

erts of the Southwest the full sun can be too much for many species. There, light shade or the shade from high-crown trees is advisable. Along the Pacific Coast or anywhere inland that is at least one U.S.D.A. Zone cooler than Phoenix, full sun is recommended. The same light requirements hold for young plants, even seedlings. The more light, the stronger the plant and the better growth and form it will have.

All species need excellent drainage. Many, especially the softer-leaved tropical species, can tolerate plenty of regular watering as long they are not permitted to remain in saturated conditions. In containers it is usually best to eschew the use of saucers (unless it is removed for watering), wicks, or automated watering systems. Seedlings and young plants can be watered as often as is necessary to prevent the soil from drying out completely. In the summer this can be daily in the Phoenix area, but is up to every 5 or 6 days in the winter. In containers, whether small or large the soil column should be nearly dry between waterings. Agaves respond poorly to mist or other constant overhead watering regimes.

Agaves generally grow in moderate to warm temperatures. There is rarely active growth when it is cold or when it is extremely hot. During the coldest part of the year be cautious with watering and be doubly certain that the soil is dry between waterings. Agave root systems rot quickly with too much water held around the roots. The same dynamic holds in the hottest part of the summer.

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The Effect of Invasive Plants on Native Ecosystems — How We Can Help®

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We all do the best we can to help create sustainable landscapes. But when that hot new bestseller comes along that's sure to perk up the bottom line, what do we do?

Invasive plants do not mean simply the loss of some pretty wildflowers in our nearest natural area. The eradication of invasive plants costs us, the taxpayer, \$13 billion per year (National Invasive Species Council, 2001). Total wholesale nursery receipts were \$13.3 billion in 2001 (USDA, 2002).

Forty-two percent of the species on the Threatened or Endangered lists are at risk primarily because of invasive plants (Pimentel et al., 1999). These plants alter natural landscapes, exclude native plants, cause species extinctions, reduce bird, game animal, and fish populations, alter water courses, are toxic to cattle and horses, and increase wildfire danger and intensity.

What can we do to ensure beautiful natural areas for our grandchildren to enjoy, in which there are abundant animals for recreation? We can:

- Check with our local agencies and parks to determine local problem species. Ensure that the invasive potential of a new plant is thoroughly assessed before introduction to the trade.

- Develop safe alternatives to local invasive plants.
- Cease the opportunity to market these truly “green” plants.
- Follow quarantine laws.
- Educate customers on invasive plants that need to be removed from home gardens.
- Provide them with materials they can use to market safe alternatives. Then sell them lots of good alternative plants.

We will discuss the negative effects of invasive plants and beautiful and useful alternatives to them. We will also discuss combining these alternatives in a habitat-gardening-focused marketing campaign.

INTRODUCTION

The nursery industry in the United States has introduced about 50,000 plants — 45,000 of those are behaving very nicely (Pimentel et al., 1999). We are concerned with the other 5000. A few of these plants have had an extremely negative impact on the native ecosystems in our park of 80,000 acres. It is an added challenge here because we interface with urban communities on the San Francisco peninsula, San Francisco, and the communities on the western side of the peninsula north of the Golden Gate (Marin County). This close proximity makes it easy for aggressive garden plants, released into an area with no natural enemies, to spread quickly.

Over 150,000 h per year is spent by staff and volunteers removing invasive exotics from the park. Research in the park has shown that not only do invasive plants reduce the diversity of native plant communities but they also negatively impact the abundance and diversity of wildlife in the park.

Due to my many years of experience in the commercial side of the nursery industry, I feel qualified to talk about the harmful invasive plants I, and many of you, have grown.

REVIEW OF LITERATURE

An extensive review of the literature on the effects of aggressive, non-native plants to native ecosystems shows the deleterious effects of invasive plants.

