KUVEMPU UNIVERSITY
DEPARTMENT OF APPLIED ZOOLOGY

REVISED COURSE CONTENTS, SCHEME OF MARKS / ASSESSMENT (CBCS)-

M.Sc., Course in WILDLIFE AND MANAGEMENT

With effect from Academic year- 2015-2016 (August -2015 onwards)

I SEMESTER

Paper Code	Theory Papers	Teaching / week	IA	Exam	Total	Credits
HC-1.1	Systematics and Biodiversity	04 hrs.	25	75	100	4
HC-1.2	Forestry and Natural Resource Conservation	04 hrs.	25	75	100	4
HC-1.3	Ecology and Wildlife biology	04 hrs.	25	75	100	4
SC- 1.4(a)	Field techniques in Wildlife studies	04 hrs.	25	75	100	4
SC- 1.4(b)	Wildlife ecotourism and wetland conservation					
	Practical papers					
Practical -1.5	Based on theory paper HC – 1.1	4 hrs	-	50	50	2
Practical -1.6	Based on theory paper HC – 1.2	4 hrs	-	50	50	2
Practical -1.7	Based on theory paper HC – 1.3			50	50	2
Practical -1.8	Based on theory paper SC 1.4	4 hrs	-	50	50	2
				Total	**600**	**24**

II SEMESTER

Paper Code	Theory Papers	Teaching / week	IA	Exam	Total	Credits
HC-2.1	Animal Ethology and wildlife distribution	05 hrs.	25	75	100	5
HC-2.2	Animal Physiology and Health care	05 hrs.	25	75	100	5
SC-2.3	Minor Project work	4 hrs.	25	75	100	4
EL-2.4	Wildlife Conservation	02 hrs.	10	40	50	2
	Practical papers					
Practical -2.5	Practical – I: Based on theory paper HC – 2.1	4 hrs	-	50	50	2
Practical -2.6	Practical – II: Based on theory paper HC – 2.2	4 hrs	-	50	50	2
				Total	**450**	**20**

III SEMESTER

Paper Code	Theory Papers	Teaching / week	IA	Exam	Total	Credits
HC-3.1	Wildlife Conservation and Management	05 hrs.	25	75	100	5
HC-3.2	Mammalogy, Ornithology, Herpetology and Ichthyology	05 hrs.	25	75	100	5
SC 3.3 a	Environmental Pollution and Monitoring	04hrs	25	75	100	4
SC 3.3 b	Entomology and Eco-toxicology					
EL-3.4	Ornithology	02 hrs.	10	40	50	2
	Practical papers					
Practical -3.5	Practical – I: Based on theory paper HC – 3.1	4 hrs	-	50	50	2
Practical -3.6	Practical – II: Based on theory paper HC – 3.2	4 hrs	-	50	50	2
Practical -3.7	Practical – III: Based on theory paper SC 3.3a or b	4 hrs	-	50	50	2
				Total	**500**	**22**

IV SEMESTER

Paper Code	Theory Papers	Teaching / week	IA	Exam	Total	Credits
HC-4.1	Protected Areas Network and Zoo Management	05 hrs.	25	75	100	5
HC-4.2	Remote Sensing and GIS and Biostatistics	05 hrs.	25	75	100	5
HC-4.3	Major Project work	4 hrs	25	75	100	4
	Practical papers					
Practical -4.4	Practical I: Based on theory paper HC – 4.1	4 hrs	-	50	50	2
Practical -4.5	Practical II: Based on theory paper HC – 4.2	4 hrs	-	50	50	2
				Total	**400**	**18**

1. Total Marks for the Course : 1950

2. Total Credits for the Course : 84 + 3 (Soft Skills) = 87

1. Dissertation (Major and minor project work) should be based on experimental / review work and valued by two examiners (one external and one internal).
2. Educational tour is compulsory in the III Semester. Tour report should be submitted for internal assessment.
3. Each candidate shall have to complete one Credit each in Communication Skill, Computer applications and Personality development within first two semester.

Internal Assessment for papers

1. Two session tests : 10 marks
2. Seminar/Tutorial/Group discussions/Tour Report : 05 marks
3. Assignment/Fieldwork : 05 marks
4. Regularity and attendance : 05 Marks

SEMESTER – I

H.C. 1.1: SYSTEMATICS AND BIODIVERSITY – 64 hrs

Unit -1: Plant Systematics: Introduction to angiosperm systematics and evolution: Morphology and Taxonomy of major groups, Plant identification and use of Taxonomic literature. Principles of plant nomenclature, Types and methods, Citation of authorities and name changes. Floral diversity and botanical regions of India. Classification of algae and plants (up to major families only). Plant conservation issues and strategies. Principles of vegetation classification. Major vegetation types of India (Champion & Seth's classification). Structural and functional attributes of vegetation. Plant succession: concepts and processes. Techniques of vegetation surveys and quantification. -20 hrs

Unit -2: Animal Systamatics: Animal Taxonomy: Development of modern taxonomy; Pre-Darwinian approaches, The discovery of Phylogeny. New systematic and future scope. Characteristics and classification of, Mammals, Reptiles, Amphibians and Fishes up to orders with suitable examples. [Classification of Protozoans, Non-chordates (major classes with Insects upto orders) and Chordates (major orders)] – 20 hrs

Unit-3:Biodiversity: Introduction, Types of Biodiversity, Climatic Zones and Biodiversity, Biodiversity as a natural resource – 8 hrs

Unit 4: Indian Biodiversity: Vegetational Zones, Zones of faunal distribution, Major protected areas & their importance - 8 hrs

Unit5: Global Biodiversity: Major Biodiversity areas of the world, Biodiversity Hot Spots and gene bankimg – 8hrs

Practicals

1. Systematic study of common plants, Field and Herbarium techniques, Study of campus flora, Status of litter layer in various forest types, Study the successional stages of various forest communities in the campus, Rapid assessment of riverine vegetation in nearby areas and Demonstration/on-site discussion on topographic features and corresponding vegetation type
2. Systematic study of common Animal species, Study of campus fauna, Rapid assessment of terrestrial fauna in nearby areas of the campus and Demonstration/on-site discussion
3. Using photographs / paintings / coloured drawings identify and study the classification, characteristics & ecological role of characteristic species (representative species only) from; *Protista – protozoans, *Non-chordates – major classes (Insecta – upto orders) *Chordates – major orders
4. Using photographs / paintings / coloured drawings identify and study the classification, characteristics & ecological role of characteristic species (representative species only) from; *algae of various types, * mosses, ferns, woody and non-woody flowering plants
5. Study the various types of Fruits, Inflorescence, Stem modifications, root modifications, inflorescence and leaf types
6. Study of social insects / types (use diagrams / photographs) in ; Honey bee, ants, termites

H.C. 1.2: Forestry and Natural Resource Conservation - 64 hrs

Unit – 1 Forestry: Introduction to forestry; Production forestry: Actual production, uses of wood, potential productivity, planning, increased production, Wood technology; anatomical, physical and mechanical properties, pulp, paper and rayon, saw milling and preservation. Forest Utilization: Logging and extraction techniques and principles, transport, storage and sale, Non wood forest produces – definition and scope, gums, resins, oleoresins, fibres, oil seeds, nuts, rubber, canes, bamboo, medicinal plants, charcoal, honey, lac and shellae, tassar silk, beedi leaves, collection, processing and disposal of non wood forest produces. – 10 hrs

Unit- 2 Forest menstruation: Methods of measuring diameter, girth, height and volume of trees, form factor, volume estimation of stand, sampling methods, yield calculation, current annual increment, mean annual increment, sample plots, yield and stand tables, scope and objectives of forestry inventory. - 10 hrs

Unit-3 Forest Management: Objectives and principles, techniques, sustained yield rotation, regulation of yield working plan preparation, General forest protection against fire, pests and diseases, Biological and chemical controle. Forest soils and their conservation: Forest soils-classification, factors affecting and soil formation, physical and chemical properties, soil conservation, causes of erosion, Types-wind and wind erosion, shelter belts, fixation sand dunes, reclamation of alkaline, saline water logged and other waste lands, waste land development, watershed management. - 10 hrs

