



Welcome
John MacLeod Lecture Thursday 9th
November 2017
Guest Speaker: Professor David Wolfe
4.40pm

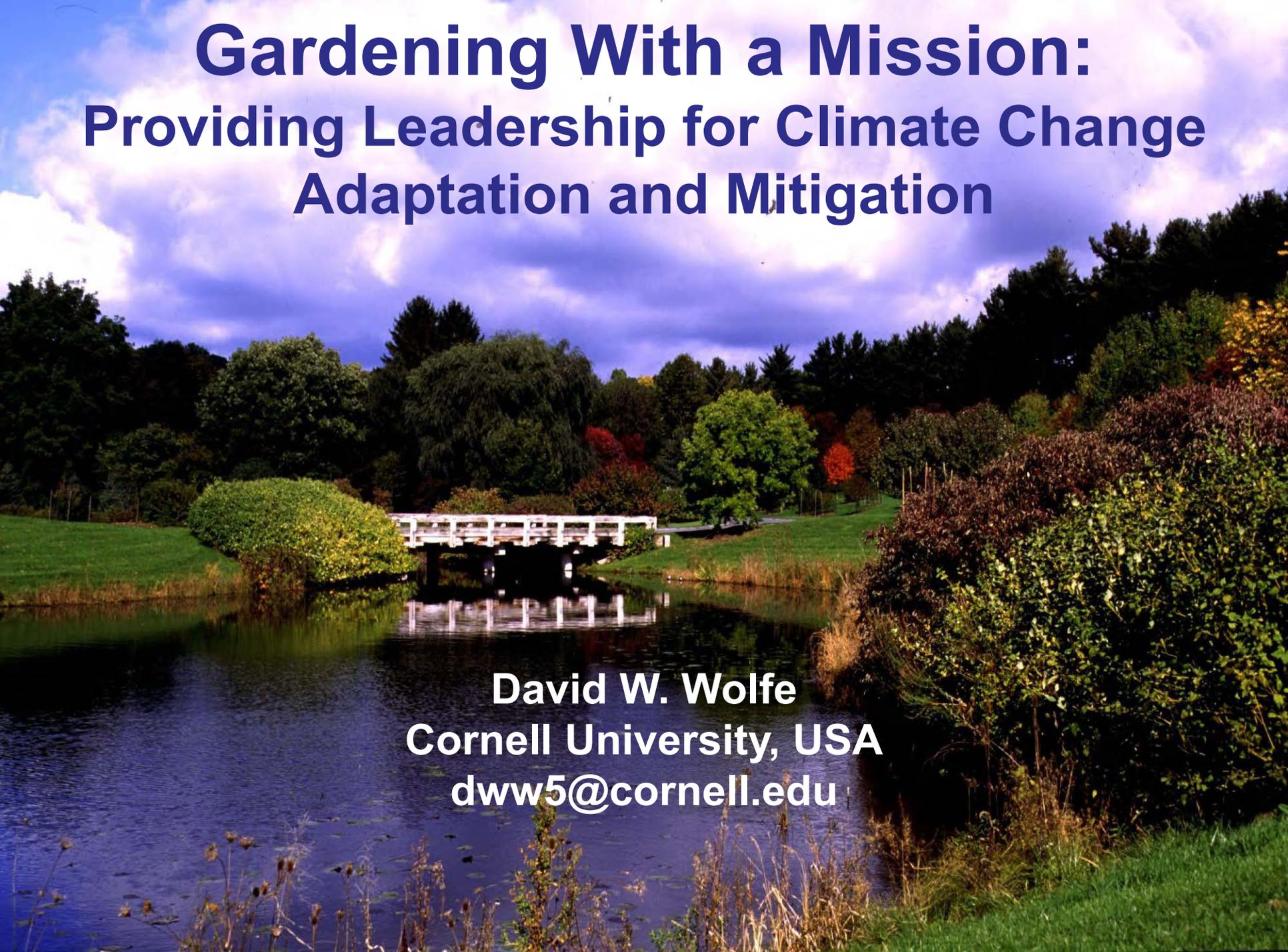
#johnmacleod2017



Sue Biggs CBE

**Director General
Royal Horticultural
Society**

Gardening With a Mission: Providing Leadership for Climate Change Adaptation and Mitigation



**David W. Wolfe
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Global Climate Change



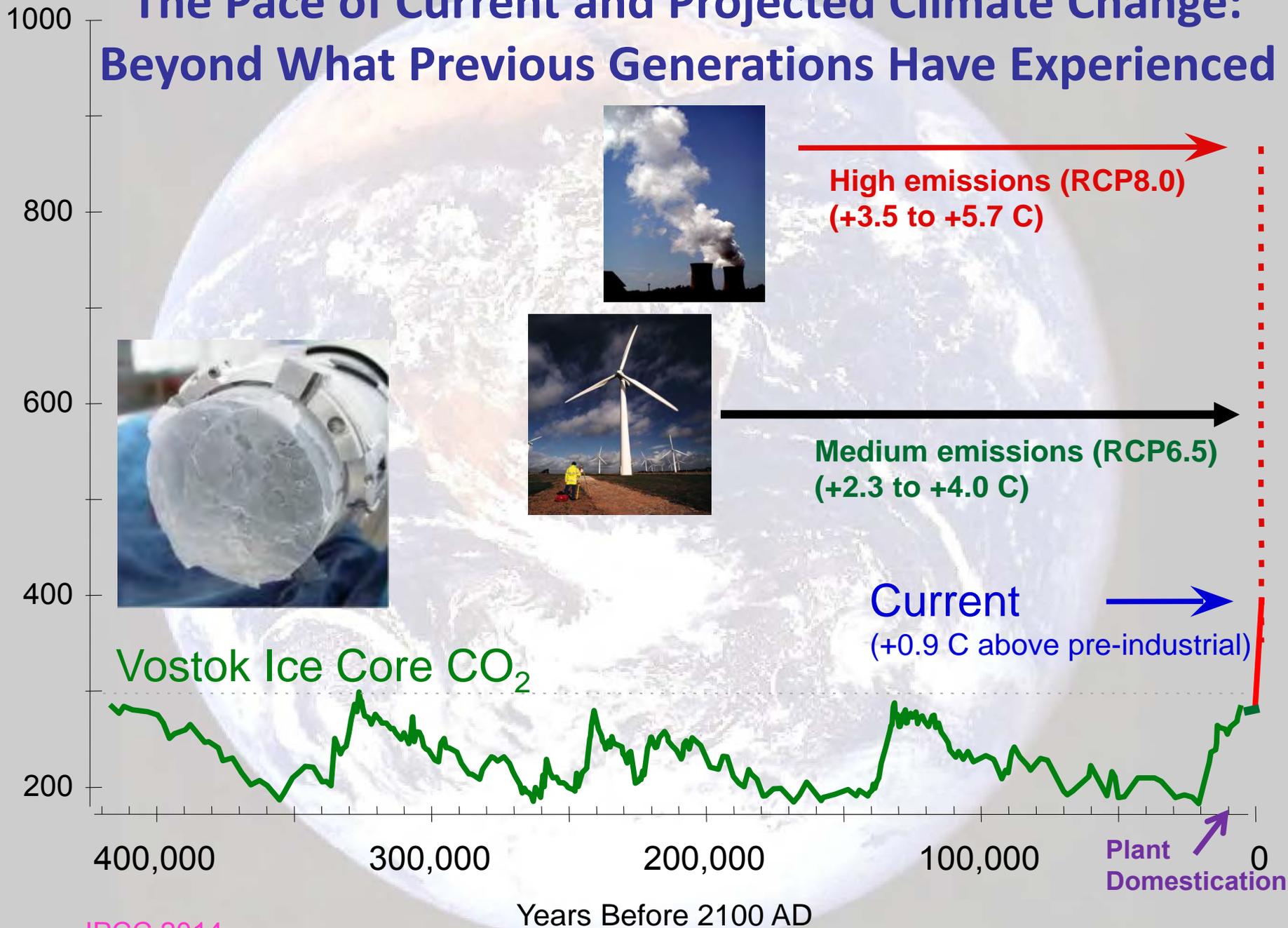
What we know with high certainty:

