

Exotics and their Ecological Ramifications

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ABSTRACT: The purposeful introduction of exotics (plant and animal species from other countries) into the United States has often been made without consideration given to the long-term negative consequences that these species may eventually have on native biotic communities. A review of the literature on exotics is presented and a case history from Illinois provides an example of how one state has addressed the issue of exotics.

INTRODUCTION

The relative merit versus the adverse impact associated with introducing exotic animal and plant species for any reason has long been argued among wildlife biologists, soil conservationists, foresters, landscapers, and ecologists. However, mounting evidence indicates that the introduction of exotic species has clearly opened a Pandora's box across the North American continent and around the world as well. Although some introductions have had minimal impacts on native populations and habitats, many have caused devastating damage to natural ecosystems (Courtenay 1978, Bratton 1982).

Generally, the case for the purposeful or accidental introduction of exotic animals is well known. Examples include carp (*Cyprinus carpio*), walking catfish (*Clarias batrachus*), African clawed frog (*Xenopus laevis*), Tokay gecko (*Gecko gecko*), nutria (*Myocastor coypus*), house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), European wild boar (*Sus scrofa*), Barbary sheep (*Ammotragus lervia*), feral horse (*Equus caballus*), house sparrow (*Passer domesticus*), European starling (*Sturnus vulgaris*), rock dove (*Columbia livia*), monk parakeet (*Myiopsitta monachus*), giant African snail (*Achatina fulica*), balsam woolly aphid (*Adeleges picea*), and gypsy moth (*Porthetria dispar*) (De Vos et al. 1956, Elton 1958, Hall 1963, Laycock 1966, Ehrenfeld 1970, Bratton 1974, Bratton 1975, Howe and Bratton 1976, Courtenay 1978, Weller 1981, Bratton 1982, Vale 1982).

The ring-necked pheasant (*Phasianus colchicus*) is usually touted as the mid-western example of a good exotic introduction. But Vance and Westemeier (1979) consider parasitism of prairie chicken (*Tympanuchus cupido*) nests by

hen pheasants and harassment of displaying male chickens by cock pheasants as contributing to the reduction of prairie chickens in Illinois. The interspecific competition between the exotic pheasant (which is expanding its range in Illinois) and the native prairie chicken (which is a declining species) may be the final factor causing the extirpation of the prairie chicken from Illinois. Moreover, this type of competitive exclusion may obviate reintroduction attempts as well. Generally, even less is understood about the tremendous damage that is occurring to our continent's ecosystems due to the escape and naturalization of exotic plants.

EFFECTS OF EXOTIC PLANTS

Of the sixty trees discussed by Little (1961) as exotic in the United States, twenty-four (40 percent) were cited as naturalized species or listed as objectionable for other reasons. One of the tree species listed by Little as becoming naturalized in Florida is melaleuca (*Melaleuca quinquenervia*). Seventeen years later, solid stands of melaleuca have replaced many native cypress and pine hammocks in south Florida wetland ecosystems. In addition to melaleuca, two other species of exotic woody plants, Brazilian pepper (*Schinus terebinthifolius*) and Australian pine (*Casuarina* spp.) are not only altering the species composition of south Florida wetlands, but are also accused of accelerating dehydration of wetlands through increased evapotranspiration. Moreover, they are adversely affecting wildlife populations by eliminating certain structural features of the habitat that are preferred by native species (Courtenay 1978, Wade et al. 1980).

In California, gorse (*Ulex europaeus*), Spanish broom (*Spartium junceum*), Scotch broom (*Cytisus scoparius*),

French broom (*C. monspessulanus*), blue gum (*Eucalyptus globulus*), tamarisk (*Tamarix ramosissima*), olive (*Oleo europaea*), fig (*Ficus carica*), pepper tree (*Schinus molle*), date palm (*Phoenix canariensis*), and tree-of-heaven (*Ailanthus altissima*) are all naturalized woody exotics causing damage to California's natural landscape (Boyd 1985a, 1985b, McClintock 1985a, Neill 1985).

