PATTERNS AND PROCESSES IN LANDSCAPE ECOLOGY: LAND USE INTERACTIONS WITH STREAM FISH COMMUNITIES ACROSS SCALES

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April 24th, 2024

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WHO AM I?

- Freshwater Biologist
- Biology Education Researcher
- Postdoctoral Researcher in Dr. Stephanie Gardner's Lab
- New Faculty at Le Moyne College in August 2024!

FIGURE SET DETAILS

- **Learning Objectives (all incorporate Core Ecological Concepts):**
  - Predict how humans cause changes in diversity across the landscape for aquatic organisms.
    - Human-Environment Interactions
  - Describe how a multi-scale approach can create a different interpretation of patterns across the landscape.
    - Cross-cutting Themes
  - Analyze figures to describe concepts related to human effects on aquatic communities.
    - Ecology Practices
  - Develop additional questions based on scientific reasoning.
    - Ecology Practices

Background Information

- Freshwater Streams in Hungary and Ozarks
- Interpretation of ordination figures

Major sections

- Land use and scale
- Land use and environmental gradients
- Land use and stream fish biodiversity

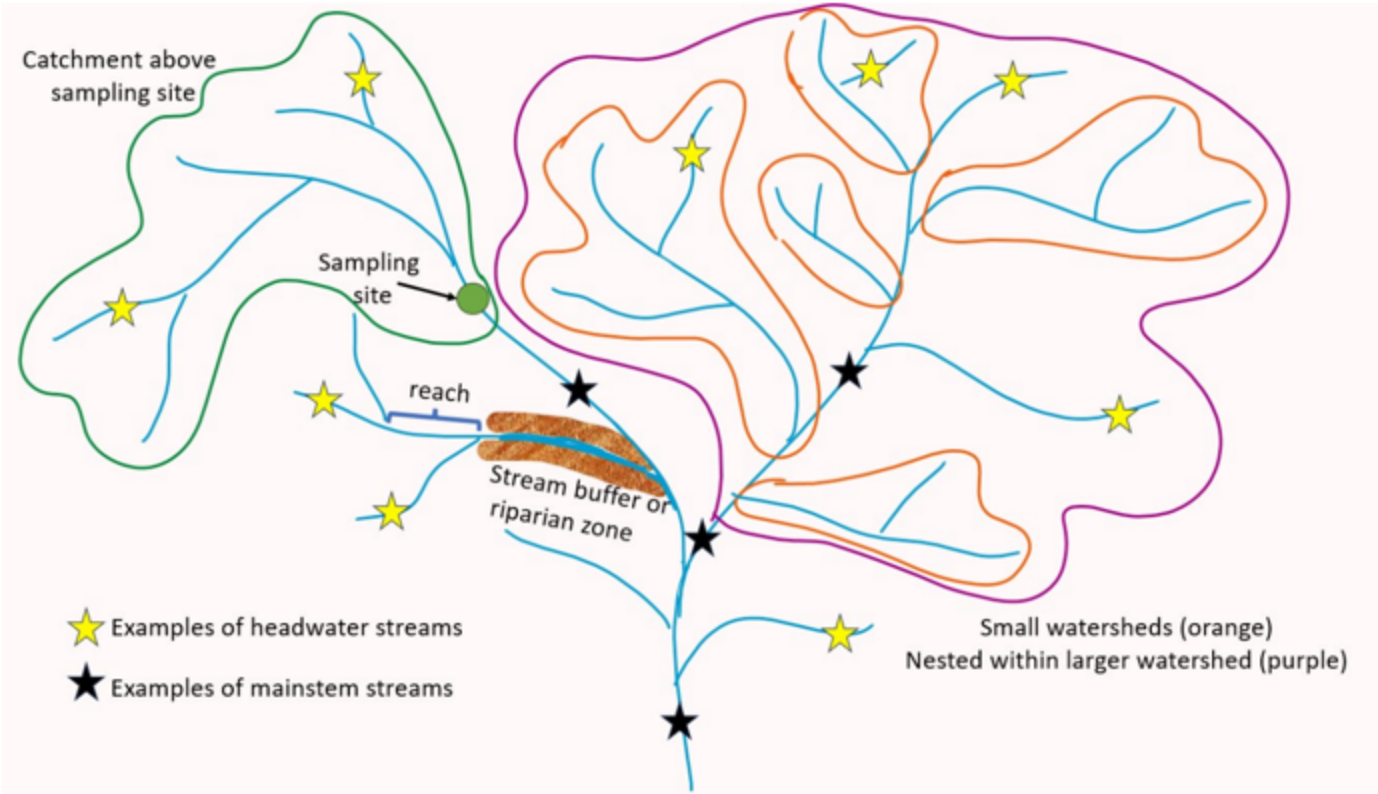
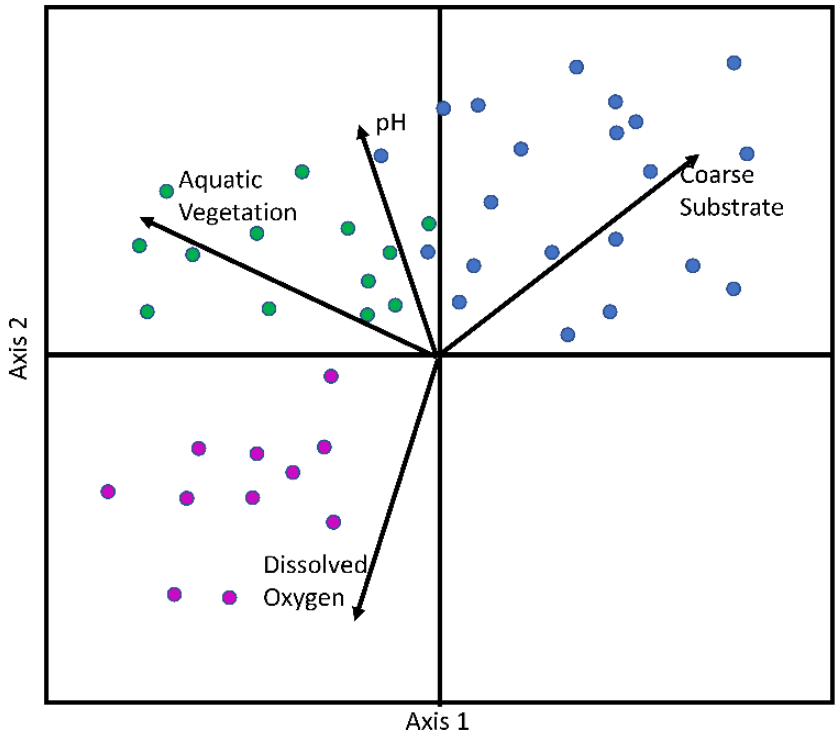
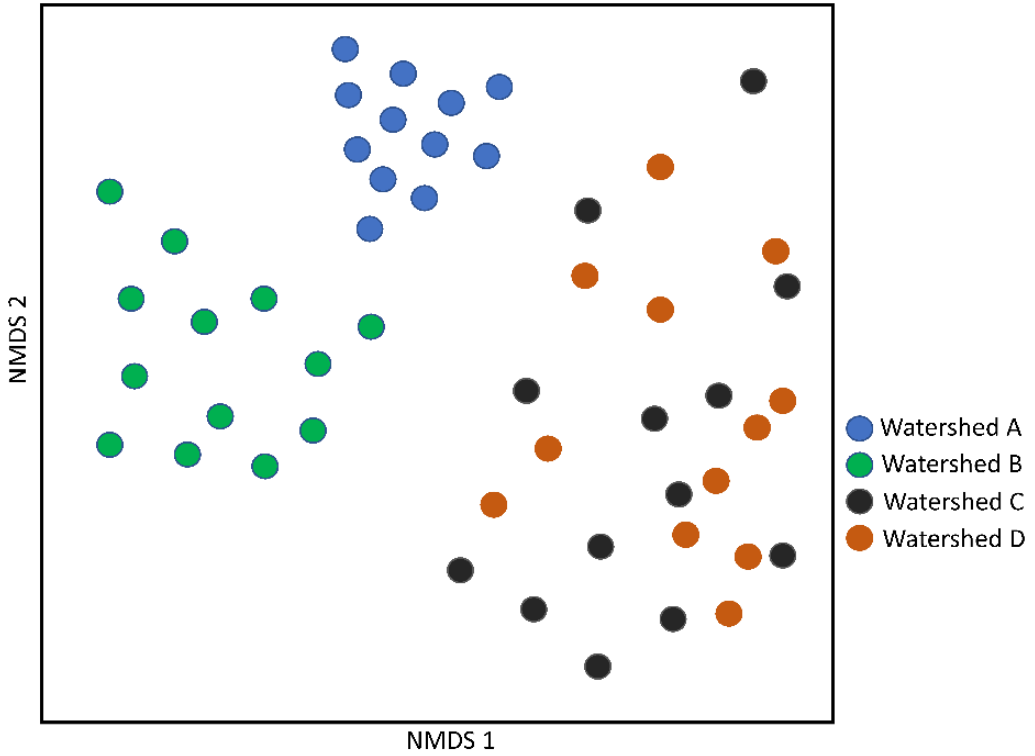