- The climate is always changing due to “natural forcing”
- But the current and projected pace of change is unprecedented in recent history
- Human greenhouse gas emissions are largely responsible
- More summer heat stress, drought, flooding
- Sea levels rising, coastal storm damage increasing
- The living world is already affected
- Natural and managed ecosystems will be disassembling and reassembling in new ways
- Inequity in adaptation capacity, and impacts on water and food security



The Pace of Current and Projected Climate Change: Beyond What Previous Generations Have Experienced

carbon dioxide (ppmv)



**Climate change will forever alter the fabric
of our . . .**

Gardens, . . .



Farms, . . .



**and Natural
Landscapes**

**...with implications for
ecosystem services**



Many challenges and opportunities for gardeners and public gardens lie ahead.

There are many things we can do, but perhaps nothing more important than inspiring others with a positive message:

**Share your fascination, passion, love, and concern
for gardens and our natural world**



It is not just weather instruments telling us the climate is changing. The living world (plants, insects, birds and other animals) are responding to change. For example, in the Northeastern US....



Grapes are blooming 6 days earlier



Apples are blooming 8 days earlier than they were in the 1960s



Lilacs are blooming 4 days earlier

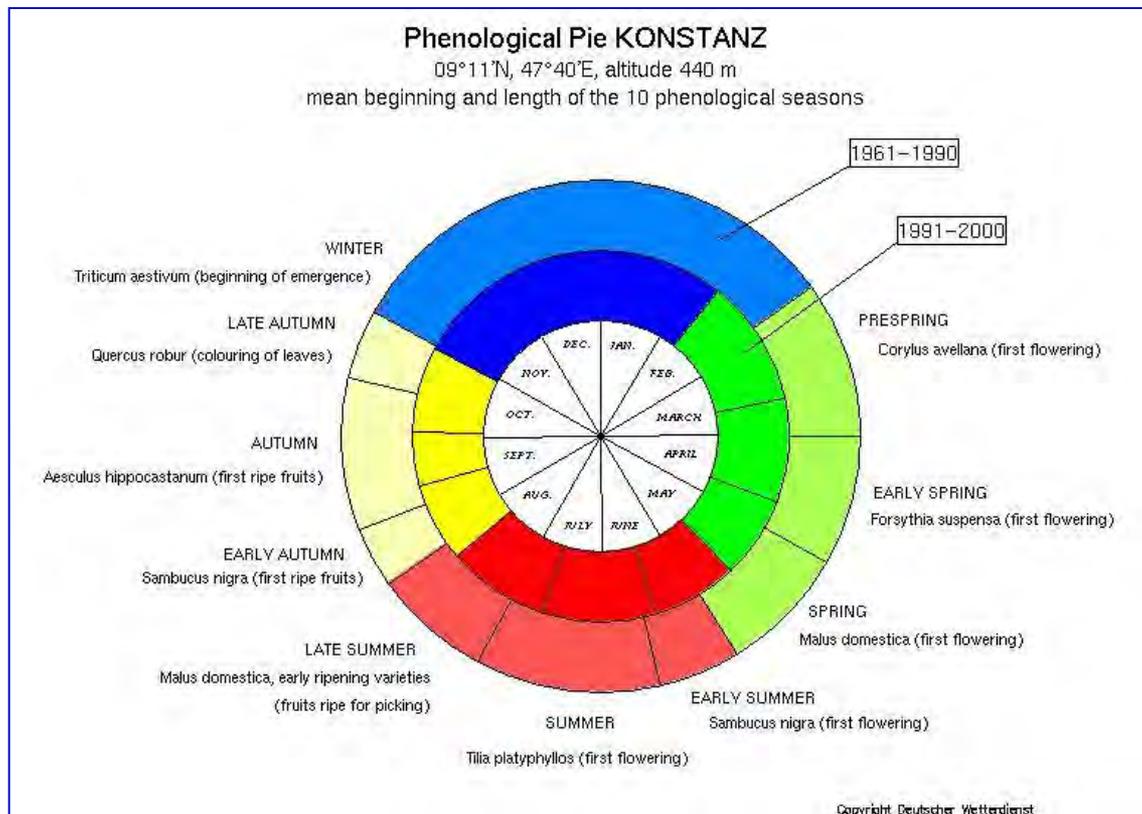
[Source: Wolfe DW et al. 2005. Internat J Biometeor 49:303-309.]



Nature's Calendar

Add a record What we record and why Analysis Blog

Help us track the effects of weather and climate change on wildlife near you



Expect the unexpected:

More frost and freeze damage in a warmer winter world?



