

# **PONDICHERRY UNIVERSITY**

**DEPARTMENT OF ECOLOGY & ENVIRONMENTAL SCIENCES**



**M.Sc. ECOLOGY & ENVIRONMENTAL SCIENCES**

## **Syllabus**

## **ANNEXURE - I**

### Curriculum of Compulsory [Hard-Core] Courses for the M.Sc. (Ecology & Environmental Sciences) Programme

<b>COURSE Code</b>	<b>Title of the Course</b>	<b>Credits</b>
<b>Semester I</b>		
ECOL 401	Introduction to Ecology & Environment Sciences	3
ECOL 402	Statistics for Ecology & Environmental Sciences	3
ECOL 403	Introduction to Population & Community Ecology <sup>b</sup>	3
ECOL 404	Terrestrial Ecology	3
ECOL 405	Aquatic Ecology	3
<b>Semester II</b>		
ECOL 411	Environmental Analysis	3
ECOL 412	Environmental Toxicology and Health <sup>b</sup>	3
ECOL 413	Plant Ecology <sup>a</sup>	3
ECOL 414	Animal Ecology <sup>a</sup>	3
<b>Semester III</b>		
ECOL 501	Conservation Biology	3
ECOL 502	Remote Sensing and GIS	3
ECOL 503	Industrial Ecology	3
ECOL 504	Global Environmental Changes	3
ECOL 505	Environmental Management	3
<b>Semester IV</b>		
ECOL 597	Project Seminar	1
ECOL 598	Project Methodology	3
ECOL 599	Dissertation Project	5

**NOTE:**

- a. Course Added; syllabus to be prepared by the Chair
- b. Course Modified; syllabus of the existing course to be modified by teacher concerned

# **SEMESTER - I**

## **HARD CORE COURSES**

### **INTRODUCTION TO ECOLOGY AND ENVIRONMENTAL SCIENCES**

**ECOL: 401**

**CREDITS: 3**

**UNIT-I** Introduction to Ecology & environmental sciences; Flow of energy and cycling of materials; water, carbon, nitrogen and phosphorus. Trophic pyramids and food webs; Alterations of ecosystem function: acid rain, nuclear winter, global warming and ozone hole. **(8 Hours)**

**UNIT-II** Diversity of life; origin of life on earth; Evolution of early life and changes in earth's atmosphere. Mendelian genetics – and Darwin Wallace theory of inheritance. Five kingdoms overview; Monera, Protists, Fungi, plant and animal kingdoms. **(8 Hours)**

**UNIT-III** Populations and communities; Birth, death and population size, age structure; Trends in human population growth; Malthusian growth. Intraspecific interactions and density dependence. Interspecific interactions; Commensalism, mutualism, competition and predation. Species diversity, community stability and disturbance. **(8 Hours)**

**UNIT-IV** Aquatic and terrestrial communities; rare communities; deep earth, deep sea floor, volcanoes. Primary productivity; basic concepts. Ecological succession inland, water; concepts. Invasive species and control. **(8 Hours)**

**UNIT-V** Practical and Field Experiments using standard methods; Estimation of density and relative abundance of species using quadrats and plotless methods. Estimation of species diversity: introduction to indices. Estimation of primary productivity. Ecological adaptations of the Plant and animal species in the hydrophytes, mesophytes and xerophytes. **(8 Hours)**

**References:**

**Text books:**

1. Chapman, J.L. & M.J. Reiss. 1998. Ecology: Principles and Applications. Cambridge Univ. press. 2<sup>nd</sup> edition. 336 pgs.
2. Krebs, C.J. 2008. Ecology: The experimental Analysis of Distribution and Abundance (6<sup>th</sup> Edition), Benjamin Cummings Publ. 688pgs.
3. Miller. G.T. 2004. Environmental Science. Thomson, California. 538 pgs.
4. Singh, J.S., Singh, S.P & Gupta, S.R. 2006. Ecology, Environment and Resource conservation. Anamaya Publ., New Delhi, 688 pp.

# STATISTICS FOR ECOLOGY & ENVIRONMENTAL SCIENCES

ECOL: 402

CREDITS: 3

**UNIT-I** Fundamentals of Biostatistics; sampling, Data collection and recording, central tendency- concept; arithmetic mean, mode, median for ungrouped and grouped data. Probability Rules and Theoretical Distributions: Basic probability rules, expectation, conditional probability; Probability distributions – Binomial, Poisson, Normal and Log-normal distributions; Fitting of probability distributions to environmental data. **(8 Hours)**

**UNIT-II** Sample survey: Need and Purpose of sampling, Sampling with and without replacement, Population and sample, Population parameters; Environmental sampling design - Methods for selecting sampling locations and times; Different techniques of sampling – simple random sampling, stratified random sampling, systematic sampling, two stage sampling, compositing and three-stage sampling; Relative advantages and disadvantages of different techniques. **(8 Hours)**

**UNIT-III** Sampling distribution and Test of Significance: Parameter and statistics; Sampling distribution, Standard error and its uses; Concept of t- distribution, F-distributions, Chi Square distribution without derivation and their applications; Null hypothesis and uses of t- test, F-test,  $\chi^2$ -tests; Test of significance of large samples. Correlation and Regression: Bi-variate data and scatter diagram; Simple (linear) correlation and regression; Coefficient of correlation and regression and their properties; Fitting of regression line; Multiple and partial correlations and regressions. **(8 Hours)**

**UNIT IV** Analysis of Variance: Different types of models used in AOV; Basic assumptions and its violation; One and two way classified data; Application of AOV to environmental data. Distribution- Normal, t and chi square test; Difference among means: f-test: 1 way ANOVA. Computer applications in environmental modeling. Computer based modeling for population and population studies. **(8 Hours)**

**UNIT-V** Multivariate analysis , hypothesis testing Model fitting; Biometry – principles and concepts; Matrices, simultaneous linear equations; tests of hypothesis and significance, time series analysis- moving averages (3 and 5 unit cycles); current development in the subject. **(8 Hours)**

## References:

1. Zar, Jerrold H. (1998). Biostatistical Analysis. Prentice Hall, N.J.
2. Walpole, R. and R. Myres (1993). Statistics for Engineers and scientists, 5<sup>th</sup> edn. Mac Millan, N.Y.
3. Wayne, R. Ott (1995). Environmental Statistics and Data analysis, CRC Press.
4. Manly (2001) statistics for environmental science and management, chapman and Hall/CRC

# INTRODUCTION TO POPULATION AND COMMUNITY ECOLOGY

**ECOL: 403**

**CREDITS: 3**

**UNIT-I** Introduction to population ecology, A review of terms and concepts, attributes of populations, introduction to Mendelian and population genetics, Hardy Weinberg's law, genetic drift, gene flow. **(8 Hours)**

**UNIT-II** Demographic parameters - Mortality, fecundity and age structure. Life tables – cohorts and static. Population growth: exponential and logistic. Population regulation. Capture - Recapture sampling (closed populations & open populations) demography. Single species populations: intra-specific competition, density dependence. **(8 Hours)**

**UNIT-III** Community Ecology - Intra-specific competition: Competition exclusion principle and Hutchinson's rule, Gause's theory of niche, coexistence patterns of competing species. Galapagos finches as a demonstration of inter-specific competition. Predator-prey interactions: Functional responses of predator to prey. Lotka-Volterra model, co-evolution of prey-predator interactions – Red Queen hypothesis. **(8 Hours)**

**UNIT-IV** Host-parasite interactions, Life history strategies – r and k selection. Meta population dynamics: Types of Meta populations - Levins Meta population, Mainland-island Meta population, Population fragmentation, Population viability analysis: deterministic and stochastic models. **(8 Hours)**

**UNIT-V** Population estimation methods- Life tables, fecundity and survivorship schedules (pre and post breeding census, field exercise in plant demography, density estimations: field and computer simulation. **(8 Hours)**

## **References:**

1. Begon M, Mortimer M, Thompson DJ (1996) Population Ecology: A Unified Study of Animals and Plants, 3rd Edition. Wiley-Blackwell. ISBN: 978-0-632-03478-9.
2. Hamilton MB (2009) Population Genetics. John Wiley & Sons Ltd, UK.
3. John H. Vandermeer Deborah E. Goldberg (2013) Population Ecology: First Principles (Second Edition). Princeton University Press, ISBN: 978-0691160313.
4. Putnam R (2010) Community ecology. Springer Publications. ISBN: 978-9048140114.
5. Ranta E, Lundberg P, Kaitala V (2006) Ecology of populations. Cambridge University Press.
6. Rockwood LL (2006) Introduction to Population Ecology. Blackwell publishing ISBN: 978-1-4051-3263-3.
7. Sudarshan KN, Trivedi KR (2011) Population and Community Ecology. Neha Publishers & Distributors. ISBN: 978-8171692804.

1. Gillespie A (2012) Conservation, Biodiversity and International Law. Edward Elgar Publishing ISBN: 9780857935151.
2. Janet Franklin (2010) Mapping Species Distributions: Spatial Inference and Prediction (Ecology, Biodiversity and Conservation). Cambridge University Press. ISBN: 978-0521700023.
3. Julie L. Lockwood, Martha F. Hooper and Michael P. Marchetti (2013) Invasion ecology (2nd edition) Wiley-Blackwell, Chichester. ISBN 978-1-4443-3364-0.
4. Krishnamurthy KV (2003) An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.
5. Singh JS, Singh SP and Gupta SR (2014) Ecology, Environmental Science and Conservation. 4<sup>th</sup> Edition. S. Chand & Company Pvt. Ltd.

#### **6. Web References**

7. [www.cites.org](http://www.cites.org); [www.fao.org/Ag/agp/agpc/doc/Publicat/TAPAFON/TAP\\_7.pdf](http://www.fao.org/Ag/agp/agpc/doc/Publicat/TAPAFON/TAP_7.pdf);  
[www.iucn.org](http://www.iucn.org); [www.wri.org/biodiv/bp-home.html](http://www.wri.org/biodiv/bp-home.html);  
[www.jamaicachm.org.jm/DHS/conservation.htm](http://www.jamaicachm.org.jm/DHS/conservation.htm); [www.cbd.int](http://www.cbd.int)

# TERRESTRIAL ECOLOGY

**ECOL: 404**

**CREDITS: 3**

**UNIT-I** Climate and distribution of terrestrial ecosystems; Distribution, climate, soil, biota, community structure and functioning, current status and conservation of following biomes: Sand dune ecosystem: formation, soil and community structure, zonation in sand dunes and functioning. **(8 Hours)**

**UNIT-II** Tropical scrubs and thorn forests – distribution, species composition, structure and functioning, land use change for plantations Tropical dry evergreen forests: Distribution, forest structure, composition, component interactions, human impacts and conservation. **(8 Hours)**

**UNIT-III** Desert ecosystem: distribution - type, climate, soil, vegetation, animals of arid zones and adaptation of various biota; human interaction. Savanna woodlands: types of savannas and their distribution; structural and functional characteristics, soils, seasonality; productivity; phenodynamics; phytomass use by animals; Deciduous forests and scrubs: distribution, seasonality, vegetation; resource use by animals. **(8 Hours)**

**UNIT-IV** Tropical rainforests: distribution, climate; stratification, floral-faunal interactions; tropical deforestation; Tundra: Tundra zone; climate and day length; soils and the process of cryoturbation, seasonality in tundra vegetation and faunal resource utilization; Taigas: distribution, climate, vegetation; serotiny; leaf litter accumulation and nutrient pools, fauna. **(8 Hours)**

**UNIT-V** Temperate broad leaved deciduous forests- distribution, species composition and seasonal changes Temperate grasslands- distribution, species composition and functional aspects; Temperate broad-leaved Sclerophyll and rainforests: Why sclerophylly? Similarities of tropical and temperate rainforests. **(8 Hours)**

## **References:**

### **Text Books:**

1. Miller.G.T., Jr. 2004. Environmental Science. Thomson, California.
2. Archibold, O.W. 1995. Ecology of World Vegetation. Chapman & Hall, London.
3. Whitmore, T.C. 1990. Introduction to Tropical rainforests. Clarendon, Amsterdam.

### **Supplementary books**

1. Singh, J.S., Singh, S.P. & Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand & Company Pvt. Ltd., New Delhi. 929p.
2. Friday, A & D.S. Ingram (Gen. Eds.) 1985. The Cambridge Encyclopedia of Life Sciences, Cambridge Univ. Press, Cambridge.
3. Ecosystems of the World Series - Nos. 1,2,3,4,5,6,7,8,12,13, & 14 Elsevier, Amsterdam.

**One day/ week-end field trip to study any three tropical ecosystems.**

# AQUATIC ECOLOGY

**ECOL: 405**

**CREDIT: 3**

**UNIT-I** Introduction to – hydrosphere – hydrocycle- aquatic systems-subdivisions – Freshwater - Wetlands - Estuarine and marine ecosystems. **(8 Hours)**

**UNIT-II** Freshwater ecosystem – lentic water bodies –Pond - lakes –types based on thermal stratification – based on origin–lotic water bodies –major Indian rivers –status of physico-chemical parameters – biotic communities. **(8 Hours)**

**UNIT-III** Wetlands – fauna and flora and ecological characteristics - perspectives-brackish water and marine ecosystems – divisions – characteristics – abiotic parameters– distribution of biotic communities-major sources and types of pollutants. **(8 Hours)**

**UNIT-IV** Ecological adaptations of aquatic fauna and flora - kinds of adaptations – primary and secondary aquatic adaptations- freshwater –estuarine -pelagic –inter tidal and deep sea. **(8 Hours)**

**UNIT-V** Aquatic system study – measurement of water temperature-light transmission in the water column -water transparency - dissolved oxygen-Collection and identification of hydrophytes-wetland plants-report writing. **(8 Hours)**

## **References:**

### **Text Books**

1. Mills, D.H. (1972) An introduction to freshwater Ecology. Liver & Boyd, Edinburg
2. Coker, R.E. (1954) Streams, Lakes & Ponds. University of North Carolina Press, chapel Hills, USA
3. Das, S.M. (1989) Hand book on Limnology & Water pollution. South Asian Publishers, New Delhi
4. Verma & Agarwal (1995) Environmental Biology (Principles of ecology) Chand & co., New Delhi



## SEMESTER II

### ENVIRONMENTAL ANALYSIS

ECOL: 411

CREDITS: 3

**UNIT-I** Introduction to Environmental Measurements and Instrumentation: Units of measurement, Performance of analytical methods: Figures of merit, Sensitivity and Detection limit. Basic Principles, Instrumentation and Applications of Ultraviolet – visible (UV-VIS) spectroscopy, Flame Spectrometry; Atomic Absorption Spectroscopy (AAS), Basic principles and applications of chromatographic methods. **(8 Hours)**

**UNIT-II** Environmental Sampling: Spatial and temporal variability, Types of samples: water sampling-surface and groundwater sampling, biological tissue sampling, soil sampling, sampling stratified levels in containers. Preservation techniques of the samples. Sample preparation techniques-extraction of organic analytes from liquid samples, concentration of sample extracts, sample clean up. **(8 Hours)**

**UNIT-III** Estimation of physico chemical parameters of water quality: temperature, colour, odour, turbidity, pH, conductivity, total solids, total dissolved solids, total suspended solids, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, hardness, acidity, alkalinity, chloride, calcium, magnesium, sodium, potassium, nitrate, phosphorus, sulphate and heavy metals. **(8 Hours)**

**UNIT-IV** Air pollutants analysis using high volume and handy samplers - SO<sub>2</sub> and NO<sub>x</sub> analysis by wet chemistry method. Measurement of noise by DB meter in silent, industrial, residential and commercial zones. **(8 Hours)**

**UNIT-V** Basic microbiology of water and wastewater, Media preparation and inoculation – staining –basic principles involved in the analysis of faecal indicator bacteria –test for plate count – coliforms – fecal coliforms – *E.coli* – *S. fecalis* – M.P.N. and M.F. techniques. **(8 Hours)**

#### **Text book and References:**

1. "Standard Methods for the Examination of Water and Wastewater", 21th Edition, American Public Health Association, Washington. D.C. 2005.
2. Sawyer, C.N. and McCarty, P.L. and Parkin, G.F. "Chemistry for Environmental Engineers", 4th Edition, McGraw Hill, New Delhi, 1994.
3. Vogel's Text Book of Quantitative Inorganic Analysis, Barnes, J.D. J., Denney, R.C.,
4. Jeffery, G.H and Mendham, J. (1999) 6th Edition, Pearson Education Ltd., U.K.
5. Fundamentals of Analytical Chemistry, Skoog, D.A and D.M.West, (2004) Thomson Asia Pvt Ltd, Singapore.
6. Environmental Chemical Analysis, B.B.Kebbekus and S.Mitra (1998), Chapman & Hall/CRC Press.
7. Instrumental Methods of Chemical Analysis, B.K. Sharma, (2001) Goal Publishing House, Meerut., India.
8. Environmental Monitoring and Instrumentation, Bucholtz, F., (1997) Optical Society of America, Washington D.C.
9. Environmental Sampling Analysis: A Practical Guide, Keith, L.H., Boca Raton, F.L. (1991), Lewis Publication.

