**Relating Late-Quaternary Plant and Animal**

**Distributions to Past and Future Climate**

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**Prior Content Covered**

1. Quaternary climate change patterns
2. Climate proxies – what they are and how they are used
3. Idea of a climate space = multivariate representation of climate variables, in which species occupy a portion of the whole

**Target Taxa**

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| Trees: | *Picea glauca* (white spruce) |
|  | *Picea mariana* (black spruce) |
|  | *Pinus strobus* (white pine) |
|  | *Pinus resinosa* (red pine) |
|  | *Quercus alba* (white oak) |
|  | *Tsuga canadensis* or all spp.(Eastern hemlock) or all *Tsuga* spp. |
|  |  |
| Other Plants: | Poaceae (all grasses) |
|  | *Artemisia* (sagebrush, mugwort, wormwood; associated with shortgrass prairie)  |
|  | *Ambrosia* (ragweed; associated with tallgrass prairie) |
|  | Chenopodiaceae & Amaranthaceae (open or disturbed areas) |
|  |  |
| Animals: | *Cynomys spp.* (prairie dog) – linked to shortgrass prairie |
|  | *Mustela nigripes* (black-footed ferret) – linked to prairie dog, but not much data |
|  | *Martes americana* (pine marten) – linked to pine |
|  | *Martes pennanti* (fisher) – good comparison to pine marten, stayed south when pine marten moved north, until extirpated in historical times due to forest clearing by European settlers (see paper by Graham and Graham 1994) |
|  | *Antilocapra americana* (pronghorn) – linked to shortgrass prairie |
|  | *Bison bison* (or *Bos bison*) (bison) – linked to tallgrass prairie |
|  | *Ovibos moschatus* (muskox) – linked to tundra – good for today but not much past data = good illustration of how database is limited |
|  | *Mammut americanum* (mastodon) – linked to forest / no-analog plant communities |
|  | *Phloeotribus piceae* (bark beetle) – linked to spruce |

 **Running the Activity in Class**

**Opening Engagement**

GOALS: Students will think about what they already know about natural landscapes and climate. Instructor will elicit preconceptions that need to be addressed and highlight concepts of uniformitarianism and organismal response to anthropogenic climate change.

1. Ask students: What did central Wisconsin [or your local area] look like 20,000 years ago? Compile responses on the board. Draw out prior knowledge and preconceptions.
2. How do we know this? What specific proxies, specific climate variables are involved in making reconstructions like this? Have students brainstorm answers, encouraging them to make use of prior knowledge from previous lectures & readings.
3. Why do we care about what Wisconsin looked like 20,000 years go? Again, compile responses.
4. Draw out two key concepts: past climate change can be related to future climate change, and organisms respond to climate change in ways that we may care about.
5. So what will central Wisconsin look like in 100 years?

**PART 1: Modern Plant and Animal Distributions and Their Relationships to Temperature and Precipitation**

GOALS: Students will understand that species have defined climate ranges that reflect sensitivities to specific climate variables, and that different species occupy different areas of climate space. Students will be able to interpret a climate space plot.

Data sources: USGS online tree atlas (<http://pubs.usgs.gov/pp/p1650-a/>)

 BONAP’s North American Plant atlas (<http://bonap.net/NAPA/Genus/Traditional/State/>)

 USDS NRCS PLANTS Database (<http://plants.usda/gov/java/>)

 Neotoma Paleoecology Database (<http://www.neotomadb.org/>)

**PART 2: Examining Past Distributions of Plant and Animals Species in Response to Quaternary Climate Change**

GOALS: Students will explore the Neotoma database structure, and relate past species distributions to changes in climate variables. Students will become familiar with some key plant and animal taxa used in the study of Late Quaternary climate change.

Whole-Class Walk-Through OR Opening Component of Student Activity (Questions 5 and 6):

1. Put up image of the modern spruce distribution.
2. Ask students to predict what the distribution of spruce would be like 20,000 years ago, 15,000 years ago, 10,000 years ago, and 5,000 years ago. Record their predictions on the board.
3. Now we’ll test those predictions using the Neotoma database: <http://neotomadb.org/>.
4. Show how to get to Neotoma database and Explorer.
5. Show how to search for spruce in Neotoma database, set pollen abundances, and limit time ranges.
6. Go through distributions for four time slices. As class looks at each one, show students how to turn on and off layers, change colors/symbols, and how to click on individual sites and call up detailed information for each site.
7. Are the students’ predictions supported?

Data sources: Neotoma Paleoecology Database (<http://neotomadb.org/>)

 USDA Climate Change Tree Atlas <http://www.fs.fed.us/nrs/atlas/>)

**PART 3: Exploring Potential Future Changes in Species Distributions**

GOALS: Students will observe and predict potential future species ranges in response to future anthropogenic climate change.

Data sources: USDA Climate Change Tree Atlas <http://www.fs.fed.us/nrs/atlas/>)

**(Optional) PART 4: Self-Directed Analysis**

GOALS: Students will independently complete an analysis of a species distribution, past, present, and future, and prepare a report and presentation to the class.

As an extension activity, students can be asked to independently research one or more species and prepare a class presentation, poster and/or written report on that species’ climate requirements and its past, present, and potential future geographic distributions.

**References**

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