P.G. 3rd SEMESTER SYLLABUS

DEPARTMENT OF ENVIRONMENTAL BIOLOGY & WILDLIFE SCIENCES

COTTON UNIVERSITY

PAPER: EWS 901C

CONSERVATION BIOLOGY AND WILDLIFE MANAGEMENT

CREDITS: 4 (3+0+1)

Unit 1: Conservation Biology (14 lectures)

The pathology of biodiversity loss: the practice of conservation; the history and distinction of conservation biology; conservation values and the ethics of conservation of biodiversity; traditional versus 'new' conservation; key conservation issues: extinction; logging and deforestation; habitat loss and fragmentation; hunting and poaching; livestock grazing; impacts of extractive uses; invasive species; linear infrastructure; shifting cultivation; oil palm and rubber plantation; large dams; human-wildlife interaction; climate change and biodiversity.

Unit 2: Applied Conservation Biology (12 lectures)

Conservation priorities: identifying need, taking action and evaluating success; levels of approach: on the appropriate scales for conservation interventions and planning; biological corridors and connectivity; relocation of wildlife; restoration, rewilding and re-introductions; citizen science and nature conservation; plant conservation: the seeds of success; the 'why', 'what' and 'how' of monitoring for conservation; conservation and human behaviour; five paradigms of collective action underlying the human dimension of conservation; designing effective solutions to conservation planning problems; leadership and listening: inspiration for conservation mission and advocacy.

Unit 3: Wildlife Management (10 lectures)

Legal instruments for managing forests, other wildlife habitats and wildlife in India; international conventions; species conservation projects; tiger, rhino, vultures, pygmy hog etc.; forest working plans and wildlife management plans; National Forest Policy, eco-development programme; joint forest management; economic instruments for nature conservation; tackling unsustainable wildlife trade; management of species outside the protected areas.

Unit 4: Conservation Genetics (12 lectures)

What is genetic diversity?; measuring genetic diversity; processes contributing to genetic diversity: mutation, migration, random mating; natural selection; random genetic drift; Allele and genotype frequencies; ideal population and Hardy-Weinberg equilibrium; evolutionary processes in small and large populations (evolutionary impacts of selection, mutation, migration, random genetic drift and random mating on small and large populations); fixation; population bottlenecks; inbreeding and inbreeding depression; measuring population size (effective population size); population fragmentation; advantages of molecular tools over conventional method in resolving taxonomic uncertainity; concept of cryptic species; introduction to PCR; concept of DNA barcoding for species identification and biodiversity conservation; landscape genetics.

Practicals: Hands-on Exercises

1. Explore the concept of biological diversity as it occurs at various taxonomic levels through the classification of life forms.
2. Learn to draw inferences and make management recommendations on the basis of population genetic information.
3. How to link the concepts of effective to adult population sizes in order to be able to estimate numbers of individuals in the field needed to limit loss of genetic diversity to a specified level.
4. To gain experience in making expert recommendations about captive breeding plans
5. Landscape genetics: identifying movement corridors.
6. Population Viability Analysis.
7. Habitat loss and fragmentation: Ecological traps, connectivity, and issues of scale
8. Diagnosing declining populations.
9. Design and implement a reintroduction plan for a plant species and to determine the effectiveness of reintroduction as a tool to establish new populations of plant species.
10. Edge effects: designing a nest predation experiment.
11. Explore through a mapping exercise what happens to a tropical forested landscape as it undergoes the fragmentation process and to predict what will happen to the biota residing within the landscape as a result of these changes.
12. Understand some basic analyses behind allocating land to different types of forest management as a vehicle for understanding the key issues involved in managing ecosystems to balance production of a commodity while maintaining biodiversity.
13. Basic technique to prioritise conservation at a regional scale and to identify the top priority "hotspots" for allocating resources for conservation.
14. Apply island biogeography theory to test basic assumption about the role of nature reserve in protecting biodiversity.
15. Mapping and analysing distribution of Western hoolock gibbon for reserve design.
16. Develop technical expertise in as well as a conceptual understanding of modeling species distribution in relation to changing climatic conditions; Learn the basics of climate envelop modeling, examine the climatic adaptation of a species, predict the entire geographic range of a species.

