but in practice this is impossible
- Factors in water quality assessment can be physico-chemical and biological

PH
Temperature
Conductivity
Water turbidity



Can be measured on site

BOD
TSS
TDS
Nutrients
Metallic and non-metallic elements



Necessarily measured in the laboratory

✓ **Turbidity**

- Is a measure of the extent of light is either absorbed or scattered by suspended material in water
- Measured by turbidimeter and expressed in nephelometric turbidity unit (**NTU**)

✓ **Water transparency**

- Is used to estimate primary productivity or phytoplankton biomass
- Can be measured using a secchi disc

✓ **Water temperature**

- Measured by a digital temperature meter

✓ **PH**

- Expressing the hydrogen ion activity as a measure of acidity of water
- Vary on a daily basis
- Measured on site using digital pH meters

✓ Conductivity

- Is a measure of the ability of the aqueous solution to conduct an electric current
- Depends on the presence of ions or salts, their concentration and mobility, and temperature
- Measured using conductivity meter and expressed as **$\mu\text{S}/\text{cm}$**
- Used to estimate the total dissolved solids (TDS) in **mg/L**
- Pure water has less conductivity than polluted water

✓ Nitrogen

- Nitrogen in water bodies can be measured in the form of nitrogen containing compounds (NH_3 NO_3^- or NO_2^-)
- Expressed as **$\mu\text{g}/\text{L}$, or mg/L**

✓ Phosphate

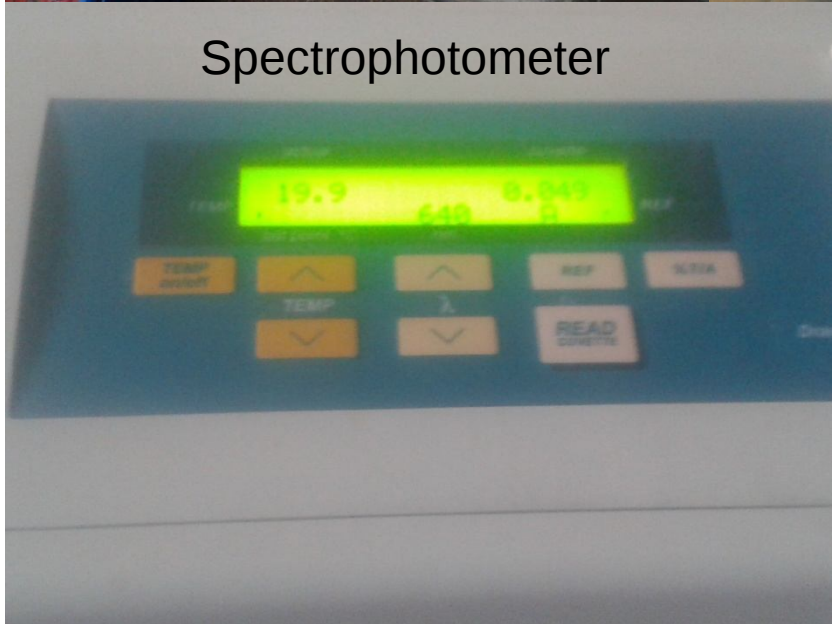
- Orthophosphate e.g (Na_3PO_4)
- and polyphosphate e.g ($\text{Na}_3\text{PO}_3)_6$)
- are the most common forms of inorganic phosphorous found in natural waters