# ENVIRONMENTAL TOXICOLOGY AND HEALTH

**ECOL: 412**

**CREDITS: 3**

**UNIT-I** Principles in toxicology; Definition of Xenobiotic. Animal management in toxicological evaluation. **(8 Hours)**

**UNIT-II** Animal toxicity tests; Statistical concepts of LD50; Dose-effect and dose response relationship; Frequency response and cumulative response; Biological and chemical factors that influence toxicity. **(8 Hours)**

**UNIT-III** Bio-transformation and bio-accumulation - Influence of ecological factors on the effects of toxicity; Concept of green chemistry. **(8 Hours)**

**UNIT-IV** Pollution of the ecosphere by industries; Global dispersion of toxic substance; Dispersion and circulating mechanisms of pollutants; degradable and non-degradable toxic substances; food chain. **(8 Hours)**

**UNIT-V** Eco-system influence on the fate and transport of toxicants. Aquatic toxicity tests; Statistical tests; Response of planktons to toxicants; EC49; Photosynthetic bacteria; Bio-absorption of heavy metals. Information management system in eco-toxicology. **(8 Hours)**

## **Text Books:**

1. Lorris G. Cockerham, Barbara S. Shane, 1994. Basic Environmental Toxicology, CRC Press.
2. David A. Wright, Pamela Welbourn, 2002. Environmental Toxicology. Cambridge University press.
3. Rana, S. V. S. 2011. Environmental Pollution: Health and Toxicology. Alpha Science International Limited.
4. Forbes V.E. and Forbes T.L. 1994 Ecotoxicology in theory and practice. Chapman & Hall, London; New York.
5. [Ecotoxicology, F. Ramade; translated by L.J.M. Hodgson. 1987. Chichester ; New York : John Wiley,](#)

## **Supplementary Books**

1. Ming-Ho Yu, Humio Tsunoda, Masashi Tsunoda, 2011. Environmental Toxicology: Biological and Health Effects of Pollutants, Third edition. CRC Press
2. Wayne G. Landis, Ruth M. Sofield, Ming-Ho Yu. 2011. Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscape. CRC Press.
3. William Hughes. 2005. Essentials of Environmental Toxicology. Taylor & Francis. Jaakko Paasivirta. 1991. [Chemical ecotoxicology](#) Chelsea, MI: Lewis Publishers.
4. H.A.M. de Kruijf ... [et al.]. 1998. Manual on aquatic ecotoxicology. Kluwer Academic Publishers.

## **Practical: Eco-Toxicology and Pollution**

1. Physicochemical and biological analysis of soil.
2. Qualitative and quantitative changes in pesticides/fungicides/insecticides.
3. Testing of cytotoxicity (onion root tip assay/pollen germination) of polluted water.
4. Biodegradation of environ-friendly materials
5. Estimation of biomass from planktonic organisms. **(30 Hrs)**

# PLANT ECOLOGY

**ECOL: 413**

**CREDITS: 3**

**UNIT-I** Plant Community: definition, structure- Clements' view, Gleason's view, the modern synthesis, life-forms in plant communities, vertical structure of plant communities, special structure of plant communities. **(8 Hours)**

**UNIT-II** Pattern of life History, growth forms of plants, environmental factors affecting plant performance, Plant biodiversity and population dynamics- temporal pattern of population dynamics, special structure of plant population, age structure in plant population, genetic structure of plant population, seeds and seedling ecology. **(8 Hours)**

**UNIT-III** Plant photosynthesis: photochemical reaction, diffusional limitation, environmental influences on photosynthetic capacity, seasonality of photosynthesis, defense against herbivores, variations on the basic photosynthetic pathway, ecological consequences of different photosynthetic pathways. **(8 Hours)**

**UNIT-IV** Plant resources- response curves and limiting resources, mechanism of resource capture, allocation of resources, efficiency of resource uses, Reproduction and growth, Structure and function of root systems, Plant pollination and dispersal. **(8 Hours)**

**UNIT-V** Field based study: Description of vegetation, analysis of vegetation and regeneration, Phenology, Population biology of seed phase- seed production, soil seed bank, and Population biology of growing plants. **(8 Hours)**

## References

1. Crawley, M 2007. Plant ecology. Blackwell scientific Publications.
2. More and Chapman, 2007. Methods in plant Ecology. Blackwell Scientific Publications.
3. Russell K. Monson, 2014. Ecology and the Environment. Springer Dordrecht, Heidelberg, New York.

## ANIMAL ECOLOGY

ECOL: 414

CREDITS: 3

**UNIT-I** Introduction – The relations of animals to environment, Historical Background of Animal Ecology, Fundamentals of Ecology, ecology and evolution, Ecology and zoogeography and Classification of Habitats. Physical and chemical Ecological factors, certain chemical and physical agencies (Light, Gravity, Molar agents), Soil and bottom - Types of Soil, Soil drainage, Soil water, Soil aeration, Soil temperatures, Soil cover and Its effects, Activities in soil number of organisms in Altitude. **(8 Hours)**

**UNIT-II** Biological Factors – Reproduction, food, morphology, physiology, protection, behavior and competition; Succession – Succession, ecological succession, annual succession, tropical regions, frigid regions, adaptations of animals, dormancy, lunar succession and rhythms. Behavioral Ecology, Hynass - Case Study of an Indian Mammal. **(8 Hours)**

**UNIT-III** Animals of the ocean – littoral animals, hard-beach animals, animals of sand beaches, pelagic animals and oceanic animals. Fresh water animals - Animals of springs, animals of standing water, littoral animals, limnetic animals, swamp and bog animals and animals of ground waters. Terrestrial animals – Subterranean animals, cave animals, animals associated with terrestrial plants, density of population in grasslands, desert animals, aerial animals and animals of islands. **(8 Hours)**

**UNIT-IV** The relations of animals to plants – Plants as food for animals, galls, seed dispersal by animals, certain symbiotic relations between plants and animals, plant enemies of animals, animals that carry plant diseases; Relations of animals to color – Concealing coloration and mimicry; Intraspecific relations – Sex relations, gregarious, colonial, and social animals, polymorphism, alternation of generations, symbionts and parasites. **(8 Hours)**

**UNIT-V** Economic relations of ecology - Influence of man on environment, resources in the ocean, food production, increasing food resources, environment and health, water supply and pollution, methods of combating pests, pests due to man's activities and conservation. **(8 Hours)**

### References:

#### Text Books:

1. Charles S. 1900- Elton, 2011. Animal ecology. Kluwer academic publishers, US America.
2. Franklin Shull, Animal Ecology. Mcgraw-Hill Publications.
3. Owen D.F. 1976. Animal ecology in tropical Africa. [london ; New york, Longman.](#)
4. [Barnard, C. J.](#), 1983. Animal behavior: ecology and evolution. New York: Croom Helm.
5. Wallwork, John Anthony, 1970. Ecology of soil animals, London: New York; McGraw-Hill.

## **SEMESTER - III**

### **CONSERVATION BIOLOGY**

**ECOL: 501**

**CREDITS: 3**

**UNIT-I** Extinction: Global deforestation rate and extinction crises. Causes for extinction: habitat loss, industrialization, hunting and invasive species. Extinction through geological time scale: mass extinction and impact on flora and fauna. Back ground extinction rate. Current extinction trends. **(8 Hours)**

**UNIT-II** Valuation of ecosystems and species: Valuation of biodiversity: consumptive and productive use values; option and existence value. Valuation of global ecosystem services; case studies Exercises on economic valuation. **(8 Hours)**

**UNIT-III** Population Genetics and Conservation: Population genetics, concept of minimum viable populations; extinction vortices. Inbreeding and outbreeding depression in natural and managed populations; rarity and endangered species conservation. In situ and exsitu conservation, captive studies and exercises. **(8 Hours)**

**UNIT-IV** Habit Fragmentation and Reserve Design: Species- area relationship and the theory of island biogeography; habitat fragmentation: area and edge effect, faunal relaxation rates; reserve size and SLOSS affect studies: BFFP Amazon project. **(8 Hours)**

**UNIT-V** Conservation Efforts: Overview of global conservation efforts: global protected area network. Protected areas and functions; UNESCO biosphere reserves; IUCN conservation categories, WCMC, CITES. **(8 Hours)**

#### **References:**

#### **Text Books**

1. Conservation Biology. 2002. Andrew S. Pullin, Cambridge University Press, UK.
2. Essentials of conservation Biology. 1998. R. B Primack, Sinauer Associates, (latest edition).
3. Conservation biology 1986. Ed. M. E. Soule, Sinauer Associates

# REMOTE SENSING AND GIS

ECOL: 502

CREDITS: 3

**UNIT-I** Principles of Remote Sensing: Concepts of Remote Sensing, Electromagnetic spectrum; effects of atmosphere, Physics of remote sensing, Principle of scanner and CCD array, Spectral reflectance of earth's surface features in different wavelength region of electromagnetic spectrum: spectral characteristics of surface features (rocks, soils, vegetations, water).

**(8 Hours)**

**UNIT-II** Space Imaging - Landsat, SPOT, IRS, NOAA, Seasat, ERS, RADARSAT, INSAT satellites and their sensors, geometry and radiometry, Orbital characteristics, Data products. **(a)** Thermal and remote sensing: Basic principles, Radiation laws, Sensing radiant energy, Thermal sensors, characteristics of image and their uses. **(b)** Microwave remote sensing: Basic definitions and principles, advantages, Types of microwave systems - RADAR, SLAR, SAR; General characteristics, spectral resolution and interpretation. Digital Image Processing: Principles, Image Rectification and restoration, Image enhancement and Mosaicing. Image classification - Supervised, Unsupervised, Ground truth data and training set manipulation, Classification accuracy assessment. **(8 Hours)**

**UNIT-III** Aerial Photographs and Satellite Imageries: Fundamentals of photogrammetry, aerial cameras, planning of aerial photography, principle of stereo photography, parallax and measurement of height & slope; characteristics of aerial photographs; Elements of image interpretation - visual interpretation of aerial photographs and satellite imageries, instruments used in interpretation; Path and Row Index Maps; selecting and ordering images; Interpretation of photographs and images for environmental analysis. **(8 Hours)**

**UNIT-IV** Geographical Information System (GIS): Basic principles and terminologies, Raster and vector data, Map projection, Topology creation, Overlay analysis, Data structure and Digital cartography; Software used in GIS Surveying: Leveling, Triangulation, Geodetic survey; Global Positioning System (GPS) - Basic principles, Applications to environmental studies. **(8 Hours)**

**UNIT-V** Application of Remote Sensing and GIS in Environmental Management: Applications of Remote Sensing and GIS in environmental monitoring and action plan development of environmental fragile area; Natural resource management - forest resources, water resources, land resources and mineral resources; Hazard and disaster mapping and management.

**(8 Hours)**

## References:

### Text Books:

1. Remote Sensing of the Environment – An earth resource perspective: J. R. Jensen; Pearson Education
2. Geographic Information Systems: Martin, Routledge
3. An Introduction to GIS: Heywood, Pearson
4. Remote Sensing in Land Evaluation: Yadav; Rajesh Pub
5. Essentials of GPS (2004): N. K. Agarwal; Spatial Networks Pvt. Ltd., Hyderabad
6. Remote Sensing, Principles and interpretation: Floyd F. Sabins Jr., W.H. Freeman & Company, New York, 2<sup>nd</sup> Ed., 1987.
7. Remote Sensing and Image interpretation: T.M. Lillesand & R.W. Kiefer, John Wiley & Sons, New York, 1994.

# INDUSTRIAL ECOLOGY

**ECOL: 503**

**CREDITS: 3**

**UNIT-I** Introduction to Industrial Ecology-History- Fundamentals & Concepts- introduction to Life Cycle assessment-History & definition of LCA; Components in a product's life cycle- Structure of LCA – Advantages of LCA. **(8 Hours)**

**UNIT-II** Industrial Ecology-viability of ecosystems-four box scheme of natural system& industrial system- similarity– foodwebs and industrialecoparks-biomimcry. **(8 Hours)**

**UNIT-III** Strategy of Industrial ecology – Material substitution-De-materialization-examples - Re use and recycling – delinking and decoupling-case study - Typical constraints on reuse and recycling. Aspects of lessening impacts-Zero emission system; dematerialization; material substitution- Measuring the balance analysis. **(8 Hours)**

**UNIT-IV** Industrial metabolism-measures of industrial metabolism – Policy implications of Industrial metabolism-Material flow analysis (MFA) – Definition and Types of MFA – Material flow accounting-indicators used in Material flow accounting- Material flow management. Industrial symbiosis-Kalundborg – a case study. **(8 Hours)**

**UNIT-V** Clean technology Centre, Ireland: objectives, industrial services, barriers and conflicts – Environment product design-I – case study-cups - plastic/paper/ceramic environment product design II case study – cellphones. **(8 Hours)**

## **Text Books**

1. A Handbook of Industrial Ecology. By R.U. Ayres & L.W. Ayres, INSEAD, France, 2012.
2. Environmental life cycle assessment. Ed. Mary Ann Curran, McGraw – Hill, New york, 2010
3. Industrial ecology Ed. Graedel and Allenby, 2010.

## **Supplementary Books:**

1. Bioenergy – vision for the new millennium, R. Ramamurthy et Al., Oxford & IBH publishing CO. Pvt. Ltd. 2000.
2. Industrial ecology – toward closing the materials cycle ED. R.U. Ayers and LW Ayers.

## GLOBAL ENVIRONMENTAL CHANGES

ECOL: 504

CREDITS: 3

**UNIT-I** The process of science: unraveling the earth system; the role of science in managing the global environment. **(8 Hours)**

**UNIT-II** A simple example of global change: stratospheric ozone depletion – Impacts and policy responses. **(8 Hours)**

**UNIT-III** A complex example of enhanced greenhouse effect - fundamentals of the climate system – changing composition of the atmosphere from human population growth & activities – climate variability in the last millennium and the recent climate record – future emissions and future climate. **(8 Hours)**

**UNIT-IV** Impacts on earth system and society – natural ecosystems; agriculture and food security; sea level rise; acid rain; human health. **(8 Hours)**

**UNIT-V** Policy responses and mitigation strategies to a changing planet – Energy options and making decisions; IPCC assessments and scenerios; Kyoto protocol; International Geosphere and Biosphere Programme (IGBP) and the planned interventions. **(8 Hours)**

### **References:**

#### **Textbook**

Global Warming; Understanding the Forecast", D. Archer, Blackwell Publ., 2007. For continuous evaluation there will be *two* 2- hour tests (September last week and October last week) given during the semester. Tests will focus on material covered since the previous examination, but basic principles covered in class will be required for later exams. There will be approximately 2 homework assignments and 1 group discussion. The Final Exam will cover the entire course content.

#### **Supplementary books:**

1. Climate Change and Biodiversity; By Thomas E. Lovejoy, Lee Jay Hannah Published by Yale University Press, 2006 ISBN 0300119801, 80300119800 418 pages.



