

UNIVERSITY OF MUMBAI



**Syllabus for
Two years M.Sc. course
in
Biodiversity, Wildlife Conservation
and Management
(PSBWCM)**

(Credit based, Semester and Grading system with
effect from the academic year 2014–2015)

**TWO YEARS M.Sc. COURSE
IN
BIODIVERSITY, WILDLIFE CONSERVATION AND MANAGEMENT**

Preamble:

In these days of diversification, super-specialisation and competition, graduates from many fields of Biological Sciences find it difficult to stay within their pure stream of Biology subject and make relevant use of the education they had taken with so much love and interest. There are a large number of professions in which the knowledge gained during graduation in Biological Sciences, can be applied, such as in the fields of Biodiversity conservation, Conservation action, Wildlife Biology, Eco-tourism and Environment education. But an undergraduate in Biological Science lacks the skills to convert the ideas and concepts, learned in the conventional Biology syllabi, into action and therefore needs further training to become a good manager/trainer.

Many Governmental, Non Governmental Organizations, Corporates and Institutions run programmes for Biodiversity conservation and Nature Conservation awareness. These programmes need many trained manpower to meet the programme objectives. Post graduates who are trained and attuned to the field requirements would find ready career opportunities both at national and international levels.

With the increasing popularity of Wildlife Biology, Eco-tourism and allied fields like wildlife and adventure (sport) based tourism, the existing travel agencies, resorts and chains of hotels find it difficult to satisfy the needs of information, assistance and guidance expected by their clientele. Additionally, with increasing demands of environmental education, schools, colleges, government and private bodies (Corporates) are augmenting their interest in conservation activities, sometimes even investing crores of rupees in ameliorative programmes under the Corporate Social Responsibility strategies.

Eco-tourism and conservation have a great deficiency of qualified personnel, who can guide, lead or organise tours and other programmes into the realm of Nature. This course intends to develop such qualified professionals with skills, information and know-how, so as to step into high-end jobs or become entrepreneurs, while sticking to the basic field of Biological Sciences.

Objectives:

- To provide graduates in Biology a specialization in the field of Biodiversity, Conservation and Wildlife Management
- To generate qualified students who can directly get jobs in the allied fields of Biodiversity, Conservation and Wildlife Management;
- To generate qualified postgraduates who can be part professional organizations working in the field of conservation and environment protection.
- To generate a team of post graduates who can take up jobs related to the environment in educational institutions.
- To generate a skilled post graduates who can undertake research in the field of Biodiversity, Wildlife biology and Nature conservation.
- To provide an alternate avenue to Biology graduates to specialize as “environmental entrepreneurs” in areas such as Environmental audits, Environmental education, Ecotourism etc.
- To create awareness about Biodiversity and Nature Conservation.

Please Note: This course is dynamic and interactive in nature. The syllabus is a broad guideline and its implementation and coverage can be varied in tune with industry requirements and the current Regulations and Acts of the Governmental agencies.

O. _____ Eligibility:

- **B.Sc.** in ANY subject or its equivalent.
- **B.Sc.** Veterinary science or its equivalent.
- **B.Sc.** Agriculture or Forestry or its equivalent.

R. _____ Fee: Rs.70, 000/- per year

❖ Tuition Fee	12,000.00
❖ Laboratory Fee (Wet and Instrument Labs.)	14,000.00
❖ Projects / Product / Service Development	07,500.00
❖ On-job training	08,000.00
❖ Field Visits / Excursions	14,000.00
❖ Library	02,000.00
❖ Gymkhana	00,500.00
❖ Utility	00,300.00
❖ Extracurricular	00,200.00
❖ Development Fund	01,000.00
❖ Computer / internet	05,000.00
❖ Other Fees	05,000.00
❖ Miscellaneous	00,500.00

TOTAL : 70,000.00

R. _____ No of Lectures:

60 lectures for each course, per semester.

4 courses per semester

R. _____ No of Practical periods: 4 practicals of four periods each per week

Work Load :

- Four periods per week per paper where each period is of ONE hour duration
- Four practical per week. Each practical is of Four periods, where each period is of ONE hour duration.
- One Seminar per Week. Each seminar is of ONE hour duration for a batch of TEN students.
- Guidance to the students for projects & assignments.
- Coordination & assistance to students for implementing / completing their projects & assignments.
- Coordinating Placement of students for on-Job training
- Field visits & excursions to places relevant to syllabus topics

R. _____ **Duration:** 2 Years

R. _____ **Number of Students:** 20 per batch

Selection: Entrance Test

R. _____ The following will be the **staffing pattern** for the course;

- Field Assistant – 01
- Lab Attendants – 02
- Lecturers – 02 (full time)
01 (part-time)
and remaining workload to be completed using guest faculty.
- Course Coordinator – 01 (Part-time) may be a current full time faculty (preferably an Associate professor / Professor)

Core Faculty

Post-graduate degree in the subject of Wildlife Biology / Conservation Biology / Botany / Zoology / Life Science / with B+ and NET / SET

Visiting Faculty from Industry & Research Institutes

The visiting Faculty will be from a post equivalent to that of Assistant Professor level with Ph. D and not less than 5 years of research / field experience or with experience in industry not below Assistant Manager Level or having owned / run a successful business (tours & travels, Ecotourism, adventure tours, Environment audit or consultancy in a relevant field (for not less than three years).

