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# RATINGS OF WHITE-TAILED DEER PREFERENCES FOR WOODY BROWSE IN INDIANA

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**ABSTRACT.** Abundant populations of white-tailed deer (*Odocoileus virginianus*) can result in levels of herbivory on woody plants sufficient to alter composition of forest communities, reduce success of afforestation and regeneration efforts, and damage landscape designs. A survey of forestry and wildlife professionals was used to test whether state-wide patterns existed in the perceived selection of white-tailed deer for native woody plant species as food. Thirty-one respondents provided ratings for 22 species of trees and 13 species of shrubs. Consistently high preference ratings were observed for oaks (*Quercus*) generally and northern red oak (*Q. rubra*) specifically. Tree species received higher preference scores, on average, than shrub species. Comparisons of responses from the northern and southern portions of the state indicated geographic differences in rankings. Preference scores were greater for six tree species in the southern portion of the state, whereas no species exhibited greater scores in the north. Environmental factors are discussed that could cause variation in selection by herbivores. The ratings provide rough guidelines and increased awareness for landowners, natural resource and landscape design professionals contemplating plantings in areas where deer are abundant. The survey results are most appropriately viewed as working hypotheses that should form the basis of future research related to forest regeneration and plantation establishment in the presence of deer.

**Keywords:** Browsing, herbivory, *Odocoileus virginianus*, shrubs, trees

White-tailed deer are generalist herbivores that feed on a variety of herbaceous and woody species of plants. Since their re-introduction to Indiana in the 1930s, deer have prospered in the state and have become overabundant in some areas, with devastating effects on vegetation and deer and human health (Ley et al. 1995; Swihart et al. 1998). When abundant, deer can play key roles in structuring forest ecosystems (Côté et al. 2004). In northeastern forests, shifts in community composition toward browse-tolerant species have been attributed to deer (Long et al. 2007), and regeneration of preferred browse species has been suppressed by deer (Russell et al. 2001; Rooney & Waller 2003; Casabon & Pothier 2008). Similarly, reduced species diversity of saplings has been attributed to deer browsing in the Great Smoky Mountains (Griggs et al. 2006).

White-tailed deer also can influence the success of woody plants in cultivated settings. Nurseries and orchards can suffer substantial economic losses due to deer browsing (Lemieux et al. 2000). Plantation hardwoods can exhibit reduced growth when browsed, and timber quality may be reduced if apical buds are removed (Putman & Moore 1998; Morrissey et al. 2008). In suburban areas of the eastern U.S., deer often modify behavior to forage in close proximity to dwellings and include a greater variety of ornamental plants in their diets, thereby causing damage to expensive landscaping designs (Swihart et al. 1995; West & Parkhurst 2002). Overall, the economic costs of damage caused by deer in the U.S. exceeded $750 million over a decade ago (Conover 1997). Damage caused by feeding likely has been underestimated (Côté et al. 2004).

To predict better which woody species are at risk from deer browsing, many studies on diet selection have been done (reviewed by Russell et al. 2001). Unfortunately, nearly all of these studies have been local in scope, and few attempts have been made to generalize findings spatially or temporally. The problem of "scaling up" from small scales is common in field

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Table 1.—Species of trees for which preference ratings were requested in a mail survey sent to consulting foresters, district foresters, and state wildlife biologists. The number of respondents providing a preference rating for a species is given in the column denoted by *N*.

| Common name | Scientific name | *N* |
|---|---|---|
| Black oak | *Quercus velutina* | 28 |
| Bur oak | *Q. macrocarpa* | 27 |
| Chestnut oak | *Q. prinus* | 8 |
| Chinkapin oak | *Q. muehlenbergii* | 23 |
| Northern red oak | *Q. rubra* | 31 |
| Pin oak | *Q. palustris* | 20 |
| Scarlet oak | *Q. coccinea* | 13 |
| Shumard oak | *Q. shumardii* | 20 |
| Swamp chestnut oak | *Q. michauxii* | 22 |
| Swamp white oak | *Q. bicolor* | 26 |
| White oak | *Q. alba* | 29 |
| Black cherry | *Prunus serotina* | 27 |
| Black walnut | *Juglans nigra* | 31 |
| Pecan | *Carya illinoinensis* | 14 |
| Persimmon | *Diospyros virginiana* | 17 |
| Red pine | *Pinus resinosa* | 22 |
| Sugar maple | *Acer saccharum* | 22 |
| Silver maple | *Acer saccharinum* | 17 |
| Sycamore | *Platanus occidentalis* | 18 |
| Sweetgum | *Liquidambar styraciflua* | 18 |
| Tulip poplar | *Liriodendron tulipifera* | 28 |
| White pine | *Pinus strobus* | 31 |

