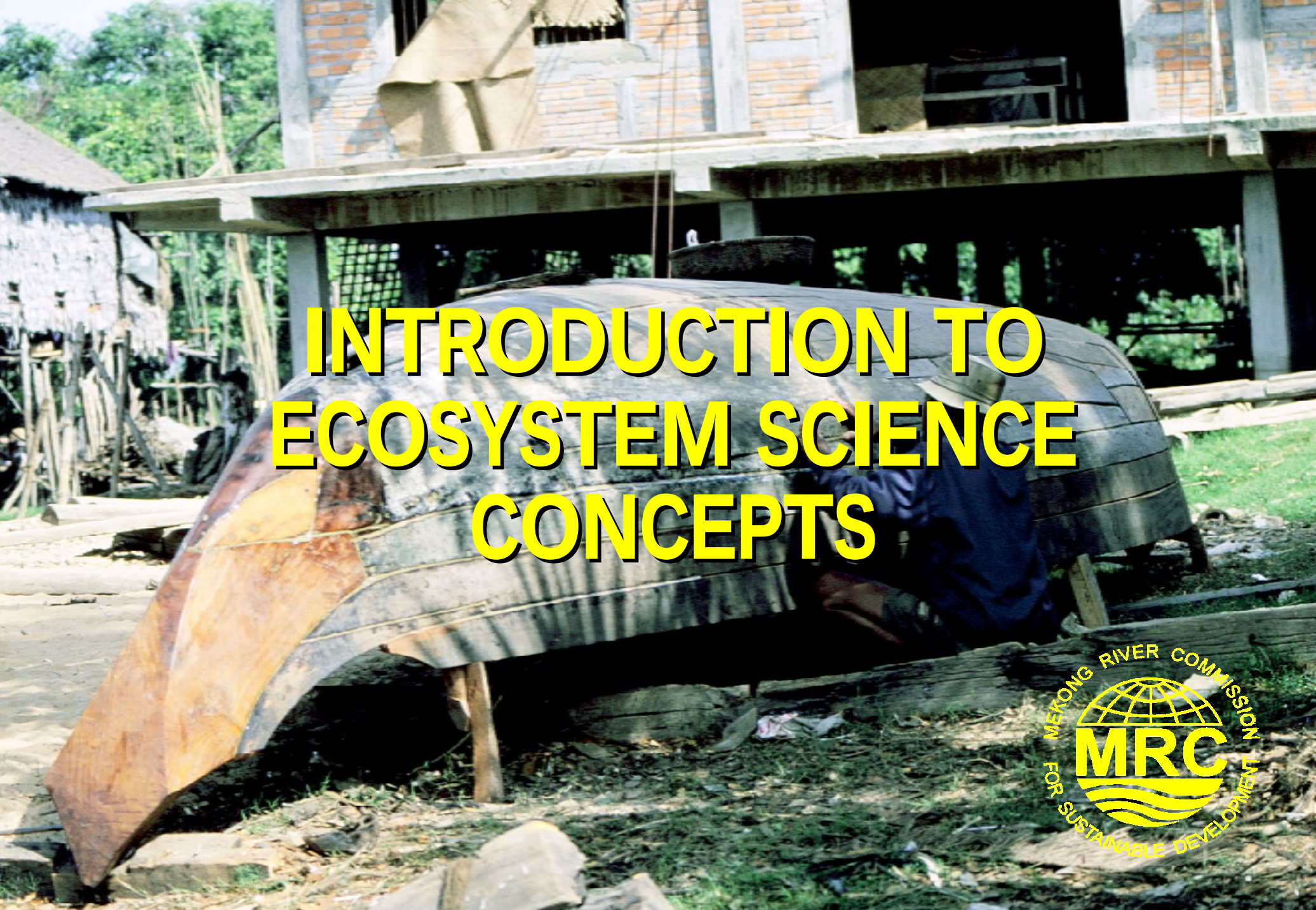

INTRODUCTION TO
ECOSYSTEM SCIENCE
CONCEPTS
MEKONG RIVER COMMISSION
MRC
FOR SUSTAINABLE DEVELOPMENT

Lesson Learning Goals

At the end of this lesson you should be able to:

- Discuss with examples the concepts of ‘food chain’ and ‘food web’
- Define ‘ecosystem’ and detail the components of an ecosystem
- Explain the concept of ‘carrying capacity’
- Describe a nutrient cycle and provide examples of disruptions to nutrient cycling within an ecosystem

Scientific Disciplines in the MRB

- A basic knowledge of several different scientific disciplines is necessary to understand the complex physical, chemical and biological relationships in the MRB
  - Biology
  - Ecology
  - Limnology
  - Hydrology

Biology

- Biology is the study of all living things, from the basic level of the cell, up to a natural system as complex as the Mekong River Basin
- Biology examines how living things harness non-living energy sources (water, oxygen, carbon dioxide) and use this energy for growth, survival, and reproduction

Energy

- All life processes require some form of energy
- Nearly all energy comes from the sun and is harnessed by plants through the process of photosynthesis
- Most living creatures obtain their energy either by consuming plants, or by eating organisms that eat plants

The First Law of Thermodynamics

- Also called the Law of Conservation of Energy
- States that matter can neither be created nor destroyed; the energy needed to do work within an organism cannot be generated from nothing
- Organisms must obtain energy from an outside source, such as through the consumption of plant material or other organisms