R. _____ **Grade Card**

- The Grade Card of the students must indicate titles of papers in the syllabus

1. For internal (continuous) assessment. A teacher may select a variety of procedures for examination such as:

- i. Short Quizzes / Viva / Presentations;
- ii. Assignments / Seminars / Laboratory Journal Work ;
- iii. Extension/Field/experimental Work;
- iv. Project by individual students or group of students; or

- v. An open Book Test / Review of Research Papers (with the concerned teacher deciding what books / scientific publications / research papers / Chapters from Reference books are to be allowed for this purpose.)
- vi. Two periodical test/case studies/on-line or combination of these
- vii. Overall conduct as a responsible student, mannerism and exhibition of leadership qualities in organizing co-curricular activities and attendance.

NOTE: Internship / project carried out during the fourth semester will be evaluated by the research committee / team of experts and by the guiding faculty during its planning, implementation.

- Practical examination, wherever applicable, will be of six hours

4.1 Internship / Project carried out during the fourth semester will be evaluated for total marks allotted on the basis of the report submitted, presentation made by the student and *viva voce*.

M.Sc.
BIODIVERSITY, WILDLIFE CONSERVATION AND MANAGEMENT
SYLLABUS IN BRIEF
M.Sc.; Semester - I

Paper	Code	Lectures	Credits	Code	Practical	Credits
Biodiversity : Global and Indian	PSBWCM 101	60	4	PSBWCMP 101	60	2
Biogeography & Natural History	PSBWCM 102	60	4	PSBWCMP 102	60	2
Basics of Wildlife Biology	PSBWCM 103	60	4	PSBWCMP 103	60	2
Planning and Execution of Field surveys	PSBWCM 104	60	4	PSBWCMP 104	60	2
TOTAL		240	16		240	8
TOTAL CREDITS					24	

Note: Field Visits may be spread out in Semester I and their reports will be assessed as a part of internal assessment.

M.Sc.; Semester - II

Paper	Code	Lectures	Credits	Code	Practical	Credits
Animal Dispersions & Animal Populations	PSBWCM 201	60	4	PSBWCMP 201	60	2
Principles of Conservation Biology	PSBWCM 202	60	4	PSBWCMP 202	60	2
Planning and Implementing Conservation programmes	PSBWCM 203	60	4	PSBWCMP 203	60	2
Advanced Techniques in Field Studies	PSBWCM 204	60	4	PSBWCMP 204	60	2
TOTAL		240	16		240	8
TOTAL CREDITS					24	

Note: Field Visits may be spread out in Semester II and their reports will be assessed as a part of internal assessment.

M.Sc.;Semester –III

Paper	Code	Lectures	Credits	Code	Practical	Credits
Principles and Practice of Sustainable Development	PSBWCM301	60	4	PSBWCMP301	60	2
Protected Areas and People's Participation in Their Sustenance	PSBWCM302	60	4	PSBWCMP302	60	2
Environment Monitoring, Environment Audits	PSBWCM303	60	4	PSBWCMP303	60	2
Applications of Information Technology in Field Biology	PSBWCM304	60	4	PSBWCMP304	60	2
TOTAL		240	16		240	8
TOTAL CREDITS			24			

Note: Field Visits may be spread out in Semester III and their reports will be assessed as a part of internal assessment.

M.Sc.; Semester –IV

This semester will include Internship / Projects involving a minimum of 130 days of field work. The work would be completed and evaluated at the end of the Semester.

Paper	Code	Planning	Execution	Evaluation	Reporting
Internship / Project	PSBWCM401	04 credits	10 credits	06 credits	04 credits
TOTAL CREDITS		24			

SYLLABUS IN DETAIL

NOTE:

- While teaching, examples from both plants and animals should be covered, wherever applicable.
- Case studies (Indian & foreign), wherever applicable should be discussed as a part of the syllabus
- Ensure that students are in touch with latest developments especially with respect to civil society's movements, Government policies, International agreements etc.

SEMESTER I

THEORY

- **PSBWCM 101: Biodiversity : Global and Indian (60 lectures)**
 - Unit 1: Biodiversity (15 lectures)
 - What is biodiversity ?
 - Types of Biodiversity
 - Climatic Zones and Biodiversity
 - Biodiversity as a natural resource
 - Unit 2: Indian Biodiversity (15 lectures)
 - Vegetational Zones
 - Zones of Faunal distribution
 - Major protected areas & their importance
 - Unit 3: Global Biodiversity (15 lectures)
 - Major Biodiversity areas of the world
 - Biodiversity Hot Spots
 - Unit 4: Basic Taxonomy (15 lectures)
 - An overview of types of classification
 - Classification of bacteria, algae, fungi and plants (major families only)
 - Classification of Protozoans, Non-chordates (major classes with insects upto orders) and Chordates (major orders)
- **PSBWCM 102: Biogeography & Natural History (60 lectures)**
 - Unit 1: Biomes of the World (15 lectures)
 - Characteristic flora and fauna
 - Threatened species
 - Unit 2: Natural History (15 lectures)
 - Natural History of Flora & Fauna of India- Major flora & Fauna
 - Natural History of Western Ghats - Major flora & Fauna
 - Methods of recording Natural History of a place
 - Red Data Book and its significance
 - Resident, Migrant, Vagrant species
 - Unit 3: Urban Biodiversity (15 lectures)
 - Biodiversity in cities & towns
 - Concept of opportunistic species
 - Species adapted to Human environs
 - Anthropological factors in species dispersal
 - Strays and feral populations
 - Unit 4: Agricultural conservation (15 lectures)
 - Conserving species of Economic significance
 - Significance of gene banks and germ plasm conservation