Secchidisc and
Conductivity meter



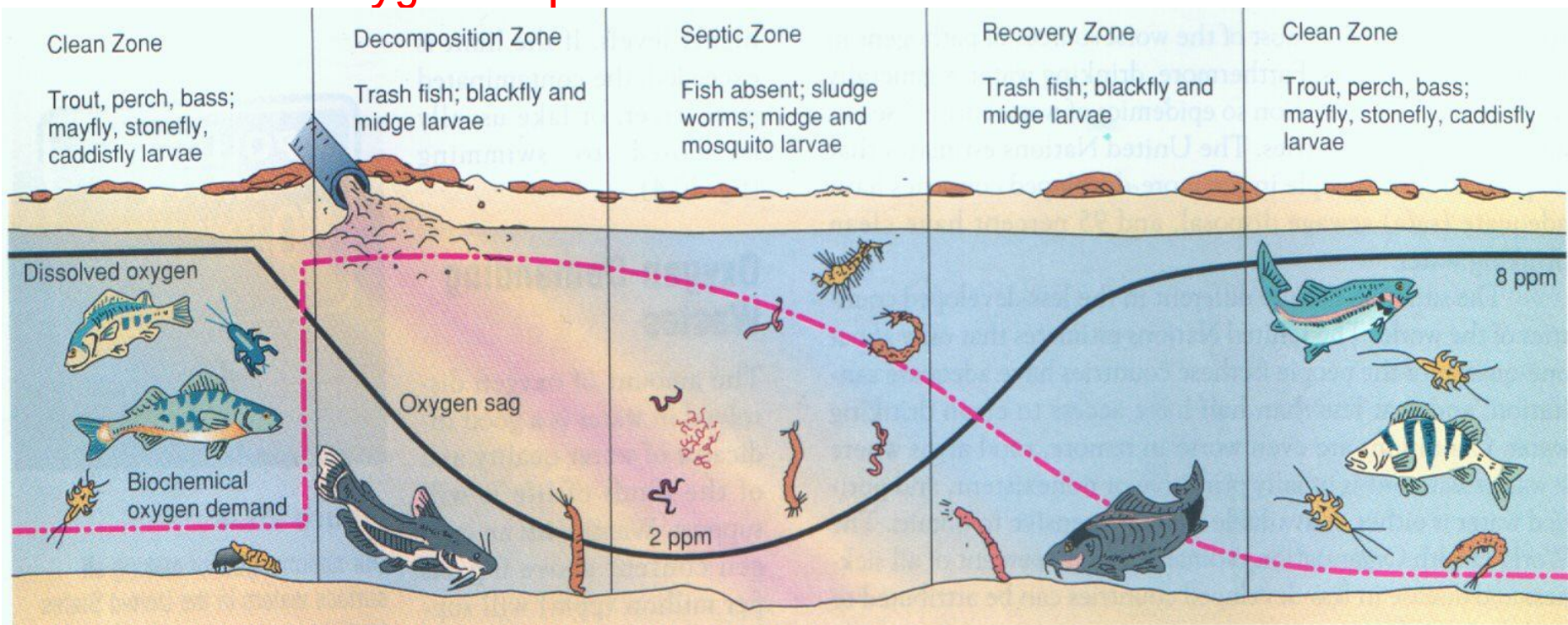
DO meter



Spectrophotometer

✓ Dissolved Oxygen (DO)

- In surface water it ranges from 7 mg/L to 14mg/L , depending on temperature, salt concentration and the amount of biodegradable organic matter
- Measured on the site using appropriate digital oxygen meter or in the laboratory using titration methods such as **Winkler method**
- **Dissolved Oxygen Depletion**



✓ Biochemical oxygen demand (BOD)

- Measure the amount of organic pollution in terms of the amount of oxygen required by the microorganisms to biologically degrade organic wastes
- Samples are incubated at 20°C in darkness
- $BOD = DO_{t0} - DO_{t5}$
- Need at least 2 mg/L change in DO over 5 days



Example 1

- A BOD test was conducted in the laboratory using wastewater being dumped into Lake Spartan. The samples are prepared by adding 3.00 mL of wastewater to the 300.0 mL BOD bottles. The bottles are filled to capacity with seeded dilution water.

Time (days)	Diluted sample DO (mg/L)	Blank Seeded Sample DO (mg/L)
0	7.95	8.15
1	3.75	8.10
2	3.45	8.05
3	2.75	8.00
4	2.15	7.95
5	1.80	7.90

Example 1: Calculations

- What is the BOD_5 of the sample?

$$BOD_m = \frac{[(DO_i - DO_f) - (B_i - B_f)(1 - P)]}{P}$$

P = dilution factor = volume sample/ total volume

B_i, B_f = initial and final DO concentrations of the seeded diluted water (blank)

DO_i, DO_f = initial and final DO concentrations of the diluted sample

- Plot the BOD with respect to time.



BOD5 solution

- Given
- DO to dark = 7.95, DO_{t5} dark=1.8
- DO to light= 8.15, DO_{t5} light=7.9
- Required BOD5?
- Solution
- $$\text{BOD5} = \frac{(\text{DO}_{\text{toL}} - \text{DO}_{\text{t5L}}) - (\text{DO}_{\text{toB}} - \text{DO}_{\text{t5B}})(1 - P)}{P}$$
- Chang DOL= 6.15, Change DOB=0.25, P=0.01
- BOD5=590mg/L

✓ Chemical oxygen demand (COD)

- Is the amount of oxygen needed to chemically oxidize organic wastes in the water under investigation
- Fast (2 to 3 hours)
- **Biological surveillance**
- Biological surveillance is a continuous, specific measurement and observation of organisms for the purpose of water quality management and operational activities
- Biological attributes refer to the number and types of organisms that inhabit water
- When the water quality is poor, the number and types of organisms that can live in it are limited

➤ Biological surveillance Cont'd...

- Some species are more sensitive to chemical and physical changes in their habitat than other species
- Organisms used as indicator of water quality include **bacteria, algae, macro invertebrates, protozoans, macrophytes and fishes**

➤ Biological indexes and scores of macroinvertebrates

1. EPT Index

- **Measures presence and abundance of members of insect orders**

2. Chandler Biotic Index

- **Recognize five levels of abundance and weighting the score of each indicator accordingly**

- **E.g** If EPT are in A or V

scores the water is said to

be less polluted by organic pollution

Species	Increasing Abundance				
	P	F	C	A	V
Each species of Ephemeroptera	79	84	90	94	97

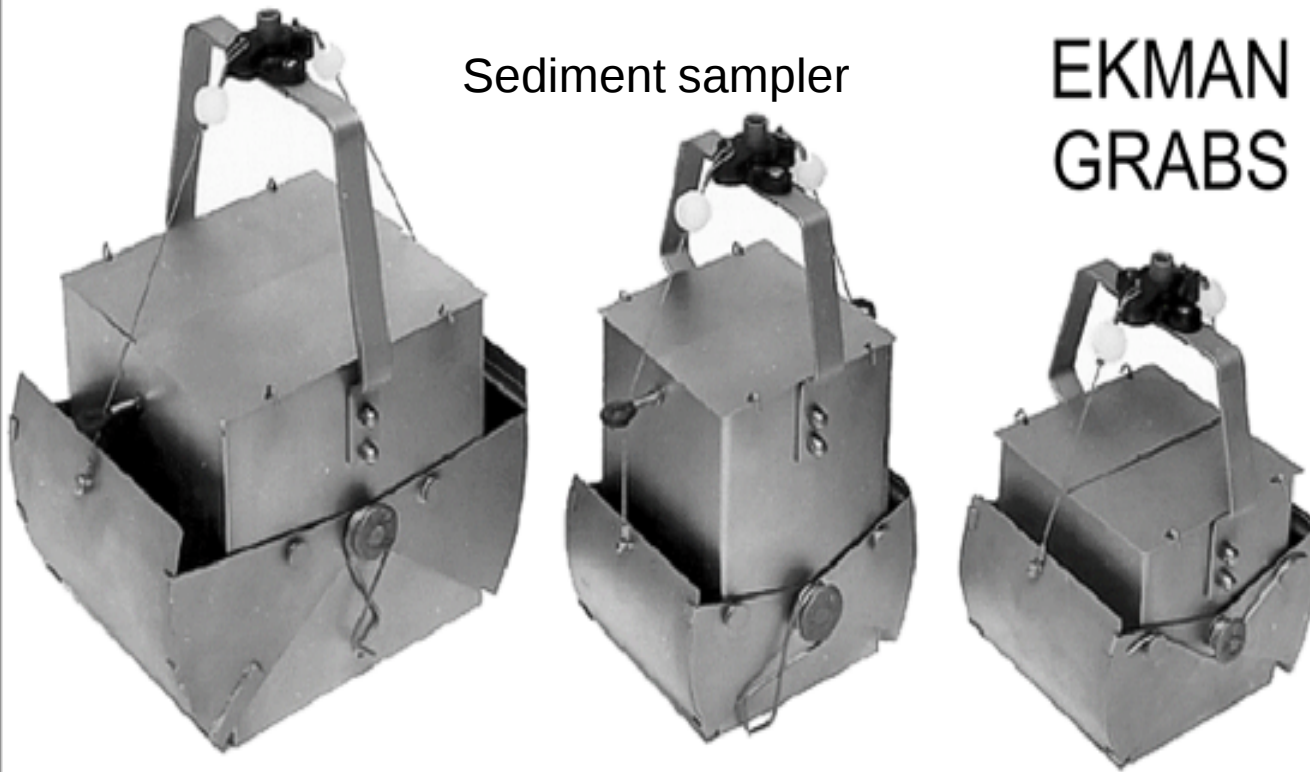
3. The Biological monitoring Working party Score

