Sub-theme: I

Eco System for Sustainable Living

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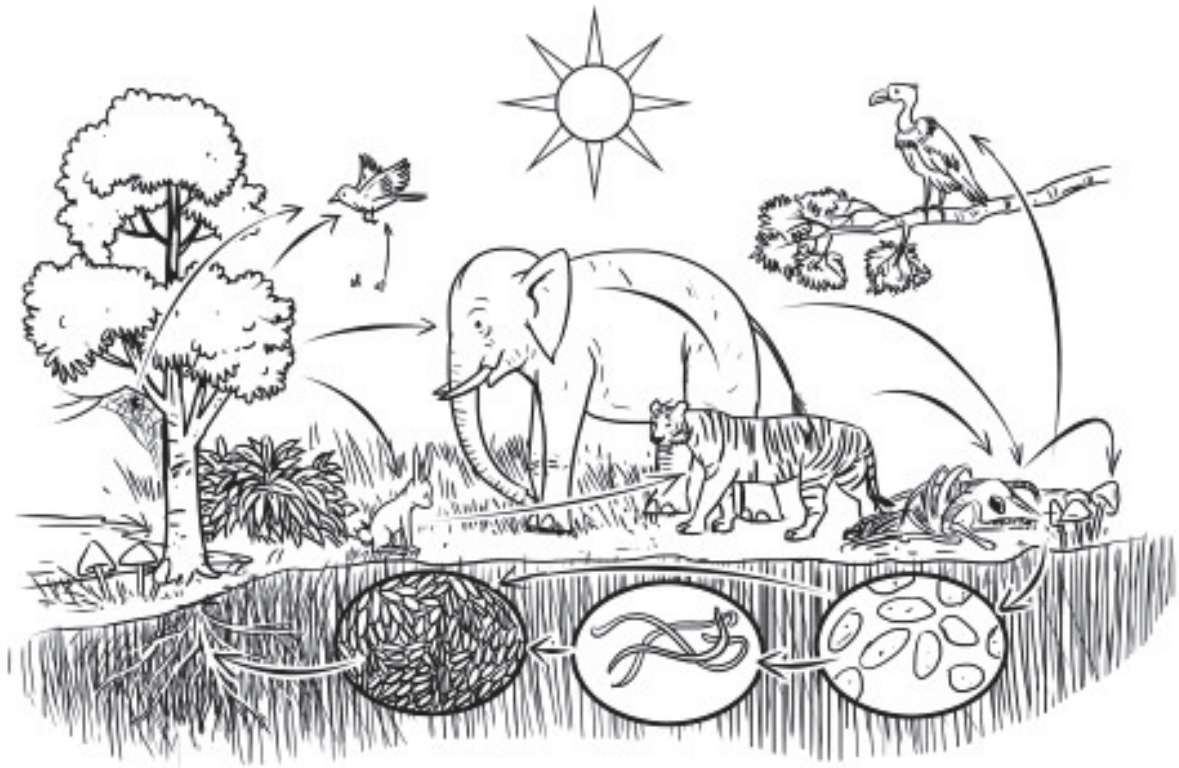
***"We cannot solve our problems with the same thinking we used when we created them."*– Albert Einstein**



'Eco' means natural habitat. The system for the existence of natural habitat of biological community (of organisms) interacting with their physical environments is the ecosystem. It includes all the living things (plants, animals, and organisms) in a given area that interact with each other, as well as with the non-living entities (weather, earth, sun, soil, climate, atmosphere, land) around them. The living and non-living (i.e. physical) components are linked together through nutrient cycles and energy flows. All the plants and animals (both macro and micro) on the Earth rely on the respective ecosystems for food and habitation. Therefore, the ecosystems must maintain a delicate balance in order to stay vital. Human beings like other organism, also rely on ecosystems to have food and natural resources. Depending on various characteristics, the eco-system has been classified primarily as Terrestrial and Aquatic; but there

are many sub-groups as shown in Box – I & II. It is to be understood, when natural resources are harvested out of an ecosystem, it can disrupt the delicate balance if not done in a rational and responsible way. Nevertheless, following diagram (Fig.1.1) shows the different components of ecosystem.

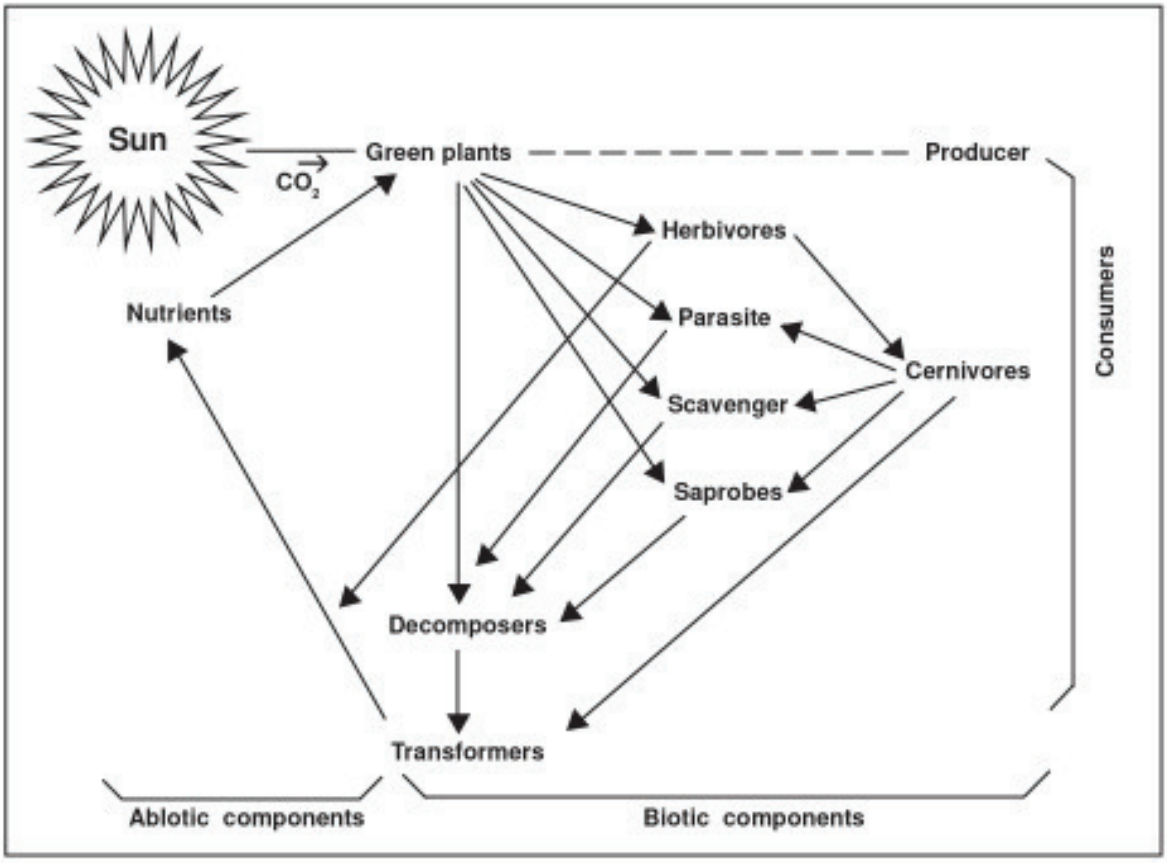


Fig.1.1. *Different component of ecosystem*

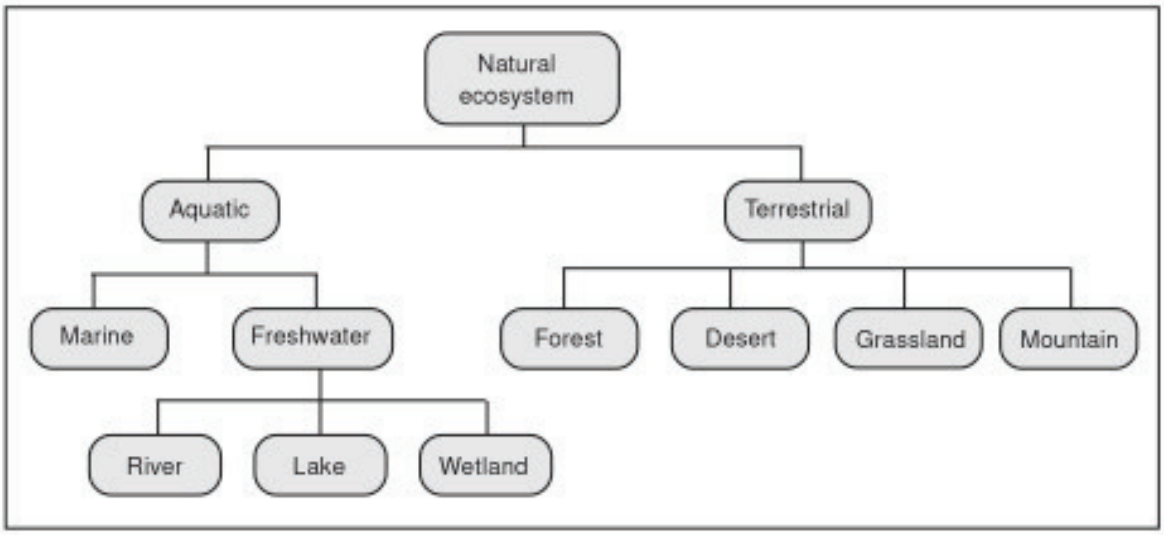


Fig.1.2 *Types of Ecosystem*

India has some of the world's most enriched ecological zones or 'eco-zones', which has been depicted through figure-1.2; and because of the country's diverse physical features and climatic conditions a variety of ecosystems have resulted. By and large these ecosystems harbour and sustain high biodiversity and contribute to overall well-being of man and animal. But, climate change, pollution and other environmental factors affect ecosystem processes (functions and services) affecting sustainable living and livelihood. Critically, sustainability includes health of the land, air and sea.