In 2012, New York apples bloomed
4 weeks earlier than normal;
Orchards lost USD \$\$ millions



Daffodils under snow

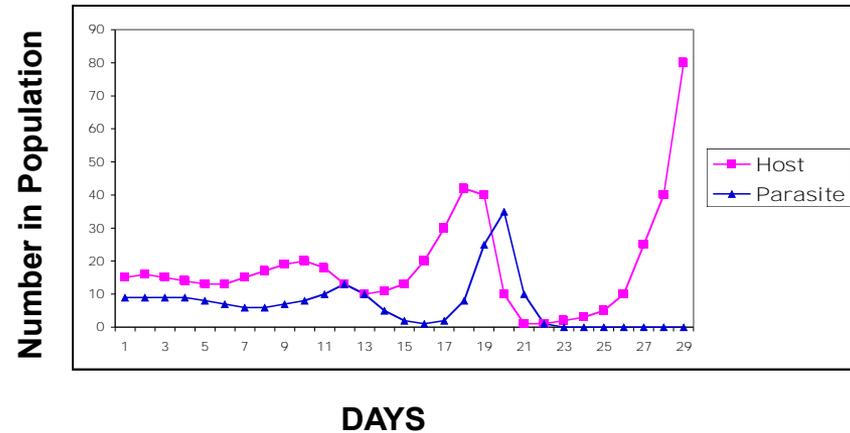
As each species responds uniquely to climate change: How will this affect important species interactions?

Uncoupled phenology

Plants and pollinators



Natural enemies of plant pests



Some parasites of garden pests less effective with warmer summers



Grey garden slug



Nematode parasite (*P. hermaphrodita*)

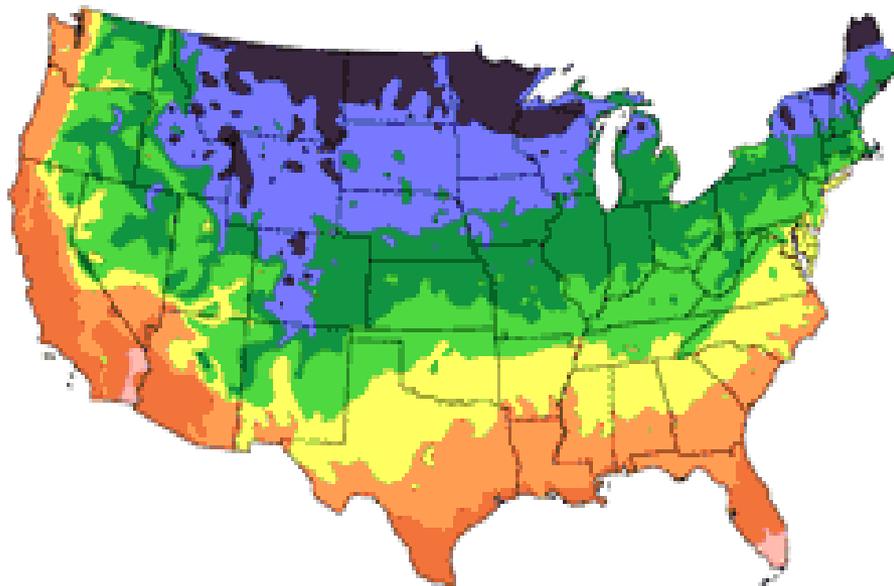
“Plant Hardiness Zones” are shifting

US Climate envelopes are shifting
(USDA maps based on minimum winter temperatures for prior 15 years)

Source: www.arborday.org

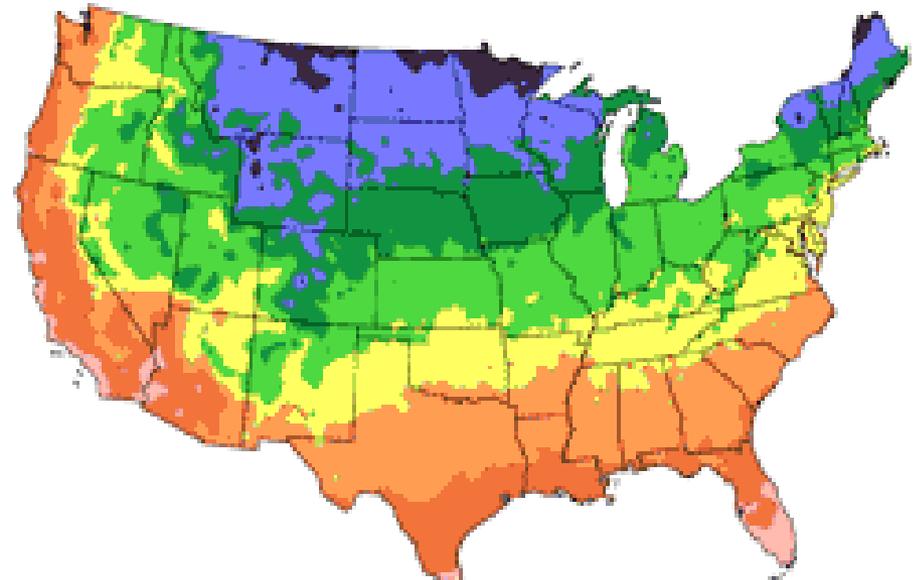
Zone	Avg. Annual Low
2	-40° through -50°
3	-30° through -40°
4	-20° through -30°
5	-10° through -20°
6	0° through -10°
7	10° through 0°
8	20° through 10°
9	30° through 20°
10	40° through 30°

1990 Map



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990.

2006 Map



National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

RHS Hardiness Ratings

RHS Rating	Temperature	Hardiness	USDA Zones
H1a	> 59°F 15°C	Tropical	13
H1b	50°F to 59°F 10°C to 15°C	Subtropical	12
H1c	41°F to 50°F 5°C to 10°C	Warm temperate	11
H2	34°F to 41°F 1°C to 5°C	Tender cool	10
H3	23°F to 24°F -5°C to 1°C	Half-hardy	9
H4	14°F to 23°F -10°C to -5°C	Hardy Average winter	8,9
H5	5°F to 14°F -15°C to -10°C	Hardy Cold winter	7,8
H6	-4°F to 5°F -20°C to -15°C	Hardy Very cold winter	6,7

With milder winters

and longer frost-free periods,

**UK gardeners may be able to
experiment with new
varieties and new species**

For Gardeners and Farmers . . .