Use of wild species for producing improved hybrid varieties
 Seed Banks & Artificial seeds in conservation
 Conservation of Live Stock species /varieties
 Alternate species for future food securities (examples);
 Job's tear plant (*Coixlacrymajobi*)
 Indian wild buffalo (*Bubalusarnee*)
 Mithun (*Bosfrontalis*)
 Hybrids between wild and domestic species (e.g. Mithun)
 Conservation of economically important aquatic species

- **PSBWCM 103:Basics of Wildlife Biology (60 lectures)**

Unit 1: Scope of Wildlife Biology (15 lectures)

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

Unit 2: Adaptations to Habitats (15 lectures)

 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

Unit 3: Wild Lifediseases (15 lectures)

 Major diseases and their control

 Domestic animals & wildlife diseases

 Governmental role in control of Wildlife diseases

 Sick animal refuges in protected areas

Unit 4: Wildlife and Human welfare (15 lectures)

 Biomimetics

 Ethnobiology& Ecosystem people

 The Economics of Ecosystem and Biodiversity (TEEB)

- **PSBWCM 104: Planning and execution of Field surveys (60 lectures)**

Unit 1: Field surveys & observations (15 lectures)

 Sampling methods and identifying study sites

 Different methods of transacts& quadrates

 Techniques of field observation

 Camouflages& Observation stations

 Non-intruding / non-interferingtechniques of field observations

Unit 2: Recording & Evaluation of Data (15 lectures)

 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

- Unit 3: Ethics in Field Studies (15 lectures)
 Dos & Don'ts in field studies
 Regulatory permissions for field observations
 Field collections & Field preservations
- Unit 4: Statistical Methods (use examples from wildlife, forestry and field experimentation) (15 lectures)
 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

Semester I Practicals

Note :

- Field visits will be integral part of the Practical. Visits to nearby Zoo, Museum, Forest, sea-shore, Nursery, Aquaria or any other relevant site must be arranged.
- The report of these visits will be submitted as part of the Practical work.

PSBWCMP101

1. 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
2. Using photographs / paintings / coloured drawings identify and study the classification, characteristics & ecological role of characteristic species (representative species only) from;
 - Monera – bacteria, cyanobacteria, spirichets
 - Protista – algae of various types
 - Fungi (upto classes) – funguses, molds, mushrooms, yeasts, mildews, smuts
 - Plantae – mosses, ferns, woody and non-woody flowering plants (major families)
3. Study of Morphological features of a fish (e.g. Mackerel, Tilapia, Dhoma (*Johniussps.*))
4. Study of morphological features of a bird (e.g. Pigeon)
5. Study of social casts / types (use diagrams / photographs) in ; Honey bee, ants, termites
6. Identification and study of venomous snakes, action of their venom and first aid for snake bites; Cobra (spectacled & monocled), Common krait, Banded krait, Russell's Viper, Saw scaled Viper, Pit vipers (Bamboo, Green, Malabar)
7. Separate and identify different foraminifera from sand samples.
8. Study of different fresh water and marine algae; common species only.

PSBWCMP102

1. Estimation of stomatal index in leaves (at least three different leaf types representing at least two different micro-climatic conditions e.g. Sun loving, shade loving).

2. UV-Visible spectrophotometer scan of extracted plant pigments; Spinach leaves, Marigold petals and *Tradescantia* leaves. Evaluation of the spectral characteristics.
3. Adaptations in animals : use pictures or photographs with suitable labels.
4. Adaptations in plants : use pictures or photographs with suitable labels.
5. Insectivorous plants : Identification, morphological adaptations and ecological distribution.
6. 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.
7. Study of morphology of plants (use photographs / paintings / coloured drawings / preserved specimen);
 - Leaf – morphology, modifications and phylotaxy
 - Flower – morphology & modifications
 - Floral formula (*Hibiscus* & sunflower)
 - Fruit – types & morphology
 - Seed – types, morphology and modifications for dispersal

PSBWCMP103

1. Estimate primary production using 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 deep sea fauna and their ecological role; (pictures / diagrams only).
5. Study of some pioneer communities in succession;
 - Lichen and their types, mosses and their types, coral and their types.

PSBWCMP104

1. Application of transacts and quadrants in Simulated pictures / photographic sheets for data collection. Record & tabulate the data.
2. Instruments for sampling; Water Sampling bottles, Plankton samplers, Core samplers, Bottom samplers, air samplers – construction, working and application (photographs or specimens and diagrams).
3. 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.

4. 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 difference in leaf length between the two plant species.

