Authors: Kayri Havens, Pati Vitt, Jennifer Schwarz, Barron Orr and Theresa Crimmins

Chicago Botanic Garden's conservation and outreach efforts on climate change

Above: *Tetraneuris herbacea*. Species monitored by Plants of Concern programme (Photo: Carol Freeman)

On January 4, 2007, giant snowdrops (Galanthus elwesii) bloomed at the Chicago Botanic Garden (CBG). This broke the previous record for earliest snowdrop bloom date, set in 2006, by 25 days. Hundreds of calls were logged at CBG's Plant Information Service regarding the anomalous bloom time. Ten reporters from local television, radio and newspapers questioned Garden staff about the relationship between global climate change and bloom times. The significant public response to this event underscores the interest in, and need for, public education on our changing climate and its impact on natural systems.

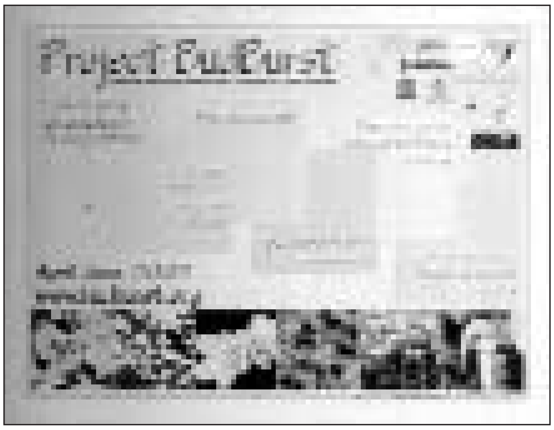
Ecological changes connected with trends in increasing temperatures and the earlier onset of spring are well documented across the globe using plant phenology data (Schwartz and Reiter, 2000, Abu-Asab *et al*., 2001, Cayan *et al*., 2001, Schwartz, 2003). These data are observations of phenological events (e.g. leaf emergence, first flower, peak flowering) recorded each year over an extended period of time. Phenological observations are highly intuitive from both interpretation and data collection standpoints and are therefore accessible to the general public. Nature and science museums, science centres, and botanic gardens and arboreta are well suited to deliver critical science and environmental content in an informal, self-directed manner. US botanic gardens, often with associated natural areas, enjoy a broad public audience (50 million visitors per year) and are particularly appropriate to connect global climate change concepts to potential impacts on plant species and ecosystems.

Left: Susanne Masi (left), manager of Plants of Concern programme with a volunteer monitor (Photo: Robin Carlson)

The Chicago Botanic Garden has several programmes underway or in development to introduce the public to climate change issues and to engage them in collecting data relevant to predicting plant responses to climate change. As illustrated by the snowdrop example, the public is often aware of climate effects, but individuals may not consider their observations scientifically valuable. The Garden's projects will capture the public's observations and provide further opportunities to engage in citizen science. While data collection activities in this project are primarily designed to educate and involve learners, the data will also contribute to critical climate change research and prediction tools. There is precedence for the efficacy of citizen collected data in several very valuable phenology and plant distribution datasets that are the result of hobby or volunteer observations (e.g., Beaubien & Johnson, 1994, Bradley *et al*., 1999, Fitter & Fitter, 2002, Wolfe *et al*., 2005, Vitt *et al*., in review) and each has furthered scientific understanding of the natural world.

Project Budburst

Piloted in 2007, this national project is a collaborative effort developed by several organizations, including Chicago Botanic Garden, and universities that are members of the US National Phenology Network (NPN). The NPN is a network of scientists and educators that collaborate to facilitate collection and dissemination of phenological data to support global change research. Project Budburst engages citizen scientists, including youth, to record phenological observations, such as first flower, first leaf, peak flower and others, on a website (www.budburst.org). About 60 native wildflowers, shrubs and trees, from Eastern Columbine (*Aquilegia canadensis*) to California Poppy (*Eschscholzia californica*), were targeted in the pilot campaign, but people can submit information on any plant species. A few commonly used landscape species, such as Forsythia (*Forsythia x intermedia*) and Lilac (*Syringa vulgaris*) and two weeds, Dandelion (*Taraxacum officinale*) and White Clover (*Trifolium repens*) are also included, so people could participate even if they could not get out to a natural area. In the first year, nearly 900 observations from 38 states were received, the majority submitted by children under 12. Next year, it is planned to expand the website to accept historical datasets (since many citizen scientists have volunteered to donate their datasets going back decades in some cases) and allow data submission year round.