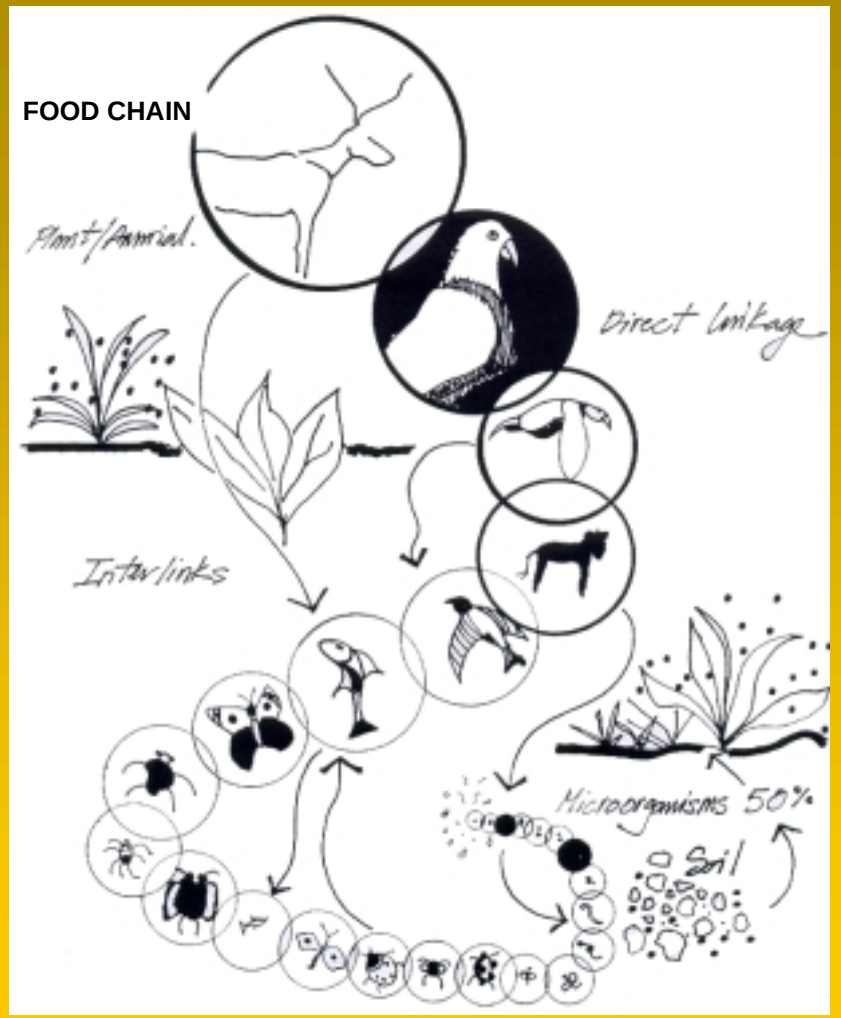
The Second Law of Thermodynamics

- In the universe as a whole, the total amount of energy available to do work is declining
- In other words, the supply of energy to support life is not limitless

Food Chains

The general sequence of who eats whom can be illustrated with a food chain

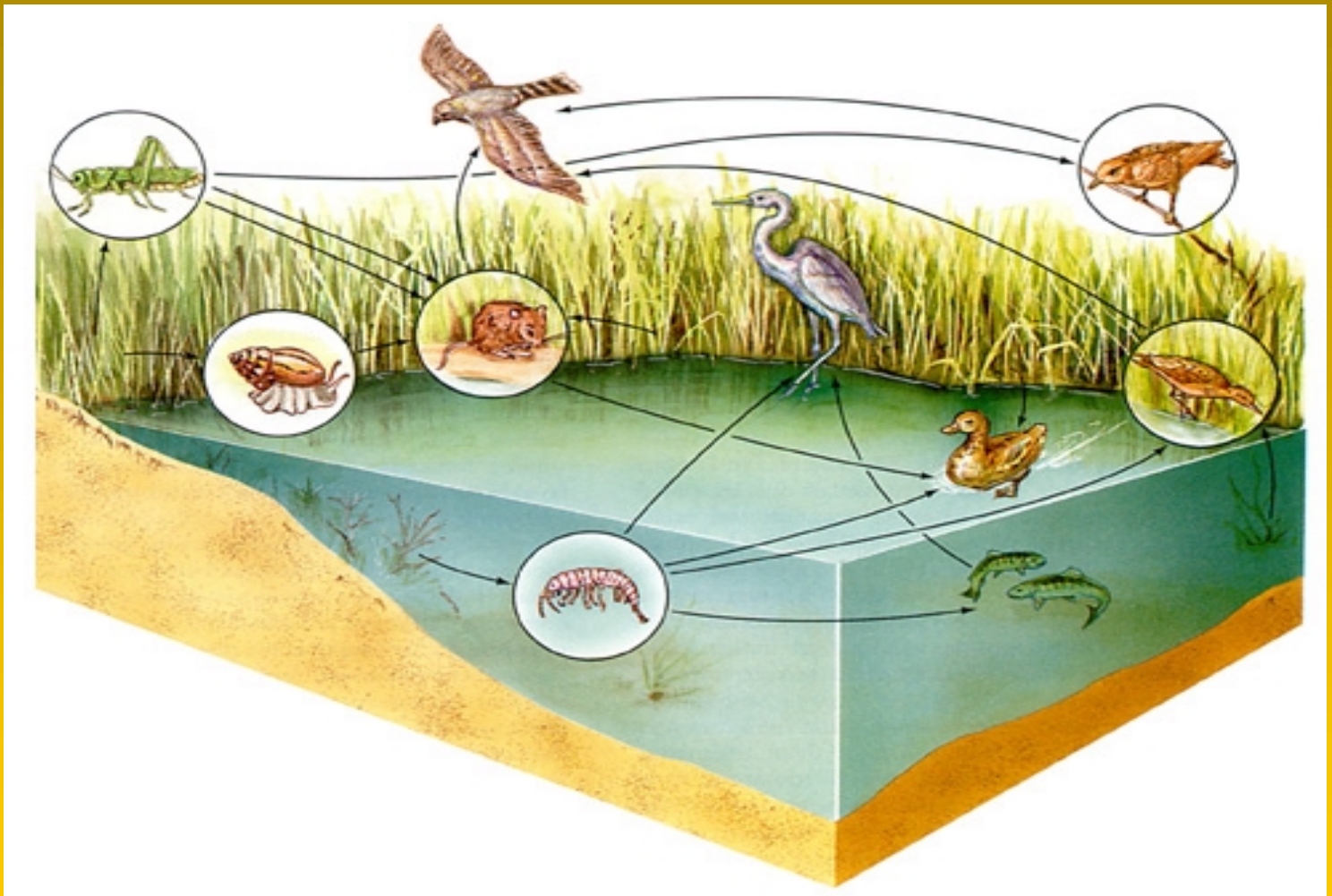
- herbivores eat plants and carnivores eat herbivores, and sometimes other carnivores



