



Preserving Unimpaired Earth's Natural Environments: Resilient Landscapes Lesson

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Overview

The theme for this week is preserving unimpaired Earth's natural environments. As the climate changes, species geographic range changes, and species shift location. National Parks protect microclimates associated with a range of habitats, acting as safe havens for species. Sometimes, the range contracts and species die out, while other times the range expands and species become more dominant. At either extreme, the variety of habitats that are connected to each other allow for the migration, shifting of species.

Learning Objectives

- YCC precipitants will have a basic understanding of some of the threats species habitats are facing from climate change and anthropogenic sources.
- YCC precipitants will learn about the factors that promote resiliency to change.
- YCC precipitants will understand how National Parks protect areas for current and future species.

Materials Needed

- A copy of the cards cut and folded beforehand.
- A copy of the answers.

General Outline

1. 1. Threats to Habitats

- a. Expanding and Contracting Species Range*
- b. Untimely Biological Processes*
- c. Land Conversion and Habitat Fragmentation*

2. Resilient and Connected Landscapes

- a. Managing Landscapes*
- b. Microclimates*
- c. Resilient Landscapes*
- d. National Parks*

3. Activity

- a. Overview*

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Background (for park employee benefit)

NPS studies resiliency through 5 components derived from the Federal Emergency Management Agency: diversity, redundancy, network connectivity, modularity, and adaptability.¹ These principles are central to maintaining landscapes for present and future species in the face of climate change.

Procedure

1. Threats to Habitats

a. Expanding Species Range

- i. A species' range is determined by a combination of abiotic factors, individual and population response to habitat quality and availability, and species interactions.² This is why we only see certain species in specific geographic areas.
- ii. As the climate changes, the geographic extent of the conditions that species prefer shifts, forcing live organisms to change where, when, and how they are able to survive.
- iii. A study of more than 4,000 species around the world saw that about 50% have already moved; on average, land species are moving more than 10 miles per decade, while marine species are moving 40 miles per decade.³
- iv. Species react to environmental shifts differently. The change is unprecedented in human records, so it is difficult to predict how species will react. How, when, to where, and if they will shift. For example:⁴
 1. Some species escape rising temperatures by going up slopes or toward the poles.
 2. In California, some mountain plants are moving downhill toward warmer temperatures, as historically-dry valleys now get rain.

b. Untimely Biological Processes

- i. Species go through biological cycles at specific times of the year. Some examples include breeding times, plants flowering, and trees and shrubs leafing out. As the climate changes, the timing of these cycles is changing.

¹ NPS. (2017) "Cultural Landscapes: Resilient Systems and Cultural Landscape Management."

² Mott, C. L. (2010) "Environmental Constraints to the Geographic Expansion of Plant and Animal Species."

³ Welch, C. (2017) "Half of All Species Are on the Move—And We're Feeling It."

⁴ Lawson, et al. (2012) "Local and landscape management of an expanding range margin under climate change." Please cite as: C. Cerpa. 2020. UERLA Informal Lesson: Preserving Unimpaired Earth's Natural Environments: Resilient Landscapes Lesson.



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- ii. In one Colorado region, wildflower blooms now last a month longer because flowers no longer bloom all at once.
- iii. Unraveling ecological relationships may threaten the survival of some species. For example, the red knot, a shorebird that migrates from the tropics to the Arctic each spring to breed and feed on insects, is suffering from the insects' early hatching due to the earlier Arctic snow melting. The birds are arriving too late, and since their beaks are only adapted to eating insects, they can't switch their diet.

c. Land Conversion and Habitat Fragmentation

- i. Habitat loss is one of the greatest threats to biodiversity.⁵ It can be caused by land conversion from human encroachment on and development of important natural areas and habitat fragmentation. The latter occurs when either humans or natural events clear parts of the land, which leads to the division of continuous habitats into smaller, isolated patches. Habitat fragmentation disrupts wildlife movement corridors, which species use for post-breeding dispersal, new territory establishment, and additional food source location.
- ii. For example, every "roadkill" is a victim of habitat fragmentation; had their movement corridor remained untouched, they would not have faced an untimely death. Many amphibians migrating to or from breeding wetlands, snakes basking on warm roads, or turtles travelling to upland nesting habitats are killed in Maryland.⁶
- iii. Species in fragmented habitats face compounded risk with climate change, because they are already limited in their geographic range. As the abiotic factors of their habitat changes, the composition of their community will change, and they are limited in their opportunity to migrate.⁷

2. Resilient and Connected Landscapes

a. Managing Landscapes

⁵ Maryland DNR. (2015) "Maryland State Wildlife Action Plan: Chapter 5"

⁶ *ibid.*

⁷ Lawson, et al. (2012) "Local and landscape management of an expanding range margin under climate change." Please cite as: C. Cerpa. 2020. UERLA Informal Lesson: Preserving Unimpaired Earth's Natural Environments: Resilient Landscapes Lesson.