Figure 1: Conceptual figure showing parts of a watershed. Watersheds are hierarchical with smaller watersheds (shown in orange) being nested within a larger watershed (shown in purple), which is nested within the entire watershed shown. **Headwaters** are where streams originate, examples are marked with yellow stars. Streams come together to form **mainstems**, which are marked with black stars. The reach scale is a small section of a stream. A buffer zone around a stream can also be referred to as the riparian zone. A **catchment** above a sampling site is all area of the watershed that drains into that point.

FOCUS ON ORDINATION FIGURES

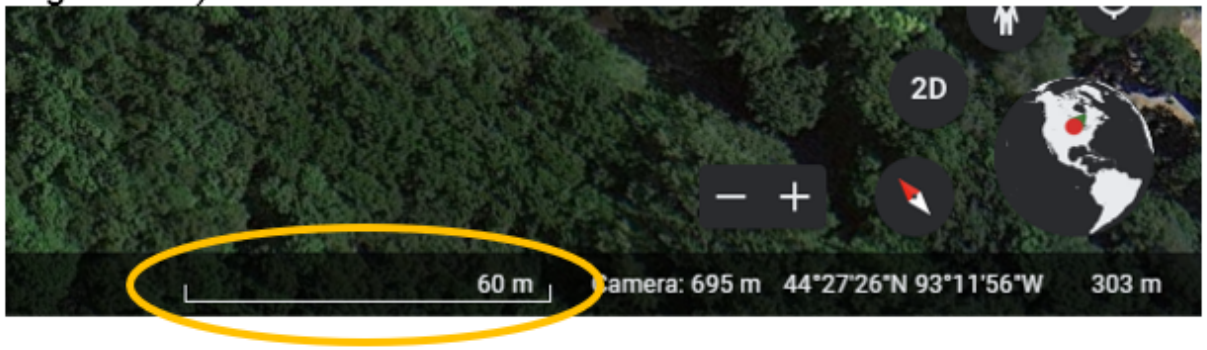




PRE-CLASS ACTIVITY

Pre-Class Activity

Use this activity to think about how variable choice should match with the spatial scale represented. Before coming to class, look up your hometown on Google Earth (http://www.google.com/earth/) and find the nearest body of water, this could be a stream, river, pond, lake, wetland etc. Answer the following questions making sure to record the scale at which you are viewing:
For each scale make sure to take a screenshot of what you see when answering the questions. Place your images, one on a page, and print them out in color and bring to class with your answers for discussion. For the scale, record the number, in meters, associated with the scale bar in the lower right-hand corner (circled in the image below).



EXAMPLE- ZOOM IN TO LOCAL SCALE

Based on the features in view across the landscape, what potential human impacts do you see, how might those impact your body of water?

50 m scale

EXAMPLE- FIRST ZOOM OUT

What additional human influences are now in your field of view, and how might those impact the communities within your aquatic habitat.

