The Sandville Wind Project: A Case Study for Teaching the Adaptive Cycle

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Summary
This case study introduces the adaptive cycle, an important concept in ecological resilience theory. The adaptive cycle demonstrates how change occurs in a wide range of complex systems, from ecosystems to economies. To teach the adaptive cycle, we use a role-playing scenario based on a fictional small town that is preparing to debate a new wind energy development project at a town hall meeting. In Part 1, students receive basic background information and learn how to create concept maps. In Part 2, students use assigned stakeholder roles to develop their stakeholder's perspective on the wind development issue. Part 3 sees the town hall debate play out as students use the perspectives they have developed to argue whether or not the town hall should proceed. Part 4 concludes the case study as the students reflect on the town hall and analyze their experience in the context of the adaptive cycle. This case study is designed to be flexible for different class lengths and takes approximately 4 hours to complete, with optional modifications available.

Relevant Topic Areas
Ecology, Environmental Science, Policy, Resilience, Socio-ecological Systems

Education Level
Upper level undergraduate students

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Learning Objectives
1. Describe the four phases of the adaptive cycle
2. Explain the basic definition of resilience
3. Relate the concept of resilience to the adaptive cycle
4. Recognize the limits of the adaptive cycle
5. Assess the importance of interdisciplinarity to the concepts of resilience and the adaptive cycle when dealing with complex, real-world problems
6. Analyze perspectives and work with other students to draw conclusions

7. Compare the strengths and limitations of each phase of the adaptive cycle as applied to human systems

Background

In this case study, students will explore the concept of the **adaptive cycle** through the eyes of a small town facing a tough decision. The adaptive cycle is a model used to depict the processes of complex **systems** and evaluate their **ecological resilience**. More resilient systems are able to withstand change or **disturbance** without losing their basic form and function. The adaptive cycle depicts how these systems follow a continual pattern of growth and change, reacting to these disturbances through four distinct phases: 1) exploitation or growth (**r**), 2) conservation (**K**), 3) release or collapse (**Ω**), and 4) reorganization (**α**). Originally conceived within the field of ecology, it has been applied to other non-biological complex systems including economies and societies.

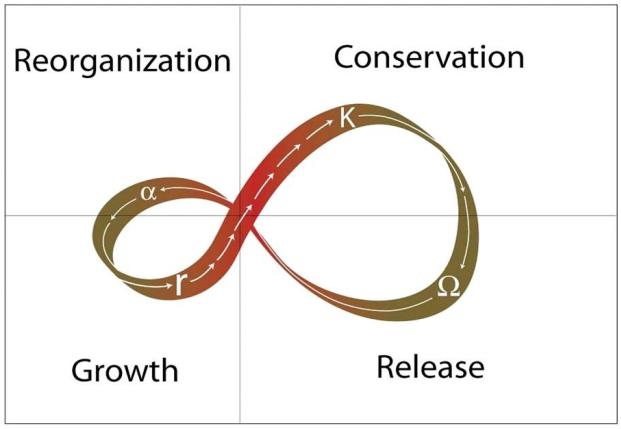


Fig. 1. The Adaptive Cycle. Courtesy A. Garmestani, US EPA.

"**r**" (**exploitation** or growth)

The **r** phase illustrates the initial growth of a system after reorganization. As the system accumulates resources, stability is increased. Connections between system parts begin to form, as the early actors in the system are free to branch out and exploit opportunities. Picture a forest that has been destroyed due to fire. Upon the seemingly barren landscape, new species have the opportunity to colonize and take advantage of the created niche. These pioneer species (in this scenario possibly grasses, annual plants, and eventually perennials and shrubs) are known as r-strategists, and they are able to endure in the face of uncertainty over their shorter lifespans. Over time, as resources are exploited to a fuller extent and more connections are made between actors, the flexibility of the system decreases and the system's structure increases in complexity. The system transitions into the **K** phase, or the conservation phase.

