Tribhuvan University
Institute of Science and Technology
4 Years Bachelor of Science (B.Sc.) Programme
B.Sc. 4th Year Zoology

Course Title: **Ecology and Fish & Fisheries** **Full Marks: 100**
Course No. : **B. Sc. Zool.403** **Pass Marks: 35**
Nature of Course: **Theory** **Year: IV**
Instruction Lectures: 150

Objectives of the Course:

At the end of course students will be able to:

- Understand the basic concepts and principles of ecology.
- Understand major environmental problems and issues.
- Understand the challenges, principles and practices of biodiversity conservation.
- Know basic taxonomy and status of indigenous fishes of Nepal.
- Understand the significance of limnological parameters, nutrition, fish disease and seed production in aquaculture.
- Gain knowledge on the importance of post-harvest and marketing of fishes.

Teaching materials required to fulfill the objectives are boards, charts, flex prints, overhead projector (OHP), power-point projector and other basic teaching materials prepared by teachers and as provided by the campuses.

Group A: Ecology and Conservation Biology (75 lec.)

Ecology				
Unit	**Sub-unit**	**Description of content of the sub-unit**	**Lectures**	**Text/Ref. for the topics**
Introduction and Ecological factors (6 Lectures)	**Scope and evolution of ecological thoughts**	Concept and scopes of ecology, and evolution of ecological thoughts; sub divisions of ecology.	1	Smith; Odum Krebs; Singh et al.;
	Habitat and ecological niche	Concepts of habitat and ecological niche: Niche theory, Fundamental and realised niche, niche width and overlap.	1	Smith; Odum; Singh et al.; Verma.
	Ecological factors- Liebig's law of the minimum, Shelford's law of tolerance	What is Ecological factors, Liebig's law of minimum: statement and explanation; Shelford's law of tolerance: statement and explanation; Factor compensation.	1	Smith; Odum; Singh et al.; Verma.
	Effects of ecological factors on the distribution and abundance of organisms	Effects of abiotic factors (Light, temperature, water, humidity, topography; edaphic factors), Effects of biotic factors.	3	
Ecosystem (12 Lectures)	**Concept and development**	Concept, types and examples of ecosystems	1	Odum; Singh et al.; Verma.
	Structure - Biotic and abiotic components	Abiotic components, biotic components, ecosystem boundary.	1	
	Ecosystem process	Production (Photosynthesis) and decomposition.	1	
	Ecosystem energetic - primary productivity, secondary productivity, energy flow, food chain and food web	Energy, laws of thermodynamics, Primary production: concept, factor affecting PP and determination of PP, secondary productivity: factor affecting SP. Energy flow: types, patterns and models, Food chain and food web, trophic structure; ecological pyramids.	4	Smith; Krebs; Odum; Singh et al.; Verma.

	Biogeochemical cycles - Gaseous cycles (C, N, O_2) and sedimentary cycles (S,P)	Biogeochemical cycles – Description of gaseous cycle (C, N, O_2) and sedimentary cycles (S, P).	4	Smith; Odum; Singh et al.; Verma.
	Human intrusion in ecosystem dynamics	Effects of human activity in ecosystem dynamics.	1	Odum; Singh et al.;
Population Ecology (8 Lectures)	**Concept, Characteristics natality, mortality, immigration, emigration, density, fecundity**	Concept of population; Population Characteristics: Density, Dispersion, Natality, Mortality, Immigration, Emigration, Fecundity;	2	Smith; Odum; Singh et al.; Verma.
	Structures - age and sex distribution, life table and survivorship curve	Age and Sex Structures; Concept of Life Tables and Survivorship Curves.	2	
	Dynamics- Population growth and regulation, density dependent and density independent regulation	**Population Growth forms**: Rate of Growth, Growth Without Limit (Exponential) and Growth Within Limit (Logistic Growth) **Population Regulation**: Density Dependent and Density Independent Population Regulation, Population Cycles and Fluctuations, Life History Strategy.	4	
Community Ecology (10 Lectures)	**Concept and characters of community**	Concepts, nature community. Characters	1	Smith; Odum; Singh et al.; Verma.
	Community structure – physical and biological structures	**Physical structure**: Life forms, vertical stratification, horizontal structure **Biological structure**: species dominance, diversity, abundance.	3	
	Species interaction and their effects	Positive (mutualism, cooperation and commensalism) and negative interactions (predation, competition, parasitism).	3	

