



2017

## Big World, Small Planet – Module 1: Getting Started with Sustainability, Teacher Edition

Facing the Future, Western Washington University

Follow this and additional works at: [https://cedar.wvu.edu/ftf\\_allpublications](https://cedar.wvu.edu/ftf_allpublications)



Part of the [Curriculum and Instruction Commons](#)

---

### Recommended Citation

Facing the Future, Western Washington University, "Big World, Small Planet – Module 1: Getting Started with Sustainability, Teacher Edition" (2017). *Facing the Future Publications*. 8.  
[https://cedar.wvu.edu/ftf\\_allpublications/8](https://cedar.wvu.edu/ftf_allpublications/8)

This Curriculum is brought to you for free and open access by the Facing the Future Curriculum at Western CEDAR. It has been accepted for inclusion in Facing the Future Publications by an authorized administrator of Western CEDAR. For more information, please contact [westerncedar@wwu.edu](mailto:westerncedar@wwu.edu).



Facing  
the Future

An icon of an open book with a green plant growing from the right side, symbolizing growth and learning.

# BIG WORLD, SMALL PLANET

## Module 1: Getting Started with Sustainability Teacher Edition



*A comprehensive guide to global  
issues and sustainable solutions*



# BIG WORLD, SMALL PLANET

*A Comprehensive Guide to Global Issues  
and Sustainable Solutions*

**Teacher Edition**

Facing   
the Future

# BIG WORLD, SMALL PLANET

**Module 1:** Getting Started with Sustainability  
Teacher Edition

**Copyright © 2017 Western Washington University**

Commercial reproduction of Facing the Future materials is prohibited without prior written permission.

ISBN 978-1-940829-14-2

Printed in the United States of America

10 9 8 7 6 5 4 3 2

## About Facing the Future

Facing the Future is a program of Western Washington University. Facing the Future's mission is to create tools for educators that equip and motivate students to develop critical thinking skills, build global awareness, and engage in positive solutions for a sustainable future.

Facing the Future develops and delivers standards-based hands-on lessons, student texts, curriculum units, and professional development opportunities for educators. Facing the Future curriculum is in use in all 50 U.S. states and over 140 countries by teachers and students in grades K-12, in post-secondary education, and across multiple subject areas. Facing the Future reaches over 1.5 million students through its programming.

For more information, visit [www.facingthefuture.org](http://www.facingthefuture.org).



### The Facing the Future Program

Western Washington University

516 High Street, MS-9102

Bellingham, WA 98225

[www.facingthefuture.org](http://www.facingthefuture.org)

# Table of Contents

---

Note to Teachers .....	iii
Proposed Unit Schedule .....	iv
Academic Standards.....	vi

## **Unit 1** Introduction to Sustainability

We're All Connected .....	2
What Is Sustainability.....	5
Sustainability as a Worldview.....	11
Changing Worldviews .....	15
The Anthropocene Period .....	16
The Big Ideas of Sustainability.....	19

## **Unit 2** Tools for Engaging with Sustainability Issues

Systems Thinking .....	29
Thinking Critically.....	64
How Systems Thinking and Critical Thinking Contribute to a Sustainability Worldview.....	52

## **Activities**

Activity 1: What is Sustainability?.....	55
Activity 2: Set Up Nature Journal.....	56
Activity 3: Nature Journal.....	58
Activity 4: My Place .....	60
Activity 5: Sustainability in My Place .....	62
Activity 6: Sustainability and My Values.....	64
Activity 7: Human and Nature Timeline .....	66
Activity 8: Local Sustainability Case Study, Part 1.....	67
Activity 9: Creating the Future We Want.....	69

# Table of Contents

---

## **Activities** *continued*

Activity 10: Introduction to Sustainability Reflection, Self-Assessment, and Commitments.....	<b>71</b>
Activity 11: Systems All Around Us.....	<b>73</b>
Activity 12: Feedback in Systems.....	<b>74</b>
Activity 13: Stock and Flow Diagrams.....	<b>75</b>
Activity 14: Local Sustainability Case Study, Part 2 Using Systems Thinking.....	<b>76</b>
Activity 15: System on the Move .....	<b>79</b>
Activity 16: Local Sustainability Case Study, Part 3 Critical Thinking.....	<b>80</b>
Activity 17: Local Sustainability Case Study, Part 4 Project Wrap-up and Debrief.....	<b>82</b>
Activity 18: Tool for Engaging with Sustainability Issues: Reflection, Self-Assessment, and Commitments.....	<b>84</b>



## To the Teacher

Here are a few comments about getting started with the Activity Guide.

1. **Teacher Edition Contents:** Some material is provided only in the Teacher Edition. In addition, the Teacher Edition also includes work papers to be copied and handed out to students when needed.

2. **Reading Assignments:** Activities note which pages should be read to prepare for that particular assignment. The unit schedule notes the pages that are required pre-reading for the activity to be done each day. It also lists recommended reading for each day of a 20-day unit. This recommended reading schedule spreads the reading over the 20-day unit and will have students prepared for each day's activities.

3. **Field Books:** In the Field Books, students will record their work during the unit; write reflections on class activities; and describe daily observations of wild nature, using both sketches and text.

The Field Books can be created using binders, 8-1/2" by 11" composition books, spiral-bound notebooks, or stacks of paper held together with brads or binder clips. Students will need to add pages from time to time; if you use bound or spiral notebooks, students will need tape or glue pages into their Field Book occasionally.

4. **Field Book Reflections and Discussion Questions:** Daily activities have Discussion Question and Field Book sections at the end. Discussion questions relate to the classwork. Field Book instructions include prompts for

nature journaling, references to Think About It boxes in the day's reading assignment, and sometimes other reflection questions or activities.

You may also choose to ask students to answer some of the Discussion Questions in their Field Book reflection pages instead of discussing them in class. You can also choose – or let students choose – which Think About It boxes you would like students to respond to in writing; there are probably more than you will want to assign on some days.

5. **Unit Schedule:** A proposed unit schedule is included. The schedule includes daily activities, reading needed for the assignment, text reading assignments, and a summary of Field Book activities and reflections.

6. **Academic Standards:** U.S. Next Generation Science, Common Core, and National Council for the Social Studies high school standards are provided. Middle school standards are available on the Facing the Future website.

## Suggested Unit Schedule

Day	Recommended Reading	Required Pre-Reading for Activity	Activities	Field Book Reflections and Observations
1	Pages 2-5		Activity One <i>What is Sustainability?</i> Activity Two <i>Set Up Field Book</i> Activity Three <i>Nature Journal</i> Activity Four Preparation <i>My Place</i>	<i>Nature Journal</i> <i>Think About It</i> box, Page 2
2	Pages 6-10	Pages 2-5	Activity Four <i>My Place</i>	<i>Nature Journal</i> <i>Think About It</i> box, Page 3
3	Pages 11-14	Pages 6-10	Activity Five <i>Sustainability in My Place</i>	<i>Nature Journal</i> <i>Think About It</i> box, Pages 11 Update <i>Learning Links</i> Page Update <i>Questions</i> Page
4	Pages 15-18	Pages 11-14	Activity Six <i>Sustainability and My Values</i>	<i>Nature Journal</i> <i>Think About It</i> box, Page 14
5	Pages 19-26	Pages 15-18	Activity Seven <i>Human and Nature Timeline</i>	
6		Pages 19-26	Activity Eight <i>Local Sustainability Case Study, Part 1</i> Day 1	<i>Nature Journal</i> <i>Think About It</i> box, Page 15 Update <i>Learning Links</i> Page Update <i>Questions</i> Page
7		Pages 19-26	Activity Eight <i>Local Sustainability Case Study, Part 1</i> Day 2	<i>Nature Journal</i> <i>Think About It</i> box, Page 20
8	Pages 27-32	Pages 1-26	Activity Nine <i>Creating the Future We Want</i> Day 1	<i>Nature Journal</i> <i>Think About It</i> box, Page 25
9	Review Pages 1-26	Review Pages 1-26	Activity Nine <i>Creating the Future We Want</i> Day 2	<i>Nature Journal</i> <i>Think About It</i> box, Page 26 Update <i>Learning Links</i> Page Update <i>Questions</i> Page
10			Activity Ten <i>Sustainability Reflection, Self-Assessment, and Commitments</i>	
11	Pages 33-36	Pages 27-32	Activity Eleven <i>Systems All Around Us</i>	New <i>Learning Links</i> and <i>Questions</i> Pages in <i>Field Book</i> <i>Nature Journal</i> <i>Think About It</i> box, Page 30
12	Pages 37-39	Pages 33-36	Activity Twelve <i>Feedback in Systems</i>	<i>Nature Journal</i> <i>Think About It</i> box, Page 35

Day	Recommended Reading	Required Pre-Reading for Activity	Activities	Field Book Reflections and Observations
13	Pages 40-45	Pages 37-39	Activity Thirteen <i>Stock and Flow Diagrams</i>	<i>Nature Journal</i> <i>Think About It</i> box, Page 35
14		Review Pages 38-39 Pages 40-45	Activity Fourteen <i>Local Sustainability Case Study, Part 2 – Applying Systems Thinking</i> Day 1	<i>Nature Journal</i> <i>Think About It</i> box, Page 36
15			Activity Fourteen <i>Local Sustainability Case Study, Part 2 – Applying Systems Thinking</i> Day 2	<i>Think About It</i> box, Page 37
16	Pages 46-51		Activity Fifteen <i>Systems on the Move</i>	<i>Nature Journal</i> <i>Think About It</i> box, Page 44 Update your <i>Learning Links</i> Pages Update your <i>Questions</i> Page
17	Pages 52-53	Pages 46-51	Activity Sixteen <i>Local Sustainability Case Study, Part 3 – Using Critical Thinking</i>	<i>Nature Journal</i> <i>Think About It</i> box, Page 46
18		Pages 52-53	Activity Seventeen <i>Local Sustainability Case Study, Part 4 – Project Write-up and Debrief</i> Day 1	<i>Nature Journal</i> <i>Think About It</i> box, Page 50
19	Review Pages 27-58		Activity Seventeen <i>Local Sustainability Case Study, Part 4 – Project Write-up and Debrief</i> Day 2	<i>Nature Journal</i> <i>Think About It</i> box, Page 53 Update your <i>Learning Links</i> Pages Update your <i>Questions</i> Page
20		Review Pages 27-58	Activity Eighteen <i>Tools for Engaging with Sustainability Issues: Reflection, Self-Assessment, and Commitments</i>	

## Academic Standards

The following standards are addressed in this module.

Standard	Description
<b>Next Generation Science Standards - High School<sup>i</sup></b>	
<b>Disciplinary Core Ideas</b>	
HS-LS2.A	Interdependent Relationships in Ecosystems: Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
HS-LS2.B	Cycles of Matter and Energy Transfer in Ecosystems: Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Plants or algae form the lowest level of the food web.
HS-LS2.C	A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. Anthropogenic changes (induced by human activity) in the environment – including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change – can disrupt an ecosystem and threaten the survival of some species.
HS-LS4.C	Adaptation: Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline – and sometimes the extinction – of some species. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.
HS-LS4.D	Biodiversity and Humans: Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
HS-ESS2.A	Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

Standard	Description
HS-ESS2.E	The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.
HS-ESS3.A	All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.
HS-ESS3.C	Human Impacts on Earth Systems: The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
	Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
HS-EST1.A	Defining and Delimiting Engineering Problems: Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
	Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
HS-EST1.B	Developing Possible Solutions: When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.
<b>Science and Engineering Practices</b>	
Constructing Explanations and Designing Solutions	Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Engaging in Argument from Evidence	Construct an oral and written argument or counter-argument based on data and evidence. Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.
Developing and Using Models	Use a model based on evidence to illustrate the relationships between systems or between components of a system.
Obtaining, Evaluating, and Communicating Information	Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Standard	Description
<b>Crosscutting Concepts</b>	
Systems and System Models	Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions – including energy, matter, and information flows – within and between systems at different scales.
	When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
	Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.
Cause and Effect	Cause and effect relationships can be suggested and predicted for complex natural- and human-designed systems by examining what is known about smaller scale mechanisms within the system.
Stability and Change	Feedback (negative or positive) can stabilize or destabilize a system.
Energy and Matter	Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
Patterns	Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
<b>Connections to Engineering, Technology, and Applications of Science</b>	
Influence of Science, Engineering, and Technology on Society and the Natural World	New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
	Analysis of costs and benefits is a critical aspect of decisions about technology.
<b>Connections of Science to Nature</b>	
Science Addresses Questions about the Natural and Material Worlds	Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.
	Science knowledge indicates what can happen in natural systems – not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.
	Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.
<b>National Council for the Social Studies Thematic Strands<sup>ii</sup></b>	
Culture	Human beings create, learn, share and adapt to culture.
	Cultures are dynamic and change over time.
Time, Continuity, and Change	Knowledge and understanding of the past enable us to analyze the causes and consequences of events and developments, and to place these in the context of institutions, values and beliefs of the periods in which they took place.

Standard	Description
People, Places, and Environments	The study of people, places, and environments allows us to understand the relationship between human populations and the physical world.
	Apply knowledge, skills and understandings to today's social, cultural, economic and civic issues: How do people interact with the environment, and what are the consequences of those interactions?
Individual Development and Identity	Personal identity is shaped by an individual's culture, by groups, by institutional influences, and by lived experiences shared with people inside and outside the individual's own culture.
	Questions related to identity and development are central to understanding who we are. How do individuals grow and change physically, emotionally and intellectually? Why do individuals behave as they do? What influences how people learn, perceive, and grow? How do people meet their basic needs in a variety of contexts? How do social, political, and cultural interactions support the development of identity?
Power, Authority, and Governance	Students study dynamic relationships between individual rights and responsibilities, the needs of social groups, and concepts of a just society. Students become more effective problem-solvers and decision-makers.
Production, Distribution, and Consumption	People have wants that often exceed limited resources. Unequal distribution of resources leads to systems of exchange. Economic decisions are increasingly global. Students need to study interdependent world economy and the role of technology in economic growth.
Science, Technology, and Society	Science, and its practical application, technology, influence social and cultural change and ways people interact with the world. Modern life, as we know it, would be impossible without technology and the science that supports it.
	Students think analytically about the consequences of change and how we can manage science and technology to increase benefits to all.
Global Connections	Analyses of the costs and benefits of increased global connections, and evaluations of the tensions between national interests and global priorities contribute to the development of possible solutions to persistent and emerging global issues. By interpreting the patterns and relationships of increased global interdependence, and its implications for different societies, cultures and institutions, students learn to examine policy alternatives that have both national and global implications.
Civic Ideals and Practices	High school students increasingly recognize the rights and responsibilities of citizens in identifying societal needs, setting directions for public policies, and working to support both individual dignity and the common good. They become familiar with methods of analyzing important public issues and evaluating different recommendations for dealing with these issues.
<b>Common Core Language Arts<sup>iii</sup></b>	
CCSS.ELA-LITERACY.RH.9-10.4	Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.
CCSS.ELA-LITERACY.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

Standard	Description
CCSS.ELA-LITERACY. W.9-10.1.D	Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
CCSS.ELA-LITERACY. W.9-10.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
CCSS.ELA-LITERACY. W.9-10.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
CCSS.ELA-LITERACY. W.9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-LITERACY. W.9-10.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
CCSS.ELA-LITERACY. W.9-10.10	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.
CCSS.ELA-LITERACY. SL.9-10.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY. SL.9-10.1.A	Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
CCSS.ELA-LITERACY. SL.9-10.1.B	Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.
CCSS.ELA-LITERACY. SL.9-10.1.C	Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.
CCSS.ELA-LITERACY. SL.9-10.1.D	Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.
CCSS.ELA-LITERACY. SL.9-10.4	Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
CCSS.ELA-LITERACY. SL.9-10.6	Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.



# Introduction to Sustainability

## Unit 1



### Essential Questions For This Unit

1. *What does sustainability mean?*
2. *Why is sustainability important to me?*
3. *How can I live more sustainably?*
4. *How can I develop a sustainability worldview?*



## We're All Connected

We live in an interconnected world. Movies, music, news, manufactured goods like clothing and electronics, and people travel across the globe. With this much exchange of ideas, culture, and material goods, our actions in one region are sure to affect people living in other regions. Understanding how and where we connect can help us understand how we might impact others. This understanding can also help us find ways to make these new lines of contact work benefit of all.

## Connecting with People

Today, we can connect with other people through various modes of technology: cell phones, social media, the Internet, even movies and television. But of course, we have not always had so many ways to communicate. For most of history, people could only connect with others near them. These close, face-to-face relationships still form an important part of our sense of belonging. We connect personally with our families, our friends, our schoolmates, and our neighbors. Maybe we have coaches or teachers, teammates, or even pets to whom we feel close. These relationships are the foundation of connection. We care about these people and know they care about us. We help each other, enjoy each other, and live our lives with each other. We're connected!

## Think About It!

*With whom do you feel connected? Are they physically near or far from you? What makes a connection feel alive and central in your life? What other connections do you have – or could you have – beyond those with other people?*



As a society, we connect in broader ways. In the United States, we share a national government and Constitution, an economy, and national holidays. Although Americans have many different beliefs and perspectives, we share values such as personal liberty, freedom of expression and religion, and democracy. These common points of view create a sense of connection throughout communities and across the nation.

The boundaries of community are expanding to become more and more global. Countries increasingly trade goods with one another through the global economy. You may wear jeans sewn in Pakistan, carry a backpack made in Canada, and use a cell phone manufactured in China.

People also connect through media. Films made in the United States (U.S.), India, and Japan spread cultural ideas to other countries. Audiences in the United Kingdom, Sweden, South Korea and the U.S. share popular music. News travels quickly over informal social networks, often reaching across the planet more quickly than news from professional news organizations. Internet game platforms can link a teenager in San Francisco, U.S., with one in Caracas, Venezuela.

These exchanges create a sense of a modern, global culture. It's easier to feel connected with people around the world than ever before. These are many ways in which our relationships with other people, individually and collectively, connect us.

## Connecting with Place

We may connect with the place where we live, too. If we've lived in a place for a while, we usually know our way around and recognize the storekeepers, the mail carriers, and other members of the community. We know the weather patterns and recognize the signs of the changing seasons. Sometimes we have a special place we go to be alone or quiet. And when we move or visit a new place, we notice differences from our familiar base.

As we recognize that feeling of home, we can extend it to wildlife and plants with which we coexist. We can value and appreciate our

community and its history. Feeling connected with our place builds empathy with others connecting with their own home places. We can see for ourselves what works, what supports us, and where things need to change. Our actions have the most impact in our own communities and families.

## Connecting with Nature

### Think About It!

*How are you part of nature? How is your community part of nature? How is nature part of you and your community?*

When you think of nature, what do you think of? Most of us think of the woods, national parks, a river, the ocean, or maybe a nearby vacant lot, city park or open space. Have you ever thought about yourself when you think of nature?

We humans are also part of nature. As such, we are connected with other living things. One way we connect is through our biology. Scientists report that we can tell how similar two species are by looking at their genes. Genes are sometimes





called the blueprint for life and carry information within our cells about characteristics or traits from one generation to the next. Amazingly, humans share a significant portion of human genes with other creatures. Our closest relatives are chimpanzees: 98% of our genes are the same as those of chimpanzees. We even share about one third of our genetic information with fruit flies!<sup>1</sup>

Given this shared biology, it makes sense to consider that we share the planet's basic life support systems of the sun, the air, water, and land with all living creatures. Plants and animals have the same needs for food, water, and physical protection as we do. Even very simple life forms like bacteria require nourishment and safety.

All living things are linked together in nature. This wide-ranging set of relationships is called the "web of life". Each species contributes something: a bird may help disperse seeds for another species, a tree may provide twigs for a nest or a hole for shelter, and a creature may be food for another. In this way, each species contributes to the well-being of the overall collection of living things, and each species is supported by the actions of other living things. Living things are also supported by the nonliving

processes on the planet, which provide water, minerals from rocks and soil, carbon to build bodies, and sunshine to provide energy.

In our modern life, it may not be obvious that we are part of nature. More than half of us now live in cities. We buy our food in grocery stores, rent or buy our homes, and get our water from a faucet. Where is nature in all this? It's important to remember that, if we work our way through a few more connections, we always find that it is nature fulfilling our needs. Farmers work hard to support and protect plants, but the plants still grow because the sun shines on them. The homes we live in are made of wood from trees, bricks from clay, concrete from sand and stones, and metal from ores found in the earth. People build complex systems to capture and deliver water to our homes, but the water itself can only come from nature. Most fundamentally, we ourselves are part of nature: we can never actually be outside of or away from it.

When we recognize this common foundation of life, we see that we are connected to all living creatures.

---

## Youth Leadership: United Nations Educational, Scientific and Cultural Organization Youth Forum

Youth leaders from around the world take part in an international forum where they talk together about challenges facing the world's youth and identify solutions. Every two years, 500 youth leaders from around the world bring their creativity, energy, and perspective to tackle global problems. Each forum focuses on a unique theme, chosen by its participants.

This forum is held by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), which works to unite the world's diverse nations, based on the ideals of education for all, understanding of different cultures, sharing scientific knowledge, and protecting freedom of expression.<sup>2</sup> UNESCO began the forum to make sure the voices of youth were heard in these efforts.

After the Forum ends, the participants can start their own projects to put their recommendations into

practice. UNESCO chooses a small number of projects to support and endorse, assisting the project team and publicizing their results.

UNESCO Youth Forum Action Projects from 2013's forum focused on social inclusion and civic engagement. Projects included supporting young people working for peace in their Middle East communities, helping young people become community leaders in Afghanistan, and preparing them for job opportunities in Uganda.<sup>3</sup>

You can find out more about the latest Youth Forum projects and recommendations across the planet on its Facebook group.

**Learn More:** Enter the words "UNESCO Youth Forum" in your Internet search engine. Find out the latest news from around the world about the many ways youth are engaged in sustainability projects.

---

## What is Sustainability

Sustainability has often been defined as meeting our own needs without limiting the ability of future generations to meet their needs.<sup>4</sup> While this definition is a good place to start, there are much broader and more inspiring ways to think of sustainability.

To sustain something can simply mean creating the necessary conditions to keep it going as it is. The word "sustainability" shares a root with "sustenance," which means providing nourishment to keep someone or something

alive. What are sources of support and nourishment? We talked earlier about family, social networks, and community relationships. Healthy relationships provide support and give us strength. We also talked about our relationship with the natural world. A healthy relationship with the natural world also supports us and gives us strength. So sustainability can be thought of as living in a way that creates healthy relationships among all people, now and in the future, and between all people and the natural world.



## How Sustainability Connects Us

Looking at the world through a lens of sustainability will reveal ways in which we are connected, along with ways in which our local, personal actions affect one another and affect all of life on earth. We find that we have relationships we didn't realize we had. We are connected with people, with the place we live, and with the natural world – even if we live in a city. Just as we care about our friends and family, we can develop a sense of caring for people and other living things distant from us. This care for the well-being of others underlies sustainability. We can take responsibility for our local actions, recognizing that they may play out on a global scale.

Protecting the well-being of future generations isn't a new idea. Most cultures throughout history, including the Chinese, the ancient Romans and Greeks, and indigenous peoples from all over the world, have acknowledged their responsibility to care for the world for their descendants.<sup>5</sup> Today we recognize that sustainability requires us to make sure that we take care of social systems, economic systems, and environmental systems all at the same time.

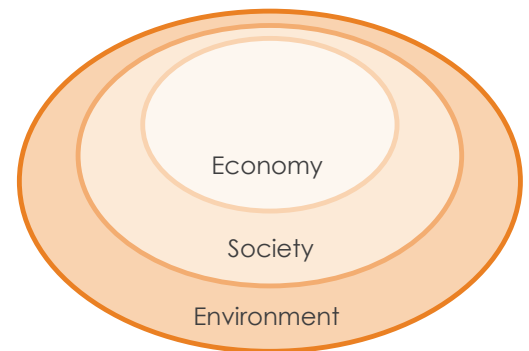
Together, the environment, the economy, and society are sometimes referred to as the “3 E's” of sustainability. People need a healthy economy and society to meet their needs; both of these depend on a healthy environment. All

### system:

*A group of related or similar parts that work together.*

three are **systems**. The environment can be thought of as the overall system that contains the other two. Human society is a system that is nested within the environment, and the economy is a system nested within society. This relationship is illustrated below.

### Nested Systems



A good working definition for sustainability is a *safe and just space for all, forever*. Sustainability is a broad concept that includes not just what we know, but also what we believe, what we want, and what we do.

Sustainability also can be thought of as **thriving**: bringing forth the most vibrant, life-affirming, peaceful, and just world we can imagine – for all living things – now and into the future. It's about creating the world we want for the ongoing, mutual benefit of all.

### thrive:

*To do well and be successful.*

This long-term perspective calls on us to think, act, evaluate and innovate differently. While we cannot know all the possible consequences of our actions, we can learn to look more broadly at causes and effects. We can recognize that living things are connected in many ways. We can learn to understand the patterns and principles that nature has used to maintain the life on the planet for billions of years and try to apply them to our own systems.

It is important to keep in mind that sustainability is not a finished product but a work in progress. It is a way of being. It rests not only on information and knowledge, but also on our values, preferences, and actions. Today, more and more individuals, businesses, organizations, institutions, and governments are taking significant steps to live and work sustainably. It's exciting – and humbling – to consider that we each have the ability and responsibility to create the world we want for ourselves and for future generations.



---

## Defining Sustainability

The definition of sustainability has evolved a lot over the last 30 years, as we have learned more about what will be needed to achieve it. The key concepts for sustainability were identified in the 1987 report “Our Common Future” by the World Commission on Environment and Development. This report laid out the first definition of sustainability mentioned above: meeting our needs without compromising the ability of future generations to meet theirs. This phrase is often referred to as the “Brundtland definition,” since the group that authored the report was chaired by Gro Harlem Brundtland, the prime minister of Norway when the report was written.

This definition joins several key ideas to form the basis of our idea of sustainability today:

**Needs:** The fundamental priority of society is to meet the basic needs of all, both today and into the future.

**Limits:** In order to meet these basic needs, we need to recognize that there are limits to what can be taken from the Earth's systems and returned as waste. Individuals and social systems also operate within limits.

**Economy, Society and Environment are Linked:** Our society requires all three of these elements to function successfully. And while economic, societal, and environmental issues may seem different, they often have similar underlying causes. By addressing these underlying causes, we can achieve improvements in all three.

**Present and Future Needs are Equally Important:** This idea reminds us that our choices today must ensure that social institutions, the economy, and the environment are in good working order for future generations.



### Environment

Sustainability begins with the recognition that we depend on a healthy environment to provide us with our basic bodily needs: air, water, food, clothing, and shelter. We take materials from the environment to meet these needs: we feed ourselves with vegetables and animal meats, build houses and cities with wood and stone, and clothe ourselves with cotton and wool. Some of these materials become waste. Some material may be unusable or left over after it was harvested. Some becomes old and worn and needs to be replaced. We put these materials back into the environment as waste.

This cycle works well when the environment can replace them as quickly as we take them and can break down and disperse the waste as quickly as we return it. These materials are referred to as **renewable**. But if we extract materials too quickly, forests, soil, or other resources can become depleted. These are nonrenewable resources. And if we return too much waste too rapidly, it piles up and becomes pollution. Or we may modify natural materials to better suit our needs, like turning petroleum into plastic. The environment may not be able to break down these modified, synthetic materials. Unless we are able to break them down through recycling, these materials also become pollution. Balancing what we exchange with the environment with nature's timing and processes is one aspect of sustainability.

#### renewable:

*A resource that can be replaced quickly and naturally. Sunlight, wind, water, and fish are all examples of renewable resources.*

### What Is A Healthy Ecosystem?

Ecology is a branch of science that studies the relationships between living things and their environments. An ecosystem is a group of elements in a particular area that function together as a whole. An **ecosystem** includes all the natural elements, such as plants and animals, and the non-living elements like air, water, sunshine, and soil. An ecosystem also includes people and their various creations.

#### ecosystem:

*A community of organisms (plant, animal, and other living organisms) together with their environment, functioning as a whole unit.*

*(cont. on next page)*



---

## What Is A Healthy Ecosystem? *(cont.)*

How does a healthy ecosystem work? Ecosystems have several basic properties that allow them to support life through changing conditions over thousands, or even millions, of years.

**No Waste:** One of the key principles of ecology is the principle of no waste within a system. Of course, individual organisms produce waste. But in a healthy ecosystem, all waste products become useful materials for other members of the community. For example, in tide pools, hermit crabs crawl out of their borrowed snail shells when the shell becomes too small for a growing crab. Another smaller hermit crab will move into the empty shell. This cycle will continue until the shell weakens and cracks, making it unsuitable as a home. The action of waves and rocks within tide pools will eventually break the shell down into sand. Small broken shells and sand adhere to the sticky outside surface of sea anemones, providing them with camouflage. And finer sand filters down to the bottom, sheltering sand dollars and sculpin fish, providing a home for these bottom-dwelling species.

Another aspect of the principle of no waste is the food web. In an ecosystem, plants, animals and microorganisms provide food for one another. This interconnection not only keeps all community members fed, but it also keeps populations of individual species in balance.

The examples above focus on ways an ecosystem reuses materials. The principle of no waste applies to energy as well. Ultimately, all energy on Earth comes from the sun. Plants in an ecosystem convert sunlight into plant material, which serves as food for animals. The food web serves as a sort of energy highway, energy to move from one organism to another.

**Adaptation:** Ecosystems can change, to some degree, when conditions change. The balance of plants and animals may shift, new species may enter or leave, or ecosystem members may

even **coevolve**. Coevolving means that the organisms' abilities change in response to the changing conditions.

An example of coevolution is the Morgan's Sphinx Moth and Darwin's Orchid. This moth has a 12-inch long tongue. Why would a moth need such a long tongue? Darwin's Orchid stores nectar at the bottom of a long tube that begins at the opening of the petals. The Morgan's Sphinx moth feeds on the nectar with its long tongue. As the moth lands on the orchid, it picks up pollen on the flower with its head and carries the pollen to other Darwin's Orchids, pollinating them as it moves from flower to flower. Early in the existence of this moth, not all individuals had long enough tongues to reach the nectar. Over time only those moths with the longest tongues survived. As the moths' tongues evolved in length, the tube of the orchid grew to match the length of the moths' tongues. These two species have coevolved to depend on each other...the flower provides food for the moth and the moth pollinates the flowers so they can reproduce.

