NATIONAL OPEN UNIVERSITY OF NIGERIA

FACULTY OF SCIENCES

COURSE CODE: BIO412

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COURSE TITLE: WILDLIFE ECOLOGY AND CONSERVATION

Course Code & Course Title: BIO412: Wildlife Ecology and Conservation

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Course Guide

Introduction

Wildlife Ecology, Conservation and Management with the course code of BIO 412 is a second semester, 3 credit unit course that is core for students of B.Sc. (Hons) Biological Sciences and faculty of education that is offering Biology or related programmes. The course consists of wildlife conservation and management to maintain and improve wildlife and control animal population by managing the habitat. The management is concerned primarily with production of wildlife quality and quantity on a sustained yield basis, but at times control measures are undertaken to preserve a species or to hold its population within bounds.

Course Competencies

The aim of this course is to enable students understand the general principles of wildlife and sustainable conservation. This will include human participatory processes.

Course Objectives

The overall Objectives of the Course are to:

1. Explain the ecology of the wildlife habitats and ecosystem.
2. Describe principles of wildlife and ecosystem management
3. Identify the different types of wildlife resources and their management o.
4. Describe the dynamics of wildlife population and the techniques of wildlife investigation.
5. Describe the local, national and international conservation legislations, policies, problems and prospects.

Working Through this Course

To successfully complete this course, you are required to read each study unit, read the textbooks and other materials provided. Reading the reference materials can also be of great assistance. Each unit has self –assessment exercise which you are advised to do. There will be a final examination at the end of the course. The course should take you about 8 weeks to complete. This course guide provides you with all the components of the course, how to go about studying and how you should allocate your time to each unit so as to finish on time and successfully.

Study Units

The study units in this course are given below:

BIO 412: WILDLIFE ECOLOGY, CONSERVATION AND MANAGEMENT

Module 1

Unit 1: Wildlife Ecology, and Adaptation
Unit 2: Wildlife Resources of Nigeria
Unit 3: World wildlife resources and their protection.
Unit 4: Forestry and wildlife
Unit 5: Conflicts related to wildlife resources
Unit 6: Climate change and wildlife resources.

Module 2: Wildlife Conservation Policies and Legislation
Unit 1: Conservation Policies
Unit 2 : Wildlife Protection Policies and Legislation
Unit 3: Problems and Threats to Wildlife Conservation
Unit 4: Conservation Status of Wildlife
Unit 5: International and national laws related to wildlife resources.

Module 3: Techniques of wildlife investigation
Unit 2: Study design for wildlife studies
Unit 2: Designing Field Studies
Unit 3: Strategies for field wildlife data collection
Unit 4: Wildlife Control Methods
Unit 5: Biological Garden

Module 4: Population dynamics and Wildlife Management
unit 1: Wildlife Population Dynamics
unit 2: Principles of ecosystem management
Unit 3: General Principles of wildlife Management
Unit 4: Wildlife Zoonoses
Unit 5: Fire as tool in terrestrial wildlife management.

References and Further Readings

You would be required to read the recommended references and textbooks as provided in each unit of the course.

Presentation Schedule
There is a time-table prepared for the early and timely completion and submissions of your TMAs as well as attending the tutorial classes. You are required to submit all your assignments by the stipulated date and time. Avoid falling behind the schedule time.

Assessment
There are three aspects to the assessment of this course. The first one is the in-text questions and the second is self-assessment exercises, while the third is the written examination or the examination to be taken at the end of the course. Review the exercises or activities in the unit by applying the information and knowledge you acquired during the course. The work submitted to your tutor for assessment will account for 30% of your total work. At the end of this course you will have to sit for a final or end of course examination of about a two hour duration and this will account for 70% of your total course mark.

How to get the Most from the Course

In this course, you have the course units and a course guide. The course guide will tell you briefly what the course is all about. It is a 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 in-text questions and Self-assessment questions which will form part of your overall assessment at the end of the course. Also, there will be 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.
This course exposes you to Introductory Ecology, a sub-discipline and very interesting field of Biological Sciences.

Online Facilitation

Eight weeks are provided for tutorials for this course. You will be notified of the dates, times and location for these tutorial classes.
As soon as you are allocated a tutorial group, the name and phone number of your facilitator will be given to you.
The duties of your facilitator is to monitor your progress and provide any necessary assistance you need.
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 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 contact with your facilitator and to ask questions which will be answered instantly. It is also a period where you can point out any problem encountered in the course of your study.

Course Information

Course Code: BIO 412
Course Title: WILDLIFE ECOLOGY, CONSERVATION AND MANAGEMENT
Credit Unit: 3
Course Status: ELECTIVE
Course Blub: This course is designed to enable students understand the general principles of wildlife and sustainable conservation.
Semester: 2 SEMESTERS
Course Duration: THIRTEEN WEEKS
Required Hours for Study: 65 hours

Ice Breaker

Ahmad AbdulHameed is a Professor of Ecology in the Department of Biological Sciences, Abubakar Tafawa Balewa University Bauchi. He is an external facilitator in In the Department of Biological Sciences. National Open University. He has vast national and international recognitions and is a research fellow of the University of Aberdeen, UK

Prof. AbdulHameed's research encompasses Plant Biodiversity (Phytosociology), Plant-Soil (Drought), Plant-animal interactions and Environmental Ecotoxicology.

Module 1: Wildlife Ecology and Resources

Module Structure

In this module we will discuss about the Wildlife Ecology and Resources with the following units:

Unit 1: Wildlife Ecology and Adaptation
Unit 2: Wildlife Resources of Nigeria
Unit 3: World wildlife resources and their protection.
Unit 4: Forestry and wildlife
Unit 5: Conflicts related to wildlife resources
Unit 6: Climate change and wildlife resources.
Glossary
End of the module Questions

Unit 1: Wildlife Ecology and Adaptation

Unit Structure

1.1 Introduction
1.2 Intended Learning Outcomes (ILOs)
1.3. Definition of Wildlife Ecology
  1.3.1 Values of wildlife
  1.3.2 Wildlife Ecosystem
1.4 Productivity
  1.4.1 Effect of light and temperature on animals
  1.4.2 Basic Requirements of Wildlife
  1.4.3 Limiting factors for wildlife
1.5 Wildlife Habitat
  1.5.1 Animal Behaviour
  1.5.2 Animal Adaptations
1.6 Summary
1.7 References/Further Readings/ Web sources
1.8 Possible Answers to SAEs

 1.1 Introduction

The definition of Wildlife Ecology, values and wildlife ecosystem will be highlighted. You will also learn about the productivity, effect of light and temperature on animals. You will be introduced to the basic requirements and limiting factors for wildlife and wildlife habitat. Lastly, you will learn about animal behaviour and adaptations.

1.2 Intended Learning Outcomes (ILOs)

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

- Define of Wildlife Ecology
- Describe the Values of wildlife
- Describe the components of Wildlife Ecosystem
- Explain the meaning of productivity in ecosystem
- Explain the effect of light and temperature on animal
- Describe the basic requirements and Limiting factors of Wildlife
- Describe wildlife habitat, animal behaviour and adaptation

1.3 Definition of Wildlife Ecology

All non-domesticated plants, animals, and other species are considered to be wildlife. It has numerous possible positive and negative values. The science that underpins the practice of managing animal populations for human benefit is known as wildlife ecology. Even while it has become increasingly quantitative, particularly since the 1990s, it still has a strong technical orientation and places more of an emphasis on statistical metrics than on ecological principles. It has essentially come together as a branch of conservation biology that is primarily concerned with managing and applying ecology to wild bird and mammal populations. Ecology is not only concerned with plants and animals. Additionally, it strongly incorporates concepts from geography, chemistry, and other disciplines.

1.3.1 Values of wildlife

Positive values of wildlife include:

1. Physical utility: use of wildlife for physical needs such as for food, clothing, and other domestic purposes.
2. Economic/Monetary value: Furs, hides, ivory, medicines.
3. Recreational value: Bird watching, parks, tourism
4. Scientific value: Development of research, discovery and invention of new things
5. Ecological value: cycling of water, nutrients and pollution reduction.
6. Existence value: it is the potential to become valuable in future. It helps in the preservation of genetic diversity.

Negative Values:

1. Wildlife damage: it includes damage to agricultural crops, livestock and timber.
2. Human animal conflict: it results in human injuries and illnesses.
3. Loss of economic productivity: grazing, damage to plantation
4. Wildlife diseases to man
5. Competition effect

1.3.2 Wildlife Ecosystem

An ecosystem is the basic fundamental unit of organisms and their environment, interacting with each other and within their own components. The main components of an ecosystem are: a) **Abiotic substances:** These are the non-living constituents of the ecosystem like carbon dioxide,

Oxygen, water, etc. b) **Biotic components:** It consists of 3 categories: i. Producers ii. Consumers iii. Decomposers

a). Abiotic factors: These can be further divided into 3 categories: i. Environmental factors ii. Edaphic factors iii. Hydrological factors

I **Environmental Factors**

1) **Light:** Sunlight, moonlight, starlight, and luminous animals are the principal sources of natural light. Solar energy is the most significant source of light among these. Cold-blooded animals like amphibians receive their lifeblood and warmth from the sun as it reaches the earth. Animals need a certain amount of light for a given amount of time at a specific intensity to support their daily metabolic processes. The following categories of animals are determined by their needs for light:

- **Long day animals:** Spring and summer are prime times for small animal and avian breeding. They are therefore referred to as long-day (LD) breeders. These animals have short gestation or incubation periods, and their young are born in the spring and summer. On the other hand, larger mammals like goats and sheep.
- **Short-day animals:** Larger mammals, like goats and sheep, on the other hand, reproduce in the fall. They are referred to be short-day (SD) breeders as a result. The gestation period for these animals is roughly six months. As a result, their children are born and raised in the spring and summer.
- **Indifferent day length animals:** Based on the available light, animals naturally exhibit distinctive morphological adaptations. Animals and fish living in deep water, for example, have larger eyes than those in areas with high light levels (such as the desert).

2) **Temperature:** The relative coolness or heat of an object is referred to as its temperature. Even animals are susceptible to temperature. Animals that live in cold climates have smaller ears, a more compact neck, and thicker hair, whereas those that live in hot climates have larger ears and thinner fur. Animals are categorized as either Euthermal or Stenothermic depending on their body temperature. Temperature is of three types:

- Maximum temperature
- Minimum temperature
- Optimum temperature

Of these, optimum temperature is the most important temperature range because it is temperature at which vital processes in animals and plants take place.

3) Relative Humidity: It is the quantity of water vapour present in the animal expressed as a percentage of the Quantity present in the air at the same temperature.

4) Wind: It is another important environmental factor that plays a role in the ecology of wildlife. It has the following features:

- Wind usually blows from high pressure zones to lower pressure zones
- In the hills, gravity winds blow towards the valley in the evening and vice versa in the early morning.
- Strong winds blow in open areas.

5) Rainfall: It is the main constituent of total annual precipitation. Others are:

- **Drizzle:** A form of precipitation in which small drops of water appear to float in the atmosphere
- **Due and Frost:** this involves the condensation of moist air on the earth's surface.

- **Hail:** The precipitation of moisture in the form of balls or lumps of ice
- **Snow:** It is the combination or collection of ice in the form of hexagonal crystals

II. **Hydrological Factors:** The hydrologic cycle, often known as the water cycle, is a continuous process that moves water from the surface of the planet (including the seas) to the atmosphere and then back to the land and oceans after being cleaned by evaporation.
Water is essential for all kinds of metabolic and chemical reactions that are going on in the body of any plant or animal. The different phases of water circulation are:

- Precipitation
- Evapotranspiration
- Transpiration
- Perspiration
- Drainage

III. Edaphic Factors: The physical, chemical, and biological characteristics of soil that are brought about by natural or man-made processes are referred to as the edaphic factor. The remarkable patterns of diversity we observe in the biotic world are a result of variations in the edaphic factor. Soil is the shallow upper layer of the earth. It performs the following functions;

- It provides support, water, nutrients and oxygen for all plant growth
- It is a basic constituents of abiotic components of the ecosystem
- All plants and animals depends on the soil forming a complex food chain together with herbivores, carnivores, predators and prey.

b). Biotic Factors: A biotic factor is **a living organism that shapes its environment**. In a freshwater ecosystem, examples might include aquatic plants, fish, amphibians, and algae. Biotic and abiotic factors work together to create a unique ecosystem. It is interlinked and interdependent on others for the following purposes.

- Food and Water
- Shelter and Protection
- To maintain its niche in the ecosystem
- Interdependence exists between animals of the same or different species. It is of two types:

I. **Intra-specific relationship:** This is the ecological relationship between Individuals of the same species within the same ecosystem.
II. **Inter-specific relationship:** This is the ecological relationship between Individuals of the different species within the same ecosystem. Inter-specific relationship is of three types:
a) Neutralism: In this case none of the species have effect on each other
b) Symbiosis: In this case, both parts get mutual benefit and there is harm to none. It is further divided into Mutualism and Commensalism.
c) **Antagonism:** In this case, both or one of the Partner, causes adverse effect on the relationship. It can be further divided into Parasitism, Predation , Competition and Ammensalism
What are the differences between animals in cold and hot climates?

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1. What are the different types of Interdependence between animals
2. List the three types of Inter-specific relationships in wildlife studies

1.4 Productivity

Productivity is the measure of a biofuel's production rate. It has to do with a species' real reproductive process. Productivity = Breeding Potential + Resistance to the Environment It is evident from the calculation above that two things have an impact on production:

i) **Breeding Potential:** It is an organism's potential or aptitude to generate offspring, regardless of the percentage that can develop into fully grown adults. It is basically an optimal breeding and reproduction scenario-related theoretical theory.

ii) Environmental Resistance: This relates to the resistance provided by a variety of environmental conditions that prevent a species from expanding biologically. The main environmental factors are:

- Predation
- Climate
- Diseases
- Survival of the fittest
- Non breeding
- Accidents

1.4.1 Effect of light and temperature on animals

a) **Effect of Light on Animals**

The effects of light on plants and animals are numerous. The presence, absence, or intensity of light can result in a composite of several effects. Some of the effects of light are:

1) **Metabolism:** the metabolic rate of animals is affected by the intensity and duration of light.

2) **Growth**: The metabolic rate and animal growth are directly related. Light affects metabolism, which has a significant impact on how an animal grows and develops. Many animals have superior chances for growth and development in life.

3**) Reproduction**: breeding and reproduction in many animals is initiated and controlled by light which brings about stimulation at their own.

4) **Skin colour**: Animal skin color can change depending on the amount of light. Due to the impact of light, a variety of chemical pigments are generated in photoreceptors. These pigments perform the functions of influencing the skin colour of animals and Camouflage

5**) Eyes:** Intensity of light influences the size of eyes of many animals.

b) Effect of Temperature on Animals

- Temperature influence metabolic rates
- Temperature influence reproduction of animals
- Temperature influence distribution of animals
- Temperature influence structure of animals: compact tailed ear neck in animals of cold regions

- whereas larger neck tail and ear in animals of tropical climate.

1.4.2 Basic Requirements of Wildlife

1. Food: All animals require food and shelter for their survival. Different statures of food as a base for wildlife management have been discussed under the following heads: 1. Food Chain 2. Food web 3. Food pyramid/Ecological Pyramid. The food requirements of a particular community depends upon:

- Physiology and digestive ability of the community
- Instinctive selection patterns of food
- Season and behaviour
- Shelter and habitat

2. Water: All animals need water for their survival. The water requirements of a particular community depends upon the following variables:

- Food and feeding habits
- Availability of water
- Shelter and habitat
- Climatic conditions

3. Shelter: Shelter refers to the quality and quantity of arrangements of essential needs for the existence of an animal or community in an area. It performs the following functions:

- Affords protection against adverse climatic conditions
- Ensures protection against enemies
- Ensures availability of food and water
- Provides suitable breeding facilities
- Satisfies the instinctive and psychological needs

4. Space: It is a basic requirement for all wildlife to forage, seek cover, protect their young, and have access to diverse habitat conditions. Space is of two types:

a. Territory: It is an area of the forest taken up by an individual for the following functions:

- To meet its requirements of food and shelter
- To serve as a breeding ground
- To meets its psychological needs

b. Home Range: It is an area over which an animal roams without the tendency to exclude others from it.

1.4.3 Limiting factors for wildlife

According to the theory of limiting factors, the distribution of a specific species or a group of species in a given area is constrained if an environmental component in that area exceeds the maximum permissible level or falls below the lowest tolerable level. The limiting factors for wildlife are:

1) **Law of Minimum:** It was put forth by Liebig in 1840 and claims that "The growth of plants is reliant on the amount of food and other necessities needed by it in minimum quantities." It is connected to the idea of limiting factors. The same is true for creatures in the wild. They must have a certain quantity of food, water, and shelter to survive in a given place.

2) **Law of Tolerance:** Shelford proposed this law in 1913. It states that "the number or expansion of species may also be affected by the availability of a necessity below or above a specific limit." This law states that a species' or a group of species' level of tolerance is

determined by all environmental conditions. Additionally, there are critical minimum and critical maximum levels. This zone of tolerance may be divided into: i. Lower limit of tolerance ii. Zone of physiological stress iii. Optimum range

3) **Zone of physiological stress** This is a transition zone near the lower limit of tolerance in which the distribution of a species is infrequent.

4) **Lower limit of tolerance:** This is the lowest limit of tolerance of an environmental factor.

5) **Upper limit of tolerance:** This is the level at which an environmental element can be tolerated. Very frequently, a full community does not entail a single limiting constraint. These elements interact to create a limit. Consequently, it can be inferred that the existence of a certain group of species in an ecosystem depends on a number of intricate circumstances. A limiting factor is any factor or set of factors that approaches or crosses the tolerance limit. In Nature, the survival of an organism is governed by:

- The physical factors that are available
- The c
- The l

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1. Outline the effects of Temperature on animals
2. State the Laws of Tolerance as limiting factors to animal survival

1.5 Wildlife Habitat

A wildlife habitat is a collection of resources intended to suit the needs of wildlife, including food, water, shelter, and space. Even a tiny yard can be designed to entice small animals, birds, butterflies, and helpful insects. Animals can find refuge and food among the trees, shrubs, and other plants. Wildlife habitat depends on the following:

1. Niche: It is employed to specify an organism's place in an ecosystem. It not only covers the environment in which a specific creature lives, but also the "Jobs" that organism does in that environment. It may also include the organism's diet and interactions with both living and non-living elements of its surroundings.

2. Carrying Capacity: The carrying capacity of an area is the most organisms that an ecosystem can sustain while using its bare-bones food supply. By adding more water stations, a region with sufficient food supplies may support more people. However, too many water sources will draw an unusually large number of animals, increasing the risk of habitat degradation.

3. Territory: A section of the forest that an individual has claimed for the purposes of meeting its needs for food, housing, a breeding place, and psychological support.

4. Home range: A home range is an area that an animal freely roams without having a preference to keep out other animals.

5. Edge: Edge effects are the outcome of a sudden transition between two nearby natural habitats that are very different from one another. Essentially, it's a break in the continuity of two nearby

ecosystems, which causes changes to the environmental and biological circumstances. The boundary of two habitats typically supports a larger diversity of creatures than either habitat alone.

6. Cruising Radius: It is defined as the distance that an animal can cover from an initial point in the course of the day.

7. **Interspersion:** This pertains to the mixture of a number of species or type of vegetation that occurs over an edge.

1.5.1 Animal Behaviour

Animal behaviour: It is the scientific study of the fascinating and wacky interactions that occur between animals, other living things, and their surroundings. It examines how animals interact with both their natural habitats and other living things, covering issues such how they locate and defend resources, evade predators, select partners, reproduce, and raise their young. Animals show the following behavioral attributes:

1. Territoriality: It is a form of intraspecific or interspecific competition that arises from the exclusion of other individuals by behavior from a certain area that is claimed as territory. It has a price even if it has great nutritional and reproductive benefits. Territoriality requires time and effort and frequently gets in the way of other essential tasks like rearing, feeding, courtship, and gathering.

2. Predation: This refers to an animal preying on another. The base of the pyramid's population would grow so rapidly in the absence of predation that there would be no room for other animals to survive. There are three types of predation:

i. **Chance predation:** occasional or casual predation, as seen in omnivores

ii. Habit predation: All predators prey regularly on prey species. This helps to control surplus or extra numbers and does not have adverse effect on population density.

iii. Sanitary predation: Predators prey upon the dying and diseased individuals of a species.

3. Gregariousness: This is the urge to stick together that many animals have. Small groups of members of the same species like to hunt and live together. Gregarious animals include monkeys, elephants, deer and antelope, among others. However, many animals would rather live alone. These are known as loners.

4. **Flocking:** One sign of gregariousness is flocking. It relates to several groups of members of the same species coexisting for a certain amount of time. Some of the factors whih indicate the size of flock are: i. Differences in age ii. Requirements of space, food and cover iii. Competition and predation

5. **Pecking order:** It is a system of social dominance based on relative strength that has developed in most species, demonstrating gregariousness and flocking. Usually, the herd's leader is its most potent member. The leader of the herd usually performs the following functions:

- Services as a sentinel
- Decides the routes and areas of the of the herd or flock for feeding
- Its actions are usually unchallenged

6. **Animal migration:** the movement of animals from one place to another is called as migration. The following are some causes responsible for migration:

- Better habitats or living conditions in winter
- In search of food.
- To avoid adverse conditions such as heavy snow fall
- For breeding

Animal migration may be of the following types:

i. Local migration: this pertains to the migration in which the distance travelled is not very large
ii. Long distance migration: this pertains to the migration in which the distance travelled is very large
iii. Altitudinal migration: in the hills, animals migrate to higher elevations in summer and come down to the shelter of valleys in winter.
7. Intra-specific Relationship: These are interactions taht happen between members of the same species.
8. Inter-specific relationshi: Inter-specific interactions are those that take place between members of different species.
9. Adaptation: An adaptation is a way an animal's body helps it survive, or live, in its environment. Camels have learned to adapt (or change) so that they can survive.

1.5.2 Animal Adaptations

An animal's body can assist it thrive or survive in its surroundings by making adaptations. A species or organism gradually grows more accustomed to its surroundings through the process of adaptation. It can also be described as the anatomical, physiological, and behavioral traits that organisms acquire in order to successfully live and reproduce in their surroundings. Structural, behavioral, and physiological adaptations are the three different categories of adaptations.

1. Structural: Through structural adaptations, an organism's environment determines how it looks. Arctic foxes have small ears to keep their body heat in while desert foxes have wide ears for heat radiation. Raccoons have separate, flexible digits for manipulating food, while seals have flippers for navigating the water. Spotted jaguars and white polar bears disappear into the shadows of the spotted jungle, respectively. Trees may develop corky bark as a fire defense. The way a knee hinges, for example, or the presence of powerful flight muscles and keen eyesight in birds that hunt their prey are all examples of how structural changes affect creatures on various levels.
2. Physiological: Biological adaptations are typically imperceptible to the naked eye since they depend on body chemistry and metabolism. They include elements like more effective kidneys for arid-dwelling creatures like kangaroo rats, substances in mosquito saliva that stop blood coagulation, or the presence of poisons in plant leaves to deter herbivores. To identify physiological adaptations, laboratory tests that assess the composition of blood, urine, and other body fluids, track metabolic pathways, or conduct microscopic examinations of an organism's tissues are frequently required. When there isn't a common ancestor or closely related species to compare results with, it can be challenging to locate them.
3. Behavioral: Changes in an organism's behavior are referred to as behavioral adaptations. While birds and whales move to milder winter regions, bears hibernate to avoid the cold. Desert wildlife is awake at night during the sweltering summer. In the morning, lizards seek out a sunny area to reach operational temperatures more quickly. A killdeer that is nesting will pose as being hurt to draw a predator away from her offspring. Behavior-related adaptations that entail mating rituals, like the Australian bowerbird's, can be incredibly intricate. To fully understand behavioral adaptations, which frequently involve physiological factors as well, thorough field and la use
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1. What are the three types of Animal migration?

2. List the three types of adaptations by animals

 1.6 Summary

You have learnt about the basic requirements for wildlife as water, food, shelter and space/ You have also studied the main components of an ecosystem being the abiotic substances **(**non-living constituents of the ecosystem like carbon dioxide, Oxygen, water, etc.) the biotic components (i. Producers ii. Consumers iii. Decomposers). Lastly you have learnt about wildlife productivity, behaviour and adaptation.

 1.7 **References/Further Readings/Web sources**

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https://www.youtube.com/watch?v=ZrSWYE37MJs

 **1.8 Possible Answers to Self-Assessment Exercises**

Answers to SAEs 1

1. The two types are

i) **Intra-specific relationship:** This is the ecological relationship between Individuals of the same species within the same ecosystem.

ii) **Inter-specific relationship:** This is the ecological relationship between Individuals of the different species within the same ecosystem.

2. The three types of Inter-specific relationship are

i) Neutralism

ii) Symbiosis

iii) **Antagonism**

Answers to SAEs 2

1. ***The*** effects of Temperature on Animals:

- Temperature influence metabolic rates
- Temperature influence reproduction of animals
- Temperature influence distribution of animals
- Temperature influence structure of animals: compact tailed ear neck in animals of cold regions
- whereas larger neck tail and ear in animals of tropical climate.

2. **Law of Tolerance states that** all environmental factors determine a tolerance level in relation to a particular species or a group of species.

Answers to SAEs 3

1. Animal migration may be of the following types:

i. Local migration: this pertains to the migration in which the distance travelled is not very large

ii. Long distance migration: this pertains to the migration in which the distance travelled is very large

iii. Altitudinal migration: in the hills, animals migrate to higher elevations in summer and come down to the shelter of valleys in winter.

2. There are three types of adaptations by animals:

Structural, Behavioral and Physiological adaptations.

Unit 2: Wildlife Resources of Nigeria

Unit Structure

2.1 Introduction

 2.1 Introduction

In this unit, you will study about the Wildlife resources as a resource of ecological, economic, and cultural importance. You will also learn that it forms a significant component of the natural ecosystem that maintains the ecological balance of nature through regulation of populations of different species

2.2 Intended Learning Outcomes (ILOs)

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

- Define Wildlife conservation
- Describe the Wildlife Resources of Nigeria
- Describe the Top Wildlife Resources in Nigeria
- Describe the Endangered Animals and Zoos in Nigeria
- Identify the Wetland Wildlife Resources
- Describe the Wetland Wildlife
- List some sightseeing protected areas
- Enumerate some Parks and Game Reserves for Wetland Wildlife

2.3 Wildlife conservation

Animals, plants, and their habitats are preserved and protected through wildlife conservation. Future generations will be able to appreciate our natural world and the amazing animals that call it home if we continue to protect wildlife. Understanding how species interact within their ecosystems and how anthropogenic and environmental factors affect them is crucial for helping to protect wildlife.

2.3.1 Wildlife Resources in Nigeria

The vegetation and fauna are included in the term wildlife. Nigeria is a country with a variety of ecosystems, including plains, mountains, marshes, and rainforests. Within its borders sits the

third-largest river delta in the world. As a result, Nigeria is home to a wide variety of species. In Nigeria, there are more than 22,000 species of both vertebrates and invertebrates. Nigeria still has a number of native species left, including the elusive pangolin, hyraxes, cuckoos, puff adders, and hoopoes. Unfortunately, many of these animals are in danger of being extinct or being endangered. Deforestation for agricultural purposes may result in the extinction of at least 21 bird species.

2.3.2 Top Wildlife Resources in Nigeria

Fish, amphibians, reptiles, birds, and mammals are among the vertebrates found in Nigeria. The mammal is the most developed of these vertebrate species. Warm-blooded mammals have four chambers hearts, hair or fur, and the ability to nurse their young. Some top wildlife resource include the following:

1. Animals

In Nigeria, there are several animal species. Therefore, you might want to spend some time visiting the many ecosystems to view the numerous distinctive species and birds that are found in just a small number of other locations worldwide. In Nigeria, most wild animals are quite harmless. Since their populations are frequently severely threatened, the most hazardous ones are frequently found in isolated regions where you might never encounter them. Therefore, the most dangerous animals in Nigeria today include:

- Puff adder – This unique snake is the deadliest across **Africa**, with approximately 32,000 people dying across the continent yearly from its bite.
- Mosquitoes – Across Africa, approximately 1 million people die annually from a mosquito bite, and another 70 million get sick with malaria or yellow fever.
- Dogs – Rabies is a huge problem in Nigeria.
- **Hippopotamuses** – These mighty animals are very territorial. Across Africa, about 3,000 people are killed by hippos annually.

2**. Birds**

In Nigeria, around 1,000 different bird species can be found. 31 of these species face population decline threats, while four are indigenous to the nation. Ibadan malimbe, Anambra waxbill, Rock firefinch, and Jos Plateau indigo bird are examples of endemic species. There is a wide variety of birds, including flamingos, ostriches, and waterfowl. Nigeria, which is ranked about 34th in the world for birding, attracts avian enthusiasts from all over the world due to its abundance of stunning and distinctive species that thrive in a variety of habitats. In addition to the aforementioned locations, there are countless other wildlife reserves and natural regions in Nigeria, all of which provide shelter to different bird visitors and locals. Of the approximately 67 bird species in Nigeria, 76% are sedentary, permanent residents, and native to Nigeria. The bulk of the aquatic bird species, such as herons, waterfowl, fish eagles, and darters, are piscivorous.

3. Fish

Fish is the primary source of protein for the people of Nigeria, which supports a large fishing sector. Numerous fishing communities can be found along the shore, while freshwater fishing can also be done inland. Fishing is governed by state and federal laws due to the local population's reliance on it for existence. However, illegal fishing continues to cost the nation an estimated $70 million annually. Nigeria is the world's top producer of catfish, a fish that is well-liked by both the local and international markets. Salmon, tilapia, crayfish, and sardines are

additional species that are frequently seen in Nigerian fish farms. There are charter cruises available off the coast for sport fishing, which is also well-liked throughout the nation. These waters are home to several well-known species, including Blue Marlin, Yellowfin Tuna, Wahoo, Mahi Mahi, and Sailfish.
It's crucial to abide by the laws and hunting and fishing regulations of the country you're visiting. Profitable fishing is very important to Nigeria because it is essential to their economy and existence.

4**. Snake**

Although Nigeria is a major hub for stunning and fascinating wildlife, there are occasionally venomous snakes that pose a threat. However, a number of snake species in the nation are non-venomous and avoid interacting with people.

Nigeria is home to several venomous snake species, including the puff adder, gaboon viper, and black-necked spitting cobra.
A few natively poisonous species in the nation, like stiletto snakes, mole vipers, and burrowing asps, actually have a minimal risk of envenomation. Members of the python family, including the African Rock Python, are non-venomous snakes. Non-venomous species that are native to Nigeria include file snakes and thread snakes. Are There Tigers in Nigeria?
Self Assessment Exercise 1

1. What is the most common animal in Nigeria?
2. Are there lions in Nigeria?

2.4 Endangered Animals and Zoos in Nigeria

In Nigeria, there are numerous endangered species. Some are under threat on a global scale, while others are only locally. Important work is being done across the nation to safeguard animals. Some important endangered animals in Nigeria include:

- Northwestern African **cheetah**
- West African **lion**
- Dama gazelle
- **Western gorilla**
- Preuss's monkey
- **Pygmy hippopotamus**
- Common **chimpanzee**
- **West African wild dog**
- Drill

Along with many natural reserves and wildlife management areas, a handful of zoos exist in several Nigerian states. The popular zoos and their top attractions are listed below.

- One of the first conservation sites in Nigeria was the Audu Bako Zoo, which was established in 1971. Lions, giraffes, hippopotamuses, zebras, and ostriches are among the species that can be found here.
- The National Children's Park and Zoo is a fantastic zoo to take kids to because it has play areas, snack bars, and enclosures with easily recognizable animals as attractions. Many of these zoos and parks are highly involved in wildlife conservation and protection, working towards combating threats to natural species and their habitats.
- Jos Wildlife Park: Hippopotamus, numerous monkey species, buffalo, crocodiles, and hyenas can all be found in Jos Wildlife Park. One of the oldest and most well-known parks in the nation, it was founded in 1956 and stretches 8 kilometers (5 miles).

2.4.1 Wetland Resources

Wetlands, according to the wetland resource center, are places that are continually or occasionally inundated or saturated with water. Marshes, ponds, lakes, streams, floodplains, and swamps are examples of inland wetlands. Saltwater marshes, estuaries, mangroves, and lagoons are examples of coastal wetlands. Artificial wetlands include salt marshes, rice paddies, and fish ponds. Wetland wildlife, for the purposes of this discussion, refers to vertebrate creatures that live, breed, and eat in water as well as those that are strongly associated with water bodies due to their eating, roosting, and other behaviors specific to the aquatic environment. It comprises mammals, birds, amphibians, and reptiles. They all have the traits of being proficient swimmers, aquatic life-adapted, piscivorous, and/or feeding on aquatic creatures. In addition to fish, many aquatic species also eat plants, aquatic insects, snails, and other invertebrates. The many habitat types for this group of species, such as open water, vegetated shorelines, and benthic regions, are frequently linked. These animals may forage, breed, and act territorially within these varied habitat types. Therefore, it makes sense to assume that the dynamics of the environment and the fisheries would change depending on whether or not non-fish aquatic animals were present in a particular body of water. For instance, the feces of aquatic birds that are thrown into the water are either consumed directly as food by omnivorous fish and other aquatic animals, or because they are rich in organic matter, they may function as fertilizer, boosting primary productivity.

2.4.2 Wetland Wildlife Status

The amount of information now available on the state of Nigeria's non-fish aquatic animal resources is still confined to a few inventories of wild stocks in the Protected areas. The management and protection of aquatic animals, especially fish, must take a wholistic approach in order to prevent irreversible loss of their genetic resources, biological diversity, food value, and socioeconomic benefits. Grasp that managing these distinct species, which occupy different trophic levels, necessitates a detailed understanding of their function in the ecology and balance of the environment, is one crucial aspect. Ecology explains how plants and animals interact with their surroundings, but the food chain, which fundamentally maintains the balance, must also be understood. In Nigeria, birds are thought of as fish predators around the coasts of big bodies of water, on fishing lines, and in fish ponds. We don't fully understand how this predation will affect the economy. On the plus side, some aquatic birds eat both meat and insects. The Hadejia-Nguru Wetland Waterfowl Projects and the Yankari Game Reserve are significant locations currently funded by the Nigerian Conservation Foundation. Aquatic birds are contributing more and more to Nigeria's tourism economy. At Foge Island on Lake Kainji, there is a large population of aquatic birds all year long, and the Kainji Lake National Park currently organizes lake excursions for bird watchers in the Lake Kainji area. This region has the potential to be a

significant water bird sanctuary while it is being developed. Large numbers of migrating Palearctic aquatic birds also make the Chad basin a significant location; these birds currently serve as a draw, primarily for foreigners who are more experienced bird watchers. However, with the right finance and administration, the tourism sector may be enhanced. The semi-aquatic animals, which are adapted to living near water and obtaining their food from the water, and those that live and spend the majority of their time in the water, are typically two categories of mammals linked with the aquatic systems of Nigeria. These latter creatures could have webbed feet and swimming and wallowing-adapted characteristics. Several mammals, including otters, civets, genets, and mongooses, eat fish and other tiny aquatic creatures. As a result, they contribute in some way to the population dynamics of this aquatic species. According to population size and geographic distribution, amphibians, especially frogs and toads, are the most common group of aquatic vertebrates other than fish. In lakes, marshes, and reservoirs, particularly those with dense aquatic and littoral flora, they are more prevalent. They are also widespread in ponds, where they could harm young fingerlings and fish fry. Frogs are typically piscivorous and essentially flesh eaters, although toads are not unless during the latter stage of the tadpole life cycle. Some frog species are delicacies and food for some ethnic groups in Nigeria and elsewhere. In Nigeria, all *Rana* species are gathered as wild bush meat from ponds and waterlogged places in both rural and urban areas because of their unusually long hind legs. The reptiles are a group of animals that eat fish as well as snakes and other fish predators. While the first group, which includes crocodiles and terrapins, spends the most of their time in the water, the tortoises, monitor lizards, and snakes spend most of their time on land near water. But each one of them helps the aquatic community's biology in some way. For their meat and skins, which are significant sources of foreign cash, crocodiles and monitor lizards are heavily hunted, sometimes to the point of extinction. Define wetlands.

Self Assessment Exercise 2

1. Why are Wetlands Important?
2. Why do we need wetland status and trends

3.5 Management of Protected Areas

The cornerstone of worldwide conservation strategy is protected areas. IN TEXT QUESTION? What makes protected areas crucial? If nations want to manage natural resources sustainably, support livelihoods dependent on resources, promote tourism, and uphold their obligations under international agreements, particularly the Convention on Biological Diversity, they must have

well-managed protected area networks (CBD). Critically endangered animals like vultures, ibises, crocodiles, turtles, and forest trees are among the species that gain from this, along with endangered and vulnerable species like elephants, wild cattle, monkeys, and forest birds, as well as a wide range of less threatened species.

3.5.1 Some Sightseeing Protected Areas in Nigeria

- Cross River gorillas: To witness Cross River gorillas in their natural habitat, visit the Afi Mountain Wildlife Sanctuary, the Mbe Mountains, or the Okwangwo Division of Cross River National Park.
- Forest elephants: In Southern Nigeria, these elephants can be found in five different locations, including the Omo Forests in Ogun State, the Okomu National Park, the Cross River National Park, the Idanre Forests and Osse River Park, as well as on Andoni Island.
- Savannah Elephants - You can see savannah elephants in Yankari National Park and the Yankari Game Reserve, but you might want to move quickly since there are less than 500 left in the wild.
- Chimpanzees from Nigeria and Cameroon are the rarest and most endangered of all chimpanzee species; you can view them in Gashaka-Gumti National Park and Ngel Nyaki Forest Reserve.
- African lions - Before they become extinct, you can hear the roar of an African lion at Yankari and Kainji-lake national parks.
- Red colobus monkeys of the Niger Delta - There are only 200 of these monkeys left in existence. To prevent the extinction of the greatest troop of red colobus monkeys in the Niger Delta, a conservatory was established at Apoi Creek Forest in October 2020.
- Cross River National Park is home to Preuss's red colobus monkeys.
- Leopards - Because they are uncommon and threatened, seeing a leopard in Nigeria can be difficult, but cameras have captured images of them in Yankari Game Reserve, Gashaka-Gumti National Park, and Kainji Lake National Park.

3.5.2 Protected Areas for Wetland Wildlife

Wetland fauna relies on Protected Areas, such as Game Reserves and National Parks. These designated locations are the last bastions where such creatures still exist in significant numbers, reproduce naturally, and possess a sizable genetic resource pool. A protected area, according to the IUCN, is a clearly defined geographic region that has been recognized, devoted, and managed in order to preserve the natural world and its ecosystem services as well as cultural values over the long term. Some protected areas, because of their suitable habitat and ecology, now serve as major sanctuaries for aquatic birds, crocodiles and manatees.

i. Gashaka/Gumti National Park:
   The largest National Park in Nigeria is the Gashaka/Gumti Game Reserve, which is situated in the country's northeast. It stretches into Cameroon and has an area of 6670 km2. It has a range of habitats, including habitat in the Guinea savanna, the mountains, and the forest. Animal life is abundant there, including crocodiles, manatees, and amphibians.
ii. Pan Dam Wildlife Park: This Plateau State attraction is well-known for its wildlife and is supported by the state government as a tourism showcase (Ebin, 1983). Its 225km2 area is made up of grasslands and isolated areas of high forest. It also has Pan Lake which is

about 150 metres wide and 3.5km long. Pan Lake is a sanctuary for manatee, red river hog, crocodile and hippopotamus and a variety of fish species.

ii. Kwale Game Reserve:
It is situated in the low coastal zone of Delta State, characterized by rain-forest vegetation and deltaic swamps. It is rich in reptiles and water associated animals, particularly red river hog, sitatunga and a variety of brackish, marine and freshwater fish species.

iii. Ologbo-Emu-Uro Game Reserve:
It has similar features to Kwale Game Reserve but is much more swampy and has similar flora and fauna. It is located in Edo State.

iv. Buturiya (Wetland) Game Reserve:
Buturiya is a game sanctuary located 40km from Hadejia. It is an important wintering-ground for migrant birds from the Palearctic regions of Europe, north-western coast of Africa and Asia. Buturiya wetland is very rich and a sanctuary for the pelican, knob-billed goose, grey hornbill and white faced duck. It is also rich in crocodiles, monitor lizards and amphibians.

v. Lake Chad National Park:

vi. Birds, animals, reptiles, and fish all have important refuges in Lake Chad. It serves as a wintering site for Palearctic migratory birds due to its Sahelian position and significance as a water resource. The wildlife reserve also contains 388.5 km2 of sahelian vegetation in addition to the lake. Clawless otters, sitatungas, crocodiles, hippopotamuses, manatees, spur-winged geese, white-faced ducks, pelicans, pintail ducks, and black ducks are just a few of the abundant species found in Lake Chad.

vii. Kainji Lake National Park:

viii. The first National Park was created, and it is a fairly sizable park. Its two main parts are the Zunguruma Sector (3970 km2) and the Kainji Lake Sector (5340 km2), and its overall area is 5340 km2 (1370 km2). The park is home to a variety of wild animals, including more than 390 species of birds, 75 of which are aquatic, four species of turtles and lizards, including numerous Nile monitors and Bosc's monitor lizards, two species of crocodiles (Crocodylus niloticus and (C. cataphractus), over 12 species of amphibians, including two species of toads, and 62 species of mammals, some of which The manatee is currently in danger from humans.

ix. Hadejia-Nguru Wetlands:
These wetlands have received worldwide financing for their conservation since they have been recognized as an important stopover for both Palearctic and Afro-tropical water birds. It's anticipated that the wetlands would be integrated into the brand-new Chad Basin National Park. Studies on these wetlands have revealed details about the usage of fuel wood, the sociocultural practices of the people that surround the wetlands, the economics of fisheries, agricultural activities, and in particular the use of small-scale irrigation and dry season irrigation technology. Waterfowl and ducks find refuge in the Hadejia-Nguru wetlands, but knowledge of other aquatic resources is still scarce.

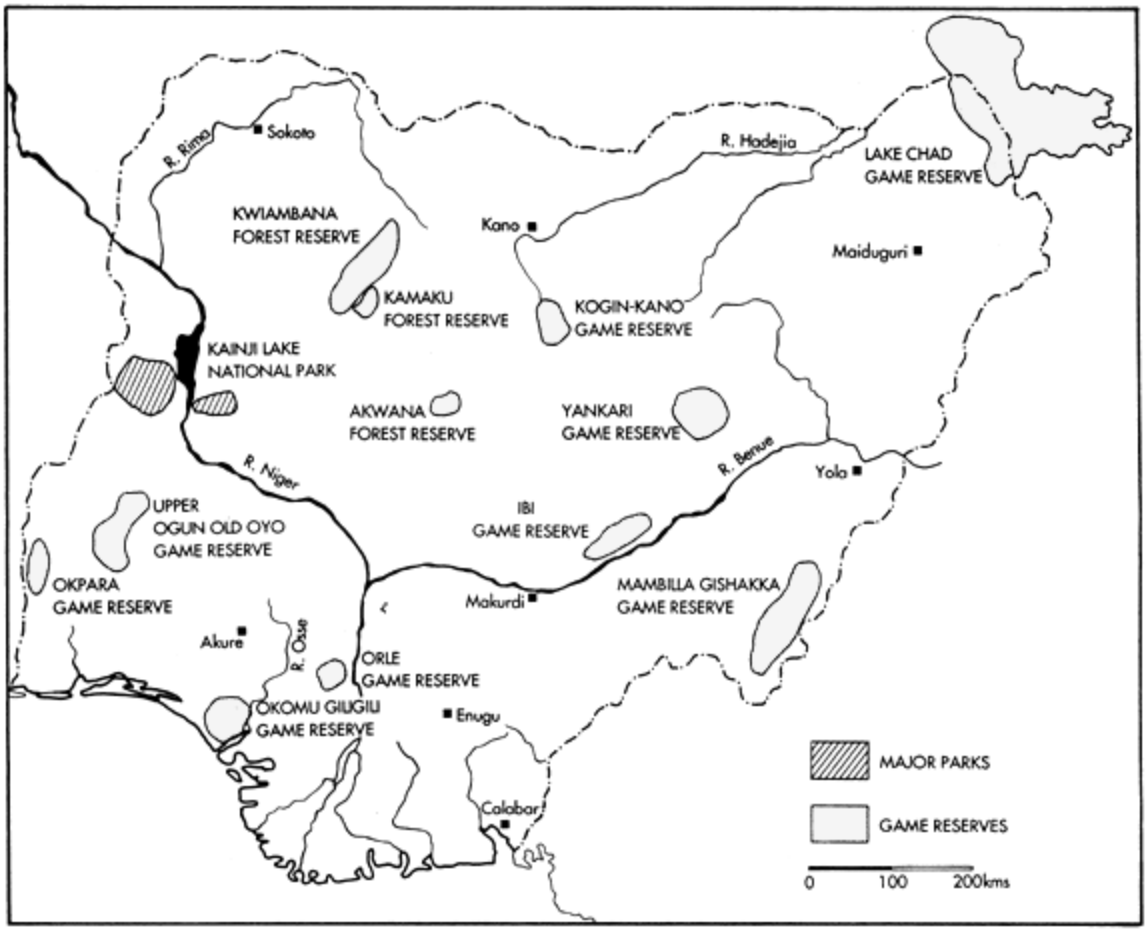

Figure 1. Major Protected Areas (Parks and Game Reserves of Nigeria)

How does the IUCN defines a protected area?

Self Assessmen

1. Why are Protected Areas important?

2. What is a protected area in conservation?

2.6 Summary

You have learned in this unit bout the Protected areas which are cornerstone of many conservation approaches, and concepts of pristineness and wilderness which are often considered central to protected area designation and management. You have also learned that they are important for the protection, conservation and management of wild animals in which killing, hunting and capture of animals and destruction or collection of animals are prohibited

2.7 References/Further Readings/Web Sources

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2.8 Possible Answers to Self-Assessment Exercises

Answers to SAE 1

1. The most common animal in Nigeria is domestic dogs. Domestic dogs who are native to Nigeria are called local dogs. Those that people have imported into the country are called foreign dogs. Some of the most common breeds in Nigeria include Rottweilers, German shepherds, Boerboels, and Caucasian shepherds.

2. While you could find lions across Northern Nigeria in the past, they have lost over 90% of their territory. Today, they live in Kainji Lake National Park and the Yankari Game Reserve. The decline in the number of natural prey by poaching is the primary cause. Agricultural expansion has also led more farmers to shoot or poison lions. There may be less than 100 lions between the two populations. Important work is going on there to try to protect these prides.

Answers to SAE 2

1. Wetlands are important features in the landscape that provide numerous beneficial services for people and for fish and wildlife. Some of these services, or functions, include protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters and maintaining surface water flow during dry periods. These valuable functions are the result of the unique natural characteristics of wetlands.

2. Status and trends information provides contemporary data about wetland loss and gains. Continued monitoring of wetland resources has been widely considered essential for identifying changes in the wetland community type and spatial extent, and guiding additional research or management actions. This information combined with historical perspectives increases our understanding of landscape patterns and processes. Up-to-date status and trends information is needed to periodically evaluate the efficacy of existing Federal programs and policies and identify national or regional wetland issues.

Answers to SAE 3

1. Well-managed protected area networks are essential if countries are to achieve sustainable natural resource management, support resource-dependent livelihoods, tourism, and honor their commitments under international conventions, in particular the Convention on Biological Diversity (CBD).

