

GRG396T: Species Distribution Modeling (Spring 2013)

Tuesday 5:00-8:00

CLA 3.106

PROFESSOR: Jennifer A. Miller**EMAIL:** Jennifer.miller@austin.utexas.edu**OFFICE:** CLA 3.428**OFFICE HOURS:** Tu, Th 3:30- 4:30 or by appt.

COURSE OBJECTIVES: While this seminar will cover some technical aspects, the main focus is to increase a student's understanding of the steps involved in conceptualizing inferential models in a GIS environment. Although many of the concepts of model-building and integrating spatial analysis and GIS discussed here are general enough to be appropriate for other types of inductive modeling applications, we will focus on species distribution models (SDM) as the application area. There is no formal lab component although students are expected to be sufficiently familiar with a GIS software package (ESRI ArcGIS is recommended) in order to perform analysis for their final project as well as for a group modeling exercise. Additional experience with spatial statistics or other statistical analysis is highly recommended. An **introductory GIS course is the only prerequisite**, although students are expected to be very computer proficient in general.

READINGS: The main weekly discussion will focus on 2-4 required articles per week that pertain to a specific technical or conceptual aspect of SDM, as well as 1-2 related articles presented by a student. All of the readings (listed in references below) are available on-line. Students should use the list of recommended references associated with each week's theme to select a paper to present and discuss. Please let me know if you have any trouble getting an electronic version of any of the papers on the required or recommended list.

RECOMMENDED BOOK: Franklin, J. (2009) [Mapping Species Distributions: Spatial Inference and Prediction](#). It's not required, but this book is a great introduction to and extensive overview of SDM and would be a really useful complement to the topics we'll discuss.

ASSESSMENT: Your grade will be determined based on an article report, group SDM exercise, final project (paper & presentation), and contribution to class discussion.

- ❖ *Article report (20%):* Each student will select one article from the list of [recommended references](#) to read, review, and report to the class.
- ❖ *SDM exercise (20%):* Students will work in groups implementing all steps of developing a species distribution model using the same dataset; results are due April 5.
- ❖ *Final project (50%):* The final project will allow each student to implement a modeling project using real data within a GIS. The final paper should be written in manuscript format (~20 pages double-spaced; follow *Ecological Modelling* guidelines here: http://www.elsevier.com/wps/find/journaldescription.cws_home/503306/authorinstructions) and will be due by 5 pm on May 10. A rubric will be available on Blackboard.
- ❖ *Participation (10%):* Seminars depend on class discussion--be prepared to read and talk a lot!

CLASS STRUCTURE: In order to facilitate the discussion-oriented seminar format, [all readings must be read by the assigned date](#). Obviously in a class that meets only once a week, attendance is very important. Please see me ahead of time if you must miss a class.

TENTATIVE CLASS SCHEDULE:

Date	Topic(s)	Required readings	Student discussant(s)
Jan. 15	Introduction/course overview		
Jan. 22	Introduction to species distribution models (SDM)	Guisan & Zimmermann (2000) Elith & Leathwick (2009)	
Jan. 29	SDM: concepts & theory	Araújo & Peterson (2012) Austin (2007) Jiménez-Valverde et al. (2008)	
Feb. 5	SDM components: response data	Vaughan & Ormerod (2003) Lobo et al. (2010) TBA	1.
Feb. 12	Scale SDM components: predictor data Prospectus due	Goodchild (2011) Parra et al. (2004) Austin & Van Niel (2011) TBA	2.
Feb. 19	SDM components: assessing outcomes (accuracy & transferability)	Randin et al. (2006) Liu et al. (2011) TBA	3.
Feb. 26	SDM issues: uncertainty	Araújo & New (2007) Wiens et al. (2009) Beale & Lennon (2012) TBA	4.
Mar. 5	SDM issues: spatial autocorrelation	Bahn & McGill (2007) Bini et al. (2009) TBA	5.
Mar. 12	Spring Break		
Mar. 19	SDM issues: spatial nonstationarity	Foody (2004) Jetz et al. (2005) Fotheringham (2009) Eiserhardt et al. (2011) TBA	6.
Mar. 26	SDM applications: simulated data	Austin et al. (2006) Elith & Graham (2009) Zurell et al. (2010) TBA	7.
Apr. 2	SDM applications: movement SDM exercise results due	Fortin et al. (2005) Franklin (2010) TBA	8.
Apr. 9	No Class		
Apr. 16	Wrap-up	TBA	