Table 2.—Species of shrubs for which preference ratings were requested in a mail survey sent to consulting foresters, district foresters, and state wildlife biologists. The number of respondents providing a preference rating for a species is given in the column denoted by *N*.

| Common name | Scientific name | *N* |
|---|---|---|
| American elderberry | *Sambucus canadensis* | 15 |
| American hazelnut | *Corylus americana* | 16 |
| American plum | *Prunus americana* | 28 |
| Black chokeberry | *Aronia melanocarpa* | 10 |
| Buttonbush | *Cephalanthus occidentalis* | 27 |
| Common chokecherry | *Prunus virginiana* | 10 |
| Eastern redbud | *Cercis canadensis* | 15 |
| Flowering dogwood | *Cornus florida* | 16 |
| Gray dogwood | *Cornus racemosa* | 14 |
| Ninebark | *Physocarpus opulifolius* | 10 |
| Pawpaw | *Asimina triloba* | 20 |
| Silky dogwood | *Cornus amomum* | 19 |
| Washington hawthorn | *Crataegus phaenopyrum* | 16 |

ecology because of the cost and logistical difficulties associated with data collection at landscape or regional scales. Recently, Swihart et al. (2007) demonstrated the value of surveys for testing ecological predictions at regional scales. The objective in the current study was to derive the first state-wide, quantitative ratings of native woody plants in terms of their preference to white-tailed deer. A survey of forestry and wildlife professionals across the state enabled acquisition of data on perceived preferences. Tests were then conducted for differences in preference ratings among species types, and for geographic variation in preference ratings.

## METHODS

**Data collection.**—A mail survey was sent in January 2008 to consulting foresters as well as district foresters and wildlife biologists employed by the Indiana Department of Natural Resources. The survey asked the 60 recipients to assign a score of 0 through 10 for each of a list of 22 species of trees (Table 1) and 13 species of shrubs (Table 2). The following rating system was used: 0 = never seen the species eaten; 1–4 = less than average preference; 5 = average preference; 6–9 = preferred; 10 = the most preferred food which is always eaten first by deer. Respondents were instructed not to assign a rating for species for which they did not have experience. Ratings were received from 31 individuals (52% response rate) and classified according to whether they worked in the southern or northern half of the state.

**Statistical analyses.**—For each species a statewide mean preference rating (± standard error) was computed. A mean preference rating also was computed for each species after categorizing responses into northern and southern Indiana. A two-sample *t* test was used to compare mean preference ratings for: a) selected pairs of species in which there was particular interest because of their popularity or value, b) oaks versus all other tree species, and c) trees and shrubs.

Geographic differences in preference ratings were assessed using Poisson regression with location (north or south), species type (shrub or tree) and their interaction as predictors. Subsequent pair-wise nonparametric Mann-Whitney tests were conducted for each species using northern versus southern ratings.

## RESULTS

Substantial differences were evident among species (Fig. 1). For trees, northern red oak