"**K**" (**conservation**)

The **K** phase is characterized by slow growth, higher connectivity, and relative stability of the system. Though the system persists, the individuals within the system may change over time. In our example of a fire-disturbed forest, perennial plants and shrubs would give way to mature trees over decades. These dominant species are known as K-strategists; these organisms typically have longer life spans, produce fewer offspring, and are better suited for stable environments. While the system is in the conservation phase, resources are not as readily available for transfer between actors. Instead, they are stored for longer periods of time in the components of the system, whether it be organisms or economic entities like large corporations or banks. As connectivity increases, the connections formed between actors become more rigid and dependent upon each other. The system becomes less resilient, and therefore more susceptible to disturbance in unfamiliar conditions.

"**Ω"** (release or **collapse)**

When disturbance is enough to overcome the resilience of the system, it collapses. This collapse can be swift - often small disturbance is enough to bring down a highly vulnerable system. Resources are released, connections are broken, and structure is lost. In a forest ecosystem, disturbance can take many forms - invasive insects, diseases, fire. As the particular disturbance begins to sow destruction, energy, biomass, and nutrients are released from the components states more easily exploited by new actors.

"α" (reorganization)

The reorganization phase is an opportunity for innovation. Resources are prime for the taking; once again, r-strategists are well-equipped to grab a foothold in the collapsed system. Actors can be familiar components attempting to recolonize their previous domain, or completely novel agents looking to invade a new system. Anything is possible. After our forest has collapsed, perhaps new species of plants are distributed and begin to compete for the newly available resources. Seeds of the original pioneer species may also reclaim their prior establishments. With the lack of rigidity that characterized the conservation phase, there are countless paths forward the system can proceed with. Over time, certain actors will prove to be the most effective colonizers, and the system will return to the growth phase.

Introduction to the Problem

Students will explore the concept of the adaptive cycle through the eyes of stakeholders from a fictional small town in the Sandhills of Nebraska, called "Sandville." Platted in the 1880s, the town has experienced a rich history full of ups and downs. Over time residents came to expect a certain lifestyle: friendly, familiar neighbors; a decent public education for their children; a way of life earned through hard work that provided for everyone's needs comfortably; and perhaps most importantly, a thriving community. Sandville was and still is economically driven by food production, as family farms and ranches make up the bulk of the local industry. Since the end of

the second world war, however, the town has experienced the same trend as the rest of the country - younger residents have left to bigger towns for college, and the number coming back home steadily decreased. Meanwhile, property taxes are high and the economic outlook uncertain.

A new economic opportunity has been the talk of the town for the past few months. A wind energy developer has been looking at land on the outskirts of Sandville city limits as a potential site for a new wind energy farm. Resident opinions are split. Some of the farmers, the local environmental advocates, and the chamber of commerce all think the proposed wind farm would be a great way to revitalize Sandville. Other landowners and biologists from the local university have reservations about the consequences of reorganizing the town's social and environmental structure to incorporate this new element. The County Board has scheduled a town hall meeting to understand citizens' positions on the issue. For this case study, students will develop their stakeholder's position on the wind farm proposal, culminating in a defense of their perspective at the town hall meeting.

Anticipated Classroom Management:

Estimated Completion Time: ~4 hours

Class Time Management Chart

Section	**Estimated Completion Time**
Part 1: R Phase	70 minutes
Part 2: K Phase	40 minutes
Part 3: Omega Phase	50 minutes
Part 4: Alpha Phase	40 minutes

Part 1: The "R" Phase: Organization
Estimated Total Completion Time: ~ 70 minutes

Objectives
Upon completion of Part 1 of the case study, the students should have:

- ✓ Learned basic information about the adaptive cycle.
- ✓ Learned about concept maps and how to create them.
- ✓ Received general background information on the case study scenario.

- ✓ Received their first assignment: Students are given their stakeholder roles and must think about their stakeholder's perspective on the issue in the case study scenario.

