UNDERSTANDING RESILIENCE WITH JENGA

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Title: Understanding Resilience with Jenga

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Topic Areas: Ecological Resilience, Agriculture, Ecology, Natural Resources, Policy, Management, Socio-Ecological Systems

This lesson plan has been classroom tested in an upper level agriculture/natural resource undergraduate course.

Link to Box with Resilience Jenga Instructions and Results Visualization Spreadsheet: https://unl.box.com/s/g0pc6ici3skugyzepxc68uw1iyph1498

Lessons on ecological resilience and related topics authored by the Council for Resilience Education are available on the Plant and Soil Science eLibrary website: https://passel2.unl.edu/view/community/70ffd07aff59

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UNDERSTANDING ECOLOGICAL RESILIENCE WITH JENGA

This class activity uses a modified version of the block-stacking game Jenga to illustrate the concept of resilience in natural resource use, policy, and management. The activity places students in teams and has them draw numbered blocks from the Jenga tower according to different sets of rules designed to illustrate various approaches to resource management, including obstructive policy, policy with limited knowledge, policy to maximize harvest, policy to maximize returns while minimizing tradeoffs, and resilience policy for working lands. Resilience is a topic of increasing relevance and popularity in the face of our modern world's complex challenges, including climate change, sustainability of our natural resources base, poverty, and social inequity. Resilience helps us visualize, understand, and manage the complex systems that are driving forces behind these systemic issues, and has been applied to practical problems across disciplines and industries.

The class activities packet is appropriate for college students in diverse courses including agronomy and agriculture, ecology, natural resources, law and policy, land and resource management, security, environmental sciences, and general inquiry into coupled social-ecological systems. The packet includes directions for setting up, moderating, and playing Jenga in class, a scoring spreadsheet for inputting data from class activity sessions and visualizing results, Kahoot! questions for immediate concept review, and discussion questions for more in-depth reflection. For a more in-depth overview of resilience and other related topics, we provide links to open-access online educational modules on the Plant and Soil Sciences eLibrary (PASSeL) - https://passel2.unl.edu/view/community/70ffd07aff59. Overall, the activities packet and related materials are designed to get students to think critically and explicitly about how policy and management decisions impact the natural resources on which we all rely.

Learning Goals

Develop a basic understanding of resilience, how it relates to natural resource management, and how resilience-based management compares to traditional yield-focused management strategies.

Learning Objectives:

By the end of this lesson plan students will be able to:

1. Describe key differences between management strategies/policies and how they relate to yield and resilience
2. Described differences in how resilience is measured and applied.
3. Identify how existing management policies promote resilience versus yield production.
4. Identify the tradeoffs between resilience and yield in management strategies/policies.
5. Identify situations where resilience versus yield focused management strategies/policies are appropriate.
6. Describe the interplay between scale and management strategies/policies.

Classroom Management:

Total estimated time: 1-1.5 hours

Overview

1. Introduction to Resilience definitions (5-10 minutes) (resilience and alternative states learning modules can be assigned before class)
2. Play Jenga (30-45 minutes)
3. Small group discussions (15-30 minutes)
4. Class discussion on scenario performance (10-15 minutes)
5. Take home essay questions

Teaching Ecological Resilience with Jenga

Necessary Materials: Students handouts; materials to display excel scoring sheet to class; Jenga towers (4); random number generating device; writing utensils.

1. Introduction to Resilience Definitions

- We begin the lesson plan with a brief introduction to Holling's resilience. We recommend assigning the ecological resilience and alternative stable state theory and regime shifts learning modules before class (https://passel2.unl.edu/view/community/70ffd07aff59) and providing a ~10 minute review at the beginning of class.

2. Play Jenga

- Divide the class into small groups of 3-6 students. Provide each group with one of the five Jenga policy scenarios, four scoring sheets, and a Jenga tower. Each group will need to designate a score keeper. As groups set up their Jenga towers, visit with each group to ensure that they understand the instructions provided on their Jenga policy scenario handout. Jenga policy scenarios are meant to illustrate natural resource management strategies/policies and include: obstructive policy scenario; policy with little knowledge of the system; policy to maximize harvest; policy to maximize return while minimizing tradeoffs; and resilience policy for working lands.
- Students play 4 rounds of Jenga according to the rules assigned in the student handout. Note that students harvest the Jenga blocks and do not replace them on top of the tower. A round is ended when the tower collapses.
- At the end of each round the instructor enters final scores into the excel scoring sheet (available for download at https://unl.box.com/s/g0pc6ici3skugyzepxc68uw1iyph1498). Note that the students will need their scoring sheets for small group discussions after all rounds have been completed.

