

# ES 200 ENVIRONMENTAL STUDIES

## Module-C

Anthropogenic effects on ecosystem, water quality & health, water & wastewater treatment



**Lecture-1**

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# Contents: Module C

- Ecosystem & Biodiversity
- Water Resources
- Water Quality & Pollution Sources
- Parameters for Water Quality Characteristics, and Standards
- Conventional Surface Water Treatment System
- Conventional Municipal Wastewater Treatment System
- Alternate Water & Wastewater Treatment

# Text/References

- Masters, G.M., Ela, W.P. (2008) Introduction to Environmental Engineering and Science, 3<sup>rd</sup> edition, PHI Learning Pvt. Ltd. Delhi.
- Cunningham W.P., Cunningham M.A. (2002) Principles of Environmental Science, 4<sup>th</sup> edition, Tata McGraw-Hill Publishing Company Ltd. New Delhi.
- Miller, G.T.J. (2005) Essentials of Ecology, 3<sup>rd</sup> edition, Thomson Learning Inc.
- Arceivala, S.J., Asolekar, S.R. (2007) Wastewater Treatment for Pollution Control and Reuse, 3<sup>rd</sup> edition, Tata McGraw-Hill Publishing Company Ltd. New Delhi.
- Other texts and references

# Evaluation

- 1 Quiz (13 Marks)
- 1 End Semester Exam (20 Marks)
- Module C – 33% weightage towards final grades

# Learning Objectives

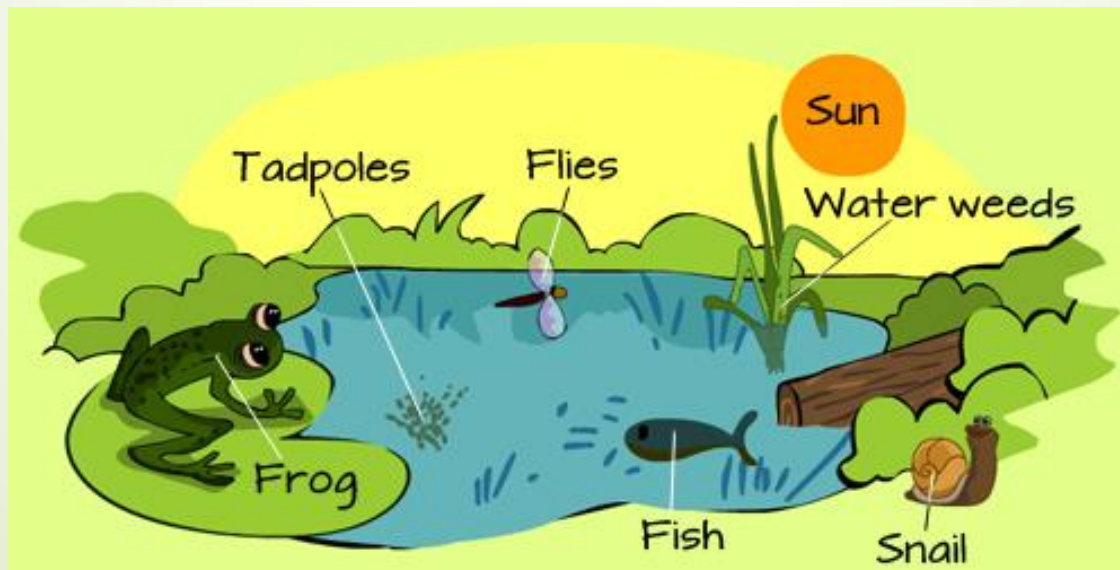
## Ecosystem & Biodiversity

- Definition and examples of ecosystem
- Important concepts and contributors in an ecosystem
- Biodiversity: concept & importance
- Biodiversity hotspots in India/World
- Conservation of biodiversity

# What is an Ecosystem?

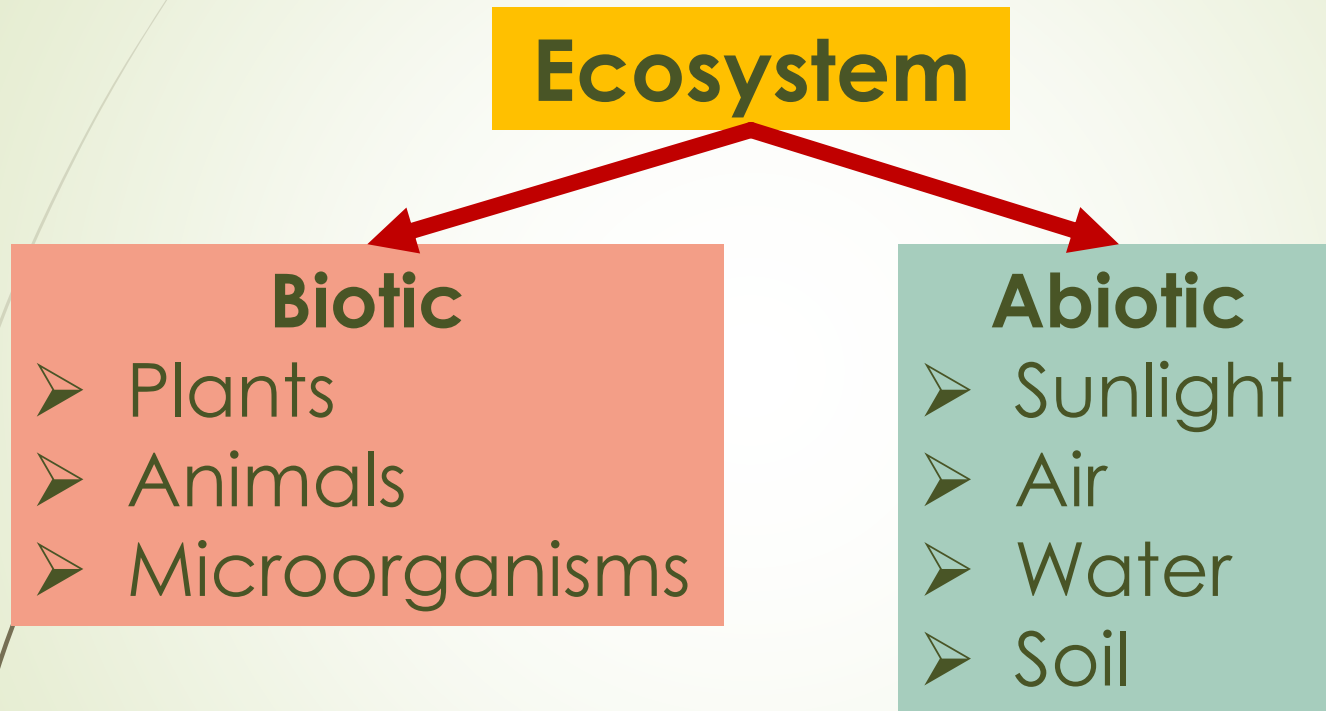
## Eco + System

An ecosystem is a community of different species interacting with one another and with their physical environment in which **matter cycles** and **energy flows**.