Unit -4 : Silviculture: Silvicultural principles, ecological, physiological factors influencing vegetation, natural and artificial regeneration of forests, nursery techniques, seed-technology, collection, storage, pretreatment and germination, establishment and tendings, silvicultural system- clear felling, uniform, shelter, section, coppiece and conservation system. Silviculture of some of the economic important species of India such has *Pinus roxuburhii*, *Acacia species*, *Dalbergia sp*. *Tectona grandis*, *terminalia sp*. Etc. - 10 hrs

Unit-5 : Natural resource conservation: Concept of conservation with special reference to forest and wildlife management, conservation verses preservation. forest and wildlife as natural resources. Conservation movement in India, socio-economic and political realities, different phases of the conservation and how it has impacted people at large. Concept of stakeholders. International conservation bodies; IUCN UNDP, FAO, WWF. Natural resource economics: Need for integrating environment and economics, the economic reasons for over-exploitation of natural resources, ecosystem functions and services, cost and benefits of biodiversity conservation. Need for ecosystem service valuation. - 24 hrs

Practicals

1. Using photographs / paintings / coloured drawings identify and study the characteristics & ecological role of minor and major forest products (representative species only)

Wood: *Tectona grandi, Artocarpus integrifolia, Eugenia janbusina, Terminalia paniculata Michalia champaca*

Non forest products: *Garcinia indica, Acasia consinna, Emblica officinale, Withania somnifere, Coffee Arabica, Sapindus trifoliate, Semicarpus anacardium, Abrus precatorinus, Vetivere zizanoids, Pepper nigraum, Cinnamomum zaydenicam.*

2. Identify the some economic important plant species and their silvicultural importance
3. Class based discussion with faculty and a range of conservation activists. Review of literature. Preparation of conservation statements.
4. Taxanomic and silvicultural characters of Tree sps..

H.C. 1.3: Ecology and wildlife biology - 64 hrs

Unit 1: Ecology: definition, branches of ecology. Ecosystem; Basic concepts and structure of ecosystem, Functioning of ecosystem, energy flow and nutrient cycles, food chains, food webs, trophic levels, autotrophs, heterotrophs, saprotrophs, biological cycles, structure and function of some Indian ecosystems. - 10 hrs

Unit 2:. **Community ecology:** Nature of communities; community structure and attributes; edges and ecotones. Species interactions: Types of interactions, competition, mutualism, commensalism, protocooperation, parasitism and predation. - 10 hrs

Unit 3: Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax. – 10 hrs

Unit 4: Scope of Wildlife Biology; Physiological Basis of Hibernation, aestivation, Awakening, Migration, Circadian rhythms, Hypothalamo- Hypophysial Axis and its role, Pineal gland and its role Day- length influences on Phenology, Seed dormancy and methods of breaking it - 15 hrs

Unit 5: Adaptations to Habitats ; Animal adaptations to water, temperature, salinity, predation, Deep sea & diving adaptations in animals , Role of blubber in marine mammals "Superspecialised" animal species (e.g. Ant eater) , Plant adaptations to water, temperature, salinity, predation , Association between animals for adaptation , Association between plants & animals for adaptation , Orientation & navigation in animals - 15 hrs

Unit 6: Understanding biological requirements of species; design of facilities, food, hygiene, disease control, breeding. Propagation of threatened plants. Case studies on Conservation Breeding Programme of endangered wild animals. - 4 hrs

Practicals

1. Estimate primary production/physic chemical characteristics of water samples from different aquatic habitats.
2. Using suitable diagram / picture identify zonations in a pond ecosystem and study the species distribution.
3. Using suitable diagram / picture identify zonations in a sea-shore ecosystem and study the species distribution.
4. Study of some pioneer communities in succession; Lichen and their types, mosses and their types, coral and their types.
5. Adaptations in animals : use pictures or photographs with suitable labels.
6. Adaptations in plants : use pictures or photographs with suitable labels.
7. Study of Fish Scales (lateral side of Body) from at least six different Marine and Fresh water fishes. Make low power microscopic observations and draw diagrams to depict the diagnostic and distinctive features of each scale type.
8. Study of morphology of plants (use photographs / paintings / coloured drawings / preserved specimen); Leaf – morphology, modifications and phylotaxy, Flower – morphology & modifications, Fruit – types & morphology, Seed – types, morphology and modifications for dispersal

S.C. 1.4(a): Field techniques in wildlife studies – 64 hrs

Unit 1: Field surveys &observations; Sampling methods and identifying study sites , Different methods of transacts& quadrates , Techniques of field observation , Camouflages& Observation stations , Non-intruding / non-interfering techniques of field observations – 15 hrs

Unit 2: Recording & Evaluation of Data; Field note book and its records, Qualitative & Quantitative data Field kit and its usage, Cameras, binoculars, field scopes, camera traps etc. , Different methods of recording field observations , Use of rings / tags, Color codes, Colour marking on animals. – 15 hrs

Unit 3: Ethics in Field Studies; Dos & Don'ts in field studies, Regulatory permissions for field observations, Field collections & Field preservations - 15 hrs

Unit 4: Statistical Methods (use examples from wildlife, forestry and field experimentation) Identifying sampling sites &Determining sample size, Central tendencies & their applications, Working with qualitative data, Depiction of data (tables, charts, graphs, Pictograms, kite diagrams etc.) Methods to evaluate significance of results , Concept of confidence interval & its application. - 19 hrs

Practicals

1. Demonstration and study the working principals of common instruments available in the laboratory.
2. Application of transacts and quadrants in Simulated pictures / photographic sheets for data collection. Record & tabulate the data.
3. Instruments for sampling; Water Sampling bottles, Plankton samplers, Core samplers, Bottom samplers, air samplers – construction, working and application (photographs or specimens and diagrams).
4. Using a suitable hand held camera photograph the following (to record diagnostic features). Record the camera settings and take 5" X 7" prints on three different papers; Butterfly / Moth, House fly, Dragonfly, a caterpillar, Fresh fish (from market) e.g. Mackerel, Hilsa, Rohu, catfish.
5. Collect matured leaves (minimum hundred for a class) from two different plants (e.g. Mango tree & False Ashoka). Measure and record the length (in cm.) along the midrib using a flexible thread. Tabulate the data, make frequency polygon, apply "t" test to the data and comment on the significance of the deference in leaf length between the two plant species

SC 1.4 (b): Wildlife ecotourism and wetland conservation 64 hrs

Unit 1: Tourism: objectives, planning, economics. Eco tourism, Protected areas in India Tourism in protected areas.- Ecotourism- a worldwide view. Ecotourism in Indian context. 8 hrs

Unit 2: Wildlife tourism: Development of Interpretative facilities, visitor characteristics, expectations and motivations, sustainability in Wildlife Tourism. Planning ecotourism in protected areas. Visitor management in ecotourism areas - zoning, carrying capacity. Game ranching and controlled off-take from wild population, rationale, management design, harvesting by management or hunting licences, marketing procedures. Conflicts in Protected areas. Participation of local people in ecotourism. Ecotourism for sustainable development of Protected Areas. New directions in ecotourism industry. 20 hrs

Unit 3:Ecotourism in protected raeas: Ecotourism in practice in important Protected areas of India – case studies of Bhadra Wildlife Sanctuary, Banneraghatta National Park, Bandipura wildlife sanctuary, Periyar Tiger Reserve, Keoladlo National Park, Kanha National Park and Jim Corbet National Park and Sunderbans Tiger Reserve. Limitations and problems of ecotourism. Ecotourism as a way for sustainable management of natural resources. Local livelihoods and eco-tourism like nomadic grazing, agro- pasturatism. 12 hrs

Unit 4: Wetlands: Classification, functions & values. Wetland ecosystems and its environmental significance. Factors affecting wetland habitats. Wetland Management -- Definition and classification. 10 hrs

Unit 5: Wetland values and functions : wetland degradation and loss. Conservation of wetlands. Wetland management principles. Identifying major problems and setting objectives and Priorities. Management of wetland habitats for ecological processes and wildlife. 14 hrs

Practical:

1. Visits to surrounding ecotourism destinations-
2. Prepare ecotourism activity maps-
3. Preparation of route maps to important National parks and sanctuaries of India.
4. Preparation of information procedure about wildlife tourist spots in India. Exercises on the preparation of location-specific model eco-tourism plans.
5. Visit to wetland areas.
6. Visit important wetlands in the country, the appraisal of the habitat,
7. Waterfowl census,
8. Documentation of threats to wetlands.

