DEMOGRAPHIC AND ENVIRONMENTAL STOCHASTICITY IN POPULATION PROCESSES

1) POPULATION DYNAMINCS (40 minutes)

We consider stochastic dynamics in populations with no age-structure driven by environmental and demographic stochasticity and discuss the role of demographic and environmental variance in extinction processes by using the diffusion approximation. Some basic definitions and results for diffusions will first be given. These concepts are further used to analyse harvesting strategies by computation of relevant harvesting statistics (relevant for some parts of lecture 3). Defining basic parameters including growth rate, age distribution and reproductive value, in age-structured dynamics we use Fisher's reproductive value and the stochastic individual contributions called individual reproductive value to define environmental and demograpic variances in age-structured populations and discuss the interpretation of these parameters. We illustrate how the diffustion approcimation for the total reproductive value can be used in sufficiently accurate analysis of the dynamics of age-structured populations.

2) COMMUNITY DYNAMICS (40 minutes)

We first consider the diffusion approximations to Ewen's infinite allele model in population genetics that is the basis for neutral community models with only demographic noise giving essentially Fisher's well-known log series abundance distribution. We then introduce more general processes with speciations and extictions where species dynamics are driven by environmental and demographic noise. Choosing one such model that also produces Fisher's model for distribution of abundance among species, we compare temporal aspects, including species turnover rates, of neutral and non-neutral models. We consider in more detail non-neutral models generating Preston's

lognormal species abundance distribution and show how a simple correlation measure can be used to measure similarity between communities at different times and/or locations. Estimation of such similarities, based on the two-dimensional Poisson lognormal distribution, together with the estimated parameters of the lognormal abundance distribution is a basic useful tool for analysing stochcastic variation in communities in space and time and effects of covariates driving changes in communities.

3) SELECTION IN FLUCTUATING ENVIRONMENTS (40 minutes)

We first mention briefly the general role of demographic variances in generating random genetic drift in populations with and without age-structure. Environmental noise acting differently on different phenotypes may generate fluctuating selection. A general result for this stochasticity given by Russell Lande in 2007 generalizes his well-known result for selection on a multivariate normally distributed character. This result can be generalized to include density-dependent selection. Using this theory we analyse evolution in a large population with neither age-structure nor genetic drift, but with stochastic dynamics and denisty-dependence. Assuming that the basic parameters describing the population fluctuations depend on a set of normally distributed quantitative trates it is shown how environmental noise driving the fluctuations affects the density-dependent selection. Short- and long-term evolution is analysed by showing how mean phenotypes evolve and how this evolution consequently generates evolution of the dynamic parameters such as growth rate r and carrying capacity K, so-called r- and K-selection. This theory is finally used to show how non-selective harvesting generates short- and long-term evolution. We show that harvesting strategies that are the most ecologically sustainable also are those giving the smaller evolutionary effects.