Biostatistics
(Biol 4590.003)
Department of Life Sciences
Spring 2020

A. COURSE INFORMATION

Course number/section: Biol 4590.003 (Lecture)
Class meeting time: Lecture: 3:30pm – 4:45pm TR
Class location: Lecture: R.R. Ferguson 108

B. INSTRUCTOR INFORMATION

Instructor: C. Edward Proffitt, Ph.D.
Office location: TH139
Office hours: M & W 4:00-5:00, T & Th 1:30-3:30 PM by appointment (email me)
Telephone: 361-825-2358
e-mail: ed.proffitt@tamucc.edu

C. COURSE DESCRIPTION

BIOL 4590.001, Biostatistics, or biometry, is the application of statistical analysis to biological data. Understanding how to apply statistical analyses to biological data goes hand in hand with understanding the principles of experimental design and determining how to frame informative research questions. At a fundamental level, these concepts are linked to the philosophy of science and how we develop understanding about the way the world works. In this course we will start with philosophy and build up through question formulation, experimental design, basic deterministic functional forms, biological distributions, importing and preparing data-sets for analysis; and univariate statistical approaches. Along the way students will be briefly introduced to a wide variety of other statistical tools in a series of short vignettes covering ordination; hierarchical models; models that deal with non-independence (time series and spatial autocorrelation); bootstrapping; and machine learning. The purpose of these introductions will be to familiarize students with the wide world of other approaches that are available. These vignettes are to ensure that in the future, students can determine if the tests covered in this course are appropriate for their needs, and if not, point them in the direction of the appropriate analytical tool(s). Homework assignments and class demonstrations will use the free programming language R.

D. PREREQUISITES AND COREQUISITES

Prerequisites
None
Corequisites
None

E. REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES

Required Textbook(s)
2) Hobbs, N.T. 2012. An ecological modeler’s primer on R. Colorado State University, Fort Collins CO, 80523. One of the better introductions to using R out there, and freely downloadable, everyone will download this primer and work through it. You’ll be given class time in support of this.

Optional Textbook(s) or Other References
Rather than follow one book alone, this course will draw from a wide range of source material including books and primary literature. The books listed below supplement the main text above. Much of the assigned reading will be in the form of primary literature that showcases various experimental designs, statistical approaches or tests, or classic foibles:
5) Hobbs, N.T. and Hooten, M.B. (2015) Bayesian Models: A statistical primer for ecologists. Princeton University Press. ISBN: 9780691159287. Don’t be alarmed by the word Bayesian, we’re not going to do more than dance lightly across the surface of that topic. However, Hobbs & Hooten’s first several chapters are a lovely introduction to deterministic functional forms and statistical distributions relevant to biologists.
7) Shipley, B. (2000) Cause and Correlation in Biology: A user’s guide to path analysis, structural equations and causal inference. Cambridge Press. ISBN: 0521791537. Another book that goes well beyond what this class will cover, but various sections do an extremely elegant job of discussing causality and just what it is that biologists are attempting to do when we conduct research.

Supplies
Access to a computer to complete homework assignments. This computer will need to have a copy of R. R is free software that may be downloaded from http://cran.r-project.org. R is a programming language with many free programs or “packages” written for statistical analysis. The language was developed by scientists and continues to be used and developed by scientists.
I work directly in the scripting window, however, there are many text editors out there that can make your scripting easier. Some you might consider include TinnR, SublimeText, and RStudio. The last is used in other courses on campus. For this course I will not expect you to get creative with your coding, I will give you bits of code that perform certain tasks, it will be your job to understand how to implement that code and to interpret the output.

F. STUDENT LEARNING OUTCOMES AND ASSESSMENT

Assessment is a process used by instructors to help improve learning. Assessment is essential for effective learning because it provides feedback to both students and instructors. A critical step in this process is making clear the course’s student learning outcomes that describe what students are expected to learn to be successful in the course. The student learning outcomes for this course are listed below. By collecting data and sharing it with students on how well they are accomplishing these learning outcomes students can more efficiently and effectively focus their learning efforts. This information can also help instructors identify challenging areas for students and adjust their teaching approach to facilitate learning.

By the end of this course, students should be able to:

1. Understand and be able to distinguish between the different versions of the scientific method, their philosophical underpinnings, and explain how these give rise to different classes of statistical tests.
2. Given biological data, be able to determine the data type, the appropriate underlying probability distribution, and calculate descriptions of distribution moments.
3. Distinguish between different general model types (phenomenological, conceptual, causal, statistical)
4. Develop conceptual models, convert these into testable hypotheses, and design an experiment that will test those hypotheses.
5. Identify appropriate statistical tests for different classes of data and types of hypotheses including (parametric vs non-parametric; monte-carlo; Bayesian; univariate vs multivariate; underlying distributions; model form).
6. Given a dataset; load it into R, prepare it for analysis (reshape, aggregate, and fill data holes), make simple plots; describe the data distribution; and implement simple statistical tests relevant for biological studies including one-way ANOVA; two-way ANOVA; linear regression; ANCOVA; logistic regression; the chi-square test; and interpret the results of those models.

