Syllabus: BIOL 6301-046

**Advanced Topics in Biology - Statistical Analysis of Ecological Communities**  
Spring 2021

Course website: <https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/SAEC.html>

Tuesday – an asynchronous lecture will be posted on YouTube; corresponding notes and assignment will be posted on this website  
Thursday, 1:00-2:20 p.m. – Iroro and I will be available live via Zoom to answer questions

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**Office hours:**Will be done virtually (via Zoom) by appointment; email either me or Iroro to set up a time.

**Course overview:** This course is designed to familiarize you with the analysis of ecological community data, and to teach you how to do so using the R software environment (powerful freeware that is now perhaps the most commonly used package for statistical analysis in ecology). We will use example data typical of community ecology studies (i.e., abundance and/or occurrence data for multiple species at multiple sites that differ in environmental characteristics). In each case, there will be observations of multiple species and observations of multiple attributes of the environment at each sampling area. Data analysis will be followed by interpretation and communication of findings via written assignments.

This course will be entirely online. Students must therefore have the following **required** **technology and skills needed for this course:**You will need access to a PC or Mac desktop, laptop, or tablet **computer**; a smartphone will be insufficient. We will be using R/RStudio to conduct all analyses; prior experience with R will be helpful but not necessary. Students will be expected to load the computer they will be using with a copy of R, RStudio, and all necessary materials. You will be accessing links to the **internet** and using YouTube to access video lectures. For internet access, the Chrome browser is recommended. Finally, I will send out announcements and assignments via **email**; please make sure that I have your current TTU email address on file, and check to ensure that emails from me are not going to your Junk folder. You will also use email to turn in your assignments.

**Expected learning outcomes:** This is a practical, hands-on course on the statistical analysis of ecological community data; we will cover main types of multivariate analyses currently used by community ecologists, including use of diversity indices, various forms of ordination, cluster analysis, and others. We will be using the R computer environment (chiefly RStudio) to conduct all analyses. Students will be expected to load their personal computers with a copy of the R package, RStudio, and all necessary materials. No prior experience with R is necessary. Having had a previous basic course in statistics would be helpful.

**Methods for assessing expected learning outcomes:** Your grades will be based on weekly homework assignments; there are no exams. Although these assignments will require you to successfully conduct statistical analyses of ecological community data in R, the primary assessment will be on your ability to interpret the output from your analyses and draw appropriate ecological conclusions from them.

**Course structure:** On Tu I will have an asynchronous lecture video available online (via YouTube) that discusses the topic; there will be corresponding online notes with the assignment. On Th I will have a synchronous Zoom session to answer questions on the lesson/assignment.

**Grading:**All assessment will be via weekly assignments in RMarkdown (no tests). Your weekly assignments should be turned in as Word documents via email to [iroro.tanshi@ttu.edu](mailto:iroro.tanshi@ttu.edu) no later than 8:00 a.m. on Monday of the following week. In your email, please include the following as the Subject line: Assignment on \_\_\_\_ (you will fill in the blank with the week’s topic; for example: Assignment on PCA)

**Potential for course modality change:** As per TTU: “If Texas Tech University campus operations are required to change because of health concerns related to the COVID-19 pandemic, it is possible that this course will move to a fully online delivery format. Should that be necessary, students will likely need a webcam and microphone and will be advised of additional technical and/or equipment requirements, including remote proctoring software.” Since this course is already online, we’re covered.

**Illness-based absence policy:**If at any time during this semester you feel ill, in the interest of your own health and safety as well as the health and safety of your instructors and classmates, you are encouraged not to attend face-to-face class meetings or events. Please review the steps outlined below that you should follow to ensure your absence for illness will be excused. These steps also apply to not participating in synchronous online class meetings if you feel too ill to do so and missing specified assignment due dates in asynchronous online classes because of illness.

