CAN WE LANDSCAPE TO ACCOMMODATE DEER? THE TRACY ESTATE RESEARCH GARDEN

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The landscape of New Jersey is remarkably rich in vegetation and open space, despite the state's reputation as the nation's most populous state. This landscape is increasingly the product of intense interaction between the white-tailed deer (Odocoileus virginianus) and both native and cultivated vegetation, particularly in suburban communities, where both the whitetail and the vegetation coexist in abundance. Nearly extirpated at the turn of the century due to over-hunting, the state's white-tailed deer population today exceeds 140,000 because habitat is ideal and hunting seasons are carefully regulated. In many instances, where landowners choose not to use hunting as a management tool, deer herds quickly exceed the cultural carrying capacity.

Two measures of cultural carrying capacity, damage to agricultural crops and to ornamental or garden plantings, are especially evident in the Garden State and in Morris County, the location for the Tracy Estate Research Garden. In New Jersey, 30% of farm cash receipts come from nursery and greenhouse plant production, most of it sold for local use. This commodity accounts for the majority of farm income in Morris County as well. The long-established horticultural tradition in Morris County supported by the county park commission is now hampered by the population of deer in this area.

Morris County, New Jersey today contains a deer population of approximately 12,000 animals that live amongst the remnants of large country estates that belonged to corporate moguls of the late 19th century. Many hired well-known landscape designers to create formal gardens modeled on Italian or English properties they knew from their travels. The Morris County Park Commission's headquarters at the former Frelinghuysen estate preserves the formal garden tradition while promoting landscape design, gardening at all scales, and introduction of new species of plants in new combinations for local residents.

Formerly a minor Morristown estate, the proposed Tracy Estate Research Garden has been owned and managed by the Morris County Park Commission since 1983. It is located just 30 miles from Manhattan in the Washington Valley area of Morris Township, where deer densities exceed 40 deer per square mile. Hunting is prohibited in Morris Township without written permission from the landowner and the township council. Little or no hunting has occurred in the township since the late 1960s. Adjoining the Tracy estate is land owned by the Morris County Municipal Utilities Authority, the Seeing Eye Foundation and the Fosterfields Historic Farm, which is owned and managed by the Morris County Park Commission. No hunting occurs on these large tracts of undeveloped land though populations of deer have been reduced at Fosterfields by park employees using special damage control permits.

The Morris County Park Commission, manager of hundreds of acres of open space in this central New Jersey county, realized that the white-tailed deer residing on park land were having a detrimental effect on the vegetation on these properties. A Wildlife Management Advisory Committee to the Commission was formed to measure the dimensions of the problem and to find ways to mitigate the effects of the dense population of deer. One recommendation of the Committee was to determine if a landscape design could be developed to use plantings less attractive to the deer; planted in ways that might discourage heavy browsing. In 1990, the Morris County Park Commission commissioned landscape architect, Helen Heinrich to design a garden based on the lines and spaces of the gardens surrounding the Tracy mansion in the 1920s and 1930s. No attempt was made to restore the original plants in the garden, but to adapt the garden as much as necessary to the demands of the present deer population. The first step in developing such a design was to determine which plants were browsed by deer in this area, and which could be utilized in the garden design. No damage control, such as fencing or repellents, would be used.

METHODS

A literature survey was conducted (MacAninch and Fargione 1987, Fargione et al. 1992, Rutgers Cooperative Extension 1987, Heinrich 1989, Totemeier 1987, Blackburn (no date), Morris County Park Commission (no date) to determine deer plant food preferences. Local nurserymen and landscape contractors (D. Feruchi, pers. commun.); (W. Flemer, pers. commun.); (S. George, pers. commun); (L. Makrancy, pers. commun.) were asked about their experience with deer browsing on plants. Loft Seed Company recommended the ornamental grasses to be relatively deer-resistant. The experience of the Heilrich design practice was consulted for plants that had proved to be relatively deer-resistant in other locations. The most deer resistant species determined by that review are reported in Appendix 1.