2. IUCN defines a protected area as: A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Unit 3: Forestry and wildlife

Unit Structure

3.1 Introduction

You will learn in this unit that wildlife depends on vegetation for its existence. The type of plant formation and its stage in eco logical succession determine the species and number of animals which can occupy a habitat. You will study the linkages between wildlife, forestry and food security. You will also be introduced to wildlife policy framework.

3.2 Intended Learning Outcomes (ILOs)

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

- Identify the Influences of Wildlife Resources
- Describe the Wildlife Damage to Forestry
- Explain the Control of Wildlife damaging forest crops
- Explain the methods for the control of wildlife damage to crops
- Describe the linkages between wildlife and forest management and wildlife and food security
- Understand the International policy framework

3.3 Influence of Wildlife Resources

Wild animals exert significant influences on food production systems which may be positive or negative. Positive implications include the use of wild animal droppings as fertilizer and the use of wild animals as pollination and seed dissemination agents. Numerous bird and animal species, including bats, monkeys, baboons, and squirrels, are recognized for dispersing fruit trees through their feeding behavior. On the downside, several species of wild animals are recognized as reservoirs or intermediate hosts for parasites and disease pathogens that can be transmitted to people and their domestic livestock. Food and cash crops are destroyed by other wild animal species, including both vertebrate and invertebrate species, both during crop development and post-harvest storage. Numerous types of wild animal species as well as a wide spectrum of crops. The pest's actions could lead to direct crop losses, such as the actual destruction of food due to contamination and pest feeding, or indirect crop losses, such as those brought on by equipment and production system damage.

3.3.1 Influences of Forestry on Wildlife

The plant and animal communities described below are interconnected, which necessitates close coordination between each community's management efforts. The impacts of forestry operations on animals are well known. These effects can be beneficial or detrimental. The beneficial effects are as follows;

(i) Logging creates environment suitable for those species whose habitat is formed by the earlysuccession.

(ii) Clearing for roads, camps and so on creates more living space for species that frequent the forest’s edge.

(iii) Reforestation speeds up the creation of protective, dense shelter which is essential for manyspecies.

(iv) Fire prevention preserves forests and also preserves the environment of the wildlife.

(ii). Construction of new roads in the forest open up areas which are not accessible before andthis lead to the development of a big game. The detrimental effects are as follows;

(i).Logging removes the habitat of forest dwelling animals.

(ii).Forest practices which cause excessive run - off water or result in soil destruction, can createsbarren of vegetation and wildlife.
(iii).Reforestation hastens the decline of wildlife that thrives on cut-over land.
(iv).Control of lightning-caused fires may reduce the natural creation of game ranges.
(v).Construction of new access road into remote areas my disturb breeding grounds of waterfowl or promote destruction of species such as wolf, bear etc frequently considered undesirable by the general public.

3.3.2 Influence of Wildlife on Forestry

The Influence of Wildlife on Forestry may be of considerable importance to the forester. The examples of beneficial influences include:

(i).Predatory wildlife, such as hawks, owls, foxes, wolves and cougars, help to control populations of seed eating rodents and birds as well as ungulates browsing on desired forest regeneration.
(ii). Birds and rodents help to control populations of tree destroying insects, and may eat the seeds of undesirable "weed" trees.
(iii). Rodents, by stem girdling, and large ungulates, such as deer, elk, and moose, by browsing, may prevent the growth of weed trees.
(iv).Beaver control and maintain water levels, and may remove "weed" trees. However, some of the detrimental effects exerted by wildlife on forestry are;(i). Grouse may feed on the buds of young desirable trees.
(ii). Birds, rodents and large ungulates may destroyJ the seeds of, or prevent growth of desirable tree species. In addition, large ungulates may compact and trample the site.
(iii). B
What i

Self-As

1. What is the likely negative wildlife influences on food production systems?
2. What are the beneficial effects of forestry on Wildlife ?

3.4 Wildlife Damage to Forest Trees

When it does happen, the majority of wildlife damage to forest trees is localized to regions where logging techniques have enhanced the environment for wildlife. The majority of invasive organisms favor the pioneer phases of plant succession. The best methods for providing beneficial habitat to harmful species are clear cutting and slash burning. Increased numbers of harmful species could cause issues with regeneration. It can be required to exert control, and the first step is to correctly identify the harmful agent. Some of these wild animals that cause damages to forest trees areas follows;

1) Small mammals: The most significant regeneration losses are brought on by the eating of seeds and seedlings by deer mice (Peromyscus maniculatus), red-blacked voles (Clethrionomys sp.), field mice (Microtus spp.), and chipmunks (Eutamias sp.). The most frequent factor in direct seeding program failure is mice. A beaver-like felling just above the snowline or ground level is a sign of seedling damage. Mice devour the roots and girdle the stems of new poplar plantings, resulting in significant damage. Tree squirrels (Tamiasciurus spp.), by consuming cones, developing conelets, buds, and bark of advance regeneration and mature trees, may seriously affect the availability of regeneration seed, particularly in years with low seed production.

2) Hare and Rabbit: Snowshoe hares (Lepus americanus), which devour seedlings, young branches, and leaders, are responsible for significant economic losses in regeneration up to five years old. Only in the lower mainland areas can eastern cottontails (Sylvilagus foridanus) inflict harm of this nature. Although they will consume ponderosa and londgepole pine, hares like Douglas-fir. Any species within the cottontail's limited range will suffer damage. Damage is indicated by branches and terminals that have been smooth-sliding cut 0.08 inches wide off close to the ground, or by stripped or gnawed bark that extends up to two feet above the ground.

3) Porcupines: Although they favor pine, these huge rodents will consume many other conifers. Instead of being widespread on huge stands, dam- age occurs locally and intensely on a few specific trees. The most frequent damage occurs near den locations, such as talus slopes or river sides, in pine woods. Branches in the crowns of young trees and older trees can sustain damage, which is recognized by significant chewing and bark stripping, which frequently results in a ragged look. The area beneath the tree is strewn with a lot of debris and vegetation. The width of the marks is 0.1 to 0.2 inches.

4) Deer: Black-tailed or mule deer browsing damage to new regeneration is especially significant along Britain's shoreline and in its south-central region. Deer prefer young red cedar trees, but they will also destroy young plantations of pine and poplar. Seedlings, needles, and branch terminals up to 0.25 inches in diameter can all be eaten and inflict damage. Antler rubbing on stems can also cause harm. Up to seven feet from the ground may have damage. In all but the finest seed years, damage to plants and, more crucially, plant consumption would drastically diminish the amount of seed available for regeneration. This is more than what is typically planted during artificial regeneration. Consequently, the most effective way to decrease the amount of seed that is consumed during artificial seeding operations is to colour the seed prior to sowing, with aluminum flakes or powdered pigment.

3.4.1 Control of Wildlife damaging forest crops

Prior to attempting control, the financial losses caused by invasive species must be compared to the expense, permanency, and benefits of control. Until the tree grows past the range of the dam- aging agent, most direct controls must be applied annually. It's important to take into account additional elements including the aesthetic value of wildlife, legal protection for wildlife species, support for natural predators, and more relaxed hunting regulations. After logging, the habitat becomes more favorable for agents that cause harm. Because complete eradication of a species is challenging, expensive, and frequently unattainable, the efficacy of a control measure should be measured by the reduction in damage rather than the number of animals killed.

3.4.2 Methods for the control of wildlife damage to crops

The various methods use to control wildlife damaging the forest crops include:

i) Biological control: The methods may be initially more expensive, but benefits are much more permanent. This form of control is achieved by increasing the environmental resistance by changing the vegetation or encouraging natural enemies. Vegetation is most readily changed by modifying regeneration practices. In areas of high seed losses, midwinter seeding is better than spring seeding, and planting instead of seeding improves regeneration success. Seedlings therefore have a better chance to becoming established and are able to grow before wildlife populations increase in the newly created favourable environment.

ii) Direct control: Hunting and trapping are useful methods in reducing numbers of bear, porcupine and beaver. Big game hunting seldom provides adequate control of deer, elk or moose, but may assist in preventing large numbers of building up initially if longer seasons and greater bag limits are allowed. These increases will bring about higher recreational values and economic returns in areas overpopulated with browsingspecies.

iii) Chemical control is one of the fastest methods of direct control but require repeated application. Chemicals can either be poisons which kill the wildlife species or repellentswhich are offensive but do not kill.

   a) Repellents: Most repellents are contact types applied as foliar sprays to stems and leaves of seedlings or saplings to prevent animal browsing or clipping. TMTD (Tetramethylthiuram disulphide) and ZAC (Zinc dimethyldithiocarbamate cy- clophyxylamine) are widely used contact repellents for protection against small mammals and deer. TNB-A (Trinitrobenzeneaniline) is successful in repelling deer, hares and rodents but it slightly phytotoxic.

   b) Poisons: Many areas are baited with poisoned cereal grains before sowing with coniferous seed. Strychnine, compound 1080 (sodium fluroacetate) and thallous sulphate are the most commonly used contact poisons. However extreme caution must be used, as they will cause secondary poisoning in other wildlife and live- stock. Because of non- selectivity, secondary poisoning hazards required repeated treatments and cost of treating adjacent areas again small

1. What is the damage caused by Mice to young poplar plantations?

2. What are the major methods use to control wildlife damaging forest crops?

3.5 **Linkages between wildlife and forest management, and food security**

Not only are wildlife and forest management compatible, but they are also inextricably linked. The majority of terrestrial biodiversity on Earth is found in forests, which are the most biologically diverse ecosystems on land. Recognizing that forest management directly affects the habitat and living conditions of wildlife is essential for putting sustainable forest mnagement (SFM) into practice. The degree and extent of forest management actions have an impact on the distribution, abundance, and coverage of the vegetation, which can occasionally result in more landscape fragmentation and poorer habitat. The amount of wildlife species, their spatial distribution, and their behavior can all be affected further by this. For instance, logging tends to simplify the vertical stratification of forest species by opening up the canopy and moving much of the primary production to the understory, often forcing birds of the canopy layer to browse at lower levels. Large terrestrial browsers like elephants and okapis in African forests or tapirs in Neotropical forests may profit from this increase in productivity. In temperate forests, clear-cutting practices may benefit roe deer, who prefer thickets for cover and clearings and forest margins for food.

Additionally, the quantity of wildlife, the presence of specific species, and their eating and behavioral patterns can all have a significant impact on the health of the forest. For instance, when cervids (deers) are under external stress, they may mark their territories by scratching trees or removing bark. This causes significant damage to the forest, lowers its production, and slows the regeneration of the forest, all of which have significant economic repercussions. With their claws, bears may remove bark to reveal newly developed timber beneath. Different species can have various effects on ecosystems in both temperate and tropical regions. Wildlife damage to forests reduces productivity and forest regeneration, which can have major economic repercussions. On the other hand, wildlife offers a wide range of ecological services that have numerous advantages for the production and health of forests. Large seeds are dispersed by some wildlife species, including gibbons, elephants, rhinoceroses, hornbills, and imperial pigeons. For instance, more tree species' seeds are dispersed by African elephants over greater distances than by any other mammal, which is why the African rainforest depends on them. Certain types of wildlife can serve as biological pest controllers. In addition to pollinating flowers and distributing seeds, bats can devour up to half of their body weight in insects, which helps reduce the population of insects that are bad for forests. SFM must take into consideration wildlife as a crucial component while also taking into account ongoing deforestation, forest fragmentation, and climate change. The distribution, abundance, and diversity of wildlife have an effect on the

productivity, wellbeing, and regeneration of forests. The socioeconomic values and functions of wildlife should be considered as part of a regional set of criteria and indicators for SFM, since wildlife issues are essential in guiding, monitoring and assessing the SFM process.

Wildlife plays a crucial role in food security, and, therefore, in the nutritional well-being of an individual, especially in developing countries, where famine and malnutrition are severe problems. Does wildlife play contribute to food security?

Se

1. What is the relationship between forest and wildlife management?

2. Does wildlife has any role in the ecosystem apart from its importance as food?

3.6 Summary

You must have learned about the influences of forestry on wildlife and the influences of wildlife on forestry which shows their interconnectedness. You have also studied the effect of wildlife damage to forest trees and the linkages between wildlife and forest management, and food security

3.7 References/Further Readings/Web Sources

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3.8 Possible Answers to Self-Assessment Exercises

Answers to SAE 1

1. On the negative side, some wild animals species are known as reservoir or intermediate hosts for parasites and disease pathogens which can be transmitted to man and his domestic stocks.
2. Forestry practices exert well defined effects on wildlife. The beneficial effects are as follows;

(i) Logging creates environment suitable for those species whose habitat is formed by the earlysuccession.
(ii) Clearing for roads, camps and so on creates more living space for species that frequent the forest's edge.
(iii) Reforestation speeds up the creation of protective, dense shelter which is essential for manyspecies.
(iv) Fire prevention preserves forests and also preserves the environment of the wildlife.

Answers to SAE 2

1. Mice cause extensivedamage to young poplar plantations by eating the roots and girdling the stems.
2. The major methods use to control wildlife damaging forest crops are: i). Biological control; ii). Direct control and iii). Chemical control

Answers to SAE 3

1. Wildlife and forest management are not only compatible, but are intrinsically interconnected.
2. Besides its importance as food, wildlife plays other crucial roles such as providing employment and generating income generating opportunities. It also has a role in the physical, spiritual and cultural well-being of people. And, it is a source of food, which is important for food security.

Unit 4: World Wildlife Resources and their protection

Unit Structure

4.1 Introduction

The evolution of the idea of conservation to its present day meaning of managing the earth living resources for the benefit of people and other alive today without threatening the interests of those who will be alive tomorrow will be highlighted. You will also learn about the idea of protected area management as cornerstone of many conservation approaches, and concepts of pristineness and wilderness are often considered central to protected area designation and management.

4.2 Intended Learning Outcomes

At the end of this unit you should be able to:

- Describe the world wildlife resources, conservation and protection.
- Explain the need and Reasons Wildlife conservation
- Discuss the Ways to Help Wild Animals

4.3 World Wildlife and Conservation

The preservation of animals and biodiversity has taken precedence over the preservation of landscape, beauty, and natural resources as the conservation justification for protected designation and management. This shift in emphasis came about as a result of a desire to preserve species for scientific purposes, as well as for potential and current advantages in terms of genetic resources and ecosystem services. The "Animal Right Movement" has partly distanced itself from conservation in recent years, while scientific methods to conservation have concentrated on worries over biodiversity loss. Initially, wildlife conservation was closely linked to humane and ethical concerns for animals. The conservation of biological variety, the sustainable use of its elements, and the just and equal distribution of the benefits resulting from the use of genetic resources are the goals of the CBD. Thus, the ideology of the wise use movement is included into biodiversity conservation, along with a focus on preserving species and ecosystems for their intrinsic and scientific value. Biodiversity conservation thus incorporates elements of the philosophy of the wise use movement, as well as a focus on conserving species and ecosystems for their intrinsic and scientific value.

4.3.1 Biodiversity protection

The basis for human existence and welfare is the biological diversity of life on earth. We are protected against natural disasters by biodiversity and healthy ecosystems, which also control the climate and give us access to food, fertile soil, and health care. However, biodiversity is dwindling, and a large portion of the world's most significant biodiversity hotspots are found in nations that are struggling with poverty, food insecurity, and accelerating climate change. The fundamental causes of biodiversity loss are unsustainable human behavior and human activity. We must adopt and encourage demand for more responsible and sustainable methods that conserve soil, water, forests, and wildlife if we are to protect biodiversity—and the prosperity of people around the world.

4.3.2 Action needed to Protect Biodiversity

1. Inspiring and empowering individuals and their communities to adopt more sustainable behaviors. Rare engages smallholder farmers and small-scale fishers in mobilizing their communities to improve land and fisheries management and reduce pressure on agriculture and fisheries.

- Fish Forever inspires fishers to shift towards more sustainable fishing practices that protect biodiversity and ecosystems, like coral reefs and mangrove forests
- Lands for Life equips farmers with techniques, such as composting and cover cropping, to reduce their impact.
- Center for Behavior & the Environment trains environmental practitioners in Behavior-Centered Design to maximize the impact of their work around the world.

2. Empowering local communities and their governments to manage their resources.

- Fish Forever works with fishing communities and their local governments to create networks of fully-protected and community-led no-take marine reserves that replenish and sustain fish populations and protect critical habitat

- Lands for Life trains and build capacity in public and private agricultural extension service agents to improve how they interact with farmers and ensures new practices have staying power.

3. Surfacing, spotlighting, and accelerating behavioral solutions to biodiversity protection.

- Rare facilitates Solution Search: Farming for Biodiversity, a contest that surfaced 338 solutions that use behavioral approaches to align biodiversity preservation with agricultural production. The contest identified the drivers making positive change in this sector, the common success factors across the solutions, and the important role that change agents play in that success.
- Our Center for Behavior & the Environment runs Campaigning for Conservation trainings in communities around the world to empower local practitioners

What

Self-A

1. List the major actions needed to Protect Biodiversity

2. How do can we protect Biodiversity?

4.4 World Wildlife Resources

The world's wildlife resources comprise all of the flora, animals, and some stray wild plants. There are laws in some nations, such as the Republic of Botswana, to safeguard the wildlife and other resources. For instance, the Relics and Antiquities Act,1970 issue influenced the community's choice to establish its own trust in order to have more control over the land and resources of the area. The Kalahari savanna ecosystem is home to a wide variety of wild animal species, including bush squirrels (Paraxerus cepapi) and elephants (Loxodonta africana). The whole range of large and small predators, as well as almost all of the major antelope species common to southern Africa, are present there. The bird populations are important from a scientific and survival perspective. On both sides of the border, particularly on the Namib ian side, there are pans (shallow lakes) that serve as resting areas for migrating ducks, some of which are quite uncommon. At least nine different bird species are targeted for food hunting, including fracolin (Francolinius adspersus) and guinea fowl (Numida meleagris).

Additionally, locals used to burn bush in an effort to promote the development of desired plant species. This tactic was sometimes referred to as "Bushman plowing." Additionally, people utilized fire to get rid of ticks and other pests that bothered both domestic and wild animals as

well as themselves. Additionally, people in this region engaged in the transplantation of desired plant species like morama (Tylosema esculentum), which yields nuts with a high nutritional value. Efforts/ strategy in the past made by local people to encourage the growth of desirable plant species by burning the bush.

4.4.1 Saving Wildlife

In order for ecosystems to be balanced and thrive, it's essential that all living animals are properly protected. Given the importance of wildlife, it's essential that we take steps to help save and protect animals. Here are some basic ways in which you can do your bit to save the wildlife:

1. Preserve Habitats

A habitat is a place where living things are able to thrive, reproduce and survive.
"Habitats include places such as rainforests, rivers, wetlands, forests and prairies. In order to preserve habitats, we have to avoid polluting waters, reduce deforestation and reduce land development."

2. Provide Water For Wildlife

As habitats are threatened, it's sometimes challenging for animals to find water. You can help by providing a source of safe, clean drinking water and monitoring it. If you live in a colder region, ensure you use a heating device to prevent the water from freezing.

3. Volunteering

You can find a range of volunteering options, including programs created through dedicated organisations. You could volunteer to clean a beach or woodland or even to teach visitors about wildlife at a local animal sanctuary. You could also help rescue wild animals.

4. Visiting Wildlife Conservations

Visiting wildlife conservation areas allows you to learn more about wildlife. Additionally, the money raised through your visit can often play a crucial role in the preservation work undertaken by conservations.

5. Adopting Wildlife

Many wildlife organisations offer the chance to "*adopt*" an animal. The money that you donate or raise can then be used to support and protect a targeted species or animal.

6. Feeding Birds And Wild Animals

During the cold winter months when food and water is scarce, it can be helpful to feed birds. However, you should avoid feeding mammals, as they may become overly dependent on food from humans or attract more dangerous predators to your yard.

7. Grow Plants

Plants can provide essential sources of food and shelter for many animals, so prevent tree cutting and instead plant more trees. Similarly, growing flowering plants can help attract wildlife which will help to pollinate other plants.

8. Use Products Which Are Eco-Friendly

Ensure you use eco-friendly products to reduce harm to wildlife and the environment. In particular, avoid using products which contain harmful chemicals, including fertilizers and pesticides. These chemicals can become introduced into the food chain and cause great harm, including to humans.

9. Avoid Trimming Shrubs During The Spring

Many animals and birds begin nesting and giving birth to their young during the spring, for which they rely upon trees and shrubs. You can help by avoiding trimming trees or shrubs during the spring, so as not to disturb the nesting season.

10. Ensure Your Home Is Wildlife Friendly

Garbage can be harmful to wildlife, so ensure you secure your trash can lids. Ensure any water you have put out for animals is clean to prevent disease transmission. You can also put decals in windows to prevent animal collisions, especially birds.

4.4.2 Reasons for wildlife conservation

1. Promoting Biodiversity

Ecosystems that are healthy and function properly depend on biodiversity. When animals are taken out of their natural habitats, it may have an adverse effect on the rest of the ecosystem on which they depend. In a same vein, by preserving wildlife, we also promote the preservation of their natural habitats and the general ecosystem.

2. Plant Pollination

To pollinate other plants, certain plants depend on animals (such birds, bees, and insects). Without wildlife, there may be a sharp decline in human-necessary food and medication sources.

3. Human Benefit

Animals can teach us a lot about ourselves as humans. Using the knowledge we have gained from studying animals, we have been able to create medications to prevent, cure, and treat a va e kn

Se

1. What are the major reasons for wildlife conservation

2. What are the World wildlife resources?

4.5 Protection of world wildlife resources

The WWF has been defending the future of nature for more than 45 years. The largest international conservation group, WWF operates in 100 nations and has about 5 million members worldwide and 1.2 million in the United States. The distinctive working style of WWF combines an international scope with a scientific foundation, involves action at all scales, from local to global, and ensures the implementation of cutting-edge solutions that satisfy the requirements of both people and nature. In the United States, legislation was passed to conserve endangered and iconic species like gray wolves, cheetahs, and leopards. Additionally, some of the most iconic and endangered animal species on the earth include terrific cats and rare dogs. By establishing new conservation programmes and creating funding streams to carry out these laws, it will help the wild animals to remain in the wild for generation to come. Conservation programmes for great cats and rare dogs has been a top priority of WWF for several years.

4.5.1` Why Protect Wildlife

In addition to being valuable in terms of themselves, animals and plants also contribute to a larger natural environment by serving as a source of food, shelter, water, and other necessities for both people and other animals. How can we choose which animals and plants to concentrate our conservation efforts and funding on when so much nature is in danger? is a topic that people frequently ask us. Although making decisions is not always simple, we do have guidelines. For example: 1) is it a species that's a vital part of a food chain? Or 2) a species that helps demonstrate broader conservation needs? Or 3) is it an important cultural icon that will garner support for wildlife conservation as a whole? These are just some of the considerations.

4.5.2 Promotion of nature and human well-being through Biological Diversity

The phrase used to describe the variety of life on Earth and the natural patterns it creates is biological diversity, often known as biodiversity. The biodiversity we observe today is the result of billions of years of evolution, which has been influenced by both natural forces and, to a greater and greater extent, by human activity. It creates the web of life, of which we are a vital part and wholly reliant.

This diversity is frequently explained in terms of the numerous different types of plants, animals, and microbes. There are about 1.75 million species known, most of which are tiny animals like insects. Although estimates range from three to 100 million, scientists think that there are actually roughly 13 million species. Genetic variations within each species—such as those between different crop kinds and livestock breeds—are also a part of biodiversity. The distinctiveness of each person and each species is determined by their chromosomes, genes, and DNA, the components of life.

The diversity of habitats, including those found in deserts, forests, marshes, mountains, lakes, rivers, and agricultural landscapes, is yet another facet of biodiversity. Every ecosystem has a community of living things, including humans, who interact with one another as well as the air, water, and soil around them. Earth has been uniquely habitable for humans due to the diversity of living forms and how they interact with one another and the rest of the environment. Numerous products and services that maintain our life are made possible by biodiversity. At the Rio Earth Summit, a comprehensive plan for "sustainable development" that satisfies our needs while

guaranteeing that we leave a livable planet for future generations was adopted. The Convention on Biological Diversity was one of the important agreements that were ratified. This agreement, signed by the vast majority of world countries, lays forth pledges for preserving the ecological foundation of the planet as we pursue economic progress. The three fundamental objectives outlined in the Convention are the preservation of biological diversity, the sustainable use of its elements, and the equitable and fair distribution of the advantages associated with the use of genetic resources.
What was the topmost priority of WWF for several years as conservation program?

Self assessment Exercise 3

1. What is the full meaning of WWF 2. What are the efforts of WWF in wildlife conservation?

4.6 Summary

You have learnt in the preceding units that Protected areas are cornerstone of many conservation approaches, and concepts of pristineness and wilderness were often considered central to protected area designation and management. You will learn about the advocacy for wise use of natural resources in this unit. The idea of limiting or controlling access to natural resources has its origins in many ancient and medieval societies; scared groves and taboos against the killing of certain animals will be highlighted.

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4.8 Possible Answers to Self-Assessment Exercises

Answer to SAE 1

1. The major actions needed to Protect Biodiversity

i. Inspiring and empowering individuals and their communities to adopt more sustainable behaviors.
ii. Empowering local communities and their governments to manage their resources.
iii. Surfacing, spotlighting, and accelerating behavioral solutions to biodiversity protection.

2. We must adopt and spur demand for more responsible and sustainable practices that safeguard soil, water, forests, and wildlife.

Answer to SAE 2

1. Reasons for saving wildlife

i. Promoting Biodiversity
ii. Pollination Of Plants
iii. Human Benefit

2. The world wildlife resources include both the fauna, flora and some wild plants scattered all overthe world.

Answer to SAE 3

1. World Wildlife Fund
2. WWF's unique way of working combines global reach with a foundation in science, involves action at every level, from local to global, and ensures the delivery of innovative solutions that meet the needs of both people and nature.

Unit 5: Conflicts related to wildlife resources

Unit Structure

5.1 Introduction

This unit will introduce you to Human–wildlife conflict (HWC) which occurs when the needs and behavior of wildlife impact negatively on humans or when humans negatively affect the needs of wildlife. These conflicts may result when wildlife damage crops, threaten, kill or injure people and domestic animals. You will also learn about the impact, mitigation and strategies for coexistence.

5.2 Intended Learning Outcomes (ILOs)

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

- Define human-wildlife conflict & examine its importance in conservation
- Describe Human–Wildlife Coexistence and Coadaptation need
- Describe the Causes and impacts of Human-Wildlife conflicts
- Explain the outcomes of Human-Wildlife conflicts
- Explain the ways to Reduce and Mitigate Human-Wildlife Conflict

5.3 Wildlife Conflicts

Conflicts between humans and wildlife are a problem that affects many nations when the needs of both are similar. Many different cultures experience conflicts with animals, especially those that are located adjacent to protected areas with large to very large herbivores (such as the buffalo, hippopotamus, rhino, and elephant) and huge carnivores. Conflicts between humans and wildlife are difficult because the resources in question are economically valuable to the population of the area while the wildlife species themselves are valuable on a national and international scale and are legally protected. Animals can directly endanger people's lives, livelihoods, and general wellness. People may lose their means of subsistence when, for instance, elephants raid fields, seals rip apart fishing nets, or jaguars destroy livestock. Often, retaliation against the species that was accused follows. The phrase "human-wildlife conflict" has historically exclusively been used to refer to these antagonistic interactions between humans and wildlife, however this implies deliberate action on the part of wildlife species and ignores disagreements among groups of people regarding the appropriate course of action.

Human-wildlife conflict is defined by the IUCN Species Survival Commission (SSC) Human-Wildlife Conflict & Coexistence Specialist Group as: conflicts that arise when the presence or behavior of wildlife poses an actual or perceived, direct and recurring threat to human interests or needs, resulting in conflicts between groups of people and adverse effects on people and/or wildlife. Human population growth, agricultural expansion, infrastructure development, climate change, and other factors that promote habitat degradation are all contributing to an increase in the frequency, severity, and prevalence of human-wildlife conflicts. Human-wildlife conflicts can occur wherever wildlife and human populations overlap, so any factor that forces wildlife and people into closer contact makes conflicts more likely.

5.3.1 Causes and Impacts of Human-Wildlife conflicts

Conflict between humans and wildlife arises when either group's wants and behaviors have a negative impact on the other. Conflicts may arise when wildlife destroys crops, poses a threat to, harms, or kills people or domestic animals. These are serious issues brought on by the expanding rural population in and around areas that support animals. Because they depend on the presence of wildlife, human-animal conflict situations are frequent but not distributed equally. Additionally, different species harm the environment in different ways and at various periods of the year. Depending on the households' level of livelihood security at the time of the incident, the damage caused has varying implications on their way of life. The growing human population near wildlife habitats is one of the main factors contributing to human-wildlife conflict. The frequency and severity of such conflicts rise as human population and resource demand rise. Increasing human encroachment on wildlife habitats may be one way to see this. Because of this, populations of species that cannot adapt to changed habitats may move into marginal areas or become less numerous. Conflicts between humans and wildlife threaten human welfare, health, and safety and have an impact on the economy and society. As a result of the reciprocal nature of HWC, which severely impacts both humans and animals, it is one of the most challenging and pressing problems in wildlife management and conservation, particularly outside of PAs. The most immediate casualties of human-animal conflict are wildlife and the local community that surround it. While conflicts between humans and wildlife may lead to the extinction or decline of certain species, they may also put communities' livelihoods, health, safety, and food security at risk. While the global community benefits from healthy wildlife populations and healthy ecosystems that enable us to survive, provide food for our families, and support our livelihoods, the costs of living with wildlife are unevenly distributed and fall disproportionately on communities that frequently encounter systemic barriers, have incomes well below the poverty line, and have limited access to economic opportunities. Therefore, human-wildlife conflict affects the income of farmers, herders, and artisanal fishers—especially those with incomes below the poverty line—and is as much a development and humanitarian issue as it is a conservation matter. In addition to causing direct harm to communities, human-wildlife conflict also indirectly affects people all over the world by putting pressure on the production of agricultural products and the global supply chain, which results in food insecurity and decreasing producer productivity.

Human–wildlife conflict occurs with various negative results. The major outcomes of human-wildlife conflict are:

a. Injury and loss of life of humans and wildlife
b. Crop damage, livestock depredation, predation of managed wildlife stock.
c. Damage to human property.
d. Trophic cascades.
e. Destruction of habitat.
f. Collapse of wildlife populations and reduction of geographic ranges

5.3.2. Containing Human-Wildlife Conflict

Conflicts are inevitable when a number of people will be working together. A "difference in opinion or some form of disagreement between two or more parties" is what is referred to as a conflict. Effective conflict resolution is required. Not only is it crucial to find a solution to the disagreement, but it's also crucial to make sure that none of the persons involved experience undue emotional stress when the matter is being resolved. Successful conflict management will

depend on finding a balance between settling the dispute to reach a resolution and preserving the emotional health of the parties involved.

As a result, it's critical to comprehend the different approaches to conflict resolution as well as what constitutes a dispute, why it arises, and its obstacles. There are two points of view about disagreements or so-called differences of opinion. Conflicts can be beneficial and productive, and different ways of thinking should be encouraged to generate a variety of ideas and solutions to issues, according to the new modern approach, which contradicts the conventional belief that "conflicts are evil and should be absolutely discouraged."

Let's approach conflict resolution with the understanding that disagreements can be constructive for the team. In order to effectively handle conflicts, a suitable environment must be created that enables people to think creatively and to express their ideas and thoughts without fear. The participants are also urged to address disagreements amicably and cooperatively among themselves. Conflict resolution requires people to put aside their personal feelings and focus on the long-term objectives of the task or project at hand. When the affected team members are unable to resolve the disagreement on their own, a manager should step in to mediate it. Disagreements over budgets, timetables, priorities, technical viewpoints, resources, administrative processes, and personalities are just a few of the reasons of conflict. Conflicts involving personalities must to be entirely avoided. There are several factors that have contributed to the loss of both wildlife and people as a result of this conflict. Human-wildlife conflict is primarily caused by urbanization, population growth, a lack of protected areas, poor transportation infrastructure, etc. All of this has a negative influence on biodiversity and sustainable development as well as the environment as a whole. There are certain actions that can be made to lessen this conflict.

Human-Wildlife conflict can be reduced by following certain measures:

- Creating more Protected Areas and buffer zones
- Steps must be taken to enhance the safety of people and wildlife and to create mutual benefits of coexistence
- Local communities can also participate in devising measures to reduce this conflict
- The concerned authorities must devise a strategy and action plan to reduce human-wildlife conflict at a national level
- Before camping, hiking, or venturing into natural areas, learn about the animals that you might encounter

Strategy for conflict resolution can be summarized as follows:

1. Problem Solving / Collaboration / Confronting
In this approach, parties to the disagreement or with divergent viewpoints step forward and engage in frank discussion of the issue at hand. They concentrate on settling the dispute and identifying the best course of action or solution for the team. They talk about putting aside one's own feelings in order to put the team's needs first. This results in a win-win situation. Here, everyone works together.
2. Compromising/Reconciling
It may be necessary for the parties engaged in certain situations to consider a middle course where both parties agree to give up something and find a resolution. This kind of approach is not long-term and will only be effective in that particular situation. Due to the fact that both sides may feel they have lost something, this results in a lose-lose situation.
3. Withdrawing/Avoiding
In certain circumstances, one of the disputing participants may elect to withdraw from the conversation and permit following the other person's viewpoint. In other cases, one of the parties may decide to keep quiet entirely in order to avoid the argument. This is effective when one of the parties to the disagreement is furious or emotionally charged. Therefore, deferring conflict resolution gives the parties concerned a chance to "cool off" before returning for a substantive resolution.
4. Forcing/Competing
In some circumstances, a person in a position of authority or power can impose his or her viewpoint and settle the dispute without allowing the opposing party or individual an opportunity to respond. This results in a win-lose situation. The individual with authority may feel like a winner in the end, whereas someone else may feel defeated. If we notice that disagreements are unneeded and bad for the team, we can use this strategy.
5. Smoothing/Accommodating
This tactic is employed when it appears that there is mistrust or anxiety among the parties concerned. Furthermore, nobody is stepping forward to mediate the conflict. In these situations, one of the parties can take the initiative and attempt to diffuse the situation by using polite language, highlighting the areas of agreement, and downplaying the areas of disagreement. This can act as a trigger to release the tension between the parties by fostering a sense of trust and enticing them to speak up and settle the dispute. How do you define conflict in the context of human-wildlife relations?

Self Assessment Exercise 1

1. What is the outcome of man-wildlife conflict?
2. List any four outcomes of Human-Wildlife conflicts

5.4 Levels of Human-Wildlife Conflict

Conflicts are complicated, according to research, and each one has its own particular ecological, cultural, social, historical, physical, economic, and political traits. Despite the temptation to apply damage reduction strategies (such fences and barriers) that work in one place and move them to another, these only work when stakeholders are involved in consultative, collaborative procedures. There may be pressure for "fast remedies" to human-wildlife conflicts, but solutions that fail to take into account local and broader societal contexts might have unforeseen effects and raise tensions. These differences may deepen if stakeholders begin to see the battle over wildlife as a challenge to their beliefs or sense of self. Solving such issues becomes incredibly challenging. Conflicts between humans and wildlife are complicated and defy easy explanations and fixes. The fields of conflict analysis and peace building offer insights into the intensity, intractability, and possible approaches to addressing different kinds of conflict. We create a framework for human-wildlife conflict that comprises of three degrees of wildlife conflict based on advancements in both of these domains and conservation practice. Level 1 conflicts often include relatively high tolerance of the species causing the damage and are arguments over things like crop or livestock loss or safety concerns. In level 2 disputes, there is a history of ineffective attempts to address these concerns in addition to the visible impact of wildlife, which breeds underlying resentment, tensions, and a sense of unfairness among at least one of the parties. The identities of the parties and the community are deeply ingrained in level 3 conflicts, which also encompass broader tensions over social identities and divergent values and views. Such conflicts call for mediated reconciliation discussions and approaches to conflict transformation. Managing conservation concerns as complicated and dynamic as conflicts over animals necessitates an organized understanding of how to resolve a conflict before it intensifies.

Figure 1. The levels of conflict over wildlife
Source: https://conbio.onlinelibrary.wiley.com/doi/full/10.1111/csp2.259

Efforts to assess and manage complex human-wildlife conflicts require collaboration across disciplines and sectors. For example, collaborations could involve conservation practitioners, community leaders, governments, researchers, businesses and other stakeholders; and need expertise in ecology, social psychology, economics, peace building and environmental law.

5.4.1 Human–Wildlife Coexistence and Co-adaptation

Researchers are looking for ways to refocus policy-relevant conflict research on developing strategies for coexisting with and adapting to wildlife. When humans and wildlife co-adapt to living in shared landscapes and human interactions with wildlife are managed by effective institutions that promote long-term animal population persistence, social legitimacy, and tolerable levels of danger, this condition is referred to as coexistence. Coexistence between people and wildlife is as complicated and context-dependent as conflict.

What is the goal of coexistence? At the most basic level, the goal of coexistence requires that at some level and in some form, humans must choose to share landscapes and natural resources with wildlife in sustainable ways. If conflicts between stakeholders over wildlife are the root of human-wildlife conflict, then maintaining coexistence ideally involves agreement or at the very least cooperation amongst stakeholders on how to handle a situation. With a wide range of growing ideas, the concept of coexistence is entering the mainstream of conservation science. It may be best mobilized as a flexible concept to ensure that various study disciplines work

together on the evolution of this concept. Since practitioners have concentrated their efforts on eliminating bad encounters rather than on fostering more good ones, the focus on human-animal conflict has frequently been a barrier to wildlife conservation. Positive relationships, peaceful coexistence, and tolerant attitudes toward wildlife are required in order to work toward solutions that optimize conservation effectiveness. In order to accomplish this, the IUCN Species Survival Commission Human-Wildlife Conflict & Coexistence Specialist Group has published an IUCN Position Statement on the Management of Human-Wildlife Conflict, urging governments, NGOs, researchers, practitioners, community leaders, environmental agencies, and others to make sure that attempts to manage human-wildlife conflicts are pursued through informed, comprehensive, and collaborative processes that take into account underlying social, cultural, and environmental factors. Briefing papers on human-wildlife conflict and human-wildlife coexistence have been released.

5.4.2 Humanity and Wildlife

Wildlife is necessary to maintain healthy ecosystems and the essential benefits they offer to humans. In order to realize the UN Vision for Biodiversity 2050, where "humankind lives in peace with environment and in which wildlife and other living species are safeguarded," it is imperative to manage human-animal conflicts. Conflicts between people and wild animals have serious effects on the livelihoods, safety, and wellbeing of communities. They also run the risk of undermining conservation efforts by decreasing support for wildlife, protected areas, and biodiversity. Retaliation against animals can seriously jeopardize the existence of a species and undo earlier conservation efforts. For instance, conflicts about how to handle the presence of large animals like wolves, bears, and others are arising as they begin to repopulate Europe. While some people appreciate their presence, others see it as a threat to their safety and way of life.
What is the area of conflict resolution provides for addressing different kinds of conflicts?

Self Assessment Exercise 2

1. What is the focus of HWC?
2. What is human/wildlife coexistence?

5.5 Global Concern

The Post-2020 Global Biodiversity Framework of the UN Convention on Biological Diversity acknowledges human-wildlife conflict as a global concern (to be adopted by Parties at CBD COP15 Part Two). To guarantee that resources are made available to handle them, several governments are starting to incorporate the management of human-wildlife conflict into national plans and strategies. Numerous strategies and actions can be used to lessen the harm or effects, defuse tensions, address threats to income and poverty, and provide long-term solutions.

Barriers (fences, nets, trenches) are occasionally used in these situations, as well as security and early warning systems, deterrents and repellents (sirens, lights, beehives), translocation (moving wildlife), compensation or insurance, offering risk-reduction alternatives, and managing tensions between the stakeholders involved. Planning and putting into action such measures effectively necessitate taking into account the best practices for community-led conservation while working with the impacted groups.

5.5.1 Ways to Reduce Human-Wildlife Conflict

Wherever there is a clash between rising human populations and abundant wildlife, adequate management is lacking. Huge and potentially deadly herbivores like elephants, hippos, and even deer, as well as large predators like bears, wolves, coyotes, lions, and crocodiles, can cause problems. Conflicts of this nature can ruin livelihoods and jeopardize conservation efforts. Thankfully, a range of creative alternatives have been developed to address human-wildlife conflicts and prevent the use of lethal control methods. While some solutions are more universally applicable, others are species-specific.

1. Strobe Lights

Farmers are more and more reliant on automatic light devices to deter nighttime creatures that might be damaging. The devices, which are half strobe light and half motion sensor, randomly flash light beams in all directions to resemble a farmer holding a flashlight. It has been demonstrated that wary nocturnal animals avoid such light signals, however the effect diminishes with time as wildlife grows accustomed to the lights.

2. Natural Barriers

Some African villages have used two odd, all-natural alternatives, bees and spicy peppers, to keep elephants away from their farms and homes. Farmers in Tanzania smother their fences with a mixture of oil and chili peppers because elephants don't like the chemical capsaicin found in chili peppers. Elephants dislike spices, but they are also frightened of bees. Due to this revelation, bee fences have been built around fields to deter roaming pachyderms.

3. Disguise

Indian villagers have recently been successful in averting tiger attacks by making use of their understanding of large cat behavior. Forest workers started donning masks on the back of their heads to protect themselves from sneak attacks since tigers pursue their prey and attack from behind. No attacks on those wearing masks were reported over a 3-year period, although 29 attacks on people without masks occurred over an 18-month period in the same area. Unfortunately, as tigers grow accustomed to the disguise, masks lose some of their effectiveness over time.

4. Electricity

Animals dislike being startled just as much as humans do. Conservationists frequently use electricity to generate a long-lasting unfavorable image to dissuade wildlife from human-dominated places. African farmers use solar-powered electric fences to keep crop-robbing elephants out of their fields, and Alaskan wildlife managers use tasers to scare away habituated moose and bears. Conservationists in India have even attempted to deter tiger assaults by electrifying humanoid models. Even though it could seem like an excessive means of animal control, a sharp electric shock is more better to fatal ones.

5. Texting

Imagine receiving a text message from an elephant in the wild. A new conservation program in India's Western Ghats uses texting as an early warning system to stop human-elephant confrontations. Elephant tracking collars with integrated SMS chips text local people as soon as an elephant moves recently. Prior to the project's implementation, 75% of the region's human deaths attributed to elephants were caused by a lack of knowledge about elephant whereabouts. Human mortality have decreased by 50% since the early warning system was put into place, and between 2010 and 2013 there were no deaths reported.

6. Corridors

By directing their movements in populated areas, wild animals can be less likely to come into confrontation with humans. Animals need a safe route to move between larger sections of intact habitat, and wildlife corridors—areas of protected native habitat in human-dominated areas—offer that. Animals can be led out of harm's way and incidents of human-wildlife conflict can be proactively prevented by constructing corridors away from possible conflict hotspots, such as farms or ranches.

7. Mapping

Researchers can locate conflict hotspots where people and wildlife are most likely to clash using GPS monitoring collars and GIS mapping tools. The data from tracked animals can reveal unique migratory patterns that may be unexpected, yet these hotspots frequently correlate with developed areas on the outskirts of national parks. By locating conflict hot places, ranger resources can be targeted to proactively address the problem of human-wildlife conflict.
8. Ecotourism

Human-wildlife conflict is made worse by poverty. It is not unexpected that such a confrontation might arouse resentment and cast doubt on conservation efforts when a rogue animal decimates the crops of a poor farmer, thereby destroying their means of subsistence. Ecotourism can stop this response by placing a value on animals. Ecotourism businesses run and owned by local groups rather than multinationals can help pull entire underdeveloped areas out of poverty by creating more jobs and stimulating the local economy.

5.5.2 Human-Wildlife Conflict Mitigation

Within Big Life's operational area, human-wildlife conflict (HWC) mostly manifests itself in three ways: livestock being killed by predators like lions; humans being hurt or killed because they coexist with wildlife; and crops being looted by wildlife, especially elephants. Big Life employs a strategic approach to reduce HWC, such as sending out rapid response ranger teams to evict elephants from fields and erecting crop-protection barriers to establish a clear separation between elephant habitat and farmland. To lessen the effects of people coexisting with apex predators like lions, Big Life also engages in predator protection projects. Because of this, the lion population in Big Life's operating region is one of the few in all of Africa that is expanding rather than contracting.

5.5.3 Your Role

Most people don’t live alongside tigers, lions, or elephants, but you can still do your part to prevent human-wildlife conflict. By following a few simple guidelines, you can minimize your risk, protect your property, and live safely alongside wildlife.

- **Be proactive** – Since most animals are naturally afraid of humans, conflicts often arise when animals become habituated to humans or associate them with food. **Avoid feeding wild animals,** securely store your garbage, and feed pets indoors to avoid attracting unwanted visitors. Fence in your garden, and plant **unpalatable vegetation** to discourage browsing.
- **Be prepared** – Before camping, hiking, or venturing into natural areas, **learn** about the animals that you might encounter. Let others know your plans before venturing off in the woods, and if possible hike with a companion. Above all, don’t approach or harass any wild animals that you encounter, and heed signage warning of potentially dangerous wildlife.
- **Be patient** – Some wildlife related property damage is unavoidable. Take a moment to breathe instead of getting angry the next time deer devour your garden or raccoons raid your trash. Remember that we share our habitat with wild animals, and that they were here first. We all have to share this planet, so we might as well get along.

How would you explain how human-wildlife conflict manifest within Big Life operational area?

Self Assessment Exercise 1

1. What are the measures to reduce human/wildlife conflict? 2. How can you imploy natural barriers to reduce the risk of wildlife?

5.7 References/Further Readings/Web Sources

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5.8 Possible Answers to Self Assessment Exercises

Answers to SAE 1

1. Wildlife and the communities that live near it are most directly impacted by human-wildlife conflict. While human-wildlife conflict can result in the **decline and potential eradication of species**, communities can experience financial losses and threats to health and safety, livelihoods, food security, and property.

2. The outcome of Human-wildlife conflicts
   a. Injury and loss of life of humans and wildlife
   b. Crop damage, livestock depredation, predation of managed wildlife stock.
   c. Damage to human property.
   d. Trophic cascades.
   e. Destruction of habitat.
   f. Collapse of wildlife populations and reduction of geographic ranges

Answers to SAE 2

1. The focus on human–wildlife conflict has often been a constraint to wildlife conservation, as practitioners have centered their attention on reducing negative interactions, rather than on increasing positive relations between humans and wildlife.
2. Human-wildlife coexistence refers to **people and wildlife existing in proximity to each other, whether in contentious, neutral, or beneficial coexistence**

Answers to SAE 3

1. Human-Wildlife conflict can be reduced by following certain measures: **Creating more Protected Areas and buffer zones**. Steps must be taken to enhance the safety of people and wildlife and to create mutual benefits of coexistence. Local communities can also participate in devising measures to reduce this conflict.
2. To keep elephants at a **safe distance** from their farms and homes, some African villagers have turned to two unlikely, all-natural solutions: **bees** and **hot peppers**. Elephants dislike the chemical capsaicin found in chili peppers, prompting farmers in Tanzania to smother their fences with a mixture of oil and chili peppers. In addition to a spice aversion, elephants are also terrified of bees. This realization has led to the construction of **bee fences** around farms to keep mhwctf.org/document-library - resource library

Unit 6: Climate Change and Wildlife Resources.

Unit Structure

6.1 Introduction

In this unit you will learnt that major risks pose by Climate change to global biodiversity in the twenty-first century as it affects ecosystems processes, flora and fauna abundances and distribution.