How Ecosystem Helps Us

An ecosystem provides habitat to wild plants and animals and supports different food chains and food webs. It regulates essential ecological processes and supports lives. It also helps in recycling of nutrients through biogeochemical cycle between biotic and abiotic components of the Earth. All these activities are termed as **Ecosystem Functions**. Fundamentally, the functions of ecosystem (Fig. 1.3) are exchange of energy and nutrients in the food chain, which sustain plant and animal life, including human being, on the planet. The decomposition of organic matter and the production of biomass are also the result of ecosystem functions. These functions, within the ecosystem, help in maintaining Earth's natural balance. So, it is a vital process related to our sustenance.

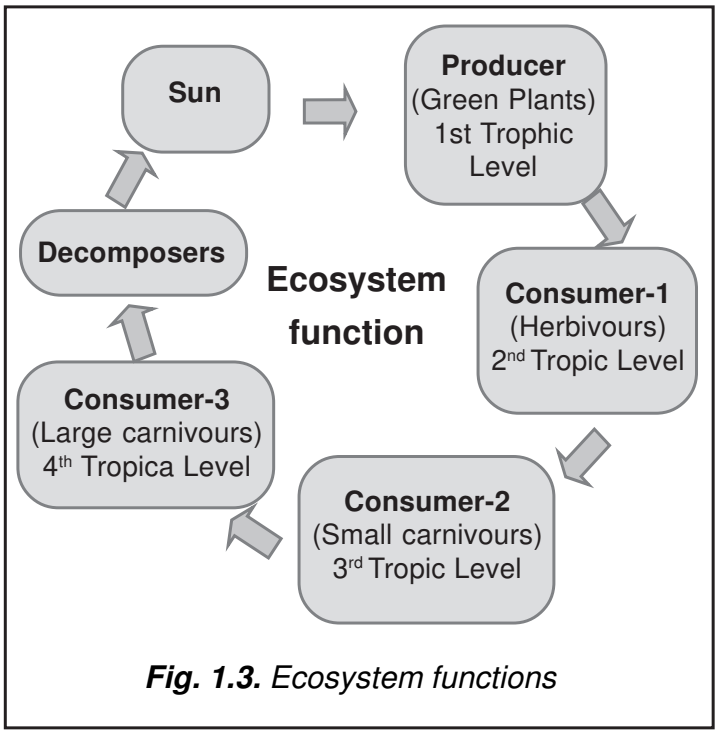


Fig. 1.3. *Ecosystem functions*

Nevertheless, as a result such functions the living organisms on the earth, including human beings, get benefit directly and indirectly from ecosystems in many a ways and these benefits are known as **E*cosystem Services*** *(Fig.1.4)*. The benefits obtained from ecosystems can be categorized as *Provisioning Services*(also known as goods) such as food and water; *Regu-*

lating Services such as flood, pest, and disease; *Cultural Services* such as spiritual and recreational benefits; and *Supporting Services* such as nutrient cycling, soil formation, carbon sequestration, primary production and so many. These services of the ecosystems primarily are the result of interaction among soil, animals, plants, water and air. The goods and services they provide are vital to sustaining not only well-being of society, but also vital to future economic and social development. It is to be noted by the beneficiaries of any ecosystem that a healthy ecosystem cleans our water, purifies our air, maintains good health of our soil, regulates climate, recycles nutrients and provides us food. They also provide raw materials and resources for shelter, industry and many other purposes to cater our various needs. They are the foundation of all civilisation and economic growth.

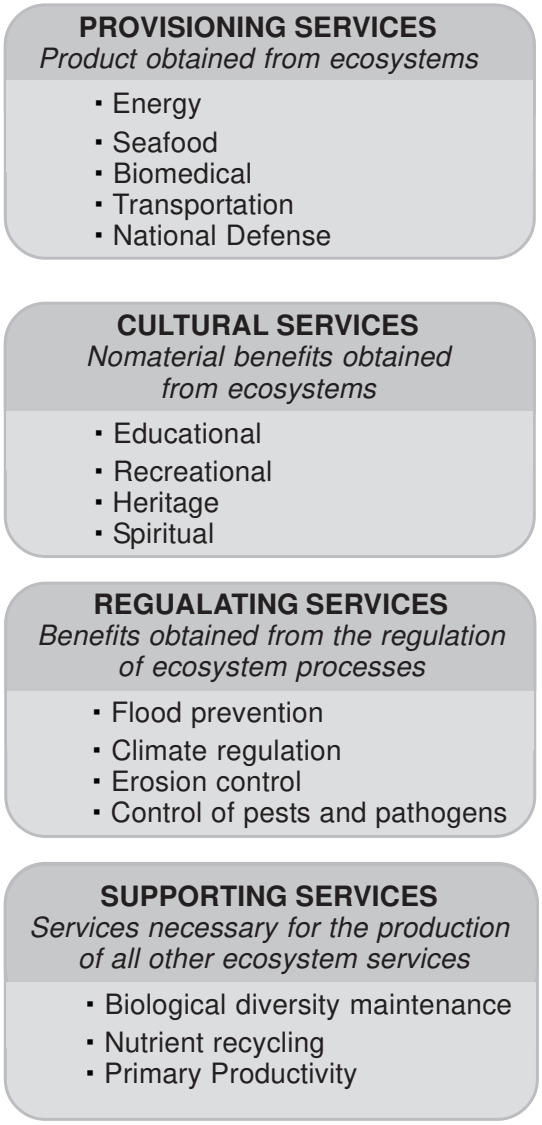
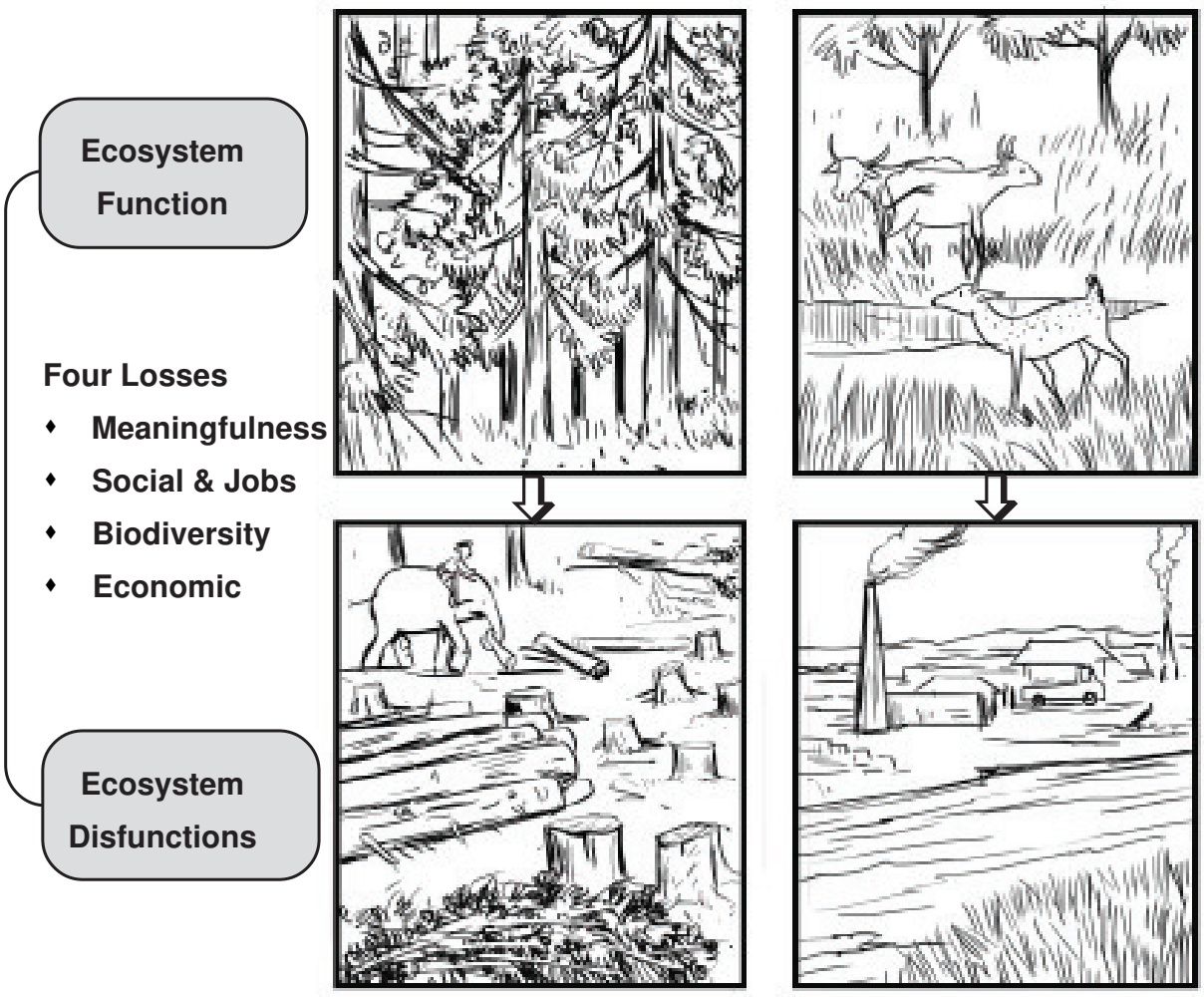