Food Web

- A food web is a network of crossing, interlinked food chains which include primary producers (e.g., grass) and a variety of consumers (e.g., birds) and decomposers (e.g., bacteria, fungi, insects)
- Establishes pathways by which nutrients flow through the ecosystem, eventually returning to the physical environment

Food Web Example



Ecology

- Ecology is the science that examines the interrelationships, distributions, and abundance of all organisms and their connections with the living and non-living environment
- The processes that determine ecosystem function and change over time are also studied

Important Ecological Processes

- Biological Process
  - food chains and webs
- Physical Process
  - hydrological cycle
- Bio-Physical Process
  - nutrient cycling and eutrophication

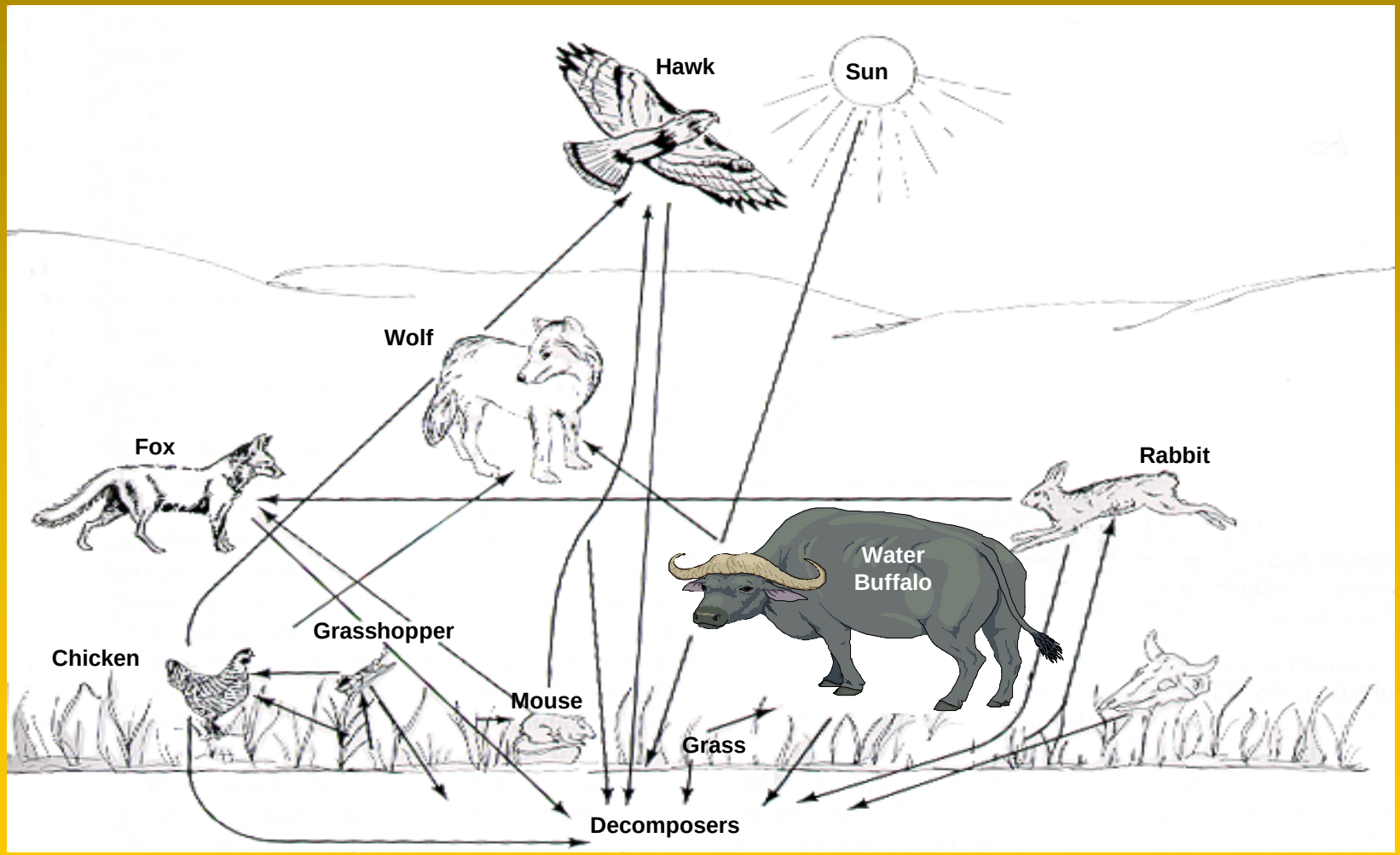
What are Ecosystems?

