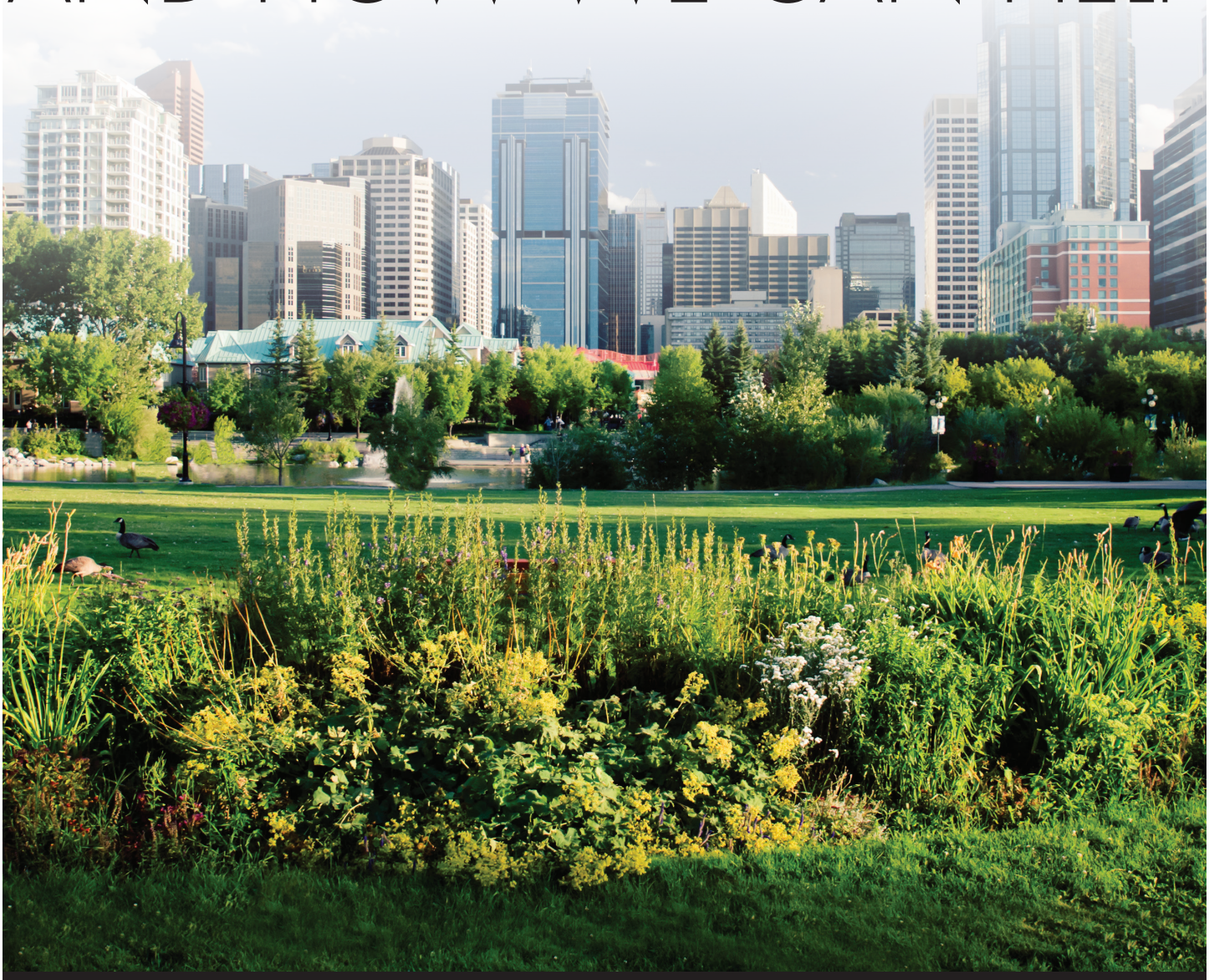
THE IMPORTANCE OF **PRESERVING BIODIVERSITY IN THE URBAN LANDSCAPE** AND HOW WE CAN HELP



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Introduction

Exotic plants are plants that evolved in a different place than where they are now found. Landscapers and individuals often choose such plants for gardens because of their attractive and aesthetically pleasing qualities. However, recent studies in ecology (the interactions between organisms and their environment and each other) have found that landscaping with exotic plants can reduce biodiversity. Biodiversity is the variety among and within plant and animal species. Greater biodiversity in a landscape makes for a more sustainable and resilient environment.

