Ecological diversity and climate change

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Autumn 2016

"I trust my oncologist to know the probabilities. I don't trust him to put them together."
climate scientist Steve Schneider on cancer treatment

ANTICIPATING CLIMATE EFFECTS ON BIODIVERSITY challenges ecologists to translate information on individual organisms and processes to ecological dynamics. How are ecologists putting the information together? How much is supported by mechanistic evidence? By theory? Are experiments and observational studies contributing in different ways? The tools applied to interpret climate effects span the foundations in jointly distributed random variables to simulation and machine learning. The two goals of this course address the confluence of science and emerging tools to interpret the evidence.

THE FIRST GOAL is to evaluate the science of biodiversity and climate change, including the changes that are happening now, in the past, and what we can expect in the future. Widespread forest diebacks, intensifying drought, increased wildfire, insect and pathogen outbreaks, and poleward migrations of land and marine populations result from individual organisms responding to the environment and to one another. What's changing and why?

SECONDARILY the course provides an overview of analytical tools. However, we reverse the traditional approach–rather than describe a model, then look for an application, we start with compelling controversies involving global change impacts. We then turn to a range of models and data sets to arrive at our own answers. Units start with a controversial question. To each topic we bring elements of basic distribution theory, data manipulation in R, and examples of simulation methods. We use real data sets. Each unit implements one or more models. We engage both foundation concepts (jointly distributed random variables, conditional independence, Bayes theorem) and exploratory data analysis (ordination, clustering, algorithmic methods). We turn to basic models (LM, GLM, GAM, SDM, GJAM) and elements of computation (optimization, simulation, MCMC).

THIS COURSE WAS DEVELOPED as part of the new Climate Science Program in NSOE and to contribute to the statistical training needed by our students. It will serve advanced undergrads, MEMs, and PhD students.

THE FORMAT combines lecture material, weekly labs, literature discussion, and individual and group assignments.

LECTURES AND LAB ORGANIZED AS 2-WK UNITS AND TECHNICAL ASIDES, examples:

- **Unit 1. Wolves, elk, aspen: Change involving Trophic Cascades** Wolves were reintroduced to YNP in 1995 and have since expanded. Elk populations, which had been increasing before wolf introduction, began to decline. There ensued a series of debates focused on the relative importance of factors that might explain the elk dynamics, including human hunting pressure outside the YNP. For management, an important question concerns the extent to which wolves influence elk dynamics, as opposed to other variables, including hunting pressure.

  Popular press; Estes, J. et al. 2011. Trophic Downgrading of Planet Earth. Science; Voucetich et al. 2005. Influence of harvest, climate and wolf predation on Yellowstone elk, 1961-2004. Oikos; Ripple and Beschta. 2012. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. Biological Conservation

- *Technical aside 1.: Wrangling big data from the internet.* Strategies for hundreds of files to data exploration to analysis; processes, observations, experiments; aggregation, stratification

  PRISM, FIA, GBIF, NEON

  subsequent units decided by students...