- A network of functional interactions involving living and non-living elements in a manner that sustains life (e.g., forest ecosystem, marine ecosystem)
- Living organisms borrow oxygen, carbon dioxide and nutrients from the ecosystem and then return these materials through the processes of respiration, excretion and decomposition

Ecosystem Components

- Biotic: the living part of the ecosystem (e.g., plants, animals)
- Abiotic: the non-living part of the ecosystem (e.g., air, water, soil)
- Functional: processes occurring within the ecosystem which are essential to biotic life (e.g., hydrological cycle)

Ecosystem Example



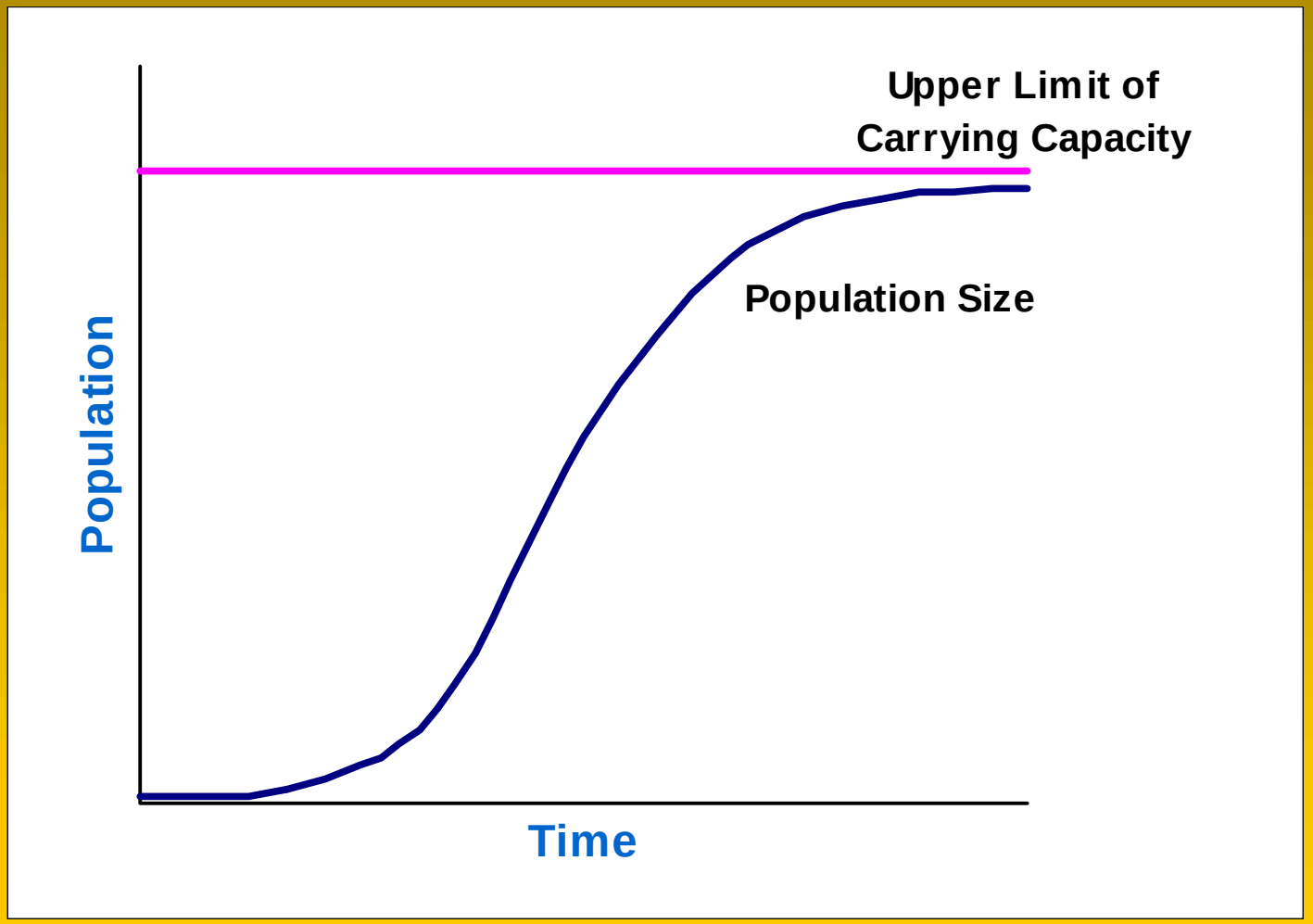
Carrying Capacity

- The concept of carrying capacity is fundamental to understanding how wildlife populations develop
- Carrying capacity refers to the number of healthy organisms of all species within an ecosystem that can survive in that ecosystem without degrading its quality

Carrying Capacity (Cont'd)

- The environment has finite sources (i.e., resources) and finite sinks which sustain ecosystems (i.e., processes for assimilating wastes and pollutants)
- Recognizing these limits, carrying capacity refers to the ability of the environment to support and maintain ecosystems

Carrying Capacity (Cont'd)