Exotic trees and shrubs are not alone in causing problems to native habitats. Japanese honeysuckle (*Lonicera japonica*), English ivy (*Hedera helix*), and European yellow iris (*Iris pseudacorus*) have been reported as causing significant alterations to plant communities associated with an island in the Potomac River in Washington, D. C. (Thomas 1980). More recently, purple loosestrife (*Lythrum salicaria*) has become a severe problem in wetland ecosystems in the eastern United States (Evans 1982). Herbaceous exotics in California that have become aggressive include pampas grass (*Cortaderia jubata*), Hottentot fig (*Carpobrotus edulis*), crown daisy (*Chrysanthemum coronarium*), Bermuda grass (*Cynodon dactylon*), Bermuda buttercup (*Oxalis pes-caprae*), German ivy (*Senecio mikanioides*), periwinkle (*Vinca major*), European beach grass (*Elymus arenaria*), and artichoke thistle (*Cynara cardunculus*) (Hillyard 1985, Kerbavaz 1985, McClintock 1985b, Van Hook 1985). Other herbaceous exotics such as kudzu (*Pueraria lobata*), hydrilla (*Hydrilla verticillata*), and water hyacinth (*Eichornia crassipes*) need no formal documentation to substantiate their enormous detrimental impacts on native aquatic and terrestrial ecosystems since their introduction.

Multiflora rose (*Rosa multiflora*) is the classic midwestern example of an exotic species that has overgrown pastures and abandoned farm ground. It was promoted in the 1940's for use as a living fence, for erosion control, and for food and cover for wildlife, with the added assurance during its initial promotion that it would not spread or become a nuisance. These claims seem naive in retrospect; nevertheless, variations of the same scenario have been used to promote autumn

olive (*Elaeagnus umbellata*), bush honeysuckle (*Lonicera tatarica*), amur honeysuckle (*L. maackii*), and many other species. Klimstra (1956) was one of the first to point out the problems associated with the widespread planting of multiflora rose; moreover, he questioned the real versus the perceived value of multiflora rose for wildlife habitat planting.

In Illinois, 811 species or 29 percent of the state's flora are naturalized from foreign countries (Henry and Scott 1980). Not all these species can be classified as problem species today, but purple loosestrife, European beach grass, multiflora rose, Japanese honeysuckle, Canada thistle (*Cirsium arvense*), nodding thistle (*Carduus nutans*), smooth and shining buckthorn (*Rhamnus cathartica* and *R. frangula*), Johnson grass (*Sorghum halepense*), tall fescue (*Festuca pratensis*), giant teasel (*Dipsacus laciniatus*), sericea lespedeza (*Lespedeza cuneata*), crown vetch (*Coronilla varia*), Tartarian honeysuckle, amur honeysuckle, tree-of-heaven, and white poplar (*Populus alba*) are examples of exotic plant introductions causing farmers, foresters, land managers, and grounds-keepers considerable

problems in various regions of the state (West 1984, J. E. Schwegman, pers. comm.).

Moreover, autumn olive, osage orange (*Maclura pomifera*), and winged-euonymus (*Euonymus alatus*), three of the long-term neutrals in the game of exotic roulette, have now adapted sufficiently to Illinois' conditions that they, too, are becoming naturalized weeds spreading from plantings into the landscape (Nyboer and Ebinger 1978, Ebinger and Lehnert 1981, Ebinger et al. 1984). Ebinger (1983) summarizes the problems that naturalized exotic shrubs (multiflora rose, Japanese honeysuckle, autumn olive, winged-euonymus, and blunt-leaved privet [*Ligustrum obtusifolium*]) are causing managers of natural areas in Illinois.

RAMIFICATIONS

The annual cost to control exotic vertebrates that have become pestilent, such as carp, European starlings, house mice, and Norway rats, is estimated to be in the millions nationwide. Add to this the cost to control exotic plants and introduced insects that have become pests of forestry and agriculture and the



Norway Rat - *Rattus norvegicus*.

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bill is estimated to be billions of dollars annually.

Although the economic cost of controlling exotic introductions can be calculated, the ecological damage cannot be measured in dollars. For example, Brandenburg Bog in northeastern Illinois was purchased to preserve, protect, and perpetuate a rare calcareous fen community. Purple loosestrife is invading the fen and it may be beyond eradication (R. Heidorn, pers. comm.). The direct cost of this exotic species to the state of Illinois in this example is at least \$379,000, the cost of purchase. However, "Brandenburg Bog is the premier calcareous fen in the state and as such is irreplaceable" (J. E. Schwegman, pers. comm.).

