Tribhuvan University
Institute of Science and Technology
M.Sc. Zoology
SEMESTER II
ECOLOGY & ENVIRONMENT

Course Title: Principles of Ecology **Credits: 3**
Course No: Zoo 557 **Lecture hrs: 48**
Nature of the Course: Theory **Full Marks: 75**
Pass Marks: 37.5

Course Objectives

To provide the student with:

- A comprehensive underlying of ecological principles governing population dynamics and regulations.
- Detailed information on the theories of species interaction and how the interaction affects the distribution and abundance of individuals and populations.
- Theoretical knowledge and practical techniques to understand and analyze community parameters.
- Knowledge on the theories and implication of ecosystem dynamics.

Course Contents

Unit 1. Foundation of Ecology **2 hrs**

1.1 Ecology and Its Domain, Conditions, Resources, Evolution of Life Histories

Unit 2. Population Ecology **8 hrs**

2.1 Review of population parameters

2.2. Demography and population dynamics

2.3. Theories on population growth and regulation

- Mathematical theory, mathematical models, population projection matrices.

2.4 Natural Regulation of population Size

- Model of population regulation,
- Intraspecific competition and population regulation,
- Implication of natural regulation

Unit 3. Species Interaction **14 hrs**

3.1. Overview of the species interaction and co-evolution

3.2 **Competition**

- Theories, Patterns, Models and Experiments: Mathematical model of Lotka and Volterra, Tileman's model, Laboratory and field examples.
- Completion and Resources Use and Partitioning
- Ecological Niche: Niche overlap, niche width and niche change.

3.1.3. Predation

- Theories, Patterns, Models of Predation (mathematic models) and experiments
- Predator- prey interaction: Prey defense, predator influence on prey distribution
- Predator- Prey System, predator response, Foraging Theory,
- Predator- Prey Dynamics/Cycle, trophic cascades and predation

3.1.3. Plant- Herbivore Interaction: Predation on plants, Theories in plant defense, irruptions of herbivore populations, models on interaction

3.1.4. Parasitism: Host as habitats and host response, population dynamics

2.1.5. Mutualism: Types of mutualism, Origin and population effects

Unit 4. Community Ecology and Estimating Community Parameters **12 hrs**

1.1 Review of community structure and patterns, Metacomunity and neutral theory

1.2 Species Diversity: Concept of diversity: Species Richness, Heterogeneity, Evenness
1.3 Stability, Equilibrium, and Nonequilibrium community
1.4 Species Richness Measures: Rarefaction Method, Jackknife Estimate, Bootstrap Procedure, Species-Area Curve Estimates
1.5 Heterogenity Measures: Simpson's Index, Shannon-Wiener Function, Brillouin Index, Logarithmic Series, Lognormal Distribution
1.6 Evenness measures
1.7 Similarity Coefficient: Binary Coefficients, Distance Coefficients, Correlation Coefficients, Other Measures: percentage similarity, Morisita's Index of Similarity,
1.8 Cluster Analysis: Single Linkage Clustering, Complete Linkage Clustering, Average Linkage Clustering
1.9 Beta Diversity Measurement
1.10 Niche Measures and Resource Preference: Resources,
1.11 Niche Breadth: Levins's Measure, Shannon-Wiener Measure, Smith's Measure, number of frequency used resources
1.12 Niche Overlap: MacArthur and Levins's Measure, Percentage Overlap, Morisita's Measure

Unit 5. Ecosystem Dynamics **12 hrs**

5.1 Trophic dynamics/cascade

5.2 Ecosystem development and dynamics

- Pattern and process in ecosystem development
- Theories and models of succession
- Stability analysis of ecosystems

5.3 Ecosystem metabolism

- Water and energy balance in ecosystem
- Carbon inputs and cycling
- Nutrient pools, exchange and cycling
- Biogeochemical cycles: Overview, anthropogenic changes on biogeochemical cycles

Recommended Readings

Chapin, III, F.A., Matson, P.A. and Mooney, H.A. .2002. Principles of Terrestrial Ecosystem Ecology. Springer Science & Business Media.

Krebs, C.J. 1999. Ecological Methodology, 2nd ed. Addison-Wesley Educational Publishers, Inc.).

Krebs, C.J. 2009. Ecology: The Experimental Analysis of Distribution and Abundance. 6th ed. Benjamin Cummings, San Francisco. 655 pp

Krebs, C.J. 2014. Ecological Methodology, 3rd ed. (in prep). Chapters revised to date (14 March 2014) are available to download for evaluation and review (PDF files):

Morin, P.J.2011 Community Ecology, Second Edition, Blackwell Science, Inc. ISBN 0-86542-350-4

Odum, E.P. 1971. Fundamentals of Ecology. Saunders College Publishing, Philadelphia USA.

Peter, P. 2001. Ecology: Theories and Applications, 4th edition. Prentice Hall.

Smith & Smith 1998. Ecology and Field Biology. Benjamin Cumming, USA.

Other Readings

Begon, M., Harper, J.L., Townsend, C.R. 1996. Ecology. Blackwell Science, Massachusetts, USA.

Bormann, H. and Likens, G.E. 1979. Ecosystem development: patterns and processes. Springer-Verlag, New York.

Campos-arceiz, A., Larrinaga, A.R. *et al.* 2008. Behavior rather than diet mediates seasonal differences in seed dispersal by Asian elephants. Ecology **89**(10): 2684-2691.