After reviewing the list of plants reported to be resistant to deer depredation, many of which were already severely weakened by deer browsing on this site, it seemed wise to test the most promising species before proposing investment in major plantings. In March, 1991 six test plots were installed with a variety of plant species from this suggested list.

Initially, the plants were set out at the test sites in their containers because it was not known how much immediate attention and damage from the deer they would receive. In May, 1991, they were surrounded by wood chips and in December, 1991, they were installed in beds and mulched with a woodchip mulch.

Plants installed in March, 1991 included:

Berberis thunbergi '	Crimson barberry
Buxus sempervirens	Common boxwood
Cotoneaster salicifolia	Willowleaf cotoneaster
Ilex glabra	Inkberry holly
Ilex meserve	Meserve holly
Juniperus chinensis 'Pfitzeriana'	Pfitzer juniper
Myrica pennsylvanica	Bayberry
Pieris japonica	Japanese andromeda
Picea glauca conica	Dwarf Alberta Spruce
Picea pungens glauca	Colorado Blue Spruce

Plants installed in July, 1991 included:

Achillea millefolium	White yarrow
Artemesia schmidtiana	Silver mound 'Silver Mound' artemesia
Eragrostis curvula	Weeping lovegrass
Erianthus ravennae	Plume grass
Festuca cinnerea	Blue fescue
Miscanthus sinensis	Silver grass
Miscanthus sinensis 'gracillimus'	Maiden grass
Monarda didyma	Violet 'Violet Queen' Queen bee balm
Nepeta faassenii	Catmint
Pennisetum alopecuroides	Fountain grass
Santolina chamaecyparissus	Lavender cotton
Stachys byzantina	Lamb's ears

In December, 1991, 21 plants were added to replace those that did not survive deer depredation or the summer drought. Several additional species were added at this time as well. These plants included:

Berberis ladwynensis	'Wm Penn' WilliamPenn barberry
Berberis spp.	Golden barberry

Buxus microphylla japonica	Japanese boxwood
Buxus sempervirens Common	boxwood
Convallaria majalis	Lily of the valley
Cotoneaster horizontalis	Rockspray cotoneaster
Epimedium spp.	Epimedium
Festuca cinnerea	Blue fescue grass
Ilex glabra	Inkberry holly
Myrica pennsyvanica	Bayberry
Picea glauca conica	Dwarf Alberta spruce
Picea pungens glauca	Colorado blue spruce
Pieris japonica	Japanese andromeda
Rhododendron sp.	Kurume Kurume azalea*
Rhododendron sp. Exbury azalea*	Exbury
Thuja occidentalis	'Woodwardi' Globe arborvitae
Viburnum rhytidophyllum	Leather-leaf viburnum
Viburnum opulus	Cranberry viburnum
Yucca spp.	Yucca

* Not originally listed as deer-resistant.

Several grass species were installed during January, 1992. These species include:

Acorus calamus	Sweet flag
Arrhenatherum elatius bulbosum	Bulbous oat grass
Calamagrostis acutiflora	Feather stricta reed grass
Chasmanthuim latifolium	Northern sea oats
Luzula nivea	Wood rush
Sasa pygmaea	Pigmy bamboo

The six test plots were monitored from March, 1991 to De-cember, 1992. Checks were made every few days after each planting, and once each week during the summer months. Plants were rated as follows:

0 - No browsing
1 - 1-25% of leaves or twigs browsed
2 - 26 - 75% of leaves or twigs browsed
3 - 76 - 100% of leaves or twigs browsed

RESULTS

The species of shrubs planted at the Tracy Estate in decreasing order of attractiveness to deer are listed as follows:

Species	Browse rate
Bayberry	3
Willowleaf cotoneaster	3
Meserve holly	3
Pfitzer juniper	3
Globe arborvitae	3
Inkberry holly	3
Cranberry viburnum	3
Leatherleaf viburnum	3
Kurume azalea*	3
Exbury azalea*	3
Crimson pigmy barberry	2
Rockspray cotoneaster	2
Golden barberry	2
Japanese boxwood	1
Colorado blue spruce	1
Common boxwood	1
Dwarf Alberta spruce	1
Japanese andromeda	1
William Penn barberry	1

*Not originally listed as deer resistant.