In spite of the mounting evidence of the ecological dangers associated with exotics and the skyrocketing costs of controlling them, new species continue to be tested and promoted for the same worn-out reasons: (1) wildlife habitat plantings; (2) landscaping purposes; (3) wood and fiber production; and (4) soil conservation practices. A recent example is the promotion of sawtooth oak (*Quercus acutissima*) as an alternative wildlife food plant (Hopkins and Huntley 1979). Klimstra (1956) pointed out the potential problems associated with planting multiflora rose; similarly, Coblenz (1981) has pointed out the lack of foresight and, more importantly, the lack of hindsight in promoting sawtooth oak for mast production for wildlife.

Once exotics become naturalized, they often change the species composition, alter the structure, and reduce the species diversity of native plant and animal communities. Moreover, if an exotic becomes naturalized and spreads throughout a system, getting it out of that system is like trying to unscramble an egg.

It is the responsibility of all natural resource professionals to provide proper and prudent management advice to private and public landowners and managers. To continue to ignore the documented consequences associated with introducing exotic species in the name

of soil conservation, wildlife management, or reforestation would fall short of this obligation.

Dr. E. Raymond Hall (1963) stated, "Introducing exotic species of vertebrates is unscientific, economically wasteful, politically shortsighted, and biologically wrong." This analysis should be applied to the introduction of exotic plant materials as well. A giant step forward is necessary to head off the invasion of exotic plant materials into the natural landscape. We must redirect our reforestation and wildlife habitat restoration efforts away from exotics and toward the utilization of native plant species that are compatible with native ecosystems. Laycock (1966) described the pursuit of exotic species as a "perpetual relay race with one generation passing the stick to the next." The time has come to drop the baton.

RECOMMENDATIONS: THE ILLINOIS EXAMPLE

The Illinois Department of Conservation nurseries began producing autumn olive in 1964. By 1982, our nurseries were distributing more than 1,000,000 autumn olive seedlings a year, which represented about 20 percent of the state nursery's production of all species combined (Sternberg 1982). We also produced a large number of the bush honeysuckles.

In 1983, our Seedling Needs Committee met to review the needs of the department relative to seedling production. This is a standing committee comprised of representatives from the divisions of Wildlife Resources, Forestry, Public Lands, Planning, Natural Heritage, and our nurserymen. The issue of exotics and the role of the state nurseries in their production was addressed by the committee. The committee agreed that further production of exotic plant materials in our nurseries was not necessary if suitable native species could be grown as substitutes for the exotics. The concept of substituting native species for exotic species is compelling when one considers that: (1) 99 percent of the wildlife species for which we are man-

aging habitat are native species; they evolved with native plant species and there is no hard evidence to support the contention that exotic plant materials are superior for wildlife (Martin et al. 1951); (2) there is no reason to believe that native species of trees and shrubs cannot be grown in nurseries using techniques similar to those we use to grow exotics (Schopmeyer 1974); and (3) when developing landscaping plans for state parks, conservation areas, and other Department of Conservation facilities, it seems more appropriate to use native plant materials in keeping with the natural setting.

Today, our nurseries produce fifty-two species of native trees and shrubs for use in developing wildlife habitat, reclamation projects, and community restorations (Table 1). The seeds necessary to propagate these native species are collected from state parks and conservation areas by our wildlife biologists, foresters, natural heritage biologists, site superintendents, maintenance workers, and volunteers.

In 1977, our nursery system moved forward once more by producing big bluestem (*Andropogon gerardi*) and Indian grass (*Sorghastrum nutans*). By 1980, our Mason Tree Nursery had expanded its operation to include thirty-eight different species of prairie forbs and now averages about twenty-five species per year (Table 2). In 1983, 35,000 prairie forbs were obtained from 596 square meters of bed space (Wallace et al. 1986).

In addition to eliminating exotic species from our nursery operations, educational articles discussing the problems with exotic plants and animals were published in our department's official publication, *Outdoor Highlights* (Harty 1985, Schwegman 1985). A colorful flier was also prepared that explained the problems associated with planting purple loosestrife and recommended measures for its control.

