ES 200 ENVIRONMENTAL STUDIES

Module-C

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

Lecture-1

Amritanshu Shriwastav
CESE, IIT Bombay
amritan@iitb.ac.in

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

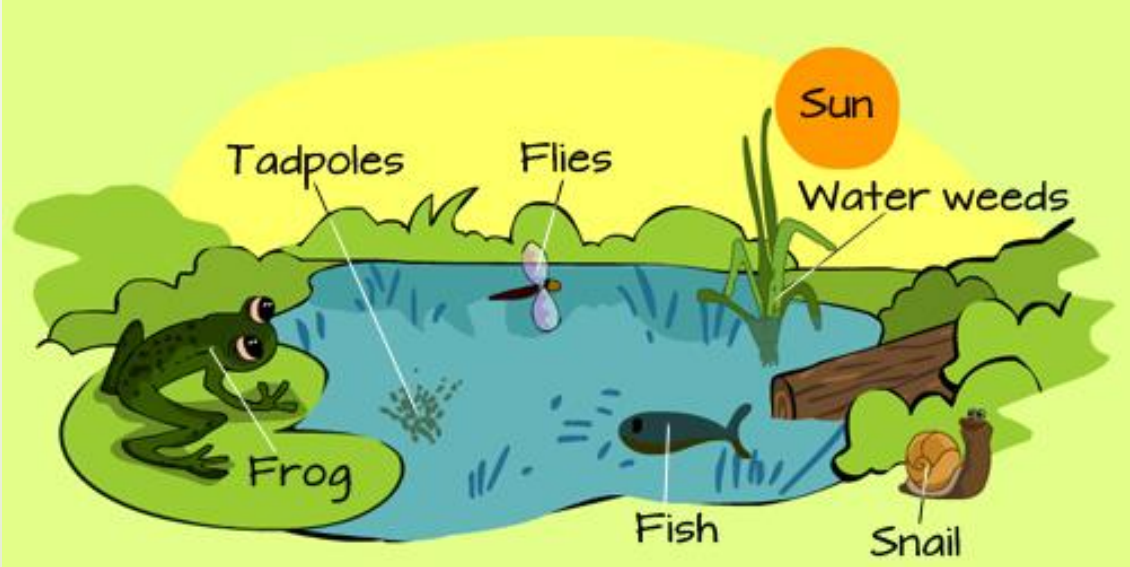
Ecosystem & Biodiversity

- 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?