	Succession/ecosystem development-	Process, and concept of climax, changes in ecosystem attributes, succession and animal life.	3	
Environmental Pollution and Issues (8 Lectures)	**Process of ozone depletion, acid rain, and eutrophication**	Ozone Layer Depletion; Causes, Process and Consequence of Ozone layer depletion Acid Rain Formation and Effects . Eutrophication: Concept and process (Nutrient enrichment, growth of plants, death of plants, growth of bacteria, lack of oxygen and suffocation).	2	Singh et al.; Asthana & Asthana; Verma.
	Climate change and its impacts on ecosystems	Climate change and its impacts on ecosystems.	2	Singh et al.; Verma; Asthana & Asthana
	Concept of Reducing Emission from Deforestation and Degradation and Clean Development Mechanism (CDM)	Concept of Reducing Emission from Deforestation and Degradation (REDD): REDD, REDD+, REDD Policies and Initiatives of Nepal; and Clean Development Mechanism (CDM): Background, Kyoto Protocol and CDM mechanism, CDM Objectives and Principles, CDM Participation requirements and process.	2	
	Biological Invasion- Characteristics of invasive species, process and impacts of biological invasion	Biological Invasion- Characteristics of invasive species, process and impacts of biological invasion.	2	Primack et al.; Asthana & Asthana.
Natural Resources (4 Lectures)	**Concepts of renewable and non- renewable natural resources**	Concepts of renewable and non- renewable natural resources.	1	Singh et al.;
	Management approach- Ecosystem and watershed approach	Management approach- Ecosystem (Concept, Principles and Process) and watershed approach (Concept, Principles and Process):	3	

Conservation Biology				
Conservation & Biodiversity (7 Lectures)	**Introduction**	Concept, scope of Biodiversity and conservation biology.	1	Primack et al.; Sodhi & Ehrlich.
	Levels and hierarchy	Genetic, species, ecosystem and landscape diversity; Alph, Beta and Gama Diversities.	1	
	Values and uses	Various values of biodiversity; Consumptive, non- consumptive. Ecological, Economic and Ethical Values.	1	
	Threats: primary threats, concept of threatened species (IUCN Red List Categories, CITES)	Natural and human induced threats, Concept Threatened Species: IUCN Red list Category (Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, NT, LC and DD). CITES: What is CITES, How CITES Works: Appendices I, II & III.	4	
Biodiversity sampling/ surveys (11 Lectures)	**Concept and Purpose of Biodiversity Assessment and Monitoring Biodiversity Indices**	Measuring Biodiversity: concept and purpose of biodiversity assessment and monitoring. Shannon index, Simpson index, Jaccard's Index and Sorenson's Index	2	Smith; Primack et al.; Sodhi & Ehrlich. Smith.
	Sampling Terrestrial Vegetation	Methods of sampling terrestrial vegetation: Quadrat or sample plots, belt transects and line intercept.	2	Sutherland; Smith; Singh & Singh.
	Sampling Animal Populations	Methods of sampling animal populations: Trapping and collection of organisms, Estimating abundance (Census, Capture- recapture, removal, line transects).	3	Smith; Krebs; Sutherland.
	Sampling indices of	Identification and Counting of Indicators (fecal	1	Krebs;