# ENVIRONMENTAL MANAGEMENT

**ECOL: 505**

**CREDITS: 3**

**UNIT-I** what, why and how of environmental management and sustainability in India; A state of the art review and case studies. **(8 Hours)**

**UNIT-II** Current status of Ecosystems – issues and challenges- Millennium Ecosystem assessment - major findings with special reference to Ecosystem vulnerability and resilience and their management implications. **(8 Hours)**

**UNIT-III** Paradigm shifts in the management of Ecosystems; Eco-restoration/remediation; the common property resources and their management; Eco-labels and Eco-funds. Tool box for environmental management – An over –view of Ecological foot prints, SEA, Ecological Economics, Geo-matics (GIS, remote sensing & GPS), PLA (PRA, RRA, Stake-holder analysis, gender analysis, SLA), conflict resolution strategies. Environmental auditing & Standards. **(8 Hours)**

**UNIT-IV** Agro-Ecology, Industrial Ecology and sustainability; Tourism and Environmental Management; Disaster preparedness and management strategies. **(8 Hours)**

**UNIT-V** Securing Sustainable futures; Millennium development goals and strategies; the earth charter; Environmental Education for sustainability, a critical review of environmental policies, legislation, planning, implementation and monitoring in our country – case studies. **(8 Hours)**

**Debates, role plays etc.,**

## **Text books**

1. Thesis, T & J Tomkin, (Ed). 2012. Sustainability: A Comprehensive Foundation, C O N N E X I O N S, Rice University, Houston, Texas, pp.591, Freely downloadable from <http://www.earth.illinois.edu/documents/col11325-1.38.pdf>
2. Tyler Miller, G. Jr, 2010. Advantage Series: Sustaining the Earth - An Integrated Approach (with CD-ROM and Info Trac) 10th Edition. Thomson/Brooks Cole, pp.384.
3. Tyler Miller, G. Jr. 2011. Living in the Environment: Principles, Connections, and Solutions (with Environmental Science (13th edition) CD-ROM and Info Trac) 17th Edition, Thomson/Brooks Cole, pp.800
4. Tyler Miller, G. Jr. 2010. Environmental Science (13th edition), Paperback, 552 Pages, Brooks Cole, 13th edition, pp.552

# **PROJECT METHODOLOGY**

## **FIELD METHODS FOR CONSERVATION STUDIES**

**ECOL: 598**

**CREDITS: 3**

**UNIT-I** Study design: Experimental, observational and descriptive studies, Hypothesis testing, Development of project design and proposals. **(8 Hours)**

**UNIT-II** Surveys, Assessments, monitoring of populations. Sustainable harvest. Rarity and commonness: Identifying rare species. **(8 Hours)**

**UNIT-III** Assessment of local community impacts on forests: harvesting pressure. **(8 Hours)**

**UNIT-IV** Assessment of attitudes of local communities and participatory conservation efforts. **(8 Hours)**

**UNIT-V** Seminars and case studies. **(8 Hours)**

## **APPLIED ECOLOGY & ENVIRONMENTAL SCIENCES**

**ECOL: 598**

**CREDIT: 3**

**UNIT-I** Hypothesis generation; Sampling techniques; Types of studies; Sample size Frequency, density, Questionnaire preparation; field application. **(8 Hours)**

**UNIT-II** Earthworm biology, physiology factors effecting population; Vermicomposting; factors effecting composting; recycling methods- factors involved. **(8 Hours)**

**UNIT-III** Interactions between organisms; Physical methods of remediation; Bioremediation; factors influencing remediation; strategies for enhancement, degradation of persistent pollutants. **(8 Hours)**

**UNIT-IV** Extraction methods- mechanical shaking and chemical extraction methods- Chromatography methods. **(8 Hours)**

**UNIT-V** Biochemical factors effecting remediation- insitu techniques-Cultures- Media- Characteristics Secondary metabolites; functional groups. **(8 Hours)**

### **References:**

#### **Books:**

1. Hodgson and Levi 1998. Text Book of Modern Toxicology; Prentice Hall New Delhi.
2. G.M. Evans and J.C. Furlon, 2006. Environmental Biotechnology John Wiley & sons.

## **BELOWGROUND FAUNAL BIODIVERSITY**

**ECOL: 598**

**CREDITS: 3**

**UNIT-I** Sampling Belowground faunal biodiversity – Pitfall trapping, dry and wet funnel extraction and estimation of their population densities per unit area. **(8 Hours)**

**UNIT-II** Measurement of and the role of belowground biodiversity in litter decomposition using litter bags and exclusion experiments. **(8 Hours)**

**UNIT-III** Formalin sampling, quadrat sampling and soil block sampling for belowground macro-invertebrate diversity and population densities. **(8 Hours)**

**UNIT-IV** Identification of belowground faunal biodiversity – meso or meio and macro faunal biodiversity and estimation of their diversity indices. **(8 Hours)**

**UNIT-V** Sediment macro-invertebrate diversity sampling and their identification, and estimation of the diversity indices in relation to DO. **(8 Hours)**

### **References**

#### **Text books**

1. Ecological Methods, 2003 9<sup>th</sup> Ed, Saunders Press, USA – TRE South wood
2. Ecological Methods, 1999, Enviro-Media, India, P. Michael
3. Soil animals – 2005 3<sup>rd</sup> Ed. JA Wallwork, Springer Verlag publ.

## FOREST STRUCTURE AND FUNCTIONAL ECOLOGY

ECOL: 598

CREDITS: 3

**UNIT-I** Forest Structural Analysis; Methods for stratification and niche use by faunal communities; Methods of rapid assessment and permanent plot inventories – BIOMON PROGRAM. **(8 Hours)**

**UNIT-II** Forest stand structure analysis\_ Stem size-class distribution – expanding, declining and disturbed populations and implication for reserve conservation. SIMPER analysis NMDS – comparing undisturbed and disturbed forests and species similarity analysis. **(8 Hours)**

**UNIT-III FOREST** regeneration-seedling, sapling and adult stages and variation at stand and species level and with sex ratios of bisexual and dioecious species. Soil seed bank analysis and germ inability. **(8 Hours)**

**UNIT-IV** Forest growth determination - Plant reproductive traits: Floral and fruit feature analysis and their functional ecology. **(8 Hours)**

**UNIT-V FOREST** phenology and patterns analysis in short and long term basis. Forest resource utilization: Levels of harvest, sustainable use and implications for conservation. **(8 Hours)**

### References

#### Text books

1. Moore, P.D. & Chapman, S.B. 2007. Methods in Plant Ecology. Blackwell, Oxford.
2. Richards, P.W. 1996. Tropical rain forests. Cambridge University Press, Cambridge.

# HUMAN ECOLOGY & ENVIRONMENTAL MANAGEMENT

ECOL: 598

CREDITS: 3

**UNIT-I SITUATION** analysis – Participatory Learning and action (PLA), stake-holder analysis, problem identification, conflict resolution strategies. **(8 Hours)**

**UNIT-II** Survey techniques; data collection methods- sources of data-primary and secondary; data quality and reliability. **(8 Hours)**

**UNIT-III** Sampling techniques, data analysis and interpretation -use of t-Test, F-Test and Anova, correlation and regression. **(8 Hours)**

**UNIT-VI** Tools- participatory mapping, environmental risk assessment, Strength, Weakness Opportunities and Threats (SWOT) analysis. **(8 Hours)**

**UNIT-V** Thesis writing- structure of a thesis - guidelines for writing different chapters; adapting standard formats for chapterisation, punctuation, illustration, tabulations, references-quoting in the text and in the reference section; appendices, abbreviation. **(8 Hours)**

## References

1. EJ Milner-Gulland and J Marcus Rowcliffe, 2007. Conservation and Sustainable Use - a handbook of Techniques Oxford University Press
2. Russell K. Schutt, 2009. Investigating the Social World - The Process and Practice of Research, Sixth Edition, Pine Forge Press
3. Tyler Miller, G. Jr. 2008. Living in the Environment: Principles, Connections, and Solutions (with CD-ROM and Info Trac) 16th Edition, Thomson/Brooks Cole, pp.627.
4. Harrad, Stuart, Miriam Diamond & Lesley Batty, 2008 Conducting Your Research Project in Quantitative Environmental Science Pbk | 047084566X | #173151A
5. Britha Mikkelsen 2005. Methods for Development Work and Research, A New Guide for Practitioners Second Edition SAGE Publications Pvt. Ltd, pp384

## APPLIED WEED ECOLOGY

ECOL: 598

CREDITS: 3

**UNIT-I** Introduction of Research topic: Definition, Origin and its development, Objectives – Research investigations in relation to the research option carried out by Agricultural Scientists. **(8 Hours)**

**UNIT-II** Materials and Methods of Research topic: An overview of study site – Climatologically data – Analysis of sampling technique: The Experimental details – Research treatments field plots – Particulars of variety – Various strategically Applications in the study site – Physico – chemical properties of soil – output of the soil samples – Estimation of macro – micronutrients – Chlorophyll - Yield characters – Procedures on weed impact of population. **(8 Hours)**

**UNIT-III** Citation of Literature of Review on the Weeds flora in the Pulse Crops – Annual, Biennials and Perennials – Nature of Growth of Crops and Weeds in the Natural and Experimental field – Soil type - Moisture conditions – Crop morphology - Various weed control methods – Status of nutrients and requirements – Critical Period of Crops and weeds – Manual weed control - Application of Weedicides - Productivity and attributes. **(8 Hours)**

**UNIT-IV** An analysis of findings of Research and its implications: Comparative research investigations between present and past in connection with the setup of the future new findings. **(8 Hours)**

**UNIT-V Various** research authors activities on the proposed research topic and its outcome of the conclusion based on anticipatory research work carried out by the citatory. **(8 Hours)**

### References:

1. Ecological Studies of Crop – Weed Competition with special reference to Blackgram (*Vigna mungo* (Linn.) Hepper var. T9) and various methods of Weed control in Bahor, Pondicherry, India.
2. Irena Rajcan and Clarence J. Swanton. 2001. Understanding maize–weed competition: resource competition, light quality and the whole plant. Department of Plant Agriculture, University of Guelph, Guelph, Ont., Canada N1G 2W1.

## MARINE ECOBIOLOGY

ECOL: 598

CREDIT: 3

**UNIT-I** Marine environment- habitats- economically and pharmacological important bio-resources - varieties- drugs from marine plants and animals-diversity in aquatic systems. **(8 Hours)**

**UNIT-II** Aquatic water sampling techniques- BOD-Dissolved oxygen, pH, Salinity, estimation of total nitrogen and phosphorus in sediments and water –transparency measurement-sacchi disc. **(8 Hours)**

**UNIT-III** Marine bioactive substances-collection of specimens – preservation and transport – extraction methods – selection of solvents – preparation of extracts for chromatographic studies. **(8 Hours)**

**UNIT-IV** Marine microbial studies – methods in water and sediment sampling – preservation and transport for microbiological studies –selection and preparation of media – culture techniques – steps involved – antibacterial property assessment methods. **(8 Hours)**

**UNIT-V** Report writing – interpretation of results – literature collection and compilation- Hypothesis – object setting – classification of data and presentation –application of statistical tools –t test, probability – ANOVA one way and two way. **(8 Hours)**

### References

1. Vogel's, P Text book of Practical organic chemistry, John's Wiley and sons, NY
2. Trivedy R.K. and Goel P.K. Practical methods in ecology environmental sciences. Environmental publications, Karad, India. 1998
3. APHA (1985) standard methods for examination of water and wastewater. American Health association 16<sup>th</sup> edition, Washington, USA.
4. Ferguson Wood. Microbiology of oceans and estuaries, Elsevier Publications Co., Amsterdam



## ENVIRONMENTAL PLANNING AND MANAGEMENT

ECOL: 598

CREDITS: 3

**UNIT-I** Course Introduction; Research Questions; Formulation of objectives. **(8 Hours)**

**UNIT II** Background and Introductory Methods; Introduction to Web of Science; Literature search. **(8 Hours)**

**UNIT-III** Formulation of Question and Experimental Design; Data Collection - Accuracy and precision of data and the sources of error and variation in surveys. **(8 Hours)**

**UNIT IV** Data Analysis and Interpretation; Experimental observations required for the interpretation of research; Computational exercises with actual data from a variety of ecological and environmental research. **(8 Hours)**

**UNIT-V** Interpretation and Next Questions; Understanding the concepts behind the testing of hypotheses with regression and analysis of variance. **(8 Hours)**

# ENVIRONMENTAL PHOTOCATALYSIS

ECOL: 598

CREDITS: 3

**UNIT-I** Introduction, Applications of photo catalysis - wastewater and effluents, drinking water disinfection, self-cleaning properties. **(8 Hours)**

**UNIT-II** Fundamental aspects of Photo catalysis, semiconductor photo catalysis, various photo catalysts, mechanism of photo catalysis, formation of reactive oxygen species. **(8 Hours)**

**UNIT-III** Mode of action of  $\text{TiO}_2$ , Biological effects of  $\text{TiO}_2$  and photo catalytic chemistry photo catalytic reactor configurations, water treatment systems, gas phase treatment systems. **(8 Hours)**

**UNIT-IV** Toxicity studies of  $\text{TiO}_2$  particles, SDS assay, single cell gel electrophoresis assay (comet assay), and mechanism of cell killing, second generation photo catalysts and nano photo catalysts. **(8 Hours)**

**UNIT-V**GLP, Laboratory safety, microbiology lab practices and safety rules, scientific writing- general guidelines. **(8 Hours)**

## Text books

1. Photo catalysis Science and Technology, M. Kaneko, I. Okura (Eds)Kodansha Springer publications, 2002,ISSN 1618-7210
2. Photo catalysis: Fundamentals and Applications, Nick Serpone, Ezio Pelizzetti, Wiley publications, 1989, ISBN: 978-0-471-62603-9.
3. The craft of scientific writing, Michael Alley-3<sup>rd</sup> ed. Springer, 1996.

## RESERARCH METHODS IN SERICULTURE

**ECOL: 598**

**CREDITS: 3**

**UNIT-I** Main features of Sericulture as bio industry Package of practices of mulberry cultivation under rain fed and irrigated conditions. **(8 Hours)**

**UNIT-II** Silkworm rearing technology – rearing types-seed cocoon rearing-commercial cocoon rearing-chawki rearing-late age rearing-mounting-spinning-harvesting of cocoons-marketing of cocoons. **(8 Hours)**

**UNIT-III** Methods of silk reeling-charkha, cottage basin, multi end and automatic reeling. Improved technologies methods of raw silk testing identification and quality analysis of silk fibers – Silk grading. **(8 Hours)**

**UNIT-IV** Recombinant DNA technology-Basic techniques-Agarose gel electrophoresis – Polymerase chain reaction- Blotting techniques-Molecular analysis of HSPS in silkworm and mulberry. **(8 Hours)**

**UNIT-V** Importance of estimation of LD50and LC50 in Environmental studies; Estimation of LD 50 in silkworm on exposure to pesticides and heavy metals. **(8 Hours)**

### **Text Books:**

1. S. R. Ullal & M.N. Narasimhanna (1981); Hand Book of Practical Sericulture CSB, Bombay
2. P.K. Gupta (2005) Cell and Molecular Biology; Rastogi Publications.

## ADVANCED GEOMATIC TECHNIQUES

ECOL: 598

CREDITS: 3

**UNIT-I** Tools and technologies available for environmental mapping and monitoring – conventional methods of environmental monitoring advanced methods of environmental mapping and monitoring, advantages and limitations. **(8 Hours)**

**UNIT-II** Manual application of space technology in environmental mapping and monitoring – Methodology to prepare vegetation cover density and vegetation type mapping – key elements of visual interpretation and classification. **(8 Hours)**

**UNIT-III** Digital application of space technology in environmental mapping and monitoring – Semi-automated resource mapping, automated resource mapping, expert classification. **(8 Hours)**

**UNIT-IV** Methodology to estimate forest cover change detection, land use/land cover dynamics, matrix analysis of land cover dynamics. **(8 Hours)**

**UNIT-V** Role of global positioning system in resource monitoring, methodology for integration of GPS into GIS domain. **(8 Hours)**

### References

#### Text Books

1. Jensen, J.R., Remote Sensing of the Environment 2006. An Earth Resource Perspective, Prentice Hall; 2 editions, 608 pages, ISBN-13: 978-0131889507.
2. Goodchild, M.F., Parks, B.O., Steyaert, L.T., (Eds.), 1993. Environmental Modeling with GIS (Spatial Information Systems) Oxford University Press, USA, 520 pages, ISBN-13: 978-0195080070.
3. Mario, G.A., 2009. Basics of Geomatics, Springer Publication, 656 pages, ISBN: 978-1-4020-9013-4.

## RESEARCH METHODS IN PLANT ECOLOGY

Ecol: 598

CREDIT: 3

**UNIT-I Field** techniques: Quadrata methods, transect method, point frame method, permanent plots – profile diagram - qualitative and quantitative characteristics – Diversity index, dominance index, species richness - evenness index. **(8 Hours)**

**UNIT-II Regeneration** studies: methods to study the soil seed banks, vegetative and reproductive phenology, methods of studying population dynamics. **(8 Hours)**

**UNIT-III Litter** dynamics: Litter Production and decomposition field methods Nutrient immobilization. **(8 Hours)**

**UNIT-V Methods** of soil sample collection – Methods of Estimating Nutrients – soil respiration – Alkali Absorption Method – Methods for Estimating fine root biomass. **(8 Hours)**

**UNIT-V** Ethno botanical survey - questionnaire preparation – Medicinal plants: Collection, preservation– Cultivation methods. **(8 Hours)**

### Text Books

1. Moore, P.D. & Chapman, S.B. 2007. Methods in Plant Ecology. Balackwell, Oxford.
2. Trivedy, R.K. and Goel, P.K. 1998. Practical methods in ecology and environmental sciences. Environmental publications, Karad, India.