Date	Topic(s)	Required readings	Student discussant(s)
Apr. 23	Student paper presentations I		
Apr. 30	Student paper presentations II		
Final paper due by 5 pm, Friday May 10			

MISCELLANEOUS DETAILS AND INFORMATION FOR GRG396T:

ARTICLE REPORT: The report should take the form of a written (2-3 pages typed) and oral (10-15 minutes) summary and critique of the article. The summary should focus on the weekly topics we'll cover in class (research question – data – model(s) – results) and should aim to place the article in the context of what we discuss. The student will also be responsible for leading the class discussion about his/her chosen article, but all students are required to read the articles presented by other students and be prepared to participate in a discussion about them.

PROSPECTUS: A 1-2 page prospectus that outlines your plan for the final project will be due at the beginning of class on Feb. 12. The prospectus should consist of your research question, data description, and the methods you intend to use, as well as what your intended outcome. I'll provide additional resources for appropriate data if you don't have your own.

MODEL SOFTWARE EXERCISE: Students will 'compete' in groups using the same data and a SDM method. The groups will follow the modeling steps outlined in class (conceptualization, formulation, assessment) and provide me with a GIS map of their product, a species distribution map, on April 2. Each group will submit a report outlining the steps they took and each individual's contribution.

REQUIRED REFERENCES:

- Araújo, M.B. & New, M., 2007. Ensemble forecasting of species distributions. *Trends in Ecology & Evolution*, 22(1), pp.42-47.
- Araújo, Miguel B., and A. Townsend Peterson. 2012. Uses and misuses of bioclimatic envelope modeling. *Ecology* 93:1527–1539. <http://dx.doi.org.ezproxy.lib.utexas.edu/10.1890/11-1930.1>
- Austin, M.P., 2007. Species distribution models and ecological theory: A critical assessment and some possible new approaches. *Ecological Modelling*, 200(1–2), pp.1-19.
- Austin, M.P. et al., 2006. Evaluation of statistical models used for predicting plant species distributions: Role of artificial data and theory. *Ecological Modelling*, 199(2), pp.197-216.
- Austin, Mike P & Van Niel, K.P., 2011. Improving species distribution models for climate change studies: variable selection and scale. *Journal of Biogeography*, 38(1), pp.1-8.
- Bahn, V. & McGill, B.J., 2007. Can niche-based distribution models outperform spatial interpolation? *Global Ecology and Biogeography*, 16(6), pp.733-742.
- Beale, C.M. & Lennon, J.J., 2012. Incorporating uncertainty in predictive species distribution modelling. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 367(1586), pp.247 - 258.
- Bini, L.M. et al., 2009. Coefficient shifts in geographical ecology: an empirical evaluation of spatial and non-spatial regression. *Ecography*, 32(2), pp.193-204.

- Eiserhardt, W.L. et al., 2011. Testing the Water–Energy Theory on American Palms (Arecaceae) Using Geographically Weighted Regression. *PLoS ONE*, 6(11), p.e27027.
- Elith, J. & Graham, C.H., 2009. Do they? How do they? WHY do they differ? On finding reasons for differing performances of species distribution models. *Ecography*, 32(1), pp.66-77.
- Elith, J. & Leathwick, J.R., 2009. Species Distribution Models: Ecological Explanation and Prediction Across Space and Time. *Annual Review of Ecology, Evolution, and Systematics*, 40(1), pp.677-697.
- Fortin, D., Beyer, H.L., Boyce, M.S., Smith, D.W., Duchesné, T. & Mao, J.S. (2005). Wolves influence elk movements: behavior shapes a trophic cascade in Yellowstone National Park. *Ecology*, 86, 1320–1331.
- Fotheringham, A.S., 2009. “The problem of spatial autocorrelation” and local spatial statistics. *Geographical Analysis*, 41(4), pp.398–403.
- Franklin, J. 2010. Moving beyond static species distribution models in support of conservation biogeography. *Diversity and Distributions* 16(3), pp. 321-330.
- Goodchild, M.F., 2011. Scale in GIS: An overview. *Geomorphology*, 130(1-2), pp.5-9.
- Guisan, A. & Zimmermann, N., 2000. Predictive habitat distribution models in ecology. *Ecological Modelling*, 135, pp.147-186.
- Jiménez-Valverde, A., Lobo, J.M. & Hortal, J., 2008. Not as good as they seem: the importance of concepts in species distribution modelling. *Diversity and Distributions*, 14(6), pp.885-890.
- Liu, C., White, M. & Newell, G., 2011. Measuring and comparing the accuracy of species distribution models with presence–absence data. *Ecography*, 34(2), pp.232-243.
- Lobo, J.M., Jiménez-Valverde, A. & Hortal, J., 2010. The uncertain nature of absences and their importance in species distribution modelling. *Ecography*, 33(1), pp.103-114.
- Parra, J.L., Graham, C.C. & Freile, J.F., 2004. Evaluating alternative data sets for ecological niche models of birds in the Andes. *Ecography*, 27(3), pp.350-360.
- Randin, C.F. et al., 2006. Are niche-based species distribution models transferable in space? *Journal of Biogeography*, 33(10), pp.1689-1703.
- Vaughan, I.P. & Ormerod, S.J., 2003. Improving the Quality of Distribution Models for Conservation by Addressing Shortcomings in the Field Collection of Training Data. *Conservation Biology*, 17(6), pp.1601-1611.
- Wiens, J.A. et al., 2009. Colloquium Papers: Niches, models, and climate change: Assessing the assumptions and uncertainties. *Proceedings of the National Academy of Sciences*, 106(Supplement_2), pp.19729-19736.
- Zurell, D. et al., 2010. The virtual ecologist approach: simulating data and observers. *Oikos*, 119(4), pp.622-635.