	animal abundance	matter, foot print, biting impression, call, etc.) of animal presence.		Sutherland.
	Sampling habitat- Introduction & use of map, remote sensing and GIS	Brief Introduction of Use of Map Remote Sensing Images (Introduction and use) GIS and GPS (introduction and Use).	3	Singh & Singh; Sutherland. Lillelsand & Keifer
Biodiversity Conservation (9 Lectures)	**History of conservation - Global and National**	Evolutionary Trend of Global and National Biodiversity Conservation.	1	Primack et al. ; National Policies and International Conventions (Web resources)
	National Policy and International conventions	National Policy and International conventions. Role policy in conservation, NPWC Act 1972; KMTNC Act 1982, Forest Act 1993 and regulations; International convention: Ramsar Convention1971, UNESCO World Heritage Convention 1972, CITES 1973, Convention on Conservation of Migratory Species (MoU on Birds of Prey) 1979, World Conservation Strategy 1980, CBD 1992)	2	
	Conservation approaches:			
	In-situ conservation -	Concept, Protected areas (IUCN categories of Protected Areas and criteria) Biosphere Reserves (Concept of Man and Biosphere Reservoir, Design and Management), Protected Areas and their Management in Nepal. Ramsar Sites of Nepal: Criteria for selection of Ramsar Site, Ramsar Sites of Nepal.	4	Primack et al.; Sodhi & Ehrlich
	Ex-situ conservation	Concept, gene bank, Zoo garden, botanical gardens, captive breeding.	1	
	Landscape level conservation.	Concept, challenges and practice of landscape based models of conservation (Examples; TAL, CHAL, KSL, SHL)	1	

Group B: Fish & Fisheries (75 lec.)

Unit	Sub-unit	Description of content of the sub-unit (depth)	Lectures	Text/Ref. for the topics (for detail see the list of text & references)
Fish Systematic (4 Lectures)	**General principles of taxonomy**	Systematic position and trends in classification of fishes.	1	Gupta and Gupta; Khanna; Shrestha,J. Shrestha, T.K.
	Classification of fishes	Classification of fishes with reference to important orders of fishes of Nepal.	2	
	General groups of fishes	Economically important fishes, game/sport fishes, Exotic fishes, endemic fishes.	1	
Fish Biology (6 Lectures)	**Accessory respiratory organs and lateral line system**	Types and significance of accessory respiratory organs. Structure, function of lateral line.	1	Khanna;
	Swim bladder and weberian ossicles,	Structure and functions.	1	
	Electric organ, sound producing organ and light producing organ,	Structures in different fishes and functions.	2	
	Colouration in fish	Sources, control of colour and significance.	1	
	Adaptive modifications (hill stream fishes).	Conditions in hill stream fishes, modification and Adaptation in fishes.	1	
Fresh Water Ecology (6 Lectures)	**River systems**	Introduction, important river systems of Nepal.	1	Sharma; Shrestha, J.; Shrestha, T.K.
	River zonation	Introduction and zonations of rivers of Nepal with reference to fishes.	2	
	Lake system	Introductions and important lakes.	1	
	Types of lakes	Types of Lakes with reference to fishes of Nepal.	2	