**Redundancy:** Ecosystems ensure their survival by having more than one organism that can perform the same function. This characteristic is known as redundancy. For example, many animals can eat several types of plants or smaller animals. If one of these becomes unavailable, food is still available from other sources. A hawk may feed on numerous small animals such as voles, mice, rabbits, ptarmigan, songbirds, and snakes. If something happens to the vole population, the hawk would still be able to survive.

These basic properties allow an ecosystem to use and reuse materials and energy so it can sustain itself over long periods of time. Adaptation and redundancy provide the system with flexibility so it can adjust to changes and continue to function.



### **Economy**

We make choices about what natural materials to use, how fast to use them, and what to do with them when we're done. These choices are influenced by our economy and our society. Our economy, which is how people trade goods and money, provides choices about what is available to purchase and how much it costs. This interconnected trading system also influences jobs and income, both of which affect how much we can buy. And our purchasing decisions affect people's jobs and incomes. A sustainable world at a minimum is based on a healthy, balanced exchange between people and the environment.

Our society influences our economy through shared values about the kinds and amounts of goods we buy. For example, when you buy a pair of shoes, what affects your decision? Maybe you've simply outgrown your old shoes. Or maybe there are some new shoes out there that may give better performance or protection in your next basketball game. Maybe there is a new style that you'd like to try. Some of these factors are based on need: we need shoes to protect our feet. Some other factors are based on wants and are influenced by our values, our social group, or broader social messages like media and advertising.

### **Society**

Humans have other needs beyond basic survival: freedom; a sense of personal identity; the ability to make choices about how to live one's life; creativity; affection; understanding; a community in which to live, work and engage; and time to relax, play and imagine. The idea of social equity means that everyone has an equal opportunity to have their deeper human needs met. Meeting these needs contributes to a sense of well-being, which reflects a satisfying life beyond mere survival.<sup>6</sup>

Balancing our personal well-being with the well-being of other people and the environment is part of a sustainable way of life. This does not necessarily create a "me-versus-them" struggle. Instead, paying attention to the broader effects of our actions often benefits everyone involved: we often feel great personal satisfaction when our actions contribute to the well-being of others.

A sustainable way of living starts with a healthy environment, which can support a healthy economy and healthy society. The environment provides people with our essential needs. Having these needs met allows us to spend time and energy on other pursuits like creating art, playing sports, and spending time with friends. A high quality of life creates a stable, functional society – a sustainable society. A healthy economy supports our social needs as it provides opportunities for meaningful work at a living wage while balancing human needs with environmental needs. This approach creates an economy that can be sustained indefinitely. Making sure the environment, the economy, and society are all in good working order is the foundation of a sustainable world.

## Why Study Sustainability?

The main reason for studying sustainability is that it provides a holistic approach for bringing about a safe and just world for all, forever. We have the opportunity in our lifetimes to create a world that offers well-being, good health, material comfort, education, and equality, while protecting these opportunities for future generations and respecting the ability of other living things to thrive. Doing so requires us to think differently and live differently, but the rewards for making these changes are immense.



What happens if we decide to continue as we have been, to carry on with a “business as usual” approach? We will create serious problems for ourselves and for future generations if we do not choose wisely.

## Sustainability as a Worldview

### What is a Worldview?

A worldview is a collection of knowledge, beliefs, values and behaviors that define how we understand our lives and the world. A person’s worldview is influenced by many cultural forces, such as their family, history, politics, religion, and education. Our worldview is a powerful driving force that influences what we do and believe, whether we are aware of the influence or not.

People within a culture may share some or all of a worldview. Different cultures often hold different worldviews. For example, if you visited India you might be surprised to see cows wandering around freely. That’s because in some places in India, cows are considered sacred and are often seen roaming freely. The worldview of a person in India regarding cows requires them to be treated as sacred beings. In many other countries, cows are owned by

farmers and ranchers and kept in pens or otherwise fenced in. The worldview in those countries is that cows are livestock, primarily valued as producers of dairy products and meat. As you explore the topic of sustainability, it is important to be aware of the worldviews that influence opinions and actions.

### Think About It!

*Which worldview regarding the way cattle should be treated is correct: the one that says they are sacred beings or the one that says they are a commodity? On what are you basing your opinion? What evidence can you present to support your opinion?*



## What is a Sustainability Worldview?

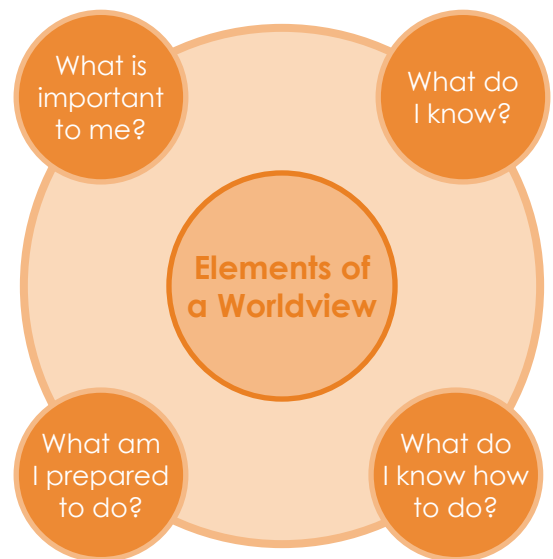
A sustainability worldview is a way of thinking that places the well-being of all people and living things, today and in the future, in a place of central importance.<sup>13</sup> This way of thinking is positive, life affirming, and focused on creating a safe and just world for all, forever.

A sustainability worldview is something that every person can work towards, and is in fact likely to be continually refined as we learn and grow. It can be applied to any topic, in and outside of school. Artists, writers, scientists, student leaders, farmers, and any other person can develop this worldview and apply it to their work and lives.

A sustainability worldview can also serve as a tool, providing a frame of reference for making choices and taking action. This requires understanding of sustainability concepts and principles, but goes further than conceptual knowledge. Someone with a sustainability worldview is willing to wrestle with the complex, interrelated issues; explore their own and others' values; and take action to bring about a more sustainable world.

People's worldviews are often linked to where they live and the environmental, economic, and social issues around them. Understanding someone's worldview can help us build empathy, as well as help bridge differences and resolve conflicts. Understanding our own worldview allows us to question our assumptions and consider different points of view.

The most common worldview today is the **mechanistic** worldview. According to this perspective, we can understand a process or object by breaking it down to its parts. These parts are expected to follow known, observable rules based on scientific principles. Any properties of the entire process or object would be predictable based on the properties of the parts. While aspects of this worldview are true, it has limits. For example, a bicycle can be used as a means of transportation. However, if we looked at the separate parts, we could not automatically conclude that they must create this result. The parts could be combined in other ways that would not be usable for transportation. Understanding something by looking at its parts is helpful, but we need to remember to put all the pieces back together again. Many processes and objects – especially living things – need to be understood in their wholeness.



When we investigate our own sustainability worldview we need to explore our **values**, **knowledge**, **intentions**, and **behaviors**.

### Values

Values reflect what a person cares about or considers important. Values are personal. The purpose of exploring values is not to specify what values should be chosen. Instead, we can evaluate whether values support a safe and just world for all, forever. We can learn to identify and explore our own values and recognize and understand the values of others.

### Knowledge

Knowledge includes intellectual and analytical knowledge like facts, concepts and other information. It also includes physical skills, such as tending a garden or repairing a bicycle. A third aspect of knowledge is thinking strategies: strategizing a solution, following instructions, or planning a presentation. The essential knowledge base for sustainability is captured in eight big ideas, which are discussed below.

### Intentions

Our intentions involve what we are likely to think or do. They can include our attitudes, our preferences, and our abilities. These may change based on our circumstances and over time. It can be helpful to thoughtfully explore our intentions based on our past wishes and actions and to build skills to carry out our intentions as they develop over time.

### Behaviors

Our behaviors are based on our ability to make choices and act in a way to carry out those choices. We need to be able to decide what needs to be done, know how to do it, and be able to fulfill our task. Changing our behavior



builds on a belief in our own ability to create change through our actions. This belief is called "self-efficacy." We might work on our own, persuade someone in a position of power to act on our behalf, or work with a team.

## Values in the Earth Charter

The **Earth Charter** is an international document that outlines the values and principles needed for a sustainable world. The Charter was officially launched by the United Nations in 2000 to establish a sound ethical foundation for the emerging global society and to help build a sustainable world based on respect for nature, universal human rights, economic justice, and a culture of peace. The Charter concludes with this call to action: "Let ours be a time remembered for the awakening of a new reverence for life, the firm resolve to achieve sustainability, the quickening of the struggle for justice and peace, and the joyful celebration of life."<sup>7</sup>



Go to [www.earthcharter.org](http://www.earthcharter.org) to read the entire Earth Charter and find out how it is being used around the world today.

## The Earth Charter – From Vision to Principles and Practice

### **I. *Respect and Care for the Community of Life***

1. Respect Earth and life in all its diversity.
2. Care for the community of life with understanding, compassion, and love.
3. Build democratic societies that are just, participatory, sustainable, and peaceful.
4. Secure Earth's bounty and beauty for present and future generations.

### **II. *Ecological Integrity***

5. Protect and restore the integrity of Earth's ecological systems, with special concern for biological diversity and the natural processes that sustain life.
6. Prevent harm as the best method of environmental protection, and when knowledge is limited, apply a precautionary approach.
7. Adopt patterns of production, consumption, and reproduction that safeguard Earth's regenerative capacities, human rights, and community well-being.
8. Advance the study of ecological sustainability and promote the open exchange and wide application of the knowledge acquired.

### **III. *Social and Economic Justice***

9. Eradicate poverty as an ethical, social, and environmental imperative.

10. Ensure that economic activities and institutions at all levels promote human development in an equitable and sustainable manner.
11. Affirm gender equality and equity as prerequisites to sustainable development, and ensure universal access to education, health care, and economic opportunity.
12. Uphold the right of all people, without discrimination, to a natural and social environment supportive of human dignity, bodily health, and spiritual well-being, with special attention to the rights of indigenous peoples and minorities.

### **IV. *Democracy, Nonviolence, and Peace***

13. Strengthen democratic institutions at all levels, and provide transparency and accountability in governance, inclusive participation in decision making, and access to justice.
14. Integrate into formal education and lifelong learning the knowledge, values, and skills needed for a sustainable way of life.
15. Treat all living beings with respect and consideration.
16. Promote a culture of tolerance, nonviolence, and peace.

## Think About It!

*Which of the Earth Charter values are most important to you?*

*How do the Earth Charter values compare with your own perspectives?*



## Changing Worldviews

While worldviews are usually held deeply by individuals and societies, they can change. An example of a major change in worldview occurred when European society shifted from a belief that the Earth was the center of the universe (**geocentrism**) to a recognition that the Earth actually revolved around the sun (**heliocentrism**). It took about 300 years from the time that solid mathematical proof was offered until the idea was generally accepted by society in the early 1800s. The change took place gradually, as scientific proof became stronger and the culture accommodated the new information.

### geocentrism:

*An old belief that the earth was the center of the universe.*

### heliocentrism:

*The belief that the earth revolves around the sun.*

Although it seems obvious to us now, this change represented a fundamental shift in worldview. It wasn't merely a question of how planets and the sun moved in space. This question represented a fundamental belief about humanity's place in the grand order of the universe. Earth and human beings were believed to have been placed at the center of the universe; this perspective tied in closely with the religious beliefs at the time, providing significant meaning, importance, and identity. A new perspective that took humanity out of the center of the known universe called people's very sense of identity into question.

Once again, our place in the world is being called into question. We have new information about how the world works. We need to recognize ourselves as part of nature, and to live within its boundaries. We will discuss these boundaries in the next section and later in the section on Sustainability Big Ideas.

### Think About It!

*Do you think you have a sustainability worldview? What values, knowledge, dispositions, and skills form your worldview? How do they compare to a sustainability worldview?*



## The Anthropocene Period

We have discussed humans as part of nature. We have also discussed how healthy ecosystems operate and adapt to change. While any species can change its ecosystem to some degree, humans have done so to a far greater degree than any other species.

Our advances in farming and industry have offered enormous improvements in the quality of life, health, and well-being for people. At the same time, our farms, cities and roads

have dramatically changed wild landscapes and wildlife habitats. We extract significant amounts of materials from the earth and put back large amounts of waste. These activities affect local ecosystems and the broader, planetary ecosystem.

The magnitude of the changes is important. The rate of change is also important. When we think of ecosystems adapting, we need to understand that adaptations take time. Larger adaptations take more time. In contrast, human-caused changes have been happening faster and faster. Agriculture based on hand tools and farm animals developed about 10,000 years ago and remained essentially unchanged for thousands of years. The **Industrial Revolution** began about 250 years ago and introduced new machines, new forms of energy, and new requirements for materials from the Earth. Within the last 60 years, population growth and a growing expectation for material wealth in much of the world has caused change to occur even more quickly.





This degree of human-caused change has not happened before in history. It is causing enough change in the Earth's ecosystems that it is being compared to other periods of major change in the Earth's geology and climate like ice ages. This era of human-driven change is informally called the **Anthropocene** (anthropo – is a root meaning “human,” and “–cene” refers to geological time periods.) Before the Industrial Revolution, there was no evidence in the geologic record of long-term human influences on the environment. However, beginning in the 18th century, humans have continued to exert a tremendous influence on a wide range of natural systems.

### anthropocene:

*The current geological period, starting in the 18th century when human activities have become the major influence on global climate and ecosystems.*

The professional scientific organization responsible for naming the various ages of the Earth's history is the International Union of Geological Sciences.<sup>8</sup> They are currently considering whether to officially identify our time – perhaps since the beginning of agriculture, perhaps since the beginning of industry, or perhaps even the most recent 60 years – as a new geological time period. This action would mark our era as a distinct time period similar to the Pleistocene, or time of the dinosaurs.

Living sustainability will help us minimize our strong impact on the Earth's ecosystems, which is one of the main reasons for studying sustainability.

## Population Growth

For most of human history, population was low and growth was slow. By the time people began farming about 10,000 years ago, world population was probably about 5 million. By the year 1 CE (Common Era), when our current system of numbering years began, there were about 250 million people on the entire Earth – fewer than the 320 million people who lived in the United States in 2015. This number had grown to over 1 billion people on Earth by the beginning of the Industrial Revolution in the early 1800s and at the end of 2015 was just under 7.3 billion.<sup>9</sup>

It took nearly all of human history – about 50,000 years – for the global population to reach 1 billion, but in only another 123 years it reached 2 billion. The third billion was added in just 33 years and the next billion in only 14 years. At current growth rates, another billion people are added to the planet every 12 to 14 years.

More people means more pressure on the environment to provide materials and absorb waste. This is particularly true as more people around the world adopt the Western lifestyle, with its high level of consumer goods.





## Wicked Problems

Wanting to live sustainably is important and is a good step. As we discussed above, intention and values are key parts of a sustainability worldview. The other two parts are knowledge and behaviors. Many of the factors contributing to unsustainable practices are complex, resulting in what are known as **wicked problems**. Wicked problems do not have obvious solutions, are hard to set apart from related issues, are caused by many factors, have underlying causes that may not be obvious, or are one-of-a-kind.

Solving wicked problems is not easy. Understanding sustainability principles and developing the skills to enable us to engage with these issues are some of the best tools we have to address these wicked problems. The Big Ideas of sustainability are described below, and tools for engaging in sustainability are covered in Unit 2.

### Success Story: Repair Café

Toss it? No way! That's what people at the Repair Café say.

At Repair Cafés, people bring in clothes, appliances, bicycles, and furniture needing repair. They meet neighbors and other local repair experts – all volunteers – who can fix their goods or even teach them how to do repairs themselves. At the same time, people chat, get acquainted, and share practical skills. Working together builds friendships and community. The cafés also support local repair businesses by reminding people to consider repairs instead of throwing items away. And sometimes a tricky repair may need a professional, so the volunteers direct café visitors to them when needed.

The cafés keep items working longer, which reduces the need for raw materials and energy to make new products. They help people question a throw-away mentality and think more about getting the most use out of what they already have.

Repair Cafés can be found around the world. After getting started in the Netherlands in 2009, the cafes have spread throughout Europe and to Japan, Egypt, India, and Chile. In the United States, they can be found in many cities, including San Francisco, Los Angeles, Chicago, Seattle, and Lincoln, Nebraska. At the end of 2015, there were more than 900 Repair Cafés worldwide. The Repair Café Foundation even offers a handbook and start-up kit if you'd like to open one of your own.

*To learn more, visit:* <https://repaircafe.org/en/>.



## The Big Ideas of Sustainability

While a major contribution to a sustainability worldview has to do with personal intentions – values and behaviors that we each hold and carry out – we need to develop a knowledge base as well. The Big Ideas of Sustainability are the principles or themes that, when understood and practiced, help individuals live in a way that brings about a more sustainable world. There are many big ideas associated with sustainability, but we will focus on eight that are the most important.

### Nature Connection

This big idea involves the way humans interact with and are part of the natural world. On a very basic level, we are creatures of nature. Our bodies breathe in oxygen and release carbon dioxide. We transfer food into our bodies for energy and release waste materials out. Like other animals we have a need for healthy habitats consisting of food, water, air, shelter, and space.

Humans can also develop an understanding of and emotional connection with other living organisms. This perspective can lead to a deep respect for nature in all of its forms, as well as a curiosity about the way that natural systems operate.

This, in turn, can lead to a desire for more direct personal engagement with the natural world. Natural elements, such as plants and animals, can be found anywhere from rural areas to the most urban of cities in vacant lots, city parks, backyards, or in the cracks of downtown sidewalks. Each of us has direct contact with nature each time we take a breath, look at the sky, or feel the sun's warmth on our skin. With greater experience and understanding of nature, we realize that the Earth does not have unlimited resources.

Nature represents a major source of expertise, and humans have much to learn from billions of years of evolution of the Earth's living systems. People have looked to systems within nature for many years to help understand and solve problems, as well as combining indigenous knowledge of nature with scientific methods. Humans have also used nature as a model for creating designs and processes that are fashioned after natural materials. For example, the hook and loop fastening system called Velcro was invented in 1948 by an electrical engineer named George de Mestral after he went for a walk in the woods with his dog and wondered why burr stuck to his trousers and his dog's fur. Mestral went to work on his idea, and in 1955 he was granted a patent for his invention.



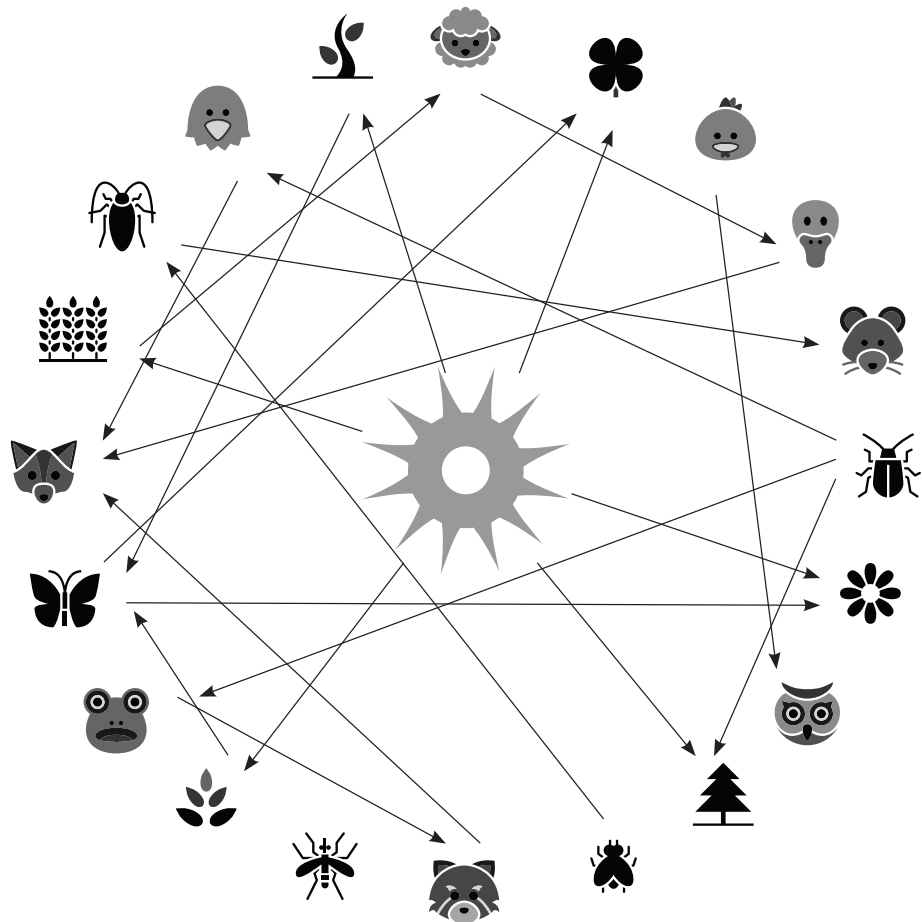
**Think About It!**  
*Have you ever had an idea that was inspired by something you saw in nature? Go for a walk in the outdoors and look for examples of ways that humans have adapted strategies from nature to make our lives easier.*

## Interconnectedness

Interconnectedness refers to the way in which a group of objects interacts with one another to form a complex whole that operates as a system. An example from nature would be a web of life.

Everything in nature is connected. If something disrupts one part, all the other parts are disrupted as well. As the famous naturalist John Muir said, "When we try to pick out anything by itself, we find it hitched to everything else in the Universe."

### Web of Life



With sustainability in mind, the idea of interconnectedness is often associated with how the environment, society, and economic systems are linked. It can also refer to how ideas, people, nature, communities, issues, and solutions can be interconnected. We often gain new insights into local issues when we see how they are connected to a larger global context.

## Universal Responsibility

Understanding that we're all connected and building a sustainability worldview help us take personal responsibility for the consequences of our own decisions and behaviors. We can also begin to explore our own potential contributions toward creating a safe and just space for all forever. We all have universal human rights. With these rights come universal human responsibilities. We are responsible for treating those other people with respect and dignity, even when we may not understand or agree with them. We are responsible for respecting the needs of others, including future generations, and avoiding behaviors that will prevent these others from meeting their own needs. We are responsible for avoiding causing harm to the natural world, which humans and other species depend on for our survival. This simply means treating others the way you want to be treated.

At the same time, universal responsibility does not only mean avoiding doing harm. We also need to use our intelligence, our care, our intentions, and our actions to work together to find constructive solutions to sustainability-related challenges. We can learn to take positive action to create the world we want.

## Respect for Limits

The term **limits** refers to the limited capacity of Earth to supply its inhabitants with the things they need for survival, such as clean air, fresh water, food and the ability to recycle waste and preserve the health of the planet's living organisms.

For the last several centuries, we have been converting and dispersing the energy stored in natural resources like coal and petroleum in ways that make it unavailable for use by future generations. Some of that energy returns to Earth, some of it is dispersed in forms that we consider waste – such as excess heat – and some of it is released into the atmosphere. At the beginning of the twentieth century, when there were 1 billion people on the planet, matter and energy were being converted and dispersed at a much slower rate than is occurring now. Today, the world human population is nearly 7 billion. As population growth accelerates, so does the rate of our dispersion of matter and energy. This increased rate of dispersion has affected the planet in many ways including increasing global temperatures.

Earth does not have unlimited resources for human use. If we stop thinking of it as though it does and begin to perceive Earth as finite – having limited resources – we may think differently about our relationships with other humans, our responsibility to future generations, our relationship with other species, and our personal needs and wants.

Thinking about respect for limits can be challenging as it means we have to consider different ways of thinking about our own behaviors and beliefs. Once we understand Earth's limits, we may choose to develop new strategies for our consumption habits that are more in line with the limits of Earth's resources.



## Local to Global

The Local to Global big idea helps us remember that, although we live our lives in our local place, we are connected with people across the globe through closely connected trade, governmental relationships, and social connections, as well as through our shared humanity. In a more concrete way than ever before, we are global citizens.

Because we buy goods from all over the world, our actions affect the people who make and sell those goods – all over the world. These economic relationships between countries mean that their governments are more interested in one another. Many countries have banded together in recent years to form trade agreements in an effort to ensure the best outcome for their citizens and businesses. These agreements create closer ties between governments, and also introduce opportunities for differences of interpretation of the agreements. What we purchase and use locally has global effects.

This big idea also captures the global spread of information, media, and ideas. Styles and goods spread quickly among countries and cultures, overtaking traditional ways and practices. Sometimes local wisdom and culture can be set aside as mass-produced, imported products and ideas take hold. However, local cultures can also influence this global community through social media and mobile technology. These technologies provide opportunities for individual, local perspectives and concerns to reach a global audience.

Many human values and goals are shared across cultures, religions, and nations. The shared desire for human rights and equal opportunity creates a global ethic that goes beyond local, national, or regional perspectives. Recognizing that we all have similar needs, hopes, and values as other people and cultures allows us to see common ground, even when we have very different ideas, opinions, and cultures. In this way, we are global citizens, even though our actions play out on a local scale. The term **glocal** is sometimes used to capture this sense of interconnectedness and mutuality between local and global concerns.

**glocal:**

*Involves both local and global issues and concerns.*

## Peace and Collaboration

Along with our basic needs for food, water, and shelter, the most fundamental human need is for peace and security. Peace can imply a range of states from the absence of violence to a feeling of calm or harmony. Maintaining a state of peace is challenging because differences are a normal part of human relationships. As we come to recognize that these differences often stem from similar wants and needs, we may be able to see differences with more understanding. More importantly, we can learn to consider the needs of others as equally important as our own. This understanding applies not only for those who are close to us, but also for those who live far away, are not known to us, are different from us, or will live in the future. We can learn to see and even value conflict as an opportunity to build greater understanding and to practice the skills needed to approach conflict in a constructive way. Learning to manage conflict with other

individuals can also help groups learn to live together peacefully.

One way to work together peacefully is through **collaboration**. Effective collaboration requires us to listen to one another, to count on one another, and to trust one another. A successful outcome depends on each participant doing their fair share of the work, and doing it well. This kind of respectful, engaged interaction builds peaceful relationships.

We can interact peacefully with the planet as well. We are beginning to understand that the same factors that contribute to peace among people – such as fairness, equal opportunity, equal safety, and impartial application of laws – also contribute to a respectful, caring way of preserving nature.

Think about how you feel when you are at peace with a friend or family member. Now think of the energy and attention you put into situations involving conflict. The energy needed to engage in conflict is enormous and pulls needed attention and energy away from the clear thinking and positive future focus needed to create a safe and just space for all, forever.

## Equity and Justice

The big idea of equity and justice refers to fair and equal access to opportunities and resources. It also means that there should not be an unjust distribution of the consequences of a lack of sustainability on any particular individual or group.

Equity and justice considers privilege, distinctions between needs and wants, and consideration of interspecies equity. This big idea includes a number of related ideas, including social justice, economic justice, environmental justice, gender equity, food justice, climate equity, and intergenerational equity.

Intergenerational equity refers to the rights of future generations to have access to adequate resources and opportunities necessary to meet their needs. The ability of future generations to meet their needs might be jeopardized if resources such as water and arable land are used up by the current generation or if the impacts of current human activities results in a compromised climate system.

Regardless of where we come from or what we do, we are all born with fundamental human rights. **Human rights** are those basic rights and freedoms to which all humans are entitled, including the right to life and liberty, freedom of thought and expression, and equality before the law.<sup>10</sup> Human rights relate to freedom, justice, and equality. **Freedom** gives you the ability to express yourself religiously, politically, and socially. **Justice** requires individuals be treated fairly and ethically. **Equality** means all people have equal access to rights and opportunities.

When people are able to live peaceful and secure lives with full access to natural resources, a clean environment, employment, education, and social services, they are more likely to contribute to sustainable communities.



---

## The Universal Declaration for Human Rights – A Future Fit for All

At the heart of international human rights is the Universal Declaration of Human Rights (UDHR), adopted by the General Assembly of the United Nations on December 10, 1948.<sup>11</sup> This document was developed right after World War II because the world was so horrified by the Holocaust that people wanted a document that clearly spells out fundamental human rights for all nations to uphold. The declaration provides inspiration and principles for governments, human rights organizations, and citizens everywhere. The Universal Declaration proclaims that respect for human rights “is the foundation of freedom, justice, and peace in the world.” To read a complete version of the Declaration, visit the website [www.ohchr.org](http://www.ohchr.org).

### *Summary of the Universal Declaration of Human Rights:*

1. All humans are born free and equal in dignity and rights.
2. Everyone is entitled to all the rights and freedoms listed in the Declaration, regardless of race, color, sex, or religion.
3. Everyone has the right to life, liberty, and security.
4. No one shall be held in slavery.
5. No one shall be subjected to torture or to cruel, inhuman, or degrading treatment or punishment.
6. Everyone has the right to recognition before the law.
7. Everyone is equal before the law.
8. Everyone has the right to an effective remedy for violation of their legal rights.
9. No one shall be subjected to arbitrary arrest, detention, or exile.
10. Everyone is entitled to a fair hearing.
11. Everyone is innocent until proved guilty.
12. No one shall suffer arbitrary interference.
13. Everyone has the right to freedom of movement.
14. Everyone has the right to seek asylum.
15. Everyone has the right to nationality.
16. Everyone has the right to marry.
17. Everyone has the right to own property.
18. Everyone has the right to freedom of thought.
19. Everyone has the right to freedom of opinion and expression.
20. Everyone has the right to freedom of assembly and association.
21. Everyone has the right to take part in government.
22. Everyone has the right to full security in society.
23. Everyone has the right to work.
24. Everyone has the right to rest and leisure.
25. Everyone has the right to a standard of living adequate for health and well-being.
26. Everyone has the right to education.
27. Everyone has the right to participate freely in the cultural life of the community.
28. Everyone has the right to a social and international order in which these rights and freedoms can be fully realized.
29. Everyone has duties to the community and a duty to respect the rights and freedoms of others.
30. Nothing in the Declaration may be interpreted as giving a right to destroy any of the rights and freedoms set out in it.

Many people will recognize these fundamental rights and freedoms as the birthright of every human and the basis for any healthy democracy. Others believe that the Universal Declaration of Human Rights is unrealistic and goes too far in promoting rights beyond those that would be considered basic. In any case, if the Universal Declaration of Human Rights becomes a reality for more of the world’s people, their quality of life will understandably improve and there will be progress regarding other global issues.