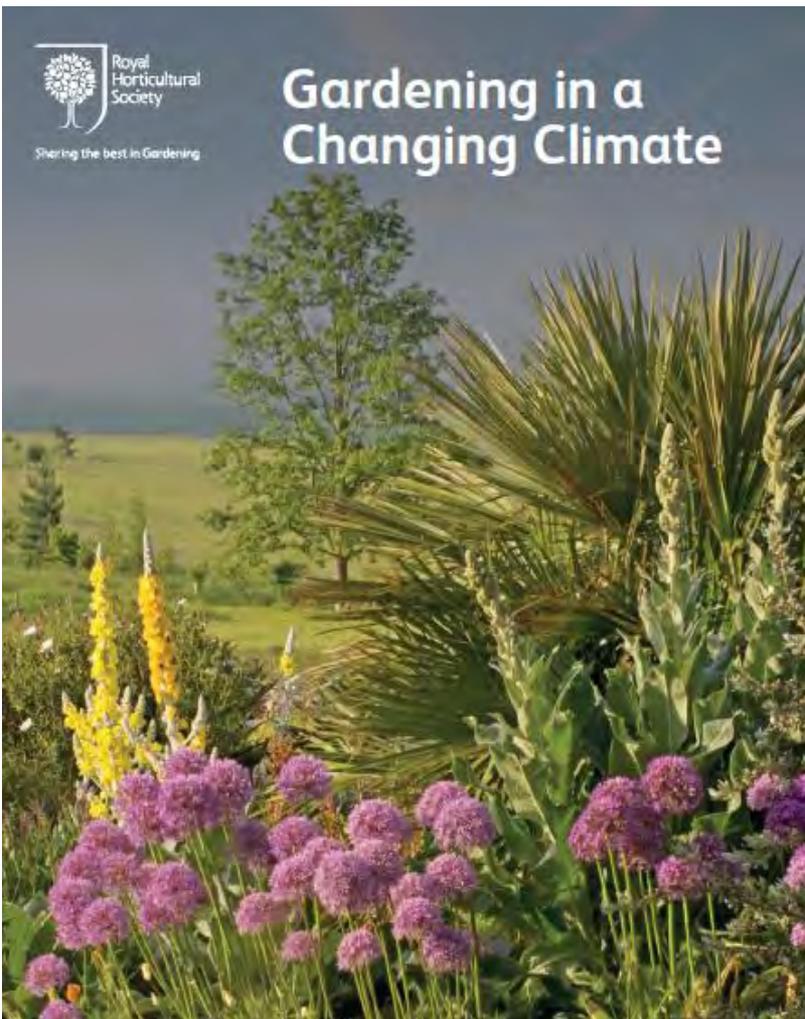
Climate change might allow exploration of new plant species and new markets,



but will also bring with it increased weed, disease, and insect pressure, damaging summer heat stress, and new challenges for water management



The UK climate is complex, with jet stream, Gulf Stream and other confounding factors

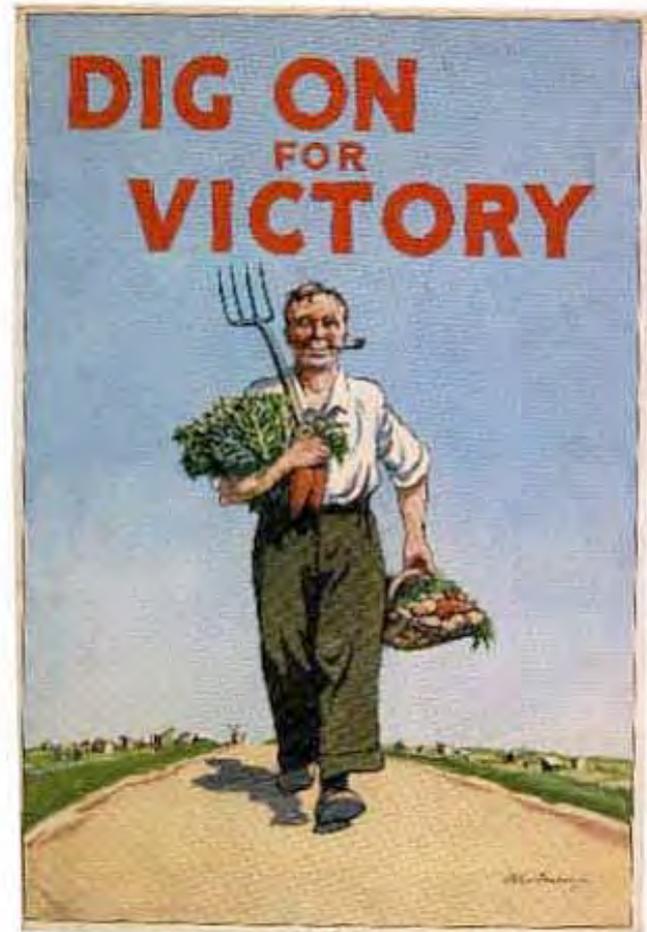


Projections for 2080s (medium emissions):

- +1 to +6.5 C increase in summer temps;
- +1 to +5 C increase in winter temps ;
- Increase in frequency of heat stress, especially in south;
- Lack of winter chilling for some species in some regions;
- Changing weed and pest dynamics;
- Fewer frost days expanding growing season;
- But unexpected spring frosts continue;
- Slightly drier summers, wetter winters, with increased freq of heavy rains;
- Increased freq of dry spells > 10 days;
- Increased risk of flooding, waterlogging

Victory in the Garden: Confronting New Challenges and Opportunities in a Changing Climate

- **ADAPTATION** – Healthy gardens and landscapes in the face of climate change (“managing the unavoidable”)
- **MITIGATION** – Greener gardens and landscapes (“avoiding the unmanageable”)



WWI poster

Adapting to Climate Change

- **Plant selection- diversification- experimenting with new species and varieties tolerant to new weather extremes, able to take advantage of longer growing season, warmer temperatures**

(Note of Caution: introduction of invasives)

- **Earlier planting dates**
- **More vigilant weed and pest monitoring and control**
- **Improved water management**
 - **Build healthier soil with more organic matter for better water holding capacity, better drainage**
 - **Site selection**
 - **Irrigation and drainage systems**
- **Frost and freeze protection:**
 - **Freeze blankets**
 - **Mist irrigation**
 - **Modify pruning timing and severity**