Fig.1.4. *Ecosystem Services*

Effects of Ecosystem Degradation

Human society is using the ecosystem resources for living and livelihood from time immemorial. Exploitation of natural *resources* is an essential condition of *human* existence throughout the history of mankind. H*umans* have exploited natural *resources* to produce the materials they needed to sustain growing *human* populations. But the way they use resources often provokes irreversible ecological change. According to the Millennium Ecosystem Assessment (MEA) sponsored by the United Nations, 60% of the ecosystems on Earth are being used up faster than they can replenish themselves. Virtually,

the degradation of ecosystems is an environmental problem that diminishes the capacity of species to survive. This degradation occurs in different ways and is manifested in a reduction in the richness of the ecosystems as well as their biological diversities, and also in the goods and services they can offer, thereby affecting both indigenous and/or migratory species. The degradation of ecosystems due to overexploitation of their resources, though serving a short-term economic goal, has had direct negative effects on social welfare. One of the main causes that contribute to the degradation of ecosystems is the deforestation due to the advancement of the agriculture and indiscriminate exploitation of forest resources. More lands are deforested for commercial agriculture and livestock rearing, and due to overexploitation of forest for wood, energy and urbanization. To be very specific, ecosystem degradation creates four major losses-



Degradation of Ecosystemaffecting four major losses

job loss, economic loss, biodiversity loss, and meaningfulness loss. These losses increase over the time if functional ecosystems degrade and cease to provide ecosystem services. If an ecosystem is not degraded, it represents a source of wealth for society, hence the importance of keeping it in good condition.

In fact, biodiversity boosts ecosystem productivity where each species, no matter how small it is, have important role to play. For example, a large number of plant species means a greater variety of crops. Greater species diversity ensures natural sustainability for all life forms including human beings.

Ecosystem and Sustainable Living

Sustainable living is a lifestyle that attempts to reduce an individual's or society's use of the Earth's natural resources and personal resources. Its users or beneficiaries often attempt to reduce their ecological footprint (including carbon footprint) by altering their methods of transportation, energy consumption, and/or diet. Its proponents aim to conduct their lives in ways that are consistent with sustainability, naturally balanced, and respectful symbiotic relationship with the Earth's natural ecology. The practice and general philosophy of ecological living closely follows the overall principles of sustainable development.

Moreover, sustainable economic growth promotes jobs and improves economies. In fact, a sustainable society is one that can continue indefinitely. Its level of consumption should reflect environmental and resource balance. It should assure its citizens equality, freedom and a healthy standard of living. So developing measurement standards that clearly define personal, social and environmental health is the need of the day and the responsibility lies in the hands of our future generation. They should think and act for the health of the ecosystem they are attached to.

Framework

With the aim of sustainable living, it is necessary to develop an understanding of structure and functioning of the ecosystems from which we draw resources for our survival. These ecosystems, therefore, should be subjected to rapid and long term empirical studies to assess the services they provide. It is only then present and the future generations would be able to manage the ecosystems for posterity better and will be able to address the harmful threats the ecosystems are undergoing in general. Keeping these in view, the framework has been depicted below through figure-1.5.

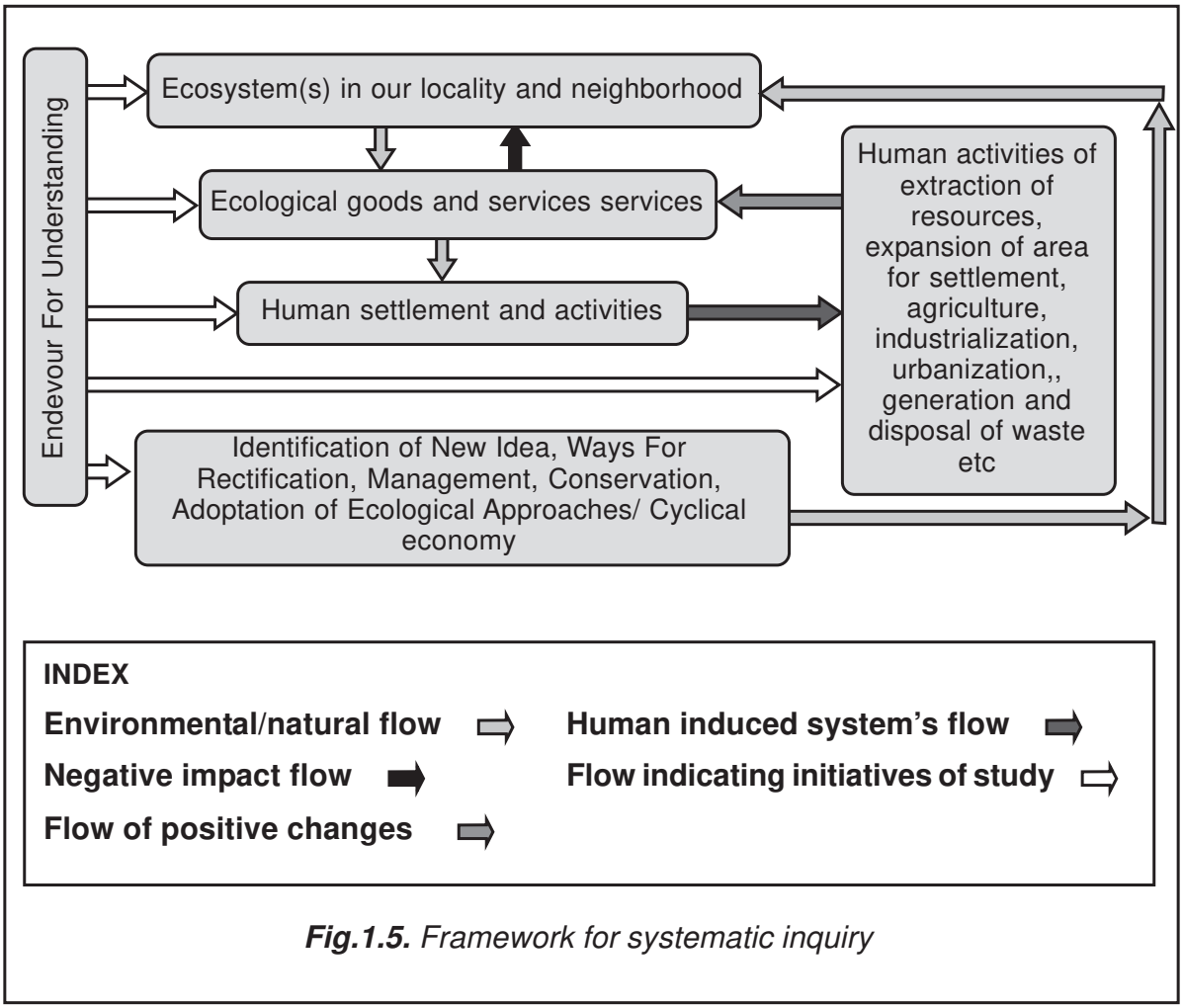


Fig.1.5. *Framework for systematic inquiry*

BOX-1.1

Types of Ecosystem

There are essentially two kinds of ecosystems, which may be categorized into the following sub-categories-

