Recommended Plant Species for Augmentation of Ecosystem Services: A Website

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Significance to Industry: The "Green Industry" produces plants for interior and exterior landscapes. The best known benefits derived from plants, besides the obvious production of oxygen necessary to breathe, are visual – they beautify the environment and "warm" the human heart! Nevertheless, there are many lessor known and less appreciated plant-based functions of equal importance for survival that are derived from interactions with the other part of biodiversity, fauna, and abiotic factors. Such functions as biological control of pests and plant pollination are two such "ecosystem services" along with factors such as water and nutrient cycling. Ecosystem functions break down when habitats are fragmented or destroyed (1). Currently, there is great need and interest in both conserving habitats and remediating damaged ones. Toward that end we have identified a number of plant species for each season of the year in the Southern Coastal Plain with qualities that are important and useful to augment pollinators, parasites, predators, butterflies, hummingbirds and other wildlife along with the ability of some to function in specialized habitats such as rain gardens. We have also developed a very effective trap cropping system for stink bug suppression which uses plants that also provide ecosystem services (9). Our objectives are four fold: 1) to enable the Green Industry to apply our results in production, marketing and maintenance; 2) to provide instruction on habitat manipulations to augment these ecosystem services; 3) to provide recommendations to consumers about assemblages of plants that will enhance specific ecological services at various times of the year; and 4) to improve environments and human well-being.

Nature of Work: Consumers are pressuring retail corporations to sell more sustainably-grown plants. These primarily "Big Box" stores are in turn challenging the Green Industry to use more sustainable production practices. However, the term "sustainably grown" remains to be well defined and a positive impact of the marketing trend on the environment is by no means assured (14). Although, plants spend a relatively small portion of their lifespan under nursery conditions and the majority in the landscape, the ecological role a particular plant plays in the landscape may be altered by treatments undergone during the short phase spent in the nursery.

Consumer pressures have been precipitated by the much publicized and continuing demise of honey bee colonies termed Colony Collapse Disorder (13). Moreover, populations of native pollinating bees have also been in decline. Important mortality

agents that have been identified are pathogens and mites with accompanying viruses that contribute to the problem. In addition, production practices in conflict are mostly concerned with pest suppression: pesticide use and their non-target impacts on beneficial insects (parasites and predators) and pollinators (5). The most controversial pesticides are the systemic neonicotinoids due to their suspected relationship with colony collapse disorder. Additionally, there have been a number of blatant non-labeled misuses of these chemicals that led to well publicized negative responses by regulatory agencies and the general public. Currently, the general impact of neonicotinoids on bees remains to be fully determined. Additionally, what role applications of other chemicals, imidacloprid, thiomethoxam, clothianidin, etc., in nursery production have on bees specifically is not known. However, it is established that insecticides, which act systemically in plants may remain in treated plants at insecticidal levels for 12 or more months post treatment. Thus, neonicotinoid applications to nursery stock under at least some circumstances could carry over to the landscape after installation.

Therefore, the production practices and insecticide use in the nursery may have a "double whammy": the fauna, pests and beneficials, are affected during their nursery growth phase and again in the landscape where a different profile of fauna is exposed to treated plants. If such plants provide food such as nectar, extrafloral nectar or pollen for their associated fauna (obvious ones are pollinating bees) then there is the potential for harm from the remaining toxins carried over from nursery applications. Moreover, a third aspect is the potential for continuing application of neonicotinoids to these landscape plants by consumers or landscape maintenance practitioners without knowledge of what they may already contain as a result of nursery practices.

From an ecological perspective, two of the major factors affecting biodiversity and thus natural ecosystem functioning is fragmentation and loss of habitats. A minimum amount of potential habitat, its spatial configuration, as well as the environmental conditions determining habitat quality, are crucial factors for species occurrence. Landscape variables such as habitat composition, quality and patchiness, and dispersal capability, all impact the abundance of organisms. When native vegetation, the flora, is lost, the fauna that relies on it are dramatically impacted because the basic ecological functions are eliminated. Permanent landscape elements such as grassland and woodland fragments play a crucial role in maintaining biodiversity in cultivated landscapes by providing habitats and refuges for many species.

Ecological functions that originate with interactions of the biodiversity present are termed ecosystem services and are processes that take place in the natural world that benefit mankind (2). These services contribute to the stability, productivity and sustainability of the environment. Management of hedgerows and other field margin and boundary vegetation affects the abundance and diversity of flora, invertebrates and birds (4). Planting costs designed for wildlife plots are often subsidized through government programs such as USDA-EQIP (3).