**PONDICHERY UNIVERSITY**  
DEPARTMENT OF ECOLOGY & ENVIRONMENTAL SCIENCES



**LIST OF SOFT CORE COURSES COMMON TO  
BOTH THE STREAMS**

**Syllabus**

## **ANNEXURE - III**

### **LIST OF SORT CORE COURSES COMMON TO BOTH THE STREAMS**

<b>COURSE Code</b>	<b>Title of the Course</b>	<b>Credits</b>
ECOL 461	Agriculture and Weed Ecology	3
ECOL 463	Landscape Ecology and Planning	3
ECOL 464	Eco-Tourism and Protected Area Management	3
ECOL 465	Forest Botany	3
ECOL 466	Marine Ecology	3
ECOL 467	Science Communication(Writing and Communication Lab)	3
ECOL 468	Human Ecology <sup>a</sup>	3
ECOL 469	Biodiversity	3
ECOL 471	Coastal Zone Management	3
ECOL 472	Plant-Animal Interactions	3
ECOL 473	Commerce and Environment	3
ECOL 474	Ornithology	3
ECOL 475	Bio indicators <sup>a</sup> &Eco remediation	3
ECOL 476	Environmental Bio Chemistry and Genomics	3
ECOL 477	Marine Biodiversity and Conservation	3
ECOL 478	Biological invasions	3
ECOL 479	Instrumentation Techniques in Ecology and Environmental Sciences	3
ECOL 480	Ecology of Medicinal Plants	3
ECOL 481	Environmental Informatics and Spatial Modelling	3
ECOL 482	Evolution <sup>a</sup>	3
ECOL 483	Genetics and Molecular Ecology	3
ECOL 484	Advanced Water Treatment Technologies	3
ECOL 485	Eco City and Sustainability	3
ECOL 486	Contemporary Environmental Issues	3
ECOL 561	Forest Ecology	3

<b>COURSE Code</b>	<b>Title of the Course</b>	<b>Credits</b>
ECOL 562	Microbial Ecology	3
ECOL 563	Environmental Seri Biotechnology	3
ECOL 571	Introduction to Theoretical Ecology <sup>a</sup>	3
ECOL 572	Bio Geography <sup>a</sup>	3
ECOL 573	Agro Ecosystems and Agroforestry	3
ECOL 574	Introduction to Ecological Modelling <sup>a</sup>	3
ECOL 575	Statistics with R for Ecology(Laboratory Course) <sup>a</sup>	3
ECOL 576	Environmental Law, Policy and Equity	3
ECOL 577	Bio Geo Chemistry <sup>b</sup>	3
ECOL 578	Environmental Surveillance	3
ECOL 580	Digital Image Processing for Environmental Applications	3
ECOL 581	Environmental Nanotechnology	3

**NOTE:**

- a. Course Added; syllabus to be prepared by the Chair
- b. Course Modified; syllabus of the existing course to be modified by teacher concerned



# LIST OF SOFT CORE COURSES COMMON TO BOTH THE STREAMS

## AGRICULTURE AND WEED ECOLOGY

**ECOL: 461**

**CREDITS: 3**

**UNIT-I** Agriculture – An interdependent resource, Introduction, Scope and branches of Agriculture, Evolution of agricultural systems and their environmental implications. Agricultural practices - Types: Shifting cultivation, multiple and rotational cropping systems, nutrient deficiency and management of seeds. Agricultural production- Application of organic manures and chemical fertilizers and agricultural practices, their environmental impacts. Ploughing, agro-chemical fertilizers and biocides on soil health and ground water pollution. **(8 Hours)**

**UNIT-II** Definition, Origin, and Characteristics of Weeds: Seed Production dormancy, Vegetative Reproduction and Root system. Classification of Weeds: Based on life span (Ontogeny) – Annuals, Biennials and Perennials. Based on morphological characteristics, Based on Place of Occurrence. Role of Weeds in the Agricultural field - Weed Biology and Ecology, Persistence Nature of Weeds: Climatic factor, edaphically factors and biotic factors. Survival mechanism of weeds: Production of Seeds, Dissemination/dispersal/migration of weed seeds, Seed Germination, Vegetative propagation/Asexual Reproduction, Dormancy, Evasiveness, Weed population, Agricultural ecotypes and self-regeneration. Allelopathy: Effect of weed on Crops, Effect of weeds on Weeds, Effect of Crops on Weeds and Biodiversity of Weeds. **(8 Hours)**

**UNIT-III** Weed management methods: Mechanical weed control -- merits, Implements, Function, Disadvantages, Dry land weeder. Cultural method of weed: Field preparation, Crop rotation, Growing of intercrops, Mulching, Solarization, Reduction in Area under bunds and Stale seed bed, Blind tillage, Crop management practices, Merits of cultural method. Biological weed control: Qualities of bio-agent, merits, demerits, Outstanding and feasible examples of biological weed control and biological control of weeds in crop field in India. **(8 Hours)**

**UNIT-IV** Soil management in agriculture, Land preparation, planting, irrigation, weeding and crop protection. Agricultural exports and imports - Trends and direction, environmentally sustainable agriculture for the third world countries- INM, IPM with biological control and Eco-agriculture. Crop-Weed Competition: Competition for Nutrients, Light, Water, and Co<sub>2</sub>, Critical Period of Crop – Weed Competition in Weed management. Factors of influencing period of Crop – Weed Competition and Factors affecting Competitive ability of crops against Weeds. **(8 Hours)**

**UNIT-V**Agricultural exports and imports - Trends and direction, environmentally sustainable agriculture for the third world countries- INM, IPM with biological control and Eco-agriculture. Chemical Weed control methods: Merits and demerits, Classification of herbicides, Time and application of herbicide application. Incorporation of herbicides in the soils, Rotation and Residue management. Integrated Weed management: Advantages of IWM, IWM for important crops, Rice nursery, Transplanted Rice, Rainfed Rice, Wheat, Sorghum & maize, Finger millet, Pulses, Oilseeds, Cotton, Sugarcane and Vegetable crops. Control of perennial and problematic weeds: Bermuda grass (*Cynodondactylon*), Control measures, *Cyperus* Species: *Cyperusesculentus* (Yellow nutsedge), Habitat and habit, Control measures. *Solanumnigrum* – control measures. *Partheniumhysterophorus* – control measures. Parasitic weeds: *Loranthus* (Bird vine), *Cuscutasp.*—control measures. **(8 Hours)**

**References:**

**Text books:**

1. Azam-Ali, 2006. Principles of Agronomy. Publisher: Agrosociences book centre, Ansari Road, New Delhi.
2. Subramaniam, S. 2006. All about Weed Control. Publisher: Agrosociences book Centre, Ansari Road, New Delhi.
3. Richardson, David M, Pysek Petre<sup>1</sup> 2008. Fifty years of invasion ecology – the Legacy of Charles Elton., Volume 14, pp. 161-168(8), Blackwell Publishing.

**Supplementary books**

1. Singh and Ajay Kumar, 2006. Sedges and Grasses of Eastern Uttar Pradesh in 2 Vol. Publisher: Daya Publishing House, Ansari Road, New Delhi.
2. Gupta. O. P. 2007. Fundamentals of Weed Science: A Text Book, Jodhpur, Agrobios, xviii, 380 p., tables, figs., ISBN 81-7754-307-5.

# LANDSCAPE ECOLOGY AND PLANNING

**ECOL: 463**

**CREDIT: 3**

**UNIT-I** Land and Landscape processes; Hierarchy: ecosystems to land units; ecological principles at work with Landscapes; Biogeochemistry of Land System. **(8 Hours)**

**UNIT-II** Human dimensions and Land Use in agro ecosystems, urban ecosystems, rangelands, riparian and wetland systems, coastal and estuarine systems; Concept of ecological land degradation - desertification, deforestation, water logging, salinisation and soil erosion. **(8 Hours)**

**UNIT-III** Ecological assessment of landscape for vegetation, wetlands, and habitats; Integrated analytical techniques such as land suitability analysis, carrying capacity studies, and environmental impact assessment; Use of soil survey, aerial photos, topographic maps and other resource data in corridor selection problems and wildlife management. **(8 Hours)**

**UNIT-IV** Land Use/Cover Change; Ecosystem and biodiversity impacts; Inventory and Tools for wasteland assessment and evaluation; Land Reclamation and Restoration; natural hazard mitigation /erosion. **(8 Hours)**

**UNIT-V** Control in watershed management; Multi-objective Land Use Planning; Transfer of development rights; Master Plans Preparation and Zoning; Citizens and stakeholders participation in land development planning; Case Studies. **(8 Hours)**

## **References:**

### **Text Books**

1. Steiner, F. 1999. The Living Landscape: An Ecological Approach to Landscape Planning, 2nd Edition. McGraw-Hill, Inc., New York.
2. Van Lier, H.N.; Jaarsma, C.F.; Jurgens, C.R.; de Buck, A.J., 1994 Sustainable Land Use Planning, Elsevier

### **Supplementary books**

1. Alongi, D. M. 1998. Coastal Ecosystem Processes. CRC Press, New York.
2. Brooks, K. N., P. F. Ffolliott, H.M. Gregerson, and J.L. Thames. 1991.
3. Hydrology and the Management of Watersheds. Iowa State University Press, Ames.
4. Chapman, G.P. 1977. Human and Environmental Systems: A Geographer's Appraisal. Academic Press, London.
5. Forman, R.T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge Univ. Press, Cambridge, UK.

# ECO-TOURISM AND PROTECTED AREA MANAGEMENT

ECOL: 464

CREDITS: 3

**UNIT-I Introduction:** Protected Areas (PAs) – definition; IUCN PAs Categories System - Category assignment basis - Ia Strict Nature Reserve; Ib Wilderness Area; II National Park; III Natural Monument or Feature; IV Habitat/Species Management Area; V Protected Landscape/ Seascape; VI Protected area with sustainable use of natural resources. An overview of Tourism-Biodiversity/Environment/livelihoods linkages and vulnerability/ resilience to climate change in the context of PA management – Ecological/ Environmental /socioeconomic/cultural implications; impacts of mass tourism and the need for alternative tourism strategies- sustainable tourism and ecotourism in mountain and coastal PAs - guiding principles. **(8 Hours)**

**UNIT-II The Debate on Eco tourism in PAs:** Is it possible/desirable to introduce tourism in PAs? The Commons and Carrying Capacity- positive and negative impacts of PA tourism- need for regulations - case studies from around the world highlighting strategies for enhancing the positive impacts and reducing the negative impacts. **(8 Hours)**

**UNIT-III Eco-tourism, conservation and Sustainable development in PAs:** Paradigm shifts in the management of PAs-Restoration and conservation of PAs and sustainable development- management principles and process- the precautionary principle, principles of tourism and visitor management, Recreation Opportunity Spectrum (ROS), Visitor Capacity and the Limits of Acceptable Change, Threefold Park and Tourism Management Framework, community based monitoring and the use of indicators; Tool box for Ecotourism in PAs- stakeholder analysis and community engagement, Participatory Learning and Action (PLA), Conflict Management, Tourism certification programmes; codes of conduct for different stake-holders. **(8 Hours)**

**UNIT-IV Eco-tourism Policy, Planning and Governance for PAs - a futuristic perspective:** A critical review of Eco-tourism Policy, planning and implementation in the PAs of India with implications for government managed, co-managed and indigenous and community conserved and privately managed PAs; case studies; an overview of PA governance and relevant legislation in India. **(8 Hours)**

**UNIT V Field work** - (Aug. II week) 2-3 days intensive field work in existing /potential Eco-tourism destinations in PAs. The work involves collection of secondary details before visiting the site, and intensive Socio-Ecological data collection (spatial & temporal) in the field under the closer supervision of the concerned Faculty. This field work will essentially consist of – situation/stake holder/SWOT analysis, human impacts and their assessment, current /suggested sustainable eco-tourism management strategies. Students will be working in groups and submit field work reports for evaluation. **(8 Hours)**

### Text books

1. Buckley, R.C. 2009. Ecotourism: Principles and Practices. CAB International, Oxford, 368pp.
2. Dudley, N. (Editor) (2008). Guidelines for Applying Protected Area Management Categories. Gland, Switzerland: IUCN. x + 86pp. WITH Stolton, S., P. Shadie and N.
3. Dudley (2013). IUCN WCPA Best Practice Guidance on Recognizing Protected Areas and Assigning Management Categories and Governance Types, Best Practice Protected Area Guidelines Series No. 21, Gland, Switzerland: IUCN. 31pp.
4. Fennell, D. A 2008. Ecotourism: An introduction. New York, NY: Routledge
5. Leung, YF, A Spenceley, G Hvenegaard and R Buckley, C Groves (Ed) 2015. Tourism and Visitor Management in Protected Areas -Guidelines for sustainability, downloadable from [https://iucn.oscar.ncsu.edu/mediawiki/images/3/3a/Sustainable\\_Tourism\\_BPG\\_Full\\_Review\\_Copy\\_for\\_WPC14\\_v2.pdf](https://iucn.oscar.ncsu.edu/mediawiki/images/3/3a/Sustainable_Tourism_BPG_Full_Review_Copy_for_WPC14_v2.pdf), pp.267.
6. Weaver, D , 2008. Ecotourism, John Wiley & Sons; 2nd Edition Paperback, pp.360

### Readings

1. Bhatt, Seema& Syed Liyakhat, 2008. Ecotourism Development in India - Communities, Capital and Conservation, Cambridge University Press India Pvt. Ltd., pp.160
2. [Ballantyne](#) R, & [J Packer](#) (Ed.), 2013. International Handbook on Ecotourism Edward Elgar, pp.520.
3. Borrini-Feyerabend, G., N. Dudley, T. Jaeger, B. Lassen, N. Pathak Broome, A. Phillips and T. Sandwith (2013). Governance of Protected Areas: From understanding to action. Best Practice Protected Area Guidelines Series No. 20, Gland, Switzerland: IUCN. xvi + 124pp.
4. Brent Ritchie JR & G I Crouch, 2005. The Competitive destination: A sustainable tourism perspective, CABI, UK.
5. Govt of India, 2011. Guidelines for ecotourism in and around Protected areas, DRAFT/02 June 2011, pp.15
6. Higham, James 2007. Critical Issues in Ecotourism- Understanding a Complex Tourism Phenomenon, Butterworth-Heinemann Ltd, pp.464.
7. Honey, M 2008. Ecotourism and Sustainable Development Who Owns Paradise? Second Edition, Island Press, USA, Paperback pp.558.
8. Honey, M & A. Rome, 2001. Protecting Paradise: Certification Programs for Sustainable Tourism and Eco-tourism, Inst. For Policy analysis, Press Release 29-10-200 <http://www.ips.dc.org/ecotourism/protectingparadise/standardsforparadise.pdf>
9. Jonathan Mitchell and Caroline Ashley, 2009. Tourism and Poverty Reduction-Pathways to Prosperity, Earth Scan, London, UK pp.192.
10. Sharpley Richard, 2009. Tourism Development and the Environment: Beyond Sustainability? Earthscan Publications Ltd. Pp.198.
11. Singer, A, 2002. Ecotourism Development – A Manual for Conservation Planners and Managers, Volume 1, the Nature Conservancy, Arlington, Virginia, USA.
12. Stronza, A. and W H. Durham 2008. Ecotourism and conservation In the Americas, CAB International, USA & UK, pp.276, downloadable from <http://www.viewson tourism.info/wordpress/wp-content/uploads/2009/04/ecotourism-and-conservation.pdf>
13. UNEP, 2005. Making Tourism More Sustainable: A Guide for Policy Makers, UNEP, Paris.
14. Wearing, Stephen & John Neil 2006, Ecotourism- Impacts, Potentials and Possibilities, Butterworth-Heinemann Ltd, pp.304.
15. Weaver David B. 2003 The Encyclopedia of Ecotourism, CABI publishing pp.688.
16. Wearing, S and J Neil, 2009. Ecotourism Impacts, Potentials and Possibilities, downloadable from <http://www.sciencedirect.com/science/book/9780750662499>
17. Wood, M,E, 2003. Eco-tourism: principles, practices and policies for sustainability, UNEP, DTIE/ TIES, 61 pp. <http://www.unep-ties.org/tourism/home.html>

# FOREST BOTANY

ECOL: 465

CREDITS: 3

**UNIT-I** Floristic diversity of tropical forests and causes of high diversity; Predominant tropical plant families and their species diversity; Outlines of principles of plant Systematics and type concept; Study of selected major tropical plant families, with details on (i) distribution (ii) diagnostic features/Field recognition features (iii) description (iv) ecological and economic importance of at least 5 species in each family: Families: Dipterocarpaceae, Myrtaceae, Caesalpiniaceae. **(8 Hours)**

**UNIT-II** Forest botany as a field endeavour: Key field characters and family/species recognition using field keys. Floras and their usage: Emphasis on Asian Floras Families: Rubiaceae, Verbenaceae, Myristicaceae. **(8 Hours)**

**UNIT-III** Plant preservation techniques; Herbaria - scope and need; world and regional herbaria; Botanic gardens; Botanical Survey of India: Organisation and role. Families: Lauraceae, Euphorbiaceae. **(8 Hours)**

**UNIT-IV** Families: Moraceae, Arecaceae  
Forest resources: Timber resources: Major tropical timbers: Teak, *Dalbergia*, *Petrocarpus* and Neem. **(8 Hours)**

**UNIT-V** Medicinal Plant resources: Selected ten plants: Name, part used active constituents, uses and distribution: *Adhatoda*, Licorice, *Cinchona*, Periwinkle (*Catharanthus roseus*) *Phyllanthus amarus*, *Acalypha indica*, *Terminalia chebula*, *Taxus baccata*, Lotus & *Strychnos nux-vomica*. **(8 Hours)**

**One-day/ week-end field trip**

## References:

### Text Books:

1. Mabberley, D. J. 2005. The Plant book. Cambridge University Press.
2. Lawrence, A. & Hawthorne, W. 2006. Plant identification. Earthscan, London. 268Pp.
3. Jones & Leschinger. 1987. Plant Systematics John Wiley.