Huston, M.A. 2002. Biological diversity. Cambridge University Press, Cambridge, U.K.

Janzen, D.H. 1980. When is it coevolution? Evolution **34**(3): 611-612.
Jennifer, L.F. and. Vitousek, P.M. 2007. Resource-use efficiency and plant invasion in low-resource systems. Nature 446. |26 April 2007| doi:10.1038/nature05719
Krebs, C.J. 1996. Ecology harper Collins College Publishers, Inc. New York.
Likens, G.E and Borman, H. 1981. Bigeochemical cycles. Springer-Verlag, New York.

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Tribhuvan University
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M.Sc. Zoology
SEMESTER II
ECOLOGY & ENVIRONMENT

Course Title: Mountain and Global Ecology **Credits: 3**
Course No: Zoo 558 **Lecture hrs: 48**
Nature of the Course: Theory **Full Marks: 75**
Pass Marks: 37.5

Course Objectives

The objectives of this course are to provide:

- Foundational understanding of the ecology of mountain environment and key ecological process and conservation,
- Critically evaluate the causes and biological consequences of the major types of global change as a result of human activities.
- Knowledge to manage invasive species within the context of theoretical and applied biology and ecology

Course Contents

Unit 1. Mountain Ecology **16 hrs**

1.1 Introduction to mountains: Mountain ranges, origin and evolution, distribution and characteristics.
1.2 Mountain ecology and environment with reference to the Himalaya
1.2.1 Climates: Influence of mountains on temperature and precipitation; clouds, mountain mass effects, seasonality, oxygen, atmospheric pressure, solar radiation and climate change
1.2.2 Mountain habitats/life zone: Habitat zonation, tree lines, alpine habitat
1.2.3 Mountain Biodiversity and its drivers, uniqueness and adaptation of the mountain biota, effects of topography, climate and elevation on biota
1.2.4 Disturbance and vulnerability of mountains: Landslide, floods earth quakes and human impacts
1.2.5 Prospects for future development in the Himalaya.
1.2.6 Mountain biogeography: Theory and practice; Examples from the Himalaya.

Unit 2. Climate Change **16 hrs**

2.1 Overview of climate system and climate change,
2.2 Greenhouse gases and climate forcing agents,
2.3 Observed and predicted scenario of climate change
2.4 Impacts of climate change on terrestrial and aquatic ecosystems; biodiversity and communities; diseases and biogeochemical cycles (water, nitrogen and carbon).

2.5 Climate change mitigation and adaptation: International initiatives, policy and strategy, mitigation measures, adaptations and preparedness.

Unit 3. Biological Invasion **16 hrs**

3.1 Introduction and overview of invasions, invasive and alien species,
3.2 Theories and hypothesis of biological invasion
3.3 Invasive alien species of Nepal
3.4 Process of invasion (transport, establishment, spread)
3.5 Invasions and global change
3.6 Characteristics of successful invaders
3.7 Community susceptibility / resistance to invasion
3.8 Impacts of Invasion
3.9 Mitigation & adaptation practices and policies
3.10 Management of invasive species:

Recommended Readings

Beall, C.M. 2007. Two routes to functional adaptation: Tibetan and Andean high-altitude natives. Proc. Natl. Acad. Sci. U.S.A. 104:8655–8660.

Ives, J. 2004. Himalayan perceptions: Environmental change and the well-being of mountain peoples. Himalayan Journal of Sciences 2:17–19.

Lockwood, J.L., Hoopes, M.F. and Marchetti, M.P. 2013. Invasion Ecology. Malden, MA: Blackwell Publishing. ISBN: 1405114189 (paperback), 304 pgs

Price, M.F., Byers, A.C., Friend, D.A., Kohler, T. and Price, L.W.eds. 2013. Mountain geography: Physical and human dimensions. Berkeley: Univ. of California Press. Berkeley, USA.

Thom, D and Seidl, R. 2016. Natural disturbance impacts on ecosystem services and biodiversity in temperate and boreal forests. Biol. Rev. 91:760–781.

Other Readings

Barber, N.A., Marquis, R..J. and Tori, W.P. 2008. Invasive prey impacts the abundance and distribution of native predators. Ecology 89(10): 2678-2683.

Bilham, R., Bodini, P. and Jackson, M. 1994 Entertaining a Great Earthquake in Western Nepal: Historic Inactivity and Geodetic Test for the Development of Strain. In: Journal of the Nepal Geologic Society, Volume 11, Special Issue.

Chalise, M.K. 2013. Mountain Ecology and Natural Hazards. Nepal Biodiversity Research Society, Lalitpur. p. 95+6.

DHM. 2001. Tsho Rolpa Glacier Lake Outburst Flood Risk Reduction Project. Kathmandu: Department of Hydrology and MeteorologyGurung, H. 2000. Mountains of Asia: a Regional Inventory. ICIMOD, Nepal.

Dixit, A.M. 2005. Experiences of Earthquake Risk Management in Nepal. In Disaster Management Achievements and Challenges. Kathmandu: NEC and Ehime University.

Ives, J.D. 2006. Himalayan Perceptions. HimAAS, Nepal.

Kindlmann, P. ed. 2012. Himalayan biodiversity in the changing world. Berlin: Springer.

Korner, C. and Spehn, E.M.2002. Mountain Biodiversity. The Parthenon Publishing Group, New York.

Körner, C. 2004. Mountain biodiversity, its causes and function. Ambio 13:11–17.

Körner, C., and Spehn, E.M. eds. 2002. Mountain biodiversity: A global assessment. London: Parthenon.

