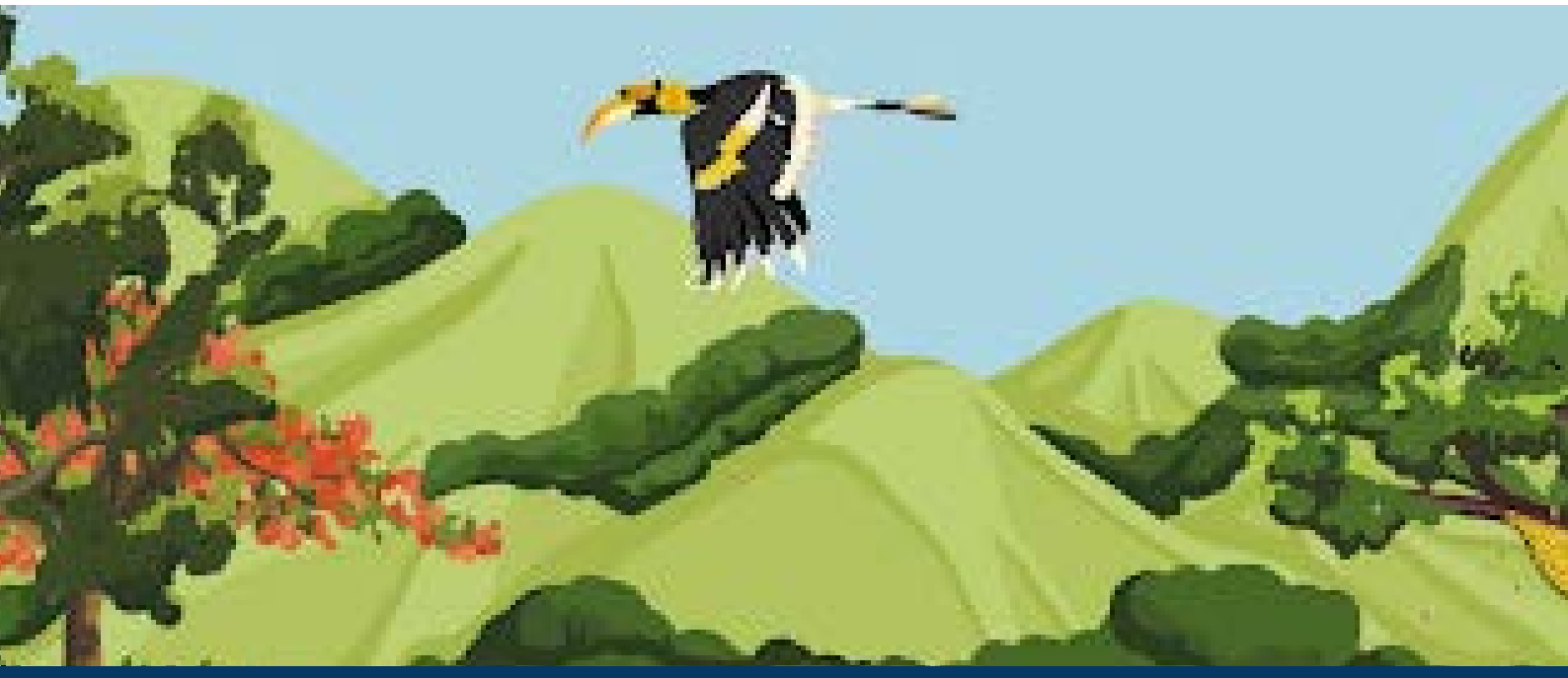
Azim Premji University

Teaching iThink Biology in your classroom

A guide to teaching the Western Ghats chapter



iThink Biology is different from the types of science textbooks we are familiar within India. The content, organization and features of the e-book have been developed with different objectives in mind. We hope that the chapter-wise guides prepared by the iThink Biology team will help a teacher make the best use of the resource in their learning spaces. The following text is a guide to teaching the Western Ghats chapter. Please read through the section on *how to read iThink Biology* before using this resource.

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Introductory notes

- The book has been written in an informal and conversational style of English and important or difficult concepts have been linked to the glossary or elaborated in detail within the text.
- The book is hosted on a website (ithinkbiology.in), so the reader will require a computer, mobile or tablet to access it. An internet connection will be required to access the different pages of the website, as well as the different interactive features of the book such as weblinks, glossary terms, video interviews, and downloadable research papers.
- Several exercises in the book may require students to step out of their classroom and observe their surroundings, such as a city area, water bodies or a garden. The possibility of such an engagement can be important to meet the learning objectives of the book.