II SEMESTER

H.C.2.1: Animal Ethology and Wildlife distribution– 80 hrs

Unit 1: Ethology; Definition & Types of Behaviors (including Innate & Learned), Cues / triggers to behavior , Genetic basis of behavior, Behavior & Ecological success (adaptation, Niche realization) Sociobiology, Animal Societies, Establishment of Hierarchies, Animal Communications , Social behaviors and Parental care. -15 hrs

Unit-2: Methods of observing and recording animal behaviors; Sampling Behaviours, Methods of observing Behaviour , Time- activity budgets, Ethograms, Social interaction, matrices and their analysis – 15 hrs

Unit 3: Population ecology ; Characteristics of population ecology, Age & Sex distribution, Recruitment ratio & population sustenance (e.g. Herbivores, Fish & Prawns), Effect of natality, mortality & migration , Survivorship curves, k & r selected species, Interaction between populations; Types of interactions, Predator – prey interactions, Competitions, Fluctuations in populations, Concept of Plant - animal Communities - 20 hrs

Unit 4: Plant – animal interactions; Shelter & Nesting by animals, Effect of grazing & browsing, Protection strategies of plants for sustaining populations, One plant – One animal dependence – e.g. Fig wasp, Orchid mantis etc. – 15 hrs

Unit 5: Distribution & Dispersal of Plants &animals; Vegetation and its effect on animal distribution , Pollination & seed dispersal, Vegetation preferences of animal species, Barriers to species distribution. – 15 hrs

Practicals

1. Using photographs / paintings / coloured drawings identify and study ecological role of characteristic animal species (major representative species only) of various Biomes.
2. Using photographs / paintings / coloured drawings identify and study ecological role of characteristic plant species (predominant trees / shrubs only) of various Biomes.
3. Identify marine and fresh water planktons (preserved water samples may be used).
4. Separate, mount and study the appendages of prawn ;penaeid and non-penaeid.
5. Study of animal architecture (photographs / diagram / abandoned specimen) ; Hive of honey bee, nest of paper wasp, nest of potter wasp, Mount of termite, Nests of Weaver Bird and tailor bird.
6. Comparative study of mouth parts (preserved specimen / diagrams only); House fly, female Mosquito, Cockroach, Butterfly / moth, Bug, beetle.
7. Using photographs / paintings / coloured drawings identify and study distribution and ecological role of common bivalves and gastropods that occur along a sea-shore.

H.C. 2.2: Animal Physiology and Health care – 80 hrs

Unit-1: Nutrition; Energy content of foods, digestive system, alimentary canal, modification in herbivores and carnivores, teeth and jaws; digestibility of food, chemistry of digestion, classification of enzymes, factors controlling the rate of enzyme reactions, mechanism of enzyme action, absorption of food nutrients. -15 hrs

Unit-2: Metabolism; metabolic rate, BMR, factors affecting metabolism, Role of hormones in co-ordination of growth and metabolism. -10 hrs

Unit-3: Water regulation; comparative account of water and salt regulation, fishes, amphibian, reptiles, birds and mammals. Thermoregulation; temperature regulation, ectothermic and endothermic vertebrates, special problems of endotherms living in climatic extremes, mechanism of temperature regulation. Receptors; Receptor organs, photo, phono, mechano and chemo receptors. -15 hrs

Unit-4: Reproduction in birds; physiology of egg formation, physiological changes during incubation. Reproduction in mammals; secondary sexual characters, reproductive cycles. Physiology of gestation, lactation, weaning, hormonal control. -10 hrs

Unit-5: Infectious wildlife diseases; Rabies, Rinderpest, Foot and Moutn, viral encephalitides, yellow fever, new castle, Psittacosis/Ornithosis, African swine flue, Kyasanur diseases. Bacterial diseases: Anthra, Brucellosis, Clostridiosis, Listeriosis. – 15 hrs

Unit-6: Non-infectious diseases wildlife diseases: Diseases of the digestive, respiratory, excretory and nervous system. Factors of disease dissemination in wildlife and animal health monitoring. – 15 hrs

Practicals

1. Determination of serum cholesterol.
2. Determination of glucose content by Folin-Wu method in normal and diabetic blood samples.
3. Estimation of liver and skeletal muscle glycogen in normal and starved mice.
4. Estimation of proteins in the liver/ skeletal muscle of mice by Lowry's method.
5. Estimation of creatinine in the urine sample.
6. Estimation of chlorides in the urine sample.
7. Estimation of serum phosphotases (Acid and alkaline)
8. Total count of RBC and WBC.
9. Differential count of WBC.
10. Observation of permanent slides/ photographs of Infectious and non infectious diseases of wildlife

S.C. 2.3: Minor Project - 64 hrs

El-2.1: WILDLIFE CONSERVATION **32 hrs**

Unit – 1: Wildlife studies : Definition of wildlife, values of wildlife, significance and scope of wildlife conservation, wildlife distribution; Global distribution, Indian wild fauna, wildlife byproducts and trade, Ethical value, Scientific value, medicinal value, game and recreation value, ecological value, wild life as natural resource in India . **9 hrs**

Unit -2 : **Wildlife categories and causes of depletion:** IUCN Red list**,** Categories of wildlife**;** Extinct, Endangered, Threatened, Vulnerable, rare; data deficient categories. Causes of wildlife depletion: Degradation and destruction of natural habitats, Exploitation for commercial purposes, Deforestation, Agricultural expansion and grazing, Urbanization and industrialization, Forest fires. Human-wildlife conflicts **9 hrs**

Unit – 3: W**ildlife conservation;** Historical background, Need of conservation projects in India, Ex- situ & in-situ conservation. National parks, Wildlife sanctuaries, wildlife reserves, Biosphere reserves. National parks and wildlife sanctuaries in Karnataka. Umbrella species, flagship species based conservation programmes. Mitigation of human-wildlife conflicts **9 hrs**

Unit – 4: **Wildlife and legislation :** Constitutional provisions, National and International guidlines and protocols. **5 hrs**

III SEMESTER

H.C. 3.1: Wildlife Conservation and Management – 80 hrs

Unit -1: Introduction, importance of wild life conservation – Economic, ecological, aesthetic, Scientific, Recreational, Medicinal. Wild life categories: Endangered, Threatened, Vulnerable, rare; data deficient categories, Red data book. Causes of wildlife depletion: Degradation and destruction of natural habitats, Exploitation for commercial purposes, Deforestation, Agricultural expansion and grazing, Urbanization and industrialization, Forest fires. -15 hrs

Unit 2: National parks, Wildlife sanctuaries, wildlife reserves, privately owned wildlife reserves & Biosphere reserves, Single species / single habitat based conservation programmes (e.g. Project tiger, Project Elephant, Valley of flowers, etc.,) - 15 hrs

Unit 3: International conventions on conservation ; Important International conventions &treaties on nature & conservation, India's role & contribution , Ex- situ & in-situ conservation, Conservation Breeding (e.g. Vulture, Pygmy hog, Gharial etc.), Institutions and their role in conservation; Zoos, Natural history museums & collections, Zoological survey of India, Botanical survey of India, Forest research Institute, Survey of India, Central Marine Fisheries research Institute - 20 hrs

Unit 4: People and conservation ; Traditional knowledge, Traditions & cultures, Women in conservation Traditional Societies (e.g. bedas, kadu kurubas, trible peoples) – 10 hrs

Unit 5: Role of NGOs in conservation; International NGOs; UNEP, GEF, WCS, Bird Life International Important NGOs in India & their contributions , WWF, ATREE, BNHS, WTI, Kalpavriksha etc. Important NGO movements , Chipko movement, Narmada Bachavo Aandholan, Pani Panchayats, Seed Movement etc. - 20 hrs

Unit 6: Wildlife and legislation : Constitutional provisions, National and International guidlines and protocols. Wildlife and forest protection acts

Practicals

1. On a phytogeopgrahic map of India locate & demarcate major sanctuaries / national parks.
2. Identify and describe false colour images of land use patterns from a satellite image; City, reservoir, forest, agricultural land, sea-shore.
3. Using photographs / paintings / coloured drawings identify and study distribution and ecological role of Endangered species of India
4. Using photographs / paintings / coloured drawings identify and study distribution and ecological role of Endemic species of Western ghats .
5. Using photographs / paintings / coloured drawings identify and study the extinct species of globe.