Körner, C., Ohsawa, M. and Spehn, E. 2005. Mountain systems. In Ecosystems and human well-being: Current state and trends. Findings of the conditions and trends working group of the Millennium Ecosystem Assessment. Edited by R. Hassan, R. Scholes, and N. Ash, 681–716. Washington, DC: Island Press.

Messerli, B. 2012. Global change and the world's mountains: Where are we coming from, and where are we going to? Mountain Research and Development 32:S55–S63.

Messerli, B., and Ives, J.D.eds. 1997. Mountains of the world: A global priority. New York: Parthenon.

Molau, U. 2004. Mountain biodiversity patterns at low and high latitudes. Ambio 13:24–28.

Peters, R.L. and Thomas E. Lovejoy. 1992. Global Warming and Biological Diversity. Yale University Press, USA.

Pradhan, B.K. 2007. Disaster Preparedness for Natural Hazards: Current Status in Nepal. ICIMOD, ISBN 9789291150304. P.96.

Preisser, E.L. and Elkinton, J.S. 2008. Exploitative competition between invasive herbivores benefits a native host plant. Ecology 89(10): 2671-2677.

Schickhoff, U. 2005. The upper timberline in the Himalayas, Hindu Kush and Karakorum: A review of geographical and ecological aspects. In Mountain ecosystems: Studies in treeline ecology. Edited by G. Broll and B. Keplin, 275–354. Berlin: Springer.

Sharma, C.K. 1990. Geology of Nepal Himalaya and Adjacent Countries. Kathmandu, Nepal.

Singh, S.P., Bassignana-Khadka, I., Karky, B.S. and Sharma, E. 2011. Climate change in the Hindu Kush-Himalayas: The state of current knowledge. Kathmandu, Nepal: ICIMOD.

Yunling, H. and Zhang, Y. 2005. Climate Change from 1960 to 2000 in the Lancang River Valley, China. Mountain Research and Development 25(4):341-348.

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M.Sc. Zoology
SEMESTER II
ECOLOGY & ENVIRONMENT

Course title: Principles of Ecology, and Mountain & Global Ecology **Credits: 2**
Course No.: Zoo 559 **Lecture hrs: 90**
Nature of the course: Practical **Full Marks: 50**
Pass Marks: 25

Course Objectives

To impart practical knowledge on topics of theory papers Zoo 557 and 558.

Course Contents

A set of hands-on exercises will be assigned to provide students with experience and field work in various aspects related to the principles of ecology and Mountain and Global Ecology. Concise written reports of each exercise need to be submitted the following week. The lists of practical exercises provided here are not limited but exercises can be designed by concern faculty based on the theory curriculum.

1. Construction of life tables
2. Construction of population growth model
3. Measuring population dispersion,
4. Measuring Inter specific association
5. Community Ordination
6. Species diversity, similarity, heterogeneity
7. Measurement of niche and resources preference
8. Measure the community structure in terrestrial ecosystem by frequency, density, abundance and IVI.
9. Study of species composition in terrestrial and aquatic ecosystems.
10. Measurement of primary productivity of a grassland and pond ecosystems.
11. Altitudinal biodiversity gradients in nearby areas.
12. Altitudinal variations in edaphic factors: Soil composition, soil profile, Soil moisture and permeability, acidity, alkalinity, humus contents and determination of carbon stock in soil
13. Review altitudinal distributional of fauna and prepare report
14. Using real secondary data (At least 20 years) from metrological stations.
    - Temperature variations- Daily, monthly, seasonal, annual; long-term periodic.
    - Local and regional trend of temperature change.
    - Analysis of Precipitation and humidity using secondary data.
15. Make an inventory of invasive plants and animals
16. Review of literature and assess the threats of climate change on the selected faunal group (eg small mammals, etc.)

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SEMESTER III
ECOLOGY & ENVIRONMENT

Course Title: Quantitative Ecology **Credits: 3**
Course No: Zoo 601 **Lecture hrs: 48**
Nature of the Course: Theory **Full Marks: 75**
Pass Marks: 37.5

Course Objectives

This course is designed to provide students with the:

- Concepts, principles, and methods used to address the basic and applied ecological questions.
- Conceptual and practical understanding of multivariate statistics in ecology and conservation.
- Theories and application of ecological models and modeling techniques to address basic and applied ecological questions.

Course Contents

Unit 1. Ecological Methods **16 hrs**

1.1 Sampling and Experimental Design

1.1.1 Sample Size Determination and Statistical Power
Significance of sample size and sampling efforts
Sample size for continuous variable, discrete Variables and Specialized Ecological variables
Statistical Power Analysis

1.1.2 Sample Design
Principles of sample design
Simple Random sampling: Steps and forms of random sampling
Stratified Random sampling: Parameter estimation, allocation of sample size, stratification, proportion and percentage
Adaptive Sampling: Adaptive cluster sampling and stratified adaptative cluster sampling
Systematic Sampling
Multistage Sampling
Sequential Sampling: Basic concept

1.1.3 Experimental Design
Principles of Experimental Design
Types of Experimental Design

Scientific Communications: Proposal, article and thesis writing, Plagiarism.

