MEES 698K / BIOL 650: Introduction to Geographic Information Systems (GIS) - 2 Credits

Instructor:	Matt Fitzpatrick	**Phone:**	301.689.7131 (Office) / 240.803.7826 (Cell)
Office:	Appalachian Lab 222	**E-mail**	mfitzpatrick@umces.edu
Office Hours:	By appointment	**Web:**	https://www.umces.edu/matt-fitzpatrick

Justification: Knowledge of how to analyze and display spatial data is increasingly required for ecological research and demanded by employers in federal, state and private agencies. Geographic Information Systems (GIS) provide a tool for working with natural resources data within a spatial context. However, many students do not possess the basic skills and experiences necessary to fully exploit the power of GIS. Through the use of self-directed tutorials, literature reviews, and a final project, this independent study course provides a basic introduction to the use and methods of GIS and will allow the student to further explore its use and applications in the field of environmental science and management.

Overview: This 2-credit course provides introductory exposure to general GIS methods through a series of self-guided tutorials before moving to more specific GIS applications. The course requires the completion of two sets of ESRI training courses totaling ~40 hours (~30 hours of core courses and ~10 hours of emphasis area courses). See course summaries below for details. In addition to completing the courses, students will (1) review three scientific papers that use GIS principles on topics related to their field of study, (2) complete an original analysis of a dataset of their choosing using the techniques that they have learned, and (3) write a short report describing their analyses.

Course Materials: *Access to ESRI training courses will be provided to registered students by the instructor, which require an active ArcGIS license.* It includes several successive core courses (~30 hours total) and a selection of several additional courses from **one** of four areas of emphasis (~10 hours total), including spatial analysis, cartography, raster analysis, and LiDAR data processing. *Contact the instructor if you would like guidance on selecting an area of emphasis or if you would like to mix and match courses from different areas of emphasis. It is also possible to design your own area of emphasis, with permission of the instructor.*

Course details are provided below (see links that take you to the course on the ESRI website). Note that ESRI course offerings (and software versions) change frequently, so please let the instructor know if you encounter any issues accessing any of the courses.

Course Objectives:

1. Learn what GIS is and how it can be used.
2. Understand how to symbolize and display spatial data as maps and charts.
3. Learn skills involving organizing, editing and manipulating spatial data.
4. Learn how to perform analysis operations with geo-processing and modeling.
5. Apply GIS skills to a current management/restoration issue in the environmental sciences.

Method of Achieving Objectives & Evaluation

Students will be evaluated on three items:

1: ESRI Training Courses: The student will use background reading materials, guided tutorials, and practice exercises to accomplish the learning objectives. ***PDF copies of the course completion documentation must be provided to the instructor as proof of successful completion of the ESRI training courses*.**

2. Three Journal Article Reviews: The student will also write a one- to two-page (single-spaced) summary for three scientific papers of their choice that have used GIS in an area of interest to the student. The write-ups should answer the following questions: How did the researchers use GIS? What insight did the researchers gain specifically through the use of GIS that would not have been possible otherwise? Please get approval for the papers you have selected to read and summarize.

3. Final Project: As a final project, the student will design and implement a GIS analysis that includes several spatial

operations (such as a clip, intersection, buffer, merge, statistical summary, etc.) to answer a research question using a dataset of their choosing. Once the student has completed the web-based tutorials, the student must discuss final project ideas with the instructor ***before proceeding with the final project***.

In the final project, the student should be careful to differentiate between a data processing step (such as importing XY data or georeferencing an image) and a ***spatial analysis***. Students will submit a report that describes the objectives and results of the analysis and includes final map products.

The final report should be no more than ~2000 words in length and ***should follow the format of a standard scientific paper (Abstract, Intro, Methods, Results, Discussion)***. Credit will be given for: (1) using GIS operations appropriate to the stated objective, accurately analyzing results, providing insightful conclusions and which include meaningful spatial operations and analyses; and (2) good technical writing including grammar, spelling, and organization. Again, note that the format for the final report should follow that of a standard scientific paper (Abstract, Introduction, Methods, etc).

The final project may be an opportunity for students to analyze data that they are collecting for their own research projects. Alternatively, the instructor will supply data for the final project if requested.

NOTE: Students should not proceed with the final project until it has been formally approved by the instructor. A final report submitted on a project that has not been approved will be returned ungraded.