## Health and Resiliency

This big idea has to do with the health and well-being of individuals and the systems we depend on. Health can involve our individual habits and lifestyle choices, such as whether we prefer fast food or home cooked meals, or it can involve broad issues affecting individuals or society. Examples might be: hunger, disease, water quality concerns, drug or alcohol abuse, homelessness, etc. Health is also impacted by environmentally related conditions caused by poor air quality, climate change, and agricultural and industrial practices that damage the environment.

Resiliency is the capacity of a system, such as a community or an ecosystem, to deal with change and to continue to function and develop by adapting over time. Individuals can also be resilient and work towards or recover from hardship. Change can be a positive element in our lives.

A sustainability worldview is concerned with the health and resiliency of individuals and the various systems upon which they depend. Exercising control over and improving our health and that of natural and built systems allows us to more easily adapt to and even thrive throughout changing times.



## Think About It!

*What are some times in your life that you have had to be resilient and adapt to life events? What elements of a healthy lifestyle do you incorporate into your life as an individual or would you like to start incorporating?*

*What elements would you like to be a part of changing so that your community is healthier? Has the community you live in had to be resilient in the face of an event? If not, can you think of another individual or community that has?*

---

## Global Visionaries

*As I continue to develop and reflect on my experiences, it is almost impossible for me to speak about my life without the inclusion of GV – one of the many homes that I was raised in. Here, I learned to be a leader, humility, social responsibility, confidence and above all, to love the work I do with others.*

*– Marita Phelps, GV participant*

Based in the U.S. city of Seattle, the mission of Global Visionaries (GV) is to empower young people to become global leaders in the creation of a just and sustainable future. High school students who participate in GV programs have multiple opportunities to increase their global awareness.

Over the course of one school year, participants in GV's Leadership Program receive cross-cultural training on global awareness, fundraising, and social action. They take part in a cultural immersion trip to Guatemala, where they meet their peers in GV's Guatemala Youth Leadership Program. Together, American and Guatemalan youth undertake work in one of four areas:

- Construction of classrooms for schools
- Reforestation of rural areas by planting trees
- Production of coffee on small, independent farms
- Support of hospital nursing staff with care for premature babies, children, adults, and the elderly

Along with service learning, students experience the local culture by trying different foods, living with Guatemalan families, taking Spanish lessons, and going on trips to the local market.

Participants learn that every action they take has a ripple effect on society and the world as a whole. They become active leaders and global citizens who promote social and environmental justice through education and service at home and abroad.

---



## Developing Your Own Sustainability Worldview

As we have learned in this unit, sustainability is more than a topic. By becoming knowledgeable about the Big Ideas of Sustainability and also clarifying one's perspective related to intentions, values, and behaviors, individuals can develop a sustainability worldview.

We can develop a sustainability worldview as a community, too. We can develop a common language and a set of skills that allow us to solve local and global issues creatively. From this foundation, we can work towards a positive, safe, and just space for all, forever. When we do this, we can live within the limits of Earth's resources as well as develop deep and meaningful connections with nature.



## Think About It!

*How does Global Visionaries enact a sustainability worldview?*

# Tools for Engaging with Sustainability Issues

## Unit 2



### Essential Questions For This Unit

1. What thinking skills are important for sustainability?
2. What is a system?
3. How can systems help me understand sustainability?
4. How can I become a critical thinker?



Yellowstone National Park is home to wolves, grizzly bears, elk, beaver, and many other species. These animals live together in a tightly interconnected web of life. Over the past century, the park became a living experiment in interconnections.

Yellowstone is located mainly in the state of Wyoming in the United States, which is also home to many cattle ranchers. Because the wolves preyed on cattle, the wolves were killed off. By 1926, no wolves were left in Yellowstone.

With the wolves gone, the elk could graze in open meadows and near riverbanks. They fed on the tender shoots of new willow, cottonwood, and aspen trees. The tree population along streams dropped. These limited changes affected all of the interconnected wildlife in the area.

Decades later, in the 1970s, people became concerned about declining wildlife populations. The United States created the **Endangered Species Act** to protect animal **species** that were at risk of becoming **extinct**. The new law protected the few wolves still living in other parts of the country. To rebuild their population, wolves were re-introduced to Yellowstone.

With the wolf – a major **predator** – back in the park, elk and deer have returned to their old ways of protecting themselves. They move

### extinct:

*No longer in existence. All members of the species have died.*

### predator:

*An organism that lives by killing and eating other animals.*

into wooded areas when wolves are nearby and return to grassy meadows and stream banks when the wolves are farther away. Without elk and deer grazing on young willow and aspen trees along the streams, the saplings can grow into strong, tall trees. Songbirds came back, now that they have more trees in which to build nests. The trees also keep the stream banks strong, preventing the flowing water from washing soil downstream. Healthy stream banks provide a home for more grasses and small shoreline animals. Beavers use the trees as food and as material for building their dams. More willows and aspens means more beavers: there are now nine beaver colonies in Yellowstone, compared to only one before the wolves came back.

Beaver dams change the way streams work. The dams create cool ponds, which make good homes for fish, ducks, frogs, turtles, and muskrats. Dams also keep stream banks stable by holding back strong water flows after rainstorms. Streams and rivers in the park actually flow straighter since the wolves returned.

Wolves also hunted coyotes, which brought back rabbit and mice populations. With more of these small animals available as food, more hawks, weasels, foxes, and badgers could live in the park. Ravens and bald eagles ate what wolves left behind, as did bears. Bear populations increased with their food supply, which included the berries on new shrubs.

Bringing wolves back to Yellowstone improved the health of bears, rabbits, mice, eagles, ravens, fish, songbirds, willow and aspen trees, bushes, and even streams. Deer and elk populations were brought into better balance with other species. The web of life in Yellowstone is strong and complete once more.<sup>12</sup>

## Thinking in Systems



The story of wolves in Yellowstone National Park shows what happens when we try to solve a problem by looking only at simple cause and effects. Wild wolves were preying on ranchers' cows, hurting the ranchers' businesses. The obvious solution was to reduce the number of wolves – or eliminate them completely. This kind of thinking is known as **linear thinking**. One event leads to another.





In this unit, we are going to work with all of these new approaches by focusing on systems thinking and critical thinking. These two tools are essential to building a sustainability worldview.

There are other types of skills that build a sustainability worldview, too. These include decision-making, leadership, effective communication, and taking action. These tools will be covered in later units.

Linear thinking is not necessarily wrong. It is just incomplete. To understand complex situations, we need to be able to see interconnections. In the Yellowstone example, eliminating the wolves did solve the ranchers' problem. But over a longer period of time, it raised new problems. The ecosystem itself was no longer working. Removing the wolves created a ripple effect, impacting many kinds of plants and animals. Populations of beavers, fish, bears, and aspen trees declined, while the elk population soared. Streams deepened, which affected the underground water supply. The reduced water supply limited tree growth. Park visitors were unhappy that it was more difficult to see wildlife. Does this sound like a wicked problem?

## Thinking Skills for Sustainability

To work with sustainability issues, we need to use new thinking skills. As the Yellowstone story shows, we need to be able to see interconnections. We also need to be able to examine information to see if it is true. We need to be able to recognize assumptions and beliefs – our own and those of others – to see how they are affecting decisions and behaviors.

## Systems Thinking and Interconnections

Systems thinking takes a comprehensive approach to problem solving that is well suited to sustainability issues. It is a field of study that looks carefully at all the important components of a system and how they interrelate – often in cycles. Systems thinking offers a particular perspective, a specialized language, and a set of tools that can be used to engage with issues.

Let's look first at what a **system** is. A system is a group of interrelated elements that form a complex and unified whole. Systems are everywhere. For example, your school and classroom, the circulatory system in your body, and the predator/prey relationships in nature are all systems.

What are some groups that are not systems? Snow drifted up against a building is not a system. Adding or taking away snow won't change the basic nature of the snowdrift. The elements – the snowflakes – are not interrelated in any important way. But if you take out parts of your circulatory system, like your heart, it definitely won't function anymore. It won't be a system.

## Think About It!

*What does the word “system” mean to you? Think about systems you’ve heard about: the solar system, our political system, your digestive system. What do these ideas have in common? What makes them systems? What evidence shows that you are part of one or more natural systems?*

## Characteristics of a System

A system is different from other groupings in a few important ways:<sup>13</sup>

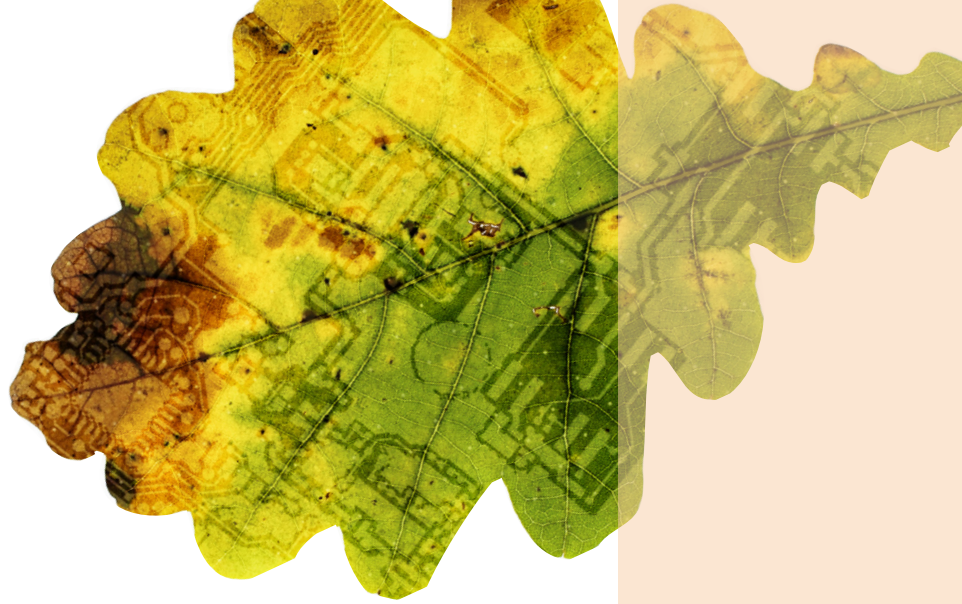
1. **Parts:** A system has a specific set of parts, or **components**. Each part has a unique job to do. If any parts are missing, then the system isn't complete and can't perform its function. Parts are things and can be named with nouns.

*For example, we could think of the water cycle as a system. Components would be clouds, rivers, lakes, the ocean, ice at the Earth's poles, and underground water. All of these parts are needed for the water cycle to work.*

2. **Interconnections:** The parts of the system are related, or interconnected. The system works as a whole because of the way its individual parts work together. The same parts connected in different ways would not create the same system.

*In the water cycle, rain and evaporation connect clouds and the various forms of water found on land. Rivers connect rainfall to lakes and oceans. It's hard to imagine these parts connecting in different ways without inventing a whole new planet!*

3. **Structure:** The interconnections between the parts cause the whole system to behave differently than the individual parts would behave. This is sometimes described as the whole being greater than the sum of its parts. It is the system's **structure**, or organization of parts and relationships, that allows it to work together. This specific function of the whole



system also defines what is and is not part of the system. If an element doesn't contribute to the function of the system, it isn't part of the system.

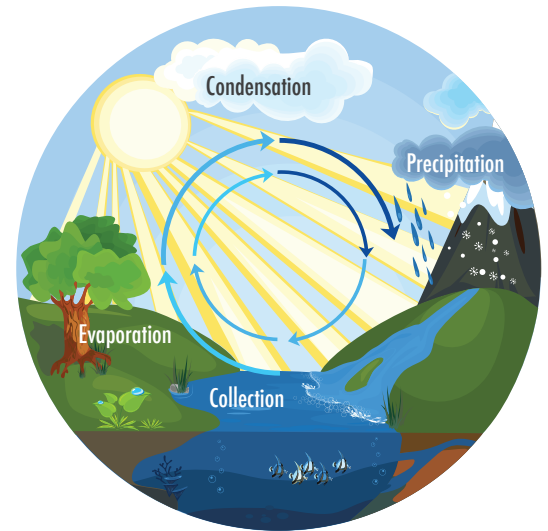
*The water cycle operates as a whole. None of the individual parts – clouds, rivers, or ice – can by themselves do more than their individual functions. Evaporation cleans water and delivers it to the clouds. Clouds redistribute water to different areas. Rivers move water from snow packs to drier regions. Only the entire cycle allows water to continually flow from place to place.*

4. **Purpose:** A system has a clear purpose that does not change over time or under different conditions. We identify the purpose by what the system actually does. It can take time to see the real purpose of a system.

*The water cycle cleans water and moves it around the planet. It has accomplished this for billions of years, clearly not changing over time or under different conditions. Keeping clean water flowing to different areas is the purpose of the water cycle.*

## The Water Cycle

Ecological systems and human social systems are **living systems**. Human-made systems such as cars and washing machines are **nonliving systems**. Systems thinkers often focus their attention on living systems, especially human social systems. Other systems thinkers are also interested in how human social systems affect the larger ecological systems of our planet.



## Fair Trade Coffee Farm in Nicaragua

An organic fair trade coffee farm in Jinotega, Nicaragua, is one example of a dynamic system, which depends on and is affected by the interactions of people and the environment.

It's a system because it meets all four of the conditions described above:

- **It has specific components.** These include the coffee trees, the soil, and the farm workers.
- **The parts are interconnected.** There are relationships between the trees, the soil, the farmers, and the marketplace.
- **The parts and relationships are structured in a certain way.** It takes all of these parts working together correctly to bring coffee to the market.
- **The system has a clear purpose that does not change.** The purpose of this group of components is to grow coffee beans and sell them at a market. Their specific actions may change according to the seasons, rainfall, or the price of coffee. But the purpose stays the same.



## Think About It!

Look back at the characteristics of systems.

Which of the following examples are systems?

- *The school library staff*
- *The city buses*
- *All the species living in a tide pool*
- *The books in the school library*
- *The people in line at the grocery store cash register*
- *Clouds in the sky*
- *Math*



## What is Systems Thinking?

**Systems thinking** is a tool that helps us analyze and evaluate situations and propose solutions to problems by studying system components, interconnections, structures, and purpose. A systems thinking approach can help structure the study and analysis of global issues in such a way as to account for the interconnections between environment, economy, and society. This approach greatly improves the chance of achieving sustainable solutions. Systems thinking can help people seek out underlying causes and address them in solutions, rather than merely responding to surface events and leaving the system unchanged.

Because it reveals interconnections, systems thinking is an important tool for developing a sustainability worldview. We can see that solutions may require the cooperation of many parts of society: scientists, governments, community groups, businesses, and individuals, just to name a few. Systems thinking can help people see patterns and seek out underlying causes. We can then address the root of a problem, rather than merely responding to surface events and leaving the system unchanged.

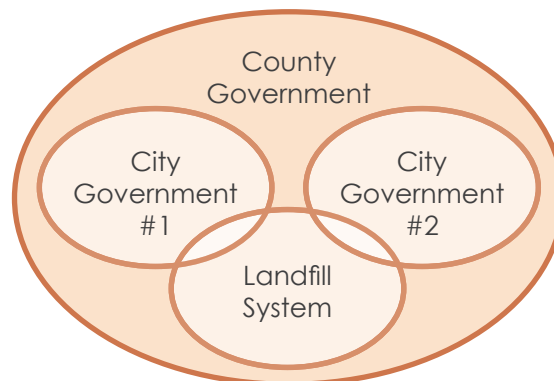
Systems thinking also helps us think about the ways in which our actions and choices affect others. We begin to question where our food, clothing, and transportation come from. Who produced them? What ecosystems were used? And when we are through using them, where does the waste go? What happens to all our belongings at the end of their useful life? Becoming aware of the systems that we live in helps us make more sustainable choices.

Suppose a landfill in a county becomes full, leaving the citizens with nowhere to put their garbage. A non-systems approach to this problem might be to build another landfill or find a landfill in another county that would take the garbage for a fee. A systems thinking approach



would look not only at these two options, but also at other aspects to this problem and ask a number of questions: Where does the garbage come from? What's in the garbage? Is there a way to reduce the amount of garbage produced? Is there a use for the garbage? Answering these questions could give the county a number of alternatives, including starting or expanding a recycling program, raising fees for garbage disposal as an incentive for residents to create less garbage, or working with manufacturers to produce less packaging for their products, thus leaving fewer materials to throw out.

### Nested and Overlapping Landfill Systems





The landfill example demonstrates the idea of **nested systems**, where one system serves a function within another function. The landfill system removes waste from the county's homes and businesses and is nested within the broader system of the county government. Systems can also **overlap** when they share components. For example, the landfill could accept waste from several cities. They might have independent fire and police departments but overlap in their waste disposal system. By looking at the way systems are nested or overlap, we can zoom in to see more detail in the landfill's operations, or we can zoom out to see the interconnections between the landfill, the county government, and city governments.

## Think About It!

*Look back at the systems you identified in the box above. What new connections do you notice if you zoom out, or look at the system from a broader perspective? What other systems is it nested within? What systems are nested within it? Does it overlap with other systems?*

## Understanding Changing Systems

Systems are **dynamic**, or active. They change and adjust depending on what is going on around them. Our circulatory system speeds up when we start to run and slows down when we go to sleep. A football team may play harder if they are facing last year's champions. The way a system adjusts depends on the way its components interconnect.

Because systems change, it is important to study them over longer time frames. When we look at simple causes and effects, it's like looking at a snapshot. Studying systems is more like watching a movie: events unfold over time. A longer time frame can reveal patterns and identify underlying causes for the system's behavior. These insights help us create better solutions. Longer time frames are also important because the effects of system changes may have delays. With climate change, for example, carbon dioxide levels in the atmosphere have been increasing since the beginning of the Industrial Revolution in the 1700s. However, global temperatures didn't begin to rise until the mid-1900s.

System components usually work together in response to information. This information can take many forms. In the example of catching a cold, the information would be the body's identification of a cold virus. The body's immune system works to rid the body of the virus, causing coughing, sneezing, and possibly a fever. When the body receives information that the virus is no longer a threat, the coughing and sneezing stop. The cold is over. This kind of information is known as **feedback**, which tells the system how its components are working with each other and with its environment.<sup>14</sup>

When feedback affects the system's behavior, a **feedback loop** is created. There is a feedback loop in the cold example above. The presence of the virus affects the body's immune system. The immune system affects the virus. One component behaves in a way that affects another component or the environment. If there is a pattern that continues over time, there is probably a feedback loop.

Sometimes feedback is used to help a system stay at some normal level. This is known as a **balancing feedback loop**. Our body maintains its normal temperature of 98.6°F by using balancing feedback. If we stay outside too long

on a chilly day, our body temperature drops. Our nerves take the message to our brain, which tells our skin to create goose bumps. These raise the hairs on our body to trap body heat, creating a blanket of warm air all around us. As our body warms up, our nerves let our brain know. The goose bumps settle down.

Another kind of feedback loop is a **reinforcing feedback loop**. This means that the change gets reinforced, or strengthened. An example is population growth. If families have more children, there will be more people to bear children in the future. As these children grow up and have families, the population increases.

**Think About It!** *Consider this situation. Many students of color in a large city high school are not graduating. The school district responds by offering counseling and tutoring services for students who miss too many school days or who are failing a math or English class in 8th grade. In a few years, more students of color do graduate with the extra help, but the school would like to do better. They make an extra effort to hire more teachers of color who are from the local community. The school administrators recognize that students in this high school need to learn from teachers who understand the systematic oppression that individuals of color encounter in our current society. When students of color feel more connected with the school and their teachers, and when they see more role models for success, they are more likely to graduate. Can you identify the system components and relationships? How did feedback affect the outcome? Was it balancing or reinforcing feedback?*

## Causal Loop Diagrams

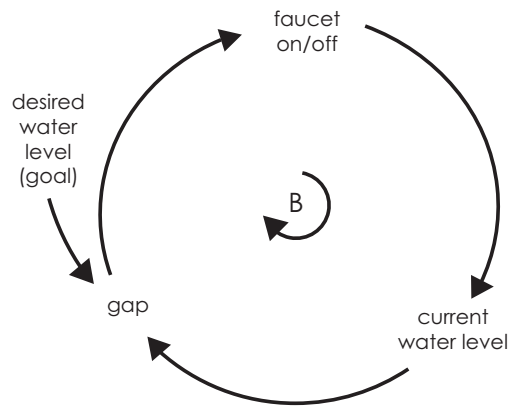
Feedback loops are also known as **causal loops**. Causal loop diagrams are systems thinking tools that show relationships in the system and with the environment, including cause-and-effect relationships.

We can use a bathtub as an example of a balancing loop. We want to maintain a constant level of water in the tub, but the drain plug leaks. Of course, the sustainable solution would be to get the leak fixed, so we don't waste water. But in this example, we will add some water now and then when we notice that the water level has gotten low. The goal is the desired water level. There is a gap, at times, between the desired water level and the actual level.

The two system components we're looking at are the water level and the on/off position of the faucet. These two components change over time. As the water leaks out, a gap opens between the actual water level and the desired level. The faucet is turned on. The flow of water increases the actual water level and closes the gap with the desired level. When the water is back up to the desired level, the faucet is turned off. We place a "B" in the center to show that the cycle tends to balance around a normal level. The arrow near the B shows the direction of the cycle. The goal, the desired water level, is shown as an outside influence.

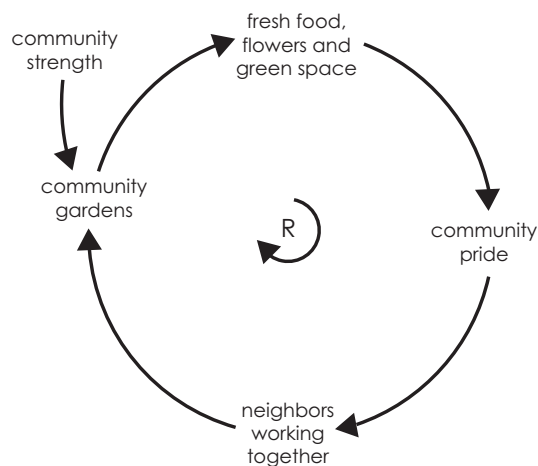


### Balancing Causal Loop Diagram for Bathtub Water Level



Now we can look at an example of a reinforcing causal loop diagram. Let's use the example of community gardens in New York City, where "green guerillas" turned trash-filled empty lots into community gardens.

### Reinforcing Causal Loop Diagram for Community Gardens



## Green Guerillas

In the early 1970s, a group of people in New York City decided to do something about the urban decay in their communities. They threw packets of flower and vegetable seeds over the fences of vacant lots, and they planted sunflowers in the center meridians of busy New York City streets. They also put flower boxes on the window ledges of abandoned buildings.

As people who lived in the neighborhoods that were experiencing decay saw vacant lots gradually transformed into productive gardens, they began to donate their time and talents. Soon, local stores and nurseries began donating vegetable starts and seeds.

The original group of "green guerillas" began rallying other people to use community gardening as a tool to reclaim urban land, stabilize city blocks, and get people working together to solve problems. Eventually, dozens of community gardens bloomed throughout New York City, and neighbors formed vital grassroots groups.

Green Guerillas has grown and changed along with the movement. Today, they are a vital nonprofit resource center, helping community gardeners cultivate community all year long. They connect city kids to the earth. They give seniors cool green spaces in which to pass summer days.

**Learn More:** Follow the latest news from the Green Guerillas at <http://www.greenguerillas.org/>.

As gardens were created, the nearby residents felt inspired and enthusiastic. The fresh produce made them feel healthier, the flowers cheered the neighborhood, and the green space provided a beautiful place to relax. As they felt encouraged, they built more gardens on other empty lots. These new gardens inspired more residents, who built more gardens: a reinforcing cycle!<sup>15</sup> Note that there is an "R" in the middle of this loop to show that it is a reinforcing loop.

## Think About It!

*The Think About It box on the previous page discussed graduation rates. The example above, discussing graduation rates. Draw a causal loop diagram for this situation. What questions do you have?*

# Stocks and Flows

One of the tools we use to understand systems structure, or organization, is a **stock and flow diagram**. A **stock** is the basic element of a system. A stock is something that increases or decreases over time. It might be money in a bank account, the number of learners in a school, or the foxes in a forest. A stock doesn't have to be physical. It can be your hope for bringing about a safe and just world or world leaders' commitment to address climate change. A stock is always a noun. Even if it can't be directly measured, it is something that can increase or decrease. When we discussed system characteristics, we talked about system components. A stock is a system component.

Stocks can increase or decrease over time through **flows**. Flows are actions or changes that affect the amount of the stock. A flow represents how a stock interconnects with other components or the environment. A flow could be money that is put into or taken out of a bank account. A flow could also be new students who come to a school or students who move away or graduate. It could be the good news you read, or local actions you take part in that give you greater hope. Or it could be news about a new global agreement to address climate change. All of these can affect how much a stock contains. A flow matches with the idea of system interconnections in our discussion of system characteristics.

The process of filling a bathtub is a good example of stocks and flows. The stock is the water in the bathtub. It's an amount of something that can change as the system operates. The water coming into the tub or draining out represents flows. Because water can flow both into and out of the tub, the bathtub has two flows. The contents of a flow may be the same thing as a stock: water makes up the flow, and water is the stock in the tub. The difference between a stock and a flow is that a flow represents change, while a stock is an amount.

## Think About It!

*Look at the following list of stocks. What would be possible flows in and out?*

- *Equal job access for everyone who is qualified*
- *Clean drinking water for all city residents*
- *Adequate land for a healthy wolf and elk predator/prey relationship*

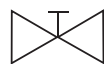
## Stock and Flow Diagrams

We use stock and flow diagrams to help us visualize the system structure. A stock is represented by a box, and a flow is represented by a valve symbol used in plumbing. A valve is like a faucet and can be turned on and off. This symbol represents the idea that a flow can increase or decrease, start or stop. Anything upstream or downstream of the part being studied is represented by a cloud symbol.

### Stock and Flow Diagram Symbols



Stock



Flow

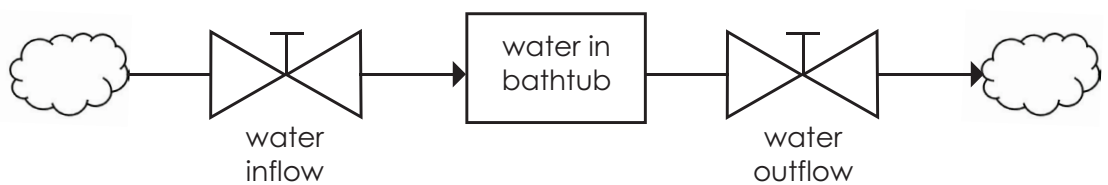


Component that isn't being considered in the diagram





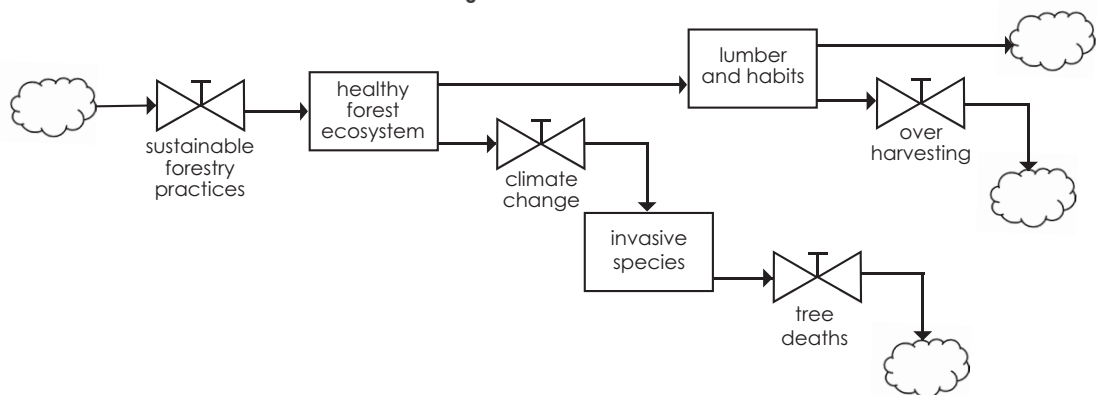
### Stock and Flow Diagram for Bathtub



System diagrams help us look at specific parts of larger, complex systems. Because system elements are interconnected and systems often nest or overlap with others, we need to decide what we want to focus on. When drawing any systems diagram, it's important to first decide what you will include. Be sure to include any elements or relationships that directly affect the specific area you are studying. Leave out those that you don't need to look at closely.

Let's look at a system with more components. The stock and flow diagram illustrated here shows that sustainable forestry practices support a healthy forest ecosystem. In turn, a healthy forest ecology can result in a renewable supply of lumber as well as thriving habitats for native species, a second stock in this diagram. However, one of the impacts of climate change is that non-native insect species can sometimes devastate a forest, leaving it vulnerable to wildfires. At the same time, overharvesting of lumber by humans also can leave a forest system less resilient to the effects of drought or species changes.

### Sustainable Forest Practices Stock and Flow Diagram



---

## Learning from Nature: Systems, Stability and Change

It is important to see how systems stay in balance. It is this very quality that has allowed nature to function for 4.5 billion years. Over that time, there have been ice ages, strikes by meteors and asteroids, volcanic eruptions, and many other physical changes. These events have changed water cycles, temperature, and the way Earth's materials have been distributed over the planet.

As life emerged, these non-living systems have blended with living systems, influencing one another. Throughout many changes, these systems shift, adjust, repair themselves, and develop new behaviors. This ever-changing nature of systems is possible because of the relationships between parts of the systems, the way that systems act as a whole rather than as individual parts, and because feedback keeps the system informed. While systems change continually, they are also essentially stable. They change within limits, while keeping their balance around normal levels.

Sometimes conditions change so much that systems cannot adjust. Then, systems may rearrange their parts, come up with new ways to interact with their

environment, or even fail. Sometimes these changes are driven by reinforcing loops, like populations growing too large for an ecosystem to support. Sometimes these changes come about because of a sudden change, like when an asteroid strike led to the extinction of the dinosaurs. When this happens, new systems form over time, filling in gaps and creating new relationships. Living things naturally form into systems with one another and with their environment.

We can see that the Earth's living and nonliving systems have two essential qualities. They try to stay within their normal levels but are flexible enough to adjust as conditions change. When conditions change so much that systems can't adjust, new systems emerge to take their place. This combination of flexibility and stability is the foundation of life on Earth.