6.2 Intended Learning Outcomes (ILOs)

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

- Know the impacts that climate change is having on the natural environment
- Understand how climate change can lead to habitat destruction and
- how habitat destruction can interact with other aspects of climate change to threaten the survival of some animal species
- Identify ways in which weather and climate events may affect local wildlife species.
- Describe the relationships among climate, habitat, vegetation types and wildlife species.
- Describe climate change threats on vital biodiversity
- Identify key impacts climate change will have on wildlife.
- List the potential climate change impacts on local species and create an action plan for helping protect these species.
- Suggest solutions to climate change impact

6.3 Climate Change and Wildlife Resources

Climate change is defined as any alteration in the climate that is manifested by changes in the mean values of climatic variables over lengthy timescales, generally decades or longer. Natural internal processes within the climate system, changes in natural or enduring anthropogenic external variability, or both, may contribute to climate change. Climate is the outcome of changes in the average state or other climate data on time scales larger than those of specific weather occurrences. Impacts of climate change, such as worsening water shortages brought on by ongoing droughts, pose a threat to animal resources and, subsequently, to livelihoods in Africa dependent on wildlife. Therefore, managing the populations of animal resources involves knowledge of the type, scope, and distribution of climatic impacts both now and in the future. All varieties of untamed flora and fauna that can be found in land or aquatic areas are together referred to as wildlife. Wildlife resources in the current study refer to animal or plant species that could be advantageous to humanity. Due to their limited potential for adaptation, people's livelihoods are more severely affected by climate change in underdeveloped nations. Nevertheless, the emphasis of this chapter is on terrestrial and semi-aquatic vertebrates, particularly mammals and their environments. Wildlife species in Southern Africa contribute to the wellbeing of local communities, especially those that are located close to protected areas. These communities make money from ecotourism, safari, consumptive hunting, and the sale of bush meat. Therefore, floods, droughts, and wildfires cause significant economic losses. Against

this backdrop, different mechanisms have been put in place to encourage climate change adaptation and mitigation in the biodiversity sector at global, regional and national levels.

6.3.1 Impacts of climate change on wildlife resources

Not only do humans experience the effects of the climate catastrophe on our world. The species and habitats of the earth will likewise see significant, occasionally disastrous alteration. Temperature rises have the potential to cause massive extinction waves and the collapse of delicate ecosystems. The decisions we make now have the potential to lessen future human and animal suffering.

Under all evaluated emission scenarios, the Intergovernmental Panel on Climate Change predicts an increase in global surface temperature throughout the twenty-first century. The average global temperature is expected to rise by 0.15 to 0.3°C every ten years. Additionally, it is likely that heat waves will occur more frequently and last longer. Precipitation events are predicted to become more frequent and extreme in many locations. The Intergovernmental Panel on Climate Change (IPCC) asserts that there is a strong possibility that some ecosystems would be exposed to climatic-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, making them vulnerable to climate variability. For the majority of Africa, Southern Europe, the Middle East, Southeast Asia, and Australia in the twenty-first century, climate models predict greater aridity and protracted droughts.

The Intergovernmental Panel on Climate Change claims that climate change is happening quicker than anticipated, especially in Southern Africa. National parks in sub-Saharan Africa should see a 10 to 24% decrease in mammalian species, according to the IPCC. Therefore, climate change brought on by natural variability has an impact on terrestrial biological systems. According to research, global warming has caused a large increase in the temperatures of terrestrial ecosystems. Seasonal variations in temperature and precipitation have a direct impact on ecosystems, and other disturbances like fire and drought have an indirect impact. According to the IPCC, there is a strong consensus that a number of terrestrial, freshwater, and marine species have altered their geographic ranges, seasonal behaviors, migration patterns, abundances, and interactions with other species as a result of climate change. The IPCC Fourth Assessment Report (AR4) notes that there is moderate confidence that recent climate change in Africa may have had some effects on terrestrial ecosystems. This is based on the scientific material that is currently accessible. The resilience of terrestrial ecosystems is further threatened by risks from extensive land use and degradation, changes in the frequency and severity of extreme events, and interactions with other pressures. The IPCC AR4 recognises that there is still a knowledge gap about how climate change is affecting various places.

6.3.2 Common Effects of Climate Change on Species and Ecosystems

Common effects of climate change include (1) changes in life-history events or phenology, (2) effects on demographic rates, such as survival and fecundity, (3) reductions in population size and (4) shifts in species distributions. Through modifications in fitness, survival, and reproductive success, climate change has both direct and indirect effects on herbivore species. Climate change is predicted to worsen the impacts of drought on food availability in semiarid environments, which might have a negative feedback loop on ungulate reproduction and offspring recruitment. Studies have shown that habitat alterations, loss, and fragmentation due to climate change are likely to have an impact on the persistence of large, space-requiring species.

In conservation biology and wildlife management, particularly proactive management and the formulation of conservation status judgments, understanding the effects of climate change and

variability on wildlife species is essential. The stewardship of ecosystems and biodiversity depends on understanding how climate change and variability affect these populations since large animal herbivores are important drivers of rangeland dynamics. The World Wide Foundation observed that it is still too early to estimate how climate change will affect biodiversity worldwide and how biological species will adapt, if at all. Few studies have examined the effects of climate fluctuation and change on the resources that support animals.
What are the common effects of climate change on species and ecosystems?

Self Assessment Exercise 1

1. How climate change is affecting the wildlife?
2. Why is climate change an important issue?

6.4. Global environmental change

Environmental science's field of study of global environmental change is relatively young. The effects of widespread occurrences on our environment are a concern. This includes the atmosphere, soils, animals, and plants. We already know that the natural environment is being severely impacted by climate change. For instance, it is known that certain rivers and lakes' water temperatures are rising. For the creatures and vegetation that inhabit there, this has significant ramifications.

Although climate change is undoubtedly one of the most important changes that our planet is presently experiencing, it will not occur alone because it impacts the entire world and will take many years to develop. Numerous other changes, both on a small and large scale, will occur at the same time. Deforestation, pollution of the air and water, and other global change phenomena may interact with climate change. When we start to think about what might happen when other things are changing simultaneously with climate change, it gets more harder to predict what would happen.

Thus, climate change has the potential to have a direct impact on wildlife resources through changes in the onset and duration of rainy seasons and drought on wildlife species, reductions in species' ranges, changes to the abundance and diversity of mammals, adjustments to calving and population growth rates, adjustments to the juvenile survival of the majority of ungulates, and

adjustments to the species richness of birds and mammals. Consequently, these changes in wildlife species abundance and distribution will have direct serious negative impacts on ecotourism and game hunting activities.

6.4.1 Influence of Climate Change on Wildlife Habitats

There are more hot days and heat waves in almost all land locations. In actuality, 2021 was among the warmest years ever recorded. Higher temperatures can make it harder to work and move around, as well as raise the risk of heat-related illnesses. When the weather is hotter, wildfires start more easily and spread more quickly. The story doesn't just begin with the temperature rising. Changes in one place frequently have an impact on changes in all other areas because the Earth is a system in which everything is interconnected. The consequences of climate change now include:

- intense droughts
- water scarcity
- severe fires
- rising sea levels
- flooding
- melting polar ice
- catastrophic storms
- declining biodiversity

The quantity and quality of habitat within savannah ecosystems are typically influenced by climate variables, especially rainfall and temperature, which in turn affects the structure, composition, and dynamics of wildlife species. Both temperature and rainfall exhibit intricate temporal variation that varies from region to region on Earth. These crucial environmental elements affect plant productivity, which in turn affects the availability of animal food. For instance, a number of studies have discussed the impact of rainfall, particularly during the dry season, on the availability of food of sufficient quality and the performance of large herbivore populations. In the African savannah, rainfall regulates ungulate grazer populations and primary productivity. Strong correlations between abundance and rainfall imply that the dynamics of African savannah ungulates are governed by rainfall, and that changes in rainfall due to global warming may significantly alter both abundance and distribution of mammals.

Rainfall components affected adult survival in several of the declining species, while negative density dependence in adult survival was evident for three of the four species that maintained high abundance. Ungulates respond to rainfall fluctuations through movements, survival and reproductive phenology. Rainfall affects the herbaceous layer's composition and quality, as well as the growth of forage plants and food production during the rainy season and the retention of green foliage during the dry season.

Droughts on a periodic and local level help control the elephant (Loxodonta Africana) population. Studies have also shown that elephant survival rates vary across different places in Africa depending on the annual variance in rainfall as well as the confusing effects of water provision and fencing. Water resources in Nigeria, which are drawn from the main basins in the nation, are also dependent on animal resources.

6.4.2 Climate Change Threats on Vital Biodiversity

The Earth has warmed by around 1.1°C (2°F) since the 1800s. By the end of the century, global temperatures are predicted to increase by 2.7°C (4.8°F). It is impossible to foresee precisely how

our planet's delicate, intricately intertwined ecosystems will be impacted by long-term changes in temperatures and weather patterns. Animals will be affected when changes in one area lead to changes in other places. Some of the climate-driven threats for wildlife include:

1 Habitat loss: Increasing temperatures have an impact on a variety of factors, including vegetation, food sources, water availability, and more. Ecosystems may lose their ability to support some species, pushing wildlife to go outside of their typical migratory patterns in search of food and livable circumstances while triggering the extinction of other species.

For instance, we might lose Africa's elephants within the next 40 years if rates of habitat loss and fragmentation caused by human growth and global warming, combined with poaching deaths, continue.

2 Natural disasters: In comparison to 50 years ago, we already experience a five-fold increase in climate and weather-related catastrophes including hurricanes, wildfires, and droughts. People, pets, and wildlife suffer devastating losses in life and habitat as a result of these catastrophes.

For instance, the Black Summer bushfires in Australia from 2019 to 2020 consumed 186,000 square kilometers (72,000 square miles), and it is thought that three billion koalas, kangaroos, and other species perished in the blazes or were forced to flee.

3 Human Wildlife Conflict: Due to habitat loss and extreme weather events brought on by climate change, people and wildlife are forced to coexist in more crowded areas. People and wildlife move farther in search of food, water, and resources as ecosystems change. Animals involved in conflicts between humans and wildlife can suffer terrible consequences. For example, jaguars sometimes prey on domestic animals and disrupt human livelihoods, leading to retaliatory killings that result in the further decline of already-dwindling jaguar populations.

4 Extinction: The confluence of problems could lead to the extinction of many species of animals. The biggest threats will likely be to the most defenseless creatures in the planet, including those who are already on the verge of extinction. For instance, the North Atlantic right whale, which has a projected 336 individual animals left—the lowest number in 20 years—is on the verge of extinction. This species may go extinct as a result of ocean warming and failure to reduce confrontations with humans (vessel hits and entanglement in fishing gear).

How do ungulates respond to rainfall fluctuations?

Self Assessment Exercise 2

1. How is climate change a threat to wildlife?

2. What impact does climate change have on wildlife?

6.5 Role of Wildlife in fighting climate change

Thankfully, animals and the ecosystems they are a part of are a potent ally in the fight against climate change. According to UN estimates, thriving ecosystems may provide 37% of the carbon reductions required to keep global temperature increases under control. Carbon from the atmosphere is absorbed and stored by healthy ecosystems with a variety of plants and trees. Consequently, protecting or restoring nature is a potent weapon in the fight against climate change. Rich biodiversity is supported by healthy ecosystems, which also filter water, function as a buffer against flooding, lessen the effects of calamities, and enhance soil health. Nearly all animals and keystone species play important, occasionally unseen roles in preserving environments and ensuring biodiversity.

For instance, whales are important for maintaining thriving marine habitats. Phytoplankton receives nutrition from whale feces. Phytoplankton remove carbon from the atmosphere by capturing vast volumes of CO2 and converting it to energy, similar to plants. When whales or other marine mammals consume phytoplankton, the carbon continues to go up the food chain, staying out of the atmosphere and not causing global warming.

Healthy ecosystems are created by elephants, which in turn absorb CO2 and keep it out of the atmosphere. Elephants disperse seeds, fertilize soil, dig wells, create trails for other animals and clear space that encourages new plant growth. Pangolins eat ants and termites, keeping those populations regulated, and excavate dens that are used by other animals, both of which are essential in the ecosystems where pangolins live. Many other animals play equally important roles in the ecosystems where they live.

6.5.1 Action towards Global climate change impact

The greatest threat to life on our planet right now is climate change, which is already taking place. Fortunately, there are numerous and well-recognized answers to the climate change problem. To put these proposals into action, top world leaders signed the Paris agreement, a significant treaty, in 2015. The reduction of greenhouse gas emissions, which must reach zero as soon as possible, is the cornerstone of all climate change solutions. Increasing the natural capacity of trees and oceans to absorb carbon dioxide can help stop global warming because both play crucial roles in controlling our climate. The main ways to stop climate change are to pressure government and business to:

Fossil fuels should remain underground. Coal, oil, and gas are examples of fossil fuels; the more of these are extracted and used, the worsening of climate change will be. As quickly as possible, all nations must transition their economy away from fossil fuels.

Spend money on green energy. The greatest solution to quit using fossil fuels is to switch to clean, renewable energy as our primary energy source. These include innovations in geothermal, wave, wave, tidal, and wind energy.

Change to eco-friendly transportation. Fossil fuels are used in petrol and diesel automobiles, airplanes, and ships. Air pollution will be decreased as a result of cutting back on flying, moving to electric vehicles, and reducing car use. Keep our homes cozy for us. Homes shouldn't be drafty and cold because doing so is expensive and uncomfortable during the winter. The government can provide assistance to homeowners who want to heat their homes in a green manner, such as by insulating the walls and roofs and switching to heat pumps instead of oil or gas boilers.

Boost agriculture and promote vegan eating. Reduced meat and dairy consumption or turning vegan entirely are two of the best methods for people to combat climate change. To assist people in the transition, businesses and food retailers can enhance farming techniques and offer more plant-based goods. Restore nature to increase carbon absorption. The natural environment is excellent at removing our pollutants, but we must take care of it. A good place to start is by strategically placing trees or returning land to its natural state through "rewilding" initiatives. Because photosynthesising plants absorb carbon dioxide as they develop and store it in soils, this is the case.
safeguard ecosystems like the Amazon. Protecting forests is a significant climate solution since they are essential in the fight against climate change. Industrial forest clearing eliminates massive trees that could absorb enormous amounts of carbon. However, businesses cut down trees to create room for soy, palm, or animal cultivation. Governments can prevent them by improving laws.
Defend the seas. Large amounts of carbon dioxide from the atmosphere are also absorbed by the oceans, which contributes to the stability of our climate. However, a lot of them are overfished, utilized for gas and oil drilling, or under danger from deep sea mining. The ultimate defense against climate change is the preservation of the oceans and the species that lives there.
People should consume less. Different aspects of our lifestyle—such as how we travel, dress, eat, and live in general—have an impact on the climate. This is frequently intentional; for instance, businesses in the fashion and technology industries frequently release considerably more products than are actually required. However difficult it may be, cutting back on the use of these goods is definitely worthwhile. Global consumption reduction in more affluent nations can lessen the burden on the environment. fewer plastics. Oil is used to make plastic, and it takes a startling amount of carbon to extract, refine, and make plastic (or even polyester for clothing) from oil. Because it decomposes slowly in nature, a lot of plastic is burned, which increases emissions. By 2050, the production and disposal of plastics will use 17% of the global carbon budget due to the rapid increase in plastic demand (this is the emissions count we need to stay within according to the Paris agreement).
It's simple to feel overburdened and like the problem of climate change is too huge to handle. But the solutions are already available; the challenge is in putting them into practice. All of these solutions require robust international collaboration between nations and corporations, especially the industries that produce the greatest pollution. By choosing better options for where they obtain their energy, how they travel, and what they consume, individuals may also contribute. However, taking action as a group is the most effective approach for everyone to stop climate change. This entails putting pressure on organizations to alter their corporate policies and operational procedures. Re-election is a goal for all governments. Additionally, companies cannot function without clients. A potent strategy for bringing about change is to demand action from them.

6.5.2 Fossil Fuel Industry and Climate Change Action

Major oil and gas companies like BP, Exxon, and Shell have invested hundreds of millions of pounds in an effort to stall or reverse government initiatives that would have assisted in addressing the climate catastrophe. Big polluting firms, who are in large part to blame for carbon emissions, continue to mine and burn fossil fuels despite the increasingly clear repercussions of climate change. Fossil fuels are profitable for a variety of industries, including banks,

automakers, and energy firms. These industries consciously prioritize profit over the survival of our planet and the security of its inhabitants.
What is the most important role played by elephants in engineering healthy ecosystems?

Self Assessment Exercise 3

1. How is wildlife affected by climate change?
2. What are world leaders doing to stop climate change?

6.7 References/Further Readings/Web Sources

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6.8 Possible Answers to Self-Assessment Exercise(s) within the content

Answers to SAE 1

1 Climate change has produced a number of threats to wildlife throughout our parks. Rising temperatures lower many species survival rates due to changes that lead to less food, less successful reproduction, and interfering with the environment for native wildlife

2. Climate change is already impacting human health. Changes in weather and climate patterns can put lives at risk. Heat is one of the most deadly weather phenomena. As ocean temperatures rise, hurricanes are getting stronger and wetter, which can cause direct and indirect deaths

Answers to SAE 2

1. Climate change has produced a number of threats to wildlife throughout our parks. Rising temperatures lower many species survival rates due to changes that lead to less food, less successful reproduction, and interfering with the environment for native wildlife

2. Climate change has produced a number of threats to wildlife throughout our parks. Rising temperatures lower many species survival rates due to changes that lead to less food, less successful reproduction, and interfering with the environment for native wildlife

Answers to SAE 3

1. Climate change has produced a number of threats to wildlife throughout our parks. Rising temperatures lower many species survival rates due to changes that lead to less food, less successful reproduction, and interfering with the environment for native wildlife.

2. With such a huge crisis facing the entire planet, the international response should be swift and decisive. Yet progress by world governments has been achingly slow. Many commitments to reduce carbon emissions have been set, but few are binding and targets are often missed.

Glossary

(")	Inches
°C	Centigrade
°F	Ferenheiht
ABZ	Audu Bako Zoo
AFC	Apoi Creek Forest
AR	Article
BGR	Buturiya (Wetland) Game Reserve
BP	British Petroluem
CBD	Convention on Biological Diversity
CBD	Convention on Biological Diversity
CO_2	Carbondioxide
COP	Congress of Parties
CRNP	Cross River National Park
DNA	Deoxyribonucleic acid
FAO	Food and Agriculture Organization
GGNP	Gashaka-Gumti National Park
GGNP	Gashaka-Gumti National Park
GIS	Geographic Information System
GPS	Global Positioning Syatem
H_2O	Water

HNWL	Hadejia-Nguru Wetlands
HWC	Human-Wildlife Conflict
IF	Idanre Forests
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IUCN	International Union of Conservation of Nature
JWP	Jos Wildlife Park
KGR	Kwale Game Reserve
KLNP	Kainji Lake National Park
Km	Kilometre
LCNP	Lake Chad National Park
LD	Long-Day
M	MILLION
MHTs	Major Habitat Types
NCPZ	National Children's Park and Zoo
NGO	Non-Governmental Organization
NNFR	Ngel Nyaki Forest Reserve
O_2	Oxygen
OF	Omo Forests
OGR	Ologbo-Emu-Uro Game Reserve
ONP	Okomu National Park
ORP	Osse River Park
Pas	Protected Areas
PDWP	Pan Dam Wildlife Park
SD	Short-Day
SFM	Sustainable Forest Management
SMS	Short Message Service
SSC	Species Survival Commission
UN	United Nation
US	United State
WCMC	World Commission on Protected Areas
WWF	World Wildlife Fund
YGR	Yankari Game Reserve
YNP	Yankari National Park

End of the module Questions

What is wildlife in ecology?

What is wildlife adaptation?

What are the wildlife resources?
What are the importance of wildlife in Nigeria economy?
Discuss the main causes for the conflict between human and wildlife
How does the climate change affect the wildlife?

Module 2: Wildlife Conservation Policies and Legislation

Module Structure

In this module we will discuss about the issues of Wildlife Conservation Policies and Legislation with the following units:

Unit 1: Conservation Policies
Unit 2 : Wildlife Protection Policies and Legislation
Unit 3: Problems and Threats to Wildlife Conservation
Unit 4: Conservation Status of Wildlife
Unit 5: International and national laws related to wildlife resources.
Glossary
End of the module questions

Unit 1: Conservation Policies

Unit Structure

1.1 Introduction

You will learn in this unit about the evolution of International biodiversity policies with different contexts and motivations. Moving from a strictly biodiversity-centred focus, with the creation of early national parks, they now include people and their needs in the conservation policy perspective.

1.2 Intended Learning Outcomes (ILO)

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

- Explain the various Conservation policies
- Enumerate the history of conservation policies
- Understand the multi-lateral environmental agreements
- Highlight the theme of Rio Declaration
- Appreciate the significance of Convention on Biological Diversity (CBD)
- Identify with the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES)
- Explain the significance of the Sustainable Development Goals
- Describe the Joint working of the CBD and SDG 2030 Agenda
- List the Important Policies related to Conservation of Nature and some important International Wildlife Conservation Bodies

1.3 **Conservation Policies**

The protection, conservation, and sustainable use of biologically varied ecosystems and habitats are encouraged by biodiversity policies. They so produce substantial public benefits and advance social welfare. National and international policies have long recognized and emphasized the value of biodiversity. While national policies to safeguard biodiversity made up the majority of the initial conservation policies, which were formulated around 150 years ago, there has been a considerable shift in emphasis toward the integration and alignment with societal goals during the past century. Early in the 20th century, policies were solely concerned with protecting species and their habitats, or "Nature for itself." Over time, however, policies have progressively embraced other human objectives.

1.3.1 History of the conservation policies

The United Nations Conference on the Human Environment, which took place in Stockholm, Sweden, in 1972, is where sustainable development at the UN began. The first significant UN conference on the topic of the environment was the United Nations Conference on the Human Environment. The Stockholm Declaration and Plan of Action, which outlined guidelines for safeguarding and improving the human environment and offered suggestions for global environmental action, were endorsed by the conference. The United Nations Environment Programme (UNEP), the first UN program completely dedicated to environmental challenges, was also established at the Conference. Twenty years later, in 1992, at the historic Earth Summit in Rio de Janeiro, Brazil, the United Nations aimed to assist governments in reconsidering economic growth and coming up with solutions to cease harming the environment and using up the planet's natural resources.

It is helpful to briefly consider their evolution in order to comprehend contemporary conservation policies. In the past, national conservation designations, including the first significant national parks,

were made as a result of conservation policies that were developed in reaction to the realization that natural habitat was being lost. By the Yellowstone National Park Act of 1872, which withdrew over one million hectares from future land use expansion to be "dedicated and set apart as a public park for the use and enjoyment of the people of the United States," Yellowstone became the first national park in the world. The 1949 National Parks and Access to the Countryside Act, which was also a direct result of a significant demand for unrestricted public access to private land, made the UK the first nation in Europe to establish national parks. One of the most frequented national parks in the world is the Peak District National Park, which was established in 1951. The creation of numerous additional national parks in Africa, Europe, and other continents followed in the 1970s and 1980s. However, frequently these designations gave little thought to regional populations and their means of subsistence, which occasionally resulted in serious confrontations and breaches of the rights of indigenous people. The cornerstones of local, regional, and global initiatives for biodiversity conservation continue to be protected areas. They have significantly contributed to halting losses of species and habitats, although their performance is at times mixed and often not known.

1.3.2 Multi-lateral Environmental Agreements

In the 1970s and 1980s, a number of international accords aimed at protecting species and habitats served as the foundation for the creation of international conservation policy (Table 1). These multilateral environmental agreements proved to be catalysts for the creation of national law once they were ratified by various nations. For instance, in reaction to the CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora (which took effect the same year), the US Endangered Species Act of 1973 was created. Another such is the Council Directive 79/409/EEC on the conservation of wild birds (Birds Directive), which was passed in 1979 and enabled the European Union to fulfill its obligations for bird species under the Bern Convention (1979) and Bonn Convention (1979). This has since been substantially amended several times to the Directive 2009/147/EC adopted in 2009 and sits alongside the *Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora* (Habitats Directive) adopted in 1992. Legal mechanisms for the achievement of international conventions at national scales are at the discretion of each member state.

Table 1.1 Important multi-lateral environmental agreements in the nature conservation context.

Treaty name	Abbreviation	Adoption	Entry into force	Parties*	Main target
Convention on Wetlands of International Importance	Ramsar	1971	1975	170	Conservation and sustainable use of wetlands
Convention Concerning the Protection of the World Cultural and Natural Heritage	WHC/World Heritage Convention	1972	175	193	Protection of the world cultural and natural heritage

Treaty name	Abbreviation	Adoption	Entry into force	Parties*	Main target
Convention on International Trade in Endangered Species of Wild Fauna and Flora	CITES	1973	1975	183	Regulation of trade of wild plants and animals
Convention on the Conservation of European Wildlife and Natural Habitats	Bern Convention	1979	1982	51	Conservation of wild flora and fauna and their natural habitats, and promotion of European cooperation
Convention on the Conservation of Migratory Species of Wild Animals	CMS/Bonn Convention	1979	1983	126	Conservation and sustainable use of migratory animals and their habitats
United Nations Framework Convention on Climate Change	UNFCCC	1992	1994	197	Prevention of dangerous anthropogenic interference with the climate system, slowing global warming and mitigating its impact
Convention on Biological Diversity	CBD	1992	1993	196	Conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources
United Nations Convention to Combat Desertification	UNCCD	1994	1996	197	Prevention of desertification and land degradation

* Number of member states as of December 2021.

Source: www.informea.org

Environmental pollution, excessive resource usage, and the accompanying loss of species and natural ecosystems received more and more attention from the general public and government leaders in the 1980s. As a result, three new conventions—the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention to Combat Desertification (UNCCD), and the Convention on Biological Diversity—were opened for signature at the 1992 "Rio World Summit" (also known as the United Nations Conference on Environment and Development, or UNCED) (CBD).

What was the thrust of conservation policies in the early part of the 20th century?

Self Assessment Exercise 1

1. What is the main role of conservation policy?

2. What is the meaning of CITES in conservation parlance?

1.4 The Rio Declaration

The 'Rio World Summit' in 1992 led to the Rio Declaration which opens a new chapter in biodiversity conservation. According to the Declaration, there can be no long-term economic success without concurrent environmental protection. This can only take place if nations create a new, equitable global partnership incorporating their governments, citizens, and important societal sectors.

1.4.1 The Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) is the most comprehensive global treaty dealing with nature conservation. The text of the CBD is made up of 42 Articles that further clarify its objectives and impose obligations on its members. Members of the member nations gather at the Conference of the Parties every two years. The CBDs, three overarching objectives are (Article 1 of the Convention):

(a)the conservation of biological diversity,
(b)the sustainable use of its components and
(c)the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

The CBD parties are separated into groups of states that discuss and align their positions in order to facilitate talks under the consensus concept. One of these members is then tasked with representing the group in the COP plenary. Important associations of states are the European Union and the official United Nations Regional Groups (African Group, Asia–Pacific Group, Eastern European Group, Latin America and Caribbean Group, Western European and Others Group), alongside some informal groups, such as an alliance of industrialised non-EU countries called JUSCANNZ (i.e. Japan, United States, Switzerland, Canada, Australia, Norway, New Zealand).

1.4.2 Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES)

IPBES was established in 2012 to produce an integrative knowledge foundation on biodiversity, ecosystems, ecosystem services, and their impact on human and societal well-being. IPBES is a science-policy interface, not a convention, that assists governments and stakeholders in making decisions at various scales.

IPBES's long-term goals include synthesizing the complex dynamics of nature and their effects on human societies and the environment. The 130 member states that make up the IPBES Plenary gather once a year to track the status of the work program and make decisions about the future.

The UN Environment Programme (UNEP), the UN Educational, Scientific and Cultural Organization (UNESCO), the Food and Agriculture Organization of the UN (FAO), and the UN Development Programme are just a few of the major United Nations programs that collaborate with IPBES, an independent intergovernmental platform (UNDP). Its work adheres to international conventions such as the CBD (e.g. Ramsar, CITES, as well as the UNCCD). Its distinctive function is to coordinate research objectives on biodiversity and its effects on society across important organizations including the International Union for the Conservation of Nature (IUCN), Future Earth, and the Group On Earth Observations Biodiversity Observation Network

(GEO BON). IPBES seeks to draw in more social scientists despite the fact that the humanities and social sciences are still underrepresented in the process. How is the Rio Declaration stated?

Self As

1. What was the aim for the 2030 agenda for SDGs?

2. What are the two relevant SDGs concerned with biodiversity conservation?

1.5 Important Policies related to Conservation of Nature

A conservation policy is **a policy aimed at conserving or restoring a declining species, a community, an ecosystem or a natural or semi-natural site**. Find below the some important policies related to conservation.

1 Conservation policy

Nigeria has been increasingly concerned over the years about protecting its native animals. Game reserves have progressively increased in number, and agreements for international cooperation in wildlife protection have been signed. The 1916 wild Animals Preservation Ordinance has been altered or repealed in each of the Federation's 19 states, and a decree governing trading in endangered animals was issued in 1985. The Nigeria Conservation Foundation's founding in 1982 signaled the start of organized private participation in the nation's advocacy of conservation ethics. Despite this, the nation's objectives of managing wildlife for tourism, sustained production of game meat (also known as "bushmeat"), and preservation of a national heritage remain challenging to achieve in light of the nation's mounting economic issues, growing population, and ongoing habitat destruction for wildlife.

2. National Forest Policy

The National Forest Policy from 2006 is replaced by this document, which establishes the nation's forest policy. It aims to increase total forest cover and enhance resource sustainability management. Prior to now, the 2006 forest policy, which outlined strategies for the sector's growth, did not take into account the needs of current and new forms of development. The policy was changed in 2020. The new strategy is based on thirty components, which are distributed

among the seven globally recognized components for sustainable forest management, with the goal of increasing the forest cover from its current 6% to 25% by 2030. It was changed to boost its function in offering goods and services to expand the area covered by forests. The Major amendments made were:

- provision for increasing forest cover in the drylands of the country
- establishment of a carbon sink to address climate change
- implementing livelihood empowerment programs
- improving resilience to climate change

Evaluation of forest policies is essential for both minor and significant changes in official public statements and administrative execution. The sustainable management and use of forest resources is improved by forest policy. The National Forest Policy of 1988's fundamental goal is to maintain ecological balance, especially atmospheric equilibrium, which is essential for the survival of all living forms, including humans, animals, and plants. This primary objective must come before any direct economic advantage. The following, among other things, are the significant accomplishments of the National Forest Policy of 1988:

• An increase in the amount of trees and woodland.

• Through the Joint Forest Management Program, local communities are involved in the preservation, management, and protection of forests.

• Fulfilling the needs of the rural and tribal communities for fuel wood, feed, and small timber.

• The preservation of the nation's genetic diversity and biological diversity through ex situ and in situ conservation efforts.

• A significant contribution to the country's environmental and ecological stability.

The following should serve as the National Forest Policy's fundamental goals:

• Preservation and, if necessary, restoration of the ecological balance that has been negatively impacted by the serious depletion of the nation's forests would help to maintain environmental stability.

• Mmaintaining the nation's remaining natural forests and their diverse flora and fauna, which serve as a representation of the tremendous ecological diversity and genetic riches of the nation.

• Reducing soil erosion and denudation in the catchment areas of rivers, lakes, and reservoirs in order to "conserve soil and water, to lessen floods and droughts, and to delay reservoir silting."

• Monitoring the growth of sand dunes in Rajasthan's desert regions and along its coastline.

• Significantly increasing the country's forest/tree cover through widespread afforestation and social forestry programmes, particularly on all deforested, degraded, and unproductive regions.

• Fulfilling the needs of the rural and tribal people in terms of fuel-wood, food, minor forest output, and small timber. Increasing the productivity of forests to meet essential national needs.

• Encouraging efficient utilisation of forest produce and maximising substitution of wood.

• Creating a massive people's movement with the involvement of women, for achieving these objectives and to minimise pressure on existing forests.

3 Environmental Policy and its Enforcement in Nigeria

The Federal Republic of Nigeria's 1999 Constitution serves as the foundation for environmental policies in that country. The State is given the authority to defend Nigeria's water, air, land, forest, and wildlife under section 20 of the Constitution. It is also given the authority to maintain and develop the environment. Additionally, according to Section 2 of the Environmental Impact Assessment Act of 1992 (EIA Act), neither the public nor the private sectors of the economy may initiate, begin, or approve projects or activities without first taking the environment's impact into account. The Federal Government of Nigeria has issued a number of rules and regulations in this regard to protect the environment in Nigeria. These include:

a). Federal Environmental Protection Agency Act of 1988 (FEPA Act) repealed by the National Environmental Standards Regulation Agency (NESREA) Act 2007. The following Regulations were made pursuant to the FEPA Act:

- National Environmental Protection (Effluent Limitation) Regulations;
- National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations; and
- National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations.

b). Environmental Impact Assessment Act of 1992 (EIA Act).

c). Harmful Wastes (Special Criminal Provisions etc.) Act of 1988 (Harmful Wastes Act).

The National Environmental Standards Regulation Agency (NESREA) (the agency) is in charge of overseeing the enforcement of environmental standards, regulations, rules, laws, policies, and guidelines as well as biodiversity conservation, sustainable development of Nigeria's natural resources, and environmental technology. This includes coordination and liaison with relevant stakeholders both inside and outside of Nigeria. Environmental Rules and Standards for the Petroleum Industry in Nigeria (EGASPIN) 2002, published by the Department of Petroleum Resources, are just one example of guidelines that other regulatory bodies with oversight duties and authority over particular industries have released (DPR).The NESREA Act allows each State and Local Government in the country to set up its own agency for the protection and improvement of the environment within the State. Each State is also empowered to make laws to protect the environment within its jurisdiction. All the States have environmental agencies and State laws; e.g. Lagos, Akwa Ibom, Abuja. The Federal Capital Territory has issued the Abuja Environmental Protection Board (Solid Waste Control/Environmental Monitoring) Regulations 2005 also referred to as "the Abuja Environmental Protection Board Regulations" which principally governs solid waste control in Abuja.

4. The Nigerian Wildlife Management Policy

The current Nigerian conservation laws cover a wide range of topics related to wildlife and game management conservation, including forestry, national parks, the preservation of wild animals and endangered species, fisheries laws, agricultural laws, laws governing seeds, crop varieties, and laws governing livestock feed. To reinforce wildlife management policy, regulatory organizations like the Federal Environmental Protection Commission, the Environmental Impact Assessment Commission, the Urban and Regional Planning Agency, and numerous State

Environmental Protection Agencies have been established. What was the major landmark by the private sector for the promotion of conservation ethics in Nigeria?

Self As

1. What are the major amendments of the national forest policy 2020?

2. What is the main thrust of National Environmental Standards Regulation Agency

You have learned about the need for wildlife conservation policy which will result in sustainable management and protection of wildlife resources. You have also learned that policy when is enacted, the implementation should be carried out to letter so as to achieve the stated objectives. You have also studied that the country's wildlife faces a rather bleak future because substantial numbers of species are either endangered or threatened with extinction. Indeed a similar fate seems to be the lot of the departments and agencies that see to conservation and management of these local resources at local, state and federal levels.

1.7 References/Further Readings/Web Sources

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1.8 Possible Answers to Self-Assessment Exercises

Answers to SAE 1

1. Biodiversity policies promote the protection, conservation, and sustainable use of biologically diverse ecosystems and habitats.
2. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Answers to SAE 2

1. The 2030 Agenda aimed to stimulate action in areas of critical importance for humanity and the planet with a set of approved goals.
2. SDG 14 life below water and SDG 15 life on land

Answers to SAE 3

1. major amendments of the national forest policy 2020

- provision for increasing forest cover in the drylands of the country
- establishment of a carbon sink to address climate change
- implementing livelihood empowerment programs
- improving resilience to climate change

2. The National Environmental Standards Regulation Agency, (NESREA) (the agency) has the responsibility for the protection an development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources, environmental technology, including coordination and liaison with relevant stake holders within and outside Nigeria on matters of enforcement of environmental standards, regulations, rules, laws, policies and guidelines.

Unit 2 : Wildlife Protection Policies and Legislation

Unit Structure

2.1 Introduction

You will learn about the wildlife protection, history and foundations and policies. You will also study the principal agreements about wildlife policies, the Linkages between International, National and Local Legislation. and the Policy Impact and Issues of wildlife. You will learn about the Sustainable Development Goals, Joint working of the CBD and SDG 2030 agenda and some important international wildlife conservation bodies

2.2 Intended Learning Outcomes (ILO)

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

- Describe the Wildlife protection policies and legislation
- Appreciate Historical Background and Scientific Foundations of wildlife
- Explain the Principal International Agreements about wildlife policies
- Understand the Linkages between International, National and Local Legislation
- Explain the Policy Impact and Issues of wildlife
- Describe the wildlife **society** and **environmental** factors
- Explain the Sustainable Development Goals, Joint working of the CBD and SDG 2030 Agenda and some important international wildlife conservation bodies

2.3 Wildlife protection policies and legislation

In order to preserve or restore habitats, safeguard threatened or endangered species, enable the restoration of populations at risk, and pursue other objectives, wildlife protection involves policies and legislation that regulate land use, hunting, trapping, and the illegal trade in animals, reptiles, birds, and products. Policies and laws pertaining to the conservation of wildlife are present at all levels, from the municipal to the worldwide. Locally, for instance, municipal committees can take into account the potential for land and watercourse degradation when evaluating development projects as part of an environmental assessment. In many nations, including the United States, federal government projects must also undergo these reviews. Numerous environmental laws at the federal level also contribute to the protection of wildlife. As a result of some migratory species' global movement and the growing understanding that environmental preservation, particularly the protection of wildlife, is a global duty, policies and legislation likewise apply on a global scale.

Through scientific research, financial incentives to encourage land use protection, and the ability to bring legal action if necessary, the CBD helps countries come up with and put into practice ways to safeguard habitats and maintain biodiversity.

The Convention on Migratory Species, another international accord, was signed in Bonn, Germany, in 1979 under the auspices of the United Nations Environment Programme (UNEP). The accord, also known as the Bonn Convention, is focused on safeguarding migratory species

as well as the habitats that are essential to their survival. The Bonn Convention has been ratified by 104 countries as of 2008.
In 1971, Ramsar, Iran, hosted the signing of the Ramsar Convention on Wetlands. The pact aims to make it easier for local, state, and international governments to protect wetlands. The 158 signatories represent more than 620,000 square miles of wetlands, or over 1,750 wetland locations (161 million hectares).

2.3.1 Historical Background and Scientific Foundations

At the start of the 20th century, there weren't many laws or rules in the US governing the hunting of wild animals. Almost all animal and bird species were hunted without regard to the number of victims or the time of year, including during mating seasons. Land use patterns moved from primarily rural and regionally based agricultural to larger, corporate managed farmland and expanding urban centers in the United States and other industrialized nations. Unspoiled land from the past was lost. The necessity of safeguarding animal populations had been acknowledged by the middle of the twentieth century. The 1962 release of Silent Spring had a significant impact on attempts to protect animals. American author Rachel Carson (1907–1964) warned of the consequences on the natural environment and humans of the widespread and extensive use of chemicals such as the pesticide DDT. The book was prophetic, with DDT exposure subsequently being linked to adverse effects in humans, animals, and birds.

2.3.2 Policy Impact and Issues

The numerous laws and policies relating to wildlife protection that are in place internationally aid in efforts to raise the numbers of species in decline, sustain populations of species at risk, and conserve habitats. These initiatives have wider advantages. A healthy environment can promote ecotourism, prevent the emergence and spread of infectious diseases, and better support human endeavors like agriculture.

The CBD's member countries made the following pledge in 2002: "to achieve by 2010 a considerable decrease in the current pace of biodiversity loss at the global, regional, and national level as a contribution to poverty alleviation and to the benefit of all life on Earth." The CBD 2010 biodiversity target has expanded awareness of the need of wildlife protection and has sparked protective actions, even though progress at the global level can be difficult to measure.
When was the Ramsar Convention on Wetlands signed and what was the aim of the pact?

Self Assessment Exercise 1

2.4 **Linkages between International, National and Local Legislation**

The adoption of environmental regulations in global or regional accords and European Community (EC) legislation has expanded dramatically over the past few decades, as has the influence of these sources on national legal systems. At the same time, there has been an increasing trend towards the transfer of authority from the federal government to local governments in the area of the environment. Wildlife is frequently one of the topics on which local authorities at some level are permitted to legislate, either independently or within the framework of legislation enacted at the central level, in States with a federal or similar decentralized system. Both of these concurrent procedures are effective methods for managing and protecting wildlife. Regarding international initiatives, the harmonization of environmental legislation among various nations is beneficial because it may raise the standards of those that typically lag behind in the adoption of stringent environmental rules to those of more active ones, while typically preventing the latter from adopting stricter protective measures. The implementation of regulations at the international level also enables the management and protection of species whose range crosses international borders. Because affected producers are made subject to the same or very comparable restrictions under unified environmental regulations, it may also help ensure fair competition between businesses for the benefit of consumers. Regarding the growing devolution of powers to the local level, this procedure may make it easier to take into account all relevant interests and properly communicate with the representatives of those interests, especially in cases where authorities are democratically elected. Additionally, it can make it easier to pinpoint specific regional needs for local species or locations. The Convention on Biological Diversity and other more recent international

environmental agreements place a strong emphasis on area-based planning and measures, which are typically best accomplished locally. The preservation of habitats outside of protected areas can be significantly aided by the integration of environmental concerns into local planning. As there is typically a closer integration among branches of the administration at this level, conflicts that frequently arise among different central authorities responsible for related sectors (such as wildlife and hunting, agriculture, forestry, and environment) may be reduced by giving local authorities overall responsibility for the development of their respective territorial areas. Local governments are typically in the greatest position to protect local communities' interests during an integrated planning process because they are the closest representatives of those communities.
Therefore, the creation and application of international and local laws can considerably aid in the conservation of species. However, the integration of these procedures might be somewhat difficult. The adoption of special domestic rules is typically required to carry out international legislation. A nation's legislative authority over the pertinent matter may have been transferred to one or more levels of local government. While the State still bears responsibility for the responsibilities to which it agreed at the international level, unified compliance, even within a single nation, may be complicated by some local authorities' inaction or potential discrepancies in how they carry out their duties. Adequate international, national and local rules are all essential means for good wildlife management. The effectiveness of these regulations is also enhanced by dealing with problems at the most suitable territorial level. For instance, species whose distribution crosses administrative borders are likely to be best managed at the national or international level because only one management strategy may be used. However, there are some regions or species whose features call for more in-depth local regulation, which is best handled primarily at the local level, while still adhering to international and national standards. It is crucial to establish unambiguous agreements regarding the division of legislative and administrative authority among the international, national, and local levels, whether or not these agreements are reflected in specific statutory provisions.
What would be the best approach concerning the adoption of various laws for wildlife manag
Self A

1. What does the incorporation of environmental concerns into local planning set to achieve in conservation parlance?
2. What are important, but parallel processes that appeared productive approaches for wildlife protection and management?

2.5 **The Sustainable Development Goals**

The launch of the Sustainable Development Goals, the new global agenda of the United Nations, coincided perfectly with the creation of IPBES (SDGs). Since the Brundtland Commission (1987), the Rio Declaration on Environment and Development, and the eight Millennium Development Goals, there have been more than 30 years of intense political debate (MDGs). These had the objective of "ensuring environmental sustainability," but they had nothing to do specifically with biodiversity. The SDGs were created as a more comprehensive and integrated approach to development after the United Nations Conference on Sustainable Development in 2012. They are based on the MDGs. In January 2016, the *2030 Agenda for Sustainable Development*, comprising 17 SDGs with 169 targets and a declaration, were officially approved during a UN Summit attended by 193 member states. With a set of endorsed objectives, the 2030 Agenda sought to spur action in areas of vital importance for mankind and the environment. This is the main innovation and strength of this framework, in which biodiversity conservation is no longer isolated. It provides a comprehensive strategy that combines economic development, social inclusion, and environmental sustainability and applies to all nations - poor, rich, and middle-income alike - and to all segments of society.

The High-Level Political Forum, which serves as its principal decision-making body, offers a central forum for all member states to assess progress made toward the SDGs and the 2030 Agenda for Sustainable Development. The United Nations collaborated with numerous governmental and non-governmental organizations across the globe to promote the implementation of the SDGs in order to ensure commitment to this cause and to improve synergies between international agreements. Although reviews have shown that the implementation of SDGs in general and the biodiversity goals in particular (SDG 14 life below water and SDG 15 life on land) are not yet sufficiently incorporated into national policies of either OECD or non-OECD countries, several international coalitions, including the G20 and G8, have incorporated the 2030 Agenda into their policy frameworks. In order to achieve the SDGs, international cooperation is necessary, and sustainable development must be ingrained as a guiding concept in all areas of policy at the national, European, and global levels. The realization of several SDGs, however, is primarily dependent on the actions taken by member states and, more importantly, necessitates the creation and adoption of potent operational concepts at both the national and regional levels. It is envisioned that governments and other stakeholders will mobilize their efforts to create national and regional plans for the SDGs' implementation. This necessitates striking a balance between addressing the scope and systemic nature of the 2030 Agenda with budgetary, political, and resource constraints that inevitably lead to countries prioritizing certain targets and the risk of adverse effects for "non-prioritised" ones, particularly if they are in conflict with one another or even mutually exclusive. Furthermore, the objectives are rarely distinct from one another, which means that setbacks in one area can swiftly impede advancement in another. To prevent success in certain areas from being accomplished at the price of development in others, national policy-makers must comprehend the interdependencies among the SDGs and achieve cogent implementation. Additionally, national policies frequently have an impact on neighboring nations or global value chains. As a result, we must avoid pursuing regional goals that have a negative impact on the goals pursued by other nations.

2.5.1 Joint working of the CBD and SDG 2030 Agenda

The CBD claims that the 2030 Agenda and the Strategic Plan for Biodiversity are compatible with one another and mutually beneficial. The Stockholm Resilience Center's new visualization of the SDGs, which depicts them as interconnected tiers of a "wedding cake," openly

acknowledges the biosphere's key role. It suggests moving away from sectoral approaches that treat the economy and society as integral components of the biosphere and acknowledges that promoting human dignity and prosperity can only be accomplished in a sustainable manner if the planet's essential biophysical processes and ecosystem services are preserved. However, setting priorities is a necessary step in advancing the SDGs' implementation in UN member states. Biodiversity concerns may not always be sufficiently grounded in other non-environmental policy areas, and as a result, they may be superseded by other interests. This is especially true when trade-offs are made between short-term development successes and long-term sustainability. The biodiversity (SDGs 14 and 15) will frequently suffer as a result of these trade-offs, which will probably have an adverse effect on a number of other SDGs, including those pertaining to food security, water supply, and climate change mitigation. Although some efforts have been made to further analyze these connections, the crucial issue of how to resolve such trade-offs in practice still has to be resolved at the local, national, and regional levels.

2.5.2 Some important international wildlife conservation bodies

- World Wide Fund for Nature (WWF) ...
- Royal Society for the Protection of Birds (RSPB) ...
- The Nature Conservancy (TNC) ...
- Savanna Conservation
- The Wildlife Trusts. ...
- The National Trust. ...
- The International Union for Conservation of Nature (IUCN) ...
- Conservation International (CI)

When was the 2030 agenda for SDG approved?