(I) Terrestrial ecosystems

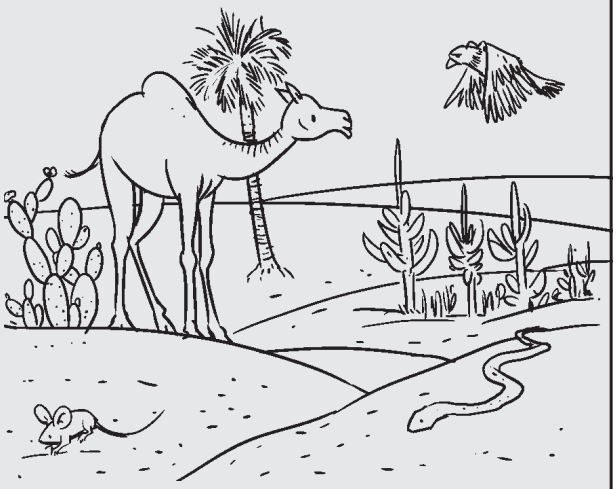
Terrestrial ecosystems can be found anywhere apart from heavily saturated places. They are broadly classed into:

(a) *Forest Ecosystems*

Under this ecosystem an abundance of flora and fauna, is seen in relatively small space. Therefore, density of living organisms is quite high. A small change in this ecosystem could affect the whole balance, bringing down the whole ecosystem services. They are further divided into:

- **Tropical evergreen forest:** The forests are characterised by dense vegetation which comprises tall trees at different heights. Each level is shelter to different types of animals.
- **Tropical deciduous forest:** Shrubs and dense bushes rule along with a broad selection of trees. This type of forest is found in quite a few parts of the world where a large variety of fauna and flora live.
- **Temperate evergreen forest:** Those have quite a few numbers of trees as mosses and ferns make up for them. Trees have spiked leaves in order to minimize transpiration.
- **Temperate deciduous forest:** The forest is located in the moist temperate places that have sufficient rainfall. Summers and winters are clearly defined and the trees shed the leaves during the winter months.

- **Taiga:** Situated just before the arctic regions, the taiga is defined by evergreen conifers. As the temperature is below zero for almost half a year, the remainder of the months, it buzzes with migratory birds and insects.

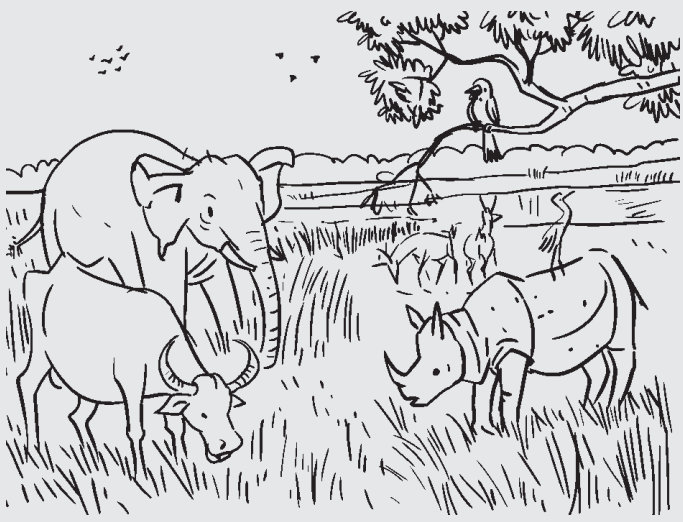


(b) ***Desert Ecosystem***

Desert ecosystems are located in regions that receive an annual rainfall less than 25cm. They occupy about 17 per cent of all the land on our planet. Due to the extremely high temperature, low water availability and intense sunlight, fauna and flora are scarce and poorly developed. The vegetation is mainly shrubs, bushes, few grasses and rare trees. The stems and leaves of the plants are modified in order to conserve water as much as possible. The best known are the succulents such as the spiny leaved cacti. The animal includes insects, birds, camels, reptiles all of which are adapted to the desert (xeric) conditions.

(c) ***Grassland Ecosystem***

Grasslands are located in both the tropical and temperate regions of the world though the ecosystems vary slightly. The area mainly comprises grasses with a little number of trees and shrubs. The main vegetation includes grasses, plants and legumes. A lot of grazing animals, insectivores and herbivores inhabit the



grasslands. The two main kinds of grasslands ecosystems are Tropical and Temperate –with several sub categories within each type.

(d) Mountain Ecosystem

Mountain land provides a scattered and diverse array of habitats where a large number of animals and plants can be found. At the higher altitudes, the harsh environmental conditions normally prevail, and only the treeless alpine vegetation can survive. The animals that live there have thick fur coats for prevention from cold and hibernation in the winter months. Lower slopes are commonly covered with coniferous forests.

(II) Aquatic Ecosystems

The aquatic ecosystem is found in a body of water. It encompasses aquatic flora, fauna and water properties, as well. There are two main types of aquatic ecosystem - Marine and Freshwater.

(a) *Marine Ecosystem*

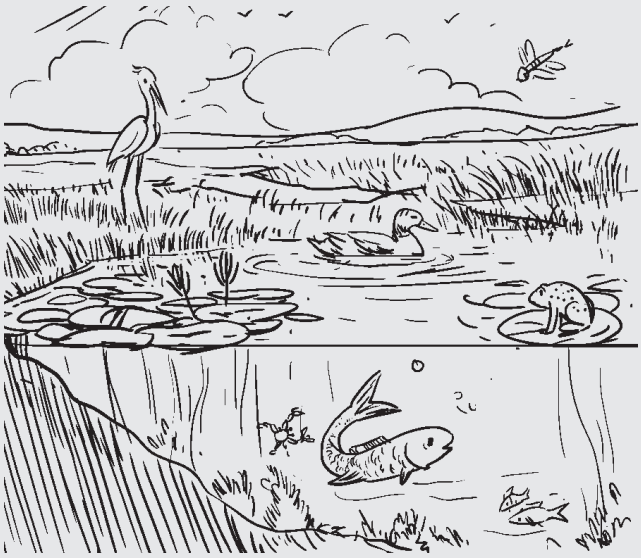
Marine ecosystems are the biggest ecosystems, which cover around 71% of Earth's surface and contain 97% of our planet's water. Water in marine ecosystems

features in high amounts of dissolved minerals and salts. The main different divisions of the marine ecosystem are:

- Oceanic: A relatively shallow part of oceans which lies on the continental shelf.
- Profundal: Deep or bottom water.
- Inter-tidal: The place between low and high tides.
- Estuaries
- Coral reefs
- Salt marshes
- Hydrothermal vents where chemosynthetic bacteria make up the food base.

Of the many kinds of organisms living in marine ecosystems a few are- Brown Algae, Corals, Cephalopods, Echinoderms, Dinoflagellates and Sharks.

(b) *Freshwater Ecosystem*



Contrary to the marine ecosystems, the freshwater ecosystem covers only 0.8% of Earth's surface and contains 0.009% of the total water. Three basic kinds of freshwater ecosystems are:

- Lentic: Slow-moving or still water like pools, lakes or ponds.
- Lotic: The ecosystem of a river, stream or spring.
- Wetlands: Places in which the soil is inundated or saturated for some lengthy period of time. It may be coastal or tidal. These ecosystems are habitats of reptiles, amphibians and around 41% of the world's fish species.

How to Go About

This sub-theme has wide scope of work in diverse areas related to the ecosystem functions and services in relation to sustainable living. But they must have to understand and explore the scientific phenomenon behind the ecosystem processes. In addition, they are to reveal the cause(s) and effect(s) of ecosystem degradation and its effect on sustainable living. The suggested areas of work for the children are-

Understanding the nature and characteristic of the eco-system; Environmental impacts of improved agriculture on environment and sustainable living; Conventional food distribution and long distance transport; Exploration of local and seasonal foods; Organic farming; Food preservation and storage; indoor home appliances; Harnessing renewable energy; Sustainable construction and many more. Moreover, children as practitioners of sustainable living can attempt to reduce their carbon footprint by altering methods of transportation, energy consumption, and diet.

Model Projects

Project 1: Study of an Agroecosystem.

Background

The existence of biotic and abiotic component in an agricultural land, their status and functional relationship are considered as agricultural ecosystem or agro ecosystem. In many cases, the crop cultivated by farmer in an agricultural field give different inputs to farm, all these together are part of biotic and abiotic components of agricultural ecosystem. Therefore, agricultural ecosystems are considered as man-made ecosystem.