<http://eschooltoday.com/ecosystems/what-is-an-ecosystem.html>

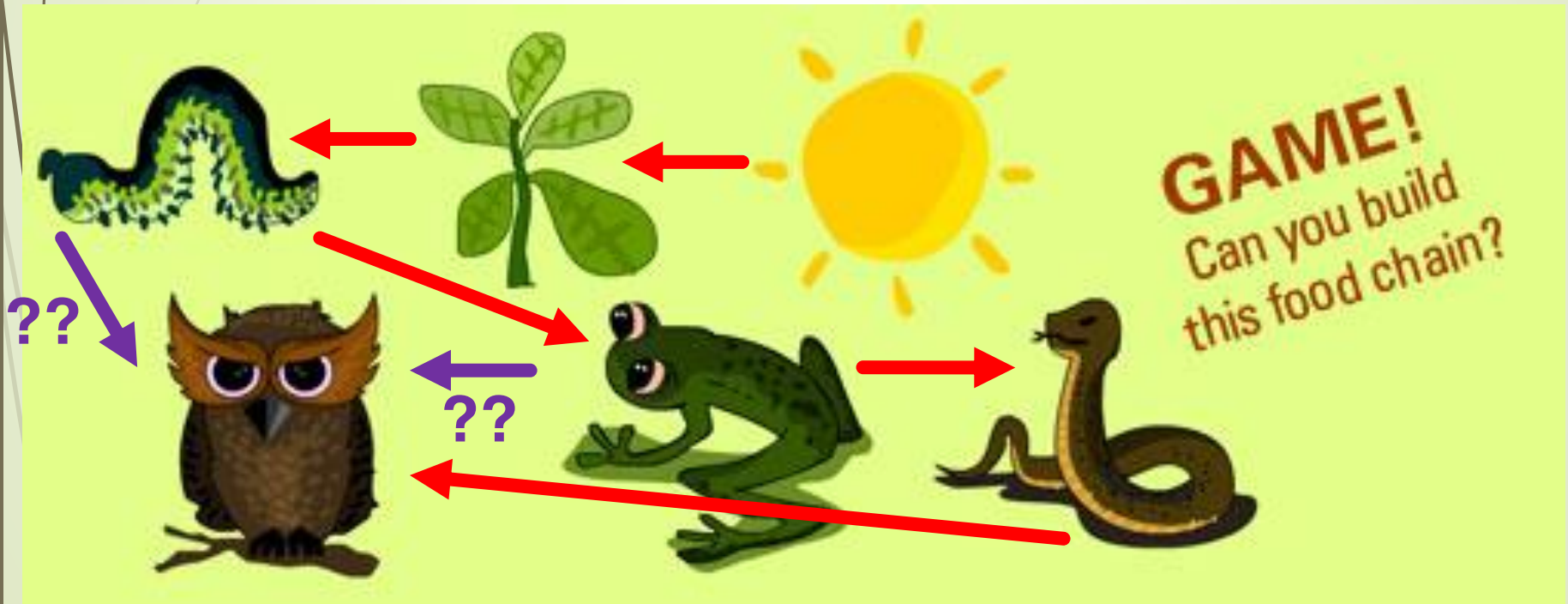
# Components of an Ecosystem





# Concepts in an Ecosystem

## Food Chain

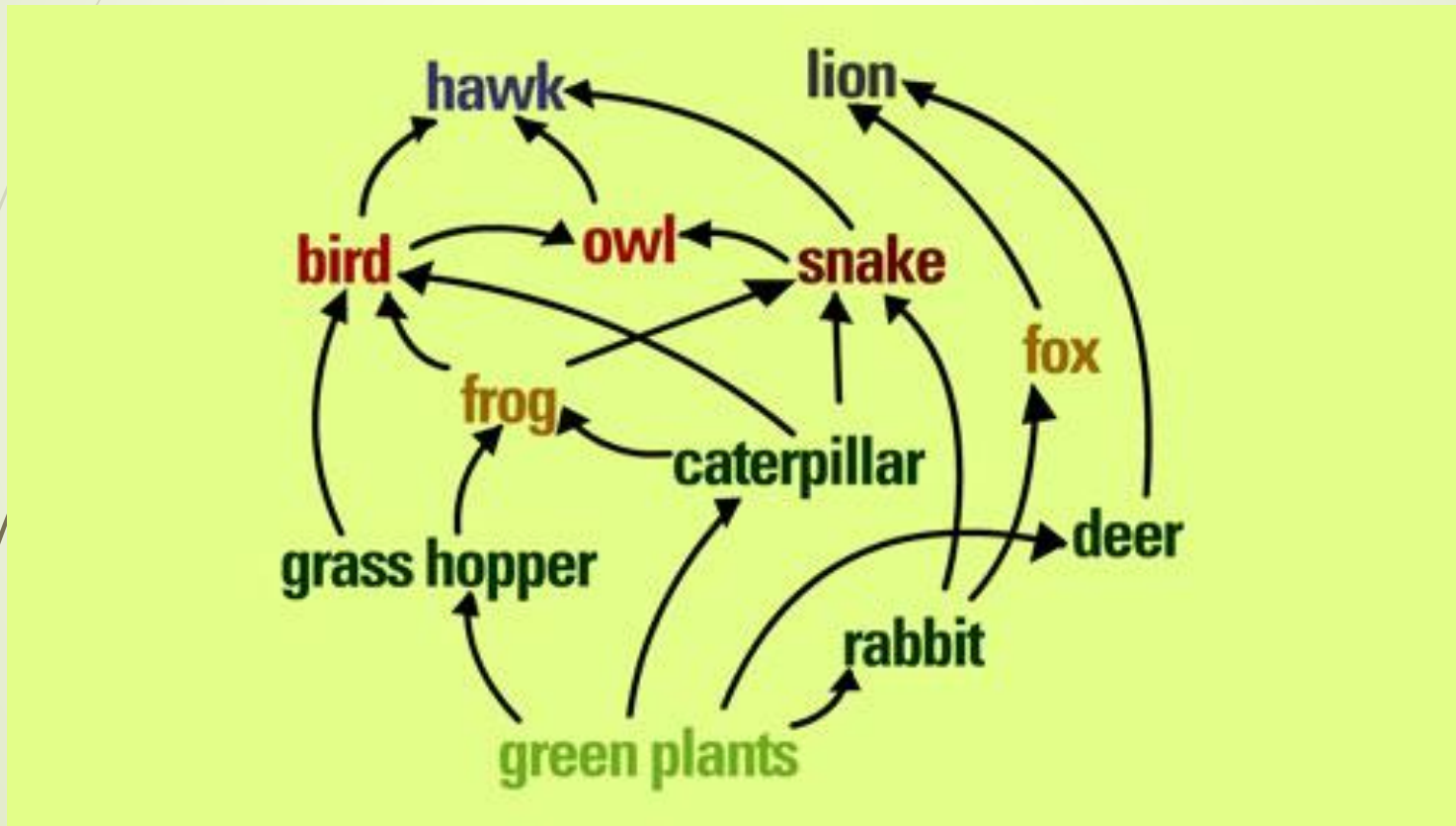


<http://eschooltoday.com/ecosystems/what-is-a-foodchain.html>



# Concepts in an Ecosystem

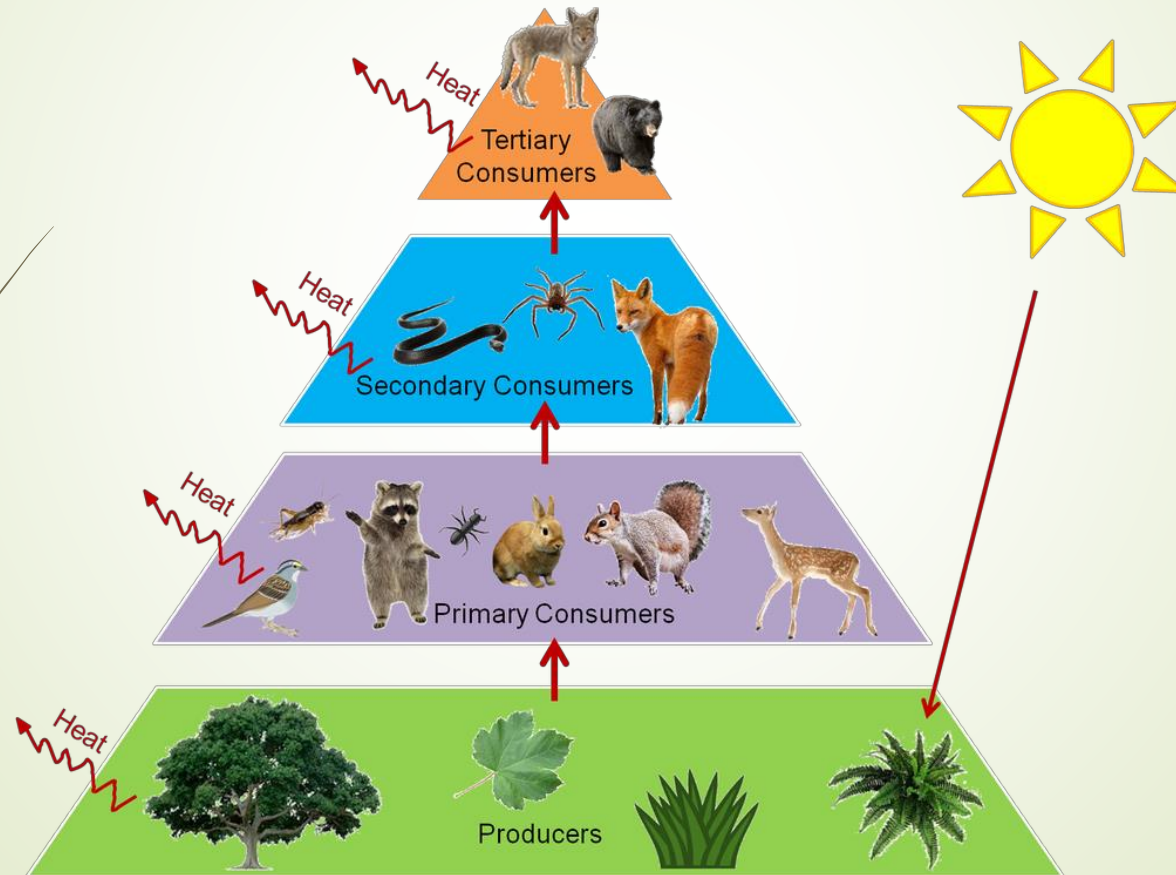
## Food Web



<http://eschooltoday.com/ecosystems/what-is-a-foodchain.html>