Self As

1. List any three significant conservation bodies you have studies

2. What is the thrust of the SDG 2030 Agenda?

2.6 Summary

You must have learnt about the wildlife protection, history, foundations and policies. You also studied the principal agreements about wildlife policies, the Linkages between International, National and Local Legislation, and the Policy Impact and Issues of wildlife. You have also learned about the Sustainable Development Goals, Joint working of the CBD and SDG 2030 agenda and some important international wildlife conservation bodies

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2.8 Possible Answers to Self-Assessment Exercise(s) within the content

Answers to SAE 1

1. The many policies and laws concerned with wildlife protection that are in effect globally help preserve habitats, sustain the populations of species at risk, and help in efforts to increase the numbers of species in decline. These efforts have broader benefits. A healthy habitat is better able to support human activities such as agriculture, reduces the development and spread of infectious diseases, and can encourage eco-tourism.

2. An important influence in wildlife protection efforts was the 1962 publication of *Silent Spring*. This was by the mid-twentieth century, the need to protect wildlife populations had been recognized.

Answers to SAE 2

1. The incorporation of environmental concerns into local planning can considerably contribute to the conservation of habitats outside protected areas.
2. **Environmental rules adopted in international fora**, such as global or regional agreements and legislation issued by the European Community (EC), and at the same time, a growing tendency towards the **devolution of powers** of central governments in

the environmental sector to local authorities.

Answers to SAE 3

1. Important internation conservation bodies

- World Wide Fund for Nature (WWF) ...
- Royal Society for the Protection of Birds (RSPB) ...
- The Nature Conservancy (TNC) ...
- Savanna Conservation
- The Wildlife Trusts. ...
- The National Trust. ...
- The International Union for Conservation of Nature (IUCN) ...
- Conservation International (CI)

2. It provides a holistic strategy that combines economic development, social inclusion and environmental sustainability and applies to all countries – poor, rich and middle-income alike – and to all segments of society; this is the major novelty and strength of this framework, in which biodiversity conservation is no longer isolated.

Unit 3: Problems and Threats to wildlife conservation

Unit Structure

3.1 Introduction

You will learn in this unit that wildlife are under threat from many different kinds of human activities. You will also study that humans have explored and left their footprint on nearly every corner of the globe. As the population and needs grow, humans are leaving less and less room for wildlife. This unit will also highlight the threats to biodiversity as it affects wildlife. You will also learn that most ecosystems are facing multiple threats and each new threat puts additional stress on already weakened ecosystems and their wildlife.

3.2 Intended Learning Outcomes (ILO)

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

- Define Wildlife conservation
- Appreciate the need to preserve Earth's wildlife
- Explain the threats to wildlife
- Explain the kinds, causes and impacts of habitat loss
- Describe the effect of climate change and diseases on wildlife and its habitat

3.3 Wildlife conservation

The term "wildlife" originally referred to undomesticated animal species, but it has since expanded to encompass any plants, fungi, and other living things that are native to a place and have not been introduced by people. There is wildlife in every habitat. There are various types of animals in deserts, forests, rain forests, plains, grasslands, and other places, including the most developed urban areas. Most experts concur that a great deal of wildlife is impacted by human activities, despite the fact that the word is typically used to describe creatures that are unaffected by human factors in popular culture. Only roughly 1.5 million of the estimated 5 to 15 million species of plants, animals, and microorganisms that exist on Earth today have been identified and described, according to biologists. The estimated total includes around 300,000 plant species, between 4 and 8 million insects, and about 50,000 vertebrate species (of which about 10,000 are birds and 4,000 are mammals).

3.3.1 The need to preserve Earth's wildlife

27,000 of the assessed species, according to the International Union for Conservation of Nature (IUCN), are thought to be in danger of going extinct. A 2019 UN report on biodiversity increased this estimate to a million species while taking into account all current species. A growing number of habitats on Earth that support endangered species are being lost, it is also recognised.

Governmental initiatives to protect Earth's species have been made on a national and worldwide level to solve these challenges. Important conservation agreements include the 1992 Convention on Biological Diversity and the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (CBD). The conservation field is also home to a large number of nongovernmental organizations (NGOs).

3.3.2 Threats to wildlife

There are hardly many areas remaining on the planet where humanity have not had an impact. We have traveled almost the entire world and made our mark there. We are reducing the amount of space we leave for wildlife as our population and requirements increase. Human activity poses a harm to wildlife in many different ways, from directly damaging habitat to spreading exotic species and illness. The majority of ecosystems are under several threats. Each new hazard increases the strain on already-fragile ecosystems and the fauna that depends on them. Climate change, economic growth, agricultural land use changes, invasive species and pollution, oil exploration and exploitation, canalization, which primarily threatens mangroves, deforestation,

desert encroachment, overhunting, land use, road and residential building construction, etc. all pose serious threats to wildlife.

i. Today, about 23% (1,130 species) of mammals and 12% (1,194 species) of birds are considered as threatened by IUCN.

ii. Our planet has lost more than 58% of its fauna since 1970, and the sixth mass extinction is currently taking place, according to numerous studies and reports. The 2016 Living Planet Report provides light on the methods we may still preserve and restore what is still left while also revealing the alarming degree of this and other environmental catastrophes around the world. According to a report by the WWF, a biodiversity index that was created using data from the Zoological Society of London was down 58 percent from 1970 to 2012 and would be down 67 percent by 2020 if current trends continue.

iii. iii. Due to factors including pollution, invasive alien species, climate change, changes in land use, and unsustainable exploitation of natural resources, among others, the loss of biodiversity worldwide is occurring far faster than natural extinction. The loss of natural habitat brought on by human land conversion is most pronounced in tropical forests and less severe in temperate, boreal, and arctic regions. Near urban centres in northern temperate regions, pollution from atmospheric nitrogen deposition is worst, and harmful alien species are frequently introduced as a result of patterns of human activity.

iv. Species loss is also compounded by:

- The ongoing growth of human populations and unsustainable consumer lifestyles
- Increasing production of waste and pollutants
- Urban development
- International conflict.
- Fewer natural wildlife habitat areas remain each year. Moreover, the habitat that remains has often been degraded to bear little resemblance to the wild areas which existed in the past.
- Habitat loss due to destruction, fragmentation, and degradation of habitat is the primary threat to the survival of wildlife.

v. Climate Change: Rainfall and flooding are getting heavier due to global warming, hurricanes are getting stronger, and droughts are getting worse. The most obvious effect of global warming on our daily lives will be the intensification of weather and climate extremes. Additionally, it is endangering the landscape of our planet and stressing out various wildlife species and their habitat. Climate change could result in a catastrophic loss of wildlife species since many different species of plants and animals have unique habitat requirements. Large seasonal changes will result from a small change in rainfall average. Mammals, reptiles, amphibians, and insects that are hibernating are damaged and disturbed. Any change in moisture level will harm plants and wildlife since they are sensitive to changes in moisture.

vi Unregulated Hunting and poaching: Poaching and unchecked hunting pose a serious threat to wildlife. Mismanagement of the forest department and forest guards also contributes to this issue.

vii **Pollution**: Many different types of species consume pollutants that are released into the environment. Various plants, insects, and rodents are poisoned by the environment due to the widespread use of pesticides and harmful chemicals.

viii **Over-exploitation:** Overexploitation is when people use certain animal and plant species excessively for things like food, clothes, pets, recreation, medicine, and many other things.

Animals and plants have long provided for human requirements such as food, clothing, medicine, shelter, and a variety of other necessities. There is a greater demand for resources than the natural world can offer. The risk is that if too many members of a species are eliminated from their natural habitat, the species may go extinct. Many other species in an ecosystem can be impacted by the extinction of one species. Unsustainable levels of wildlife hunting, trapping, collecting, and fishing are nothing new. Early in the 20th century, overhunting nearly led to the extinction of the American bison, and the passenger pigeon was killed to extinction.

ix **Deforestation:** The habitats of wildlife are being invaded as a result of human expansion and development. As the population of humans increases, they remove forest area to make more room. Because there are fewer places for wildlife to live and eat, there is stress on wildlife populations.

x. **Population**: The growing human population poses a serious threat to wildlife. More trash is produced because there are more people on the planet, who also consume more food, water, and fuel. The rising human population directly contributes to major challenges to animals. Less human interference means less wildlife disturbance.

What was the most important conservation moves of the 1990s?

Self-Assessment Exercises 1

1. What are the main problems facing wildlife in this part of the world?
2. What are the problems of wildlife conservation in Nigeria?

3.4 Habitat loss

An alarming amount of habitat is being lost. It is the main threat to the species. As they are cut down for human consumption and cleared to make room for industrial development, such as agriculture, homes, highways, and pipelines, the world's forests, marshes, grasslands, lakes, and other habitats, continue to disappear. Important natural habitats will continue to be destroyed in the absence of a solid plan to establish land and marine protected areas. The biggest danger to wildlife's survival is habitat loss, which results from habitat destruction, fragmentation, or degradation. An ecosystem may no longer be able to offer the food, water, cover, and places to raise young that species need to survive when it has been significantly altered by human activity,

such as agriculture, oil and gas exploration, commercial development, or water diversion. The number of habitats available to wildlife is decreasing daily. Additionally, 85% of all species included on the IUCN Red List have this issue defined as their primary threat (those species officially classified as "Threatened" and "Endangered"). A key factor in the transformation of natural habitat into agricultural land is rising food production. Expanding agricultural land, extensive harvesting of lumber, wood for fuel, and other forest products, as well as other factors, are the main causes of forest loss and degradation. Many African species rely on a healthy, connected ecosystem to survive. This is especially crucial for animals like lions, elephants, and wild dogs, which need wide home ranges and the presence of essential migration routes. For instance, the African lion now only inhabits less than 10% of the area it once did. There may only be 20,000 lions left in the wild after a population halving over the past 20 years. The demands on the land will increase quickly as the human population of Africa is projected to triple to 4.4 billion by the end of this century. However, safeguarding habitat and healthy ecosystems is crucial for both the wildlife's survival and the wellbeing of local communities, contributing to safeguard water and food supplies, and reduce the impacts of natural disasters. Finding solutions that benefit both people and wildlife is urgently needed. The ultimate conservation challenge is to find a place where they can coexist.

3.4.1 Major Kinds of Habitat Loss

Habitat destruction: The classic illustration of habitat devastation is a bulldozer tearing down trees. Other ways individuals directly harm habitat are through dredging rivers, mowing fields, filling in wetlands, and cutting down trees.

Habitat fragmentation: Roads and industrialization have broken up much of the remaining terrestrial wildlife habitat in the United States into small pieces. Dams and water diversions have broken up the habitats of aquatic creatures. These habitat patches might not be sufficiently large or interconnected to support species that require a sizable territory where they can find mates and food. Migratory species struggle to find locations to rest and eat along their migration paths due to habitat loss and fragmentation.

Habitat degradation: Habitats may become sufficiently damaged by pollution, invasive species, and modification of ecosystem processes (like altering the intensity of fires in an ecosystem) that they can no longer support local fauna.

3.4.2 Main Causes of Habitat Loss

Agriculture: When settlers turned woods and prairies into crops, a large portion of the habitat loss caused by agriculture was done long ago. Pressure to repurpose conserved lands for high-priced food and biofuel crops is rising now.

Land conversion for development: Even amid the current economic crisis, lands that once served as wildlife habitat are still being converted to housing developments, roadways, office parks, strip malls, parking lots, and industrial locations.

Water development: Water is siphoned off and disconnected by dams and other water diversions, which alters the hydrology and chemical of the water (when nutrients are not able to flow downstream). By the time the Colorado River reaches the Sea of Cortez during the dry season, it has little to no water.

Pollution: Wildlife in freshwater is most affected by pollution. Pollutants including raw sewage, mining waste, acid rain, fertilizers, and pesticides concentrate in rivers, lakes, and wetlands before making their way to estuaries and the food chain.
Climate change: Climate change is a new factor contributing to habitat loss. The American pika and other animals that require the chilly temperatures of high elevations may soon run out of habitat. As sea levels rise, coastal species may discover that their habitat is underwater.

3.4.3 Impacts of Habitat Loss

The carrying capacity of native plants, animals, and other organisms is diminished when a habitat is destroyed, which causes populations to dwindle and occasionally reach the point of extinction. Perhaps the biggest threat to organisms and biodiversity is habitat loss. According to research, habitat loss posed a serious threat to 82% of the bird species that are considered endangered. Loss of native habitat is a hazard to the majority of amphibian species, and some are now restricted to breeding in modified habitat. Due to the fact that these organisms are endemic and have small geographic ranges, they are particularly vulnerable to habitat loss and have a lower chance of recovery. Many endemic creatures have very specialized life needs that can only be met in a particular ecosystem, leading to their extinction.
Extinction debt, a phenomena that can occur many years after habitat devastation, describes this possibility. The range of some organism populations may be reduced as a result of habitat degradation. As a result, there may be a decrease in genetic diversity and maybe more sterile young since these organisms are more likely to mate with other members of their species or related members of their community. The effects on China's giant panda, which was once prevalent in many areas of Sichuan, are among the most well-known examples. Due to extensive deforestation in the 20th century, it is now only found in scattered and isolated areas in the southwest of the nation. As a habitat is destroyed, the species diversity shifts from a population of habitat specialists and generalists to one that is dominated by generalist species. Commonly, invasive species are generalists capable of surviving in a wider variety of settings. The balance of species maintaining up with the extinction threshold is thrown off by habitat damage resulting in climate change, increasing the likelihood of extinction.
On a local, regional, and global level, habitat loss is one of the major environmental factors contributing to the decline of biodiversity. Many people think that habitat loss is the biggest threat to biodiversity; however, some think that habitat fragmentation comes in second. A unique landscape made up of isolated pockets of appropriate habitat scattered throughout a hostile environment or matrix is produced as a result of the reduction in the amount of habitat that is available. Typically, both fragmentation effects and pure habitat loss are to blame for this process. Pure habitat loss describes changes in the landscape's character that result in a decline in the number of individuals. Effects that are added as a result of habitat alterations are referred to as fragmentation effects. The dynamics of species richness can suffer as a result of habitat loss. A domino effect between the plant-pollinator interactions could have significant conservation implications for the order Hymenoptera, a diverse group of plant pollinators that is extremely susceptible to the adverse effects of habitat degradation.
What are the most challenging impact of species habitat loss?

Self-Assessment Exercises 2

1. What are the causes of habitat loss?
2. What are the types of habitat loss?

3.5 Effect of Climate change on Wildlife Habitat

The largest threat to the long-term survival of animals is emerging as climate change. Climate change is not just a problem for future generations; it is currently being observed all across the world, and people, animals, and plants are all experiencing the heat. Along with melting glaciers and polar ice caps, this warming signal is also present in ocean and soil temperatures. It has been connected to significant effects on ecosystems all over the world. All of this overwhelming data suggests that our globe is warming and that natural systems are having difficulty keeping up with it. The various way by which climate affects wildlife could be summarized as follows:

1. **Temperatures are increasing:** Closely examined data that demonstrate a reasonably rapid and broad increase in temperature over the past century are the most compelling evidence of a climate change trend. The United States' average temperatures have risen by more than one degree Fahrenheit over the past century, and the Earth's atmosphere has warmed by 1.5 degrees Fahrenheit since 1900. The ten warmest years on record, with 2016 being the warmest on record, have all happened since 1998. Because of the rapid rate of growth and the fact that measurements of the Sun's energy reaching the Earth during that time period allowed scientists to conclude that the Earth's warming was not caused by changes in the Sun, the rising temperatures reported after 1978 are particularly notable.

2. **Sea levels are rising:** Over the last century, the sea level has risen by around eight inches, and the rate of rise is accelerating. Sea level rise is a result of two factors related to climate change: the expansion of warm ocean water and the melting of land-based ice in glaciers and ice sheets. Even more quickly than scientists had projected a few years ago, sea levels have started rising. According to recent predictions, a 2 to 3 degree Fahrenheit warming could result in a global sea level increase of around 3 feet by 2100, uprooting over 56 million people from 84 developing nations. Due to the saltwater inundation of low-lying areas, coastal habitats also experience significant alterations.

3. **Sea ice is melting:** One of the most obvious effects of climate change on our planet is shrinking sea ice. According to the National Snow and Ice Data Center, the amount of Arctic sea ice in September (when the yearly minimum is attained) has decreased by more than 30% since 1979. In other seasons as well, the ice extent has been decreasing. Despite somewhat bigger ice extents in 2009, recent observations showed that the ice is more younger and thinner than it ever

was (less multi-year ice). These expanses of floating ice, which average 9.6 million square miles in size, play a significant role in controlling our temperature by reflecting some sunlight back to space and in the life cycles of many arctic species, including polar bears.

4. **Precipitation patterns are changing:** There are certain regions that receive more rain than others. Since warmer air can store more water vapor, nearly everywhere is experiencing an increase in heavy rainfall events. Some significant patterns in precipitation are already apparent right here in the United States. Dust Bowl-like circumstances will apparently grow more common in the Southwest as the region's climate changes to one that is drier. In the past 50 years, annual precipitation totals in the Northeast, Midwest, and Plains have grown by 5 to 20 percent. Both drought and flooding are increasing in the Southeast of the United States. Learn more about how extreme weather is being brought on by climate change.

5. **Oceans are acidifying:** The amount of carbon dioxide that burning fossil fuels has sent into the atmosphere has been mostly absorbed by the ocean, which has slowed the rate of climate change. But the ocean is also being affected by all this extra carbon dioxide. If no action is made to reduce fossil fuel emissions, the pH of surface seawater has fallen by 0.1 units since 1750 and is expected to fall another 0.5 units by 2100. It would take tens of thousands of years to undo these modifications.

3.5.1 Human Impact and Climate change

Human activity is to blame for climate change. Scientists have determined that burning coal, oil, and gas accounts for the majority of the observed warming. Based on a thorough knowledge of the atmospheric greenhouse effect and how human activities have been affecting it, this conclusion has been reached. At the same time, it has been determined that there are no other plausible causes, most notably changes in the sun. Our planet is naturally kept warm enough to support life thanks to the atmospheric greenhouse effect. The atmosphere lets sunlight through. Clouds and ice caps are examples of light-colored surfaces that reflect some heat back into space. But the majority of the heat entering the planet warms its surface. The atmosphere is then heated again by the earth. By using greenhouses, some of the heat is trapped. Human activity—such as burning fossil fuels—causes more greenhouse gases to build up in the atmosphere. More heat is trapped inside the atmosphere when it "thickens" with more greenhouse gases. Because they contain a lot of carbon, fossil fuels like oil, coal, and natural gas release a lot of carbon dioxide when burned. When gasoline is burned, 19 pounds of carbon dioxide are released into the environment from one gallon of fuel. Svante Arrhenius, a Swedish physicist, was the first to show how atmospheric carbon dioxide contributes to surface warming more than a century ago. Since then, scientific evidence has shown that variations in temperature have closely correlated with variations in atmospheric carbon dioxide concentrations for hundreds of thousands of years. The combustion of coal, oil, and natural gas has released around 500 billion tons of carbon dioxide during the Industrial Revolution, about half of which is still present in the atmosphere today.

3.5.2 Wildlife Health and Human Health

People live closer together, travel more frequently, affect the environment, and have diverse connections with animals for companionship, education, food, and other purposes as the population of Earth increases. These modifications make it simpler for diseases to transmit from humans and animals. Tracking animal diseases promotes the health of domestic and wild animals and can help stop the spread of sickness to humans. Did you know that human health is closely connected to the health of animals, plants, and the environment?

Zoonotic illnesses are those that can transfer from animals to humans. Rabies, Salmonella, and the West Nile virus are just a handful of the viruses that can be transferred by animals and account for more than half of all human infections. Recent outbreaks of the West Nile virus and avian influenza serve as examples of the interconnectedness between wildlife and human health. More wildlife diseases, like as SARS, are spreading swiftly around the globe. It's increasingly likely that diseases will spread between people and wildlife when people come into closer contact with wildlife, their habitat, and domestic animals. For the sake of both our own health and the future of America's wildlife, we must maintain healthy ecosystems to lower the danger of animal sickness. But in addition to being a source of ailments, the natural world also holds the possibility for curing them. We learn more every year about disease treatments using substances we find in nature. To conserve all of the potentially beneficial molecules that nature is constantly creating, we must protect biodiversity.

What cause the build-up of more green house gases in the atmosphere?

Self-Assessment Exercises 3

1. What is the harmful effects of climate change and wildlife?

2. How are human and animal health related?

3.6 Summary

You have learnt in this unit that the increase in the population of both humans and their livestock has placed immense pressures on wildlife species and their habitats. Similarly, increased developmental activities like construction of roads, dams, military bases, towns and agricultural lands etc. in wild lands have also increased the threats to wildlife species and their access to their intact habitats. Due to manmade disasters, climate change have affected wildlife adversely.

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1.8 Possible Answers to SAEs

Answers to SAE 1

1. Sadly, **many human activities such as mining, farming and construction** are constantly putting wildlife in danger. We are cutting down too many trees, clearing too much ground and building so many roads that we are destroying the natural habitats of millions of species and putting the world's biodiversity at risk.

2. The main problems facing wildlife conservation in Nigeria include **poaching, over exploitation, lack of accurate data, bush burning that destroys wildlife habitat**. There is inadequate reliable database to facilitate forestry planning and development.

Answers to SAE 2

1. What causes habitat loss? There are many causes of habitat loss, including land conversion for development from growing populations, mining for materials, harvesting lumber for paper products and, of course, agriculture.

2. The three main types of habitat loss are habitat destruction, habitat degradation and habitat fragmentation. The effects of habitat loss echo up the food chain and disrupt the entire ecosystem.

Answers to SAE 3

1. Humans and wild animals face new challenges for survival because of climate change. More frequent and intense drought, storms, heat waves, rising sea levels, melting

glaciers and warming oceans can directly harm animals, destroy the places they live, and wreak havoc on people's livelihoods and communities.

2. Human health and animal health are closely intertwined. We share hundreds of diseases with animals, and they are vectors for many diseases that assail humans—but, at the same time, they are essential to many treatments and cures.

Unit 4: Conservation status of Wildlife

Unit structure

4.1 Introduction

In this unit, you will learn that the wildlife estate consists of the flora and fauna. You will also learn that Nigeria has a wide variety of different habitats, ranging from mangrove swamps and tropical rainforest to savanna with scattered clumps of trees. About 290 species of mammal and 940 species of bird have been recorded in the country.

4.2 Intended Learning Outcomes (ILOs)

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

- Explain the meaning of Wildlife conservation
- Describe the various Wildlife components (Flora and Fauna)
- Explain the meaning of IUCN red list and
- Describe the IUCN guidelines & Red List Categories

4.3 Wildlife Conservation

Particularly in the tropics and subtropics, species abundance, variety, and distribution are experiencing striking declines as a result of climate change, rapid economic growth, overexploitation of natural resources, and perhaps social apathy about biological resource

conservation. Given how important biodiversity is to people's socioeconomic well-being, its importance cannot be overstated. Due to our grasp of biological diversity, this is feasible.

4.3.1 Floral Diversity

Because mangroves make up the majority of the vegetation, the southernmost region of the nation is referred to as a "salt water swamp" or "mangrove swamp." A freshwater marsh region, featuring salt-intolerant plants like the raffia palm, is to the north of this, and the rainforest is to the north of that. Once more moving north, the landscape changes to a savanna with sporadic stands of trees. *Brachystegia eurycoma* is a typical species found in riverine woods in the south. These primary zones can be separated further. All eight West African mangrove species can be found in the coastal swamp forest, which stretches many kilometers inland. Rhizophora racemosa predominates on the outside margin, *R. harrisonii* in the center, and R. mangle on the inner edge. 40 percent of fish captured at sea are thought to spawn in the mangrove swamps of the Niger Delta. The inland rainforest zone is about 270 km (170 mi) long, although it has a very diverse ecosystem. Rainfall decreases from west to east and from south to north. For instance, many Diospyros species, *Tabernaemontana pachysiphon, Octolobus angustatus, Strombosia pustulata, Drypetes gossweileri, Rothmania hispida, Hunteria unbellata, Rinorea dentata, Voacanga africana,* and *Anthonotha aubryanum* among the most prevalent trees in Omo Forest Reserve. The Guinean forest-savanna mosaic ecoregion, which comprises almost half of Nigeria, is characterized by scattered groupings of low trees surrounded by tall grasses and strips of gallery forest along the watercourses. The *Lophira lanceolata, Afzelia africana, Daniellia oliveri, Borassus aethiopum, Anogeissus leiocarpa, Vitellaria paradoxa, Ceratonia siliqua,* and species *of Isoberlinia* are typical trees that can withstand the seasonal dryness and frequent wildfires.

4.3.2 Faunal Diversity

Nigeria has a variety of biodiversity (plants and animals). There are over 22,000 species of vertebrate and invertebrate in Nigeria, and 0.14 percent of them are endangered or threatened. Various fauna species include:

1 Mammals

With its numerous ecosystems, Nigeria is home to a wide variety of animals. Animals that fall under this category include lions, leopards, mongooses, hyenas, side-striped jackals, African elephants, African buffaloes, African manatees, rhinoceroses, antelopes, waterbuck, giraffes, warthogs, red river hogs, hippopotamuses, pangolins, aardvarks, western tree hyraxes, bushbabies, monkey In addition to this, numerous whale and dolphin species pass through Nigerian seas.

2 Birds

Five of the approximately 940 bird species that have been identified in Nigeria are indigenous to the nation. Few bird species may be found in both forest and savanna, with each geographical region having its own distinctive bird species. Numerous types of heron and egret, African pygmy geese, comb-crested jacana, black-winged stilt, Egyptian plover, and black crake are

among the waterfowl that can be observed near the Oba Dam, located east of Ibadan. The adjacent rainforest is home to several species of Malimbus, a genus that is only found in West Africa, as well as the western square-tailed drongo and glossy-backed drongo, the African oriole and black-headed orioles, painted-snipe, several species of dove, Klaas' and Diederik cuckoos, as well as kingfishers, bee-eaters, rollers, and bushshrikes, including the fiery-breasted bushshrike. The hooded vulture, stone partridge, Guineafowl, black-billed wood dove, black cuckoo, blue-naped mousebird, and Abyssinian roller are a few of the birds that can be found in open savanna. The Ibadan malimbe, the Jos Plateau indigobird, the rock firefinch, and the Anambra waxbill are some of the birds native to Nigeria.

3 Reptiles

Snakes, turtles, lizards, and crocodilians make up the majority of the vertebrate group known as reptiles. The most distinctive feature of these creatures is their scaly, dry skin. The majority of reptiles, like the boa constrictor, are cold-blooded and lay eggs, but the majority of them also give birth to live offspring. Reptiles have lungs for breathing, not gills like fish or amphibians do.

4 Amphibians

Frogs, toads, salamanders, newts, and caecilians are examples of the group of cold-blooded vertebrates known as amphibians (wormlike animals with poorly developed eyes). All amphibians live a portion of their lives in the water and a portion on land, giving them the moniker "amphibian," which is derived from the Greek for "double life." These creatures are born with gills; some lose them as they mature, while others keep them throughout their entire lives.

The most endangered group of animals in nature are amphibians. Because of their porous eggs and semi-permeable skin, they are very vulnerable to environmental dangers. Amphibians are seriously at risk from all main threats, including illness, pollution, and climate change.

What are the factors militating the decline of species abundance, variety, and distribution?

Self Assessment Exercise 1

1. What is the composition of Wildlife in Nigeria?

2. What is biodiversity like in Nigeria?

4.4 ‘IUCN Red List

The 'IUCN Red List of Threatened Species' is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species. The IUCN Red List is mainly used to guide conservation activities of governments, NGOs and scientific institutions. The scientifically rigorous approach to determine risks of extinction that is applicable to all species, has become a world standard. The IUCN Species Programme collaborates with the IUCN Survival Commission (SSC) and with IUCN members to produce the IUCN Red List of Threatened Species. It also draws on and mobilizes a network of scientists and partner organizations operating in nearly every country in the world, who collectively possess what is likely the most comprehensive scientific knowledge base on the biology and conservation status of species.

There is a thorough examination of the IUCN Red List Categories and Criteria. The IUCN Council approved the updated Categories and Criteria (IUCN Red List Categories and Criteria version 3.1), which were implemented in 2001. The criteria and rules for using the IUCN Red List are reviewed on a regular basis. (the recent most review, Version 8.1; August 2010).

The goals of the IUCN Red List are to:

- Identify and document those species most in need of conservation attention if global extinction rates are to be reduced; and
- Provide a global index of the state of change of biodiversity.

To achieve these Goals, the IUCN Red List aims to:

- Establish a baseline from which to monitor the change in status of species;
- Provide a global context for the establishment of conservation priorities at the local level;
- Monitor, on a continuing basis, the status of a representative selection of species (as biodiversity indicators) that cover all the major ecosystems of the world.

4.4.1 Nature of the categories

There are nine clearly defined categories into which every taxon in the world (excluding micro-organisms) can be classified (Figure 1). Complete definitions of the categories are given in the Figure 2. Extinct and Extinct in the Wild are the first two categories, and they are both quite self-explanatory.

Extinct indicates that the last member of the species has definitely passed away. Extinct in the Wild denotes the extinction of a taxon in its native environment.

Red List Guidelines 8 assign the following three categories to species based on quantitative criteria that are intended to reflect varying levels of extinction threat: Critically Endangered, Endangered, and Vulnerable.

Taxa that do not currently meet the criteria for the threatened category but may soon do so are classified as Near Threatened. Taxa that do not meet the criteria for being threatened or almost threatened are classified as Least Concern. The threat status of taxa is not represented by the remaining two categories. The category Data Deficient identifies taxa for which there is insufficient data to reliably determine their status. It should be emphasized that while there may be a strong tendency to classify taxa as Evidence Deficient, assessors must fully utilize all available data when conducting a Red List assessment. Even though the criteria are extremely quantitative and stated, one might utilize predictions, assumptions, and inferences to classify a taxon in the right group because precise information on rare taxa is typically missing. Data Deficient is not a threat category, hence species put in this group are not as obvious targets for conservation action, although having potentially urgent requirements. Assessors should conduct evaluations based on all relevant and available information and only classify taxa as Data Deficient when there is truly no other option. Advice on how to handle ambiguity is particularly

pertinent when dealing with taxa that are less well-known. Taxa that have not yet been assessed based on the Red List Criteria fall under the category of Not Evaluated.
Taxa that are often presented on the Red List are referred to as "red-listed" and fall under all IUCN Red List Categories, with the exception of LC and NE. Although these species haven't been referred to as "red-listed," they are all included in the 2003 edition of the IUCN Red List of Threatened Species and all revisions that followed (available up until 2010). This is crucial, for instance, for taxa that were previously Red-listed but have now been down-listed.

4.4.2 Description of IUCN Red List Categories

Following is a brief description of IUCN Red List Categories:

1. Extinct (EX)

When there is no doubt that the last member of a taxon has passed away, the taxon is considered extinct. Extensive searches in known and/or anticipated habitat, during relevant seasons (diurnal, seasonal, annual), across the historic range of a taxon have failed to find an individual. Surveys should be conducted over a period of time consistent with the life cycles and life form of the taxon.

2. Extinct in the Wild (EW)

When a taxon is only known to have survived in captivity, in cultivation, or as a naturalized population (or populations) far from its former distribution, it is said to be extinct in the wild. A taxon is assumed to be extinct in the wild when thorough surveys across the entirety of its historical range at relevant times (diurnal, seasonal, annual), in known and/or expected habitat, have failed to record an individual. Surveys should be conducted over a period of time consistent with the life cycle and life form of the taxon.

3. Critically Endangered (CR)

When the strongest evidence suggests that a taxon satisfies any of the criteria A through E for Critically Endangered, that taxon is deemed to be facing an extremely high risk of extinction in the wild.

4. Threatened (EN)

When a taxon satisfies any of the Endangered species criteria A through E, according to the best available evidence, it is deemed to be in danger of going extinct in the wild.

5. Susceptible (VU)

When the strongest evidence suggests that a taxon satisfies any of the criteria for vulnerability (A to E), it is deemed to be vulnerable because there is a substantial chance that it will go extinct in the wild.

6. Near Threatened (NT)

When a taxon has been assessed against the criteria and does not yet fall within the categories of Critically Endangered, Endangered, or Vulnerable but is on the verge of doing so or is likely to do so in the near future, it is considered to be Near Threatened.

7. Minimal Concern (LC)

When a taxon has been assessed against the criteria and does not meet the criteria for Critically Endangered, Endangered, Vulnerable, or Near Threatened, it is considered to be of Least Concern. This category includes taxa that are widespread and numerous.

8. **Data Deficient (DD)**

When there is insufficient data to provide a direct or indirect evaluation of a taxon's danger of extinction based on its range and/or population status, the taxon is considered data deficient. The

biology of a taxon in this category may have been extensively examined, but there may not be sufficient information on its abundance and/or distribution. Therefore, "Data Deficient" is not a threat category. Taxa included in this category acknowledge the need for more research and the likelihood that further analysis will support the designation of these species as threatened. Making good use of the facts that are available is crucial. In many situations, selecting between DD and a threatened status requires tremendous caution. Threatened classification may be warranted if a taxon's range is thought to be somewhat constrained and if a sizable amount of time has passed since the taxon was last recorded.

9. Not Assessed (NE): When a taxon has not yet been evaluated against the criteria, it is not assessed.

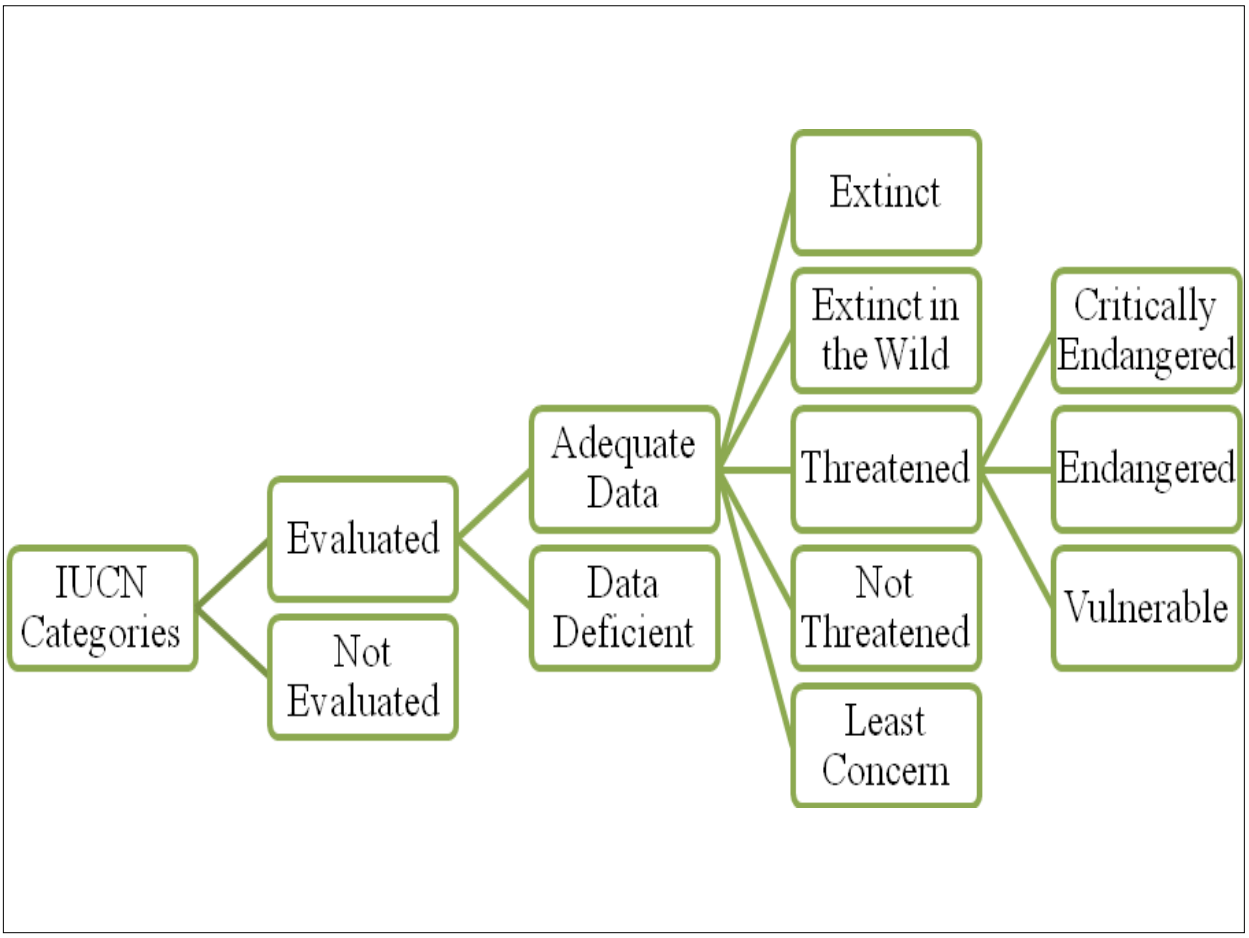

Figure 1. Description of IUCN Red List Categories
Source: IUCN Standards and Petitions Subcommittee

What is the role of IUCN Red List?

Self Assessment Exercise 2

1. What is the role of IUCN REd List
2. What are the goals of the IUCN Red List?

4.5 Red List Guidelines

A list of the five factors (A–E) that determine whether a taxon falls under the category of vulnerable species (Critically Endangered, Endangered or Vulnerable). Multilateral Environmental Agreements make choices based on information from the IUCN Red List. It is frequently used as a guide to update the annexes of certain significant international accords, including the Convention on Migratory Species and the Convention on International Trade in Endangered Species (CITES) (CMS).

Use any of the criteria A-E	**Critically Endangered**	**Endangered**	**Vulnerable**
A. Population reduction	Declines measured over the longer of 10 years or 3 generations		
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%
A1. Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible AND understood AND have ceased, based on and specifying any of the following: (a) direct observation (b) an index of abundance appropriate to the taxon (c) a decline in area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality (d) actual or potential levels of exploitation			

(e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.			
A2. Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible, based on (a) to (e) under A1.			
A3. Population reduction projected or suspected to be met in the future (up to a maximum of 100 years) based on (b) to (e) under A1.			
A4. An observed, estimated, inferred, projected or suspected population reduction (up to a maximum of 100 years) where the time period must include both the past and the future, and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible, based on (a) to (e) under A1.			
B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)			
B1. Extent of occurrence (EOO)	< 100 km	< 5,000 km²	< 20,000 km²
B2. Area of occupancy (AOO)	< 10 km	< 500 km²	< 2,000 km²
AND at least 2 of the following:			
(a) Severely fragmented, OR			
Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals.			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			
C. Small population size and decline			
Number of mature individuals	< 250	< 2,500	< 10,000
AND either C1 or C2:			
C1. An estimated continuing decline of at least	25% in 3 years or 1 generation	20% in 5 years or 2 generations	10% in 10 years or 3 generations
(up to a max. of 100 years in future)			

C2. A continuing decline AND (a) and/or (b):			
(a i) Number of mature individuals in each subpopulation: < 50 < 250 < 1,000 or	< 50	< 250	< 1,000
(a ii) % individuals in one subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals.			
D. Very small or restricted population Either:			
Number of mature individuals	< 50	< 250	D1. < 1,000 AND/OR
VU D2. Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.			D2. typically: AOO<20 km² or number of locations ≤ 5
E. Quantitative Analysis			
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations (100 years max.)	≥ 20% in 20 years or 5 generations (100 years max.)	≥ 10% in 100 years

Figure 2. Guidelines for Using the IUCN Red List Categories and Criteria. Version 8.1. Prepared by the Standards and Petitions Subcommittee in March 2010.
Source: IUCN Standards and Petitions Subcommittee. 2010.

What does CITES stands for**?**

Self Assessment Exercise 3

1. What is the Red List criteria?
2. What are two uses for Red List data?

4.6 Summary

You have learnt about the conservation of wildlife in Nigeria, IUCN Red data list, its categories and guidelines of usage in this unit.

4.7 References/Further Readings/Web Sources

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4.8 Possible Answers to Self-Assessment Exercise(s) within the content

Answers to SAE 1

1. The **wildlife of Nigeria** consists of the flora and fauna of this country in West Africa. Nigeria has a wide variety of different habitats, ranging from mangrove swamps and tropical rainforest to savanna with scattered clumps of trees. About 290 species of mammal and 940 species of bird have been recorded in the country.

2.Nigeria is endowed with several biodiversity (plants and animals). Nigeria has about 22,000 vertebrate and invertebrate species, and of these, **about 0.14% is threatened and 0.22% is endangered**.

Answers to SAE 2

1. The 'IUCN Red List of Threatened Species' is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species.

2. The goals of the IUCN Red List are to:

- Identify and document those species most in need of conservation attention if global extinction rates are to be reduced; and
- Provide a global index of the state of change of biodiversity.

Answers to **SAE 3**

1. Species are classified by the IUCN Red List into nine groups, specified through criteria such as **rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation**.

2. The IUCN Red List is used **to inform decisions taken by Multilateral Environmental Agreements**. It is often used as a guide to revise the annexes of some important international agreements, such as the Convention on International Trade in Endangered Species (CITES) and the Convention on Migratory Species (CMS).

Unit 5: International and National laws related to wildlife resources

Unit Structure

5.1 Introduction

In this unit the knowledge of international and national laws and its suitability (and advantages) as a regulatory tool, its limitations for that purpose, as well as the factors that determine or affect the effectiveness of laws (determinants) will be discussed. It has also discussed the role that law can play in conservation and management of wildlife; and even identified the attributes of an ideal wildlife management law.

5.2 Intended Learning Outcomes (ILOs)

By the end of this unit you should be able to:

- Appreciate the knowledge of international and national laws and its suitability (and advantages) as a regulatory tool,
- Understand the limitations of international and national laws
- Describe the role law can play in conservation and management of wildlife; and
- Identify the attributes of an ideal wildlife management law.

5.3 Principal International Agreements

Numerous international accords that have been adopted at the global and regional levels deal with wildlife or may do so in the future. The major international accords are briefly summarized in this part because they have greatly influenced the creation of national legislation.

1. The first is the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). CITES, one of the most important agreements, was ratified in Washington in 1973. The Convention protects endangered species by restricting and regulating their international trade through export permit systems based on species status as follows:

- For species threatened with extinction which are or may be affected by trade, export permits may be granted only in exceptional circumstances and subject to strict requirements; the importation of these species also requires a permit, while trade for primarily commercial purposes is not allowed.
- For species which may become endangered if their trade is not subject to strict regulation, export permits (including for commercial trade) can only be granted if export is not detrimental to the survival of that species and if other requirements are met.
- For species subject to national regulation and needing international cooperation for trade control, export permits may be granted for specimens not obtained illegally.
- Additions and deletions of species from the specified lists are made by the Conference of Parties, according to established criteria.

In 1994, the Conference adopted new criteria, repealing those long in force. The new criteria encompass general principles such as the precautionary principle, and detailed biological and other requirements.

The Convention requires states to adopt legislation that penalizes trade in and possession of covered species, and to provide for the confiscation or return to the state of illegal exports. In the last decade, the Conference of Parties has adopted several resolutions on enforcement and compliance, such as

- Resolution 9.9 (1994), recommending confiscation of specimens exported illegally;
- Resolution 9.10 (Rev.) (1994), on disposal of confiscated specimens or parts or derivatives thereof; and
- Resolution 11.3 (2000), recommending greater co-ordination between competent authorities, and outlining measures to promote enforcement, such as creating appropriate incentives for local and rural communities.
- The Conference has also adopted resolutions on trade in specified species, and on ranching and breeding of protected species.

2. **Convention on the Conservation of Migratory Species of Wild Animals** . Another significant international agreement is the **Convention on the Conservation of Migratory Species of Wild Animals**, adopted at Bonn in 1979, which requires cooperation among "range" States hosts to migratory species regularly crossing international boundaries. With regard to species considered as endangered, states must do the following:

- conserve and restore their habitats;
- prevent, remove or minimize impediments to their migration;
- prevent, reduce and control factors endangering them; and
- prohibit their taking.

With regard to other species which have an unfavourable conservation status, range states undertake to conclude agreements to maintain or restore concerned species in a favourable conservation status. One post-Rio agreement adopted under the Convention is the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (1995).

3. Convention is the Agreement on the Conservation of African-Eurasian Migratory Waterbirds. This provides for concerted actions to be taken by the Range States (117 countries, from the northern reaches of Canada and the Russian Federation to the southernmost tip of Africa) throughout the migration systems of the 172 species of water birds to which it applies.

A "Strategy for the Future Development of the Convention" was adopted by the Conference of Parties in 1997, prioritizing objectives for the triennium 1998-2000. In 1999, the Conference adopted the Strategic Plan for 2000-2005, with the following objectives:

- prioritizing conservation actions for migratory species (*inter alia* by integrating consideration for migratory species in government policies, by mitigating obstacles to migration, and by
- identifying priority species for the conclusion of agreements under the Convention;
- promoting accession of targeted countries to the Convention; and
- facilitating and improving implementation of the Convention, by mobilizing financial resources, rationalizing institutional arrangements and strengthening linkages with other international biodiversity-related arrangements.

4. Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar).

While CITES and the Bonn Convention are species-based treaties, the protection of specific habitats important for wildlife is also achieved through area-based treaties, such as the Ramsar and the Convention Concerning the Protection of the World Cultural and Natural Heritage. Parties to the **Ramsar Convention** must designate wetlands in their territory for inclusion in a List of Wetlands of International Importance, and promote their conservation and wise use, for example by establishing nature reserves. "Criteria for Identifying Wetlands of International Importance" were adopted at the 4th, 6th and 7th meetings of the Conference of the Contracting Parties in 1990, 1996 and 1999, respectively. A Strategic Plan 1997-2002 was adopted by the 1996 Conference of Parties, emphasizing the need to integrate wetland protection with sustainable development (considered as synonymous with "wise use"), to promote participation of local communities and involvement of the private sector and to mobilize resources at the international level.

5. Convention Concerning the Protection of the World Cultural and Natural Heritage

The **World Heritage Convention** provides for the identification and conservation of sites of outstanding universal value from a natural or cultural point of view, to be included in the World Heritage List. While responsibility for conservation is primarily vested in the state where the site is located, the Convention also provides for international assistance funded by the World Heritage Fund. At the time of writing, 721 properties were listed, including 144 natural and 23 mixed (cultural and natural).

6. **Convention on Biological Diversity**

More recently, concern for the protection of biodiversity as a whole has grown due to an increased understanding of how species and all other living things interact with one another and with human activities. This development is reflected in the Convention on Biological Diversity, which was adopted in Rio de Janeiro in 1992 and is gradually being incorporated into national legislation. According to the Convention, in order to achieve biodiversity conservation and sustainable use, particular methods must be adopted, as well as any relevant concerns must be incorporated into any plans, programs, and policies (art. 6). In making national decisions, the sustainable utilization of biodiversity must be taken into account (art. 10). Restoration of vulnerable species and, specifically, the enactment of legislation for the protection of endangered species, are among the responsibilities for parties (art. 8). Parties must also control, regulate, and manage any sources that could have a negative impact on biodiversity (Article 7). Projects that are anticipated to have "substantial unfavorable consequences" on biological diversity must undergo environmental impact studies (art. 14).

Two new principles in international environmental law have been developed by the Bonn Convention and the Biodiversity Convention. One is the idea of "conservation status," since it has become increasingly necessary under international law that species or populations be kept in a favorable state for conservation. The EC Habitats Directive, for instance, makes use of the same idea. A variety of "obligations de moyen" are required to manage and resist potentially detrimental actions in order to accomplish the goal of a favorable conservation status. The phrase "potentially hazardous procedure" is another novel idea. The Biodiversity Convention's provisions, which demand limiting the causes of negative effects and conducting environmental impact studies, reflect this (arts. 7 and 14). Thus, the focus has shifted from the management of species to the control of processes that may endanger them.