Optimizing Sources and Sinks

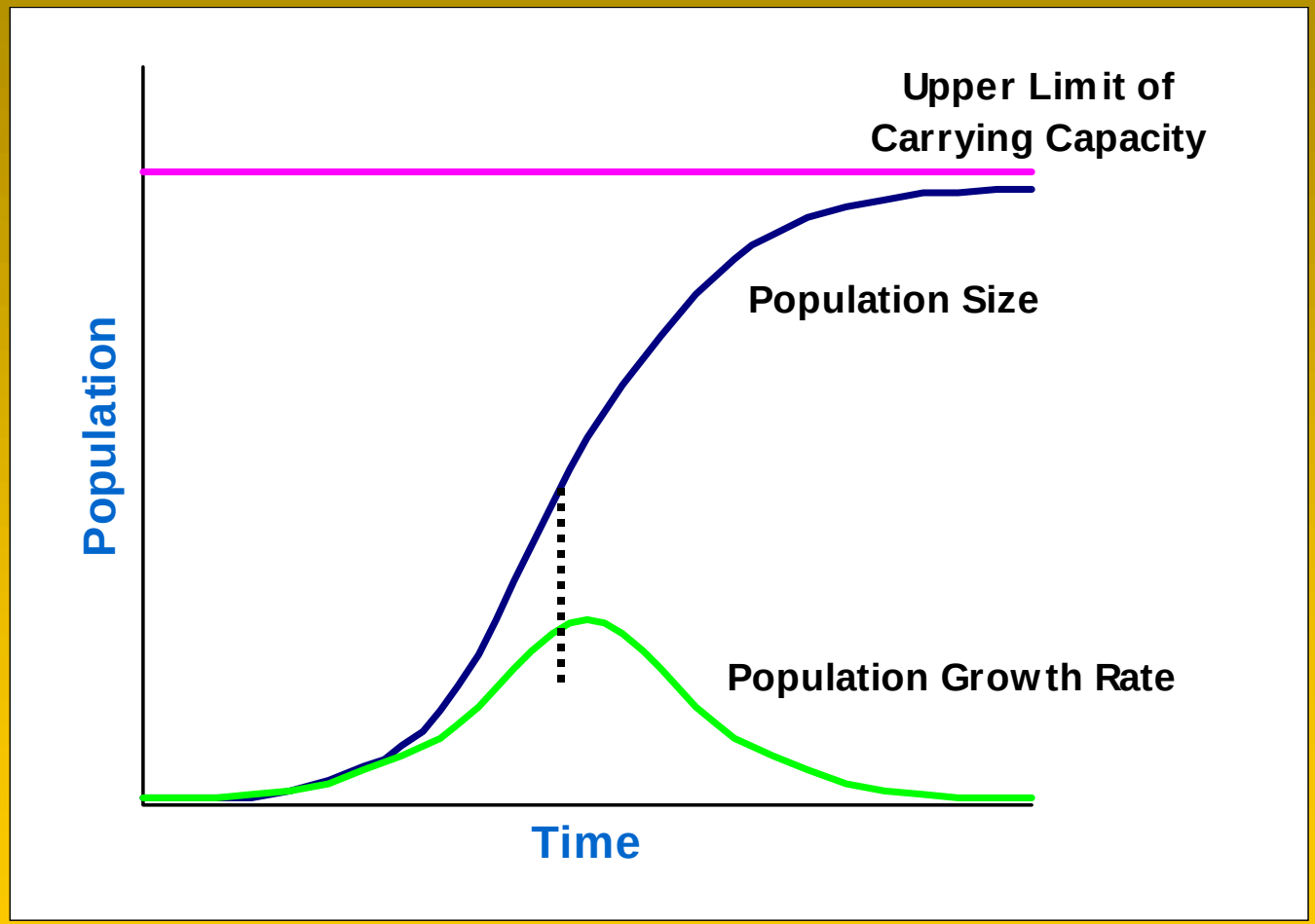
The question that should be asked is:

What is the optimal amount
of fish that could be harvested?

NOT

What is the total amount
of fish that can be harvested?

Optimizing Sources and Sinks (Cont'd)



