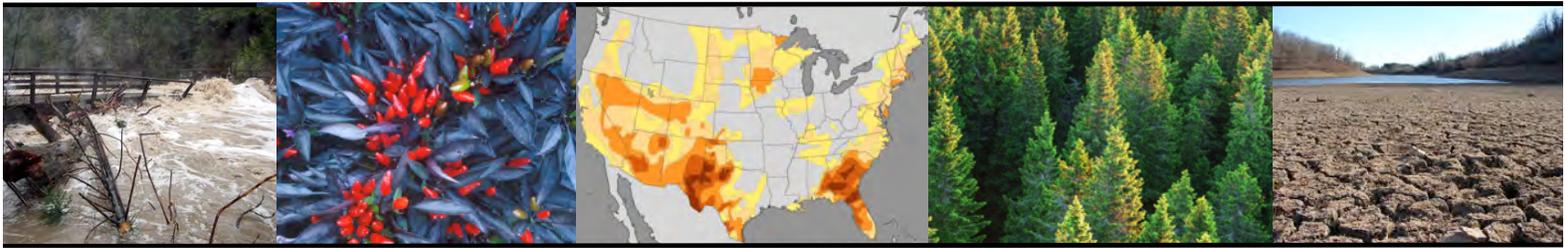


A Growing Interest 2

Climate and Economic Impacts on the Plant Sector



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EXECUTIVE SUMMARY

From food security and tourism, to floriculture, national and state parks, the industries that rely on the health and wellbeing of plants have broad economic impacts at the local, state and national level. To advance understanding of how climate change may impact the U.S. green sector economy, the Institute for Global Environmental Strategies (IGES) along with the North Carolina Arboretum convened the *A Growing Interest 2: Climate and Economic Impacts on the Plant Sector* workshop in Asheville, N.C. on March 21-22, 2012. Bringing together plant sector representatives and climate science experts from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA), the meeting served to assess the current state of this diverse sector and how NOAA science, data, and information might help to identify new business opportunities and better manage climate change risks.

Key Themes

A Fragmented But Resilient Sector The plant sector is made up of an often disconnected and highly fragmented group of individuals and businesses that lacks a single cohesive voice. This makes adopting or communicating sector-wide policies or strategies a difficult challenge. Still suffering from the economic crisis, the overall sector is a smaller part of the U.S. economy than in 2008.

The Challenge of Monetization Driven by continuing economic stresses and by the challenges posed by climate change, there is greater emphasis on the need to monetize the value of plants and the services they provide.

Emerging Information Needs In the Face of Climate Change There is no consensus about the relevance of climate change and about whether or how to take action. Nevertheless, there are emerging long-term forecasting information needs, such as: information that goes beyond temperature, that ties back to the state of basic resources, and that describes the level of confidence associated with the data. Closer interaction with climate information providers is needed to meet recognized needs and to provide valuable input into research requirements.

Leading Climate Change Communication Plant sector communities are uniquely positioned to communicate climate change issues to the public. Public gardens, led by the American Public Gardens Association (APGA) in partnership with NOAA, have a far-reaching role in teaching about climate change causes, effects and adaptation practices. Making better use of education and communication tools and strategies will contribute to a more positive, action-driven engagement.

Opportunities For Partnerships Effective partnerships between the relevant actors will help:

- meet the climate or long-term forecasting information needs of this critical sector
- grow the climate research portfolio by identifying new questions of interest to the community
- support far-reaching communication strategies by offering compelling examples of the real-world application of climate science, data, and information
- leverage limited resources across the sector. The NOAA-APGA partnership serves as a model for success.

This meeting was successful in bringing together two communities that do not often interact and that are trying to find new ways to do business together. Plant sector representatives, concerned about the resiliency of their activities, will benefit from closer interaction with NCDC and climate information providers to ensure that their emerging information needs are met. Climate providers, in turn, will benefit from the interaction with a vibrant community of users that could help demonstrate and articulate the benefits of their services and products to a national audience. Further research is needed into: • the specific needs of different plant sector communities that considers a variety of issues, such as impacts of extreme weather events, and the availability of key resources • how best to structure the engagement between these communities.

This research was conducted by Nancy Colleton and Laura Delgado López through the Cooperative Institute for Climate and Satellites—North Carolina (CICS-NC), under North Carolina State University Subaward 2009-1380-08.