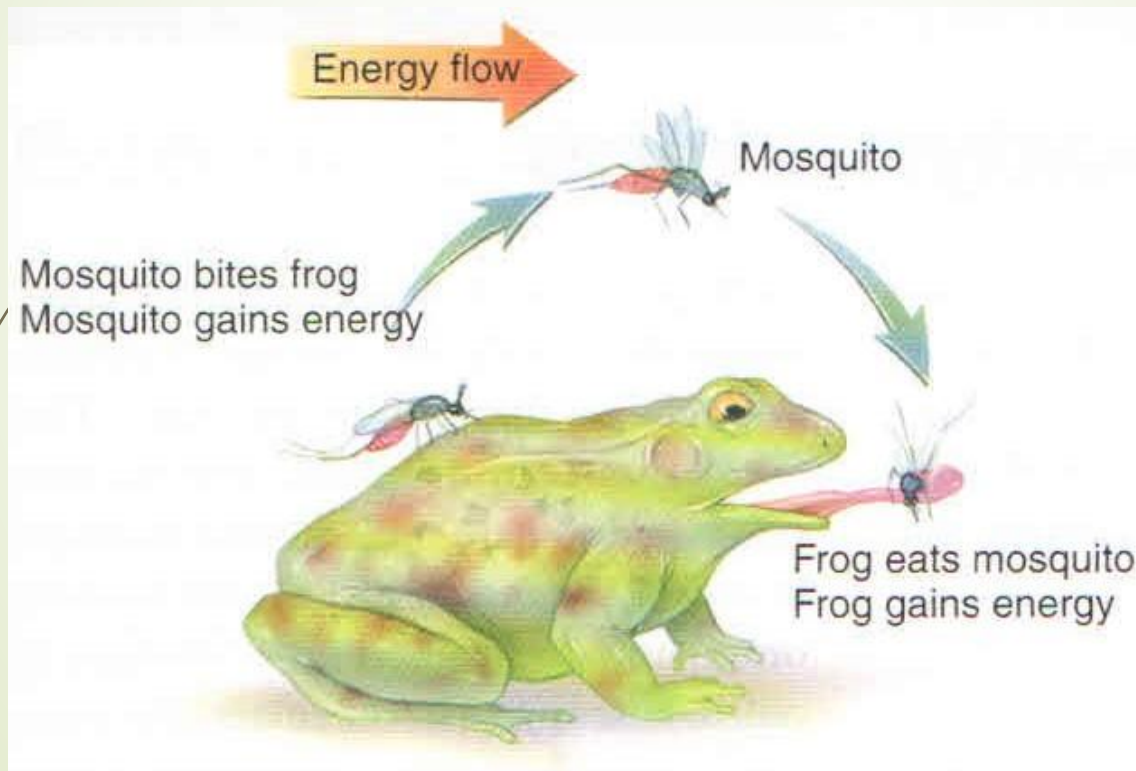
# Concepts in an Ecosystem

## Trophic Levels of Food Chain



# Concepts in an Ecosystem

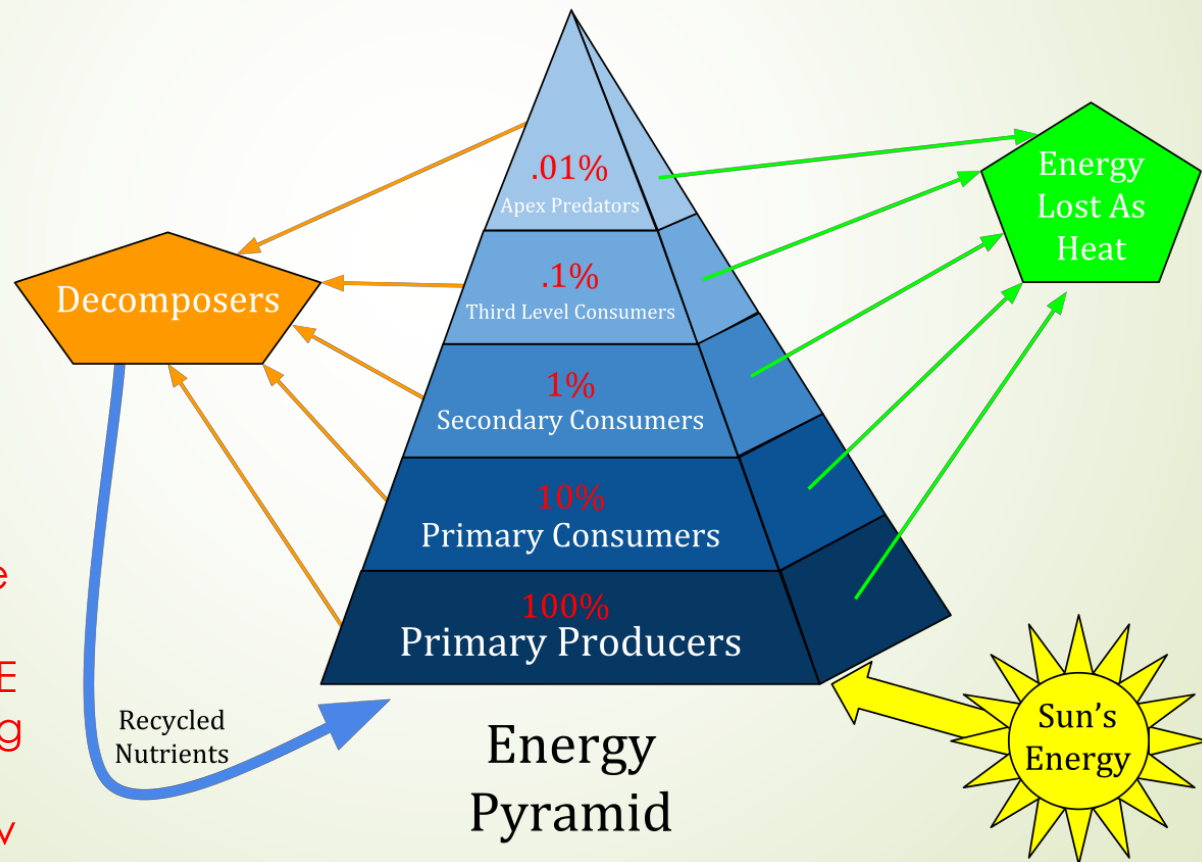
## Is it Possible??



Botkin and Keller (2010)

# Concepts in an Ecosystem

## Pyramid of Energy



[https://upload.wikimedia.org/wikipedia/commons/thumb/3/3a/Ecological\\_Pyramid.svg/1200px-Ecological\\_Pyramid.svg.png](https://upload.wikimedia.org/wikipedia/commons/thumb/3/3a/Ecological_Pyramid.svg/1200px-Ecological_Pyramid.svg.png)

# Concepts in an Ecosystem

## Primary Productivity

- The rate at which an ecosystem's producers convert solar energy into chemical energy as biomass is the ecosystem's **Gross Primary Productivity (GPP)**.
- To stay alive, grow, and reproduce, an ecosystem's producers must use some of the biomass they produce for their own **respiration (R)**.