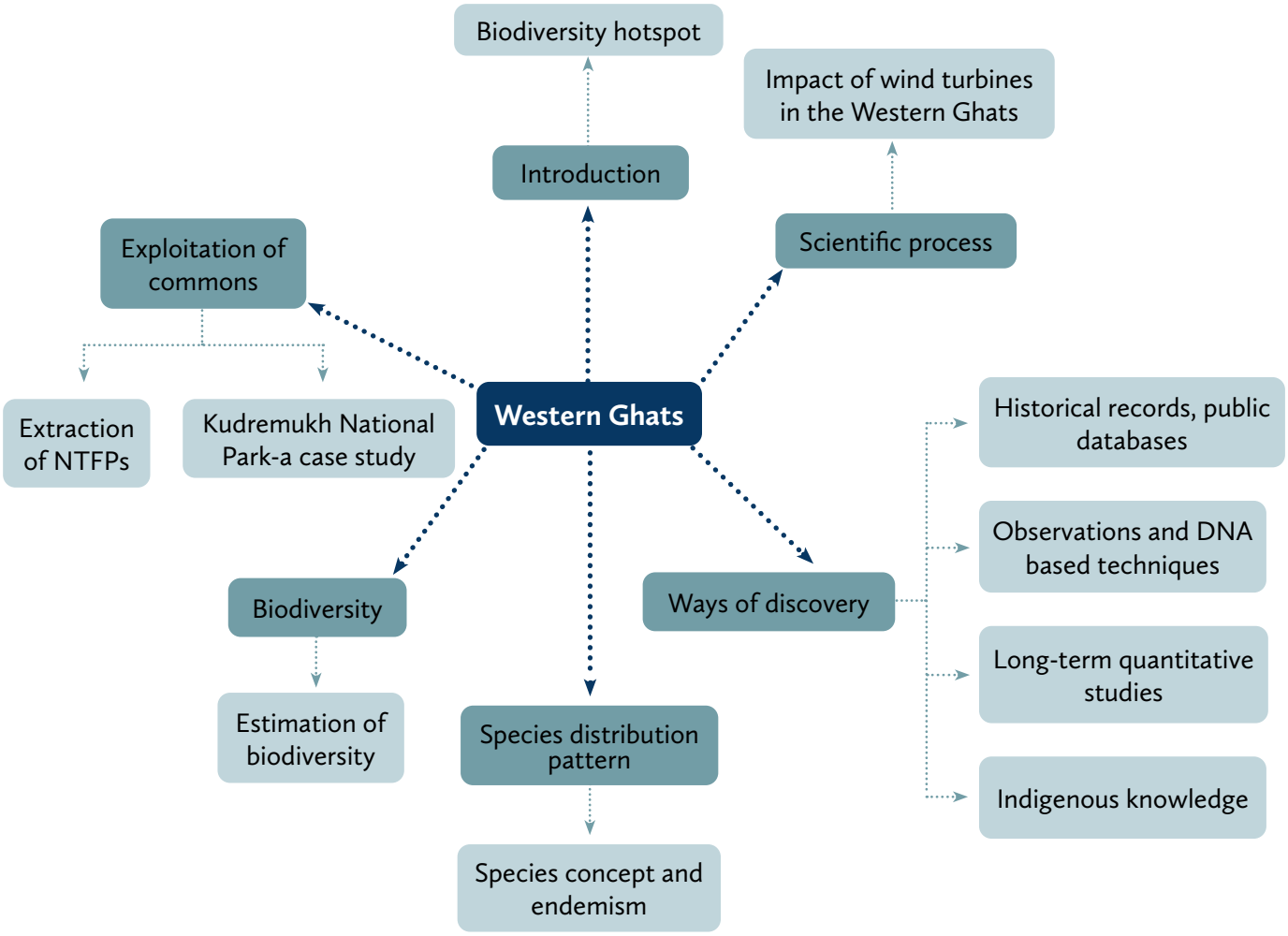
Content Mapping

This table will help you map parts of your syllabus to the content and capacity-building approach in iThinkBiology.

In the first column, you will find units and topics from your syllabus and the subsequent columns contain the sections, subsections and concepts from our book iThinkBiology. By using this table, you can easily identify the relevant concepts from the book that align with your syllabus.