3. Small Group Discussions

- Provide students 5-10 minutes to discuss questions 1-3 from the handout:
  1. Based on Holling's resilience, calculate the resilience of your policy scenario.
  2. Calculate the yield of your policy scenario.
  3. Describe management policies or incentives that align with your policy scenario.
- Ask each small group to give a 2-3 minute overview of their Jenga scenario and their responses to questions 1-3.
- Expectation: Ensure that students understand that the number of blocks harvested before collapse is a measure of Holling's resilience. Students should be able to identify components of their Jenga scenario that relate to natural resource management strategies/policies.
- As a class discuss the following question:
  - What would happen to Holling's resilience if bounce back was optimized?
- Expectation: In the context of Jenga, students should be able to recognize that Holling's resilience would be reduced if the goal was to re-assemble the tower as quickly as possible. Students should also be able to identify how this may apply to natural resource management.

4. Discussion of Scenario Performance

- Show the class how the different Jenga policy scenarios scored in terms of yield and resilience using the excel scoring sheet provided. Make sure to highlight comparisons between score means and variance. For example, two scenarios may have similar mean yields but different variance, illustrating the difference between dependable production and boom and bust.
- As a class, discuss some of the key performance similarities and differences among scenarios and how these relate to real-world examples.
- As a class, discuss the relationship between yield and resilience. Can they both be maximized or do tradeoffs exist?
- Expectation: Yield increases as an increasing number of blocks are harvested (resilience metric). However, not all policies can achieve both high yield and resilience and we oftentimes see a tradeoff in real-world examples. The take home essay questions are meant to further explore tradeoffs and the appropriateness of resilience versus yield focused management under different circumstances (e.g., scale).

5. Take Home Essay Questions:

1. Imagine you are the lead manager of a greenhouse tasked with growing produce for the summer, how would manage for yield versus resilience? In your answer, indicate whether this profession tends to optimize yield or resilience and management practices that support yield, resilience, or both.

2. Now, imagine that you are the lead manager of a wildlife refuge complex tasked with managing wildlife for the next 50 years. How would you manage for yield versus resilience? In your answer, indicate whether this profession tends to optimize yield or resilience and management practices that support yield, resilience, or both.

Modification Options

Take home essay questions: These questions are meant to contrast management policies/ strategies under different circumstances (and scales) to generate reflection about the appropriateness of yield versus resilience focused management. We have selected two general themes that work well with students in cross-listed agriculture and natural resource courses. However, these questions can be modified to better reflect your classroom by selecting a more disciplinary specific example if this is desired.

Examples:

- Fisheries: Hatchery manager versus a manager of a network of lakes
- Wildlife: Raising captive wildlife versus creating a state wildlife action plan
- Agriculture: Managing a greenhouse versus a farm or ranch operation

Suggested Readings:

Allen, C. R., Angeler, D. G., Chaffin, B. C., Twidwell, D., & Garmestani, A. (2019). Resilience reconciled. Nature Sustainability, 2(10), 898-900.

Birgé, H. E., Allen, C. R., Garmestani, A. S., & Pope, K. L. (2016). Adaptive management for ecosystem services. Journal of Environmental Management, 183, 343-352.

Gunderson, L. H. (2000). Ecological resilience—in theory and application. Annual review of ecology and systematics, 31(1), 425-439.

Holling, C. S., & Meffe, G. K. (1996). Command and control and the pathology of natural resource management. Conservation biology, 10(2), 328-337.

Twidwell, D., Allred, B. W., & Fuhlendorf, S. D. (2013). National-scale assessment of ecological content in the world's largest land management framework. Ecosphere, 4(8), 1-27.

Twidwell, D., Wonkka, C. L., Wang, H. H., Grant, W. E., Allen, C. R., Fuhlendorf, S. D., ... & Rogers, W. E. (2019). Coerced resilience in fire management. Journal of environmental management, 240, 368-373.

