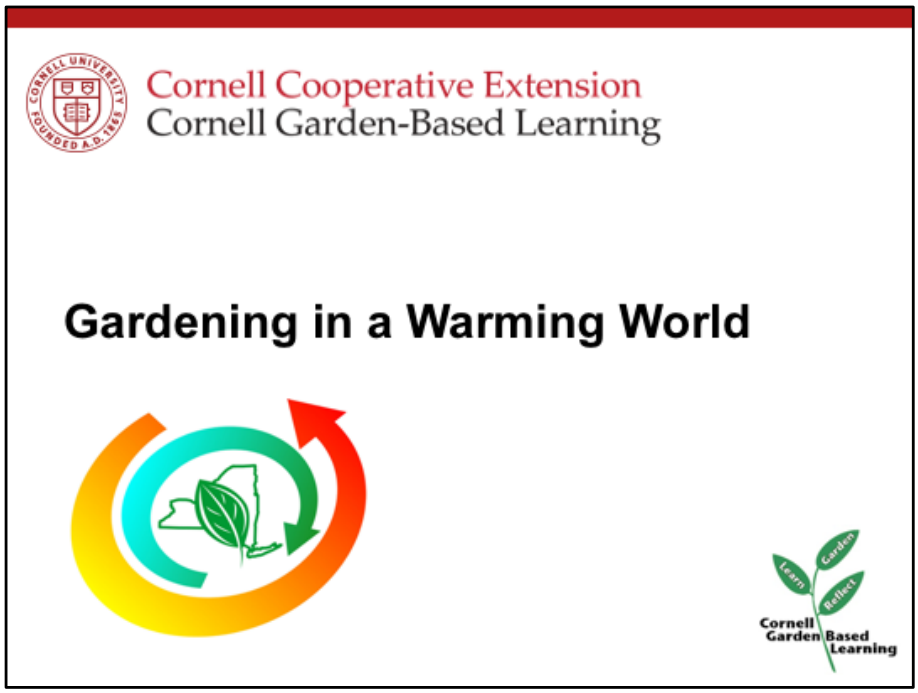


Welcome everyone to Gardening in a Warming World
Briefly review agenda, housekeeping and ground rules

This presentation is part of the Gardening in a Warming World curriculum which includes:

- Climate Smart Gardening Course Book
- Facilitator's Notebook
- Companion presentation
- Presentation notes

All Items can be downloaded from http://climatechange.cornell.edu/gardening
This is the September 2018 edition.

[1]CCE Gardening in a Warming World logo was designed by CCE Orleans County MGV Don O'Keefe.

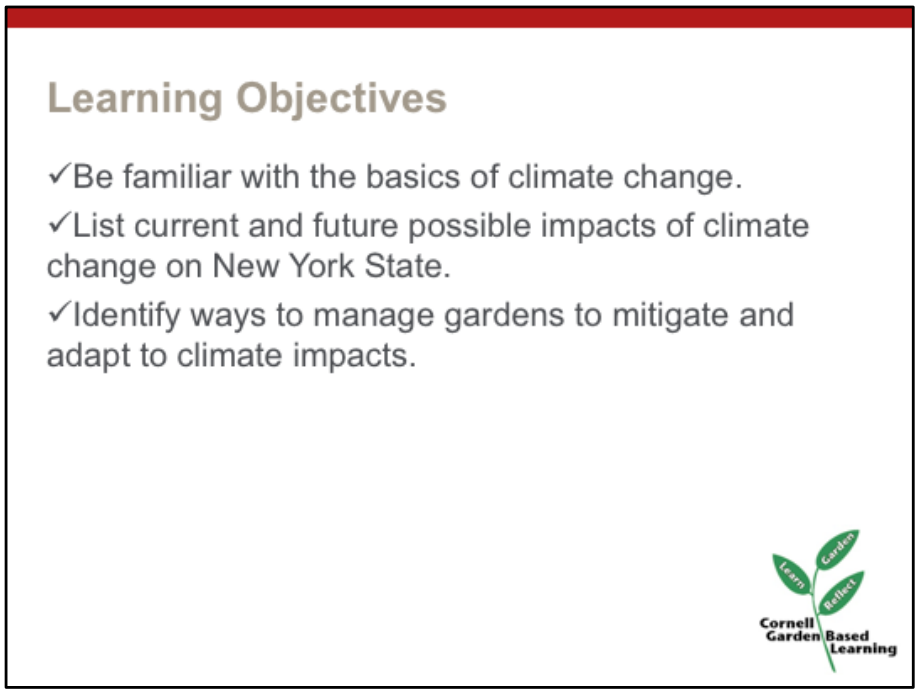
This ice breaker aims to get participants thinking about their garden spaces – how they see them, what they know about them.

It is an opportunity for you the facilitator to not 'teach' but to listen and learn about where the audience is at. Note that at home they may already be engaging in systems thinking and climate friendly gardening practices. Consider how you will use where they are at to connect them with concepts and knowledge you wish to introduce.

Provide a blank sheet of paper to participants. Ask people to take a couple of minutes to individually reflect and answer this question on the sheet of paper. Bring whole group back together and ask if 2 or 3 might volunteer to share their reflections (their words and/or image) with the group.

You may also choose to revisit their responses to this question at the end of the session to consider how responses may change with the new information or perspective provided today.

[2] Pounder Vegetable Garden. Image credit: Cornell Botanic Gardens Retrieved June 1, 2017 from http://www.cornellbotanicgardens.org/gallery/209

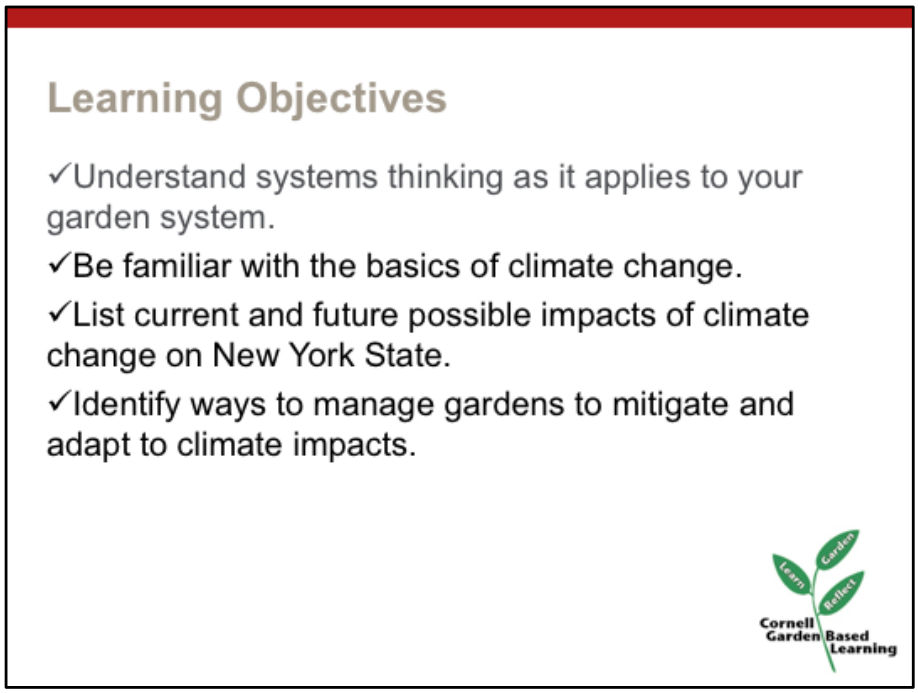


Learning outcomes for a 30-minute and 45-minute presentation, as outlined in the Facilitator's Notebook section 4.
Explain that this presentation closely mirrors the structure of the Course Book.

