Justification for new course ENVI\_SCI 510 (Species Distribution Modeling)

Graduate students working with wild animals require knowledge of new techniques and models for evaluating distribution, abundance, and habitat selection, as well as general proficiency with manipulating spatial data. A marked increase over the last 10 years in the number of studies that employ distribution models to address key theoretical and applied topics in ecology and conservation, such as response to global change, necessitates that our graduate students have sufficient training in these techniques to be competitive for academic, NGO, or governmental positions. This course provides background in the theory and application of these modeling techniques, including ecological niche models, occupancy models, and capture-recapture models. This course has been taught twice as a special topics course, with participation from graduate students in School of Environment, Zoology, and Entomology. This course therefore fills a gap in quantitative and modeling courses for graduate students within the School of Environment, and more broadly within the agricultural and life sciences.

**ENVI\_SCI 510: SPECIES DISTRIBUTION MODELING (3 credits)**

**Course prerequisites:** None

**Instructor:** Daniel Thornton

**Office:** Heald 523 (phone: 509-335-3713)

**Office Hours:** Tues 10:00-12:00, or by appointment

**Email:** daniel.thornton@wsu.edu

**Room**: Tues - Johnson Hall 158, Thurs - Johnson Hall 116 (computer room)

**Required text**: None - all readings will be supplied via Angel (lms.wsu.edu)

**COURSE DESCRIPTION:**

Species distribution modeling is one of the fastest growing areas of applied ecology. These models are being used to address some of the most pressing issues in ecology and conservation, including prediction of species response to climate change, impact of land use changes on biodiversity, niche conservatism, and strategic conservation planning, among others. Despite their potential usefulness and wide application, species distribution models can be surprisingly difficult to develop, analyze and interpret properly. This course aims to give students a grounding in the theory and application of species distribution modeling. This course is not a statistics course, and therefore the focus of the class will be on application and interpretation. The course will be a combination of lecture, discussion, and hands-on development and implementation of species distribution models using a variety of software packages, including R, Maxent, ArcGIS, and PRESENCE. We will also touch briefly on models used to estimate animal abundance, not just distribution, using non-spatial and spatial capture-recapture methods. Major topics to be covered include: niche concepts, scale concepts, testing scientific predictions with models, manipulation of spatial environmental and species data, ecological niche modeling, occupancy modeling, spatial and non-spatial capture-recapture analysis, and conservation applications.

**COURSE CREDITS:** 3

**LEARNING GOALS:**

***Upon completion of this course, students should be able to*:**

1) Articulate what species distribution represents and why we might want to model it (evaluated through tests/independent projects)

2) Articulate the assumptions and limitations of various modeling techniques (evaluated through tests/independent projects/computer exercises)

3) Define, describe, and debate various concepts of the species "niche" (evaluated through tests/independent projects)

4) Demonstrate an increase in the ability to locate, manage, and manipulate spatial environmental and species data (evaluated through computer exercises)

5) Demonstrate ability to use various software packages that are commonly employed in modeling species distribution and abundance (evaluated through computer exercises)

6) Articulate the application of species distribution modeling in conservation and likely avenues for the future evolution of the field (evaluated through tests/independent projects/computer exercises)

**TEXTBOOKS & READINGS:**

 Required readings (articles and book chapters) will be assigned throughout the semester. Electronic versions of these readings will be provided by the instructor via Angel (**lms.wsu.edu**)

**CLASS FORMAT:**

As a general rule, Tuesday's class will involve lecture/discussion of key topics, and Thursday's class will involve discussion and hands-on exercises on the computer. However, there will be some variability in this, dependent on timing and other considerations. Lectures will incorporate Powerpoint slides and discussion. Powerpoints will be posted on Angel prior to class. However, powerpoints will not contain a lot of the information discussed in lecture…so come to class and be ready to take notes. **I do not distribute copies of class notes.** Computer exercises will generally involve a "cookbook" exercise, followed by more independent work and a few questions/model outputs to assess performance. ***Please bring a memory stick to the computer room to save your work!*** The schedule of lectures/computer work/readings is subject to revision during the semester. Changes will be announced in lecture.

Attendance: I will not take formal attendance, but expect students to be present. It is important to attend lectures regularly.

**GRADING**

* Computer exercises -- 45% of class grade. Grade will be based on assessment questions and output that students need to provide at the end of each exercise. Questions from previous week are due at the start of class the following week.
* Project -- 55% of class grade (15% presentation, 40% paper). Graduate students will be expected to develop an independent project involving the techniques and methodology we employ in the class. These projects should address specific ecological or methodological questions. I am very flexible in terms of what is an acceptable project. If relevant, I encourage you to develop a project that could be used as part of your thesis. If not, I encourage you to think of a project that develops skills you might need, is a topic of interest, or is a project that you think could be publishable. Final products of this project will include a paper (following normal scientific publication format), and a 10-15 minute class presentation.

Grading Scale:

94-100% = A 80-83% = B- 67-69% = D+

90-93% = A- 77-79% = C+ 60-66% = D

87-89% = B+ 74-76% = C < 60% = F

84-86% = B 70-73% = C-

**GENERAL POLICIES:**

**Late work policy:** Make-up exams will **NOT** be allowed except under exceptional and formally documented circumstances. Scores for assignments handed in late will be reduced by 10% for each day late.

