Aquatic Bodies & Biodiversity and Their Sustainability

Lecture 7

ENHL 220

OUTLINE

- 1- Aquatic Environments: An Overview

- 2- Saltwater Life Zone

✓ 2.1- Benefits of Saltwater Life Zones
✓ 2.2- Saltwater Life Zones (Oceans, estuaries, coastal wetlands, coral reefs)
✓ 2.3- Human Impacts on Saltwater Life Zones

- 3- Freshwater Life Zone

✓ 3.1- Benefits of Freshwater Life Zones
✓ 3.2- Types of Water Bodies
✓ 3.3- Standing Water Bodies (ex: Lakes, Inland wetlands)
✓ 3.4- Flowing Water Bodies (ex: Streams, Rivers)
✓ 3.5- Human Impacts on Freshwater Life Zones

- 4- Human Impacts on Aquatic Biodiversity
- 5- Patterns of Marine Biodiversity & Protection Difficulties
- 6- Protecting & Sustaining Marine Biodiversity

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
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1- Aquatic Environments:
An Overview

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1- Aquatic Environments: An Overview

- Water → saltwater + freshwater → cover about three-fourth of the earth's surface (71% -- saltwater) → more accurate name for the earth = Ocean)

- Aquatic Life Zones (Aquatic Environments):

✓ definition →"marine & freshwater proportion of the biosphere" (Miller ,2009/7).

- What mainly determines the types of organisms found in an aquatic environment = Salinity (amount of different salts dissolved in a volume of water – ex: [NaCl])

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1- Aquatic Environments: An Overview (Cont'd)

- As a result , Aquatic Life Zones are classified into 2 major types:
- ✓ Saltwater Life Zones (ex: mainly oceans, coastal wetlands, estuaries, coral reefs,…)
- ✓ Freshwater Life Zones (ex: mainly rivers, streams, lakes, Inland wetlands…)

- Four environmental factors mainly determine the type & number of organisms at different depths in a water body. These are:
- ✓ 1- temperature
- ✓ 2- access to sunlight for photosynthesis
- ✓ 3- dissolved oxygen content
- ✓ 4- availability of nutrients.

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2- Saltwater Life Zones

(Mainly **Oceans**, estuaries, coastal wetlands & coral reefs)

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2.1- Benefits of Saltwater Life Zones

- Some important ecological & economic services of the marine ecosystems are:

