**Neotoma: Climate Change and Small Mammal Dispersal**

**Handout for Instructors**

**Introductory Module**

There are two class sessions included in the introductory module.

***Class One***

PART ONE: WARM UP DISCUSSION

Lead with questions and informal discussion.

Examples:   
What is a mammal?   
What do they eat?   
Where do mammals live?  
What are some local mammals?   
What do you think would happen to the mammals in this area if winters became warmer?  
What if the environment changed-for example, the local forest disappeared?

PART TWO: LECTURE

Lecture about migration and dispersal and climate/environment variables using the included powerpoint.

Cover variables affecting mammal distribution:  
Temperature  
Precipitation  
Effective Moisture  
Relative Humidity  
Aridity  
Vegetation  
Predator/Prey Relationships  
Review concept of oxygen isotopes as temperature proxies  
Examples of past change-think about how animals might respond to cold and warm intervals

PART THREE: ACTIVITY

Think-Pair-Share on modern example of a species range shift.

***Class Two***

PART ONE: WARM UP DISCUSSION

Review previous class (what happens to lemmings populations when it gets warmer)? Address any additional questions.

PART TWO: LECTURE

How do we use actual data to evaluate these changes? We need a database to help us see trends in space and time, not just at the local level but on a broader scale. Spend 10 minutes on Neotoma website, introduce it and explain where the data comes from (peer review and research process). Walk through example of modern distribution and demonstrate how to use different functions on Neotoma Explorer using the example provided in included step-by-step word document.

PART THREE: ACTIVITY

Have students do a distribution example similar to the one just performed and troubleshoot. Then, have class (groups or individuals) test a "given" hypothesis (example provided in powerpoint). Each individual or group has their own species to test (see recommended species list below). If completing the introductory module only, have students share their results at the end of class and discuss their findings.

***Take-home points for Introductory Level*** 

* There are different biotic responses to climate change and one of them is dispersal
* Recognizing stasis vs. dispersal

***If continuing to Mid-level***

* Have students generate their own hypothesis for one or more species and be prepared to discuss findings in next class.

**Mid-Level Module**

***Class Three***

PART ONE: WARM UP DISCUSSION

Have each group or individual summarize their findings for each particular species for the rest of the class. Leading questions: was your hypothesis right or wrong? Why or why not?

STEP TWO: LECTURE

Discuss regional and individual (species) level variation. Address single site versus regional and the importance of data quality and resolution.

STEP THREE: ACTIVITY

Create a jigsaw scenario and organize students who worked on different species into groups to consider a number of species by region. Each group is assigned a different region and should use Neotoma to address what type of movement is occurring (E-W or N-S) for different species? Identify what species are most resilient to change versus what species seem most sensitive (i.e. disappear) and discuss food and habitat needs for those species.

Wrap up with presentations of findings by group representative (by transect).

***Take home points for Middle Level***

* Larger trends are evident using larger datasets and different responses are possible (keywords: extinction, dispersal, stasis)
* Demonstrated effect of climate change

***If continuing to Advanced Level***

* Response to climate change does not explain everything! Other variables will be considered in the next class. Assign students reading/independent research on feeding and other behaviors of their chosen species for next class (number of species chosen can be adjusted per class size).

**Advanced Level Module**

***Class Four***

PART ONE: WARM UP DISCUSSION

Have students brainstorm other variables affecting species distribution.

First Level (testable) (addresses first goal-will develop through class activity)  
Climate (GRIP)-Temperature and Precip  
Precipitation  
Food source (Modern data)-MOM Database  
Vegetation (Pollen)-Neotoma

Second Level (may be impossible to test) (addresses second goal-discuss in lecture)  
Predator (ferrets, coyotes, foxes)  
Soil Type (modern distribution overlay of soil map)  
Disease (?)

PART TWO: LECTURE

Lecture briefly on inability to evaluate all variables, importance of being able to use data to infer and make predictions. Introduce the importance of bringing together multiple proxies, strength of Neotoma but also need for working together with other databases. Discuss importance of application of statistics to these types of data in order to evaluate strength of relationships. Demonstrate an example of simple statistical test (t-test). Hand out stats cheat sheet (link provided below).

PART THREE: ACTIVITY

Using their previously researched species (from Introductory Module) have individuals download/obtain data on food resource, modern distribution, and vegetation variables relevant for that species (pulling from Neotoma, Smithsonian and MOM databases-links included below). Have students create a new data spreadsheet that combines these data. Open for class discussion and questions on appropriate stats.

*Final Assignment*

Have students perform a few relevant simple stats tests comparing effect of variables on species ranges and write up findings in a short (5-page) paper. What are the relationships between climate change versus vegetation versus food source? Summarize previous work and knowledge about range/habitat/food preference of animals.