People can learn from this systems way of being. We can use it to understand situations and create solutions. We can build in flexibility and recognize the boundaries where conditions may be stretched too far. We can use systems thinking as a foundation of human society.





## Sustainability Case Study

Let's use systems thinking to understand the dilemma facing the Daillos, a family living in Senegal, Africa.

### Case Study:

#### The Diallo Family

The Daillos' main source of food and livelihood comes from a small plot of land on which they grow corn and peanuts. The Diallo family includes Mr. and Mrs. Diallo, three boys (ages five, twelve, and seventeen) and two girls (ages one and eight). The father and the oldest son spend most of their days in a distant city looking for work. The younger boys attend school in the nearby village for about three hours a day. This leaves the mother, Assitou, and her eight-year-old daughter with the bulk of

the farming and household work. In the last few years, the Daillos' plot of land has been much less productive because of poor soil quality and a lack of water. This has left the family in a serious state of malnutrition and poor health. Assitou would like to limit the size of her family, but she doesn't have the money to buy contraceptives and there is no health-care clinic in their village. The Diallo family is a small system that is part of a larger system of poverty in the country of Senegal.

How and where could one intervene in this system of poverty and scarcity? Using the steps below, let's see how a systems thinking approach might guide someone in deciding how to help. What else can be learned about

this family and their community, village, or country that might help you figure out what to do? Systems are dynamic and changing, so it is important to continue to learn even after you have begun to address the issue.



### Step 1: Tie in the Big Ideas of Sustainability

As you begin to think about an issue, keep in mind the big ideas of sustainability. They will help you identify interconnections and underlying causes.

In wicked problems, many – and sometimes all – of the big ideas will be represented.

For the Daillo family situation, the big ideas reveal the following interconnections.

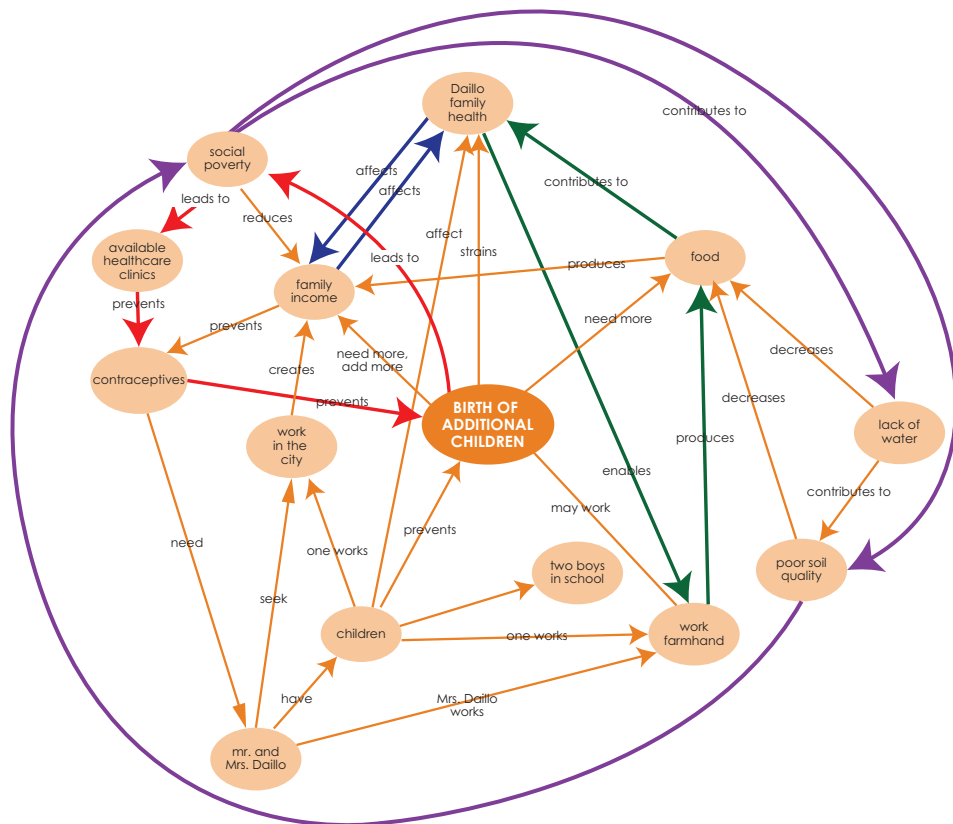
Sustainability Big Ideas and the Daillo Case Study	
Sustainability Big Ideas	Daillo Case Study Tie-In
Interconnectedness	<ul style="list-style-type: none"><li>• Poverty and poor soil quality</li><li>• Poor soil quality, malnutrition and poor health</li><li>• Societal poverty and lack of access to contraception</li><li>• Family size, poverty, malnutrition and poor health</li></ul>
Universal Responsibility	<ul style="list-style-type: none"><li>• Mr. and Mrs. Daillo are responsible for managing the size of their family and providing for them, and for the long-term health of their land</li><li>• Their society is responsible for providing services to meet their health and economic needs</li><li>• Wealthier nations are responsible for treating Senegal and its population with fairness, justice, and equity</li></ul>
Respect for Limits	<ul style="list-style-type: none"><li>• The poor soil quality and lack of water limit how many people the land can support</li></ul>
Connecting with Nature	<ul style="list-style-type: none"><li>• The farm could be more successful if farming were performed in line with ecological principles, as in permaculture farming</li></ul>
Local to Global	<ul style="list-style-type: none"><li>• As members of the global community, the Daillos are part of a larger pattern of poverty in the developing world</li></ul>
Equity and Justice	<ul style="list-style-type: none"><li>• Gender equity would be improved by sending the daughter to school and having the male family members help with farming and household work</li></ul>
Peace and Collaboration	<ul style="list-style-type: none"><li>• The Daillos are not subject to violence. However, they lack “positive peace,” which includes fair opportunity and fair distribution of resources <sup>16</sup></li></ul>
Health and Resiliency	<ul style="list-style-type: none"><li>• Malnutrition affects the family’s health. Poor health makes them less resilient, or less able to withstand other stresses or illness</li></ul>

### Step 2: Mind Map

Draw a mind map to identify key relationships. A mind map is a diagram that can help you organize information and identify relationships. To create a mind map, start with a single idea or key concept at the center of a piece of paper and then use arrows and circles to connect additional ideas and concepts. This early step can make it easier to create the next diagrams.

Sometimes it is necessary to play around with these diagrams for a while, and you might find it helpful to work with small pieces of paper to make it easier to move ideas around. You may find that you need to add arrows as you see relationships where cause and effect work in a cycle. Note big ideas where it is appropriate. An example of a mind map for the Daillo Family Case Study is shown here.

### Mind Map for the Daillo Family Case Study



### Step 3: Causal Loop Diagram

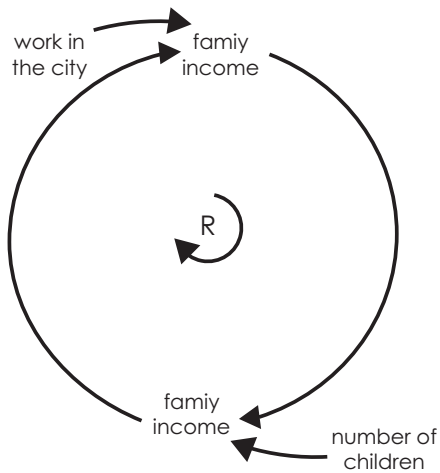
To identify the cause-and-effect relationships in the Daillo family situation, let's create a causal loop diagram. First, we need to see where we have cause-and-effect relationships. The mind map reveals these possible cycles:

- 3.1. Family income and family health (blue arrows)
- 3.2. Ability to work farmland, produce food, and family health (green arrows)
- 3.3. Societal poverty, available health-care clinics, contraceptives, and possible additional children (red arrows)
- 3.4. Societal poverty, lack of water, and poor soil quality (purple arrows)

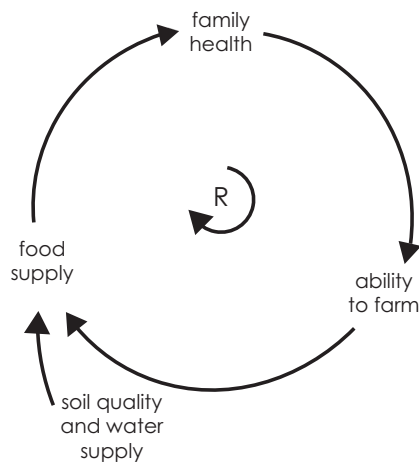


We can draw individual causal loop diagrams for each of these cause-and-effect cycles.

**Daillo Family Case Study Causal Loop Diagram 1**



**Daillo Family Case Study Causal Loop Diagram 2**



Cycle 1 is a reinforcing loop because, as family income goes down, family health goes down. And as family health goes down, family income is likely to go down. The same relationship applies if health and income increase.

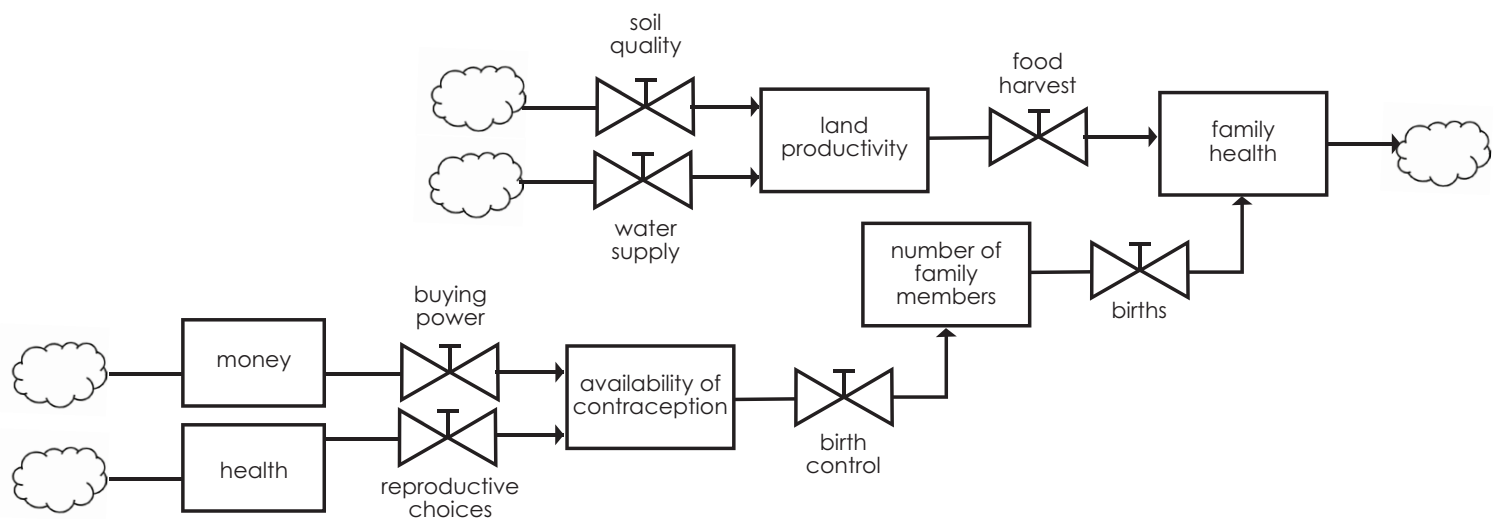
Studying the causal loop diagrams allows us to see causes and effects. The diagrams also highlight which changes reinforce one another and which ones balance one another.

#### Step 4: Stock and Flow Diagram

Now, let's create a stock and flow diagram. The key stock we want to explore, in order to create solutions later on, is family health. Looking at our mind map, we see that family health is affected by flows of food, income, and the number of people in their family. Societal poverty also affects their health indirectly by making work

difficult to find, by leading to overuse of the soil so its quality declines, by creating poor water supply, and by creating a lack of reproductive options. If there were no mind map, these relationships could also be found by working backwards from a goal of improved family health.

#### Stock and Flow of the Daillo Family Case Study



We can use this diagram to begin to think about ways to improve family health. We can look at the factors that flow into the stock of family health. Flows can increase desirable stocks or reduce undesirable stocks. It becomes clear that we would want to improve the flow of healthy food to the family and reduce the number of new births. In this way, a stock and flow diagram helps us begin to visualize possible solutions.

Note also that we did not include the stock of societal poverty in this diagram. In every systems diagram, we need to choose where to draw the boundaries. These choices depend on our purpose. If we were working directly with this individual family, we might want to draw the diagram as shown. If we worked with an international aid organization whose purpose was to address deep societal poverty, we would include the organization in the diagram.

## Think About It!

*What sustainability values would help frame solutions for the Daillo family?*

## A New Way of Thinking

Systems thinking shows us that we understand situations better when we see relationships and interconnections between the parts. Understanding these relationships between parts helps us see the big picture of sustainability issues. We can see how information flows and recognize hidden causes of problems. We can use this knowledge to create better solutions.

Learning to think in systems calls on us to think differently than we have done before. The Center for Ecoliteracy calls this change in thinking a “shift in perception.” They compare systems thinking with the way we usually think, which is focused on simple cause-and-effect relationships. The table shown below summarizes these comparisons.



### Traditional and Systems Thinking<sup>17</sup>

<b>Cause-and-Effect Thinking</b> <i>The focus is on:</i>	<b>Systems Thinking</b> <i>The focus is on:</i>
Objects	Relationships
How parts behave	How the combined whole behaves
Single events	Patterns of events, underlying causes, and longer time frames
Things that can be measured	Both things that can be measured and things that cannot be measured
Right answers	Right way of thinking

Now that you have learned the basics of systems thinking, you may start to see systems all around you. With practice, you will see interconnections everywhere. This skill will be a strong foundation for your growing sustainability worldview.



## Thinking Critically

**Critical thinking** is another important concept and tool for a learner of sustainability issues. Critical thinking is the process of acquiring information and evaluating it to reach a logical conclusion or answer. Critical thinking requires thinking carefully and deeply, with concern for accurate evidence to support generalizations, arguments, and ideas. The study of sustainability issues requires us to constantly make connections between the environment, economy, and society. It requires the analysis of competing arguments around difficult and relatively new topics, like climate change or consumerism. Critical thinking means asking questions, both small and large.

Critical thinking also includes our way of approaching issues. Critical thinkers care that they have their facts right, that they make decisions based on facts, that they are truthful, and that they treat others with respect. They are willing to re-examine an issue when they come across new information or a different point of view. With sustainability in mind, they question whether possible solutions build toward a safe and just world for all, forever.

### Think About It!

*Have you ever heard of “d  j   vu?” It’s a French phrase that means “seen before.” It’s used to describe a strange feeling you get when you’re in a new place or situation but feel like you’ve been there before. The late comedian George Carlin turned the phrase around, into “vuja de.” He described it “the strange feeling that, somehow, none of this has ever happened before.” Business leaders and innovators have taken up this phrase, using it as a reminder to see familiar things with fresh eyes, as if they’ve never been seen before.*

*What situations in your daily life can you look at with a fresh perspective, with vuja de? What assumptions cause you, your friends, your classmates, your teachers, or your family to act in routine ways? If those assumptions changed, how would your or their actions change?*

## Critical Thinking Skills

Here are skills that make up critical thinking:<sup>18</sup>

1. Make sure that facts are accurate.
2. Ask good questions.
3. Recognize assumptions that we, and others, make.
4. Decide if the source can be trusted.
5. Analyze conclusions.
6. See issues from multiple points of view.
7. Use evidence to explain your point of view and make decisions.

Let's look more closely at each of these skills.

### 1. **Make sure the facts are accurate.**

The most basic aspect of critical thinking is making sure the facts are accurate. Facts are the foundation for making arguments, drawing conclusions, and making decisions.

Fact-checking is also the easiest part of critical thinking to accomplish. Many facts can be checked by doing research or talking to an expert. Is there clear information available to prove that a fact is true? Can it be confirmed by more than one source? The more significant a fact is, the more important it is to make sure it is true. It's also important to make sure the facts are **relevant**, meaning that they provide information that applies to our situation. A fact could be true under certain circumstances, but not be true in other circumstances.

### 2. **Ask good questions.**

Good questions help us understand a topic, dig deeper into evidence, and make sure we can see a line of reasoning. Critical thinking involves asking questions to clear up uncertainty, digging deeper into a fact or assumption, asking for examples, or checking for meaning.

### 3. **Recognize assumptions.**

Assumptions are those ideas that we have accepted as so true that we don't need to think about them any more. Brushing our teeth prevents cavities. Exercise keeps us healthy.

The atmosphere is huge and can absorb an endless amount of air pollution. This last example shows how assumptions can turn out to be incorrect. Clearly, this outdated belief about the atmosphere has been proven wrong.

What assumptions are being made? Are they justified? How do they shape the person's point of view? Which assumptions should be questioned?

The process of revealing assumptions is important because it can open up new possibilities for creating solutions. It isn't easy to see our own assumptions – or someone else's. With careful examination and practice, this process can become easier. Looking at an issue from multiple points of view helps identify assumptions.

### 4. **Decide if a source can be trusted.**

Some sources of information are more reliable than others. It's important to make sure that our information comes from sources we can rely on. Some of the qualities that credible sources





have are long experience working in the area being studied, education in the field, a good reputation, and no other interests that would encourage them to take a certain point of view. Credible sources will give evidence to support their points, describe experiences that apply to the situation, or provide supporting information. Good sources also will go deeply enough into a subject to address any complex ideas. If the source ignores more difficult parts of a question, it may not be credible. We can also check to see if other experts agree with our source.

### **5. Analyze arguments and conclusions.**

In critical thinking, we can think of facts and assumptions as inputs and arguments, inferences, value judgments, and decisions as outputs. We can follow the logical flow from one to the other to see whether the output is justified. Here are some of the aspects we can consider:

**5.1. Identify the arguments or conclusions** – the output. What is being claimed? What decisions are being suggested? Is it supported by data or strong information?

**5.2. Identify the reasons.** Reasons may or may not be stated. Can you understand how the conclusion was reached?

**5.3. Look for relevance.** As you follow the line of reasoning, ask whether all the facts apply to this case. If they don't, what happens to the argument if those facts are left out?

**5.4. See how the argument is built.** Is there an if-then link between facts and conclusions? Do all the facts build toward the conclusion? Is there enough information to reach the conclusion, and is it clear and accurate? Are there any conclusions that are not supported by facts? Are there other explanations that have been left out?

**5.5. Are generalizations reasonable?** Generalizing information happens when we take something that is true in a specific situation and use it in other situations.

**5.6. Consider the consequences.** What happens if the conclusion or argument is true, or if the decision is made? Are the consequences acceptable? Are they worthwhile? Are they complete?

### **6. See issues from multiple points of view.**

Another useful tool in the study of sustainability issues is being able to look at an issue from multiple perspectives. This refers to valuing cultural and intellectual diversity and promoting healthy competition and sharing of ideas. This is in contrast to viewing and considering sustainability issues solely from the perspective of one particular group, belief system, or worldview.

How might different groups of people perceive, understand, and begin to solve a particular sustainability issue? Consider the knowledge, needs, and values of each perspective. How would each perspective view the big ideas of sustainability and the Earth Charter values?



## 7. Use evidence to explain your point of view and make decisions.

The previous points focused on how you might evaluate material using critical thinking. This last point can help you prepare valid conclusions and make good decisions. Use the above tools to evaluate your own thinking, writing, and decision-making, making sure that you are using accurate, relevant evidence and logical thinking.



## Multiple perspectives: Differences in Worldview<sup>19</sup>

An ability to appreciate differences in worldview can help increase understanding among different people throughout the world. Roz Wolmmering learned this fact firsthand when she became a Peace Corps volunteer in the West African country of Guinea-Bissau. The Peace Corps, an organization started in 1960, sends US citizens as volunteers to live and work in developing countries with the aim of increasing world peace. Peace Corps volunteers work in such fields as education, health, business development, agriculture, and youth development.

Roz was assigned to be a teacher in a classroom of 47 learners. On the first day of classes, Roz showed up promptly, charged with excitement. Her belief was, “Always wiser to be punctual and prepared than be tardy and unequipped.” Imagine her surprise when she found only two learners in the classroom playing cards. Eventually, more and more learners arrived in the next month, but she had classroom management issues and couldn’t seem to get learners interested in what they were learning.

Roz finally asked her learners what the problem was. They informed her:

- No one comes to school on the first day because learners are typically still on farms finishing harvests for their family or trying to register for class.
- Teachers only begin teaching the third week of school.
- Learners believed Roz didn’t command respect from them because she never told them to wear their school jackets.
- Teachers typically walk in after all learners are in the class so learners could stand up and honor them. Roz was always in the class-room waiting for her learners so they could never honor her.
- While Roz demanded that her learners write all the time, Guineans are more used to verbal communication.

Roz’s willingness to hear from her learners helped to clear up these differences in worldview.



## Media Literacy

Think of how much information you receive daily through the Internet, television, radio, and print. Do you ever question where it comes from or who provides you this information? Have you ever thought about how news a person receives in Egypt could look quite different from news someone might receive in the United States or China?

**Media literacy** is part of critical thinking. It is the ability to access and evaluate media messages of all kinds in order to understand how these messages create meaning and what impact they have on society. Depending on where the media you read or view is created, it is likely to present a certain point of view or be associated with a certain value. In the United States, a small handful of huge conglomerates – companies that own many other companies – run the majority of news and entertainment media. Well-known ones include Comcast, Disney and TimeWarner. These companies and just a few others produce most global media. When a few companies control messages that filter through the media, do you think there are some messages that might get left out?

In some places, the government exerts control over the media and may censor certain types of news. For example, when the 2011 Egyptian uprisings happened and President Mubarak was asked to step down, China censored certain websites that used the word “Egypt.” The Chinese government was wary of how the social movement in Egypt might spur political reform and demands for democracy within China.

Media messages have economic, political, and social purposes. Media literacy helps to reveal the purposes behind these messages. When you read newspapers, watch the news, explore the internet, and pay attention to other types of media, you can use the guidelines above about ask the following questions to help you determine possible bias:

- For whom was this message written?
- From whose perspective is this story told?
- Whose story is not told in this message?

## Think About It!

*What sources of information do you use?  
What point of view do they represent? Do  
you ever look for different points of view?*

## Youth Leadership: Foundation for Environmental Education’s Youth Reporters for the Environment

With help from the Youth Reporters from the Environment (YRE), young people are doing more than evaluating media. They’re creating it.

YRE involves youth from more than 25 countries around the world. The young reporters investigate sustainability issues occurring in their community and propose solutions. They create articles, photographs, and videos to document their work and educate community members.

The program helps support a new generation of environmental journalists who can identify sustainability issues and bring them to the public’s attention. The organization provides guidance on preparing effective articles, engaging photographs, and meaningful videos. Once a year, youth journalists can submit their best work to a panel of experts who select top submissions.<sup>20</sup>

## Point - Counterpoint

### *Has Yellowstone National Park been restored by reintroducing wolves?*

In the years since wolves were reintroduced to Yellowstone, scientists have continued to study wildlife in the park. A significant debate is underway, challenging how much the park has actually recovered and how big a part the wolves played in that recovery. This kind of debate is an important aspect of scientific research. Scientists use critical thinking to examine one another's findings, challenge their assumptions and conclusions, and propose alternative possibilities.

Point	Counterpoint
<p><b>Yes</b> <sup>21</sup></p> <ul style="list-style-type: none"> <li>• <b>The ecosystem has improved.</b> In some areas, trees are growing back. Beaver populations have increased, as have many other species' populations. As each species strengthens, others with which it interconnects will also strengthen.</li> <li>• <b>Other factors have helped.</b> Other predators, including bears and cougars, have also reduced the elk population. Drought has dried up streams, making it harder for willows to survive. And there may not be enough wolves to fill their natural role in the ecosystem.</li> <li>• <b>Change takes time.</b> Although there have been real improvements, we shouldn't expect to see Yellowstone return to its original condition in just a couple of decades. Ecosystems are slow to change.</li> <li>• <b>Are humans the top predator?</b> It is human activities, like ranching, mining, and farming, which limit wildlife populations in most areas. Considering ourselves as part of these ecosystems would give us a more realistic view of interconnections and system functions, and help us evaluate change more realistically.</li> </ul>	<p><b>No</b> <sup>22</sup></p> <ul style="list-style-type: none"> <li>• <b>Trees have not regrown.</b> Yellowstone's recovery depends on the regrowth of trees near streams. Beavers rely on trees, and other animals depend on beavers' impact on streams. And the trees haven't recovered.</li> <li>• <b>Wolves have not affected the elk.</b> Elk eat young trees near streams. Some studies show that elk don't move away from streams when wolves are nearby. Elk are able to avoid and defend themselves against wolves. Although there are fewer elk, it's mainly due to hunting by humans, more bears as predators, and drought.</li> <li>• <b>Yellowstone's ecosystem changed too much.</b> The ecosystem changed so much while the wolves were gone that it can't go back to its previous condition. During that time, the elk virtually wiped out the willows along stream banks. The beaver population dropped when they did not have willows to eat. With fewer beaver dams, there were fewer pools in the streams. These pools allowed water to filter back into the groundwater, which the willow roots tapped into. Without the pools, the level of groundwater dropped, so tree roots can no longer reach it.</li> <li>• <b>We need deeper fixes.</b> It is challenging for humans to live together with wilderness – especially large predators. We should try to solve the conflicts created by ranching and farming in the presence of wildlife.</li> </ul>

It's impossible to know for sure where the truth lies. Ecosystems, as living systems, are complex and change over time. Scientists continue to study the park and its changes. It is interesting that both sides see a need to address human-wildlife interconnections. As we observe and learn from these relationships within nature and between nature and humans, we can improve our ability to live within nature's boundaries and apply nature's principles to human society.



# How Systems Thinking and Critical Thinking Contribute to a Sustainability Worldview

## Thinking Skills for Sustainability

Recall that a sustainability worldview is made up of values, knowledge, intentions and capabilities, and behaviors. How have these

qualities changed as you have worked through this unit? Some examples are listed below. What would you add to these lists?

### Thinking Skills and My Sustainability Worldview

What is important to me?	What do I know?	What am I prepared to do?	What do I know how to do?
<ul style="list-style-type: none"> <li>• Only you can answer this!</li> <li>• How do your new understandings affect what is important</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainability issues are complex and interconnected, not simple cause-and-effect issues</li> <li>• Systems are made up of parts, relationships, structures, and purposes</li> <li>• I can learn new ways of thinking, which will help me understand issues and make decisions better</li> <li>• Critical thinking involves checking facts, assumptions, perspectives, conclusions, and sources of information</li> </ul>	<ul style="list-style-type: none"> <li>• Look for interconnections in my personal and school life</li> <li>• Look for feedback, stocks and flows</li> <li>• Practice critical thinking</li> </ul>	<ul style="list-style-type: none"> <li>• See relationships and wholes, rather than separate parts</li> <li>• Use systems thinking to understand issues</li> <li>• Figure out whether facts and opinions are correct</li> <li>• Challenge other perspectives politely</li> </ul>



## Think About It!

*What else would you like to know about these new ways of thinking?*

*How can you use them to understand sustainability issues you are interested in?*

### *Think also about the big ideas of sustainability from Unit 1:*

- Nature Connection
- Interconnectedness
- Universal Responsibility
- Respect for Limits
- Local to Global
- Peace and Collaboration
- Equity and Justice
- Health and Resiliency

These big ideas are often interconnected, and elements from some or all may contribute to sustainability issues. As you practice systems thinking, use these big ideas as a guide to look for hidden causes and possible solutions. The Earth Charter values, also presented in Unit 1, can help with critical thinking. They can be used to help you evaluate multiple perspectives and assumptions.

Changing the way we think isn't easy and takes time. Learning these new thinking skills is worth the effort, though. They will help build your ability to understand complex situations and wicked sustainability issues. Ultimately, they will help you contribute towards building a safe and just world for all, forever.



# Getting Started with Sustainably Activity Section





## Activity One

# What is Sustainability?

## Activity

In your Field Book, copy the following questions and write your responses.

1. **Think about the word "sustainability."** Jot down a few notes about what you think this term means.
2. **How does the word "sustainability" apply to your community?** What are examples of sustainable and unsustainable practices?
3. **Think about the objects and materials that you use every day.** Make a list of several items. Next to each item, write down or draw its source in nature.
4. **Write about an experience you have had outside during which you felt connected with nature or other living creatures.** Make a sketch if you like.
5. **Think about the word "interconnected." What do you think this word means?** List some examples of interconnections.
6. **What does the word "system" mean?** Write down examples of systems you know of or are part of.
7. **When you think about the future, what do you visualize for yourself, your family, and your children's children?** What would you like the future to be like for people and other species?
8. **What would you like to know about sustainability?**

MODULE ONE

55

## Summary

Learners answer questions to document their initial understanding of sustainability concepts. They will consider these questions again at the end of the unit, comparing their knowledge and understanding at the beginning and end of the unit.

## Time Required

- 20 minutes

## Key Concepts

- Sustainability
- Interconnectedness
- Nature Connection

## Objectives

- To document students' initial understanding of sustainability topics

## Inquiry/ Critical Thinking Questions

- What is sustainability?

## Discussion Questions

- What is sustainability?
- In what ways is our community sustainable?
- What sustainability issues exist in our community?

## Additional Resources

- Victor Nolet. (2016). *Educating for Sustainability: Principles and Practices for Teachers*. New York: Routledge.

## Summary

In this unit, learners will explore the following essential questions:

- What does sustainability mean?
- Why is sustainability important to me?
- How can I live more sustainably?
- How can I develop a sustainability worldview?

At the end of the unit, learners will be asked to respond to these questions.

Students will set up a Field Book that they will use throughout the unit to record their work, write reflections, and document daily observations of nature.

## Time Required

- 15-20 minutes

## Objectives

- To create a record of their work
- To document any changes in their sustainability worldview
- To provide evidence for self-assessments and formal assessment

## Materials

- For each student: 1" binder, or 8-1/2" x 11" composition book, or 3 brads, or a spiral-bound notebook. If students use spiral binders, they will need to tape or glue work papers into the notebook.
- Lined paper, as needed
- Blank paper for the cover
- Colored pencils
- Tape or glue



## Activity Two

# Set Up Field Book

## Activity

### 1. Create Your Field Book.<sup>23</sup>

#### a. Create a Cover page.

Include:

- i. The module's title, "Getting Started with Sustainability"
- ii. Your name
- iii. Name of class
- iv. School term and year
- v. Illustration, collage, or other artwork representing the module's topics

Tape your cover to your Field Book.

