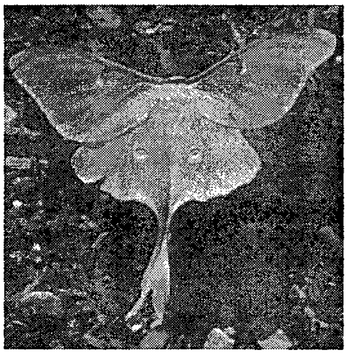
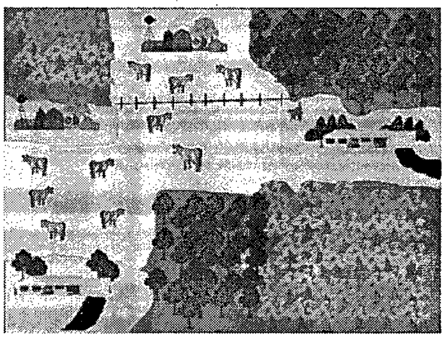
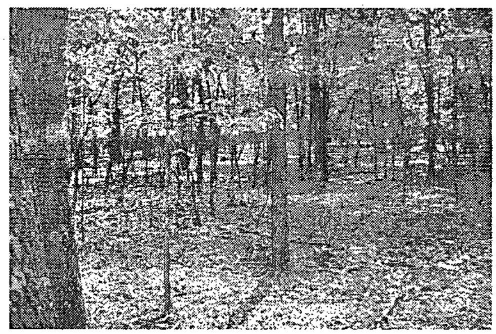
New Jersey Audubon Society's

Forest Health and Ecological Integrity
Stressors and Solutions
Policy White Paper





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Executive Summary

The mission of New Jersey Audubon Society (NJAS) is "to foster environmental awareness and a conservation ethic among New Jersey's citizens; protect New Jersey's birds, mammals, other animals, and plants, especially endangered and threatened species; and promote preservation of New Jersey's valuable natural habitats." For over a century, New Jersey Audubon has worked to staunchly fulfill this mission, playing a leading role in supporting and developing innovative solutions for protecting natural habitats in New Jersey such as the New Jersey Freshwater Wetlands Protection Act, Pinelands Protection Act, creation of the Garden State Preservation Trust, and Highlands Water Protection and Planning Act.

The fight against the development of sensitive lands will continue in New Jersey until every last acre is either preserved or lost to development. An analysis of landscape change conducted by Rutgers University has indicated that in about 40 years, New Jersey will become the first state to reach build-out (Hasse and Lathrop 2001). Clearly this is the most imminent threat to natural habitats in New Jersey. However, other major threats exist that, over the long-term, threaten the viability of many of New Jersey's native ecological communities and the native plants and animals that dwell within them. Regardless of the amount of land protected in New Jersey, modern civilization has both directly and indirectly impacted the functionality of the state's natural ecosystems. The natural disturbances that created New Jersey's terrestrial ecosystems, flood, fire, and wind have been replaced by severe, foreign disturbances introduced by humans.

The integrity of New Jersey's natural ecosystems is being threatened by alien disruptions that include **habitat loss and fragmentation, overabundant herbivores, invasive organisms** including plants, insects, and disease, **climatic changes**, and **pollution.** Because these threats are new, natural ecosystems have no built-in defenses against them, and lack time for adequate natural defenses to evolve. The result is slow ecosystem decay that includes the loss of many native species and habitats. Without intervention to try and offset or counter these emerging threats, the beauty of the Garden State's natural habitats will disappear as ecosystems collapse under elements against which they have no natural defense. Such loss of ecosystem function and habitat quality is a direct threat to the mission of NJAS.

NJAS has been a leader in supporting the protection of species and natural habitats throughout New Jersey and will continue to support measures that protect farmland, open space, and other critical sites. NJAS takes a clear stance against anything that threatens the ecological integrity or sustainability of natural ecosystems and native plants and wildlife in New Jersey and supports measures that will restore ecosystem health and balance. We believe that ignoring or neglecting these human-induced threats is both an unacceptable and irresponsible course with dire consequences for New Jersey's natural landscape. NJAS further believes that because natural processes have been permanently altered by human civilization that direct management of these threats is called for. A dramatic change in New Jersey's native ecosystems is already well underway, and the survival and integrity of the state's natural ecosystems, native species, and populations are at stake.

Loss of Ecosystem Forces

Prior to widespread settlement by Europeans, both major and minor forms of disturbance helped shape the ecosystems of New Jersey. Fires molded the ecological communities of the Pine Barrens and created grassland habitats elsewhere in the state. Floods periodically scoured riverbanks and dumped silt into adjacent floodplains, resetting plant community succession. Severe weather events, including thunderstorms, hurricanes, and ice storms, created openings in the forest in which second growth vegetation thrived until young saplings could rise to fill the canopy gaps. In modern New Jersey, these key forces that renew ecosystems have been altered. Fires are now suppressed in the Pine Barrens, resulting in dangerously overstocked conditions that provide neither optimum habitat for Pine Barrens animals and plants nor protection for the region's human populations from cataclysmic wildfire. Where fires are allowed, they are burned during the dormant season. Dormant season burns alter the understory and midstory vegetation composition from that created by warm season burns that better mimic historic conditions, altering both plant and animal communities (Boyer 1993; Jacqmain *et al.* 1999).