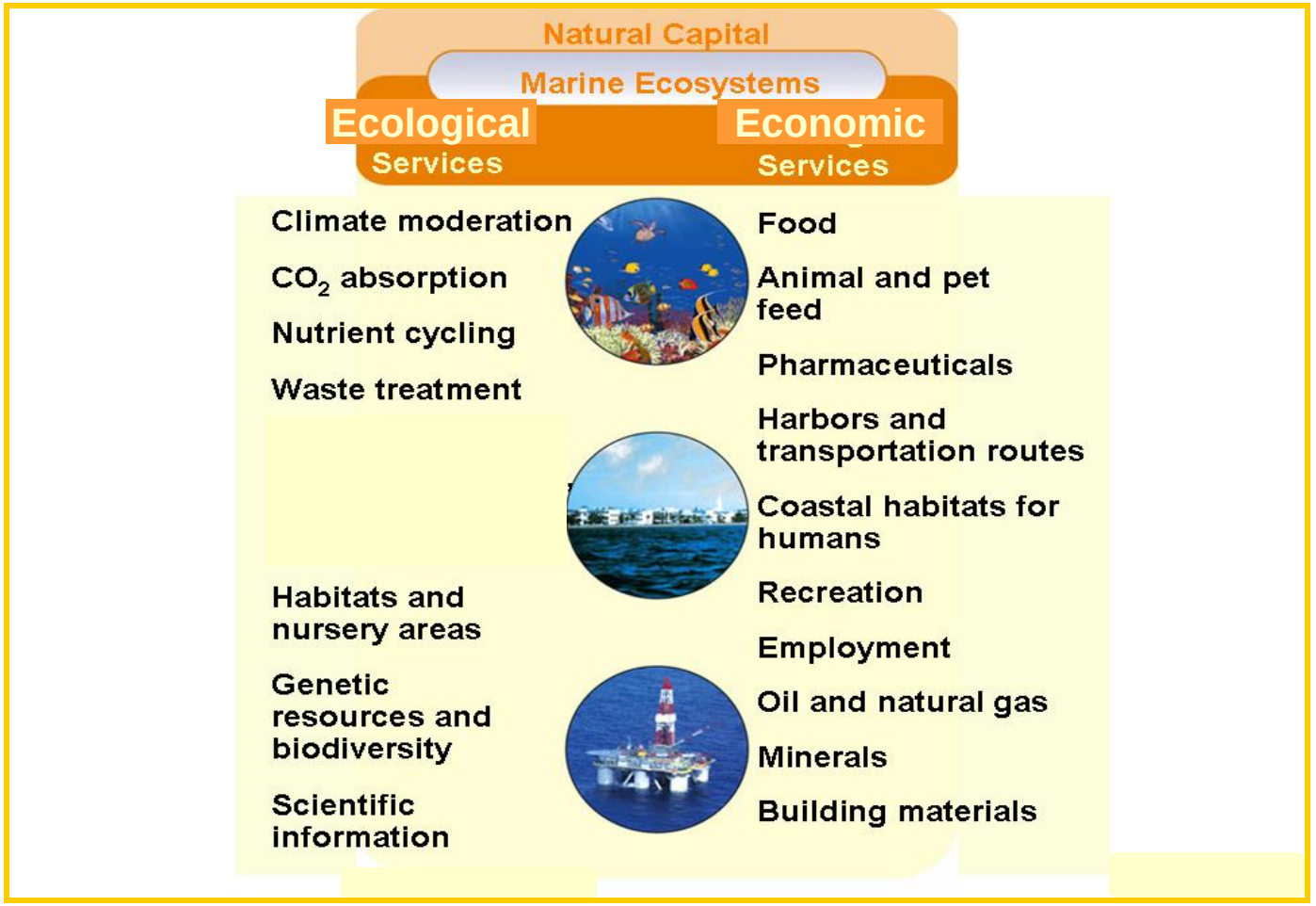

Figure 1: Ecological & Economic services of Marine Ecosystems (Miller, 2009/7)

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2.2- Saltwater Life Zones (Cont'd)

- "Oceans": have two major life zones:

✓ 1- the coastal zone

✓ 2- the open sea.

2.2- Saltwater Life Zones (Cont'd)

- <u>1- Coastal Zone:</u>

✓ makes up 10% of the ocean area.

✓ contain 90% of all the marine species.

✓ warm, nutrient rich & shallow water.

✓ site of most commercial marine fisheries.

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2.2- Saltwater Life Zones (Cont'd)

- ✓ *"Estuary":*
  - where rivers meet the sea
  - highly productive area in the coastal zone