1.2 Estimating Abundance, relative abundance and occupancy

1.2.1 Estimating Abundance
Census and sampling,
Capture Mark Recapture (estimating in closed and open population dynamics),
Camera trapping: Use of camera traps, applications in density and abundance estimates, behaviour and activity patterns, shortfalls and future applications
Distance based method (line and point transect),

1.2.2. Estimation of relative abundance

1.2.3. Occupancy Estimation
Single species distribution
Extinction and colonization dynamics

Multispecies occupancy

1.2.4 Orientation on data analysis Program for population (examples Capture/Density/MARK/ SPCECAP) and occupancy estimation (Example Presence/MARK).

Unit 2. Applied Statistics for Ecological Data Analysis 16 hrs

3.1. Simple trend Analysis (correlation, regression) and for differences (Chi-square, t-tests, ANOVAs)

3.2 Multivariate Statistics

- Multivariate Data
  - Introduction and data screening
- Group Data
  - Cluster analysis
  - Discernment Analysis
- Gradient Analysis
  - Unconstrained ordination- Principal components analysis (PCA), Correspondence analysis (CA, DCA)
  - Constrained ordination- Redundancy analysis (RDA), Canonical correspondence analysis (CCA)

Unit 3. Ecological Modeling 16 hrs

1. Fundamentals of Ecological Modelling

- Nature of ecological model
- Need, scope and importance of model and modeling
- Role of Models in ecological Research
- Model types
- Principles of modeling
- Application of models

2. Model Building

- Model parameters
- Steps of modeling
- Validation, calibration, sensitivity analysis, errors and uncertainty in Model

3. Mathematical models in Ecology

- Introduction,
- Deterministic Models of Population dynamics
  - Discrete one and two- species models
  - Continuous one and two species models
- Probabilistic models for probabilistic events
  - Simulating discrete probabilistic models
- Species distribution model
- Spatial model: Habitat suitability model

Required Readings

Bibby, C.J., Burgess, N.D., Hill, D.A., and Mustoe, S.H. 1992. Bird Census Techniques. Academic Press, Amsterdam

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L. 2001. Introduction to distance dampling. Oxford University Press.

Caswell, H. 2001. Matrix population models. Second edition. Sinauer, Sunderland, MA.

Conroy, M.J. and Carroll, J. 2009. Quantitative Conservation of Vertebrates. Wiley-Blackwell Publishing. 337pp

Fowler, J., Cohen, L. and Jarvis, P. 1998. Practical Statistics for Field Biology. New York: John Wiley & Sons.

Freedman, D.A. 2009. Statistical models: theory and practice. Cambridge University Press, Cambridge.

Johnson, R.A. and Wichern, D.W. 2007. Applied multivariate statistical methods" 6th edition Prentice Hall. ISBN: 0130925535.

Jørgensen, S.E. and Fath, B.D. 2011. Fundamentals of ecological modelling: applications in environmental management and research. 4th ed. Elsevier.

Krebs, C.J. 1999. Ecological Methodology. Second Edition. Menlo Park, CA USA: Addison, Wesley, Longman, Inc. Zar, J. H. 1999. Biostatistical Analysis. Fourth Edition. Upper Saddle River, New Jersey, USA: Prentice-Hall Inc.

Krebs, C.J. 2009. Ecology, the experimental analysis of distribution and abundance, 6th edition. Cummings, Boston

Krebs, C.J. 2014. Ecological Methodology, 3rd ed. (in prep). Chapters revised to date (14 March 2014) are available to download for evaluation and review (PDF files):

Landi, R., Engen, S. and Saether, B. 2003. Stochastic population dynamics in Ecology and conservation. Oxford University Press.

McGarigal, K., Cushman, S.A. and Stafford, S. 2000. Multivariate Statistics for Wildlife and Ecology Research. Springer-Verlag, New York.

Nicholas, J. Gotell.2008. A Primer of Ecology, Sinauer Associates, Inc.

Smith, J. and Smith, P. 2000. Introduction to environmental modeling. Oxford University Press, Oxford. (Unit 1).

Southwood, T and Henderson, P.A. 2000. Ecological methods. 3rd ed. Oxford: Blackwell Science.

Sutherland, W.J. (Ed.). 2006. Ecological census techniques: a handbook. Cambridge, University Press Cambridge.

Wainwright, J. and Mullingan, M. 2013. Environmental modeling: finding simplicity in complexity. Wiley-Blackwell. (Unit 4)

Wesley, Longman, Inc. JH Zar. 1999. Biostatistical Analysis. Fourth Edition. Upper Saddle River, New Jersey, USA: Prentice-Hall Inc

Zill, D.G. 2013. A first course in differential equations with 35odeling application. 10th ed. Brook/Cole, Cengage Learning, USA.

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Tribhuvan University
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M.Sc. Zoology
SEMESTER III
ECOLOGY & ENVIRONMENT

Course Title: Conservation Biology **Credits: 3**
Course No: Zoo 602 **Lecture hrs: 48**
Nature of the Course: Theory **Full Marks: 75**
Pass Marks: 37.5

Course Objectives

This course is designed to provide students with the:

- Foundational knowledge on science of conservation biology,
- Major theoretical and empirical approaches and strategies in conservation biology,
- Theories and practices of wildlife conservation.