New Jersey's major rivers have been altered by dams, channelization, and canals. These modifications prevent major flood events capable of altering vegetation communities through silt deposition over a large floodplain or infrequent scouring of streamside vegetation. Due to dramatic increases in impervious cover, and erosion control structures along waterways that shunt water, floods in many areas today are more frequent, violent and concentrated. Flood waters are controlled to prevent them from spreading over large areas. As a result, the most severe flooding is generally contained within smaller areas rather than throughout a river's course.

Storm impacts to forests are a bit different. Unlike floods and fires, storm damage and natural treefalls still occur with regularity in New Jersey. A variety of wildlife species are dependent upon forest openings that vary between single treefall gaps to openings several acres in extent. Birds that nest in the mid- and understory of forests (e.g, Hooded Warbler, Kentucky Warbler, and Indigo Bunting) utilize smaller forest openings for nesting while others (e.g., Golden-winged Warblers, White-eyed Vireos, and Chestnut-sided Warblers) select much larger openings. Many forest interior songbirds like Wood Thrush, utilize forest openings in the post-fledging stage (Vega Rivera *et al.* 1998). Without an adequate distribution of sites near to the nest, young fledglings are exposed to an increased predation risk as they move further away from their natal site in search of cover and food.

Another important source of forest openings and disturbance historically was beaver (Askins 2002). When first settled by Europeans, the eastern United States harbored a much larger beaver population than currently exists in New Jersey. Beaver were exterminated in most of New Jersey during settlement, but presently they are found throughout the state at low densities. Because beaver dam streams and create ponds, they are generally seen as nuisance animals. However, this same behavior can create gradations of habitat succession in the forest thousands of acres in extent.

Habitat Loss and Fragmentation

As natural disturbances have disappeared from New Jersey's ecosystems, natural habitats have become inundated with newly introduced forms of disturbance. Perhaps the greatest of these, and the one which acts in synergy with all others, is habitat fragmentation. Habitat loss and fragmentation results from disruption of the contiguity of a habitat block, whether the habitat type be forest, grassland, or shrubland. Urban sprawl is currently the greatest source of fragmentation to natural habitats, as the roads, housing developments, service related businesses, and powerlines it brings with it divide and destroy contiguous patches.

The post-World War II push to create the interstate highway system gave birth to widespread urban sprawl. The new highways allowed urban dwellers to move out to suburban areas, away from the congestion of the cities. Since that time, the effects of sprawl have proceeded like a domino effect. The demand for a suburban lifestyle has increased as the extent of suburban development has reached well beyond urban centers. The rate of suburban development accelerates and the need for additional infrastructure, schools, shopping centers, roads, powerlines, etc. increases as well. Therefore the effects of fragmentation continually rise.

Habitat fragmentation is extremely harmful to a number of species. Snakes have been shown to decrease greatly with increased road density (Rudolph *et al.* 1998). Many bird species are area sensitive, requiring a certain size of habitat block before they can occupy a site and nest successfully. This includes both Cerulean Warbler (a forest interior species requiring large forested blocks) Henslow's Sparrow (a grassland bird nesting only in large contiguous grasslands) and Golden-winged Warbler (a shrub-nesting species that does not occur in small shrublands).

Habitat fragmentation introduces a number of factors that are detrimental to nesting bird populations. Parasitism by brown-headed cowbirds and nest predation both increase with greater landscape fragmentation (Robinson *et al.* 1995). Many species that favor fragmented edge habitats are present in elevated abundances near human habitation. These include nest predators like blue jay, American crow, raccoon, and domestic cats, thereby increasing the exposure risk for nesting birds in these areas. In addition to creating habitat for potential nest predators, suburban habitats are also particularly attractive to the white-tailed deer. Because they are browsers, preferring to forage on woody vegetation and herbaceous plants in the understory, deer thrive in edge environments. The ornamental shrubs of fragmented, suburban habitats provide an ample supply of forage for hungry deer and the suburbs themselves offer a nearly predator-free environment. Under these scenarios, deer can reach peak levels of abundance.

Potential Solutions

For nearly half a century New Jersey Audubon Society has sought amelioration of the effects of habitat fragmentation through land acquisition, stewardship, land use planning and natural resource legislation and regulations. Purchase of large contiguous tracts of habitat uninterrupted by human-centric land use (e.g. homes and roads) plays a critical role in our ability to protect wildlife, plants, and ecological communities throughout New Jersey. NJAS has played a leadership role in the passage of every Green Acres bond initiative since the 1960's. Most recently, NJAS President Thomas Gilmore played a pivotal role in Governor Christine Whitman's million-acre (the target number set by NJAS) and Governor James McGreevey's open space funding campaign.

New Jersey Audubon's Conservation Department and Research Department will continue to help guide state policy and practices on land acquisition through a three-prong strategy: 1) secure federal, state, local and private funding for land acquisition in New Jersey, 2) provide information on important locations (e.g., Research Department's migrant landbird radar mapping and the Conservation Department's Important Bird and Birding Area program) throughout New Jersey, and 3) actively advocate for purchase of select key parcels, In general, land acquisition and planning should be guided by good reserve design precepts including size (in general bigger is better), connectivity (allowing for migration/immigration) and affording public access and recreation opportunities.