One important way that exotic plants can affect biodiversity is through the food web (Figure 1). Unlike exotic plants, native plants have evolved together over eons with insects and animals of a geographic region. As a result, many native butterflies and other insects have adapted to certain native plants. Choosing to landscape using exotic plants can have negative effects on native insects and the animals that depend on them. This affects the insect population because these insects lose their food source—the native plants. Food loss affects the entire food chain with potential negative effects on other organisms, such as insect-eating birds, reptiles, and spiders, and on beneficial soil organisms.

Figure 1. Landscaping with exotic plants in place of native plants can have negative effects on native insects and birds. The insect population is affected by the loss of its food source—the native plants. This causes animals that eat insects to then lose an important food source.

Because of these negative effects, conservation groups and U.S. federal and state agencies encourage increasing the use of native plants in the design of landscapes. However, achieving this will be a challenge because of the amount of land in the U.S. that is managed for its aesthetic value.

There is roughly the same amount of land in urban landscapes (100 million acres) as there is in all U.S. national and state parks combined, and this number is growing. Native ornamental plants are not currently being produced on a scale needed for this large area.

To preserve biodiversity in urban landscapes, native plants need to be provided in a way that maintains their ecological benefits. At the same time, native plants need to be attractive to consumers and economically feasible for nurseries to produce. There is currently a limited availability of native ornamental plants that both help the ecology and appear aesthetically pleasing. Increasing their use in landscaping requires satisfying these different demands.

Effects of Exotic Plants on Insect and Bird Abundance and Diversity

A recent U.S. Environmental Protection Agency report[1] summarizes the effects of landscaping practices on the environment, stating:

- the widespread replacement of millions of acres of native vegetation with primarily non-native ornamental plants in managed landscapes is a growing problem for the organisms that depend on native plants for food, shelter, and places to rear their young (Figure 2);
- many studies have documented the negative effect that non-native plants can have on the abundance and diversity of insect herbivores;
- if ornamental plants cannot serve as food for the same number and diversity of herbivores, the energy available for food webs decreases.

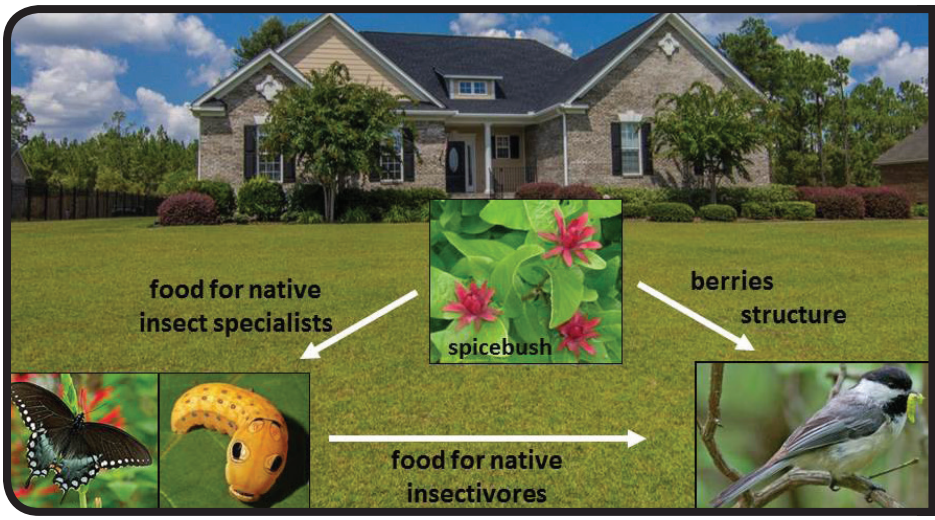


Figure 2. Increasing the use of native plants in landscaping provides a food source for regional insects, which in turn provides food for native insect-eaters such as birds.