HC-3.2: Mammalogy, Ornithology, Herpetology and Ichthyology – 80 hrs

Unit-1: Mammalogy: History of Mammalogy. Evolution of mammals and morphology. Adaptations in mammals; hibernation, torpor, aestivation, locomotion and water regulation. Metabolism and thermoregulation; ectothermy, homeothermy and cold stress, body size versus homeothermy. Body size variation in mammals and its influence on life history, metabolic rate, weight constraints, feeding behaviour, niche width and reproduction. Mammalian skin and its derivatives. Behaviour and social organization in mammals; social and mating systems; territories; communication. Mammalian diet; digestive systems; anatomy, morphology and function.
– 25 hrs

Unit – 2: Ornithology : Habitat ecology of Indian birds; Coastal birds, Inland water birds, Birds of high altitude and deserts. Distribution of birds in India. Morphometric measurement used in food habit studies. Feeding ecology- Insectivores, Frugivores, Nectarivores, Graminivores, Carnivores and Scavengers. Territoriality; functions and types of territoriality, sizes and shapes of territory, Defense and site fidelity. Songs and calls; Functions of voice, birds vocabularies, nature of song, non vocal songs. Nesting; Functions, choice of nest sites, colonial nesting, forms of nests, nest materials and nest building and multiple nests. Reproduction; Breeding seasons, Factors influencing breeding seasons, seasonal reproductive cycles, photo periodism, courtship and display, sexual selection, pair bond, sexual dimorphism, mating systems, polyandry, polygyny, promiscuity, co-operative breeding, brood parasites. Egg laying- Timing of egg laying, clutch size, incubation patterns, hatching. Parental care- Feeding, nest sanitation,. Feathers and Moulting – Types, Functions, growth, Moulting. Birds Migration; Economic values of birds. endangered and threatened birds. - 25 hrs

Unit -3: Herpetology: Systematics and Zoogeography of amphibians and reptails: Factors affecting distribution and abundance of amphibian and reptilian fauna of Indian sub-continent. Biology of major Indian amphibians, fresh water and marine turtles, crocodilians, lizards and snakes. Thermo-regulation, its role, aestivation, hibernation and other eco-physiological adaptations. Role of temperature in sex determination in reptiles. An Overview of conservation problems and issues of herpeto-fauna of Indian sub-continent. Case studies. -15 hrs

Unit – 4: Ichthyology: Classification and evolution of major groups of fishes in India. Ichthyogeography and diversity of freshwater fishes of India. Ecology and adaptation of fishes in different ecosystems. Economic importance of sport fishes of India. Threats and conservation perspectives of fish biodiversity in India as well as at global level. Threatened fishes of India. Methods to study ecology of fish diversity, abundance, growth and their habitats. – 15 hrs

Practicals:

1. Study of epidermal derivatives; comparative morphology of dentition and skull; mapping distribution of primates, carnivores and ungulates.
2. Examination and drawing of museum materials: skins, skulls, feet, eggs and nests of characteristic species. Birds skin preparation and measurement of specimens. Mist-net techniques, methods for handling and ringing.
3. Examination and drawing of museum materials and morphometric study
4. Fish morphometric study (in lab), and Methods for fish ecological studies (in field).

S.C. 3.3a : Environmental Pollution and Environment monitoring. – 64 hrs

Unit 1. Concept of Biosphere and its components, hydrosphere, atmosphere, and lithosphere. Water pollution: Definition and sources, Types and classification of pollutants. Effects of Water Pollution - 12 hrs

Unit 2: Air pollution: Sources and Primary and secondary air pollutants. Biological effects of Nox, SOx, SPM, Hydrocarbons, acid rain, global warming, photochemical smog and ozone depletion. Effects on biota and Control measures. – 12 hrs

Unit 3: Solid waste and Hazardous waste: Types, Sources, collection, transport, treatment, Disposal and recycling methods. Soil Pollution: Soil pollutants and their effects, and their control measures, . Noise Pollution: Sources, biological effects, control measures.Radiation pollution: Sources, types, effects, atmospheric fallout and their control measures. – 12 hrs

Unit-4: Environmental impact Assessment: Basic elements, Methods and criteria for industrial, Aquaculture, transport and water related EIA, Environmental Auditing and Case studies: Konkan Railway and Bhopal Tragedy. Environmental education and awareness. Legal aspects – 15 hrs

Unit- 5: Monitoring Environment: Abiotic parameters to be monitored for various types of habitats Keystone species & Indicator species , Continuous & seasonal monitoring , Various monitoring techniques & methods. – 13 hrs

Practicals

1. Test of Soil samples for ; pH, Texture, Total organic content.
2. Test of Soil samples for ; N, P, K contents.
3. Test of Water samples for; Dissolved Oxygen, BOD, COD.
4. Test of Water samples for; Salinity, pH, hardness, Calcium, Magnesium, pH, conductivity, TDS etc.,
5. Using a Simulated data perform the following: Classify the data and calculate ecological indices ; Dominance index, Shannon-Wiener Index, Similarity Index, Diversity index. Evaluate and interpret each of the index values.
6. Prepare an audio-visual presentation to communicate conservation to the youth & general public on some environment issues (e.g. : Destruction of local biodiversity site like mangrove or sea shore or a forest patch, Human-wildlife conflict, Developmental activity that has potential threat to local biodiversity etc.)
7. Design a self-guided trail for a nature reserve / biodiversity park and submit a report.

S.C. 3.3b: Entomology and Eco-toxicology - 64 hrs

Unit-1: Introduction to Entomology: Insect taxonomy and diversity. Their living and non-living environment, economic importance, ecological roles, adaptation, Insects as indicator for biodiversity monitoring. Diversity patterns across biogeographic zones, provinces, regions and neighbouring countries. – 14 hrs

Unit-2: Insect fauna in prominent Indian PAs. Specific case studies on forest infestation by sal borer and other forest pests and their life cycle and management – 14 hrs

Unit -3: Ecotoxicology, Introduction, fundamentals and scope of toxicology, Bioassay methods, Acute, chronic and reproductive toxicity, Factors and dose response relationships, factors effecting toxicity. Mechanisms of Bio-accumulation and Bio-transformation, Detoxification, Bio-monitoring. – 14 hrs

Unit- 4: Pesticides (Xenobiotics): Introduction, classification, basic aspects of pesticide toxicity, metabolism (DDE, parathion, carbaryl) and their effects on animals. Metals – Survey,effects and management. Arsenic, Cadmium, Lead, and Mercury - 12 hrs

Unit -5: Natural toxicants: Animal venoms and poisons, Toxins produced by fishes, Microbial (Algal and bacterial) and plant toxins. Safety standards and regulatory provisions - 10 hrs

Practicals

1. Study the insect Collection methods and equipment. Preservation and storage. Study and identification.
2. Demonstration of LC50 & LD50
3. Estimation of Glycogen
4. Estimation of Protein (Total, Soluble and Structural)
5. Estimation of Inorganic phosphates in tissues
6. Estimation of catalase activity
7. Estimation of Transaminase enzymes
8. Bioaccumulation studies

PAPER- El-3.1: ORNITHOLOGY **32 hrs**

Unit – 1: Habitat ecology of birds : Habitat ecology of Indian birds; Coastal birds, Inland water birds, Birds of high altitude and deserts. Distribution of birds in India. Morphometric measurement used in food habit studies. 5 hrs

Unit-2: Feeding ecology of Birds; Insectivores, Frugivores, Nectarivores, Graminivores, Carnivores and Scavengers. 5 hrs