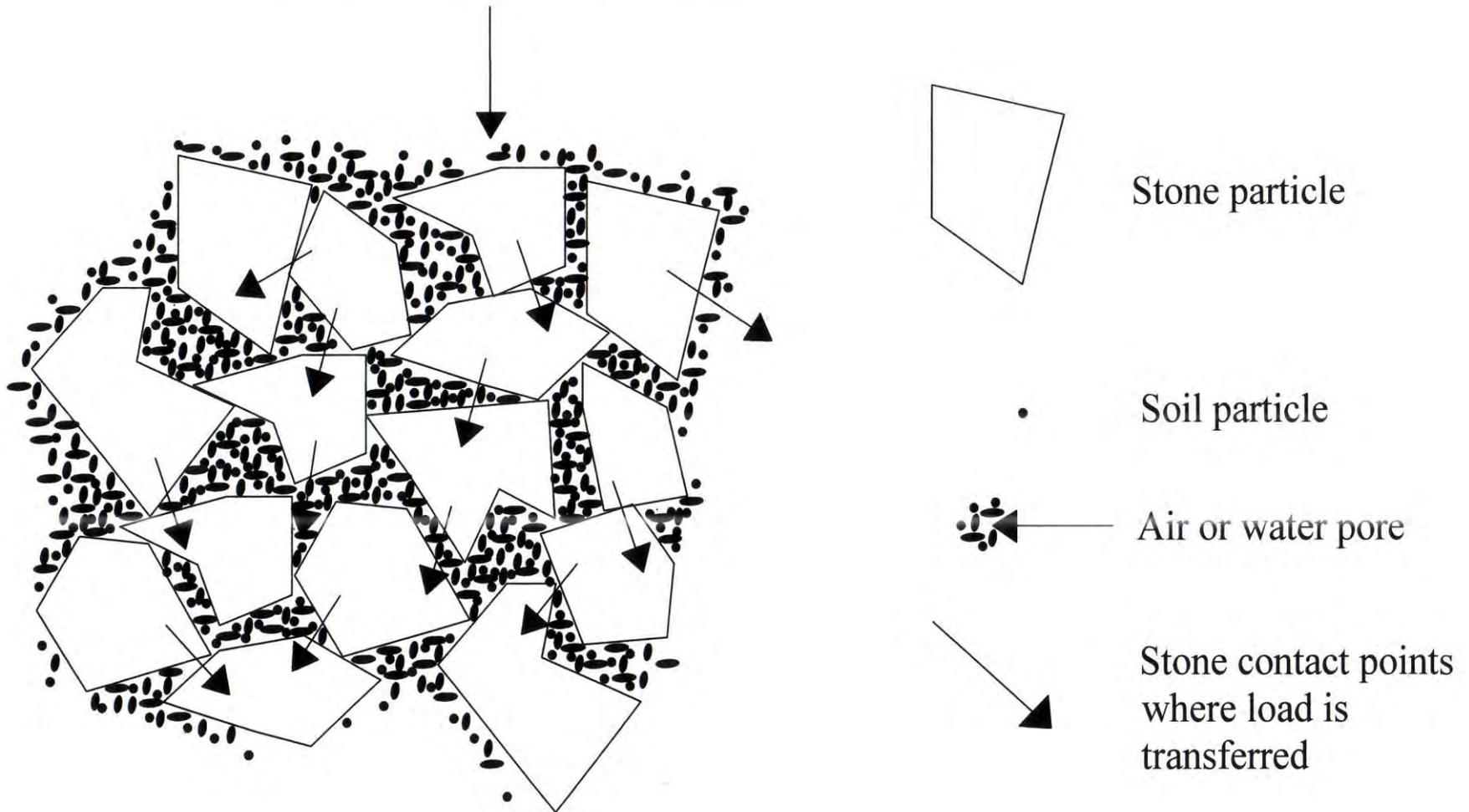
Need new approaches to garden design and urban landscape construction



Compacting soils prior to laying cement

“Structural Soil” allows required compaction AND good drainage and root penetration

Loading or Compaction Effort





Sydney Olympic site:
Improved tree growth
with structural soil

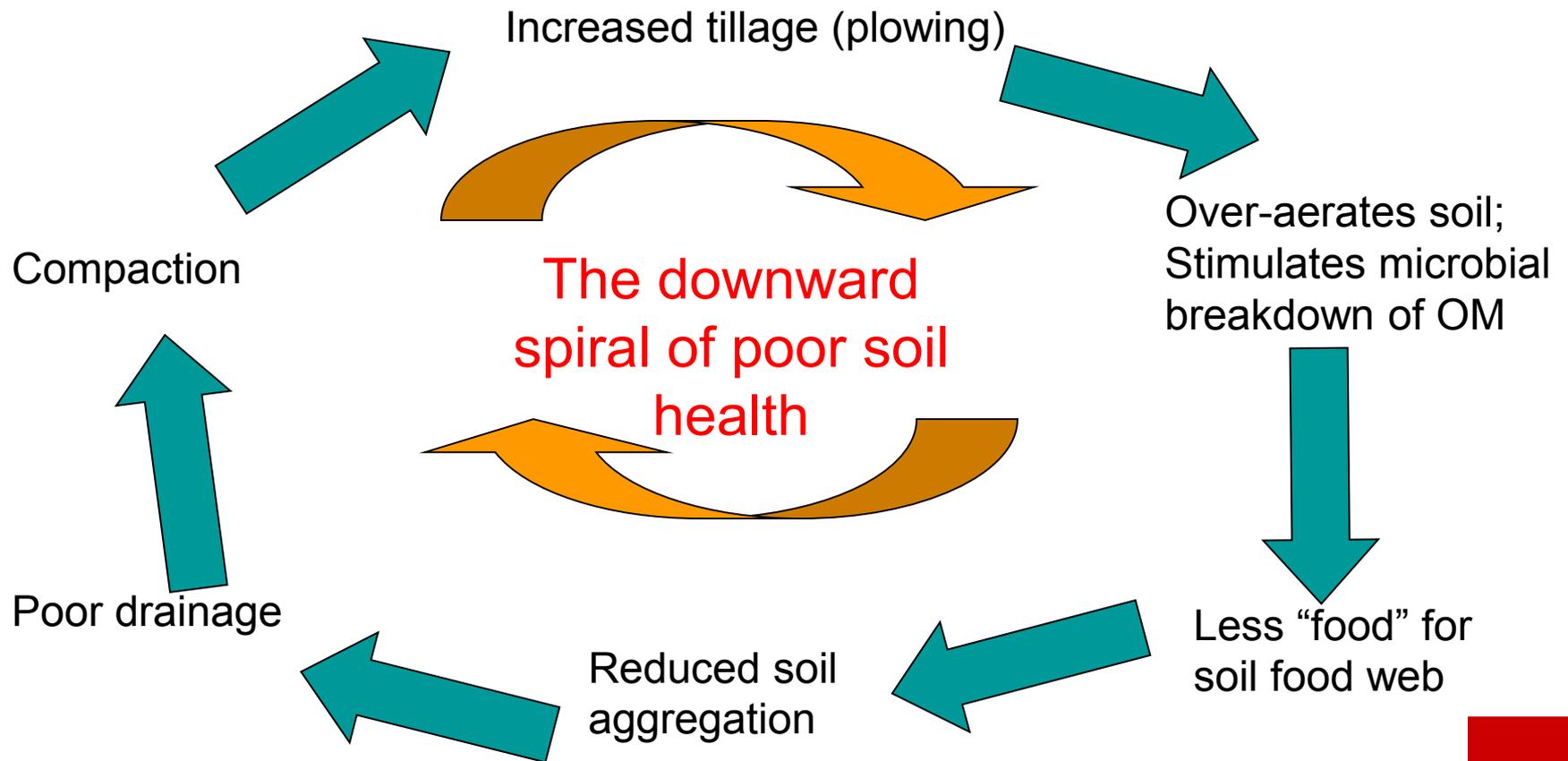
Sydney Olympic site
without structural soil