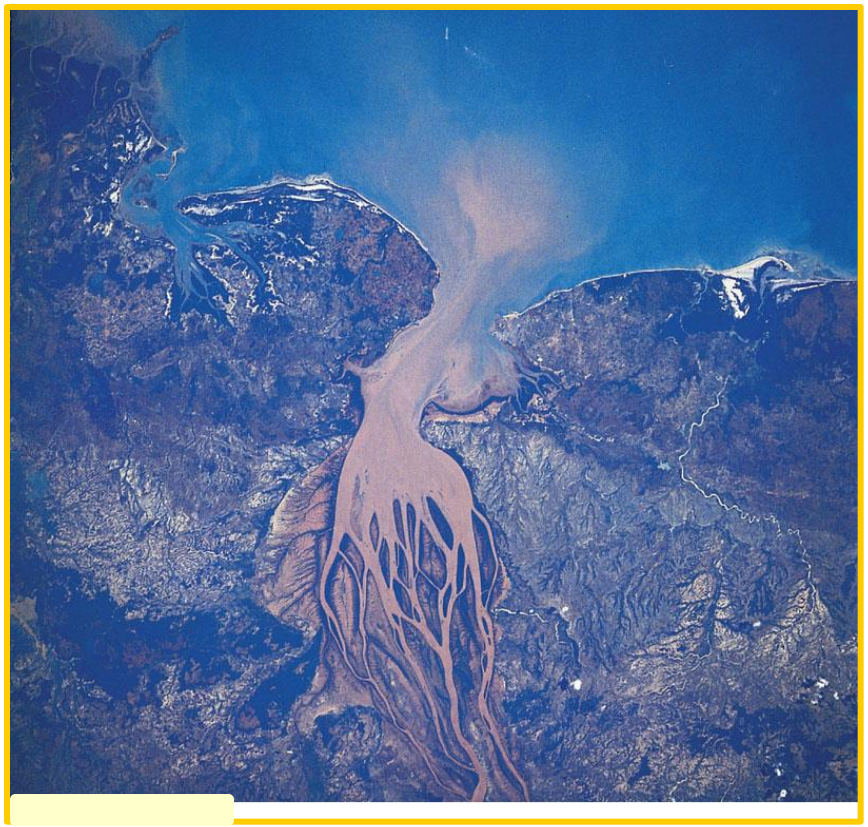

Figure 2: Estuary Ecosystem (Miller, 2009/7)

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2.2- Saltwater Life Zones (Cont'd)

✓ *"Coastal Wetland":*

- Land along the coastline covered with saltwater all or part of the year

  (ex: marshes, mangroves….)

- highly productive ecosystem

Figure 3: Mangrove forest ecosystem (Miller, 2009/7)

Figure 4: Salt Marsh ecosystem (Miller, 2009/7)

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2.2- Saltwater Life Zones (Cont'd)

✓ *"Coral Reef":*

- "formation produced by massive colonies containing billions of tiny coral animals called polyps that secrete a stony substance (calcium carbonate) around themselves for protection. When the corals die their empty outer skeleton form layers and cause the reef to grow." (Miller, 2009/7).

Figure 5: Coral Reef ecosystem (Miller, 2009/7)

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2.2- Saltwater Life Zones (Cont'd)

- Coral reefs form in clear, warm, shallow coastal water of constant high salinity & a temperature of 18-30C.
- they provide homes for ¼ of the marine species.
- They are vulnerable because they grow slowly & are disrupted easily.

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2.2- Saltwater Life Zones (Cont'd)

- <u>2- Open Sea:</u> (vast volume of the ocean)

✓ the sharp increase in water depth separate the coastal zone from the vast volume of the ocean called the "open sea".

✓ Open Sea =

- surface layer / zone
- middle layer / zone
- bottom layer / zone

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2.2- Saltwater Life Zones (Cont'd)

- ✓ on the bases of the sunlight penetration it is divided into three zones/Layers. These are:

	Light	Nutrient Level	Dissolved Oxygen	Photosynthesizing Producers
Euphotic Zone (Top Layer)	Bright	Low	High	Present
Bathyal Zone (Middle Layer)	Dim	Medium	Medium to Low	Absent
Abyssal Zone (Bottom Layer)	Dark	High	Low	Absent

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2.2- Saltwater Life Zones (Cont'd)

- ✓ Most organisms of the deep water & ocean floor feed on dead & decaying organisms drifting down from upper lighted levels of the ocean

2.3- Human Impacts on Saltwater Life Zones

- Major human impacts on the Marine Ecosystems:

✓ many coastal wetlands lost → by agriculture & urban development

✓ many beaches eroded → by coastal development & rising sea levels

✓ ocean bottom habitats degraded

✓ many coral reefs already damaged or threatened→ by ocean warming, algal growth, soil erosion, from fishing & diving….

