

## Being a Systems Thinker

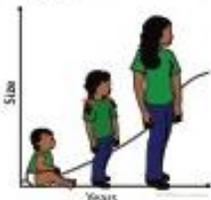
Systems thinking considers the formulation, diagnosis, and resolution of issues that arise from complex forms of interaction in systems. Different parts of a system are so interconnected that if we alter one part of a system it will change other parts. Fundamentally, systems thinkers focus on wholes rather than on parts. Within the context of the whole, they concern themselves with relationships more than objects, and with networks more than hierarchies.

### A Systems Thinker:

- Sees the whole: sees the world in terms of interrelated “wholes” or systems, rather than as single events, or snapshots.
- Looks for connections: assumes that nothing stands in isolation; and so tends to look for connections among nature, ourselves, people, problems, and events.
- Pays attention to boundaries: “goes wide” (uses peripheral vision) to check the boundaries drawn around problems, knowing that systems are nested and how you define the system is critical to what you consider and don’t consider.
- Changes perspective: changes perspective to increase understanding, knowing that what we see depends on where we are in the system.
- Looks for stocks: knows that hidden accumulations (of knowledge, carbon dioxide, debt, and so on) can create delays and inertia.
- Challenges mental models: challenges one’s own assumptions about how the world works (our mental models) — and looks for how they may limit thinking.
- Anticipates unintended consequences: traces loops of cause and effect and always asks “what happens next?”
- Looks for change over time: sees today’s events as a result of past trends and a harbinger of future ones.
- Sees self as part of the system: looks for influences from within the system, focusing less on blame and more on how the structure (or set of interrelationships) may be influencing behavior.
- Embraces ambiguity: holds the tension of paradox and ambiguity, without trying to resolve it quickly.
- Finds leverage: knows that solutions may be far away from problems and looks for areas of leverage, where a small change can have a large impact on the whole system.
- Watches for win/lose attitudes: knows dichotomous attitudes usually make matters worse in situations of high interdependence.

This listing is adapted from ***Thinking About Systems: 12 Habits of Mind*** by Linda Booth Sweeney, online at: <http://www.lindaboothsweeney.net/thinking/habits>

# Being a Systems Thinker

<p>Seeks to understand the big picture</p> 	<p>Observes how elements within systems change over time, generating patterns and trends</p> 	<p>Recognizes that a system's structure generates its behavior</p> 
<p>Identifies the circular nature of complex cause and effect relationships</p> 	<p>Makes meaningful connections within and between systems</p> 	<p>Changes perspectives to increase understanding</p> 
<p>Surfaces and tests assumptions</p> 	<p><b>Habits of a Systems Thinker</b></p> 	<p>Considers an issue fully and resists the urge to come to a quick conclusion</p> 
<p>Considers how mental models affect current reality and the future</p> 	<p>Uses understanding of system structure to identify possible leverage actions</p> 	<p>Considers short-term, long-term and unintended consequences of actions</p> 
<p>Pays attention to accumulations and their rates of change</p> 	<p>Recognizes the impact of time delays when exploring cause and effect relationships</p> 	<p>Checks results and changes actions if needed: "successive approximation"</p> 

## **Knowing your Garden Systems**

Mapping a garden landscape is a common approach that utilizes systems thinking. A base map with overlays can shift focus from the parts to the whole and be a tool for considering relationships, connectedness, and context that are the essence of systems thinking. These maps need not be professional drawings or elaborate. Sketches with colored pencils on graph and tracing paper will do. Take some time to try to create some maps of a real garden place. It may be a landscape on a property you or friends or relatives own or rent; a community garden; a school garden; or another public space you can access.

### **Base map**

An accurate base map is the result of a series of direct field observations of your site. Using colored pencils and graph paper draw the property to scale. Include on the base map footprints of houses or buildings; driveways, paths, decks, patios or other hardscape features; utility lines; an arrow pointing North; and the scale of the map (e.g. 1 foot in real life = 1/4 inch on graph paper).