This presentation is part of the Gardening in a Warming World curriculum which also includes:

- Gardening in Gardening in a Warming World A Climate Smart Gardening Course Book
- Gardening in a Warming World Facilitators Notebook
- This companion presentation

All Items can be downloaded from http://climatechange.cornell.edu/gardening

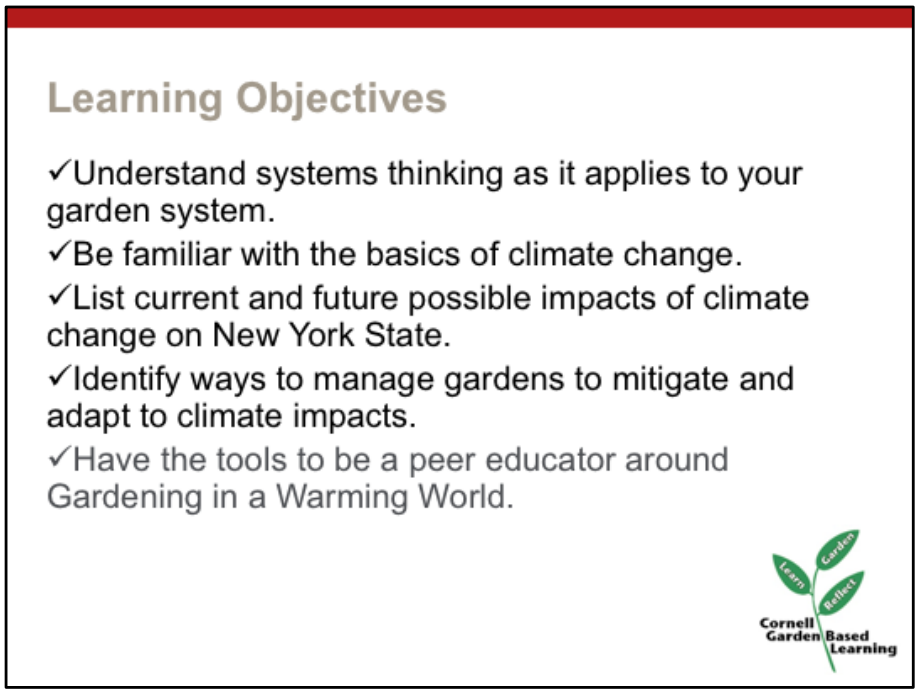


Additional learning outcome for the 60 minute session, as outlined in the Facilitator's Notebook section 4.
Explain that this presentation closely mirrors the structure of the Course Book.

This presentation is part of the Gardening in a Warming World curriculum which also includes:

- Gardening in Gardening in a Warming World A Climate Smart Gardening Course Book
- Gardening in a Warming World Facilitators Notebook
- This companion presentation

All Items can be downloaded from http://climatechange.cornell.edu/gardening



Additional learning outcome for 2½ hour session, as outlined in the Facilitator's Notebook section 4.
Explain that this presentation closely mirrors the structure of the Course Book.

This presentation is part of the Gardening in a Warming World curriculum which also includes:

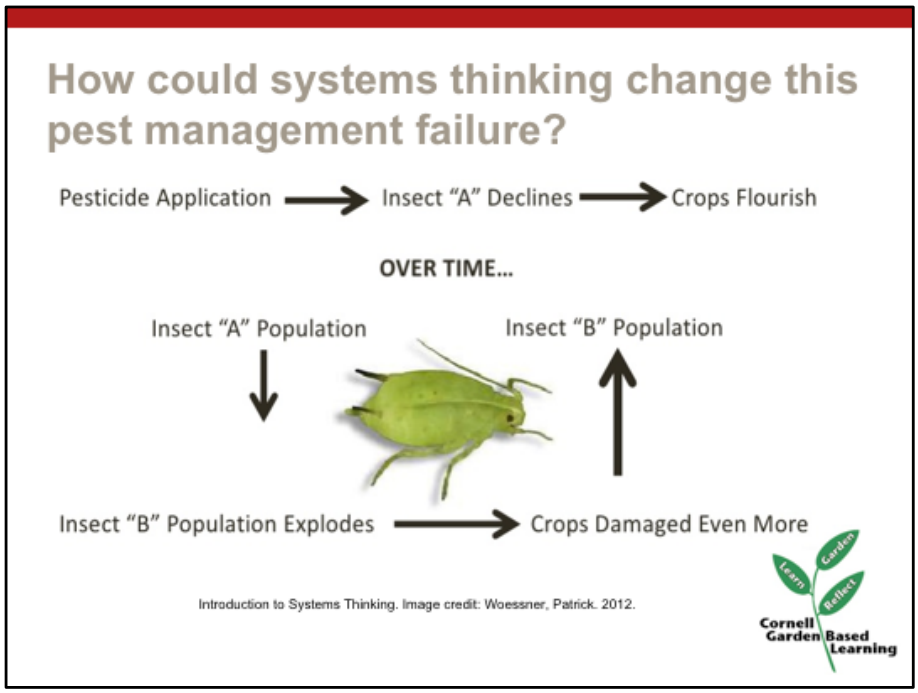
- Gardening in Gardening in a Warming World A Climate Smart Gardening Course Book
- Gardening in a Warming World Facilitators Notebook
- This companion presentation

All Items can be downloaded from http://climatechange.cornell.edu/gardening

Unit 1: Benefits of Systems Thinking for Sustainable Gardening

… We see trees, certainly, as well as other plants, soil, water, birds, animals and often much more. If we placed some trees, soil, a pool of water, and squirrels and chipmunks together, however, we clearly would not have a forest. A forest is the complexity of relationships among these elements and other connected systems such as weather, climate, and human settlements. The systems thinking approach aims to understand the complexity of the world in terms of relationships, connectedness, and context.

[3] Forest Management. Image credit: Cornell Cooperative Extension Dutchess County. Retrieved June 4, 2017 from http://ccedutchess.org/environment/natural-resources/forest-management-1

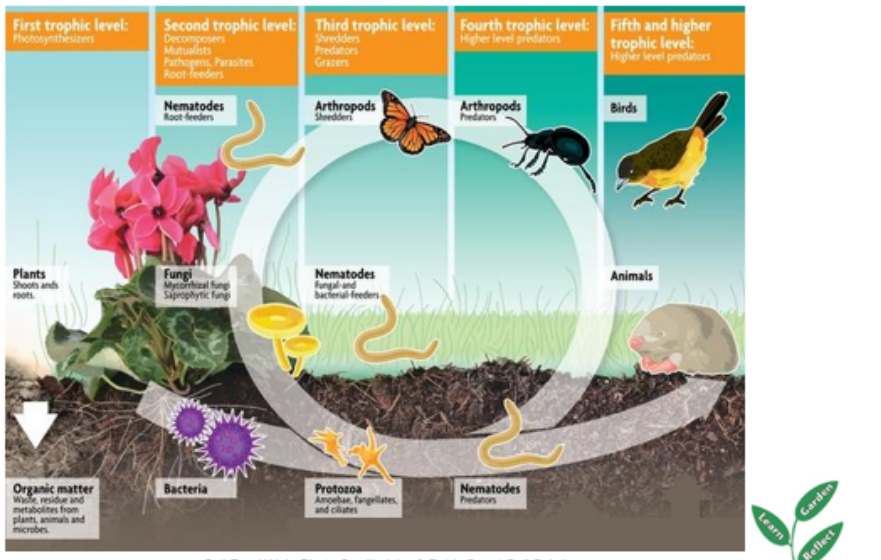


Unit 1: Benefits of Systems Thinking for Sustainable Gardening

Ask participants to take several minutes to review the *Habits of a Systems Thinker* sheet and consider how systems thinking could lead to great success in pest management.

Find *Habits of a Systems Thinker* pages in UNIT 1: Benefits of Systems Thinking for Sustainable in the Gardening in Gardening in a Warming World A Climate Smart Gardening Course Book or in the Appendix (handout section) of the Gardening in a Warming World Facilitators Notebook.
All Items can be downloaded from http://climatechange.cornell.edu/gardening

[4] Introduction to Systems Thinking. Image credit: Woessner, Patrick. 2012. Lausanne Laptop Institute. Retrieved 31 July, 2017. https://www.slideshare.net/pwoessner/systems-thinking-lli2012



Soil Food Web. Photo Credit: John & Bob's Smart Soil Solutions

Cornell Garden Based Learning

Unit 1: Benefits of Systems Thinking for Sustainable Gardening

Instead of concentrating on a specific element like a pest, the systems approach emphasizes principles of organization focused on the key idea of observing relationships.

What is preserved in a garden area is not individual plants or organisms but a complex web of relationships between them. A gardener's awareness of the interconnections of things is heightened through systems thinking. Intentionally observing and documenting changes in our garden landscapes and noticing the relationships among those changes is a powerful tool for gardening success.

