Title: Mapping species distributions

Purpose:

- Discover relationships between climate and the distributions of species
- Examine relationships between biotic and abiotic components of ecosystems
- Introduce mapping (reading of maps, mapping of variables (e.g. rainfall, temperature) and techniques for mapping data, extraction of data from maps)
- Introduce GISystems
- Discuss types of climate variables and how they are derived

Overview:

This lesson asks students to develop maps based upon climate variables. These maps are created as "overlays" on tracing paper so that the students can stack the "layers" to examine relationships between the variables. The students then compare their maps to an existing vegetation or biotic communities map and are asked to develop a general set of "rules" regarding the variables they mapped and their influence on vegetation patterns. The vegetation maps are used as a "base map" to map the distribution of 2 species of the students' choice using the environmental requirements listed for the species in field guides or resource management databases.

This lesson may require background information on limiting factors to species distributions, how climate and other environmental variables affect distributions, how distributions of species change over time in response to changes in environmental and/or climate, and general mapping skills. Additional topics could include GISystems, general "laws" that describe species distributions, how to read/use field guides, and how to create and/or read topographical maps.

Relationship to Research:

This lesson is directly related to several components of my research. I am interested in human-environment interactions and how species distributions change in response to human-induced changes to the environment (e.g. agriculture, development, forestry, and so on). I use GISystems (and GIScience) to examine the spatial patterns of distributions, as well as to store and display the maps created from environmental and climate variables that contribute to the distributions.

Grade Levels: 7-9

Materials:

- Tracing paper (3 pieces per group of 2-4)
- Environmental data (e.g. elevation, rainfall, snowfall, temperature, number of days above freezing, etc.)
- Map of state with climate stations or cities where data are available (can be combined with topographical map)
- Vegetation, biotic communities, or plant communities map
- Crayons/markers/colored pencils
- Information on species distributions (e.g. elevation where found, food, water, associations, biotic community, etc.)

Time required: Two 50-minute class sessions

Learning Activity

Day 1:

Bell-ringer activity and introduction to mapping (**~15 minutes**).

Give students climate data, topographic and climate station/city map, and tracing paper. Ask students to map two of the climate variables for 18 of the locations (one variable per map; 2 maps will be created). Ask them to select variables they think will affect the distributions of vegetation (**~30 minutes**).

Ask students to overlay the maps they created with the topographic map. Have them begin looking for relationships between the variables. Ask them to begin thinking about how the variables (individually and as layers) affect the distributions of vegetation. If the students have not finished their maps, they will need to complete them at home for Day 2 activities (**~5 minutes**).

Day 2:

Give students vegetation/biotic communities/habitat map (often available from local Game and Fish, Natural Resources, or Forest Service). Ask them to compare their overlay (topographic and climate variables) to this map. Discuss similarities and differences (**~10 minutes**).

Give the students species descriptions, field guides, or data from resource managers that provide a description of the ecological requirements of the species (elevation range, moisture requirements, habitat preferences, etc.) Ask the students to pick 1 to 2 species (dependent upon time restrictions) to map range/occurrence. They will use the climate data maps they created the day before, the topographical map, and the vegetation map as base maps/data extraction layers for their distribution map. They will create the distribution map(s) on a new sheet of tracing paper (more than one can be mapped on the same sheet; gets students to think about map design and symbolization) (**~25-30 minutes**).

Ask students to write a paragraph explaining where the species lives and why it lives there. Specifics to ask: how do the variables you selected to map relate to the distributions of the species you mapped; what resources do the species you selected need to survive; would the distribution of the species change if one of the variables you selected changed (e.g. rainfall declined, temperature increased, or number of frost days increased); what would happen if the climate changes were sudden and prolonged; what factors would play a role in the survival of the species? (**~10 minutes/homework**)

Questions to ask students/consider:

- Why are the climate variables and vegetation and/or species distributions related?
- How would a change in your environmental variable impact the distribution of the species you selected to map?

- Do you think other variables (addition of or instead of) might be more helpful in explaining the vegetation/biotic communities/habitat map? What about the species you selected to map?
- How do you think these maps are used? Are they helpful for any specific purpose(s)?
- Do you think one variable alone can describe the distributions of species? If so, which one and why is that one important? If not, why?

Assessment:

Day 1 – Informal assessment of group dynamics and student understanding.
Day 2 – Students will turn in their 3 completed maps and descriptive paragraphs.

State and National Standards:

Arizona Science Standards Descriptions for Grade 8

Strand 1: Inquiry Process

Concept 1: Observations, Questions, and Hypotheses: Formulate predictions, questions, or hypotheses based on observations. Locate appropriate resources.