1. If you are ill and think the symptoms might be COVID-19-related:  
a. Call Student Health Services at (806) 743-2848 or your health care provider.  
b. Self-report as soon as possible using the [ttucovid19.ttu.edu](http://ttucovid19.ttu.edu/) management system. This website has specific directions about how to upload documentation from a medical provider and what will happen if your illness renders you unable to participate in classes for more than one week.  
c. If your illness is determined to be COVID-19-related, all remaining documentation and communication will be handled through the Office of the Dean of Students, including notification of your instructors.  
d. If your illness is determined not to be COVID-19-related, please follow steps 2a through 2d below.

2. If you are ill and can attribute your symptoms to something other than COVID-19:  
a. If your illness renders you unable to attend face-to-face classes, participate in synchronous online classes, or miss specified assignment due dates in asynchronous online classes, you are encouraged to visit with Student Health Services at (806) 743-2848 or your health care provider. Note that Student Health Services and your own and other health care providers may arrange virtual visits.  
b. During the health provider visit, request a “return to school” note.  
c. E-mail the instructor a picture of that note.  
d. Return to class by the next class period after the date indicated on your note.

Following the steps outlined above helps to keep your instructors informed about your absences and ensures your absence or missing an assignment due date because of illness will be marked excused. You will still be responsible to complete within a week of returning to class any assignments, quizzes, or exams you miss because of illness. Links for additional info:[Student Health Services](https://www.depts.ttu.edu/studenthealth/)  
[Student Affair COVID-19](http://www.depts.ttu.edu/studentaffairs/SACOVID19.php)  
[Student COVID-19 Protocol](https://www.depts.ttu.edu/communications/emergency/coronavirus/provostdocs/Student_COVID-19_Flowchart_07-21-20.pdf)  
[Texas Tech Commitment](http://www.ttu.edu/commitment/)

**Students with disabilities:**Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact me as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services. Please note that instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, please contact the Student Disability Services office at 335 West Hall or (806) 742-2405.

**Religious holy day statement:** "Religious holy day" means a holy day observed by a religion whose places of worship are exempt from property taxation under Texas Tax Code §11.20. A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. A student who is absent from classes for the observance of a religious holy day shall be allowed to take an examination or complete an assignment scheduled for that day within a reasonable time after the absence. A student who is excused under section 2 may not be penalized for the absence; however, the instructor may respond appropriately if the student fails to complete the assignment satisfactorily.

**Academic integrity:** Academic integrity is taking responsibility for one’s own class and/or course work, being individually accountable, and demonstrating intellectual honesty and ethical behavior. Academic integrity is a personal choice to abide by the standards of intellectual honesty and responsibility. Because education is a shared effort to achieve learning through the exchange of ideas, students, faculty, and staff have the collective responsibility to build mutual trust and respect. Ethical behavior and independent thought are essential for the highest level of academic achievement, which then must be measured. Academic achievement includes scholarship, teaching, and learning, all of which are shared endeavors. Grades are a device used to quantify the successful accumulation of knowledge through learning. Adhering to the standards of academic integrity ensures grades are earned honestly. Academic integrity is the foundation upon which students, faculty, and staff build their educational and professional careers. [Texas Tech University (“University”) Quality Enhancement Plan, Academic Integrity Task Force, 2010]

**Academic dishonesty:** Academic dishonesty includes, but is not limited to, cheating, plagiarism, collusion, falsifying academic records, misrepresenting facts, and any act designed to give unfair academic advantage to the student (such as, but not limited to, submission of essentially the same assignment for two courses without the prior permission of the instructor) or the attempt to commit such an act. If a student is involved in any form of academic misconduct and is proven that the action took place, the instructor may initiate a disciplinary action. The penalties for academic dishonesty can include but are not limited to a zero or a grade of "F" on the work in question, a grade of "F" in the course, or suspension. Please make sure that you review the university’s Academic Integrity Policy (<https://www.depts.ttu.edu/opmanual/OP34.12.php>).