When was "Criteria for identifying wetlands of international importance" adopted?

Self Assessment Exercise 1

1. Outline the objectives of Strategic Plan for 2000-2005, of the "Strategy for the Future Development of the Convention" of the Agreement on the Conservation of African-Eurasian Migratory Waterbirds.

2. What was the theme of the Convention Concerning the Protection of the World Cultural and Natural Heritage?

5.4 **Law as a tool in Protecting Wildlife Species**

The protection of wildlife species and their habitats is a necessary component of any ideal wildlife management law. When it comes to protecting wildlife species, such provisions will cover management of conservation and preservation efforts as well as the defense of species against harm, particularly that caused by negative human behavior and activities. While conservation refers to smart use, preservation is a "hands off" strategy that signifies "no use" (for the aim of protecting against harm).

Thirdly, it should include clauses that prevent human activity and enterprise from encroaching on wildlife habitats and territories. In certain cases, the legal protection may be explicit because the law specifically protects such species, but in other cases, the legal protection may be implicit, implied, or incidental, such as when this protection serves a secondary purpose. He uses the example of other legal frameworks, such as protected area legislation, that, while not particularly designed to safeguard individual species, yet offer protection to their habitats and help to preserve wild species.

1.Provisions Protecting Wildlife Species

A law for managing wildlife should include protections to safeguard wildlife species. The species to which preservation (preservation management) may be applied and those that must only be conserved must be specified, as was already indicated above (to which conservation management is to be employed). The main goal of conservation law is to protect wild species and ecosystems, whereas general law regulates interactions between people or between people and society. There are two main strategies for managing wildlife, namely conservation and preservation. While preservation entails non-use and primarily applies to non-renewable resources as well as renewable resources that fall into one of three special categories or statuses of species, namely: endangered species, vulnerable species, and rare species, conservation

primarily applies to renewable resources and allows for wise use in such a way that the resource is exploited in a way that ensures such exploitation does not exceed the regeneration capacity. According to the International Union for the Conservation of Nature (IUCN), "endangered species" are those that are in danger of going extinct and whose survival is improbable if the underlying causes persist; "vulnerable species" are those that, while not yet classified as "endangered species," are moving in that direction and are likely to do so; and "rare species" are those with small populations that are neither endangered nor vulnerable but may become so in the future. Therefore, "vulnerable species" and "rare species" need particular consideration or special protection, exactly like those in the "endangered species" category. This is due to the fact that "rare species" typically have small populations that are concentrated within well defined geographic boundaries or dispersed across a rather wide range. "Vulnerable species" are those that are edging closer to the "endangered species" category over time due to risk factors like immaturity, pregnancy, breastfeeding, albinism, or melanism. If the underlying causes remain in place, the species in this group are expected to become critically endangered soon. These elements include widespread habitat loss and overuse of resources. The "endangered species" category, in contrast to the other two, refers to a legal status established for a certain species by a government or the international community. such that a species can only be formally designated after being so declared. However, because they are rare, endangered, or typical of their biomes, the species falling into these three categories need further protection. Their protection is therefore very useful in wildlife management.

2. Provisions Protecting Wildlife from Harm

The law also encourages the conservation of wildlife by preventing it from being harmed, particularly by humans. Therefore, rules that aim to save animals from harm should be included in a perfect wildlife management law. This provisioning is accomplished by establishing policies that explicitly or generally safeguard wildlife from human intervention or harm. Additionally, it will take the shape of provisions that expressly forbid humans from causing direct physical harm to wildlife through engineering or other means. For example, they might forbid harming or torturing wild animals, attacking them, or otherwise disturbing them. The creation of certain categories of wild animals, restrictions on their killing, injuring, hunting, and capturing, and rules governing the admission of firearms into wildlife protected areas are the three main ways that this protection is typically provided. Additionally, it occasionally grants special protection to certain creatures because they are in danger, rare, or endangered. When separating the preserv already been identifi wildlife?

Self As

1. What is the key object of conservation laws as against general laws which target humans?

2. Even though an ideal wildlife management law should have provisions

5.5 **Law as a tool in Protecting Wildlife Habitats and other matters**

1. Provisions Protecting Wildlife Habitats

Wildlife habitats should be protected by laws governing wildlife management, notably against human interference and actions. Undoubtedly, protecting wildlife territory is one method of protecting wildlife. For instance, this is accomplished by designating wildlife protected areas (WPAs) and establishing regulations that limit human access and activity there. Almost every jurisdiction in the world has established wildlife protected areas through legal means. These consist of wildlife management areas, national parks, national reserves, and game sanctuaries (WMAs). In the context of this essay, a WPA is a geographically defined area set aside for the conservation of wildlife, inside the bounds of which the law restricts human access and activities. These WPAs are legally protected by law, and without the consent of the appropriate state or governmental authority, their limits cannot be changed. In many nations, the protected area system is the main strategy for managing wildlife. It establishes rules that limit access to and activity by humans in some wildlife habitats that are designated as protected areas (PAs). Settlement, cultivation, hunting, grazing, mining, honey prospecting, fishing, and traffic are prohibited in these protected areas. Carrying weapons and explosives, setting traps or poison, possessing game animals or their parts, introducing domestic animals, destroying vegetation, destroying infrastructure, such as water installations and fences, erecting buildings or infrastructure, passing through such areas, and starting fires are all prohibited behaviors in such areas. When it comes to safeguarding wildlife habitats, the focus should be on conflict avoidance rather than methods for dealing with it after it has already happened. Therefore, a perfect wildlife management law should include clauses against human interference with wildlife habitats. Such regulations may, for example, limit access to such places by requiring a permission from the relevant wildlife authority; provide for the fencing, demarcation, and even titling of wildlife areas; or restrict specific activities, like farming and human habitation, in such areas.

2. Law as Provisions Regulating the Allocation and Use of Wildlife and Wildlife Resources

By allocating access and user rights and regulating their exploitation for sustainable development, wildlife conservation law seeks to ensure the sustainable and rational use of wildlife and wildlife resources. Therefore, the purpose of this law is to establish a framework for allocating wildlife and wildlife resources and to control how they are used and managed. Therefore, a perfect wildlife law should include clauses that are designed to control how wildlife and wildlife resources are allocated and used. These contain clauses governing usage rights and access, as well as those establishing utilization quotas.

3. Law as Provisions Establishing Wildlife Agencies and Spelling out their Responsibilities

The approach of conservation law, on the other hand, primarily creates institutions and procedures designed to facilitate and encourage conservation and management programmes, to organize conservation as a public service, and to promote better public awareness of conservation requirements. This is in contrast to other branches of law that adopt the traditional regulatory and punitive approach based on the police power of the state. In fact, wildlife conservation legislation differs from ordinary law in that it is mostly administrative in nature and provides institutions with the responsibility for managing and conserving wildlife and wildlife resources. Although this law is primarily administrative in nature, it also establishes wildlife offenses and imposes fines for violations. Therefore, a perfect wildlife law would establish

entities responsible for managing and conserving wildlife and specify the roles and duties of these authorities.

4. Law as Provisions Prescribing Measures for Mitigating the Negative Costs of Wildlife

Controlling the negative costs of wildlife, particularly in terms of limited resources like land and losses from harmed species, is another way the law supports wildlife conservation. The law handles them through land planning and by upholding the legal framework surrounding animal trespass. The latter is accomplished primarily by eradicating pest wildlife, allowing for wildlife to be destroyed to protect human life and property, and compensating for harm caused by wildlife. Regarding the latter, the law may establish institutions and procedures for taking reports and handling claims resulting from incidences of animal damage. It may also offer compensation for such harm. Therefore, an ideal wildlife management law should include rules that specify actions to be taken to reduce the negative consequences of wildlife, such as competition for resources and predation and depredation.

5. It Should Have Provisions Setting Up Mechanisms for Settling Wildlife-Related Disputes

Given the existence of diverse and frequently at odds interests and interest groups, an ideal wildlife management law should include provisions establishing methods for resolving wildlife-related disputes. The resolution of disputes is one of the social tasks of law; as a result, the establishment of structures and procedures for the resolution of disputes relating to wildlife should play a significant role in wildlife conservation law. The function of law, according to prominent legal scholar Roscoe Pound, is social engineering because it seeks to reconcile competing societal interests so that they can coexist with the least amount of friction and waste possible. Notably, the success of such a law is significantly influenced by the efficiency of the systems in place for the settlement of wildlife-related disputes. However, it should be emphasized that there are various interest groups with varying and occasionally competing group interests with respect to wildlife protection. Because of this, disagreements over wildlife will always persist as long as these opposing interests exist side by side. These disagreements frequently occur between individuals as well as between individuals and wildlife officials. The law makes sure that these conflicting interests may coexist with the least amount of friction by preserving dispute resolution procedures.

A local community (small-scale farmers and pastoralists), local wildlife conservation officials (game wardens and rangers), the state (the executive branch and various government agencies), and international wildlife conservation players are the four main interest groups that are highlighted. These interests frequently have an influence on people's attitudes about conservation. Regarding wildlife conservation, there are significant differences between the interests of local peasants, local politicians, wildlife officers, international wildlife agencies and donors, policy-makers, wildlife authorities, and conservationists. The opinions and attitudes of different interest groups regarding wildlife vary noticeably. These various viewpoints and attitudes are what this study refers to as group interests. They could be referred to as "class interests," and the author warns that "the odds of adopting a sustainable policy of wildlife conservation are not high" unless these interests are harmonized. The government's and environmentalists' interests interact with local communities in ways that are frequently adversarial and at odds with one another. For effective wildlife management, it is necessary to strike a balance between these conflicting group interests, which can be done, among other things, by maintaining appropriate and effective mechanisms for resolving wildlife-related disputes. Conflict and antagonism typically undermine conservation efforts.

6. It Should have Provisions on Participation by Local Communities

A perfect wildlife management law would involve the local communities that live adjacent to wildlife areas in managing the wildlife as well as sharing in the advantages and income generated by the species. It should include clauses allowing local communities to take part in managing wildlife as well as sharing in the advantages and income generated by managing wildlife and wildlife resources. Regarding income sharing, the law should establish such participation, develop a formula for sharing, and specify how the community's share will be reached, specifically with regard to whether payments should be made to organized bodies like community associations or to specific community members. According to commentators, the significance of transferring wildlife to the state and centralizing wildlife management is that people and communities who had previously used wildlife resources for their own purposes were no longer able to do so legally. The enormous logistical burden this places on government and public institutions for managing wildlife will inevitably lead to local populations' lack of concern for the welfare and conservation of wildlife, and possibly even to hostility between these populations and the public authorities charged with overseeing the wildlife sector.
Why does the law that protect wildlife needs local community participation?

Self As

1. What is the provisions of an ideal wildlife management law on Participation by Local Communities?

2. What are the Provisions Setting Up Mechanisms for Settling Wildlife-Related Disputes?

5.6 Summary

You must have learnt that wildlife ownership and use for establishing wildlife agencies and spelling out their respective duties; for protecting wildlife from harm, especially that arising from human conduct and activities; for protecting wildlife habitats from encroachment by humans; and for mitigating the negative costs of wildlife such as competition for resources as well as wildlife predation and depredation. You have also learnt that while law has some advantages that make it suitable for that purpose, it also has certain limitations. There are also several factors that determine or affect the effectiveness of laws (determinants)—mainly institutional ones. In that

even with properly formulated laws, for law to be effective and play its intended role, there is need for those factors (determinants) to be addressed.

5.7 References/Further Readings/Web Sources

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5.8 Possible Answers to Self-Assessment Exercises

Answer to SAE 1

1. The "Strategy for the Future Development of the Convention" the following objectives:

- prioritizing conservation actions for migratory species (*inter alia* by integrating consideration for migratory species in government policies, by mitigating obstacles to migration, and by
- identifying priority species for the conclusion of agreements under the Convention;
- promoting accession of targeted countries to the Convention; and
- facilitating and improving implementation of the Convention, by mobilizing financial resources, rationalizing institutional arrangements and strengthening linkages with other international biodiversity-related arrangements.

2. The **World Heritage Convention** provides for the identification and conservation of sites of outstanding universal value from a natural or cultural point of view, to be included in the World Heritage List.

Answer to SAE 2

1. While general law governs relationships between persons or between persons and society, the key object of conservation law is to conserve wild species and ecosystems.
2. There is need for provisions specifying the species to which preservation (preservation management) may be applied, and those that need to be to be merely conserved (to which conservation management is to be employed).

Answer to SAE 3

1. An ideal wildlife management law should allow local communities living close to wildlife areas to participate in the management of wildlife, and also in the sharing of benefits and revenue accruing from this wildlife.
2. The law ensures that the divergent interests co-exist with minimum friction, and allowed for the establishment of dispute resolution committee with the membership of the four major interest groups, namely, (a) Local communities (small scale cultivators and pastoralists); (b) Local wildlife conservation officials (game rangers and wardens); (c) State (both the executive branch and different government departments); and (d) International wildlife conservation actors.

Glossary

art.	Article
CBD	Convention on Biological Diversity

CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species
COP	Congress of Parties
CR	Critically Endangered
DD	Data Deficient
DDT	Dichlorodiphenyltrichloroethane
DPR	Department of Petroleum Resources
EC	European Community
EGASPIN	Environmental Guidelines and Standards for the Petroleum Industry in Nigeria
EIA	Environmental Impact Assessment
EN	Threatened
EW	Extinct in the Wild
EX	Extinct
FAO	Food and Agriculture Organization
FE	Future Earth
G20	Group of Twenty
G8	Group of Eight
GEO BON	Group On Earth Observations Biodiversity Observation Network
IPBES	Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
JUSCANNZ	Japan, United States, Switzerland, Canada, Australia, Norway, New Zealand
Km	Kilometre
LC	Minimal Concern
MDGs	Millennium Development Goals
MEP	Multidisciplinary Expert Panel
NCF	Nigerian Conservation Foundation
NE	Not Assessed
NESREA	The National Environmental Standards Regulation Agency
Non-OECD	Non Members of **Organization for Economic Cooperation and Development**
NT	Near Threatened
OECD	**Organization for Economic Cooperation and Development**
PAs	Protected areas
Ramsar	Convention on Wetlands of International Importance
RC	Ramsar Convention
SDGs	Sustainable Development Goals
UK	United Kingdom
UN	United Nation
UNCCD	United Nations Convention to Combat Desertification

UNCED	United Nations Conference on Environment and Development, UNCED
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nation Education Scientific Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USA	United State of America
VU	Susceptible
WHC	Convention Concerning the Protection of the World Cultural and Natural Heritage
WHC	World Heritage Convention.
WMAs	Wildlife management areas
WPAs	Wildlife protected areas

End of Module Questions

1. Discuss the relevance of law in the provisions of protecting wildlife habitats
2. Discuss the relevance of law in the provisions of protecting wildlife species
3. What are the threats of conservation?
4. What is a conservation status for animals?
5. What are the different conservation status?
6. What activity is regulated under the Cites agreement?

Module 3: Techniques of Wildlife Management

Module Structure

In this module we will discuss about the techniques of wildlife investigation with the following units:
Unit 1: Study design for wildlife studies
Unit 2: Designing Field Studies
Unit 3: Strategies for field wildlife data collection
Unit 4: Wildlife Control Methods
Unit 5: Biological Garden

Unit 1: Study design for wildlife studies

Unit structure

1.1 Introduction

You will learn the differentiate investigative methods for wildlife studies in this unit. You will also learn how to organized a good study design for wildlife animals and understand some sampling techniques in wildlife ecology

1.2 Intended Learning Objectives

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

- Describe the study design for wildlife studies
- Understand the sampling terminologies
- Explain the Sampling units, types of sampling units and sampling validity
- Describe the meaning of sampling frames and methods in wildlife studies

- Differentiate between probability sampling and non-probability sampling

1.3 Study Design in Wildlife Studies

According to the context, study design refers to the quantity and spatiotemporal distribution of appropriately defined sampling units (also known as experimental and observational units) as well as the specific manipulations (i.e., treatments) and/or observations to be made on each unit in order to address a particular research question. The goal of study design is generally to provide the most efficient (in terms of cost) and precise estimates of parameters of the population (suitably defined) given the real-world practical and logistical constraints confronting the study. There are many important factors to consider in achieving this goal. Why do we need to sample? Have you ever taken part in a **census**, such as a national human population census, or a livestock census? A census involves collecting data from every single unit (such as a human, animal, farm) in the population. A real census requires a lot of resources to be conducted. What happens if we want to know how frequently Escherichia coli isolated from farmed hens exhibits resistance to third-generation cephalosporins? Is it required to gather information about each and every chicken in a nation in order to provide a response? Most of the time, it is not feasible to carry out a census, especially when we need to gather samples from each and every person or animal in the community, such as blood, urine, or feces. Fortunately, conducting a census is not necessary for the bulk of study or surveillance. Instead, we can choose a representative sample of participants from the general community. We can draw conclusions about a bigger group thanks to sampling. But there are several steps we must take to guarantee that our sample is representative (exactly reflects the characteristics) of the larger population that we are interested in; we cannot simply choose any animals we happen to find and expect that this "sample" allows us to draw inferences (apply the findings to the entire population). Going through these steps is the focus of this unit.

1.3.1 Sampling terminology

How can we determine what constitutes an ‘appropriate’ sample? It is helpful to introduce some terminology as we go through the steps in selecting a sample.

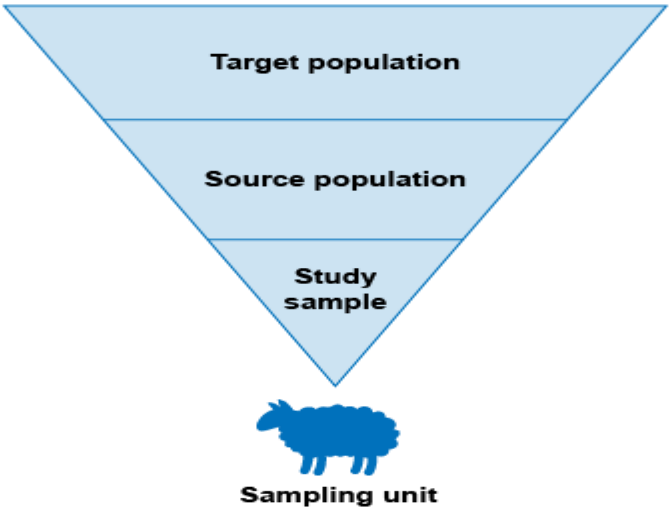

Figure 1 From populations to samples.

First, we need to identify the population in which we are interested – this is known as the ‘target (reference) population’. Then we need to identify how we can choose a sample that is representative of the target population.

1.3.2 Sampling units

The population members from whose measurements are taken during sampling are known as sample units. Sample units are separate, non-overlapping things like quadrats or transects, single plants, individual branches, etc. Sample accuracy and sample precision are significantly influenced by the characteristics of the sample unit (and therefore sampling costs). Additionally, sample unit dimensions can be changed to encourage a normal distribution in the data obtained, enabling the use of standard analysis of variance models for statistical analysis. It is important and not as simple as it may seem to select the appropriate sampling unit to correspond with the research issue. What is a sampling unit in ecology? State the goal of a study design.

Self-Assessment Exercises 1

1. What is sampling unit in ecology?

2. What is a study design?

1.4 Types of Sample Units

The form of the sample unit must be decided during the planning stages for the inventory or monitoring program because the goals of these efforts will require a particular sample unit. The general goal of inventory or monitoring programs is to describe attributes of the vegetation at a site. Therefore, sample units are usually one of the following types of delineated small-scale area within the general area of interest: Quadrat; Nested Quadrats; Transect and Plotless. The following aspects of sample units are also important to consider:

i. Sample Unit Size: Depending on the feature being described, the size of the plants present, and the scale of spatial patterns within the vegetation, the ideal sample unit size for rangeland sampling will vary. Sometimes convention or prior habits affect the size used in a rangeland inventory or monitoring program. In reality, it's crucial to keep making measurements using the same-sized sample units. Because sample unit size plays such a crucial role in defining sample accuracy and precision, it must be carefully taken into account during the planning stages.

ii. Sample Unit Shape: The typical shapes of the sample units used to sample vegetative properties are round, square, or rectangular. Using sample units of the same shape for every subsequent or comparative measurements is crucial in a monitoring program. Even though it is a

characteristic that has the potential to dramatically affect sample accuracy and sample precision, the form that is chosen for a study is occasionally dictated by convention or previous practices.
By regulating the possibility of bias associated with boundary decisions, sample unit shape affects sample accuracy. How can we influence sampling precision?

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1.4.1 Sampling and validity

Why are these sampling parameters needed to be identified and described? Here, we must consider the "validity" of sampling, or how accurately a measurement captures the actual condition. You may remember that the terms internal validity and external validity analyze if the study's findings can be applied to different contexts and whether its design, execution, and analysis provide unbiased answers to the research questions, respectively. The relationship between the study sample and the target population is used to define these notions. The same epidemiological concepts that apply to sampling in human populations also apply to sampling in animal populations. Similar definitions are required for the target population, the source population, the study sample, and the sampling unit in human health. Individuals are the most prevalent lowest-level sampling unit in human health. Because all the animals in a herd are in the same physical location and are exposed to the same risk factors, choosing a flock, herd, or other group as the lowest-level sampling unit in animal health is considerably more prevalent than it is in human health. The lowest level sample unit for well-established wildlife sampling techniques is farms or slaughterhouses.

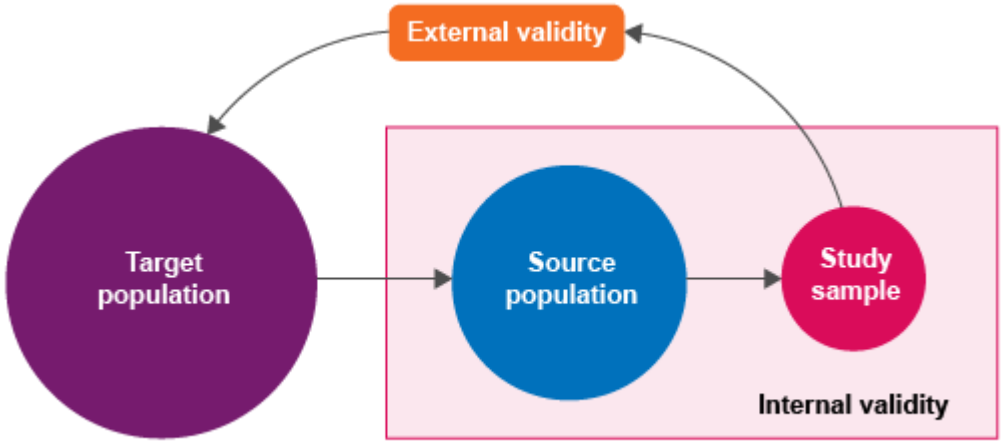

Figure 2 External and internal validity.
Source:

1.4.2 Sampling frames

We now understand that before we can sample from a population, we must first determine who will be in the source (research) population and who will be the target population. Next, we choose the study sample. But how can we tell which sampling points are drawn from the source population? A sample frame is required.
A list of all the chicken farms in the province(s) chosen as the source population could serve as a sampling frame, for instance. A sample frame in human health might include a list of every hospital in a region, together with a list of every patient receiving care there during a specific time period (either as an inpatient or an outpatient, depending on the topic of interest). You should be aware that because sampling frames contain identifying information about farmers,

such as their names and farm addresses, extra care must be taken to ensure that this data is stored securely and that only authorized members of the research team or surveillance program have access to it. Sampling frames are vulnerable to the same dangers of bias and error as all other wildlife-related data collecting and analysis since they are a data-collection process. The majority of the time, the source population's actual size does not exactly match the sampling frames that are available: for example, a sampling frame for wildlife surveillance in poultry might consist of a list of registered poultry slaughterhouses. However, not all slaughterhouses might be registered – the list might be out of date, or only record slaughterhouses of a minimum processing capacity. Further, not all poultry are processed through slaughterhouses: some are slaughtered at the point of sale in live animal markets, or in backyards for home consumption. In general, a sampling frame should include facilities (such as slaughterhouses or farms) that account for at least 80% of the target population. What is the goal of an inventory program?

Self-Ass

1. Differentiate between Internal and External validity
2. What are the commonest sampling units in species inventory?

1.5 Sampling methods

Once we have a sampling frame, or a suitable substitute, we need procedures to choose the sampling units themselves. There are several types, and various academic publications give lists of sampling techniques that vary somewhat. The general opinion is that probability and non-probability methods are the two classes into which all sampling techniques fall. The choice between using a probability or a non-probability approach to sampling depends on a variety of factors:

1. Objectives and scope of the study
2. Method of data collection
3. Precision of the results
4. Availability of a sampling frame and resources required to maintain the frame
5. Availability of extra information about the members of the population

1.5.1 Probability sampling

Every sampling unit within the population has the same (or known) probability of being chosen in probability sampling methods. They enable representative sampling (so that findings may be extrapolated to the target population) and reduce bias. Probability sampling methods include the following:

- **Simple random sampling:** Where a sampling frame is available and is used to randomly generate a list of units to be sampled. This can be done manually (such as 'pulling numbers out of a hat') or using a random number generator to compile a list of sampling units.
- **Systematic random sampling:** And each nth unit is chosen because each unit displays (or appears). This might include picking every tenth fish that swims through a race, for instance. In terms of public health, this would entail choosing each fifth patient who arrives at a primary healthcare institution that is part of the sampling frame. Random selection should be used to choose the sample interval (what value n takes) and starting point (whether systematic sampling begins with the first, second, third, or nth unit).

There are important extensions to simple random sampling or systematic random sampling, to allow for probability sampling of primary, secondary and tertiary sampling units, as required. This includes the following:

- **Multistage sampling:** A random sample of primary units is selected, followed by a random sample of secondary units (and then tertiary, and so forth). For example, randomly selecting regions and then randomly selecting farms and then randomly selecting animals from each farm.
- **Stratified random sampling:** The source population is divided into mutually exclusive strata based on factors that may affect the outcome, such as geographic region. A known number of units are then randomly selected from each stratum.
- **Cluster sampling:** This is similar to multistage sampling, except that all sampling units are sampled in the final stage. That is, the farms are randomly selected, and then all animals on those farms are sampled.

These different sampling methods can be combined. For example, stratified sampling can be included within a multistage sampling design.

1.5.2 Non-probability sampling

In non-probability sampling methods, sampling is done without determining a sampling unit's probability of being sampled. Non-probability sampling methods should be avoided, as they introduce substantial bias, and greatly limit the applicability of the findings to the target population. There are two broad types of non-probability sampling methods:

- Convenience sampling is the collecting of readily available sampling units, such as animals that are brought in to a veterinary office or farms adjacent to a facility with the ability to conduct antimicrobial susceptibility tests (AST). Although convenience sampling is frequently used in wildlife surveillance programs, it is very subject to bias. Farms in more rural locations might, for instance, have different biosecurity procedures than farms near to veterinary laboratories. The results from convenience samples cannot be applied to

the target group since convenience samples are often not well representative of the source population. Consequently, despite the fact that convenience sampling is a rather prevalent practice, it is challenging to defend. The use of sample frames should be identified and encouraged above convenience sampling.

- In purposive sampling, units are chosen on purpose because they meet certain criteria. When addressing an extremely rare disease or other health-related feature, purposeful sampling may be suitable because it may be impractical to employ probability-based sampling in these situations. The goal is to sample as many sampling units as possible that exhibit the condition or trait.
- Simply put, when there was a small number of animals, all of them were sampled; however, because numbers are much larger in the formal meat sector, it was possible to use systematic random sampling. What are the major types of sampling methods in wildlife ecology?

Se

1. What is non-probability sampling method?

2. What are the different types of sampling methods?

1.6 Summary

In this unit you have learned about different approaches to sampling for Wildlife studies and surveillance in animals. You have learned about important parameters and best practice methods for sampling animals, and have also learned that many Wildlife studies and surveillance programs use less than ideal sampling methods.

1.7 References/Further Readings/Web Sources

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1.8 Possible Answers to Self-Assessment Exercise(s)

Answers to SAEs 1

1. Sample units are the members of the population from which measurements are taken during sampling. Sample units are distinct and non-overlapping entities, such as quadrats or transects, individual plants, branches within a plant.
2. Broadly speaking, study design refers to the number and spatio-temporal distribution of suitably defined sampling units (also referred to as experimental and observational units depending on the context) and the particular manipulations (i.e., treatments) and/or observations to be made on each unit for the purposes of answering a specific research question

Answers to SAEs 2

1. Internal validity examines whether the study design, conduct, and analysis answer the research questions without bias, while external validity examines whether the study findings can be generalized to other contexts.

2. The commonest sampling units in species inventory are usually one of the following types of delineated small-scale area within the general area of interest: Quadrat; Nested Quadrats; Transect and Plotless.

Answers to SAEs 3

1. In non-probability sampling method, sampling is done without determining a sampling unit's probability of being sampled.
2. There are many types; different academic sources report slightly different lists of sampling methods. However, the consensus is that all sampling methods are categorised into two groups: probability and non-probability methods.

UNIT 2

2.1 Introduction

You will learn how to design and source for good field studies. You will learn about the method and procedure for collecting wildlife investigation data. You will learn about study

design, scales measurement, data precision and accuracy. You will also be able to make some statistical inferences.

2.2 Intended Learning Outcomes (ILOs)

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

- Design good wildlife field studies
- Explain the various types of scales of measurements in wildlife study
- Describe the degree of precision, accuracy and statistical inferences about wildlife studies

2.3 Designing Good Field Studies

Like other biologists, ecologists gather data that will be used to test hypotheses or describe the natural world. Modern science advances by hypothesis and testing, supposition and debunking, ideas and data, and it also advances through compiling accurate descriptions of ecological events. Because ecology is an empirical science, it can't be studied exclusively on a whiteboard or computer; it also needs data from the field and the lab. But ecology is more than just statistics or ecological measures. At best, one may say that data make up half of science. The other half consists of ecological hypotheses or ideas. Some ecologists believe that hypotheses are more significant than evidence, whilst others disagree. Modern empirical science's fundamental premise is that both are required. Without data, hypothese are of little utility, and without hypothese, data are useless. What to measure is a challenge shared by all sciences, and there are several instances of measurements throughout science history that proved to be fruitless. Science philosophers contend that we should only measure the things that theory suggests are crucial. In theory, this is OK, yet every field ecologist observes phenomena they could measure and about which current theory is silent. An ecologist studying the acidity of precipitation or the amount of CO2 in the air in 1950 would have been deemed unfit for real science since theory develops in a complex feedback loop with facts. The term "crazy ecologist" is more commonly used to describe someone who measures everything. Avoid trying this as you will waste time and money gathering pointless data. For a variety of reasons, data may not be useful. It could not be dependable or reproducible. This is arguably the most prevalent ecological mistake. Even if it is absolutely accurate and reliable, the issue at hand may not be affected. Even if it is trustworthy, correct, and extremely pertinent, it may not have been gathered at the appropriate time of year. Another possibility is that the experimental setup is so dismal that a statistical analysis is impossible.

Do you have any control over the events you want to investigate, or must you focus on uncontrolled ones? When planning your field studies, this is the first and most crucial distinction you must make. You are at the mercy of the recent fire season if you are researching how naturally occurring forest fires affect herb production. Ideally, you can regulate where and when logging takes place if you are researching how logging affects herb production. All the concepts you learned in introductory statistics concerning replicated experimental plots and replicated control plots may be applied in this second situation, and the analyses you must conduct are comparable to those used in agricultural field research, the mother lode of modern statistics. As opposed to controlled events, uncontrolled occurrences require a distinct approach based on sampling theory. All ecological studies that aim to address an issue should use sampling studies, which are a component of descriptive statistics. What took place? The main question you should ask is what is your goal in doing these researches. Hypothesis testing may

or may not be a significant component of sampling studies. How does field of Wildlife ecology advances?

Self-As

1. What is more important in ecological studies between hypotheses or ideas and data?

2. What is an ecological data?

2.4 Scales of Measurement

Three fundamental measurement scales can be used to collect data. You can find various areas where authors do not recognize these distinctions and their limitations, even though they may appear trivial to you in the age of computers.

(1) Nominal Scale: A nominal scale is a measurement scale that is used to categorize events or things into distinct groups. This type of scale only needs one-of-a-kind identifiers to mark each separate category instead of requiring the usage of numerical values or categories ranked by class. Nominal data, which are qualities like sex or species, show measurement in its most basic form. The single formal characteristic of nominal scale data that we cannot discern is if two objects are equivalent. Ecology frequently uses nominal data, and we frequently count the number of individuals in various groupings. One may determine that the names of various bug species captured in light traps or the colors of gastropods on a seashore serve as a nominal scale.

(2) Ranking Scale: A ranking scale is a type of variable measurement scale that is used to show the order of variables rather than the differences between them. In general, these scales are used to represent non-mathematical concepts like frequency, pleasure, happiness, level of discomfort, etc. Individuals can be ranked in relation to one another even though some biological traits cannot be quantified on a numerical scale. For instance, based on cafeteria testing, diet items may be ranked from more favored to less preferred. We have a number of classes, similar to the nominal scale, but now the classes are ranked in relation to one another. In ranking data, the formal characteristics equivalence and greater than are present. We can symbolize our ordered classes by the conventional number or letter order: 1, 2, 3, 4..... or A, B, C, D, E……. I recommend using the letters rather than numbers because the most common mistake with ranking data is to assume that they are measured on an absolute scale. For example, we might rank 5 deer in a dominance hierarchy from 1 (low) to 5 (high) by means of

their relative aggression. One may be tempted to assume erroneously that an animal ranked 4 is really twice as dominant as a bird ranked 2 in the hierarchy, a not uncommon error in ecological papers. Do not confuse ranking numbers with absolute numbers.

Note that any quantitative measurement can also be expressed on a ranking scale. Clearly, if we weigh 14 fish, we can also rank these from lightest to heaviest in weight. In some cases, we may deliberately adopt a ranking scale for ecological measurements because it is faster and cheaper than doing a precise quantitative measurement. An example might be the relative biomass of plants in a series of quadrats of fixed size.

(3) Interval and Ratio Scales: These sorts of data contain all the qualities of a rating scale, but they also include knowledge about the separations between the classes. A quantitative measuring scale with order, meaningful and equal differences between the two variables, and arbitrary zero presence is known as an interval scale. A sort of variable measurement scale that is quantitative in nature is a ratio scale. It enables any researcher to contrast the ranges or variations. These measure variables that are spaced equally apart along a same scale. For interval and ratio data, we need a unit of measurement, such as cm of length, degrees of temperature, kg of biomass, density, or abundance of sparrows. A ratio scale of measurement exists if we have a unit of measurement and a real zero point. The measurement variable must vanish at zero to be considered a valid zero point. As a result, fish biomass and length are measured using a ratio scale, where a 4 kg fish weighs twice as much as a 2 kg fish. However, since 0°C is not the coldest conceivable temperature and 8°C is not twice as hot as 4°C, water temperature is measured on an interval scale. These two scales serve as a precise, quantitative kind of measurement for statistical purposes, and much of statistics is concerned with the analysis of this kind of data. Interval or ratio scale data make up the majority of the measurements we obtain during ecological field research. The list of variables includes height, weight, age, clutch size, population size, species richness, and on and on. A centimeter is a centimeter is a centimeter, hence data of this kind can be submitted to the standard arithmetic operations of addition, subtraction, multiplication, and division. The data on a ratio scale can be continuous or discontinuous. Because discrete data only accept integer values of 0, 1, 2, and 3, they are typically straightforward. Ecology is rife with illustrations, such as the quantity of fish in a net, eggs in a nest, or plants in a quadrat. Counts of this sort are typically exact (or should be exact) and error-free, at least when the numbers involved are small, because discrete data does not allow for the possibility of intermediate values. Since viewers' visual acuity can vary, it may be impossible to count all of the elephants in an aerial photo accurately.

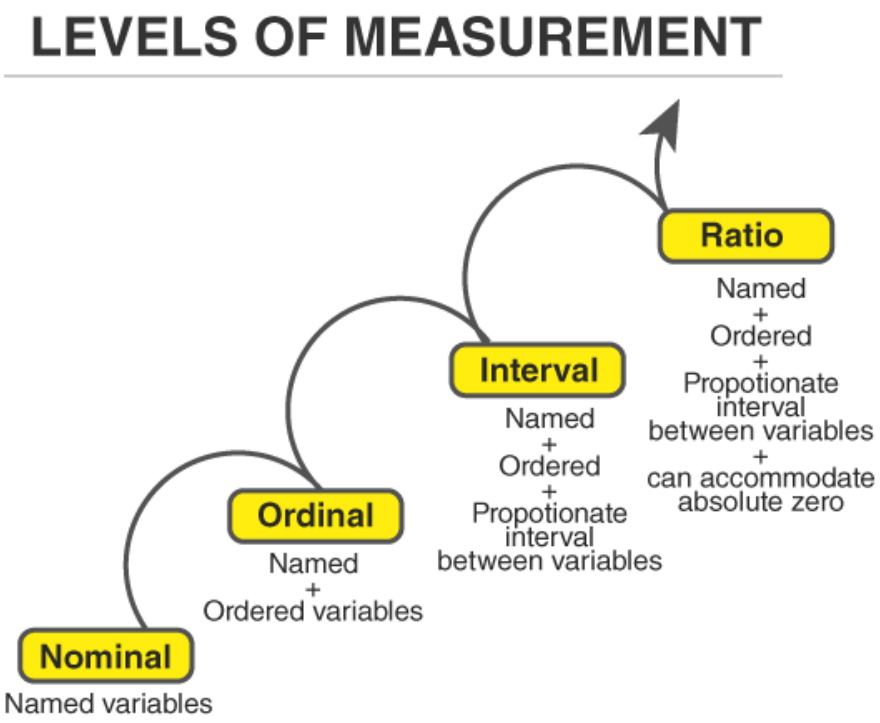

Figure 1. Levels of measurement
Source: https://byjus.com/maths/scales-of-measurement/

What ar

Self-As

1. List the four ecological scales of measurement
2. What is **a** Nominal Scale of measurement?

2.5 Degree of Precision, Accuracy and Statistical Inference

Continuous data are not a straightforward condition because they can be measured with any level of accuracy. We must first make a distinction between accuracy and precision. The degree to which a measured value is accurate depends on the caliber of the measuring equipment or device used. Several ecological data points are wildly off. For instance, estimates of CO2 increases used to calculate primary production in forests may have low precision and bias.

Studies on biodiversity frequently underestimate the number of species in a region. Standard live trap estimates of vole population density may only reflect half of the actual density. The history of ecological measurement is mostly the history of attempts to develop better sampling or measuring methods that would allow for more precise measurements. The consistency of repeated measurements is known as precision. If we are diligent, every repeated measurement of a fish with this ruler will result in almost the same numerical number, therefore a ruler that has been marked off incorrectly and is too short may offer a highly precise measurement of a fish's length. However, the ruler would provide a biased measurement and this exact measurement would be quite inaccurate. Bias is a common issue with many estimating approaches and plays a significant role in many ecological measurements. We will discover that some ecological methodologies yield estimates that are biased, thus it is crucial to attempt and determine how big the bias is. Although a skewed estimate is preferable to none at all, we must be careful to recognize when bias exists in our ecological assessments. Every measurement has its inherent boundaries, and continuous data are recorded with a fixed level of precision:
Table 1. Implied measurement limits for smaller numbers

Measurement	Implied limits
67	66.5 to 67.5
67.2	67.15 to 67.25
67.23	67.225 to 67.235

Large numbers are frequently presented with less care than they should be, making it difficult to determine the degree of precision. The most frequent instances of this are in statistical programs and computer applications like Excel, where, for instance, correlation coefficients are provided to four decimal places for a sample of five data points. Either traditional rounding or the usage of exponential notation can fix this flaw.

Table 2. Implied measurement limits for larger numbers

Measurement	Implied limits
31,000	not clear - could be any of the following
3.1×10^4	3.05×10^4 to 3.15×10^4
3.10×10^4	3.095×10^4 to 3.105×10^4
3.100×10^4	3.0995×10^4 to 3.1005×10^4

Significant figures are defined as the digits in a number which denote the accuracy. In gathering ecological data we must often make some decision about how many significant figures to use. Ecologist make a practical rule of thumb, as follows: the number of unit steps from the smallest to the largest measurement should be between 30 and 300. For example, if we are measuring fish lengths and the smallest fish is 3.917 cm long and the largest fish is 38.142 cm long, we should record to the nearest centimeter (4 to 38 cm) to give 34 one-cm steps. By contrast if individual weights of zooplankton vary from 0.01 to 0.05, you should measure to three

significant digits to give 40 steps of 0.001 values. There is no point in recording these data to 0.1 or 0.000001 places of significant figures.

Due to the fact that estimating and sample issues are far more challenging in ecology than they are in other biological sciences, ecological statistics place a different emphasis on these issues than most other types of statistics. Most statistics books typically devote a brief section to descriptive statistics, and random sampling is frequently simply mentioned in passing. The descriptive statistics of ecology and the many sample techniques that ecologists might use are the main topics of this course. For instance, despite being conceptually straightforward, it is challenging to estimate the fluctuating population size, which is essential for the majority of ecological study. In ecology, statistical inference is extremely challenging. The unfortunate dualism of the word "population" is a persistent source of confusion because statistical populations are not biological populations. The "target" population must be identified in order to make any legitimate statistical inferences, but this is difficult to perform in the majority of ecological studies. If we define the statistical population very broadly, we cannot randomly sample it because biological populations and communities vary in space and time in such a complex way. The whole basis of typical statistical reasoning in ecology is undermined by this fundamental issue. A second major difficulty in ecological statistics is that statistical methods can cope only with random errors. In actual circumstances systemic errors or bias may be more significant, and skewed data cannot be detected by a straightforward statistical test. We work to remove measuring bias in order to eliminate this potential source of mistake.
What is precision in ecological measurements?

Self-As

1. Why is does ecological statistics differ in emphasis from most types of statistics?
2. What is the meaning of Bias in ecological measurements?

2.6 Summary

You have learned about designing a good fiel research in wildlife studies. You have studied about the various scales of ecological measurements, precision, accuracy, and statistical inference.

2.7 References/Further Reading/Web Sourcess

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2.8 Possible Answers to SAEs

Answers to SAE 1

1. The central tenet of modern empirical science is that both are necessary.
2. Ecological data can be defined as **the collection of information about the ecology**. These data are used in several ecological developments that can help to sustain a good ecosystem and manage the activities that affect life of several organisms.

Answers to SAE 2

1. The four scale of measurement in ecology are: Nominal; Ranking, Interval and Ratio Scales

2. A nominal scale is **a scale of measurement used to assign events or objects into discrete categories**. This form of scale does not require the use of numeric values or categories ranked by class, but simply unique identifiers to label each distinct category.

Answers to SAE 3

1. Ecological statistics differ in emphasis from most types of statistics because the problems of estimation and the problems of sampling are much more difficult in ecology than they are in other biological disciplines.
2. Bias is very important in many ecological measurements and is a recurrent problem with many estimation techniques.

Unit 3: Wildlife Sampling Techniques
Unit Structure

3.1 Introduction

You will learn the sampling methods for invertebrates, fish and wildlife in this unit. You will also learn about wildlife direct and indirect observation techniques, the use of live and snap traps.

3.2 Intended Learning Outcomes (ILOs)
By the end of this unit, you should be able to:

- Describe the methods for invertebrates sampling and Observation
- **Explain insect netting and f**ish sampling techniques
- Describe wildlife sampling method, observation, live and snap traps.

3.3 Invertebrates Sampling

Invertebrate surveys are generally performed for threatened and endangered species (TES), species of special concern, or commercially important species (e.g., blue crab). In addition, aquatic invertebrates, especially emergent aquatic insect larvae and crayfish, can serve as indicators of stream health. In order to make the best choices for wildlife management and conservation, it is crucial to conduct invertebrate surveys. Although this is only an option for a small number of taxa, species are identified when possible in the field or through images. Because many invertebrates are so tiny or differ greatly in their microscopic traits between species, a microscope is required for identification. Unfortunately, this necessitates the collection, killing, and preservation of specimens. However, once they have been recognized and noted, they become crucial information for researchers and environmentalists to document

changes in the animals and environment. Additionally, conserved specimens are utilized as a guide to help identify upcoming samples. It is crucial to keep in mind that any surveying or collecting must adhere to ethical standards and the law. Invertebrates are sampled using a range of methods. Here are some of the more typical techniques that might be used.

3.3.1 Invertebrate Observation

This is frequently the simplest and least disruptive way to look for invertebrates, but in order to identify any species found in the wild, a skilled invertebrate zoologist is needed. Experienced field biologists can review descriptions and life histories, look at known museum specimens, including similar species that may also occur in the area, and other available information to make themselves capable of finding and identifying target species if specific TES and special concern species are targeted. Observations can be categorized as direct or indirect, both of which are described below:

- Direct observation. Invertebrates can be observed directly by using a hand lens magnifier, the naked eye, or some other tool. It can be applied to any species of invertebrate. A mask and snorkel may be appropriate for aquatic species. It is possible to make direct observations both with and without collecting the relevant organism.
- Indirect observation. Invertebrate remains like cast exoskeletons (exuviae), broken shells, or egg and larval stages can be used as indirect observations. Spent shells are a particularly effective indicator of the presence of freshwater mussels and can be discovered around muskrat middens and near waterways.

The location of the survey is crucial and will be determined by the target species, survey objectives, and survey authorization. It would be necessary to sample as many distinct habitats as possible over a long period of time and using various techniques in order to collect data on a variety of invertebrates. Because invertebrates have complicated life cycles, factors including the season, day of the week, temperature, weather, sample technique, and even the color of the traps might change the species you detect.

3.3.2 Methods for Invertebrate Sampling

Much like site selection, the sampling method used will also be determined by the reason for the survey and any focus taxa. Some techniques you may encounter are listed and described below, alongside the taxa that can generally be collected from them.

- **Sweep Netting** – This method involves waving a sweep net through vegetation. Invertebrates can then be removed from the net using collection pots or pooters. It's a great method for collecting sheild bugs, leaf hoppers, hoverflies, spiders and flies - to name a few.
- **Direct Searching** – Every entomologist has probably utilized this method at some point, especially when we notice something that piques our interest. It is one of the simplest surveying techniques since it may be explored once the desired environment has been located. This may entail exploring underneath cover, such as boulders and logs, or rummaging through vegetation; just remember to return stones and logs to their original locations. Invertebrates can be captured as you locate them with the use of a pooter. With this technique, you can discover a wide range of invertebrate species, including millipedes, harvestmen, and beetles.
- **Sieving** – Sieving, which is similar to direct searching, can be used to remove invertebrates from small material like leaf litter and rotten wood. Another technique that can

detect a wide variety of invertebrates is this one. Finding fly or beetle larvae, as well as adult animals like worms, pseudoscorpions, and earwigs, might be useful examples.

- **Pitfall Traps** – These traps are used to catch surface-dwelling invertebrates in bare or sparsely vegetated environments. Invertebrates will fall into containers that have been drilled into the ground with the top level with the ground. Pitfall trapping is an indirect trapping technique that results in a lot of by-catches, hence we suggest using it unless it is absolutely necessary. Please make sure to identify and record any by-catch if you use this method, either by doing so yourself or by giving samples to another person. Typically, pitfall traps gather taxa like harvestmen, millipedes, centipedes, and woodlice. However, scanning ground beetles and their larvae makes use of it particularly well.
- **Light Traps** – The utilization of light will draw a lot of insects that fly at night. These traps can be simple or extremely complicated, but they all generate a white or blueish light that attracts insects that can then be captured either temporarily or permanently. Although you can find surprises in the traps, this method works great for monitoring moths. Learn more about the other species you might come across here.