Above: Card of Project Budburst

Below: *Sisyrhinchium montanum.* Species monitored by Plants of Concern programme (Photo: Carol Freeman)

Global Climate Change Monitoring Gardens

This project, under development for a 2008 launch, consists of “global climate change monitoring gardens” which will be planted at 13 botanic gardens (Table 1), thus creating a nationwide “ecological antenna” where citizen scientists record climate data and a standard set of phenological events. After piloting the monitoring gardens at the 13 botanic gardens, monitoring gardens will be provided to community organizations working with urban and underserved youth audiences. The monitoring gardens are designed to hold genetic variance constant and standardize growing conditions. Environmental response variables – to be measured by participating community youth, garden visitors, and scientists – will include: date of first open flower, peak flowering, first fruit ripened, last fruit ripened, total flowering period, and fecundity. Each garden will contain genetically-identical cloned plants which will act like a network of climate sensors or “phytometers.” The Global Climate Change Monitoring (GCCM) gardens will include native species that are long-lived and exhibit a variety of breeding systems. Gardens will also include both a C3 and a C4 grass; these contrasting photosynthetic pathways are expected to respond differently to elevated CO_2 levels. Target species, including False Indigo (*Baptisia australis*), Summer Phlox (*Phlox paniculata*), Bee Balm (*Monarda fistulosa*), Indian Grass, a C4 grass (*Sorghastrum nutans*), and Western Wheatgrass, a C3 grass (*Pascopyrum smithii*), have wide geographic ranges, which allow them to be planted at the participating gardens; have flowering times that are initiated by temperature, as opposed to daylength; are easy to clone; and are attractive in a garden setting. Plant responses to the different climates of the 13 participating

Right: *Platanthera leucophaea*, Species monitored by Plants of Concern volunteers

gardens will allow inferences about how the species might respond to future climate change. Repeat photos will be displayed on a project website, enabling website visitors to see phenological changes and patterns through time, as well as spatially across all participating sites. This “ecological antenna” will allow the following conservation research questions to be addressed: (1) How do clones respond phenologically to various bioclimatic zones? (2) Is phenologic behaviour different across bioclimatic zones? (3) Can observations be related to future climatic shifts in the region? and, (4) Over time, how do the cloned plants respond phenologically to the changing climate in each of the bioclimatic zones where they are located?

At eight of the 13 gardens, climate and phenological observations in the gardens will be interpreted in a regional and national context at an accompanying public access computer kiosk and display, as well as on the project website available to all. Display of these products will be accompanied by additional evidence that represents the current understanding of how climate is changing globally. Figure 1 illustrates the relationships between the climate change gardens at botanic gardens, at associated community organizations and the programming team at University of Arizona.

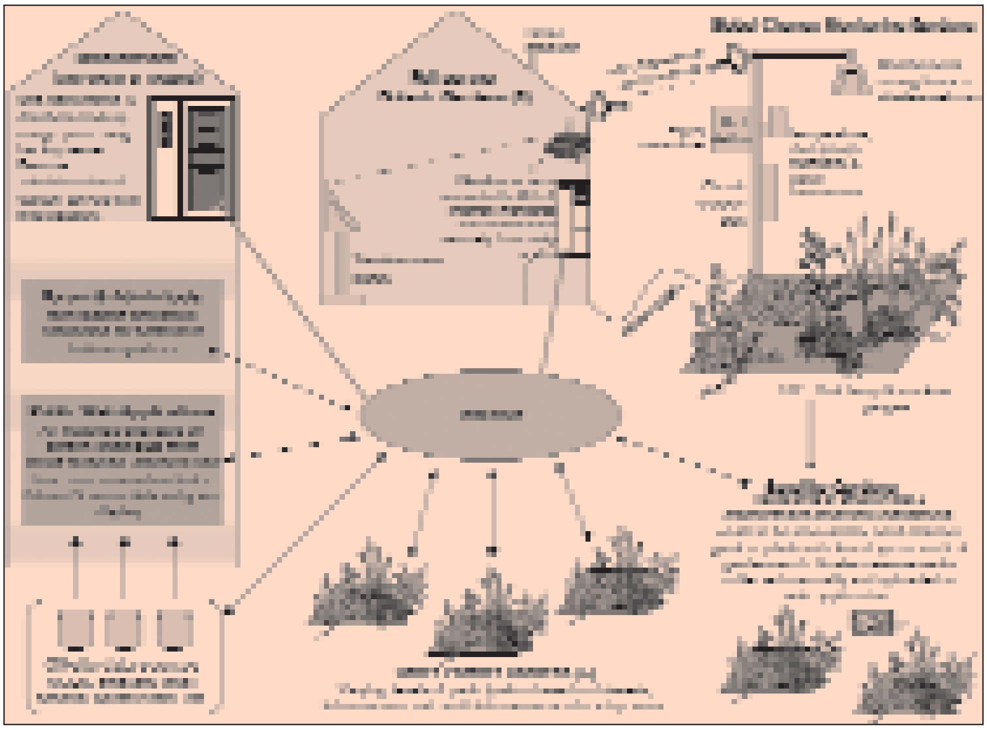
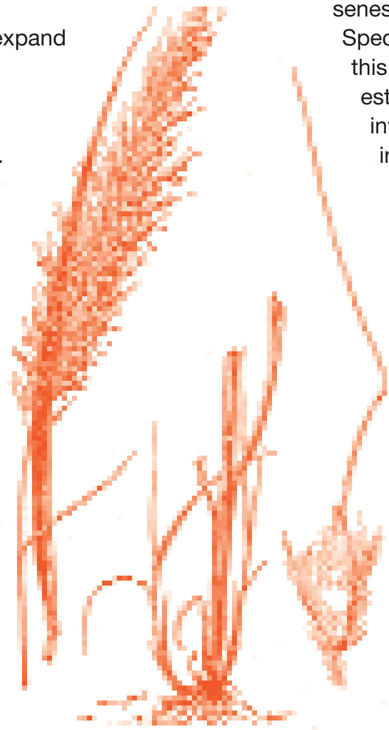


