Using BGCI's databases to connect plant collections and expertise to support the development of an international Sentinel Plant Network

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Abstract

There are over 2,600 botanic gardens in operation today, located in nearly every country and ecosystem around the world. It is estimated that 30-40% of the world's known plant species are grown in the living collections of these botanic gardens, often not in the country or even on the continent in which they are native. This presents a significant opportunity to understand and predict when and where species may become pests, or when and where they may be susceptible to other introduced pests (particularly fungus and insects). The Sentinel Plant Network is a proposed formal structure under which individual gardens would be able to act collectively to increase the predictive power of their collections. However, without an understanding of which species are held where, and what resources are currently resident within botanic gardens around the world, the activities of a Sentinel Plant Network will be hindered. There is an opportunity to increase the scope, content, and utility of BGCI's two global, publicly accessible databases in order to support key components of a Sentinel Plant Network to help predict and prevent new pest incursions around the world.

Keywords

Early warning system; Insect pest; Invasive plant; Monitoring; Plant collections database; Plant pathogen; Sentinel Plant Network;

Article

The concept of a Sentinel Plant Network

Botanic gardens that maintain living plant collections from around the world could work together to form the basis for an international Sentinel Plant Network, where living plant collections are connected and capable of serving as early warning systems to help predict and prevent the incursion of new pests (insects, pathogens, or invasive plants). The idea of a sentinel network is not new, and in a few cases model programmes (such as New Zealand's expatriate plant pilot programme) have been implemented on a national or regional scale (Fagan, Bithell, and Dick, 2008; Fagan, 2008; Miller, Beed, and Harmon, 2009; Britton et al., 2010). There is a demonstrated need for more effective early warning systems for new pests, which if implemented could eliminate significant environmental and economic costs of future invasive insects, pathogens, and plants.

A clear example of why a Sentinel Plant Network could help mitigate environmental and economic costs via early detection and prevention of new pests comes from the 2002 discovery of the Emerald Ash Borer in Michigan, USA. The infestation of this beetle (native to Asia) was not identified in time to eradicate it and prevent its spread, so its range is rapidly increasing throughout the United States and Canada. After only 5 years, over 53 million native ash trees (*Fraxinus* spp.) were killed by the beetle, and in the next ten years the infestation is predicted to cost an estimated $10.7 billion to treat, remove, and replace the more than 17 million planted ash trees likely to be killed in urban areas alone (Kovacs et al., 2010). If a Sentinel Plant Network had been in place allowing botanic gardens in Asia growing ash trees native to North America to monitor and report any unusual insect damage, the extreme susceptibility of North

American ash trees to the Emerald Ash Borer could have been predicted and measures put in place to monitor and eradicate any occurrences before they became too large to control.

While the need is greater than ever, a number of components are required for the development of a truly international Sentinel Plant Network of botanic gardens. In this article we address four key components that are needed to help form the basis of such a Network, which include: 1) connecting plant collections to identify which plants are growing where, 2) locating reliable information on the native distribution of plants growing in collections around the world, 3) identifying which gardens have the capacity or partners in place to be able to monitor for potentially new and invasive pests/pathogens/plants, and 4) establishing a network (formal or informal) of botanic gardens and partners that is based on collections information and expertise, and provides a specific means of communication, collaboration and information sharing.

Which plants are growing where?

An increasing number of online databases exist that are connecting accession-level information about the living collections at botanic gardens and arboreta around the world, which will only grow in content and functionality in the coming years. However, the only database that connects living collections (at the taxa-level) around the world is BGCI's PlantSearch database (see www.bgci.org/plant_search.php). This database is powerful because it allows free participation by any institution able to provide an electronic list of the taxa found in their living collections. In March 2010, this database contained 611,000 records representing 181,000 taxa growing in 700 botanic garden collections in 112 countries around the world. This included collections information for 73 botanic gardens in the United States, 34 in China, and 18 in Russia.