INTRODUCTION

Numerous reports consider the potential impacts of climate change on plants and the role of plants in the climate cycle. Notable among these is *Plants and Climate Change: Which Future?* Published in 2008 by Botanic Gardens Conservation International (BGCI), this report examines the physiological responses of plants to climate change and states that:

In looking to the future, it is increasingly critical to understand how plants respond on a basic level to the changes imposed upon them by continued increases in atmospheric CO₂, as well as the cascade of climatic and environmental changes triggered by this increase.¹

Studies looking at the impacts on specific regions, species or processes abound and paint a picture of increasing complexity. For example, recent research has found that higher temperatures in the Arctic region have decreased the proportion of bare ground making plants grow greener and taller.² A decade-long study of grassland ecosystems found that plants initially grow faster as a result of warming then deteriorate quickly.³ Another study, in turn, concluded that the root crop cassava actually thrives under warming conditions.⁴ The multiplicity of impacts observed has prompted a panel of international experts that considered the results of 50 studies across the world to conclude that shifts in the timing of flowering and leafing could be greater than estimated by experiments.

While this research is ongoing, the question of how climate change may impact the U.S. green sector economy has not been as extensively studied. Whether by means of rising temperatures, extreme weather, extended growing seasons, false spring, heat waves or changes in the timing and number of days with frost, the effects of climate change on plants have the potential to impact drastically the national economy.

From food security, tourism, golf, and floriculture, to national and state parks, the industries that rely on the health and wellbeing of plants have broad economic impacts at the local, state and national level. [Figure 1] With such an important economic role to play, it is imperative that the economic impact of climate on this sector be better understood.

Figure 1: A Key Economic Sector

A key theme from the first *A Growing Interest* workshop in 2008 highlighted the sector's significant, though somewhat "invisible," economic contribution to the national economy. As the figures cited below reveal, the diverse communities that make up the plant-based sector play an important role in local, state and national economies.

- *According to a 2009 figure of the U.S. Department of Commerce's Bureau of Economic Analysis, the national floriculture industry accounts for more than \$32.6 billion and employs 450,000 people.⁵*
- *The value of sales from the horticultural industry comprised 5.6 percent of the total value of agricultural products sold in the United States in 2007.⁶*
- *In 2002 the national golf industry was estimated to equal \$62 billion in 2000, a figure that grew to \$76 billion by 2007.⁷*
- *State parks account for more than \$20 billion in the national economy.⁸*
- *According to Greg Cumberford, President of Bent Creek Institute, Inc. at the North Carolina Arboretum, the size of the botanicals industry in the United States is \$5.4 billion (2010).*

Some questions to consider include:

- *What is the value of climate – or long-term forecasting – information to the communities within the plant sector?*
- *How can NOAA science, data and information help the plant sector better manage risk?*
- *How can NOAA science, data and information enable improved business opportunities?*

To address these critical questions, the Institute for Global Environmental Strategies (IGES) along with the North Carolina Arboretum, convened a workshop aimed at providing plant sector representatives with an overview of current climate change science and engage them in discussions about the economic impacts of climate and climate change to their specific communities. *A Growing Interest 2: Climate and Economic Impacts on the Plant Sector*, also engaged climate science experts from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA). The workshop took place in the North Carolina Arboretum, in Asheville, N.C., on March 21-22, 2012.

A follow-up to the first *A Growing Interest* workshop [Figure 2], this meeting helped assess what has changed in the climate and climate change literacy of the different communities and identify the climate information priorities of this critical sector. Representatives of the public gardens and arboreta, nursery and landscape, botanical and natural products, forest service and horticulture sectors joined NCDC scientists in a dynamic discussion on the current state of this diverse sector and on how NOAA science, data and information might help to better manage climate change risks and to identify potential business opportunities or advantages.

This work was conducted as part of the Cooperative Institute for Climate and Satellites (CICS) at North Carolina State University (NCSU). The project, *Stakeholder Engagement to Better Understand Climate Information Needs*, is provided under NCSU Sub-Award Number: 2009-1380-08.

Figure 2: **Climate Change and the Plant Sector: A Growing Interest 1**

In 2008, plant sector leaders and climate change experts came together for the first time to understand this unique sector's level of knowledge and interest in climate change. The meeting revealed a number of shared themes and challenges across very diverse and fragmented sub-sectors – from landscape architecture, gardening, and arboreta to golf course design and maintenance and public land management.

Among the shared themes identified, representatives expressed an interest in understanding the risks and impacts of climate change, enhancing resilience in their activities, as well as their own ability to identify, access, understand and use climate information.

Key challenges that were discussed include:

- Emphasizing the significant but often “invisible” economic contributions of landscape services and plants,
- Addressing the applicability of information,
- Increasing the credibility of the messenger and messages,
- Meeting the need for up-to-date information on climate change,
- Communicating science more effectively,
- Improving public awareness and engagement, and
- Documenting and sharing lessons learned within the sector.