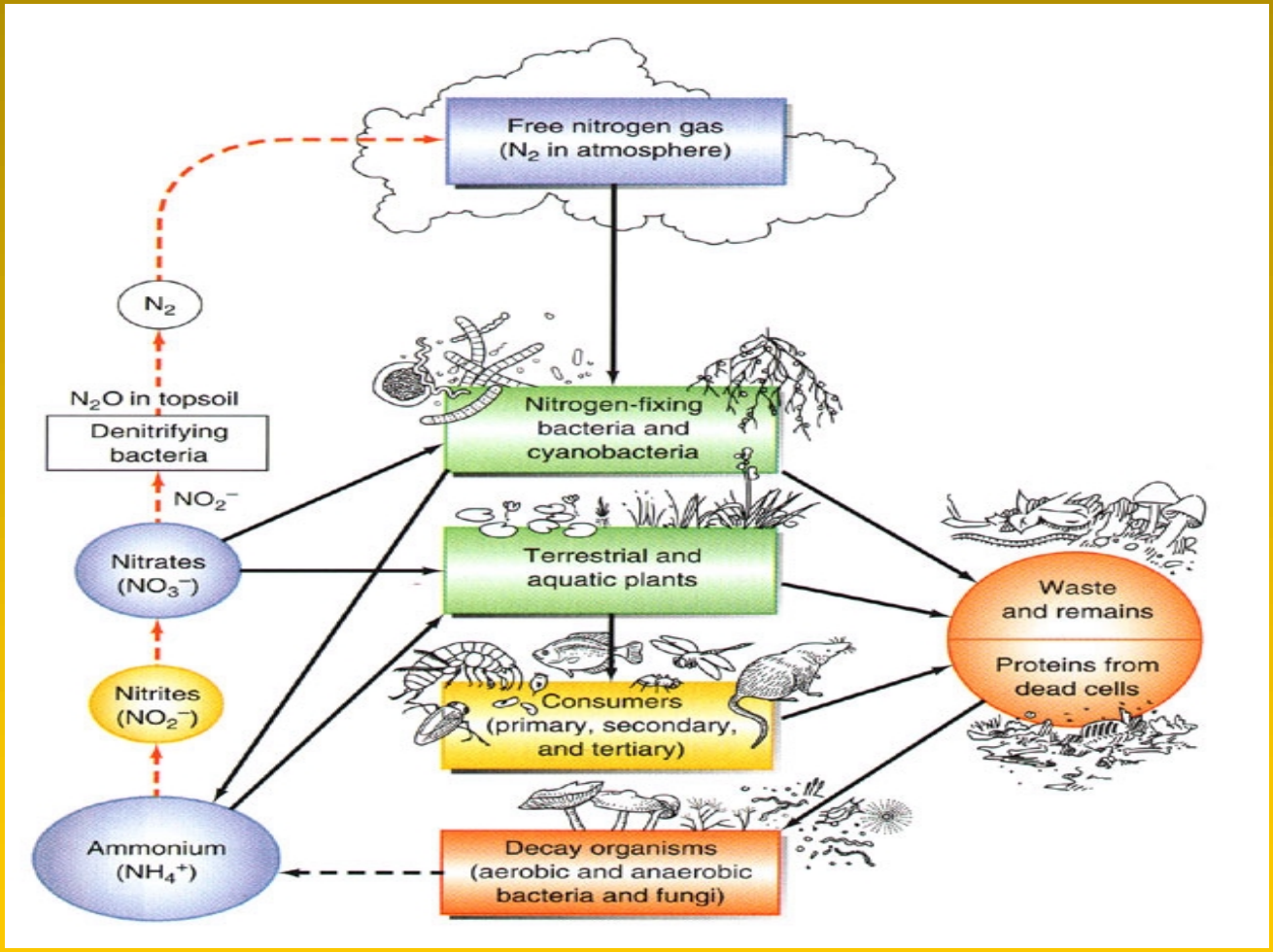
Nutrient Cycle

- A repeating cycle in which nutrients (e.g., nitrogen, carbon) flow through the ecosystem
- Nutrients include:
  - carbon, nitrogen, magnesium, calcium, iron and phosphorous
- Plants use nutrients in many ways, such as:
  - nitrogen to make proteins
  - magnesium in the manufacture of chlorophyll, a substance used to capture the sun's energy

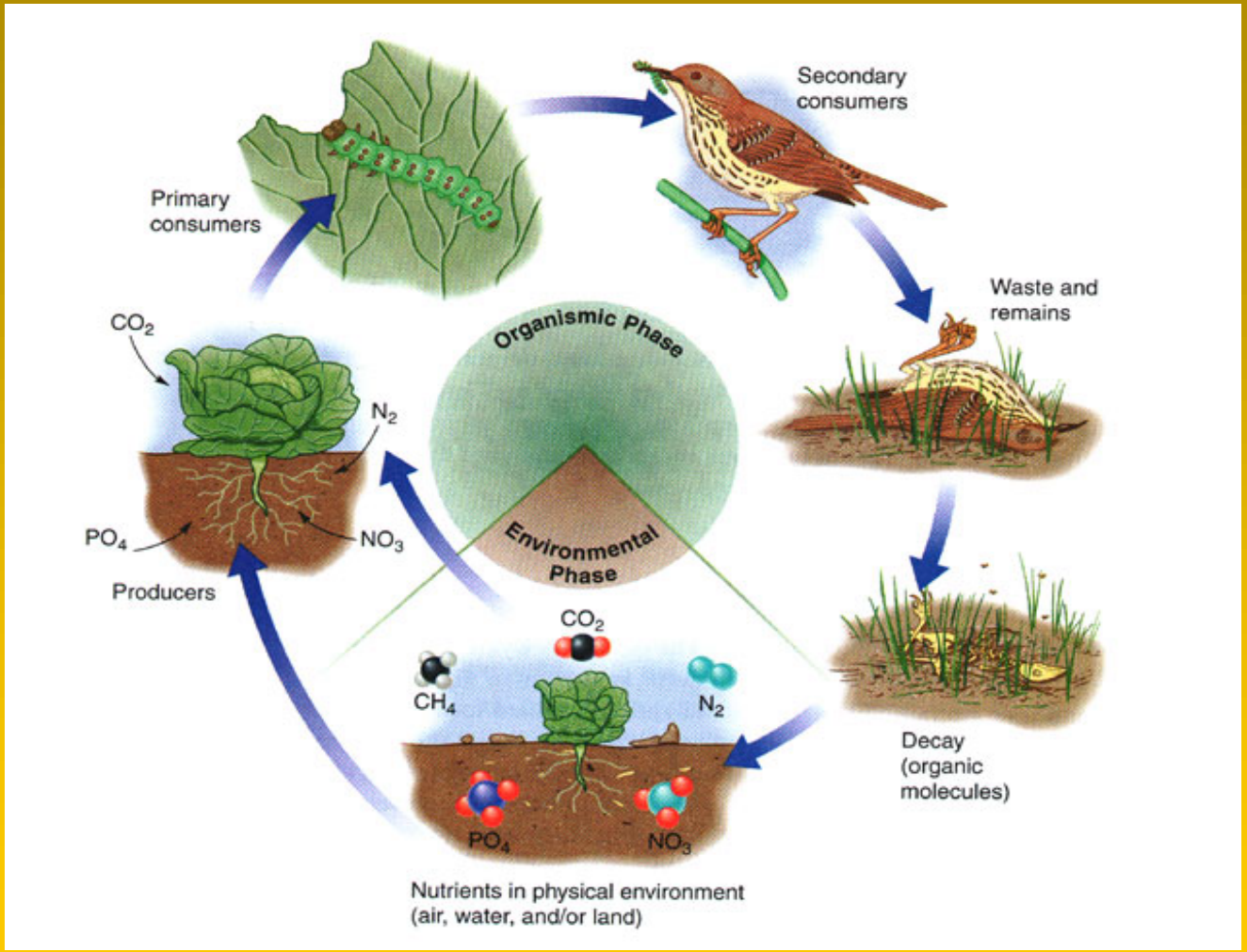
How Nutrients Cycle

- Many things contribute to how nutrients move through an ecosystem
  - rainwater washes nutrients through soil from one place to another
  - trees draw nutrients from the soil through their roots and into their leaves, which fall, decompose, and leave nutrients in a new place
  - animals eat green plants, deposit nutrients in their wastes, and transfer nutrients when they are consumed by other animals