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3- Freshwater Life Zones

(Mainly Lakes, Inland wetlands, Rivers & Streams)

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3.1- Benefits of Freshwater Life Zone

- Some important ecological & economic services of Freshwater Life Zones.

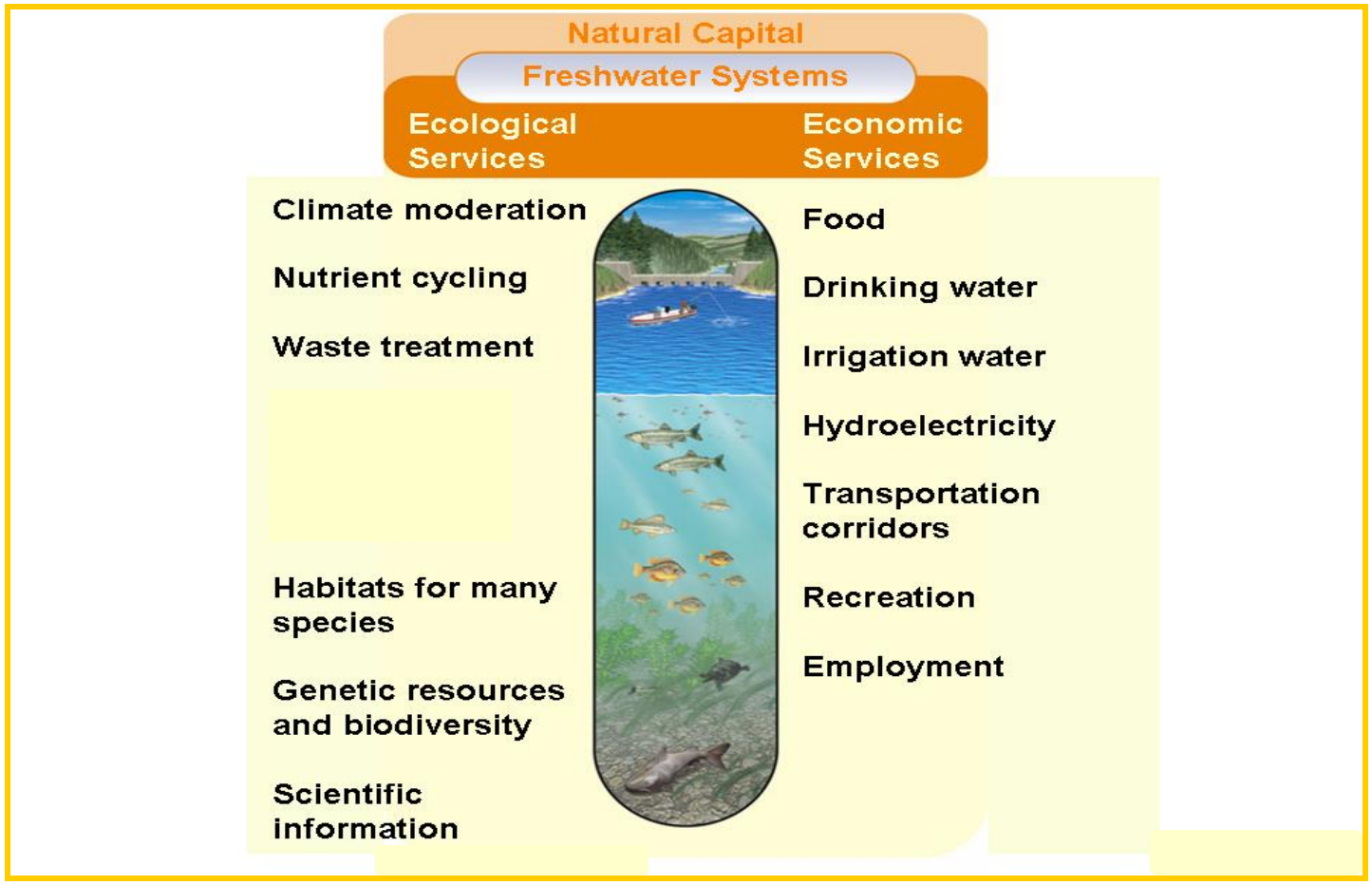

Figure 6: Ecological & Economic Services of Freshwater Systems (Miller, 2009/7)

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3.2- Types of Water Bodies

- Include two types of water bodies. These are:

✓ Standing Water Bodies (ex: lakes, Inland wetlands…).