- Identification to the family levels
- Some of benthic macro invertebrates based on their sensitivity and tolerance to water pollution

Good quality water	Good or fair quality	Any quality water
Stone fly	Damselfly	Aquatic worm
May fly	Alderfly	Black fly
Caddis fly	Dragonfly	Leech
Planarian	Crayfish	Lunged snail

Sediment sampler

EKMAN
GRABS



Bacteriological analysis-

- Aerobic count
- Total coliforms
- Fecal coliforms
- E.coli & salmonella are common in animal and human gut
- If present it indicate sewage contamination of the water source

- Coliform number range in water quality estimation
 - **No per 100ml,if**
 - O-used for drinking purpose
 - <20-body contact
 - >20 visit
 - >200 poor

Chlorophyll a

Used to estimate phytoplankton biomass

Measured by spectrophotometer that measures the wave length of the pigments



Sampling of Surface Waters

✓ Sampling programme

- Before any fieldwork is undertaken the objectives of the sampling programme must be defined
- A simple protocol for the assessment of water quality in surface water monitoring follows several steps:
 - 1) **Define objectives**
 - 2) **Preliminary survey**
 - 3) **Programme design**
 - 4) **Sample collection**
 - 5) **Handling, transport and storage**
 - 6) **Laboratory analysis**
 - 7) **Data handling**
 - 8) **Data analysis**
 - 9) **Interpretation and reporting**
 - 10) **Utilization of information**

✓ **Mixing**

- Water must be sufficiently well mixed for a single sample of water to be representative of physico-chemical water quality
- Uniformity can usually be assumed after mixing

✓ **Safety**

- Surface waters can often contain pathogens and those taking water or biological samples are particularly at risk
- During surface waters sampling wear rubber gloves, avoid hand-to-mouth contact and all wounds, scratches and skin rashes must be protected from contact with water
- Some general guidelines are given below to help avoid serious injury while carrying out a sampling programme:

a) **Never work alone**

b) **Always have a first-aid kit and be trained in at least primary first aid**

c) **Always take a mobile phone with you in order to summon assistance**

d) **Never wade out of your depth**

e) **Never use chest waders as these significantly increase the risk of drowning and**

f) **familiarize yourself with the concepts of risk assessment and minimization, and act on them**

Chemical sampling

- The collection of water samples from surface waters is normally done by hand
- It is only necessary to have sterile bottles if microbial parameters are to be measured, otherwise bottles should be acid washed and thoroughly rinsed
- It should be submerged approximately 20 cm below the surface with the open mouth facing slightly downwards towards the current

✓ **Biological sampling**

- There are six major of biological sampling methods
 - i. Ecologica
 - ii. Microbial
 - iii. physiological and biochemical-Response of organisms to variations in water quality
 - iv. Bioassays and toxicity tests
 - v. Chemical analysis of biota
 - vi. Histological and morphological

+ **Multivariate analysis**

- Indices reduce complex data into single values for ease of analysis and interpretation
- They allow the relationship between communities, individual species and water quality variables to be explored, thus relating community modification to environmental change