Good stewardship is needed on public and private lands to help maintain, enhance and restore biodiversity. New Jersey Audubon has launched a major stewardship initiative to provide guidance, planning and incentives for private and public landowners to better manage their lands for wildlife, plants and communities. Our efforts in stewardship include: 1) creating model stewardship sites for public and private lands, 2) securing appropriations for private landowner incentive programs, 3) helping craft forest management policy for the Pinelands (1.1 million acres or 21% of the state), 4) helping guide state funding policy for landowner incentive programs, and 5) directing landowners to appropriate state and federal agencies which administer these funds.

In addition to identifying areas were development is inappropriate, NJAS will also lend effort to initiatives steering development into appropriate areas. Specifically, NJAS will support initiatives to encourage redevelopment of urban centers including revitalization of urban residential and industrial areas. Good planning and zoning based on sound natural resource inventories can help steer development into appropriate areas (e.g. in-fill and brownfield development) and away from critical habitats such as the large contiguous forests of the Highlands. NJ Audubon has played a leadership role in passage of progressive regional planning including the Pinelands Preservation Act and the Highlands Water Protection and Planning Act. NJAS also looks for opportunities to support innovative land use planning. We recently participated on the Toms River/Jackson Task Force which made sweeping planning and zoning recommendations to better protect water and endangered wildlife. These recommendations were formally accepted by the Pinelands Commission. We will continue to advocate for smart growth legislation empowering proactive land use planning and work with willing municipalities.

Finally, NJAS works to support new state resource protection laws and regulations which will reduce habitat fragmentation. Thomas Gilmore played a leadership role in the passage of the Freshwater Wetlands Protection Act, which safeguards hundreds of thousands of contiguous and disjunct habitat in New Jersey. Our more recent efforts have included supporting the NJDEP Stormwater Rules which have permanently protected 600' vegetated buffers on over 6,000 miles of streams in New Jersey. NJAS is working with NJDEP to adopt and implement new rules protecting endangered species habitat and our water supply.

In sum, the collective leadership effort of NJAS on land acquisition, stewardship, land use planning and natural resource legislation and regulations are seeking to comprehensively minimize the effects of habitat loss and fragmentation.

Overabundant White-tailed Deer

Deer are more abundant today than ever before. In many regions of New Jersey, they are driving rapid ecosystem alterations resulting in local extirpation of native plants and a subsequent takeover by invasive species. While white-tailed deer are clearly a native inhabitant of New Jersey, their current level of abundance is not. Since European settlement, white-tailed deer have expanded their geographic range and greatly increased in abundance. Methods used to estimate pre-settlement deer densities have reported an average density of 2 – 4.2 deer per km^2 (McCabe and McCabe 1997; Alverson *et al.* 1988). Present-day deer densities in New Jersey exceed these estimates. Statewide, deer densities range from a low of 5 deer per km^2 in South Jersey in the Pine Barrens up to 30 per km^2 in central New Jersey. However, some local populations of deer are estimated to be as high as 78 deer per km^2 (NJ Division of Fish, Game and Wildlife 1999).

New Jersey's natural ecosystems evolved under less intense pressure from browsing animals. The pre-settlement landscape of New Jersey included additional herbivores, i.e. elk and moose, but also included native predators of these animals including mountain lion, grey wolf, and bobcat. Today, moose and elk are extirpated in New Jersey along with their major predators. Only bobcat remains, but it is now so rare as to merit listing as endangered in the state. While bobcats, wolves, moose and elk proved inadaptable to environmental conditions brought by settlement, after an initial decline, deer were able to adapt and thrive within this environment. Deer are browsers that thrive in fragmented landscapes complete with high amounts of edge that provide an abundance of browse.

The increasing suburbanization of New Jersey provides a highly fragmented environment with reduced predation and abundant food sources along with open spaces where hunting access is limited or restricted. With freedom from predation, high birth rates and increased longevity, suburban areas can experience exponential deer population growth. Suburbia also shelters deer from another major source of natural mortality –

harsh winter food shortages. In a suburban interface, ornamental shrubs and even feeders (both bird and deer) provide an ample source of winter food. Supplemental food sources during winter can serve to concentrate deer, and may make the browse impact on adjacent natural vegetation even more severe (Doenier et al. 1997).

Although citizens understandably often react positively to deer sightings in suburban areas, the elevated deer densities dramatically alter the structure and composition of natural ecosystems leading to overall degradation of ecosystem health. The impact of browsing deer on natural ecosystems is so great that they have been classified as a keystone herbivore, capable of driving long-term vegetative changes (Waller and Alverson 1997). Extensive research has documented the impacts browsing white-tailed deer have on native plants. Elevated deer densities have devastating impacts on the understory of forests and even the regeneration of the forest itself. Most wildflowers and herbs that grow in the forest understory are preferred forage of white-tailed deer and their disappearance is one of the earliest indicators of unbalanced deer densities. Deer selectively browse flowering plants in the understory such as trilliums (*Trillium spp.*). If high deer densities persist, the number of plants flowering decreases along with the size of individual plants, inhibiting the plants ability to reproduce and effectively photosynthesize (Anderson 1994). In a study of browsing impacts on another forest herb, Canada mayflower, plants protected from deer herbivory were 30 percent larger, 3900 percent more likely to flower, and had population densities 300 percent larger than unprotected plants (Rooney 2001). Continued loss of above-ground biomass robs plants of vegetative matter vital for photosynthesis and precious below-ground resources stored in the roots. This annual reproductive failure, futile expenditures of finite energy reserves, and reductions of individual plant size can only lead to eventual local extirpation of herbaceous plants.