### **Soil map**

Using tracing paper over the base map, outline the following characteristics: > Areas of erosion and compaction > Low areas that are commonly wet > Exposed rock > Shallow soils > Areas where the soil abruptly changes texture or structure > pH or soil test results, which include:

- Texture, structure, consistence profile, drainage
- Topsoil Fertility: pH, % OM (organic matter), N, P, K, Ca
- Toxins: lead, mercury, asbestos, cadmium

### **Water map**

- Existing sources of supply: location, quality, quantity, dependability, network
- Watershed boundaries and flow patterns: roof runoff, driveway and road runoff, storm drains, flood- prone areas, vernal pools or temporary ponds
- Pollution sources: autos, neighbors, nearby commerce, industry or farms, entry points on the site
- Potential sources of water supply: location, quality, quantity, cost to develop
- Existing infrastructure: on site & nearby culverts, wells, water lines, tanks, sewage lines, septic tanks, leach fields, cisterns
- Erosion: existing and potential
- Domestic sources: wells, streams, ponds

### **Vegetation map**

Your gardening experiences no doubt has already shown that you need to know the characteristics/cultural needs of each species of plant you have in your garden. My lavender plants for example, didn't like the small space I gave them, and let me know when their roots were too wet. Mapping out the following characteristics will help you to understand the present needs and plan for the future as conditions change.

- Existing Plant Species: locations, size, quantity, patterns, uses
- Habitat Types: food/water/shelter availability
- Animal Species: domesticated, wildlife, pests
- Old Trees
- Established Communities
- Invasive/Non-native
- Rare/Medicinal Plants
- Native Species

# Knowing your Garden Systems

## Light, air flow, temperature map

Make note of your regional climate and the micro-climate of your own back yard. Identify the hardiness zone for your region. Note your observations of the beginning dates of seasons. Where does the wind usually blow in your yard, how much sunlight does your garden get, and at what time of day?

- Plant Hardiness Zone
- Annual Precipitation, Seasonal Distribution
- Latitude
- Wind: prevailing, seasonal, storms, effect on vegetation, change with time of day
- Frost free dates (average, extremes)
- Fire: evidence of former fires, direction, pyriscent (fire-loving)-species, hazardous areas
- Flood: evidence, vulnerable areas, use for capturing/storing energy
- Temperature Fluctuations
- Sunshine
- Weather patterns, including precipitation and fog