SEMESTER II

THEORY

- **PSBWCM 201: Animal Dispersions & Animal Populations (60 lectures)**
 - Unit 1: Population ecology (15 lectures)
 - 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
 - Unit 2: Plant – animal interactions (15 lectures)
 - 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.
 - Unit 3: Distribution & Dispersal of Plants & animals (15 lectures)
 - Vegetation and its effect on animal distribution
 - Pollination & seed dispersal
 - Vegetation preferences of animal species
 - Barriers to species distribution
 - Unit 4: Behavioural Ecology (15 lectures)
 - 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
 - Tribal societies & conservation of their knowledge
 - Traditional tribes of Andaman & Nicobar islands
 - Methods of observing and recording animal behaviors
 - Sampling Behaviours
 - Methods of observing Behaviour
 - Time- activity budgets, Ethograms, Social interaction matrices and their analysis
- **PSBWCM 202 : Principles of Conservation Biology (60 lectures)**

- Unit 1: Habitat Ecology (15 lectures)
 - Types of Habitats & their major ecological factors
 - Ecological Succession & climax ecosystems (e.g. Sholas)
 - Maximizing usage of Habitat resources by populations
 - Insular habitats & insular flora & fauna
 - Extreme Habitats and their flora & fauna (Dark Caves, deep sea etc.)
- Unit 2: Habitat selection in animals (15 lectures)
 - Concept of Home range, Familiar areas
 - Manipulating Home ranges to increase population density
 - Territoriality and Habitat utilization in animals
 - Concept of niches, its realization & its continuity
 - Micro-Habitats : Fallen Log, Treetop-puddles etc.
- Unit 3: Concept of carrying Capacity (15 lectures)
 - Limiting factors in habitats
 - Improving carrying capacity in wildlife areas
- Unit 4: Human – wildlife interactions (15 lectures)
 - Conservation Vs protection
 - Concept of Buffer zones, Wildlife corridors
 - Strategies to reduce human-wildlife interactions
 - Role of Government and NGOs in controlling human-wildlife interactions
 - Socio-economic issues related to human-wildlife interactions

- **PSBWCM 203: Planning and Implementing Conservation programmes (60 lectures)**

- Unit 1: Wildlife parks, wildlife reserves, privately owned wildlife reserves & Biosphere reserves (15 lectures)
 - Single species / single habitat based conservation programmes (e.g. Project tiger, Valley of flowers)
- Unit 2: International conventions on conservation (15 lectures)
 - Important International conventions & treaties on nature & conservation
 - India's role & contribution (including VISION 2040)
 - 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
- Unit 3: People and conservation (15 lectures)
 - Traditional knowledge
 - Traditions & cultures
 - Women in conservation
 - Traditional Societies (e.g. Bishnois)
- Unit 4: Role of NGOs in conservation (15 lectures)
 - 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 BachavoAandholan
 - PaniPanchayats, Seed Movement etc.

- **PSBWCM 204: Advanced techniques in field studies (60 lectures)**

- Unit 1: Molecular Techniques – Genomics (General concepts & applications) (15 lectures)
- Extraction of DNA from samples
 - PCR & RTPCR
 - DNA sequencing
 - DNA fingerprinting
 - Southern Blotting and its applications
- Unit 2: Molecular Techniques – Proteomics (General concepts & applications) (15lectures)
- Extraction & Evaluation of Proteins
 - Protein Fingerprinting (e.g. Venom proteins, Plant proteins)
 - Western Blotting and its applications
 - Protein characterization
- Unit 3: Analysis of Animal tracks & signs (General concepts) (15 Lectures)
- Tracking Large mammals
 - Studying & analyzing Animal Tracks & signs
 - Scat analysis and evaluation of food, feeding and health
 - Enumeration using tracks & signs, Nest census
- Unit 4: Modeling techniques (15 lectures)
- Various software platforms for modeling
 - Collecting data for modeling
 - Applications of Modeling
 - Case studies: e.g. KeoladeoNational Park, Serengeti, Velavadar etc.

Semester II

Practicals

Note :

- Field visits will be integral part of the Practical. Visits to nearby sea-shore, lake, pond, river, reserved forest, Buffer area of a reserve, inhabitations / settlements near wild life areas or any other relevant site must be arranged.
- The report of these visits will be submitted as part of the Practical work.

PSBWCMP201

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.

PSBWCMP202

1. Behavioural observations on Siamese fighter fish in different settings; Male in front of mirror, Male in front of female, Male in front of male, Male in front of other fish species (aggressive and timid species). (Use specially designed small aquarium tanks and suitable method to record observation).
2. Identification, biology & ecological role of following introduced species;
Parthenium, Eichornia, Lantera camera.
3. Using a suitable experimental set up (with respective controls) to study the effect of synthetic Auxin, Gibberellic Acid and 2,4-D on germination of seeds (e.g. Moong / Mustard / wheat).
4. Identification, biology & ecological role of the following using suitable diagram / picture;
Pangolin, blind cave fish – as adaptation to extreme
Pollination of fig flowers by fig wasp,
Pollination of orchids by psuedocopulation – obligatory Interaction
5. Determination of LC₅₀ of a suitable toxicant (e.g. CuSO₄ / Neem leaf extract) using a suitable model e.g. Daphnia, Cyclops, Mosquito larvae, Chironomous larvae, rice weevil)

PSBWCMP203

1. On a phytogeopgraphic 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. Western Blotting of proteins and their identification on suitable membrane (use kits).
4. Separate serum proteins using PAGE and identify protein sizes using a protein ladder.
5. Extraction of DNA from a suitable Mammalian Blood sample (use kits).