Course Contents

Unit 1 Biodiversity Pattern and Process **16 hrs**

1 Introduction to Conservation Biology: Foundation, scope and fields, principles
2 Overview of biodiversity: Theories of speciation and types of diversity,
3 Global Biodiversity patterns and processes
   - Patterns in space (latitudinal and altitudinal gradients, biodiversity hotspots, ecoregion) and time (succesional and evolutionary pattern), Patterns of endemism
   - Factors/theories regulating biodiversity patterns: Island biogeography, spatial heterogeneity, competition, predation, climate variability, energy model hypothesis, productivity, disturbance
4 Threats to Biodiversity:
   - Threats, causes and threatening process
   - Threatened species: IUCN Red List Category and Assessment procedures
5 Biodiversity endangerment and extinction:
   - Causes and patterns of current losses,
   - Extinction crisis, characteristics of extinction prone species
   - Mass extinction
6 Measuring biodiversity: Mapping, inventorying, monitoring and measuring methods
7 Conservation values and Ethics
8. Genetic analysis of populations: Single population (genetic diversity, factors influencing genetic diversity, Population bottlenecks, founder effects, natural selection) and multiple population (population subdivision- genetic distance and F-statistics; gene flow-quantification, factors affecting gene flow; population differentiation)

Unit 2 Conservation Approaches and Strategies **16 hrs**

2.1 Conservation policy and legislation: International convention: RAMSAR, UNESCO's WH Convention, CITES, CMS, CBD (WCS), National legislation, policy and strategies.
2.2 Ex-situ and in-situ conservation: IUCN criteria and categories of PA system, Theories on PA designs, PA of Nepal, Ex-situ practices
2.3 Population Approach:

- Conservation biology of small populations: Minimum viable population, Population viability,
- Conservation genetics: loss of genetic variation, Effective population size, demographic and environmental stochasticity, Extinction vertex.
- Small population approach and declining population approach,
- Meta-population: concepts, Levin's model and development of theory, meta-population structure and dynamics
- Optimal harvesting and population management,

2.4 Establishing new population: translocation, reintroduction, population bottle neck and founder effect

2.5 Species Approach: Single Species and Multi-species approach, Species Action Plan

2.6 Ecosystem Approach

2.7 Landscape Approach

2.8 Ecoregion Approach

2.9 Priority Conservation sites

Unit 3 Wildlife Conservation **16 hrs**

3.1 Population dynamics, ecology, ecological role and Behaviour of tiger, wolf, elephants, assumes macaque, crocodile. etc.

3.2 Food and Nutrition

- Foraging theory
- Diet analysis techniques of carnivore and herbivores

3.3. Habitat

- Habitat components
- Habitat Evaluation and Habitat Suitability Index
- Habitat Improvement

3.4 Wildlife behavior

- Forage selection
- Habitat selection theories and measures
- Social organization and mate choice
- Communications.

3.5 Wildlife Management

- Principles of Wildlife Management
- Management tools and techniques
- Habitat Management,
- Law enforcement

3.6 Capture, immobilization and transportation of wildlife: Ethics, standards and protocol

Recommended Readings

Bolen, E.G. and Robinson, W.L. 2003. Wildlife ecology and management. 5th ed. Prentice Hall. New Jersey.

Braun, C. E. 2003. Techniques for wildlife investigations and management. The Wildlife Society, USA.

Braun, C.E. and Robioson, W.L. 2003. Wildlife ecology and management. Prentice- Hall, Upper Saddle River, New Jersey.

Groom, M.J., Meffe G.F., and Carroll, C.R. 2006. Principles of conservation biology. Sinauer Associates, Inc, Sunderland, MA, USA.

Koh, L.P., Dunn, P.R., Sodhi, N.S., Colwell, R.K., Proctor, H.C. and Smith, V.S. 2004. Species co extinctions and the biodiversity crisis. Science, 305 (5690), 1632-1634.

Morris, W.F. and Doak, D.F. 2002. Quantitative Conservation Biology: Theory and practice of Population Viability Analysis. W. H. Freeman Publishers.

Nova, J.S. (Ed). 2012. The wildlife techniques manual (Volume 1: Research and Volume 2: Management). 7th ed. Johns Hopkins University Press, Baltimore, Maryland, USA.

Primack, R. 2014. Essentials of Conservation Biology (Sixth Edition). Sinauer Associates, Inc., USA

Primack, R.B. 2010. Essentials of conservation biology. 5th ed. Sinauer Associates.

Primack, R.B., Poudel, P.K. and Bhattarai, B.P. 2013. Conservation biology: a primer for Nepal. Dreamland Publication, Kathmandu.

Sinclair, A.R.E., Fryxell, J.M. and Caughly, G. 2006. Wildlife ecology, conservation and management. 2nd ed. Blackwell Publishing, USA.

Sodhi, N.S. and Ehrlich, P.R. 2010. Conservation biology for all. Oxford University Press, New York. http://www.mongabay.com/conservation-biology-for-all.html.

Sodhi, N.S. and Ehrlich, P.R. 2010. Conservation biology for all. Oxford University Press, London, United Kingdom.

Thompson, W.L. (Ed.). 2004. Sampling rare or elusive species: concepts, designs, and techniques for estimating population parameters. Island Press.

Van Dyke, F. 2008. Conservation Biology Foundations, Concepts, Applications 2nd Edition, Springer.

Williams, BK, JD Nichols and MJ Conroy. 2001. Analysis and management of animal populations. Academic Press.

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Tribhuvan University
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M.Sc. Zoology
SEMESTER III
ECOLOGY & ENVIRONMENT

Course Title: Landscape and Spatial Ecology **Credits: 3**
Course No: Zoo 603 **Lecture hrs: 48**
Nature of the Course: Theory **Full Marks: 75**
Pass Marks: 37.5

Course Objectives

This module is designed to provide students with:

- Fundamental knowledge on the principles of landscape ecology as a framework for landscape research, analysis and management.
- Theoretical knowledge and practical skills in Remote Sensing to meet ecological needs.
- Theoretical understanding and practical skills in the Geographical Information System (GIS) to data integration, analyses and production of the map to meet ecological needs.

