Course Description:

This course covers advanced techniques in ecological modeling, including population dynamics, community modeling, spatial modeling, and ecosystem simulation. Students will build, analyze, and apply models to real-world ecological problems using statistical programming tools. Emphasis is placed on model construction, parameter estimation, sensitivity analysis, model validation, and uncertainty quantification.

Course Objectives:

By the end of the course, students will be able to:

- Develop and interpret deterministic and stochastic ecological models.
- Apply population, community, and ecosystem-level modeling approaches.
- Use spatially explicit and agent-based models.
- Calibrate, validate, and assess model uncertainty.
- Critically evaluate ecological models in scientific literature.
- Apply ecological modeling tools to inform conservation and management strategies.

Prerequisites:

Basic Ecology and Introductory Statistics; proficiency in R or Python recommended.

Textbook (Recommended):

- *A Primer of Ecological Modeling* by Karline Soetaert and Peter M.J. Herman
- *Modeling Population Dynamics* by Bruce Hannon and Matthias Ruth (optional supplementary)

Software and Tools:

- R (with packages: deSolve, nlme, mgcv, sp, raster)
- Python (optional; packages: SciPy, NumPy, Matplotlib)
- NetLogo (for Agent-Based Modeling)
- QGIS (for spatial model inputs/outputs)

Weekly Topics:

Week	Topics
1	Introduction to Ecological Modeling: Scope and Importance
2	Review of Basic Models: Exponential and Logistic Growth
3	Structured Population Models: Matrix Models (Leslie, Lefkovitch)
4	Metapopulation and Source-Sink Models

Week	Topics
5	Predator-Prey and Competition Models (Lotka-Volterra Systems)
6	Ecosystem Modeling and Biogeochemical Cycles
7	Stochastic Models and Uncertainty in Ecological Systems
8	Model Calibration and Validation Techniques
9	Spatially Explicit Models and Landscape Ecology
10	Introduction to Agent-Based Modeling
11	Species Distribution Models and Habitat Suitability
12	Sensitivity and Scenario Analysis
13	Applications in Conservation Biology and Climate Change Research
14	Student Model Presentations and Course Wrap-Up

Assessment:

- Homework and Modeling Exercises (25%)
- Midterm Exam (20%)
- Final Modeling Project (35%)
- Final Exam (15%)
- Participation and Discussions (5%)

Final Project:

Students will select a real-world ecological problem, develop a model, calibrate it using real or simulated data, run sensitivity analyses, and present both a written report and an oral presentation.

Course Policies:

- Attendance and participation are expected, especially during discussions and presentations.
- Assignments must be submitted on time unless arrangements are made beforehand.
- Plagiarism or academic misconduct will result in disciplinary action.

Important Dates:

- Midterm Exam: Week 7
- Final Exam: Week 14
- Final Project Presentation: Week 13