Biology 669. Seminar in Ecology
Spring 2011
Wed 10:00 – 11:50, 331 Wilson Hall

Use of large-scale vegetation plot databases in ecological research

This semester the plant ecology seminar will examine the types of research questions that can be addressed with large vegetation plot databases and will explore some of these questions in greater detail through analysis of available data.

Vegetation science seeks to understand and predict plant communities, yet community composition and dynamics are very much contingent on idiosyncrasies of local environment and biotic history, which can only be recognized and corrected for if the local study is placed in a much larger context. Until recently, this was very difficult to impossible, but is now increasingly facilitated by greatly increased access to three types of data. The first type includes vegetation-plot records (plotXspecies matrices), broadly defined as records of plant taxon co-occurrence at particular sites This constitutes the primary descriptive data on which much of vegetation science is based and serves as the single most important data resource available to vegetation scientists. The second is information about places, and in particular the environment and history of places (plotXdiscriptor matrices). The third is information about types of organizims, or taxa and includes information such as phylogeny, trait and life-history data, and geographic distribution (speciesXattribute matrices).

The original purpose for most of the current large vegetation-plot databases was the preparation of detailed national or regional systems of vegetation classification. In many cases these databases have been used subsequently for related studies of large-scale vegetation patterns. However, the modern use of data from vegetation-plot databases goes far beyond traditional vegetation science, and they now have multiple applications in ecological and biogeographical research as well as in applied studies addressing environmental issues. For example, vegetation-plot data have been used to identify species responses to environmental gradients and to model spatial distributions of species or whole plant communities. Vegetation-plot databases can also assist in the study of species traits across landscapes or habitats and in testing specific hypotheses on plant adaptations to different environments.

The UNC Plant Ecology Lab (PEL) and the associated Carolina Vegetation Survey (CVS) have assembled a database of vegetation plot data from the Carolinas and surrounding states containing in excess of 8000 plots and 300,000 species occurrences. This database is exceptional not only in its size, but in that it contains a large percentage of plots with observations made at multiple spatial scales and a large percentage with associated soil data. These data provide our group with a unique resource that we can explore for patterns in vegetation composition and structure.

Some questions are best asked at larger spatial scales than the Carolinas, or by comparisons of patterns in multiple regions. Fortunately, in recent years many vegetation plots have become available in digital format. The new Global Index of Vegetation Plots (GIVD) documents characteristics and availability of in excess of 2.3 million plots (Dengler et al. 2011). The 108 databases registered in GIVD will be more fully described in a special issue of *Ecology and Biodiversity* to be published in early in 2011. In addition, new standards for distribution and sharing of vegetation plot data have recently been developed (Wiser et al. 2011). We have access to some of these data and could potentially draw on them to ask larger-scale questions.

Part 1: Organization and Background. In the first few meetings we will focus on the structure of plot databases and the integration of plot data. I will give particular emphasis to a few core plot databases, the new VegX exchange standard, and the challenges of integrating data of mixed provenance.

Jan 12 Organizational discussion

Jan 19 Plot databases and their structure: GIVD, CVS, VegBank, TurboVeg

Reading 1: Dengler,J., F. Jansen, F. Glöckler, R.K. Peet, M. De Cáceres, M. Chytrý, J. Ewald, J. Oldeland, M. Finckh, L. Mucina, J.H.J. Schaminée & N. Spencer. 2011. The Global Index of Vegetation-Plot Databases 1 (GIVD): a new resource for vegetation science. *J. Vegetation Science* (in press). http://www.bio.unc.edu/faculty/peet/pubs/GIVD.pdf

Reading 2: Wiser, S.K. N. Spencer, M. De Cáceres, M. Kleikamp, B. Boyle & R.K. Peet. 2011. Veg-X – An exchange standard for plot-based vegetation data. J. Vegetation Science (in press). http://www.bio.unc.edu/faculty/peet/pubs/sAVS2011.pdf

Jan 26 Discovering, viewing, integrating, and sharing data

Weeks 4-11. Recent applications. We will examine a series of recent papers that have drawn on large plot databases to ask novel ecological questions. I list a few example topics and papers at the end. This section will be organized around student presentations and group discussions of their focal topics (to be announced shortly).

Feb 2 Forbes Boyle (this day only – 1:00-2:50, 119 Coker Hall)

Feb 9 Bianca Lopez – Beta Diversity

Feb 16 Stacy Zhang

Feb 23 Kimberly Israel

Mar 2 Jackie White

Mar 16 Katie Becraft

Mar 23 Peter Wilfahrt

Mar 30 Kyle Palmquist

Apr 6 Megan Faesel & Sam Tessel – Scale dependence of co-occurrence?

Weeks 12-15. Projects. Sometime in early February members of the seminar will each select a topic for more in-depth research. Small groups of 1-4 persons will be created, each with a focal topic. During the final three sessions, groups will present reports on work accomplished and lead discussions of future possible directions. The goal for each group will be to create a draft of a publishable paper.

Apr 13, Apr 20, Apr 27

Example topics and possible papers for discussion.

Abundance. What is the relationship between local and global abundance? What is the correlation between local abundance and geographic range? How does abundance vary with location in range? Does environment influence relative abundance distributions?

> Canham, C.D. and R.Q. Thomas. 2010. Frequency, not relative abundance, of temperate tree species varies along climatic gradients in eastern North America. *Ecology* 91:3433-3440.
>
> Murphy, H.T., J. VanDerWal and J. Lovett-Doust. 2006. Distribution of abundance across the range in eastern North American trees. *Global Ecology and Biogeography* 15:63–71
>
> Holt, R. D.,.Lawton, J. H., Gaston, K. J., and T. M. Blackburn. 1997. On the relationship between range size and local abundance: back to basics. *Oikos* 78: 183-190.