$$\text{Net Primary Productivity (NPP)} = \text{GPP} - \text{R}$$

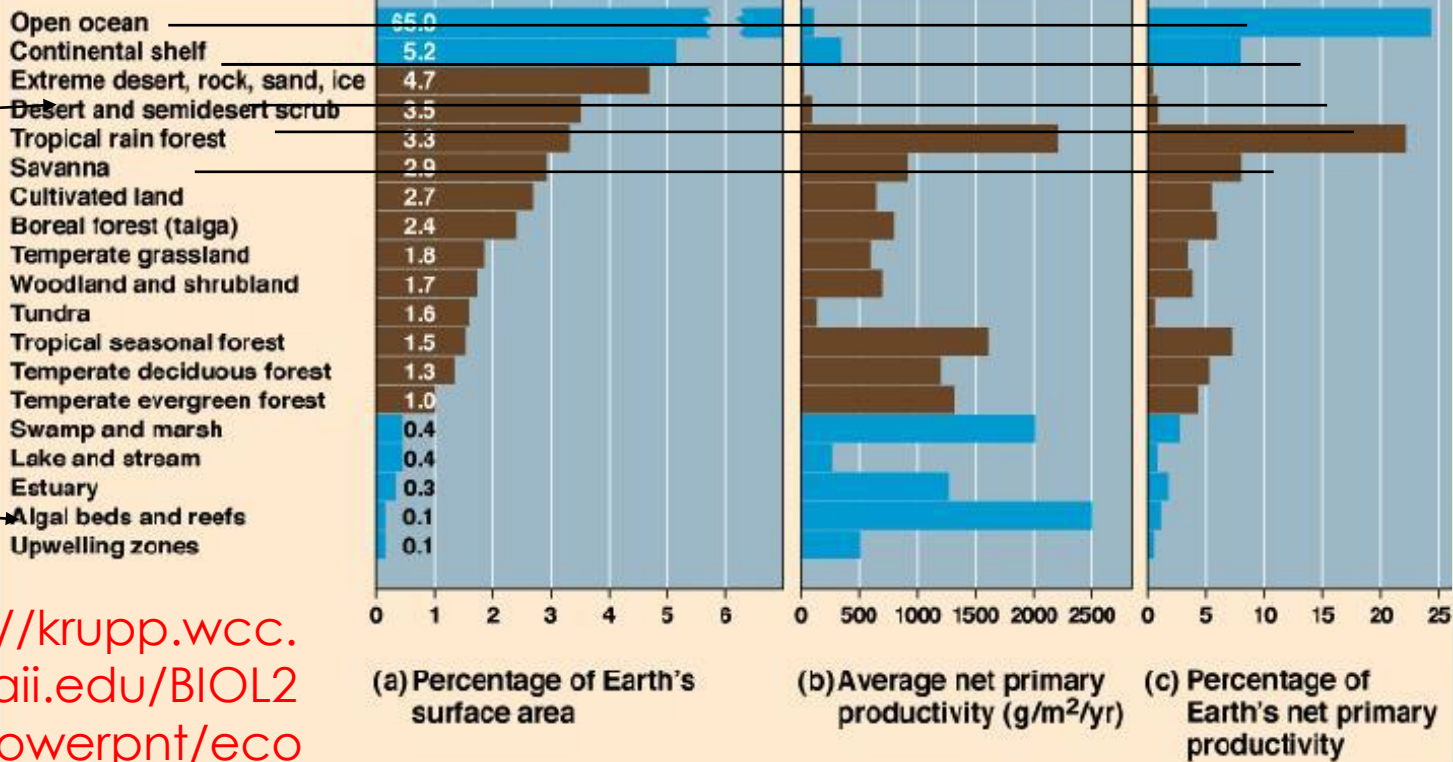
NPP is a measure of how fast producers can provide the food needed by consumers in an ecosystem.

**The planet's NPP ultimately limits the number of consumers (including humans) that can survive on the Earth.**



# Concepts in an Ecosystem

## Primary Productivity of Different Ecosystems



<http://krupp.wcc.hawaii.edu/BIOL200/powerpnt/ecolprin/img040.jpg>



# Concepts in an Ecosystem

## Ecological Efficiency

**Ecological efficiency** is the efficiency with which production at one trophic level is converted into production at the next level.

$$\eta_{\text{ecological}} = \eta_{\text{consumption}} \times \eta_{\text{assimilation}} \times \eta_{\text{productivity}}$$

$$\eta_{\text{consumption}} = \frac{\text{Food (biomass) consumed}}{\text{Food (biomass) available}}$$

$$\eta_{\text{assimilation}} = \frac{\text{Food (biomass) assimilated}}{\text{Food (biomass) consumed}}$$

$$\eta_{\text{productivity}} = \frac{\text{Biomass produced}}{\text{Food (biomass) assimilated}}$$

$$\eta_{\text{ecological of trophic level (n + 1)}} = \frac{\text{Biomass produced at trophic level (n + 1)}}{\text{Biomass available at trophic level (n)}}$$

# Examples of Ecosystem

## Tropical Rain Forest Ecosystem

[http://2.bp.blogspot.com/\\_Rz2Y\\_s3rZko/TT48FkAO-GI/AAAAAAAK4/4wIw9GqUWpM/s1600/Rainforest+Scene+%2526+Animals.jpg](http://2.bp.blogspot.com/_Rz2Y_s3rZko/TT48FkAO-GI/AAAAAAAK4/4wIw9GqUWpM/s1600/Rainforest+Scene+%2526+Animals.jpg)



# Examples of Ecosystem

## Fresh Water Ecosystem



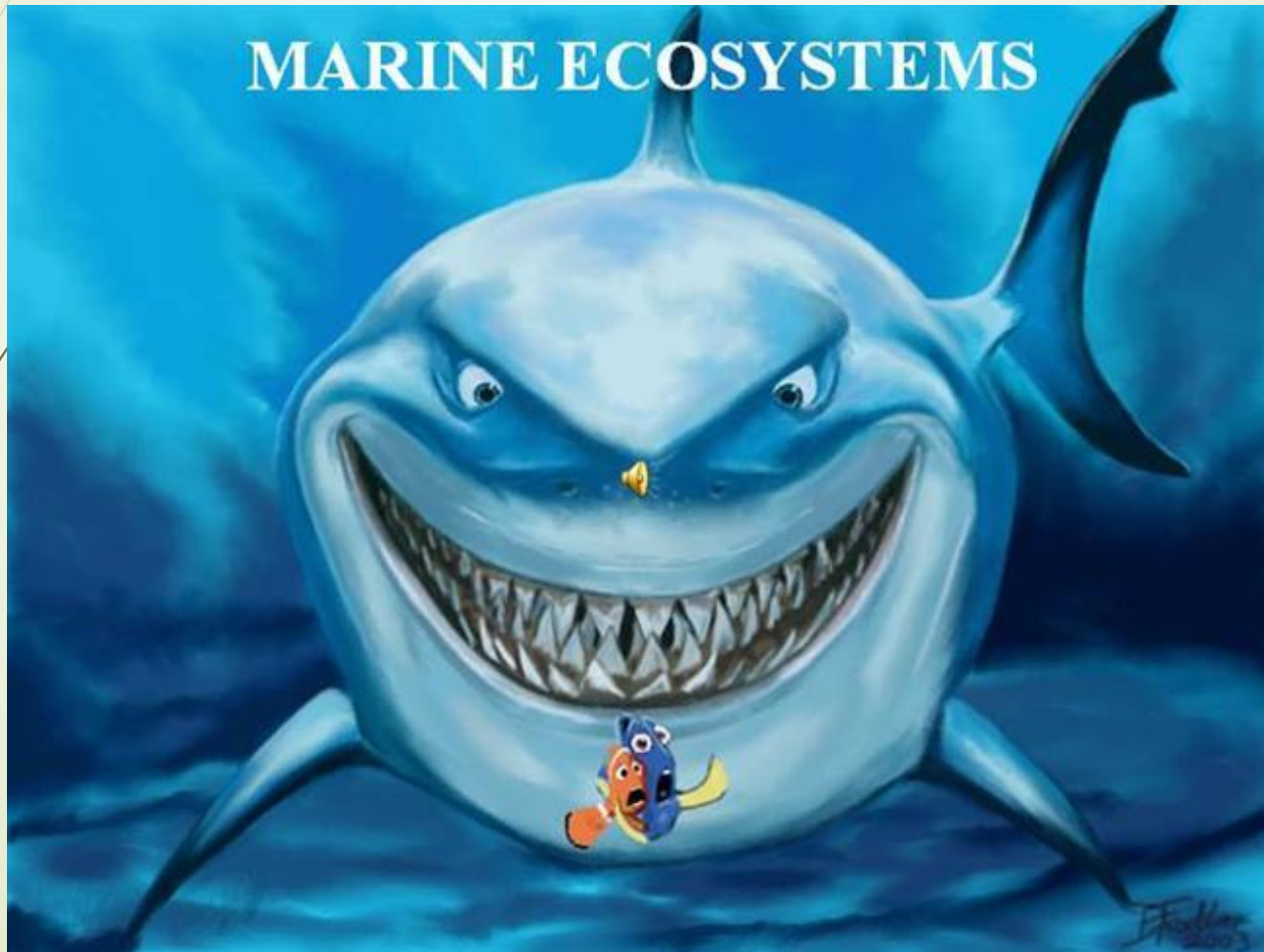
illustration by Jeff Grader / property of Delta Education

