BIOL 6301-029

Terrestrial Ecosystem Modeling

Spring 2025

1 Course Description

Students in this course will learn the principles of terrestrial ecosystem modeling. This will include the core concepts behind systems thinking and model building. The ultimate goal of the course will be develop a terrestrial ecosystem model, with a focus on carbon and nutrient cycle dynamics. Through course-based model development, students will learn the skills necessary to develop their own model and to understand the workings of models developed by others. The course is primarily for biology graduate students with a background in plant physiological and ecosystem ecology.

1.1 Class Time and Location

Tuesdays and Thursdays 12:30-13:50

Science Building Room 204

1.2 Instructor

Dr. Nick Smith

Experimental Sciences Building II (ESBII) Room 402D

806-834-7363

nick.smith@ttu.edu

1.3 Office Hours

Thursdays 14:00-14:50

1.4 Recommended Texts

Climate Change and Terrestrial Ecosystem Modeling by Bonan https://doi.org/10.1017/9781107339217

Principles of Terrestrial Ecosystem Ecology (2nd Edition; 2011) by Chapin, Matson, and Vitousek

The book can be accessed from Springer here: https://link.springer.com/book/10.1007/978-1-4419-9504-9. Click on "Access this title on SpringerLink." It can also be accessed through the TTU library.

2 Course Materials

All course materials, including lecture slides, readings, activities, and code will be posted to a GitHub repository for the course. The primary repository address is https://github.com/SmithEcophysLab/ecosys_modeling_sprin2025. The repository will include the syllabus and all other miscellaneous class materials as the semester progresses. A README file will contain information on the repository, including links to different sections at https://github.com/SmithEcophysLab/ecosys_modeling_sprin2025/README.md.

3 Learning Objective

This course will broadly focus on understanding the principles underlying the development of process-based terrestrial ecosystem models. An emphasis will be placed on how to build these models to understand the interactions between terrestrial ecosystems and drivers of global change, including climate change, changes in atmospheric gas concentration, and eutrophication. Course topics will be taught through the lens of classical and more contemporary primary and secondary literature. There will be a strong emphasis on hands-on modeling

skill development. Topics will be flexible and modified to match student interests where possible.

4 Attendance Policy

Attendance will not be taken, but is strongly recommended. In class activity points will only be granted if students are in class. Makeups will not be granted.

5 Course Assessment

5.1 *Participation and Engagement*

Being an active and engaged participant in the class will benefit your understanding of material as well as your peers'. Examples include asking questions, providing feedback, and facilitating discussion.

5.2 *Quizzes*

Short quizzes will be given periodically to test student knowledge of core concepts and to stimulate discussion. In some cases, quizzes will be developed and administered by class weekly co-leads.

5.3 *Weekly co-leads*

Throughout the semester, students will be asked to co-lead on the week's discussion topic with Dr. Smith. This will consist of leading a jigsaw-style discussion of a literature article on Tuesdays and developing a quiz for students on Thursdays. Students will be evaluated on their ability to respond accurately to their peers' questions as well as their ability to summarize and generate discussion on the week's topic.

5.4 *Model module development*

The primary semester project will be to develop a module for the class terrestrial ecosystem model based on the student's interest. The module will be written in R and must be able to run as a stand-alone module as well as in connection with the larger class model. The student will be required to write a full description of the module to coincide with the code in both README and manuscript style format.

6 Grading

Participation and Engagement: 25%

Quizzes: 10%

Weekly co-lead: 25%

Module proposal: 10%

Module presentation: 5%

Final module: 25%

Grades will be made available on Blackboard. All grades posted at the end of the course will be final, unless an error has been made in their calculation. Please contact Dr. Smith if you feel your grade has been calculated incorrectly.

7 Grading Scale

A: $\geq$ 90%

B: 80 – 90%

C: 70 – 80%

D: 60 – 70%

F: $\leq$ 59.9%

8 Missing In-class Activities

Students will be required to be in class to receive in-class activity points. Please contact Dr. Smith if you plan to miss class for a university function *prior to class*. If class is missed due to an illness, please let Dr. Smith know as soon as possible. Documentation will need to be provided in order to be able to make up any missed work.

9 Special Considerations

Texas Tech Policies Concerning Academic Honesty, Special Accommodations for Students with Disabilities, Student Absences for Observance of Religious Holy Days, Accommodations for Pregnant Students, and other policies may be found at this link: `https://www.depts.ttu.edu/tlpdc/RequiredSyllabusStatements.php`.

9.1 AI Use

The use of generative AI tools (such as ChatGPT) is strictly prohibited in this course for any purpose. Information gathered from AI cannot be used even with appropriate citation. Submission of AI-generated content (i.e., information, text, or images) as your own work is a violation of academic integrity and may result in referral to the Office of Student Conduct. Please contact your instructor if you have questions regarding this course policy.

10 Plagiarism Statement

Texas Tech University expects students to "understand the principles of academic integrity and abide by them in all class and/or course work at the University" (OP 34.12.5). Plagiarism is a form of academic misconduct that involves (1) the representation of words, ideas, illustrations, structure, computer code, other expression, or media of another as one's own and/or failing to properly cite direct, paraphrased, or summarized materials; or (2) self-plagiarism, which involves the submission of the same academic work more than once without the prior permission of the instructor and/or failure to correctly cite previous work

written by the same student. Please review Section B of the TTU Student Handbook for more information related to other forms of academic misconduct, and contact your instructor if you have questions about plagiarism or other academic concerns in your courses. To learn more about the importance of academic integrity and practical tips for avoiding plagiarism, explore the resources provided by the TTU Library and the School of Law.

Schedule of Topics by Week

01/13/2023 – Systems Thinking

01/20/2023 – Terrestrial Ecosystem C N cycling; downloading and using R

01/27/2023 – Terrestrial Ecosystem Models; GitHub and the class model environment

02/03/2023 – 3 R's of Terrestrial Ecosystem Modeling; working collaboratively in GitHub

02/10/2023 – Integrating Ecology into Models; writing functions in R

02/17/2023 – Eco-evolutionary Optimality Theory; model repository structure

02/24/2023 – Model development: Carbon In

03/03/2023 – Model Development: Plant Carbon Allocation

03/10/2023 – **Module proposal presentations**

03/17/2023 – NO CLASS

03/24/2023 – Model Development: Plant Nutrient Demand and Acquisition

03/31/2023 – Model Development: Soil Carbon Cycling

04/07/2023 - Model Development: Vegetation Dynamics

04/14/2023 – **Module presentations**

04/21/2023 – **Module presentations**; **Final module due**

04/28/2023 – NO CLASS 05/06/2023 – NO CLASS

General Weekly Schedule

Generally, each Tuesday will consist of a lecture and jigsaw-style paper discussion. Thursdays will consist of a quiz and class model development exercise.