The species of ornamental grasses and perennials planted at the Tracy estate, in decreasing order of attractiveness to deer are listed as follows:

Species	Browse Rate
White yarrow	3
Yucca	3
Lavender cotton	2
Violet queen bee balm	2
Blue fescue	2
Lamb's ear	1
Christmas fern	3
Weeping love	1
Maiden grass	1

The plants in the test plots at the Tracy estate exhibiting no signs of deer depredation include the following species:

Catmint
Silver grass
Plume grass
Fountain grass
Silver mound artemesia
Bulbous oat grass
Feather reed grass
Epimedium

Additional plant species already on the site apparently not attractive to the deer on this site are:

Pachysandra
American holly
Hay scented fern*
Narcissus
Scilla*
Foxglove
Siberian iris
White snakeroot*
Japanese barberry
Japanese andromeda
Fragrant sumac

*Not on original list of deer resistant plants.

The Tracy garden spaces were redesigned using the plants proven to be the most resistant to deer depredation at this site along with others that are believed to be likely candidates. The Morris County Park Commission is currently seeking funding to implement the design and continue testing against the nutritional needs of the current deer population.

DISCUSSION

Some plants reportedly resistant to deer depredation, such as bayberry, juniper, holly, cotoneaster, yucca, arborvitae, viburnums and azaleas were highly preferred by deer at the Tracy estate. While severe deer damage to test plantings did not occur overnight, there was clear evidence of preference for certain plants within two or three days.

In some cases physical location protected vulnerable species, such as azaleas. Placing preferred species out of reach or surrounded by a barrier plant, such as the William Penn barberry, afforded some protection. The use of plants unattractive to deer, such as the ornamental grasses to surround a preferred species, such as the burning bush (Euonymus alatus) afforded additional protection. Physical barriers provided by some plant species seem to deter browsing. Gray dogwood was found to protect the attractive native tree seedlings (Austin 1991, Underwood et al. 1991) in Saratoga National Historical Park in New York, because the dense thicket of dogwood kept the seedlings out of reach. Thorns, rigid, sharp leaves, spiny foliage, and dense, thickets around a more palatable plant may provide some protection (L. Makrancy, pers. commun.; W. Flemer pers. commun.; Porter 1991).

Physical damage occurred from rubbing, nibbling the growing tips in an apparent attempt to determine whether the plant was palatable. Boxwood, Colorado blue spruce, pachysandra, and dwarf Alberta spruce all were bitten by animals at times when other food was scarce. The latter was permanently damaged by removal of its leader which is not replaced in this slow-growing species.

Vegetation showed that deer continued throughout the year to pull down plants to be within browsing reach. Damage to the form and normal effectiveness of the plant will prevent its sale in the nursery and frustrate property owners to the point of political action, expensive exclusionary devices, or, if they have the resources, replacement by a less attractive species if possible.

A wide variety of perennials, such as Lamb's ear, iris, and foxglove may be used to fill in the spaces left vacant by deer depredation. However, many of perennials require full sun to grow and bloom and the

list of shade tolerant perennials that are also deer-resistant is limited.

Evidence of deer presence and browsing existed in the garden throughout the year. Deer movements did not change much from month to month. However, they quickly responded to food sources made available when storms caused trees to blow down. They responded quickly to new test plantings, as well. The winter during the study period was relatively mild with only one snow fall. One cannot generalize that the Tracy estate deer would exhibit the same feeding preferences and impact on the vegetation if heavy snow cover existed over a long period of time. On the other hand, a hunting program including the Tracy property and the surrounding large open tracts to reduce the density of deer may alleviate the pressure on the ornamentals planted there. Some neighboring landowners interviewed in the course of this study expressed the belief that a majority of property owners were ready to work with the Morris County Park Commission to reduce deer populations and damage to their properties.