Suggested Readings

1. Macdonald DW and Willis KJ (ed) (2013). *Key topics in Conservation Biology 2*. Wiley-Blackwell
2. Dyke FV (2008). *Conservation Biology: Foundations, Concepts, Applications (2nd Edition)*. Springer
3. Hunter Jr ML and Gibbs JP (2007). *Fundamentals of Conservation Biology (3rd Edition)*. Blackwell Publishing
4. Gibbs JP, Hunter Jr ML and Sterling EJ (2008). *Problem-solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing

P.G. 3rd SEMESTER SYLLABUS

DEPARTMENT OF ENVIRONMENTAL BIOLOGY & WILDLIFE SCIENCES

COTTON UNIVERSITY

PAPER: EWS 902C

ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

CREDITS: 4 (2+1+1)

Unit 1: Introduction to Environmental Microbiology (10 lectures)

Characteristics of major groups of microorganisms: bacteria, fungi, algae, protozoa, viruses; microbial habitats; microbial interactions.

Unit 2: Microbes of Environmental Importance (12 lectures)

Microbes and biogeochemical cycles; role of microbes in carbon sequestration; Nitrogen fixation and other related microbes; bioremoval of xenobiotics; coliforms as indicator of microbial water pollution; microbial role in wastewater treatment; mycorrhiza and their environmental significance; bio-indicators; microbial degradation of naturally occurring compounds: cellulose, lignin, hydrocarbons.

Unit 3: Basic Concepts of Molecular Biology and Environmental Biotechnology (14 lectures)

Basic concepts of molecular biology: genetic material; gene structure; protein synthesis and its regulation in prokaryotes and eukaryotes; definition and scope of biotechnology: basic techniques in genetic engineering; basic of environmental biotechnology.

Unit 4: Applications of Biotechnology in Environmental Management (12 lectures)

Biosensors for the detection of pollutants; genetic control of industrial pollution through natural and genetically engineered micro-organisms: bioremediation of metal contaminated soils; removal of spilled oil and grease deposits; Biotechnology in forestry and wasteland development; gene banks, germplasm banks and their management; concept of DNA sequencing; concept of environmental metagenomics.

Practicals

1. Estimation of bacteria in soil through dilution plate method
2. Estimation of fungi in soil through dilution plate method
3. Estimation of microflora in water samples through dilution plate method
4. Coliform count in water samples by MPN technique

Suggested Readings

1. Sayler G, Fox S and Blackburn J (eds) (1991). *Environmental Biotechnology for waste treatment*. Planum Press
2. Atlas RM and Bastha R (1997). *Microbial Ecology: Fundamentals and Applications,* Benjamin/Cummings Publication
3. Evans GM and Furlong JC (2002). *Environmental Biotechnology*. Willey
4. Ivanov V (2011). *Environmental Microbiology for Engineers,* CRC Press
5. Bertrand et al (2011). *Environmental Microbiology: Fundamentals and Applications, Microbial Ecology*, Springer

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P.G. 3rd SEMESTER SYLLABUS

DEPARTMENT OF ENVIRONMENTAL BIOLOGY & WILDLIFE SCIENCES

COTTON UNIVERSITY

PAPER: EWS 903C

POLLUTION CONTROL AND WASTE MANAGEMENT

CREDITS: 4 (3+1+0)

Unit 1: Water and Wastewater Treatment (18 lectures)

Sedimentation principle; coagulation and floculation process, filtration process and type; disinfection technologies; water softening; defluoridation; nanotechnology applications in drinking water treatment; types of wastewater and their characteristics; primary treatment: screening, sedimentation; secondary treatment: activated sludge process; trickling filter; rotating biological contactors, up flow anaerobic sludge blanket (UASB); tertiary treatment; concept of common effluent treatment plant (CETP); echo-technological approaches for wastewater treatment: phytoremediation, phycoremediation, constructed wetlands; laws and acts related to water pollution and management.

Unit 2: Air Pollution Control and Management (6 lectures)

General methods of control of gaseous pollutants: adsorption, absorption, combustion and condensation; control of particulate matter: cyclones, venture scrubbers, electrostatic precipitators, indoor air quality control; green belt development; alternate fuels; laws and acts related to air pollution and management.

Unit 3: Noise Pollution Control and Management (4 lectures)

Noise pollution control: absorbing materials, barrier materials, damping materials, acoustical enclosures, reactive silencers and filters; active noise control methods; laws and acts related to noise pollution and management.