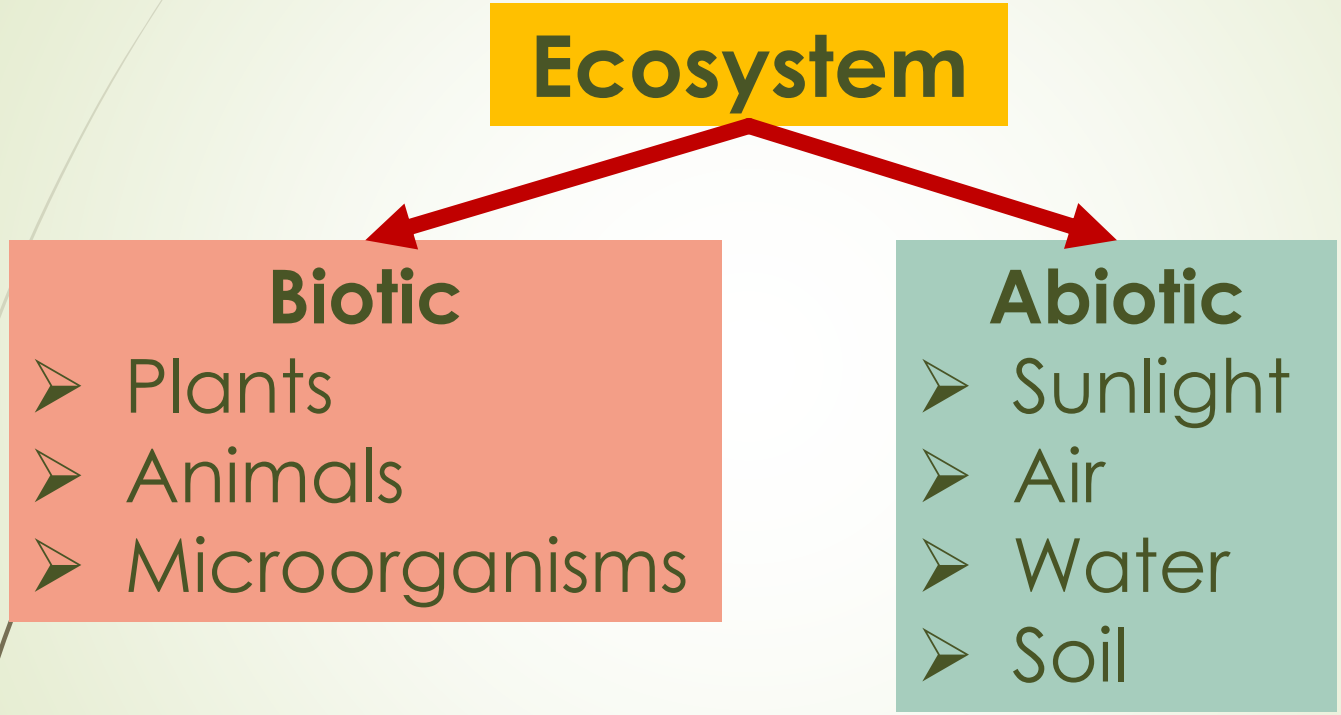
Eco + System

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



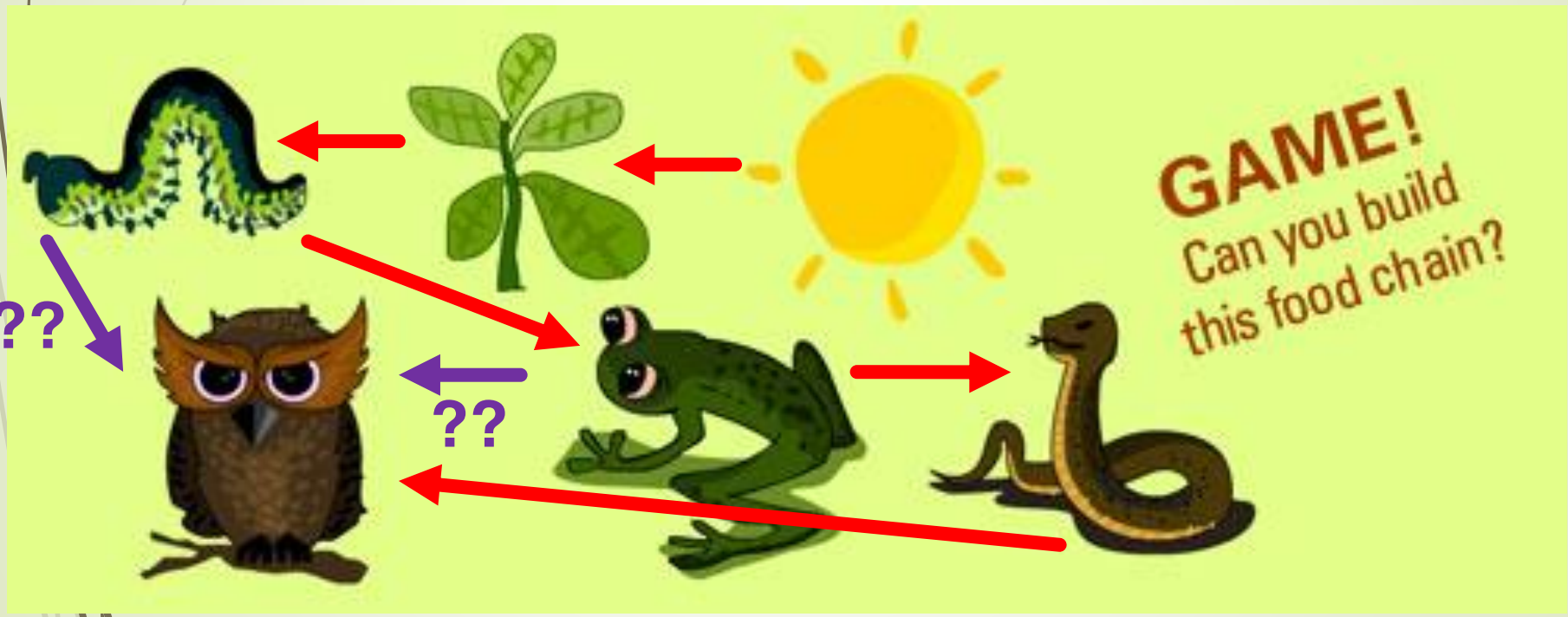
http://eschooltoday.com/ecosystems/what-is-an-ecosystem.html