Another favored food for browsing deer is buds and young shoots of woody shrubs and saplings. This can cause a severe problem for forest regeneration and structure. Deer densities as low as 4 km^2 can prevent regeneration of woody species like Canada yew (*Taxus canadensis*), eastern hemlock (*Tsuga canadensis*), and arborvitae (*Thuja occidentalis*), a plant classified as endangered in the wild in New Jersey (Alverson *et al.* 1988). When browsing on woody plants, deer show clear preferences, with sugar maple, white ash, oaks, yellow poplar, hemlock, white pine, and white cedar being a few of their favorites (Drake *et al.* 2002). This can lead to a complete alteration of the species composition of forests. In New England and the Upper Great Lakes, eastern hemlock has been undergoing decades of recruitment failure. Rooney et al. (2000) demonstrated that deer are playing a significant role in limiting regional hemlock recruitment. A 20-year study of vegetation in the Allegany National Forest in Pennsylvania revealed that the deer herd depleted the browse supply and damaged reproduction of hemlocks and hardwoods, effectively preventing understory recovery (Hough 1965). Even in South Jersey where deer herds are the lowest in the state, regeneration of Atlantic white cedar is greatly inhibited by white-tailed deer (Zimmerman *et al.* 1997). White cedar regeneration projects in South Jersey currently require expensive exclosure construction to allow trees to grow in the absence of pressure from browsing deer.

If a forest or shrubland is subjected to continued elevated deer densities, the understory and mid-story layers will disappear. The long-term impact of such a scenario is the creation of "deer savannas" or "deer parks". These aesthetically pleasing but biologically destitute areas are characterized by higher densities of ferns and grasses (species not preferred by deer) or park-like habitats of large trees completely lacking an understory that are clear and open beneath, allowing extensive visibility for long distances (Rooney 2001). Such drastic changes in forest structure also impact wildlife. deCalesta (1994) found that both species richness and abundance declined significantly for intermediate canopy nesting birds (nesting 0.5 m – 7.5 m) on heavily browsed sites with a number of species absent entirely from browsed areas. Casey and Hein (1983) found species nesting in forest understory and midstory at higher abundances on lightly browsed sites versus heavily browsed sites with many species found exclusively on the lightly browsed sites. The only species seen exclusively or at higher abundances on the heavily browsed sites were bark-foraging species that could take advantage of the large trees on the site. These results show clear evidence of eventual avian species impacts and losses under increasing browsing pressure.

For those birds that actually succeed in fledgling young within heavily browsed areas, their effort may still be futile. Vega-Rivera *et al.* (1998) found that Wood Thrush seek shrubby, second growth areas within the forest during the post-fledging stage to take advantage of heavier cover and food sources available in these areas. Young fledglings lacking adequate areas close to the nest site face a greater predation risk as they move longer distances seeking cover and food. Young birds in a heavily browsed forest are doomed. It provides no such sites for the newly fledged birds.

Potential Solutions

In a survey of public attitudes about deer in New Jersey conducted by Rutgers University, 50% of respondents agreed with the statement "There are too many deer in New Jersey." and 57% of those interviewed disagreed with the statement "Nothing needs to be done about the number of deer in New Jersey." Another 43% believed that "Deer can change the types of plants growing in a natural area," (Drake *et al.* 2002).

A number of solutions to overabundant deer populations have been offered including construction of deer exclosures, reproductive control, culling, trap and relocation, or simply doing nothing. The consequences of doing nothing about New Jersey's deer problem have already been broadly presented. In the absence of intervention, deer will ultimately destroy many native terrestrial ecosystems in New Jersey. Each of the other potential solutions poses its own problems - economic, logistic, and social.

Excluding deer with tall or electric fences is a highly successful technique in unique situations. A well-maintained deer fence can successfully exclude deer from regenerating saplings and herbaceous plants, allowing young plants to escape damaging impacts to growth from browsing. The need to patrol fences to check for breaches as well as their excessive installation cost makes them most effective on small, discrete areas. One of the largest deer exclosures in New Jersey is located in Somerset County at Hartley

Farms, a collaborative project with New Jersey Audubon Society, where 175 acres are currently within a deer exclosure. The construction cost of this deer exclosure was $250,000, over $1400 per acre (Platt pers. comm). The proposed 10-acre exclosure at Scherman-Hoffman will extend 3173 linear feet at a cost of $6.98 per foot. The total cost including a cattleguard at the entrance will exceed $33,000. In addition, extensive manpower costs are required for maintenance, with periodic patrols of the entire perimeter needed to check the fences. Deer exclosures can be effective locally, but require deep fiscal and personnel commitments that do not offer landscape or regional solutions to the problem of overbrowsing deer. Fences also have unintended effects on nontarget species, altering home ranges and dispersal of turtles and some medium-sized mammals.