Nutrient Cycle Example



Another Nutrient Cycle Example



Disruptions in Nutrient Cycling

- Many things can disrupt nutrient cycling within an ecosystem
  - acid rain can change the chemistry of soil and change the form of certain nutrients
  - clear-cutting a forest often causes erosion, which washes away soil nutrients, reducing nutrient availability for future plants

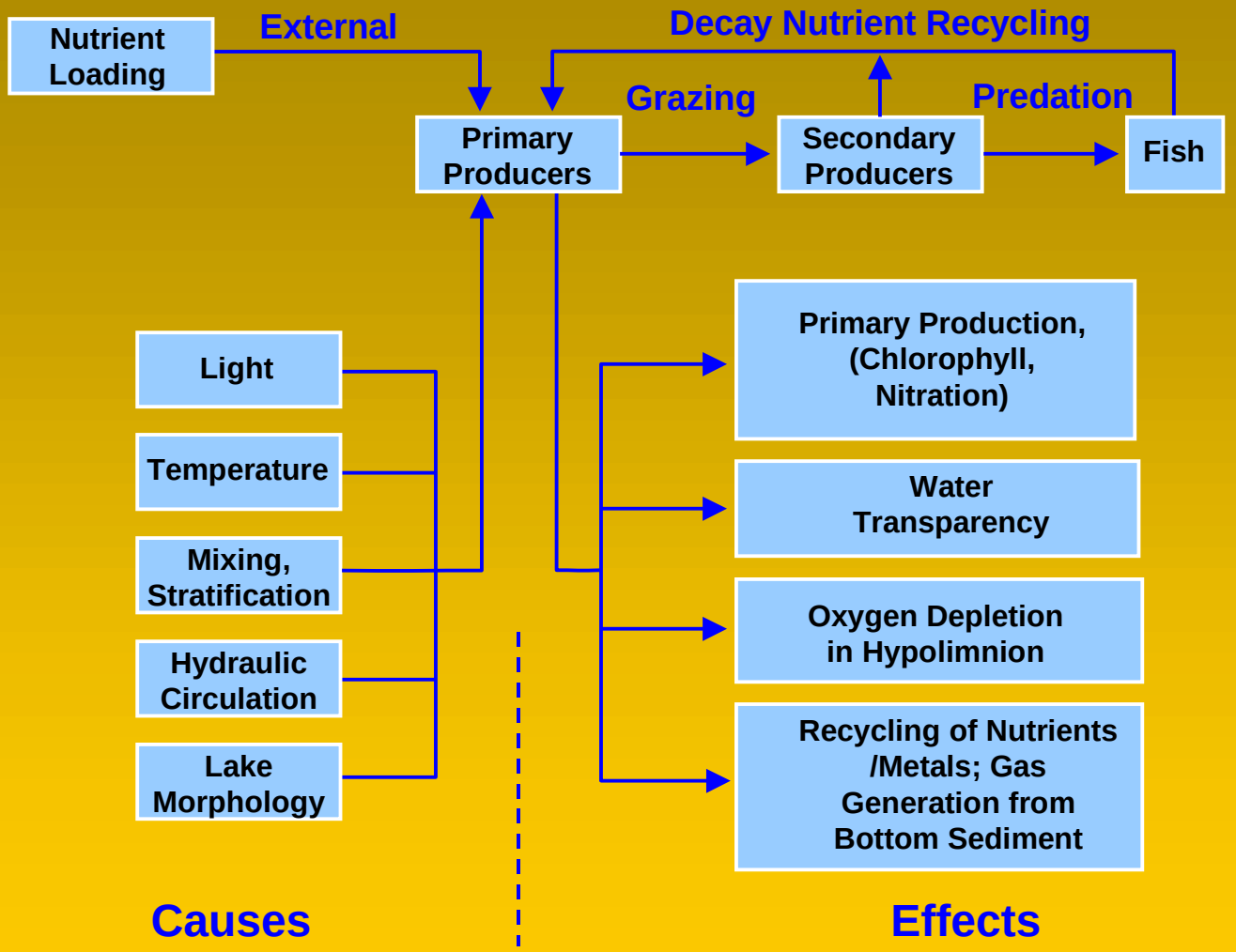
Eutrophication

- Eutrophic means well-nourished
- The biological response to high nutrient inputs, natural or artificial, to a body of water leading to an increase in biomass
- Eutrophication can have beneficial effects such as, increased fish production, or negative effects, such as fish kills caused by increased algal growth

Eutrophication (Cont'd)

- The excess nutrients that cause eutrophication frequently are derived from sources of pollution on adjacent lands or water bodies, such as:
  - farmland
  - fish farms
  - waste water treatment plants

Causes and Effects of Eutrophication



Limnology

- Limnology is the study of freshwater inland ecosystems, primarily rivers and lakes
- The shape and structure of the Mekong River (i.e., its geomorphology) and its tributaries influence the physical, chemical and biological processes of the river basin

