COURSE
GUIDE

EHS 210
BIODIVERSITY AND CLIMATE CHANGE

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INTRODUCTION

EHS 210 Biodiversity and Climate Change is a two (2) credit unit compulsory course for all students offering Bachelor of Science (B.EHS). Biodiversity and climate change refers to the variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form. This living wealth is the product of hundreds of millions of years of evolutionary history. In places as ancient as Australia, this history can still be seen today in 'living fossils' whose origins date back hundreds of millions of years.

Biodiversity is the variety and differences among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part. It is virtually synonymous with “Life on earth”.

Biologists most often define "biological diversity" or "biodiversity" as the "totality of genes, species, and ecosystems of a region”. The biodiversity found on Earth today consists of many millions of distinct biological species, which is the product of nearly 3.5 billion years of evolution.

WHAT YOU WILL LEARN IN THIS COURSE

In this course, you have the course units and a course guide. The course guide will tell you what the course is all about. It is the general overview of the course materials you will be using and how to use those materials. It also helps you to allocate the appropriate time to each unit so that you can successfully complete the course within the stipulated time limit.

The course guide also helps you to know how to go about your Tutor-Marked Assignments (TMAs) which will form part of your overall assessment at the end of the course. Also, there will be regular tutorial classes that are related to this course, where you can interact with your facilitators and other students. Please, I encourage you to attend these tutorial classes.

COURSE AIM

The course aims to give you a understanding of Biodiversity which is an important branch of Biology.

COURSE OBJECTIVES

To achieve the aim set above, there are objectives. Each unit has a set of objectives presented at the beginning of the unit. These objectives will give you what to concentrate / focus on while studying the unit. Please read the objectives before studying the unit and during your study to check your progress.

The comprehensive objectives of the Course are given below. At the end of the course/after going through this course, you should be able to:

- Explain the concept of biodiversity
- List various life-forms both contemporary and extinct
- Explain the concept of genetic diversity
- Discuss the fundamentals of biodiversity
- Explain the meaning of the term: species diversity
- Explain the types of ecosystems
- Explain the types of ecosystems
- Discuss the fundamentals of biodiversity
- Explain the meaning of the term ecosystem diversity.
- Explain the meaning of ecological sampling
- List and explain different sampling techniques
- Compare advantages and otherwise of different sampling methods
- List the sources of biodiversity record
- Explain the sources of Biodiversity Records
- List the ecosystem benefits of Biodiversity
- Explain biodiversity as Biological resource
- Examine the social benefits of Biodiversity
- Define the term extinction
- List and explain factors causing extinction
- Explain species richness and abundance
- List and explain the factors affecting distribution
- Explain climate change in relation to animal survival
- Define the terms sustainability and survival.
- Define conservation
- List and explain the various conservation efforts.

WORKING THROUGH THIS COURSE

To successfully complete this course, you are required to read each study unit in the course material provided by the National Open University of Nigeria.

Reading the referenced materials can also be of great assistance.

Each unit has self-assessment exercises which you are advised to do and at certain periods during the course you will be required to submit your assignment for the purpose of assessment.

There will be a final examination at the end of the course. The course should take you about 17 weeks to complete.

This course guide will provide you with all the components of the course, how to go about studying it and how you should allocate your time to each unit so as to finish on time and successfully.

THE COURSE MATERIAL

The main components of the course are:

- The Study Guide
- Study Units
- Reference/Further Readings
- Assignments
- Presentation Schedule

STUDY UNITS

The study units for this course are made up of three (3) modules and nine (9) units as given below:

Module 1 Introduction to the Concept of Biodiversity

Unit 1 Genetic Diversity

Unit 2 Species Diversity

Unit 3 Ecosystem Diversity

Module 2 Biodiversity Sampling

Unit 1 Methods of Sampling Biodiversity

Unit 2 Sources of Biodiversity Records

Unit 3 The Value of Biodiversity Components

Module 3 Climate Change, Biological Sustainability and Survival

Unit 1 Biodiversity and species extinction

Unit 2 Animal survival and sustainability

Unit 3 The Role of Climate and Animal Extinction in Relation to Biological Sustainability and Animal Survival

Module 1 is concerned with understanding biodiversity as it relates to specialisation.

Units one to two examine the driving forces for biodiversity ranging from gene diversity to ecosystem diversity as they affect species adaptation while Unit 3 covers the aspect of species extinction as a result of environmental dynamics discussed in the introduction. It highlights the factors inducing extinction of species and also factors responsible for species abundance and distribution.

Module 2 examines biodiversity sampling procedures, advantages and disadvantages of specific sampling procedure. Unit two critically looks at sources of biodiversity records while the module ends with the value of biodiversity to man

Module 3, unit one focuses on climate change, meaning and effect on ecosystem sustainability and species survival. Unit three is centered on conservation of biodiversity and sundry efforts geared towards preventing species extinction.

There are activities related to the lecture in each unit which will help your progress and comprehension of the unit. You are required to work on these exercises which together with the TMAs will enable you to achieve the objectives of each unit.

ASSIGNMENT FILE

There are two types of assessments in this course. First are the Tutor-Marked Assessments (TMAs); second is the written examination. In solving the questions in the assignments, you are expected to apply the information, knowledge and experience acquired during the course. The assignments must be submitted to your facilitator for formal assessment in accordance with prescribed deadlines stated in the assignment file. The work you submit to your facilitator for assessment accounts for 30 percent of your total course mark. At the end of the course, you will be required to sit for a final examination of 1½ hours duration at your study center. This final examination will account for 70 % of your total course mark.

PRESENTATION SCHEDULE

There is a time-table prepared for the early and timely completion and submission of your TMAs as well as attending the tutorial classes. You are required to submit all your assignments at the stipulated time and date. Avoid falling behind the schedule time. The presentation schedule included in this course guide provides you with important dates for completion of each e-tutor marked assignment (e-TMAs). You should therefore try to meet the deadlines.

ASSESSMENT

There are three aspects to the assessment for this course. The first one is the self-assessment exercises. The second is the Tutor Marked Assignments and the third is the written examination which is to be taken at the end of the course.

Do the exercises or activities in the units by applying the information and knowledge you acquired during the course. The Tutor Marked Assignments must be submitted to your facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file.

The work submitted to your tutor for assessment will count for 30% of your total course work. At the end of this course, you have to sit for a final or end of course examination of 1½ hours duration which will count for 70% of your total course mark.

TUTOR-MARKED ASSIGNMENTS (TMAS)

This is the continuous assessment component of this course and it accounts for 30% of the total score. You will be given four (4) TMAs by your facilitator to answer. Three of which must be answered before you are allowed to sit for the end of course examination. The mean TMA score will be computed with the examination score to give you your final score in the course. Note that if you did not complete your TMAs, even though you sit for the examination, your score will not be computed because there is no TMA score. So please endeavor to do all your TMAs. These answered assignments must be returned to your facilitator.

You are expected to complete the assignments by using the information and material in your readings references and study units. Reading and researching into you references will give you a wider view point and give you a deeper understanding of the subject.

1. Make sure that each assignment reaches your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you are not able to complete your assignment, make sure you contact your facilitator before the assignment is due to discuss the possibility of an extension. Request for extension will not be granted after the due date unless there in exceptional circumstances.

2. Make sure you revise the whole course content before sitting or the examination. The self-assessment activities and TMAs will be useful for this purpose and if you have any comment please do before the examination. The end of course examination covers information from all parts of the course.

FINAL EXAMINATION AND GRADING

The final examination for EHS 210: Biodiversity and climate change will be of 1½ hours duration. This accounts for 70 % of the total course grade. The examination will consist of questions which reflect the practice, exercises and the tutor-marked assignments you have already attempted in the past. Note that all areas of the course will be assessed. To revise the entire course, you must start from the first unit to the twelfth unit in order to get prepared for the examination. It may be useful to go over your TMAs and probably discuss with your course mates or group if need be. This will make you to be more prepared, since the examination covers information from all aspects of the course.

COURSE MARKING SCHEME

Table 1: Course Marking Scheme

Assignments	**Marks**
Tutor Marked Assignments (TMAs) 1 – 4	Four TMAs, best three marks out of the four count at 10% each, i.e. 30% of course marks.
End of course examination	70% of overall course marks
Total	**100% of course materials**

Table 2: Course Organisation

Unit	**Title of Work**	**Weeks Activity**	**Assessment (End of Unit)**
	Course Guide	**Week**	
1	Genetic diversity	Week 1	Assignment 1
2	Species diversity	Week 2	Assignment 2
3	Ecosystem diversity	Week 3	Assignment 3
4	Methods of sampling biodiversity	Week 4	Assignment 4
5	Sources of biodiversity records	Week 5	Assignment 5
6	The value of biodiversity components	Week 6	Assignment 6
7	Biodiversity and species extinction	Week 7	Assignment 7
8	Animal survival and sustainability	Week 8	Assignment

			8
9	The role of climate and animal extinction in relation to biological sustainability and animal survival	Week 9	Assignment 9

HOW TO GET THE MOST OUT OF THIS COURSE

In distance learning, the study units replace the university lecturer. This is one of the huge advantages of distance learning mode; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best. Think of it as reading from the teacher, the study guide tells you what to read, when to read and the relevant texts to consult. You are provided exercises at appropriate points, just as a lecturer might give you an in-class exercise.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next to this is a set of learning objectives. These learning objectives are meant to guide your studies. The moment a unit is finished, you must go back and check whether you have achieved the objectives. If this is made a habit, then you will significantly improve your chances of passing the course.

The main body of the units also guides you through the required readings from other sources. This will usually be either from a set book or from other sources.

Self-assessment exercises are provided throughout the unit, to aid personal studies and answers are provided at the end of the unit. Working through these self-tests will help you to achieve the objectives of the unit and also prepare you for tutor marked assignments and examinations. You should attempt each self-test as you encounter them in the units.

The following are practical strategies for working through this course

1. Read the Course Guide thoroughly.

2. Organize a study schedule. Refer to the course overview for more details. Note the time you are expected to spend on each unit and how the assignment relates to the units. Important details, e.g. details of your tutorials and the date of the first day of the semester are available. You need to gather together all these information in one place such as a diary, a wall chart calendar or an organizer. Whatever method you choose, you should decide on and write in your own dates for working on each unit.

3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course works. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.
4. Turn to Unit 1 and read the introduction and the objectives for the unit.
5 . Assemble the study materials. Information about what you need for a unit is given in the table of contents at the beginning of each unit. You will almost always need both the study unit you are working on and one of the materials recommended for further readings, on your desk at the same time.
6. Work through the unit, the content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit, you will be encouraged to read from your set books.
7. Keep in mind that you will learn a lot by doing all your assignments carefully. They have been designed to help you meet the objectives of the course and will help you pass the examination.
8. Review the objectives of each study unit to confirm that you have achieved them. If you are not certain about any of the objectives, review the study material and consult your tutor.
9. When you are confident that you have achieved a unit's objectives, you can start on the next unit. Proceed unit by unit through the course and try to pace your study so that you can keep yourself on schedule.
10. When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also that written on the assignment. Consult you tutor as soon as possible if you have any questions or problems.
11. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this course guide).

FACILITATORS/TUTORS AND TUTORIALS

Sixteen (16) hours are provided for tutorials for this course. You may be notified of the dates, times and location for these tutorial classes if the number of students offering the course meets the University requirement for the course to be facilitated. As soon as you are allocated a tutorial group, the name and phone number of your facilitator will be given to you.

These are the duties of your facilitator: He or she will mark and comment on your assignments. He will monitor your progress and provide any necessary assistance you may need. He or she will mark your TMAs and return to you as soon as possible.