IGES, the North Carolina Arboretum and the University Corporation for Atmospheric Research organized the *A Growing Interest 1* workshop. To learn more, please visit: <http://agrowinginterest.com/>

KEY THEMES

This section captures a series of common themes that resonated throughout the workshop. To view the agenda as well as the available presentations of the speakers, please visit the *Stakeholder Engagement to Better Understand Climate Information Needs* page of the IGES website: <http://strategies.org/environmental-information/stakeholder-engagement-climate-information/a-growing-interest-2/>. A list of workshop participants is included in Appendix A.

A FRAGMENTED BUT RESILIENT SECTOR

“The non-food portion of the plant sector is smaller, with fewer resources and opportunities than when we met in 2008.”
– Robert Hayter, Principal, The Hayter Firm

The 2008 *A Growing Interest 1* workshop served as a starting point to consider the state of the sector and its evolution since then. Robert Hayter, principal of The Hayter Firm, provided the following observations of the plant sector:

- It involves a complicated mix of horticultural crop activities and landscapes;
- It is made up of an often disconnected and highly fragmented group of individuals and businesses;
- It lacks a unified voice with authority to speak for the whole industry.

Expanding on this characteristic of fragmentation, Hayter emphasized that this community is made up of “fiercely independent segments,” and added that about 80% of workers do not have any affiliations in trade representations. This is true even within the subsectors. According to Warren Quinn, vice president of operations at the American Nursery and Landscape Association (ANLA), the oldest organization in North America, ANLA members only represent about 1 in 40 of practitioners in the field. This phenomenon is critical to understand the inherent limitations of describing the sum of plant-based economic activities as a single or cohesive sector. It is also a key consideration when designing and adopting effective communication strategies that seek to reach most of the sector practitioners.

Despite unique stresses specific to each subsector – landscape architecture, forestry, gardens, botanicals, etc. – participants agreed that the international economic crisis of the past several years has had an overall negative effect on their communities and has produced marked decreases in the activities of the different players. Speaking of the plant sector in general terms, Hayter noted the following:

- **Producers:** There are between 20-50% fewer producers than in 2008. The overall sector is a smaller part of the U.S. economy as a result.
- **Brokers and Re-Wholesalers:** While there was a slight increase since the Great Recession started, these now appear to be less in number than in 2008.
- **Specifiers/Designers:** Sources indicate that 1 in 2 landscape architects are unemployed. Landscape architecture graduates have the lowest employment demand in history.
- **Consumer Outlets:** Sources indicate a 20-30% decline in total green goods sales since 2008.

- **Trade and Professional Associations:** These have experienced a significant decline in membership, reduction in programs and events, and increased reliance in sponsorship.

MONETIZATION AND IDENTIFYING TRUE ECONOMIC VALUE

“Monetizing the value of plants may be a game-changer for this sector.”
 – Nancy Colleton, (Workshop Co-Chair) President, IGES

With the plant-based sector still reeling from the economic downturn, there has been renewed emphasis in the need to demonstrate the economic value of plants and the contributions of the sector to the local, state and national economies. Quinn noted that despite the public becoming “much more sophisticated” in understanding the value of plants in the last 50 years, economic stresses and the challenges brought on by climate change reveal that plants are often the last consideration and the first to be affected by budgetary reductions.

Numerous figures can be cited to help articulate the role that these sectors play in the economy. For example, according to Greg Cumberland, president of Bent Creek Institute, the botanicals sector represents \$596 million in producer income and \$5.9 billion in consumer spending. California’s wine industry in turn, the 4th largest producer in the world, provides \$61.5 billion in state economic impact and \$121.8 billion in national economic impact.⁶ While data such as these exist, they are sparse and collected irregularly. For example, a 2011 report cited by Quinn used 2002 data to conclude that the nursery and landscape industry represented \$148 billion and 2 million jobs nationally, a figure that has likely changed since then.

Economic analyses to capture the value of this sector must go beyond describing employment and spending or trade figures. Participants agreed that the monetization of plants from the perspective of ecosystem system services is critical to measure the true value of the plant sector. According to Sclar, this kind of work should also articulate the cost of *not* having these services, such as those that disappear when not having healthy landscapes or vibrant and dynamic urban forests. North Carolina Arboretum Executive Director and Workshop Co-Chair George Briggs noted that the sector must develop a sense of strategy around this issue. One idea he suggested is to bring together a task force of industry association representatives, federal agencies, and agricultural economists, among others, to develop specialized expertise that considers the unique characteristics of the plant sector.

With climate change exacerbating these challenges, the need to capture true economic value will only become more pressing as the different communities consider how to evolve and continue delivering critical services to local communities and to the nation.