Source: N. Bassuk, Cornell Univ

Compaction, Excessive Tillage, and Soil Health

Assessing the whole soil system



Biological Management and Soil Compaction



“The plow is one of the most ancient and most valuable of man’s inventions; but long before he existed the land was in fact regularly plowed, and still continues to be plowed by earthworms.”

- Charles Darwin, 1881

Soil Health and “win-win” solutions:

Low-cost resilience to weather extremes while helping to slow the pace of climate change



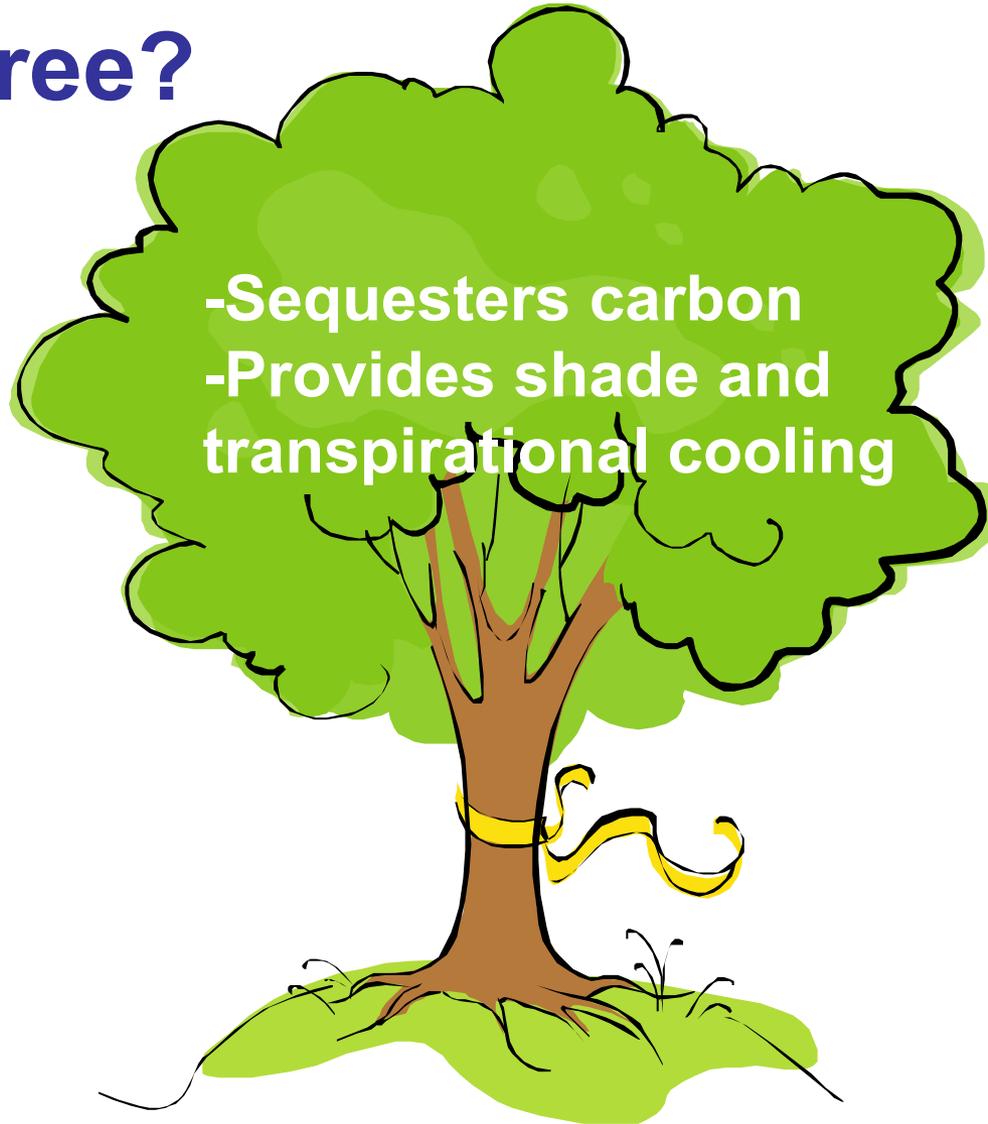
Building soil organic matter (reducing tillage; winter cover crops; using manure, composts, biochar; more perennial crops):

- Adaptation: increases resilience to drought, flooding, erosion
- Mitigation: stores carbon in the soil that otherwise would be in the air as CO₂

Growing a Greener Garden (Mitigation: Becoming Part of the Solution)

Plant a tree?