Unit-3: Territoriality and Nesting; Functions and types of territoriality, sizes and shapes of territory, Defense and site fidelity. Songs and calls; Functions of voice, birds vocabularies, nature of song, non vocal songs. Nesting; Functions, choice of nest sites, colonial nesting, forms of nests, nest materials and nest building and multiple nests. 10 hrs

Unit-4: Reproduction and Migration; Breeding seasons, Factors influencing breeding seasons, seasonal reproductive cycles, photo periodism, courtship and display, sexual selection, pair bond, sexual dimorphism, mating systems, polyandry, polygyny, promiscuity, co-operative breeding, brood parasites. Egg laying- Timing of egg laying, clutch size, incubation patterns, hatching. Parental care- Feeding, nest sanitation,. Feathers and Moulting – Types, Functions, growth, Moulting. Birds Migration; Economic values of birds, endangered and threatened birds. 12hrs

IV SEMESTER

H.C. 4.1: Protected Areas Network and Zoo Management – 80 hrs

Unit 1: Management of Protected areas ; Principles of wildlife management, Wildlife management techniques, Habitat management, Plantations, nesting places , Nesting materials, Hides & shelters, Census & enumeration of species, Prey-predator ratio, Improving carrying capacity, Water holes, salt licks, stall feeding, Controlled grazing, controlled fire Culling & translocation Dealing with Human –Wildlife conflicts , Compensating losses , Regulating forest usage (e.g. grazing at Keoladeo / Gir, Fishing in Sunderbans, Mahua collection in Kanha)

– 20 hrs

Unit 2: People's participation in managing protected areas, Integrating Local Community in conservation (e.g. Kaziranga, Eagle's Nest), Training & skill development of local human resource, Interpretation Centers & Interpretation to visitors , Hospitality & Conducted tours , Resource sharing & income sharing Case studies of success stories: (e.g. Ranthambor, Periyar, Lakswadweep, Van samitis). – 15 hrs

Unit 3: Wildlife Trade and Laws ; Wildlife protection Act of India, CITES, TRAFFIC, RED Data Book, Measures to control poaching & wildlife trade. -10 hrs

Unit 4: Regulations & Acts related to protected areas; General concepts of Private forests, Reserve forests, Sanctuaries, National Parks, Wildlife reserves, Coastal Regulation Zone, Protected Areas Network. – 15 hrs

Unit 5: Zoos and their management: Aims of Zoos, different types of zoo records and their use. Zoo foods – Natural food, substitute for natural foods, food supplements – 20 hrs

Practicals

1. Using a suitable insect model, apply the capture – recapture technique for enumeration of population size (e.g. rice weevil using - marker pen)
2. Collect an abandoned nest of a bird (made of twigs /grass preferably collected after the breeding season). e.g. Bulbul or Crow or Warbler. Carry out the following analysis; Record the weight of the nest. Gently separate the nesting material one by one and segregate them as per their lengths. Weight each length group separately and note their group total weights. Note down any ushioning material /artificial materials used. Make a frequency table of nesting material lengths & weights. Depict your observations using suitable statistical tools and evaluate your data. Make interpretations regarding preferences in nesting material.
3. Study of Pugmarks: Make plaster cast of pugmark (e.g. of domestic cat or dog). From the plaster cast make measurements and record the same. Trace the pug mark using glass slab and make a record. Take measurements and keep a record. Study the applications of the same. If possible, repeat the experiment with Plaster cast of pug mark of Tiger / Leopard (take help from Wildlife authority to obtain plaster casts)
4. Study of animal Tracks & signs using photographs or drawings. e.g. pugmarks, foot prints, tracks, claw marks, browse lines, dung mounts, regurgitates (e.g. owls), hair, scats, burrows, dens, nests etc.
5. Study the various zoo animal food habits and sanitation equipments.

HC 4.2: Remote Sensing and GIS and Biostatistics 80 hrs

Unit 1: Principles of Remote Sensing: Basic concepts, Electromagnetic spectrum, energy sources and radiation principles, Energy interaction with air, water, soil, rock and vegetation. Remote sensing data acquisition systems, Concept of spectral and spatial resolution in remote sensing. Micro wave remote sensing - 15 hrs

Unit – 2: Aerial Remote Sensing: Introduction to basics, Aerial photography, Geometric characteristics of aerial photographs, Film and filter combination techniques of photography, Instrumentation in aerial photography, vertical exaggeration and radial triangulation, Principle keys to interpretation of aerial photographs. Satellite Remote sensing: Indian remote sensing missions, Satellite data products, Hard copy and soft copy data and their uses. Interpretation of satellite data, Visual and Digital data. Visual interpretation keys. Digital image processing. Analysis of remote sensing data. – 15 hrs

Unit-3: Geographic Information System (GIS): Introduction, fundamentals and functions of GIS. Components of GIS. Data models (Raste and Vector models). Resolution, orientation, Zones. Over laying techniques. GIS – analysis. Inputs – outputs, meta data and conceptual design. GIS system integration and application development. Application of Remote sensing and GIS: Forestry and wildlife monitoring and management. Forestry – classification of forest types, inventory and mapping of forestland, Forest cover monitoring, damage detection and assessment and forest area development and planning. Wildlife Management – Wildlife habitat evaluation, Mapping of corridors. Network of wildlife reserves and mapping of potential habitats. -10 hrs

Unit- 4 : Biostatistics; . Introduction: statistical terms, Sampling methods, classification of data, presentation of data, Frequency distribution: Class interval, relative frequency, percentage frequency, cumulative frequency, types of frequency distribution- normal, skewed, binomial and poisson distribution. Central tendency: Arthematic mean, geometric mean, median, mode, Measures of Dispersion: Definition, range, mean deviation, standard deviation, coefficient of variability, standard error, degrees of freedom, confidence limit. Graphic representation of biometric data: histogram, frequency polygon, frequency curve, Ogive scatter or dot diagram, bar diagram, pie chart. or sector diagram - 20 hrs

Unit – 5: Tests of Significance: t- test, z-test, chi square test. Correlation: types of correlation, Correlation and reserves, methods of studying correlation, coefficient of determination, significance test for 'r', coefficient of non-determination, coefficient of alienation, partial correlation, multiple correlation. Analysis of Variance. Regression analysis: regression line, regression equation, procedure of regression test, partial, curvi linear and multiple regression. - 20 hrs

Practicals

1. By using Satellite imageries map the important protected areas, vegetation type, soil type, wetlands etc.,
2. Measures of central tendency: calculation of mean, median and mode for ungrouped and grouped series.
3. Measures of dispersion: calculation of standard deviation and standard error.
4. Graphical representation of biometric data: preparation of histogram, frequency polygon and frequency curve, cumulative frequency or ogive and scatter; line, bar and pie-diagram.
5. Tests of significance (problems for Student's *'t'* test, analysis of variance, z-test, Chi-square test)
6. Problem on Karl Pearson's Coefficient of correlation.