Do not delay to contact your facilitator by telephone or e-mail for necessary assistance if you do not understand any part of the study units in the course material; you have difficulty with the self-assessment activities; you have a problem or question with an assignment or with the grading of the assignment.

It is important and necessary you attend the tutorial classes because this is the only chance to have face to face content with your facilitator and to ask questions which will be answered instantly. It is also a period where you can say any problem encountered in the course of your study.

SUMMARY

Biodiversity and Climate Change (EHS210) is a course that introduces you to the variety of life form. In this unit, you will learn about what conservation is all about; the need to conserve biodiversity and various methods of conservation will be critically examined.

Conservation of biodiversity is an integral part of efforts towards ecosystem sustenance and checking the effect of species extinction as well rolling back the effects of global warming.

On completion of this course, you will have an understanding of basic knowledge of biodiversity, the history of men and women who contributed to this field of study by their discoveries during their research works and the general characteristics. In addition you will be able to answer the following questions:

1. Explain the term biodiversity
2. How does the gene factor drive or induce biodiversity
3. examine biodiversity in the light of species diversity
4. State the ecosystem component
5. Explain the factors resulting in different ecosystems
6. Explain the term ecological sampling
7. Briefly compare and contrast any two sampling methods

The list of questions you are expected to answer is not limited to the above list. Finally, you are expected to apply the knowledge you have acquired during this course to your practical life.

I wish you success in this course.

MAIN COURSE

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MODULE 1 INTRODUCTION TO THE CONCEPT OF BIODIVERSITY

UNIT 1 GENETIC DIVERSITY

CONTENTS

1.0 INTRODUCTION

Biological diversity or biodiversity refers to the variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form. This living wealth is the product of hundreds of millions of years of evolutionary history. In places as ancient as Australia, this history can still be seen today in 'living fossils' whose origins date back hundreds of millions of years.

Biodiversity is the variety and differences among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part. It is virtually synonymous with “Life on earth”. Biologists most often define "biological diversity" or "biodiversity" as the "totality of genes, species, and ecosystems of a region. The biodiversity found on earth today consists of many millions of distinct biological species, which is the product of nearly 3.5 billion years of evolution. Biological diversity or biodiversity is the term given to the variety of life on earth and the natural patterns it forms, the variety and variability of life-forms, both contemporary and extinct, including genetic and ecosystem diversity, in a defined area at and over time. Biological diversity is a measure of the diversity of all life at all levels of organization.

Biodiversity is all of the hereditary variation in organisms, from differences in ecosystems to the species composing each ecosystem, thence to the genetic variation in each of the species. As a term, biodiversity may be used to refer to the variety of life of all of Earth or to any part of its Living structures called stromatolites which can be seen in Shark Bay, Western Australia, represent one of the longest continual biological lineages known, some 1900 million years. The process of evolution means that the pool of living diversity is dynamic: it increases when new genetic variation is produced, a new species is created or a novel ecosystem formed; it decreases when the genetic variation within a species decreases, a species becomes extinct or an ecosystem complex is lost. The concept emphasises the interrelated nature of the living world and its processes.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- explain the concept of biodiversity
- list various life-forms both contemporary and extinct
- explain the concept of genetic diversity.

3.0 MAIN CONTENT

3.1 Genetic Diversity

Genetic diversity refers to the variation of genes within species. This covers genetic variation between distinct populations of the same species, such as the four varieties of white-cheeked rosella, *Platycercuseximius.* It also covers genetic variation within a population, which tends to be relatively high in widespread eucalypts such as *Eucalyptus cloeziana*, *E. delegatensis*, and *E. saligna*. Genetic diversity can be measured using a variety of DNA-based and other techniques.

New genetic variation is produced in populations of organisms that can reproduce sexually by recombination and in individuals by gene and chromosome mutations. The pool of genetic variation present in an interbreeding population is shaped by selection. Selection leads to certain genetic attributes being preferred and results in changes to the frequency of genes within this pool. The large differences in the amount and distribution of genetic variation can be attributed in part to the enormous variety and complexity of habitats, and the different ways organisms obtain their living.

One estimate is that there are 10,000,000,000 different genes distributed across the world's biota, though they do not all make an identical contribution to overall genetic diversity. In particular, those genes which control fundamental biochemical processes are strongly conserved across different species groups (or taxa) and generally show little variation. Other more specialized genes display a greater degree of variation.

Figure 1: Genetic variation within the White-cheeked Rosella. Source: Wikipedia

The White cheeked Rosella, for example, is made up of four varieties, each with its own distinct colour combination and markings. The diagram shows where these varieties are found. Genetic variation within a species can express itself in many ways.

3.2 Levels of Biodiversity

Biological diversity is usually considered at three different levels:

i. Genetic diversity refers to the variety of genetic information contained in all of the individual plants, animals and microorganisms. Genetic diversity occurs within and between populations of species as well as between species.
ii. Species diversity refers to the variety of living species.
iii. Ecosystem diversity relates to the variety of habitats, biotic communities, and ecological processes, as well as the tremendous

diversity present within ecosystems in terms of habitat differences and the variety of ecological processes.

4.0 CONCLUSION

In this unit, you learnt about the general idea on biodiversity. Also, you were introduced to gene mediated diversity and factors affecting gene expression. You have been introduced into the field of biodiversity including the fundamental reason for this study. You were also introduced to the effects of genes on biodiversity.

5.0 SUMMARY

Biological diversity or biodiversity refers to the variety of life forms in ecosystems. These living wealth arise from evolution. Biodiversity portrays the variety and differences among living organisms addressing the hereditary variation in organisms, from differences in ecosystems at genetic, species or ecosystem levels. Genetic diversity refers to the variation of genes within and between species and covers genetic variation within a population. It can be measured with a variety of DNA-based and other techniques. New genetic variation is produced in populations that can reproduce sexually by recombination and in individuals by gene and chromosome mutations. Selection produces some preferred genetic attributes and results in changes in the frequency of genes within the pool.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the term biodiversity.
2. How does the gene factor drive or induce biodiversity.

7.0 REFERENCES/FURTHER READING

Jefferies, M. J. (1997). Biodiversity Conservation. New York:Routledge.

O'Riordan, T. (Ed.). (1995). Environmental Science for Environmental Management. Harlow: Longman.

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Biodiversity and climate change picture. Worlddatlabs.com. Front page

UNIT 2 SPECIES DIVERSITY

CONTENTS

1.0 INTRODUCTION

Species diversity refers to the variety of species. Aspects of species diversity can be measured in a number of ways. Most of these ways can be classified into three groups of measurement: species richness, species abundance and taxonomic or phylogenetic diversity. Measure of species richness, count the number of species in a defined area and measure of species abundance, sample the relative numbers among species. A typical sample may contain several very common species, a few less common species and numerous rare species. Measures of species diversity that simplify information on species richness and relative abundance into a single index are in extensive use.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- discuss the fundamentals of biodiversity
- explain the meaning of the term species diversity.

3.0 MAIN CONTENT

3.1 Species Diversity

Species diversity refers to the variety of species. Aspects of species diversity can be measured in a number of ways. Most of these ways can be classified into three groups of measurement: species richness, species abundance and taxonomic or phylogenetic diversity.

Measure of species richness, count the number of species in a defined area and measure of species abundance, sample the relative numbers among species. A typical sample may contain several very common species, a few less common species and numerous rare species.

Measures of species diversity that simplify information on species richness and relative abundance into a single index are in extensive use. Another approach is to measure taxonomic or phylogenetic diversity, which considers the genetic relationships between different groups of species. These measures are based on analysis which results in a hierarchical classification usually represented by a 'tree' that depicts the branching pattern which is thought to best represent the phylogenetic evolution of the taxa concerned.

Different measures of taxonomic diversity emphasise various taxic characteristics and relationships. The species level is generally regarded to be the most appropriate to consider the diversity between organisms. This is because species are the primary focus of evolutionary mechanisms and therefore are relatively well defined. At the global level, an estimated 1.7 million species have been described to date; current estimates for the total number of species in existence vary from five million to nearly 100 million. In Australia, with an estimated total number of native species (excluding bacteria and viruses) of 475 000, about half are known, but only a quarter formally described. Estimations of the number of species can be expected to improve with study into a number of poorly assessed groups: namely microorganisms, fungi, nematodes, mites and insects.

On a broad scale species diversity is not evenly distributed across the globe. The single most obvious pattern in the global distribution of species is that overall species richness is concentrated in equatorial regions and tends to decrease as one moves from equatorial to polar regions. In general, there are more species per unit area in the tropics than in temperate regions and far more species in temperate regions than there are in Polar Regions. In addition, diversity in land ecosystems generally decreases with increasing altitude. Other factors which are generally believed to influence diversity on land are rainfall patterns and nutrient levels. In marine ecosystems, species richness tends to be concentrated on continental shelves, though deep sea communities are also significant.

4.0 CONCLUSION

In this unit, you learnt about biodiversity in general and specifically highlights species diversity as a component of biodiversity. You learnt species diversity and its component parts which include species richness and abundance as well as their taxonomic or phylogenetic diversity.

5.0 SUMMARY

Species diversity refers to the variety of species. Species diversity can be measured by species richness, species abundance and taxonomic or phylogenetic diversity; the most extensive used being that which simplify information on species richness and relative abundance into a single index. Diversity between organisms is best considered at the species level. On a broad scale species diversity is not evenly distributed across the globe, but in the following order: Tropics > Temperate regions > Polar regions. Other factors that influence diversity on land are rainfall patterns and nutrient levels. In marine ecosystems however, species richness tends to be concentrated on continental shelves.

6.0 TUTOR-MARKED ASSIGNMENT

Examine biodiversity in the light of species diversity.

7.0 REFERENCES/FURTHER READING

Beattie, A. (1991). Biodiversity and Bioresources - The Forgotten Connection. Search, Vol 22, No 2, March 1991.

McNeely, J.A. (1988). Economics and Biological Diversity. IUCN, Gland, Switzerland.

Ecologically Sustainable Development (ESD) Working Group on Tourism. (1991). Ecologically Sustainable Development Working Groups: Final Report - Tourism. AGPS, Canberra.www.wikipedia.com

UNIT 3 ECOSYSTEM DIVERSITY

CONTENTS

1.0 INTRODUCTION

Ecosystem diversity encompasses the broad differences between ecosystem types, and the diversity of habitats and ecological processes occurring within each ecosystem type. It is harder to define ecosystem diversity than species or genetic diversity because the 'boundaries' of communities (associations of species) and ecosystems are more fluid. Since the ecosystem concept is dynamic and thus variable, it can be applied at different scales, though for management purposes it is generally used to group broadly similar assemblages of communities, such as temperate rainforests or coral reefs. A key element in the consideration of ecosystems is that in the natural state, ecological processes such as energy flows and water cycles are conserved.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- explain the types of ecosystems
- discuss the fundamentals of biodiversity
- explain the meaning of the term ecosystem diversity.

