fire

MDPI

Perspective

Selecting Low-Flammability Plants as Green Firebreaks within Sustainable Urban Garden Design

Brad R. Murray [1,*], Leigh J. Martin [1], Colin Brown [2], Daniel W. Krix [1] and Megan L. Phillips [1]

[1] School of Life Sciences, University of Technology Sydney, PO Box 123, Broadway, NSW 2007, Australia; leigh.martin@uts.edu.au (L.J.M.); daniel.krix@uts.edu.au (D.W.K.); megan.phillips@uts.edu.au (M.L.P.)
[2] NSW Rural Fire Service, Blaxland Rural Fire Brigade, NSW 2774, Australia; col@bluemtns.com
* Correspondence: brad.murray@uts.edu.au

Received: 20 April 2018; Accepted: 7 May 2018; Published: 9 May 2018

In response to an increasing risk of property loss from wildfires at the urban–wildland interface, there has been growing interest around the world in the plant characteristics of urban gardens that can be manipulated to minimize the chances of property damage or destruction. To date, considerable discussion of this issue can be found in the 'grey' literature, covering garden characteristics such as the spatial arrangement of plants in relation to each other, proximity of plants to houses, plant litter and fuel reduction, and the use of low-flammability plants as green firebreaks [1–4]. Recently, scientific studies from a geographically wide range of fire-prone regions including Europe [5], the USA [6], Australia [7], South Africa [8], and New Zealand [9] have been explicitly seeking to quantify variation among plant species with respect to different aspects of their flammability and to identify low-flammability horticultural species appropriate for implementation as green firebreaks in urban landscapes. The future prospects of this scientific work will ultimately depend on how successfully the results are integrated into the broader context of garden design in fire-prone regions at the urban–wildland interface. Although modern design of urban gardens must consider more than just the issue of green firebreaks, we and others [10,11] believe that selection of low-flammability plants should be high on the priority list of plant selection criteria in fire-prone regions.

Successful inclusion of low-flammability plants into residential gardens, public gardens, and roadside plantings at the urban–wildland interface might initially seem a complicated and difficult goal to achieve, given the range of interests that need to be considered in the choice of garden plants. To simplify the task, and to emphasize the importance of considering low-flammability plants, we present a procedure for selecting resilient plant species that carefully integrates the range of potentially competing interests. Here, we define resilient plant species as those that are well suited to meet current and future challenges under global environmental change. The procedure resolves potential conflicts by treating each of these interests as complementary factors to be considered in selecting plant species. The goal is thus to assist home-owners in particular in selecting species that fulfil multiple objectives in urban gardens. At a broader scale of consideration, the selection of appropriate plant species in terms of their flammability can also be considered usefully in conjunction with the issue of vegetation removal so as to provide defensible space around homes and infrastructure [12,13] that does not result in completely denuded landscapes. The challenges of plant selection, which also represent the potentially competing interests, include (i) the preservation of native biodiversity in urban environments; (ii) an increasing prevalence of wildfires at the urban-wildland interface; and (iii) shifting weather conditions that include prolonged periods either with or without rain or spikes in either very high or very low temperatures (these will depend on the geographic region in which the garden is situated). Modern garden design must also consider the issues of community (including individual) values in relation to selection of plant species (e.g., aesthetics, plants selected for food

production for families or communities), as well as the fact that some plant species are either allergenic or toxic and should be avoided for health reasons. We consider all of these challenges and interests in our plant selection procedure.

From our perspective, an ideal resilient plant species for urban gardens is one that offers refuge or resources for native wildlife, is of low flammability, is weather-proof for the climatic region now and into the future, presents no health risks for human welfare, and meets community values. In Figure 1, we illustrate a process for selecting plant species with these characteristics from an overall pool of available species. Our model of an ideal plant is flexible, and the selection criteria may be reordered to suit site-specific needs (e.g., Heritage gardens, areas in commercial zones, preschools, or hospital grounds). Alternatively, because different stakeholders might weight the selection criteria rather than require all of them, some steps of the procedure can easily be omitted where and when necessary. Here, we suggest that a good starting point is selecting native plant species that are known to be used by local wildlife (step A). This is because (a) there is a good deal of information available about those plants that are 'biodiversity-promoting' and which play an important role in biodiversity conservation: for example, there is usually an accumulated knowledge about those plants that provide habitat and food for native birds [14,15]; and (b) native plants and animals in urban gardens are playing increasingly significant roles in the provision of ecosystem services [16,17]. From this biodiversity-promoting pool of species, 'low-flammability' species should be selected (Figure 1, step B). Researchers are still in the pioneering stage of identifying broad generalities in the morphological, chemical and structural characteristics of low-flammability species; however, within the next ten years, we believe there will be a surge in the volume of empirical scientific work that will make it explicitly clear which plants can be described as being of low flammability and will thus be best suited for wildfire resilience to provide a level of protection for homes. A critical objective of this work will be to untangle the varied meanings for plant species of terms such as 'low-flammability', 'fire-resilient', and 'non-flammable', as these terms are currently used in a range of different ways. The establishment of frameworks that clearly define these terms for broad use is highly desirable (e.g., [18,19]). There is also growing awareness of the need to identify the properties of species will make them 'weather-proof' in the context of climate change [20], which will make the identification and selection of weather-proof plant species (Figure 1, step C) much simpler in the future. The final two steps in the procedure ensure that only 'health-safe' plant species (step D), which pose minimal risk to human health, and plant species that meet community values (step E), are selected for urban gardens.