✓ Flowing Water Bodies (ex: rivers, streams…).

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3.3- Standing Water Bodies

- <u>Lakes:</u>

✓ "are large natural bodies of standing freshwater formed when precipitation, runoff, & groundwater seepage fill depressions in earth's surface" (Miller, 2009/7).

✓ vary in depth, size & nutrient content.

✓ Three types of lakes exist. These are:

- 1- Oligotrophic Lake: newly formed lake + small supply of plant nutrients.
- 2- Eutrophic Lake: old + nutrient rich (mostly nitrates & phosphates)
- 3- Mesotrophic Lake: between two extremes of nutrient enrichment.

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3.3- Standing Water Bodies (Cont'd)

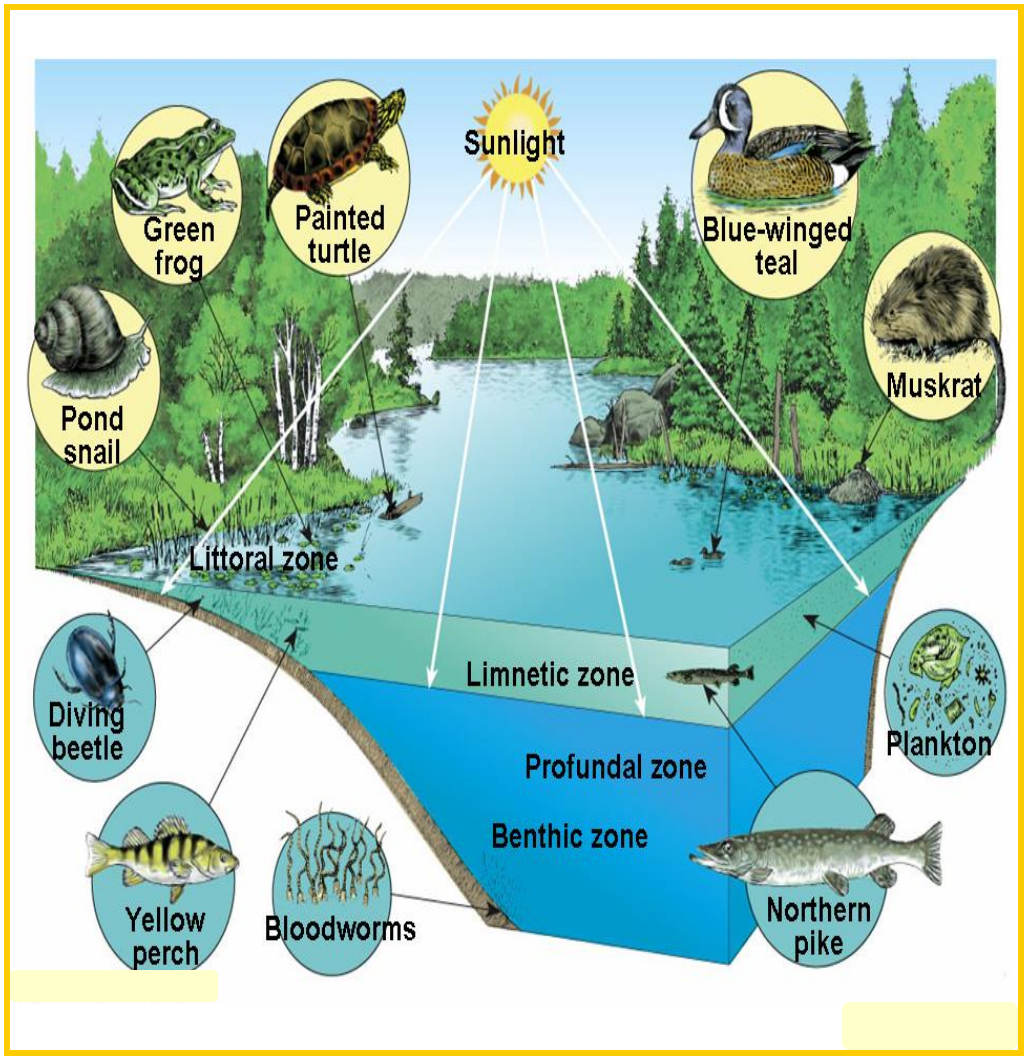

Figure 7: Zones of a Deep Lake (Miller, 2009/7)

- ✓ Deep lakes usually consist of 4 zones. These are:

- o 1- Littoral Zone: near shore- shallow (until depth where with rooted plants stop growing)- sunlight- most productive zone- high biodiversity.

- o 2- Limnetic Zone: open water (offshore)- extend to depth penetrated by the sun- sunlit- highly photosynthetic zone.

- o 3- Profundal zone: open water- deep- too dark for photosynthesis- poor in oxygen.

- o 4- Benthic Zone: bottom of lake- nourished by dead matter from upper zones- inhabited mostly by decomposers.

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3.3- Standing Water Bodies (Cont'd)

- <u>Inland Wetlands:</u>

"Lands covered with freshwater all or part of the year & located away from coastal areas" (Miller, 2009/7)

3.4- Flowing Water Bodies (Cont'd)

- <u>Streams & Rivers:</u>

✓ watershed or drainage basin: "land area that delivers runoff, sediments & dissolved substances to a stream" (Miller, 2009/7).

✓ small streams join → to form rivers → and rivers flow to oceans.

✓ the downward flow of surface water from the mountains to the sea take place in 3 different aquatic zones. These are:

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3.4- Flowing Water Bodies (Cont'd)