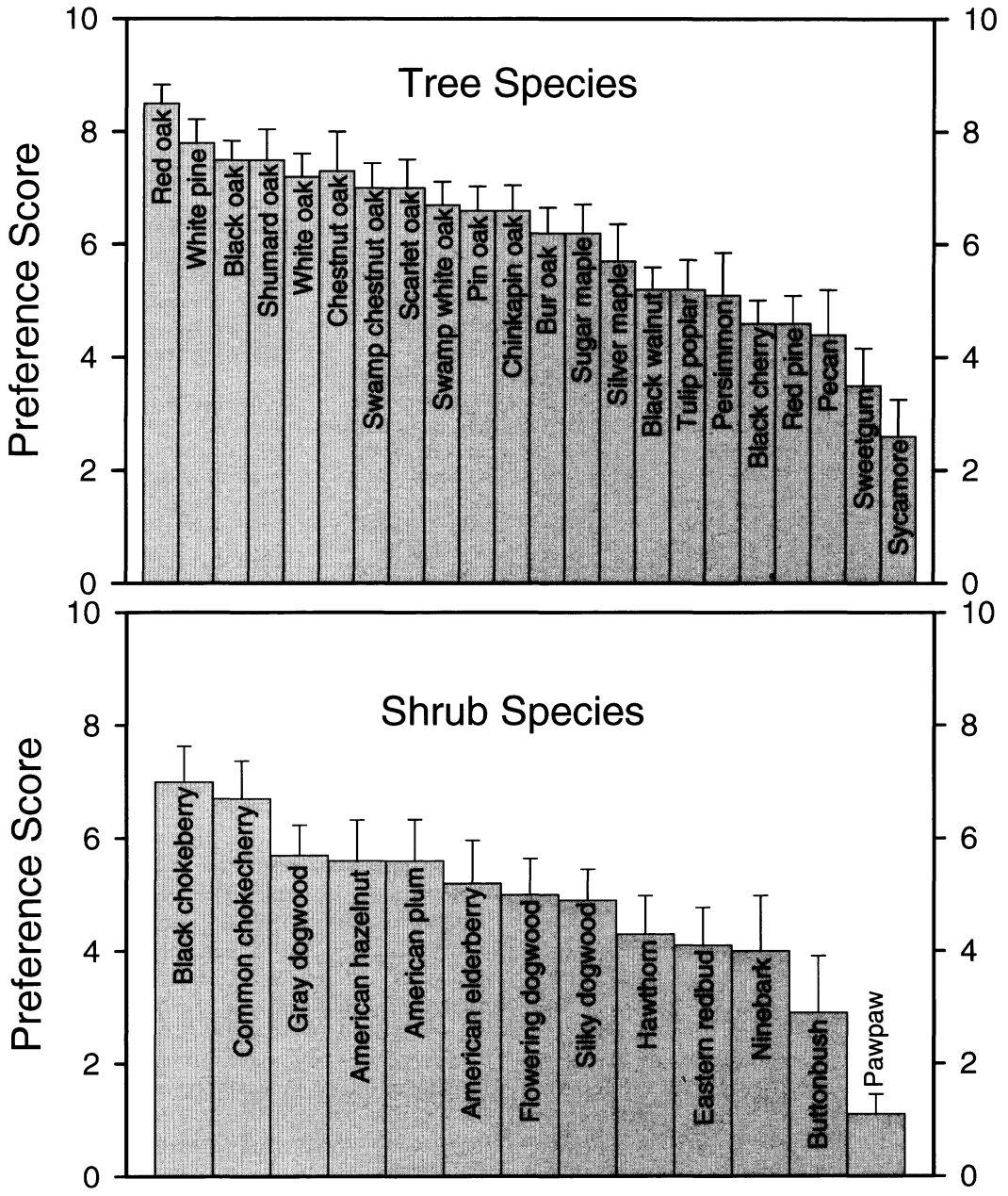


Figure 1.—Mean (+ standard error) preference ratings for tree and shrub species as deer browse in Indiana based on perceptions of forestry and wildlife professionals. Species are arranged in descending order of mean ratings. Sample sizes associated with standard error bars are provided in Tables 1 and 2.

received the highest mean (± standard error) preference rating (8.5 ± 0.3), whereas sycamore was rated as the least preferred of the tree species surveyed (2.6 ± 0.6). Oaks on average received greater preference ratings than other tree species ($t$ = 4.62, $n$ = 22, $P$ = 0.002). Indeed, the oaks ranked as 11 of the 12 most preferred tree species surveyed (Fig. 1). For shrubs, black chokeberry received the highest rating (7.0 ± 0.6), whereas pawpaw received the lowest rating (1.1 ± 0.3). With the exception of black chokeberry and common