Needed Materials

- ✓ Student Handout 1
- ✓ Large paper pad, easel, and sticky notes, or whiteboards
- ✓ Writing supplies
- ✓ Student Handout 2 (one or multiple copies of each version, depending on class size)

Procedure

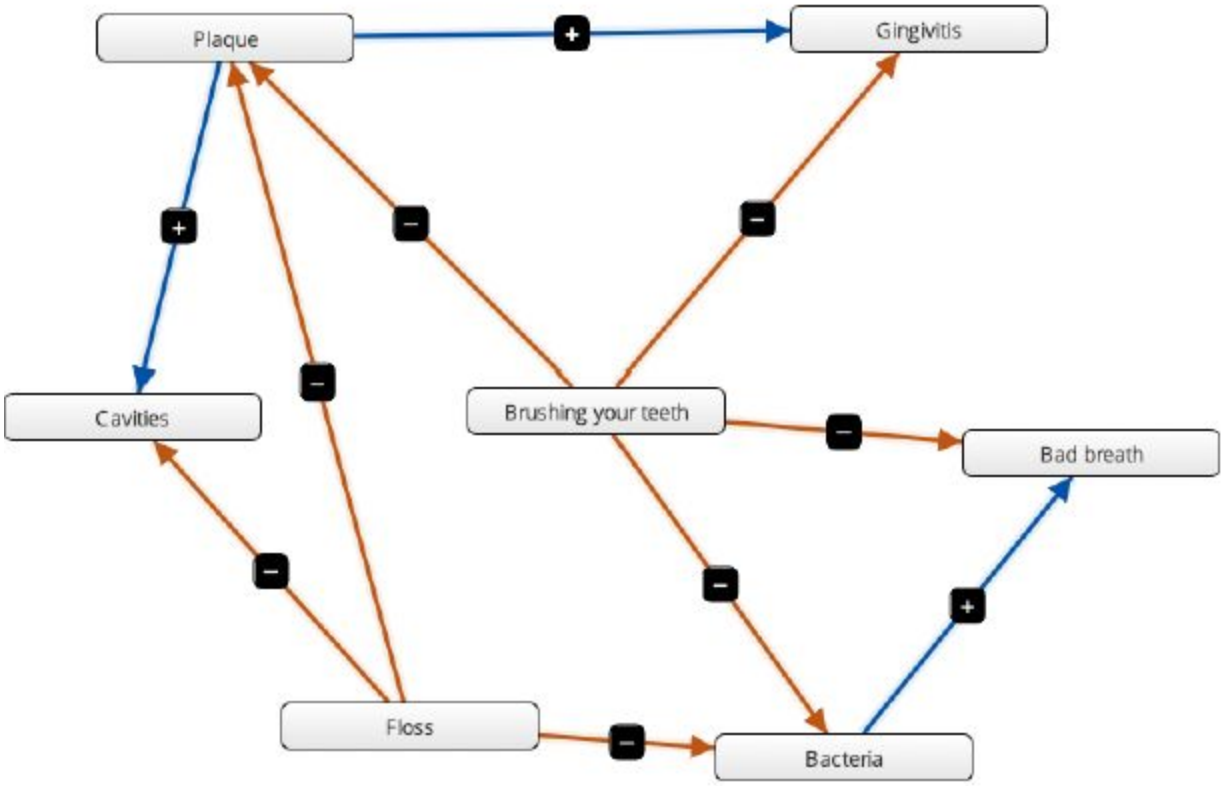
Step 1: Give the students Student Handout 1, which includes background on the adaptive cycle. You can either assign this before class begins as preparation homework or provide the handout at the beginning of class. Estimated completion time: 15 minutes.

Step 2: Go through the adaptive cycle section of Student Handout 1 with the students and point out the key concepts of the adaptive cycle, including the "r" phase, "k" phase, "omega" phase, and "alpha" phase. Estimated completion time: 15 minutes.

> *Note: Student Handout 1 is anticipated to be sufficient for this step, but if you believe further additional information would be beneficial (or you receive lots of questions), consider using the free adaptive cycle online module, available on the University of Nebraska-Lincoln's Plant and Soil Sciences eLibrary (PASSEL) website: https://passel2.unl.edu/view/lesson/b4790b02d93e.