# MARINE ECOLOGY

**ECOL: 466**

**CREDITS: 3**

**UNIT I** Marine environment –classification-pelagic – benthic –deep sea -Galapagos Archipelago - hydrothermal vents - ecological factors – light-temperature-salinity-hydrostatic pressure. **(8 Hours)**

**UNIT II** Coastal Habitats - sandy – rocky - muddy shores- characteristics- Ecologically sensitive coastal ecosystems - estuaries- mangroves - coral reefs - sea grasses – importance- coastal /marine pollution. **(8 Hours)**

**UNIT-III** Community Succession-primary film-process of fouling-substrate modification-settlement and development-marine fouling & Boring communities-polychaetes-arthropods-bivalves-animal associations. **(8 Hours)**

**UNIT-IV** Marine biodiversity – Biodiversity of coral reefs - mangroves- Bio-diversity conservation Marine Bio Reserves. Great Barrier Reef Programme – Great Nicobar BR- Gulf of Mannar Bio-reserves - International conventions. **(8 Hours)**

**UNIT-V:** Understanding & skill development - Marine fouling- specimen collection - observation - habitat loss with reference to coastal erosion- field observation – report writing. **(8 Hours)**

## **Text Books:**

1. Nybakkar, J.N (1997) Marine Biology-An ecological approach. Addison Wesley, Educational publication Inc.
2. Barnes R.S.K. & Hughes 1999: An introduction to marine ecology. Blackwell Science, NY
3. Levinstein, J.S. 1982 Marine Ecology, Prentice Hall Inc., New Jersey.
4. Odum, E.P. 1987: Basic ecology, Saunders college publications, Philadelphia.

# SCIENCE COMMUNICATION

ECOL: 467

CREDITS: 3

**UNIT-I**Why Science Communication – Philosophy and history of Science Communication of Science in through human history; Informal and formal communication. **(8 Hours)**

**UNIT-II**Communication Media – Tools of communication – voice media – visual media – traditional media – mass communication. **(8 Hours)**

**UNIT-III**Writing to communicate – writing laboratory - How to be effective communicator of science – Specialized tools associated with science. **(8 Hours)**

**UNIT-IV**Electronic media for communication – practice laboratory for effective presentation to lay audience as well as peers. **(8 Hours)**

**UNIT-V**Communicating complex ideas to lay and young audience – communicating controversial ideas; communication for policy making and conflict resolution. **(8 Hours)**

## Reference

MIT Open source:

1. <http://ocw.mit.edu/courses/science-technology-and-society/sts-034-science-communication-a-practical-guide-fall-2011>
2. James G, Paradis and Muriel L. Zimmerman, The MIT Guide to Science and Engineering Communication. MIT Press, UK, 2002.



# HUMAN ECOLOGY

**ECOL: 468**

**CREDITS: 3**

**UNIT-I Introduction:** What is human ecology? The Anthropocene -- Ecosystems under Stress- Exponential human population growth and the consequences in a finite planet- over-view of ecosystem stresses due to habitat destruction, water diversion, deforestation, over-harvesting, pollution (including GHG emission, ozone holes, acid rain), invasive species, zoonotic diseases, loss of biodiversity and degradation of Ecosystem services; Coupled Human –Natural Systems (CHANS) as complex adaptive systems- coevolution and coadaptation; coadaptation in traditional social systems; human migrations –urbanisation and diasasters; tragedy of the commons; coevolution of the social system and ecosystem from traditional to modern agriculture and their socio ecological implications. **(8 Hours)**

**UNIT-II Classical and modern views on the subject;** human ecological processes ( e.g., concentration – dispersion dichotomy, centripetal – centrifugal forces ) and their role in shaping human ecological organization; Human ecological organizations : Physical, socio – economic, cultural; formal / non – formal.**(8 Hours)**

**UNIT-III Ecological imbalance and strategies to combat it :** Ecological imbalances caused by natural factors; human factors; impact on human ecological systems; man’s perception and adjustment to such imbalances; sustainable population and sustainable settlements in the context of a regional ecosystem- linkages between food/nutritional / water/ livelihood/ energy security and sustainability.**(8 Hours)**

**UNIT-IV Changing Concept of Development –** Emphasis on Equality and sustainability – towards human centered development – welfare approach – investment in human capital approach, Physical Quality of Life Index (PQLI), Human Development Index (HDI), Happiness Index and other indices. Population and development- impacts on natural resources and the environment- impacts on the quality of life – health, employment, urbanization, poverty, housing, transport, safe drinking water, sanitation, etc. **(8 Hours)**

**UNIT-V Future perspectives-** Restoration Ecology, Bioregionalism and social/ecological resilience - an integrative framework for socio-ecological research, ecological democracy; climate resilient development- transition to a low carbon/ green economy -leap-frogging traditional development pathways-.Social Tipping Points?**(8 Hours)**

## **Text books**

1. Bates, D G., &n J Tucker, (Eds.) 2010. Human Ecology Contemporary Research and Practice, XIV, pp. 377 23 illus.
2. Dyball, R & B Newell, 2014. Understanding Human Ecology: A Systems Approach to Sustainability Earthscan Ltd Hardback, pp. 234
3. Forman RTT, 2014. Urban Ecology Science of Cities, Cambridge University press, pp.474.
4. Grillo, O. 2014. Biodiversity - The Dynamic Balance of the Planet, Intec, pp. 378 downloadable from <http://www.intechopen.com/books/biodiversity-the-dynamic-balance-of-the-planet>
5. Marten, G G. 2001. Human Ecology - Basic Concepts for Sustainable Development

# BIODIVERSITY

**ECOL: 469**

**CREDITS: 3**

**UNIT-I** Biodiversity: Magnitude and global accumulation of biodiversity; diversification through geological time scale; Levels of biodiversity: Community diversity (alpha, beta and gamma biodiversity), Gradients of Biodiversity (latitudinal, insular), Ecosystems diversity: brief account of Earth's major terrestrial and aquatic ecosystems and their characteristic features.

**(8 Hours)**

**UNIT-II** Species diversity: Inventories and monitoring – case studies of inventories (i) tree diversity in tropical forest – patterns of diversity in Asian, African & Neotropical regions, (ii) Diversity and ecology of lianas, (iii) Litter arthropods: sampling methods and role in nutrient cycling and (iii) small mammals in tropical forests: diversity and role in ecosystem functioning.

**(8 Hours)**

**UNIT-III** Genetic diversity – measurement of genetic diversity, transgenic organisms, Agrobiodiversity and wild relatives of cultigens, Measurement of biodiversity – Species richness & abundances, diversity indices – Shannon, Simpson & Fisher's Alpha. Biodiversity as bio resources – use and values of biodiversity as sources of food, fodder, timber, medicinal and ornamental plants. **(8 Hours)**

**UNIT-IV** Biodiversity and various ecosystem services; Biodiversity prospecting and indigenous knowledge systems, community biodiversity registers. Regulation of biodiversity: Convention on Biological Diversity, National Biodiversity Authority, CITES. Problems in biodiversity regulation. **(8 Hours)**

**UNIT-V** Biodiversity hot spots, hottest hot spots, mega diversity countries, centers of plant diversity and endemism, threats to and loss of biodiversity, deforestation – causes and consequences, Bio invasions; invasive species: wiser use & management. IUCN categories- endangered, threatened, vulnerable, Red Data Books. **(8 Hours)**

## References

### Text books

1. Anne E. Magurran, Brian J. McGill (2011) Biological Diversity: Frontiers in Measurement and Assessment. Oxford University Press. ISBN: 978-0199580675.
2. Berlatsky (2013) Biodiversity – Global Viewpoints. Gale Cengage Publishers. ISBN: 9780737769050.
3. Dadhich LK and Sharma AP (2002) Biodiversity – Strategies for Conservation, APH Publishing Corporation, New Delhi.
4. Gary G. Mittelbach (2012) Community Ecology. Sinauer Associates, Inc.; 1 edition. ISBN: 978-0878935093.
5. Gillespie A (2012) Conservation, Biodiversity and International Law. Edward Elgar Publishing ISBN: 9780857935151.

6. Janet Franklin (2010) Mapping Species Distributions: Spatial Inference and Prediction (Ecology, Biodiversity and Conservation). Cambridge University Press. ISBN: 978-0521700023.
7. Julie L. Lockwood, Martha F. Hooper and Michael P. Marchetti (2013) Invasion ecology (2nd edition) Wiley-Blackwell, Chichester. ISBN 978-1-4443-3364-0.
8. Krishnamurthy KV (2003) An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.
9. Singh JS, Singh SP and Gupta SR (2014) Ecology, Environmental Science and Conservation. 4<sup>th</sup> Edition. S. Chand & Company Pvt. Ltd.

#### **10. Web References**

11. [www.cites.org](http://www.cites.org); [www.fao.org/Ag/agp/agpc/doc/Publicat/TAPAFON/TAP\\_7.pdf](http://www.fao.org/Ag/agp/agpc/doc/Publicat/TAPAFON/TAP_7.pdf);  
[www.iucn.org](http://www.iucn.org); [www.wri.org/biodiv/bp-home.html](http://www.wri.org/biodiv/bp-home.html);  
[www.jamaicachm.org.jm/DHS/conservation.htm](http://www.jamaicachm.org.jm/DHS/conservation.htm); [www.cbd.int](http://www.cbd.int)

# COASTAL ZONE MANAGEMENT

ECOL: 471

CREDITS: 3

## **UNIT-I An introduction to ICZM:**

Definitions- Integration, coastal zones, management, Governance, Integrated Coastal zone management; need, scope, potentials and constraints for ICZM.(8 Hours)

## **UNIT-II Coastal zones and their uses**

Land–sea interactions, multiple uses of the Coastal zones and conflicts; Coastal settlements- human impacts on the Coastal zones with special emphasis on artisanal fishing, Coastal aqua-culture and Coastal tourism.(8 Hours)

## **UNIT-III Critical coastal habitats**

Coastal vulnerability - Mangroves, wetlands, sand dunes, sea-grasses, lagoons and enclosed seas, islands, coral reefs and other protected areas.(8 Hours)

## **UNIT-IV Major ICZM concepts, principles and methodologies:**

Major principles and premises ICZM/ICAM and Coastal Resources Management Programme (CRMP)- Ecological land use/water use planning; An overview of Environmental monitoring - Ecological and Social indicators, Ecological foot prints, EIA, Ecological Economics, GIS & remote sensing for ICZM; Application of PRA &RRA, Stakeholder analysis, conflict resolution strategies, local knowledge and management systems and integrated systems approach; the coastal commons and their management; Artificial reefs; Co-management; Coastal information management & communication - Basic Principles.(8 Hours)

## **UNIT-V ICZM Legislation, regulations, policies and planning**

The Coastal management cycle- issue identification and assessment; Need and scope for evolving participatory, community based/community run ICZM strategies with special emphasis on poverty eradication and gender equity for coastal Biodiversity conservation/management; Legal principles/regulations to support ICZM; Experiences and case studies from around the world.(8 Hours)

## **REFERENCES**

1. Beatley T, D. J Brower &A. K Schwab, 2002. An Introduction to Coastal Zone Management , Second Edition , Island Press, pp. 285
2. Belfiore, S, M, Balgos, B McLean, J Galofre, M Blaydes, and DTesch, 2003. A reference guide on the use of indicators for integrated coastal management. in collaboration with: Department of Fisheries and Oceans, Government of Canada,National Oceanic and Atmospheric Administration, Center for the Study of Marine Policy & Intergovernmental Oceanographic Commission of UNESCO, pp.138.
3. Brown, K, E L. Tompkins and N Adger, 2002.Making Waves - integrating coastal conservation and development, Earth Scan.

4. Cicin-Sain, B., Knecht, R.W., Vallega, A. and Harakunarak, A. (2000) Education and training in integrated coastal management: lessons from the international arena. *Ocean and Coastal Management* 43, 291-330.
5. Christie, P, 2005. Is Integrated Coastal Management Sustainable? *Ocean & Coastal Management* 48 , 208–232
6. Clark,J.R, 1994. Integrated management of coastal zones.FAO Fisheries Technical Paper. No. 327. Rome, FAO, pp.167. <http://www.fao.org/DOCREP/003/T0708E/T0708E00.HTM>
7. Clark, J.R, 1995. *Coastal Zone Management Handbook*, CRC Press.
8. Chua, T-E and D.Pauly, (Ed.). 1989. *Coastal area management in South East Asia; policies, management strategies and case studies*, ICLARM Proc.19, pp. 254.
9. Meltzer, E. (1998). International review of Integrated Coastal zone management<http://www.oceansconservation.com/iczm/meltzer1.htm>;
10. Puthucherril , T, G, 2015. *Institutionalizing Integrated Coastal Zone and Coastal Climate Change Adaptation in South Asia- towards Sustainable Coastal development*, Brill Academic Pub, rill\Nijhoff, pp.490.
11. UNEP, 2002.*The UNEP Handbook on the Development and Implementation of a National Programme of Action for the Protection of the Marine Environment from Land-based Activities*, pp42.

## PLANT - ANIMAL INTERACTIONS

ECOL: 472

CREDITS: 3

**UNIT-I** Ecology and evolution of antagonistic and mutualistic relationships between plants and animals. Role of plants and animals in global ecosystem services, pharmaceutical industry. Case studies. Evolution of interaction, principle of allocation. **(8 Hours)**

**UNIT-II** Pollination Ecology- Evolution of pollination systems. Floral morphology and adaptations for pollination: pollination syndromes. Sexual and breeding systems. Pollinator diversity. Global patterns of diversity and distribution of pollinators. Foraging ecology of pollinators and pollen flow. Obligate pollination systems. Figs and fig wasps, orchids and euglosine bees, mistletoes and birds. **(8 Hours)**

**UNIT-III** Frugivory and Seed Dispersal- Evolution of fruit type and frugivory. Fruity syndromes and fruit types. Keystone fruit resources and dispersal. Seed shadow seed predators Seed dispersal and forest structure/ mega faunal dispersal. **(8 Hours)**

**UNIT-IV** Herbivory - Plant-herbivore interactions, quantitative and qualitative defenses, animal offence chemistry of plants defenses, grazing systems, ant-plant mutualisms, ecological effects of herbivores on plant population communities. **(8 Hours)**

**UNIT-V** Conservation Mutualisms- Global declines in pollinators and frugivores due to habitat loss, fragmentation, pesticide use and hunting. Effects on plant populations. Global conservation efforts. **(8 Hours)**

### **References:**

#### **Text books**

1. Herrera, C.M. and Pellmyr, O. 2003. Plant animal interactions: an evolutionary approach. Blackwell publishing, UK.
2. Howe, H.F. and Westley, L. 1988. Ecological relationships and animals. Oxford University Press, oxford.

# COMMERCE AND ENVIRONMENT

**ECOL: 473**

**CREDITS: 3**

**UNIT-I** Sustainability is increasingly used as a unifying concept to help us grasp such varied topics as global warming, fossil fuel prices and scarcity, trends in wealth and income levels and distribution, diversity, renewable energy education and social justice. A companion concept that came into use in the late 1990s is the “triple bottom line.” It suggests that balanced social, environmental, and economic performance by companies contributes to the sustainable development of the communities and regions where they operate, and is of strategic importance to their long-term performance. **(8 Hours)**

**UNIT-II** Ecology of Food, Water, Energy and their connections to heating, lighting, transportation and human health; Climate Change: Understanding, Measurement and Mitigation; Responses from corporations; Bridging the business world with ecological responsibilities; Foundations of Sustainable Business. **(8 Hours)**

**UNIT-III** Emerging Sustainability Issues for Business in the next decade; NGO – Business Partnership in Corporate Social Responsibility; Governments and Corporations; Major global corporate sustainability initiatives , certification systems, Eco labeling; socially responsive investing; Carbon Taxes. **(8 Hours)**

**UNIT-IV** Corporate Accounting and Auditing for Sustainability and Life Cycle Assessment; Strategic Management for Sustainable Enterprise /Small Planet - Application of the strategy “toolkit,” especially strategy maps & matrix. **(8 Hours)**

**UNIT-V** Specific Cases involving corporate sustainability issues – Interface, Coca Cola, Citigroup and JPMorgan Chase, Wal-Mart etc., Performance in Environmental technologies and its impact on business measures such as profits, dividends and capital formation. Exploring alternatives to BAU in energy sector; Green and the Competitive: ending the stalemate; Environmental Safety and Poverty alleviation as an integral part of Compliance. **(8 Hours)**

## **References:**

### **Text Books**

1. Richard Welford and Richard Starkey: Business and The Environment Universities Press, 1996

### **Supplementary books**

1. David Hunt and Catherine Johnson: Environmental Management Systems, McGraw-Hill 1995
2. Peter Roberts, Environmentally Sustainable Business : A local and Regional Perspective , Paul Chapman Publishing 1999

# ORNITHOLOGY

**ECOL: 474**

**CREDITS: 3**

**UNIT-I** Introduction to bird study. Avian phylogeny. Bird anatomy and physiology. Adaptation and evolution of flight and feathers. Identifying birds in the field. **(8 Hours)**

**UNIT-II** Evolutionary and history of birds in the light of recent fossil evidence. Avian biogeography, diversity and distribution. Adaptive radiation of birds: recent evidence. **(8 Hours)**

**UNIT-III** Ecology and evolution of migration: long distance and local migration. Cues used for migration. Recent evidence and case studies, Modern tools to study migration biology. **(8 Hours)**

**UNIT-IV** Bird Song, Anatomy, function, learning, inter and intraspecific communication, signals and deception. Case studies. **(8 Hours)**

**UNIT-V** Global efforts for bird conservation, red data book, important bird areas, declines of Indian birds, endangered species. **(8 Hours)**

## References:

### Text books

1. PETTINGILL, OS JR. (1961). A laboratory and field manual of ornithology. Burgers publishing Co. Minnea Polis (latest edition).
2. ALI, S and RIPLEY, D 1989. Hand book of the birds of India and Pakistan (Compact edition), Oxford University Press.