RECOMMENDED REFERENCES FOR STUDENT PRESENTATIONS:

Response data:

- Barbet-Massin, M., Jiguet, F., Albert, C. H. and Thuiller, W. (2012), Selecting pseudo-absences for species distribution models: how, where and how many? *Methods in Ecology and Evolution*, 3: 327–338. doi: 10.1111/j.2041-210X.2011.00172.x
- Feeley, K. J. and Silman, M. R. (2011), Keep collecting: accurate species distribution modelling requires more collections than previously thought. *Diversity and Distributions*, 17: 1132–1140. doi: 10.1111/j.1472-4642.2011.00813.x
- Li, W., Guo, Q. & Elkan, C. (2011) Can we model the probability of presence of species without absence data? *Ecography*, 34, 1096–1105.

- Rota, C.T. et al., 2011. Does accounting for imperfect detection improve species distribution models? *Ecography*, 34(4), pp.659-670.
- VanDerWal, J. et al., 2009. Selecting pseudo-absence data for presence-only distribution modeling: How far should you stray from what you know? *Ecological Modelling*, 220(4), pp.589-594.

Scale/Predictor variables:

- Franklin, J., Davis, F. W., Ikegami, M., Syphard, A. D., Flint, L. E., Flint, A. L. and Hannah, L. (2013), Modeling plant species distributions under future climates: how fine scale do climate projections need to be? *Global Change Biology*, 19: 473–483. doi: 10.1111/gcb.12051
- Guisan, A. et al., 2007. Sensitivity of predictive species distribution models to change in grain size. Available at: http://eprints.jcu.edu.au/2333/1/17262_Guisan_et_al_2007.pdf [Accessed January 15, 2012].

Assessing outcomes:

- Bahn, V. and McGill, B (2012/in press). Testing the predictive performance of distribution models. *Oikos*. DOI: 10.1111/j.1600-0706.2012.00299.x
- Fitzpatrick, M.C. et al., 2007. The biogeography of prediction error: why does the introduced range of the fire ant over-predict its native range? *Global Ecology and Biogeography*, 16(1), pp.24-33.
- Hanspach, J. et al., 2011. Geographical patterns in prediction errors of species distribution models. *Global Ecology and Biogeography*, 20(5), pp.779-788.
- Heikkinen, R. K., Marmion, M. and Luoto, M. (2012), Does the interpolation accuracy of species distribution models come at the expense of transferability?. *Ecography*, 35: 276–288. doi: 10.1111/j.1600-0587.2011.06999.x
- Mouton, A.M., De Baets, B. & Goethals, P.L.M., 2010. Ecological relevance of performance criteria for species distribution models. *Ecological Modelling*, 221(16), pp.1995-2002.
- Nenzén, H.K. & Araújo, M.B., 2011. Choice of threshold alters projections of species range shifts under climate change. *Ecological Modelling*, 222(18), pp.3346-3354.
- Peterson, A.T., Papeş, M. & Eaton, M., 2007. Transferability and model evaluation in ecological niche modeling: a comparison of GARP and Maxent. *Ecography*, 30(4), pp.550-560.
- Roberts, D.R. & Hamann, A. (2012) Method selection for species distribution modelling: are temporally or spatially independent evaluations necessary? *Ecography*. DOI 10.1111/j.1600-0587.2011.07147.x.
- Zanini, F., Pellet, J. & Schmidt, B.R., 2009. The transferability of distribution models across regions: an amphibian case study. *Diversity and Distributions*, 15(3), pp.469-480.