<https://cdn.thinglink.me/api/image/622143932586786818/1240/10/scaleto width>



# Examples of Ecosystem

## Marine Ecosystem



[http://c.asstatic.com/images/1121648\\_634472039995696628-1.jpg](http://c.asstatic.com/images/1121648_634472039995696628-1.jpg)

# Examples of Ecosystem

## Homework

Identify members in various **trophic levels** in the following ecosystems, and develop their food chains and food webs:

- Tropical rain forest ecosystem
- Freshwater ecosystem
- Marine ecosystem
- Desert ecosystem

# Ecosystem Services

## PROVISIONING SERVICES

*Products obtained from ecosystems*

- Energy
- Seafood
- Biomedial
- Transportation
- National defense

## REGULATING SERVICES

*Benefits obtained from the regulation of ecosystem processes*

- Flood prevention
- Climate regulation
- Erosion control
- Control of pests and pathogens

## CULTURAL SERVICES

*Nonmaterial benefits obtained from ecosystems*

- Educational
- Recreational
- Heritage
- Spiritual

## SUPPORTING SERVICES

*Services necessary for the production of all other ecosystem services*

- Biological diversity maintenance
- Nutrient recycling
- Primary productivity



source: *Final Recommendations of the Interagency Ocean Policy Taskforce, 2010*



# Human Impacts on Ecosystems

## Healthy Coral

## Bleached Coral

## What causes coral bleaching?

- • Chemical sunscreens
- • Pollution in oceans
- • Fishing practices that use cyanide or dynamite
- • Ocean acidification from greenhouse gases
- • Temperature increase

[https://www.google.co.in/imgres?imgurl=http%3A%2F%2Fwww.goddessgarden.com%2Fwp-content%2Fuploads%2F2017%2F03%2FCoral.jpg&imgrefurl=http%3A%2F%2Fwww.goddessgarden.com%2Fblog%2Fwhy-we-care-about-coral-reefs%2F&docid=xRBi-OnfpJfroM&tbnid=1bQNeXjLEmyzaM%3A&vet=10ahUKEwih\\_zN0pnUAhUDTY8KHbHXAL4QMwg9KBQwFA..i&w=561&h=393&client=firefox-b&bih=947&biw=1920&q=human%20impact%20on%20coral%20bleaching&ved=0ahUKEwih\\_zN0pnUAhUDTY8KHbHXAL4QMwg9KBQwFA&iact=mrc&uact=8#h=393&imgdii=ycoTa\\_9XIRwF6M:&vet=10ahUKEwih\\_zN0pnUAhUDTY8KHbHXAL4QMwg9KBQwFA..i&w=561](https://www.google.co.in/imgres?imgurl=http%3A%2F%2Fwww.goddessgarden.com%2Fwp-content%2Fuploads%2F2017%2F03%2FCoral.jpg&imgrefurl=http%3A%2F%2Fwww.goddessgarden.com%2Fblog%2Fwhy-we-care-about-coral-reefs%2F&docid=xRBi-OnfpJfroM&tbnid=1bQNeXjLEmyzaM%3A&vet=10ahUKEwih_zN0pnUAhUDTY8KHbHXAL4QMwg9KBQwFA..i&w=561&h=393&client=firefox-b&bih=947&biw=1920&q=human%20impact%20on%20coral%20bleaching&ved=0ahUKEwih_zN0pnUAhUDTY8KHbHXAL4QMwg9KBQwFA&iact=mrc&uact=8#h=393&imgdii=ycoTa_9XIRwF6M:&vet=10ahUKEwih_zN0pnUAhUDTY8KHbHXAL4QMwg9KBQwFA..i&w=561)

# Human Impacts on Ecosystems

## RAISING RED FLAG OVER DISAPPEARING GREENS

> 300 acres of mangroves disappeared between Diva and Dombivli in the past year due to illegal sand-mining

> Debris-dumping on mangroves along Palm Beach Road

> Instances of mangroves destruction between Kharghar and Kamothe for land-grabbing and

sand-mining. Police and Panvel tehsildar have conducted raids at the sites

> Over 80 aqua ponds, created by destroying mangroves along Airoli-Rabale-Ghansoli coastal belt, for illegal crab-farming

> Mumbai & Thane lost 40% wetlands and mangroves between the early 1990s and 2005

**SAVE THE MANGROVES**



A satellite image of mangroves along Palm Beach Road shows how the green zone has been sliced

**Mangroves notified in Mumbai**

**4,000 hectares**

**Navi Mumbai**

**1,470 ha**

> Destruction of mangroves is illegal under Environment Protection Act and Forest Conservation Act. Can be fined up to ₹2,000 and/or imprisoned for a year

[http://www.indpaedia.com/ind/images/0/0c/The\\_status\\_of\\_mangroves\\_and\\_wetlands\\_in\\_Mumbai%2C\\_2010-15.jpg](http://www.indpaedia.com/ind/images/0/0c/The_status_of_mangroves_and_wetlands_in_Mumbai%2C_2010-15.jpg)

The Times of India, Nov 12, 2015

# Human Impacts on Ecosystems

Between 1990 and 2015, the world lost

129 million ha of forest



└ An area the size of South Africa ┘

[http://awsassets.panda.org/img/original/infographic\\_\\_deforestation\\_since\\_1990.png](http://awsassets.panda.org/img/original/infographic__deforestation_since_1990.png)



# Human Impacts on Ecosystems



[http://naturalsociety.com/wp-content/uploads/fish\\_plastic\\_pollution.png](http://naturalsociety.com/wp-content/uploads/fish_plastic_pollution.png)



Pelican coated in oil after BP Deepwater Horizon spill

<http://www.marinedefenders.com/oilpollutionfacts/images/pelican.jpg>



Acid rain destroys fish life in lakes & streams.