Invasive plants infest 100 million acres in the U.S.A. That is growing by 3 million additional acres per year (National Invasive Species Council, 2001). Why are these nursery-grown plants escaping to the wild? They are a nursery person’s dream. They germinate easily and are hardy without complicated dormancy-scarification or stratification requirements. Breeding tends to select for these weedy characteristics. They are growing in their new wild areas without the predators and pathogens that keep them in check in their native territory of origin.

According to then Director Robert G. Stanton, 1.5 million acres of our National Parks are infested with invasive plants (Babbitt, 1998). The National Parks Service mission is to conserve natural and cultural resources unimpaired for future generations. More than 99% of the natural resource work in our park, Golden Gate National Recreation Area, is devoted to invasive plant removal. Why do we need to remove these plants? They are obviously successful survivors. These invasive plants have overtaken and destroyed habitat for birds, mammals, reptiles, and amphibians; from the bottom to the top of the food chain. The nursery industry in California, with the best of intentions, has introduced 41 of 78 plants on the California Exotic Pest Plant Council’s list of “Pest Plants of Greatest Ecological Concern”

(CalEPPC list, 1999). In California, 30 of 53 federally-listed endangered species are threatened by invasive plants (Garden Club of America, 1997). Forty-two percent of all the species on the Federal threatened or endangered species lists are at risk primarily because of invasive plants (Pimentel et al., 1999).

Of prime concern in California and other western states, are the many horticultural plants under the common name of broom; *Cytisus scoparius*, *C. striatus*, *Genista monspessulana*, *Spartium junceum*. These species cover over 800,000 acres in California. The brooms are beautiful plants, and visitors love the way it looks on our hillsides in the spring. Native plants don't give that massive yellow display. However, Scotch broom, *C. scoparius*, is toxic to cows and horses, makes reforestation difficult and increases fire danger by carrying fire into the tree canopy. Seeds are viable up to 20 years. French broom, *G. monspessulana*, can produce 10,000 seeds m⁻² (Bossard et al., 2000). Do we want birds, mammals, and amphibians in our lives? As far as wildlife is concerned the hillsides may as well be paved over.

Cape ivy (syn. German ivy), *Delairea odorata*, has become a huge problem along the coast and riparian areas. This is a hard plant to find in its native South Africa. But in the GGNRA Cape ivy grew from 8.8 acres in 1987 to 162 acres in 9 years (Alvarez, 1997). Several studies have been done in the GGNRA along Redwood Creek that drains from Mount Tamalpais, flows through Muir Woods National Monument and out into the Pacific Ocean 3 miles downstream. It is the southernmost creek with a population of Coho Salmon and steelhead, both now on the federal list of threatened and endangered species. In a study by, Alison Fisher, graduate student intern in the park, the abundance of *Diptera* and *Coleoptera* trapped in areas invaded by cape ivy was reduced compared to remnant native plant habitat. Initial experiments indicate that fish survival is reduced. One hundred percent of fish were killed within 3 days in a 248 ppm extract of cape ivy or with an 18-node cutting of cape ivy in a 10-gal tank (Bossard et al., 2000).

Studies by the Point Reyes Bird Observatory indicated that songbird nests were fewer in a Cape ivy dominated territory compared to a comparatively intact native riparian habitat. Fewer songbird sightings and nests of five species, Warbling vireo, Swainson's thrush, Wilson's warbler, song sparrow, and black-headed grosbeak, were found in areas along Redwood Creek dominated by cape ivy compared to a reference site on Lagunitas Creek which supports undamaged habitat (Scoggins et al., 2000). Warbling vireo abundance was positively correlated with the width of the riparian corridor (Gardali et al., 2001). Structural variety in the riparian corridor promoted nesting success. Successful nesting was positively correlated with the presence of at least 2.5 California bay, *Umbellularia californica*, in the surrounding area. Nests were constructed in the shorter tree and large shrub species, mainly red alder, *Alnus rubra*, and arroyo willow, *Salix lasiolepis*. Note native blackberry was heavily preferred over Himalayan. (Table 1)

In a just completed study by the U.S. Geological Survey, Biological Research Division, preliminary data from a 2-year study along one of the dune areas in the GGNRA, show that more Avian species are present in a restored native plant (4.38 ± 0.79 species) community compared to unfenced iceplant (1.5 ± 0.46 species), *Carprobrotus edulis* or *C. chilensis* (Fig. 1).