3.0 MAIN CONTENT

3.1 Ecosystem Diversity

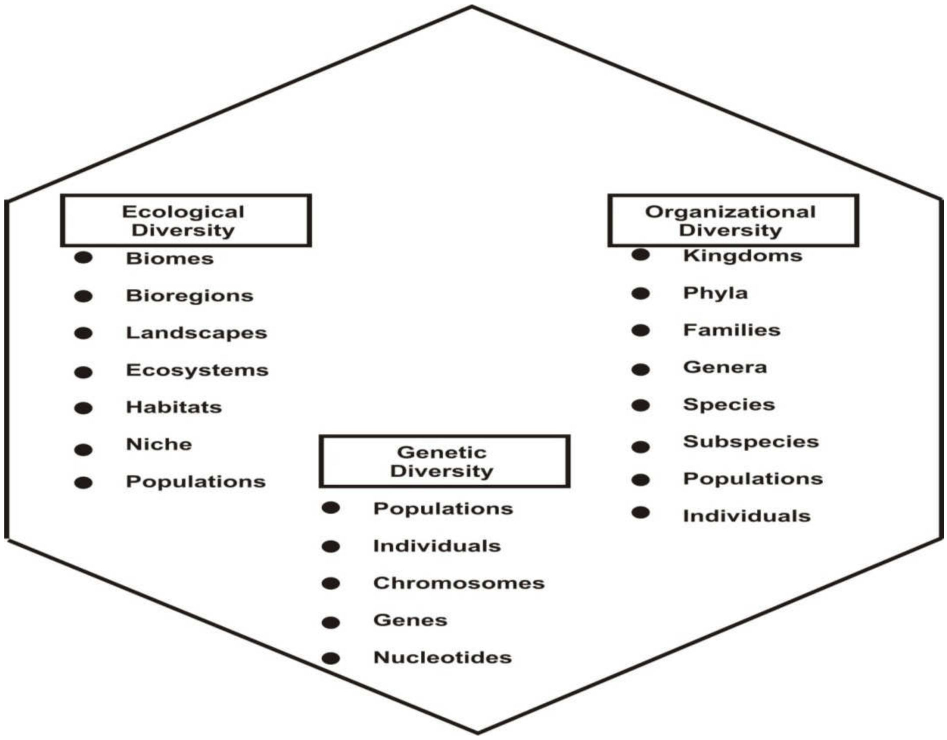
The classification of the Earth's immense variety of ecosystems into a manageable system is a major scientific challenge, and is important for management and conservation of the biosphere. At the global level, most classification systems have attempted to steer a middle course between the complexities of community ecology and the oversimplified terms of a general habitat classification.

Generally these systems use a combination of a habitat type definition with a climatic descriptor; for example, tropical moist forest, or temperate grassland. Some systems also incorporate global biogeography to account for differences in biota between regions of the world which may have very similar climate and physical characteristics.

Australia and its territories encompass an enormous range of terrestrial and aquatic environments, from polar ice-caps to arid grasslands and tropical rainforests, from coral reefs to the deep sea. Each of these comprises a great variety of habitats and interactions between and within biotic and abiotic components. For example, the spinifex grasslands of the arid zone encompass both treed and treeless communities. Within each spinifex tussock itself there are a range of microhabitats. Different species involved in a range of ecological processes such as seed dispersal (for example, by ant species) and nutrient recycling occur within each microhabitat.

The measurement of ecosystem diversity is still in its infancy. Nevertheless, ecosystem diversity is an essential element of total biodiversity and accordingly should be reflected in any biodiversity assessment.

Figure 2: Composition and level of Biodiversity



4.0 CONCLUSION

In this unit, you have learnt the broad description of the ecosystem and attempts at narrowing the diverse ecosystems into manageable units. You were taught about the fundamentals of the ecosystem as a larger unit containing various habitat types. You also learnt about the interplay of biotic and abiotic factors resulting in different ecosystems.

5.0 SUMMARY

Ecosystem diversity comprises the broad differences between ecosystem types, and the diversity of habitats and ecological processes occurring within each ecosystem type. It can be applied at different scales, though for management purposes it is generally used to group broadly similar assemblages of communities, such as temperate rainforests or coral reefs. A key element in the consideration of ecosystems is that ecological processes are conserved in the natural state.

The classification of the Earth's immense variety of ecosystems into a manageable system is a major scientific challenge, and is important for management and conservation of the biosphere.

6.0 TUTOR-MARKED ASSIGNMENT

1. State the ecosystem component.
2. Explain the factors resulting in different ecosystems.

7.0 REFERENCE/FURTHER READING

Plotkin, M.J. (1988). The outlook for new agricultural and industrial products from the tropics. In: E.O. Wilson (ed) *Biodiversity*. National Academy Press, Washington DC.pp.106-116.

Reid, W.V. and Miller, K.R. (1989*). Keeping Options Alive: The Scientific Basis for Conserving Biological Diversity*. World Resources Institute, Washington DC.

Tyler, M.J. (1989). *Australian Frogs*. Viking O'Neil, Melbourne.
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MODULE 2 BIODIVERSITY SAMPLING METHODS

UNIT 1 SAMPLING METHODS

CONTENTS

1.0 INTRODUCTION

Random sampling is usually designed to ensure that each of the population of sampling units has an equal chance of being selected.
Standard statistical methods can then be used to analyze the data. Plot location should not in any way be influenced by any prior knowledge. Randomly located plots are picked from a numbered list of all plots that could be surveyed, by using random numbers generated by a computer or from tables. Locating plots by eye does not yield randomness, because samples are usually spaced too evenly. Throwing quadrats to obtain locations, although better than locating by eye, does not achieve true randomness either (this is known as haphazard sampling). Random samples can, however, be time-consuming to locate in the field.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

i. explain the meaning of ecological sampling
ii. list and explain different sampling techniques
iii. compare advantages and otherwise of different sampling methods.

3.0 MAIN CONTENT

3.1 Method of Studying Biodiversity

3.1.1 Random Sampling

When the goal of sampling is to provide an indication of what is happening across the whole site, random sampling designs are generally recommended. Random sampling is usually designed to ensure that each of the population of sampling units has an equal chance of being selected.

Standard statistical methods can then be used to analyze the data. Plot location should not in any way be influenced by any prior knowledge. Randomly located plots are picked from a numbered list of all plots that could be surveyed, by using random numbers generated by a computer or from tables. Locating plots by eye does not yield randomness, because samples are usually spaced too evenly. Throwing quadrats to obtain locations, although better than locating by eye, does not achieve true randomness either (this is known as haphazard sampling). Random samples can, however, be time-consuming to locate in the field.

Units that are found to fall outside the area are ignored. Transect lines may also be located by utilizing these points. Transects are essentially long, thin quadrats, and many of the same considerations apply. The direction of fixed-length transect lines should usually be randomly allocated. However, it may be desirable to select a direction that allows samples to be taken along a perceived environmental gradient (e.g. a transition from acid to calcareous grassland). This has the effect of reducing variation between transects, thereby improving precision.

Sometimes it is impossible not to deviate from randomness when sampling, for instance if access to a particular area is not possible. If the inaccessible area is small this may not matter, but if significant bias is possible, the issue should be documented and population estimates may need adjustment.

3.1.2 Systematic Sampling

It is often convenient to take samples at regular intervals, for instance at fixed distances along a river. However, this method creates one main problem: if the sampling interval constantly coincides with a particular regularity in a species or habitat being monitored, the results will be biased. For example, if you are sampling vegetation at 10 m intervals, and this interval coincides with the raised parts of a hummock–hollow microtopography (perhaps stretching the example!), the vegetation in the hollows (which may be different) will not be sampled. The results will therefore give a biased picture of the vegetation. Systematic samples are not placed independently of each other (unlike random samples) so, strictly, statistical analysis is not valid. However, if a large number of samples are taken, systematic samples can usually be treated as random samples without causing substantial problems, unless a systematic bias such as that outlined above occurs. Sophisticated statistical techniques have been developed for spatial analysis of both systematic and random samples, which enable distribution and density maps to be developed as well as providing alternative estimation methods. Systematic sampling can be useful because sample sites are relatively easy to select and relocate, and the approach is often more appealing and straightforward to surveyors. A particular use may be when trying to map both distribution and total abundance of an organism across a study area. The advantages of a regular distribution of sample sites might then outweigh the population estimation disadvantages, for example, if a distribution map based on a regular grid were the objective of the study. Grid surveys repeated regularly can provide excellent comparative data to identify potential causes and influences of change.

3.1.3 Stratified Sampling

Stratified sampling is very commonly used in environmental monitoring as a way of improving the precision of estimates. Very often there is substantial variation across the site in the feature attributes being measured. This may be due to environmental gradients or differences in management, for example. In this situation it makes sense to divide the site into sub-units (strata) that relate to the different values of the attributes being monitored (e.g. different densities of a particular species) and sample each sub-unit separately. Separate estimates are then made for each stratum, which are then combined to provide an estimate for the whole site.

The advantages include:

i. An attribute can be estimated with greater precision, provided that the value of the attribute differs substantially between strata and there is more variation in the attribute between strata than within strata uses and influences of change.

ii. Separate estimates can be made for each stratum if these are of interest in their own right.

iii. Stratification slightly reduces the time taken to randomly locate samples.

To maximise the benefits of stratification the site should be subdivided in such a way that it minimizes the within-stratum variability in the attribute being measured (i.e. strata should be as uniform, or homogeneous, as possible). This normally requires previous survey data or a preliminary survey to be carried out. Alternatively, you can stratify according to known site variations in habitat or ecological factors, which are believed to influence the feature attributes (e.g. a sudden change in soil type).

Although these divisions are not going to be as accurate, as long as there is lower variability within strata this sampling method will provide better results than simple sampling across the whole site. If the cost of sampling varies, or the within stratum variance in each stratum differs, sampling should be more intensive in the strata in which the costs of sampling are lower or which are more variable. Sample size should be proportional to the size of the strata if the costs and variances of each stratum are similar, or in the absence of such information.

3.1.4 Multi-Stage and Cluster Sampling

In many situations a site may be so large that a high proportion of time is spent travelling between sample sites. In this instance cluster or multi-stage sampling could be considered as a means of increasing sampling efficiency and in some instances can improve precision for a given sample size. Multistage sampling is also known as multi-level sampling or subsampling. With multi-stage and cluster sampling a major sample unit is selected, which is divided up into minor units. Data are then collected from some or all of the minor units. With cluster sampling all the minor units are sampled, but with multi-stage sampling a random or systematic sample of minor units is selected. In some cases the minor units are themselves sampled (three-stage sampling) but two-stage sampling is the most common technique. A common example is one in which the major units are transects and the minor units are quadrats along each transect. If all quadrats are sampled this is known as a belt transect.

The main consideration with this technique is that sample units within each major unit are unlikely to be independent of one another since spatial correlation may occur (i.e. sample units are likely to be more similar the closer they are to each other). Unless the minor units are sufficiently far apart to avoid this, overall precision is likely to be mainly determined by the variation between the major units. In cluster sampling, the minor units are usually combined and analysis is reduced to simple random sampling of the major units. This may still be advantageous, compared with simple random sampling of minor units, if there is a significant reduction in the variation between sampling units as these units get larger.

Thus, cluster and multi-stage sampling are likely to be most useful when the area being sampled is relatively uniform at large spatial scales and most of the variance occurs at small spatial scales (but at scales larger than the size of the sample unit). Transects will be most effective if oriented along a gradient in the attribute being measured. For example, in a study of tree regeneration around woodland, the transects may be oriented away from the woodland, assuming regeneration will decline with distance.

The precision of the overall estimate is primarily affected by the variance between the mean values for major units and, to a lesser extent, by the variance between minor units within each major unit. Precision is also affected by the number of units sampled at each level. In order to determine the optimum number of major and minor units to sample, some knowledge of the two variances and of the relative cost of sampling at the two stages is required.

This may be obtained through a preliminary survey, or estimated based on available knowledge of the habitat in question. A preliminary survey may also be designed to investigate the optimal size of the major units as there will be a trade-off between the benefit of having a large sample of major units and increasing their size to reduce between-unit variation. These methods assume that all minor units are of equal size and that each major unit contains the same number of minor units.