# BIOINDICATORS

**ECOL: 475**

**CREDITS: 3**

**UNIT-I** Introduction and concept of Eco-remediation- indicators and markers- significance of remediation for ecological health. **(8 Hours)**

**UNIT-II** Composting – introduction- nutrient source-major types-Open-air systems, enclosed systems- advantages, Vermicomposting–earthworm biology-physiology-end products-process and characteristics. **(8 Hours)**

**UNIT-III** Bio stimulation- concept- uses and advantages – biological properties; Bio augmentation – types – Bacteria and Fungi with examples; Bio surfactant-microbial degraders- sub surface agents- types of bio surfactants and microorganisms. **(8 Hours)**

**UNIT-IV** Chemotaxis–bacterial cells–temporal changes-chemical stimuli- positive and negative stimuli- examples. **(8 Hours)**

**UNIT-V** Phytoremediation – role of roots –specific characteristics- process with specific examples. **(8 Hours)**

## **Reference books:**

### **Text Books:**

1. Microbial Ecology by Atlas RM, Bartha R Pearson Education, Singapore 2000.
2. Bioremediation and Biodegradation by Alexander Martin, Academic Press, NewYork, 1999.

### **Supplementary Books:**

1. Applied Bioremediation and Phytoremediation by Ajay Singh, Owen P Ward, Springer, New York, 1999.
2. Phytoremediation and Rhizoremediation by [Mackova, Martina Dowling, David and Macek thomas Eds.](#) Springer, NewYork, 2002.
3. Wastewater Engineering – Treatment, Disposal & Reuse.
4. Metcalf & Eddy, Inc. Tata McGraw Hill, New Delhi. Current edition, 2003.

# ENVIRONMENTAL BIOCHEMISTRY & GENOMICS

**ECOL: 476**

**CREDITS: 3**

**UNIT-I** Environmental Biochemistry- Definition, scope. Understanding biochemical aspects in relation to environmental science and technology; Environmental biochemistry in relation to chemistry. **(8 Hours)**

**UNIT-II** Environmental physiology with considerations of intermediary metabolism- approaches for studying energy metabolism and body temperature changes; Thermo regulation and adaptation. **(8 Hours)**

**UNIT-III** Oxygen uptake from the environment, respiration and metabolism. Electron transport system and oxidative phosphorylation. Photosynthesis: C1, C3, C4 pathways and their regulation. Photorespiration. **(8 Hours)**

**UNIT-IV** Biochemistry of altered membrane permeability, free radical formation, lipid peroxidation, lysosomal degradation, superoxide dismutase. Environmental pollutants and their effects on living system. Biochemical approaches to the detoxification of xenobiotics through cellular metabolism. **(8 Hours)**

**UNIT-V** Gene expression profiling, whole genome and chromosome mutation detection, and methods to assay genome diversity and polymorphisms within a particular environment. Environmental impact and ensuring human health and the sustainability of natural populations. **(8 Hours)**

## **References:**

### **Text Books:**

1. Neelima Rajvaidya, Dilip Kumar Markandey, 2005. Environmental Biochemistry, KulBhushan Nangia A.P.H. Publishing corporation.
2. **Martin, C. Cristofre** (Ed.). 2008. Environmental Genomics. Springer edition.

### **Supplimentary Books:**

1. **Martin, C. Cristofre** (Ed.). 2008. Environmental Genomics. Springer edition.
2. Klaus H. Hoffman, Berlin. 1985. Environmental physiology and biochemistry of insects. Pringer-Verlag.
3. Harborne J.B. 1977. Introduction to ecological biochemistry. Academic press, London.
4. Alberto Frigerio, 1981. Recent development in mass spectrometry in biochemistry, medicine, and environmental research, 8: proceedings of the 8<sup>th</sup> International symposium on mass spectrometry in biochemistry, medicine, and environmental research. Elsevier Scientific Pub. Co.,

## MARINE BIODIVERSITY & CONSERVATION

ECOL: 477

CREDITS: 3

**UNIT-I** Introduction to Biosphere – hydrosphere – sea and its environments- different zones –characteristics – importance of habitat diversity.(8 Hours)

**UNIT-II**Ecologically sensitive coastal Habitats - Inter tidal -sandy – rocky - muddy habitats- biotic resources – Resourceful coastal ecosystems - mangroves - coral reefs - sea grasses – seaweeds- diversity and importance. (8 Hours)

**UNIT-III** Factors influencing biodiversity shrinkage –habitat destruction – coastal tourism – commercial fishing – unregulated fishing operations –dredging and benthic habitat loss - by-catch waste-impact of aquaculture-oil pollution-ballast water and oil spills. (8 Hours)

**UNIT-IV** Marine Biodiversity conservation– programmes – World Marine Bio-Reserves – Great Barrier Reef Programme – Great Nicobar BR-Gulf of MannarBio reserves - International conventions-IUCN. (8 Hours)

**UNIT-V**Field visit to fish landing centres – observation on by catch waste-unregulated fishing gears used – knowledge about fishing regulation –craft and gears used – a regional outlook-report writing. (8 Hours)

### **References:**

#### **Text Books**

1. Seshappa,G Indian Marine Biology, Tamil nadu Book House, Chennai 1997
2. Sinha,R.K. Marine resources and applicable law, Tamilnadu Book House, Chennai, 1997.Boaden.PJ.S. An introduction to coastal ecology, NPH, Delhi 1995.
3. Yadav. B.N. Fish and fisheries, NPH, Delhi, 1995.
4. Nybakkan,J.N (1997) Marine Biology-An ecological approach.AdditonWesley,Eduational publication Inc.

# BIOLOGICAL INVASIONS

ECOL: 478

CREDIT: 3

**Unit-I** Biological invasions: Introduction- Elton's hypothesis – Invasion patterns and Process- Biological attributes for invasion: Reproductive potential Allelopathy – Phenotypic plasticity- fitness to the new environment. **(8 Hours)**

**Unit-II** Hypotheses for invasion success: Natural enemy hypothesis- Evolution of invasiveness hypothesis-Empty niche hypothesis-Novel weapon hypothesis- Disturbance hypothesis and Propagule pressure hypothesis - worst 100 invasive species- Databases for biological invasions. **(8 Hours)**

**Unit-III** Marine bio invasions: Introduction- Natural and climate change mediated invasions-vectors of marine invasions- Biofouling- Ballest water management – establishment of marine invasive species -Ecological factors affecting community invisibility- case study: *caulerpa*. **(8 Hours)**

**Unit-IV** Impacts and Management of Invasions: Impacts of exotics on Biodiversity- Productivity- Nutrient cycling. Management: Biocontrol programmes- Mechanical and chemical control- Positive utilization- Quarantine and EIA assessments. **(8 Hours)**

**Unit-V** Current developments in invasion studies: Global climate change and bioinvasions – Economic damage caused by invasive species- Economic development and biological invasions - Mathematical models for biological invasion – Role of remote sensing in invasion studies. **(8 Hours)**

## Reference:

1. Elton, C.S. 1958. *The Ecology of Invasion by Plants and Animals*. Methuem, London.
2. Herro, J.L. Maron, J.L. and Callaway, R.M. 2005. Allelopathy and exotic plant invasions. *Plant and Soil*, **256**: 29-39.
3. Pimentel, D., McNair, S., Janecka, J., Wightman, J., Simmonds, C., O'Connell. C., Wong. E., Russel, L., Zern, J., Aquino, T. and Tsomondo, T. 2001. Economic and environmental threats of alien plants, animal, and microbe invasions. *Agriculture, Ecosystems and Environment*, **84**: 1-20.
4. Ramakrishnan, P.S. 1991. *Ecology of Biological Invasion in the Tropics*. International Scientific Publications, New Delhi,
5. Ramakrishnan, P.S., *Shifting Agriculture and Sustainable Development*, UNESCO, MAB, Paris, 1992.
6. Rilov, G. and Crooks. (2009). Biological invasions in marine ecosystems- ecological, Managemant and Geographic Perspectives. Springer-Verlag, Berlin Heideberg.
7. Sharma, G.P., Singh, J.S. and Raghubanshi, A.S. 2005. Plant invasions: emerging trends and future implications. *Current Science*, **88**: 726-734.
8. Singh, S.P., *Biological Suppression of Weeds*. Biological Control Centre, Bangalore, 1989.
9. Williamson, M. 1996. *Biological Invasion*, Chapman & Hall, London.

## **INSTRUMENTATION TECHNIQUES IN ECOLOGY& ENV. SCIENCES**

**ECOL: 479**

**CREDITS: 3**

**UNIT-I Basics of Microscopy**-Features, Working principle, Advantages and limitations  
Introduction- Bright field Microscopy, Dark Field Microscopy, Light microscopy-Construction and working of compound microscope  
Phase contrast microscopy, Electron microscopy-TEM, SEM. **(8 Hours)**

**UNIT-II Staining methods** - Simple staining; Gram staining  
Lactophenol cotton blue staining. **(8 Hours)**

**UNIT-III Optical Methods**- Features, Working principle, Advantages and limitations  
Absorption Methods; Ultraviolet Spectrophotometer; Infrared spectrophotometer  
Emission methods; Atomic Absorption Spectrophotometer (AAS)  
Flame Photometry. **(8 Hours)**

**UNIT-IV Chromatography methods**- Features, Working principle, Advantages and High Performance liquid chromatography (HPLC) Gas Chromatography. **(8 Hours)**

**UNIT-V Biotechnology and Immunological techniques**- Features, Working principle, Advantages and limitations  
Electrophoresis –Introduction, Types of elctrophoresis, Agarose gel electrophoresis, Gradient gel electrophoresis, DNA finger printing  
PCR Technique  
ELISA (Enzyme Linked ImmunoSorbant Assay) **(8 Hours)**

### **Reference Books:**

1. Environmental Science and biotechnology-Theory and Techniques, A. R. Murugesan and C. Rajakumari, MJP Publishers-2005
2. Bioanalytical Techniques, M. L. Srivastava, Narosa Publishing House-2008
3. Elements of Analytical Chemistry, R.Gopalan, P.S.Subramanian and K.Rangarajan, Sultan Chand and Sons-2007
4. Biochemical methods, S.Sadasivam and A. Manicham, New Age International Publishers-2007

## ECOLOGY OF MEDICINAL PLANTS

ECOL: 480

CREDITS: 3

**UNIT-I Introduction, Definition and classification of Medicinal plants:** Introduction to medicinal plants and its definitions; History of medicinal herbs, shrubs and trees; Classification based of adaptation Eg. Jujube, *Zizyphus jujube*. Rhamnaceae. Culture: Location, soil, irrigation, fertilization, pruning, propagation, pest and disease; classification of Ornamental plants, Classification based on hardiness plants. **(8 Hours)**

**UNIT-II Ecology, Distribution and Diversity of Medicinal plants and Economic importance:** Distribution and Diversity of Medicinal herbs, shrubs and trees- worldwide and India; Ecological study of important indigenous medicinal plants and its agriculture practice for cultivation. Uses of traditional medicinal plants; active constituents of medicinal plants ant its uses; Dietary products from medicinal plants; Medicinal plant extracts and psychotherapeutics; value added products from medicinal plants. **(8 Hours)**

**UNIT-III Cultivation, Management and conservation strategies for Medicinal Plants:** Ecological farming systems- objectives of ecological farming-history, major aims, concept and needs: Nature farming; Regenerative agriculture; permaculture; Bio-dynamic farming; Mulching practices. Threats to medicinal plants; IUCN red listed medicinal plants. **(8 Hours)**

**UNIT-IV Need for conservation:** *In-situ* conservation- Sustainable management of medicinal plants; *Ex-situ* Conservation- ethno medicinal plants garden, nurseries, gene banks; medicinal plant data base; Herbarium. **(8 Hours)**

**UNIT-V Present status and future strategy for medicinal plants:** Status of traditional medicinal plants; Global and domestic herbal market; National medicinal plants board; Globalization of medicinal plant sectors; Development of medicinal plant sector. Role of planning commission and world health organization to maintain for future strategy for medicinal plants. **(8 Hours)**

### Text Books:

1. Purohit, S.S. and S.P. Vyas. Medicinal plants- Cultivation-A Scientific Approach. Agrobiosindia(2007). ISBN:81-7754-214-1.
2. Chopra, A.K., D.R. Khanna. G.Prasad, D.S. Malik and R. Bhutiani 2007. Medicinal plants: Conservation, Cultivation and Utilization. Daya Publishing house, Delhi. ISBN 81-7035-486-2
3. K. Janardhan Reddy; BirBahadur; B Bhadraiah and MLN Rao. Advances in Medicinal plants: Universities Press, 2007, pbk, ISBN:81-7371-588-2

# ENVIRONMENTAL INFORMATICS AND SPATIAL MODELING

**ECOL - 481**

**CREDIT: 3**

**Unit– I** Introduction to environmental informatics, components, history and developmental stages, introduction to environmental resources, their interrelations and significance, land resources - soil, forest, biodiversity, water resources – inland water resources and ocean; conventional resources management and disadvantages, need for environmental informatics. **(8 Hours)**

**Unit–II** Data collection and management: Data – definition, database management system (DBMS), significance of DBMS, data types, data storage, data query and retrieval; spatial and non-spatial data; spatial data structure – raster data, vector data; thematic and attribute data, hardware and software requirements. **(8 Hours)**

**Unit–III** Information extraction: Resource information extraction from aerial survey – air born data, space born data, global positioning system, topographical maps, climatic data – temperature, rainfall; spatial database creation - thematic maps, definition, types of thematic maps, components of map, scale of map, abstraction, mapping accuracy; digital database creation – scanning and digitization; non-spatial database creation. **(8 Hours)**

**Unit–IV** Analysis and spatial modeling: definition, principles – data input, process, output; data layers – class value/weightage, layer value/weightage; data integration in GIS domain – grid data, cell size, spatial environment; spatial analysis: proximity/buffer analysis, overlay analysis, arithmetic overlay, weighted overlay; case study - environmental suitability modeling for afforestation, environmental vulnerability modeling for forest fire. **(8 Hours)**

**Unit–V** Information systems: Components, structure, organization, maintenance, updating, advantages and limitations of following information systems - agriculture information system, forest information system, biodiversity information system, soil information system, ocean information system. **(8 Hours)**

## **Text Books:**

1. Goodchild, M.F., Parks, B.O., Steyaert, L.T., (Eds.), 1993. Environmental Modeling with GIS (Spatial Information Systems) Oxford University Press, USA, 520 pages, ISBN-13: 978-0195080070.
2. Agarwal, S.K., 2002. Eco-informatics, APH Publishing Corporation, 1535 pages, ISBN-13: 978-8176483247.
3. Jorgensen, S. E., Chon, T-S., Recknage, F. A., 2009. Handbook of Ecological Modeling and Informatics, WIT Press, 448 pages, ISBN-13: 978-1845642075.

## **Reference Books:**

1. Coronel, C., Morris, S., Rob, P., 2009. Database Systems: Design, Implementation and Management, 9<sup>th</sup> Ed., Course Technology, 700 pages, ISBN-13: 978-0538748841.
2. Maguire, D., Batty, M., Goodchild, M., (Eds.) 2005, GIS, Spatial Analysis, and Modeling, Esri Press, 496 pages, ISBN-13: 978-1589481305.