H.C. 4.3 Major Project work - 64 hrs

REFERENCE AND SUGGESTED READINGS

SEMESTER – I

Paper – H.C.1.1: Systematics and Biodiversity

1. Agarwal. S.K.S. Tiwari and P.S. Dubey, 1966. Biodiversity and Environment APH. Pub. Corp. New Delhi.
2. Bhattachargya. B and B.M. Johri. 1998. Flowering plants –Taxonomy and phylogeny. Narosa Pub. House, New Delhi. Pp 753.
3. Dash, M.C. 1993, Fundamentals of Ecology, Mc-Graw hill co., New Delhi.
4. FAO. 1992. Conservation and Development of Tropical Forest Resources, FAO Publications, Rome.
5. Frankal, Otto H., Anthony, A., Brown, D. and Burdon, Jeremy J., The conservation of plant biodiversity. Cambridge University Press, 1995.
6. Hosetti, B.B. 2002. Glimpses of Biodiversity**,** Daya Publishing House, Delhi-35, India.
7. Hosetti, B.B. and Venkateshwarlu M. 2001.Wildlife Trends in Biodiversity Conservation and Management, Daya publishing House, Delhi-35, India.
8. Hosetti, B.B. Concepts in Wildlife Management, Daya Publishing House, Delhi. 1997.
9. Hooker. J.D 1894. The flora of British India. Vol. 6:1-792, Reeve and co. London.
10. Katwal/Banerjee, Biodiversity conservation in managed and protected Areas, Agrobios, India, 2002.
11. Krishnamurty. K.V, Senthil Kumar T, and Nandagopalan (1995) Taxonomy and Biodiversity. Ed. AK Pandey, CBS Publ. New Delhi.
12. Lawrence. GHM. 1967. Taxonomy of vascular plants Oxford and IBH, New Delhi.
13. Myers, N.R.A. Mittermeier, C.G.Mitter meri, GAB Kents. 2000. Biodiversity hot spots for conservation priorities, Nature 403:553-858.
14. Myers. N. 1988. Threatened biotas: hot spots in tropical forestry. The Environmentalist 8:1-20.
15. Negi, S.S. 2002. Hand book of National Parks, Wildlife Sanctuaries and Biosphere reserves in India. Indus Publ., New Delhi.
16. Negi, S.S., Biodiversity and its conservation in India, Indus Publishing Co., New Delhi. 1993.
17. Prashant, M.S. and B.B. Hosetti, 2010. Basic elements of Environmental Science**,** Pratiksha Publisher, Jaipur,
18. Primack, R.B. Essentials of Conservation Biology, Sinauer Associates, Inc. Sunderland, MA , 1998.
19. Pulliah. T. 1998. Taxonomy of Angiosperms. Regency Publications, New Delhi
20. Sharma, B.D, Indian Wildlife Resources Ecology and Development, Daya Publishing House, Delhi, 1999.
21. Shukia P. and S.P. Misra. 1985. An Introduction to Taxonomy of Angiosperms. Vani Educational Books, New Delhi.
22. Singh. G. 1999, Plant systematic's. Theory and practice. Oxford and IBH co. Pvt. Ltd., New Delhi, Calcutta, pp. 359.
23. Singh. G. 1999, Plant systematic's. Theory and practice. Oxford and IBH co. Pvt. Ltd., New Delhi, Calcutta, pp. 359.
24. Sukachev, V and N. Dlis 1964. Fundamental of Forest Biogeocoenology. Oliver and Byod, Edinburg.

Paper – H.C.1.2: Forestry and Natural Resource Conservation

1. Agarwala, V.P. 1980. Forests in India. Oxford and IBH publishing Co., New Delhi.
2. FAO. 1992. Conservation and Development of Tropical Forest Resources, FAO Publications, Rome.
3. Frankal, Otto H., Anthony, A., Brown, D. and Burdon, Jeremy J., The conservation of plant biodiversity. Cambridge University Press, 1995.
4. Hosetti, B.B 2002. Wetlands Conservation and Management. Pointer Publishers, Jaipur, India.
5. Hosetti, B.B. 2002. Glimpses of Biodiversity**,** Daya Publishing House, Delhi-35, India.
6. Hosetti, B.B. Concepts in Wildlife Management, Daya Publishing House, Delhi. 1997.
7. Katwal/Banerjee, Biodiversity conservation in managed and protected Areas, Agrobios, India, 2002.
8. Negi, S.S. A handbook of forestry. International Book Distributor, Dehradun. 2005.
9. Negi, S.S., Biodiversity and its conservation in India, Indus Publishing Co., New Delhi. 1993.
10. Primack, R.B. Essentials of Conservation Biology, Sinauer Associates, Inc. Sunderland, MA , 1998.
11. Puri, G.S., Meher, V.M. Gupta, R.K. and S. Puri, 1981. Forest Ecology. Oxford and IBH Publishing Co., Newyork.
12. Sharma, B.D, Indian Wildlife Resources Ecology and Development, Daya Publishing House, Delhi, 1999.
13. Sinha, P.C., Wildlife and Forest Conservation, Anmol Publishing Pvt. Ltd., New Delhi. 1998.
14. Sukachev, V and N. Dlis 1964. Fundamental of Forest Biogeocoenology. Oliver and Byod, Edinburg.
15. Tiwari, K.M and Singh, R.V. 1980. Social Forestry plantations. Oxford and IBH publishing Co., New Delhi.
16. Tony Prato, Natural Resource and Environmental Economics, Iowa State University Press, 1988.
17. Warning, R.H. and Schlesinger, W.H. 1985. Forest Ecosystems; Concepts and Management. Academic press, New York.

Paper – H.C.1.3: Ecology and Wildlife biology

1. Aaron, N.M., Wildlife ecology, W.H. Freeman Co. San Francisco, U.S.A., 1973.
2. Ali, Salim, The Book of Indian Birds, Oxford University Press, Mumbai, 1997.
3. Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly, Wildlife Ecology, Conservation and Management, Blackwell Publishing, U.S.A., 2006.
4. Apte, Deepak, The Book of Indian Shells, Oxford University Press, Mumbai. 2006.
5. Arora B. M. , Editor, Indian Wildlife Yearbook, AIZ & WV, Bareilly and Central Zoo Authority, New Delhi , 2002
6. Brander, A.A, Wild Animals in Central India, Natraj Publisher, Dehradun.
7. Dash, M.C. 1993, Fundamentals of Ecology, Mc-Graw hill co., New Delhi.
8. Giles, R.H Jr. 1984, Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington, D.C. Nataraj Publishers, Dehra Dun, India

9. Gopal, Rajesh, Fundamentals of Wildlife Management, Justice Home, Allahabad, India. 1992.
10. Hosetti, B.B. 2001. A Text Book of Applied Aquatic Biology**,** Daya Publishing House, Delhi
11. Kormondy, E.J. 1992. Concepts of Ecology, Prentice hall of India Pvt. Ltd., New Delhi.
12. Negi, S.S. 2002. Hand book of National Parks, Wildlife Sanctuaries and Biosphere reserves in India. Indus Publ., New Delhi.
13. Primack, R.B. Essentials of Conservation Biology, Sinauer Associates, Inc. Sunderland, MA , 1998.
14. Puri, G.S., Meher, V.M. Gupta, R.K. and S. Puri, 1981. Forest Ecology. Oxford and IBH Publishing Co., Newyork.
15. Sharma, B.D, Indian Wildlife Resources Ecology and Development, Daya Publishing House, Delhi, 1999.
16. Singh, S.K. Text Book of Wildlife Management. IBDC, Lucknow. 2005
17. Stephen, H.B. and V.B. Saharia, Wildlife research and management. Asian and American Approaches , Oxford University Press, Delhi, 1995.
18. Sukachev, V and N. Dlis 1964. Fundamental of Forest Biogeocoenology. Oliver and Byod, Edinburg.
19. Trivedi, P.R and Gurudeep Raj. 1992. Environmental Ecology. Akashdeep public.House, New Delhi.
20. Warning, R.H. and Schlesinger, W.H. 1985. Forest Ecosystems; Concepts and Management. Academic press, New York.

Paper – S.C.1.4: Field techniques in Wildlife studies

1. Aaron, N.M., Wildlife ecology, W.H. Freeman Co. San Francisco, U.S.A., 1973.
2. Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly, Wildlife Ecology, Conservation and Management, Blackwell Publishing, U.S.A., 2006.
3. APHA, AWWA and WEF. 1992: Standard Methods for Examination of Water and Wastewater, XVIII Ed, American Public Health Association. NY, USA
4. Chandel S.R.S,. A Text Book of Agricultural Statistics Achal Prakashan Mandir, Kanpur, 1999.
5. Chang – Kang, Tsung, Introduction to Geographic Information Systems, Tata McGraw - Hill Publishing Company Limited, New Delhi, 2002.
6. Giles, R.H Jr. 1984, Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington, D.C. Nataraj Publishers, Dehra Dun, India
7. Gopal, Rajesh, Fundamentals of Wildlife Management, Justice Home, Allahabad, India. 1992.
8. John C Antenucci, Geographical Information System : A Guide to Technology — Van Norstrand Reinhold Publications
9. Moulton, M. P. & J. Sanderson, Wildlife Issues in a Changing World, St. Lucie Press, 1997.
10. Rodgers, W.A. 1991. Techniques for wildlife census in India – A Field Manual; Technical Manual – TM – 2 WII.
11. Sale, J.B. and Berkmuller, K. Manual of wildlife techniques for India. WII, FAO, Dehra Dun, India, 1988

12. Shiv N.Pandey, Photogeology and Image Interpretation –, Wiley Eastern, New Delhi
13. Stephen, H.B. and V.B. Saharia, Wildlife research and management. Asian and American Approaches , Oxford University Press, Delhi, 1995.
14. William Sutherland 1984, Ecological census techniques, Cambridge

SC 1.4 (b): Wildlife ecotourism and wetland conservation

1. Corbett, Jim (2007). The Temple Tiger. Oxford University Press, New Delhi.
2. A Vet in Wilderness. Central Zoo Authority, New Delhi
3. Sharma, B.D. 1999. Indian wildlife resources: Ecology and development. Daya Publishing House, Delhi.
4. Sharma, V.B. 1998. Wildlife in India. Nataraj Publications, Dehra Dun.
5. Rahmani, Asad R. & Ugra, Gayatri. Birds of Wetlands and Grasslands. Bombay Natural History Society, Mumbai.
6. Ali, Salim (1997). The Book of Indian Birds, Oxford University Press, Mumbai.