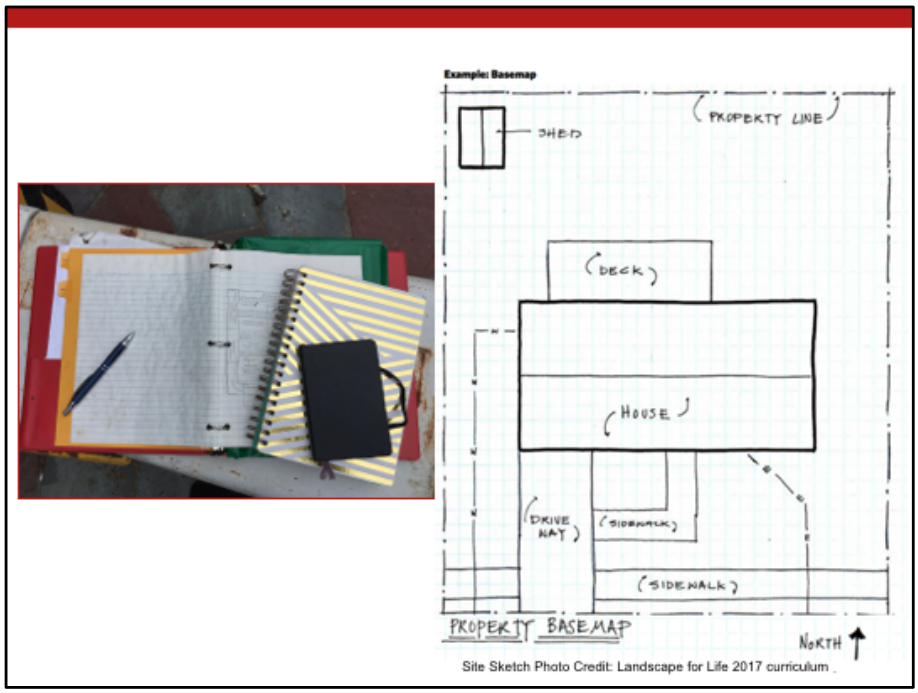
All natural systems are wholes whose specific structures arise from the interactions and interdependence of their parts. The activity of systems involves simultaneous and mutually interdependent interaction between multiple components.

[5] Soil Food Web. Photo Credit: John & Bob's Smart Soil Solutions. Retrieved June 2017 from: https://www.johnandbobs.com/blogs/news/52693445-the-lasagna-method-dont-till-your-soil

Unit 2: Knowing Our Garden Systems

Consider ways to apply systems thinking to your garden. Start small and find delight in the ongoing discovery process that emerges as your habit of systems thinking expands. You might begin your adventure simply with an introspective or meditative observational experience. Sit outside or walk around your garden spaces rallying all your senses - look, touch and taste (do skip this one if you are unsure of toxicity!), listen, and smell.

What are you doing in your garden to support thriving systems? What is your role in the system?



Site Sketch Photo Credit: Landscape for Life 2017 curriculum .

Unit 2: Knowing Our Garden Systems
Gardeners use lots of observational techniques to deepen our understanding of our garden systems. Ask participants what they use. Share a few additional ideas as needed.

Journaling Garden - journals are most popular and take a number of forms including photographs, sketches, listings, descriptive text, and calendars.
Creating a Garden Calendar – try out online calendar apps; use images, reminders, etc.
Cataloging Your Garden Site – plants & critters Are the Bloom Dates Changing and More?
Mapping - Creating a map of a garden landscape is also a common practice to document your garden system. soil, water, vegetation, weather, climate, patterns

Provide participants with 2-page handout "Knowing your Garden System" found in Facilitator's Notebook appendix. Ask if them to return to their product from ice breaker "How might you sketch or describe in words your gardening space?" and begin to add details to shape a base map or another map described in handout. Bring whole group back together and ask if 2 or 3 might volunteer to share their reflections (their words and/or image) with the group.

[6] Site Sketch Photo Credit: Landscape for Life 2017 curriculum. Retrieved July 2017 from: http://landscapeforlife.org/wp-content/uploads/2012/03/Slide53.jpg

Unit 2: Knowing Our Garden Systems
Before we move to explore more about our changing climate, encourage participants to share their observations around this question.

Start by having them sharing with a person next to them then after a moment (depending on your time) open it to whole group share themes that are emerging or unique observations.
If time allows you might ask for additional comment on:
What changes are challenging your garden success? How are they challenging?
Any enhancing your gardening success?

This is another opportunity for you the facilitator to not 'teach' but to listen and learn about where the audience is at. Items raised in this initial discussion we will likely cover as we move through additional material. Don't feel you need to address them. What the audience shares is reinforcing why we are together to learn more in the time ahead.

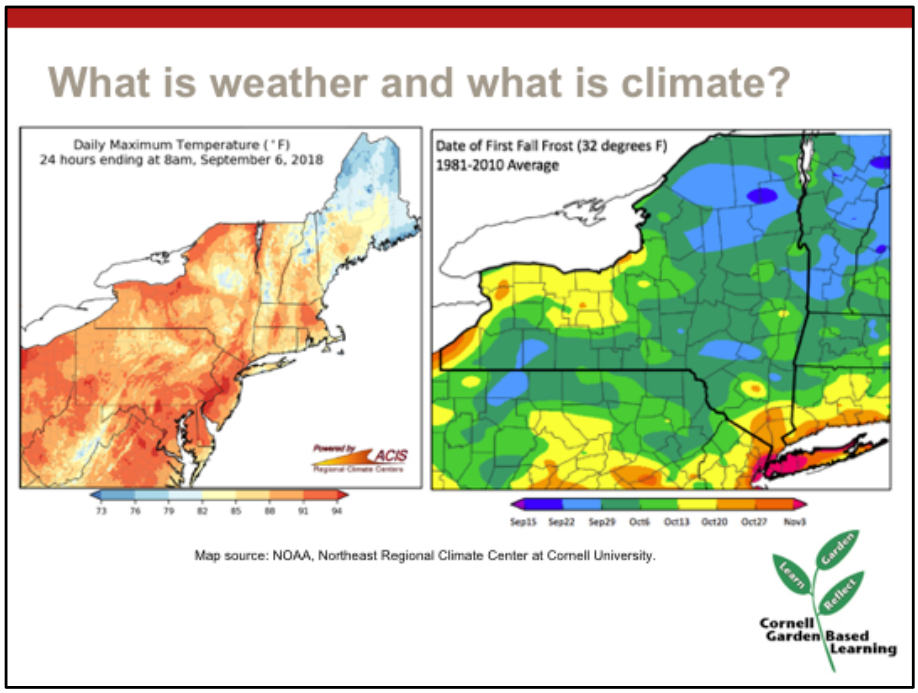
Are participants mentioning…
More rainfall? More drought?
Either plant species thriving where they once failed, or vice versa? New species?

[7]Vegetable Variety Trial Garden. Image credit: Cornell Cooperative Extension Wayne County

Unit 3: Climate Change Basics

Good to have you share your gardening observation. You have come to the right place to find tools to help you meet your challenges.

The videos found in the following link will offer climate change basics in a very clear and concise manner: http://www.climatelearning.net/e-learning-modules/

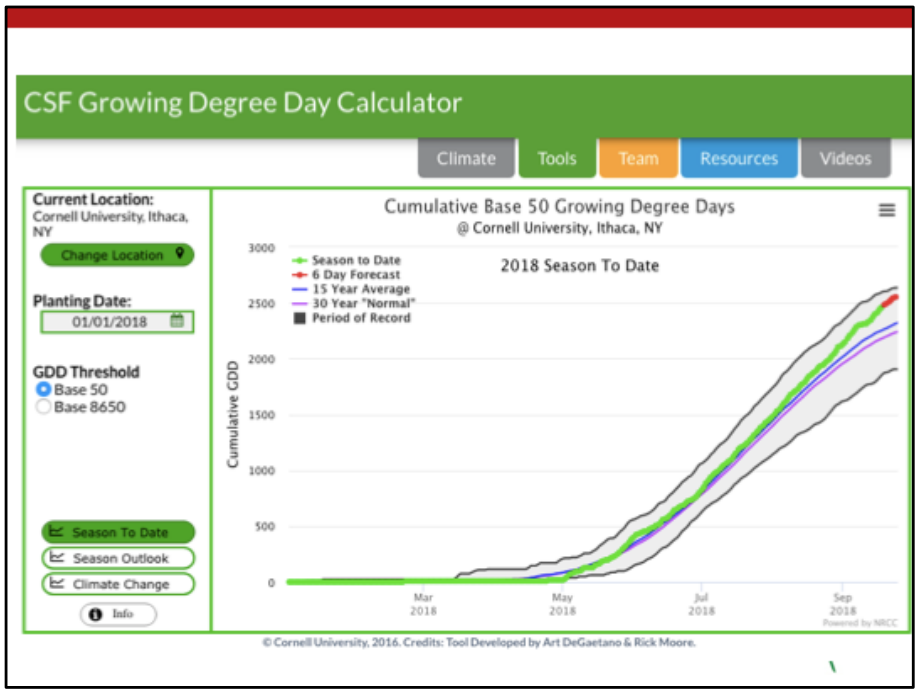


Unit 3: Climate Change Basics
Ask participants to try to define for you before you share…

Weather is the state of the atmosphere at a specific time and place. It is the short-term variations of the atmosphere (from minutes to weeks).Weather is often referred to in terms of brightness, cloudiness, humidity, precipitation, temperature, visibility, and wind. We commonly talk about the weather in terms of "What will it be like today?", "How hot is it right now?" and "When will that snow storm hit our town?"
Gardeners listen avidly to the daily weather reports from local meteorologists to figure out the best day for gardening practices affected by the weather.