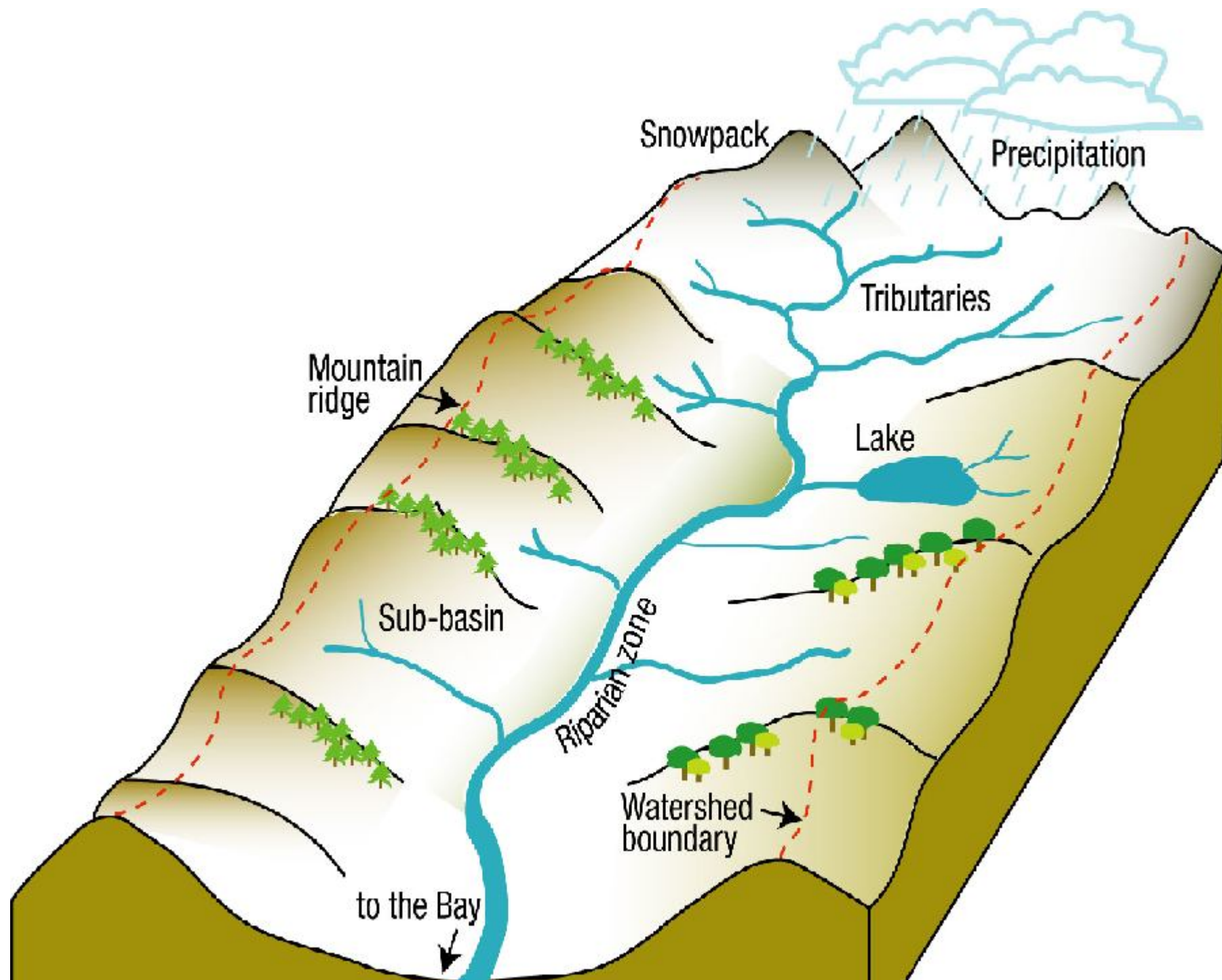
✓ Chemical data

- Many Water Quality Indices (WQI) have been developed to analyze chemical data, and while many require complex computation
- Water Quality Indices refer to two or more parameters that indicate the "healthiness" of water
- In some cases, indices reflect ecosystem behavior; in other cases, they indicate conditions of the aquatic environment
- Currently, water quality indices are of the following types
 - a. Numerical Indices:** There are commonly a half dozen indices that combine various chemical measures of water quality into an integrated index
 - b. Effects Indices:** These generally are some measure of biological reaction to aquatic pollutants
 - c. Biotic Indices:** The index represents the nature of benthic response, mainly to organic pollution
 - d. Other Chemical Indicators:** These are integrating chemical measures of groups of compounds

Unit six: Aquatic ecosystems and their catchments

Catchment size and form

- Land and water are ecologically linked in a natural system called a catchment, drainage basin, or watershed
- It is the area drained by tributary streams that coalesce into the main channel
- the river product of the land it inhabits, the type of rock and soil, the shape of the land, the amount of rainfall and type of vegetation are some of the factors that determine the river's shape, size and flow
- A catchment also includes all the humans, plants and animals that live in it, and all the things we have added to it such as buildings and roads
- Because water runs downhill, a catchment usually starts at the top of a hill, mountain or ridge, which is called a divide or watershed
- A typical catchment is a network of smaller rivers or streams called tributaries, which link to each other, and eventually into a bigger river



Watershed



Cont'd...

- Catchment topography and shape determine the time taken for rain to reach the river, while
- catchment size, soil type and development determine the amount of water to reach the river

+ **Types of drainage basin**

➤ **Dendritic drainage basin**

- there are many contributing streams (like the trunk and bark of a tree), which are then joined together into the tributaries of larger rivers



Fig.6.1.Dendritic drainage system

➤ **Parallel drainage system**

- A parallel drainage system is a pattern of rivers caused by steep slopes with some relief
- the streams are swift and straight, with very few tributaries, and all flow in the same direction

➤ Trellis drainage system

- As the river flows along a strike valley, smaller tributaries feed into it from the steep slopes on the sides of mountains
- Trellis drainage is characteristic of folded mountains

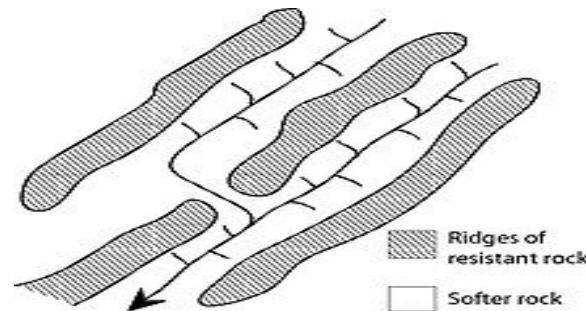


Fig 6.2 Trellis drainage

➤ Rectangular drainage system

- develops on rocks that are of approximately uniform resistance to erosion

➤ Radial drainage system

- In a radial drainage system the streams radiate outwards from a central high point
- Volcanos usually display excellent radial drainage

