Principles of Sustainability in Ecosystems
The Strongest Tree

Overview
This activity is centered on a very short story about the Strongest Tree written by Gunter Pauli. While very simple on first read, the story has been carefully designed by top scientists to contain a wealth of information on the kingdoms of nature and fundamental systems relationships in ecosystems.

Topics
- Ecological design and biomimicry
- Systems principles: closed loop systems, feedback, interdependence
- Ecosystem principles: waste=food, kingdoms of nature and their interrelationships

Big Ideas
- An ecosystem is a prime example of a sustainable system, one that has been operating sustainably for billions of years.
- Ecosystems recycle energy and materials in an ongoing fashion.
- The principle of "waste=food" is what enables an ecosystem to be sustainable.
- The principle of waste=food is an important teaching that the ecosystem gives us for how humans can design sustainable systems in the future.

Contexts for use
- <u>Grade level</u>: adaptable for grades 4-12
- <u>DoRight Leadership Corps curriculum and project</u>
  Training segment prior to project phase.
  This lesson should follow Silent Squares and precede Industrial Agriculture in a longer module that generates the concepts of Biomimicry and Ecological Design as solutions to the industrial agriculture problem.

Objectives
- <u>Activity/Strategic</u>
  This activity establishes the principle of feedback of energy and materials in sustainable systems, waste=food. This principle is used to generate the concept of biomimicry when the ecosystem is compared to the industrial agriculture system.
- <u>Student learning</u>
  - Understanding of the big ideas listed above.
  - Reinforcement of systems concepts from Silent Squares
  - Introductory understanding of topics listed.

Preparation: Prerequisites and Materials
- Conduct the Silent Squares activity prior
- Story handout for students: The Strongest Tree
- Drawing paper and colored pencils or crayons

Activity Script
This process involves ongoing inquiry where students and teacher jointly create a concept map of the story and explore relationships.

1. Following the Silent Squares debrief, the next step is to examine in more detail one of the systems from the brainstorm list that the students created. Tell students we will first choose the ecosystem, and explain that one great way to understand it is through the story of the Strongest Tree.

2. Read the story to the students. I would suggest NOT having them read along on their text. Let them just absorb it. Without reading they are free to more vividly generate the images of the story in their minds.

3. After reading the story explain that there was so much information there it would be good to make a picture of it so we can see what is happening. We are most interested in the relationships so we will make a **concept map** as opposed to a picture of the scene. A concept map used names and lines as connectors to show relationships. To begin, have students verbally recall the characters of the story. They need to walk through it in their minds, and they can use the text at this point (though it can be very useful NOT to use the text at all. This forces them to think and discuss more.) Tell them they will create the concept map with you, so have them place the word tree in the center, and as the students recall the characters, list them in an oval around the word "tree" (see fig. 1). **Explain to students that we will create a concept map by drawing lines between characters that depend on each other or interact with each other.**

4. Inquiry:
Q: Does the tree depend on all these characters? <yes, draw lines from tree to all (fig 2)>
Q: Now, give me an example of two characters that depend on each other? <variable, connect them>
After connecting a variety of characters, make a statement: "you know, we could keep doing this for some time. Actually, if we kept doing it eventually we would see that all the characters depend on each other, and everything would be connected! So go ahead now and connect every character (fig 3).

5. Debrief—develop the concept that the ecosystem has zero waste; waste=food
A key strategy here is to get them to discover the difference between the whole system and the individual parts. The individual parts have waste, but the SYSTEM as a WHOLE has no waste.
Q: Where do you see waste here? (Don't use the word "system" yet. Save that for the next question.
 <Variable answers, some will point out the leaves, bird droppings, etc. Some may make the leap that there is no waste>
Q: Ok, this absolutely true. Each of these characters has its own waste. **But now take a look at our diagram as a whole system. Does the whole system create waste?**
<leave some hang time and discussion here, many students will recognize that when viewed this way, there is in fact no waste "left over.">
Q: So this is a curious thing. There is individual waste, but not for the system as a whole. What happens to the individual wastes we have identified earlier?
<They get used by something else. Lead to the conclusion that waste=food, or, one man's trash is another man's treasure, etc. Then **establish that the ecosystem is a "sustainable" system that has been going for billions of years, largely because it uses the principle of waste=food, a key principle of sustainability.**>
Move on to explore more ways that this sustainable ecosystem demonstrates principles required for systems to be sustainable:
Q: Does this system operate by the systems principles we discovered in Silent Squares? If so, how?
<Yes—go through the various points on the silent squares systems list>
Q: What would happen if one of the characters decided not to play, and left the system? What would happen if one of the characters did not have enough to do its job? What would happen in one of the players got greedy and took too much? (Continue querying about the Silent Squares principles).
<Discuss these points as examples of how the Silent Squares principles are in fact principles for sustainable systems.>