Climate is the prevalent long-term weather conditions in a particular place. Generally, climate is considered the weather in a place over a period of 30+ years. Climatic elements include precipitation, temperature, humidity, sunshine and wind velocity, and phenomena such as fog, frost and snow.
Gardeners look to the average date of the last frost in spring to help plan when to transplant plants that are not frost-tolerant. The average date of the **first frost in fall** helps plan when to plant late-season or fall crops, and when you can expect frost-sensitive plants to finally succumb to freezing temperatures if not covered with sufficient protection. The period between the last frost in spring and the first frost in fall is called the freeze free period or frost-free days.

[8] Map source: NOAA, Northeast Regional Climate Center at Cornell University. 2018. http://www.nrcc.cornell.edu provided these on August 2018



Unit 3: Climate Change Basics

Though more common among commercial growers the calculation of **growing degree days** (GDD) or the "heat" accumulated during each growing season is a formal way to estimate timing of growth of an organism including bud break, flowering, as well as, when eggs of a particular pest are going to hatch or approximately when vulnerable stages of certain pest will be present. GDD's are a much more accurate method of estimating the timing of events than the calendar method. Japanese beetles do not just wake up one morning and say, "Ooops. June 15th already. Time to get out there." Rather, their emergence is determined by the accumulation of growing degree days. They make an earlier appearance when spring is warm and GDDs accumulate early and appear later when it's cool. Calculating GDD's involves a comparison of daily maximum and minimum temperatures to a lower and upper base temperature for growth of an organism. No need to do the math yourself find this growing degree calculator for Northeastern US at: climatesmartfarming.org/tools

[9] Climate Smart Farming Growing Degree Day Calculator. Image credit: Cornell University, 2016. Tool Developed by Art DeGaetano & Rick Moore.

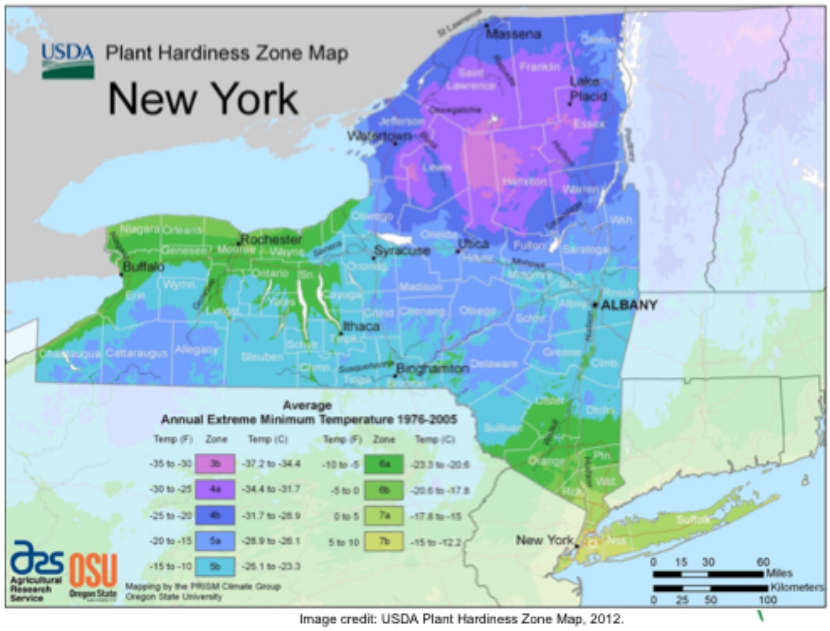
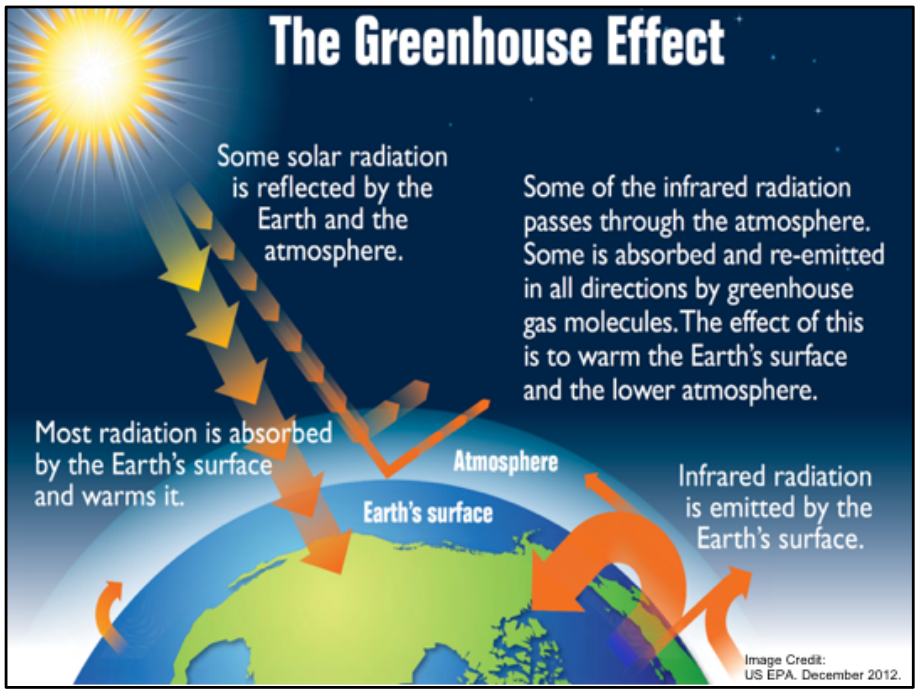


Image credit: USDA Plant Hardiness Zone Map, 2012.

Unit 3: Climate Change Basics

While growing degree days focus on current weather the US Department of Agriculture (USDA) Hardiness Zone Map uses decades of past minimum average winter temperatures to divides North America into 13 zones of 10 degrees Fahrenheit (figure 4). Plant hardiness zone provides gardeners with information to determine which herbaceous perennials and woody trees, shrubs and vines will survive winters where they want to garden. The information is commonly on tags when you purchase perennial plants and is standard in plant catalogs, though you may see slight differences depending on the source.

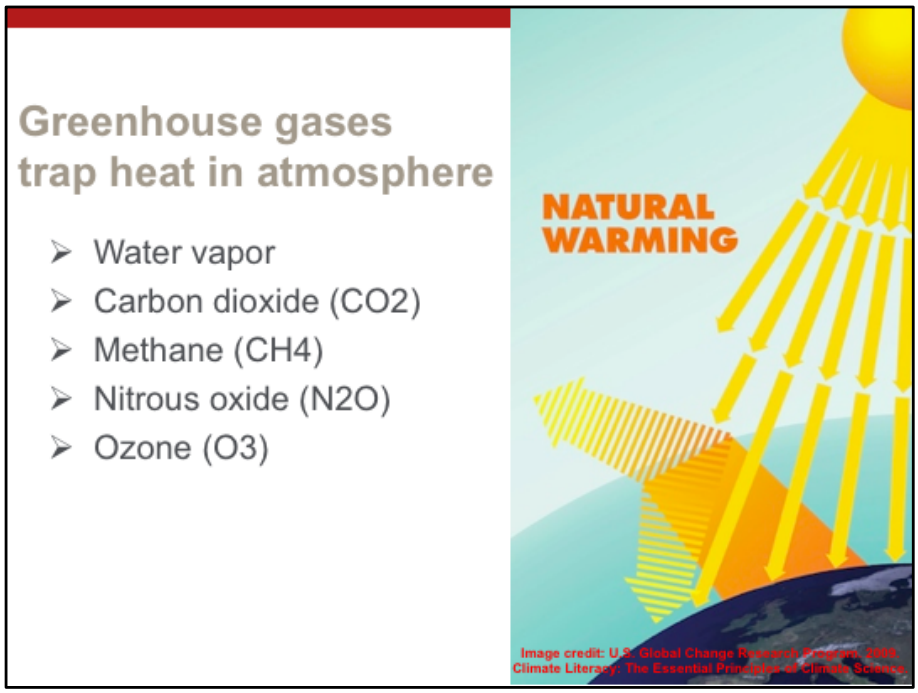
[10] USDA Plant Hardiness Zone Map, 2012. Agricultural Research Service, U.S. Department of Agriculture. Accessed September 17, 2018 from https://planthardiness.ars.usda.gov



Unit 3: Climate Change Basics
Provide participants with 1 -page handout "What is the Greenhouse Effect?" found in Facilitator's Notebook appendix.