#### b. Make a Table of Contents page.

This page will be completed over the course of the unit. Include the pages described below and leave room for additional note pages and classwork to be added.

#### c. Make a Questions page.

Note any questions you have about the upcoming unit. Add questions to this page as you go through the unit.

d. **Make a Learning Links page.** This is a two-page spread; when the binder is open, both pages can be seen, as shown below. Write the essential questions near the middle of the page. For Unit 1, "Introduction to Sustainability," these questions are:

- i. What does sustainability mean?
- ii. Why is sustainability important to me?
- iii. How can I live more sustainably?
- iv. How can I develop a sustainability worldview?

As you work through the unit, create a mind map using text, drawings, and graphs. This page lets you document your developing answer to the primary question as you go through the unit. Include preliminary conclusions and evidence to support them. Draw arrows and lines to link elements.

56

FacingTheFuture.org

Students will record their work, add work papers, write reflections, and create a nature journal in their Field Book. It is meant to be a record of academic work and reflections, analysis, and creativity. It should document their explorations, curiosity, and evolving understanding of the opportunities humanity has to learn from the natural world.

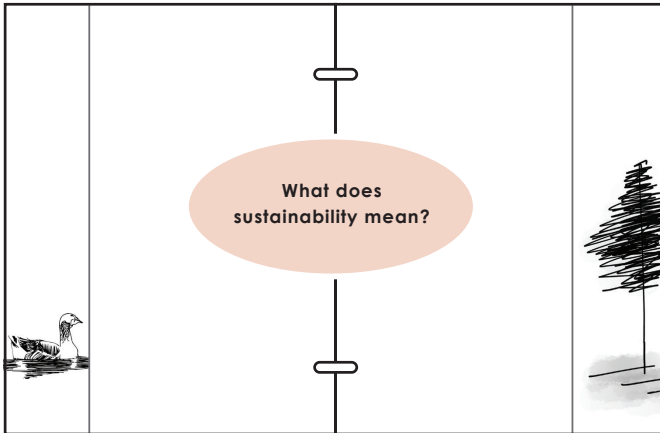
Daily activities have a Field Book section at the end. These sections include prompts for nature journaling, references to Think About It boxes in the day's reading assignment, and some other reflection questions or activities. You may also

choose to ask students to write about some of the Discussion Questions listed under daily activities instead of discussing them in class.

Please encourage the use of color to highlight key insights and connections, drawings and sketches, charts and graphics, and even snippets of song lyrics that relate to the subject, as well as note-taking and assignment completion.

When you have handouts, students can add them to a notebook or tape or glue them to pages in a spiral-bound notebook or composition book.





e. **Add work papers as needed.**

Generally, right-hand pages will be for notes, information, tables, and other analytical work. Left-hand pages will be for drawings, reflections, Field Book notes described in activities, or other reflections or artwork.

f. **On all your pages, leave wide margins**—about 1-1/2 inches each—at the top, bottom, and outside edges. These margins will be used in a later activity.

2. **Add your work papers from class activities to your Field Book.** Throughout this unit, as you complete work on handouts given in class, add the pages to your Field Book. Add titles and page numbers to your work papers, and add these pages to your Table of Contents.

## Field Book

1. Write responses to the **Think About It** boxes on pages 2 and 5.

## Summary

Students will adopt a daily practice of noticing and recording an example of wild nature in their everyday lives, throughout the duration of the module.

## Time Required

- 5 to 10 minutes per day

## Key Concepts

- Nature is everywhere
- I am part of nature

## Objectives

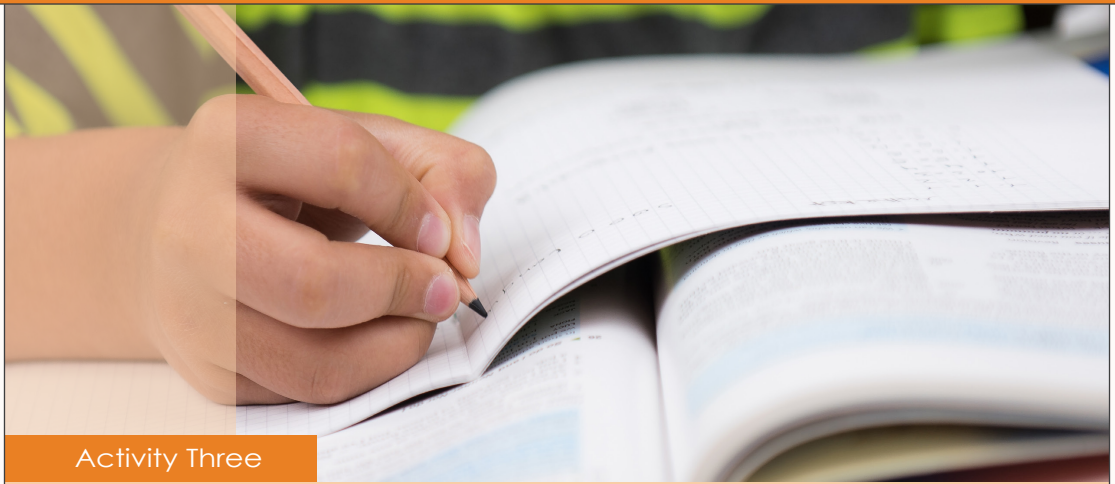
- To create a sense of belonging in and awareness of the student's local place
- To build a habit of recognizing nature's continual presence in everyday life
- To bring an appreciation of natural beauty to students

## Inquiry/ Critical Thinking Questions

- Do I live in wild nature?

## Materials

- Colored pencils



### Activity Three

## Nature Journal

### Activity

1. **Observe wild nature.** Each day, look for an example of wild nature in your daily life. You might notice a bird on a nearby tree, hear rain falling on the roof, or spot a weed pushing up through cracks in the sidewalk. The only requirement is that the observation not reflect a manufactured object or anything made with a manufactured object.

One option is to choose something to observe every day over the 4 weeks of the unit. You could notice the phases of the moon, the time and location of the sunset, the presence of birds or insects, patterns of wind or clouds, or something else that catches your interest.

Here is a mindfulness-based process you can use for observing wild organisms and building a sense of nature connection:

Step outside with the intention of experiencing yourself as part of nature. Try to let your thoughts run in the background of your mind without focusing on them. As you step outside, use your entire field of vision to take in your surroundings. Notice everything, living and non-living alike. Tune in to all of your senses. Notice sights, smells, sounds, temperature, wind, and sun. Allow some living organism to draw your attention. Keep your focus on it for at least 10 to 15 seconds, longer if you can. Just silently observe. Notice



58

FacingTheFuture.org

One way to use this activity is to ask students to respond to the prompts in the Field Book sections of each activity. These prompts are intended to help learners see connections between themselves and nature in ways that relate to the content.

You can also choose to have students use this activity for finding a daily nature connection, making their own informal observations or – if they choose – using the mindfulness-based observation

process below. Daily nature observation helps build a sense of nature connection and often reduces stress. The instructions below guide students in this method of nature journaling.

You can have students spend the first five minutes of class writing or drawing in their nature journal. Or they can complete the journal at home. Have colored pencils available, or have students have a set at home or at school.

the organism in its ecosystem, linked with other creatures. Notice yourself similarly surrounded by your ecosystem, linked with others – including, in some way, this organism. As your attention shifts away, see if you feel gratitude for this other living creature.

You are also welcome to observe in your own way or to use the prompts that are offered in the Field Book sections of the activities.

2. **Record your observation.** In your Field Book, write a few sentences each day describing your observation of wild nature. You can describe what you saw as a scientist would, including details of shape, color, movement, location, and other aspects of nature that were present. You can also write a personal journal about your feelings or reaction to your observation. Another possibility would be to write a short poem, haiku, or fast fiction story about what you observed, centering on the natural elements.

Sketch pictures to accompany your daily entries, using colored pencils, colored pens, or crayons. This activity isn't a drawing contest; it's just a way to document what you saw. Artistry is welcome if you are inspired, but not needed. You can include in your sketch your subject's surroundings and interconnections or fill in details like a snowflake or bird feather. On some days you may just want to fill in the margins with the colors of the day.<sup>24</sup>

Record your observations and sketches in the margins of your daily work pages. Use the top, side, and bottom margins, and fill them in with images, color, and text. Weaving your observations in with your analytical work helps create a visual message that nature itself is woven throughout human society. It also can make your work pages look artistic and beautiful. You can draw a straight line on the three outside edges of your pages



to create a margin, or use your creativity to design artistic borders. You can also write longer observation notes or add sketches at the bottom of pages or on entire sheets of your reflection pages, if you like.

## Field Book

1. **Nature Journal:** When you step outside, notice the living beings and geological systems that share your space: plants, trees, birds, insects, other people, food systems, air, weather, and more. What do you notice? How are you connected with these different beings and systems? Write about or draw your interconnections.
2. Write a response to the **Think About It** box on page 2.

## Summary

Learners spend time noticing what they love about their community, school, and neighborhoods and what they would change if they could. They will focus on both human and natural systems. They will create a physical or digital collage representing their place.

## Time Required

- One 50-minute class period, plus preparation time

## Reading Prior to Assignment

- Pages 2-5

## Key Concepts

- Sense of place

## Objectives

- To develop in students an awareness of and appreciation for their local place
- To recognize both human and natural systems in their local place
- To identify opportunities for change
- To create a foundation for later work on applying sustainability concepts and principles to students' local place

## Inquiry/ Critical Thinking Questions

- What do I love about my local place?
- What would I change about my local place if I could?
- How do human and natural systems in my local place meet the needs of people and nature?



## Activity Four

# My Place

## Preparation

Over the next day, pay special attention to your community – both your human and natural community. In your town, school, and neighborhood, notice what seems to be working and what you would change if you could.

What are your favorite parts of your local place? What do you love about where you live? What would you change if you could? In what ways are the needs of people or nature not being met? Are people happy? Are they secure? Are people involved in the community? Are people healthy? Do people have good opportunities for work at a living wage, self-expression, justice, and equity? Are people's basic needs met: do people have enough water, food, sanitation,

shelter, and clothing? Are people's higher-order needs met? Psychologist Abraham Maslow described peoples' needs beyond basic body and safety needs as follows:

- Belonging and love
- Self-esteem
- Knowledge and thinking
- Beauty
- Self-actualization
- Transcendence<sup>25</sup>

Also notice how nature fits in with your community. Is your community clean and free of pollution? Are resources like water and energy used at the same rate at which nature can replace them? Are local ecosystems, including

60

FacingTheFuture.org

## Materials

- 1 piece of poster board or card stock for each student
- Tape or glue
- OR digital media to create a collage

urban wildlife like birds and trees, healthy? What natural features or living beings are important to you? What elements of the natural world are easy for you to access? In what ways would you like your life to be more closely linked with nature?

Take notes about what you see. Begin to take or collect photographs, printed words from newspapers or magazines, sketches or other images, ticket stubs, fallen leaves, or other items that represent the human and natural elements of your place. Include poetry or other writing. Continue to collect these items over the next ten days.

## Activity

1. **Create a collage** to reflect your perceptions about your place, using the materials you have collected. If necessary, leave some blank space to add material you collect over the next several days.
2. **Share your work with the class.** Take time to look at the work other students have created.

## Field Book

1. **Nature Journal:** Try to find an elder in your community and have a conversation with them about how they perceived and interacted with nature when they were your age. Did they live in a city or in the country? Did they grow food, hunt, or fish? How much time did they spend outdoors in nature? How did their experiences compare with yours? How do their ideas about nature and humans' place in nature compare with yours?
2. Write a response to the **Think About It** box on page 3.



Students can continue to add to their collage over the course of the unit.

## Discussion Questions

- What human and natural features of the community are the students most drawn to and most satisfied with?
- What human and natural features are the students most concerned about or most interested in changing?
- What differences in viewpoints have emerged from looking at other students' collages?
- Do these different viewpoints strengthen or weaken the group's understanding of the community?

## Extensions

- Write and submit essays as part of Orion Magazine's "Place Where You Live" essay project. The website includes a few guiding questions about the reader's local place and invites contributions of 350-word maximum essays about local place. The website also includes a map showing places covered by reader essays and links to essays others have written. A few essays are published in their magazine. Please see: <https://orionmagazine.org/place-where-you-live>
- Identify words and phrases that describe local plant or animal life or natural phenomena. For examples and background information, please see: <https://orionmagazine.org/article/landspeak/>

## Summary

Learners apply sustainability concepts to the ideas about their community that the learners identified in Activity Four.

## Time Required

- One 50-minute class period

## Reading Prior to Assignment

- Pages 6-10

## Key Concepts

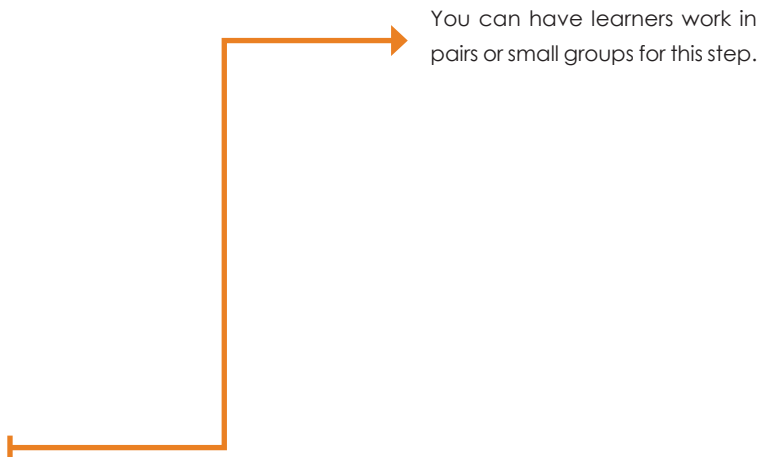
- Sustainability Definitions
- Properties of a Healthy Ecosystem

## Objectives

- To apply sustainability definitions to the local human and natural systems
- To identify local examples of healthy ecosystems
- To explore ways in which properties of healthy ecosystems can be used to make human systems more sustainable

## Inquiry/ Critical Thinking Questions

- What is sustainability?
- What factors contribute to sustainability?
- What is a healthy ecosystem?
- How can ecosystem properties apply to human systems?



## Additional Resources

- Visit the Earth Charter Youth Network website, which includes leadership courses, project implementation resources, a showcase of previous Earth Charter-based sustainability projects, a youth network, and more. Please see: <http://earthcharter.org/youth/>

In your Field Book, write down the two definitions. Below the definitions, make a T-chart with the headings, "Most Sustainable" and "Least Sustainable." Note the three to five aspects of your community that, according to these definitions, you consider most and least sustainable.

3. **Identify examples from nature in your community of the three characteristics of healthy ecosystems** described on pages 8-9: no waste, adaptation, and redundancy. Try to also identify ways in which human systems in your town, school, or neighborhood demonstrate no waste, adaptation, and redundancy. Write your examples from both natural and human systems in your Field Book.
4. **As a class, discuss your findings.**

## Field Book

1. **Nature Journal:** Spend one day communicating only with people that you can reach physically. Avoid phone, email, or other electronic contact with people who are too far away to talk with in person. Imagine what your life would be like without modern communication and transportation. Write about your experiences.
2. Write a response to the **Think About It** box on page 11.



## Discussion Questions

- What economic, social, and environmental aspects of your human and natural systems are sustainable? Which of these aspects represent sustainability challenges?
- What aspects of your community do the students feel are most and least sustainable?
- What examples of healthy natural ecosystems did students identify?
- What examples of healthy human systems did students identify? How could other human systems adopt these three ecosystem properties – no waste, adaptation, and redundancy – to become more like nature and therefore more sustainable?

## Extensions

- Explore a view of interconnections between race and wilderness in a brief essay called "Desegregating Wilderness" by Jourdan Imani Keith at: <https://orionmagazine.org/article/desegregating-wilderness/>. Discuss how this essay addresses the sustainability concepts of environment, economy, and society.
- Take the "Where You At? A Bioregional Quiz", adapted from Leonard Charles, et. al, Coevolution Quarterly 32 (Winter 1981). Please see: <http://oly-wa.us/herbnwisdom/PDF/BioregionalQuiz.pdf>.

## Summary

Learners investigate their personal values and compare their values with sustainability values presented in the Earth Charter.

## Time Required

- One 50-minute class period

## Reading Prior to Assignment

- Pages 11-14

## Key Concepts

- Diversity of Values
- Sustainability Values
- Earth Charter

## Objectives

- To become aware of individual values and how they compare with sustainability values
- To take responsibility for choosing personal values
- To practice hearing and accepting diverse values

## Inquiry/ Critical Thinking Questions

- What values are most important to me?
- What values support a safe and just world for all, forever?

## Materials

- Colored pencils (optional)



### Activity Six

## Sustainability and My Values

### Activity

1. **Create a Values Web Graphic in your Field Book.** Draw a circle that takes up most of a page and write the following values around the circle, spacing the words evenly:<sup>26</sup>
  - a. Democracy and freedom
  - b. Openness to new perspectives and experiences
  - c. Well-being
  - d. Wealth
  - e. Equity and fairness
  - f. Peace
  - g. Respect for authority
  - h. Tolerance and diversity
  - i. Respect and care for others and prevention of harm
  - j. Tradition
  - k. Security
  - l. Loyalty
  - m. Integrity
2. **Rank the values in order of importance to you.** Try to focus only on your own priorities and beliefs, eliminating influence from peers, society, or other sources. Write each ranking near the value on the outside of the circle.
3. **Connect related values.** Draw lines between values that you feel support one another, focusing on one or two links per value.
4. **Compare Earth Charter values with the values on your Values Web.** Refer to the Earth Charter principles on page 14. Circle or otherwise highlight the values on your Values Web that you feel match up with Earth Charter principles. Using a different color or style of line than you used in Step 3, draw lines showing interconnections between the Earth Charter-related values you selected.

Encourage students to creatively embellish their graphic as time allows.

64

FacingTheFuture.org

## Extensions

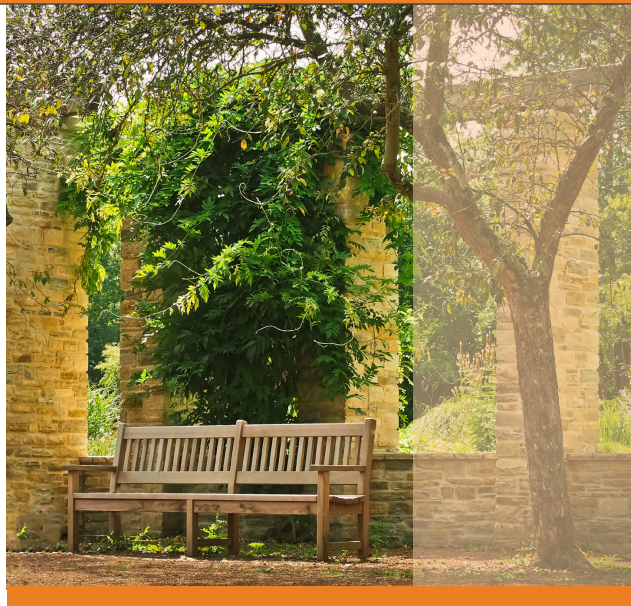
- Have learners read the Preamble to the Earth Charter, along with the more detailed descriptions of the Earth Charter principles. In response to the reading, students can write a reflective essay; create a work of visual art, poetry, or music; or select a principle to work to support over time. Please see: <http://earthcharter.org/discover/the-earth-charter/>

Discuss the students' results as a class. Explore which values were most important to students. Encourage students to listen openly and nonjudgmentally to the reasons their classmates offer for choosing and ranking their values. If students do not agree with their classmates' choices, have students try to ask questions to build understanding.



## Field Book

1. **Nature Journal:** Notice the number of natural and manufactured items in your immediate surroundings. Over the next day, notice how much of your world is natural and how much is manufactured. How do you count the air you breathe? How do you count sunshine? How do you count natural processes like photosynthesis, growth, cycling of energy and matter, and gravity? Write about or draw representations of your observations and thoughts.
2. Write a response to the **Think About It** box on page 14.



## Discussion Questions

- What values were most important to the class? Why?
- What values seem to be most closely linked with the Earth Charter?
- Which of your preferred values best support sustainability? Which ones may be in conflict with sustainability?
- Do you consider your worldview to be a sustainability worldview? Why or why not? Are some parts of your worldview more sustainable than other parts?
- What are examples of world views other than those presented in the Earth Charter?

## Additional Resources

- The Earth Charter: <http://earthcharter.org/discover/the-earth-charter/>
- Visit the Earth Charter Youth Network website, which includes leadership courses, project implementation resources, a showcase of previous Earth Charter-based sustainability projects, a youth network, and more. Please see: <http://earthcharter.org/youth/>
- Brown University Choices Program on values and public policy: <http://www.choices.edu/resources/values.php>

## Summary

Learners create a physical timeline showing the span of Earth and human history, highlighting sustainability milestones.

## Time Required

- One 50-minute class period

## Reading Prior to Assignment

- Pages 15-18

## Key Concepts

- Anthropocene Period
- Population Growth
- Wicked Problems

## Objectives

- To obtain a physical sense of the immense span of Earth's history and humanity's place in that timeline
- To identify the significance of human impacts on Earth in a short period of time

## Inquiry/ Critical Thinking Questions

- How much of Earth's history have humans been part of?
- How much of the planet do we impact?
- What progress are we making toward minimizing our impact?
- Are we living in an Anthropocene Period?

## Handouts

- Timeline Cards divided among the students

## Materials

- Cut apart the Timeline Cards on pages 66B-66F along the bold lines

Clear an area of the classroom where students can line up next to each other; space along the walls is fine. Identify one end of the line-up area as "ancient history" and the other end as "modern time." Divide the Timeline Cards evenly among the students; please see pages 66B-66F.

## Activity Seven

# Human and Nature Timeline

## Activity

1. **Read the Timeline Card(s) given to you by your teacher.**<sup>27</sup>
2. **Form a timeline by lining up with the other students in the order of the events shown on your Timeline Cards.** If more than one student has a card for the same decade, those students can stand in a line perpendicular to the timeline. Create a sense of scale by standing farther from a student whose Timeline Card year is more distant from yours and closer to a student whose Timeline Card year is nearer to yours.
3. **As instructed by your teacher, read your Timeline Card event and year aloud.**

Ask students to begin reading their cards, one at a time, once they are all in place.

66

FacingTheFuture.org

## Extensions

- Highlight trends by having all students with Timeline Cards related to specific topics step forward and re-read their cards. Possible topics include development and understanding of nature, development of laws and government, human population growth, energy, social justice, or pollution.
- Have students prepare a timeline to scale, showing key events including the formation of Earth, evolution of different species, evolution of humans, key milestones in human development, and key sustainability events. Note the extremely small amount of the timeline occupied by human activity.

### Discussion Questions

- How much of Earth's history has included humans?
- What impact have humans had on Earth during our time on the planet?
- Have other species affected Earth as much as we have? Provide evidence for your answers.
- Do you think the current period of history should be named the Anthropocene? Why or why not?
- What general trends do you notice in the timeline? Provide evidence.
- What wicked problems are linked with population growth and industrialization?

### Additional Resources

- "Affluenza" Quiz: Have students take the PBS quiz to test their Consumption Quotient. Please see: <http://earthcharter.org/youth/>

## Timeline Cards

<b>4,300,000,000,000 BCE</b>	<b>3,800,000,000,000 BCE</b>	<b>2,450,000,000 BCE</b>
Earth formed.	Life began on Earth.	Oxygen enriched Earth's atmosphere.
<b>530,000,000 BCE</b>	<b>475,000,000 BCE</b>	<b>300,000,000 BCE</b>
The first fish evolved.	The first land plants evolved.	Fossil fuels – coal, oil, and natural gas – were formed.
<b>225,000,000 BCE</b>	<b>200,000,000 BCE</b>	<b>4,000,000 BCE</b>
Dinosaurs evolved.	The first mammals evolved.	The amount of carbon dioxide – a greenhouse gas – in the atmosphere was at the high level of 400 parts per million. The planet was much warmer than it is today.
<b>1,000,000 BCE</b>	<b>200,000 BCE</b>	<b>65,000 BCE</b>
The earliest evidence shows early humans using fire.	Modern humans ( <i>Homo sapiens</i> ) evolved.	Early humans first left Africa.

<b>18,000 BCE</b>	<b>12,000 BCE</b>	<b>10,000 BCE</b>
Last ice age ended, with ice sheets covering much of Asia, Europe, and North America beginning to melt.	Humans lived on Africa, Asia, Europe, North America, and South America.	Agriculture began, primarily in Asia and North America.
<b>10,000 BCE</b>	<b>5000 BCE</b>	<b>4000 BCE</b>
World population was about 5 million.	World population was about 10 million.	Oil was first used by ancient Sumerians, Assyrians, and Babylonians.
<b>4000 BCE</b>	<b>1750 BCE</b>	<b>1600 BCE</b>
Natural gas was first discovered in Iran.	Mathematics was first developed.	Humans recorded observations of astronomy, according to the first written records found on the subject.
<b>1000 BCE</b>	<b>500 BCE</b>	<b>0 CE</b>
Coal was first mined in China.	World population was about 100 million.	World population reached 300 million.

<b>1000</b>	<b>1445</b>	<b>1685</b>
World population was still about 300 million.	The printing press was invented.	The Scientific Revolution began, emphasizing science and reason.
<b>1712</b>	<b>1775</b>	<b>1777</b>
The steam engine was invented.	Native Americans taught George Washington how to treat frostbite using petroleum oil.	The State of Vermont, which was an independent republic at the time, was the first nation to abolish slavery.
<b>1783</b>	<b>1804</b>	<b>1850s</b>
American Revolution creates modern democratic government.	The first railroad was built in Wales.	A British engineer developed the first process for mass-producing steel at a low cost. This development helped launch the Industrial Revolution.
<b>1859</b>	<b>1865</b>	<b>1879</b>
Oil was first pumped from underground.	About 1/5 of British factory workers were younger than 15 years old.	Electricity was first sold to customers.
<b>1886</b>	<b>1899</b>	<b>1907</b>
The first gasoline-powered car was invented in Germany.	American consumers bought 2,500 motor vehicles.	Plastic was first made from fossil fuels.

<b>1913</b>	<b>1914</b>	<b>1927</b>
Globally, 600,000 cars were made.	The first commercial airline began business.	World population reached 2 billion.
<b>1927</b>	<b>1938</b>	<b>1945</b>
Over 15 million Model T cars had been sold.	U.S. President Franklin D. Roosevelt signed the Fair Labor Standards Act. The law limited work hours for all workers to 44 hours per week, set a minimum wage, and ended child labor.	United Nations was formed to maintain international peace, support equal rights, and to build international cooperation.
<b>1954</b>	<b>1954</b>	<b>1956</b>
Olympia, Washington, U.S. was the first city to pay for the return of aluminum cans for recycling.	Electricity was first generated from sunlight.	The City of London adopted the first air quality law, the Clean Air Act of 1956.
<b>1960</b>	<b>1964</b>	<b>1970</b>
World population reached 3 billion.	The United States Civil Rights Act of 1964 banned discrimination based on race, color, religion, sex, or national origin.	The first Earth Day was held to bring attention to build support for environmental protection.
<b>1970s</b>	<b>1974</b>	<b>1987</b>
Permaculture, a farming technique based on the principles of ecology and the work of farmers in Australia, Japan, and the U.S., was developed.	World population reached 4 billion.	Global agreement was reached to reduce emissions causing the stratospheric ozone hole.

<b>1987</b>	<b>1999</b>	<b>2008</b>
World population reached 5 billion.	World population reached 6 billion.	United Nations adopted the Declaration on the Rights of Indigenous People.
<b>2008</b>	<b>2008</b>	<b>2011</b>
Ecuador added rights of nature to its constitution.	Humans occupied, farmed, or otherwise affected over 4/5 of Earth's land.	Scientists estimated there are 3 to 100 million species of living organisms on the planet.
<b>2014</b>	<b>2014</b>	<b>2015</b>
There were 1.2 billion vehicles on the world's roads.	Scientists discovered that trees use networks of fungi weaving through the trees' roots to share nutrients, support young trees, fight off invasive species, and even signal one another to develop protective defenses against pests.	The amount of carbon dioxide – a greenhouse gas – in the atmosphere reached 400 parts per million, mainly due to burning fossil fuels. Scientists believe that a concentration of 350 parts per million CO <sub>2</sub> would maintain the planet's climate.
<b>2015</b>	<b>2015</b>	
The world's nations approved the Paris Agreement to limit greenhouse gas emissions and reduce climate change.	24% of all electricity generated worldwide came from renewable sources (solar, wind, hydroelectric, geothermal, and biomass).	





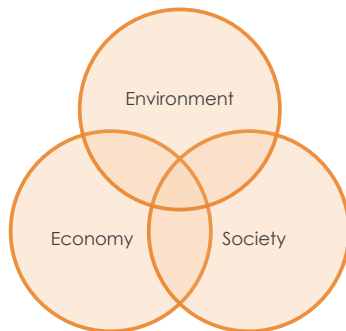
Students can work in small groups or pairs for this activity. Let students know that they will build on the work they do in this activity during a later activity.

## Activity Eight

# Local Sustainability Case Study, Part 1

### Activity I

1. **Identify a sustainability issue** that you feel passionate about or interested in. For ideas, review the issues you identified in Activity 5, Sustainability in My Place. Other sources of inspiration include work done by a local organization, a school situation, a scientific or technological development, a law or government policy, a current event, or an item in the news. Remember that sustainability issues include environmental, social, and economic interconnections. Look for a topic that gives you the opportunity to look at all three of these factors.



2. **Write a brief description of your issue.** In your Field Book, write a few paragraphs explaining your issue and the sustainability implications it represents. Describe the situation carefully and consider different points of view. Use a table or Venn diagram to summarize the environmental, social, and economic aspects.

3. **Use the Big Ideas of Sustainability Organizer to analyze your issue.** Note examples of ways in which your issue reflects each Big Idea. Where possible, be sure to include strengths, where your topic successfully applies the Big Idea. Also note weaknesses, where the Big Idea is not represented. Use color or

MODULE ONE

67

Students should choose issues that are complex enough to work in some depth, that they know something about or can easily research key information, and for which they can brainstorm feasible solutions.

### Summary

Learners will use sustainability principles to analyze a local real-world wicked problem of their choosing. The real-world issue students select in this activity will be used in Activities Fourteen, Sixteen, and Seventeen.