➤ **Deranged drainage system**

- It happens in areas where there has been much geological disruption

+ **Geomorphology of lake basins**

- The most common morphometric parameters
 - ✓ Maximum length
 - ✓ Maximum width or breadth
 - ✓ Area
 - ✓ Volume
 - ✓ Maximum depth
 - ✓ Mean depth

❑ **Catchments soil and vegetation**

➡ **Catchments soil**

- Soils can be divided into

1. Residual soils

formed from underlying "parent" rock formations

2. Transported soils

- are moved by gravity, wind or water to a different location
- Climate strongly affects soil formation

➡ **Catchment vegetation**

- Grasses, shrubs and trees make up the major plant cover types in a catchment, and all are important to catchment management
- Trees play a major role in catchments in the following ways
 - ✓ Trees store carbon
 - ✓ deep roots can extract water from a low water table
 - ✓ the canopy protects people, animals and crops from sun, wind and rain
 - ✓ forests help filter the air

Impact of people in the catchment

- ✓ Deforestation
- ✓ Increased siltation from deforested slopes
- ✓ Farmers and city planners drain wetlands
- ✓ Urbanization
- ✓ dam is built for flood control and other uses

Catchment and the water body

- A catchment basin is an extent or area of land where water from rain and melting snow or ice drains downhill into a body of water
- The drainage basin acts as a funnel by collecting all the water within the area covered by the basin and channeling it into a water way

CHAPTER SEVEN AQUATIC RESOURCES

- Fisheries, industry of harvesting fish, shellfish, and other aquatic animals.
- Fisheries may be large commercial fisheries, recreational fisheries, or small subsistence fisheries
- The term fishery is also used to describe the waters where fishing takes place
- or the species of fish being harvested
- Fisheries include familiar finned fish species, like
- cod and flounder; mollusks, including oysters and squid; and crustaceans, such as shrimp and crabs.

- Lesser-known fisheries include **echinoderms**, like sea **urchins**; some amphibians, including **frogs**; and **cnidarians**, such as **jellyfish**. Even the harvest of **whales** is usually considered a fishery
- Today, fisheries are estimated to provide 16% of the world population's protein
- The top producing countries were, in order, the People's Republic of China (excluding Hong Kong and Taiwan), Peru, Japan, the United States, Chile, Indonesia, Russia, India, Thailand, Norway and Iceland

Fish and fisheries

- Fishery comes into capture fishery and aquaculture
- Fish refers to the aquatic vertebrates with fins appendages and gills as respiratory structure(finfish)
- They inhabit both fresh and marine habitats
- Or it includes invertebrates (shell fish)
- Taxonomic hierarchy of finfish
- **Kingdom: Animalia**
- **Phylum: Chordata**
- **Subphylum: Vertebrata**
- **Classes of fish**
 - ✓ **Ostracoderms**
 - ✓ **Cyclostomata**
 - ✓ **Placodermi**
 - ✓ **Acanthodi**
 - ✓ **Chondrichthyes**
 - ✓ **Osteichthyes**



southern pigfish
(*Congiopodus leucopaecilus*)



ghost flathead
(*Hoplichthys langsdorffii*)



rock greenling
(*Hexagrammos lagocephalus*)



alligatorfish
(*Aspidophoroides monopterygius*)



tub gurnard
(*Chelidonichthys lucerna*)



lumpfish, or lumpsucker
(*Cyclopterus lumpus*)



longhorn sculpin
(*Myoxocephalus octodecemspinosus*)



golden redfish
(*Sebastes norvegicus*)



bartail, or Indian, flathead
(*Platycephalus indicus*)



stonefish
(*Synanceia verrucosa*)



flying gurnard
(*Dactylopterus volitans*)



plumed scorpionfish
(*Scorpaena grandicornis*)



1. The jawless fish

- Are primitive
- Known as agnathan fish
- Lack of paired fins and n have notochord instead of vertebral column
- Are largely extinct (Ostracoderms) and some are extant (Cyclostomes) include Lampreys (blood sucking) and Hag fish(scavengers) groups

2. The jawed fish

- Also known as gnathostomatan
- Develop jawed and paired fins
- Include:
- Placodermi and Acanthodi(extinct)
- Chondrichthyes and Osteichthyes(extant)

2.1 The cartilaginous fish

- Two subgroups namely elasmobranches(sharks, rays, skates) and holocephalans(chimaeras or ratfish)
- Develop cartilage endoskeleton, teeth like placoid scales
- Lack of swim bladder, gill covering
- Exclusively marine in distribution

2.2 The Bony fish

- Include :
 - ✓ sarcopterygian (Dipnoi and Crossopterygii)
- Fleshy finned
 - ✓ and actinopterygian(Chondrostei, Holostei and Teleostei)
- Ray finned fishes
- Possession of bony skeletons, swim bladder and operculum

Ethiopian aquatic resource

- Ethiopia is a land-locked country and depends on its inland water bodies for fish supply for its population
- Ethiopia is endowed with a number of lakes and rivers, which are believed to be promising potentials of different fish stock
- Apart from Lake Tana, which belongs to the Nile River Basin, the most important water bodies are found south of Addis Ababa in the Rift Valley

Ethiopian freshwater fish species

- According to Glostov and Mina (2003) the total number of valid species in Ethiopia inland waters is about 168 to 183 including 37 to 57 country wide endemics
- Classification
 - Class- Chordrithyes- sharks, rays, chimaeras
 - Osteichthyes
 - Order- about 35 orders eg. Perciforms (perch like fish). Have spiny fin rays on their dorsal fins
 - Family-Cichilidae- the tilapia groups
 - Genus- Oreochromis – mouth brooders
 - Species- Oreochromis niloticus
- A). Family cichilidae meaning the tilapia
 - E.g. Tilapia- the dominated fish group in Ethiopian fresh water bodies
 - The most commercially fish in Ethiopian wise
 - Have few intramuscular bone
- Small in size- maximum