Unit 4: Solid and Hazardous Waste Management (12 lectures)

Sources and generation of solid waste, their characterization; management options: landfill: site selection, design, operation, leachate and landfill gas management, composting, vermi-composting, incineration; hazardous wastes: definition, types characterisation of hazardous waste source, effects and management; biomedical waste definition and different categories; biomedical and e-wastes management; case studies of MSW management in some cities in India.

Unit 5: Sustainability (8 lectures)

Concept of sustainability and sustainability science; concept of earth capital, ecological foot print, food security, factors governing sustainable development; linkages among sustainable development, environment and poverty; sustainable development goals, sustainable development and green building; case studies on sustainable development.

Suggested Readings

1. Gilbert M (2008). *Introduction to Environmental Engineering and Science*, Pearson Education
2. Metcalf and Eddy (2003). *Wastewater Engineering-Treatment and Reuse*, Tata McGraw Hill, New Delhi

3. Sincero AP and Sincero GA (1996). *Environmental Engineering: A Design Approach,* Prentice Hall
4. Hammer MJ and Hammer Jr MJ (2000). *Water and Wastewater Technology* (3ed Edition). Prentice Hall of India
5. Miller GT (2000). *Living in the Environment*. Brooks/Cole
6. Azapezic A, Perdan S and Clift R (2004). *Sustainable Development in Practice: Case Studies for Engineers and Scientists*. Willey

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PG 3rd Semester: SPECIAL PAPER

PAPER: EWS 904D

STUDY DESIGN AND DATA ANALYSIS

CREDITS: 5 (3+1+1)

Unit 1: Designing Successful Field Studies (9 lectures)

What is the point of the study? manipulative experiments; natural experiments; snapshot versus trajectory experiments; press versus pulse experiments; replication; ensuring independence; avoiding confounding factors; replication and randomisation; power analysis; designing effective field experiments and sampling studies.

Unit 2: A Bestiary of Experimental and Sampling Design (9 lectures)

Categorical versus continuous variables; dependent and independent variables; four classes of experimental design: regression designs, ANOVA designs, alternative to ANOVA: experimental regression, tabular designs, alternative to tabular designs: proportional designs.

Unit 3: Managing and Curating Data (5 lectures)

The first step: managing raw data; the second step: storing and curating the data; the third step: checking the data; the final step: transforming the data; summary: the data management flow.

Unit 4: Regression (6 lectures)

Defining the straight line and its two parameters; fitting data to a linear model; variances and covariances; least squares parameters estimates; variance components and the coefficient of determination; hypothesis test with regression; assumptions of regression; diagnostic tests for regression; Monte Carlo and Bayesian analyses; other kinds of regression analyses; model selection criteria.

Unit 5: The Analysis of Variance (8 lectures)

Symbols and labels of ANOVA; ANOVA and paritioning of the sum of squares; the assumptions of ANOVA; hypothesis tests with ANOVA; constructing F-ratios; a bestiary of ANOVA tables; random versus fixed factors in ANOVA; partitioning the variance in ANOVA; after ANOVA: plotting and understanding interaction terms; comparing means; Bonferroni corrections and the problems of multiple tests.

Unit 6: The Analysis of Categorical Data (3 lectures)

Two-way contingency tables; multi-way contingency tables; test for Goodness-of fit.

Unit 7: The Analysis Multivariate Data (8 lectures)

Approaching multivariate data; comparing multivariate means; the multivariate normal distribution, measurements of multivariate distance; ordination; classification; multivariate multiple regression.

Practical: The students will conceive a project; execute it and analyse the data and present the result as a project report and PowerPoint presentation.

Suggested Readings

1. Gotelli NJ and Ellison AM (2012). *A Primer of Ecological Statistics (2nd Edition)*. Oxford University Press

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PAPER: EWS 905D

SOIL, AGRICULTURE AND ENVIRONMENT

CREDITS: 5 (4+1+0)

Unit 1: General Introduction to the Soil System (14 lectures)

Lithosphere and pedosphere; pedology and edaphology; soil formation; soil horizons; soil composition, physical and chemical properties; soil biological properties-microflora, microfauna, mesofauna, macrofauna and megafauna, plant roots and rhizosphere.

Unit 2: Soil Ecology (14 lectures)

Detritivores and food webs in soil; soil biodiversity-pattern and distribution; functions of soil organisms - soil mixing and aeration, stabilization of soil structure, nutrient cycling, nitrogen fixation, greenhouse gas production, effect of root growth on soil physical structure and soil biota, root-microbe interaction, root exudates, nutrient availability and plant uptake; vesicular arbuscular mycorrhizae; plant growth promoting rhizobacteria; phosphate solubilizing bacteria.