Step 3: Give the students Student Handout 2, which introduces **concept mapping** (CM) and how it can be used to trace relationships among multiple interacting components in a system (for example, stakeholders). Provide the students time to read through the CM section of Student Handout 2. Estimated completion time: 10 minutes.

Step 4: Break the students out into groups and hand out the easel and paper or whiteboard supplies to each group. Using the supplies, students will create a practice concept map using the example in the "Practicing Concept Mapping" section of Student Handout 2. The students' concept maps should ultimately look similar to this:



Modification: Provide students with a copy of the example concept map to use as they develop their own concept maps.

Estimated completion time: 15 minutes.

Step 5: Distribute Student Handout 3 and Student Handout 4. Student Handout 3 contains general information about the Sandville case study scenario and should be provided to all students. Student Handout 4 provides information about the particular stakeholder each student will be roleplaying. It is envisioned that students will be formed into groups, with each group roleplaying a particular stakeholder, but if there are few students one student may represent one particular stakeholder. Feel free to assign students to a particular stakeholder however you wish. Some suggestions:

- ✓ Assign each stakeholder a number, then count off students (or draw from a hat)
- ✓ Allow students to pick a stakeholder that sounds most interesting to them

Estimated completion time: 5 minutes.

Step 6: Assign students to read through their stakeholder roles and think about their particular stakeholder's perspective to prepare for a concept mapping exercise next class with the rest of their group. Estimated completion time: 10 minutes.

Modification: Assign students to bring 2-3 articles or other sources of information about a similar stakeholder in the real world.
Modification: For longer class periods, have the students spend some time (15-20 minutes) looking up information about a parallel real-life stakeholder and thinking about what their perspective would be on the Sandville scenario. This would serve as a break between Parts 1 and 2.

Part 2: The "K" Phase: Establishing the Status Quo
Estimated Total Completion Time: ~40 minutes

Objectives
Upon completion of Part 2 of the case study, the students should have:

- ✓ Discussed in their stakeholder groups the ideas they generated on their stakeholder's perspective on the Sandville wind development project.
- ✓ Created a concept map of their stakeholder's perspective on the Sandville wind development project.
- ✓ Prepared arguments to advocate their perspective and anticipated counter-arguments from other stakeholder groups.

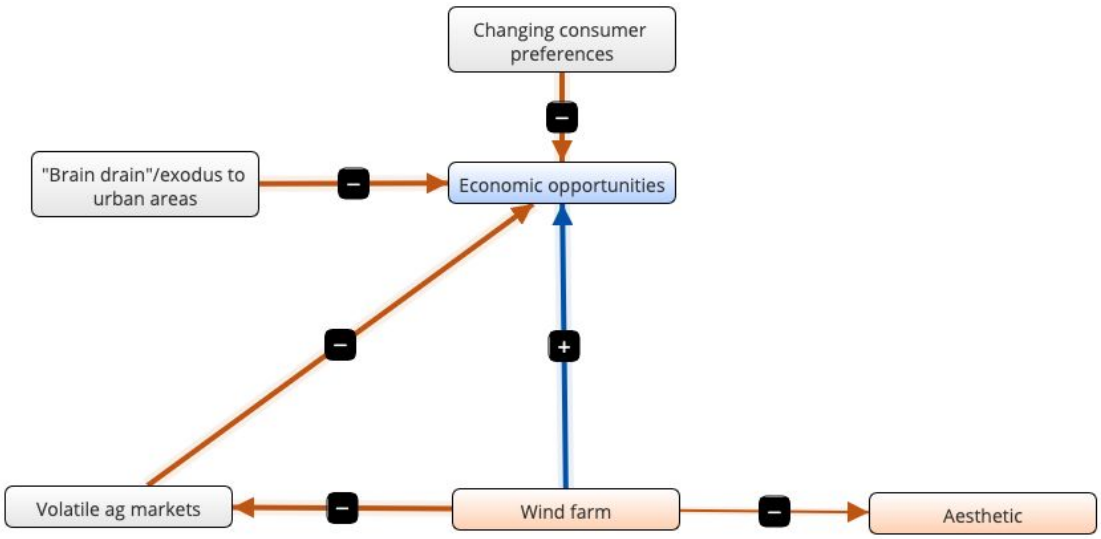
Needed Materials

- ✓ Student Handouts from Part 1
- ✓ Large paper pad, easel, and sticky notes, or whiteboards
- ✓ Writing supplies