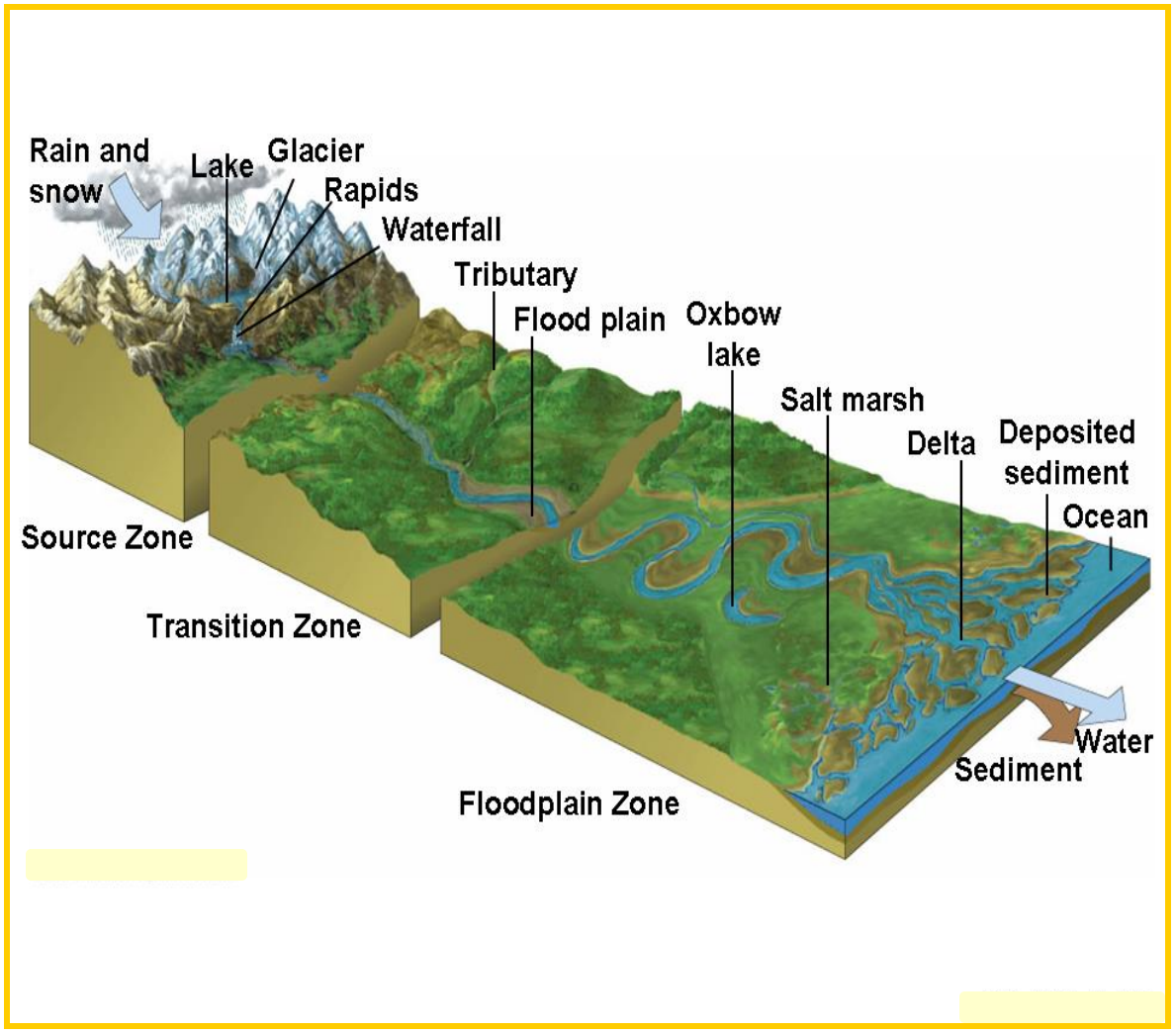

Figure 8: Downward Flow Streams: The Aquatic Zones (Miller, 2009/7)

- 1- Source Zone: narrow-shallow-cold-clear-high dissolved oxygen from the air.
- 2 –Transition Zone: streams merge-wider-deeper-warmer-less dissolved oxygen-cloudier.
- 3- Floodplain Zone: streams join into wider & deeper rivers-warmer-less dissolved oxygen-cloudier.

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3.5- Human Impacts on Freshwater Life Zone (Cont'd)

- Human activities affect freshwater systems in 3 major ways. These are:

✓ Dams, canals & flood control levees → alter & destroy wildlife habitat

✓ Cities & farmlands → pollutants

✓ Inland wetlands covered with concrete → alter ecosystems.

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4- Human Impacts on Aquatic Biodiversity

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4- Human Impacts on Aquatic Biodiversity (Cont'd)

- As with the terrestrial biodiversity, human impacts on aquatic biodiversity can be summarized using the HIPPO acronym:

✓ Habitat Loss: (HIPPO → H → Habitat loss & degradation)

✓ Invasive species: (HIPPO → I → Invasive species)

✓ Population growth: (HIPPO → P → Population Growth)

✓ Pollution: (HIPPO → P → Pollution)

✓ Overfishing & Extinction: (HIPPO → O → Overfishing)

- "commercial extinction": occurs when it is no longer profitable to continue fishing the affected species.
- Bycatch: "nontarget species caught while hunting. They are usually thrown overboard dead or dying" (Miller, 2009/7).

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5- Patterns of Marine Biodiversity & Protection Difficulties

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5- Patterns of Marine Biodiversity & Protection Difficulties

- The three general patterns of marine biodiversity:

✓ 1- greatest marine biodiversity → coral reefs, estuaries & deep ocean floor.