Another significant step forward is the current effort to develop a windbreak manual for Illinois. This is a cooperative effort by the University of Illinois, Department of Forestry, Cooperative

Extension Service, the U.S.D.A. Soil Conservation Service, and the Illinois Department of Conservation. The issue of exotics was addressed early in the planning of this manual, and the committee, which is comprised of inter-agency foresters, wildlife biologists, and natural heritage biologists, recommended thirty-one native trees and shrubs and three non-native species as suitable for use for windbreaks and snow trips in Illinois (Table 3). The three non-native species to Illinois, Norway spruce (*Picea abies*), blue spruce (*Picea pungens*), and Douglas-fir (*Pseudotsuga menziesii*), have been planted throughout Illinois for many years and have not been found to reproduce spontaneously from seed.

Illinois is extremely fortunate to have natural resource agencies and resource professionals who have taken decisive action in addressing the issue of exotic species. It is the author's hope that this paper will stimulate activity in other states to address the issue of exotic species within their boundaries.

POSTSCRIPT

An Exotic Weed Control Act will be introduced in the spring 1987 session of the Illinois General Assembly. If passed into law, it will prohibit the sale and planting of problem exotic plants in Illinois.

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TABLE 1. Native trees and shrubs grown at Illinois Department of Conservation nurseries.*

<i>Acer rubrum</i>	Red Maple
<i>A. saccharinum</i>	Silver Maple
<i>A. saccharum</i>	Sugar Maple
<i>Aronia melanocarpa</i>	Black chokeberry
<i>Betula nigra</i>	River birch
<i>Carya ovata</i>	Shagbark hickory
<i>C. ovalis, glabra, cordiformis, tomentosa</i>	(mixed species)
<i>Celtis occidentalis</i>	Hackberry
<i>Cephalanthus occidentalis</i>	Buttonbush
<i>Cercis canadensis</i>	Redbud
<i>Cornus racemosa</i>	Gray dogwood
<i>C. obliqua</i>	Pale dogwood
<i>Corylus americana</i>	Hazelnut
<i>Crataegus phaenopyrum</i>	Washington hawthorn
<i>Diospyros virginiana</i>	Common persimmon
<i>Fraxinus pennsylvanica</i>	Green ash
<i>F. americana</i>	White ash
<i>Gymnocladus dioica</i>	Kentucky coffee-tree
<i>Ilex decidua</i>	Swamp holly
<i>Juglans nigra</i>	Black walnut
<i>Juniperus virginiana</i>	Red cedar
<i>Liquidambar styraciflua</i>	Sweet gum
<i>Liriodendron tulipifera</i>	Tulip tree
<i>Malus ioensis</i>	Iowa crab apple
<i>Morus rubra</i>	Red mulberry
<i>Pinus resinosa</i>	Red pine
<i>P. strobus</i>	White pine
<i>P. taeda</i>	Loblolly pine
<i>Platanus occidentalis</i>	Sycamore
<i>Prunus americana</i>	Wild plum
<i>P. serotina</i>	Wild black cherry
<i>Quercus alba</i>	White oak
<i>Q. bicolor</i>	Swamp white oak
<i>Q. lyrata</i>	Overcup oak
<i>Q. macrocarpa</i>	Bur oak
<i>Q. michauxii</i>	Basket oak
<i>Q. palustris</i>	Pin oak
<i>Q. rubra</i>	Red oak
<i>Q. velutina</i>	Black oak
<i>Robinia pseudoacacia</i>	Black locust
<i>Rhus aromatica</i>	Fragrant sumac
<i>R. glabra</i>	Smooth sumac
<i>R. typhina</i>	Staghorn sumac
<i>Rubus allegheniensis</i>	Common blackberry
<i>Sambucus canadensis</i>	Elderberry
<i>Symphoricarpos orbiculatus</i>	Coralberry
<i>Taxodium distichum</i>	Bald cypress
<i>Viburnum trilobum</i>	High-bush cranberry
<i>V. recognitum</i>	Smooth arrowwood

*Nomenclature follows Mohlenbrock (1986).