Components of an Ecosystem



Concepts in an Ecosystem

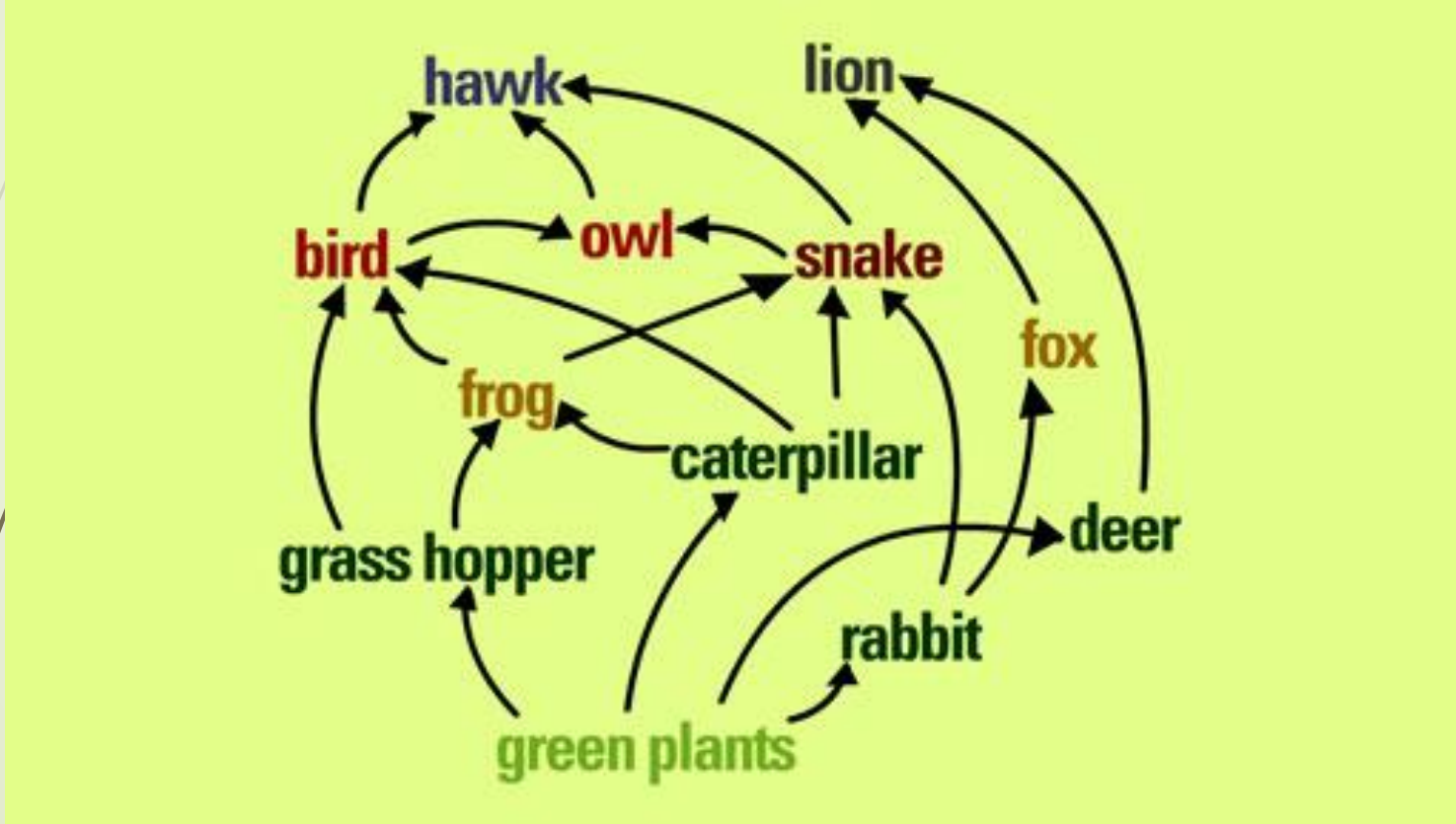
Food Chain



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

Concepts in an Ecosystem

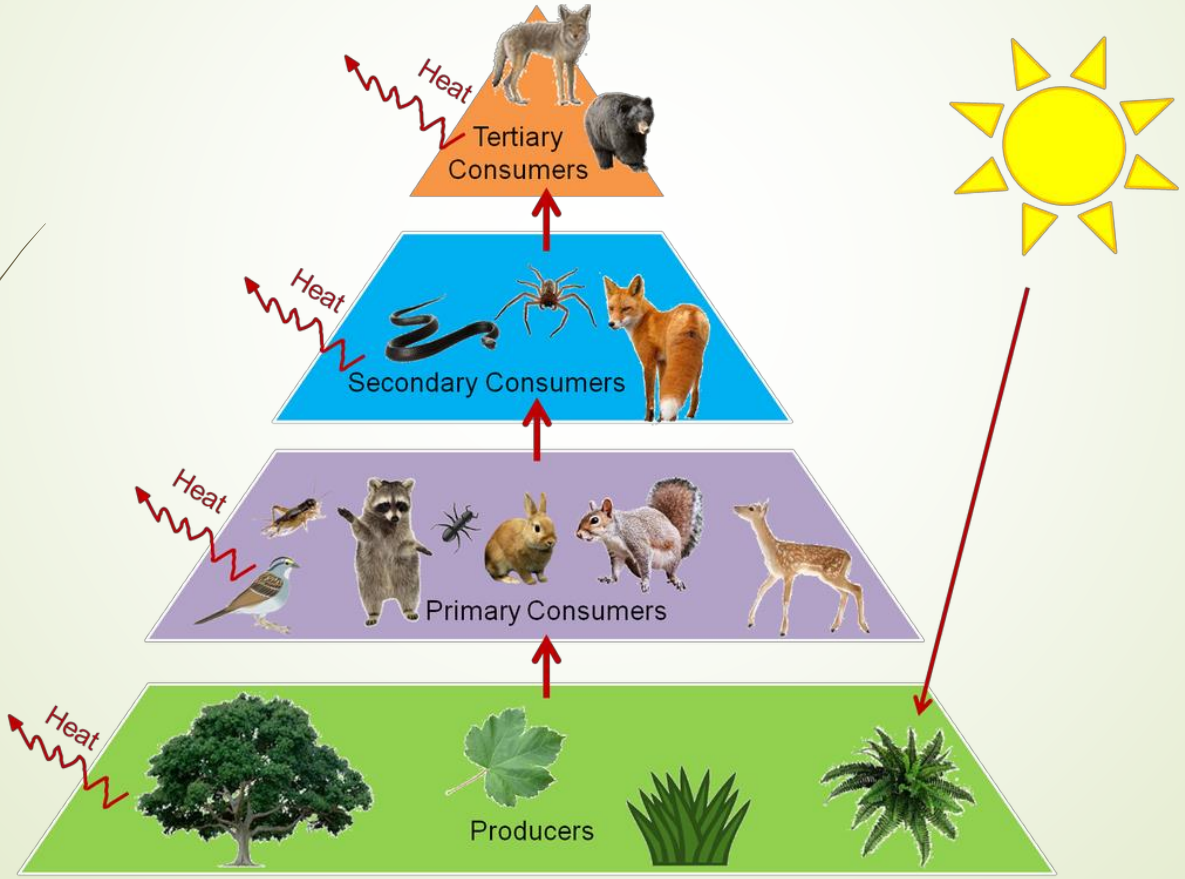
Food Web



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

Concepts in an Ecosystem

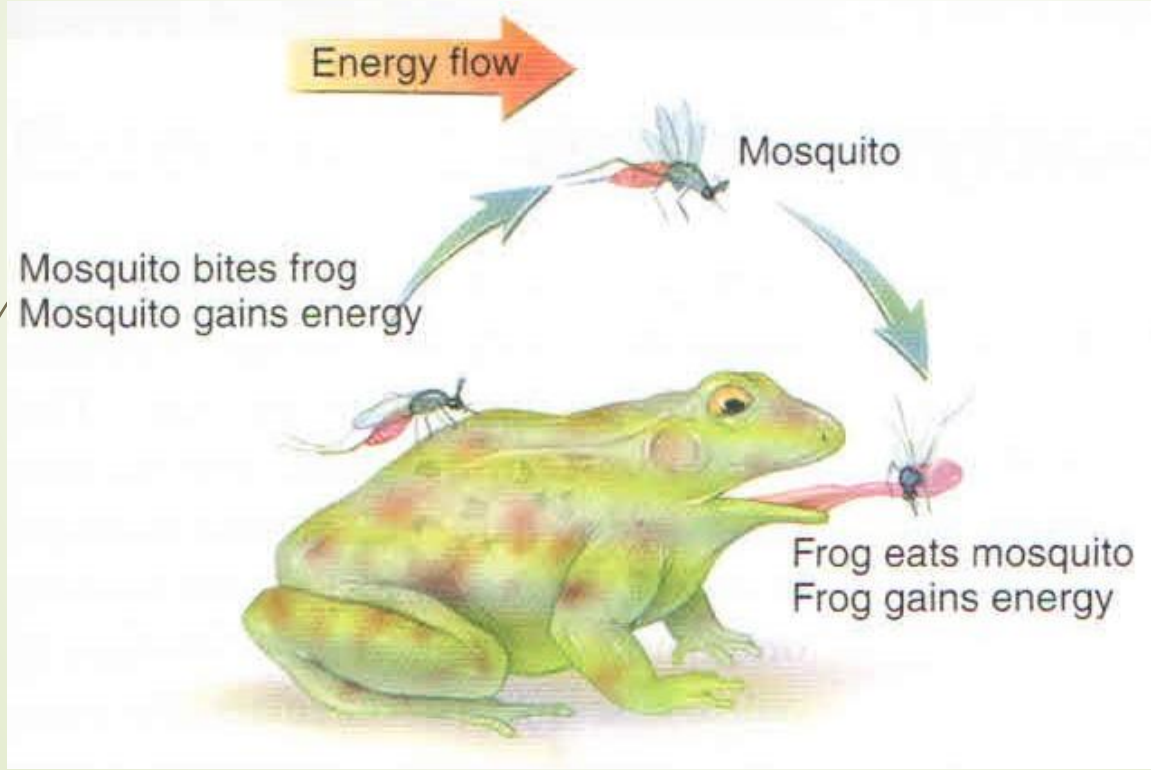
Trophic Levels of Food Chain



http://apbioecologyproject.weebly.com/uploads/4/9/7/2/49723057/1416103_orig.png

Concepts in an Ecosystem