Semester – II

Paper H.C. 2.1: Animal Ethology and Wildlife distribution

1. Aaron, N.M., Wildlife ecology, W.H. Freeman Co. San Francisco, U.S.A., 1973.
2. Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly, Wildlife Ecology, Conservation and Management, Blackwell Publishing, U.S.A., 2006.
3. Kormondy, E.J. 1992. Concepts of Ecology, Prentice hall of India Pvt. Ltd., New Delhi.
4. Krebs, J.R. and Davies, N.B. An introduction to Behavioural Ecology, 3rd Edition, Blackmell scientific Publications.
5. Manning A and Dawkins M. 1997. An Introduction to Animal Behaviour- IV Ed., Cambridge Univ. Press
6. Puri, G.S., Meher, V.M. Gupta, R.K. and S. Puri, 1981. Forest Ecology. Oxford and IBH Publishing Co., Newyork.
7. Reena Mathur., 1996. Animal Behaviour, 1st Edition, Vivek Rostogi for Rostogi and company.
8. Robert, A.W, The ecology and evolution of animal behavior, Good Year Pub. Co. California, U.S.A. 1979
9. Sharma, B.D, Indian Wildlife Resources Ecology and Development, Daya Publishing House, Delhi, 1999.
10. Sinclair, Anthony R.E., Fryxell, John M. and Caughly, Graeme, Wildlife Ecology, Conservation and Management, Blackwell Publishing, U.S.A. 2006.
11. Trivedi, P.R and Gurudeep Raj. 1992. Environmental Ecology. Akashdeep public.House, New Delhi.

Paper H.C. 2.2: Animal Physiology and Health care

1. Arora, B.M. Indian Wildlife Diseases and Disorders. AIZ & WV, Bareilly and Central Zoo Authority, New Delhi , 2001
2. Arora, B.M. Rehabilitation in free living wild animals . AIZ & WV, Bareilly and Central Zoo Authority, New Delhi , 2007.
3. Arora, B.M. Reproduction in Wild Mammalia & Conservation ,. AIZ & WV, Bareilly and Central Zoo Authority, New Delhi , 2002.

4. Banerjee, S., A Text Book of Developmental Biology, IBD, Dehradun, 2001.
5. Davis, J.W and Anderson, 1971. Infectious diseases of wild mammals. The Iowa State Univ. Press. Lowa
6. Davis, J.W and Anderson, 1971. Infectious diseases of wild mammals. The Iowa State Univ. Press. Lowa
7. Krebs, J.R. and Davies, N.B. An introduction to Behavioural Ecology, 3rd Edition, Blackmell scientific Publications.
8. Manning A and Dawkins M. 1997. An Introduction to Animal Behaviour- IV Ed., Cambridge Univ. Press
9. Marshall, P.T. and G.M. Hughes. 1980. Physiology of Mammals and other vertebrates. Camb. Univ. Press. New York.
10. . Dobson, The Ecology of Wildlife Diseases. Oxford University Press, Oxford , 2002.
11. Reena Mathur., 1996. Animal Behaviour, 1st Edition, Vivek Rostogi for Rostogi and company.
12. Robert, A.W, The ecology and evolution of animal behavior, Good Year Pub. Co. California, U.S.A. 1979

PAPER- El-2.1: WILDLIFE CONSERVATION

1. Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly, 2006. Wildlife Ecology, Conservation and Management, Blackwell Publishing, U.S.A.
2. Apte, Deepak, 2006. The Book of Indian Shells, Oxford University Press, Mumbai.
3. Arora B. M. , Editor, Indian Wildlife Yearbook, AIZ & WV, 2002. Bareilly and Central Zoo Authority, New Delhi.
4. Giles, R.H Jr. 1984. Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington, D.C. Nataraj Publishers, Dehra Dun, India
5. Gopal and Rajesh, 1992. Fundamentals of Wildlife Management, 2nd edition, Nataraj publishers, Dehra Dun.
6. Hosetti, B.B. 2003. Wetlands conservation and management, Pointer publishers, Jaipur, India.
7. Hosetti, B.B. 1997. Concepts in Wildlife Management, Daya Publishing House, Delhi.
8. Katwal/Banerjee, 2002. Biodiversity conservation in managed and protected Areas, Agrobios, India.
9. Negi, S.S. 2002. Hand book of National Parks, Wildlife Sanctuaries and Biosphere reserves in India. Indus Publ., New Delhi.
10. Negi, S.S., 1993. Biodiversity and its conservation in India, Indus Publishing Co., New Delhi.
11. Primack, R.B., 1998. Essentials of Conservation Biology, Sinauer Associates, Inc. Sunderland, MA.
12. Singh, S.K., 2009. Text book of Wildlife Management, 2nd edition, International book distributing Co., Lucknow.

Paper H.C. 3.1: Wildlife Conservation and Management

1. Aaron, N.M., Wildlife ecology, W.H. Freeman Co. San Francisco, U.S.A., 1973.

2. Ali, S and S.D. Ripley. 1969. The Handbook of Birds of India and Pakistan. Oxford University Press – New Delhi
3. Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly, Wildlife Ecology, Conservation and Management, Blackwell Publishing, U.S.A., 2006.
4. Apte, Deepak, The Book of Indian Shells, Oxford University Press, Mumbai. 2006.
5. Arora B. M. , Editor, Indian Wildlife Yearbook, AIZ & WV, Bareilly and Central Zoo Authority, New Delhi , 2002
6. Brander, A.A, Wild Animals in Central India, Natraj Publisher, Dehradun.
7. FAO. 1992. Conservation and Development of Tropical Forest Resources, FAO Publications, Rome.
8. Frankal, Otto H., Anthony, A., Brown, D. and Burdon, Jeremy J., The conservation of plant biodiversity. Cambridge University Press, 1995.
9. Giles, R.H Jr. 1984, Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington, D.C. Nataraj Publishers, Dehra Dun, India
10. Gopal, Rajesh, Fundamentals of Wildlife Management, Justice Home, Allahabad, India. 1992.
11. Hosetti, B.B 2002. Wetlands Conservation and Management. Pointer Publishers, Jaipur, India.
12. Hosetti, B.B. 2003. Wetlands conservation and management, Pointer publishers, Jaipur, India.
13. Hosetti, B.B. Concepts in Wildlife Management, Daya Publishing House, Delhi. 1997.
14. Katwal/Banerjee, Biodiversity conservation in managed and protected Areas, Agrobios, India, 2002.
15. Negi, S.S. 2002. Hand book of National Parks, Wildlife Sanctuaries and Biosphere reserves in India. Indus Publ., New Delhi.
16. Negi, S.S., Biodiversity and its conservation in India, Indus Publishing Co., New Delhi. 1993.
17. Primack, R.B. Essentials of Conservation Biology, Sinauer Associates, Inc. Sunderland, MA , 1998.
18. Robert, G.H. Wildlife management, W.H. Freeman and Co., San Francisco, U.S.A. 1978.
19. Rodgers, W.A. 1991. Techniques for wildlife census in India – A Field Manual; Technical Manual – TM – 2 WII.
20. Sinclair, Anthony R.E., Fryxell, John M. and Caughly, Graeme, Wildlife Ecology, Conservation and Management, Blackwell Publishing, U.S.A. 2006.
21. Singh, S.K. Text Book of Wildlife Management. IBDC, Lucknow. 2005
22. Stephen, H.B. and V.B. Saharia, Wildlife research and management. Asian and American Approaches , Oxford University Press, Delhi, 1995.