Agricultural ecosystem is one of the important man-made ecosystems, which has highly evolved for last few decades due to introduction of modern inputs like mechanical tools, high yielding varieties, irrigation, chemical fertilizers, pesticides etc., to facilitate more production. Intensive monoculture practices, exercising higher cropping intensity make agro-ecosystem more vulnerable for other organisms and take away from sustainable approach. Diversity of agro-

ecosystems in terms of crops, cultivation practices, landscapes, seasons, agro-climatic conditions etc. in the country is significant and represent high volume of information of variability of biotic and abiotic components. By considering the prospect and importance in present scenario, several projects may be undertaken in this aspect-

The child scientist can ask questions to formulate the projects like what are different types of agro ecosystem available in the area; what are the different crops cultivated; how different slopes of land are utilized for different crops; how are they cultivated; what are the inputs (traditional plough/tractor/fertilizer etc.); how and in which way each agro-ecosystem supports livelihood in your area (staple food, vegetables, housing materials etc.); which agro-ecosystem is most sustainable; how other agro-ecosystem can be made sustainable etc.

Objective

To understand different agro-ecosystems for sustainable services

Methodology

The study is to be carried out step-by-step, as mentioned below.

1. List out the agro-ecosystem in your area e.g. rice agro-ecosystem, mustard agro-ecosystem, homestead garden agro-ecosystem, potato agro-ecosystem etc.
2. List out the crops in field in each ecosystem e.g. Rice in rice ecosystem; potato, amaranthus, pumpkin etc. in potato ecosystem; chilli, potato, tomato, vegetables.
3. Study the method of cultivation whether it is organic or inorganic. List out the inputs commercially procured and indigenously prepared. Calculate the

cost of production. Document the pest problems and major pests with natural enemies

4. List out the inputs of each ecosystems like pesticides (herbicides, insecticides, fungicides, acaricides etc.), fertilizers (Urea, Di-ammonium Phosphate, Single Super Phosphate, Murate of Potash, Micronutrients etc.), Seeds (high yielding variety, hybrid variety, local seeds), farm machineries (plough, seeders/ planters, weeder, sprayer, harvester etc.). Study how crop ecosystems are dependent on different inputs and their relation to each other. Calculate the cost of inputs and production with output in different ecosystem.

5. List out the produces in each ecosystem. List out the local need of agri product with volume of production of each crop and consumption. Calculate the income from marketable product from each ecosystem in local and outside market

6. List out the crops, input expenditure, labour cost and outcome of each ecosystem. Correlate these with productivity and sustainability.

7. List out factors responsible for increasing productivity. List out factors which are limiting in the studied ecosystem. Correlate your findings with sustainable factors for productivity.

8. Document current practice of each ecosystem. Find out advantages and disadvantages of the system. Make plan for sustainability.

Significance

Child scientists will know how ecosystem of each crop is different and significant difference of agricultural ecosystem due to crop diversity (monoculture vs multi-crop culture, crop rotation, cropping diversity etc.), inputs, mechanisation, irrigation, nature (organic vs inorganic) etc. They will learn the present prospect and constrain of each crop ecosystem and how sustainable they are ; what plan is required to make agro ecosystem more eco-friendly and sustainable ? How agro-ecosystems are linked and connected with other ecosystems? These issues will be realised by the child scientists and these will make them more curious towards the dynamisms of agro-ecosystems.

Project 2: Conservation status of Dellinia indica in Northeast India.

Background:

It can be seen that certain tree species are more valued for their cultural, economic significance and medicinal properties in the homesteads and villages. Species like *Dillenia indica* in northeast, *Madhuca* and tendu (*Diospyros melanoxylon*) in Central India, *Garcinia* in South India *Sterculia urens* and Khejeri in Western India, *Quercussemi carpifolia* (Oak) in Kumaon and Garhwal are some examples to be mentioned. Children would explore and map the distribution using low cost GPS. They will explore other species they associate with. They would calculate the abundance and the present status. People keep some trees in their homestead garden. The naturally grown trees have significant value in society in terms of its use in different aspects like role to support other lives as well as being used as medicines.

Objectives

1. To understand the distribution and status of *D. indica*
2. To learn tools and techniques to map distribution of tree species
3. To assess the cultural, social and economic linkages of the tree

Methodology

1. Reconnaissance survey
2. Recognising suitable locations
3. Collect coordinates for occurrence with low cost GPS
4. Lay quadrates of suitable size and calculate relative density and abundance
5. Ascertain if the species show an association with other species in the area
6. Questionnaire survey and analysis

Significance

The child will develop an idea of the habitat of *D indica*. Map will show the distribution of the tree in identified study area. Student has to prepare a report on preliminary vegetation analysis. The project will provide the provisioning and cultural ecosystem services and livelihood linkages of human with the tree.

Project 3: Evaluation of pollinator diversity in ecosystems

Background

Pollination is a keystone process in both human-managed and natural terrestrial ecosystems. It is critical for food production, human livelihood and directly linked to wild ecosystems with agricultural production systems. The vast majority of flowering plant species produce seeds only if animal pollinators move pollen from the anthers to the stigmas of their flowers. Without this service, many interconnected species and processes functioning within an ecosystem would collapse. The proposed project is to examine the pollination services in different ecosystems

Hypothesis

The anthropogenic activities affect sustenance of pollinators in different ecosystems

Objectives

1. To estimate the population and diversity of pollinators in selected ecosystems
2. To assess the ecosystem services rendered by the pollinators
3. Developing awareness about pollinators and their services in the ecosystems

Methodology

(A) Materials Required

Field guides to identify plants, birds and insect species, polythene bags, camera, binoculars, GPS instrument, measuring tape, hand lens, gloves, data sheets etc.

(B) Experimentation

1. Reconnaissance visit to different ecosystems (sacred groves, agricultural lands, fallow lands etc.) in a landscape. Observation at different time intervals on different plant species (including keystone and umbrella species); floral morphology evaluation (i.e. which pollinator species were feeding on which flowering plant species).
2. Classification of flora based on type of pollination system/pollinating agent.
3. Specific observation on host plant availability for larval and adult stages of pollinating insects.
4. For keystone and umbrella species consolidate the pollinator species complex.
5. Identify common characters of pollinator species pollinating each specific species.
6. Identify and describe the niche of at least a few pollinating species.
7. List out the impacts of human interference, if any, in the system

Significance

1. Understanding about different ecosystems which support and sustain plant productivity and pollinator diversity
2. Predict niche loss of the pollinating species

Project 4: A study of urban habitat as Refugia to Avifauna

Background

Urban habitat is rather a man-made habitat. Rapid urbanisation for the last few decades has made this habitat more prominent. Several animal species adopted the urban habitat and evolved to fit into the new habitat. It will be interesting to study how different bird species adapt themselves to fit in to the urban habitat.

Objective

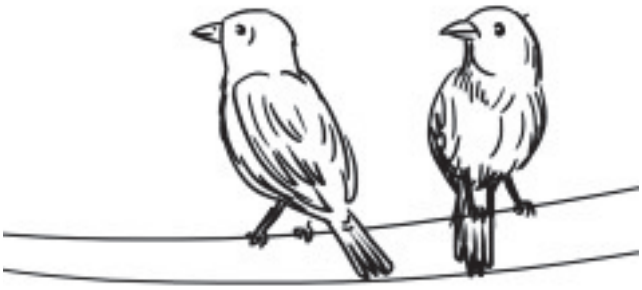
To understand the role of birds in an urban ecosystem

Methodology

Following are the steps to be followed to conduct the study.

1. Reconnaissance survey
2. Observation and categorisation of micro habitat
3. Identify and prepare checklist of birds
4. Refer to bird guide book and collate information
5. Prepare criteria for short listing for details
6. Organise data collection on social behaviour,

a. Nesting habitat
b. Roosting habit
c. Feeding habit
d. Prey and predator
e. Prefer to be solitary or in group
f. Nature of call and signs



7. Survey preference of seasons
8. Ascertain if resident or migratory
9. Assess relative abundance
10. Consult local avifauna experts
11. Assess level of threats and conservation status

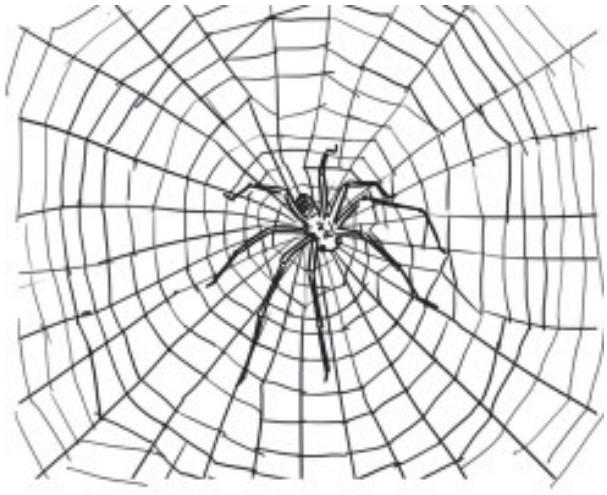
Prepare a report based on above mentioned observations.