Species-Area relationships. What factors appear to drive variation in species-area curves. How do environmental factors (and habitat types) influence small-scale (within-plot) rates of species accumulation? How does species accumulation with area vary across different community types? How can one separate increasing environmental variation and habitat variation from increasing scale of observation?

> Fridley, J.D., R.K. Peet, T.R. Wentworth and P.S. White. 2005. Connecting fine- and broad-scale patterns of species diversity: species-area relationships of Southeastern U.S. flora. *Ecology* 86:1172-1177.

Species richness. What is the relationship between species richness and environmental variables? How does this vary with scale and geographically? Which types of communities have the greatest species richness.

> Belmaker, J. & W. Jetz. 2010. Cross-scale variation in species richness–environment associations. *Global Ecology and Biogeography.*
>
> Michael D. Weiser, Brian J. Enquist, Brad Boyle, Timothy J. Killeen, Peter M. Jørgensen, Gustavo Fonseca, Michael D. Jennings, Andrew J. Kerkhoff, Thomas E. Lacher Jr, Abel Monteagudo, M. Percy Núñez Vargas, Oliver L. Phillips, Nathan G. Swenson and Rodolfo Vásquez Martínez. 2007. Latitudinal patterns of range size and species richness of New World woody plants. *Global Ecology and Biogeography* 16: 679–688
>
> Peet, R.K., J.D. Fridley and Joel M. Gramling. 2003. Variation in species richness and species pool size across a pH gradient in forests of the southern Blue Ridge Mountains. *Folio Geobotanica* 38:391-401.

Niche breadth & Species co-occurrence. Do niche breadths consistently differ between adults and juveniles (trees)? Do co-occurrence patterns shift with scale of observation?

> Manthey, M., Fridley, J.D. and Peet, R.K. 2011. Niche expansion after competitor extinction? A comparative assessment of habitat generalists and specialists in the tree floras of southeastern North America and southeastern Europe. *Journal of Biogeography* (in press).
>
> Fridley, J.D., D.B. Vandermast, D.M. Kuppinger, M. Manthey, and R.K. Peet. 2007. Co-occurrence-based assessment of habitat generalists and specialists: a new approach for the measurement of niche width. *Journal of Ecology* 95:707-722.

Traits. What environments favor adaptations of evergreenness, lobed leaves, shade tolerance, small seeds, and on and on. What are the growth forms and other attributes of taxa that are always common (we seem to see vines first, then trees, then herbs), and how does this vary geographically within the Carolinas and more globally? Compare specific growth forms (e.g., vines, geophytes) with respect to ecology, abundance, distribution, environmental correlates , and then how do these patterns compare with those in other regions for a particular biome, like Europe or Asia.

Swenson, N.G. and B.J. Enquist. 2009. Opposing assembly mechanisms in a Neotropical dry forest: implications for phylogenetic and functional community ecology. *Ecology* 90:2161–2170

Swenson, N.G. and M.D. Weiser. 2010. Plant geography upon the basis of functional traits: an example from eastern North American trees. *Ecology* 91:2234–2241

Graves, J.H., R.K. Peet, and P.S. White. 2006. The influence of carbon - nutrient balance on herb and woody plant abundance in temperate forest understories. *Journal of Vegetation Science 17*: 217-226.

Rarity. Do plants with small ranges tend to be rare relative to widespread species? Which types of habitats contain the largest numbers of rare species and do they have any commonalities

Stohlgren, T.J., D.A. Guenther, P.H. Evangelista and N. Alley. 2005. Patterns of plant species richness, rarity, endemism, and uniqueness in an arid landscape. Ecological Applications, 15:715–725

Environment & history. How do the variables that are predictive of species composition vary with spatial scale? How important is history versus environment?

Svenning & Skov .2005. The relative roles of environment and history as controls of tree species composition and richness in Europe. *Journal of Biogeography* 32:1019-1033

Kreft, H & W. Jetz. 2007. *PNAS* 14:5925-5930.

Dispersal and connectedness. Are isolated communities less predictable?

Flinn, K.M. T.C. Gouhier, M.J. Lechowicz and M.J. Waterway. 2010. The role of dispersal in shaping plant community composition of wetlands within an old-growth forest. *Journal of Ecology* 98:1292-1299.

Leibold, M.A., Holyoak, M., Mouquet, N., Amarasekare, P., Chase, J.M., Hoopes, M.F., Holt, R.D., Shurin, J.B., Law, R., Tilman, D., Loreau, M. &Gonzalez, A. 2004. The metacommunity concept: a framework for multiscale community ecology. *Ecology Letters* 7:601–613.

Beta diversity. How does compositional turnover and beta diversity vary geographically and with geographic distance.

Carr, S.C., Robertson, K.M., Platt, W.J. & Peet, R.K. 2009. A model of geographical, environmental and regional variation in vegetation composition of pyrogenic grasslands of Florida. *Journal of Biogeography* 36:1600–1612

Anderson, M.J., T.O. Crist, J.M. Chase, M. Vellend, B.D. Inouye, A.L. Freestone, N.J. Sanders, H.V. Cornell, L.S. Comita, K.F. Davies, S.P. Harrison, N.J.B. Kraft, J.C. Stegen, and N.G. Swenson. 2010. Navigating the multiple meanings of β-diversity: a roadmap for the practicing ecologist. *Ecology Letters*, in press.