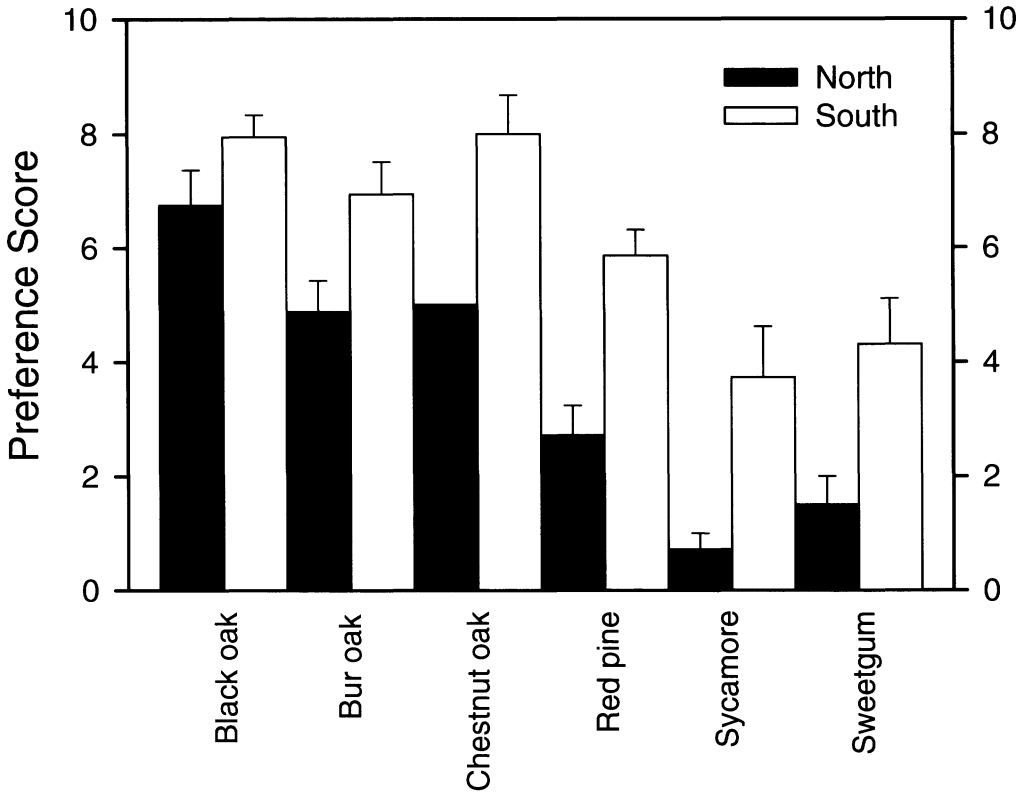


Figure 2.—Mean (+ standard error) preference ratings for woody species that differed significantly ($P < 0.05$) between northern and southern respondents in Indiana. Note that northern populations received lower preference ratings for all species.

chokecherry, ratings for the shrubs fell into the "average" or "less than average" preference categories (Fig. 1). Trees on average received higher preference ratings than shrubs ($t = 2.42$, $n = 35$, $P = 0.025$). American hazelnut and ninebark were the most variable species in terms of preference ratings, with ranges of 0–10 and 0–9, respectively.

A comparison of hardwood species highly valued for their timber revealed the following ordering according to preference ratings (species sharing a common superscript did not differ at the 0.05 level of significance): northern red oak$^{a}$ > white oak$^{b}$ ≥ sugar maple$^{bc}$ ≥ black walnut$^{cd}$ = black cherry$^{d}$. Statistically, sugar maple had a marginally ($P = 0.12$) lower preference rating than white oak and a marginally ($P = 0.11$) greater preference rating than black walnut.

Geographic differences in preference ratings also were evident. A Poisson regression fitting ratings to species type (shrub or tree), location (north or south portion of state), and their interaction indicated lower overall preference ratings in northern than southern Indiana (Wald $X^2 = 2.92$, $df = 1$, $P = 0.09$). Subsequent pair-wise nonparametric comparisons for each species revealed that geographic differences were evident for black, bur, and chestnut oak, as well as red pine, sycamore, and sweetgum. Ratings of deer preference were lower in northern Indiana for all of these species (Fig. 2).