G. INSTRUCTIONAL METHODS AND ACTIVITIES

The course will be taught through interactive lectures; discussions; and simple directed programming exercises. Programming exercises will be conducted with a combination of scripts prepared by Dr. Patrick and exercises where students write their own simple analyses.
In class demonstrations will be performed using the projector and students will have opportunities to follow along on personal computers during lecture.

**MAJOR COURSE REQUIREMENTS AND GRADING**

The learning outcomes stated earlier will be assessed through a variety of methods as noted in the following table.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>% of FINAL GRADE</th>
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<tbody>
<tr>
<td>Exams (2)</td>
<td>40</td>
</tr>
<tr>
<td>Class Participation</td>
<td>10</td>
</tr>
<tr>
<td>Homework</td>
<td>30</td>
</tr>
<tr>
<td>Final Exam*</td>
<td>20</td>
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</table>

*Entry to the classroom will be closed on the day of final exam soon as the first student to complete an exam has left the room. Students absent or arriving after room closure will receive a zero for the exam.

**Grading:** There will be a total of three (3) written exams. Exams may be composed of any, or all, of the following: multiple choice, matching, fill in the blank, problem solving and short essay. The final exam is a comprehensive exam. All exams count toward your class grade. No exam grade will be dropped. No make-up exams will be given. If an exam is missed with proper prior notification, the test may be taken as soon as possible after the exam date, but no later than the following class day. If the exam is not taken a grade of zero (0) will be entered. No extra credit assignments will be given. Class attendance and participation will also be factored into your final grade. The grading scale is: A=90-100%, B=80-89%, C=70-79%, D=60-69%, and F=0-59%. All grades will be rounded to the nearest whole number, therefore, a grade of 89.50% would be rounded to 90% (A) and a grade of 89.49% would be an 89% (B).