Significance

The project will be useful to understand the adaption strategies of birds in a comparatively new man-made habitat i.e. urban habitat. The cost of this adaption can also be documented. The project will help to compare the nature of adaption in man-made and nature habitat.

Project 5. Studies of different type of web-forming spiders and their preys in the ecosystems at your locality

Background



Spiders play an important role in every ecosystem. They are generalist predators and prey upon wide variety of insects like agricultural pests, mosquito, housefly etc. Some spiders directly capture preys which are called hunting spiders. Other are web-forming spiders that form webs with silk and sit, wait for capturing preys in the web. Web forming spiders prepare different size and pattern of webs for capturing varieties of prey. Their web-forming sites are different which allow specific prey only. In agricultural ecosystem, some spiders prepare web twisting the crop leaves; house-dwelling spiders make their web in the walls and roof; tree-dwelling spiders construct web in the tree.

Objective

To study web forming spider diversity in different ecosystems with patterns and type of webs and nature of preys

Methodology

(i) Survey different ecosystems (forest, grass lands, agricultural crops like rice, maize, sugarcane, millet etc.) in your locality through trail walk method. Organic and inorganic agro-ecosystems may also be targeted to document diversity and numbers of spider species.

(ii) Document the diversity of spiders (draw diagram, size, colour, take photograph) and document both the sexes - generally, female is larger and

mainly sits and waits for the prey, male is much smaller and remains in one corner of the web.

(iii) Draw the pattern of each web of different species of spiders and measure their size (radius)

(iv) Measure and count different parts of spider web (bridge thread, anchor thread, anchor point, auxiliary spiral, capture spiral etc.) in different species.

(v) Observe the behaviour of web forming and capturing prey of different species

(vi) Document the types of prey captured by each species per day.

Significance

The project will help introduce the child scientist to the fascinating life of spiders and particularly web forming spiders and their various activities. It will also be useful for them to understand the predatory potential of spiders and their importance in the food chain and ecosystem functioning. Every ecosystem has preys and predators with different survival strategies.

Project 6. A systematic study of different fruit-bearing plants in a homestead garden

Background

Plants are one of the essential components of ecosystem. They are the one which can directly store energy from sunlight and convert them to food source available for other organisms. Plants include trees, shrubs, herbs, grasses, ferns, mosses.

Objectives

(i) To understand the role of homestead gardens in sustainable living

(ii) To study the best practices of homestead garden

Methodology

The study is to be conducted following the steps mentioned below.

1. Measure the extend of homestead garden in acres/bigha
2. Reconnaissance survey
3. Observation and identification of plant species and preparing a check list
4. Interview with the owner of the homestead garden/Interview with farmer
5. Consult with agriculture/nutrition expert
6. Assessment of nutrient/calorific value of the fruit harvested.
7. Economy of fruits harvested
8. Different types of tools used for propagation, sowing, planting and cleaning of homestead garden
9. Fertilizers used (organic and inorganic)
10. Source of fertilizer used.
11. Periodicity of input of fertilizers
12. Refer to plant guide book

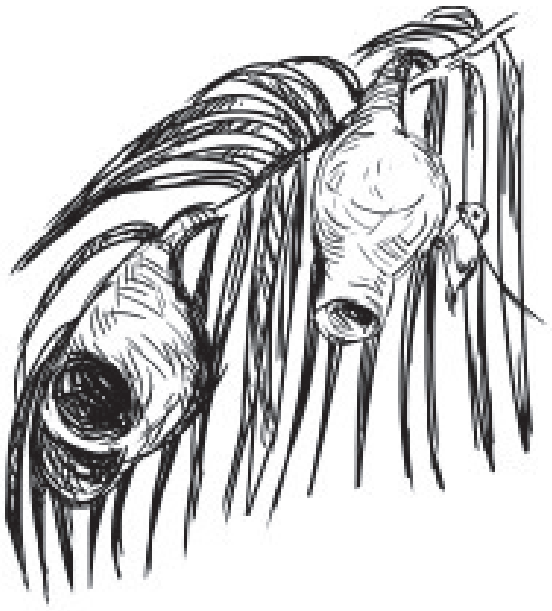
Significance

This study will enhance the observation skills. This will also help to understand the ecosystem services of homestead garden and how it is contributing to the livelihood and sustenance of a family.

Project 7. Study on the association of bird diversity in a homestead garden

Background

Birds are one of the easily found groups of biotic component of an ecosystem. They are found everywhere and in all types of habitats and ecosystems. Birds play important ecological role as pollinators, in seed dispersal, pest control, food source, etc.



Objectives

(i) To understand the habitat utilisation, ecosystem services provided by birds in a homestead garden

(ii) Conservation of birds in the habitat

Methodology

The step-by-step procedure has been explained below for conducting the study.

1. Survey and identification of birds using bird guides.
2. Enlist migratory/resident birds in the area
3. Study the seasonality and social structure
4. Social behaviour data (nesting/roosting/feeding/predator/prey)
5. Study the threats and impacts of human activities

Significance

Children will learn how to observe and identify birds. They will know about diversity of birds in their locality and the seasonality, instigating them to think about the phenomenon of bird migration. The children understand the ecosystem services provided by the bird community and the need to conserve them

Project 8. Understanding impact of human activities on flora/fauna and their abundance

Background

Ecosystems provide us different types of services to live a quality life. With increase in population of humans and reduced forest areas, different habitats are under pressure due to anthropogenic activities. Humans repeatedly use such habitat and collect natural resources for livelihood and sustenance. This impacts the habitat and biodiversity in it which, in

turn, impacts its services to nature and humans. Increase in human disturbances probably reduces the biodiversity and abundance in the habitat of species. Through this exercise, child scientist is expected to understand the impact of human disturbances on a habitat in the neighbourhood and on ecosystems at large.

Hypothesis

Human disturbances have direct impact on biodiversity and its abundance.

Objectives

(i) To estimate flora/fauna of an area
(ii) To record different types of human disturbances
(iii) To estimate impact of human disturbances on flora/fauna and ecology
(iv) To create awareness about impact of human activities on ecosystem functioning

Undisturbed habitats are richer in biodiversity and abundance compared to disturbed habitats. Human venture into habitats for its day-to-day needs and presence of human and ancillary activities causes disturbances to flora and fauna. An undisturbed/least disturbed habitat when compared with similar habitat which is disturbed, is likely to have more diversity and abundance.

Methodology

(A) Materials Required

Field guides to identify plants, birds and insect species, polythene bags, camera, binocular, GPS instrument/maps, measuring tape, 1x1 m quadrate rope, hand lens, gloves, data sheets, etc.

(B) Experimentation

1. Reconnaissance visit to identify two similar habitats (at least 10 ha area) where one is undisturbed/least disturbed and other is frequently disturbed by human activities (Cutting, lopping, firewood collection, cattle grazing, construction work, fishing, etc.).
2. Observe the area on regular intervals (e.g. weekly or monthly).
3. Record and classify different types of human disturbances as mentioned above.
4. Walk 50m trail on each habitat and record different types of human disturbances on the datasheet.
5. Record, signs (hoof mark, scratch mark, dropping of animals) both wild and domestic separately.
6. Record number of such signs of each identified species in the 50m trail.
7. At the beginning and end of the 50m trail, lay 1x1m quadrate and record different species of plants observed on a datasheet.
8. On the trail, observe different species of fauna and number of individuals of a species observed and record on datasheet.
9. Repeat the trail survey at regular interval, ensure equal number of repeats in the early morning and late afternoon.

Significance

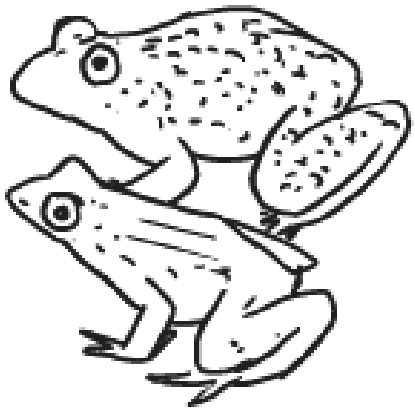
1. Understanding the habitats and multiple habitat parameters those enrich an ecosystem and its services.
2. Understanding impact of human disturbances on a habitat or an ecosystem by measuring observable components.
3. Evolving approaches for protecting ecosystems for sustainable future.