Limnological Parameters (6 Lectures)	**Physical parameters**	Turbidity and temperature – Introduction, measurement, importance/significance.	1	Jhingran; Khanna; Parihar.
	Chemical parameters	pH, dissolved oxygen, dissolved CO_2, alkalinity, hardness, ammonia, phosphorus, BOD, COD - Introduction, laboratory measurement, importance/ significance.	3	
	Biological parameters	Phytoplankton, zooplanktons, nekton and zoo benthos - Introduction, collection, role and significance.	2	
Environment Impact Assessment (3 Lectures)	**Concept**	Introduction to EIA.	1	Matsya Palan Srinkhala
	Importance and significance	Importance and significance in the context of Nepal.	1	
	Application of EIA	For the conservation of water resources, natural fish stock and people based on it for livelihood.	1	
Capture and Culture Fisheries (14 Lectures)	**Capture fishery**	Introduction, warm water and cold water fishery in Nepal. Status of inland water resources and inland capture fishery. Fish exploitation, threats and conservation management of capture fishery.	5	Gupta and Gupta; Jhingran; Khanna; Matsya Srinkhala; Shrestha, J.; Shrestha, T.K.
	Culture fishery	Introduction, principles and scope of culture fishery, Different systems of fish culture, status of fish culture and aquaculture.	4	
	Pond preparation	Pond engineering, criteria for selection of fish species for culture, characteristics of cultivable species, common cultivable fishes of Nepal, pre stocking and post stocking management.	5	
Fish Breeding and Management (7 Lectures)	**Maturation and spawning**	Concept and identification of maturation and spawning of brood fishes for breeding.	1	Gupta and Gupta; Jhingran & Pullin; Khanna; Matsya P. Srinkhala;
	Role of gonadotropin in fish breeding	Introduction and significance of pituitary hormones and commercial gonadotropins used in	1	

		fish breeding.		Parihar;
	Induced breeding of indigenous major carps	Basis of induced breeding. Methods and process (Dose determination and extract preparation for injection).	1	Pillay; Santhanam et al.
	Management and rearing of hatchling	Introduction to different systems – Jars, circular tank, cemented tank. Duration, feeding, water flow and water quality maintenance.	1	
	Management and rearing of fry	Pond preparation, water depth, feeding, duration, water quality maintenance.	1	
	Management and rearing of fingerling	Pond preparation, water depth, feeding, duration, water quality maintenance.	1	
	Management and rearing of broodstock.	Pond size, feeding level, care, water quality maintenance.	1	
Nutrition (10 Lectures)	**Biomolecular compounds**	Importance of different biomolecular compounds in fish feed like carbohydrate, lipid, protein, vitamins, minerals. Significance of balanced feed in fish growth and health.	2	Jhingran & Pullin; Khanna; Matsya P. Srinkhala; Parihar; Pillay; Santhanam et al.
	Nutritional requirement of fishes	Nutritional requirement of fishes in different stages of life - Hatchlings - Fry - Fingerlings - Grow out fish - Brood fish On the basis of feeding habits - Herbivorous fish - Carnivorous fish - Omnivorous fish	4	

	Feed formulation.	Introduction to artificial feed formulation. • Supplementary feed and • pellet feed	2	
	Nutrient deficient diseases in fishes.	Introduction, identification to different nutrient deficient diseases in fishes – different vitamin deficiency diseases, protein deficiency diseases.	2	
Fish Pathology (10 Lectures)	**Bacterial, Fungal, Protozoan and Metazoan fish diseases**	Introduction, morphology, life cycle, symptoms, prophylaxis and therapy of important infectious diseases of fishes like • Bacterial (tail and fin rot) • Fungal (Saprolegniasis and Epizootic Ulcerative Syndrome) • Protozoan (Ichthyophthiriasis) and • Metazoan (Argulosis).	9	Amlacher; Jhingran & Pullin; Khanna; Matsya P. Srinkhala; Parihar; Pillay; Santhanam et al.
	Importance of management of fish diseases	Introduction to Importance of management of fish diseases.	1	
Post Harvest Technology, Fish Marketing and Extension (9 Lectures)	**Post harvest technology**	Introduction, causes of fish spoilage Principles and importance of fish preservation. Traditional (smoking/drying) and advanced methods of fish preservation like chilling, freezing, salting, vacuum packing, canning.	3	Gupta and Gupta; Jhingran & Pullin; Khanna; Matsya P.Srinkhala; Parihar; Pillay; Santhanam et al.
	Fish Marketing	Introduction, fish transportation, status of present fish marketing in Nepal.	3	
	Extension	Cooperatives and their importance in fish production and marketing.	3	

Suggested Readings:

Ecology (latest editions)

Asthana, D.K. & Asthana, M. 1998. Environment Problems and Solutions. S chand and Company.