3.3.3 Insect Netting

Insect netting, or sweep netting, during appropriate season and time of day is a general method for collecting insects and consists of using a net specially tailored for capturing flying insects.

i). Trapping: Two types of traps used to capture invertebrates are described below:

- Light traps. Light traps use an ultraviolet or black light to attract insects, especially moths, where they are collected in a trap or attracted to a white sheet and selectively identified and removed. This is one of the better methods to survey moths.
- Baited traps or stations. Invertebrates are attracted to bait (e.g., honey) and become trapped or feed at a station. Traps can be left over time but bait stations must be visited at regular intervals to increase the chance of encountering feeding individuals.

ii). Grab Sample. A grab sample is one sediment sample collected from a specific area. For obtaining grab samples, a variety of devices is available. The Ponar sampler, the Ekman dredge, and the Smith-McIntyre substrate sampler are a few of the more popular sediment grab sampling tools. These all offer a quantifiable sample. In shallow water, a straightforward trowel or shovel can be used to collect a qualitative grab sample.

iii) Surber Sampler. For quantitative sampling in shallow, flowing water (30 cm or less), a Surber sampler is utilized. It consists of a double-framed construction with a net fastened to one of the frames, which is hinged along one edge. In riffle/run areas, one of the frames is firmly set on the stream bottom, and the other frame holding the net is positioned perpendicular to the bottom. The user disturbs the region enclosed by the bottom-mounted frame and takes out any adhered creatures. Benthic creatures that are separated and disturbed then flow into the net attached to the other frame with the current.

- Drift Net: To collect macroinvertebrates that have moved or become dislodged into the current, this sampling tool uses a net that is anchored in moving water. In order to minimize clogging, sampling should be carried out for a defined period of time, and nets should be checked often. It is best to sample between sunset and 1:00 AM.
- Tow Net: Benthic invertebrates are sampled qualitatively using tow nets, which can be as simple as sled-mounted nets or as sophisticated as complicated machines. When

dragged for a predetermined amount of time, these nets, which are pulled by boats, can produce quantitative data.

- Kick or Dip Net: These nets can be used in a variety of shallow, flowing water collection situations. These tools are often used for qualitative sampling, while they can also be used for semi-quantitative sample when coupled with a consistent kicking technique.
- Clam Rake: This tool is useful for qualitative mollusk sampling since it selectively keeps larger objects and creatures. It is typically employed along creek and river shorelines to enhance data collected from other sampling techniques.
- Trawl Net: A funnel-shaped net known as a trawl is trailed behind a boat. The blue crab is the sole invertebrate often targeted by this technique, in which case the net would be positioned along the bottom of the water body.

iv) Artificial Substrate Sampler: These samplers have a set design and composition, and they are submerged in water for a predetermined amount of time before the level of macroinvertebrate colonization is assessed. The Hester-Dendy sampler and the basket sampler are two examples of the several artificial substrate samplers that are offered.

Why Su[illegible]

Self-A

1. For which category of invertebrate species surveys were being made?
2. What is an Artificial Substrate Sampler?

3.4 Fish Sampling

Ecologists regularly collect samples of fish and shellfish populations, as well as the water itself, in both freshwater and saltwater environments. Each kind of sampling collects samples from a range of ages and targets diverse species in varying sizes. Every sample approach is consistent; over time, the same tools, procedures, seasons, and locations are frequently used. A waterbody's many habitats are represented by the sampling stations that were chosen. In addition to counting and measuring their samples, biologists occasionally dissect and analyze them to learn more about their sex, age, diet, and reproductive characteristics. They then employ this data in other research projects and to evaluate the condition of fish and shellfish populations. Simple random sampling, which selects a predefined number of sample sites from among all feasible sites so that each has an equal chance of being chosen, is the most fundamental probability sampling technique used in fish population sampling. Techniques for fish surveys vary depending on the species and kind of environment. Since the majority of techniques only work on specific demographics, it is usually best to combine several techniques.

1. Observation: Fish species can be directly observed from the shore or from a boat. Binoculars or sunglasses with polarized lenses are frequently helpful accessories when employing this method. Observations are helpful, but they rarely include every species that is present. Thus, if used, they should be combined with some of the additional techniques described below.

2. Electroshocking: When there is no specified target species, electroshocking is generally the best technique to utilize for general fish surveys. However, depending on the species, environment, and size of the fish, it may not always be effective. Electroshocking is ineffective in water bodies with moderate to high conductivity, despite the fact that the operating salinity range of the shocking units varies. How many types of Electroshocking units are available? Three types of electroshocking units are available: i). Backpack Electroshocker; Anode and cathode probes for a backpack electroshocker are typically held in front of the operator by hand, however the cathode probe may trail behind. The power unit is slung across the operator's back like a backpack. This kind of electroshocker can only be used in smaller streams, creeks, and brooks because it must be operated while wading in the water body. ii). Stream Electroshocker. A power unit for a stream electroshocker is typically resting on the stream bank or floating in the water on a small boat and is typically powered by a generator. While wading in the water body, the operator operates the probes. Typically, two additional people are needed to net the fish. For streams, brooks, and minor rivers, this sort of electroshocker is typically used; iii). Boat Electroshocker. In deeper water, a boat electroshocker is typically utilized (rivers, large ponds, and lakes). The complete equipment, including the power supply, generator, and probes, is housed on a boat for this kind of electroshocker. Two individuals typically run the probes and net the fish while one person steers the boat. Typically, pressing a pedal is used to actuate the probes.

•Trawls. A trawl is a kind of funnel-shaped net pulled by a boat. It is frequently used for both juvenile and adult fish and can be adjusted to different depths in the water column.

•Seines. A particular kind of net called a seine is used along the shoreline to enclose fish and pull them in. Seines perform best in areas with minimal to moderate current, few underwater obstacles, and generally sloping shorelines. Fish that live in habitat close to the beach are collected using this technique.

• Trap Nets. Migrating fish are guided into the trap of a net by trap nets. There are many different types of trap net designs, but they typically include one to three leads or webbing wings that are intended to catch migrating fish. From the net's mouth to an anchor, the leads and wings are attached. Fish that come across these impediments swim around them and into the net's mouth. A passive technique that works well in seas with little current is the use of trap nets. With the exception of potential predation in the trap, this technique doesn't do much harm to the fish. Additionally, it is selective for species of migratory fish that swim close to shorelines or other built features. Nearshore is where trap nets are most frequently employed.

• Gill Nets. Gill nets are nets with a carefully constructed mesh size that cause fish to become entangled in the net by their gills, even though this technique is severely discouraged within the City. The gills of the target fish become caught in the net as they try to swim backwards to escape because they are too big to fit through the net. Gill nets are typically utilized in still waters, but they can also occasionally be seen on larger rivers. Gill nets are rarely frequently employed since they could seriously harm fish (loss of slime coat, loss of scales, stress, and potential asphyxia).

• Larval/Ichthyoplankton Nets. Fine mesh nets called larval or ichthyoplankton nets are used to catch young fish. They can be pulled behind boats in the water column or along the bottom. Some of them are fastened to benthic sleds. The type of eggs laid (demersal, adhesive, or pelagic) and the behavior of the larvae determine where they are (pelagic, demersal, etc.). These nets should be used in accordance with the species' and life stage(s) targeted occurrence period.
• Benthic Sled. A benthic sled is a sled-like device with a net attached that is pulled behind a boat. This sample tool is most frequently used in conjunction with a larval net to gather young fish that are found around the bottom.
• The crow survey. A creel survey asks anglers about their catches while being selective for game species. The fish can occasionally be weighed and recognized after being caught. In other situations, the angler is asked for information verbally.
• Hook & Line. It is possible to use this technique from a boat, the shore, a pier, or a dock. A rod and reel are used. This method should typically only be used for qualitative assessments of species presence/absence and as a supplement to other techniques because it is selective and frequently time-consuming.
•Dipnet. A dipnet is a tiny, hand-held net that is used to catch small fish off banks, shorelines, and other places. It is selective for specific species, just as the hook and line approach, and takes a lot of time. Therefore, it should only be applied in combination with other methods.
How many types of Electroshocking units are available?

Self-Assessment Exercises 2

1. List the three types of Electroshocking units

2. How do you sample a fish population?

3.5 Wildlife Sampling

When threatened and endangered species or species of particular concern are likely to occur, it is very important to know which species to expect to be present when doing wildlife studies. In order to choose stations and time the surveys to optimize the likelihood of seeing different species, it is crucial to have knowledge of the different types of habitat as well as general information on the seasonal presence, activity patterns, and behavior of the wildlife expected in the area. Additionally, reconnaissance surveys assist in determining what species may be local and in choosing sampling sites. At times when such species are most likely to be found, areas of potentially suitable habitat for Threatened or Endangered Species (TES) or species of special concern should be explored. The selection and search of additional specific habitats is also necessary. Vernal pools, springs, streams, rock outcrops, snags, and other features might be

among them. A qualified wildlife biologist with substantial expertise locating the target TES should be employed for species-specific TES surveys. The capacity to quickly identify animal species by sight, sound, and sign is a requirement for performing wildlife observations by qualified persons. Figures, images, or even video could be used to show where sample stations are distributed across different survey types.

3.5.1 Observation.

Wildlife sightings may occur accidentally while doing other surveys or as a result of targeting particular species at specific times of day or night and during specific seasons. For instance, incidental wildlife sightings can be noted while delineating wetlands. Incidental observations should only be used when a basic understanding of the sorts of animals exploiting a site is required or to concentrate additional wildlife surveys because they are insufficient for analyzing potential consequences to wildlife. Both focused and incidental observations can be direct or indirect, as follows:

- Direct observation. Direct observations can be made by using a spotting scope, binoculars, the human eye alone, or another tool to see wildlife. Any type of wildlife species can be trained using this method. It is possible to make direct observations both with and without collecting the organism. By looking under rubble, logs, and rocks, the likelihood of seeing tiny mammals, reptiles, and amphibians up close increases.
- Indirect observation. Indirect observations include signs of animals, such as songs, tracks, droppings, burrows, runs, caches, and remains, such as feathers, bones, and skeletons, as well as roadkill and amphibian and bird sounds.

3.5.2 Live and Snap Traps.

Trapping might be the most effective method to find out if tiny mammals are present because they are nocturnal and secretive. Snap traps and live traps, which are intended to prevent the animal from being killed, can be used to catch small mammals (traps designed to kill the animal instantaneously). A variety of small mammals can be caught using live traps, and if necessary, different types of bait can be employed to focus on particular species. Unless specifically mandated by a natural resource agency, snap traps should be avoided. Specimens that are killed should be rescued if possible and given to museums together with details on where and when they were gathered. Results from trapping can reveal both absolute (if live traps are used in conjunction with marking) and relative abundance. Because of the sometimes-heavy traffic that can occur in some natural settings, care should be taken to make any traps set out as unobtrusive as possible. Given the potential for human intervention, traps may need to be examined more frequently. Depending on the site where the research is conducted, this sampling technique would require city, state, and potentially federal scientific collecting permissions, and a NYSDEC License to Collect or Possess would probably be required for trapping operations. To ascertain any permitting needs, consultation with pertinent agencies is required.

- Pitfall Traps: Animals can't escape from depressions in the ground known as pitfall traps, which they fall into. Drift fences, which are brief vertical fences that extend out from the trap and serve as runways to pull the animal(s) into the trap, are utilized in conjunction with them for best results. These kinds of traps are effective for catching salamanders, other tiny mammals, including shrews. The depth of the trap should be sufficient to stop escape but

not so great that it injures the animal. If salamanders are the target or are likely to be caught, the trap should have just enough water in it to keep the salamander from drying out but not too much that it drowns the salamander (s). To prevent drowning from the excessive water buildup in the trap and to prevent excessive sun exposure, pitfall traps should be fitted with raised covers. Pitfall traps should be used with caution before being set up since they need to be examined frequently to avoid the trapped animal from being exposed to excessive heat or cold, stress, or malnutrition (s). This approach requires a lot of time. Using this sampling technique would necessitate the acquisition of city, state, and perhaps federal scientific collecting permissions, as well as a NYSDEC License to Collect or Possess, depending on the location of the research site. Trapping would also probably necessitate such a license. To ascertain any permitting needs, it is required to consult with the appropriate agencies.

- Cover Boards. To attract tiny mammals, snakes, and salamanders for long-term investigations, cover boards are positioned on the ground. They are periodically checked and left out for lengthy periods of time. The species discovered beneath the boards are named and noted. A number of materials, such exterior plywood or corrugated roofing, can be used to create cover boards. Depending on the site where the research is conducted, this sampling technique would require city, state, and potentially federal scientific collecting permissions, and a NYSDEC License to Collect or Possess would probably be required for trapping operations. To ascertain any permitting needs, consultation with pertinent agencies is required.
- Hair Snares: Hair snares are carpet-based traps that are fastened to a small (4x4-inch) wooden piece that is nailed to a tree about two feet above the ground. A Velcro patch can be added to the device to change it. The target animal is then "baited" using readily available animal scent, which draws it to the hair snare. The aroma causes the animal to rub against the snare, leaving hairs behind for later identification. This technique needs a skilled biologist who is able to recognize the large carnivore hairs and is suitable for determining the presence of large predators like coyotes and fox.
- Track Tubes. For identification and analysis, tiny mammals' fur is snared in tubes with Velcro inserts known as "hair snare tubes." The surface of the track tubes is designed to leave animal-track marks. These tubes can be baited—typically with food—to entice the animal inside. The usage of hair snare tubes necessitates a qualified biologist who can recognize little mammal hairs, just like a conventional hair snare. Depending on the site where the research is conducted, this sampling technique would require city, state, and potentially federal scientific collecting permissions, and a NYSDEC License to Collect or Possess would probably be required for trapping operations. To ascertain, it is important to consult with relevant agencies to determine any permitting requirements.
- Owl Pellets: There are places where owls are known to roost. If owls are foraging in the area and their roosts are known, their pellets can be a source of sorted and identifiable local small animal skulls and bones. To evaluate if the prey may have been obtained off-site, this technique requires knowledge of the foraging range of the relevant owl species.
- Call Playback: Call playback can also be used to survey for coyotes, which is typically done to find birds. This technique involves playing calls or music recordings and waiting for a response. The call or song may belong to the species being surveyed or to a different species that is anticipated to cause the species being surveyed to make a call. Typically, calls are played for three minutes before being silenced for one. The following are a few examples of call playback applications, but there are many more. Diurnal Raptor Surveys,

item 1. To get nocturnal raptors to respond, call stations might play recordings of specific hawks and owls. From dawn to roughly midday, call stations for hawks (Cooper's, red-shouldered, northern goshawk, and sharp-shinned) are surveyed. Hawks frequently respond to the great horned owl sound, hence it should be used at hawk stations. You can also play the barred owl cry in the early morning because this species is active then. ii). Surveys of Nocturnal Raptors (OWL). To get owls to react, owl cries recorded on tape can be played. From dusk till dawn, owl call stations are surveyed using cries unique to the species being studied.

- Marsh Bird Surveys. At dusk and in the morning, marsh birds are counted. These surveys should be conducted from a canoe or on foot while playing back recordings of the American bittern, least bittern, black rail, sora rail, Virginia rail, pied-billed grebe, sedge wren, clapper rail, and marsh wren.
- Turtle Traps. Turtle traps include funnel-shaped entrances that reduce the animal's ability to escape the trap. To lure the animal into the trap, it may have wings or leads. To prevent the animal from drowning, turtle traps that are positioned in water should be staked such that part of the trap is above water. These traps, like other live trapping equipment, need to be checked on frequently to prevent malnutrition or undue stress on the caught animal. Depending on the site where the research is conducted, this sampling technique would require city, state, and potentially federal scientific collecting permissions, and a NYSDEC License to Collect or Possess would probably be required for trapping operations. Consultation with relevant agencies is necessary to determine any permitting requirements.Why do we conduct reconnaissance surveys?

Sel

1. Differentiate between direct and indirect observations in wildlife studies
2. What are Pitfall Traps in wildlife studies?

3.6 Summary

You must have learned through the preceding unit the various sampling methods of invertebrate, fish and wildlife

3.7 References/Further Readings/Web Sources

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3.8 Possible Answers to SAEs

Answers to SAE 1

1. Invertebrate surveys are generally performed for threatened and endangered species (TES), species of special concern, or commercially important species (e.g., blue crab).
2. These types of samplers are of a standard composition and configuration and are placed in the water for a predetermined period of time, after which the degree of colonization by macroinvertebrates is determined.

Answers to SAE 2

1. The three types of Electroshocking units are:
Backpack Electroshocker Stream Electroshocker Boat Electroshocker
2. The most basic probability sampling procedure used in fish population sampling is **simple random sampling**, in which a predetermined number of sampling sites is selected from all possible sampling sites such that every potential site has an equal chance of being selected (Hansen et al. 2007).

Answers to SAE 3

1. Direct observations may include observing wildlife with the naked eye, through binoculars, spotting scopes, or via another apparatus. This technique can be used for any type of wildlife species. Direct observations can be made with or without collection of the organism. The probability of direct observation of small mammals, reptiles, and amphibians is increased by searching under debris, logs, and rocks; while Indirect observations include evidence of wildlife, such as amphibian and bird calls, bird songs, tracks, droppings, burrows, runs, caches, and remains, such as feathers, bones, skeletons, and road kill.
2. Pitfall traps are depressions in the ground that animals fall into and from which they cannot escape.

Unit 4: Wildlife Control Methods

4.1 Introduction
4.2 Intended Learning Outcomes (ILOs)
4.3 Wildlife Management Tools

4.1 Introduction

In wildlife damage management (WDM), a variety of methods and tools can be used to reduce wildlife conflicts to tolerable levels. Several methods exist because usually no single technique will eliminate all conflicts. This unit highlights those methods and tools.

4.2 Intended Learning Objectives (ILOs)

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

- Identify the Wildlife management tools
- Explain the need and importance of having a variety of techniques for WDM.
- List tools suggested for WDM.
- Describe methods for resolving wildlife conflicts using Integrated Pest Management (IPM) methods.

4.3 Wildlife Management Tools

The methods a wildlife manager will employ to keep species within the habitat's carrying capacity are outlined in management plans. Since wildlife populations, habitat conditions, and societal tolerances might fluctuate from year to year, these designs must be adaptable. It's also crucial to remember that the finest wildlife management plans frequently combine all of the available management strategies. Wildlife managers must gather accurate data on habitat and wildlife populations throughout the year - every year - to identify the kinds of tools required to establish a management strategy.

Today, hunting and trapping are strictly controlled to remove a portion of the surplus animals from a population each year. Because hunters can be governed by rules and regulations, hunting and trapping continue to be among the most crucial management methods. When game populations are robust, hunting and trapping seasons are longer and harvests are higher. When wildlife populations are low, seasons may be shorter and harvests may be less. In order to maintain healthy wildlife populations, to keep species within the carrying capacity of their environment, and to safeguard the habitat from harm, hunting and trapping might be used. Even when the habitat and carrying capacity are adequate, they are also employed to lower specific animal populations to levels that are acceptable to humans. In order to properly manage any wildlife species, biologists and managers must have a good understanding of all the animals. Research allows biologists and the rest of us to learn all we can about animals and management. Research objectives include:

- Identify habitat needs for individual species, and evaluate the impacts of a variety of land use practices;
- Study and explain the population dynamics of wildlife under varying habitat and environmental conditions;
- Evaluate the social and economic values of wildlife; and
- Educate other biologists, wildlife resource agencies, legislators and the public of the results of the research and the needs of the animals, habitat and the public.

Surveys are conducted annually as a vital part of wildlife management programs. The surveys are needed to evaluate:

- How many animals were harvested from certain populations or areas;
- Trends in animal population levels, habitat conditions or crop impacts;
- Hunter pressure and over harvest patterns on public and private land;
- Basic biological information of the sex and age of the animals harvested.

A species of animal may be legally protected if there are too few of that species left. As with threatened or endangered species, hunting can be scaled back or discontinued to assist reduce mortality rates and boost population levels. In some circumstances, legislation to safeguard the habitat may even be passed. Most often, laws are used when long-term or permanent measures are required.

Hunting can be used to control animal populations if there are too many of them. For instance, hunting laws frequently alter from year to year to account for variations in animal populations. The length of the hunting season may also be changed to take into account the animal numbers. Daily bag limits or harvest quotas - the number of animals that hunters can take in a day or season - can also be set larger or smaller. Why do managers and scientist need to have good information about a protected area?

Self-As

1. Where is the best keep tools a wildlife manager needs to help keep wildlife within the carrying capacity of its habitat?
2. What do managers need to do If species of animal are becoming too few in number in a protected area?

4.4 Wildlife Management Areas (WMA)

Wildlife managers have access to additional tools through wildlife management areas. These are lands that have been set aside with the intention of protecting important wildlife habitat and expanding the diversity of species. A wildlife management area's main objective is to protect at least a few species so that the population can grow. However, this kind of defense may end up serving no useful function. Elk and deer populations, for instance, could rise to the point where they compete with the existing food source. The habitat is then damaged. A wildlife management area's management plan needs to be adaptable if it is to allow wildlife managers to keep species, including those in the WMA, in balance with their habitat. Perhaps another successful special wildlife management area is the waterfowl refuges. This could be a breeding area, a wintering area or a migration refuge between summering and wintering areas. Breeding area refuges offer a place for laying eggs and raising young. The birds are protected in wintering areas so they can endure until the following breeding season. Birds migrating to and from breeding or wintering grounds can stop at a migration refuge for a place to rest and eat. Only when effectively used in conjunction with other management techniques are Wildlife Management Areas effective. The majority of wildlife species benefit from the land and management techniques, even when a particular animal may be the focus of an area's management.

Using stocking as a management method can aid places with limited populations of animals or establish new wildlife populations. Because these creatures are already accustomed to living in the wild, trapping them and relocating them into new locations is the most efficient method. In Montana, stocking started more than 50 years ago. The ring-necked pheasant, the Hungarian partridge, and the Merriam's turkey were among the animal species that were brought to Montana by stocking. However, one of the issues with the early stocking operations was that wildlife managers occasionally failed to take social acceptance and environmental constraints into account. Today, wildlife managers thoroughly inspect the locations before stocking, boosting the likelihood of the animal's survival, its ability to live with other species, and the desire of people to have it there.

tat. Perhaps another successful special wildlife management area is the waterfowl refuges. **IN TEXT QUESTION**: *What is a waterfowl refuge*? This could be a breeding area, a wintering area or a migration refuge between summering and wintering areas.

Self-Assessment Exercises 2

Self-Assessment Exercises 2
1. What are wildlife management areas? 2. Why do wildlife managers study the WMA before stocking?

4.5 Wildlife Damage Management (WDM) Methods

WDM is not a one-size-fits-all activity when you take into account the diversity of species and issue scenarios. Additionally, a variety of techniques can be combined with one another. In fact, if possible, it is advised to combine several treatments, especially to deal with instances where there has been ongoing damage. The broad groups of WDM techniques are listed below. When possible, use non-lethal control methods and think about what would have the least negative impact on the ecosystem when utilizing an IPM approach. If the nuisance or damage is below a tolerable threshold, the following methods could be useful:

a). Habitat modification

Animals require shelter, food, and water to survive. Animals cannot survive if any of these factors are absent. All three of these necessities are taken care of by habit change. Paving a lawn in asphalt to prevent mole damage is a severe example of habitat alteration. Even though it would be radical, it would work and be rather long-lasting. The majority of habitat changes are less obvious, such trimming the brush around the yard's edge, but they are crucial to long-term WDM. However, keep in mind that altering the ecosystem to impede one species' population expansion may promote it in others.

Typical habitat modifications include: trimming back bushes and trees to lessen shelter and access to structures, removing vegetation near a building foundation, and getting rid of brush, woodpiles, and junk are all ways to prevent spilt seed from reaching the ground.

Mowing tall grass to minimize vole populations or letting grass grow to deter geese are two other examples of habitat alteration. The effectiveness of other strategies can be increased even with little adjustments. Hard to resolve wildlife disputes may have long-term solutions through habitat modification. Expect considerable client opposition because some improvements can be pricey. But when long-term implications are taken into account, habitat change might be financially advantageous.

b). Exclusion and Frightening devices

Exclusion is the process of preventing wildlife from entering a space and inflicting harm by employing barriers like nets, cylinders, and fences. Exclusion can be quite expensive when protecting vast areas, but this strategy can offer significant levels of protection over the short- and long-term. Exclusion is a common IPM strategy that is good for wildlife. Although some experts believe that exclusion is an element of habitat alteration, we address it separately because there are so many unique instruments and approaches for exclusion that it deserves its own unit.
Through non-chemical ways, frighteners deter wildlife from a certain area. There are four types of frightening technology: visual, acoustic, audio-visual, and biological. Animals quickly get used to terrifying devices, with the possible exception of biologically frightening ones.

c). Biological and Chemical methods

Guard animals like dogs and llamas are occasionally used to keep livestock, particularly sheep, safe from harm. Both the guard animal and the cattle must remain inside of a fence. Dogs can prevent deer or turkey damage to orchards, Christmas tree plantations, or vineyards. Dogs contained within an invisible-fence system may lessen deer damage to landscaping and home gardens. Hazing is the practice of removing unwanted animals from a location using dogs, hawks, falcons, radio-controlled planes, or watercraft. In order to get rid of Canada geese from golf courses, public parks, or other places, border collies can be trained to haze them. Hawks are occasionally deployed to chase other birds off of vineyards or airport runways. The Migratory Bird Treaty Act prohibits hazing of birds during the nesting season in their nesting sites (MBTA). It is not advisable to haze geese during their molt, which typically lasts from mid-June to mid-July. Before starting hazing actions, obtain a permit that enables the capturing of geese. Even a well-trained dog has the potential to harm a goose by accident when chasing it. This would be against MBTA rules without a permit.

d). Repellents and Toxicants

How do repellents impact animals, and what are they? Chemicals known as repellents prevent animal activity by contact, pain, fear, or unpleasant conditioning. To use these products commercially, you often need a pesticide applicator license. On their land, homeowners are allowed to buy and use over-the-counter products. The motivation of problem animals, available resources, the weather, the applicator's expertise, the animal's prior exposure to the repellent, and the active components in the repellent all affect how effective they are. Be aware that in order to sell a product as a repellent, manufacturers just need to demonstrate that it is secure when used according to labeling. Many repellents have not been thoroughly studied, but they are not required to demonstrate that they function. Chemical substances known as toxicants are employed to eliminate pest animals such house mice, Norway rats, pigeons, starlings, and house sparrows. Toxicants must be used with extreme caution to reduce dangers to non-target species, including pets, livestock, wildlife, and people. All applicators must receive training and certification from the US Environmental Protection Agency (EPA) before using restricted use pesticides. Toxicants should be integrated with other WDM methods, such as habitat modification and exclusion, to increase their effectiveness. Always read the label for details and restrictions on the use of a toxicant. For example, most toxicants for rats and mice only can be used “in and around structures” and are not legal for use in landscapes away from buildings.

e). Other methods

To manage a target population, biological management frequently entails the introduction of a disease or predator. Disease-based control is rarely used because there is a chance of unintended outcomes. In the US, there are no registered disease-based products for controlling wildlife. Although often appreciated by the public, predator-based wildlife control rarely works. For instance, some individuals believe that mice and voles can be controlled by putting perch poles all throughout a field to attract raptors. However, predation rarely brings down prey populations to the levels required by landowners. House cats may be skilled "mousers," but they are unable to manage large rodent populations and risk capturing non-target species like songbirds and small mammals. Birth control is essentially fertility control. The majority of contraceptive methods are still in need of approval and are only available to researchers and veterinary professionals. Innolytics, LLC, however, offers an over-the-counter substance that, if administered to wild pigeons for a long enough period of time, may prevent them from laying fertile eggs. The use of these compounds may call for specialized training, permissions, or a pesticide applicator's license and is not permitted in all states.

There are extremely few instances of long-term usage of fertility control medicines actually reducing wildlife numbers and related harm because many wildlife species have long lifespans. Additionally, in open populations, the introduction of new species to the region may make up for a lack of reproduction. Fertility control has occasionally slowed population expansion while leaving animal populations unaffected or with detrimental effects. For medium-sized to large mammals (squirrel-sized and larger), birds, and reptiles, shooting is appropriate. Shooting is not advised for homeowners or Master Gardeners as it demands training and skill. We include it on this list because it is occasionally the most practical and economical approach to resolve a wildlife issue. Before firing, one must take legal and safety considerations into account. Attend a hunter education course or a training school put on by the National Rifle Association for the proper instruction in the use of firearms.

Despite the fact that shooting could be common in some rural locations, many states and localities have laws or ordinances that restrict the use of weapons. You will become familiar with the various kinds of traps and how to use them thanks to the knowledge on trapping. It is crucial to comprehend how traps operate and how to utilize them because they are one of the most often employed techniques to manage wildlife harm. Although many other traps also capture animals alive, the term "live trap" is frequently misused to refer only to cage and box traps. In this guidebook, we'll refer to those that hold animals captive using the more precise names cage traps and box traps. For the majority of their trapping, we generally advise Master Gardeners and homeowners to use cage and box traps. The use of a cage or box trap has numerous benefits. For instance, you can release non-target animals after seeing what you have captured. Box and cage traps are simple to put up and serve as carriers. When an animal treads on a treadle within a cage or box trap, the door(s) at the end(s) of the trap close. Usually, not much site preparation is required. In most cases, both children and dogs are protected from these traps. The majority of people believe themselves to be compassionate, however some animals may harm themselves out of stress from being held or from trying to flee.

How do you get increase the effectiveness of toxicants as a wildlife control agent?

1. What is Biological control in wildlife management?

4.6 Summary

You must have learned about wildlife damage management (WDM) tools and techniques in this unit. You also learned about the need and importance of having a variety of techniques for WDM. You also learn how to resolve wildlife conflicts using Integrated Pest Management (IPM) methods.

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4.8 Possible Answers to Self-Assessment Exercise(s)

Answers to SAE 1

1. Management plans describe the tools a wildlife manager will use for keeping wildlife within the carrying capacity of its habitat**.**

2. If a species of animal is too few in number, those animals can be protected by Laws. Hunting can be reduced or stopped to help lower their death rate increasing population levels; as with threatened or endangered species. In some cases, laws may even be passed to protect the habitat. Laws are mostly used when there is a need for long-term or permanent actions.

Answers to SAE 2

1. Wildlife management areas provide another tool for wildlife managers. These are lands which are set aside for the purpose of increasing wildlife numbers by protecting wildlife and key habitat.

2. W***ildlife managers carefully study the areas before stocking, thus increasing the chances of the animal's survival , coexistence with existing species and people's desire to have them there.***

Answers to SAE 3

1. Biological control typically involves the introduction of a disease or predator to manage a target population.

2. Frightening devices fall into four categories: visual, audio, audio-visual, and biological.

Unit 5: Biological Garden

Unit structure

5.1 Introduction

In this unit you will learn about the botanical garden design, construction, functions and history in relation to conservation practice

5.2 Learning Outcomes

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

- Understand the meaning of a biological garden
- Explain the overall aim of establishing a biological garden
- Explain the functions of a biological garden
- Describe biological gardens as spatial and informational hubs
- Describe the role of Botanical Gardens as Conservation areas
- Describe the history of botanical gardens
- Describe the g**lobal strategies for plant conservation and Perseverance of Botanical garden**

5.3 The Meaning of Biological Garden

Biological gardens (BG)otherwise called botanical or botanic garden, is a collection of living plants designed to show relationships within plant groups. The garden is generally defined as a place for growing flowers, fruits or vegetables. The botanic garden, however, serves as an educational facility for both scientific professionals and the general people, igniting their curiosity in plant life. The gardens are extremely valuable to millions of domestic and foreign visitors in addition to botanists, home gardeners, nurserymen, horticulturists, landscape gardeners, and foresters.

The garden offers a chance to create large-scale environmentally useful landscapes while also instructing people, professionals, and organizations about sustainable green infrastructure. They have a special ability to dramatically affect the direction and pace of urban green space design and development due to their size and function as educational facilities. Large urban parks offer an abundance of natural and informal educational opportunities.

5.3.1 Functions of Biological gardens

The botanical gardens are the natural source of science and culture. The functions of gardens are following:

1. Research Function

When designing and implementing botanical gardens, it is first important to research the relationships between the existing local flora and the plants that will be planted and grown there. Herbaceous and woody plant gardens are used, and their placement is determined by the relationships between the local plant species as determined by the botanical classifications made. The plant species in these gardens are then identified. The botanical name of the plant, its family, its endemic origin, etc. are mentioned on these labels. Through these labels, any visitor to the botanical garden can learn all they need to know about a specific plant. Additionally, botanical gardens act as research hubs by facilitating studies in the field of botany, identifying plant species that are globally endangered, preserving the variety of plant species, and promoting the persistence of habitats and biological diversity.

2. Recreational Function

The availability of green spaces decreases as concrete construction accelerates urbanization. Without previous city planning, concrete structures are built, leaving cities with no green space. Man's increasing longing for nature as a result of his alienation from it leads to the demand for open, green space in metropolitan settings, often known as breathing spaces. There are numerous ways to develop and construct open green space. People are able to spend time in nature and fulfill their leisure demands thanks to the open, green spaces created and used as botanical gardens. These locations help to create a healthy society by providing psychological relaxation to those who feel the need to leave their surroundings for reasons like intense job.

3. Educational Function

A multidisciplinary branch of study known as environmental education refers to systematic initiatives to teach how natural environments work, and in particular, how humans can control behavior and ecosystems to live sustainably and build a citizenship idea sensitive to nature. It is important to preserve environmental sensitivity and awareness in order to develop a culture of intellectually-inclined citizens who can resolve the conflict between environmental problems and moral principles and stop the emergence of new environmental issues. Environmental education should also help people ask better questions and solve problems and make better decisions. Therefore, environmental education must aid in the attainment of high quality living standards by creating an environment of high quality. Botanical gardens are crucial to achieving the objectives of environmental education. With the use of environmental education seminars and individualized, hands-on instruction, people are taught to love nature. Botanical gardens educate tourists about endemic as well as plants growing in various places as part of their objective to promote the native flora of their area.

4. Other Functions

- They provide the physical stability of the city and put the city from an aesthetic aspect to the fore.
- Prevent the pollution of the city air by producing oxygen.
- Enable the city to have a microclimatic feature through an impact on the urban climate.
- Enable the import of new plants into that area and thus increase the economic importance and attractiveness of the region.

5.3.2 Biological gardens as spatial and informational hubs.

One botanical garden is typically all that a city can support. However, they frequently consist of a number of landscapes or are linked to partner gardens, all of which have different foci and are situated in various surroundings. The botanical garden and its satellite partners' expansive, varied

landscapes offer several options for the development of varied, ecologically functional systems. In addition to filtering and storing water in the urban landscape, they can act as source landscapes and refuges for biological creatures at various scales.
By actively teaching the public through seminars, the creation of demonstration landscapes, and acting as a clearinghouse for sustainable design knowledge, biological gardens can serve as a city's informational resource for ecologically sustainable design. In order to draw visitors to the gardens and disseminate knowledge about sustainable design, botanical gardens should make a substantial effort to ensure accessible to the general public.

5.3.3 Botanical Gardens and Conservation

Ex situ conservation is a last-resort shelter: a dangerous refuge from which there may be no escape. Botanical gardens play a more immediate function in research and teaching than actual conservation in the ex-situ culture of rare and endangered species. If we want to have enough information on plant populations that are in danger of going extinct to be able to manage them, this job is vitally essential. The most notable trend in botanical gardens around the world over the 20th century has been an increased awareness of their ability to support conservation efforts, despite the fact that they continue to be vital for recreation and education. Current threats to biodiversity include industrialization, pollution, urbanization, suburbanization, rainforest destruction, climate change, the spread of invasive species as a result of globalization, and the extinction of plant species on a daily basis.
Ex situ conservation is something that botanical gardens can provide for species that are being driven out of their natural habitats. With the establishment of the Botanic Gardens Conservation Secretariat in 1987, the first effort was made to include botanical gardens from all around the world in coordinated conservation activities. The Center for Plant Conservation is currently home to 580 endangered native American species. However, according to its figures, 730 of the 20,000 native plant species in America are now classified as endangered, and about 4,000 are threatened. The most significant scientific role of botanical gardens today seems to be conservation.
The creation of meticulous, consistent, easily accessible, and hence computer-based record systems is essential to the function of botanical gardens in conservation research. If this research is to be successfully implemented, it is not only crucial to have source information and knowledge of the ecology of the wild population; moreover, plant material ex situ must be meticulously inventoried along with thorough records of all treatments and the resulting reactions. Results from earlier studies must be preserved along with records of ex situ living accessions, methodologies used, and, preferably, copies of unprocessed results for later researchers planning to expand on them to evaluate and reanalyse. What is a biological garden?

Self-As

1. How could biological garden serve as information hub?

2. When was the first attempt to involve botanical gardens in a coordinated conservation effort in the world?

5.4 History of Botanical Gardens:

The gardens predate civilization itself. Man had started to grow plants in gardens, provide himself with food conveniently, make medications, or create lovely flowers. Even extremely primitive tribes grow their own vegetables and, quite frequently, flowers. Gardens were major elements of the grounds of temples or palaces in ancient civilizations, as well as the dwellings of the nobles. The quantity of plants that the ancient Egyptians had under cultivation astounded their neighbors. Among the wonders of the ancient world are Babylon's "Hanging Gardens." The art of gardening flourished as a result of new excitement brought on by the Renaissance and the expansion of men's horizons. A new enthusiasm for plant introduction was sparked by the strange and precious species from the recently discovered lands.

As we've seen, herbalists of the sixteenth century introduced the world to hundreds of plants, many of which were found in gardens. The introduction of species from around the world was prompted by a growing interest in flower cultivation to spruce up the areas around residences. The same zeal for knowledge that sparked the growth of the great colleges also gave rise to the building of botanical gardens associated with the educational institutions.

The number of public botanical gardens, many of which were connected to universities or other research institutions, significantly increased in the late nineteenth and early twentieth centuries. Some were left as public gifts. Notable among the botanical gardens begun in this period include the Arnold Arboretum (1872), the New York Botanical Garden (1891), The University of California Botanical Garden in Berkeley, Longwood Gardens, the Brooklyn Botanic Garden, the Huntington Botanical Gardens, the Smith College Botanic Garden, and the Huntington Botanic Gardens were all built between 1893 and 1894. Botanical gardens symbolize the splendor of a nation or a country as well as the development of human culture in the areas in which they are located today. We learn from the thousands of years of history of Nigeria that the emergence of various governments coincided with the flourishing of these gardens. The British colonial administration did, however, create renowned botanical gardens in the middle of the 1880s in order to bring profitable crops from other tropics into Nigeria and to nurture African plants for export to other areas of the empire. However, by the 1930s, a large portion of the grounds had been sold, leaving the remaining space to house the headquarters of the state government's Forestry Commission. The Commission attempted in vain to create a zoo in the garden, and the area has been abandoned for more than 20 years. Despite this, as it is the only green space close to the university and the business district of Calabar city, people still come here to relax in the

shade of its enormous, old trees. The logging activity in the area has put many of these native trees to the rainforests of Cross River State under peril.

Botanical classifications and study started to shift away from morphology and toward physiology near the end of the nineteenth century. This prompted a departure from Linnaean presentations and increased the quantity of scientific equipment needed for a botanical garden.

What ar

Self-As

1. Which was the first botanical garden and did it come to being?

2. What was the purpose of the first botanical garden by the colonial administration in the 1880s?

5.5 Botanical Gardens Collections

A botanical garden typically refers to an outdoor space where different species of plant life are grown and cultivated. An instructive meeting place in a tranquil, rural location or a welcome reprieve in the middle of a busy city center, a botanical garden can improve your town. A botanical garden is a large-scale collection of plants. There is always room for improvement in botanical gardens that preserve all kinds of diversity. There is a need to cultivate more plants, particularly tropical species. Instead of focusing on weeds or cultivars, more attention should be paid to natural variety. Only 5% of the collection consists of non-vascular plants like liverworts and mosses. For everyone, this is a worrying situation. Botanical gardens are more valuable than they are beautiful, though. Botanical gardens serve vital purposes in terms of aesthetics, society, economy, culture, and science. A vast number of species have habitat thanks to the study conducted in botanical gardens, which has an impact on local and worldwide socioeconomics. Although botanical gardens have a rich historical tradition and feature numerous exotic or imported species, such as eucalyptus and conocrispus, there is currently a strong emphasis on species conservation.

5.5.1 Global strategies for plant conservation

Botanical gardens have collectively accumulated skills and resources over many years, and as a result, they now play a crucial role in plant maintenance and monitoring. While many of these accomplishments contribute to ex-situ maintenance, botanic yards also serve a crucial role in sitting maintenance. The botanical garden must adhere to international laws and regulations, such as the Convention on Biological Diversity and the Convention on the International Trade in Endangered Species of Wild Animals and Plants. To stop the increasing extinction of biodiversity, these regulations are essential. The botanical garden is managed scientifically and is the subject of research. Plant variety is preserved in botanical gardens. These tactics concentrate

on how plant species preserve life on earth and work to safeguard plant species around the planet. In every region of the biosphere, there is a wide range in the size and also types of botanical gardens, which are constructed in ways to communicate information regarding effectiveness as well as proof. The following tactics are employed by botanic gardens to preserve the ecological plant biodiversity within an ecosystem. A botanical garden is distinguished from other public gardens by the sorts of plants it contains and its intended use. For instance, a botanical garden may have educational and research objectives. Each plant's common and scientific names, place of origin, requirements for maintenance, advantages, and possibly some lesser-known facts are noted on signs that guide visitors around the garden. Specific botanical garden design guidelines:

- Be open to the public even on a limited basis
- Have an aesthetic, educational and/or research purpose
- Keep records of plants
- Have at least one paid or unpaid staff member
- Help visitors identify plants through informative markers or maps

5.5.2 Perseverance of Botanical garden

Regarding their preservation, numerous collections of authorizations have actually been put together, including the capability of systems for types inventorying and also standing surveillance, as well as the requirement for worked with preservation techniques based on both sitting and also in situ approaches. Long-term use wild sources may be a dependable preservation option for medical plants with severely constrained product lines. Due to the enormous demands of sizable populations, the situation is especially crucial in China and South Africa. The main perseverance of botanical garden is to conserve plant species e.g. cedrus deodara, Dalbergia sissoo

- Without plant there is no life, no energy as our survival depend upon the plants.
- Due to increasing pressure of human population Deforestation, Habitat destruction, Habitat exploitation, Hunting, Habitat fragmentation, two third of the world plant species are near to extinction.
- Botanical garden play vital role to conserve the all types of plants.
- Research can be conducted easily in botanical garden.
  How can a botanical garden enhance your community?

Self-A

1. What are the specific biological garden design guidelines?
2. How can a botanical garden enhance your community/town through its services?

5.6 Summary

Botanical gardens are very significant organizations which protect the environment against the increasing environmental problems, provide environmental education for people, offer recreation possibilities, etc They are important places that discover and share knowledge about plants and their environment, in order to preserve and enrich life. The Garden seeks to engage its visitors on a profound level - "to preserve and enrich life" by illuminating the importance of plants to the balance of life on Earth.

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4.9 Possible Answers to Self-Assessment Exercises

Answer to SAE 1

1. Biological gardens can serve as a city's informational database for ecologically sustainable design by actively educating the public through classes and the construction of demonstration landscapes as well as by serving as a clearing house for information about sustainable design.

Answer to SAE 2

1. Arnold Arboretum in 1872
2. To introduce economic crops into Nigeria from other parts of the tropics and to cultivate African plants for export to other parts of the empire.

Answer to SAE 3

2. The first attempt to involve botanical gardens around the world in coordinated conservation efforts was made in 1987 with the founding of the Botanic Gardens Conservation Secretariat.

1. Biological garden design guidelines include the following specific guidelines:

- Be open to the public even on a limited basis
- Have an aesthetic, educational and/or research purpose
- Keep records of plants
- Have at least one paid or unpaid staff member
- Help visitors identify plants through informative markers or maps.

2. A botanical garden can enhance your town by providing a welcome respite in the midst of a bustling city center or an educational gathering spot in a sleepy, rural area.

Glossary

°C	Centigrade
BG	Biological garden/ Botanical garden
Cm	Centimetre
co2	Carbondioxide
EPA	Environmental Protection Agency
Kg	Kilogram
MBTA	Migratory Bird Treaty Act
NYSDEC	New York State Department of Environmental Conservation
TES	Threatened and Endangered Species
US	United State
WDM	Wildlife Damage Management
WMAs	Wildlife Management Areas

End of Module Questions

1. Explain the stepwise procedure in the establishment of biological garden
2. What are the problems of wildlife management in Nigeria?
3. What are the three main aims of wildlife management?
4. Provide some examples of habitat modification and the species for which the technique would be appropriate.
5. If trapping an animal that is causing damage, how would you decide which of the three categories of lures to use?

Module 4: Population Dynamics and Wildlife Management

Module Structure

In this module we will discuss about population dynamics and wildlife management with the following units:
Unit 1: Wildlife Population Dynamics
Unit 2: Principles of ecosystem management
Unit 3: General Principles of wildlife Management
Unit 4: Wildlife Zoonoses
Unit 5: Fire as tool in terrestrial wildlife management.

Unit 1 Wildlife Population Dynamics

Unit structure

1.1 Wildlife population Dynamics

In this unit we provide an overview of some core concepts, describe exponential growth as the basic foundation for understanding population dynamics, and discuss some of the factors that can

affect wildlife population dynamics. We then show how management insights that can be gained from analyzing the dynamics of individual age or stage classes, examine dynamics of multiple populations across a landscape, consider key aspects of monitoring wildlife population dynamics, and close with a case study applying many of the topics in the chapter.

1.2 Intended Learning Outcomes (ILOs)

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

- Explain the Basics of Population Dynamics
- Describe population characteristics
- Describe how to measuring population density
- Explain the three types of population models
- Understand that the models can be used to understand and predict population dynamics
- Explain that biotic interactions and abiotic conditions limit the sizes of populations
- Describe the Density-Dependent Regulation and Density-Independent Regulation and the Interaction with Density-Dependent Factors

1.3. The Basics of Population Dynamics

The area of ecology known as population dynamics deals with how population size and density for one or more species change across time and space. Wildlife experts typically refer to a population as the total number of a specific species in a particular area. They refer to the change in the population's size and demographic makeup through time as dynamics. Regardless of the species, all types of wildlife will experience swings in animal populations in response to changes in habitat, hunting or trapping, and weather. While many significant ideas will be covered, one overarching topic should always be kept in mind. There is always some change in the habitat, whether or not a property is maintained in a particular year. Wildlife must adapt to this fluctuation, therefore no population remains constant from year to year. Wildlife experts typically refer to a population as the total number of a specific species in a particular area. They refer to the change in the population's size and demographic makeup through time as dynamics. A population is a collection of people belonging to the same species that are present in a certain location at a particular time. The population density, birthrate, and deathrate are a few traits of populations that biologists are interested in. The immigration rate and emigration rate are also interesting if there is emigration from or into the population. When taken as a whole, these demographic metrics or traits explain how the population density varies through time. Population dynamics is the study of how populations change through time, either increasing, declining, or doing both.