- Sequesters carbon
- Provides shade and transpirational cooling



Tree shading effect of various tree species

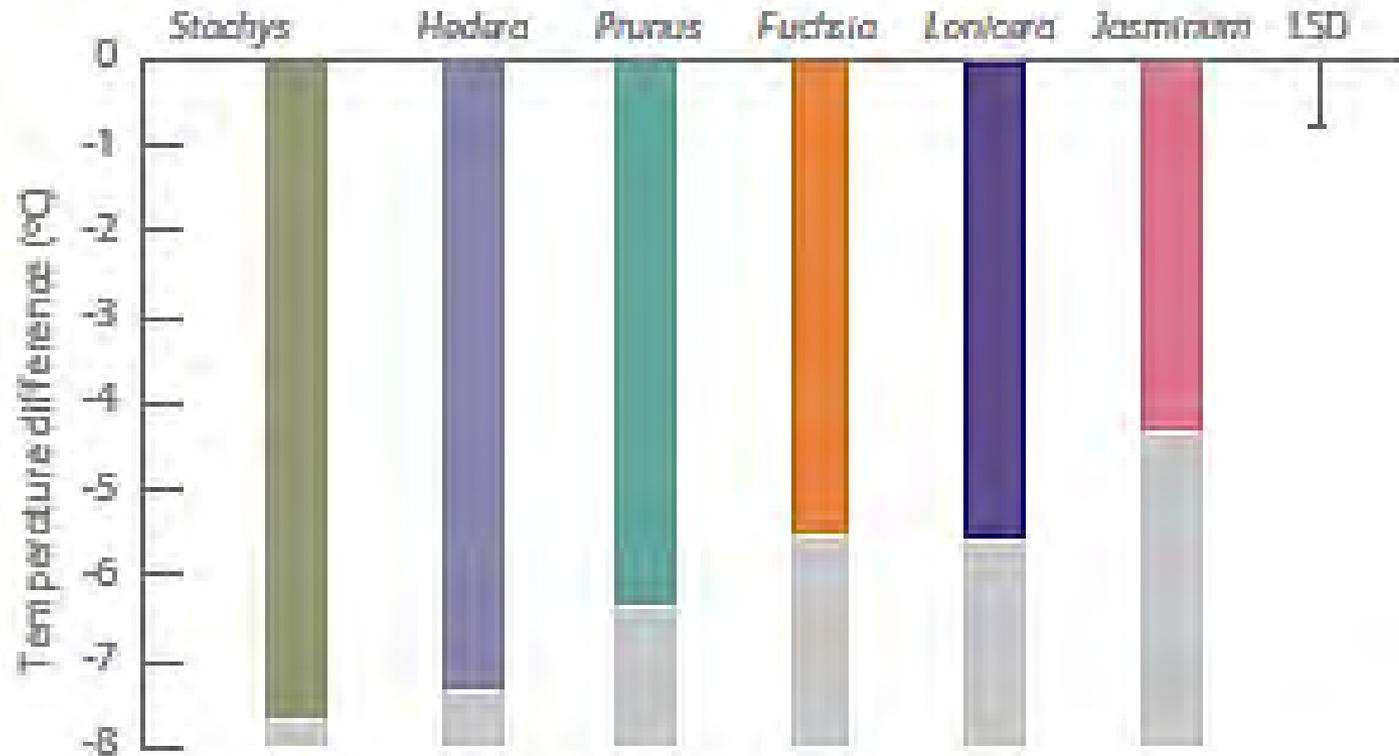


Figure 7.2: The extent to which different plant species can provide cooling to a building wall. The use of plant screens can reduce the amount of solar irradiance impacting on a building, thus reducing the requirement for artificial air conditioning. Comparison of a range of wall shrubs/ climbers with *Stachys* as a comparison (Cameron et al. 2014).

Garden and Lawn Nitrogen Management and Greenhouse Gas Mitigation



- Synthetic N fertilizers are energy-intensive to produce
- N fertilizer gives off nitrous oxide (N_2O), a potent greenhouse gas, as it degrades in soils
- N management by homeowners and landscape managers is often excessive and inefficient
- Urban lawn acreage is substantial (e.g. 3 million acres in New York State alone!)

Improving N Use Efficiency for Lawns

- Select grasses with relatively low N requirement
- Consider clover (legume) mix
- Mow high (≥ 8 cm) to promote root growth
- Recycle lawn clippings
- Use organic N sources
- Urea is preferable to ammonium sulfate or ammonium nitrate
- Healthy mature lawns, shaded areas, may only need 2 applications per year (early summer and late fall) and lower annual rate

AND: Consider replacing some lawn areas with gardens or managed meadows



The Energy-Waste Management Challenge:

**Re-coupling animal and plant production systems
to re-cycle nitrogen, carbon, energy**

Mitigation: A Role for Consumers and the Market Chain

Consumer choices affect
supermarket choices → farmer
choices → sustainability, and the
carbon footprint of agriculture

- Food sources using sustainable and “climate-smart” practices
- Local foods in season
- Minimize packaging and waste; recycle, compost
- A diet rich in fruits, vegetables, grains, and modest meat consumption



Growing a Greener Garden

(Mitigation: Becoming Part of the Solution)

- **Plant trees (and other perennials) in the garden (cools the environment , reducing human energy use, and sequesters carbon in above- and below-ground biomass)**
- **Do *less* to do *more*...**
 - **Reduce frequency and intensity of tillage (increases organic matter and thus C in soil)**
 - **Reduce and improve efficiency of N fertilizer use**
 - **Mow the lawn less often (reduces fossil fuel use, allows grass to grow deeper roots and accumulate more C)**
 - **Reduce use of fossil fuels and replace with renewables**
 - **Reduce use of disposable products like plastics**
- **Grow, consume and buy local foods in season**

The Many Roles of Public Gardens

- **Adapting to impacts on current collections**
- **Conservation programs that provide a safety net for endangered species worldwide**
- **Research and outreach on climate change impacts, adaptation, and mitigation**
- **Expand community awareness about climate change and what individuals can do**
 - **Develop new learning opportunities for the public**
 - **Emphasize relationships between biodiversity, cultural diversity, sustainability and climate change**
 - **Demonstrate how plants can be used to monitor climate change**

Impacts on Public Gardens: Recent Hurricane Damage Montgomery Botanical Center-Florida USA

Assessing Hurricane Irma's Storm Surge At
Montgomery Botanical Center



RESEARCHERS INVESTIGATE IMPACTS OF CLIMATE CHANGE ON RARE TROPICAL PLANTS



Research led by the Missouri Botanical Garden and the University of York (UK) has found that the impacts of climate change on rare plants in tropical mountains will vary considerably from site to site and from species to species.

While some species will react to climate change by moving upslope, others will move downslope, driven by changes in seasonality and water availability. The researchers believe that this predicted variation, together with the long-term isolation and relative climatic stability of the mountains, may shed light on historical processes behind current patterns of biodiversity.

The study, published in the journal *Ecography*, focused on the Eastern Arc Mountains of Tanzania and Kenya, home to some of the oldest and most biodiverse habitats on Earth. Thousands of plant and animal species live in this chain of increasingly fragmented patches of forest, woodland and grassland, many hundreds of which are found nowhere else.



Research on slowing deforestation for conservation and reducing CO2 emissions

SCIENCE TALK

EXPLORING THE SCIENCE OF PLANTS, FROM THE FIELD TO THE LAB

A Biological Strategy for Cooling a Warming Planet

Posted in [Environment](#) on December 9, 2016 by [Brian Boom](#)

Brian M. Boom, Ph.D., is Vice President for Conservation Strategy; Director, [NYBG Press](#) and Science Outreach; and Bassett Maguire Curator of Botany at [NYBG](#).