<https://image.slidesharecdn.com/presentation1-160425160529/95/air-pollution-effect-on-animals-plants-3-638.jpg?cb=1461600458>

# Biodiversity

Biodiversity refers to the variety of life-forms, commonly expressed as the number of species in an area, or the number of genetic types in an area.

- ❖ Biodiversity helps maintain the sustainability and ecological functioning of ecosystems
- ❖ It also serves as a source of adaptations to changing environmental conditions

## Biodiversity includes:

- ✓ **Genetic diversity:** variety in the genetic makeup among individuals within a species or a population
- ✓ **Species diversity:** variety among the species found in different habitats
- ✓ **Ecological diversity:** variety of different ecosystems found in an area or on the Earth

# Importance of Biodiversity

- ✓ Instrumental Value for Humans
- ✓ Intrinsic Value and Ecological Services



# Biodiversity Index

Species	Location-1	Location-2	Location-3
A ( $n_A$ )	200	550	950
B ( $n_B$ )	250	420	50
C ( $n_C$ )	250	20	0
D ( $n_D$ )	150	8	0
E ( $n_E$ )	150	2	0
Total (N)	1000	1000	1000

Simpson's	0.79	0.52	0.10
Shannon's	1.58	0.82	0.20

Simpson's Index of Diversity

$$D = 1 - \sum \left( \frac{n_i}{N} \right)^2$$

Shannon's Index

$$D = - \sum \left( \frac{n_i}{N} \right) \ln \left( \frac{n_i}{N} \right)$$

# Threat to Biodiversity

- Habitat destruction
- Habitat fragmentation
- Pollution
- Over exploitation
- Introduction of exotic or invasive species
- Diseases
- Poaching of wild life

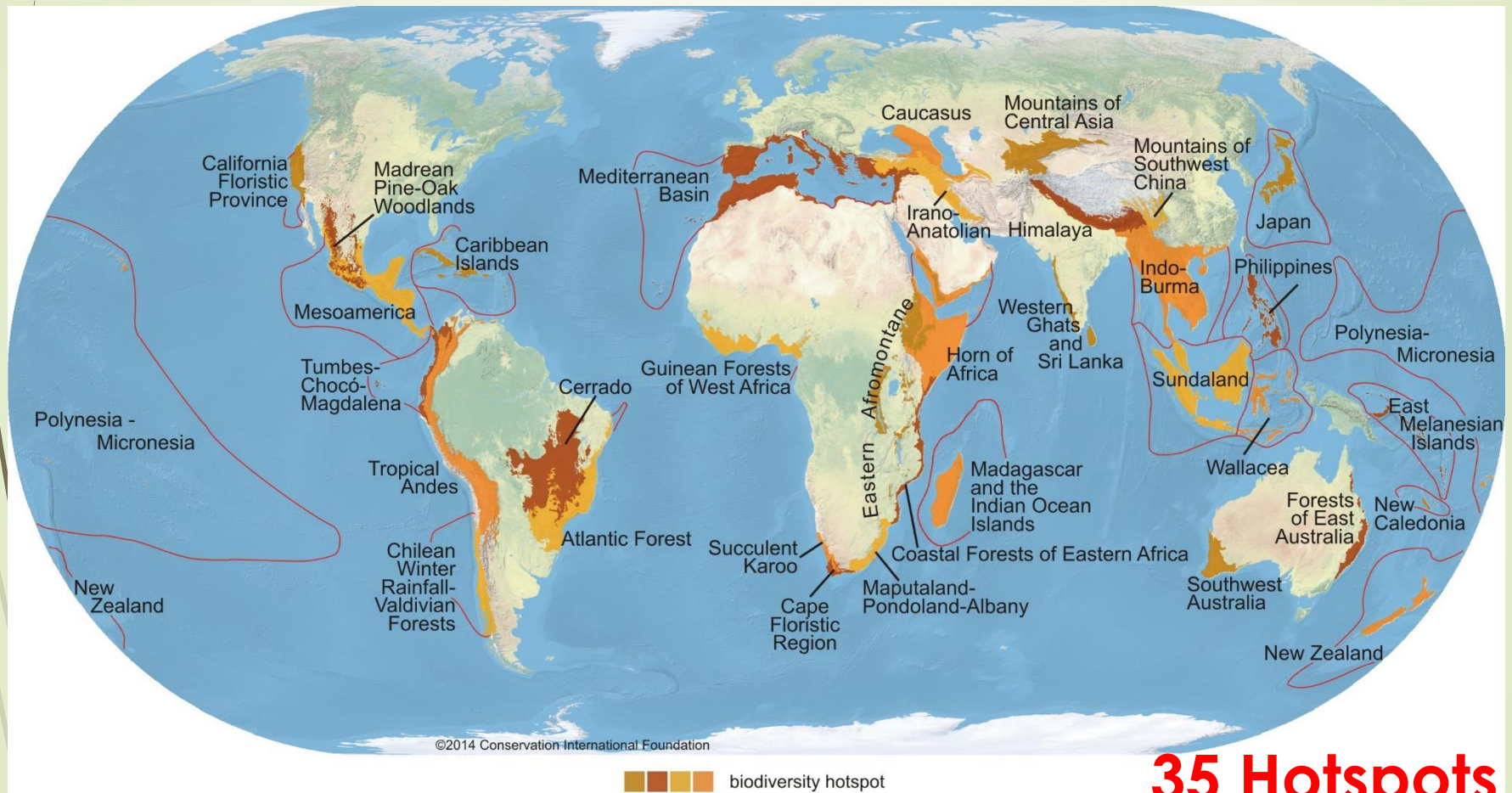
# Biodiversity Hotspots

Any region with very high biodiversity endangered with destruction may be called as biodiversity hotspot.

To qualify as a hotspot a region must meet **two strict criteria**:

1. It must contain at least 1,500 species of vascular plants (> 0.5% of the world's total) as endemics,
2. It has to have lost at least 70% of its original habitat.