The sun is the primary source of energy for earth's climate system.
Some of the incoming solar energy (sunlight) is reflected back to space by the surface, clouds, or ice. Because the Earth is cooler than the sun, the Earth emits energy into the atmosphere in the form of infrared radiation, at wavelengths longer than the incoming solar energy.
The greenhouse effect is a natural phenomenon where gases in the atmosphere prevent the energy from escaping, then re-emit this energy in all directions, heating the Earth's land, ocean, and atmosphere as well as the lower atmosphere. This keeps the Earth's surface at a temperature that is habitable for the current organisms on the planet, including humans. Because gases in the Earth's atmosphere also let in light but trap heat, many people call this phenomenon the "greenhouse effect."

[11] Image Credit: "The Greenhouse Effect" in: "Introduction," in: US EPA (December 2012) Climate Change Indicators in the United States, 2nd edition[1], Washington, DC, USA: US EPA, p.3. EPA 430-R-12-004. currently can find it online at:
https://commons.wikimedia.org/wiki/File:Earth%27s_greenhouse_effect_(US_EPA,_2012).png



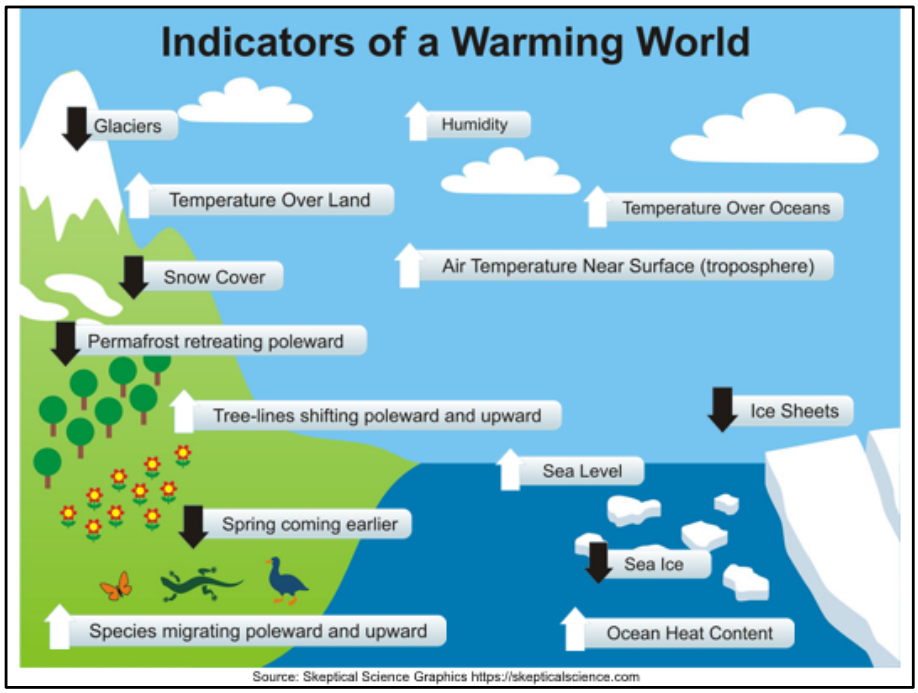
Unit 3: Climate Change Basics

Gases that trap heat in the atmosphere are called greenhouse gases.

When Earth emits the same amount of energy as it absorbs, its energy budget is in balance, and its average temperature remains stable (steady-state conditions)

Increasing the concentration of heat-trapping gases (greenhouse gases) in the atmosphere amplifies or enhances the natural greenhouse effect. This "thickening of the Earth's blanket" of greenhouse gases surrounding the planet means more heat energy will be trapped in atmosphere, making the Earth's surface warmer

[12] 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

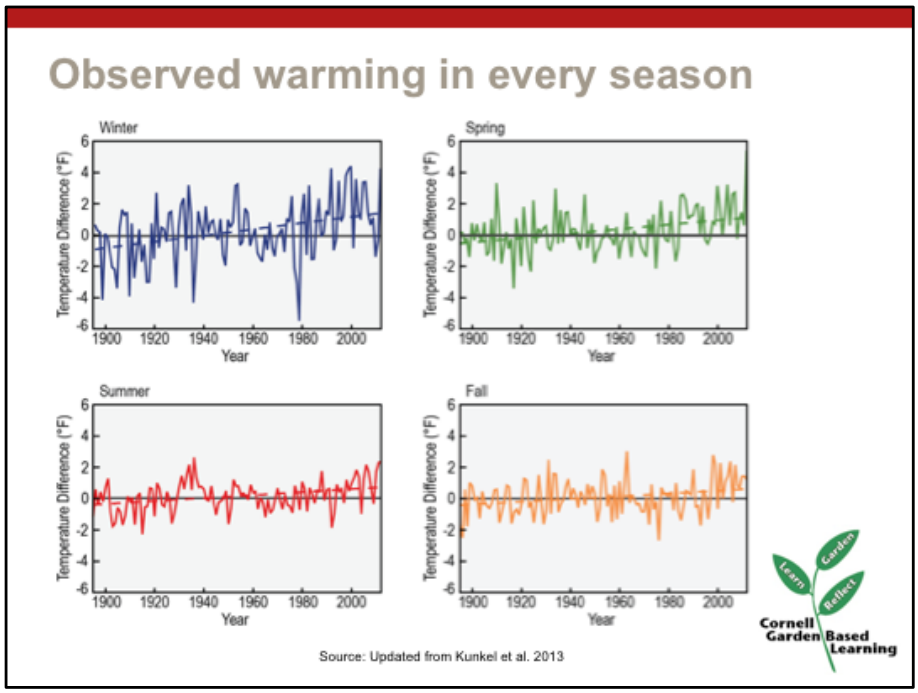


Unit 3: Climate Change Basics

Provide participants with 1 -page handout "What Happens in New York State When the Climate Changes?" found in Facilitator's Notebook appendix.

Overwhelming scientific data shows that earth's climate is warming at an accelerating pace. Since 1850, the beginning of the Industrial Age, the atmospheric global temperature has warmed about 2 degrees Fahrenheit. The three decades from 1983 to 2012 were the warmest 30-year period of the last 1400 years according to the International Panel on Climate Change (IPCC) Fifth Assessment Report, and the year 2016 has broken all previous records.

[13] Source: Skeptical Science Graphics by Skeptical Science. Retrieved September, 2018. https://skepticalscience.com/graphics.php?g=8



Unit 3: Climate Change Basics

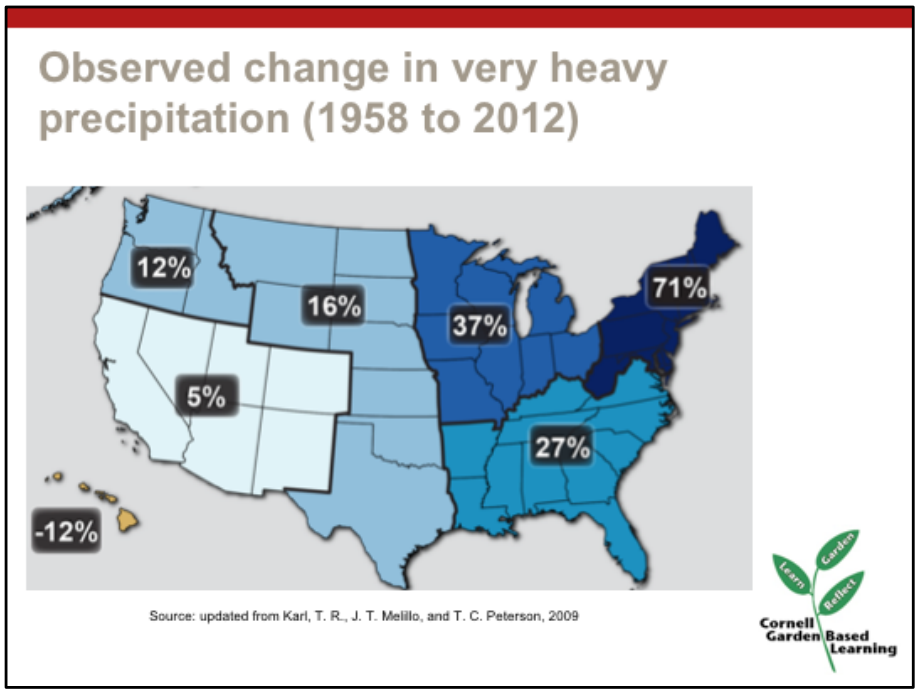
Temperature shifts are occurring in all seasons. Winter's warming is particularly clear (blue graph). The graphs show continental U.S. seasonal temperatures (relative to the 1901-1960 average). Dashed lines show the linear trends.