MANAGEMENT IMPLICATIONS

The new Tracy garden planting design represents a compromise between deer and an ornamental landscape. It demonstrates that although the selection of plants has to be limited, a garden is more than a variety of flowers and shrubs. The form and shape of a garden can be preserved by using plants found to be most resistant to depredation. The functions of a garden can be maintained with a different palette of species whether the purpose is the view from a window, a place to take an afternoon stroll, or an attraction for butterflies or hummingbirds.

Plant species selection must be limited in areas of dense deer populations and the selection might become even more limited if a severe winter restricted the food available to the deer. More of a monocultural plant palette would run the risk of greater plant loss because increased species diversity provides a buffer against pests and disease.

Some native wildflowers, shrubs and trees may be relatively deer-resistant. These native species are likely to be more resistant to disease and pests and require less maintenance and are more valuable in the landscape because they provide habitat for other native animals and plants besides ornamental effects. But many valuable native species can be totally extirpated by repeated overbrowsing by deer. This is particularly the case with relatively scarce woodland spring wildflowers.

Plants selected by deer depend upon the food preferences of the individual herd and the competition for alternative food sources. The list of plants showing little damage included in this paper should only be used as a guideline in other locales. Homeowners should be encouraged to experiment with plant species reported to be deer-resistant in their area. Nursery businesses should become aware of the flowers, shrubs, and trees considered to be resistant to deer depredation in their area and be encouraged to propagate and maintain a greater variety deer-resistant plants in stock.

A combination of fencing, repellents, population control through hunting, experimenting with less desirable plants, and an increased tolerance of some amount of deer damage is suggested for homeowners in areas of dense deer populations. Such a balanced approach with reasonable aesthetic goals must contend, however, with the idealized visual images of gardens prevalent in all forms of media, a standard that is difficult to meet even when deer damage is slight.

Previous studies show (Heinrich 1986) that most Americans invest the landscape design of their residence with connotations of self-expression, self-worth, and social and economic status. Close to 80% of American households garden, investing billions of dollars on plants and tools (Gibbs 1988). Landscaping has been reported to have a recovery value upon resale of the property of 100-200 percent, more than any other popular home remodeling project (USDA 1993). In this context it is understandable that many gardeners are willing to seek any solution to reduce deer damage to bearable levels. In possession of more biological information about this prolific species, they may become active proponents for multi-faceted population management approaches which prove effective.

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APPENDIX 1

SPECIES REPORTED TO BE MOST DEER RESISTANT

BOTANICAL NAME	COMMON NAME
Abies spp.	Fir
Acanthopanax siemboldianus	Five leaf aralia
Acer negundo	Box-elder
Achillea millefolium	Yarrow
Aconitum uncinatum	Monkshood
Acorus calamus	Sweet flag
Ageratum houstonianum	Flossflower, ageratum
Ailanthus altissima	Tree of heaven
Allium spp.	Garlic, chives, wild onion
Alnus serrulata	Smooth alder
Alnus glutinosa	Black alder
Althaea rosea	Hollyhock
Anaphallis margaritacea	Pearly everlasting
Anchusa azurea	Italian bugloss
Anemone japonica	Anemone
Anemone vitifolia robustissima	Anemone
Aquilegia spp.	Columbine
Aralia spinosa	Devils walkingstick
Aralia elata	Japanese angelica tree
Arctostaphylos uva-ursi	Bearberry
Arctotis stoechadifolia	African daisy
Arrhenatherum elatius bulbosom	Bulbous oat grass
Artemesia spp.	Artemesia
Asclepias tuberosa	Butterfly weed
Asimina triloba	Pawpaw
Astilbe spp.	Astilbe
Aruncus dioicus	Goatsbeard
Berberis spp.	Barberry
Betula spp.	Birches
Buddleia alternifolia	Fountain butterfly-bush
Buddleia davidii	Orange-eye butterfly-bush
Buxus spp.	Boxwood
Cactaceae spp.	Cactus
Calamagrostis acutiflora stricta	Feather reed grass
Calendula officinalis	Pot marigold
Callicarpa dichotoma	Purple beautyberry
Callicarpa japonica	Japanese beautyberry
Calluna vulgaris	Heather
Calycanthus fertilis	Pale sweetshrub
Cassia spp.	Senna, cassia