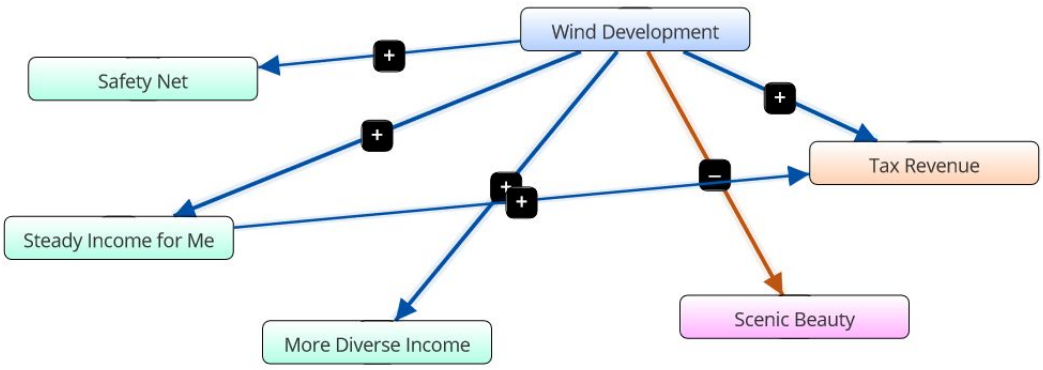
Procedure
Step 1: Have the students gather into their stakeholder groups and discuss what their stakeholder's perspective on the Sandville wind development will look like. Estimated completion time: 6 minutes.

Step 2: Using the easel or whiteboard writing supplies, each group should create a concept map of their stakeholder's perspective. The concept map should include the anticipated direct and indirect impacts of the wind project as they relate to the stakeholder, either positively or negatively. Depending on their particular stakeholder, student concept maps should look similar to the following:

Example 1:



Example 2:



Estimated completion time: 20 minutes.

Step 3: Have the students use their discussions and stakeholder concept map to list the positions of other stakeholders and what their arguments are likely to be. Estimated completion time: 7 minutes.

Step 4: Using the list from Step 3, the students should next develop counter-arguments in favor of their desired outcome (pro- or anti-wind development) in anticipation of the town hall meeting of Part 3. Estimated completion time: 7 minutes.

Part 3: The "Omega" Phase: Stakeholders Collide
Estimated Total Completion Time: 50 minutes

Objectives
Upon completion of Part 3 of the case study, the students should have:

- Presented arguments of their stakeholder's perspective in front of the County Board
- Delivered arguments for and against other stakeholder's propositions and defended their own stakeholder's perspective
- Adapted their perspective in light of other viewpoints and criticisms

Needed Materials

- ✓ Student Handouts from Part 1
- ✓ Student Handout 3
- ✓ Writing supplies

Procedure
Step 1: Each stakeholder group will elect one member to represent their group at a town hall meeting. Stakeholder representatives will prepare a two-minute speech on their group's position using the prepared arguments from step 4 of part 2. Estimated completion time: 7 minutes.

Step 2: Designate a non-student entity to play the role of the County Board (TA or professor). Have the class consolidate into an arrangement where a "town hall" discussion can be held, presided over by the County Board. The County Board will call on the stakeholder representatives to take turns giving their two-minute speeches on their group's position on the proposed wind farm development. As each speaker presents, the rest of the class will mark down pros and cons of each stakeholder perspective on Student Handout 3. Estimated completion time: 13 minutes

Step 3: The County Board will open up the floor to group discussion of each stakeholder argument, taking care to make sure the discussion stays on track. All students are encouraged to share their thoughts on what they agree and disagree with from each stakeholder perspective. Estimated completion time: 20 minutes.