# EVOLUTION

ECOL - 482

CREDIT: 3

**UNIT-I** Introduction - Scaling and the hierarchical structure of biology, levels of approach in biology, domain of ecology, definitions and ground work; anthropocentrism, the importance of wild organisms in pristine natural environments, the urgency of basic ecological research; scientific methodology; models; multiple causality; limiting factors, tolerance limits, the principle of allocation; natural selection, self-replicating molecular assemblages; units of selection. **(8 Hours)**

**UNIT-II** Population Structure - Population of communities and structure ; factors affecting populations; population "cycles," cause and effect; use of space (vagility, home range, territoriality, foraging tactics); evolution of sex; sex ratio; mating systems; sexual selection; fitness and the individual's status in the population; kin selection, inclusive fitness; reciprocal altruism, parent-offspring conflict. **(8 Hours)**

**UNIT-III** Interaction amongst species Competition and Niche Theory: Lotka-Volterra equations and competition theory; diffuse competition; niche overlap and competition; niche dimensionality; niche breadth (specialization versus generalization); evolutionary consequences; laboratory and field experiments; other evidence from nature; future prospects. Predation: Theory; predator-prey oscillations; aspect diversity; "prudent" predation and optimal yield; evolutionary consequences; predator escape tactics; adaptive coloration; mimicry; warning calls; coevolution; plant-herbivore interactions and plant-appetency theory; parasitism; Darwinian medicine; selected other observations and experiments. **(8 Hours)**

**Unit-IV** Evolution of Communities Phylogenetic systematics, independent contrasts, the comparative method, evolutionary Eco morphology, recovering the history of the vanishing book of life on Earth Macro descriptors; compartmentation in communities (trophic levels, guild structure, and food webs); connectance; pyramids of numbers, biomass, and energy; energy flow and ecological energetics; secondary succession and transition matrices; community matrix; saturation with individuals and with species; species diversity; diversity of lowland rainforest trees; community stability; types of stability; chaotic attractors; evolutionary convergence and ecological equivalents; evolution of communities; pseudo-communities. **(8 Hours)**

**Unit-V** Biogeography - Distribution of communities and island biogeography; examples. **(8 Hours)**

## Text

Evolutionary Ecology by E R Pianka



# GENETICS AND MOLECULAR ECOLOGY

ECOL - 483

CREDIT: 3

**UNIT-I** Introduction and scope of Genetics, DNA as genetic material, Basic structure of DNA and RNA. DNA replication: Messelson and Stahl Experiment, Carins Experiment, Okazaki Experiment, Basic mechanism of DNA replication. Cell division and Cell cycle: Mitosis, Meiosis, Chromosomal basis of inheritance. **(8 Hours)**

**UNIT-II** Basic Principles of Mendelian Inheritance: Segregation and Independent Assortment, Alleles and Multiple Alleles, Human pedigrees and inheritance. Gene Interaction: Fine Structure of gene and gene concept: Fine structure of rII gene – Benzer's experiments, complementation analysis and fine structure of gene, Complementation and recombination, concept of gene. Bacterial Genetics: Transformation, Conjugation, Transduction. **(8 Hours)**

**UNIT-III** Chromosome Structure: Centromeres, Telomeres. Mutations, Spontaneous and induced mutations, Chromosomal mutation and aberrations, Change in chromosome number: trisomy and polyploidy. Changes in chromosome structure, Properties of chromosomes for detection of structural changes. Mechanism of chromosome mutations genetic and cytological features of deletions, Duplications, inversions and translocations, Somatic vs germinal mutation. **(8 Hours)**

**UNIT-IV** Population genetics: application of Mendel's laws to whole population, Calculation of allele frequencies, HardyWeinberg principal for: Calculating recessive gene frequency, Calculating frequency of sex –linked alleles. **(8 Hours)**

**UNIT-V** History of molecular ecology, Molecular biology for ecologists, Molecular identification: species, individuals, and sex, Behavioural ecology, Population genetics, Molecular and adaptive variation, Phylogeography, Conservation genetics, Microbial ecology and the metagenome, genetically modified organisms. **(8 Hours)**

## Text Books

1. Introduction to Genetic Analysis, 9<sup>th</sup> edition by Griffiths et al, 2008
2. Concepts of Genetics, 9<sup>th</sup> edition, 2009 by Klug et al
3. Principles of Genetics by Snustad et al (2004)
4. **An introduction to molecular ecology**, Trevor J. C. Beebee , Graham Rowe, 2. ed. : Oxford : Oxford University Press : 2008 : 400 s. : ISBN: 978-0-19-929205-9.

# ADVANCED WATER TREATMENT TECHNOLOGIES

**ECOL: 484**

**CREDITS: 3**

**UNIT-I**Water- introduction, unique physical and chemical properties and its significance, water quality scenario in India, specifications for drinking water (physical, chemical and bacteriological) by Bureau of Indian standards, World Health Organization, packaged drinking water. **(8 Hours)**

**UNIT-II**Water quality parameters-physical, chemical and biological, indicator organisms, testing for coli form bacteria, water sampling and preservation techniques. **(8 Hours)**

**UNIT-III**Drinking Water Treatment- pretreatment, sedimentation, coagulation, flocculation, filtration, disinfection- chlorination advantages and disadvantages, chlorination chemistry, break point chlorination, factors affecting chlorination, UV irradiation, ozonation. **(8 Hours)**

**UNIT-IV**Other treatment technologies- water softening-chemical precipitation and non-chemical precipitation methods, aeration, activated carbon, membrane filtration processes, membrane fouling, reverse osmosis, desalination. **(8 Hours)**

**UNIT-V**Green technologies- solar disinfection (SODIS), photo catalytic oxidation process for water treatment- titanium dioxide photo catalysis, point-of-use (POU) home devices for drinking water treatment, introduction to nanotechnology, environmental applications and implications. **(8 Hours)**

Field visit to drinking water treatment plant, observation and report writing

## **Text books**

1. Wastewater Engineering – Treatment and Reuse. Metcalf & Eddy, Inc.-4<sup>th</sup> ed. Tata McGraw Hill Publishing Company Limited, 2003, New Delhi.
2. Water Quality Monitoring – A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programmes. Edited by Jamie Bartram and Richard Balance; Published on behalf of United Nations Environment Programme and World Health Organization, 1996.

## **References**

1. Standard Methods for Examination of Water and Wastewater, American Public Health Association (APHA), Clesceri, A.E., Greenberg, A.D.Eaton.1998, Washington.
2. Water Quality and Treatment; a Hand Book on Drinking Water; American Water Works Association and James Edzwald, 2010.
3. Nanotechnology- Environmental Implication and Solutions  
Louis Theodore and Robert G. Kunz, John Wiley & Sons, INC., Publication, 2005

## ECO CITY & SUSTAINABILITY

**ECOL: 485**

**CREDITS: 3**

**UNIT-I** Introduction: Eco Campus/ Eco city & sustainability-definitions - need, scope and importance in India. **(8 Hours)**

**UNIT-II**Campus/city Sustainability tools part 1 – campus/city soil/water/bio-diversity assessment; Energy /environmental monitoring of the operations – energy auditing of buildings and all other operations, environmental impact assessment of all campus activities – analysis of water /carbon /ecological foot prints of campus /city operations – GHG emission inventory (will include offsite impacts too); **(8 Hours)**

**UNIT-III**Campus/city Sustainability tools part 2- biodiversity assessment; changes in soil profile/quality; measurement of water table levels/water quality and potential for harvesting rain water, reuse of grey water; characterization/ quantification of all campus solid wastes and percentage solid wastes recycled. **(8 Hours)**

**UNIT-IV**Campus/city Sustainability tools part 3 - Potential for energy/nutrient /cost savings by adopting eco-technologies such as biogas, value added compost, reuse of metal/plastic/paper wastes life cycle analysis of all campus/city operations; economic analysis of campus operations, Sustainability Tracking, Assessment and Rating System (STARS). **(8 Hours)**

**UNIT-V**Campus /city sustainability field work plan - University presentation.**(8 Hours)**

**UNIT-VI**Campus /city sustainability field work final report - Public presentation. **(8 Hours)**

### **Text Books**

1. Jones, P., Selby D., and Sterling S. (Ed). (2010), "Sustainability Education- Perspectives and Practice across Higher Education", Earthscan, UK. pp.384
2. Walter Leal Filho(Ed), 2012. Sustainable Development at Universities: Series: Environmental Education, Communication and Sustainability, Peter Lang Scientific Publishers: Frankfurtam Main, Berlin, Bern, Brussels, New York, Oxford, Vienna, pp 994.

## CONTEMPRORY ENVIRONMENTAL ISSUES

**ECOL: 486**

**CREDITS: 3**

**UNIT-I** Global warming- industrial sectors- refrigeration & air conditioning, Cleaning solvents- Aerosols- Sterilants, Adhesives, coating and inks, Substitutes, Alternative policy programs. **(8 Hours)**

**UNIT -II**Earth summit 2002- elements – social conservation- strengthening and means of implementation. **(8 Hours)**

**UNIT-III** Montreal Protocol, international action- UN frame work convention on Climate Change, Vienna convention, Intergovernmental Panel on climate change. **(8 Hours)**

**UNIT-IV**Kyoto Protocol – Developed vs. Developing nations- Clean development mechanisms. **(8 Hours)**

**UNIT-V**Antarctic Treaty- to demilitarize Antarctica, a zone free of nuclear tests and the disposal of radioactive waste, and to ensure that it is used for peaceful purposes only; to promote international scientific cooperation in Antarctica; to set aside disputes over territorial sovereignty. **(8 Hours)**

**References:**

**Text Books:**

1. Climate change- Biological and Human aspects by Jonathan Courie, Oxfiordpubl, 2002.
2. Environmental Chemistry By G.S.Sodi

## **FOREST ECOLOGY**

**ECOL: 561**

**CREDITS: 3**

**UNIT-I** Tropical forest types, Structure and biota: Rain forests and monsoon forests semi-evergreen, deciduous forests, tropical dry evergreen forests and mangroves; distribution and characteristics. Forest synusia; stratification, growth forms in plant life and seasonal rhythms; Animal life: Richness, diversity and carrying capacity. Niches in the forests and their utilization by animals. **(8 Hours)**

**UNIT-II** Plant species diversity and its maintenance: Tropical forest Tree & Liana diversity; Analysis of population structure of forest trees, regeneration status and implications for conservation; Diversity & ecology of forest understory species. **(8 Hours)**

**UNIT-III** Forest functioning: Growth of the forest, plant-plant interaction: Diversity & ecology of epiphytes: Complex web of floral, faunal interactions and implications for conservation. **(8 Hours)**

**UNIT-IV** Forest dynamics: Micro climates, disturbance regimes in forests: tree falls and gap dynamics; silviculture & forest regeneration, tree species recruitment and mortality and stand dynamics. **(8 Hours)**

**UNIT-V** Nutrient cycling in forests: Soils and their nutrients; nutrient uptake and Accumulation in biomass; Nutrient return to the system: litter fall, seasonality and litter decomposition; nutrient conserving mechanisms in forest. Role of arthropods, birds and mammals in forest functioning. Mycorrhizae and forests; Forests and forestry in India; Sacred groves; Social forestry and Agro-forestry Human impacts on forests: Population growth and forests timber extraction; Non-timber forest produce; Rainforest destruction; Trends and causes for concern; Management and conservation of tropical forests. **(8 Hours)**

### **References:**

#### **Text Book:**

1. Richards, P.W. 1996. Tropical rainforest. 2<sup>nd</sup> Edition Cambridge Univ. Press.
2. Sutherland, W.J. 2000. The Conservation Handbook. Blackwell. Oxford. 278p.
3. Whitmore, T.C. 1990. An introduction to Tropical rain forests. Clarendon Press. Oxford.

#### **Supplementary Books:**

1. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publ., New Delhi. 688p.
2. Sutton, S.L., T.C. Whitmore and A.C. Chadwick (eds) 1983. Tropical rainforests Ecology Management. Blackwell Sci. Publ. Oxford.
3. Edmonds, R.L., et al. 2000. Forest Health and Protection. McGraw Hill. Boston. 630p.
4. Laurance, W.F. & Bierregaard, R.O. Jr. 1997. Tropical forest remnants. The University of Chicago Press.

**One-day/ week-end field trip to diagnose forest vegetation type, analyse structure, and component interactions.**

# MICROBIAL ECOLOGY

ECOL: 562

CREDITS: 3

**UNIT-I** Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, Evolution, phylogenetic diversity, preservation of microorganisms, DNA, RNA, Replication, Recombinant DNA technology. **(8 Hours)**

**UNIT-II** Distributions of microorganisms – Distribution/diversity of Microorganisms – fresh and marine, terrestrial – microbes in surface soil, Air – Outdoor and Indoor, aerosols, biosafety in Laboratory – Extreme Environment – archaeobacteria- significance in water supplies – problems and control. Transmissible diseases. **(8 Hours)**

**UNIT-III** Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic – fermentation, glycolysis. Krebs's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics. **(8 Hours)**

**UNIT-IV** Introduction to Water borne Pathogens and Parasites and their effects on Human, Animal and Plant health, Transmission of pathogens – Bacterial, Viral, Protozoan, and Helminths, Indicator organisms of water – Coliforms – total coliforms, E-coli, Streptococcus, Clostridium, Concentration and detection of virus. Control of microorganisms; Microbiology of biological treatment processes – aerobic and anaerobic,  $\alpha$ -oxidation,  $\beta$ -oxidation, nitrification and denitrification, eutrophication. Nutrients Removal – BODS, Nitrogen, Phosphate. Microbiology of Sewage Sludge. **(8 Hours)**

**UNIT-V** Ecotoxicology – toxicants and toxicity, Factors influencing toxicity. Effects – acute, chronic, Test organisms – toxicity testing, Bio concentration – Bioaccumulation, Biomagnification, Bioassay, Biomonitoring and Bioleaching. Microbial health-pharmaceutical, food and beverage industry and biofuels, Molecular biotechnological applications. **(8 Hours)**

## References:

### Text Books:

1. S.C Bhatia, Hand Book of Environmental Microbiology, Part 1 and 2, Atlantic Publisher
2. Gabriel Bitton, Wastewater Microbiology, 2<sup>nd</sup> Edition.
3. Raina M. Maier, Lan L. Pepper, Charles P. Gerba, Environmental Microbiology, Academic Press.

### Supplementary Books

1. SVS. Rana, Essentials of Ecology and Environmental Science, 3<sup>rd</sup> Edition, Prentice Hall of India Private Limited.
2. Stanley E. Manahan, Environmental Science and Technology, Lewis Publishers.
3. Hurst, C.J. (2002) Manual of Environmental Microbiology, 2<sup>nd</sup> Ed. ASM PRESS, Washington, D.C. ISBN 1-55581 – 199 – X.
4. Frank C. Lu and Sam Kacew, LU's Basic Toxicology, Taylor & Francis, London (4 Ed), 2002.

# ENVIRONMENTAL SERIBIOTECHNOLOGY

ECOL: 563

CREDITS: 3

**UNIT-I Nature and Scope of Seri biotechnology:** General Introduction to Seri biotechnology Sericulture and its distribution in India - Insect and non-insect fauna producing silk; types of silk produced in India; status of mulberry and non-mulberry sericulture in India. Sericulture organization in India - Scope of sericulture in India, Environmental issues of sericulture.

**(8 Hours)**

**UNIT-II Mulberry production Technology:** Host plants of mulberry and non-mulberry silkworms; mulberry varieties for irrigated and rain fed conditions -Soils, location and climate for mulberry cultivation. – Methods of Tissue culture in mulberry and non- mulberry plants. Package of practices for mulberry cultivation under rain fed and irrigated conditions Pruning – objectives and methods; harvesting, transportation and preservation of mulberry leaf .Pests and diseases of mulberry and their management Ecosystem influence on the fate and transport of pesticides.

**Practical:** Tissue culture of mulberry. **(8 Hours)**

**UNIT-III Silkworm Production Technology:** Mulberry silkworm Varieties **Grainage operations:** Grainage building, equipment, climatic condition , hormonal and physiological aspects-short term and long term chilling and incubation. **Rearing operations:** silkworm biology, silkworm rearing methods, young and late-age rearing, chawki rearing Units environmental requirements– Pests and diseases of silkworm and their management Disinfectants and other chemicals- occupational health hazards.

**Practical:** Demonstration of metamorphic stages in silkworm, *B. Mori*. **(8 Hours)**

**UNIT-IV Post Cocoon Technology:** Status of post cocoon sector, Physical and commercial characteristics of cocoons, stifling, object of cooking, silk spinning, testing and grading of raw silk; weaving and dyeing. Environmental contaminants –Fuel, steam-chemicals like softeners, hardeners, Dyes, binders solvents, oils, urea, kerosene, acid, cleansers etc., Remedial measures- Eco-friendly dyes.

**Practical:** Assessment of commercial potentiality of cocoon characters. **(8 Hours)**

**UNIT-V Bioengineering & Bioinformatics:** Silkworm as a bioreactor to express foreign gene to produce medicinally valuable substances. Production of antibacterial protein, antibacterial peptides and lactins - isolation, purification and their expression through baculovirus vector in silkworm - Byproducts of sericulture industry and their utilization –Applications of Bioinformatics– Describe the insect Myosin/ HSP/GFP proteins. **(8 Hours)**

**Practical:** Retrieve the insect Myosin/GFP/HSP-analyse – nucleotides- protein sequences and discuss its motif and patterns with regard to its function – also visualize - structure from PDB data base - identify its active sites and structural features with regard to its function. **(8 Hours)**

## Reference Books:

1. FAO Manuals (4Vol.) Agricultural Organization, United Nation 1985.
2. Silk culture, S.K. Anantanarayanan, 2008, Daya Publishing House
3. The Global silk Industry: a complete source book - R.K. Dutta & Nanavaty, 2007, APH. Pub.
4. Fundamental concepts of bioinformatics – Dane Krane & Michael L Raymer. Pearson Edn. Publication, 2003.
5. Integrated insect pest management: Physiological and molecular approaches - D.M. Mamata and K. Sreedevi. 2010, VDM Pub, Germany.