Dash, M.C. Fundamentals of Ecology. Tata McGraw-Hill Publishing Company Limited.

Groom, M..J., Meffe, G.K. and Carroll, C.R. eds. Principles of Conservation Biology. 3rd ed. Sinauer Assoc. Inc.

IUCN. Inventory of Wetland of Nepal. IUCN.

Krebs, C.J. Ecology: An Experimental Analysis of Distribution and Abundance of Animal Population. Addision-Wesley Edu. Pub.

Kormondy, E.J. Concepts of Ecology. Prentice Hall of India, New Delhi.

Odum, E.P. Fundamentals of Ecology. W. B. Saunders Company, Philadelphia.

Primack, R.B., Poudel P.K. & Bhattarai B.P. 2013. Conservation Biology: A Primer for Nepal. Dreamland Publication, Kathmandu.

Smith, R.L. Ecology and Field Biology. Harper Collins College Publisher.

Sodhi, N.S. and Ehrlich, P.R. Conservation Biology for All. Oxford University Press.

Sharma, P.D. Ecology and Environment. Rastogi Publication.

Singh, J.S., Singh, S.P. & Gupta, S.R. 2014. Ecology Environmental Science and Conservation. S Chand and Company

Southwood, T.R.E. and Hendersen, P.A. 2009. Ecological Methods. John Wiley & Sons.

Sutherland, W. Ecological Census Technique- A Handbook. Cambridge

Verma, P.S. & Agarwal,V.K. 2000. Environmental Biology: Principles of Ecology.

Fish and Fisheries

Amlacher, E., 1970. Textbook of Fish Diseases. Translated from German by D.A. Conroy and R.L. Herman. Jersey City, N.J., T.F.H. Publications Inc., 302 p.

Gupta, S.K and Gupta, P.C. 2014. General and Applied Ichthyology (Fish and Fisheries) Pub. S. Chand & Company Pvt. Ltd. New Delhi, India.

Jhingran, V.G. 1991. Fish and Fisheries of India. 3rd ed. Hindustan Publishing Corporation New Delhi, 727 p.

Jhingran, V.G. & Pullin, R.S.V. 1985. A Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM Studies and Reviews 11, 191 pp. Asian Development Bank, Manila, Philippines and International Center for Living Aquatic Resources Management, Metro Manila, Philippines.

Khanna, S.S. 2006. An Introduction to Fishes. Silver Line Publications, New Delhi. Revised and Up-graded Edition.

Matsya Palan Srinkhala - 5 1999. Proceedings of the National Workshop on the "Prospects of Fisheries Development under the

Agriculture Perspective Plan". Nepal.
Pillay, T.V.R. 1990. Aquaculture Principles and Practices (English) Pillay, T.V.R., / Oxford (UK), Fishing News Books, 575 p.
Parihar, R.P. 2009. Fish Biology and Indian Fisheries. Central Publishing House, Allahabad.
Santhanam, N. Sukumaran and Natrajan, P. 1987. Fresh Water Aquaculture. Oxford and IBH Publishing Co. Pvt. Ltd.
Sharma, C.K. 1997. A Treatise on Water Resources of Nepal. Published by: Ms. Sangeeta Sharma, Bishal Nagar, Kathmandu, Nepal. 493 p. Kathmandu :
Shrestha, J. 1981. Fishes of Nepal. Curriculum Development Centre, Tribhuvan University, Kathmandu, Nepal.
Shrestha, J. 1994. Fishes, Fishing Implements and Methods of Nepal. ISBN 974-7315-55-6, Crafts Press Bangkok.
Shrestha, T.K. 2008. Ichthyology of Nepal – A Study of Fishes of the Himalayan Waters. Published by Himalayan Ecosphere, Kathmandu, Nepal.

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Course Title: Ecology and Fish &Fisheries **Full Marks: 50**
Course No. : B. Sc. Zool.404 **Pass Marks: 20**
Nature of Course: Practical **Year: IV**
Objective of the Course: For better understanding of the topics of Zool.403.

