

GEOL 553 Lab 7: Biostratigraphic Record of Climate Change

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Lesson Overview

This lab is designed to introduce you to the Neotoma Paleocology Database and Neotoma Explorer. Neotoma DB is a public-access and community-supported repository of paleoecological data. Public-access means that anyone can find and download data from Neotoma. Community-supported means that it is a community resource, with many scientists contributing their data to Neotoma. Explorer is a graphical interface that is very handy for a first-pass search, discovery, and viewing of paleoecological data.

Lesson Goals

- **Gain familiarity with Neotoma Explorer interface**, as tool for discovering and exploring paleoecological data
- Learn how to **search for data**, using various search options.
- Learn how to **make quick maps** of species distributions over time
- Learn how to **view** data, using stratigraphic pollen diagrams.
- Learn how to **download** paleoecological datasets from Neotoma.
- Do a bit of thinking along the way about **ecological patterns and processes** revealed by these first-pass analyses.

This lab is intentionally somewhat light on instructions. Neotoma Explorer is designed to be a fairly intuitive interface for searching, viewing, and downloading data. Hence, these instructions are designed to point you in the right direction but leave some steps for you to figure out.

For all **QUESTIONS** – write down the answer and turn this in as part of your assignment. For this exercise, most of these Questions are pretty simple – the main intent is to make sure that you are hitting the marks with this exercise. A few ask you to think and reflect about ecological patterns and processes revealed by this analysis. Deadline: two weeks.

Work in a team of 2-3 people, be sure to take turns at the computer. Research has shown that the student actively working at the computer learns much more than the person passively watching. Your team will turn in just one homework (with all your names on it) – but please turn in a copy for each of you. Email to the instructor.

I. Getting Started

1. Go to <http://www.neotomadb.org/>
2. Click on the 'Explorer' picture
3. Change the zoom so that your window is centered on North America, including all of the lower 48 states and the southern half of Canada.

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II. Search for Data

1. Find a Site
 - a. Using the Search dialog window (Advanced tab, Metadata subtab, Site Name field), find this site: Devil's Lake, WI.
 - b. Once you've found it, click on the dot. A window will pop up with some information about this record.
 - c. **QUESTION 1:** What is the latitude and longitude of Devil's Lake? What is the Site ID? [Note: Apparently the choice of Site ID for Devil's Lake is just a coincidence...]
2. Find a Taxon (Search Window, Basic Tab, use Taxon and Abundance fields)
 - a. Find all sites with at least 20% *Picea* (spruce) pollen, between 21,000 and 18,000 years ago.
 - b. **QUESTION 2:** What state has the southernmost location of *Picea* in this search? (For comparison, the southern range limit of *Picea* today is in the northern Great Lakes, plus a few scattered outliers e.g. at the top of the Appalachian Mountains).
3. Find all sites produced by a researcher (Search Window, Advanced Tab, Metadata subtab, Person Name field)
 - a. Find all sites produced by Lou Maher
 - b. **QUESTION 3:** In which states has Lou worked?
4. Find all fossil pollen records in North America (Search window, Advanced Tab, Dataset field)
 - a. **QUESTION 4:** The generation of fossil pollen records is labor intensive and hence expensive – e.g. the costs of fieldwork, the money spent on radiocarbon dates, the time required for a trained analysis to identify and count pollen data, etc. A rough time/cost estimate for a single fossil pollen record is on the order of two years and \$30,000. Given this, give an order-of-magnitude estimate of the number of person-years and dollars it took to generate these fossil pollen records now stored in Neotoma. (Order-of-magnitude = 10 person-years? 100 person-years? 1000? etc.)
 - b. **QUESTION 5:** Notice there is a fairly dense network of fossil pollen sites in an arc stretching from Minnesota to Nova Scotia. Why might there be such a dense network in this region?
5. Show/Hide Search Results
 - a. You now have many search layers – it may be getting a bit confusing. Find the icon that lets you show/hide/combine search layers and use it to hide some of your searches.
6. Multi-Taxon Search
 - a. Find all sites with at least 20% *Picea* pollen between 15,000 and 12,000 years ago.
 - b. Find all sites with *Mammut* (mastodon) between 15,000 and 12,000 years ago.
 - i. For *Mammut*, use the 'Advanced Taxon Selection' which you can use by clicking on the gears icon to the right of the 'Taxon' field in the 'Search' window.
 1. In the ATS window, choose 'Mammals' for Taxa Group and then enter *Mammut* into the 'Search for' window. Then click 'Go'
 2. Note that the search returned taxon names for both *Mammut* (mastodon) and *Mammuthus* (mammoth). Click all boxes for all variants of *Mammut* but do not click the *Mammuthus* boxes