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- i. One way to protect climate-sensitive species is by conserving habitats at-risk of becoming uninhabitable to those species, and increasing connectivity between fragmented habitats.⁸ Having a variety of connected habitats will support various naturally-occurring solutions for migrating species.
- ii. Managing individual habitat patches should have the goal to increase the population density by increasing resilience to climate change through high quality plant availability and bare ground cover. Given that plants are the base of all food chains, it is crucial to have native plants that provide a lot of nutrients and calories. Ground cover provides nutrients to other plants, protects the soil, and is the live basis for the ecosystem.
- b. *Microclimates*
 - i. Microclimate is the climate of a small, restricted area that is different than the climate around it. They are caused by a variety of factors, including topography (mountains), bodies of water, rich or dry soils, plant life, and man-made features.
 - ii. Areas with high microclimate diversity provide plants and animals with a range of habitats to survive in locally, even as the regional climate changes and becomes unsuitable for local species.
- c. *Resilient Landscapes*
 - i. Resilient means a capacity to withstand change or recover from unexpected impacts quickly. In this case, it refers to a habitat's ability to maintain ecosystem function as the climate changes.⁹
 - ii. Resilient areas are spaces buffered from the extreme effects of climate change because of their many connected microclimates, with temperature and moisture options that can differ as much as 50-59°F with the surrounding area, providing options for continued ecosystem function.¹⁰
 - iii. Additional factors that impact the resiliency of a landscape include:

⁸ Lawson, et al. (2012) "Local and landscape management of an expanding range margin under climate change."

⁹ NPS. "Cultural Landscapes: Resilient Systems and Cultural Landscape Management."

¹⁰ Anderson, et al. (2016) "Resilient and Connected Landscapes for Terrestrial Conservation."

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1. Landscape diversity: presence of characteristics that create microclimates and habitat variety, such as topography, elevation range, wetland density, and soil variety
2. Local connectedness: absence of habitat fragmentation factors that could prevent species from accessing adjacent microclimates.
3. Climate corridors: areas with a high concentration of movement of species in response to climate change. They typically occur in the least fragmented parts of the region: intact natural areas. Examples include natural ridgelines, forested regions, and riparian and floodplain areas.
 - a. As mentioned, species driven away from their geographic ranges by climate change are often directional, specifically upslope and poleward into cooler climate zones, or downslope into a moist shady area near water.
4. Confirmed diversity: known locations of rare species or unique communities based on ground inventory. The quality of species present, particularly plant life, significantly impacts the resiliency of the area.
- iv. Not every landscape needs to have all these factors, but the more they have, the more resilient they are. A network of resilient, linked sites could, if adequately managed and conserved, sustain the regional diversity under a changing climate.¹¹
- v. A study by the Nature Conservancy of 44 million acres in the Eastern U.S. identified a prioritized network of resilient and connected sites that covered 23 percent of the region, amounting to 106 million acres. These landscapes contained more than 80,000 rare species and communities, stored 56 percent of the region's carbon, contained 75 percent of water supply land, and 16 percent is secured against conversion.¹²

d. National Parks

¹¹ Anderson, et al. (2016) "Resilient and Connected Landscapes for Terrestrial Conservation."

¹² *ibid.*

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- i. Land and water that is permanently protected against development is one of the most effective, long-lasting, and essential tools for conserving the region's habitats and species.¹³
- ii. Even if current species move away, resilient sites allow for safe species movement and can provide a habitat to incoming species to adapt and thrive.
- iii. National Parks provide shelter to countless present and future species by conserving and managing landscapes. MONO, in particular, acts as a resilient area in a highly urbanized region. The Park continues to support biological diversity, productivity and ecological function even as the surrounding area changes in response to climate and land use change.¹⁴
- iv. Park leadership studies the components of resilient systems to examine current landscape vulnerability and minimize climate change impact. Those components, derived from the Federal Emergency Management Agency's "National Incident Management System", are:¹⁵
 1. Diversity: protect against massive loss through the presence of a range of responses to stress.
 2. Redundancy: backups in case of stress, loss, or failure.
 3. Network connectivity: system interactions that promote robustness and discourage brittleness.
 4. Modularity: structurally/functionally autonomous parts during stress events.
 5. Adaptability: ability of a system to function under stress.

3. Activity

a. Overview

- i. Tell YCC precipitants: "Together, we are going to apply the 5 components of a resilient system: Diversity, Redundancy, Network Connectivity, Modularity, and Adaptability. Let's compare how the degree of resiliency of a landscape impacts species by going on a journey like they would.

¹³ Anderson, et al. (2016) "Resilient and Connected Landscapes for Terrestrial Conservation."

¹⁴ Anderson, et al. (2016) "Resilient and Connected Landscapes for Terrestrial Conservation."

¹⁵ NPS. (2017) "Cultural Landscapes: Resilient Systems and Cultural Landscape Management."