**Classroom behavior: I expect all students to treat each other and me with respect** at all times. No opinions or speech that discriminate against or are derogatory towards others on the basis of race, ethnicity, age, gender, religion, sexual orientation, political affiliation, or disability will be tolerated.

 Laptop use in class is permitted, but students engaging in overt and constant web surfing will be asked to close their computers, as this distracts the entire class. Students should also refrain from unacceptable behavior such as sleeping, using their cell phones, or talking with classmates at inappropriate times. If you engage in such behavior you will be asked to leave the classroom.

**Students with Disabilities:** “Students with Disabilities: Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building 217; 509-335-3417) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For more information contact a Disability Specialist on your home campus:

**Pullman or WSU Online**: 509-335-3417  [http://accesscenter.wsu.edu](http://accesscenter.wsu.edu/), Access.Center@wsu.edu

**Academic Integrity**: “Academic integrity will be strongly enforced in this course. Any student caught cheating on any assignment will be given an F grade for the course and will be reported to the Office Student Standards and Accountability. Cheating is defined in the Standards for Student Conduct WAC 504-26-010 (3). It is strongly suggested that you read and understand these definitions.”

**Safety**: Washington State University is committed to enhancing the safety of the students, faculty, staff, and visitors. It is highly recommended that you review the Campus Safety Plan (<http://safetyplan.wsu.edu/>) and visit the Office of Emergency Management web site (<http://oem.wsu.edu/>) for a comprehensive listing of university policies, procedures, statistics, and information related to campus safety, emergency management, and the health and welfare of the campus community.

**EXAMPLE COURSE SCHEDULE:**

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| **Week** | **Date** | **Topic** | **Readings** |
| 1 | Aug. 26 | Course orientation | Peterson 2011 |
|  | Aug. 28 | Computer exercise: Obtaining and manipulating species data | Graham et al. 2004 |
| 2 | Sep. 2 | What are SDMs? Begin Niche lecture |  |
|  | Sep. 4 | Computer exercise: Obtaining and manipulating environmental data | Thornton and Peers Book Chapter |
| 3 | Sept. 9 | Presence-only data lecture (Bioclim/MaxEnt) | Elith et al. 2006; Elith et al. 2011 |
|  | Sept. 11 | Computer exercise: Presence-only modeling  | Barve et al. 2011; Phillips et al. 2009 |
| 4 | Sept. 16 | Assumptions (niche conservatism and biotic interactions) |  |
|  | Sept. 18 | Computer exercise: Presence-only modeling (climate change) |  |
| 5 | Sept. 23 | Conservation applications 1  | Puschendorf et al. 2009; Carroll et al. 2010 |
|  | Sept. 25 | Computer exercise: Presence-only modeling (incorporating dispersal) | Engler and Guisan 2009 |
| 6 | Sept. 30 | Presence-absence data lecture | Agresti Book Chapters chapter 1 and 5 |
|  | Oct. 2 | Computer exercise: Presence-absence modeling |  |
| 7 | Oct. 7 | Development and testing of hypotheses in Ecology | Murray et al. Book chapter |
|  | Oct. 9 | Computer exercise: Presence-absence modeling (testing multiple models) | McDonald et al. 2013 |
| 8 | Oct. 14 | Occupancy data lecture - intro | MacKenzie et al. 2002 |
|  | Oct. 16 | Computer exercise: Occupancy modeling basics | Sunarto 2013 |
| 9 | Oct. 21 | Occupancy data lecture – extinction/colonization and point abundance estimation | MacKenzie et al. 2003 |
|  | Oct. 23 | Computer exercise: Occupancy modeling multi-season |  |
| 10 | Oct. 28 | Mechanistic models (discussion) | Estes et al 2013; Buckley et al. 2010 |
|  | Oct. 30 | Computer exercise: Occupancy modeling- multi-method and abundance-induced heterogeneity | MacKenzie chapter 6 |
| 11 | Nov. 4 | Frontiers in SDMs | Boulengeat et al. 2013; Keith et al. 2008; Hamann and Aitkin 2013 |
|  | Nov. 6 | Project time/catch up |  |
| 12 | Nov. 11 | Capture-recapture - intro | O’Brien et al. 2011 |
|  | Nov. 13 | Computer exercise: Capture-recapture |  |
| 13 | Nov. 18 | Discussion of how to make a good presentation; independent project time |  |
|  | Nov. 20 | Project time |  |
| 14 | Nov. 25 | **THANKSGIVING WEEK – NO CLASSES** |  |
|  | Nov. 27 | **THANKSGIVING WEEK – NO CLASSES** |  |
| 15 | Dec. 2 | Spatial capture-recapture - intro | Royle et al. 2014; Thornton and Pekins in prep |
|  | Dec. 4 | Spatial capture-recapture  |  |
| 16 | Dec. 9 | **Finish spatial capture-recapture/begin class presentations**  |  |
|  | Dec. 11 | **Class presentations** |  |
| 17 | Dec. 19 3:10-5:10pm | **Paper due (Finals week)** |  |