The impetus for this effort originated with the development of plants suitable for year-round trap cropping of stink bugs by the senior author. The progression and challenges of that research (10), the fact that the plant species selected provided additional ecosystem services and new literature calling for wider habitat augmentation (8,9) led to the realization that such a database, if available, could be of immediate and general value to the Green Industry and the public. Therefore, a general search of the literature, our own experience, and new observations of suitable plants were used to develop the list of recommendations for the website. We have not limited our inclusions to native plants for both practical (needed a broad variety of available plants with the requisite services that would do the job (re: trap cropping is difficult)) and philosophical reasons (7,11). Plants were included or excluded from the website based on several criteria. We tried to avoid plants that had known side effects or were considered invasive. Plants recommended in the general literature for the target area were vetted as closely as possible for any negative qualities before acceptance, and many of the plants were specifically observed and tested over a period of years by the authors for their provision of specific services.

Results and Discussion: The website focuses on the regulating services of plant pollination and biological control directly concerning biodiversity (flora and fauna) and the cultural services related to the appreciation and enjoyment of flora such as flowering plants and associated fauna of butterflies, birds and other wildlife. We have included plants suitable for use in “trap cropping” of stink bugs (10) as an effective and practical example of how habitat manipulation of flora species can be applied to suppress pest populations as well as augment beneficial organisms in what is termed “multifunctional’ plots (8,9) The recommended plants are primarily for the Coastal Plain area of the southern U.S. which loosely includes the area within the latitudes from Tifton, GA in the north (latitude 31.4623° N) to Wildwood, FL in the south (latitude 28.8586°N). This area also represents the USDA Horticultural Zones 8 and 9, however, many of the listed plant species are applicable to the entire southern region and beyond. From the perspective of plant species, there are many cultivars available of the recommended plants more suitable to other areas that could be considered. However, we caution that all cultivars of the species in the database may not provide similar services. For example, many sunflower cultivars developed for the cut flower industry do not produce pollen.

Nursery producers and retail garden centers should consider using this approach and recommend plant species in the following ways: 1) Plant species that have characteristics that attract pollinators and other useful insects should be identified along with the time of year that the characters occur and management decisions to avoid destroying the associated fauna should be enforced. Incidentally, this could be claimed as a sustainable practice if that becomes important; 2) Those plants that are attractive to beneficials –insect parasites and predators- might be planted around the nursery to enhance biological pest suppression; 3) Because consumers are interested in the concepts (and will have access to the database), plants that provide ecosystem services could be specifically identified and marketed in those categories; 4) honey

bees require nectar and pollen sources during many times of the year, especially in the cool parts of the year when such plants are rare. Therefore, plants that bloom in early or late season or even during the summer, crape myrtle for example (12), in the lower South could be touted for this purpose.

Land owners are encouraged to evaluate and inventory the vegetation in yards, gardens and other managed habitats such as hedgerows, shelterbelts, etc. “Home gardens” have been important to human beings for millennia and now are recognized in many parts of the world as critical areas with high biodiversity and as repositories of vanishing native plant species (6). Much research has investigated the functions and uses of native plants for their obvious importance under natural conditions or for landscape remediation. However, in an agricultural setting or backyard, logistical factors, such as seed and plant availability and the plant species ease of culture, become paramount in developing functioning landscapes to provide and enhance ecological services. There are a number of plant species that are readily available and easily grown without side effects that offer the qualities useful in efforts to augment ecological services. Interestingly, the plant species recommended for use in stink bug trap cropping (buckwheat, sunflower, sorghum, millet, okra, etc.) provide other ecological services such as augmentation of wildlife, beneficials, butterflies and pollinators. They, as well as many of the other recommendations, may also be used in portable containers as trap crops, for monitoring of pests, or for augmentation of ecosystem services.

We are soliciting feedback and suggestion of plant species in a “Citizen’s Science” mode to add to the database to broaden its appeal in two major areas: 1) Suggestions on how the website might be improved to make it easier to use and more effective, and 2) Suggestions of additional plant species suitable for inclusion in the database for recommendation to the public, or suggestions of plants to delete with corresponding justification. There will be an email generation box on the website to enable correspondence. Our goal is to expand the breath of the site by adding to the plant lists for the focus area and to include adjacent areas to the north and south. The authors will consider the suggested plants, and if we agree that they are appropriate to our purpose, they will be added to the database. We will credit any selected inputs by adding the correspondent’s name to the credit page on the website.

The database will be linked to the NFREC-Quincy center website: http://nfrec.ifas.ufl.edu.

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