B) Family Centropomidae – the Nile perch

- Lates niloticus- African in origin Distribute in the Nile River
- Mostly found in the South Rift Valley lakes
- The largest fresh water fish in Ethiopia

C. Family Cyprinidae- largest family

Includes carps, minnows, barbus, labeo found in Lake koka, Abasamuel

- i. Common carps Fast growth until 7kg and introduce from abroad
- ii .Barbous intermedius- The big barbus, Commercially important
- iii. Labeo horie – migratory fish

D. Family Clariidae

- The catfish
- Air breathing fish

Commercially important fishes of Ethiopia

- the **bulk** of the fish catch originates from the six main water bodies: **Tana, Ziway, Langano, Awassa, Abaya and Chamo**.
- The remaining production originates from minor lakes (**Hora, Beseka, Lego Hyke, Hashengie, and Small Abaya**), reservoirs and dams (**Koka, Fincha-Amerti, Denbi, Melka-Wakena, Alwero, Tekezé, Gigel Gibe I**) and rivers

- The rivers include the Abay or Blue Nile, Wabi Shebelle, Awash, Genale, Dawa, Omo, Tekezé, Gibe, Mereb, Baro, Akobo, Angereb and their tributaries.
- Riverine fishing activities are mostly performed on the Baro River near Gambela in the western part of the country and the Omo River in the southern area near the border with Kenya (Breuil, 1995)

- the bulk of production is made of **Tilapine** species, **Nile Perch** (*Lates niloticus*), and **Barbus**, **Bagrus**, **Clarias** and **Labeo** species.
- **Nile perch** is mostly caught on lakes Abaya, Chamo and Turkana, as well as in major riverine fisheries
- Lakes Abaya and Chamo are different from other Rift Valley Lakes to the north in that they have a high diversity of the fish fauna with more than 20 species.
- However, the commercially important ones are only four: *Oreochromis niloticus*, *Lates niloticus* and the catfishes *Bagrus docmak* and *Clarias gariepinus* (Ward and Wakayo in ACP Fish II. 2013).
- On Lake Ziway, there are six fish species of commercial relevance, of which four are introduced species, namely *Tilapia zillii*, *Clarias gariepinus*, *Caracius caracius* (Crucian Carp) and *Cyprinus carpio* (Common Carp)
- clam

Fish species in Lake Tana



Nile perch



Bagrus docmak



Nile tilapia



Catfish



Barbus intermedius

Unit 8. Water basin management

- Water used for agriculture, hydropower(Tekeze,Ghibe I.II), drinking water supply, navigation recreation ,for healthy ecosystem,
- All multiple uses on water demand coordinated action and management to ensure sustainability of the water resource
- Water management and development should be based on **participatory approach**, involving users, planners, policy makers and other stakeholders
- Such management approach is called Integrated water resource management (IWRM), IWRM is a tool that promote
 - Balance social and economic needs
 - Ensures the protection and sustainability of ecosystem for future generation

Water frame work directive

- The best way to protect and manage water is by close international co-operation between all the countries within the river basin bringing together all interests upstream and downstream
- The water framework plan is intended to meet challenges such as;
 - ✓ **An overly centralized, fragmented and sub-sectoral management approach;**
 - ✓ **A need of IWRM mainstreaming at the regional and local levels;**
 - ✓ **Insufficient investment for water supply and sanitation;**
 - ✓ **Lack of technical capability of implementing agencies**
 - ✓ **A need of efficient and effective information flows; and**
 - ✓ **A need to link freshwater management with coastal management**

Water-related management challenges include;

- Increased coverage of safe water and sanitation;
- Absence of river basin office in some of the major and principal river basins;
- A rising trend of floods and other water-induced disasters;
- Inadequate river control and drainage facilities;
- Pollution of surface water and groundwater as a result of urbanization
- Industrialization, and inadequate sewerage and sanitation facilities;
- Indiscriminate land use & land development causing catchment degradation; and
- Governance concerns due to overlapping functions among agencies working on water and water-related projects and programs

The river basin framework plan

- Integrated River Basin Management and Development Framework Plan provide guidance and directions for the action-oriented planning at the basin level
 - The framework identifies essential aspects of sustainable basin-level development and their corresponding management regimes
1. Prevention and response management of natural and human-made disasters;
 2. Water use and supply management;
 - 3 .water pollution and waste reduction management;
 4. Water security and livelihoods management; and
 5. Creation and mobilization of river basin officials

▪ **The framework can be strengthened by four supplemental framework components**

- (i) Water quality protection and monitoring;
- (ii) Information and decision support systems;
- (iii) River and coastal area protection and rehabilitation; and
- Iv) River basin organization and governance.