3.1.5 Stratified systematic unaligned sampling

This is a variation of stratified sampling that combines the advantages of random and systematic sampling. The area to be sampled is first stratified into equally sized blocks (not strata based on habitat characteristics as in stratified random sampling). Samples are placed in each block by using different x co-ordinates for each column of blocks but the same x co-ordinate within one column, and different y co-ordinates for each row of blocks but the same y co-ordinate within one row.

This technique can be an improvement on stratified random sampling because the systematic misalignment is not subject to localised clustering. This technique does not appear to have been widely used.

The time taken to position samples is similar to that for stratified random sampling.

In comparing the techniques discussed, the stratified techniques exhibited greater overall comparative precision than random or systematic techniques, especially at low sample densities with clustered distributions. In this situation, the sampling strategies ranked in increasing order of relative precision were: random, systematic (regular), stratified random, stratified systematic unaligned.

3.1.6 Adaptive sampling

Another approach to consider for features that have very clustered distributions is adaptive sampling. This involves selecting an initial random or systematic sample. If the target species is found in a given sampling unit, the adjacent sampling units are also included on the basis that there is a good chance these will also contain the species. Potential advantages include:

i. although specialised formulae are required for estimation, adaptive sampling can provide better precision for a given amount of effort than simple random sampling;

ii. the method is more satisfying for surveyors, as they do not have to ignore sightings that fall just outside a sampling unit;

iii. a better picture of the species' spatial distribution is obtained.

One disadvantage is that the sample size cannot be determined in advance; it will depend on what is encountered in the initial sample.

4.0 CONCLUSION

In this unit, you have learnt the importance of sampling and various sampling methods to effective study of Biodiversity. You were sufficiently exposed to the merits and demerits of each sampling technique.

Various methods of sampling are employed based on the population to be studied, area to be studied, behaviour of biodiversity and sundry other factors. For small area the quadrat is easily used while for large area, sub-sampling is employed. Other sampling materials include the line and the transect.

5.0 SUMMARY

The methods of sampling varies; Random sampling is usually designed to ensure that each of the population of sampling units has an equal chance of being selected. In systematic sampling, it is often convenient to take samples at regular intervals, for instance at fixed distances along a river. However, this method creates one main problem: if the sampling interval constantly coincides with a particular regularity in a species or habitat being monitored, the results will be biased. The stratified sampling is very commonly used in environmental monitoring as a way of improving the precision of estimates. Very often there is substantial variation across the site in the feature attributes being measured. This may be due to environmental gradients or differences in management. However, there are advantages associated with the use of this method. In many situations a site may be so large that a high proportion of time is spent travelling between sample sites. In this instance cluster or multi-stage sampling could be considered as a means of increasing sampling efficiency and in some instances can improve precision for a given sample size. Multistage sampling is also known as multi-level sampling or subsampling. The stratified systematic unaligned sampling is a variation of stratified sampling that combines the advantages of random and systematic sampling. The advantageous method to be considered for features that have clustered distribution is the adaptive sampling. This involves selecting an initial random or systematic sample. If the target species is found in a given sampling unit, the adjacent sampling units are also included on the basis that there is a good chance that these will also contain the species.

6.0 TUTOR-MARKED ASSIGNMENT

i. Explain the term ecological sampling .
ii. Briefly compare and contrast any two sampling methods.

7.0 REFERENCES/FURTHER READING

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UNIT 2 SOURCES OF BIODIVERSITY RECORD

CONTENTS

1.0 INTRODUCTION

Knowledge of the history of biodiversity is derives from two primary sources. The first is analyses of data from the fossil record, and the second is analyses of molecular data.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- list the sources of biodiversity record
- explain the sources of Biodiversity Records.

3.0 MAIN CONTENT

3.1 Fossil Record

Much of the modern-day geological landscape owes its origins to past biodiversity, which has left behind a rich fossil record. This has provided extraordinary insights into the history of life on Earth. However, working with the fossil record to understand this history is an important constraint for three reasons. First, as recognized by Darwin when marshalling evidence for his theory of evolution, this record is far from perfect or even.

The record is much better for some periods than for others, and estimates of the numbers of species leaving a fossil record range from less than one to, at most, a few per cent of those that have ever lived .Second, of this fossil record, only a tiny fraction has actually been recovered. Third, the record, and that portion of it that has been recovered, is biased towards the more abundant, the more widespread, and the longer lived species, and more towards some groups of organisms than others. For instance, soft-bodied organisms, such as some cnidarians (jellyfish, sea anemones) are rarely fossilized and are exceptional in the fossil record, whereas the number of individual fossils of brachiopods, which are hard-bodied organisms, has been estimated to be in the billions.

Some of the major soft-bodied animal groupings have left no fossil remains: animals like the Platyhelminthes (flatworms, flukes and tapeworms).

The fossil record for animals with hard body parts, such as the brachiopods and molluscs, echinoderms and vertebrates, while often much better, is still far from complete and not always representative: 95% of all fossil species are marine animals while 85% of today's recorded plants and animals are terrestrial. In short, many of the pages of the history of biodiversity written in the fossil record are missing, and those that have been obtained only capture a biased portion of that history.

The paucity of the fossil record, even with regard to individual taxa, is well illustrated by a group that possesses hard body parts and is relatively well researched, having caught the attention and imagination of people of all ages and from all walks of life: the dinosaurs. Although something of the history of this group is familiar even to many primary/elementary school children, it remains based on a remarkably small window on the past. As of 1990, 900–1200 genera of dinosaurs were estimated to ever have lived. Of these, only 285 (336 species) were known from fossils, and nearly half of these were from only a single specimen; complete skulls and skeletons were known from only 20% of known genera. Similarly, it has been estimated that no more than 7% of all the primate species that have existed are known from fossils.

While it is clear that the documented fossil record is far from complete, in many different ways, it still provides an invaluable pictorial history of life on Earth, where many of the major events in that history have left their mark in, or on, the rocks. Notwithstanding its limitations, it is still possible to construct an understanding of changes in biodiversity through geological time using the fossil record. However, because of the constraints, it will often be necessary to make recourse to the temporal dynamics of numbers of higher taxa rather than of species because these are less vulnerable to the constraints. This should not pose too much of a problem, for not only do numbers of higher taxa act as a surrogate for numbers of species but it is also true that they act as a measure of biodiversity in their own right.

3.2 Molecular evidence

Whilst the fossil record continues to provide the bulk of insights into the history of biodiversity, molecular evidence is playing an increasingly significant role. Comparison of molecular data for different organisms enables the generation of branching trees representing hypotheses of their patterns of phylogenetic relatedness, with those organisms with sequences that are more different being assumed to have diverged earlier in the evolutionary process. If assumptions are made about the rate at which molecular sequences diverge (a 'molecular clock'), then the timings of different evolutionary events can be estimated.

Fossil and molecular evidence do not always agree, particularly over the dates of first appearance of groups. For example, molecular evidence suggests that at least six animal phyla originated deep in the Precambrian, more than 400 million years (Myr) earlier than their first appearance known from the fossil record. Likewise, molecular data suggest that primates diverged from other placental mammalsc. Myr ago whereas the oldest known fossil primates are from 55Myr ago. The fossil record is always liable to underestimate dates of first appearance, because the likelihood of such early individuals being fossilized and the fossils recovered is low. Equally, of course, the accuracy of first appearances estimated from molecular evidence rests on the interpretation of the molecular divergence data and particularly on the assumptions about the nature and dynamics of the molecular clock. However, together, fossil and molecular evidence provide a powerful combination for unlocking many of the secrets of the past.

4.0 CONCLUSION

Tracing the reason for the diverse and varied organisms will be practically impossible using just the phenotypic characteristics. Detailed evidence is derived from analysis of fossil data and subjecting to samples to molecular examination. In this unit, you learnt about the sources of biodiversity records with reference to the diverse group of organisms.

5.0 SUMMARY

Knowledge of the history of biodiversity is derives from two primary sources; analyses of data from the fossil record, and analyses of molecular data. Fossils are important in the study of the origin of past biodiversity, however there are pitfalls. While it is clear that the documented fossil record is far from complete, in many different ways, it still provides an invaluable pictorial history of life on Earth; where many of the major events in history have left their mark in, or on, the rocks. Notwithstanding its limitations, it is still possible to construct an understanding of changes in biodiversity through geological time using the fossil record. However, due to the constraints, it will often be necessary to make recourse to the temporal dynamics of numbers of higher taxa rather than of species because these are less vulnerable to the constraints. While fossil record continues to provide the bulk of insights into the history of biodiversity, molecular evidence is playing an increasingly significant role. Comparison of molecular data for different organisms enables the generation of branching trees representing hypotheses of their patterns of phylogenetic relatedness, with those organisms with sequences that are more different being assumed to have diverged earlier in the evolutionary process. The fossil record is always liable to underestimate dates of first appearance, because the likelihood of such early individuals being fossilized and the fossils recovered is low. Equally, of course, the accuracy of first appearances estimated from molecular evidence rests on the interpretation of the molecular divergence data and particularly on the assumptions about the nature and dynamics of the molecular clock. However, fossil and molecular evidence together provide a powerful combination for unlocking many of the secrets of the past.

6.0 TUTOR-MARKED ASSIGNMENT

Explain the sources of biodiversity records.

7.0 REFERENCE/FURTHER READING

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UNIT 3 THE VALUE OF BIODIVERSITY COMPONENTS

CONTENTS

1.0 INTRODUCTION

Generally, benefits arising from the conservation of components of biological diversity can be considered in three groups: ecosystem services, biological resources and social benefits. Some examples of these benefits are as follows.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- list the ecosystem benefits of biodiversity
- explain biodiversity as biological resource

- examine the social benefits of biodiversity.

3.0 MAIN CONTENT

3.1 Ecosystem Services

3.1.1 Protection of Water Resources

Natural vegetation cover in water catchments helps to maintain hydrological cycles, regulating and stabilising water runoff, and acting as a buffer against extreme events such as flood and drought. Vegetation removal results in siltation of catchment waterways, loss of water yield and quality, and degradation of aquatic habitat, among other things. Vegetation also helps to regulate underground water tables, preventing dry land salinity which affects vast areas of Australia's agricultural lands, at great cost to the community. Wetlands and forests act as water purifying systems, while mangroves trap silt, reducing impacts on marine ecosystems.

These services translate into substantial financial benefits. A Victorian Government sponsored study, for example, calculated the financial benefit of water supplied to Melbourne from forested catchments at $250 million per year. This amount is based on a study which valued water collected in the Thomson’s reservoir and supplied to Melbourne at $530 per mega liter, and the fact that the bulk of water supplied to Melbourne is harvested from 80 000 ha of catchment forested with ash-type eucalypts. Annual water yields from these forests vary from six to twelve mega liters per hectare, depending on whether the forest is 30 year old regrowth or old growth more than 200 years old. Presently most of the ash-type eucalypt forest in the catchments is 54 years old. Over the next 50 to 100 years, as the regrowth fore stage, the value of water produced each year will increase by $150 million due to natural stream flow increases.

3.1.2 Soils formation and protection

Biological diversity helps in the formation and maintenance of soil structure and the retention of moisture and nutrient levels. The loss of biological diversity through clearing of vegetation has contributed to the salinisation of soils, leaching of nutrients, laterisation of minerals and accelerated erosion of topsoil, reducing the land's productivity. Trees, on the other hand, lower the water table and remove deposited salt from the upper soil horizons.

