# 16 Deer and Ecosystem Management

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Within the last decade, managers of public and private forestlands have contemplated managing forest resources in ways that address the desired (future) condition (outcomes) of these resources (Society of American Foresters 1993), which include all plant and animal species, noncommercial as well as commercial. Such management necessitates dealing with ecosystems and dovetails with an emerging management concept identified as "ecosystem management" (Society of American Foresters 1993; Grumbine 1994; Salwasser 1994).

According to Grumbine (1994), ecosystem management integrates knowledge of ecological relationships within a sociopolitical values framework. The goal of ecosystem management is to protect native ecosystem integrity over the long term. Grumbine (1994) identified a dominant theme of ecosystem management as that of managing to preserve diversity of communities (species and populations) and ecosystems as well as ecological patterns and processes. Such management will shape the future age, structure, species composition, and abundance of forest resources, which together constitute forest condition.

Ecosystem diversity and ecological patterns and processes constitute ecosystem integrity. Ecosystem integrity and forest condition form the building blocks, or biological components, of ecosystem management as defined by Grumbine (1994). These biological components of ecosystem management are affected by weather and by patterns and composition of vegetation that occur within landscapes. Weather and composition and pattern of vegetation change over time as does the spatial arrangement of vegetative patterns. Human sociological, economic, and political events influence, for example, harvest of timber and subsequent landscape patterns of vegetation. Forest health factors (insect and disease) and browsing by deer also affect the landscape pattern and composition of vegetation. Interactions among these factors, and the effects of these interactions on landscape patterns of vegetation, constitute ecosystem management contexts that influence the status of ecosystem components.

Ecosystem management is defined as a strategy by which, in aggregate, the full array of forest values and functions is maintained at the landscape level over long periods of time (Society of American Foresters 1993; Irland et al. 1994), suggesting the importance of spatial and temporal scales.

Definitions of ecosystem management do not include identification of plant or animal species that can affect ecosystem management components profoundly enough to be identified as keystone species, which by Hunter's (1990 :240-241) definition includes species upon which the integrity of whole ecosystems rely. In this context, McShea and Rappole (1992) identified the white-tailed deer as a keystone species. The premise of this chapter is that the effect of white-tailed deer, a keystone species, on vegetation can be of a magnitude sufficient to influence (1) ecosystem integrity, (2) future condition of forest resources, and, (3) the conduct and outcome of ecosystem management.

## CONCEPTUAL FRAMEWORK

The interrelationships among ecosystem management components and contexts and deer impact may be expressed by a flow diagram (Figure 16.1). Ecosystem management contexts influence ecosystem management components as mediated by deer impact. Marquis et al. (1992) and Redding (1995) defined deer impact as a joint function of deer density and forage availability, suggesting that as forage availability increases, the impact of deer on forest resources decreases. Deer density is affected primarily by mortality associated with winter severity, hunting harvest, and deer–vehicle collisions (Witmer and deCalesta 1992).

Forage availability and deer density are affected by landscape patterns of vegetation and deer harvest as they vary through space and time. Severe winter can limit the ability of deer to move to find forage under deep snow and can induce winter mortality. Natural (windstorm) and

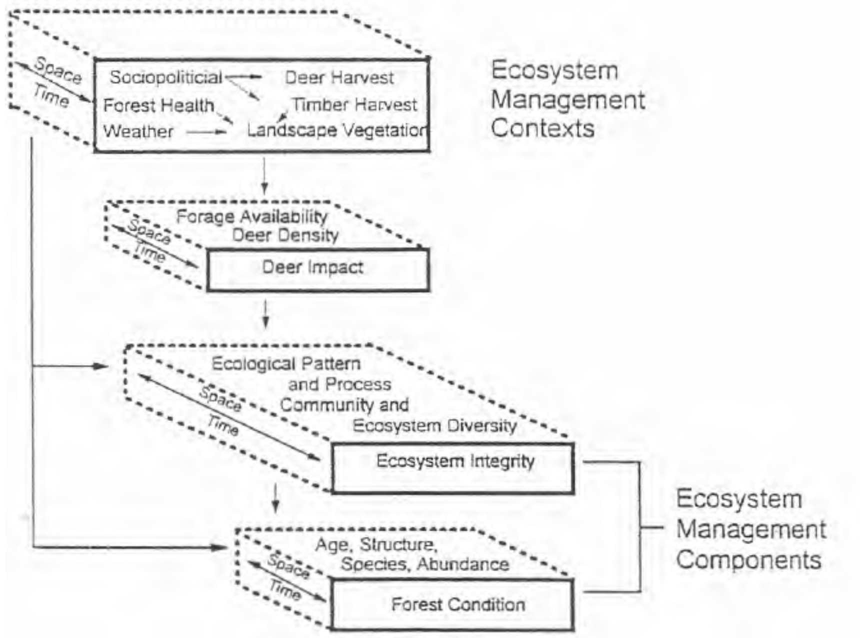


FIGURE 16.1. Relationships among deer impact and ecosystem management components and contexts.

human-induced (timber harvest) disturbance creates patterns and amounts of forest openings that produce deer forage. Mortality of trees from insect and disease organisms (forest health factors) can result in increased deer forage production by increasing the amount of light reaching the forest floor. Social and political values concerning use of natural resources affect timber and deer harvests.