CLIMATE CHANGE: EMERGING INFORMATION NEEDS

*“Surely you want to be prepared if the historical record repeats itself...
 We’re not prepared for a climate repeat, let alone climate change.”*
 –Danny Lee, Director, EFETAC, USDA Forest Service

During the workshop, participants heard from two NCDC experts, Dr. Thomas Karl, director, and Dr. Thomas Peterson, principal scientist, about the latest climate change science, uncertainties and trends of interest to the community. Their contributions highlighted the following points:

- The record number of 14 billion-dollar disasters experienced in the United States in 2011 is a result of changing weather and climate conditions, coupled with other factors, such as location and population.
- Experts have recently paid increasing attention to their ability to understand and predict specific phenomena from a decadal and multi-decadal perspective, as well as their overall confidence in the data. Their analysis suggests a more advanced physical understanding of phenomena such as heat waves and precipitation, while less of

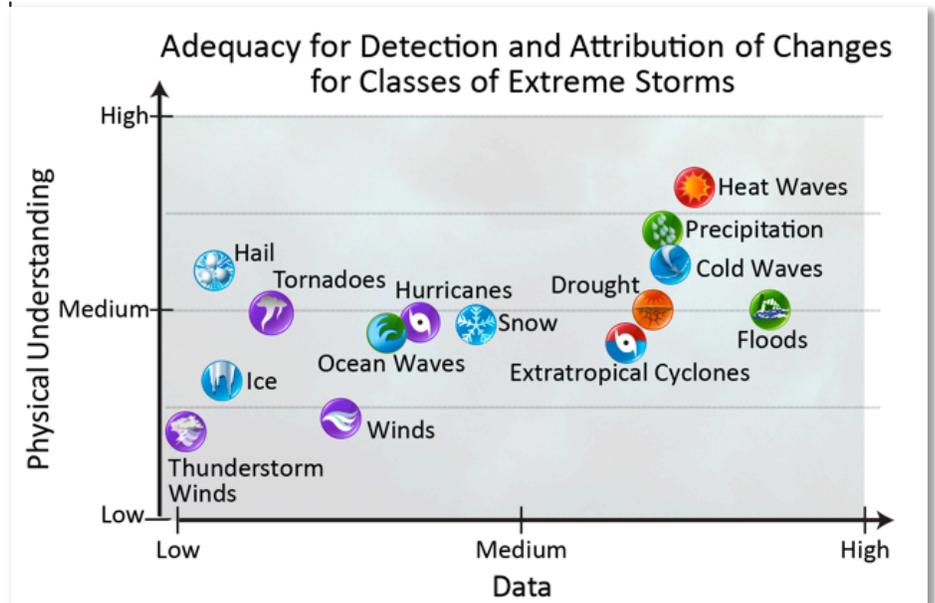


Figure 3: This figure depicts the widely varying suitability of our data and physical understanding of various extreme events. CREDIT: Adapted from Jane Lubchenco, and Thomas Karl (2012) “Predicting and managing extreme weather events” *Physics Today*, 31.

thunderstorms and winds [Figure 3.]

- Inherent complexity in predicting highly variable
- phenomena implies limitations in the predictions developed. For example, Karl noted that even as temperatures get warmer, it is nearly impossible to say for sure that there will not be big snowstorms.
- It is a mistake to think of climate change as a transformation from “Climate A” to “Climate B.” The Earth’s climate is in a state of “continual change,” as Peterson explained. The rate of change is the most important in our analysis and in determining adequate responses.
- The impacts of these changes will affect a variety of our activities. For example, projected changes in New England’s ecology and a reduction in maple forests could impact the character of the region, economic and tourism activities, and more.

All of these considerations are important for the plant-based sector to make decisions to adapt and, in some cases, take advantage of the opportunities represented by these changes. With respect to sub-sector perspectives on climate change, the following trends stand out:

Different attitudes

There is no consensus within the plant sector communities about the relevance of climate change to their activities and about whether or how to take action. To approach this question, Hayter conducted an informal survey of 24 individuals from six states representative of each subsector. The results of his survey revealed widely divergent attitudes, with some individuals stating that they have “few concerns” about climate change, and others defining it as a strategic “business issue” that has become part of their organization’s regular discussions.

Among those realizing the multiplicity of climate change impacts is the horticultural sector. According to David Ellis, director of communications and editor at the American Horticultural Society (AHS),

“gardeners view climate change simplistically” with a tendency to think of warmer temperatures as an opportunity to grow a larger variety of plants. Yet practitioners are increasingly realizing that changes such as extreme temperatures greatly impact their activities that revolve on the growing season. Concerns include an increased need for summer and fall irrigation, and proliferation of invasive plants, pests and diseases. In time, this uncertainty and volatility may lead the horticultural sector to assume a different perspective on the opportunities and risks associated with climate change.