Population density is the ratio of people to units of land area, such as the number of deer per square kilometer. Although this is simple in theory, it can be difficult to estimate population densities for many species in practice. A **population** is a convergence of individuals of the same species who live, interact, and reproduce in the same geographic region. Dynamics refers to the factors that cause change. The result of combining the two is population dynamics. The study of population dynamics examines how a population's size changes over time in response to changes in the rates of immigration, emigration, births, and deaths. To better understand how a population interacts with its environment, we should go over basic terms before we begin our discussion of population dynamics. Ecology may use population dynamics in a wide range of practical ways. Departments of fish and game keep an eye on the population to guarantee that fishing and hunting are safe. To safeguard their crops, agricultural groups keep tabs on pest numbers. Environmental protection organizations monitor changes in population levels to safeguard the

survival of vulnerable, endangered, or endangered species. Populations must adjust to the biotic and abiotic elements of their surroundings in order to persist in their ecosystems. There is a lot of rivalry and a lack of resources when population and community density are high. When vying for resources, some species are particularly successful. They expend a great deal of energy on this instead of on reproduction. As a result, their population only occasionally grows faster than their carrying capacity. A K-selected species has fewer offspring and slow, logistic growth-curve-following population increase. Examples of K-selected species include bears, tortoises, and elephants. However, certain species don't make for effective rivals. In order to make up for this, these species have evolved high population increase during times of resource plenty, when competition is less important. These r-selected species produce high numbers of offspring and have rapid exponential population growth, temporarily exceeding the ecosystem's carrying capacity. Booms and crashes in population expansion are common occurrences for the r-selected species. Examples of r-selected species include mouse swarms during abundant growing seasons or salmon spawning during the breeding season.

1.3.1 Population characteristics

The study of population dynamics tracks changes in the populations' static physical characteristics. These are the main traits of populations that can be seen.

Size

Size is the total number of people in a population. This total symbolizes a distinct moment in time. We therefore require at least two data points at time A and time B when observing population dynamics. The capital letter "N" is frequently used in population ecology as a sign for population size.

Density

The population density is the number of people in a region. For instance, a population of squirrels that is particularly dense might have one squirrel every square meter, but a population that is more dispersed would have one squirrel per square kilometer. The amount of competition increases with population density. There may be competition among the numerous squirrels in the square meter for the same acorn. The relationship between density and biotic factors influencing population growth is very significant.

Dispersion

The geographic distribution, or clustering, of the members of a population is referred to as dispersion (Fig. 2). Similar to density, but slightly different, is this attribute. For instance, a woodpecker living in a beech-maple forest roams the entire forest, but because of the soft bark of maple trees, it may congregate there.

Sex distribution

The percentage of males and females in a population is known as the sex distribution. The highest possible birth rate can be calculated using population dynamics by calculating the number of people of each sex in a population. Population growth can be projected by extrapolating the number of breeding females. A sex ratio, which is a percentage that compares the proportion of people of one sex (for example, women) to people of the other sex, can be used to quickly summarize the distribution of people by sexes (e.g., males).

Age distribution

The term "age distribution" refers to the number of people in a population who fall within a given age range and who are organized into classes or cohorts. A cohort is a group of people in a population who were all born around the same time. Cohorts are used in population dynamics to determine a population's age, boom or bust status.

1.3.2 Measuring Population Density

Simply counting all the people is one technique to gauge population density. But doing this can be time-consuming. As an alternative, the quadrat approach frequently yields accurate estimates of population density. In the quadrat approach, every member of a certain species is tallied in a particular subplot of the entire study area. The total number of individuals for the entire habitat is then calculated using this data. The quadrat approach is especially well adapted for determining the population densities of species that are dispersed across the environment pretty equally. For instance, it has been applied to estimate the population density of species found in the soil, like nematode worms. It is frequently used to calculate the density of plant populations. The capture-recapture technique might be applied to creatures that are more mobile. This method allows for the capture, marking, and release of several people. A second group of people is taken after some time has passed, long enough for the population to mix. The proportion of people who are marked in the second capture set can be used to estimate the size of the population as a whole. Obviously, this approach only succeeds if one can anticipate that members of the population will mingle and move around frequently. For instance, in territorial animals where individuals like to hang around their territories, it would not function. The number of new people generated in a population per unit of time is known as the birthrate. The death rate, also known as the mortality rate, refers to the quantity of people who pass away within a population per unit of time. The amount of people who enter a population from a different place per unit of time is known as the immigration rate. The emigration rates give the number of people leaving the population each unit of time. We can predict whether a population will grow or shrink based on the values of these four population characteristics. The formula for calculating a population's "intrinsic rate of increase" (r) is given as r = (birth rate immigration rate +)-(death rate + emigration rate).

If r is positive, then the population will grow by more people than it will shrink. As a result, more people will live there. If r is negative, the population will get smaller because more people will leave the population than join it. The population size is steady and does not vary if r is exactly zero. A population is said to be in equilibrium when its density is stable.

What exactly is meant when using the term population dynamics in biology?

Self-As

1. When is a population said to be in **equilibrium**?

2. How can good estimates of mobile population density be obtained in wildlife studies?

1.4 Population Models

We will now look at a number of population models, each of which can be used in a variety of environmental situations. We will also take into account how well these models match population data from studies of natural populations in the wild and laboratory experiments.

1.4.1 Exponential growth.

The first and most fundamental model of population dynamics makes the assumption that an ecosystem has infinite resources and is capable of supporting an infinite population. Although in many scenarios it is obvious that this assumption is untrue, there are some situations when there are enough resources available to make this model work. In these conditions, the population growth rate is constant and equal to the intrinsic growth rate, r. Exponential growth is another name for this. If *r* is negative, the population declines quickly to extinction. However, if r is positive, the population grows, initially slowly and then steadily faster. Because the population size curve over time has a "J-shaped" shape, exponential growth is also referred to as "J-shaped growth." Additionally, exponential growth is also known as "density-independent growth" because it is continuous and does not depend on population density. Small populations, which are more likely to have abundant resources, frequently experience exponential expansion. However, J-shaped expansion cannot last, and a population fall is ultimately unavoidable. Numerous species do in fact experience exponential growth cycles followed by population declines. Lab-grown bacteria serve as a great illustration of exponential development. With exponential growth, the population's growth rate gradually rises over time in line with the population's size. Consider a population of mice that increases exponentially every year by a factor of two, starting with 2 in the first year and increasing to 4 in the second, 8 in the third, 16 in the fourth, and so on. In this example, the population is increasing by a factor of 2 year.

1.4.2 Logistic growth.

Logistic growth is an alternative model of population expansion. Due to the S-shaped curve that describes population density over time, logistic growth is also known as "S-shaped growth." The rate of population increase in an S-shaped growth relies on the population's density. The rate of growth is strong when the population is small. But the rate of growth slows down when population density rises. Finally, the population stops expanding and begins to shrink once the population density reaches a specific level. Logistic growth is also referred to as "density-dependent growth" because the population's pace of expansion is based on population density. Analyzing population size over time under logistic growth reveals that, similar to J-shaped growth, population size increases slowly at initially before increasing more fast. Contrary to exponential growth, this increase stops there. Instead, growth decreases and the population reaches a fixed, maximum population density, where it stabilizes. The number of people who can be sustained by the resources present in a specific habitat is expressed as a defined maximum, known as the carrying capacity. The variable K stands for carrying capacity. If people are added to a population above and above the carrying capacity, population size will fall until it reaches K because the carrying capacity reflects a stable equilibrium for a population. On the other hand, a population will grow until it exceeds the carrying capacity if it is less than that amount. However, keep in mind that the carrying capacity might alter over time. K is influenced by a

wide range of variables, including both abiotic circumstances and the influence of other living things.

A realistic picture of many species' population dynamics can be obtained using logistic growth. It has been created in experimental settings using fruit flies and single-celled organisms, frequently when populations are kept in a small area with consistent environmental conditions.

Perhaps surprisingly, natural populations have fewer instances of logistic expansion. This could be because the model assumes that the response of population growth to density (i.e., that population growth slows with increasing population densities and actually decreases in size when density is above carrying capacity) is instantaneous. In reality, it almost never takes immediately after a high population density to feel its effects. Due to the relatively short life cycles and relatively quick reproduction of most species employed in laboratory investigations, the time lag may also be the reason why it is simpler to generate logistic growth patterns in the lab. Biological species may be classified as either r-selected or k-selected, depending on whether their population dynamics tend to follow exponential or logistic growth more frequently. Dramatic oscillations, such as periods of exponential expansion followed by population crashes, are common in r-selected organisms. These species have evolved for rapid growth and reproduction as well as high dispersal skills, making them especially well-suited to taking advantage of transient moments of enormous resource abundance.

Population density is more steady in the k-selected species, frequently as a result of the relatively stable environments that these species occupy. There is fierce rivalry among members of the same species for scarce resources because k-selected species are found at densities that are almost equal to the carrying capacity of the habitat. As a result, k-selected individuals frequently possess characteristics that maximize their capacity for competition. These two life history techniques are associated with a variety of biological features.

1.4.3 Lotka-Volterra models.

We have been concentrating on the population dynamics of a single species in isolation up to this point. The logistic model of growth only takes into account competing species, possible prey, and prospective predators to the extent that they have an impact on the environment's carrying capacity. However, population dynamics models can also directly take into account interactions between species. The Lotka-Volterra models, one for competition between two species and the other for interactions between predators and prey, have each been the subject of in-depth research.

Competition represents a situation when two populations of different species make use of a limited resource. Two outcomes are possible, according to the Lotka-Volterra models of population dynamics of competition: either the two competing species are able to coexist, or one species eradicates the other. These models have undergone extensive testing in the lab, frequently using rival yeasts or grain beetles.

In lab experiments, numerous instances of competitive elimination were noted. When another species is introduced into the same environment, a species that had been thriving in isolation will start to deteriorate and eventually die extinct. It was also possible to create coexistence between two species in the lab. These experiments, in an interesting turn of events, demonstrated how much the particular environmental conditions dictated the outcome of competitive experiments. The outcome of competitions between yeasts frequently depended on minute alterations in the environment, such as temperature.

Competition is a rather regular occurrence in natural populations, according to studies. For instance, when one species is eliminated, it frequently results in an increase in the number of

other species that rely on the same resources. Two species can never share the same niche, which is another crucial finding of the Lotka-Volterra competition equations. If they both utilize resources in the same manner, they will inevitably drive each other extinct. The competitive exclusion principle refers to this. There are four conceivable outcomes from the Lotka-Volterra models for the dynamics of interacting predator and prey populations. First, populations of both predators and prey may attain stable equilibrium points. Second, there's a chance that both predators and prey go through endless oscillating (alternating) cycles of growth and decline. Third, the prey species may reach a stable population level that is equivalent to its carrying capacity after the predator species goes extinct. Fourth, the predator may starve to extinction and then force its prey to extinction.

Biologists have attempted to replicate each of these impacts in experimental conditions, just like with competitive dynamics. These studies yielded an intriguing finding: in relatively straightforward, constrained circumstances, the predator will always kill the prey before starving to death. Both predator and prey species appeared to be reliant on surviving in a moderately complicated environment that had areas for the prey to hide. Predator removal experiments have been used in investigations of predator-prey interactions in wild populations. Unexpectedly, it has frequently been challenging to provide solid evidence that predators restrict prey densities. This could be as a result of the predators' preference for weak, ill, or elderly people in many predator-prey relationships. However, the eradication of dingoes in some parts of Australia provided a convincing illustration of a predator's ability to control prey density. After the predators were eliminated, the number of kangaroos in these areas increased dramatically. Continuous shifts in the ratio of predators to prey do not seem to be typical in natural populations. But there is one instance of oscillations in the populations of the snowshoe hare, a prey species of the Canada lynx. About every ten years, both species reach their highest levels of abundance. What happens to population size over time under exponential growth?

Self-As

1. How is **competitive exclusion principle** stated?

2. What does the carrying capacity concept represents?

1.5 Predicting population dynamics

Mathematical models are frequently used by population dynamics researchers to describe, forecast, and comprehend the factors influencing population dynamics. Can we forecast how many Kirtland's Warblers will be present next year, or in ten years, if there are 2500 of them in Michigan this year? The Kirtland's Warbler was designated as an Endangered Species in 1967 due to its tiny population size. It was delisted in 2019 and is now regarded as "Near-threatened." Ecologists are particularly interested in utilizing models to forecast future Kirtland's Warbler population sizes and the factors that influence their growth and decline. The conceptual and mathematical approaches ecologists employ to comprehend population dynamics and forecast future trends will be covered in the following unit.

1.5.1 Biotic interactions and abiotic conditions limit the sizes of populations

Numerous techniques can be used to control population dynamics. These are divided into two categories: density-dependent factors, which impact growth rate and mortality depending on population density at a specific moment, and density-independent factors, which have no effect on population density. Be aware that in the first scenario, the population's response to the factor depends on its initial density. Understanding both categories is important for conservation biologists because it allows them to manage populations and stop extinction or overpopulation.

1.5.2 Density-Dependent Regulation

Predation, intra- and interspecific competition, waste buildup, and diseases including parasitic diseases are among the biological (biotic) variables that affect density the most. Typically, a population's death rate increases with population density. For instance, the individuals' reproductive rates will often be lower during intra- and interspecific competition, slowing the rate of population expansion. Additionally, because the predator has a harder time locating its food supply, low prey density raises the mortality rate of the prey.

Figure 1 below presents findings from a study concentrating on the giant intestinal roundworm (Ascaris lumbricoides), a parasite of humans and other mammals, as an illustration of density-dependent control. Less fecundity, or fewer eggs, was seen in denser parasite populations. This could be explained by the fact that smaller females would lay fewer eggs in denser populations since there would be less resources available to them. In a 2009 study, this concept was examined and refuted, demonstrating that female weight had no bearing (Walker et al. 2009). Further research is needed to determine the exact reason for this organism's density-dependent fecundity.

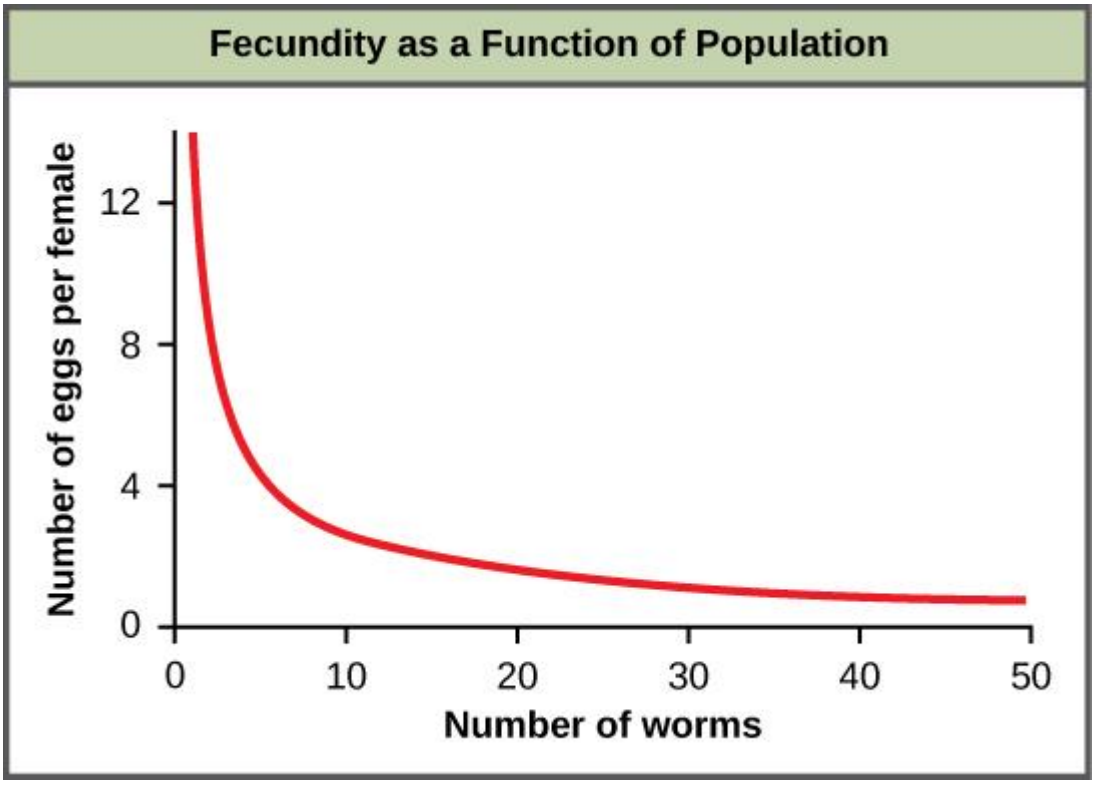

Figure 1. In this population of roundworms *Ascaris lumbricoides*, fecundity (number of eggs) decreases with population density.

1.5.3 Density-Independent Regulation and Interaction with Density-Dependent Factors

Regardless of population density, a number of abiotic (physical or chemical in nature) elements, such as weather, natural catastrophes, and pollution, affect death rates. Regardless of how many deer happen to be around, a single deer could perish in a forest fire. Whether there is a large or low population density, its odds of survival are the same. The chilly winter weather is no different. Population control in the actual world is extremely complex, and independent and dependent factors may interact. A dense population that is decreased by one or more environmental factors in a density-independent manner will be able to rebound in a different way than a sparse population. For example, a population of deer affected by a harsh winter will recover faster if there are more deer remaining to reproduce.

What is the relationship between population models and dynamics?

Self-Assessment Exercises 3

1. How can models e used to understand and predict population dynamics?
2. How can population dynamics can be regulated?

1.6 Summary

You have learned in this unit about the meaning of population studies and population dynamics as the scientific study of human populations and the analysis of the factors that affect the increase, stability, and decrease of populations over time respectively. You have also studied about the main components of population change are births, deaths, and migration. "Natural increase" is defined as the difference between live births and deaths. "Net migration" is defined as the difference between the number of people moving into an area and the number of people moving out.

1.7 References/Further Readings/Web Sources

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1.8 Possible Answers to SAEs

Answers to SAE 1

1. A population whose density is not changing is said to be at equilibrium.

2. Estimates of mobile population densities cab be obtained using the mobile organisms, the capture-recapture method

Answers to SAE 2

1. The competitive exclusion principle states that "two species can never share the same niche" If they use resources in exactly the same way, one will inevitably drive the other to extinction.
2. The carrying capacity concept represents the maximum number of individuals that can be supported by the resources available in the given habitat. Carrying capacity is denoted by the variable *K*. The fact that the carrying capacity represents a stable equilibrium for a population means that if individuals are added to a population above and beyond the carrying capacity, population size will decrease until it returns to *K*.

Answers to SAE 3

1 Researchers who study population dynamics often use mathematical models to describe and predict population dynamics and understand what factors are driving those changes

2. 2. Population dynamics can be regulated in a variety of ways; these are grouped into density-dependent factors, in which the density of the population at a given time affects growth rate and mortality, and density-independent factors, which influence mortality in a population regardless of population density.

Unit 2: Ecosystem Management

Unit Structure

2.1 Introduction

This learning unit will discuss the meaning and types of ecosystem management as its relate to biodiversity conservation. It will describe the approaches to Ecosystem Management from conservation point of view which will help to meet the worlds socioeconomic, political and cultural needs and protect the environment for the future generation.

2.2 Intended Learning Outcomes (ILOs)

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

- Define and explain the meaning of an **Ecosystem**
- Describe what is Ecosystems Management
- Understand the Principles in Ecosystem Management
- Identify the Stakeholders in Ecosystem management
- Describe the Types of Ecosystem Management
- Explain the Approaches to Ecosystem Management
- Describe the Strategy for Sustainable Development

2.3 The meaning of Ecosystem

An ecosystem is a region where a bubble of life is created by plants, animals, and other organisms interacting with the weather, environment, and other factors. Abiotic variables, or nonliving components, coexist with biotic components in ecosystems. Plants, animals, and other species are biotic factors. Along with rocks, temperature and humidity are abiotic variables. A community or group of living things that coexist and interact in a particular habitat is the most basic definition of an ecosystem. Ecosystems are "the basic unit in the field of the scientific study of nature," according to the recognized scientific definition. This field defines an ecosystem as a physically defined environment that consists of two interdependent parts: i) The biotope (abiotic): a particular physical environment with specific physical characteristics such as the climate, temperature, humidity, concentration of nutrients or pH; and ii). The biocenosis (biotic): a set of living organisms such as animals, plants or micro-organisms, that are in constant interaction and are, therefore, in a situation of interdependence. There are various scales of magnitude at which the term "ecosystem" is applicable. From lakes, mountain ranges, forests, or multicellular organisms like insects, animals, or plants to the entire planet Earth.

Every component of an ecosystem is directly or indirectly dependent upon every other component. An ecosystem's temperature changes frequently have an impact on the types of plants that may flourish there, for example. Animals that rely on plants for food and shelter must evolve with the times, relocate to another ecosystem, or perish.

Ecosystems can vary greatly in size. Tide pools, or the ponds that the ocean leaves behind as the tide recedes, are full-fledged, miniature ecosystems. Seaweed, a type of algae, which employs photosynthesis to produce, is found in tide pools.

Seaweed is consumed by herbivores like abalone. Sea stars and other carnivorous creatures in tide pools consume clams and mussels. Tide pools are reliant on the fluctuating ocean water level. In an aquatic setting, when the tide is in and the pool is full, some creatures, like seaweed, thrive. Hermit crabs, for example, cannot survive underwater and are dependent on the shallow

pools that low tides leave behind. The biotic components of the ecosystem are thus dependent on abiotic elements.

Earth's surface is made up of a network of interconnected ecosystems. In a bigger biome, ecosystems are frequently interconnected. Large areas of land, water, or atmosphere are known as biomes. For instance, biomes include things like forests, ponds, reefs, and tundra. They are arranged fairly broadly according on the kinds of animals and plants that inhabit them. You will find a variety of habitats in every forest, pond, reef, and area of tundra.

For instance, the Sahara Desert biome has a diverse range of ecosystems. The biome is characterized by its hot and dry weather. Oasis habitats with date palm trees, freshwater, and creatures like crocodiles can be found within the Sahara. Additionally, the Sahara features dune ecosystems, with the wind controlling the shifting topography. These ecosystems' inhabitants, such snakes and scorpions, must be able to endure long periods of time in sand dunes. Even the ocean is a part of the Sahara, as the Atlantic Ocean produces cold fogs on the coast of Northwest Africa. This Saharan habitat is home to shrubs and creatures like goats that eat tiny trees.

Even biomes with a similar name may have very different ecosystems. For instance, the Gobi Desert biome in Mongolia and China is substantially dissimilar from the Sahara Desert biome. A chilly desert with frequent precipitation and subfreezing temperatures is the Gobi. In contrast to the Sahara, the Gobi features ecosystems built on miles of bare rock, not sand. Some grasses can thrive in the harsh, dry weather. As a result, grazing animals like gazelles and even the endangered wild horse species takhi can be found in these Gobi environments.
What is biocenosis as a component of ecosystem?

Self-As

1. What are the physically two inseparable components of an ecosystem?

2. What are the possible scales of magnitude of the concept of ecosystem?

2.4 Ecosystem Management

Ecosystem management is a strategy for managing natural resources that strives to maintain an ecosystem's capacity to function and provide benefits over the long term while also addressing economical, political, and cultural concerns. The practice of maintaining the major ecological goods and services while repairing and conserving the natural resources that support productive grasslands is further defined as ecosystem management. Ecosystem management techniques offer ways to increase biodiversity conservation at various scales, lessen habitat loss and fragmentation, rehabilitate habitat for wildlife and endangered species, increase forage production, maintain watershed and soil protection, and more. The foundation of a sustainable ranching enterprise and a factor in the environmental surroundings is a healthy grassland ecosystem. Additionally, by increasing the land's capacity for production and lowering production risks, these measures can lessen the demand for inputs like pesticides and fertilizers. They could be able to keep or even raise operational profitability. Adopting such advantageous management techniques can also raise the value of the land and open up chances for alternative revenue production through leisure and other niche market activities.

The ecosystem approach is a method for managing land, water, and living resources in an equitable manner while promoting conservation and sustainable use. The three goals of the Convention on Biological Diversity can thus be balanced with the help of the ecosystem approach: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The fundamental structure, processes, functions, and interactions between organisms and their environment are included in an ecosystem approach, which is based on the use of appropriate scientific procedures targeted at levels of biological organization. It acknowledges that people, with their wide variety of cultures, are an essential part of many ecosystems.

The Convention on Biological Diversity approved of the ecological concept. The implementation of this strategy entails, among other things, intersectoral cooperation, management decentralization to the lowest effective level, equitable benefit distribution, and the use of adaptive management policies that can deal with uncertainties and are modified in light of experience and shifting conditions. Article 8(j) of the Convention will be supplemented by the implementation process by drawing on the expertise, ideas, and customs of local communities. It is necessary to use a multidisciplinary strategy that considers scientific, social, and economic factors.

The definition of "ecosystem" in Article 2 of the Convention on Biological Diversity is congruent with this emphasis on structure, processes, functions, and interactions: "A dynamic complex of plant, animal, and microbial communities as well as their non-living surroundings functioning as a functional unit is referred to as an ecosystem." Unlike the Convention definition of "habitat," which specifies a specific spatial unit or scale, this definition leaves both open. As a result, the term "ecosystem" does not necessarily equate to the terms "biome" or "ecological zone," but instead can apply to any functional unit. Indeed, the scope of the investigation and the course of action should depend on the issue at hand. For instance, it might be a single soil molecule, a pond, a forest, a biome, or the entire biosphere.

Due to ecosystems' complexity, dynamic nature, and lack of perfect knowledge or understanding of how they work, the ecosystem approach necessitates adaptive management. Ecosystem processes are frequently non-linear, and the results frequently exhibit delays. Discontinuities as a result cause surprise and uncertainty. In order to respond to such uncertainties, management must be adaptable and incorporate "learning-by-doing" or research input. Even if some cause-and-effect linkages are not yet fully proved scientifically, action may still be required. The ecosystem approach could instead integrate all of these approaches and other methodologies to deal with complex situations. Other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, are not excluded by the ecosystem approach. The ecosystem method can be applied in a variety of ways depending on local, provincial, national, regional, and even global circumstances. Ecosystem techniques can, in fact, be applied in a variety of ways as a framework for achieving the Convention's practical goals.

The objectives-appropriate spatial and temporal scales should define the ecosystem approach's boundaries. The operational definition of management boundaries will involve users, managers, scientists, and indigenous and local peoples. Where necessary, connectivity between places should be encouraged. The hierarchy of biological diversity, as demonstrated by the interaction and integration of genes, species, and ecosystems, is the foundation of the ecosystem approach.

3.4.1 Principles in Ecosystem Management

1. Promote societal choice using transparent and equitable processes and tools

Use decision support tools that incorporate viewpoints of stakeholders; recognise conflicting positions and trade-offs and build into processes and decisions in a transparent manner.

2. Delegate decisions to the most suitable scale

Tools to be operable at and across different scales to engage all potential stakeholders; they need to be accessible, robust, flexible and intuitive to enable multiple participants to work at different levels.

3. Assess adjacent effects

Tools that treat ecosystems as interconnected, operative systems, yet which can operate in the absence of sufficient data. The utilization of natural borders at a landscape scale is one of the necessary mechanisms to improve framing and bounding of evaluations.

4. Incorporate social and economic factors

Identify and comprehend the connections between ecological systems, society, and the economy. Recognize and evaluate the forces driving change while taking uncertainty and knowledge gaps into account. Recognize that repercussions might be unpredictable and that natural systems (not just stocks) are complex. Tools that can cope with spatial repercussions, equality issues, and prospects for new markets are required.

5. Encourage ecosystem resilience

Determine the advantages that people receive from ecosystem services so that preservation, improvement, and, when necessary, restoration of specific ecological structures, functions, and services may be guided. The body of evidence is an important factor. Ecosystem services must be effectively incorporated using current valuation and decision-making tools.

6. Address environmental limit uncertainties

Environmental boundaries are not well understood at this time. The use of adaptive management tools and the precautionary principle are both essential. Integrate social learning into your tools to enhance future reactions and comprehension. Recognize that many decisions are made in situations that resemble courts and offer appeal opportunities.

7. Operate at and across multiple spatial and temporal scales

To achieve management objectives, management interventions and instruments must function at several geographical and temporal scales because ecosystem drivers and responses vary both spatially and across time.

8. Promote a long-term strategy.

Consider long-term horizons to improve the long-term satisfaction of human needs, the resilience of productive ecosystems, and the sustained flow of ecosystem services. Diverse temporal scales and delayed effects define ecosystem processes. The short-term orientation of economic and political institutions is naturally at odds with this.

9. Manage change to best advantage

To get good/ideal results, tools should make it easier to understand and manage change. Consider how things have changed and use your learnings into ongoing management and policy development. When making rigid judgments, proceed with prudence.

10. Encourage biotic diversity

Include the non-market worth of biological diversity in the tools and procedures used for making decisions. Biological diversity is essential for ecosystem integrity, resilience, and functioning to deliver the services that we all eventually depend on, as well as for its intrinsic value.

11. Optimise evidence from multiple sources

Obtain evidence from all relevant parties in the various built- and natural-environment sectors (local and expert). Maximize clear, solid decision-making while making sure that tools can balance divergent knowledge and viewpoints.

12. Increase and uphold stakeholder involvement

Utilize expert and local knowledge across scales and sectors to gather and engage the necessary expertise, integrating disagreements into the development of solutions and judgments rather than "defending" expert opinions once they have been established and made public. To gather public opinion and create an engaging conversation, employ deliberative and iterative engagement techniques and focus on both usual and unusual suspects.

2.4.2 Stakeholders in Ecosystem management

Everyone is impacted by environmental choices and activities in ecosystem management, but we also have the ability to shape how those choices and actions affect our ecosystem and the globe as a whole. The complexity of ecosystem management decisions, from local to global scales, necessitates stakeholder involvement from a variety of knowledge, perspectives, and values of nature. Different interests in ecosystem services will frequently exist among stakeholders. This means that in order to negotiate effectively about matters of shared interest and establish partnerships that benefit both parties, it is necessary to build mutual trust.

What necessitates stakeholder involvement in ecosystem management?

Self-Assessment Exercises 2

1. How do you ensure the incorporation of economic and social drivers in ecosystem management?
2. How do you encourage ecosystem resilience in ecosystem management?

2.5 Types of Ecosystem Management

• Adaptive Management. The idea behind adaptive management is that it is difficult and constrained to foresee the impacts and disturbances that will affect an ecosystem in the future. As a result, adaptive management aims to manage the ecosystem in a way that maximizes ecological integrity while also using management techniques that can adjust in response to new information and insights.

• Natural Resource Management. When dealing with a specific resource for human use rather than managing the entire ecosystem, the term "natural resource management" is usually employed. Sustainability for future generations is a key goal of natural resource management, and ecosystem managers are charged with finding a long-term balance between resource use and conservation. At various spatial and temporal scales, the harmonious interaction between each resource in an ecosystem is susceptible to change. It is necessary to take individual and landscape-level considerations of factors including soils, vegetation, and fauna, as well as watersheds. Natural resources can be used to provide food, medicine, energy, and shelter.

• Strategic Management. Setting goals that will benefit the ecosystem while keeping socioeconomic and political concerns in mind is encouraged by strategic management. Strategic management is distinct from other approaches to ecosystem management in that it involves all relevant parties and depends on their input to determine the most effective management plan for a given ecosystem. The evaluation and review of any changes, advancements, or negative effects are given great priority in this strategy, just like in other ecosystem management strategies, and flexibility in altering management protocols in response to new information is given priority.

• Landscape level control/Conservation. When conducting conservation programs, landscape level conservation takes the needs of species at a larger landscape scale into account. This method of managing ecosystems takes the whole breadth of an environmental issue into account by taking into account large, interconnected ecological systems. It can be difficult to balance human demands with wildlife needs in a world where humans are predominate.

• Command and control management. In command and control management, a perceived problem is resolved by controlling tools including laws, threats, contracts, and/or agreements. This method of problem resolution is known as linear problem solving. This top-down method, which is employed across a wide range of disciplines, performs best with issues that are clear-cut, well-defined, and cause-and-effect in nature. The use of command and control management

has frequently sought to regulate nature in an effort to increase product extraction, provide predictability, and lessen risks. The use of herbicides and pesticides to protect crops in order to harvest more products, the eradication of predators in order to obtain larger, more dependable game species, and the protection of the timber supply by putting out forest fires are a few clear examples of command and control management practices.

2.5.1 Approaches to Ecosystem Management

Without compromising the socioeconomic, cultural, and cultural interests of the present and future generations, ecosystem management attempts to protect important ecological functions and restore natural resources. Four basic strategies are used to manage ecosystems: preservation, conservation, use, and exploitation. Despite being separate strategies, many of them can be combined and interwoven.

Preservation in the context of ecosystem management refers to the safeguarding of habitats and species in their current state. This frequently entails outright banning any human activity there, putting all artificial activities at risk in the name of preserving the natural environment. This method of managing ecosystems confines natural regions to which people are not allowed access regardless of their activities, thus wasting resources. Despite the possibility of overlap, resource management is not necessary for preservation because there is no human activity. A land trust that guards a forest against logging or other destructive activities is an illustration of ecosystem preservation.

Conservation is the intentional efforts to reduce harm to an environment and the sustainable management of resources. A national park is one example of a place that uses its natural resources to generate some economic benefit while maintaining the health of its ecology and surroundings. Although it doesn't go as far as preservation, conservation makes use of the resources at hand to draw attention, reduce harm and environmental waste, and maintain an area's natural beauty.

2.5.2 Strategy for Sustainable Development

The idea of a sustainable development strategy was established in recognition of the necessity to address environmental challenges as well as the requirement to sustain development and progress. The idea for the Sustainable Development Strategy includes:

- Assimilating environmental considerations in administration
- Apposite pricing of natural resources
- Conservation of biodiversity
- Rehabilitation of ecosystems
- Control of population growth and human resources development
- Inducing growth in rural areas
- Promotion of environmental education
- Strengthening citizens participation
- Promoting small to medium sized enterprises
- Sustainable agricultural and forestry practices.
- One of the initiatives signed in part of the strategy was the 1992 Earth Summit.

What is the aim of adaptive ecosystem management?

Self-Assessment Exercises 3

1. What are the different types of Ecosystem Management?

2. What are the four ways in which the ecosystem management approach is premised?

2.6 Summary

You have learnt the meaning of an ecosystem and ecosystem management as a community or group of living organisms that live in and interact with each other in a specific environment, and as managing areas at various scales in such a way that ecological services and biological resources are conserved while appropriate human uses are sustained. You also have learnt about the approaches for ecosystem management and the strategies for sustainable development.

2.7 **References/Further Readings/Web Sources**

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2.8 Possible Answers to Self-Assessment Exercises

Answers to SAEs 1

1. The two physically inseparable components of an ecosystem are:

i) The biotope (abiotic): a particular physical environment with specific physical characteristics such as the climate, temperature, humidity, concentration of nutrients or pH; and

ii). The biocenosis (biotic): a set of living organisms such as animals, plants or micro-organisms, that are in constant interaction and are, therefore, in a situation of interdependence.

2. The scales of magnitude of the concept of ecosystem was from multicellular organisms such as insects animals or plants to lakes, mountain ranges or forests to the planet Earth as a whole.

Answers to SAEs 2

1. To incorporate economic and social drivers in ecosystem management, we need to:

- Address and understand relationships between natural systems, people and the economy.
- Recognise and assess drivers of change that consider both knowledge gaps and uncertainty.
- Recognise the complexity of natural systems (not simply stocks) and that impacts can be difficult to predict.
- Need tools that can help realise opportunities for new markets and deal with spatial impacts and equity implications

2. To encourage ecosystem resilience, we need to:

- Identify and value the benefits people obtain from ecosystem services to signpost maintenance, enhancement and, where appropriate, restoration of particular ecological structures, functions and services.
- The tools to be used need to be effective at incorporating ecosystem services into contemporary valuation and decision-making

Answers to SAEs 3

1. The different types of ecosystem management are:

Adaptive Management; Natural Resource Management; Strategic Management; Landscape level control/Conservation; and Command and control management.

2, The four main ways on which the ecosystem management approach is premised are: preservation, conservation, utilization, and exploitation.

Unit 3 General Principles of Wildlife Management

Unit structure

3.1 Introduction

The meaning, history and evolution of wildlife management will be highlighted in this unit. You will learn about the objectives, principles categories and issues pertaining to wildlife management and practices. You will study about the meaning of biological diversity protection and the future of wildlife management.

3.2 Intended Learning Outcomes (ILOs)

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

- Understand the meaning of wildlife management
- Appreciate the history of and evolution of wildlife management
- Describe wildlife management practices
- Describe the basic principles of wildlife management
- Explain the principles of managing wildlife
- Describe the categories and management objectives of protected areas
- Identify the issues of wildlife management in the twenty-first century
- Explain the meaning of Biological Diversity Protection
- Explain the future of wildlife management

3.3 Introduction to Wildlife Management

There are many ways to define wildlife management, but the general ideas are to put an emphasis on the connection between habitat and animal populations, to work to support these populations, and to manipulate habitats or populations in order to achieve a certain human objective. Wildlife management, according to early wildlife biologists, was the skill

of getting a property to produce enough game for recreational use (hunting, fishing, or trapping). The science of modifying wild animal populations and their habitats for particular human objectives was highlighted in later definitions of wildlife management. Current definitions emphasize the importance of applying animal ecology to manage wildlife for the benefit of both animal and human populations as well as the habitat. Landowners and biologists perform habitat and wildlife population inventories and evaluations as part of the complex process of wildlife management. Additionally, they decide what the public wants from the wildlife resource and set management priorities to achieve this. Managing the habitat, the wildlife population, or the people will ultimately result in the achievement of the targeted management goals.

On the other hand, wildlife conservation focuses on maintaining and wisely using natural resources in an effort to guarantee that such resources will be available for future generations (sustainability).

Management, which is essentially the activities aimed at managing, guiding, or manipulating wildlife populations and their habitats, can be a part of conservation. In this situation, wildlife managers typically work to stabilize a population by reducing harvesting, stabilizing the population, and increasing it by providing food, shelter, and water (sustained yield) Since ancient times, there has been an understanding of the need to conserve species. The Bible mentions limitations on killing animals, and Kubla Kahn may have instituted the first regulated hunting season in the 13th century. Although wildlife conservation is now a science, its main objective—ensuring the judicious use and management of renewable resources—remains unchanged. Living things that we refer to as renewable resources have an endless capacity for self-renewal.

Additional meanings An animal is considered to be wild if its phenotypic has not been influenced by human selection and it does not live under direct human observation or control. A wild animal that is kept in captivity or otherwise under direct human control, including zoo animals and pets, is one whose phenotypic has not been considerably altered by human selection. An animal that has been domesticated but is now living free from direct human control or supervision is called a "feral animal." However, a definition of wildlife should include all living organisms outside of man's influence, including undomesticated or cultivated plants and animals. Wildlife include uncultivated, free-ranging terrestrial vertebrates, including reptiles, amphibians, birds, and mammals. Conservation, preservation, consumption, and non-consumptive objectives are the main goals of wildlife management.

3.3.1 History of and Evolution of Wildlife Management

Wildlife management isn't exactly a new concept. Early humans and possibly even protohumans controlled wildlife for subsistence hunting, such as by burning fields to make grass for ungulates. At least as far back as ancient Egyptian civilizations, game management—and in particular, management of animals for sport hunting—has been documented. Large game fields that were controlled for sport were kept up for the royal recreation of Egypt. Hunting prohibitions, which are seen as the forerunners of contemporary wildlife management, can be linked to ancient tribal taboos and practices. Usually, just a few species were managed, and it was done decentralizedly over a small region with a focus on food, sport, and occasionally aesthetics. In most industrialized countries, game management has been supplemented with more thorough wildlife management since the twentieth century, primarily as a result of a convergence of ecological and social processes. The political appeal of game management programs and the fact that they have

a reliable source of funding in the form of hunting and fishing license fees allow them to frequently rule government wildlife management divisions. With the groundbreaking work of Aldo Leopold, wildlife management was introduced alongside game programs in the 1920s. Later, many countries redefined game management as a subset of the larger field of wildlife management, and in the early twenty-first century, the majority of governments now have agencies that take some accountability for preserving healthy populations of practically all indigenous species. The Forest Service's policies for managing wildlife have changed over time. While employed by the organization in the Southwest Region from 1909 to 1924, Aldo Leopold created the framework for wildlife management.

The 1907 Agricultural Appropriations Act included a provision that made it a law that "hereafter officials of the Forest Service shall, in all ways that are practicable, aid in the enforcement of the laws of the States and Territories with regard to...the protection of fish and game." Originally, states had jurisdiction over wildlife. Conflicts over controlling the overgrown deer herds on the Kaibab National Forest resulted in a Supreme Court ruling in the 1920s. The Forest Service was allowed to safeguard the fodder resource from overgrazing by deer because the court decided that staff might hunt extra game to "avoid property harm."

Wild turkey hunters were outraged by clear-cutting on West Virginia's Monongahela National Forest in the 1960s. Isaak Walton League was persuaded to take the Forest Service to court by them. The case went against the agency. The National Forest Management Act of 1976, a result of later legislation, mandates that the agency undertake its planning in a way that ensures a diversity of plant and animal species. When the northern spotted owl was listed as an endangered species in 1990, national forests and communities in Washington and Oregon that depended on timber were closely examined as groups of people worked out the habitat boundaries and harvesting compromises.

3.3.2 Wildlife Management Practices

i) Monitoring Wildlife Populations: The birth and death rates of different species as well as the state of their habitat are constantly monitored by wildlife managers. This gives the information required to establish hunting laws and assess whether additional wildlife management techniques are required to conserve a wildlife species.

ii) Habitat Improvement: As succession takes place, the habitat's ability to support particular species and populations of wildlife changes. Forested areas may be cleared or burned by wildlife managers to encourage new growth and halt the succession process. They are able to produce more of some wildlife species because to this approach.

iii) Hunting Regulations: Regulations on hunting safeguard habitats and maintain animal populations. Regulations include establishing time limitations for each day and each season, bag limits, and acceptable ways to take wildlife.

iv) Hunting: Hunting is a useful tool for managing animals. Hunting methods provide revenue for wildlife management and assist wildlife managers in maintaining animal populations in harmony with their habitat.

v) Predator Control: Reducing predator populations helps animal populations, especially threatened or endangered species, maintain stable populations. Predator hunting and trapping are examples of predator control techniques.

vi) Artificial Stocking: In several regions of the country, restocking of game animals has been successful. Restocking involves capturing animals in regions where they are plentiful and releasing them in other areas with suitable habitat.

vii) Controlling or Preventing the Spread of Disease: Wildlife can suffer terrible consequences from disease. For instance, the threat posed by avian cholera is significant, particularly for ducks and geese wintering in congested areas. In order to stop the spread of cholera after it has started, managers must collect and burn waterfowl carcasses every day.
viii) Management Programs/Funds: The Pittman-Robertson Act (federal excise tax) provides financing, although several states have also started programs to aid in supporting conservation initiatives. What is the current emphasis in the definition of wildlife management?

Self-Assessment Exercises 1

1. What is the most important part of wildlife management?
2. What are the three main aims of wildlife management?

3.4 Basic Principles of Wildlife Management

Wildlife management is the skill of getting a land to consistently supply wild wildlife for both sustenance and leisure every year. Wildlife management is the science and art of changing the characteristics and interactions of habitats, populations of wild animals, and man to further certain human objectives. Despite the scientific nature of the concepts guiding wildlife management, there are chances for technology integration. Ecological concepts provide the basis of wildlife management. And ecology is the relationship between an organism and its surroundings, as well as other living things that share the same fundamental resources, such as soil, water, vegetation, and the atmosphere. One or more of these ideas can be combined. In order to increase wildlife for human benefit, it is the goal of the wildlife expert to pinpoint the reasons reducing wild animal abundance. Studying each species in relation to the others is crucial because if one species becomes more numerous, it could be harmful to another. It is important to replicate declining species under controlled circumstances and release them into their preferred habitats. Similarly, species from densely inhabited places need to be moved elsewhere. Wildlife management must be based on sound ecological, environmental, social, and economic factors, according to the principles of wildlife management. Ecological factors include species ecology, status of conservation, potential effects of management actions on a species, and potential effects of climate change on species.

3.4.1 Principles for managing wildlife

The following have been identified as the basic principles for managing wildlife:

- Wildlife and conservation are not confined to reserves proclaimed under the **National Parks and Wildlife Act 1972** (NPW Act)
- wildlife management must be based on sound ecological, environmental, social and economic factors:
    - **ecological factors** - species ecology, species conservation status, potential effects of management actions on a species and potential effects of climate change on species
    - **environmental factors** - the extent of damage/impact on the environment caused by wildlife
    - **social factors** - animal welfare, community sensitivities, values and expectations, needs of landholders, land managers and industry
    - **economic factors** - the extent of damage/impact being caused by wildlife

the welfare of all wildlife is intrinsically important

landholders, land and resource managers, community and industry have a need to control the impact caused by wildlife to acceptable levels to protect their livelihoods, safety and biodiversity assets, where it is consistent with the objectives of the NPW Act.

3.4.2 **Categories and Management Objectives of Protected Areas**

Below are the different categories and management objectives of protected areas:

1. Scientific Reserve/Strict Nature Reserve

In order to have ecologically representative examples of the natural environment available for scientific study, environmental monitoring and education, as well as the maintenance of genetic resources in an evolutionary state, it is important to protect nature and keep natural processes in an unaltered state.

2. National Park

To preserve relatively large, significant natural and scenic regions for research, education, and recreation that are managed by the highest competent authority of a country. These areas may be of national or international significance.

3. Natural Monument/Natural Landmark

To protect and preserve nationally significant natural features because of their specific interest or unique characteristics.

4. Managed Nature Reserve/Wildlife Sanctuary

to maintain the natural circumstances essential to safeguard biotic communities, physical aspects of the environment, or groups of species that require particular human intervention in order to survive.

5. Protected Landscapes

To maintain nationally significant natural landscapes characteristic of the harmonious interaction of man and land while providing opportunities for public enjoyment through recreation and tourism.

6. Resource Reserve
To protect the natural resources of the area for future use and prevent or contain development activities that could affect those resources.

7. Natural Biotic Area/Anthropological Reserve
To allow the way of life of societies living in harmony with the environment to continue undisturbed by modern technology.

8. Multiple-Use Management Area/Managed Resource Area
To provide for the sustained production of water, timber, wildlife, pasture and outdoor recreation, with the conservation of nature primarily oriented to the support of these economic activities.

9. Biosphere Reserve
To protect the genetic diversity of species, which is essential for their continued evolution, as well as the diversity and integrity of representative biotic communities of plants and animals within natural environments.

10. World Heritage Site
To protect the natural features for which the areas was considered to be of world heritage value and to provide information for worldwide public enlightenment.

What is the objectives of Biosphere reserves?

Self-Assessment Exercises 2

1. What does the principles of managing wildlife implied?
2. What is the management objectives of a scientific reserve?

3.5 Issues of Wildlife Management in the Twenty-first Century

Since Leopold's time, and particularly since the 1980s, efforts to preserve biological diversity—a very broad and nuanced notion that encompasses wildlife—have been made in addition to management of wildlife. The Endangered Species Act of 1973, which limits actions that endanger threatened species and also requires species and habitat restoration for species that are

listed due to risk of extinction or extirpation from local ecosystems, has affected biodiversity policy in the United States. Despite political controversy, the majority of the public still places a high premium on protecting species. There have been numerous attempts to reorganize wildlife management in order to save ecosystems and habitats, and the act has also come under fire for continuing to favor single-species management. The protection of endangered species is a key component of this overall effort, and even though the act places a strong emphasis on single species management, it nonetheless safeguards a variety of species and their habitats by designating and preserving critical habitats for listed species, which are naturally shared with other plants and animals.