APPENDIX 1 (Continued)

Catalpa bignonioides	Common catalpa
Centaurea montana	Mountain bluet
Cephalotaxus harringtonia	Japanese plum-yew
Cercis occidentalis	Red bud
Chamaecyparis obtusa	Hinoki false cypress
Chamaedaphne calyculata	Leatherleaf
Chasmanthium latifolium	No. sea oats
Chelone spp.	Turtlehead
Chionanthus virginicus	American fringetree
Chrysanthemum maximum	Shasta daisy
Cimicifuga racemosa	Bugbane
Clematis spp.	Clematis
Clerodendron trichotomum	Harlequin glory-bower
Clethra alnifolia	Sweet clethra, summersweet
Colchicum spp.	Autumn crocus
Comptonia peregrina	Sweet-fern
Convallaria majalis	Lily of the Valley
Cotinus coggygria	Smoke tree
Cornus spp.	Dogwood
Cotoneaster spp.	Cotoneaster
Crataegus laevigata	Hawthorne
Cryptomeria japonica	Cryptomeria
Cunninghamia lanceolata	China fir
Cytisus scoparius	Scotch Broom
Davidia involucrata	Davidia
Delphinium spp.	Larkspur
Dicentra spectabilis	Bleeding heart
Digitalis spp.	Foxglove
Elaeagnus angustifolia	Russian-olive
Eleagnus commutata	Silverberry
Enkianthus campanulatus	Redvein enkianthus
Epimedium spp.	Epimedium
Erianthus ravennae	Plume grass
Erica carnea	Winter heath
Erigeron philadelphicus	Fleabane
Euonymus alatus	Winged euonymus
Euonymus atropurpureus	Wahoo
Euphorbia cyparissias	Spurge
Festuca cinnerea	Blue fescue
Ficus spp.	Fig
Forsythia intermedia	Forsythia
Galanthus nivalis	Snowdrops
Gaultheria procumbens	Checkerberry
Gayllussacia baccata	Black huckleberry
Geranium spp.	Cranesbill
Gingko biloba	Gingko, maidenhair tree

APPENDIX 1 (Continued)

Gleditsia triacanthos	Honey locust
Gymnocladus dioica	Kentucky coffee tree
Gypsophila paniculata	Baby's breath
Hamamelis virginiana	Common witch hazel
Hedera helix	Englllish ivy
Helianthus spp.	Sunflower
Helichrysum spp.	Strawflower
Helleborus spp.	Hellebore
Hydrangea paniculata	Hydrangea
Ilex aquifolium	English holly
Ilex cornuta	Chinese holly
Ilex crenata	Japanese holly
Ilex glabra	Inkberry
Ilex opaca	American holly
Ilex vertcillata	Black-alder
Iris spp.	Iris
Juglans regia	English walnut
Juglans nigra	Black walnut
Juglans cinerea	Butternut
Juniperus chinensis	Chinese juniper
Juniperus rigida	Needle juniper
Juniperus communis	Common juniper
Knophofia uvaria	Devils or red hot poker
Kolkwitzia amabilis	Beautybush
Lantana montevidensis	Trailing lantana
Larix decidua	European larch
Lavandula officinalis	Lavender
Leucothoe fontanesiana	Drooping leucothoe
Leucothoe racemosa	Sweetbells
Ligustrum obtusifolium	Myama privet
Ligustrum ovalifolium	California privet
Lindera benzoin	Spicebush
Liquidambar styraciflua	American sweetgum
Lonicera fragrantissima	Winter honeysuckle
Lonicera maackii	Amur honeysuckle
Lonicera tatarica	Tartarian honeysuckle
Lupinus spp.	Lupine
Lusimachia nummularia	Moneywort
Luzula nivea	Wood rush
Lychnis chalcedonica	Maltese cross
Lyonia ligustrina	Male-berry
Lyonia mariana	Staggergush
Maclura domfera	Osage orange
Magnolia spp.	Magnolia
Mimulus spp.	Mimulus, Monkey flower
Miscanthus sinensis	Chinese silver grass
Miscanthus sinensis 'gracillimus'	Maiden grass
Monarda didyma	Bee balm
Myosotis spp.	Forget-me-not
Myrica californica	Wax myrtle