Existing syllabi	Corresponding Topics in iThink Biology			
Subject, Topic	**Headings/ Sections**	**Subsection**	**Concepts explored**	**Capacities**
Plant Diversity and Human welfare, endemism, biodiversity hotspots in India	Introduction to the Western Ghats	Biodiversity hotspot	Significance, endemism, diversity of organisms	Reading and Interpreting
Research Methodology, developing a research plan	Scientific discoveries	The scientific process	Series of steps to make a discovery	Scientific process
Natural resource management, renewable energy, sustainable utilization		Wind turbines in Western Ghats: an illustration of the scientific process	Thaker *et al.* case study, 'space for time' substitution, impact of wind turbines on predatory birds	Scientific process
Biotic interactions, Predator-prey relationships		Impact on prey species	Thaker *et al.* case study, predator release	Scientific process
Biodiversity, threats, IUCN Red Data List **Research Methodology**, methods of data collection, **Taxonomy**, classification, indigenous knowledge, **Environment and Public Health**		The many paths of discovery	Scientific investigations—threat assessment to a species, discovery of a new species, documenting indigenous practices, impact assessment	Scientific process, scientific tools
Plant Systematics, species concept	Plant and animal distribution across the Western Ghats	Understanding patterns in nature	Species richness, species concept	Reading and interpreting
Ecology, endemism, Biodiversity, IUCN Red Data List		Patterns of species distribution	Dominant, rare and endemic species, IUCN's Red List	Reading and interpreting
Biodiversity, levels of biodiversity, biodiversity assessment		What is biodiversity?	Levels of biodiversity, exercise for estimating biodiversity	Reading and interpreting, Quantitative skills
Biodiversity, national parks, **Environmental issues**	Commons: many takers of the Kudremukh National Park	Kudremukh National Park	Iron ore extraction in Kudremukh and environmental problems	Bridging science, society and the environment
Natural Resource Management, forest products, sustainable utilization		Ecological costs and livelihood gains from non-timber forest products (NTFPs)	Sustainable harvesting practices	Bridging science, society and the environment

Concepts introduced in the chapter



Capacities developed in this chapter

You will notice that every chapter has a set of questions appearing at the beginning of the chapter. These describe the content (indicated by the questions) related to the capacity (indicated by the icon).

In this guide, we have followed different subsections from the ithinkbiology book. We have suggested different activities that are focused on answering the critical thinking questions given in the book. We have added an annexure to this guide. Annexure-I has two worksheets that teachers can provide to students to record observations for different suggested activities.

Notes for Instructors

In this document, we provide some suggestions for instructors on how to get students to engage with the critical thinking questions that are present throughout the chapter. We have provided the answers, suggested activities for each section in the book. It would be ideal to use these questions along with the book chapter but do adopt these questions and activities to related topics in your curriculum. We hope that this document encourages you to create similar critical thinking questions for the concepts in your course syllabus.

In our experience, there is much value in group work conducted between students. If a student can be accompanied by even one other student while attempting some of the exercises, it will make a difference to their learning experience.

If you do conduct these exercises in groups, ensure that the group sizes are not too large (not more than 5 students per group) so that all the students participate in the discussions. Students tend to be curious but having a few pre-prepared questions and hints to promote conversation in groups might be helpful. A wrap-up discussion to combine and connect the individual group learnings is essential to ensure learning objectives are achieved. Do keep some extra time while conducting group work since they tend to run longer than the time estimated.

A1.1 Introduction to the Western Ghats

Reading and Interpreting

Question

Western Ghats are a biodiversity hotspot. What makes the Western Ghats a unique biodiverse ecosystem?

Answer: To teach students about the diversity of the Western Ghats, we suggest teachers use this presentation.

https://docs.google.com/presentation/d/1VYN-DNQKMBMf5_gMHtvUl0jDyuXtSon7/edit#slide=id.p1

Suggested reading:

Sahyadris: India's Western Ghats - A Vanishing Heritage by Sandesh Kadur and Kamal Bawa

We suggest that the teachers show this video in the classroom:

https://www.youtube.com/watch?v=vduaDm5Rnjk

A1.2 Scientific Discoveries

Reading and Interpreting

Question

What are the different renewable resources of energy? What are the advantages and disadvantages of these natural resources?

Hint

Make a list of renewable resources of energy along with pros and cons.

Answer: Renewable sources of energy are those that can be used repeatedly as they are replenished naturally. Some common examples are - wind energy, solar energy, hydropower, and geothermal energy.

Suggested Activity

Suggested time: *This activity can be completed in one hour of class. For filling out the Venn diagrams, give 20 minutes to students.*

The teacher can start the class by introducing students to different renewable energy sources. After a brief introduction, the teacher will divide the class into 4 groups. Each group can further be divided into two subgroups. Each group will be given one Venn diagram to write the pros and cons of the energy sources. In each group, one sub-group will work on the pros of the energy source and the other sub-group will work on the cons.

For instance, group 1 will further have two subgroups - 1a and 1b. Subgroup 1a will work on the pros of wind energy and subgroup 1b will work on the cons of wind energy. Then, both subgroups will collectively analyse the pros and cons list and write the conclusion.

Group 1	Group 2
a. Pros of wind energy	a. Pros of solar energy
b. Cons of wind energy	b. Cons of solar energy
Group 3	**Group 4**
a. Pros of hydropower	a. Pros of geothermal energy
b. Cons of hydropower	b. Cons of geothermal energy

The teacher can then conclude the class by discussing pros and cons of energy sources. They will discuss the cost and benefit of every technology before implementing it.