Step 4: Students will return to their stakeholder groups and discuss how their group's position could be modified in light of criticisms from other groups, as well as other positive ideas shared from other stakeholders. Estimated completion time: 10 minutes.

Part 4: The "Alpha" Phase: Reorganization and Debrief
Estimated Total Completion Time: 40 minutes

Objectives
Upon completion of Part 4 of the case study, the students should have:

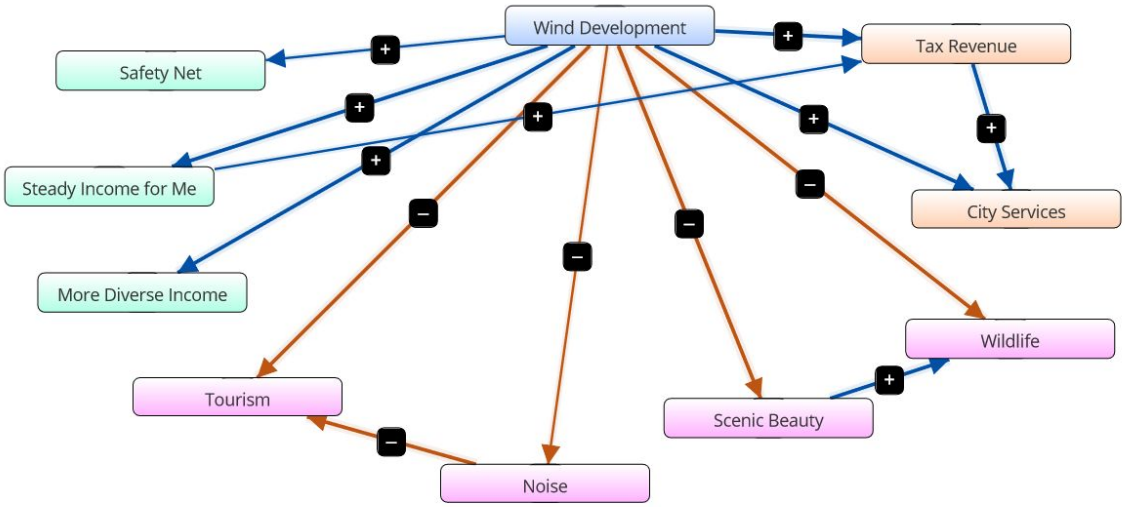
- Created new concept maps incorporating elements of other stakeholder perspectives they found important or significant to address in order to proceed
- Discussed the relationships of all the stakeholders to assess if there are any strong relationships or alliances that formed based on their stakeholder perspective
- Discussed the outcomes as a class and discuss how they arrived at the outcome
    - May differ among different stakeholder groups
- Linked the experience to the adaptive cycle, both in the specific scenario as well as what the students themselves experienced as they received their stakeholder assignments, developed arguments, played those arguments out, then came back together again to re-evaluate

Needed Materials

- ✓ Student Handouts from Part 1
- ✓ Writing supplies
- ✓ Whiteboard

Procedure
Step 1: Students will come back together to create a concept map incorporating other stakeholders' point of view. Each stakeholder group should summarize the changes made to their concept maps and elect one member to represent their group in step 2 (below). Concept maps are expected to look like the following:

Example 1



Estimated completion time: 10 minutes.

Step 2: Discuss the outcome of the town hall meeting and mention any strong relationships that were developed during the exercise. For example, if the pro-wind development stakeholders teamed up to make their opinions heard and persuade the other stakeholders or vice-versa for the anti-wind development groups. The instructor should write down commonalities and anything that stands out. The class can then talk about how their group overcame disagreement and differences in opinion. In addition, have each group provide top arguments for their stance on the wind development project (e.g., political, environmental, economics, agriculture, etc). Estimated completion time: 20 minutes.