Factors that affect forage availability and deer density vary through time and space, creating stochasticities of forage availability and deer density that are integrated as deer impact. Deer impact, in turn varying through space and time, contributes to stochasticities of ecosystem integrity and forest condition. Managing for deer impact on ecosystem management requires an understanding of the relationships among deer impact and ecosystem management components and contexts.

The following discussion of the effects of white-tailed deer on ecosystem management is based on research conducted in northern hardwood forest type in northwestern Pennsylvania at the Warren Laboratory, Northeastern Forest Experiment Station, U.S. Forest Service. The effect of varying white-tailed deer densities on regeneration of woody vegetation

favorable to favorable. Overabundant white-tailed deer populations were hypothesized as the primary cause for failure of advance regeneration. In 1994 only 33% of maturing forestland within the Allegheny National Forest carried sufficient advance regeneration to permit removal of overstory timber with reasonable expectation of successful regeneration (L. DeMarco, Allegheny National Forest, Warren, Pennsylvania, personal communication).

Thus, management of deer and timber has been driven by social and political values and has resulted in creation of deer densities and forage production over the last 70 years that have exceeded levels created by natural disturbance and deer mortality. Changes in species composition of floral communities have been associated with these changes in deer density and forage production.

## DEER AND ECOSYSTEM MANAGEMENT COMPONENTS

### Deer Impact on Process: Regeneration

When overstory forest trees are removed by natural processes (e.g., fire, windstorm, or insect and disease mortality) or by timber harvest, the succeeding forest is promulgated by seeds and vegetative reproduction from overstory trees. Seedlings constituting the advance regeneration are present at the time of overstory removal and form the nucleus of the emerging timber stand. Failure of advance regeneration (inadequate seedling abundance, height, and species richness) following timber harvest in the mid-1950s in northwestern Pennsylvania prompted research to determine causes of the failure (Tilghman 1989; Redding 1995).

This 10-year study in northwestern Pennsylvania demonstrated that species richness, abundance (expressed as percent plots fully stocked), and height of saplings (small trees with diameter at breast height less than 2.5–14 cm) declined significantly once deer density exceeded 7.9 deer/km2 (Tilghman 1989; deCalesta 1992). At deer densities greater than 7.9 deer/$km^2$, seedlings of six woody tree species were missing or prevented by deer browsing from becoming incorporated into the overstory (deCalesta 1992). As deer densities exceeded 7.9 deer/$km^2$ clear-cut sites approached monocultures of black cherry *(Prunus serotina);* on uncut sites, American beech *(Fagus grandifolia)* and striped maple *(Ater pensylvanicum)* dominated (Tilghman 1989). Deer negatively affected the regeneration process and future overstory when populations exceeded estimated pre-European settlement deer density (Tilghman 1989; deCalesta 1992).

tion and elimination of genetic material. Three communities (songbird, herb and shrub, and tree) were affected by deer, exhibiting changes in species composition, dominance, and abundance within communities. The toss of some species (herbs and shrubs) occurred over approximately 70 years, reflecting a temporal aspect of biodiversity.

## Deer Effects on Forest Condition

The effect of deer on forest condition is largely a function of how deer influence biodiversity—the abundance and richness of the various species composing the many forest communities, floral and faunal—over time and space. Deer impact is a long-term influence: species richness and abundance of tree seedlings determine the composition and structure of stands that develop following natural or human disturbances and that will persist for decades or longer. Characteristics of understory vegetation (species richness and abundance and vertical habitat structure) and associated wildlife communities are likewise affected by deer and by the nature of the overstory vegetation as influenced by deer.

Unmanaged mature forests in northwestern Pennsylvania consist primarily of eastern hemlock, American beech, and sugar maple (Acer *saccharum)* (Braun 1964; Marquis *1975).* Retention of these forests depends on continual seed supply and regeneration success of trees. Deer can prevent successful regeneration of eastern hemlock by eliminating seedlings in the understory (Aiverson et al. 1988). Beech bark disease, an introduced scale insect and fungus complex, can eliminate American beech from the overstory (Houston 1975) and remove it as a reliable seed supplier. Sugar maple decline syndrome is associated with a general failure of sugar maple regeneration in parts of northwestern Pennsylvania (R. White, Allegheny National Forest, personal communication). It is possible that deer can eliminate eastern hemlock regeneration and that overstory American beech and sugar maple trees may become unreliable seedling producers as a result of disease and parasitic organisms. This scenario could result in no replacement of eastern hemlock, American beech, or sugar maple trees to provide the seed source for future forests. The resulting forest might then be populated by species resistant to deer browsing (black cherry and striped maple) or others not affected by the disease and parasitic organisms. Composition, structure, and age of such forests, as affected by deer, may be quite different from past and present forests. Wildlife communities associated with these deer-affected forests may also differ.

Second-growth Allegheny hardwood forests in northwestern Pennsyl-

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