Concerns about the welfare of wild animals kept in captivity are a significant ethical issue. Animal rights organizations attack zoos as animal prisons and question the keeping of wild animals in captivity as a way to supplement or shore up declining wild populations, despite the fact that zoos have since the late 20th century changed their message from purely recreational enjoyment of animals toward a conservation emphasis. What gives humans, who have already upended animal groups all over the world, the right to capture and detain animals for conservation breeding reasons, argue opponents of the invasive management of specimen animals? Since 1970, several significant consensuses about both objectives and approaches have arisen as wildlife management and biodiversity protection strategies have become more scientific by including ecology and numerous other physical and social sciences into the management process. One noteworthy agreement is that even huge parks frequently lose considerable numbers of mammal species, proving that large parks and preserves are necessary but typically insufficient to safeguard all types of wildlife. As a result, there is growing interest in managing the network of private properties within which reserves are embedded. This may involve creating buffer zones of lighter use around reserves, and creation of protected riparian corridors to connect various reserves and populations of animals.

3.5.1 Protecting Biological Diversity

The most cutting-edge technique for preserving biological variety is gap analysis. This method compares biodiversity priorities with current and prospective reserves to evaluate ecosystem and habitat conservation projects. Conservation efforts can be focused on protecting all community types and, as a result, the animal species that depend on them by identifying gaps—important biological communities that do not receive protection. Protecting representative samples of all the world's biological communities is the aim of worldwide conservation. In certain places, like the Greater Yellowstone Ecosystem in the western United States, efforts are being made to restore entire ecological systems and to reintroduce predators. Restoration of wildlife populations and preservation of their habitat are hailed for their ecological advantages as well as their capacity to engage local people in conservation initiatives, foster community leadership, and improve environmental awareness among the populace.

3.5.2 The future of wildlife management

In the early twenty-first century, the future of wildlife management—and of wildlife itself—is uncertain. It gets harder to maintain populations of many species, especially large predators, as towns spread out into the countryside. Scientists worry that it will get harder to safeguard species like wolves, mountain lions, and bears. Wildlife will need to be controlled more aggressively to preserve the unique ecological heritage that each generation has inherited as areas not dominated by human uses dwindle. However, as Leopold emphasized, such management degrades the wildness of wildlife and has an impact on how well people can interact with wild animals. Learning to protect truly wild populations will be a challenge for the future. Rapidly accelerating

rates of extinction demonstrate that humans have not learned these protection methods yet. As ubiquitous species that readily coexist with humans take over the remaining, fragmented habitats, much wildlife will be lost as the pressures of growing populations and cities continue through the twenty-first century. The biological environment in which humans evolved cannot be prevented from being drastically simplified without a deliberate effort to comprehend and to take effective action. An unprecedented level of collaboration between scientists, governments, private landowners, and wildlife management organizations would be required for such an endeavor to succeed. Techniques for managing entire regions to maintain sufficient reserves and other protections are necessary to create a complex matrix of human and natural communities.
What is likely to be the most important challenge for wildlife management in the future?

Self-As

1. What is Gap analysis in biodiversity protection?
2. What is the future of wildlife management—and of wildlife itself—in the early twenty-first century?

3.6 Summary

You have learned about the definition, history and evolution of Wildlife management. Wildlife *has been defined as a* process of influencing interactions among and between wildlife, its habitats and people to achieve predefined impacts. You have also learnt about the categories, principles and future trends of wildlife management.

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3.8 Possible Answers to Self-Assessment Exercises

Answers to SAE 1

1. The most essential aspect of wildlife management is managing habitat for game species. This provides a species with the essential elements needed to meet its needs: food, water, cover, space, and an arrangement of these elements that lets animals meet their needs.
2. Human goals in wildlife management include conservation, preservation, consumption, and non-consumptive objectives.

Answers to SAE 2

1. The principles of wildlife management affirmed that wildlife management must be based on sound ecological, environmental, social and economic factors
2. The management objectives of a scientific reserve/Strict Nature Reserve is to protect nature and maintain natural processes in an undisturbed state in order to have ecologically representative examples of the natural environment available for scientific study, environmental monitoring and education, and for the maintenance of genetic resources in an evolutionary state.

Answers to SAE 3

1. It is a technique in which ecosystem and habitat conservation programs are judged by comparing biodiversity priorities with existing and proposed reserves.
2. As cities expand into countryside, it becomes more difficult to maintain populations of many species, especially large predators, therefore the future of wildlife management and of wildlife itself in the early twenty-first century is uncertain

Unit 4: Wildlife Zoonoses

Unit Structure

4.1 Introduction

In this unit, you will learn that, even though most animals have beneficial effects, a lot can sometimes carry harmful germs that can spread to people and cause illness – these are known as **zoonotic diseases** or zoonoses. Zoonotic diseases are caused by harmful germs like viruses, bacteria, parasites, and fungi. These germs can cause many different types of illnesses in people and animals, ranging from mild to serious illness and even death.

4.2 Intended Learning Outcomes (ILOs)

By the end of this unit, you must be to:

- Give an overview of wildlife diseases
- Give historic examples and spread of wildlife diseases
- Outline the illnesses associated with animal contact
- Describe how to control zoonoses
- Explain the connection of COVID -19 to wildlife
- Identify the relations between germs, animals and people and
- Describe the people at risk of serious illness from zoonotic diseases

4.3 Wildlife Diseases

Zoonoses, also known as zoootic diseases, are brought on by the transmission of germs between people and non-human animals. These germs, which can manifest as bacteria, viruses, parasites, or fungus, can be transmitted to people either directly through physical contact or indirectly through intermediate hosts like animals or insects or the air. The majority of the time, wildlife is a reservoir for these illnesses, which means that it is capable of spreading the illness even in the absence of symptoms. Humans, however, are frequently at great danger of developing a major sickness or passing away because they lack a natural immune to many of these diseases. Zoonotic diseases, including the COVID-19 pandemic, are on the rise because of climate change, loss of habitat including deforestation, and wildlife trafficking. Further enhancing the contact between wildlife, domestic animals, and humans, continuous globalization of society, human population increase, and related landscape changes facilitate the introduction of novel infectious diseases. An effective surveillance system for animal diseases enables the early identification of potential health risks. Preventive measures and quick responses to outbreaks could stop harmful diseases before they cause harm and protect both the health of humans and animals.

Disease monitoring can be carried out in two methods that can involve a variety of stakeholders at different levels: 1) Investigating sick or deceased wild animals that are then reported to the appropriate authorities, Or, ii), a more focused examination of a particular illness or animal population may also be carried out. To ensure prompt information on the appearance of microorganisms, both techniques necessitate strong collaboration between veterinary and

wildlife authorities. This guarantees that surveillance systems are operating precisely and successfully to stop, identify, and react to disease outbreaks.

4.3.1 Historic examples and spread of wildlife diseases

Many of these diseases are already ones that we are familiar with: Zoonoses include diseases including SARS, rabies, yellow fever, swine and other zoonotic flu, Lyme disease, and West Nile virus. These two diseases, which have just been added to the list and are particularly infamous for their wide outbreaks, deadliness, and capacity to spread swiftly throughout the world, are COVID-19 and Ebola. With the expansion of human populations, deforestation, climate change, and human-wildlife interactions over time, so too have techniques of zoonosis contraction. Most zoonotic illnesses were primarily spread to humans by domestic animals for centuries (such as ringworm from house cats). The danger of transmission to humans from non-domesticated species then grew when people encroached on wild animal habitats through construction, deforestation, and other land changes. Climate change is also partially to blame for this. For instance, as temperatures have increased, wildlife has moved to cooler locations and mosquitoes have been able to spread their range to new populated areas. As a result of the wildlife trade and trafficking, humans have come into contact with a variety of new species, including rare, threatened, and endangered species, many of which are disease hosts.

4.3.2 Illnesses Associated with Animal Contact

Zoonoses, like Ebola, are first discovered in wildlife. The international community should pay special attention to any diseases for which wildlife serves as a reservoir and which affect populations of animals (both domestic and wild) and people, or a combination of all three. Some of these include:

1. Anthrax

a sickness that affects both domesticated animals and wild animals, as well as people. Animals typically pass away abruptly, showing no signs of sickness. However, there is a powerful vaccine to stop the illness. Additionally, the transmission of the illness can be stopped by handling afflicted carcasses properly. The bacterium Bacillus anthraces is to blame for this. Animals that pass away from this illness must be disposed of carefully. The resilient spores, which can survive in the soil for many years, are released when the corpses are split open. Bloody discharge from the mouth, anus, and skin are some of the symptoms, and they are also essential in the transmission of the illness.

2. Ebola

Humans and nonhuman primates can contract the severe, frequently fatal disease Ebola hemorrhagic fever (some monkeys, gorillas, and chimpanzees). Ebola is regarded as a zoonotic disease. Some bat species that are native to tropical woods are believed to be the principal natural reservoir. Large-scale extinctions of non-human primates from endangered species have been connected to Ebola infection, and infected animals can spread the disease to humans. Hunting and handling of infected wildlife are most likely causes of human Ebola epidemics.

3. Rabies

Mammal neurological systems are harmed by the disease rabies. It is brought on by a virus and normally spreads when an animal that has the disease bites another animal or person. Once symptoms arise, rabies cannot be cured and is a deadly condition. Fortunately, immunization can effectively stave off rabies.

4. Wild Boar Wild boar can harbor a variety of diseases, including brucellosis, foot and mouth disease, pseudorabies, classical swine fever, and African swine fever. Due to high mortality rates

and slaughter for disease management, these illnesses have the potential to have a serious impact on the domestic swine industry and cause significant output losses.

5. Blastomycosis (***Blastomyces dermatitidis***)

A fungus called Blastomyces dermatitidis that can be found in wood and soil produces the rare fungal infection known as blastomycosis, which is typically contracted by inhaling its spores.

6. Psittacosis (*Chlamydophila psittaci*, *Chlamydia psittaci*)

In poultry and companion birds (birds maintained by people as pets), Chlamydophila psittaci infection, formerly known as Chlamydia psittaci infection, is the cause of systemic sickness. A common name for this condition in birds is avian chlamydiosis, which is sometimes referred to as parrot fever, ornithosis, and psittacosis.

7. Reptiles and Amphibians: *Salmonella*

While some reptiles and amphibians make great pets, they can potentially be a health risk. Salmonella is carried by both reptiles and amphibians, such as iguanas, turtles, and snakes.

8. **Chytrid Fungus**: *Batrachochytrium dendrobatidis* (or "chytrid" for short), is a fungus that grows amphibians' skin, preventing them from breathing or absorbing water through their skin. Frog populations have been infected and decimated as a result of its global expansion. It is an all-encompassing amphibian killer.

9. Trichinosis (***Trichinella spiralis***)

Trichinella spiralis, a roundworm, is the illness that causes trichnosis. The parasite larvae have the ability to move and settle inside muscles. People typically contract this sickness by eating improperly cooked wild game.

10. Cat Scratch Disease *(Bartonella henselae)*

Fibropapillomatosis: This virus-possibly-caused illness, which causes tumors to develop on the skin or inside, is infecting sea turtles all over the world. These tumors can impair a turtle's ability to swim, eat, or see, and they can make its immune systems less effective.

11. Chronic Wasting Disease**:** Spongiform encephalopathy, a brain condition that is lethal and mostly affects deer and elk, is the name of this illness. The disease is thought to be brought on by a prion, a mutated protein.

12. Whirling Disease: In 25 states, the parasite Myxobolus cerebralis that causes whirling illness has infected trout, salmon, and whitefish. Young fish perish from nerve and cartilage damage, and adult fish move in a tail-chasing or whirling manner that makes it difficult for them to find food and makes them more vulnerable to predators.

13. Fleas, body lice, sand flies, or contact with animals that have been exposed to fleas can all transmit the bartonella bacteria to people. There is no proof that ticks can transmit the Bartonella infection to humans.

14. Histoplasmosis *(Histoplasma capsulatum)*

The fungus Histoplasma capsulatum's reproductive cells (spores) are what cause histoplasmosis. When dirt or other materials are disturbed, they float upward. The fungus grows in moist soil that is rich in organic matter, particularly bird and bat droppings.

15 White-Nose Syndrome: The white-nose fungus has infected or killed hundreds of thousands of bats in the Northeast and mid-Atlantic regions. Bats in hibernation are affected by the illness, which gives them the appearance of having a white substance on their faces and wings.

16. Large game diseases

Ranaviruses and fungus infections in amphibians. The fungus chytridiomycosis and diseases brought on by ranaviruses are two amphibian diseases of great concern on the global scale. Both have a connection to the urgent amphibian population reduction that is happening on a worldw

Self As

1. What is **Chronic Wasting Disease?**

2. What is the cause of Histoplasmosis?

4.4 Parasites and Disease

Every member of a community of wild animals is a host to a variety of parasites. However, when a game population is small, a host's immunity and general well-being play a protective role against the spread of disease and the harmful effects of parasites. Even though some of the people may be severely infected, the parasites and sickness won't have much of a chance to spread to the rest of the population if they don't interact with it frequently. There are a number of variables that, as the game population grows, inevitably lead to severe parasite-disease outbreaks:

i) Environmental disasters, such as food scarcity-related starvation, inadequate shelter-related exposure, and extreme drought or rainfall.

ii) Unusual crowding lowers a person's resistance and raises the chance of parasite transmission.

iv) Poor predation leading to congestion

iv) Interaction with domesticated animals, which introduces new illnesses or parasites to which wildlife may not be immune to or tolerable

4.4.1 Control of Zoonoses

Zoonoses can be difficult to control because their range transcends political boundaries, but there are policy options that can be pursued. Strengthening existing international laws on the trade in wildlife is one preventative measure. For instance, China has outlawed the trading and consumption of wild animals in response to COVID-19, akin to the temporary restriction it imposed in 2002 in response to the SARS outbreak. This restriction covers both endangered species designated by CITES as well as wild animals trafficked for human consumption (Convention on International Trade in Endangered Species of Wild Fauna and Flora). For instance, in East Asia, where strong cultural and social traditions favor consumption, despite the fact that such prohibitions can seem to be successful policy measures, they might be challenging to implement. Traditional remedies, for instance, frequently use animal ingredients, which makes it difficult to implement this regulation. Others, such as the pangolin (the most widely

transported mammal in the world and another putative COVID-19 intermediate host in issue), are regarded as delicacy. Strict enforcement, consideration and sensitivity for the shifting livelihoods and cultures of those who can no longer consume wild animals, as well as surveillance and monitoring for the emergence of underground markets will be necessary for permanent bans to be effective. Nations may and should contribute to upholding international CITES limitations on wildlife trading on their own territory, notwithstanding the fact that the situation in East Asia is somewhat problematic. Nations should also take part in the GLEWS animal illness fast reporting and information exchange system of the World Health Organization. Global Early Warning System for Major Animal Disease, Including Zoonoses, is known as GLEWS.

4.4.2 COVID -19 and its connection to wildlife

Through the selling of wild animals in seafood and live animal markets, such as those in Wuhan, China, where the new COVID-19 strain of coronavirus is suspected to have originated, humans have worsened the spread of zoonotic diseases. In addition to human excretions like spit, blood, and urine that give to the "wet" prefix, these wet markets have allowed for close contact with disease-carrying wildlife. The Center for Disease Control reports that coronaviruses are widespread in both humans and other animal species, including bats, cats, cattle, and camels. The stress on the animals and the proximity of these market settings make it easier for the virus to infect both animals and people. Zoonoses normally only affect humans, hence there is no evidence of transmission to animals. But a Malaysian tiger at the Bronx Zoo tested positive with COVID-19 in April 2020, and other tigers and lions there have also tested positive. Similar transmissions have been reported in Hong Kong and New York, where numerous cats and dogs have tested positive after receiving a diagnosis from their owners. This recent development raises concerns about the virus's potential to be spread by humans to animals, particularly the susceptibility of other domestic animals like livestock, on whom people rely to provide food.

How sh

Self-As

1. What are the four set of factors which automatically pave way for serious parasite-disease outbreaks?
2. What does GLEWS stands for in relation to Zoonoses?

4.5 Wildlife and Humans

People gain various advantages from animals. Animals are a common part of daily life for many people, both at home and away from home. For people all across the world, animals provide food, fiber, livelihoods, travel, sport, friendship, and education. Numerous animals or pets have

been domesticated by millions of homes. Animals may come into contact with us while traveling, visiting animal exhibits, engaging in outdoor activities, or in urban or rural environments.

4.5.1 Germs, Animals and People

Given the intimate ties between humans and other animals, it's critical to understand the typical routes through which people might contract pathogens that cause zoonotic diseases. These can include:

1. **Direct contact:** coming into contact with an infected animal's saliva, blood, urine, mucus, excrement, or other body fluids. Animal petting, animal contact, and bites and scratches are a few examples.
2. **Indirect contact:** interacting with objects or surfaces that have been contaminated with germs, as well as places where animals frequently congregate and roam. Examples include the water in aquarium tanks, pet habitats, poultry coops, barns, plants, dirt, and food and water bowls for animals.
3. **Vector-borne:** Being bitten by a tick, or an insect like a mosquito or a flea.
4. **Foodborne:** Every year, eating tainted food makes 1 in 6 Americans ill. eating or drinking something dangerous, such as unpasteurized (raw) milk, raw produce that has been tainted with animal excrement, undercooked meat or eggs, or unwashed fruits and vegetables. Both humans and animals, including pets, can become unwell from consuming contaminated food.
5. **Waterborne:** Drinking or coming in contact with water that has been contaminated with feces from an infected animal.

4.5.2 People at risk of serious illness from zoonotic diseases

A zoonotic disease can infect anyone, even healthy people. However, certain people are more vulnerable than others, and they should take precautions to safeguard their families. These people are more susceptible than others to contracting certain diseases, becoming seriously ill, and even passing away. These groups of people include:

- Children younger than 5
- Adults older than 65
- People with weakened immune systems
- Pregnant women

People can come in contact with animals in many places. This includes at home and away from home, in places like petting zoos, fairs, schools, stores, and parks. Insects, like mosquitoes and fleas, and ticks bite people and animals day and night. Thankfully, there are things you can do to protect yourself and your family from zoonotic diseases.

- Keep hands clean**.** Even if you didn't touch any animals, washing your hands right away after being around them is one of the most crucial precautions you can take to prevent getting sick and infecting others. By failing to thoroughly wash hands with soap and clean, flowing water, many bacteria are disseminated. You can use an alcohol-based hand sanitizer with at least 60% alcohol if soap and water are not readily available. If available, wash your hands with soap and water to remove any remaining germs because hand sanitizers do not completely eradicate all forms of bacteria.
- Know the simple things you can do to stay safe around your pets.
- Prevent bites from mosquitoes, ticks, and fleas.

- Learn more about ways to handle food safely—whether it's for yourself or your family, your pet, or other animals.
- Be aware of zoonotic diseases both at home, away from home (such as at petting zoos or other animal exhibits), in childcare settings or schools and when you travel.
- Avoid bites and scratches from animals.

What can you do to protect yourself and your family from zoonotic diseases?

Self Assessment Exercise

1.Outline any four common ways people can get infected with germs that can cause zoonotic diseases.

2. Who are at high risk of contacting zoonotic diseases?

4.6 Summary

You have learned in this unit that wildlife is affected by various diseases which are caused by different pathogenic organisms. These diseases could be cause by; bacterial, fungal, virus or parasites. You have also learned about the role of some of these animals in spreading of diseases. The infection is usually acquired by drinking contaminated water, grazing on contaminated pastures or when animals lick contaminated skins, bones, blood and carcasses.

4.7 References/Further Readings/Web Sources

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4.8 Possible Answers to Self-Assessment Exercises

Answer to SAE 1

1. This disease is a highly contagious, fatal neurological disease (spongiform encephalopathy) primarily infecting deer and elk. The disease is believed to be caused by a modified protein called a prion.

2. Histoplasmosis is caused by the reproductive cells (spores) of the fungus *Histoplasma capsulatum.* They float into the air when dirt or other material is disturbed. The fungus thrives in damp soil that's rich in organic material, especially the droppings from birds and bats.

Answer to SAE 2

1. The sets of factors which automatically pave way for serious parasite-disease outbreaks could be outline as follows:

i) Disaster conditions in the environment, such as malnutrition due to food shortage, exposure due to inadequate shelter, and excessive drought or rainfall.

ii) Abnormal crowding reducing the individual's resistance and increasing the probability of parasite transmission.

iii) Inadequate predation causing overcrowding.

iv) Contact with domestic livestock, introducing new diseases or parasites for which wildlife may have neither immunity nor tolerance

2. GLEWS stands for Global Early Warning System for Major Animal Disease, including Zoonoses.

Answer to SAE 3

1. The common ways people can get infected with germs that can cause zoonotic diseases include: Direct contact; Indirect contact; Vector-borne; Foodborne; Waterborne

2. These people are more likely than others to get really sick, and even die, from infection with certain diseases:

- Children younger than 5
- Adults older than 65
- People with weakened immune systems
- Pregnant women

Unit 5: Fire as a tool in terrestrial wildlife management

Unit Structure

5.1 Introduction

You will learn in this unit that while it is necessary to prevent catastrophic wildfires, fire is necessary for the proper functioning of forest ecosystems and thus wildlife management. You will also learn that recent ecological research has shown, however, that fire is an integral component in the function and biodiversity of many natural habitats, and that the organisms within these communities have adapted to withstand, and even to exploit, natural wildfire

5.2 Intended Learning Outcomes (ILOs)

At the end of this unit you should be able to
understand the knowledge of use of fire in wildlife managements and the various methods would be understood. Its use in the maintenance of biodiversity and ecological processes and its contributions to the distinctive nature of terrestrial environment.

5.3 Fire and its Components

A wildfire, also known as a forest fire, bushfire, wildland fire, wildland fire, or rural fire, is an unplanned, uncontrolled, and unexpected fire that starts in both rural and urban regions in an area of combustible vegetation. In their native form, several forest ecosystems rely on wildfire. A wildfire may also be more explicitly categorized as a bushfire, desert fire, grass fire, hill fire, peat fire, prairie fire, vegetation fire, or veld fire, depending on the type of vegetation that is present. Controlled burns, which are beneficial fire usage, are separate from wildfires, yet controlled burns can develop into wildfires.
Wildfires likely started shortly after terrestrial plants first appeared, which occurred in the Silurian epoch 419 million years ago, according to fossil charcoal. The fact that wildfires have

occurred frequently throughout the history of terrestrial life begs speculation that fire must have had significant evolutionary effects on the flora and fauna of the majority of ecosystems. The abundance of carbon-rich flora on Earth, seasonal dryness, atmospheric oxygen, and frequent lightning and volcanic ignitions all contribute to favorable fire-starting circumstances.

Wildfires are frequently categorized according to their origin, physical makeup, presence of combustibles, and relationship to the weather. The behavior and severity of wildfires are influenced by a number of variables, including the amount of fuel available, the environment, and the weather. Severe wildfires frequently precede climatic cycles that include rainy periods that produce substantial fuels and are later followed by dryness and heat. Heat waves and droughts brought on by climate change exacerbate these cycles. The pattern that fire follows in a specific ecosystem is known as a fire regime. Ecologists use the word "severity" to describe the effect a fire has on an ecosystem. Ecologists have several ways to describe this, but one is through estimating plant mortality. Three floors can be burned by fire. I Soils rich in organic materials will be consumed by ground fires. ii) Material from dead plants that is lying on the ground will be consumed by surface fires. iii) Tree and shrub tops will burn from crown fires. One of these fire regimes may predominate in ecosystems, or a combination of all three. While wildfires may also frequently occur at a period of year when lightning is plentiful, fires usually start during a dry season.

5.3.1 Abiotic responses

Fire has important effects on the abiotic (non-living) components of an ecosystem, particularly the soil:

• Both direct contact with fire and the impacts of fire on the local plant population can have an impact on the soil.

• By eliminating the vegetation above the soil, fire can increase solar radiation on the soil surface during the day, causing higher warmth, and more cooling at night due to the loss of radiative heat.

• In addition, plant transpiration will be reduced after a fire, allowing the soil to retain more moisture.

• Fewer leaves remaining to deflect rain will allow more rainwater to reach the soil surface.

• Because of acid combustion, overall soils become more basic (higher pH) after fires. Using new chemical processes to be accelerated at high temperatures,

Negative impacts of fire are also bound:

- However, exposure to sunlight, wind, and evaporation will have the opposite effect, drying the soil.
- If organic matter on the ground was burned by the fire into a waxy residue, it may have generated an impenetrable crust at the soil surface, and if this has happened, it may have accelerated soil erosion through surface run-off.
- A number of processes, such as oxidation, volatilization, and increased water erosion and leaching, may result in nutrient loss as a result of fire.
- As a result of its absorptive qualities, charcoal is able to partially offset some nutrient and water loss.
- However, it takes very high temperatures to significantly reduce the amount of nutrients lost, which are frequently replaced by organic matter that is left behind in the fire.
- By changing the clay content and porosity of the soil, fire can even change the texture and structure of soils.

5.3.2 Biotic responses and adaptations

For plants to survive fire, several adaptations have evolved over time. For instance, in some neighborhoods, certain plants have leaves covered with combustible substances that promote a vigorous fire. Their heat-activated seeds begin to sprout, allowing the budding plants to take advantage of the charred landscape's dearth of rivals. Other plants have buds or seeds that are activated by smoke or fire. The Lodgepole pine (Pinuscontorta), which has serotinous cones, has a resin covering that a fire melts away to reveal the seeds. Many plant species, such as the shade-intolerant giant sequoia (Sequoiadendron giganteum), depend on fire to create openings in the vegetation canopy that will let light in. This will enable their seedlings to compete with seedlings of other species that can tolerate more shade and eventually establish themselves. Plant species may only be fire-intolerant, fire-tolerant or fire-resistant.

Fire intolerance

Plant species that are not tolerant to fire are typically very combustible and fully destroyed by fire. After a fire, some of these plants and their seeds may simply disappear from the area and not reappear, while others have evolved to make sure that their progeny survives into the following generation. In order to reproduce and replenish their seed banks before the next fire, "obligate seeders" are trees and plants with sizable, fire-activated seed banks that sprout, grow, and mature quickly after a fire.

Fire tolerance

Species that are tolerant to fire can endure some burning and carry on growing despite fire damage. Sometimes these plants are referred to as "resprouters." According to research by ecologists, some species of resprouters store additional energy in their roots to help them recover and re-grow after a fire. For instance, the Mountain Grey Gum tree (Eucalyptus cypellocarpa) in Australia begins to produce a mass of leaf shoots from the base of the tree all the way up the trunk toward the top, giving it the appearance of a black stick fully covered in young, green leaves.

Fire resistance

Plants that can withstand fire are not severely harmed by a typical fire regime. Large trees with combustible portions located far from surface fires are among them. Because it sheds its lower, more vulnerable branches as it ages, the mature Ponderosa Pine (Pinus ponderosa) is an example of a tree species that has almost minimal crown damage under a naturally mild fire regime.

Within ecosystems that are adapted to fire, fire performs a variety of significant tasks. In the maintenance of biodiversity, nutrient cycle, and habitat structure, fire is crucial. The control of fire can result in unanticipated ecosystem changes that frequently have a negative impact on the plants, animals, and people who depend on that area. "Uncharacteristic fires" are wildfires that change from a previous fire regime as a result of fire suppression. How can we safely reintroduce fire to the landscape in order to achieve our management and restoration goals? becomes the challenge. Prescribed burns are one method of utilizing the advantages of fire. These are controlled, purposeful fires that have been started in an effort to prevent negative outcomes. One of the many options in the arsenal for managing forests is prescribed fire. However, the widespread use of fire for forest management is divisive and makes managing animals very challenging. In addition to the fact that fire behavior is inherently complex, discussions about burning our forests raise a number of environmental issues. What is a wildfire?

Self-Assessment Exercises 1

1. Differentiate between Fire intolerant and fire tolerant species
2. What are the Negative impacts of Fire

5.4 The Ecology of Fire

Humanity is a creature of fire, and Earth is a planet of fire, and their interactions have a very old ecosystem. The presence of fire is a characteristic of all living things on Earth. Both the oxygen needed for combustion and the hydrocarbon fuels it runs on were generated by life. Life now provides more ignitions than any other source, exceeding lightning, which was the previous leader before the intervention of humans. Fire destroys what photosynthesis has built up because it has a biochemical chemistry. As a result of the nature of life on Earth, fire is not something to which organisms must adapt that is unrelated to life. Fire can take on various ecological forms. Fire is what its conditions make it—a reaction, not a substance. They are plural. It combines its environment. Its taxonomy reflects this diversity, with different fire types being identified according to the combustibles they consume. Organic soil is burned by a ground fire. A surface fire travels through shrubs, grasses, and detritus from the forest. Through the canopy of brush and trees, a crown fire ignites. All of these combustion types may be present in a single burn. A same location may see a variety of flames that range in size, frequency, and intensity across the seasons and years.

The ensuing mixture forms the regime of fire. Like climate, a regime is a statistical composite. Similar to how a certain climate can support several storm types, a given fire regime can support various fire types; nevertheless, when they are gathered, they exhibit clear patterns. The rhythm of rain and drying is a geographic factor that supports regimes. A site must be both moist enough to produce fuels and dry enough to prepare them for burning; how these conditions interact and mix with ignition determines the features of the fire. The regime notion is crucial because organisms adapt to a pattern of burning and are not more or less "adapted to fire" than they are to water. A trait suitable to survive one kind of fire may not help in another kind of fire. This diversity goes all the way back in time. Fusain-like fossil fires are found throughout the geologic record (fossilized charcoal). They originate from the early Devonian, when plants first started conquering the earth. Different areas and times have burnt more frequently or in different ways than others. Major coalbeds contain sizable amounts of fossilized fire debris, especially those from the Paleozoic. Today, this process is going the other way around; buried biomass is being burned far more quickly than it is being stored. Similar to this, molecular phylogenetics attests to fire's historic evolutionary function as a selecting force. Thus, Earth's biosphere and atmosphere have effectively co-evolved with the pyrosphere domain of fire. Change in one has an impact on the others.

5.4.1 The Effect of Fire on Organisms

Thus, the accommodations for fire are substantial, rich, and reciprocal. Not only do species adapt to fire, but they also shape its nature. Fire requires a biotic matrix to be sustained, in contrast to mechanical disturbances like floods or winds that can happen without any indication of life, and in accommodating fire, living societies affect the behavior of fire. Modeling this extensive connection has proven challenging, and conventional explanations of fire ecology instead focus on how fire affects soil, air, water, plants, animals, and other living things. These effects take place at scales ranging from the planet to the individual organism. Many plants show adaptations for coping with fire, some of which appear to be specific to fire, but most of which involve a suite of traits that accommodate a suite of stresses. Prairie grasses, for example, store most of their biomass underground, which helps the plant to survive drought, grazing, and fire. Wildfires have the greatest impact on wildlife habitat by changing the three things that animals depend on most**: food, water, and shelter**. When food-producing understory plants and shrubs are gone, animals frequently leaves for locations with easier access to food, water, and shelter.

However, some characteristics do seem to be more focused on reacting especially to the influence of fire. Vital characteristics are protected from a heat wave by the thick bark of conifers, the water-dense leaves that cover the buds of flowering plants, and seed banks in mineral soils. The heat is shed off by organisms or is swiftly responded to after it has passed. After severe surface fires, aspen succumb. Some pines are able to produce new apical buds and survive even crown scorch. Many eucalyptus trees can sucker from the roots or resprout epicormically, sending out new branches to replace those that have been burned.

Some features depend on fire to ensure the organism's success in reproduction, going beyond mere defenses against heat. Serotiny, in which plants store seeds in the canopy within wax-sealed cones, woody capsules, or woody inflorescences, is one of the most fascinating types of seed storage. These coatings protect the seeds from a flash of flame before opening to disperse them across an ashy surface. Similar to this, many plants rely on heat or smoke to encourage the development of buds into fruits or to help seeds germinate in the soil. Hard shells can be cracked open by heat shock, releasing seeds or letting water in. Some species' flowering can be sparked by smoke alone, and fires can release a wave of chemicals that can both fertilize and clean the soil. Many annuals are promoted by charcoal. Although many of their mechanisms are still unknown, the variety of chemical cues that are known to exist in air, water, and soil continues to grow. The crucial factor is how fires interact with the creatures' life histories. Adaptation includes certain fires burning in specific ways and at specific times. Except where conditions are uniform, fires burn patchily. They also vary by intensity, size, frequency, and seasonality, and their effects vary accordingly. However, a large portion of this patchiness, timing, and flame front (i.e., the fire regime) are the result of previous fire histories and choices made to either protect against or take advantage of fire's chances.

5.4.2 The Effect of Fire on Communities

Fire alters both the structure and dynamics of communities at the landscape level. It behaves more like a big herbivore in certain situations while acting more like a massive physical disruption in others. In appropriate environments, it decomposes 80% of the above-ground primary output, converting biomass into released nutrients, changing the microclimate, eradicating some species, and promoting others. As a force of renewal and transformation, fire is crucial in forming ecosystems. However, fire can be fatal, burning buildings, forests, and habitat for wildlife while also contaminating the air with hazardous fumes to people's health. Carbon

dioxide, a significant greenhouse gas, is also released into the atmosphere by fire. Wildfire smoke can cause a variety of adverse health effects, from eye and respiratory tract irritation to more serious conditions like impaired lung function, bronchitis, asthmatic flare-ups, heart failure, and even early death. The elderly, children, and pregnant women are particularly at risk from smoke exposure. As a result of the spread of a fire, aged structures' physical decomposition and the stored biomass' chemical decomposition are followed by the propagation of a chemical front into the air, soil, and water. This shock has the potential to contaminate immediately. Long-term rejuvenation is possible by releasing rare nutrients (such as phosphate), removing insulating organic material, exposing soil to sunlight, and briefly rearranging the competing species. If the correct sorts of fires do not happen, certain creatures will disappear while others would suffer under the new conditions. The immediate aftershock is where these impacts are most noticeable. About three years later, the situation has largely stabilized.

The precise impacts depend on the biota's evolution, the nature of the accommodations provided by fire, and what transpires following the burn. Fire is very engaging since it is a reaction. The emergence of exotic species or a drought will alter the results. Likewise, fire's earlier history will. As it has in tropical rainforests, fire may prove disruptive if introduced to settings where it is unfamiliar (or in a form not previously encountered). However, if fire happens within its known regime, the community may absorb its effects without undue commotion; in fact, it may become more agitated by fire's unexpected absence than by its anticipated presence. Fire, which appears so radical in its immediate effects, can actually be conservative in this way. Its results are more likely to recycle than to transform on diverse scales.

What is the Effect of Fire on Communities?

Self-Assessment Exercises 2

1. What happens to organisms in a forest fire?
2. What is the effect of fire on people?

5.5 Humans as Regulators of Fire

Because we are the primary species in the ecology of fire, only humans have the ability to control it. By regulating ignition, we can directly affect flames, but we can also indirectly affect them by altering their environment. Over millennia, this control has grown to the extent where

studying fire ecology in the absence of people is merely a theoretical endeavor, similar to researching the ideal frictionless surfaces. Control of ignition marked the beginning of human hegemony. Fires might be started by people and, to a certain extent, put out. However, a fire's ability to spread depends on the terrain's capacity to do so. However, by altering the frequency, timing, size, and severity of fires in areas that were intended to burn, people could change regimes. Later, people started slicing, draining, or otherwise mincing and drying surface biomass to manipulate fuels. They altered the pulses and patches that characterize fire regimes by turning landscapes into combustibles. All of this relates to applied fire ecology; for instance, the rhythm of swidden farming perfectly corresponds to the three-year pattern of post-fire recovery. Humanity turned to fossil biomass to further boost its weaponry. People started burning geologically old landscapes, which required them to burn those fuels in specific chambers.

Over the past two centuries, the repercussions of this pyric shift have driven global change. Industrial societies do away with open burning as a technology and instead replace it with internal combustion. The ecology of fire changes to one without fire. Meanwhile, a significant portion of the increase in greenhouse gas levels has been attributed to the effluent of industrial burning. It has degraded soils, contaminated rivers, and changed every landscape it has come into contact with. The industrial realm, which burns fossil biomass, and the pre- or partially-industrial realm, which burns surface biomass, are the two combustion worlds that the Earth is currently separating into. The two only occasionally cross paths and during transitional periods. Earth's pyrogeography is mostly a product of human activity.

In the industrial world, fire is machined, cultivated, feral, or wild. Without using an open flame, it is burned in specialized chambers to generate heat and light. It is employed sparingly in agricultural situations where controlling the cultivated landscape is necessary to manage the fire; if the cultivated landscape has unraveled (due to desertion, for example), the fires may go feral. It also flourishes in the wildlands or nature reserves that industrial societies seek to establish and where the continued presence of fire as a natural mechanism maintains ecological integrity. Earth is still a world of fire: It can only be what it is. While future energy sources that do not rely on combustion (and its associated greenhouse gas byproducts) are likely to replace humanity's pyrotechnologies, open burning will likely continue in areas where humankind has not fully conquered the landscape or where people want to preserve living landscapes that are largely natural or that are important to their cultural heritage. There is no technical substitute for fire in such environments, and there is no ecological agent other than people to manage it.

5.5.1 Prescribed burning

In wildlife habitats, fire is a widely employed management tool to accomplish multiple goals at once. The accepted justification for burning rangelands in Southern Africa, according to scientists, progressive livestock producers, and wildlife managers, is to eliminate undesirable plant material (tophamper and/or moribund material), eradicate undesirable plant species, or prevent their expansion. These are the main motivations behind burning rangeland. Removing extra or undesirable vegetation makes it easier to access fresh growth and makes it easier to introduce exotic species. As demonstrated by the burning of vleis in late winter to produce an early winter flush, fire can be utilized to drive out-of-season growth. This is frequently done in the summer and late fall to give animals green grazing. However, because it causes rangeland degradation, this malpractice is totally unacceptable. In the dry season, green flush can give animals a green bite, but growth is short-lived. In addition to the general harm to grass plants, the vital root supplies are exhausted, decreasing growth vigor in the ensuing dry season. Early winter

burns expose the soil to sunlight and erosion throughout the winter, which causes compaction and erosion when the rains arrive. Use of fire can affect plant productivity by favoring desirable plants or reducing the abundance of undesirable species. By using fire in the right circumstances, existing grazing and browsing can be made more palatable and more nutritious. Additionally, fire can be utilized to better distribute grazing by luring animals to ungrazed areas. Compared to unburned treatments, livestock tend to choose and graze on new plant material from burned treatments. On burned rangelands, the new growth is pleasant and contains a lot of crude protein. According to some theories, rangeland burning can reduce pest and parasite infestation (by destroying insect nymphal and adult stages) as well as disease vectors during the dry season. The risk of intentional or unintentional fires, which could destroy structures, wildlife, and protected pastures, is reduced by prescribed burning. Prescribed burning, however, appears to have minimal impact on the frequency of devastating wildfires, according to some studies. An affordable and environmentally sound alternative to current rangeland management techniques may be to use fire to enhance the habitats of rangelands for animals and livestock. The advantages of controlled burning to rangeland and animal productivity need to be confirmed and further supported by data. Prescribed burning reduces fire hazards or accidental fires, which could destroy buildings, wildlife and protected pastures. Prescribed burning, however, appears to have minimal impact on the frequency of devastating wildfires, according to some studies. An affordable and environmentally sound alternative to current rangeland management techniques may be to use fire to enhance the habitats of rangelands for animals and livestock. The advantages of controlled burning to rangeland and animal productivity need to be confirmed and further supported by data. In – Text Question: What are the importance of prescribed burning? Fresh green shoots of new growth on burned rangelands are palatable and high in crude protein content. According to some theories, rangeland burning can reduce pest and parasite infestation (by destroying insect nymphal and adult stages) as well as disease vectors during the dry season. The use of prescribed burning lessens the risk of intentional or unintentional fires, which could destroy structures, wildlife, and protected pastures.

5.5.2 Fire as a Tool in Land Management

Fire can be a useful tool for modifying the vegetation's composition, structure, and fuel loads on rangelands if it is correctly controlled and managed (and other wild land ecosystems). At the right spots on the landscape, controlled fire may build and maintain a mosaic of plant communities, delivering crucial ecological services that are beneficial to a variety of rangeland resources. Among these are:

- “cleaning” or removing unwanted vegetation from landscapes to reduce fuel loads and the risk of large catastrophic fires
- changing the relative balance between herbaceous (grasses and forbs) and woody plants to improve forage availability for livestock or wildlife
- changing the structure or size class of plants across appropriate distances to benefit wildlife
- creating variability both within and among plant communities for wildlife and other rangeland resources
- promoting seed germination and the regeneration of desired plants; and
- maintaining the hydrologic cycle to promote the infiltration of water and to prevent rapid runoff and accelerated erosion.

In order for burned and unburned patches to stay on the landscape, fire must be used as a management tool at the proper frequency (return interval), intensity (heat release), and spatial size. In contrast to a homogeneous landscape of either early- or late-seral plant communities, a mosaic of burned and unburned patches often produces a mix of early- to late-seral communities.

5.5.3 The Importance of Fire Intervals

Before European settlers arrived in North America, the majority of the continent's rangelands occasionally burned. Among various rangeland habitats (such as tall-grass prairie, sagebrush steppe, and ponderosa pine forest), the return period between fires varied greatly, but it was generally constant within one ecosystem. While some pre-settlement fires were started accidentally by lightning, others were started on purpose by Native Americans to accomplish vegetation management goals. The majority of rangeland vegetation has adapted to periodic burning because fire, regardless of its source, was an ecological event that occurred frequently and with a generally regular frequency. The vegetation typically develops early-seral plant communities after a fire. Wildlife species that require mid- to late-seral plant communities to complete their yearly life cycle cannot occupy the area or have very tiny populations if there are few unburned "islands." When fire return intervals are so brief that mid- and late-seral plant communities never form, the same ecological consequence takes place. Excessively long or short fire return intervals tend to exclude (or drastically diminish) the wildlife species that require a diversified habitat structure formed by a mosaic of early- to late-seral plant communities. They also create homogenous plant communities across huge areas.

On the majority of rangelands, modern fire return intervals are either greater or shorter than the pattern that developed before settlement. As a result, there have been unintended vegetation changes that frequently have a negative impact on rangeland resources. Longer than the evolved interval fire return intervals result in a significant rise in shrubs and/or trees (woody fuel) and a drop in many desirable grasses and forbs. Because most shrubs and trees live a long time, their dead branches, stems, and leaves decompose slowly compared to herbaceous vegetation, which results in significant fuel loads and a fuel ladder that can take a fire into the higher canopy of the vegetation. Excessive fuel loads and horizontal and vertical continuity of the vegetation (fuel) can cause massive, severe wildfires that spread over tens of thousands of acres or more. Individual fires in the western United States that burn 100,000 to 200,000 acres or more are becoming more frequent.

In order to thin the woody vegetation on property they administer or manage, public land management organizations and certain private owners of range and forestland are stepping up their efforts. Their objectives are to lower the risk of wildfire and develop plant communities that are more resistant to pests, illnesses, and the upcoming wildfires. Treatments that thin shrub- and tree-dominated ecosystems can both lower fuel loads and produce significant amounts of woody biomass that can be used as a substitute fuel in society. On range and forest areas, there are an estimated 8.4 billion tons of dry biomass, but with the present fuel reduction techniques, only 60 million dry tons can be removed annually. Since it will take at least 140 years to reduce the woody fuel loads at the current clearance pace, more large-scale catastrophic fires are unavoidable in many regions. What is prescribed burning?

Self Assessment Exercise 3

1. Outline any six management goals envisaged by the use of fire as a management tool.

2. What are the plants' responses and adaptation to fire?

5.6 Summary

You have learnt in this unit that fire is critical to the maintenance of biodiversity and ecological processes and contributes to the distinctive nature of rangelands. However, the role of fire in maintaining wildlife has been misunderstood by the public in general; thus, over time the use of fire has been reduced. This is unfortunate because prescribed burning is an effective means for controlling selected unwanted and undesirable plant species on rangelands and enhances wildlife animal population. On the other hand, inappropriate application of fire can eliminate useful forage and pose serious threats to wildlife, property, community assets, air quality and rangeland values including water, and biodiversity.

5.7 References/Further Readings/Web Sources

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5.8 Possible Answers to Self-Assessment Exercises

Answer to SAE 1

1. Fire-intolerant plant species tend to be highly inflammable and are destroyed completely by fire. Some of these plants and their seeds may simply fade from the community after a fire and not return, others have adapted to ensure that their offspring survives into the next generation. Whereas Fire-tolerant species are able to withstand a degree of burning and continue growing despite damage from fire. These plants are sometimes referred to as "resprouters."
2. Exposure to sunlight, wind and evaporation, however, will work in the other way, to dry the soil. The fire may have created an impermeable crust at the soil surface, if organic matter on the ground was heated by the fire into a waxy residue, and if this has happened, it may lead to increased soil erosion through surface run-off. Fire may cause nutrient loss through a variety of mechanisms, including oxidation, volatilization, and increased erosion and leaching by water.

Answer to SAE 2

1. The biggest effect wildfire has on wildlife habitat is by altering the three things animals need most: food, water, and shelter. Tender understory plants and shrubs that provide food are lost, and this loss often results in wildlife moving away to areas where food, water, and shelter are more readily available.

2. The effects of smoke from wildfires can range from eye and respiratory tract irritation to more serious disorders, including reduced lung function, bronchitis, exacerbation of asthma and heart failure, and premature death. Children, pregnant women, and the elderly are especially vulnerable to smoke exposure.14

Answer to SAE 3

1. The management goals envisaged by the use of fire as a management tool are:

- "cleaning" or removing unwanted vegetation from landscapes to reduce fuel loads and the risk of large catastrophic fires
- changing the relative balance between herbaceous (grasses and forbs) and woody plants to improve forage availability for livestock or wildlife
- changing the structure or size class of plants across appropriate distances to benefit wildlife
- creating variability both within and among plant communities for wildlife and other rangeland resources
- promoting seed germination and the regeneration of desired plants; and
- maintaining the hydrologic cycle to promote the infiltration of water and to prevent rapid runoff and accelerated erosion.

2. Plants' responses and adaptation to fire include:

Plants have evolved many adaptations to cope with fire such as possession of leaves coated in flammable oils that encourage an intense fire. This heat causes their fire-activated seeds to germinate and the young plants can then capitalize on the lack of competition in a burnt landscape.

Other plants have smoke-activated seeds, or fire-activated buds. The serotinous cones of the Lodgepole pine (*Pinus contorta*) are sealed with a resin that a fire melts away, releasing the seeds.

Many plant species, including the shade-intolerant giant sequoia (*Sequoiadendron giganteum*), require fire to make gaps in the vegetation canopy that will let in light, allowing their seedlings

to compete with the more shade-tolerant seedlings of other species, and so establish themselves. Plant species may only be fire-intolerant, fire-tolerant or fire-resistant.

Glossary

CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna.
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
GLEWS	Global Early Warning System for Major Animal Disease
IUCN	International Union for the Conservation of Nature
IUCN	International Union for the Conservation of Nature.
SARS	Severe Acute Respiratory Syndrome
US	United State

End of Module Questions

Explain the stepwise procedure in the establishment of biological garden

Write concise note on nature of tolerance of plants to fire

What are the major components of population dynamics?

How does population dynamics affect the environment?

Explain the basic principles of ecosystem management.

How can we improve ecosystem management?