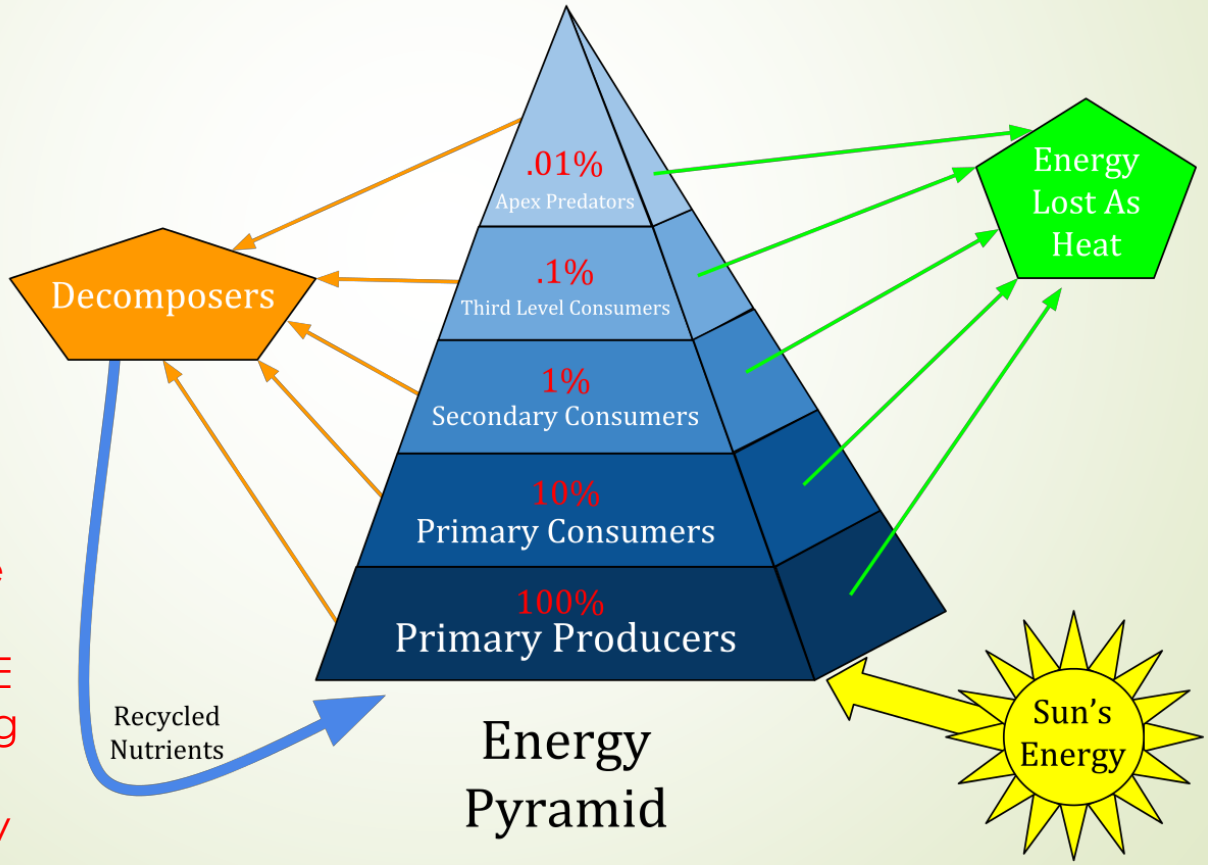
Is it Possible??



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

Concepts in an Ecosystem

Primary Productivity

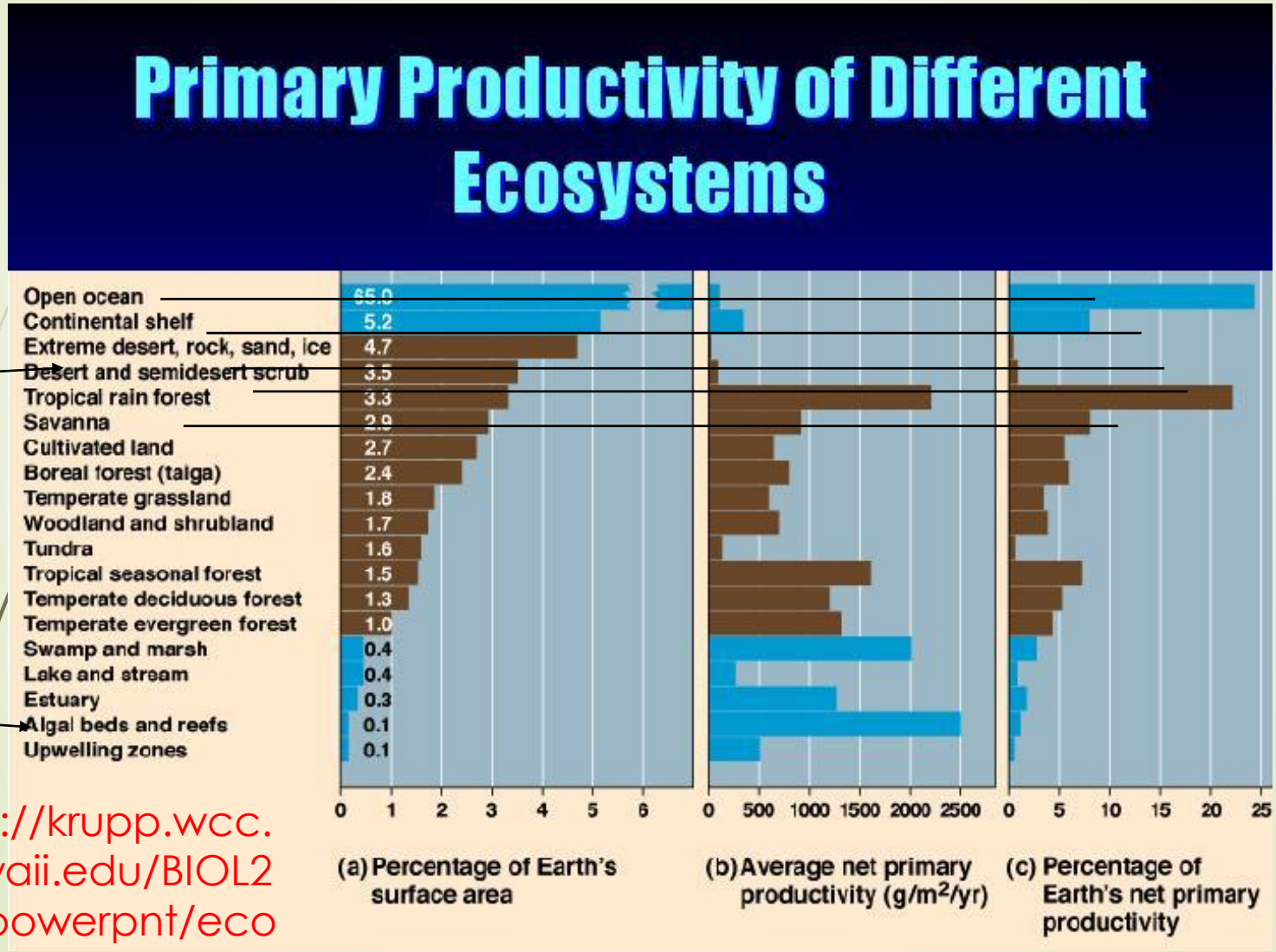
- The rate at which an ecosystem's producers convert solar energy into chemical energy as biomass is the ecosystem's **Gross Primary Productivity (GPP)**.
- To stay alive, grow, and reproduce, an ecosystem's producers must use some of the biomass they produce for their own **respiration (R)**.