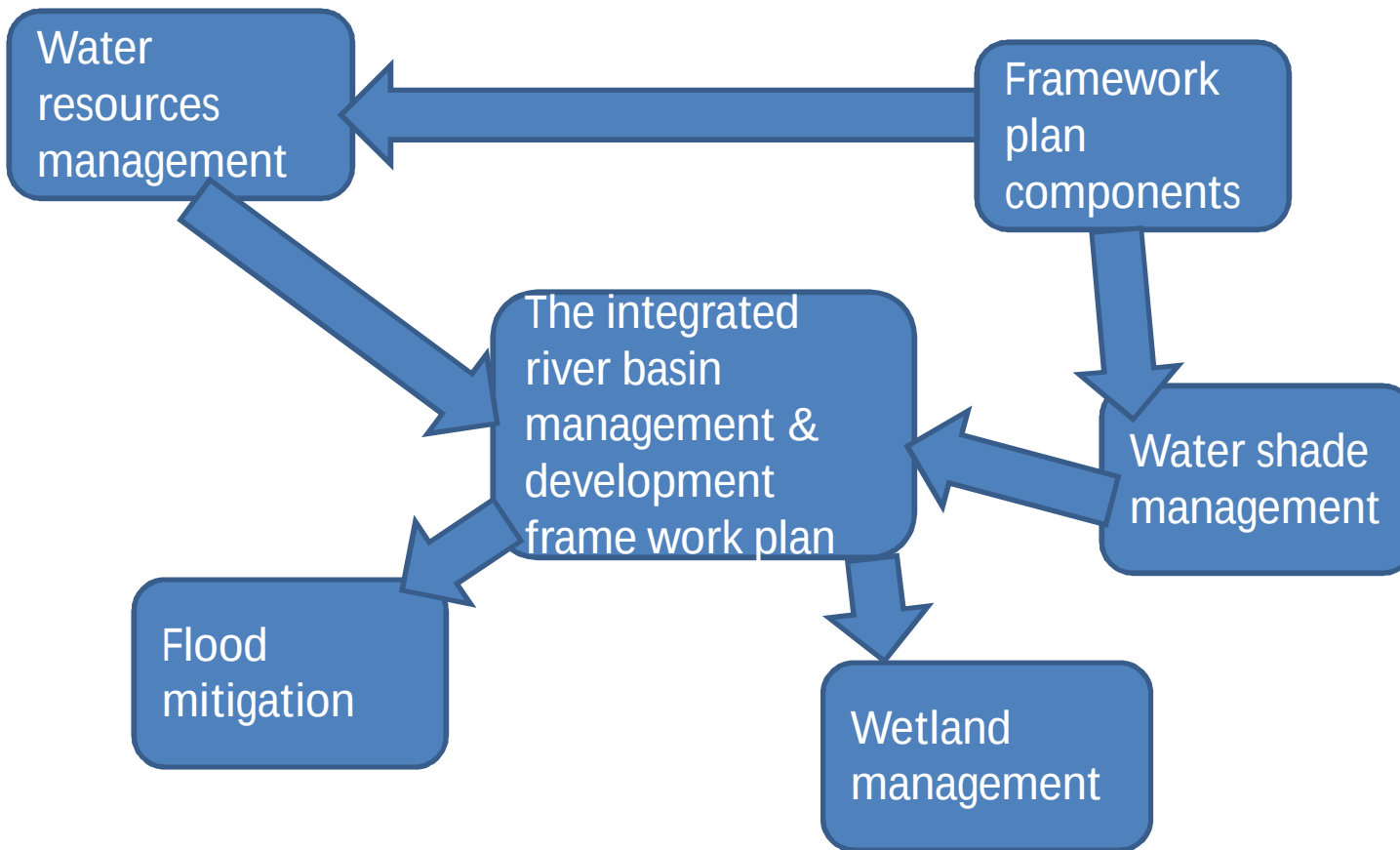


Fig.8.1 Framework plan components

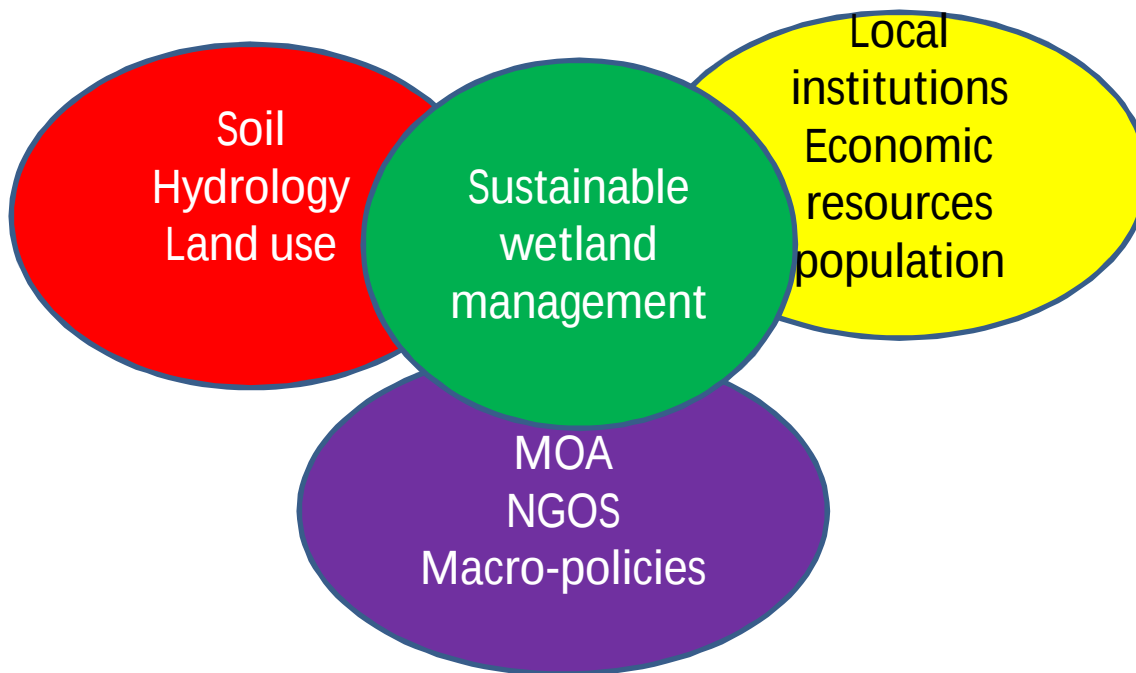
Water quality and regulation

- **Water quality management**
- The Clean Water Act requires developing criteria for water quality that accurately reflects the latest scientific knowledge.
- These criteria are based solely on data and scientific judgments on pollutant concentrations and environmental or human health effects.
- Criteria are developed for the protection of aquatic life as well as for human health