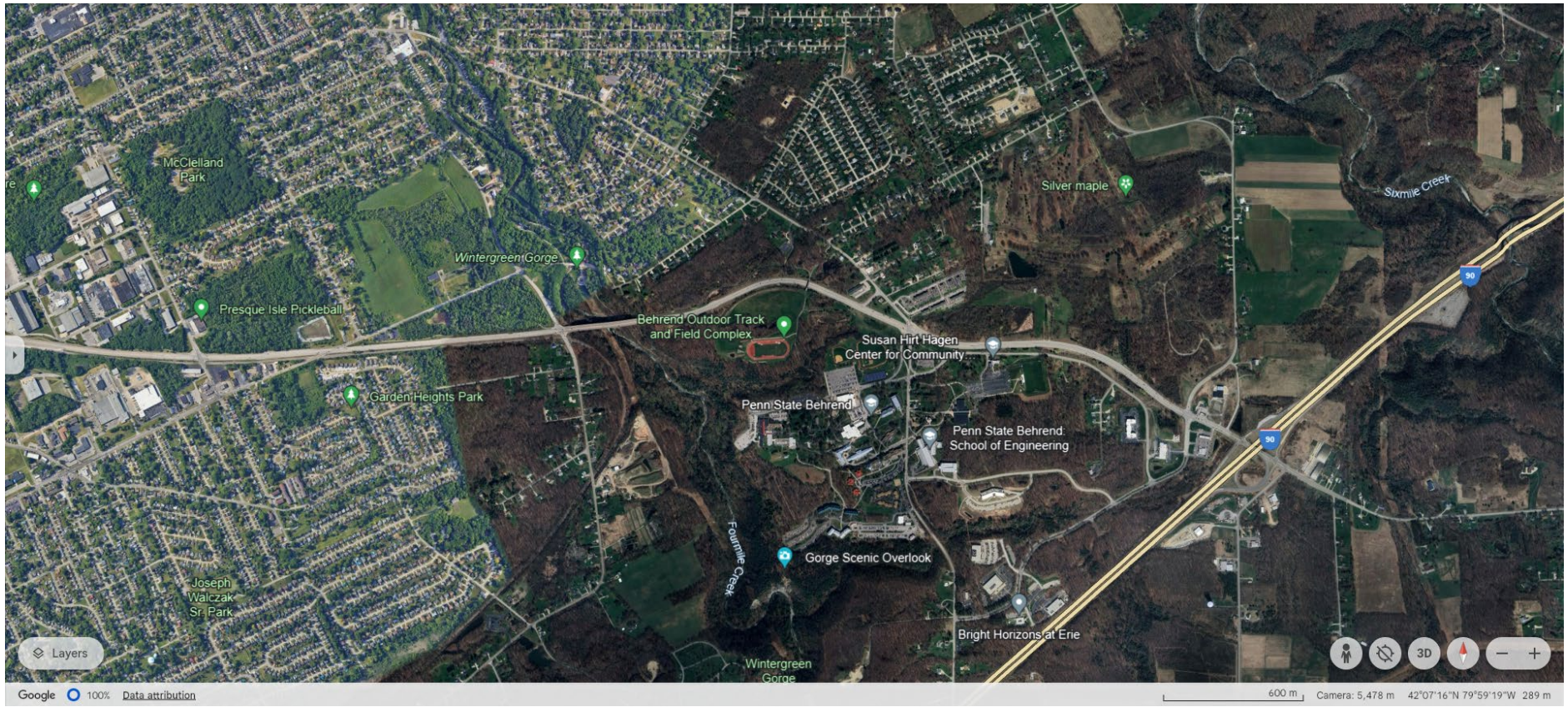
200 m scale

EXAMPLE- SECOND ZOOM OUT

Are there any additional features that should now be considered regarding human influences on your chosen aquatic habitat?

As you zoomed out, do any of the human impacts you wrote down at a smaller scale now seem unnecessary?