Paper H.C. 3.2: Mammalogy, Ornithology, Herpetology and Ichthyology

1. Ali, S and S.D. Ripley. 1969. The Handbook of Birds of India and Pakistan. Oxford University Press – New Delhi
2. Ali, Salim, The Book of Indian Birds, Oxford University Press, Mumbai, 1997.
3. Apte, Deepak, The Book of Indian Shells, Oxford University Press, Mumbai. 2006.
4. Arora B. M. , Editor, Indian Wildlife Yearbook, AIZ & WV, Bareilly and Central Zoo Authority, New Delhi , 2002

5. Arora, B.M. Dietary Husbandry of Wild Mammalia AIZ & WV, Bareilly and Central Zoo Authority, New Delhi , 2001
6. Arora, B.M. Rehabilitation in free living wild animals . AIZ & WV, Bareilly and Central Zoo Authority, New Delhi , 2007.
7. Daniel, J.C. The Book of Indian Reptiles and Amphibians, Oxford University, Press, Mumbai.
8. Deoras, P.J. 1965. Snakes of India. National Book trust, New Delhi
9. Goin, G.J., and O.R. Goin. 1971. Introduction to Herpetology. W.H. Freeman and Company, San Francisco.
10. Singh, S.K. Text Book of Wildlife Management. IBDC, Lucknow. 2005
11. Sinha, P.C., Wildlife and Forest Conservation, Anmol Publishing Pvt. Ltd., New Delhi. 1998.
12. Stebbing, E.P. 1977. A manual of elementary forest zoology for India. International book distributors, Dehradun.
13. Welty, J. 1982. The Life of Birds. Saunders College Publishing, New York
14. William Sutherland 1984, Ecological census techniques, Cambridge

Paper S.C. 3.3a: Environmental Pollution and Monitoring

1. Agarwal S.K. 1991, Polution Ecology, Himalayan Pub. Udaipur.
2. APHA, AWWA and WEF. 1992: Standard Methods for Examination of Water and Wastewater, XVIII Ed, American Public Health Association. NY, USA
3. Barett, E.C. and Anton Micallef, Remote Sensing for Hazard Monitoring and Disaster Assessment , Taylor and Francis, London, 1991.
4. Canter, L. W. , Environmental Impact Assessment, Graw, Mc, , Hill Publication, New York.
5. Justice Kuldip Singh, Handbook of Environment, Forest and Wildlife Protection Laws in India, Natraj Publishers, Dehradun, 1998.
6. Karmin, M.A., 1997. Pesticide Profiles: Toxicity, Environmental Impacts and Fate. CRC press Ohio, USA.
7. Menon, Vivek and Kumar, Ashok, Wildlife Crime, Natraj Publisher, Dehradun, 1999.
8. Moulton, M. P. & J. Sanderson, Wildlife Issues in a Changing World, St. Lucie Press, 1997.
9. Singh and Vijaykumar, Economics of PA's and its effect on biodiversity, APH Publishing Corporation, New Delhi. 2001
10. Tony Prato, Natural Resource and Environmental Economics, Iowa State University Press, 1988.
11. Vanclay F. and Bronstein, D.A. Environmental and social impact assessment John Wiley & Sons, New York.1995.

Paper S.C. 3.4b: Entomology and Eco-toxicology

1. Dhaliwal G.S. Ramsingh and B.S. Chillar 2006, Essentials of Agricultural entomology**.** Kalyani Publishers, New Delhi.
2. Gorge W. Warne, 1988. Reviews of Environmental contamination of Toxicology, Springer-verlag, New York.

3. Hassall, K.A. 1990. The Biochemistry and uses Pesticides structure, metabolism and Mode of action and uses in crop protection, John Wiley & Sons. Inc.
4. Karmin, M.A., 1997. Pesticide Profiles: Toxicity, Environmental Impacts and Fate. CRC press Ohio, USA.
5. Pandey, K. and J.P. Shukla, 1990. Elements of Toxicology. Radha publ. New Delhi
6. Philip, L. Williams, Robert C. Jawes, Stephen M. Roberts, 2000. Principles of Toxicology, II Ed. A Wiley Science publication John Wiley & Sons. INC. New York.
7. Rajendra singh. 2007. Elements of Entomology**.** Published by Rakesh kumar. Rastogi and Rastogi Publications. Gangotri, Shivaji Road. Meerut.
8. Trigunayat M.M. 2009, A Manual of practical entomology, scientific publishers, Jodhpur, India.

PAPER- El-3.1: ORNITHOLOGY

1. Ali, S and S.D. Ripley. 1969. The Handbook of Birds of India and Pakistan. Oxford University Press – New Delhi
2. Ali, Salim,1997. The Book of Indian Birds, Oxford University Press, Mumbai.
3. Arora B. M. , 2002. Editor, Indian Wildlife Yearbook, AIZ & WV, Bareilly and Central Zoo Authority, New Delhi.
4. Arora, B.M. 2007. Rehabilitation in free living wild animals . AIZ & WV, Bareilly and Central Zoo Authority, New Delhi.
5. Singh, S.K. 2005. Text Book of Wildlife Management. IBDC, Lucknow.
6. Welty, J. 1982. The Life of Birds. Saunders College Publishing, New York
7. William Sutherland, 1984. Ecological census techniques, Cambridge

Paper H.C. 4.1: Protected Areas Network and Zoo Management

1. FAO. 1992. Conservation and Development of Tropical Forest Resources, FAO Publications, Rome.
2. Frankal, Otto H., Anthony, A., Brown, D. and Burdon, Jeremy J., The conservation of plant biodiversity. Cambridge University Press, 1995.
3. Giles, R.H Jr. 1984, Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington, D.C. Nataraj Publishers, Dehra Dun, India
4. Gopal, Rajesh, Fundamentals of Wildlife Management, Justice Home, Allahabad, India. 1992.
5. Hosetti, B.B. 2003. Wetlands conservation and management, Pointer publishers, Jaipur, India.
6. Hosetti, B.B. Concepts in Wildlife Management, Daya Publishing House, Delhi. 1997.
7. Katwal/Banerjee, Biodiversity conservation in managed and protected Areas, Agrobios, India, 2002.
8. Moulton, M. P. & J. Sanderson, Wildlife Issues in a Changing World, St. Lucie Press, 1997.
9. Negi, S.S. 2002. Hand book of National Parks, Wildlife Sanctuaries and Biosphere reserves in India. Indus Publ., New Delhi.
10. Robert, G.H. Wildlife management, W.H. Freeman and Co., San Francisco, U.S.A. 1978.

11. Stebbing, E.P. 1977. A manual of elementary forest zoology for India. International book distributors, Dehradun.
12. Stephen, H.B. and V.B. Saharia, Wildlife research and management. Asian and American Approaches , Oxford University Press, Delhi, 1995.

Paper H.C. 4.2: Remote Sensing and GIS and Biostatistics

1. Barett, E.C. and Anton Micallef, Remote Sensing for Hazard Monitoring and Disaster Assessment , Taylor and Francis, London, 1991.
2. Burrough P.A.Principles of Geographical Information System for Land Resource assessment — Oxford University Press
3. Chandel S.R.S,. A Text Book of Agricultural Statistics Achal Prakashan Mandir, Kanpur, 1999.
4. Chang – Kang, Tsung, Introduction to Geographic Information Systems, Tata McGraw - Hill Publishing Company Limited, New Delhi, 2002.
5. John C Antenucci, Geographical Information System : A Guide to Technology — Van Norstrand Reinhold Publications
6. Chouhan T.S and K.N.Joshi, Applied Remote Sensing and Photo Interpretation –- Vignan Prakasan, Jaipur
7. Snedecor D.W. and Cochran W.G. 1967. Statistical Methods. Ed. VI. Oxford and IBH Publishing Co., New Delh