Soil protection by maintenance of biological diversity can preserve the productive capacity of the soil, prevent landslides, safeguard coastlines and riverbanks, and prevent the degradation of coral reefs and riverine and coastal fisheries by siltation.

Trees and other vegetation also assist in soil formation. A significant contribution is the introduction of organic matter through litter formation and the decay and regeneration of tiny fibrous roots, both of which facilitate microbial activity. Another contribution is through the effects of root systems which break up soil and rock leading to, amongst other things, penetration of water. Root systems also bring mineral nutrients to the surface through root uptake. Organic matter formed by the decay of tiny fibrous roots can also bind with minerals, such as iron and aluminum, which can reduce the potential deleterious effects of these minerals on other vegetation.

3.1.3 Nutrient Storage and Cycling

Ecosystems perform the vital function of recycling nutrients. These nutrients include the elements of the atmosphere as well as those found in the soil, which are necessary for the maintenance of life.

Biological diversity is essential in this process. Plants are able to take up nutrients from the soil as well as from the air, and these nutrients can then form the basis of food chains, to be used by a wide range of other life forms. The soil's nutrient status, in turn, is replenished by dead or waste matter which is transformed by microorganisms; this may then feed other species such as earthworms which also mix and aerate the soil and make nutrients more readily available.

3.1.4 Pollution Breakdown and Absorption

Ecosystems and ecological processes play an important role in the breakdown and absorption of many pollutants created by humans and their activities. These include wastes such as sewage, garbage and oil spills. Components of ecosystems from bacteria to higher life forms are involved in these breakdown and assimilative processes. Excessive quantities of any pollutant, however, can be detrimental to the integrity of ecosystems and their biota.

Some ecosystems, especially wetlands, have qualities that are particularly well suited to breaking down and absorbing pollutants. Natural and artificial wetlands are being used to filter effluents to remove nutrients, heavy metals and suspended solids, reduce the biochemical oxygen demand and destroy potentially harmful microorganisms.

3.1.5 Contribution to Climate Stability

Vegetation influences climate at the macro and micro levels. Growing evidence suggests that undisturbed forest helps to maintain the rainfall in its immediate vicinity by recycling water vapour at a steady rate back into the atmosphere and through the canopy's effect in promoting atmospheric turbulence. At smaller scales, vegetation has a moderating influence on local climates and may create quite specific micro-climates. Some organisms are dependent on such micro-climates for their existence.

3.1.6 Maintenance of Ecosystems

Ecosystem relationships resemble a web of connections from one living thing to many other living and non-living things. They not only allow survival, but also maintain a balance between living things and the resources (such as food and shelter) they need to survive. Vegetation is integral to the maintenance of water and humidity levels and is essential for the maintenance of the oxygen/carbon dioxide balance of the atmosphere. Due to the complex nature of ecosystem relationships, the removal or disturbance of one part of the ecosystem could affect the functioning of many other components of the ecosystem.

Our knowledge of these relationships is incomplete, and the results of disturbance are thus to some extent unpredictable.

Maintaining natural habitats helps ecosystem functions over a wider area. Natural habitats afford sanctuary to breeding populations of birds and other predators which help control insect pests in agricultural areas, thus reducing the need for, and cost of artificial control measures. Birds and nectar loving insects roost and breed in natural habitats may range some distance and pollinate crops and native flora in surrounding areas.

3.1.7 Recovery from Unpredictable Events

Maintaining healthy ecosystems improves the chances of recovery of plant and animal populations from unpredictable natural catastrophic events such as fire, flood and cyclones and from disasters caused by humans. Inadequately conserved and isolated populations, and ecosystems which are degraded, are less likely to recover or to recover as quickly, to their former state. Populations of biota may end up with small, possibly non-viable, genetic bases, which can lead to extinctions.

3.2 Biological Resources

A biological resource means any product that is harvested from nature is the part of biological resources. These resources come under several categories such as medicine, food, wood products, fibers etc. For example under one category i.e., Food more than 7,000 species of plants are involved, although we dependent mainly on only 12 major crops for food.

3.2.1 Food

Human existence (and that of most other organisms) is heavily dependent on what biologists call primary producers, mainly plants. Five thousand plant species have been used as food by humans, but less than twenty now feed the majority of the world's population and just three or four carbohydrate crops are staples for a vast majority. One of the important benefits of conservation of biodiversity is the wild plant gene pool which is available to augment the narrow genetic base of these established food crops, providing disease resistance, improved productivity and different environmental tolerances.

Australia's native species are contributing to the global food capacity. Australia has important native fish and crustacean harvesting industries and is the reservoir of genetic diversity for the macadamia and quandong. Such reservoirs increase the opportunities for enhancing agricultural productivity.

Australia, for example, has 15 of the world's 16 species of wild soybean. These may prove to be extremely valuable genetic stock in the future because, unlike current commercial varieties, many of these wild plants have genes that help them resist leaf rust diseases.

There is also great food potential in native Australian plants. The nutritional value of 'bush' foods is quite high, some having greater amounts of protein, fats, carbohydrates, minerals and vitamins than cultivated plant foods. For example, acacia seeds, some 50 types of which were used by Aboriginal people for food, are superior to rice and wheat in energy, protein and fats. The potential of Australian acacias to augment diets in Africa is currently being investigated 26, and Australian native species of Vigna are being explored to add useful characteristics to the domesticated mung bean, and for their potential as food in their own right. The seeds of pigweed (*Portulacaoleracea*), which were commonly eaten by Aboriginal peoples, contain 20 per cent protein, 16 per cent fat, and high levels of iron. A native fig, *Ficusplatypoda*, has very high levels of calcium (4000mg/100g), as well as higher protein and fat content than expected for fruits, while the wild Arnhem Land plum has spectacular amounts of Vitamin C - more than 50 times the level found in exotic citrus fruit. New chemical structures are being discovered all the time, and the conservation of biological diversity is essential for the continuation of this research.

The short and long-term values of these genetic resources are enormous and most improvements in agriculture and silviculture depend on their preservation. Moreover, the gene pool value of natural habitats will increase as remaining natural habitats become more scarce. These areas are therefore of great value as in situ gene banks, and need to be effectively managed.

3.3 Medicinal Resources

People have long used biological resources for medicinal purposes. Australian Aboriginal societies made use of many native plants as medicines; at least 70 were used by central Australian Aboriginal people alone. Examples cover many genera, and include acacias and eremophilas, as well as individual species such as *Isotomapetraea* and the parrot plant (*Crotolariacunninghamii*). A few Aboriginal medicines have been widely used in western medicine, such as the ubiquitous eucalyptus oil for relief of respiratory tract infections, but many more are now being investigated. A prime example is provided by current research into the bark of a tree found in the Kimberleys, which is known to Aboriginal people as a powerful painkiller.

A number of Australian species are the basis of medicinal products. Hyoscine (or scopolamine), used to treat motion sickness, stomach disorders and the effects of cancer therapy, is a product of two species of corkwood (Duboisia). One of these, *D. leichhardtii*, is restricted to Queensland, and the hybrid between the two species produces more hyoscine than any other plant. The vine Tylophora is thesource of the drug tylocrebrine, which has been effective in treating lymphoid leukemia, while the kangaroo apples *Solanumaviculare* and *S. laciniatum*, found in Australia and New Zealand and cultivated overseas, provide salasodine, which is easily converted to steroids.

Wild plant, animal and microorganism resources are also of great importance in the search for new medically active compounds, and the potential of other Australian biota to contribute to modern medicine has scarcely begun to be realised. Many of the drugs presently used are derived from plants; many medicines, in particular antibiotics, are derived from microorganisms, and new chemical structures are being discovered all the time. The native pepper (*Piper novae-hollandiae*) and the blackbean (*Castanospermumaustrale*) both offer potential in the treatment of cancer. Current work at Macquarie University is exploring the antibiotic potential of secretions from glands of bulldog ants (Myrmecia). The substances have strong antibiotic properties, and kill a wide range of selected bacteria and fungi. Their potential, particularly as industrial biocides, is enormous.

Studies of various chemicals produced by animals have led to discoveries of medicinally useful substances. A substance called Prostaglandin E2, which could be of importance in the treatment of gastric ulcers, was originally discovered in the two species of gastric brooding frogs (Rheobatrachus) found only in the rainforests of

Queensland. Unfortunately, both species have not been sighted for some time, and it is conceivable that one at least (*R. silus*) is now extinct.

3.3.1 Wood Products

Wood is a basic commodity used worldwide, and is still largely harvested from the wild. It is a primary source of fuel, is used in construction, and forms the basis for paper production.

Australian native plants have been of continued importance in the construction of buildings and furniture, and more recently for paper production. The timber industries form a significant part of our modern economy. The unique nature of Australian species has been well recognised: huon pine (*Lagarostrobusfranklinii)* does not decay; gidgee (*Acacia cambagei*) and mulga (*Acacia aneurasens.lat.*) are very hard woods currently being investigated for musical instruments; and the lignotubers of some eucalypts and banksias are favoured for highly decorative furniture. Many Australian species, notably eucalypts, are grown overseas for timber products.

3.3.2 Ornamental Plants

Native Australian species are increasingly being used for ornamental and horticultural purposes, with new hybrids and strains being developed and marketed. One well known example is the Grevillea" Robyn Gordon". The cut flower trade of Western Australia is also of great importance, with many species harvested, and some being cultivated for this purpose.

3.3.3 Breeding Stocks

Natural areas provide support systems for commercially valuable environmental benefits and resources. Some habitats protect crucial life stages or elements of wildlife populations that are widely and profitably harvested outside these habitats, such as spawning areas in mangroves and wetlands. For example, when mangrove areas are cleared for resort and urban development, populations of commercial fish species which rely on mangroves for breeding habitats also diminish. Some of these crucial habitats have been declared protected areas, as their importance for maintaining stocks of fish, crustaceans such as prawns and mud-crabs, and other aquatic fauna has been recognized.

Other habitats act as genetic reservoirs from which seed and other material can be assessed for enhancement of harvested species. The leaf oil content of several Western Australian eucalyptus mallee species, for example, is being assessed from across their natural distributions to identify high yield populations for potential propagation.

3.4 Future Resources

About 50 per cent of species in Australia are known but only a quarter formally described. As knowledge improves, new bio-resources to increase human welfare will be discovered and developed. There is a clear relationship between the conservation of biological diversity and the discovery of new biological resources. The relatively few developed plant species currently cultivated have had a large amount of research and selective breeding applied to them. Many presently under utilised food crops have the potential to become important in the future. The documentation of indigenous peoples' use of plants is often the source for ideas on developing plant species for wider use and/or economic benefit and there are a large number of as yet undiscovered plant species which could prove useful.

Potential products which may be derived from biological resources include sunscreens from corals, light and high tensile fibres from spider silk, and instant adhesives from velvet worms or barnacles. Microorganisms are important in the production of extensive ranges of agrochemicals, protein for animal feed, enzymes and biopolymers.There is also potential for further development of biotic resources for natural pesticides, similar to the insecticidal microorganism *Bacillus thuringiensis*, and other useful products such as fats, and oils.

The conservation of diversity is also essential for finding effective biological control organisms and for breeding disease resistant species. Genetic engineering of microorganisms promises further advances in the production of new compounds and processes.

3.5 Social Benefits

3.5.1 Research, Education and Monitoring

There is still much to learn on how to get better use from biological resources, how to maintain the genetic base of harvested biological resources, and how to rehabilitate degraded ecosystems. Natural areas provide excellent living laboratories for such studies, for comparison with other areas under different systems of use, and for valuable research into ecology and evolution. Unaltered habitats are often essential for certain research approaches, providing controls against which the changes brought about by different management regimes may be measured and assessed.