Various studies done both in the U.S. and around the world have found a direct correlation of the type of landscaping plants used (exotic or native) and the abundance and diversity of insects and birds. Butterflies and birds are often used to measure biodiversity because they are easy to observe and sensitive to change.

A survey done in Pennsylvania found that suburban yards landscaped with exotic plants had fewer and less diverse butterfly and bird species than yards with native plants.[2] Likewise, in Singapore the butterfly and bird diversity decreased as the use of exotic plants increased[3] (Figure 3). A study conducted in Phoenix, Arizona, found that native bird species were more abundant in neighborhoods landscaped with native plants.[4] Suburbs of Canberra, Australia, that had at least 30% native street trees had a significantly higher number of bird species than those with exotic trees.[5]

Not all exotic plants have the same impact on insects, though. Exotic plants that have a close native relative were found to support insects better than completely novel plants.[6] For example, Korean cherry (*Prunus serrulata*) does not support as many insects as the native black cherry (*Prunus serotina*), but it is a better host than exotic plants with no native relatives. This may be due to similarity in chemistry between closely related plants. Exotic plants affected young insects, like caterpillars, more than adults. Butterfly bush and other exotic plants used in butterfly gardens can provide nectar to adult butterflies but cannot be used as food by their caterpillars.

Invasive exotic plant species can also have an effect on biodiversity. These are exotic plant species that spread widely in an environment and may become harmful when they displace native organisms. Many invasive plants in the U.S. were introduced for landscaping purposes as ornamentals.[7] Field studies have found that invasive exotic plants can shift the insect population from large, specialist insects (those with few plant hosts) to small, generalist insects (those with many plant hosts). This significantly reduces the amount of insects available as a food source.[8]