Similarly for New York the according to our ClimAID report (2011, 2014), the National Climate Assessment (2014), and other research:

- 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

[14] Updated from Kunkel et al. 2013: Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 9. Climate of the Contiguous United States. NOAA Technical Report NESDIS 142-9. 85 pp., National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C. Retrieved September 2018 from https://nca2014.globalchange.gov/report/appendices/climate-science-supplement#tab1-images

[15] NYSDEC Impacts of Climate Change in New York World. Accessed September 17, 2018 from https://www.dec.ny.gov/energy/94702.html



Unit 3: Climate Change Basics

As the world has warmed, that warming has triggered other changes to the Earth's climate. Over the last 50 years, the U.S. has seen increases in the number and strength of extreme weather events including prolonged periods of excessively high temperatures, drought, floods, and heavy downpours.

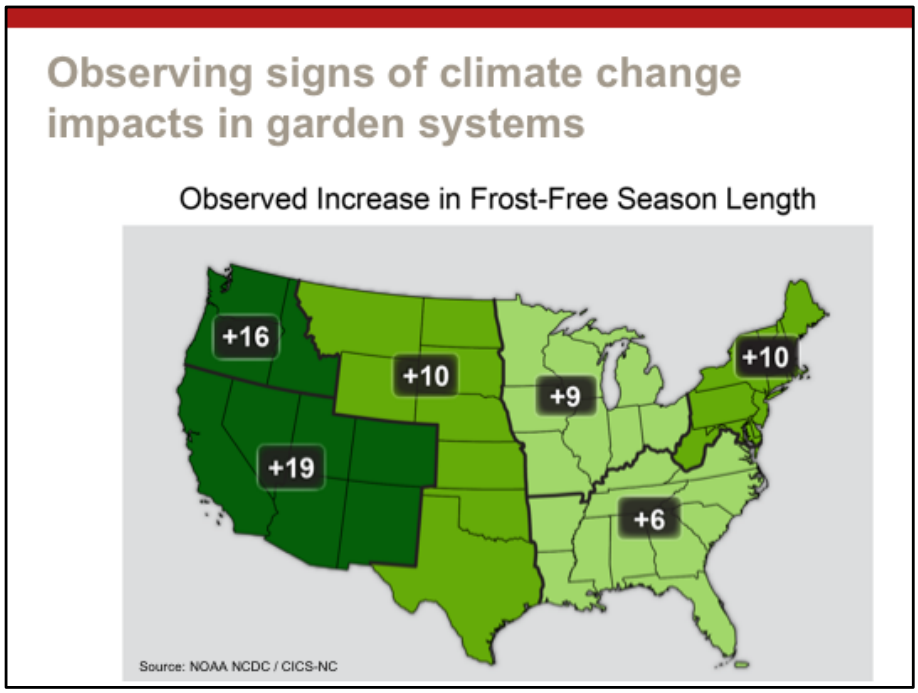
This map shows the percent increases in the amount of precipitation falling in very heavy events for regions of U.S. The changes shown in this figure are calculated from the beginning and end points of the trends for 1958 to 2012.

In New York the according to our ClimAID report (2011, 2014), the National Climate Assessment (2014), and other research:

- 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.

[15] NYSDEC Impacts of Climate Change in New York World. Accessed September 17, 2018 from https://www.dec.ny.gov/energy/94702.html

[16] Source: updated from Karl, T. R., J. T. Melillo, and T. C. Peterson, 2009: Global Climate Change Impacts in the United States. Accessed September 11, 2018 from https://nca2014.globalchange.gov/report/our-changing-climate/heavy-downpours-increasing

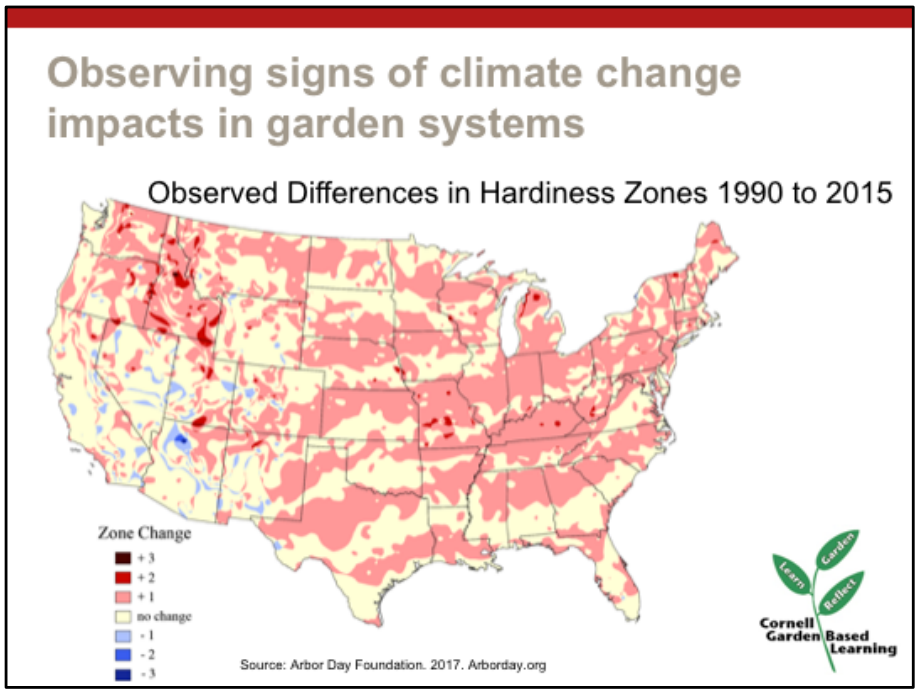


Unit 3: Climate Change Basics

Observed increase in frost-free season length and changes in hardiness zones have gardeners questioning how confidently we can rely on frameworks that have provide a foundation to plan and achieve success in our garden settings.

Map shows observed increase in frost-free season length from 1991-2012 compared to 1901-1960.

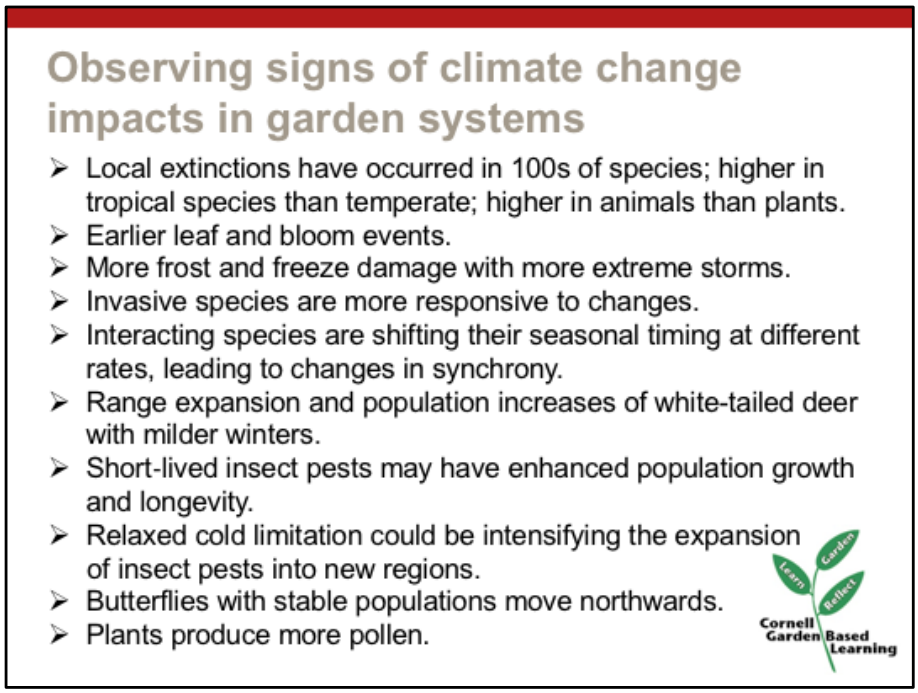
[17] NOAA NCDC / CICS-NC. Kenneth E. Kunkel, Cooperative Institute for Climate and Satellites – NC. Accessed September 2018 from https://nca2014.globalchange.gov/report/our-changing-climate/frost-free-season



Unit 3: Climate Change Basics

Observed increase in frost-free season length and changes in hardiness zones have gardeners questioning how confidently we can rely on frameworks that have provide a foundation to plan and achieve success in our garden settings.