PSBWCMP204

1. Isolation of plasmid from a suitable vector & its separation on Gel (use kits).
2. Separation and isolation of pure DNA and its amplification using PCR. Separate amplicons using electrophoresis to demonstrate amplification (use kits).
3. Using a suitable camera fitted with a macro lens, take close-up photograph of the following (to record diagnostic features). Record the camera settings and take 5" X 7" prints on three different papers;
Head of Cockroach, Eye of prawn
4. Compare and interpret given sonograms of bird calls (any two e.g. Courtship calls, Alarm calls).
5. Identify and study specifications & applications of various ringing & tagging devices

(Photographs or Models or working models and diagrams).

6. Preparation of herbaria using suitable fresh plant samples (spreading, drying, pressing and labeling); e.g. Mint, Coriander, Curry leaves, *Hibiscus* -twig with flower.

SEMESTER III

THEORY

- **PSBWCM 301: Principles and practice of Sustainable development (60 lectures)**
 - Unit 1: Eco development (15 lectures)
 - Sustainability of Natural resources
 - Natural Resource Management (with special reference to Fisheries & Forestry)
 - Regulations on fishing
 - Estimating sustainability of fish populations
 - Concept of MSY in marine resources
 - Regulations on use of forest produce
 - Controlled logging
 - Alternate energy sources, their applications and practice
 - Unit 2: Recombinant DNA technology (General concepts & applications) (15 lectures)
 - DNA isolation, cDNA synthesis
 - DNA probes, Oligonucleotide synthesis
 - Plasmids & Vectors
 - Transformation of Viruses and Bacteria
 - Introduction of foreign DNA into animal cells & plant cells
 - Stability of recombinant organisms (concept of mutational rates)
 - Unit 3: GMOs and their applications (Agriculture & Animal husbandry) (15 lectures)
 - Ecological effects
 - Potential threats
 - Field trials
 - Some success stories
 - Unit 4: Eco-tourism (15 lectures)
 - Scope of Eco tourism in India
 - Hospitality & Logistics in Eco-tourism
 - Planning and executing Eco-tourism
 - Customized Eco-tours (e.g. Bird watching, Adventure Tourism, Agro-tourism)
 - Local community's participation in Eco-tourism
 - Public awareness & Interpretation towards environment
 - Orienting Corporate Social Responsibility towards environment
- **PSBWCM 302: Protected Areas and People's Participation in their sustenance (60 lectures)**
 - Unit 1: Management of Protected areas (15 lectures)
 - 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)
- Unit 2: People's participation in managing protected areas (15 lectures)
 - 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)
- Unit 3: Wildlife Trade and Laws (15 lectures)
 - Wildlife protection Act of India
 - CITES
 - TRAFFIC
 - RED Data Book
 - Measures to control poaching & wildlife trade
- Unit 4: Regulations & Acts related to protected areas (15 lectures)
 - General concepts of
 - Private forests, Reserve forests, Sanctuaries, National Parks, Wildlife reserves, Coastal Regulation Zone
 - Protected Areas Network

- **PSBWCM 303: Environment Monitoring & Environment Audits (60 lectures)**

- Unit 1: Monitoring Environment (15 lectures)
 - Abiotic parameters to be monitored for various types of habitats
 - Keystone species & Indicator species
 - Continuous & seasonal monitoring
 - Various monitoring techniques & methods
- Unit 2: Environmental Journalism (15 lectures)
 - Investigating environmental issues
 - Important Governmental agencies
 - RTI and its judicious use
 - Interacting with affected people
 - Mass media and its role
 - e.g books – Silent spring, Small is beautiful
 - films – Home (BBC documentary), Inconvenient truth
 - Reporting Environmental issues
- Unit 3: Environmental Audits & reporting (15 lectures)
 - Planning environmental audits
 - Audit parameters : major biotic and abiotic factors
 - Environment safety audits
 - Carbon Audits, its significance, applications and practice
 - Reporting audit findings

Predictive value of audit findings

Unit 4: Environmental education Techniques (15 lectures)

Need & scope of Environmental Education

Identifying Audience & their needs

Children, General public, Decision makers

Techniques in environmental education

Class-room techniques (examples)

Talks, Nature games, role playing, models, competitions, songs, drama, mass-media etc.

Field techniques

For e.g. Surveys, Street plays, demonstrations, Art Cultural practices, exhibitions etc.

Environment education on specific issues (Examples);

For e.g. Smoke-less chulas, solar cooker, biogas plant, cattle immunization etc.

- **PSBWCM 304: Applications of Information Technology in Field Biology (60 lectures)**

Unit 1: Computational needs in the field (15 lectures)

Field computer & its applications

Using computers in field

Various field input devices

Alternate power sources

Managing data integrity & safety in field

Unit 2: Radio-telemetry (15 lectures)

Various restraining, capture techniques and types of cages for animals.