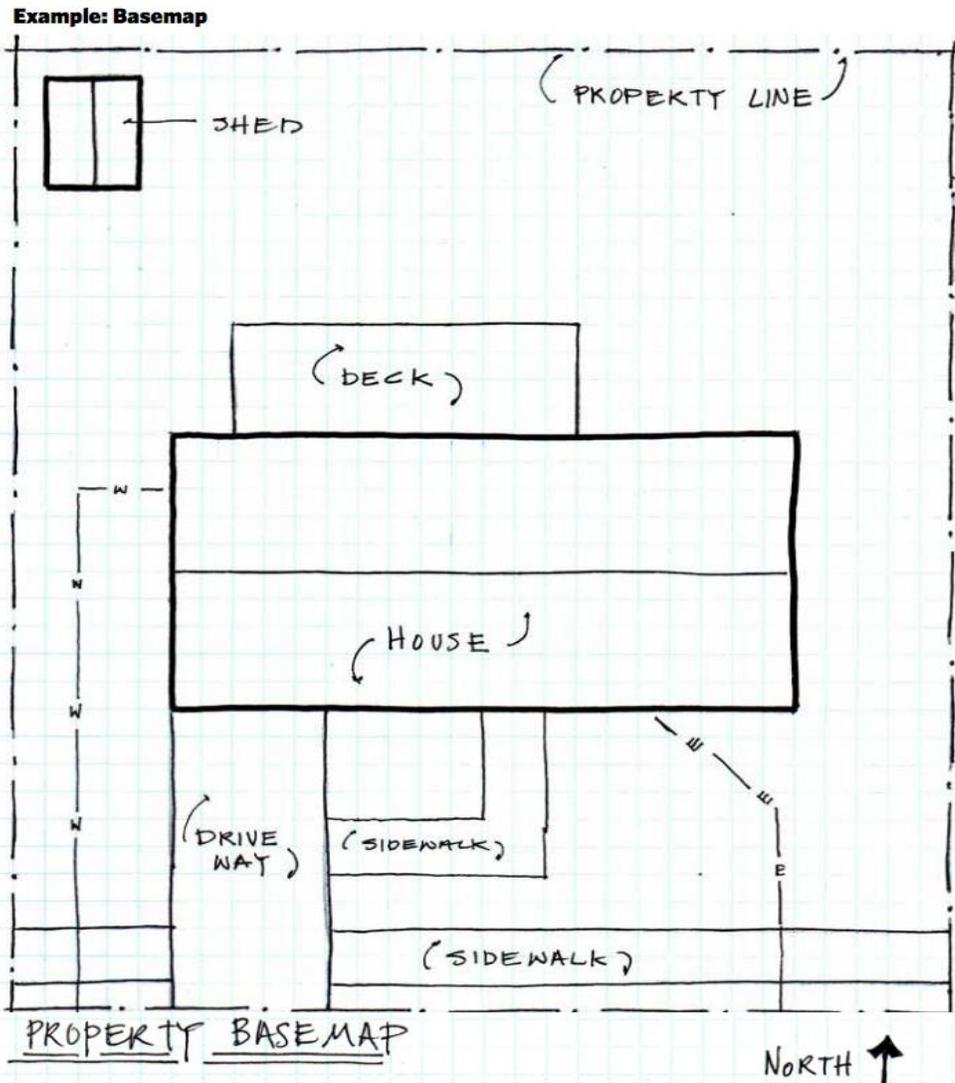
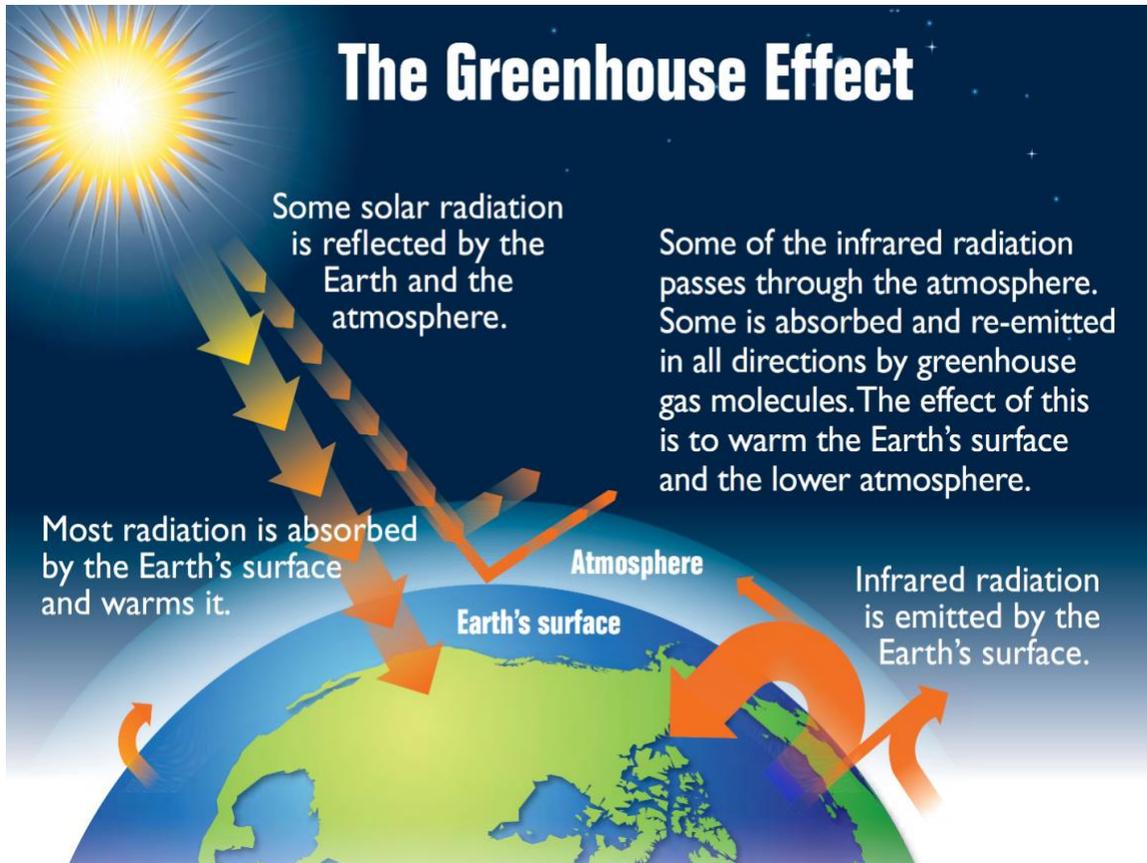
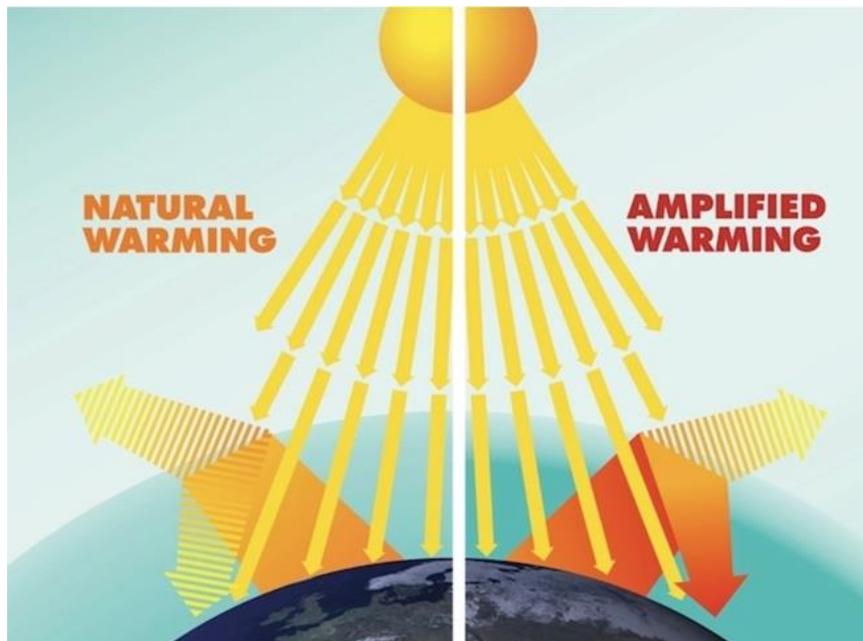