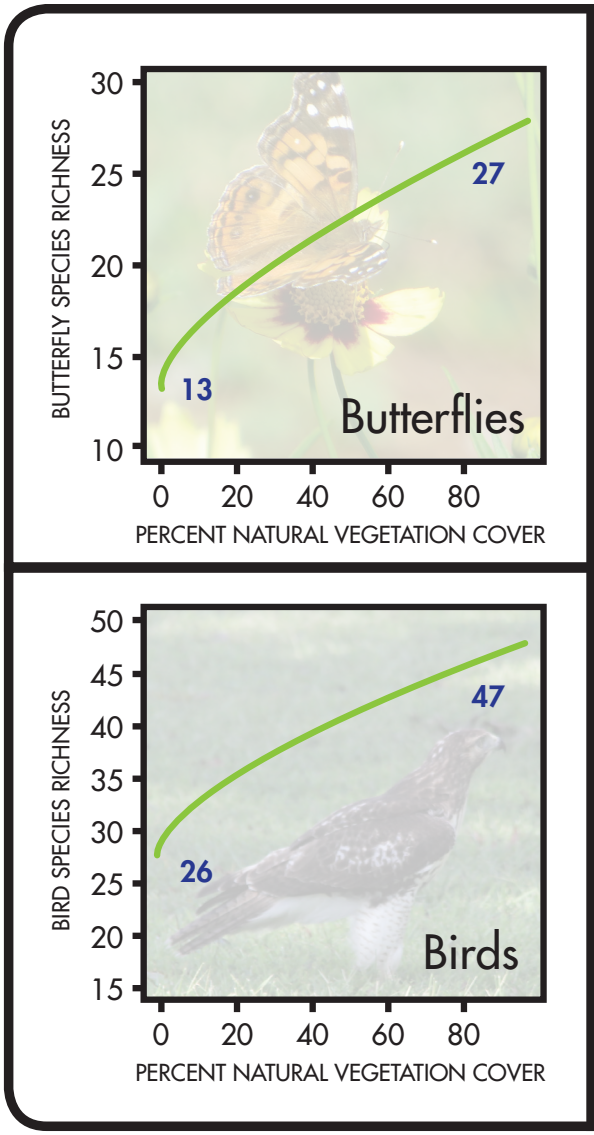


Figure 3. Urban vegetation has a negative effect on the diversity of bird and butterfly species. (Adapted from "Not all Green is as Good: Different Effects of the Natural and Cultivated Components of Urban Vegetation on Bird and Butterfly Diversity," by K. Y. Chong, S. Teo, B. Kurukulasuriya, Y. F. Chung, S. Rajathurai, and H. T. W. Tan, 2014, *Biological Conservation, 171*, pp. 303-304).

The replacement of native plants with exotic plants can affect insect populations by other ways than as a food source. One study found that caterpillars were smaller and developed more slowly on exotic plants.[9] Another study found that insect mate choice was affected because attraction to mates was reduced on exotic plants.[10] Another problem was that pollinators of native plants tended to visit exotic plants more frequently, causing native plants to be pollinated less frequently.[11]

Breeding and Selection of Native Ornamental Plants

In the U.S., there is a niche market for native ornamental plants that both support the regional wildlife and thrive because they are adapted to the local region. The American Beauties™ program, a partnership between the National Wildlife Federation and two wholesale nurseries, provides over 350 native plant species to garden centers and landscapers in the northeastern U.S. There are over 400 native ornamentals that can be ordered directly from local nurseries in the U.S.

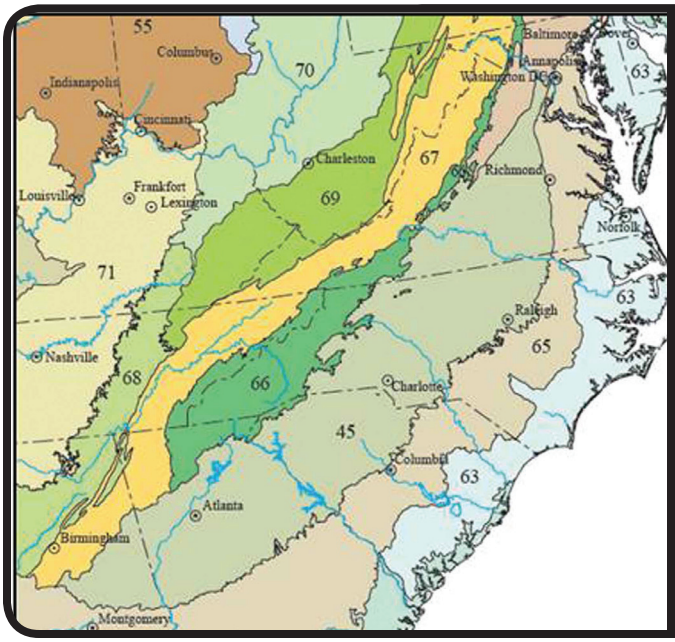
North American ornamental native plants generally come from breeding, genotype selection, or open-pollinated seed. They have been selectively bred to enhance their flowers, architecture, foliage, and disease-resistance (Figure 4). Programs in the private sector have done much of this breeding, although there are public breeding programs for native ornamentals at U.S. universities as well. Through selection and breeding, native plants could provide aesthetic qualities desired by consumers in addition to ecological services for the environment.

Figure 4. Cultivated varieties of *Coreopsis verticillata*, Tickseed, a North American perennial native, exhibit a greater variety of bloom colors and increased flowering compared to the wild species Coreopsis 'Big Bang Full Moon' (top left), *C.* 'ChaCha' (top right), and *C.* 'Route 66' (bottom left).