Reproductive control including sterilization, contraception, and contragestation has also been proposed as a means to control overabundant deer populations. Reproductive control agents have been demonstrated on individual animals but an efficient, cost-effective means of delivering large-scale population control of deer is not yet available. Difficulty arises in identifying a cost-effective means of treating individual animals. Surgical sterilization is highly effective, but extremely costly, requiring capture and handling of each individual animal. Effective contragestation drugs like prostaglandin are known, but require precise delivery within the gestational cycle of does to allow effective abortion of the fetus. Contraceptive drugs are currently classified as experimental by the FDA and not legal for widespread use in the U.S. Safety concerns about drug impacts on deer meat are also slowing advancement of these drugs. Contraceptive and contragestation drugs carry a per animal cost between $430 and $1000 per animal per treatment with a need to retreat individual animals annually (Peck and Stahl 1997, Schantz et al. 2001).

Reproductive controls can be effective when used on a closed or nearly closed deer population, with little or no ingress. For example, reproductive control may be effective on captive herds or in small, self-contained urban parks generally lacking corridors connecting the park to other potential habitat and deer populations. However, when reproductive control methods are used on deer populations that are already creating overbrowsing problems, they will not be successful without a companion strategy to lower the current deer herd to levels compatible with local ecosystem health. Urban and suburban deer experience extremely low annual mortality rates, increased longevity and high birth rates. An effective reproductive control program would have to be paired with an initial population reduction in order to meet restoration objectives (Nielson *et al.* 1997).

Permanent removal of individual deer from an impacted area has proven to successfully reduce local deer density (McNulty *et al.* 1997; Kilpatrick *et al.* 2002). Permanent removal of deer involves either trap and relocation or lethal control. Either method can permanently remove animals from an overabundant population. Trap and relocation of deer was once widely practiced. However, it has become less feasible as areas needing population augmentation have dwindled and concerns over disease transmission have arisen. The advent of chronic wasting disease has lead to tightened regulations on deer importations and relocation nationwide. The per animal cost of trapping and relocating white-tailed deer is high, from $400 - $2931 per animal (Ishmael and Rongstad 1984; Drummond 1995, Ishmael *et al.* 1995, Mayer *et al.* 1995). Deer relocation is also extremely stressful to the animal, with up to 50% of translocated deer dying following relocation (Jones and Witham 1990).

Perhaps the greatest drawback to any lethal control is public perception. Lethal control of deer populations is an emotionally charged, controversial issue. Lethal control of deer seeks to directly reduce local deer herds through culling of animals by hunters or contracted sharpshooters. The New Jersey Division of Fish and Wildlife has attempted to tackle New Jersey's escalating deer problem through its hunting program. Bag limits have been liberalized in many problem areas and the state has initiated an "Earn a Buck" program that requires hunters to kill an antlerless deer before taking a buck. The Earn a Buck Program has greatly increased the overall deer harvest as well as increasing the percentage of antlerless deer taken in the overall harvest. In 1998, the last year before implementation of the Earn a Buck program, antlerless deer accounted for 55% of the overall harvest. In 2003, antlerless deer accounted for 66% of the overall harvest (NJ Division of Fish and Wildlife 2004). The Division has also created a Community-based Deer Management Program to aid suburban areas with overabundant deer populations.

Despite increases in antlerless and overall harvest, problems still persist in the form of deer overabundance. The most recent report on deer harvest in New Jersey attributes nuisance deer problems and damage complaints to a lack of hunter access to areas of excessive development or areas where hunting is prohibited. (NJ Division of Fish and Wildlife 2004). Although access is clearly a contributing problem to New Jersey's deer problem, traditional deer management exacerbates the problem.

Because regulated deer hunting generates revenue through license sales, it can be a cost-effective and efficient means for deer population management. However, the effectiveness of deer control via regulated hunting is contingent upon a clear departure from traditional goals of "maximum sustained yield" and "biological carrying capacity" to a more biodiversity based objective. Wildlife management to facilitate hunting opportunities has been a key contributor to deer overpopulation. Traditional deer management centered for years on the maximum sustainable yield model. Under this form of management, deer populations are maintained from year-to-year at a level that produces maximum recruitment with the maximum number of animals available for hunters to harvest (McCullough 1984). The major problem with this method is that if deer herds are managed for maximum sustainable yield, they are being maintained well above relative deer density levels associated with sustaining biodiversity and timber productivity and regeneration (deCalesta and Stout 1997). In a 1999 report to the governor, the Division of Fish and Wildlife stated that, "It should be noted that deer populations are below the biological carrying capacity throughout much of New Jersey's deer range." This perception is an inherent problem because the "biological carrying capacity" for deer greatly exceeds the ecological carrying capacity of the habitat. On this point traditional deer management fails to allow perpetual sustainability of the habitat. If this remains as the Division's official position, then the need for change is obvious.

The Division of Fish and Wildlife bases its decision of whether to increase and decrease deer populations within a given management zone on a number of factors that include damage to agricultural crops and residential landscaping, the incidence of deer-vehicle collisions, and the continued encroachment of New Jersey's human population on formerly rural lands (NJ Division of Fish, Game and Wildlife 1999). Much stronger weight needs to be given to ecological integrity measures such as percent of tree seedlings, midstory vegetation density, and diversity of understory. Biological carrying capacity measures the number of deer that a given area can support in good condition over an extended period of time, it has no mechanism to measure what deer density an area can tolerate before experiencing plant species loss or reduction in forest regeneration. A better metric is needed that can effectively measure the ecological carrying capacity of a landscape.