Limnology (Cont'd)

- River system zonation:
  - lentic zone is characterized by slower moving water and a vertical temperature gradient which varies from temperate to tropical river systems
  - lotic zone is the portion of the river with the highest flow velocity; nutrients, sediments, and potential pollutants are carried in this zone and deposited at points downstream

Hydrology

- Hydrology is the study of water's movement through the hydrologic cycle
- The hydrologic cycle is the repeating cycle in which water evaporates from land, oceans, lakes and rivers, returns in the form of precipitation and replenishes surface and groundwater
- Sources of water:
  - precipitation, surface run-off, groundwater seepage

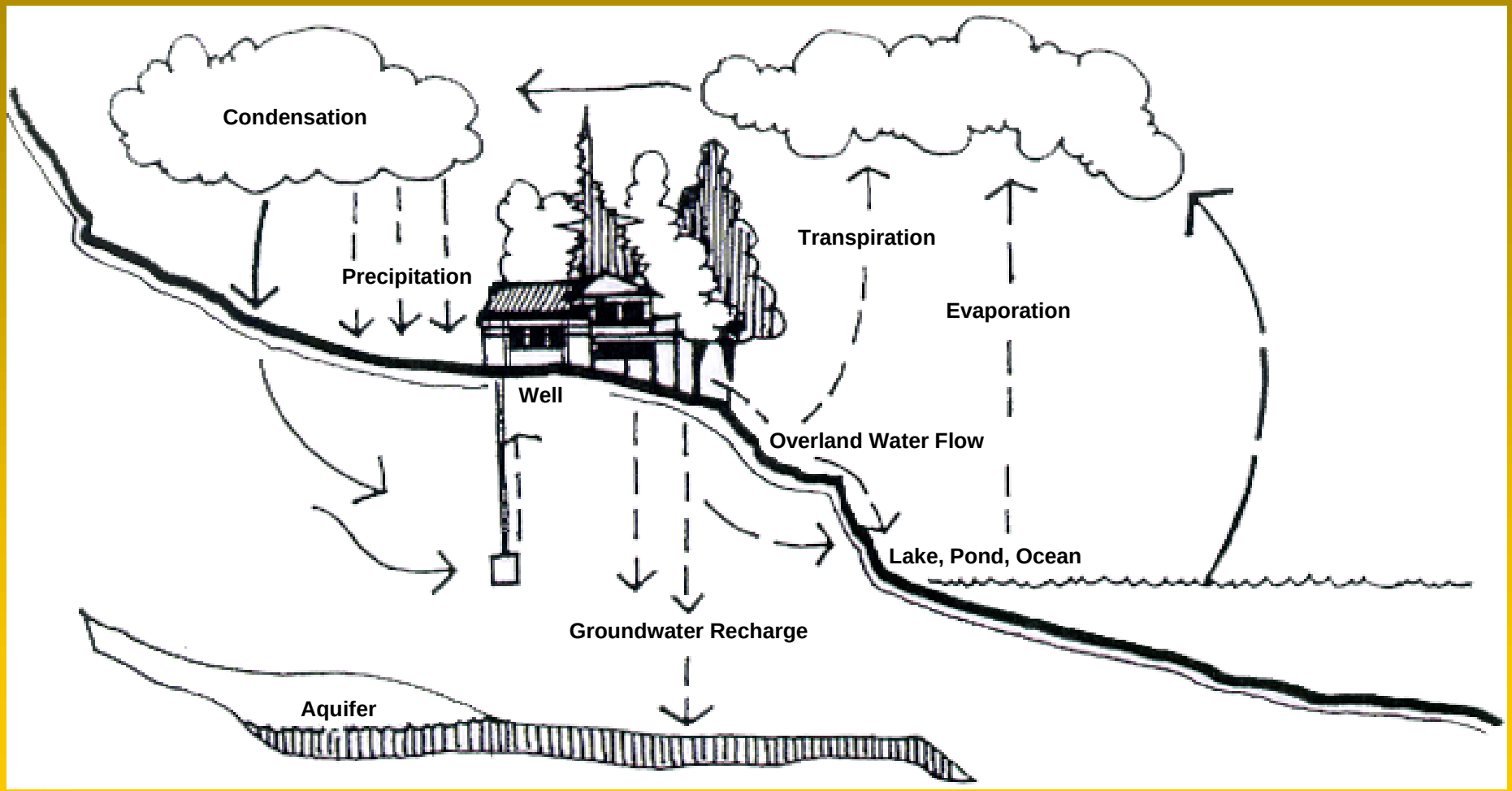
Hydrology (Cont'd)

- Water loss:
  - evaporation, flow through a surface outlet, flow through a sub-surface outlet into groundwater, evapotranspiration from aquatic plants
- Changes in water storage and retention within the Mekong River Basin results from alterations between input rates from sources of water and rates of water loss

Hydrology (Cont'd)

- The hydrologic cycle is the most fundamental principle of hydrology
  - water evaporates from the oceans and land surface
  - water precipitates as rain or snow
  - water is intercepted by trees and plants
  - water provides run-off on the land surface
  - water infiltrates into soils and recharges groundwater
  - water discharges into rivers and streams

Hydrologic Cycle



Concluding Thoughts

Important points to remember are:

- Study of complex systems such as the MRB encompasses numerous scientific disciplines
- Ecology involves the study of interrelationships, distribution and abundance of living and non-living organisms and the processes that determine ecosystem function
- Limnology is the study of freshwater inland ecosystems such as rivers and lakes
- Hydrology is the study of the movement of water through the hydrological cycle