### Time Required

- Two 50-minute class periods

### Reading Prior to Assignment

- Pages 19-26

### Key Concepts

- Sustainability Big Ideas
- Sustainability Worldview

### Objectives

- To frame a local issue using sustainability principles
- To establish a basis for further analysis and problem solving in Activities Fourteen, Sixteen and Seventeen

### Inquiry/ Critical Thinking Questions

- How can the Big Ideas of Sustainability help analyze a problem?
- How can a sustainability worldview help develop a solution for a real-world problem?
- How can I find a "less bad/ more good" solution for a wicked problem?

### Handouts

- Big Ideas of Sustainability Organizer, page 68A
- Sustainability Worldview Organizer, page 68B

### Materials

- Prepare copies of the Big Ideas of Sustainability Organizer and Sustainability Worldview Organizer for each learner

## Discussion Questions

- Is your issue a wicked problem? Why or why not?
- Which Big Ideas of Sustainability helped you identify the root causes of your issue?
- Which Big Ideas helped point you toward possible solutions?

notes to highlight particular strengths and weaknesses. Also use lines to link boxes that represent important interconnections. Use dashed lines to represent links that do not exist but could be created to strengthen the system you are examining.

4. **Use the Sustainability Worldview Organizer to analyze your issue further.** Consider how your issue can be seen from a sustainability worldview. On the Organizer, describe how sustainability-based knowledge, values, dispositions, and behaviors could apply to the situation. How can the Big Ideas of Sustainability help identify the sources of the problem and possible interconnections? How can Earth Charter values and the Universal Declaration of Human Rights help frame a solution to work towards? What other species' rights need to be considered? What dispositions – capabilities, intentions, and beliefs – and behaviors can help you understand and solve your issue?
5. **Identify possible root causes and potential solutions for your issue.** In your Field Book, note underlying factors that contribute to the problem you have identified. What interconnections can you identify? Also make notes about ideas you have for possible solutions. What would be a "more good/less bad" solution? Considering the definitions of sustainability in the text, what would be the most sustainable outcome you can imagine?
6. **Share your work with the class.** Discuss your idea, the Big Ideas, Earth Charter values, and the rights of humans and other species that you considered.

## Field Book

### Day 1

1. **Nature Journal:** Over the next several days, notice something outside that is changing: a leaf changing color in the fall, a flower bud opening in the spring, a change in the phase of the moon at any time of year.
2. Write a response to the **Think About It** box on page 15.
3. Update your Learning Links and Questions pages.

## Field Book

### Day 2

1. **Nature Journal:** Guess the age of trees, weeds, animals, insects, and landforms like mountains, rivers, or even rocks that you can see around you. Think about their lifecycle: how they came to be here and where they will go at the end of their life.
2. Write a response to the **Think About It** box on page 20.

# Big Ideas of Sustainability Organizer

Name: \_\_\_\_\_  
Issue: \_\_\_\_\_

Note examples of each big idea in the appropriate box. Draw lines to connect related big ideas.

Universal Responsibility

Respect for Limits

Connecting with Nature

Interconnectedness

Equity and Justice

Health and Resiliency

Peace and Collaboration

Name: \_\_\_\_\_

Issue: \_\_\_\_\_

## Sustainability Worldview Organizer

### Knowledge

Note what you know and what you need to know to understand the issue.

### Values

Note values demonstrated and how they are demonstrated. Also note what values could lead to a solution.

### Disposition

Describe wants, preferences, intentions and capabilities that support sustainability.

### Behaviors

Describe behaviors and actions that support sustainability.

Start the activity by asking students to describe the world they would like to live in and pass on to future generations – including other species. What would that world look like? How would people live? How would they share the planet with other species? Ask them to consider jobs, government, peace, food and water, energy, and other aspects. What would make this world sustainable? Use this discussion as a foundation for the following activity steps.

Please see the Elements of a Sustainable World table on page 12.

Provide each student with a Big Ideas of Sustainability Organizer.

## Activity Nine

# Creating the Future We Want

### Activity

1. **As a class, brainstorm a list of topics** that would need to be considered when designing a safe and just world for all, forever.
  - b. Use the Big Ideas of Sustainability Organizer, provided by your teacher, to explore possible interconnections and solutions.
    - i. On your organizer, make notes about how each Big Idea applies to your topic. What aspects of your topic are sustainable or unsustainable according to each Big Idea? Use the Earth Charter principles on page 14 and the Declaration of Universal Human Rights on page 24 to guide your group discussion.
    - ii. Draw lines between interconnected Big Ideas. On the lines, make notes that describe the interconnections.
 

For example, suppose your topic is Climate Change. One issue within the Big Idea of Equity and Justice could be the loss of jobs for coal miners. Because burning coal releases more greenhouse gases than burning other fossil fuels – and certainly releases more greenhouse gases than does using renewable
2. **Imagine your ideal sustainable future.** Spend about five minutes imagining and making notes about your vision of a sustainable world. In your Field Book, write a description, create a mind map, or make a drawing to capture your thoughts. Highlight the topics that are most important to you.
3. **As a class, make a list of the topics that students are most interested in.**
4. **In small groups, discuss your topic as it exists today and as you would like to see it in the future.**
  - a. Consider the following questions and write your responses in your Field Book:
    - i. What people, other species, Earth systems, or social systems are affected by your issue?
    - ii. What are local impacts?
    - iii. What are global impacts?

Identify enough groups to have all students work in small groups on one of their top choices; each group will need at least four students. Make sure there is a list of topics that all students can see, because they will need to work with other groups as they identify interconnections between topics.

### Handouts

- Big Ideas of Sustainability Organizer

### Materials

- Make one copy of the Big Ideas of Sustainability Organizer, page 68B, for each student.

### Inquiry/ Critical Thinking Questions

- What qualities would a safe and just world for all, forever, have?
- How can my classmates and I help bring about a more sustainable world?

### Summary

Learners will work together to visualize a safe and just world for all and identify specific changes they would like to see. Students will explore interconnections between issues and consider ways to include these interconnections in their proposed solutions. Optional extensions include research into local issues or solutions; presenting their vision to class parents, school or community leaders, or other interested audiences; and taking action on their proposals.

### Time Required

- Two 50-minute class periods

You may want to ask students to research their topics outside of class for the work in Steps 4 and 5.

### Reading Prior to Assignment

- Review pages 1-26

### Key Concepts

- Positive Future Focus
- Big Ideas of Sustainability
- Earth Charter Values
- Universal Declaration of Human Rights
- Agency

### Objectives

- To create a vision of a safe and just world for all, forever
- To identify interconnections between sustainability issues
- To develop a positive future focus
- To develop confidence in the ability to bring about positive change

**Optional:** Make commitments and take action. Students can make commitments to take action based on their proposals. The class can follow up with one another periodically to support one another, work through challenges, and celebrate successes.

Collect the top interconnections from the groups. Ask each group to select two students to represent their group in discussions with the two interconnected groups; one student will go to each of the two groups.

### Discussion Questions

- How do you feel about the future after going through this activity?
- How do you feel about your ability to bring about positive change?
- What parts of the class master plan are most exciting and motivating to you?
- How difficult or easy was it to reach agreements in your group? What changes could make that process easier?

### Extensions

- Present the class proposal to school or community leadership. Seek support for the commitments made by students.
- Present the class proposal to local news media. Seek support from other community members and organizations.

energy – less coal is likely to be used in a low- or no-carbon future. The Big Idea of Universal Responsibility might include being responsible for using low- or no-carbon energy and ensuring that society provides job retraining for workers whose jobs are eliminated in the transition away from high-carbon fuels. A line between these two boxes could note this need for job retraining.

- iii. Consider interconnections with other topics being considered by your class. Note the top two interconnections between your topic and other topics. For example, how can water issues and energy issues work together to improve sustainability?

- c. **Explore interconnections with other groups.** How might changes in one topic affect another topic, increasing or decreasing sustainability? As you look for overall societal improvements, how can you optimize the sustainability of the overall system? Are you encountering any wicked problems – where you need to look for “more good/less bad” solutions – rather than solutions that are clearly an improvement overall?

- d. **In your original small group, organize your ideas into a proposal.** Write a summary of your proposal, including answers to the following questions: Within your topic and its interconnections, what could the future look like? What are the benefits of your proposal? What are tradeoffs or downsides of your proposal? What are key challenges to realizing this future? What actions would need to be taken to achieve your vision? What actions could students take today to begin to bring about your vision? Fine-tune any interconnecting issues with other groups.

5. **Create a master plan.** Along with the other groups, present your proposal to the class.

### Field Book

#### Day 1

1. **Nature Journal:** Notice places where you have an impact on another living being. Examples include your social relationships, the space you occupy that is not habitat for a wild creature, the food you eat, the resources you use, or recreational travel you take part in. If you practiced universal responsibility, would your actions be the same or different from your current actions?
2. Write a response to the **Think About It** box on page 25.

### Field Book

#### Day 2

1. **Nature Journal:** With the next bite of food you take, imagine Earth in space. Imagine sunlight on different parts of the planet, powering photosynthesis and spurring plant growth all over the world. Imagine the sunlight that contributed to the food you are eating and all of the transformations of matter and energy that occurred between that sunlight and the act of you eating. Imagine all the other living organisms taking in matter and energy powered by the sun. Notice people and other living things near you and imagine others across the planet, also powered by sunlight.
2. Write a response to the **Think About It** box on page 26.
3. Update your Learning Links and Questions pages.

### Additional Resources

- The Kids' Guide to Social Action by Barbara Lewis. Please see: <https://www.freespirit.com/files/original/Kids-Guide-Social-Action-preview-1.pdf>
- Kate Raworth's essay "A Safe and Just Space for Humanity: Can We Live within the Donut?" Please see: <https://www.oxfam.org/sites/www.oxfam.org/files/dp-a-safe-and-just-space-for-humanity-130212-en.pdf>



## Activity Ten

# Introduction to Sustainability Reflection, Self-Assessment, and Commitments

## Activity

1. **Revisit the sustainability questions from Activity One.** In your Field Book, copy the following questions and write your responses. How have your answers changed since the beginning of the unit?
  - a. **Think about the word "sustainability."** Jot down a few notes about what you think this term means.
  - b. **How does the word "sustainability" apply to your community?** What are examples of sustainable and unsustainable practices?
  - c. **Think about the objects and materials that you use every day.** Make a list of several items. Next to each item, write down or draw its source in nature.
  - d. **Write about an experience you have had outside during which you felt connected with nature or other living creatures.** Make a sketch if you like.
  - e. **Think about the word "interconnected."** What do you think this word means? List some examples of interconnections.
  - f. **What does the word "system" mean?** Write down examples of systems you know of or are part of.
  - g. **When you think about the future, what do you visualize** for yourself, your family, and your children's children? What would you like the future to be like for people and other species?
  - h. **What would you like to know about sustainability?**
2. **In your Field Book, respond to the following questions and prompts.**
  - a. **Write one paragraph in response to each of the unit's essential questions:**
    - i. What does sustainability mean?
    - ii. Why is sustainability important to me?
    - iii. How can I live more sustainably?
    - iv. How can I develop a sustainability worldview?
  - b. **What can you do to carry through with possible sustainability actions and issues that you identified in this unit?**

MODULE ONE

71

## Summary

Students examine next steps they would like to take and reflect on their learning.

## Time Required

- One fifty-minute class period

## Reading Prior to Assignment

- Review pages 1-26

## Key Concepts

- Definition of Sustainability
- Big Ideas of Sustainability
- Earth Charter Principles
- Universal Human Rights
- Sustainability Worldview

## Objectives

- To reflect on learning and changes in worldview
- To transfer learning outside of class

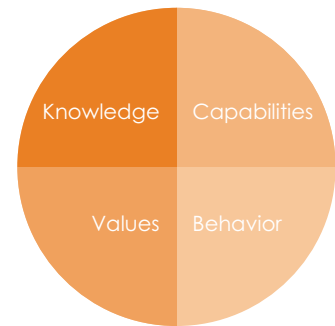
## Materials

Colored pencils, optional



With whom can you share your sustainability knowledge? Write down concrete action steps, goals, and timing for any commitments you would like to make. What might make it difficult for you to take these steps? How can you overcome these obstacles?

- c. **Think about how your worldview has changed through what you have learned about sustainability.** A sustainability worldview is based on knowledge, capabilities, values, and behavior. Make a circle and divide it into quarters. Write one of the elements of a sustainability worldview in each quarter. Note any changes that have taken place in these areas; use arrows to show interconnections between the four quarters. Use colors.
- d. **Look back at the Questions page in your Field Book.** Are there unanswered questions? How can you get them answered? What else would you like to know about sustainability in the future?



- e. **How have the daily nature connection activities affected you?**
- f. **What parts of the Introduction to Sustainability unit represented your best work?** What would you like to do differently?



Review the definition of a system and the characteristics of a system from the text. Discuss how the Yellowstone example shows the importance of considering interconnections beyond immediate cause-and-effect relationships. Discuss the implications for considering interconnections in sustainability thinking.



## Activity Eleven

# Systems All Around Us

### Activity

1. **Look at the list of groupings in the Think About It box on page 32.** In your Field Book, make a T-chart with the headings "Systems" and "Non-Systems." Write each of the examples in the Think About It box in the column you think is most appropriate.
2. **Add examples of systems and non-systems.** In each column of your T-chart, add several additional examples of systems and other groupings.
3. **Working in pairs, select a few systems to explore further.** Make a table in your Field Book with the headings "System," "Components," "Interconnections and Structure," and "Purpose." For each system you have selected, describe each element in your table.
4. **With your partner, make a list of systems you are part of.** Consider the events, tasks, routines, and pleasures of your everyday life. What systems support these activities? List these systems in your Field Book.

### Field Book

1. **Nature Journal:** Actively choose to spread peace in all of your dealings with other people and other species for the next 24 hours. Then write about what happened. How was your day different from what it might have been?
2. Write a response to the **Think About It** box on page 30.
3. Create new Learning Links and Questions pages for the Tools for Engaging with Sustainability Issues unit.

Discuss the findings as a class.

Discuss each group's findings as a class.

As a class, discuss the systems each pair identified.

MODULE ONE

73

## Summary

Learners will identify systems and system components in their daily lives.

## Time Required

- One fifty-minute class period

## Reading Prior to Assignment

- Pages 27-32

## Key Concepts

- System
- System Components
- Interconnections
- System Structure
- System Purpose

## Objectives

- To define a system
- To recognize the difference between systems and other groups of elements
- To identify systems in daily life

## Inquiry/Critical Thinking Questions

- What is a system?
- How is a system different from other groups of elements?
- What are the characteristics of a system?

## Discussion Questions

- How do these interconnections affect the way you see the world?
- When you think about interconnections, does the world seem bigger, smaller, or both? Give reasons.
- In what ways are you independent, dependent, and interdependent? Give examples and reasoning.

## Additional Resources

- "A World of Systems" 9-minute video, narrated and illustrated by David Macaulay and developed with systems educator Linda Booth Sweeney. Please see: [https://www.youtube.com/watch?v=A\\_BtS008J0k&feature=youtu.be](https://www.youtube.com/watch?v=A_BtS008J0k&feature=youtu.be).
- The Waters Foundation has a variety of systems thinking tools and resources on their website; please see: <http://watersfoundation.org>.
- Systems education resources by educator Linda Booth Sweeney; please see: <http://www.lindaboothsweeney.net>.

## Extensions

- Have students track systems they observe over the next two weeks. Share results.
- Continue to identify and discuss systems in other coursework throughout the school term.

## Summary

Learners will identify feedback in systems, look for ways to add feedback to systems where it does not exist, and create causal loop diagrams to represent feedback loops.

## Time Required

- One 50-minute class period

## Reading Prior to Assignment

- Pages 33-36

## Key Concepts

- Feedback
- Balancing Loop
- Reinforcing Loop
- Causal Loop Diagram

## Objectives

- To identify feedback – and the lack of feedback – in systems
- To represent feedback loops in systems using causal loop diagrams
- To know the difference between reinforcing and balancing feedback
- To build feedback into relationships into simple cause-and-effect relationships to improve sustainability

## Inquiry/ Critical Thinking Questions

- How does feedback affect a system?
- How can feedback help address sustainability issues?

## Handouts

- Feedback and Systems Worksheet, pages 74A-74D; see solutions on pages 74E - 74H



Review the idea of linear thinking from page 29. Review material on feedback.

You can decide whether to have the students work through the problems together as a class with your guidance, in pairs or small groups, or individually.

## Activity Twelve

# Feedback in Systems

## Activity

1. **Complete the Feedback and Systems worksheet provided by your teacher.**
2. **Discuss the worksheet problems and answers in class.**

## Field Book

1. **Nature Journal:** Practice the Big Idea of Equity and Justice for the next 24 hours. You might practice social justice by using your power to create positive change; you might practice gender equity through your treatment of others. You can practice climate equity by avoiding activities that generate greenhouse gas emissions like eating meat or using fossil fuels. You can practice intergenerational equity by acting to protect resources for future generations. After 24 hours, write about your experiences. What did you do differently? How did it feel to consider equity and justice in your actions?
2. Write a response to the **Think About It** box on page 34.

74

FacingTheFuture.org

## Materials

- Make a copy of the Feedback and Systems Worksheet for each student on pages 74A - 74D

## Discussion Questions

- How does feedback improve sustainability outcomes?
- How do causal loop diagrams help show relationships in a system?

## Extensions

- Continue to look for and discuss feedback systems throughout the school term.

Name: \_\_\_\_\_

## Feedback in Systems

1. The concentration of carbon dioxide ( $\text{CO}_2$ ) in the atmosphere has been increasing since the Industrial Revolution began in the 1700s. However, the average global temperature did not begin to rise until the mid-1900s.

a. What feedback exists in the atmospheric system?

---

---

---

---

b. What feedback do humans receive from the atmospheric system?

---

---

---

---

c. How do humans use this feedback?

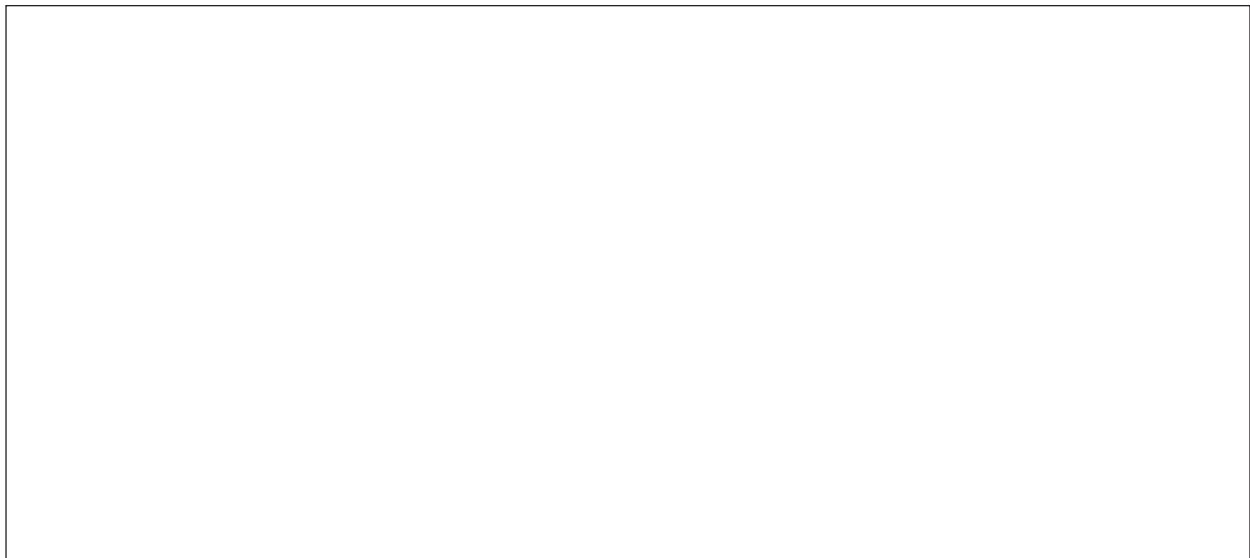
---

---

---

---

d. Draw a causal loop diagram for this system.



Name: \_\_\_\_\_

## Feedback in Systems *continued*

2. The city landfill is getting full. The city weighs the trash trucks when the trucks bring trash for disposal. City workers estimate trash volume based on trash weight; the workers compare the incoming trash volume to the available volume at the landfill. From these figures, the city workers predict how long the landfill can stay open. City residents do not know that the landfill is almost full, so they continue to generate trash at the usual rate.

a. What feedback does the city receive about landfill capacity?

---

---

b. How might the city use feedback about landfill capacity?

---

---

c. What feedback do the city residents receive about landfill capacity?

---

---

d. What feedback could the city residents receive about landfill capacity?

---

---

e. How could the city residents use feedback about landfill capacity?

---

---

f. Draw a causal loop diagram for the system. Draw a causal loop diagram for the system.

Name: \_\_\_\_\_

## Feedback in Systems *continued*

3. The library staff at a school consists of a librarian and several student assistants. The librarian maintains the computerized book and periodical catalog, orders books, decides which books should be retired, renews magazines and newspapers, and reviews the computerized reports of overdue books. If a book is not returned, the student who checked it out receives an overdue notice. The student assistants check books out to students, check returned books back into the computerized system, and re-shelve books.

a. What is the purpose of the library staff system?

---

---

b. Where is there feedback in this system?

---

---

c. Is the feedback reinforcing or balancing?

---

---

d. Draw a causal loop diagram for the system when a student returns a book on time. Draw your diagram in the box below question e, leaving room to add a second loop in the next question.

e. Add elements and arrows in a second loop to show how the system works when a student does not return a book on time.

Name: \_\_\_\_\_

## Feedback in Systems *continued*

4. How could feedback be added to the following situations to improve sustainability?

a. A significant amount of manufacturing has been moved from developed countries like the United States to developing countries like India, China, Brazil, and Bangladesh. As manufacturing has increased in these countries, air pollution laws have been slowly adopted. Developing countries are following the same pattern that developed countries followed: air pollution has increased a faster rate than have laws that limit pollution. Consumers buying goods manufactured in developing countries may not know about the pollution that is related to their purchases.

---

---

---

---

b. Automobile drivers can reduce their fuel efficiency with the following practices:<sup>27a</sup>

- i. Keep tires properly inflated: increase fuel efficiency by 5%
- ii. Use cruise control on the highway: increase fuel efficiency by 6%
- iii. Avoid engine idling: save 0.5 to 1 gallon of gasoline per hour
- iv. Drive smoothly – accelerate and brake lightly, when conditions allow: increase fuel efficiency by up to 30%
- v. Combine trips to make sure you operate the car with a warmed-up engine: increase fuel efficiency by up to 50% on short trips

How can drivers be given feedback to encourage them to use these practices, which will help them reduce fossil fuel use, reduce air pollution, and reduce climate change?

---

---

---

---

c. Although most countries require that workers earn a minimum wage, the minimum wages in some cases not provide enough money to afford housing, food, clothing, basic medical care, and other basic needs. Employers are concerned that increased wages will make them lose customers, and customers are unable or unwilling to pay higher prices.

---

---

---

---

# Feedback in Systems

## Solutions

1. The concentration of carbon dioxide (CO<sub>2</sub>) in the atmosphere has been increasing since the Industrial Revolution began in the 1700s. However, the average global temperature did not begin to rise until the mid-1900s.

a. What feedback exists in the atmospheric system?

**Temperature increases – after a delay – when the CO<sub>2</sub> concentration increases.**

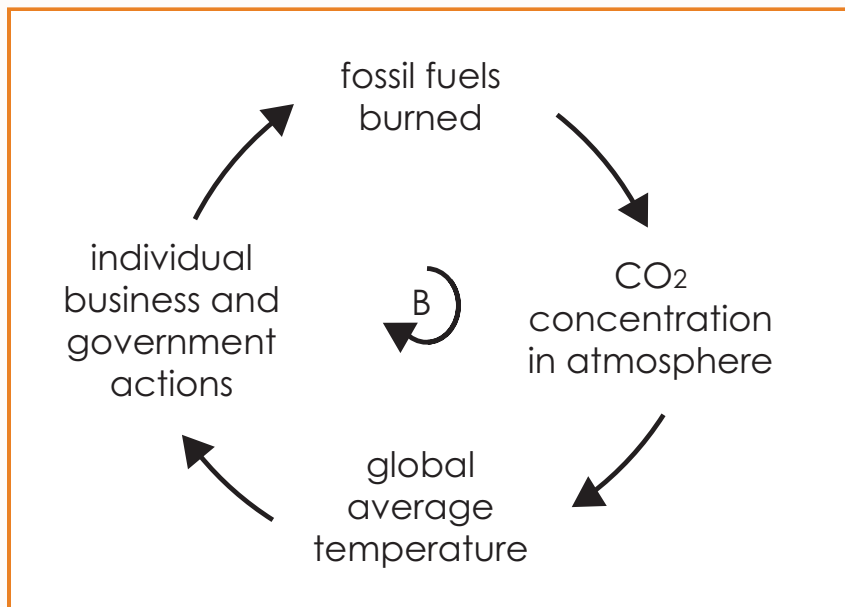
b. What feedback do humans receive from the atmospheric system?

**Governments, scientists, universities, and weather forecasters collect information about temperature, atmospheric concentrations, and other atmospheric conditions.**

c. How do humans use this feedback?

**Scientists have created computer models and conducted other experiments to try to understand the complex chemical and physical relationships in the atmosphere. Researchers have continued to collect data to see if their models are accurate. Because almost all climate scientists now agree that increases of CO<sub>2</sub> in the atmosphere – caused by people – are warming the atmosphere, governments, businesses, and individuals are now taking action to reduce their use of fossil fuels and reduce warming.**

d. Draw a causal loop diagram for this system.



# Feedback in Systems

## Solutions

2. The city landfill is getting full. The city weighs the trash trucks when the trucks bring trash for disposal. City workers estimate trash volume based on trash weight; the workers compare the incoming trash volume to the available volume at the landfill. From these figures, the city workers predict how long the landfill can stay open. City residents do not know that the landfill is almost full, so they continue to generate trash at the usual rate.

a. What feedback does the city receive about landfill capacity?

**The city receives feedback (information) about available landfill capacity and predictions about how long the landfill can stay open.**

b. How might the city use feedback about landfill capacity?

**The city can use this information to decide whether to open a new landfill or to adopt other waste disposal practices like recycling or increased disposal fees.**

c. What feedback do the city residents receive about landfill capacity?

**City residents receive no feedback about landfill capacity.**

d. What feedback could the city residents receive about landfill capacity?

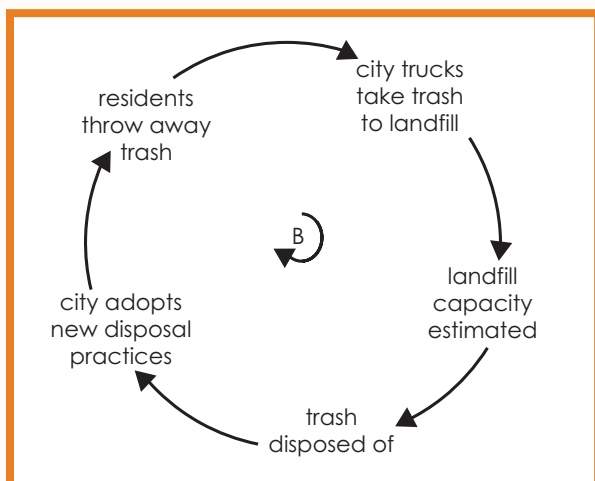
**City residents could receive reports from the landfill operators or news reports, for example. Other forms of feedback could include increased disposal fees as landfill capacity declines.**

e. How could the city residents use feedback about landfill capacity?

**If city residents knew that their landfill was reaching capacity, the residents could choose to generate less trash, recycle more trash, compost garden and food waste, or donate used goods to charity instead of disposing of them.**

f. Draw a causal loop diagram for the system. Draw a causal loop diagram for the system.

**Initially, there is no feedback involving the city residents. Instead, we have a linear cause-and-effect relationship. Once the city adopts new practices, feedback becomes available to residents.**





# Feedback in Systems

## Solutions

3. The library staff at a school consists of a librarian and several student assistants. The librarian maintains the computerized book and periodical catalog, orders books, decides which books should be retired, renews magazines and newspapers, and reviews the computerized reports of overdue books. If a book is not returned, the student who checked it out receives an overdue notice. The student assistants check books out to students, check returned books back into the computerized system, and re-shelve books. **You may want to go over this example together in class to show students how to create a causal loop diagram with two loops; see (e) below.**

a. What is the purpose of the library staff system?

**To maintain the book collection, including making sure that books are returned after they have been checked out.**

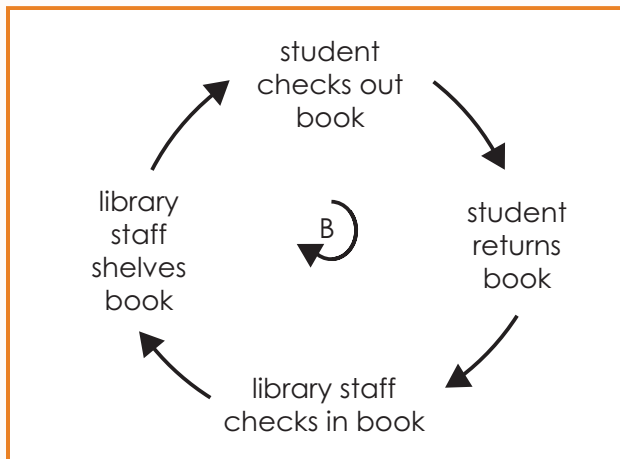
b. Where is there feedback in this system?

**The check-out/check-in system, computerized reports of overdue books, and notifications provide feedback, providing the librarian with information if books are not returned.**

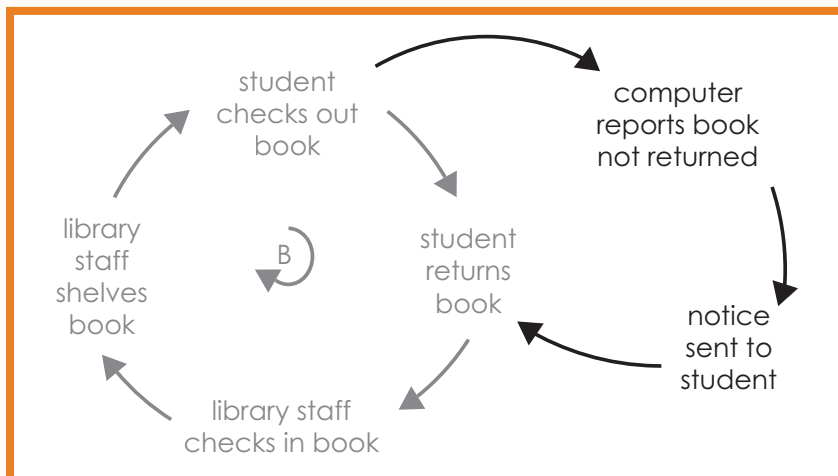
c. Is the feedback reinforcing or balancing?