Grading

Your final grade in the course will be based on the following breakdown (the schedule for completion of these tasks has been provided via email):

1: Timely completion of ESRI Training Courses: 20%

2. Journal Reviews: 30% (10% for each article)

3. Final Project: 50%

ESRI Training Courses – Available as of January 2022

I. Core GIS Courses: 28.5 hours total (take in order)

C1: Getting started with GIS (3.5 hours - ArcMap only)
GIS helps people visualize & create information that can be used to make decisions and solve problems. Get an introduction to the basic components of a GIS. Learn fundamental concepts that underlie the use of a GIS with hands-on experience with maps and geographic data.

C2: Basics of Geographic Coordinate Systems (1.25 hours - Pro and ArcMap)
How do you accurately represent the location of features on the earth's surface on paper or a computer screen? In a GIS, the answer starts with a geographic coordinate system. Learn the fundamental concepts of geographic coordinate systems.

C3: Basics of Map Projections (3 hours - ArcMap only)

Decide which map projection to use for your GIS project. This course explores categories of map projections and their properties. Learn which projections are best for different types of GIS maps and how to choose a projection for a given mapping project.

C4: Working with Coordinate Systems (2.75 hours - ArcMap only)
A coordinate system is responsible for ensuring your features display in the right location. You will learn practical guidelines for solving challenges as well as techniques to correct problems caused by unknown and missing coordinate system information.

C5: Referencing Data to Real-World Locations (3.25 hours - ArcMap only)
Displaying real-world features in the right location on a map requires a coordinate system. You will learn fundamental concepts of coordinate systems and understand why they are essential to creating accurate maps and performing reliable analysis.

C6: Getting Started with the Geodatabase (3.5 hours - Pro and ArcMap)
Displaying real-world features in the right location on a map requires a coordinate system. You will learn fundamental concepts of coordinate systems and understand why they are essential to creating accurate maps and performing reliable analysis.

C7: Displaying Raster Data in ArcGIS (3.25 hours - Pro and ArcMap)
Learn techniques to display and enhance rasters and imagery in ArcGIS. Learn to appropriately symbolize rasters based on their attributes and intended use, modify raster properties to support better visualization and interpretation, and apply out-of-the-box appearance functions to enhance the viewing experience.

C8: Managing Raster Data (2 hours - Pro and ArcMap)
Because raster data collections have very large file sizes, efficient storage is a must. For those who will be using the data for visualization and analysis, fast display performance is a must. In this course, you will learn how the mosaic dataset helps you accomplish both.

C9: Georeferencing Raster Data (3 hours - ArcMap only)
Raster data is an important data source for GIS analysis & visualization. It must be referenced to the correct location on the earth's surface to be reliable. Learn workflows to align raster data with its real-world location & evaluate the accuracy of georeferencing results.

C10: Image Processing with ArcGIS (3 hours - ArcMap only)
Imagery is a pervasive data source used for geographic context, visualization, and analysis. Learn techniques to enhance and control image display, perform change detection and derive new products from a single image source.

II. Emphasis Areas: 10-15 hours total

Complete all courses within **ONE** of the following four course groupings (Spatial Emphasis, Raster Emphasis, Cartography, or LiDAR Analysis).

Contact the instructor if you would like to mix and match courses among emphasis areas to suit your specific training needs / interests. You can find a listing of available courses at: https://www.esri.com/training/

E1: Spatial Emphasis (5 courses, 13.5 hours total)

E1.1: Exploring Spatial Patterns in Your Data (3.5 hours - ArcMap only)
Go beyond a simple visualization to an in-depth examination of your data's characteristics. Learn how to use spatial statistics tools and ArcGIS Geostatistical Analyst tools to better understand your data.

E1.2: Getting Started with Spatial Analysis (1.25 hours - Pro and ArcMap)
Spatial analysis helps you to understand your world. Explore how the six categories of spatial analysis can help you answer geographic questions. Navigate these questions using the spatial analysis workflow and learn how to apply it to your own projects.

E1.3: Distance Analysis Using ArcGIS (3.5 hours - ArcMap only)
Distance analysis helps answer questions like who will be impacted, what is nearest, and what path is most efficient. Learn to use ArcGIS Spatial Analyst to create raster surfaces that identify the shortest distance as well as cost-effective paths that reflect a project's specific criteria.