APPENDIX 1 (Continued)

Myrica pensylvanica	Northern bayberry
Myrtus communis	Myrtle
Narcissus spp.	Daffodil, Jonquil
Nepeta faassenii	Catmint
Nyssa sylvatica	Tupelo, pepperidge
Oxalis oregana	Oxalis, redwood sorrel
Oxydendrum arboreum	Sorrel tree
Pachysandra terminalis	Japanese pachysandra
Paeonia spp.	Peony
Paulownia tomentosa	Empress-tree
Papayer orientale	Oriental poppy
Parkinsonia aculeata	Jerusalem thorn
Pennisetum alopecuroides	Fountain grass
Phaedranthus buccinatorius	Blood red trumpet vine
Philadelphus spp.	Mockorange
Phyllostachys aurea	Golden bamboo
Phyllostachys aureosulcata	Gold-furrowed bamboo
Physocarpus opulifolius	Common ninebark
Physostegia virginiana	Obedience plant
Picea abies	Norway spruce
Picea glauca	White spruce
Picea glauca conica	Dwarf Alberta spruce
Picea pungens glauca	Colorado blue spruce
Picea pungens	Blue spruce
Picea rubens	Red spruce
Picea mariana	Black spruce
Pieris japonica	Japanese andromeda,
Pinus spp.	Pine
Poncirus trifoliata	Hardy orange
Pseodosas japonica	Metake
Pulmonaria officinalis	Lungwort
Rhamnus catharticus	Common buckthorn
Rhamnus frangula	Glossy buckthorn
Rheum rhaponticum	Rhubarb, Pie plant
Rhododendron nudiflorum	Pinxter azalea
Rhododendron roseum	Honeysuckle azalea
Rhododendron viscosum	Swamp azalea
Rhus aromatica	Fragrant sumac
Ribes odoratum	Clove current
Ribes sativum	Red garden currant
Ribes uva crispa	European gooseberry
Robinia pseudoacacia	Black locust
Rudbeckia gloriosa	Gloriosa daisy
Salvia spp.	Sage and salvia
Sambucus racemosa	Red elderberry
Santolina spp.	Santolina
Sasa palmata	Chimaki sasa

APPENDIX 1 (Continued)

Sasa pygmaea	Pigmy bamboo
Sassafras albidum	Sassafras
Scilla siberica	Siberian squill
Sedum spectabile	Showy sedum
Solanum spp.	Nightshade
Stachys byzantina	Lamb's ear
Stokesia laevis	Stokes aster
Styrax japonica	Japanese styrax
Symphoricarpos albus	Snowberry
Syringa chinensis	Rouen lilac
Syringa reticulata	Japanese tree lilac
Syringa vulgaris	Garden lilac
Tagetes spp.	Marigolds
Taxodium distichum	Bald cypress
Thalictrum spp.	Meadow rue
Thuja spp.	Arborvitae
Thymus serphyllum	Mother of thyme
Thyme vulgaris	Common thyme
Torreya nucifera	Japanese torreya
Tradescantia virginiana	Spiderwort
Trillium spp.	Trillium, Wake-robin
Trollius laxus	Globeflower
Tulipa spp.	Tulip
Vaccinium stamineum	Deerberry
Vaccinium corymbosum	Northern highbush blueberry
Vaccinium vacillans	Dwarf dryland blueberry
Vaccinium ngustifolium	Low sggar blueberry
Vaccinium macrocarpon	Large cranberry
Valeriana spp.	Valerian
Viburnum spp.	Viburnum
Vinca major	Periwinkle
Vitex negundo	Negundo chaste-tree
Yucca spp.	Yucca, Spanish bayonet
Zantedeschia spp.	Calla lily
Zanthoxylum americanum	Prickly-ash