**H. COURSE CONTENT/SCHEDULE**

<table>
<thead>
<tr>
<th>Date</th>
<th>Lecture &amp; classroom activities</th>
<th>Work Assigned</th>
<th>Work Due</th>
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</thead>
<tbody>
<tr>
<td>1/21</td>
<td>Hand out the syllabus, first introduction to R and the many things it can do (data manipulations; statistics; web service; mapping; simulations); class goals, examples</td>
<td>Ecological Detective (12-22); Ecological Understanding (18-26), Assign Modelers Primer</td>
<td>Discussion Questions Assignment</td>
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<tr>
<td>1/23</td>
<td>Working through the R Primer</td>
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<td>1st Primer Assignment</td>
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<tr>
<td>1/28</td>
<td>Working through the R Primer</td>
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<td>2nd Primer Assignment</td>
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<tr>
<td>1/30</td>
<td>Scientific method; relationship with history of biological statistics;</td>
<td>Probability Reading.1.2</td>
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<tr>
<td>Date</td>
<td>Topic</td>
<td>Assignment, Reading, HW due</td>
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<td>------------------------------------------------------------------</td>
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<tr>
<td>2/4</td>
<td>Probability and Data 1</td>
<td>ProbabilityReading 3, Completed Primer Assignment - All Typed Out with Output</td>
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<tr>
<td>2/6</td>
<td>Probability and Data 2</td>
<td>Biological Distributions Assignment</td>
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<tr>
<td>2/11</td>
<td>Probability and Data 3</td>
<td>Reading – H.H. Deterministic Models</td>
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<td></td>
<td>Deterministic Models and Functional Forms</td>
<td>Homework in R - Graphing Deterministic Models (Primer, pg 55-61); Reading: Cause &amp; Correlation, Shipley</td>
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<td>2/13</td>
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<td></td>
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<td>Homework: Hurlbert assignment</td>
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<tr>
<td>2/20</td>
<td>Paper Discussion and Lecture</td>
<td>STUDY!!</td>
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<tr>
<td>2/25</td>
<td>EXAM 1</td>
<td></td>
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<tr>
<td>2/27</td>
<td>EXAM Review &amp; P-values; Type 1 and 2 error</td>
<td>Reading on P-values, Type 1 and 2 error. P-value HW assigned</td>
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<tr>
<td>3/3</td>
<td>Regression I – Simple Linear Regression,</td>
<td>Reading: Regression Chapter, Assignment: Regression I</td>
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<td></td>
<td>Confidence Interval,</td>
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<tr>
<td>3/5</td>
<td>Regression II – Diagnostic Plots,</td>
<td>Reading: Regression Chapter, Assignment: Regression Spring Break Assignment</td>
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<td></td>
<td>Transformations, Quantile Regression</td>
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<td>3/10</td>
<td>Spring Break</td>
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<tr>
<td>3/12</td>
<td>Spring Break</td>
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<tr>
<td>3/17</td>
<td>Regression III – Logistic Regression,</td>
<td>Reading: t-tests and comparisons; Assignment: t-tests and Regression 3 HW</td>
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<td></td>
<td>Multiple Linear Regression, Model</td>
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<td></td>
<td>Comparison (AIC, Likelihood)</td>
<td>Regression II Project Due</td>
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<tr>
<td>3/24</td>
<td>t-test; multiple comparisons; corrections</td>
<td>Assignment: t-tests, Practice Exam Assigned (NG)</td>
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<tr>
<td>3/25</td>
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<tr>
<td>Date</td>
<td>Topic</td>
<td>Reading/Assignment</td>
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<tr>
<td>3/26</td>
<td>Exam 2 Review</td>
<td>Review and Study!</td>
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<tr>
<td>3/31</td>
<td><strong>EXAM 2</strong></td>
<td>Reading: ANOVA 1</td>
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<tr>
<td>4/2</td>
<td>Tailed Tests, One-Way ANOVA</td>
<td>Reading: ANOVA1; Assignment: ANOVA 1</td>
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<tr>
<td>4/7</td>
<td>Two-Way ANOVA, a bestiary of ANOVA tables (ANCOVA, Split Plot, etc); <em>a priori</em> and post-hoc contrasts</td>
<td>Reading: Categorical Data; Assignment: ANOVA 2</td>
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<tr>
<td>4/9</td>
<td>Chi-square ($x^2$); G-test</td>
<td>Reading: Randomization Tests Reading; Cutler et al. 2007 Assignment: Categorical Data</td>
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<tr>
<td>4/14</td>
<td>Randomization - Monte Carlo and Bootstrapping; Machine Learning</td>
<td>Reading: Multivariate Distributions and Ordination Assignment: Simulating Data and Machine Learning</td>
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<tr>
<td>4/16</td>
<td>Multivariate Data</td>
<td>Reading: Sokal &amp; Thomson 1987 Assignment: Exercise comparing SLR, Mixed-Effects Models, and SEM for a single simple dataset</td>
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<tr>
<td>4/21</td>
<td>Heirarchical Models; SEM;</td>
<td>Reading: Cottenie et al. 2005 ANOVA v Regression w/ 1 paragraph summary</td>
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<tr>
<td>4/23</td>
<td>Autocorrelation - (Space and Time) common problems and fixes (Mantel Test, Partial RDA)</td>
<td>Exercise comparing SLR, Mixed-Effects Models, and SEM for a single simple dataset</td>
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<tr>
<td>4/28</td>
<td>Path analysis 1</td>
<td>TBA</td>
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<tr>
<td>4/30</td>
<td>Path analysis &amp; Structural Eq Modeling 2</td>
<td>Summary Paragraph due</td>
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<tr>
<td>5/5</td>
<td>Using biostat tools wisely</td>
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I. COURSE POLICIES

Attendance/Tardiness
Each student’s individual career experiences provide valuable perspective to their peers. Therefore, it is critical that you attend class regularly to be a partner in this enhanced learning environment. At each class meeting, attendance will be noted. It is each student’s responsibility to contact the instructor directly (phone or e-mail), in advance, if class will be missed. The instructor will not accept late work without valid reasons. Students with a university approved scheduled absence (athletics, military duty, etc.) must contact the instructor well in advance (>72 hrs) of a scheduled absence. Exams may be taken early in those specific cases. Students who do not arrange to take exams ahead of time will not be eligible for this special consideration. A written excuse from the university department involved is required.

Students are encouraged to contact the instructor anytime they are not achieving their intended level of success, prior to taking any other action. Students who need to withdraw must complete an official form and submit it consistent with college policy no later than the official published date. “Incomplete” grades are awarded only when an emergency prevents a student from completing a minor portion of the course assignments. Active participation is a part of your grade. It includes (1) asking questions; (2) answering questions with supportive evidence; (3) responding to other student’s comments, etc. Students are expected to be on time for class, to address others with respect, and to project an attentive and concerned demeanor.

Late Work and Make-up Exams
All exams count toward your class grade. No exam grade will be dropped. No make-up exams will be given. If an exam is missed with proper prior notification, the test may be taken as soon as possible after the exam date, but no later than the following class day. If the exam is not taken a grade of zero (0) will be entered.