E1.4: Introduction to Surface Modeling Using ArcGIS (3.5 hours - ArcMap only)
For most applications, it is impossible to collect data for every point in an area of interest. ArcGIS Geostatistical Analyst tools help predict values at every location across a surface. This course focuses on the kriging geostatistical interpolation method.

E1.5: Regression Analysis (2.75 hours - ArcMap only)
The goal of a GIS analysis is finding where something occurs. The goal of a regression analysis is understanding why something occurs. With both, you can determine factors that influence patterns and predict how the pattern will change in the future.

E2: Raster Emphasis (5 courses, 12 hours total)

E2.1: Performing Unsupervised Pixel-Based Image Classification (1 hour - Pro and ArcMap)

Imagery from satellite sensors can have coarse spatial resolution, which makes it difficult to classify visually. Through unsupervised pixel-based image classification, you can identify the computer-created pixel clusters to create informative data products. This course introduces the unsupervised pixel-based image classification technique for creating thematic classified rasters in ArcGIS.

E2.2: Performing Supervised Object-Based Image Classification (1.25 hours - Pro and ArcMap)
Supervised object-based image classification allows you to classify imagery based on user-identified objects or segments paired with machine learning. In this web course, you will learn about the workflow to use supervised object-based image classification, and you will understand the limitations and benefits of the technique.

E2.3: Deriving Rasters for Terrain Analysis (2.75 hours - ArcMap only)
Elevation data in raster format is used to model the earth's surface, solve problems, and support decision making. This course teaches how to use ArcGIS Spatial Analyst tools to derive raster data from an elevation raster for visualization and analysis.

E2.4: Introduction to Surface Modeling Using ArcGIS (3.5 hours - ArcMap only)
For most applications, it is impossible to collect data for every point in an area of interest. ArcGIS Geostatistical Analyst tools help predict values at every location across a surface. This course focuses on the kriging geostatistical interpolation method.

E2.5: Distance Analysis (3.5 hours - ArcMap only)
Distance analysis helps answer questions like who will be impacted, what is nearest, and what path is most efficient. Learn to use Spatial Analyst to create raster surfaces that identify the shortest distance as well as cost-effective paths that reflect a project's specific criteria.

E3: Cartography (4 courses, 11.25 hours total)

E3.1: Getting Started with Cartographic Representations (5.5 hours - ArcMap only)
Cartographic representations are used to create rule-based map symbology that can be reused. Create unique symbology to support different map purposes and scales without data duplication or processing. Learn concepts of cartographic representations to optimize map production workflows and solve cartographic challenges.

E3.2: Planning a Cartography Project (2 hours - ArcMap only)
This course introduces a standard five-step workflow for creating high-quality maps. Learn the key factors to consider when planning a cartography project and preparing data that supports your map's purpose, audience, and format.

E3.3: Map Design Fundamentals (2 hours - ArcMap only)
This course presents design principles you can apply to create appealing maps that are easy to use and understand. You will learn how to combine layout composition, color, symbology, and text to design a map that clearly communicates your intended message.

E3.4: Advanced Techniques for Cartographic Representations (1.75 hours - ArcMap only)
Cartographic representations provide a rule-based solution that supports efficient map production workflows. As with all rules, there are exceptions. Learn to account for exceptions within representation rules to optimize cartographic display, improve map readability, and adapt feature symbology.

E4: LiDAR Data Processing & Analysis (3 courses, 10.75 hours total)

E4.1: Managing Lidar Data Using LAS Datasets (2.5 hours - ArcMap only)
LAS datasets provide fast access to large volumes of lidar and surface data. In this course, you will learn how to efficiently organize lidar data using LAS files, quickly access information about the data, and techniques to display lidar points in ArcMap.

E4.2: Managing Lidar Data Using Mosaic Datasets (3.5 hours - ArcMap only)
Mosaic datasets are an ideal option when performing raster-based analysis. They also provide fast visualization and dynamic on-the-fly processing capabilities. This course teaches techniques to optimize mosaic datasets as well as functions that enhance visualization and generate new information from lidar data.

E4.3: Managing Lidar Data Using Terrain Datasets (4.75 hours - ArcMap only)
LAS datasets are useful for performing quality assurance on lidar data. And terrain datasets support fast data retrieval and display. Learn to create a terrain dataset, then use it to visualize and analyze lidar data.