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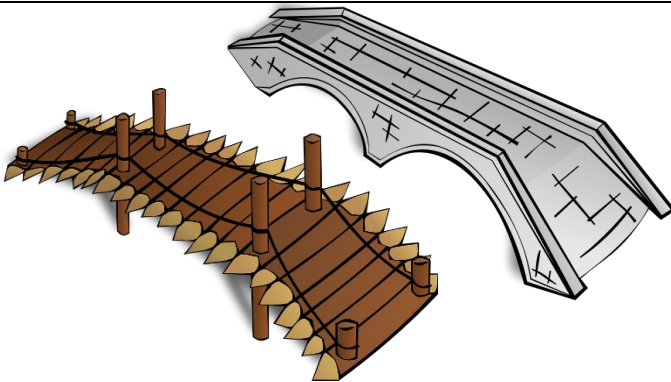
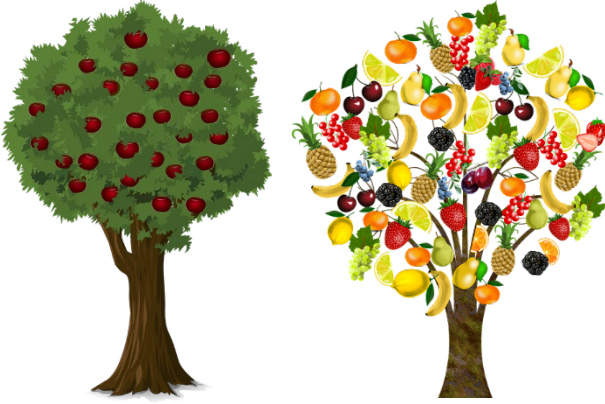
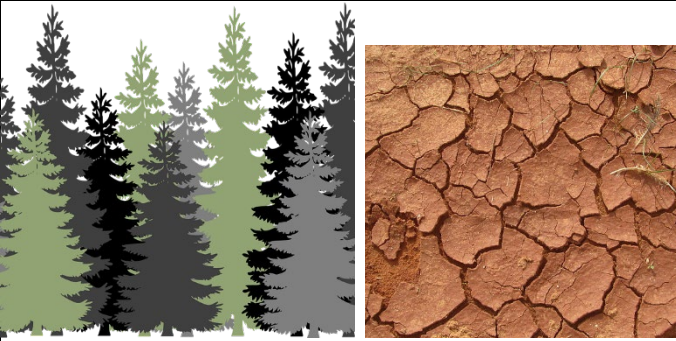
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Each card is going to describe a scenario, and we have to choose the best path. Then, we will talk about what resiliency principle or principles the choice represents. For example, we could be forced to choose between a fast train with a single car, or a slow train with 5 cars that can travel individually. In this case, the slower train with individual cars is the best choice, because if one breaks down, other cars could be used. In the case of the fastest, single-car train, if anything happens to it, we would be stuck. This represents redundancy, as we have backups if some fail. ”

- ii. Have a student read the scenario in the card, and encourage them to discuss amongst themselves how the choices relate to resiliency. You will have the answers, so feel free to prompt them if they feel stuck!



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You are trying to cross a river, and you see two bridges. a) This bridge is made of rope and planks, and it seems shaky. b) This bridge is made of steel and planks. Some planks are missing, but you can walk on the steel beams. Which path is the best choice? What resiliency principle(s) does it show?	
You feel hungry right as you get to a fork in the road. You don't know the state of the fruit trees ahead. a) You know this path leads to a field with 10 trees: 2 apricot, 2 peach, 2 apple, 2 plum, and 2 pear. b) You know this path leads to a field with 20 pear trees, your favorite fruit. Which path is the best choice? What resiliency principle(s) does it show?	
A downpour just started! You are on the last stretch of your journey. a) You choose the quickest path, through bare soil. b) You choose the slowest path, through a forested area. Which path is the best choice? What resiliency principle(s) does it show?	

Diversity: protect against massive loss through the presence of a range of responses to stress.

Redundancy: backups in case of stress, loss, or failure.

Network connectivity: system interactions that promote robustness and discourage brittleness.

Modularity: structurally/functionally autonomous parts during stress events.

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Network Connectivity: it allows the two sides of the river to connect. Redundancy: they are both good bridges, but they provide a backup if the other is lost or fails.	Bridges Answer: Either!
Diversity: having multiple species of trees protects the food source! If a pest were to attack apples, the path with many other tree species would still have fruit. The one with just apples would be bare. Redundancy: in the diverse path, there is more than one tree of each species, so if one fails, the other remains. Modularity: each tree is autonomous to an extent, so after a period of tress they can recover individually.	Fruit Trees Answer: many tree species
Adaptability: the vegetation absorbs the water, allowing the ecosystem to continue function. Bare soil doesn't, causing floods and runoff.	Bare Soil Answer: forested area

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