Project 9. Study of Amphibian diversity by observing the morphological features of amphibians in an area.

Background

Amphibians play various roles in the ecosystem by providing a number of ecological services such as acting as a secondary consumer as well as prey for other carnivores in different food chains and also perform the services as indicator species and biological pest controllers, etc. Amphibians are very sensitive to any change in the environment that helps us to assess various environmental threats as mentioned below -

1. Habitat fragmentation
2. Ecosystem stress that poses a serious threat to productivity of the ecosystem
3. Impact of pesticides and chemical fertilizers
4. Anthropogenic activities, etc.
5. Climate change



Moreover, amphibians have immense socio-cultural value due to their age-old integration into the art, literature and culture of different communities; e.g. holding frog marriages to please Lord *Indra* for rain is a common practice among various communities of Assam and some other states. We can see incorporation of amphibians, mainly the anurans (an order of animals in the class Amphibia) in major art forms of India such as-

Sl. No.	Art Form	Region in which practised
1	Madhubani	Bihar
2	Pichwai	Rajasthan
3	Warli	Maharashtra
4	Gond	Madhya Pradesh
5	Patachitra	Odisha & West Bengal

Source:https://scroll.in/magazine/865512/frogs-have-an-abiding-presence-in-indian-art-and-mythology-then-why-dont-we-try-to-conserve-them

Such cultural integration caters greatly in favour of conservation of amphibian species due to their relevance and importance to the society.

Objectives

1) To study the diversity of amphibian species in a particular area
2) To study the relative abundance of selected species
3) To study the conservation aspects of amphibians

Methodology

The following methods are suggested for this study-

1) ***Visual Encounter Survey***Amphibians can be found and examined while walking through the study area during the time when they are most active (June-August, rainy days). Surveys to be carried out during evening hours 18.00 hours to 22.00 hours, subject to variation with respect to the region in which the study is conducted. One of the most effective sampling methods is trail walk (walk in any trail which can be of length say 50 meters in a frogs' habitat).
2) ***Listening/recording frog calls*:** One of the major features of amphibians are that every species has a different type of call. Children may record such calls of the organisms and get them verified by experts to identify the species.

Method of Identification

Identification of the amphibian species are done in various ways. But, the most basic and widely practised method for beginners is identification through examination of the morphology, that can only be obtained if good photographs have been taken from various angles for proper assessment and comparison. Some of the methods of identification are:

1) Comparing the morphological features from the photographs with a field guide.
2) Consulting with a qualified herpetologist for maintaining accuracy of the specimens identified

Significance

These studies will help children understand amphibians that are available in and around their locality and create an awareness towards significance of these much neglected but a major group of organisms in terms of maintaining

equilibrium in the ecosystem. Therefore, the ultimate goal of this study will be conservation of amphibians by involving children and propagate the message of biodiversity conservation and coexistence.

Project 10. Status of Invasive Alien Species, their/its Impacts on Local Biodiversity and Control Measures

Background

Different habitats differ in susceptibility to invasion by alien species. It is not essential that an invasive species reaching a habitat will always succeed in naturalising in the new habitat. There are many attributes that make a habitat susceptible to invasion such as species poverty, poorly adapted native species, gaps created by disturbances, constant harvesting of indigenous vegetation for various purposes, vacated habitats of native species, etc. Proposed activity attempts to identify and investigate the distribution of invasive alien species in an area and their impacts on the local biodiversity with the aim of thinking and trying out their control**.**

Hypothesis

Occurrence and distribution of invasive alien species are harmful to the native biodiversity as well as the local livelihood opportunities.

Objectives

1) Preparation of inventory of invasive alien species in the area along with their occurrence and distribution.

2) Estimation of their impacts on native biodiversity, both qualitatively and quantitatively.
3) Design and try control/management options for invasive alien species so as to protect the local biodiversity and its ecosystem functions.

Methodology

(A) Materials Required

Field guides to identify plants and animal species (samples of invasive plant species may be taken from herbarium), camera, designed data sheets, herbarium sheet, cadastral map, GPS instrument or simply mobile GPS function can be used as an alternative tool for recording geographical location and mapping etc.

(B) Experimentation

(I) Finding Status of Invasive Alien Species in the Area

i) It is good to undertake reconnaissance visit of the area marked for the study and prepare the list of plants and animal species occurring there. Taking help from the village elders is a good option for the purpose of knowing local names of the species and also the timeline when certain (invasive alien) species appeared in the area and its (their) distribution trend during the past years.

ii) Collection of samples of plant species that are identified as invasive alien (take help of local elders, guide teacher and experts. To know about invasive species in India one can visit - http://www.bsienvis.nic.in/Database/Invasive_Alien_species_15896.), prepare their herbarium record for further reference and make a list assigning their codes.

iii) Take the cadastral map of the area and divide it in grids of uniform size (mention the scale of the grid in reference to the actual area size, viz. 1 cm = 100 meters). If cadastral map is not available, you can draw one.

iv) Refer the cadastral map of the area to observe the occurrence and number of individuals of the species (for tree & shrub and animal species like Giant

African Snail) found in the particular grid. Also do the same listing of other (native) tree and shrub species. In case of dense shrubs, if counting of the individual plants is not possible then mark their proportionate area of occurrence in the respective grid.

v) Mark the grids where certain (alien) species appeared or extended for the first time (year/month) in consultation with the guide teacher, village elders, experts and with help of secondary information.

vi) Calculate the frequency, density and abundance of invasive alien species as well as native tree and shrub species with the help of structured data sheets. In case of proportionate area as marked in the grid, you can tabulate the proportionate area occupied by the thickets of the species.

(II) Assessment of threats/impacts by Invasive Alien Species

a. List out the native species that are facing competition from alien invasive species in existence, distribution and regeneration in consultation with the local elders, guide teacher, experts and referring secondary information, if any.

b. You can also calculate the proportional area affected by invasive alien species by using the grid map. Referring to above point '(v)' you can also draw the timeline map of spre

c. Collect the information through structured data sheets and interview forms regarding occurrence of fodder species as well as their availability for the local livestock previously as well as currently and the changes in the availability of the fodder plants in the area.

d. To ascertain the impact of invasive alien species on native plants, you can set experiments using their seeds, leaf extracts, root extracts and soil samples etc.

e. You can also ascertain the comparative soil characteristics of the area affected and not-affected by the invasive alien species.

f. Record the anthropogenic factors causing adverse changes (use photographic / mapping tools like cadastral map for marking the reference points e.g. points of human activities; disturbances etc); record human activities affecting the overall habitats, lifecycle and diurnal activities of animals and plants in relation to time and space (grazing pattern, lopping and cutting of local species, mining or industrial emissions/release nearby etc).

(III) Control measures

Design options for control / management of invasive alien species and lab / field trials so as to prove the efficacy of the designed measure.

Calculation

Following are the formulae for calculating different parameters-

Frequency = Number of units in which the species occur/ Total number of grids X 100

Density = [(Individuals per square unit area) – (Total number of individuals of the species)] / Total area of sampling

Abundance = Total number of individuals of a species / Total area of units in which the species found occurring

(IV) Tabulation and Interpretation

- Designing of data table will depend on the criteria set for the investigation. For example, to fulfil the part of first objective a suggestive data table is given below for listing of Invasive Alien Species found in the study area -

S. No.	Name of Species	Scientific Name	CommonName (Vernacular)	Habit of Plant

- For compiling the information of occurrence and distribution of each species, the occurrence points in the grid map can be tabulated as suggested in table –

S. No.	Name of Species	Number of grids in which the species found occurring	Percentage of the total grids in which the species was out of the total study area	Proportional area occupied by the species

Significance

The record of invasive alien species in the country, their total number and impact on native biodiversity has been hardly studied till date. Lack of baseline information about their regional occurrence has been a major hindrance in their proper evaluation and devising control strategies. This study is an attempt to orient the investigators towards addressing the issue.

Project 11: How does organic component influence soil properties of different ecosystem?

Background

Organic materials are very important to agriculture. Farmers and gardeners use it to increase the nutrients in their soil. Organic materials retain higher amount of water and in turn, supply it to the plants on which they grow. Moreover, organic matter may influence various soil properties like soil colour, pH, organic-carbon content etc. So, studying soils containing different level of inherent organic materials in it will provide a relative idea of water availability, soil colour, organic-carbon content, soil pH etc. Organic material also supply nutrients into soil and plants can take both water and nutrient from soil. This assists better plant growth.

Hypothesis

Organic components of soil influence soil properties irrespective of ecosystems.