Figure 1. Schematic design of relationships and linkages between monitoring gardens, kiosks, servers, data and the University of Arizona programming team (Diagram: Anne Thwaits, University of Arizona).

Plants of Concern

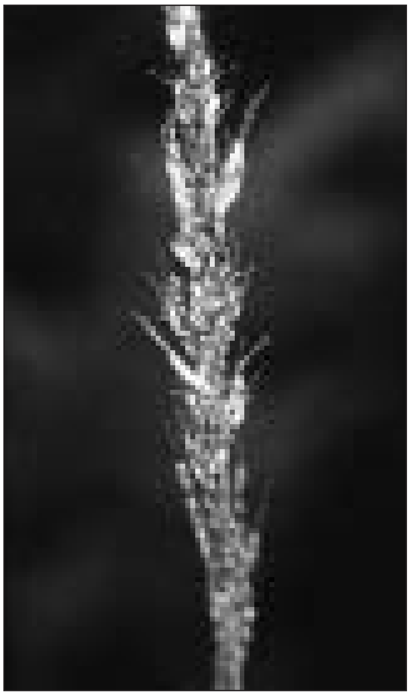
The global climate change monitoring gardens will provide information on the response of plants in a controlled design to different environments nationally. It is alos interesting to find out how rare and invasive plant species respond, both phenologically and demographically, over time in the wild. Plants of Concern (POC), founded in 2001, is a citizen-science monitoring programme designed to collect these types of data on rare plants in the northeastern Illinois region. To date over 300 volunteers have monitored over 400 rare plant populations representing 145 species. The volunteer retention rate over the life of the programme is quite high (61%). Volunteer data quality has been verified experimentally, and there were no significant differences between staff and volunteer collected data (Vitt, unpublished data).

In 2008, it is planned to expand the programme, both geographically and conceptually, to include invasive plant monitoring. Of the many factors involved in the endangerment of native plants, invasive species rank second only to habitat loss, and issues such as native plant rarity, invasive species, and habitat destruction are entwined. Many invasive species thrive in disturbed ecosystems, and climate change is one type of disturbance that is predicted to increase for the foreseeable future. Thus continued invasion may be favoured by climate change (Dukes & Mooney, 1999), while rare species are more likely to be negatively impacted.



For the invasive species monitoring component, data on all fields in the North American Weed Management Association (NAWMA, 2007) standards will be collected, as well as additional phenological (flowering and fruiting times) and demographic (percent of plants flowering and fruiting, seedling recruitment, senescence, etc.) data. Species selected for this study include well-established regional invasives and incipient invasives popular in horticulture. Aggregate report data will allow conservation biology researchers to answer questions such as: How fast do these emerging invasive species spread, and does rate of spread change as climate changes? Which non-native species are becoming invasive? Do certain regions (such as urban areas) serve as refugia for emerging invasive species? Are there certain population characteristics that could help identify emerging species?