**Recommended references on community ecology analyses:**

* [Multivariate Statistics for Wildlife and Ecology Research (McGarigal et al., 2000)](https://www.amazon.com/Multivariate-Statistics-Wildlife-Ecology-Research/dp/0387986421) – although this book is somewhat dated now, it provides a clear explanation for many multivariate stats tests that are used in wildlife biology and ecology; this book would be most useful if you have already had a basic statistics class
* [Community Ecology: Analytical Methods using R and Excel (Gardener, 2014)](https://www.amazon.com/Community-Ecology-Analytical-Methods-Using/dp/1907807616/ref=sr_1_2?dchild=1&keywords=multivariate+community+ecology+analyses&qid=1601588061&s=books&sr=1-2) – this book covers how to perform some basic analyses on biodiversity data in both R and Microsoft Excel

**Recommended references for learning and using R:**

* [Getting Started with R: An Introduction for Biologists, 2nd ed. (Beckerman et al., 2017)](https://www.amazon.com/Getting-Started-R-Introduction-Biologists/dp/0198787847/ref=sr_1_1?dchild=1&keywords=getting+started+with+r&qid=1598655986&sr=8-1) – this is a very good and short book that will teach you how to load data, do some simple stats tests (t-test, ANOVA), and make some simple plots/graphs
* [The R Book, 2nd ed. (Crawley, 2012)](https://www.amazon.com/R-Book-Michael-J-Crawley/dp/0470973927/ref=sr_1_1?dchild=1&keywords=crawley+r+book&qid=1601587996&s=books&sr=1-1) – this is the comprehensive reference for R

**Important notes:**This is a new course, and it is the first time that I will have taught a course entirely online. I will be teaching out of my home from my old laptop (because my work desktop does not have a camera). I will be working from a PC platform but anticipate that several of you will be using Macs. Finally, I developed and maintain this website, which is not part of TTU’s Blackboard platform. Not using Blackboard has pros and cons. I do not use it primarily because I make my teaching materials available to everyone worldwide and not just enrolled TTU students (Blackboard materials require a TTU login whereas my website and YouTube channel do not). For all of these reasons, I expect there to be quite a few technological glitches. Please inform me of any problems right away!

Moreover, there is a very large disparity in students in terms of previous experience with R and with data analysis. (That is, some of you will already be experienced with these things whereas other students will have had no experience with them.) This disparity may make live video sessions uncomfortable for those students who don’t understand something; such a student may be reluctant to speak up if he/she thinks (based on questions/discussion in the live sessions, etc.) that he/she is the only one to not “get it.” Please do not hesitate to ask questions. You can also contact me or the T.A. to set up an individual appointment on Zoom.

I recommend that you interact with the course materials in the following order each week:  
1. First, read the week's online notes and work through the R scripts.  
2. Then watch the lecture video.  
3. Then do the assignment.

**List of topics to be covered:**

1. Introduction to ecological communities: what are they, why do we study them, and what kinds of data are involved?  
2. Introduction to R  
         R – see primers at <https://rstudio.cloud/learn/primers>  
         RStudio  
         RMarkdown – see primers at <https://rmarkdown.rstudio.com/>  
         Loading and manipulating site x species and site x environment data  
         Simple graphical summaries and basic statistical analyses of data  
3. How do I describe the structure of a community?  
         Richness + evenness = diversity  
         Abundance  
4. How do I measure other dimensions of biodiversity?  
         Phylogenetic and functional diversity  
5. How do I summarize complex relationships and identify the most important patterns from a near-infinite number of possible arrangements of multivariate data ?  
         Ordination  
6. How do I identify the most important variables driving patterns in a large dataset of correlated variables (and then use those variables in other analyses)?  
         Principal Components Analysis (PCA)  
         Redundancy Analysis (RDA)  
7. How can I determine which environmental variables are associated with species occurrences at different sites?  
         Nonmetric Multi-Dimensional Scaling (NMDS)  
         Canonical Correspondence Analysis (CCA)  
8. How do I determine whether my data are grouped?  
         Cluster Analysis  
9. If I have communities with *a priori* groupings, how do I determine whether those groups are valid?  
         Discriminant Function Analysis (DFA) via CART (Classification and Regression Trees)