Various telemetry devices (including data loggers)

Ethics in telemetry applications

Hand held & satellite based systems

Limitations of telemetry observations

Applications of telemetry

e.g. Habitat usage, migration studies

“Digital” tagging & its applications(e.g. implanting micro chips)

Unit 3: Audiorecords (15 lectures)

Various audio recording techniques

Sonogram and its evaluation

Software for sonogram evaluation

Applications of audio recordings

e.g. (Bird songs, Insect calls, Habitat usage by Bats, Marine mammals)

Unit 4: GIS and its interpretation (15 lectures)

Principles and Practice of Geographic Information System

Satellite imageries and false colour imaging

GPS and its application in field

Preparation of field maps, vegetation maps

Semester III

Practicals

Note :

- Field visits will be integral part of the Practical. Visits to nearby sea-shore, lake, pond, river, reserved forest, eco-tourism centre, park visitor - interpretation center, animal rescue centers or any other relevant site must be arranged.
- The report of these visits will be submitted as part of the Practical work.

PSBWCMP301

1. Undertake a survey of Fishermen's village / Tribal village near forest. Use a suitable questionnaire (1) to record the extent of dependence of the community on the natural resource base, (2) to record their pattern of usage of the natural resource, (3) to document the anthropogenic influences on the ecosystem and (4) to suggest ameliorative measures including environment awareness programmes. Apply suitable Statistical tools for tabulating, representing and evaluating both quantitative and qualitative data obtained during the survey. Interpret the results and make a report.
2. Extraction of DNA from a suitable plant material (use kits).
3. Introduction of a suitable plasmid into a suitable vector to demonstrate transformation (use kits).
4. Identification GMO by an electrophoresis based technique (e.g. DNA analysis) (use kits).
5. Prepare a plan, itinerary & brochure for an eco-tour using simulated data provided (maximum three days & two nights, excluding travel);
 - a) A place of interest from Natural History – e.g. wildlife reserve
 - b) A place of interest from Adventure Tourism – e.g. a riverine valley
 - c) A place of interest from Agro-tourism – e.g. an organic farm

(PSBWCMP302)

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 cushioning 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)

2. 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.

PSBWCMP303

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.
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.

(PSBWCMP304)

1. Identify and study specifications & applications of various telemetric devices (Photographs or Models or working models and diagrams);
 - Antennae, transmitters (ingestible, implantable, strap-on (attachable) type)
 - Digitized tags (e.g. implantable micro chips)
 - Dart Gun & Tranquilizing agents & there action.
2. Make an audio recording of a song bird. e.g., bulbul, magpie robin, sunbird. Observe and note the activity of the bird while recording the call. Make a sonogram of the recording. Analyze the call and correlate with the behavioral observations. Classify the call as advertisement call, territorial call, alarm call, courtship call etc.
3. Study of various input devises (construction, use and applications) using photographs / models / actual devises, that could be used with a field computer ;
Types of input ports, Imaging devices, audio devices, Telemetric devices, Note pads & scribble pads, pressure devices, Remote control devices, external memory devices etc.
4. Using a hand held GPS instrument locate coordinates of a demarcated field site (example college campus).
5. Prepare a ready reference data base of resources available in the **Public domain** that is useful in field. e.g. environment education films, charts & pictures, images, audio-visual presentations, reference articles, books, legal petitions, judgments etc. Make a report that will be ready reckoner.

SEMESTER IV

- **PSBWCM 401To PSBWCM 404: Projects / Internship with Report**

The students are required to undertake a project / internship in the last semester which should be for a maximum duration of 180 days. The project/ internship should consist of a minimum of 130 days of field work, followed by minimum of 30 days of report preparation. The area of work will be related to the topics covered under the course and work will be decided by the students in consultation with faculty members. A survey of literature and feasibility studies will be undertaken by the students, who plan to undertake a project, during the third semester or during early part of fourth semester. Those who undertake internship will undertake a background study of the institution / organization where they plan to complete their internship, during the third semester or during early part of fourth semester.

Each project will be supervised by a faculty member or a group of faculty members and experts. The students will be guided time to time during the project. This exercise will provide the students with valuable experience of proper planning, executing, evaluating and reporting a research project. The students should be encouraged to publish the findings (*if possible*). The faculty / team of experts will advise and monitor the students interning at different institutions or organizations. This exercise will provide the students with valuable experience of planning, executing and reporting various environment / conservation related projects / programmes and field work. The students should be encouraged to interact with NGOs, corporates, governmental agencies, civil society groups both national & international (*if possible*).

Evaluation:

Internal evaluation: Internship / project carried out during the fourth semester will be evaluated by the research committee / team of experts and by the guiding faculty during its planning, implementation.

External evaluation: Internship / Project carried out during the fourth semester will be evaluated at the end semester examination on the basis of the report submitted, presentation made by the student and *viva voce*.

QUESTION PAPER PATTERN

THEORY

Total Marks – 60

Total duration – two and half hours

Total question – 04

Marks for each question – 15

Coverage of each question – each question will correspond to each unit taught in that semester

Options – There will be internal options in each question (within 15 marks)

Compulsory questions – All four questions will be compulsory.

PRACTICAL

Total Marks – 50

Total duration – Six hours

Total questions – 05

Distribution of marks – Question No. 1, 2, and 3 – 12 marks each (performance & results)
Question No. 4 – Reports of field visits – 10 marks

Question No. 5 – Viva voce –04 marks

EVALUATION OF PROJECT / INTERNSHIP

Total marks – 200

Distribution of marks :-

Submission of Outline of project- 20

Report – 120 marks, the report must be supported by raw data generated in the project.