3.5.2 Recreation

Biological diversity is an intrinsic part of many areas valued in Australia for tourism and recreational purposes. The aesthetic qualities of such areas are often strikingly different, in large part due to the range of biological diversity to be found on this continent. People value such areas for a variety of recreational pursuits: film, photographs or literature based on or using wildlife, natural habitats and natural features; bird watching; and ecological field study and other scientific pursuits. The Australian environment is a major factor in attracting tourists. Studies have shown that over 85 per cent of Japanese visitors and 70 per cent of European and American travellers identified such factors as beautiful scenery and wildlife as key elements of their travel decisions. In addition, it has been conservatively estimated that at least 10 million people visited natural environments in Australia in 1987/88; five million visited parks and reserves, four million visited the four major zoological gardens and one million visited botanical gardens.

3.5.3 Cultural values

The cultural value of biological diversity conservation for present and future generations is an important reason for conserving it today. Human cultures coevolve with their environment, and the conservation of biological diversity can be important for cultural identity throughout Australia. The natural environment provides for many of the inspirational, aesthetic, spiritual and educational needs of people, of all cultures, now and in the future. Australian society places great cultural value on the 'bush' while certain species, such as the kangaroo, koala and the emu, have become national icons.

The aesthetic values of our natural ecosystems and landscapes contribute to the emotional and spiritual well-being of a highly urbanised population. The conservation of biological diversity also has ethical benefits. The presence of a wide range of living organisms reminds people that they are but one interdependent part of Earth.

Aboriginal relationships to the land and sea, and its animals and plants are complex. To these people the land and sea has a deep spiritual, economic, social, protective and recreational significance. By hunting and gathering, tribal Aboriginal people are not only supplementing their diet with food very high in nutritional value; they are also confirming their self-sufficiency and, more importantly, educating their children in relationships to the land and to other aspects of their culture. Biological diversity conservation can contribute to the conservation of Aboriginal cultural identity.

3.5.4 Benefits of Timely Action

Another benefit of conservation is the avoidance of the rising costs of inaction. Already Australia is suffering losses in production from environmental degradation and is spending considerable sums in environmental repair. Land degradation costs in Australia have been estimated at $1150 million annually, and the CSIRO has classified some 52 per cent of the continent as degraded in one way or another and in need of reclamation. Salinity related problems in the Murrary-Darling Basin alone are estimated to cost $35 million annually, and losses to agriculture in this region are in the order of $260 million each year. These costs are those identified today. Currently, some $320 million has been directed to the Decade of Landcare, much of which will be for the control of land degradation. Without remedial action degradation will inevitably increase and the costs of repair faced by the community in the future will be much greater. These costs can be reduced by strategic and timely conservation actions.

4.0 CONCLUSION

In this unit, you learnt about the values of biodiversity in every aspect of nature. The significance of Biodiversity as revealed include, (1) ecosystem support (2) as a Biological resource as well as social benefits. Biodiversity plays a crucial role in the working and sustenance of the ecosystem. It is major driving force of the ecosystem

5.0 SUMMARY

Ecosystem services, biological resources and social benefits are benefits arising from the conservation of components of biological diversity. In ecosystem services, protection of water resources, soil formation and protection, nutrient storage and cycling, pollution breakdown and absorption, contribution to climate stability, maintenance of ecosystems, and recovery from unpredictable events all accounts for the benefits. A biological resource means any product that is harvested from nature is the part of biological resources. These resources come under several categories such as medicine, food, wood products, fibers, etc.

Social benefits as a component of biodiversity benefit, is not reckoned without the activities of research education and monitoring; recreation; and cultural values. Another benefit of conservation is the avoidance of the rising costs of inaction. Without remedial action, degradation will inevitably increase and the costs of repair faced by the community in the future will be much greater. These costs can be reduced by strategic and timely conservation actions.

6.0 TUTOR-MARKED ASSIGNMENT

1. Briefly enumerate the importance of biodiversity to the ecosystem
2. Explain the importance of Biodiversity as a Biological resource.

7.0 REFERENCES/FURTHER READING

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MODULE 3 CLIMATE CHANGE, BIOLOGICAL SUSTAINABILITY AND SURVIVAL

UNIT 1 BIODIVERSITY AND SPECIES EXTINCTION

CONTENTS

1.0 INTRODUCTION

When there is a threat to biodiversity, what would quickly come to mind is extinction. Extinction is a natural event and, from a geological perspective, routine. We now know that most species that have ever lived have gone extinct. The average rate over the past 200 million years is 1-2 species per million species present per year. The average duration of a species is 1-10 million years (based on the last 200 million years). There have also been several episodes of mass extinction, when many taxa representing a wide array of life forms have gone extinct in the same blink of geological time.

In the modern era, due to human actions, species and ecosystems are threatened with destruction to an extent rarely seen in Earth history. Probably only during the handful of mass extinction events have so many species been threatened, in so short a time.

First, we can attribute the loss of species and ecosystems to the accelerating transformation of the Earth by a growing human population. As the human population passes the 6 billion mark, we have transformed, degraded or destroyed roughly half of the world's forests. We appropriate roughly half of the world's net primary productivity for human use. We appropriate most available fresh water, and we harvest virtually all of the available productivity of the oceans. It is little wonder that species are disappearing and ecosystems are being destroyed.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- define the term extinction
- list and explain factors causing extinction.

3.0 MAIN CONTENT

3.1 Factors that Affect the Extinction of Biodiversity

3.1.1 Over-hunting

Over-hunting has been a significant cause of the extinction of hundreds of species and the endangerment of many more, such as whales and many African large mammals. Most extinctions over the past several hundred years are mainly due to over-harvesting for food, fashion, and profit. Commercial hunting, both legal and illegal (poaching), is the principal threat. The snowy egret, passenger pigeon, and heath hen are US examples. At US $16,000 per pound, and US $40,000 to US $100,000 per horn, it is little wonder that some rhino species are down to only a few thousand individuals, with only a slim hope of survival in the wild. The recent expansion of road networks into previously remote tropical forests enables the bush meat trade, resulting in what some conservationist describe as "empty forests" as more and more wild animals are shot for food.

The pet and decorative plant trade falls within this commercial hunting category, and includes a mix of legal and illegal activities. The annual trade is estimated to be at least US $5 billion, with perhaps one-quarter to one-third of it illegal. Sport or recreational hunting causes no endangerment of species where it is well regulated, and may help to bring back a species from the edge of extinction. Many wildlife managers view sport hunting as the principal basis for protection of wildlife.

While over-hunting, particularly illegal poaching, remains a serious threat to certain species, for the future, it is globally less important than other factors.

3.1.2 Habitat Loss, Degradation, Fragmentation

Habitat loss, degradation, and fragmentation are important causes of known extinctions. As deforestation proceeds in tropical forests, this promises to become the main cause of mass extinctions caused by human activity.

All species have specific food and habitat needs. The more specific these needs and localized the habitat, the greater the vulnerability of species to loss of habitat to agricultural land, livestock, roads and cities. In the future, the only species that survive are likely to be those whose habitats are highly protected, or whose habitat corresponds to the degraded state associated with human activity (human commensals).

Habitat damage, especially the conversion of forested land to agriculture (and, often, subsequent abandonment as marginal land), has a long human history. It began in China about 4,000 years ago, was largely completed in Europe by about 400 years ago, and swept across the US over the past 200 years or so. Viewed in this historical context, we are now mopping up the last forests of the Pacific Northwest.

In the New World tropics, lowland, seasonal, deciduous forests began to disappear after 1500 with Spanish and Portuguese colonization of the New World. These were the forested regions most easily converted to agriculture, and with a more welcoming climate. The more forbidding, tropical humid forests came under attack mainly in twentieth century, under the combined influences of population growth, inequitable land and income distribution, and development policies that targeted rain forests as the new frontier to colonize.

Tropical forests are so important because they harbor at least 50 percent, and perhaps more, of the world's biodiversity. Direct observations, reinforced by satellite data, document that these forests are declining. The original extent of tropical rain forests was 15 million square km. Now there remains about 7.5-8 million square km, so half is gone. The current rate of loss is estimated at near 2 percent annually (100,000 square km destroyed, another 100,000 square km degraded). While there is uncertainty regarding the rate of loss, and what it will be in future, the likelihood is that tropical forests will be reduced to 10-25 percent of their original extent by late twenty-first century.

Habitat fragmentation is a further aspect of habitat loss that often goes unrecognized. The forest, meadow, or other habitat that remains generally is in small, isolated bits rather than in large, intact units. Each is a tiny island that can at best maintain a very small population. Environmental fluctuations, disease, and other chance factors make such small isolates highly vulnerable to extinction. Any species that requires a large home range, such as a grizzly bear, will not survive if the area is too small. Finally, we know that small land units are strongly affected by their surroundings, in terms of climate, dispersing species, etc. As a consequence, the ecology of a small isolate may differ from that of a similar ecosystem on a larger scale.

For the future, habitat loss, degradation, and fragmentation combined is the single most important factor in the projected extinction crisis.

3.1.3 Invasion of Non-Native Species

Invasion of non-native species is an important and often overlooked cause of extinctions. The African Great Lakes--Victoria, Malawi and Tanganyika--are famous for their great diversity of endemic species, termed "species flocks," of cichlid fishes. In Lake Victoria, a single, exotic species, the Nile Perch, has become established and may cause the extinction of most of the native species, by simply eating them all. It was a purposeful introduction for subsistence and sports fishing, and a great disaster.

Of all documented extinctions since 1600, introduced species appear to have played a role in at least half. The clue is the disproportionate number of species lost from islands: some 93 percent of 30 documented extinctions of species and sub-species of amphibians and reptiles, 93 percent of 176 species and sub-species of land and freshwater birds, but only 27 percent of 114 species and subspecies of mammals. Why are island species so vulnerable, and why is this evidence of the role of non-indigenous species? Islands are laboratories for evolution.

3.1.4 Domino Effects

Domino effects occur when the removal of one species (an extinction event) or the addition of one species (an invasion event) affects the entire biological system. Domino effects are especially likely when two or more species are highly interdependent, or when the affected species is a "keystone" species, meaning that it has strong connections to many other species.

A keystone species is one whose influence on others is disproportionately great. A seminal study of marine invertebrates in the rocky intertidal region of Washington State found that the top predator, a starfish, facilitated the coexistence of many other invertebrates by selectively consuming mussels, which otherwise would crowd out other organisms. Thus a keystone species is one whose presence or absence both directly and indirectly influences other species through food web connectivity. Contrary to what some may think, not all species are "keystones", and it requires careful experimental studies to identify keystone species.

3.1.5 Pollution

Pollution from chemical contaminants certainly poses a further threat to species and ecosystems. While not commonly a cause of extinction, it likely can be for species whose range is extremely small, and threatened by contamination. Several species of desert pupfish, occurring in small isolated pools in the US Southwest, are examples.

3.1.6 Climate change

A changing global climate threatens species and ecosystems. The distribution of species (biogeography) is largely determined by climate, as is the distribution of ecosystems and plant vegetation zones (biomes). Climate change may simply shift these distributions but, for a number of reasons, plants and animals may not be able to adjust. The pace of climate change almost certainly will be more rapid than most plants are able to migrate. The presence of roads, cities, and other barriers associated with human presence may provide no opportunity for distributional shifts. Parks and nature reserves are fixed locations. The climate that characterizes present-day Yellowstone Park will shift several hundred miles northward. The park itself is a fixed location. For these reasons, some species and ecosystems are likely to be eliminated by climate change. Mountaintop species are especially vulnerable. The plants and animals found on high mountains of the American West include many remnants of a Pleistocene fauna that long ago was displaced toward the arctic, or upslope. With further warming, many of these mountaintop species likely will be eliminated.