The fundamental principle on which our selection process is based is that resilient plant species can perform multiple functions in their environments. This is the key paradigm shift that is needed to lead to increased acceptance and successful inclusion of low-flammability plants into broader modern garden design. Rather than selecting plants for just one purpose, e.g., as ornamentals or as drought-tolerant, plants can be selected for gardens in the face of multiple challenges. Success, in terms of the adoption of the idea that low-flammability plants are useful, will ultimately be measured by appreciable use of low-flammability horticultural plants by home-owners wishing to make their gardens more resilient to wildfires. Personal economics must be considered here, such that those plant species with resilient characteristics and which are available for purchase should not be expensive or increase energy consumption costs, and they should not for whatever reason decrease property values. A further constraint may be that retail availability of plants for selection is limited: but this hurdle can be overcome over time with increasing knowledge about, and demand for, low-flammability plants by home-owners and nurseries in fire-prone regions. Home gardens are for the most part privately owned and home-owners will make their own choices, but hopefully the procedure that we present here might help to promote choices that include a wide range of plant species that offer a broad suite of resilient characteristics – importantly, including plant species with low-flammability characteristics.

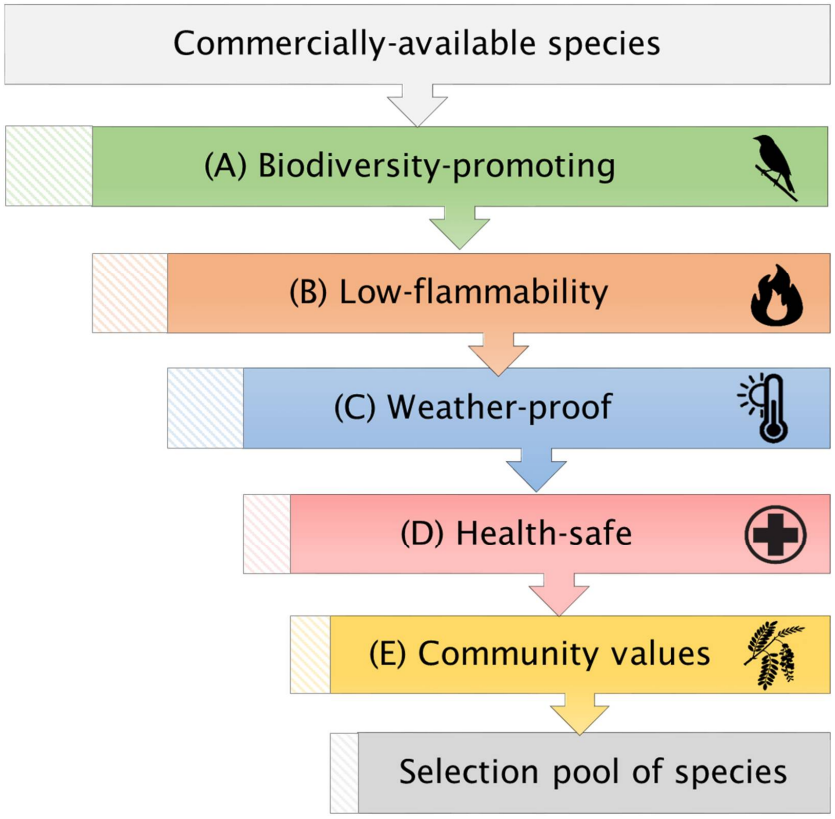

Figure 1. A process for selecting plant species with resilient characteristics for gardens in fire-prone regions at the urban–wildland interface. The process begins at step (A) with the choice of biodiversity-promoting plant species; then, the process gradually reduces the pool of appropriate species through selection of species that are (B) low on the flammability spectrum, (C) resilient to future climate change, (D) pose minimal health risks to humans, and (E) meet community (including individual) values. This leads to a final selection pool of plant species from which to choose resilient garden species. The stippled boxes next to each selection stage represent those species excluded at each stage.