600 m scale



LAND USE AND ENVIRONMENTAL GRADIENTS

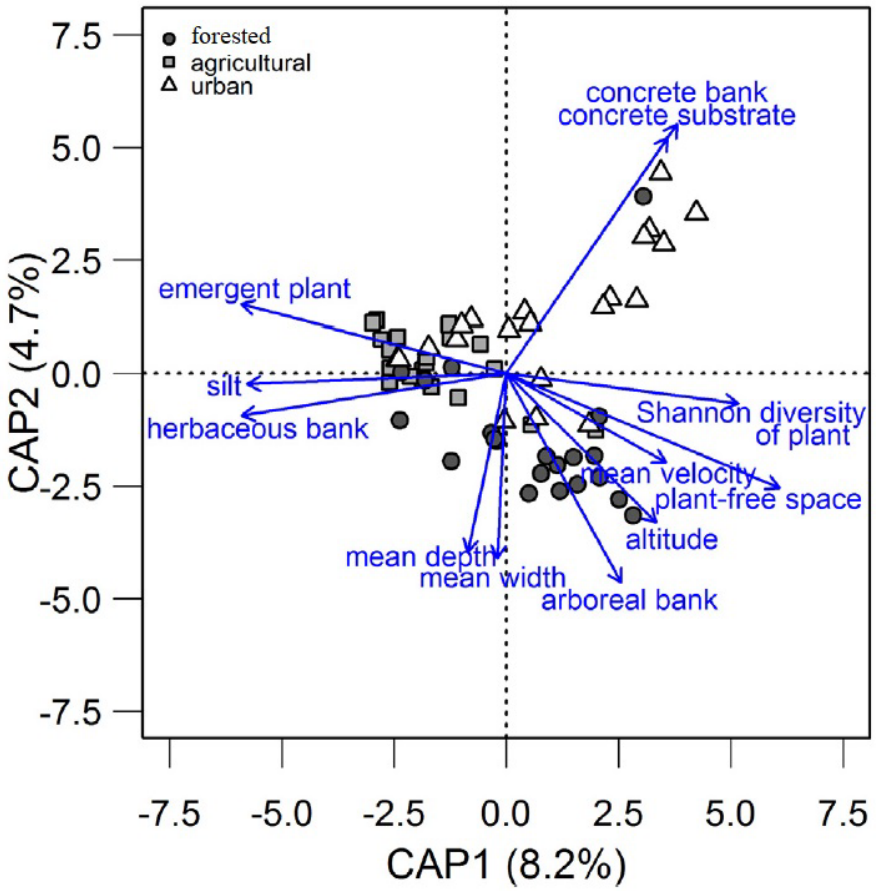
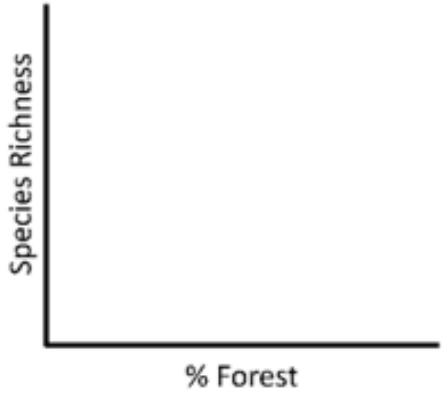
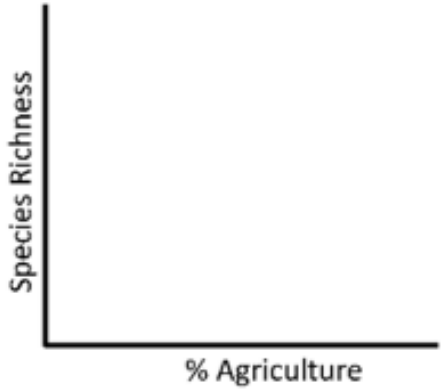
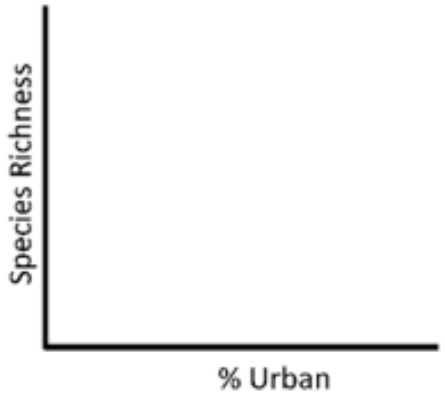


Figure adapted with permission from Tóth, R., Czeglédi, I., Kern, B., & Erős, T. (2019). Land use effects in riverscapes: Diversity and environmental drivers of stream fish communities in protected, agricultural and urban landscapes. *Ecological indicators*, *101*, 742-748.

Figure 2: Constrained Analysis of Principal Coordinates (CAP) investigating land use influences on habitat characteristics within streams. Fish communities from streams in forested lands are shown by circles, fish communities from streams in agricultural lands are shown by squares, fish communities from streams in urban lands are shown by triangles. Directionality of the vectors associated with the habitat variables point towards the land use that habitat is most associated with.