CORNELL
BOTANIC
GARDENS

Making Change: Designing a New Model for Climate Change Interpretation and Experimentation

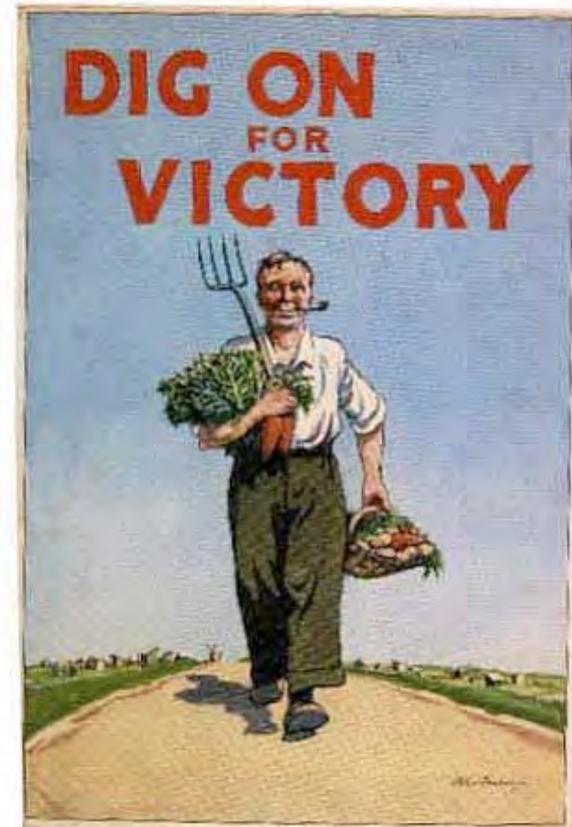


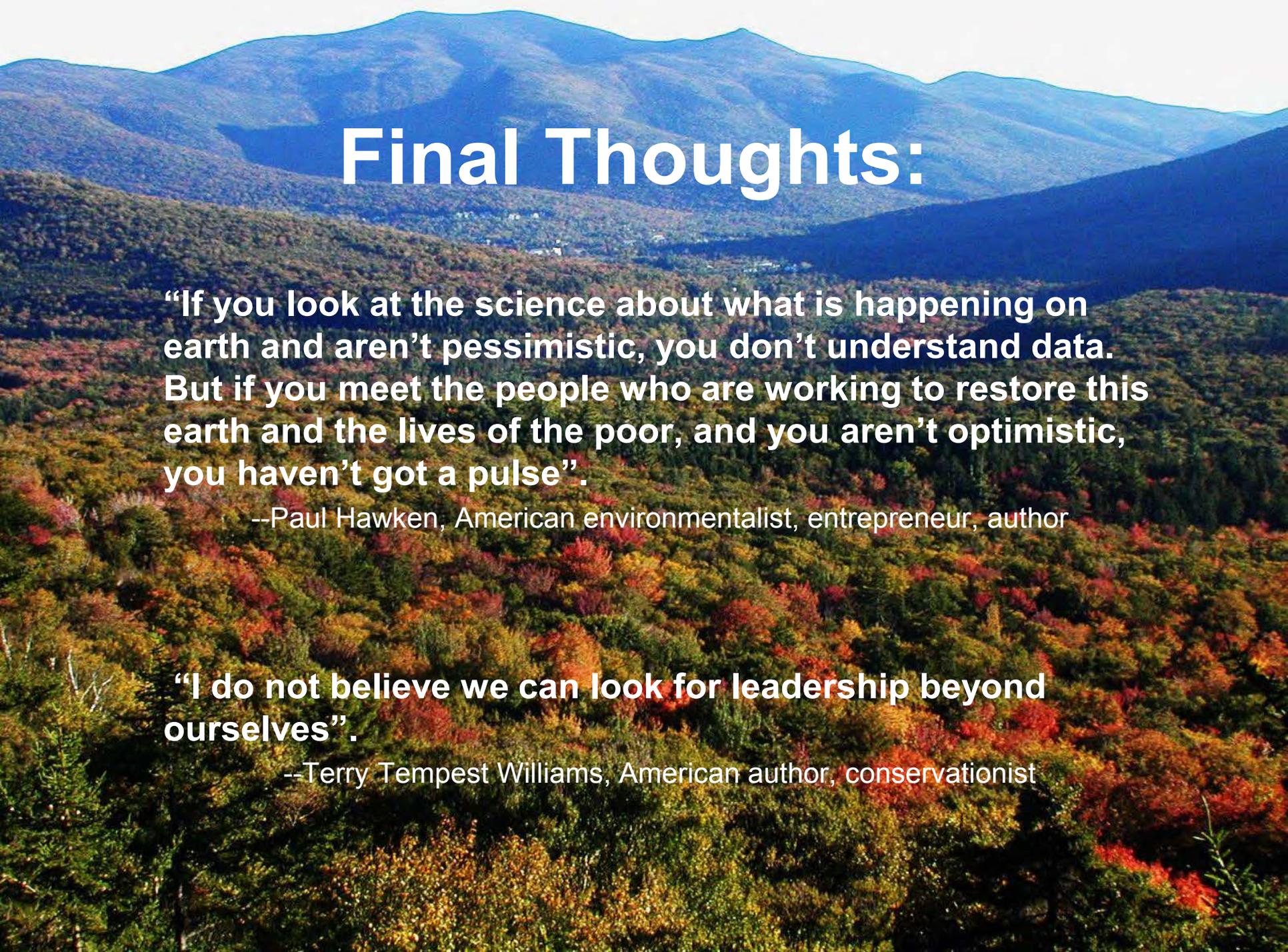
Joshua F. Cerra
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MARCH ON!

- Share your passion for gardening and nature
- Learn more about climate change solutions
- Take action in the garden
- Engage in the public dialogue





Final Thoughts:

“If you look at the science about what is happening on earth and aren’t pessimistic, you don’t understand data. But if you meet the people who are working to restore this earth and the lives of the poor, and you aren’t optimistic, you haven’t got a pulse”.

--Paul Hawken, American environmentalist, entrepreneur, author

“I do not believe we can look for leadership beyond ourselves”.

--Terry Tempest Williams, American author, conservationist

THANK YOU!

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www.hort.cornell.edu/wolfe

http://climateinstitute.cals.cornell.edu

http://soilhealth.cals.cornell.edu

The RHS John MacLeod Lecture 2017



Any Questions?



Sharing the best in Gardening

MARSH
Christian Trust

Marsh Christian Trust Award

Marsh Christian Trust Award Winner



Donald Fraser, University of Bristol

‘A trick of the light: UV-B treatments for potted herbs’. How plants sense and adapt their physiology to their environment.



Sharing the best in Gardening

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Thank you