✓ 2- biodiversity is higher near coasts than in the open sea (due to the variety in producers & habitats).

✓ 3- biodiversity is higher in the bottom region than on the surface (greater variety of habitats & food sources)

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5- Patterns of Marine Biodiversity & Protection Difficulties (Cont'd)

- Protecting aquatic biodiversity is difficult for many reasons. These are:

✓ 1- increasing human impacts → human ecological footprint is expanding rapidly into aquatic areas.

✓ 2- invisibility of problems → much of the damage to the ocean is not visible to most people.

✓ 3- citizen unawareness → many people view the seas as an inexhaustible resource that can absorb infinite amounts of wastes and pollutants.

✓ 4- lack of legal jurisdiction → most of the world's ocean areas lie outside the legal jurisdiction of any country (open-access resources).

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6- Protecting & Sustaining Marine/Freshwater Biodiversity

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6- Protecting & Sustaining Marine/Freshwater Biodiversity

- Protecting & Sustaining Marine Biodiversity can take place through various means. The main & **most common** ones are:

✓ 1- Laws, international treaties & education

- ex: CITES, CBD….

✓ 2- Marine Sanctuaries:

- Two main types of marine sanctuaries:

- Marine Protected Areas (MPA): areas of ocean partially protected from human activities (ex: fishing…).

- Marine Reserves: areas where no extraction & alteration of any living or nonliving resource is allowed → fully protected.

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6- Protecting & Sustaining Marine/Freshwater Biodiversity (Cont'd)

- "Exclusive Economic Zones" → by international law, a country's offshore fishing zone extends to 370 Km from its shore → fishing vessels can take certain quotas of fish within such zones only with the government's permission.

- "High Seas" → ocean areas beyond the jurisdiction of any country. Laws & treaties of high seas are difficult to monitor & enforce.

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6- Protecting & Sustaining Marine/Freshwater Biodiversity (Cont'd)

- ✓ 3- Integrated Coastal Management:
  - a community based effort to develop & use coastal resources more sustainably.
  - the aim is for all conservationists, citizens, politicians… competing for the use of coastal resources to → to identify shared problems & goals → to attempt to develop workable, cost-effective & adaptable solutions.

- ✓ 4- Poverty & population growth reduction

- ✓ 5- Including the ecological services of aquatic life zones in estimating their economic value

- ✓ 6- People's education

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6- Protecting & Sustaining Marine/Freshwater Biodiversity (Cont'd)

- Ways to protect lakes, rivers and streams:

✓ 1- Reducing water withdrawal for irrigation
✓ 2- Reducing pollution (ex: agricultural fertilizers….)
✓ 3- Reducing overfishing activities
✓ 4- Poverty & population growth reduction
✓ 5- Including the ecological services of aquatic life zones in estimating their economic value
✓ 6- People's education
✓ 7- Protecting the land around it

N.B: sustainably managing and protecting any ecosystem (terrestrial or aquatic) starts by targeting the cause of the problem (in other words, targeting the HIPPO acronym)

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6- Protecting & Sustaining Marine/Freshwater Biodiversity (Cont'd)

- Ways to manage marine & freshwater fisheries more sustainably:

1- Fishery regulations (ex: catch limits….)
2- Economic approach (ex: set fees…)
3- Protected areas (ex: establish no-fishing areas…)
4- Consumer information (ex: publicize threatened species…)
5- Bycatch (ex: use wide meshed nets to allow small fish to escape…)
6- Aquaculture (ex: control pollution more strictly…)
7- Nonnative invasions (ex: invasion from shiploads…)
8- Building and protecting populations of desired species
9- Decreasing populations of less desired species

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Reference Book

Reference Book:

Miller, T. & Spoolman, S (2009). *Living in the Environment* (16th ed.) Canada: Cengage Learning – Brooks/Cole

Co- reference: Same Book – Editions 15 & 17 & 18

n.b: All the material in this class presentation is taken from the previously mentioned reference book.

(for educational purposes)