Below we have provided answers for the teacher's reference. These answers are not absolute, and more points can be added to these.

In the annexure, worksheet-1 is given which can be provided to the students for this exercise.

Image 1: Pros and cons of wind energy

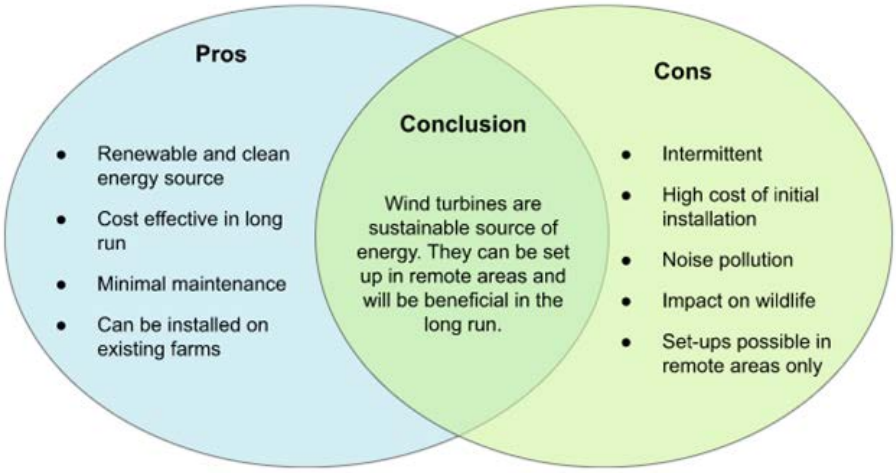


Image 2: Pros and cons of solar energy

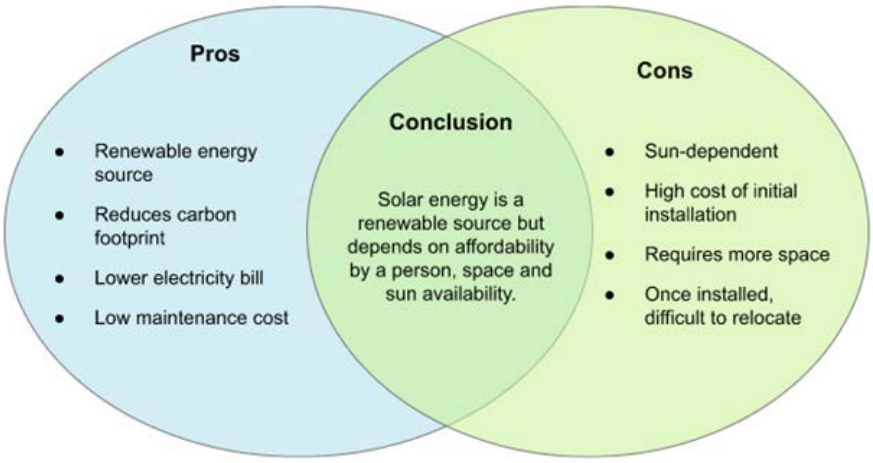


Image 3: Pros and cons of hydropower

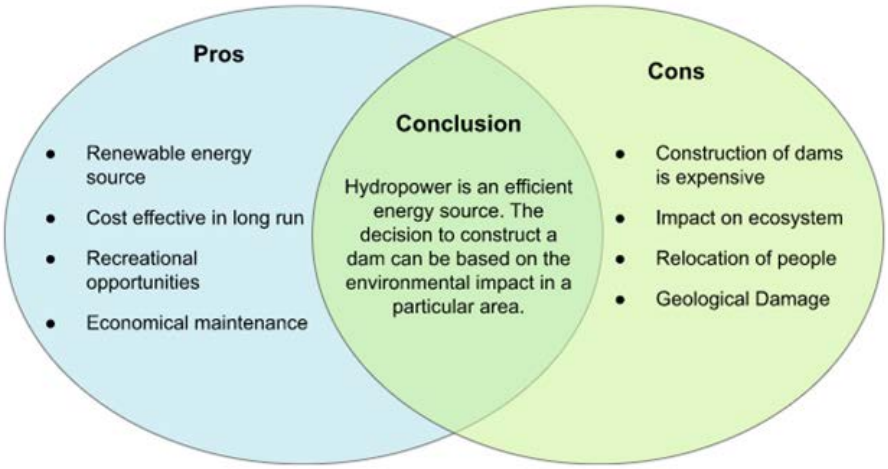
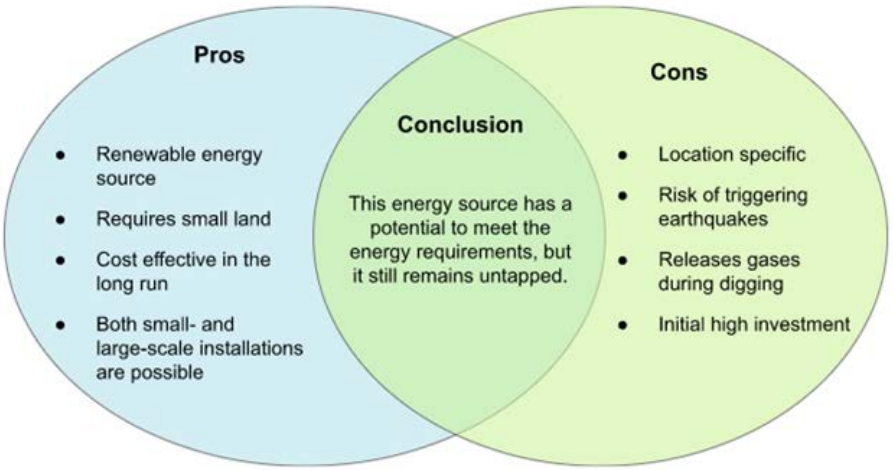