Course Contents

Unit 1. Landscape Ecology: Introduction of landscape ecology **16 hrs**

1. Fundamentals of Landscape Ecology: Introduction, history, scope, scales and hierarchy
2. Landscape Structure: Characteristics, concept of Patch, metrics and corridor
3. Landscape Pattern and Process: causes of landscape patterns, abiotic, biotic and anthropogenic causes
4. Landscape Dynamics and drivers of landscape change
5. Implication of landscape structures
6. Landscape management

Software orientation: Patch analyst, Fragstat

Unit 2 Remote Sensing application in Ecology **16 hrs**

2.1 Fundamentals of Remote Sensing

- Introduction and history
- Electromagnetic radiation (EMR) and spectrum,
- EMR interactions with atmosphere and earth surface features
- Spectral signatures and **s**pectral characteristics of soils, snow, ice, and water
- Types of remote sensing

2. 2 Satellites and Sensors:

- Satellites, Sensors, Platforms, and Orbital characteristics
- Types of remote sensing: Thermal and microwave remote sensing, Hyper-spectral remote sensing

2.3. Digital Image and Image Processing

2.3.1. Digital Image

- Characteristics of image,
- Image resolution (Spectral, radiometric, spatial and temporal),

2.3.1. Digital Image Processing

- Pre-processing, corrections and Orthorectification
- Image Enhancement
- Color composites and Visual image interpretation
- Image classification

- Image indices

2.4. Application of Remote Sensing in Ecology: Case Studies presentation.

(Software use: ERDAS Imagine, ILWIS, etc)

Unit 3. Global Positioning Systems (GPS): Concept, History, GPS systems, Sources of Errors, Differential GPS, Application of GPS

Unit 4. Geographic Information System (GIS) 16 hrs

1.1 Geographic Information System: Overview, history, basic concepts and components
1.2 Projections and Coordinate systems
1.3 GIS data: Sources, models of data, Relational data bases and file formats
1.4 Spatial analysis: Vector models, Raster models, proximity and overlay analysis
1.5 Digital elevation model (DEM): Concepts and application
1.6 Map: different types of maps, map design and production
1.7 Integration of GIS, GPS and Remote Sensing
3.8 Application of Geographic Information Systems in Ecological studies.
(Software use: ARC GIS, Arcview, Q GIS. etc.)

Recommended Readings

Keane, R. et al. 2015**.** Representing climate, disturbance, and vegetation interactions in landscape models. Ecological Modelling 309–310: 33–47

Fischer, J. and Lindenmayer, D. 2007. Landscape modification and habitat fragmentation: a synthesis. Global Ecology and Biogeography. DOI: 10.1111/j.1466-8238.2007.00287.x

Janssen, Lucas L.F. and Huurneman, G.C. 2001. Principle of Remote Sensing. ITC Educational Text Book series 2. International Institute of Geoinformation Science and Earth Observation (ITC). Enschede.

Jensen, J.R. 2004. Introductory Digital Image Processing: A Remote Sensing Perspective. Prentice Hall.

Jensen, J.R. 2009. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Dorling Kindersley.

George, J. 2005. Fundamentals of Remote Sensing, 2nd Edition. University Press India.

Lillisand, T., Kiefer, R.W., and Chipman, J. 2007. Remote Sensing and Image Interpretation. Wiley India. 18

Lindenmayer et al. 2008. A checklist for ecological management of landscapes for conservation. Ecology Letters 11:78-91.

Lo, C.P., and Yeung, A.K.W. 2009. Concepts and Techniques of Geographic Information Systems, 2nd Edition. PHI Learning.

Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W. 2005. Geographic Information System and Science, 2nd Edition. John Wiley and Sons.

McGarigal, K. Introduction to landscape ecology. Duke University misc. report.

Sabins, F.F. 2007. Remote Sensing: Principle and Interpretation. Waveland Press.

Turner, MG. 2006. Landscape Ecology: What is the state of the science? Ann. Rev. Ecol. Evol. Syst. 2005. 36:319–44.

Turner, M.G. and Gardner, R.H. 2015. Landscape Ecology in Theory and Practice, 2nd edition. Springer, New York.

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Tribhuvan University
Institute of Science and Technology
M.Sc. Zoology
SEMESTER III
ECOLOGY & ENVIRONMENT

Course Title: Ecosystem Assessment and Management **Credits: 3**
Course No: Zoo 604 **Lecture hrs: 48**
Nature of the Course: Theory **Full Marks: 75**
Pass Marks: 37.5

Course Objectives

This module is designed to provide students with:

- Basic theory and practical approaches needed to conduct EIA
- Principles and approaches of ecosystem management
- Fundamental knowledge on wetland ecology and management practices

Course Contents

Unit 1. Environmental Impact Assessment (EIA) **16 hrs**

1. Introduction: Concept of EIA, IEE, SIA, and objectives
    a. History- Evolution/development from national and international perspective
    b. Policies: policies and legislations of Nepal, environmental standards (species protection list, emission standard, water quality, etc.)
2. Steps of EIA: EIA and the project cycle, EIA Report Format
3. Environmental Screening and initial environmental examination
4. Scoping, scoping methods, and Terms of Reference
5. Baseline data: Sources and methods of data collection and processing
6. Identification of environmental impacts
    a. Types of impacts
    b. Methods of impact identification (existing environmental conditions, altered conditions, Alternative Analysis
    c. impact prediction and impact ranking)
7. Impact Mitigating measures and Enhancement measures
8. Environmental Management Plan
    a. Environmental Monitoring - types, principles, process and timing
    b. Environmental Auditing - types, principles, process and timing
9. Preparing Environmental Report following EIA report format