Presentation – minimum 20 min. – 40 marks

- Content
- Presentation
- Effective usage of audio-visual aids
- Clarity of concepts
- Application of techniques in the project
- Response to questions
- Over-all impression

Viva voce – 20 marks

Note:The student will submit a written report on the day of evaluation which will include a synopsis of the project / internship, replies to comments by the evaluator with clarifications (if any) and a brief note on the findings / experiences highlighting the following:

- Name of the work
- Agencies collaborated
- Major gains and skills attained
- Important experiences / observations / results
- Over-all impression

SUGGESTED READINGS

Sr. No.	Title	Author	Publisher	Year
1.	Protected Area Update; Newsletter	-----	Kalpavriksh Environment Action Group, Pune , India	Periodical
2.	Zoos in India; Legislation, Policy, Guidelines and Strategy	-----	Central Zoo Authority, New Delhi	2007
3.	Wildlife ecology	Aaron, N.M.	W.H. Freeman Co. San Francisco, U.S.A.	1973
4.	The Book of Indian Birds	Ali, Salim	Oxford University Press, Mumbai	1997
5.	Wildlife Ecology, Conservation and Management	Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly	Blackwell Publishing, U.S.A.	2006
6.	The Book of Indian Shells.	Apte, Deepak.	Oxford University Press, Mumbai.	
7.	Colorful Atlas on Indian Wildlife Diseases and Disorders	Arora and BipulChakraborty B.M.	IBDC, Lucknow.	2008
8.	Indian Wildlife Yearbook	Arora B. M. , Editor	AIZ & WV, Bareilly and	2002

			Central Zoo Authority, New Delhi	
9.	Dietary Husbandry of Wild Mammalia	Arora, B.M.	AIZ & WV, Bareilly and CZA, New Delhi.	2001
10.	Indian Wildlife Diseases and Disorders.	Arora, B.M.		
11.	Rehabilitation in free living wild animals	Arora, B.M.	AIZ & WV, Bareilly	2007
12.	Reproduction in Wild Mammalia & Conservation	Arora, B.M.	AIZ & WV, Bareilly.	2002
13.	A Text Book of Developmental Biology	Banerjee, S.	IBD, Dehradun	2001
14.	Remote Sensing for Hazard Monitoring and Disaster Assessment	Barett, E.C. and Anton Micallef	Taylor and Francis, London	1991
15.	Statistics in Research	Bernard Ostle and R.W.Mensing		
16.	Wild Animals in Central India	Brander, A.A	Natraj Publisher, Dehradun.	
17.	Method of Statistical Analysis	C.H. Goulden	John Wiley & Sons	
18.	Environmental Impact Assessment	Canter, L. W.	Graw, Mc, , Hill Publication, New York.	
19.	A Text Book of Agricultural Statistics	Chandel S.R.S.,.	AchalPrakashanMandir, Kanpur	1999
Sr. No.	Title	Author	Publisher	Year
20.	Introduction to Geographic Information Systems,	Chang – Kang, Tsung	Tata McGraw -Hill Publishing Company Limited, New Delhi	2002
21.	A guide to Chemical Restraint of Wild Animals.	Chowdhury, Sushant and Malik, Pradeep	Natraj Publishers, Dehradun.	
22.	EIA – A Biography	Clark, B. D., Bissel, B. D. and Watheam, P.	School of Forestry and Environment, SHIATS-Deemed University, Allahabad	
23.	The Temple Tiger.	Corbett, Jim	Oxford University Press, New Delhi	2007
24.	Asian Elephant,	Daniel, J.C.	Natraj Publishers, Dehradun	
25.	The Book of Indian Reptiles and Amphibians	Daniel, J.C.	Oxford University Press, Mumbai.	
26.	Resource and Environmental Economics	Fisher, A.C.	New York: John Wiley & Sons	1979
27.	The conservation of plant biodiversity.	Frankal, Otto H., Anthony, A., Brown, D. and Burdon, Jeremy J.	Cambridge University Press	1995
28.	Statistical Methods	G.W. Snedecor and W.G. Cochran		

29.	The Serengeti Lion	George B. Schaller		
30.	Fundamentals of Wildlife Management	Gopal, Rajesh	Justice Home, Allahabad, India.	1992
31.	Encyclopedia of mammals	Grzimek	McGraw Hill Publishing House, New Delhi.	1988
32.	Wild Animals, Their Minds and Manners	Hornaday, W.T.	IBD, Dehradun.	1989
33.	Concepts in Wildlife Management	Hosetti, B.B.	Daya Publishing House, Delhi.	1997
34.	Collection and preservation of animals	Jairajpuri M. S.	Zoological Survey of India	1990
35.	Statistical Ecology	John A. Ludwig & James F. Reynolds	John Wiley & Sons	1988
36.	Handbook of Environment, Forest and Wildlife Protection Laws in India	Justice Kuldip Singh	Natraj Publishers, Dehradun	1998
37.	Biodiversity conservation in managed and protected areas	Katwal/Banerjee	Agrobios, India	2002
Sr. No.	Title	Author	Publisher	Year
38.	Advances in Fish and Wildlife Ecology and Biology	Kaul, B.L.		1999
39.	A Vet in Wilderness	Khan Ali M. G.	Central Zoo Authority, New Delhi	
40.	Modern Textbook of Zoology, Vertebrates.	Kotpal, R.L.	Rastogi Publications, Merrut.	
41.	Remote Sensing and Image Interpretation	Lilleand, T.M. and Kieffer, R.W	John Wiley and Sons	
42.	Wild Animals of India, Burma, Malaya and Tibet	Lydekker, R.,	Natraj Publishers, Dehradun.	
43.	Wildlife Crime	Menon, Vivek and Kumar, Ashok	Natraj Publisher, Dehradun.	1999
44.	Wildlife Issues in a Changing World	Moulton, M. P. & J. Sanderson	St. Lucie Press	1997
45.	A handbook of forestry.	Negi, S.S.	International Book Distributor, Dehradun.	2005
46.	Biodiversity and its conservation in India	Negi, S.S.	Indus Publishing Co., New Delhi.	1993
47.	Manual for Wildlife Management in India	Negi, S.S.		
48.	Fundamentals of Ecology	Odum, Eugene P	Natraj Publishers, Dehradun.	
49.	Applied Anatomy of the Domestic Animals.	Ommer, P.A. and Harshan, K.R.	Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.	
50.	Natural Resource Information for Economic Development	Orris C. Herfindahl	Baltimore: The Johns Hopkins University Press	1969