Ecology

1. Tools and techniques: Principle and applications of Sechi disc, Altimeter, Soil thermometer, Min-Max thermometer, Maps, GPS, etc…...
2. Determination of minimum number and size of quadrat.
3. Determination of water holding capacity of the soil/soil organic matter.
4. Determination of physico-chemical properties of water (O_2, CO_2, chlorides, alkalinity, etc).
5. Determination of density/frequency/abundance/IVI of the vegetation by quadrat method.
6. Biodiversity assessment using indices: Indices of diversity (Simpson, Shannon), dominance (Simpson) and similarity (Jaccard, Sorrenson).
7. Estimation of population density of animals from aquatic and terrestrial habitat.
8. Determination of primary productivity of:
   (i) aquatic ecosystem: Light and dark bottle method
   (ii) terrestrial ecosystem: Harvest method

9. Use of statistical tools as per required.

Fish & Fisheries

1. Identification of fishes: Taxonomic study to identify the important locally available freshwater fishes of Nepal.
2. Study of accessory respiratory organs in locally available fishes (Clarias, Channa, Anabas, Heteropneustes fossilis etc.)
3. Identifying disease and pathogen of fishes: Collection of diseased fishes and preparation of permanent slides for disease identification (Name of the disease, symptom and causative agent/ pathogen and identifying characters of the pathogen).
4. Study of water quality parameters and planktons.
5. Determination of GSI (Gastro-somatic index).
6. To determine and analyze the stomach contents of a given fish.

Practical note book preparation as regular study.

Report writing: Survey of any locality regarding any topic of Zool. 403and writing a report of about 5-10 pages. Conduct **seminar** on the report and submit the final report accommodating suggestions made in the seminar.

Examples:

- Visit to riverine system, lakes/ ponds or any water bodies and fish markets for fish collection, preservation in 4% formalin and interview with fishermen communities. Prepare report on fish diversity, abundance of dominant fish species, use of local fishing gears and status of fishermen communities.
- Field visit to any freshwater fish farm (warm and cold water). Prepare report on aquaculture technology on different constituents of fish farms like hatchery system, nursery and rearing of fishes, artificial fish feed.
- Prepare market survey report to show market status/trend on any one: whole sale/retail fish market/edible fish market/fish seed market/fish feed market/processed fish product market etc.
- Visit to any animal management organization (local or nearby) and get acquainted with its activities.
- Study of an ecosystem with their biotic and abiotic components.
- Pollution study.
- Fish diseases
- Hydropower dam

Suggested Readings:

Ecology

Krebs, C.J. 2009. Ecology: An Experimental Analysis of Distribution and Abundance of Animal Population. 6th Edition, Addision-Wesley Edu. Pub.

Sharma, P.D. 2011. Ecology and Environment (11th Revised Edition). Rastogi Publication.

Sutherland, W. 2006. Ecological Census Technique (2nd Edition)- A Handbook. Cambridge

Trivedi, R.K and Goel, P.K. Chemical and Biological Methods for Water Pollution Studies, Environmental Publication, India 1986

Fish & Fisheries

Biswas, S.P. 1992. Manuals of Methods in Fish Biology. South Asian Publishers Pvt.Ltd.

Gupta, P.C. & Gupta, S.K. 2013 General and Applied Ichthyology: (Fish and Fisheries).S. Chand & Company Ltd,

Khanna, S.S. An Introduction to Fishes. S. Chand & Co., New Delhi. Latest ed.

Kotpal, R.L. 2009. Modern Text Book of Zoology: Vertebrates. Rastogi Publications.

Piska, R.S., Naik, S.J.K. Practical Manual - Fish Biology and Ecology. University College of Science, Osmania University Hyderabad

Srivastava, C.B.L. 2002. A Text Book of Fishery Science and Indian Fisheries, Kitab Mahal, Publications, Allahabad.

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