University of Alaska **Fairbanks**

LESSON PLAN: **Range and Distribution**

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Overview

In this activity, students will explore how to determine how to assemble information about plant distributions, and relate those distributional to the environment by assembling information on temperature, precipitation and elevation available on the Internet.

Objectives

The student will:
- Assemble evidence about where three different Alaksan plant species are located.
- Examine temperature, precipitation, and elevation maps of Alaska by looking at maps or utilizing a geographic information system (depending on skill level)
- Explain what abiotic factors are responsible for plant ranges.
- Predict other areas that have favorable characteristics where the plant species may occur

Materials

Access to ARCTOS herbarium database (http://arctos.database.museum/SpecimenSearch.cfm)
Access to the Global Biodiversity Information System data portal (http://www.gbif.org/occurrence/search)
Student Worksheet: "Range and Distribution"
Handouts: Elevation map (http://www2.gi.alaska.edu/river_ice/geog_general1.html or similar map), Temperature map (http://www.nps.gov/dena/naturescience/climate-change.htm mean January temperatures), Precipitation map (http://www.climatesource.com/map_gallery.html#ak)

Background

Species distributions refer to how species are arranged geographically on the planet. We learn about species distributions by surveying those species and recording where they were found. Assembling all that knowledge of where species are found and in what conditions allow us to ultimately have knowledge about the area of extent and occupancy of a species, and these measures are critical for determining if a species is considered "widespread", "commom", "restricted" or "endemic". A major challenge in environment sciences is assembling knowledge about species distributions. One very useful abstraction of species distribution data is called a "range map", which shows the boundaries of where species are found.

Distribution data tell us not only about geographic arrangement of species, but can give a view of the what factors may limit where species can occur. The distribution of organisms such as plants on the landscape can be affected by a number of abiotic (nonliving) and biotic (living) factors. Abiotic factors include rainfall, temperature, sunlight, and geography (e.g. soils and topography). Biotic factors include seed dispersal, pollination, and natural enemies (e.g., herbivores and pathogens). Finally, species own dispersal characteristics may be a determinant which limits where they can be found.

Where a plant grows has important consequences for its morphology. For instance, in Alaska, plants that grow in the tundra (alpine or arctic) tend to be small in stature. High wind speeds, low temperatures, and low moisture all contribute to this pattern. In this exercise, students will examine one arctic tundra forb (*Smelowskia media*), one alpine tundra forb (*Cryptogramma stelleri*), and one tree with a southern coastal distribution (*Malus fusca*).

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1. Ask students to plot museum specimens on maps and to examine those locations along with sources of information about elevation, precipitation and temperature.
2. Ask students to think about what species occurrences tell them about the distribution of plants. How can that information be useful for predicting new places where that species might occur.
3. Ask students to think about what kinds of plants grow in southern vs. northern Alaska. If students aren't familiar with the differences in the flora of these regions, show some pictures (e.g., rainforest vs. tundra).
4. Ask students to brainstorm at least three abiotic factors that might contribute to the differences in flora seen in these regions.
5. Pass out the Student Worksheet "Range and Distribution. " Explain that students will access an online database of plants that have been collected across Alaska. Tell students that they will explore the ranges of three different species: *Smelowskia media* (Alpine smelowskia), *Malus fusca* (Pacific crabapple), and *Cryptogramma stelleri* (Slender cliffbrake).
6. When students have completed the worksheet, discuss their observations.

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Student Worksheet: Range and distribution

Overview

Many factors, such as rainfall, temperature, and soil type, can impact where different plant species can and cannot live. In this activity, you will access an online database of plant specimens that have been collected from different parts of Alaska. You will map the range of three plant species and determine which factors might be responsible for their ranges.

Directions

1. Navigate to this site: http://arctos.database.museum/SpecimenSearch.cfm

2. Read the "about" page. What is Arctos? What data is made available from it? Where do these data come from?

3. In the "Identification and Taxonomy" Field, enter the name of the first species, "*Smelowskia media*," then hit "Search."

4. Click on one of the entries in the "Cat Num" column. Look in the lower right hand corner for an image of this plant. Click on the picture (image/jpg) to enlarge it.

4. Describe the plant. Is it short? tall? A tree? An herb? What do the leaves look like? Are they smooth? Hairy? Light? Dark? Enter your answers in the data table below.

5. Click the "back" button on your browser to go back to the original list of specimens. Click the "download" button and get a comma separated value file. You can upload this file to a Google Spreadsheet or use a common software package such as Excel to open it. Pay attention to the columns in the file, and what each colum tells you about the record.

6. Download the following data from Worldclid (http://www.worldclim.org/current): Generic grids of elevation, and bioclim at 5 degree resolution. These grids are called "rasters" and you can think of as being just like pictures of the planet, made of pixels, with each pixel holding a value of interest like elevation. The only difference is that the picture is georeferenced to define the location and extent of the pixels. The 5 degree resolution refers to how coarse each grid cell. The lower the number, the more "zoomed in" the dataset is.

7. Download QGIS here: http://www.qgis.org/en/site/forusers/download.html. You can load your rasters file you got from worldclim right into QGIS under "Layer" -> "Add Raster Layer". Select one of your .bil layers that you download (e.g. elevation). When you load it, you should see a black&white image appear that shows the elevation of the planet. You can do a lot of exploring right now, but one quick thing you can do is make the image more "colorful". Do this as an advanced exercise in QGIS (see supplement).

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8. You can have many layers load into QGIS. The bioclim layers you download include mean annual temperature (bioclim 1) and mean annual precipitation (bioclim 9). Feel free to load those as well.

9. Finally, you remember the .csv files you downloaded for "*Smelowskia media*"? You can load those occurrences into your GIS as well. To do so, go to "Layer" -> "Add delimited text layer", choose that .csv file you loaded, and go to the X-field and Y-field drop down menus and select "Decimal Longitude" for your X-field and "Decimal latitude" for your Y-field. Hit ok and your points should show up on the map!

10. You can find out something about the conditions at the points where *Smelowskia media* occurs. You'll notice a tool on the toobar that has an "i" in a blue circle with a mouse pointer. Find that icon and select it. You can now click a point record and get information about. If you choose a different layer in your layers list to the far right, by clicking on that layer, and use the "information tool", it will show you the value for elevation or temperature where you click. Cool.

11. Repeat this procedure for the two other species, "*Malus fusca*" and "*Cryptogramma stelleri*."

12. What do you notice about where the 3 species are found. What kinds of elevation, temperature and precipitation values do you find for each species using the tools you have learned above. Try to collect some values where you see the species has occurred. How could you predict places where you might find new records of the species given the information about the conditions where the species occurs.

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9. Which factors best explain the distribution of each of these three plant species?

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10. How might the morphology (physical characteristics) of these plants be related to the characteristics of their range (e.g., temperature, precipitation, and/or elevation)?

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Data Table

Species	Description	Range	Temp/precip/elev
Smelowskia media			
Malus fusca			
Cryptogramma stelleri			