**Data files:**[butterfly\_pres\_abs.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/butterfly_pres_abs.csv)  
[butterfly\_sites.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/butterfly_sites.csv)  
[brycesite.zip](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/brycesite.zip) - this is a zipped folder that contains the file brycesite.R; download it and extract the file to your computer  
[bryceveg.zip](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/bryceveg.zip) - this is a zipped folder that contains the file bryceveg.R; download it and extract the file to your computer  
[div\_data.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/div_data.csv)  
[grassland.community.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/grassland.community.csv)  
[grassland.species.traits.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/grassland.species.traits.csv)  
[grassland.phylogeny.newick.zip](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_communities/grassland.phylogeny.newick.zip) - this is a zipped folder; download it and extract the file to your computer  
[GBbiol.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/GBbiol.csv)  
[GBsite.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/GBsite.csv)  
[Ground\_beetles\_abundance.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/Ground_beetles_abundance.csv)  
[Ground\_beetles\_habitat.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/Ground_beetles_habitat.csv)  
[hsere.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/hsere.csv)  
[hsere\_ph.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/hsere_ph.csv)  
[NGBat.samp.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/NGBat.samp.csv)  
[NGBat.traits.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/NGBat.traits.csv)  
[NigBatTree.zip](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/NigBatTree.zip) - this is a zipped folder; download it and extract the file to your computer  
[plot.metadata.csv](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/plot.metadata.csv)  
[data\_sources\_info.docx](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/data_sources_info.docx) **Course schedule:**