Image 4: Pros and cons of geothermal energy



If time permits, this activity can further be extended. Students can create Venn diagrams to compare different types of energy such as wind vs. solar energy, wind energy vs. hydropower etc.

Suggested questions:

The teacher can ask some questions to students

- Why does India need to increase its energy generation capacity?
- Ask students to produce a list of the top 10 projects in the country related to renewable energy sources? (This question can be given as a small project/ assignment to the students)

What does this question make students do?

Students will learn about different types of renewable energy sources. They will learn the advantages and disadvantages of different energy sources and analyse the cost and benefits of implementing them.

Scientific process, Reading and interpreting

Background information: In section A.2 of the book, there is one subsection — the many paths of discovery. This subsection discusses four case studies of different scientific investigations. These studies give you an overview of different ways in which scientific investigations can be carried out.

Question

What are the different steps involved in conducting different scientific investigations?

Hint

Use the checklist given in Exercise A1.1 to write the steps of different case studies.

Suggested Activity

***Suggested time**: 1-hour*

Teacher can ask students to read these four case studies before coming to the class. Students can fill out the table given below in the class. This activity can be done in groups of two students.

We have filled in some of the columns for the teacher's reference.

Worksheet 2 is provided in the annexure for students to fill out.

Steps	Case study - 1	Case study - 2	Case study - 3	Case study - 4
Observation			Cutaneous leishmaniasis is endemic in indigenous Kani people.	
Question	What is the threat status of the Nilgiri pipit?			What is the impact of mining activities in the Kudremukh National Park?
Hypothesis		Spotted lizards in the Western Ghats are new undocumented species.		Mining is the main source of sediment release in the river.
Experiment	**Source of data:** historical records of where the bird used to be found. Museum records		Researchers conducted interviews with adult members of different households.	
Results	The habitat of the bird is restricted to around 450 km^2.			
Conclusions		Two species of lizards are identified in the Western Ghats and reclassification of lizards is required.		They concluded that mining has resulted in the release of sediments in the river.

Once the students fill this table, discuss the following questions with them:

- Do all the case studies follow a similar approach?
- Do all case studies follow the same sequence of scientific investigation?
- What would be the timeline for different case studies?
- How different are methodologies among these case studies?

What does this question make students do?

With this activity, students will learn about the process of a scientific investigation. They will understand that each scientific study may not follow a similar path.

Scientific Process, Reading and interpreting

Question

What is the impact of species extinction on an ecosystem?

Hint

Think about the effect on a food chain if a species goes extinct.

Suggested activity

This activity is to be done as a class discussion.

Suggested time: *1 hour*

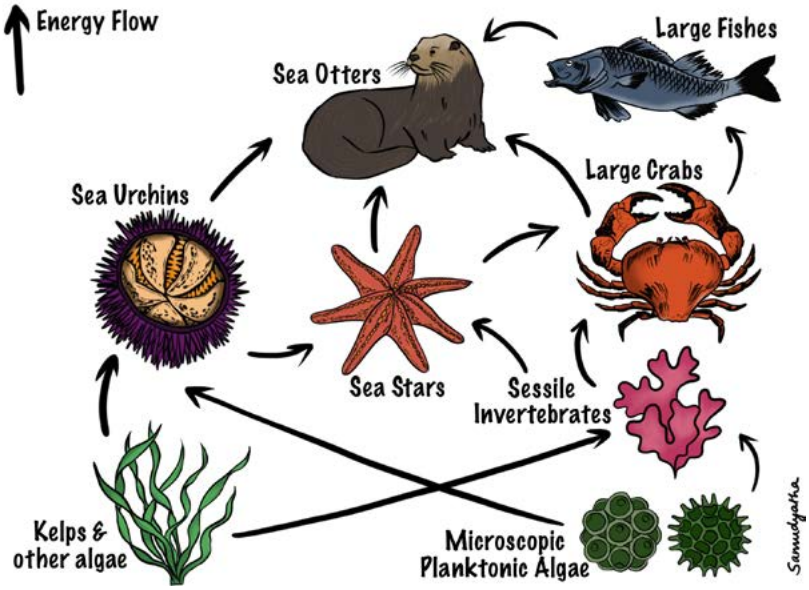
To answer this question, the teacher can introduce students to the following terms: trophic cascades, keystone species and apex predator.