**The feedback is balancing.**

d. Draw a causal loop diagram for the system when a student returns a book on time. Draw your diagram in the box below question e, leaving room to add a second loop in the next question.



e. Add elements and arrows in a second loop to show how the system works when a student does not return a book on time. **Causal loops can be joined together, as in this example.**



# Feedback in Systems

## Solutions

4. How could feedback be added to the following situations to improve sustainability?

- a. A significant amount of manufacturing has been moved from developed countries like the United States to developing countries like India, China, Brazil, and Bangladesh. As manufacturing has increased in these countries, air pollution laws have been slowly adopted. Developing countries are following the same pattern that developed countries followed: air pollution has increased a faster rate than have laws that limit pollution. Consumers buying goods manufactured in developing countries may not know about the pollution that is related to their purchases.

**Feedback to consumers could come in the form of news reports, air pollution fees on exported goods, tags on manufactured goods, or other methods. Feedback to government agencies could include health effects on local residents or air quality data.**

- b. Automobile drivers can reduce their fuel efficiency with the following practices:<sup>27a</sup>

- i. Keep tires properly inflated: increase fuel efficiency by 5%
- ii. Use cruise control on the highway: increase fuel efficiency by 6%
- iii. Avoid engine idling: save 0.5 to 1 gallon of gasoline per hour
- iv. Drive smoothly – accelerate and brake lightly, when conditions allow: increase fuel efficiency by up to 30%
- v. Combine trips to make sure you operate the car with a warmed-up engine: increase fuel efficiency by up to 50% on short trips

How can drivers be given feedback to encourage them to use these practices, which will help them reduce fossil fuel use, reduce air pollution, and reduce climate change?

**Cars could be built with messaging systems to remind drivers of these practices or alert drivers when they are not following these practices; car user manuals could prominently highlight these practices; notices could be placed on gasoline pumps; public education campaigns could be conducted; community leaders could adopt and promote these practices; air quality agencies could predict the improvement in air quality based on these practices and provide this information to the public; schools and other locations where cars tend to idle could post signs; cost savings from improving efficiency could be calculated and presented to drivers.**

- c. Although most countries require that workers earn a minimum wage, the minimum wages in some cases not provide enough money to afford housing, food, clothing, basic medical care, and other basic needs. Employers are concerned that increased wages will make them lose customers, and customers are unable or unwilling to pay higher prices.

**This wage-price relationship is a wicked problem – there is no simple solution that works for everyone involved. We need to look for a more good/less bad solution. One solution is to challenge the underlying consumer culture, which promotes overconsumption. If consumers avoid unnecessary purchases and buy durable, well-made goods, it may be easier to justify higher prices.**



You may choose to have the class work together, in pairs or small groups, or individually to complete the handout.

### Summary

Learners identify stocks and flows and use these ideas to analyze the structure of systems.

### Time Required

- One fifty-minute class period

### Reading Prior to Assignment

- Pages 37-39

### Key Concepts

- Stocks
- Flows
- System Change

### Objectives

- To identify stocks and flows in systems
- To use the ideas of stocks and flows to understand system structure
- To represent systems using stock and flow diagrams

### Inquiry/Critical Thinking Questions

- How can systems be represented with stocks and flows?
- How do stocks and flows help us understand system change?

### Handouts

- Stocks and Flows, pages 75A-75C

### Materials/Preparation

- Prepare one Stocks and Flows handout for each student

### Extensions

- With the class, look for examples of other stocks and flows at school or in your community. Try to find environmental, social, and economic issues where you can use these ideas. Identify stocks and flows and draw diagrams to show the system structures. Talk through ways in which the diagrams can help analyze the situation and lead to improvements. Have the students document these examples in their Field Books.

### Discussion Questions

- How do stock and flow diagrams help analyze and identify improvements to systems?
- What other examples of systems, stocks, and flows can you think of in your day-to-day life or in the news?

Name: \_\_\_\_\_

## Stocks and Flows

1. Let's consider the planetary water cycle as a system. The system contains many stocks – portions of the system that store water – and flows – parts of the system that allow movement of water.

a. List some stocks in the water cycle.

---

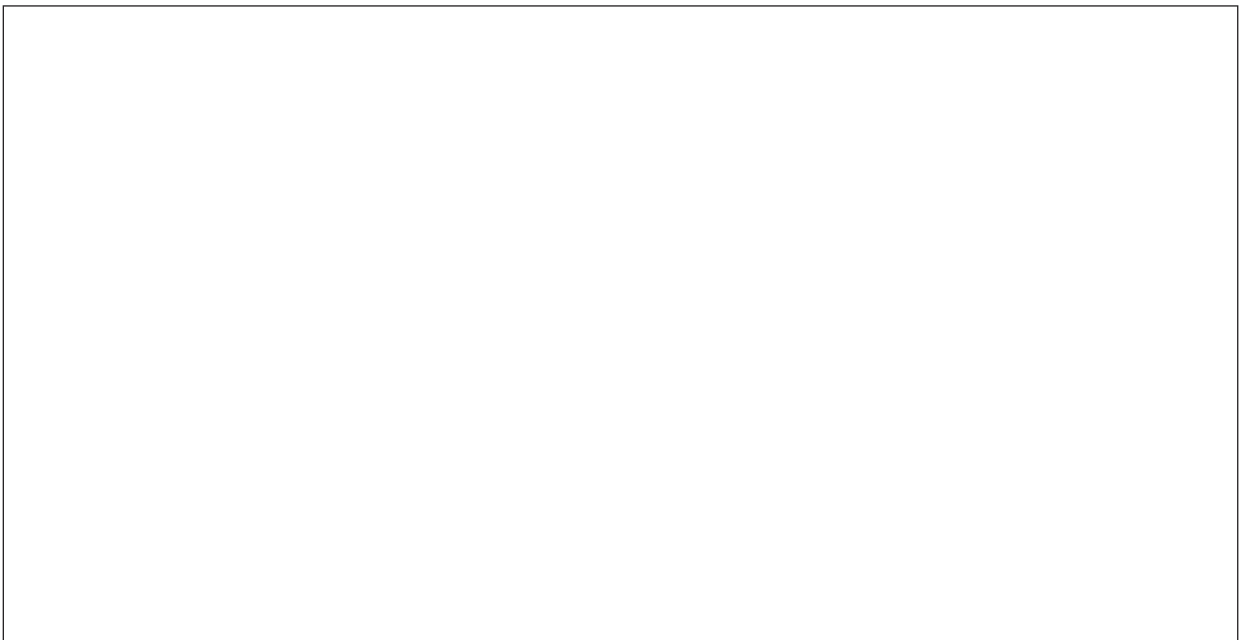
---

b. List some flows in the water cycle.

---

---

c. Draw a simple stock and flow diagram of a stock – a cloud – with an inflow of evaporation and an outflow of rainfall.



Name: \_\_\_\_\_

## Stocks and Flows *continued*

2. Let's look at a social system. Suppose we want to study factors influencing voting rights; voting rights will be the stock we want to optimize. What could be flows in and out of the voting rights stock?

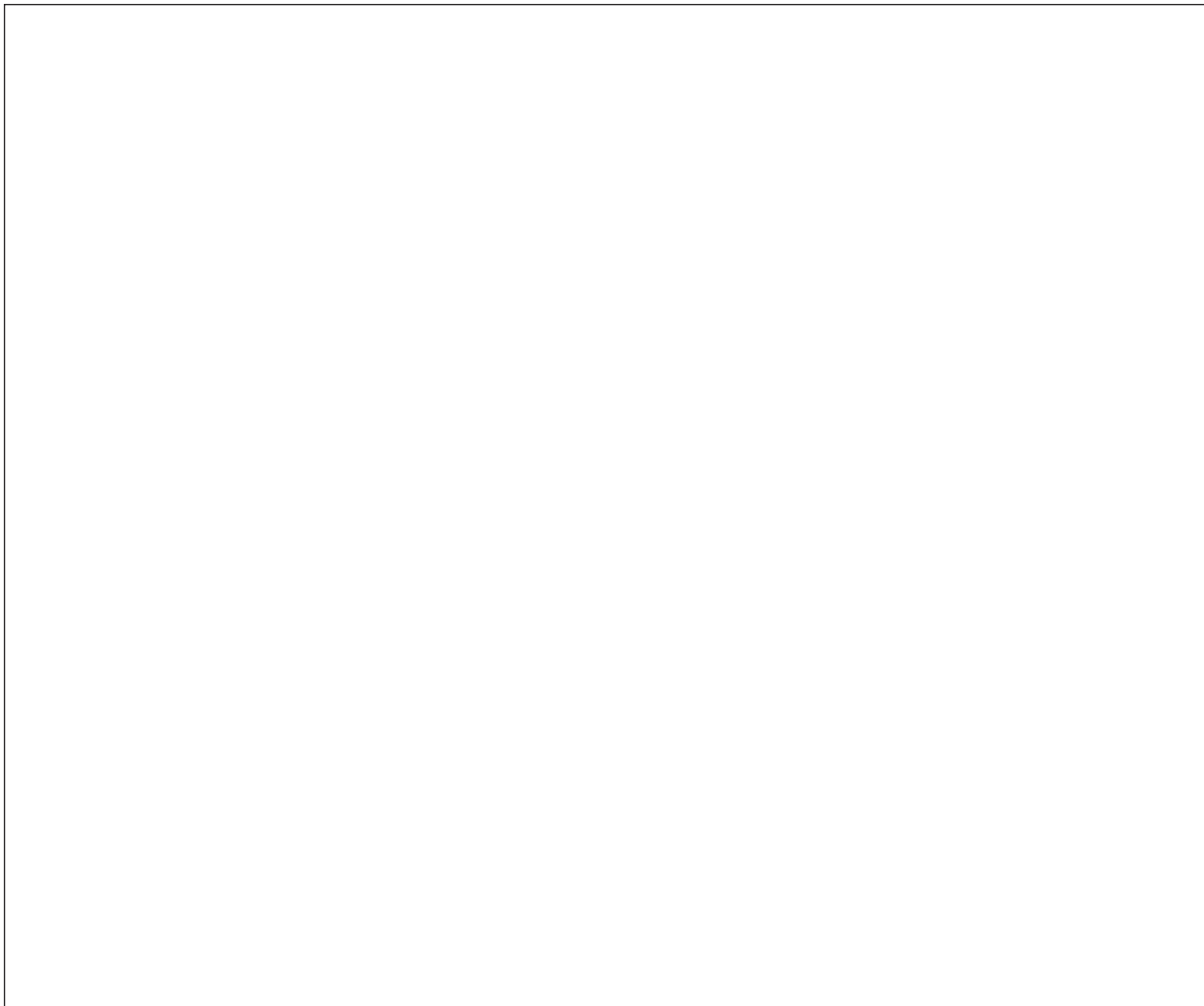
---

---

---

---

Draw a stock and flow diagram of voting rights.



Name: \_\_\_\_\_

## Stocks and Flows *continued*

3. When studying a system, we always need to decide which portions we want to study. There are usually more stocks and flows than we need to examine when considering a particular issue.

Let's consider the idea of replenishing groundwater in agricultural areas in central California. After several years of drought, groundwater levels are low. At the same time, snowmelt in wet years can overwhelm the state water collection system. Floodwaters can bypass levees and reservoirs. Stanford University has estimated that the state could collect and store six times more water by boosting groundwater storage than by expanding and building new reservoirs – for the same cost and with fewer environmental problems. Enhancing underground storage helps solve several problems: it collects snowmelt that could otherwise cause flooding; it refills underground aquifers; and it costs less, uses fewer resources, and creates fewer environmental problems than do other solutions. Let's create a stock and flow diagram to represent this situation.

List stocks in the portion of the water cycle and human water system being studied.

---

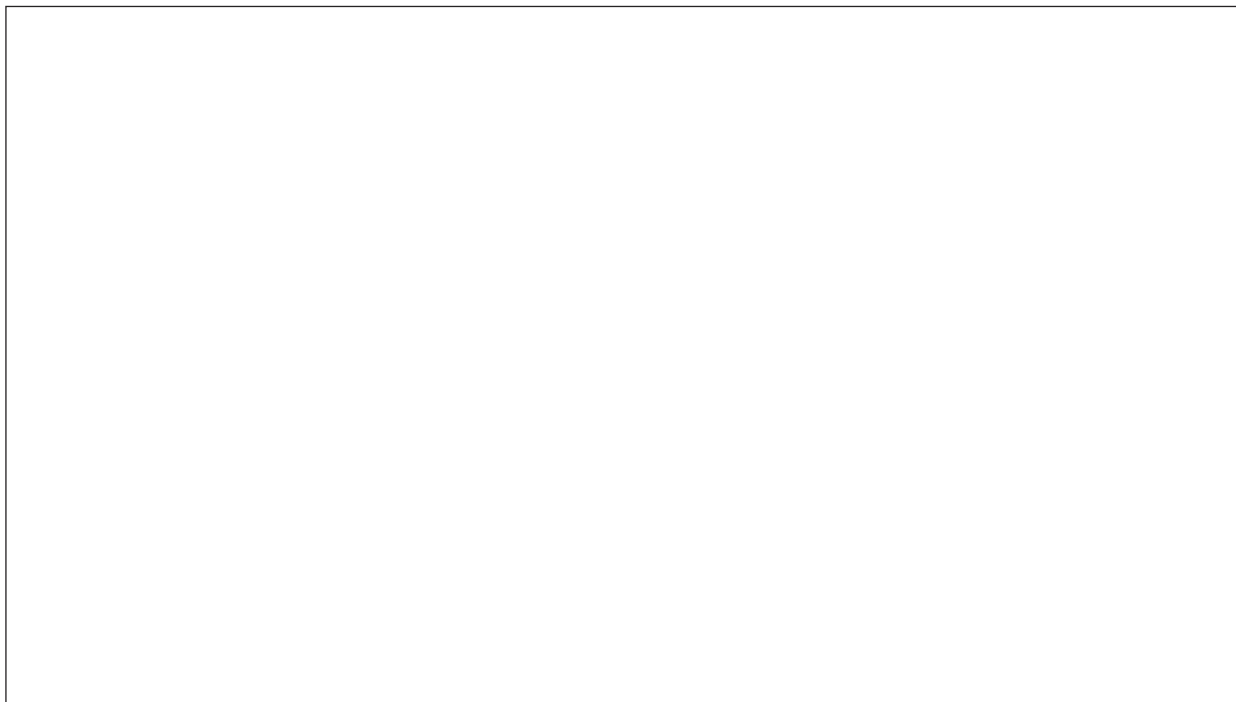
---

List flows in this scenario.

---

---

Create a stock and flow diagram for this scenario. Start small at first, with the basics of the system. Include the main stock – the water in the aquifer – and the three main flows – the snowmelt, natural percolation, and the pumping of water out of the aquifer. Note that stock and flow diagrams can have a flow leading into a stock or into another flow.



# Stocks and Flows

## Solutions

1. Let's consider the planetary water cycle as a system. The system contains many stocks – portions of the system that store water – and flows – parts of the system that allow movement of water.

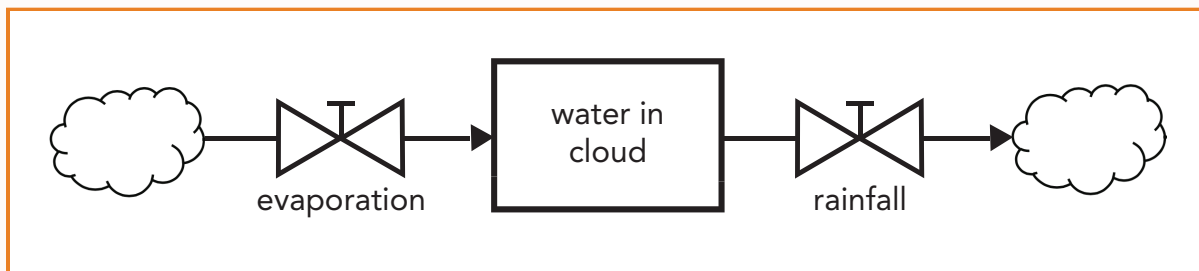
a. List some stocks in the water cycle.

**Stocks include oceans, lakes, rivers, seas, clouds, snowpack, and underground aquifers.**

b. List some flows in the water cycle.

**Flows include evaporation, rainfall, percolation of water through layers of Earth to reach groundwater, pumping of water from underground aquifers, and runoff from snowmelt.**

c. Draw a simple stock and flow diagram of a stock – a cloud – with an inflow of evaporation and an outflow of rainfall.



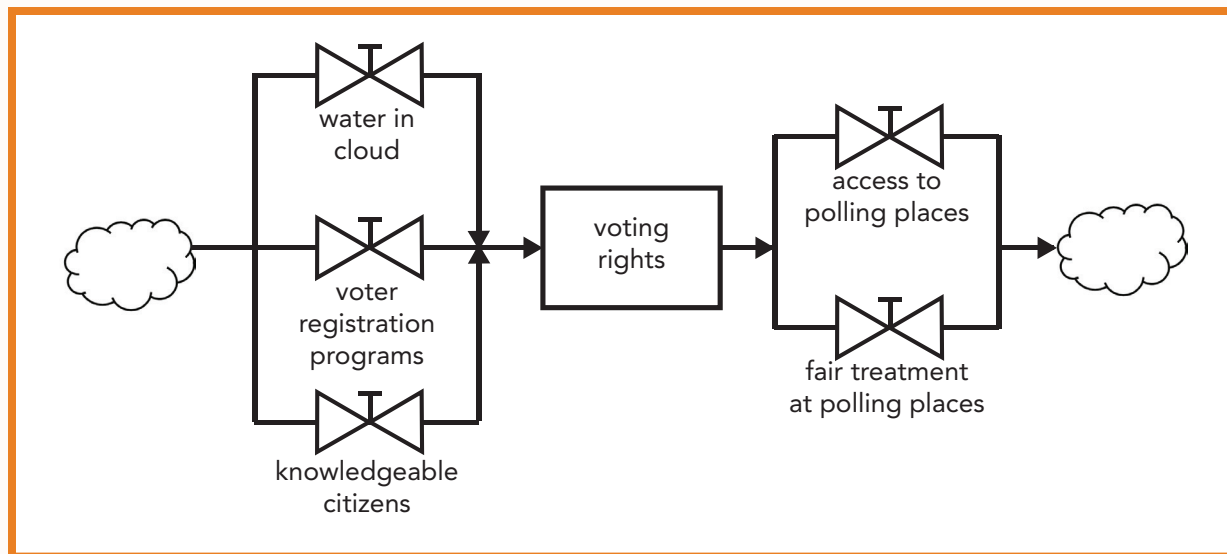
# Stocks and Flows

## Solutions

2. Let's look at a social system. Suppose we want to study factors influencing voting rights; voting rights will be the stock we want to optimize. What could be flows in and out of the voting rights stock?

**Input flows would build the supply of voting rights; these flows could include laws, local programs including voter registration and mail-in ballot programs, and knowledgeable citizens. Voting rights would increase or decrease depending on the success of these programs. Output flows represent actions that affect existing rights; these could include implementation of programs, such as access to polling places or treatment of voters at polling places. Other factors like having a candidate you wish to vote for or your candidate getting elected are not examples of flows in this scenario; these factors do not affect the right to vote.**

Draw a stock and flow diagram of voting rights.



**Note that the three input flows are parallel to each another, and the two output flows are also parallel to each other.**

3. When studying a system, we always need to decide which portions we want to study. There are usually more stocks and flows than we need to examine when considering a particular issue.

Let's consider the idea of replenishing groundwater in agricultural areas in central California. After several years of drought, groundwater levels are low. At the same time, snowmelt in wet years can overwhelm the state water collection system. Floodwaters can bypass levees and reservoirs. Stanford University has estimated that the state could collect and store six times more water by boosting groundwater storage than by expanding and building new reservoirs – for the same cost and with fewer environmental problems. Enhancing underground storage helps solve several problems: it collects snowmelt that could otherwise cause flooding; it refills underground aquifers; and it costs less, uses fewer resources, and creates fewer environmental problems than do other solutions. Let's create a stock and flow diagram to represent this situation. **You may want to go through this problem with the class.**

List stocks in the portion of the water cycle and human water system being studied.

**Stocks include underground aquifers, snowpack, and reservoirs.**

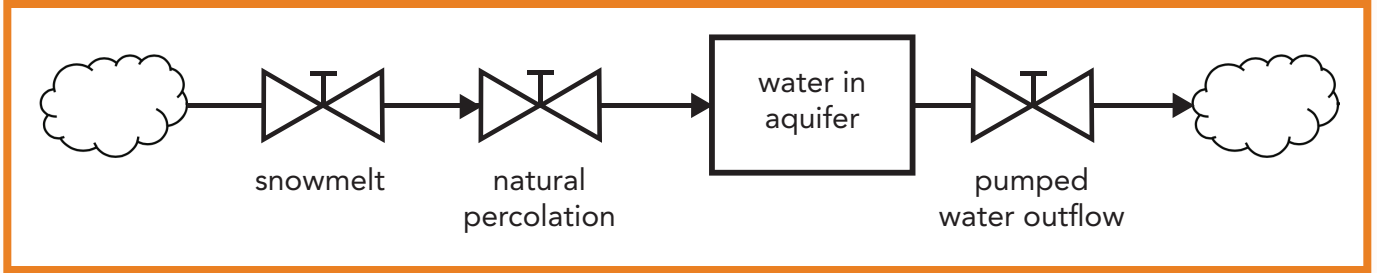
List flows in this scenario. **Flows include snowmelt, natural percolation into aquifers, pumped water into aquifers, floodwaters, and pumped water out of aquifers.**



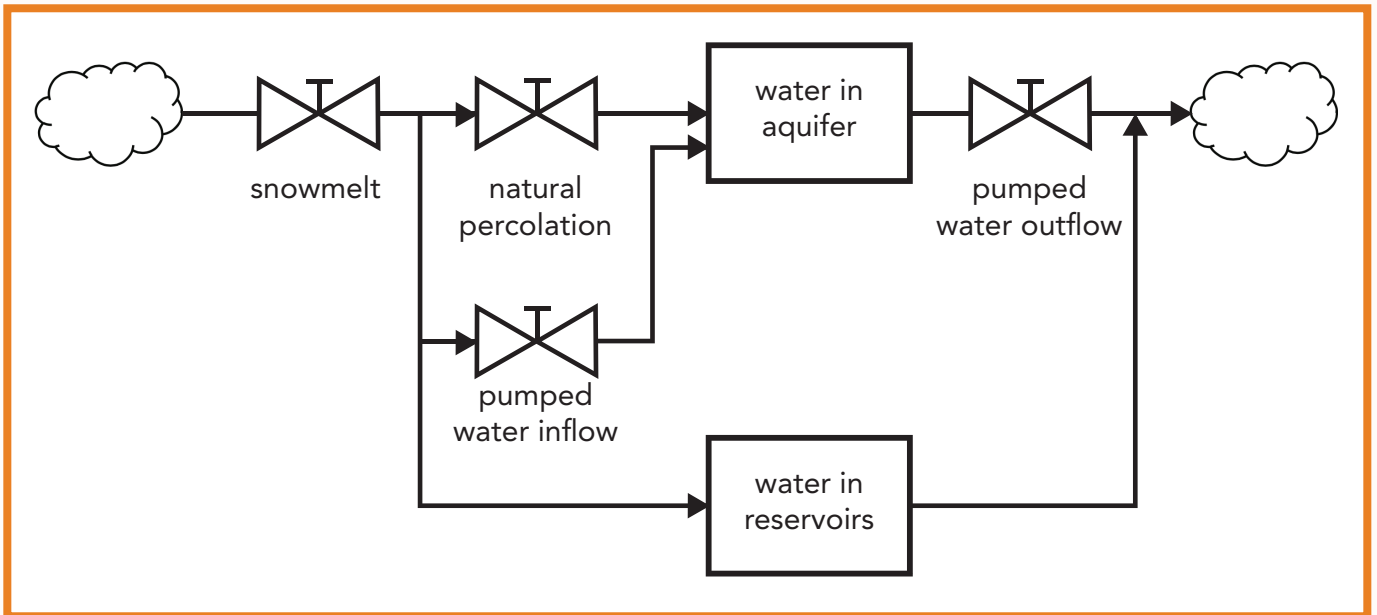
# Stocks and Flows

## Solutions

Create a stock and flow diagram for this scenario. Start small at first, with the basics of the system. Include the main stock – the water in the aquifer – and the three main flows – the snowmelt, natural percolation, and the pumping of water out of the aquifer. Note that stock and flow diagrams can have a flow leading into a stock or into another flow.



Next, add the new options: pumping water into the aquifer and storing water in a reservoir.



By looking at this diagram, we can see that increases or decreases in the flows of snowmelt, natural percolation, and pumped water inflow and outflow will all affect the amount of water stored in aquifers and reservoirs. We can see that snowmelt drives the other parts of this system. If we want to maximize the amount of water stored in aquifers, this diagram helps us see which system elements are interconnected with aquifers. Awareness of these interconnections helps us make better decisions.

## Summary

Learners will apply systems thinking to their case study from Activity Eight. Learners will examine the system structure using stocks and flows, identify existing feedback or propose ways to build in feedback, and use leverage points to propose solutions to their case study issue.

## Time Required

- Two 50-minute class periods

## Reading Prior to Assignment

- Review pages 33-34
- Read pages 40-45

## Key Concepts

- Systems Thinking
- Stocks and Flows
- Feedback
- Big Ideas of Sustainability
- Leverage Points

## Objectives

- To analyze and propose solutions for a real-world issue using systems thinking
- To identify leverage points in a system

## Inquiry/ Critical Thinking Questions

- How can systems thinking help me understand and solve a problem?
- What are leverage points in a system?



## Activity Fourteen

# Local Sustainability Case Study, Part 2 Using Systems Thinking

## Background

Systems expert Donella Meadows identified twelve "leverage points" in a system: places within systems that a small change can make a big difference. She cautions, "Complex systems are, well, complex. It's dangerous to generalize about them. It's not a recipe for finding leverage points. Rather it's an invitation to think more broadly about system change." As food for thought, this list of leverage points may help identify ways to improve systems and lead to more sustainable solutions. **These leverage points are listed from least to most effective.**

**XII. Numbers:** guidelines like speed limits, miles per gallon requirements for vehicles, and legal limits on release of pollutants.

**XI. Buffers:** safety margins or margins for error. For example, blender jars often have warnings: "do not fill above this line." Even though the blender jar may only be half full, the warning recognizes that turning on the blender motor can make the contents expand or jump around, spurting out of the blender jar. When safety margins are given, it's worth asking if they are the right size and the right controls.

**X. Physical structure of stocks and flows:** Can physical changes be made?

**IX. Length of delays:** Does the system allow enough time, or too much time, for feedback and adjustments to take place?

**VIII. Strength of balancing feedback loops:** Are they able to keep the system in balance? Are they so strong that they unnecessarily dampen important changes?

**VII. Gains from reinforcing feedback loops:** Reinforcing feedback loops continue a cycle of change. Population growth is a good example. Larger families tend to have more descendants, increasing population growth through many generations. When reinforcing feedback loops occur, we can ask whether some growth is beneficial and how it can be controlled. Or is the system in danger of growing uncontrollably?

**VI. Rules:** Does the system have rewards or punishments? Should it? Do any rewards or punishments achieve the desired effects? Examples of rewards or punishments include money, status, power, material goods, fines or fees, jail time, or reputation.

**V. Information flows:** Who does and does not have information? Who should and should not have information? Information might be the impacts of pollution from a factory in a distant country, where manufacturing of consumer goods has moved, for example.

**IV. Power:** How does the system change? Can it change itself as conditions change? Does someone need to deliberately act for change to occur? What process to support system change would be most beneficial?

**III. Goals:** What is the purpose and desired outcome of the system? Are these the right goals? Is the system achieving those goals?

**II. Mindset:** This leverage point could be considered the worldview in which the system operates. What knowledge, capabilities and intentions, values, and behavior define the situation in which the system operates?

**I. Freedom:** Can the system move beyond the mindset or worldview in which it operates? How might that kind of movement or change occur?

## Activity

### Day 1

1. **In your Field Book, make a list of systems** that are interconnected with your case study topic. For example, in the landfill scenario on pages 38-39, the main system is the landfill. Related systems include the county's homes and businesses, the county government, and other local cities that also use the landfill.
2. **In your Field Book, draw a diagram** showing how the systems you identified in Step 1 above nest or overlap with your case study system. See the diagram on page 33 for an example.



3. **In your Field Book, write a paragraph or two** describing the different perspective you gain by "zooming out" to consider nesting and overlapping systems. What different influences can you see? What possible sources of solutions can you see? If you "zoom in" to see details of your system, what new perspectives do you gain?

4. **Consider your case study topic using a systems thinking focus.** In your Field Book, make a T-chart with the headings "Systems Thinking Element" and "Case Study Example." Under "Systems Thinking Element," list the five elements of systems thinking presented in the Traditional and Systems Thinking table on page 45. Under the "Case Study Example" heading, fill in examples of each element from your case study.

5. **Create a stock and flow diagram of your system.** In your Field Book, make a list of key stocks and flows. What is the main stock you would like to increase or decrease in your case study? What flows currently add to or decrease that stock? How could helpful flows be supported? How could damaging flows be reduced? What flows could be added? Link the stocks and flows together in a stock and flow diagram.

## Discussion Questions

- What feedback loops did you identify?
- Did you identify reinforcing or balancing feedback, or both?
- What feedback systems do you suggest adding to your system?
- What leverage ideas did you identify for your case study? How can you bring about more sustainable outcomes?

Review nested and overlapping systems; please see pages 33-34.

You can have students work in pairs and choose one of their case studies to work on.