Unit 2. Ecosystem Management **8 hrs**

- Ecosystem Services and values,
- Ecosystem Concepts in Management
    - Natural Variability
    - Resilience and Stability
    - State Factors and Interactive Controls
- Principles of ecosystem management
- Management process, integrated ecosystem management, Ecosystem resilience and key elements, Watershed management,
- Application of Ecosystem Knowledge in Management
    - Ecosystem Restoration

- Forest management
- Grassland management

- Approaches to Ecosystem Management

Unit 3. Wetland Ecology and Management 8 hrs

1. Introduction to Wetlands: Classification, values: functions and services: Biodiversity, Flows of water and nutrients, riparian vegetation, land water ecotone
2. Wetland Environment: Wetland Hydrology, soils, flora, fauna, ecosystem development, zonation, stratification, Land water ecotone,
3. Threats to wetlands: Climate change, Invasive species, anthropogenic threats, sedimentation, eutrophication
4. Wetland Management:
   - Concept of integrated river Basin Management
   - Restoration of wetlands
   - RAMSAR Convention and its implication in Nepal
   - Wetland management in Nepal: Characteristics, status and distribution of wetlands in Nepal (with focus on Ramsar sites and recent initiatives).

Unit 4. Ethnobiology 16 hrs

1. Ethnobilogy history and inventories. Concept, history and inventories,
2. Sub-discipline of ethnobiology: Ethnozoology, Ethnobotany, Ethnoecology
3. Medicoethnobiology: Medicoethnozoology and Medicoethnobotany
4. Extensive study of Principles of ethnobiology
5. Code of ethics and guidelines for ethnobiological research
6. Status and field of ethnobiology in Nepal and in the world
7. Field and Laboratory Methods of ethnobiology: Ethnobiological research and methods
8. Ethnobiology and Biodiversity conservation: Ethnobiollogy and biological, cultural and linguistic diversity conservation. Traditional practices and Beliefs in preservation of cultural and biological diversity, Cultural identity and resource use
9. Ethnobiology and Indigenous knowledge systems: Different forms of Indigenous knowledge systems practiced by indigenous ethnic groups, Indigenous people and their knowledge in rural development and resource management
10. Ethnomedicine: Various forms of medical practices by indigenous people to treat diseases. Integrated medicine. Role of indigenous ethnic people to develop drugs
11. Indigenous health: Ethno-food, nutrition and traditional farming systems, Evolution, Adaptation, and the Origins of Diet and Medicine
12. Evolution, Folk taxonomy (systematic) and Ethnoecology
13. Ethnobiological landscape and global trends
14. Ethnobiology and biocomplexity
15. Database systems of ethnobiology
16. Innovation in Ethnobiology: Innovations in ethnobiological research, Ethnopharmacology, Local knowledge, and IPR, Collective intellectual property rights Vs. Private property rights. Policy issues and community rights
17. Applications of ethnobiology
18. Ethnobiology for human welfare

Recommended Readings

Carter, L. 1996. Environmental Impact Assessment, McGraw Hill, New Delhi.

Chapin, F.S. III, Matson, P.A. and Mooney, H.A. 2002. Principles of Terrestrial Ecosystem Ecology. Springer Science & Business Media

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Charles, H. Eccleston. 2011. Environmental Impact Assessment, CRC Press, New York.

Clewell, A.F. and Aronson, J. 2007. *Ecological Restoration: Principles, Values, and Structure of an Emerging Profession*. Island Press, ISBN: 978-1597261692.

Falk, D.A., Palmer, M.A. and Zedler, J.B. (eds.). 2006. *Foundations of Restoration Ecology*. Island Press, ISBN: 1-59726-017-7

Glasson, J., Therivel, R. and Chadwick, A. 2012. Introduction to Environmental Impact Assessment, 4th edition, Routledge, London.

Holder, J. and McGillivray, D. (eds.). 2007. Taking Stock of Environmental Assessment law, policy and practice, Routledge, London.

Keddy, P.A. 2010. Wetland Ecology: Principles and Conservation. Cambridge Studies in Ecology, Cambridge University Press, New York, NY, second edition.

Lawrence, D.P. 2003. Environmental Impact Assessment: practical solutions to recurrent problems, Wiley-Interscience, New York.

Lee, N. and George, C. (eds.). 2000. Environmental Assessment in Developing and Transitional Countries, Wiley, Chichester.

Morris, P. and Therivel, R. 2001. Methods of Environmental Impact Assessment, Spoon Press.

Morris, P. and Therivel, R. (eds.). 2009. Methods of Environmental Impact Assessment, 3rd edition, Routledge, London.

Noble, B. 2006. Introduction to Environmental Impact Assessment: a guide to principles and practice, OUP, Oxford.

Wood, C. 2003. Environmental Impact Assessment: A Comparative Review, 2nd edition, Longman, Harlow.