[18] Source: Arbor Day Foundation. 2017. Differences between 1990 USDA Hardiness Zones and 2015. Arborday.org Hardiness Zones. Accessed September 7, 2018 from https://www.arborday.org/media/map_change.cfm



Unit 3: Climate Change Basics

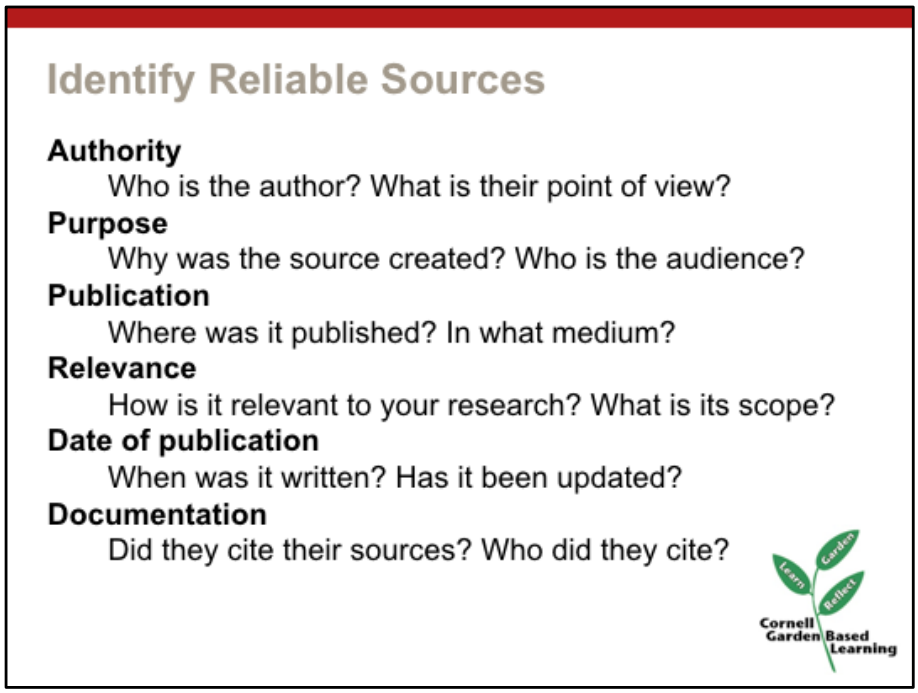
Here are a few examples of the most common ecological response to climate change mainstream scientists have documented. How do these compare to the changes have you noticed in your garden? (shared in our earlier discussion)

See more details on each of these and other responses in Gardening in Gardening in a Warming World A Climate Smart Gardening Course Book Unit 3 Climate Change Basics Section Observing Signs of Climate Change Impacts in Garden Systems page 14.

Source for the above statements can be found on the Source List slide at the end of presentation (#19 through #29) as well as in the Endnotes in course book mentioned above.

Consider asking participants to add to this list of impacts. Reflect on what categorize the impact might fall into:

- ❑ observed in the real-world (like the earlier bloom of cherry trees in Washington)
- ❑ observed in controlled experiments or simulations (as with poison ivy response to CO_2)
- ❑ a prediction or extrapolation based on current evidence

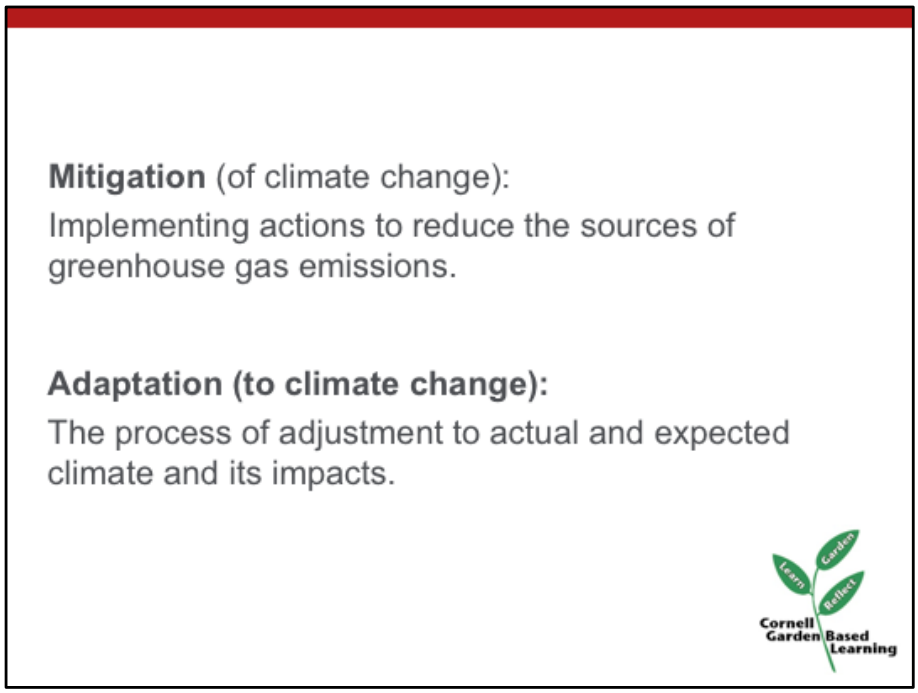


Unit 3: Climate Change Basics

Provide participants with 2-page handout "Reliable Resources Matrix" found in Facilitator's Notebook appendix. Also see Course Book tail end of Unit 3

As others share to the list of impacts direct their attention to this worksheet. There is highly politicized condemnation of climate change science; it is important that we use reliable, research-based information in both learning ourselves and educating others.

Use and share this tool a checklist to organize and evaluate resources related to climate change.



Unit 4: Climate-Friendly Sustainable Garden Audit

Gardeners are on the leading edge of climate change impacts and so are well-positioned to be significant community leaders in addressing the management of this challenge. To date, the response to manage the climate crisis is a two-pronged approach through mitigation and adaptation.

Can you name some actions to mitigate climate change?

Can you name some actions to adapt to climate change?

What are some additional examples of how you might adapt to climate change in your garden?

Provide participants with 4-page worksheet "Climate-smart gardening put into action" found in Facilitator's Notebook appendix handout section. Direct participants to take a shot at categorizing each of the action. You may have them work individually, in pairs or small groups. Return to large group to discuss a few observations when completing worksheet or other highlights, common themes with others, what participants are already doing…

Unit 4: Climate-Friendly Sustainable Garden Audit
When it comes to dire problems like climate change, cultivating a dialogue among gardeners can be a critical aspect of understanding the challenge, and ultimately can lead to changes in behavior grounded in sustainable practices and environmental stewardship.

Our Sustainable Garden Audit focuses on mitigation and adaption actions in these major practices. (See details in Course Book Unit 4)

Our aim is to inspire deeper learning and discussion not provide a check list of what to do to call yourself a good steward (the one and done attitude will not do). Instead, recall Habits of a Systems Thinker* and embrace that there are no single solutions, practices are interrelated, one strategy influences the other. As you reflect on the 6 areas above focus on:

1. What are you already doing and what additional actions can you take to reduce (mitigate) GHG emission in our gardening practice?
2. What are you already doing and what additional actions can you take to adapt our gardens to climate change?

Break up into smaller groups and having each focus on just one area that is assigned to them or chosen by them (okay if not all are covered and different groups are discussing the same area). After some time in small groups, come back together as a whole group and highlight or list the full range of strategies gardeners are or could be implementing through mitigation and adaptation.

*Find *Habits of a Systems Thinker* in UNIT 1: Benefits of Systems in Course Book or in the Appendix (handout section) of the Gardening in a Warming World Facilitators Notebook.

Integration of local knowledge with additional scientific and technical knowledge can improve disaster risk reduction and climate change adaptation. Local populations document their experiences with the changing climate, particularly extreme weather events, in many different ways, and this self-generated knowledge can uncover existing capacity within the community.

Unit 4: Climate-Friendly Sustainable Garden Audit

Gardener are well-positioned to be significant community leaders in addressing the management of the challenge of climate change. It is important to understand climate change so we gardeners can be significant community leaders in public discourse; and leaders in integrating knowledge into our gardening practices.

[28] This statement is from the 2012 Intergovernmental Panel on Climate Change report Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation Summary for Policymakers, p.15.

Talk with others about Gardening in a Warming World

Most individuals do not make decisions about undertaking a behavior change on the basis of scientific studies of the consequences of making the change.