Image from Landscape for Life Manual; <https://landscapeforlife.org/>

## What is the Greenhouse Effect?



Course Book Figure 6. The Greenhouse Effect. Image credit: US Environmental Protection Agency.<sup>1</sup>



Presentation Figure on Slide 17. Image credit: U.S. Global Change Research Program.<sup>2</sup>

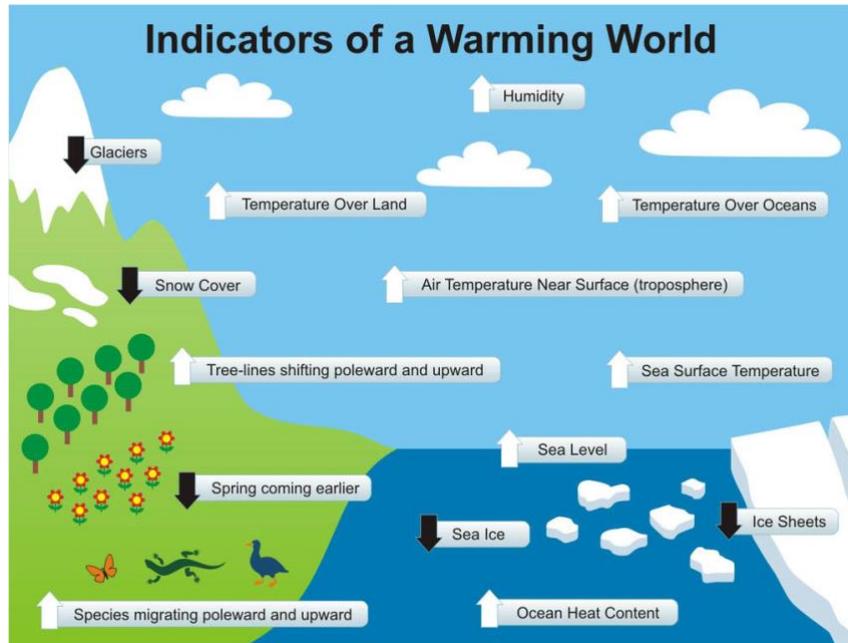
<sup>1</sup>US EPA. 2012. The Greenhouse Effect. Accessed Sept 2018 from [https://commons.wikimedia.org/wiki/File:Earth%27s\\_greenhouse\\_effect\\_\(US\\_EPA,\\_2012\).png](https://commons.wikimedia.org/wiki/File:Earth%27s_greenhouse_effect_(US_EPA,_2012).png)