Two sectors that have a more sophisticated view of how their actions are affected by climate change are botanicals and forestry. In his remarks, Cumberford described ongoing research into the climate change effects on medicinal plants. A study of interest looked at the vulnerability of wild American ginseng to extreme early spring, for example. He also noted increasing concerns for identifying potential supply chain disruptions as a result of climate change.

Regarding forestry, Dr. Danny Lee, director of the U.S. Forest Service’s Eastern Forest Environmental Threat Assessment Center (EFETAC), explained that experts are considering issues related both to adaptation, such as water supply demand and the impact of invasive species, and mitigation, such as the carbon storage role of trees.

Emerging information needs

Despite these differences, the plant sector has shared emerging climate or long-term forecasting information needs. These include:

- ***Information sets that go beyond temperature.*** Users are interested in data and information related to a variety of issues, such as the impact of extreme weather, predictions of storm severity, floods and drought, CO2 levels and extinction.
- ***Data and information that ties back to the state of basic resources, such as water.*** Presenting climate information in this vein can help users directly see its implications and value, even if climate change has not been an issue of concern in the past.
- ***Information that describes the levels of uncertainty and confidence associated with it.*** Confidence levels of the predictive quality of information to answer basic questions can help users make valuable decisions. For example, metadata can describe the level of confidence on the chances of a freeze occurring in a 30-day, 60-day or 90-day window.

Need for improved communication between providers and users

Improved communication between NCDC and plant sector users will be fundamental moving forward. From the outset, insufficient communication limits relatively new users from fully utilizing climate information. Both sides will benefit from establishing a dialogue that helps communicate what resources are available, how they are made, and how and where to find them. This dialogue will also help address an issue that became evident during the workshop: the mismatch between existing services and products that can meet, with little or no adaptation, the recognized needs of plant sector users.

In addition, this engagement will enable users to provide valuable input into the identification of key areas of research and the development of new products and services [Figure 4]. According to Briggs, this dialogue could bring more “unity of purpose” among public and business stakeholders, helping NCDC and private sector providers identify new targets.

Figure 4: NCDC Climate Services and Resources

NCDC's mission is to provide access and stewardship to the nation's resource of global climate and weather related data and information, and assess and monitor climate variation and change. As the world's largest active archive of weather data, NCDC plays a critical role in preparing and delivering basic climate data and information products to users in the United States and all over the world.

Workshop participants heard from several NCDC representatives on initiatives and programs aimed at engaging in a continuing dialogue with users to improve the Center's ability to meet its mission.

PRODUCT DEVELOPMENT BRANCH

NCDC's Dr. Russell Vose, who leads the Center's product development activities, urged participants to communicate to NOAA their questions and concerns to ensure that products meet emerging needs. Speaking about how these products evolve, Vose mentioned the *Alternative Climate Normals and Impacts to the Energy Industry* workshop, scheduled for April 24-25, 2012, which will review the state of the knowledge regarding existing and new "normal" calculations and identify the needs of the energy sector to better utilize this data.

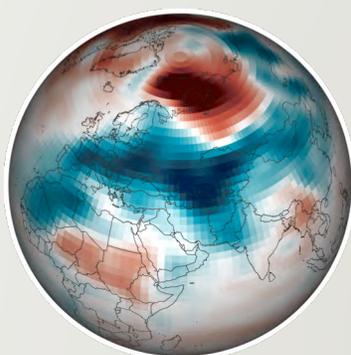
SECTORAL ENGAGEMENT

NCDC's Sectoral Engagement Coordinator Tami Houston provided a brief overview of the center's engagement activities with 12 climate-sensitive sectors of the U.S. economy, including forestry, agriculture and water resources. NCDC teams engage sector representatives to learn about needs, establish partnerships, and serve as a link between them and NOAA scientists. To learn more about these activities and to download the 12 sector fact sheets, please visit:

<http://www.ncdc.noaa.gov/oa/userengagement/userengagement.html>

CLIMATE DATA RECORD PROJECT

NCDC's Dr. Jeff Privette and Dr. L. DeWayne Cecil, Global Science & Technology, Inc., introduced participants to the Climate Data Records (CDR) project. CRD aims to combine all past and current satellite observations data into consistent long-term data records for the atmosphere, oceans and land surface. The goal is to take advantage of and make sense of this unique and global set of records that has taken a comprehensive look at the environment for over 35 years. CDRs will be used to develop climate information records to answer climate-related questions of interest to businesses, decision-makers and the public. To learn more, visit: <http://www.ncdc.noaa.gov/cdr/index.html>