Gary, J.M. 1996. Ethnobotany: A Methods Manual. Chapman and Hall, University press, Cambridge, UK

Jain, S.K.1994: Ethnobiology in Human Welfare. Proceedings of IV International Congress of Ethnobiology held at Lucknow, Inida, during 17-21 Novermber). Deep Publications, A-3/27 A. D.D.A. Plats, Paschim Vihar, New Delhi 110063, India.

Kabuye, C. 1996. Ethnobiology and Convervation of Cultural and Biologial Diversity. Proceedings of Fifth International Congress of Ethnobiology held at Nairobi, Kenya, , during 2-6 September).

Singh,N.B. 1997: Ethnobiology and Biodiverstiy. Published by Global Research Carrel for Ethnobiology (GLORECA, "EThNOBIOLOGY"), Kathmandu, Nepal.

Anderson, E.N., Pearsall, D., Hunn, E. and Turner, N. (editors). 2012. Ethnobiology, Wiley-Blackwell. ISBN 978-0-470-54785-4

Tribhuvan University
Institute of Science and Technology
M.Sc. Zoology
SEMESTER III
ECOLOGY & ENVIRONMENT

Course title: Quantitative Ecology and Conservation Biology **Credits: 2**
Course No.: Zoo 605 **Lecture hrs: 90**
Nature of the course: Practical **Full Marks: 50**
Pass Marks: 25

Course Objectives

To impart practical knowledge on topics of theory papers Zoo 601& 602.

Course Contents

A set of hands-on exercises will be assigned to provide students with experience in various aspects of quantitative ecology and conservation biology. Concise written reports of each exercise need to be submitted the following week. The Lab component involves "hands-on" use of an analytical software packages (eg. Capture/MARK/SPACECAP, Presence/MARK and R). ERDAS, ArcGIS. The lists of practical exercises provided here are not limited but exercises can be designed by concern faculty based on the theory curriculum.

Ecological methods in terrestrial and aquatic environment:

1. Sampling design
2. Determination of sample size and efforts (eg Transect, quadrats, etc.)
3. Estimation of abundance: Censes, sampling, Capture- Mark- recapture, Distance sampling
4. Occupancy estimation (single species- single season)
5. Use of data analysis program for population (examples; Capture/Density/MARK/ SPCECAP) and occupancy estimation (Example Presence/MARK) with primary and secondary data.
6. Use of statistics in trend analysis
7. Cluster analysis
8. Review of literatures on the thematic areas of ecological model and modeling techniques (Population model, species distribution model, etc.)
9. Population dynamics of single and interacting species using discrete and continuous data.
10. Measuring biodiversity
11. Population viability analysis
12. Threat assessment of species using IUCN criteria
13. Gap analysis of protected areas of Nepal for the selected species
14. Diet analysis, Habitat evaluation and Behavior observation
15. Literature review on the wildlife darting and translocation

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Tribhuvan University
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M.Sc. Zoology
SEMESTER III
ECOLOGY & ENVIRONMENT

Course title: Landscape & Spatial Ecology, and Ecosystem Management **Credits: 2**
Course No.: Zoo 606 **Lecture hrs: 90**
Nature of the course: Practical **Full Marks: 50**
Pass Marks: 25

Course Objective

To impart practical knowledge on topics of theory papers Zoo 603 & 604.

Course Contents

A set of hands-on exercises will be assigned to provide students with experience in various aspects of landscape ecology, remote sensing and GIS. Concise written reports of each exercise need to be submitted the following week. The lists of practical exercises provided here are not limited but exercises can be designed by concern faculty based on the theory curriculum. The Lab component involves "hands-on" use of an analytical software package, ERDAS, ArcGIS and Fragstats. Each student will also be required to apply and integrate various GIS operations on their course project involving spatial analysis, requiring some time outside of class hours.

1. Exploration and orientation of Software: ERDAS Imagine, ARC GIS, Patch analyst, Fragstat, etc.
2. Digital Image Classification: Supervised, Unsupervised
3. Display of digital image: Single band and multiple band images and digital numbers.
4. Image enhancement: Contrast enhancement, linear stretching, histogram equalization, etc.
5. Geo-referencing of digital images. Rationing and Normalised Rationing and NDVI analysis.
6. Image classification –Supervised classification and unsupervised classification.
7. Acquisition of Google Earth images for land use/ land cover mapping.
8. Image subletting and mosaicing
9. GPS field data collection and import to computer / software
10. Data visualization: Intro to GIS: viewing and analyzing spatial data (Arc GIS),
11. Analyzing and displaying spatial data (Arc GIS)
12. Modeling: Spatial data collecting and model building (Arc GIS Model Builder)
10. Landscape analysis: Analyzing habitat-species relationships, Quantifying spatial pattern (ARC GIS, FRAGSTATS
11. Landscape analysis: Suitability Analysis (ARC GIS), Analyzing connectivity (ARC GIS), Patch metrics, etc.
12. Case study on the values and services of ecosystems
13. Field visit and report preparation on the ecosystem management
13. Assessment of physic- chemical parameters of wetland
14. Biodiversity assessment of wetland ecosystem
15. Review EIA reports
16. Prepare EIA report on the infrastructure development project
17. Taking a particular ethnic group, students can make an extensive report on the use of various animals and plants for their livelihood.
18. Making a research report on the use of various medicinal animals and plants for the treatment of different diseases.
19. Exploring different forms of indigenous knowledge systems practiced by ethnic groups.
20. Carrying a research related to the impact of climate change on the ethnic groups in general.
21. Making a report based on an indigenous technology useful for socio-economic condition of indigenous ethnic groups.