International treaties and Convention of Fresh water and wetland management

Environmental
factors

Socio-economic
factors



Policy factors

- Fig 8.2 factors involved in the sustainable management of wetlands

Laws and regulations guiding water quality management

- aim to protect all waters from degradation via point and non-point sources pollutants and wetland alteration to maintain existing water uses of all aquatic and wetland habitats and the level of water quality
- **International treaties and conventions on fresh water and wetland management**
 - i. The convention on wetlands of international importance
- ✚ **Ramsar Convention**
 - is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

ii. Convention on the protection and use of trans-boundary watercourses and international lakes

+ The UNECE Water Convention

- UNECE has to tackle a wide range of water quantity and water quality problems: high water stress and overexploitation of water resources, increasing droughts and floods, contaminated water resulting in water-related diseases, etc

iii. The Nile Basin Initiative (NBI)

- The Nile Basin Initiative (NBI) is a partnership initiated and led by the riparian states of the Nile River through the Council of Ministers of Water Affairs of the Nile Basin states (Nile Council of Ministers, or (NILE-COM)
- The NBI seeks to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security

Nile basin initiatives

- Nile is the longest river in the world, Two major TRIBUTARY rivers, white & blue Nile
- White Nile from Victoria and Blue Nile from Lake Tana , meet together at Khartoum to form Nile
- Nile to flow to Egypt- Mediterranean sea
- The Nile is longest river in the world at 6,695km.
- It is shared by 11 riparian countries, namely Burundi, the Democratic Republic of Congo (DRC), Kenya, Egypt, Ethiopia, Rwanda, South Sudan, Sudan, Tanzania, Uganda, and Eritrea
- Ethiopia, is the source of 85 percent of Nile waters courtesy of the

- Since 1970, Ethiopia has wanted to develop the Nile waters. It first approached an American company to conduct an impact study of dam construction on the Nile
- This so infuriated Egypt that the former president Anwar Sadat, threatened to attack Ethiopia
- in the past five decades British colonial administrations and previous Egyptian governments followed a successful strategy of threatening and dissuading external financial assistance to Ethiopia and the other riparian states
- They thereby weakened Ethiopia's internal capacity to construct the dam
- As a result, Ethiopia was only able to finance the dam by mobilizing resources through domestic means.

- Before the current progress could be achieved
- Egypt used three strategies to impede Ethiopia's plans to implement water development projects at the headwaters of the Nile:
 - 1) threatening military action;
 - 2) thwarting any external funding requests made by Ethiopia to develop its water resources using its diplomatic advantage
 - and 3) destabilizing Ethiopia by encouraging neighbouring countries to do so and by supporting domestic rebel groups

The Nile water Agreement of 1929 and 1959

- In 1929, an agreement was signed between Egypt and the United Kingdom on usage of the Nile waters
- Subsequently, in 1959, an agreement was signed between Egypt and Sudan that excluded all the other riparian countries
- Based on the 1959 treaty, Egypt claims that it has an 'historical' and 'acquired' right to 55.5 billion cubic meters of water
- Sudan was allocated 18.5 billion cubic meters
- These two agreements excluded Ethiopia
- Any project that could threaten the volume of water reaching Egypt are forbidden
- The agreement gave Egypt the right to inspect the entire length of Nile

- **Egypt has the right to use 75%, Sudan 11% and** the remaining countries have the right to share the remaining.
- It is colonial treaty which is not acceptable

2.Nile Basin Initiatives

- Established by basin countries in 1999
- Transitional arrangement held in Tanzania on 22 February 1999
- Its aim is to foster cooperative and sustainable development of The Nile for basin countries
- Substantial socio economic benefits, promote regional peace & security

The New Nile Basin Framework of 2010 [Doc1.docx](#)

- Signed by Ethiopia, Rwanda, Tanzania, Uganda in Uganda on 14 May 2010
- All basin countries have equal right
- Kenya, DR Congo and Burundi are expected to sign soon
- **Reason for agreement**
 - ✓ **The old colonial treaty signed was not fair**
 - ✓ **The riparian countries are now independent states and have equal rights as Egypt to use the Nile water**

The Grand Ethiopian Renaissance Dam (GERD)

- is Africa's biggest hydroelectric project and the 10th largest in the world
- It is a \$5 billion project that was expected to increase the country's hydroelectric power capacity fivefold
- Commenced in April 2011 on the Blue Nile River in a place called Guba, 60 kilometres from Sudan
- When completed which will hold 74 billion cubic meters (BCM)
- produce 6000 MW¹ electric power
- Owned and operated by the Ethiopian Electric Power company,
- the 145-m-tall roller-compacted concrete gravity dam
- will flood 1,874 km² at a normal pool elevation of 640 m,
- will have a tributary catchment of 172,250 km²
- With a volume of 74 km³,



GERD's potential benefits and costs

- generate benefits to the river and to Eastern Nile countries.
- regulating the river flow, controlling floods, sedimentation and siltation, producing hydropower that can be traded with other riparian states, and reducing water losses by moving storage in areas with lower evaporation rates upstream
- mitigate the human impact on climate change globally
- and, according to an Independent Panel of Experts (IPoE), will benefit Egypt, Sudan and Ethiopia
- The GERD carries some benefits for the Ethiopian economy

- in addition to the future opportunities that will be created when business facilities are established at the site of the project
- Ethiopia's increasing dependence on hydropower would also reduce the environmental and health problems related to the reliance on biomass fuel by most of the population
- Power exports from the GERD are also expected to secure hard currency for Ethiopia
- The GERD in its grandeur is a source of national pride,





THE END !!!

Thank you !!!