51.	Watching and Conserving	Oxford Anthology of Indian Wildlife	Oxford University Press, New Delhi.	
52.	Aerial Photography and Image Interpretation for Resource Management.	Paine, D.P.	John Wiley and Sons.	
53.	The Ecology of Wildlife Diseases.	Peter J. Hudson, Annapaola Rizzoli, Bryan T. Grenfell, Hans Heestrbeek and Andy P. Dobson	Oxford University Press, Oxford	2002
54.	Book of Indian Animals.	Prater, S.H.	Bombay Natural History Society, Mumbai.	
55.	Essentials of Conservation Biology	Primack, R.B.	Sinauer Associates, Inc. Sunderland, MA	1998
Sr. No.	Title	Author	Publisher	Year
56.	Principles and Procedures of Statistics (with special reference to Biological Sciences)	R.G. Steel and J.H. Torrie		
57.	A Text Book of Agricultural Statistics	R.Rangaswamy		
58.	Birds of Wetlands and Grasslands	Rahmani, Asad R. &Ugra, Gayatri	Bombay Natural History Society, Mumbai.	
59.	A Handbook of the Management of Animals in Captivity.	Ram BramhaSanyal		1995
60.	Hunting and Shooting	Rangarajan, Mahesh	The Oxford Anthology of Indian Wildlife.	1999
61.	The ecology and evolution of animal behavior	Robert, A.W	Good Year Pub. Co. California, U.S.A.	1979
62.	Wildlife management.	Robert, G.H.	W.H. Freeman and Co., San Francisco, U.S.A.	1978
63.	The Care and Feeding of Infant Orphaned Wild Birds.	S.M.L. Grose.	IBD, Dehradun	
64.	Remote Sensing: Principles and Applications	Sabbins, F.E., Freeman		
65.	Manual of wildlife techniques for India.	Sale, J.B. and Berkmuller, K.	WII, FAO, Dehra Dun, India	1988
66.	A Handbook of the Management of Animals in Captivity.	Sanyal, Ram Bramha		1995
67.	Indian Wildlife Resources Ecology and Development	Sharma, B.D	Daya Publishing House, Delhi	1999

68.	A New Approach to Linear Programming	Sharma, S.D.	Kedarnath, Ramnath and Co. Meerut	1975
69.	Wildlife Ecology, Conservation and Management	Sinclair, Anthony R.E., Fryxell, John M. and Caughly, Graeme	Blackwell Publishing, U.S.A.	2006
70.	Economics of PA's and its effect on biodiversity.	Singh and Vijaykumar.	APH Publishing Corporation, New Delhi.	2001
71.	Text Book of Wildlife Management.	Singh, S.K.	IBDC, Lucknow.	2005
Sr. No.	Title	Author	Publisher	Year
72.	Conserving India's Natural Heritage	Singh, Samar	Natraj Publication, Dehra Dun.	1987
73.	Wildlife and Forest Conservation	Sinha, P.C.	Anmol Publishing Pvt. Ltd., New Delhi.	1998
74.	Mammals Skin.	Sokolov, V.E.	IBD, Dehradun.	1982
75.	Wildlife research and management. Asian and American Approaches	Stephen, H.B. and V.B. Saharia	Oxford University Press, Delhi	1995
76.	Zoogeography of India and Asia.	Tiwari, S.K.	CBS Publisher and Distributors, New Delhi.	
77.	Natural Resource and Environmental Economics	Tony Prato,	Iowa State University Press	1998
78.	Environmental and social impact assessment	Vanclay F. and Bronstein, D.A.	John Wiley & Sons, New York.	1995
79.	Guide for Planning Wildlife Management in Protected Areas and Managed Landscapes	VishwasSawarkar	Natraj Publisher. Dehradun	
80.	Experimental Designs	W.G. Cochran and G.M.Cox		
81.	Parasitic Diseases of Wild Animals.	W.M. Samuel, M.J. Pybus and A.A. Kocan		2005
82.	Vertebrate Zoology and Evolution.	Yadav, B.N.	IBD, Dehradun.	2000