Lethal control of white-tailed deer populations has proven highly successful at significantly reducing local deer herds over a short period of time (Frost 1997). At the Great Swamp National Wildlife Refuge, a deer hunting program has been used for 30-years to control the deer population (Hollein 2004). Initial positive vegetative responses have been recorded in years immediately following initiation of managed hunts in extremely overbrowsed parks (Mitchell *et al.* 1997).

Controlled hunts on previously closed areas or urban/suburban parks can bring additional revenue beyond standard licenses and fees through issuance of special hunt permits. Direct costs for controlled hunts are minimal, but indirect costs rise from needs to minimize conflicts with those attempting to disrupt the hunt, costing $45 to $622 per animal removed (Peck and Stahl 1997; Sigmund and Bernier 1999; DeNicola *et al.* 2000). This cost could be expected to decrease substantially, as security needs and conflict resolution with hunt protesters greatly declines over subsequent years (Mitchel *et al.* 1997).

In communities where hunting is unfeasible (i.e., for safety reasons) or ineffective, professional sharpshooters can be used to reduce deer herds. Use of sharpshooters has the benefit of rapid success, maximized safety and discretion. However, it also comes with an extremely high price of $91 to $310 per deer harvested (Frost et al. 1997). In New Jersey, community sharpshooter hunts have proven successful. In 2001, 322 deer were harvested in a Princeton cull operation, costing approximately $343 per deer (J. Clawson, Princeton Township, New Jersey, pers. comm. *taken from* Drake et al. 2002).

NJAS will advocate for state policies to manage deer herds based on ecological integrity, including biodiversity conservation, that focuses the issue on ecosystem health rather than producing the highest number of animals for hunters to harvest.

Invasive Organisms

Invasive species have wreaked extraordinary havoc on New Jersey's natural ecosystems and legitimately threaten the continued existence of many wildlife and plant species in the state. Nationwide, invasive species cause over $138 billion worth of damage annually (Pimentel et al. 1999). The primary threat to nearly 42% of the 958 species listed as federally threatened or endangered under the Endangered Species Act in the United States is considered to be competition with and predation from nonnative species (Stein and Flack 1996; Wilcove *et al.* 1998). Exotic plant diseases have attacked individual species, virtually eliminating them from the landscape. Historically, American chestnut was one of the most valuable and reliable mast-producing trees of the eastern deciduous forest. Common in New Jersey, this tree that dominated the eastern forest has been completely destroyed by an exotic fungus introduced from Asia, *Endothia parasitica.* By the early 1910's, chestnut trees as far south as Philadelphia were dying from this blight. Within 40 years, nearly every American chestnut tree was dead. The utter dominance of this tree within the eastern deciduous forest can be measured by its accounting for over 50% of the value of all hardwood within this forest (Treadwell 1996).

Chestnut blight was not the last of its kind. In fact, in recent years, the appearance of introduced pathogens has seemed to accelerate. In 1930, Dutch elm disease was introduced into the United States and has had a chillingly similar effect on American elm. Today, both urban and forest American elms have been decimated by this pathogen that continues to extend its range westward (Schlarbaum *et al.* 1999). Sudden Oak Death (*Phytophthora ramorum*) has been ravaging California oaks since 1995. This disease is a highly fatal killer that has had devastating impacts in California. A California nursery with infected stock shipped material to 30 states over the past two years, including Maryland (MD Dept. Ag. Press Release April 21, 2004) and New Jersey. As a direct result, the disease has recently been discovered on horticultural plantings traced from this shipment in New Jersey (NJ Dept. Ag. Press Release May 28, 2004) and other neighboring states. If sudden oak death spreads into the wild in the eastern United States, consequences for eastern oak species could be dire. Eastern hemlocks are dying throughout New Jersey, the result of a statewide infestation of an exotic insect, the hemlock wooly adelgid (*Adelges tsugae*). A number of wildlife species within the state are dependent on hemlocks. Hemlocks are important thermo regulators of trout streams and provide habitat for nesting Blackburnian Warblers and Black-throated-blue Warblers in New Jersey.

In addition to exotic diseases and insects, nonnative animals also pose serious threats to wildlife. Feral cats and free ranging housecats kill hundreds of millions of birds, small mammals, frogs and reptiles annually. Predation from feral cats is one of the leading sources of mortality for many rare, threatened, and endangered species in certain parts of the country.

Non-native plants are also degrading natural ecosystems throughout New Jersey at a rapid pace. The invasion of native ecosystems often acts in tandem with the stressor of overabundant white-tailed deer. Deer browse of the understory, including regenerating trees, over time will convert forests to more open, sparsely wooded areas as young saplings are prevented by deer from reaching a height that allows them to fill gaps made by the death of mature trees. Throughout central New Jersey, as forest gaps appear aided by dying trees and blowdowns, the only plants that can withstand the heavy deer browse are unpalatable, exotic plants that can quickly invade and take over forest openings. Excessive deer browsing in central New Jersey is taking plant succession one step further. In central New Jersey, forested habitats are not being replaced by deer savannas and fern parks. They are instead being converted into completely foreign habitats dominated by invasive plants.