KAHOOT! QUIZ QUESTIONS

**Kahoot! quiz available online (questions shortened to meet Kahoot! character limits):
https://create.kahoot.it/share/resilience-jenga/ef2eefe3-2479-459c-ba94-9641ec6ee4eb

**Bold indicates correct answer

1. Under which scenario do you try to maximize your yield, but the current policies in place limit your actions to an area that will only degrade your social-ecological system?
    a. Policy to maximize return and minimize trade-offs scenario
    b. **Obstructive policy scenario**
    c. Resilience policy scenario
    d. Little knowledge of the system scenario

2. What does the Jenga tower itself represent in Resilience Jenga?
    a. Yield value
    b. **The ecosystem**
    c. Harvestable units
    d. Resource policy

3. In which scenario do you attempt to harvest the most yield, but a lack of knowledge of the system creates policy constraints and limits your ability to manage the system?
    a. Resilience policy scenario
    b. Maximize harvest scenario
    c. **Little knowledge of the system scenario**
    d. Obstructive policy scenario

4. The resource manager focuses solely on maximizing yield in this scenario:
    a. **Maximize harvest scenario**
    b. Resilience scenario
    c. Obstructive policy scenario
    d. None of the above

5. The numbers located on the Jenga blocks represent:
    a. **Yield value**
    b. Resilience value
    c. Resource type
    d. Ecosystem services

6. The policy in this scenario is to avoid collapse of the Jenga tower while harvesting as many blocks as you can:

    a. **Resilience scenario**
    b. Obstructive policy
    c. Little knowledge of the system
    d. None of the above

7. Name That Concept: The ability of a system to absorb some disturbance while retaining its structure and function.

    a. Adaptive Cycle
    b. Disturbance theory
    c. **Ecological resilience**
    d. Photosynthesis

8. Name That Concept: the spatial or temporal dimension of natural phenomena which provides context for observations and measurement of objects, time, and processes.

    a. Ecological resilience
    b. Time
    c. Heterogeneity
    d. **Scale**

9. Name That Concept: Variability or complexity at temporal and spatial scales, often in the context of landscapes.

    a. Grain
    b. **Heterogeneity**
    c. Extent
    d. Photosynthesis

STUDENT HANDOUTS

Obstructive Policy Scenario

Objective: Harvest the most yield, but policy and management constraints limit your actions to an area that can make the problem worse – not better

Roles:

- Harvest recorder (1 player)

- Harvesters (all players including harvest recorder)

Game Components:

- Jenga tower = ecosystem

- Blocks = harvestable units

- Block numbers = yield value

- Students = resource users

Directions:

1. Set up the jenga tower.
2. One player at a time pulls 1 jenga block from the bottom 4 rows of the tower. Move on to next player. Rotate clockwise.
3. Harvest recorder – record (i) the number of blocks removed from the tower and (ii) the value of each block.
4. After the tower collapses make sure that the number of jenga blocks harvested and the value of each block is recorded for the group.

Group Tasks:

1. *Based on Holling's resilience, calculate the resilience of your policy scenario.*
2. *Calculate the yield of your policy scenario.*
3. *Describe management policies or incentives that align with your policy scenario.*

Policy with Little Knowledge of the System

Objective: Harvest the most yield, but lack of knowledge of the system resulted in policy constraints that limit actions to randomly-generated resource harvest

Roles:

- Harvest recorder (1 player)

- Random number generator (1 player)

- Harvesters (all players including harvest recorder and number generator)

Game Components:

- Jenga tower = ecosystem

- Blocks = harvestable units

- Block numbers = yield value

- Students = resource users

Directions:

1. Set up the jenga tower.
2. Random number generator – Google random number generator. This will be used to assign each player a new random number (1-9) for every turn.
3. One player at a time pull 1 jenga block with the randomly assigned number. Rotate clockwise.
4. Harvest recorder – record the number of blocks removed from the tower and the value of each block.
5. After the tower collapses make sure that the number of jenga blocks harvested and the value of each block is recorded for the group.