<sup>2</sup>U.S. Global Change Research Program. 2009. Climate Literacy: The Essential Principles of Climate Science. Retrieved 31 July 2017.

<https://www.climate.gov/teaching/essential-principles-climate-literacy/essential-principles-climate-literacy>

# What Happens in New York State When the Climate Changes?

The videos found at Climate Learning Network will offer climate change basics in a very clear and concise manner: <http://www.climatelearning.net/e-learning-modules/>



Course Book Figure 9. Indicators of a Warming World. Image credit: [www.skepticalscience.com](http://www.skepticalscience.com)<sup>1</sup>

## Observing Climate Change Impacts in New York<sup>2</sup>

New York's ClimAID report (2011, 2014), the National Climate Assessment (2014), and other research show that a variety of climate change impacts have already been observed.

### Temperature

- The annual average temperature statewide has risen about 2.4°F since 1970, with winter warming exceeding 4.4°F. This equals about 0.25°F per decade since 1900.
- Annual average temperatures have increased across the state.

### Precipitation

- Overall, average annual precipitation has increased across New York State since 1900, with year-to-year (and multiyear) variability becoming more pronounced.
- New York is getting more precipitation in the winter and less precipitation in the summer.
- Between 1958 and 2010, the amount of precipitation falling in very heavy events (downpours) increased more than 70% across the northeastern United States.

### Sea-level rise

- Sea levels along New York's coast have already risen more than a foot since 1900.
- New York's rate of rise (about 1.2 inches per decade) is almost twice the observed global rate (0.7 inches per decade) over the same period.

### Natural resources

- Spring begins a week earlier than it did a few decades ago; the first leaf date is more than 8 days earlier & the first bloom date is more than 4 days earlier than in the 1950s.
- Winter snow cover is decreasing.
- Pollinating bees in the northeastern US arrive about 10 days earlier than in the 1880s.
- NY breeding bird & ocean fish population ranges have shifted northward over the last decades.

<sup>1</sup>US EPA. 2012. The Greenhouse Effect. Accessed Sept 2018 from [https://commons.wikimedia.org/wiki/File:Earth%27s\\_greenhouse\\_effect\\_\(US\\_EPA,\\_2012\).png](https://commons.wikimedia.org/wiki/File:Earth%27s_greenhouse_effect_(US_EPA,_2012).png)

<sup>2</sup>NYSDEC Impacts of Climate Change in New York World. Accessed September 17, 2018 from <https://www.dec.ny.gov/energy/94702.html>