Extra Credit
Over the course of the semester there will be several opportunities to gain extra credit in the form of bonus questions on exams or extra assignment. The sum total of extra credit offered will equal 3% of the total course grade, thus giving a student who does all of the extra credit the opportunity to boost their grade of 87% to an “A”, 77% to a “B”, etc.

Cell Phone Use
The use of cell phones and other personal electronic devices (PEDs) are prohibited during class. All cell phones must be turned off during the class period. If you are emergency
personnel (i.e., EMT, fire, or police) you may set your device to vibrate. Any student who uses a cell phone to make or answer a call, send and read text messages or e-mails (other than TAMUCC emergency messages), or any other use of a personal electronic device during class may have that device confiscated and be asked to leave class, which will be considered an absence for that class. No student has the right to disturb the teaching and learning process. Voice recording of lectures is allowed, but no video/photography are allowed during class, except with instructor permission.

Laptop Use
Laptop computers and tablets may be used in the classroom for taking notes, as long as they are not a nuisance to other students. However, laptops shall not be used for items as noted above for cell phones or PEDs.

Food in Class
There is NO eating or drinking in the classroom or in the lab.

Missed Exam
If an exam is missed with proper prior notification, the test may be taken as soon as possible after the exam date, but no later than the following class day. If the exam is not taken by then a grade of zero (0) will be entered. If the final is missed without proper prior notification and arrangement, a grade of zero will be entered for the final exam.

Participation
Four or more absences, with the exception of death in the nuclear family, sick child/spouse, or personal sickness may result in a failing grade at the discretion of the instructor. You must contact the instructor by phone message or e-mail before class to let the instructor know of your absence.

Other
Plagiarism and Cheating will not be tolerated.

Plagiarism: The Merriam-Webster Dictionary defines plagiarism as "To pass off as one’s own words or ideas of another.”
Plagiarism involves:
- Submitting another person's work as one's own
- Submitting work from any source that is not properly acknowledged by footnote, bibliography, or reference within a paper
- Submitting work pieced together from phrases and/or sentences from various sources without acknowledgement
• Submitting work with another person's phrase(s) rearranged without acknowledgement
• Submitting work that uses any phrase, sentence, or stylistic mannerism without acknowledgement
• Omitting quotation marks from any directly quoted material
• Failure to use three dots (…) to indicate omission of one or more words
• Any other actions deemed to be plagiarism by the faculty

Cheating is defined as:
• Copying to any extent the work of another student
• Intentionally assisting another student during an examination
• Having access to material related to an examination during an examination
• Possessing or having access to unauthorized copies of an examination
• Departing from any stated examination conditions

*Cheating or other academic dishonesty for exams and assignments will not be tolerated and will result in a Failing (F) grade for the class and suspension.

J. COLLEGE AND UNIVERSITY POLICIES

• Academic Integrity (University)
  University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one’s own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a failing grade.

• Classroom/Professional Behavior
  Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor’s ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

• Statement of Civility
  Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex, ethnic/racial
origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

**Deadline for Dropping a Course with a Grade of W (University)**

I hope that you never find it necessary to drop this or any other class. However, events can sometimes occur that make dropping a course necessary or wise. **Please consult with your academic advisor, the Financial Aid Office, and me, before you decide to drop this course.** Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class. Please consult the Academic Calendar (http://www.tamucc.edu/academics/calendar/) for the last day to drop a course.

- **Grade Appeals (College of Science and Engineering)**
  As stated in University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at http://www.tamucc.edu/provost/university_rules/index.html, and the College of Science and Engineering Grade Appeals webpage at http://sci.tamucc.edu/students/GradeAppeal.html. For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

- **Disability Services**
  The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call (361) 825-5816 or visit Disability Services in Corpus Christi Hall 116.

If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.
http://disabilityservices.tamucc.edu/

- **Statement of Academic Continuity**
  In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi, this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.

**K. OTHER INFORMATION**

- **Academic Advising**
  The College of Science & Engineering requires that students meet with an Academic Advisor as soon as they are ready to declare a major. The Academic Advisor will set up a degree plan, which must be signed by the student, a faculty mentor, and the department chair. Meetings are by appointment only; advisors do not take walk-ins. Please call or stop by the Advising Center to check availability and schedule an appointment. The College’s Academic Advising Center is located in Center for Instruction 350 or can be reached at (361) 825-3928.

- **Methods of Achieving Success**
  Achieving success in this course will require a time commitment outside of class that averages three to six hours per week for reading and studying. Students benefit from actively participating in the field work, classroom discussion, and lab demonstrations and activities.

**GENERAL DISCLAIMER**

I reserve the right to modify the information, schedule, assignments, deadlines, and course policies in this syllabus if and when necessary. I will announce such changes in a timely manner during regularly scheduled lecture periods.