Group Tasks:

1. *Based on Holling's resilience, calculate the resilience of your policy scenario.*
2. *Calculate the yield of your policy scenario.*
3. *Describe management policies or incentives that align with your policy scenario.*

Policy to Maximize Harvest

Objective: Maximize yield and harvest efficiency

Roles:

- Harvest recorder (1 player)

- Harvesters (all players including harvest recorder)

Game Components:

- Jenga tower = Great Plains Ecosystem

- Blocks = harvestable units

- Block numbers = yield value

- Students = resource users

Directions:

1. Set up jenga tower.
2. One player at a time harvest the highest valued jenga block from the tower. Move on to the next player. Rotate clockwise.
3. Note: the highest valued blocks must be harvested before harvesting lower valued blocks, even if it causes the collapse of the tower.
4. Harvest recorder – record the number of blocks removed from the tower and the value of each block.
5. After the tower collapses make sure that the number of jenga blocks harvested and the value of each block is recorded for the group.

Group Tasks:

1. *Based on Holling's resilience, calculate the resilience of your policy scenario.*
2. *Calculate the yield of your policy scenario.*
3. *Describe management policies or incentives that align with your policy scenario.*

Policy to Maximize Return While Minimizing Trade-Offs

Objective: Maximize yield and harvest efficiency, while minimizing loss of tower integrity and collapse

Roles:

- Harvest recorder (1 player)

- Harvesters (all players including harvest recorder)

Game Components:

- Jenga tower = Great Plains Ecosystem

- Blocks = harvestable units

- Block numbers = yield value

- Students = resource users

Directions:

1. Set up the jenga tower.
2. One player at a time harvest the most high-yielding blocks while deciding which blocks to leave to maintain tower integrity and prevent collapse. Move on to the next player. Rotate clockwise.
3. Harvest recorder – record the number of blocks removed from the tower and the value of each block.
4. After the tower collapses make sure that the number of jenga blocks harvested and the value of each block is recorded for the group.

Group Tasks:

1. *Based on Holling's resilience, calculate the resilience of your policy scenario.*
2. *Calculate the yield of your policy scenario.*
3. *Describe management policies or incentives that align with your policy scenario.*

Resilience Policy for Working Lands

Objective: Avoid collapse while harvesting as many blocks as possible

Roles:

- Harvest recorder (1 player)

- Harvesters (all players including harvest recorder)

Game Components:

- Jenga tower = Great Plains Ecosystem

- Blocks = harvestable units

- Block numbers = yield value

- Students = resource users

Directions:

1. Set up the jenga tower.

2. One player at a time, harvest a single block from the tower in a manner that maximizes tower integrity, regardless of the value of the block. Move on to the next player. Rotate clockwise.

3. The next player harvests a single block from a row that is NOT within 2 rows of the block harvested in the previous players turn, if possible. This rule is no longer in use when the tower becomes too small.

4. Harvest recorder – record the number of blocks removed from the tower and the value of each block.

Group Tasks:

1. *Based on Holling's resilience, calculate the resilience of your policy scenario.*
2. *Calculate the yield of your policy scenario.*
3. *Describe management policies or incentives that align with your policy scenario.*

Scoring Sheet

Scenario name: _____

Round number: _____

Block	Value	Block	Value	Block	Value	Block	Value
1		16		31		46	
2		17		32		47	
3		18		33		48	
4		19		34		49	
5		20		35		50	
6		21		36		51	
7		22		37		52	
8		23		38		53	
9		24		39		54	
10		25		40		55	
11		26		41		56	
12		27		42		57	
13		28		43		58	
14		29		44		59	
15		30		45		60	

Calculate:

1. Total yield (unit yield = value of each block)

= _____

2. Number of harvested units (blocks) before collapse

= _____

Notes:

Take Home Essay Questions

1. Imagine you are the lead manager of a greenhouse tasked with growing produce for the summer, how would you manage for yield versus ecological resilience? In your answer, identify management practices that would be the same for yield and resilience and practices that would be specific to yield or resilience.

2. Now, imagine that you are the lead manager of the Valentine National Wildlife Refuge Complex (72,000 acres) in the Nebraska Sandhills, tasked with managing wildlife for the next 50 years. How would you manage for yield and ecological resilience? In your answer, identify management practices that would be the same for yield and resilience and practices that would be specific to yield or resilience.