Additionally, there were more individual animals: mammals, reptiles, and amphibians, in the restored native plant community compared to iceplant (Fig. 2). Not only were there more animals but more species of animals in the native habitat compared to iceplant.

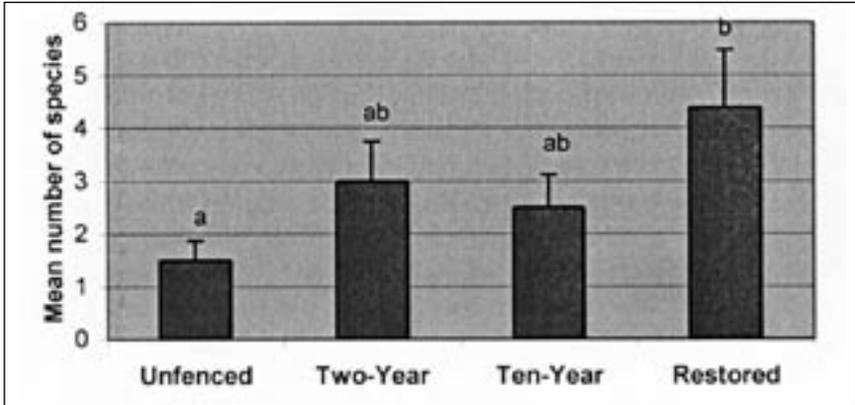


Figure 1. Avian species richness (mean number of species \pm standard error) in four habitat treatment types; $p < 0.005$. Unfenced refers to unfenced iceplant areas of study, Two-Year = iceplant fenced for two years, Ten-Year = iceplant fenced for 10 years, Restored =restored native habitat.

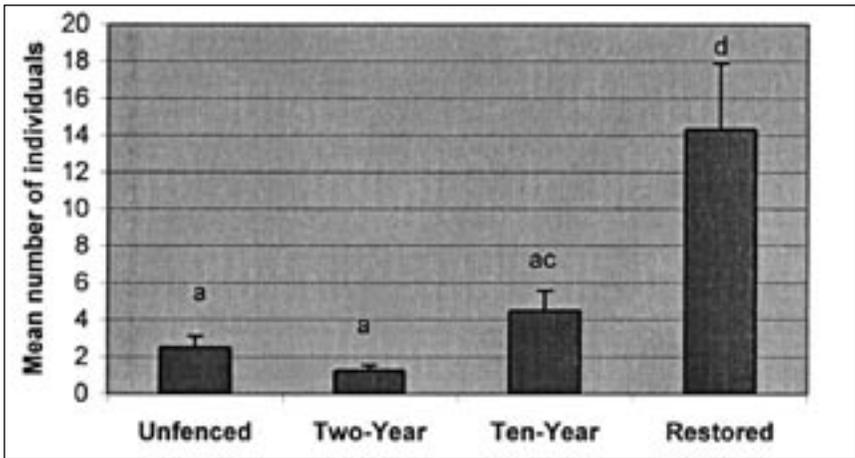


Figure 2. Vertebrate abundance (mammal, reptile, and amphibian abundance) (mean number of individuals \pm standard error) in four habitat treatment types; $p < 0.001$. (Shulzitski, 2002)

Table 1. All songbird species and sites combined, 1995-1998. n=421. (See Gardali et al., 1999)