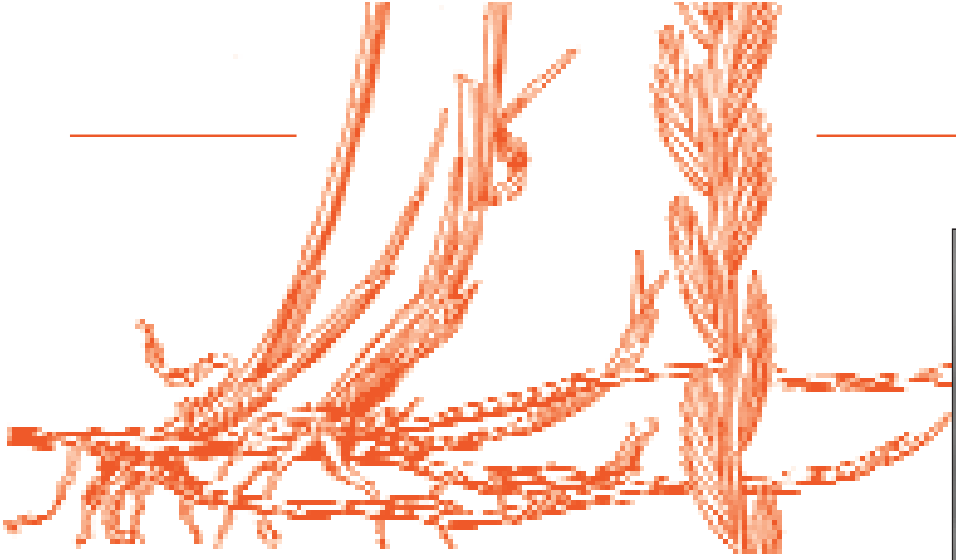
Taken together, these projects lead learners through one or more, loosely, yet systematically, linked informal education opportunities toward an increasing awareness of how individual behaviour can affect climate change. Ultimately, it is hoped that individual behaviour will be influenced to reflect both an understanding of climate change and to create awareness that

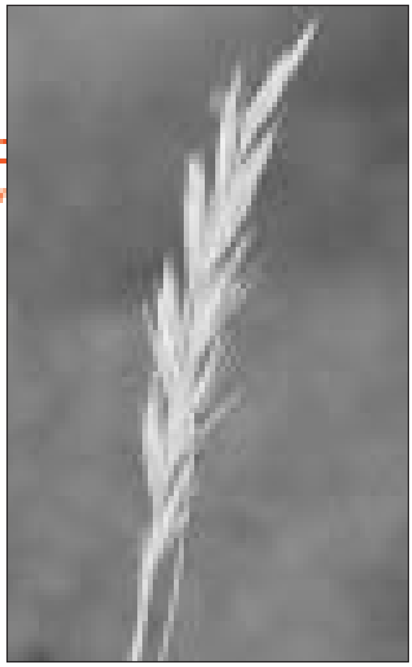


Sorghastrum nutans (Indian grass) a C4 grass and target species for the Global Climate Change Monitoring Gardens Project

Far left: (Hitchcock, A.S.). 1950. *Manual of the grasses of the United States.* USDA Misc. Publ. No. 200. 1950).

Left: (Robert H. Mohlenbrock. USDA SCS. 1991. *Southern wetland flora: Field office guide to plant species.* South National Technical Center, Fort Worth. Courtesy of USDA NRCS Wetland Science Institute)





Pascopyrum smithii (Western Wheatgrass) a C3 grass and target species for the Global Climate Change Monitoring Gardens Project

Above: (Robert H. Mohlenbrock. USDA SCS. 1989. Midwest wetland flora: Field office illustrated guide to plant species. Midwest National Technical Center, Lincoln, NE. Courtesy of USDA NRCS Wetland Science Institute)

Far right: (Hitchcock, A.S. (rev. A. Chase). 1950. Manual of the grasses of the United States. USDA Misc. Publ. No. 200. Washington, DC. 1950)

individuals can positively affect this environmental issue. In addition, these projects provide valuable data that the Garden and others will use to improve predictions about how plant species will respond as the climate changes.

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Table 1 Global Climate Change Monitoring Garden project partners

Arboretum at Flagstaff
Berry Botanic Garden
Chicago Botanic Garden
Cincinnati Zoo & Botanic Garden
Cornell Plantations
Denver Botanic Garden
Holden Arboretum
Missouri Botanical Garden
The Morton Arboretum
New England Wild Flower Society at Garden in the Woods
North Carolina Botanical Garden
Santa Barbara Botanic Garden
University of Washington Botanic Garden

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Kayri Havens, Pati Vitt and Jennifer Schwarz
Institute for Plant Biology and Conservation
Chicago Botanic Garden
1000 Lake Cook Road
Glencoe, IL 60022
Email:
khavens@chicagobotanic.org
Internet:
http://www.chicagobotanic.org/
and
Barron Orr and Theresa Crimmins
University of Arizona