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3. Enter a search name (e.g. '*Mammut* – all') and click Save
 4. In the general search window, click 'Search'
 - c. **QUESTION 6:** Take a screenshot of this map and include it in your homework. Does mastodon tend to live in places with spruce, or without spruce? Suggest two hypotheses that might explain the observed association.
7. Multi-Time Search
- a. Hide your previous searches.
 - b. Find all sites with at least 20% *Picea* pollen between 21,000 and 18,000 years ago.
 - c. Find all sites with at least 20% *Picea* pollen between 15,000 and 12,000 years ago.
 - d. Find all sites with at least 20% *Picea* pollen between 10,000 and 7,000 years ago.
 - e. Find all sites with at least 20% *Picea* pollen between 5,000 and 1,000 years ago.
 - f. **QUESTION 7:** Take a screenshot of this map and include it in your homework. Describe the history of *Picea* distributions in eastern North America over the last 21,000 years (i.e. ignore the Rockies and points west). What environmental change(s) might be causing this shift in *Picea* distributions? Given that trees are sessile (immobile) organisms, what processes might allow the observed range shifts?

III. View Data

1. Go find Devil's Lake (WI) again. Click on the site.
2. In the popup window with metadata for Devil's Lake, note that the bottom includes a list of datasets available at the site. (P = pollen; P^ = pollen surface sample; clock = geochronological data; W = water sample; O^ = ostracode surface sample)
3. Hold the mouse over the pollen dataset. Note that an eyeball and '+' appear to the right.
4. Click on the eyeball to view the Devil's Lake pollen dataset. This opens up a new window with more detail about your dataset.
 - a. Samples: A data table. Each row is a different variable and each column is a stratigraphic depth.
 - b. Diagram: Plots a stratigraphic diagram. Change the Primary Axis to 'COHMAP Chron 2' (this switches the vertical axis from a depth axis to time axis; more about depth vs. time later) then click 'Draw.'
 - c. **QUESTION 8:** Take a screenshot of this diagram and include it in your homework assignment.
 - i. What was the most abundant plant taxon at Devil's Lake during the end of the Pleistocene? (i.e. prior to 11,000 years ago)
 - ii. What has been the most abundant taxon during the Holocene? (from 11,000 years ago to present)
 - iii. (Note: Here we are assuming that plant with the most abundant pollen in sediments is also the most abundant on the landscape. This isn't necessarily a good assumption; we'll save that challenge for another day.)
 - d. **QUESTION 9:** Using the information in the Chronology tab, how many age controls are stored for Devil's Lake? How many of these are radiocarbon dates?
 - e. **QUESTION 10:** What publications are listed for Devil's Lake?

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IV. Download Data

1. In the popup window with metadata for Devil's Lake, hold the mouse over the pollen dataset. Note that an eyeball and '+' appear to the right. Click on the '+'. This adds the dataset to a 'Datasets' tray.
2. Find the icon for the 'Saved Datasets Tray' and click on it.
3. Hover over the dataset then click on the Save icon to the right. The dataset will be saved as a text file in CSV (comma separated value) format.
4. Open the downloaded CSV file in Excel or a text editor (e.g. Notepad, Wordpad) to look at it.
5. **QUESTION 11:** What is the most abundant taxon at Depth = 1 cm?

V. Hypothesis Testing

1. Go to Neotoma Database: <http://www.neotomadb.org/>
2. Select Explorer at bottom left
3. Enlarge North American Map with sliding scale at upper left
4. Select modern distribution (red polygon at top) and enter species name
5. Hypothesis: If the climate is colder from 15,000 to 20,000 years ago, then *Myodes gapperi* should occur farther to the: south, north, east, or west (select one and test hypothesis)
6. Open search form (binoculars) at top left and enter species name (*Myodes gapperi*) and dates 20,000 to 15,000 and hit SEARCH
7. **QUESTION 14:** Is the hypothesis supported by these data?

VI. Explore on Your Own

1. For this last part, explore! This is an unbounded part of the exercise. Using the skills you have learned, search and explore within Neotoma.
2. **QUESTION 13:** What did you find? (~0.5 to 1 page, with a mixture of text and screenshots). There's no wrong answer here; I'm mainly interested in seeing you try out experiments, searches, and visualizations that go beyond the above script. Find something interesting and describe what you find.
3. A few tips:
 - a. Pro Tip 1: When searching for taxa, you usually will have better luck if you search at the genus level with all variants than looking for a particular species (e.g. *Mammut*). Neotoma only accepts scientific names for species, so use the internet to find scientific names for the taxa that you're interested in.
 - b. Pro Tip 2: Charismatic megafauna are always fun!
 - c. Pro Tip 3: some common plants: pine, birch, oak, ash, elm, hemlock, beech, chestnut, grass...