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| --- | --- | --- | --- |
| **Day** | **Date** | **Topic** | **Links to Materials** |
| Th | 21 Jan. | No live session: Install R and RStudio on your home computer and work through primers on your own (if you are unfamiliar with R) | R primers: <https://rstudio.cloud/learn/primers> <https://rmarkdown.rstudio.com/> <https://ourcodingclub.github.io/tutorials/rmarkdown/> (There are lots of others out there as well if you want more practice working with R, RStudio, or RMarkdown.) |
| Tu | 26 Jan. | Introduction to the course and to ecological communities | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/ecological%20communities.docx) for notes  YouTube URL: <https://youtu.be/a2io3F5JZI8> |
| Th | 28 Jan. | Introduction to live session structure | 1:00-2:20; Zoom link will be emailed |
| M | 1 Feb | No assignment this week | - |
| Tu | 2 Feb. | Introduction to R, R Studio, and RMarkdown | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/Intro%20to%20R%20and%20RStudio.docx) for notes  YouTube URL: <https://youtu.be/sZp-2NQtFqA> |
| Th | 4 Feb. | R, RStudio, RMarkdown | 1:00-2:20; Zoom link will be emailed |
| M | 8 Feb. | Assignment due | - |
| Tu | 9 Feb. | Working with site x species data | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/site%20species%20data.docx) for notes  YouTube URL: <https://youtu.be/fftppBYyexE> |
| Th | 11 Feb. | Working with site x species data | 1:00-2:20; Zoom link will be emailed |
| M | 15 Feb. | Assignment due | - |
| Tu | 16 Feb. | Working with site x environment data | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/site%20environ%20data.docx) for notes  YouTube URL: <https://youtu.be/sCmXMKHAE9s> |
| Th | 18 Feb. | Working with site x environment data | 1:00-2:20; Zoom link will be emailed |
| M | 22 Feb. | Assignment due | - |
| Tu | 23 Feb. | Patterns in community data | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/community_patterns.docx) for notes  YouTube URL: <https://youtu.be/oZsaNU-YXCw> |
| Th | 25 Feb. | Patterns of species occurrence and abundance | 1:00-2:20; Zoom link will be emailed |
| M | 1Mar. | Assignment due | - |
| Tu | 2 Mar. | How do I describe the structure of a community? (part 1 of 2) | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/diversity%20indices.docx) for notes  YouTube URL: <https://youtu.be/7eXgEwbERVs> |
| Th | 4 Mar. | Diversity indices | 1:00-2:20; Zoom link will be emailed |
| M | 8 Mar. | Assignment due | - |
| Tu | 9 Mar. | How do I describe the structure of a community? (part 2 of 2) | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/abundance.docx) for notes  YouTube URL: <https://youtu.be/awN2ks75AP0> |
| Th | 11 Mar. | Abundance | 1:00-2:20; Zoom link will be emailed |
| M | 15 Mar. | Assignment due | - |
| Tu | 16 Mar. | How do I measure other dimensions of biodiversity? | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/SAEC_phy_func_div_v3.docx) for notes  YouTube URL: [https://youtu.be/qmGAG4ToJVY](https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fyoutu.be%2FqmGAG4ToJVY&data=04%7C01%7CNancy.Mcintyre%40ttu.edu%7C0ccf9c603a894a0f571908d8e2be0a0b%7C178a51bf8b2049ffb65556245d5c173c%7C0%7C0%7C637508653130455286%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=0hj6VeYosmSxzntlhcFAfYHaRUnZTvt5r9IJiBt0wiI%3D&reserved=0) |
| Th | 18 Mar. | Phylogenetic and functional diversity | 1:00-2:20; Zoom link will be emailed |
| M | 22 Mar. | Assignment due | - |
| Tu | 23 Mar. | How do I summarize complex relationships and identify the most important patterns from a near-infinite number of possible arrangements of multivariate data? | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/Ordination_intro.docx) for notes  YouTube URL: <https://youtu.be/LAv_2j0eK6I> |
| Th | 25 Mar. | Ordination | 1:00-2:20; Zoom link will be emailed |
| M | 29 Mar. | Assignment due | - |
| Tu | 30 Mar. | How do I identify the most important variables driving patterns in a large dataset of correlated variables (and then use those variables in other analyses)? | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/PCA.docx) for notes  YouTube URL: <https://youtu.be/Wqa7_18jf5A> |
| Th | 1 Apr. | PCA, RDA | 1:00-2:20; Zoom link will be emailed |
| M | 5 Apr. | Assignment due | - |
| Tu | 6 Apr. | How can I determine which environmental variables are associated with species occurrences at different sites? (part 1 of 2) | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/NMDS.docx) for notes  YouTube URL: <https://youtu.be/l3Rp3uiqFqw> |
| Th | 8 Apr. | NMDS | 1:00-2:20; Zoom link will be emailed |
| M | 12 Apr. | Assignment due | - |
| Tu | 13 Apr. | How can I determine which environmental variables are associated with species occurrences at different sites? (part 2 of 2) | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/CCA.docx) for notes  YouTube URL: <https://youtu.be/raPTZtjyNos> |
| Th | 15 Apr. | CCA | 1:00-2:20; Zoom link will be emailed |
| M | 19 Apr. | Assignment due | - |
| Tu | 20 Apr. | How do I determine whether my data are grouped? | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/cluster%20analysis.docx) for notes  YouTube URL: <https://youtu.be/Y-ZGHA2GZ3g> |
| Th | 22 Apr. | Cluster analyses | 1:00-2:20; Zoom link will be emailed |
| M | 26 Apr. | Assignment due | - |
| Tu | 27 Apr. | If I have communities with *a priori* groupings, how do I determine whether those groups are valid? | Click on [this link](https://myweb.ttu.edu/nmcintyr/Stat_Analysis_Ecol_Communities/DFA.docx) for notes  YouTube URL: <https://youtu.be/y7e8FJPjKe4> |
| Th | 29 Apr. | DFA via CART | 1:00-2:20; Zoom link will be emailed |
| M | 3 May | Assignment due | - |
| Tu | 4 May | No class | No class |