The information in PlantSearch is searchable on-line, but the identity of gardens holding specific collections is not revealed. Instead, researchers interested in contacting specific gardens regarding a taxon in their collection can submit a request through BGCI's online system, and collection holders have the option of responding to requests or not. Expanded off-line searching capabilities currently allow BGCI staff to perform more specific searches, for example the database currently contains nearly 2,000 records of Ash trees (*Fraxinus* spp.) growing in botanic gardens located in 33 countries.

BGCI is working to increase the content and quality of data in the PlantSearch database, as well as its utility to botanic garden contributors and other end-users such as researchers and conservation planners. BGCI encourages all gardens, regardless of collections size or focus, to upload taxa lists to PlantSearch to gain useful information on the taxa in their collection and to ensure their collections are globally connected through this database tool. BGCI is also assessing the potential to expand on-line querying capabilities for garden contributors, which could facilitate more direct communication amongst botanic gardens taking part in an international sentinel plant network than is currently possible.

What is the native distribution of plants found in botanic garden collections?

The PlantSearch database currently allows queries against different lists which help BGCI or contributing botanic gardens identify taxa in their collections that are known to be threatened, possess medicinal properties, or are crop wild relatives. This functionality of the database has recently been expanded, allowing BGCI and contributing gardens to identify taxa native to the United States and Canada, following information on global ranks provided by NatureServe (NatureServe, 2010). While this is an useful expansion which could facilitate monitoring at individual gardens as well as communication amongst gardens, expanding PlantSearch's

capability to include distribution data for other continents and countries will be an important future addition to guide the establishment and work of a Sentinel Plant Network.

Where are resources and expertise located?

Knowing where plants are being grown is only one piece of the puzzle in laying the groundwork for a Sentinel Plant Network. An additional component is the need to know which gardens have the capacity to monitor, identify, and report potentially invasive pests, pathogens, and plants. For this, we believe GardenSearch, the only global database of botanical expertise and capacity in the world's botanic gardens (see www.bgci.org/garden_search.php), has the potential to fill this role. However, targeted upgrades in database structure and content will be necessary before this database will be fully useful. Currently, by searching on keyword, the online interface of this database can be used to locate gardens in different countries with expertise in botanical research, conservation and education. Yet none of the current fields contain information on the specific resources and expertise that may help connect and inform a Sentinel Plant Network. In addition, the database's online search functionality is very limited, although expanded off-line searching capabilities currently allow BGCI staff to perform more specific searches, for example to identify gardens with research programmes on invasive species biology and control in the United States.

To support the Sentinel Plant Network, the GardenSearch database could be updated to include new fields which easily identify gardens who maintain plant pathology programmes, provide pest/pathogen identification services to visitors, or who already monitor their collections for new pests, pathogens, or potentially invasive plant species. This year, BGCI will be carrying out an online survey that allows the global botanic garden community to identify where resources, expertise, and interest exist that could help form the foundation of a Sentinel Plant Network (BGCI, 2010).

Establishing a network for information gathering, sharing, and communication

Connecting plant collections as well as resources and expertise through comprehensive global databases is an important step in forming the foundation of a Sentinel Plant Network, but communication pathways will need to be enhanced in other ways as well to make the network as efficient and valuable as possible. This includes communication between gardens holding plants, between garden staff and outside organizations that can help identify new pests or pathogens, between gardens and the general public (which could have an important role to play in expanding monitoring efforts – the American Public Gardens Association will be working on this in 2010-2011), and between gardens and organizations working to predict and prevent new pests. For this, will be critical to engage not only a broad array of botanic garden staff, including those involved in pest management, plant records, entomology, and pathology, but also organizations in other sectors, including researchers at academic institutions as well as individuals at government agencies.

We believe that it is important for the global botanic garden community to begin taking the steps necessary to build a Sentinel Plant Network. This network has the potential to not only increase predictive and preventative measures available to stop the next insect pest, plant pathogen, or invasive plant incursion, but also the power to demonstrate the value of living collections, and the opportunity to educate and engage botanic garden visitors on a relevant and timely topic where they can help make an impact.

For more information, visit www.bgci.org/usa/sentinel.

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