## INTRODUCTION TO THEORETICAL ECOLOGY

**ECOL: 571**

**CREDITS: 3**

**UNIT-I** Introduction-Principles of Ecology–Application of principles–Elements of Modeling – verification and validation of Models. **(8 Hours)**

**UNIT-II** Models of Population–Coherence of individuals into populations–interaction between species. **(8 Hours)**

**UNIT-III** Communities–relationship between elements of communities–plant population dynamics – persistence of communities. **(8 Hours)**

**UNIT-IV** Stability in Ecosystems – stability and complexity – chaotic dynamics. **(8 Hours)**

**UNIT-V** Climate change and ecological communities. **(8 Hours)**

### **Reference:**

#### **Text Book**

Theoretical Ecology edited by Robert May and Angela McClean, Oxford University Press (2007).



# BIOGEOGRAPHY

**ECOL: 572**

**CREDITS: 3**

**UNIT-I** Introduction and history of biogeography; Weather and climate - The ecological niche Limits to distributions: local to global scales; Communities and ecosystems Evolution; Introduction to dispersal Patterns of biodiversity. **(8 Hours)**

**UNIT-II** Pleistocene climate, Pleistocene biogeography, and paleoecology Plate tectonics; from evolution to patterns of life. **(8 Hours)**

**UNIT-III** Life and death on islands; the theory of Island Biogeography; Island Biogeography: fragmentation and conservation. **(8 Hours)**

**UNIT-IV** Geography of Life Today. **(8 Hours)**

**UNIT-V** Advent of Humanity & Pleistocene megafauna extinctions Conservation Biogeography: Mega-extinctions and Climate Change. **(8 Hours)**

## **Reference:**

1. Biogeography, 8th Edition by C. Barry Cox and Peter D. Moore. Wiley.
2. Biogeography, MV Lomolino, BR Riddle, RJ Whittaker, and JH Brown. Sinauer Associates; 4<sup>th</sup> edition (2010)

## AGRO ECOSYSTEMS AND AGROFORESTRY

ECOL: 573

CREDITS: 3

**UNIT-I** Definition, scope and characteristics: structure, sustainability, increased productivity and socioeconomic / cultural adaptability fundamental ecological features of agro forestry. Importance of agro forestry; ecological - waste landscapes, rehabilitation. **(8 Hours)**

**UNIT-II** Scope, characteristics and types of agro ecosystems, an overview of agro ecology and agro ecosystems, ecological perspective of farming and economic crisis-farmers classification: important role of trees, soil. Characteristics and fertility, microclimate, hydrology associated biological components and productivity. **(8 Hours)**

**UNIT-III** Systems of agro-forestry: designing and planning, plant arrangements, examples of agro forestry, forests in India: destruction and protection, role of (icraf) international centre on agro forestry. Economics of agro- forestry-income source, livelihood and community development; resources-trade and other benefits. **(8 Hours)**

**UNIT-VI** Management of agro ecosystems: ecological approaches to weed and pest management. Economics of agro forestry-income source, livelihood and community development; resources-trade and other benefits. - Resource, interactions among biotic communities - resource, competition, predation, and mutualism. **(8 Hours)**

**UNIT-V** Stability, modernization, mechanization and various resources of agro ecosystems and agroforestry. **(8 Hours)**

### **References:**

### **Text books:**

1. Sharma, v. k. 2004. Trees and protection of environment. deep & Deep publications pvt. Ltd.
2. Altieri, 2005. Biodiversity and pest management in agro ecosystems, 2nd edition. Publisher jain books & periodicals.
3. James r. brandle, xinhuazhou, lauriehodes, 2008. Agroforestry: enhancing water use efficiency, published in encyclopedia of water science, second edition, doi: 10.1081/e - ews2 - 120010098.

### **Supplementary books**

1. Sinha, r. k. 2006. Sustainable agriculture. publisher: agro science book Centre ansari road, New Delhi.
2. Stephen r. gliessman. 2006. Multi scale integrated analysis of agro ecosystems - 46: 494 - 495. University of california. mariogiampietro. crc press, 6000 broken sound parkway nw, suite 300,
3. Marian Stamp Dawkins and Roland Bonney 2008. Future of Animal Farmers, Blackwell Publishing. University of Oxford ICBN No.0781405177820

# INTRODUCTION TO ECOLOGICAL MODELING

ECOL: 574

CREDITS: 3

**UNIT-I**Mathematical Models – Deterministic and Stochastic Models – Linear and Non-linear Models – Analysis of Models. **(8 Hours)**

**UNIT-II**Models in Population Ecology - Logistic models – Predator-Prey Models; Continuous and discrete Models – Bifurcation route to chaos. **(8 Hours)**

**UNIT-III**Stochastic models – Simulation models - Predictive models – Stability and complexity. **(8 Hours)**

**UNIT-IV**Models of Animal Behaviour – Game theory models of Animal behavior. **(8 Hours)**

**UNIT-V**Climate Models – predictions – Proxy data sets and model validation. **(8 Hours)**

1. Roughgarden, Jonathan; May, Robert M.; and Levin, Simon A., eds. Perspectives in Ecological Theory Princeton, NJ: Princeton University Press, 1989
2. Hallam, TG & Levin SA "Mathematical Ecology: an Introduction"
3. S. A. Levin, T. G. Hallam, and L. J. Gross, editors. Applied Mathematical Ecology
4. Gore, A P and Paranjape S A, "Mathematical and Statistical Ecology"
5. Jeffers, J N R. " A practitioners Handbook on the Modeling of Dynamic Change in Ecosystems"
6. J. D. Murray. Mathematical Biology,

## STATISTICS WITH R FOR ECOLOGY

ECOL: 575

CREDITS: 3

**UNIT-I** To give hands on exposure to doing Statistics with the R Statistical language Elements of R. **(8 Hours)**

**UNIT-II** Input output; Functions and libraries. **(8 Hours)**

**UNIT-III** Basic statistical analysis with R. **(8 Hours)**

**UNIT-IV** Using packaged interfaces such as R-Commander. **(8 Hours)**

**UNIT-V** Scripts in R and analysis of large scale environmental data. **(8 Hours)**

**Text:**

Introductory Statistics with R (2 ed)– Peter Dalgaard Springer Verlag 2008.

# ENVIRONMENTAL LAW, POLICY AND EQUITY

ECOL: 576

CREDITS: 3

**UNIT-I** International Environmental Laws: Evolution and Development on International Environmental Laws with references to Stockholm Conference, Nairobi Declaration, Rio conference, Rio+5, Rio +10 Environmental issues and international laws: to control Global warming, Ozone depletion, Acid rain, hazardous waste, CITES Role of UN authorities in protection of Global Environment, Multinational authorities and agreements, future of International law. **(8 Hours)**

**UNIT-II** Environmental Laws in India: Environmental Policy and Laws. Constitutional and Statutory laws in India: Doctrine Principles of State Policy, Fundamental duties and Fundamental Rights and Panchayat Raj System, Statutory protection of the Human environment: such as Indian penal court, Factories Act, Motor Vehicle Act, Hazardous waste legislation for pollution abatement. Anti-Pollution Acts: The Water Act, 1974, The Air Act, 1981. The Environment Protection Act 1986. Objectives of the Anti-Pollution Acts. Institutional mechanism created under these acts and role contribution in combating environmental pollution. The role of courts. **(8 Hours)**

**UNIT-III** Equity Environment versus Development: Importance of critical review of plan with respect to local, regional & immediate & long term gains & Effect of development. Comparison between a Exploitation and safe guard for conservation, b. rate of utilisation and regeneration, c. natural and manmade growth, d. Survival need of mankind and protection of Environment Integration of development with carrying capacity of environment Case study of current issue Requirement of Rule 14 for Environmental audit under Environment protection Act 1986; Rule & regulation & guidelines given for disposal of hazardous protection waste, municipal solid wastes & bio-medical waste. **(8 Hours)**

**UNIT-IV** National Environmental Policy: National Policy on EIA and Regulatory Framework: Rule & regulation of central & State Government and Central & State pollution control boards for Safeguard for Environment Protection. **(8 Hours)**

**UNIT-V** Sustainable Development: Definition and concepts of Sustainable development, Integration of: a. Economic, Social and Environmental sustainability, b. Biodiversity and c. Availability of natural resources in development. Critical review of drawbacks in traditional (base on economics) evaluation development, Cost benefit analysis. Introduction of Ecological growth factor similar for sustainable development. **(8 Hours)**

## References:

### Text Books

1. Declaration of: The Stockholm Conference, Roi, Rio+5 and Rio +10
2. Anti-Pollution Acts (3) and Commentaries published theorem

# BIOGEOCHEMISTRY

ECOL: 577

CREDITS: 3

**UNIT-I** Introduction to Physical , Chemical Processes in oceans; Basic characteristics of Sea waters – Materials in sea water; Salinity Variations; Land Ocean Interaction in the Coastal Zone and Near Shore Dynamics – Sedimentation and Turbulence. **(8 Hours)**

**UNIT-II** Oceans and Climate – Ocean and Atmosphere Interaction; Evaporation and Precipitation; Heat Budget; Green House Effect; Land –Sea Variations and Storms. **(8 Hours)**

**UNIT-III** Life and Primary Production – Organic Synthesis, the nutrients, Measuring productivity, General patterns in productivity, Geographical and Seasonal variations, and Food web. **(8 Hours)**

**UNIT-IV** Air and Sea Interaction – Boundary layers, Tropical Meteorology Ocean data and Ocean Models. Ocean Energy Resources – renewable supply, Energy from water motion, Oil and Natural Gas. **(8 Hours)**

**UNIT-V** Coastal Development and Pollution; Vulnerabilities; Estuarine Problems, Chemicals and Nuclear Wastes – The overall impacts and solutions. **(8 Hours)**

## Text Book

Keith Stove(1996) , Exploring Ocean Science, John Wiley & Sons, New York

## References

1. Tom S.Garrison (2005) Essentials of Oceanography, Brooka Cole 4<sup>th</sup> edition
2. Susan M.Libes (2007) an Introduction to Marine Biogeochemistry, John Wiley Sons New York

# ENVIRONMENTAL SURVEILLANCE

**ECOL: 578**

**CREDITS: 3**

**UNIT-I** Environmental Surveillance Monitoring – definition, advantages, disadvantages, scale of observation, GEMS and its goal current and future status of environmental surveillance and monitoring. **(8 Hours)**

**UNIT-II** Types of Environmental surveillance, systematic ground surveys (SGS), soil, surface water and air surveillance – parameters and instruments, standards, sensors and RUSS, Surveillance devices, Social Network Analysis. **(8 Hours)**

**UNIT-III** Water quality surveillance and air, water and health, Water quality and sanitary inspection data collection. Sampling site selection and sample approaches. systematic aerial reconnaissance flight surveillance, Using the surveillance data, Household water and the safe water chain. **(8 Hours)**

**UNIT-IV** Biological surveillance Programme for the monitoring of crop pests, Biometric surveillance– aquatic bodies, various invertebrates and vertebrate vectors surveillance, Biomarkers in environmental surveillance. **(8 Hours)**

**UNIT-V** Disease surveillance (of pathogens) – Definition, World Health Organization AIDS surveillance case definition, Anthrax, Avian influenza, Dengue hemorrhagic fever, Hepatitis, Influenza, Plague, Severe Acute Respiratory Syndrome, Smallpox. **(8 Hours)**

## **Books:**

1. Environmental monitoring, surveillance by Artiola, AF and Brusseau, ML, Academic Press, 2007
2. Environmental Sampling and analyses: Practical Guide. American Chem. Soc. Publ., Chelsea Mi, 2001
3. Environmental Biological Surveillance: JM Lynch, Wiseman, A. Cambridge Univ. Press, 2008
4. Standard Methods for the Examination of Water and Wastewater, 25<sup>th</sup> Ed. APHA, Washington, 2003.
5. Biological Indicators of Environmental Pollution and Management: Hellawell, JM Elsevier Applied Sc. Publ., London, 2006

# DIGITAL IMAGE PROCESSING FOR ENVIRONMENTAL APPLICATIONS

ECOL: 580

CREDITS: 3

## 1. Satellite data-Introduction

Import/Export / Data Format / Metadata detail / Layer Stacking. **(8 Hours)**

## 2. Introduction to ERDAS IMAGINE 2011

View Module / Data Preparation Module / Classification Module / Map Composer Module. **(8 Hours)**

## 3. Study of PAN chromatic, Multispectral, Hype spectral images and Elevations data

Raster layer information / Layer statistics / FCC creation. **(8 Hours)**

## 4. Data Preparation

Geometric correction of scanned maps and satellite images / Projection and reprojection / Mosaicing/Stitching / Sub-setting/Masking. **(8 Hours)**

## 5. Data enhancement

Histogram Manipulation / Lookup table handling / Filtering / Data merging. **(8 Hours)**

## 6. Analysis of spectral characteristics

Spectral reflectance pattern ofVegetation / Soil / Water / Urban. **(8 Hours)**

## 7. Data Processing

Unsupervised classification / Band rationing / Digital elevation model / Slope and aspect creation. **(8 Hours)**

## 8. Accuracy assessment (8 Hours)

## 9. Map composition and printing (8 Hours)

### Reference Books

1. ERDAS IMAGINE Field Guide, Erdas Inc., USA, 2009
2. ERDAS IMAGINE User Guide, ErdasInc, USA, 2009
3. Remote Sensing and Image Interpretation-Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman, Sixty Edition, John Wiley & Sons, Inc, 2008
4. Remote Sensing of the Environment: An Earth Resource Perspective – John R. Jensen, 2<sup>nd</sup> Edition, Prentice Hall. 200



# ENVIRONMENTAL NANO TECHNOLOGY

**ECOL: 581**

**CREDITS: 3**

## **UNIT–I FUNDAMENTALS AND OVERVIEW OF NANOSCIENCE**

Nano-definitions and scaling The fundamental science behind nanotechnology, Properties at Nano scale Tools used in measuring nanostructures. Nano materials- the current state of applications. **(8 Hours)**

## **UNIT–II NANOTECHNOLOGY AND ENVIRONMENTAL APPLICATIONS**

Application of nanotechnology in green energy -Nanomaterial use in pollution control: Zero valent iron in environmental remediation, Nanomaterial enabled disinfection, Arsenic removal using Nano scale magnetite, Nanocatalysts for water contaminated with chlorinated priority pollutants, Air pollution control etc. **(8 Hours)**

## **UNIT–III POTENTIAL ECOLOGICAL HAZARDS OF NANOMATERIALS**

Nanomaterial in Environment –Potential exposure pathways for nanomaterial, Principles of ecological exposure, effects and risk, Anticipated hazards to terrestrial ecosystems, Anticipated hazards to aquatic ecosystems, Methodologies for evaluating hazards and their limitations. **(8 Hours)**

## **UNIT-IV NANOTECHNOLOGY HEALTH AND SAFETY**

Environmental risk issues, Case studies, Issues in applying risk assessment to nanotechnology, Treatment of nanoparticles in wastewater, Life cycle analysis for sustainable nanotechnology. **(8 Hours)**

## **UNIT–V NANO TOXICOLOGY AND RISK ASSESSMENT**

Risk assessment and nanomaterial, Exposure and effects through ingestion, dermal absorption, and inhalation, Known toxicity of nanomaterial, Mechanisms of toxicity, Short term toxicity tests, Studies of nanomaterial toxicity to fish. **(8 Hours)**

### **Text books &References**

1. Mark Ratner, Daniel Ratner, “Nanotechnology-A gentle introduction to the next big idea”, Pearson Education
2. M.A.Shah and Tokeer Ahmad, “Principles of Nanoscience and Nanotechnology”, Narosa Publishing House
3. Kathleen Sellers, Christopher Mackay, Lynn L. Bergeson, Stephen R. Clough, Marilyn Hoyt, Julie Chen, Kim Henry, Jane Hamblen “Nanotechnology and the Environment”, CRC Press
4. Jo Anne Shatkin “Nanotechnology Health and Environmental Risks”, CRC Press.
5. Richard Brooker and Earl Boysen, “Nanotechnology The fun and easy way to explore the science of matter’s smallest particles” Wiley India Pvt.Ltd.
6. Yuliang Zhao and Hari Singh Nalwa, ‘Nanotoxicology: Interactions of Nanomaterials with Biological Systems, American Scientific Publishers, 2007