A changing climate will have many other effects. The southern extent of the Everglades, today the site of the most ambitious and expensive restoration project ever undertaken, may be underwater, along with significant areas of human habitation. Agricultural production likely will show regional variation in gains and losses, depending upon crops and climate. Some coral reefs will expand, and others will contract or die off. Ecological changes due to an altered climate are difficult to forecast, but expected to be serious.

As a consequence of these multiple forces, many scientists fear that by end of next century, perhaps 25 percent of existing species will be lost.

4.0 CONCLUSION

In this unit, you have learnt the above factors that may result in extinction of Biodiversity which include but not limited to habitat destruction and excessive hunting. Extinction of Biodiversity is the greatest threat to species richness and abundance. Growth in human population and the need to cater for the increase in population is a major concern to the ecosystem and life within.

5.0 SUMMARY

When there is a threat to biodiversity, what would quickly come to mind is extinction. Extinction is said to occur when species and ecosystems are threatened with destruction, to an extent rarely seen in Earth history. Extinction is a natural event and, from a geological perspective, routine. We now know that most species that have ever lived have gone extinct. Extinction of biodiversity is facilitated by many factors; Over-hunting has been a significant cause of the extinction of hundreds of species and the endangerment of many more, such as whales and many African large mammals; Habitat loss, degradation, and fragmentation are important causes of known extinctions; Invasion of non-native species is an important and often overlooked cause of extinctions. The African Great Lakes--Victoria, Malawi and Tanganyika--are famous for their great diversity of endemic species, termed "species flocks," of cichlid fishes. Invasion of non-native species is an important and often overlooked cause of extinctions. Domino effects occur when the removal of one species (an extinction event) or the addition of one species (an invasion event) affects the entire biological system. Pollution from chemical contaminants certainly poses a further threat to species and ecosystems. A changing global climate threatens species and ecosystems. The distribution of species (biogeography) is largely determined by climate, as is the distribution of ecosystems and plant vegetation zones (biomes).

6.0 TUTOR-MARKED ASSIGNMENT

1. What do you understand by the term extinction?
2. List and explain five factors responsible for species extinction.

7.0 REFERENCES/FURTHER READING

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UNIT 2 ANIMAL SURVIVAL AND SUSTAINABILITY

CONTENTS

1.0 INTRODUCTION

The sun is the main source of energy to all life on earth. Green plants and photosynthetic bacteria need light to manufacture their food. Animals depend on plants for food. Light affects living things in terms of intensity, quality and duration. Light intensity and quality affects photosynthesis, flowering and germination of plants while in animals affects migration, hibernation and reproduction. A photographic light meter is used to measure light intensity while the seechi disc measures light penetration in water.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- explain species richness and abundance
- list and explain the factors affecting distribution.

3.0 MAIN CONTENT

3.1 ENVIRONMENTAL FACTORS THAT INFLUENCE THE DISTRIBUTION AND ABUNDANCE OF BIODIVERSITY

3.1.1 Light

The sun is the main source of energy to all life on earth. Green plants and photosynthetic bacteria need light to manufacture their food. Animals depend on plants for food. Light affects living things in terms of intensity, quality and duration. Light intensity and quality affects photosynthesis, flowering and germination of plants while in animals affects migration, hibernation and reproduction. A photographic light meter is used to measure light intensity while the seechi disc measures light penetration in water.

3.1.2 Temperature

Biochemical processes of most organisms function effectively within a narrow range of temperature. Temperature varies due to seasons, altitude, latitude and also diurnally especially in hot deserts. This therefore affects the distribution of organisms in a habitat. Temperature variations influence the distribution of organisms more in terrestrial habitats than aquatic habitats. Living organisms must develop necessary physiological and behavioral adaptations to cope with extremes of temperatures.

3.1.3 Atmospheric Pressure

The atmosphere has a definite weight and so it exerts pressure on the earth. On the surface of the earth, atmospheric pressure varies with altitude. Variations I atmospheric pressure affects the amount of Oxygen available for respiration and of carbon (IV) oxide for photosynthesis. These two gases affect the distribution of organisms.

3.1.4 Rainfall

The main source of soil water is precipitation. The rainfall provides water to plants and animals. Rainfall occurs due to interchange of water between earth’s surface and the atmosphere. This is known as the hydrologic cycle. In this cycle two important things are precipitation and evapotranspiration.

Annual rainfall determines the types of vegetation in any region. We find evergreen forests in tropical regions due to heavy rainfall throughout the year. Grasslands are found in such regions where there is heavy rainfall during summer and low rainfall during winter.

In our country there are differences in the quantity of annual rainfall. Also, the distribution of rainfall in different seasons of the year is different. Therefore, we find that vegetation types in different parts of the country are much different from each other. We also notice different types of animals and birds in different geographical regions due to changes in vegetation and in turn, vegetation causes changes in the types of forests, animals and birds.

Different regions of the earth receive, different quantity of rain-fall depending upon the geographical features and the availability of moisture laden winds. The quantity, duration and intensity of rainfall regulate plant life.

Only a part of the rain water is used by the plants, the rest is lost in many ways like evaporation and run-off. Thus, there is a difference between the actual rainfall and the effective rainfall.

The evaporation is governed by the moisture content and the temperature of the atmosphere, and hence, in effective rainfall the total rainfall in relation to temperature is taken into account.

The quantity of water that a soil holds or that infiltrates into the soil depends upon the properties of soil and type and den-sity of vegetation covering it. In a bare area, the rain drops beat the compact surface of the soil and loosen the soil particles which are washed away.

In a clay soil, the clay particles are densely packed and these stick to each other. For space is reduced and water percolation is checked. This results in horizontal movement of water in the form of run-off, resulting in the loss of effective rainfall. Inverse is the case with a sandy soil, where in water infiltrates into the soil. The vegetation intercepts the beating effect of rainfall and thus, water is gradually soaked in soil from where plants use it over a long period. The degree of slope is another factor for water loss. There-fore, on hill slopes, terrace cropping is practised.

3.1.5 Humidity

It refers to the amount of water vapour in the atmosphere. When humidity is high there is much water vapour and vice versa. Humidity affects the rate at which water evaporates from the surface of organisms such as in transpiration or sweating. This in turn affects their distribution on earth. Paper Hydrometer is used to measure or a wet and dry bulb hydrometer.

3.1.6 Wind

Wind is moving air. It increases the rate of water loss from the organisms, therefore affecting their distribution. Wind is also important in formation of rain. In deserts winds form sand dunes which can be habitats for other organisms. Wind causes wave formation in lakes and ocean, which enhance aeration of water in this water bodies. Trees in areas experiencing strong winds may have stunted growth and distorted growth. Wind also disperses spores and seeds hence influence disposal and migration of flying animals Wind wafts scent hence determines the positioning of hinting animals with respect to their prey in a habitat. A wind vane or windsock is used to determine the direction of prevailing wind. Anemoter is used to measure the speed of wind.

3.1.7 Salinity

It refers to the salt concentration of water, causing a division of the aquatic environment into marine, estuarine and fresh water. Saline conditions immediately outside the body of organism pose the problem of water loss from the body to the environment. Only animals with suitable osmoregulation adaptations can occupy such habitats. Salinity can be determined by calculating percentage of salts on water or by the acid-base titration method.

3.1.8 pH (Hydrogen ion Concentration)

pH is the measure of how acidic or alkaline water is in aquatic animals or soil solution. It influences the distribution of plants and animals in soil and fresh water ponds. Some plants drive well in acidic conditions while others in alkaline conditions. The pH of a soil can be altered by leaching fertilizers' applied or soil exhaustion. pH is expressed in terms of pH scale by use of BDH universal indicator solution or paper and pH meter.

4.0 CONCLUSION

In this unit, you learnt about abundance and distribution of organism base on certain environmental factors. Because species have different tolerance range for every environmental factor, this there determines where they would be found given the prevailing conditions. Environmental influence on the distribution of biodiversity has been extensively studied. This knowledge provides useful tool to conservationist and ecologist on how to protect Biodiversity.

5.0 SUMMARY

The distribution and abundance of biodiversity is influenced by many factors. The sun is the main source of energy to all life on earth. Green plants and photosynthetic bacteria need light to manufacture their food. Animals depend on plants for food. Light affects living things in terms of intensity, quality and duration. The biochemical processes of most organisms function effectively within a narrow range of temperature. This therefore affects the distribution of organisms in a habitat. Temperature variations influence the distribution of organisms more in terrestrial habitats than aquatic habitats. Living organisms must develop necessary physiological and behavioral adaptations to cope with extremes of temperatures. The atmosphere has a definite weight and so it exerts pressure on the earth. On the surface of the earth, atmospheric pressure varies with altitude.

Rainfall occurs due to interchange of water between earth's surface and the atmosphere. This is known as the hydrologic cycle. In this cycle two important things are precipitation and evapotranspiration. The factor humidity refers to the amount of water vapour in the atmosphere. When humidity is high there is much water vapour and vice versa. Wind as a factor can be said to be the moving air. It increases the rate of water loss from the organisms, therefore affecting their distribution.
Salinity is another factor which is referred as the salt concentration of water, leading to a division of the aquatic environment into marine, estuarine and fresh water. High saline conditions immediately outside the body of organism pose the problem of water loss from the body to the environment. The factors are not complete if pH scale is not included. pH is the measure of how acidic or alkaline water is in aquatic animals or soil solution. It influences the distribution of plants and animals in soil and fresh water ponds.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss five factors affecting distribution of species.
2. List and explain five factors responsible for species extinction.

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UNIT 3 THE ROLE OF CLIMATE AND ANIMAL EXTINCTION IN RELATION TO BIOLOGICAL SUSTAINABILITY AND ANIMAL SURVIVAL

CONTENTS

1.0 INTRODUCTION

Recent changes in climate, such as warmer temperatures in certain regions, have already had significant impacts on biodiversity and ecosystems. They have affected species distributions, population sizes, and the timing of reproduction or migration events, as well as the frequency of pest and disease outbreaks. Projected changes in climate by 2050 could lead to the extinction of many species living in certain limited geographical regions. By the end of the century, climate change and its impacts may become the main direct driver of overall biodiversity loss.

Climate affects both, spread in space and time of species and the necessary resources (water, nutrients etc.) for their existence As indirect effect, significant role is attributed to the ratio of nutrients and invasive species Impact of climate change on global biodiversity is mainly associated with the increase of temperature,

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- explain climate change in relation to animal survival
- define the terms sustainability and survival.
- define conservation.
- list and explain the various conservation efforts.

3.0 MAIN CONTENT

3.1 Climate Change and Sustainability

Recent changes in climate, such as warmer temperatures in certain regions, have already had significant impacts on biodiversity and ecosystems. They have affected species distributions, population sizes, and the timing of reproduction or migration events, as well as the frequency of pest and disease outbreaks. Projected changes in climate by 2050 could lead to the extinction of many species living in certain limited geographical regions. By the end of the century, climate change and its impacts may become the main direct driver of overall biodiversity loss.

Climate affects both, spread in space and time of species and the necessary resources (water, nutrients etc.) for their existence As indirect effect, significant role is attributed to the ratio of nutrients and invasive species Impact of climate change on global biodiversity is mainly associated with the increase of temperature, but as an important side factor the amount of precipitation is mentioned For living organisms the interaction of these two factors is vitally important If a predator’s tolerance to changes of temperature or humidity is large enough, but a victim - an object of a predator’s nutrition, is more sensitive to these changes, the impact of climate change on a predator will be indirect As a species-newcomers often do not have any natural enemies in a new ecosystem, they often multiply in huge quantities and may suppress or completely outrival native species.