### Reliable Resources Matrix – Example

➤ <b>Title of Resource:</b> <i>The Climate Conscious Gardener</i> by Janet Marinelli, Editor						
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>Rating</b>
<b>Who?</b> – The author's experience with this area.	Author background is unknown.	Little evidence – a few or minor publications in this area.	Some evidence – more than a few/minor publications in this area.	More evidence – several publications in this area.	Author is known authority in this area. <i>Former Director of the Brooklyn Botanical Garden</i>	5
<b>What?</b> – Are the points relevant to our needs or tasks?	No, little, or marginal relevant points.	Some relevant points.	Several relevant points.	Numerous relevant points. <i>Book offers many strategies for sustainable climate change gardening</i>	Content and points closely match our needs or tasks.	4
<b>Where?</b> – Context/situation of content is similar to ours?	Situation is different.	Minimal similarities.	Some similarities.	Number of similarities. <i>Book offers examples I can use for my vegetable gardening</i>	Context/situation matches ours.	4
<b>When?</b> – Publication date.*	Date is not clear or older than 20 years.	10 to 20 years old.	5 to 10 years old. <i>Written in 2010</i>	2 to 5 years old.	Published or updated in the last 2 years.	3
<b>Why?</b> – Reasons or purpose of article?	No apparent motive.	Opinion based publication.	Trade magazine or commercial publication.	News or information publication lacking specific research based references.	Peer reviewed publication with research based references cited.	5
<b>Total Score</b>	➡	➡	➡	➡	➡	21
Provide a few sentences to summarize the content of this resource:						
<p><i>This book offers gardeners specific techniques for mitigating climate change and adapting to climate impacts in their back-yard gardens. It is very reader friendly and has numerous helpful graphs and photos. I found the chapter on reducing your garden's carbon emissions very useful and interesting.</i></p>						
In which of the following <b>category</b> would you put this resource? (Choose the ONE BEST fit).						
Climate Science		Adaptation Measures		<input checked="" type="checkbox"/> Sustainable/Gardening		
Climate Status Report		Mitigation Methods		Other (specify)		

**Reliable Resources Matrix - Worksheet**

<b>Title of Resource:</b>						
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>Rating</b>
<b>Who?</b> – The author's experience with this area.	Author background is unknown.	Little evidence – a few or minor publications in this area.	Some evidence – more than a few/minor publications in this area.	More evidence – several publications in this area.	Author is known authority in this area.	
<b>What?</b> – Are the points relevant to our needs or tasks?	No, little, or marginal relevant points.	Some relevant points.	Several relevant points.	Numerous relevant points.	Content and points closely match our needs or tasks.	
<b>Where?</b> – Context/situation of content is similar to ours?	Situation is different.	Minimal similarities.	Some similarities.	Number of similarities.	Context/situation matches ours.	
<b>When?</b> – Publication date.*	Date is not clear or older than 20 years.	10 to 20 years old.	5 to 10 years old.	2 to 5 years old.	Published or updated in the last 2 years.	
<b>Why?</b> – Reasons or purpose of article?	No apparent motive.	Opinion based publication.	Trade magazine or commercial publication.	News or information publication lacking specific research based references.	Peer reviewed publication with research based references cited.	
<b>Total Score</b>						
Provide a few sentences to summarize the content of this resource:						
In which of the following <b>category</b> would you put this resource? (Choose the ONE BEST fit).						
<b>Climate Science</b>		<b>Adaptation Measures</b>		<b>× Sustainable Gardening</b>		
<b>Climate Status Report</b>		<b>Mitigation Methods</b>		<b>Other (specify)</b>		

## Handouts

The following pages include handouts that you may find useful in your outreach efforts on the topic of gardening in a warming world:

- Handout#1 – ***Being a Systems Thinker***  
This 2-page handout is adapted from author Linda Booth Sweeney's *12 Habits of Mind* lists the key characteristics of a systems thinker on one page and pictures on the next.
- Handout #2 – ***Knowing your Garden System***  
This 2-page handout is a checklist of ways to map your garden landscape.
- Handout #3 – ***What is the Greenhouse Effect?***  
These images on a 1-page handout depict the general concept of how greenhouse gases warm the planet.
- Handout#4 – ***What Happens in New York State When the Climate Changes?***  
This 1-page handout provides an image of warming indicators and lists a the variety of NYS climate change impacts.
- Handout#5– ***Reliable Resources Matrix***  
This 2-page worksheet provides a tool to document and quantify the value of each resource, how accurate it is, and how reliable.
- Handout #6 – ***Climate-smart gardening put into action***  
This 4-page worksheet has a list of actions to reduce your carbon footprint. Reflect on their contribution to mitigation or/and adaptation.

Other resources can be downloaded for free at [climatechange.cornell.edu/gardening](https://climatechange.cornell.edu/gardening)

- Climate Smart Gardening Course Book
- Facilitator's Notebook (this document)
- Companion presentation
- Presentation notes