Net Primary Productivity (NPP) = GPP – 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



least npp per area

maximum avg per area

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.

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

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

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

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

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

Examples of Ecosystem

Tropical Rain Forest Ecosystem

http://2.bp.blogspot.com/_Rz2Y_s3rZko/TT48FkAO-GI/AAAAAAAAAAK4/4wlw9GqUWpM/s1600/Rainforest+Scene+%2526+Animals.jpg

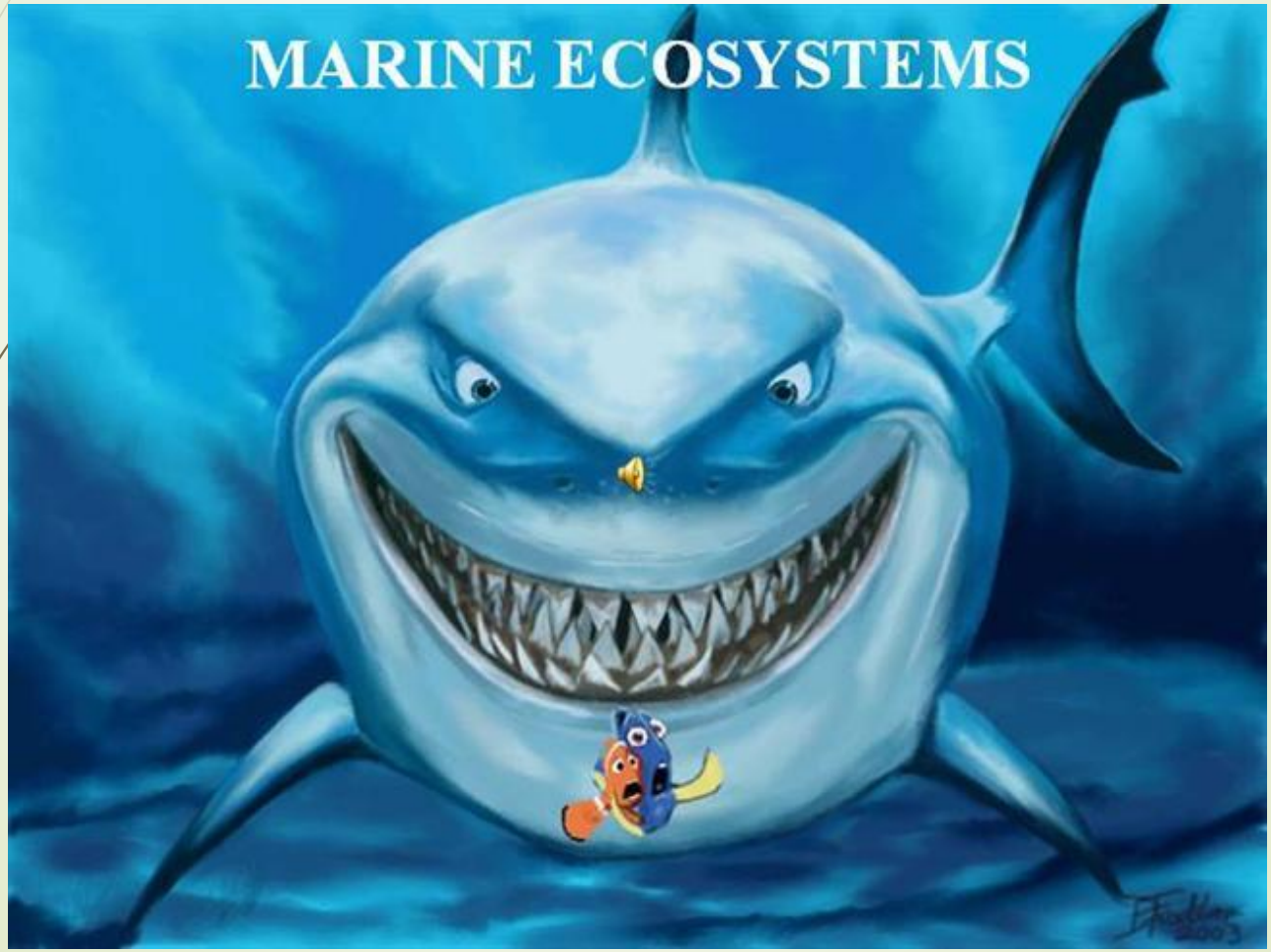
Examples of Ecosystem

Fresh Water Ecosystem

https://cdn.thinglink.me/api/image/622143932586786818/1240/10/scaletowidth

Examples of Ecosystem

Marine Ecosystem



http://c.asstatic.com/images/121648_634472039995696628-1.jpg

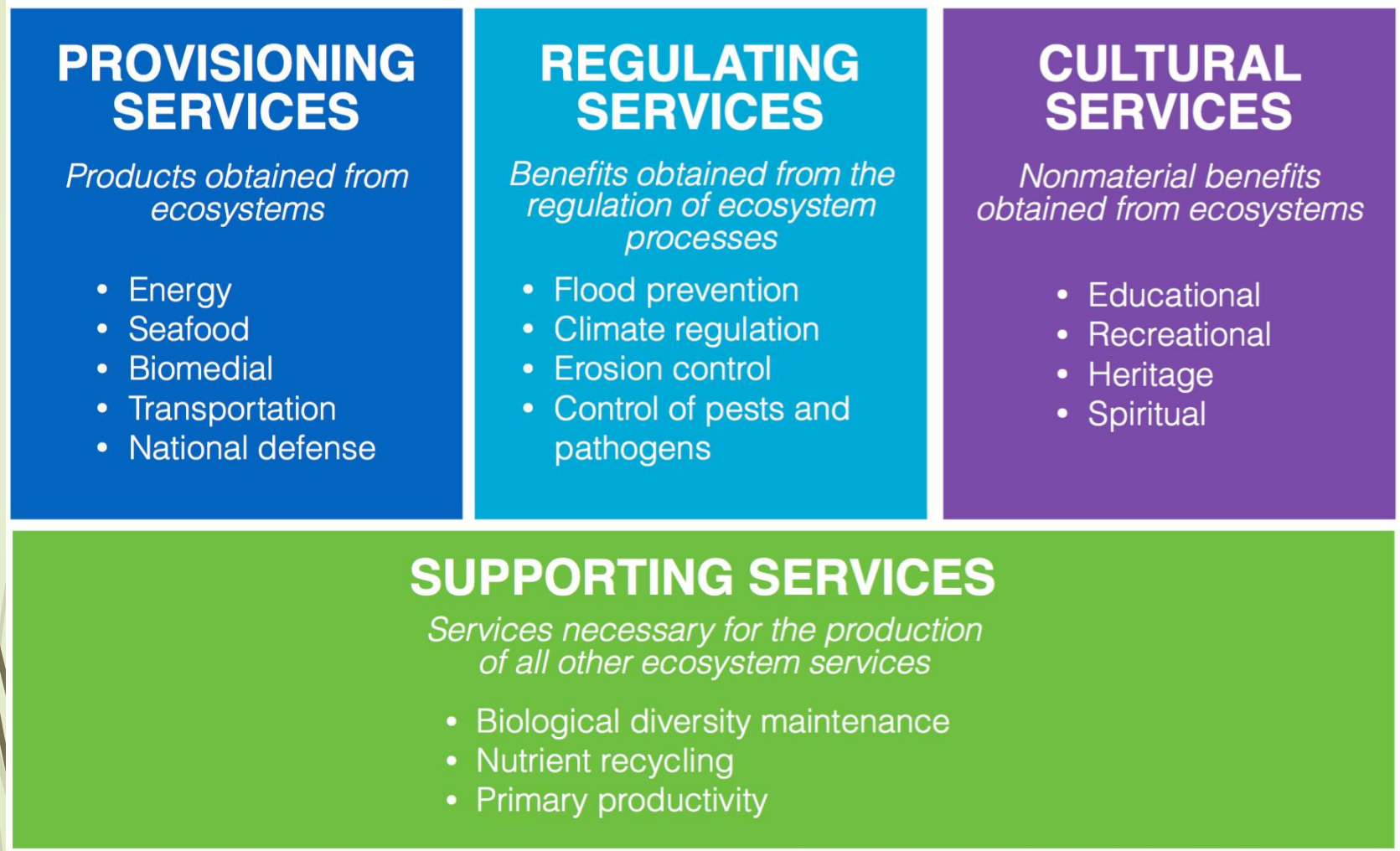
Examples of Ecosystem

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**

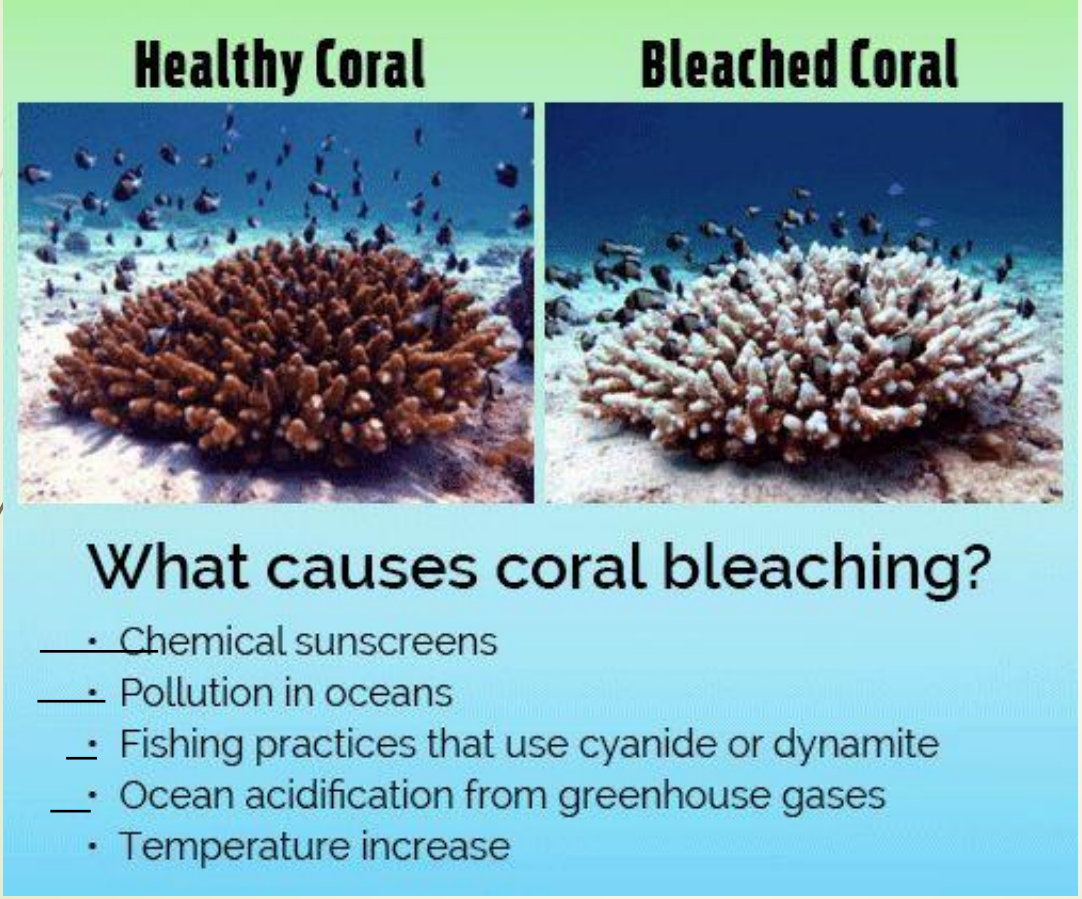
Ecosystem Services



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

http://roa.midatlanticocean.org/wp-content/uploads/2015/12/ecosystem_services.png