While the growing season in Europe has lengthened over the last 30 years, in some regions of Africa the combination of regional climate changes and human pressures have led to decreased cereal crop production since 1970. Changes in fish populations have also been linked to large-scale climate variations such as "El Nino". As climate change will become more severe, the harmful impacts on ecosystem services will outweigh the benefits in most regions of the world. The Intergovernmental Panel on Climate Change (IPCC) project that the average surface temperature will rise by 2 to 6.4C by 2100 compared to pre-industrial levels. This is expected to cause global negative impacts on biodiversity.

Besides direct human impact on certain ecosystems, the burning of hydrocarbons and coal due to human activity has led, since 1950, to a massive increase in greenhouse gas concentrations. Since then, the global mean surface temperature has risen by 0.6°C. Models predict that by the end of the 21st century this average global temperature will have increased by between 1.5°C and 5.8°C.

Global warming has already to begun to manifest its impact on biodiversity. For instance, of the 95 most common species of passerine birds, those in northern regions are declining the fastest. This trend was confirmed during and after the heatwave of 2003. The most pessimistic projections predict that by 2050, 35% of living species will probably have disappeared, with global warming coming on top of the other three major causes of extinction: environmental deterioration, biological invasions and overexploitation by humans.

In return, biodiversity makes a big contribution to the absorption of anthropogenic emissions of carbon, and is thus slowing down ongoing climate change. The greater the biodiversity, the greater the biomass. Biodiversity and climate change are therefore connected. The way in which biodiversity evolves will lead to either an acceleration or a slowing down of climate change in the future. Besides the reorganization of communities, the impact of global warming on the diversity of species could be made worse by the reduction in size of their ranges. The number of species liable to disappear could double if individuals are not able to migrate to their new ranges. Biodiversity monitoring stations are pointing to the existence of real difficulties for migrating species. Specialist species (dependent on one particular type of habitat) are the most likely to decline in abundance and go extinct.

These movements of species are seriously disrupted by human land-use management. Human pressure is fragmenting natural habitats. A species whose demographic potential diminishes due to the deterioration of its environment caused by human activities (urban growth, building of roads and freeways, barriers which prevent movement of migratory animals, etc.) is even more likely to become extinct if climatic conditions are no longer conducive to its survival.

3.1.1 Biological Sustainability and Animal Survival

This is the ability to maintain ecological processes over long periods of time.

Sustainability of an ecosystem is the ability of that ecosystem to maintain its structure and function over time in the face of external stress. Sustainability is strongly linked to ecosystem health. The more sustainable an ecosystem is, the healthier it is because it is able to “deal” with external stress better (i.e. limiting factors).

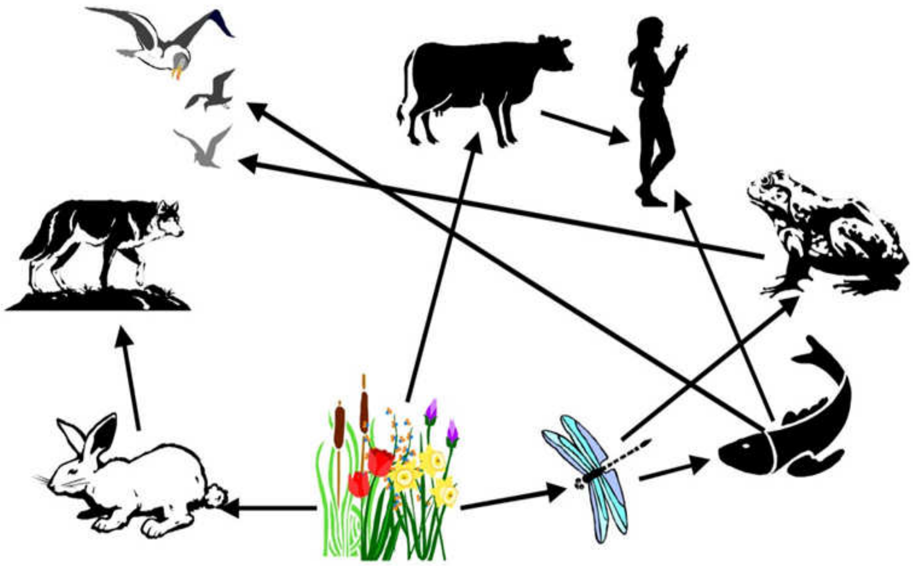

Figure 3: Food web
Source: www.wikipedia

3.2 Methods of Biodiversity Conservation

Conservation of biodiversity is an essential part of the environment. By conservation, we do not mean preservation, but conservation means the utilization of natural sources in such a way that they are not allowed to destroy. The maintenance of species and ecosystems is a keystone sustainable development. Conservation of biodiversity includes all human efforts to preserve wildlife and plants from extinction as well as wise management of wildlife, plants and their environment.

3.2.1 In-situ Biodiversity Conservation

In-situ conservation means the conservation of species within their natural habitats, this way of conserving biodiversity is the most appropriate method for biodiversity conservation. In this strategy you have to find out the area with high biodiversity means the area in which number of plants and animals are present. After that this high biodiversity area should be covered in the form of natural park sanctuary/biosphere reserve etc. In this way biodiversity can be conserve in their natural habitat from human activities.

3.2.2 Ex-Situ Conservation Methods

Ex-situ conservation involves the conservation of biological diversity outside of their natural habitats. This involves conservation of genetic resources, as well as wild and cultivated or species, and draws on a diverse body of techniques and facilities. Ex-situ Biodiversity conservation can be done as following:

- By forming Gene banks: In this store seeds, sperm and ova at extremely low temperature and humidity.
- It is very helpful to save large variety of species of plants and animals in a very small space. e.g. sperm and ova banks, seed banks.
- Forming Zoo and botanical garden: for research purpose and to increase public awareness collecting living organisms for aquaria, zoos and botanic gardens.
- Collections of In vitro plant tissue and microbial culture.
- Captive breeding of animals and artificial propagation of plants, with possible reintroduction into the wild.

Ex-situ biodiversity conservation strategy also plays an important role in recovery programmes for endangered species. The Kew Seed Bank in England has 1.5 per cent of the world’s flora - about 4,000 species - on deposit.

In agriculture, ex-situ conservation measures maintain domesticated plants which cannot survive in nature unaided.

It provides good platform for research opportunities on the components of biological diversity. Some of the institutions also play a major role in public education and in increasing awareness among public by bringing members of the public into contact with plants and animals they may not normally come in contact with. It is estimated over 600 million people visit zoos every year worldwide.

Fig. 4: Methods of Biodiversity Conservation
Source: www.goole.com

3.2.3 Wildlife Sanctuary

It is a consecrated place where sacred species are kept. It is not open for general public, unlike zoo. In other words, we say, it tries not to allow any activity that would place the animals in an unduly stressful situation. India has 543 wildlife sanctuaries.

Characteristics of Wildlife sanctuary

i. It is natural area which is reserve by a governmental or private agency for the protection of particular species.
ii. Area is designated for the protection of wild animals.
iii. Only animals are conserved, Could be private property also, outside activities allowed.
iv. It came under the category called “Protected Areas”. The Protected Areas are declared under Wildlife (Protection) Act, 1972.
v. International Union for Conservation of Nature (IUCN) has defined its Category IV type of protected areas.

3.2.4 National Park

It is a home to many species of birds and animals which is established by central and state government for the conservation.

Characteristics of National Park

i. Reserve area of land, owned by the government.
ii. Area is protected from human exploitation, industrialization and pollution.
iii. No cutting, Grazing allowed, Outside Species Allowed.
iv. It came under the category called “Protected Areas”. The Protected Areas are declared under Wildlife (Protection) Act, 1972.
v. Conservation of 'wild nature' for posterity and as a symbol of national pride.
vi. International Union for Conservation of Nature (IUCN), and its World Commission on Protected Areas, has defined its Category II type of protected areas.

3.2.5 Biosphere Reserves

Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located.

The International Co-ordinating Council (ICC) of UNESCO designated of ‘Biosphere reserve’ for natural areas from November, 1971. There are 18 Biosphere Reserves in India.

Characteristics of Biosphere Reserve

i. Notified areas which cover a larger area of land which may cover multiple National Parks, Sanctuaries and reserves as well.
ii. Areas are meant for conservation of biodiversity of a specific area.
iii. Three areas: Core, Buffer & Marginal. No outside Species allowed Conservation and research purpose.
iv. It is internationally recognized within the framework of UNESCO’s Man and Biosphere (MAB) programme and nominated by national governments.
v. The Ministry of Environment and Forest provides financial assistance to the respective State governments for conservation of landscape and biological diversity and cultural heritage.

3.2.6 Seed banking

Seed banking is a valuable conservation tool that enables the long-term storage of genetic diversity of a large number of plant species. It involves collecting, cleaning, drying, recording, and storing seeds at low temperatures for future conservation and restoration uses.

Seed Banking: Steps

- Collecting
- Drying
- Cleaning
- Testing viability
- Storage.

4.0 CONCLUSION

In this unit, you learnt the meaning of the term Climate change as it affects the weather pattern world-wide. This change leads to increase in the average temperature of the earth which has led to loss of biodiversity. Global warming results from human activities through massive burning of fossil fuel leading to the release of greenhouse gases.

Climate change has a huge impact on the normal functioning of the ecosystem. These effect ranges from change in weather pattern, flooding, differential rainfall and disease spread. However, human race is making effort at rolling this menace back through concerted afforestation

In this unit, you learnt about what conservation is all about and the need to conserve biodiversity various methods of conservation were critically examined. Conservation of biodiversity is an integral part of efforts towards ecosystem sustenance and checking the effect of species extinction as well rolling back the effects of global warming.

5.0 SUMMARY

Recent changes in climate have had significant impacts on biodiversity and ecosystems. They have affected species distributions, population sizes, and the timing of reproduction or migration events, as well as the frequency of pest and disease outbreaks. Global warming has begun to manifest its impact on biodiversity. For instance, of the 95 most common species of passerine birds, those in northern regions are declining the fastest. Biodiversity and climate change are thus connected.

Biological sustainability and animal survival is the ability to maintain ecological processes over long periods of time.

Conservation means the utilization of natural sources in such a way that they are not allowed to destroy. Conservation of biodiversity includes all human efforts to preserve wildlife and plants from extinction as well as wise management of wildlife, plants and their environment.

In-situ conservation means the conservation of species within their natural habitats. This is the most appropriate method for biodiversity conservation. In this strategy you have to find out the area with high biodiversity.

Ex-situ conservation involves the conservation of biological diversity outside of their natural habitats. This involves conservation of genetic resources, as well as wild and cultivated of species, and draws on a diverse body of techniques and facilities.

National park is a reserve area of land, owned by the government which is protected from human exploitation, industrialization and pollution; No cutting, Grazing allowed, Outside Species Allowed; it came under the category called “Protected Areas”. The Protected Areas are declared under Wildlife (Protection) Act, 1972; Conservation of 'wild nature' for posterity and as a symbol of national pride.

Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, and within the frame work of UNESCO.

6.0 TUTOR-MARKED ASSIGNMENT

1. Briefly establish a relationship between global warming and greenhouse effect.
2. How does climate change affect survival of organisms?
3. Clearly enumerate the five conservation efforts.
4. What is Biodiversity?

7.0 REFERENCE/FURTHER READING

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