Most people depend mainly upon subjective evaluations of ideas that are new to them; and rely on other individuals like themselves who have previously adopted the idea or behavior.

Rogers 2003

Farmers Market. Image credit: Cornell Cooperative Extension Wayne County

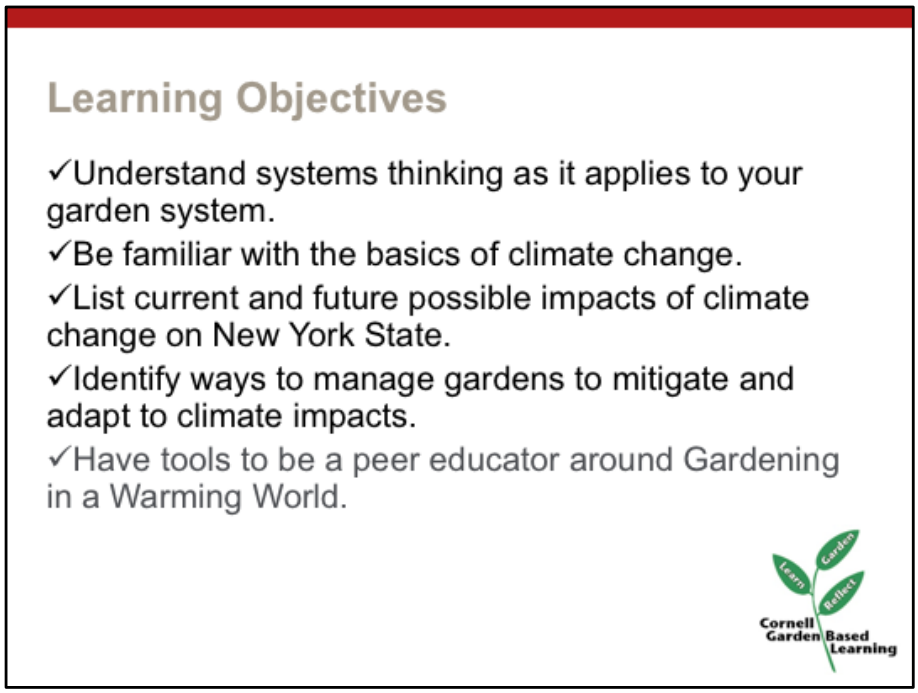
Cornell Garden Based Learning

Gardeners are often the first to notice changes in seasonal temperature patterns and impacts of extreme weather events on landscapes. Not surprisingly, garden-based educators and volunteers are increasingly called upon to offer guidance on the topic of climate change as part of community education efforts related to gardening. As peers, gardeners, play a vital role as agents of change within our networks and the broader community.

For those of us who would like to participate in engaging the public, there is an accompanying facilitator's notebook to this course book, found at climatechange.cornell.edu/gardening. It emphasizes conversations that allow people to process the emotional responses – such as worry, curiosity, etc. – that emerge in gaining understanding about climate change and inspires the use of scientific evidence through background information, engaging questions and hands-on activities. The facilitator's notebook included the list of Principles of Climate Change developed by Columbia University's Center for Research on Environmental Decisions to help guide instructors toward meaningful, respectful discussions about climate change.

You may wish to share from the *Facilitators Notebook:*
Section 5: Creating a Study Circle for Gardening in a Warming World (1 page)
Section 6: How to Talk About Gardening in Warming World with Others (5 pages)

[29] Adapted from Diffusion of Innovations by Everett Rogers. 2003. Free Press. New York

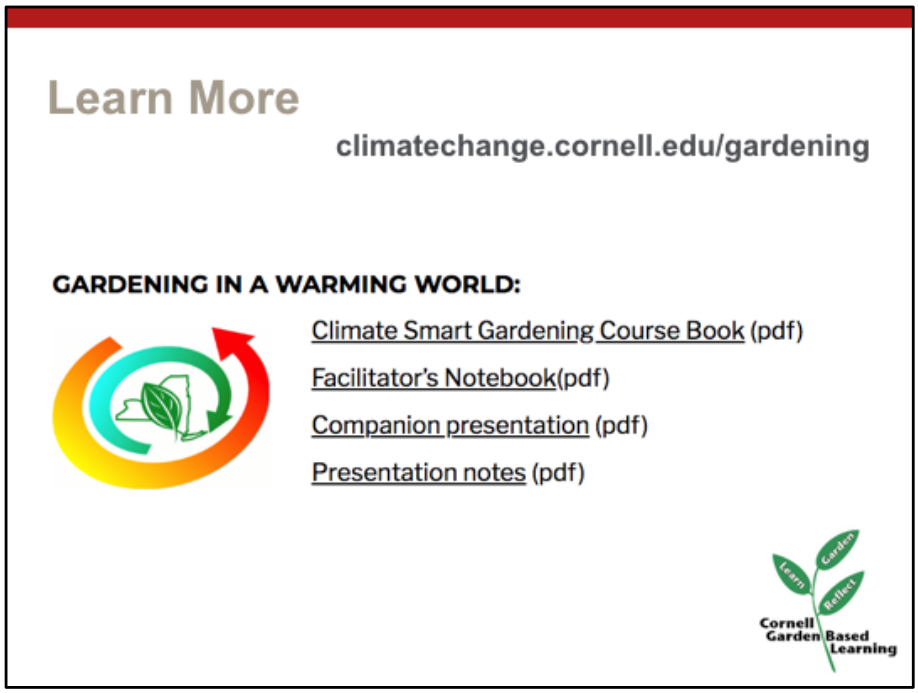


Additional learning outcome for 2½ hour session, as outlined in the Facilitator's Notebook section 4.
Explain that this presentation closely mirrors the structure of the Course Book.

This presentation is part of the Gardening in a Warming World curriculum which also includes:

- Gardening in Gardening in a Warming World A Climate Smart Gardening Course Book
- Gardening in a Warming World Facilitators Notebook
- This companion presentation

All Items can be downloaded from http://climatechange.cornell.edu/gardening



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Source List

1. CCE Gardening in a Warming World logo was designed by CCE Orleans County MGV Don O'Keefe.
2. Pounder Vegetable Garden. Image credit: Cornell Botanic Gardens. Retrieved June 1, 2017 from www.cornellbotanicgardens.org/gallery/209
3. Forest Management. Image credit: Cornell Cooperative Extension Dutchess County. Retrieved June 2017 from http://ccedutchess.org/environment/natural-resources/forest-management-1
4. Introduction to Systems Thinking. Image credit: Woessner, Patrick. 2012. Lausanne Laptop Institute. Retrieved July 2017. https://www.slideshare.net/pwoessner/systems-thinking-lli2012
5. Soil Food Web. Photo Credit: John & Bob's Smart Soil Solutions. Retrieved June 2017 from: https://www.johnandbobs.com/blogs/news/52693445-the-lasagna-method-dont-till-your-soil
6. Site Sketch Photo Credit: Landscape for Life 2017 curriculum. Retrieved July 2017 from: http://landscapeforlife.org/wp-content/uploads/2012/03/Slide53.jpg
7. Vegetable Variety Trial Garden. Image credit: Cornell Cooperative Extension Wayne County
8. Map credit: NOAA, Northeast Regional Climate Center at Cornell University. 2018. http://www.nrcc.cornell.edu provided on Aug 2018
9. Climate Smart Farming Growing Degree Day Calculator. Image credit: Cornell University, 2016. Tool Developed by Art DeGaetano & Rick Moore. Retrieved September 2018 from: http://climatesmartfarming.org/tools/csf-growing-degree-day-calculator/
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17. NOAA NCDC / CICS-NC. Kenneth E. Kunkel, Cooperative Institute for Climate and Satellites – NC. Accessed September 2018 from https://nca2014.globalchange.gov/report/our-changing-climate/frost-free-season

Provide participants with 2-page handout "Reliable Resources Matrix" found in Facilitator's Notebook appendix. Also see Course Book tail end of Unit 3

There is highly politicized condemnation of climate change science; it is important that we use reliable, research-based information in both learning ourselves and educating others.

Use and share this tool a checklist to organize and evaluate resources related to climate change.

Source List Continued

18. Arbor Day Foundation. 2017. Differences between 1990 USDA Hardiness Zones and 2015 Arborday.org Hardiness Zones. Accessed September 7, 2018 from https://www.arborday.org/media/map_change.cfm
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30. 2012 Intergovernmental Panel on Climate Change report Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation Summary for Policymakers, p.15
31. Adapted from Diffusion of Innovations by Everett Rogers. 2003. Free Press. New York

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Use and share this tool a checklist to organize and evaluate resources related to climate change.