This map depicts differences from normal temperatures during February 2012 as compared to data from 1981-2010. Locations in blue were up to 16 degrees Fahrenheit colder than normal, while locations in red were 16 degrees Fahrenheit warmer than normal. CREDIT: NOAA maps by Hunter Allen. Original Source: NOAA ClimateWatch Magazine

LEADING IMPROVED CLIMATE CHANGE COMMUNICATION

“We represent a way to tell the story to the public.”
– *George Briggs (Workshop Co-Chair), Executive Director, The North Carolina Arboretum*

A recurring theme revolved around the issue of effective communication of climate change. Participants agreed that plant sector communities are uniquely positioned to communicate climate change issues to the public. Public gardens, for example, draw a large numbers of visitors every year and represent a space where people can learn about the causes and effects of climate change as well as experience some of the sustainable practices being implemented to adapt to these changes. [Figure 5]

Effective climate change communication requires a shift in strategy to engage with the public. This translates into a shift from data emphasis and hard science into public awareness, understanding and actions. Strategies to take advantage of the plant sector’s assets as climate change communication tools and settings must take into account lessons-learned from the experience of groups and actors already engaged in climate change communication as well as integration of the more creative, artistic and social side of communication. Some of the challenges identified in the discussion include:

- Difficulty in explaining complex phenomena. The public often confuses and misunderstands the causes of the extreme weather or climate changes they experience. For example, many people incorrectly attribute global warming to the hole in the ozone or to space weather.
- Obstacles related to the highly polarized and increasingly political nature of the issue and of related terms, such as “adaptation.”
- Difficulty in helping people relate to an issue that may seem overly remote and disconnected to the activities they already engage in. This brings up the issue of the real or perceived costs of changing practices to become more sustainable.
- Much of the science communicated to the public is often negative and uncertain, increasing a sense of hopelessness in the public.

In a discussion focused on this topic, Mary Pat Matheson, director of the Atlanta Botanical Garden, drew from her organization’s success in communicating these issues to argue that effective communication identifies the following:

- **Goal:** *What is the actionable message?*
- **Audience:** *Is the audience policy makers, media or the public? Who is it within the public?*
- **Partners:** *Who needs to work together and how?*

Participants discussed innovative ways by which communication can encourage the general public to be engaged and active in climate change-related issues. Key recommendations include:

- ***Communicating messages in a positive and creative way.*** Dr. Casey Sclar, interim executive director at the American Public Gardens Association (APGA) and plant health care leader at Longwood Gardens, emphasized the use of “stories” to make the message positive and motivational, inspiring people to do “the right thing” without giving anything up.
- ***Making real connections.*** Telling the whole story of the plant-based products and services that people enjoy and depend on, and how climate change represents a threat to these, can be a powerful argument. It introduces an element of ownership and translates a message that is sometimes perceived as remote into something that directly impacts the listener.

- **Integrating communication tools, such as social media.** Social media tools may be an effective tool to marshal communication away from problems towards solutions. As Cumberland explained, this corresponds to a shift from a “combative” toward an “adaptive” response. Briggs also noted that integrating tools like this will help reap the benefits of the more creative, artistic and social side of communication.
- **Taking advantage of local gardens’ far-reaching role.** As non-partisan environments that capitalize on community engagement, public gardens serve as natural interpreters of the climate change message. Gardens can play a direct role in reaching broad audiences to communicate the “global, yet local” element of climate change and helping people see the impact of these changes and their own actions more directly.