- **Trophic cascades** - It is a phenomenon which results in changing the structure of an ecosystem due to the removal or addition of a species at a trophic level. There are two types of trophic cascades:
    - Top-down trophic cascades - it occurs when the top predators are removed from the higher trophic level. This results in the alteration of the food web at lower trophic levels.
    - Bottom-up trophic cascades - it occurs when the species are removed from the lower tropic levels, thus impacting higher trophic levels.

Teachers can use this simulation to explain this concept to the students: *https://bit.ly/3j1QLOm*

- **Keystone species** - the species that have a large impact on the structure and functioning of the ecosystem. The removal of keystone species will dramatically change the whole ecosystem, or it might cease to exist.

In the food web given below, sea otters are the keystone species that preferably feed on the sea urchins keeping their population in check. If the population of sea urchins increases excessively, they will feed on the kelps and reduce their population. Hence, sea otters help maintain the balance in the ecosystem



Using this food web as an example, ask the following questions to the students:

- What if the keystone species (Sea otters) is removed from this food web?
- Which organisms will be negatively affected by the removal of sea otters?
- Will the removal of sea otters have a positive impact on any species?

Answers:

- The removal of sea otters from this ecosystem will affect multiple species. This will lead to a cascading effect, disrupting the functioning of the ecosystem.
- Removal of sea otters will lead to an increase in the number of sea urchins, which in turn will decrease the kelps and other algae. Large fishes, octopuses, crabs, and sessile invertebrates will decrease in number.
- Sea stars and sea urchins will increase in number.

- **Apex predator** - The top predator in a food chain that does not have any natural predators of its own.

  For example, vultures are scavengers in an ecosystem that feed primarily on dead animal matter. They break down the organic matter and return nutrients to the soil. They are also an apex predator.

  Importance of vultures in an ecosystem:

  As vultures feed on the dead carcass, they prevent the spread of microbes that can cause deadly diseases such as tuberculosis, anthrax, brucellosis and foot and mouth disease, which can be a threat to the ecosystem. Vultures become the endpoints of these pathogens as they can digest the diseased carcasses due to their high body temperatures and corrosive stomach acids which

have pH values around 1.0. Thus, they protect wildlife, cattle, and humans from such infectious diseases.

What will be the impact of vulture extinction/decline in an ecosystem?

- Without vultures feeding on dead matter, the number of carcasses increases, which may lead to other organisms feeding on them, like dogs and rats. But these organisms do not have the physiology like vultures to eliminate diseases from the ecosystem. Since dogs and rats are not effective dead ends for diseases, they instead become carriers of the disease. One of the examples is the transmission of canine distemper from dogs to lions at Gir National Park, Gujarat. This led to the death of 24 endangered Asiatic lions.
- In the absence of vultures, the rate of decomposition will also decrease. This will lead to slow replenishment of nutrients in the soil, which can result in reduced soil fertility.

The teacher can discuss the following questions:

- Does the removal of each species have a similar effect on the ecosystem?
- If one species goes extinct, can it be replaced by another?
- Can the removal of an animal species affect the flora of the ecosystem and vice versa?

***Supplementary reading**: Prakash, V., 1999. Status of Vultures in Keoladeo National Park, Bharatpur, Rajasthan with special reference to population crash in Gyps species. Journal of the Bombay Natural History Society, 96, pp.365-378.*

Suggested readings:

Mondal, K., Gupta, S., Bhattacharjee, S., Qureshi, Q., & Sankar, K. (2012). Response of leopards to re-introduced tigers in Sariska Tiger Reserve, Western India. International Journal of Biodiversity and Conservation, 4(5), 228-236.

Suggested activity

Furthermore, we suggest that students look around their neighbourhood and note down the organisms they see and discuss the consequences of the extinction of those species.

What does this question make students do?

Students will learn about different cascading effects that occur in an ecosystem even with the removal of one species.

Additional reading:

One of the most annoying creatures for humans is mosquitoes. They are the carriers of many deadly diseases such as malaria, yellow fever, dengue fever, etc. Humans have often wondered what if there were no mosquitoes on earth. Will their eradication have negative cascading effects or life will simply go on? Read this article to understand what will happen if we remove mosquitoes from the ecosystem.

https://www.nature.com/articles/466432a

A1.3 Plant and Animal Distribution across the Western Ghats

Quantitative skills

Question

If it is not possible to count each organism in an area, then how do you estimate the biodiversity of a particular area?