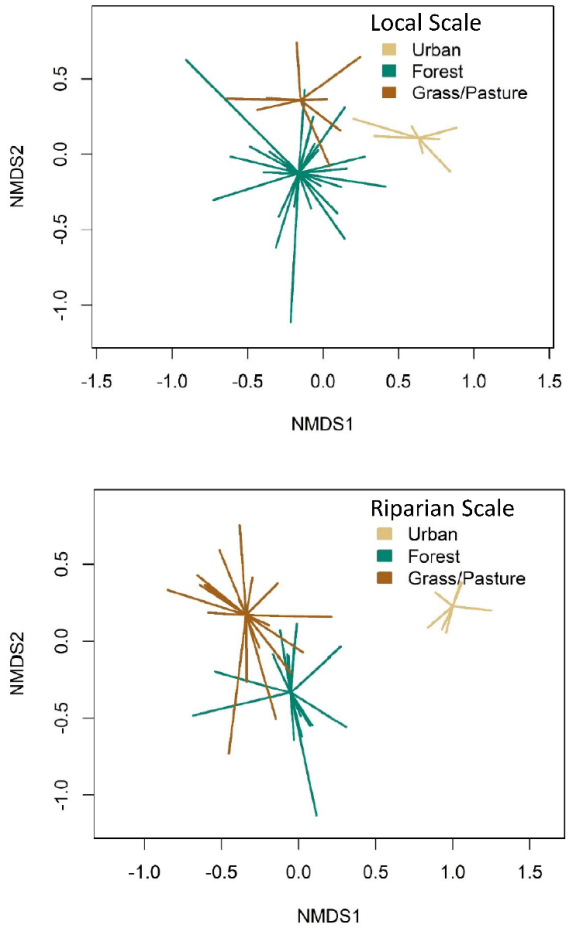






Make predictions for how species richness for stream fish would change across a gradient of each land use type. Blank graphs are provided on the next page to get you started. Your predictions do not have to be linear. After you have finished your graphical predictions, find a partner, and compare predictions. How similar or different were the predictions you made?

LAND USE AND SCALE



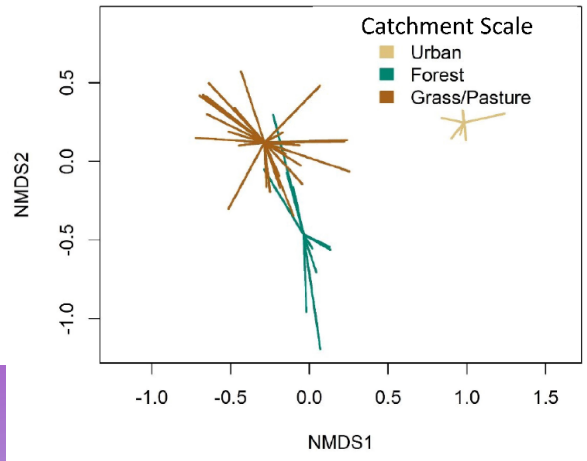


Figure 3: Non-Metric Multidimensional Scaling (NMDS) of Missouri Ozark stream fish. Investigating how fish beta diversity is influenced by land use at three different scales: local scale (A), riparian scale (B), and catchment scale (C). In these plots, the tips of the lines represent a sampled community. The lines of the same color converge on the centroid, which is the equivalent to the “average” community for a particular land use type. Figures adapted with permission from Sickler, S. M. (2018). Long-Term Trends of Stream Fish Community Assemblages in Southern Missouri with Contemporary Land Use Impacts.