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Plant used common name	Botanical name	Percent use
California blackberry	<i>Rubus ursinus</i>	27
Himalayan blackberry	<i>Rubus discolor</i>	3
Red alder	<i>Alnus rubra</i>	19
Willow	<i>Salix</i> spp.	12
Sword fern	<i>Polystichum munitum</i>	5
Red elderberry	<i>Sambucus racemosa</i>	3
California bay	<i>Umbellularia californica</i>	3
Lady fern	<i>Athyrium filix-femina</i>	3
Box elder	<i>Acer negundo</i> var. <i>californicum</i>	3
Oregon ash	<i>Fraxinus latifolia</i>	2
Cape ivy	<i>Delairea odorata</i>	4
Grass, all, native and, non-native		2
All other species combined		15

RECOMMENDATIONS

In our park, we are slowly gaining control of the broom species, and most Cape ivy populations have been contained or eradicated. This control has happened with the blood, sweat, toil, and tears of an average of 14,000 volunteers who give 160,000 h per year to remove invasive plants and the seed collection, propagation, growing, and outplanting of natives to restore these severely impaired habitats. Although much of the work was performed by volunteers from surrounding communities, there are still costs involved. For Cape ivy alone, the park service spent over \$601,000 of our tax dollars in the last 3 years to reach just this partial level of control.

How can the nursery industry help? Quit growing invasive plants. I think many nursery people have ceased production of the worst invasive plants - the brooms, *Arundo donax* (giant reed) and *Tamarix* spp. (salt cedar). However, some broadly invasive, e.g., *Cortaderia* spp., *Pennisetum setaceum*, and many locally invasive plants are a challenge. Many wholesale growers market to broad areas and are unfamiliar with problem species in all the areas to which they sell. Many species, like malignant tumors, do not reach critical population levels for many years, and therefore, the industry does not immediately know they have become problems. In our park, species that have reached problem levels, include, *Erigeron karvinskianus*, *Cortaderia jubata*, *Cortaderia selloana*, *Helichrysum petiolare*, *Cotoneaster pannosus*, *Cotoneaster lacteus*, *Leucanthemum vulgare*, *Vinca major*, *Ageratina adenophora*, *Carpobrotus edulis*, and *Centranthus ruber*. These are all certainly a problem throughout coastal California.

Invasive plants are becoming such a huge and expensive problem that the Federal government is gearing up for possible additional regulation. In 2001 the

National Invasive Species Council was formed under Presidential Executive Order 13112 in Feb. 1999. This order calls for the Council to develop and test a fair, feasible and risk-based, comprehensive, invasive-species screening system. Initially, the system is evaluating first-time introductions in consultation with stakeholders. Later, screening system modifications or measures would be developed to address those intentional invasive species introductions (Williams, 2001; National Invasive Species Council, 2001).

It will be to our benefit to find creative solutions to this problem. I ask you, the industry leaders, for your help and expertise. It is much easier and cheaper to prevent infestation than to clean it up. Each of us can think of “good” substitutions for known invasive plants. Here are just a few.

If we want, rich bio-diverse habitats, with the sounds of birds, fish in our streams and on our tables, and mammals in our wild areas, for our children and grandchildren to enjoy, we must all work together. Open space managers and field plant ecologists need to get the word out to the industry before new invasives are out of control. We must educate our retail customers and stop selling plants to them that are invasive in their area. We must encourage our retailers to market replacements for invasive plants that are eco-friendly. Voluntary guidelines have been recommended by the Missouri Botanical Garden workshop on “Linking Ecology and Horticulture to Prevent Plant Invasions” (Fay, 2001). I would modify them to these simple steps:

Draft Voluntary Codes of conduct for nursery professionals

- 1) Ensure that invasive potential is assessed prior to introducing and marketing plant species in any region to which you sell. Garden test for several years, or have one of your customer nurseries test on their site, in each region to which your market. If it spreads, don't sell it in that region.
- 2) Check with your local parks, open space district, weed abatement districts (and in California, the CalEPPC Species of Concern List) and academics to find out what plants are problems in your selling areas. Identify plants that could be suitable alternatives in those regions. Don't sell those plants.
- 3) Develop alternative plant materials through plant selection and breeding. Market those plants and others that are not harmful.
- 4) Follow all laws on importation and quarantine of plant materials across political boundaries.
- 5) Encourage customers to use, and garden writers to promote, non-invasive plants.