Hint

Biodiversity estimation can be carried out using quadrat sampling

Answer: Species diversity is the most important and basic characteristic of a community. Diversity depends on species richness and abundance.

Suggested Activity

We have provided exercise A1.3 in the *chapter* that students can do in the class without requiring any extra material to understand the concept of biodiversity estimation.

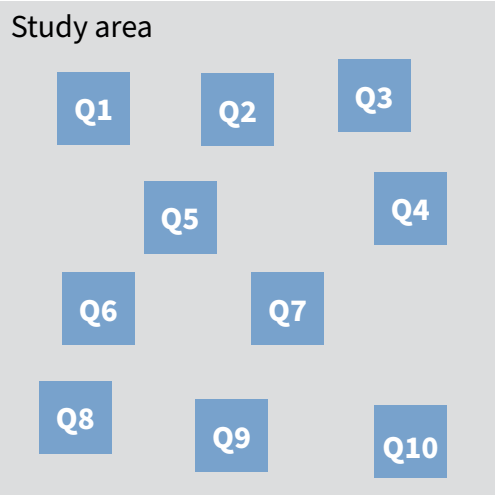
We suggest that students try to do this activity outside of class. They can do this activity in a nearby garden or any area with vegetation.

Background Information: Since it is physically impossible to count the number of organisms in a large area, sampling is done using quadrats. Quadrats are squares of a set size that are placed in a particular area. and plant and animal species within the quadrat are identified and their numbers are recorded. These quadrats are placed randomly in a study site.

Materials required: Hammer, nails, thread

Procedure:

- In the selected site, create a 1 m X 1 m quadrat with the help of nails and thread.
- Use a hammer to add nails to the soil, and make sure you do not destroy the vegetation.
- Place 10 such quadrats in your sampling site randomly. You can name them Q1, Q2 and so on.
- In each quadrat, count the number of individuals of each species.
- If you don't know a species name, then assign it an alphabet A, B, C and so on. Make sure you assign the same alphabet to each species in each quadrat.



Quadrats (in blue) laid in an area to be studied (grey)

Record your observations in the table given below.

Species name	Number of individuals in each quadrat										Total no. of individuals (N)	Population Density
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		
A												
B												
C												
D												
E												

Population density = total number of individuals / Total number of quadrats

Estimate the biodiversity using Shannon's diversity index:

$$H = -\sum[(p_i) \times \ln(p_i)]$$

Where,

p_i = proportion of total sample represented by species i (divide number of individuals of species i by total number of samples)

S = number of species or species richness

H_{max} = ln (S) = maximum diversity possible

E = evenness = H/H_{max} (Shannon's diversity index)

Note:

- This quadrat sampling can be used for plants and slow-moving organisms such as bugs, snails, etc. It cannot be used for bigger organisms.
- The size of the quadrat can be altered based on the size of the area studied.

> Suggestion:
> If it is not possible to do this activity outside, then we recommend that students use the simulation to understand biodiversity estimation on this website:
> *https://amrita.olabs.edu.in/?sub=79&brch=18&sim=239&cnt=4*

Some questions for discussion in the class:

- What are some limitations of measuring biodiversity using quadrat sampling?
- How can you sample faster-moving animals?

What does this question make students do?

Students will learn to measure biodiversity using species richness and abundance in a given community.

A1.4 Commons: Many Takers of the Kudremukh National Park

Bridging science, society and environment; Reading and Interpreting

Question

Select forest produce that you use in your household. Find out where it comes from, and who is involved in harvesting the raw materials. Do you think the practices are sustainable?

Hint

You will have to do some Internet searches to find out about the specifics of the product. To judge whether a product is sustainable, you should look at several aspects: livelihoods, short- and long-term impact on the environment including surrounding flora and fauna, water bodies, and soil quality.

Suggested Activity

For this activity, we suggest doing a stakeholder analysis in the class.

***Suggested time**: 1 class*

Stakeholder simply means an individual or group that has an interest in any decision or activity or they are affected by it.

To do a stakeholder analysis, you need to identify key players involved in a particular activity.

Divide students into groups of 4. To each group, provide a forest product that they commonly use in their households. Ask each group to identify key stakeholders for that forest produce and fill in the table given below.