Ecological Services and Adaptability of Native Ornamental Plants

Not much information is available on whether native varieties can provide the same ecological benefits as their parent species. Plants need to be further studied to see if cultivars can support biodiversity. The extent of cultivar genetic diversity needed to provide ecological services in their region has yet to be determined for marketing on a regional basis.

Genetic diversity is also a concern for ecological restoration projects. For these projects, environmentally defined regions, such as EPA ecoregions, can be useful for estimating where native plants can adapt and do well (Figure 5). These ecoregions are geographic areas with similar geology, climate, vegetation, soils, and hydrology. The use of these ecoregions could encourage biodiversity by using them to discover where native plants might thrive best and encouraging their use in that area.



Economics
What is the number of genotypes that can be provided profitably for regional markets?

Ecology
What is the genetic diversity needed in a native plant species to provide ecological services regionally?

Genetics
Is there sufficient regional genetic diversity for breeding ornamental traits?

Figure 5. EPA level III ecoregions in the eastern U.S. Different shades and numbers indicate different ecoregions. These could be useful for studying the interrelated questions of genetics, ecology, and economics posed by scaling up the use of native plants.

There are different ecoregion levels that describe geographic areas with increasing detail. Level III ecoregions have been used to estimate seed transfer zones, which are regions in which plant material can be dispersed and adapt relatively well. Just like plant hardiness zones are used now, these ecoregions could be used to estimate whether native plants are suitable to a certain region. These ecoregions are also large enough that they may be appropriate markets for landscaping of native plants.

Scaling Up the Use of Native Ornamentals

Native plants currently only make up about 13% of total nursery sales in the U.S. Surveys of nursery owners, landscape architects, and Master Gardeners have been conducted to better understand the issues limiting the use of native plants in landscaping. Three general factors were found to be important: availability of native plants, consumer preferences, and knowledge of native plants.

The use of botanical gardens and citizen science (scientific research conducted by nonprofessional scientists) can increase knowledge of native plants. These avenues can increase public awareness of how native plants are cultivated and of the ecological benefits they can provide. Educating the public and landscape professionals on the importance of biodiversity for ecological health and on the use of native plants for increasing biodiversity is a key factor in encouraging the use of native plants in personal landscapes. Universities offer extensive publications on native plants as well as state native plant societies (e.g., www.gnps.org).

University of Georgia Cooperative Extension has published the following resources:

- Native Plants for Georgia Part I: Trees, Shrubs and Woody Vines (Bulletin 987) – http://extension.uga.edu/publications/detail.cfm?number=B987
- Native Plants for Georgia Part II: Ferns (Bulletin 987-2) – http://extension.uga.edu/publications/detail.cfm?number=B987-2
- Native Plants for Georgia Part III: Wildflowers (Bulletin 987-3) – http://extension.uga.edu/publications/detail.cfm?number=B987-3
- Native Plants for Georgia Part IV: Grasses and Sedges (Bulletin 987-4) – http://extension.uga.edu/publications/detail.cfm?number=B987-4
- Native Plants of North Georgia: A Photo Guide for Plant Enthusiasts (Bulletin 1339) – http://extension.uga.edu/publications/detail.cfm?number=B1339

Most exotic ornamental plants go to market through landscape firms, garden centers, plant brokers, and mass merchandisers. Using these existing supply chains would effectively increase the availability of native ornamental plants to consumers. The more available native plants are to the average consumer, the more likely they are to be incorporated in gardening and landscape designs. This would help improve the ecological health of the area by increasing biodiversity.

Consumers prefer specific ornamental traits in their landscape plants such as longer periods of flowering, novel floral types (such as double flowers), compactness, and disease-resistance. Examples of exotic plants that have these traits are ‘Knockout’ roses, ‘Encore’ azaleas, and ‘Endless Summer’ hydrangeas. Native ornamentals must be able to compete with the already easily accessible exotic plants. The development of such qualities in native ornamentals can increase their use among consumers. Although native plants tend to be more expensive than exotic plants, plant cost was found to be one of the least important factors in surveys. In fact, about 50% of consumers considered plants labeled “native” or “non-invasive” to be worth the extra cost.[12] This means that the ecological benefits of these native plants could be considered value-added traits for which some consumers are willing to pay more.