MOVING BEYOND LAND USE

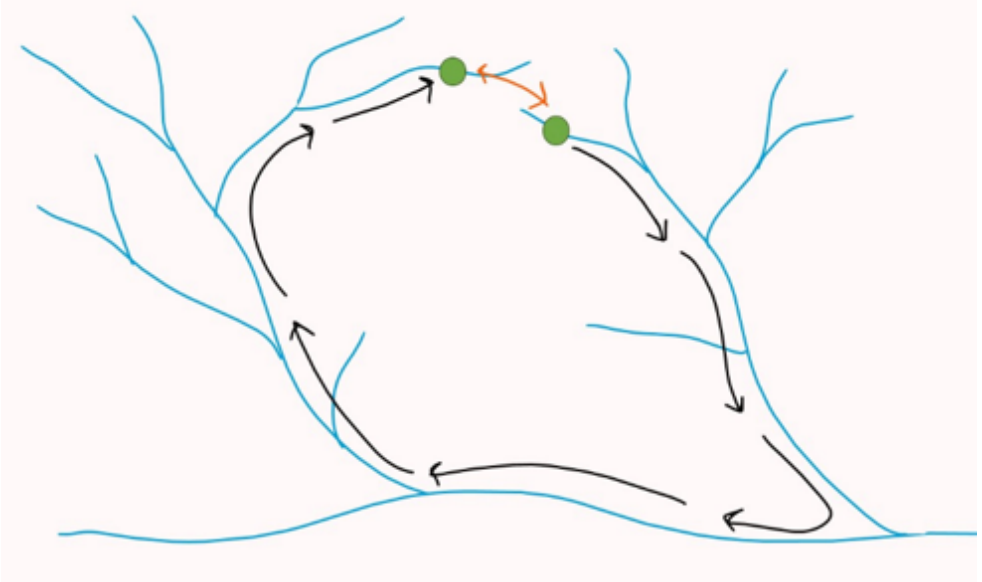


Figure 4: Conceptual diagram showing how two communities (green dots) can be close in overland distance, but far apart in network distance (how far a fish would need to swim to get from one community to the other).

MOVING BEYOND LAND USE

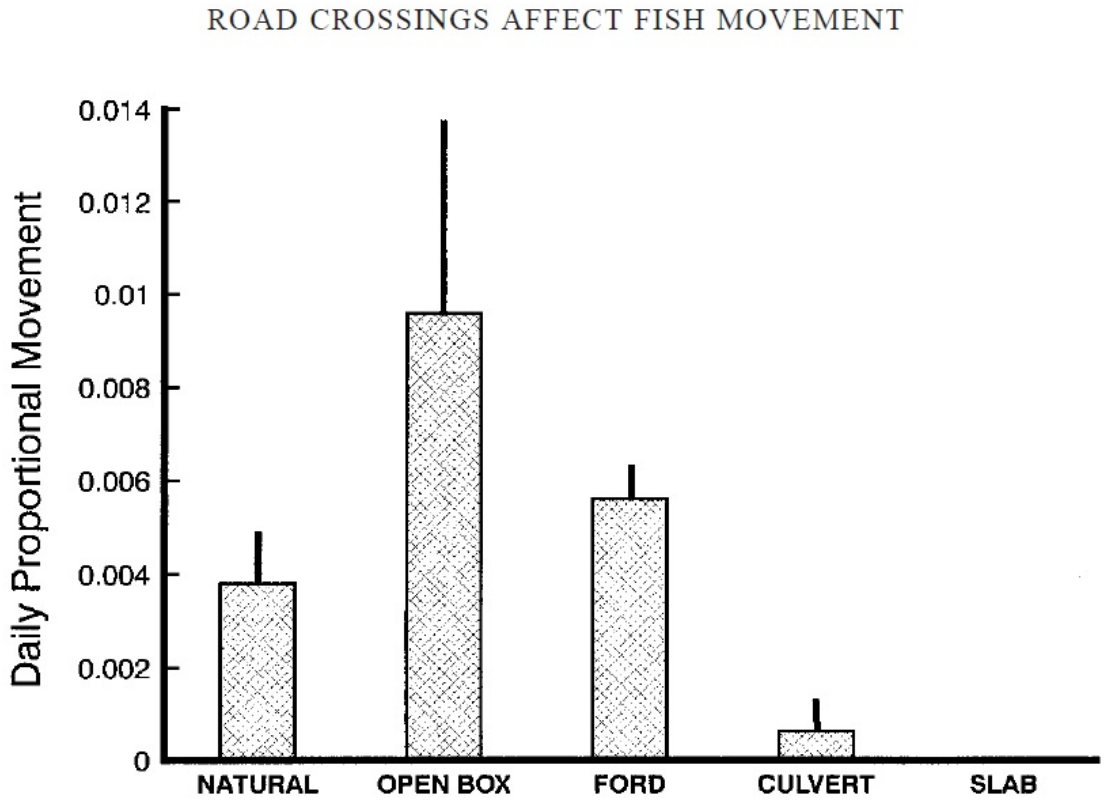


Figure 5: Mean (error bars are standard error) daily proportional movement of fishes through four road crossing types and natural reaches. Sampling completed in the Ouachita National Forest in west/central Arkansas. Sampling took place over nine road crossings on eight streams. The sampling included over 6,000 individuals of 26 fish species from eight families. Figure used with permission from Warren and Pardew 1998 – Road Crossings as Barriers to Small-Stream Fish Movement.


Have you specifically taught about creating and interpreting graphs in your ecology courses?
Questions?
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What struggles have you faced teaching your students to create and interpret graphs?