6. **Look for feedback in your system.** Your system may or may not have feedback. In fact, a lack of feedback may be one factor that makes your case study system unsustainable. Look for examples of feedback and list them in your Field Book. Do these examples reflect balancing or reinforcing feedback? Brainstorm types of feedback that could lead to a more positive outcome. Draw a causal loop diagram showing existing feedback, if available, and another diagram showing feedback you recommend adding to the system.

## Field Book

### Day 1

1. **Nature Journal:** Notice your connection with the atmospheric cycle. What is your role in the cycle? Sketch connections and impacts of the atmosphere around you.
2. Write a response to the **Think About It** box on page 36.

## Activity

### Day 2

1. **Brainstorm leverage points.** Make another T-Chart in your Field Book, with "Leverage Points" and "Case Study Examples" as headings. List the twelve leverage point titles and think of ways to apply these leverage points to create more sustainable outcomes for your case study.
2. **Draft possible solutions or improvements for your issue.** Use your systems analysis and leverage points to brainstorm possible solutions for your issue. You may be working with a wicked problem, which would mean a

solution is likely to be "more good/less bad" rather than a complete solution. Make notes of your ideas in your Field Book

3. **Share results with the class.** Discuss ideas for using leverage points and systems thinking to improve sustainability outcomes.

## Field Book

### Day 2

1. Write a response to the **Think About It** box on page 37.

## Additional Resources

- Donella Meadows' essay "Leverage Points: Places to Intervene in a System." Please see: <http://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/>



## Activity Fifteen

# System on the Move

### Activity

1. Engage in the physical activity and discussion as explained by your teacher.

### Field Book

1. **Nature Journal:** Notice other species' connection with the atmospheric cycle. How do local birds, other wild animals, trees, and geological features interact with the atmosphere? How are their connections similar to or different from yours? How do you connect with them through the atmospheric cycle? Write about or draw your observations.
2. Write a response to the **Think About It** box on page 44.
3. Update your Learning Links and Questions pages.

MODULE ONE

79

See Introduction to activity on pages 79A-79B.

### Summary

Learners directly experience the dynamic, interconnected, self-organizing qualities of systems through a physical movement activity. This activity is best conducted in an open space: outdoors, in a large space like a gymnasium, or in a classroom with desks pushed against the walls.

### Time Required

- One fifty-minute class period

### Key Concepts

- Interconnection
- System Parts and Whole
- System Structure and Purpose
- Self-organization

### Objectives

- To experience system interconnections, dynamics, and self-organization
- To experience how changes in components can change system function

### Inquiry/Critical Thinking Questions

- How do systems self-organize under changing, dynamic conditions?
- How can changes in components affect the overall functioning of the system?

## Introduction

Ask students to define a system. What are some of the important characteristics of a system? Answers may include: a system is made up of interconnected parts that work together as a whole for some purpose; changing one or more parts can change the whole system; systems can be understood by looking at long-term patterns and underlying causes.

1. Let students know that they will be engaging in a physical activity that models some characteristics of systems.
2. Ask for two volunteers to leave the room while instructions are given to the other students. The two volunteers will observe the activity and try to identify the purpose of the system the other students are participating in.
3. Have students spread out a few feet apart from one another to begin Round 1 of the activity.

a. Give students the following rules:

- i. Each student should mentally select two other students in the class, but should give no indication of whom they have selected.
- ii. When you ask them to begin the activity, they will move so that they keep an equal distance between themselves and their two selected students. This does not mean that they necessarily need to be at a midpoint between the other students.

To achieve their objective, students will move around the space, with each movement triggering new – and interdependent – movements by others.

- b. Bring in the two volunteers and have them observe the other students. They may walk among the other

students or stand to the side. Ask the other students to begin the activity.

- c. After a few minutes, movement will likely slow down. Have students stop where they are and notice how close they are to equidistant from their selected students. Notice how long it took for the group's movement to slow down.

4. Conduct a debrief on the activity:

- a. Ask the two volunteers if they could detect the purpose of the system. If they cannot detect it, let them know the goal the other students were trying to achieve. Ask whether they could have organized this process from the outside; the purpose of this question is to highlight the idea that systems are often so complex that the only way they can operate is through self-regulation.

Review the systems thinking focus points in the Traditional and Systems Thinking table on page 45. Note that complex systems do feature patterns of events and underlying causes, but we often need longer time frames to identify them.

- b. Ask students how close they were to equal distance from their two selected students. Note the results.
- c. What were the system parts? What was the whole system? What was the function of the system?
- d. How did the group organize itself? (Explain that self-organization is a property of systems and one of the ways they are resilient – able to function even in changing conditions.)

- e. Ask the group what they experienced. See if you can translate their observations into systems terms: they may talk about interdependence of all the parts or continuing to move in response to others' movement as a form of balancing feedback.
  - f. Ask students where their attention was focused: on their own movement, the movement of their selected students, or on the group as a whole? How did this focus affect the functioning of the group as a system?
5. Run a second round of the activity, but quietly pull aside a few students, one by one, and give them a different objective. Ask them to move slowly and apparently randomly from corner to corner of the group's space. Ask them not to reveal this different purpose to other students.

After about the same time as the group spent on Round 1, ask the students to stop where they are.

6. Discuss Round 2.
- a. Ask students how close they were to equal distance from their two selected students in this round. How did the results compare to Round 1?
  - b. What was their experience like in Round 2 compared to Round 1? Where was their focus?
  - c. Let students know of the change in objective for the few students; ask the students with the different objective to raise their hands. How did changes to a few parts of the system affect the ability of the overall system to function? What can students generalize about changes to parts of systems affecting the functioning of the system as a whole?

- d. What other systems can they think of that are interconnected, dynamic, and self-regulating? Examples include ecosystems, city government/citizen relationships, businesses, drivers on the road, etc.
- e. What are advantages and disadvantages of systems thinking compared to traditional thinking?
- f. How can you use systems thinking in other classwork and in your daily life?

## Summary

Learners will apply critical thinking skills to their Local Sustainability Case Study systems analysis and proposed solutions from Activity Fourteen. This work will build toward a Local Sustainability Case Study Final Report. Students will also practice using constructive and respectful communication skills to support critical thinking with partners.

## Time Required

- One 50-minute class period

## Reading Prior to Assignment

- Review pages 46-51

## Key Concepts

- Critical Thinking
- Constructive and Respectful Communication

## Objectives

- To practice using critical thinking skills
- To apply critical thinking skills to the Local Sustainability Case Study
- To practice respectfully encouraging critical thinking in others

## Inquiry/ Critical Thinking Questions

- What is critical thinking?
- What are critical thinking skills?
- How can I support critical thinking in others in a respectful and constructive way?
- Where have I used – or not used – critical thinking in my analysis of my Local Sustainability Case Study topic



Activity Sixteen

# Local Sustainability Case Study, Part 3 Critical Thinking

## Background

In this activity, you will work with a partner to explore underlying assumptions and identify gaps in critical thinking. In this kind of conversation, it is very important to be constructive and courteous. Critical thinking expert Stephen Brookfield offers the following examples of questions that explore another person's thinking in a respectful way:

- Can you tell me more about... ?
- Why do you think that's the case?
- What's the most convincing piece of evidence for that view?
- If I understand you correctly, you seem to be saying...?
- Can I just check that I've followed your argument correctly?<sup>28</sup>

When you disagree with another person, Brookings offers the following suggestions for phrasing your disagreement:

- I take a different view on this and here's why I think the way I do.
- In my thinking, I take a different approach. Here's my line of thinking.<sup>29</sup>

## Handouts

- Case Study Critical Thinking Evaluation, pages 81A-81B.

## Materials

- Make one copy of the Case Study Critical Thinking Evaluation handout for each student, please see pages 81A-81B.



## Activity

1. **Working in pairs, explore each other's critical thinking in your Local Sustainability Case Studies.** Briefly describe your Local Sustainability Case Study topic, the underlying issues, leverage points, and possible solutions. With your partner, take turns constructively and politely helping each other uncover assumptions, gaps in logic, need for additional information, and other gaps in critical thinking.
2. **Complete the Case Study Critical Thinking Evaluation** provided by your teacher.

## Field Book

1. **Nature Journal:** What was the best adventure you ever had in nature? What adventure would you like to have in nature? How does having an adventure in nature feel different than a human-created adventure like a roller coaster ride or a movie?
2. Write a response to the **Think About It** box on page 46.



## Discussion Questions

- How can you use critical thinking in other classwork and in your daily life?
- What gaps have you identified in your critical thinking in your Local Sustainability Case Study? How can you close any gaps in critical thinking?
- Were there any patterns in the kinds of gaps in critical thinking that students identified?

## Extensions

- Have students conduct research on their sustainability issue using media literacy skills described on page 50.
- Use critical thinking guidelines to evaluate the assumptions that a fictional, historical, or real-world person makes in other studies in your class. Investigate alternative explanations for assumptions made by your study subject.<sup>29a</sup>

## Additional Resources

- Brookfield, S. (2011). Teaching for Critical Thinking: Tools and Techniques to Help Students Question Their Assumptions. San Francisco: Jossey-Bass.
- Nolet, V. (2016). Educating for Sustainability: Principles and Practices for Teachers. New York: Routledge Publishers.
- For a magazine that profiles stories of hope and human innovation across global issues: Yes – A Journal of Positive Futures, Positive Futures Network: [www.yesmagazine.org](http://www.yesmagazine.org)
- Mindwalk (Paramount Home Video) is a movie by Bernt Capra. Mindwalk explores the scientific, social, and ecological questions about the nature of perception.

Name: \_\_\_\_\_

## Case Study Critical Thinking Evaluation

Answer the following questions to check and improve your critical thinking on your case study topic and the possible solutions you identified in Activities 8 and 14. Use the critical thinking guidelines on pages 47-49 to develop your answers.

1. **Make sure the facts are accurate.** What facts are you using to understand and explain your issue? How do you know these facts are true? Are they relevant to the case study?

---

---

---

2. **Ask good questions.** What questions will help you understand your topic thoroughly, challenge evidence, and reveal reasoning? Where is there uncertainty in your topic? Do you need to dig deeper?

---

---

---

---

3. **Recognize assumptions.** What assumptions are others – or you – making? Are these assumptions accurate? How might they shape someone's point of view?

---

---

---

---

4. **Decide if a source can be trusted.** What sources of information are you using? Do they have the experience, education, and reputation to be credible sources? Do they have other interests that might influence their behavior or opinions?

---

---

---

---

Name: \_\_\_\_\_

## Case Study Critical Thinking Evaluation *continued*

5. **Analyze arguments and conclusions.** What arguments or conclusions have been made about your topic? What is the reasoning behind these arguments and conclusions? Are the arguments, reasoning, and supporting facts relevant to your issue? Is the argument valid if irrelevant facts are left out? Is there a logical link between facts and conclusions? What consequences flow from the reasoning – are they acceptable?

---

---

---

---

6. **Consider multiple points of view.** What do other interested people think? Who is not being heard from – possibly including other species?

---

---

---

---

7. **Make decisions using reasoning and evidence.** What solutions are you considering? Are they based on logic and facts?

---

---

---

---

## Summary

Learners finalize their recommended solutions for their Local Sustainability Case Study topics in narrative or graphic presentations. They discuss their findings with the class; as time permits, students can give more formal presentations of their findings.

## Time Required

- Two 50-minute class periods

## Reading Prior to Assignment

- Pages 52-53

## Key Concepts

- Big Ideas of Sustainability
- Earth Charter Values
- Universal Declaration of Human Rights
- Systems Thinking
- Critical Thinking

## Objectives

- To tie together the sustainability tools presented in this unit
- To apply sustainability tools to Local Sustainability Case Study issues

## Inquiry/ Critical Thinking Questions

- What are possible solutions to my Local Sustainability Case Study issue?
- How do sustainability tools and systems thinking help create workable solutions to sustainability issues?

Begin with a class discussion of the case study topics students are working on. What topics are they focusing on? Where are there overlaps or similarities in projects? What issues are being focused on by multiple students? How are the issues interconnected? Draw a mind map on the board showing how different topics are interconnected.

Break students into small groups to talk about related topics.

## Activity Seventeen

# Local Sustainability Case Study, Part 4 Project Write-up and Debrief

## Activity

1. **In your small group, examine similarities between your case study topics.** What similar underlying causes, assumptions, worldviews, or systems contribute to their issues? What leverage points do the issues share? Do the issues represent wicked problems, where improvement in one area may result in further problems in another area? How can students' solutions support – and not hinder – one another? Create a mind map in your Field Book showing interconnections with other students' issues and other issues raised in class.
2. **Create a mind map** in your Field Book showing interconnections with other students' issues and other issues raised in class.
3. **Working individually, finalize your proposed solutions** for your Local Sustainability Case Study. Check in with other students as needed to fine-tune your solutions and coordinate them with other students' work.
4. **Write a narrative description or create a graphic display of your issue,** proposed solution(s), and sustainability perspectives. Note Big Ideas of Sustainability, Earth Charter values, and Universal Human Rights, interconnections, feedback, and leverage points, that tie in with your proposal. Describe obstacles to carrying out your solution and possible ways to overcome the obstacles. Use your prior work on the Case Study to complete your description.
5. **Share your results with the class.**

## Field Book Day 1

1. **Nature Journal:** What elements of nature can you see right outside your home?
2. Write a response to the **Think About It** boxes on page 50.

This activity helps students "zoom out" and consider a bigger scale for their issue.

Depending on the amount of time you have available, some or all students can give brief presentations of their ideas or you can informally discuss their conclusions.

## Field Book

### Day 2

1. **Nature Journal:** Imagine your great grandchildren. Imagine them looking out at the same sun, moon, and other natural surroundings that you see. What is nature like in their world? How is it the same? How is it different?
2. Write a response to the **Think About It** boxes on page 53.
3. Update your Learning Links and Questions pages.



### Discussion Questions

- How do sustainability tools like Big Ideas of Sustainability, Earth Charter values, and the Universal Declaration of Human Rights help lead to possible solutions of sustainability issues?
- How does systems thinking help develop workable solutions to sustainability issues?
- What ideas and tools were most helpful for you in identifying solutions?

### Extensions

- Present the class's Local Sustainability Case Study recommendations to decision-makers and others involved in the issues the students studied.
- Ask students to take steps to carry out their proposed solutions to their Local Sustainability Case Study issues

## Summary

Students examine next steps they would like to take and reflect on their learning.

## Time Required

- One 50-minute class period

## Reading Prior to Assignment

- Review pages 27-53

## Key Concepts

- Systems Thinking
- Critical Thinking
- Sustainability Worldview

## Objectives

- To reflect on learning and changes in worldview
- To transfer learning outside of class

## Materials

- Colored pencils, optional



## Activity Eighteen

# Tool for Engaging with Sustainability Issues: Reflection, Self-Assessment, and Commitments

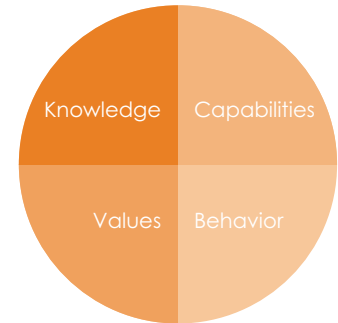
## Activity

1. In your Field Book, respond to the following questions and prompts.

a. Write one paragraph in response to each of the unit's essential questions:

- What thinking skills are important for sustainability?
- What is a system?
- How can systems help me understand sustainability?
- How can I become a critical thinker?

b. What can you do to carry through with possible sustainability actions and issues that you identified in this unit? With whom can you share your sustainability knowledge? Write down concrete action steps, goals, and timing for any commitments you would like to make, including those



related to your Local Sustainability Case Study? What might make it difficult for you to take these steps? How can you overcome these obstacles?

**c. Think about how your worldview has changed through what you have learned about sustainability.**

A sustainability worldview is based on knowledge, capabilities, values, and behavior. Make a circle and divide it into quarters. Write one of the elements of a sustainability worldview in each quarter. Note any changes that have taken place in these areas; use arrows to show interconnections between the four quarters. Use colors.

**d. How can you use systems thinking in your daily life or in other classwork?**

**e. How can you use critical thinking in your daily life or in other classwork?**

**f. Look back at the Questions page in your Field Book.** Are there unanswered questions? How can you get them answered? What else would you like to know about sustainability in the future?

**g. How have the daily nature connection activities affected you?**

**2. What parts of the Tools for Engaging with Sustainability Issues unit represented your best work?** What would you like to do differently?



---

## References

- i Next Generation Science Standards. (n.d.) **Improving Science Education Through Three-Dimensional Learning**. Retrieved from <http://www.nextgenscience.org>.
  - ii National Council for the Social Studies. (n.d.) **National Curriculum Standards for Social Studies: Chapter 2 – The Themes for Social Studies**. Retrieved from <http://www.socialstudies.org/standards/strands>.
  - iii Common Core State Standards Initiative. (2017). **English Language Arts Standards**. Retrieved from <http://www.corestandards.org/ELA-Literacy/>.
  - 1 The Tech Museum of Innovation (2013). **Genes in Common**. Retrieved from <http://genetics.thetech.org/onlineexhibits/genes-common>.
  - 2 United Nations Educational, Scientific and Cultural Organization (UNESCO) (2016). **Introducing UNESCO**. Retrieved from <http://en.unesco.org/about-us/introducing-unesco>.
  - 3 United Nations Educational, Scientific and Cultural Organization (UNESCO) (2013). **15 Action Projects receive the 8th UNESCO Youth Forum label**. Retrieved from <http://www.unesco.org/new/en/youth-forum-2013/participate/youth-led-projects/15-youth-led-action-projects/>.
  - 4 **World Commission on Environment and Development**. (1987). *Our Common Future*, London: Oxford University Press.
  - 5 Manuel-Navarrete, D., Kay, J.J., and Dolderman, D. (2004). **Ecological integrity: Linking biology with cultural transmutation**. *Human Ecology Review*, 11(3), 215-229.
  - 6 Max-Neef, M. (1991). **Human Scale Development**. New York: Apex Press.
  - 7 The Earth Charter International (2015) **Earth Charter: Values and Principles for a Sustainable Future**. Retrieved from: <http://www.earthcharterinaction.org/>.
  - 8 International Union of Geological Sciences (IUGS). (2014). **What Is the “Anthropocene”? Current Definition and Status**. Retrieved from: <http://quaternary.stratigraphy.org/workinggroups/anthropocene/>.
  - 9 Population Reference Bureau (2016). **2015 World Population Data Sheet & Digital Visualization**. Retrieved from <http://www.prb.org>.
  - 10 United Nations Office of High Commissioner for Human Rights (OHCHR). (2016) **What are Human Rights?** Retrieved from <http://www.ohchr.org/EN/Issues/Pages/WhatareHumanRights.aspx>.
  - 11 United Nations Office of the High Commissioner for Human Rights (OHCHR). (1998). **Universal Declaration of Human Rights**. Retrieved from <http://www.ohchr.org/EN/UDHR/Pages/Language.aspx?LangID=eng>.
  - 12 Farquhar, B. (2016). **Wolf Reintroduction Changes Ecosystem**. Yellowstone Park. Retrieved from <http://www.yellowstonepark.com/wolf-reintroduction-changes-ecosystem/>.  
Gemmell, D. (2016) **Gray Wolf Reintroduction – Yellowstone National Park**. Ecology Education Consulting, Inc. Retrieved from [http://www.ecologyedu.com/ecology\\_education\\_resources/gray\\_wolf\\_reintroduction/introductionpage\\_1.html](http://www.ecologyedu.com/ecology_education_resources/gray_wolf_reintroduction/introductionpage_1.html).
  - 13 Nolet, V (2016). **Educating for Sustainability: Principles and Practices for Teachers**. New York: Taylor and Francis
  - 14 Richardson, G. P., & Pugh, A. L. (1981). **Introduction to System Dynamics Modeling With DYNAMO**. Cambridge, MA: MIT Press.
  - 15 Brooks, S. & Marten, G. (2005). **Green Guerillas: Revitalizing Urban Neighborhoods with Community Gardens**. The EcoTipping Points Project: Models of Success in Times of Crisis. Retrieved from <http://ecotippingpoints.org/our-stories/indepth/usa-new-york-community-garden-urban-renewal.html>.
  - 16 Galtung J.(1996). **Peace by Peaceful Means: Peace and Conflict, Development and Civilization**. Thousand Oaks, CA: Sage Publications.
  - 17 Center for Ecoliteracy. (2016). **Systems Thinking**. Retrieved from <http://www.ecoliteracy.org/article/systems-thinking>.
  - 18 Beyer, B.K. (1995). **Critical Thinking**. Bloomington, IN: Phi Delta Kappa Educational Foundation.  
Ennis, R.H. (2001). Goals for a critical thinking curriculum and its assessment. In A.L. Costa (Ed.), **Developing Minds: A Resource Book for Teaching Thinking** (pp. 44-46). Alexandria, VA: ASCD.  
Paul, R. & Elder, L. (2014). **Critical Thinking Concepts and Tools**. Tomales, CA: Foundation for Critical Thinking.
  - 19 Wollmering, R. (2016). **Cross-Cultural Dialogue. Voices from the Field: Reading and Writing about the World, Our selves, and Others**. Retrieved from: <http://www.peacecorps.gov/www/search/publications/voices-field/>.
  - 20 National Wildlife Federation (2016). **Young Reporters for the Environment**. Retrieved from <http://www.nwf.org/Young-Reporters-for-the-Environment/About-Young-Reporters/2015-Winning-Entries.aspx>.
-



---

## References

- <sup>21</sup> Smith, D. (2016). **Wolves and Trophic Cascades**. Wolf Park. Retrieved from: <http://wolfpark.org/research/articles/wolves-and-trophic-cascades/>.
- <sup>22</sup> Middleton, A. (2014). **Is the Wolf a Real American Hero?** New York Times. Retrieved from: <http://www.nytimes.com/2014/03/10/opinion/is-the-wolf-a-real-american-hero.html>.
- <sup>23</sup> Gil, C. (2016). **Interactive Notebooks: No Special Hardware Required**. Edutopia. Retrieved from <https://www.edutopia.org/blog/interactive-notebooks-no-special-hardware-christina-lovdal-gil>.  
Interactive Notebooks Wiki. (n.d.) **Interactive Notebooks**. Retrieved from <http://interactive-notebooks.wikispaces.com>.
- Marcarelli, Kellie. (2010). **Teaching Science with Interactive Notebooks**. Thousand Oaks: Corwin.
- <sup>24</sup> Leslie, Clare Walker and Charles E. Roth. (2000). **Keeping a Nature Journal**. North Adams, MA: Storey Publishing.
- <sup>25</sup> Maslow, A. (1943). **A theory of human motivation**. *Psychological Review*, 50, 370-396.  
Maslow, A. (1970). **Motivation and Personality**. New York: Harper and Row.
- <sup>26</sup> Brown University. (n.d.) **The Choices Program: Values and Public Policy**. Retrieved from <http://www.choices.edu/resources/values.php>.  
Haidt, J. (2013). **The Righteous Mind**. New York: Vintage Books.  
Nolet, V. (2016). **Educating for Sustainability: Principles and Practices for Teachers**. New York: Routledge.
- <sup>27</sup> Asmodee. (n.d.) Timeline.
- <sup>27a</sup> MacGregor, R. (2010). **The Globe and Mail. 20 ways to improve your car's fuel efficiency**. Retrieved from <http://www.theglobeandmail.com/globe-drive/culture/commuting/20-ways-to-improve-your-cars-fuel-efficiency/article1379796/>.
- <sup>28</sup> Brookfield, S. (2011). **Teaching for Critical Thinking: Tools and Techniques to Help Students Question Their Assumptions**. San Francisco: Jossey-Bass.
- <sup>29</sup> Brookfield, S. (2011). **Teaching for Critical Thinking: Tools and Techniques to Help Students Question Their Assumptions**. San Francisco: Jossey-Bass.
- <sup>29a</sup> Brookfield, S. (2011). **Teaching for Critical Thinking: Tools and Techniques to Help Students Question Their Assumptions**. San Francisco: Jossey-Bass.
-

---

## Photo and Image Credits

*Thank you to the generous and talented photographers and artists who contributed their photos and art.*

- p. 1 Earth ©Adobe Stock Photo/Robert
- p. 2 Multiracial group of friends embraced in a circle ©Adobe Stock Photo/william87
- p. 2 Asia Trip ©Nikita Pretty
- p. 3 Small waterfall and moss ©Adobe Stock Photo/kellyvandellen
- p. 4 Planting a new life ©Adobe Stock Photo/janonkas
- p. 6 Larch forest with sunlight and shadows at sunrise ©Adobe Stock Photo/tortoon
- p. 7 Ejemplar de petirrojo entre musgo ©Adobe Stock Photo/Sergio Martinez
- p. 8 Leaf with rain droplets ©Adobe Stock Photo/hankimage9
- p. 10 Crecimiento personal ©Adobe Stock Photo/Mondela
- p. 11 Yaks und jurten in kirgisien ©Adobe Stock Photo/klange76
- p. 12 Peruvian dancers at the parade in Cusco ©Adobe Stock Photo/Mariusz Prusaczyk
- p. 13 Crowd of bikes ©Adobe Stock Photo/Connel Design
- p. 14 Many hands together ©Adobe Stock Photo/mangostock
- p. 15 Forest ©Adobe Stock Photo/SkyLine
- p. 16 London city urban ©Pixabay/chafleks
- p. 16 Wind turbines silhouette ©Adobe Stock Photo/Mimadeo
- p. 17 Yong woman collects garbage in woods ©Adobe Stock Photo/itakdalee
- p. 18 Bike in town ©Adobe Stock Photo/ jon\_chica
- p. 19 Famous postcard view of various houses and churches ©Adobe Stock Photo/oscity
- p. 20 Green leaves ©Adobe Stock Photo/springtime78
- p. 20 53 animals and natures pixel perfect icons ©Adobe Stock Photo/iconbeast
- p. 22 Alministi in cordata sul Monte Bianco ©Adobe Stock Photo/fidelio
- p. 23 Young man with a paper with the text human rights ©Adobe Stock Photo/nito
- p. 25 Athlete runner feet running in nature ©Adobe Stock Photo/glisic\_albina
- P. 25 Fresh veggie salad ©Pixabay/jill111
- p. 26 Maya temple tikal in Guatelmala ©Adobe Stock Photo/martin613
- p. 26 Guatemala market ©Barbara Schmidt
- p. 27 Lupo grigio ©Adobe Stock Photo/giorgiape
- p. 28 Yellowstone national park entrance sign ©Adobe Stock Photo/blvdone
- p. 29 Tree root in a green forest ©Adobe Stock Photo/chaloemphan
- p. 30 Forest waterfall ©Adobe Stock Photo/dreamsofmemory
- p. 31 Digitalization idea ©Adobe Stock Photo/amphotolt
- p. 32 The water cycle ©Adobe Stock Photo/flaya
- p. 32 St Helena coffee farmer picking ripe cherry beans ©Adobe Stock Photo/Darrin Henry
- p. 33 Household garbage heap make pollution of flora ©Adobe Stock Photo/FMUA
- p. 34 A bulldozer and garbage truck o a landfull waste site ©Adobe Stock Photo/rob245w
- p. 36 Classroom ©Dollar Photo/monkeybusiness
- p. 37 Drain in sink ©Adobe Stock Photo/Win Nondakowit
- p. 38 Harvesting timber logs ©Adobe Stock Photo/kingan
- p. 39 Fossil ©Adobe Stock Photo/Bastos
- p. 40 Eco friendly ©Adobe Stock Photo/UMB-O
- p. 43 Happy interracial family is enjoying a day in the park ©Adobe Stock Photo/\_jure
- p. 45 Acceleration of mind shapes ©Adobe Stock Photo/agsandrew

---

## Photo and Image Credits

- p. 46 Infinite question marks on plane ©Adobe Stock Photo/tostphoto
- p. 47 Where, who, when, how, why ©Adobe Stock Photo/Sondem
- p. 48 Conclusions word in wood type ©Adobe Stock Photo/Marek
- p. 49 Open book ©Adobe Stock Photo/Valkh
- p. 50 Television production technology ©Adobe Stock Photo/Kentoh
- p. 52 Corn field ©Adobe Stock Photo/Jita
- p. 53 Chimpanzee ©Adobe Stock Photo/Kitch Bain
- p. 53 Idea concept with row of light bulbs ©Adobe Stock Photo/ chones
- p. 54 Wind turbine environmental ©Pixabay/fxxu
- p. 55 Glass ball mirror image ©Pixabay/Gabriela\_Neumeier
- p. 56 Notebook paper study ©Pixabay/Snufkin
- p. 58 Drawing ©Adobe Stock Photo/Picture-Factory
- p. 58 Monarch caterpillar ©Pixabay/631372
- p. 59 Trees hill park ©Pixabay/Skitterphoto
- p. 60 Primrose hill park ©Pixabay/maovice123
- p. 61 Paloma park bird ©Pixabay/josemdelaa
- p. 62 Solar panel installation ©Adobe Stock Photo/Elenathewise
- p. 63 Green leaves ©Adobe Stock Photo/springtime78
- p. 64 Planting environment nature ©Pixabay/artisano
- p. 65 Park bench garden ©Pixabay/Michael Gaida
- p. 66 Dolphin ©Adobe Stock Photo/rangiroa
- p. 67 Friendly woman tending organic vegetables ©Adobe Stock Photo/Julie
- p. 69 Multiracial group of friends with hands in stack ©Adobe Stock Photo/william87
- p. 71 Solan panel energy house ©Pixabay/afrndz
- p. 72 Windmill turbine ©Pixabay/Steppinstars
- p. 73 Potato field plant plow ©Pixabay/meganelford0
- p. 74 GPS navigation elevation profile ©Pixabay/Simon
- p. 75 Lake scenic landscape ©Pixabay/tpsdave
- p. 76 Architecture cityscape highway ©Pixabay/Pexels
- p. 77 Woman construction worker ©Pixabay/skeeze
- p. 79 Vosika nests macro ©Pixabay/zdenet
- p. 80 Farmers local market ©Pixabay/mrganso
- p. 81 forest hiking trail ©Pixabay/thomashendale
- p. 82 Business woman drawing flow chart ©Adobe Stock Photo/zmkstudio
- p. 83 Two boys walk in park ©Pixabay/ebpilgrim
- p. 84 Green roof in urban setting ©Adobe Stock Photo/alisonhancock
- p. 85 Dandelion seeds ©Pixabay/eacuna

---

Photo and Image Credits ©Facing the Future