Possible discussion questions:

- What are some examples of cooperation and competition from the town hall meeting?
- Did any innovation occur as a result of the town hall meeting?
- How do you think the outcomes of the town hall meeting will influence Sandville in the short-, mid-, and long-term?
- What might future phases of the adaptive cycle look like in Sandville? I.e., what might cause subsequent exploitation, conservation, collapse, and reorganization phases?

Step 3: Have the class identify the “reorganization” of the stakeholders’ disagreements and agreements from the town hall meeting. For the final part of the case study, demonstrate to the class how they themselves have gone through the four phases of the adaptive cycle in the course of this case study:

- Part 1: the “r” or initial growth phase: students learned the background material and began to organize information and develop a stakeholder perspective.

- Part 2: the “k” or conservation phase: students solidified their perspective and prepared to defend it against possible counterarguments.
- Part 3: the “Ω” or collapse phase: stakeholder perspectives collided and students were forced to consider costs and benefits to the wind development project they did not need to factor in before.
- Part 4: the “α” or reorganization phase: students reevaluated their perspective, including costs, benefits, and connections to other stakeholders, and assessed how they could proceed forward as a town.

Step 4: Ask the students to provide examples of where the adaptive cycle can be found in the real world. Explore with the students which phase of the adaptive cycle each example is presently in and what the other phases might look like. Students may provide examples from a number of different disciplines, including ecology, political science, business, medicine, and more. Estimated completion time: 20 minutes.

Glossary

Adaptive Cycle: The interactions among the biotic and abiotic elements of a system within a single scale, including elements’ organization, growth, and decay.

Concept map: A method for organizing and demonstrating relationships of components in a system.

Conservation: A phase of the adaptive cycle characterized by stable, rigid structures and processes that conserve energy and often emphasize production (“K” phase).

Ecological Resilience: The capacity of an ecosystem to withstand **perturbation/disturbances** without altering established processes, functions, and structures. This concept can be applied to other systems such as economies, governments, or companies, despite the term “ecological”.

Exploitation: A phase of the adaptive cycle characterized by rapid accumulation of resources and a new trajectory of a system (“r” phase).

Perturbation (or Disturbance): An event or input to a system that causes a loss of the system’s capital. It may cause a **regime shift**. For example, wildfire in a forest, ocean acidification and coral reefs, woody encroachment in a grassland.

Release: A phase of the adaptive cycle which follows some kind of disturbance to the system, and is characterized by a collapse of system structure and process (“Ω” phase).

Reorganization: A phase of the adaptive cycle characterized by recombination of system components to create similar or novel structures and processes (“α” phase).

System: A whole made up of interacting components.

Zoning: A form of land use regulation where a city or county government restricts what a particular parcel of land can be used for, such as residential, agriculture, or industrial purposes.

Suggested Readings/References

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Appendix I

Optional change to the "Mayor" character

If you wish to add another layer of complexity to the case study, another stakeholder identity - the mayor of Sandville - may be assigned to a single student. Background information about this stakeholder is included in Student Handout #3. Unlike other stakeholders, the mayor does not initially have a stance on the issue of wind farm development in town. Instead, they are mainly

concerned with getting reelected in the upcoming election. In order to accomplish this goal, the mayor needs to swiftly guide their town through the wind farm conflict. Modifications to the case study proceedings are as follows:

Part 1
No major changes are necessary. The student assigned the role of mayor will create a concept map along with the other students.

Part 2
The mayor will develop a concept map on the potential impacts of adopting or declining the wind farm development plan from the perspective of the entire town. Their map should incorporate elements from multiple different stakeholder groups (they may choose to talk to the stakeholder groups during this time in order to gain more information).

Part 3
At the town hall meeting, the mayor will act as moderator. They can choose to offer an opening statement, or proceed directly to calling on stakeholder representatives to share their prepared arguments. If time permits, the mayor can also ask questions to the stakeholder groups in order to facilitate discussion and compromise. Remember, the mayor iis not particularly invested in the outcome as long as it is one that strengthens the community and boosts support for reelection.

Part 4
No major changes are needed for part four. The mayor will participate in the discussion along with the rest of the class, offering their holistic perspective as someone who has communicated with multiple different stakeholder groups.