TABLE 2. Native prairie forb species grown at the Mason Tree Nursery, Topeka, Illinois (Wallace et al. 1986).*

<i>Amorpha canescens</i>	Leadplant
<i>Asclepias tuberosa</i>	Butterfly-weed
<i>Aster laevis</i>	Smooth aster
<i>A. novae-angliae</i>	New England aster
<i>Baptisia lactea</i>	White wild indigo
<i>B. leucophaea</i>	Cream wild indigo
<i>Camassia scilloides</i>	Wild hyacinth
<i>Ceanothus americanus</i>	New Jersey tea
<i>Coreopsis palmata</i>	Prairie coreopsis
<i>C. tripteris</i>	Tall tickseed
<i>Dalea candida</i>	White prairie clover
<i>D. purpurea</i>	Purple prairie clover
<i>Desmodium canadense</i>	Showy tick trefoil
<i>D. illinoense</i>	Illinois tick trefoil
<i>Dodecatheon meadia</i>	Shooting-star
<i>Echinacea pallida</i>	Pale coneflower
<i>Eryngium yuccifolium</i>	Rattlesnake master
<i>Helianthus occidentalis</i>	Western sunflower
<i>Heliopsis helianthoides</i>	False sunflower
<i>Hieracium longipilum</i>	Hairy hawkweed
<i>Lespedeza capitata</i>	Round-headed bush clover
<i>L. leptostachya</i>	Prairie bush clover
<i>Liatris aspera</i>	Rough blazing star
<i>L. pycnostachya</i>	Prairie blazing star
<i>Parthenium integrifolium</i>	American feverfew
<i>Physostegia virginiana</i>	False dragonhead
<i>Polytaenia nuttalli</i>	Prairie parsley
<i>Potentilla arguta</i>	Prairie cinquefoil
<i>Prenanthes aspera</i>	Rough white lettuce
<i>Ratibida pinnata</i>	Drooping coneflower
<i>Rosa carolina</i>	Pasture rose
<i>Rudbeckia subtomentosa</i>	Fragrant coneflower
<i>Silphium integrifolium</i>	Rosinweed
<i>S. laciniatum</i>	Compass-plant
<i>S. terebinthinaceum</i>	Prairie-dock
<i>Solidago rigida</i>	Rigid goldenrod
<i>Tradescantia ohimensis</i>	Spiderwort

*Nomenclature follows Mohlenbrock (1986).

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TABLE 3. Native tree and shrub species recommended for windbreaks and snow trips in Illinois (Illinois Windbreak Manual, in press).*

<i>Amelanchier arborea</i>	Shadbush
<i>Aronia melanocarpa</i>	Black chokeberry
<i>Cornus alternifolia</i>	Alternative-leaved dogwood
<i>C. drummondii</i>	Rough-leaved dogwood
<i>C. obliqua</i>	Pale dogwood
<i>C. racemosa</i>	Gray dogwood
<i>C. stolonifera</i>	Red osier dogwood
<i>Corylus americana</i>	Hazelnut
<i>Crataegus crus-galli</i>	Cock-spur thorn
<i>C. mollis</i>	Red haw
<i>C. phaenopyrum</i>	Washington hawthorn
<i>Hamamelis virginiana</i>	Witch-hazel
<i>Ilex verticillata</i>	Winterberry
<i>Juniperus communis</i>	Common juniper
<i>J. virginiana</i>	Red cedar
<i>Malus ioensis</i>	Iowa crab apple
<i>Picea abies</i>	Norway spruce
<i>P. pungens</i>	Blue spruce
<i>Pinus strobus</i>	White pine
<i>Prunus americana</i>	Wild plum
<i>P. virginiana</i>	Common chokecherry
<i>Pseudotsuga menziesii</i>	Douglas-fir
<i>Symphoricarpos orbiculatus</i>	Coralberry
<i>Taxus canadensis</i>	Canada yew
<i>Thuja occidentalis</i>	Arbor vitae
<i>Viburnum acerifolium</i>	Maple-leaved arrowwood
<i>V. lentago</i>	Nannyberry
<i>V. prunifolium</i>	Black haw
<i>V. rafinesquianum</i>	Downy arrowwood
<i>V. recognitum</i> (<i>V. dentatum</i>)	Smooth arrowwood
<i>V. rufidulum</i>	Southern black haw
<i>V. trilobum</i>	High-bush cranberry

*Nomenclature follows Mohlenbrock (1986).

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