Author Contributions: B.R.M. wrote the manuscript, with conceptual and editorial inputs from all authors.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Country Fire Authority Victoria. Landscaping for Bushfire: Garden Design and Plant Selection. Available online: https://www.cfa.vic.gov.au/plan-prepare/landscaping/ (accessed on 15 March 2018).
2. National Fire Protection Association. Firewise USA: Residents Reducing Wildfire Risk. Available online: https://www.nfpa.org/Public-Education/By-topic/Wildfire/Firewise-USA (accessed on 20 April 2018).
3. South African Landscapers Institute. Firescape Your Garden. Available online: https://www.sali.co.za/firescape-your-garden/ (accessed on 6 May 2018).
4. Kelly, L.; Bach, E.P.; Bernet, M.F. Wildfires are Raging in the Mediterranean. What Can We Learn? Available online: https://theconversation.com/wildfires-are-raging-in-the-mediterranean-what-can-we-learn-81121 (accessed on 6 May 2018).
5. Ganteaume, A.; Jappiot, M.; Lampin, C.; Guijarro, M.; Hernando, C. Flammability of some ornamental species in wildland–urban interfaces in Southeastern France: Laboratory assessment at particle level. *Environ. Manag.* **2013**, *52*, 467–480. [CrossRef] [PubMed]
6. de Magalhães, R.M.Q.; Schwilk, D.W. Leaf traits and litter flammability: evidence for non-additive mixture effects in a temperate forest. *J. Ecol.* **2012**, *100*, 1153–1163. [CrossRef]

7. Murray, B.R.; Hardstaff, L.K.; Phillips, M.L. Differences in leaf flammability, leaf traits and flammability-trait relationships between native and exotic plant species of dry sclerophyll forest. *PLoS ONE* **2013**, *8*, e79205. [CrossRef] [PubMed]
8. Simpson, K.J.; Ripley, B.S.; Christin, P.-A.; Belcher, C.M.; Lehmann, C.E.R.; Thomas, G.H.; Osborne, C.P. Determinants of flammability in savanna grass species. *J. Ecol.* **2016**, *104*, 138–148. [CrossRef] [PubMed]
9. Wyse, S.V.; Perry, G.L.W.; O'Connell, D.M.; Holland, P.S.; Wright, M.J.; Hosted, C.L.; Whitelock, S.L.; Geary, I.J.; Maurin, K.J.L.; Curran, T.J. A quantitative assessment of shoot flammability for 60 tree and shrub species supports rankings based on expert opinion. *Int. J. Wildland Fire* **2016**, *25*, 466–477.
10. Smith, A.M.S.; Kolden, C.A.; Paveglio, T.B.; Cochrane, M.A.; Bowman, D.M.J.S.; Moritz, M.A.; Kliskey, A.D.; Alessa, L.; Hudak, A.T.; Hoffman, C.M.; et al. The science of firescapes: Achieving fire-resilient communities. *BioScience* **2016**, *66*, 130–146. [CrossRef] [PubMed]
11. Curran, T.J.; Perry, G.L.W.; Wyse, S.V.; Alam, M.A. Managing fire and biodiversity in the wildland-urban interface: A role for green firebreaks. *Fire* **2018**, *1*, 3. [CrossRef]
12. Penman, T.D.; Collins, L.; Syphard, A.D.; Keeley, J.E.; Bradstock, R.A. Influence of fuels, weather and the built environment on the exposure of property to wildfire. *PLoS ONE* **2014**, *9*, e111414. [CrossRef] [PubMed]
13. Syphard, A.; Brennan, T.J.; Keeley, J.E. The role of defensible space for residential structure protection during wildfires. *Int. J. Wildland Fire* **2014**, *23*, 1165–1175. [CrossRef]
14. Nature Conservation Council of NSW. Creating Bird-Friendly Gardens in Bush Fire Prone Areas: Fact Sheet. Available online: https://www.nature.org.au/healthy-ecosystems/bushfire-program/fact-sheets/ (accessed on 15 March 2018).
15. National Audubon Society. 10 Plants for a Bird-Friendly Yard. Available online: http://www.audubon.org/news/10-plants-bird-friendly-yard (accessed on 6 May 2018).
16. Konstantinos, T.; Kalevi, K.; Venn, S.; Yli-Pelkonen, V.; Kaźmierczak, A.; Niemela, J.; James, P. Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landsc. Urban Plan.* **2007**, *81*, 167–178.
17. Threlfall, C.G.; Kendal, D. The distinct ecological and social roles that wild spaces play in urban ecosystems. *Urban Forest. Urban Green.* **2018**, *29*, 348–356. [CrossRef]
18. Pausas, J.G.; Keeley, J.E.; Schwilk, D.W. Flammability as an ecological and evolutionary driver. *J. Ecol.* **2017**, *105*, 289–297. [CrossRef]
19. Prior, L.D.; Murphy, B.P.; Bowman, D.M.J.S. Conceptualizing ecological flammability: An experimental test of three frameworks using various types and loads of surface fuels. *Fire* **2018**, *1*, 14. [CrossRef]
20. Lowe, A. How do We Keep Gardening in the Face of a Changing Climate? Available online: https://theconversation.com/how-do-we-keep-gardening-in-the-face-of-a-changing-climate-72647 (accessed on 15 March 2018).