It would be important to work on the breeding of native woody plants in particular because they have the highest wholesale value in the U.S. ornamental plant market and because they host the greatest diversity of lepidopteran insect species, an order which includes moths and butterflies (Figure 6). Care must be taken to ensure that the ecological benefits are maintained while developing ornamental traits. It would be best if these ecological benefits were examined regionally.

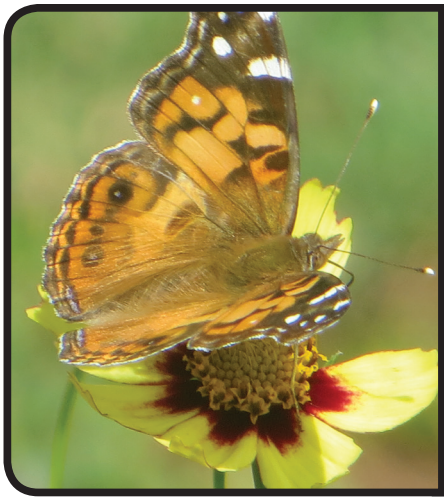


Figure 6. Native plants support biodiversity by providing resources for insects and pollinators such as butterflies. Shown is an American Painted Lady on a tickseed flower.

Conclusions

The current difficulties that limit the use of natives must be addressed in order to increase their use. The main limitation is their availability to consumers. This can be addressed by learning how to provide native plants through the major market channels. Increasing public awareness of the importance of biodiversity is another critical step. Determining the genetic diversity necessary for a native species to provide ecological benefits is a question that needs to be answered. Scientists from different disciplines, such as genetics, economics, and ecology, could help determine the best method for increasing the use of native plants while simultaneously maintaining ecological function, consumer appeal, and cost effectiveness.

Reducing the number of native shrubs and trees providing cover can create changes in the structure of native animal populations. For example, bird species that forage for food on the ground become more populous than those that forage in tree and shrub canopies. However, the effect of exotic plants on biodiversity is not always obvious. These exotic species are introduced more quickly than native species disappear, so local biodiversity can appear to be high for a while. However, urban development tends to select for the same human-adapted species in different places. As the types of plants and animals of different places become more similar, biodiversity on a regional scale is reduced.

The impact of urbanization on biodiversity is expected to increase. For example, the southeastern U.S. has one of the highest levels of biodiversity in the country.[13] This region is also one of the fastest growing regions, with the biggest changes occurring in the Piedmont ecoregion (Figure 7). The U.S. Geological Survey has predicted that, if current development trends continue, there will be an urban area stretching from Atlanta to Raleigh by the year 2060.[14]

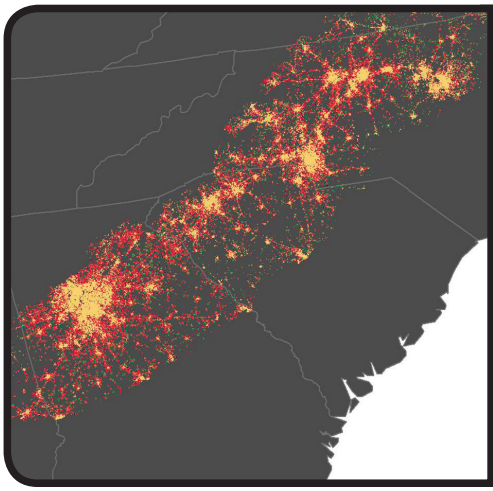


Figure 7. Projection of urban development in the Piedmont ecoregion in 2060. Red areas are likely to be developed based on growth patterns of currently urbanized areas (yellow).

Increased urbanization is expected to have a significant effect on the region's ecosystem. Urban areas will need to play a role in preserving biodiversity. The increased use of native plants in urban landscapes will help maintain a healthier ecological environment.

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