## DISCUSSION

Plant species exhibit a range of susceptibility to herbivory (Swihart & Bryant 2001), and the species considered in the survey were no exception. Forestry and wildlife professionals recognized considerable variation among browse species in terms of perceived preferences of deer. Statewide, northern red oak received the highest preference rating, and oaks generally were classified as "preferred". Negative

effects of deer on oaks have been documented in other studies (Healy 1997; Rooney & Waller 2003) and suggest that oaks are relatively poorly defended. In contrast, several species, such as sycamore, pawpaw, and button bush, appear to be unpalatable to deer and thus likely are resistant to the potential negative effects of herbivory. In species with moderate preference ratings (such as sugar maple, tulip poplar, and black cherry), other studies have demonstrated negative effects attributable to deer (reviewed by Russell et al. 2001). Whether deer negatively affect growth and survival of these species in Indiana will depend on factors such as deer density and availability of other food plants (reviewed by Côté et al. 2004).

The survey revealed some differences from a study of browse preferences done in central Illinois (Strole & Anderson 1992). Of the species included in the current survey, Strole & Anderson (1992) listed chokecherry, gray dogwood, white oak, and black cherry as preferred, and sugar maple and hazelnut as low use. Indiana respondents rated white oak (mean = 7.2) and chokecherry (6.7) as preferred. Gray dogwood was above average preference (5.7) and variable, with ratings ranging from 2–8. Black cherry was rated as about average preference in Indiana (4.6), but it also was quite variable (range = 1–9). In contrast to Illinois, sugar maple (mean = 6.2) and American hazelnut (mean = 5.6) are considered above average in preference to deer in Indiana.

In temperate North America, conspecific and congeneric variation in palatability of woody plants to mammalian herbivores tends to exhibit latitudinal patterns, with southern genotypes more palatable than their northern counterparts (Swihart & Bryant 2001). Survey results from the current study are consistent with this trend, as northern populations in Indiana received lower preference ratings than southern populations for all six species in which significant differences occurred. Historical gradients in browsing pressure have been proposed as a factor driving these patterns, an explanation supported by selection for plant defenses on islands to which herbivores have only recently been introduced (Vourc'h et al. 2001). Effects of deer on woody plants is predicted to be greater in landscapes fragmented by human activity (Reimoser 2003), due in part to seasonal concentration of animals in forest remnants and to resource supplementation in agricultural areas that enhances carrying capacity beyond levels supported by native vegetation. The northern, glaciated portion of Indiana has been fragmented by agriculture for 175 years and consisted of a confluence of native eco-regions before European settlement. Thus, historical browsing pressure may well have been greater in northern Indiana.

The lower preference ratings for shrubs relative to trees also may be explained by evolved defenses against herbivory. Shrubs are exposed to herbivory throughout their lives, whereas trees typically are susceptible only while within reach of deer during the juvenile stage of growth. A meta-analysis of 37 tree species demonstrated that palatability to mammalian herbivores is much greater in the mature (out-of-reach) stage than the juvenile (within-reach) stage of ontogeny (Swihart & Bryant 2001).

From a practical perspective, the findings from the survey provide a basis for selecting planting stock when planning a tree planting or landscaping project. In areas accessible to many deer, selection of species with high preference ratings is likely to result in browse damage. In fairly large plantings, selecting a mixture of species with average or below average preference ratings could reduce deer visitation and browsing at a site. If all else is equal, landowners should use shrubs in areas prone to deer traffic. For oaks, regeneration in the presence of deer likely will depend on control in the form of, e.g., fencing or hunting.

The preference ratings provided here are rooted in taxonomic categorizations of woody plants. Of course, browse selection by deer should focus on factors that maximize fitness, which may have little to do with taxonomy. Thus, future work should consider how deer preferences for woody browse are related to plant morphological, chemical, and life history traits, in conjunction with energetic, nutritional, and other constraints affecting foraging deer.

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