Human Impacts on Ecosystems



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=10ahUKEwiuh_zN0pnUAhUDTY8KHbHXAL4QMwg9KBQwFA..i&w=561&h=393&client=firefox-b&bih=947&biw=1920&q=human%20impact%20on%20coral%20bleaching&ved=0ahUKEwiuh_zN0pnUAhUDTY8KHbHXAL4QMwg9KBQwFA&iact=mrc&uact=8#h=393&imgdii=ycoTa_9XIRwF6M:&vet=10ahUKEwiuh_zN0pnUAhUDTY8KHbHXAL4QMwg9KBQwFA..i&w=561

Human Impacts on Ecosystems

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

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://www.marinedefenders.com/oilpollutionfacts/images/pelican.jpg

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

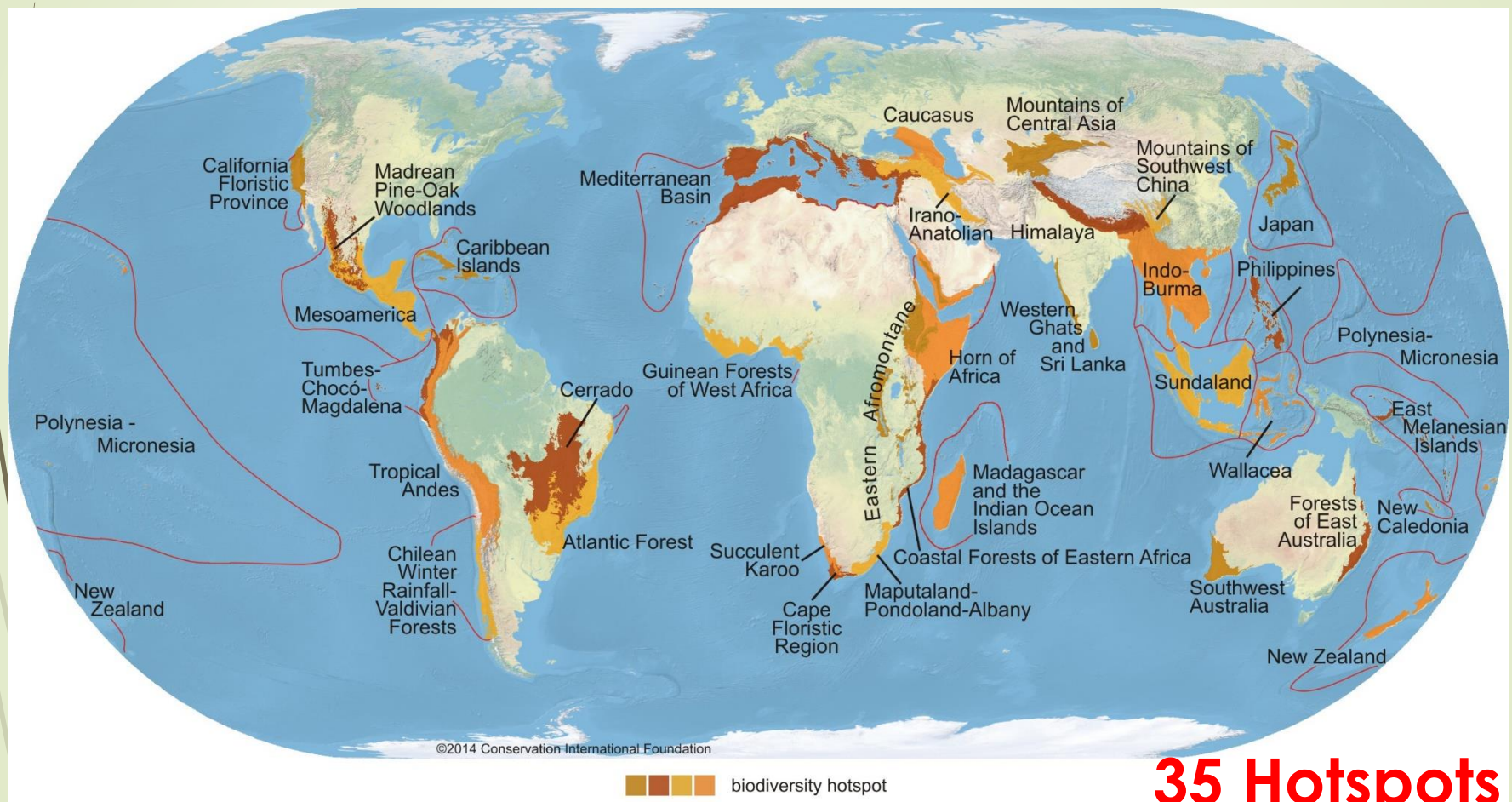