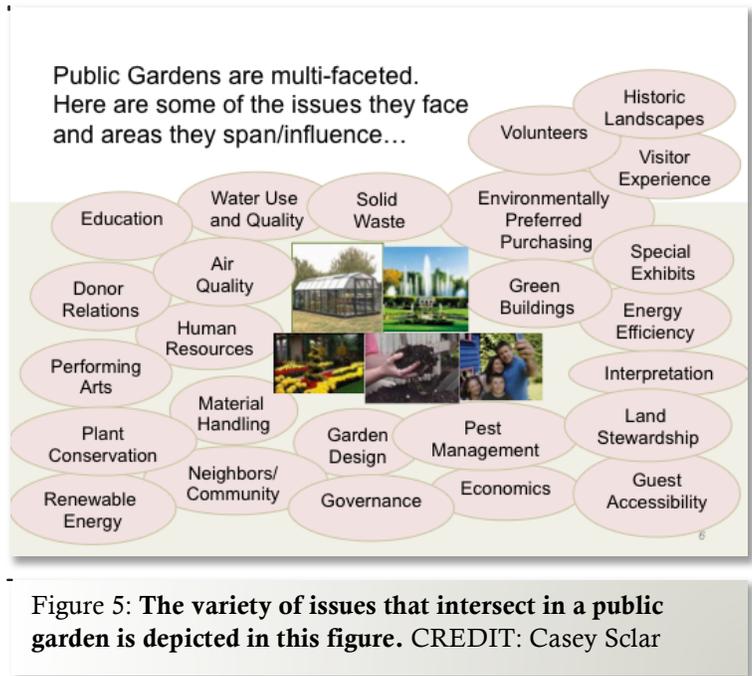


Figure 5: The variety of issues that intersect in a public garden is depicted in this figure. CREDIT: Casey Sclar

AN OPPORTUNITY FOR PARTNERSHIPS

“NOAA can provide the product, but to make it meaningful and useful, we need user input.”
 – Thomas R. Karl, Director, NCDC, NOAA

Partnerships and improved cooperation between the relevant actors will prove critical in the success of climate change education and adaptation strategies across the plant sector. As was alluded to before, strengthened partnerships could deliver the following key benefits:

- Meeting the climate or long-term forecasting information needs of this critical sector;
- Growing the climate research portfolio by identifying new questions of interest to the community;
- Supporting effective communication strategies by offering compelling examples of the real-world application of climate science, data and information; and
- Leveraging limited resources across the sector.

Learning from the partnership experience of actively engaged actors like APGA [Figure 6] may be a first step in the right direction. As their experience demonstrates, with NOAA providing science, data and information, users in the community will be able to help tell the story of how this information is used to identify business opportunities, as well as address and adapt to climate change. This can feed into stories that engage people in climate change-related issues. Partners that could contribute in crafting and communicating the right stories include garden writers associations, university horticulture professors, representatives from the ecosystem services and tourism industry, etc.

Recent developments to expand this initiative focused on leveraging ongoing education initiatives that have proven successful for other communities. For example the IGES-National Science Foundation (NSF) Earth System Science Education Alliance (ESSEA) offers a model to distribute information nation-wide by making use of science, technology, engineering and mathematics (STEM) education standards. A proposal that would adopt this model was submitted to NSF by IGES and APGA under the name *A Growing Interest* 3. At this point, the partners are still looking for funding to implement this proposal.

Figure 6: NOAA and APGA

NOAA and APGA recently launched a broad agreement to develop climate change programming that takes advantage of the agency's world-class research and the association's network of gardens, which together receive more than 70 million visitors a year.

According to the APGA website, priorities of the agreement include:

- Increased climate change education at public gardens;
- Increased community engagement in addressing climate variability and change as part of both short- and long-term community planning and adaptation;
- Ongoing professional exchanges between NOAA and public garden professionals on climate change issues; and
- Development of a public clearinghouse for information about climate change and adaptation.

The first deliverable of this agreement was the successful development of a modifiable template for interpretive signage and cell phone tour script. In the summer of 2011, a pilot of the cell phone tour was completed at Longwood Gardens in Kennet Square, Pennsylvania.

In this way APGA is positioning itself to become a national resource. To learn more about the NOAA-APGA agreement, visit: <http://www.publicgardens.org/content/noaa-and-apga>.

CONCLUSION

A Growing Interest 2 was successful in bringing together two communities that do not often interact and that are trying to find new ways to do business together. Plant sector participants learned about NCDC science, data services and information products, communicated their emerging information needs, and engaged in a productive discussion about different perspectives towards climate change and the opportunities and challenges it represents. NCDC officials interacted with a vibrant community of users that could help demonstrate and articulate the benefits of services and products the Center and private sector providers already offer and plan to develop in the future.

The key themes described in the previous section revealed widely divergent communities that share common concerns for articulating the economic value of their activities, learning about, finding value in and adapting to the effects of climate change on their businesses, and leading in the climate change education challenge through improved partnerships. These suggest the following conclusions:

Monetizing the value of plants is a game changer. Effectively articulating the value of plants will largely determine the continued survival of the sector. Climate information can play a critical role in enabling the resiliency of this sector.

Climate data and information are still relatively unknown and, as a result, not easily accessible to most users. To facilitate the delivery and use of science, data and information, a sustained dialogue between NOAA and the plant sector is essential to better understand sector trends and concerns and where climate data and information products can be most useful. Part of this will depend on better communicating and describing “climate” data and information. For example, a user may not readily recognize how climate data and information may be useful to their operations. However, if communicated in terms of long-term forecasting for weather and water, such information may be more understandable and useful. This ongoing dialogue will help NOAA and private sector providers identify new opportunities and inform their development of new products and services.