Unit 3: Soil and Agriculture (14 lectures)

Origin of agriculture, history of crop domestication, ancient civilizations and crop cultivation; Green Revolution; agronomy and agro-ecology; conventional and sustainable agriculture; cropping systems; agro-biodiversity; crop-pollinator interaction; agricultural pests and their control; factors affecting agricultural production-soil organisms, soil health, water and air quality, other environmental factors (light, temperature, moisture etc.), traditional and high yielding crop varieties.

Unit 4: Environmental Impacts of Agriculture (14 lectures)

Air pollution - mechanization of agriculture, power and fossil fuel consumption, biomass burning; soil and water pollution - heavy use of synthetic nitrogenous fertilizers, pesticides, herbicides, insecticides etc.; agriculture as a source of greenhouse gas emissions; depletion of water resources; deforestation, loss of habitat and biodiversity; genetically engineered crops and dominance of weeds; waterlogging and salinization; soil erosion and degradation; impact on soil biota.

Unit 5: Sociocultural Dimensions of Agriculture (8 lectures)

Agriculture and food security; agriculture dependent livelihoods of local communities; markets for agricultural produce; participation of women in agriculture; agricultural practices in north east India - *Jhum* or shifting cultivation, traditional rice cultivation practices in Assam; rice agriculture and the economy of Assam.

Suggested Readings

1. Bardgett D (2005). *The Biology of Soil: A Community and Ecosystem Approach*. Oxford University Press
2. Dion P (ed) (2010). *Soil Biology and Agriculture in the Tropics*. Springer
3. Wall DH (ed) (2012). *Soil Ecology and Ecosystem Services*. Oxford University Press
4. Lavelle P and Spain AV (2003*). Soil Ecology*. Kluwer Academic Publishers
5. Paul EA (ed) (2014). *Soil Microbiology, Ecology and Biochemistry (4th edition)*. Academic Press
6. Martin K and Sauerborn J (2013). *Agroecology*. Springer
7. Lockie S and Carpenter D (eds) (2010). *Agriculture, Biodiversity and Markets*. Earthscan, London, Washington D.C
8. Cauvin J (2000). *The Birth of the Gods and the Origins of Agriculture*. Cambridge University Press
9. Sundh et al. (eds) (2012). *Beneficial microorganisms in Agriculture, Food and the Environment*. CAB International
10. Maxted et al. (eds) (2012). *Agrobiodiversity Conservation: Securing the diversity of crop wild relatives and landraces*. CAB International

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PAPER: EWS 906P

WILDLIFE OF NORTHEAST INDIA

CREDITS: 4 (2+1+1)

Unit 1: Biodiversity of Northeast India: Patterns and Processes (6 lectures)

Why is northeast India so rich in biodiversity? history of wildlife research in northeast India; key wildlife habitats of northeast India; pattern and distribution of major faunal groups – mammals, birds, butterflies, herpetofauna and plants; endemic wildlife of the region; geological and historical drivers of habitat change in northeast India.

Unit 2: Conservation and Management Issues (10 lectures)

Habitat conservation issues: habitat loss and fragmentation, deforestation and logging, oil palm, rubber and shifting cultivation, large dams and its impact, grassland burning; Species conservation issues: hunting, poaching, local extinction and human-wildlife interaction; Ecosystem conservation issues: invasive species, linear infrastructure, climate change, air and water pollution.

Unit 3: Wildlife Conservation: Opportunities and Challenges (10 lectures)

Development *versus* wildlife conservation; successful conservation stories from northeast India: habitat protection and species conservation; role of interdisciplinary research in addressing conservation issues; people or parks: the human dimension of wildlife conservation in northeast India; advocacy for wildlife conservation, legal instruments of wildlife conservation.

Unit 4: Tools and Techniques in Wildlife Research (6 lectures)

Use of binoculars, compass, Global Positioning System (GPS), camera trap; introduction to citizen science tools such as eBird, SeasonWatch, Assam Biodiversity Portal; basics of wildlife photography.

Field Work

- Documentation of the biodiversity of key wildlife habitats within the Guwahati City.
- Identification of the threats to wildlife and their habitats and possible preventive and mitigative measures.

Suggested Reading Materials:

Various books, peer-reviewed journal articles, popular and reports will be provided during the class.

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