As native habitats are denuded of native vegetation by white-tailed deer, opportunities are opened for invasive, exotic plants to fill the niche. Some of the most invasive and most problematic species in New Jersey are somewhat unpalatable and therefore spread rapidly and relatively unchecked. Japanese barberry (*Berberis thunbergii*), a nonpreferred forage of deer, is overtaking understories of central New Jersey forests. Nonnative plants negatively affect wildlife by altering the structure and composition of native habitats and by enticing wildlife to lower quality food sources. Many prolific exotic plants, like multiflora rose (*Rosa multiflora*) and Japanese barberry, offer an attractive food source to wildlife, especially birds. However, due to low fat content, they are an energy sink, offering little in return for effort expended foraging on their fruit. For example, muliflora rosehip is 40 percent sugar and only 10 percent lipids. To the contrary, many native plants like poison ivy and dogwood provide lipid-rich pulp that provides a high return for foraging animals. The native spicebush, for example, produces a berry that is 35 percent lipids (Sauer 1998).

Potential Solutions

Although the use of pesticides and herbicides is controversial, it often provides the only opportunity to check the spread of many invasive pests and to reclaim infested sites for restoration of native animal and plant communities. In restoration, targeted sites are often completely overrun by invasive species. The only way to initiate restoration is to first destroy what is present. Herbicides and pesticides that are known to be harmful to the environment or that do not dissipate quickly when used should be avoided. However, many pesticides and herbicides do not transfer to groundwater and dissipate quickly after use.

Whenever possible, resources should be expended to identify biological controls to destroy nonnative pests. However, great caution should be taken to avoid the disastrous effects associated with release of agents that do not attack their intended host and create new problems. Cases of these scenarios are well-documented. The giant toad (*Bufo marinus*) was introduced into Hawaii and Australia to control agricultural pests. The toads are now widespread, and do not eat their target pests. Throughout the Caribbean, mongooses were introduced to control rats in sugarcane fields. Subsequently, mongooses have had devastating impacts on resident birds, amphibians and reptiles. The

House Sparrow was introduced to the United States to help control agricultural pests and is now a major pest that directly competes with native birds.

The state of New Jersey has recently taken strides to address the issue of invasive exotic species. In February 2004 Governor James McGreevey signed Executive Order #97 forming the New Jersey Invasive Species Council and requiring the development of a comprehensive New Jersey Invasive Species Management Plan. Following this, DEP Commissioner Bradley Campbell New Jersey DEP issued Policy Directive 2004-02 (Subject: Invasive Nonindigenous Plant Species) that, among other things, prohibits department employees from using harmful nonindigenous plants on DEP projects. The directive issued an invasive, nonindigenous plants list as an appendix to the directive for guidance (see Appendix for a copy of the Directive and the plant list).

NJAS will seek passage of legislation that will help stop the spread of nonnative, exotic organisms. NJAS will also expand its efforts to educate visitors to its centers about the threats of invasive, exotic plants and the importance of using native plants in landscaping. NJAS will also continue to participate in and promote programs such as *Cats Indoors* program (http://www.abcbirds.org/cats) that seek to reduce the impact of nonnative species on wildlife and plant communities.

Climatic Change

Avian ecology is often correlated with seasonal change. Changes in weather mark the initiation of migration which is synchronized with the availability of food. As the temperature warms, plants flower, attracting insect prey for migratory birds. During the return migration, synchronicity with plant fruiting is important. Disruption of either of these cycles could severely jeopardize birds.

Global warming threatens to create shifts in vegetative communities and regional climatic patterns. These changes could greatly disrupt migratory birds if the plants they depend on for food become absent in a region, flower or fruit earlier or later due to climatic changes. A study of 35 North American warblers found that the range of seven species have shifted northward an average of > 65 miles over the past 24 years, while none of the 35 species shifted southward (Price and Root, unpubl. data *in* Price and Glick 2002).

In addition, scientists have discovered behavioral changes in birds that correspond with warming spring temperatures. These changes are resulting in earlier migration. In North American, the date of first arrival for 20 species was earlier rangewide in 1995 than 1965 by up to 21 days, while only a small number showed delayed dates (Root unpubl. data *in* Price and Glick 2002). Changes in migration chronology could have devastating consequences for birds. Red Knots synchronize their migration with the annual nesting of horseshoe crabs along the Delaware Bay in New Jersey and Delaware. Climatic shifts may disrupt this association, causing Red Knots to arrive during a period when horseshoe crab nesting is not at its peak. Alternatively, climatic changes may cause the crabs to shift their breeding location away from this area where Red Knots congregate (Baker *et al.* 2004).

Birds that are associated with very specialized habitat types are very vulnerable to climatic shifts because such shifts may eliminate their habitats. (Both and Visser 2001). This could lead to extirpation of the Golden-cheeked Warbler, which relies on mature oak-juniper woodlands occurring only in Central Texas. In New Jersey, a number of species may be lost as breeders in the state as a consequence of global warming due to their dependence on natural communities that may disappear with rising temperatures. These include Black-throated Blue Warbler, Golden-winged Warbler, Chestnut-sided Warbler, Blackburnian Warbler, and Rose-breasted Grosbeak (Price 2002).

Potential Solutions

The effects of global warming will need to be ameliorated through sweeping changes to rules, legislation, incentives and land use planning governing emissions, fuel efficiency, energy conservation, and renewable energy. Federal and state governments must adopt policies which 1) adhere to carbon-capping and 2) reduce production and emissions of other greenhouse gases.