The plant sector is uniquely positioned to engage the public in climate change issues. Botanic gardens, exemplified by the role of APGA in its relationship with NOAA, are an example of an ability to engage a national audience. Their interaction with the public will benefit from a shift in focus from data and hard science as primary communication tools to more creative communication vehicles, based on positive, local and relatable stories.

More research is needed to identify and define the specific needs of the plant sector communities. Since climate change is not recognized as a relevant issue by all, this conversation could start from the basis of the impacts of extreme weather events, inter- and intra-seasonal variations that impact plant growth, trends in the availability of key resources, etc.

Given the economic importance of the combined activities of this sector, it should be a priority to ensure that climate information providers are able to meet the medium and long-term planning information needs of plant sector communities. This will be fundamental to support the efforts of these communities to become more resilient as they continue providing critical services to the nation – for seasons to come.

REFERENCES

1. "Report Summary: Climate Change and Plants; Which Future?" Botanic Gardens Conservation International. Last accessed 18 January 2012 from: <http://www.bgci.org/ourwork/2093>
2. "Arctic Getting Greener," (11 June 2012) *Science Daily*. Last accessed 28 June 2012 from: <http://www.sciencedaily.com/releases/2012/06/120611122544.htm>
3. Zhuoting Wu, Paul Dijkstra, George W. Koch, Bruce A. Hungate (2012) "Biogeochemical and ecological feedbacks in grassland responses to warming" *Nature Climate Change* (2), 458-461.
4. Andy Jarvis, Julian Ramirez-Villegas, Beatriz Vanessa Herrera Campo, Carlos Navarro Racines, (2012), "Is Cassava the Answer to African Climate Change Adaptation?" *Tropical Plant Biology* (5:1), 9-29.
5. "Statistics: Floriculture Industry Overview." Society of American Florists. Last accessed 1 January 2012 from: <http://www.safnow.org/node/345>
6. *2007 Census of Agriculture: Greenhouse, Nursery and Floriculture Operations*, National Agricultural Statistics Service, U.S. Department of Agriculture. Last accessed 26 January 2012 from: http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/nursery.pdf
7. "Economic Impact Reports," Golf 20/20. Last accessed 18 January 2012 from: <http://golf2020.com/economicresearch.aspx>
8. Caroline Barnhill. "Study Shows Attendance At State Parks Grows, Even As Funding Decreases." (15 March 2011). North Carolina State University. Last accessed 18 January 2012 from <http://news.ncsu.edu/releases/cbstateparks/>
9. "California Wine Profile 2010" (2010). Wine Institute, Gomberg-Fredrikson Report, Stonebridge Research, California Department of Food & Agriculture, U.S. Tax & Trade Bureau, and U.S. Department of Commerce . Last accessed 18 January 2012 from http://www.wineinstitute.org/files/CA_EIR_Flyer_2011_Apr15.pdf

APENDIX A

Participants

- George Briggs, ASLA, Director, North Carolina Arboretum (*Workshop Co-Chair*)
- Nancy Colleton, President, Institute for Global Environmental Strategies (IGES) (*Workshop Co-Chair*)
- Greg W. Cumberland, President, Bent Creek Institute, Inc.
- Laura Delgado López, Earth Observations Associate, IGES
- L. DeWayne Cecil, Ph.D., Program Manager, NCDC Climate Data Records Program, Global Science & Technology, Inc.
- David Ellis, Director of Communications & Editor, American Horticultural Society (AHS)
- Robert S. Hayter, RLA, ASLA, OPM, Principal, The Hayter Firm
- Tamara G. Houston, Sectoral Engagement Coordinator, National Climatic Data Center (NCDC), National Oceanic and Atmospheric Administration (NOAA)
- Thomas R. Karl, L.H.D., Director, NCDC, NOAA
- Danny C. Lee, Ph.D., Director, Eastern Forest Environmental Threat Assessment Center (EFETAC), USDA Forest Service
- Mary Pat Matheson, Executive Director, Atlanta Botanical Gardens
- Thomas C. Peterson, Ph.D., Principal Scientist, NCDC, NOAA
- Jeffrey L. Privette, Ph.D., Chief Scientist, Climate Data Records Program, NOAA, NCDC
- Warren Quinn, Esq., CAE, Vice President for Operations, American Nursery and Landscape Association (ANLA)
- Casey Sclar, Ph.D., Interim Executive Director, American Public Gardens Association (APGA); Plant Health Care Leader, Longwood Gardens
- Russell S. Vose, Chief, Product Development Branch, NCDC, NOAA