Uncertainty:

- Araújo, M. et al., 2005. Reducing uncertainty in projections of extinction risk from climate change. *Global Ecology & Biogeography*, 14(6), pp.529-538.
- Buisson, Laëtita et al., 2010. Uncertainty in ensemble forecasting of species distribution. *Global Change Biology*, 16(4), pp.1145-1157.
- Diniz-Filho, J.A.F. et al., 2009. Partitioning and mapping uncertainties in ensembles of forecasts of species turnover under climate change. *Ecography*, 32(6), pp.897-906.
- Dormann, C.F. et al., 2008. Components of Uncertainty in Species Distribution Analysis: A Case Study of the Great Grey Shrike. *Ecology*, 89(12), pp.3371-3386.

- Grenouillet, Gael et al., 2011. Ensemble modelling of species distribution: the effects of geographical and environmental ranges. *Ecography*, 34(1), pp.9-17.

Spatial autocorrelation:

- Bahn, V., Krohn, W.B. & O'Connor, R.J., 2008. Dispersal leads to spatial autocorrelation in species distributions: A simulation model. *Ecological Modelling*, 213(3–4), pp.285-292.
- Bahn, V., O'Connor, R. & Krohn, W., 2006. Importance of spatial autocorrelation in modeling bird distributions at a continental scale. *Ecography*, 29, pp.835-844.
- Kühn, I., 2007. Incorporating spatial autocorrelation may invert observed patterns. *Diversity and Distributions*, 13(1), pp.66-69.
- Segurado, P., Araújo, M. & Kunin, W., 2006. Consequences of spatial autocorrelation for niche-based models. *Journal of Applied Ecology*, 43, pp.433-444.
- Václavík, T., Kupfer, J.A. & Meentemeyer, R.K., 2012. Accounting for multi-scale spatial autocorrelation improves performance of invasive species distribution modelling (iSDM). *Journal of Biogeography*, 39(1), pp.42-55.

Spatial nonstationarity:

- Bickford, S. & Laffan, S., 2006. Multi-extent analysis of the relationship between pteridophyte species richness and climate. *Global Ecology & Biogeography*, 15, pp.588-601.
- Kupfer, J. & Farris, C., 2007. Incorporating spatial non-stationarity of regression coefficients into predictive vegetation models. *Landscape Ecology*, 22, pp.837-852.
- Martín-Queller, E., Gil-Tena, A. & Saura, S., 2011. Species richness of woody plants in the landscapes of Central Spain: the role of management disturbances, environment and non-stationarity. *Journal of Vegetation Science*, 22(2), pp.238-250.
- Osborne, P., Foody, G. & Suárez-Seoane, S., 2007. Non-stationarity and local approaches to modelling the distribution of wildlife. *Diversity and Distributions*, 13, pp.313-323.
- Powney, G.D. et al., 2010. Hot, dry and different: Australian lizard richness is unlike that of mammals, amphibians and birds. *Global Ecology and Biogeography*, 19(3), pp.386-396.

Simulated Data:

- Bombi, P. & D'Amen, M. (2012) Scaling down distribution maps from atlas data: a test of different approaches with virtual species. *Journal of Biogeography*, 39, 640–651.
- Larson, E. R. and Olden, J. D. (2012), Using avatar species to model the potential distribution of emerging invaders. *Global Ecology and Biogeography*, 21: 1114–1125. doi: 10.1111/j.1466-8238.2012.00758.x
- Meynard, C. N., Kaplan, D. M. (2013), Using virtual species to study species distributions and model performance. *Journal of Biogeography*, 40: 1–8. doi: 10.1111/jbi.12006
- Santika, T. (2011) Assessing the effect of prevalence on the predictive performance of species distribution models using simulated data. *Global Ecology and Biogeography*, 20, 181–192.