Federal actions include but are not limited to the following:

1. Ratification of the Kyoto Treaty governing greenhouse gas emissions.
2. Passage of legislation like the McCain-Lieberman Climate Stewardship Act to address global warming.
3. Increasing CAFÉ standards to raise fuel efficiency standards for vehicles.
4. List carbon dioxide as a regulated pollutant.
5. Provide full funding for a national mass transit system.
6. Adoption of a national energy plan including dedicated funding which weans the United States from fossil fuels and promotes clean, renewable energy and fuel sources.
7. Adoption of a comprehensive energy conservation plan for the public and private sector.
8. Replace old, coal-fired and nuclear power plants with renewable energy sources.
9. Adoption of stricter emission standards for all motorized equipment, including vehicles, construction equipment, lawn mowers, and other common 2-cycle engines.
10. Provide fiscal incentives for private sector participation (e.g. green buildings) in energy conservation and renewable energy use.
11. Provide appropriate funding for private sector research and development projects consistent with reduction of greenhouse gases.

State actions should include the following:

1. In general, the state of New Jersey should continue to play a leadership role ahead of lagging federal policy and legislation. This will help maintain pressure on the federal level.
2. NJAS should support New Jersey's initiative to attain 4% of all energy consumed in NJ from renewable sources by 2008 and 20% by 2020.

3. Board of Public Utilities should develop a comprehensive plan for use of incentives funds from the Grid Power Supply program to achieve Governor McGreevey's goals and promote energy conservation.
4. Engage in efforts to complement and lead federal actions 4-11.
5. Promote Smart Growth which decreases commuter miles driven and promotes use of mass transit.

Pollution

The impact that pollution can have on ecological communities manifests itself in a number of ways. A number of studies have shown that concentrations of air pollutants common in many areas of the United States can alter vegetation communities. The vitality of young seedlings is directly impacted by air pollutants that cause reductions in growth and photosynthesis (Pyle 1988). Two key air pollutants, carbon dioxide and ozone, also dramatically alter the growth of older trees (Univ. Wisc. 2003). High carbon dioxide increases the growth of many species while high ozone decreases their growth. Over the long-term, the gases may change forest ecology and diversity.

If the ecology and vegetative composition of natural communities is impacted by pollution, subsequently there will be an obvious impact on native wildlife populations. However, pollution can also have a more direct impact on the reproductive biology of organisms. Some herbicides used on lawns and agricultural crops contain endocrine disrupting chemicals that can harm wildlife and humans and their progeny, underscoring the need for caution when using herbicides in ecological restorations (Miyamoto and Burger 2003).The impacts of DDT on raptors are well-known. Both Bald Eagles and Peregrine Falcons were nearly extirpated from the lower 48 states as a result of reproductive failure from indirect ingestion of this agricultural chemical. DDT caused the birds to lay thin-shelled eggs that would break when the females attempted to incubate. DDT was outlawed in the United States in 1972; however other environmental pollutants continue to have an impact. Leaching of calcium from the soil by acid rain may be having a negative impact on the nesting success of Wood Thrush and other species dependent on environmental calcium for egg laying (Hames *et al.* 2002).

Potential Solutions

Because many greenhouse gases (e.g. carbon dioxide and nitrous oxide compounds) are also pollutants, the solutions for Global Warming also apply to this section. In addition, the federal and state government need to adopt policies which 1) shift burden of proof to the chemical industry (per the European Union model), 2) protect human and wildlife health, 3) recognize endocrine inhibiting compounds as a systemic problem, 4) create incentives for better land use practices, and 5) seek full monetary remuneration and restoration for human and natural resource damages arising from pollution plumes. Also, per the global warming paradigm, New Jersey state government can and should play a leadership role ahead of lagging federal actions.

Federal actions include but are not limited to the following:

1. The Environmental Protection Agency needs to base its rules and its risk assessments on the following principles:
    a. Its list of regulated compounds must be expanded considerably.
    b. Endocrine-inhibiting compounds must be specifically examined.
    c. Chemicals may interact synergistically and therefore tests must be done to demonstrate no harm when in concert with other environmental pollutants.
    d. The burden of proof regarding safety must be moved from the public to private sector per the current European Union model.
2. Do not allow special interests to override protection of wildlife health like the recent use of Fenthion (insecticide) in Florida which is lethal to the federally threatened Piping Plover.
3. Adoption of policies recognizing landscape level harm caused by acid rain and adopting emission standards consistent with preventing this damage.
4. Disallow use of chemicals which cause harm to humans and the environment while offering little benefit to human health and safety (e.g. chemical cocktail lawn of herbicides, insecticides, fungicides, etc.).
5. Adopt clean air and water standards per federal legislation protective of human and wildlife health.
6. Seek reauthorization of federal legislation such as Superfund to fund site clean up.
7. Adoption of rules seeking full monetary compensation and restoration for natural resource damages.
8. Recognize pollution as an environmental justice and natural resource protection issue.

State actions should include playing a leadership role ahead of and which complement federal efforts 1-8. The executive branch and legislators are currently engaged in addressing many of these items including:

1. Launching a proactive natural resource damage program at NJDEP to seek monetary remuneration and clean-up of pollution plumes in New Jersey.
2. Implementing Clean Car legislation more stringent than federal standards, governing auto emissions standards.
3. Enforcing the new NJDEP stormwater rules which utilize 300' vegetated buffers to cleanse drinking water, and completing rule adoption for streams statewide meeting Category One (C1) criteria. These also are highly protective of riparian wildlife habitat.

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