- PO1. Formulate questions based on observations that lead to the development of a hypothesis.
- PO2. Use appropriate research information, not limited to a single source, to use in the development of a testable hypothesis.
- PO3. Generate a hypothesis that can be tested.

Concept 2: Scientific Testing (Investigating and Modeling): Design and conduct controlled investigations.

- PO1. Demonstrate safe behavior and appropriate procedures (e.g. use and care of technology, materials, organisms) in all science inquiry.
- PO4. Perform measurements using appropriate scientific tools (e.g. balances, microscopes, probes, micrometers).
- PO5. Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs.

Concept 3: Analysis and Conclusions: Analyze and interpret data to explain correlations and results; formulate new questions.

- PO1. Analyze data obtained in a scientific investigation to identify trends.
- PO2. Form a logical argument about a correlation between variables or sequence of events (e.g. construct a cause-and-effect chain that explains a sequence of events).
- PO3. Interpret data to show a variety of possible relationships between two variables including:
  - Positive relationship
  - Negative relationship
  - No relationship
- PO4. Formulate a future investigation based on the data collected.
- PO5. Explain how evidence supports the validity and reliability of a conclusion.
- PO6. Identify the potential investigational error that may occur (e.g. flawed investigational design, inaccurate measurement, computational errors, unethical reporting).
- PO7. Critique scientific reports from periodicals, television, or other media.

PO8. Formulate new questions based on the results of a previous investigation.

Concept 4: Communication: Communicate results of investigations.

PO1. Communicate the results of an investigation.

PO3. Present analyses and conclusions in clear, concise formats.

PO4. Write clear, step-by-step instructions for conducting investigations or operating equipment (without use of personal pronouns).

PO5. Communicate the results and conclusion of the investigation.

Strand 2: History and Nature of Science

Concept 1: History of Science as a Human Endeavor: Identify individual, cultural, and technological contributions to scientific knowledge.

PO3. Evaluate the impact of a major scientific development occurring within the past decade.

PO4. Evaluate career opportunities related to life and physical sciences.

Concept 2: Nature of Scientific Knowledge: Understand how science is a process for generating knowledge.

PO1. Apply the following scientific processes to other problem solving or decision making situations:

Observing	Predicting
Questioning	Organizing data
Communicating	Inferring
Comparing	Generating hypotheses
Measuring	Indentifying variables
Classifying	

PO2. Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories.

PO4. Explain why scientific claims may be questionable if based on very small samples of data, biased samples, or samples for which there were no control.

Strand 3: Science in Personal and Social Perspectives

Concept 1: Changes in Environments: Describe the interactions between human populations, natural hazards, and the environment.

PO1. Analyze the risk factors associated with natural, human induced, and/or biological hazards.

PO2. Analyze possible solutions to address the environmental risks associated with chemicals and biological systems.

Concept 2: Science in Technology and Society: Develop viable solutions to a need or problem.

PO1. Propose viable methods to responding to an identified need or problem.

PO2. Compare solutions to best address an identified need or problem.

PO3. Design and construct a solution to an identified need or problem using simple classroom materials.

PO4. Compare risks and benefits of technological advances.

Strand 4: Life Science

Concept 4: Diversity, Adaptation and Behavior: Identify structural and behavioral adaptations.

PO1. Explain how an organism's behavior allows it to survive in an environment.
PO3. Determine characteristics of organisms that could change over several generations.
PO5. Analyze the following behavioral cycles of organisms:
Hibernation
Migration
Dormancy (plants)

Additional Resources:

Arizona Department of Game and Fish Natural Heritage Program: Heritage Database Management System (HDMS) http://www.azgfd.gov/w_c/edits/species_concern.shtml

Field guides

The University of Arizona Institutional Repository (UAiR) Arizona Geospatial Data and Maps http://uair.arizona.edu/item/292543/browse-data?page=1

Extension Activities:

1. If time permits, or as an extension have student present why they chose the specific variables they mapped and how these relate to the species they chose to map.

2. Give students the IPCC climate projections (for future or past climate) and ask the students to try to remap the species distributions (it may be necessary to get them to think about how the vegetation maps may change first, then have them map the species in response to their ideas on changes to the vegetation maps). Ask them to compare their maps and explain where and why differences occur in the distributions.

3. Ask students to map specific species with particular relationships to each other or the environment/climate variables (e.g. predator and several of its prey; a generalist species; an extinct/extirpated/endangered species).