I would also recommend checking in your area, for a task force to help with research and education on this issue. Join your local task force. If one does not exist, form one. In Northern California, a task force began work last June at University of Californai Botanical Garden. If you are interested in joining, contact, “Alternatives to Invasive Landscape Garden Plants” Task Force Coordinator, Alison Stanton at <travertine@earthlink.net>. Check helpful websites, such as <www.mobot.org/iss/>, <www.caleppc.org>, <www.tncweeds.ucdavis.org>, and <www.gardenclubsamerica.org> for problem plants in your area and alternatives.

We, as nursery people, can look on this problem as a marketing opportunity. One marketing possibility is to promote the current trend in habitat gardening.

Table 2. Invasive species of concern and habitat friendly substitutions.

Invasive	Alternatives	Wildlife value
<i>Erigeron karvinskianus</i> (heabane)	<i>Fragaria chiloensis</i> <i>Fragaria californica</i> <i>Vitis californica</i> <i>Lonicera hispidula</i>	Food, cover Food, cover Food, cover Food, cover
<i>Cortaderia selloana</i> <i>C. jubata</i> (pampas grass)	<i>Calamagrotis nutkaensis</i> <i>Miscanthus sinensis</i> <i>Festuca californica</i>	Food, cover Food, cover Food, cover
<i>Helichrysum petiolare</i>	<i>Santolina chamaecyparissus</i> <i>Lavandula angustifolia</i> Rosmarinus officinalis Prostratus Group <i>Abruplex leucophylla</i>	
<i>Cotoneaster pannosus</i>	<i>Heteromeles salicifolia</i> (syn. <i>H. arbutifolia</i>) <i>Ceanothus</i> spp.	Food, nesting, cover Food, nesting, cover
<i>Pennisetum setaceum</i> (fountain grass)	<i>Calamagrotis nutkaensis</i> <i>Miscanthus sinensis</i> <i>Festuca californica</i>	Food, cover
<i>Sapium sebiferum</i> (Chinese tallow tree)	Native oaks — <i>Quercus kelloggii</i> is deciduous <i>Acer macrophyllum</i>	Food, nesting, cover Food, nesting, cover
<i>Albizia julibrissin</i> (silk tree)	<i>Arbutus</i> 'Marina' <i>Cercis occidentalis</i> (redbud)	Nesting, cover Food, nesting, cover
<i>Maytenus boaria</i> (mayten tree)	<i>Ceanothus</i> 'Ray Hartman' <i>Acer circinatum</i> (vine maple)	Food, nesting, cover Food, nesting, cover
<i>Ligustrum</i> sp. (privet)	<i>Chionanthus retusus</i> (Chinese fringe tree) <i>Crataegus</i> spp. <i>Citrus</i>	Food, nesting, cover Food, nesting, cover Cover
South California, and the SW: <i>Tamarix chinensis</i> , <i>T. gallica</i> (salt cedar)	Native riparian plants	Nesting, food, cover
<i>Arundo donax</i> (giant reed)	Native riparian plants	Nesting, food, cover

In Northern California, at least, there is a strong movement in gardening towards plants that attract birds and butterflies to the garden. Gardeners want to feel they are doing something positive for the environment. We can encourage that concern by recommending the removal of invasive plants and their replacement with beneficial plants providing, food, nesting opportunity, or cover for birds and butterflies. You can do well by doing good. By providing your retail customers with fact sheets, to post or give to gardeners, about the invasive plants to be removed and beneficials to plant, you can help rather than hurt your bottom line.

It's a great marketing opportunity and a great contribution to a sustainable world.

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