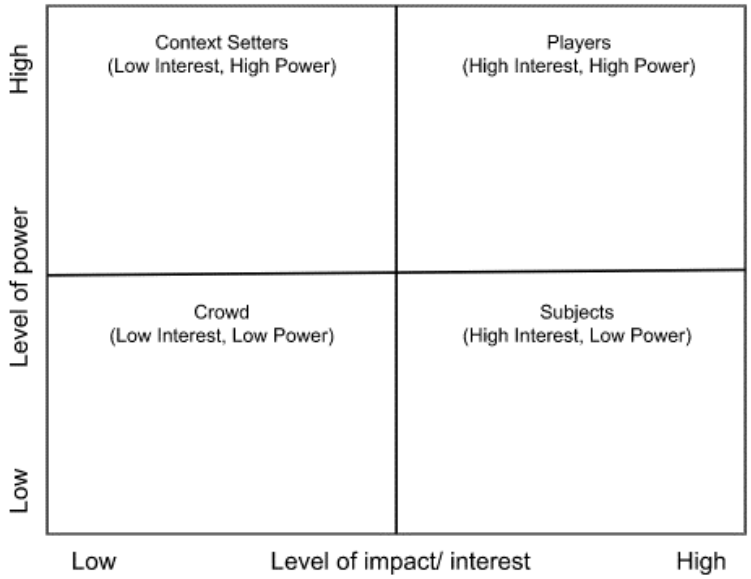
For example, one of the most common forests produce in a household is fruits and honey. The stakeholders associated with collecting produce to delivering them to your house are –

Farmers, workers, seed providers, water availability, the pesticides industry, government, banks or insurance companies, distributors, retailers, and consumers.

Identify which of the stakeholders have the most power and impact, and which have the least. Fill in the table given below and discuss the following in the class:

- Do all the key stakeholders hold an equal share of power?
- Discuss how can honey and fruits be grown sustainably?
- What is sustainable harvesting?
- Who decides what is sustainable?
- How can one make harvests more sustainable?

- Which stakeholder do you think should have the highest power? Why?
- Whose interest is it to keep the harvest sustainable?



This activity can be done for multiple forest produce that is used in our household, such as timber, spices, oil, etc.

What does this question make students do?

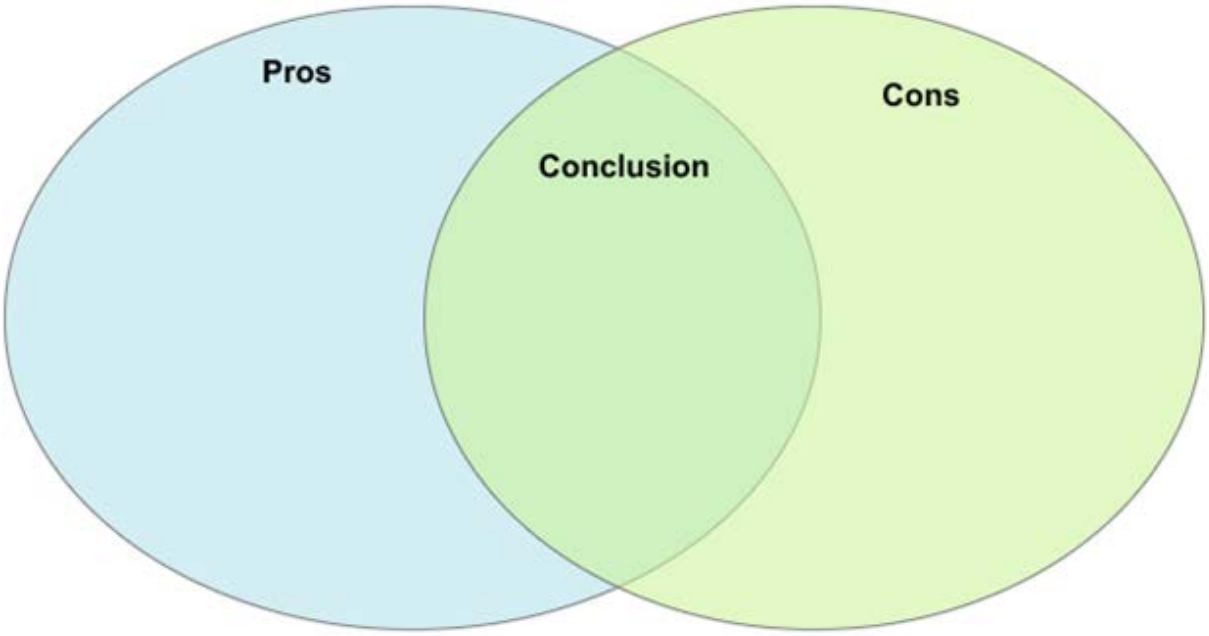
This activity will help students understand the role of all the stakeholders involved in a process. They will be able to identify key stakeholders and how can forest produce be made more sustainable.

Annexure-I

Worksheet - 1

Students will fill out the list of pros and cons along with the conclusion they can draw for different types of renewable energy.

Suggested time: 20 minutes



Worksheet-2

Students are expected to read the material before coming to class.

Suggested time to fill the table - 40 mins

Steps	Case study - 1	Case study - 2	Case study - 3	Case study - 4
Observation				
Question				
Hypothesis				
Experiment				
Results				
Conclusions				

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