Objectives

1. To study variation of organic content of soils under different land use
2. To determine the water retention capacity of soils under different land use
3. To determine the colour, pH, organic-carbon content of soils under different land use

Methodology

(A) Materials Required

1. Select three ecosystems in your locality viz. agricultural, forest and grass lands.
2. Spade/ khurpi, colour chart, wash bottle, sieve set, sample collection bags, paper tags/label, perforated container.
3. Soil test kit for organic carbon

(B) Experimentation

1. Prepare a land use map of your locality
2. Collect representative surface (0-15 cm) soil sample from each land type and land use (for example, forest land, grass land, barren land, steep land, soil under agricultural crops, orchards, etc.). Air dry the samples, grind and pass through 2mm sieve for studying the following parameters-

1. Water holding capacity

1. Take 500g soil sample in perforated containers add the soil slowly followed by tapping so that soil of the container comes to natural compaction.
2. Place beaker under each container to collect the leachate drain out water.
3. Pour measured volume of water from a measuring cylinder to each container and record the volume of water needed to completely saturate the column. Add approximately 100 ml of water additionally to form a thin film of water over the soils of the container.
4. Wait for 12 hours
5. Measure the volume of water collected in the beaker, then subtract this from total quantity of water added.
6. Repeat the experiment three times for soils of each land type/use

Observations

Land use	*Agricultural land*	*Forest land*	*Grass land*
Replication	*I II III*	*I II III*	*I II III*
Observation 1 *WHC* *Soil Colour* *Soil pH* *Organic Carbon*			
Observation 2*WHC* *Soil Colour* *Soil pH* *Organic Carbon*			
Observation 3 *WHCSoil Colour* *Soil pH* *Organic Carbon*			
Mean value *WHC* *Soil Colour* *Soil pH* *Organic Carbon*			

2. Soil Colour

Take a table-spoon of soil and place into individual petri-dishes, or any similar glass or plastic containers. Be sure to label each dish appropriately. Now compare the colour of the soil with the Munsell colour chart (may be collected from Soil/Agriculture Department) and note their dominant colours (red, brown, grey, yellow, yellowish red etc.). Moist the soil

In colorimetry, the **Munsell colour system**is a colour that specifies colours based on three properties of colour: hue(basic colour),chroma (colour intensity), and value (lightness). It was created by Prof. Albert H. Munsell in the first decade of the 20th century.

with few drops of water and record the moist colour also. Repeat the experiment three times for soils of each land type/use.

3. Soil pH

Take a tablespoon of soil and place into individual petri-dishes or any similar glass or plastic containers. Be sure to label each dish properly. Wet each soil sample with 2 tablespoons of distilled water. Allow to sit for 3 to 5 minutes. Place one piece of pH paper on each soil sample. (Use pH paper with a range from at least 5-10). Determine the approximate pH or acid/base level of your soil. Repeat the experiment three times for soils of each land type/use.

4. Soil OrganicCarbon (*Kit Method*)

Take 1 gram of soil in test tube. Add 2 ml of organic carbon reagent I (1N $K_2Cr_2O_7$)and 2 ml of organic carbon Reagent II (Conc. Sulphuric Acid) in the test tube. After 15 minutes stay, determine the approximate organic carbon content of the soil under experiment from the colour chart matching. Repeat the experiment three times for soils of each land type/use.

Colour	Oxidizable organic Carbon,(%)	SoilQuality
Dark green	>0.75	High
Red	0.50 – 0.75	Medium
Orange	< 0.50	Low

Results

Water drained from the soil was measured exactly 12 hours after the water had been initially added.

Then draw inference of the experiment

Relevance

The study will throw light on the variation of water retention capacity, colour, pH, organic carbon content of soils under different land type and land use. It will give an idea of importance of organic matter in controlling the availability of water, regulation of temperature due to colour, soil pH and organic carbon content thus nutrient availability for plant growth.

BOX- 1.2

Tragedy of the Commons

In 1833, the English economist William Forster Lloyd published a pamphlet which included a hypothetical example of over-use of a common resource. This was the situation of cattle herders sharing a common parcel of land on which each of them were entitled to let their cows graze, as was the custom in English villages. He postulated that if a herder put more than his allotted number of cattle on the common, overgrazing could result, which ultimately caused the collapse of the commons. “Tragedy of the commons” is a phrase later coined by Garrett Hardin in 1968 to explain why much of the public-owned land and other natural resources collapsed because of the greed and deeds for short term gains. In our country, this tragedy of the commons plays out daily in our lives in a thousand different ways. At the macro- level our “commons” are our national resources. These include the air we breathe, the land we live on, and our water bodies, rivers and seas.

Many examples can be drawn in establishing how the over exploitation of the natural resources resulted in intensifying the tragedy in the context of natural disaster like flood and drought. We are leaving behind a poor legacy for the future generation. The indiscriminate destruction of the forests in the Himalayas and the Western Ghats intensified the landslides and fury of the flood manifold in the recent calamities. The intensified air pollution in seasons in Delhi and resultant suffering of the inhabitants is another example.

BOX – 1.3

The Ecosystem Approach

The ecosystem concept is considered as a valuable framework for analyzing and acting on the linkages between people and their environment. The Convention on Biological Diversity (CBD) and the Millennium Ecosystem Assessment (MA) conceptual framework have endorsed the ecosystem approach. The CBD defines the ecosystem approach as a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The ecosystem approach aims to attain a balance of the three objectives of CBD: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The ecosystem approach is based on the essential structure, processes, functions and interactions among organisms and their environment. The approach recognises humans as an integral component of many ecosystems. The ecosystem approach depends on local, national, regional, and global conditions.

BOX – 1.4.

Broader natural and man-made ecosystems in India

Let us develop an understanding of Ecosystems in India which are both natural and man-made. These could be broadly categorised into:

1. Wetlands, 2. Marine, 3. Coastal, 4. Forest, 5. Island, 6. Desert, 7. Urban, 8. Mountain, 9. Freshwater, 10. Agricultural

Each of these ecosystems can be further categorised. For example, forest ecosystems are of the following types:

- Tropical wet evergreen forests
- Tropical dry evergreen forest
- Tropical moist deciduous forests
- Tropical dry deciduous forests
- High altitude montane shola -grasslands
- Scrub jungle

- Subtropical pine forests
- Himalayan wet/ moist temperate forests
- Himalayan dry temperate forests
- Mangroves
- Sal forests
- Littoral swamps
- Alluvial grasslands
- Dry alpine

Additional Project Ideas

1. Ecological significance of the ecosystem (forest, river, mountain, tea garden, grassland) and how local people are getting benefit from that ecosystem.
2. Dependency of local people on ecosystem services from the ecosystem
3. An integrated assessment of effects of human impacts on an ecosystem-biodiversity assessment, ecosystem assessment and livelihood assessment
4. Mapping of invasive plant species in various ecosystem and its various alternative uses.
5. Impact of invasive alien plants on terrestrial native vegetation (grasses / gardens / forest)
6. Butterflies/insect diversity in our locality and their role in ecosystem
7. Ecological importance of mosquitoes
8. Monitoring of bird nesting/bat colonies in urban environment
9. Human-wildlife conflict pattern in your locality and its various mitigation methods.
10. Seasonal monitoring diversity of birds and their roosting site around your village.
11. Inventory and monitoring different species of insects visiting the school garden/grassland patch.
12. Seed germination period and performance of different types of soil.
13. How ecosystem services contributing in your neighbourhood.
14. Document ecosystem services monthly or seasonally in nearby areas.
15. Role of spider/ant in the ecosystem

16. Study on the feed plants of local livestock in relation to their sustainable availability
17. Sacred groves as repositories of native germplasm
18. Role of lower plants in local ecology
19. Dust capturing capacity of roadside plants and suggestive measures for creating road-side green belts.
20. Understanding wetland health through diversity and distribution of fish fauna
21. Urban cemeteries as hot spots of local biodiversity
22. Indicator plants for ground water prospecting
23. Symbiotic relationship between two or more species helping each other's life cycle.
24. Study of biodiversity hotspots in urban environment
25. Assessment of living and non-living components of an intermediate zone (Ecotone) and its associated conservation issues.
26. Beach Erosion - causes, impacts and restoration
27. Change in drainage pattern due to land use changes and impact on ecosystem characteristics
28. Grazing and spread of plant species through dung/excreta
29. Invasive alien fishes and their impact on the aquatic ecosystem
30. Study on the natural seasonal changes in a garden or natural grove and impact of anthropogenic activities.
31. Relationship of small mammal species and their host plants
32. Role of sacred groves in regulation of micro-climatic conditions
33. Habitat mapping of mammalian species on the basis of direct and indirect evidences
34. A market survey to estimate potential demand for various medicinal plants in your locality
35. Understanding impact of human in different ecosystems
36. Understanding pollination and role of pollinating insects
37. Non-biodegradable polythene load in selected drainage of an urban area and its impacts.