Biodiversity Hotspots

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

Conservation of Biodiversity

UN BIODIVERSITY CONFERENCE
COP13 -COPMOP8-COPMOP2
CANCUN, MEXICO 2016
MAINSTREAMING BIODIVERSITY FOR WELL-BEING

http://69.90.183.227/images/slideshow/slide-cop13.png

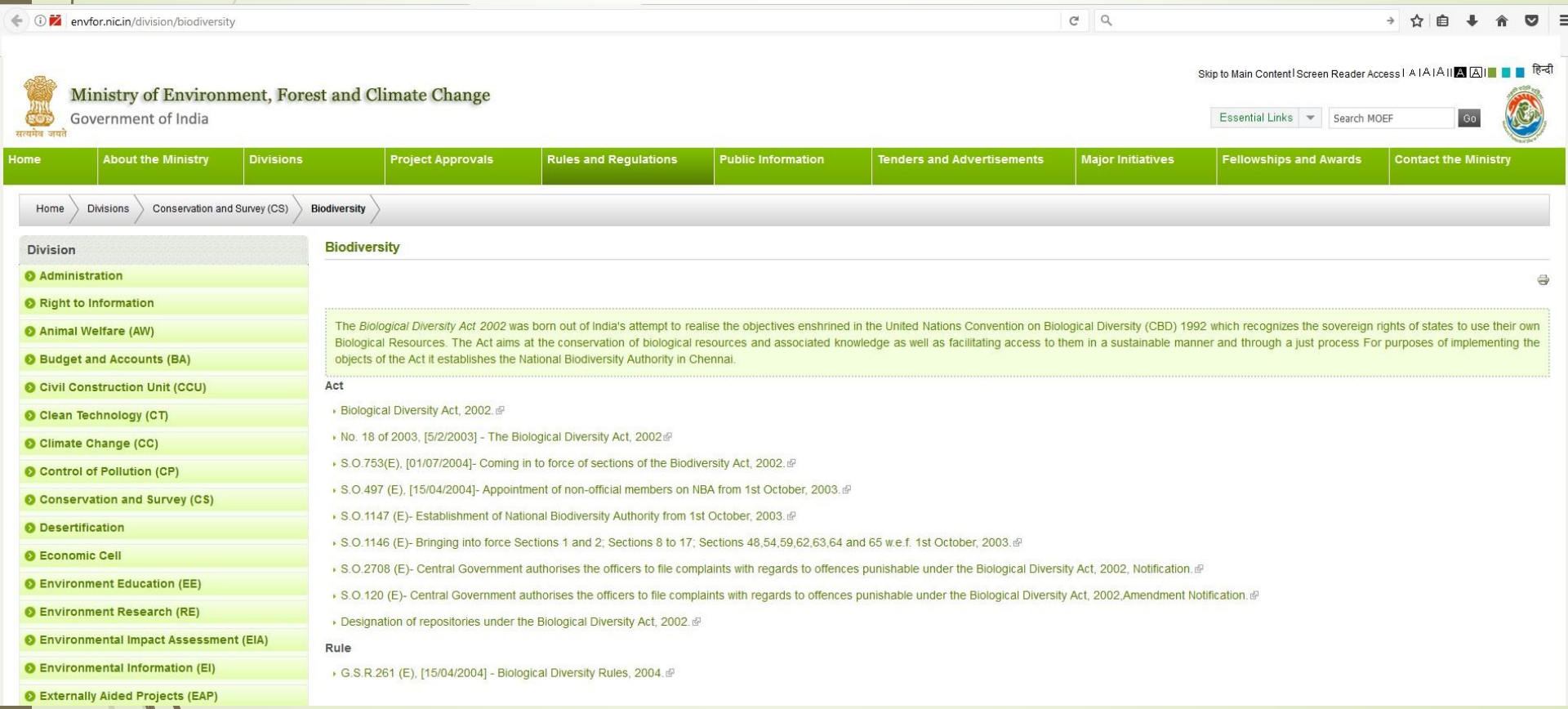
Effective: 29 December 1993
Parties: 193

National Biodiversity Strategies and Action Plans

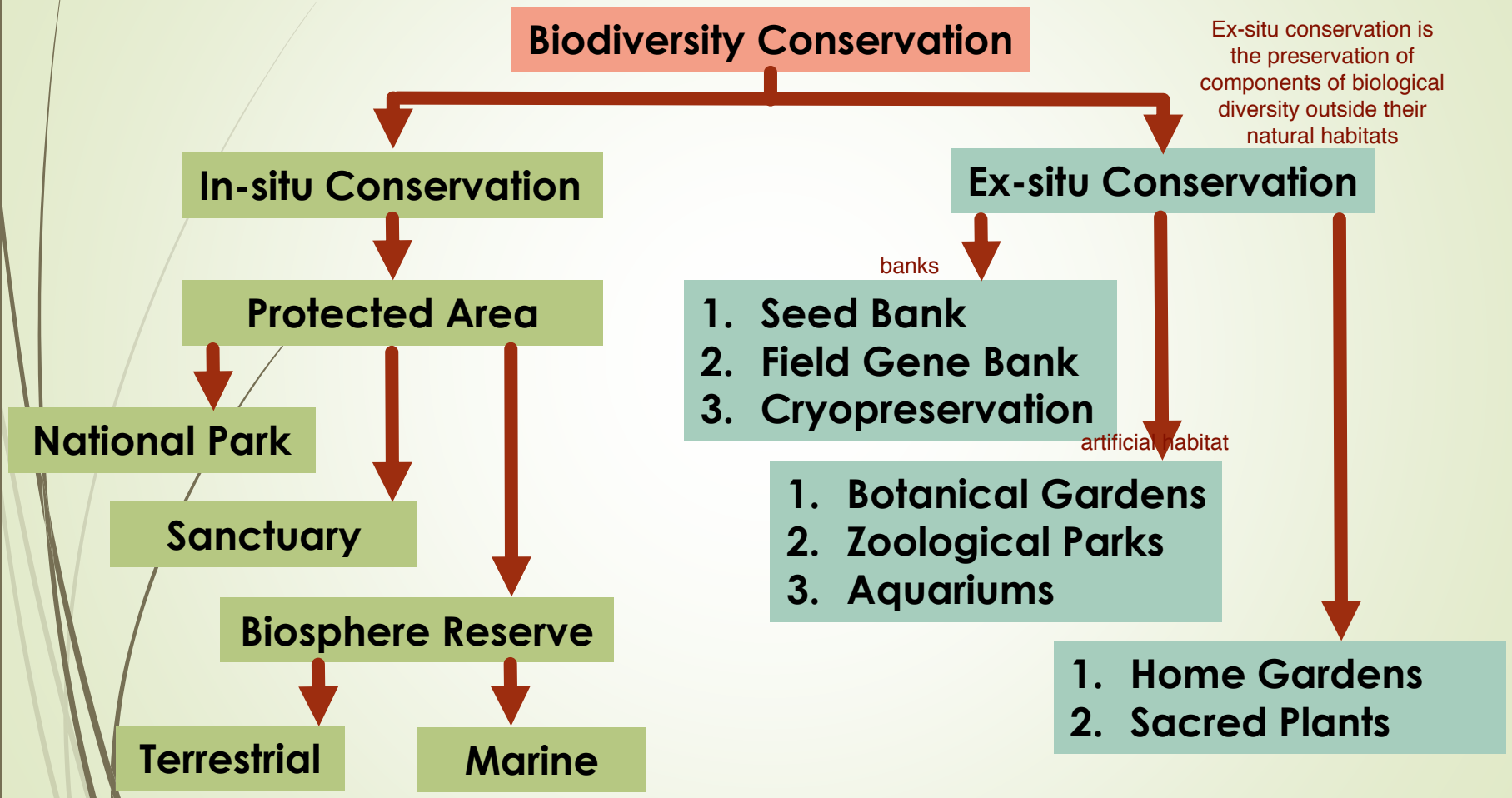
Conservation of Biodiversity

National Biodiversity Action Plan (NBAP), MoEF, GoI

Biological Diversity Act in 2002



Conservation of Biodiversity



Next Lecture:

Water Resources