# Biodiversity Hotspots



## 35 Hotspots

Conservation International (conservation.org) defines 35 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

[https://www.e-education.psu.edu/geog30/sites/www.e-education.psu.edu/geog30/files/Biodiversity\\_Hotspots\\_Map.jpg](https://www.e-education.psu.edu/geog30/sites/www.e-education.psu.edu/geog30/files/Biodiversity_Hotspots_Map.jpg)



# Conservation of Biodiversity



UN **BIODIVERSITY**  
CONFERENCE

**COP13**-COPMOP8-COPMOP2  
CANCUN, MEXICO 2016

MAINSTREAMING BIODIVERSITY FOR WELL-BEING



<http://69.90.183.27/images/slideshow/slide-cop13.png>

Effective: 29 December 1993  
Parties: 193

**National Biodiversity Strategies and Action Plans**


# Conservation of Biodiversity

## National Biodiversity Action Plan (NBAP), MoEF, GoI

## Biological Diversity Act in 2002

envfor.nic.in/division/biodiversity

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Biodiversity

The Biological Diversity Act 2002 was born out of India's attempt to realise the objectives enshrined in the United Nations Convention on Biological Diversity (CBD) 1992 which recognizes the sovereign rights of states to use their own Biological Resources. The Act aims at the conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner and through a just process For purposes of implementing the objects of the Act it establishes the National Biodiversity Authority in Chennai.

Act

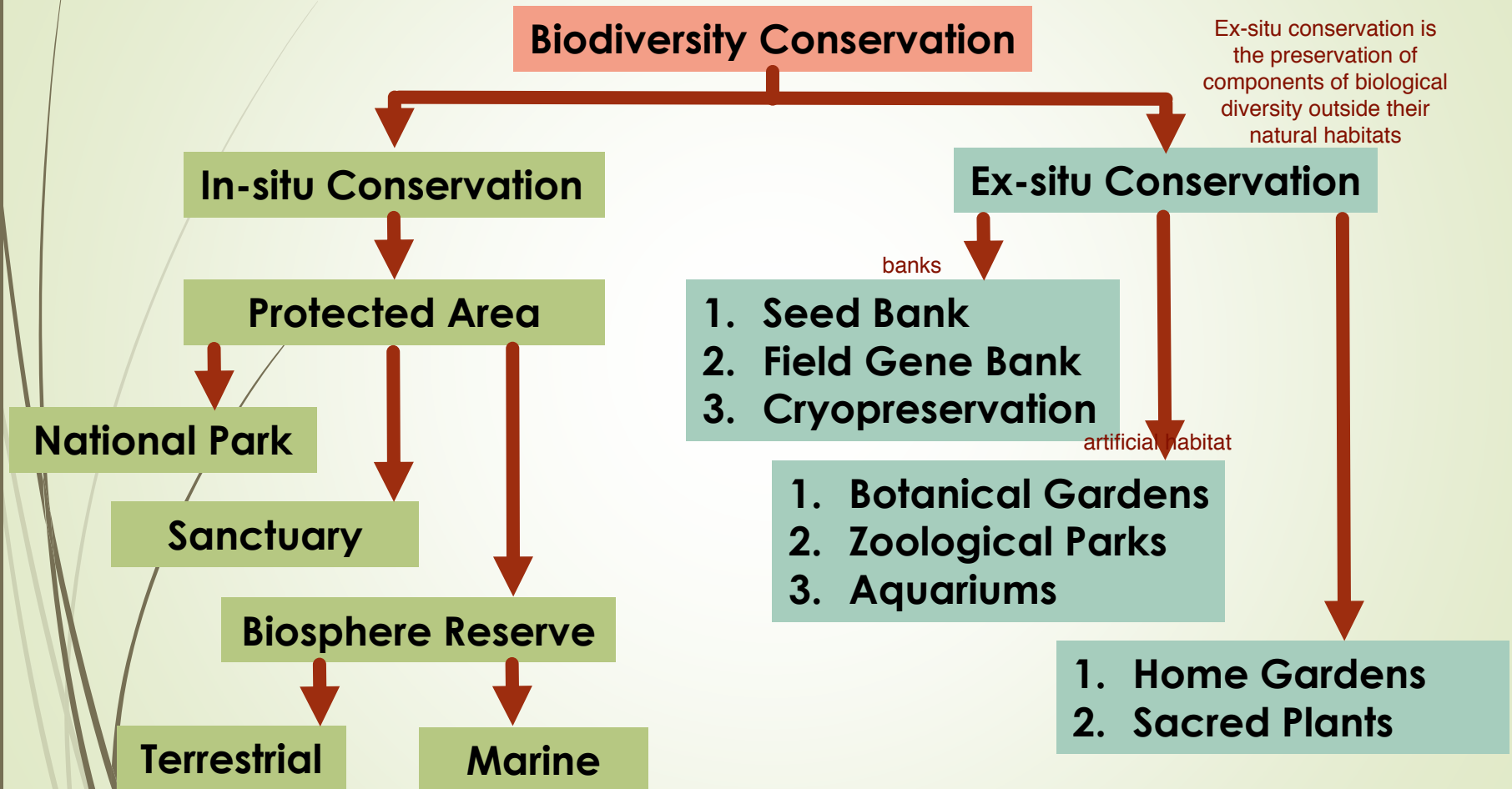
- Biological Diversity Act, 2002 .
- No. 18 of 2003, [5/2/2003] - The Biological Diversity Act, 2002 .
- S.O.753(E), [01/07/2004]- Coming in to force of sections of the Biodiversity Act, 2002 .
- S.O.497 (E), [15/04/2004]- Appointment of non-official members on NBA from 1st October, 2003 .
- S.O.1147 (E)- Establishment of National Biodiversity Authority from 1st October, 2003 .
- S.O.1146 (E)- Bringing into force Sections 1 and 2; Sections 8 to 17; Sections 48,54,59,62,63,64 and 65 w.e.f. 1st October, 2003 .
- S.O.2708 (E)- Central Government authorises the officers to file complaints with regards to offences punishable under the Biological Diversity Act, 2002, Notification .
- S.O.120 (E)- Central Government authorises the officers to file complaints with regards to offences punishable under the Biological Diversity Act, 2002,Amendment Notification .
- Designation of repositories under the Biological Diversity Act, 2002 .

Rule

- G.S.R.261 (E), [15/04/2004] - Biological Diversity Rules, 2004 .



# Conservation of Biodiversity



# Next Lecture:

## Water Resources